



Universidad
Zaragoza

**ESCUELA UNIVERSITARIA POLITÉCNICA
DE LA ALMUNIA DE DOÑA GODINA (ZARAGOZA)**

PLANOS

**DISEÑO SUBSTACIÓN ELECTRICA
MOVIL 66/12kV, 10MV**

Mobile Substation Design 66/12kV, 10MVA

424.13.131

Autor: Rony Moises Pinedo Cordova

Director: Carmelo Jose Borque Horna

Fecha: 30-11-2016

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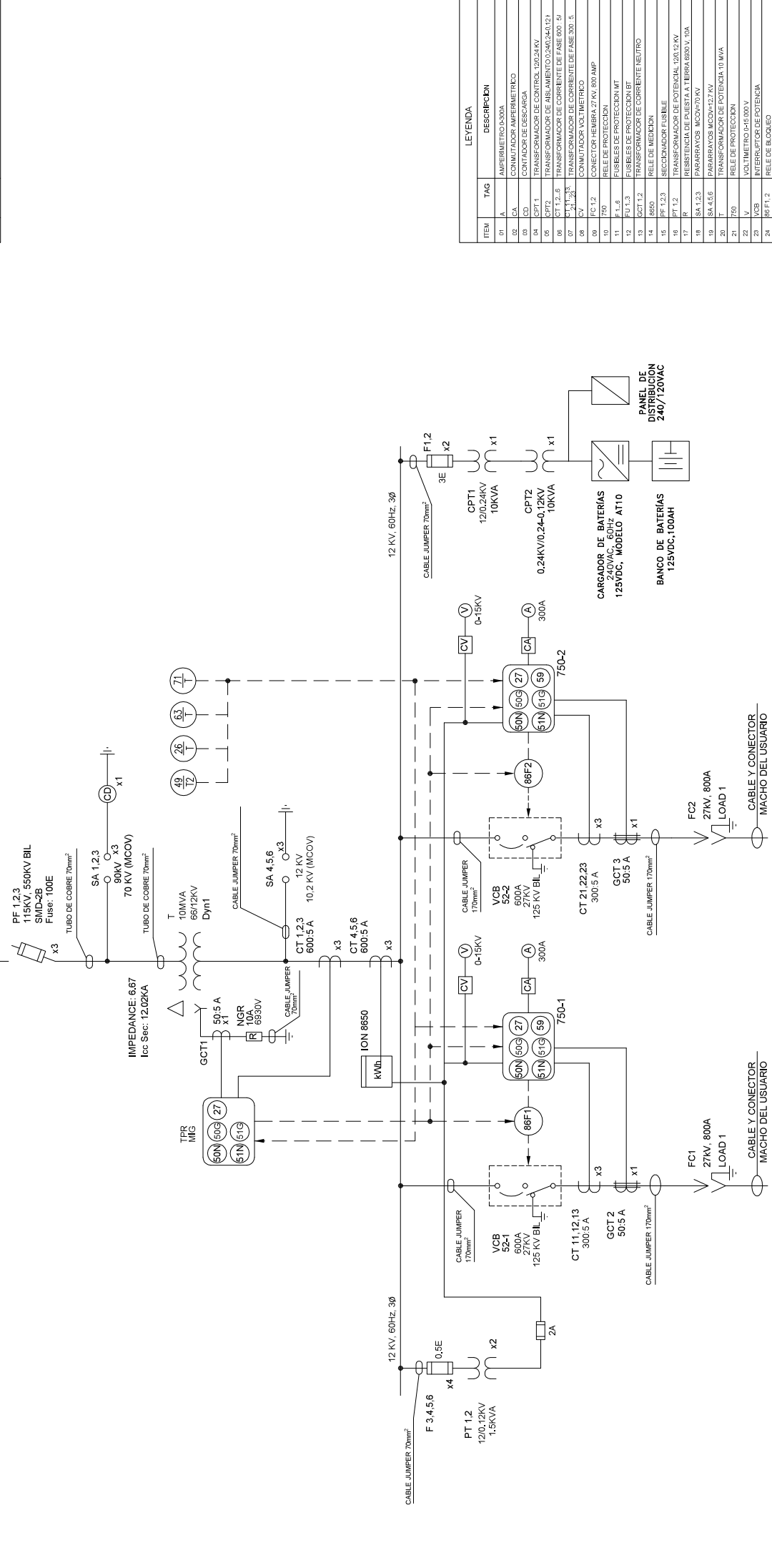
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1. PLANOS ELÉCTRICOS

INDICE DE PLANOS ELECTRICOS

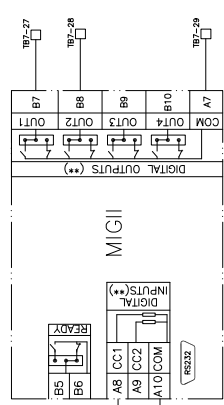
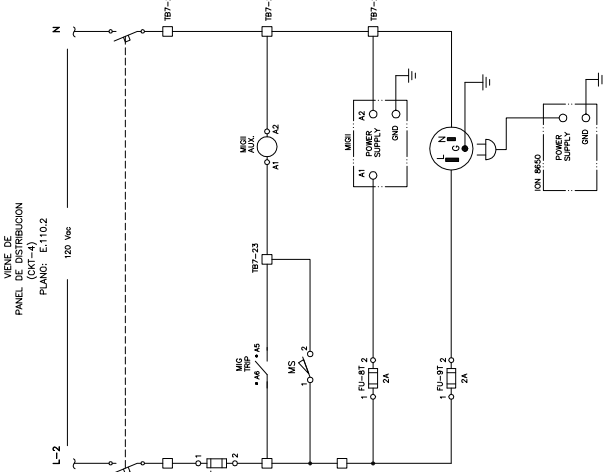
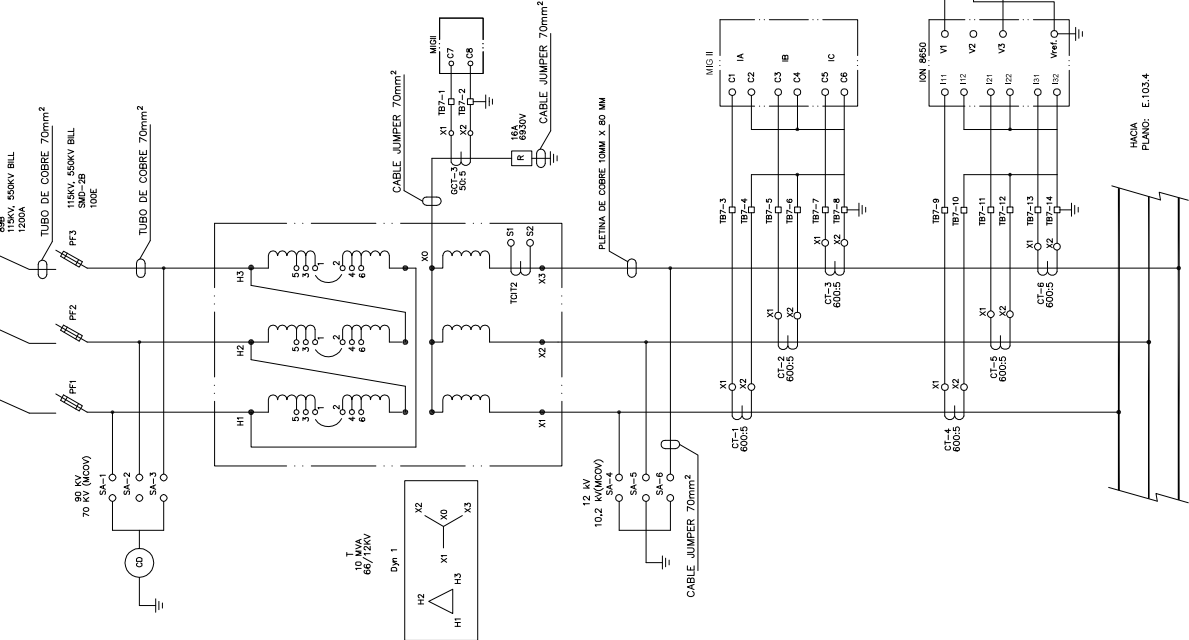
It	PLANOS ELECTRICOS	Nro. Plano
1	ESQUEMA UNIFILAR	E.101
2	ESQUEMA DE MEDICION Y PROTECCION DE TRANSFORMADOR 10MVA	E.102
3	ESQUEMA DE MEDICION Y PROTECCION ALIMENTADORES 12 kV	E.103
4	PROTECCION Y ALARMAS DE TRANSFORMADOR 10MVA	E.104
5	ESQUEMA DE CONTROL INTERRUPTOR DE VACIO 1	E.105
6	ESQUEMA DE CONTROL INTERRUPTOR DE VACIO 2	E.106
7	OPERACIÓN DE SECCIONADOR - MANDO MOTORIZADO	E.107
8	SEÑALIZADOR E ILUMACION	E.108
9	ILUMINACION EXTERIOR E INTERIOR	E.109
10	PANEL DE DISTRIBUCION 120/240 VAC	E.110
11	BATERIAS, CARGADOR Y PANEL DE DISTRIBUCION 125 VDC	E.111

LEYENDA DE PROTECCIONES	
ITEM	DESCRIPCION
01	TERMOSTATO
02	IMAGEN TERMICA
03	RELE BUCHOLZ
04	NIVEL DE ACEITE
05	50 G
06	51 G
07	50
08	51



OBSERVACIONES GENERALES		OBSERVACIONES DE PAGINA	
DIBUJADO		FECHA	
COMPROBADO		01/11/2016	
IDEN.S.NORMA		RONY PINEDO CORDOVA	
HOJA 1		SUBESTACION MOVIL 66/12KV, 10MVA	
DE 11		UNIFILAR	
		N° Plano :E.100	
		N° Original :E.100	
		Nom. Ficher. :E.101.dwg	

LLEGADA DEL CLIENTE
66KV, 60Hz



ITEM	TAB	DESCRIPCION
1	1	TRANSFORMADOR DE POTENCIA
2	2	TRANSFORMADOR DE POTENCIA
3	3	TRANSFORMADOR DE POTENCIA
4	4	TRANSFORMADOR DE POTENCIA
5	5	TRANSFORMADOR DE POTENCIA
6	6	TRANSFORMADOR DE POTENCIA
7	7	TRANSFORMADOR DE POTENCIA
8	8	TRANSFORMADOR DE POTENCIA
9	9	TRANSFORMADOR DE POTENCIA
10	10	TRANSFORMADOR DE POTENCIA
11	11	TRANSFORMADOR DE POTENCIA
12	12	TRANSFORMADOR DE POTENCIA
13	13	TRANSFORMADOR DE POTENCIA

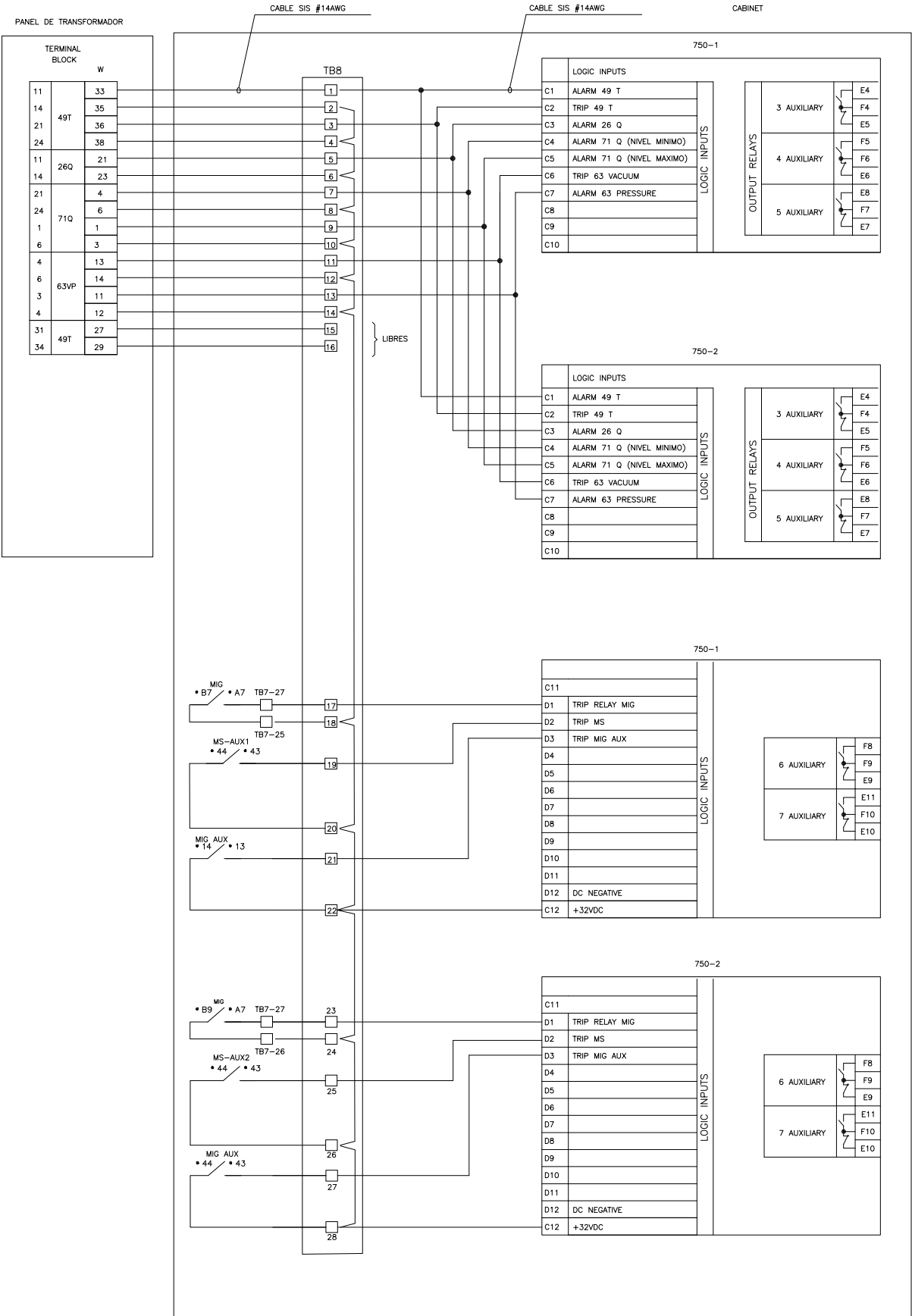
1	PT's signal to 750-1
2	PT's signal to 750-2
3	PT's signal to ION 8600

OBSERVACIONES GENERALES		OBSERVACIONES DE PAGINA		SUBSTACION MOVIL 66/12KV, 10MVA ESQUEMA DE MEDICION Y PROTECCION TRANSFORMADOR DE 10MVA		N° Original :E:100 N° Plano :E:100 Nom. Ficher. :E:102.dwg	
DIBUJADO		FECHA		NOMBRE		eupla	
COMPROBADO		01/11/2016		RONY PINEDO CORDOVA		ESQUEMA DE MEDICION Y PROTECCION	
IDEN.S.NORMA						La Almunia de Doria Godina (Zaragoza)	
HOJA 2						ESQUEMA DE MEDICION Y PROTECCION	
DE 11						N° Original :E:100	
						N° Plano :E:100	
						Nom. Ficher. :E:102.dwg	

LEYENDA		
ITEM	TAG	DESCRIPCION
01	TB7,TB8	BLOQUE DE TERMINALES DE CONTROL
02	W	BLOQUE DE TERMINALES DE ALARMA DEL TRANSFORMADOR

LEYENDA DE ARMAS DE TRANSFORMADOR		
ITEM	TAG	DESCRIPCION
01	49 T	RELE DE IMAGEN TERMICA
02	26 Q	TERMOMETRO DE ACEITE
03	20 T	VALVULA DE SEGURIDAD
04	63 VP	RELE BUCHOLZ
05	71 Q	INDICADOR DE NIVEL DE ACEITE

PANEL DE ALARMAS Y PROTECCION





ESCUOLA UNIVERSITARIA POLITÉCNICA
La Almunia de Doña Godina (Zaragoza)

FECHA

01/11/2016

NOMBRE

RONY PINEDO CORDOVA

OBSERVACIONES GENERALES

OBSERVACIONES DE PAGINA

ESQUEMA

1

HOJA

4

DE

11

SUBSTACION MOVIL 66/12KV, 10MVA

PROTECCION Y ALARMAS

TRANSFORMADOR DE 10MVA

Nº Plano

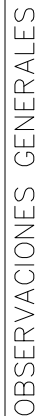
:E.100

Nº Original

:E.100

Norm. Ficher

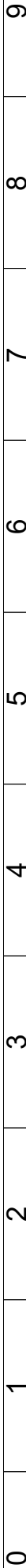
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OBSERVACIONES DE PAGINA

DIBUJADO
COMPROBADO
IDEN.S.NORMA

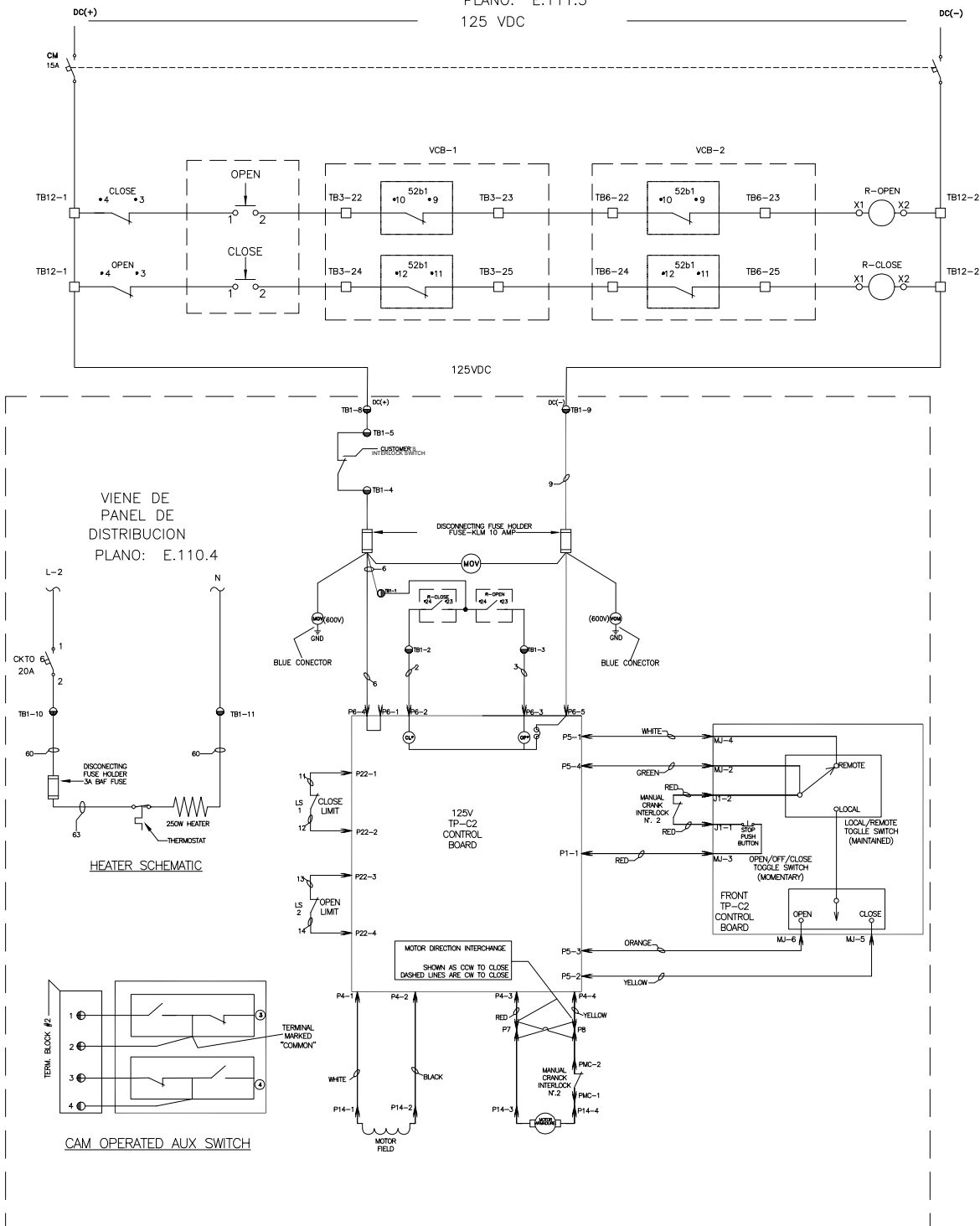
FECHA	NOMBRE
11/11/2016	RONY PINEDO CORDOVA

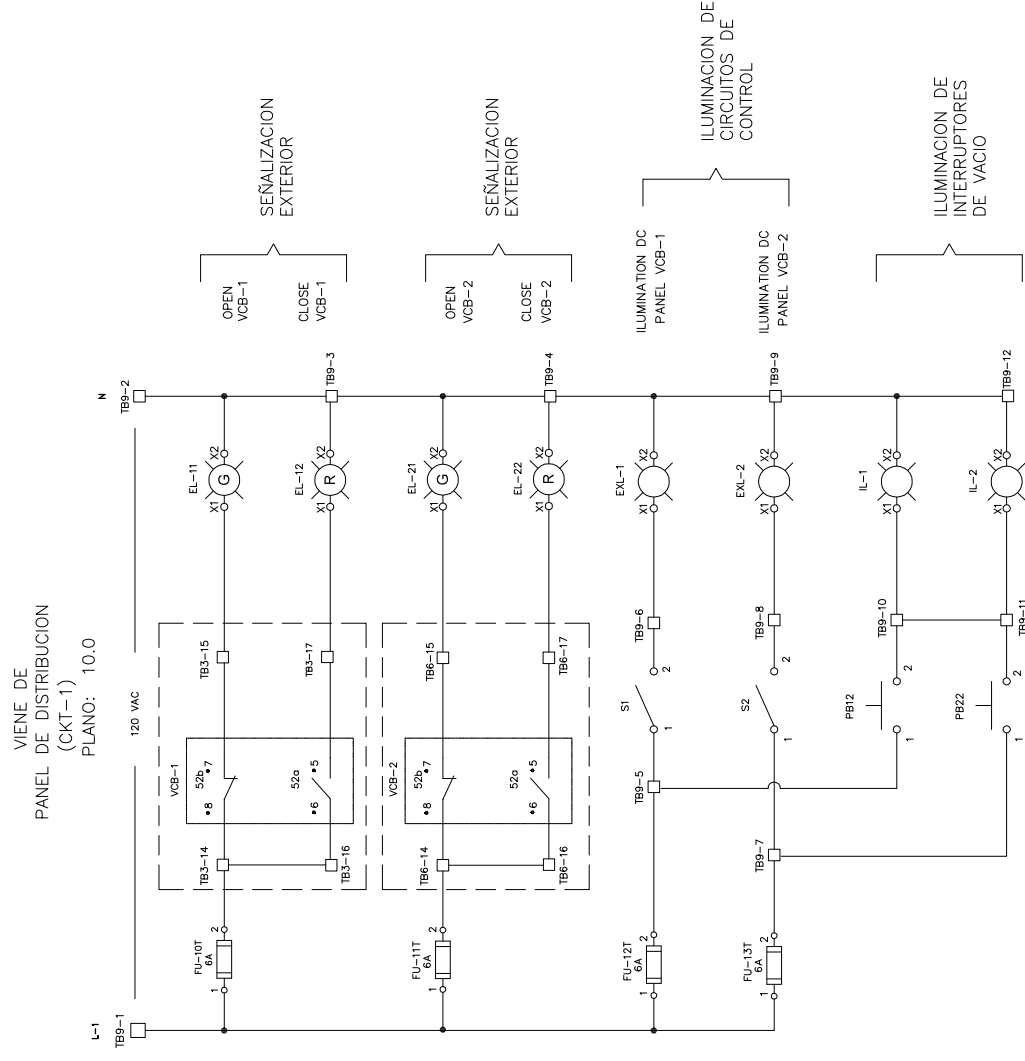
SUBESTACION MOVIL 66/12KV, 10MVA
ESQUEMA DE CONTROL
INTERRUPTOR DE VACIO 1



LEYENDA		
ITEM	TAG	DESCRIPCION
01	DS TRIP	BOBINA AUXILIAR PARA DISPARO DE SECCIONADOR
02	R-OPEN	APERTURA REMOTA DE SECCIONADOR
03	R-CLOSE	CIERRE REMOTO DE SECCIONADOR
04	DS R	OPERACION REMOTA DE SECCIONADOR

VIENE DE
PANEL DC
(CBC2)
PLANO: E.111.5
125 VDC

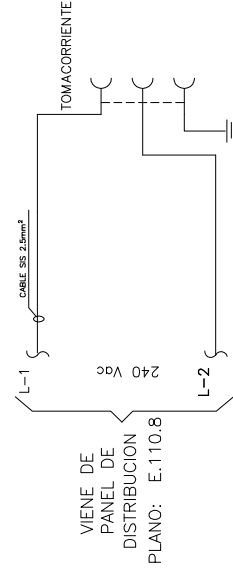
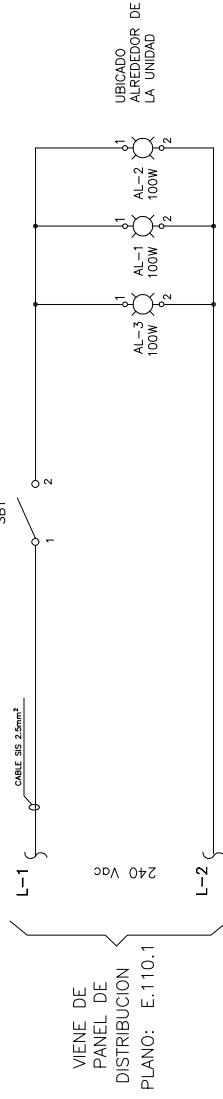
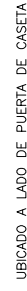
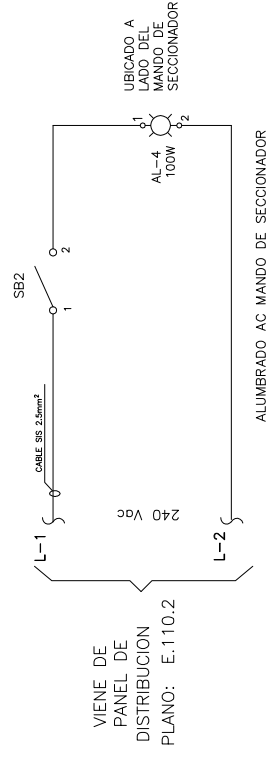
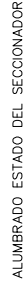
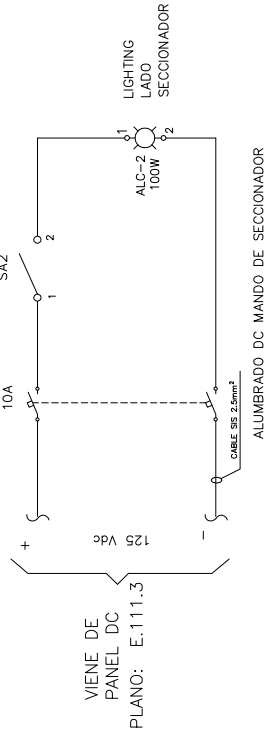
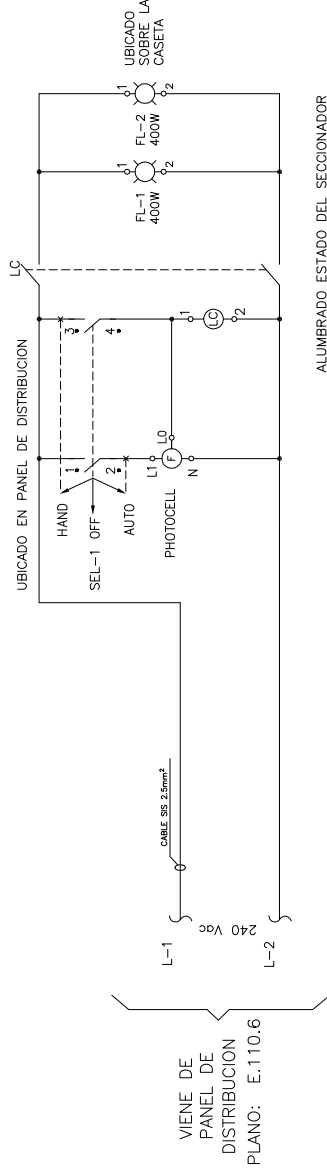




LEYENDA		
ITEM	TAG	DESCRIPCION
01	FU	FUSIBLES DE PROTECCION BT
02	VCB	INTERRUPTOR DE POTENCIA
03	EL	INDICADOR LUMINOSO INTERRUPTOR
04	EXL	INDICADOR LUMINOSO MODULO DE CONTROL
05	IL	INDICADOR LUMINOSO INTERRUPTOR
06	SL 1,2	INTERRUPTOR DE ILUMINACION
07	PB	PULSADOR DE ILUMINACION
08	TB	BLOQUE DE TERMINALES DE CONTROL

OBSERVACIONES GENERALES	OBSERVACIONES DE PAGINA	DIBUJADO	FECHA	NOMBRE	 eupla ESCUELA UNIVERSITARIA POLITÉCNICA La Alameda de Doña Godina (Zaragoza)
		COMPROBADO	01/11/2016	RONY PINEDO CORDOVA	
		IDEN.S.NORMA			
		HOJA 8	SUBESTACION MOVIL 66/12KV, 10MVA		
		DE 11	SEÑALIZACION E ILUMINACION		
		Nº Plano : E.100		Nº Original : E.100	
				Nom. Ficher. : E.108.dwg	

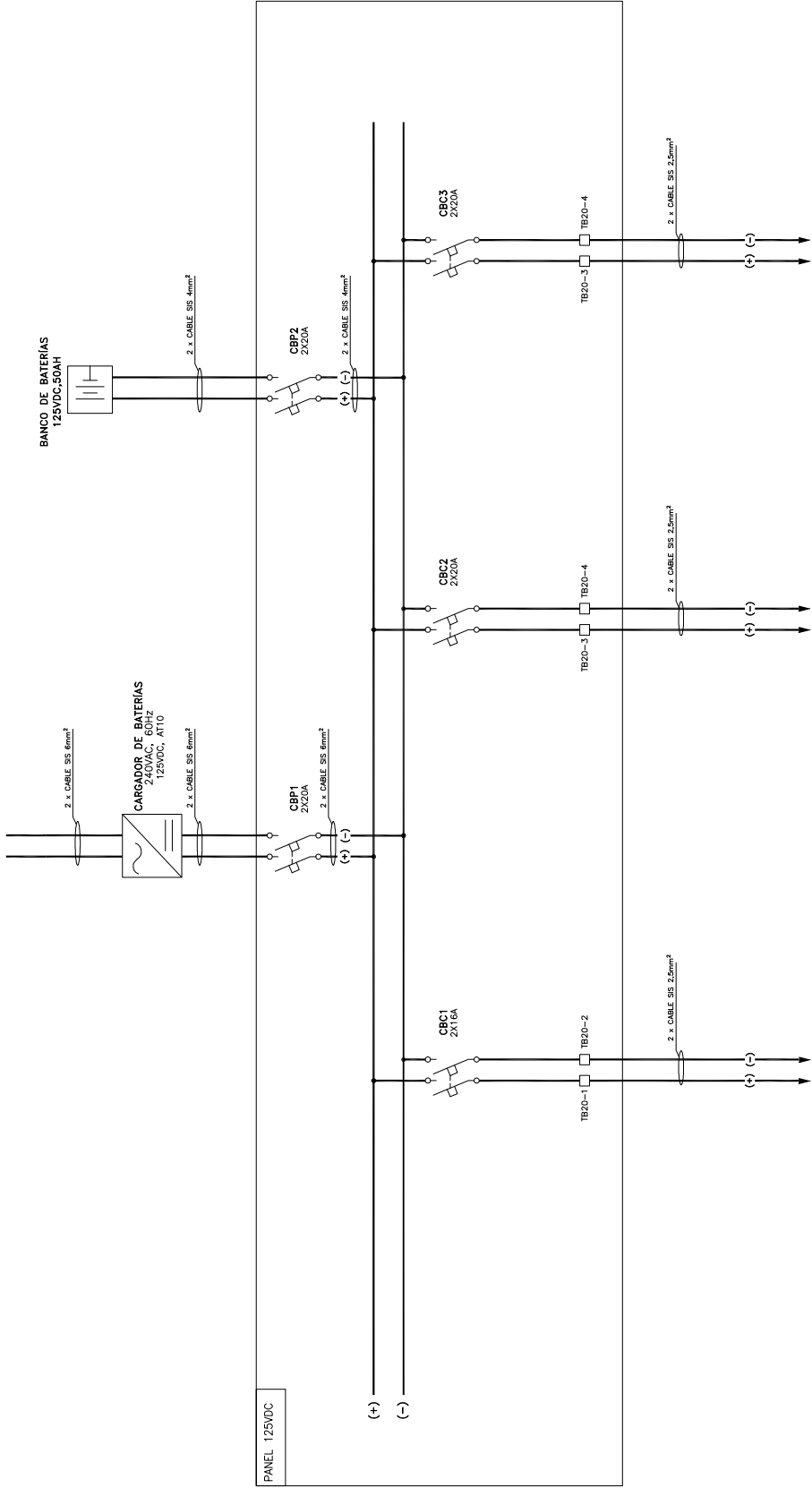
0	1	2	3	4	5	6	7	8	9
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ITEM	TAG	DESCRIPCION
01	SEL	SELECTOR MANUAL O AUTO
02	FL	REFLECTORES 400W
03	F	FOTOCELDA
04	FU	FUSIBLE DE PROTECCION BT
05	S	INTERRUPTOR DE ILUMINACION
06	AL	EQUIPO DE ILUMINACION 100W
07	LC	CONTACTOR DE ILUMINACION

OBSERVACIONES GENERALES		OBSERVACIONES DE PAGINA		 eupla ESCUELA UNIVERSITARIA POLITÉCNICA La Alfranca de Dofra, Gádiz (Cádiz)	
				FECHA	NOMBRE
				01/11/2016	RONY PINEDO CORDOVA
		DIBUJADO	SUBESTACION MOVIL 66/12KV, 10MVA ILUMINACION EXTERIOR E INTERIOR		
		COMPROBADO			
		IDEN.S.NORMA			
		HOJA 9	N° Plano : E.100		
		DE 11	N° Original : E.100		
			Norm. Ficher. : E.109.dwg		

VIENE DE CPT2
PLANO: E.103.8

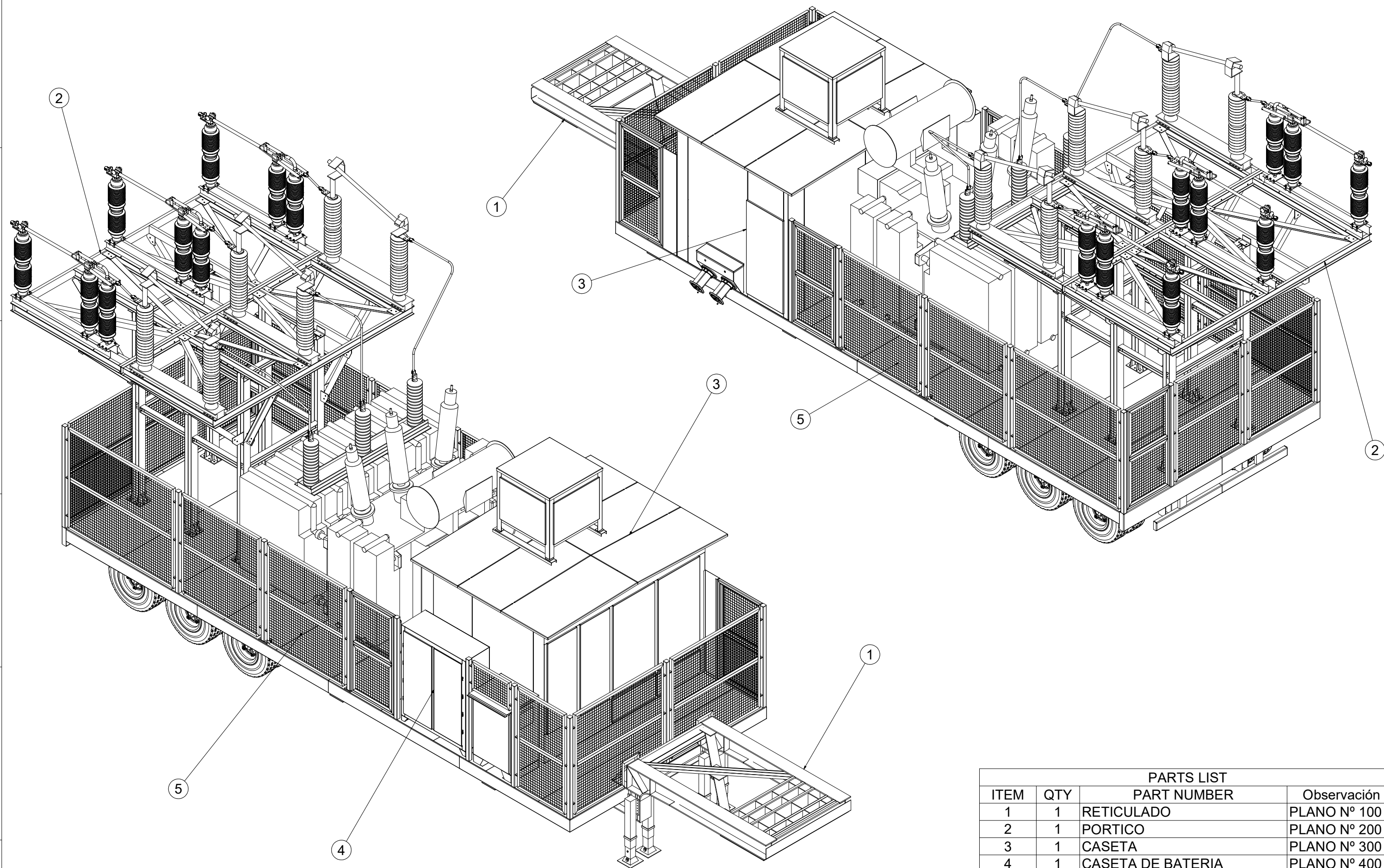


OBSERVACIONES GENERALES		OBSERVACIONES DE PAGINA				 eupla	
		DIBUJADO	01/11/2016	NOMBRE			
		COMPROBADO		RONY PINEDO CORDOVA			
		IDENTIFICADO					
		IDENTIFICADO					
		IDENTIFICADO					
				SUBESTACION MOVIL 66/12KV, 10MVA		ESUELA UNIVERSITARIA POLITECNICA La Almunia de Dofa Godina (Zaragoza)	
				BATERIAS, CARGADOR Y PANEL 125 V DC			
				HOJA 11		Nº Plano :E.100	
				DE 11		Nº Original :E.100	
						Nom. Ficher. :E.111.dwg	

2. PLANOS MECÁNICOS

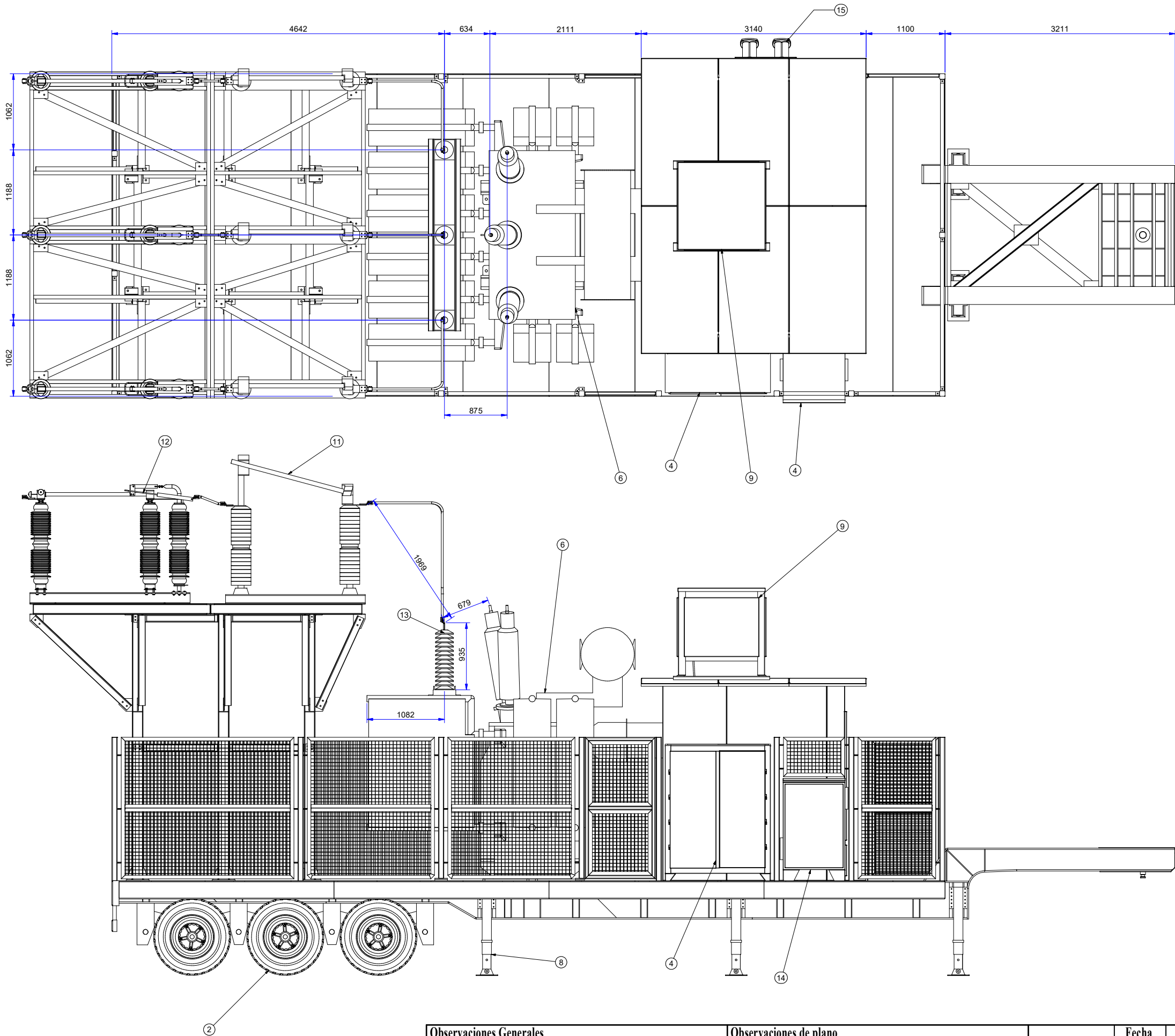
INDICE DE PLANOS MECANICOS

It	PLANOS MECANICOS	Nro. Plano
1	VISTAS GENERALES	000
2	MONTAJE DE EQUIPOS	001
3	MONTAJE DE EQUIPOS INTERNOS	002
4	RETICULADO	100
5	RETICULADO DETALLE	101
6	RETICULADO DETALLE	102
7	VIGAS PRICIPALES	103
8	PORTICO MONTAJE	200
9	PORTICO PLATAFORMA	201
10	CASETA	300
11	CASETA VISTA FRONTAL	301
12	CASET MONTAJE DE EQUIPOS	302
13	CASET MONTAJE DE EQUIPOS	303
14	CASETA DE BATERIAS	400
15	ESTANTE DE BATERIAS	401
16	CERCO PERIMETRICO	500



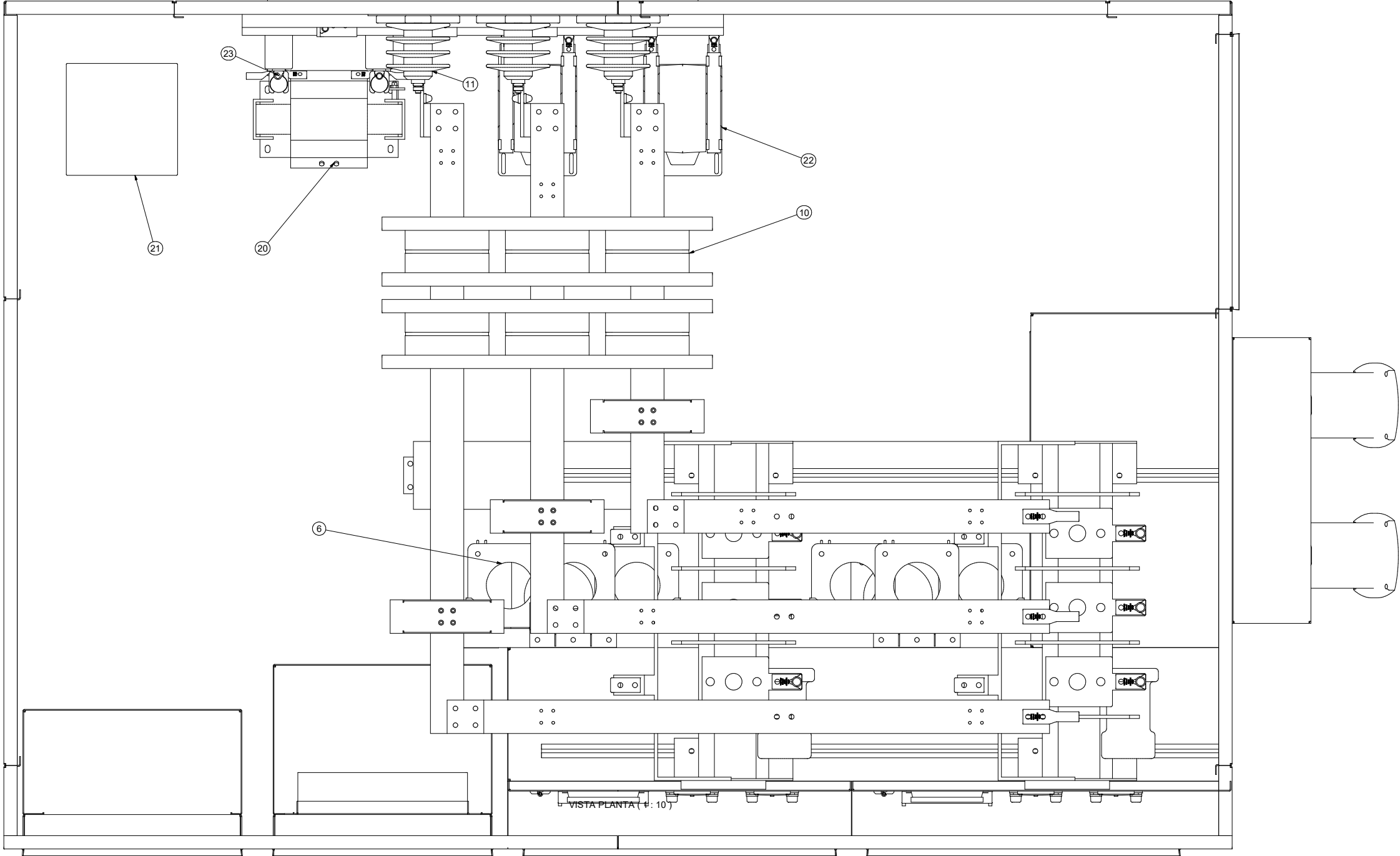
PARTS LIST			
ITEM	QTY	PART NUMBER	Observación
1	1	RETICULADO	PLANO Nº 100
2	1	PORTICO	PLANO Nº 200
3	1	CASETA	PLANO Nº 300
4	1	CASETA DE BATERIA	PLANO Nº 400
5	1	CERCO PERIMETRICO	PLANO Nº 500

Observaciones Generales		Observaciones de plano			Fecha	Nombre	 eupla ESCUELA UNIVERSITARIA POLITECNICA La Almunia de D.ª Godina -ZARAGOZA-
Proyecto:		Plano nº: 1 de: 1 Formato: A2 Coment:	Dibujado	12/03/2015	R.P.C.		
Palabras clave:			Comprobado				
Empresa:			Idem.s.normas				
Estado del proyecto: WorkInProgress			ESCALA	SUBESTACION MOVIL			Nº P.: 000
Versión: V310			S/E	MONTAJE			Nº O.: 000
				VISTAS GENERALES			Nom.Ar.: 000.idw



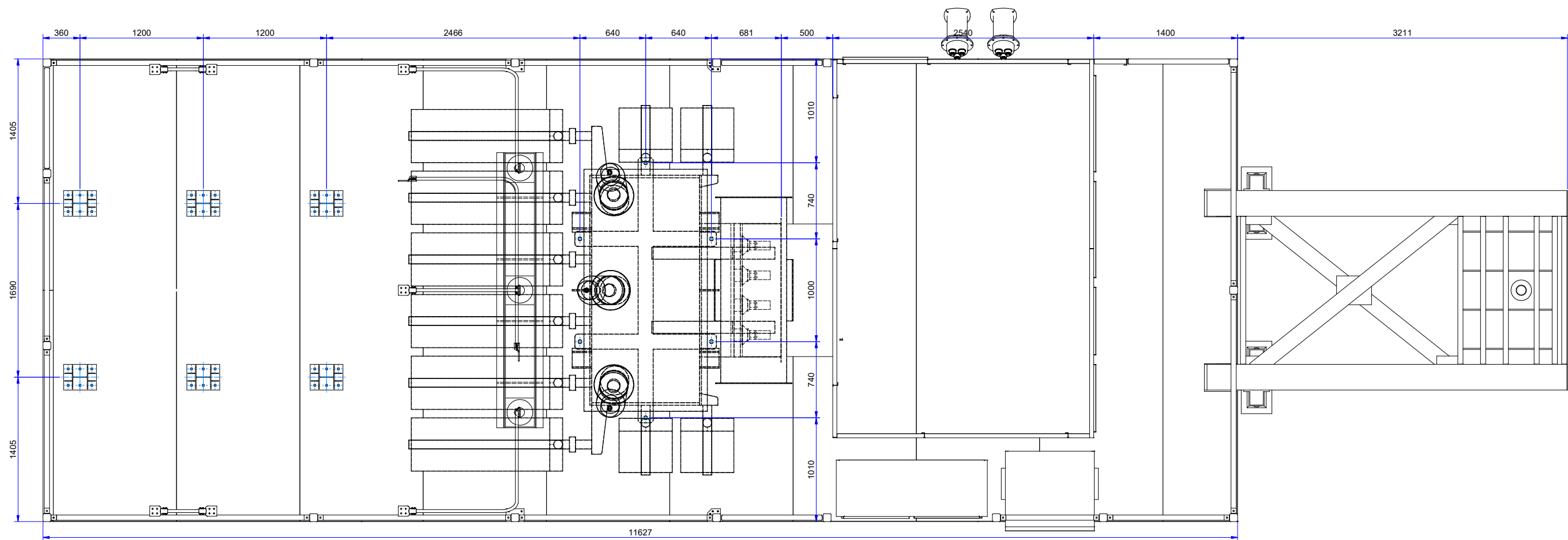
PARTS LIST		
ITEM	QTY	PART NUMBER
4	1	CASETA DE BATERIA
6	1	TRANSFORMADOR 10MVA
7	12	RUEDA
8	6	GATA HIDRAULICA
9	1	RESISTENCIA NEUTRO
11	3	FUSIBLES A.T.
12	1	SECCIONADOR A.T.
13	3	PARARRAYOS A.T.
14	1	CARGADOR DE BATERIAS
15	2	CONECTORES DE SALIDA

Observaciones Generales		Observaciones de plano		Dibujado	Fecha	Nombre	 eupla ESCUELA UNIVERSITARIA POLITECNICA La Almunia de D ^a Godina -ZARAGOZA-	
Proyecto:		Plano nº: 1 de: 1		Comprobado	12/03/2015	R.P.C.		
Palabras clave:		Formato: A2		Idem.s.normas				
Empresa:		Estado del proyecto: WorkInProgress		ESCALA		SUBESTACION MOVIL		Nº P.: 001
Versión: V315		Coment:				MONTAJE DE EQUIPOS		Nº O.: 000
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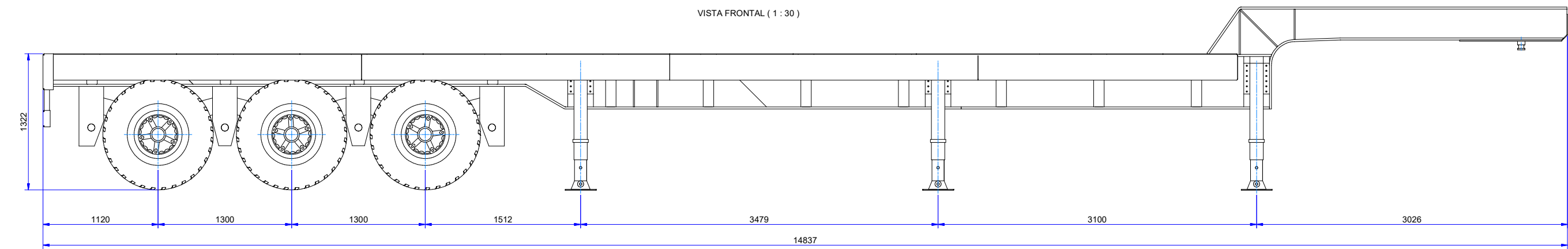


PARTS LIST		
ITEM	QTY	PART NUMBER
6	6	CT de alimentador
10	6	CT lado secundario
11	1	Pararrayos lado secundario
20	1	CPT1: Trasformador de control
21	1	CPT2: Transformador de aislamiento
22	2	PT12: Transformadores de potencial
23	2	Fusible M.T.

Observaciones Generales		Observaciones de plano			Fecha	Nombre	 eupla ESCUELA UNIVERSITARIA POLITECNICA La Alfranca de Dª Godina -ZARAGOZA-
Proyecto:		Plano n°: 1 de: 1 Formato: A2 Coment:	Dibujado	12/03/2015	R.P.C.		
Palabras clave:			Comprobado				
Empresa:			Idem.s.normas				
Estado del proyecto: WorkInProgress							
Versión: V9			ESCALA	SUBESTACION MOVIL MONTAJE DE EQUIPOS INTERNOS			Nº P.: 002 Nº O.: 000 Nom.Ar.: 002.idw

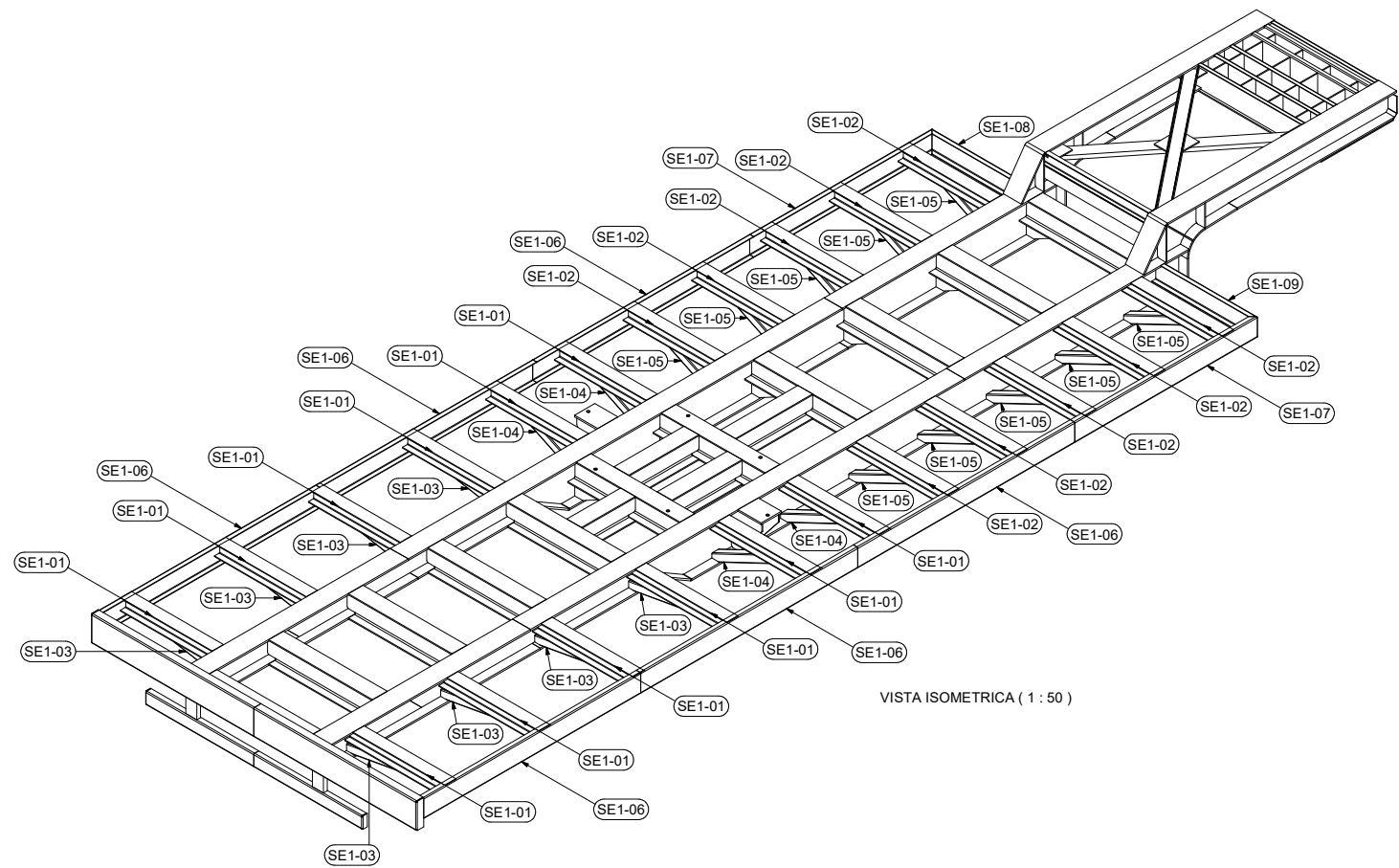


VISTA DE PLANTA (1 : 30)

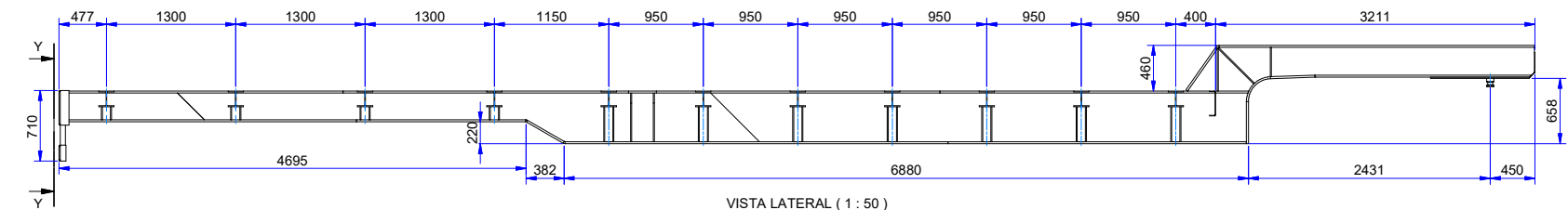


VISTA FRONTAL (1 : 30)

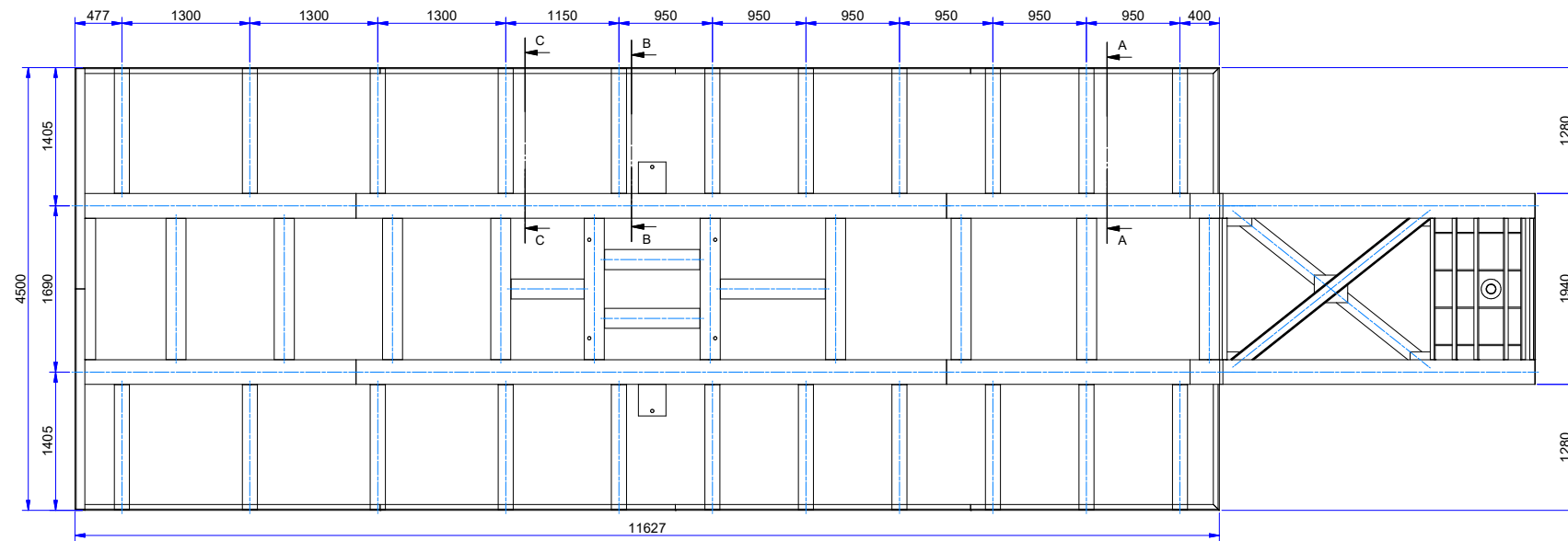
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Proyecto:		Plano nº: 1 de: 1		Dibujado	06/04/2011	R.P.C.	
Palabras clave:		Formato: A2		Comprobado			
Empresa:		Coment:		Idem.s.normas			
Estado del proyecto: WorkInProgress				ESCALA	SUBESTACION MOVIL		Nº P.: 100
Versión: V312				S/E	RETICULADO		Nº O.: 000
							Nom.Ar.: 100.idw



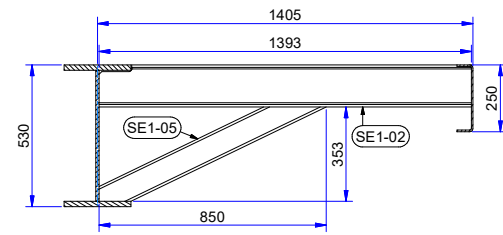
VISTA ISOMETRICA (1 : 50)



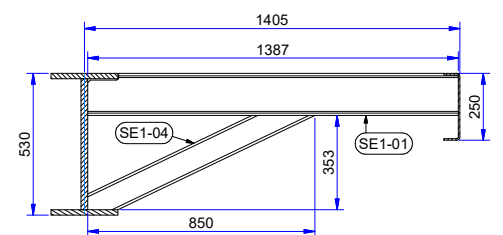
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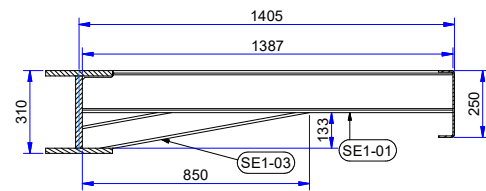
VISTA PLANTA (1 : 50)



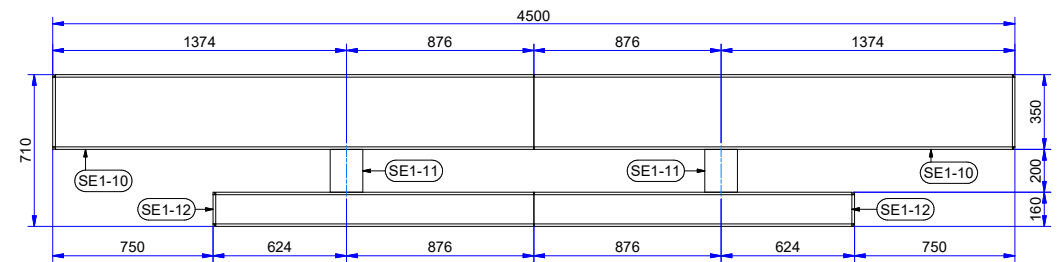
CORTE A-A (1 : 20)



CORTE B-B (1 : 20)



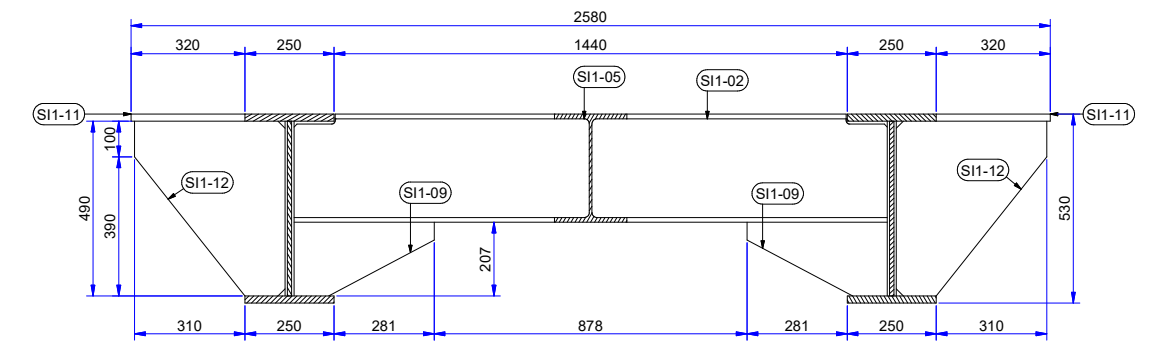
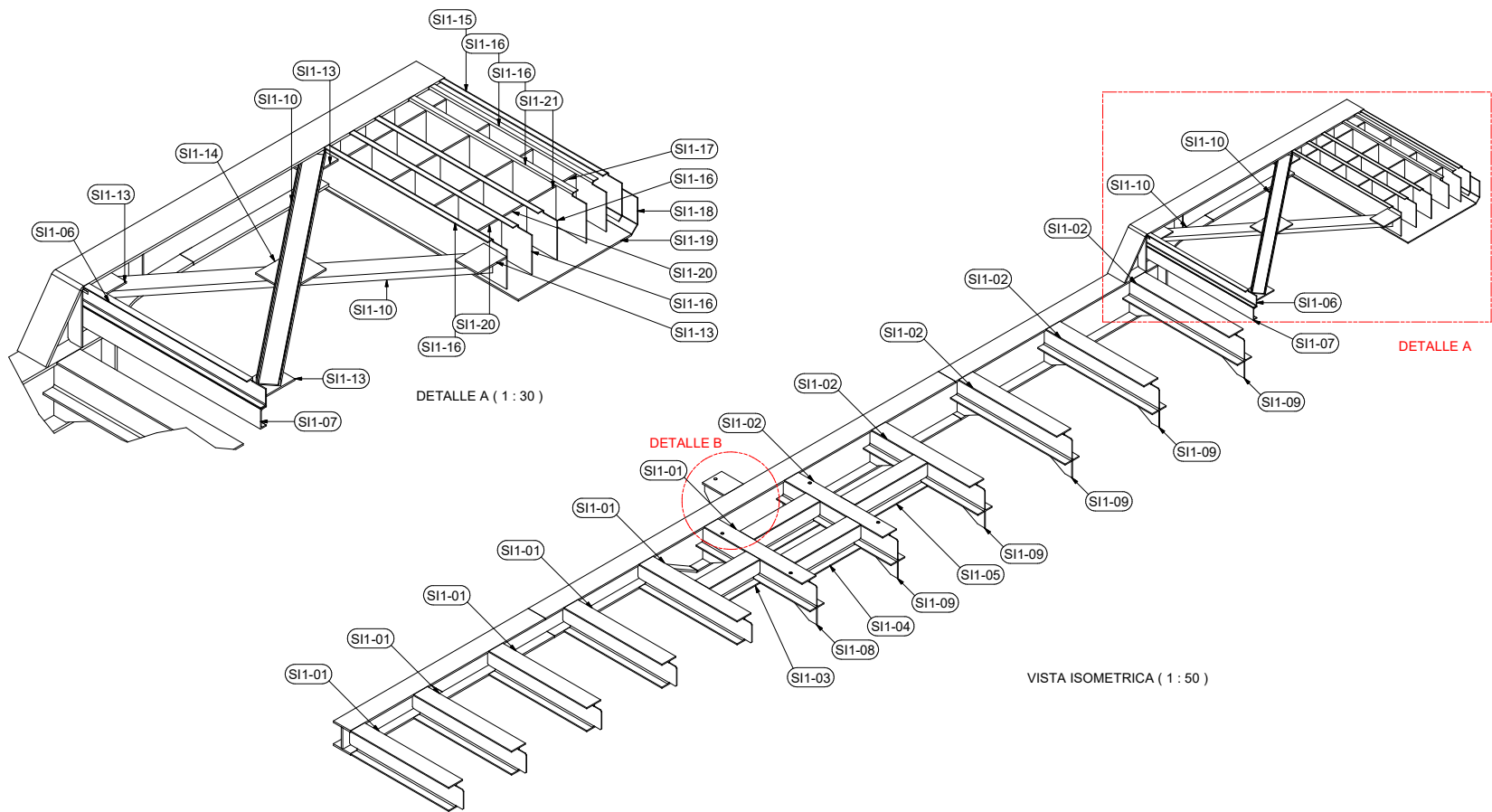
CORTE C-C (1 : 20)



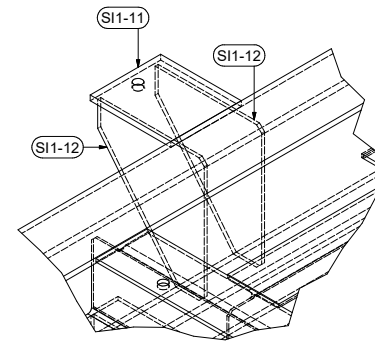
VISTA Y (1 : 25)

				TOTAL				
12	2	SE1-12	PARACHOQUE	PL LAC 6 x 276 x 2558			A-36	
11	2	SE1-11	PARACHOQUE	C 6" x 10.5 lb x 200			A-36	
10	2	SE1-10	PARACHOQUE	PL LAC 6 x 526 x 2338			A-36	
9	1	SE1-09	PERIMETRO	PL LAC 6 x 346 x 1400			A-36	
8	1	SE1-08	PERIMETRO	PL LAC 6 x 346 x 1400			A-36	
7	2	SE1-07	PERIMETRO	PL LAC 6 x 346 x 2527			A-36	
6	6	SE1-06	PERIMETRO	PL LAC 6 x 346 x 3000			A-36	
5	10	SE1-05	SOPORTE	HSS 4" x 4" x 4 mm x 920			A-36	
4	4	SE1-04	SOPORTE	HSS 4" x 4" x 4 mm x 920			A-36	
3	8	SE1-03	SOPORTE	HSS 4" x 4" x 4 mm x 860			A-36	
2	10	SE1-02	SOPORTE	W 6" x 20 lb x 1393			A-36	
1	12	SE1-01	SOPORTE	W 6" x 20 lb x 1387			A-36	
Item	Cant.	Código	Denominación	Norma / Dimensión	Area m2	Peso Kg.	Material	Observación

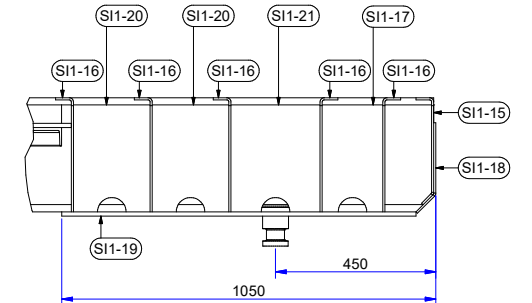
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Proyecto: Palabras clave: Empresa: Estado del proyecto: WorkInProgress Versión: V296		Plano n°: 1 de: 1 Formato: A2 Coment:		Dibujado		12/03/2015		R.P.C.				ESCUELA UNIVERSITARIA POLITECNICA La Almunia de D.ª Godina -ZARAGOZA-		N° P.: 101 N° O.: 100 Nom.Ar.: 101.idw	
				Comprobado											
				Idem.s.normas											
				ESCALA		SUBESTACION MOVIL									
				S/E				RETICULADO DETALLE							



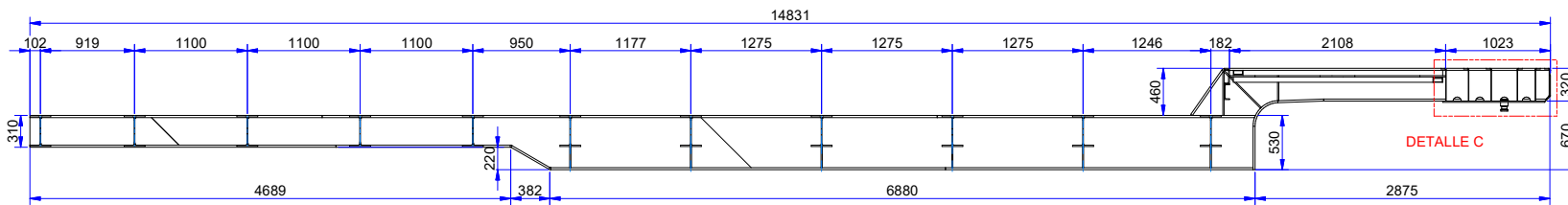
CORTE X-X (1 : 15)



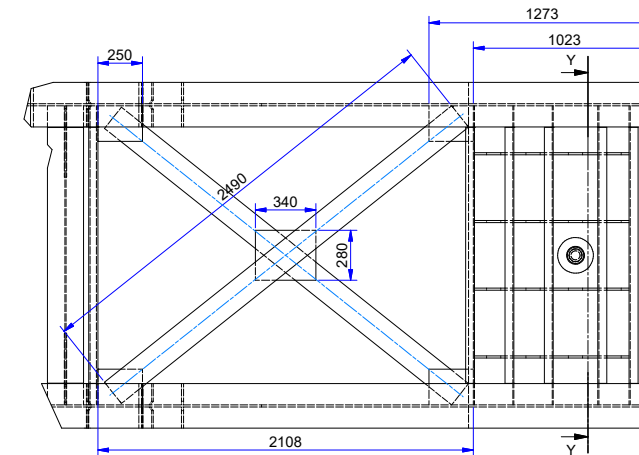
DETALLE B (1 : 15)



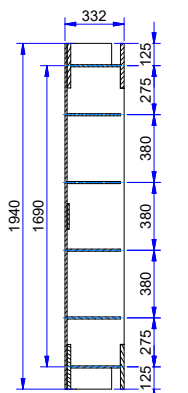
DETALLE C (1 : 15)



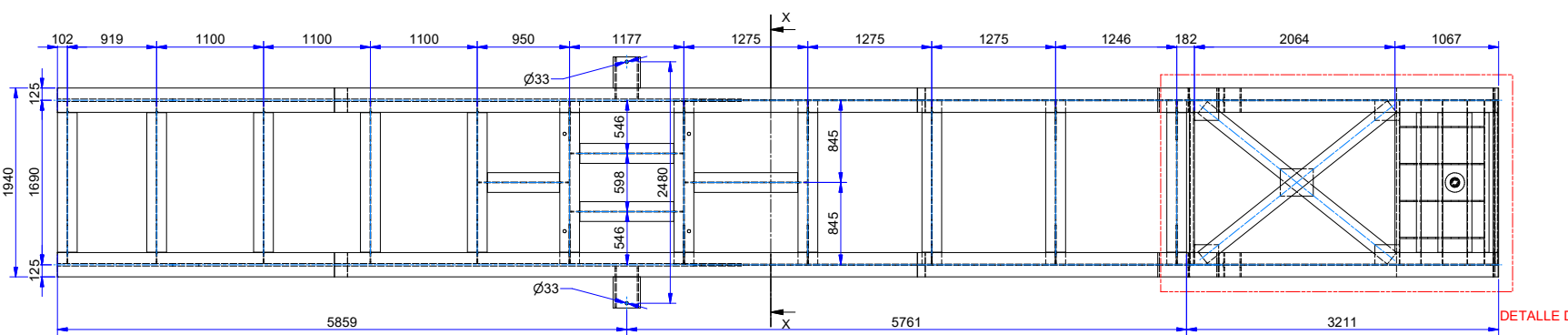
VISTA FRONTA (1 : 50)



DETALLE D (1 : 30)



CORTE Y-Y (1 : 30)



VISTA PLANTA (1 : 50)

Item	Cant.	Código	Denominación	Norma / Dimensión	Area m2	Peso Kg.	Material	Observación
22	1	SI1-22	TAPA	PL LAC 6 x 1131 x 1940			A-36	
21	4	SI1-21	TROMPA	PL LAC 12 x 250 x 300			A-36	
20	8	SI1-20	TROMPA	PL LAC 12 x 215 x 300			A-36	
19	1	SI1-19	TROMPA	PL LAC 12 x 994 x 1940			A-36	
18	1	SI1-18	TROMPA	PL LAC 6 x 272 x 1940			A-36	
17	4	SI1-17	TROMPA	PL LAC 12 x 170 x 300			A-36	
16	5	SI1-16	TROMPA	PL LAC 6 x 358 x 1678			A-36	
15	1	SI1-15	TROMPA	PL LAC 6 x 347 x 1678			A-36	
14	1	SI1-14	CARTELA	PL LAC 12 x 280 x 340			A-36	
13	4	SI1-13	CARTELA	PL LAC 12 x 200 x 250			A-36	
12	4	SI1-12	CARTELA	PL LAC 12 x 423 x 490			A-36	
11	2	SI1-11	BASE	PL LAC 20 x 280 x 320			A-36	
10	2	SI1-10	CRUCETA	C 6" x 10.5 lb x 2490			A-36	
9	10	SI1-09	CARTELA	PL LAC 12 x 207 x 400			A-36	
8	2	SI1-08	CARTELA	PL LAC 12 x 207 x 400			A-36	
7	1	SI1-07	SOPORTE	C 6" x 10.5 lb x 1678			A-36	
6	1	SI1-06	SOPORTE	C 6" x 10.5 lb x 1678			A-36	
5	1	SI1-05	SOPORTE	W 12" x 40 lb x 1268			A-36	
4	2	SI1-04	SOPORTE	W 12" x 40 lb x 1169			A-36	
3	1	SI1-03	SOPORTE	W 12" x 40 lb x 943			A-36	
2	5	SI1-02	SOPORTE	W 12" x 40 lb x 1678			A-36	
1	6	SI1-01	SOPORTE	W 12" x 40 lb x 1665			A-36	

Observaciones Generales			Observaciones de plano			eupla		
Proyecto:			Plano nº: 1 de: 1			ESCUELA UNIVERSITARIA POLITECNICA		
Palabras clave:			Formato: A2			La Almunia de D ^a Godina-ZARAGOZA-		
Empresa:			Coment:			Nº P.: 102		
Estado del proyecto: WorkInProgress						Nº O.: 100		
Versión: V303						Nom.Ar.: 102.idw		

Dibujado
Comprobado
Idem.s.normas

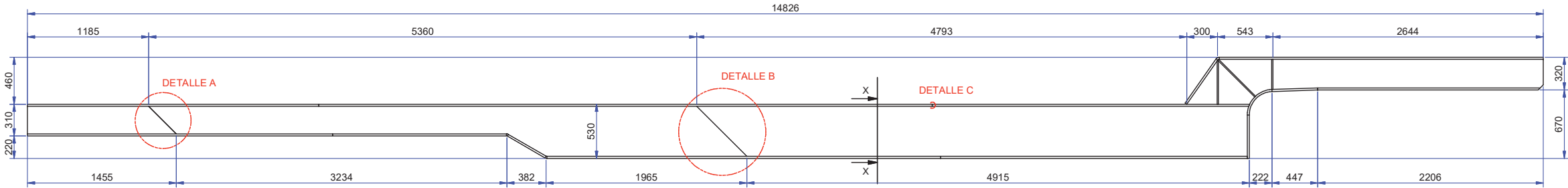
Fecha
12/03/2015

Nombre
R.P.C.

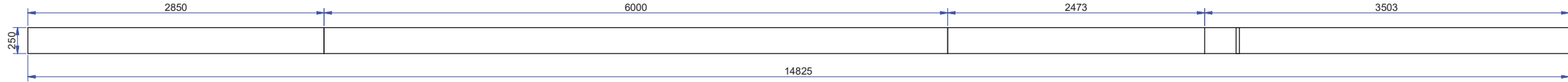
ESCALA
S/E

SUBESTACION MOVIL
RETICULADO
DETALLE

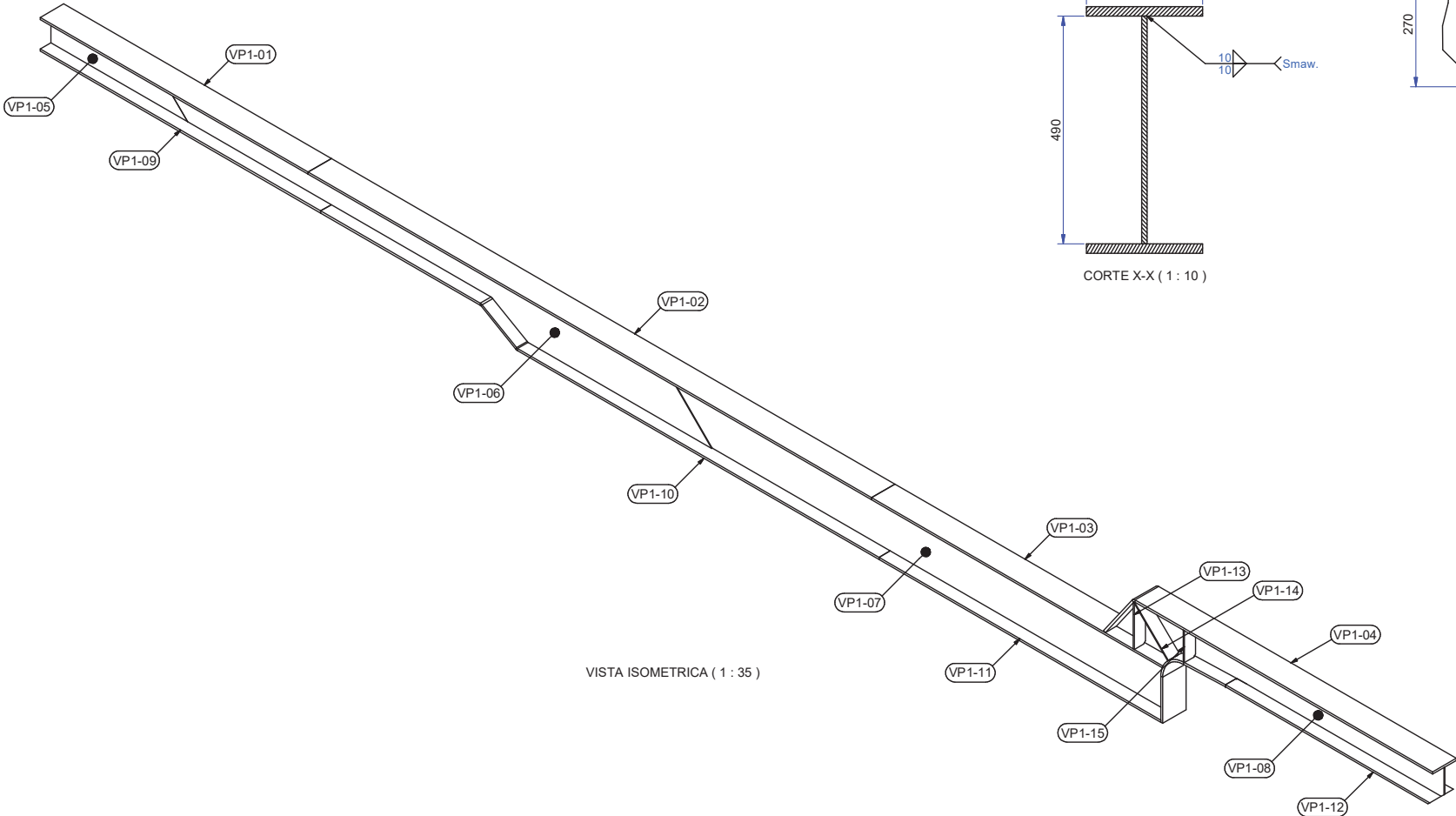
Nº P.: 102
Nº O.: 100
Nom.Ar.: 102.idw



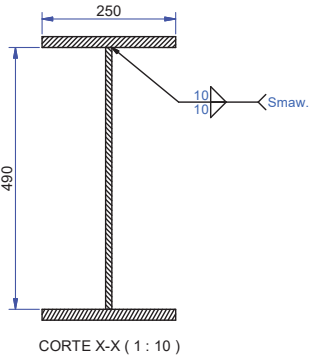
VISTA FRONTAL (1 : 35)



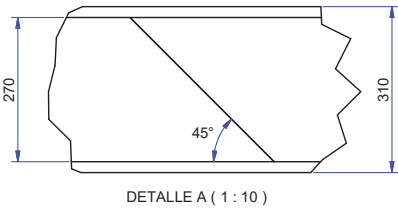
VISTA PLANTA (1 : 35)



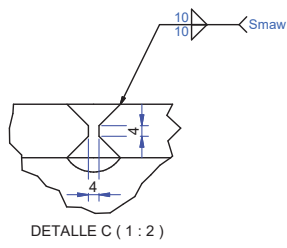
VISTA ISOMETRICA (1 : 35)



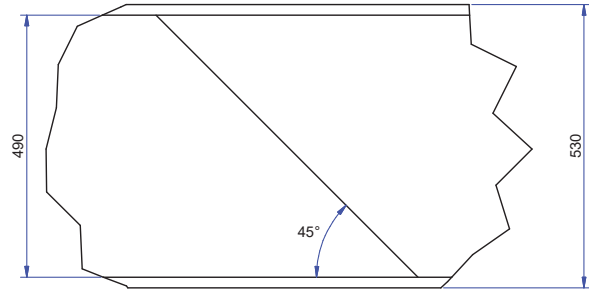
CORTE X-X (1 : 10)



DETALLE A (1 : 10)



DETALLE C (1 : 2)



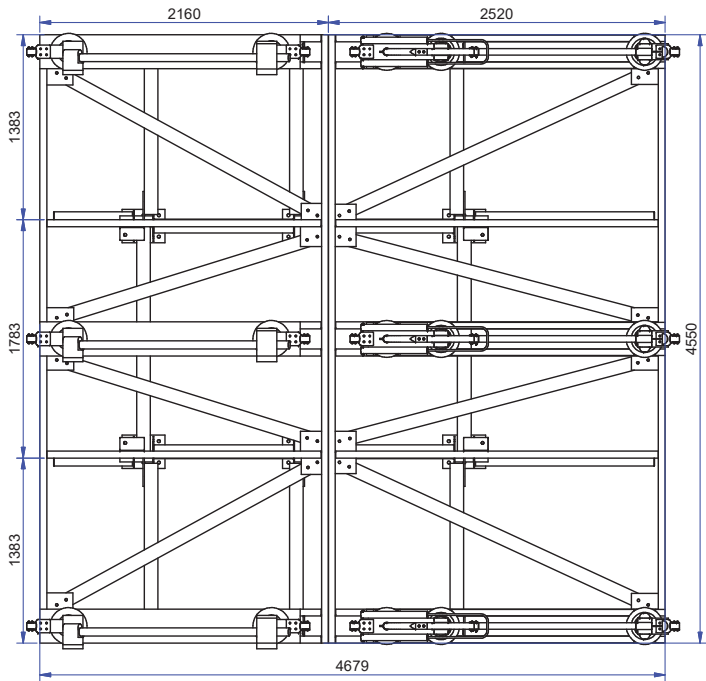
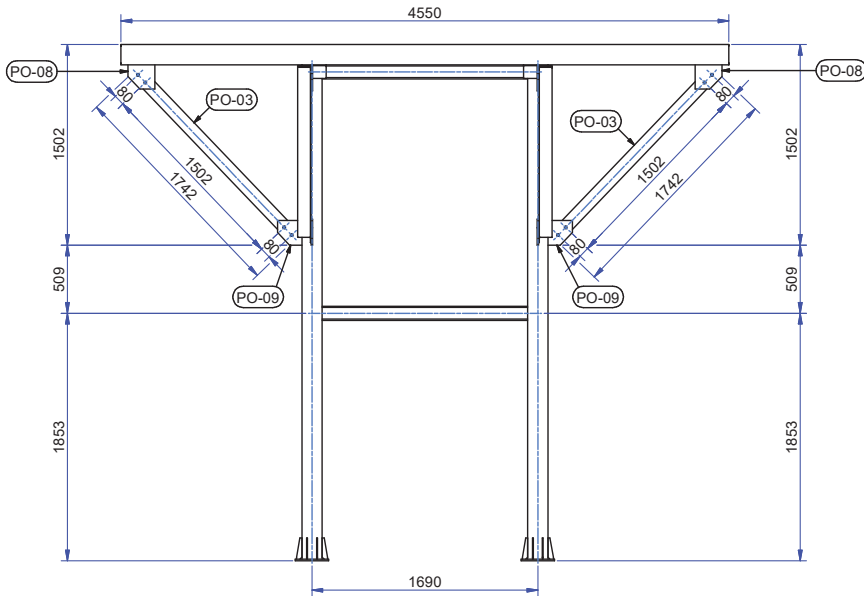
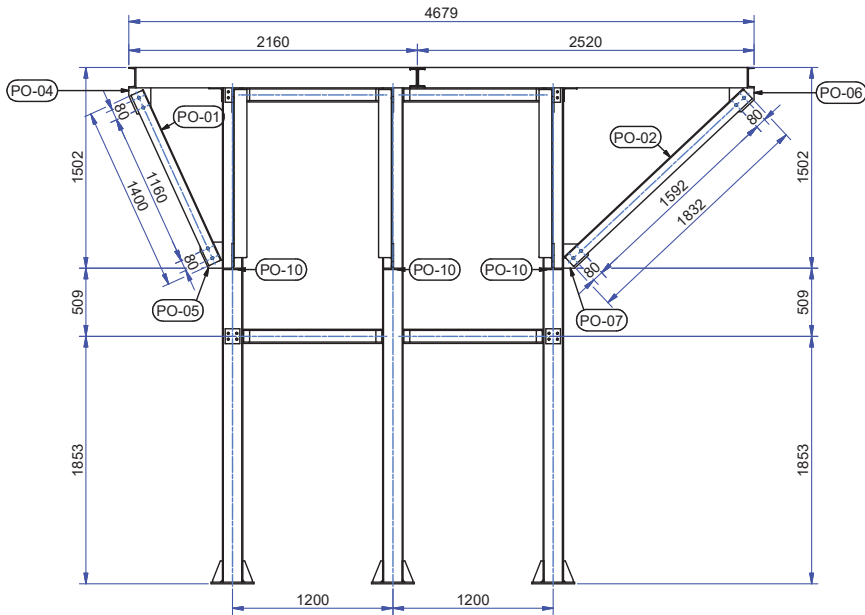
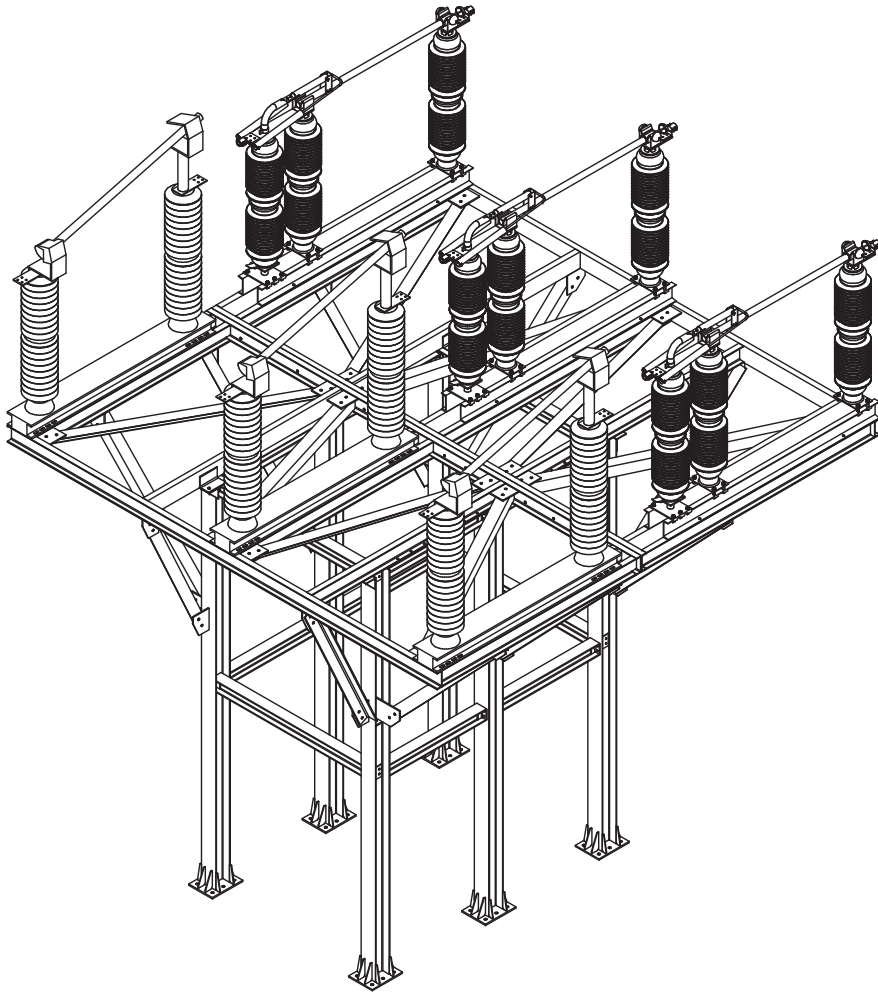
DETALLE B (1 : 10)

Item	Cant.	Código	Denominación	Norma / Dimensión	Area m2	Peso Kg.	Material	Observación
15	4	VPR1-15	CARTELA	PL LAC 12 x 119 x 295			A-36	
14	4	VPR1-14	CARTELA	PL LAC 12 x 119 x 511			A-36	
13	4	VPR1-13	CARTELA	PL LAC 12 x 119 x 425			A-36	
12	2	VPR1-12	ALA INF.	PL LAC 20 x 250 x 3410			A-36	
11	2	VPR1-11	ALA INF.	PL LAC 20 x 250 x 3000			A-36	
10	2	VPR1-10	ALA INF.	PL LAC 20 x 250 x 6000			A-36	
9	2	VPR1-09	ALA INF.	PL LAC 20 x 250 x 2984			A-36	
8	2	VPR1-08	ALMA	PL LAC 12 x 440 x 3487			A-36	
7	2	VPR1-07	ALMA	PL LAC 12 x 490 x 5400			A-36	
6	2	VPR1-06	ALMA	PL LAC 25 x 490 x 5850			A-36	
5	2	VPR1-05	ALMA	PL LAC 25 x 270 x 1455			A-36	
4	2	VPR1-04	ALA SUP.	PL LAC 20 x 250 x 3719			A-36	
3	2	VPR1-03	ALA SUP.	PL LAC 20 x 250 x 3104			A-36	
2	2	VPR1-02	ALA SUP.	PL LAC 20 x 250 x 6000			A-36	
1	2	VPR1-01	ALA SUP.	PL LAC 20 x 250 x 2850			A-36	

Observaciones Generales		Observaciones de plano		Fecha		Nombre		Nº P.:	
Proyecto:		Plano nº: 1 de: 1		12/03/2015		R.P.C.		Nº O.:	
Palabras clave:		Formato: A2						Nom.Ar.: 103.idw	
Empresa:		Coment:							
Estado del proyecto: WorkInProgress									
Versión: V288									

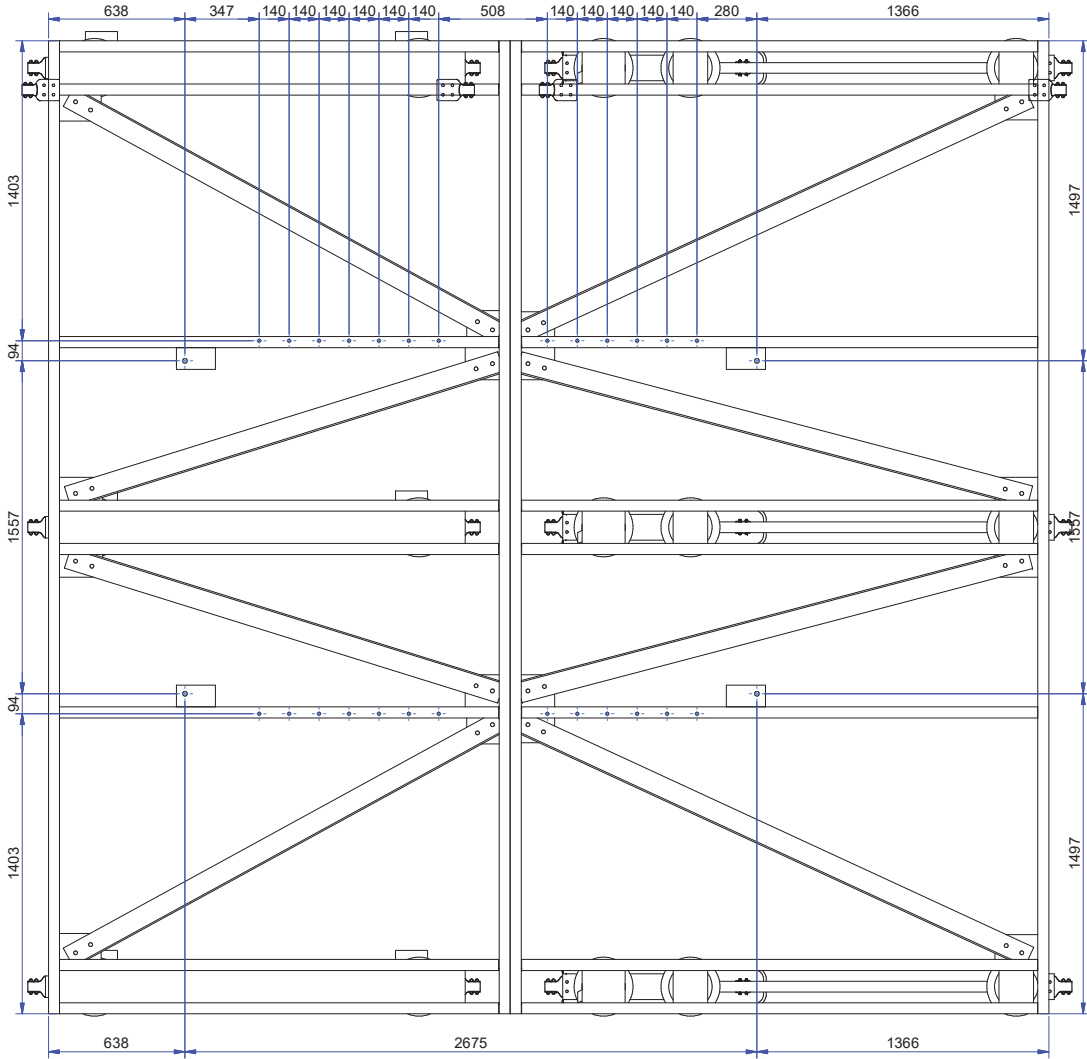
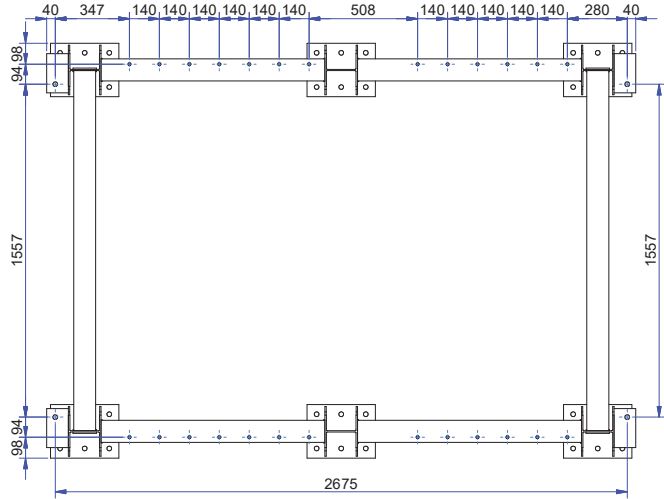
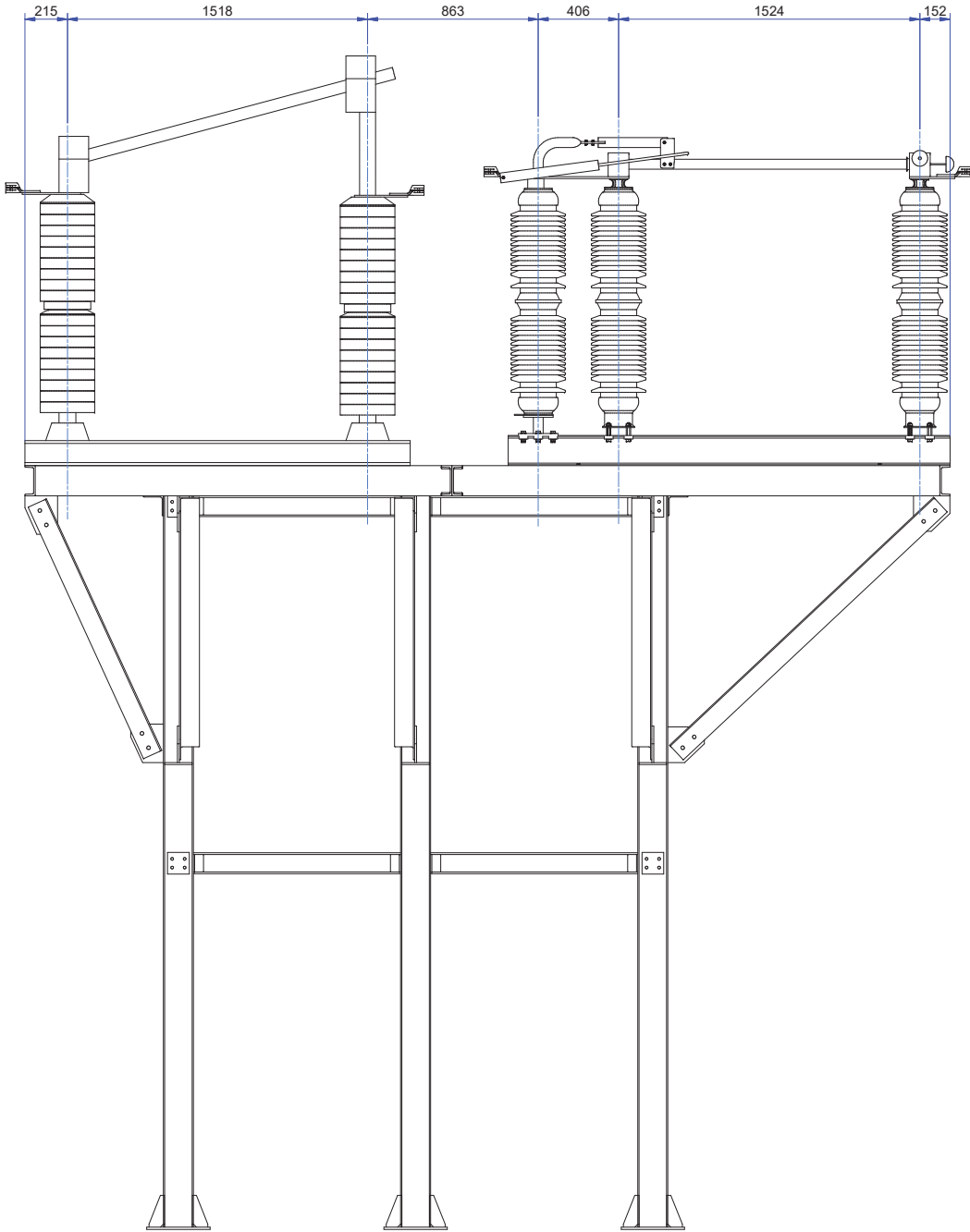
**eupla**
ESCUELA UNIVERSITARIA POLITECNICA
La Almunia de Dº Godina-ZARAGOZA-

Subestacion Movil

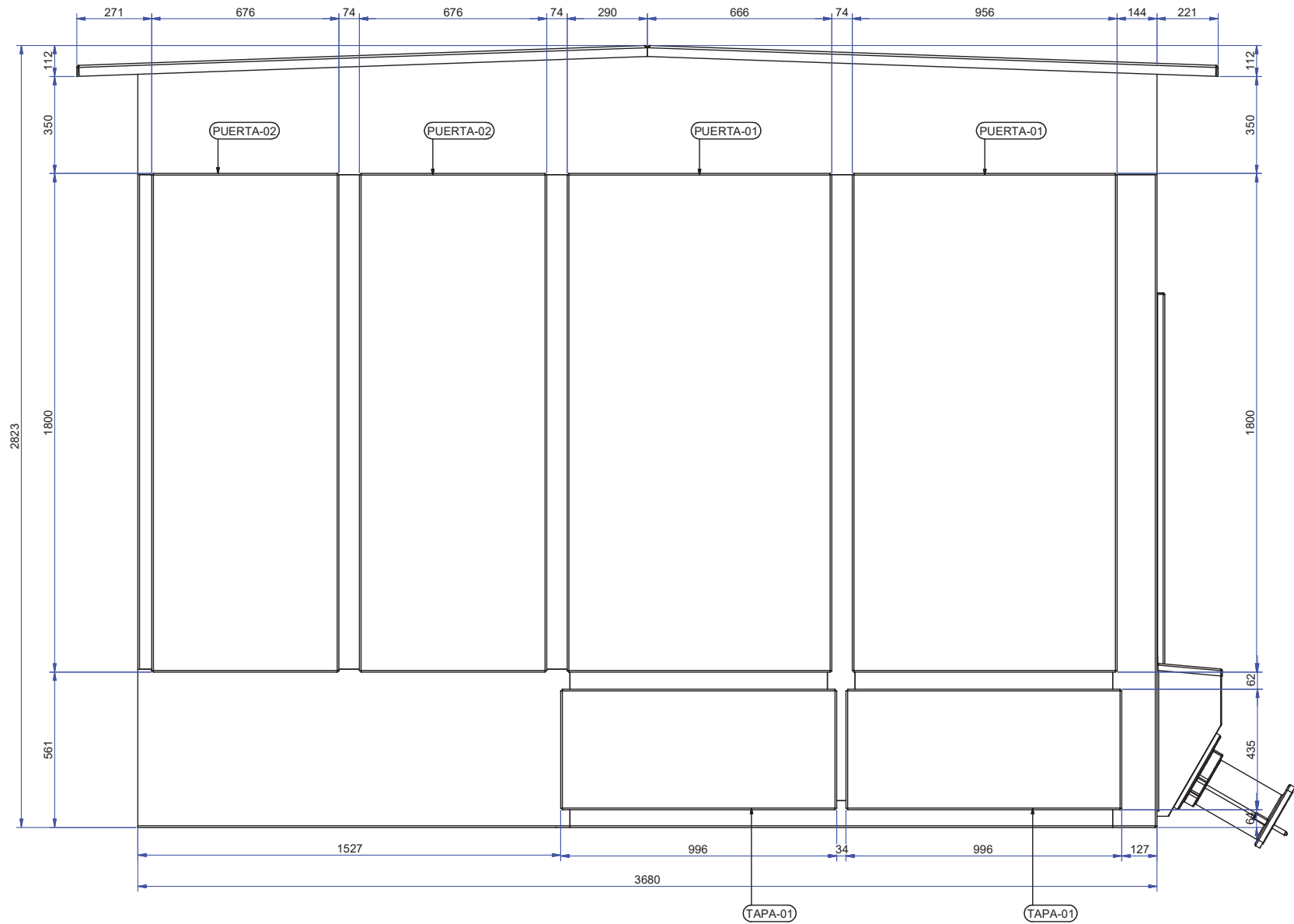


				TOTAL				
39	48	PO-39	ARMAZON	L 2" x 2" x 6 mm x 88			A-36	
38	2	PO-38	ARMAZON	W 6" x 15 lb x 3700			A-36	
37	4	PO-37	ARMAZON	W 6" x 15 lb x 3700			A-36	
36	24	PO-36	ARMAZON	PL LAC 6 x 73 x 160			A-36	
35	24	PO-35	ARMAZON	PL LAC 6 x 40 x 160			A-36	
34	6	PO-34	ARMAZON	PL LAC 12 x 250 x 320			A-36	
33	4	PO-33	ARMAZON	W 4" x 13 lb x 1684			A-36	
32	8	PO-32	ARMAZON	W 4" x 13 lb x 1048			A-36	
31	8	PO-31	ARMAZON	PL LAC 6 x 110 x 110			A-36	
30	2	PO-30	SOPORTE	PL LAC 10 x 150 x 200			A-36	
29	2	PO-29	SOPORTE	PL LAC 10 x 150 x 200			A-36	
28	2	PO-28	SOPORTE	PL LAC 10 x 160 x 200			A-36	
27	2	PO-27	SOPORTE	PL LAC 10 x 160 x 200			A-36	
26	2	PO-26	SOPORTE	PL LAC 10 x 150 x 202			A-36	
25	2	PO-25	SOPORTE	PL LAC 10 x 150 x 202			A-36	
24	2	PO-24	SOPORTE	PL LAC 10 x 165 x 195			A-36	
23	2	PO-23	SOPORTE	PL LAC 10 x 165 x 195			A-36	
22	2	PO-22	SOPORTE	L 4" x 4" x 6 mm x 2468			A-36	
21	2	PO-21	SOPORTE	L 4" x 4" x 6 mm x 2624			A-36	
20	2	PO-20	SOPORTE	L 4" x 4" x 6 mm x 2122			A-36	
19	2	PO-19	SOPORTE	L 4" x 4" x 6 mm x 2303			A-36	
18	4	PO-18	SOPORTE	C 6" x 10.5 lb x 2460			A-36	
17	4	PO-17	SOPORTE	C 6" x 10.5 lb x 2460			A-36	
16	4	PO-16	SOPORTE	C 6" x 10.5 lb x 2100			A-36	
15	4	PO-15	SOPORTE	C 6" x 10.5 lb x 2100			A-36	
14	4	PO-14	SOPORTE	L 4" x 4" x 6 mm x 183			A-36	
13	4	PO-13	SOPORTE	L 4" x 4" x 6 mm x 183			A-36	
12	2	PO-12	SOPORTE	C 6" x 10.5 lb x 4550			A-36	
11	2	PO-11	SOPORTE	C 6" x 10.5 lb x 4550			A-36	
10	6	PO-10	TRANSLICHE	PL LAC 10 x 73 x 139			A-36	
9	6	PO-09	TRANSLICHE	PL LAC 10 x 185 x 255			A-36	
8	6	PO-08	TRANSLICHE	PL LAC 10 x 201 x 335			A-36	
7	2	PO-07	TRANSLICHE	PL LAC 10 x 180 x 185			A-36	
6	2	PO-06	TRANSLICHE	PL LAC 10 x 180 x 185			A-36	
5	2	PO-05	TRANSLICHE	PL LAC 10 x 165 x 195			A-36	
4	2	PO-04	TRANSLICHE	PL LAC 10 x 165 x 195			A-36	
3	6	PO-03	TRANSLICHE	L 4" x 4" x 6 mm x 1742			A-36	
2	2	PO-02	TRANSLICHE	L 4" x 4" x 6 mm x 1832			A-36	
1	2	PO-01	TRANSLICHE	L 4" x 4" x 6 mm x 1400			A-36	
Item	Cant.	Código	Denominación	Norma / Dimensión	Area m2	Peso Kg.	Material	Observación

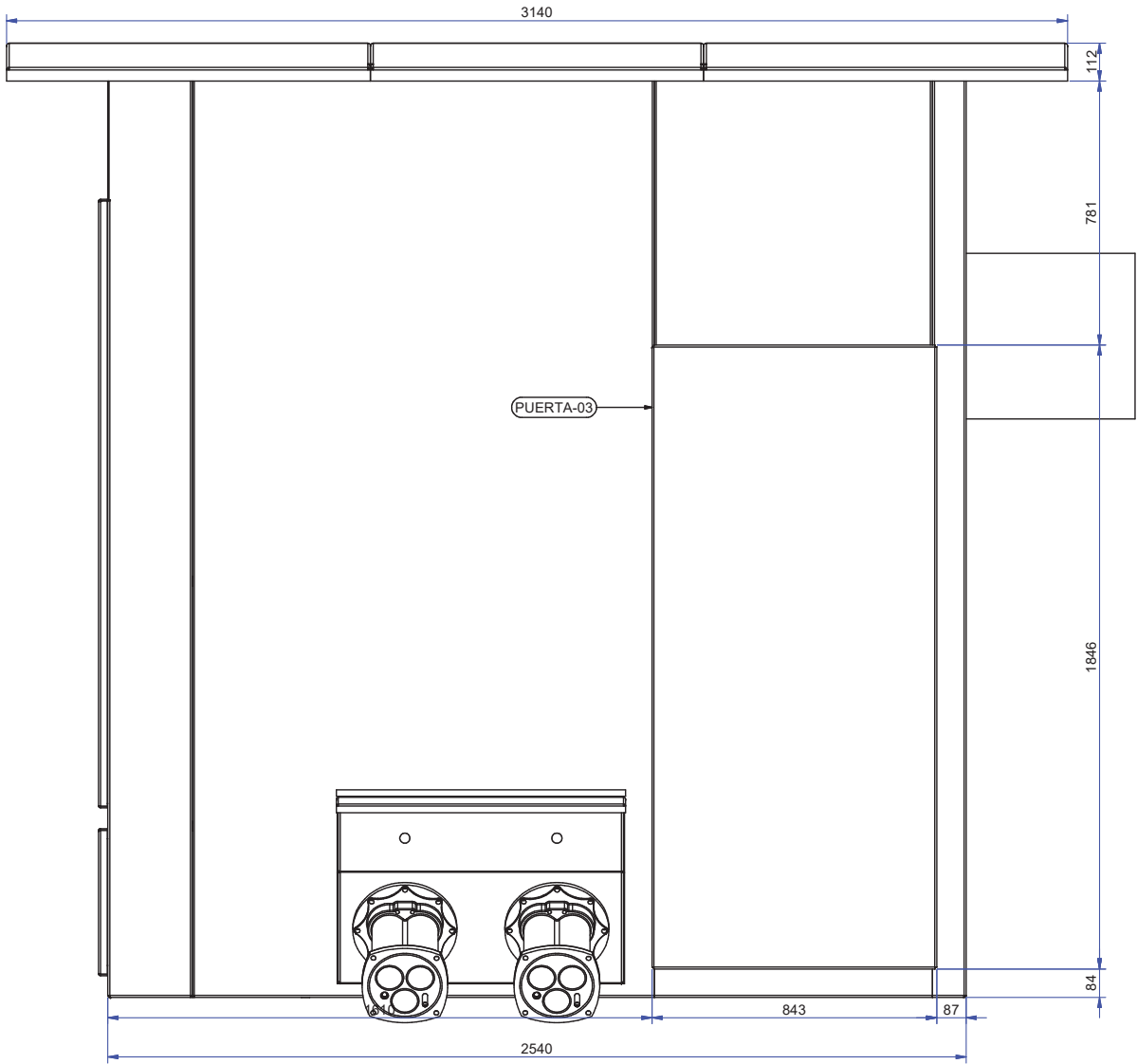
Observaciones Generales		Observaciones de plano		Fecha	Nombre	 eupla ESCUELA UNIVERSITARIA POLITECNICA La Almunia de D^a Godina -ZARAGOZA-	
Proyecto:	Plano n°: 1 de: 1 Formato: A2 Coment:	Dibujado	12/03/2015	R.P.C.			
Palabras clave:		Comprobado					
Empresa:		Idem.s.normas					
Estado del proyecto: WorkInProgress		ESCALA	SUBESTACION MOVIL		N° P.: 200		
Versión: V309	S/E	PORTICO MONTAJE		N° O.: 000			
				Nom.Ar.: 200.idw			



Observaciones Generales		Observaciones de plano			Fecha	Nombre			ESCUELA UNIVERSITARIA POLITECNICA La Almunia de D ^a Godina -ZARAGOZA-
Proyecto:		Plano n°: 1 de: 1		Dibujado	12/03/2015	R.P.C.			
Palabras clave:		Formato: A2		Comprobado					
Empresa:		Coment:		Idem.s.normas					
Estado del proyecto: WorkInProgress				ESCALA	SUBESTACION MOVIL			N° P.: 201	
Versión: V301				S/E	PORTICO PLATAFORMA			N° O.: 200	
								Nom.Ar.: 201.idw	



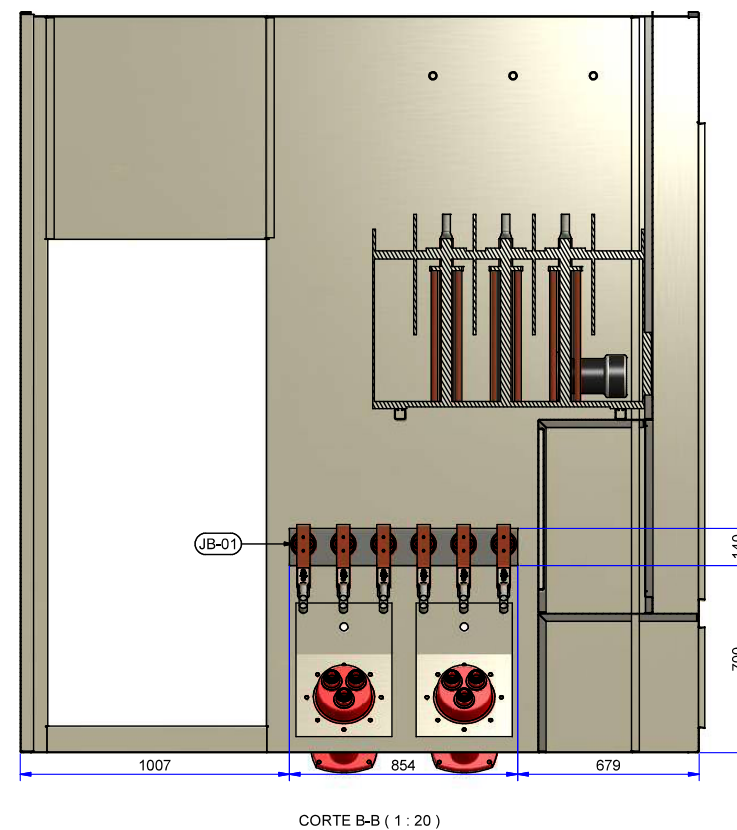
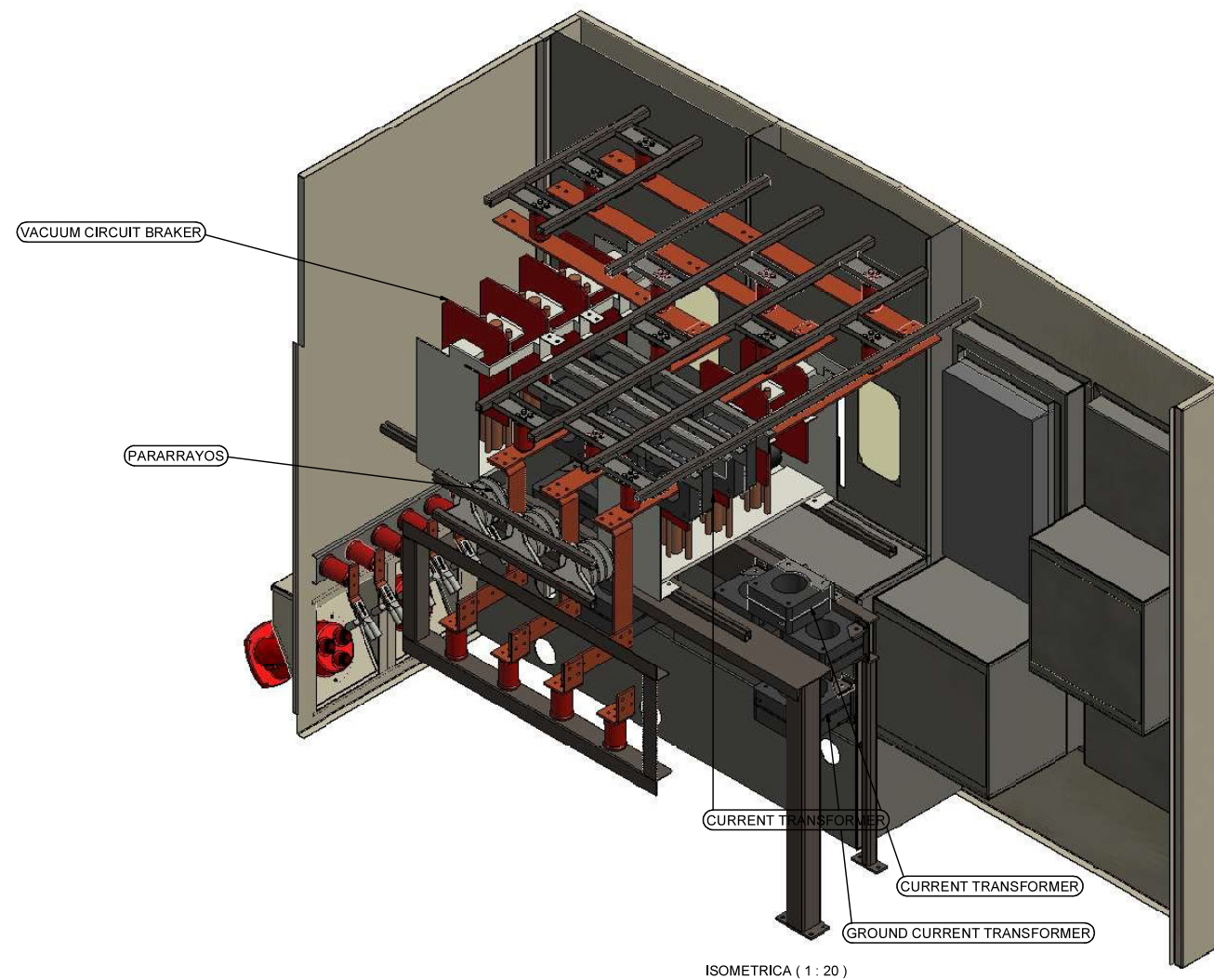
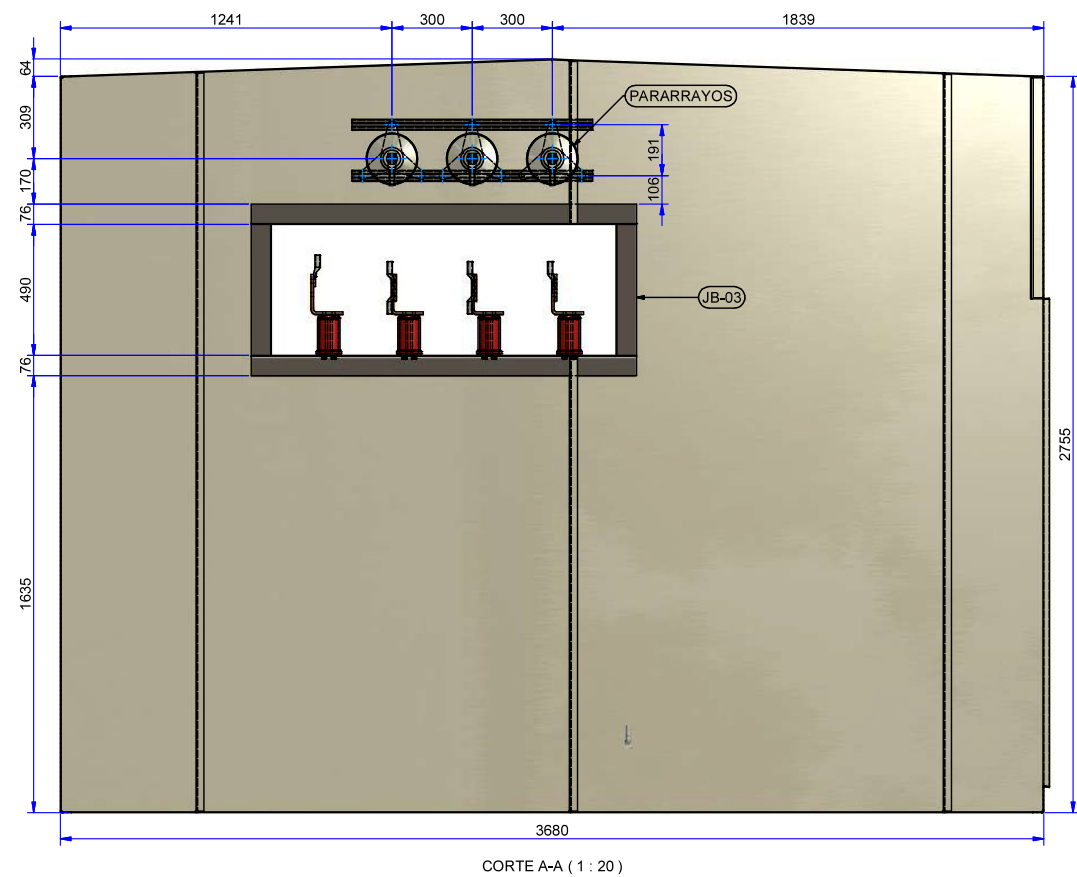
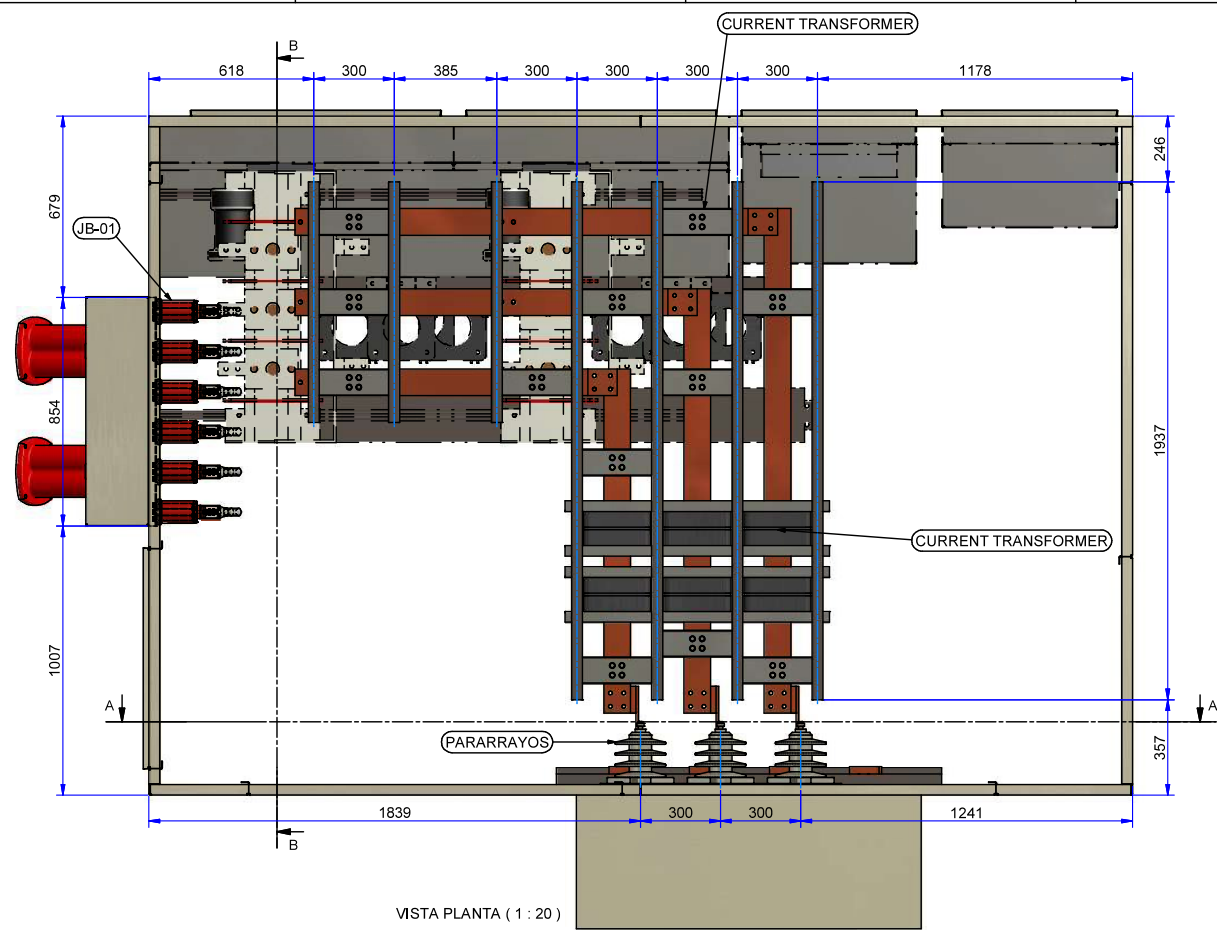
VISTA FRONTAL (1 : 15)



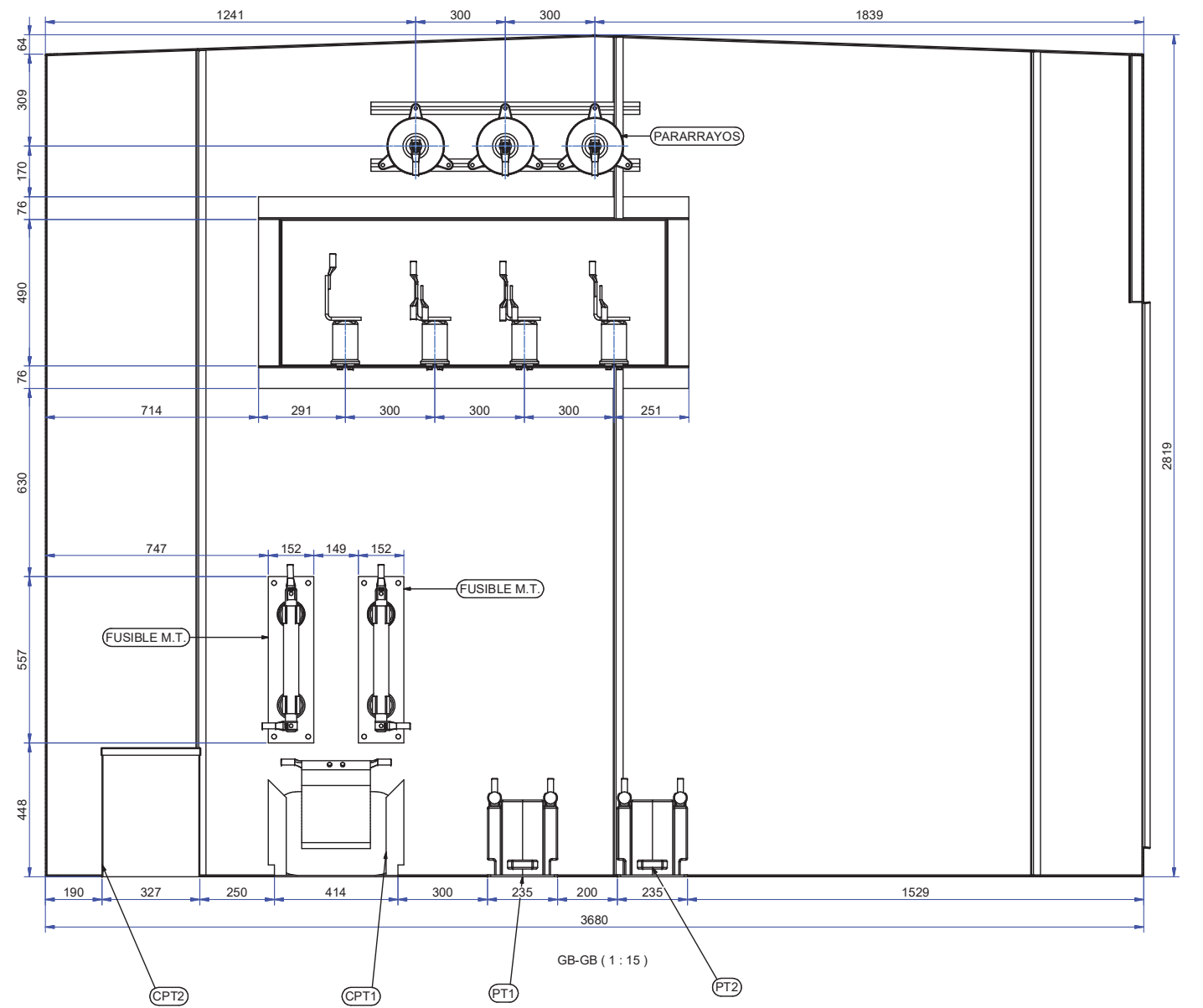
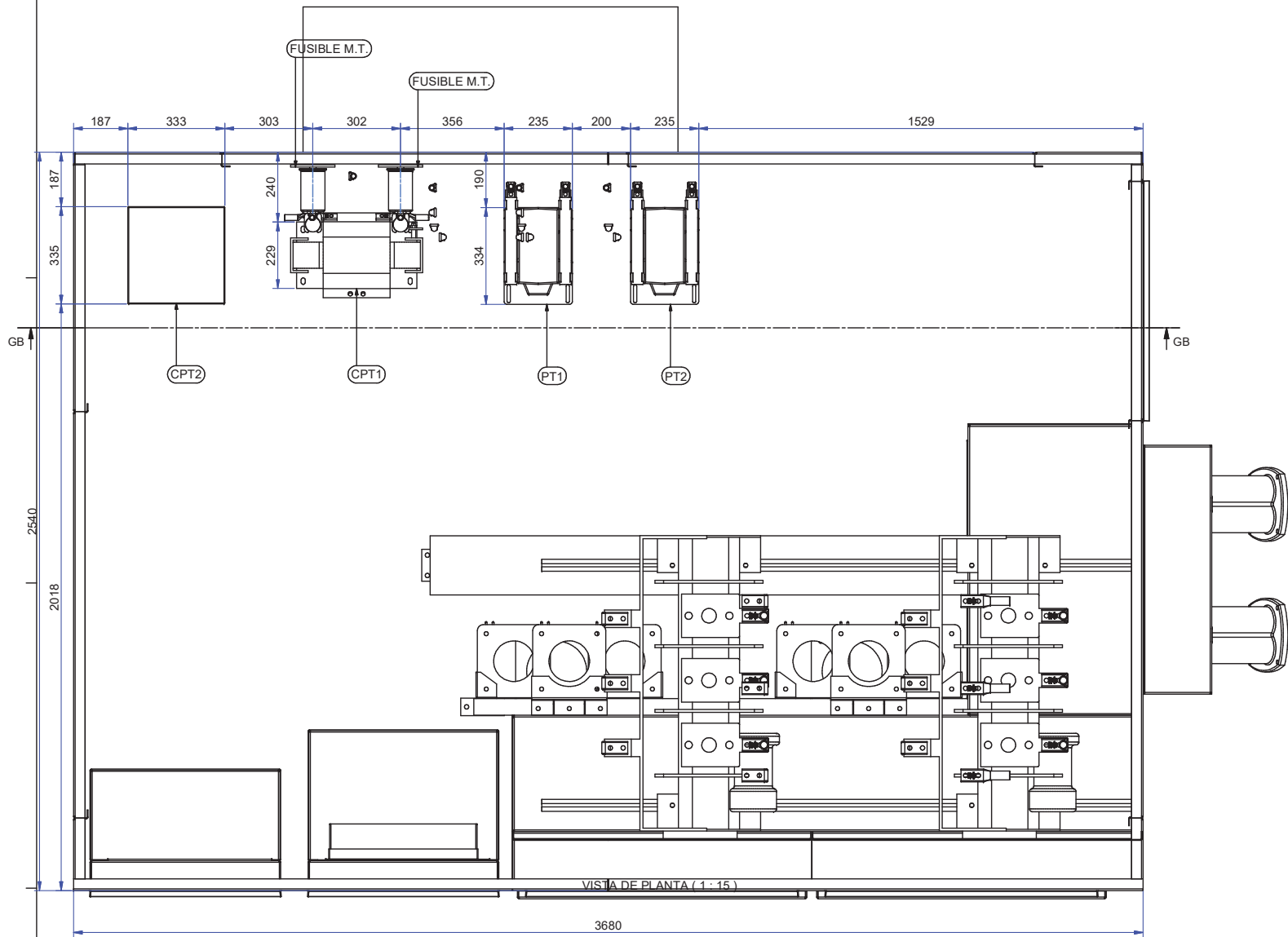
VISTA LATERAL (1 : 15)

				TOTAL				
4	2	TAPA-01	TAPA	PL LAC 3 x 475 x 1036			A-36	
3	1	PUERTA-03	PUERTA	PL LAC 3 x 883 x 1886			A-36	
2	2	PUERTA-02	PUERTA	PL LAC 3 x 716 x 1840			A-36	
1	2	PUERTA-01	PUERTA	PL LAC 3 x 996 x 1840			A-36	
Item	Cant.	Código	Denominación	Norma / Dimensión	Area m2	Peso Kg.	Material	Observación

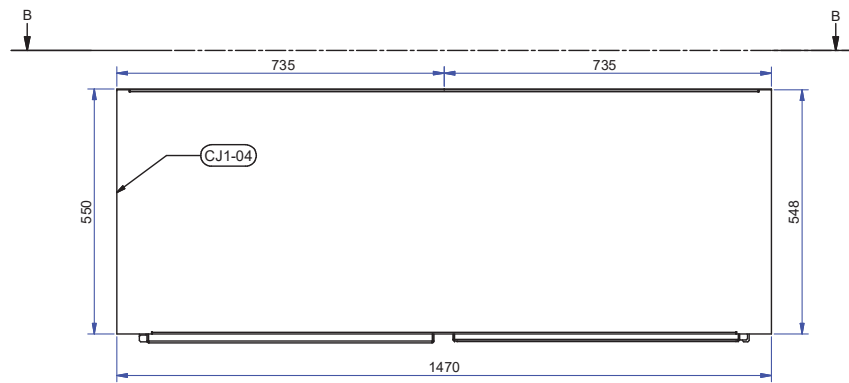
Observaciones Generales		Observaciones de plano		Fecha		Nombre			
Proyecto:		Plano nº: 1 de: 1		Dibujado		R.P.C.			
Palabras clave:		Formato: A2		Comprobado					
Empresa:		Coment:		Idem.s.normas					
Estado del proyecto: WorkInProgress				ESCALA		SUBESTACION MOVIL		Nº P.: 300	
Versión: V312				S/E		CASETA		Nº O.: 000	
								Nom.Ar.: 300.idw	



Observaciones Generales		Observaciones de plano			Fecha	Nombre	 eupla ESCUELA UNIVERSITARIA POLITECNICA La Almunia de D.ª Godina -ZARAGOZA-
Proyecto: Palabras clave: Empresa: Estado del proyecto: WorkInProgress Versión: V316	Plano nº: 1 de: 1 Formato: A2 Coment:	Dibujado	12/03/2015		R.P.C.		
		Comprobado					
		Idem.s.normas					
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S/E		CASETA MONTAJE DE EQUIPOS		Nº O.: 300 Nom.Ar.: 302.idw			

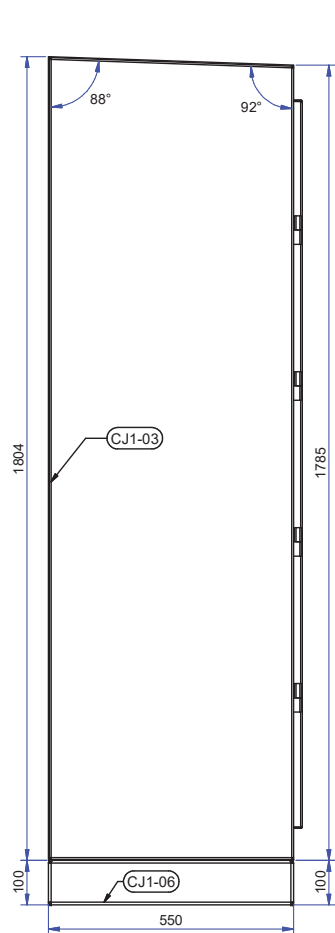


Observaciones Generales		Observaciones de plano		Dibujado	Fecha	Nombre	 eupla ESCUELA UNIVERSITARIA POLITECNICA La Alfranca de Dª Godina-ZARAGOZA-
Proyecto: Palabras clave: Empresa: Estado del proyecto: WorkInProgress Versión: V314		Plano nº: 1 de: 1 Formato: A2 Coment:		Comprobado	12/03/2015	R.P.C.	
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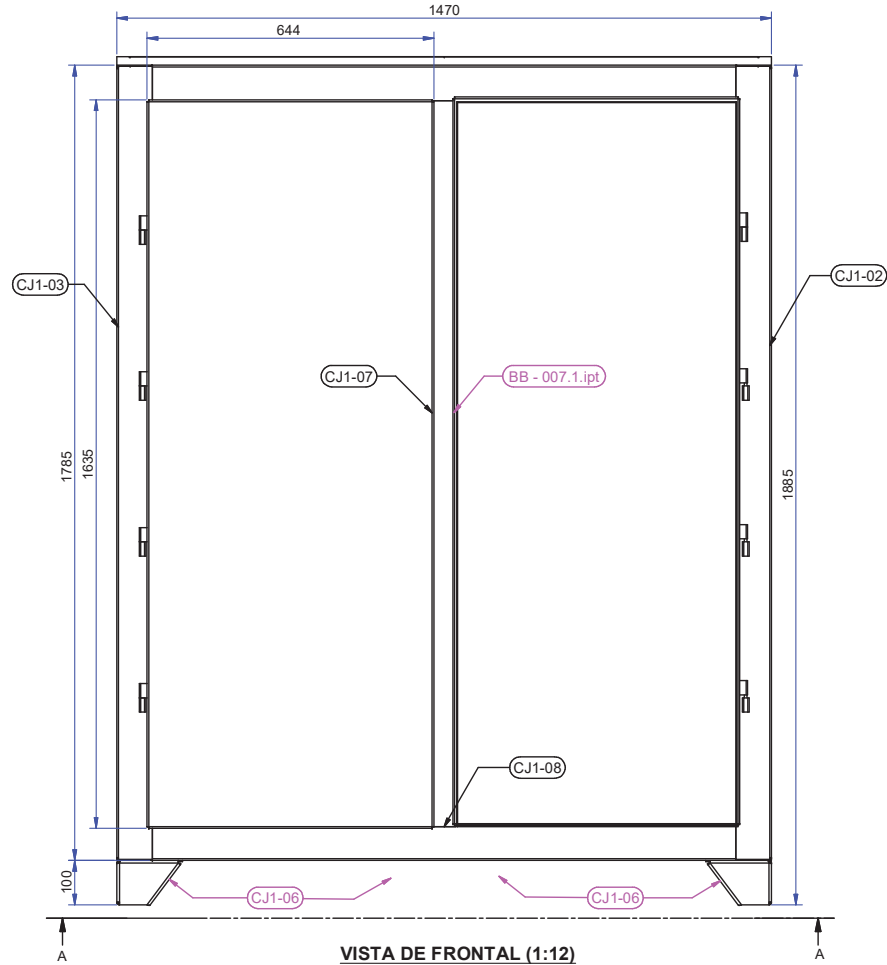


VISTA DE PLANTA (1:12)

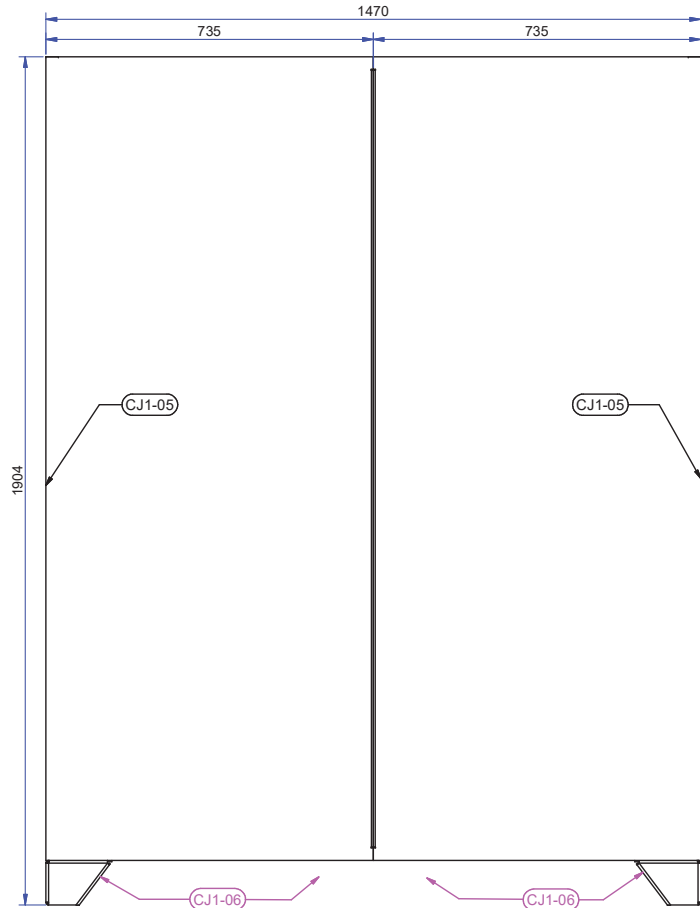
Lista de Materiales							
Item	Código	Cant.	Descripción	Dimensión	Peso	Material	Observación
1	CJ1-01	1	PL LAF 3.0mm	664X1470	15.04 kg	Steel	
2	CJ1-02	1		670X1852	19.16 kg	Steel	
3	CJ1-03	1		670X1852	19.15 kg	Steel	
4	CJ1-04	1		675X1470	15.21 kg	Steel	
5	CJ1-05	2			21.41 kg	Steel	
6	CJ1-06	2	PL LAF 4.0mm	184X854	3.21 kg	Steel	
7	CJ1-07	2		688X1679	17.72 kg	Steel	
8	CJ1-08	1		100X1629	2.34 kg	Steel	
9	Emka 1056-U34 - 01.ipt	4			0.01 kg	Generic	
10	Emka 1056-U34 - 02.ipt	4			0.01 kg	Generic	
11	Emka 1056-U34 - 01.1.ipt	4			0.01 kg	Generic	
12	BB - 007.1.ipt	1			17.72 kg	Steel	
13	Emka 1056-U34 - 02.1.ipt	4			0.01 kg	Generic	



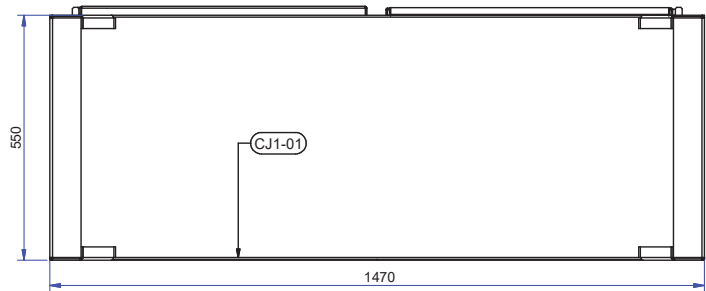
VISTA LAT.IZQ. (1:12)



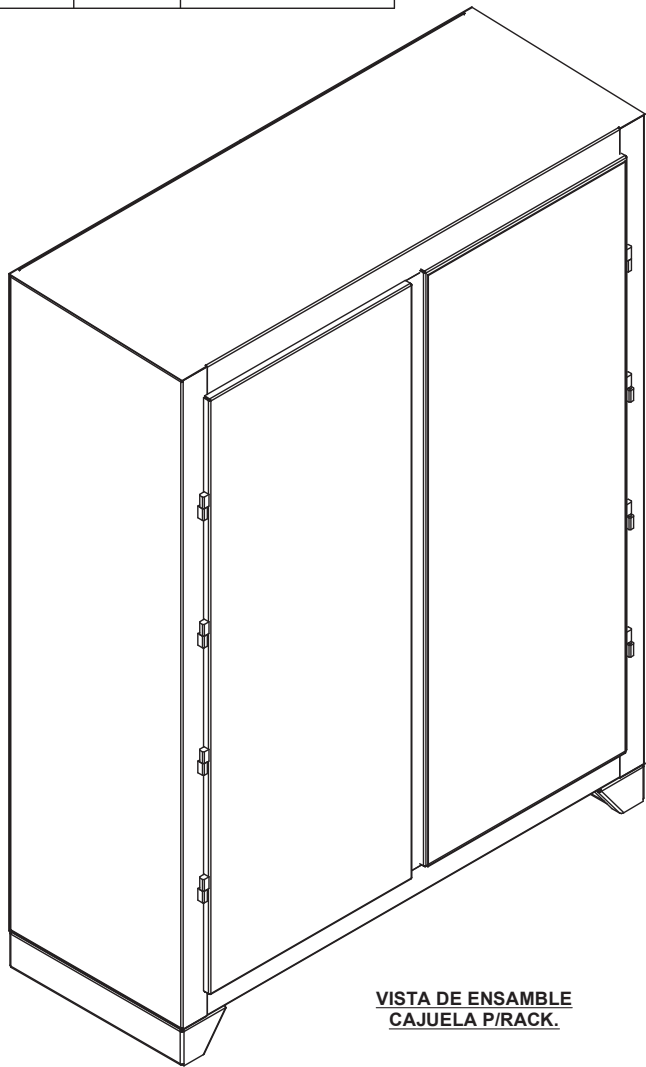
VISTA DE FRONTAL (1:12)



CORTE B-B (1:12)

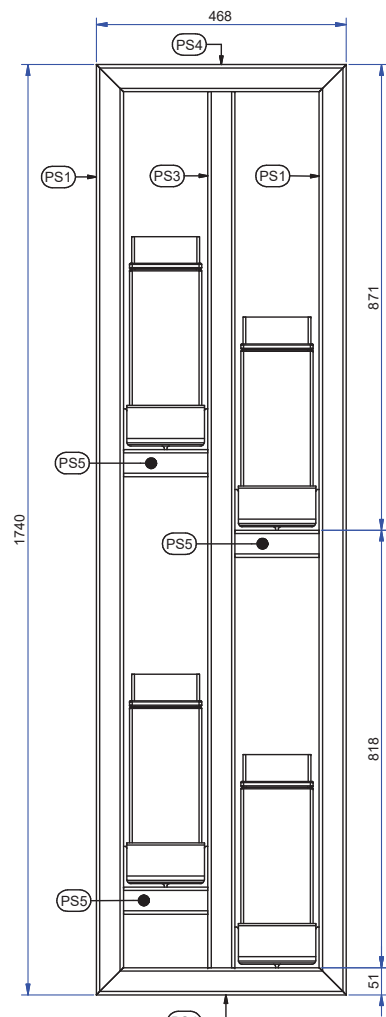


CORTE A-A (1:12)

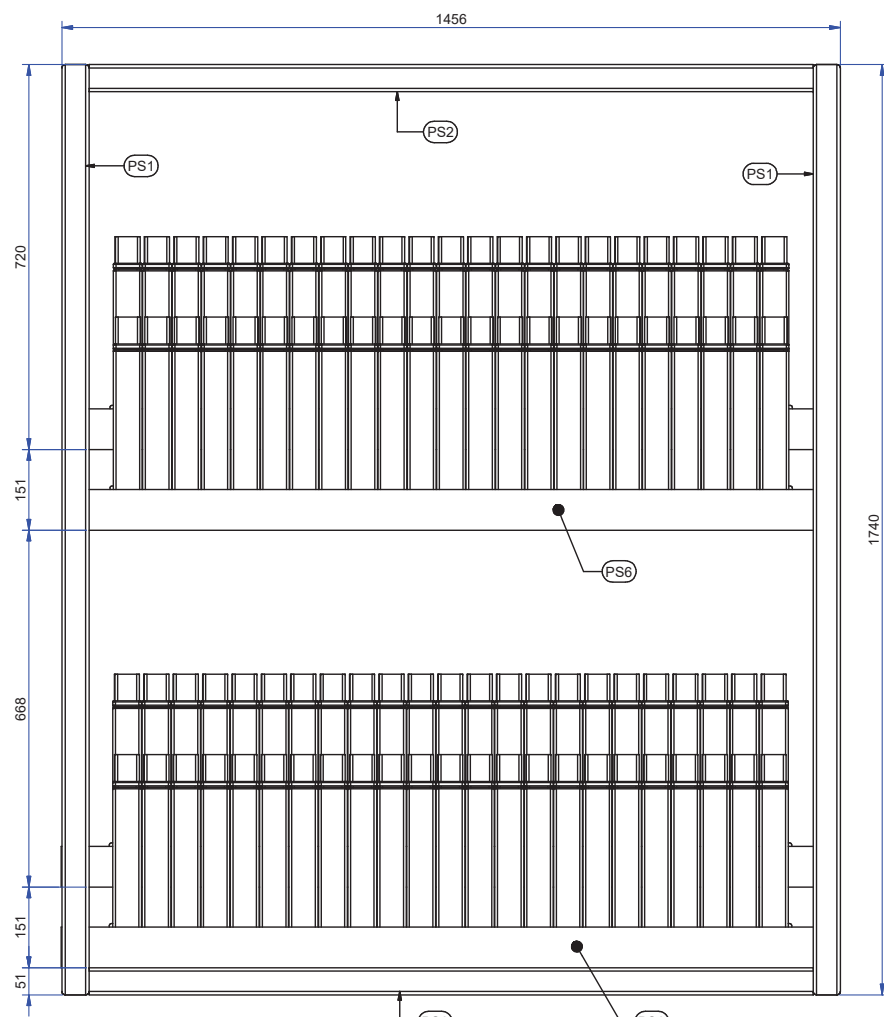


VISTA DE ENSAMBLE
CAJUELA P/RACK.

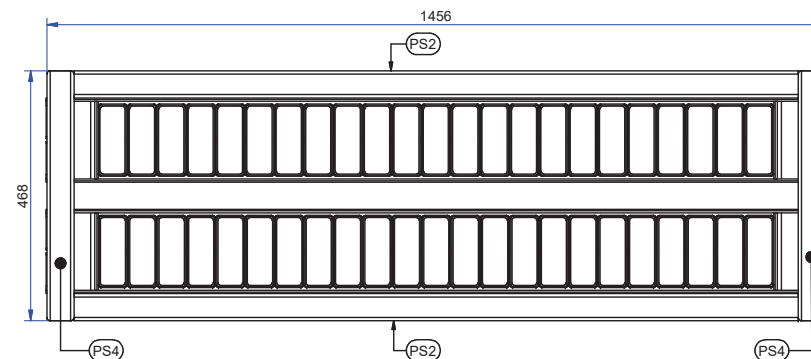
Observaciones Generales		Observaciones de plano		Dibujado		Fecha	Nombre		ESCUELA UNIVERSITARIA POLITECNICA La Almunia de D ^a Godina-ZARAGOZA-
Proyecto: Palabras clave: Empresa: Estado del proyecto: WorkInProgress Versión: V338		Plano nº: 1 de 1 Formato: A2 Coment:		Comprobado		12/03/2015	R.P.C.		
				Idem.s.normas					
				ESCALA		SUBESTACION MOVIL		Nº P.:	400
				S/E		CASETA DE BATERIAS		Nº O.:	000
						MONTAJE		Nom.Ar.:	400.idw



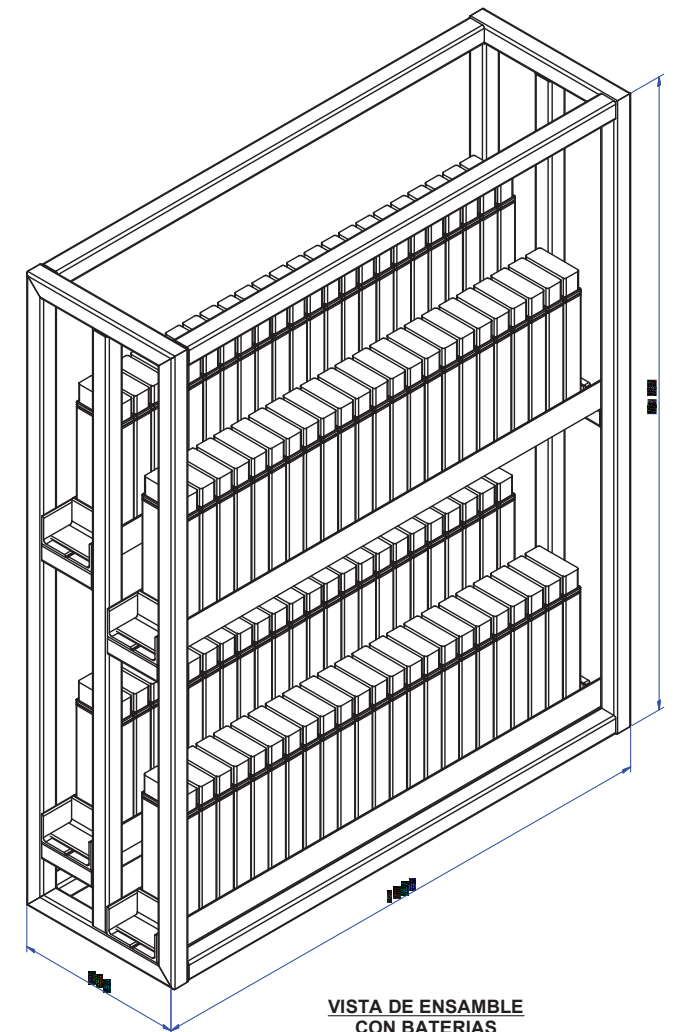
VISTA LAT. IZQ. (1:10)



VISTA DE FRONTAL (1:10)

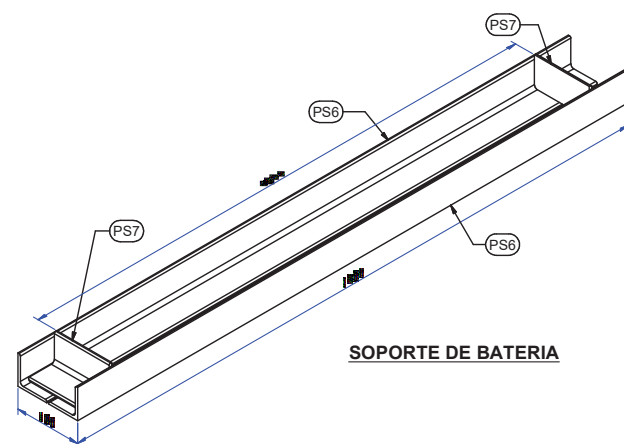


VISTA DE PLANTA (1:10)

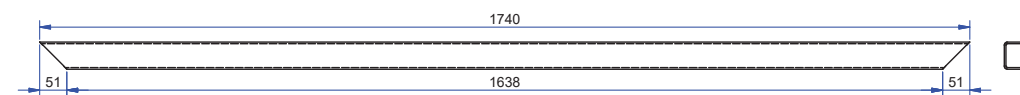


VISTA DE ENSAMBLE
CON BATERIAS

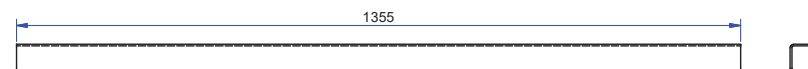
LISTA DE MATERIALES					
Item	Código	Cant.	Descripción	Longitud	Observación
1	PS1	04	TUBO CUD. 2X1/8"	1740	---
2	PS2	04	TUBO CUD. 2X1/8"	1355	---
3	PS3	02	TUBO CUD. 2X1/8"	1638	---
4	PS4	04	TUBO CUD. 2X1/8"	468	---
5	PS5	06	TUBO CUD. 2X1/8"	158	---
6	PS6	08	L 3X3X1/4"	1456	SOPORTE D/BATERIAS
7	PS7	08	L 3X3X1/4"	145	SOPORTE D/BATERIAS



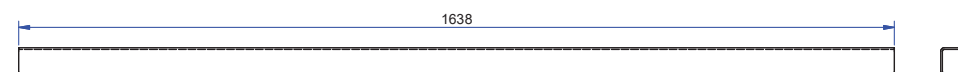
SOPORTE DE BATERIA



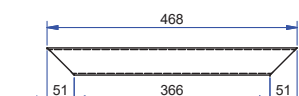
PS1 (1:10)



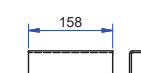
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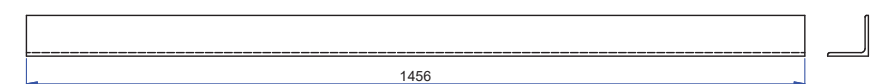
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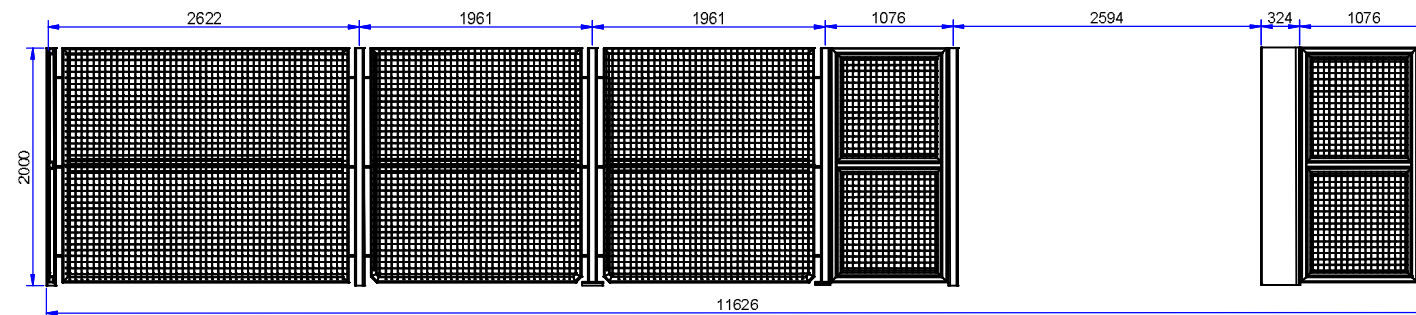
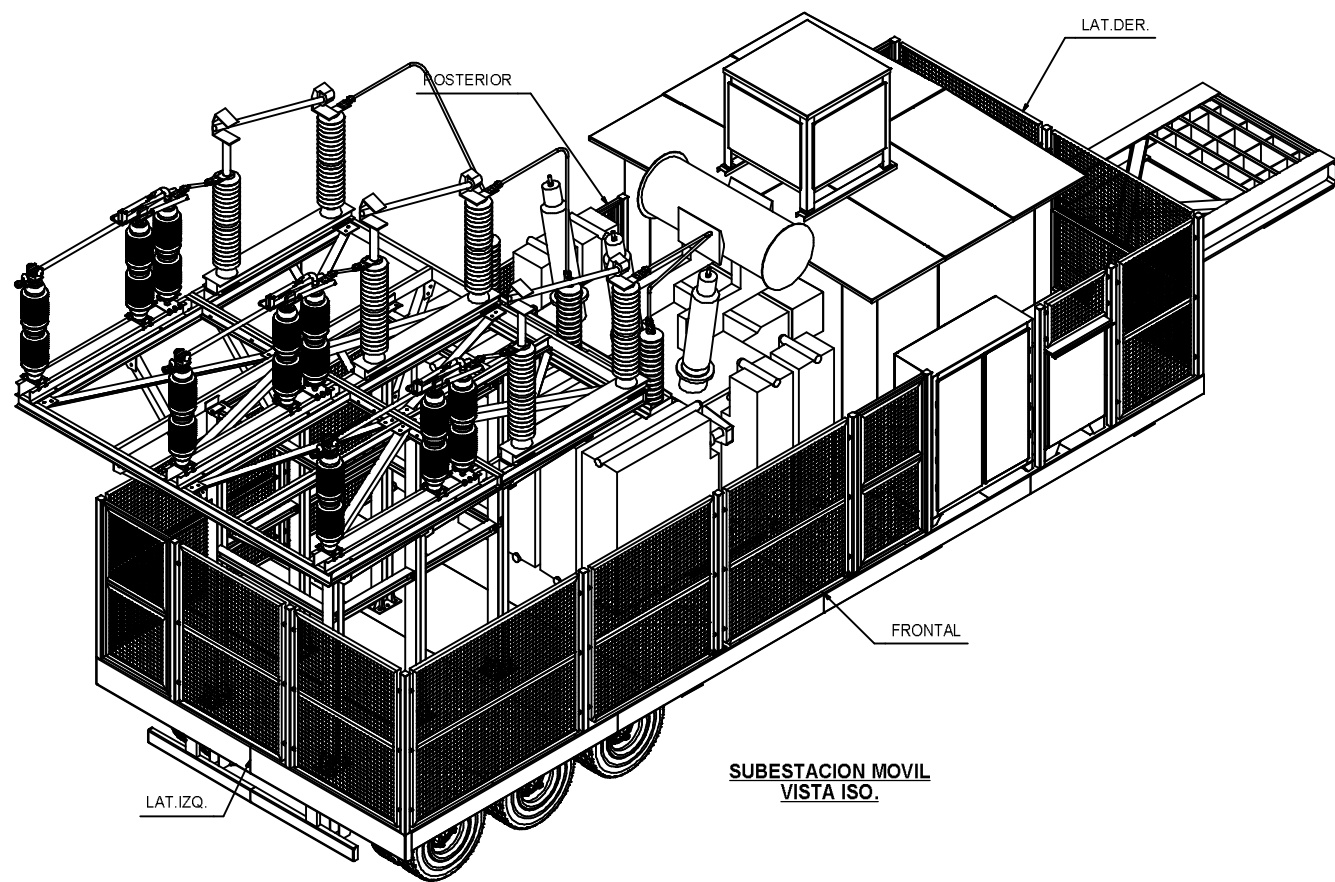


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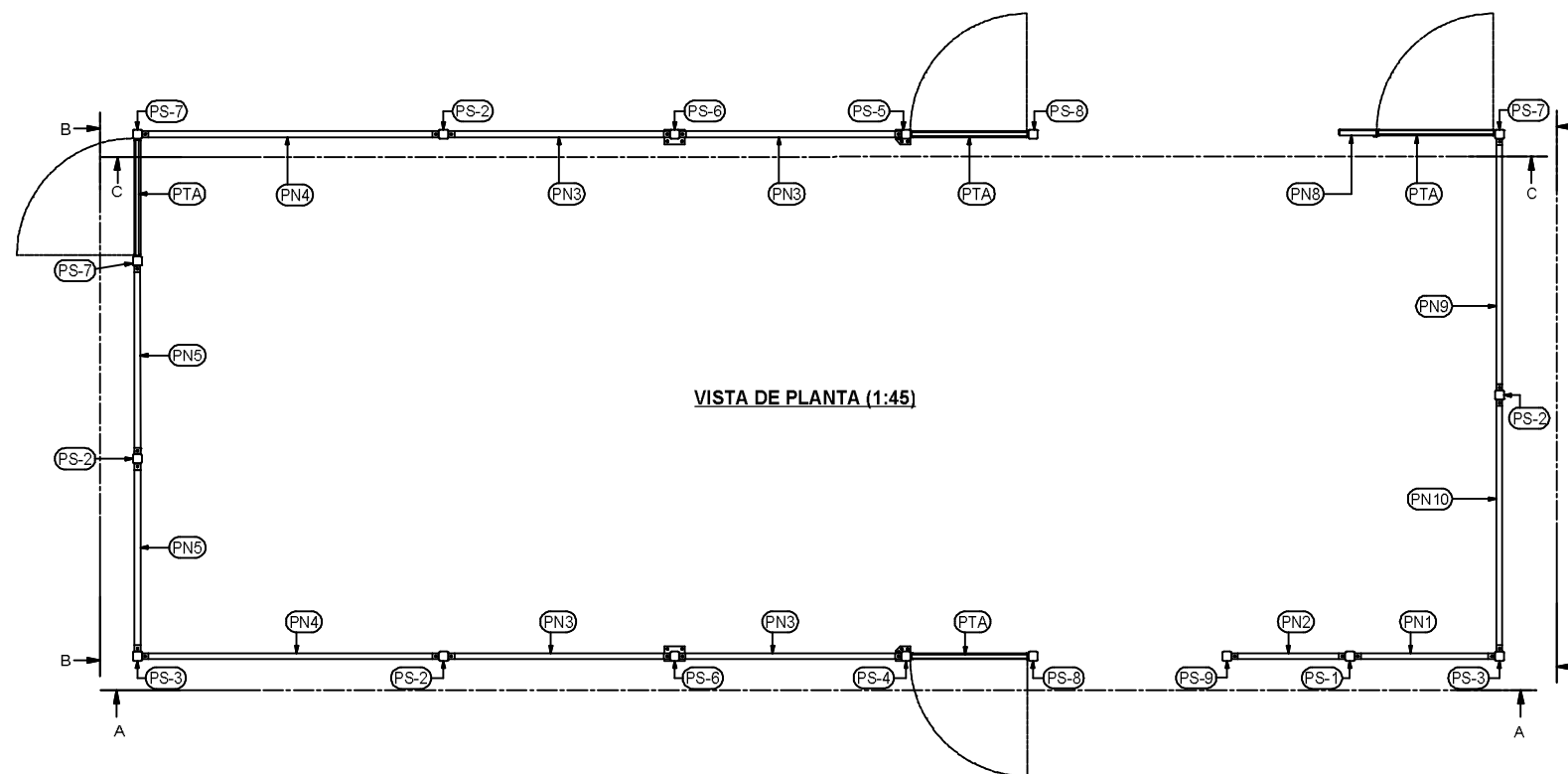


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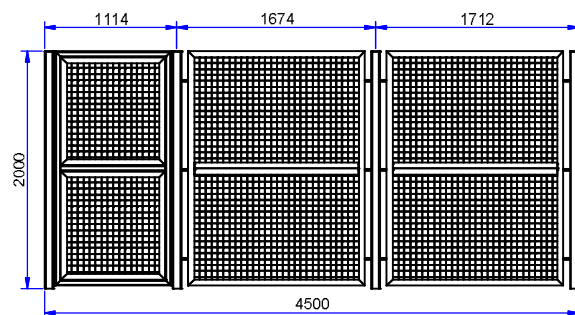
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Proyecto:		Plano nº: 1 de: 1		Dibujado	12/03/2015	R.P.C.	
Palabras clave:		Formato: A2		Comprobado			
Empresa:		Coment:		Idem.s.normas			
Estado del proyecto: WorkInProgress				ESCALA	SUBESTACION MOVIL		Nº P.: 401
Versión: V327				S/E	CASETA DE BATERIAS VISTA INTERNA		Nº O.: 400
							Nom.Ar.: 401.idw



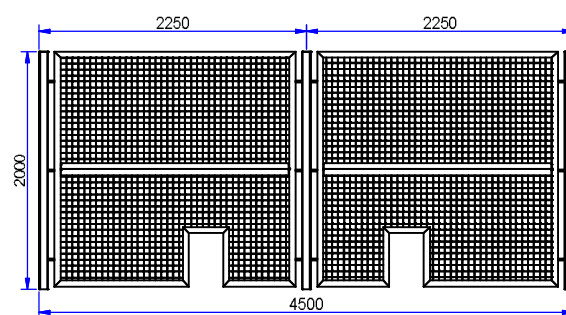
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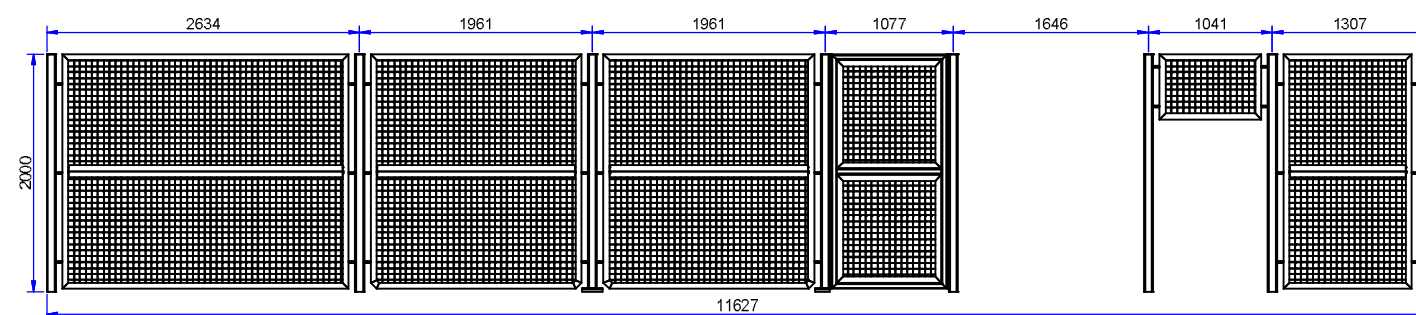
VISTA DE PLANTA (1:45)



CORTE B-B (1 : 45)



CORTE D-D (1 : 45)



CORTE A-A (1 : 45)

Observaciones Generales		Observaciones de plano		Dibujado	Fecha	Nombre	 eupla ESCUELA UNIVERSITARIA POLITECNICA La Almunia de D ^a Godina - ZARAGOZA
Proyecto:		Plano n°: 1 de: 1		Comprobado	12/03/2015	R.P.C.	
Palabras clave:		Formato: A2		Idem.s.normas			
Empresa:		Coment:		ESCALA		SUBESTACION MOVIL	N° P.: 500
Estado del proyecto: WorkInProgress				S/E		CERCO PERIMETRICO	N° O.: 000
Versión: V310							Nom.Ar.: 500.idw

Relación de documentos

☐ Memoria	94	páginas
☒ Planos	29	páginas
☐ Presupuesto	19	páginas
☐ Pliego de Condiciones.....	17	páginas
☐ Anexos	331	páginas

La Almunia, a 30 de noviembre de 2016

Firmado: Rony Moises Pinedo Cordova



Universidad
Zaragoza

**ESCUELA UNIVERSITARIA POLITÉCNICA
DE LA ALMUNIA DE DOÑA GODINA (ZARAGOZA)**

PRESUPUESTO

**DISEÑO SUBSTACIÓN ELECTRICA
MOVIL 66/12kV, 10MV**

Mobile Substation Design 66/12kV, 10MVA

424.13.131

Autor: Rony Moises Pinedo Cordova

Director: Carmelo Jose Borque Horna

Fecha: 30-11-2016

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PRESUPUESTO

Para la elaboración del presupuesto se realizó la clasificación según los siguientes sistemas:

Sistema eléctrico

- Equipamiento

Incluye todo el equipamiento primordial de la subestación eléctrica, principalmente equipamiento de alto y medio voltaje como transformador de potencia, interruptores conectores de salida, etc.

También incluye relés de medición y protección, transformadores de corriente y potencial.

- Sistema de fuerza

Incluye todos buses de barras, aisladores, cables de fuerza, terminales y terminaciones.

- Sistema de control

Incluye relés auxiliares de bajo voltaje, cables de control, pilotos indicadores, pulsadores, borneras, fusibles, interruptores, etc.

- Servicios auxiliares

Incluye iluminación, tomacorrientes, resistencias calefactoras y todo lo necesario para su instalación como tuberías, cajas de paso.

- Aterramiento

Incluye cable desnudo, barras de cobre, terminales, etc.

- Ferretería eléctrica

Demás artículos menores como etiquetas, pegatinas de señalización, etc.

Sistema mecánico

- Sistema tracto

Incluye ejes, ruedas, muelles, sistema de frenos, patas de apoyo, luces del camión, etc.

- Materiales de acero

Incluye vigas, tubos cuadrados, planchas y toda la perfilaría mecánica, también se incluye malla de cerco.

- Pintura

Incluye todos los tipos y colores de pintura, disolventes, etc.

- Arenado

Servicio con el cual se retira todo el óxido de la estructura y se deja habilitado para el proceso de pintura.

- Consumibles

Incluye, material de soldadura, brocas y demás herramientas, agentes abrasivos, adhesivos cintas, agentes de limpieza, lubricantes, grasas, etc.

Mano de obra

- Diseño

Incluye diseño eléctrico y mecánico, desarrollo de estudios, elaboración de planos de fabricación, así como las coordinaciones necesarias con el cliente y el área de fabricación.

- Fabricación

Incluye la totalidad de la fabricación tanto en estructura mecánica, instalación del sistema de tracto, como instalación de todos los sistemas eléctricos.

- Calidad y puesta en servicio

El coste del aseguramiento de la calidad garantiza el funcionamiento de la subestación, pruebas eléctricas, etc. También asegura el cumplimiento de las normativas de pintado, iluminación, distancias de seguridad, etc.

El coste de puesta en servicio se realiza en sitio para levantar las últimas observaciones brindadas por el cliente.

1. MEDICIONES Y MATERIALES

1.1. SISTEMA ELÉCTRICO

1.1.1. Equipamiento

Item	Descripción	Unid.	Cantidad
1	TRANSFORMADOR DE POTENCIA, TRIFÁSICO, 60HZ, INMERSO EN ACEITE MINERAL, 10MVA ONAN, 66/12KV, DYN1, CON CONMUTADOS SIN TENSIÓN EN EL LADO DE AT, OPERACIÓN HASTA 3800 MSNM	UND	1
2	SHELL DIALA S3 ZX-I (POTENTIAL TRANSFORMER OIL)	CIL	21
3	OUTDOOR AIRBREAK SWITCH, TYPE RL-C, SINGLE SIDE BREAK, THREE POLE, GROUP OPERATED, RATED 115 KV, 1200 AMP., 61 KA MOMENTARY, 550 KV BIL.	UND	3
4	TP-C2 MOTOR OPERATOR FOR OUTDOOR AIRBREAK SWITCH	UND	1
5	FUSE UNIT, S&C CATALOG NO. 468100R4, VOLTS:115000 AMPERES:100 SMD-2B FUSE UNIT, OUTDOOR TRANSMISSION TCC 153-1 (ESTIMATED WT AND DIMS: 30 LBS., 65X5X5 EACH)	UND	3
6	POWER FUSE, S&C CATALOG NO. 186428R3, VOLTS: 115000 AMPERES: 250 SMD-2B POWER FUSE, OUTDOOR TRANSMISSION VERTICAL MOUNTING 45-DEGREE OPENING INCLUDING CONNECTORS CAT. NO. 4741R2 (ESTIMATED WT AND DIMS	UND	3
7	NEUTRAL GROUNDING RESISTOR 6950 V L/N, 5 AMPS, 10 SEC. NEMA 3R ENCLOSURE PAINTED GRAY ANSI 61, 3800 MASL C/W 50-5 CT, ALUMINUM NAMEPLATE AND IPPC SKID	UND	1
8	VACUUM CIRCUIT BREAKER, 600A, 15KV WITH 120VAC MOTOR DRIVE, 240VDC SHUNT TRIP AND CAPACITOR TRIP SOLENOID, 120VAC UNDERVOLTAGE RELEASE GROUNDING BAR CAT. 20-2116-35G LINE POWER	PZA	4
9	RELE DE PROTECCION DE GENERADOR MOD. MIGII-P-A-5-5-E-0-0-HI-00 GE MULTILIN	UND	1
10	RELE DE ALIMENTADOR PRINCIPAL GE MODELO: 750-P5-G5-S5-HI-A20-R-E GE MULTILIN	PZA	2
11	INST. TRANS. CAT. Nº CPT5-95-5-722A CONTROL POWER TRANSFORMER 7200:120/240V, 60HZ, 15KV VOLTAGE CLASS, 95KVBIL, 5KVA @30DEG C AMBIENT, +/-7.5% TAPS ON PRIMARY	PZA	1
12	POTENTIAL TRANSFORMER FUSES PART NUMBER A720T3E-1 FERRAZ SHAWMUT	PZA	2
13	INST. TRANS. CAT. Nº PTW5-2-110-722FF INDOOR VOLTAGE TRANSFORMER, 7200:120V, 60HZ, 15KV, 110KV BIL, 0.3Z ACCURACY CLASS, TWO BUSHING FUSED PRIMARIES, 1500VA @30DEG C AMBIENT	PZA	2
14	INSULATION TRANSFORMER 120X240-120/240 VOLTS, 60 HZ 5KVA, NO TAPS CAT. SE120N5F FEDERAL PACIFIC	PZA	2
15	INSULATION TRANSFORMER 240X480-120/240 VOLTS	PZA	1

Item	Descripción	Unid.	Cantidad
16	CAT. N°17-0009 HIGH VOLTAGE GROUND MONITOR (115 VAC CONTROL VOLTAGE) LINE POWER	PZA	2
17	CAPACITOR TRIP DEVICE, CIT-10QA, FOR TRIPPING	PZA	2
18	MANUAL RESET LOR CAT. # 7803F MULTI CONTACT LOCK OUT RELAYS SERIES 24, COIL F, NOMINAL VOLTAGE 240VDC ELECTROSWITCH	PZA	2
19	BLOCKING AND TEST MODULE CAT. 515 GENERAL ELECTRIC	PZA	2
20	FLASHING LIGHT LED, 120-240VAC	PZA	2
21	FLASHING LIGHT, LED, 120-240	PZA	2
22	SURGE ARRESTER CAT. NUM. # ZSP0090-3231 POLYMER STATION CLASS RETED 90KV, MCOV 70 KV ENERGY ABSORPTION CAPABILITY 6.1 KJ/KV JOSLYN MANUFACTURING CO.	PZA	3
23	SURGE ARRESTER, CAT ZSP0009-1231 9KV, STATION CLASS JOSLYN MANUFACTURING	PZA	3
24	INST. TRANS. CAT. N° 137-601 CURRENT TRANSFORMER 600:5A, 50-400HZ, 600V VOLTAGE CLASS, 10KV BIL, C200 RELAY CLASS, 0.3B1.8 METERING CLASS @60HZ	PZA	6
25	INST. TRANS. CAT. N° 137-301 CURRENT TRANSFORMER 300:5A, 50-400HZ, 600V VOLTAGE CLASS, 10KV BIL, C200 RELAY CLASS, 0.3B1.8 METERING CLASS @60HZ	PZA	6
26	INST. TRANS. CAT. N° 141-500 CURRENT TRANSFORMER MODEL 141 CURRENT RATIO 50:5, RELAY CLASS C 10 WINDOW DIAMETER 8.13 FREQUENCY 50-400HZ 0.6KV, BIL 10KV FULL WAVE	PZA	2
27	SHUNT FLEXIBLE	PZA	4
28	4.5 INCH LONG SCALE SWITHBOARD METER AC AMMETER - RMS COMPENSATED SPEC. ANSI C 39.1(ANSI.FIXING/SCALING & CAPTIONS) STANDARD. ES. 0/5 AMPS AC SCALED. 0/600 AMPS AC FREQUENCY. 50/60 HERTZ. CAT :	PZA	2
29	4.5 INCH LONG SCALE SWITCHBOARD METER AC VOLTMETER - RMS COMPENSATED SPEC. ANSI C 39.1(ANSI.FIXING/SCALING & CAPTIONS) STANDARD. ES. 0/150 VOLTS AC SCALED. 0/9000 VOLTS AC FREQUENCY. 50/60 HERTZ.	PZA	2
30	VOLTMETER TRANSFER SWITCHES SERIES 24 CAT# 2404C 3 PHASE, PHASE TO PHASE HANDLE: ROUND, KNURLED ELECTROSWITCH	PZA	2
31	AMMETER TRANSFER SWITCHES SERIES 24 CAT# 2409C 3 PHASE, 3 CURRENT TRANSFORMER HANDLE: ROUND, KNURLED ENGRAVING AND JUMPERING AS SHOW ELECTROSWITCH	PZA	2
32	LARGE COMPACT FLOODLIGHT (WIRED)	PZA	2
33	CIRCUIT BREAKER - CONTROL SWITCH ORDER # SERIES 24 = 2441D DEPTH BEHIND PANEL: 2.4 HANDLE: PISTOL GRIP, SPRING RETURN ENGRAVING AND JUMPERING AS SHOW	PZA	2
34	RESISTENCIA CALEFACTORA MARCA: TEMPCO CAT.: EHT0008	PZA	2
35	25 KV COBLE COUPLER, 400 AMP	PZA	2

1.1.2. Sistema de fuerza

Item	Descripción	Unid.	Cantidad
1	15KV INSULATOR FOR BUS BAR	PZA	20
2	ANIXTER# : 5R-1011 TIGER BRAND 1 COND, 1/0 MCM, 5/15KV NON SHIELDED; JUMPER CABLE 90 DEGREE	FT	140
3	ANIXTER# : 5R-3501 TIGER BRAND 1 COND, 350 MCM, 5/15KV NON SHIELDED; JUMPER CABLE 90 DEGREE	FT	500
4	TERMINAL COMPRESION BARRIL LARGO CU ESTAÑADO 400MCM 2H 1/2 35KV	PZA	45
5	TERMINAL COMPRESION BARRIL LARGO CU ESTAÑADO 400MCM 2H 1/2 35KV	PZA	36

1.1.3. Sistema de control

Item	Descripción	Unid.	Cantidad
1	CONTACTOR, 3 POLOS, COIL 230VAC, NEMA SIZE 00 CAT CN15AN3BB CUTLER HAMMER	PZA	1
2	RELE AUXILIAR 120VAC 2NO + 2NC	PZA	4
3	RELE AUXILIAR 120VAC 2NO + 2NC	PZA	4
4	RELE AUXILIAR 120VAC 2NO + 2NC	PZA	1
5	PILOTO LUMINOSO COLOR AMBAR 120VAC	PZA	4
6	PILOTO LUMINOSO COLOR VERDE 120VAC	PZA	4
7	PILOTO LUMINOSO COLOR ROJO 120VAC	PZA	4
8	PILOTO LUMINOSO COLOR BLANCO 120V	PZA	4
9	PILOTO LUMINOSO COLOR AMBAR 120VAC	PZA	2
10	PILOTO LUMINOSO COLOR VERDE 120VAC	PZA	2
11	PILOTO LUMINOSO COLOR ROJO 120VAC	PZA	2
12	PILOTO LUMINOSO COLOR BLANCO 120V	PZA	2
13	MOMENTARY PUSHBUTTON OPERATORS NON ILUMINATED JUMBO MUSHROOM EMERGENCY STOP (RED)	PZA	6
14	MOMENTARY PUSHBUTTON OPERATORS NON ILUMINATED JUMBO MUSHROOM EMERGENCY STOP (RED)	PZA	2
15	SELECTOR DE 03 POSICIONES CON BLOQUE DE CONTACTO 2 NO	PZA	1
16	PLACA DE ACERO INOXIDABLE CALIDAD 304 DE:	PZA	2
17	PUSH BUTTON COLOR NEGRO C/ 1NO	PZA	4
18	PUSH BUTTON COLOR NEGRO C/ 1NO	PZA	2
19	BORNERA DE 12 PUNTOS 30 AMP	PZA	38
20	BORNERA DE 12 PUNTOS 30 AMP	PZA	30
21	INTERRUPTOR 2 X 30A, 110/220V	PZA	4
22	INTERRUPTOR 2 X 20A, 110/220V	PZA	2
23	INTERRUPTOR 2 X 15A, 110/220V	PZA	1

1.2. SISTEMA MECÁNICO

1.2.1. Sistema tracto

Item	Descripción	Unidad	Cantidad
1	CAMARA DE FRENO SENCILLA TIPO 30 PARA EJE IMT	PZA	6
2	EJE REDONDO 5" POR PARED 5/8" POR TROCHA 110", CON FRENO 16.5 X 7.0"	PZA	3
3	ENCHUFE DE PRUEBA HEXAPOLAR MARCA: G.E. MODELO: PK2-6129533G2	PZA	1
4	ENCHUFE DE PRUEBA TETRAPOLAR MARCA: G.E. MODELO: PK2-6129533G1	PZA	1
5	KING PIN DE 2" PARA PLANCHA DE 1/2	PZA	1
6	RUEDA 1000R20 D.HAPPINESS 18P DR908 TCF MIX	PZA	13
7	PATAS DE APOYO JOST C200T	JGO	6
8	RUEDA ARTILLERA PARA EJE IMT DE 20", 5 RAYOS, MARCA WEBB	PZA	6
9	SCREW ON HINGE	PZA	15
10	SUSPENSION MECANICA DE 3.1/2 X 1/2 PARA 3 EJES	JGO	1
11	RETEN DE GRASA PARA EJE IMT	PZA	6
12	RODAMIENTO EXTERNO (BEARING CONE OUTER) PARA EJE IMT	PZA	12
13	ARO ARTILLERO	PZA	13

1.2.2. Materiales de acero

Item	Descripción	Unidad	Cantidad
1	VIGA H 12"X26LBX40'	UNID	2
2	VIGA H 8X18LB/PIE X40'	UNID	1
3	VIGA H 8" X 18 LB/PIE X 6MTS	UNID	1
4	CANAL U 8" X 11.5 LB/PIE X 6 MTR ASTM A36	UNID	17
5	ANGULO 3" X 3" X 5/16" X 6MTR	UNID	15
6	PLE4.5X1.2X2.4 (Plancha Estriada)	UNID	6
7	CANAL U 6" X 8.2LB/PIE X 20'	PZA	2
8	ANGULO 1.1/2 X 1.1/2 X 3/16 X 6MTS	PZA	30
9	PLATINA DE FIERRO DE 1" X1/8" X6MTR ASTM A36	PZA	1

Item	Descripción	Unidad	Cantidad
10	TUBO CUADRADO 3"X5/32"X20' ASTM A36	UNID	10
11	TUBO CUADRADO 2 X 1/8 X 6MTR	UNID	2
12	TUBO ESTRUCTURAL 1x1/8/6m	UNID	3
13	MALLA ELECTROSOLDADA DE 2 X 2 EN ALAMBRE Nº8 (4.19MM) DE 1765 X 2804 GALVANIZADA	UND	21
14	PLETINA 10MM X 40MM	MTR	19,5
15	PLANCHA GALVANIZADA DE 2.0 X 1200 X 3030MM	PZA	22
16	PLANCHA GALVANIZADA DE 2.0 X 1200 X 3030MM	PZA	4
17	PLANCHA GALVANIZADA DE 2.0 X 1200 X 3030MM	PZA	8

2. CUADRO DE PRECIOS DESCOMPUESTOS

2.1. SISTEMA ELÉCTRICO

2.1.1. Equipamiento

Item	Descripción	Marca	Código	Unid.	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	TRANSFORMADOR DE POTENCIA, TRIFÁSICO, 60HZ, INMERSO EN ACEITE MINERAL, 10MVA ONAN, 66/12KV, DYN1, CON CONMUTADOS SIN TENSIÓN EN EL LADO DE AT, OPERACIÓN HASTA 3800 MSNM	WEG	WEG_10MVA_SPL	UND	1	172.774,39	172.774,39
2	SHELL DIALA S3 ZX-I (POTENTIAL TRANSFORMER OIL)	SHELL	S3-ZX-I	CIL	21	929,98	19.529,60
3	OUTDOOR AIRBREAK SWITCH, TYPE RL-C, SINGLE SIDE BREAK, THREE POLE, GROUP OPERATED, RATED 115 KV, 1200 AMP., 61 KA MOMENTARY, 550 KV BIL.	CLEVELAND & PRICE	C06B036G02	UND	3	7.165,59	21.496,77
4	TP-C2 MOTOR OPERATOR FOR OUTDOOR AIRBREAK SWITCH	CLEVELAND & PRICE	C11A008G05	UND	1	1.136,67	1.136,67
5	FUSE UNIT, S&C CATALOG NO. 468100R4, VOLTS:115000 AMPERES:100 SMD-2B FUSE UNIT, OUTDOOR TRANSMISSION TCC 153-1 (ESTIMATED WT AND DIMS: 30 LBS., 65X5X5 EACH)	S & C ELECTRIC	468100R4	UND	3	2.234,25	6.702,74
6	POWER FUSE, S&C CATALOG NO. 186428R3, VOLTS: 115000 AMPERES: 250 SMD-2B POWER FUSE, OUTDOOR TRANSMISSION VERTICAL MOUNTING 45-DEGREE OPENING INCLUDING CONNECTORS CAT. NO. 4741R2 (ESTIMATED WT AND DIMS	S & C ELECTRIC	186428R3	UND	3	6.173,77	18.521,32
7	NEUTRAL GROUNDING RESISTOR 6950 V L/N, 5 AMPS, 10 SEC. NEMA 3R ENCLOSURE PAINTED GRAY ANSI 61, 3800 MASL C/W 50-5 CT, ALUMINUM NAMEPLATE AND IPPC SKID	POST GLOVER	NGR6950-5-10S	UND	1	3.880,15	3.880,15
8	VACUUM CIRCUIT BREAKER, 600A, 15KV WITH 120VAC MOTOR DRIVE, 240VDC SHUNT TRIP AND CAPACITOR TRIP SOLENOID, 120VAC UNDERVOLTAGE RELEASE GROUNDING BAR CAT. 20-2116-35G LINE POWER	LINE POWER	20-2116-35G	PZA	4	8.907,38	35.629,54

Item	Descripción	Marca	Código	Unid.	Cant.	Costo Unit (EUR)	Sub Total (EUR)
9	RELE DE PROTECCION DE GENERADOR MOD. MIGII-P-A-5-5-E-0-0-HI-00 GE MULTILIN	GENERAL ELECTRIC	MIGIIPA55E00HI00	UND	1	1.454,94	1.454,94
10	RELE DE ALIMENTADOR PRINCIPAL GE MODELO: 750-P5-G5-S5-HI-A20-R-E GE MULTILIN	GENERAL ELECTRIC	750P5G5S5HIA20R	PZA	2	3.901,06	7.802,13
11	INST. TRANS. CAT. Nº CPT5-95-5-722A CONTROL POWER TRANSFORMER 7200:120/240V, 60HZ, 15KV VOLTAGE CLASS, 95KVBIL, 5KVA @30DEG C AMBIENT, +/-7.5% TAPS ON PRIMARY	INSTRUMENT TRANSFORMERS, INC	CPT5-95-5-722A	PZA	1	2.087,74	2.087,74
12	POTENTIAL TRANSFORMER FUSES PART NUMBER A720T3E-1 FERRAZ SHAWMUT	FERRAZ SHAW	A720T3E-1	PZA	2	45,07	90,13
13	INST. TRANS. CAT. Nº PTW5-2-110-722FF INDOOR VOLTAGE TRANSFORMER, 7200:120V, 60HZ, 15KV, 110KV BIL, 0.3Z ACCURACY CLASS, TWO BUSHING FUSED PRIMARIES, 1500VA @30DEG C AMBIENT	INSTRUMENT TRANSFORMERS, INC	PTW5-2-110-722F	PZA	2	1.170,61	2.341,22
14	INSULATION TRANSFORMER 120X240-120/240 VOLTS, 60 HZ 5KVA, NO TAPS CAT. SE120N5F FEDERAL PACIFIC	FEDERAL PACIFIC COMP.	SE120N5F	PZA	2	341,27	682,53
15	INSULATION TRANSFORMER 240X480-120/240 VOLTS	FEDERAL PACIFIC COMP.	SE2N5FS	PZA	1	230,59	230,59
16	CAT. Nº17-0009 HIGH VOLTAGE GROUND MONITOR (115 VAC CONTROL VOLTAGE) LINE POWER	LINE POWER	17-0009	PZA	2	1.109,48	2.218,97
17	CAPACITOR TRIP DEVICE, CIT-10QA, FOR TRIPPING	TOSHIBA	CIT-10QA	PZA	2	716,10	1.432,21
18	MANUAL RESET LOR CAT. # 7803F MULTI CONTACT LOCK OUT RELAYS SERIES 24, COIL F, NOMINAL VOLTAGE 240VDC ELECTROSWITCH	ELECTROSWITCH	7803F	PZA	2	394,29	788,58
19	BLOCKING AND TEST MODULE CAT. 515 GENERAL ELECTRIC	G.E. MULTILIN/CANADA	515	PZA	2	354,64	709,28
20	FLASHING LIGHT LED, 120-240VAC	FEDERAL SIGNAL	191XL-120-240G	PZA	2	342,86	685,71
21	FLASHING LIGHT, LED, 120-240	FEDERAL SIGNAL	191XL-120-240R	PZA	2	257,81	515,61
22	SURGE ARRESTER CAT. NUM. # ZSP0090-3231 POLYMER STATION CLASS RETED 90KV, MCOV 70 KV ENERGY ABSORPTION CAPABILITY 6.1 KJ/KV JOSLYN MANUFACTURING CO.	JOSLYN MANUFACTURING CO.	ZSP0090-3231		3	558,56	1.675,68
23	SURGE ARRESTER, CAT ZSP0009-1231 9KV, STATION CLASS JOSLYN MANUFACTURING	JOSLYN MANUFACTURING CO.	ZSP0009-1231	PZA	3	248,97	746,90

Cuadro de precios descompuestos

Item	Descripción	Marca	Código	Unid.	Cant.	Costo Unit (EUR)	Sub Total (EUR)
24	INST. TRANS. CAT. Nº 137-601 CURRENT TRANSFORMER 600:5A, 50-400HZ, 600V VOLTAGE CLASS, 10KV BIL, C200 RELAY CLASS, 0.3B1.8 METERING CLASS @60HZ	INSTRUMENT TRANSFORMERS, INC	137-601	PZA	6	217,77	1.306,61
25	INST. TRANS. CAT. Nº 137-301 CURRENT TRANSFORMER 300:5A, 50-400HZ, 600V VOLTAGE CLASS, 10KV BIL, C200 RELAY CLASS, 0.3B1.8 METERING CLASS @60HZ	INSTRUMENT TRANSFORMERS, INC	137-301	PZA	6	243,84	1.463,04
26	INST. TRANS. CAT. Nº 141-500 CURRENT TRANSFORMER MODEL 141 CURRENT RATIO 50:5, RELAY CLASS C 10 WINDOW DIAMETER 8.13 FREQUENCY 50- 400HZ 0.6KV, BIL 10KV FULL WAVE	INSTRUMENT TRANSFORMERS, INC	141-500	PZA	2	222,79	445,58
27	SHUNT FLEXIBLE	WATTEREDGE	1284-4	PZA	4	143,22	572,88
28	4.5 INCH LONG SCALE SWITHBOARD METER AC AMMETER - RMS COMPENSATED SPEC. ANSI C 39.1(ANSI.FIXING/SCALING & CAPTIONS) STANDARD. ES. 0/5 AMPS AC SCALED. 0/600 AMPS AC FREQUENCY. 50/60 HERTZ. CAT :	CROMPTON	007-05FA-LSSJC7	PZA	2	139,78	279,57
29	4.5 INCH LONG SCALE SWITCHBOARD METER AC VOLTMETER - RMS COMPENSATED SPEC. ANSI C 39.1(ANSI.FIXING/SCALING & CAPTIONS) STANDARD. ES. 0/150 VOLTS AC SCALED. 0/9000 VOLTS AC FREQUENCY. 50/60 HERTZ.	CROMPTON	007-05GA-PZUYC7	PZA	2	139,78	279,57
30	VOLTMETER TRANSFER SWITCHES SERIES 24 CAT# 2404C 3 PHASE, PHASE TO PHASE HANDLE: ROUND, KNURLED ELECTROSWITCH	ELECTROSWITCH	2404C	PZA	2	134,47	268,95
31	AMMETER TRANSFER SWITCHES SERIES 24 CAT# 2409C 3 PHASE, 3 CURRENT TRANSFORMER HANDLE: ROUND, KNURLED ENGRAVING AND JUMPERING AS SHOW ELECTROSWITCH	ELECTROSWITCH	2409C	PZA	2	113,53	227,06
32	LARGE COMPACT FLOODLIGHT (WIRED)	JADEMAR	JFL400MHQVC-PK	PZA	2	105,03	210,06
33	CIRCUIT BREAKER - CONTROL SWITCH ORDER # SERIES 24 = 2441D DEPTH BEHIND PANEL: 2.4 HANDLE: PISTOL GRIP, SPRING RETURN ENGRAVING AND JUMPERING AS SHOW	ELECTROSWITCH	2441D	PZA	2	85,41	170,81

Item	Descripción	Marca	Código	Unid.	Cant.	Costo Unit (EUR)	Sub Total (EUR)
34	RESISTENCIA CALEFACTORA MARCA: TEMPCO CAT.: EHT0008	TEMPCO	EHT00008	PZA	2	64,26	128,53
35	25 KV COBLE COUPLER, 400 AMP	PATTON & COOKE	C250F2001Y	PZA	2	3.748,30	7.496,60
							<u>315.982,67</u>

2.1.2. Sistema de fuerza

Item	Descripción	Marca	Código	Unid.	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	15KV INSULATOR FOR BUS BAR	PENN COMPRESSION	AR5420-16A	PZA	20	16,53	330,64
2	ANIXTER# : 5R-1011 TIGER BRAND 1 COND, 1/0 MCM, 5/15KV NON SHIELDED; JUMPER CABLE 90 DEGREE	ANIXTER	5R-1011	FT	140	4,40	616,10
3	ANIXTER# : 5R-3501 TIGER BRAND 1 COND, 350 MCM, 5/15KV NON SHIELDED; JUMPER CABLE 90 DEGREE	ANIXTER	5R-3501	FT	500	12,55	6.272,96
4	TERMINAL COMPRESION BARRIL LARGO CU ESTAÑADO 400MCM 2H 1/2 35KV	BURNDY	YA32-2N	PZA	45	9,27	416,98
5	TERMINAL COMPRESION BARRIL LARGO CU ESTAÑADO 400MCM 2H 1/2 35KV	BURNDY	YA32-2N	PZA	36	9,27	333,58
							<u>7.970,25</u>

2.1.3. Sistema de control

Item	Descripción	Marca	Código	Unid.	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	CONTACTOR, 3 POLOS, COIL 230VAC, NEMA SIZE 00 CAT CN15AN3BB CUTLER HAMMER	CUTLER HAMMER	CN15AN3BB	PZA	1	43,04	43,04
2	RELE AUXILIAR 120VAC 2NO + 2NC	CROMPTON INSTRUMENTS	D15CR22AB	PZA	4	23,62	94,50
3	RELE AUXILIAR 120VAC 2NO + 2NC	CROMPTON INSTRUMENTS	D15CR22AB	PZA	4	23,62	94,50



Item	Descripción	Marca	Código	Unid.	Cant.	Costo Unit (EUR)	Sub Total (EUR)
4	RELE AUXILIAR 120VAC 2NO + 2NC	CROMPTON INSTRUMENTS	D15CR22AB	PZA	1	23,62	23,62
5	PILOTO LUMINOSO COLOR AMBAR 120VAC	CUTLER HAMMER	10250T197LAP2A	PZA	4	23,56	94,24
6	PILOTO LUMINOSO COLOR VERDE 120VAC	CUTLER HAMMER	10250T197LGP2A	PZA	4	23,56	94,24
7	PILOTO LUMINOSO COLOR ROJO 120VAC	CUTLER HAMMER	10250T197LRP2A	PZA	4	23,56	94,24
8	PILOTO LUMINOSO COLOR BLANCO 120V	CUTLER HAMMER	10250T197LWP2A	PZA	4	23,56	94,24
9	PILOTO LUMINOSO COLOR AMBAR 120VAC	CUTLER HAMMER	10250T197LAP2A	PZA	2	23,56	47,12
10	PILOTO LUMINOSO COLOR VERDE 120VAC	CUTLER HAMMER	10250T197LGP2A	PZA	2	23,56	47,12
11	PILOTO LUMINOSO COLOR ROJO 120VAC	CUTLER HAMMER	10250T197LRP2A	PZA	2	23,56	47,12
12	PILOTO LUMINOSO COLOR BLANCO 120V	CUTLER HAMMER	10250T197LWP2A	PZA	2	23,56	47,12
13	MOMENTARY PUSHBUTTON OPERATORS NON ILUMINATED JUMBO MUSHROOM EMERGENCY STOP (RED)	CUTLER HAMMER	10250T29	PZA	6	20,02	120,14
14	MOMENTARY PUSHBUTTON OPERATORS NON ILUMINATED JUMBO MUSHROOM EMERGENCY STOP (RED)	CUTLER HAMMER	10250T29	PZA	2	20,02	40,05
15	SELECTOR DE 03 POSICIONES CON BLOQUE DE CONTACTO 2 NO	CUTLER HAMMER	10250T21KB	PZA	1	14,73	14,73
16	PLACA DE ACERO INOXIDABLE CALIDAD 304 DE:	PLACOR	PL-DI-SH01080	PZA	2	11,93	23,86
17	PUSH BUTTON COLOR NEGRO C/ 1NO	CUTLER HAMMER	10250T23B	PZA	4	9,07	36,26
18	PUSH BUTTON COLOR NEGRO C/ 1NO	CUTLER HAMMER	10250T23B	PZA	2	9,07	18,13
19	BORNERA DE 12 PUNTOS 30 AMP	GENERAL ELECTRIC	CR151B2	PZA	38	5,68	215,97
20	BORNERA DE 12 PUNTOS 30 AMP	GENERAL ELECTRIC	CR151B2	PZA	30	5,68	170,50
21	INTERRUPTOR 2 X 30A, 110/220V	CUTLER HAMMER	QC2030	PZA	4	4,87	19,50
22	INTERRUPTOR 2 X 20A, 110/220V	CUTLER HAMMER	QC2020	PZA	2	4,87	9,75
23	INTERRUPTOR 2 X 15A, 110/220V	CUTLER HAMMER	QC2015	PZA	1	4,87	4,87

1.494,89

2.1.4. Servicios auxiliares

Item	Descripción	Marca	Código	Unid.	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	15 AMP, 120/277 VOLT, TOGGLE 3-WAY AC QUIET SWITCH, COMMERCIAL GRADE, GROUNDING, BACK & SIDE WIRED, - IVORY			UNID	3	5,05	16,65
2	1-GANG TOGGLE DEVICE SWITCH WALLPLATE, STANDARD SIZE, 430 STAINLESS STEEL, DEVICE MOUNT, - STAINLESS STEEL			UNID	3	1,06	3,51
3	CAJA RECTANGULAR DE 3/4 T/PESADO LEVITON/EAGLE/COOPER SALIDAS DE ACERO			UNID	13	3,64	52,00
4	CONTRA TUERCA BUSHING 3/4"			UNID	39	0,36	15,60
5	CONECTOR BUSHING 3/4"			UNID	16	0,32	5,60
6	NUTS 228 WITH SPRING FOR CHANNEL B22, B24,B26,B32 B-LINE Ø 3/8			UNID	100	0,91	100,00
7	PERNO HEXAGONAL GRADO 5 3/8 X 1 ZINCADO			UNID	20	0,06	1,40
8	ARANDELA PLANA ZINCADA 3/8			UNID	40	0,02	0,80
9	1-GANG DUPLEX DEVICE RECEPTACLE WALLPLATE, WEATHER-RESISTANT, DIE-CAST ZINC, DEVICE MOUNT, HORIZONTAL 2-SELF CLOSING LIDS - GRAY			UNID	10	3,25	35,70
10	RECEPTABLE DUPLEX, 20A 250VAC, NEMA 6-20R STEEL STRAMP, INDUSTRIAL GRADE CAT 5462-I LEVITON			UNID	10	7,25	79,70
11	CAJA CONDULET 3/4" TIPO T			UNID	10	2,18	24,00
12	CAJA CONDULET 3/4" TIPO L			UNID	10	2,18	24,00
13	CAJA CONDULET 3/4" TIPO LB PESADO			UNID	10	4,59	50,50
14	TUBO CONDUIT RGS DE 3/4" X3 MTS DIAMETRO EXTERIOR PULG: 1.050" ESPESOR DE PARED PULG: 0.107 PESO KG: 5.173 MARCA: COLMENA			UNID	60	11,14	735,00
15	LUMINARIA EXTERIOR			UNID	8	136,40	1.200,00
16	LUMINARIA INTERIOR			UNID	10	22,51	247,50
17	LUMINARIA DE EMERGENCIA			UNID	5	95,48	525,00
18	FIN DE CARRERA CON RESORTE , 1NO - 1NC 3SE3120-1RA			UNID	1	48,99	53,87

Item	Descripción	Marca	Código	Unid.	Cant.	Costo Unit (EUR)	Sub Total (EUR)
19	REFLECTOR DE HALOGENURO METALICO HPI-T 400W/220V			UNID	2	98,64	216,96
20	CIRCUIT BREAKER 02 POLE			UNID	2	8,93	19,64
21	SELECTOR DE 03 POSICIONES CON BLOQUE DE CONTACTO 2 NO			UNID	1	14,73	16,20
22	CHANNEL STRIP HEATERS			UNID	2	36,47	80,22
23	TYPE F FRAME, AUX SWITCH			UNID	2	74,42	163,67
24	SMALL WALL LIGHT-GLASS			UNID	6	113,60	749,57

4.417,09

2.1.5. Sistema de aterramiento

Item	Descripción	Marca	Código	Unid.	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	TERMINAL DE COMPRESION DE CU DE 1 HUECO 8AWG DIAM. 1/4 B.T.			UNID	20	0,37	0,82
2	TERMINAL DE COMPRESION DE CU DE 1 HUECO DIAMETRO 3/8' PARA CABLE DE 8AWG			UNID	30	0,37	1,22
3	CABLE DE TIERRA AMARILLO/VERDE TIPO H07V-K , DE 450/750V FLEXIBLE, TEMP : -5° C A + 70°C 1 X 4MM2 (12AWG) TOP CABLE - ESPAÑA			UNID	50	0,74	40,95
4	TERMINAL COMPRESION DE CU DE 1 HUECO PARA CABLE 2/0 ; AGUJERO 3/8			UNID	25	1,27	34,82
5	TERMINAL DE COMPRESION CU DE 1 HUECO PARA CABLE 4/0			UNID	37	2,20	89,51
6	CONDUCTOR DE MASA CU-ES 16MM2 34796 LEGRAND			UNID	21	3,30	76,32
7	PLATINA DE FIERRO DE 1" X1/8" X6MTR ASTM A36			UNID	24	3,89	102,72
8	CABLE COBRE DESNUDO 2/0 (70MM)			UNID	50	7,27	399,75
9	GRAPA PARALELA PARA CONDUCTOR DE CABLE CONDUCTOR: 10-2/0 AWG, PERNO M10 CAT. GPB-49-1 MARCA. INTELLI			UNID	10	9,09	99,96
10	CABLE COBRE DESNUDO 120MM2 MARCA : INDECO			UNID	50	13,25	728,46
11	GRAPA PARALELA			UNID	10	13,62	149,73
12	PLETINA CU 10MM X 80MM			UNID	12	89,99	1.187,55

2.911,81

2.1.6. Ferretería eléctrica

Item	Descripción	Observación	Código	Unid.	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	FERRETERIA ELÉCTRICA	(TERMINALES, CABLES, ETIQUETAS, ETC)		Gbl	01		7.385,00

7.385,00

2.2. SISTEMA MECÁNICO

2.2.1. Sistema tracto

Item	Descripción	Observación	Código	Unidad	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	CAMARA DE FRENO SENCILLA TIPO 30 PARA EJE IMT			PZA	6	25,12	165,75
2	EJE REDONDO 5" POR PARED 5/8" POR TROCHA 110", CON FRENO 16.5 X 7.0"			PZA	3	317,56	952,68
3	ENCHUFE DE PRUEBA HEXAPOLAR MARCA: G.E. MODELO: PK2-6129533G2			PZA	1	73,11	80,40
4	ENCHUFE DE PRUEBA TETRAPOLAR MARCA: G.E. MODELO: PK2-6129533G1			PZA	1	62,82	69,08
5	KING PIN DE 2" PARA PLANCHAS DE 1/2			PZA	1	38,53	42,37
6	RUEDA 1000R20 D.HAPPINESS 18P DR908 TCF MIX			PZA	13	244,38	3.493,75
7	PATAS DE APOYO JOST C200T			JGO	6	231,19	1.525,42
8	RUEDA ARTILLERA PARA EJE IMT DE 20", 5 RAYOS, MARCA WEBB			PZA	6	488,45	3.222,89
9	SCREW ON HINGE			PZA	15	5,55	91,50
10	SUSPENSION MECANICA DE 3.1/2 X 1/2 PARA 3 EJES			JGO	1	1.618,31	1.779,66
11	RETEN DE GRASA PARA EJE IMT			PZA	6	12,17	80,30
12	RODAMIENTO EXTERNO (BEARING CONE OUTER) PARA EJE IMT			PZA	12	16,93	223,46
13	ARO ARTILLERO			PZA	13	345,31	4.489,06

16.216,32

2.2.2. Materiales de acero

Item	Descripción	Observación	Código	Unidad	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	VIGA H 12"X26LBX40'	CAMION		UNID	2	373,29	746,58
2	VIGA H 8X18LB/PIE X40'	CAMION		UNID	1	342,24	342,24
3	VIGA H 8" X 18 LB/PIE X 6MTS	CAMION		UNID	1	171,12	171,12
4	CANAL U 8" X 11.5 LB/PIE X 6 MTR ASTM A36	CAMION		UNID	17	93,43	1.588,23
5	ANGULO 3" X 3" X 5/16" X 6MTR	CAMION		UNID	15	52,01	780,08
6	PLE4.5X1.2X2.4 (Plancha Estriada)	CAMION		UNID	6	90,93	545,60
7	CANAL U 6" X 8.2LB/PIE X 20'	PORTICO		PZA	2	64,70	142,30
8	ANGULO 1.1/2 X 1.1/2 X 3/16 X 6MTS	PORTICO		PZA	30	14,96	546,25
9	PLATINA DE FIERRO DE 1" X1/8" X6MTR ASTM A36	PORTICO		PZA	1	3,32	3,65
10	TUBO CUADRADO 3"X5/32"X20' ASTM A36	CERCO		UNID	10	55,18	551,82
11	TUBO CUADRADO 2 X 1/8 X 6MTR	CERCO		UNID	2	27,99	55,98
12	TUBO ESTRUCTURAL 1x1/8/6m	CERCO		UNID	3	13,40	40,21
13	MALLA ELECTROSOLDADA DE 2 X 2 EN ALAMBRE N°8 (4.19MM) DE 1765 X 2804 GALVANIZADA	CERCO		UND	21	27,28	602,61
14	PLETINA 10MM X 40MM	CERCO		MTR	19,5	43,08	846,07
15	PLANCHA GALVANIZADA DE 2.0 X 1200 X 3030MM	CASETA		PZA	22	49,37	1.194,53
16	PLANCHA GALVANIZADA DE 2.0 X 1200 X 3030MM	CASETA CARGADOR		PZA	4	49,37	217,19
17	PLANCHA GALVANIZADA DE 2.0 X 1200 X 3030MM	CASETA BATERIA		PZA	8	49,37	434,37
							8.808,82

2.2.3. Pintura

Item	Descripción	Observación	Código	Unidad	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	DILUYENTE AMERCOAT 65			GI	47	12,76	659,41
2	AMERCOAT 71/ ROJO OXIDO/PINTURA+CATALIZADOR/KIT			GI	188	31,50	6.512,32
3	AMERLOCK 400 / GRIS ANSI 61			GI	34	85,48	3.196,00
							10.367,73

2.2.4. Arenado

Item	Descripción	Observación	Código	Unidad	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	ARENADO DE PLANCHAS (663 M ²)			Glb	1	4,38	3.192,22
2	ARENADO DE VIGAS (181M ²)			Glb	1	4,38	871,48
							4.063,70

2.2.5. Ferretería mecánica

Item	Descripción	Observación	Código	Unidad	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	(PERNOS, ALAMBRE, SELLADOR, LIJAS, ETC)			Glb	01		9.400,00
							9.400,00

2.2.6. Consumibles mecánicos

Item	Descripción	Observación	Código	Unidad	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	(BROCAS, DISCO DE CORTE, SOLDADURA, ETC)			Glb	01		4.422,00
							4.422,00

3. COSTES DE LA MANO DE OBRA

DISEÑO

Item	Descripción	Observación		Unidad	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	DISEÑADOR ELECTRICISTA	INGENIERIA DE DETALLE		H-H	314	21,50	3.155,70
2	DISEÑADOR ESTRUCTURAL	INGENIERIA DE DETALLE		H-H	471	18,75	4.733,55
							<u>7.889,25</u>

FABRICACION

Item	Descripción	Observación	Código	Unidad	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	TÉCNICO MECÁNICO			H-H	4906	12,25	25.854,62
2	TÉCNICO ELÉCTRICISTA			H-H	2274	10,25	10.710,54
							<u>36.565,16</u>

CALIDAD Y PUESTA EN SERVICIO

Item	Descripción	Observación	Código	Unidad	Cant.	Costo Unit (EUR)	Sub Total (EUR)
1	SUPERVISOR ELECTRICO	PRUBAS Y LEVANTAMIENTO DE OBSERVACIONES		H-H	188	15,50	1.835,92
2	SUPERVISOR MECANICO	PRUBAS Y LEVANTAMIENTO DE OBSERVACIONES		H-H	124	13,50	954,29
							<u>2.790,21</u>

4. PRECIO TOTAL Y SUBTOTALES

Todos los montos de equipos y materiales incluyen costes estimados de importación.

Los precios mostrados en todas las tablas NO incluyen IVA.

El coste total de fricación de la subestación asciende a **CUATROCIENTOS CUARENTA MIL SIESCIENTOS OCHENTA Y CUATRO EUROS CON 90 CÉNTIMOS.**

SUBESTACIÓN ELÉCTRICA		440.684,90 EUR
MATERIALES		393.440,28 EUR
	SISTEMA ELÉCTRICO	340.161,70 EUR
	ESTRUCTURA MECÁNICA	53.278,57 EUR
MANO DE OBRA		47.244,62 EUR
	DISEÑO	7.889,25 EUR
	FABRICACION	36.565,16 EUR
	CALIDAD Y PUESTA EN SERVICIO	2.790,21 EUR

Relación de documentos

☐ Memoria	94	páginas
☐ Planos	29	páginas
☒ Presupuesto	19	páginas
☐ Pliego de Condiciones.....	17	páginas
☐ Anexos	331	páginas

La Almunia, a 30 de noviembre de 2016

Firmado: Rony Moises Pinedo Cordova



**ESCUELA UNIVERSITARIA POLITÉCNICA
DE LA ALMUNIA DE DOÑA GODINA (ZARAGOZA)**

PLIEGO DE CONDICIONES

**DISEÑO SUBSTACIÓN ELECTRICA
MOVIL 66/12kV, 10MV**

Mobile Substation Design 66/12kV, 10MVA

424.13.131

Autor: Rony Moises Pinedo Cordova

Director: Carmelo Jose Borque Horna

Fecha: 30-11-2016

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1. DEFINICIÓN Y ALCANCE DEL PLIEGO

El presente pliego detalla el conjunto de normas, especificaciones, condiciones y plazos que el vendedor está obligado a seguir para la adecuada ejecución del presente proyecto en su totalidad.

- Normas, leyes y reglamento
Se detalla las diversas normas a cumplir para que el diseño supere con los estándares de seguridad.
- Materiales y especificaciones técnicas
Se detalla la constitución del proyecto, su concepción del funcionamiento y especificaciones técnicas del equipamiento y materiales para su fabricación.
- Condiciones económicas
Se detalla la forma y plazos de pago, cambios, cancelaciones, penalidades, garantías y adicionales que debe incluir el vendedor.
- Plazos de entrega
Se detallan los plazos de entrega incluyendo los hitos más importantes a revisar por el cliente para la verificación del avance.

2. NORMAS, LEYES Y REGLAMENTOS

Los trabajos deberán ajustarse a las normas vigentes, incluidos los aspectos relacionados con la seguridad, la salud o las leyes locales municipales o decretos, y con la última edición de las siguientes normas

Normativas eléctricas:

- Real Decreto 3275/1982.
- Real Decreto 223/2008 y complementos al ITC-LAT 01 a 09.
- Real Decreto 560/2010.
- Real Decreto 560/2010.
- Real Decreto 1432/2008.
- ITC-LAT 02: Normas y especificaciones técnicas.
- ITC-LAT 04: Documentación y puesta en servicio de líneas de alta tensión.
- ITC-LAC 05 Verificaciones e inspecciones.
- ITC-LAC 07 Líneas aéreas con conductores desnudos.

Normativas mecánicas

- El CTE DB SE A - Documento Básico de Seguridad Estructural de Acero del Código Técnico de la Edificación.
- La EAE 2011 - Instrucción Española de Acero Estructural.
- UNE EN 1990 Eurocódigo 0: Bases de Diseño Estructural.
- UNE-ENV 1991-2-6 Eurocódigo 1: Acciones sobre las Estructuras.
- UNE-EN 1993-1-3:2012 Eurocódigo 3: Diseño de Estructuras de Acero.

Otras normativas:

- IEEE Institute of Electrical and Electronics Engineers
- NEMA National Electrical Manufacturers Association
- IEC International Electrotechnical Commission (como alternativa a IEEE / ANSI / NEMA)
- UL Underwriters Laboratories Inc.
- ICEA Insulated Cable Engineers Association

- IES Illuminating Engineering Society
 - NESC National Electrical Safety Code
 - NEC/NFPA 70 National Electrical Code / 2008
 - ASHRAE American Society of Heating Refrigerating and Airconditioning Engineers
 - NFPA 496 Purged and Pressurized Enclosures for Electrical Equipment.
 - ANSI American National Standards Institute
-
- NBC National Building Code, technical Standard of Building
 - E.030 Earthquake-Resistant Design.
 - ASCE 7 American Society of Civil Engineering, Minimum Design Loads for Buildings and other Structures.
 - ASTM American Society for Testing and Materials
 - AWS American Welding Society
 - AISI American Iron and Steel Institute
 - ASME American Society of Mechanical Engineers
 - OSHA United States Occupational Safety and Health Administration
 - IEEE Std. 979-1994 IEEE Guide for Substation Fire Protection (2.3 Exits, 2.4 Door locks, 2.5 Fire extinguishers).
 - IEEE Std. 693 Recommendations for Seismic Design

3. MATERIALES Y CONDICIONES TÉCNICAS

3.1. UBICACIÓN DE LA SUBESTACIÓN MÓVIL

Las subestaciones serán destinadas a las operaciones de mina, por lo que su ubicación será en el tajo y los picos y debe ser diseñada para estas condiciones.

3.2. CONSTITUCIÓN

El equipamiento el cual deberá ser suministrado e instalado en la subestación móvil, incluye lo siguiente:

- Un camión de tres ejes importado para el montaje de los equipos que comprende la Subestación.
- Transformador de Potencia 10 MVA, 66/12 kV.
- Entrada aérea desde poste de alta tensión.
- Celda de salida 12 kV con equipamiento descrito más adelante.
- Tableros de control, Protección y Medición.
- Servicios Auxiliares.
- Iluminación de emergencia tipo LED, alimentada desde el banco de baterías
- Compartimiento independiente para el banco de baterías con instalaciones a prueba de explosión y con sistema de extracción de gases.
- Salidas tipo industrial para tomacorrientes doble 1Ph, 240 Vac
- Iluminación exterior del tipo LED
- Luces de señalización de la subestación del tipo LED de colores
- Las subestaciones móviles incluido el equipamiento, material, deberán ser fabricado bajo norma, asimismo deberán ser nuevos y fabricados por empresas reconocidas.
- La subestación móvil deberá ser diseñado para que pueda ser traslado en diferentes ubicaciones y por caminos agrestes propios del proceso en minería.

3.3. CONCEPCIÓN

La alimentación del transformador será proveniente de la línea en 66 kV, que antes de su ingreso tendrá una protección mediante seccionador y fusibles seccionables. La apertura del seccionador se efectuará cuando ocurra una de las siguientes condiciones:

- Apertura por mando local o remoto
- Actuación como respaldo de las protecciones de los alimentadores.
- Actuación de la protección contra arco interno.
- La salida del transformador en 12 kV, a través de un ducto de barras llega a conformar una celda de 02 alimentadores idénticos y 01 celda de servicios auxiliares.
- Las celdas idénticas de 12 kV, soportarán cargas como las palas y perforadoras, y cada una de ellas contara con un sistema de protección:
- Multifunción para alimentador que incluya al menos las funciones de sobrecorriente a tierra instantánea y temporizada, sobrecorriente entre fases instantánea y temporizada (50, 51, 50P y 51P respectivamente),
- Relés para falla a tierra temporizada y protección contra desconexión de hilo piloto de los cables de fuerza de Palas y Perforadoras.
- Los interruptores son de vacío y de 600 A. de capacidad fijos.

3.4. PARÁMETROS DE DISEÑO

Las subestaciones móviles serán destinadas a las operaciones de mina por el cual deberán estar diseñadas para soportar los siguientes parámetros de diseño:

- Altitud : 3800 msnm
- Máxima temperatura ambiente exterior : 22 °C
- Mínima temperatura ambiente exterior : -9 °C
- Máxima humedad relativa en invierno : 83%
- Máxima humedad relativa en verano : 83%
- Máxima velocidad de viento : 85.3 Km/h
- Locación de operación : Exterior (tajo y picos)
- Nivel ceráunico de tormenta : 60
- Área peligrosa de operación (Si/No) : No
- Polución (Si/No) : Si

Materiales y condiciones técnicas

- Máxima precipitaciones fluviales (anual) : 2333 mm/año
- Promedio precipitaciones fluviales (anual) : 1241 mm/año
- Mínima precipitaciones fluviales (anual) : 819 mm/año
- Nivel básico de aislamiento en 69 kV : 450 kV
- Nivel básico de aislamiento en 12 kV : 125 kV
- Corriente de cortocircuito en 66 kV : 61 kA
- Corriente de cortocircuito en 12 kV : 40 kA

3.5. ESPECIFICACIONES DE LA ESTRUCTURA

Las subestaciones móviles deberán contar con las siguientes características generales:

- | | |
|---|--------------------------|
| • Tipo de subestación móvil | : Montado en tráiler |
| • Cantidad de celdas eléctricas montadas | : 1 |
| • Protección de la carcasa en la sala eléctrica | : NEMA 4 |
| • Tiempo de vida operativa | : 20 años |
| • Transformador montado exteriormente (Si/No) | : Si |
| • Dimensiones de plataforma | : Definido por el postor |
| • Tipo de tráiler | : Definido por el postor |
| • Tipo de freno | : Definido por el postor |
| • Separación de los ambientes | : Definido por el postor |
| • Diseño para operación continua (Si/No) | : Si |
| • Peso de la subestación móvil | : Definido por el postor |

3.5.1. Especificación de la base (reticulado)

- | | |
|---|--------------------------|
| • Material de la base estructural de acero | : ASTM-A36 rígido |
| • Perfiles a usar | :Viga (H, I o U) |
| • Espesor y carga de la cubierta | : Definido por el postor |
| • Factor de seguridad para elevación y remolque | : 2 |
| • Cubre neumáticos (Si/No) | : Si |
| • Color pintado externo | : Gris ANSI 61 |
| • Corredores en cada base (Si/No) | : Si |

3.5.2. Especificación del Piso de subestación Eléctrica

- Material del piso de la sala eléctrica : Acero
- Espesor mínimo del piso : 6 mm
- Tipo de revestimiento del piso : Antideslizante
- Color del piso : RAL7001 (gris claro)
- Zonas seguras de operación y de tránsito (Si/No) : Si

3.5.3. Especificación de las Paredes de la Celda Eléctrica

- Costura de los paneles de las paredes : Soldadura continua
- Material de las paredes : Acero laminado en frio
- Espesor mínimo del paredes externas : 2.9 mm
- Color pintado externo : Gris ANSI 61
- Espesor final de las paredes : Definido por el postor

3.5.4. Especificación del Techo de la Celda Eléctrica

- Costura de los paneles de las paredes : Soldadura continua
- Material de las paredes externas : Acero laminado en frio
- Espesor mínimo del paredes externas : 1.9 mm
- Color pintado externo : Gris ANSI 61
- Carga promedio de diseño : 250 kg / m2

3.5.5. *Especificación de las puertas de la Celda Eléctrica*

- Material de la puerta : Acero sin soldadura
- Dimensiones de las puertas para acceso de equipos : Definido por el postor
- Dimensiones de la puerta para acceso del personal : 2200 mm x 1000 mm
- Cierre automático (Si/No) : NO
- Barra antipático (Si/No) : NO
- Bloqueo manual (Si/No) : Si
- Espesor final de las paredes : Definido por el postor
- Color pintado exterior : Gris ANSI 61
- Color pintado interior : Gris ANSI 61

3.6. ESPECIFICACIONES ELÉCTRICAS

3.6.1. *Especificaciones de transformador*

- Sumergido en aceite (Si/No) : SI
- Tipo de aceite : Aceite Mineral
- Normas de fabricación : ANSI
- Presurizado con gas nitrógeno (Si/No) : Si
- Altura máxima de operación : 3800 msnm
- N° de fases del sistema : 3
- Material bobinado : Cobre.
- Potencia nominal : 10 MVA
- Sistema de refrigeración : ONAN
- Tensión nominal AT : 66 kV.
- Tensión nominal BT : 12 kV.
- Máxima tensión nominal : 69.3 kV.
- Nivel básico de impulso (BIL) en bobinado primario: 450 kV.
- Nivel básico de impulso (BIL) en bobinado secundario: 95 kV.
- Frecuencia nominal : 60 Hz
- Relación de transformación sin carga : $66 \pm 2 \times 2.5\% / 12 \text{ kV}$

- Conmutador bajo carga (Si/No) : No
- Conmutador ubicado en lado AT (Si/No) : Si.
- Grupo de conexión : Dyn1
- Conexión del arrollamiento AT : Delta
- Conexión del arrollamiento BT : Estrella con neutro
- Tensión de cortocircuito : 6.0%
- Material terminal (bushings) de alta y baja tensión: Porcelana.
- Conectores en alta y baja tensión : Tipo terminal.
- Nivel básico de impulso (BIL) en Bushings primario: 550 kV.
- Nivel básico de impulso (BIL) en Bushings secundario: 125 kV.
- Nivel básico de impulso (BIL) en Bushings neutro : 125 kV.
- Ubicación de bushings AT : Lateral
- Ubicación de bushings BT : Lateral
- Ubicación del bushing neutro BT : Lateral
- Calentamiento en el aceite a temperatura ambiente : 65 °C
- Calentamiento en arrollamientos a temperatura ambiente : 65 °C
- Temperatura ambiente máxima de operación : 40°C
- Tipo tanque sellado preparado para termovacío (Si/No) : Si
- Aterramiento son resistencia en el neutro (Si/No) : Si
- Color del pintado : RAL 7001(Gris)
- Dimensiones : Definido por el postor

Accesorios de transformador de potencia

- Un cambiador de tomas en vacío (5 tomas) con mando manual en el tanque.
- Un juego de radiadores y válvulas tipo mariposa (shut-off).
- Una batería de mando y protección de ventiladores que servirá como caja de bornes.
- Un termómetro de aceite con contactos de alarma y desconexión.
- Un indicador de nivel de aceite magnético con contactos de alarma y desconexión.
- Una válvula de seguridad (válvula de sobrepresión) con contactos de desconexión.
- Dos válvulas de circulación de aceite (filtrado).
- Manómetro de presión de Nitrógeno.
- Una válvula de drenaje y muestreo.
- Tablero de conexiones con grado de conexión IP66.

Materiales y condiciones técnicas

- Accesorios para maniobra y facilidades para izar, gatear y remolcar el transformador.
- Dos placas de puesta a tierra colocada en el tanque del transformador.
- Una placa de características en material inoxidable según las normas ANSI.
- Refuerzos en la base del transformador para la colocación de los gatos de izaje.
- Tablero monitoreo en tiempo real de parámetros operativos del transformador (definido por el postor)
- Equipo digital monitoreo de aceite en tiempo real (Definido por el postor)

Pruebas en fábrica y comisionamiento en mina del transformador

- Inspección general del transformador.
- Medida de la resistencia óhmica de los arrollamientos en cada toma del conmutador.
- Medida de la relación de transformación en cada toma del conmutador.
- Medida de la resistencia del aislamiento.
- Comprobación de la secuencia de fases y grupo de conexión.
- Medición de la corriente de excitación y las pérdidas en vacío.
- Medición de la tensión de cortocircuito y las pérdidas en los arrollamientos.
- Medición de las pérdidas totales y de la impedancia de cortocircuito.
- Medición de la impedancia de secuencia cero.
- Ensayos de tensión inducida.
- Ensayos de tensión aplicada.
- Análisis de la respuesta de barrido de frecuencia (SFRA).
- Análisis de aceite físico químico, cromatografico, furanos y PCB.
- El postor deberá entregar copia de los certificados registro de pruebas.

Especificación de la Resistencia del Neutro del transformador

- | | |
|---|--------------------|
| • Material de Elementos | : Acero Inoxidable |
| • Tensión | : 6930 Volts. |
| • Corriente | : 10 A / 10seg |
| • Con transformador de corriente (Si/No) | : Si |
| • Con soporte estructural (Si/No) | : Si |
| • Altura máxima de operación | : 3800 msnm |
| • Placa con indicación de altitud (Si/No) | : Si |

3.6.2. Especificación Sistema Protección

- Tipo de relé : Multifunción
- ANSI 51/51N) sobrecorriente temporizado (Si/No) : Si
- ANSI (87T) diferencial (Si/No) : Si
- ANSI (27) mínima tensión (Si/No) : Si
- ANSI (81) mínima frecuencia (Si/No) : Si
- ANSI (50/50N) sobrecorriente instantánea (Si/No) : Si
- ANSI (49) imagen térmica (Si/No) : Si
- ANSI (86) bloqueo (Si/No) : Si
- ANSI (50BF) falla interruptor (Si/No) : Si
- ANSI (74TC) supervisión de disparo (Si/No) : Si
- ANSI (46) desbalance/secuencia negativa (Si/No) : Si

3.6.3. Especificación Sistema Medición

- Tipo de medición : Digital
- Modelo : ION 8650
- Trifásico (Si/No) : Si
- Tensión línea y fase (Si/No) : Si
- Medición de potencia activa en kW (Si/No) : Si
- Medición de potencia reactiva en kVar (Si/No) : Si
- Medición de potencia aparente en kVA (Si/No) : Si
- Armónicos (Si/No) : Si
- Medición de energía kWh, kVarh (Si/No) : Si
- Captura de oscilografías : Si

3.6.4. Especificación Sistema instrumentación

- Tipo de equipo : Digital
- Monitoreo de temperatura bobinado transformador (Si/No) : Si
- Monitoreo de temperatura aceite transformador (Si/No) : Si
- Monitoreo de temperatura sala eléctrica (Si/No) : Si

Materiales y condiciones técnicas

- Monitoreo de temperatura cable (Si/No) : Si
- Monitoreo de presión positiva en la sal eléctrica (Si/No) : Si
- Monitoreo de temperatura ambiente (Si/No) : Si
- Monitoreo de nivel de aceite (Si/No) : Si
- Monitoreo de presión nitrógeno (Si/No) : Si
- Análisis físico químico del aceite dieléctrico (Si/No) : Si
- Análisis físico cromatografico del aceite dieléctrico (Si/No) : Si
- Puerto de comunicación (Si/No) : NO

3.6.5. Especificación Señalización

- Luz estroboscópica roja por disparo de protección (Si/No) : Si
- Alarma sonora por disparo de protección (Si/No) : Si
- Tipo luces de señalización : Led
- Color luz de interruptor cerrado : Rojo
- Color luz de interruptor abierto : Verde
- Color luz de interruptor abierto por disparo falla : Ámbar
- Color luz de interruptor abierto por disparo falla tierra : Blanco

3.6.6. Especificación Accesorios Adicionales

- Borneras de prueba para protección, medición (Si/No) : Si
- Calentador (Si/No) : Si
- Color cable tierra : Verde o Amarillo con verde
- Color cable eléctrico tensión AC : Rojo, Negro, Azul
- Color cable eléctrico tensión DC : Negro, Blanco

3.6.7. Especificación Sistema Tensión DC

- Marca : Definido por el postor
- Tensión de entrada : 240 V
- Tensión de salida : 125 VDC
- Tipo de batería : Nickel-Cadmio
- Autonomía : 90 min
- Tiempo de vida : mínimo 12 años
- Número de celdas : Definido por el postor
- Sistema aterramiento : Aislado
- Rack de la batería : Definido por el postor
- Corriente nominal del cargador : Definido por el postor
- Tiempo de descarga del cargador : Definido por el postor
- Ondulación sin baterías : < 5%
- Ondulación con baterías : < 1%
- Grado de protección : NEMA 12 – IP22
- Panel de distribución 125VDC (Si/No) : Si
- Número de circuitos de salida : Definido por el postor
- Capacidad para alimentar sistema protección y medición : 10 h
- Capacidad para alimentar sistema alumbrado de emergencia : 04 h
- Capacidad para alimentar sistema control : 10 h

3.6.8. Especificación Sistema Alumbrado y Fuerza

- Tensión de distribución alumbrado y fuerza : 240 V – 120 V
- Protección diferencial (Si/No) : Si
- Número de circuito de salida para alumbrado interior : 12
- Número de circuito de salida para alumbrado exterior : 6
- Control de alumbrado exterior con fotocelda (Si/No) : Si
- Número de circuito de salida para fuerza : 6
- Capacidad de ruptura del interruptor principal : 10 kA

4. CONDICIONES ECONÓMICAS

4.1. FORMA DE PAGO

- 20% con la entrega de planos para aprobación (con la presentación de la factura empieza el conteo del tiempo de entrega)
- 40% con la compra de todo el equipamiento crítico.
- 20% al termino de las pruebas FAT
- 20% con la puesta en servicio (tiempo máximo contemplado es de 4 – 6 semanas desde la llegada de la subestación a sitio)

Cualquier cambio después de la aprobación de planos de Ingeniería se reconocerá un adicional en costo y tiempo de entrega.

Cambios y sustituciones.

El cliente estará permitido de realizar los cambios o sustituciones convenientes en la orden de compra, incluyendo aquellos que afecten la identidad, alcance y entrega de los productos. Estos serán documentados por escrito y estarán sujetos a la evaluación del vendedor y del ajuste en el precio según acuerdo, ajustes en horario y otros términos y condiciones que se vean afectados. El vendedor podrá hacer uso del derecho a rechazar cambios que considere inseguros, o que no sea técnicamente recomendable o inconsistente con los estándares y especificaciones de la ingeniería o calidad, o incompatible con la capacidad de diseño o manufactura del vendedor. El vendedor tiene derecho para sustituir, utilizando la última actualización o serie o productos equivalentes que sean comparables en forma, tamaño y función.

Cancelación de la orden de compra

En caso de cancelación unilateral de la orden de compra por parte del cliente, se conceden los siguientes costos de cancelación:

- Después de la emisión de planos para aprobación por el vendedor: el cliente reconocerá el 30% del valor de la O/C.
- Después de la emisión de órdenes de compra del equipamiento crítico por el vendedor, no podrá ser efectiva la cancelación.

Penalizaciones

- 0.5% semanal por la parte demorada hasta un máximo de 5% por toda la orden de compra.

4.2. GARANTÍA

- Garantía del fabricante, garantía extendida de dos (02 años), el fabricante entregara carta de garantía por todo el equipamiento.
- El vendedor debe garantizar que los equipos entregados suministrados de conformidad con estos términos y condiciones, estará libre de defectos de materiales, de mano de obra y de diseño, por un período de un (1) año, contado a partir de la fecha de la entrega en condición Ex Works, entrega de la factura expedida por el vendedor o sus distribuidores autorizados, según sea el caso.
- El vendedor reemplazara los equipos que presenten fallas por deficiencias en la calidad de materiales o fabricación. Los Productos reparados o reemplazados como resultado de esta garantía estarán igualmente garantizados por un período de seis (6) meses contados a partir de la fecha de entrega al Comprador o, por el período restante de la garantía original correspondiente al Producto, el período que resulte mayor.
- Servicios: El vendedor debe garantizar que los productos relativos a servicios (v.g. entrenamiento, reparación, ingeniería y servicios de programación de aplicación personalizada) serán proporcionados por personal debidamente entrenado, que será empleado o contratado por el vendedor.
- La garantía no será válida cuando el defecto reclamado ha sido causado por mal uso, negligencia, instalación inapropiada, operación, mantenimiento, reparación, alteración o modificación por persona no calificada; accidente, deterioro o degradación inusual de los productos o partes de los mismos debido al ambiente físico o un ambiente de ruido eléctrico o electromagnético.

4.3. ADICIONALES

- La asistencia a una inspección visual en locaciones del fabricante del transformador de potencia para dos (02) ingenieros por parte del cliente final, incluido gastos de viaje.
- Pruebas FAT
 - *Equipamiento Mecánico de la Sala Eléctrica:
 - Prueba de Hermeticidad en Planta.
 - Pruebas de Rugosidad en la limpieza del metal
 - Pruebas de Espesor de Pintura.
 - Pruebas de Adherencia
 - Pruebas de Soldadura (muestras elegidas por el cliente).
 - Apertura y Cierre de Puertas, Hermeticidad.
 - Prueba de control dimensional.
 - *Equipamiento Eléctrico
 - Inspección de transformador de potencia
 - Pruebas de aislamiento equipos y cableados
 - Pruebas de timbrado de los circuitos de control.
 - Pruebas funcionales de los circuitos de control.
- Los servicios de puesta en marcha están a cargo del proveedor.
- Capacitación técnica de operación y mantenimiento del equipamiento de la subestación móvil que incluirá temas de operación del sistema y de sus componentes principales por un (01) Ingeniero especialista y certificado durante dos días, 08 horas/día.

5. PLAZOS DE ENTREGA

40 semanas después de emitir la orden de compra por parte del cliente o 31 semanas, después de la aprobación de planos por parte del cliente, el plazo mayor.

Los hitos más importantes a ser verificados por el cliente son:

- Semana 5 a partir de la orden de compra: Emisión de las órdenes de compra de los equipos críticos.
- Semana 29: Llegada de transformador de potencia.
- Semana 33 - 35: Terminó de las pruebas FAT

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Relación de documentos

☐ Memoria	94	páginas
☐ Planos	29	páginas
☐ Presupuesto	19	páginas
☒ Pliego de Condiciones	17	páginas
☐ Anexos	331	páginas

La Almunia, a 30 de noviembre de 2016

Firmado: Rony Moises Pinedo Cordova



**ESCUELA UNIVERSITARIA POLITÉCNICA
DE LA ALMUNIA DE DOÑA GODINA (ZARAGOZA)**

ANEXO: CÁLCULOS JUSTIFICATIVOS

**DISEÑO SUBSTACIÓN ELÉCTRICA
MOVIL 66/12kV, 10MV**

Mobile Substation Design 66/12kV, 10MVA

424.13.131

Autor: Rony Moises Pinedo Cordova

Director: Carmelo Jose Borque Horna

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1. CALCULOS ELECTRICOS

1.1. EFECTOS DE LA ALTITUD

En américa latina existen diversos países con alturas geográficas de gran consideración, por lo que es necesario incluir factores de corrección en el diseño eléctrico.

La figura 48 muestra el porcentaje de minas que se encuentran a una altura superior a los 1000 msnm con respecto al total de minas en cada país.

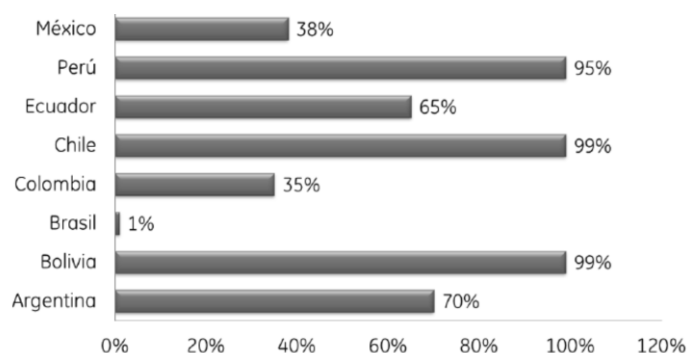


Figura 1 – Porcentaje de minas a mas de 1000msnm.

1.2. NIVELES DE AISLAMIENTO

Los niveles de aislamiento están diseñados para soportar las sobretensiones, en lugar de sólo los voltajes de funcionamiento normales. Dado que las líneas y equipos de aislamiento está protegido por los descargadores de sobretensión que drenan las oleadas rápidamente antes de que el aislamiento está dañado.

El nivel mínimo es conocido como el nivel de aislamiento básico (BIL) Que debe ser la de todos los componentes de un sistema.

Se procede al cálculo de nivel de aislamiento para las tensiones:

Tensión lado primario:	66kV
Tensión lado secundario:	12kV
Altura de operación:	3600 m.s.n.m.
Contaminación ambientas:	baja
Descargas atmosféricas:	frecuente

Efectos de la altitud

Una vez superado los 1000 msnm, el factor de corrección incrementa en 1,25%
Por cada 100 metros adicionales.

$$f_r = 1 + 0,0125 \left(\frac{msnm - 1000}{100} \right)$$

- fr: factor de corrección por altura

Para una altura de operación de 3600msnm

$$f_r = 1 + 0,0125 \left(\frac{3600 - 1000}{100} \right) = 1,325$$

Para el lado primario con voltaje nominal: 66kV

$$V_d = V_n * f_r$$

- Vd : voltaje de diseño
- Fc : factor de corrección
- Vn=66kV : Voltaje nominal

$$V_d = 66kV (1,325) = 87,45kV$$

Según tablas el valor de voltaje de diseño normalizado: Vdn=115kV

Para el lado secundario con voltaje nominal: 12kV

$$V_d = V_n \cdot F_c$$

- V_d : voltaje de diseño
- F_c : factor de corrección
- $V_n = 12\text{kV}$: Voltaje nominal

$$12\text{kV} (1,325) = 15,9\text{kV}$$

Según tablas el valor de voltaje de diseño normalizado: $V_{dn} = 20\text{kV}$

Efectos de contaminación ambiental

Dado que la contaminación es baja no se considera sus efectos en el factor de correlación por este concepto.

- Lado primario tensión nominal 66kV

Para una tensión normalizada de equipamiento de 115kV le corresponde 450kV BIL (nivel básico de aislamiento).

Tabla 1 - Niveles de aislamiento normalizado por IEC

TENSIONES NOMINALES DEL SISTEMA kV	TENSION MAXIMA PARA EL EQUIPO kV ef.	NIVEL DE AISLAMIENTO AL IMPULSO		NIVEL DE AISLAMIENTO A BAJA FRECUENCIA	
		AISLAMIENTO PLENO kV pico	AISLAMIENTO REDUCIDO kV pico	AISLAMIENTO PLENO kV ef.	AISLAMIENTO REDUCIDO kV ef.
88-94	100	450	380	185	150
110-115	123	550	450	230	185
132-138	145	650	550	275	230
150-161	170	750	650	325	275
220-230	245	1050	900	460	395
			825		360
			750		325
275-287	300		1175		510
			1050		460
			900		395
330-345	362		1300		570
			1175		510
			1050		460
380-400	420		1675		740
			1550		680
			1425		630
			1300		570
500	525		1800		790
			1675		740
			1550		680
			1425		630

- Lado secundario de tensión nominal 12kV.

Para la tensión normalizada de equipamiento de 20kV le corresponde 125kV BIL (nivel básico de aislamiento)

Tabla 2 - Niveles de aislamiento normalizado por IEC

Tensión nominal del sistema	Tensión máxima entre fases	Nivel de aislam. Al impulso	K . A 2.000 m s.n.m	TCF NORMA L BIL 0.961	TCF DISEÑO TCF NORM
$U_N [Kv]$	$U_m [Kv]$	BIL o BLS [Kv]	&	[Kv]	[Kv]
A	B	C	D	E	F
3	3.6	45	0.893	46.8	52.4
6	7.2	60	0.893	62.4	69.9
10	12	75	0.893	78	87.4
15	17.5	95	0.893	98.8	110.6
20	24	125	0.893	130	145.6
30	36	170	0.893	176.8	198
45	52	250	0.893	260	291.2
60	72.5	325	0.893	338	378.5
88	100	380	0.893	395	442.3

1.3. DISTANCIAS ELÉCTRICAS DE SEGURIDAD

Son las distancias que se deben conservar como mínimo entre líneas eléctricas y demás elementos (equipos, tierra, cerco, etc.) esto para asegurar la seguridad del personal operativo y de mantenimiento.

Las partes electrificadas vivas deben quedar fuera del alcance del personal usando las distancias de seguridad, y brindando zonas de trabajo y tránsito que eviten contacto con partes vivas.

Se puede hacer uso de barreras o cercos, así como materiales dieléctricos (mantas, alfombrillas, micas, mangas) con lo que encerramos las partes electrificadas.

Para el lado primario con tensión nominal de 66kv, tensión normalizada de 115kV según la tabla 5 corresponde 991mm de fase a fase y 864mm de fase a tierra (para exteriores).

Para el lado secundario con tensión nominal 12kV, tensión normalizada de 22kV según la tabla 4 corresponde 241mm de fase a fase y 140mm de fase a tierra (para interiores).

Tabla 3 - Distancias de seguridad para interiores.

INDOOR		
Voltage in KV	Phase to earth in mm	Phase to phase in mm
0.415	15.8	19.05
0.600	19.05	19.05
3.3	50.8	50.8
6.6	63.5	88.9
11	76.2	127.0
15	101.6	165.1
22	139.7	241.3
33	222.25	355.6

Tabla 4 - Distancias de seguridad para exteriores.

OUTDOOR		
Voltage in KV	Phase to earth in mm	Phase to phase in mm
6.6	139.7	177.8
11	177.8	228.6
22	279.4	330.2
33	381	431.8
66	685.8	787.4
110	863.6	990.6
132	1066.8	1219.2
220	1778	2057.4

Altura mínima de los conductores:

Según MIE-RAT-14, 5.1.2

Los elementos en tensión no protegidos que se encuentren sobre pasillos, deberán estar a una altura mínima h.

$$h(\text{cm})=230 + d$$

- h: altura mínima
- d: distancia de seguridad

Tabla 5 -Altura minima segun MIE-RAT-14, 5.1.2

Tensión nominal de la instalación KV ≤	20	30	45	66	110	132	220
«d» en centímetros	20	27	38	57	95	110	185

Para la tensión nominal 66kV, consideraremos la tensión normalizada 110kV, por lo tanto:

$$H=230 + 95 = 325 \text{ cm.}$$

1.4. DIMENSIONAMIENTO DEL TRANSFORMADOR DE POTENCIA

Calculo Corriente nominal lado primario.

Se procede a calcular la corriente nominal primaria de fase del circuito trifásico.

$$I_p = \frac{P}{V_p \cdot \sqrt{3}} = \frac{10MVA}{66kV \cdot \sqrt{3}} \cong 88 \text{ A}$$

Donde:

- I_p : Corriente nominal en el lado primario
- $P=10MVA$: Potencia del transformador.
- $V_p=66kV$: Voltaje nominal en el lado primario

Calculo Corriente nominal lado secundario.

Se procede a calcular la corriente nominal primaria de fase del circuito trifásico.

$$I_s = \frac{P}{V_s \cdot \sqrt{3}} = \frac{10MVA}{12kV \cdot \sqrt{3}} \cong 481 \text{ A}$$

Donde:

- I_s : Corriente nominal en lado secundario
- $P=10MVA$: Potencia del transformador.
- $V_s=66kV$: Voltaje nominal en el lado secundario

Derrateo por altura.

El presente proyecto se diseña para trabajar a una altura de 3600m.

- H: altura (m.s.n.m.) =3600 m

Corrección de voltaje.

Cálculo del factor de corrección de voltaje k

$$k = e^{\frac{H-1000}{8150}}$$

Donde:

- k : factor de corrección de voltaje
- H=3600m : Altura de operación

$$k = e^{\frac{3500-1000}{8150}} = 1,36$$

Voltaje primario derrateado = $V_p \cdot k = 66 \cdot 1,36 = 89,7 \text{ kV}$

Voltaje secundario derrateado = $V_s \cdot k = 12 \cdot 1,36 = 16,3 \text{ kV}$

Corrección de corriente.

Cálculo de factor de corrección de corriente AFC.

$$ACF = 1 - 0,02 * \frac{H - 1000}{1000}$$

Donde:

- ACF: factor de corrección de corriente
- H=3600m : Altura de operación

$$ACF = 1 - 0,02 * \frac{3500 - 1000}{1000} = 0,95$$

Corriente lado primario derrateado = $I_p \cdot k = 88 \cdot 0,95 = 83,6 \text{ A}$

Corriente lado secundario derrateado = $I_s \cdot k = 481 \cdot 0,95 = 456,9 \text{ A}$

Potencia (MVA)	=	10	
Vn (tensión nominal) (kV)	=	66	12
Vmax sist (1,05Vn) (kV)	=	69,3	12,6
Vm (tensión max del equipo)	=	123	24
Tensión sost. a la frec (kV)	=	185	95
Tensión sost. BIL (kVp)	=	450	125

1.5. SECCIONADOR DE POTENCIA

NEC [450.14]. Se requiere un seccionador para desconectar todos los conductores primarios sin conexión a tierra del transformador. La desconexión debe estar situada a la vista del transformador, a menos que la ubicación de la desconexión esté marcada en el campo en el transformador y la desconexión sea bloqueable. Este requisito del Código se aplica a los transformadores de cualquier voltaje

El seccionador debe ser modelado de acuerdo a la función, a la instalación, a la tensión del servicio, corriente y nivel de aislamiento.

Un seccionador debe poder soportar de forma indefinida las corrientes que se presentan en condiciones normales y las que se presentan en condiciones excepcionales, como las de cortocircuito.

De acuerdo a los cálculos ya realizados cuando se modelo el transformador de potencia la corriente en el lado primario derrateado por altura es 83,6A.

Según norma dado por el NEC CODE 2011, en los seccionadores se aplica un factor de seguridad alto de valor 12.

Por lo que la corriente viene a ser $12 \times 83,6 = 1000$ A.

El nivel de voltaje nominal derrateado por altura y normalizado se estableció en 115kV.

El nivel de aislamiento se calculó en los apartados anteriores y se estableció en 450 kV BIL.

Se procede a seleccionar un seccionador sin cuchillas de puesta a tierra, que opera SIN carga, aislamiento de aire, marca Cleveland & Price de apertura vertical.

Las características eléctricas que más se acercas según las tablas del fabricante son:

Voltaje	: 115kV
Voltaje máx.	: 123kV
Aislamiento	: 550kV BIL
Corriente	: 1200 A

1.6. FUSIBLES DE POTENCIA.

Los fusibles de potencia se clasifican según la corriente E.

Los fusibles de clasificación E tienen características de corriente en función del tiempo diseñado para brindar protección de límite de corriente en los transformadores de potencia, centrales, alimentadores, y subestaciones Cundo se aplica correctamente puede proteger contra subidas y bajadas de corriente.

Las normas NEMA para los fusibles de media tensión con clasificación E requieren que los fusibles de una clasificación 100E o menos abran en menos de 300 segundos (5 minutos) cuando es sometido a un valor RMS de 200-240% de su valor nominal de corriente. Y Fusibles con una clasificación superior a 100E debe abrir en 600 segundos (10 minutos) cuando es sometido a un valor RMS de 200-240% de su valor nominal de corriente. Estos valores establecen un punto en la curva tiempo-corriente.

El nivel de aislamiento también debe ser considerado para la selección del fusible, para nuestro caso 115kV BIL.

La figura 49 muestra la velocidad de operación de los fusibles de clasificación E en la marca S&C power fuses, S&C brinda fusibles con tres velocidades de operación,

fusibles de velocidad estándar, fusibles de velocidad lenta y fusibles de velocidad rápida.
La presente curva representa a los fusibles de velocidad estándar.

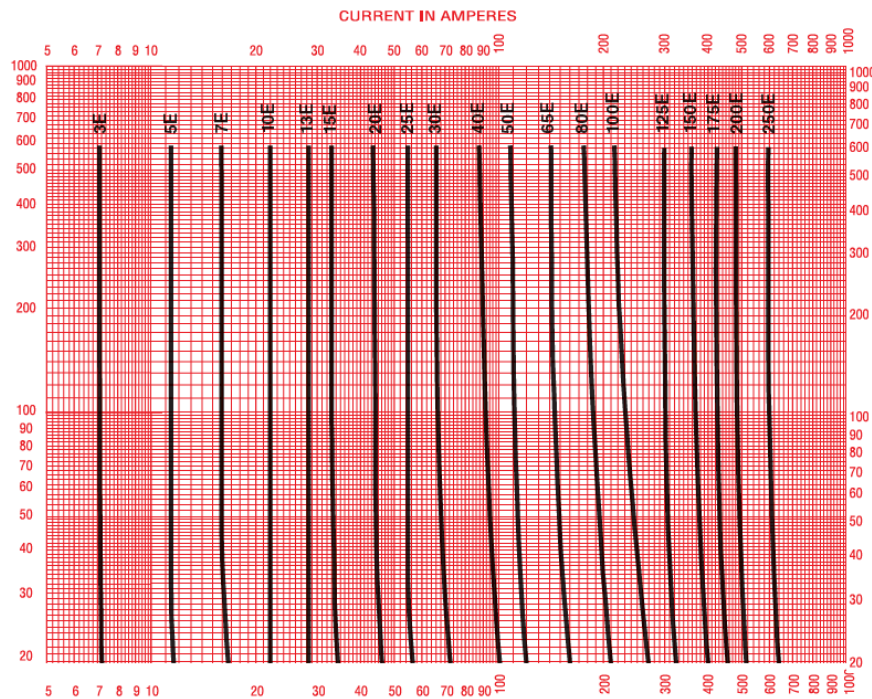


Figura 2 - Curva de actuación de fusibles de potencia.

1.7. BASE PORTAFUSIBLE

Para nuestro caso con derrateo para una altura de 3600 msnm se estableció:

Debe cumplir nuestro voltaje nominal de 115kV.

Debe cumplir nuestras características de aislamiento: 450kV BIL

Además:

Debe ser capaz de soportar la corriente de los fusibles de potencia 100E.

Según catalogo se procede a escoger el dispositivo que más se acerque a estas características. Por lo tanto 115kV, 550 kV BIL, 250E.

1.8. PARARRAYOS LADO PRIMARIO

Para la selección de la tensión nominal de los pararrayos se tiene que observar los siguientes conceptos:

- Tensión nominal: valor máximo de la tensión, en condiciones normales de explotación, a frecuencia industrial admisible entre los bornes del pararrayos.
- Corriente de descarga: onda de corriente evacuada por el pararrayos en una descarga.
- Corriente de descarga nominal: corriente de descarga con una amplitud y forma de onda concreta que se utiliza para definir un pararrayos.
- Tensión de cebado a frecuencia industrial: es la tensión que al aplicar entre bornes del pararrayos, provoca la descarga del arco eléctrico.
- Tensión de cebado a la onda de choque: es el valor de cresta de la tensión que aparece justo antes del momento de paso de la corriente de descarga.
- Factor de puesta a tierra (K_e): Depende del tipo de conexión.
- Sobretensión Temporal (TOV): Tensión que excede a la tensión nominal del sistema y que se presentan debido a fallos.

$$TOV = K_e \frac{V_m}{\sqrt{3}}$$

Donde:

- $K_e = 1,4$ para sistemas con neutro aterrado

$K_e = \sqrt{3}$ para sistemas aislados

V_m = Tensión máxima de servicio

Tensión Máxima de Operación Continua (MCOV): Es la tensión máxima que puede aparecer en operación continua, en los terminales del pararrayos.

$$MCOV = K_e \frac{V_m}{\sqrt{3}}$$

Donde:

- $K_e = 1$: para sistemas con neutro aterrado
- $K_e = \sqrt{3}$: para sistemas aislados
- V_m : Tensión máxima de servicio

Nivel de Protección de los Pararrayos (Np): Tomando en cuenta la Tabla K1 de la Publicación IEC N° 60099-4 "Pararrayos de óxido de metal", se tiene:

$$N_p = 2,8 \times V_n$$

Donde:

- N_p : Nivel de protección
- V_n : voltaje nominal

Coeficiente de Protección de los Pararrayos: margen de protección o coeficiente de seguridad que ofrecen los pararrayos está dado por:

$$C_p = \frac{BIL}{N_p} > 1,2$$

Donde:

- C_p : Coeficiente de protección
- BIL : Nivel de aislamiento
- N_p : Nivel de protección

Para un nivel de voltaje de 66kV.

Lado primario aislado

Por efectos de la altura $V_m=87,45kV$

$$TOV = K_e \frac{V_m}{\sqrt{3}} = \sqrt{3} \frac{87,45}{\sqrt{3}} = 87,45kV$$

$$MCOV = K_e \frac{V_m}{\sqrt{3}} = \sqrt{3} \frac{87,45}{\sqrt{3}} = 87,45kV$$

Según las tablas del fabricante los valores más próximos pertenecen al modelo ZSP0090.

BIL: 450kV

$$N_p = 2,8 \times 66 = 184,8kV$$

$$C_p = \frac{BIL}{N_p} = \frac{450}{184,8} = 2,43 > 1,2$$

1.9. PARARRAYOS LADO SECUNDARIO

Aplicando mismos conceptos (K_e , TOV, MCOV) que el cálculo de pararrayos del lado primario.

Para un nivel de voltaje de 12kV.

Lado secundario aterrado

Por efectos de altura $V_m = 15,9\text{kV}$

$$TOV = K_e \frac{V_m}{\sqrt{3}} = 1,4 \frac{15,9}{\sqrt{3}} = 12,85\text{kV}$$

$$MCOV = K_e \frac{V_m}{\sqrt{3}} = 1,0 \frac{15,9}{\sqrt{3}} = 9,18\text{kV}$$

Según las tablas del fabricante los valores más próximos pertenecen al modelo ZSP0012.

BIL: 125kV

$$N_p = 2,8 * 12 = 33,6\text{kV}$$

$$C_p = \frac{BIL}{N_p} = \frac{125}{33,6} = 3,72 > 1,2$$

1.10. RESISTENCIA DE PUESTA A TIERRA

Para esta subestación estamos usando un transformador de Potencia cuyo tipo de conexión es DYN5 en donde la resistencia de puesta a tierra del neutro irá conectada al secundario.

De donde tenemos lo siguiente para la selección de la resistencia:

Voltaje entre líneas en el secundario es 12000 V, voltaje de trabajo de resistencia

$$V_{L-N} = \frac{V_{L-L}}{\sqrt{3}}$$

- V_{L-N} : Voltaje de línea a neutro
- V_{L-L} : Voltaje de línea a línea (fase a fase)

$$V_{L-N} = \frac{12000}{\sqrt{3}} = 6930\text{V}$$

En sistemas de media y alta tensión por casa 1MVA de potencia en el transformador se necesita 1A en la resistencia neutro, dado que disponemos de un transformador de potencia con 10MVA se instalara una resistencia neutro de 10A.

Dado que se dispone de un relé de protección en el transformador, seleccionaremos un rating de 10 segundos para la resistencia.

A veces la resistencia de neutro se escoge según sugerencias del fabricante del transformador de potencia, del fabricante de resistencias de neutro y/o requerimientos del cliente.

1.11. INTERRUPTOR DE POTENCIA

El Voltaje en el lado secundario $V_n=12\text{kV}$, con derrateo por altura 15,9kV y normalizado 20kV.

Para una corriente nominal de 481A considerando el derrateo por altura 455A, se considera una reserva de 25% en la carga por lo tanto se necesitaría $455 \times 1,25 = 570\text{A}$, por lo cual se selecciona un interruptor para una corriente máxima de 600 A.

En la marca Line Power existen dos clases de interruptores, clase 15,5kV y clase 27kV, dado que nuestro sistema tiene un voltaje máximo normalizado de 20kV procederemos con la clase 27kV con 125kV BIL, 12,5kA capacidad de interrupción. A la vez debemos de indicar que el interruptor presenta un seccionador de puesta a tierra ante la apertura del interruptor, bobinas de disparo para un sobre o bajo voltaje detectado.

1.12. TRANSFORMADORES DE INSTRUMENTACIÓN

Ratio: relación de transformación, en este caso el estándar es 5 amperios en el lado secundario.

Precisión (Accuracy): es el porcentaje de corrección para obtener una lectura adecuada.

Tabla 6 - Error en ratio y desp. de fase, para medicion según IEC 61869.

Accuracy class	Ratio error from 0,8Un to 1,2Un	Phase displ. from 0,8Un to 1,2Un
0,1	0,1%	5'
0,2	0,2%	10'
0,5	0,5%	20'
1	1%	40'
3	3%	-

Tabla 7 - Error en ratio y desp. de fase, para proteccion IEC 61869.

Accuracy class	Ratio error from 0,05Un to voltage factor x Un	Phase displ. from 0,05Un to voltage factor x Un
3P	3%	120'
6P	6%	240'

Potencia nominal (Burden): capacidad de carga, se expresa en VA a un factor de potencia dado.

Tabla 8 - Cargas asociadas estándares para transf. de voltaje.

STANDARD VT BURDENS					
Burden Designation	Resistance (Ohms)	Inductance (mH)	Impedance (Ohms)	VA @ 5 Amps	Power Factor
W	115.2	3.04	1152	12.5	0.1
X	403.2	1.09	576	25	0.7
M	82.3	1.07	411	35	0.2
Y	163.2	0.268	192	75	0.85
Z	61.2	0.101	72	200	0.85
ZZ	30.6	0.0503	36	400	0.85
*Applicable only at 60Hz and a 120V secondary					

Tabla 9 - Cargas asociadas estandares para transf. de corriente.

STANDARD CT BURDENS						
Application	Burden Designation	Resistance (Ohms)	Inductance (mH)	Impedance (Ohms)	VA @ 5 Amps	Power Factor
Metering	B0.1	0.09	0.116	0.1	2.5	0.9
	B0.2	0.18	0.232	0.2	5	0.9
	B0.5	10.45	0.58	0.5	12.5	0.9
	B0.9	0.81	1.04	0.9	22.5	0.9
	B1.8	1.62	2.08	1.8	45	0.9
Relaying	B-1	0.5	2.3	1	25	0.5
	B-2	1	4.6	2	50	0.5
	B-4	2	9.2	4	100	0.5
	B-8	4	18.4	8	200	0.5

Tabla 10 - Clase de rele y carga asociada

Relay Class & Associated Burdens	
Secondary terminal Voltage	Standard Burden
C10	B-0.1
C20	B-0.2
C50	B-0.5
C100	B-1
C200	B-2
C400	B-4
C800	B-8

Clases de precisión: las clases de precisión para transformadores de corriente son:

Tabla 11 - Clases de precision para tranformadores.

CLASE	UTILIZACIÓN
0.10	Calibración.
0.20-0.30	Mediciones en Laboratorios, Alimentación de Integradores para Sistemas de Potencia.
0.50-0.60	Instrumentos de Medición e Integradores. Watthorímetros para Facturación
1.20-3.00	Amperímetros de Tableros. Amperímetros de Registradores. Vatímetros de Tableros. Watthorímetros Indicadores. Fasómetros Indicadores. Fasómetros Registradores. Frecuencímetros de Tableros. Protecciones Diferenciales. Relevadores de Impedancia. Relevadores de Distancia, etc.
5.00	Relevadores de Protección en general.

Transformadores de voltaje

- Definición de la relación de transformadores V_p/V_s

- Preferentemente seleccione como tensión primaria la tensión nominal de servicio de la red.
- Seleccione como tensión secundaria la tensión de entrada nominal del equipo que se va a alimentar.

- Definición de la clase de precisión en función de la aplicación

- Recuerde que los errores instrumentales se suman a los errores de los transformadores que alimentan a ellos.

- Definición del factor de voltaje

- El factor de tensión viene determinado por la tensión de servicio máxima, que depende del sistema de neutro y de las condiciones de puesta a tierra del devanado primario del transformador de tensión.
- Cuando el transformador de tensión se conecta entre dos fases, el factor de tensión es de $1,2 V_n$ continuo.

Las características del transformador que estamos usando es: 12000:120

VAC, 60Hz, 1.5 kVA voltage class, 110kV BIL y está diseñado para una precisión de 0.3 WXYM según normas ANSI. Los cuales llevarán fusibles de protección en el lado primario.

Transformadores de corriente

- La determinación de la relación de transformación I_p/I_s
- Para Transformar la corriente principal, seleccione el valor de la hora estándar inmediatamente superior a la corriente a medir.
- Para La corriente secundaria, elija 1A o 5A DEPENDIENDO el relé o instrumento, y de la distancia entre les transformación y el instrumento se esté alimentando:

5A secundaria se utiliza cuando los instrumentos o relés se encuentran cerca de la transformación, es decir, menos de 10 metros (30 pies).

1A secundario se selecciona preferiblemente Cuando la distancia Entre el transformador de corriente y el instrumento o gire el relé está por encima de 10 metros (30 pies). Las pérdidas por efecto Joule por la resistencia del cable son 25 veces más altas que con 5A con 1A.

- La determinación de la salida de transformar
- Con el fin de definir la salida de transformar en VA, resumir las cargas absorbidas por los equipos conectados a la vez, y la carga de plomo.
- Se recomienda seleccionar la potencia de salida lo más cerca posible a usted, el objetivo más alto que la carga calculada, ya que las características en cuanto a precisión y factor de seguridad pueden ser modificados de otra manera.
- Definición de la clase de precisión
- Recuerde que los errores instrumentales se suman a los errores de los transformadores que alimentan a ellos.
- Definición del tipo de transformador con enfoque en la conexión y montaje.

- Cuando la corriente primaria es muy baja, unos pocos amperios a algunas decenas de amperios, se utiliza preferiblemente un transformador primario herido.
- Los transformadores de tipo ventana, donde el conductor primario es un cable o una barra que pasa a través del transformador, se utilizan cuando las corrientes a medir son superiores a 150 A. Sus prestaciones se reducen cuando la corriente primaria es bastante baja (entre 40 y 150 A).
- No es práctico ni económico usarlos por debajo de 40A. El modelo se selecciona en función del tipo de conductor primario, cable o barra colectora, y de su sección transversal.

En la línea principal

$I=456,9A$ => inmediato superior : $I_p=600A$
Relé ubicado a menos de 10 metros : $I_s=5A$
Se usa un busbar de 10x40mm : ventana de 5,5" (140mm)

Medición: 30 VA – CL 0,3, 600:5A

Protección: 30 VA – CL C200; 600:5A

En la línea de los dos alimentadores

$I/2=228,5A$ => inmediato superior : $I_p=300A$
Relé ubicado a menos de 10 metros : $I_s=5A$
Se usa cable jumper 70mm² : ventana de 5,5" (140mm)

Medición: 30 VA – CL 0,3, 300:5A

Protección: 30 VA – CL C100; 300-5A

1.13. TRASFORMADOR DE CONTROL

El transformador de control alimenta únicamente el transformador de aislamiento por lo que las potencias de estos dos transformadores deben la 10KVA (ver cálculo de transformador de aislamiento)

También se debe cumplir los niveles de voltaje nominal y nivel de aislamiento, para nuestro caso

- Nominal : 20KV
- Aislamiento: 125 kV BIL

Debemos escoger según catálogos el equipo que más se aproxime con estas características.

En el presente proyecto se presenta un problema para la selección de este dispositivo dado que el fabricante Instrument Transformers Inc no presenta la gamma deseada, y el inmediato superior es demasiado grande y costoso.

Analizamos nuevamente nuestro sistema sin derrateo por altura.

Para un voltaje de línea de 12kV normalizado a 15kV corresponde un nivel de aislamiento de 95kV BIL. Con esta solución verificando las tablas del fabricante se puede escoger un transformador CPT5-90-10-123 (15kV, 90kV BIL, 10KVA, 1200A)

1.14. FUSIBLES DE MT PARA TRANSFORMADOR DE CONTROL

Según Norma ANSI C37.40

Los fusibles de media tensión clasificados por E, de bajo amperaje son fusibles limitadores de corriente de uso general. Un fusible de limitación de corriente de propósito general es capaz de interrumpir toda la corriente desde la corriente de interrupción nominal hasta la corriente que causa la fusión del elemento fusible en 1 hora.

Según Norma ANSI C37.46

El elemento de respuesta a la corriente se fundirá en 300 segundos a una corriente RMS dentro del rango de 200% a 240% de la corriente continua del fusible, recarga de fusibles o enlace. (Para fusibles de 100E o menos).

Para transformadores con voltajes superiores a 600V y protección primaria y secundaria: En lugares no supervisados, con primaria sobre 600V, el fusible primario puede ser clasificado en un máximo del 300%. Si el secundario es también superior a 600 V, los fusibles secundarios se pueden dimensionar a un máximo de 250% para transformadores con impedancias no superiores al 6% o 225% para transformadores con impedancias superiores al 6% y no superiores al 10%. Si la secundaria es de 600 V o menos, los fusibles secundarios pueden dimensionarse a un máximo de 125%. Cuando estas clasificaciones no corresponden a un tamaño de fusible estándar, se permite el siguiente tamaño estándar más alto.

Para una potencia de 10kVA

Voltaje de línea: 12kV

$$I = 10\text{kVA} / 12\text{ kV} = 0,8\text{ A}$$

Usado la regla del 300%

$$300\% \times (0,8\text{A}) = 2,4\text{ A}$$

Se escoge un fusible inmediato superior a 2,4 A, en este caso se escogerá 3E.

Cabe indicar también que el fabricante ya ha considerado las normas anteriormente citadas y nos brinda directamente una solución. Para nuestro caso; un transformador CPT5-90-10-123 el fabricante recomienda 2 fusibles 3E.

También se debe cumplir la regla de voltaje nominal y que esta coincidan con el valor elegido para transformador a proteger (transformador de control), para este caso 15kV.

1.15. TRANSFORMADOR DE AISLAMIENTO

El transformador de aislamiento alimenta las dos siguientes cargas:

- Cargador de baterías
- Tablero de servicios auxiliares

Cargador de baterías

$$P=V.I$$

Donde:

- P : Potencia del cargador
- I=15A : Corriente que suministra el cargador (ver cálculo del cargador)
- V=240V : Voltaje de alimentación del cargador

Nota: se está considerando perdidas mínimas en el cargador.

$$P= 240Vac*15,5 A = 3,7KVA$$

Tablero de servicios auxiliares

- Señalización	: (04) x 15W = 60W	=> 0,5 Amp
- Alumbrado externo	: (04) x 100W = 400W	=> 3,5 Amp
- Alumbrado externo	: (02) x 400W = 800W	=> 6,5 Amp
- Relés	: (04) x 50W	=> 2 Amp
- Circuitos de control	:	=> 2 Amp
- Operador remoto de secc.:		=> 8 Amp
- Tablero de transf. de Pot. :		=> 1 Amp
- Tomacorrientes	: 400W	=> 3,5 Amp
- Reserva	: 400W	=> 3,5 Amp
TOTAL	:	=> 30,5 Amp

$$\text{KVA} = 30,5 \text{ Amp} * 120\text{Vac} = 3,66 \text{ KVA}$$

Sumando las potencias consumidas por el cargador de baterías y el panel de distribución de servicios auxiliares

$$\text{KVA} = 3,7 + 3,66 = 7,38 \text{ KVA}$$

Se escoge según tablas el transformador inmediato superior, según el fabricante 10KVA.

Dado que el voltaje primario de este transformador es 240Vac (bajo voltaje) se necesita un nivel de aislamiento de 1kV.

1.16. BATERÍAS

Las baterías KPM tienen una carga máxima de 1,60Vcc por cada celda, y un voltaje final de descarga de 1,10Vcc, por lo que la carga media es de 1,35Vcc para llegar a los 125Vcc se necesitan 92 celdas; $92 \times 1,35\text{Vcc} = 124,2\text{Vcc}$

La voltaje máximo de carga del banco de baterías es $92 \times 1,60\text{Vcc} = 147\text{Vcc}$.

El voltaje final de descarga del banco de baterías es $92\text{celdas} \times 1,10 \text{ V} = 101,2\text{Vcc}$.

Para baterías KPM-70P del cuadro de descargas proporcionado por el fabricante se puede entregar una corriente de 8,5A durante 8 horas.

1.17. CARGADOR DE BATERÍAS

El cargador debe ser capaz de brindar la potencia para de forma simultánea cargar la batería y alimentar el resto de cargas en corriente continua.

Corriente necesaria para cargar la batería

El banco de baterías consume después de una descarga profunda una corriente de recarga durante 8 horas de:

$$I_{\text{baterias}} = 70\text{Ah} \times 1.20 / 8\text{horas} = 10,5 \text{ Amperios.}$$

(El banco de baterías luego que está cargado y se encuentra en flotación consume menos de 1 Amperio).

Resto de cargas en corriente continua.

- Cargas permanentes: Iluminación que consume 5 Amperios
- Cargas momentáneas: Motor del seccionador que consume unos 6Amperios entre 5 y 11 segundos.

Para la evaluación de la capacidad, se debe tomar solo la carga permanente, dado que la momentánea tiene muy corta duración y es compensada entre el cargador y el banco de baterías conectados en paralelo.

$$I_{\text{cargas}} = 5 \text{ A}$$

Luego el cargador debe poder entregar en la condición más exigente como mínimo ambas corrientes:

$$I_{\text{baterias}} + I_{\text{carga}} = 10,5 + 5 = 15,5 \text{ A}$$

Según el catalogo del fabricante (Alpha), el cargador con corriente de salida inmediato superior a 15,5A es 20A.

A vece cabe recalcar que el cliente establece condiciones adicionales por ejemplo en este caso se solicitó que el cargador brinde una corriente como mínimo de 40A por lo que se procedió a elegir según catalogo el de 50A.

1.18. BARRAS DE COBRE

Se usaran barras de cobre en el lado secundario con $V_n=12\text{kV}$

Las barras de cobre deben poder soportar la corriente nominal derrateado para una altura de 3800 msnm, a una temperatura ambiental de 35°C .

Como se procedió en el dimensionamiento del transformador de potencia.

$$I_s = \frac{P}{V \cdot \sqrt{3}} = \frac{10\text{MVA}}{12\text{kV} \cdot \sqrt{3}} \cong 481\text{ A}$$

$$ACF = 1 - 0,02 * \frac{H - 1000}{1000} = 1 - 0,02 * \frac{3500 - 1000}{1000} = 0,95$$

Corriente lado secundario derrateado = $I_s * k = 481 * 0,95 = 457\text{ A}$

Procedemos a seleccionar barras de cobre con ancho de 10mm y alto de 50mm que según tablas soporta hasta 1020A.

1.19. CABLES DE FUERZA

Desde las barras de cobre se desprenden los dos alimentadores, la conexión desde las barras hasta los conectores de salida de los alimentadores se realiza mediante cable.

La corriente nominal derrateada es: $457/2=228\text{A}$

Dado que se debe mantener una reserva de carga del 25%, la corriente de dimensionamiento es $1,25*228=289\text{ A}$.

Para el pequeño espacio que se dispone en la caseta el cable de fuerza debe ser extraflexible, apantallado para garantizar las descargas residuales,

Según la tabla del fabricante líneas abajo:

Se seleccionara cable jumper de 25kV, 300A. Estos conductores debes tener una separación mínima entre fases, debe estar aislado por aire o usar material dieléctrico aislante.

Para la conexión de neutro a tierra dado que el $V_{L-N}=6930V$, se usará cable jumper de 15kV, 250A.

Tabla 12 - Cable jumper

	CAT NO	SIZE AWG	STRANDING	RATING AMPS	WEIGHT PER 1,000 FT
15KV	12198	#2	259	200	440 LBS
	12199	1/0	427	250	600 LBS
	12200	2/0	427	300	710 LBS
	12201	4/0	532	400	1,050 LBS
25KV	6874	2/0	427	300	903 LBS
35KV	6859	1/0	427	250	1,130 LBS

1.20. AISLADORES

Los aisladores son usados para soportar los conductores eléctricos y aislarlos de tierra y de otros conductores.

En nuestro caso se usaran aisladores para soportar las barras de cobre.

Debe aislar eléctricamente el conductor soportando el voltaje en condiciones normales y las sobretensiones en sus condiciones máximas previstas.

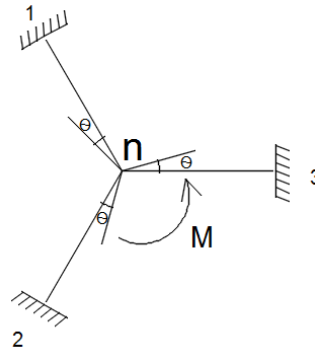
El uso de los niveles básicos de aislamiento (BIL) para los voltajes nominales del sistema, debe permitir en forma adecuada la coordinación del aislamiento con el resto del aislamiento de la instalación y con los equipos de protección.

Para nuestro sistema de 12kV derrateado y normalizado a 20kV, por lo que se procederá a usar soportes aisladores de barra de 24kV para uso en interiores.

2. CALCULOS MECANICOS

METODO DE CROSS

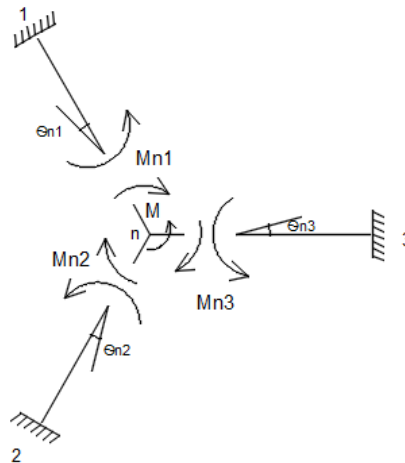
Método simplificado de cálculo de estructuras reticuladas planas.



M: momento exterior aplicado en el nodo n.

θ : giro que se produce en el nodo n.

Aislamos el nodo de las barras.

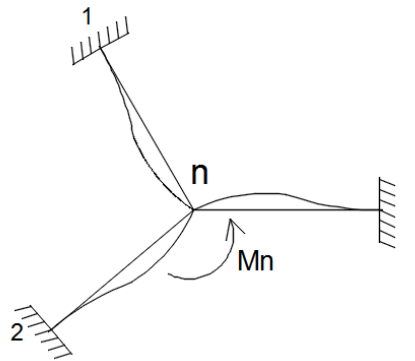


El momento M aplicado sobre el nodo "n" se reparte entre las barras que confluyen en el nodo, de manera proporcional a la rigidez de las barras.

$$M_{n1} + M_{n2} + M_{n3} = M$$

El ángulo de giro en el nodo "n" es el mismo en todas las barras que confluyen en el nodo.

$$\theta_{n1} = \theta_{n2} = \theta_{n3} = \theta$$



Reparto del momento

$$M_{in} = \mu_{in} * M_n$$

μ_{in} : Coeficiente de reparto de la barra "in"

$$\mu_{in} = \frac{K_{in}}{\sum K_{in}}$$

K_{in} : Coeficiente de rigidez de la barra "in"

$$K_{in} = \frac{4E_{in}I_{in}}{L_{in}}$$

E_{in} : Modulo de elasticidad de la barra "in"

I_{in} : Momento de inercia de la barra "in"

Transmisión de momento

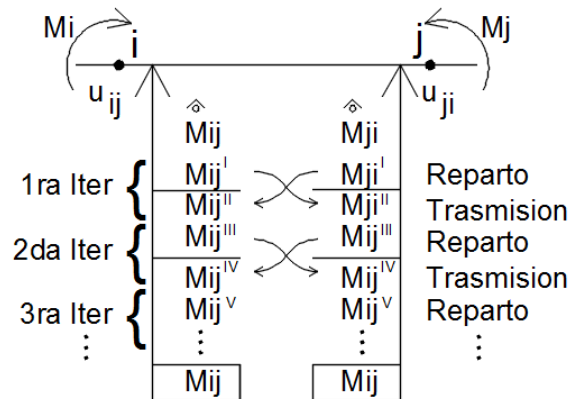
Parte del momento que aparece en la barra en el nodo en el que se aplica el momento exterior se transmite al extremo opuesto.

$$M_{ni} = \gamma_{ni} * M_{in}$$

γ_{ni} : Coeficiente de transmisión

$\gamma = 0,5$ (para barras de sección constante)

Barra genérica



Enclavamos los nodos "i" y "j"

$\hat{M}$: Empotramiento perfecto.

1ra Iteración

- Desequilibrio

$$M_{desq_i} = M_i - \sum \hat{M}_i$$

$$M_{desq_j} = M_j - \sum \hat{M}_j$$

- Reparto: Quitamos el enclavamiento M_{desq} actúa sobre los nodos y se produce el reparto.

$$M_{ij}^I = \mu_{ij} * M_{desq_i}$$

$$M_{ji}^I = \mu_{ji} * M_{desq_j}$$

En estos momentos la estructura se encuentra en equilibrio.

- Trasmisión: Los momentos repartidos se transmiten a sus nodos opuestos.

$$M_{ij}^{II} = \gamma_{ij} * M_{ji}^I$$

$$M_{ji}^{II} = \gamma_{ji} * M_{ij}^I$$

2da iteración

- Nuevos momentos de desequilibrio.

$$M_{desq_i} = -\sum M_i^{II} = 0$$

$$M_{desq_j} = -\sum M_j^{II} = 0$$

- Reparto

$$M_{ij}^{III} = \mu_{ij} * M_{desq_i}$$

$$M_{ji}^{III} = \mu_{ji} * M_{desq_j}$$

- Trasmisión

$$M_{ij}^{IV} = \gamma_{ij} * M_{ji}^{III}$$

$$M_{ji}^{IV} = \gamma_{ji} * M_{ij}^{III}$$

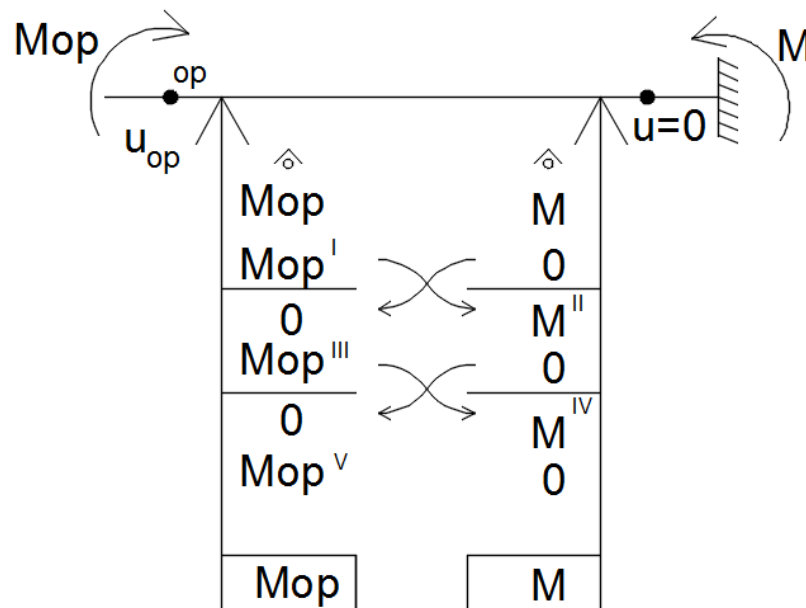
El proceso se repite hasta obtener un momento de reparto máximo del 10% del máximo momento de empotramiento perfecto $\hat{M}$.

En la última iteración solo se hace reparto, el momento final es la suma de todos los momentos calculados.

$$M_{ij} = \hat{M}_{ij} + M_{ij}^I + M_{ij}^{II} + M_{ij}^{III} + \dots$$

$$M_{ji} = \hat{M}_{ji} + M_{ji}^I + M_{ji}^{II} + M_{ji}^{III} + \dots$$

Barra con un nodo empotrado.

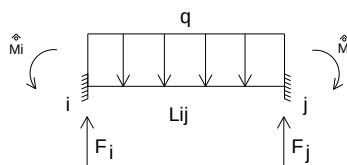


Se puede calcular el momento en el nodo empotrado directamente con los datos del nodo opuesto "op"

$$M = \hat{M} + \gamma(M_{op} - \hat{M}_{op})$$

Empotramiento perfecto

- Carga distribuida

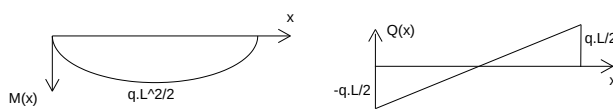


$\hat{M}$: Momento generado por la aplicación de la carga q.

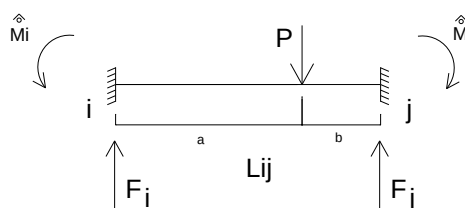
F: Fuerza de reacción generado por la aplicación de la carga q.

$$\hat{M}_{ij} = \hat{M}_{ji} = \frac{q \cdot L_{ij}^2}{12} ; \quad M_{max} = \frac{q \cdot L_{ij}^2}{8} ; \quad F_{ij} = F_{ji} = \frac{q \cdot L_{ij}}{2}$$

Diagrama de momentos flectores y fuerza de corte.



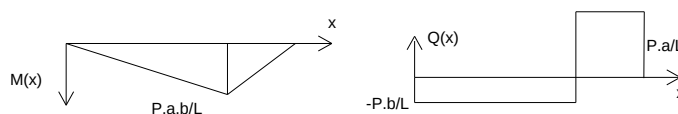
- Para una carga puntual



$\hat{M}$: Momento generado por la aplicación de la carga q.

F: Fuerza de reacción generado por la aplicación de la carga q.

$$\hat{M}_i = \frac{P \cdot a \cdot b^2}{L_{ij}^2} ; \quad \hat{M}_j = \frac{P \cdot b \cdot a^2}{L_{ij}^2} ; \quad \hat{M}_i = \frac{P \cdot a \cdot b}{L_{ij}} ; \quad F_i = \frac{P \cdot b}{L_{ij}} ; \quad F_j = \frac{P \cdot a}{L_{ij}}$$



DIMENSIONADO DE VIGAS

Para el dimensionamiento de las vigas se deben analizar la fuerza de corte, la fuerza axial y el momento flector máximo sobre cada viga.

- M_{ED} : Momento flector máximo aplicado sobre la viga.
- V_{ED} : Fuerza cortante máxima aplicada sobre la viga.
- N_{ED} : Fuerza de normal máxima aplicada sobre la viga.

Limite elástico de diseño (f_{yd})

$$f_{yd} = \frac{f_y}{\gamma_{M0}}$$

- $f_y = 200MPa$: Limite elástico del acero clase S200.
- $\gamma_{M0} = 1.05$: Coeficiente de seguridad relativo a la plastificación del material.

Resistencia de las secciones a la flexión ($M_{C,Rd}$)

$$M_{C,Rd} = W \cdot f_{yd}$$

- W : Modulo resistente de la viga.

Resistencia de las secciones al corte ($V_{C,Rd}$)

$$V_{C,Rd} = A \cdot \frac{f_{yd}}{\sqrt{3}}$$

- A : Área cortante

Resistencia de las secciones a cargas axiales (N_{Rd})

$$N_{Rd} = A \cdot f_{yd}$$

Pandeo

Resistencia de la barra al pandeo ($N_{b,Rd}$)

$$N_{b,Rd} = X \cdot A \cdot f_{yd}$$

- X : Coeficiente de reducción por pandeo.
- A : Área.

$$f_{yd} = \frac{f_y}{\gamma_{M1}}$$

- $\gamma_{M1} = 1.05$: Coeficiente de seguridad relativo al pandeo.

Compresión critica por pandeo (N_{CR})

$$N_{CR} = \left(\frac{\pi}{L_k} \right)^2 E \cdot I$$

- $E = 200\text{GPa}$: Modulo de elasticidad del acero.
- I : Momento de inercia en el plano considerado.
- L_k : Longitud de pandeo de la pieza.

$$L_k = \beta \cdot L$$

- β : Coeficiente de longitud (Tabla 6.1 del Código Básico SE-A)
- L : Longitud de la pieza

Esbeltez reducida ($\bar{\lambda}$)

$$\bar{\lambda} = \sqrt{\frac{A \cdot f_y}{N_{CR}}}$$

Coeficiente de reducción por pandeo (X)

$$X = \frac{1}{\phi + \sqrt{\phi^2 - \bar{\lambda}^2}}$$

Siendo ϕ

$$\phi = 0.5(1 + \alpha(\bar{\lambda} - 0.2) + \bar{\lambda}^2)$$

$\alpha=0,13$: Coeficiente de imperfección. (Tabla 6.2 de Documento Básico SE-A)

Pandeo lateral

Resistencia de la barra al pandeo lateral ($N_{b,Rd}$)

$$N_{b,Rd} = X_{LT} \cdot A \cdot f_{yd}$$

- X_{LT} : Coeficiente de reducción por pandeo lateral.

Resistencia de la barra al pandeo lateral ($M_{b,Rd}$)

$$M_{b,Rd_{LT}} = X_{LT} \cdot W_{LT} \cdot f_{yd}$$

- W_{LT} : Modulo resistente de la viga en el sentido lateral.

$$f_{yd} = \frac{f_y}{\gamma_{M1}}$$

- $\gamma_{M1} = 1.05$: Coeficiente de seguridad relativo al pandeo.

Esbeltez reducida frente a pandeo latera ($\overline{\lambda}_{LT}$)

$$\overline{\lambda}_{LT} = \sqrt{\frac{W_{LT} \cdot f_y}{M_{CR}}}$$

- M_{CR} : Momento crítico de pandeo lateral

Coeficiente de reducción por pandeo (X_{LT})

$$X_{LT} = \frac{1}{\phi_{LT} + \sqrt{\phi_{LT}^2 - \overline{\lambda}_{LT}^2}}$$

Siendo ϕ_{LT}

$$\phi_{LT} = 0.5 \left(1 + \alpha(\overline{\lambda}_{LT} - 0.2) + \overline{\lambda}_{LT}^2 \right)$$

$\alpha=0,74$: Coeficiente de imperfección (tabla 6.6 de Documento Básico SE-A)

Comprobaciones para el diseño:

Verificación de que los perfiles seleccionados cumplen la normativa del Código Cásico de Seguridad Estructural Acero.

Verificación de flexión simple (momento flector + fuerza cortante)

$$\frac{V_{ED}}{V_{C,Rd}} < 1$$

Si $\frac{V_{ED}}{V_{C,Rd}} < 0,5$ se debe comprobar la siguiente expresión.

$$\frac{M_{ED}}{M_{v,Rd}} < 1$$

Siendo

$$M_{v,Rd} = W - \frac{\rho \cdot A_v^2}{4 \cdot t_w}$$

$$\rho = \left(2 \cdot \frac{V_{ED}}{V_{C,Rd}} - 1 \right)^2$$

Verificación de la flexión compuesta (momento flector + fuerza axial)

$$\frac{N_{ED}}{N_{Rd}} + \frac{M_{ED}}{M_{C,Rd}} \leq 1$$

Verificación pandeo lateral

$$\frac{M_{ED}}{M_{b,Rd}} < 1$$

Verificación de interacción (pandeo + flexión)

$$\frac{N_{Ed}}{N_{b,Rd}} + k_y * \frac{c_m \cdot M_{Ed}}{X_{LT} \cdot W_{LT} \cdot f_{yd}} \leq 1$$
$$\frac{N_{Ed}}{N_{b,Rd_{LT}}} + \alpha_y \cdot k_y * \frac{c_m \cdot M_{Ed}}{W_{LT} \cdot f_{yd}} \leq 1 \quad \text{Lateral}$$

$$k_y = 1 + 0.6\bar{\lambda} \cdot \frac{N_{Ed}}{X_{..} N_{CR}}$$

Tabla 6.9 del Código Básico SE-A

$$c_m = 0.2 + 0.8\alpha$$

Coficiente de momento equivalente (Tabla 6.10 del CB SE-A)

$$\alpha_y = 0.8$$

Tabla 6.8 del Código Básico SE-A

2.1. PÓRTICO.

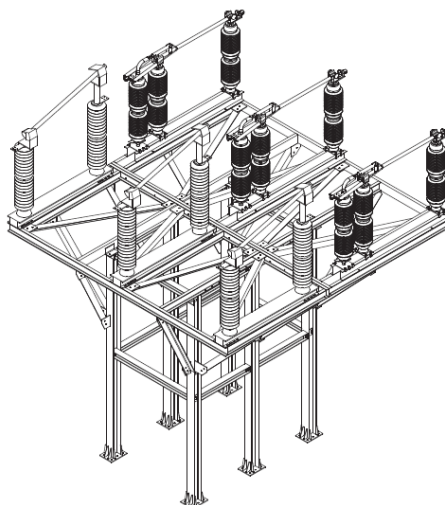


Figura 3 - Portico vista isométrica

2.1.1. Vista posterior

2.1.1.1. Calculo por método de Cross

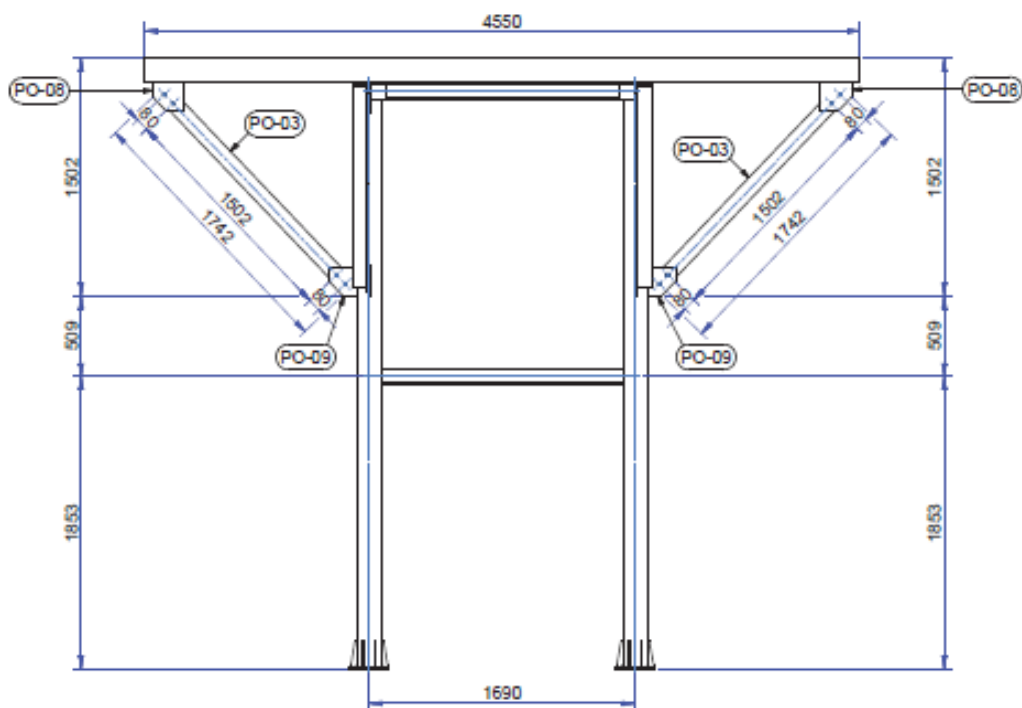


Figura 4 - Pórtico vista posterior.

Con los datos de pesos de los equipos procedemos al cálculo de las fuerzas aplicadas.

Carga	DESCRIPCION	Unid	Cant	Peso Unit (kg)	Peso (Kg)
1	Seccionador de Potencia	Fases	03	150	450
2	Portafusibles y fusibles	Fases	03	318	954

De la figura 3 podemos notar que existen 3 pórticos idénticos

La fuerza total aplicado sobre el pórtico de la vista posterior será 1/3 del peso total.

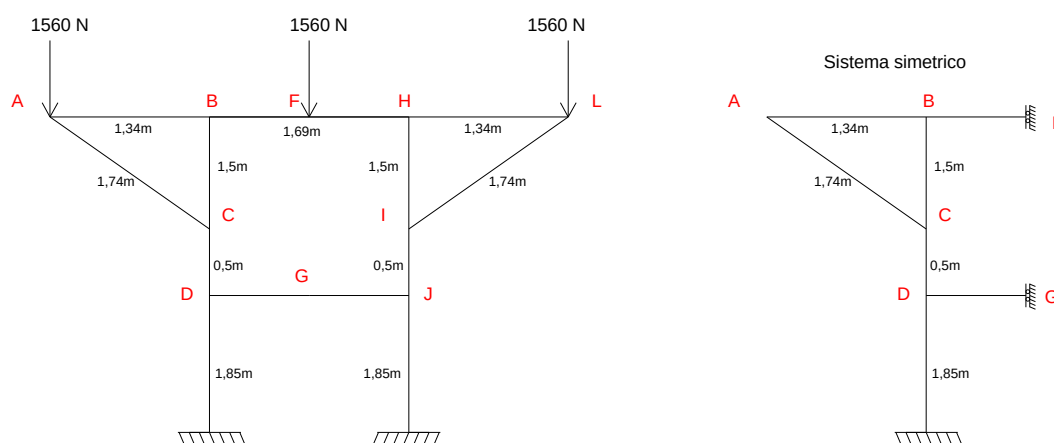
$$\text{Carga}_1 = 1/3 (450 + 954) = 468 \text{ kg}$$

Esta carga se concentra por partes iguales en los extremos y en el centro, dado que es donde se ubican cada fase de los equipos.

Por lo tanto

$$\text{Carga}_{2l} = 1/3 (468 \text{ Kg}) = 156 \text{ kg (1560 N)}$$

Diagrama para cálculo por método de Cross.



Momentos de inercia

Los momentos de inercia se obtienen de tablas de perfiles.

It	Barra	DESCRIPCION	Sentido de la viga	Longitud (mm)	Inercia (cm ⁴)
1	AB	Viga U 150mm x 50mm x 15,5 Kg/m	x-x	1340	609
2	AC	Angulo 100mm x 100mm x 6mm	x-x	1742	126
3	BC	Viga W 150mm x 150mm x 22,5 Kg/m	y-y	1502	387
4	BF	Viga U 150mm x 50mm x 15,5 Kg/m	x-x	1690	609
5	CD	Viga W 150mm x 150mm x 22,5 Kg/m	y-y	509	387
6	DE	Viga W 150mm x 150mm x 22,5 Kg/m	y-y	1853	387
7	DG	Viga W 100mm x 100mm x 19,3 Kg/m	x-x	1690	476

Coeficientes de rigidez (kN-m)

Se procederá con acero ($E = 2 \cdot 10^7 \frac{kN}{m^2}$)

K	A	B	C	D	E	F	G
A		Kab	Kac				
B	Kba		Kbc			Kbf	
C	Kca	Kcb		Kcd			
D			Kdc		Kde		Kdg
E				Ked			
F		Kfb					
G				Kgd			

K	A	B	C	D	E	F	G
A		364	58				
B	364		206			144	
C	58	206		608			
D			608		167		113
E				167			
F		144					
G				113			

Nodo i	$\sum K_i$
A	421
B	714
C	871
D	887
E	167
F	144
G	113

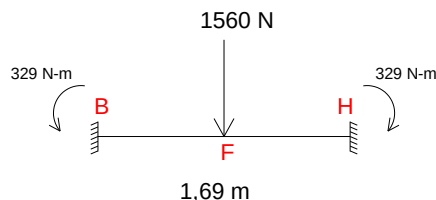
Coeficientes de reparto

μ	A	B	C	D	E	F	G
A		μ_{ab}	μ_{ac}				
B	μ_{ba}		μ_{bc}			μ_{bf}	
C	μ_{ca}	μ_{cb}		μ_{cd}			
D			μ_{dc}		μ_{de}		μ_{dg}
E				μ_{ed}			
F		μ_{fb}					
G				μ_{gd}			

μ	A	B	C	D	E	F	G
A		0,86	0,14				
B	0,51		0,29			0,20	
C	0,07	0,24		0,70			
D			0,68		0,19		0,13
E				1,00			
F		1,00					
G				1,00			

Nodo	Σ
A	1,00
B	1,00
C	1,00
D	1,00
E	1,00
F	1,00
G	1,00

Momento de empotramiento perfecto

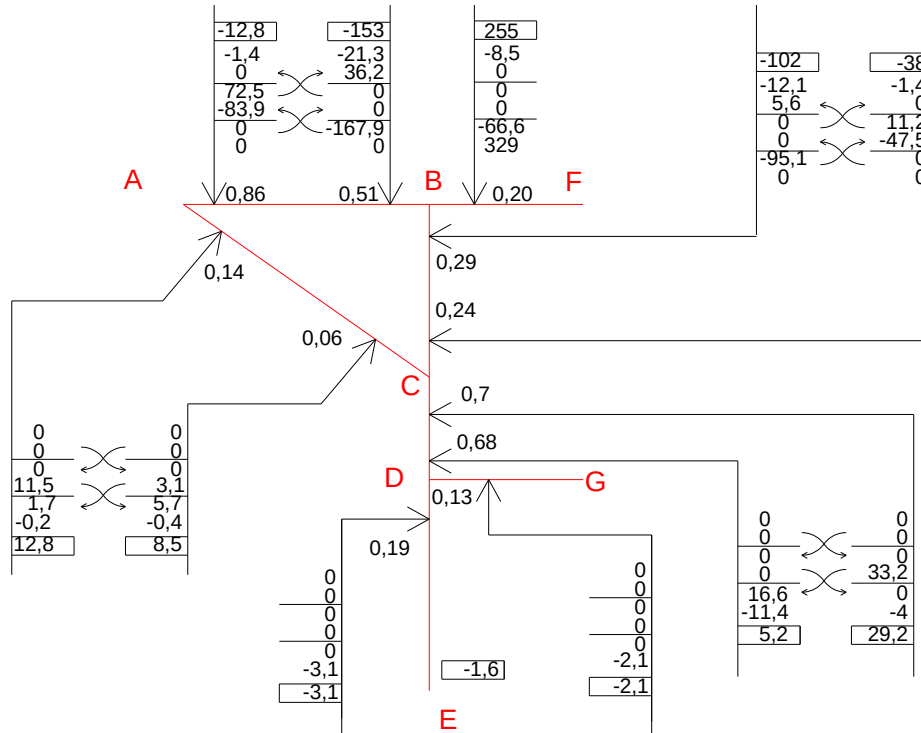


Se realizaron 3 iteraciones, en la tercera iteración se encuentra un momento de reparto máximo -21,3 N-m en el la barra BA en el nodo B, dicho momento es menor al 10% del momento de empotramiento perfecto máximo de -329 N-m que se da en la barra AB en el nodo A.

A continuación e muestran los momentos de desequilibrio de los cálculos, unidades en N-m

Nodo	Momento de desequilibrio		
	1ra Iteración	2da Iteración	3ra Iteración
A	0,0	83,9	-1,6
B	-329,6	0,0	-41,8
C	0,0	47,5	-5,7
D	0,0	0,0	-16,6
E	0,0	0,0	0,0
F	0,0	0,0	0,0
G	0,0	0,0	0,0

A continuación se muestran los repartos y transmisiones de momento de las 3 iteraciones, unidades en N.-m.



Momentos resultantes, unidades en N.-m.

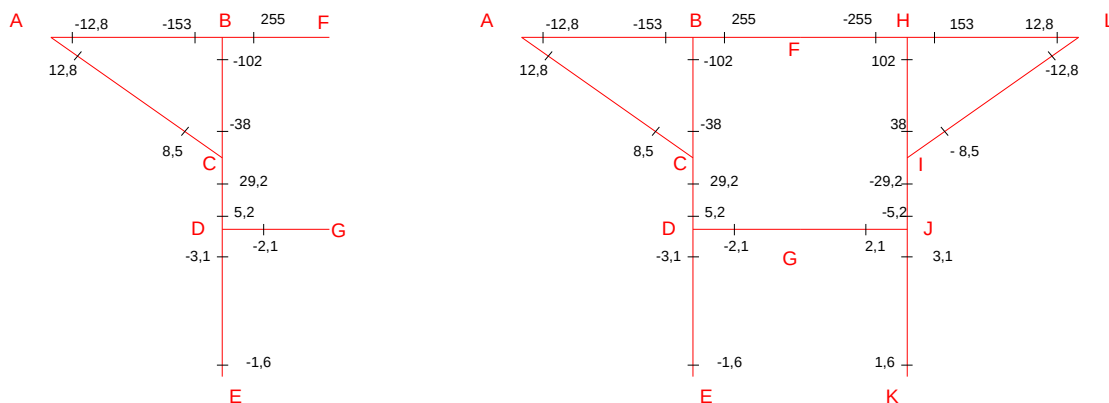
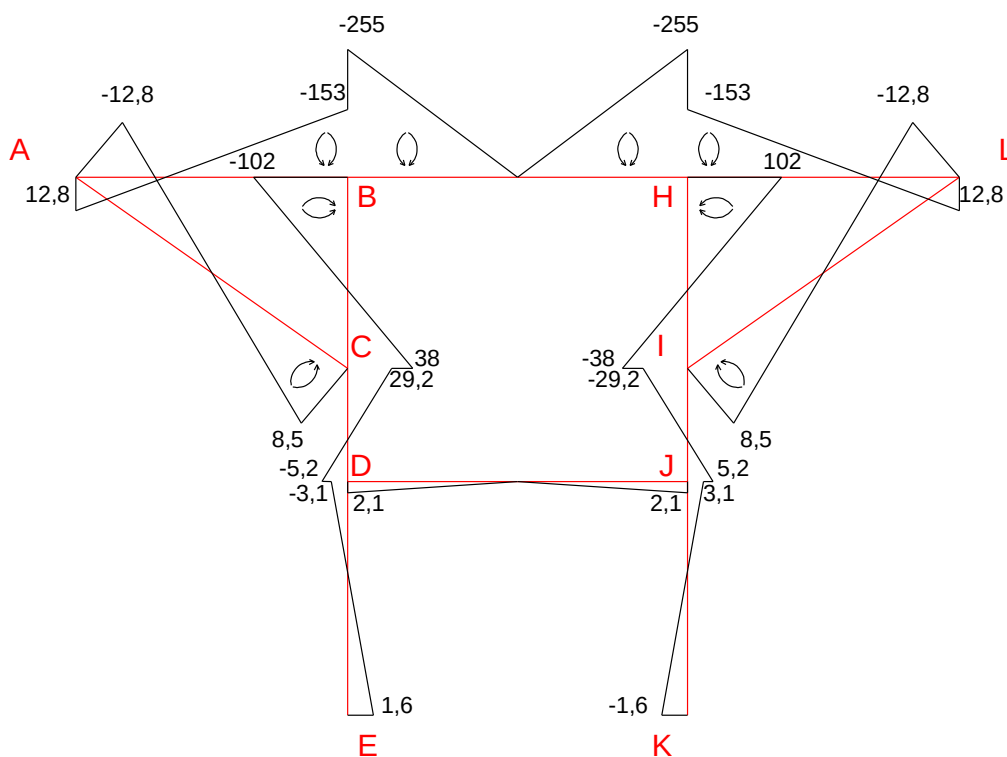
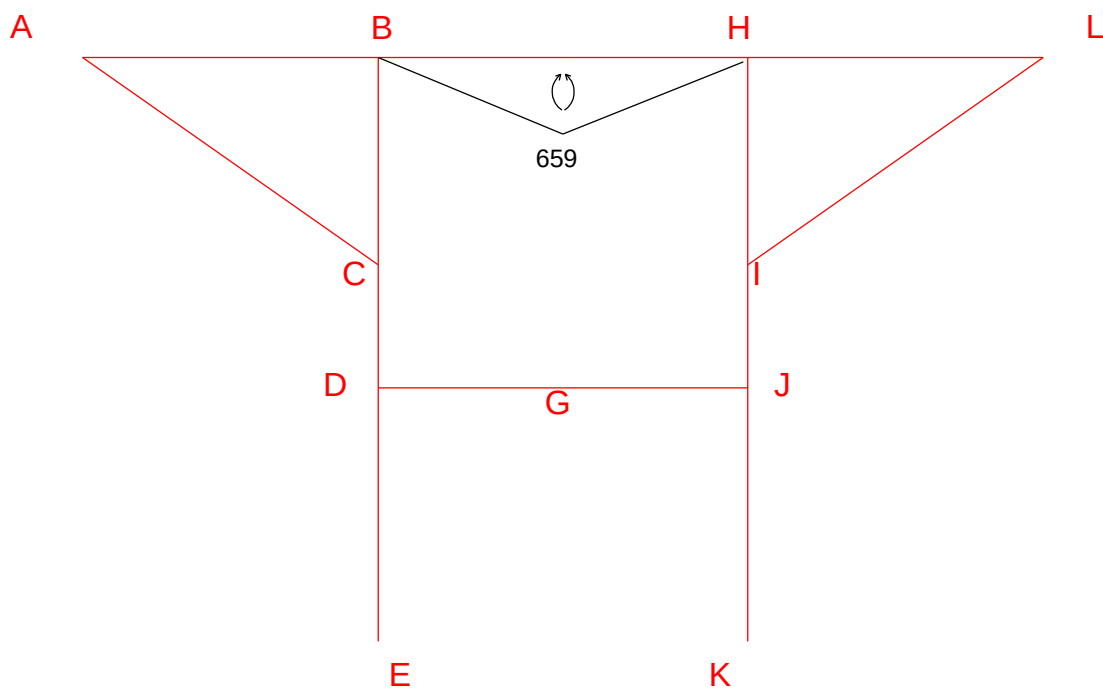


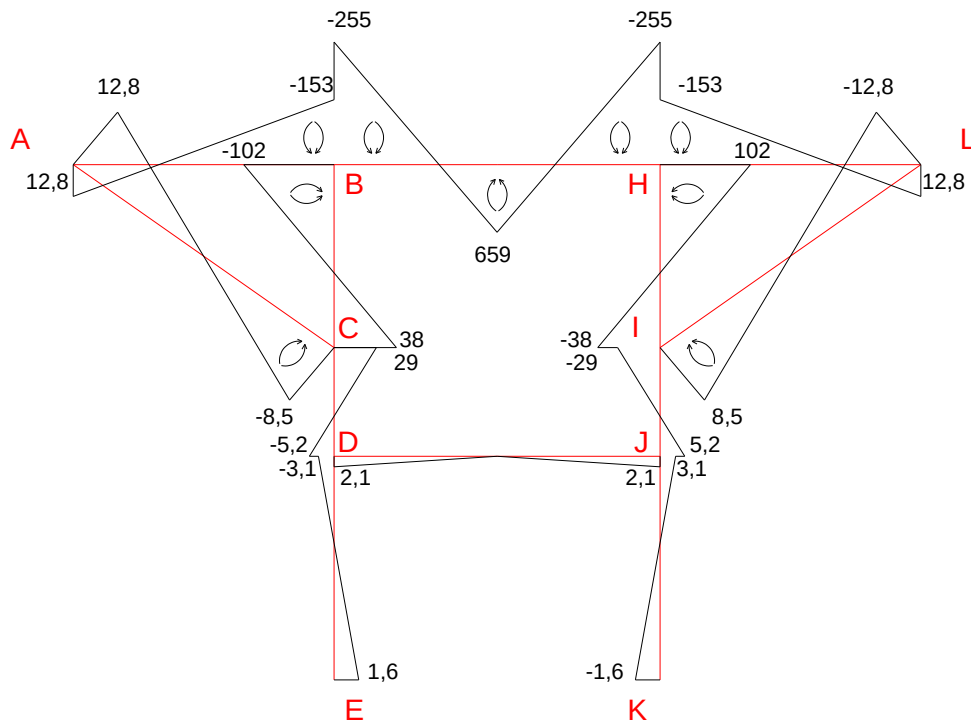
Diagrama de momentos flectores de los resultados de Cross, unidades en N-m.



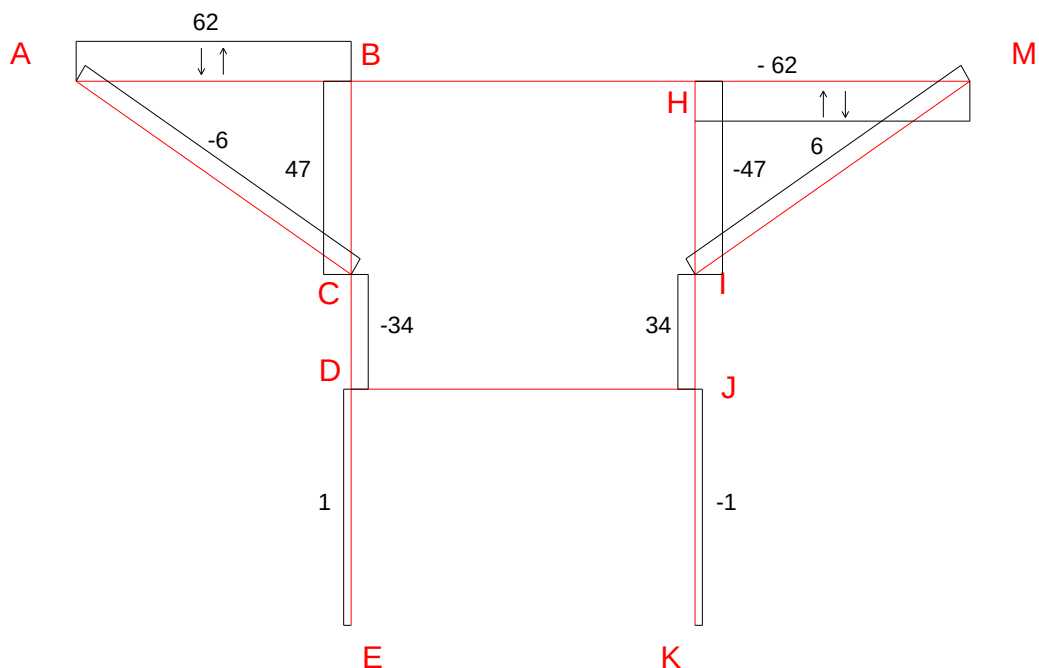
Momentos del empotramiento perfecto, unidades en N-m.



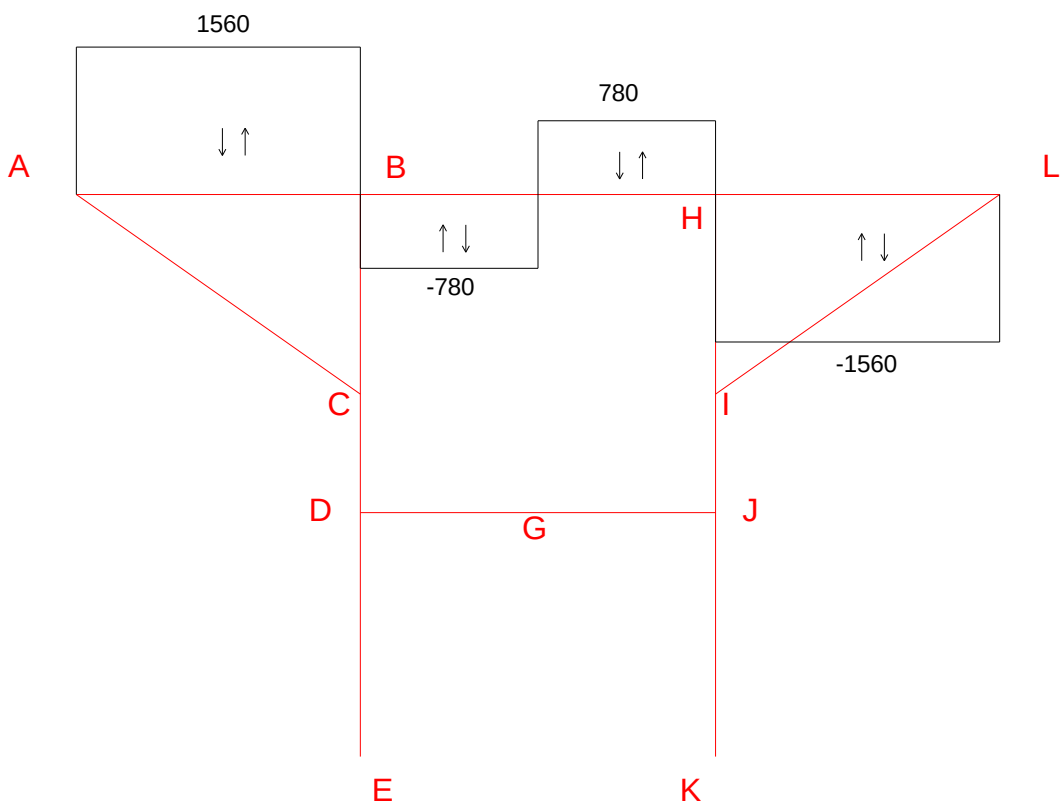
Momento flector resultante (N-m): sumando ambos efectos (cross + empotramiento perfecto)



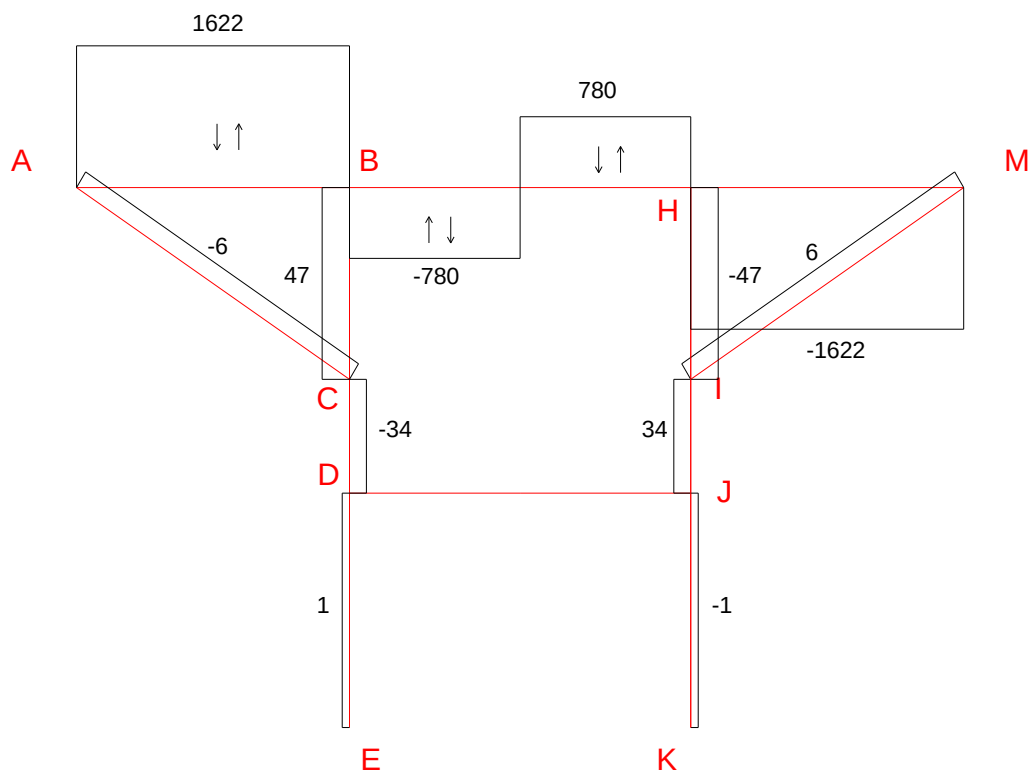
Fuerzas cortantes de los resultados de cross, unidades en N.

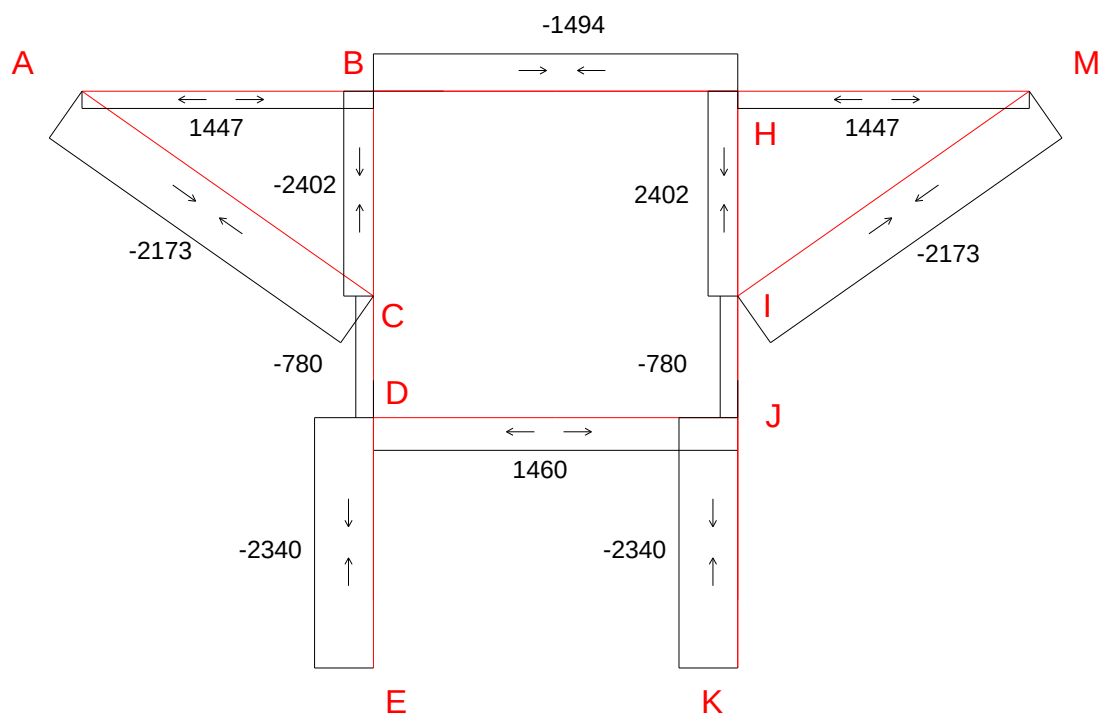


Fuerza cortante en el empotramiento perfecto, unidades en N.



Fuerza cortante resultante: sumando ambos efectos (cross + empotramiento perfecto), unidades en N.



Fuerzas axiales (N)

2.1.1.2. Dimensionamiento de los perfiles

- $f_y = 200MPa$
- $\gamma_{M0} = 1.05$
- $f_{yd} = 200MPa / 1,05 = 190Mpa$
- $E = 200GPa$

De los resultados de Cross, de los gráficos de momento flector, fuerza cortante y fuerza axial se obtienen:

IT	BARRA	Momento flector máximo	Fuerza cortante máxima	Fuerza normal máxima
		M_ED	V_ED	N_ED
		N-m	N	N
1	AB	153	1.622	1.447
2	AC	13	6	2.173
3	BC	102	147	2.402
4	BF	659	780	1.494
5	CD	29	34	780
6	DE	3	1	2.340
7	DG	2	0	1.460

Las características de cada barra son:

IT	BARRA	DESCRIPCION	Momento de inercia	Modulo resistente	Modulo resistente sentido lateral	Área de corte
		NOTACION	I	W	W_LT	A
		Unidades	cm ⁴	cm ³	cm ³	cm ²
1	AB	U 150mm x 50mm x 15,5 Kg/m	609	82	9	20
2	AC	L 100mm x 100mm x 6mm	126	17	17	13
3	BC	W 150mm x 150mm x 22,5 Kg/m	387	51	159	28
4	BF	U 150mm x 50mm x 15,5 Kg/m	609	82	9	20
5	CD	W 150mm x 150mm x 22,5 Kg/m	387	51	159	28
6	DE	W 150mm x 150mm x 22,5 Kg/m	387	51	159	28
7	DG	W 100mm x 100mm x 19,3 Kg/m	476	90	31	24

Se calcula la resistencia a la flexión, al corte y a la carga axial usando las siguientes expresiones:

$$M_{C,Rd} = W \cdot f_{yd}; \quad V_{C,Rd} = A \cdot \frac{f_{yd}}{\sqrt{3}}; \quad N_{Rd} = A \cdot f_{yd}$$

IT	BARRA	Resistencia de las secciones a la flexión	Resistencia de las secciones al corte	Resistencia de las secciones a cargas axiales
		M_C,Rd	V_C,Rd	N_Rd
		N-m	N	N_Rd
1	AB	15.607	217.814	377.265
2	AC	3.192	140.763	243.810
3	BC	9.690	313.199	542.476
4	BF	15.607	217.814	377.265
5	CD	9.690	313.199	542.476
6	DE	9.690	313.199	542.476
7	DG	17.103	265.031	459.048

Verificación de flexión simple

$$\frac{V_{ED}}{V_{C,Rd}} < 1$$

IT	BARRA	Fuerza cortante máxima	Resistencia de las secciones al corte	Verificación de flexión simple
		V_ED	V_C,Rd	
		N	N	
				(10 ⁻³)
1	AB	1.622	217.814	7,4467
2	AC	6	140.763	0,0426
3	BC	147	313.199	0,4694
4	BF	780	217.814	3,5810
5	CD	34	313.199	0,1086
6	DE	1	313.199	0,0032
7	DG	0	265.031	0,0000

Verificación de la flexión compuesta

$$\frac{N_{ED}}{N_{Rd}} + \frac{M_{ED}}{M_{C,Rd}} \leq 1$$

IT	BARRA	Momento flector máximo	Fuerza normal máxima	Resistencia de las secciones a la flexión	Resistencia de las secciones a cargas axiales	Verificación de la flexión compuesta
		M_ED	N_ED	M_C,Rd	N_Rd	
		N-m	N	N-m	N	
1	AB	153	1.447	15.607	377.265	0,0136
2	AC	13	2.173	3.192	243.810	0,0129
3	BC	102	2.402	9.690	542.476	0,0150
4	BF	659	1.494	15.607	377.265	0,0462
5	CD	29	780	9.690	542.476	0,0044
6	DE	3	2.340	9.690	542.476	0,0046
7	DG	2	1.460	17.103	459.048	0,0033

Pandeo

- $f_y = 200MPa$
- $\gamma_{M1} = 1.05$
- $f_{yd} = 200MPa / 1,05 = 190Mpa$
- $\alpha=0,13$: Coeficiente de imperfección de pandeo.
- $c_m = 0.2 + 0.8\alpha = 0,2+0,8*0,13=0,3$
- $\alpha_y=0,8$
- $X_{LT}=1$ para esbeltez reducida $< 0,4$

$$L_k = \beta \cdot L; \quad \bar{\lambda} = \sqrt{\frac{A \cdot f_y}{N_{CR}}}; \quad \phi = 0.5(1 + \alpha(\bar{\lambda} - 0.2) + \bar{\lambda}^2); \quad X = \frac{1}{\phi + \sqrt{\phi^2 - \bar{\lambda}^2}}$$

IT	BARRA	Coeficiente de pandeo	Longitud de pandeo	Esbeltez reducida	ϕ	Coeficiente de reducción por pandeo
		β	L_k	λ		χ
			m			
1	AB	1,0	1,3	0,24	0,5	0,99
2	AC	1,0	1,7	0,56	0,7	0,94
3	BC	1,0	1,5	0,41	0,6	0,97
4	BF	1,0	1,7	0,31	0,6	0,98
5	CD	1,0	0,5	0,14	0,5	1,01
6	DE	0,7	1,3	0,35	0,6	0,98
7	DG	1,0	1,7	0,38	0,6	0,97

Resistencias:

$$N_{CR} = \left(\frac{\pi}{L_k} \right)^2 E \cdot I; \quad N_{b,Rd} = \chi \cdot A \cdot f_{yd}; \quad N_{b,Rd} = X_{LT} \cdot A \cdot f_{yd}; \quad M_{b,Rd_{LT}} = X_{LT} \cdot W_{LT} \cdot f_{yd};$$

IT	BARRA	Compresión crítica por pandeo	Resistencia de la barra al pandeo	Resistencia de la barra al pandeo lateral	Resistencia de la barra al pandeo lateral
		N_{CR}	$N_{b,Rd}$	$N_{b,Rd_{LT}}$	$M_{b,Rd}$
		N	N	N	N
1	AB	6.687.423	375.018	377.265	1779
2	AC	815.719	228.638	243.810	3192
3	BC	3.379.180	525.293	542.476	30210
4	BF	4.204.313	371.570	377.265	1779
5	CD	29.424.939	546.890	542.476	30210
6	DE	4.531.106	530.328	542.476	30210
7	DG	3.285.728	446.652	459.048	5941

Verificación pandeo lateral

$$\frac{M_{ED}}{M_{b,Rd}} < 1$$

IT	BARRA	Momento flector máximo	Resistencia de la barra al pandeo lateral	Verificación pandeo lateral
		M_ED	M_b,Rd	
		N-m	N-m	
1	AB	153	1779	0,0860
2	AC	13	3192	0,0040
3	BC	102	30210	0,0034
4	BF	659	1779	0,3704
5	CD	29	30210	0,0010
6	DE	3	30210	0,0001
7	DG	2	5941	0,0004

Verificación de interacción (pandeo + flexión)

$$\frac{N_{Ed}}{N_{b,Rd}} + k_y * \frac{c_m \cdot M_{Ed}}{X_{LT} \cdot W_{LT} \cdot f_{yd}} \leq 1$$

$$\frac{N_{Ed}}{N_{b,Rd_{LT}}} + \alpha_y \cdot k_y * \frac{c_m \cdot M_{Ed}}{W_{LT} \cdot f_{yd}} \leq 1 \quad \text{Lateral}$$

IT	BARRA	Momento flector máximo	Fuerza normal máxima	Resistencia de la barra al pandeo	Resistencia de la barra al pandeo lateral	Ky	Verificación de interacción (pandeo + flexión)	
		M_ED	N_ED	N_b,Rd	N_b,Rd_LT			Lateral
		N-m	N	N	N			
1	AB	153	1.447	375.018	377.265	1,00	0,03	0,02
2	AC	13	2.173	228.638	243.810	1,00	0,01	0,01
3	BC	102	2.402	525.293	542.476	1,00	0,01	0,01
4	BF	659	1.494	371.570	377.265	1,00	0,12	0,09
5	CD	29	780	546.890	542.476	1,00	0,00	0,00
6	DE	3	2.340	530.328	542.476	1,00	0,00	0,00
7	DG	2	1.460	446.652	459.048	1,00	0,00	0,00

2.1.2. Vista lateral

2.1.2.1. Calculo por método de Cross

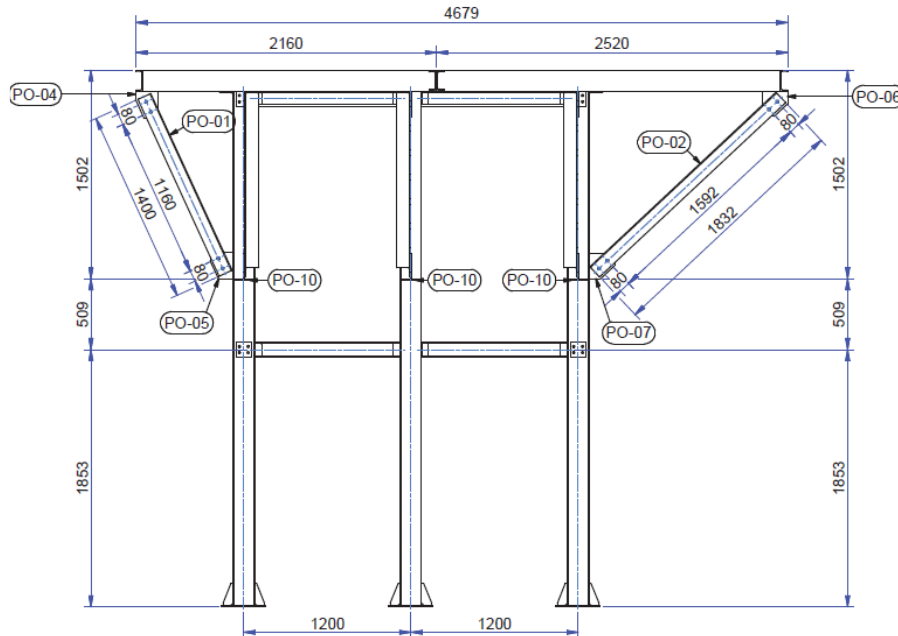


Figura 5 - Portico vista lateral

Con los datos de pesos de los equipos procedemos al cálculo de las fuerzas aplicadas.

Carga	DESCRIPCION	Unid	Cant	Peso Unit (kg)	Peso (Kg)
1	Seccionador de Potencia	Fases	03	150	450
2	Portafusibles y fusibles	Fases	03	318	954

De la figura 3 podemos notar que existen 2 pórticos idénticos al pórtico de la figura 5.

La fuerza total aplicado sobre el pórtico de la vista posterior será 1/2 del peso total.

$$\text{Carga}_1 = 450 / 2 = 225 \text{ Kg (2250 N)}$$

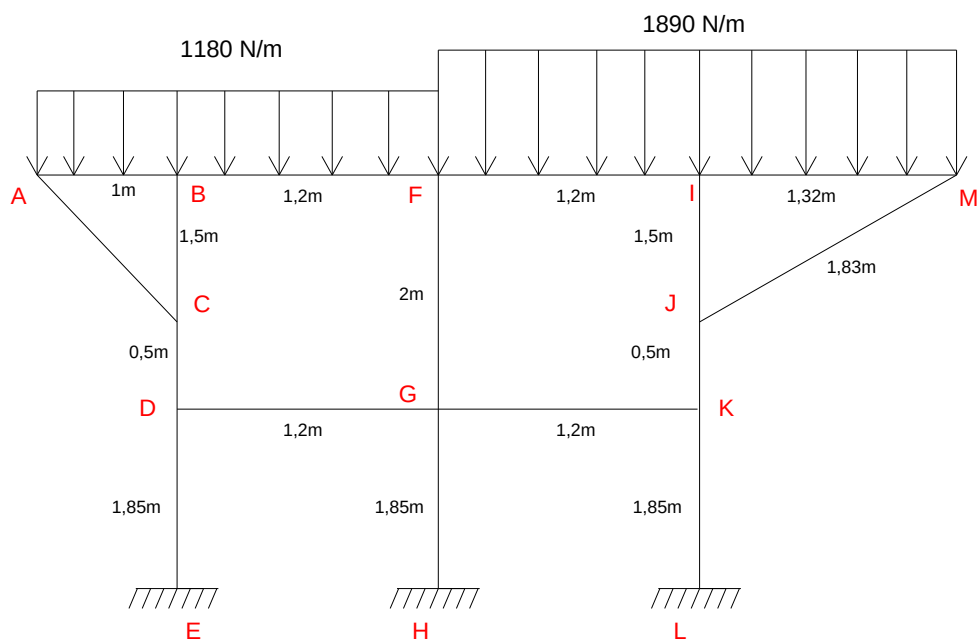
$$\text{Carga}_2 = 954 / 2 = 477 \text{ Kg (4770 N)}$$

Estas cargas serán cargas distribuidas a lo largo de sus soportes respectivos.

$$\text{Carga}_1 = 2250 \text{ N} / 2,1\text{m} = 1180 \text{ N/m}$$

$$\text{Carga}_2 = 4770 \text{ N} / 2,5\text{m} = 1890 \text{ N/m}$$

Diagrama para cálculo por método de Cross.



Momentos de inercia

Los momentos de inercia se obtienen de tablas de perfiles.

It	Barra	DESCRIPCION	Sentido de la viga	Longitud (mm)	Inercia (cm^4)
1	AB	Viga W 150mm x 150mm x 22,5 Kg/m	x-x	1206	1206
2	AC	Angulo 100mm x 100mm x 6mm	y-y	126	126
3	BC	Viga W 150mm x 150mm x 22,5 Kg/m	x-x	1206	1206
4	BF	Viga U 150mm x 50mm x 15,5 Kg/m	x-x	609	609
5	CD	Viga W 150mm x 150mm x 22,5 Kg/m	x-x	1206	1206
6	DE	Viga W 150mm x 150mm x 22,5 Kg/m	x-x	1206	1206
7	DG	Viga W 100mm x 100mm x 19,3 Kg/m	x-x	476	476
8	FG	Viga W 150mm x 150mm x 22,5 Kg/m	x-x	1206	1206
9	FI	Viga U 150mm x 50mm x 15,5 Kg/m	x-x	609	609
10	GH	Viga W 150mm x 150mm x 22,5 Kg/m	x-x	1206	1206
11	GK	Viga W 100mm x 100mm x 19,3 Kg/m	x-x	476	476
12	IJ	Viga W 150mm x 150mm x 22,5 Kg/m	x-x	1206	1206
13	IM	Viga U 150mm x 50mm x 15,5 Kg/m	x-x	609	609
14	JK	Viga W 150mm x 150mm x 22,5 Kg/m	x-x	1206	1206
15	JM	Angulo 100mm x 100mm x 6mm	y-y	126	16
16	KL	Viga W 150mm x 150mm x 22,5 Kg/m	x-x	1206	1206

Coeficientes de rigidez (kN-m)

Se procederá con acero ($E = 2.10^7 \frac{kN}{m^2}$)

K	A	B	C	D	E	F	G	H	I	J	K	L	M
A		Kab	Kac										
B	Kba		Kbc			Kbf							
C	Kca	Kcb		Kcd									
D			Kdc		Kde		Kdg						
E				Ked									
F		Kfb					Kfg		Kfi				
G				Kgd		Kgf		Kgh			Kgk		
H							Khg						
I						Kif				Kij			Kim
J									Kji		Kjk		Kjm
K							Kkg			Kkj		Kkl	
L											Klk		
M									Kmi	Kmj			

K	A	B	C	D	E	F	G	H	I	J	K	L	M
A		1005	72										
B	1005		642			406							
C	72	642		1895									
D			1895		521		317						
E				521									
F		406					480		406				
G				317		480		521			317		
H							521						
I						406				642			369
J									642		1895		55
K							317			1895		521	
L											521		
M									369	55			

Nodo	$\sum K_i$
A	1077
B	2053
C	2610
D	2733
E	521
F	1292
G	1635
H	521
I	1417
J	2593
K	2733
L	521
M	424

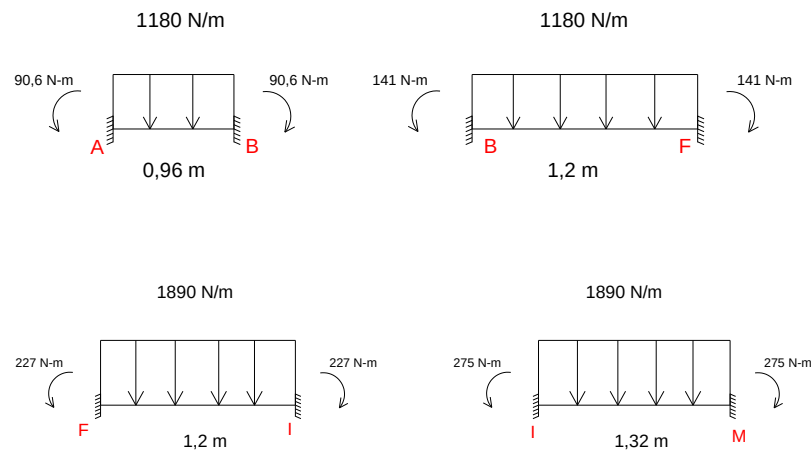
Coeficientes de reparto

μ	A	B	C	D	E	F	G	H	I	J	K	L	M
A		μ_{ab}	μ_{ac}										
B	μ_{ba}		μ_{bc}			μ_{bf}							
C	μ_{ca}	μ_{cb}		μ_{cd}									
D			μ_{dc}		μ_{de}		μ_{dg}						
E				μ_{ed}									
F		μ_{fb}					μ_{fg}		μ_{fi}				
G				μ_{gd}		μ_{gf}		μ_{gh}			μ_{gk}		
H							μ_{hg}						
I						μ_{if}				μ_{ij}			μ_{im}
J									μ_{ji}		μ_{jk}		μ_{jm}
K							μ_{kg}			μ_{kj}		μ_{kl}	
L											μ_{lk}		
M									μ_{mi}	μ_{mj}			

μ	A	B	C	D	E	F	G	H	I	J	K	L	M
A		0,93	0,07										
B	0,49		0,31			0,20							
C	0,03	0,25		0,73									
D			0,69		0,19		0,12						
E				1,00									
F		0,31					0,37		0,31				
G				0,19		0,29		0,32			0,19		
H							1,00						
I						0,29				0,45			0,26
J									0,25		0,73		0,02
K							0,12			0,69		0,19	
L											1,00		
M									0,87	0,13			

Nodo	Σ
A	1
B	1
C	1
D	1
E	1
F	1
G	1
H	1
I	1
J	1
K	1
L	1
M	1

Momentos de empotramiento perfecto.

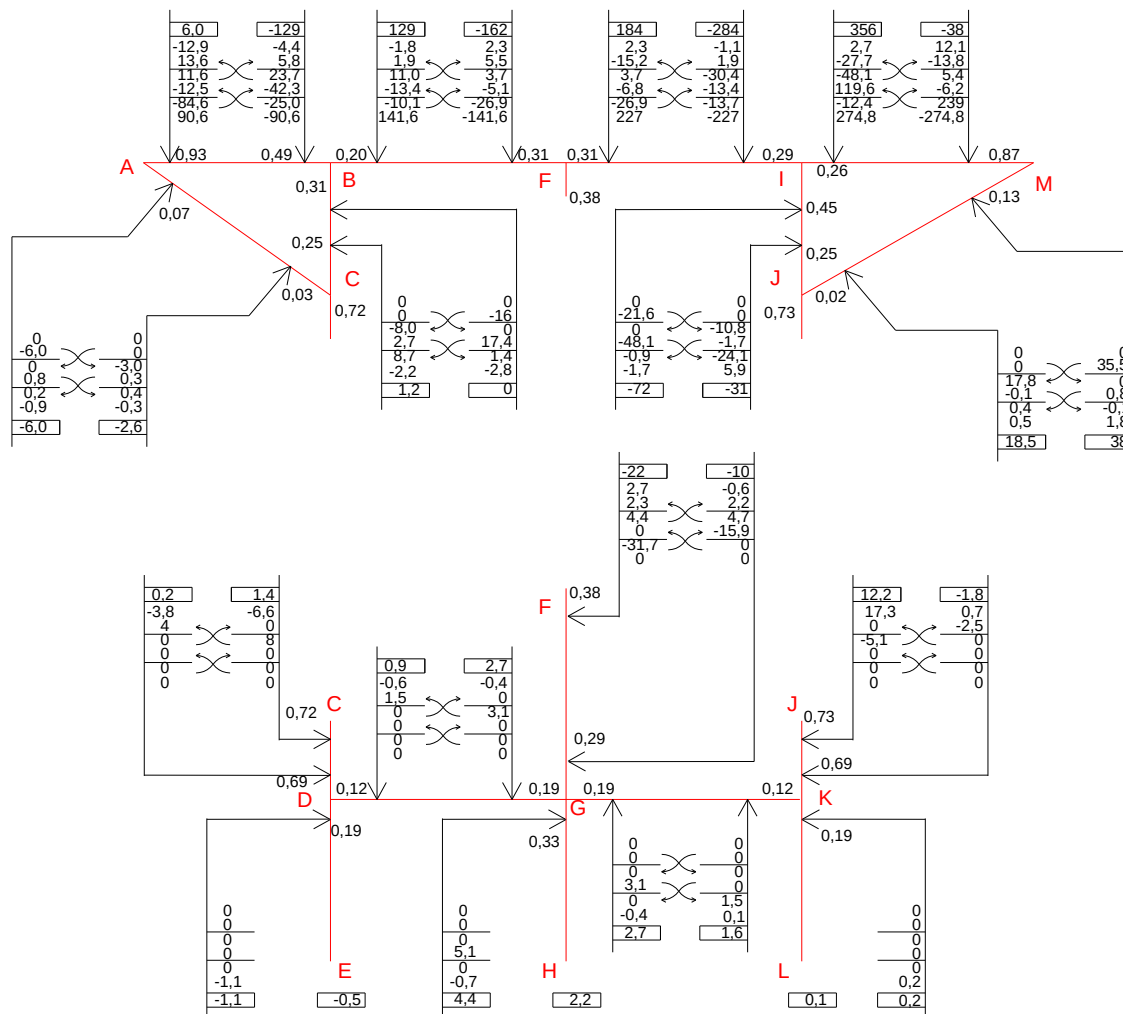


Se realizaron 3 iteraciones, en la tercera iteración se encuentra un momento de reparto máximo 17,3 N-m en el la barra JK en el nodo J, dicho momento es menor al 10% del momento de empotramiento perfecto máximo de 275 N-m que se da en la barra IM tanto en el nodo I como en M.

A continuación e muestran los momentos de desequilibrio de los cálculos, unidades en N-m.

Nodo	Momento de desequilibrio		
	1ra Iteración	2da Iteración	3ra Iteración
A	-90,67	12,48	-13,79
B	-51,00	55,75	-9,04
C	0	11,00	-9,14
D	0	0	-5,53
E	0	0	0
F	-85,48	11,87	7,37
G	0,00	15,87	-2,20
H	-47,70	0,00	-2,53
I	0	-106,22	-3,71
J	0	-6,96	23,67
K	0	0	1,01
L	0	0	0
M	274,84	6,21	13,90

A continuación se muestran los repartos y trasmisiones de momento de las 3 iteraciones, unidades en N-m.



Momentos resultantes, unidades en N-m.

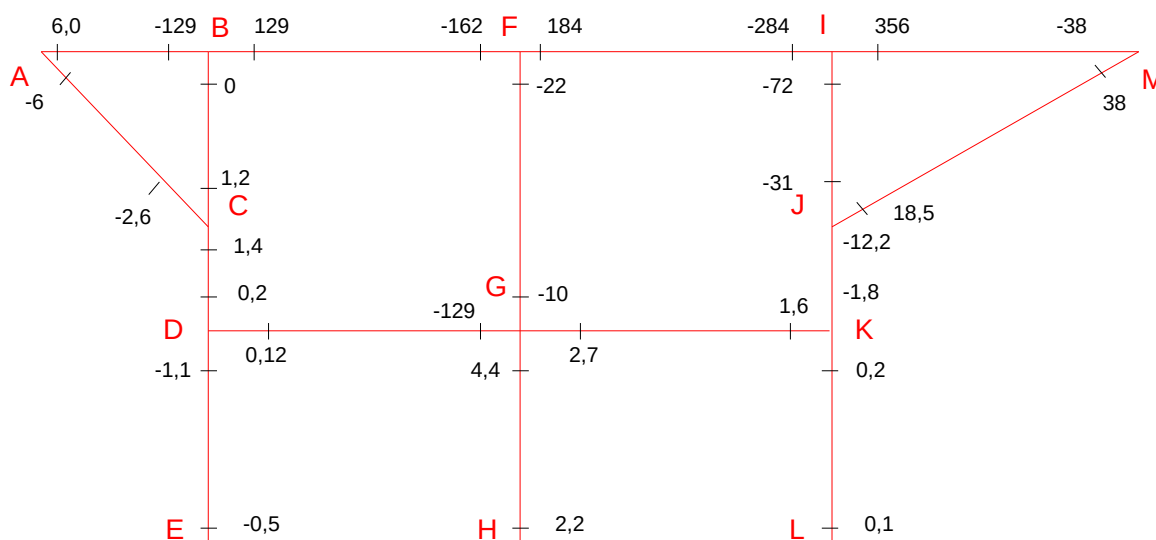
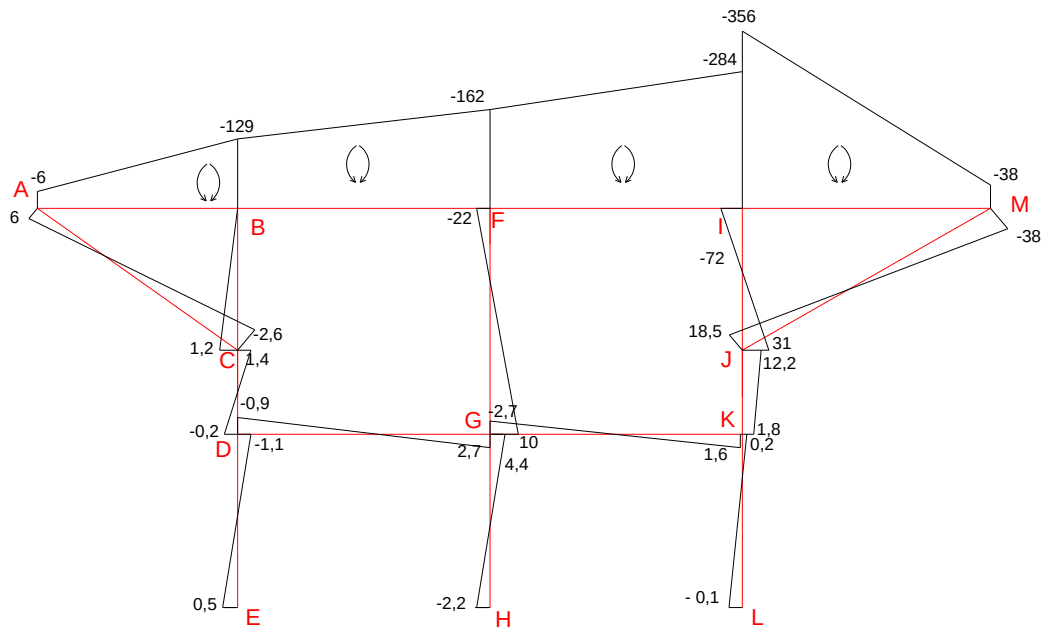
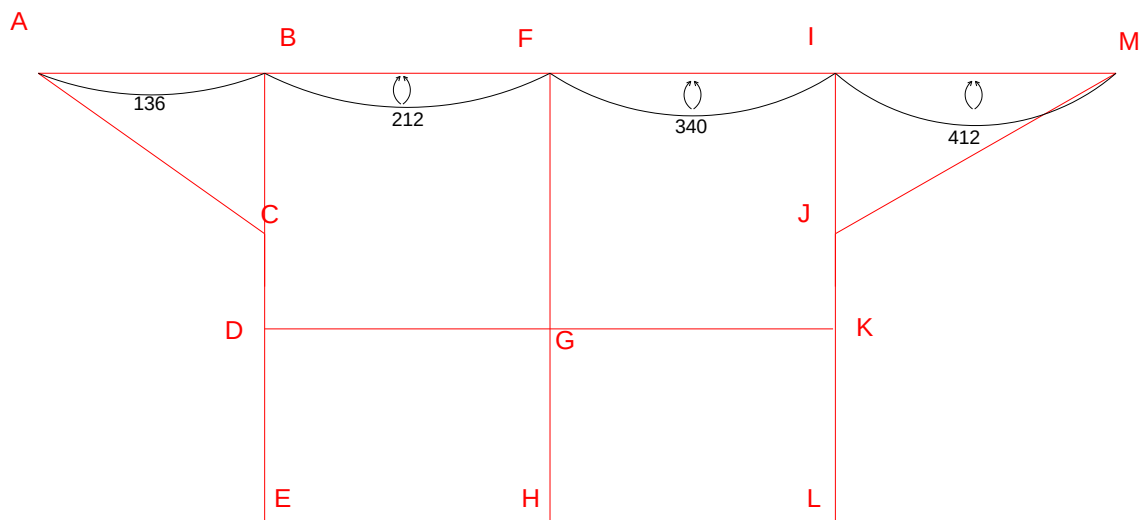


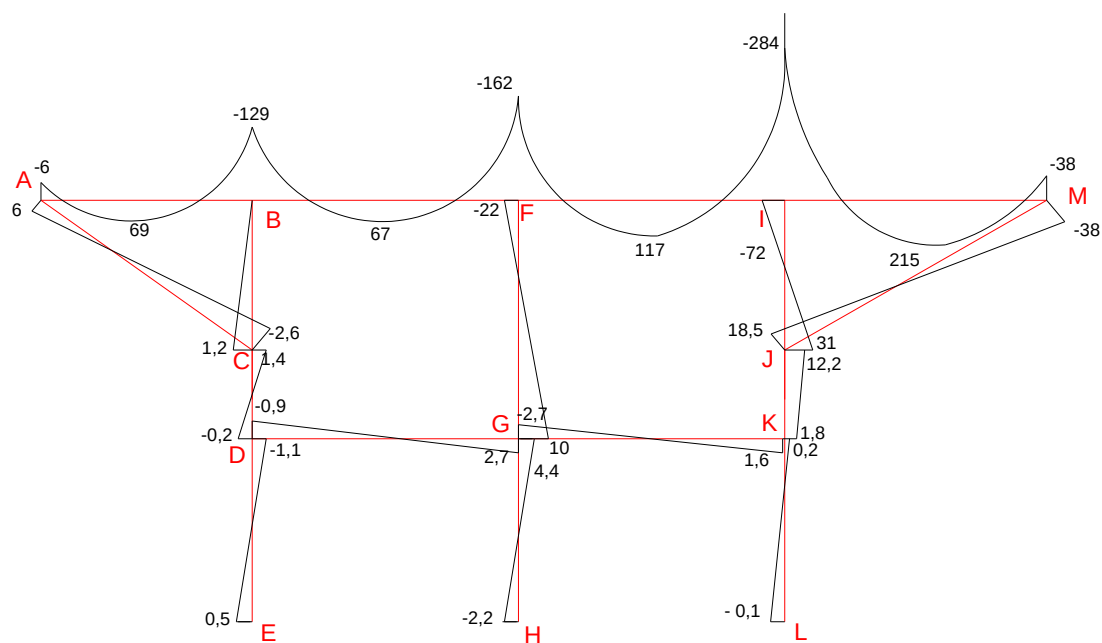
Diagrama de momentos flectores de los resultados de Cross, unidades en N-m



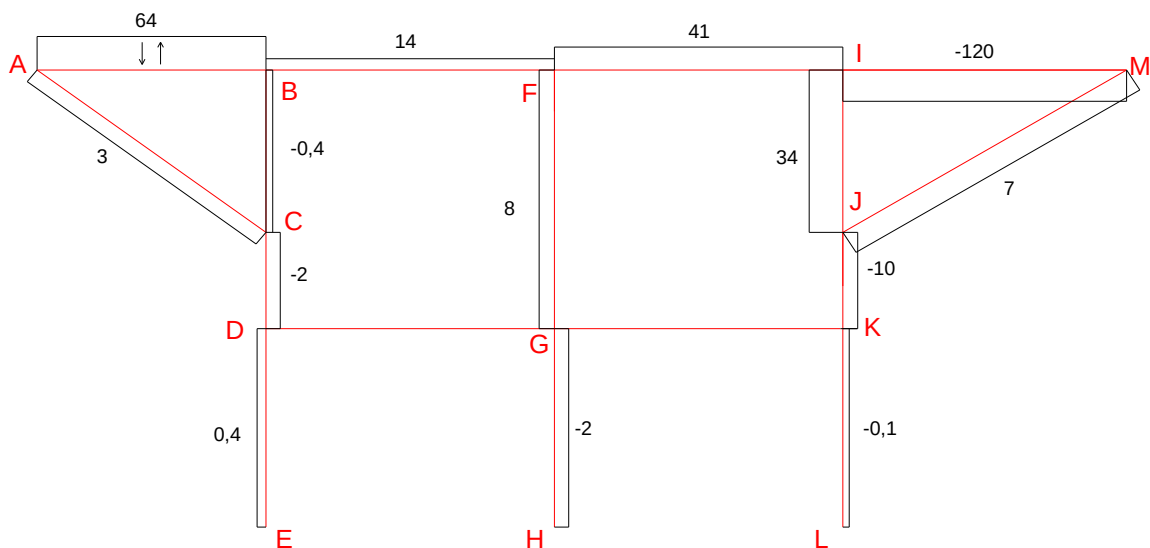
Momentos del empotramiento perfecto, unidades en N-m.



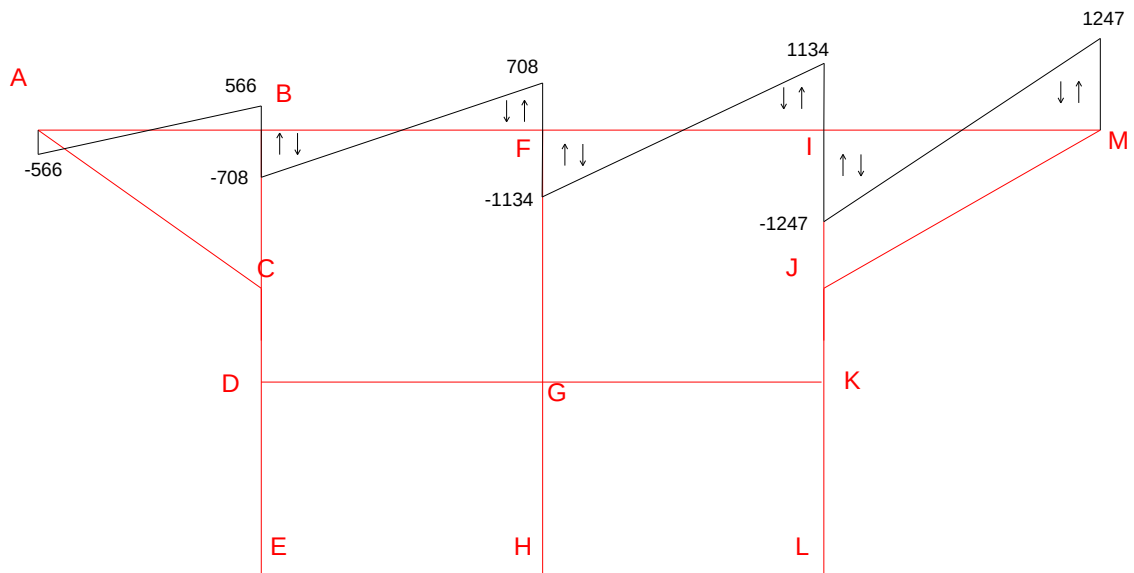
Momento flector resultante (N-m): sumando ambos efectos (cross + empotramiento perfecto)



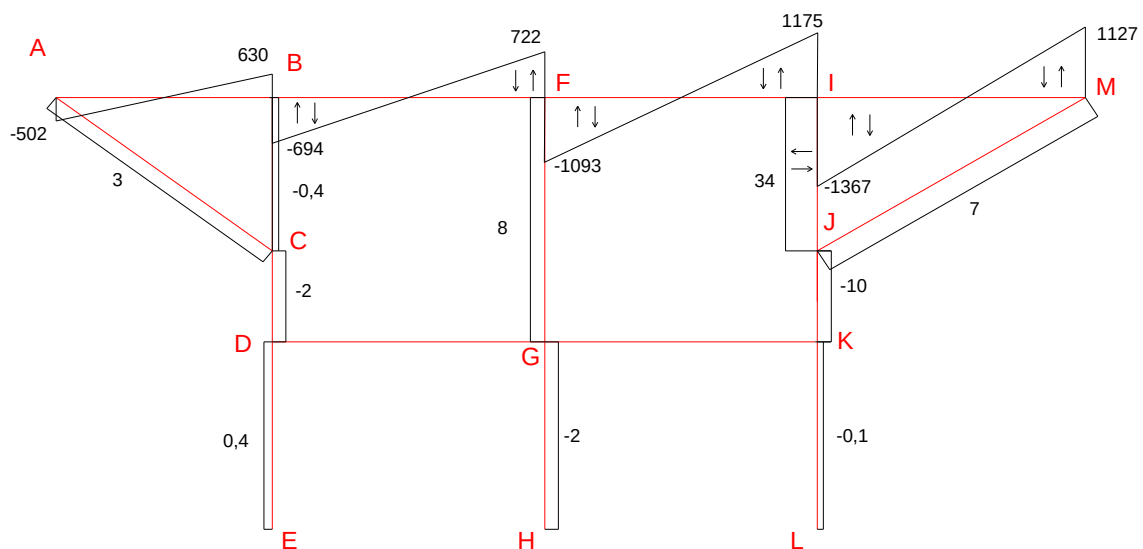
Fuerzas cortantes de los resultados de Cross, unidades en N.



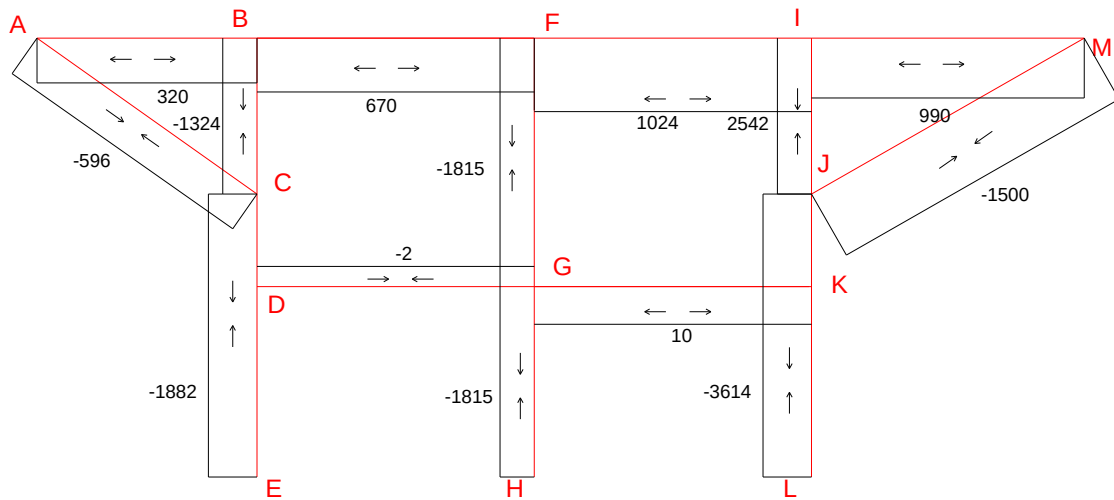
Fuerza cortante en el empotramiento perfecto, unidades en N.



Fuerza cortante resultante (N): sumando ambos efectos (cross + empotramiento perfecto)



Fuerzas axiales (N)



2.1.2.2. Dimensionamiento de los perfiles

- $f_y = 200MPa$
- $\gamma_{M0} = 1.05$
- $f_{yd} = 200MPa / 1,05 = 190Mpa$
- $E = 200GPa$

De los resultados de Cross, de los gráficos de momento flector, fuerza cortante y fuerza axial se obtienen:

IT	BARRA	Momento flector máximo	Fuerza cortante máxima	Fuerza normal máxima
		M_ED	V_ED	N_ED
		N-m	N	N
1	AB	129	630	320
2	AC	6	3	596
3	BC	1,2	0,4	1324
4	BF	162	694	670
5	CD	1,4	2	1882
6	DE	1,1	0,4	1882

IT	BARRA	Momento flector máximo	Fuerza cortante máxima	Fuerza normal máxima
		M_ED	V_ED	N_ED
		N-m	N	N
7	DG	2,7	0	2
8	FG	2,7	8	1815
9	FI	282	1175	1024
10	GH	10	2	1815
11	GK	2,7	0	10
12	IJ	72	34	2542
13	IM	356	1367	990
14	JK	12,2	10	3614
15	JM	38	7	1500
16	KL	1,8	0,1	3614

Las características de cada barra son:

IT	BARRA	DESCRIPCION	Momento de inercia	Modulo resistente	Modulo resistente sentido lateral	Área de corte
		NOTACION	I	W	W_LT	A
		Unidades	cm ⁴	cm ³	cm ³	cm ²
1	AB	W 150mm x 150mm x 22,5 Kg/m	1206	159	50,9	28,5
2	AC	L 100mm x 100mm x 6mm	126	17	16,8	12,8
3	BC	W 150mm x 150mm x 22,5 Kg/m	1206	159	50,9	28,5
4	BF	U 150mm x 50mm x 15,5 Kg/m	609	82	9,3	19,8
5	CD	W 150mm x 150mm x 22,5 Kg/m	1206	159	50,9	28,5
6	DE	W 150mm x 150mm x 22,5 Kg/m	1206	159	50,9	28,5
7	DG	W 100mm x 100mm x 19,3 Kg/m	476	90	31,2	24,1
8	FG	W 150mm x 150mm x 22,5 Kg/m	1206	159	50,9	28,5
9	FI	U 150mm x 50mm x 15,5 Kg/m	609	82	9,3	19,8
10	GH	W 150mm x 150mm x 22,5 Kg/m	1206	159	50,9	28,5
11	GK	W 100mm x 100mm x 19,3 Kg/m	476	90	31,2	24,1
12	IJ	W 150mm x 150mm x 22,5 Kg/m	1206	159	50,9	28,5
13	IM	U 150mm x 50mm x 15,5 Kg/m	609	82	9,3	19,8
14	JK	W 150mm x 150mm x 22,5 Kg/m	1206	159	50,9	28,5
15	JM	L 100mm x 100mm x 6mm	126	17	16,8	12,8
16	KL	W 150mm x 150mm x 22,5 Kg/m	1206	159	50,9	28,5

Se calcula la resistencia a la flexión, al corte y a la carga axial usando las siguientes expresiones:

$$M_{C,Rd} = W \cdot f_{yd}; \quad V_{C,Rd} = A \cdot \frac{f_{yd}}{\sqrt{3}}; \quad N_{Rd} = A \cdot f_{yd}$$

IT	BARRA	Resistencia de las secciones a la flexión	Resistencia de las secciones al corte	Resistencia de las secciones a cargas axiales
		M_C,Rd	V_C,Rd	N_Rd
		N-m	N	N
1	AB	30.210	313.199	542.476
2	AC	3.192	140.763	243.810
3	BC	30.210	313.199	542.476
4	BF	15.607	217.814	377.265
5	CD	30.210	313.199	542.476
6	DE	30.210	313.199	542.476
7	DG	17.103	265.031	459.048
8	FG	30.210	313.199	542.476
9	FI	15.607	217.814	377.265
10	GH	30.210	313.199	542.476
11	GK	17.103	265.031	459.048
12	IJ	30.210	313.199	542.476
13	IM	15.607	217.814	377.265
14	JK	30.210	313.199	542.476
15	JM	3.192	140.763	243.810
16	KL	30.210	313.199	542.476

Verificación de flexión simple

$$\frac{V_{ED}}{V_{C,Rd}} < 1$$

IT	BARRA	Fuerza cortante máxima	Resistencia de las secciones al corte	Verificación de flexión simple (10^-3)
		V_ED	V_C,Rd	
		N	N	
1	AB	630	313.199	2,01
2	AC	3	140.763	0,02
3	BC	0,4	313.199	0,00
4	BF	694	217.814	3,19

IT	BARRA	Fuerza cortante máxima	Resistencia de las secciones al corte	Verificación de flexión simple
		V_ED	V_C,Rd	
		N	N	
				(10 ⁻³)
5	CD	2	313.199	0,01
6	DE	0,4	313.199	0,00
7	DG	0	265.031	0,00
8	FG	8	313.199	0,03
9	FI	1175	217.814	5,39
10	GH	2	313.199	0,01
11	GK	0	265.031	0,00
12	IJ	34	313.199	0,11
13	IM	1367	217.814	6,28
14	JK	10	313.199	0,03
15	JM	7	140.763	0,05
16	KL	0,1	313.199	0,00

Verificación de la flexión compuesta

$$\frac{N_{ED}}{N_{Rd}} + \frac{M_{ED}}{M_{C,Rd}} \leq 1$$

IT	BARRA	Momento flector máximo	Fuerza normal máxima	Resistencia de las secciones a la flexión	Resistencia de las secciones a cargas axiales	Verificación de la flexión compuesta
		M_ED	N_ED	M_C,Rd	N_Rd	
		N-m	N	N-m	N_Rd	
1	AB	129	320	30.210	542.476	0,0049
2	AC	6	596	3.192	243.810	0,0043
3	BC	1,2	1324	30.210	542.476	0,0025
4	BF	162	670	15.607	377.265	0,0122
5	CD	1,4	1882	30.210	542.476	0,0035
6	DE	1,1	1882	30.210	542.476	0,0035
7	DG	2,7	2	17.103	459.048	0,0002
8	FG	2,7	1815	30.210	542.476	0,0034
9	FI	282	1024	15.607	377.265	0,0208
10	GH	10	1815	30.210	542.476	0,0037
11	GK	2,7	10	17.103	459.048	0,0002
12	IJ	72	2542	30.210	542.476	0,0071

IT	BARRA	Momento flector máximo	Fuerza normal máxima	Resistencia de las secciones a la flexión	Resistencia de las secciones a cargas axiales	Verificación de la flexión compuesta
		M_ED	N_ED	M_C,Rd	N_Rd	
		N-m	N	N-m	N_Rd	
13	IM	356	990	15.607	377.265	0,0254
14	JK	12,2	3614	30.210	542.476	0,0071
15	JM	38	1500	3.192	243.810	0,0181
16	KL	1,8	3614	30.210	542.476	0,0067

Pandeo

- $f_y = 200MPa$
- $\gamma_{M1} = 1.05$
- $f_{yd} = 200MPa / 1,05 = 190Mpa$
- $\alpha=0,13$: Coeficiente de imperfección de pandeo.
- $c_m = 0.2 + 0.8\alpha = 0,2+0,8*0,13=0,3$
- $\alpha_y=0,8$
- $X_{LT}=1$ para esbeltez reducida $< 0,4$

$$L_k = \beta \cdot L; \quad \bar{\lambda} = \sqrt{\frac{A \cdot f_y}{N_{CR}}}; \quad \phi = 0.5(1 + \alpha(\bar{\lambda} - 0.2) + \bar{\lambda}^2); \quad X = \frac{1}{\phi + \sqrt{\phi^2 - \bar{\lambda}^2}}$$

IT	BARRA	Coeficiente de pandeo	Longitud de pandeo	Esbeltez reducida	ϕ	Coeficiente de reducción por pandeo
		β	L_k	$\bar{\lambda}$		X
			m			
1	AB	1,0	1,0	0,15	0,5	1,01
2	AC	1,0	1,4	0,45	0,6	0,96
3	BC	1,0	1,5	0,23	0,5	1,00
4	BF	1,0	1,2	0,22	0,5	1,00
5	CD	1,0	0,5	0,08	0,5	1,02
6	DE	0,7	1,3	0,20	0,5	1,00
7	DG	1,0	1,2	0,27	0,5	0,99
8	FG	1,0	2,0	0,31	0,6	0,98
9	FI	1,0	1,2	0,22	0,5	1,00
10	GH	0,7	1,3	0,20	0,5	1,00

IT	BARRA	Coeficiente de pandeo	Longitud de pandeo	Esbeltez reducida	$\emptyset$	Coeficiente de reducción por pandeo
		β	L_k	λ		χ
			m			
11	GK	1,0	1,2	0,27	0,5	0,99
12	IJ	1,0	1,5	0,23	0,5	1,00
13	IM	1,0	1,3	0,24	0,5	0,99
14	JK	1,0	0,5	0,08	0,5	1,02
15	JM	1,0	1,8	0,59	0,7	0,93
16	KL	0,7	1,3	0,20	0,5	1,00

Resistencias:

$$N_{CR} = \left(\frac{\pi}{L_k}\right)^2 E \cdot I; \quad N_{b,Rd} = \chi \cdot A \cdot f_{yd}; \quad N_{b,Rd} = \chi_{LT} \cdot A \cdot f_{yd}; \quad M_{b,Rd_{LT}} = \chi_{LT} \cdot W_{LT} \cdot f_{yd};$$

IT	BARRA	Compresión crítica por pandeo	Resistencia de la barra al pandeo	Resistencia de la barra al pandeo lateral	Resistencia de la barra al pandeo lateral
		N_{CR}	$N_{b,Rd}$	$N_{b,Rd_{LT}}$	$M_{b,Rd}$
		N	N	N	N-m
1	AB	6.451.105	535.074	542.476	9690
2	AC	140.326	115.614	243.810	3192
3	BC	658.835	421.046	542.476	9690
4	BF	333.554	247.548	377.265	1779
5	CD	2.549.755	519.076	542.476	9690
6	DE	141.348	125.133	542.476	9690
7	DG	101.827	90.834	459.048	5941
8	FG	72.598	65.908	542.476	9690
9	FI	83.388	74.397	377.265	1779
10	GH	57.240	52.281	542.476	9690
11	GK	45.256	41.400	459.048	5941
12	IJ	62.375	56.853	542.476	9690
13	IM	35.161	32.204	377.265	1779
14	JK	407.961	318.193	542.476	9690
15	JM	2.881	2.707	243.810	3192
16	KL	23.966	22.232	542.476	9690

Verificación pandeo lateral

$$\frac{M_{ED}}{M_{b,Rd}} < 1$$

IT	BARRA	Momento flector máximo	Resistencia de la barra al pandeo lateral	Verificación pandeo lateral
		M_ED	M_b,Rd	
		N-m	N-m	
1	AB	129	9690	0,0133
2	AC	6	3192	0,0019
3	BC	1,2	9690	0,0001
4	BF	162	1779	0,0911
5	CD	1,4	9690	0,0001
6	DE	1,1	9690	0,0001
7	DG	2,7	5941	0,0005
8	FG	2,7	9690	0,0003
9	FI	282	1779	0,1585
10	GH	10	9690	0,0010
11	GK	2,7	5941	0,0005
12	IJ	72	9690	0,0074
13	IM	356	1779	0,2001
14	JK	12,2	9690	0,0013
15	JM	38	3192	0,0119
16	KL	1,8	9690	0,0002

Verificación de interacción (pandeo + flexión)

$$\frac{N_{Ed}}{N_{b,Rd}} + k_y * \frac{c_m \cdot M_{Ed}}{X_{LT} \cdot w_{LT} \cdot f_{yd}} \leq 1$$

$$\frac{N_{Ed}}{N_{b,Rd_{LT}}} + \alpha_y \cdot k_y * \frac{c_m \cdot M_{Ed}}{w_{LT} \cdot f_{yd}} \leq 1 \quad \text{Lateral}$$

IT	BARRA	Momento flector máximo	Fuerza normal máxima	Resistencia de la barra al pandeo	Resistencia de la barra al pandeo lateral	Ky	Verificación de interacción (pandeo + flexión)	
		M_ED	N_ED	N_b,Rd	N_b,Rd_LT			
		N-m	N	N	N			Lateral
1	AB	129	320	535.074	542.476	1,00	0,00	0,00
2	AC	6	596	115.614	243.810	1,01	0,01	0,00
3	BC	1,2	1324	421.046	542.476	1,00	0,00	0,00
4	BF	162	670	247.548	377.265	1,00	0,03	0,02
5	CD	1,4	1882	519.076	542.476	1,00	0,00	0,00
6	DE	1,1	1882	125.133	542.476	1,07	0,02	0,00
7	DG	2,7	2	90.834	459.048	1,00	0,00	0,00
8	FG	2,7	1815	65.908	542.476	1,35	0,03	0,00
9	FI	282	1024	74.397	377.265	1,08	0,07	0,04
10	GH	10	1815	52.281	542.476	1,62	0,04	0,00
11	GK	2,7	10	41.400	459.048	1,00	0,00	0,00
12	IJ	72	2542	56.853	542.476	1,71	0,05	0,01
13	IM	356	990	32.204	377.265	1,66	0,13	0,08
14	JK	12,2	3614	318.193	542.476	1,01	0,01	0,01
15	JM	38	1500	2.707	243.810	266,23	1,52	0,78
16	KL	1,8	3614	22.232	542.476	11,76	0,16	0,01

2.2. VIGAS PRINCIPALES.

2.2.1.1. Cálculo por método de Cross

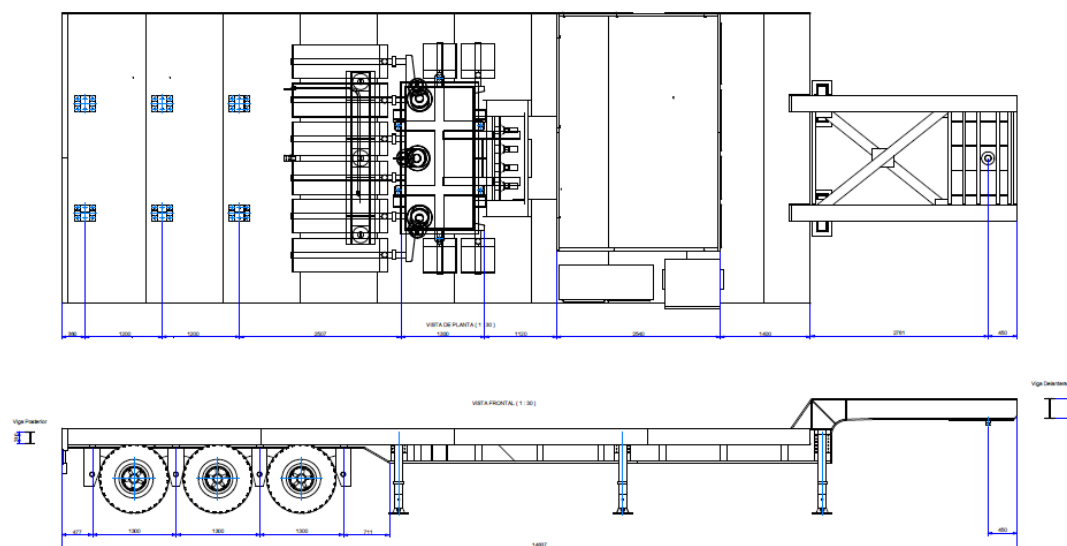


Figura 6 - Vista de perfil de viga principal

Con los datos de pesos de los equipos procedemos al cálculo de las fuerzas aplicadas.

Carga	DESCRIPCION	Unid	Cant	Peso Unit (kg)	Peso Sub total (Kg)	Peso (Kg)
1	Pórtico (estructura metálica)	Unid	01	2.112	2112	3586
	Seccionador de Potencia	Fases	03	150	450	
	Mando de seccionador	Unid	01	70	70	
	Portafusibles y fusibles	Fases	03	318	954	
2	Transformador de potencia	Unid	01	19900	19900	19954
	Pararrayos lado primario	Fases	03	18	54	
3	Caseta (estructura metálica)	Unid	01	1.526	1.526	3794
	Pararrayos lado secundario	Unid	03	18	54	
	Resistencia neutro	Unid	01	194	194	
	Interruptores de potencia	Unid	02	73	146	
	Transformadores de corriente	Unid	12	13	150	
	Transformadores de corriente neutro	Unid	02	13	25	
	Transformadores de potencial	Unid	02	90	180	
	Transformador de control	Unid	01	155	155	
	Transformador de aislamiento	Unid	01	75	75	
	Tablero SS.AA.	Unid	01	35	35	
	Aisladores	Unid	30	0,5	15	
	Barras de cobre	Glb	01	150	150	
	Cable de fuerza	Metros	30	2	60	
	Conectores 7.2Kv	Unid	02	8	15	
	Control y Otros	Glb	01	250	250	
	Caseta y estante de baterías	Glb	01	177,8	177,8	
	Baterías	Unid	92	4,1	377,2	
	Caseta cargador de baterías	Unid	01	55	55	
	Cargador de baterías	Unid	01	154	154	

La plataforma base está conformada por 2 vigas principales.

$$\text{Carga}_1 = 3586 / 2 = 1793 \text{ Kg } (17\,930 \text{ N})$$

$$\text{Carga}_2 = 19954 / 2 = 9977 \text{ Kg } (99\,770 \text{ N})$$

$$\text{Carga}_3 = 3794 / 2 = 1897 \text{ Kg } (18\,970 \text{ N})$$

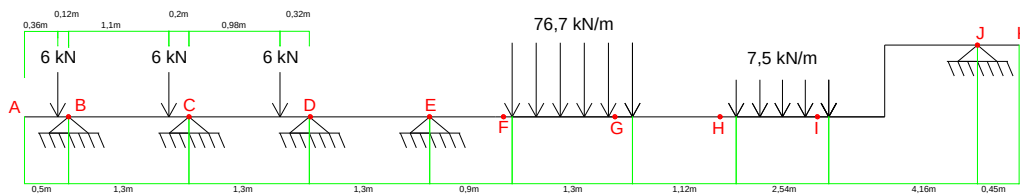
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$$\text{Carga}_1 = 17\,930 \text{ N} / 6 = 6 \text{ kN} \quad (\text{sobre cada uno de los 6 postes})$$

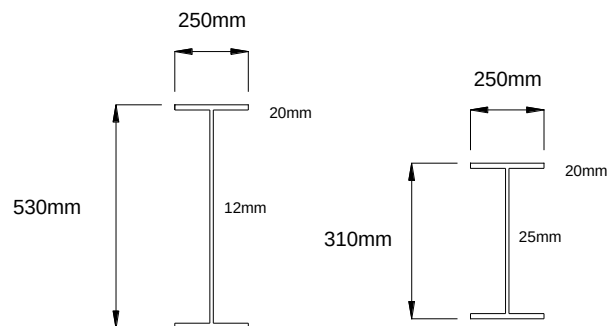
$$\text{Carga}_2 = 99\,770 \text{ N} / 1,3 \text{ m} = 76,7 \text{ kN/m} \quad (\text{carga distribuida})$$

$$\text{Carga}_3 = 18\,970 \text{ N} / 2,54 \text{ m} = 7,5 \text{ kN} \quad (\text{carga distribuida})$$

Diagrama para cálculo por método de Cross.



Momentos de inercia



	Viga delantera	Viga posterior
Inercia del alma (cm ⁴)	14888	6206
Inercia de una ala (cm ⁴)	35129	12029
Inercia de la viga (cm ⁴)	85146	30265

Coeficientes de rigidez (kN-m)

K	A	B	C	D	E	F	G	H	I	J
A		Kab								
B	Kba		Kbc							
C		Kcb		Kcd						
D			Kdc		Kde					
E				Ked		Kef				
F					Kef		Kfg			
G						Kgf		Kgh		
H							Khg		Khi	
I								Khi		Kij
J									Kji	

K	A	B	C	D	E	F	G	H	I	J
A		50441								
B	50441		18624							
C		18624		18624						
D			18624		18624					
E				18624		27204				
F					27204		52398			
G						52398		60819		
H							60819		26818	
I								26818		16374
J									16374	

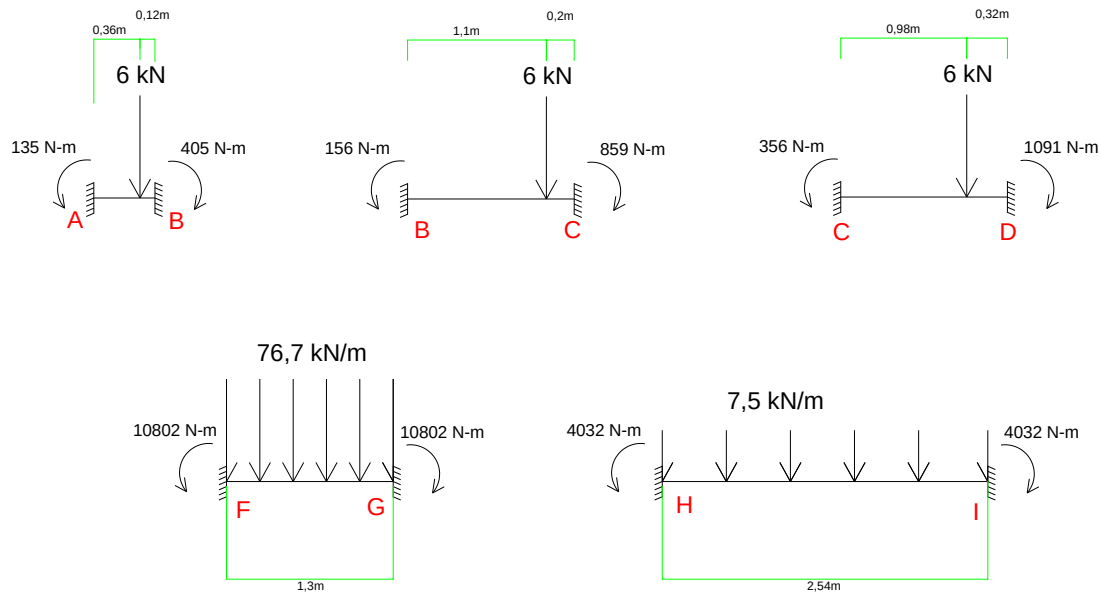
Nodo	ΣK_i
A	50441
B	69066
C	37249
D	37249
E	45829
F	79602
G	113216
H	60819
I	26818
J	0

Coeficientes de reparto

μ	A	B	C	D	E	F	G	H	I	J
A		μ_{ab}								
B	μ_{ba}		μ_{bc}							
C		μ_{cb}		μ_{cd}						
D			μ_{dc}		μ_{de}					
E				μ_{ed}		μ_{ef}				
F					μ_{ef}		μ_{fg}			
G						μ_{gf}		μ_{gh}		
H							μ_{hg}		μ_{hi}	
I								μ_{hi}		μ_{ij}
J									μ_{ji}	

μ	A	B	C	D	E	F	G	H	I	J
A		1,00								
B	0,73		0,27							
C		0,50		0,50						
D			0,50		0,50					
E				0,41		0,59				
F					0,34		0,66			
G						0,46		0,54		
H							0,69		0,31	
I								0,62		0,38
J									1,00	

Nodo	$\Sigma \mu_i$
A	1,0
B	1,0
C	1,0
D	1,0
E	1,0
F	1,0
G	1,0
H	1,0
I	1,0
J	1,0

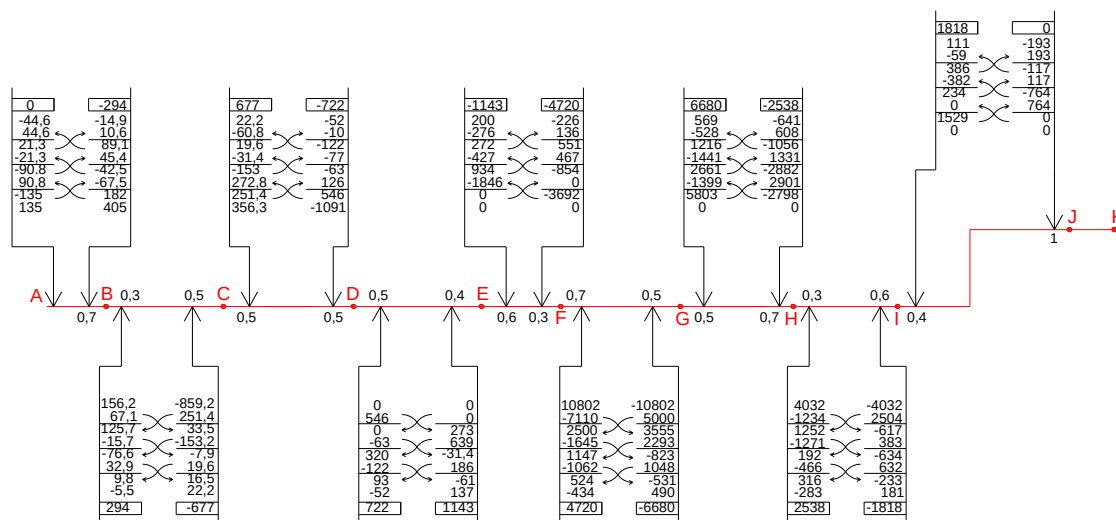
Momentos de empotramiento perfecto.

Se realizaron 4 iteraciones, en la cuarta iteración se encuentra un momento de reparto máximo de -641 N-m en el la barra HG en el nodo H, dicho momento es menor al 10% del momento de empotramiento perfecto máximo de 10802 N-m que se da en la barra FG tanto en el nodo F como en G.

A continuación e muestran los momentos de desequilibrio de los cálculos, unidades en N-m.

Nodo	Momento de desequilibrio			
	1ra Iteración	2da Iteración	3ra Iteración	4ta Iteración
A	-135	-91	21	-45
B	249	-58	122	-20
C	503	-306	39	44
D	1091	-126	-243	-103
E	0	1573	459	336
F	-10802	-2500	-1613	-660
G	10802	4954	2264	1059
H	-4032	-4153	-1522	-924
I	4032	617	1018	291
J	0	-764	-117	-193
K	0	0	0	0

A continuación se muestran los repartos y trasmisiones de momento de las 4 iteraciones, unidades en N-m.



Momentos resultantes

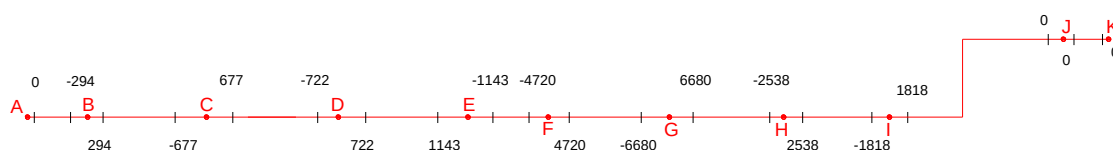
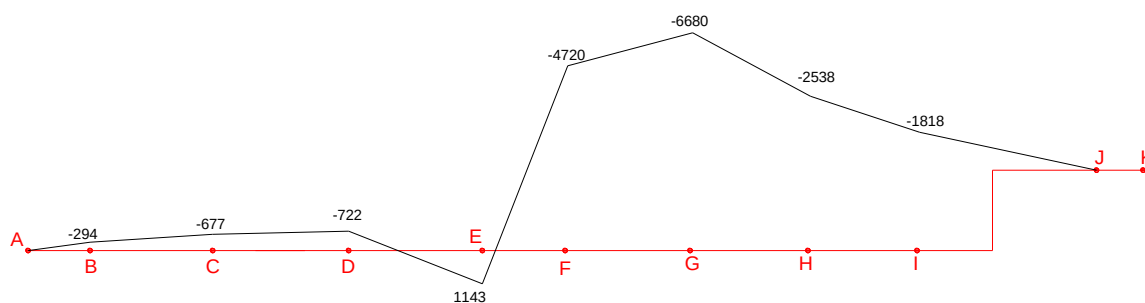
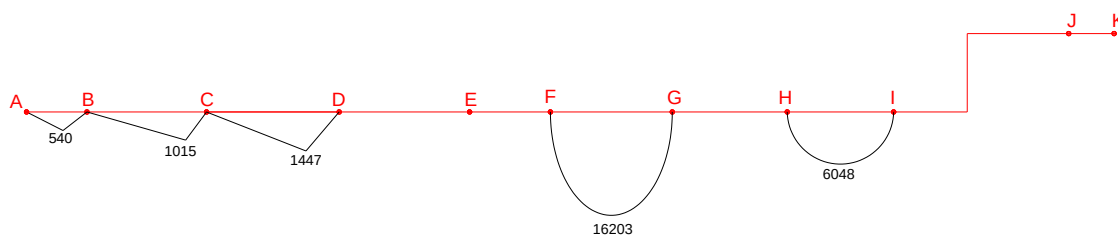


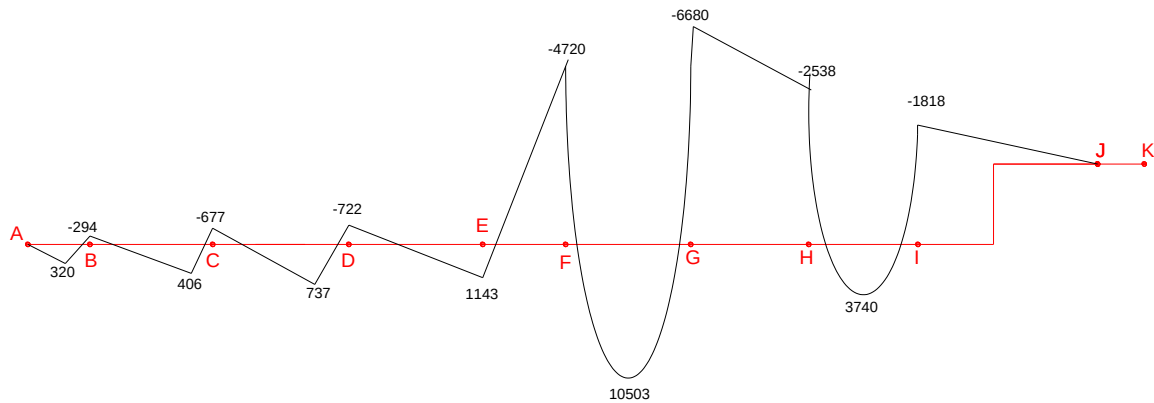
Diagrama de momentos flectores de los resultados de Cross, unidades en N-m.



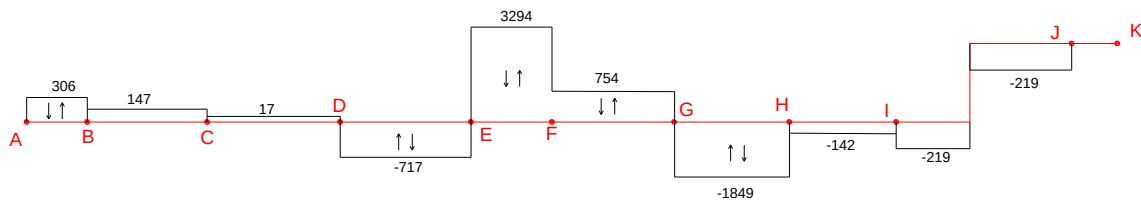
Momentos del empotramiento perfecto, unidades en N-m.



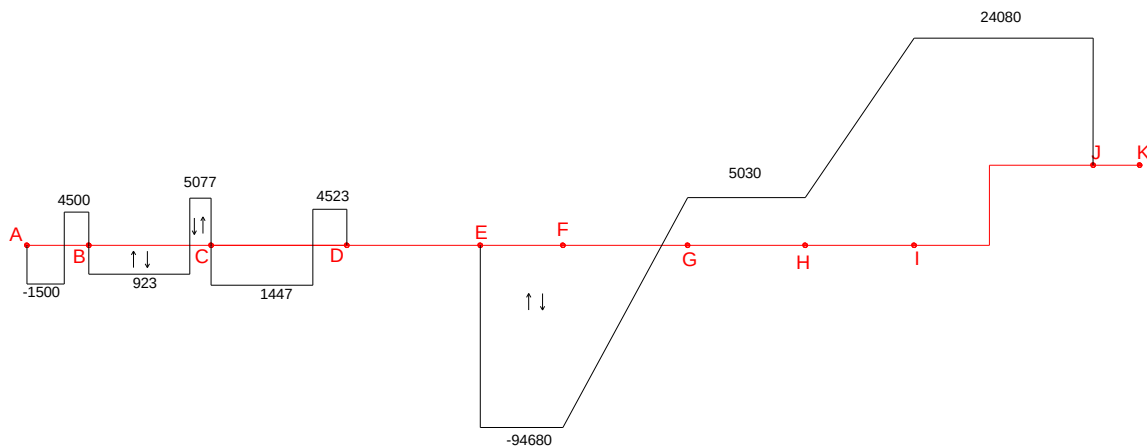
Momento flector resultante (N-m): sumando ambos efectos (cross + empotramiento perfecto)



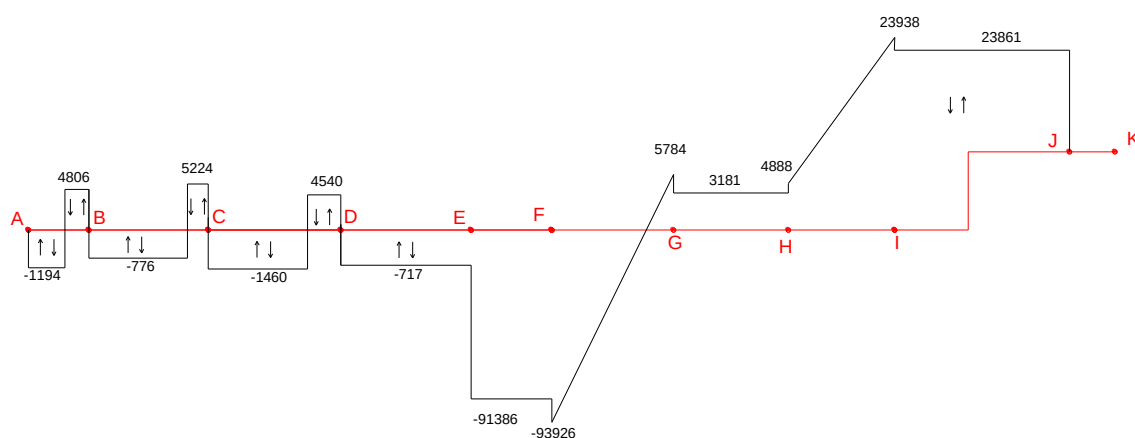
Fuerzas cortantes de los resultados de cross, unidades en N.



Fuerza cortante en el empotramiento perfecto, unidades en N.



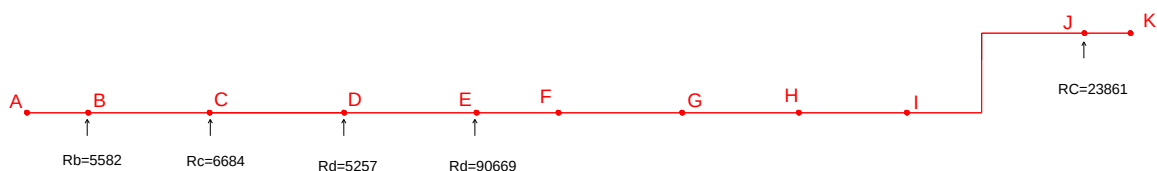
Fuerza cortante resultante (N): sumando ambos efectos (cross + empotramiento perfecto)



Cargas axiales (N)



Reacciones



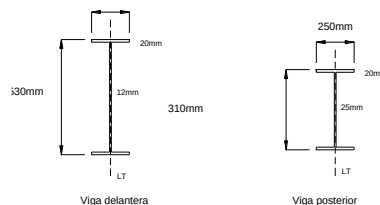
2.2.1.2. Dimensionamiento de los perfiles

- $f_y = 200MPa$
- $\gamma_{M0} = 1.05$
- $f_{yd} = 200MPa / 1.05 = 190MPa$
- $E = 200GPa$

De los resultados de Cross, de los gráficos de momento flector, fuerza cortante y fuerza axial se obtienen:

IT	BARRA	Momento flector máximo	Fuerza cortante máxima	Fuerza normal máxima
		M_ED	V_ED	N_ED
		N-m	N	N
1	AB	320	4806	0
2	BC	677	5224	0
3	CD	737	4540	0
4	DE	1143	717	0
5	EF	4720	91386	0
6	FG	10503	93926	0
7	GH	6680	3181	0
8	HI	3740	23938	0
9	IJ	1818	23861	2381

Mediante cálculos determinamos las áreas, momentos de inercia y módulos resistentes



IT	BARRA	DESCRIPCION	Long.	Momento de inercia	Modulo resistente	Modulo resistente sentido lateral	Área de corte
		NOTACION	L	I	W	W_LT	A
		Unidades	mm	cm^4	cm^3	cm^3	cm^2
1	AB	Viga posterior	480	30265	1953	417	177,5
2	BC	Viga posterior	1300	30265	1953	417	177,5
3	CD	Viga posterior	1300	30265	1953	417	177,5
4	DE	Viga posterior	1300	30265	1953	417	177,5
5	EF	Viga posterior	890	30265	1953	417	177,5
6	FG	Viga delantera	1300	85146	3213	417	163,6
7	GH	Viga delantera	1120	85146	3213	417	163,6
8	HI	Viga delantera	2540	85146	3213	417	163,6
9	IJ	Viga delantera	4160	85146	3213	417	163,6

Se calcula la resistencia a la flexión, al corte y a la carga axial usando las siguientes expresiones:

$$M_{C,Rd} = W \cdot f_{yd}; \quad V_{C,Rd} = A \cdot \frac{f_{yd}}{\sqrt{3}}; \quad N_{Rd} = A \cdot f_{yd}$$

IT	BARRA	Resistencia de las secciones a la flexión	Resistencia de las secciones al corte	Resistencia de las secciones a cargas axiales
		M_C,Rd	V_C,Rd	N_Rd
		N-m	N	N
1	AB	371.918	1.951.994	3.380.952
2	BC	371.918	1.951.994	3.380.952
3	CD	371.918	1.951.994	3.380.952
4	DE	371.918	1.951.994	3.380.952
5	EF	371.918	1.951.994	3.380.952
6	FG	612.011	1.799.133	3.116.190
7	GH	612.011	1.799.133	3.116.190
8	HI	612.011	1.799.133	3.116.190
9	IJ	612.011	1.799.133	3.116.190

Verificación de flexión simple

$$\frac{V_{ED}}{V_{C,Rd}} < 1$$

IT	BARRA	Fuerza cortante máxima	Resistencia de las secciones al corte	Verificación de flexión simple (10 ⁻³)
		V_ED	V_C,Rd	
		N	N	
1	AB	4806	1.951.994	2,46
2	BC	5224	1.951.994	2,68
3	CD	4540	1.951.994	2,33
4	DE	717	1.951.994	0,37
5	EF	91386	1.951.994	46,82
6	FG	93926	1.799.133	52,21
7	GH	3181	1.799.133	1,77
8	HI	23938	1.799.133	13,31
9	IJ	23861	1.799.133	13,26

Verificación de la flexión compuesta

$$\frac{N_{ED}}{N_{Rd}} + \frac{M_{ED}}{M_{C,Rd}} \leq 1$$

IT	BARRA	Momento flector máximo	Fuerza normal máxima	Resistencia de las secciones a la flexión	Resistencia de las secciones a cargas axiales	Verificación de la flexión compuesta
		M_ED	N_ED	M_C,Rd	N_Rd	
		N-m	N	N-m	N	
1	AB	320	0	371.918	3.380.952	0,0009
2	BC	677	0	371.918	3.380.952	0,0018
3	CD	737	0	371.918	3.380.952	0,0020
4	DE	1143	0	371.918	3.380.952	0,0031
5	EF	4720	0	371.918	3.380.952	0,0127
6	FG	10503	0	612.011	3.116.190	0,0172
7	GH	6680	0	612.011	3.116.190	0,0109
8	HI	3740	0	612.011	3.116.190	0,0061
9	IJ	1818	2381	612.011	3.116.190	0,0037

Pandeo

- $f_y = 200MPa$
- $\gamma_{M1} = 1.05$
- $f_{yd} = 200MPa / 1,05 = 190Mpa$
- $\alpha=0,13$: Coeficiente de imperfección de pandeo.
- $c_m = 0.2 + 0.8\alpha = 0,2+0,8*0,13=0,3$
- $\alpha_y=0,8$
- $X_{LT}=1$ para esbeltez reducida $< 0,4$

$$L_k = \beta \cdot L; \quad \bar{\lambda} = \sqrt{\frac{A \cdot f_y}{N_{CR}}}; \quad \phi = 0.5(1 + \alpha(\bar{\lambda} - 0.2) + \bar{\lambda}^2); \quad X = \frac{1}{\phi + \sqrt{\phi^2 - \bar{\lambda}^2}}$$

IT	BARRA	Coeficiente de pandeo	Longitud de pandeo	Esbeltez reducida	ϕ	Coeficiente de reducción por pandeo
		β	L_k	$\bar{\lambda}$		X
			m			
1	AB	2	1,0	0,07	0,5	1,02
2	BC	1	1,3	0,10	0,5	1,01
3	CD	1	1,3	0,10	0,5	1,01
4	DE	1	1,3	0,10	0,5	1,01
5	EF	1	0,9	0,07	0,5	1,02
6	FG	1	1,3	0,06	0,5	1,02
7	GH	1	1,1	0,05	0,5	1,02
8	HI	1	2,5	0,11	0,5	1,01
9	IJ	1	4,2	0,18	0,5	1,00

Resistencias:

$$N_{CR} = \left(\frac{\pi}{L_k}\right)^2 E \cdot I; \quad N_{b,Rd} = X \cdot A \cdot f_{yd}; \quad N_{b,Rd} = X_{LT} \cdot A \cdot f_{yd}; \quad M_{b,Rd_{LT}} = X_{LT} \cdot W_{LT} \cdot f_{yd};$$

IT	BARRA	Compresión crítica por pandeo	Resistencia de la barra al pandeo	Resistencia de la barra al pandeo lateral	Resistencia de la barra al pandeo lateral
		N_CR	N_b,Rd	N_b,Rd_LT	M_b,Rd
		N	N	N	N-m
1	AB	647.566.710	3.437.557	3.380.952	79365
2	BC	353.134.603	3.425.828	3.380.952	79365
3	CD	353.134.603	3.425.828	3.380.952	79365
4	DE	353.134.603	3.425.828	3.380.952	79365
5	EF	753.437.041	3.439.978	3.380.952	79365
6	FG	993.498.024	3.175.256	3.116.190	79365
7	GH	1.338.497.816	3.178.558	3.116.190	79365
8	HI	260.247.328	3.152.669	3.116.190	79365
9	IJ	97.021.291	3.123.064	3.116.190	79365

Verificación pandeo lateral

$$\frac{M_{ED}}{M_{b,Rd}} < 1$$

IT	BARRA	Momento flector máximo	Resistencia de la barra al pandeo lateral	Verificación pandeo lateral
		M_ED	M_b,Rd	
		N-m	N-m	
1	AB	320	79365	0,0040
2	BC	677	79365	0,0085
3	CD	737	79365	0,0093
4	DE	1143	79365	0,0144
5	EF	4720	79365	0,0595
6	FG	10503	79365	0,1323
7	GH	6680	79365	0,0842
8	HI	3740	79365	0,0471
9	IJ	1818	79365	0,0229

Verificación de interacción (pandeo + flexión)

$$\frac{N_{Ed}}{N_{b,Rd}} + k_y * \frac{c_m \cdot M_{Ed}}{X_{LT} \cdot w_{LT} \cdot f_{yd}} \leq 1$$

$$\frac{N_{Ed}}{N_{b,Rd_{LT}}} + \alpha_y \cdot k_y * \frac{c_m \cdot M_{Ed}}{w_{LT} \cdot f_{yd}} \leq 1 \quad Lateral$$

IT	BARRA	Momento flector máximo	Fuerza normal máxima	Resistencia de la barra al pandeo	Resistencia de la barra al pandeo lateral	Ky	Verificación de interacción (pandeo + flexión)	
		M_ED	N_ED	N_b,Rd	N_b,Rd_LT			
		N-m	N	N	N			Lateral
1	AB	320	0	3.437.557	3.380.952	1,00	0,00	0,00
2	BC	677	0	3.425.828	3.380.952	1,00	0,00	0,00
3	CD	737	0	3.425.828	3.380.952	1,00	0,00	0,00
4	DE	1143	0	3.425.828	3.380.952	1,00	0,00	0,00
5	EF	4720	0	3.439.978	3.380.952	1,00	0,02	0,01
6	FG	10503	0	3.175.256	3.116.190	1,00	0,04	0,03
7	GH	6680	0	3.178.558	3.116.190	1,00	0,03	0,02
8	HI	3740	0	3.152.669	3.116.190	1,00	0,01	0,01
9	IJ	1818	2381	3.123.064	3.116.190	1,00	0,01	0,01

Relación de documentos

() Memoria	94	páginas
(X) Anexo: Cálculos Justificativos	79	páginas
() Anexo: Planos	29	páginas
() Anexo: Planificación	16	páginas
() Anexo: Presupuesto	19	páginas
() Anexo: Pliego de Condiciones.....	17	páginas
() Anexo: Simulación de Esfuerzos	79	páginas
() Anexo: Hojas Técnicas	157	páginas

La Almunia, a 30 de noviembre de 2016

Firmado: Rony Moises Pinedo Cordova



Universidad
Zaragoza

**ESCUELA UNIVERSITARIA POLITÉCNICA
DE LA ALMUNIA DE DOÑA GODINA (ZARAGOZA)**

ANEXO: PLANIFICACIÓN

**DISEÑO SUBSTACIÓN ELÉCTRICA
MOVIL 66/12kV, 10MV**

Mobile Substation Design 66/12kV, 10MVA

424.13.131

Autor: Rony Moises Pinedo Cordova

Director: Carmelo Jose Borque Horna

Fecha: 30-11-2016

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1. LISTA DE TRABAJOS/TAREAS/ACTIVIDADES

Nombre de tarea
Diseño
Diseño eléctrico
Selección de Transformador de Potencia
Calculo eléctrico lado primario
Selección equipos eléctricos lado primario
Calculo eléctrico lado secundario
Selección equipos eléctricos lado secundario
Diseño protección, medición y control
Selección de equipamiento de protección, medición y control.
Planos Eléctricos
Planos unifilares
Planos trefilares
Planos de Control y Señalización
Planos de servicios auxiliares
Diseño Mecánico
Cálculos estructurales
Diseño de pórtico y caseta
Análisis de estrés de pórtico y caseta
Diseño de Plataforma
Análisis de estrés de plataforma
Planos mecánicos
Planos de ingeniería básica
Planos de ingeniería de detalle
Planos de fabricación plataforma
Planos de fabricación pórtico
Planos de fabricación caseta
Plano de montaje de equipos
Compra de equipos eléctricos
Transformador 10MVA
Lado primario
Lado secundario
Protección y medición
Control
Compra de Materiales Mecánicos
Tracto (ejes, aros, gatos, etc.)
Vigas para plataforma
Perfilería para pórtico
Tubos y malla de cerco

Plancha para caseta
Pintura
Ferretería
Consumibles
Fabricación mecánica
Plataforma
Pórtico (fabricación y montaje)
Cerco (fabricación y montaje)
Caseta (fabricación e instalación)
Pintado general
Instalación de equipos mecánicos
Montaje equipos
Transformador 10MVA
Seccionador y fusibles de potencia
Equipamiento lado secundario
Baterías y cargador
Instalación eléctrica
Equipos lado secundario
Baterías, cargador y paneles
Cableado de control
Servicios auxiliares
Pruebas FAT
Cierre
Embalaje
Despacho
Puesta en servicio

2. HITOS

Nombre de tarea
Valorización 20% (planos emitidos)
Valorización 40% (equipos comprados)
Llegada de transformador 10MVA
Valorización 20% (Pruebas FAT)
Valorización 20% (Cierre)

Los hitos importantes del proyecto se basan en puntos técnicos estratégicos para el desarrollo del mismo así como económicos.

Primer hito: Valorización 20% (planos electricos)

Con la emisión de planos para el cliente, este procederá a realizar la aprobación de estos y de lo que contiene, información como características del equipamiento eléctricos.

Con la aprobación de planos mecánicos, el cliente dará conformidad que se fabrique con la distribución solicitada por ellos, así como dimensiones exteriores las cuales son importantes para no presentar problemas de transporte y operación.

Si los planos no son aprobados por el cliente, se detiene la compra del equipamiento electrico así como tampoco puede iniciar la fabricación de la estructura, económicamente la empresa se verá afectada ya que no podrá hacer el primer cobro (20%).

Segundo hito: Valorización 40% (equipos comprados)

La compra de equipos es el punto más crítico del proyecto, sin estos la subestación no podrá operar, por lo que la compra adecuada y a tiempo es de fundamental importancia, así como su impacto económico, tiene un coste elevado por lo que según acuerdo comercial con el cliente, este procederá con el pago del 40% del proyecto una vez el vendedor haya emitido todas las órdenes de compra de los equipos.

Tercer hito: Llegada de transformador 10MVA

Si bien se puede realizar toda la fabricación de la estructura mecánica y las conexiones eléctricas del lado primario y lado secundario y solo dejar habilitado para el montaje y conexionado del transformador, la subestación no podrá ser despachada sin



este. El impacto económico sería considerable dado que habría que enviar a sitio el transformador por separado además de montarlo en sitio.

Cuarto hito: Valorización 20% (Pruebas FAT)

La conformidad de las pruebas FAT por parte del cliente son importante para su despacho, el cliente no aceptara el ingreso de la subestación a sitio sin esta aprobación dado que los trabajos pendientes se podría prolongar varias semanas, así el cliente obliga al vendedor a conservar la subestación hasta que todas las pruebas sean conformes.

Una vez la aprobación de estas pruebas el cliente abonara el pago de un 20%, por lo que también existe un impacto económico en el desarrollo del proyecto.

Quinto hito: Valorización 20% (Cierre)

Ya en sitio el cliente procede a firmar el acta de conformidad técnica, y con ello se terminan los trabajos realizados por el vendedor.

Recordar que aún queda la vigencia de garantía por un año por lo que si bien el vendedor ya realizo el proyecto en su integridad en incluso procede con el cobro del ultimo 20%, contablemente el proyecto sigue abierto debido a posibles costes adicionales futuros.

3. DIAGRAMA DE GANTT

Según contrato el proyecto debe ser entregado en 40 semanas. Los primeros meses estarán dispuestos al diseño y compra de equipos y materiales, se puede avanzar con la fabricación de la estructura una vez aprobado los planos mecánicos. Pero las instalaciones eléctricas se podrán iniciar una vez que empiece a llegar todo el equipamiento.

Diseño

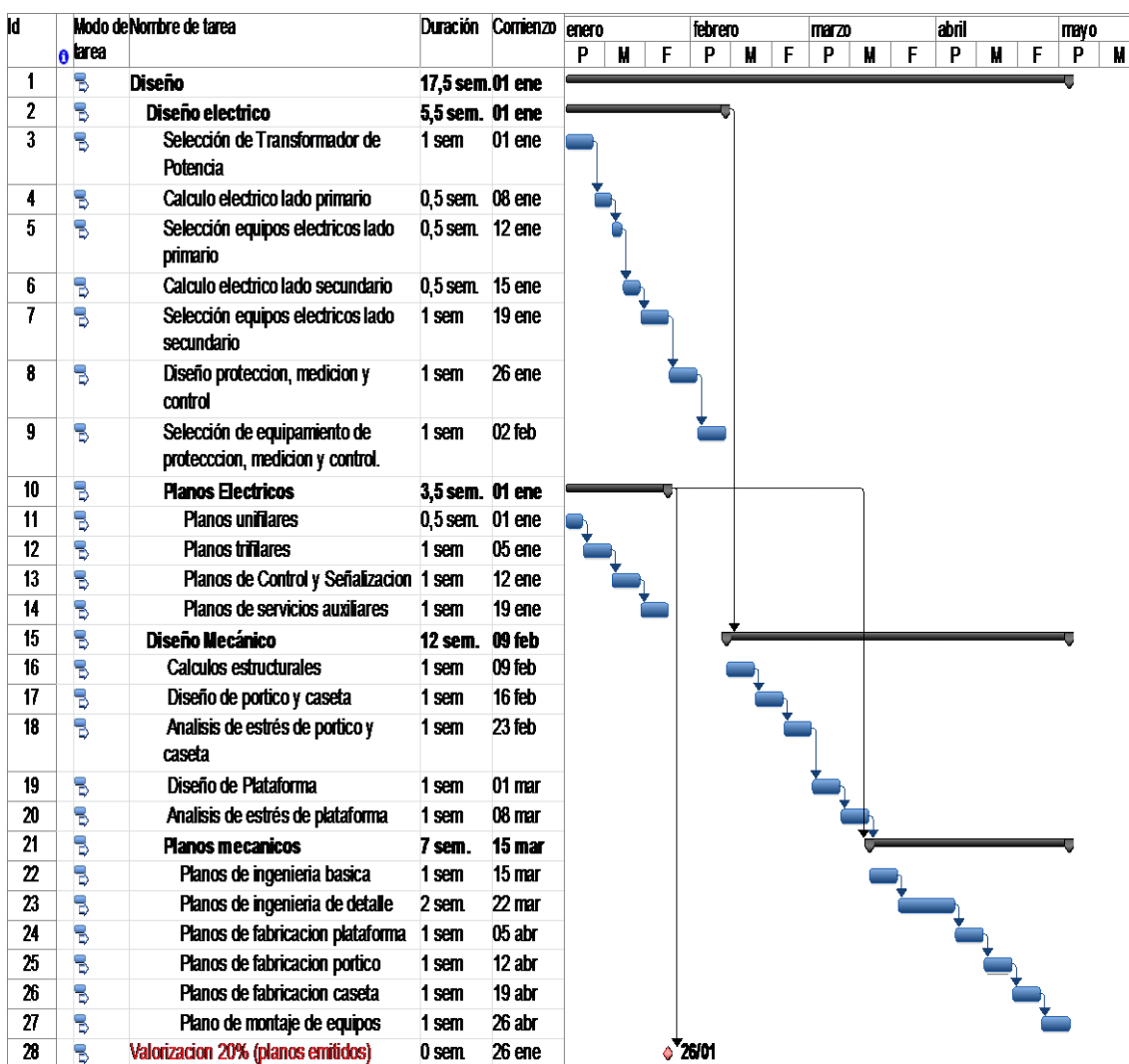
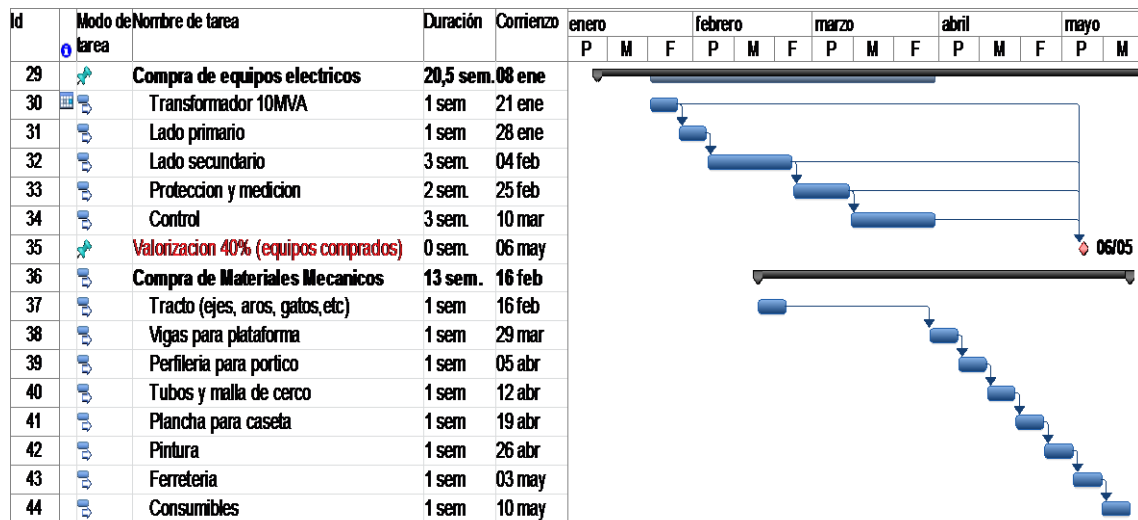
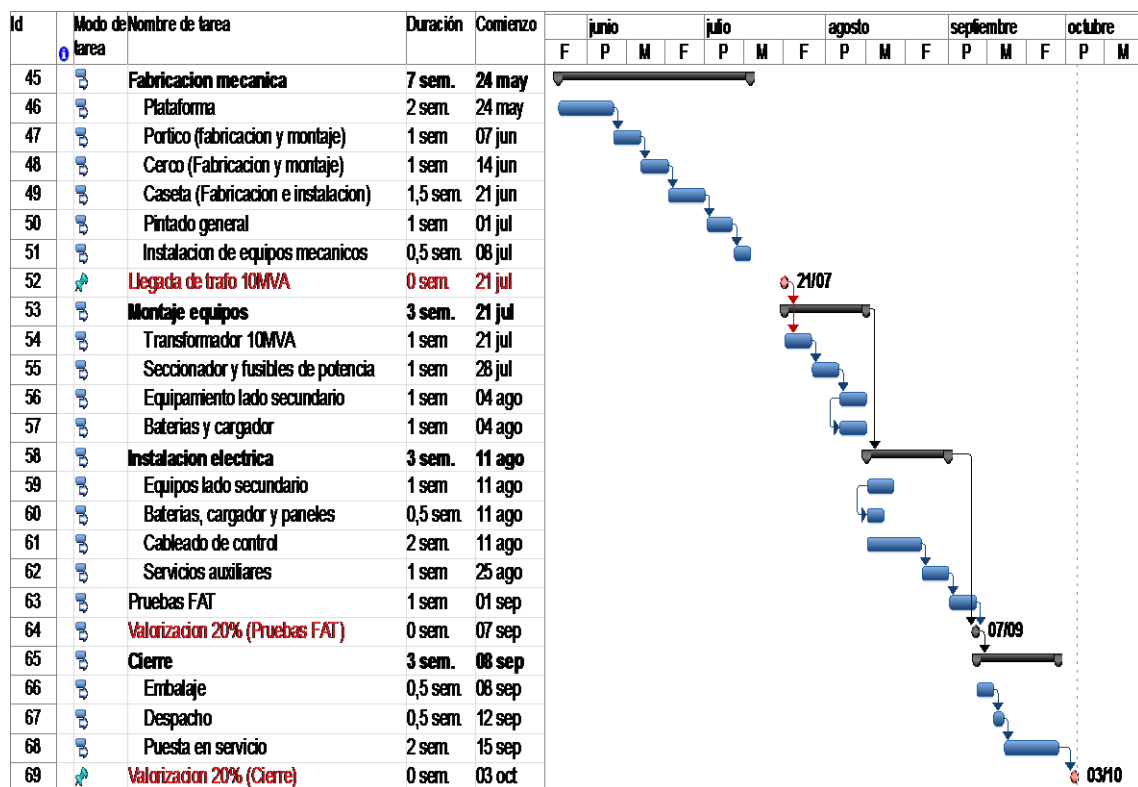


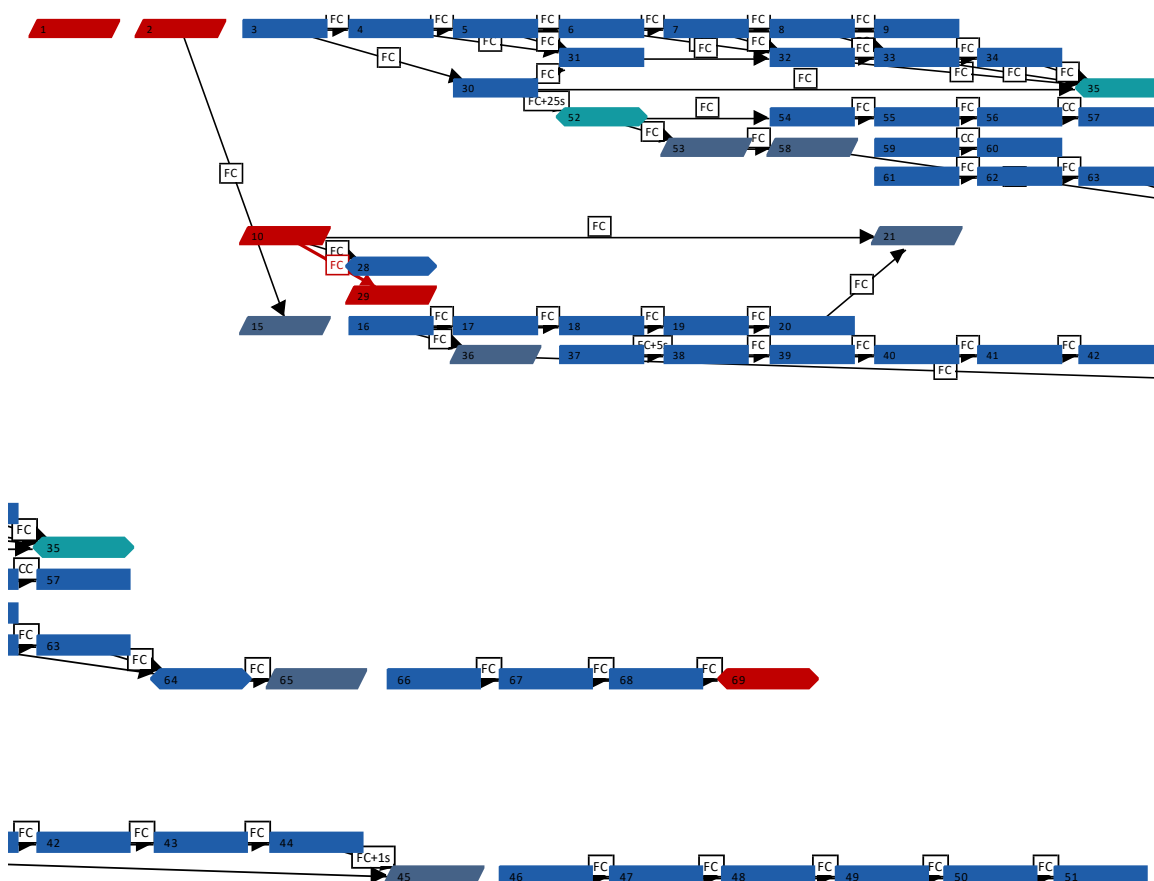
Diagrama de Gantt

ComprasFabricación-Montaje-Instalación y Cierre.

4. DIAGRAMA DE RED

Según los gráficos de resumen abajo, las rutas críticas se encuentran en la primera fase del proyecto, con la aprobación de planos, estos permiten la compra del equipamiento eléctrico, sin este punto superado el proyecto se corre peligro de no terminar en el plazo.

Otros hitos como la llegada del transformador de potencia o las pruebas FAT si bien son indispensables para sus siguientes actividades no conforman la ruta crítica dado que se dispone de tiempo necesario para prever cualquier contingencia además de contar con actividades alternas que se pueden ir realizando en paralelo.



5. INFORMES PRESUPUESTARIOS.

La planificación de cobros y pagos es determinante en la ejecución de un proyecto, es necesario saber que costes tendrán que realizarse mes a mes y el monto de dinero disponible para estos fines.

Para una adecuada y confiable planificación, en el cuadro de cobros y pagos se debe considerar todas sus partidas y subpartidas como: IVA, impuestos, intereses, mano de obra, pago de beneficios sociales del personal, retenciones e incluso subvenciones.

De debe determinar capital inicial con el cual se debe contar para iniciar el proyecto, decidir si se procederá con capital propio o con financiación y el porcentaje de endeudamiento al cual estemos dispuestos a someternos considerando los riesgos del caso.

En este tipo de proyectos donde el cliente va realizando pagos a medida que el proyecto avanza no es necesario contar con el capital (sea propio o financiado) en su totalidad.

En el presente proyecto los costes elevados se dan en la compra del equipamiento y estos ocurren en el primer y tercer mes, con lo que debemos asegurar la disponibilidad del efectivo y así no detener el proyecto en su punto más crítico. Esta información fue la más importante para la determinación del capital inicial.

Según lo estimado el proyecto puede iniciar con un capital de 200 mil euros y un préstamo de 100mil euros a una tasa del 9% anual, pagadas en 3 cuotas a partir del cuarto mes sin generar mayores costes y problemas de liquidez.

Solicitar un número mayor de cuota solo generaría mayores costes en intereses dado que a partir del cuarto mes ya se cuta con el efectivo necesario.

Una vez valorizado la realización de planos (20% de OC) en el segundo mes y emitida las órdenes de compra (valorización del 40%) de los equipos en el cuarto mes, según lo estipulado en las condiciones económicas, ya se dispone del dinero suficiente para las siguientes etapas.

Una vez alcanzado el cuarto mes en adelante no se presentaran problemas de liquidez para la continuación y finalización del proyecto.

Según los acuerdos el proyecto debe ser entregado en la semana 40 (mes 10) y se procede al cobro, pero a meses futuros la empresa todavía tiene costes por cubrir incluso dos meses después, por ejemplo declaración de impuestos y cierre contable, por lo que el proyecto aún no puede ser cerrado contablemente y se debe reservar el monto necesario para estos acontecimientos.

Después del noveno mes, al realizar las pruebas FAT se valoriza un 20%, a partir de este punto y quedando poco para finalizar el proyecto, ya se puede destinar parte del dinero para otros fines, debido a que se dispone de liquidez en exceso.

Para el presente proyecto se estableció como el precio de venta, la cantidad de 650 mil euros (no incluye IVA), con lo cual se obtiene un beneficio neto superior a 124mil euros.

A continuación se detalla la planificación detallada de costos y cobros mes a mes, todos los montos en euros.

MES	01	02	03	04
COBROS				
Ventas		130.000,00		260.000,00
IVA ventas (21%)	-	27.300,00	-	54.600,00
COBROS VENTAS	-	-	157.300,00	-
Subvenciones				
TOTAL COBROS EXPLOTACIÓN	-	-	157.300,00	-
PAGOS EXPLOTACIÓN				
Sueldos brutos	986,16	986,16	6.157,08	6.157,08
IRPF trabajador	- 78,89	- 78,89	- 492,57	- 492,57
Seguridad social trabajador	- 88,75	- 88,75	- 554,14	- 554,14

PAGO NÓMINAS	- 818,51	- 818,51	- 5.110,38	- 5.110,38
Seguridad social empresa	- 295,85	- 295,85	- 1.847,12	- 1.847,12
PAGO SEGURIDAD SOCIAL		- 384,60	- 384,60	- 2.401,26
Suministros	- 172.774,39	- 995,05	- 156.782,60	- 24.464,23
IVA Suministros (21%)	- 36.282,62	- 208,96	- 32.924,35	- 5.137,49
PAGO SUMINISTROS	- 209.057,02	- 1.204,01	- 189.706,95	- 29.601,72
Proveedores				
IVA Proveedores (21%)	-	-	-	-
PAGO PROVEEDORES	-	-	-	-
Impuestos retención				
IVA (liquidación por trimestre)				43.375,93
Gatos. Gestión	- 500,00	- 500,00	- 500,00	- 500,00
IVA Gatos. Gestión (21%)	- 105,00	- 105,00	- 105,00	- 105,00
PAGO GASTOS GESTIÓN	- 605,00	- 605,00	- 605,00	42.770,93
TOTAL PAGOS EXPLOTACIÓN	- 210.480,53	- 3.012,12	- 195.806,93	5.657,58
EXCESO O DÉFICIT EXPLOTACIÓN	- 210.480,53	- 3.012,12	- 38.506,93	5.657,58
COBROS CAPITAL				
Petición préstamo	100.000,00			
Gastos y Comisiones de Apertura	- 7.500,00			
TOTAL COBROS CAPITAL	92.500,00	-	-	-
PAGOS CAPITAL	-	-	-	- 33.834,58
Amortización préstamo				- 33.834,58
Leasing	- 500,00	- 2.000,00	- 2.000,00	- 2.000,00
IVA Leasing (21%)	- 105,00	- 420,00	- 420,00	- 420,00
PAGO LEASING	- 605,00	- 2.420,00	- 2.420,00	- 2.420,00
TOTAL PAGOS CAPITAL	- 605,00	- 2.420,00	- 2.420,00	- 36.254,58
EXCESO O DÉFICIT DE CAPITAL	91.895,00	- 2.420,00	- 2.420,00	- 36.254,58
SUPERAVIT / DÉFICIT MENSUAL	- 118.585,53	- 5.432,12	- 40.926,93	- 30.597,00
SALDO DE EFECTIVO INICIAL	200.000,00	81.414,47	75.982,36	35.055,43
SALDO DE EFECTIVO FINAL	81.414,47	75.982,36	35.055,43	4.458,42

MES	05	06	07	08
COBROS				
Ventas				
IVA ventas (21%)	-	-	-	-
COBROS VENTAS	314.600,00	-	-	-
Subvenciones				
TOTAL COBROS EXPLOTACIÓN	314.600,00	-	-	-
PAGOS EXPLOTACIÓN				
Sueldos brutos	6.157,08	6.157,08	9.727,26	4.556,34
IRPF trabajador	- 492,57	- 492,57	- 778,18	- 364,51
Seguridad social trabajador	- 554,14	- 554,14	- 875,45	- 410,07
PAGO NÓMINAS	- 5.110,38	- 5.110,38	- 8.073,63	- 3.781,76
Seguridad social empresa	- 1.847,12	- 1.847,12	- 2.918,18	- 1.366,90
PAGO SEGURIDAD SOCIAL	- 2.401,26	- 2.401,26	- 2.401,26	- 3.793,63

Suministros	-	7.711,86	-	30.712,14	-	-
IVA Suministros (21%)	-	1.619,49	-	6.449,55	-	-
PAGO SUMINISTROS	-	9.331,35	-	37.161,69	-	-
Proveedores						
IVA Proveedores (21%)	-	-	-	-	-	-
PAGO PROVEEDORES	-	-	-	-	-	-
Impuestos retención						
IVA (liquidación por trimestre)			-	39.818,47		
Gatos. Gestión	-	500,00	-	500,00	-	500,00
IVA Gatos. Gestión (21%)	-	105,00	-	105,00	-	105,00
PAGO GASTOS GESTIÓN	-	605,00	-	605,00	-	40.423,47
TOTAL PAGOS EXPLOTACIÓN	-	17.447,99	-	45.278,33	-	50.898,36
EXCESO O DÉFICIT EXPLOTACIÓN		297.152,01	-	45.278,33	-	50.898,36
COBROS CAPITAL						
Petición préstamo						
Gastos y Comisiones de Apertura						
TOTAL COBROS CAPITAL	-	-	-	-	-	-
PAGOS CAPITAL	-	33.834,58	-	33.834,58	-	-
Amortización préstamo	-	33.834,58	-	33.834,58		
Leasing	-	2.000,00	-	2.000,00	-	2.000,00
IVA Leasing (21%)	-	420,00	-	420,00	-	420,00
PAGO LEASING	-	2.420,00	-	2.420,00	-	2.420,00
TOTAL PAGOS CAPITAL	-	36.254,58	-	36.254,58	-	2.420,00
EXCESO O DÉFICIT DE CAPITAL	-	36.254,58	-	36.254,58	-	2.420,00
SUPERAVIT / DÉFICIT MENSUAL		260.897,43	-	81.532,91	-	53.318,36
SALDO DE EFECTIVO INICIAL		4.458,42		265.355,86		183.822,95
SALDO DE EFECTIVO FINAL		265.355,86		183.822,95		130.504,59

MES	09	10	11	12
COBROS				
Ventas	130.000,00	130.000,00		
IVA ventas (21%)	27.300,00	27.300,00		
COBROS VENTAS	-	157.300,00	157.300,00	
Subvenciones				
TOTAL COBROS EXPLOTACIÓN	-	157.300,00	157.300,00	
PAGOS EXPLOTACIÓN				
Sueldos brutos	3.570,18	2.790,21		
IRPF trabajador	- 285,61	- 223,22		
Seguridad social trabajador	- 321,32	- 251,12		
PAGO NÓMINAS	- 2.963,25	- 2.315,87	-	-
Seguridad social empresa	- 1.071,05	- 837,06		

PAGO SEGURIDAD SOCIAL	- 1.776,97	- 1.392,37	- 1.088,18	-
Suministros	-	-		
IVA Suministros (21%)	-	-	-	
PAGO SUMINISTROS	-	-	-	-
Proveedores				
IVA Proveedores (21%)	-	-	-	
PAGO PROVEEDORES	-	-	-	-
Impuestos retención				
IVA (liquidación por trimestre)		- 25.725,00		- 26.670,00
Gatos. Gestión	- 500,00	- 500,00	- 500,00	
IVA Gatos. Gestión (21%)	- 105,00	- 105,00	- 105,00	-
PAGO GASTOS GESTIÓN	- 605,00	- 26.330,00	- 605,00	- 26.670,00
TOTAL PAGOS EXPLOTACIÓN	- 5.345,22	- 30.038,24	- 1.693,18	- 26.670,00
EXCESO O DÉFICIT EXPLOTACIÓN	- 5.345,22	127.261,76	155.606,82	- 26.670,00
COBROS CAPITAL				
Petición préstamo				
Gastos y Comisiones de Apertura				
TOTAL COBROS CAPITAL	-	-		
PAGOS CAPITAL	-	-	-	-
Amortización préstamo				
Leasing	- 2.000,00	- 2.000,00		
IVA Leasing (21%)	- 420,00	- 420,00	-	-
PAGO LEASING	- 2.420,00	- 2.420,00	-	-
TOTAL PAGOS CAPITAL	- 2.420,00	- 2.420,00	-	-
EXCESO O DÉFICIT DE CAPITAL	- 2.420,00	- 2.420,00	-	-
SUPERAVIT / DÉFICIT MENSUAL	- 7.765,22	124.841,76	155.606,82	- 26.670,00
SALDO DE EFECTIVO INICIAL	119.904,20	112.138,98	236.980,73	392.587,55
SALDO DE EFECTIVO FINAL	112.138,98	236.980,73	392.587,55	365.917,55

A continuación se muestra el detalle anual, donde se verá el resumen de todos los pagos y cobros.

MES	MONTO
COBROS	
Ventas	650.000,00 EUR
IVA ventas (21%)	136.500,00 EUR
COBROS VENTAS	786.500,00 EUR
Subvenciones	0,00 EUR
	0,00 EUR
TOTAL COBROS EXPLOTACIÓN	786.500,00 EUR
	0,00 EUR
PAGOS EXPLOTACIÓN	0,00 EUR
Sueldos brutos	47.244,62 EUR
IRPF trabajador	-3.779,57 EUR
Seguridad social trabajador	-4.252,02 EUR
PAGO NÓMINAS	-39.213,03 EUR
Seguridad social empresa	-14.173,39 EUR

PAGO SEGURIDAD SOCIAL	-18.425,40 EUR
Suministros	-393.440,28 EUR
IVA Suministros (21%)	-82.622,46 EUR
PAGO SUMINISTROS	-476.062,73 EUR
Proveedores	0,00 EUR
IVA Proveedores (21%)	0,00 EUR
PAGO PROVEEDORES	0,00 EUR
Impuestos retención	0,00 EUR
IVA (liquidación por trimestre)	-48.837,54 EUR
Gatos. Gestión	-5.500,00 EUR
IVA Gatos. Gestión (21%)	-1.155,00 EUR
PAGO GASTOS GESTIÓN	-55.492,54 EUR
TOTAL PAGOS EXPLOTACIÓN	-589.193,71 EUR
	0,00 EUR
EXCESO O DÉFICIT EXPLOTACIÓN	197.306,29 EUR
COBROS CAPITAL	0,00 EUR
Petición préstamo	100.000,00 EUR
Gastos y Comisiones de Apertura	-7.500,00 EUR
TOTAL COBROS CAPITAL	92.500,00 EUR
PAGOS CAPITAL	-101.503,74 EUR
Amortización préstamo	-101.503,74 EUR
Leasing	-18.500,00 EUR
IVA Leasing (21%)	-3.885,00 EUR
PAGO LEASING	-22.385,00 EUR
TOTAL PAGOS CAPITAL	-123.888,74 EUR
EXCESO O DÉFICIT DE CAPITAL	-31.388,74 EUR
SUPERAVIT / DÉFICIT MENSUAL	165.917,55 EUR
SALDO DE EFECTIVO INICIAL	200.000,00 EUR
SALDO DE EFECTIVO FINAL	365.917,55 EUR
Capital inicial	-200.000,00 EUR
Beneficio antes de Impuesto	165.917,55 EUR
IMPUESTO A LAS SOCIEDADES (25%)	-41.479,39 EUR
BENEFICIO NETO	124.438,16 EUR

6. INFORMES DE COSTES

Para la determinación si el proyecto es conveniente no es suficiente con saber el costo de venta o mucho menos fijar el coste en función de la competencia, es más importante conocer los costes internos y como evolucionaran una vez adquirido un nuevo proyecto.

En el presente proyecto existirá un incremento en los costos variables debido a la producción. Los costes fijos también se verán afectados, debido a que probablemente se tenga que contratar personal adicional si no existe el disponible, los costes de financiación también se verán incrementados, costes de alquileres de locales o almacenes, etc.

Según los cuadros líneas abajo vemos que los primeros meses los beneficios son negativo, esto debido a que se está utilizando nuestros recursos sin aun recibir ninguna pago: Al final de todo el periodo se pueden observar los beneficios netos totales.

A continuación se muestra a evolución de los costes variables, costes fijos, ingresos, intereses, impuestos y beneficios mes a mes, todos los montos en euros.

MES	01	02	03	04
INGRESOS	-	130.000,00	-	260.000,00
Costes variables	- 172.774,39	- 995,05	- 156.782,60	- 24.464,23
Coste fijos	- 1.818,51	- 3.703,11	- 7.994,98	- 10.011,64
Beneficios antes de interés e impuestos	- 174.592,90	125.301,84	- 164.777,58	225.524,13
Intereses	92.500,00	-	-	- 33.834,58
Beneficio antes de impuestos	- 82.092,90	125.301,84	- 164.777,58	191.689,56
Impuestos	20.523,23	- 31.325,46	41.194,40	- 47.922,39
Beneficios netos	- 61.569,68	93.976,38	- 123.583,19	143.767,17

MES	05	06	07	08
INGRESOS	-	-	-	-
Costes variables	- 7.711,86	- 30.712,14	-	-
Coste fijos	- 10.011,64	- 10.011,64	- 12.974,89	- 10.075,39
Beneficios antes de interés e impuestos	- 17.723,50	- 40.723,78	- 12.974,89	- 10.075,39
Intereses	- 33.834,58	- 33.834,58	-	-
Beneficio antes de impuestos	- 51.558,08	- 74.558,36	- 12.974,89	- 10.075,39
Impuestos	12.889,52	18.639,59	3.243,72	2.518,85
Beneficios netos	- 38.668,56	- 55.918,77	- 9.731,17	- 7.556,54

MES	09	10	11	TOTAL
INGRESOS	130.000,00	130.000,00	-	650.000,00 EUR
Costes variables	-	-	-	-393.440,28 EUR
Coste fijos	- 7.240,22	- 6.208,24	- 1.588,18	-81.638,44 EUR
Beneficios antes de interés e impuestos	122.759,78	123.791,76	- 1.588,18	174.921,29 EUR
Intereses	-	-	-	-9.003,74 EUR
Beneficio antes de impuestos	122.759,78	123.791,76	- 1.588,18	165.917,55 EUR
Impuestos	- 30.689,94	- 30.947,94	397,05	-41.479,39 EUR
Beneficios netos	92.069,83	92.843,82	- 1.191,14	124.438,16 EUR

7. FECHAS.

Se estableció un tiempo de entrega de 40 semanas y el inicio se realiza el 01 de enero.

El siguiente cuadro muestra las fechas límites planificadas para el desenvolvimiento sin problemas de la fabricación.

Nombre de tarea	Fecha Limite
Diseño	03 may
Diseño eléctrico	09 feb
Diseño Mecánico	03 may
Valorizacion 20% (planos emitidos)	26 ene
Compra de equipos eléctricos	31 may
Valorizacion 40% (equipos comprados)	06 may
Compra de Materiales Mecánicos	17 may
Fabricación mecánica	12 jul
Llegada de trato 10MVA	21 jul
Montaje equipos	10 ago.
Instalación eléctrica	31 ago.
Pruebas FAT	07 sep.
Valorizacion 20% (Pruebas FAT)	07 sep.
Cierre	28 sep.
Valorizacion 20% (Cierre)	03 oct

Relación de documentos

☐ Memoria	94	páginas
☐ Anexo: Cálculos Justificativos	79	páginas
☐ Anexo: Planos	29	páginas
☒ Anexo: Planificación	16	páginas
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La Almunia, a 30 de noviembre de 2016

Firmado: Rony Moises Pinedo Cordova



**ESCUELA UNIVERSITARIA POLITÉCNICA
DE LA ALMUNIA DE DOÑA GODINA (ZARAGOZA)**

ANEXO: SIMULACIÓN DE ESFUERZOS

**DISEÑO SUBSTACIÓN ELECTRICA
MOVIL 66/12kV, 10MV**

Mobile Substation Design 66/12kV, 10MVA

424.13.131

Autor: Rony Moises Pinedo Cordova

Director: Carmelo Jose Borque Horna

Fecha: 30-11-2016

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2. ANEXO 7 (HOJAS TÉCNICAS)	¡ERROR! MARCADOR NO DEFINIDO.

1. ANÁLISIS DE ESFUERZOS (PORTICO)



Analyzed File:	Portico.iam
Autodesk Inventor Version:	2015 (Build 190159000, 159)
Creation Date:	08/11/2016, 2:17
Simulation Author:	Rony Pinedo Cordova
Resumen:	

Project Info (iProperties)

Resumen

Author	R.P.C.
--------	--------

Project

Part Number	Portico
Designer	R.P.C.
Cost	0,00 €
Date Created	12/03/2015

Status

Design Status	WorkInProgress
---------------	----------------

Physical

Mass	3586,53 kg
Área	125572000 mm ²
Volume	1328120000 mm ³
Center of Gravity	x=-855,982 mm y=1225,7 mm z=1778,31 mm

Note: Physical values could be different from Physical values used by FEA reported below.

1.1. SIMULACION

General objective and settings:

Design Objective	Single Point
Simulation Type	Static Analysis
Last Modification Date	08/11/2016, 2:12
Detect and Eliminate Rigid Body Modes	No
Separate Stresses Across Contact Surfaces	No
Motion Loads Analysis	No

Mesh settings:

Avg. Element Size (fraction of model diameter)	0,2
Min. Element Size (fraction of avg. size)	0,2
Grading Factor	1,5
Max. Turn Angle	60 deg
Create Curved Mesh Elements	Yes
Use part based measure for Assembly mesh	Yes

Material(s)

Name	Steel, Cast	
General	Mass Density	7,85 g/cm ³
	Yield Strength	250 MPa
	Ultimate Tensile Strength	300 MPa
Stress	Young's Modulus	210 GPa
	Poisson's Ratio	0,3 ul
	Shear Modulus	80,7692 GPa
Part Name(s)	PO - PL12 - 01 PO - W6 x 15 - 02 PO - PL6 - 01 PO - PL6 - 01 PO - PL6 - 01 PO - PL6 - 01 PO - PL6 - 02 PO - PL6 - 02 PO - PL6 - 02 PO - PL6 - 02 PO - PL12 - 01 PO - W6 x 15 - 02 PO - PL6 - 01 PO - PL6 - 01 PO - PL6 - 01 PO - PL6 - 01 PO - PL6 - 02	

PO - PL6 - 02
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL12 - 01
 PO - W6 x 15 - 02
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL12 - 01
 PO - W6 x 15 - 02
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL12 - 01
 PO - W6 x 15 - 02
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL12 - 01
 PO - W6 x 15 - 02
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 01
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL6 - 02
 PO - PL6 - 02
 PO - W4 x 13 - 01
 PO - L2 x 2 x 1_4 - 01
 PO - L2 x 2 x 1_4 - 01
 PO - L2 x 2 x 1_4 - 01
 PO - L2 x 2 x 1_4 - 01
 PO - L2 x 2 x 1_4 - 01
 PO - W4 x 13 - 01
 PO - L2 x 2 x 1_4 - 01
 PO - L2 x 2 x 1_4 - 01
 PO - L2 x 2 x 1_4 - 01
 PO - L2 x 2 x 1_4 - 01
 PO - L2 x 2 x 1_4 - 01
 PO - W4 x 13 - 01
 PO - L2 x 2 x 1_4 - 01
 PO - L2 x 2 x 1_4 - 01

PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - W4 x 13 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - W4 x 13 - 02
PO - PL6 - 03
PO - PL6 - 03
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - W4 x 13 - 02
PO - PL6 - 03
PO - PL6 - 03
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L4 x 4 x 1_4 - 08
PO - L4 x 4 x 1_4 - 09
PO - W4 x 13 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - W4 x 13 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - W4 x 13 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - W4 x 13 - 02
PO - PL6 - 03
PO - PL6 - 03
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - W4 x 13 - 02
PO - PL6 - 03
PO - PL6 - 03
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01
PO - L2 x 2 x 1_4 - 01

PO - L2 x 2 x 1_4 - 01
 PO - C6 x 10.5 - 07
 PO - C6 x 10.5 - 08
 PO - C6 x 10.5 - 07
 PO - C6 x 10.5 - 07
 PO - C6 x 10.5 - 08
 PO - C6 x 10.5 - 08
 PO - C6 x 10.5 - 08
 PO - C6 x 10.5 - 09
 PO - C6 x 10.5 - 10
 PO - PL10 - 11
 PO - PL10 - 10
 PO - L4 x 4 x 1_4 - 04
 PO - PL10 - 11
 PO - PL10 - 10
 PO - L4 x 4 x 1_4 - 04
 PO - PL10 - 12
 PO - PL10 - 13
 PO - L4 x 4 x 1_4 - 05
 PO - PL10 - 12
 PO - PL10 - 13
 PO - L4 x 4 x 1_4 - 05
 PO - L4 x 4 x 1_4 - 08
 PO - L4 x 4 x 1_4 - 09
 PO - PL10 - 07
 PO - PL10 - 06
 PO - L4 x 4 x 1_4 - 01
 PO - PL10 - 06
 PO - PL10 - 07
 PO - L4 x 4 x 1_4 - 01
 PO - PL10 - 02
 PO - PL10 - 03
 PO - L4 x 4 x 1_4 - 02
 PO - PL10 - 04
 PO - PL10 - 02
 PO - PL10 - 03
 PO - L4 x 4 x 1_4 - 02
 PO - PL10 - 04
 PO - PL10 - 02
 PO - PL10 - 03
 PO - L4 x 4 x 1_4 - 02
 PO - PL10 - 04
 PO - PL10 - 02
 PO - PL10 - 03
 PO - L4 x 4 x 1_4 - 02
 PO - PL10 - 04
 PO - PL10 - 02
 PO - PL10 - 03
 PO - L4 x 4 x 1_4 - 02
 PO - PL10 - 04
 PO - PL10 - 09
 PO - PL10 - 08
 PO - L4 x 4 x 1_4 - 03

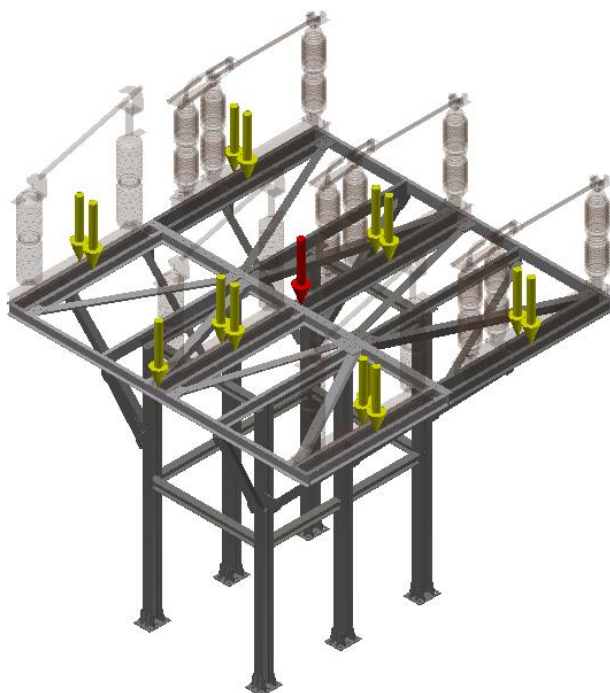
PO - PL10 - 09
PO - PL10 - 08
PO - L4 x 4 x 1_4 - 03
PO - L4 x 4 x 1_4 - 08
PO - L4 x 4 x 1_4 - 09
PO - L4 x 4 x 1_4 - 08
PO - L4 x 4 x 1_4 - 09

Name	Steel, Alloy	
General	Mass Density	7,73 g/cm ³
	Yield Strength	250 MPa
	Ultimate Tensile Strength	400 MPa
Stress	Young's Modulus	205 GPa
	Poisson's Ratio	0,3 ul
	Shear Modulus	78,8462 GPa
Part Name(s)	PO - C6 x 10.5 - 01	
	PO - C6 x 10.5 - 02	
	PO - C6 x 10.5 - 03	
	PO - C6 x 10.5 - 04	
	PO - C6 x 10.5 - 03	
	PO - C6 x 10.5 - 03	
	PO - C6 x 10.5 - 04	
	PO - C6 x 10.5 - 04	
	PO - C6 x 10.5 - 05	
	PO - C6 x 10.5 - 06	
	PO - PL10 - 15	
	PO - PL10 - 14	
	PO - L4 x 4 x 1_4 - 06	
	PO - PL10 - 14	
	PO - PL10 - 15	
	PO - L4 x 4 x 1_4 - 06	
	PO - PL10 - 16	
	PO - PL10 - 17	
	PO - L4 x 4 x 1_4 - 07	
	PO - PL10 - 16	
	PO - PL10 - 17	
	PO - L4 x 4 x 1_4 - 07	
	PO - C6 x 10.5 - 01	
	PO - C6 x 10.5 - 02	

Operating conditions

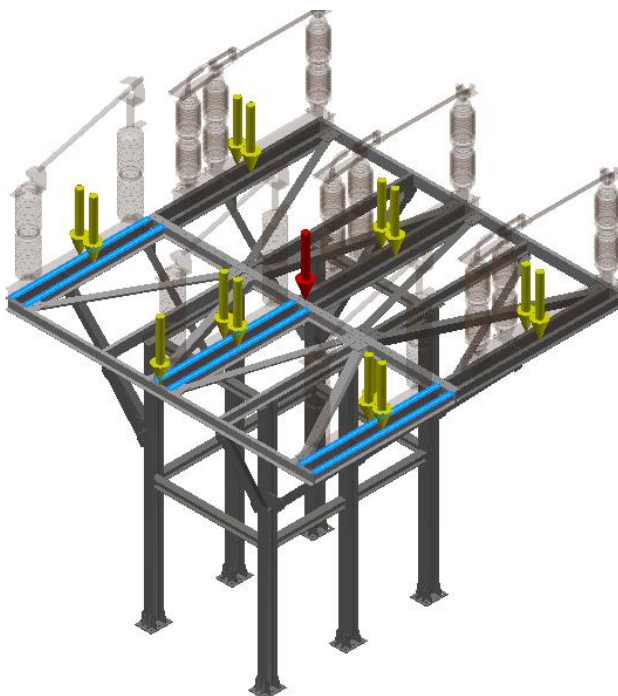
Gravedad

Load Type	Gravity
Magnitude	9810.000 mm/s ²
Vector X	0.000 mm/s ²
Vector Y	0.000 mm/s ²
Vector Z	-9810.000 mm/s ²



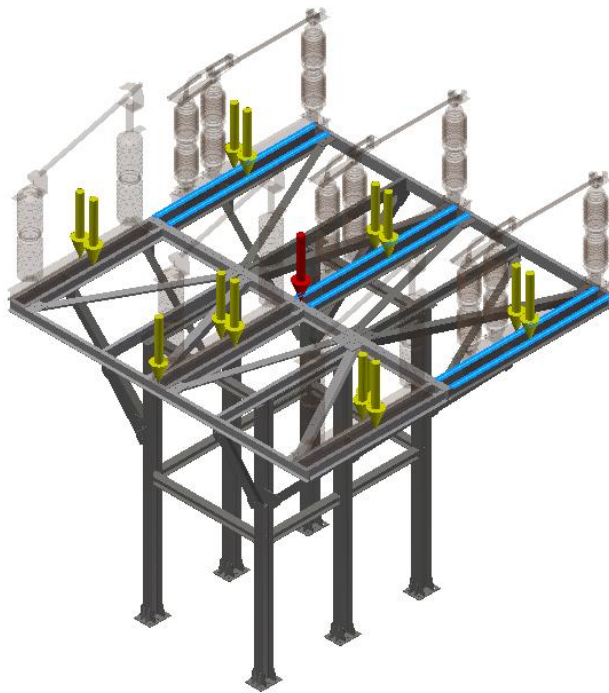
Seccionador

Load Type	Force
Magnitude	4500.000 N
Vector X	-0.000 N
Vector Y	0.000 N
Vector Z	-4500.000 N



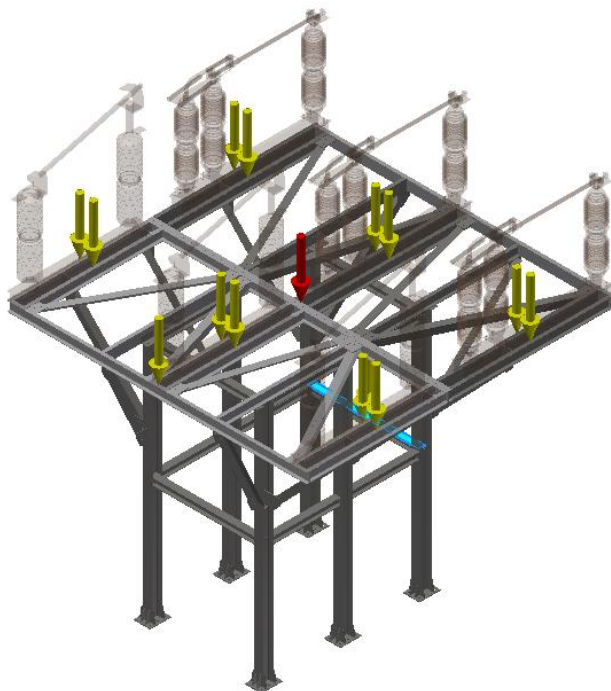
Fusibles

Load Type	Force
Magnitude	9540.000 N
Vector X	0.000 N
Vector Y	0.000 N
Vector Z	-9540.000 N



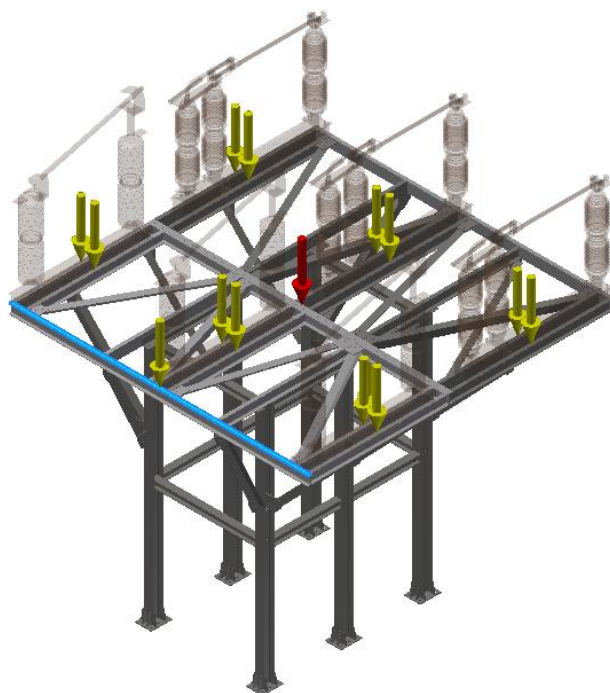
Mando de Seccionador

Load Type	Force
Magnitude	700.000 N
Vector X	0.000 N
Vector Y	0.000 N
Vector Z	-700.000 N



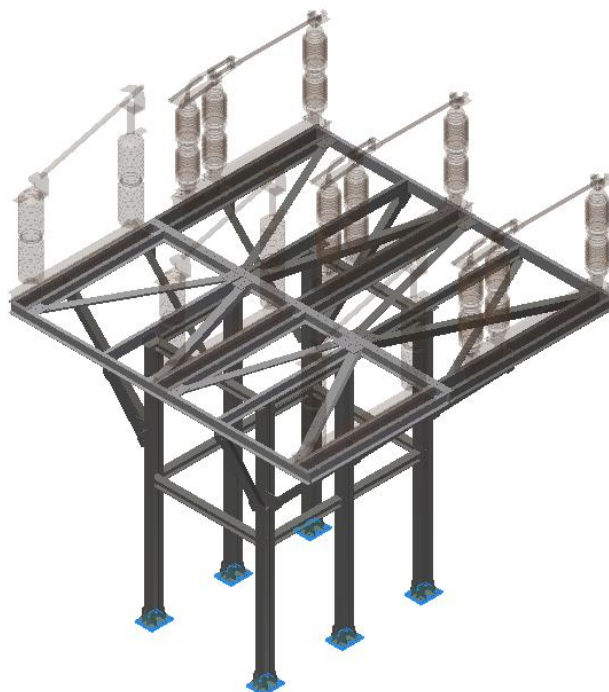
Personal

Load Type	Force
Magnitude	1500.000 N
Vector X	0.000 N
Vector Y	0.000 N
Vector Z	-1500.000 N



Fixed Constraint: (Puntos de sujeción)

Constraint Type	Fixed Constraint
-----------------	------------------



1.2. RESULTADOS

Reaction Force and Moment on Constraints

Constraint Name	Reaction Force		Reaction Moment	
	Magnitude	Component (X,Y,Z)	Magnitude	Component (X,Y,Z)
Fixed Constraint:1	18769,6 N	0 N	5755,1 N m	5755,1 N m
		0 N		0 N m
		18769,6 N		0 N m
Fixed Constraint:2	18769,6 N	0 N	5755,1 N m	5755,1 N m
		0 N		0 N m
		18769,6 N		0 N m

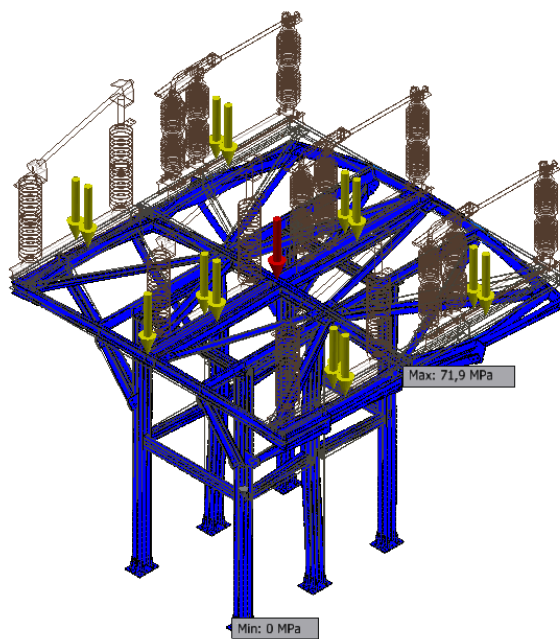
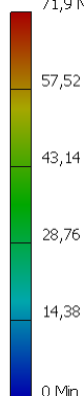
Result Resumen

Name	Minimum	Maximum
Volume	1325590000 mm ³	
Mass	2179,69 kg	
Von Mises Stress	0,000339032 MPa	71,8994 MPa
1st Principal Stress	-19,0902 MPa	88,0685 MPa
3rd Principal Stress	-73,7163 MPa	28,6161 MPa
Displacement	0 mm	2,33612 mm
Safety Factor	3,47708 ul	15 ul
Stress XX	-40,5553 MPa	39,7053 MPa
Stress XY	-20,4545 MPa	21,8675 MPa
Stress XZ	-20,8692 MPa	21,4215 MPa
Stress YY	-65,7944 MPa	79,4415 MPa
Stress YZ	-28,8019 MPa	27,7954 MPa
Stress ZZ	-33,2163 MPa	32,832 MPa
X Displacement	-1,44764 mm	1,46399 mm
Y Displacement	-0,0305744 mm	0,335087 mm
Z Displacement	-2,32261 mm	0,0829309 mm
Equivalent Strain	0,00000000143818 ul	0,00032365 ul
1st Principal Strain	-0,00000464061 ul	0,000381642 ul
3rd Principal Strain	-0,000325471 ul	0,00000350179 ul
Strain XX	-0,000131788 ul	0,000124009 ul
Strain XY	-0,000129711 ul	0,000138672 ul
Strain XZ	-0,000132341 ul	0,000135844 ul
Strain YY	-0,000275235 ul	0,000326934 ul
Strain YZ	-0,000182646 ul	0,000172067 ul
Strain ZZ	-0,000118795 ul	0,000126121 ul
Contact Pressure	0 MPa	502,93 MPa
Contact Pressure X	-385,321 MPa	393,969 MPa
Contact Pressure Y	-131,734 MPa	319,461 MPa
Contact Pressure Z	-98,3907 MPa	152,648 MPa

1.3. GRAFICOS

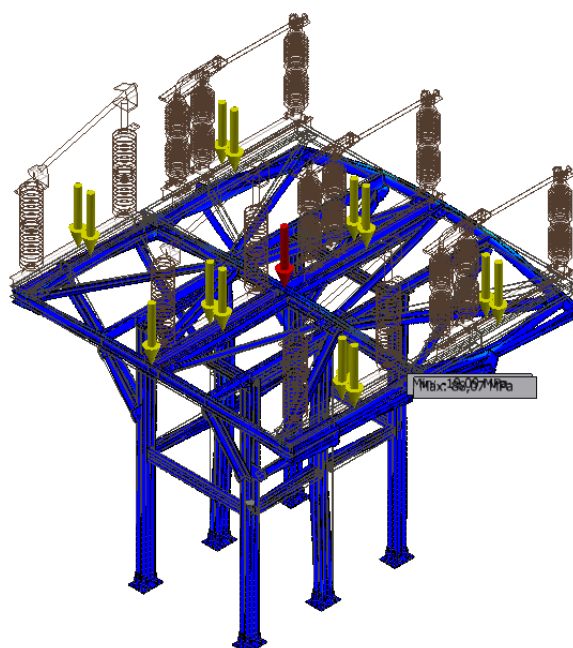
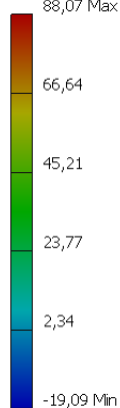
Von Mises Stress

Type: Von Mises Stress
Unit: MPa
18/11/2016, 1:57:12
71,9 Max



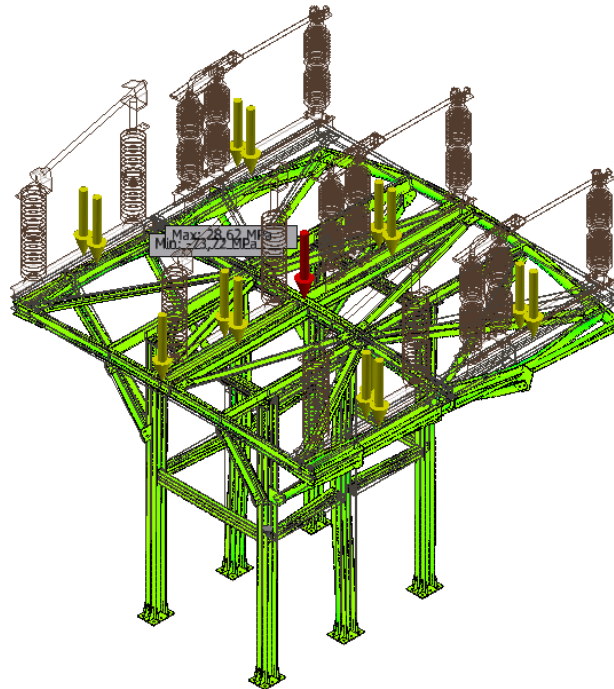
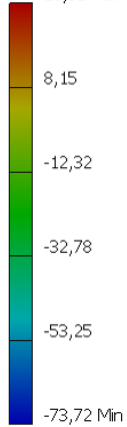
1st Principal Stress

Type: 1st Principal Stress
Unit: MPa
18/11/2016, 1:57:22
88,07 Max



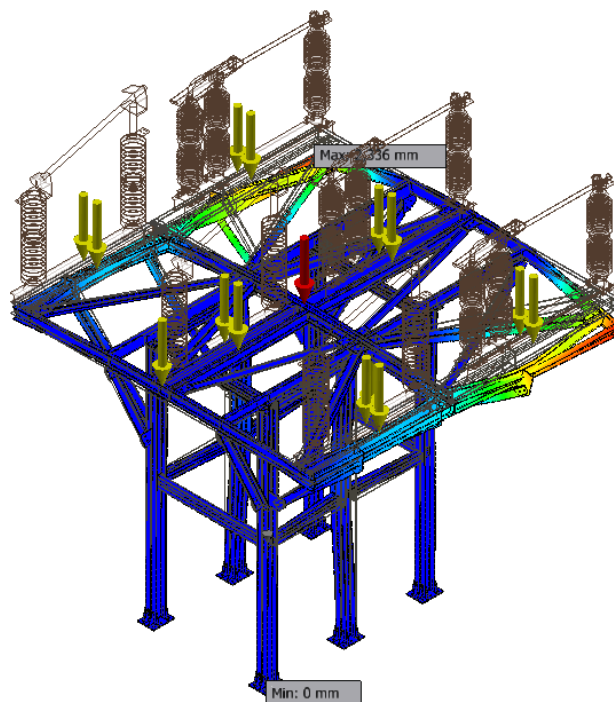
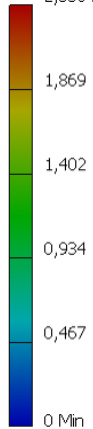
3rd Principal Stress

Type: 3rd Principal Stress
Unit: MPa
18/11/2016, 1:57:26
28,62 Max



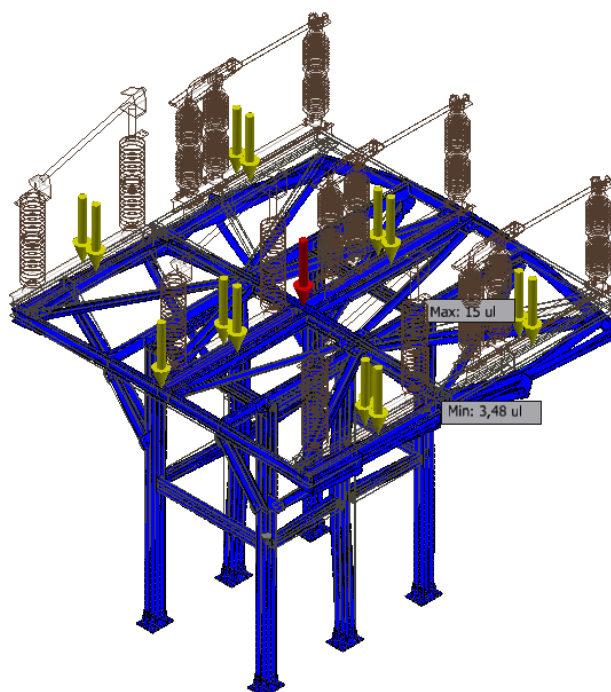
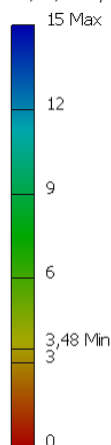
Displacement

Type: Displacement
Unit: mm
18/11/2016, 1:58:02
2,336 Max



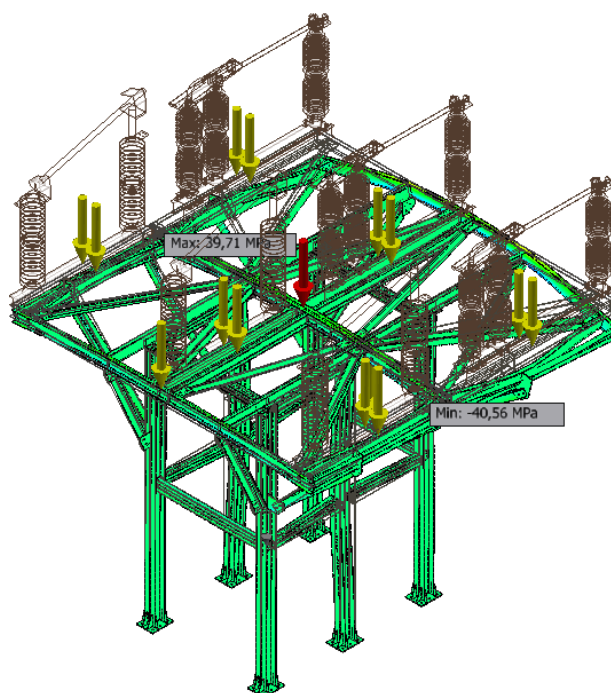
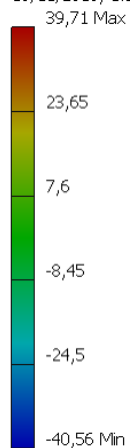
Safety Factor

Type: Safety Factor
Unit: ul
18/11/2016, 1:57:57



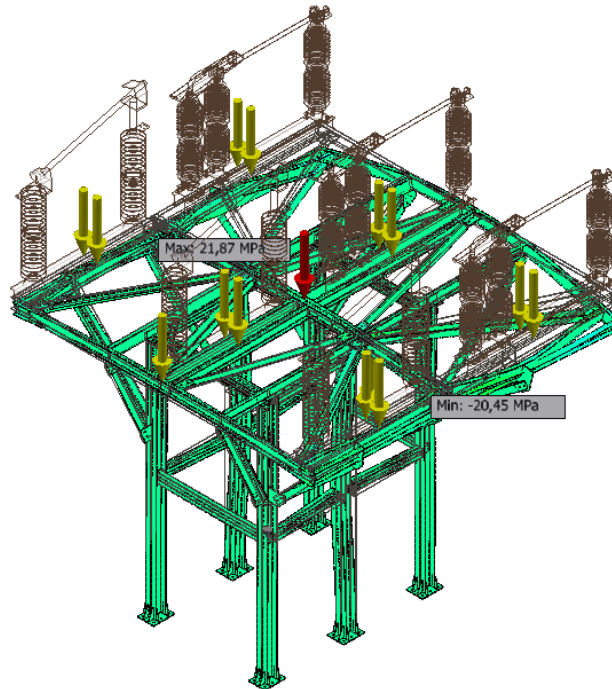
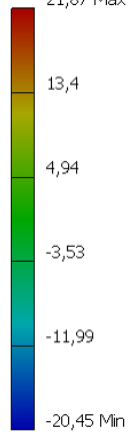
Stress XX

Type: Stress XX
Unit: MPa
18/11/2016, 1:57:30



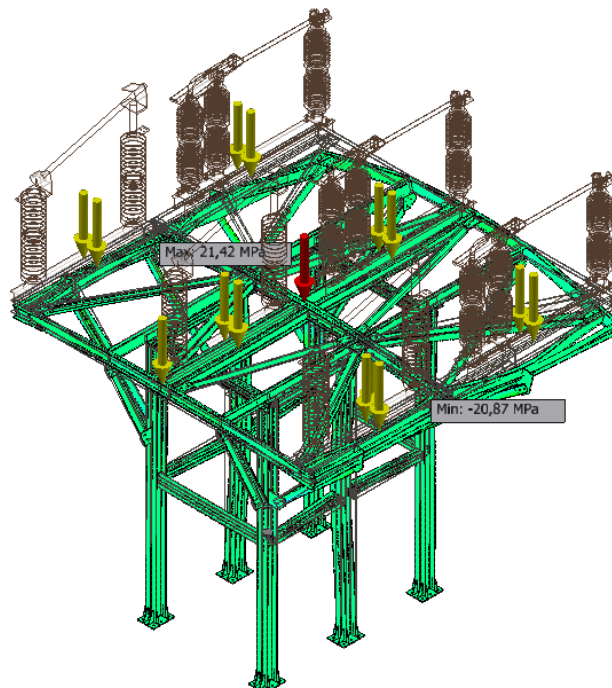
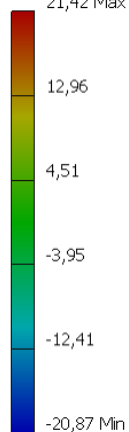
Stress XY

Type: Stress XY
Unit: MPa
18/11/2016, 1:57:34
21,87 Max



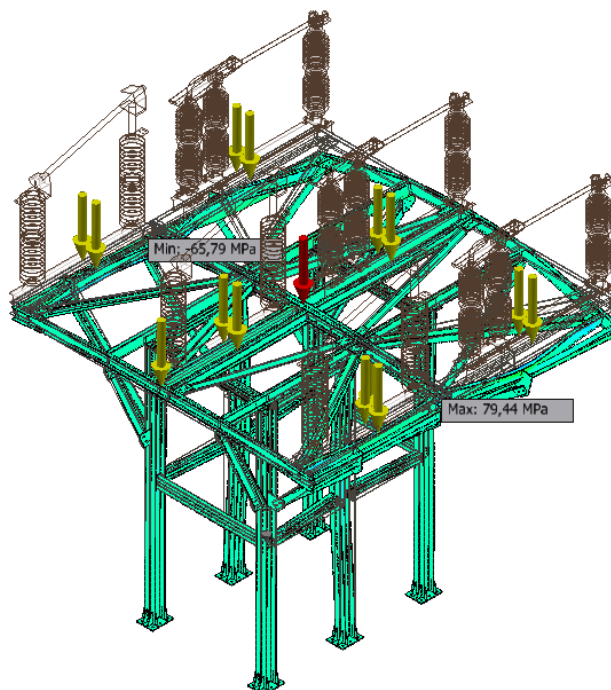
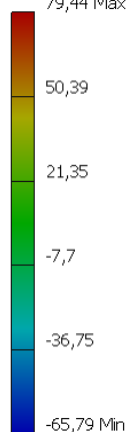
Stress XZ

Type: Stress XZ
Unit: MPa
18/11/2016, 1:57:38
21,42 Max



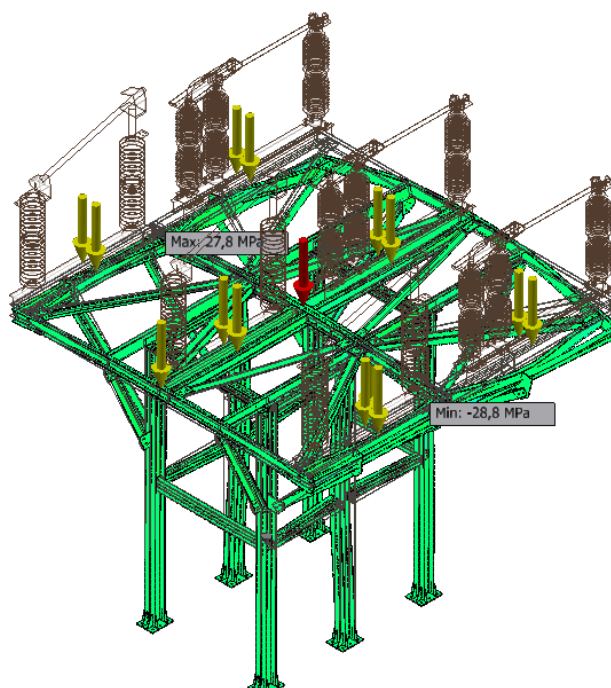
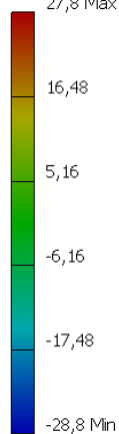
Stress YY

Type: Stress YY
Unit: MPa
18/11/2016, 1:57:43
79,44 Max



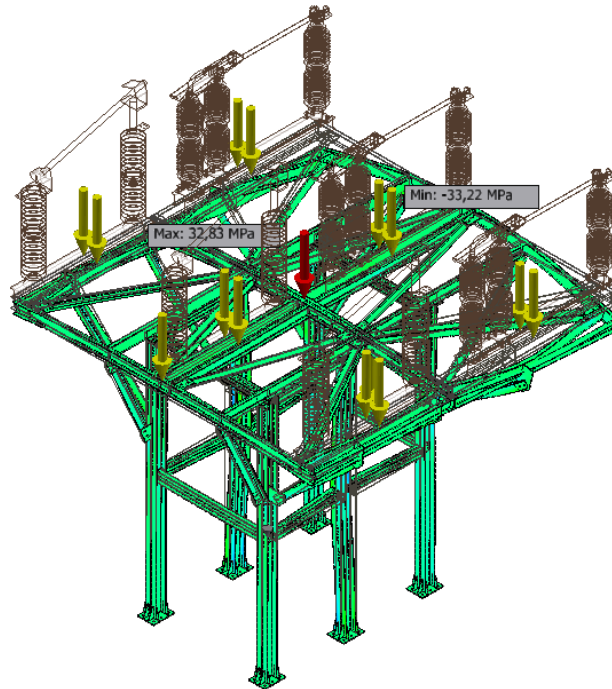
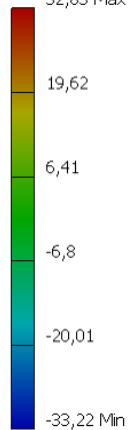
Stress YZ

Type: Stress YZ
Unit: MPa
18/11/2016, 1:57:47
27,8 Max



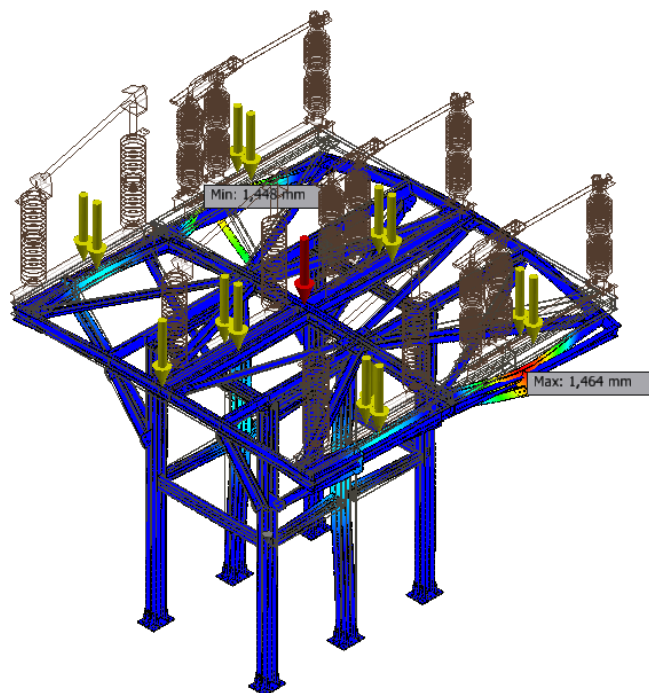
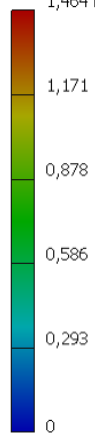
Stress ZZ

Type: Stress ZZ
Unit: MPa
18/11/2016, 1:57:52
32,83 Max



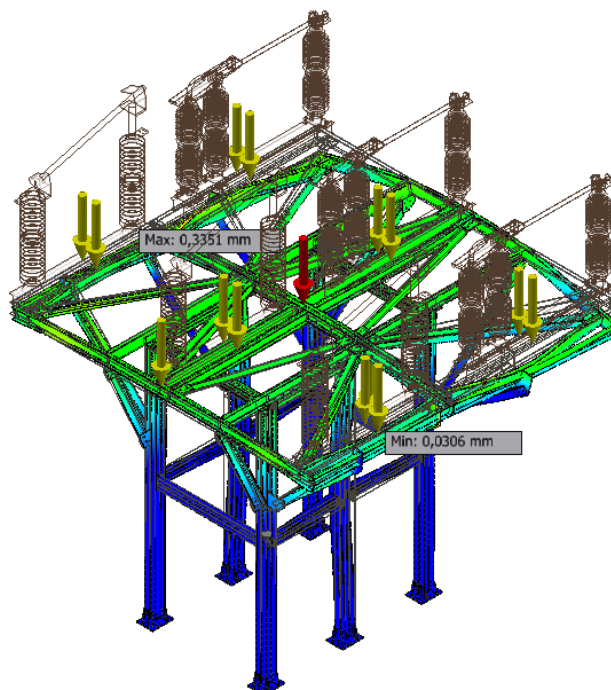
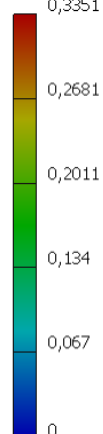
X Displacement

Type: X Displacement
Unit: mm
18/11/2016, 1:58:08
1,464 Max



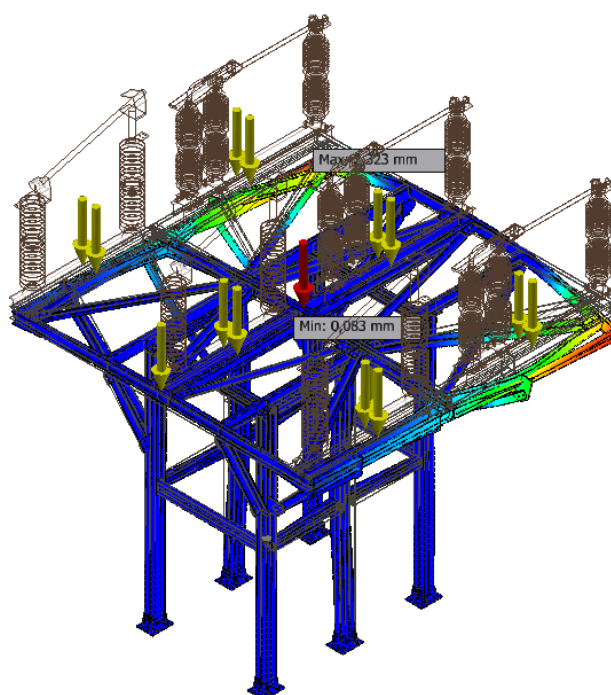
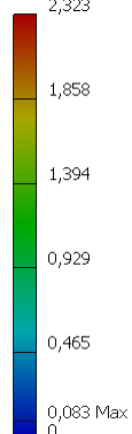
Y Displacement

Type: Y Displacement
Unit: mm
18/11/2016, 1:58:14
0,3351 Max



Z Displacement

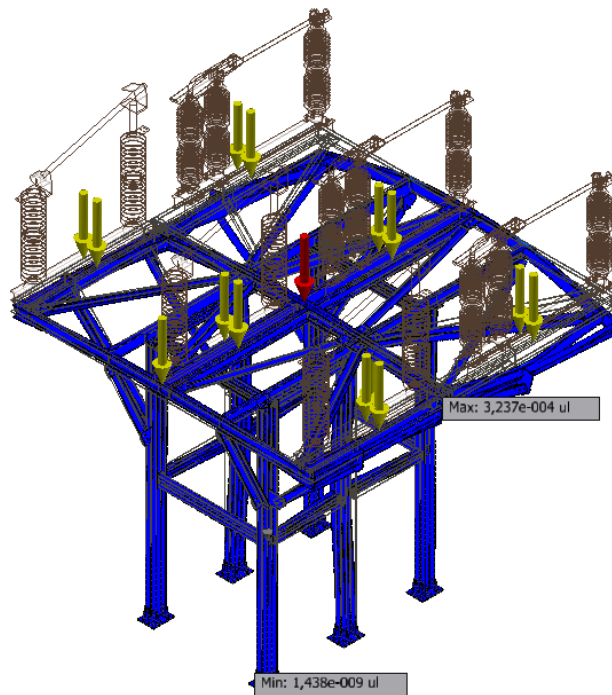
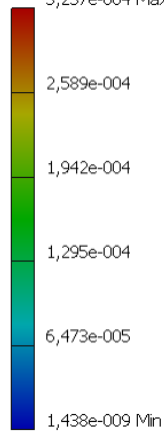
Type: Z Displacement
Unit: mm
18/11/2016, 1:58:20
2,323 Max



7

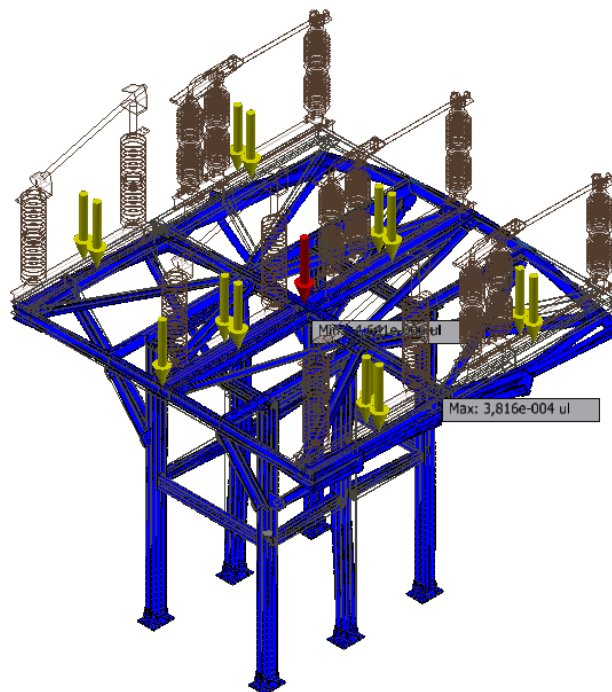
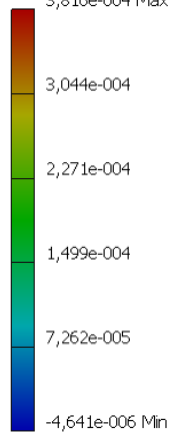
Equivalent Strain

Type: Equivalent Strain
Unit: ul
18/11/2016, 1:58:25
3,237e-004 Max



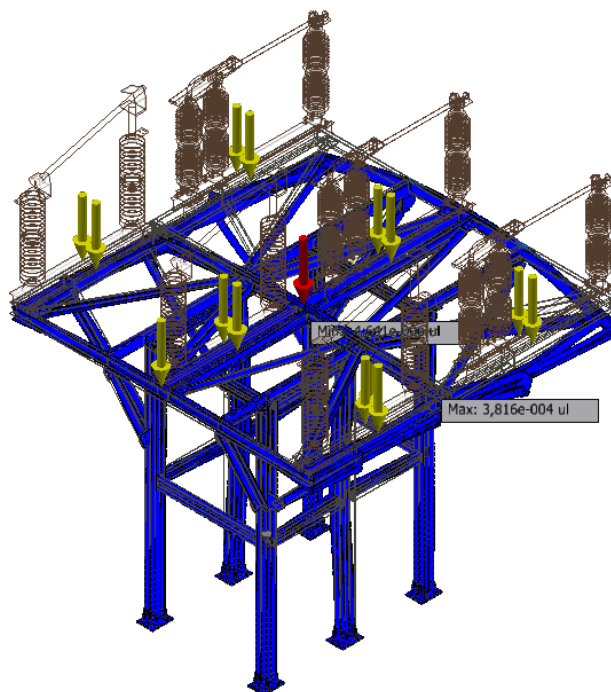
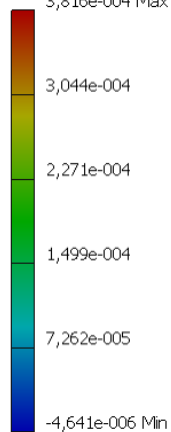
1st Principal Strain

Type: 1st Principal Strain
Unit: ul
18/11/2016, 1:58:31
3,816e-004 Max



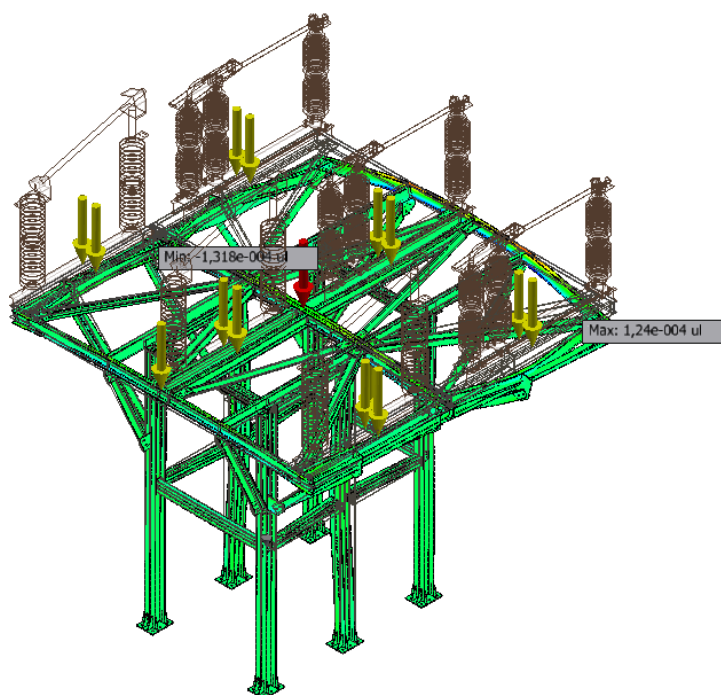
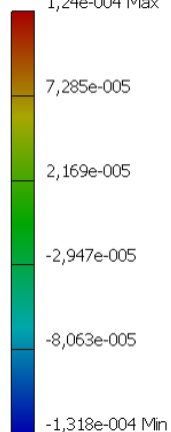
3rd Principal Strain

Type: 1st Principal Strain
Unit: ul
18/11/2016, 1:58:31
3,816e-004 Max



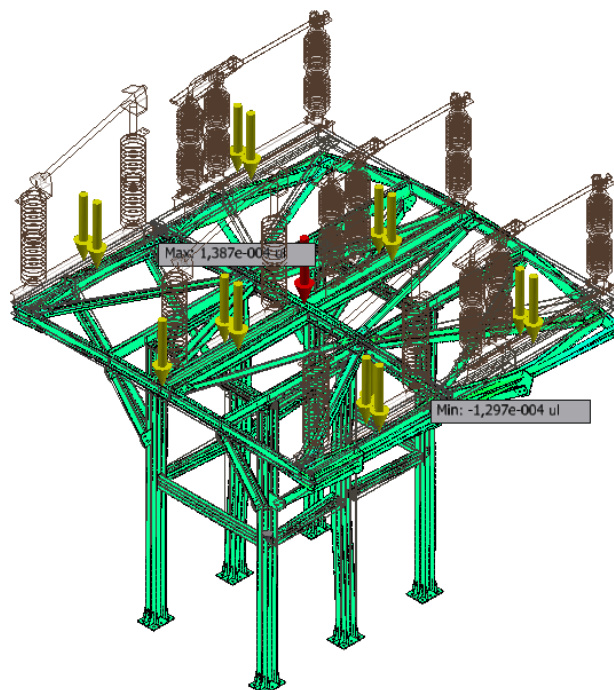
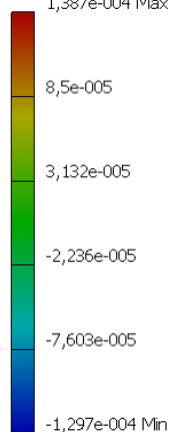
Strain XX

Type: Strain XX
Unit: ul
18/11/2016, 1:58:44
1,24e-004 Max



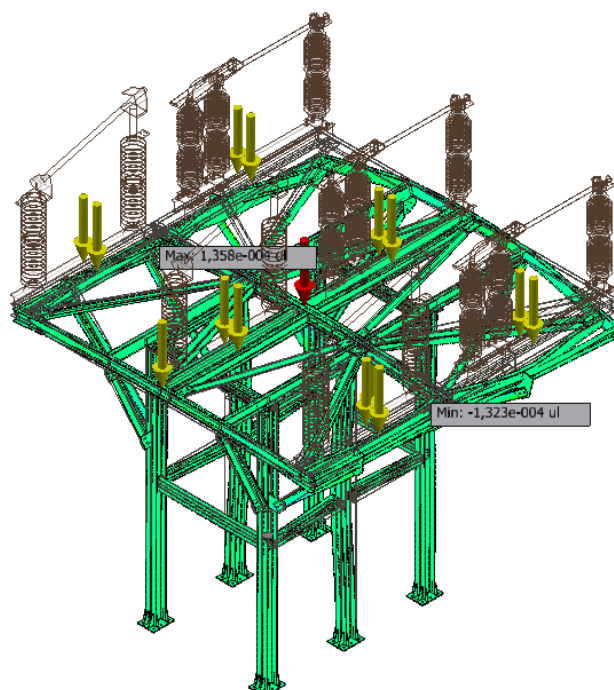
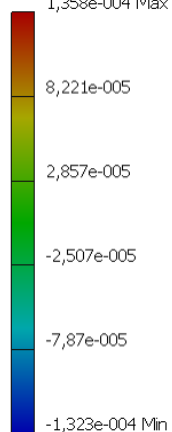
Strain XY

Type: Strain XY
Unit: ul
18/11/2016, 1:58:50
1,387e-004 Max



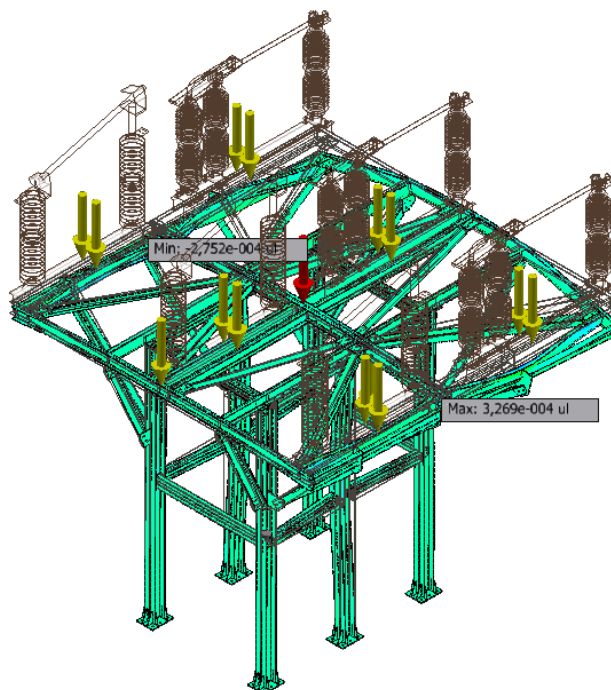
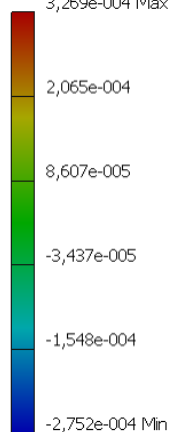
Strain XZ

Type: Strain XZ
Unit: ul
18/11/2016, 1:58:57
1,358e-004 Max



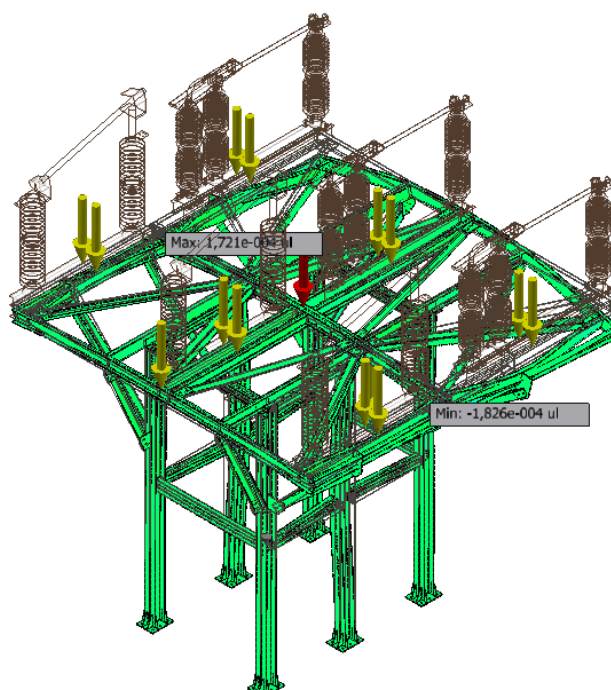
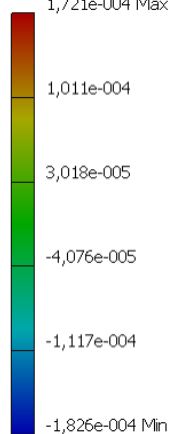
Strain YY

Type: Strain YY
Unit: ul
18/11/2016, 1:59:04
3,269e-004 Max



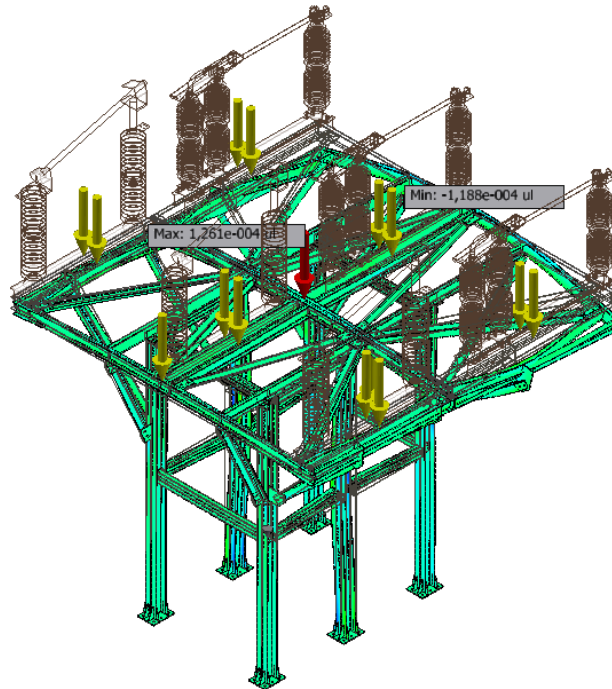
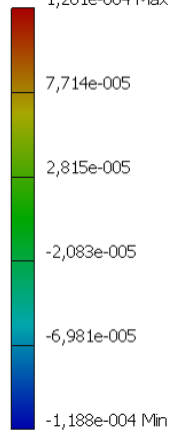
Strain YZ

Type: Strain YZ
Unit: ul
18/11/2016, 1:59:11
1,721e-004 Max



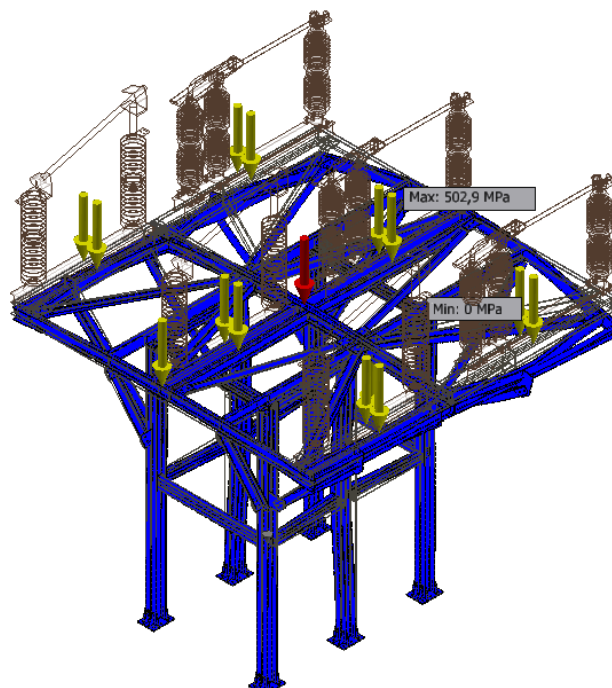
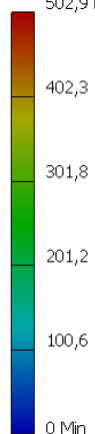
Strain ZZ

Type: Strain ZZ
Unit: ul
18/11/2016, 1:59:18
1,261e-004 Max



Contact Pressure

Type: Contact Pressure
Unit: MPa
18/11/2016, 1:59:25
502,9 Max



Contact Pressure X

Type: Contact Pressure X

Unit: MPa

18/11/2016, 1:59:32

394 Max

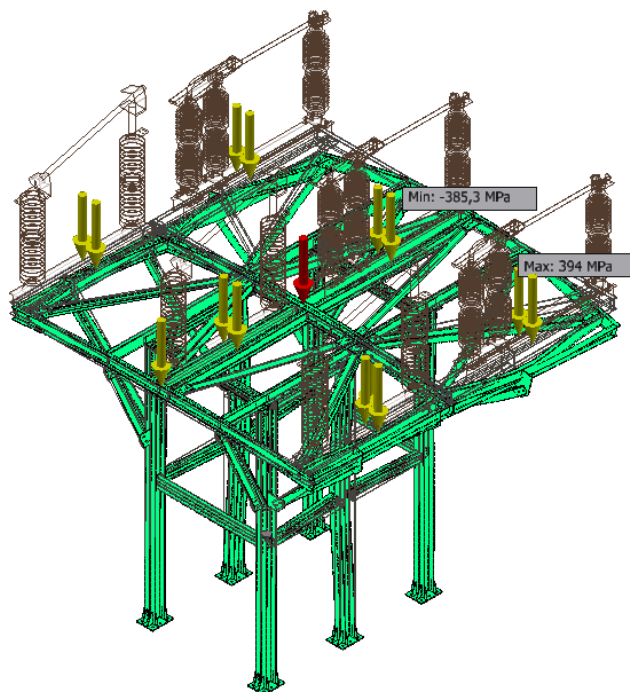
238,1

82,3

-73,6

-229,5

-385,3 Min



Contact Pressure Y

Type: Contact Pressure Y

Unit: MPa

18/11/2016, 1:59:40

319,5 Max

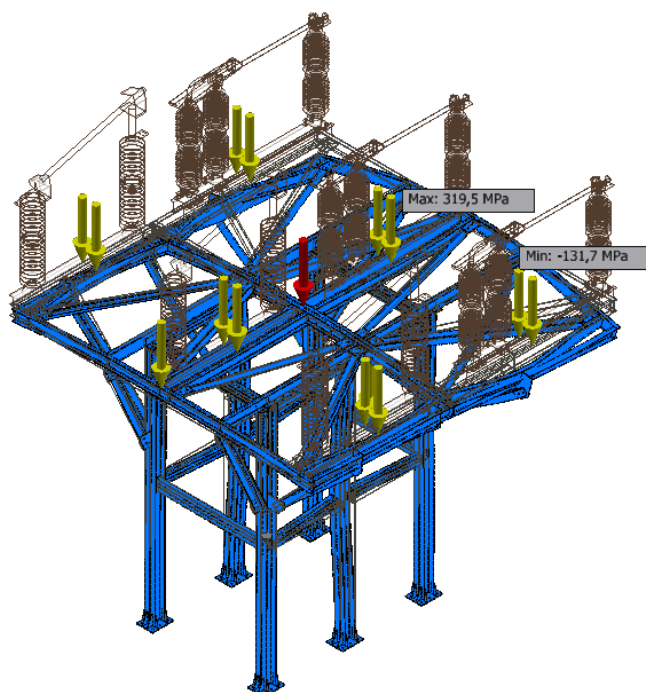
229,2

139

48,7

-41,5

-131,7 Min



Contact Pressure Z

Type: Contact Pressure Z

Unit: MPa

18/11/2016, 1:59:47

152,6 Max

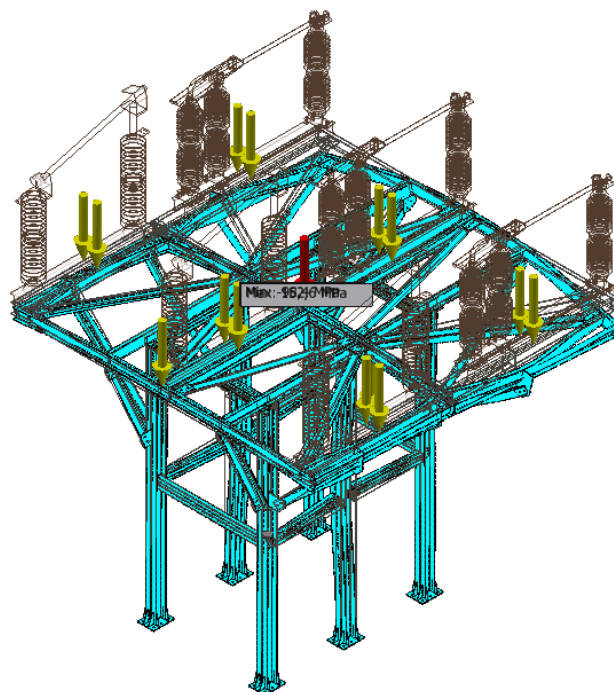
102,4

52,2

2

-48,2

-98,4 Min



2. ANÁLISIS DE ESFUERZOS (CASETA)



Analyzed File:	Caseta _Soldadura.iam
Autodesk Inventor Version:	2015 (Build 190159000, 159)
Creation Date:	08/11/2016, 9:30
Simulation Author:	Rony Pinedo Cordova
Summary:	

Project Info (iProperties)

Resumen

Author	R.P.C.
--------	--------

Physical

Mass	752,132 kg
Área	98102000 mm ²
Volume	160580000 mm ³
Center of Gravity	x=16,5423 mm y=-177,395 mm z=1047,9 mm

Note: Physical values could be different from Physical values used by FEA reported below.

2.1. SIMULACION

General objective and settings:

Design Objective	Single Point
Simulation Type	Static Analysis
Last Modification Date	08/11/2016, 9:24
Detect and Eliminate Rigid Body Modes	No
Separate Stresses Across Contact Surfaces	No
Motion Loads Analysis	No

Mesh settings:

Avg. Element Size (fraction of model diameter)	0,5
Avg. Element Size in Shells	0,05
Min. Element Size (fraction of avg. size)	0,2
Grading Factor	1,5
Max. Turn Angle	60 deg
Create Curved Mesh Elements	No
Use part based measure for Assembly mesh	Yes

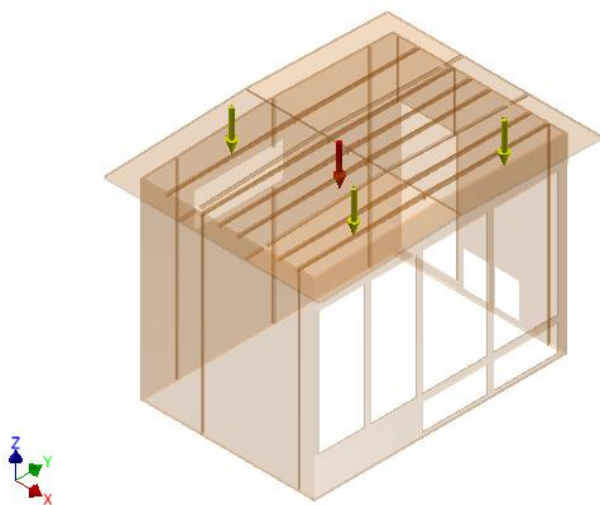
Material(s)

Name	Steel, Alloy	
General	Mass Density	7,73 g/cm ³
	Yield Strength	250 MPa
	Ultimate Tensile Strength	400 MPa
Stress	Young's Modulus	205 GPa
	Poisson's Ratio	0,3 ul
	Shear Modulus	78,8462 GPa

Operating conditions

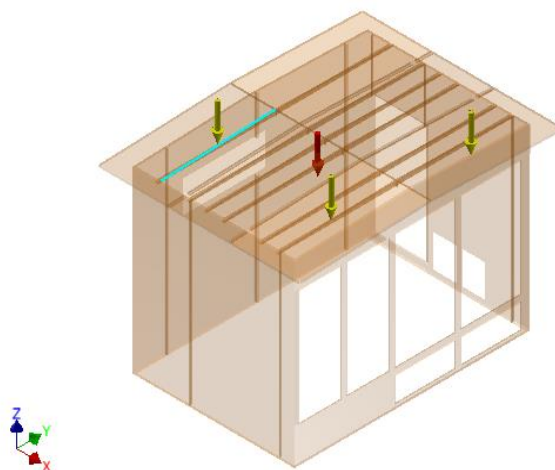
Gravedad

Load Type	Gravity
Magnitude	9810,000 mm/s ²
Vector X	0,000 mm/s ²
Vector Y	-0,000 mm/s ²
Vector Z	-9810,000 mm/s ²



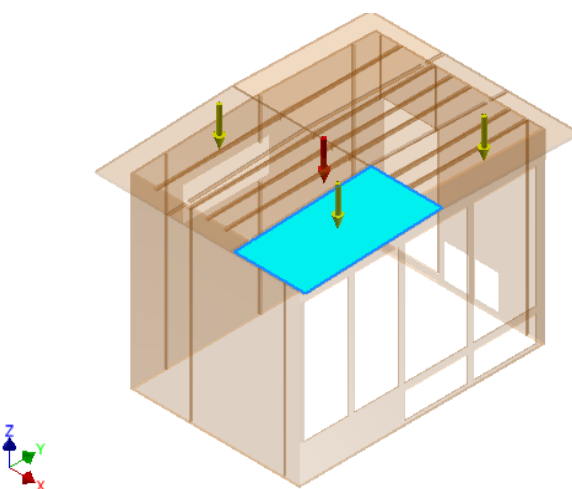
Resistencia Neutra

Load Type	Force
Magnitude	1940,000 N
Vector X	0,000 N
Vector Y	0,000 N
Vector Z	-1940,000 N



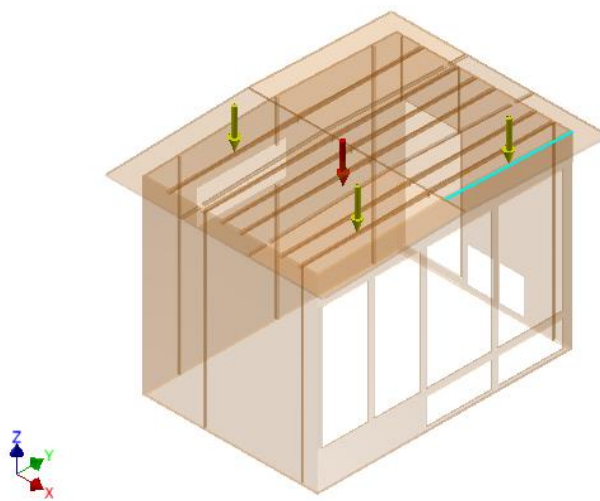
Personal: 1

Load Type	Force
Magnitude	1500,000 N
Vector X	0,000 N
Vector Y	0,000 N
Vector Z	-1500,000 N



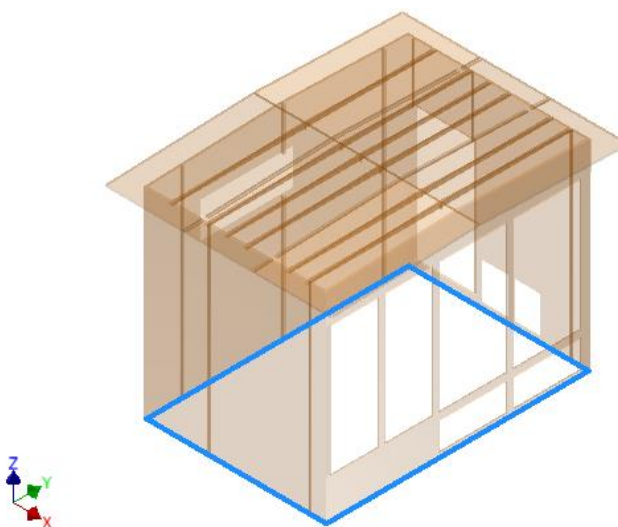
Personal: 2

Load Type	Force
Magnitude	1500,000 N
Vector X	0,000 N
Vector Y	0,000 N
Vector Z	-1500,000 N



Fixed Constraint: (Puntos de sujeción)

Constraint Type	Fixed Constraint
-----------------	------------------



2.2. RESULTADOS

Reaction Force and Moment on Constraints

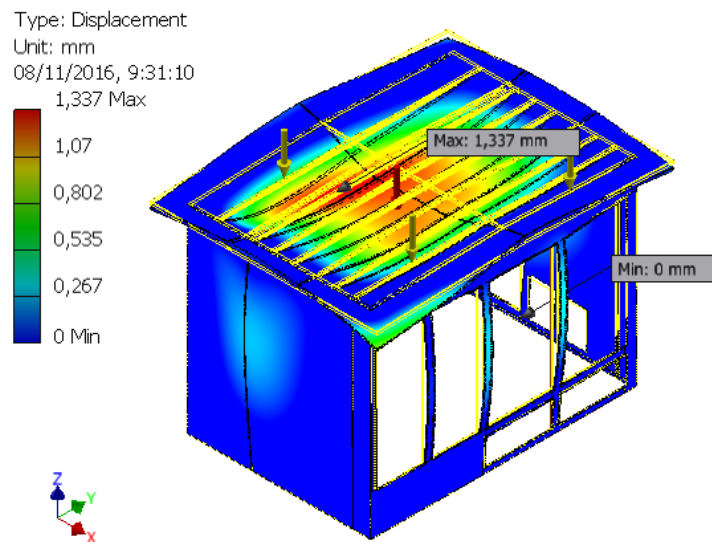
Constraint Name	Reaction Force		Reaction Moment	
	Magnitude	Component (X,Y,Z)	Magnitude	Component (X,Y,Z)
Fixed Constraint:1	17184,7 N	0 N	2735,89 N m	-2715,83 N m
		0 N		-330,637 N m
		17184,7 N		0 N m

Result Resumen

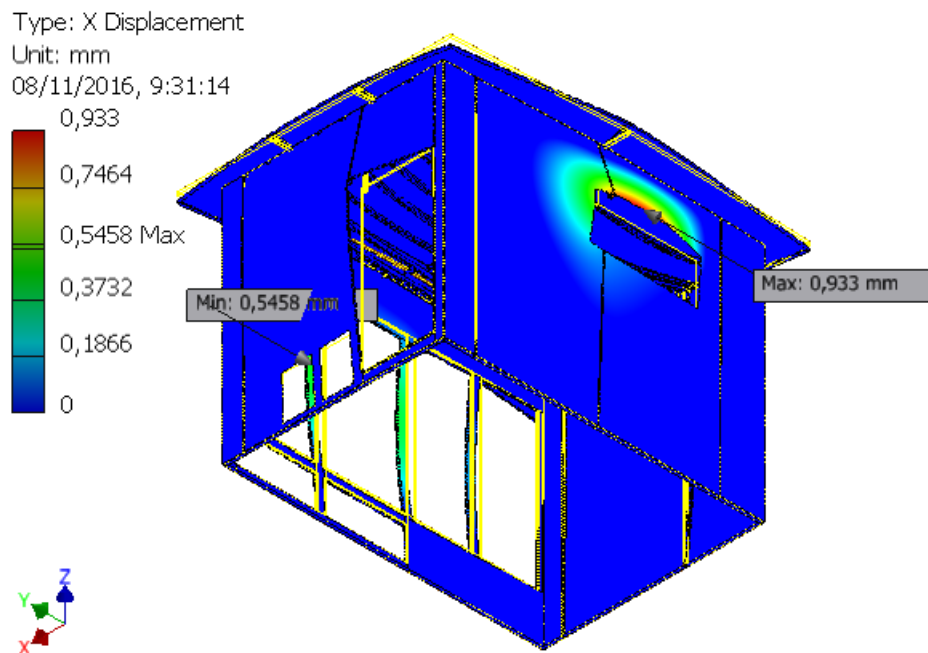
Name	Minimum	Maximum
Volume	160580000 mm ³	
Mass	1250,12 kg	
Displacement	0 mm	1,33721 mm
X Displacement	-0,933022 mm	0,545771 mm
Y Displacement	-0,477514 mm	0,798657 mm
Z Displacement	-1,33716 mm	0,37974 mm
Contact Pressure	0 MPa	0 MPa
Contact Pressure X	0 MPa	0 MPa
Contact Pressure Y	0 MPa	0 MPa
Contact Pressure Z	0 MPa	0 MPa
Von Mises Stress	0 MPa	114,262 MPa
Rotation	0 deg	0,204853 deg
X Rotation	-0,132183 deg	0,164586 deg
Y Rotation	-0,109224 deg	0,204092 deg
Z Rotation	-0,079735 deg	0,0801884 deg
1st Principal Stress	-3,63236 MPa	69,9014 MPa
3rd Principal Stress	-64,6338 MPa	3,65896 MPa
Safety Factor	1,81163 ul	15 ul
Stress XX	-24,0568 MPa	40,1679 MPa
Stress XY	-32,3187 MPa	51,5594 MPa
Stress XZ	-42,4631 MPa	17,5719 MPa
Stress YY	-34,0843 MPa	51,4518 MPa
Stress YZ	-37,9667 MPa	18,9627 MPa
Stress ZZ	-26,2061 MPa	31,2972 MPa
Strain XX	-0,000113609 ul	0,000189074 ul
Strain XY	-0,000204948 ul	0,000319177 ul
Strain XZ	-0,000262867 ul	0,000111431 ul
Strain YY	-0,000147474 ul	0,000242124 ul
Strain YZ	-0,000240764 ul	0,000120251 ul
Strain ZZ	-0,0000992968 ul	0,000163392 ul
Equivalent Strain	0 ul	0,000471609 ul
1st Principal Strain	0 ul	0,000421453 ul
3rd Principal Strain	-0,000396241 ul	0 ul

2.3. GRAFICOS

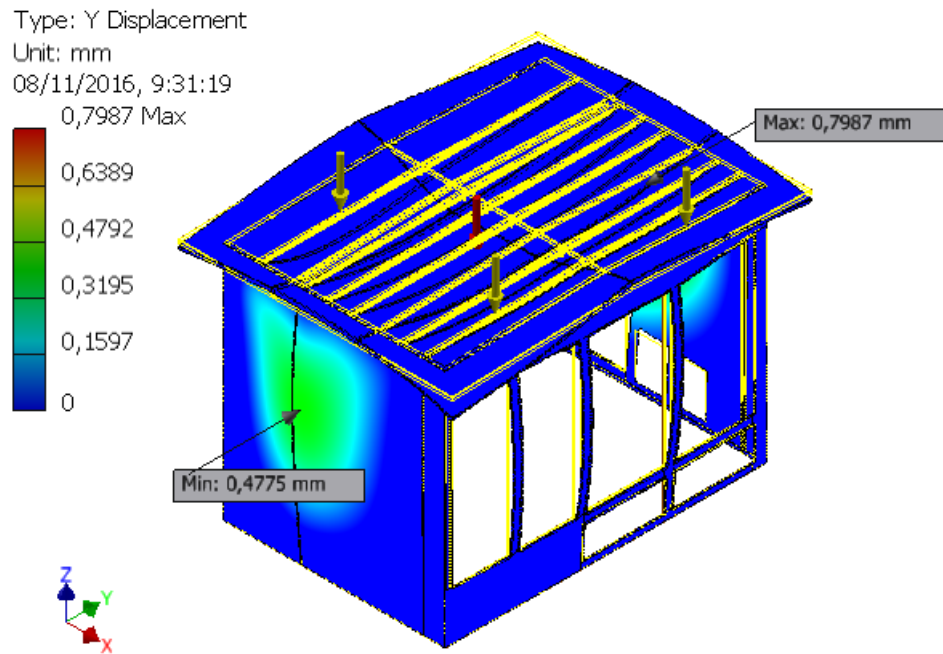
Displacement



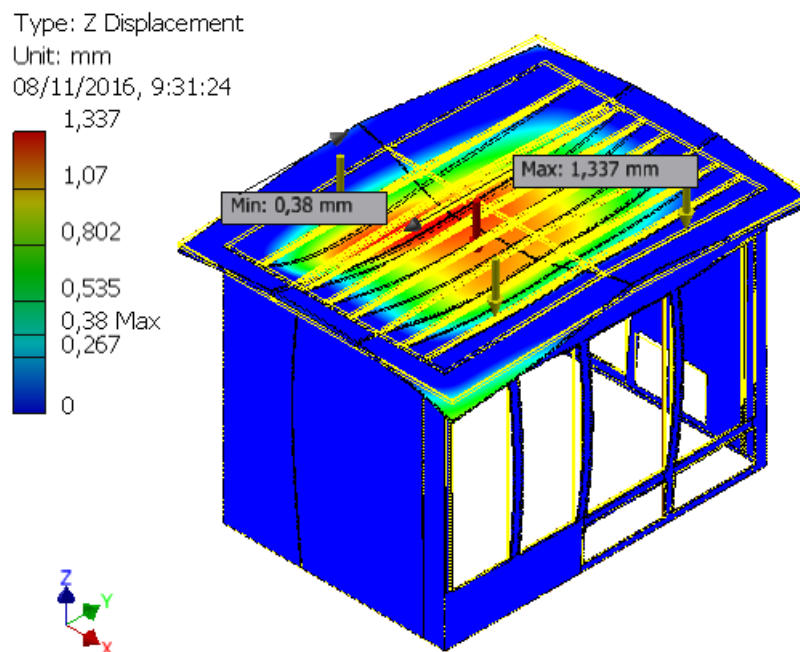
X Displacement



Y Displacement



Z Displacement

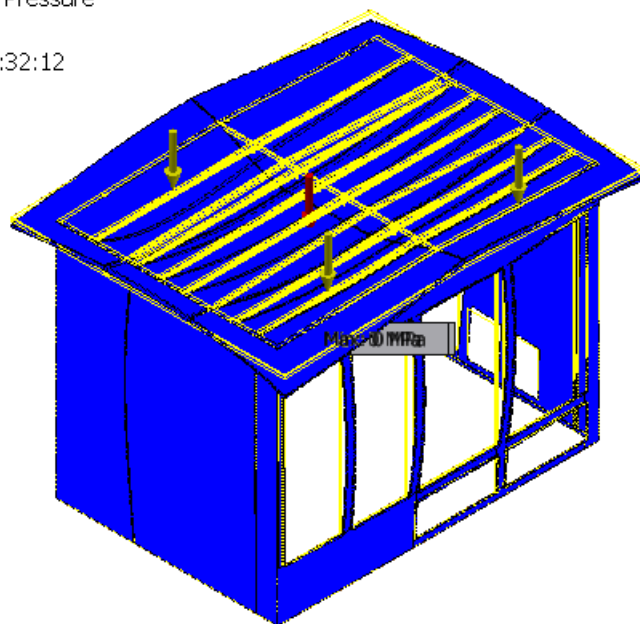
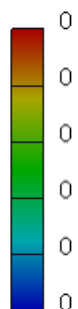


Contact Pressure

Type: Contact Pressure

Unit: MPa

08/11/2016, 9:32:12

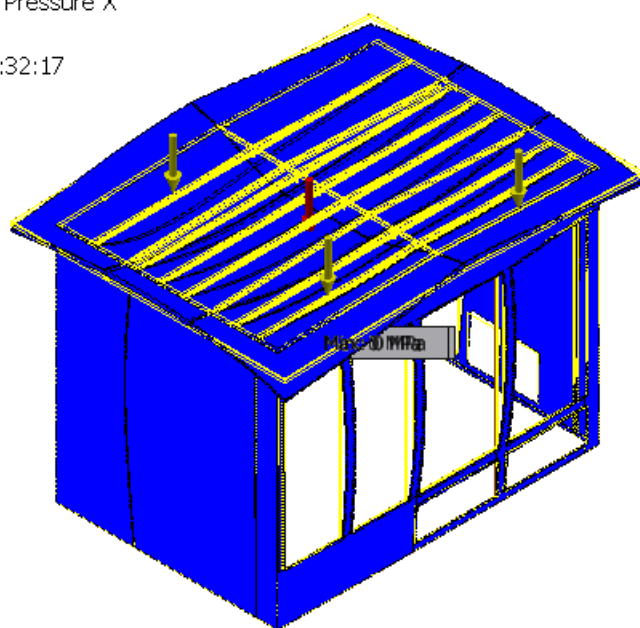
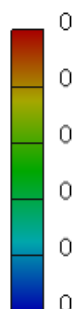


Contact Pressure X

Type: Contact Pressure X

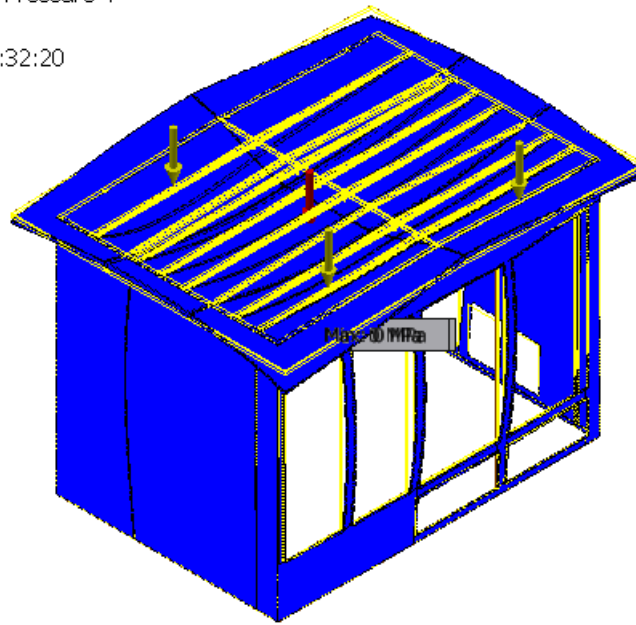
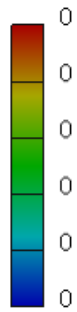
Unit: MPa

08/11/2016, 9:32:17



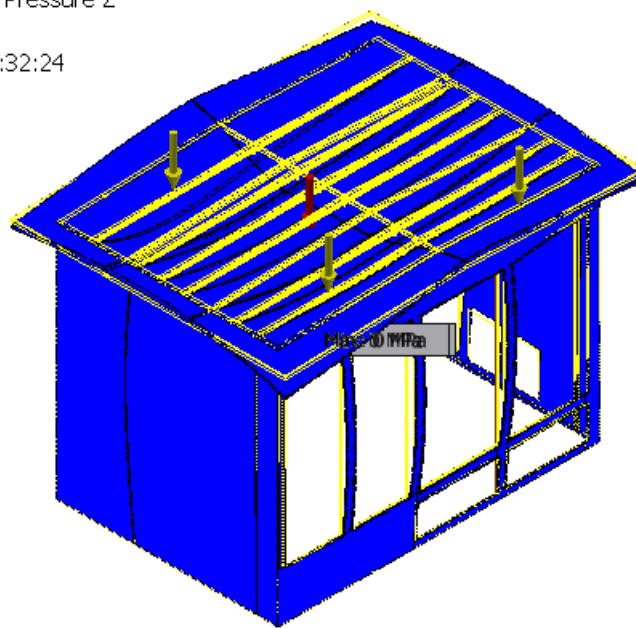
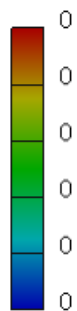
Contact Pressure Y

Type: Contact Pressure Y
Unit: MPa
08/11/2016, 9:32:20



Contact Pressure Z

Type: Contact Pressure Z
Unit: MPa
08/11/2016, 9:32:24



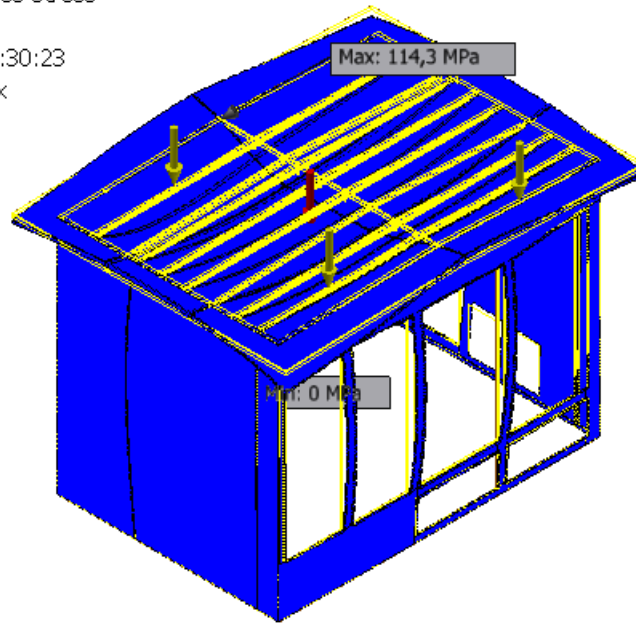
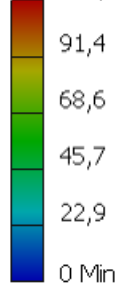
Von Mises Stress

Type: Von Mises Stress

Unit: MPa

08/11/2016, 9:30:23

114,3 Max



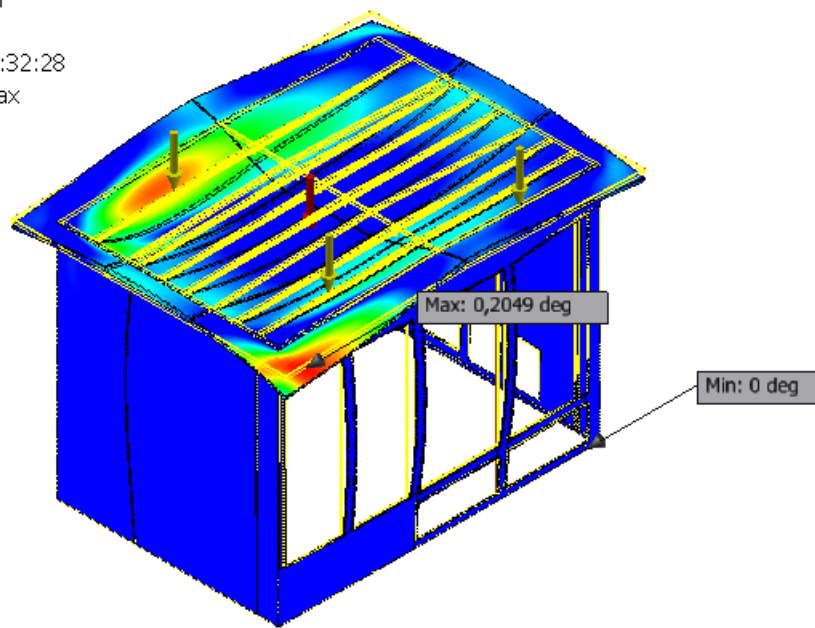
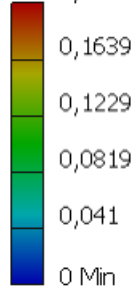
Rotation

Type: Rotation

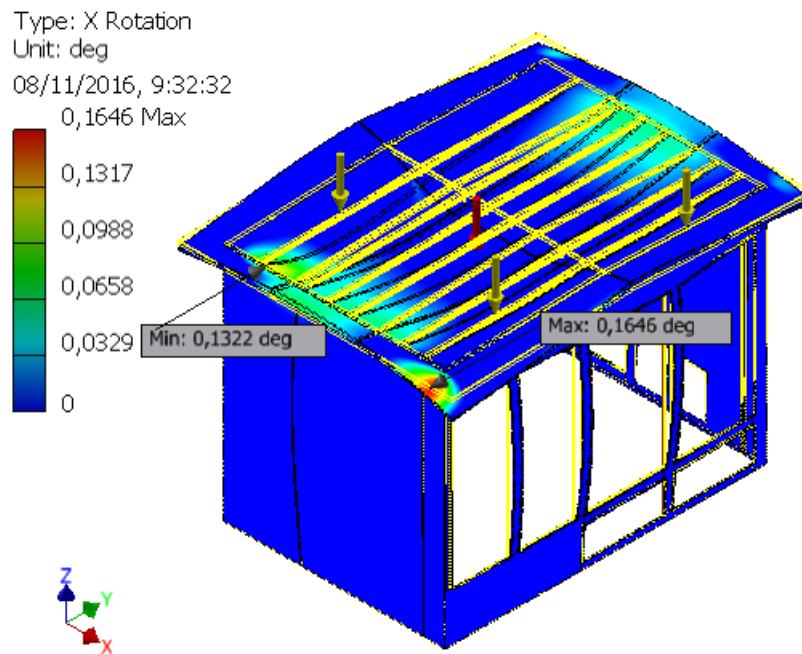
Unit: deg

08/11/2016, 9:32:28

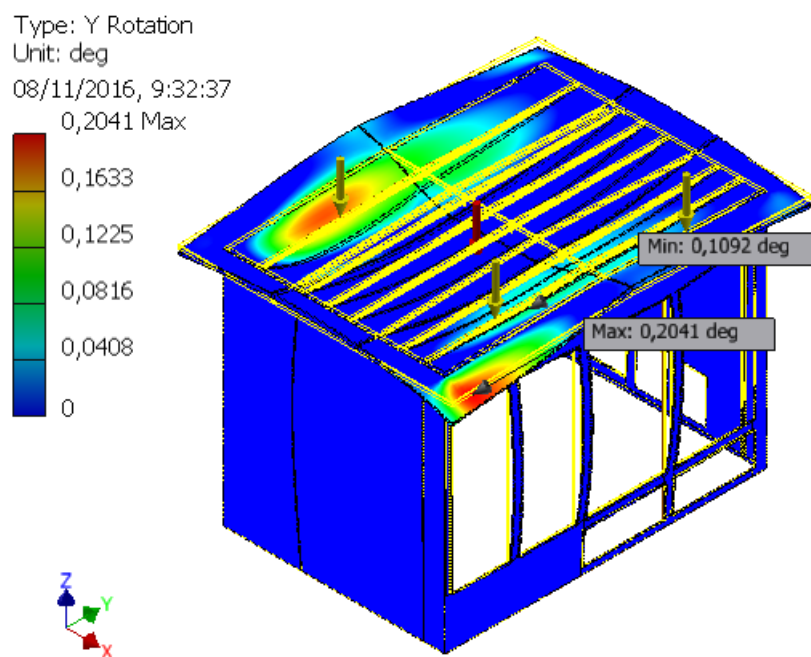
0,2049 Max



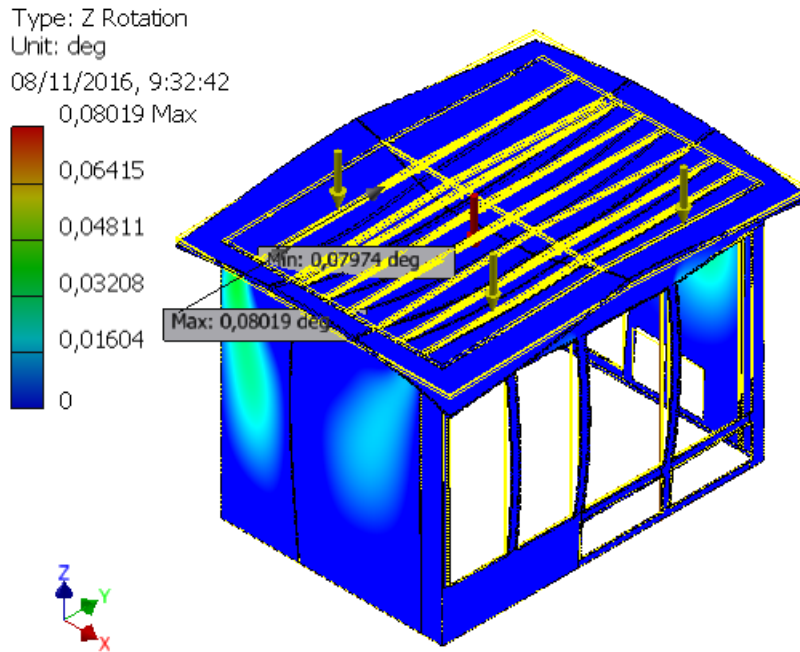
X Rotation



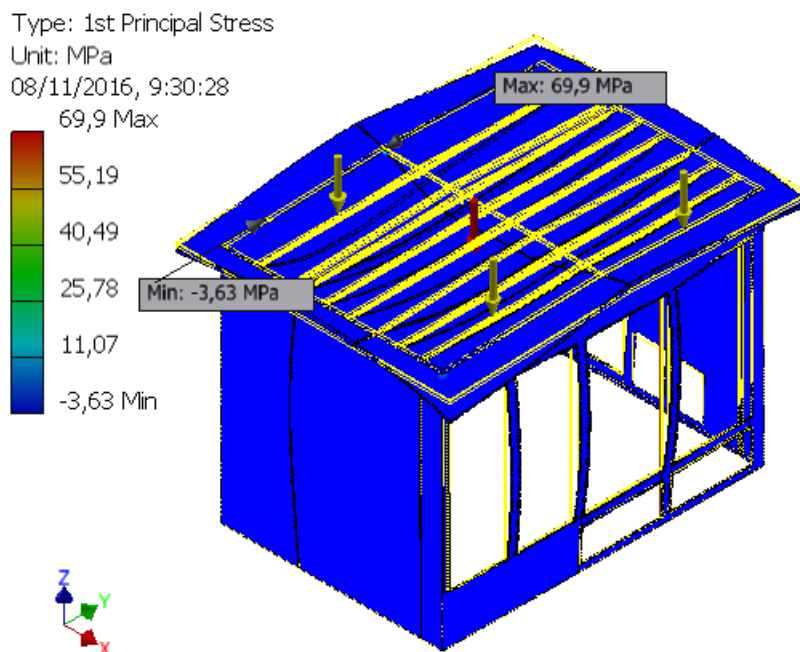
Y Rotation



Z Rotation



1st Principal Stress



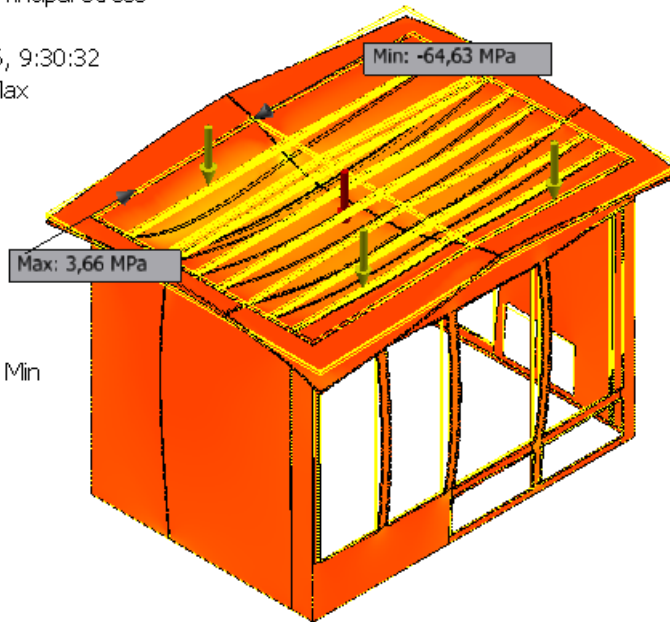
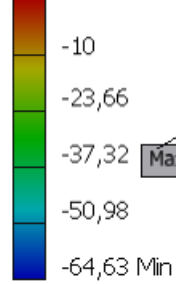
3rd Principal Stress

Type: 3rd Principal Stress

Unit: MPa

08/11/2016, 9:30:32

3,66 Max



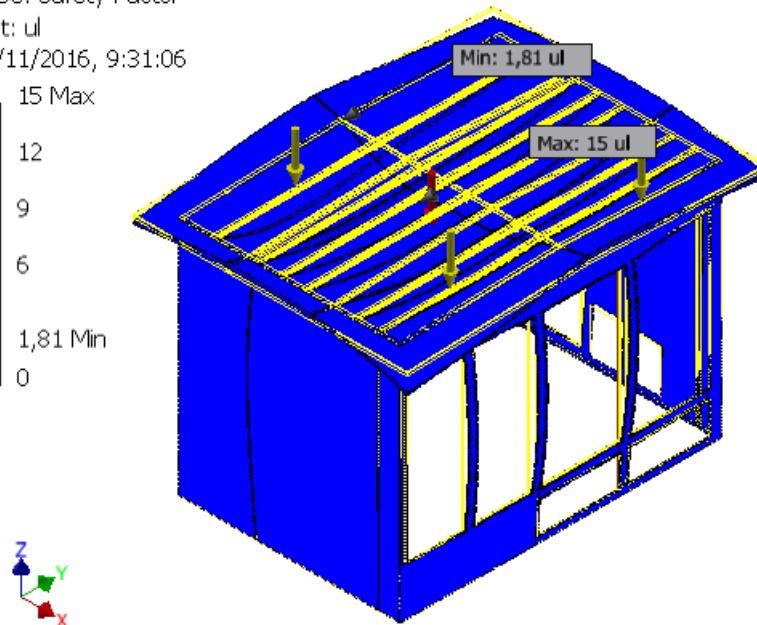
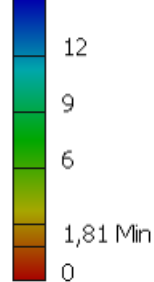
Safety Factor

Type: Safety Factor

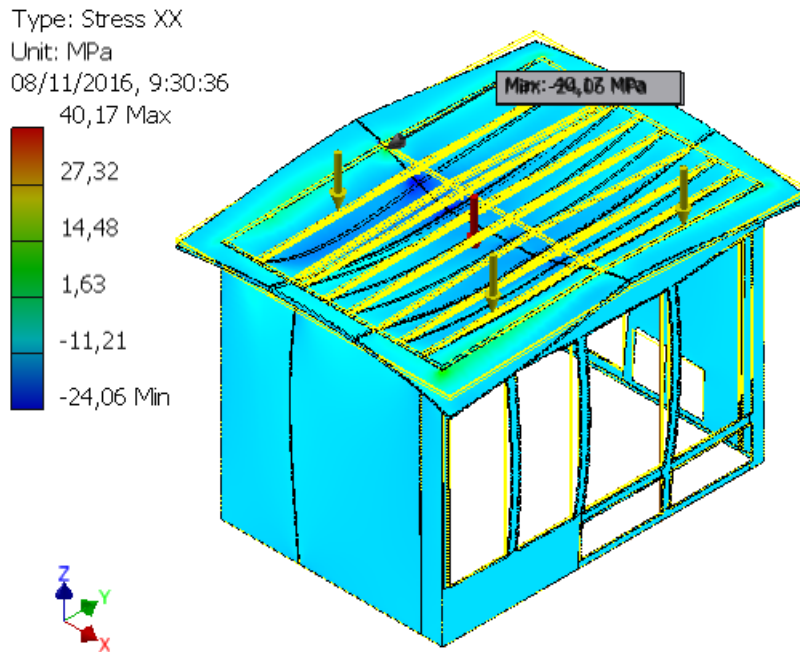
Unit: ul

08/11/2016, 9:31:06

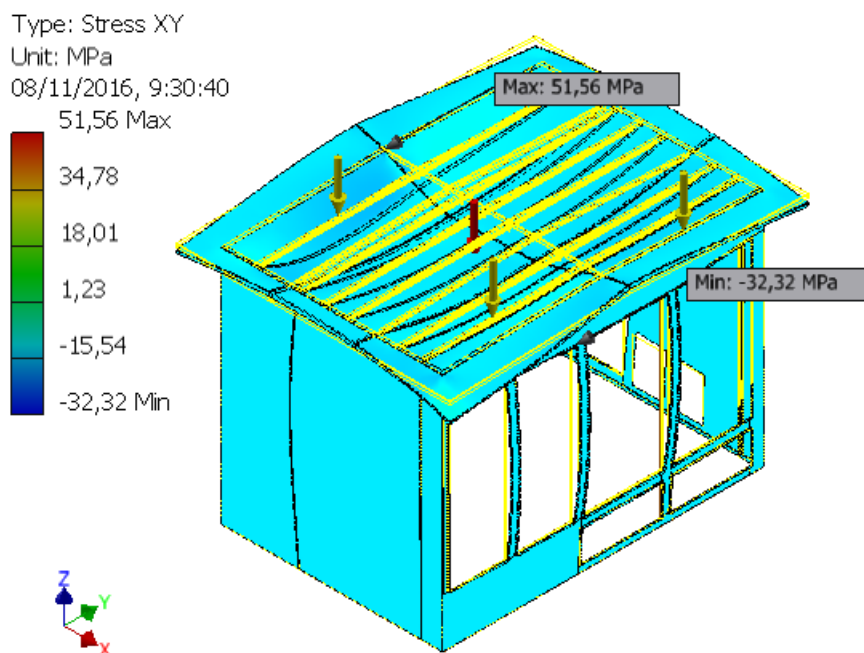
15 Max



Stress XX

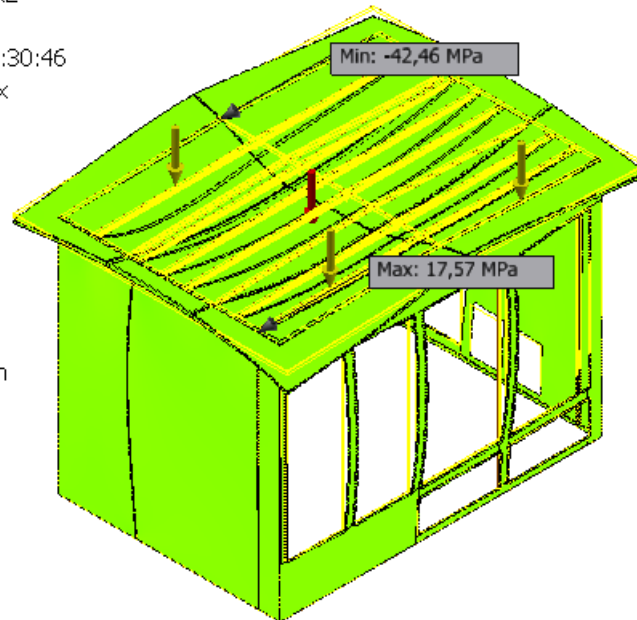
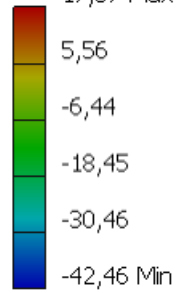


Stress XY



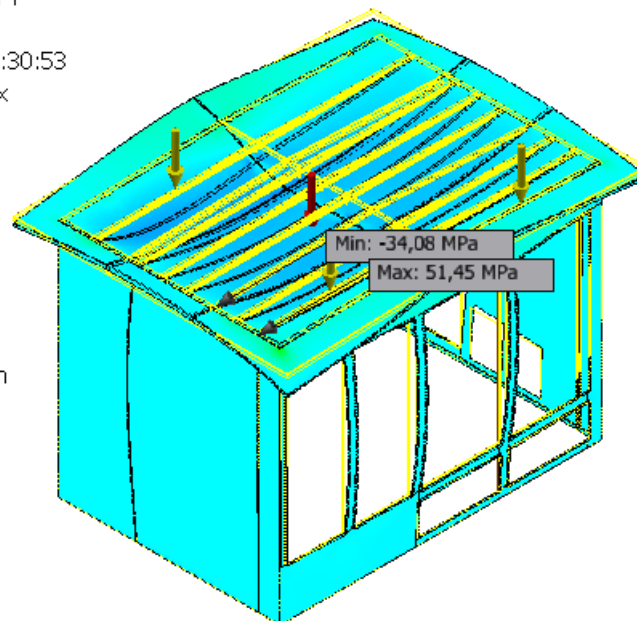
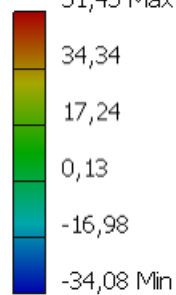
Stress XZ

Type: Stress XZ
Unit: MPa
08/11/2016, 9:30:46
17,57 Max

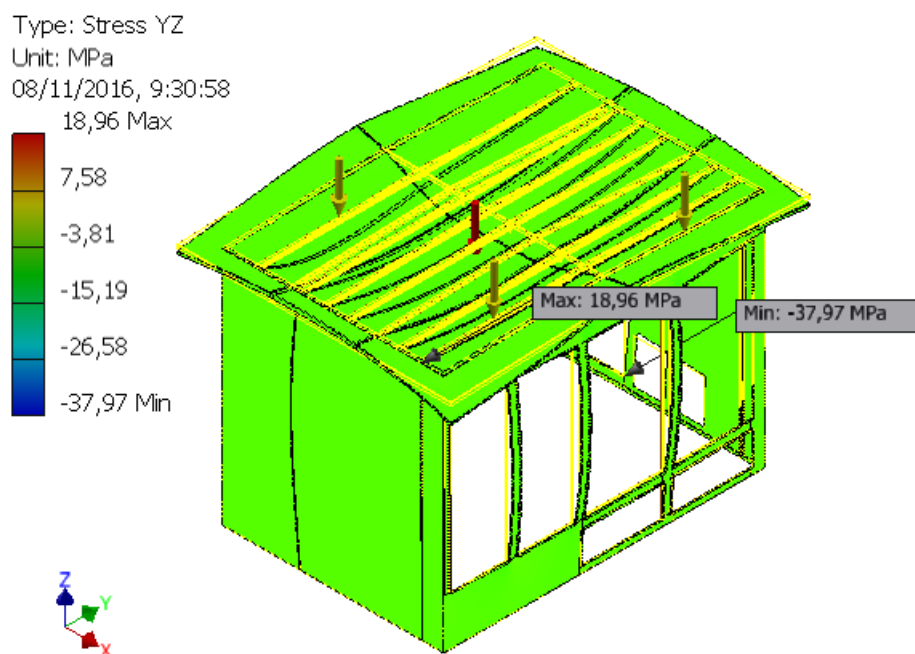


Stress YY

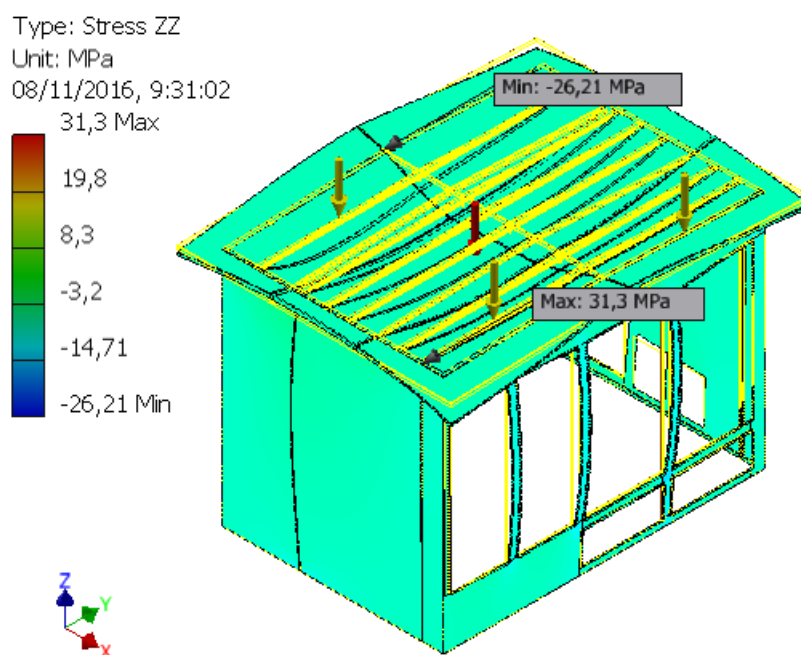
Type: Stress YY
Unit: MPa
08/11/2016, 9:30:53
51,45 Max



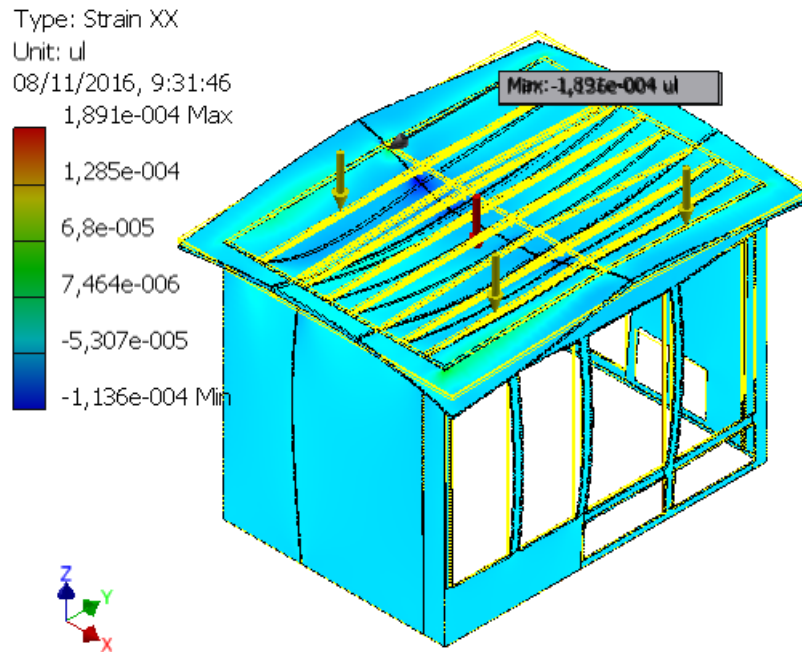
Stress YZ



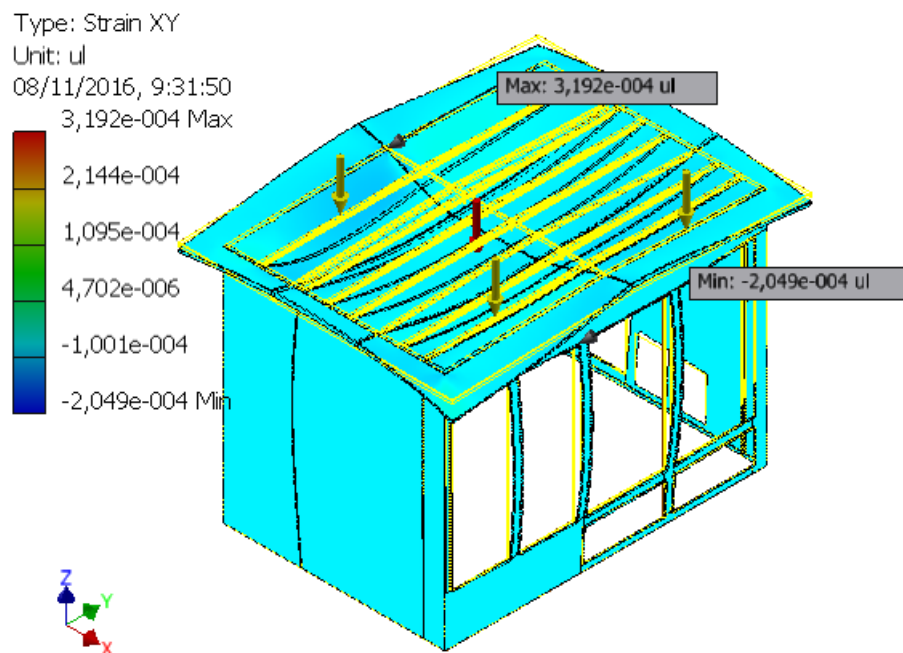
Stress ZZ



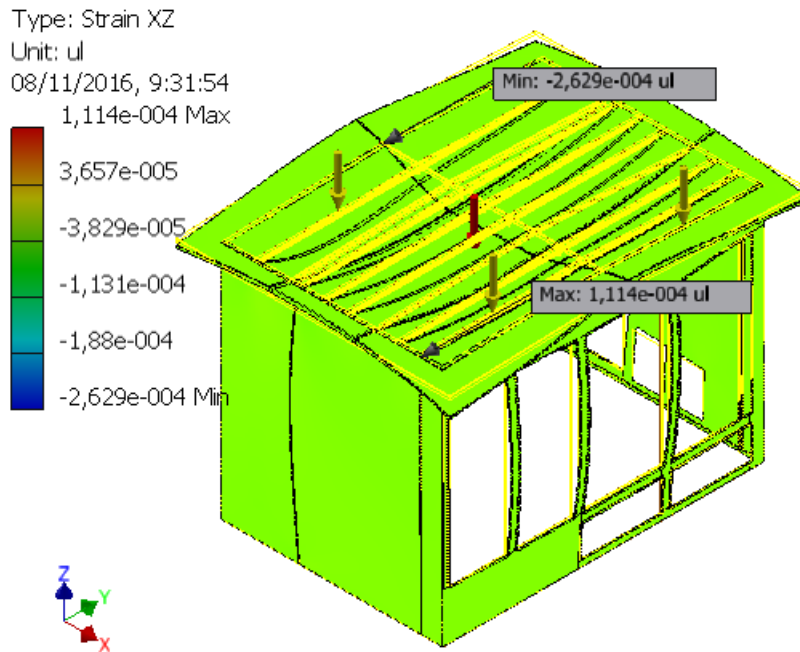
Strain XX



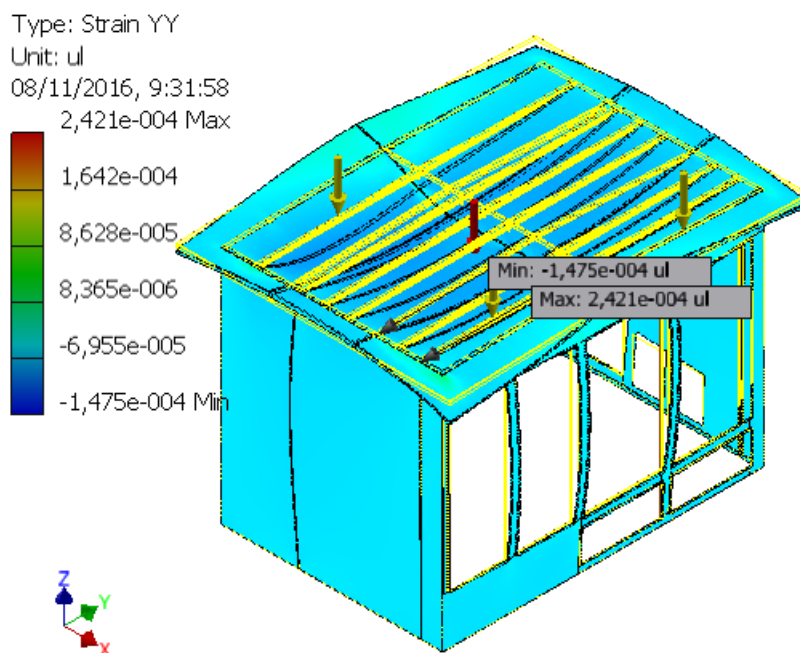
Strain XY



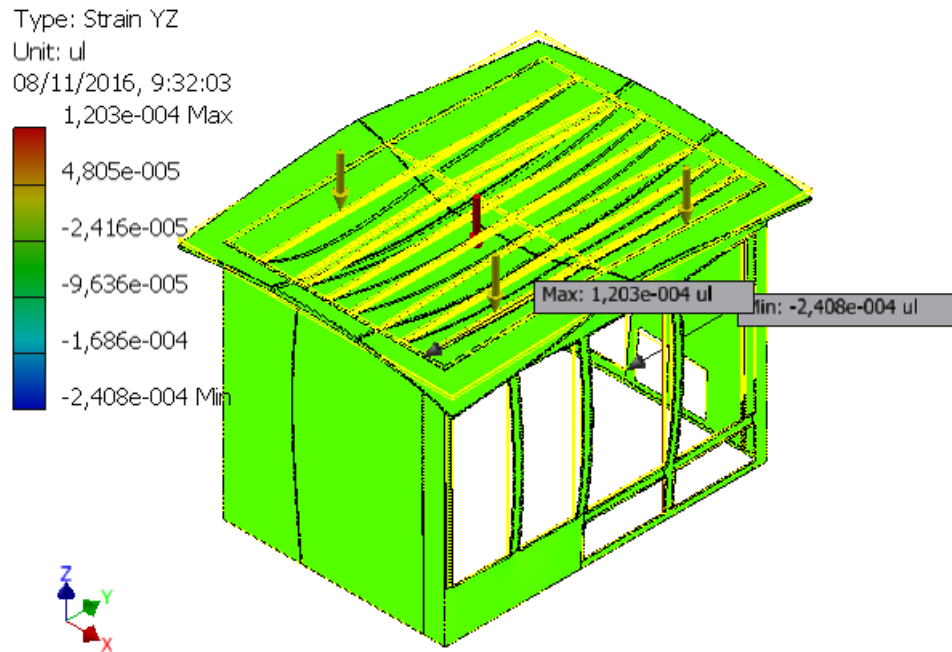
Strain XZ



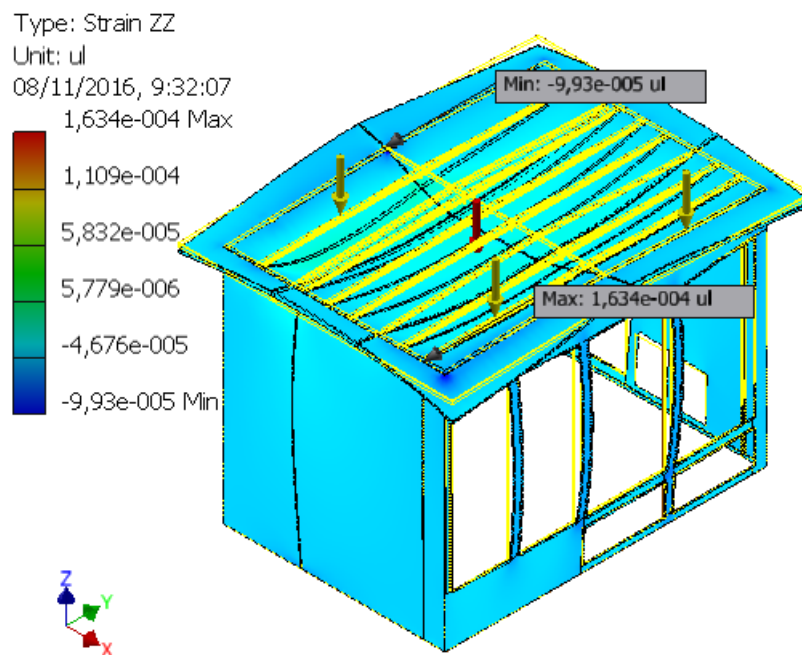
Strain YY



Strain YZ



Strain ZZ



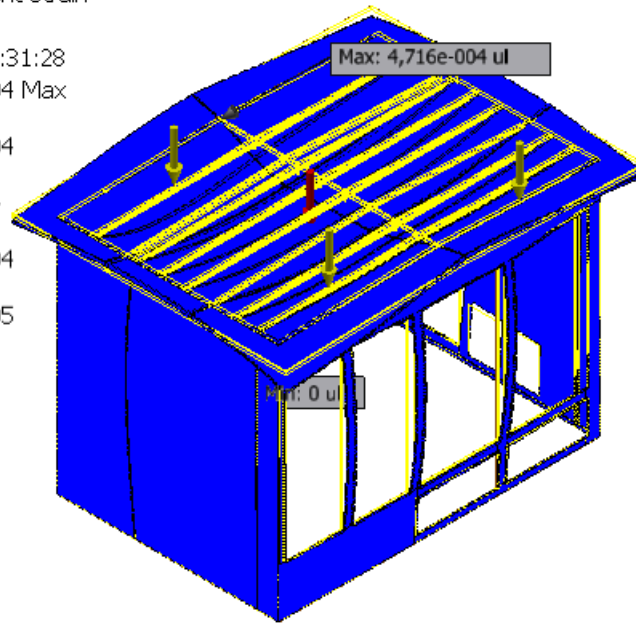
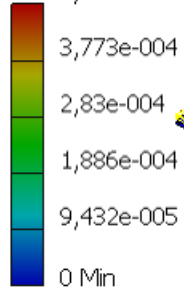
Equivalent Strain

Type: Equivalent Strain

Unit: ul

08/11/2016, 9:31:28

4,716e-004 Max



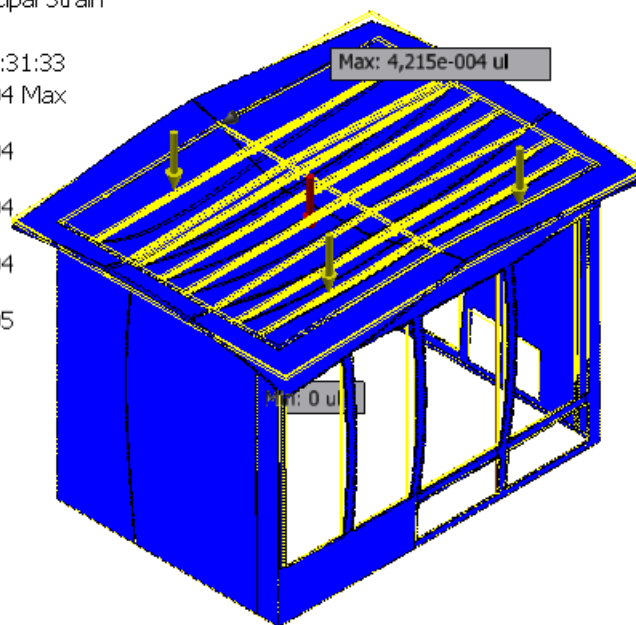
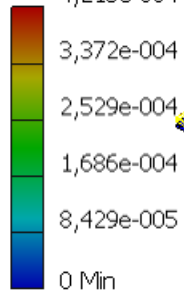
1st Principal Strain

Type: 1st Principal Strain

Unit: ul

08/11/2016, 9:31:33

4,215e-004 Max



3rd Principal Strain

Type: 3rd Principal Strain

Unit: ul

08/11/2016, 9:31:42

0 Max

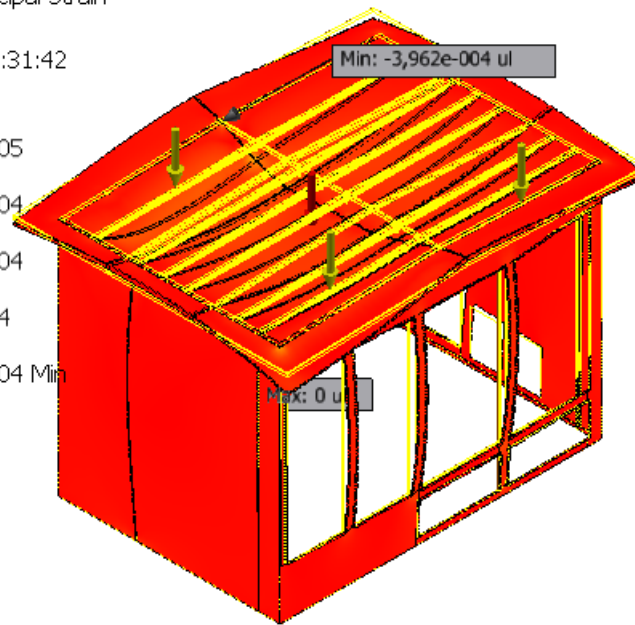
-7,925e-005

-1,585e-004

-2,377e-004

-3,17e-004

-3,962e-004 Min



3. ANÁLISIS DE ESFUERZOS (RETICULADO)



Analyzed File:	Reticulado.iam
Autodesk Inventor Version:	2015 (Build 190159000, 159)
Creation Date:	08/11/2016, 14:15
Simulation Author:	Rony Pinedo Cordova
Summary:	

Project Info (iProperties)

Resumen

Author	R.P.C.
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Project

Part Number	Reticulado
Designer	R.P.C.
Cost	0,00 €
Date Created	12/03/2015

Status

Design Status	WorkInProgress
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Physical

Mass	7842,57 kg
Área	179470000 mm ²
Volume	999054000 mm ³
Center of Gravity	x=51,6542 mm y=-1080,91 mm z=-61,7469 mm

Note: Physical values could be different from Physical values used by FEA reported below.

3.1. SIMULACION

General objective and settings:

Design Objective	Single Point
Simulation Type	Static Analysis
Last Modification Date	08/11/2016, 11:59
Detect and Eliminate Rigid Body Modes	No
Separate Stresses Across Contact Surfaces	No
Motion Loads Analysis	No

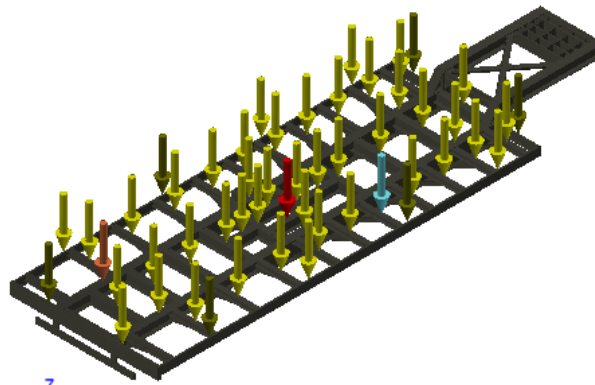
Material(s)

Name	Steel, Cast	
General	Mass Density	7,85 g/cm ³
	Yield Strength	250 MPa
	Ultimate Tensile Strength	300 MPa
Stress	Young's Modulus	210 GPa
	Poisson's Ratio	0,3 ul
	Shear Modulus	80,7692 GPa

Operating conditions

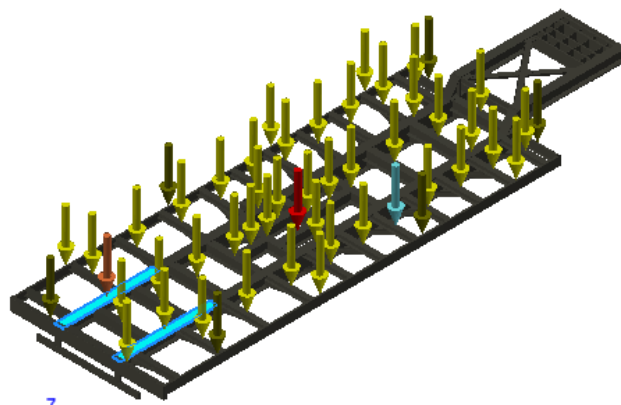
Gravedad

Load Type	Gravity
Magnitude	9810.000 mm/s ²
Vector X	-0.000 mm/s ²
Vector Y	-0.000 mm/s ²
Vector Z	-9810.000 mm/s ²



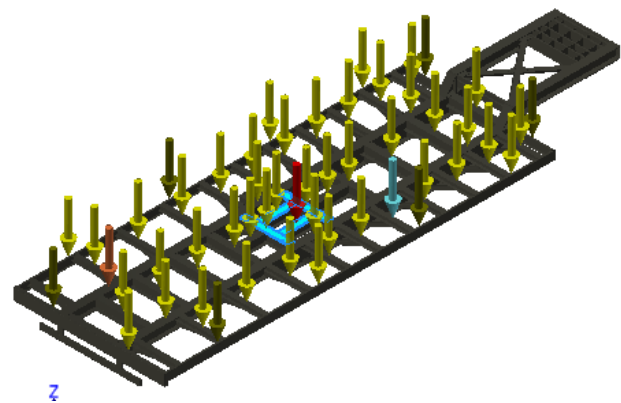
Peso de Portico y aparamenta eléctrica

Load Type	Force
Magnitude	35860.000 N
Vector X	-0.000 N
Vector Y	-0.000 N
Vector Z	-35860.000 N



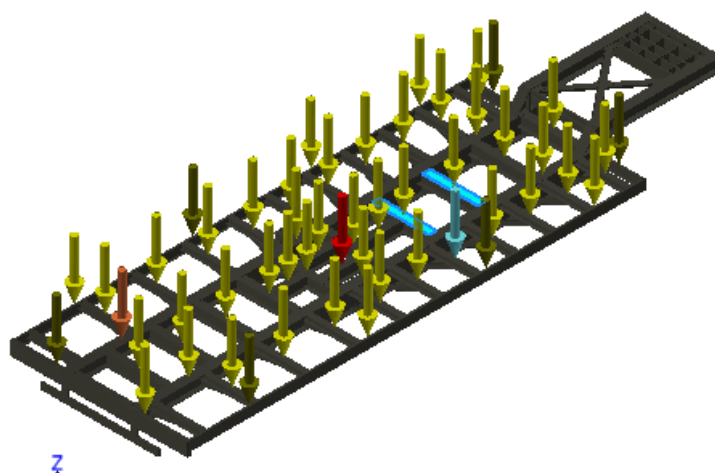
Peso del Transformador de potencia

Load Type	Force
Magnitude	199540.000 N
Vector X	-0.000 N
Vector Y	-0.000 N
Vector Z	-199540.000 N



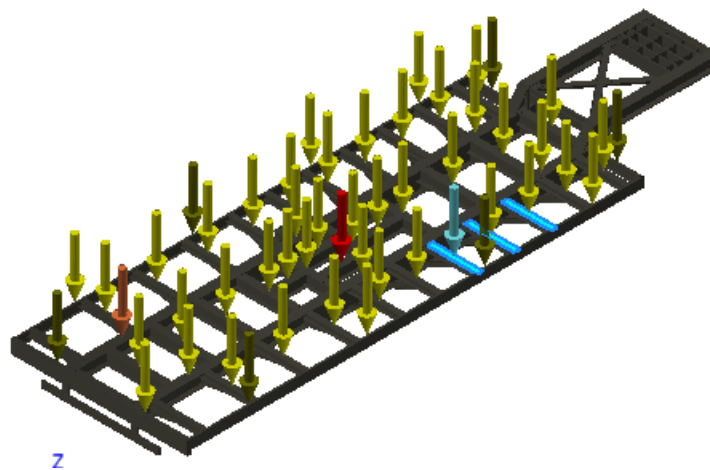
Peso de Caseta y equipamiento electrico

Load Type	Force
Magnitude	30300.000 N
Vector X	-0.000 N
Vector Y	0.000 N
Vector Z	-30300.000 N



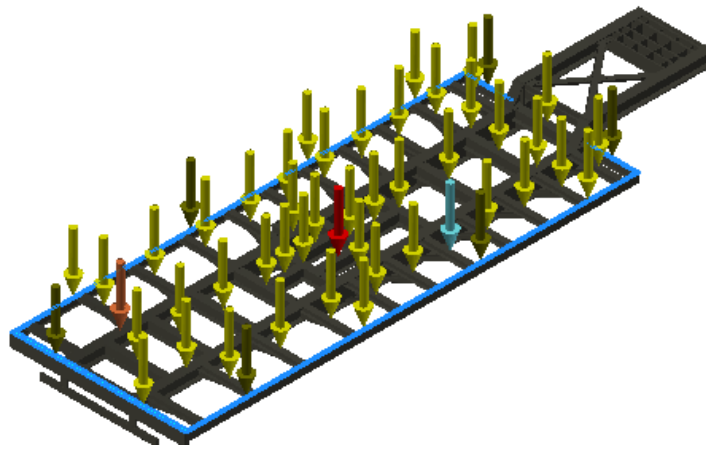
Peso de Cargador y Batería, incluye casetas.

Load Type	Force
Magnitude	7640.000 N
Vector X	0.000 N
Vector Y	-0.000 N
Vector Z	-7640.000 N



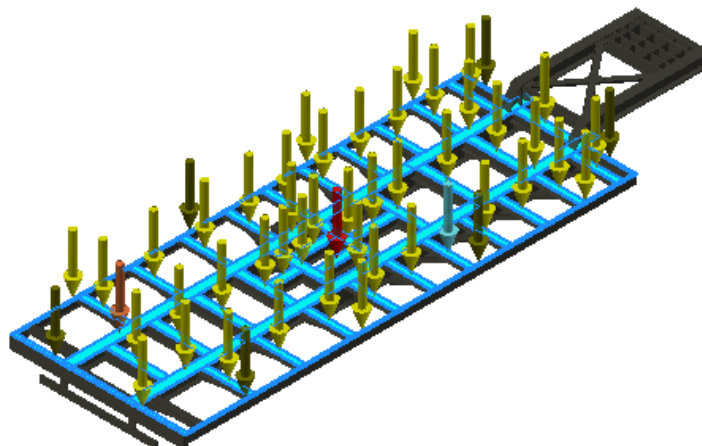
Peso del Cerco Perimetrico

Load Type	Force
Magnitude	4840.000 N
Vector X	-0.000 N
Vector Y	-0.000 N
Vector Z	-4840.000 N



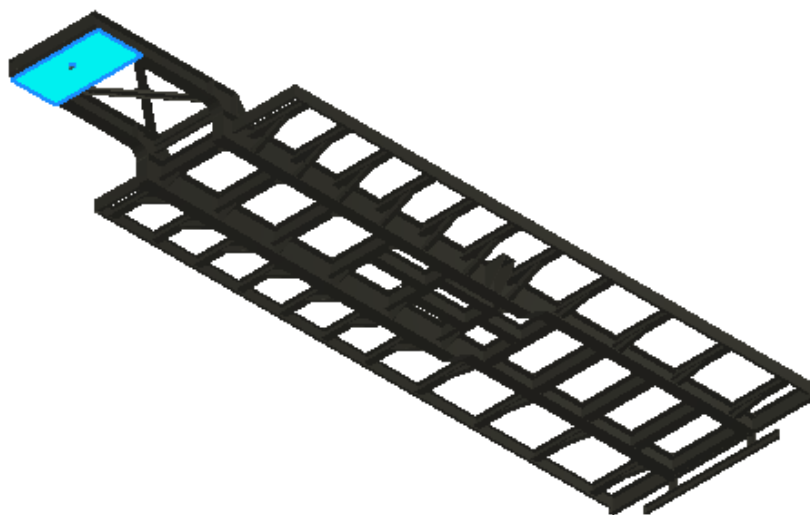
Peso del Piso (plancha de 6mm)

Load Type	Force
Magnitude	28280.000 N
Vector X	-0.000 N
Vector Y	0.000 N
Vector Z	-28280.000 N



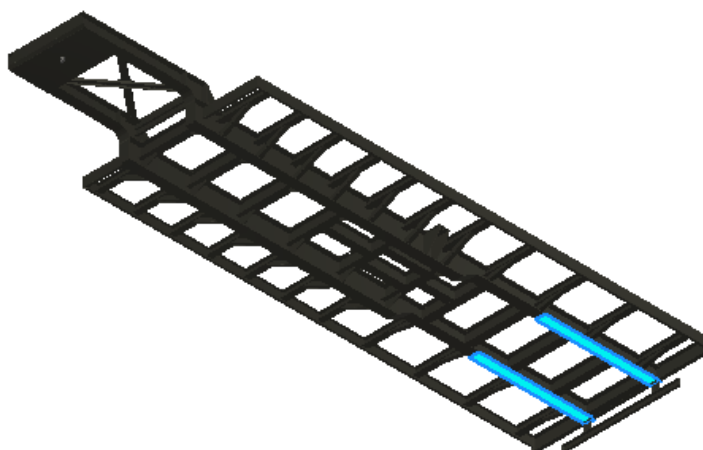
Fixed Constraint: (Puntos de sujeción) 1

Constraint Type	Fixed Constraint
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Fixed Constraint: (Puntos de sujeción) 2

Constraint Type	Fixed Constraint
-----------------	------------------



3.2. RESULTADOS

Reaction Force and Moment on Constraints

Constraint Name	Reaction Force		Reaction Moment	
	Magnitude	Component (X,Y,Z)	Magnitude	Component (X,Y,Z)
Fixed Constraint:1	368908 N	349528 N	243020 N m	-6721,28 N m
		0 N		242364 N m
		117999 N		16533,6 N m
Fixed Constraint:2	438634 N	-349630 N	605241 N m	-5846,03 N m
		0 N		-604902 N m
		264876 N		-19379,8 N m

Result Resumen

Name	Minimum	Maximum
Volume	985864000 mm ³	
Mass	7739,03 kg	
Von Mises Stress	0,000105062 MPa	167,859 MPa
1st Principal Stress	-34,9101 MPa	189,087 MPa
3rd Principal Stress	-198,579 MPa	30,4604 MPa
Displacement	0 mm	6,83381 mm
Safety Factor	1,48935 ul	15 ul
Stress XX	-167,703 MPa	162,95 MPa
Stress XY	-34,8099 MPa	36,4791 MPa
Stress XZ	-63,4363 MPa	74,0428 MPa
Stress YY	-113,214 MPa	91,3321 MPa
Stress YZ	-67,2467 MPa	68,3725 MPa
Stress ZZ	-145,724 MPa	77,8461 MPa
X Displacement	-0,400139 mm	0,646033 mm
Y Displacement	-0,147467 mm	0,345949 mm
Z Displacement	-6,83171 mm	0,03052 mm
Equivalent Strain	0,000000000603765 ul	0,00073182 ul
1st Principal Strain	-0,00000979108 ul	0,00081031 ul
3rd Principal Strain	-0,00085396 ul	0,0000142712 ul
Strain XX	-0,000658101 ul	0,00064851 ul
Strain XY	-0,00021549 ul	0,000225823 ul
Strain XZ	-0,000392701 ul	0,00045836 ul
Strain YY	-0,000373126 ul	0,000366907 ul
Strain YZ	-0,000416289 ul	0,000423258 ul
Strain ZZ	-0,000574807 ul	0,000357147 ul
Contact Pressure	0 MPa	802,89 MPa
Contact Pressure X	-651,537 MPa	585,629 MPa
Contact Pressure Y	-290,418 MPa	322,193 MPa
Contact Pressure Z	-461,762 MPa	260,032 MPa

3.3. GRAFICOS

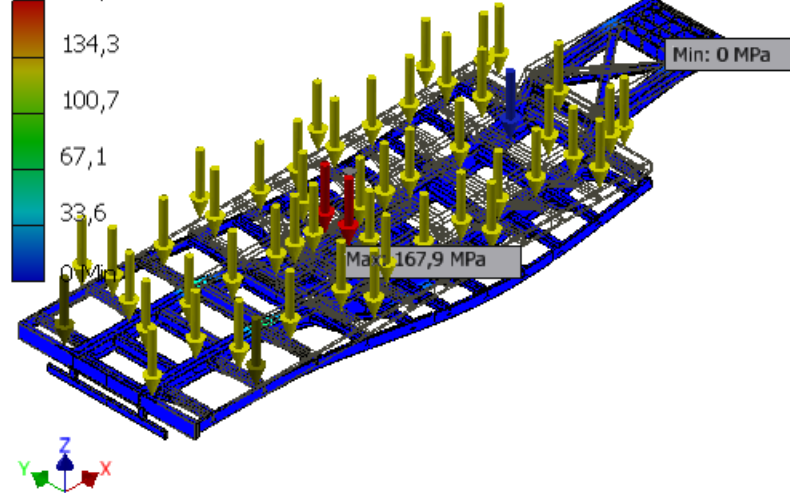
Von Mises Stress

Type: Von Mises Stress

Unit: MPa

08/11/2016, 14:15:22

167,9 Max

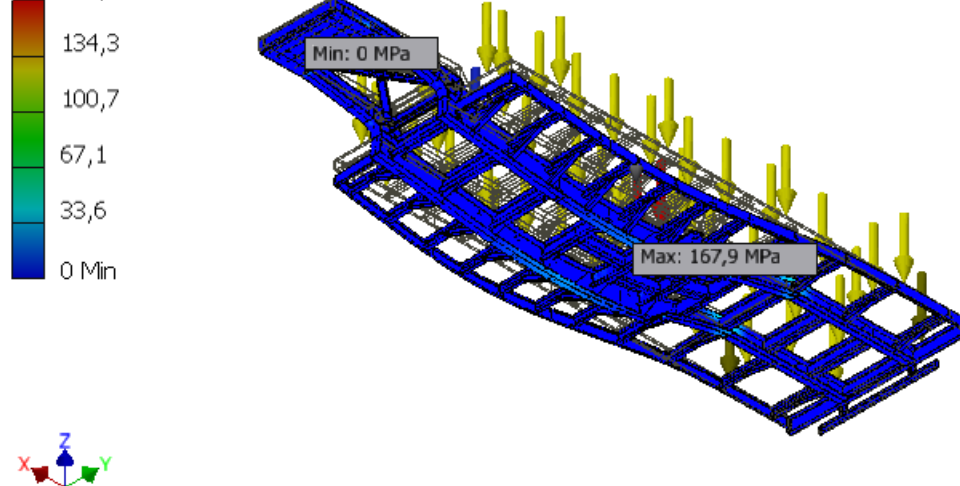


Type: Von Mises Stress

Unit: MPa

08/11/2016, 14:15:22

167,9 Max

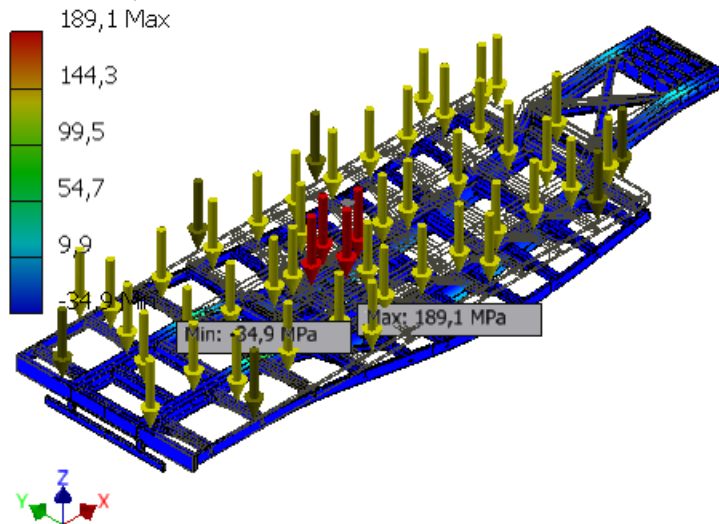


1st Principal Stress

Type: 1st Principal Stress

Unit: MPa

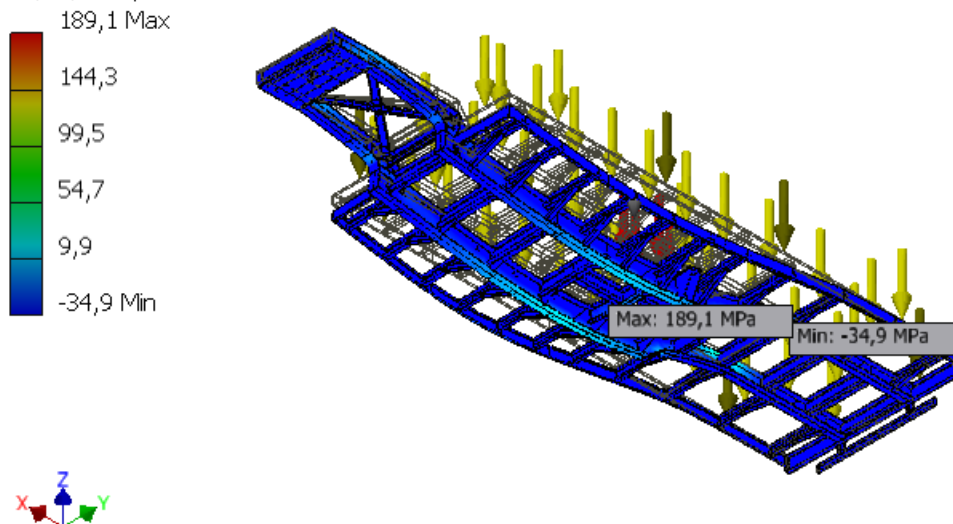
08/11/2016, 14:15:27



Type: 1st Principal Stress

Unit: MPa

08/11/2016, 14:15:27



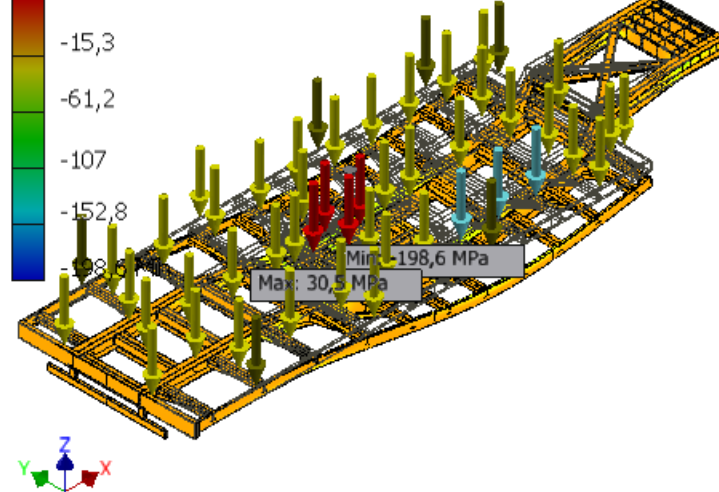
3rd Principal Stress

Type: 3rd Principal Stress

Unit: MPa

08/11/2016, 14:15:38

30,5 Max

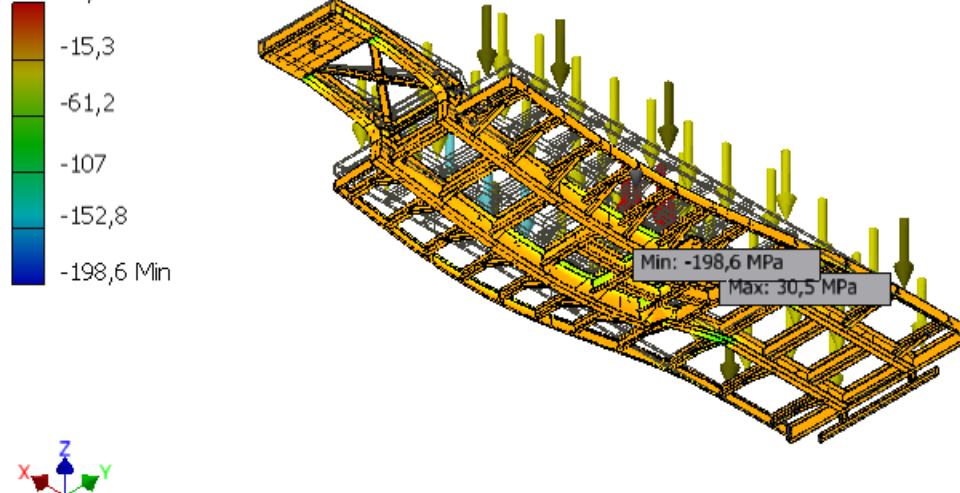


Type: 3rd Principal Stress

Unit: MPa

08/11/2016, 14:15:38

30,5 Max



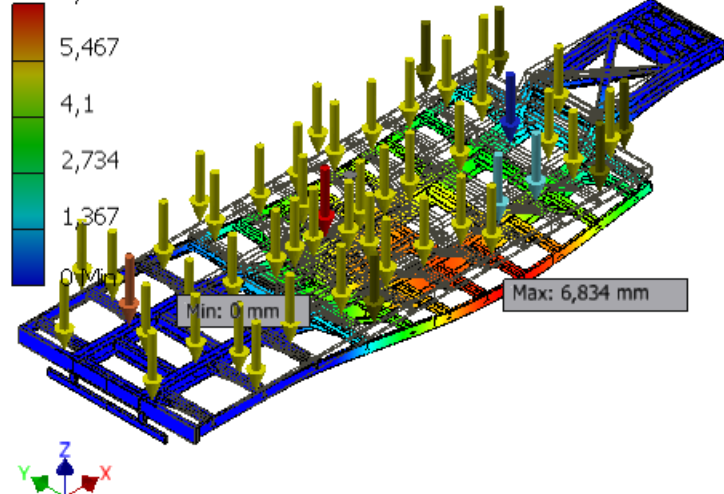
Displacement

Type: Displacement

Unit: mm

08/11/2016, 14:16:13

6,834 Max

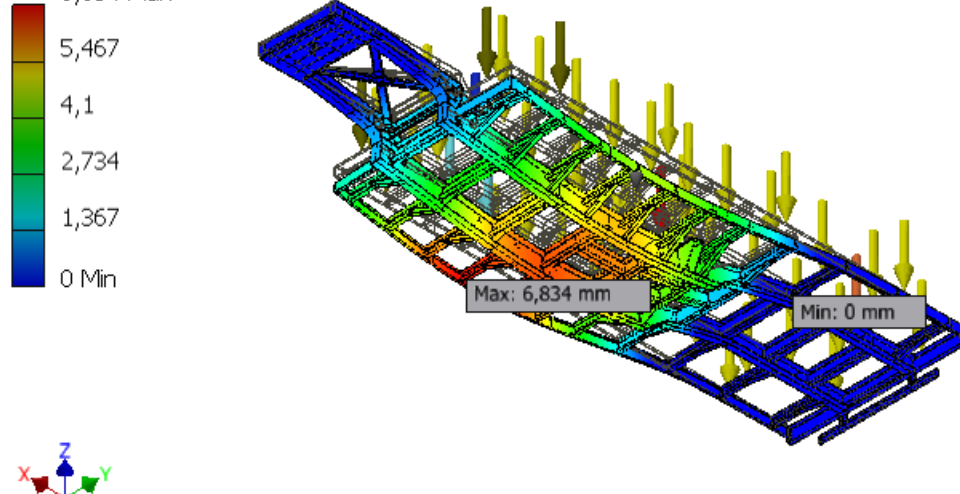


Type: Displacement

Unit: mm

08/11/2016, 14:16:13

6,834 Max

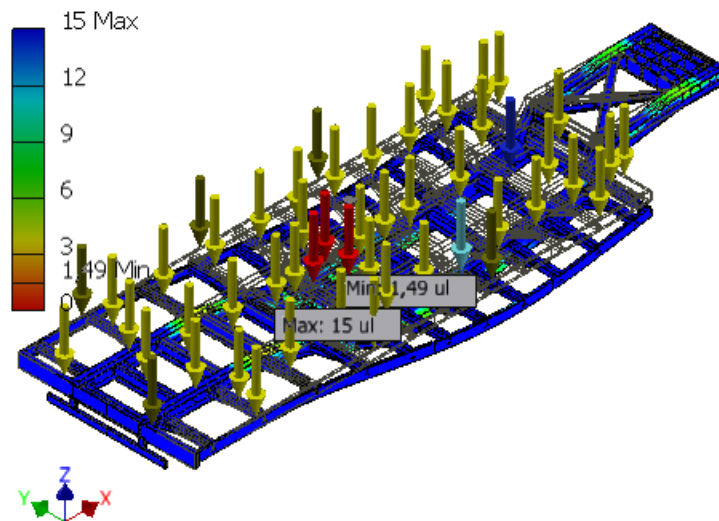


Safety Factor

Type: Safety Factor

Unit: ul

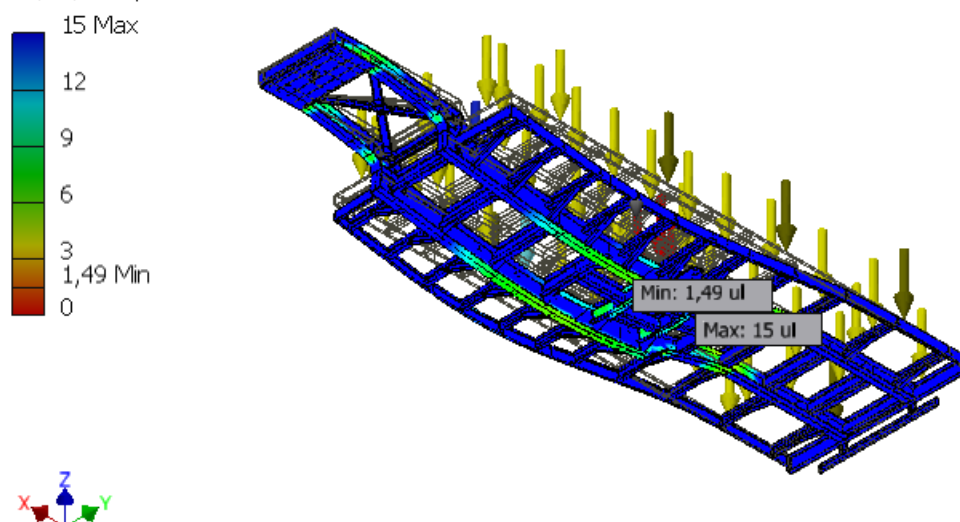
08/11/2016, 14:16:09



Type: Safety Factor

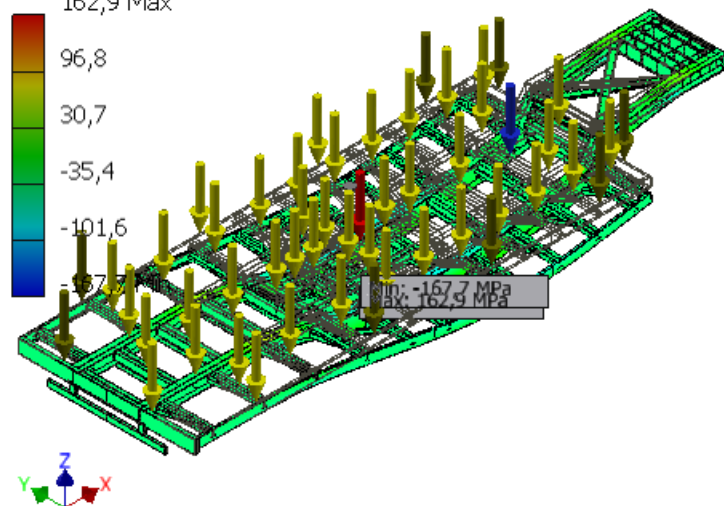
Unit: ul

08/11/2016, 14:16:09

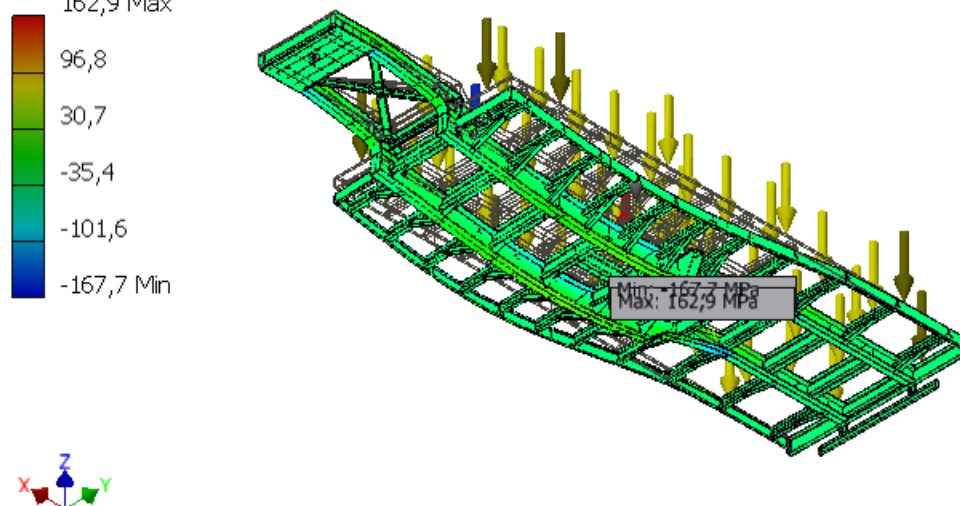


Stress XX

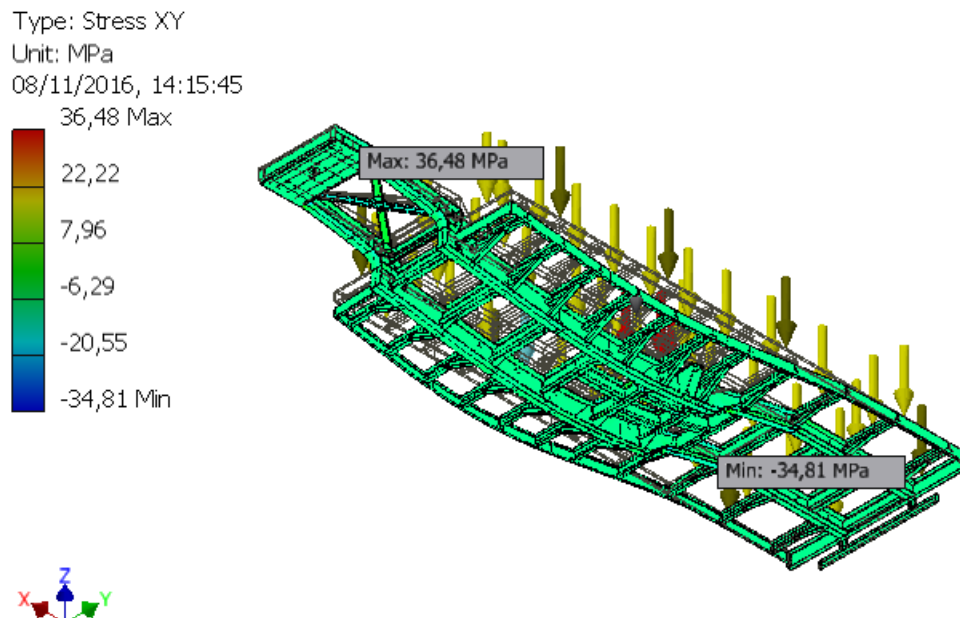
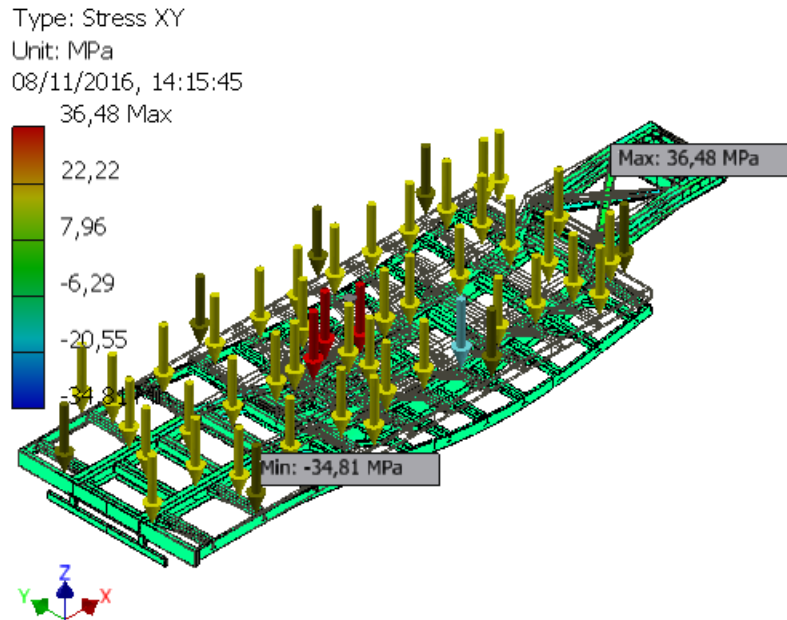
Type: Stress XX
Unit: MPa
08/11/2016, 14:15:41
162,9 Max



Type: Stress XX
Unit: MPa
08/11/2016, 14:15:41
162,9 Max



Stress XY



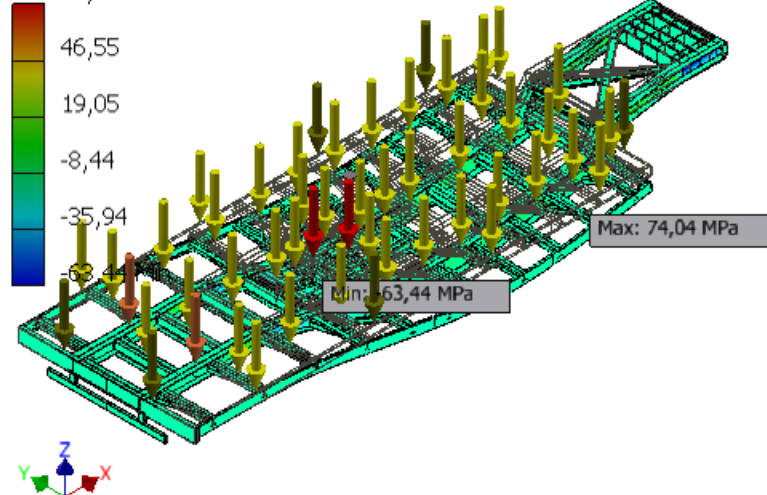
Stress XZ

Type: Stress XZ

Unit: MPa

08/11/2016, 14:15:48

74,04 Max

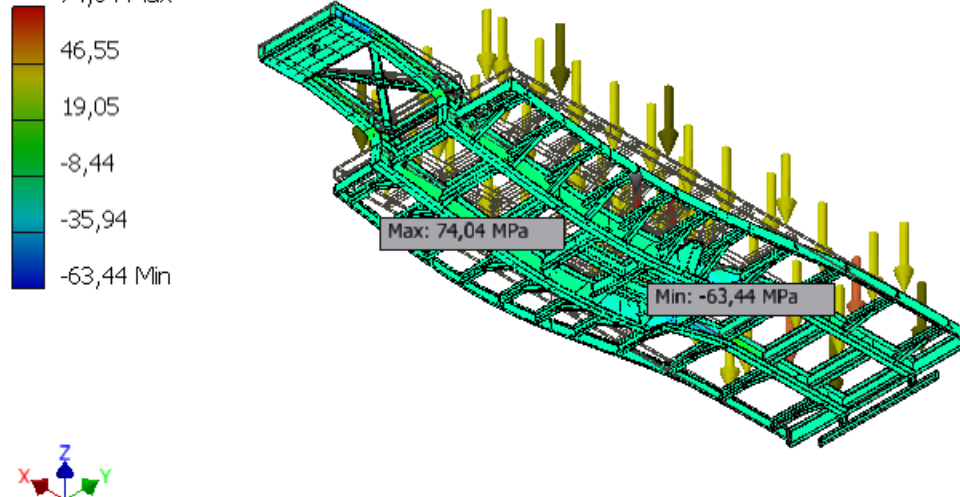


Type: Stress XZ

Unit: MPa

08/11/2016, 14:15:48

74,04 Max



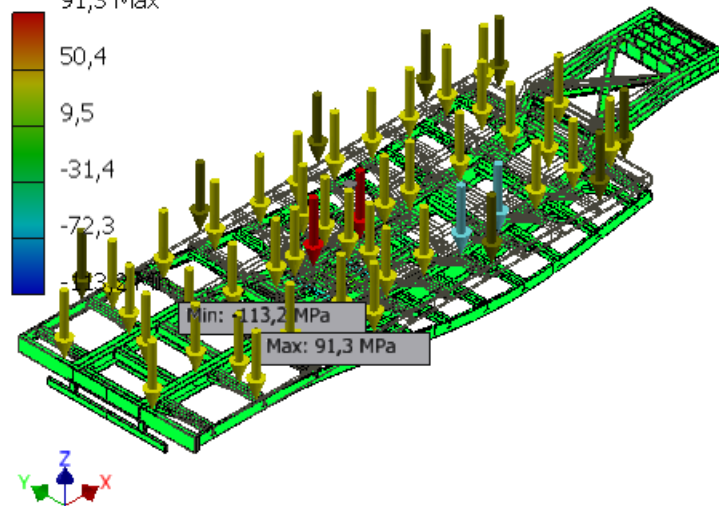
Stress YY

Type: Stress YY

Unit: MPa

08/11/2016, 14:15:52

91,3 Max

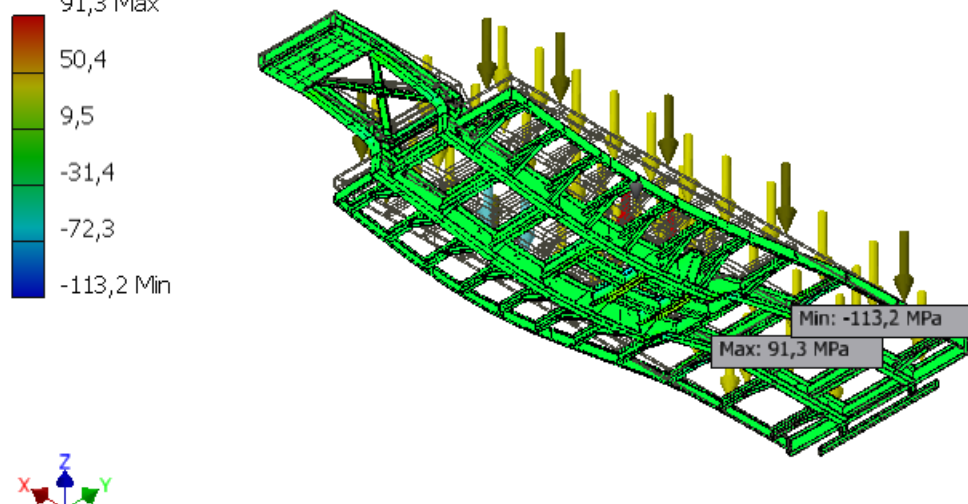


Type: Stress YY

Unit: MPa

08/11/2016, 14:15:52

91,3 Max



Stress YZ

Type: Stress YZ

Unit: MPa

08/11/2016, 14:16:00

68,37 Max

41,25

14,12

-13

-40,12

-67,25

68,37 Max

Min: -67,25 MPa



Type: Stress YZ

Unit: MPa

08/11/2016, 14:16:00

68,37 Max

41,25

14,12

-13

-40,12

-67,25 Min

68,37 Max

Max: 68,37 MPa

Min: -67,25 MPa



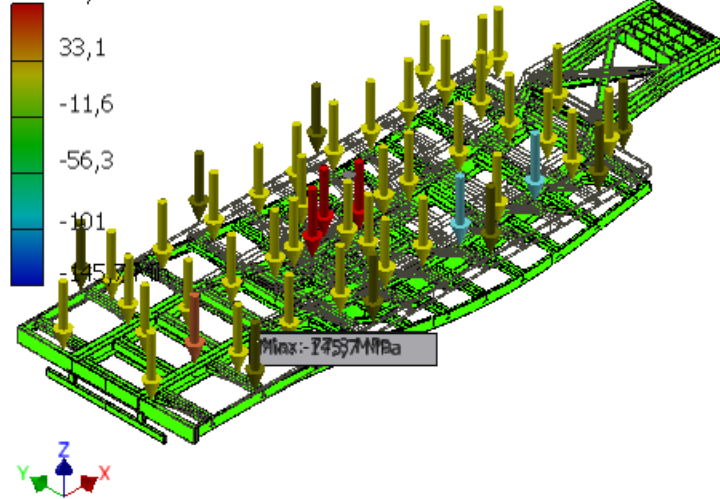
Stress ZZ

Type: Stress ZZ

Unit: MPa

08/11/2016, 14:16:05

77,8 Max

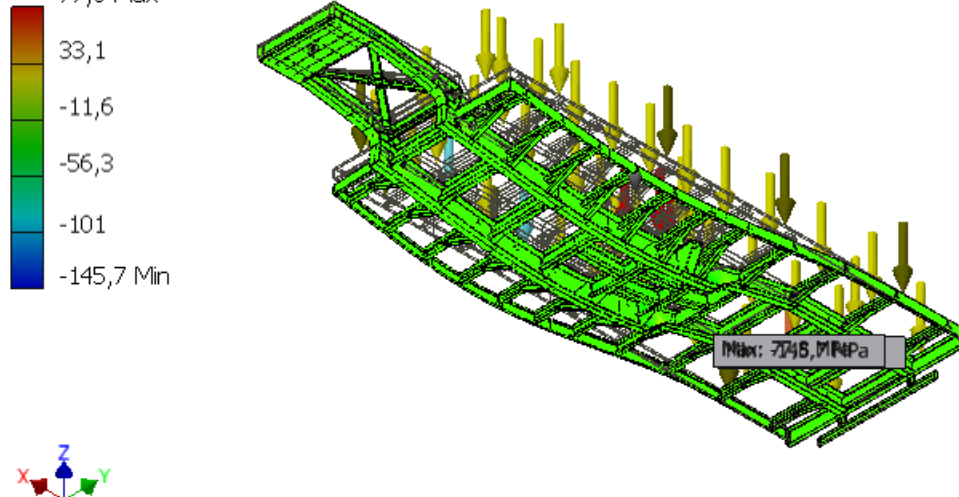


Type: Stress ZZ

Unit: MPa

08/11/2016, 14:16:05

77,8 Max



X Displacement

Type: X Displacement

Unit: mm

08/11/2016, 14:16:17

0,646 Max

0,5168

0,3876

0,2584

0,1292

0



Type: X Displacement

Unit: mm

08/11/2016, 14:16:17

0,646 Max

0,5168

0,3876

0,2584

0,1292

0



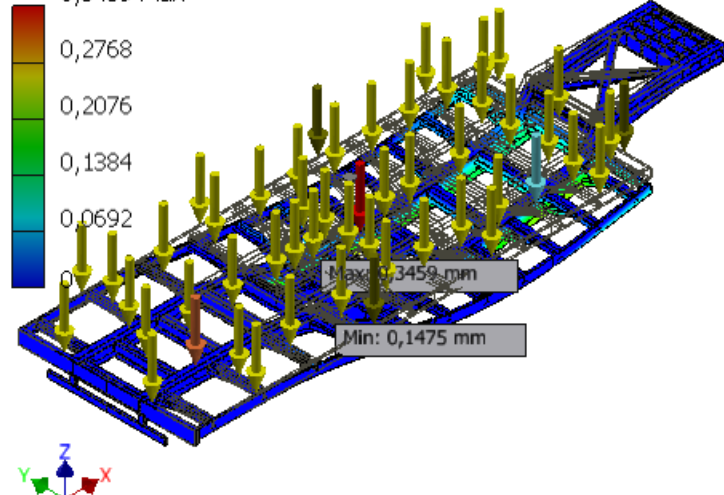
Y Displacement

Type: Y Displacement

Unit: mm

08/11/2016, 14:16:21

0,3459 Max

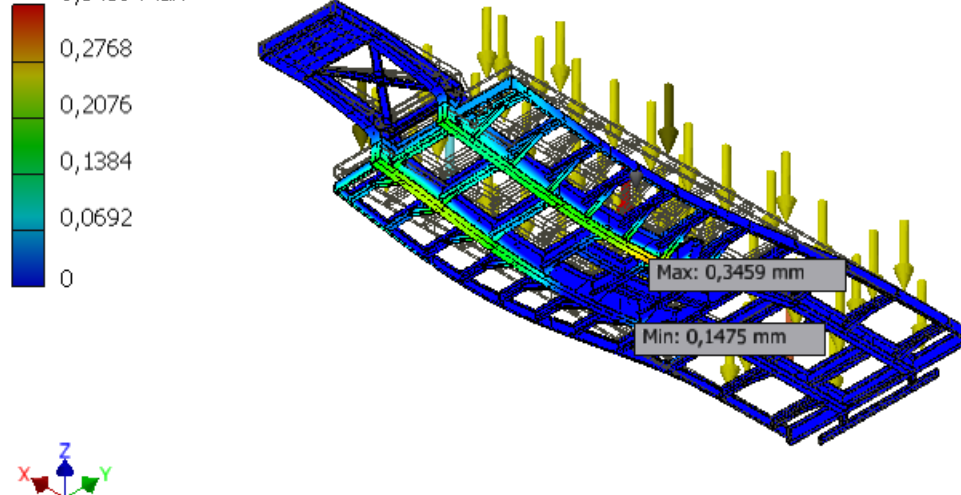


Type: Y Displacement

Unit: mm

08/11/2016, 14:16:21

0,3459 Max

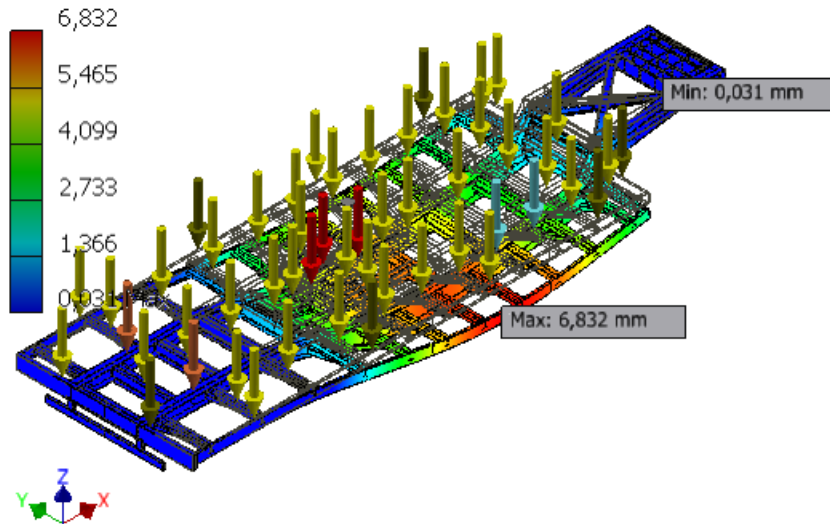


Z Displacement

Type: Z Displacement

Unit: mm

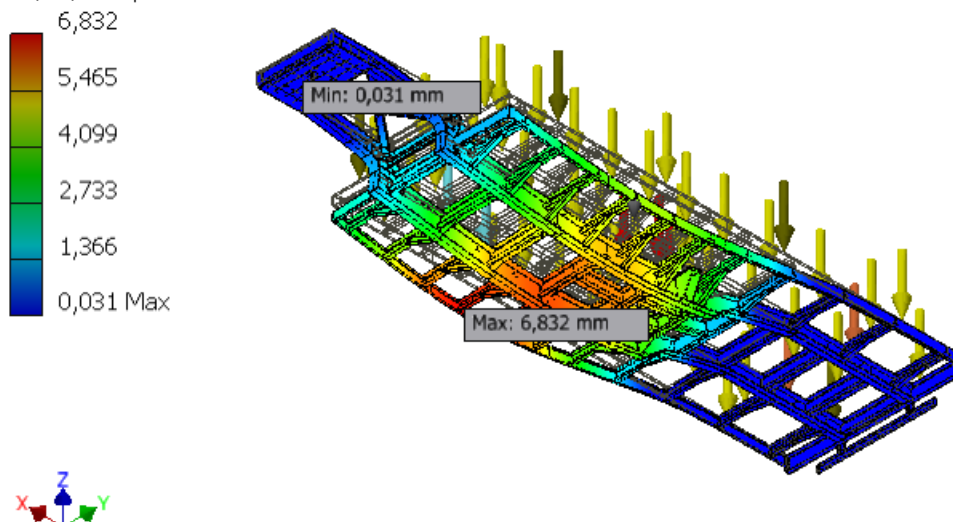
08/11/2016, 14:16:27



Type: Z Displacement

Unit: mm

08/11/2016, 14:16:27



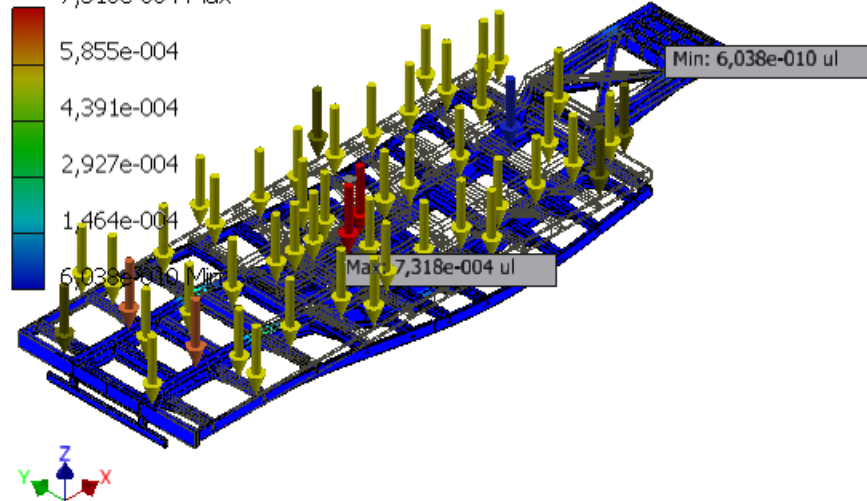
Equivalent Strain

Type: Equivalent Strain

Unit: ul

08/11/2016, 14:16:31

7,318e-004 Max

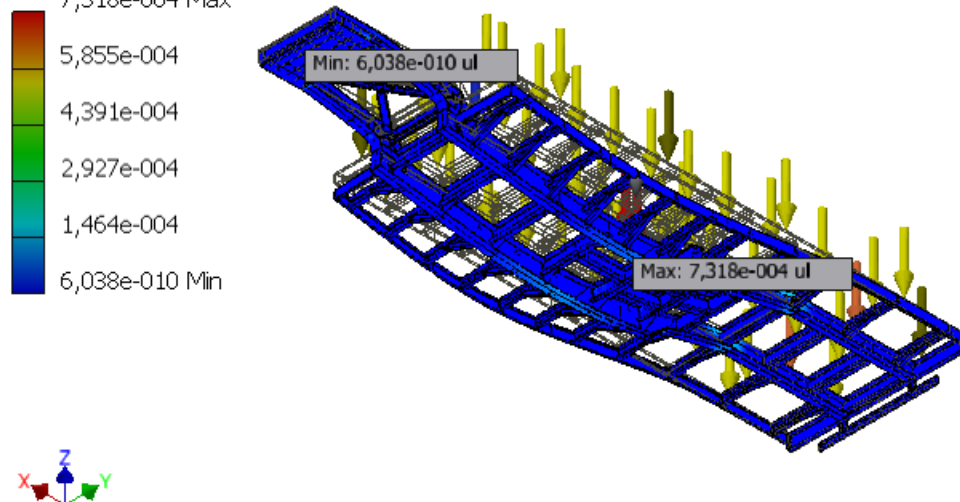


Type: Equivalent Strain

Unit: ul

08/11/2016, 14:16:31

7,318e-004 Max



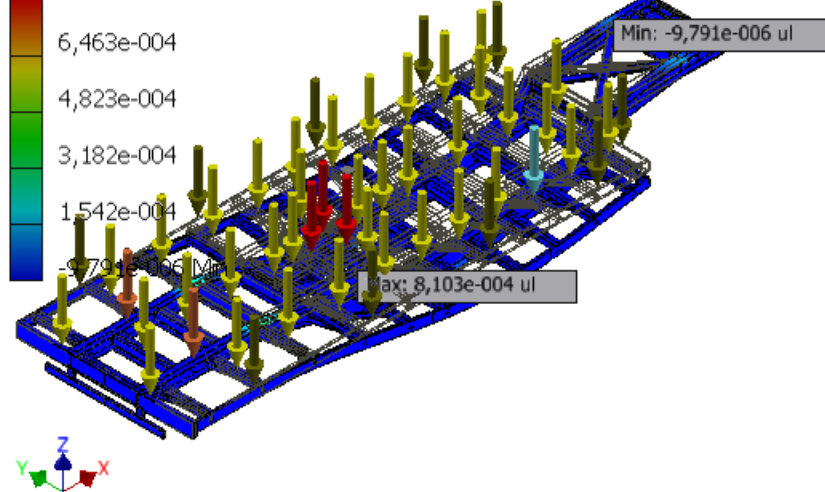
1st Principal Strain

Type: 1st Principal Strain

Unit: ul

08/11/2016, 14:16:37

8,103e-004 Max

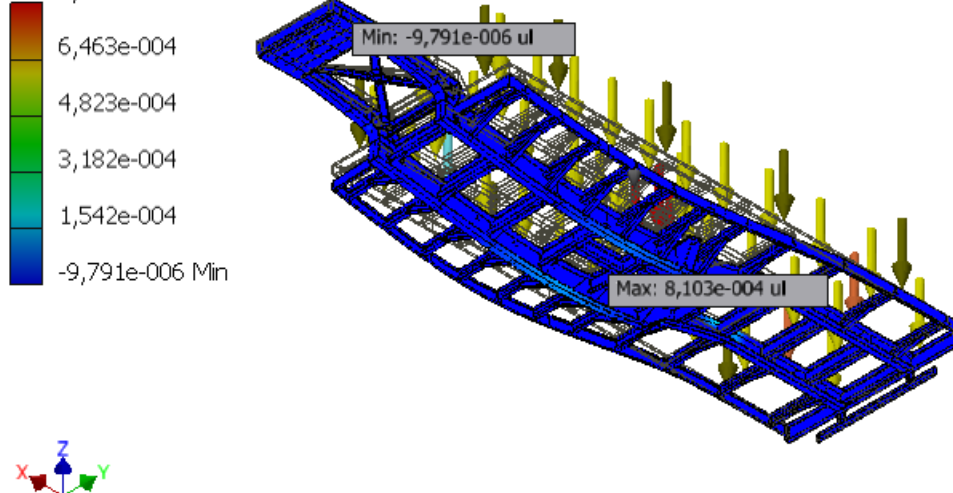


Type: 1st Principal Strain

Unit: ul

08/11/2016, 14:16:37

8,103e-004 Max



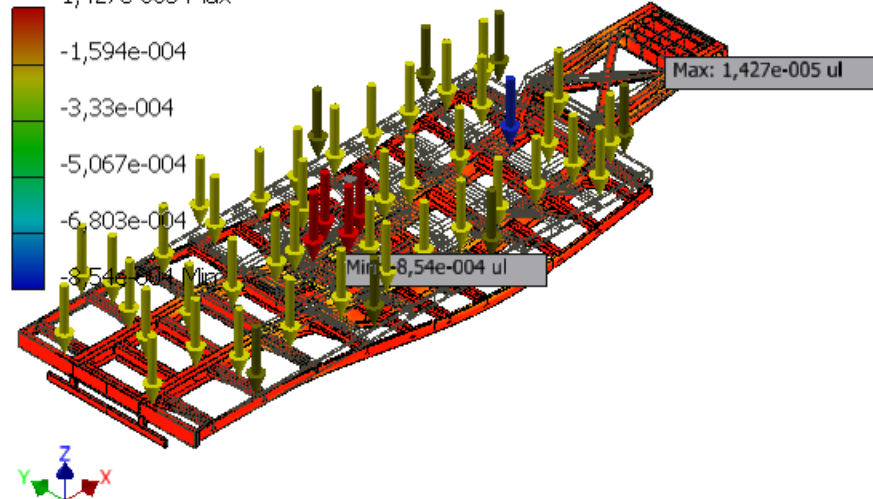
3rd Principal Strain

Type: 3rd Principal Strain

Unit: ul

08/11/2016, 14:16:41

1,427e-005 Max

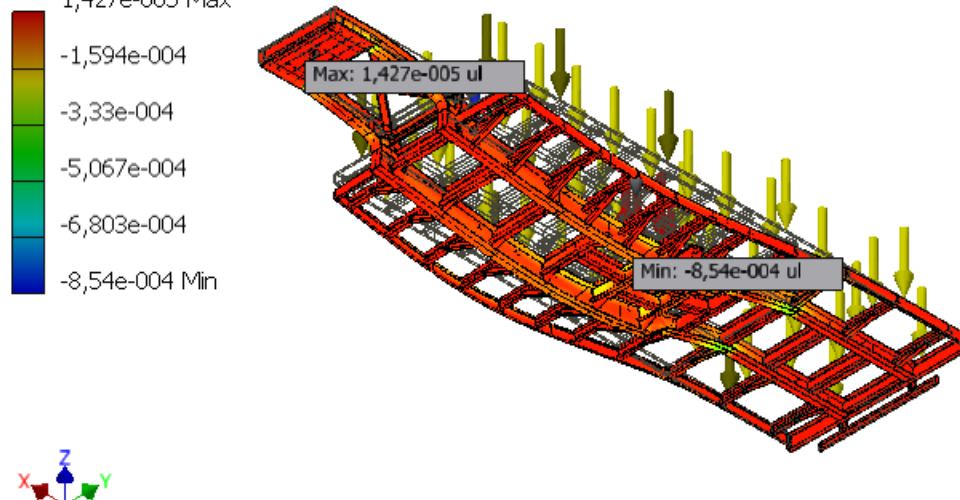


Type: 3rd Principal Strain

Unit: ul

08/11/2016, 14:16:41

1,427e-005 Max



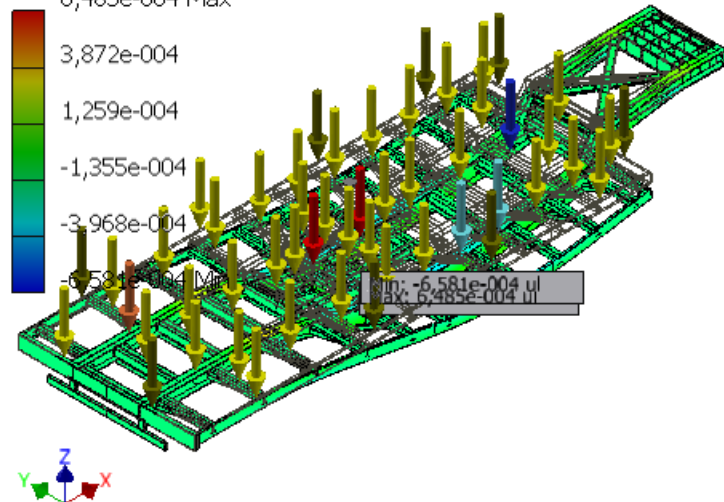
Strain XX

Type: Strain XX

Unit: ul

08/11/2016, 14:16:46

6,485e-004 Max

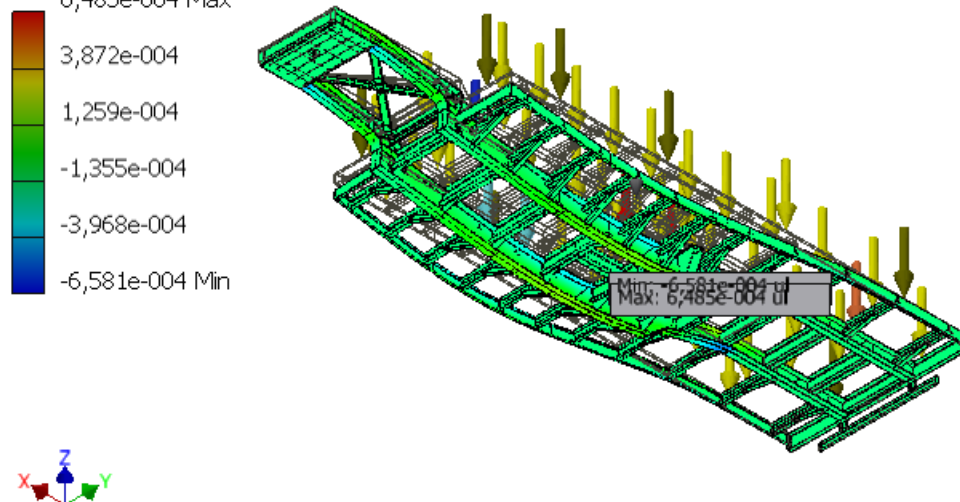


Type: Strain XX

Unit: ul

08/11/2016, 14:16:46

6,485e-004 Max



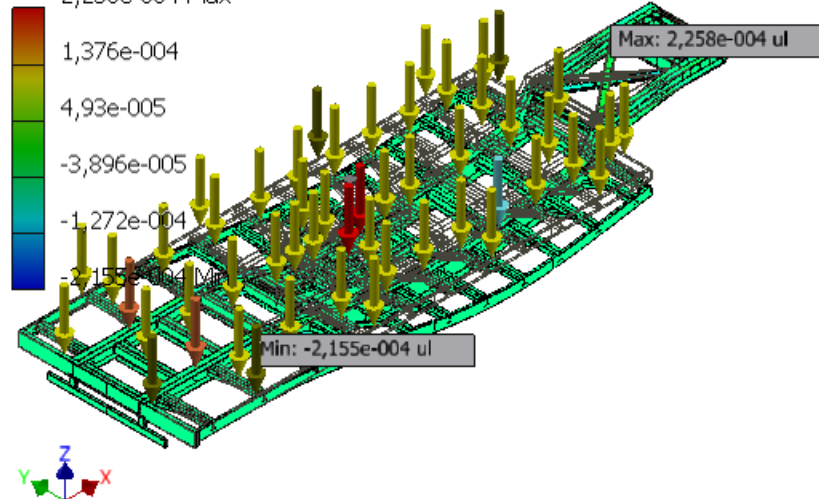
Strain XY

Type: Strain XY

Unit: ul

08/11/2016, 14:16:51

2,258e-004 Max

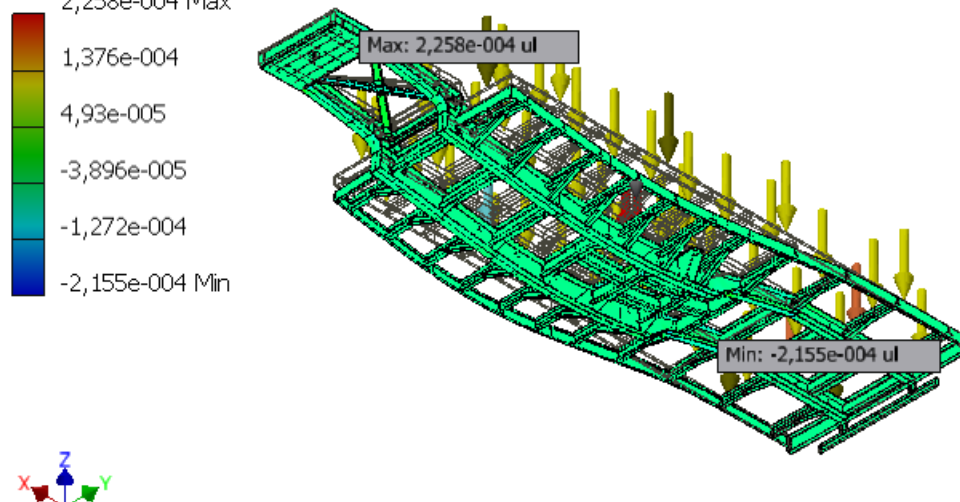


Type: Strain XY

Unit: ul

08/11/2016, 14:16:51

2,258e-004 Max



Strain XZ

Type: Strain XZ

Unit: ul

08/11/2016, 14:16:57

4,584e-004 Max

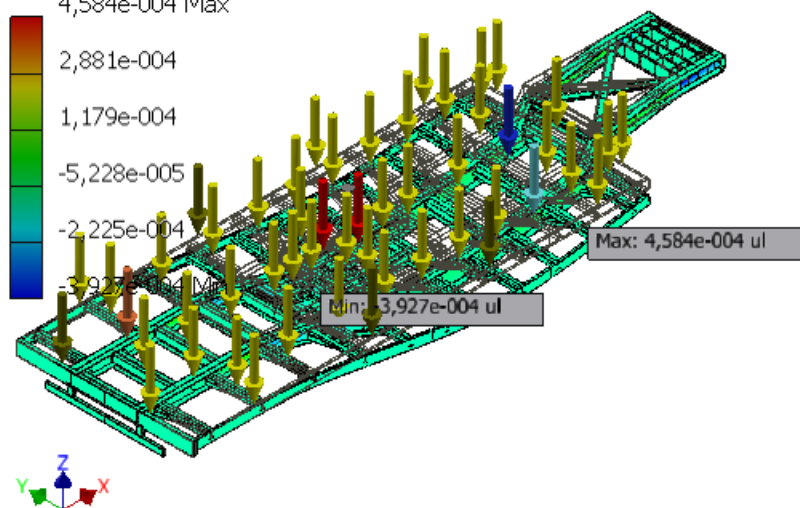
2,881e-004

1,179e-004

-5,228e-005

-2,225e-004

-3,927e-004 Min



Type: Strain XZ

Unit: ul

08/11/2016, 14:16:57

4,584e-004 Max

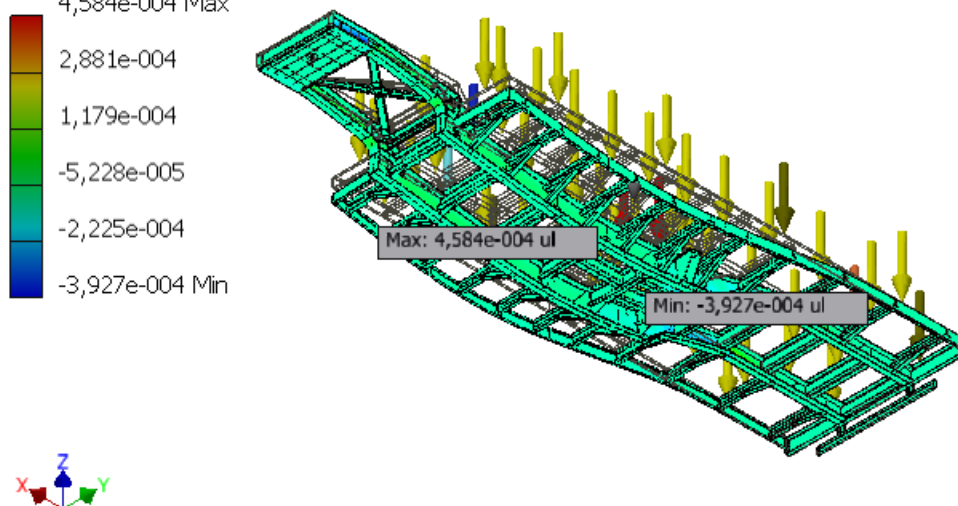
2,881e-004

1,179e-004

-5,228e-005

-2,225e-004

-3,927e-004 Min



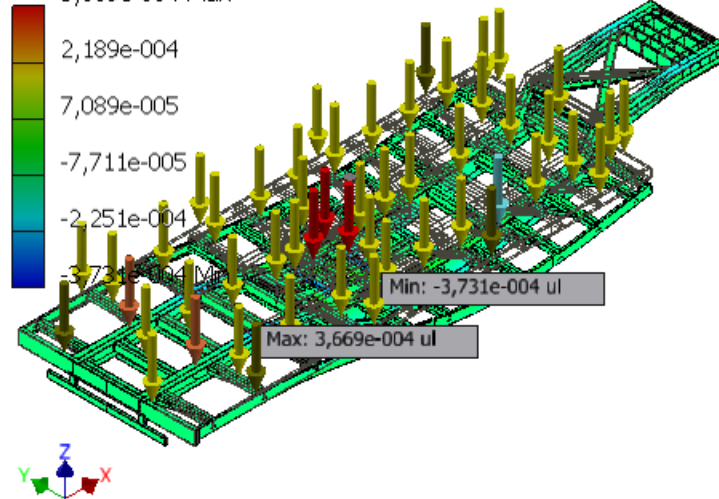
Strain YY

Type: Strain YY

Unit: ul

08/11/2016, 14:17:02

3,669e-004 Max

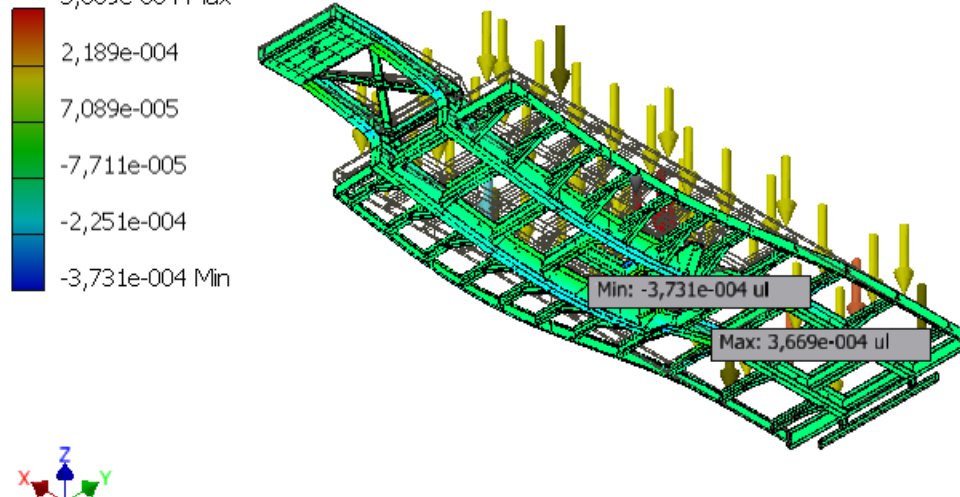


Type: Strain YY

Unit: ul

08/11/2016, 14:17:02

3,669e-004 Max



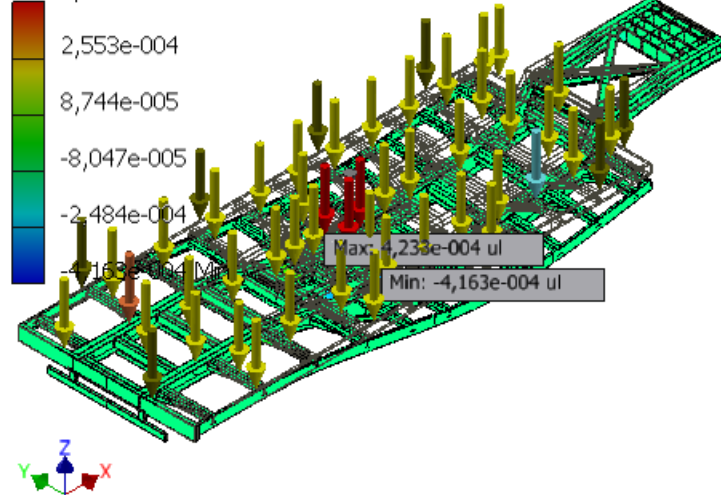
Strain YZ

Type: Strain YZ

Unit: ul

08/11/2016, 14:17:07

4,233e-004 Max

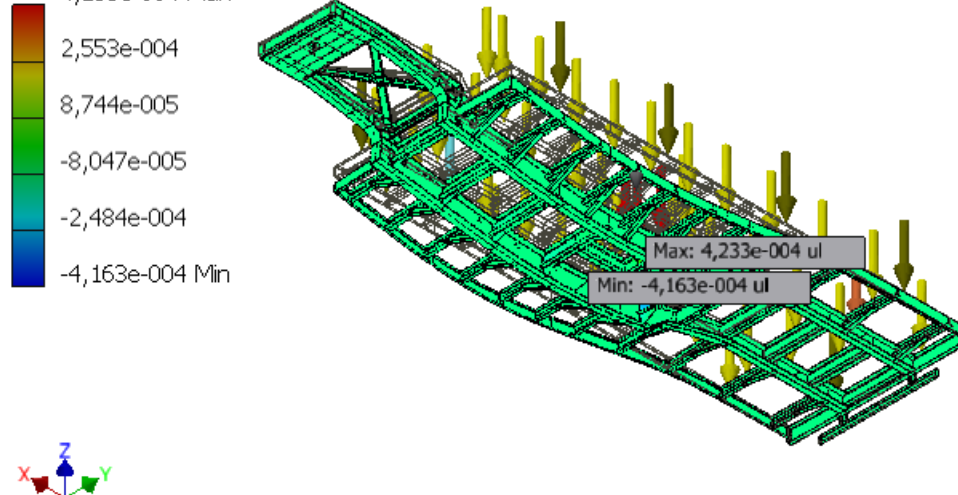


Type: Strain YZ

Unit: ul

08/11/2016, 14:17:07

4,233e-004 Max



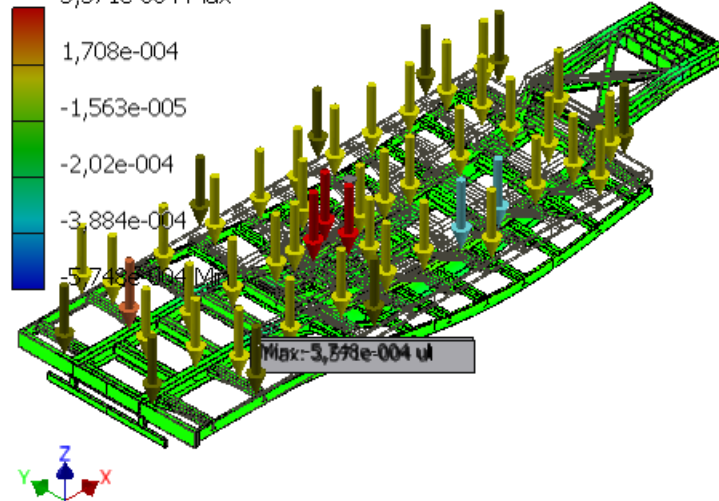
Strain ZZ

Type: Strain ZZ

Unit: ul

08/11/2016, 14:17:13

3,571e-004 Max

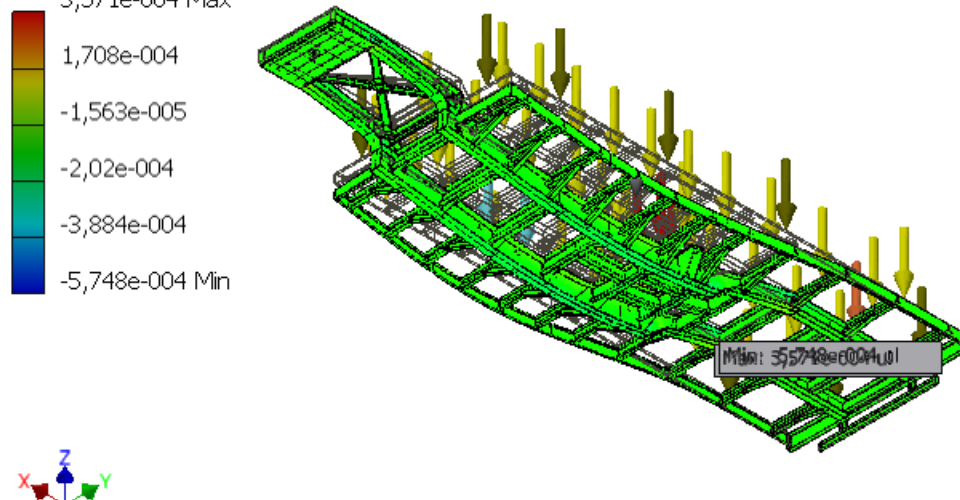


Type: Strain ZZ

Unit: ul

08/11/2016, 14:17:13

3,571e-004 Max



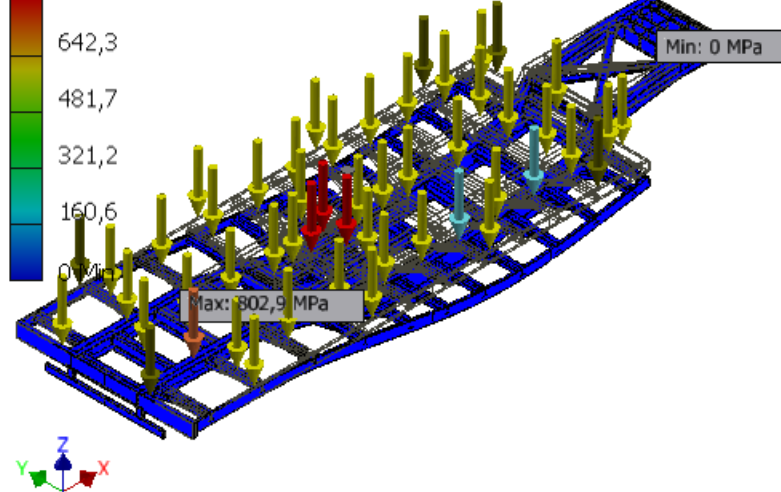
Contact Pressure

Type: Contact Pressure

Unit: MPa

08/11/2016, 14:17:18

802,9 Max

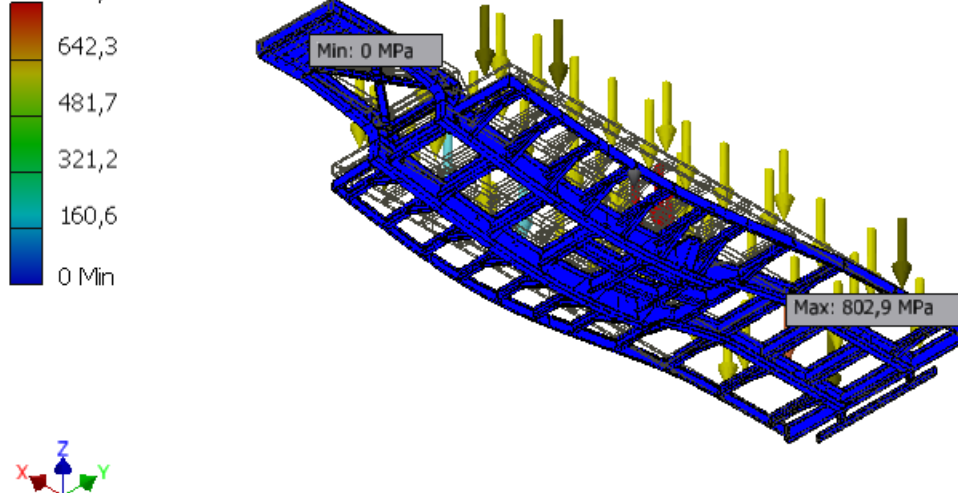


Type: Contact Pressure

Unit: MPa

08/11/2016, 14:17:18

802,9 Max



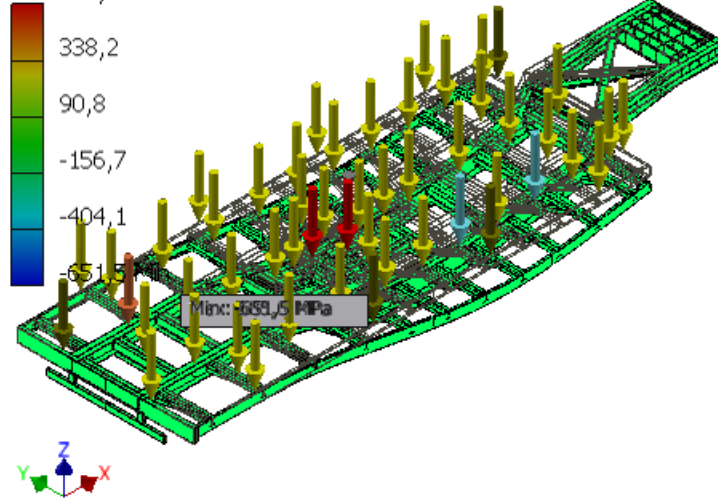
Contact Pressure X

Type: Contact Pressure X

Unit: MPa

08/11/2016, 14:17:24

585,6 Max

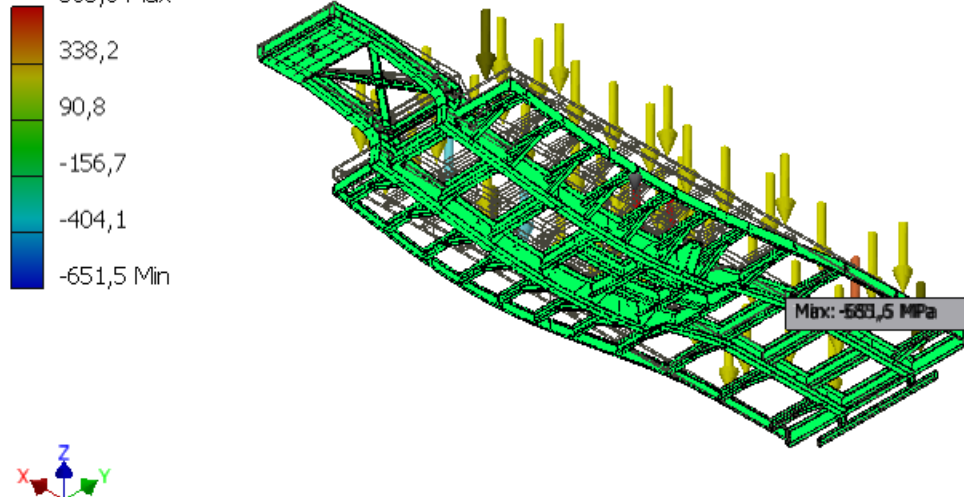


Type: Contact Pressure X

Unit: MPa

08/11/2016, 14:17:24

585,6 Max

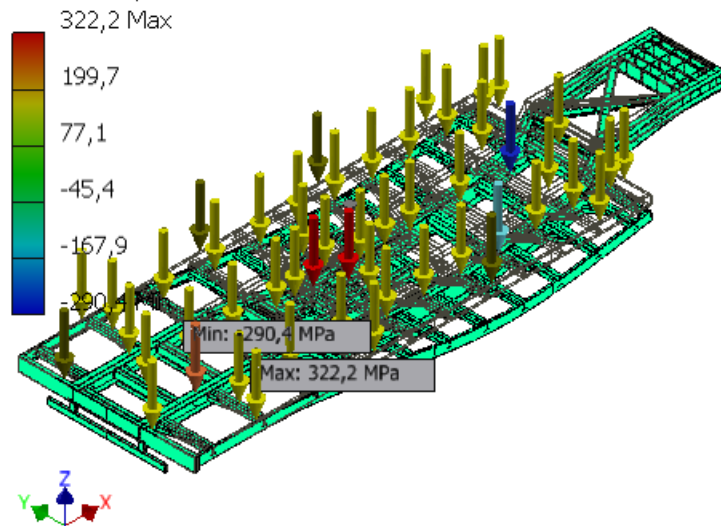


Contact Pressure Y

Type: Contact Pressure Y

Unit: MPa

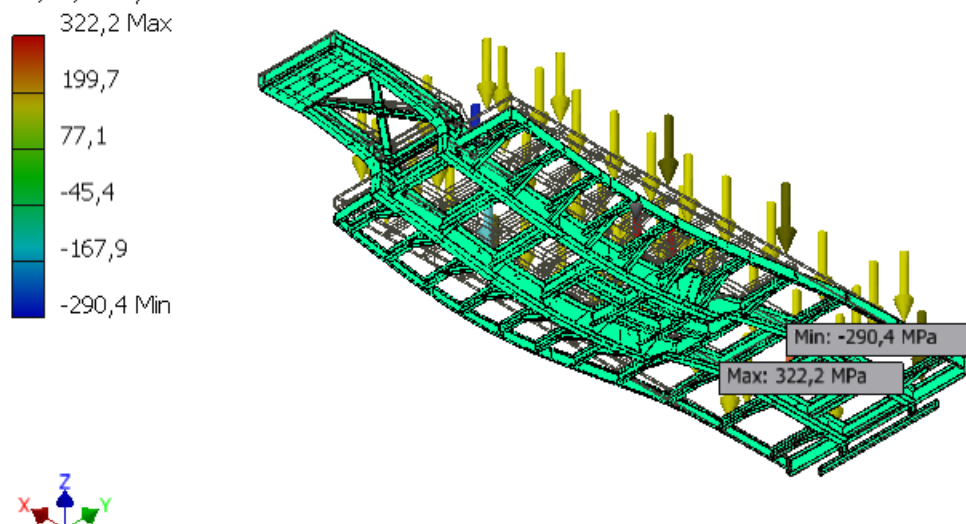
08/11/2016, 14:17:31



Type: Contact Pressure Y

Unit: MPa

08/11/2016, 14:17:31

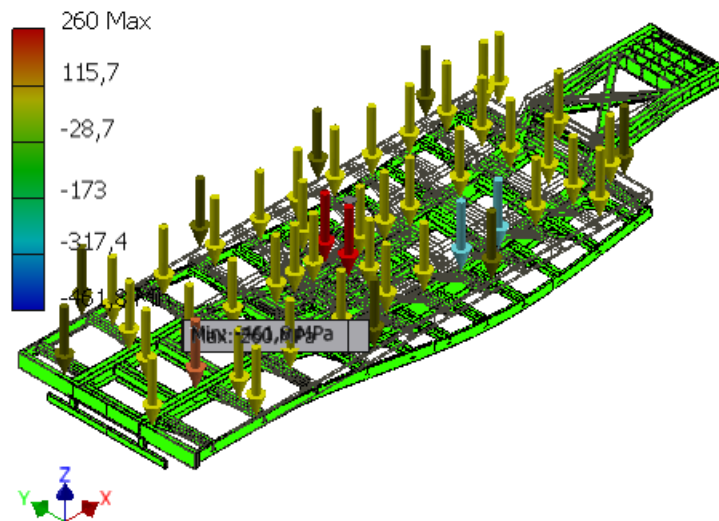


Contact Pressure Z

Type: Contact Pressure Z

Unit: MPa

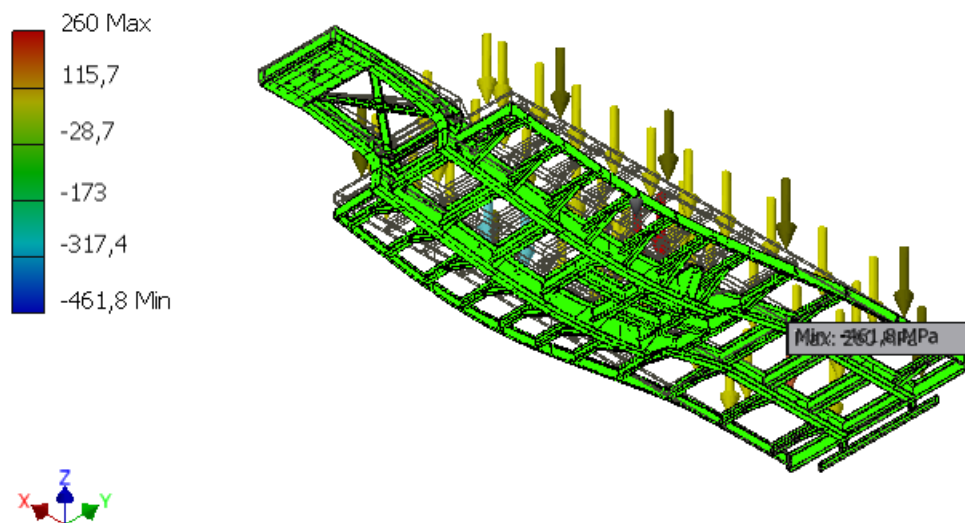
08/11/2016, 14:17:37



Type: Contact Pressure Z

Unit: MPa

08/11/2016, 14:17:37



Relación de documentos

() Memoria	94	páginas
() Anexo: Cálculos Justificativos	79	páginas
() Anexo: Planos	29	páginas
() Anexo: Planificación	16	páginas
() Anexo: Presupuesto	19	páginas
() Anexo: Pliego de Condiciones.....	17	páginas
(X) Anexo: Simulación de Esfuerzos	79	páginas
() Anexo: Hojas Técnicas	157	páginas

La Almunia, a 30 de noviembre de 2016

Firmado: Rony Moises Pinedo Cordova



Universidad
Zaragoza

**ESCUELA UNIVERSITARIA POLITÉCNICA
DE LA ALMUNIA DE DOÑA GODINA (ZARAGOZA)**

ANEXO: HOJAS TÉCNICAS

**DISEÑO SUBSTACIÓN ELECTRICA
MOVIL 66/12kV, 10MV**

Mobile Substation Design 66/12kV, 10MVA

424.13.131

Autor: Carmelo Jose Borque Horna

Director: 30-11-2016

Fecha:

Rony Moises Pinedo
Cordova

HOJAS TÉCNICAS

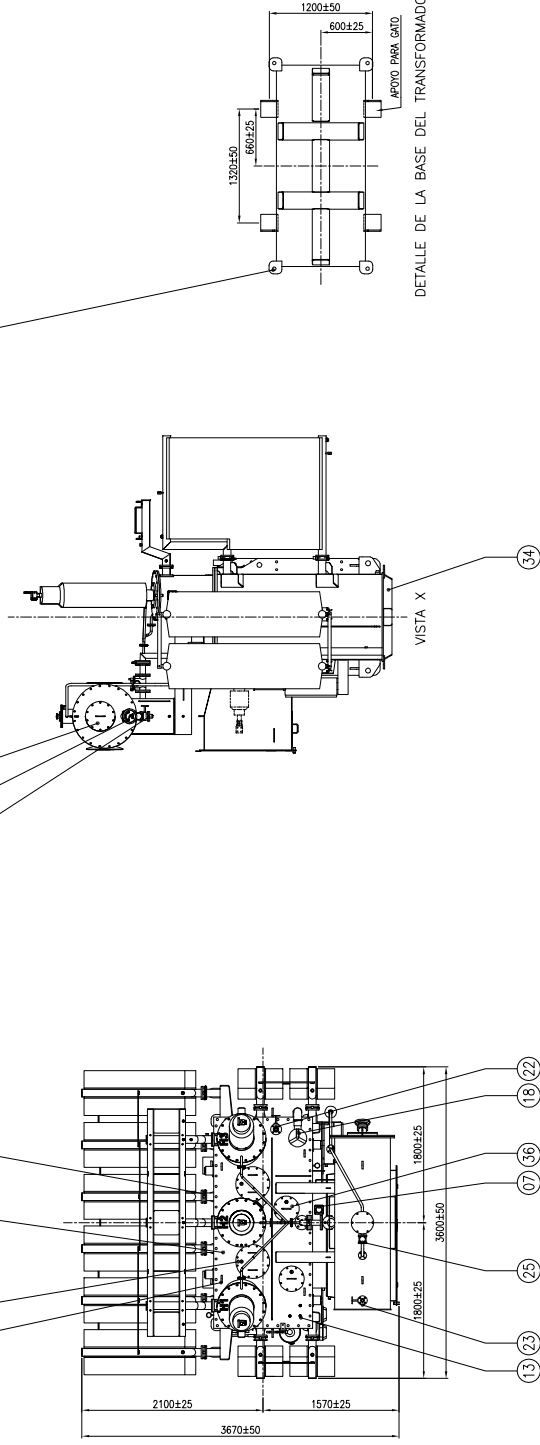
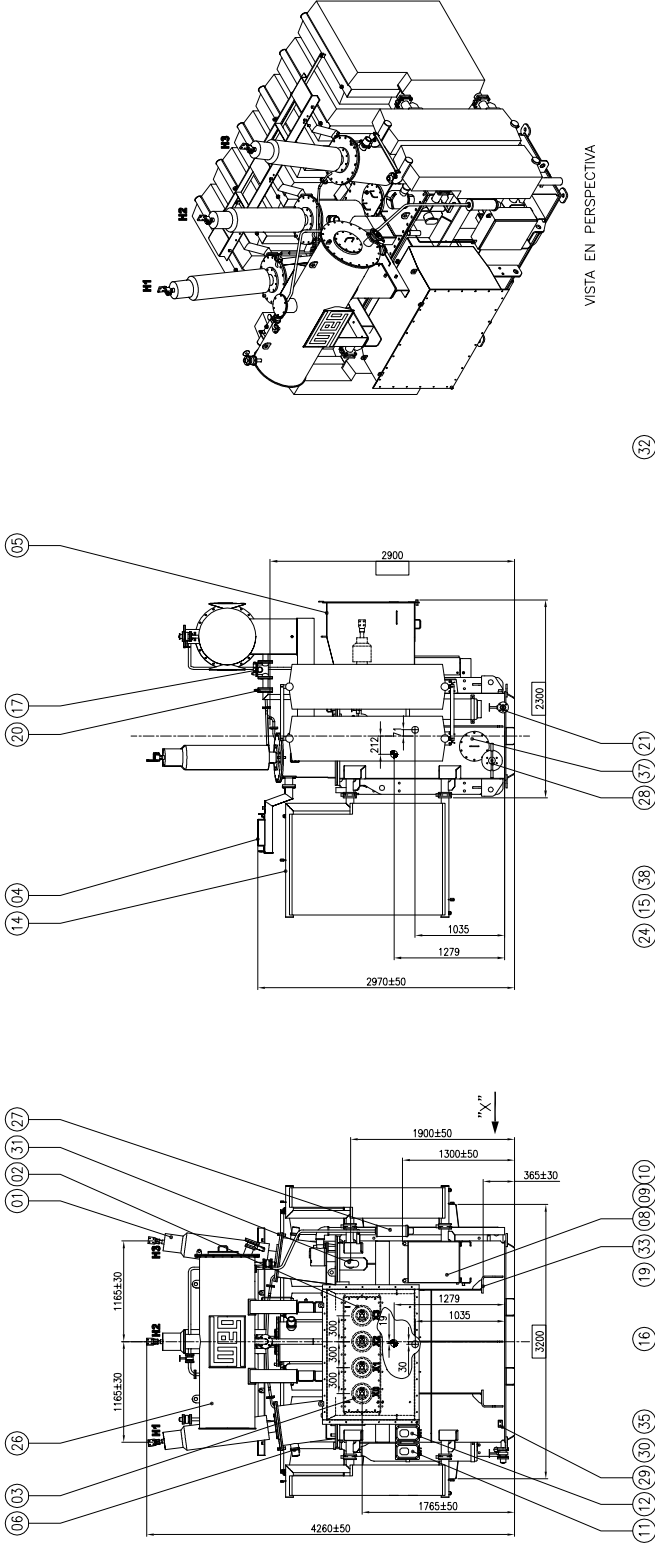
Índice de hojas técnicas

1. Transformador de potencia.	"WEG"
2. Aceite de transformador.	"Shell Diala S3 "
3. Seccionador de potencia.	"V2-C, cleveland & price"
4. Fusibles de potencia y base portafusible.	"SMD, S&C power fuses"
5. Pararrayos.	"ZSP, Joslyn"
6. Resistencia de neutro a tierra.	"Post Glover"
7. Interruptor de potencia.	"Vaccum circuit breaker"
8. Conectores de salida.	"KonNx"
9. Relé de protección de transformador.	"MIG II"
10. Relé de medición.	"ION 8650"
11. Relé de protección de alimentador.	"750/760"
12. Transformador de potencial.	"PTW5"
13. Transformadores de corriente.	"Modelo 137"
14. Transformador de corriente neutro a tierra.	"Modelo JKM-5C"
15. Transformadores de corriente neutro.	"Modelo 141"
16. Transformadores de control.	"Modelo CP3 y CPT5"
17. Fusibles de media tensión.	"Mersen"
18. Transformador de aislamiento.	"SE2N"
19. Baterías.	"KPM"
20. Cargador de baterías.	"Spectra charger SCR"
21. Monitor de fallo a tierra.	"High voltage ground monitor"
22. Capacitor de disparo.	"CTB-6"
23. Relé Switch de control.	"2441D"
24. Relé de bloqueo.	"7803D"

25. Bloque de pruebas.	"515"
26. Amperímetro	"070 series"
27. Control de amperímetro	"Electroswitch 24"
28. Voltímetro.	"070 series"
29. Control de voltímetro	"Electroswitch 24"
30. Pilotos externos	"Flashing led XLT"
31. Aisladores.	"Insulator"
32. Manga termocontraíble.	"CBTM"
33. Cable de fuerza.	"Jumper cable"
34. Shunt flexible.	"Braided Flexible conectors"
35. Cable de control.	"Anixter"
36. Patas de apoyo	"Jost"
37. Eje de camión.	"Ingersol axles"
38. Aros de camión.	"Maxion wheels"
39. King pin.	"Jost King pin"



11		PESOS APROXIMADAS (kg)	
PART. ACTIVA	7600		
CUBA Y ACCESORIOS	7620		
ACEITE ASISTENTE	5300 L		
PESO APROXIMADO MAYOR PIEZA PARA TRANSPORTAR CON ACEITE	19400		
DIMENSIONES PARA TRANSPORTE (mm)	14408		
ALTO	2900		
ANCHUR	2300		
CARGO	3200		
NOTAS			
1) EN EL CASO DE ENSAYO DE ELERACION DE TEMPERATURA NO SEAN NECESARIO, SENCILLAMENTE COMERCIAL ENTRE LAS PARTES, EL EQUIPO SEAN INSPECCIONADO SIN LOS RADADORES.			
2) EL SISTEMA DEL CABLEADO DE LOS ACCESORIOS ES NO SE ESTA UTILIZANDO TUBERIAS RIGIDAS.			
3) LAS BASES DE LOS SOPORTES DE APARTAMENTOS SERAN BARREANOS EN OBRA YA QUE NO TENEMOS DETALLES DE LOS MISMOS.			
4) C.C.C. TRANSFORMADOR PARA TRANSPORTE.			
5) C.C.C. TRANSFORMADOR MONOFASE.			
6) C.C.C. TRANSFORMADOR PARA TRANSPORTE.			

[illegible][illegible]

Shell Diala S3 ZX-I



- Extra performance
- Meets IEC 60296: high oxidation stability and low sulphur content



DESIGNED TO MEET CHALLENGES

Every part of your machine or process has been meticulously engineered, so you want to use a lubricant that has been designed to ensure that your equipment is well protected and works efficiently.

The Shell Diala range of electrical oils has been developed to enable equipment operators to select the oil that will deliver optimum value to their operations through

- **system protection**
- **long oil life**
- **system efficiency.**

Performance at a glance

	Protection	Oil life	System efficiency
Shell Diala S3 ZX-I ■ Extra performance ■ Meets IEC 60296: high oxidation stability and low sulphur content	✓✓✓✓	✓✓✓✓	✓✓✓✓
Shell Diala S2 ZU-I ■ Reliable performance ■ Meets IEC 60296	✓✓✓	✓✓✓	✓✓✓

Performance level is a relative indication only.

SHELL'S PREMIUM INHIBITED ELECTRICAL INSULATING OIL

Shell Diala S3 ZX-I is a state-of-the-art, inhibited electrical insulating oil. It is manufactured from specially refined mineral oils and has an ultra-low sulphur content and long-life characteristics.

In addition, it is widely recognised and approved by leading equipment manufacturers as being non-corrosive to copper and not requiring a copper passivator, as proved in the latest and most severe copper corrosion tests.

It also has good low-temperature properties, which are vital for efficient heat transfer inside the transformer, even at low temperatures.

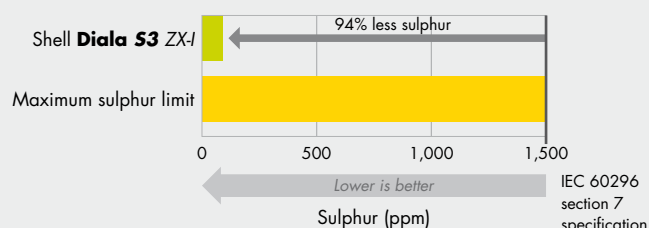
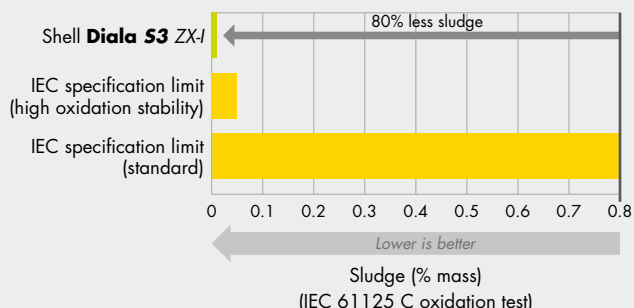
DESIGNED TO PROTECT

Protecting components from damage can help to increase service life and maximise your return on investment in equipment.

Shell Diala S3 ZX-I provides continuing transformer protection in service and is intrinsically non-corrosive owing to its low-sulphur base oil. In industry-standard tests, it typically

- **produces less than 80% of the maximum specified limit for sludge**

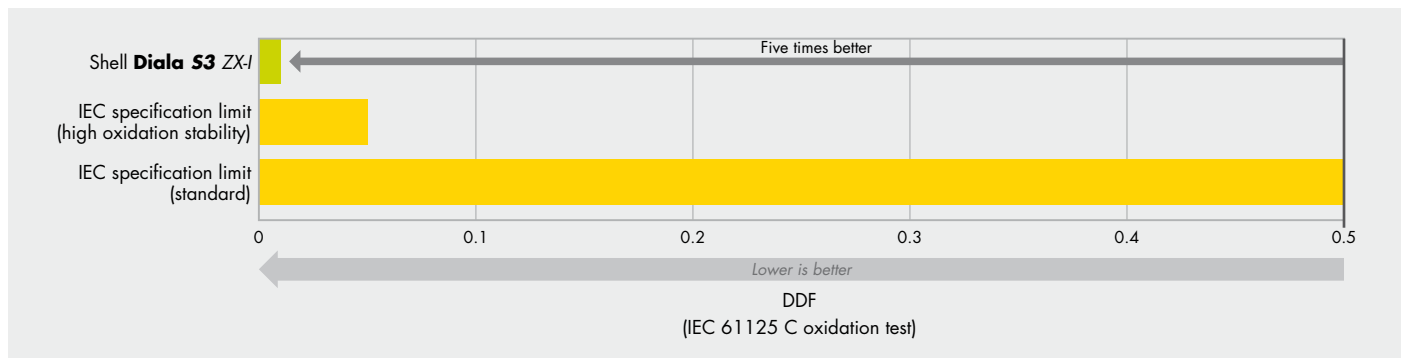
- **has less than 6% of the maximum sulphur limit.**



DESIGNED FOR LONG OIL LIFE

Inhibited oils such as Shell Diala S3 ZX-I contain small amounts of additives to inhibit oxidation and thus prolong their life. The industry-standard test for inhibited oils is 500 hours – three times longer than for uninhibited oils. In addition, Shell Diala S3 ZX-I typically has

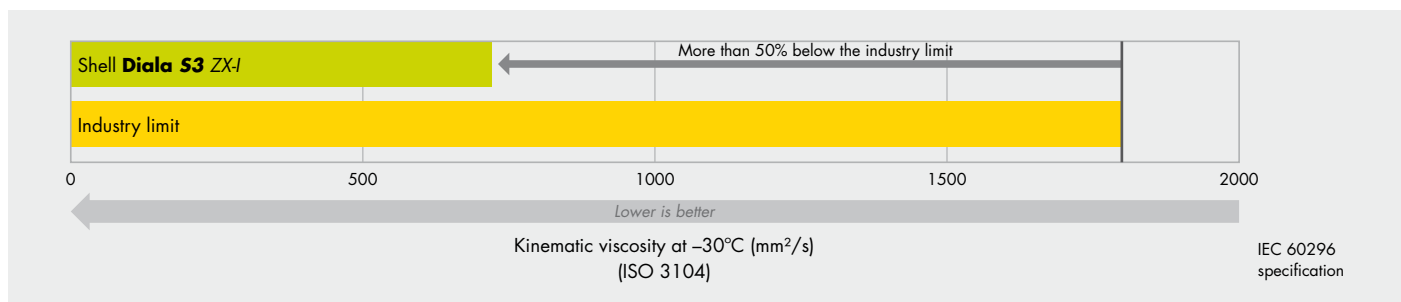
- **a dielectric dissipation factor (DDF) after the IEC test that is 20% of the permitted maximum** for the higher oxidation test according to Section 7.1 in IEC 60296.



DESIGNED FOR SYSTEM EFFICIENCY

Shell Diala S3 ZX-I is designed to help maximise effectiveness by helping equipment to meet or exceed its design capabilities. Compared with the industry minimum requirements, it offers

- **good low-temperature viscosity** to provide optimised heat transfer at low temperatures.



SPECIFICATIONS AND APPROVALS

Shell Diala S3 ZX-I meets the requirements of the key industry tests and the specifications for most equipment manufacturers and utility companies.

Meets requirements

IEC 60296 Table 2 Transformer Oil (II) (inhibited oil) Section 7.1 (higher oxidation stability)
IEC 62535
ASTM D1275B

APPLICATIONS



Preferred choice for use as an electrical insulating oil in power transmission and distribution transformers, traction transformers and shunt reactors



Suitable for use in a wide range of electrical equipment such as switchgears, circuit breakers and rectifiers

REAL-WORLD VALUE DELIVERY

Shell Diala S3 ZX-I is Shell's premium fully inhibited electrical insulating oil. It is designed to offer exceptional oxidation stability and is formulated from specially refined base oils to give an ultra-low sulphur content.

FULL PRODUCT AND SERVICE PORTFOLIO

Whatever your needs or application, we can provide a full range of oils and greases, including synthetic, high-performance products and additional services.

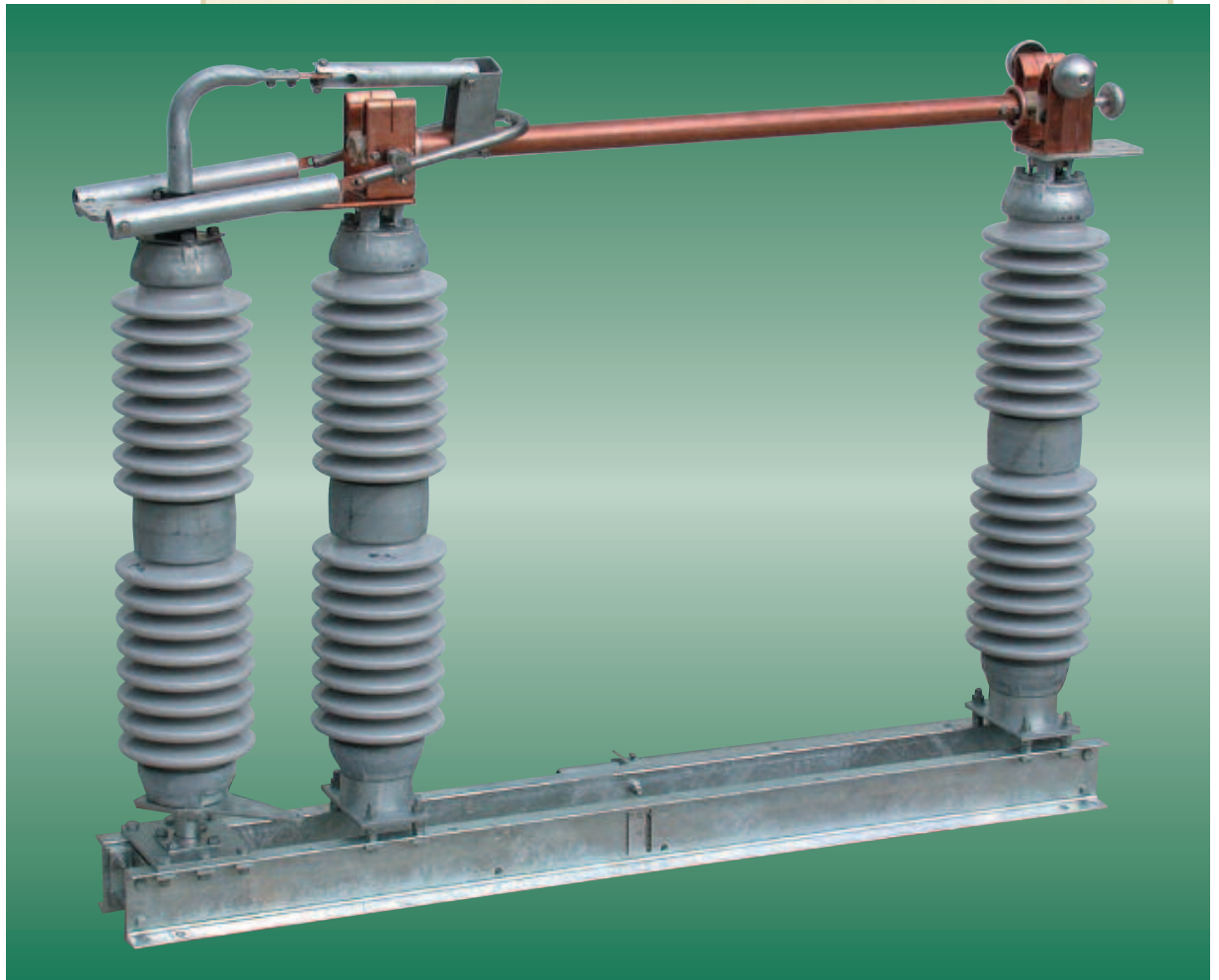
For more information, please contact

shell.com/lubricants



Type V2-C
**Copper
Vertical Break Switch**

115 - 230 kV
600 - 3000 A.



CP **CLEAVELAND/PRICE INC.**

14000 Rt. 993, Trafford, PA 15085 (724) 864-4177

FAX (724) 864-9040

E-mail: sales@cleavelandprice.com

Designed for Simplicity

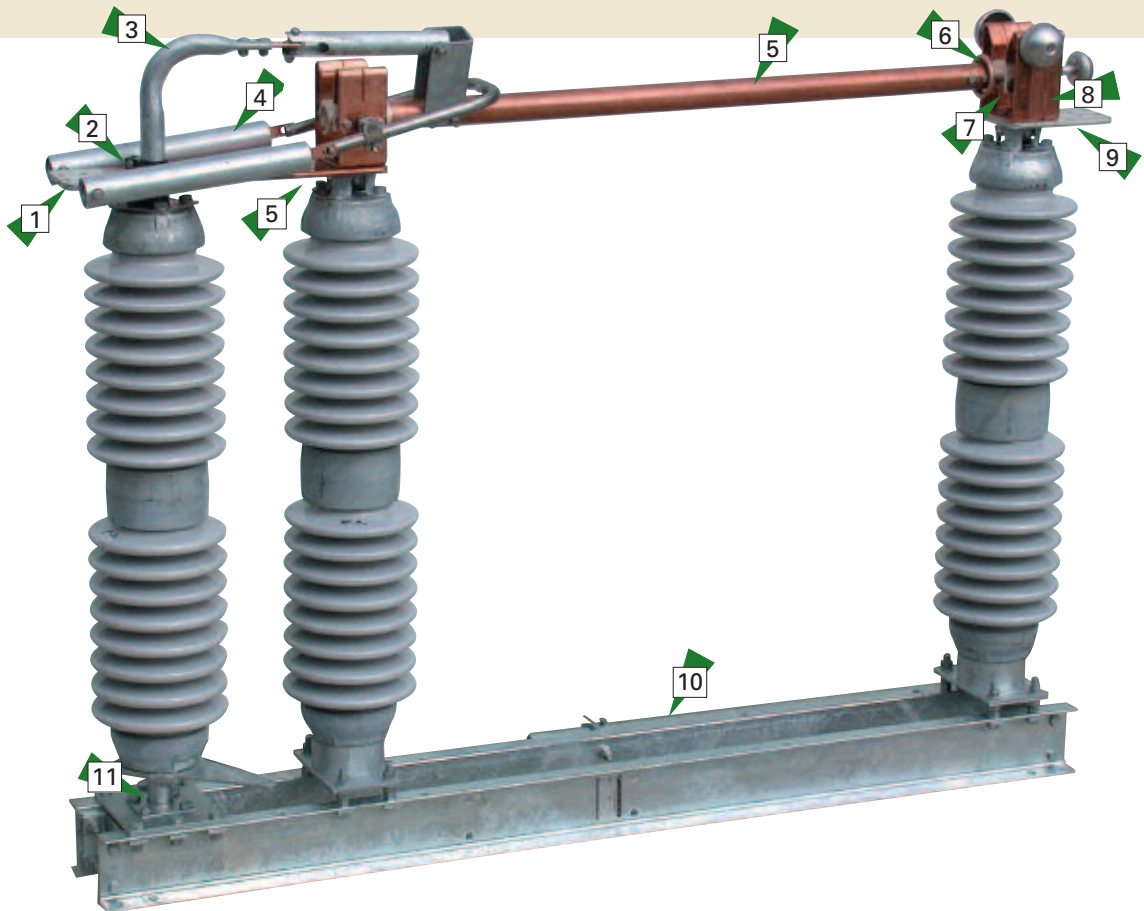
V2-C APPLICATION

The **Cleaveland/Price V2-C** is a three pole, group operated, copper vertical break switch for installation in substation or distribution line locations. The switch can be mounted in the horizontal-upright, vertical, or horizontal-underhung position. The V2-C is suitable for use in a variety of applications including line disconnecting and sectionalizing, circuit breaker by-pass and isolation, and transformer isolation.

Arc horns or quick break whips are supplied when small amounts of transformer magnetizing currents and line charging currents must be interrupted.

Accessories and options needed to adapt the switch to a customer's particular requirements are available. The V2-C may be manually operated by use of a swing handle or wormgear mechanism or electrically operated by use of a type TP-C2 motor operator.

The V2-C meets NEMA and IEEE Standards and the rating requirements of applicable IEC Standards.



- | | |
|--|--|
| 1 ➤ Unbreakable, non-cast copper terminal pads with NEMA standard hole pattern | 6 ➤ Silver-to-silver contacts at hinge and jaw |
| 2 ➤ Fully insulated journal bearing | 7 ➤ Stainless steel contact springs insulated from the current path |
| 3 ➤ Unbreakable, non-cast operating crank | 8 ➤ Hard-drawn, high conductivity copper contact fingers at hinge and jaw |
| 4 ➤ Stainless steel counterbalance springs that are insulated from the current path | 9 ➤ Plain or tin-plated terminal pads |
| 5 ➤ Hard-drawn, high conductivity copper current-carrying parts | 10 ➤ Hot-dip galvanized steel base |
| | 11 ➤ Double-sealed, maintenance-free bearing assembly |

Engineered for Performance

THE CLEAVELAND/PRICE APPROACH

Cleaveland/Price has a very basic approach to design . . . keep it simple. It is an approach that is employed from material selection to mechanical design.

The Cleaveland/Price V2-C disconnect switch current carrying parts are manufactured from high strength, high conductivity copper. All switches are of non-cast design for superior dependability of parts. Switch performance is not troubled by flaws that could occur in the casting process.

Contacts are designed to take advantage of electromagnetic forces by using a reverse loop configuration at both the hinge and jaw of the switch. Current transfer points are kept to a minimum.

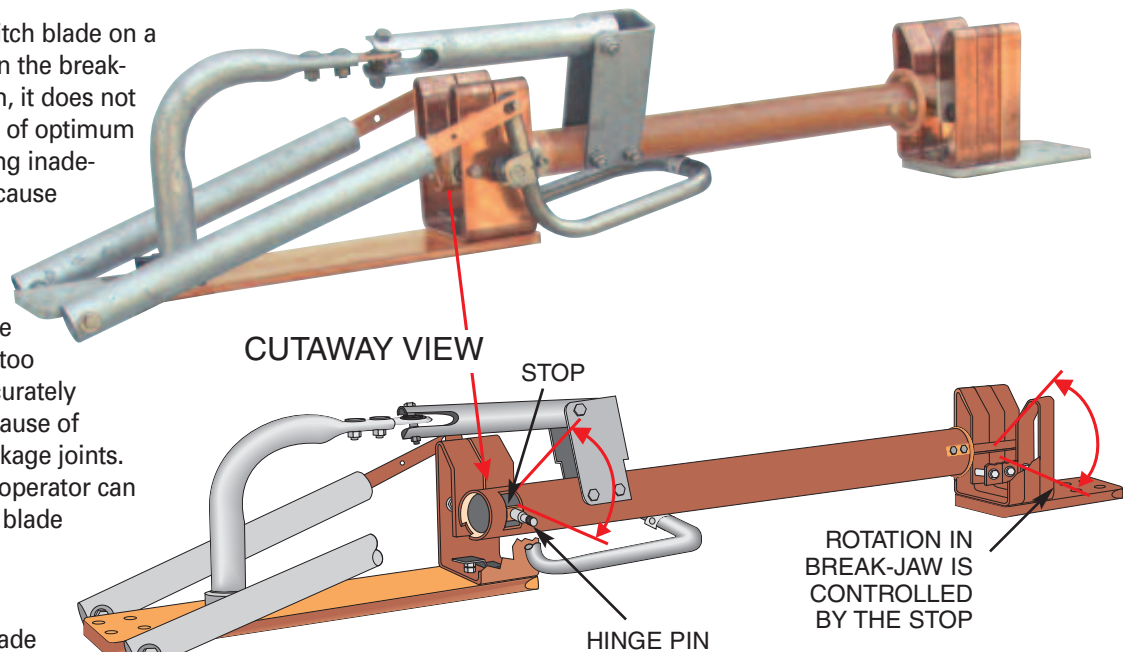
PROBLEM: When the switch blade on a conventional switch rotates in the break-jaw to the final blade position, it does not consistently stop at the point of optimum contact pressure. The resulting inadequate contact pressure may cause contact pitting and burning.

Many switches use a stop on the rotating insulator to try to set proper blade position. This type of stop is too remote from the blade to accurately control the blade motion because of the cumulative play in the linkage joints. Variation in the speed of the operator can actually affect the amount of blade turnover.

SOLUTION: On the Cleaveland/Price V2-C, the blade stop is on the blade itself instead of an intermediate linkage point (the rotating insulator). The V2-C stop location assures that blade rotation in the break-jaw will accurately and consistently stop at the point of maximum contact pressure.

The cutaway view shows how the unique Cleaveland/Price turnover stop allows the blade to rotate until the slot in the blade engages with the hinge pin. This sets the proper turnover angle.

The stop angle is factory-machined for built-in accuracy. No matter how fast or slow the blade moves, it doesn't stop moving until it has fully turned over.



CLEAVELAND/PRICE FEATURES FOR OUTSTANDING PERFORMANCE AND LONG LIFE

The V2-C is made of the finest materials for dependable, trouble-free service. Knowledge gained from maintaining switches in the field for over 60 years has played a major part in refining the V2-C. Significant design features include:

- Total non-cast copper and steel construction resulting in the superior dependability of parts
- Live parts constructed from hard-drawn, high conductivity copper producing stronger, more conductive components than parts made of cast materials
- Silver-to-silver moving contacts
- Open construction of the hinge and smooth non-cast surfaces throughout, enabling the V2-C to break ice with amazing ease
- Wiping action on both the break-jaw and hinge keeps contacts clean for years of reliable service
- Visible hinge contacts allow easy verification of contact condition without disassembly
- Reverse loop electromagnetic design at hinge and break-jaw on all ratings gives outstanding performance under fault conditions

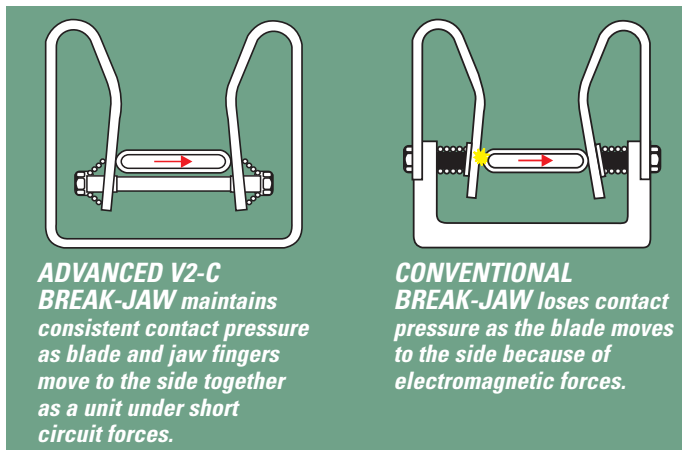
Exclusive Cleaveland/Price V2-C Features

The Cleaveland/Price V2-C is an advanced design vertical break switch with features of genuine value to the customer. It incorporates several patented improvements:

1. Positive blade turnover stop is the key to consistent and complete contact pressure to prevent contact burning.
2. Insulating journal bearing prevents current flow through the live operating linkage.
3. Floating break-jaw contacts allow blade and break-jaw fingers to move together under short circuit and seismic duty to outperform conventional contact systems.

UNIQUE BREAK-JAW DESIGN

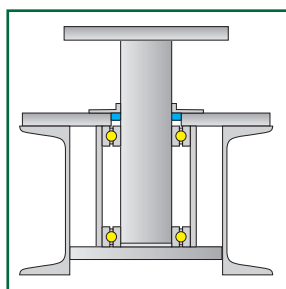
Short circuit tests prove that the V2-C break-jaw is superior to conventional break-jaws. On the V2-C, phase-to-phase electromagnetic forces that pull the blade side-to-side do not decrease the contact pressure since the fingers of the jaw are joined together to create a floating spring system that moves with the blade. Maximum contact pressure is maintained on all contact surfaces during short circuit and seismic events.



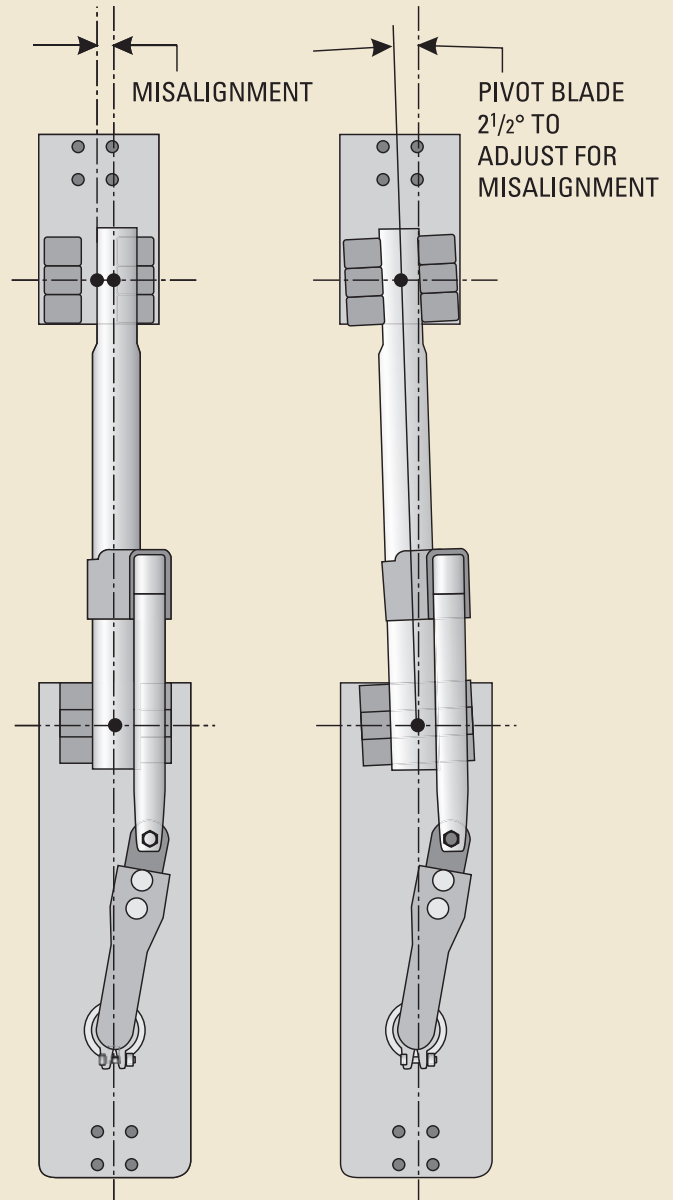
ANSI standards require that a switch pass the rated short circuit test only once. Standards also allow live parts to be changed for each test. The V2-C gives greater confidence in short circuit performance as demonstrated by 12 consecutive test shots on a 2000 amperes switch using the same set of live parts.

Superior Bearing Assembly

- High strength, non-cast, hot-dip galvanized steel shaft
- Special ozone and ultraviolet resistant seals outlast conventional seals and contain no metal parts which typically corrode
- Maintenance free, permanently lubricated construction
- Individually sealed ball bearing assemblies in sealed, grease-packed housing
- Permanently adjusted bearing



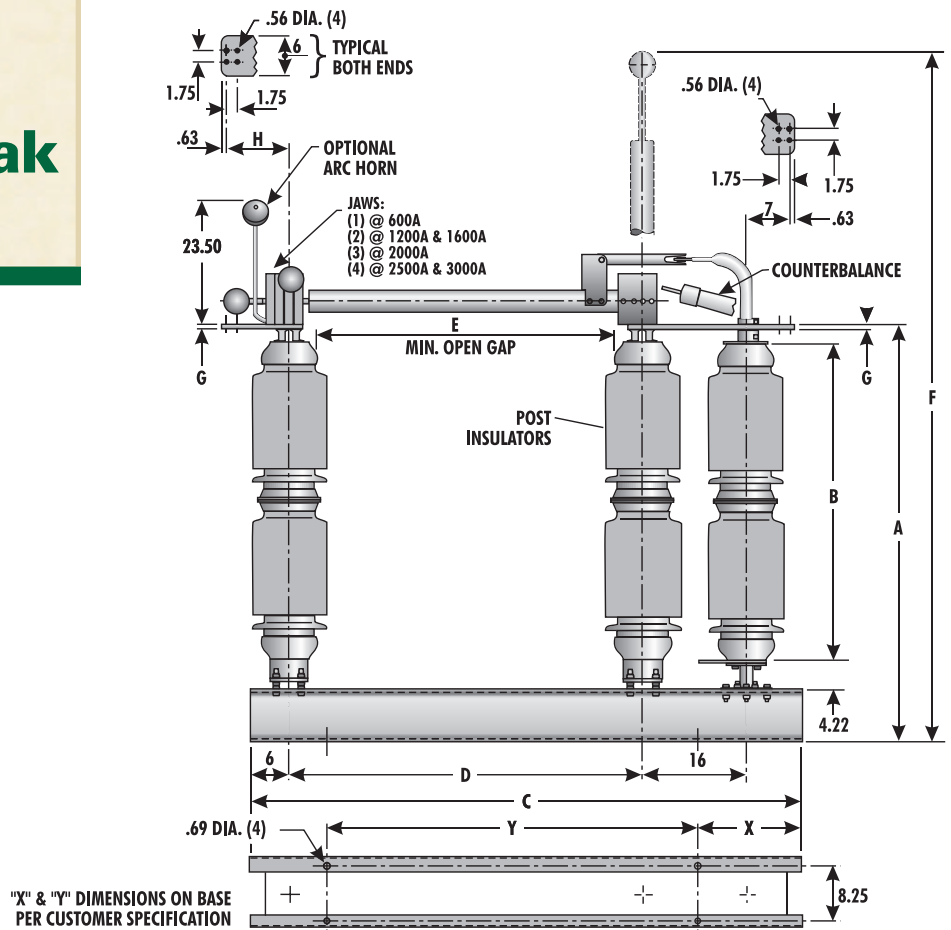
FEATURE FOR EASY ADJUSTMENT



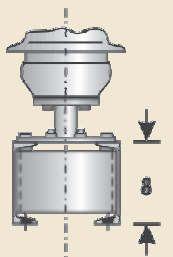
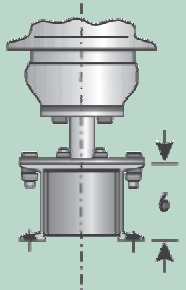
PIVOTING HINGE

During installation, the blade may be misaligned with the break-jaw, requiring adjustment of the insulators. However, it is often easier to pivot the blade to attain alignment with the jaw contact. This is particularly true when bus and ground blades have been installed at the jaw terminal and the blades are not perfectly adjusted. By loosening the bolts that attach the hinge and jaw to the stationary insulators and closing the switch, the blade and jaw automatically seat themselves in the proper alignment. Retighten the bolts and the adjustment is complete without having to realign the ground switch or bus.

Type V2-C Copper Vertical Break Switch



BASE CONFIGURATION



Nom. kV	Max. kV	kV BIL	Ins. TR#	Amp.	Mom. kA	Switch Style Number	A	B	C	D	E	F	G	H	Wt./ Pole		
115	123	550	286	600	40	C06B036G01	57.78	45	88	60	52	126.72	.50	7	915		
				1200	61	C06B036G02									928		
				1600	70	C06B036G03									937		
				2000	100	C06B036G04	128.22					10		942			
				2500	100	C06B036G05*	129.72							967			
				3000	120	C06B036G06*	58.03							129.97	.75	992	
138	145	650	288	600	40	C06B036G07	66.78	54	98	70	62	145.72	.50	7	1013		
				1200	61	C06B036G08									1025		
				1600	70	C06B036G09									1045		
				2000	100	C06B036G10	147.22					10		1050			
				2500	100	C06B036G11*	148.72							1075			
				3000	120	C06B036G12*	67.03							148.97	.75	1091	
161	170	750	291	600	40	C06B036G13	74.78	62	106	78	70	161.72	.50	7	1112		
				1200	61	C06B036G14									1125		
				1600	70	C06B036G15									1140		
				2000	100	C06B036G16	163.22					10		1145			
				2500	100	C06B036G17*	164.72							1170			
				3000	120	C06B036G18*	75.03							164.97	.75	1195	
230	242	900	304	600	40	C06B037G01	94.78	80	124.5	94	84	199.41	.50	10	1667		
				1200	61	C06B037G02									1683		
				1600	70	C06B037G03									1688		
				2000	100	C06B037G04*	200.91					10			1570		
				2500	100	C06B037G05*	95.03								202.66	.75	1609
				3000	120	C06B037G06*											
230	242	1050	312	600	40	C06B037G07*	106.78	92	144.5	114	104	231.65	.50	10	1751		
				1200	61	C06B037G08*									1770		
				1600	70	C06B037G09*									1773		
				2000	100	C06B037G10*	233.16					10			1776		
				2500	100	C06B037G11*	107.03								234.91	.75	1815
				3000	120	C06B037G12*											

* Supplied with an aluminum blade.

Operators / Accessories



Swing Handle Operator



Handcrank Operator



Motor Operator Type TP-C2

Standard Operator Features

- Swing handle or handcrank operator
- Padlock provision in both the open and closed positions
- Ground strap for vertical operating pipe
- Adjustable stops
- Clamp-on open/closed indicators
- Self-lubricating, maintenance-free outboard bearing
- 2" IPS galvanized steel vertical operating pipe
- Adjustable radius outboard bearing lever
- Threaded interphase and drive lever adjustment

Ordering Information

Furnish:

Switch type
Voltage
Amperage
Momentary rating
BIL level
Mounting position
Operator type
Accessories required
Base mounting details

Available Accessories

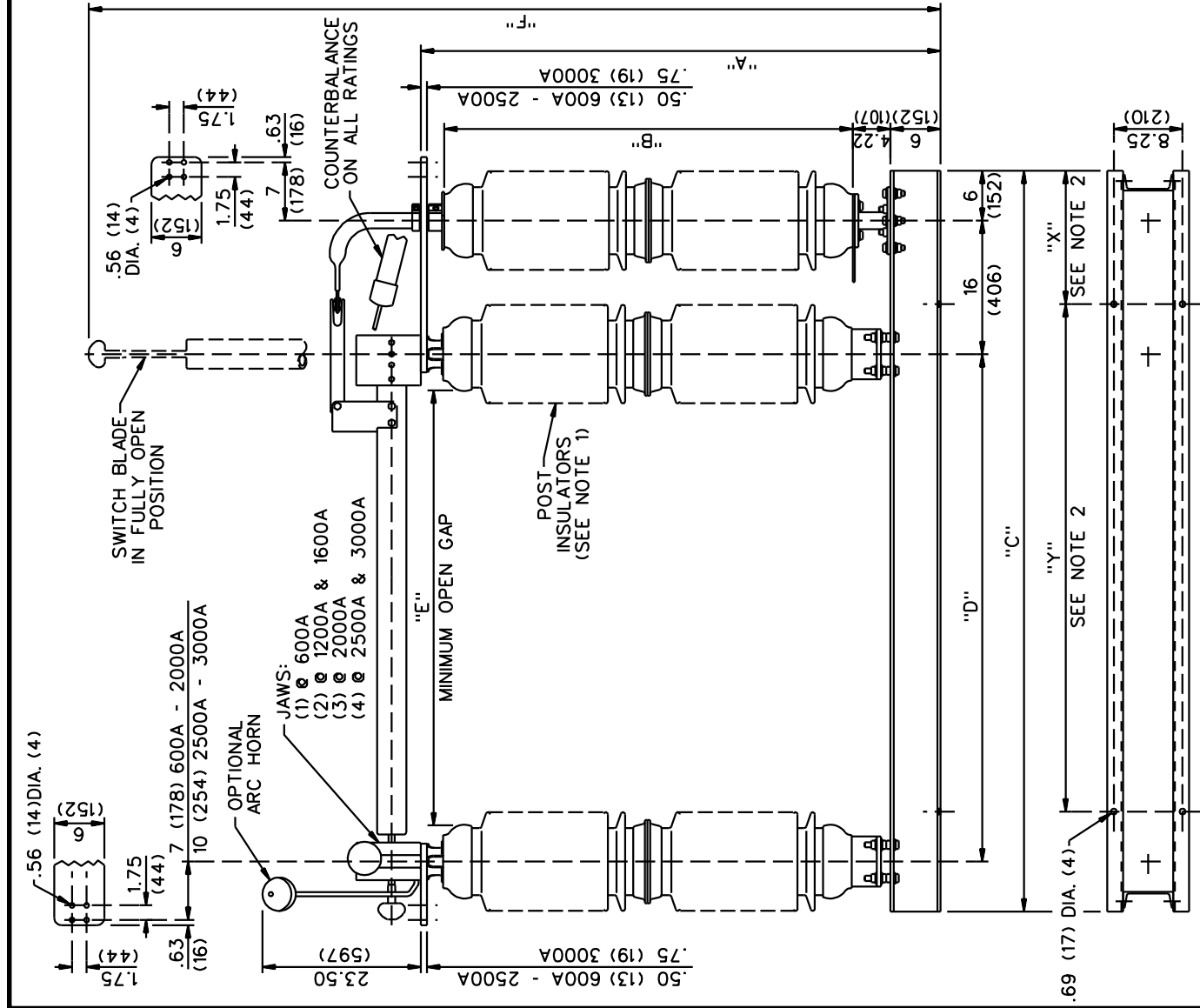
Arc horns
Auxiliary switch
Braidless ground contact
Electrical interlock
Extended operator
Ground blades
Ground blade mechanical interlock
Insulated vertical pipe
Interrupting device
Key interlock
Mounting hardware
Operator grounding platform
Outriggers
Quick break whips
Spill gaps
Terminal connectors

This brochure describes our standard product and does not show variations in design that may be available. Contact the factory for additional details.

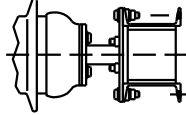
Cleveland/Price reserves the right to make changes or improvements to the product shown in this brochure without notice or obligation.

 **CLEVELAND/PRICE INC.**

14000 Route 993 • Trafford • PA 15085
Telephone (724) 864-4177 • FAX (724) 864-9040
website: www.clevelandprice.com



SWITCH STYLE NO.	RATINGS				POST INSUL NEMA TR*	DIMENSIONS IN INCHES MILLIMETERS SHOWN IN ()					WEIGHT/POLE (INCL. INSUL.)		
	NOM kV	MAX kV	kV BIL	AMPS		MOM kA	"A"	"B"	"C"	"D"	"E"	"F"	LBS.
C06B036G01				600	40							126.72 (3219)	915 (416)
C06B036G02				1200	61								928 (422)
C06B036G03				1600	70								937 (426)
C06B036G04	115	123	550	2000	100	286	57.78 (1468)	45 (1143)	88 (2235)	60 (1524)	52 (1321)	128.22 (3257)	942 (428)
☒ C06B036G05				2500	100							129.72 (3295)	967 (439)
☒ C06B036G06				3000	120		58.03 (1474)					129.97 (3301)	992 (450)
C06B036G07				600	40							145.72 (3701)	1013 (460)
C06B036G08				1200	61							1025 (466)	
C06B036G09				1600	70		66.78 (1696)	54 (1372)	98 (2489)	70 (1778)	62 (1575)	147.22 (3739)	1045 (475)
☒ C06B036G10	138	145	650	2000	100	288						1050 (477)	
C06B036G11				2500	100							148.72 (3777)	1075 (488)
☒ C06B036G12				3000	120		67.03 (1703)					148.97 (3784)	1091 (495)
C06B036G13				600	40							1112 (505)	
C06B036G14				1200	61							161.72 (4108)	1125 (511)
C06B036G15				1600	70		74.78 (1899)	62 (1575)	106 (2692)	78 (1981)	70 (1778)	1140 (518)	
☒ C06B036G16	161	170	750	2000	100	291						163.22 (4146)	1145 (520)
C06B036G17				2500	100							164.72 (4184)	1170 (531)
☒ C06B036G18				3000	120		75.03 (1906)					164.97 (4190)	1195 (542)

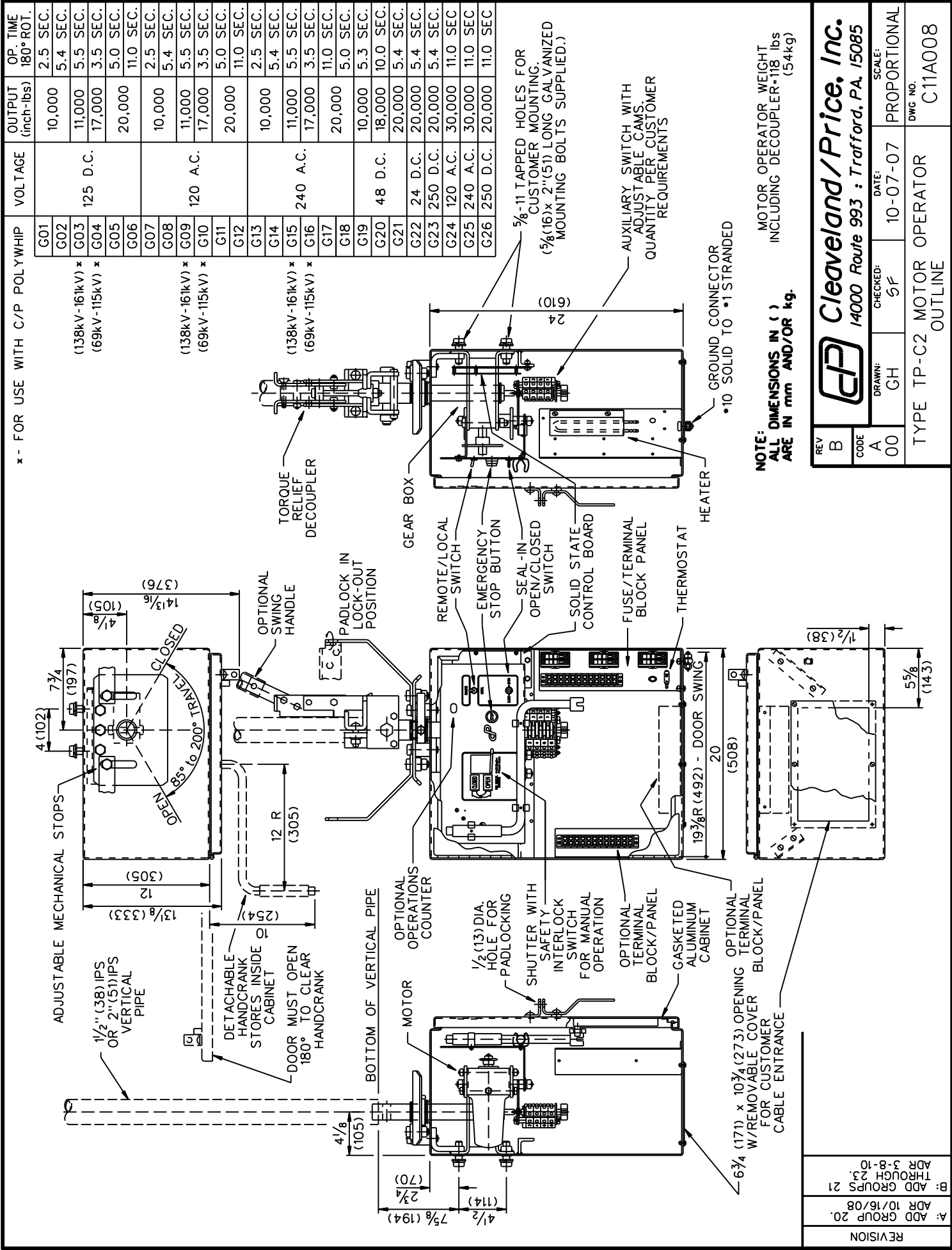


☒ - COPPER TERMINAL PADS WITH ALUMINUM BLADE

NOTES:

1. INSULATORS INVERTED FOR UNDERHUNG MOUNTING. (SEE NOTE 6)
2. CUSTOMER TO SUPPLY "X" & "Y" DIMENSIONS.
3. ALL DIMENSIONS ARE IN INCHES.
4. DIMENSIONS IN () ARE IN mm.
5. WEIGHTS IN () ARE IN KG.
6. SWITCH STYLE NUMBERS SHOWN WITH ☒, ARE NOT AVAILABLE IN UNDERHUNG MOUNTING CONFIGURATION.

REV B		CODE A		DRAWING MJG		CHECKED DP		DATE 08/15/2001		DISTRIBUTION 001		SCALE PROPORTIONAL	
Cleaveland/Price, Inc. 1400 Route 993 : Trafford, PA. 15085												C06B036 V2-C COPPER VERTICAL BREAK DISCONNECT SWITCH 115kV-161kV; 600A-3000A	
REVISION A- ADDED ASTERISK FOR UNDERHUNG C/BALANCE CH 01-04-02 B - UPDATE MAX KV LAB 9/13/04													



REV	B	Cleaveland/Price, Inc. 14000 Route 993 : Trafford, PA. 15085				SCALE:	PROPORTIONAL
		CODE	DRAWN:	CHECKED:	DATE:		
	A	00	GH	5F	10-07-07		DWG NO.
TYPE TP-C2 MOTOR OPERATOR OUTLINE							C11A008

REVISION		A: ADD GROUP 20. ADR 10/16/08	B: ADD GROUPS 21 THROUGH 23. ADR 3-8-10
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S&C Power Fuses★

Types SMD-1A, SMD-2B, SMD-2C, SMD-3, and SMD-50

Outdoor Distribution (34.5 kV through 138 kV)

Specifications

Conditions of Sale

STANDARD: Seller's standard conditions of sale set forth in Price Sheet 150 apply.

SPECIAL TO THIS PRODUCT:

INCLUSIONS: Complete SMD® mountings and live parts include fuse-unit end fittings.

EXCLUSIONS: Complete mountings and live parts do not include fuse units.

Complete mountings and live parts do not include connectors. Various connectors are available as listed in the table on page 10. Specify quantity and catalog numbers of connectors desired.

SPECIFICATION NOTE: Gray station post insulators are standard for all mounting styles. When mountings are to be provided with special insulators, consult your nearest S&C Sales Office for availability.

Mountings can be supplied less insulators. Add suffix “-Z1” to the catalog number obtained from the tables on pages 2 and 3. Mountings (except Right-Angle Style and those rated 69 kV) of a given voltage rating can be provided with insulators of the next *higher* voltage rating—add suffix “-Z3” to the catalog number. In instances where insulators of the next higher voltage rating have different bolt-circle dimensions, adapters are required; consult your nearest S&C Sales Office for availability.

Mountings can be supplied less bases, but including insulators—add suffix “-Z4” to the catalog number.

Mountings and live parts (except SMD-50 Mountings and Live Parts and Upright Style SMD-2B Mountings and Live Parts rated 115 kV and 138 kV) can be supplied with tin-plated terminal pads. To specify, add suffix “-Z5” to the catalog number.

PACKING NOTE: Mountings rated 46 kV or less are shipped assembled with insulators. Higher rated mountings are shipped disassembled.

MAINTENANCE: Unlike relay-actuated protective devices such as circuit breakers and reclosers, power fuses have maintenance-free time-current characteristics and require only minimal physical maintenance—such as periodic checking of the condition of the fuse-unit bore and occasional refinishing of fuse tubes exposed to severe weathering. Checking the condition of the fuse-unit bore can easily be done in the field for SMD-1A, SMD-2B, and SMD-2C Fuse Units using the S&C Airflow Test Instrument. SMD-50 and SMD-3 Fuse Units are not suitable for airflow testing, but can be returned to S&C for disassembly and inspection, for a nominal charge. Refer to the tables entitled, “MAINTENANCE SUPPLIES” and “INSPECTION EQUIPMENT AND SERVICES” on page 11.

How to Order a Complete Power Fuse

1. Obtain the catalog number of the desired mounting from the “Complete Mounting” column on pages 2 through 5. If only live parts are desired, obtain catalog number from the “Live Parts” column.
2. Obtain the catalog number of the applicable fuse unit from the tables on pages 6 through 9, taking care to match the type and voltage rating of the fuse unit to that of the mounting. **Note:** If spare fuse-unit end fittings are required, refer to the selection table on page 12.
3. Obtain the catalog number of connectors from the table on page 10. Order two connectors for each mounting or set of live parts.

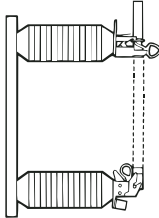
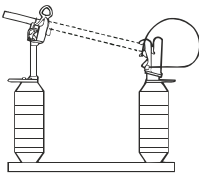
How to Order Handling Tools

Obtain the catalog number(s) of recommended handling tool(s) from the table on page 11. Refer to Specification Bulletin 851-31.

★ S&C Type SMD Power Fuses are manufactured in accordance with a quality system certified to ISO 9001:2000, and they are Rural Utilities Service (RUS) accepted.



MOUNTINGS—Less Connectors^①

Style	For Fuse Unit	Rating					Catalog Number			Page Reference for Dimensional Information
		kV			Amperes, RMS Symmetrical		Insulator T.R. No.	Complete Mounting (including Live Parts)	Live Parts (including End Fittings)	
		Nom.	Max	BIL	Max	Inter-rupting ^②				
Vertical 180° Opening^③ 	SMD-50	34.5	38	200	100E	6 700	210	86534R3	3500R2	18
		46	48.3	250	100E	5 000	214	86535R3		
		69	72.5	350	100E	3 350	216	86536R3		
	SMD-1A	34.5	38	200	200E	17 500	210	186704R1	3700R3	19
		46	48.3	250	200E	13 100	214	186705R1		
		69	72.5	350	200E	8 750	216	186706R1		
	SMD-2C	34.5	38	200	300E	33 500	210	186924R1	3600R1	19
		46	48.3	250	300E	31 500	214	186925R1		
		69	72.5	350	300E	17 500	216	186926R1		
	SMD-2B	69	72.5	350	300E	17 500	216	186926R1	3600R1	19
115		121	550	250E	10 500	286	186518	3980	20	
138		145	650	250E	8 750	288	186519			
138	145	750	250E	8 750	291	186619				
SMD-3	69	72.5	350	300E	25 000	216	192086	3610	19	
Vertical 45° Opening	SMD-2B	115	121	550	250E	10 500	286	186428R3	3900R3	20
		138	145	650	250E	8 750	288	186829R3		
		138	145	750	250E	8 750	291	186429R3		
Upright 	SMD-1A	34.5	38	200	200E	17 500	210	186724R1	3974■	21
		46	48.3	250	200E	13 100	214	186725R1	3975■	
		69	72.5	350	200E	8 750	216	186726R1	3976■	
	SMD-2C	34.5	38	200	300E	33 500	210	186994R1	3994★	21
		46	48.3	250	300E	31 500	214	186995R1	3995★	
		69	72.5	350	300E	17 500	216	186996R1	3996★	
	SMD-2B	69	72.5	350	300E	17 500	216	186996R1	3996★	21
		115	121	550	250E	10 500	286	186498R3	3948R3▲	22
		138	145	650	250E	8 750	288	186899R3	3949R3▲	
	138	145	750	250E	8 750	291	186499R3	3949R3▲		
SMD-3	69	72.5	350	300E	25 000	216	192096	3656◆	21	

① For available connectors, refer to page 10.

② Symmetrical ratings assigned are based on available short-circuit current at locations where the X/R ratio is 15. The interrupting ratings expressed in amperes, RMS, asymmetrical are 1.6 times the symmetrical ratings listed. Higher symmetrical ratings have been determined for these fuses applied at lower system voltages and in locations where X/R = 10 and X/R = 5. These higher ratings as well as asymmetrical ratings are given in S&C Descriptive Bulletin 212-30.

③ Vertical 180° Opening Style Mountings (except SMD-50) are available with a hook to accommodate the obsolete S&C SMD Fuse Hoist. To specify mountings so equipped, add Suffix “-H” to the catalog number of the mounting selected.

■ Where the hinge-end portions of the live parts are to be mounted on transformer bushings, specify Catalog Number 3744R1, 3745R1, or 3746R1, rated 34.5, 46, and 69 kV respectively. For information on bushing mounting of fuses, see S&C Information Sheet 212-450.

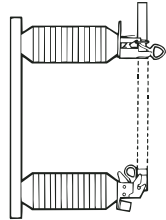
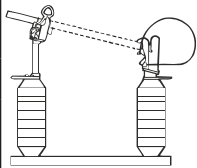
★ Where the hinge-end portions of the live parts are to be mounted on transformer bushings, specify Catalog Number 3644R1, 3645R1, or 3646R1, rated 34.5, 46, and 69 kV respectively. **Note:** For such applications the interrupting duty must be limited to 16,700, 12,500, or 8,400 amperes three-phase symmetrical at 34.5 kV, 46 kV, and 69 kV, respectively. For more information on bushing mounting of fuses, see S&C Information Sheet 212-450.

▲ Not recommended for mounting on transformer bushings; however, when absolutely required, the main-contact-end portions of the live parts must be mounted on the transformer bushings and the interrupting duty must be limited to 5,000 or 4,200 amperes three-phase symmetrical at 115 kV and 138 kV, respectively. For more information on bushing mounting of fuses, see S&C Information Sheet 212-450.

◆ Not recommended for mounting on transformer bushings.

TABLE CONTINUED ►

MOUNTINGS WITH SILICONE-HOUSED COMPOSITE POLYMER OR CYPOXY® INSULATORS—Less Connectors^①

Style	For Fuse Unit	Rating					Complete Mounting (Including Live Parts)				Page Reference for Dimensional Information
		kV			Amperes, RMS Symmetrical		Insulator T.R. No.③	Catalog Number with Silicone-Housed Composite Polymer Insulators	Catalog Number with Cypoxy® Insulators	Live Parts (including End Fittings)	
		Nom.	Max	BIL	Max	Inter-rupting②					
Vertical 180° Opening④ 	SMD-50	34.5	38	200	100E	6 700	210	86534R3-P	86534R3-E	3500R2	20
		46	48.3	250	100E	5 000	214	86535R3-P	86535R3-E		
		69	72.5	350	100E	3 350	216	86536R3-P	—		
	SMD-1A	34.5	38	200	200E	17 500	210	186704R1-P	186704R1-E	3700R3	21
		46	48.3	250	200E	13 100	214	186705R1-P	186705R1-E		
	69	72.5	350	200E	8 750	216	186706R1-P	—			
	SMD-2C	34.5	38	200	300E	33 500	210	186924R1-P	—	3600R1	21
46		48.3	250	300E	31 500	214	186925R1-P	186925R1-E			
69		72.5	350	300E	17 500	216	186926R1-P	—			
SMD-2B	69	72.5	350	300E	17 500	216	186926R1-P	—	3600R1	21	
	115	121	550	250E	10 500	286	186518-P	—	3980	22	
	138	145	650	250E	8 750	288	186519-P	—			
138	145	750	250E	8 750	291	186619-P	—				
SMD-3	69	72.5	350	300E	25 000	216	192086-P	—	3610	21	
Vertical 45° Opening	SMD-2B	115	121	550	250E	10 500	286	186428R3-P	—	3900R3	22
		138	145	650	250E	8 750	288	186829R3-P	—		
		138	145	750	250E	8 750	291	186429R3-P	—		
Upright 	SMD-1A	34.5	38	200	200E	17 500	210	186724R1-P	186724R1-E	3974■	23
		46	48.3	250	200E	13 100	214	186725R1-P	186725R1-E		
		69	72.5	350	200E	8 750	216	186726R1-P	—		
	SMD-2C	34.5	38	200	300E	33 500	210	186994R1-P	—	3994★ 3995★	23
		46	48.3	250	300E	31 500	214	186995R1-P	186995R1-E		
	69	72.5	350	300E	17 500	216	186996R1-P	—	3996★	23	
	SMD-2B	115	121	550	250E	10 500	286	186498R3-P	—	3948R3▲	24
138		145	650	250E	8 750	288	186899R3-P	—			
138		145	750	250E	8 750	291	186499R3-P	—			
SMD-3	69	72.5	350	300E	25 000	216	192096-P	—	3656◆	23	

① For available connectors, refer to page 10.

② Symmetrical ratings assigned are based on available short-circuit current at locations where the X/R ratio is 15. The interrupting ratings expressed in amperes, RMS, asymmetrical are 1.6 times the symmetrical ratings listed. Higher symmetrical ratings have been determined for these fuses applied at lower system voltages and in locations where X/R = 10 and X/R = 5. These higher ratings as well as asymmetrical ratings are given in S&C Descriptive Bulletin 212-30.

③ T.R. No. shown is from corresponding mounting having porcelain station post insulators.

④ Vertical 180° Opening Style Mountings (except SMD-50) are available with a hook to accommodate the obsolete S&C SMD Fuse Hoist. To specify mountings so equipped, add Suffix “-H” to the catalog number of the mounting selected.

■ Where the hinge-end portions of the live parts are to be mounted on transformer bushings, specify Catalog Number 3744R1, 3745R1, or 3746R1, rated 34.5, 46, and 69 kV respectively. For information on bushing mounting of fuses, see S&C Information Sheet 212-450.

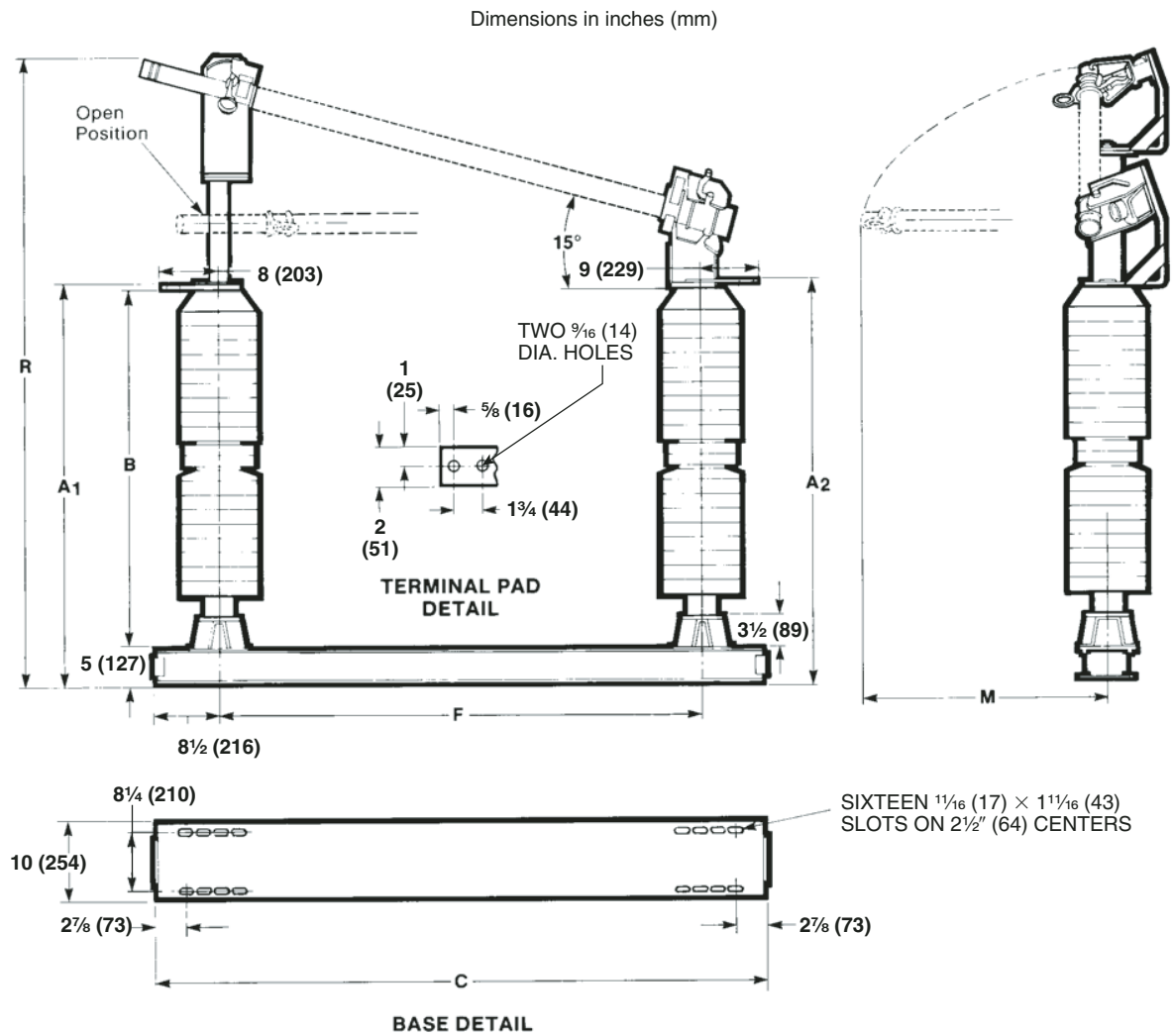
★ Where the hinge-end portions of the live parts are to be mounted on transformer bushings, specify Catalog Number 3644R1, 3645R1, or 3646R1, rated 34.5, 46, and 69 kV respectively. **Note:** For such applications the interrupting duty must be limited to 16,700, 12,500, or 8,400 amperes three-phase symmetrical at 34.5 kV, 46 kV, and 69 kV, respectively. For more information on bushing mounting of fuses, see S&C Information Sheet 212-450.

▲ Not recommended for mounting on transformer bushings; however, when absolutely required, the main-contact-end portions of the live parts must be mounted on the transformer bushings and the interrupting duty must be limited to 5,000 or 4,200 amperes three-phase symmetrical at 115 kV and 138 kV, respectively. For more information on bushing mounting of fuses, see S&C Information Sheet 212-450.

◆ Not recommended for mounting on transformer bushings.

TABLE CONTINUED ►

Upright Style
SMD-2B
115 and 138 kV



Rating			Catalog Number Complete Mounting (including Live Parts)	Dimensions in Inches (mm)							Net Wt., Lbs. (Kg.) ①	
kV				A ₁	A ₂	B	C	F	M	R		
Nom.	Max	BIL										
115	121	550	250E	186498R3, 186498R3-P	53 ⁷ / ₈ (1368)	54 ³ / ₈ (1381)	48 ¹ / ₂ (1232)	76 ³ / ₄ (1949)	59 ³ / ₄ (1518)	26 ¹ / ₈ (664)	81 ⁵ / ₈ (2073)	600 (272)
138	145	650	250E	186899R3, 186899R3-P	62 ⁷ / ₈ (1597)	63 ³ / ₈ (1610)	57 ¹ / ₂ (1461)	84 ³ / ₄ (2153)	67 ³ / ₄ (1721)	34 ¹ / ₈ (870)	92 ⁵ / ₈ (2353)	655 (297)
138	145	750	250E	186499R3, 186499R3-P	70 ⁷ / ₈ (1800)	71 ³ / ₈ (1813)	65 ¹ / ₂ (1664)	84 ³ / ₄ (2153)	67 ³ / ₄ (1721)	34 ¹ / ₈ (870)	100 ⁵ / ₈ (2556)	715 (324)

① Weights shown apply to mountings furnished with porcelain insulators. Mountings furnished with polymer or Cyproxy insulators weigh less.

Pararrayos Poliméricos de Pedestal

Tipo “ZSP”

Rango de 3kV a 192kV

El tipo de pararrayos de pedestal “ZSP” ofrece las ventajas proporcionadas por las cubiertas de polímero para sistemas con voltajes hasta 192kV. Los pararrayos “ZSP” pesan aproximadamente un 25% del peso equivalente de uno de porcelana. El manejo y la instalación se convierten en tareas mucho más fáciles. Se reduce también el riesgo de daño a la cubierta en comparación con el de porcelana.

Diseño

El diseño consiste en un número de válvulas de óxido de metal contenidas dentro de un envoltorio de fibra de vidrio que luego es recubierta con un polímero. El tipo pararrayos “ZSP” se despacha como unidades individuales en todos los rangos desde 3kV hasta 192kV. No hay necesidad de combinar secciones, incluso para el rango de 192kV. Los elementos de la válvula de óxido de metal combinan excelentes características de protección con el funcionamiento regular del pararrayos para maximizar la protección durante muchos años de servicio.

Corriente de Falla no Disruptiva

La severidad de una falla depende de la duración y de la magnitud de la corriente de falla que está siendo conducida a través del pararrayos en el momento de la falla. El tipo de pararrayos “ZSP” con su cubierta de polímero elimina el peligro potencial de la fragmentación de la porcelana. El diseño “ZSP” utiliza un envoltorio de fibra de vidrio epóxica de alta resistencia para aliviar la presión existente durante una falla. Los pararrayos alcanzaron una capacidad de falla no disruptiva de 80kA.

Funcionamiento

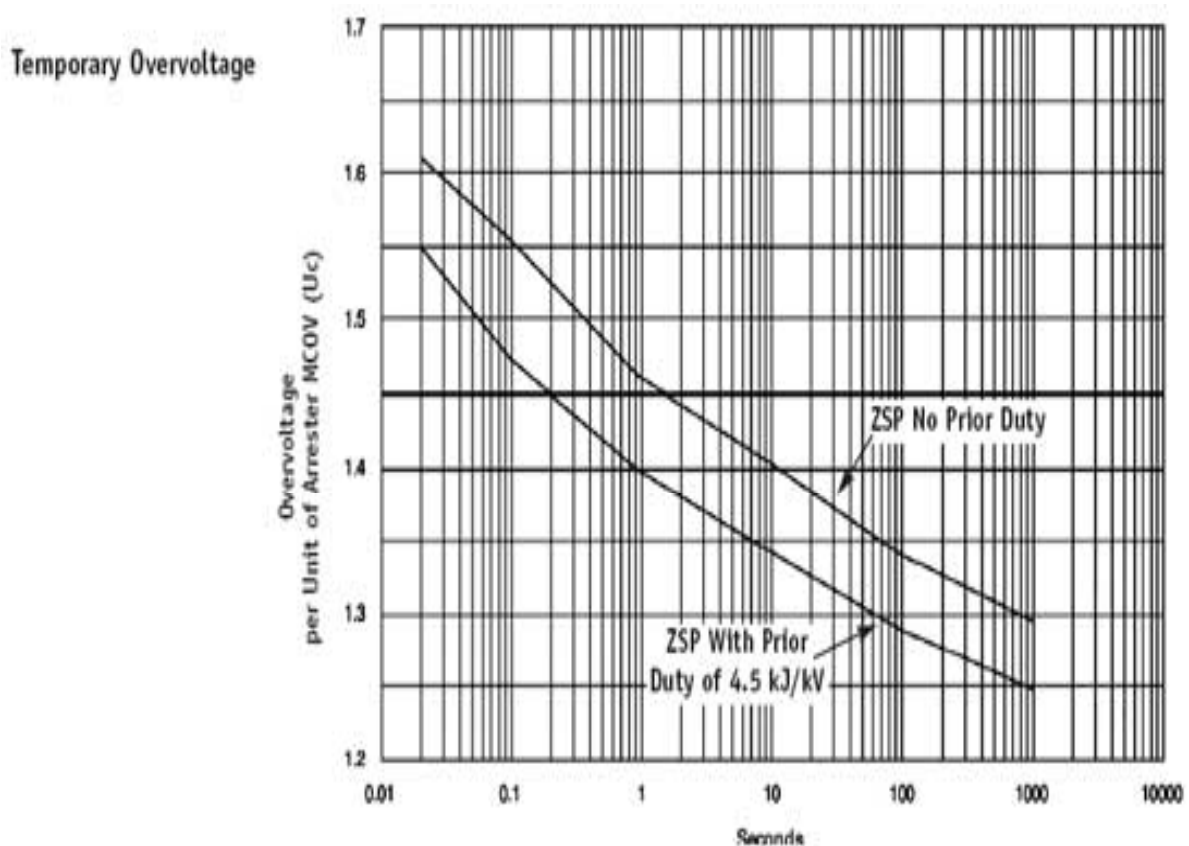
Los pararrayos “ZSP” están disponibles en rangos de 3kV hasta 192kV (2,55kV hasta 152kV MCOV) y se diseñan para voltajes de línea-línea desde 2,4kV hasta 230kV. El diseño del pararrayos “ZSP” se prueba de acuerdo con los estándares más recientes de la industria para los pararrayos de óxido de metal. Los pararrayos “ZSP” soportan las siguientes pruebas mínimas de diseño:

- Corriente de Corta Duración: de 100kA máximo.

- Descarga de la Línea de Transmisión: Excede los estándares de la clase 2 de ANSI/IEEE y del IEC
- Ciclo de Trabajo para ANSI: 10kA
- Corriente Nominal de Descarga para el IEC: 10kA
- Clase de Descarga para IEC: Clase 2
- Capacidad Mínima de Energía: 6,1 kJ/kV MCOV
- Capacidad de Falla no Disruptiva: 80kA rms
- Fuerza de Trabajo en Voladizo (o Cantilever): 10.000 pulg. - lb.
- Listado REA

Confiabilidad

Cada unidad de pararrayos "ZSP" terminada debe pasar las siguientes pruebas eléctricas: voltaje de referencia, pérdida de energía, corriente total de fuga y RIV (Radio Influence Voltage). Estas pruebas se suman a las pruebas de producción que se efectúan a los elementos de la válvula de óxido de metal. Cada pararrayos es también sometido a una prueba de escape en el espectrómetro de masa de helio para asegurar la integridad del sistema de sellado.



Los Pararrayos de Polímero de Pedestal- Tipo “ZSP” - Características Eléctricas

N° Catálogo	Rango kV	MCOV kv rms	TOV ¹		Máximo. Equivalente. FOW ² kV (máximo)	Máximo. Conmutación ³ Sobretensión kV (máximo)	Voltaje de Descarga Máximo (máximo kV) Utilizando un impulso de corriente de μ sec de 8/20					
			1 s kV rms	10 s kV rms			1.5kA	3kA	5kA	10kA	20kA	40kA
ZSP0003	3	2.55	3.7	3.5	8.1	6.2	6.6	6.9	7.1	7.6	8.1	8.9
ZSP0006	6	5.10	7.4	7.1	16.2	12.4	13.3	13.8	14.2	15.1	16.3	17.8
ZSP0009	9	7.65	11.2	10.6	24.3	18.5	19.9	20.7	21.3	22.7	24.4	26.7
ZSP0010	10	8.40	12.3	11.7	27.0	20.6	22.1	23.1	23.7	25.2	27.1	29.6
ZSP0012	12	10.2	14.9	14.2	32.3	24.7	26.5	27.7	28.4	30.3	32.5	35.6
ZSP0015	15	12.7	18.5	17.7	40.4	30.9	33.2	34.6	35.6	37.8	40.6	44.5
ZSP0018	18	15.3	22.3	21.3	48.5	37.1	39.8	41.5	42.7	45.4	48.8	53.3
ZSP0021	21	17.0	24.8	23.6	53.9	41.2	44.2	46.1	47.4	50.5	54.2	59.3
ZSP0024	24	19.5	28.5	27.1	62.0	47.4	50.8	53.0	54.5	58.0	62.3	68.2
ZSP0027	27	22.0	32.1	30.6	70.1	53.6	57.5	59.9	61.6	65.6	70.4	77.1
ZSP0030	30	24.4	35.6	33.9	78.2	59.7	64.1	66.9	68.7	73.2	78.6	86.0
ZSP0033	33	26.7	39.0	37.1	86.3	65.9	70.7	73.8	75.8	80.7	86.7	94.8
ZSP0036	36	29.0	42.3	40.3	93.5	71.4	76.6	79.9	82.2	87.5	93.9	103.0
ZSP0039	39	31.5	46.0	43.8	102.0	77.6	83.3	86.8	89.3	95.0	102.0	112.0
ZSP0042	42	34.0	49.6	47.3	108.0	82.4	88.4	92.2	94.8	101.0	108.0	119.0
ZSP0045	45	36.5	53.3	50.7	116.0	88.6	95.1	99.1	102.0	108.0	116.0	127.0
ZSP0048	48	39.0	56.9	54.2	124.0	94.8	102.0	106.0	109.0	116.0	125.0	136.0
ZSP0054	54	42.0	61.3	58.4	134.0	102.0	110.0	114.0	118.0	125.0	135.0	147.0
ZSP0060	60	48.0	70.1	66.7	151.0	116.0	124.0	129.0	133.0	142.0	152.0	166.0
ZSP0063	63	50.0	73.4	69.8	159.0	122.0	130.0	136.0	140.0	149.0	160.0	175.0
ZSP0066	66	54.0	78.8	75.1	167.0	128.0	137.0	143.0	147.0	156.0	168.0	183.0
ZSP0072	72	57.0	83.2	79.2	178.0	136.0	146.0	152.0	157.0	167.0	179.0	196.0
ZSP0072-58*	72	58.0	83.2	79.2	178.0	136.0	146.0	152.0	157.0	167.0	179.0	196.0
ZSP0090	90	70.0	102.0	97.3	224.0	171.0	184.0	192.0	197.0	210.0	225.0	247.0
ZSP0090-74*	90	74.0	108.0	103.0	232.0	177.0	190.0	198.0	204.0	217.0	233.0	255.0
ZSP0096	96	76.0	111.0	106.0	240.0	183.0	197.0	205.0	211.0	224.0	241.0	264.0
ZSP0108	108	84.0	123.0	117.0	268.0	205.0	219.0	229.0	235.0	250.0	269.0	294.0
ZSP0108-88*	108	88.0	128.0	122.0	271.0	215.0	222.0	232.0	238.0	254.0	272.0	298.0
ZSP0120	120	98.0	143.0	136.0	301.0	238.0	247.0	257.0	264.0	281.0	302.0	331.0
ZSP120-102*	120	102.0	149.0	142.0	318.0	252.0	261.0	272.0	280.0	298.0	320.0	350.0
ZSP0132	132	106.0	155.0	147.0	329.0	261.0	270.0	282.0	290.0	308.0	331.0	362.0
ZSP0144	144	115.0	168.0	160.0	356.0	282.0	292.0	305.0	313.0	333.0	358.0	392.0
ZSP0168	168	131.0	191.0	182.0	419.0	332.0	343.0	358.0	368.0	392.0	421.0	461.0
ZSP0172	172	140.0	204.0	195.0	436.0	345.0	358.0	373.0	384.0	408.0	438.0	480.0
ZSP0180	180	144.0	210.0	200.0	452.0	358.0	371.0	386.0	397.0	423.0	454.0	497.0
ZSP0192	192	152.0	222.0	211.0	477.0	378.0	391.0	408.0	419.0	446.0	479.0	525.0
ZSP0198	198	158.0	231.0	220.0	493.0	390.0	404.0	421.0	433.0	461.0	495.0	542.0

¹ Sobretensión temporal sin ningún Trabajo Anterior.

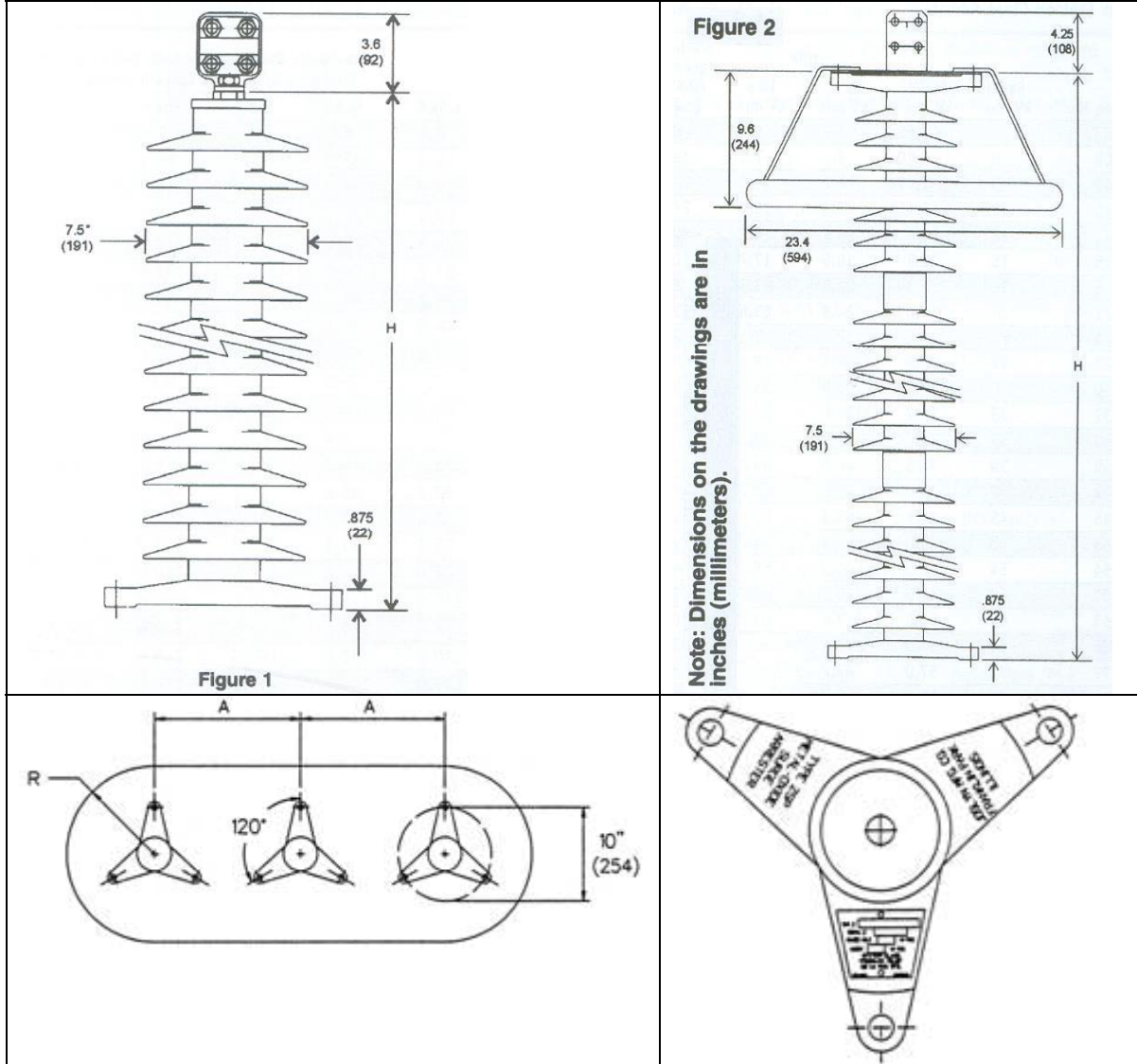
² El Frente de Onda equivalente es el voltaje máximo de descarga para una corriente de impulso

Pararrayos

JOSLYN Manufacturing Co.

³ Basado en una corriente de sobretensión de conmutación de 500 amperes para los pararrayos clasificados entre 2,55kV y 84kV MCOV y de 1000 amperes para los pararrayos que van desde 88kV hasta 152kV MCOV.

* El número de catálogo para los niveles especiales de MCOV usaría el siguiente formato: ZSP0090-1231-74 y ZSP0108-1231-88.



DISPOSICIÓN TRIFÁSICA DE LA INSTALACIÓN

Los orificios para el montaje son de 0,56 pulgadas (14.2 milímetros) para los pernos de ½". En la base del trípode hay tres orificios para pernos con una disposición en 120° en un diámetro de 10". No se incluyen los pernos y la ferretería de ensamblaje con los pararrayos.

PLACAS DE IDENTIFICACIÓN

Además de la información que se incluye en la base del trípode, se adjunta una placa de identificación al bastidor para proporcionar todos los detalles requeridos respecto al pararrayos. Se indica: el número de catálogo, el rango de voltaje, el voltaje de operación continuo y el grado máximo de descarga. El número de serie incluye la información sobre la fecha de fabricación.

Los Pararrayos de Polímero de Pedestal - tipo "ZSP" Características físicas y separaciones

Nº Catálogo	Rango kV	MCOV kV	(h) Altura total		Fuga		Peso neto		Separaciones Mínimas ¹				Fig. Nº
			(Pulg.)	(mm)	(Pulg.)	(mm)	(Libras)	(Kg.)	A		R		
									(Pulg.)	(mm)	(Pulg.)	(mm)	
ZSP0003	3	2.55	7.5	191	18.1	459	18	8.2	11	279	7	178	1
ZSP0006	6	5.10	7.5	191	18.1	459	18	8.2	11	279	7	178	1
ZSP0009	9	7.65	7.5	191	18.1	459	18	8.2	11	279	7	178	1
ZSP0010	10	8.40	9.2	234	24.1	611	21	9.5	11	279	7	178	1
ZSP0012	12	10.2	9.2	234	24.1	611	21	9.5	11	279	7	178	1
ZSP0015	15	12.7	9.2	234	24.1	611	21	9.5	12	305	8	203	1
ZSP0018	18	15.3	10.9	277	30.1	764	25	11.3	12	305	8	203	1
ZSP0021	21	17.0	10.9	277	30.1	764	25	11.3	12	305	8	203	1
ZSP0024	24	19.5	10.9	277	30.1	764	25	11.3	12	305	8	203	1
ZSP0027	27	22.0	12.7	323	36.1	916	29	13.2	12	305	9	229	1
ZSP0030	30	24.4	12.7	323	36.1	916	29	13.2	12	305	9	229	1
ZSP0033	33	26.7	13.3	338	36.7	933	30	13.6	13	330	11	279	1
ZSP0036	36	29.0	14.3	363	42.0	1066	32	14.5	13	330	11	279	1
ZSP0039	39	31.5	16.0	406	48.0	1219	36	16.3	15	381	12	305	1
ZSP0042	42	34.0	18.1	460	54.4	1381	41	18.6	16	406	14	356	1
ZSP0045	45	36.5	18.1	460	54.4	1381	41	18.6	18	457	14	356	1
ZSP0048	48	39.0	18.1	460	54.4	1381	41	18.6	19	483	16	406	1
ZSP0054	54	42.0	19.6	498	60.2	1528	44	20.0	21	540	16	399	1
ZSP0060	60	48.0	23.2	589	72.4	1838	52	23.6	23	583	17	441	1
ZSP0063	63	51.0	23.2	589	72.4	1838	52	23.6	24	602	18	460	1
ZSP0066	66	54.0	23.2	589	72.4	1838	52	23.6	24	621	19	479	1
ZSP0072	72	57.0	23.7	602	72.8	1850	53	24.0	26	648	20	507	1
ZSP0072-58*	72	58.0	23.7	602	72.8	1850	53	24.0	26	648	20	507	1
ZSP0090	90	70.0	34.6	879	109.5	2780	77	34.9	30	760	24	619	1
ZSP0090-74*	90	74.0	34.6	879	109.5	2780	77	34.9	31	779	25	638	1
ZSP0096	96	76.0	34.6	879	109.5	2780	77	34.9	31	798	26	657	1
ZSP0108	108	84.0	37.7	958	121.1	3075	84	38.1	34	866	29	725	1
ZSP0108-88*	108	88.0	39.8	1011	127.5	3238	88	39.9	34	874	29	733	1
ZSP0120	120	98.0	45.0	1142	145.5	3695	99	44.9	37	946	32	805	1
ZSP0132	132	106.0	45.4	1153	145.9	3706	100	45.4	40	1016	34	875	1
ZSP0144	144	115.0	45.9	1166	146.4	3718	101	45.8	43	1082	37	940	1
ZSP0168	168	131.0	59.9	1520	194.2	4932	146	66.2	61	1544	49	1248	2
ZSP0172	172	140.0	63.5	1613	206.4	5242	154	69.8	62	1587	51	1290	2
ZSP0180	180	144.0	63.5	1613	206.4	5242	154	69.8	64	1625	52	1328	2
ZSP0192	192	152.0	67.1	1704	218.6	5552	162	73.5	66	1686	55	1390	2
ZSP0198	198	157.0	67.1	1704	218.6	5552	162	73.5	68	1724	56	1428	2

¹ Estas separaciones mínimas son determinadas por las capacidades protectoras de los pararrayos y son secundarias a cualquier otra separación requerida que pueda existir para usos específicos.

* El número de catálogo para los niveles especiales de MCOV usaría el siguiente formato:: ZSP0090-1231-74 y ZSP0108-1231-88.

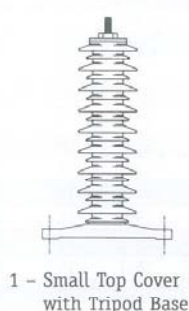
ORDERING INFORMATION

Z S P X X X X - X X X 1

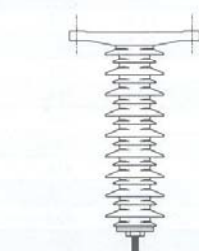
KV RATING

0003 = 3kV
0006 = 6kV
0009 = 9kV
0010 = 10kV
0012 = 12kV
0015 = 15kV
0018 = 18kV
0021 = 21kV
0024 = 24kV
0027 = 27kV
0030 = 30kV
0033 = 33kV
0036 = 36kV
0039 = 39kV
0042 = 42kV
0045 = 45kV
0048 = 48kV
0054 = 54kV
0060 = 60kV
0063 = 63kV
0066 = 66kV
0072 = 72kV
0090 = 90kV
0096 = 96kV
0108 = 108kV
0120 = 120kV
0132 = 132kV
0144 = 144kV
0168 = 168kV
0172 = 172kV
0180 = 180kV
0192 = 192kV
0198 = 198kV

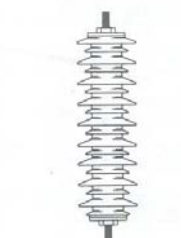
CONFIGURATION



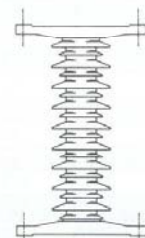
1 - Small Top Cover with Tripod Base



2 - Tripod Top with Small Top Cover (Inverted Mounting)

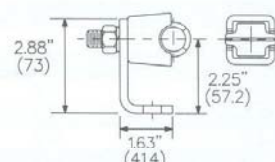


3 - Small Covers on Both Ends

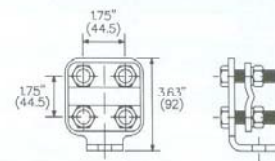


4 - Tripod Base on Both Ends

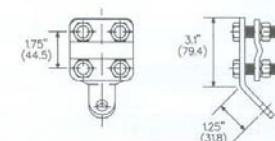
TOP & BOTTOM CONNECTORS (not available on "D" series)



1 - Eyebolt with a 90° angle bracket.
Conductor Size Range: 0.25" dia. to 0.75" dia. (6.35 to 19.05mm)



2 - 4 hole NEMA pad with a 90° angle
Conductor Size Range: 0.25" dia. to 1.25" dia. (6.35 to 31.75mm)



3 - 4 hole NEMA pad with a 45° angle
Conductor Size Range: 0.25" dia. to 1.25" dia. (6.35 to 31.75mm)

Packaging

The standard packaging will be cardboard cartons for 3 kV to 30 kV units. Wood crates will be used for ratings above 30 kV.

Special Needs

For special arrester characteristics other than those shown in this brochure, contact your Joslyn representative.

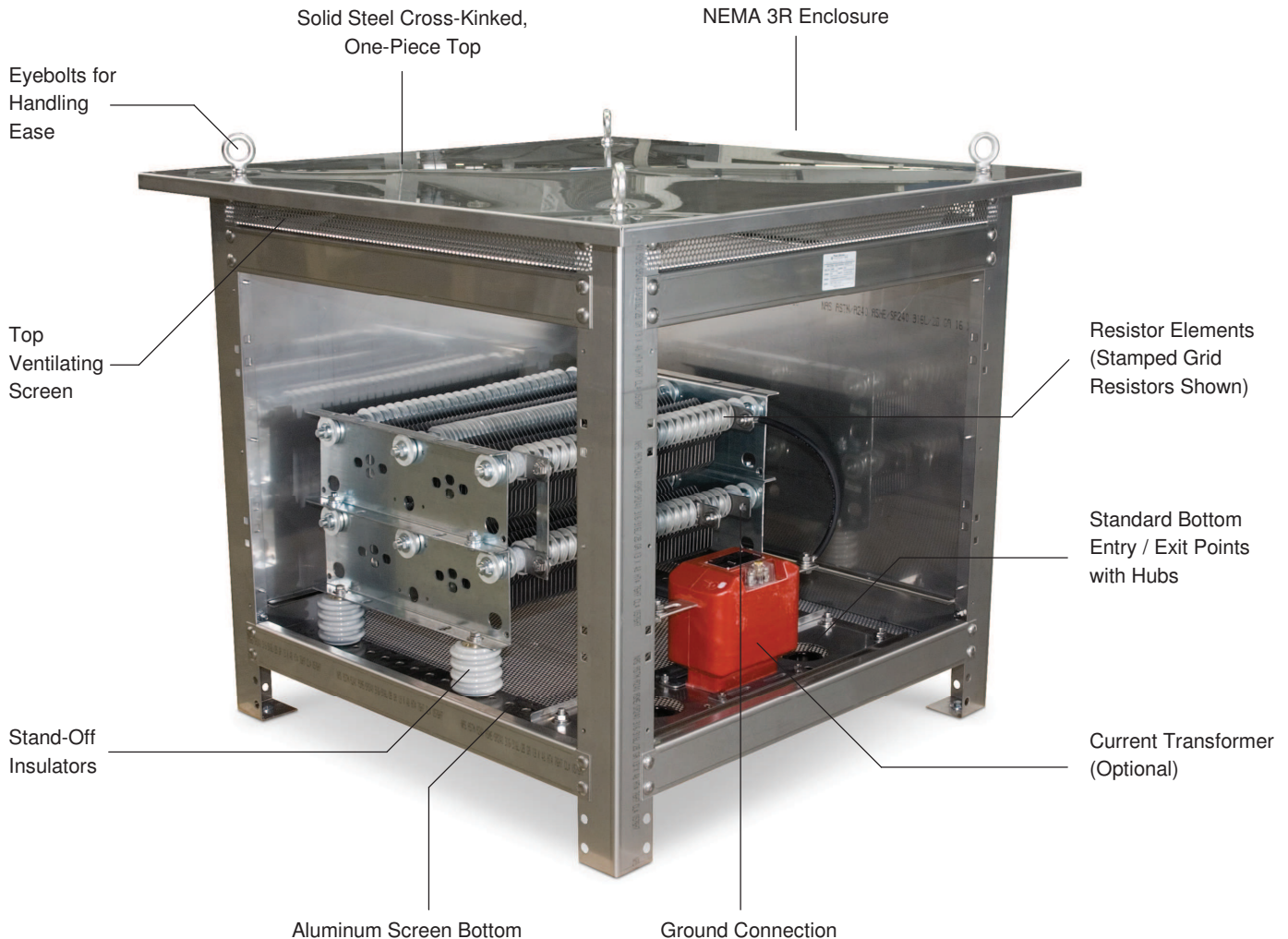
Example

108 kV rated arrester with:
Small top cover & tripod base.
Top - eyebolt w/90° angle
Bottom - 4 hole pad w/45° angle

Catalog Number: ZSP0108-1131

Standard Neutral Grounding Resistors

Post Glover Neutral Grounding Resistor in NEMA 3R Enclosure



Optional Features

- Top- or Side-Mounted Exit & Entrance Bushing(s)
- Powder Coat Finish
- Stainless Steel Enclosure
- Elevating Stand
- Current Transformer
- Disconnect Switch

Resistor Element Options

- Stainless Steel Stamped Grid
- Stainless Steel Edgewound
- Stainless Steel Wirewound

UL and CSA Ratings up to 8 kV L-N available

Meets all Requirements of IEEE 32 and IEC



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Phone: 800-537-6144 / 859-283-0778 • Fax: 859-283-2978
www.postglover.com

Serving the Electrical Industry Since 1892

Standard Neutral Grounding Resistors

Commonly Specified Ratings and Dimensions

Voltage Line to Neutral	Initial Current Amps	Core Part Number	Approximate Weight (lbs)	Footprint L"xW"xH"
----------------------------	-------------------------	---------------------	-----------------------------	-----------------------

Ten Second Ratings

1390	50	NG013A050	260	36x36x36
1390	100	NG013A100	260	36x36x36
1390	200	NG013A200	260	36x36x36
1390	400	NG013A400	260	36x36x36
2400	50	NG024A050	300	36x36x36
2400	100	NG024A100	300	36x36x36
2400	200	NG024A200	300	36x36x36
2400	400	NG024A400	300	36x36x36
4160	50	NG041A050	500	48x48x48
4160	100	NG041A100	500	48x48x48
4160	200	NG041A200	500	48x48x48
4160	400	NG041A400	500	48x48x48
7200	50	NG072A050	750	48x48x48
7200	100	NG072A100	750	48x48x48
7200	200	NG072A200	750	48x48x48
7200	400	NG072A400	750	48x48x48
7620	50	NG076A050	750	48x48x48
7620	100	NG076A100	750	48x48x48
7620	200	NG076A200	750	48x48x48
7620	400	NG076A400	750	48x48x48
8000	50	NG080A050	750	48x48x48
8000	100	NG080A100	750	48x48x48
8000	200	NG080A200	750	48x48x48
8000	400	NG080A400	750	48x48x48
8000	800	NG080A800	750	48x48x48
8000	1000	NG080A1KA	1500	96x48x48
19,900	200	NG199A200	2000	96x56x72
19,900	400	NG199A400	2200	96x56x72

Continuous Ratings

277	5	NG027C005	100	29x18x17
277	10	NG027C010	100	29x18x17
347	5	NG034C005	100	29x18x17
347	10	NG034C010	100	29x18x17
1390	5	NG013C005	250	36x36x36
1390	10	NG013C010	250	36x36x36
1390	25	NG013C025	500	48x48x48
2400	5	NG024C005	300	36x36x36
2400	10	NG024C010	500	48x48x48
2400	25	NG024C025	550	48x48x48

Extended Ratings

1390	25	NG013E025	250	36x36x36
1390	50	NG013E050	250	36x36x36
2400	25	NG024E025	300	36x36x36
2400	50	NG024E050	500	48x48x48
4160	25	NG041E025	750	48x48x48
4160	50	NG041E050	900	48x48x56



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Serving the Electrical Industry Since 1892

Distribution Vacuum Circuit Breaker

Distribution Vacuum Circuit Breaker Three-Phase Distribution Vacuum Circuit Breaker Type DVCB with Electronic Control

The Line Power Three-Phase Distribution Vacuum Circuit Breaker is a rugged and servicable DVCB utilizing a simple straight line operator and stored energy spring mechanism. Line Power includes the following standard and optional features. Additionally, Line Power specializes in accessories and ratings to meet special application requirements.

Standard Ratings

Maximum Voltage	15.5 kV	15.5 kV	27 kV
BIL	95 kV	95 kV	125 kV
Continuous Current	600A	1200A	600A
Interrupting Rating (Sym)	12.5 kA	18.0 kA	12.5 kA
Operations Before Maintenance	2000	2000	2000

Standard Features

- Operations Counter
- One Relay Accuracy CT Per Phase
- Selector Switch (TRIP, CLOSE)
- DC Capacitor Tripping with Fail Safe Trip Circuit
- Heavy-Duty Gear Motor with Spring Charging Mechanism That is Electrically and Mechanically TRIP FREE
- Control Voltage: 120 VAC
- Electronic Overcurrent Relay with ANSI/IEC Time-Current Curve Selections, Ground Fault Sensing, and Time-Delay Settings
- 14-gauge NEMA 3R Cabinets
- Adjustable Height Base
- Swingout Control Panel for Maintenance
- Number Markers on All Control Wiring
- Durable ANSI #61 Gray Paint
- Thermostatically Controlled Heaters
- Visible Bottle Wear Indication
- Visible Load Side Disconnect with Automatic Grounding

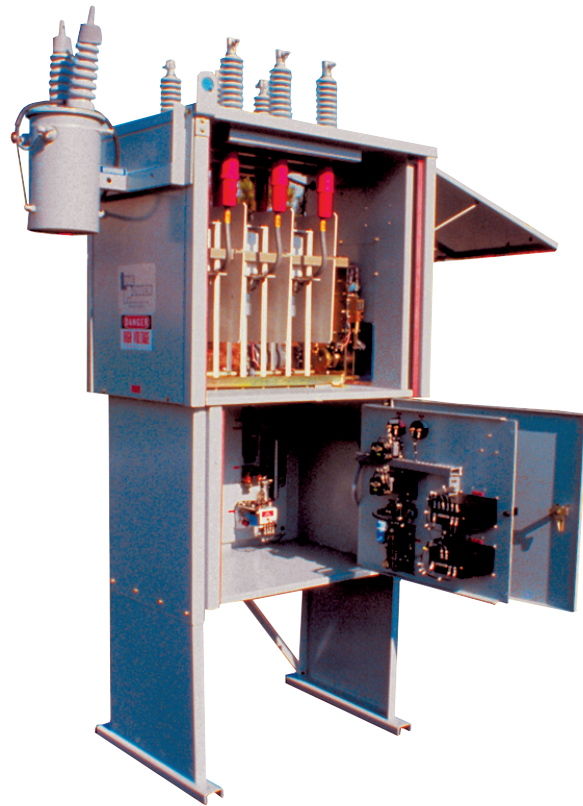
Optional Features and Accessories Include:

- Remote Control for Trip and Close
- Extra Creep Bushings
- NEMA 12 Enclosure
- Pad-mount Enclosure
- Stainless-Steel Cabinet and Hardware
- Extra CTs for Relaying and Metering
- Internal or External VTs for Phase Sequence Relaying and/or Control Power
- SCADA Terminal Points
- Zone 4 Seismic Duty
- Lightning Arresters
- Cabinet Options: Colors, Powder Paint, Stainless Steel
- Customized Protection and Control Schemes



Other Products Manufactured by Line Power

- Apparatus Enclosures
- Component Electrical Parts
- Custom Control Houses
- Explosion Tested Controls
- Ground Monitors
- High Voltage Couplers
- High Voltage Switches
- Low Voltage Couplers
- Motor Controls
- Motor Starters
- Motor Test Centers
- Power Centers
- Rebuilding and Test Equipment
- Substations
- Switches
- Switchgear
- Transformers
- Vacuum Circuit Breakers
- Outdoor Protected Aisle Enclosures
- And many more products

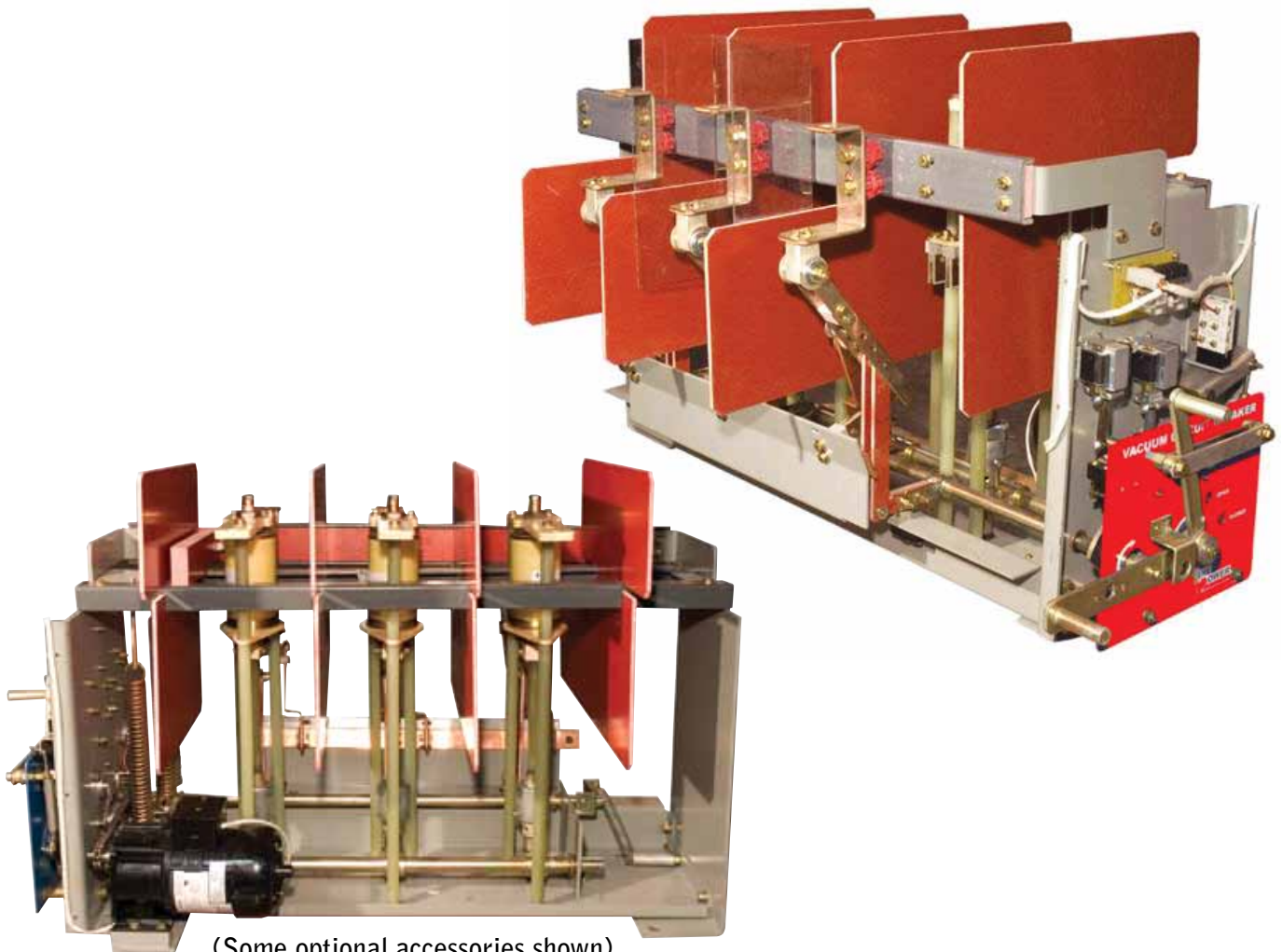


(Pole Mount Available)



27 kV 600 Amp Vacuum Circuit Breaker

General Information
Specifications



(Some optional accessories shown)

Application

Line Power Manufacturing's Vacuum Circuit Breaker, 3-phase, 27 kV power interrupting device, is designed to provide protection for all types of electric feed circuits within its ratings.

Ratings (600 Amp Model)

Continuous Current 600 Amperes*
Maximum Voltage 27 kV
Symmetrical Interrupting Current 12,500 Amperes
Lightning Impulse Withstand (BIL) 125 kV
Switching Current..... 600 Amperes

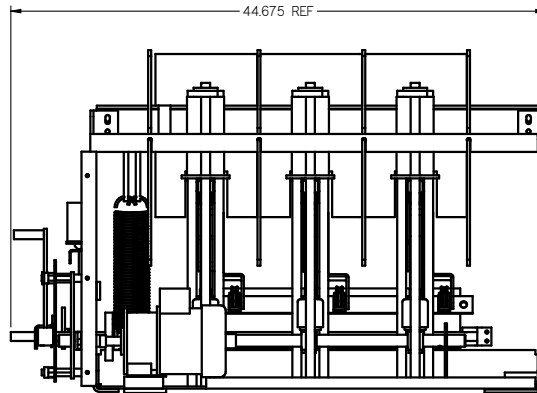
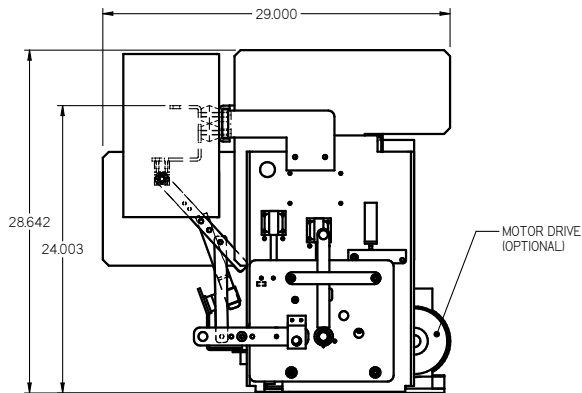
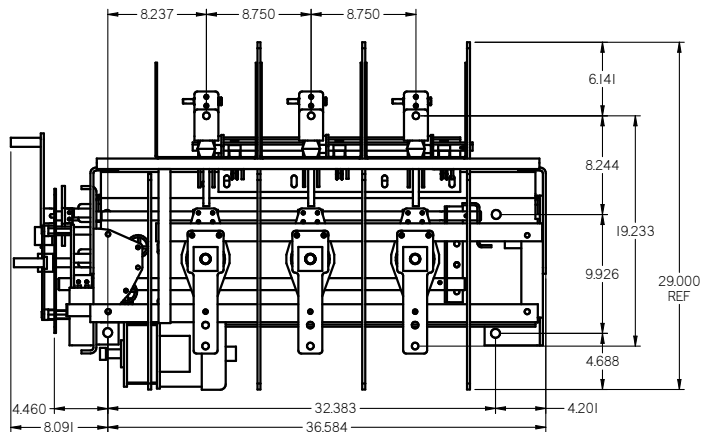
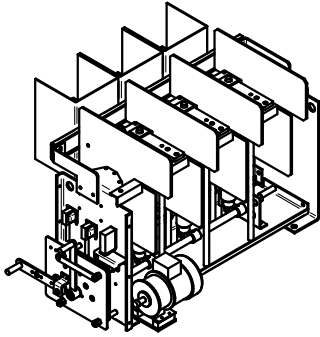
* The VCB is rated 600 amps continuously in a 40° C environment with one square foot of total ventilation or a 35° C environment with no ventilation.

Derating to 580 amps is required if the VCB is operated at 40° C environment without ventilation.

Features

- Mechanically interlocked visible disconnect.
- Independent bottle wear indicators.
- Each bottle assembly can be independently adjusted for proper contact pressure to insure that adequate interrupting capacities are met.
- Optional Accessories
 - Load side grounding of visible disconnect
 - Non-isolated
 - Isolated
 - Shunt Trip
 - Undervoltage release
 - Motor operation
 - Key interlocks

27kV, 600 Amp Vacuum Circuit Breaker with Visible Disconnect and Grounding Profile



SELECTION CHART

DESCRIPTION	PART NO.	20-2119-01	20-2119-02	20-2119-03	20-2119-04	20-2119-05	20-2119-06	20-2119-16	20-2119-17	20-2119-18	20-2119-19	20-2119-20	20-2119-21	20-2119-22	20-2119-23	20-2119-24	20-2119-34	20-2119-35	20-2119-36
BASIC		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
VISIBLE DISCONNECT		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MOTOR DRIVE																			
NONE		X	X	X	X	X	X	X	X	X									
120V											X	X	X	X	X	X	X	X	X
SHUNT TRIP																			
NONE		X	X	X							X	X	X						
48Vdc - 175Vdc					X	X	X							X	X	X			
CAP TRIP (120Vdc - 375Vdc)*								X	X	X							X	X	X
UNDERVOLTAGE																			
NONE		X			X			X			X			X			X		
120 VAC			X			X			X			X			X			X	
240 VAC				X			X			X			X			X			X
SUFFIX LETTERS																			
G		OUTPUT GROUNDING (NON-ISOLATED)																	
IG		OUTPUT GROUNDING (ISOLATED)																	
K		KIRKLOCK PROVISION																	
KK		2 KEY KIRKLOCK PROVISION																	

Drawing is based on Vacuum Breaker part number 20-2119-05.

*A series of two auxiliary contacts are recommended for tripping with dc voltage over 170Vdc.

KONNx

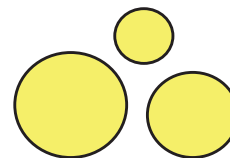
TECH 03

DESIGNERS, MANUFACTURERS
AND SUPPLIERS
OF
HIGH VOLTAGE BOLTED
COUPLER & ADAPTOR SYSTEMS



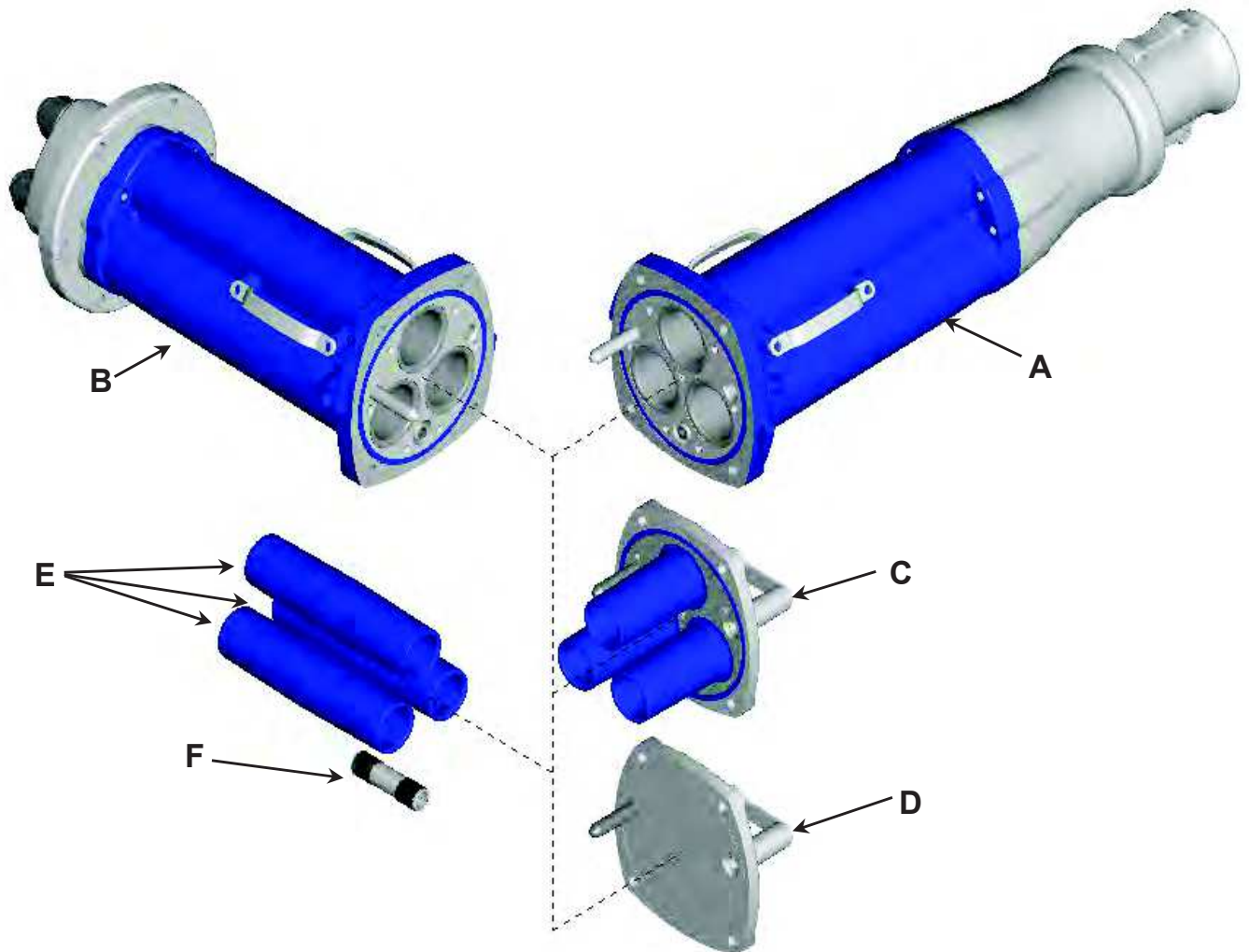
KONNx 
8.7kV, 15kV & 25kV
Coupler Systems

Pioneering the Difference.



Section 1	25kV 800A Bolted System	Page No
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	Accessories	1C
	Technical Guide.....	1D
	Body Assembly.....	1E
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	Accessories	2C
	Technical Guide.....	2D
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	Accessories	3C
	Technical Guide.....	3D
	Keying Coupler.....	3E
	Body Assembly.....	3F
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	15kV 800A Gear Mount Adaptor.....	7D
	8.7kV 800A Half Coupler.....	7E
	8.7kV 800A Gear Mount Adaptor.....	7F

High Voltage Cable Coupler System Model N° Selection Guide - 25kV 800A



Description

Model No.

A	Half Coupler – Unarmoured Cable.....	25BU Refer to page 1B
B	Adaptor – Gear Mount.....	25BD Refer to page 1B
C	Insulated End Cover	RS845 Refer to page 1F
D	Cast Protection Cover	RS851 Refer to page 4B
E	Phase Connectors (3 required per join).....	RS282
F	Earth Pilot Connector (1 required per join)....	RS117

High Voltage Cable Coupler System Cable and Gear Mount Equipment

25kV Gear Mount Flange

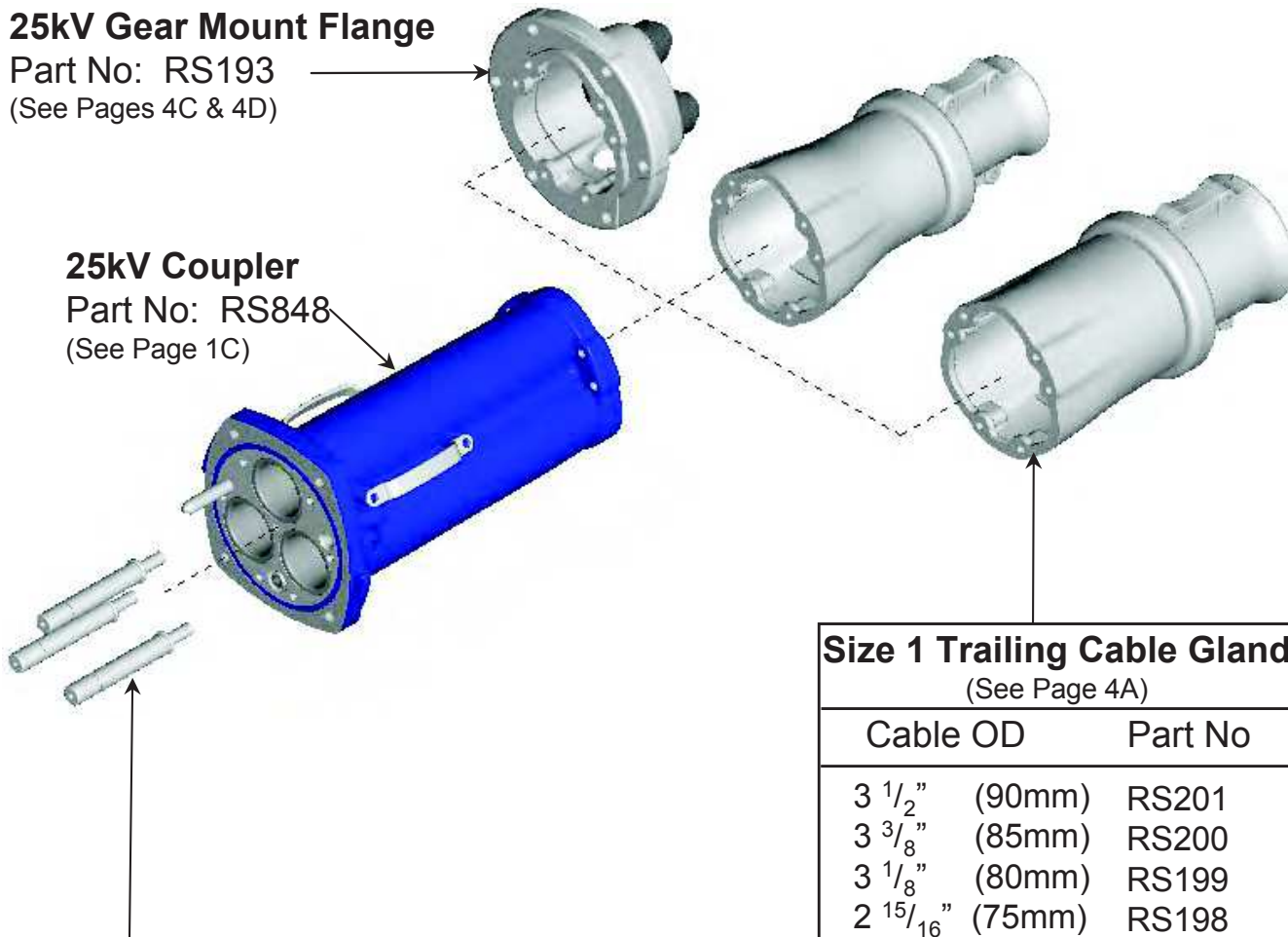
Part No: RS193

(See Pages 4C & 4D)

25kV Coupler

Part No: RS848

(See Page 1C)



25kV Contact Selection

Size	Crimp for SHD Type	Crimp for MP Type	Solder for SHD Type	Solder for MP Type
1/0 AWG	RS166	RS741	RS247	RS774
2/0 AWG	RS167	RS742	RS248	RS775
3/0 AWG	RS168	RS743	RS249	RS776
4/0 AWG	RS169	RS744	RS250	RS777
250 MCM	RS170	RS745	RS251	RS778
300 MCM	RS171	RS746	RS252	RS779
350 MCM	RS172	RS747	RS253	RS780
400 MCM	RS173	RS748	RS254	RS781
450 MCM	RS174	RS749	RS255	RS782
500 MCM	RS175	RS750	RS256	RS783
600 MCM	RS701	RS751	RS702	RS784
120 mm ²	RS467	RS811	RS466	RS838
240 mm ²	RS469	RS814	RS468	RS841

Size 1 Trailing Cable Gland

(See Page 4A)

Cable OD	Part No
3 1/2" (90mm)	RS201
3 3/8" (85mm)	RS200
3 1/8" (80mm)	RS199
2 15/16" (75mm)	RS198
2 3/4" (70mm)	RS197
2 9/16" (65mm)	RS196
2 3/8" (60mm)	RS195
2 1/8" (55mm)	RS194
1 15/16" (50mm)	RS426
1 3/4" (45mm)	RS425

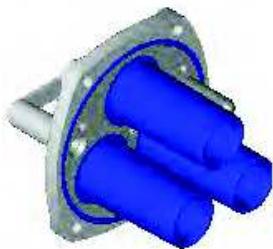
Size 2 Trailing Cable Gland

(See Page 4A)

Cable OD	Part No
4 5/8" (117mm)	RS207
4 9/16" (115mm)	RS206
4 5/16" (110mm)	RS205
4 1/8" (105mm)	RS204
3 15/16" (100mm)	RS203
3 3/4" (95mm)	RS202

High Voltage Cable Coupler System Accessories

25kV Insulated End Cover



RS845
25kV Universal Insulated End Cover
Pilot to ground/diode/resistor

Alignment Sticks

RS178

Phase guide stick set for assembly (3 included)



25kV Termination Kit Large

RS322

(to suit core outer diameter
 $1\frac{5}{16}$ " (24mm) – $1\frac{7}{8}$ " (48mm))



▪ 4.9L Compound



▪ 3 x M Tubes



▪ 3 x QT5672



▪ CC2



▪ 13 Tape

25kV Termination Kit Small

RS537

(to suit core outer diameter
 $\frac{5}{8}$ " (16mm) – $1\frac{1}{8}$ " (28.5mm))



▪ 4.9L Compound



▪ 3 x M Tubes



▪ 3 x QT5671



▪ CC2



▪ 13 Tape

KonNx Coupler Tool Kit (All Voltages)

Part No. RS284

2 off		1246	Spanners
1 off		RS325	Racking Tool
1 off		RS177	Slide Hammer
1 off		RS176	Earth Pilot Removal Tool
15 off		1278	High Voltage Cleaning Tissues
1 off		1274	Tool Box

High Voltage Cable Coupler System Technical Guide



Model No: 25BU

Description: Half Coupler – Unarmoured Cable

Rating: 25kV 800A

Material: Aluminium **Mass:** 43 lbs (19.5kg)

LOA: 31 1/2" (800mm) **Volume:** 4.7 Litres



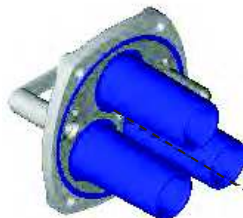
Model No: 25BD

Description: Adaptor – Gear Mount

Rating: 25kV 800A

Material: Aluminium **Mass:** 43 lbs (19.5kg)

LOA: 23 3/4" (560mm) **Volume:** 4.7 Litres

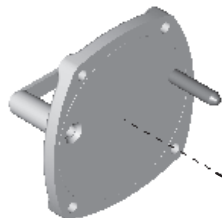


Model No: RS845

Description: Insulated End Cover

Rating: 25kV 800A

Material: Aluminium **Mass:** 11 lbs (5kg)



Model No: RS851

Description: Cast Protection Cover

Rating: 25kV 800A

Material: Aluminium **Mass:** 6.6 lbs (3kg)



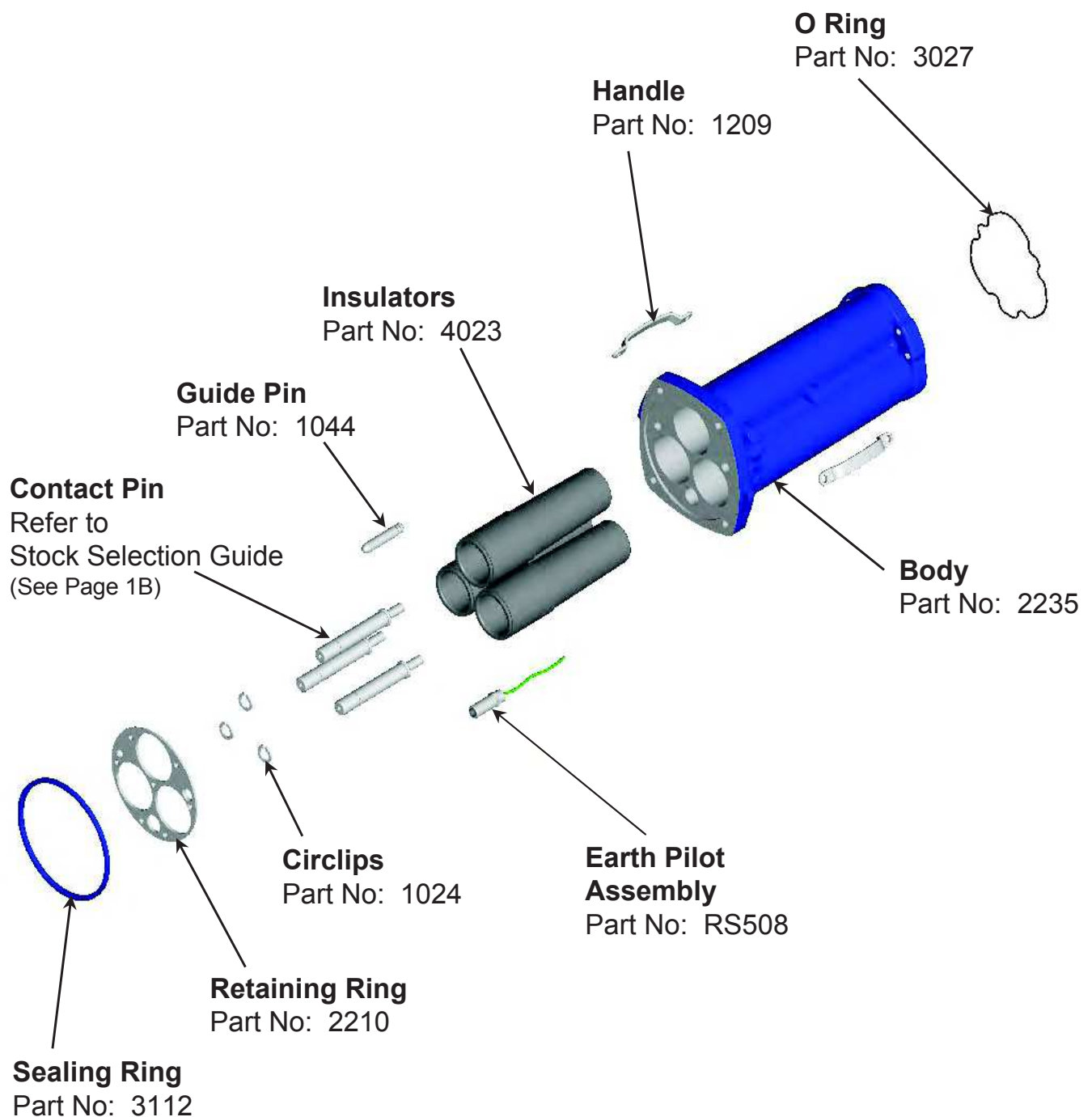
Model No: RS282 & RS117

Description: Phase Connectors &
Earth Pilot Connector

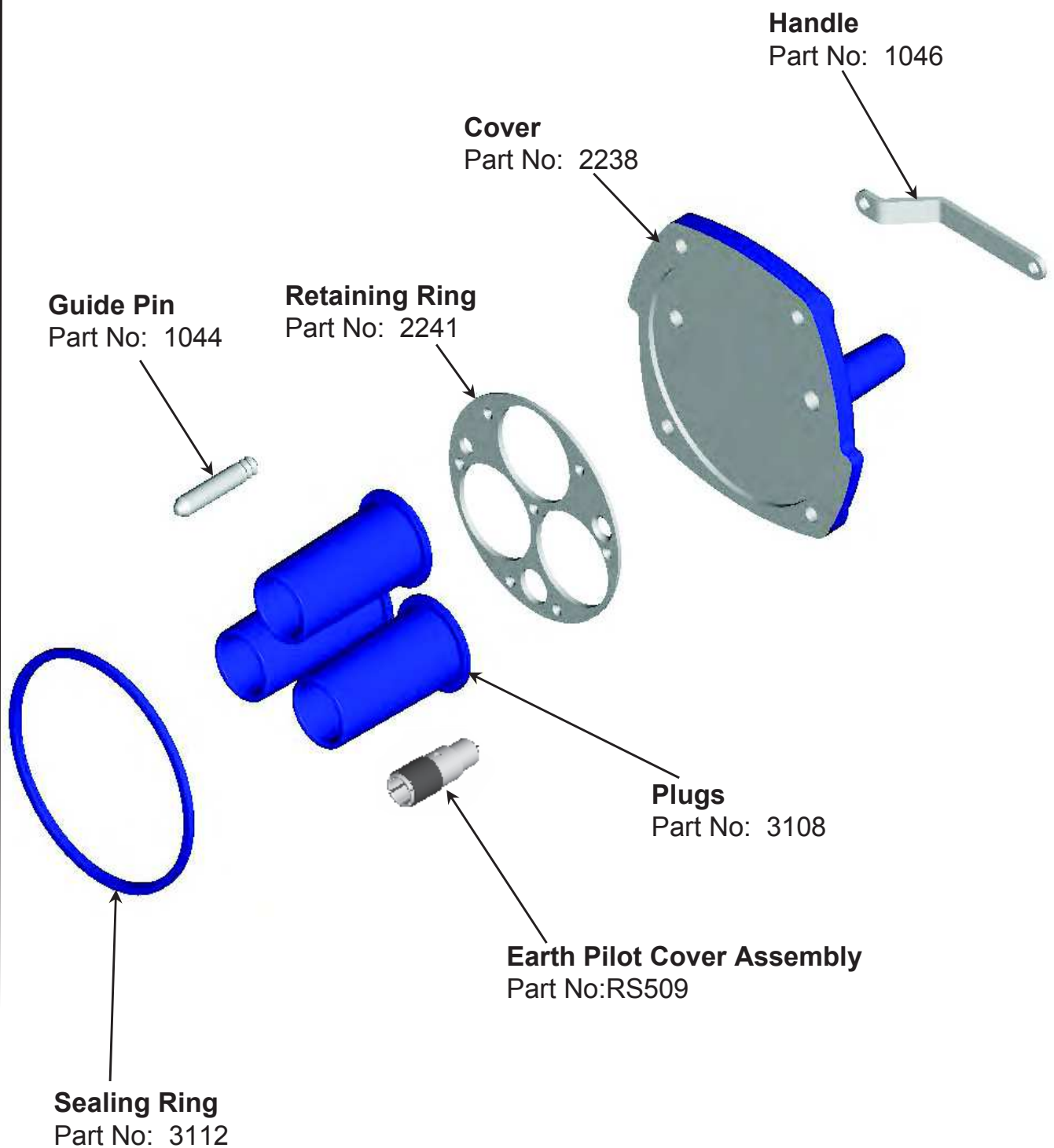
Rating: 25kV 800A



High Voltage Cable Bolted Coupler Body Assembly 25kV



Insulated End Cover Assembly 25kV





MIG II

GENERATOR PROTECTION SYSTEM

Three-phase and ground protection for small generators

KEY BENEFITS

- Reduce troubleshooting and maintenance cost - event recording, and analog/digital oscillography
- Design flexibility - Easy to use programming logic
- Access to information - Modbus RTU communications
- Configurable logic, curves, digital I/Os, and LEDs
- Follow technology evolution - Flash memory for product field upgrade
- Two settings groups
- Password protection for local operation
- Automatic display of last fault information
- AC/DC power supply
- Access via front panel keypad or communication links
- EnerVista™ compatible
- Isolated RS232 port

APPLICATIONS

- Small generators and motors
- Component for bigger generator packages
- Standby/critical power protection main unit
- Small motor protection
- Transformer protection

FEATURES

Protection and Control

- Phase, ground TOC
- Phase, ground IOC
- Thermal image protection
- Circuit breaker control (open and close)
- Negative Sequence Element
- Restricted Ground Differential Element
- Undercurrent
- Maximum number of starts
- Locked rotor
- Configurable I/O
- Six outputs: trip, service, 4 auxiliary
- 4 pre-configured overcurrent curves (ANSI, IEC)

Monitoring and Metering

- 24-event record
- Analog/digital oscillography
- Per phase current metering
- Monitoring of the last 5 trips information from the display

User Interfaces

- 2x16 character LCD display
- 6 LED indicators, 4 configurable in function and color
- Front RS232 and rear RS485 ports using ModBus® RTU protocol up to 19,200 bps
- EnerVista™ Software - an industry leading suite of software tools that simplifies every aspect of working with GE Multilin devices



Overview

The MIG II, member of the MII Family of protection relays, is a microprocessor based relay that provides basic protection for electrical machines. The primary application is for the protection of generator equipment however, it can also be used for motor protection.

Basic protection features include thermal image protection, three phase time delayed overcurrent, phase instantaneous overcurrent, ground & neutral time delayed overcurrent, ground & neutral instantaneous overcurrent, negative sequence, undercurrent, starts/hour, and time between starts.

Each protection element can be selectively enabled either via the front panel or via communication. Flexible settings, selectable ANSI or IEC curves, plus the choice of a user configurable overcurrent curve enable accurate coordination with other devices.

The MIG II has two digital inputs and six configurable digital outputs. The MIG II has a total of six LEDs, four configurable in function and color.

The front panel also features a 5 button keypad and a 16x2 LCD display that provides an easy to use user interface.

The front keypad allows the user to set the baud rate and relay address for communication. A front RS232 and a rear RS485 communication port are provided for computer access using ModBus® RTU protocol. The rear RS485 can be converted to an RS232 or fiber optic port (plastic or glass fiber optics) by means of using an external converter, such as GE Multilin DAC300 or F485. Windows® based EnerVista™ software is provided free of charge with the relay to allow setup and configuration of MIG II features.

Computer access allows setting and configuration (inputs, outputs, LEDs and configurable logic) of the units, display of metering information and real time status of the unit. It also allows the display of event records and an oscillography record for the last fault.

The MIG II has a drawout construction in 1/4 of a 19" rack case.

can be set as a function of heating time constant T1 (adjustable between 3 to 600 minutes). Cool down time constant T2 is adjustable from 1 to 6 the heating constant. The algorithm of the thermal image takes into account the effect of the negative sequence components via the K1 constant. This K1 value protects the machine against side effects caused by the negative component, which causes overheating in the stator and rotor, with the same effect as overload.

Unbalance

The presence of negative sequence current can result in greatly increased rotor heating. The unit can be set either with a definite time (up to 255s) or with a $I^2t=K$ curve model where K is a value between 1 to 100.

Three Phase Time Overcurrent

The MIG II provides time overcurrent protection that can be set from 0.1 to 2.4 times FLC. Four separate ANSI or IEC time overcurrent curves can be selected in addition to a user configurable curve. ANSI and IEC curves include: definite time, normal inverse, very inverse, and extremely inverse. For each curve, different time multipliers may be set. This allows the

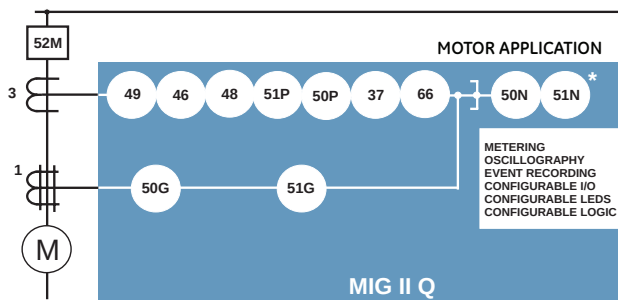
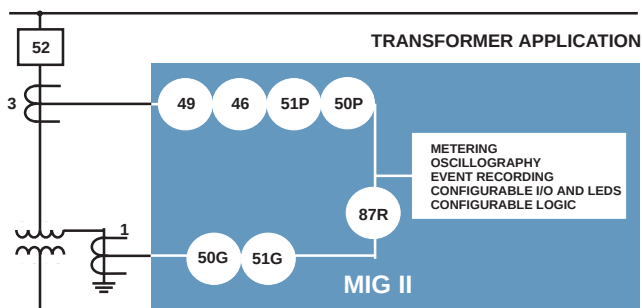
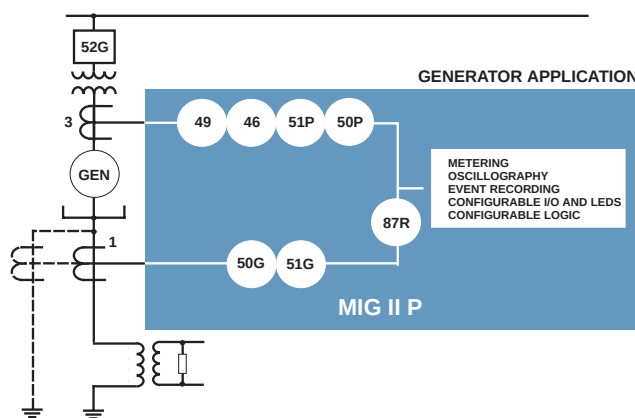
Protection

Thermal Image Element

A thermal image unit is included to protect equipment against overheating due to excessive load. Several operating curves

Functional Block Diagram

ANSI	IEC/BS142
normal inverse	IEC A
very inverse	IEC B
extremely inverse	IEC C
definite time	definite time



(*) Alternative Connections

selection of the optimum curve for coordination with fuses, feeders, motors, transformers, etc.

Phase Instantaneous Overcurrent

The MIG II includes one adjustable phase instantaneous overcurrent unit. Settings allow the pickup setpoint to be set from 0.1 to 30 times FLC and a time delay from 0 to 100 seconds to be set.

Ground Time Overcurrent

The ground time overcurrent protection has the same curve selection choices and settings as the phase time overcurrent unit. The ground signal is normally derived as the residual sum of the three phase CTs eliminating the need for an additional ground sensor. Alternatively, for more sensitive detection, an additional core balance (zero sequence) ground sensor encircling the 3 phase conductors can be used. The MIG II can also be ordered with more sensitive ground inputs, capable of measuring current values as low as 0.005 A.

Ground Instantaneous Overcurrent

The ground instantaneous overcurrent protection has the same settings and features as the phase instantaneous overcurrent unit.

Restricted Ground Differential Element (MIG II P model only)

This unit detects ground faults in solidly grounded generators, through resistance and high impedance reactance.

This feature calculates $3I_0$ TERMINAL current from the measured phase currents, and measures the generator ground current $3I_0$ NEUTRAL. The calculated difference between both values is the differential current I_{diff} . This value must exceed a user-programmable pick up value (setting) in order to activate the protection unit.

Negative Sequence Element

The MIG II relay incorporates a negative sequence protection element in order to detect system conditions that can cause unbalanced three-phase currents in the generator. As previously mentioned, these unbalances can be of higher magnitude than the load unbalance.

Undercurrent (MIG II Q model only)

The undercurrent function is mostly used in motor applications in order to detect a decrease in the machine current caused by a load decrease, and to prevent the pumps from working without load.

The unit can be selected either as an alarm or as a trip.

Starts/hour & Time Between Starts. (MIG II Q model only)

This unit counts the number of the machine starts and makes sure they do not exceed a number programmed by the user. The number of starts is controlled over a period of time called the Time Window. If the number of starts is exceeded then the unit blocks any new attempts and maintains the trip contact closed during the restart block time.

Locked Rotor (MIG II Q model only)

This unit protects the machine for excessive long starts that can damage the rotor due to excessive overcurrent conditions during the start-up. This is of major importance for those critical power applications where the motor drives the generator into service.

Multiple Setting Groups

Two separate settings groups are stored in MIG II non volatile memory, with only one group active at a given time. Switching between setting groups 1 and 2 can be done by means of a setting, a communication

command or digital input activation.

Settings are divided in 2 categories, main and advanced settings. This allows users to have access to main relay functionalities in an extremely simple, user friendly way by entering only main settings, while having access to complete functionality for more complex use through advanced settings.

Metering

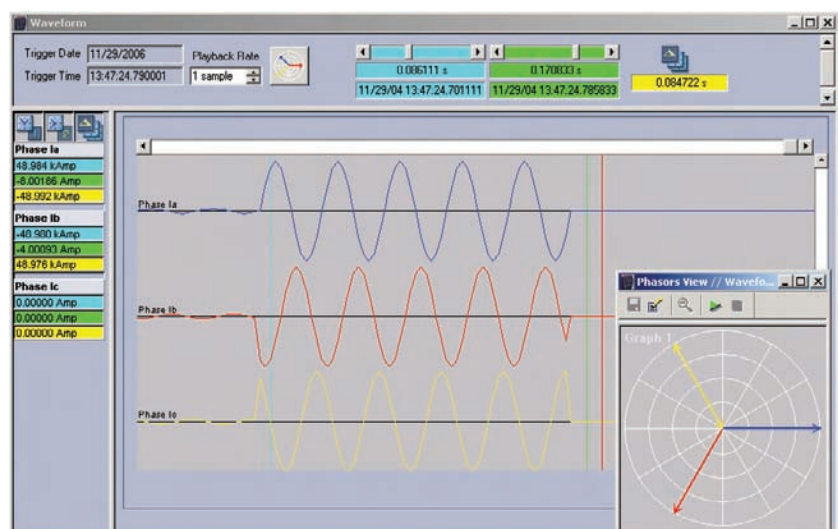
MIG II provides metering values for phase and ground currents. The accuracy is 3% in the complete range, and 1% at the rated current.

Primary or Secondary Metering

The MIG II can monitor both the primary and secondary current metering values, by previously setting the corresponding CT ratio.

Event Recording

Events consist of a broad range of change of state occurrences, including pickups, trips, contact operations, alarms and self test status. The MIG II stores up to 24 events time tagged to the nearest millisecond. This provides the information needed to determine sequence of events which facilitates diagnosis of relay operation. Each event is individually maskable in order to avoid the generation of undesired events, and includes the values of currents and status of all the protection elements at the moment of the event.



Use the oscillography feature as an accurate troubleshooting and diagnostics tool

Oscillography

MIG II captures current waveforms and digital channels at 8 samples per cycle. One oscillography record with a maximum length of 24 cycles is stored in memory. Oscillography is triggered either by internal signals or an external contact.

Configurable I/O and LEDs

Two digital inputs are user configurable. Out of the six digital outputs incorporated, two have a fixed function (trip and service required), while the other four are user programmable. Those configurable outputs can be assigned either to a set of pre-configured values, or an OR/NOT combination of the same values. Each configurable output can be independently latched, and individually selected as NO or NC by means of a jumper. Outputs 1 and 2 can be isolated from outputs 2 and 3 by removing jumper JX.

Four of the 6 LED indicators can also be programmed by the user. The first LED has a fixed assignment (relay in service), the second is fixed for trip, and the remaining four LEDs are configurable in function, memory and color (red or green).

Configurable Logic

Up to a maximum of 4 configurable logic schemes can be implemented into the MIG II by means of using a set of 4 pre-configured logic gates and timer cells. A graphical user interface is provided for configuration of MIG II logic. The inputs of the MIG II configurable logic can be assigned to contact outputs and/or LEDs.

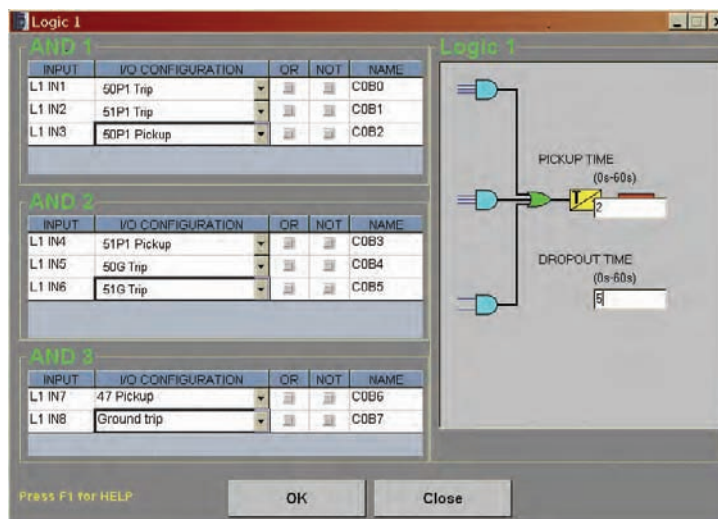
Circuit Breaker Control

The MIG II permits operation of the circuit breaker. Breaker opening and closing operations can be carried out by programming specific outputs, and digital inputs can be used for verifying the success of the operation.

User Interfaces

Display

Measurement data (actual values), fault reports for the last five trips, and settings are shown on the 16x2 characters LCD display.



Use Programmable Logic to set the MIG II to meet specific application needs

Status LEDs

The MIG II incorporates 6 LED indicators in the front plate. The first one is a green LED identified as "READY", used to indicate the status of the protection elements. When "ON" it means the relay is energized and ready to protect, and at least one protection element has been enabled.

The second one is a red LED used for TRIP indication. It will be "ON" when a fault occurs and the relay energizes the trip outputs. Once energized, it will remain latched until the ESC/RESET key is pressed for three seconds to RESET the relay.

Four additional LEDs are programmable in function and color. The factory default functions of the programmable LEDs are: Phase Trip, Ground Trip, 50 Trip, and Pickup, while the color is set to RED, and

the status memory as self-resetting. The user may change the function and status memory through the use of the EnerVista™ software.

The LED color can be modified using the relay keypad. The status memory may be programmed either self-resetting or latching. If programmed as self-resetting, when the associated function drops out the corresponding LEDs turn off. If programmed as latched, the LED will remain "ON" until the ESC/RESET key is pressed for three seconds to reset the relay.

In order to test LEDs, pressing the ESC/RESET key for three seconds will turn "ON" all LEDs. When the key is released, the LEDs will turn off (except if the function pickups are still active). This allows easy testing of the equipment.



Connect up to 32 ModBus devices to your ethernet network including M II devices

Keypad

A five-button keypad allows user access for easy relay interrogation and change of settings.

Access to events and oscillography records, and unit configuration is possible only through PC communication.

Self-Test Diagnostics

Comprehensive self-test diagnostics occur at power up and continuously during relay operation. Any problem found by self-tests causes an alarm and an event is logged.

Communication Ports

A front mounted RS232 and a rear RS485 port allow easy user interface via a PC. ModBus® RTU protocol is used for all ports. The relay supports baud rates from 300 to 19,200 bps. Up to 32 GE Multilin devices can be addressed on a single communications channel. A unique address must be assigned to each relay via a setting when multiple relays are connected.

MultiNet™ compatible

MultiNet is a communications module that provides GE Multilin serial ModBus IEDs with ModBus TCP/IP communications over Ethernet, allowing connection to fiber optic LAN and WAN network systems.

MultiNet has the capability to connect up to 32 serial ModBus devices eliminating complex wiring and additional communications converters, and providing a streamlined and economical Ethernet hub. Unlike most communications converters that are designed for commercial use, MultiNet is environmentally hardened to withstand severe utility and industrial conditions.

- Converts Modbus RTU over RS485 into Modbus TCP/IP over Ethernet
- Supports both 10BaseT and 10BaseF fiber connections
- Connect up to 32 RS485 serial devices to an Ethernet network
- Modbus TCP/IP provides multiple SCADA masters allowing simultaneous communications to the same IED
- Flexible mounting options allow retro-fit to existing devices
- Industrially hardened for utility and industrial applications
- Simple "plug & play" device setup with EnerVista™ software

MultiNet gives you the ability to connect M II serial devices to new or existing Ethernet networks. It has a 10BaseF fiber optic interface that provides high EMI/RFI immunity and inherent electrical isolation over long cable runs. MultiNet setup is simple, with a Windows® based EnerVista™ software program for installing and configuring the communication drivers.

EnerVista™ Software

The EnerVista™ Suite is an industry-leading set of software programs that simplifies every aspect of using the relay. The EnerVista™ suite provides all the tools to monitor the status of the protected asset, maintain the relay, and integrate information measured into DCS or SCADA monitoring systems. Convenient waveform and Sequence of Events viewers are an integral part of the MII Setup software included with every MIG II relay, to carry out postmortem event analysis to ensure proper protection system operation.

EnerVista™ Launchpad

EnerVista™ Launchpad is a powerful software package that provides users with all of the setup and support tools needed for configuring and maintaining GE Multilin products. The setup software within Launchpad allows configuring devices in real-time by communicating using serial, Ethernet, or modem connections, or offline by creating setting files to be sent to devices at a later time.

Included in Launchpad is a document archiving and management system that ensures critical documentation is up-to-date and available when needed. Documents made available include:

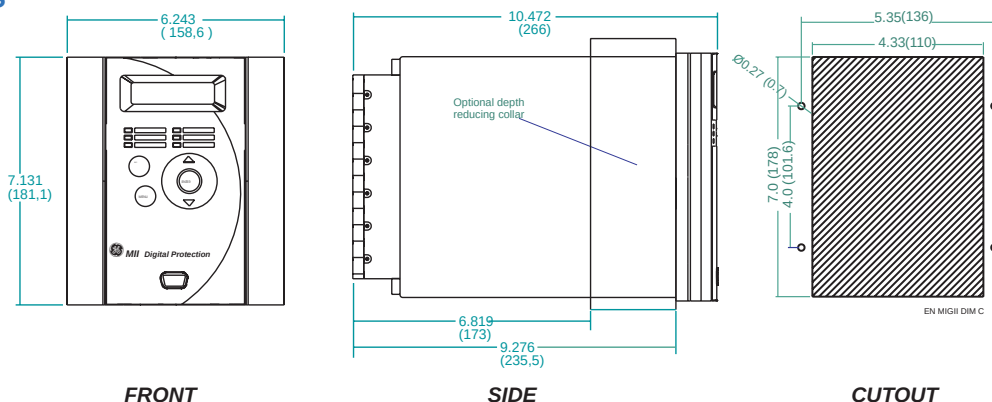
- Manuals
- Application Notes
- Guideform Specifications
- Brochures
- Wiring Diagrams
- FAQs
- Service Bulletins

Viewpoint Monitoring

Viewpoint Monitoring is a simple-to-use and full-featured monitoring and data recording software package for small systems. Viewpoint Monitoring provides a complete HMI package with the following functionality:

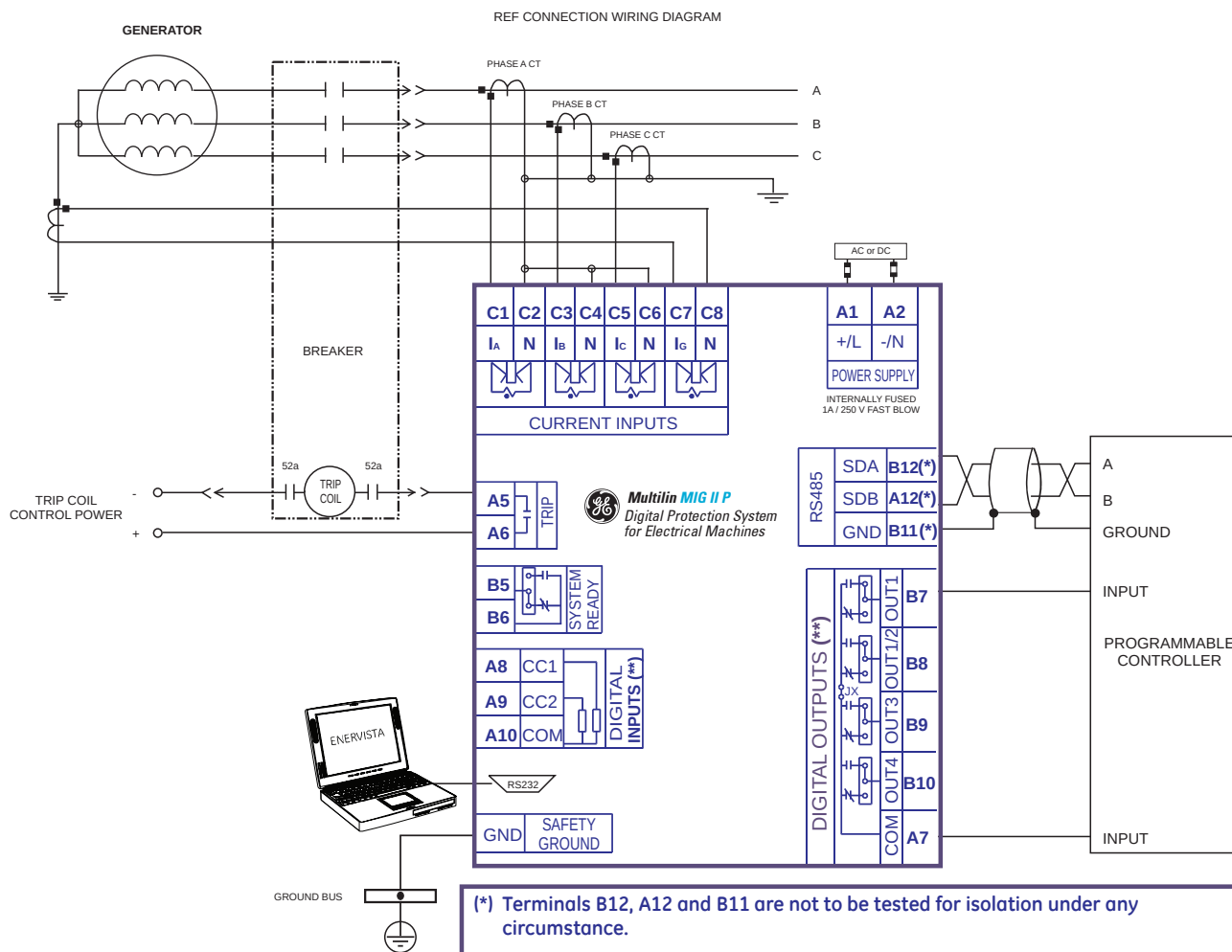
- Plug-&-Play Device Monitoring
- System Single-Line Monitoring & Control
- Annunciator Alarm Screens
- Trending Reports
- Automatic Event Retrieval
- Automatic Waveform Retrieval

Dimensions



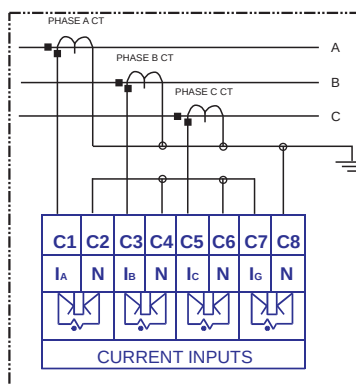
Typical Wiring

Note: Only for reference. For particular connections for any MIG II model, please refer to its external connections drawing.

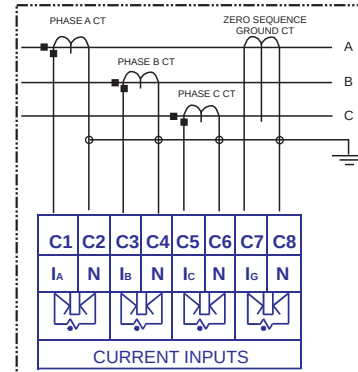


WARNING:
GROUND PC TO RELAY GROUND.
OTHERWISE USE UNGROUNDED PC

ALTERNATIVE CT WIRING FOR
RESIDUAL GROUND DETECTION



ZERO SEQUENCE
GROUND SENSING CONNECTION



Technical Specifications

PROTECTION

PHASE AND GROUND TIME OVERCURRENT (51P, 51G)

Current:	Fundamental
Pickup level:	0.1 - 2.4 FLC in steps of 0.01
Drop out level:	97% of the pickup level
Accuracy:	±3% in the complete range
Curves	IEC or ANSI inverse, very inverse, extremely inverse, user defined (depending on model). Definite time 0.00 to 600.00 s in steps of 0.01 s
Reset type:	Instantaneous
Timer accuracy:	±50 ms or 3% for I > 1.2 times the pickup level

PHASE AND GROUND INSTANTANEOUS OVERCURRENT (50P, 50G)

Current:	Fundamental
Pickup level:	0.1 - 30 FLC in steps of 0.01
Drop out level:	97% of the pickup level
Accuracy:	±3% in the complete range
Overreach:	< 2%
Timer:	0.00 to 600.00 s in steps of 0.01 s
Reset type:	Instantaneous
Timer accuracy:	+50ms for timer set to 0 ms ±20 ms or 3% of total time for timer set to > 0 ms

THERMAL IMAGE (49)

Current:	Equivalent fundamental
Tap level:	0.1 - 2.4 FLC in steps of 0.01
Reset type:	97% of the tap level
Accuracy:	±3% in the complete range
Heating constant t1:	3 to 600 minutes in steps of 1 min.
Heating constant t2:	1 to 6 times t1 in steps of 1 t1
Overload alarm:	70-100% of Itap in steps of 1% Itap

Tripping time accuracy:	5% for times over 5 s.
Negative sequence constant K:	1 to 8 in steps of 1

CURRENT UNBALANCE (46)

Current:	Negative sequence fundamental
Pickup level:	0.05 to 0.99 FLC in steps of 0.01
Curve:	In accordance to $k = I_2 \cdot t$
K Constant:	1 to 100 in steps of 1
Definite time range:	0.00 to 600.00 s in steps of 0.01 s

Tripping time accuracy:	±250 ms or 5%
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LOCKED ROTOR (48)

Current:	Fundamental
Pickup level:	1.01 to 10 FLC in steps of 0.01 FLC

Time:	
Tripping time accuracy:	±250 ms or 5%

UNDERCURRENT (37)

Current:	Fundamental
Pickup level:	0.1 to 10 FLC in steps of 0.1
Timing:	0.00 to 600.00 s in steps of 0.01 s

Tripping time accuracy:	±250 ms or 5%
-------------------------	---------------

MAXIMUM NUMBER OF STARTS (66)

Current:	Fundamental
Pickup level:	0 to 10 in steps of 1
Start blocking timer:	to 100 minutes in steps of 1 min.
Tripping time accuracy:	±250 ms or 5%

RESTRICTED GROUND DIFFERENTIAL (87R)

Current:	Fundamental
Minimum 3Iog Sensitivity (S):	2% In
Minimum 3Iog sensitivity (K1):	2% In
Timer:	0.00 - 99.99 s
Tripping time accuracy:	±500 ms or 5%

COMMUNICATIONS

Local communication:	2x16 LCD display; 5 button front keypad
----------------------	---

Remote communication:	
(Local or remote PC and communications network):	
Mode:	Modbus RTU
Baud rate:	300 to 19200 bps DB9 connector for RS232 ports on the front (1) and RS485 on the rear

OUTPUTS

TRIPPING CONTACTS

Contact capacity:	
Max. Operating Voltage:	440 Vca
Continuous current:	16 A
Make and Carry:	48 A
Breaking:	4000 VA

OUTPUT RELAYS

Configuration:	6 electromechanical, form C silver alloy suited for inductive loads
Contact Material:	8 ms

Operating Time:	
Maximum ratings for 100,000 operations:	

Voltage	Make & Carry	M&C Cont.	Break 0.2 seg	Max Load
DC Resist	24 Vdc	16A	48A	16A
	48 Vdc	16A	48A	2.6A
	125 Vdc	16A	48A	0.6A
	250 Vdc	16A	48A	0.5A
AC Resist	120Vdc	16A	48A	16A
	250 Vdc	16A	48A	16A
AC Induct PF=0.4	250 Vdc	10A	30A	10A

INPUTS

AC CURRENT

Secondary Rated Current:	1A or 5 A depending on the selected model
Frequency:	50 / 60 Hz (The unit can be set to 50 or 60 Hz)
Relay Burden:	< 0.2 VA @ In = 5A secondary 0.08 VA @ In = 1A secondary
Current Withstand:	4 x In continuously. 100 x In for 1 sec.

DIGITAL INPUTS

High Range	
Voltage Threshold:	75 Vdc
Maximum Voltage:	300 Vdc
Relay Burden:	5 mA @ 300 Vdc
Low Range	
Voltage Threshold:	12 Vdc
Maximum Voltage:	57 Vdc
Relay Burden:	2 mA @ 57 Vdc

POWER SUPPLY

LOW RANGE

Rated DC Voltage:	24 to 48 Vdc
Min./Max. DC Voltage:	19 / 58 Vdc

HIGH RANGE

Rated DC Voltage:	110 to 250 Vdc
Min./Max. DC Voltage:	88 / 300 Vdc
Rated AC Voltage:	110 to 230 Vac @ 48 - 62 Hz
Min./Max. AV Voltage:	88 / 264 Vac @ 48 - 62 Hz
Power Consumption:	Max. = 10 W
Backup time:	(date, time and log memory) without power supply voltage > 1 week

METERING

THERMAL CAPACITY

Current Circuits	
Continuously:	4 x In
During 3 Sec:	50 x In
During 1 Sec:	100 x In

MECHANICAL CHARACTERISTICS

- Metallic package in 1/4 19" rack and 4 units high
- Protection class IP52 (according to IEC 529)

ENVIRONMENTAL

Temperature:	
Storage:	-40°C to +80°C
Operation:	-20°C to +60°C.
Humidity:	Up to 95% without condensing.

PACKAGING

Approximate Weight:	
Net:	2.7 kgs (5.9 lbs)
Ship:	3.2 kgs (7 lbs)

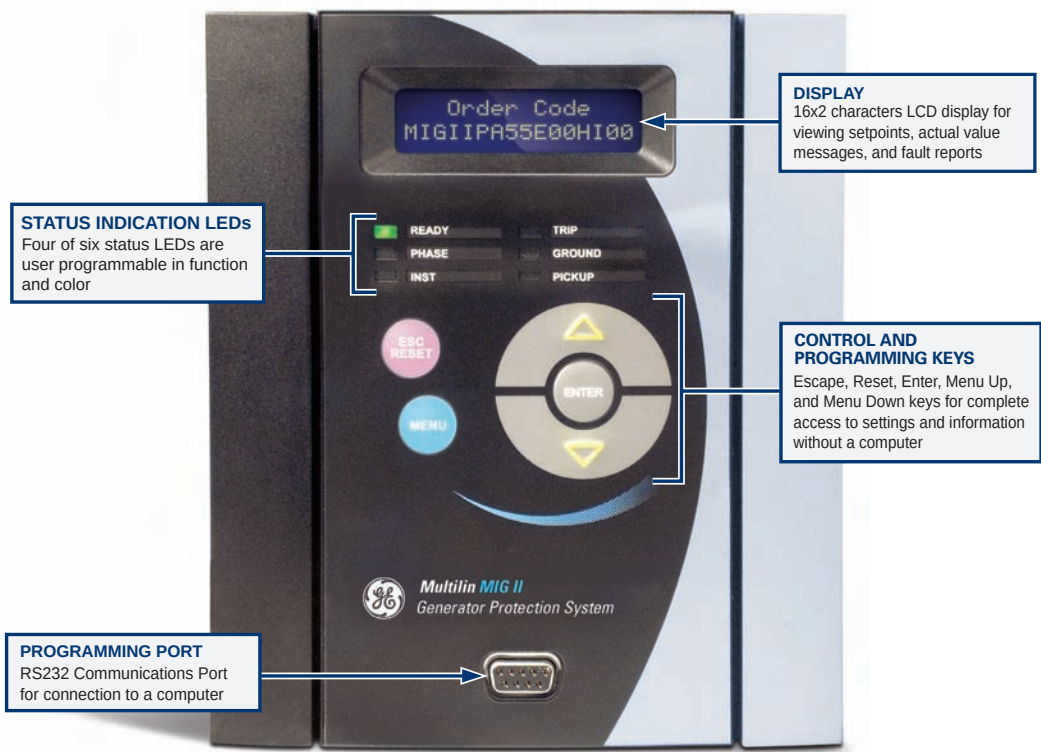
TYPE TESTS

TEST	STANDARD	CLASS
Insulation Test Voltage:	IEC 60255-5	2kV, 50/60 Hz 1 min
Surge Test Voltage:	IEC 60255-5	5 kV, 0.5 J. (3 positive pulses and 3 negative.)
1 MHz Interference:	IEC 60255-22-1	III
Electrostatic Discharge:	IEC 60255-22-2 EN 61000-4-2	IV 8 kV in contact, 15 kV through air
Radio interference:	IEC 60255-22-3: 40 MHz, 151 MHz, 450 MHz and cellular phone.	III
Radiated Electromagnetic fields with amplitude modulation:	ENV 50140	10 V/m
Radiated Electromagnetic fields with amplitude modulation. Common mode.	ENV 50141	10 V/m
Radiated Electromagnetic fields with frequency modulation.	ENV 50204	10 V/m
Fast Transients:	ANSI/IEEE C37.90.1 IEC 60255-22-4 BS EN 61000-4-4	IV IV IV
Magnetic fields at industrial frequency:	EN 61000-4-8	30 A/Vm
Power Supply interruptions:	IEC 60255-11	
Temperature:	IEC 57 (CO) 22	
RF Emission:	EN 55011	B
Sinusoidal Vibration:	IEC 60255-21-1	II
Shock:	IEC 60255-21-2	I
Insulation Test:	IEC255-5 (Tested on CTs, Power Supply terminals, Contact Inputs and Contact Outputs)	

APPROVALS

CE:	Conforms to 89/336/CEE and 73/23/CEE
ISO:	Manufactured to an ISO9001 registered program

User Interface



Ordering

To order select the basic model and the desired features from the Selection Guide below:

MIG II	*	*	*	*	E	0	0	*	0	0	Description
Application	P	Q									Generator protection elements
Curves		A	I	U							Motor protection elements
PHASE CT			5	1							ANSI
GROUND CT					5						IEC
					1						IAC
POWER SUPPLY								LO			CT In = 5 A (0.5 - 12 A)
								HI			CT In = 1 A (0.1 - 2.4 A)
											CT In = 5 A (0.5 - 12 A)
											CT In = 1 A (0.1 - 2.4 A)
											CT In = 1 A (0.005 - 0.12 A) *
											24 - 48 Vdc (19.2 - 57.6 Vdc)
											110 - 250 Vdc (88 - 300 Vdc)
											110 - 230 Vac (88 - 264 Vac)

Visit www.GEMultilin.com/MIGII to:



- View Guideform specifications
- Download the instruction manual
- Review applications notes and support documents
- Buy a MIG II online
- View the MIG II brochure

PowerLogic power-monitoring units

ION8650

Technical data sheet

2011



ION8650

Functions and characteristics

PB107500



PowerLogic ION8650 socket meter

Used to monitor electric energy provider networks, service entrances and substations, PowerLogic ION8650 meters are ideal for independent power producers and cogeneration applications that need to accurately measure energy bi-directionally in both generation and stand-by modes. These meters give utilities the tools to manage complex energy supply contracts that include commitments to power quality. Integrate them with our ION Enterprise™ operations software or other energy management and SCADA systems through multiple communication channels and protocols, including Itron MV-90.

Applications

- Revenue metering
- Co-generation and IPP monitoring
- Compliance monitoring
- Power quality analysis
- Demand and power factor control
- Load curtailment
- Equipment monitoring and control
- Energy pulsing and totalisation
- Instrument transformer correction

Main characteristics

ANSI Class 0.2 and IEC 62053-22/23 Class 0,2S metering

For interconnection points on medium, high, and ultra-high voltage networks; twice as accurate as current IEC and ANSI Class 0.2 standards over all conditions and including single wide range current measurement.

Power quality compliance monitoring

Monitor compliance with international quality-of-supply standards (IEC 61000-4-30 Class A/S, EN50160, IEC 61000-4-7, IEC 61000-4-15, IEEE 1159, IEEE 519).

Digital fault recording

Simultaneous capture of voltage and current channels for sub-cycle disturbance transients.

Complete communications

Multi-port, multi-protocol ports including serial, infrared, modem and ethernet. Simultaneously supports multiple industry standard protocols including: Itron MV-90, Modbus, Modbus Master, DNP 3.0 and IEC 61850.

Multiple tariffs and time-of-use

Apply tariffs, seasonal rate schedules to measure energy and demand values for time periods with specific billing requirements.

Multiple setpoints for alarm and control functions

A total of 65 setpoints are configurable for 1-second or 1/2 - cycle operation.

Power quality summary

Consolidation of all the power quality characteristics into a single trendable index.

Integrate with software

Easily integrate with ION Enterprise operations software or other energy management systems; MV90, DNP, Modbus, IEC 61850.

Transformer/line loss compensation

Determine technical system losses in real time.

Instrument transformer correction

Save money and improve accuracy by correcting for less accurate transformers.

Alarm notification via email

High-priority alarms, data logs sent directly to the user's PC. Instant notification of power quality events by email.

Part numbers

ION8650 meters	
ION8650A	M8650A
ION8650B	M8650B
ION8650C	M8650C

See page 6 for complete part number descriptions.

Options

See page 7.

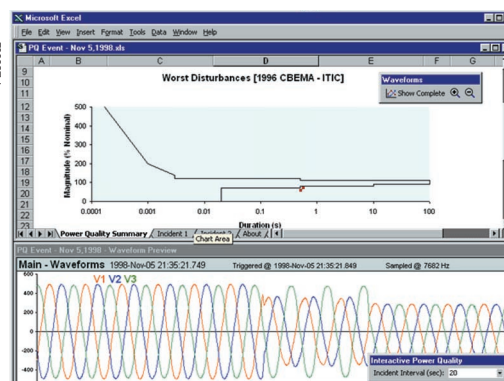
PE86002-95



PowerLogic ION8650 socket meter.

- 1 Terminals
- 2 Optical port
- 3 Main display status bar
- 4 Watt LED
- 5 Navigation, ALT/Enter buttons
- 6 VAR LED
- 7 Nameplate label
- 8 Demand reset switch

PE86002



Disturbance waveform capture and power quality report

Selection guide		ION8650 A	ION8650 B	ION8650 C
General				
Use on LV and HV systems		■	■	■
Current accuracy		0.1 % reading	0.1 % reading	0.1 % reading
Voltage accuracy		0.1 % reading	0.1 % reading	0.1 % reading
Power accuracy		0.1 % reading	0.1 % reading	0.1 % reading
Samples/cycle		1024	1024	1024
Instantaneous values				
Current, voltage, frequency		■	■	■
Active, reactive, apparent power Total & per phase		■	■	■
Power factor Total & per phase		■	■	■
Current measurement range (autoranging)		0.01 - 20A	0.01 - 20A	0.01 - 20A
Energy values				
Active, reactive, apparent energy		■	■	■
Settable accumulation modes		■	■	■
Demand values				
Current Present & max. values		■	■	■
Active, reactive, apparent power Present & max. values		■	■	■
Predicted active, reactive, apparent power		■	■	■
Synchronisation of the measurement window		■	■	■
Demand modes: Block (sliding), thermal (exponential)		■	■	■
Power quality measurements				
Harmonic distortion Current & voltage		■	■	■
Individual harmonics Via front panel		63	63	31
Waveform and transient capture		■	-	-
Harmonics: magnitude, phase, and interharmonics		50	40	-
Detection of voltage sags and swells		■	■	■
IEC 61000-4-30 class A/S		A	S	-
IEC 61000-4-15 (Flicker)		■	■	-
High speed data recording (down to 10 ms)		■	■	-
EN50160 compliance reporting		■	■	-
Programmable (logic and math functions)		■	■	■
Data recording				
Onboard Memory (in Mbytes)		128	64	32
Revenue logs		■	■	■
Event logs		■	■	■
Historical logs		■	■	■
Harmonics logs		■	■	■
Sag/swell logs		■	■	■
Transient logs		■	-	-
Time stamping to 1 ms		■	■	■
GPS synchronisation (IRIG-B standard)		■	■	■
Display and I/O				
Front panel display		■	■	■
Wiring self-test (requires PowerLogic ION Setup)		■	■	■
Pulse output (front panel LED)		2	2	2
Digital or analogue inputs ⁽¹⁾ (max)		11	11	11
Digital or analogue outputs ⁽¹⁾ (max, including pulse output)		16	16	16
Direct connection voltage		277V ⁽²⁾	277V ⁽²⁾	277V ⁽²⁾
Communication				
Infrared port		1	1	1
RS 485 / RS 232 port		1	1	1 ⁽³⁾
RS 485 port		1	1	1 ⁽³⁾
Ethernet port (Modbus/TCP/IP protocol) with gateway		1	1	1 ⁽³⁾
Internal modem with gateway (ModemGate)		1	1	1 ⁽³⁾
HTML web page server (WebMeter)		■	■	■
IRIG-B port (unmodulated IRIG B00x time format)		1	1	1
Modbus TCP Master / Slave (Ethernet port)		■ / ■	■ / ■	- / ■
Modbus RTU Master / Slave (Serial ports)		■ / ■	■ / ■	- / ■
DNP 3.0 through serial, modem, and I/R ports		■	■	■

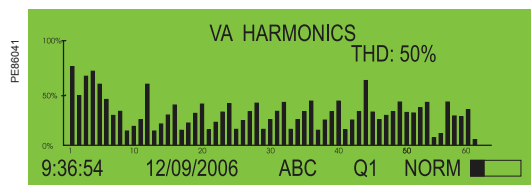
(1) With optional I/O Expander.

(2) For 9S, and 36S only. For 35S system up to 480V line-to-line.

(3) Infrared port plus two other communications ports maximum

ION8650

Functions and characteristics (cont.)



PowerLogic ION8650 front panel harmonic display.



ION8650 front panel phasor display and table.

Electrical characteristics

Type of measurement	True rms 1024 samples per cycle
Measurement accuracy	Current and voltage 0.1 % Reading Power 0.1 % Frequency ±0.001 Hz Power factor 0.1 % Energy 0.1 %, twice as accurate as ANSI Class 0.2 and IEC 62053-22/23 (0,2S)
Data update rate	0.5 cycle or 1 second (depending on value)
Input-voltage characteristics (1)	Nominal voltage 57V to 277VLL rms autoranging (9S) 100V to 480VLL rms autoranging (35S) Maximum voltage 347 VLN rms, 600 VLL rms (9S) 600 VLL rms (35S) Impedance 5 MΩ /phase (phase-Uref/Ground) Inputs V1, V2, V3, VREF
Input-current characteristics	Rated nominal/current class 1A, 2 A, 5 A and/or 10 A (Class 1/2/10/20) Accuracy range 0.01 - 20 A autoranging (standard range) Measurement range 0 001 - 24 A Permissible overload 500A rms for 1 second, non-recurring (standard) Burden per phase Socket - 0.05VA at 5A (0.002 Ω max) Switchboard - 0.05VA at 1A (0.05 Ω max)
Power supply	Standard power supply, 120-277 VAC 120-277 VLN RMS (-15%/+20%) 47-63 Hz or 120-480 VLL RMS (-15%/+20%) 47-63 Hz (35S) Auxiliary power cable assembly, 65-120 VAC AC: 65-120 (+/- 15%) VLN RMS, 47-63 Hz DC: 80-160 (+/- 20%) VDC Auxiliary power cable assembly, 160-277 VAC AC: 160-277 (+/- 20%) VLN RMS, 47-63 Hz DC: 200-300 (+/- 20%) VDC Ride-through time, 120-277 VAC (Standard power supply) Min 100 ms (6 cycles at 60 Hz at 96 VAC), 200 ms (12 cycles at 60 Hz at 120 VAC), 800 ms (48 cycles at 60 Hz at 240 VAC)
Input/outputs	Digital outputs (Form C) 4 Solid state relays (130 V AC/ 200 V DC) 50 mA AC/DC Digital outputs (Form A) 4 Solid state relays (via optional I/O Expander) Digital inputs 4 Solid state inputs (via optional I/O Expander)

Mechanical characteristics

Weight	7.0 kg
IP degree of protection	Socket Front IP65, back IP51 Switchboard Front IP50, back IP30
Dimensions	Socket 178 x 237 mm Switchboard 285 x 228 x 163 mm

Environmental conditions

Operating temperature	-40°C to +85°C
Display operating range	-20°C to +60°C
Storage temperature	-40°C to +85°C
Humidity rating	5 to 95 % RH non-condensing
Pollution degree	2
Installation category	Cat III
Dielectric withstand	2.5kV, 50Hz, 1 min

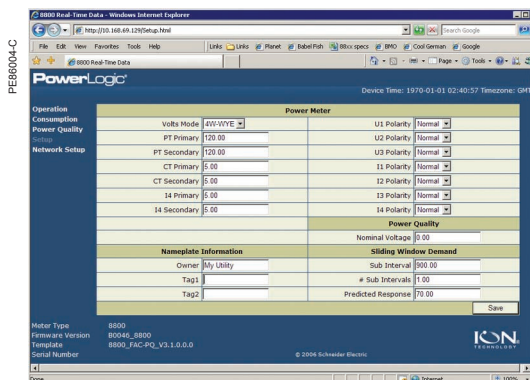
Electromagnetic compatibility

Electrostatic discharge	IEC 61000-4-2
Immunity to radiated fields	IEC 61000-4-3
Immunity to fast transients	IEC 61000-4-4
Immunity to surge	IEC 61000-4-5
Immunity conducted	IEC61000-4-6
Damped oscillatory waves immunity	IEC61000-4-12
Conducted and radiated emissions	CISPR 22 (class B)

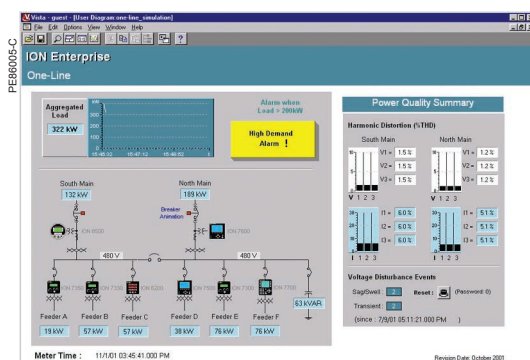
Safety

Europe	As per IEC62052-11
North America	As per ANSI C12.1

(1) Specifications are limited by the operating range of the power supply if a non-aux power supply is used.



Example embedded webserver page (WebMeter) showing realtime values.



Communication

RS 232 / RS 485 port (COM1)	User-selectable RS 232 or RS 485. 300 - 115,200 bauds (RS485 limited to 57,600 bps); protocols: ION, Modbus/RTU/Mastering, DNP 3.0, GPSTIME/DATUM.
Internal modem port (COM2)	300 bps-57,600 bauds (automatic detection supported)
ANSI 12.18 Type II optical port (COM3)	Up to 19200 bauds
RS 485 port (COM4)	Up to 57,600 bauds, Modbus, direct connection to a PC or modem
Ethernet port	10/100 BaseT, RJ45 connector, protocols: DNP, ION, Modbus/TCP/Mastering, IEC 61850
EtherGate	Up to 31 slave devices via serial ports
ModemGate	Up to 31 slave devices
Embedded web server (WebMeter)	4 standard pages, up to 5 customisable pages

Firmware characteristics

High-speed data recording	Up to 1/2-cycle interval burst recording, stores detailed characteristics of disturbances or outages. Trigger recording by a user-defined setpoint, or from external equipment. Can log data only during critical event to conserve memory
Harmonic distortion	Up to 63rd harmonic for all voltage and current inputs
Dip/swell detection	Analyse severity/potential impact of dips and swells: - magnitude and duration data suitable for plotting on voltage tolerance curves - per phase triggers for waveform recording or control operations
Instantaneous	High accuracy (1s) and high-speed (1/2 cycle) measurements, including true rms per phase / total for: - voltage and current - active power (kW) and reactive power (kVAR) - apparent power (kVA) - power factor and frequency - voltage and current unbalance - phase reversal
Load profiling	Channel assignments are user configurable: - 800 channels via 50 data recorders (feature set A), - 720 channels via 45 data recorders (feature set B), - 64 channels via 4 data recorders (feature set C). Configure for historical trend recording of energy, demand, voltage, current, power quality, other measured parameter. Recorders can trigger on time interval basis, calendar schedule, alarm/event condition, manually.
Waveform captures	Simultaneous capture of all voltage and current channels - sub-cycle disturbance capture (16 to 1024 samples/cycle)
Alarms	Threshold alarms: - adjustable pickup and dropout setpoints and time delays, numerous activation levels possible for a given type of alarm - user-defined priority levels - boolean combination of alarms possible
Advanced security	Up to 16 users with unique access rights. Perform resets, time syncs, or meter configurations based on user privileges.
Transformer correction	Correct for phase / magnitude inaccuracies in current transformers (CTs), potential transformers (PTs)
Memory	32 Mbytes (C), 64 Mbytes (B), 128 Mbytes (A)
Firmware update	Update via the communication ports
Display characteristics	
Type	FSTN transreflective LCD
Backlight	LED
Languages	English

PEB0043 C

1	2	3	4	5	6	7	8	9	10	11					
M	8	6	5	0	A	1	C	0	E	5	C	1	A	0	A

Example product part number.

- 1 Model.
- 2 Feature set.
- 3 Form factor.
- 4 Current inputs.
- 5 Voltage inputs.
- 6 Power supply.
- 7 System frequency.
- 8 Communications.
- 9 Input/output options.
- 10 Security.
- 11 Special order options.

PowerLogic ION8650 meter with switchboard case

PB107507



Part Numbers

Item	Code	Description
1 Model	M8650	Schneider Electric advanced tariff meter.
2 Feature Set	A	128MB Memory Class A power quality analysis, waveforms and transient capture with 1024 samples/cycle.
	B	64MB memory, energy meter Class S EN50160 power quality monitoring.
	C	32MB memory, basic tariff/energy metering (4 data recorders, 64 channels).
3 Form Factor (1)	0	Form 9S/29S/36S Base, 57-277 VLN (autoranging) 3-Element, 4-Wire / 2 1/2-Element, 4-Wire
	1	Form 35S Base - 120-480 VLL (autoranging) 2-Element, 3-Wire
	4	Form 9/29/35/36S FT21 Switchboard (meter + case) with break out panel
	7	Form 9/29/35/36S FT21 Switchboard (meter + case) with break out cable
4 Current Inputs	C	1, 2 or 5 Amp nominal, 20 Amp full scale (24 Amp fault capture, start at 0.001 A)
5 Voltage Inputs	0	Standard (see Form Factor above)
6 Power Supply	E	Form 9/29/35/36S, (socket) and Form 9, 36 (FT21 switchboard): 120-277 VAC. Form 35S (socket) and Form 35 (FT21 switchboard): 120-480 VAC. Powered from the meter's voltage connections, low end measurement range limited to 120 VLL.
	H	Auxiliary Power Pigtail: 65-120 VAC or 80-160 VDC (power from external source)
	J	Auxiliary Power Pigtail: 160-277 VAC or 200-300 VDC (power from external source)
7 System Frequency	5	Calibrated for 50 Hz systems.
	6	Calibrated for 60 Hz systems.
8 Communications	A 0	Infrared optical port, RS 232/RS 485 port, RS 485 port
	C 1	Infrared optical port, Ethernet (10/100 BaseT), RS 232/485 port, RS 485 port (note: in addition to infrared optical port, Feature Set C can use any two ports (configurable)), 56k universal internal modem (RJ11)
	M 1	Infrared optical port, RS 232/485 port, RS 485 port (note: in addition to infrared optical port, Feature Set C can use any two ports (configurable)), 56k universal internal modem (RJ11)
	E 0	Infrared optical port, Ethernet (10/100 BaseT), RS 232/485 port, RS 485 port (note: in addition to infrared optical port, Feature Set C can use any two ports (configurable)).
9 Onboard I/O	A	None.
	B	4 Form C digital outputs, 3 Form A digital inputs.
	C	4 Form C digital outputs, 1 Form A digital output, 1 digital input.
10 Security	0	Password protected, no security lock
	1	Password protected with security lock enabled (requires removal of outer cover to configure billing parameters)
	3	RMICAN (Measurement Canada approved)
	4	RMICAN-SEAL (Measurement Canada approved, and factory sealed)**
11 Special Order	A	None

(1) Specifications are limited by the operating range of the power supply if a non-aux power supply is used.

PE86044

1 2 3

P 8 5 0 E A 2

Example order code. Use this group of codes when ordering the I/O Expander.

- 1 Digital / Analog I/O.
- 2 I/O option.
- 3 Cable option.



Part numbers (cont.)

I/O Expander

Digital/Analog I/O	P850E	Schneider Electric I/O Expander for ION8600 meters: Inputs and Outputs for energy pulsing, control, energy counting, status monitoring, and analog interface to SCADA.
I/O option	A	External I/O box with 8 digital inputs and 8 digital outputs (4 Form A, 4 Form C)
	B	External I/O box with 8 digital inputs and 4 digital outputs (4 Form C) and 4 analog outputs (0 to 20mA)
	C	External I/O box with 8 digital inputs and 4 digital outputs (4 Form C) and 4 analog outputs (-1mA to 1mA)
	D	External I/O box with 8 digital inputs and 4 digital outputs (4 Form C) and 4 analog outputs (two -1 to 1 mA, and two 0 to 20 mA outputs)
Cable option	0	No cable - cables for the I/O box are no ordered as a separate part number. Refer to part numbers: CBL-8X00IOE5FT, CBL-8X00IOE15FT and CBL-8XX0-BOP-IOBOX under Connector cables, below.

A-base adapters

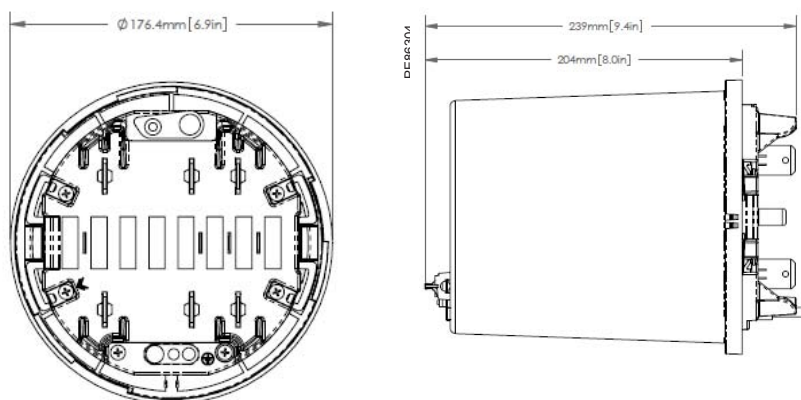
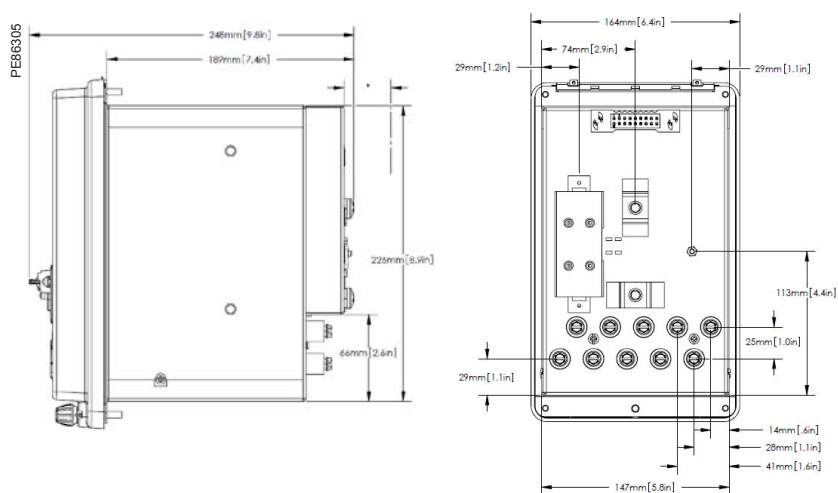
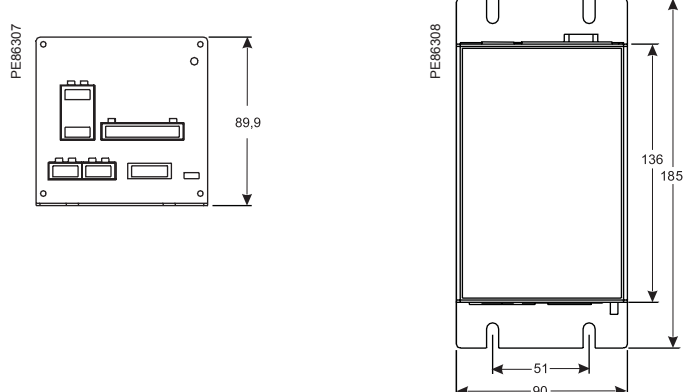
A-BASE-ADAPTER-9	Form 9S to Form 9A adapter
A-BASE-ADAPTER-35	Form 35S to Form 35A adapter

Optical communication interface

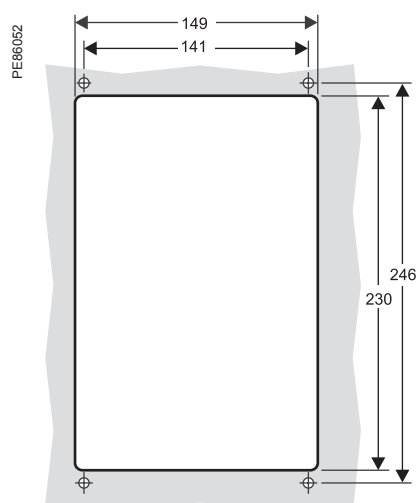
OPTICAL-PROBE	Optical communication interface
----------------------	---------------------------------

Connector cables

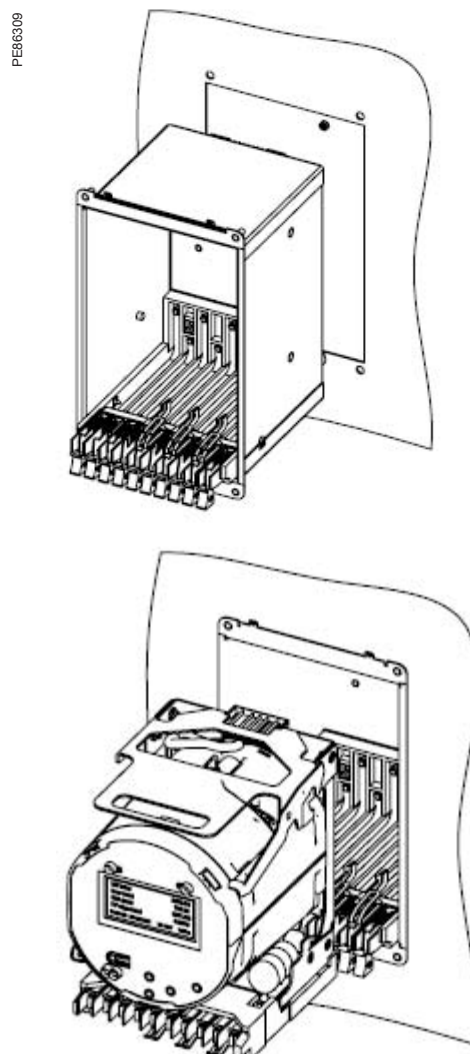
CBL-8X00BRKOUT	5ft Breakout Cable: 24-pin female Molex connector to one DB9 female connector for RS 232, and 2 sets of twisted pair wires for two RS 485 port connections
CBL-8X00IOE5FT	5ft extension cable, mates with 24-pin male Molex connector from the meter to the 24-pin female Molex connector on the I/O Expander box (not for use with breakout panel E8, F8 & G8 form factors)
CBL-8X00IOE15FT	15ft extension cable, mates with 24-pin male Molex connector from the meter to the 24-pin female Molex connector on the I/O Expander box (not for use with breakout panel E8, F8 & G8 form factors)
CBL-8XX0-BOP-IOBOX	6ft connector cable, 24-pin male to 14-pin male Molex connector for connecting an ION8650 meter with breakout panel to an I/O Expander Box

ION8650 socket dimensions**ION8650 switchboard dimensions****I/O Expander dimensions**

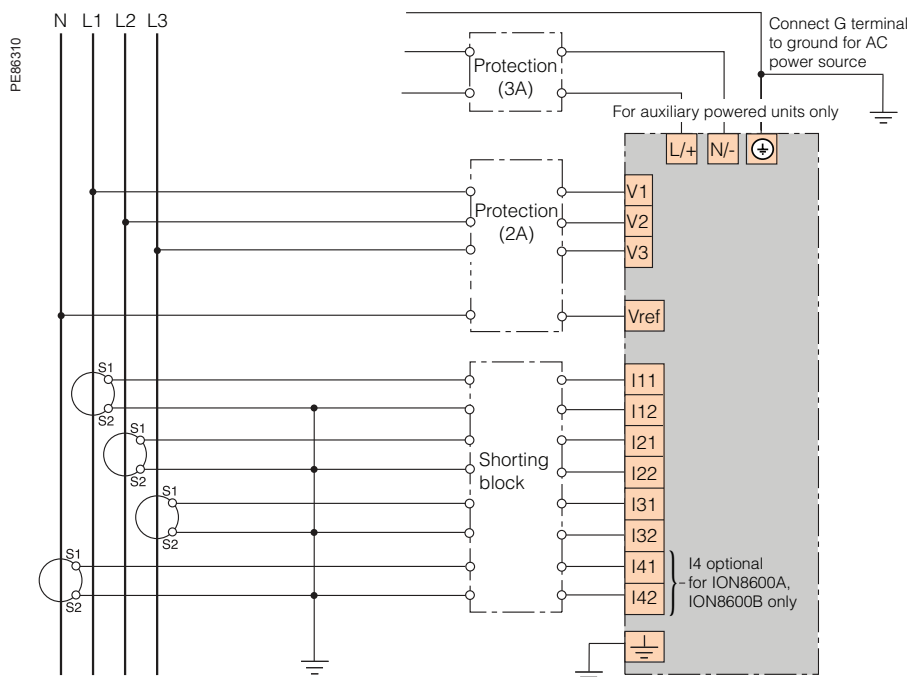
ION8650 suggested switchboard mounting dimensions



ION8650 switchboard mounting

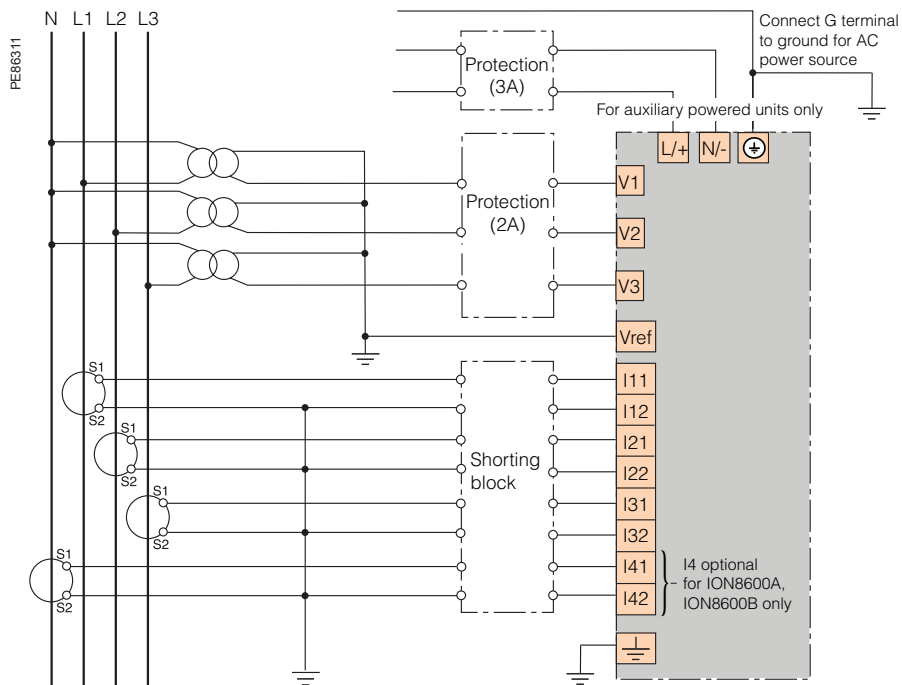


4-Wire 3 element direct connection



Connection representation only. Other types of connection are possible. See product installation guide for complete wiring and communication connection details.

4-Wire 3 element, 3 PT connection



Connection representation only. Other types of connection are possible. See product installation guide for complete wiring and communication connection details.

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GE Industrial Systems

750/760 Feeder Management Relay®

Instruction Manual

Firmware Rev: 5.X

Manual P/N: 1601-0044-AP (GEK-106293D)

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GE Multilin's Quality
Management System is
registered to ISO9001:2000

QMI # 005094
UL # A3775

2.1.1 DESCRIPTION

The 750/760 Feeder Management Relays are microprocessor-based units intended for the management and primary protection of distribution feeders, as well as for the management and backup protection of buses, transformers, and transmission lines. The 760 relay is particularly suited to overhead feeders, where automatic reclosing is normally applied.

Each relay provides protection, control, and monitoring functions with both local and remote human interfaces. They also display the present trip/alarm conditions, and most of the more than 35 measured system parameters. Recording of past trip, alarm or control events, maximum demand levels, and energy consumption is also performed.

These relays contain many innovative features. To meet diverse utility standards and industry requirements, these features have the flexibility to be programmed to meet specific user needs. This flexibility will naturally make a piece of equipment difficult to learn. To aid new users in getting basic protection operating quickly, setpoints are set to typical default values and advanced features are disabled. These settings can be reprogrammed at any time.

Programming can be accomplished with the front panel keys and display. Due to the numerous settings, this manual method can be somewhat laborious. To simplify programming and provide a more intuitive interface, setpoints can be entered with a PC running the 750/760PC software provided with the relay. Even with minimal computer knowledge, this menu-driven software provides easy access to all front panel functions. Actual values and setpoints can be displayed, altered, stored, and printed. If settings are stored in a setpoint file, they can be downloaded at any time to the front panel program port of the relay via a computer cable connected to the serial port of any personal computer.

A summary of the available functions and a single-line diagram of protection and control features is shown below. For a complete understanding of each features operation, refer to Chapter 5: Setpoints. The logic diagrams include a reference to every setpoint related to a feature and show all logic signals passed between individual features. Information related to the selection of settings for each setpoint is also provided.

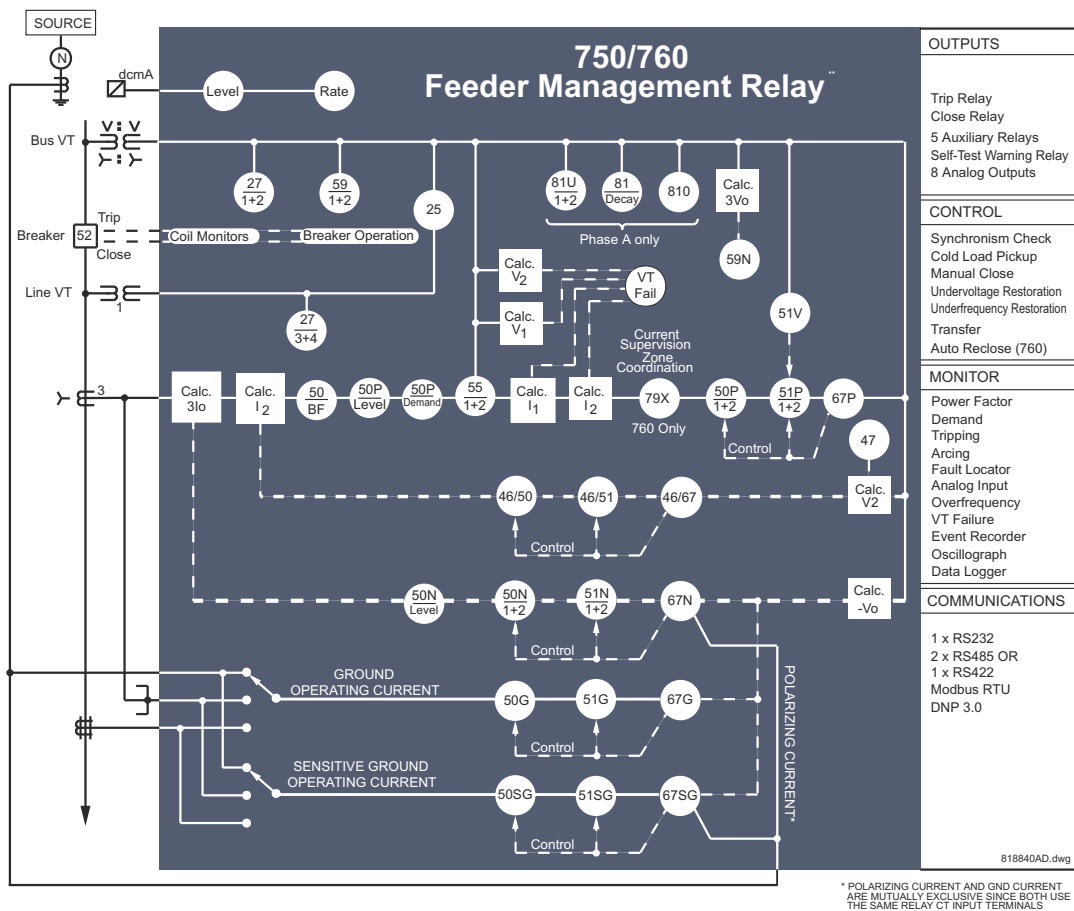


Figure 2-1: FUNCTIONAL BLOCK DIAGRAM

2.1.3 ORDERING

The relay model number will be indicated on the side of the drawout unit. This identification label can be interpreted with the following order code.

Table 2–1: 750/760 ORDER CODES

	750	–	*	–	*	–	*	–	*	–	*		750 Feeder Management Relay
	760	–	*	–	*	–	*	–	*	–	*		760 Feeder Management Relay
Base Unit	750												750 Feeder Management Relay
	760												760 Feeder Management Relay with Autoreclose
Phase Current Inputs		P1											1 A Phase Current Inputs
		P5											5 A Phase Current Inputs
Zero-Sequence Current Inputs			G1										1 A Zero-Sequence Current Inputs
			G5										5 A Zero-Sequence Current Inputs
Sensitive Ground Current Input				S1									1 A Sensitive Ground Current Input
				S5									5 A Sensitive Ground Current Input
Control Power					LO								25 to 60 V DC; 20 to 48 V AC at 48 to 62 Hz
					HI								88 to 300 V DC; 70 to 265 V AC at 48 to 62 Hz
Analog Outputs						A1							Eight (8) 0 to 1 mA Analog Outputs
						A5							Eight (8) 0 to 5 mA Analog Outputs
						A10							Eight (8) 0 to 10 mA Analog Outputs
						A20							Eight (8) 4 to 20 mA Analog Outputs
Breaker Closed LED							R						Red LED for Breaker Closed indicator
							G						Green LED for Breaker Closed Indicator

Examples: the 750-P1-G1-S1-LO-A10-R specifies a 750 Feeder Management Relay with 1 A Phase, Zero-Sequence, and Sensitive Ground Current Inputs, low control power, eight 0 to 10 mA Analog Outputs and a red LED for the Breaker Closed indicator; the 760-P5-G5-S5-HI-A20-G specifies a 760 Feeder Management Relay with Autoreclose, 5 A Phase, Zero-Sequence, and Sensitive Ground Current Inputs, high control power, eight 4 to 20 mA Analog Outputs and a green LED for the Breaker Closed indicator.

The following accessories are also available:

- **DEMO:** Metal carry case in which the 750/760 can be mounted
- **SR19-1 or SR19-2 PANEL:** Single or double cutout 19" panels
- **RS-232/485:** RS232 to RS485 converter box for harsh industrial environments
- **5 A PHASE CT:** 50, 75, 100, 150, 200, 250, 300, 350, 400, 500, 600, 750, 1000 ratios
- **1 A PHASE CT:** 50, 75, 100, 150, 200, 250, 300, 350, 400, 500, 600, 750, 1000 ratios
- **SR 1 3/8" COLLAR:** For shallow switchgear, the collar reduces the depth of the relay by 1 3/8"
- **SR 3" COLLAR:** For shallow switchgear, the collar reduces the depth of the relay by 3"

2.2.1 APPLICABILITY

APPLICABILITY

Systems:	3 or 4 wire, 600 kV maximum 5000 A maximum
Frequency:	25 to 60 Hz nominal (frequency tracking allows operation from 16 to 65 Hz)

2.2.2 INPUTS

CONTROL POWER

Options:	LO/HI (specified when ordering)
LO range:	DC = 20 to 60 V AC = 20 to 48 V at 48 to 62 Hz.
HI range:	DC = 88 to 300 V AC = 70 to 265 V at 48 to 62 Hz.
Power:	25 VA nominal, 35 VA maximum
Voltage loss hold-up time:	30 ms

PHASE CURRENT

Source CT:	1 to 50000 A primary, 1 or 5 A secondary
Relay input:	1 A or 5 A (specified when ordering)
Burden:	Less than 0.2 VA at 1 or 5 A
Conversion range:	0.01 to $20 \times CT$ (fundamental frequency only)
Accuracy:	at $< 2 \times CT$: $\pm 0.5\%$ of $2 \times CT$ at $\geq 2 \times CT$: $\pm 1\%$ of $20 \times CT$
Overload withstand:	1 second at $80 \times$ rated current continuous at $3 \times$ rated current
Calculated neutral current errors:	$3 \times$ phase inputs

GROUND CURRENT

Source CT:	1 to 50000 A primary, 1 or 5 A secondary
Relay input:	1 A or 5 A (specified when ordering)
Burden:	Less than 0.2 VA at 1 or 5 A
Conversion range:	0.01 to $20 \times CT$ (fundamental frequency only)
Accuracy:	at $< 2 \times CT$: $\pm 0.5\%$ of $2 \times CT$ at $\geq 2 \times CT$: $\pm 1\%$ of $20 \times CT$
Overload withstand:	1 second at $80 \times$ rated current continuous at $3 \times$ rated current

SENSITIVE GROUND CURRENT

Source CT:	1 to 50000 A primary, 1 or 5 A secondary
Relay input:	1 A or 5 A (specified when ordering)
Burden:	Less than 0.2 VA at 1 or 5 A
Conversion range:	Low end: $0.005 \times CT$ Maximum: 500 A primary (fundamental frequency only)
Accuracy:	at $< 0.1 \times CT$: $\pm 0.2\%$ of $1 \times CT$ at $\geq 0.1 \times CT$: $\pm 1\%$ of $1 \times CT$
Overload withstand:	1 second at $80 \times$ rated current continuous at $3 \times$ rated current

BUS AND LINE VOLTAGE

Source VT:	0.12 to 600 kV / 50 to 240 V
Source VT ratio:	1 to 5000 in steps of 0.1
Relay input:	50 to 240 V phase-neutral
Burden:	Less than 0.025 VA at 120 V or > 576 KW
Maximum continuous:	273 V phase-neutral (full-scale) CT (fundamental frequency only)
Accuracy (0 to 40°C):	$\pm 0.25\%$ of full scale (10 to 130 V); $\pm 0.8\%$ of full scale (130 to 273 V) (For open delta, the calculated phase has errors 2 times those shown above)

LOGIC INPUTS

Inputs:	14 contact and / or virtual inputs, 6 virtual only (functions assigned to logic inputs)
Dry contacts:	1000 Ω maximum ON resistance (32 V DC at 2 mA provided by relay)
Wet contacts:	30 to 300 V DC at 2.0 mA (External DC voltage only)

ANALOG INPUTS

Current Input:	0 to 1 mA, 0 to 5 mA, 0 to 10 mA, 0 to 20 mA, or 4 to 20 mA (programmable)
Input Impedance:	375 $\Omega \pm 10\%$
Conversion Range:	0 to 21 mA
Accuracy:	$\pm 1\%$ of full scale

TRIP AND CLOSE COIL MONITORING

Acceptable voltage range:	20 to 250 V DC
Trickle current:	2 to 5 mA

IRIG-B

Amplitude modulated:	2.5 to 6 Vpk-pk at 3:1 signal ratio
DC shift:	TTL
Input impedance:	20 k $\Omega \pm 10\%$
Error:	± 1.0 ms

2.2.3 MEASURED PARAMETERS



In the following specifications, accuracies based on less than $2 \times CT$ and 50 to 130 V inputs. The full-scale is defined as follows: Full Scale = $2 \times CT$ at $1 \times VT_{Full\ Scale} \times \sqrt{3}$.

NOTE

The harmonic components of current and voltage are removed from the input voltage and current parameters, so all relay measurements based on these quantities respond to the fundamental component only. To minimize errors, the A/D process utilizes a sampling rate that is automatically adjusted to be 16 samples per power frequency cycle when a measurable voltage is available. To prevent overreaching of overcurrent elements, a digital filter removes the transient DC component of currents.

CURRENT

Phasors: Phase A RMS current
Phase B RMS current
Phase C RMS current

% of load-to-trip accuracy: $\pm 0.5\%$ of full scale

VOLTAGE

Phasors: Phase A-N (A-B) voltage
Phase B-N (B-C) voltage
Phase C-N (C-A) voltage

Accuracy: $\pm 0.25\%$ of full scale

FREQUENCY

Measured: A-N (A-B) bus and line voltage
Range: 16 to 90 Hz
Accuracy: ± 0.02 Hz

SYMMETRICAL COMPONENTS

Current level accuracy: $\pm 1.5\%$ of full scale
Voltage level accuracy: $\pm 0.75\%$ of full scale
Current and voltage angle accuracy: $\pm 2^\circ$

3Φ POWER FACTOR

Range: 0.00 Lag to 1.00 to 0.00 Lead
Accuracy: ± 0.02

3Φ REAL POWER

Range: -3000.0 to 3000.0 MW
Accuracy: $\pm 1\%$ of full scale

3Φ REACTIVE POWER

Range: -3000.0 to 3000.0 Mvar
Accuracy: $\pm 1\%$ of full scale (see note above)

3Φ APPARENT POWER

Range: -3000.0 to 3000.0 MVA
Accuracy: $\pm 1\%$ of full scale (see note above)

WATT-HOURS

Range: -2.1×10^8 to 2.1×10^8 MWh
Accuracy: $\pm 2\%$ of full scale (see note above) per hr

VAR-HOURS

Range: -2.1×10^8 to 2.1×10^8 Mvarh
Accuracy: $\pm 2\%$ of full scale (see note above) per hr

DEMAND

Phase A/B/C current range: 0 to 65535 A
3Φ real power range: -3000.0 to 3000.0 MW
3Φ reactive power range: -3000.0 to 3000.0 Mvar
3Φ apparent power range: -3000.0 to 3000.0 MVA
Measurement type:
Thermal Exponential, 90% response time (programmed):
5, 10, 15, 20, 30, or 60 min.
Block Interval / Rolling Demand, time interval (programmed):
5, 10, 15, 20, 30, or 60 min.
Accuracy: $\pm 2\%$ of full scale (see note above)

2.2.4 PROTECTION ELEMENTS

PHASE / NEUTRAL / GROUND / NEG SEQ TOC

Pickup level: 0.05 to $20.00 \times CT$ in steps of 0.01
Dropout level: 97 to 98% of pickup
Curve shapes: ANSI Extremely/Very/Moderately/Normally Inverse, Definite Time (0.1 s base curve), IEC Curve A/B/C and Short, FlexCurve™ A/B (programmable curves), IAC Extreme/Very/Inverse/Short
Curve multiplier: 0.00 to 100.00 in steps of 0.01
Reset type: Instantaneous/Linear
Level accuracy: per current input (I_2 is $3 \times$ input error)
Timing accuracy: $\pm 3\%$ of trip time or ± 40 ms (whichever is greater) at $\geq 1.03 \times PU$

SENSITIVE GROUND TOC

Pickup level: 0.005 to $1.000 \times CT$ in steps of 0.001
Dropout level: 97 to 98% of Pickup
Curve shapes: ANSI Extremely/Very/Moderately/Normally Inverse, Definite Time (0.1 s base curve), IEC Curve A/B/C and Short, FlexCurve™ A/B (programmable curves), IAC Extreme/Very/Inverse/Short
Curve multiplier: 0.00 to 100.00 in steps of 0.01
Reset type: Instantaneous/Linear
Level accuracy: per current input (I_2 is $3 \times$ input error)
Timing accuracy: $\pm 3\%$ of trip time or ± 40 ms (whichever is greater) at $\geq 1.03 \times PU$

VOLTAGE RESTRAINED PHASE TOC

Pickup adjustment: Modifies pickup from 0.10 to $0.90 \times VT$ nominal in a fixed line relationship

PHASE / NEUTRAL / GROUND / NEG SEQ IOC

Pickup level:	0.05 to 20.00 × CT in steps of 0.01
Dropout level:	97 to 98% of pickup
Time delay:	0.00 to 600.00 s in steps of 0.01
Level accuracy:	per phase / neutral / ground current input (I_2 is 3 × phase input error)
Timing accuracy at 0 ms time delay (no intentional delay):	relay contacts = 50 ms max. solid state output = 45 ms max.
Timing accuracy at non-zero time delay:	delay accuracy = 0 to 20 ms
Phases:	Any one, any two, or all three (programmable) phases must operate for output (not for I_2)

SENSITIVE GROUND IOC

Pickup level:	0.005 to 1.000 × CT in steps of 0.00
Dropout level:	97 to 98% of pickup
Time delay:	0.00 to 600.00 s in steps of 0.01
Level accuracy:	per phase / neutral / ground current input (I_2 is 3 × phase input error)
Timing accuracy at 0 ms time delay (no intentional delay):	relay contacts = 50 ms max. solid state output = 45 ms max.
Timing accuracy at non-zero time delay:	delay accuracy = 0 to 20 ms
Phases:	Any one, any two, or all three (programmable) phases must operate for output (not for I_2)

PHASE DIRECTIONAL

Relay Connection:	90° (quadrature)
Polarizing Voltage:	Phase A: Vbc; Phase B: Vca; Phase C: Vab
MTA:	0 to 359° in steps of 1
Angle Accuracy:	±2°
Operation Delay:	25 to 40 ms

NEUTRAL DIRECTIONAL

 Polarized by voltage, current, or both voltage and current. For voltage element polarizing, the source VTs must be connected in Wye.

Polarizing voltage:	–Vo
Polarizing current:	Ig
MTA:	0 to 359° in steps of 1
Angle accuracy:	±2°
Operation delay:	25 to 40 ms

GROUND / SENSITIVE GROUND DIRECTIONAL

 Polarized by voltage, current, or both voltage and current. For voltage element polarizing, the source VTs must be connected in Wye.

Polarizing voltage:	–Vo
Polarizing current:	Ig
MTA:	0 to 359° in steps of 1
Angle accuracy:	±2°
Operation delay:	25 to 40 ms

BUS / LINE UNDERVOLTAGE

Minimum voltage:	> programmable threshold from 0.00 to 1.25 × VT in steps of 0.01
Pickup level:	0.00 to 1.25 × VT in steps of 0.01
Dropout level:	102 to 103% of pickup
Curve:	Definite Time or Inverse Time
Time delay:	0.0 to 6000.0 s in steps of 0.1
Phases:	Any one, any two, or all three (programmable) phases must operate for output (Bus Undervoltage only)
Level accuracy:	per voltage input
Timing accuracy:	±100 ms

OVERVOLTAGE

Pickup level:	0.00 to 1.25 × VT in steps of 0.01
Dropout level:	97 to 98% of pickup
Time delay:	0.0 to 6000.0 s in steps of 0.1 (Definite Time)
Phases:	Any one, any two, or all three (programmable) phases must operate for output
Level accuracy:	per voltage input
Timing accuracy:	±100 ms

NEGATIVE SEQUENCE VOLTAGE

Pickup level:	0.00 to 1.25 × VT in steps of 0.01
Dropout level:	97 to 98% of pickup
Time delay:	0 to 6000.0 s in steps of 0.1 (Definite Time or Inverse Time)
Level accuracy:	3 × voltage input error
Timing accuracy:	±100 ms

UNDERFREQUENCY

Minimum voltage:	0.00 to 1.25 × VT in steps of 0.01 in Phase A
Pickup level:	20.00 to 65.00 Hz in steps of 0.01
Dropout level:	Pickup + 0.03 Hz
Time delay:	0 to 600.00 s in steps of 0.01 (Definite Time)
Level accuracy:	±0.02 Hz
Timing accuracy:	±25 ms at 60 Hz; ±30 ms at 50 Hz

BREAKER FAILURE

Pickup level:	0.05 to 20.0 × CT in steps of 0.01
Dropout level:	97 to 98% of pickup
Time delay:	0.03 to 1.00 s in steps of 10
Timing accuracy:	±20 ms error
Level accuracy:	per CT input

NEUTRAL DISPLACEMENT

Pickup level:	0.00 to 1.25 × VT in steps of 0.01
Dropout level:	97 to 98% of pickup
Curve shapes:	ANSI Extremely/Very/Moderately/Normally Inverse, Definite Time (0.1 s base curve), IEC Curve A/B/C and Short, FlexCurve™ A/B (programmable curves), IAC Extreme/Very/Inverse/Short
Curve multiplier:	0.00 to 100.00 in steps of 0.01
Reset type:	Instantaneous/Linear
Level accuracy:	3 × voltage input error
Timing accuracy:	±50 ms

REVERSE POWER (IF ENABLED)

Pickup level:	0.015 to 0.600 × rated power
Dropout level:	94 to 95% of pickup
Reset time:	less than 100 ms
Time delay:	see 3F Real Power metering
Timing accuracy:	±200 ms (includes Reverse Power pickup time)

2.2.5 MONITORING ELEMENTS

2

PHASE/NEUTRAL CURRENT

Pickup level:	0.05 to 20.00 × CT in steps of 0.01
Dropout level:	97 to 98% of pickup
Time delay:	0 to 60000 s in steps of 1 (Definite Time)
Level accuracy:	per current input
Timing accuracy:	±100 ms

POWER FACTOR

Required voltage:	>30% of nominal in all phases
Pickup level:	0.50 lag to 0.50 lead in steps of 0.01
Dropout level:	0.50 lag to 0.50 lead in steps of 0.01
Time delay:	0 to 60000 s in steps of 1 (Definite Time)
Level accuracy:	±0.02
Timing accuracy:	±100 ms

ANALOG IN THRESHOLD

Pickup level:	0 to 65535 units in steps of 1
Dropout level:	2 to 20% of Pickup (programmable, under or over)
Time delay:	0 to 60000 s in steps of 1
Level accuracy:	±1%
Timing accuracy:	±100 ms

ANALOG IN RATE

Pickup level:	–1000 to 1000 mA/hr in steps of 0.1
Dropout level:	97 to 98% of Pickup
Time delay:	0 to 60000.0 s in steps of 1
Level accuracy:	±1%
Timing accuracy:	±100 ms

OVERFREQUENCY

Required voltage:	>30% of nominal in Phase A
Pickup level:	20.01 to 65.00 Hz in steps of 0.01
Dropout level:	Pickup – 0.03 Hz
Time delay:	0.0 to 6000.0 s in steps of 0.1
Level accuracy:	±0.02 Hz
Timing accuracy:	±34 ms at 60 Hz; ±40 ms at 50 Hz

FAULT LOCATOR

Range:	–327.68 to 327.66 km/miles 0 to 65534 ohms
Memory:	stores the 10 most recent faults

DATA LOGGER

Data channels:	8 channels; same parameters as for analog outputs available
Sample rate:	per cycle / per second / per minute / every 5, 10, 15, 20, 30, or 60 minutes
Trigger source:	pickup/trip/dropout, control/alarm event, logic input, manual command, or continuous
Trigger position:	0 to 100%
Storage capacity:	2 to 16 events with 2048 to 256 samples of data respectively (4096 if continuous)

TRIP COUNTERS

Accumulates all ground, sensitive ground, neutral, negative sequence, and phase overcurrent trips.

DEMAND

Demand accuracies are based on less than 2 × CT and 50 to 130 V inputs.

Measured values:	Phase A/B/C current (A), 3Φ real power (MW), 3Φ reactive power (Mvar), 3Φ apparent power (MVA)
------------------	--

Measurement type:

Thermal Exponential, 90% response time (programmed):
5, 10, 15, 20, 30, or 60 min.

Block Interval / Rolling Demand, time interval (programmed):
5, 10, 15, 20, 30, or 60 min.

Block Interval with Start Demand Interval Logic Input pulses

Amps pickup level:	10 to 10000 in steps of 1
MW pickup level:	0.1 to 3000.0 in steps of 0.1
Mvar pickup level:	0.1 to 3000.0 in steps of 0.1
MVA pickup level:	0.1 to 3000.0 in steps of 0.1
Level accuracy:	±2%

VT FAILURE

Programmable to inhibit dependent features.

BREAKER FAILURE TO OPERATE

Time delay:	30 to 1000 ms in steps of 10
Timing accuracy:	0 to 20 ms error

ACCUMULATED ARCING CURRENT

Pickup level:	1 to 50000 kA ² -seconds in steps of 1
Start delay:	0 to 100 ms in steps of 1

TRIP / CLOSE COIL MONITORS

Detect open trip and close circuits.

PULSED OUTPUT

Pulsed output is 1 second on time and one second off time after the programmed interval.

2.2 SPECIFICATIONS

2 INTRODUCTION

WAVEFORM CAPTURE

Data channels:	4 currents, 3 voltages, 14 logic input states and 8 output relays
Sample rate:	16 per cycle
Trigger source:	Element pickup/trip/dropout, control/alarm event, logic input or manual command
Trigger position:	0 to 100%
Storage capacity:	2 to 16 events with 2048 to 256 samples of data respectively

EVENT RECORDER

Number of events:	128
Content:	event cause, 3 phase current phasors, 1 ground current phasor, sensitive ground current phasors, 3 voltage phasors, system frequency, synchronizing voltage, synchronizing frequency, and analog input level with a 1 ms time stamp.

LAST TRIP DATA

Records cause of most recent trip, 4 RMS currents, and 3 RMS voltages with a 1 ms time stamp.

2.2.6 CONTROL ELEMENTS

SYNCHROCHECK

Voltage difference:	0.01 to 100.00 kV in steps of 0.01
Phase difference:	0 to 100° in steps of 2
Frequency difference:	0.00 to 5.00 Hz in steps of 0.02
Bypass permissives:	DB & DL (dead bus and dead line) LL & DB (live line and dead bus) DL & LB (dead line and live bus) DL DB (dead line or dead bus) DL X DB (either dead line or dead bus)

SETPOINT GROUPS

Number of groups:	4
Accessibility:	Can be changed from logic input or through communications
Included features:	TOC Curves, Phase TOC and IOC, Neutral TOC and IOC, Ground TOC and IOC, Negative Sequence OC and Voltage, Phase Directional, Ground Directional, Overvoltage, Undervoltage, Underfrequency, Breaker Failure

UNDERVOLTAGE RESTORATION

Initiated by:	Trip from Undervoltage 1, 2, 3 or 4
Minimum voltage level:	0.00 to $1.25 \times VT$ in steps of 0.01
Time delay:	0.1 to 100.0 s in steps of 0.1
Incomplete seq. time:	1 to 10000 min. in steps of 1
Phases:	Any one, any two, or all three (programmable) phases must operate for output
Level accuracy:	per voltage input
Timing accuracy:	±100 ms

UNDERFREQUENCY RESTORATION

Initiated by:	Trip from Underfrequency 1 or 2
Minimum voltage level:	0.00 to $1.25 \times VT$ in steps of 0.01
Minimum freq. level:	20.00 to 60.00 Hz in steps of 0.01
Time delay:	0.1 to 100.0 s in steps of 0.1
Incomplete seq. time:	1 to 10000 min in steps of 1
Level accuracy:	Per voltage and frequency input
Timing accuracy:	±100 ms

MANUAL CLOSE FEATURE BLOCKING

Operated by:	manual close command.
Programmability:	Block IOC for a selected period. Raise TOC pickup for a selected period.

COLD LOAD PICKUP FEATURE BLOCKING

Operated by:	logic input command or automatically
Programmability:	Block IOC for a selected period. Raise TOC pickup for a selected period.

TRANSFER SCHEME

Applicability:	Used for double-bus system with two normally-closed incoming and one normally-open bus tie circuit breaker.
Closing:	Automatic closing of the bus tie breaker after a loss of one source, with bus decayed voltage permissive.
Trip:	Trips a pre-selected breaker after the third breaker is manually closed (prevent-parallel operation).

AUTORECLOSE (760 ONLY)

Reclose attempts:	Up to four (4) before lockout.
Blocking:	Each reclose shot can block IOC and raise TOC Pickup.
Adjustability:	Current supervision can adjust the maximum number of shots to be attempted.

2.2.7 OUTPUTS

ANALOG OUTPUTS

Type:	Active
Outputs:	8 Channels; specify one of the following output ranges when ordering:
Output ranges:	0 to 1 mA, 0 to 5 mA, 0 to 10 mA, 4 to 20 mA
Maximum load:	12 k Ω for 0 to 1 mA output, 2.4 k Ω for 0 to 5 mA output, 1.2 k Ω for 0 to 10 mA output, 600 k Ω for 4 to 20 mA output
Isolation:	Fully isolated
Accuracy:	$\pm 1\%$ of full scale
Response time:	100% indication in less than 6 power system cycles (100 ms at 60 Hz)

SOLID STATE TRIP

Make and carry:	15 A at 250 V DC for 500 ms
-----------------	-----------------------------

2.2.8 OUTPUT RELAYS



Relay contacts must be considered unsafe to touch when the 750/760 is energized! If the output relay contacts are required for low voltage accessible applications, it is the customer's responsibility to ensure proper insulation levels.

CONFIGURATION

Number:	8
Type:	Trip (1) and Close (2) Relays: Form A Auxiliary Relays 3 to 7: Form C Self-Test Warning Relay 8: Form C
Contact material:	silver alloy
Contact durability:	100 000 operations (at 1800 operations/hour) at rated load

FORM A CONTACT RATINGS

Applicability:	Trip and Close Relays (Relays 1 and 2)
Make:	30 A (per ANSI/IEEE C37.90)
Carry:	20 A continuous
Break (DC):	300 W resistive, 150 W inductive (L/R = 40 ms)
Break (AC):	5000 VA resistive 5000 VA inductive (PF = 0.4)

FORM C CONTACT RATINGS

Applicability:	Auxiliary Relays 3 to 7 Self-Test Warning Relay (Relay 8)
Make:	30 A (per ANSI/IEEE C37.90)
Carry:	10 A continuous for 15 seconds 5 A continuous
Break (DC):	150 W resistive, 90 W inductive (L/R = 40 ms)
Break (AC):	1250 VA resistive 500 VA inductive (PF = 0.4)

2.2.9 CPU

COMMUNICATIONS

Baud rate:	300 to 19200 baud
Parity:	programmable
Protocol:	Modbus RTU or DNP 3.0 protocol

EEPROM

100000 program/erase cycles max.

CLOCK

Resolution:	1 ms
Accuracy with IRIG-B:	± 1 ms
Accuracy without IRIG-B:	± 1 minute/month
Backup battery life:	10 years continuous use

2.2 SPECIFICATIONS

2 INTRODUCTION

2.2.10 PHYSICAL

TEMPERATURE

Operating range: -40°C to $+60^{\circ}\text{C}$ Ambient storage: -40°C to $+80^{\circ}\text{C}$ Ambient shipping: -40°C to $+80^{\circ}\text{C}$ 

At temperatures below -20°C , the LCD contrast may become impaired

NOTE

ENVIRONMENTAL

Humidity: up to 90% non-condensing

Pollution degree: 2

IP Rating: 40-X

LONG-TERM STORAGE

Environment: In addition to the above environmental considerations, the relay should be stored in an environment that is dry, corrosive-free, and not in direct sunlight.

Correct storage: Prevents premature component failures caused by environmental factors such as moisture or corrosive gases. Exposure to high humidity or corro-

sive environments will prematurely degrade the electronic components in any electronic device regardless of its use or manufacturer, unless specific precautions, such as those mentioned in the Environmental section above, are taken.



NOTE

It is recommended that all relays be powered up once per year, for one hour continuously, to avoid deterioration of electrolytic capacitors and subsequent relay failure.

CASE

Type: Fully drawout unit (automatic CT shorts)

Approvals: Meets CE drawout specifications

Seal: Seal provision

Door: Dust tight door

Mounting: Panel or 19" rack mount

Weight: 7.9 kg (case and relay)

9.4 kg (shipping weight)

2.2.11 TESTING

SIMULATION

Simulation modes: Programmable prefault, fault, and post-fault parameters. Simulation of circuit breaker and selection of whether or not to operate outputs relays.

TYPE TESTING

Fast transient: per ANSI/IEEE C37.90.1 and IEC 801.4 Level 4 (5 kV at 5×50 ns, $R_i = 50 \Omega$)

Insulation resistance: per IEC 255-5 (500 V DC, 2000 MW)

Dielectric strength: per IEC 255-5 and ANSI/IEEE C37.90 (2 kV at 60 Hz for 1 minute)

Surge withstand: per IEC 255-22-1 and IEC 255-4 Class 3 (fast transient common mode 2.5 kV, differential modes 1 kV); per IEC 255-4 and ANSI/IEEE C37.90.1 (2.5 kV at 1 MHz, 400/second for 2 seconds, $R_i = 200 \Omega$)

Electrostatic discharge: per IEC 801.2 Class 4 (15 kV, 150 pF, 150 W)

Impulse voltage: per IEC 255-5, 0.5 Joule 5kV (5 kV at 1.2×50 ms, 0.5 J, $R_i = 500 \Omega$ common and differential modes)

Current withstand: per ANSI/IEEE C37.90 ($40 \times$ rated A for 2 sec., $80 \times I_r$ for 1 sec.)

RFI: per Ontario Hydro (150/450 MHz, 5 W transmitter at 25 cm and 50 MHz, 15 W mobile transmitter at 25 cm)

EMI: per ANSI/IEEE C37.90.2 Electromagnetic Interference at 150 MHz and 450 MHz, 10V/m

Static: per IEC 801-2 Static Discharge

Stress vibration: per IEC 68-2-6 and IEC 255-21-1

PRODUCTION TESTS

Thermal cycling: Operational test at ambient, reducing to -40°C and then increasing to 60°C

Dielectric strength: 1.9 kV AC for 1 second or 1.6 kV AC for 1 minute, per UL 508.



WARNING

DO NOT CONNECT FILTER GROUND TO SAFETY GROUND DURING ANY PRODUCTION TESTS!

2.2.12 APPROVALS

UL

Recognized under E83849

CSA

Approved under LR 41286-56



NOTE

Specifications subject to change without notice.

CE

Conforms to IEC 947-1, IEC 1010-1

ISO

Manufactured to an ISO9001 registered program.

3.2.1 TYPICAL WIRING

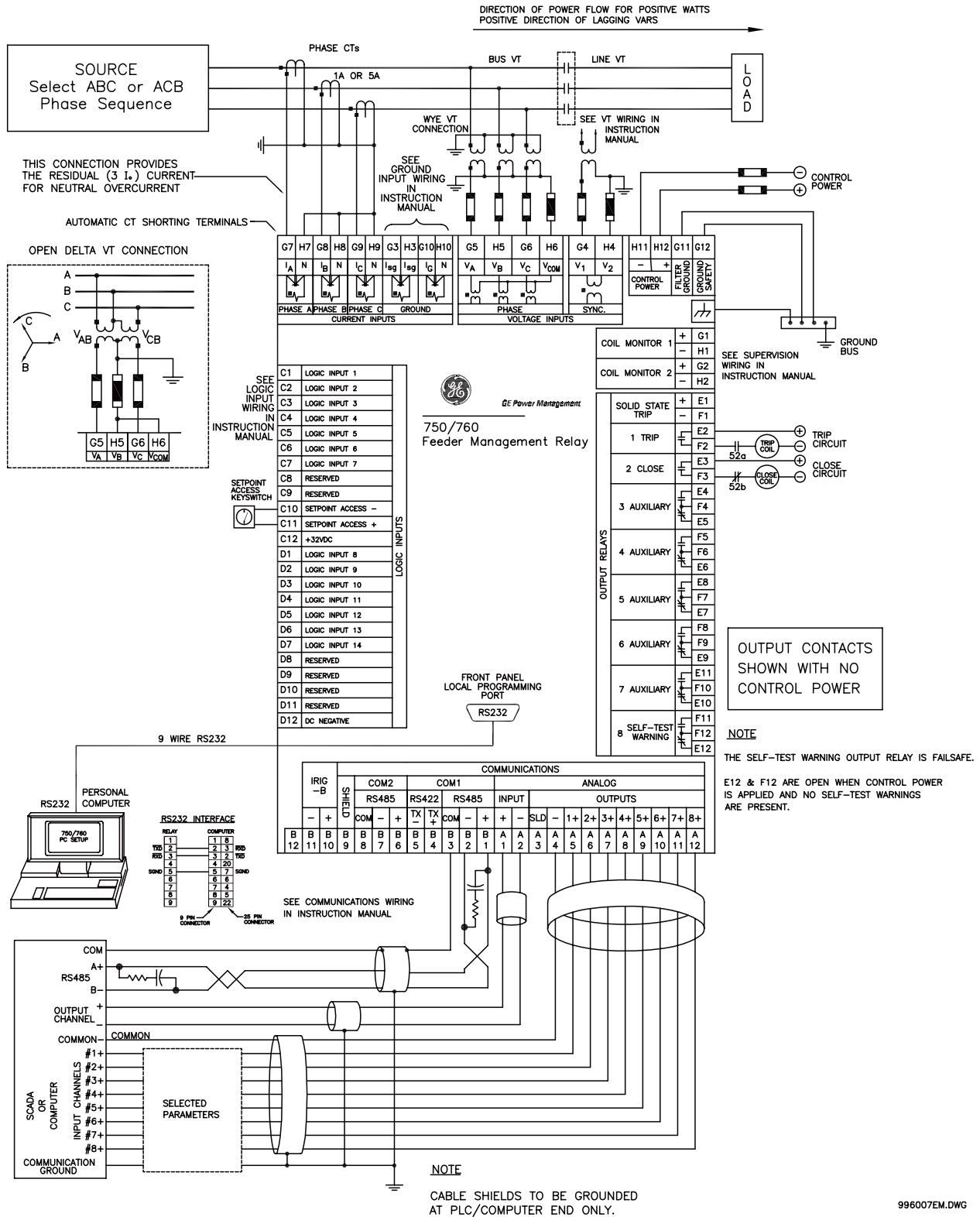


Figure 3-9: TYPICAL WIRING DIAGRAM



INSTRUMENT TRANSFORMERS



INSTRUMENT TRANSFORMERS

LOW VOLTAGE CURRENT TRANSFORMERS 600 Volt Class - Indoor Type	420
LOW VOLTAGE POTENTIAL TRANSFORMERS 600 Volt Class - Indoor Type	422
BUSHING CURRENT TRANSFORMERS 600 Volt Class	425
MEDIUM VOLTAGE CURRENT & POTENTIAL TRANSFORMERS 5KV to 38kV - Indoor type	426
CONTROL POWER TRANSFORMERS 5KV to 38kV - Indoor type	427
CURRENT TRANSDUCERS 600 Volt Class	428



Split Core Current Transformers

Applications

- Energy management
- Load surveys
- Sub metering

Features

- Window sizes from 0.75 x 0.75 to 12 x 30 inches
- Ratios from 100:5A to 10,000:5A
- Voltage output available
- Weather proof model available
- UL Recognized and CSA Approved



Auxiliary Current Transformers

Applications

- Designed for use in the secondary of main current transformers to change the ratio for metering or relaying applications

Features

- Several models available
- Wound primary up to 50A
- IEEE or IEC metering and relay class
- Summation CT's up to six secondaries
- UL Recognized and CSA Approved



Three Phase Current Transformers

Applications

- Three phase metering and motor overload protection

Features

- Over 50 models available
- Saves space and reduces installation time
- Zero sequence core in the same package available for most models
- Ratios from 50:5A to and up
- UL Recognized and CSA Approved



To order Instrument Transformers
visit the online store www.GEMultilin.com/onlinestore



Current Transformers

Applications

- For use with ammeters in panelboards, control panels and engine generators

Features

- Wide range of window sizes
- Ratios 50:5A to 2000:5A
- 1 Amp secondaries are available
- Supplied with leads or terminals
- Integral feet or mounting brackets available
- UL Listed and CSA Approved



Current Transformers

Applications

- For metering and relaying applications in low voltage switchboards, switchgear and motor control

Features

- Wide range of window sizes
- Ratios 50:5A to 6000:5A
- 1 Amp secondaries are available
- Supplied with leads or terminals
- Multi ratios model available
- Designed to meet IEEE C57. 13 or IEC 60044-1
- UL listed and CSA Approved

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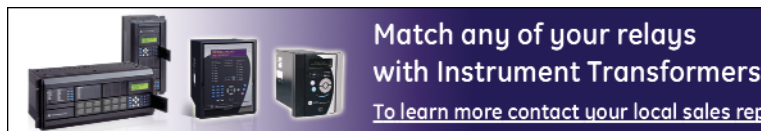
Current Transformers

Applications

- Designed for specific mount applications in medium voltage switchgear

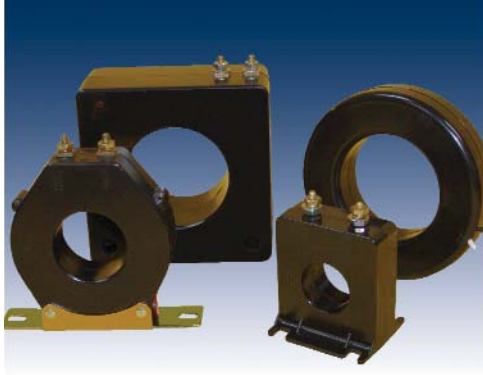
Features

- Wide range of window sizes
- Ratios 50:5A to 6000:5A
- 1 Amp secondaries are available
- Multi ratios model available
- Designed to meet IEEE C57. 13
- UL listed and CSA Approved



Match any of your relays
with Instrument Transformers

To learn more contact your local sales rep



Current Transformers

Applications

- For ammeters, wattmeters, and cross current compensation applications

Features

- Wide range of window sizes
- Ratios 50:5A to 6000:5A
- 1 Amp secondaries are available
- Supplied with leads or terminals
- Integral feet or mounting brackets available
- UL Listed and CSA Approved



Ground Fault Sensors

Applications

- To sense zero sequence ground fault currents

Features

- Window sizes up to 30x 10 inches are available
- Ratios 50:5A and up
- Special ratios and physical sizes built to customer specifications
- UL Recognized and CSA Approved



Ground Fault Sensors Type HGF

Applications

- Designed to match the ground fault input of GE Multilin motor protection relays

Features

- Window sizes 3.75" , 5.75" or 8.13"
- Ratio 50:0.025A 60 Hz
- IEC versions also available
- UL and CUL recognized



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visit the online store www.GEMultilin.com/onlinestore



Current Transformers

Applications

- Designed for operation of meters and instruments
- Utility metering
- Mounts directly on busbars or padmount transformer spade

Features

- Window sizes 3.46" x 4.16"
- Ratios 200:5 to 4000:5
- Meet ANSI C12 size and mounting



Current Transformers

Applications

- Designed for operation of meters and instruments
- Utility metering small window

Features

- Designed for outdoor service
- Encapsulated in cast polyurethane resin
- Compression type terminals
- Ratios from 100:5A to 800:5A
- Dual ratio models available
- Engraved aluminum name plate
- Meet ANSI C12 size and mounting



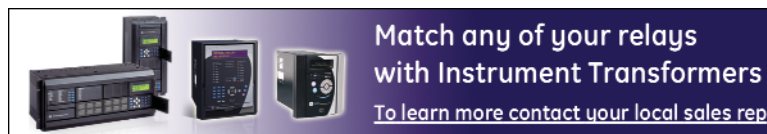
Current Transformers

Applications

- Designed for operation of meters and instruments
- Utility metering large window

Features

- Designed for outdoor service
- Compression type terminals
- Ratios from 200:5A to 4000:5A
- Dual ratio models available
- Engraved aluminum name plate
- Meet ANSI C12 size and mounting





Voltage Transformers

Applications

- For single phase voltage measurement in AC power system

Features

- Resin cast moulded plastic cases
- Integral fuses available on some models
- Designed to meet IEEE C57.13
- 50Hz design available
- UL Recognized and CSA Approved



Voltage Transformers

Applications

- For three phase voltage measure in AC power system

Features

- Resin cast moulded plastic cases
- Integral fuses available on some models
- Designed to meet IEEE C57.13
- 50Hz design available
- UL Recognized and CSA Approved



JVA Voltage Transformers

Applications

- Designed for outdoor service, generating meter instruments and relays
- Utility metering

Features

- Housed in a resin filled plastic case
- Compression type terminals
- 50Hz design available
- Transparent plastic terminals cover
- Engraved aluminum nameplate
- Designed to meet IEEE C57.13



To order Instrument Transformers
visit the online store www.GEMultilin.com/onlinestore



Cast Resin Unit

Applications

- For use over bushings of power transformers and dead tank circuit breakers
- For metering and relaying applications

Features

- Indoor or outdoor service
- 600 class to IEEE C57.13 or IEC 60044-1
- Ratios 600: 50:5 to 25000:5
- Single and multi ratios available
- Optional ground shield available



Taped Unit

Applications

- Designed to customers specifications for metering and relaying applications
- High voltage circuit breakers and power transformers

Features

- 600 class to IEEE C57.13 - 1993
- Single and multi ratios designs available
- Leads or terminals available
- Designs for use in oil are available



Board Mounted Unit

Applications

- Designed for mounting and stacking over the bushings of large generators
- For metering and relaying applications

Features

- Ratios up to 40,000:5A
- 1 Amp secondaries and IEC design available
- 600V class 50 or 60Hz
- Shield winding available



Match any of your relays
with Instrument Transformers
[To learn more contact your local sales rep](#)



Voltage Transformers

Applications

- Indoor voltage transformer for metering and relaying applications in AC power systems

Features

- Vacuum cast polyurethane resin
- Designed to meet IEEE C57.13
- 5kV to 38kV with BIL rating up to 200kV
- UL Recognized and CSA Approved



Current Transformers

Applications

- Indoor current transformer for metering and relaying applications in AC power systems

Features

- Vacuum cast polyurethane resin
- Designed to meet IEEE C57.13
- 15kV with BIL rating up to 110kV
- UL Recognized and CSA Approved



Current Transformers

Applications

- Indoor current transformer for metering and relaying applications in AC power systems.

Features

- Vacuum cast using polyurethane resin
- Designed to meet IEEE C57.13
- 5kV to 8.7kV with BIL rating up to 60kV
- UL Recognized and CSA Approved



To order Instrument Transformers
visit the online store www.GEMultilin.com/onlinestore



Single Phase Cast Coil transformers

Applications

- To provide control power in medium voltage switchgear

Features

- Vacuum cast primary coil using epoxy resin
- Single phase rating from 5 kVA to 15 kVA
- Voltage rating 5 to 15 kV and BIL rating to 95 kV BIL



Single Phase Cast Coil transformers

Applications

- To provide control power in medium voltage switchgear
- Generator neutral grounding transformer

Features

- Vacuum cast primary and secondary coils using epoxy resin
- Single phase rating from 25 kVA to 75 kVA
- Voltage rating 5 to 38kV and BIL rating to 150 kV BIL



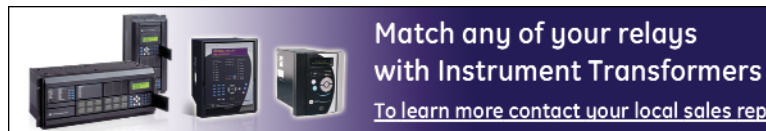
Three Phase Cast Coil transformers

Applications

- To provide control power in medium voltage switchgear

Features

- Vacuum cast using epoxy resin
- Three phase rating from 15 kVA to 150 kVA
- Voltage rating 5 to 38kV and BIL rating to 150 kV BIL
- Horizontal and vertical mounting available in some models





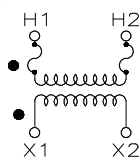
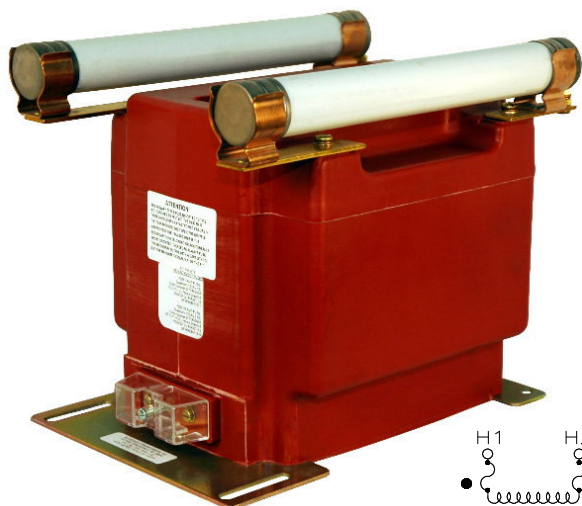
Current Transducers

Applications

- Process control
- Industrial measurement

Features

- Models available for 5 to 600 primary AC current
- Output Options: 0-5 Vdc, 0-10 Vdc, and 4-20 mA
- Self powered, two wire option
- UL recognized



TWO FUSE
Two Bushing

ACCURACY CLASS:

0.3. WXYZ 1.2ZZ at 100% rated voltage with 120V based ANSI burden.

0.3 WXYZ, 1.2Z at 58% rated voltage with 69.3V based ANSI burden.

FREQUENCY:

60 Hz.

MAXIMUM SYSTEM VOLTAGE:

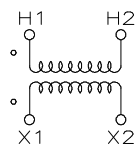
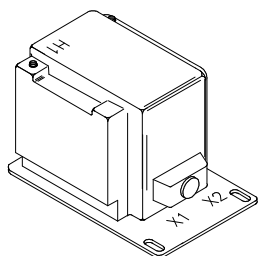
15.5kV, BIL 110kV.

THERMAL RATING:

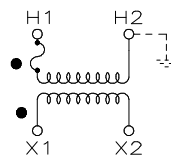
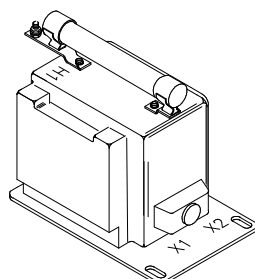
1500 VA at 30°C amb.

1000 VA at 55°C amb.

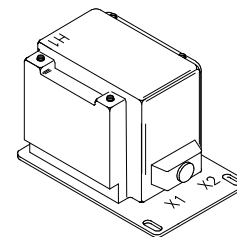
Approximate weight 85 lbs. unfused.



UNFUSED
Two Bushing



ONE FUSE
One Bushing



**SWITCHGEAR
STYLE**
Two Bushing

TWO BUSHING (a)				CATALOG NUMBERS			
GROUP	PRIMARY VOLTAGE	RATIO	SECONDARY VOLTAGE	UNFUSED	FUSES	FUSE CLIPS ONLY	SWITCHGEAR STYLE
1	*7200	60:1	120	PTW5-2-110-722	PTW5-2-110-722FF	PTW5-2-110-722CC	PTW5-2-110-722SS
1	*8400	70:1	120	PTW5-2-110-842	PTW5-2-110-842FF	PTW5-2-110-842CC	PTW5-2-110-842SS
2	11000	100:1	110-50Hz	PTW5-2-110-113	PTW5-2-110-113FF	PTW5-2-110-113CC	PTW5-2-110-113SS
2	*12000	100:1	120	PTW5-2-110-123	PTW5-2-110-123FF	PTW5-2-110-123CC	PTW5-2-110-123SS
2	13200	110:1	120	PTW5-2-110-1322	PTW5-2-110-1322FF	PTW5-2-110-1322CC	PTW5-2-110-1322SS
2	*14400	120:1	120	PTW5-2-110-1442	PTW5-2-110-1442FF	PTW5-2-110-1442CC	PTW5-2-110-1442SS

ONE BUSHING (b)				CATALOG NUMBERS			
GROUP	PRIMARY VOLTAGE	RATIO	SECONDARY VOLTAGE	R FR (c)	FUSES	FUSE CLIPS ONLY	SWITCHGEAR STYLE
4A	*7200	60:1	120	65	PTW5-1-110-722F	PTW5-1-110-722C	PTW5-1-110-722S
4A	*8400	70:1	120	65	PTW5-1-110-842F	PTW5-1-110-842C	PTW5-1-110-842S
4B	11000	100:1	110-50Hz	65	PTW5-1-110-113F	PTW5-1-110-113C	PTW5-1-110-113S
4B	*12000	100:1	120	65	PTW5-1-110-123F	PTW5-1-110-123C	PTW5-1-110-123S
4B	13200	110:1	120	65	PTW5-1-110-1322F	PTW5-1-110-1322C	PTW5-1-110-1322S
4B	*14000	120:1	120	65	PTW5-1-110-1442F	PTW5-1-110-1442C	PTW5-1-110-1442S

NOTE: All Primary voltages marked with an asterisk (*) are approved for revenue metering in Canada by Industry Canada, Approval No. AE-0431 Rev.01

Models PTW5-1-110 & PTW5-2-110

(a) Two fuse transformers should not be used for Y connections. It is preferred practice to connect one lead from each voltage transformer directly to the neutral terminal, using a fuse in the line side of the primary only. By using this connection a transformer can never be made "live" from the line side by reason of a blown fuse in the neutral side. For continuous operation the transformer primary voltage should not exceed 110% of rated value.

(b) Voltage transformers connected line-to-ground cannot be considered to be grounding transformers and must not be operated with the secondaries in closed delta because excessive currents may flow in the delta.

(c) See page 32, item 1 for ferroresonance considerations. Values in table are in ohms.

Note: It is recommended that system line-to-line voltage not exceed the transformer maximum system voltage level.

FUSE FOR MODEL PTW5 TRANSFORMER	RATING VOLTS	INTERRUPTING AMPERES (SYM)	SUGGESTED RATING CONTINUOUS AMPERES	CAP DIA. INCHES	LENGTH INCHES	CLIP CENTERS INCHES
7200:120V	15.5kV	80,000	1.0E	1.63	13	11.50
4800:120V	15.5kV	80,000	1.0E	1.63	13	11.50
11000:120V	15.5kV	80,000	0.5E	1.63	13	11.50
12000:120V	15.5kV	80,000	0.5E	1.63	13	11.50
13200:120V	15.5kV	80,000	0.5E	1.63	13	11.50
14200:120V	15.5kV	80,000	0.5E	1.63	13	11.50

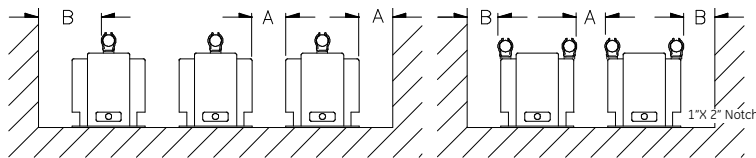
- Primary terminals that are unfused are 1/4-20 brass screws with one flatwasher and lockwasher.
- Primary terminals that are fused are 1/4-20 brass screws with one flatwasher and lockwasher and two nuts.
- Secondary terminals are No. 10-32 brass screws with one flatwasher and lockwasher.
- The core and coil assembly is vacuum encapsulated in polyurethane resin.
- Thermal burden rating is for 120 volt secondaries.
- Switch gear style is similar to fused style. No fuse or fuse clip is provide, but inserts for fuse clips are supplied.
- A test card is provided with each unit.

RECOMMENDED MINIMUM SPACINGS

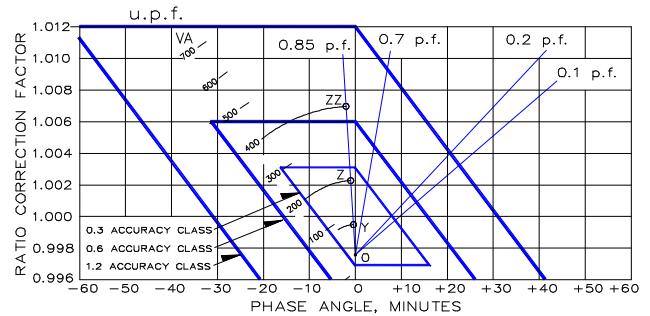
A = Unit to Unit or to Ground = 1.25" minimum.

B = HV to Ground in air = 6.50" minimum.

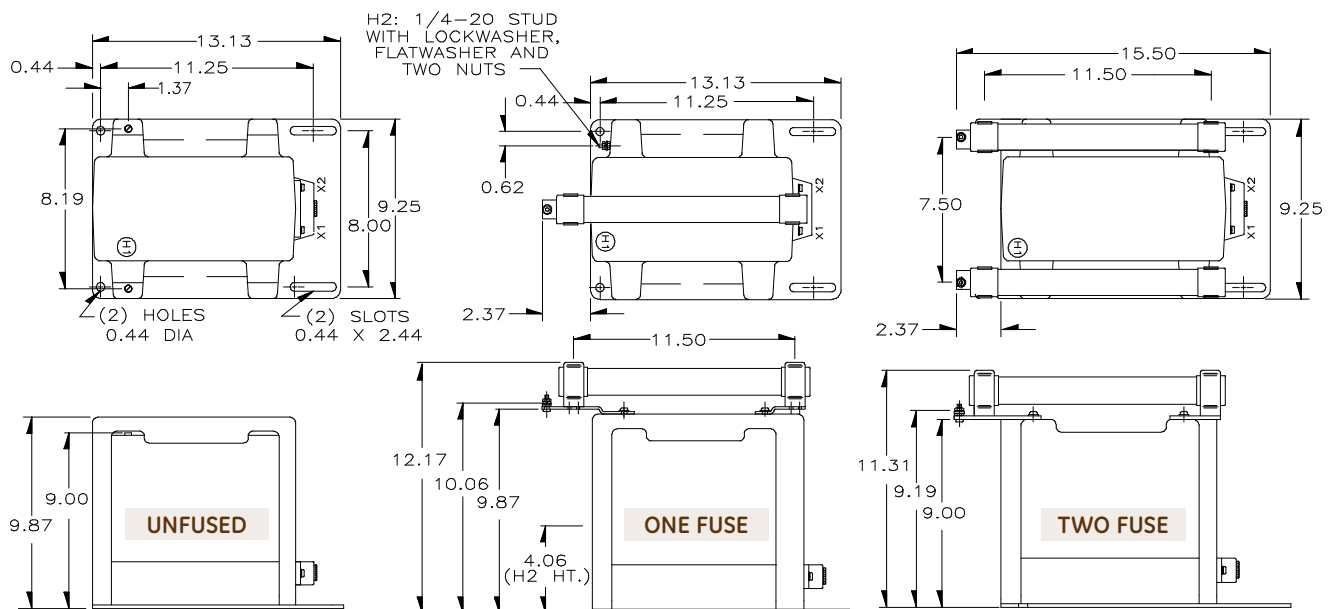
Recommended spacing are for guidance only. User needs to set appropriate values to assure performance for high potential test, impulse test, high humidity, partial discharge, high altitude, and other considerations like configuration.



CIRCLE DIAGRAM



The circle diagram can be used to predict the performance of a transformer for various loads and power factors. A convenient scale of volt-ampere is shown on the unity power factor line (u.p.f.) and commences at the zero or no-load locus. To use the diagram, measure the known V.A. and scribe an arc about the "Zero" locus of a length that contains the angle of the burden power factor. The point at which the arc terminates is the error locus in phase angle minutes and ratio correction factor.



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REGULATORY AGENCY APPROVALS



E93779



LR89403

Manufactured to meet the requirements of ANSI/IEEE C57.13.
Classified by U.L. in accordance with IEC 44-1**APPLICATION:**

Relaying and metering.

FREQUENCY:

50-400 Hz.

INSULATION LEVEL:

600 Volts, 10 kV BIL full wave.

Terminals are brass screws No. 10-32 with one flatwasher and lockwasher.

Order mounting bracket kit 0221B01528 separately.

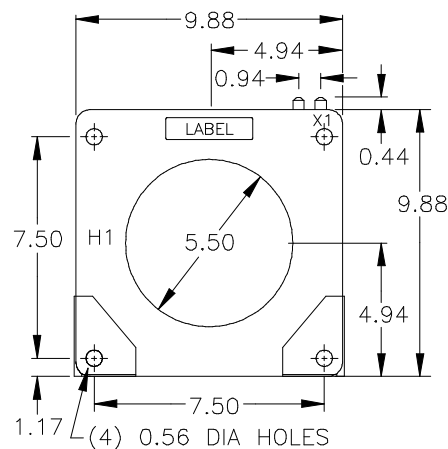
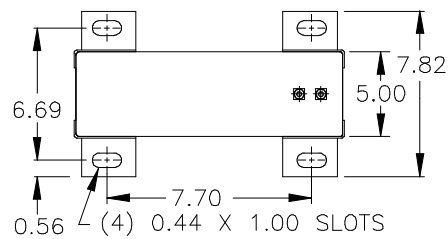
Multi-ratios available on request.

Approximate weight 50 lbs.

CATALOG NUMBER	CURRENT RATIO	RELAY CLASS	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE (OHMS @ 75°C)	CONTINUOUS THERMAL RATING FACTOR	
			BO.1	BO.2	BO.5	BO.9	B1.8		@ 30°C	@ 55°C
137-500	50:5	C10	2.4	4.8	—	—	—	0.019	2.0	2.0
137-750	75:5	C20	1.2	2.4	4.8	—	—	0.029	2.0	2.0
137-101	100:5	C20	1.2	1.2	2.4	4.8	—	0.039	2.0	2.0
137-151	150:5 *	C20	0.6	0.6	1.2	2.4	4.8	0.058	2.0	2.0
137-201	200:5 *	C50	0.3	0.6	1.2	1.2	2.4	0.078	2.0	2.0
137-251	250:5 *	C50	0.3	0.3	0.6	1.2	1.2	0.097	2.0	2.0
137-301	300:5 *	C100	0.3	0.3	0.6	0.6	1.2	0.116	2.0	2.0
137-401	400:5 *	C100	0.3	0.3	0.3	0.3	0.6	0.155	2.0	2.0
137-501	500:5 *	C100	0.3	0.3	0.3	0.3	0.6	0.194	2.0	2.0
137-601	600:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.233	2.0	2.0
137-751	750:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.291	2.0	2.0
137-801	800:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.390	2.0	2.0
137-102	1000:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.488	2.0	1.5
137-122	1200:5 *	C400	0.3	0.3	0.3	0.3	0.3	0.585	2.0	1.5
137-152	1500:5 *	C400	0.3	0.3	0.3	0.3	0.3	0.678	1.5	1.33
137-162	1600:5 *	C400	0.3	0.3	0.3	0.3	0.3	0.723	1.5	1.33
137-202	2000:5 *	C400	0.3	0.3	0.3	0.3	0.3	0.903	1.5	1.0
137-252	2500:5 *	C400	0.3	0.3	0.3	0.3	0.3	1.129	1.5	1.0
137-302	3000:5 *	C400	0.3	0.3	0.3	0.3	0.3	1.279	1.33	1.0
137-352	3500:5 *	C400	0.3	0.3	0.3	0.3	0.3	1.492	1.0	0.8
137-402	4000:5 *	C400	0.3	0.3	0.3	0.3	0.3	2.136	1.0	0.8
137-502	5000:5 *	C400	0.3	0.3	0.3	0.3	0.3	4.199	0.6	0.3

Approved for revenue metering by Industry Canada No. T-260

2



e-mail: gemultilin.euro@ge.com

CS00A40466 Rev.



Indoor Current Transformer, Wound Primary Model JKM-5C 15kV, 110kV BIL, 5-800A

REGULATORY AGENCY APPROVALS



E145172



LR89403

Manufactured to meet the requirements of ANSI/IEEE C57.13.



APPLICATION

Designed for indoor service; Suitable for operating meters, instruments and control devices.

WEIGHT

(Approximate)53 lbs

REFERENCE DRAWINGS

Outline0162C34108

INSULATION LEVEL

15.5kV; BIL 110kV full wave

FREQUENCY

50-60 Hz

JKM-5C DATA TABLE

JKM-5C DATA TABLE										
Current Ratio (Amps) Pri : Sec	ANSI Accuracy Class, 60 Hz			Continuous Thermal Current Rating Factor		Primary Bar Size		Mech. Limit Amps	One Second Thermal Limit, Amps	Catalog Number
	ANSI Meter Class Burden		Relay Class							
	B0.1 to B0.5	B0.9 to 1.8		@ 30 °C Amb.	@ 55 °C Amb.	Width ins.	Thick ins.			
Single Ratio										
5:5	0.3	0.3	T200	1.5	1.33	1.50	0.188	625	465	755X142001
10:5	0.3	0.3	T200	1.5	1.33	1.50	0.188	1250	930	755X142002
15:5	0.3	0.3	T200	1.5	1.33	1.50	0.188	1875	1470	755X142003
20:5	0.3	0.3	T200	1.5	1.33	1.50	0.188	2500	1850	755X142004
25:5	0.3	0.3	T200	1.5	1.33	1.50	0.188	3125	2300	755X142005
30:5	0.3	0.3	T200	1.5	1.33	1.50	0.188	3750	2460	755X142006
40:5	0.3	0.3	T200	1.5	1.33	1.50	0.188	5000	3720	755X142007
50:5	0.3	0.3	T200	1.5	1.33	1.50	0.188	6250	4600	755X142008
75:5	0.3	0.3	T200	1.5	1.33	1.50	0.188	9375	6375	755X142009
100:5	0.3	0.3	T200	1.5	1.33	1.50	0.188	12500	8600	755X142010
150:5	0.3	0.3	T200	1.5	1.33	1.50	0.188	18750	12750	755X142011
200:5	0.3	0.3	T200	1.5	1.33	2.00	0.25	25000	17200	755X142012
300:5	0.3	0.3	T200	1.5	1.33	2.00	0.25	37500	25800	755X142014
400:5	0.3	0.3	T200	1.5	1.33	2.00	0.25	50000	36000	755X142015
500:5	0.3	0.3	T200	1.5	1.33	2.00	0.38	53500	42000	755X142016
600:5	0.3	0.3	T200	1.5	1.33	2.00	0.38	75000	51600	755X142017
800:5	0.3	0.3	T200	1.2	0.85	2.00	0.38	80000	63200	755X142018
Tapped Secondary										
50/100:5	0.3	---	T100	2.0	1.5	1.50	0.188	12500	4300	755X142039
	0.3	0.3	T200	1.5	1.0				8600	
75/150:5	0.3	---	T100	2.0	1.5	1.50	0.188	18750	6375	755X142040
	0.3	0.3	T200	1.5	1.0				12750	
100/200:5	0.3	---	T100	2.0	1.5	2.00	0.25	25000	8600	755X142041
	0.3	0.3	T200	1.5	1.0				17200	
150/300:5	0.3	---	T100	2.0	1.5	2.00	0.25	37500	12900	755X142042
	0.3	0.3	T200	1.5	1.0				25800	
200/400:5	0.3	---	T100	2.0	1.5	2.00	0.25	50000	18000	755X142043
	0.3	0.3	T200	1.5	1.0				36000	
300/600:5	0.3	---	T100	2.0	1.5	2.00	0.38	75000	25800	755X142044
	0.3	0.3	T200	1.5	1.0				51600	
400/800:5	0.3	---	T100	2.0	1.5	2.00	0.38	80000	31600	755X142045
	0.3	0.3	T200	1.2	0.85				63200	

Construction and Insulation

The core and coil assembly is encapsulated in vacuum cast polyurethane resin. This tough material has excellent electrical and mechanical properties over a wide temperature range, has low water absorption and is resistant to oil and a variety of chemicals.

Core and Coils

The core is made from high quality grain oriented silicon steel, annealed under rigidly controlled factory conditions. The primary winding consists of two coils in series, one around each leg of the core. This construction minimizes flux leakage thus improving the accuracy of the transformer. The secondary winding consists of two coils in parallel. Each coil is located inside the corresponding primary coil and surrounds one leg of the core.

Terminals

Secondary terminals are tin plated brass, compression type with a 0.275" diameter cross-hole for wiring and a 1/4-28 clamp screw. A shorting device is provided and interlocked to the terminal cover. The terminal cover is made of a clear plastic. Provision is made for sealing the cover.

Primary Bars

The primary terminals are tin plated copper bars molded into the cast resin insulation. They have one hole and one slot at each end, suitable for 1/2" bolts.

Polarity

The primary and secondary polarity markers H1, X1, are molded in the insulation. They are thus permanent and integral parts of the transformer and cannot be readily obliterated. They are also marked white.

Nameplates

The nameplate is laser engraved aluminum.

Base plate and Mounting

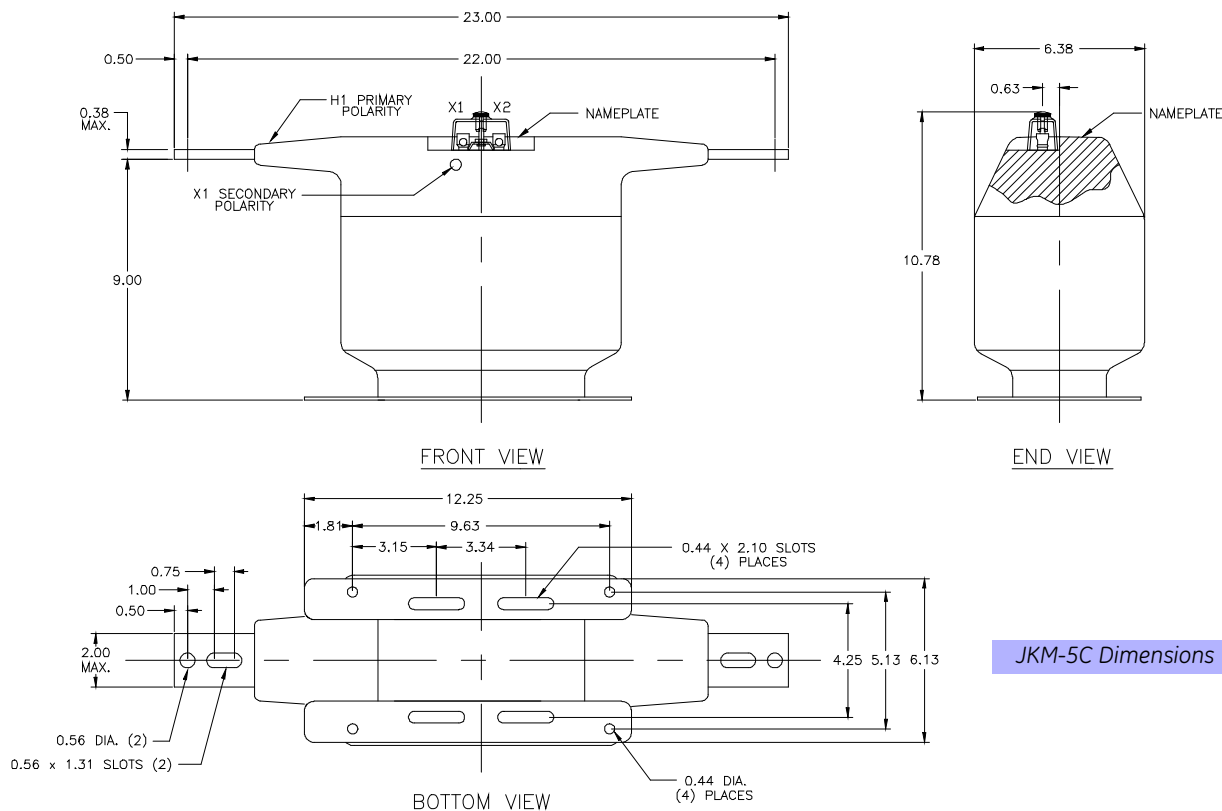
The base plate is made of stainless steel; it is provided with four slots for mounting. The transformer may be mounted in any orientation.

Maintenance

These transformers require no maintenance, other than occasional cleaning, if installed where air contamination is severe.

Data subject to change without notice

To purchase or obtain more information about GE Instrument Transformer products, please call GE Multilin at 1-800-547-8629. Product information is also available on our web site at <http://www.GEMultilin.com>. Click on the Product Index button (right column), select Transformers and follow the menus to **Product Information** or a **Solutions Advisor**.



JKM-5C Dimensions

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Europe, Middle East, Africa

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e-mail: gmultilin.euro@ge.com



Current Transformer Model 141

Window Diameter 8.13"

REGULATORY AGENCY APPROVALS



E93779



LR89403

Manufactured to meet the requirements of ANSI/IEEE C57.13.
Classified by U.L. in accordance with IEC 44-1



APPLICATION:

Relaying and metering.

FREQUENCY:

50-400 Hz.

INSULATION LEVEL:

600 Volts, 10 kV BIL full wave.

Terminals are brass screws No. 10-32 with one flatwasher and lockwasher.

Order mounting bracket kit 0221B00775 separately.

Multi-ratios available on request.

Approximate weight 44 lbs.

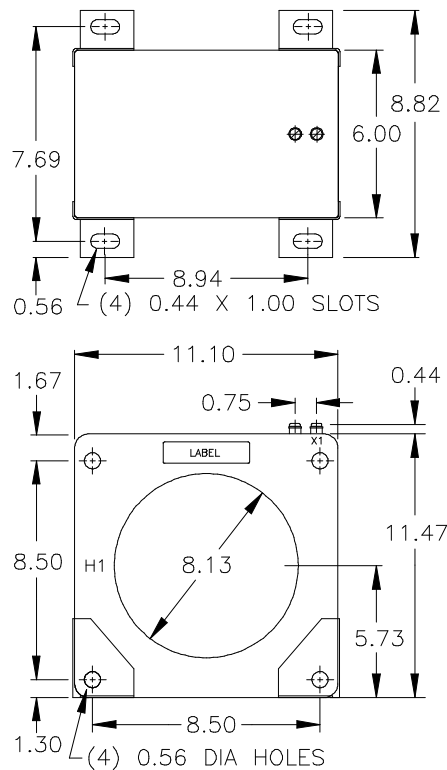
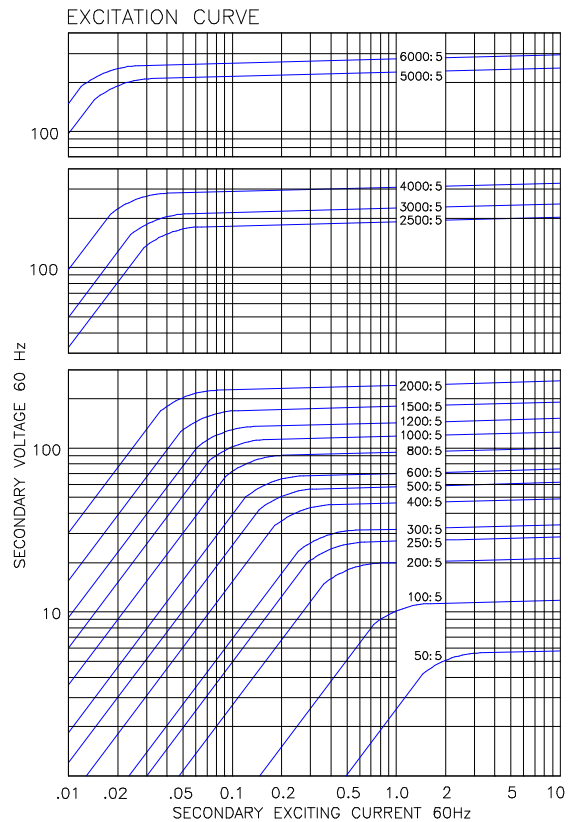
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CATALOG NUMBER	CURRENT RATIO	RELAY CLASS	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE (OHMS @ 75°C)	CONTINUOUS THERMAL RATING FACTOR	
			BO.1	BO.2	BO.5	BO.9	B1.8		@ 30°C	@ 55°C
141-500	50:5	C10	4.8	—	—	—	—	0.033	2.0	2.0
141-101	100:5	C10	2.4	2.4	—	—	—	0.066	2.0	2.0
141-201	200:5	C20	0.6	1.2	1.2	2.4	4.8	0.117	2.0	2.0
141-301	300:5	C50	0.6	0.6	1.2	1.2	2.4	0.248	2.0	2.0
141-401	400:5 *	C50	0.3	0.3	0.6	0.6	1.2	0.277	2.0	2.0
141-501	500:5 *	C100	0.3	0.3	0.3	0.6	0.6	0.415	2.0	2.0
141-601	600:5 *	C100	0.3	0.3	0.3	0.3	0.6	0.498	2.0	1.5
141-801	800:5 *	C100	0.3	0.3	0.3	0.3	0.3	0.664	2.0	1.5
141-102	1000:5 *	C200	0.3	0.3	0.3	0.3	0.3	0.829	2.0	1.5
141-122	1200:5 *	C200	0.3	0.3	0.3	0.3	0.3	1.002	2.0	1.5
141-152	1500:5 *	C400	0.3	0.3	0.3	0.3	0.3	1.253	1.5	1.0
141-202	2000:5 *	C400	0.3	0.3	0.3	0.3	0.3	1.659	1.33	1.0
141-252	2500:5 *	C400	0.3	0.3	0.3	0.3	0.3	1.963	1.5	1.33
141-302	3000:5 *	C400	0.3	0.3	0.3	0.3	0.3	2.356	1.5	1.0
141-402	4000:5 *	C400	0.3	0.3	0.3	0.3	0.3	3.141	1.0	0.8
141-502	5000:5 *	C400	0.3	0.3	0.3	0.3	0.3	2.862	1.0	0.8
141-602	6000:5 *	C400	0.3	0.3	0.3	0.3	0.3	4.302	1.0	0.6

Approved for revenue metering by Industry Canada No. AE-0658

Model 141

2



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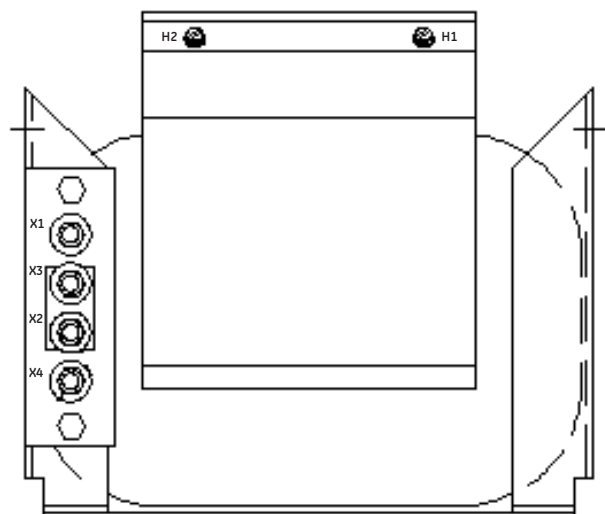


Instrument Transformers, Inc.

a division of GE Multilin



Medium Voltage Control Power Transformer Model CPT3-60-10 & CPT5-95-10



APPLICATION:

To provide control power in medium voltage switchgear.

FREQUENCY:

60 Hz.

INSULATION LEVEL:

CPT3: 5 kV, 60 kV BIL full wave.

CPT5: 15 kV, 95 kV BIL full wave.

THERMAL RATING:

10 kVA at 30°C ambient.

8.6 kVA at 55°C ambient.

Primary terminals are brass screws

1/4-20 with one flatwasher and starwasher.

Secondary terminals are brass studs 1/2-13 with one flatwasher, lockwasher and two nuts, plus series/parallel links.

Supplied with $1 \pm 7 \frac{1}{2}\%$ or $2 \pm 2 \frac{1}{2}\%$ taps above and below nominal voltage on the primary winding.

Windings are encapsulated in epoxy resin.

Mounting base is steel.

Assembly is varnish coated.

Available as unfused only.

Self cooled.

For indoor use.

Approximate weight 250 lbs.

**CATALOG NUMBER	PRIMARY VOLTAGE	RATIO	SECONDARY VOLTAGE	*FUSE RATING
CPT3-60-10-242**	2400	20:1	120/240	15E
CPT3-60-10-4161**	4160	34.7:1	120/240	7E
CPT3-60-10-482**	4800	40:1	120/240	7E
CPT5-95-10-722**	7200	60:1	120/240	5E
CPT5-95-10-842**	8400	70:1	120/240	5E
CPT5-95-10-123**	12000	100:1	120/240	3E
CPT5-95-10-1242**	12470	104:1	120/240	3E
CPT5-95-10-1322**	13200	110:1	120/240	3E
CPT5-95-10-1382**	13800	115:1	120/240	3E
CPT5-95-10-1442**	14400	120:1	120/240	3E

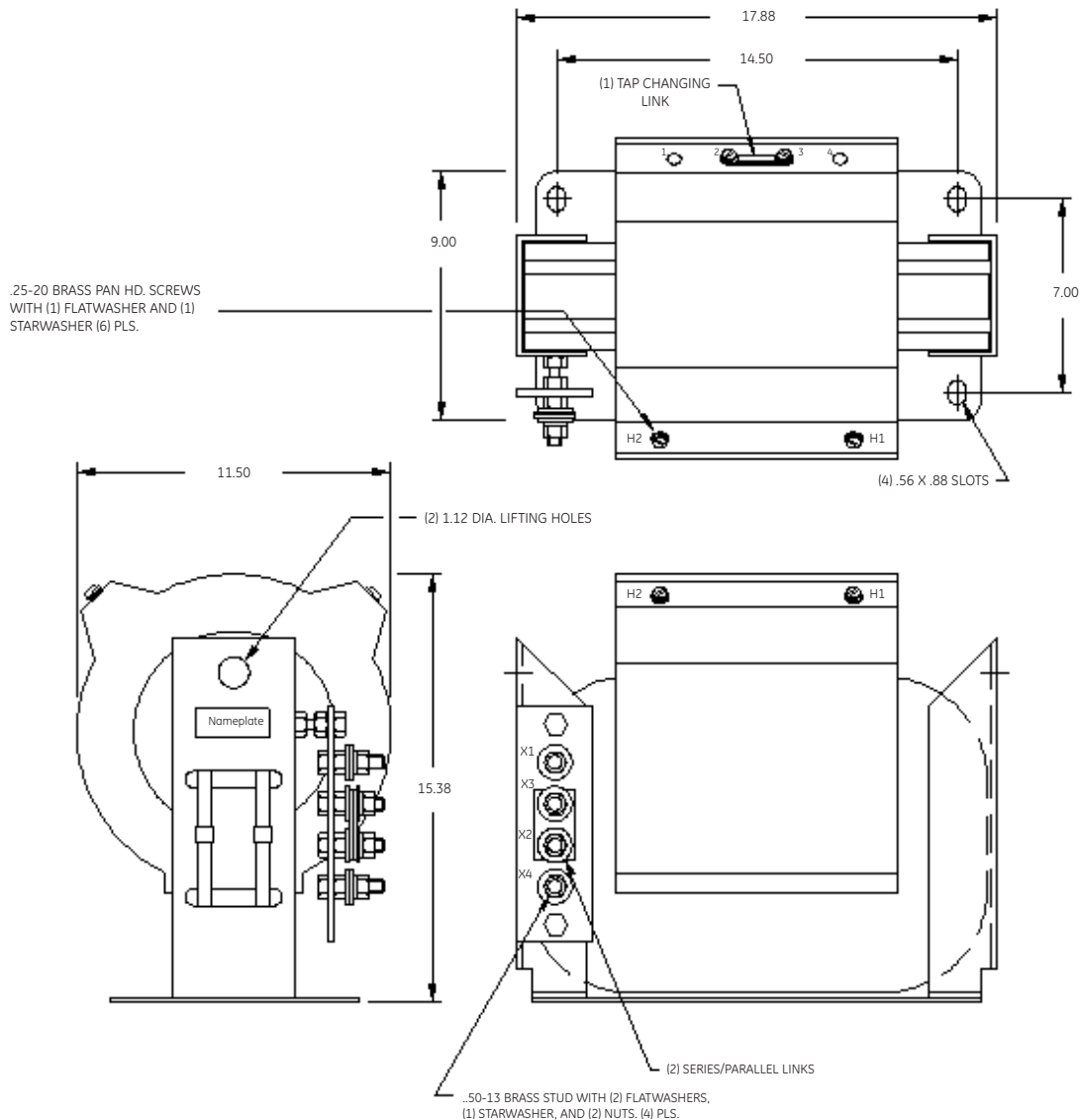
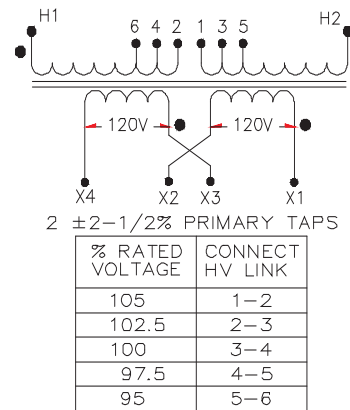
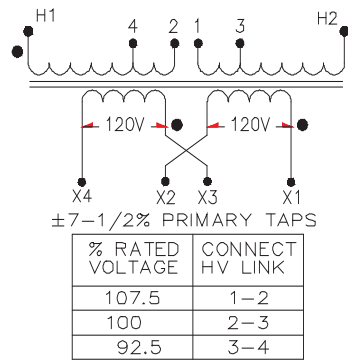
*Note all fuse rating are based on NEC transformer overcurrent protection recommendations. Specific applications may require other other ratings.

**For $1 \pm 7 \frac{1}{2}\%$ taps use suffix "A" after Catalog No.

**For $2 \pm 2 \frac{1}{2}\%$ taps use suffix "B" after Catalog No.

Models CPT3-60-10 & CPT5-95-10

Connection Diagrams



USA, Canada, Asia, Latin America

Tel: +1-800-547-8629

Fax: +1-905-201-2455

e-mail: sales.multilin@ge.com

Europe, Middle East, Africa

Tel: +34-94-485-88-00

Fax: +34-94-485-88-45

e-mail: gemultilin.euro@ge.com

Medium Voltage Fuses & Accessories

Various types. Different configurations.

Many ratings. One solution.

Your problem:

On one hand you need current limiting protection for medium voltage transformers and distribution systems that supply industrial plants, shopping centers, hospitals, schools, office buildings and underground residential service. On the other, you need high short-circuit current protection to avoid damages to busway, motors, switches and other equipment.

Our solution: Current-limiting power fuses are widely used in these applications because they afford excellent over-current protection and noiseless operation, and because they can be used in confined spaces. The amount of damage in the faulted area and the mechanical stress and strain on busway, switches and other apparatus carrying the fault current is proportional to the square of the current and to the length of time the fault persists. By limiting the let through energy at the fault, properly applied current-limiting fuses assist in limiting or preventing short-circuit damage to busway, circuit breakers, switches, and other electrical components. Current-limiting power fuses are manufactured in ratings ranging from 1kV through 38 kV and in continuous current ratings from 0.5 amperes through 1200 amperes. Various designs are available for use with motors, transformers, capacitors, and circuit-protection equipment.

Want more information fast? For more technical or application-specific information, please call our Medium Voltage experts, at 978-462-6662; 416-252-9371 in Canada; or visit our website at ep-us.mersen.com.



E Medium Voltage Fuses and Accessories

Transformer Protection

- Amp-Trap® CS-3 and 9F60/9F62 Series E2
- Amp-Trap® & 9F62 Bolt-In Series... E12
- Amp-Trap® CL-14 Series E16

Motor Protection

- Amp-Trap® & 9F60 Series E21
- Amp-Trap® Bolt-in Series..... E27
- Amp-Trap® DIN-style Series E30

Potential Transformer Protection

- Amp-Trap® & 9F60 Series PT Fuses E32

Capacitor Protection

- Amp-Trap® & 9F60 Series E36

Distribution Transformer Protection

- Sure Guard 9F59U Series ETP E44

IEC Standard Back-up Fuse Links

- IEC Standard Back-up Fuse-Links E48

Accessories

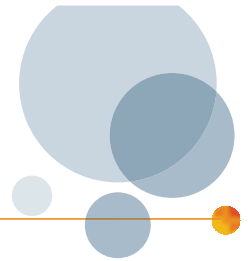
- Type EK 9F61 Series E53

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Transformer Protection

Amp-Trap® CS-3 Series and 9F60/9F62 Series



15kV / 15.5kV Ferrule mounted fuses:

15.5kV Power Distribution fuses – 9F60 Series, E-Rated EJ-1

12" (305 mm) Clip Centers - Suitable for use indoors or in an enclosure only

Catalog No.	Amp Rating	No. of Barrels	Indicating	Diameter Inches (mm)	Length Inches (mm)	Max Voltage	Max IR RMS Sym	Fuse Support Indoor (EK-1)	Fuse Support Outdoor (EK0-1)	Fuse Disconnect Indoor (EK-3)	Fuse Disconnect Outdoor (EK0-3)
9F60CJH002	2E	1	Yes	2 (50.8)	14.18 (360)	15.5 kV	50kA*	9F61AEG201	N/A	9F61AEG205	N/A
9F60CJH003	3E										
9F60CJH005	5E										
9F60CJH007	7E										
9F60CJH010	10E										

* These fuses were designed and originally tested at a higher maximum interrupting rating value. Consult factory for further information.

15.5kV Power Distribution fuses – 9F60 Series, E-Rated EJO-1

15" (381 mm) Clip Centers - Suitable for use indoors or outdoors



Catalog No.	Amp Rating	No. of Barrels	Indicating	Diameter Inches (mm)	Length Inches (mm)	Max Voltage	Max IR RMS Sym	Fuse Support Indoor (EK-1)	Fuse Support Outdoor (EK0-1)	Fuse Disconnect Indoor (EK-3)	Fuse Disconnect Outdoor (EK0-3)
9F60DMH905	0.5E	1	Yes	2 (50.8)	17.2 (437)	15.5 kV	50kA*	9F61AGG201 (13.8kV nominal - 95kV BIL) 9F61AGJ201 (14.4kV nominal - 110kV BIL)	9F61CGL209	9F61AGG205 (13.8kV nominal - 95kV BIL) 9F61AGJ205 (14.4kV nominal - 110kV BIL)	9F61CGL210
9F60DMH001	1E										
9F60DMH002	2E										
9F60DMH003	3E										
9F60DMH005	5E										
9F60DMH007	7E	1	Yes	3 (76.2)	18.88 (480)	15.5 kV	50kA	9F61AGG301 (13.8kV nominal - 95kV BIL) 9F61AGJ301 (14.4kV nominal - 110kV BIL)	9F61CGL309	9F61AGG305 (13.8kV nominal - 95kV BIL) 9F61AGJ305 (14.4kV nominal - 110kV BIL)	9F61CGL310
9F60DMH010	10E										
9F60FMH015	15E										
9F60FMH020	20E										
9F60FMH025	25E										
9F60FMH030	30E	2	Yes	3 (76.2)	18.88 (480)	15.5 kV	50kA	9F61AGG401 (13.8kV nominal - 95kV BIL) 9F61AGJ401 (14.4kV nominal - 110kV BIL)	9F61CGL409	9F61AGG405 (13.8kV nominal - 95kV BIL) 9F61AGJ405 (14.4kV nominal - 110kV BIL)	9F61CGL410
9F60FMH040	40E										
9F60FMH050	50E										
9F60HMH065	65E										
9F60HMH080	80E										
9F60HMH100	100E										

* These fuses were designed and originally tested at a higher maximum interrupting rating value. Consult factory for further information.

Federal Pacific General Purpose Transformer

SE2N.050F to SE2T15F

240x480 Primary Volts - 120/240 Secondary Volts

Subcategory :	Isolation
Phase :	Single
Frequency:	60 Hz
kVA:	0.05 to 15 kVA
K rating:	1
Pri. configuration:	Two winding
Sec. configuration:	Two winding
Reverse connectable:	No, Yes (1 kva and up)
Winding material:	Copper
Electrostatic shielded:	No
Temperature rise:	115 Deg C
Insulation system:	180 Deg C
Enclosure rating:	NEMA 3R
Enclosure material:	Steel
Construction style:	Enclosed - Encapsulated Core & Coil
Mounting type:	Wall
Connection type:	Wire Leads
Cooling:	Air/dry
Agency approvals:	UL and cUL Listed, CSA Approved.
Sound level:	Below NEMA standards.
Warranty:	12 years



Federal Pacific General Purpose Transformer
SE2N.050F to SE2T15F

240x480 Primary Volts - 120/240 Secondary Volts


 Single-Phase
.050 to 3 KVA

 Single-Phase
5 KVA to 15 KVA

 Three-Phase
3 KVA to 15 KVA

Dimensions (in inches)

Part #	kVA	Height	Width	Depth	Weight (lbs)	Wiring Diagram
SE2N.050F	0.05	8.25	3.25	4.25	8	1
SE2N.075F	0.075	8.25	3.25	4.25	9	1
SE2N.100F	0.1	8.25	3.25	4.25	10	1
SE2N.150F	0.15	9.25	4	5	14	1
SE2N.250F	0.25	9.25	4	5	15	1
SE2N.500F	0.5	11.25	5.25	6.5	21	1
SE2N.750F	0.75	11.25	5.25	6.5	25	1
SE2N1F	1	11.25	5.25	6.5	28	1
SE2N1.5F	1.5	13.25	6.25	7.75	45	1
SE2N2F	2	13.25	6.25	7.75	50	1
SE2N3FS	3	13.25	6.25	7.75	60	10
SE2T3F	3	13.25	6.25	7.75	60	8
SE2N5FS	5	15	10.1875	10.625	110	10
SE2T5F	5	15	10.1875	10.625	110	8
SE2N7.5F	7.5	15	10.1875	10.625	150	1
SE2T7.5F	7.5	15	10.1875	10.625	150	8
SE2N10F	10	17	13.1875	13.125	175	1
SE2T10F	10	17	13.1875	13.125	175	8
SE2N15F	15	17	13.1875	13.125	270	1
SE2T15F	15	17	13.1875	13.125	270	8

Corporate Headquarters: TEMCo – Tower Electric Motor Company 41474 Christy Street Fremont, CA 94538
 Inside USA (877) 474-8209 International (510) 490-2187 Fax (510) 490-1507 www.temcoindustrialpower.com

Federal Pacific General Purpose Transformer

SE2N.050F to SE2T15F

240x480 Primary Volts - 120/240 Secondary Volts

Diagram #1

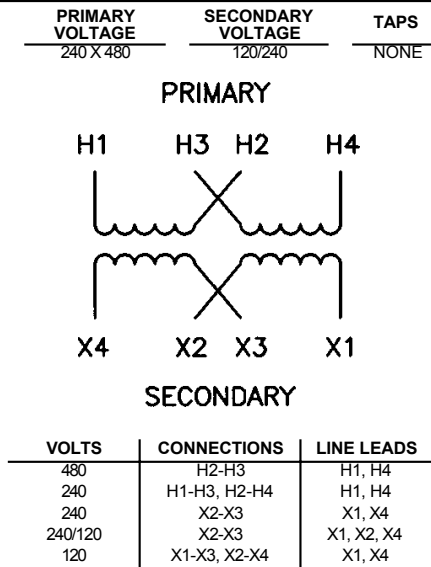


Diagram #8

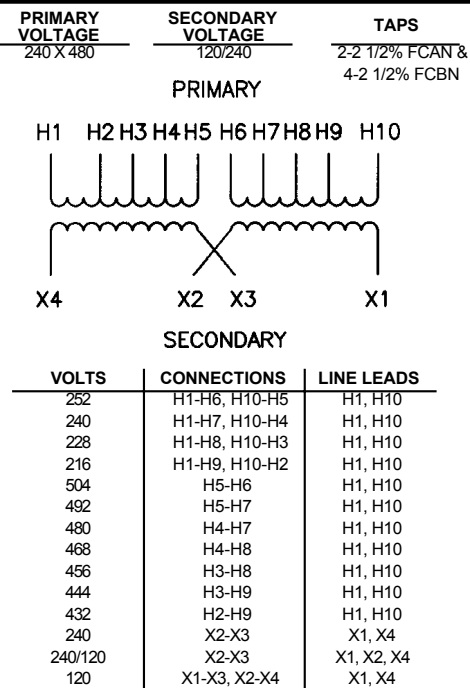
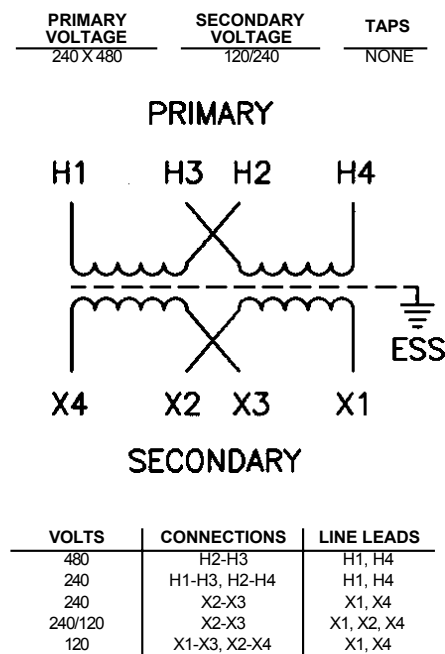


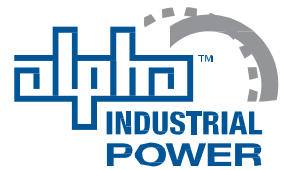
Diagram #10



Nickel Cadmium Batteries KPM Models



Nickel Cadmium Batteries



Translucent Nickel Cadmium Pocket Plate Batteries

Alpha Industrial Power's Translucent Nickel Cadmium Pocket Plate Type Batteries are designed and manufactured in three categories—long, medium, and high—to the highest standards to provide unparalleled reliability and performance.

Alpha Industrial Power's Nickel Cadmium Batteries are typically deployed for process control, utilities, railway operation, and petrochemical.

Maintenance intervals are greatly extended and well suited to provide effective power back-up with the properly sized equipment at competitive pricing. According to the discharge rate:

- KPL Type: To a discharge rate of 0.5 C5 (A); Optimum use for discharge periods of 5 or more hours
- KPM Type: To a discharge rate of 0.5 to 3.5 C5 (A); Optimum use for discharge periods of 30 minutes to 3 hours
- KPH Type: To a discharge rate of 3.5 to 7 C5 (A); Optimum use for discharge periods of 30 minutes or less

Characteristics and Advantages

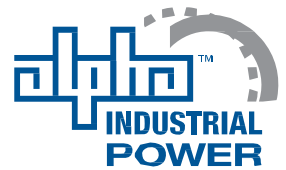
- Designed for mobile and stationary applications, fitted in mobile crates or placed on racks
- Robust construction with high energy density
- Superior performance in harsh operating conditions (-40°C to 50°C / -40°F to 122°F)
- Minimum self-discharge
- Long life and high cycling capabilities
- Recyclable, easy assembly, handling and minimal maintenance
- Low internal resistance
- Compliant with IEC 60623

Charging

- Constant current charging
- Charging at constant voltage in the range of 1.40 V to 1.60 V per cell
- Charging according to current limiting
- Boost charging
 - Boost (accelerated) charging is applied before putting batteries into operation or after longer storage periods, as well as after long operation in difficult or deep discharge conditions.
- Float charging
 - After extended storage periods and/or for the purpose of sustaining charge conditions, the battery is continuously float charged at a voltage range of 1.40 to 1.42



Nickel Cadmium Batteries

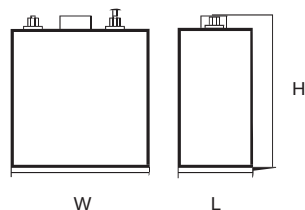


Cell Type KPM

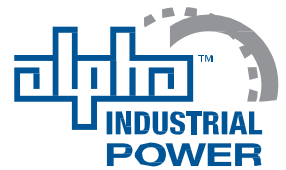
Cell Designation	C5(Ah)	Cell Dimension	Terminals		Cell Weight (kg / lb)	
		WxLxH (mm / in)	No.	M (mm)	With Electrolyte	Electrolyte
KPM-20P	20	85x45x256 / 3.35x1.77x10.1	2	10	1.5 / 3.3	0.2 / 0.44
KPM-30P	30	85x45x256 / 3.35x1.77x10.1	2	10	1.72 / 3.78	0.37 / 0.81
KPM-40P	40	85x85x256 / 3.35x3.35x10.1	2	10	2.8 / 6.16	0.9 / 1.98
KPM-50P	50	85x85x256 / 3.35x3.35x10.1	2	10	2.9 / 6.3	0.67 / 1.47
KPM-70P	70	130x70x310 / 5.12x2.76x12.20	2	10	4.1 / 9.02	0.7 / 1.54
KPM-80P	80	130x70x330 / 5.12x2.76x12.99	2	10	5.0 / 11.0	1.0 / 2.2
KPM-100P	100	130x70x330 / 5.12x2.76x12.99	2	16	5.7 / 12.54	1.1 / 2.42
KPM-120	120	135x110x320 / 5.31x4.33x12.60	2	10	7.5 / 16.5	2.5 / 5.5
KPM-140P	140	196x86x403 / 7.72x3.39x15.87	2	10	8.6 / 18.92	1.75 / 3.85
KPM-150P	150	135x110x320 / 5.31x4.33x12.60	2	10	8.8 / 19.36	1.3 / 2.86
KPM 180P	180	165x105x400 / 6.50x4.13x15.75	2	16	11.0 / 24.25	2.65 / 5.83
KPM-190P	190	165x110x320 / 6.50x4.33x12.60	2	10	11.2 / 24.64	2.5 / 5.5
KPM-200P	200	165x105x400 / 6.50x4.13x15.75	2	20	11.5 / 25.3	3.0 / 6.6
KPM-225P	225	165x105x397 / 6.50x4.13x15.63	2	10	11.6 / 25.52	2.2 / 4.84
KPM-240P	240	165x105x355 / 6.50x4.13x13.98	2	10	12.0 / 26.46	2.0 / 4.4
KPM-260P	260	165x105x400 / 6.50x4.13x15.75	2	10	14.0 / 30.86	2.5 / 5.5
KPM-280P	280	196x110x403 / 7.72x4.33x15.87	4	20	15.5 / 34.17	3.0 / 6.6
KPM-300P	300	196x110x403 / 7.72x4.33x15.87	4	20	16.2 / 35.71	3.2 / 7.04
KPM-320P	320	196x110x403 / 7.72x4.33x15.87	4	20	16.8 / 36.96	3.4 / 7.48
KPM-375P	375	196x147x403 / 7.72x5.79x15.87	4	10	18.5 / 40.79	4.5 / 9.9
KPM-400P	400	196x147x403 / 7.72x5.79x15.87	4	10	20.8 / 45.86	4.3 / 9.46
KPM-450P	450	196x147x403 / 7.72x5.79x15.87	4	10	23.0 / 50.71	4.0 / 8.8
KPM-500P	500	246x176x408 / 9.69x6.93x16.06	4	10	28.3 / 62.39	7.1 / 15.62
KPM-550P	550	246x176x408 / 9.69x6.93x16.06	4	10	29.3 / 64.60	6.9 / 15.18
KPM-600P	600	368x176x408 / 14.49x6.93x16.14	4	20	40.7 / 89.73	13.7 / 30.14

Marking: P – Plastic casing

Other cell capacities can be provided according to specific customer requirements.



Nickel Cadmium Batteries

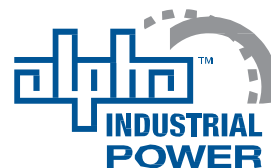


Discharge Performance KPM

Current-(Amps)-to-1.00V/Cell-@-20°C-(68°F)											
Cell-Type	C5-(Ah)	Discharge-Time-in-Hours					Discharge-Time-in-Minutes				
		8	5	3	2	90	60	30	20	10	5
KPM-20P	20	2.6	4.0	6.6	9.5	11.5	15	22	24.6	30.1	36.6
KPM-30P	30	3.9	6.0	9.9	14.2	17.2	22.5	33	36.9	45.2	54.9
KPM-40P	40	5.2	8.0	13.2	19	22.9	30	44	49.2	60.2	73.2
KPM-50P	50	6.5	10	16.5	23.7	28.6	37.5	55	61.6	75.3	91.5
KPM-70P	70	9.1	14	23.1	33.2	40.1	52.5	77	86.1	105.4	128.1
KPM-80P	80	10.4	16	26.4	38	45.8	60	88	98.5	120.4	146.4
KPM-100P	100	13	20	33	47.5	57.3	75	110	123.1	150.6	183.1
KPM-120P	120	15.6	24	39.6	57	68.8	90	132	147.7	180.7	219.7
KPM-140P	140	18.2	28	46.2	66.5	80.3	105	154	172.3	210.8	256.3
KPM-150P	150	19.5	30	49.5	71.2	86	112.5	165	184.7	225.9	274.6
KPM-180P	180	23.4	36	59.4	85.5	103.2	135	198	221.6	271	329.5
KPM-190P	190	24.7	38	62.7	90.2	108.9	142.5	209	233.9	286.1	347.9
KPM-200P	200	26	40	66	95	114.6	150	220	246.2	301.2	366.2
KPM-225P	220	28.6	44	72.6	104.5	126.1	165	242	270.8	331.3	402.8
KPM-240P	240	31.2	48	79.2	114	137.6	180	264	295.5	361.4	439.4
KPM-260P	260	33.8	52	85.8	123.5	149.1	195	286	320	391.5	476
KPM-280P	280	36.4	56	92.4	133	160.5	210	308	344.7	421.6	512.6
KPM-300P	300	39.0	60	99.0	142.5	172	225	330	369.3	451.8	549.3
KPM-320P	320	41.6	64	105.6	152	183.4	240	352	394	481.9	585.9
KPM-375P	375	48.7	75	123.7	178.1	215	281	412.5	461.7	564.7	686.6
KPM-400P	400	52.0	80	132	190	229.3	300	440	492.5	602.4	732.4
KPM-450P	450	58.5	90	148.5	213.7	258	337.5	495	554	677.7	823.9
KPM-500P	500	65.0	100	165	237	286	375	550	616	753	915
KPM-550P	550	71.5	110	181.5	260.7	314.6	412.5	605	677.6	828.3	1006.5
KPM-600P	600	78.0	120	198	284.4	343.2	450	660	739.2	903.6	1098

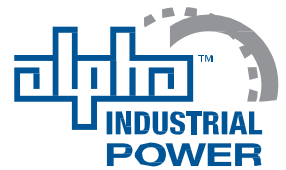
Nickel Cadmium Batteries

Cell Type KPM



Cell-Type	Current-(Amps)-to-1.05V/Cell-@-20°C-(68°F)										
	C5-(Ah)	Discharge-Time-in-Hours				Discharge-Time-in-Minutes					
		8	5	3	2	90	60	30	20	10	5
KPM-20P	20	2.5	3.9	6.4	8.3	9.9	13.2	17.6	19.9	25.0	29.6
KPM-30P	30	3.7	5.9	9.6	12.4	14.8	19.8	26.4	29.9	37.5	44.4
KPM-40P	40	5.0	7.8	12.8	16.6	19.9	26.4	35.2	39.9	50.0	59.3
KPM-50P	50	6.2	9.8	16.0	20.7	24.8	33.0	44.0	49.8	62.5	74.1
KPM-70P	70	8.7	13.8	22.4	29.0	34.8	46.2	61.6	69.8	87.5	103.7
KPM-80P	80	10	15.7	25.6	33.2	39.8	52.8	70.4	79.8	100	118.6
KPM-100P	100	12.5	19.7	32.0	41.5	49.8	66	88	99.8	125	148.2
KPM-120P	120	15	23.6	38.4	49.8	59.7	79.2	105.6	119.7	150	177.9
KPM-140P	140	17.5	27.5	44.8	58.1	69.7	92.4	123.2	139.7	175	207.5
KPM-150P	150	18.7	29.5	48	62.2	74.6	99	132	149.6	187.5	222.3
KPM-180P	180	22.5	35.4	57.6	74.7	89.6	118.8	158.4	179.6	225	266.8
KPM-190P	190	23.7	37.4	60.8	78.8	94.5	125.4	167.2	189.6	237.5	281.6
KPM-200P	200	25	39.4	64	83.0	99.6	132	176	199.5	250	296.5
KPM-225P	220	27.5	43.3	70.4	91.3	109.5	145.2	193.6	219.5	275	326.1
KPM-240P	240	30.0	47.2	76.8	99.6	119.5	158.4	211.2	239.5	300	355.8
KPM-260P	260	32.5	51.2	83.2	107.9	129.4	171.6	228.8	259.4	325	385.4
KPM-280P	280	35.0	55.1	89.6	116.2	139.4	184.8	246.4	279.4	350	415.1
KPM-300P	300	37.5	59.1	96.0	124.5	149.4	198	264	299.3	375	444.7
KPM-320P	320	40.0	63.0	102.4	132.8	159.3	211.2	281.6	319.3	400	474.4
KPM-375P	375	46.8	73.8	120.0	155.6	186.7	247.5	330	374.2	468.7	555.8
KPM-400P	400	50.0	78.8	128.0	166.0	199.2	264	352	399.1	500	593
KPM-450P	450	56.2	88.6	144.0	186.7	224	297	396	449	562.5	667.1
KPM-500P	500	62	98	160	207	248	330	440	498	625	741
KPM-550P	550	68.2	104.5	176	227.7	272.8	363	484	547.8	687.5	815.1
KPM-600P	600	74.4	117.6	192	248.4	297.6	396	528	597.6	750	889.2

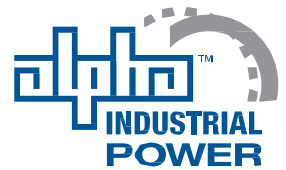
Nickel Cadmium Batteries



Cell Type KPM

Cell-Type	Current-(Amps)-to-1.10V/Cell-@-20°C-(68°F)										
	C5-(Ah)	Discharge-Time-in-Hours				Discharge-Time-in-Minutes					
		8	5	3	2	90	60	30	20	10	5
KPM-20P	20	2.4	3.8	5.7	7.4	8.8	11.1	14.4	16.8	20.0	24.2
KPM-30P	30	3.6	5.8	8.5	11.1	13.2	16.6	21.6	25.2	30.0	36.4
KPM-40P	40	4.9	7.7	11.4	14.8	17.6	22.2	28.8	33.6	40.0	48.6
KPM-50P	50	6.1	9.7	14.3	18.5	22.0	27.7	36.0	42.0	50.0	60.8
KPM-70P	70	8.5	13.5	20.0	25.9	30.8	38.8	50.4	58.8	70.0	85.1
KPM-80P	80	9.8	15.5	22.8	29.6	35.2	44.4	57.6	67.2	80.0	97.2
KPM-100P	100	12.2	19.4	28.6	37.0	44.0	55.5	72.0	84.0	100.	121.6
KPM-120P	120	14.7	23.2	34.3	44.4	52.8	66.6	86.4	100.8	120	145.9
KPM-140P	140	17.1	27.1	40.0	51.8	61.6	77.7	100.8	117.6	140	170.2
KPM-150P	150	18.3	29.1	42.9	55.5	66.0	83.2	108	126	150	182.4
KPM-180P	180	22.0	34.9	51.4	66.6	79.2	99.9	129.6	151.2	180	218.8
KPM-190P	190	23.2	36.8	54.3	70.3	83.6	105.4	136.8	159.6	190	231
KPM-200P	200	24.5	38.8	57.2	74.0	88.0	111.0	144	168	200	243.2
KPM-225P	220	26.9	42.6	62.9	81.4	96.8	122.1	158.4	184.8	220	267.5
KPM-240P	240	29.4	46.5	68.6	88.8	105.6	133.2	172.8	201.6	240	291.8
KPM-260P	260	31.8	50.4	74.3	96.2	114.4	144.3	187.2	218.4	260	316.1
KPM-280P	280	34.3	54.3	80.0	103.6	123.2	155.4	201.6	235.2	280	340.4
KPM-300P	300	36.7	58.2	85.8	111	132	166.5	216	252	300	364.8
KPM-320P	320	39.2	62.0	91.5	118.4	140.8	177.6	230.4	268.8	320	389.1
KPM-375P	375	45.9	72.7	107.2	138.7	165	208.1	270	315	375	456
KPM-400P	400	49	77.6	114.4	148	176	222	288	336	400	486.4
KPM-450P	450	55.1	87.3	128.7	166.5	198	249.7	324	378	450	547.2
KPM-500P	500	61	97	143	185	220	277	360	420	500	608
KPM-550P	550	67.1	106.7	157.3	203.5	242	304.7	396	462	550	668.8
KPM-600P	600	73.2	116.4	171.6	222	264	332.4	432	504	600	729.6

Nickel Cadmium Batteries

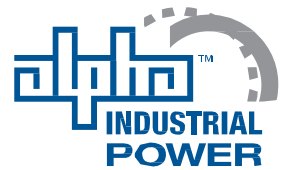


Cell Type KPM

Cell-Type	Current-(Amps)-to-1.14V/Cell-@-20°C-(68°F)										
	C5-(Ah)	Discharge-Time-in-Hours				Discharge-Time-in-Minutes					
		8	5	3	2	90	60	30	20	10	5
KPM-20P	20	2.38	3.50	5.00	6.30	7.60	8.9	11.2	13.2	15.6	19.5
KPM-30P	30	3.56	5.25	7.50	9.45	11.40	13.3	16.8	19.8	23.4	29.2
KPM-40P	40	4.75	7.00	10.00	12.60	15.20	17.8	22.4	26.4	31.3	39.0
KPM-50P	50	5.94	8.75	12.50	15.75	19.00	22.2	28.0	33.0	39.1	48.7
KPM-70P	70	8.31	12.30	17.50	22.05	26.60	31.1	39.2	46.2	54.8	68.3
KPM-80P	80	9.50	14.20	20.00	25.20	30.40	35.6	44.8	52.8	62.6	78.0
KPM-100P	100	11.87	17.60	25.00	31.50	38.00	44.5	56.0	66.0	78.3	97.5
KPM-120P	120	14.25	21.10	30.00	37.80	45.60	53.4	67.2	79.2	93.7	117.0
KPM-140P	140	16.62	24.60	35.00	44.10	53.20	62.3	78.4	92.4	109.6	136.6
KPM-150P	150	17.81	26.25	37.50	47.25	57.00	66.7	84.0	99.0	117.4	146.3
KPM-180P	180	21.37	31.50	45.00	56.70	68.40	80.1	100.8	118.9	140.9	175.6
KPM-190P	190	22.56	33.60	47.50	59.85	72.20	84.5	106.4	125.5	148.7	185.4
KPM-200P	200	23.75	35.00	50.00	63.00	76.00	89.0	112	132.1	156.6	195.1
KPM-225P	220	26.12	38.60	55.00	69.30	83.60	97.9	123.2	145.3	172.2	214.4
KPM-240P	240	28.50	42.60	60.00	75.60	91.20	106.8	134.4	158.5	187.9	234.2
KPM-260P	260	30.87	45.70	65.00	81.90	98.80	115.7	145.6	171.7	203.6	253.7
KPM-280P	280	33.25	49.00	70.00	88.20	106.4	124.6	156.8	184.9	219.2	273.2
KPM-300P	300	35.62	52.90	75.00	94.50	114.0	133.5	168.0	198.1	234.9	292.7
KPM-320P	320	38.00	56.00	80.00	100.8	121.6	142.4	179.2	211.3	250.6	312.2
KPM-375P	375	44.53	64.90	93.75	118.10	142.5	166.9	210	247.7	293.6	365.0
KPM-400P	400	47.50	70.70	100.0	126.00	152.0	178.0	224	261.8	313.2	390.3
KPM-450P	450	53.43	78.75	112.50	141.70	171.0	200.2	252	297.2	352.4	439.0
KPM-500P	500	59.40	87.50	125.00	157.50	190.0	222.0	280.0	330.0	391.0	487.0
KPM-550P	550	65.30	96.20	137.50	173.20	209.0	244.2	308.0	363.0	430.0	535.7
KPM-600P	600	71.20	105.00	150.00	189.00	228.0	266.4	336.0	396.0	469.2	584.4

Nickel Cadmium Batteries

Battery Racks



Features

- Flexibility – Modular Design allows for system versatility and ease of set-up and movement. Plastic acid-resistant adjustable isolators are provided to permit leveling up to 0.6".
- Strength – All main rack components are made of powder-coated steel.
- Protection – All Steel parts are completely powder-coated with black or gray polyethylene for electrolyte protection and electrical insulation.



Optional Seismic-rated Configuration Available

With optional components, AlphaRac™ battery racks become seismic-rated system suitable for use in earthquake-prone areas. Seismic-rated AlphaRac battery racks are designed to meet the requirements for IEEE 693-2005, IBC 2006 and CBC 2007.

Custom Designed Racks

Special applications and unusual installation locations often require an adaptable, unique battery rack. Custom configured AlphaRac battery racks are modular and can be designed to meet almost any requirement.



For more information visit www.alpha.com

Alpha Industrial Power United States Suwanee, Georgia Tel: 800 996 6104 Fax: 678 584 9259

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049-383-10-001 (11/11)

Power

Spectra Charger

SCR Automatic Battery Charger



- Industrial-grade battery charger
- Microprocessor control and digital display
- Universal control boards; and control disable for tamper-free operation
- Online adjustment
- Modular construction for easy maintenance and replacement
- Battery Eliminator option for use as a DC source without batteries
- UL Listed and CSA label

The Alpha Spectra Industrial Battery Charger incorporates the latest digital and power electronics technologies, making it one of the most reliable battery chargers available. The unique SCR rectifier with a double wound isolation transformer provides precise regulated DC output and current limiting capabilities. Three different output-filtering configurations are available to match powering requirements. Approved UL, CSA and EMI standards. Made in the USA.

Spectra Battery Charger

Specifications

Electrical

AC Input Voltage: 120, 208 or 240V +10%, -12%
 Phase: 1
 Frequency: 50 or 60Hz $\pm$ 3Hz
 Power Factor: 0.8 typical full load
 Efficiency: 80 to 90% at 50 to 100% load

DC Output Voltage: 24, 48 or 130VDC nominal
 Current: 6, 12, 20, 25 or 50ADC
 Continuous Rating: 110% rated current at max equalize voltage at 50°C
 Voltage Regulation: $\pm$.25% for line, load and temperature
 Transient Response: <±6% with 20 to 100% step load with battery connected
 Electrical Noise: 30m Vrms/32BDnrc weighted maximum on filtered versions (battery eliminator)
 <2%Vrms for 130VDC output
 <1%Vrms for 48VDC output

Mechanical

NEMA 1 Enclosures: Standard
 Dimensions S1 (in): 17.5H x 19W x 16.75D
 (mm): 445H x 483W x 425D
 Dimensions S2 (in): 26.25H x 19W x 16.75D
 (mm): 667H x 483W x 426D
 Dimensions S3 (in): 35H x 19W x 13.75D
 (mm): 889H x 483W x 425D

Environmental

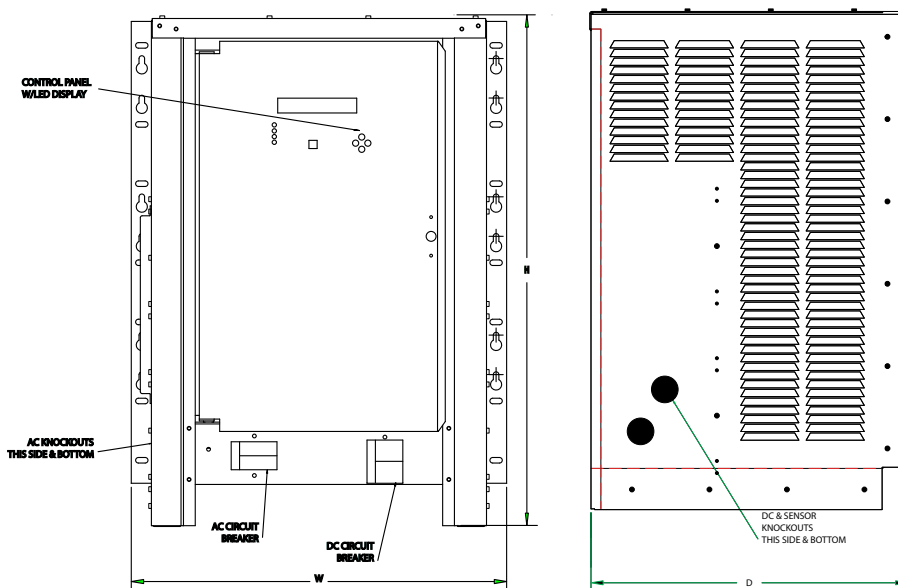
Natural Convection
 Ambient Temperature: 0 to 40°C (32 to 105°F)
 Elevation: 1000m (3000ft) without derating
 Relative Humidity: 0 to 95% (non-condensing)

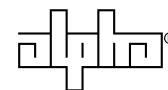
Standard Features

LCD Display
 Charger Pause 0-60 Min
 Reverse Polarity Protection
 Sprinkler Resistant Ventilation
 UL Listed
 Stackable Enclosure
 Summary Alarm Buzzer
 AC H/L Voltage Alarm and AC Fail Indication
 H/L DC Voltage Alarm
 AC Input and DC Output Circuit Breakers
 Control Panel and Circuit Breakers Recessed
 Bottom/Side Cable Entry
 AC, DC, Float and Equalize Indicator Lights
 Field Programmable with Security Levels
 Compression Terminal Strip for Field Wiring
 High DC Voltage Shutdown
 Push Button Mode Selection
 AC and DC Surge Suppressors
 Wire Protection on Field Connections
 Floor Mount Legs
 Summary Alarm Contact Relay

Optional Features

DC Output Filter
 Battery Eliminator Filter
 Input Lightning Arrestor
 Remote Control Panel
 Parallel Charging
 Remote DC Voltage Sensor
 Special AC Power Connections
 Local or Remote Voltage Sensor
 Remote Temperature Compensation
 Individual Alarm Relay Contact Board (alarm input/output board)
 Conformal Seal on Electronic Boards
 Anti-Fungus Coating
 Special AC Input Voltage
 19" or 23" Relay Rack Mounting
 NEMA 4 or 12 Enclosure
 Cabinet Heater





ST Series Rating Table

Output Voltage	Float Voltage Range	Equalize Voltage Range	DC Ampere Rating	6A			12A			18A			20A			25A			50A		
			AC Input	120	208	240	120	208	240	120	208	240	120	208	240	120	208	240	120	208	240
24 VDC	24VDC to 30VDC	24VDC to 30VDC	AC Input Amperes (Nominal)	5A	4A	3A	7A	5A	5A	12A	8A	8A	12A	8A	8A	14A	10A	10A	30A	22A	22A
			AC Input Circuit Breaker	10A	10A	10A	10A	10A	10A	15A	15A	10A	15A	15A	10A	20A	15A	10A	40A	30A	30A
			DC Output Circuit Breaker	15A	15A	15A	30A	30A	30A	40A	40A	40A	40A	40A	40A	60A	60A	60A	90A	90A	90A
			Cabinet Style	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S3	S3	S3
			Shipping Weight (lbs)	70	70	70	75	70	75	85	85	85	85	85	85	90	90	90	125	125	125
48VDC	48VDC to 60VDC	48VDC to 60VDC	AC Input Amperes (Nominal)	7A	5A	5A	14A	10A	10A	23A	14A	15A	23A	14A	15A	28A	17A	20A	54A	27A	27A
			AC Input Circuit Breaker	10A	10A	10A	20A	10A	10A	30A	20A	15A	30A	20A	15A	30A	25A	20A	70A	40A	40A
			DC Output Circuit Breaker	15A	15A	15A	30A	30A	30A	50A	40A	50A	50A	50A	50A	60A	60A	60A	90A	90A	90A
			Cabinet Style	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S3	S3	S3
			Shipping Weight (lbs)	75	75	75	90	90	90	110	110	110	110	110	110	115	115	115	222	222	222
130VDC	120VDC to 150VDC	120VDC to 150VDC	AC Input Amperes (Nominal)	14A	11A	8A	27A	17A	15A	45A	26A	22A	45A	24A	22A	56A	32A	27A	n/a	68A	50A
			AC Input Circuit Breaker	20A	15A	15A	40A	30A	25A	60A	40A	30A	60A	40A	30A	70A	60A	40A	n/a	90A	70A
			DC Output Circuit Breaker	15A	15A	15A	25A	25A	25A	40A	40A	40A	40A	40A	40A	60A	60A	60A	n/a	90A	90A
			Cabinet Style	S1	S1	S1	S1	S1	S1	S2	S2	S2	S2	S2	S2	S2	S2	S2	n/a	S3	S3
			Shipping Weight (lbs)	100	100	100	130	130	130	175	175	175	175	175	175	190	190	190	n/a	340	340

ST Model Number Configuration

	ST																
A		B			C			D	E	F	G	H	I	J	K		

If a space has no option selected a zero must be inserted.

Box	ST	Description
A	1	1 Phase
B	024 048 130	Nominal DC Output Voltage 24VDC 48VDC 130VDC
C	006 012 020 025 050	Nominal DC Output Current 6ADC 12ADC 20ADC 25ADC* 50ADC*
D	1 2 3	Input Voltage 120 208 (not UL listed) 240
E	0 1	Filtering Unfiltered Filtered / Eliminator
F	0 1	Relays No Relays Individual Alarm Relay Contact Board

Box	ST	Description
G	0 1 2 3 4 5 6 7	Remote Sensing Not Supplied Remote Control Panel Remote Temperature Compensation Remote DC Voltage Sensing Lines 1 & 2 Lines 1 & 3 Lines 2 & 3 Lines 1, 2 & 3
H	0 1	Lightning Arrestor Not Supplied Included
I	0 1 2	Charging Not Supplied Parallel Charging NOT AVAILABLE
J	0 1 2 3	Special Treatments Nothing Fungus Proofing Conformal Seal On Electronic DC Board Option 1 and 2
K	0 1 2 3 4 5 6 7	Other Options Nothing Lockable enclosure door NOT AVAILABLE 19" Rack flanges @6.0" from front 23" Rack flanges @6.0" from front Lines 1 & 4 Lines 1 & 5

For more information visit www.alpha.com

Alpha Industrial Power
MTI Systems

United States
Canada

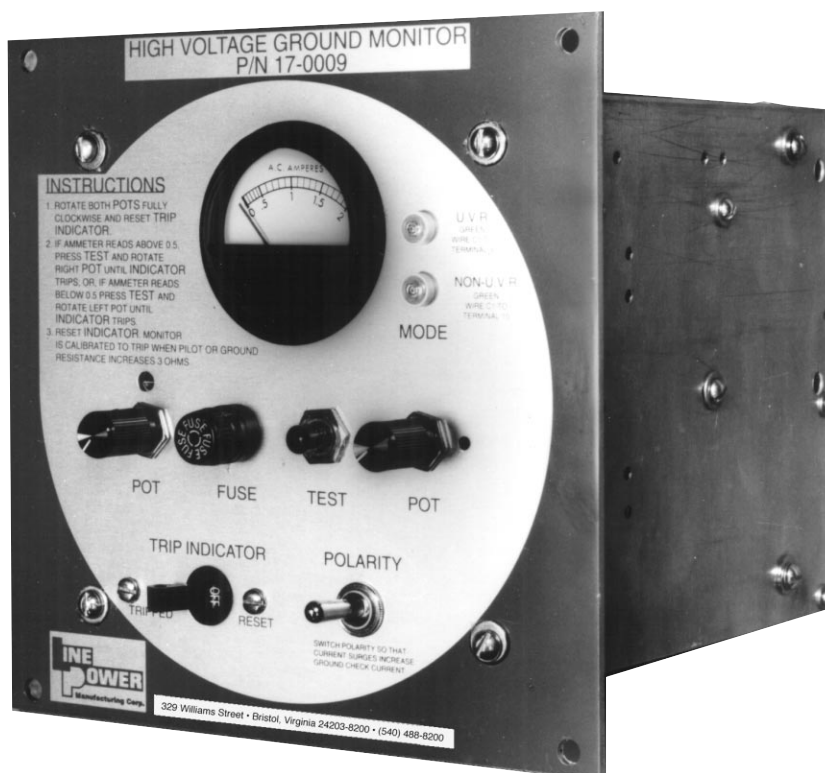
Bellingham, Washington Tel: 360 647 2360 Fax: 360 671 4936
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049-215-33-003 (1/06)

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High Voltage Ground Monitor

Product
Data
Sheet



Part Number 17-0009

Application

The Line Power Manufacturing High Voltage Ground Monitor is an impedance-type ground monitor that can operate in either of two modes: UVR Mode or Non-UVR mode. Mode selection is made by changing the position of the "C1" lead on the rear of the unit. The unit is normally shipped wired in the UVR Mode. The UVR mode is fail-safe where the Non-UVR mode is not fail-safe.

In the UVR Mode, the monitor relay will energize when control power is present and the pilot-ground loop is complete with normal continuity. If the ground loop is "lost" (impedance increases 3 ohms or more after proper initial adjustment of the unit) the monitor relay will trip (de-energize) and the face plate indicator will indicate "Tripped." The monitor is shipped wired for manual ("lockout" or "hand reset mode") and can be wired for automatic reset by the addition of a jumper on the rear

terminals. When this jumper is added, the trip indicator continues to function, but the relay will automatically reset when the ground loop is restored.

In the Non-UVR Mode, the relay is normally de-energized. The relay energizes to perform a trip function only when control power is present and the ground loop is open. To utilize the advantages of the monitor in the Non-UVR mode, the associated circuit breaker must employ a potential trip device. As with the UVR mode, the lock-out function can be defeated with a jumper. With this jumper (while in the Non-UVR mode) the relay states are reversed (lock-out puts the relay into an energized state instead of de-energized.)



Features

A 0.25 second time delay is incorporated into the monitor to prevent relay trip from occurring when power is removed and re-applied in the Non-UVR mode.

Initial Adjustment

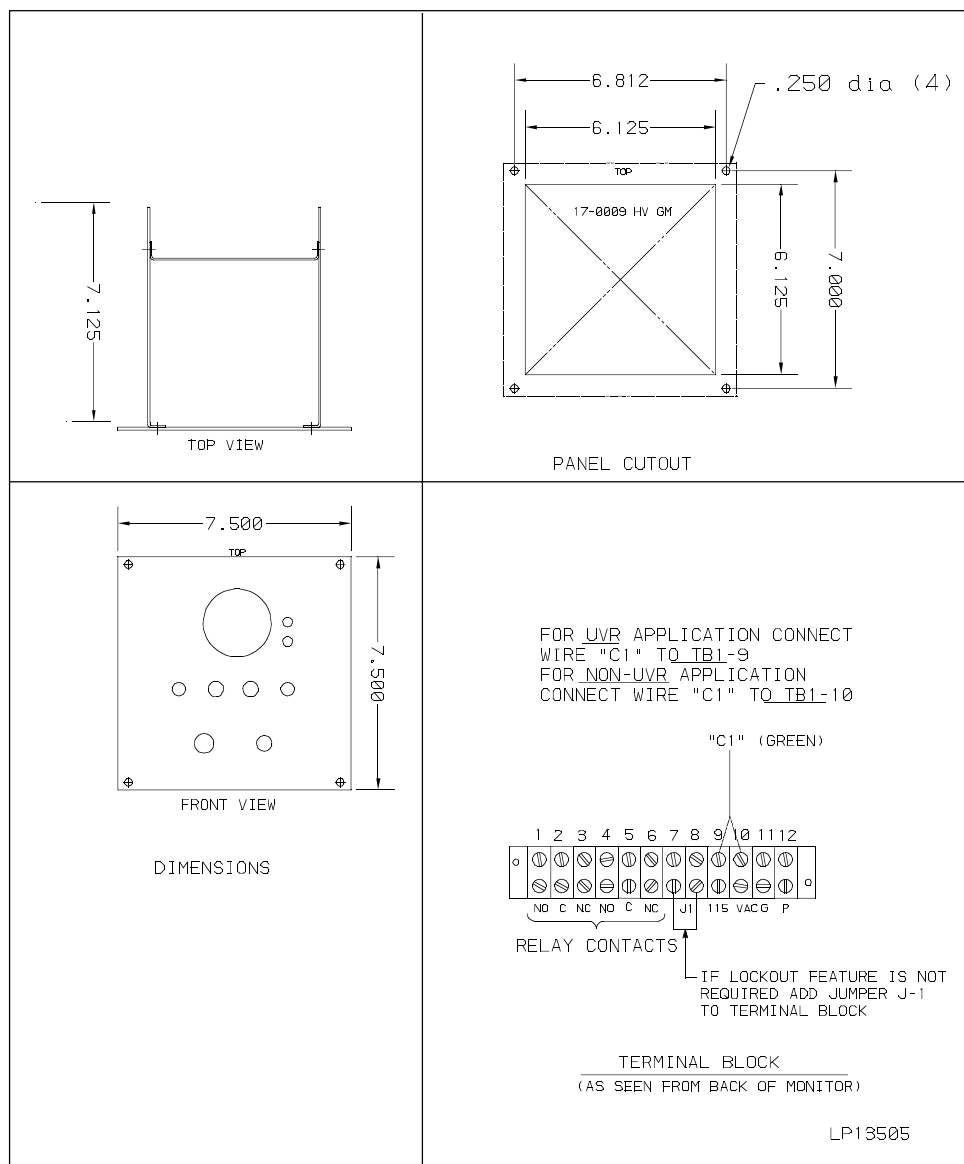
The monitor must be adjusted for the particular installation with its cable at the time it is commissioned into service. Full adjustment instructions are printed on the face plate of the monitor. Also at this time, the polarity switch position should be set according to the instructions on the monitor face plate. The monitor can be adjusted for operation with up to 15 ohms total pilot-ground loop impedance.

Specifications

Control Power: 115 VAC, +/- 15% Continuous¹
Pilot Output: Maximum 16 VAC, 50/60 Hz.
Maximum 1.5 Amps.

Operating Temperature: + 10° F to +120° F

¹ Allowed dip will vary from installation to installation. However, generally a 30% dip will not cause problems. Should dips greater than 30% be anticipated, the addition of a constant voltage transformer (50/60 Hz, 100 VA Minimum) is recommended.



Specifications subject to change without notice.



Instrument Transformers, Inc.

a division of GE Multilin



Capacitor Trip Device With Battery Back-Up Model CTDB-6

APPLICATION:

Provides a source of energy for circuit breaker and switch trip coil operation during a loss of AC control voltage.

Tripping power is available immediately upon energization before capacitors charged.

FREQUENCY:

50/ 60 Hz.o 400Hz.

NORMAL INPUT:

120/240 Volts ac.



Specifications

Max. Input Voltage:

2 Va burden continuous
2 Va burden continuous

Available Energy:

CTDB-6-120: 64 joules
CTDB-6-240: 57 joules

Normal Output Voltage:

CTDB-6-120: 169 Vdc
CTD-6-240: 340Vdc

Capacitance:

CTDB-6-120: 4500 uF $\pm$ 20%
CTDB-6-240: 990 uF $\pm$ 20%

Operating temperature range:

-30°C to 60°C

Storage temp range:

-50°C to 80°C

Short Circuit Protection:

Continuous

Mounting:

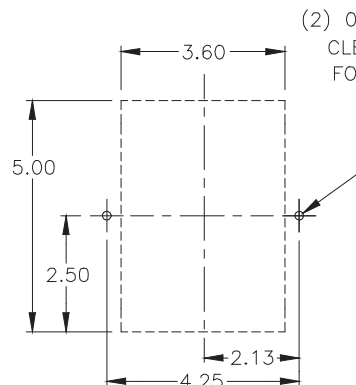
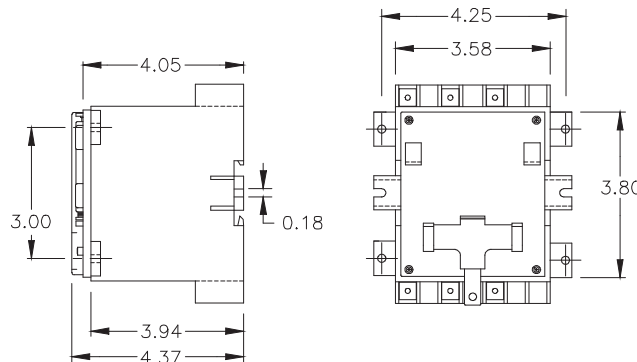
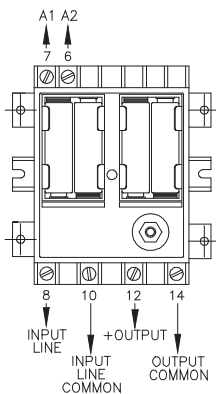
Vertical or horizontal

Input Surge Protection:

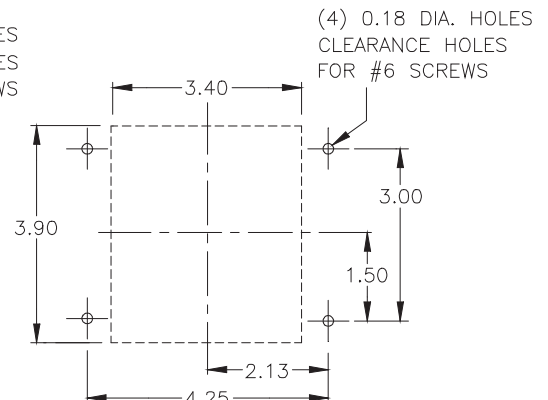
MOV protected to 65 joules pulse surge

• The Automatic Charging Trip Device (CTDB-6) is used to trip circuit breakers and lock out relay when a battery or standby source is not available to provide circuit breaker trip power. The CTDB-6 converts ac bus voltage to dc voltage and stores enough energy to operate a lock out relay or trip a circuit breaker, often more than once. The CTDB-6, when fully charged, will maintain a charge for a minimum of 3 days after the ac power has been interrupted. In normal operation, the batteries are trickle charged from the ac voltage source. Voltage is available from the ac power supply for tripping immediately upon ac voltage power up. Capacitors do not need to be charged to have tripping voltage available on the output of the device, this is because the output is automatically fed from the full wave bridge rectified ac signal or the charged capacitors, which ever is greater. Capacitor charge current is limited to protect the control power system from a large current in-rush. this feature allows the use of many CTDB-6 units from the same control power voltage source without coordination problems. Additionally, the CTDB-6 is self-protected from short circuit damage on the output. Batteries: 4 - rechargeable 1.2 volt Ni-Cad Cells * Electrical specifications are at 25 deg C

Notice: Ac power must be applied continually for minimum of 2 hours before the CTDB-6 is capable of developing full charge on the capacitors with a sustained interruption in ac input. It is highly recommended that batteries be fully charged before installing into the CTDB-6. The CTDB-6 is designed to trickle charge the batteries to hold a charge indefinitely, but the CTDB-6 trickle charge circuit can take as long as 48 hours to charge batteries that are completely discharged. The CTDB-6 capacitor trip device is not intended for use as a dc power supply. The self protecting feature of the unit will severely limit the continuous output current and voltage.



PANEL MOUNTING LAYOUT



DOOR MOUNTING LAYOUT

Servicing: See Next Page

Danger!
Lethal voltages are present qualified persons should install, operate, and service this device.

* Battery Disposal Information:



This product may contain portable batteries. In accordance with the European Directive 2006/66/EC, batteries and accumulators are marked with the crossed out wheeled bin, which indicates that they cannot be disposed of as unsorted municipal waste in the European Union. The marking may also include a chemical symbol (Pb for Lead, Hg for Mercury, and Cd for Cadmium) indicating that the battery contains substances classified as hazardous by the European Commission. Users of batteries must use the collection points available to customers for the return, recycling, and treatment of batteries. Customer participation is important to minimize the negative effects of batteries to the environment and sustain available natural resources. For more information see www.veeerohsinfo.com.

Operation:

Nominal ac volts is applied across terminals #8 and #10. This voltage is full wave bridge rectified and applied across the trip capacitors producing a steady state output trip voltage. The charge stored in these capacitor is available across terminals # 12 (positive) and #14 (negative).

A battery operated oscillator circuit will maintain the charge on the capacitors for a minimum period of 3 days provided that terminals #6 is connected to terminal #7 and the batteries are fully charged. Terminals #6 and #7 can be connected with a normally open relay contact operated by the ac power supply so that the oscillator is activated upon power failure. The batteries charge continuously when power applied to the circuit. Since batteries can take up to 48 hours to charge while installed in the CTDB-6, we recommended that fully charged batteries be installed in the CTDB-6 unit prior to putting the unit into service.

A push button and led indicator are used to determine if the CTDB-6 is operationally ready. When the button on the front panel is pushed, the LED will illuminate if the Capacitor has minimum charge of 90 Vdc for the CTDB-6-120, and 200 Vdc for the CTDB-6-240. The push button should only be pressed long enough to observe the illumination of the LED. The push button and LED does not indicate the present of ac voltage.

Servicing:

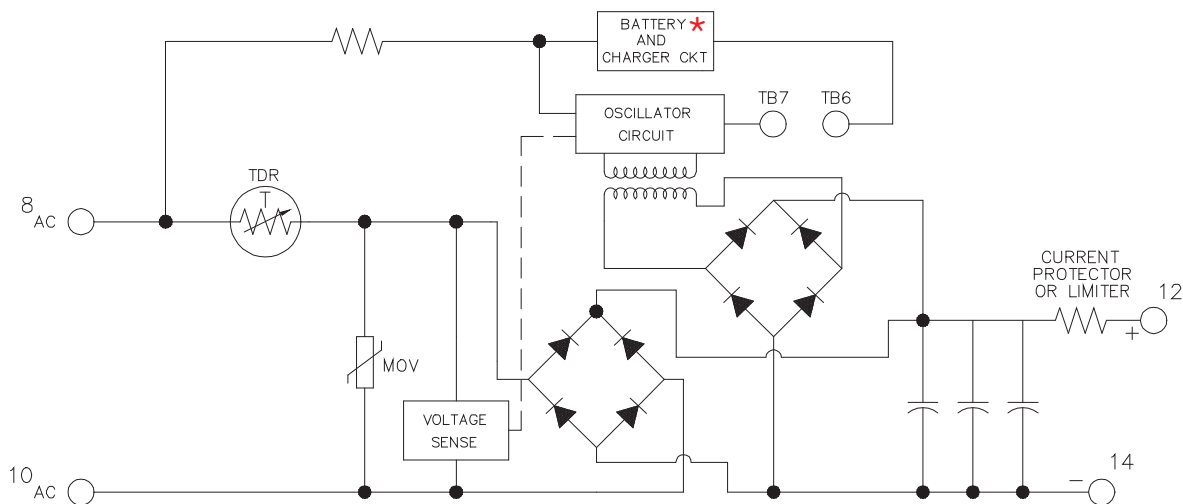
Never remove the clear plastic cover without this discharge procedure:

1. Remove the 120 Vac control power.
2. Remove the jumper, or open the relay contact, across terminals #6 and #7.
3. Discharge the capacitor trip device. (A 5 watt resistor of approximately 500 ohms across Terminal #12 and #14 can be used for this purpose)

Replace the 4 rechargeable 1.2 Volt Ni-Cad Cells according the battery manufactures recommended schedule. Never attempt to change batteries without following the discharge produce. Battery terminals voltages are not isolated from the control and trip power.

The CTDB-6 unit will recharge itself if terminals #6 and #7 remain shorted! Follow the discharge procedure prior to any service or maintenance of the CTDB-6 unit or trip system.

CTDB-6 Panel Layout



USA, Canada, Asia, Latin America

Tel: +1-800-547-8629

Fax: +1-905-201-2455

e-mail: sales.multilin@ge.com

Europe, Middle East, Africa

Tel: +34-94-485-88-00

Fax: +34-94-485-88-45

e-mail: gemultilin.euro@ge.com

Please refer to our website www.GEMultilin.com for more detailed contact information

CS00A40785 Rev.2 9/10



CONTROL SWITCH RELAYS

Electroswitch Control Switch Relays (CSR) combine the function of a control switch with a remote controlled solenoid allowing one device to do both the manual and supervisory control function in the control of power circuit breakers. They eliminate the need to redesign substations for redundant separate relays when manual substations convert to supervisory control. CSRs provide manual or electric control switch operation by supervisory control. The CSR looks, acts, and feels identical to a control switch.

Note: The Series 24 CSR Class 1E utility products comply with the following Nuclear Standards: ANSI/IEEE C37.90, ANSI/IEEE C37.90.01, ANSI/IEEE C37.98, ANSI/IEEE C37.105, ANSI/IEEE 323, ANSI/IEEE 344, ANSI/ASME NQA -1.

Series 24 Control Switch Relays

- | | |
|---------------------|---|
| HIGH QUALITY | <ul style="list-style-type: none"> Designed and manufactured to the highest standards in the industry Qualified to UL, CSA, ANSI/IEEE 37.90 and 37.90 .1 |
| VERSATILITY | <ul style="list-style-type: none"> Replaces a manual breaker switch, interposing relays, and associated wiring Direct retrofit to existing manual breaker control switch Electric or manual operation Three circuits to satisfy different industry applications Multiple voltages: 48VDC, 125VDC, standard, others available All standard Series 24 circuit breaker control switch contacting (see page 17) available Available with custom contacting (consult factory) |
| SAFETY | <ul style="list-style-type: none"> Target flag agreement (regardless of manual or electric trip) Available with SCADA disable for operator safety during service 1E Nuclear qualified |
| AVAILABILITY | <ul style="list-style-type: none"> Virtually all Universal Circuits in standard voltages of the Series 24 CSRs are available from stock for quick delivery. See pg.14 (Switch Section) for Series 24 Universal Circuits. |
| SERVICE | <ul style="list-style-type: none"> The Electroswitch team of Customer Service and Applications Professionals stand behind every Electroswitch product. Let us put over 50 years of know-how to work for you! |

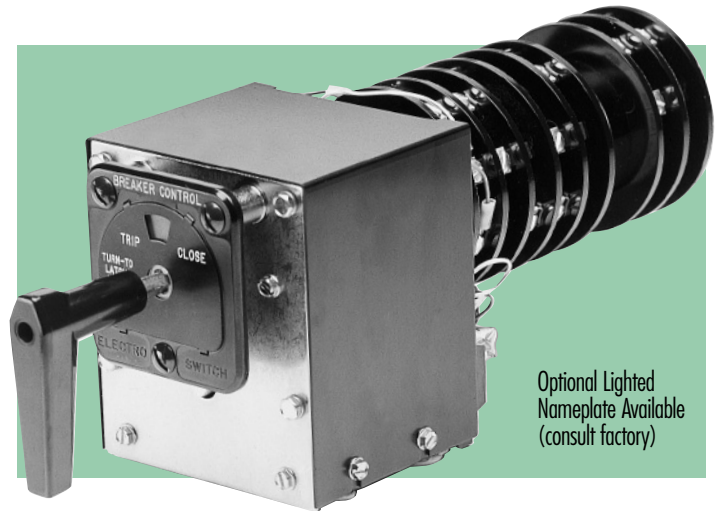
Basic Circuit Operation

The control of the CSR Control Switch Relay for electric operation requires no special wiring. It only requires two contacts (S1 and S2) to command the CSR to either the TRIP or CLOSE position. Low level contacts (rated 1 ampere) may be used since S1 and S2 do not control the rotary drive solenoid directly.

The standard station control bus voltage is used on all three circuits. The device, when shown in the following figures is in the vertical NORMAL position. The CSR coil form shown on the figures represents the rotary solenoid that drives the CSR. Its operation is further described later. LS1 is a linear solenoid within the device that changes the sense of direction of the CSR from left (TRIP) to right (CLOSE). The contacts shown as CSR are contacts within the device. Other components are shown by conventional designations.

Mechanical Target

When the CSR Switch handle is turned, a mechanical target contained in the nameplate is turned as well (GREEN for TRIP, RED for CLOSE). The target remains latched when the handle returns to normal position and always shows the last active position.

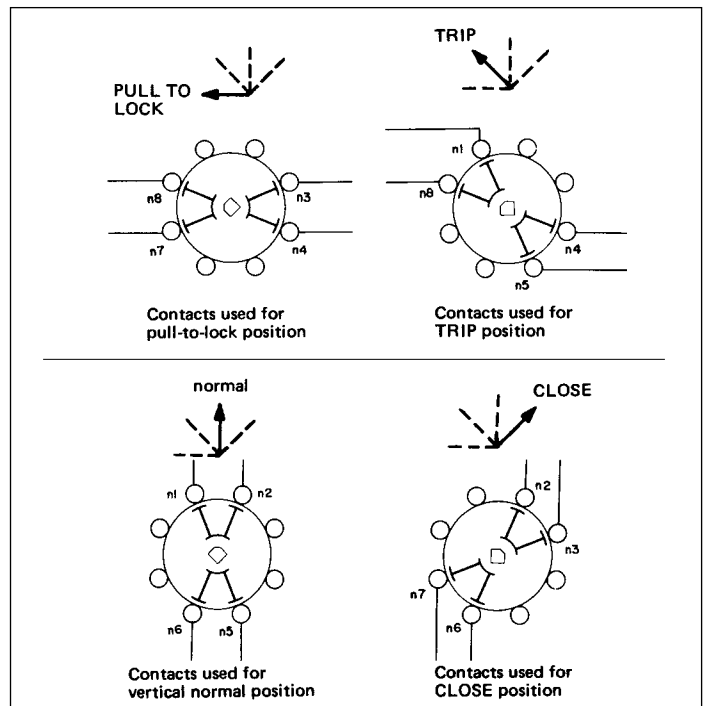


Contact Deck Arrangement

The blade and terminal configuration enables the use of multiple contacts in the same deck, and simple stacking procedures enable the fabrication of many independent contacts in one relay. Specifically, two N/O contacts or two N/C contacts are provided in each deck, and ten decks can be stacked, resulting in a relay with up to twenty contacts.

NOTES:

- The numbers are the same for all decks
- "n" becomes the deck number, e.g., 11 and 12 are CLOSE contacts on deck 1; 51 and 52 are CLOSE contacts on deck 5
- TRIP plus normal after TRIP contacts have the same contact numbers as the normal position contacts
- CLOSE plus normal after CLOSE contacts have the same contact numbers as the CLOSE contacts
- Decks with slip contacts are placed at end of switch/relay





CONTROL SWITCH RELAYS

Transient Protection

The CSR Control Switch Relay is designed and tested to operate reliably in a normal power industry environment. This includes being subjected to transients on the control bus up to 3.5KV. Since the CSR is normally isolated from the bus, it will experience transients only if they occur in the operating mode. This precludes the possibility of a detrimental, accumulating affect over the life of the unit. As such, no transient protection is needed with circuits B and C. Circuit A with its voltage divider circuit does remain on the bus and therefore contains a bipolar diode, as previously explained, to clip the transients to an acceptable value.

Because of the nature of the operation of the rotary solenoid, the CSR does generate transients that may be of interest to the user. These transients are less than 2KV and generally in the 1.5KV to 1.8KV range. When used in conjunction with unprotected static devices, like solid state relays, a bipolar diode is recommended across the rotary solenoid and the relay contact.

The CSR is available with Serial Communication Control.

Coil Voltage Data

COIL	COIL CIRCUIT VOLTS	COIL CIRCUIT DC OHMS @ 25°C	BURDEN (AMPS) AT RATED VOLTAGE
C	48VDC	4.83	9.9
D	125VDC	18.96	6.6

24VDC and 250VDC available — Consult factory.

Contact Ratings

CONTACT CIRCUIT VOLTS	INTERRUPTIVE RATING (AMPS)		SHORT TIME RATING* (AMPS)	CONTINUOUS RATING (AMPS)
	RESISTIVE	INDUCTIVE		
	SINGLE CONTACT	SINGLE CONTACT		
12VDC	—	—	60	30
24VDC	—	—	60	30
48VDC	—	—	60	30
125VDC	3	3	60	30
250VDC	—	—	—	—
600VDC	—	—	—	—
120VAC	20	20	60	30
240VAC	15	15	60	30
480VAC	10	10	60	30
600VAC	6	6	60	30

* Short time current is for one minute.

Coil Burden Data

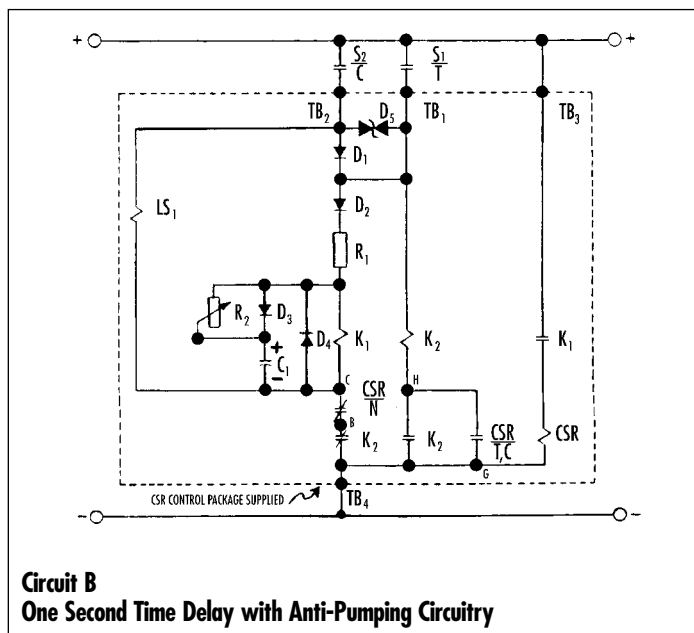
COIL	NOMINAL VOLTAGE	VOLTAGE RANGE
C	48VDC	41-56VDC
D	125VDC	106-140VDC

OPTIONS

Three basic circuits are available to satisfy different power industry applications.

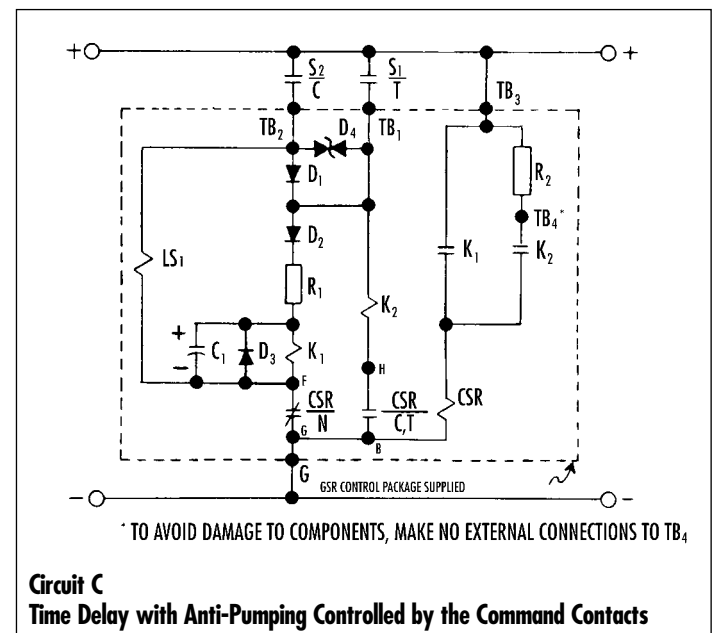
Circuit B One Second Time Delay With Anti-Pumping Circuitry

Circuit B has a time delay that holds the CSR in the command position for 1 sec. It also has anti-pumping circuitry so that the command contact may be closed indefinitely (greater than 100 msec).



Circuit C Time Delay And Anti-Pumping Controlled By the Command Contacts

Circuit C has no built in time delay. It exactly follows (or is a slave to) the operation of the command contact (maximum 15 second time delay).



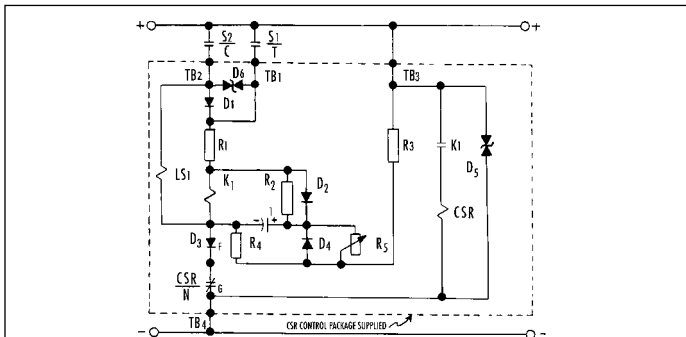


CONTROL SWITCH RELAYS

Circuit A

One To Three Second Time Delay With No Anti-Pumping Circuitry - Not Recommended Where SCADA Timing Sequence is Greater Than Three Seconds.

Circuit A has a factory adjustable time delay that holds the CSR in the commanded position for 1 to 3 sec. The command contact closure time should be greater than 100 msec and less than the time delay setting (to avoid pumping). This circuit is not recommended for applications where the SCADA timing sequence is greater than three seconds as it will cause pumping.



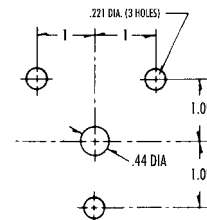
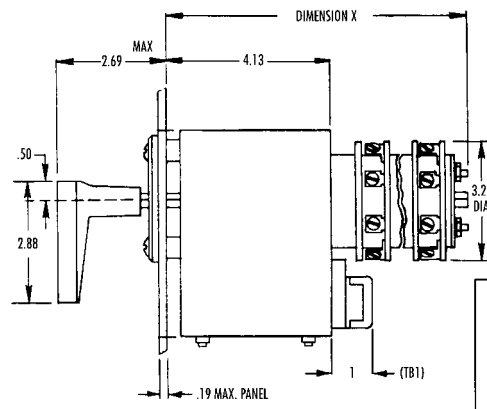
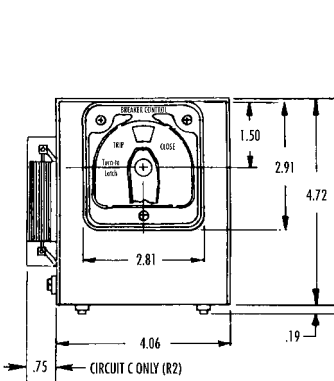
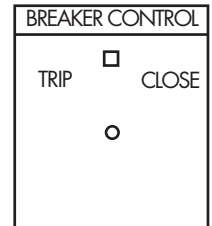
Circuit A

One to Three Second Time Delay with No Anti-Pumping Circuitry

Contact Chart

DECKS	CONTACTS	POS.			
		TRIP	INAT	NAC	CLOSE
1	12 ○— — —○ 13				✗
	16 ○— — —○ 17				✗
2	21 ○— — —○ 28	✗			
	24 ○— — —○ 25	✗			
3	31 ○— — —○ 32		✗	✗	
	35 ○— — —○ 36		✗	✗	
4	42 ○— — —○ 43				✗
	46 ○— — —○ 47				✗
5	51 ○— — —○ 52	✗			
	55 ○— — —○ 56	✗			

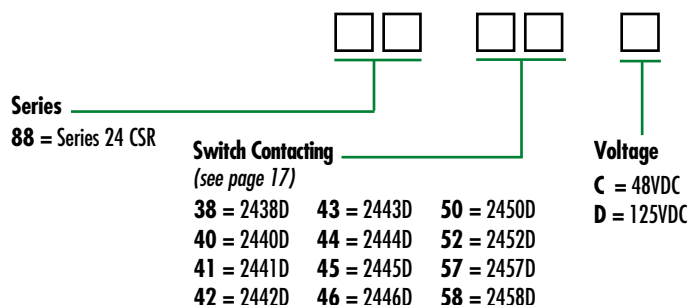
nat = normal after TRIP
nac = normal after CLOSE



DEPTH BEHIND PANEL (DIM X)

No of Decks	Standard Config.	With Slip Contacts
1	6.5	7.9
2	7.1	8.6
3	7.9	9.0
4	8.6	9.7
5	9.0	10.5
6	9.7	11.0

Series 24 CSR ORDERING INFORMATION



CSR Circuit

- A = 1-3 Sec. Time Delay
- B = 1 Sec. Time Delay Seal-in-Relay
- C = Up to 15 Sec. Time Delay Hold-in-Resistor

The circuit breaker control switch relays include an engraved nameplate, mechanical target, and pistol-grip handle. Circuits 50, 52 and 58 also have a Turn-To-Latch position. Also included are the control circuits previously explained.

CSR Control Switch Relays have the same flexibility of design as the Series 24 line of Instrument and Control Switches and are available with all the different contact configurations expected from this type of switch. Refer to switch section for details.



Electroswitch • 180 King Avenue • Weymouth, MA 02188 • TEL: (781) 335-5200 • FAX: (781) 335-4253 • www.electroswitch.com 55



CONTROL SWITCH RELAYS WITH SCADA DISABLE

The Control Switch Relay with SCADA Disable (CSR/SD) operates like a standard CSR, allowing both SCADA and manual operation. Pushing in the handle disables remote operation leaving only Local/Manual operation possible, allowing testing and service to be performed safely. In addition, the CSR/SD also provides 2 N/O and 2 N/C contacts, push activated, for customer use as SCADA feedback of status indication.

Series 24 Control Switch Relays with SCADA Disable

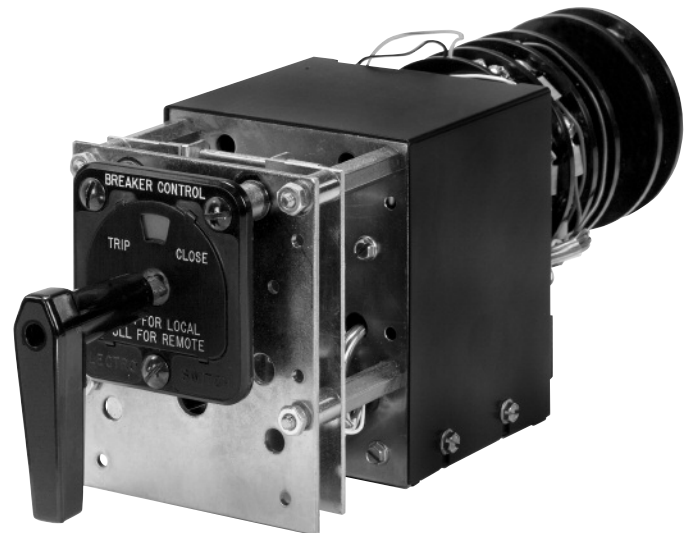
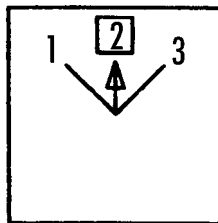
The CSR/SD maintains all the exceptional quality and functionality of the CSR with the added benefit of a SCADA disable function. Consult factory for control circuit designs and ordering information.

OPERATION

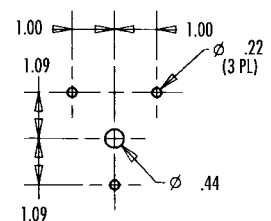
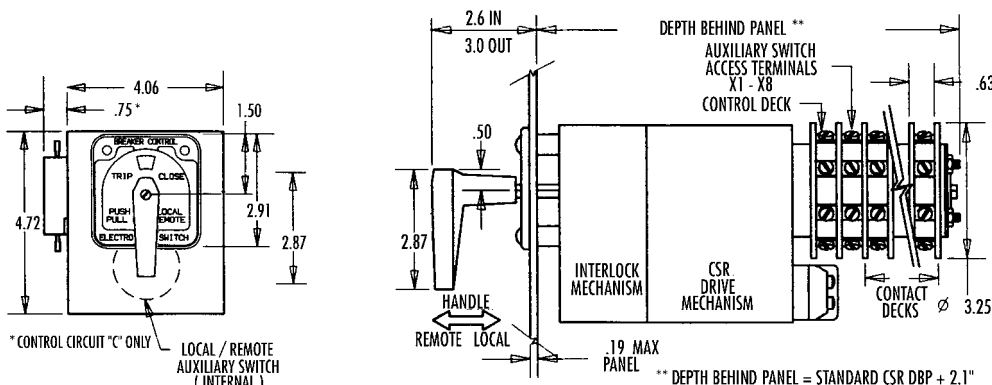
- Handle pulls out 3/8" to allow remote operation of the CSR from SCADA, as well as local/manual operation.
- When the CSR handle and shaft is pushed in, the remote operation of the CSR is disabled, and only local/manual operation remains possible.
- The CSR remains in the "Normal" position, vertical at 0 degrees.
- 2 N/O and 2 N/C lateral contacts are provided and will operate via the 3/8 " axial movement (push/pull) of the CSR/SD handle shaft.
- Target flag agreement is always true regardless of remote or local mode.
- Electrical connections (15 amp, 600 volt) are provided for the 2 N/C and N/O contacts at the terminal block deck located at the rear of the CSR/SD. These can be used to provide customer status indication.

DECK	CONTACTS	PUSH	PULL	POS.			
				TRIP	NAT	N/C	CLOSE
AUX CONT	X 1 — I — I — I — X 3	✓	✓	1	2 FROM 1 3		
	X 2 — I — I — I — X 4		✓				
	X 5 — I — I — I — X 7	✓	✓				
	X 6 — I — I — I — X 8		✓				
1	1 2 — I — I — I — 1 3						✓
	1 6 — I — I — I — 1 7						✓
2	2 1 — I — I — I — 2 8		✓				
	2 4 — I — I — I — 2 5		✓				
3	3 1 — I — I — I — 3 2				✓	✓	
	3 5 — I — I — I — 3 6				✓	✓	
4	4 2 — I — I — I — 4 3					✓	✓
	4 6 — I — I — I — 4 7					✓	✓
5	5 1 — I — I — I — 5 2		✓				
	5 5 — I — I — I — 5 6		✓				

HANDLE POSITIONS



SPRING RETURN TO POSITION 2





LOCK-OUT RELAYS

By definition the Lock-Out Relay plays a pivotal role in the most crucial utility applications. In an emergency, Lock-Out Relay performance can spell the difference between a routine outage and the destruction of expensive equipment. Protect your system and safeguard your personnel with the industry standard for safety and reliability. There's NEVER A DOUBT with the Electroswitch family of Lock-Out Relays.

Note: The Series 24 LOR Class 1E utility products comply with the following Nuclear Standards: ANSI/IEEE C37.90, ANSI/IEEE C37.90.01, ANSI/IEEE C37.98, ANSI/IEEE C37.105, ANSI/IEEE 323, ANSI/IEEE 344, ANSI/ASME NQA -1.

The Series 24 Lock-Out Relays

HIGH QUALITY

- Designed and manufactured to the highest standards in the industry
- Qualified to UL, CSA

VERSATILITY

- 9 Different trip coils to choose from
- Up to 20 N/O and 20 N/C contacts in one standard LOR.
- Available with electric reset capability
- Available with built-in coil monitoring and fault signal detection/indication

HIGH SPEED

- Transition times of less than 8mSec (less than 1/2 cycle) are standard

SAFETY

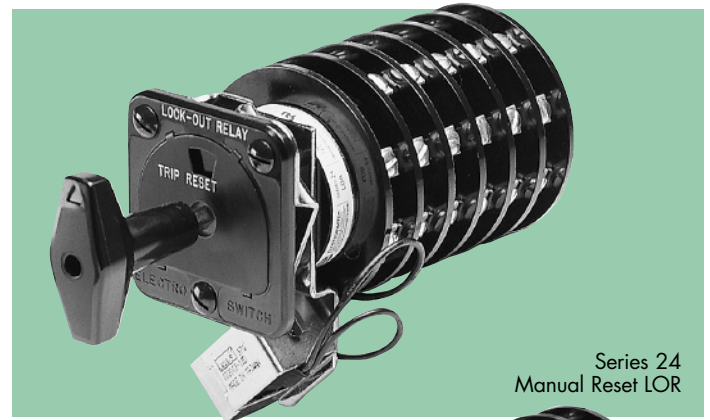
- Series 24 - 1E Nuclear Qualified, UL, CSA

AVAILABILITY

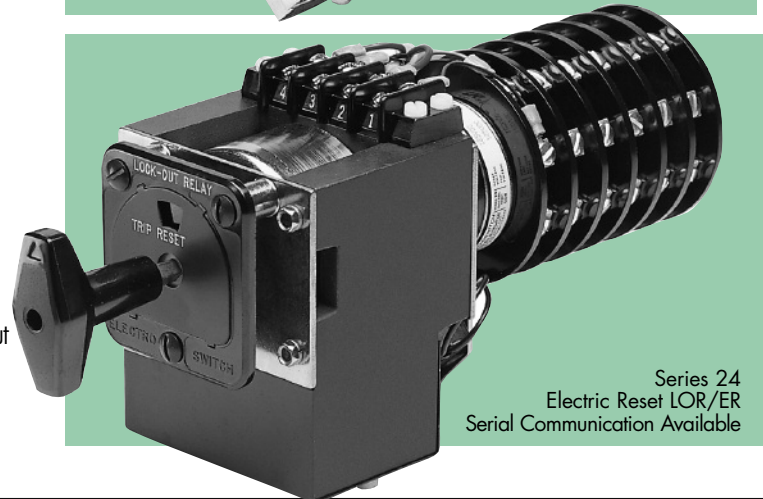
- Virtually all Series 24 Manual Reset LORs are available from stock for immediate delivery
- The most popular Electric Reset LOR/ERs are also in stock

SERVICE

- The Electroswitch team of Customer Service and Applications Professionals stand behind every Electroswitch product. Let us put over 50 years of know-how to work for you!



Series 24
Manual Reset LOR

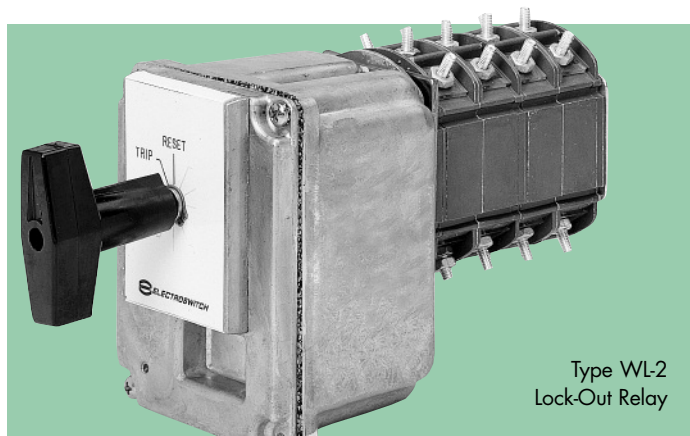


Series 24
Electric Reset LOR/ER
Serial Communication Available

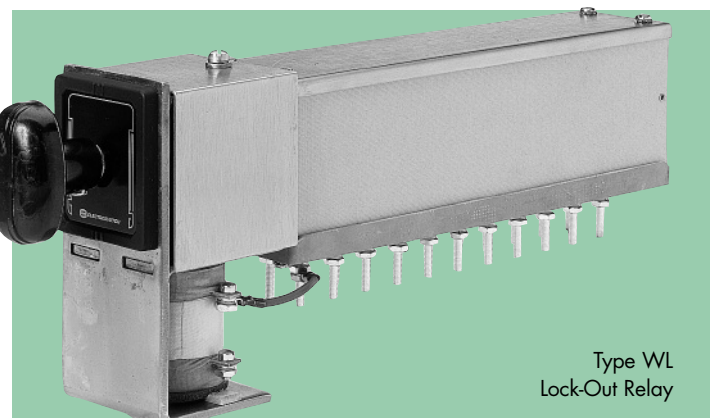
Type WL-2 and WL Lock-Out Relays

Since 1988 Electroswitch has been the source for the Type WL-2 and WL Lock-Out Relays. These rugged, dependable devices, designed and originally manufactured by Westinghouse, have stood the test of time in utility and industrial applications worldwide. Now they are

available for either new applications or replacement, backed by the industry leading Electroswitch commitment to Quality and Service.



Type WL-2
Lock-Out Relay



Type WL
Lock-Out Relay



NEW
PRODUCT

SERIES 24 LOR

With Lighted Target Nameplate

Lighted Target Nameplates Save Panel Space and Reduce Costs

The Electroswitch Series 24 Lock-Out Relay, the Utility Industry Standard for Quality and Reliability, is now available with:

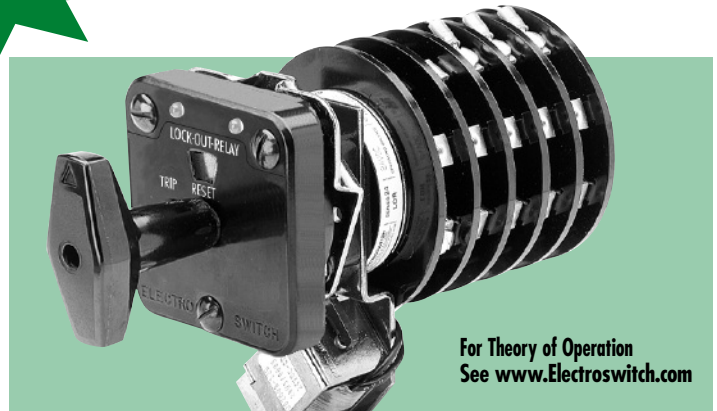
- Integral Coil Monitoring with LED Display and SCADA Feedback.
- LED Indication of Existing Fault Signal.

The Lock-Out Relay fills one of the most critical needs in the utility industry protection scheme. A fast, reliable Lock-Out Relay can mean the difference between a routine fault clearance and a disastrous loss of service, maintenance time and expensive equipment damage.

To assure that this crucial device is functioning and ready to operate, many utilities install pilot lamps on the panel to monitor the integrity of the LOR coil. This can involve expensive inter-wiring and use precious panel space. Because of this, Electroswitch has integrated these monitoring functions and more on a new electronic nameplate for the LOR.

Features

- Cost-effective Elimination of Additional Wiring and Lamps Needed to Perform this Function. Just Attach the Pre-wired Leads per the Enclosed Instructions.
- Save Valuable Panel Space. The Entire Package Fits in the Same Space as a Standard Mechanical LOR Nameplate.
- Both LOCAL (LED) and REMOTE (SCADA Signal) Indication is Provided; Reliable Protection for Unmanned Stations.
- Green LED indicates LOR Coil is Intact and Ready to Operate.
- Red LED Warns Against Resetting into an Existing Fault Signal and Possibly Damaging LOR Coils.
- Bright LEDs Visible Through 135°, > 11 Year Life (Typical).
- LEDs are Field Replaceable From the Front of Panel.
- LEDs are Available in Different Colors (Red, Amber, Green, Blue, and White).
- DC Unit Covers IEEE 24VDC and 48V/125V Ranges (38 to 140VDC).
- The Monitoring Package can be Implemented with Little or no Operator Training.
- A Retrofit Kit is Available to Provide this Enhanced Protection Package to Series 24 Lock-Out Relays Already in the Field.
- This Product is Designed and Manufactured by Electroswitch to Work Flawlessly with the Ultra-reliable, High Speed Series 24 Lock-Out Relay.
- Optional Push-to-Test.



For Theory of Operation
See www.Electroswitch.com

Benefits

- Provides Local and Remote (SCADA) Annunciation of an LOR Trip Coil Failure.
- Provides Clear Warning Against Closing into a Fault.
- Saves Panel Space.
- Reduces Purchase and Installation Cost.
- Easy to Use... No Special Operator Training.

How it Works

When the LOR is in the RESET position, one high visibility LED on the nameplate glows a continuous GREEN, giving local indication that coil continuity is intact and the Lock-Out Relay is ready to respond to a trip signal. Should the coil fail, the LED extinguishes and a built-in solid state contact closes, sending a warning signal to SCADA.

In the TRIP position, the red LED functions as a Trip Signal Monitor. As long as the Trip Signal is present on the LOR coil, the LED glows a continuous RED as a warning against resetting into a fault and possibly damaging the LOR coil. Other LED colors available (Amber, Blue and White).

The new design also retains the proven mechanical orange/black flag to indicate a trip. Contact your local Electroswitch Representative or call us directly for more details on how we can put the Electroswitch tradition of value and innovation to work for you.

Ordering Information

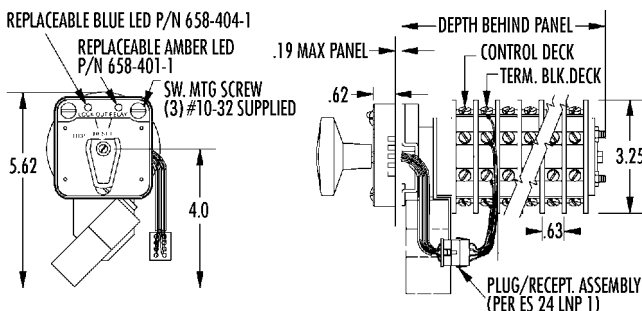
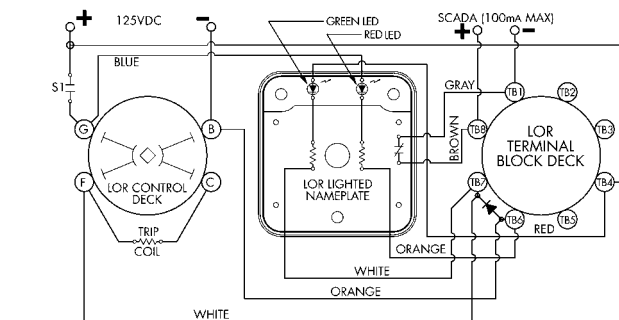
Part Numbers for the Series 24 LORs with Lighted Target Nameplate are fairly simple. Find the part number of the product you wish to order in the Electroswitch catalog, then simply add a two letter code after the second digit in its part number. The first letter of the two letter code will always be "P" indicating a Lighted Target Nameplate. The second letter of the code will change depending on the other options as follows.

A = One LED, 48/125VDC **B** = Two LEDs, 48/125VDC **K** = Two LEDs, 24VDC
Please Specify LED Colors. **Color Options** - Red, Green, Amber, Blue and White.

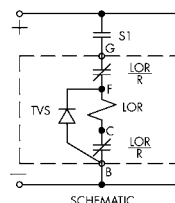
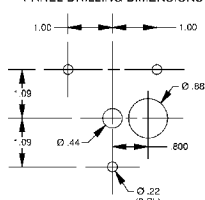
Example:

A Series 24 Manual Reset Lock-Out Relay with one deck and Trip Coil 'D' is part number **7801D**. The same Lock-Out Relay with a Lighted Target Nameplate, Two LEDs, and 48/125VDC LED voltage would become part number **78PB01D**.

Consult factory for 24VDC, 250VDC, and retrofit kits.



PANEL DRILLING DIMENSIONS



Depth Behind Panel

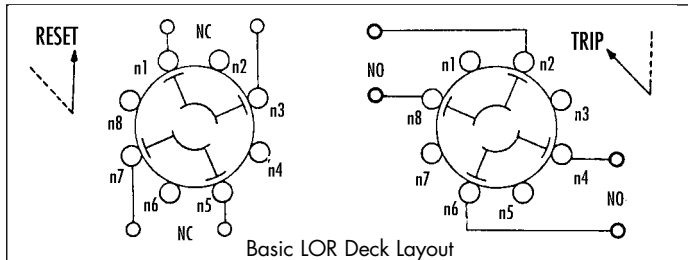
Decks	Depth
1	4.28
2	5.03
3	5.40
4	6.15
5	6.90
6	8.15
7	8.78
8	9.15
10	10.28



SERIES 24 LOCK-OUT RELAYS

FEATURES

Typical Contact Deck Arrangement



The blade and terminal configuration enables the use of multiple contacts in the same deck, and simple stacking procedures enable the fabrication of many independent contacts in one relay. Specifically, two N/O contacts and two N/C contacts are provided in each deck, and up to ten decks can be stacked, resulting in a relay with up to forty contacts (twenty N/O and twenty N/C). For good practice, however, it is suggested that polarized voltages should not be used on adjacent contacts. This is because of the remote possibility of flashover during transition between adjacent contacts -- especially at the higher DC ratings, or in highly inductive circuits. The illustration shows a single deck. For multideck units the second digit of the terminal number is the same as shown, but the first digit changes to denote the deck number. As an example, terminal 82 is in the eighth deck, directly under terminal 12 and is connected to terminal 88 in the trip position.

DECKS	CONTACTS	POS.	
		TRIP	RESET
1	11 —○— —○— 13		✓
	12 —○— —○— 18	✓	
	15 —○— —○— 17		✓
	16 —○— —○— 14	✓	
2	21 —○— —○— 23		✓
	22 —○— —○— 28	✓	
	25 —○— —○— 27		✓
	26 —○— —○— 24	✓	

Contact Charts

The illustration shows decks one and two of a typical Series 24 LOR and graphically describes the operation of the contacts.

Target Used with Lock-out Relays

All the Lock-out Relays have a mechanical target as part of the nameplate — BLACK for RESET and ORANGE for TRIP. This indicates the condition of the LOR. The target resets when the LOR resets (with the exception of the high-speed trip electric-reset LOR/ER and self-reset LOR/SR where the memory target is manually reset).

Contact Ratings

Contact ratings for LOR

Contact Circuit Volts	Interrupting Rating (AMPS)		Short Time Rating** (AMPS)	Continuous Rating (AMPS)
	Resistive	Inductive*		
	Single Contact	Single Contact		
125VDC	5	2	60	30
250VDC	3	1	60	30
120VAC	20	20	60	30
240VAC	15	10	60	30
480VAC	7.5	5	60	30
600VAC	6	5	60	30

* AC PF = 0.4; DC L/R = 0.04

** Short time current is for one minute

The interrupting ratings are based on a 10,000 operation life at rated voltage with no extensive burning of contacts. Short time and continuous ratings are based on temperature rise in contact members and supporting parts not to exceed 50° above ambient.

UL file No. E80080

- IEEE Std. 323 - 1984
- IEEE Std. 344 - 1987



Trip Speed in Lock-Out Relays

The manual reset Series 24 LOR has a nominal trip speed of less than 8 milliseconds at rated voltage as tested on 10 deck units. There is very little difference in LORs with fewer decks.

Both the Electric Reset and the Self Reset LORs are available in Standard Trip and High-Speed Trip configurations.

- **Standard Trip** models operate in approximately 12–15 mSec and come equipped with the standard LOR target nameplate or the optional LOR Monitor Nameplate.
- **High Speed Trip** LOR/ER models have the same 8 mSec trip speed as the Manual Reset LOR and come equipped with the Memory Target which displays an orange flag until it is manually reset.
- **Lighted Nameplate** with multiple LED indicators is available for all Series 24 LORs.

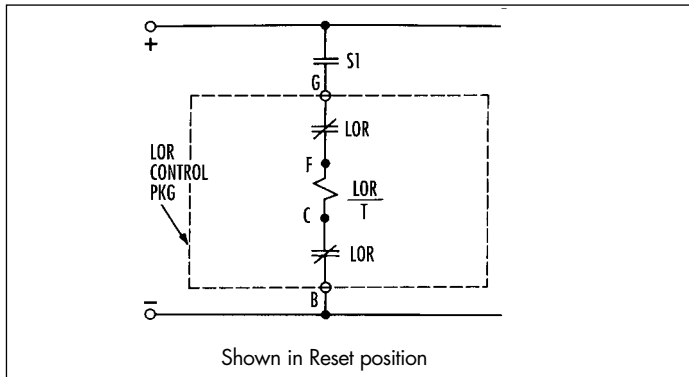


SERIES 24 LOCK-OUT RELAYS

OPTIONS

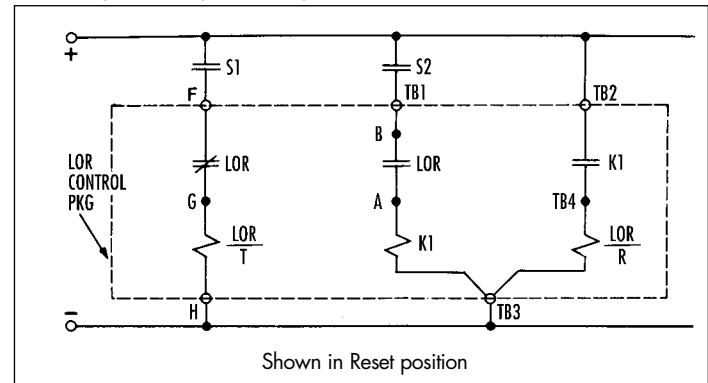
Manual Reset LOR

Closing S1 energizes the linear solenoid $\frac{LOR}{T}$ which releases the trigger mechanism and causes the LOR to snap to the Trip position. The control deck blades rotate to interrupt current flow to the coil.



Electric Reset LOR

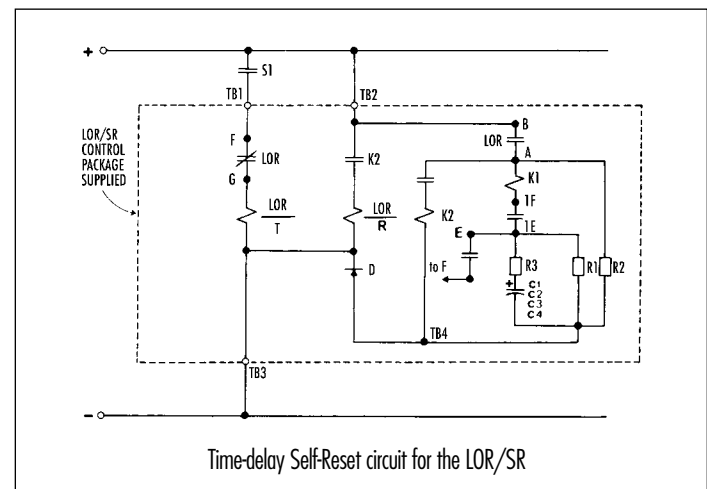
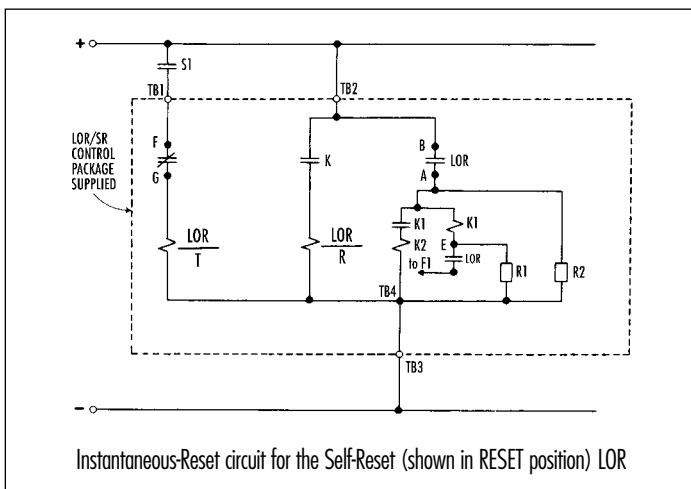
The Electric Reset LOR is tripped by the same method as the Manual Reset LOR. In the Trip position, closing S2 operates relay K1 which closes relay contact K1. The current then flows through solenoid $\frac{LOR}{R}$ which rotates the LOR/ER back into the reset position, while at the same time terminals A-B open to interrupt the K1 relay. Transition time is 80mSec.



Self Reset LOR

The Self Reset LOR is a special Electric Reset LOR which can be both TRIPPED and RESET from a single command contact. In both diagrams below, closing S1 will cause the LOR/SR to snap to the TRIP position. The unit will remain in TRIP as long as S1 remains closed. When S1 is opened, K1 is picked up and the LOR/SR returns to the reset position. The Instant Reset

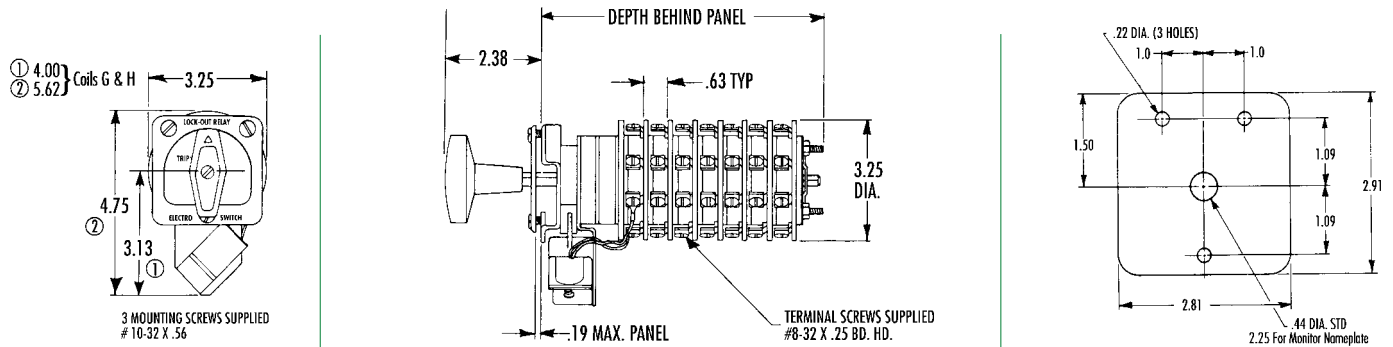
LOR/SR will reset itself within 80mS of the opening of S1. The Time Delay LOR/SR has factory preset circuitry which causes a time delay of .3 to .6 seconds from the time S1 opens until the LOR/SR contacts reclose.



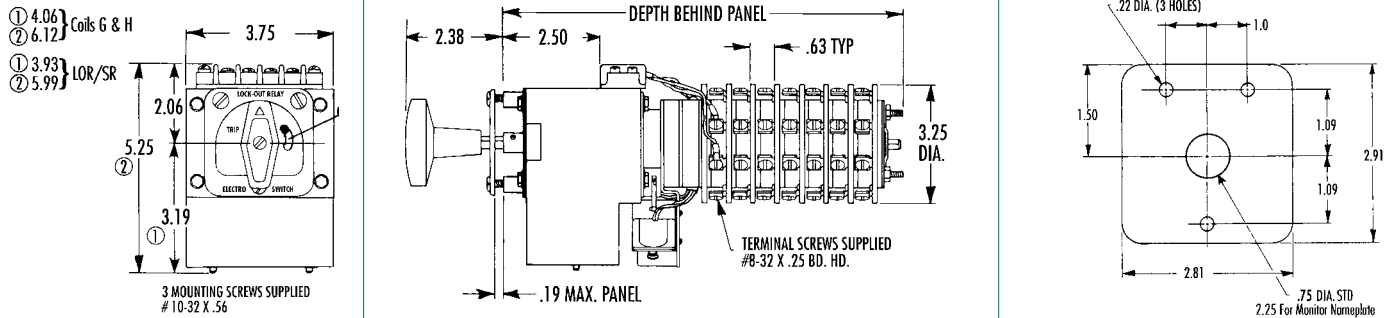


SERIES 24 LOCK-OUT RELAYS

SERIES 24 MANUAL RESET LOR



SERIES 24 LOR/ER, LOR/SR ELECTRIC RESET & SELF-RESET



DEPTH BEHIND PANEL

NO. OF DECKS	MAN. RESET LOR	HI SPEED TRIP LOR/ER	LOR/ER AND INSTANT LOR/SR TIME DELAY	RESET LOR/SR
1	3.63	—	—	—
2	4.38	—	—	—
3	4.75	8.00	8.00	8.63
4	5.50	—	—	—
5	6.25	9.75	9.75	10.38
6	7.50	—	—	—
7	8.13	—	—	11.63
8	8.50	11.63	11.63	—
10	9.63	12.90	—	—

COIL BURDEN DATA

COIL	COIL CIRCUIT VOLTS	TRIP COIL		RESET COIL	
		COIL CIRCUIT DC OHMS @ 25°C	BURDEN (AMPS) AT RATED VOLTAGE	COIL CIRCUIT DC OHMS @ 25°C	BURDEN (AMPS) AT RATED VOLTAGE
A	24VDC	3.3	7.3	.7	33.8
B	24VDC	7.7	3.1	—	—
C	48VDC	13.0	3.7	3.0	15.9
D	125VDC	27.0	4.6	12.4	10.1
E	125VDC	50.0	2.5	—	—
F	250VDC	104.0	2.4	80.6	3.1
G	125VDC	27.0	4.6	—	—
H	250VDC	104.0	2.4	—	—
K	125VDC	27.0	4.6	—	—

TRIP COIL VOLTAGE DATA

Coil	Nominal Voltage	Threshold Voltage	Operating Range
A	24VDC	6VDC	10 - 40VDC
B	24VDC	9VDC	18 - 50VDC
C	48VDC	12VDC	24 - 70VDC
D	125VDC 120VAC	16VDC 20VAC	30 - 140VDC 30 - 140VAC
E	125VDC	23VDC	45 - 140VDC
F	250VDC 240VAC	33VDC 40VAC	70 - 280VDC 60 - 280VAC
G	125VDC	70VDC	90 - 140VDC
H	250VDC	140VDC	180 - 280VDC
K	125VDC	16VDC	100-150VDC

RESET COIL VOLTAGE DATA

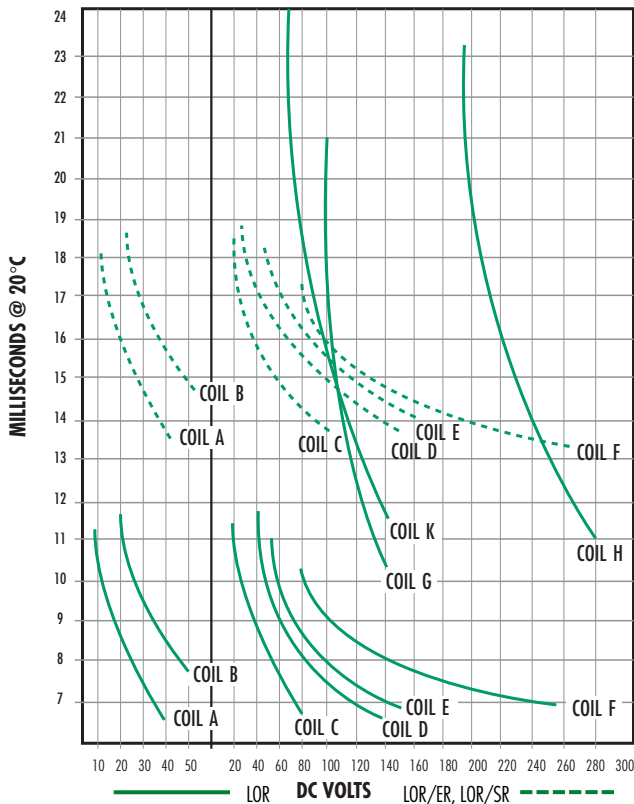
Coil	Nominal Voltage	Normal Voltage Operating Range
A	24VDC	19.2 to 28VDC
C	48VDC	38.4 to 57.6VDC
D	125VDC	100 to 150VDC
F	250VDC	200 to 275VDC



SERIES 24 LOCK-OUT RELAYS

LOR RESPONSE TIMES*

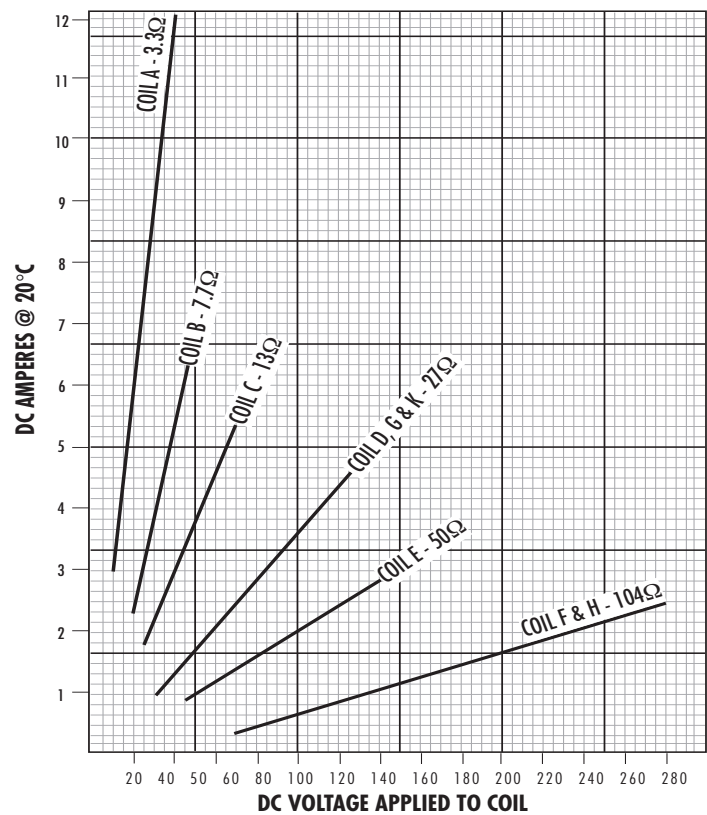
Time to Close Normally Open Contacts



*For AC Applications refer to Trip Coil Voltage Data on page 47

LOR CURRENT

Voltage Characteristics Of The Trip Coils



ORDERING INFORMATION

Selecting a Series 24 Lock-Out Relay:

1. Select type of LOR (Manual Reset, Electric Reset or Self Reset).
2. Fill out appropriate ordering matrix.
3. When selecting Trip and Reset Coils use information from tables below.
4. Contact factory for custom features and nonstandard configurations.

Electric Reset LOR/ER

78	☐	☐	☐	☐
Model				Reset Coil
78 = LOR				A = 24VDC D = 125VDC C = 48VDC F = 250VDC
Configuration				Trip Coil (See Page 47)
2 = Std. Trip LOR/ER 3 = Hi-Spd. Trip LOR/ER				A = Coil A F = Coil F B = Coil B G = Coil G C = Coil C H = Coil H D = Coil D K = Coil K E = Coil E
	No. of Decks			
	3 = 3 5 = 5 8 = 8 (10 Consult Factory)			

Manual Reset LOR

78	☐	☐	☐
Model		No. of Decks	Trip Coil (See Page 47)
78 = LOR		03 = 3 08 = 8 05 = 5 10 = 10	A = Coil A D = Coil D G = Coil G B = Coil B E = Coil E H = Coil H C = Coil C F = Coil F K = Coil K

Self Reset LOR/SR

78	☐	☐	☐	D
Model				Reset Coil
78 = LOR				D = 125VDC
Configuration				Trip Coil
4 = Std. Trip, Instant Reset, LOR/SR 5 = Std. Trip, Time Delay Reset, LOR/SR 6 = Hi-Spd. Trip, Instant Reset, LOR/SR 7 = Hi-Spd. Trip, Time Delay Reset, LOR/SR				D, E, F, G Available for Std. Trip LOR/SR D, E, F Available for Hi-Spd. Trip LOR/SR
		No. of Decks		
		3 = 3 5 = 5 7 = 7 (time delay units only) 8 = 8 (instant reset units only)		



TYPE WL-2 LOCK-OUT RELAYS

The Type WL-2 Lock-Out Relay was designed and manufactured by Westinghouse to provide dependable tripping in a variety of protection schemes. Since acquiring the line in 1988, Electroswitch has supplied hundreds of these rugged, reliable relays for both new applications as well as replacement units for the enormous installed base of WL-2s all over the world.

Features

- Low Current Magnetic Trip Mechanism
- Both Handle Trip and Non-Handle Trip Versions Available
- The Electroswitch Tradition of Quality, Value and Customer Service

How to Order

Contact the factory with the part number for the WL-2 Lock-Out Relay you are replacing or provide us with the following information:

- Number of N/O (Type A) and N/C (Type B) contacts required
- The required control voltage
- Whether the unit is to be Non-Handle Trip (standard) or Handle Trip (optional)

We will promptly respond with an approval drawing of the appropriate WL-2 Lock-Out Relay as well as any further technical information you may require.

Contact Ratings

Voltage	SINGLE CONTACT								TWO CONTACTS IN SERIES							
	INDUCTIVE AMPERES							RESISTIVE AMPS	INDUCTIVE AMPERES							RESISTIVE AMPS
	4.5mH	12mH	31mH	63mH	130mH	243mH			4.5mH	12mH	31mH	63mH	130mH	243mH		
125VDC	4.65	3.67	2.85	2.1	1.53	0.9	-	7.55	27.0	14.75	7.7	4.85	2.92	1.9	-	7.8
250VDC	1.6	1.6	1.0	1.0	0.98	0.78	-	1.6	6.4	5.0	3.85	3.1	2.4	1.6	-	6.7
500VDC	-	-	-	-	-	-	-	-	1.5	1.7	1.5	1.35	1.15	0.98	-	1.7
120VAC	-	-	-	-	-	-	7.53	7.95	-	-	-	-	-	-	68.0	-
240VAC	-	-	-	-	-	-	1.16	1.95	-	-	-	-	-	-	9.1	9.0
480VAC	-	-	-	-	-	-	.54	0.9	-	-	-	-	-	-	1.5	1.55

TYPE WL-2 LOCK-OUT RELAY

NOMINAL OPERATING VOLTAGE	AVERAGE COIL CURRENT	INDUCTANCE (H)	RESISTANCE (Ω)	IMPEDANCE (Ω)	MINIMUM PICK UP	OPERATING TIME AVERAGE	
						CYCLES	mSEC
24VDC	3.6A	.0029	6.6		19VDC	1.06	17.7
48VDC	7.3A	.0029	6.6		19VDC	.96	16.0
125VDC	1.2A	.030	104		90VDC	1.05	17.5
250VDC	2.4A	.030	104		90VDC	1.01	16.8
120VAC	1.4A	.030		85	90VAC	1.58	26.3
120VAC RECTIFIED	1.4A	.030		85	90VAC	1.08	18.0
240VAC	3.0A	.030		80	90VAC	1.54	25.7
240VAC RECTIFIED	3.0A	.030		80	90VAC	1.05	17.5
480VAC	6.0A	.030		80	90VAC	1.50	25.0



TYPE WL LOCK-OUT RELAY

The Type WL Lock-Out Relay product line was also acquired from Westinghouse in 1988. Countless Type WLs are still providing reliable protection in older facilities decades after they were first installed. Electroswitch is pleased to announce that we can provide replacement

units for most of the WLs still in service. Please contact us with the WL part number of the switch you are replacing and we will be happy to respond with an approval drawing or a suggested replacement if your WL cannot be duplicated.

TABLE I: WL SWITCH STYLES (less coils)

No. of Stages	Style Numbers Without Coils				Rotor Contacts											
	Modern Handle		Heavy-Duty Handle		A = Contact Open in Reset. Closed in Trip Position. N.O. B = Contact Closed in Reset. Open in Trip Position. N.C.											
	Non-Trip by Handle	Trip by Handle	Non-Trip by Handle	Trip by Handle	Coil	1-2 ①	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	
2	422D949G01	422D950G01	422D949G08	422D950G08	B	A	A									
3	422D949G02	422D950G02	422D949G09	422D950G09	B	A	A	A								
4	422D949G03	422D950G03	422D949G10	422D950G10	B	A	A	A	A							
5	422D949G04	422D950G04	422D949G11	422D950G11	B	A	A	A	A	A						
6	422D949G05	422D950G05	422D949G12	422D950G12	B	A	A	A	A	A	A					
8	422D949G06	422D950G06	422D949G13	422D950G13	B	A	A	A	A	A	A	A	A			
10	422D949G07	422D950G07	422D949G14	422D950G14	B	A	A	A	A	A	A	A	A	A	A	
2	422D949G15	422D950G15	422D949G41	422D950G41	B	B	A									
3	422D949G16	422D950G16	422D949G42	422D950G42	B	B	A	A								
4	422D949G17	422D950G17	422D949G43	422D950G43	B	B	A	A	A							
5	422D949G18	422D950G18	422D949G44	422D950G44	B	B	A	A	A	A						
6	422D949G19	422D950G19	422D949G45	422D950G45	B	B	A	A	A	A	A					
8	422D949G20	422D950G20	422D949G46	422D950G46	B	B	A	A	A	A	A	A	A			
10	422D949G21	422D950G21	422D949G47	422D950G47	B	B	A	A	A	A	A	A	A	A	A	
3	422D949G22	422D950G22	422D949G48	422D950G48	B	B	B	A								
4	422D949G23	422D950G23	422D949G49	422D950G49	B	B	B	A	A							
5	422D949G24	422D950G24	422D949G50	422D950G50	B	B	B	A	A	A						
6	422D949G25	422D950G25	422D949G51	422D950G51	B	B	B	A	A	A	A					
8	422D949G26	422D950G26	422D949G52	422D950G52	B	B	B	A	A	A	A	A	A			
10	422D949G27	422D950G27	422D949G53	422D950G53	B	B	B	A	A	A	A	A	A	A	A	
4	422D949G28	422D950G28	422D949G54	422D950G54	B	B	B	B	A							
5	422D949G29	422D950G29	422D949G55	422D950G55	B	B	B	B	A	A						
6	422D949G30	422D950G30	422D949G56	422D950G56	B	B	B	B	A	A	A					
8	422D949G31	422D950G31	422D949G57	422D950G57	B	B	B	B	A	A	A	A	A			
10	422D949G32	422D950G32	422D949G58	422D950G58	B	B	B	B	A	A	A	A	A	A	A	
5	422D949G33	422D950G33	422D949G59	422D950G59	B	B	B	B	B	A						
6	422D949G34	422D950G34	422D949G60	422D950G60	B	B	B	B	B	A	A					
8	422D949G35	422D950G35	422D949G61	422D950G61	B	B	B	B	B	A	A	A	A			
10	422D949G36	422D950G36	422D949G62	422D950G62	B	B	B	B	B	A	A	A	A	A	A	
6	422D949G37	422D950G37	422D949G63	422D950G63	B	B	B	B	B	B	A					
8	422D949G38	422D950G38	422D949G64	422D950G64	B	B	B	B	B	B	A	A	A			
10	422D949G39	422D950G39	422D949G65	422D950G65	B	B	B	B	B	B	A	A	A	A	A	

① On 250 volts dc control circuits this contact must be connected in series with coil contact.

TABLE II: COIL OPERATING CHARACTERISTICS

Coil part numbers must be specified at the time of order. Those marked with an asterisk (*) are considered to be standard for the operating voltage indicated. These coils should not be used for 5 ampere series

trip operation from secondary of current transformers, as the burden is too great. Time is in milliseconds. Time may vary slightly for AC tripping, depending on point of AC cycles at which the coil is energized.

Direct Current				Alternating Current - 60 Cycles							
Coil Code	Coil Style Number	Ohms Resistance	Minimum Trip DC Volts	Control Voltage-DC				Ohms impedance (not tripped)	Minimum Trip AC Volts	Control Voltage-AC	
				24	48	125	250			110	220
				Time in Milliseconds						Time in Milliseconds	
A	701B500G01	.73	8.7	*16				6.2	50	*16	
B	701B501G01	2.68	17.1		16			21.0	95	19	16
C	701B502G01	4.05	21.4		*17			30.0	115		16
D	701B503G01	6.2	27.0		19	13		43.0	135		*17
E	701B504G01	8.6	31.0			14		52.0	155		18
F	701B505G01	12.2	33.0			14		97.0	200		
G	701B506G01	18.5	44.0			16		140.0	243		
H	701B507G01	28.0	54.0			*17	14	208.0	297		
I	701B508G01	45.5	70.0			19	15				
J	701B509G01	59.0	84.0				*16				
K	701B510G01	104.0	111.0				17				

515



BLOCKING AND TEST MODULE



FEATURES

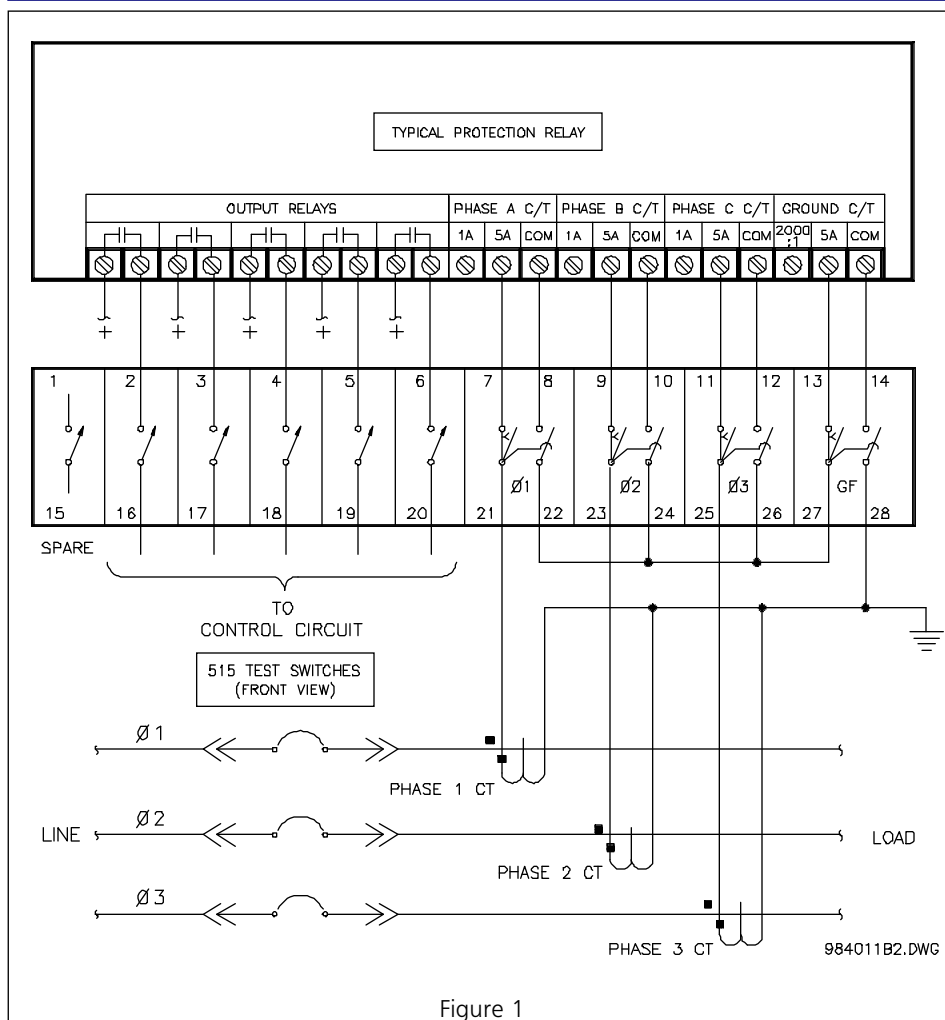
- 14 Pole switchbank
- CT inputs short when current switches are open.
- Current injection for each phase
- Ability to visually isolate (open) trip relay output circuits.
- Cover provided
- Suitable for utility and industrial use.
- 515 test plugs available.

DESCRIPTION

The 515 Blocking and Test Module provides an effective means of trip blocking, relay isolation and testing of Multilin relays. By opening the switches and inserting test plugs, phase and residual currents from the primary CTs can be monitored. Currents can be injected into the relay from a secondary injection test set during commissioning.

Prior to withdrawal, the trip and auxiliary circuits must be opened first, to prevent nuisance tripping, and CT's can then be shorted. Conversely, when the test is done and the relay is put back in operation, the CT switches should be closed first to ensure normal operation of the relay, prior to closing the trip and auxiliary circuits.

TYPICAL WIRING



1601-0024-A4, 04/18/96



MOUNTING & INSTALLATION

The 515 Blocking and Test Module consists of a metal chassis attached to the 515 test switches that slides into the panel. A single cutout in the panel, as per the dimensions shown in Figure 4, is required to mount the 515 test switches.

Slide the metal chassis attached to the 515 test switches into the cutout from the front of the panel. While firmly applying pressure from the front of the 515 module to ensure the chassis fits snugly, bend out the retaining tabs as shown in Figure 3. Usually the retaining tabs will be sufficient to hold the 515 module securely in place. If additional fastening is desired bend out the clamping screw tabs at both ends of the chassis at right angles. Insert the #8 screws provided in the accessory pouch into the tapped holes with the vibration proof nut between the tab and the panel. Tighten each screw until the end of the screw butts firmly against the front panel. Ensure the nut is installed tightly against the bent tab. Nylon inserts in these nuts prevent them from vibrating loose. The 515 test switch module should now be securely mounted to the panel with no movement

ready for rear terminal wiring. When completed, place the front cover over the mounted 515 test module and push the fasteners at both ends down into place, as shown in Figure 2.

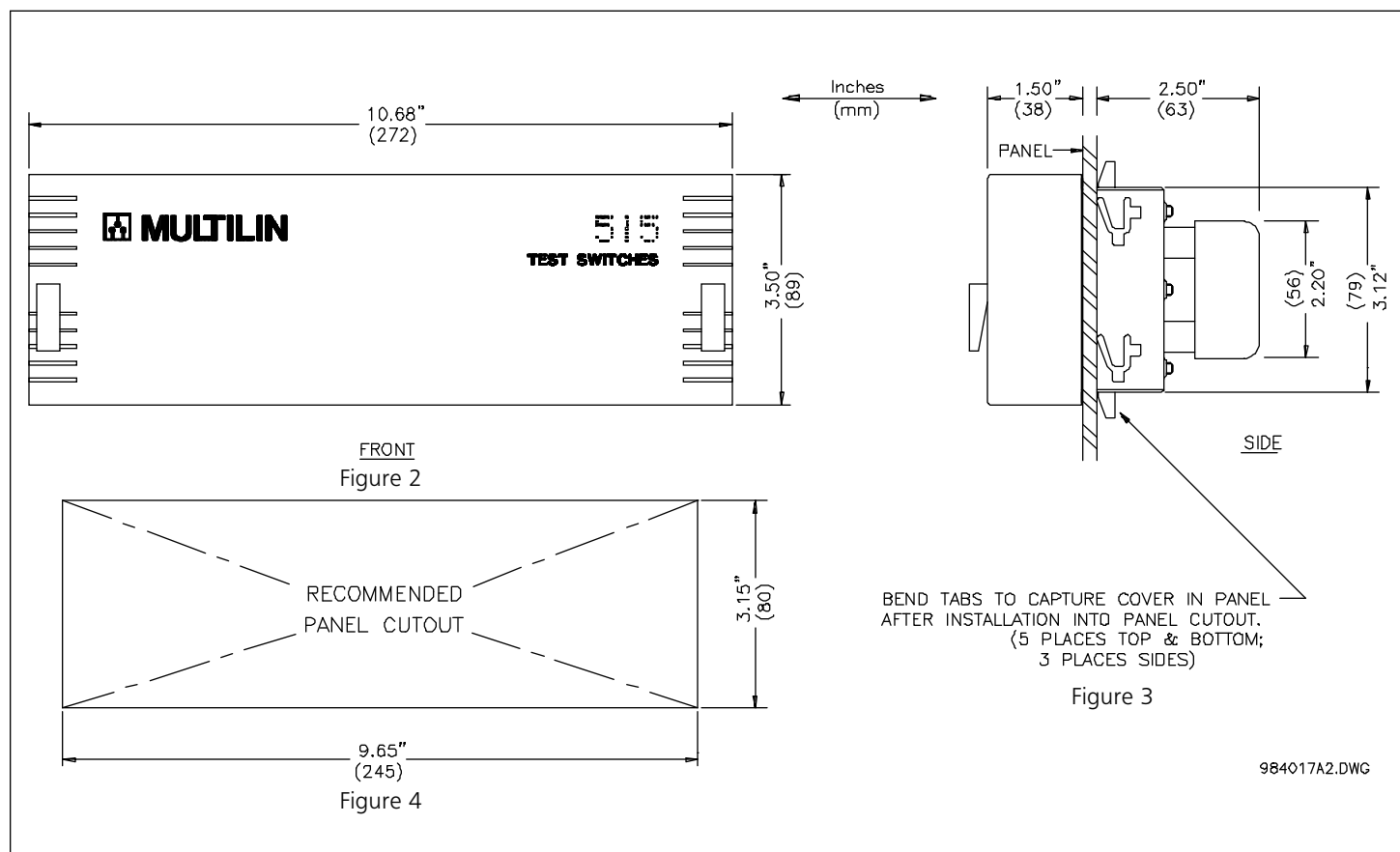
DETAILED OPERATION

To put the 515 Blocking & Test Module into operation, additional parts have been provided:

- 1 package containing at least 28 terminal nuts
- 14 white tags for identification of each of the switches

The 515 provides a means of trip blocking, relay isolation, and testing of Multilin relays. The 515 accomplishes this with a total of 14 switches. There are 6 single pole throw switches for use with the output relays, and 4 groups of 2 switches each for use with the current transformers as illustrated in Figure 1.

PHYSICAL DIMENSIONS



DETAILED OPERATION

Isolation or opening of the relay's output circuits is accomplished with the six switches at terminals 1 through 6 and 15 through 20. These switches can be used to simply open the protection relay's output contacts and thus provide a means of blocking trips. The 4 remaining groups of 2 switches at terminals 7 through 14 and 21 through 28 are used for shorting of the CT inputs, injection of test current, and measuring of CT current. The 4 groups correspond to Phase 1 Current, Phase 2 Current, Phase 3 Current, and Ground Current.

Each group is made up of two switches.. The first switch for the Phase 1 group is at terminal 7 and 21 and is configured as in Figure 5. Note that terminals 7 and 21 are shorted together regardless of whether the switch is open or closed. The second switch for the Phase 1 group is at terminals 8 and 22. It is configured as in Figures 6 & 7. Note that this switch operates as make before break. When this switch is closed terminals 8 and 22 are shorted together. When this switch is open, terminals 8 and 22 open and 22 shorts with 7 and 21. This in turn shorts Phase 1 CT. It is essential that the CT is connected to the shorted side of the switch as shown in Figure 8. Otherwise, dangerously high voltages would be present at the open circuited current transformer. Also note that currents can be injected into the protection relay from a secondary injection test set. See Figure 8.

With the switch between terminals 7 and 21 open and the switch between terminals 8 and 22 closed as shown in Figure 9, a 515 test plug can be inserted between terminals 7 and 21 to monitor the CT current. See Figure 10. Note that the 515 test plug is made up of two conductors separated by an insulator as shown in Figures 10 & 11.

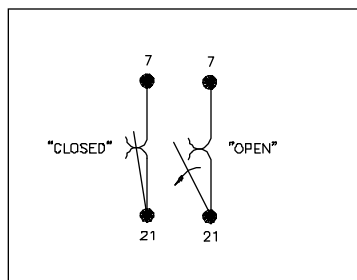


Figure 5

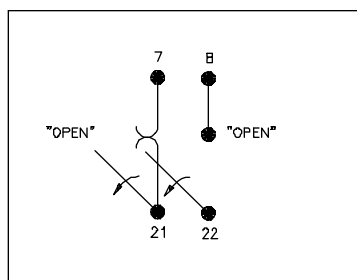


Figure 7

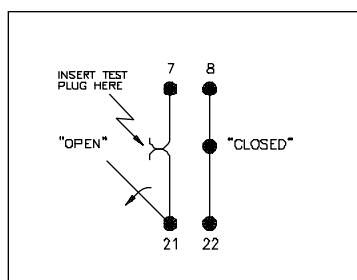
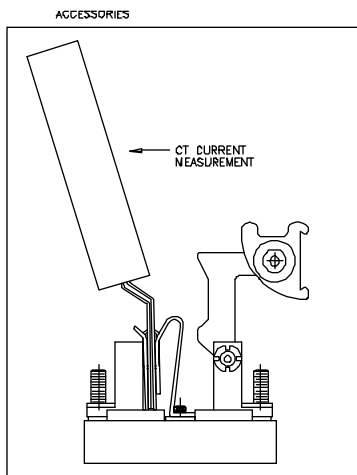


Figure 9



BY INSERTING THE DUEL CIRCUIT PLUG (P/N. X920-0002) INTO THE TEST JACK, SAFE MEASUREMENTS CAN BE MADE OF CT SECONDARY CURRENT.

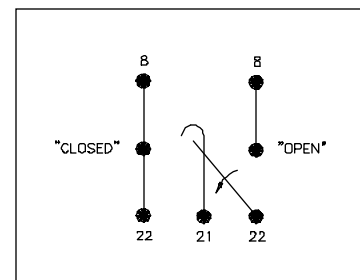


Figure 6

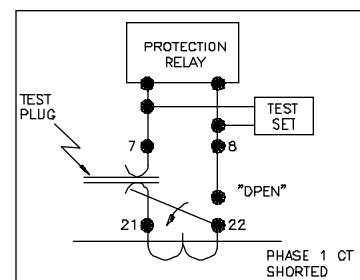


Figure 8

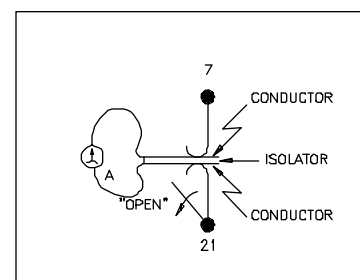
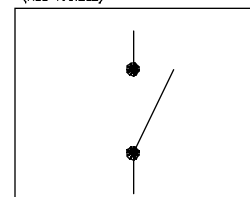
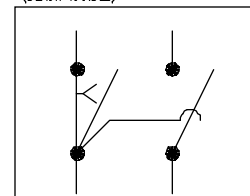


Figure 10

SINGLE-POLE ARRANGEMENT (RED HANDLE)

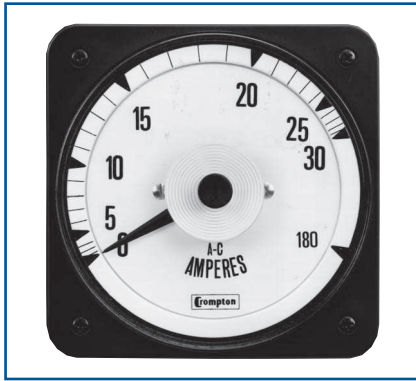


TWO-POLE SHORT-CIRCUITING ARRANGEMENT WITH TEST JACK (BLACK HANDLE)



984020A2 DWG

Figure 11



A.C. Overload Ammeters

Moving Iron A.C. Ammeters

Product Codes – Self Contained 40/70Hz (Accuracy $\pm 1\%$, 60Hz)***

Rating	Scaling*	4 1/2" Square Flange		8 3/4" Square Flange
		Standard Case Catalogue No.	Sealed Case Hi-Shock Catalogue No.	Standard Case Catalogue No.
1A	0-1A	•/077-08AA-LALA-C6	078-08AJ-LALA-C6	•079-08AA-LALA-C6
1.5A	0-1.5A	•/077-08AA-LCLC-C6	078-08AJ-LCLC-C6	•079-08AA-LCLC-C6
2A	0-2A	•/077-08AA-LELE-C6	078-08AJ-LELE-C6	•079-08AA-LELE-C6
3A	0-3A	•/077-08AA-LJLJ-C6	078-08AJ-LJLJ-C6	•079-08AA-LJLJ-C6
5A	0-5A	•/077-08AA-LSLS-C6	078-08AJ-LSLS-C6	•079-08AA-LSLS-C6
7.5A	0-7.5A	•/077-08AA-MFMF-C6	078-08AJ-MFMF-C6	•079-08AA-MFMF-C6
10A	0-10A	•/077-08AA-MTMT-C6	078-08AJ-MTMT-C6	•079-08AA-MTMT-C6
15A	0-15A	•/077-08AA-NDND-C6	078-08AJ-NDND-C6	•079-08AA-NDND-C6
20A	0-20A	•/077-08AA-NGNG-C6	078-08AJ-NGNG-C6	•079-08AA-NGNG-C6
30A	0-30A	•/077-08AA-NLNL-C6	078-08AJ-NLNL-C6	•079-08AA-NLNL-C6

Product Codes – Transformer Rated 40/70Hz - Burden 0.3VA***

5 A	0-10A	•/077-08AA-LSMT-C6	078-08AJ-LSMT-C6	•079-08AA-LSMT-C6
5 A	0-15A	•/077-08AA-LSND-C6	078-08AJ-LSND-C6	•079-08AA-LSND-C6
5 A	0-20A	•/077-08AA-LSNG-C6	078-08AJ-LSNG-C6	•079-08AA-LSNG-C6
5 A	0-25A	•/077-08AA-LSNJ-C6	078-08AJ-LSNJ-C6	•079-08AA-LSNJ-C6
5 A	0-30A	•/077-08AA-LSNL-C6	078-08AJ-LSNL-C6	•079-08AA-LSNL-C6
5 A	0-40A	•/077-08AA-LSNP-C6	078-08AJ-LSNP-C6	•079-08AA-LSNP-C6
5 A	0-50A	•/077-08AA-LSNT-C6	078-08AJ-LSNT-C6	•079-08AA-LSNT-C6
5 A	0-75A	•/077-08AA-LSPB-C6	078-08AJ-LSPB-C6	•079-08AA-LSPB-C6
5 A	0-100A	•/077-08AA-LSPK-C6	078-08AJ-LSPK-C6	•079-08AA-LSPK-C6
5 A	0-150A	•/077-08AA-LSPZ-C6	078-08AJ-LSPZ-C6	•079-08AA-LSPZ-C6
5 A	0-200A	•/077-08AA-LSRL-C6	078-08AJ-LSRL-C6	•079-08AA-LSRL-C6
5 A	0-250A	•/077-08AA-LSRS-C6	078-08AJ-LSRS-C6	•079-08AA-LSRS-C6
5 A	0-300A	•/077-08AA-LSRX-C6	078-08AJ-LSRX-C6	•079-08AA-LSRX-C6
5 A	0-400A	•/077-08AA-LSSC-C6	078-08AJ-LSSC-C6	•079-08AA-LSSC-C6
5 A	0-500A	•/077-08AA-LSSF-C6	078-08AJ-LSSF-C6	•079-08AA-LSSF-C6
5 A	0-600A	•/077-08AA-LSSJ-C6	078-08AJ-LSSJ-C6	•079-08AA-LSSJ-C6
5 A	0-800A	•/077-08AA-LSSN-C6	078-08AJ-LSSN-C6	•079-08AA-LSSN-C6
5 A	0-1000A	•/077-08AA-LSSS-C6	078-08AJ-LSSS-C6	•079-08AA-LSSS-C6
5 A	0-1200A	•/077-08AA-LSSU-C6	078-08AJ-LSSU-C6	•079-08AA-LSSU-C6
5 A	0-1500A	•/077-08AA-LSTC-C6	078-08AJ-LSTC-C6	•079-08AA-LSTC-C6
5 A	0-1600A	•/077-08AA-LSTE-C6	078-08AJ-LSTE-C6	•079-08AA-LSTE-C6
5 A	0-2000A	•/077-08AA-LSTM-C6	078-08AJ-LSTM-C6	•079-08AA-LSTM-C6
5 A	0-2500A	•/077-08AA-LSTU-C6	078-08AJ-LSTU-C6	•079-08AA-LSTU-C6
5 A	0-3000A	•/077-08AA-LSUA-C6	078-08AJ-LSUA-C6	•079-08AA-LSUA-C6
5 A	0-4000A	•/077-08AA-LSUE-C6	078-08AJ-LSUE-C6	•079-08AA-LSUE-C6
5 A	0-5000A	•/077-08AA-LSUJ-C6	078-08AJ-LSUJ-C6	•079-08AA-LSUJ-C6
5 A	0-6000A	•/077-08AA-LSUP-C6	078-08AJ-LSUP-C6	•079-08AA-LSUP-C6
5 A	0-7000A	•/077-08AA-LSUS-C6	078-08AJ-LSUS-C6	•079-08AA-LSUS-C6
5 A	0-8000A	•/077-08AA-LSUW-C6	078-08AJ-LSUW-C6	•079-08AA-LSUW-C6

Product Code – A.C. Overload Ammeters - True RMS Reading*** Self contained 40/70Hz (Accuracy $\pm 1\%$)

5/30A	TO SUIT	077-086A-LS**-C6	078-086J-LS**-C6	079-086A-LS**-C6
-------	---------	------------------	------------------	------------------

077 moving iron ammeters available as listed above

Rated 5A for standard C.T.'s with 6 x full scale.
Overload portion of the scale is not subject to the accuracy guarantee.
• UL recognised File # E87815
+ CSA Approved File # LR52592

* Other scales are available
** Specify scale required
*** Case types 077/078/079 use 10-32 UNF terminals. For M5 screw clamp terminals stipulate case type 075



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APPLICATION SPECIFIC SWITCHES SERIES 24 AND SERIES 31 ROTARY SWITCHES

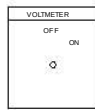
VOLTMETER- Transfer Switches

2-wire, single-phase or D.C.

Depth Behind Panel: 2.4"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	1
2	12 0-1-1-0-1-1	2
3	13 0-1-1-0-1-1	3

Order #

Series 24 = 2401C

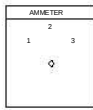
Series 31 = 3101C

4-wire, two-phase or
two separate D.C. circuits

Depth Behind Panel: 2.4"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	1
2	12 0-1-1-0-1-1	2
3	13 0-1-1-0-1-1	3
4	14 0-1-1-0-1-1	4

Order #

Series 24 = 2402C

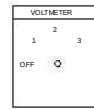
Series 31 = 3102C

3-phase, phase-to-neutral

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	1
2	12 0-1-1-0-1-1	2
3	13 0-1-1-0-1-1	3
4	14 0-1-1-0-1-1	4

Order #

Series 24 = 2403C

Series 31 = 3103C

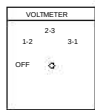
VOLTMETER- Transfer Switches

3-phase, phase-to-phase

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	1
2	12 0-1-1-0-1-1	2
3	13 0-1-1-0-1-1	3
4	14 0-1-1-0-1-1	4

Order #

Series 24 = 2404C

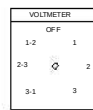
Series 31 = 3104C

3-phase, phase-to-phase
and phase-to-neutral

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	1
2	12 0-1-1-0-1-1	2
3	13 0-1-1-0-1-1	3
4	14 0-1-1-0-1-1	4

Order #

Series 24 = 2405C

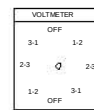
Series 31 = 3105C

6-wire, two 3-phase circuits;
phase-to-phase

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	1
2	12 0-1-1-0-1-1	2
3	13 0-1-1-0-1-1	3
4	14 0-1-1-0-1-1	4

Order #

Series 24 = 2406C

Series 31 = 3106C

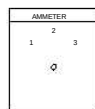
AMMETER- Transfer Switches

3-phase, two current-transformers

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	1
2	12 0-1-1-0-1-1	2
3	13 0-1-1-0-1-1	3
4	14 0-1-1-0-1-1	4

* Denotes make-before-break

Order #

Series 24 = 2407C

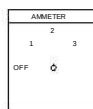
Series 31 = 3107C

3-phase, two current-transformers

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	1
2	12 0-1-1-0-1-1	2
3	13 0-1-1-0-1-1	3
4	14 0-1-1-0-1-1	4

* Denotes make-before-break

Order #

Series 24 = 2408C

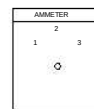
Series 31 = 3108C

3-phase, three current-transformers

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



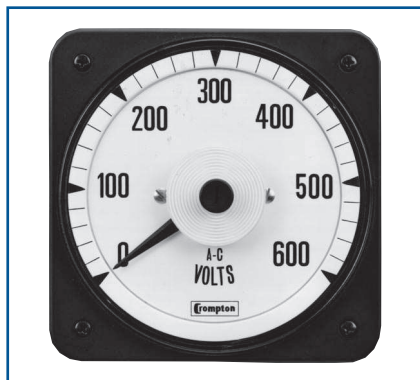
POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	1
2	12 0-1-1-0-1-1	2
3	13 0-1-1-0-1-1	3
4	14 0-1-1-0-1-1	4

* Denotes make-before-break

Order #

Series 24 = 2409C

Series 31 = 3109C



A.C. Voltmeter

Moving Iron A.C. Voltmeters

Product Codes – Self Contained 60Hz $\pm 20\%$ (Accuracy $\pm 1\%$)***

Rating	Scaling*	4 1/2" Square Flange		8 3/4" Square Flange
		Standard Case Catalogue No.	Sealed Case Hi-Shock Catalogue No.	Standard Case Catalogue No.
150V	0-150V	•/+077-08VA-PZPZ-C6	078-08VJ-PZPZ-C6	•079-08VA-PZPZ-C6
250V	0-250V	•/+077-08VA-RSRS-C6	078-08VJ-RSRS-C6	•079-08VA-RSRS-C6
300V	0-300V	•/+077-08VA-RXRX-C6	078-08VJ-RXRX-C6	•079-08VA-RXRX-C6
500V	0-500V	•/+077-08VA-SFSF-C6	078-08VJ-SFSF-C6	•079-08VA-SFSF-C6
600V	0-600V	•/+077-08VA-SJSJ-C6	078-08VJ-SJSJ-C6	•079-08VA-SJSJ-C6
750V	0-750V	077-08VA-SMSM-C6	078-08VJ-SMSM-C6	079-08VA-SMSM-C6

Product Codes – Transformer Rated 50/60HZ (Accuracy $\pm 1\%$) 0.8VA @150V***

150V	0-300V	•/+077-08VA-PZRX-C6	078-08VJ-PZRX-C6	•079-08VA-PZRX-C6
150V	0-600V	•/+077-08VA-PZSJ-C6	078-08VJ-PZSJ-C6	•079-08VA-PZSJ-C6
150V	0-750V	•/+077-08VA-PZSM-C6	078-08VJ-PZSM-C6	•079-08VA-PZSM-C6
150V	0-3000V	•/+077-08VA-PZUA-C6	078-08VJ-PZUA-C6	•079-08VA-PZUA-C6
150V	0-5250V	•/+077-08VA-PZUL-C6	078-08VJ-PZUL-C6	•079-08VA-PZUL-C6
150V	0-6000V	•/+077-08VA-PZUP-C6	078-08VJ-PZUP-C6	•079-08VA-PZUP-C6
150V	0-9000V	•/+077-08VA-PZUY-C6	078-08VJ-PZUY-C6	•079-08VA-PZUY-C6
150V	0-15KV	•/+077-08VA-PZWC-C6	078-08VJ-PZWC-C6	•079-08VA-PZWC-C6
150V	0-18KV	•/+077-08VA-PZWD-C6	078-08VJ-PZWD-C6	•079-08VA-PZWD-C6
150V	0-45KV	•/+077-08VA-PZWJ-C6	078-08VJ-PZWJ-C6	•079-08VA-PZWJ-C6
250V	0-600V	•/+077-08VA-RSSJ-C6	078-08VJ-RSSJ-C6	•079-08VA-RSSJ-C6

- UL recognised File # E87815
- + CSA Approved File # LR52592

- * Other scales are available
- *** Case types 077/078/079 use 10-32 UNF terminals. For M5 screw clamp terminals stipulate case type 075


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APPLICATION SPECIFIC SWITCHES

SERIES 24 AND SERIES 31 ROTARY SWITCHES

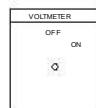
VOLTMETER- Transfer Switches

2-wire, single-phase or D.C.

Depth Behind Panel: 2.4"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	2
	12 0-1-1-0-1-1	
	13 0-1-1-0-1-1	

Order #

Series 24 = 2401C

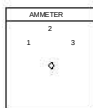
Series 31 = 3101C

 4-wire, two-phase or
 two separate D.C. circuits

Depth Behind Panel: 2.4"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	2
	12 0-1-1-0-1-1	
	13 0-1-1-0-1-1	
	14 0-1-1-0-1-1	

Order #

Series 24 = 2402C

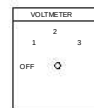
Series 31 = 3102C

3-phase, phase-to-neutral

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	2
	12 0-1-1-0-1-1	
	13 0-1-1-0-1-1	
	14 0-1-1-0-1-1	
	15 0-1-1-0-1-1	

Order #

Series 24 = 2403C

Series 31 = 3103C

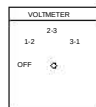
VOLTMETER- Transfer Switches

3-phase, phase-to-phase

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	2
	12 0-1-1-0-1-1	
	13 0-1-1-0-1-1	
	14 0-1-1-0-1-1	
	15 0-1-1-0-1-1	

Order #

Series 24 = 2404C

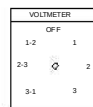
Series 31 = 3104C

 3-phase, phase-to-phase
 and phase-to-neutral

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	2
	12 0-1-1-0-1-1	
	13 0-1-1-0-1-1	
	14 0-1-1-0-1-1	
	15 0-1-1-0-1-1	
	16 0-1-1-0-1-1	

Order #

Series 24 = 2405C

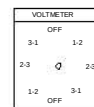
Series 31 = 3105C

 6-wire, two 3-phase circuits;
 phase-to-phase

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	2
	12 0-1-1-0-1-1	
	13 0-1-1-0-1-1	
	14 0-1-1-0-1-1	
	15 0-1-1-0-1-1	
	16 0-1-1-0-1-1	
	17 0-1-1-0-1-1	

Order #

Series 24 = 2406C

Series 31 = 3106C

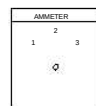
AMMETER- Transfer Switches

3-phase, two current-transformers

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	2
	12 0-1-1-0-1-1	
	13 0-1-1-0-1-1	
	14 0-1-1-0-1-1	
	15 0-1-1-0-1-1	

* Denotes make-before-break

Order #

Series 24 = 2407C

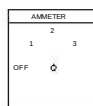
Series 31 = 3107C

3-phase, two current-transformers

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	2
	12 0-1-1-0-1-1	
	13 0-1-1-0-1-1	
	14 0-1-1-0-1-1	
	15 0-1-1-0-1-1	

* Denotes make-before-break

Order #

Series 24 = 2408C

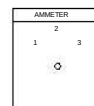
Series 31 = 3108C

3-phase, three current-transformers

Depth Behind Panel: 2.9"

Handle: Round, Knurled

Engraving and jumpering as shown



POS.	CONTACTS	POS.
1	11 0-1-1-0-1-1	2
	12 0-1-1-0-1-1	
	13 0-1-1-0-1-1	
	14 0-1-1-0-1-1	
	15 0-1-1-0-1-1	
	16 0-1-1-0-1-1	

* Denotes make-before-break

Order #

Series 24 = 2409C

Series 31 = 3109C



Flashing LED Hazardous Location Warning Light with XLT™

Model 191XL

RUGGED DESIGN FOR USE IN HAZARDOUS LOCATIONS

- XLT™ Technology
- Available in 24VAC/DC, 120-240VAC and 277VAC
- Five lamp/lens colors
- Flashing mode standard, configurable to Steady-burn
- 60,000 hour, vibration resistant LED lamp
- Available in 3/4-inch NPT pipe mount or surface mount
- Dome guard included
- Type 4X, IP66 enclosure, Marine Listed
- UL and cUL Listed

The model 191XL is a hazardous location flashing signal light that features the super bright LED array with XLT™, eXtreme Light Technology. The unit is available in 24VAC/DC, 120VAC or 240VAC and five colors: Amber, Blue, Clear, Green, and Red. The 191XL comes standard in flashing mode and is field configurable to steady burn mode for maximum functionality.

The Model 191XL has been certified by UL as meeting Type 4X water-tight and corrosion-resistant requirements, and IP66 rated. This hazardous location warning light has an aluminum base, coated for corrosion-resistance, that can be ordered. A dome guard fits over the glass dome to protect it against accidental collision with moving equipment, such as a forklift.

Federal Signal's super bright LED array used in the 191XL produces intense light output and 60,000 hours of service. Increased shock and vibration resistance add to this unit's rugged industrial portfolio of features.

The 191XL is UL Listed for Class I, Division 2, Groups A, B, C and D; Class II Division 1, Groups E, F and G; and Class III.



Model	Voltage	Operating Current	In-rush Current	Flash Rate/Minute	Mount
191XL-1024 ²	24VAC/DC	0.38 amps	1.75 amps, 5.0 mS	60	3/4" NPT Pipe
191XL-1120-240 ²	120/240VAC	0.21/0.13 amps	2.0 amps, 0.25 mS	60	3/4" NPT Pipe
191XL-1277 ²	277VAC	0.13 amps	9.75 amps, 0.25mS	60	3/4" NPT Pipe

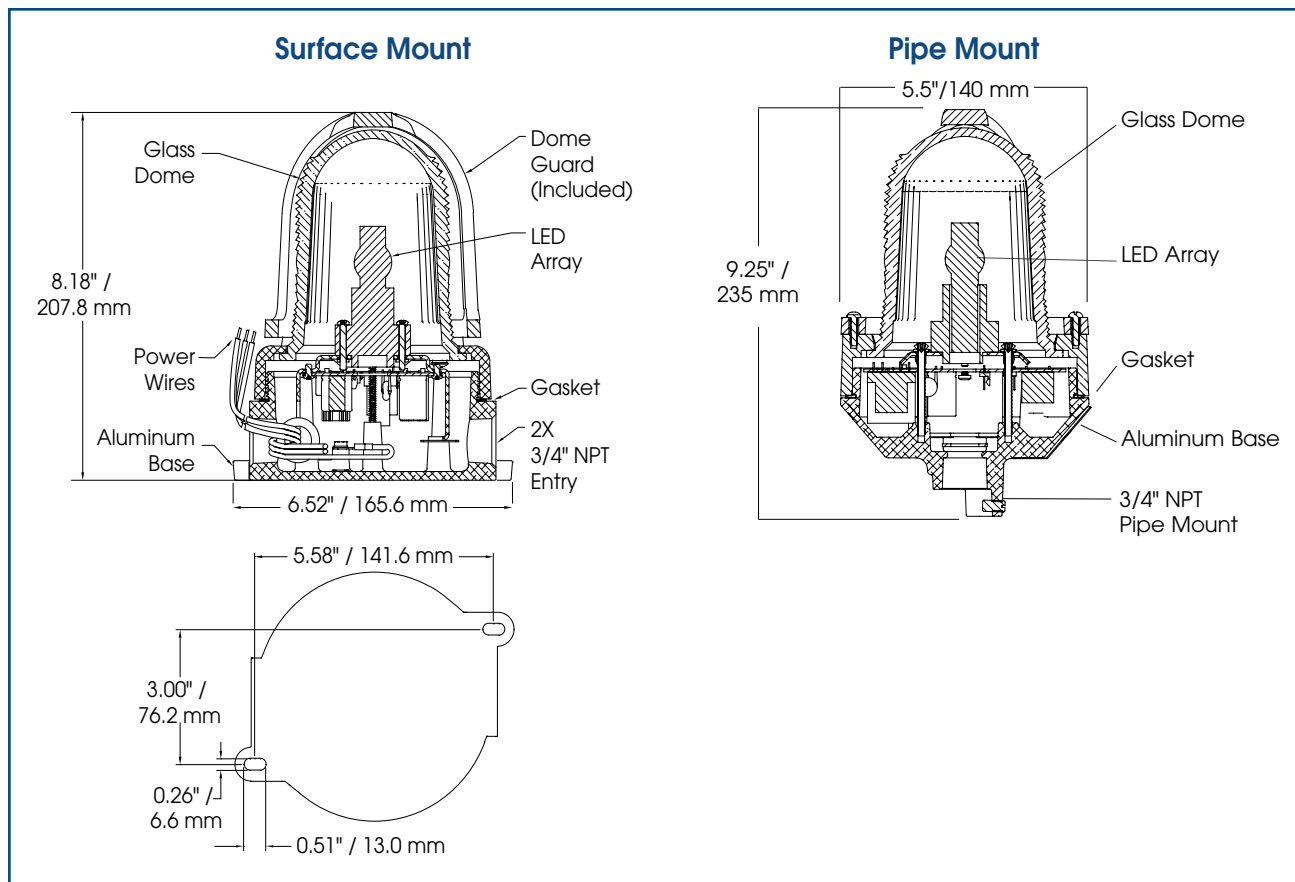
¹Include (S) Surface Mount

²Indicates color: (A) Amber, (B) Blue, (C) Clear, (G) Green or (R) Red

Hazardous Location Rating:

Hazardous Location	T-Code at Maximum Ambient Temperature, °C								
	40°C			55°C			66°C		
	24V	100-265VAC	277VAC	24V	100-265VAC	277VAC	24V	100-265VAC	277VAC
Class I, Div 2, Groups A, B, C, D	T6	T6	T5	T5	T5	T5	T4A	T4A	T5
Class II, Div 1, Groups E, F and G	T6	T6	T5	T6	T6	T5	T6	T6	T5
Class III	T6	T6	T5	T6	T6	T5	T6	T6	T5

HAZARDOUS LOCATION LED WARNING LIGHT (191XL)



SPECIFICATIONS

Lamp Life:	60,000 Hours	60,000 Hours
Light Source:	LED Array	LED Array
Operating Temperature:	-58°F to 150°F	-50°C to 66°C
Net Weight:	4.0 lbs.	1.82 kg
Shipping Weight:	4.25 lbs.	1.93 kg
Height (with Dome Guard):	9.25"	235.0 mm
Diameter:	5.5"	140.0 mm

HOW TO ORDER

- Specify model, mount, voltage, and color
- Optional Accessories:
Hazardous Location Mounting Bracket (LHWB)
- Please refer to Model Number Index 191XL beginning on page 370

REPLACEMENT PARTS

<u>Description</u>	<u>Part Number</u>	<u>Dome and Ring Assembly</u>	
PC Board Assembly, 24VDC	K2005455A	Glass Dome/Ring Assembly, Amber	K8449078C-01
PC Board Assembly, 120/240VAC	K2005416A	Glass Dome/Ring Assembly, Blue	K8449078C-06
PC Board Assembly, 277VAC	K2005416A-01	Glass Dome/Ring Assembly, Clear	K8449078C-04
LED array, Amber	K147169A-06	Glass Dome/Ring Assembly, Green	K8449078C-07
LED array, Blue	K147169A-07	Glass Dome/Ring Assembly, Red	K8449078C
LED array, Clear	K147169A-10	Gasket	K8449080B
LED array, Green	K147169A-08	Guard	K8449090B
LED array, Red	K147169A-09		

**INSULATORS
ISOLATEURS
ISOLATOREN**

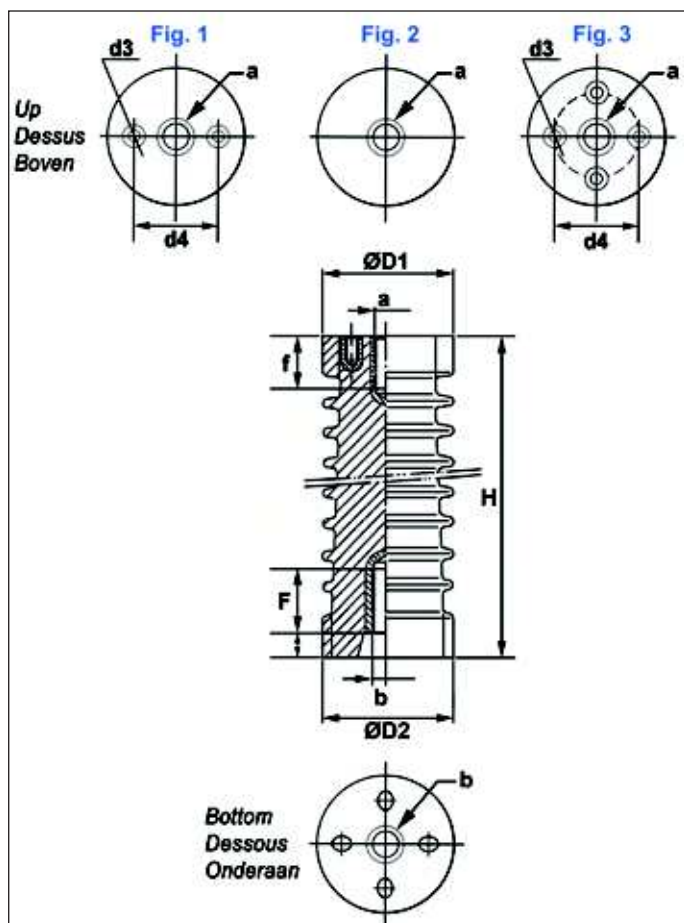
2015



Indoor epoxy insulators
Isolateurs intérieur en epoxy
Isolatoren in epoxy voor binnendienst

Article :

JO...



Recommended service voltage
Tension assignee d'emploi
Aanbevolen dienstspanning

24 kV



B221



B547



Rated values according to IEC 60273 - Tests acc. to IEC 60660
Valeurs assignée selon IEC 60273 - Testé selon IEC 60660
Toegekende waarden volgens IEC 60273 - Tests volgens IEC 60660

(1)	Rated Highest voltage for equipment (Um) Tension assignée la plus élevée pour le matériel (Um) Toegekende Maximale systeemspanning (Um)
(2)	Rated Power Frequency Withstand Voltage, dry (50 Hz, 1 min) Tension de tenue assignée à fréquence industrielle, à sec (50 Hz, 1 min) Toegekende overspanning bij industriële frekwentie, droog (50 Hz, 1 min)
(3)	Rated Lightning impulse withstand (1.2/50 µs) Tension de tenue assignée au choc de foudre (1.2/50 µs) Toegekende Stootspanningsniveau (1.2/50 µs)
Cr	Creepage distance / Ligne de fuite / Kruipafstand.
N	Flexion resistance / Résistance à la flexion / Buigweerstand

TYPE	Art.	1 kV	2 kV	3 kV	H ± 1 mm	Cr mm	N N	ØD1/D2 mm	Fig	a	b	f mm	F mm	d3	d4 mm	Weight kg
JO 6 - 125	B95 (*)	24	50	125	210	296	5000	70	1	M10	M16	16	33	M6 x 12	36	1,2
	B105		50	125	210	296	5000	70	1	M10	M16	16	33	M6 x 12	36	1,2
	B143-1		50	125	210	296	5000	70	2	M10	M16	16	33			1,2
	B380-1		50	125	210	296	5000	70	3	M10	M16	16	33	M6 x 12	36	1,2
	B547 (*)		50	125	210	296	5000	70	1	M12	M16	18	33	M6 x 12	36	1,2
JO 10 - 125	B550		50	125	210	308	10000	85	1	M16	M20	33	34	M10 x 16	46	1,9
	B221-1 (*)		50	125	210	308	10000	85	2	M16	M20	33	34			1,9
	B220-1		50	125	210	308	10000	85/87	3	M16	M20	33	34	M10 x 16	46	1,9
	B225		50	125	210	275	10000	89	1	M16	M24	33	35	M10 x 16	66	2,6
	B553-1		50	125	210	275	10000	89	1	M16	M24	33	34	M10 x 16	66	2,6
	B4541 (*)		50	125	210	417	10000	98	1	M16	M20	33	34	M10 x 16	46	2,1
JO 20 - 125	B687-1		50	125	210	404	20000	130	1	M16	M24	33	34	M10 x 16	66	4,15

(*) = stock



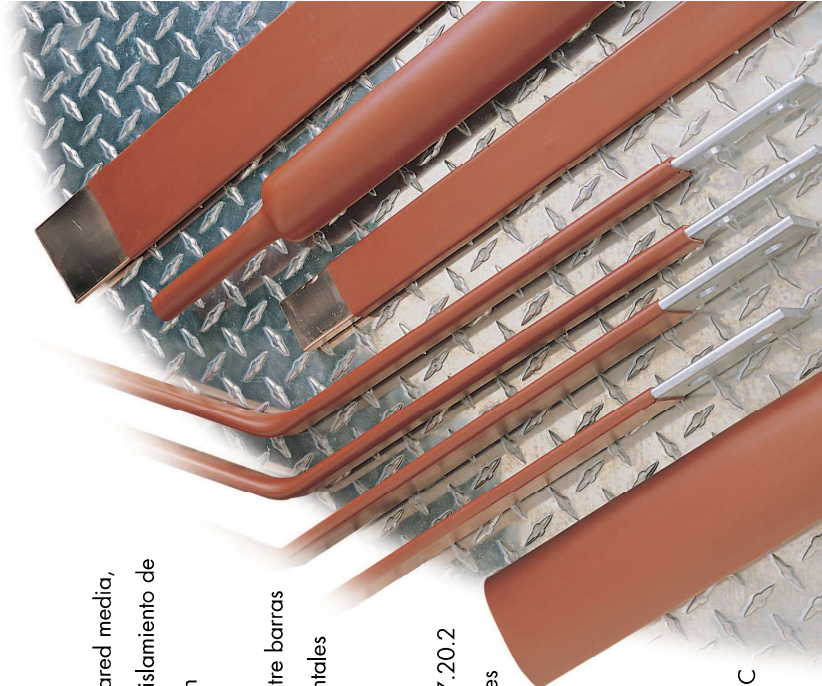
CBTM

Tubo de Poliolefina reticulada para aislamiento de barras eléctricas de Media Tensión



Características

- Tubo termoretráctil anti track de pared media, especialmente diseñado para el aislamiento de barras eléctricas de Media Tensión
- Retardo a la llama
- Reduce requisitos de distancias entre barras
- Protege contra llamaradas accidentales
- Anti-track
- Libre de halógenos
- Probado con estándares ANSI C37.20.2 para aplicaciones de conmutadores de alta tensión de voltaje medio de hasta 36 kV
- Componente reconocido UL
- Temperatura continua de utilización: -40°C a 125°C
- Temperatura de contracción: 120°C



Dimensiones

CBTM - para tensiones de servicio hasta 36kV en embarrados eléctricos

NÚM. REF. PEDIDO	EXPANDIDO	CONTRAÍDO		RANGOS APLICACIONES				UNIDADES ENTREGA
		Ø MÉTRICO INTERNO (MÍN) D	Ø MÉTRICO INTERNO (MÁX) D	ESPESOR PARED (NOM) W	BARRAS RECTANGULARES (MÍN)	BARRAS RECTANGULARES (MÁX)	BARRAS REDONDAS (MÍN)	
	mm	mm	mm	mm	mm	mm	mm	m
CBTM 0750	19,0	5,5	2,70	6,4	6,4	6,8	15,2	15
CBTM 1300	33,0	10,1	3,00	12,7	28,5	12,4	27,9	15
CBTM 2050	52,0	19,0	2,80	31,5	50,8	22,3	43,1	15
CBTM 2750	69,8	25,4	2,90	44,4	76,2	29,7	58,4	15
CBTM 3500	88,9	29,9	3,10	57,1	101,6	35,8	73,6	15
CBTM 4700	119,3	39,9	3,20	73	142,8	47,7	101,6	15
CBTM 6700	170,1	58,4	3,20	114,3	203,2	69,5	144,7	15

Los barras rectangulares tienen un grosor de 1/4 a 5/8 pulgadas.

Los rangos de aplicaciones mencionados anteriormente han sido seleccionados para obtener el grosor de aislamiento mínimo requerido para cumplir los requisitos de resistencia ANSI C37.20.2 en el espectro de las barras que se indican a continuación. Estos espacios han sido determinados a partir de un número limitado de configuraciones de prueba. Debido a la amplia variedad de configuraciones de barras, estos espacios no deben emplearse sin que sean medidos de forma real por el usuario.

Márgenes con aislamiento

TENSIÓN DEL SISTEMA	BIL kV	CBTM Tubo de pared media p a p (mm)	
15 kV	95	86,0	106,0
25 kV	125	114,0	152,0
36 kV	150	165,0	203,0

p a p: Orientación de fase a fase
p a g: Orientación de fase a tierra
Espacio basado en las dimensiones de perfil a menos antes del aislamiento
Especifico basado en grosor de pared de aislamiento por rango de aplicaciones de la tabla anterior

Datos Técnicos

Físicos

Propiedad	Método de prueba	Rendimiento tipo
Resistencia a tracción	ASTM D 412, ISO 37	9,3 MPa
Alargamiento	ASTM D 412, ISO 37	370%
Envejecimiento térmico (7 días at 125°C)	ASTM D 2671	10. Alto
Resistencia a tracción Alargamiento	ASTM D 2671	200%
Choque térmico (4 h a 125°C)	ASTM D 2671	No agrieta, no pérdidas
Flexibilidad de baja temperatura (4 h a -25°C)	ASTM D 2671	no agrieta
Combustibilidad	ASTM D 2671	aprobado

Eléctricos

Propiedad	Método de prueba	Rendimiento tipo
Resistencia a perforación	ASTM D 149	20 kV/mm
Resistividad de superficie	ASTM D 257	510 x 10 ¹² Ω
Resistividad por volumen	ASTM D 257	1,9 x 10 ¹⁴ Ω cm
Constante dieléctrica	ASTM D 150	3,4
Resistencia seguimiento (2500 V, 300 min)	ANSI C37.20	sin seguimiento
Atenuación atmosférica	ASTM D 2303	sin seguimiento tras 6000 horas

Químicos

Propiedad	Método de prueba	Rendimiento tipo
Acción corrosiva	ASTM D 2671	no corrosivo
Resistencia a fluidos	MIL-STD-20033/15	bueno a excelente
Absorción agua	ASTM D 570	0,25%

Colores estándar rojo	Colores especiales
	No disponible

Pedido: **Especifique el nombre del producto** y cada una de las siguientes opciones: 1) Tamaño 2) Color 3) Cantidad total + Unidad de entrega
Por ejemplo: CBTM 52/19 rojo, 1.500 m, carrete 15m

INSULATED JUMPER CABLE - 15KV, 25KV, 35KV

- 15KV Jumper cable available in four sizes
- Conductive strand shield improves service life, dielectric strength and eliminates internal corona
- Insulation is mold cured from ethylene propylene rubber (EPR) and resists abrasion, heat, moisture, and ultra violet rays
- Flexible at low temperatures
- Copper stranding is extra flexible and alloy coated
- Note: These cables are not intended for use as permanently installed or portable power cable. To avoid possible cable damage and high leakage currents, these cables must be positioned away from grounded surfaces or energized conductors other than those to which they are connected.

	CAT NO	SIZE AWG	STRANDING	RATING AMPS	WEIGHT PER 1,000 FT
15KV	12198	#2	259	200	440 LBS
	12199	1/0	427	250	600 LBS
	12200	2/0	427	300	710 LBS
	12201	4/0	532	400	1,050 LBS
25KV	6874	2/0	427	300	903 LBS
35KV	6859	1/0	427	250	1,130 LBS



12200

JUMPER CABLE FERRULE ASSEMBLES
WITH 5/8-11 NC THREADS

- Tin plated copper
- Ferrule has flat side for use with jumper head

CAT NO	CABLE SIZE	LBS
13100	#2	0.3
13101	1/0	0.3
13102	2/0	0.3
13103	4/0	0.4



13102

BRAIDED FLEXIBLE CONNECTORS

Technical Specifications

Standard Braids

Standard Braids are available in 1", 1 1/4", 1 3/8", 1 1/2", 2", 3", 4", 5" and 6" width.

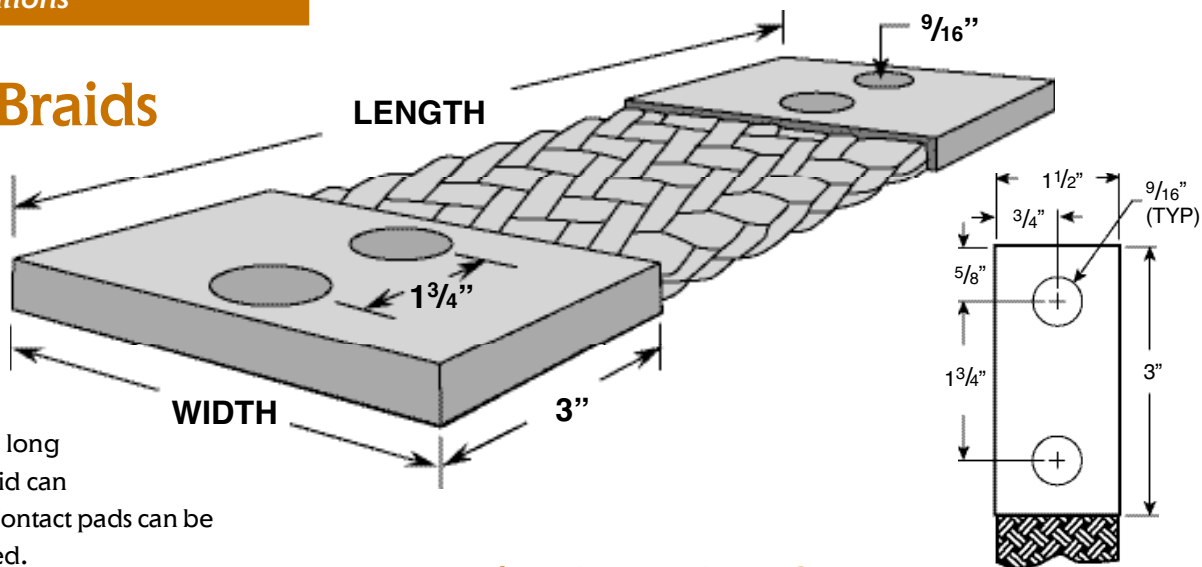
Drilling patterns are NEMA standards or per customer request.

Ferrules are typically 3" long (Maximum is 5 7/8"). Braid can

be bare or tin plated. Contact pads can be silver, tin or nickel plated.

Current capacity to 3200 amps is available.

Current capacity is based on a single conductor in free air with a temperature rise of 30 degrees centigrade, or 50 degrees centigrade.



1 1/2" Wide Braided Connectors

Part Number	Description MCM	Approx. Term. Thickness	Term. Width	Ampacity	
				30° C	50° C
240 - 1.5	105	.250"	1 1/2"	240	315
350 - 1.5	210	.270"	1 1/2"	350	460
450 - 1.5	315	.400"	1 1/2"	450	590
540 - 1.5	420	.450"	1 1/2"	540	710
625 - 1.5	525	.500"	1 1/2"	625	825
705 - 1.5	630	.560"	1 1/2"	705	930
785 - 1.5	735	.620"	1 1/2"	785	1035
865 - 1.5	840	.750"	1 1/2"	865	1140
945 - 1.5	945	.800"	1 1/2"	945	1245
1020 - 1.5	1050	.880"	1 1/2"	1020	1345
1095 - 1.5	1155	.950"	1 1/2"	1095	1445
1175 - 1.5	1260	1.00"	1 1/2"	1175	1550
1250 - 1.5	1365	1.00"	1 1/2"	1250	1650
1325 - 1.5	1470	1.125"	1 1/2"	1325	1745
1400 - 1.5	1575	1.250"	1 1/2"	1400	1845
1475 - 1.5	1680	1.280"	1 1/2"	1475	1945
1550 - 1.5	1785	1.350"	1 1/2"	1550	2045
1620 - 1.5	1890	1.460"	1 1/2"	1620	2140
1695 - 1.5	1995	1.54"	1 1/2"	1695	2235
1775 - 1.5	2100	1.62"	1 1/2"	1775	2340
1850 - 1.5	2440	1.7"	1 1/2"	1850	2440
1920 - 1.5	2310	1.78"	1 1/2"	1920	2535
2000 - 1.5	2415	1.86"	1 1/2"	2000	2640

1" Wide Braided Connectors

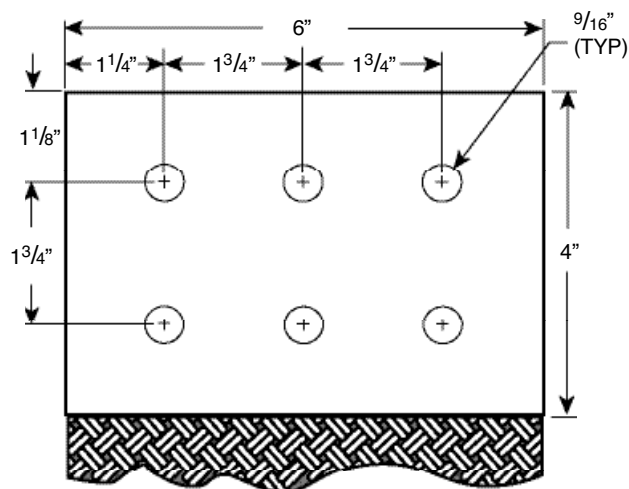
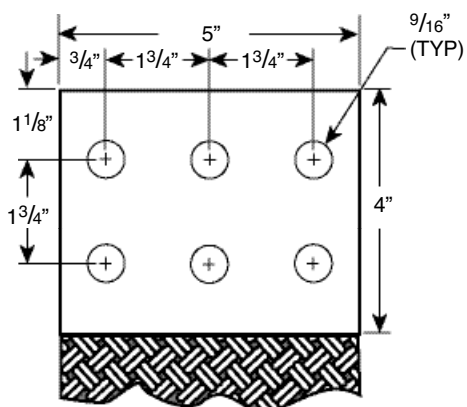
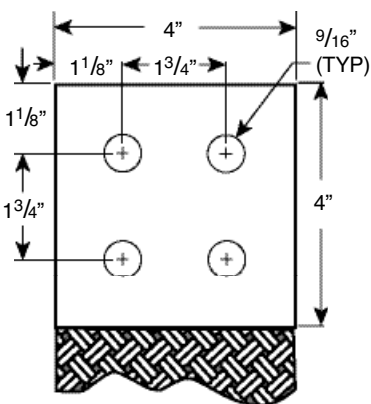
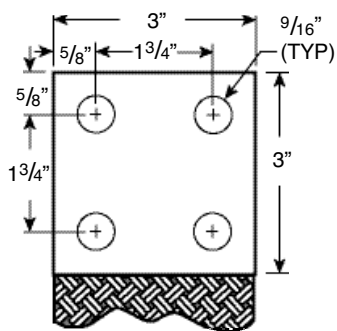
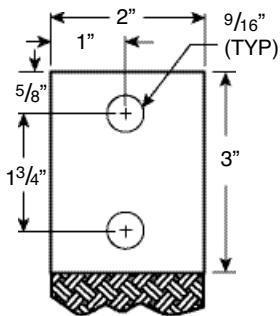
Part Number	Description MCM	Approx. Term. Thickness	Term. Width	Ampacity	
				30° C	50° C
180 - 1	84	.160"	1"	180	235
275 - 1	168	.190"	1"	275	360
350 - 1	252	.350"	1"	350	460
420 - 1	336	.390"	1"	420	550

Additional Ampacity Available

BRAIDED FLEXIBLE CONNECTORS (continued)

2" to 6" Wide Braided Connectors

Part Number	Description MCM	Approx. Term. Thickness	Term. Width	Ampacity	
				30° C	50° C
569 - 2	420	.375"	2"	569	755
724 - 2	630	.5"	2"	724	961
866 - 2	840	.625"	2"	866	1149
1000 - 2	1050	.75"	2"	1000	1328
801 - 3	630	.375"	3"	801	1062
1007 - 3	945	.5"	3"	1007	1337
1194 - 3	1260	.625"	3"	1194	1584
1367 - 3	1575	.75"	3"	1367	1814
1026 - 4	840	.375"	4"	1026	1361
1284 - 4	1260	.5"	4"	1284	1703
1512 - 4	1680	.625"	4"	1512	2006
1724 - 4	2100	.75"	4"	1724	2286
1248 - 5	1050	.375"	5"	1248	1654
1554 - 5	1575	.5"	5"	1554	2061
1825 - 5	2100	.625"	5"	1825	2420
2073 - 5	2625	.75"	5"	2073	2749
1465 - 6	1260	.375"	6"	1465	1943
1821 - 6	1890	.5"	6"	1821	2414
2132 - 6	2520	.625"	6"	2132	2827
2417 - 6	3150	.75"	6"	2417	3204



BRAIDED FLEXIBLE CONNECTORS

Tough, Dependable, Efficient Performance

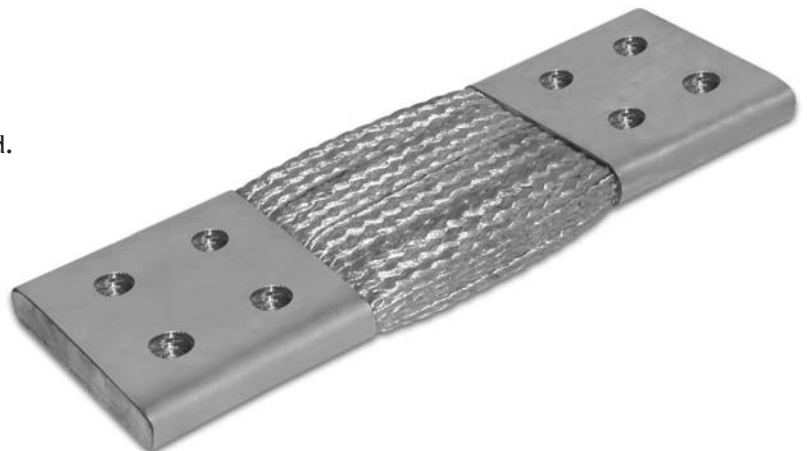


Watteredge Braided Flexible Connectors are built to perform dependably during the transmission of medium to high amperage electrical currents. They deliver the maximum amount of power while maintaining peak efficiency. And, they are designed to compensate for vibration, heat expansion/contraction of busses. Tin plated, corrosion fighting material is used in the manufacture of our flexible connectors allowing for a longer production life.

Watteredge Braided Flexible Connectors can be made to exact specifications. For superior quality, connector ends can be presswelded into a single homogeneous mass using the exclusive Watteredge Press Weld™ process. This process manages the resistance level to half the level of many present connectors. Plus, the resistance is minimized over time.

Standard Braid Features

- Available in 1", 1 1/4", 1 3/4", 1 1/2", 2", 3", 4", 5" and 6" width.
- Drilling patterns are NEMA standards or as requested.
- Ferrules are typically 3" long (max 5 7/8").
- Copper can be bare or tin-plated.
- Contact pads can be silver, tin or nickel plated.
- Current capacity to 3200 amps is available. Current capacity is based on a single conductor in free air with a temperature rise of 30 degrees centigrade or 50 degrees centigrade.



Selection Form

Width Size (circle one)

1" 1 1/4" 1 3/8" 1 1/2" 2" 3" 4" 5" 6"

Overall Length (please specify in inches) _____

Ferrule Length (please specify 3" - 5 7/8") _____

Ampacity Rating _____

Watteredge Part No. _____

Copper Braid (circle one) Bare Tin Plated

Contact Pads (circle one) Silver Plated Tin Plated Nickel Plated

Quantity _____

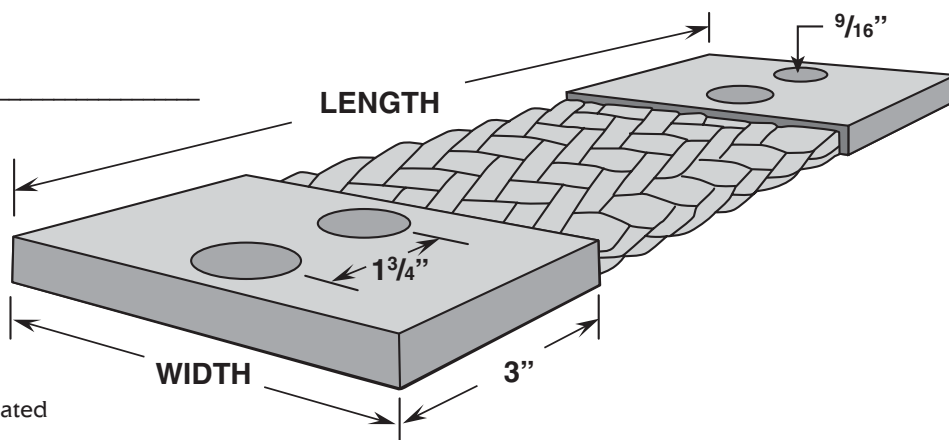
Company Name _____

Address _____

City _____ State _____ Country _____ Zip _____

Phone _____ Fax _____

Buyer's Name _____ Email _____



Specialty Braided Flexible Connectors

A standard connector may not be the answer to your more rigorous production needs. Watteredge has the ability to customize a braided flexible connector to meet your job specific application. Our custom braided flexible connectors can be designed in a variety of sizes and designs, and can be formed using our unique Press Weld™ technology. Simply ask us about our made-to-order assemblies and tell us your performance expectations. The Power Professionals at Watteredge will work with you to provide the right solution to all your power applications.

Specialty Braided Flexible Connectors Features

- Provides quintessential electrical value
- Minimizes voltage loss
- Compensates for vibration, expansion, contraction



Specialty Laminated Shunts

Our custom designed laminated shunts are the ideal solution when a standard shunt configuration does not sufficiently meet your production requirements. Watteredge designs and engineers laminated shunts to provide solutions to the most difficult production challenges. Our shunts are manufactured using our patented Press Weld™ process or are available using a riveted method. The Power Professionals at Watteredge provide solutions that open the way to maximum productivity.

Specialty Shunts Features

- Lower resistance values equal to flat copper bar
- Minimal voltage loss
- Balanced flow of electrical current



Specialty Jumpers

Watteredge provides specialty jumpers that are custom designed and engineered to customers applications. Made by the most advanced manufacturing technologies and the most exacting standards, our jumpers are subjected to highly rigorous quality controls. Watteredge custom jumpers are available in the widest range of materials and sizes, and can be formed using our unique Press Weld™ technology. Contact the Power Professionals at Watteredge for solutions to your special production requirements.



Custom Jumper Features

- Unlimited electrical capacity and configurations
- Single or multiple cables or laminations
- Single or multiple terminations
- Terminations to fit your existing equipment
- Forced cooling or water, if required
- Heat shrink
- A variety of covers available (i.e. neoprene, hypalon)

SIS

XLP Insulation/Jacket
90°C, 600 Volts

APPLICATIONS:

For use in wiring switchboards and control apparatus. Resists heat, moisture, flame, oil and corrosive vapors.



SPECIFICATIONS:

1. CONDUCTOR: Tinned, annealed stranded copper per ASTM B-8 and B-33. A separator tape may be applied over the conductor.
2. INSULATION: Cross-linked polyethylene (XLP).
3. STANDARDS: Meets the UL requirements for Type SIS switchboard wire (14 AWG and larger only).
4. TEMPERATURE: 90°C
5. VOLTAGE: 600 Volts

Anixter Number*	Conductor Size	Number of Strands	Insulation Thickness	Nominal O.D.	Approximate Weight Lbs. 1000 Ft.
	AWG/kcmil		IN	IN	
6KL-1801S	18	7	.030	.113	10
6KL-1601S	16	7	.030	.125	14
6KL-1401S	14	7	.030	.140	19
6KL-1201S	12	7	.030	.159	28
6KL-1001S	10	7	.030	.183	41
6KL-0801S	8	7	.045	.243	69
6KL-0601S	6	7	.060	.313	112
6KL-0401S	4	7	.060	.361	166
6KL-1801F	18	16	.030	.112	10
6KL-1601F	16	26	.030	.125	14
6KL-1401F	14	41	.030	.140	20
6KL-1201F	12	65	.030	.155	30
6KL-1001F	10	104	.030	.180	41
6KL-0801F	8	133	.045	.260	75
6KL-0601F	6	133	.060	.340	130
6KL-0401F	4	133	.060	.390	185

*Use Color Code Suffix when ordering, (e.g. 6KL-1401F-09).

*VW-1 rating available. Use Suffix V (e.g. 6KL-1401FV-09).

NOTE: Diameters and weights may vary between manufacturers.

**POWER TO SPARE
FOR THE EASIEST LANDINGS
ANYWHERE.**



JOST
LANDING GEAR

THE NUMBER ONE NAME IN DURABILITY AND SAFETY OFFERS A DRAMATICALLY IMPROVED LANDING GEAR.

For over forty years, JOST has been the world's leading manufacturer of truck and trailer components for the international road transport market.

The superior performance of JOST components in rugged road conditions all over the world has earned JOST a rock-solid reputation for quality.

When JOST developed a landing gear that would bear the JOST name, this reputation ensured that a very high standard would be set. The landing gear designed and built at JOST's advanced manufacturing facilities is distinctly superior in performance, durability and safety.

Let's start with the geartrain.

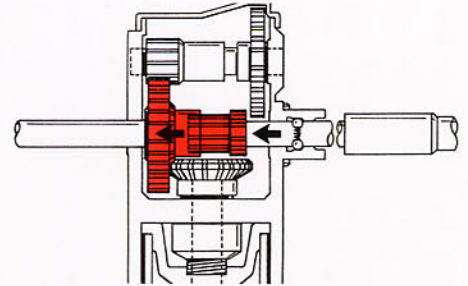
At first glance, the difference in the JOST landing gear is obvious. *No external gearbox.* The gearing mechanism is an integral part of one sturdy leg column – streamlined and protected from road wear. It contains fewer parts, is simpler to maintain, and looks better.

So how does it perform?

This is where the differences become dramatic. An exceptionally well engineered geartrain means real savings in time, money and maintenance.

A really FAST high gear.

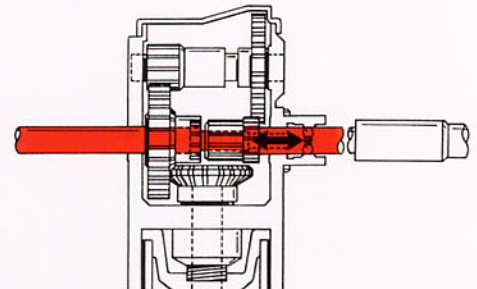
Among the fastest in the business. It disengages the lower gears to reduce effort at the crank AND save wear on the gears.



In high gear, the portion of the geartrain that drives low gear turns freely without engagement, especially in cold weather.

Spline shifting:

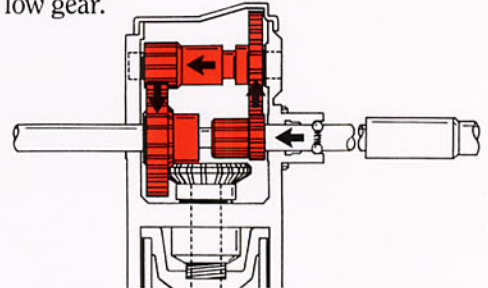
The easiest possible shifting. Only the inside of the gear moves when changing from high to low gear. The in-line shaft keeps the shifting smooth and stable, eliminating problems caused by excessive play in the geartrain.



JOST's geartrain design is not only easier to use, but with reduced wear on the gear teeth, lasts longer and requires less maintenance.

Double reduction* delivers real power in low gear.

The gear configuration has been developed to give the most efficient mechanical advantage for lifting power in low gear.



Shift smoothly into low gear and engage another set of gears that multiply your lifting power more efficiently than in any other geartrain design.

*Patent Pending



Load Capacities per pair

Lifting Capacity 50,000 lbs.
at 100 ft. lbs. input torque

Static Load Capacity 160,000 lbs.

Side Load Capacity 29,000 lbs.

Gear Ratio

Low Gear 32 Turns = 1" Travel

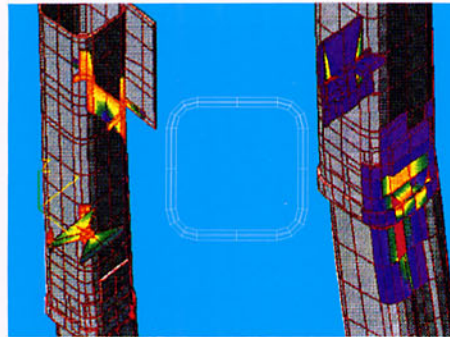
High Gear 3.5 Turns = 1" Travel

A lighter, stronger leg.

Over 40 pounds lighter than the leading competitor. But is it strong? JOST made use of current state-of-the-art computer technology to determine the ideal metal composition and leg shape for maximum strength without extra weight.

The warranty: second to none.

Five years! JOST warrants its A400 Series Landing Gear, when properly applied and installed, to be free of defects in materials and workmanship under normal use and service for a period of five years.



Nonlinear analysis (left) was employed to determine the optimum grade of high strength low alloy steel for the landing gear. Finite analysis (right) yielded the ideal shape.

Meets or exceeds industry standards.

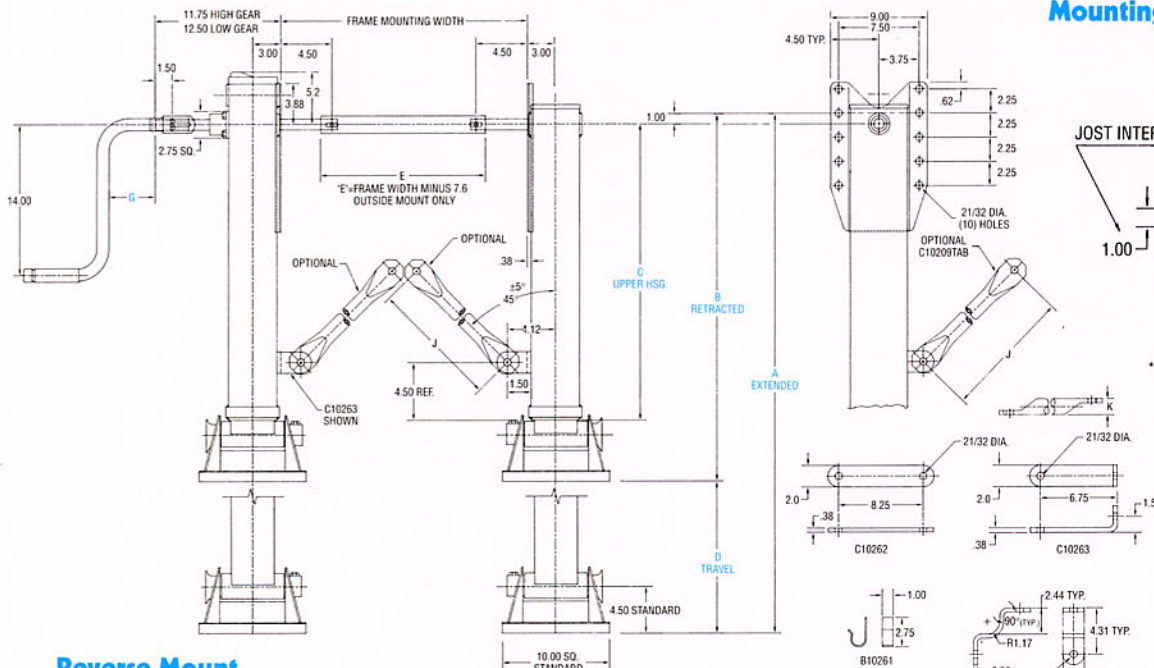
The new JOST landing gear meets all AAR and TTMA specifications.

Depend on the people who know fleets.

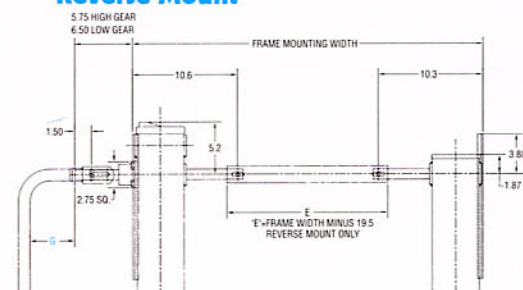
The people at JOST feel there are many good reasons to choose the new JOST landing gear. But the most compelling reason to buy JOST with confidence is an international reputation for durability and safety on the toughest roads in the world.

Landing Gear Dimensions

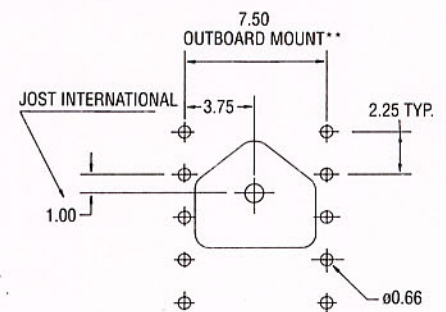
Outside Mount



Reverse Mount



AAR/TTMA Mounting Bracket Window



**NOTE: CALL FACTORY FOR MOUNTING INFORMATION FOR REVERSE MOUNTING.

Travel Option Dimensions

D-Travel	A-Extended	B-Retracted	C-Upper Hsg.
14"	42 ⁵ / ₈ "	28 ⁵ / ₈ "	21 ¹⁵ / ₁₆ "
17"	48 ⁵ / ₈ "	31 ⁵ / ₈ "	24 ¹⁵ / ₁₆ "
19"	52 ⁵ / ₈ "	33 ⁵ / ₈ "	26 ¹⁵ / ₁₆ "

Crank Options

G-Dimension	Part No.
5 ¹ / ₄ "	C10592.1
8 ¹ / ₄ "	C10592.2
10 ¹ / ₂ "	C10592.3
17 ³ / ₄ "	C10592.4
14 ³ / ₄ "	C10592.5

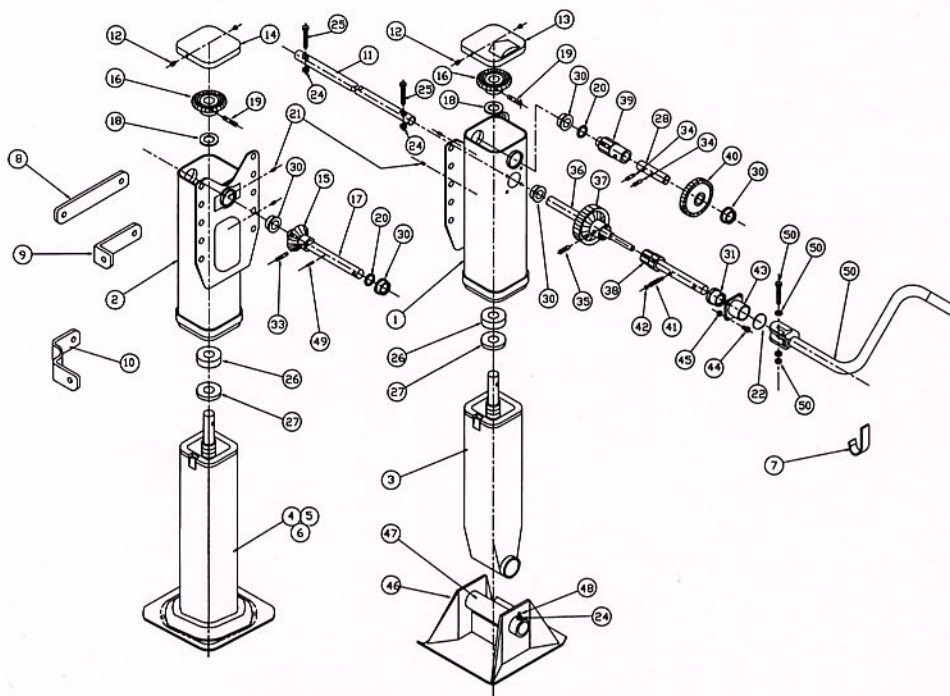
Landing Gear Models and Options

Model	Mounting	Travel	Leg Assemblies	
A400	Outside Frame 2 1/32" Holes	14", 17", 19"	A400R	2-Speed
			A400L	1-Speed
A401	Inside Frame 2 1/32" Holes	14", 17", 19"	A401R	2-Speed
			A401L	1-Speed

Standard Models: **A400 T17** – Outside Mount with Sand Shoes, 17" Travel
Includes 8.25" Crank, Crank Hanger, Brace Lugs, Cross Shaft.

Footwear Options

Description	Order Code	Description	Order Code
10" x 10" Cushion Foot	G	10" x 10" x 4 1/2" Sand Shoes	T
12" x 12" Cushion Foot	G1	10" x 10" x 2" Sand Shoes	T1
9" Dia. Standard Wheels	R	10" x 12" x 4 1/2" Sand Shoes	T2
9" 3rd Disc Wheels	R1	10" x 12" x 2" Sand Shoes	T3
10" x 10" Cushion Foot Lo Pro	G3	No Footwear	NA



• INCLUDED IN B10229S ASSEMBLY

▲ INCLUDED IN B10285 ASSEMBLY



JOST
INTERNATIONAL

1770 Hayes Road
P.O. Box 327
Grand Haven, Michigan 49417
616/846-7700
WATS 800/253-5105 • FAX 616/846-0310
EMAIL sales@jostinternational.com

Component Assemblies

Item	Description	Part No.		
		14" Travel	17" Travel	19" Travel
1	Outer Housing 2 Speed	D10201.1	D10201.2	D10201.3
2	Outer Housing 1 Speed	D10116.1	D10116.2	D10116.3
3	Inner Leg Assy. Standard	C10140.1	C10140.2	C10140.3
4	Inner Leg Assy. 10" Cushion	C10146.1	C10146.2	C10146.3
5	Inner Leg Assy. 12" Cushion	C10254.1	C10254.2	C10254.3
6	Inner Leg Assy. G3	C10580.1	C10580.2	C10580.3

Individual Components

Item	Description	Qty.	Part No.
7	Crank Hanger	1	B10261
8	Brace Lug – Flat	2	C10262
9	Brace Lug – 90°	2	C10263
10	Brace Lug – W Standard	2	C10108
11	Intermediate Cross Shaft	1	B10066
12	Cover Screw	4	A10059.1
13	Cover – 2 Speed	1	C10217
14	Cover – 1 Speed	1	C10259
15	Pinion Gear	1	C10177
16	Bevel Gear	2	C10155
17	Pinion Shaft – 1 Speed	1	B10130
18	Thrust Washer	2	A10102
19	Grooved Pin	2	A10052.3
20	Spacer Washer	2	A10218
21	Grease Fitting	4	A10040
22	Grease Seal	1	A10283 •▲
23	Strut Brace (not shown)	4	C10209
24	Self Locking Nut	4	A10038.7
25	Cross Shaft Bolt – 3/8" x 2" Gr5	2	A10037.1
26	Thrust Bearing	2	A10033
27	Collar	2	A10101
28	Output Shaft	1	A10212
30	Bushing	5	A10255
31	Detent Bushing NOT SOLD	1	A10642.2 •▲
33	Roll Pin – 3/8" x 1 1/2"	1	A10054.3
34	Spiral Pin	2	A10260.1
35	Roll Pin – 3/8" x 1 3/4"	1	A10054.7
36	Output Cluster Shaft	1	B10236
37	Output Cluster Gear	1	C10234
38	Input Gear Shaft	1	C10233 ▲
39	Output Spur Gear	1	C10078
40	Input Spur Gear	1	C10085
41	Detent Spring	1	A10049 •▲
42	Detent Ball	2	A10048 •▲
43	Shift Housing	1	B10229 •▲
44	Shift Housing Bolt	4	A10230
45	Self Locking Nut	4	A10038.6
46	Shoe – 10" x 10" x 4 1/2" Standard	2	C10035
46	Shoe – 10" x 10" x 2"	2	C10135
46	Shoe – 10" x 12" x 4 1/2"	2	C10256
46	Shoe – 10" x 12" x 2"	2	C10257
47	Shoe Axle	2	B10036
48	Hex Head Bolt	2	A10037.3
49	Roll Pin – 1/4" x 1 1/4"	1	A10054.6
50	Standard Crank w/Hardware	1	C10592.2

Cover photo of Utah salt flats: Marvin E. Newman/The Image Bank

THE GUIDE TO STANDARD AXLES

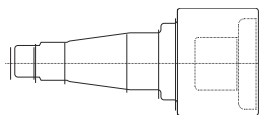
APPLICATION GUIDE

SPINDLE	CAPACITY (LBS)	TUBE OD	WALL THICKNESS	APPLICATION
F12	13,200	5"	S-Wall	Light Duty, Aux Truck
F22/F23 (Tapered)	25,000	5"	H-Wall	Vans & Flats
	25,000		T-Wall	Dumps, Tanks, Live Loads, Off-Road
F24 (Parallel)	25,000	5"	H-Wall	Vans & Flats
	26,000		T-Wall	Dumps, Tanks, Live Loads, Off-Road
F26	30,000	5-3/4"	S-Wall -5-3/4"	Severe Duty, Specialty
K45	45,000	5-3/4"	Solid 5-3/4" Bar	Extreme Duty, Specialty

SPINDLE TYPES

F12

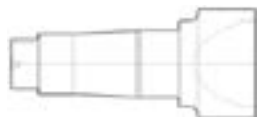
Bearing Group:
Inner Cone HM212049
Outer Cone:



The F12 uses the same bearings, hubs and brake components as the most popular North American truck front steering axle. The brakes are 15"x4". The rugged axle is a friction welded product, and is manufactured with a seamless 5" round tube.

F26

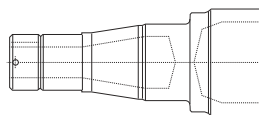
Bearing Group:
Inner Cone 759
Outer Cone 740



The F26 series axle are first choice for both on-highway and off-highway "extra heavy-duty use." The durability of the F26 series sets the standard throughout the North American logging industry, as well as South America and Africa.

F23

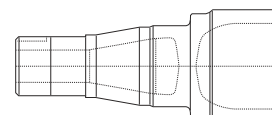
Bearing Group:
Inner Cone HM218248
Outer Cone: X333213



Developed for overseas market, especially Europe, certified to EC-13 brake code. Available with cast steel or aluminum, regular, and Pre-Set™ hubs.

F22/F23

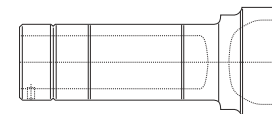
Bearing Group:
Inner Cone: HM218248
Outer Cone: HM212049



The F22 tapered spindle configuration is accepted as the most used axle in North America. The F22 spindle has durability which is unsurpassed. Also, Ingersoll Axles has the widest range of certified brake linings in North America (FMVSS121, CMVSS121). All components are off the shelf and available throughout North America, the Far East and the Pacific Rim.

F24

Bearing Group:
Inner Cone HM518445
Outer Cone: HM518445



The F24 parallel spindle is recognized world-wide and the F24 finds service in the African bushlands, throughout North and South America and Europe. The axle has a wide range of applications and is the preferred axle for heavy-duty bulk tanker containers.

To view our full line of products and services, please visit www.ingersollaxles.com



Application Guide for Commercial Wheels



2016

COMMERCIAL VEHICLE WHEELS

Quick Reference Guide



MAXION
WHEELS MATTER



Hub-Piloted Steel Disc Wheels | Bus Mountings

- Robust construction to meet heavy-duty bus applications and usage.
- Hub-piloted configuration with increased bolt hole diameter to accommodate larger hub studs.
- Hub-piloted center hole provides a truer mounting than stud-piloted wheels.



Part Number	Size	Wheel Offset	Disc Thickness	Approximate Weight	Hand Holes	Maximum Load Rating	Maximum Inflation	Recommended Valve
10 Bolt Hole • 285.75mm (11.250") Bolt Circle • 220.19mm (8.669") Center Hole								
87934	22.5 x 8.25	6.62"	0.425"	79 lbs.	5	7,400 lbs.	120 psi	TR-573
91720	24.5 x 8.25	6.62"	0.432"	88 lbs.	5	7,400 lbs.	120 psi	TR-573



Wide-Base Steel Disc Wheels | Hub- & Stud-Piloted

- All Wide-Base steel disc wheels are topcoat painted white. Customer colors are available upon request.
- These wheels offer weight savings for better fuel economy, higher load applications, and less tire wear.



Part Number	Size	Outset (pos.)	Inset (neg.)	Aproximate Weight	Hand Holes	Maximum Load Rating	Maximum Inflation	Recommended Valve ⁽⁵⁾
HUB-PILOTED: 10 Bolt Hole • 285.75mm (11.250") Bolt Circle • 220.09mm (8.665") Center Hole								
10034	22.5 x 12.25	4.54"	4.00"	111 lbs.	5	11,400 lbs.	125 psi	TR-500
10035	22.5 x 12.25	5.29"	4.75"	111 lbs.	5	11,400 lbs.	125 psi	TR-574-E26
10039	22.5 x 13.00	0.50"	0"	119 lbs.	5	11,000 lbs.	110 psi	TR-574-E26
10043	22.5 x 13.00	3.12"	2.62"	119 lbs.	5	11,000 lbs.	110 psi	TR-500
10059	22.5 x 13.00	4.84"	4.32"	121 lbs.	5	11,700 lbs.	130 psi	TR-574-E26
10056	22.5 x 13.00	5.80"	5.25"	117 lbs.	5	11,400 lbs.	125 psi	TR-574-E26
10084 ⁽⁶⁾	22.5 x 14.00	2.00"	⁽⁷⁾ ---	113 lbs.	20	11,000 lbs.	125 psi	TR-500
10085	22.5 x 14.00	2.00"	⁽⁷⁾ ---	113 lbs.	20	11,000 lbs.	125 psi	TR-500
10086	22.5 x 14.00	⁽⁷⁾ ---	0"	113 lbs.	20	12,300 lbs.	120 psi	TR-500
STUD-PILOTED: 10 Bolt Hole • 285.75mm (11.250") Bolt Circle • 221.87mm (8.735") Center Hole								
10032	22.5 x 12.25	4.54"	4.00"	112 lbs.	2	11,400 lbs.	125 psi	TR-500
10033	22.5 x 12.25	5.29"	4.75"	112 lbs.	2	11,400 lbs.	125 psi	TR-574-E26
10042	22.5 x 13.00	0.50"	0"	120 lbs.	2	11,000 lbs.	110 psi	TR-574-E26
10036	22.5 x 13.00	3.12"	2.62"	120 lbs.	2	11,000 lbs.	110 psi	TR-500
10060	22.5 x 13.00	4.83"	4.32"	121 lbs.	5	11,000 lbs.	130 psi	TR-574-E26
10070	22.5 x 14.00	2.00"	⁽⁷⁾ ---	125 lbs.	0	11,000 lbs.	125 psi	TR-575/ TR-570-E14
STUD-PILOTED: 10 Bolt Hole • 335.00mm (13.189") Bolt Circle • 281.10mm (11.067") Center Hole								
2920524	22.5 x 11.75	1.87"	1.34"	96 lbs.	20	9,920 lbs.	130 psi	V3-22-1 ⁽⁸⁾
HEAVY DUTY STUD-PILOTED: 10 Bolt Hole • 335.00mm (13.189") Bolt Circle • 270.51mm (10.650") Center Hole								
10044	22.5 x 13.00	⁽⁷⁾ ---	6.12"	122 lbs.	0	10,210 lbs.	110 psi	TR-570
10045	22.5 x 13.00	⁽⁷⁾ ---	6.12"	123 lbs.	0	12,500 lbs.	125 psi	TR-570

⁽⁵⁾ The recommended valves listed for the 12.25" and 13.00" rim sizes are for the INSET position.

⁽⁶⁾ For 10084: Cautionary stamp provided for N-spindle applications.

⁽⁷⁾ Wheel not intended to be used in this position.

⁽⁸⁾ For 2920524: This wheel requires a specific valve, per ETRTO standards. There is no T&RA equivalent standard.

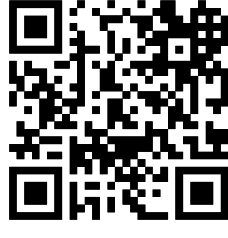
For complete information, questions, or special applications, please call (800) 337-0457.



Kingpin

DE
EN
FR
IT
ES

Montage- und Betriebsanleitung
Installation and operating instruction
Instructions de montage et d'utilisation
Istruzioni per il montaggio e l'uso
Instrucciones de montaje y funcionamiento



3 Utilización según las normas

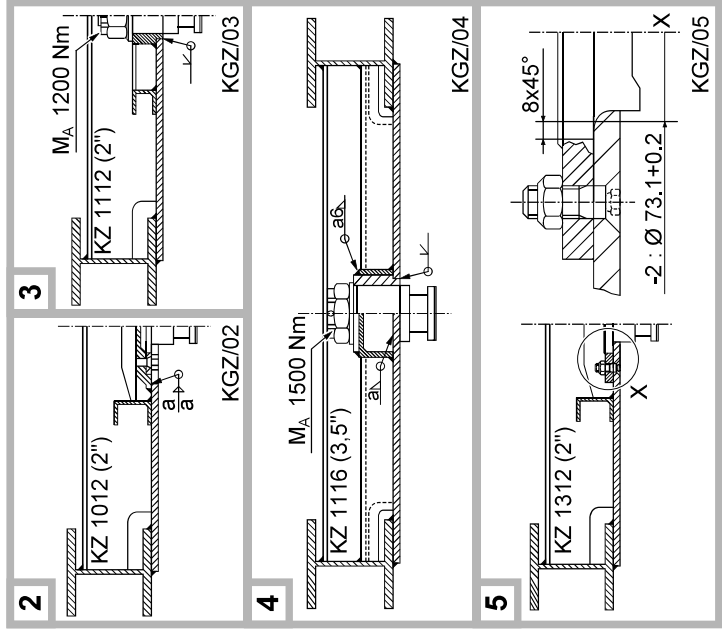
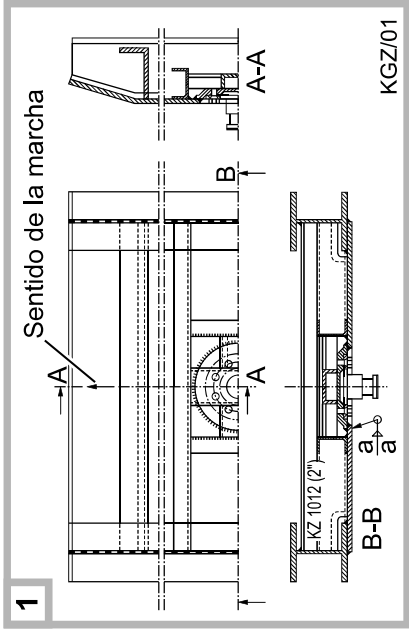
Datos de carga admisibles

Tipo	Marca de homologación	King pin	Valor D [kN]
KZ 10	E1 55R - 01 0145	KZ 1006-1012	162
KZ 1016	E1 55R - 01 0150	KZ 1016	320
KZ 11	E1 55R - 01 0146	KZ 1108-1112	152
KZ 1116	E1 55R - 01 0151	KZ 1116	260
KZ 14	E1 55R - 01 0147	KZ 1410-1412	162
KZ 1416	E1 55R - 01 1572	KZ 1416	170
KZ 15	E1 55R - 01 0148	KZ 1516	170
KZ 1312	F 3458	KZ 1312	105
	RDW 17010244	KZ 2816	152

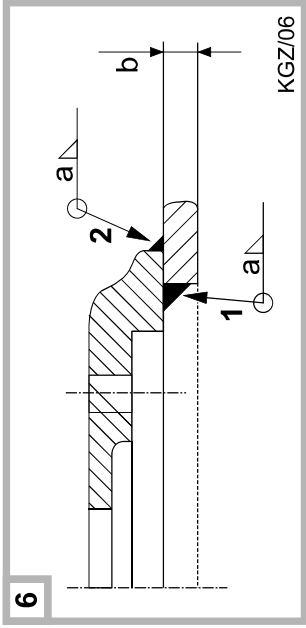


4.1 Propuestas de montaje

Dependiendo del tipo de placa de apoyo, existen diferentes posibilidades de montaje de king pin (véanse las imágenes 1 - 6). A continuación se presentan los gráficos de las diferentes posibilidades. (El patrón de agujeros aparece girado 22,5°).



4.2 Grosor del cordón de soldadura



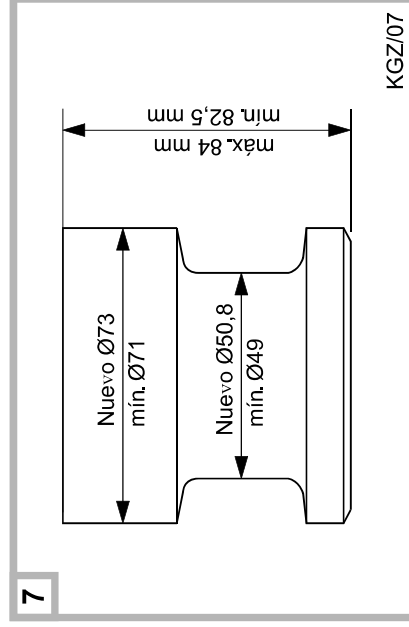
El grosor del cordón de soldadura necesario "a" para soldar el cono/plato de soporte depende del grosor de la placa de apoyo.

Designación de modelos KZ XYY	b (grosor de placas de apoyo)		a (grosor de soldadura)	
	1	2	1	2
YY = 06	6 mm	6 mm	4 mm	6 mm
YY = 07	7 mm	6 mm	5 mm	6 mm
YY = 08	8 mm	7 mm	5 mm	7 mm
YY = 10	10 mm	7 mm	7 mm	7 mm
YY = 12	12 mm	8 mm	8 mm	8 mm
YY = 16	16 mm	8 mm	8 mm	8 mm

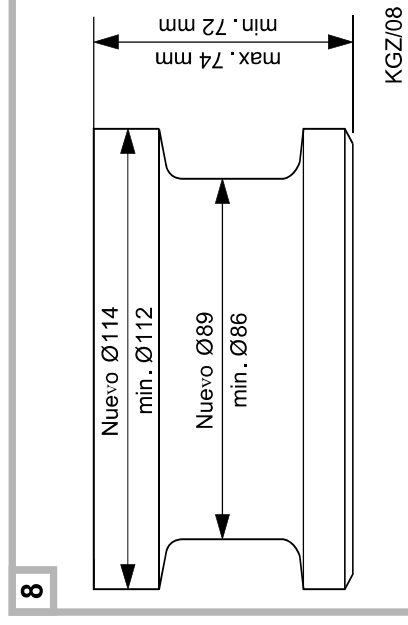
5 Mantenimiento e inspección

Antes de la puesta en marcha del soporte, se debe realizar un engrasado profundo del king pin, de la placa de apoyo y del cierre de la quinta rueda. Recomendamos que utilice el lubricante de alto rendimiento de JOST (n.º de art. SKE 005 670 000). La abundante lubricación del king pin y de la quinta rueda es decisiva para su vida útil.

5.1 King pin 50 (2")



5.2 King pin 90 (3,5")



5.4 Comprobación de desgaste

Dependiendo de las condiciones de uso, la quinta rueda y el king pin están sometidos en mayor o menor grado a un desgaste elevado, el cual se hace patente mediante un juego en el sentido de la marcha. Demasiado juego lleva a golpes y puede provocar inseguridad en el tráfico y daños en la quinta rueda, la plancha de montaje y el bastidor del vehículo.



¡ATENCIÓN!

El desgaste del king pin no se debe compensar con el ajuste de la quinta rueda.

Cuando se alcance el límite de desgaste del king pin, se deberá cambiar. Después de cambiar el king pin, se deberá ajustar de nuevo el cierre de la quinta rueda. El juego producido por el desgaste del king pin se deberá aceptar en el marco del límite de desgaste admisible del king pin o se deberá sustituir el king pin.

5.3 Instrucción de inspección

Dependiendo de las condiciones de uso y como máximo cada 50.000 km o cada seis meses, la plancha de montaje, el king pin y los elementos de fijación deben ser comprobados para asegurar el correcto funcionamiento. Asimismo no deben presentar desgastes, daños o roturas y deben ser reparados en caso necesario. Se deberán comprobar los diferentes pares de apriete de los elementos de fijación respectivos.

FW0070



Capacidad

70.000 lb Carga vertical máxima

200.000 lb Arrastre máximo de la barra de tracción (montaje estacionario)

150.000 lb Arrastre máximo de la barra de tracción (montaje deslizante)

Aplicaciones

Exigencia moderada y pesada

Características

- Construcción de acero moldeado
- Cierre de acero forjado, maquinado y termotratado
- Ajuste fácil de cierre infinito
- Cierre secundario manual
- Ranuras fundidas para grasa

Garantía

- Materiales y mano de obra por 5 años/500.000 millas

Opciones disponibles

- Seguro de perno rey de 3,5 pulgadas

Números de parte de las placas superiores

DESCRIPCIÓN	NÚMERO DE PARTE	SEGURO DE PERNO REY	PESO
Liberación a la izquierda	XA-71-DAP	2"	316 lb
Liberación a la izquierda	XA-71-OAP	3,5"	316 lb

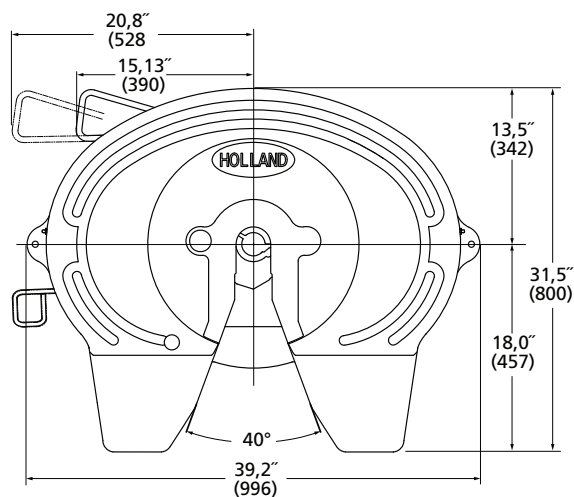
Sistemas de montaje disponibles

Para los números completos de parte de los conjuntos consulte las páginas de "Sistema de montaje".

NOTA: La altura y los datos de viaje están expresados en PULGADAS

ESTILOS ESTACIONARIOS	ALTURAS	
BASES ESTÁNDAR		
Montaje de pie	7, 8, 9	
Placa de montaje integrada		
Sólo soportes		
Soportes con angulares de montaje		
BASES KOMPENSATOR		
Montaje externo	10, 12, 13	
ESTILOS DESLIZANTES	ALTURAS	DESPLAZAMIENTO
BASES ESTÁNDAR		
Interna para montaje con angular	8, 9	11, 17, 25, 41, 54, 66
BASES KOMPENSATOR		
Interna para montaje con angular	13	11, 17, 25, 41, 54, 66

Dimensiones



Equipos de reconstrucción y reemplazo

DESCRIPCIÓN	SEGURO DEL PERNO REY	NÚMERO DE PARTE
Reconstrucción	2"	RK-65014
Reconstrucción (FW2570-7103*, FW2570-7450*)	2"	RK-65014-1
Reconstrucción	3,5"	RK-65015
Reconstrucción (FW2570-7103*, FW2570-7450*)	3,5"	RK-65015-1
Equipo de reemplazo de cierre	2"	RK-65024
Equipo de reemplazo de cierre	3,5"	RK-65024-1
Equipo de reemplazo del cierre secundario		RK-65025
Equipo de reemplazo de la manija de liberación		XA-1117-H
Equipo de reemplazo de la manija de liberación (FW2570-7103*, FW2570-7450*)		XA-03715

Relación de documentos

() Memoria	94	páginas
() Anexo: Cálculos Justificativos	79	páginas
() Anexo: Planos	29	páginas
() Anexo: Planificación	16	páginas
() Anexo: Presupuesto	19	páginas
() Anexo: Pliego de Condiciones.....	17	páginas
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La Almunia, a 30 de noviembre de 2016

Firmado: Rony Moises Pinedo Cordova