ANEXOS

1 MECHANICS

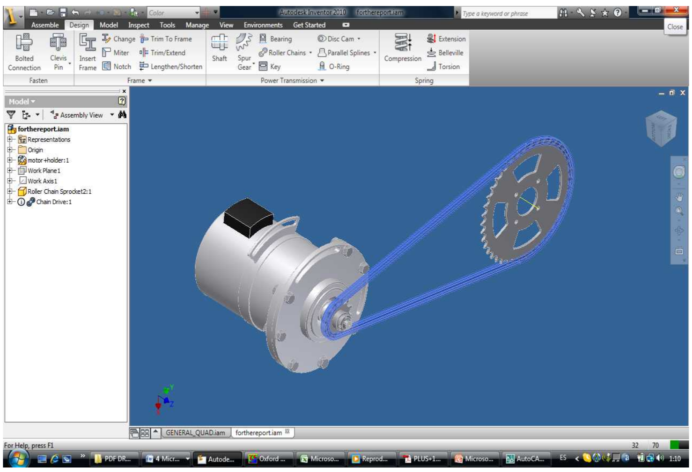
1.1 TRANSMISSION

There is going to be a big difference in transmission between the gasoline engine and the electric one. In the first type there is a chain rotating on the sprockets and a gearbox which is connected to the engine.

We are going use the same kind of transmission that we used in the previous system, a ROLLER CHAIN. But now of course there is not going to be a gearbox.

So, now as we do not have previous gearbox, in order to make sure that we will have power, and torque enough to move the quad, we will choose a proper roller chain transmission in order to supply more torque to the rear wheels by decreasing the rotation speed.

Also the quad speed is going to depend on the transmission rate, so we will decrease the number of teeth of the driver sprocket wheel (Z1) and increase the number of teeth of the big sprocket wheel (Z2).



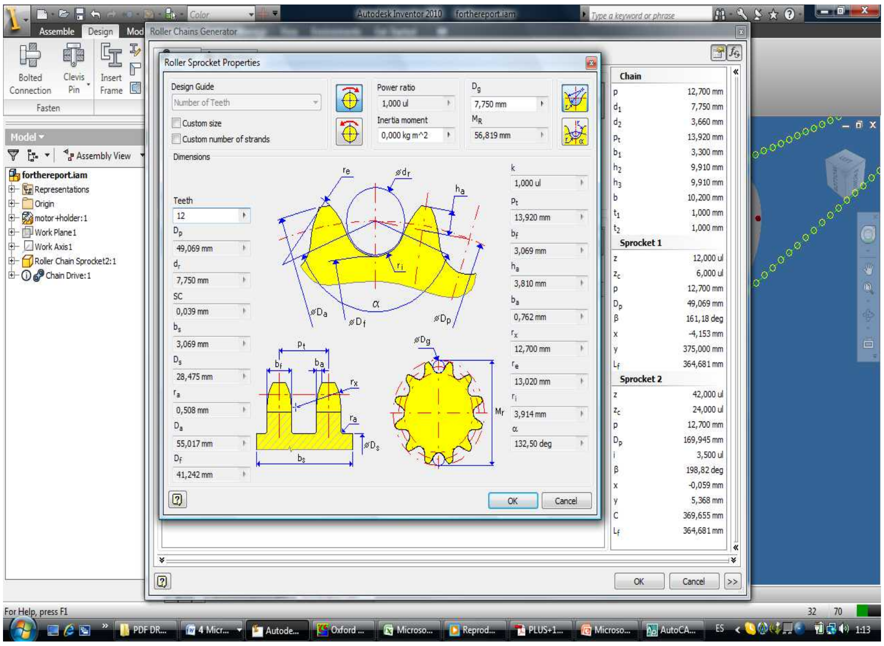
The general data of the transmission are:

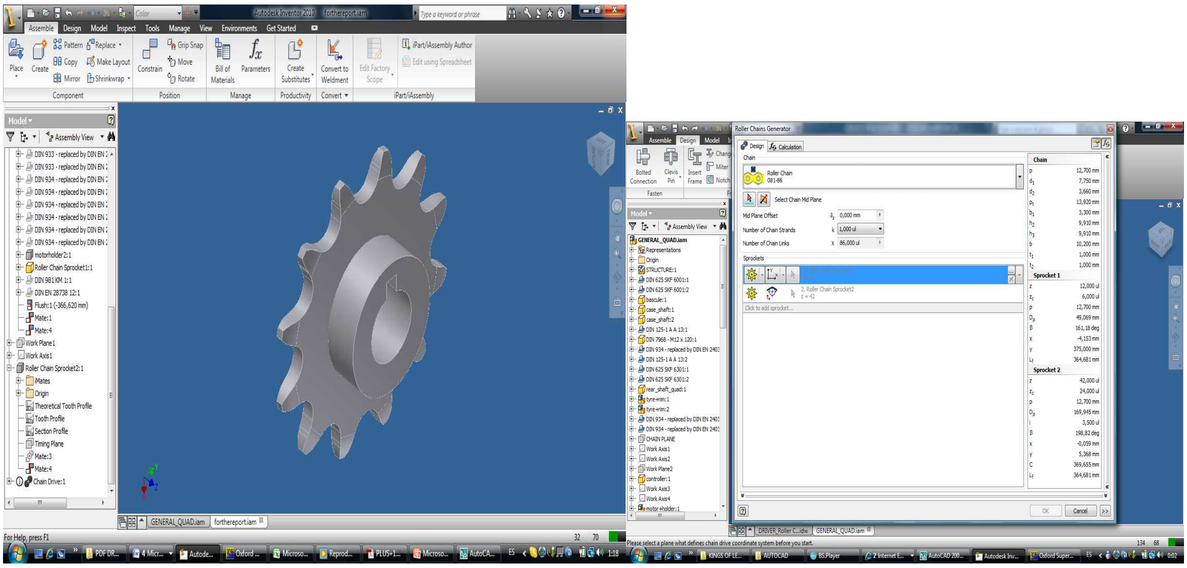
PITCH 12,7 mm

Z1	12
Z2	42
i = z1/z2	0,28571429

1.2 DRIVER SPROCKET

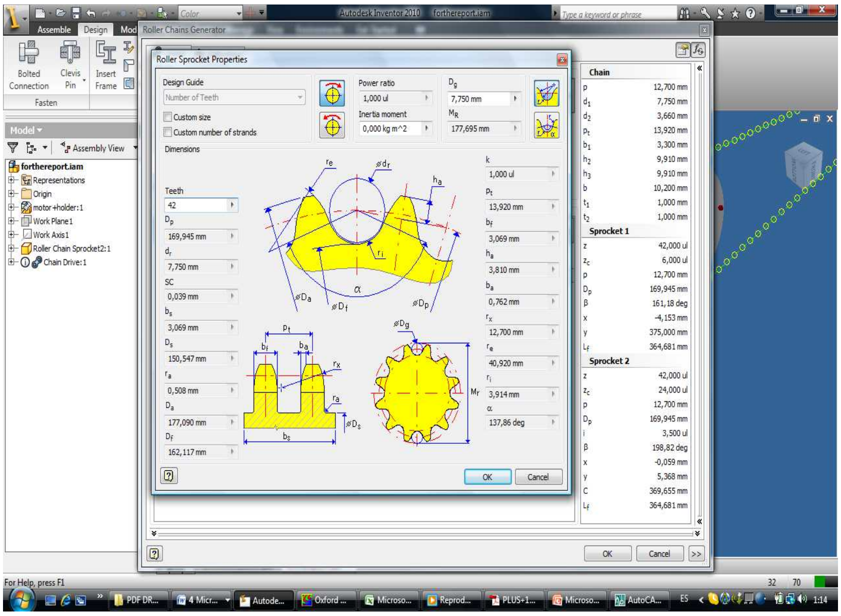
Data:

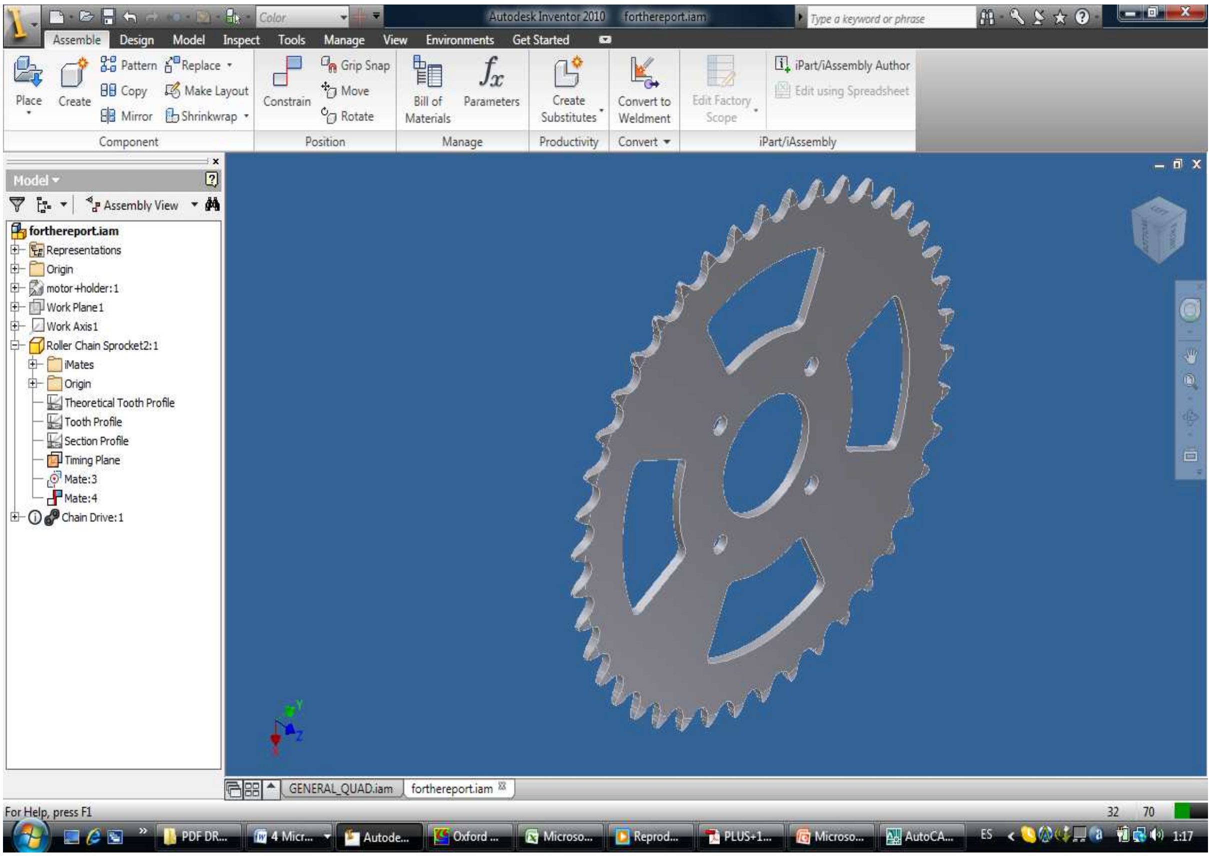


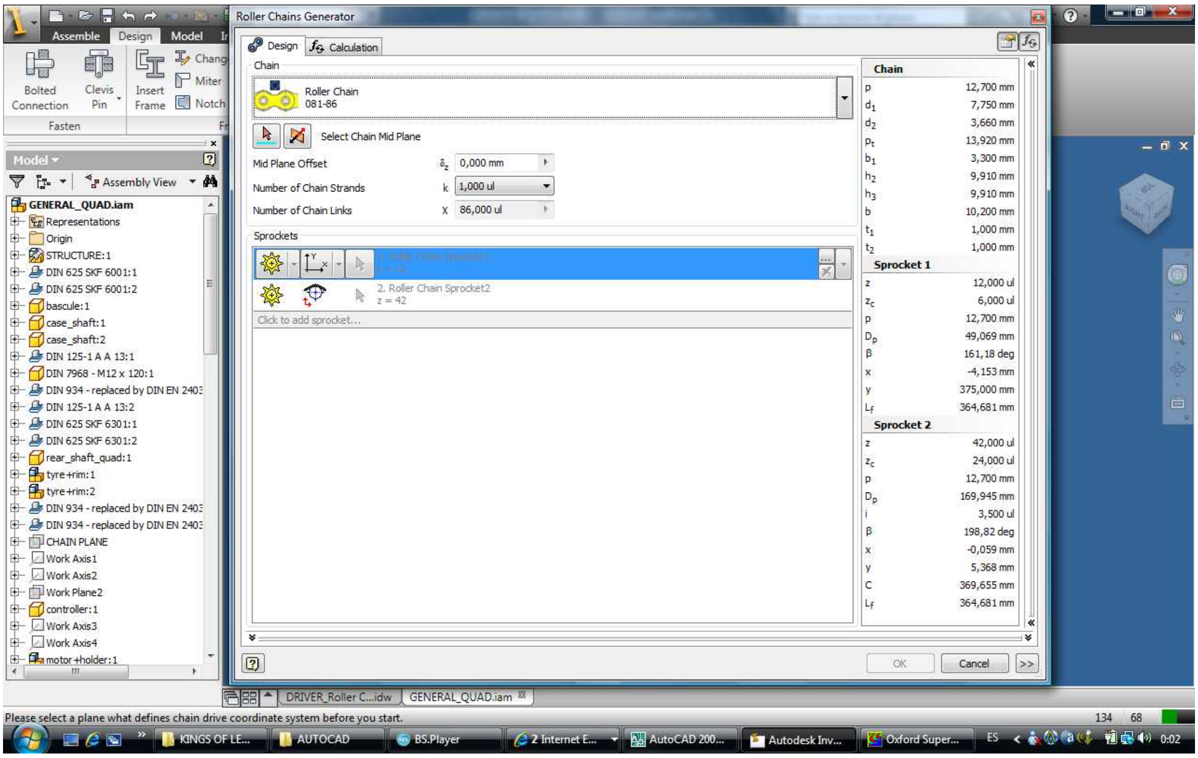


1.3 SPROCKET WHEEL

Data:







Roller Chains Generator
Assemble
Design
Model
Bolted Connection
Clevis Pin
Insert Frame
Fasten
Model
Assembly View
GENERAL_QUAD.iam
Representations
Origin
STRUCTURE:1
DIN 625 SKF 6001:1
DIN 625 SKF 6001:2
bascule:1
case_shaft:1
case_shaft:2
DIN 125-1 A A 13:1
DIN 7968 - M12 x 120:1
DIN 125-1 A A 13:2
DIN 625 SKF 6301:1
DIN 625 SKF 6301:2
rear_shaft_quad:1
tyre+rim:1
tyre+rim:2
CHAIN PLANE
Work Axis1
Work Axis2
Work Plane2
controller:1
Work Axis3
Work Axis4
motor+holder:1
Design
Calculation
Chain
Roller Chain
081-86
Select Chain Mid Plane
Mid Plane Offset
0,000 mm
Number of Chain Strands
1,000 ul
Number of Chain Links
86,000 ul
Sprockets
2. Roller Chain Sprocket2
z = 42
Click to add sprocket...
Chain
p 12,700 mm
b 10,200 mm
Sprocket 1
z 12,000 ul
p 12,700 mm
β 161,18 deg
x -4,153 mm
y 375,000 mm
Sprocket 2
z 42,000 ul
p 12,700 mm
i 3,500 ul
β 198,82 deg
x -0,059 mm
y 5,368 mm
C 369,655 mm
OK
Cancel
DRIVER_Roller C...idw
GENERAL_QUAD.iam
Please select a plane what defines chain drive coordinate system before you start.
KINGS OF LE...
AUTOCAD
BS.Player
2 Internet E...
AutoCAD 200...
Autodesk Inv...
Oxford Super...
0:02

2 CHAIN

TRANSMISSION OPTIMIZATION

Formulas used:

Roller chain:

Figure 17–17 shows a sprocket driving a chain and rotating in a counterclockwise direction. Denoting the chain pitch by p, the pitch angle by γ, and the pitch diameter of the sprocket by D, from the trigonometry of the figure we see

$$\sin\frac{\gamma}{2} = \frac{p/2}{D/2} \qquad \text{or} \qquad D = \frac{p}{\sin(\gamma/2)} \qquad (a)$$

Since $\gamma = 360°/N$, where N is the number of sprocket teeth, Eq. (a) can be written

$$D = \frac{p}{\sin(180°/N)} \qquad (17\text{–}29)$$

Where:

D = sprocket Wheel pitch diameter [mm].

P = chain pitch [mm].

N = number of sprocket teeth.

Where:

i= transmission rate.

Z1 = teeth number of the driver sprocket wheel.

Z2 = teeth number of the sprocket wheel.

Power, torque and speed:

$$T2 = T1 * \varsigma * \frac{1}{i}$$

Where:

T_x= torque [mN]

ς = efficiency.

i= transmission rate.

$$P = T * N$$

Where:

P = power [W]

T = torque [N*m]

N= speed [rad/s]

$$V = R \cdot \omega$$

V= lineal speed [m/s]

R= radius [m]

CALCULATIONS DATA OR PARAMETERS:

Initial SPROKET WHEEL

Z1(i)	14
Z2(i)	37
pitch	12,7 mm

MOTOR DATA (nominal)

TORQUE	5,68 mN
POWER	2 kW
SPEED	3360 r.p.m

Transmission Chain Efficiency 0,85

Wheel diameter (tyres) 0,4 m

CALCULATION

We designed an excel table in order to optimize the teeth number of the sprockets, trying to get a good torque and a good speed.

					REAR SHAFT			
z1	d1(mm)	z2	d2(mm)	i	Torque(mN)	speed(r.p.m.)	speed(rad/s)	Quad speed(km/h)
14	57,07328193	34	137,641983	0,41	11,73	1383,53	144,88	104,32
14	57,07328193	35	141,678915	0,40	12,08	1344,00	140,74	101,34
14	57,07328193	36	145,716158	0,39	12,42	1306,67	136,83	98,52
14	57,07328193	37	149,753689	0,38	12,77	1271,35	133,14	95,86
14	57,07328193	38	153,791483	0,37	13,11	1237,89	129,63	93,34
14	57,07328193	39	157,829521	0,36	13,46	1206,15	126,31	90,94
14	57,07328193	40	161,867785	0,35	13,80	1176,00	123,15	88,67
14	57,07328193	41	165,906257	0,34	14,15	1147,32	120,15	86,51
14	57,07328193	42	169,944923	0,33	14,49	1120,00	117,29	84,45
14	57,07328193	43	173,983769	0,33	14,84	1093,95	114,56	82,48
13	53,06798465	34	137,641983	0,38	12,64	1284,71	134,53	96,86
13	53,06798465	35	141,678915	0,37	13,01	1248,00	130,69	94,10
13	53,06798465	36	145,716158	0,36	13,38	1213,33	127,06	91,48
13	53,06798465	37	149,753689	0,35	13,75	1180,54	123,63	89,01
13	53,06798465	38	153,791483	0,34	14,12	1149,47	120,37	86,67
13	53,06798465	39	157,829521	0,33	14,49	1120,00	117,29	84,45
13	53,06798465	40	161,867785	0,33	14,87	1092,00	114,35	82,33
13	53,06798465	41	165,906257	0,32	15,24	1065,37	111,56	80,33
13	53,06798465	42	169,944923	0,31	15,61	1040,00	108,91	78,41
13	53,06798465	43	173,983769	0,30	15,98	1015,81	106,38	76,59
12	49,06903198	34	137,641983	0,35	13,69	1185,88	124,19	89,41
12	49,06903198	35	141,678915	0,34	14,09	1152,00	120,64	86,86
12	49,06903198	36	145,716158	0,33	14,49	1120,00	117,29	84,45
12	49,06903198	37	149,753689	0,32	14,90	1089,73	114,12	82,16
12	49,06903198	38	153,791483	0,32	15,30	1061,05	111,11	80,00
12	49,06903198	39	157,829521	0,31	15,70	1033,85	108,26	77,95
12	49,06903198	40	161,867785	0,30	16,10	1008,00	105,56	76,00
12	49,06903198	41	165,906257	0,29	16,51	983,41	102,98	74,15
12	49,06903198	42	169,944923	0,29	16,91	960,00	100,53	72,38
12	49,06903198	43	173,983769	0,28	17,31	937,67	98,19	70,70
11	45,07821227	34	137,641983	0,32	14,93	1087,06	113,84	81,96
11	45,07821227	35	141,678915	0,31	15,37	1056,00	110,58	79,62

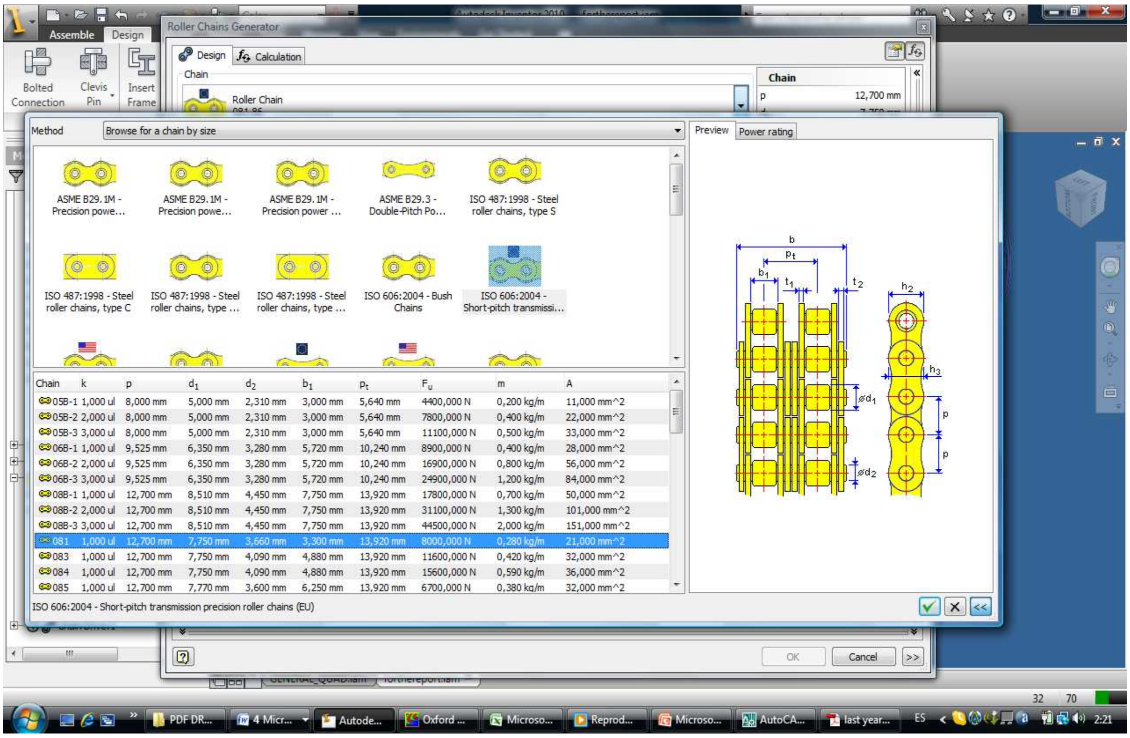
11	45,07821227	36	145,716158	0,31	15,81	1026,67	107,51	77,41
11	45,07821227	37	149,753689	0,30	16,25	998,92	104,61	75,32
11	45,07821227	38	153,791483	0,29	16,69	972,63	101,85	73,33
11	45,07821227	39	157,829521	0,28	17,13	947,69	99,24	71,45
11	45,07821227	40	161,867785	0,28	17,57	924,00	96,76	69,67
11	45,07821227	41	165,906257	0,27	18,01	901,46	94,40	67,97
11	45,07821227	42	169,944923	0,26	18,45	880,00	92,15	66,35
11	45,07821227	43	173,983769	0,26	18,89	859,53	90,01	64,81

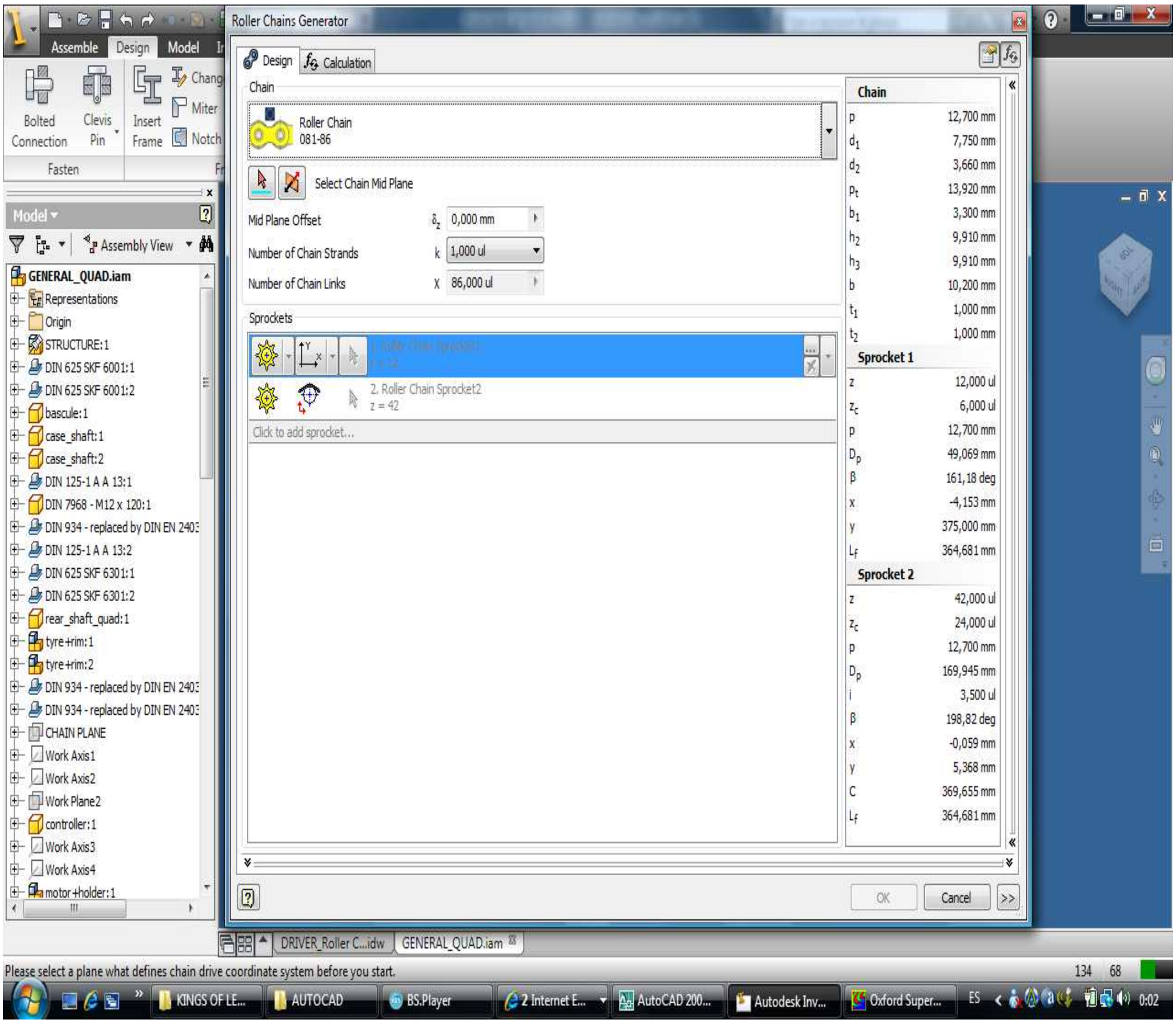
RESULT:

Finally as we explained we choose the transmission highlighted in yellow.

Where we have got a torque of 16’91 m*N at the rear wheels, which is pretty acceptable, and the quad speed is 72’38 Km/h, which is pretty close to 65 Km/h that was the previous speed of the quad with the gasoline engine.

Data:




Roller Chains Generator
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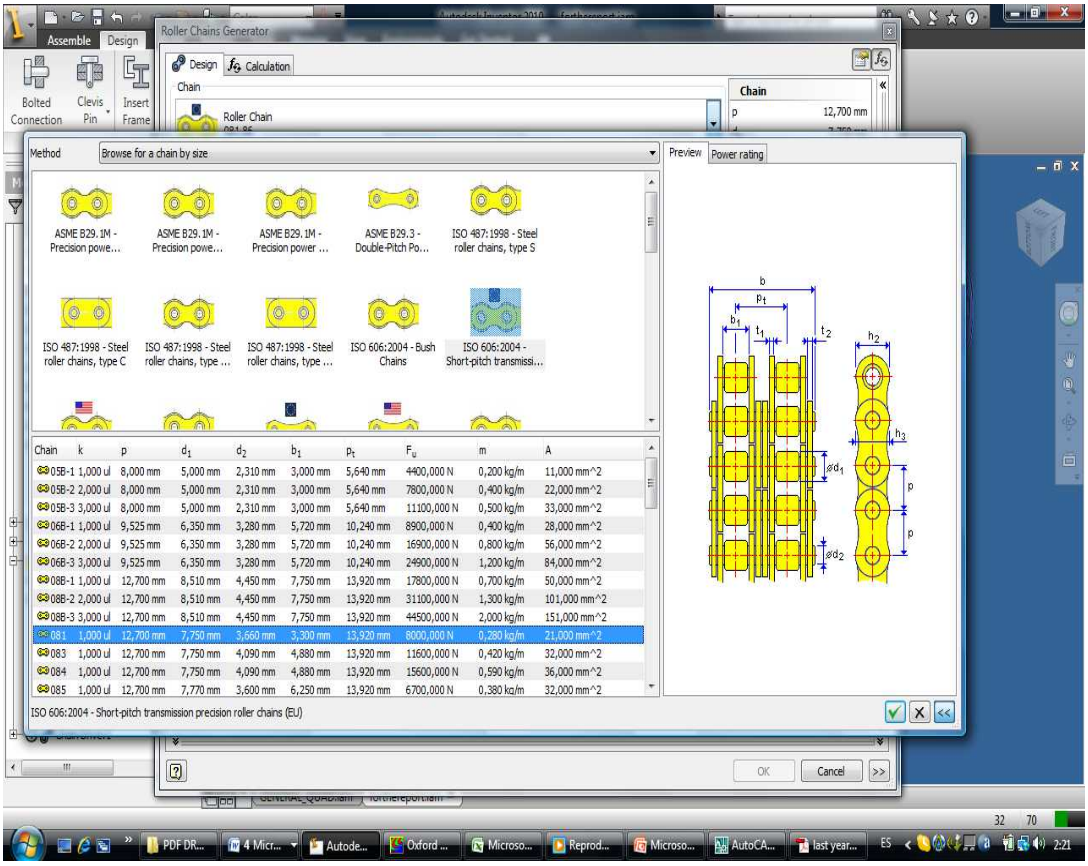
DIN 125-1 A A 13:2
DIN 625 SKF 6301:1
DIN 625 SKF 6301:2
rear_shaft_quad:1
tyre+rim:1
tyre+rim:2
CHAIN PLANE
Work Axis1
Work Axis2
Work Plane2
controller:1
Work Axis3
Work Axis4
motor+holder:1
Design
Calculation
Chain
Roller Chain
081-86
Select Chain Mid Plane
Mid Plane Offset
0,000 mm
Number of Chain Strands
1,000 ul
Number of Chain Links
86,000 ul
Sprockets
2. Roller Chain Sprocket2
z = 42
Click to add sprocket...
Chain
p 12,700 mm
d1 7,750 mm
d2 3,660 mm
pt 13,920 mm
b1 3,300 mm
h2 9,910 mm
h3 9,910 mm
b 10,200 mm
t1 1,000 mm
t2 1,000 mm
Sprocket 1
z 12,000 ul
zc 6,000 ul
p 12,700 mm
Dp 49,069 mm
β 161,18 deg
x -4,153 mm
y 375,000 mm
Lf 364,681 mm
Sprocket 2
z 42,000 ul
zc 24,000 ul
p 12,700 mm
Dp 169,945 mm
i 3,500 ul
β 198,82 deg
x -0,059 mm
y 5,368 mm
C 369,655 mm
Lf 364,681 mm
OK
Cancel
DRIVER_Roller C...idw
GENERAL_QUAD.iam
Please select a plane what defines chain drive coordinate system before you start.
134 68
AUTOCAD
BS.Player
Autodesk Inv...
0:02



Number of chain strands	K = 1
Number of chain links	86
Norm	ISO 606:2004 short-pitch

3 MECHANICS Spring Semester

a. Analysis of the previous work

The project of conversion of the ATV quad from combustion to electric motor, started in the first semester. We were already supposed to use a triphase servo-motor SAUER DANFOSS TSA120-80, a couple of 10Ah-12V Rechargeable Sealed lead acid batteriesand an inverter to convert batteries' dc in alternating current for powering the electric engine. The removal of combustion motor and the tank leftthe necessary space to lodge all the components mentioned above.

Concerning the inverter, it was already thought to be blocked to the chassis by 4 little plastic bands, so we didn't operate any change for its placing.

Regarding the placing of the two batteries it has been planned a grid for supporting them.

Our work focused on the design and manufacturing of suitable structures for fixing the electric motor to the chassis. First semester team already drew, using a 3D graphic software, two flanges to fix them on the front and back side of the motor, utilizing the holes on it.

Due to some mistakes in the mechanical drawings of the first semester, we had to design two completely new flanges.

b. Design and manufacturing of flanges, fixing of the engine to the chassis

Back flange

We chose to design the back flange like a solid disc with a diameter of 65 mm, with four through holes for M8 screws placed on a 99.75 diameter circumference, with 90 degrees between each other and a central hole of 22 mm diameter to permit the flange to stay on the motor.

The disc is extended on the radius for other 45 mm only for an angle of 168.7 degrees. This protrusion is the flange itself and it has two eyelets that follow the circumference for M8 blots, one for every eye-bolt on the right side of the chassis. The first semester solution with a holed disc was something not easy to realize, because it needed some opening mechanism to put it on the motor, because there are powering cables on the surface which don’t permit the fixing.

Moreover we had to increase the radius dimensions of the flange to permit the connection between triphase terminals on the motor and batteries, trying to avoid unwanted contacts with the chassis. All the dimensions for both flanges have been taken according with the mechanical drawings of the Sauer Danfoss motor and measuring directly on the chassis of the quad. We couldn’t make a first 3D model of the flange because of its too long radius.

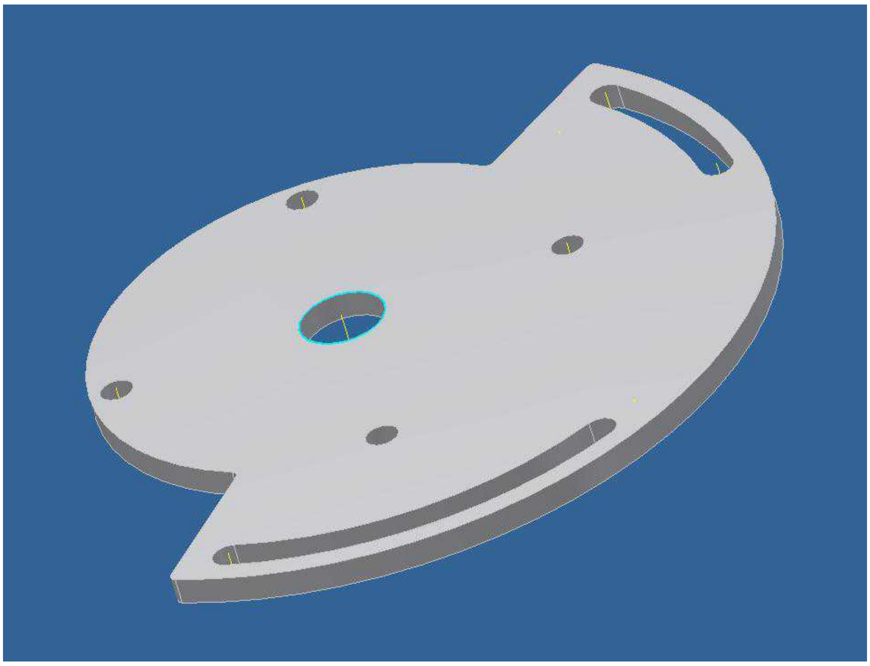


Figure 13: 3D model of the back flang

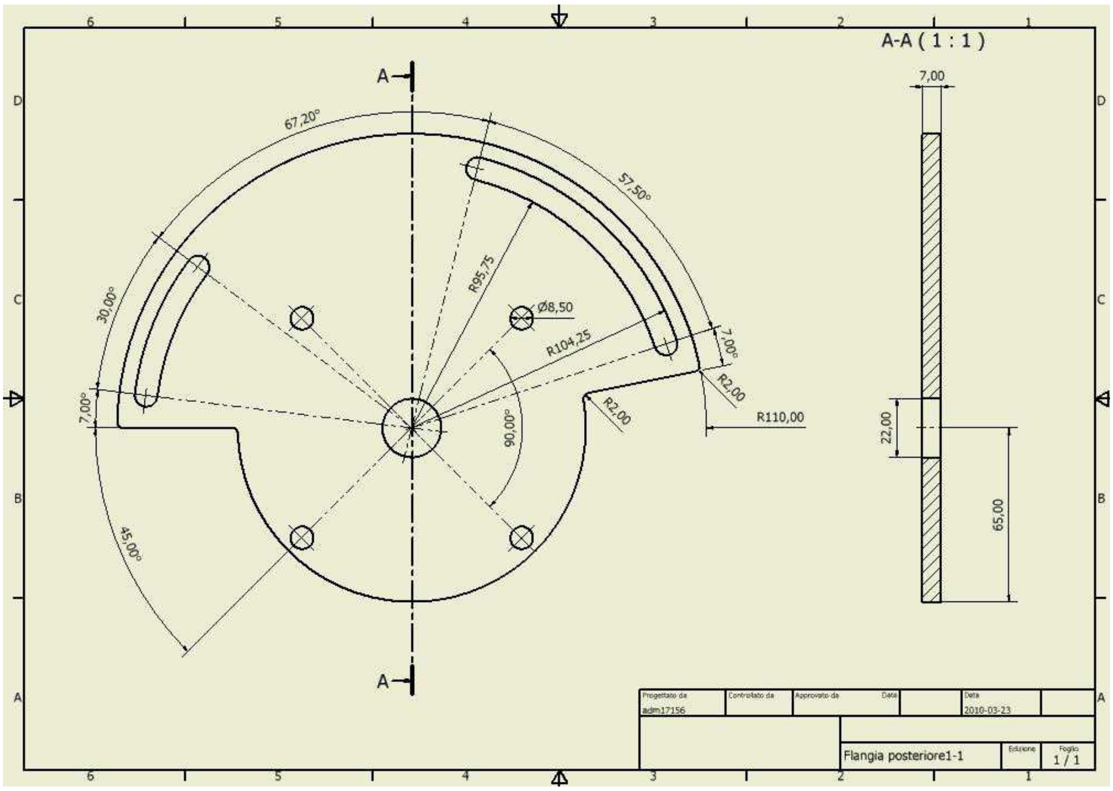


Figure 14: Mechanical draw of the back flang

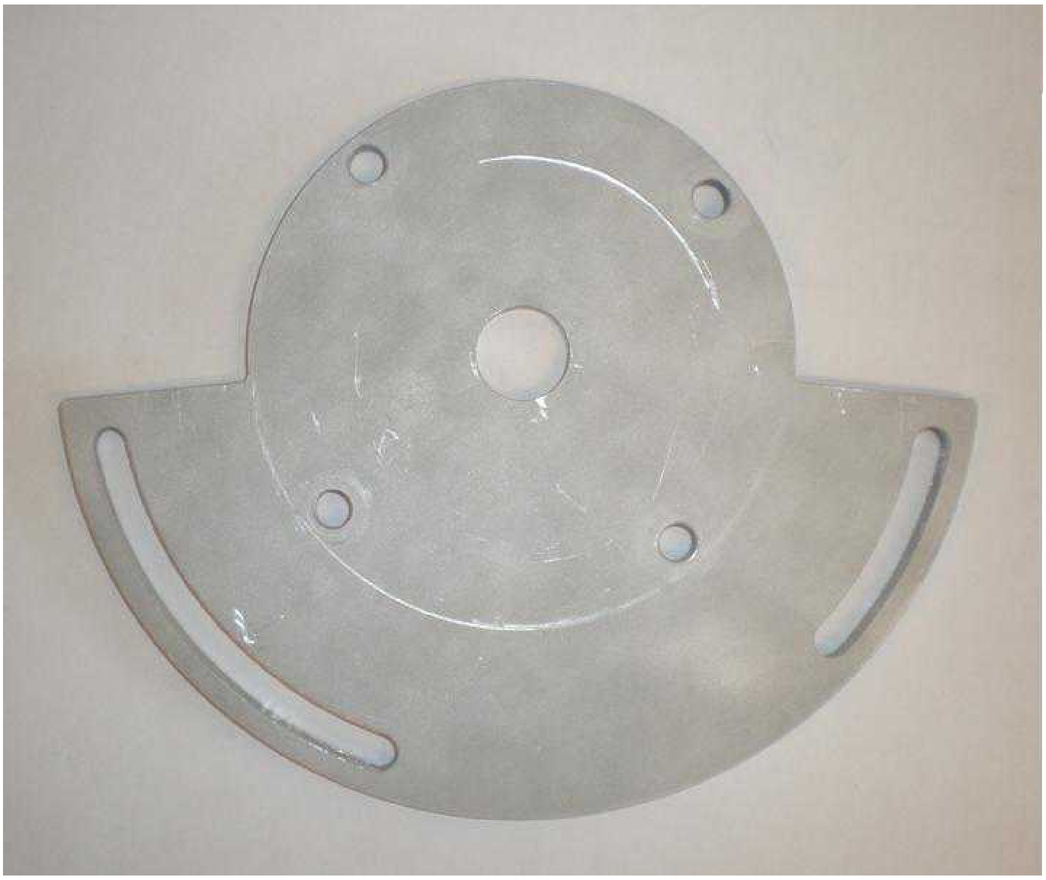


Figure 15: Back flang

Front flange (motor cover)

The model of the flange realized in the first semester has been a good start for the design of the complete part. In fact with the help of it we have been able to realize a first 3D plastic model manufactured by the 3D printer.

This flange presents seven M8 holes placed on a circumference with diameter xx mm with different angles between one and the other to permit the connection with the seven holes placed on the circular front of the motor. The flange is also useful to protect the stator windings of the engine from dirt. Once designed the new 3D model, we haven’t been able to print a plastic model for the same reason of the other flange (radial dimensions too long). Thus we had to order it directly without test it.

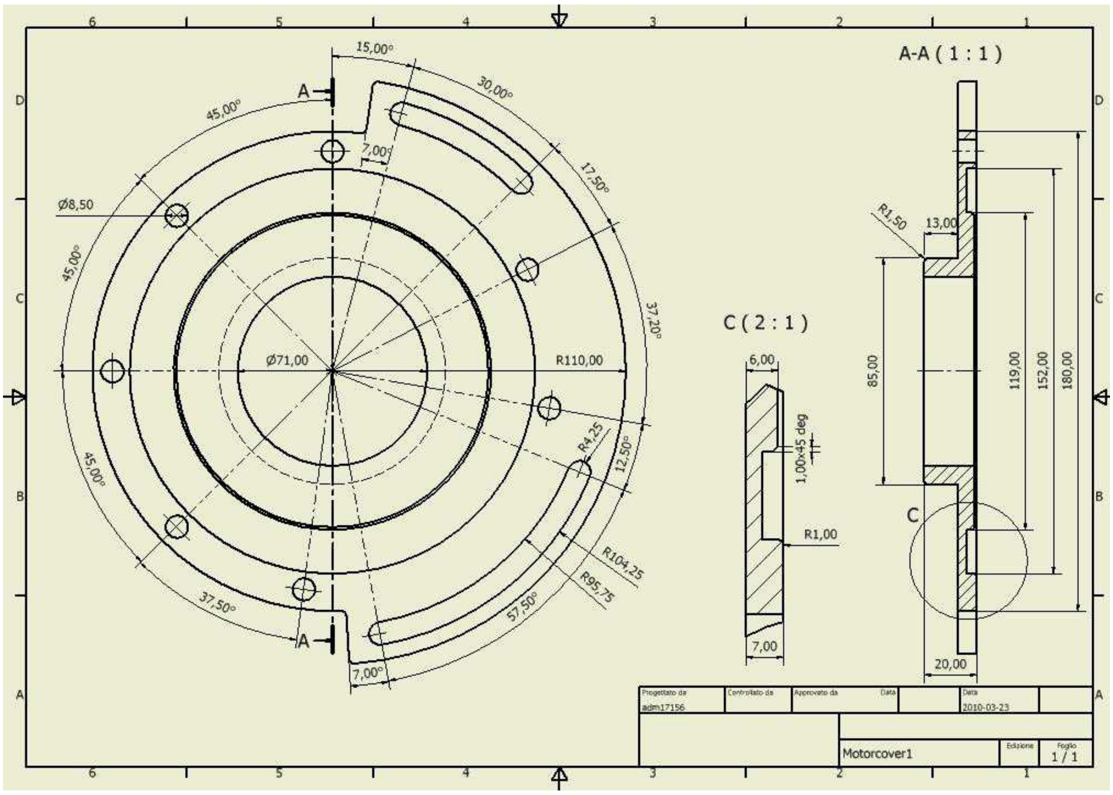


Figure 16: mechanical draw of the front flange

Figure 17: Front flange

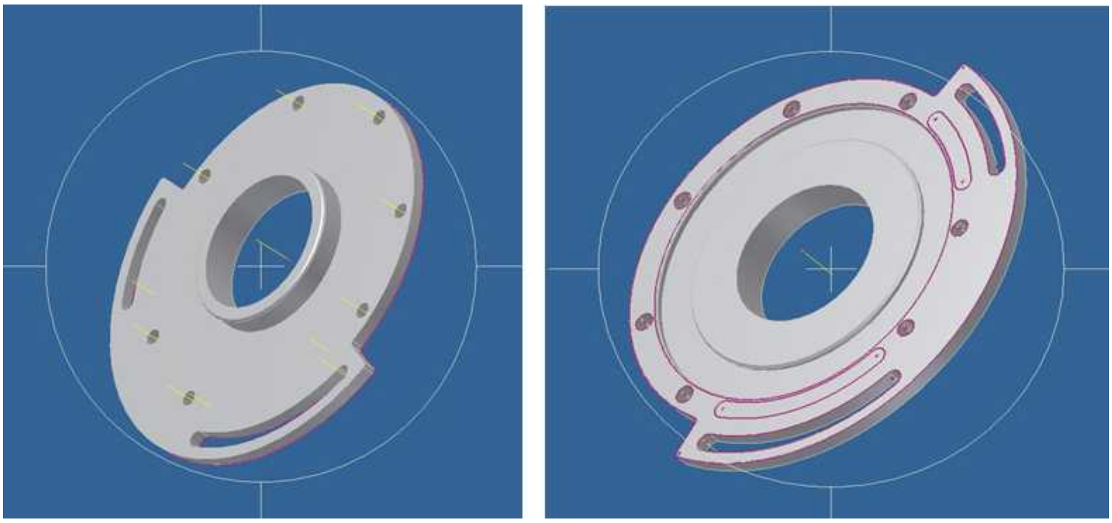


Figure 18: 3D model of the front flange

Manufacturing of flanges

The two flanges have been manufactured in aluminium alloy. These two parts cost 8200 DKK, the price is high but it was the only solution to connect the engine to the chassis, because of the new shape of the motor which had to be placed using the pre-existing braces for the previous combustion motor.

Fixing of flanges

The back flange has been screwed on the lower base of the cylinder of the motor using four M8 8.8 screws with lock washers.

The front flange has been screwed on the higher base of the cylinder of the engine using seven M8 8.8 bolts with washers.

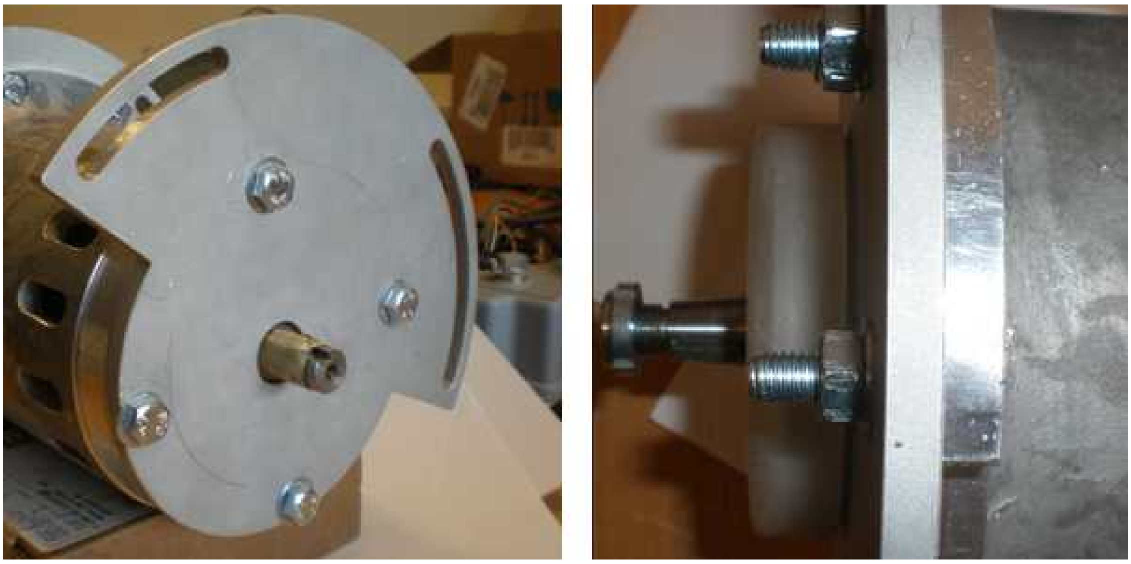


Figure 19: Back flang mounted and detail of the screw with lock washers.

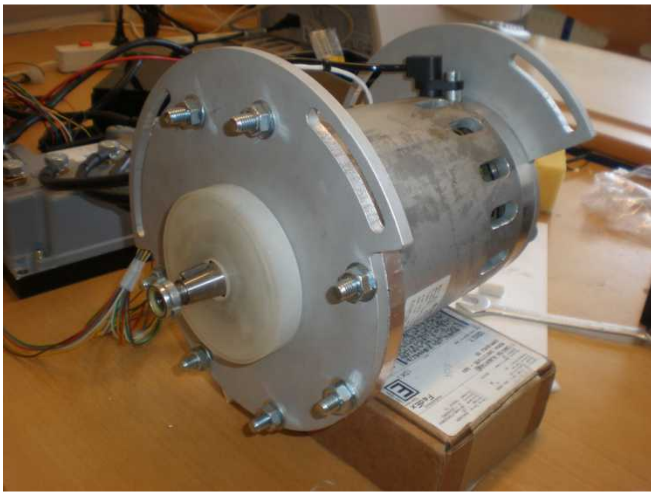


Figure 20: Front flang mounted

Motor placing

The motor has been placed in the same position where the combustion engine was. Obviously it is an electric motor so it needs less space compared to the previous one, even if their weights are almost the same.

Next pictures show the holes on the braces, useful references for mounting the engine.

Figure 21: Location of the motor in the chassis

Threaded pivots and spacers

Once manufactured the flanges, and mounted on the motor, we realized two threaded pivots because each of them has to cross both flanges and braces to support the engine.

Then we realized in the mechanical laboratory two metal spacers obtained by cutting with a band saw a pipe with an internal diameter of 8 mm and an external one of 11 mm. They are useful because only on one side the two braces are on the same plane.

Due to vibrations produced by the motor, it will be necessary to use rubber rings and washers to compensate the space between spacers, flanges and braces' holes.

The following picture shows the motor mounted without rubber rings because they didn't come on time.

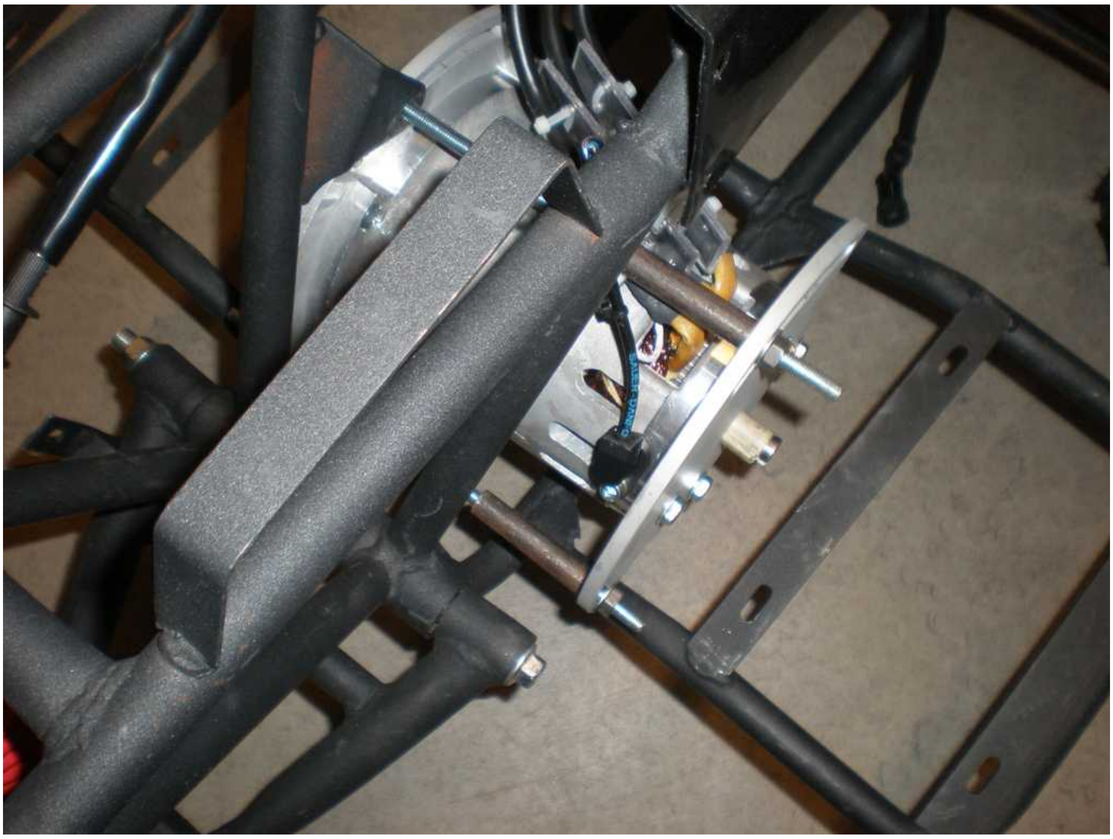


Figure 21: Motor mounted 1

Figure 22: Motor mounted 2

Protection of the ball bearing

We created a system to protect the ball bearing which was exposed to air and very close to the ground, so easy to be damaged. We chose to realize a plastic cover to put it on the central part of the flange, before mounting the toothed wheel on the motor shaft. So we realized a 3D drawing which after has been manufactured.

Figure 23: Plastic cover

Toothed wheels and transmission chain

Once mounted the engine we focused on the transmission between the motor shaft and the one of the two back wheels. The pre-existing transmission consisted of a driving wheel with 14 teeth and the free one with 37 teeth. Calculations done in the first semester on the torque and maximum speed required, helped us to find the new numbers of teeth that we needed. We obtained two wheels of 12 and 42 teeth, as we can see in the following table:

Table : Toothwheels

					REAR SHAFT			
z1	d1(mm)	z2	d2(mm)	i	Torque(mN)	speed(r.p.m.)	speed(rad/s)	Quad speed(km/h)
14	57,07328193	34	137,641983	0,41	11,73	1383,53	144,88	104,32
14	57,07328193	35	141,678915	0,40	12,08	1344,00	140,74	101,34
14	57,07328193	36	145,716158	0,39	12,42	1306,67	136,83	98,52
14	57,07328193	37	149,753689	0,38	12,77	1271,35	133,14	95,86
14	57,07328193	38	153,791483	0,37	13,11	1237,89	129,63	93,34
14	57,07328193	39	157,829521	0,36	13,46	1206,15	126,31	90,94
14	57,07328193	40	161,867785	0,35	13,80	1176,00	123,15	88,67
14	57,07328193	41	165,906257	0,34	14,15	1147,32	120,15	86,51
14	57,07328193	42	169,944923	0,33	14,49	1120,00	117,29	84,45
14	57,07328193	43	173,983769	0,33	14,84	1093,95	114,56	82,48
13	53,06798465	34	137,641983	0,38	12,64	1284,71	134,53	96,86
13	53,06798465	35	141,678915	0,37	13,01	1248,00	130,69	94,10
13	53,06798465	36	145,716158	0,36	13,38	1213,33	127,06	91,48
13	53,06798465	37	149,753689	0,35	13,75	1180,54	123,63	89,01
13	53,06798465	38	153,791483	0,34	14,12	1149,47	120,37	86,67
13	53,06798465	39	157,829521	0,33	14,49	1120,00	117,29	84,45
13	53,06798465	40	161,867785	0,33	14,87	1092,00	114,35	82,33
13	53,06798465	41	165,906257	0,32	15,24	1065,37	111,56	80,33
13	53,06798465	42	169,944923	0,31	15,61	1040,00	108,91	78,41
13	53,06798465	43	173,983769	0,30	15,98	1015,81	106,38	76,59
12	49,06903198	34	137,641983	0,35	13,69	1185,88	124,19	89,41
12	49,06903198	35	141,678915	0,34	14,09	1152,00	120,64	86,86
12	49,06903198	36	145,716158	0,33	14,49	1120,00	117,29	84,45
12	49,06903198	37	149,753689	0,32	14,90	1089,73	114,12	82,16
12	49,06903198	38	153,791483	0,32	15,30	1061,05	111,11	80,00
12	49,06903198	39	157,829521	0,31	15,70	1033,85	108,26	77,95
12	49,06903198	40	161,867785	0,30	16,10	1008,00	105,56	76,00
12	49,06903198	41	165,906257	0,29	16,51	983,41	102,98	74,15
12	49,06903198	42	169,944923	0,29	16,91	960,00	100,53	72,38
12	49,06903198	43	173,983769	0,28	17,31	937,67	98,19	70,70

We also verified that the peripheral velocity on the driving wheel was lower than 4 m/s, so there is not risk for polygonal problem due to the low number of teeth.

Sprocket wheel

The sprocket had to be placed on the motor shaft which is cone shaped and with a woodruff key. We ordered a toothed wheel with a central hole that equals the minimum diameter of the cone, so that we can after manufacture it to obtain the cone shape desired and the space for the key.

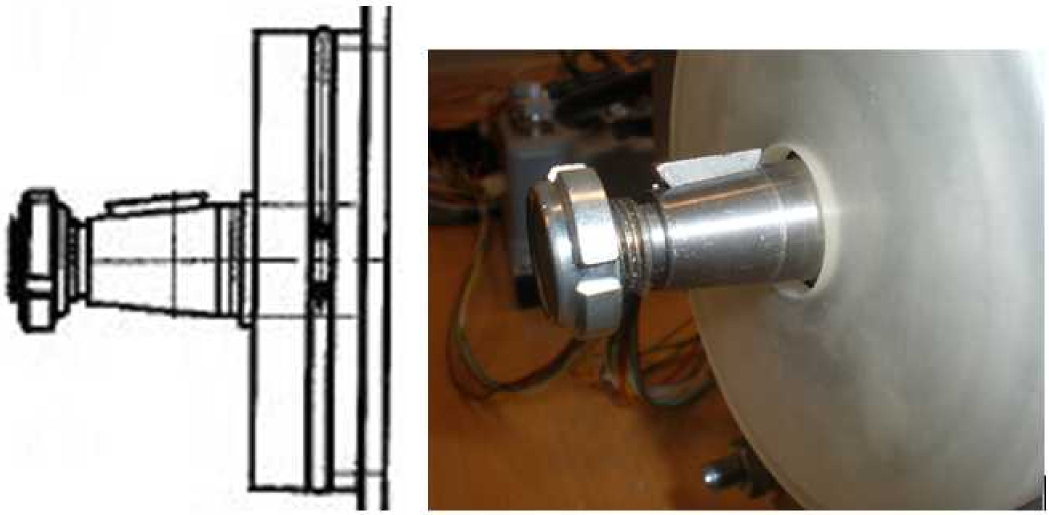


Figure 24: Mechanical draw of the motor shaft and real part

Figure 25: New sprocket wheel before manifacturing

Free toothed wheel

For this toothed wheel we chose to use the previous support which presents a ribbed profile for the coupling with the shaft of the two back wheels.

Figure 26: Free toothed wheel

In the previous toothed wheel the connection with the support has been realized by four screws without bolts. The first thing to do is taking the old toothed wheel down from the support, heating the piece to melt the glue which has been used on the screws. So we ordered a toothed wheel solid inside, that we can perforate in the laboratory and then connect to the support with four bolts, without threading the holes created.

Figure 27: New free toothed wheel before manifacturing

Toothed wheels designs

What we wanted to obtain is shown in the following mechanical drawings. These designs represent how the new toothed wheels were intended to be realized.

The chain has been ordered together with two toothed wheels. The wheel base is 390 mm.

Table :Chain

Chain	k	p	d_1	d_2	b_1	p_t	F_u	m	A
05B-1	1,000 ul	8,000 mm	5,000 mm	2,310 mm	3,000 mm	5,640 mm	4400,000 N	0,200 kg/m	11,000 mm^2
05B-2	2,000 ul	8,000 mm	5,000 mm	2,310 mm	3,000 mm	5,640 mm	7800,000 N	0,400 kg/m	22,000 mm^2
05B-3	3,000 ul	8,000 mm	5,000 mm	2,310 mm	3,000 mm	5,640 mm	11100,000 N	0,500 kg/m	33,000 mm^2
06B-1	1,000 ul	9,525 mm	6,350 mm	3,280 mm	5,720 mm	10,240 mm	8900,000 N	0,400 kg/m	28,000 mm^2
06B-2	2,000 ul	9,525 mm	6,350 mm	3,280 mm	5,720 mm	10,240 mm	16900,000 N	0,800 kg/m	56,000 mm^2
06B-3	3,000 ul	9,525 mm	6,350 mm	3,280 mm	5,720 mm	10,240 mm	24900,000 N	1,200 kg/m	84,000 mm^2
08B-1	1,000 ul	12,700 mm	8,510 mm	4,450 mm	7,750 mm	13,920 mm	17800,000 N	0,700 kg/m	50,000 mm^2
08B-2	2,000 ul	12,700 mm	8,510 mm	4,450 mm	7,750 mm	13,920 mm	31100,000 N	1,300 kg/m	101,000 mm^2
08B-3	3,000 ul	12,700 mm	8,510 mm	4,450 mm	7,750 mm	13,920 mm	44500,000 N	2,000 kg/m	151,000 mm^2
081	1,000 ul	12,700 mm	7,750 mm	3,660 mm	3,300 mm	13,920 mm	8000,000 N	0,280 kg/m	21,000 mm^2
083	1,000 ul	12,700 mm	7,750 mm	4,090 mm	4,880 mm	13,920 mm	11600,000 N	0,420 kg/m	32,000 mm^2
084	1,000 ul	12,700 mm	7,750 mm	4,090 mm	4,880 mm	13,920 mm	15600,000 N	0,590 kg/m	36,000 mm^2

Figure 28: New chain

Engine and brakes operations

The project of conversion counts to control the motor and electrical brakes by inputs sent by two potentiometers to a microcontroller. The potentiometers can transform a mechanical linear input in a control signal.

We have decided to use the same lever of the previous throttle, on the right side of the quad, to activate the potentiometer of the electrical brakes. For the new throttle we decided to mount a new rotating handle, the same used on motorbikes.

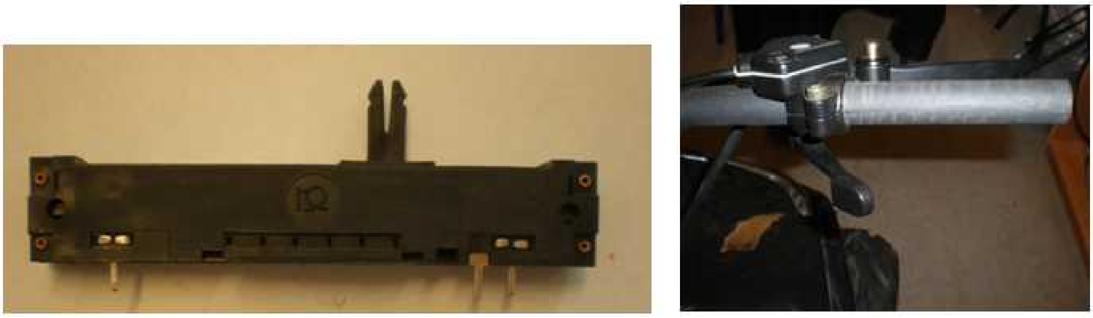


Figure 29: Linear potenziometer and right handlebars without the old rubber cover

Figure 30: New rotating handle mounted

Most of this work has still to be done, we should realize the proper structures for the support of the two metal cables which active the potentiometers.

Placing of electronic components

The space under the saddle is the place chosen for the electronic components of the quad. There we should place the mother board with the microcontroller and the two potentiometers connected to the board. We need to remove a part of the plastic under the saddle in order to create enough space for all the components.

Figure 31: The space under the saddle

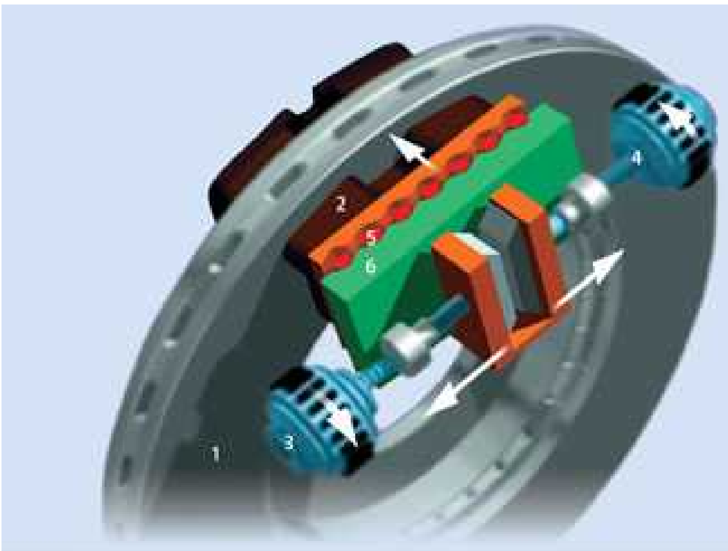
4 REGENERATIVE BRAKES

Recuperative braking (regenerative braking, electrodynamic braking with energy recovery - used in electric traction vehicles in mechanisms to recover kinetic energy during braking and convert it into electricity instead of heat (useless). System improves the energy efficiency of the vehicle.

During braking the electric motors act as generators. Generated by the current may be used in several ways:

The first way is the accumulation of energy directly to the vehicle, and then using it for the next boot. The advantage of this method is the lack of energy losses associated with its transmission, while the disadvantage of the need to increase vehicle weight of energy storage devices. In practice, the vehicle braking energy are used for propelling the wheels during acceleration of the vehicle which serves as a prime mover or as an auxiliary drive

The second way is to transfer energy by rail network and its use by other traction appearing on the episode. Recovered energy can be stored in power substations.



model of the mechanism

As shown in the drawing, the brake rotor (1) and washers (2) come into contact with each other by electric motors (3, 4) by means of several roller screws (5) wedge-shaped along the surface (6). Wedge effect is automatically amplified as a result of rotation of the wheel allows varying degrees of braking force to be created with little effort.

Our idea was to connect regenerative break to supply system and use it while breaking for convert energy which we don't need for break for charge batteries. While this operation motor is working as a generator and its output is supplied to an electrical load. The transfer of energy to the load provides the braking effect.

In last year in Formula One was using similar mechanism – Kinetic Energy Recover System (KERS). This system allows use saved energy at fast part of track for drivers. At every circuit they were allowed to add extra around 70 PH for car for few second what is very useful with overtake cars. Teams worked a lot about this system, but after one season FIA abandoned this system because develop it was too expensive and that was difficult with install it into a car, because of the weight – 25 kg in one piece, what is very big problem with keep balance of the car. But teams still work about make it smaller and probably KERS will back to Formula One in the next season.

Data Sheet

SAUER DANFOSS

PLUS+1™ Inverter MI06-S-XX/400

AC Motor Controller

The PLUS+1 Inverter family is designed to control AC-motors in all types of electric vehicles. Adaptable motor control, using a Flux Vector Control algorithm, offers best performance for drive systems, while plug in data files enable easy matching and optimization of PLUS+1 compliant TSA AC induction motors and the MI 06 inverter.

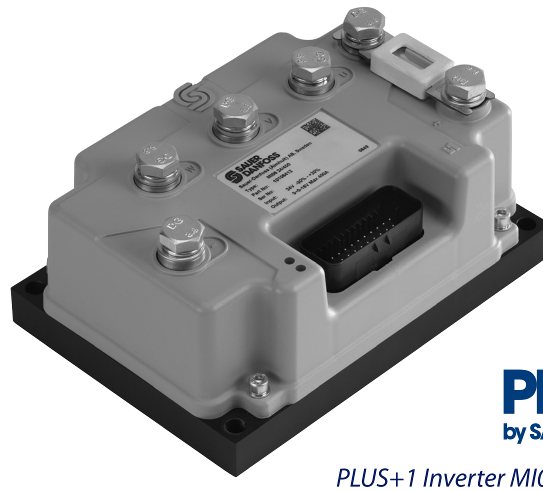
Mobile Machine Management

The PLUS+1 MI06 Inverter is both a motor inverter and a vehicle controller in one unit. With configurable I/O functionality and analog, digital, and CAN communication ports, the inverter is able to interface with a wide range of external devices.

Vehicle Application Development

Users develop MI06-S-XX/400 applications with PLUS+1 GUIDE. This user-friendly, Microsoft Windows based development environment features a field proven graphical programming tool, application downloader, and service tool. Software application blocks for typical applications are available in the Sauer-Danfoss software library and can be simply adapted and expanded for individual vehicle applications.

Local Address:



PLUS+1™ by SAUER-DANFOSS

PLUS+1 Inverter MI06-S-48/400-P

Displayed fuse not included

Features

- Advanced motor control performance
  - Flux Vector Control for best drive performance in all speed modes and minimal power losses in the drive system
  - Easy Motor Characterization for any AC motor using the PLUS+1 Service tool
  - Plug and perform motor setup for Sauer-Danfoss PLUS+1 Compliant AC motors (type TSA), using the web application downloader
- Designed for quality and reliability
  - Superior thermal performance with SMD technology and copper based IMS (Insulated Metal Substrate) power electronics
  - Single AMPSEAL connector for high machine reliability
  - Sealed to IP 64 with breathable membrane
  - Enhanced EMC Performance
  - Operating ambient temperature range -40°C to +50°C
  - Redundant watchdog timers
  - Protected I/O and Wire Off detection
  - Powerful computing capability with DSP (Digital Signal Processor)
- Integrated vehicle control functionality
  - All functions are user-programmable with PLUS+1 GUIDE (Graphical User Integrated Development Environment)
  - Easy to handle and flexible control configuration for managing sensors and actuators
  - Database of predefined Function Blocks for typical functions and applications (traction application, pump application, battery state of charge algorithm, hour meter, vehicle safety and fault management…)
- Comprehensive interface concept
  - CAN 2.0 B port, use for different protocols (CAN, J1939, CANopen, …)
  - High number of I/Os
  - Configurable I/O functionality for improved flexibility in adapting to different applications
  - “Safety” outputs with redundant transistors for advanced safety requirements.
  - I/O supply voltage independent from battery
- Compact design with different cooling alternatives for flexible packaging (conduction cooling, air cooling)
- Easy access to service, status and diagnostic information
  - PC Service Tool for field service (Parameter up/down-load, Oscilloscope, Data logging, …)
  - Status and fault monitoring with two LED indicators

11042732 • Rev AA • May 2008

PLUS+1™ Inverter
MI06-S-XX/400

Technical Data

Power Section

Type: MI06-S-	24/400-	48/400-
Nominal voltage	24 Vdc	36 - 48 Vdc
Input voltage range	16…36 Vdc	18…62 Vdc
Nominal current	200 Arms	200 Arms
Maximum current S2 - 2min	400 Arms	400 Arms
Peak current	420 Arms	420 Arms
Output voltage	3 x 0…16 V (@24V input V)	3 x 0…24 (@36V input V) 3 x 0…32 (@48V input V)
Dimensions W H D	140 mm [5.51 in] 200 mm [7.87 in] 98 mm [3.86 in] (plate version), 118 mm [4.65 in] (finned version)	
Power connectors	M10	
Weight	3.5 kg [7.72 lb] (plate version) 3.7 kg [8.16 lb] (finned version)	

Interface

	Number in default configuration	Maximum number
Digital input	8	15
Analog input unipolar 0…10V	1	
Analog input bipolar ± 10V	2	
Digital output	5	7
Digital output for safety relevant components	1	
Current controlled output 0…2A	1	
Current controlled output for safety relevant components 0…2A	1	
Motor temperature sensor	1	
Incremental encoder	1	2
CAN interface	1	

Product Part Number

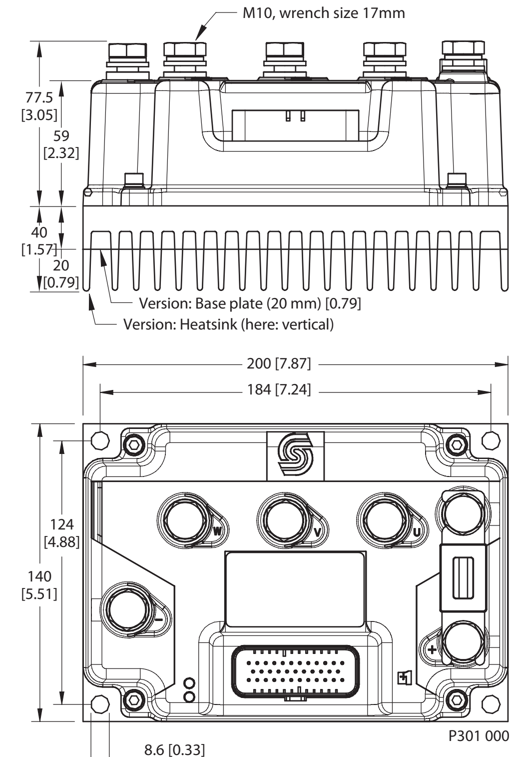
MI06-S-24/400-P	Plate-Type Heat Sink	10107497
MI06-S-24/400-FH	Finned-Type Heat Sink (Horizontal)	10107498
MI06-S-24/400-FV	Finned-Type Heat Sink (Vertical)	10107499
MI06-S-48/400-P	Plate-Type Heat Sink	10107500
MI06-S-48/400-FH	Finned-Type Heat Sink (Horizontal)	10107501
MI06-S-48/400-FV	Finned-Type Heat Sink (Vertical)	10107502

Related Products Part Number

35 pin AMPSEAL Mating Connector Bag Assembly	10107896
CG150 CAN/USB Gateway	10104136
Optional bolt connected power fuses for different current ratings	on request

Dimensions

in millimeters [inches]



Displayed fuse not included

Caution:
PLUS+1 devices are not field serviceable. Opening the device housing will void the warrenty.

Others

Switching frequency	8kHz standard; adjustable 4, 8, 12, 16 kHz
Efficiency	min 98% at nominal output
Output frequency	0…300 Hz
Ambient temperature range	-40°C … 50°C [-40°F…122°F]
Maximum heat-sink temperature @ full current	85°C [185°F]
Operation signal	2 built-in LEDs (red and green)
Signal line connectors	AMPSEAL 35 pins
IP protection	IP64 with membrane
EMC / ESD	50V/m / 15kV
Safety	EN 1175
Vibration / Shock	5g / 50g
UL	UL583

Comprehensive technical information: *PLUS+1 MI06 Technical Information, **11047294***
Sauer-Danfoss product literature on line at: www.sauer.danfoss.com

CENTRUM TRYK

MI06

SYS-File:	10107978v130.SYS
SYS-File Family	10107950
Hardware:	MI06-S-48/400-FH (10107501)
	MI06-S-48/400-FV (10107502)
	MI06-S-48/400-P (10107500)
	MI06-S-24/400-FH (10107498)
	MI06-S-24/400-FV (10107499)
	MI06-S-24/400-P (10107497)

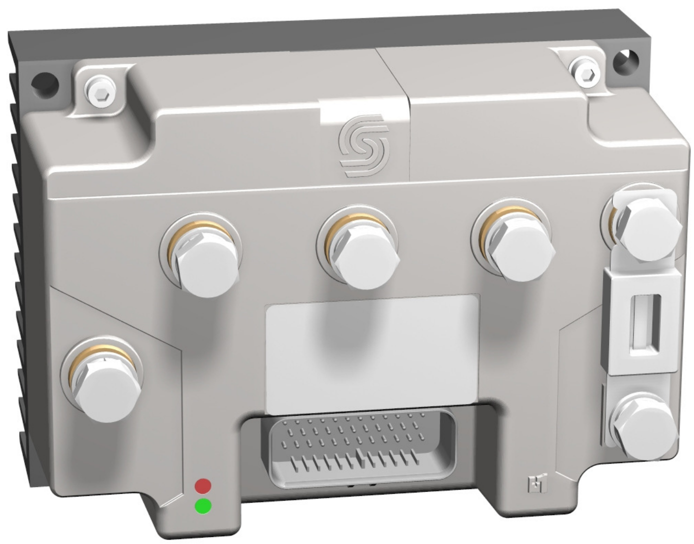


Table of Contents

1. General

1.1. BIOS functionality

The functionality is defined around the pin. If no *Variable Type* is specified the *Variable Name* contains elements, defined later.
The pins are defined as C(ConnectorNumber)p(PinNumber) .

Example:

The pin C1p19 has 3 variables;
C1p19.DigIn,
C1p19.DebounceConfig,
C1p19.PinStatus.

Also C1p20 has 3 variables;
C1p20.DigIn,
C1p20.DebounceConfig,
C1p20.PinStatus.

Etc.

1.2. BIOS Default Settings

The default value of variables is 0 if nothing is specified.

2. API Interface

2.1. Multi function Inputs (Dig/Freq)

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Multi function Inputs (Dig/Freq)	
C1p18	-			Encoder signal A, if .FreqConfig = 1
Elements				
.PinConfig	U16	Write	Config 0 = no pull-up (Active High) 1 = pull-up 1.1kOhm to +15V (Active Low) (default value = 0)	**Note1, Note3** Affects also C1p30
.FreqConfig	U16	Write	Configuration of used mode 0 = normal counter mode, result in .Count 1 = Quad encoder mode, result in .QuadCount (default value = 0)	**Note2, Note3** Affects also C1p30 Maximum input frequency in normal counter and quad encoder mode = 100 Hz. Quad encoder mode count 4 pulses per encoder period.
.DebounceConfig	U16	Write	Sets the time to debounce the digital input. 0…100 [ms]	**Note1, Note4** Only for .DigIn! The input signal will be delayed for that time. (fixed sample time 1 ms)
.DigIn	BOOL	Read	Digital in Active = True	The digital input works independently from selected mode at .FreqConfig.
.Count	U16	Read	Number of measured counts this loop. Counter counts rising and falling edge.	Only valid when .FreqConfig = 0.
.QuadCount	S16	Read	Number of measured counts this loop for quad encoder signals at C1p18 and C1p30. Sign defines direction.	Only valid when .FreqConfig = 1.
.PinStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .PinConfig Bit1 0 = OK 1 = ConfigError at .DebounceConfig Bit2 0 = OK 1 = Hardware Watchdog error	ConfigError indicates wrong values at .PinConfig and .DebounceConfig. Hardware Watchdog error indicates an error of the ext. HW watchdog of the unit.
.FreqStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .FreqConfig Bit1 0 = OK 1 = QuadError	ConfigError indicates wrong values at .FreqConfig. QuadError indicates wrong signal sequence at C1p18 and C1p30.

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Multi function Inputs (Dig/Freq)	
C1p30	-			Encoder signal B, if C1p18.FreqConfig = 1
Elements				
.DebounceConfig	U16	Write	Sets the time to debounce the digital input. 0…100 [ms]	**Note1, Note4** Only for .DigIn! The input signal will be delayed for that time. (fixed sample time 1 ms)
.DigIn	BOOL	Read	Digital in Active = True	The digital input works independently from selected mode at C1p18.FreqConfig.
.Count	U16	Read	Number of measured counts this loop. Counter counts rising and falling edge.	Only valid when C1p18.FreqConfig = 0.
.PinStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .DebounceConfig Bit1 0 = OK 1 = Hardware Watchdog error	ConfigError indicates wrong values at .DebounceConfig. Hardware Watchdog error indicates an error of the ext. HW watchdog of the unit.

2.2. Digital Inputs

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Digital Inputs	
C1p19	-			
C1p20	-			
C1p21	-			
C1p31	-			
C1p32	-			
C1p33	-			
Elements				
.DebounceConfig	U16	Write	Sets the time to debounce the digital input. 0…100 [ms]	**Note1, Note4** The input signal will be delayed for that time. (fixed sample time 1 ms)
.DigIn	BOOL	Read	Digital in High = True	
.PinStatus	U16	Read	0 = OK 1 = ConfigError at .DebounceConfig	ConfigError indicates wrong values at .DebounceConfig

2.3. General purpose Inputs/Outputs

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			General purpose Inputs/Outputs	
C1p14	-			
C1p15	-			
C1p25	-			
C1p26	-			
Elements				
.PinConfig	U16	Write	Config 0 = Digital output 1 = PWM output 2 = Digital input (default value = 0)	**Note1, Note3** Sinking output
.DigOut	BOOL	Write	Digital out False = off (inactive) True = on (active)	**Note2** For .PinConfig = 0
.OutputValue	U16	Write	Set point value 0…10000 [0.01%]	**Note2, Note4** For .PinConfig = 1; PWM frequency = 100 Hz; Resolution = 10 %; .OutputValue will be rounded internally to the nearest 10% value;
.DebounceConfig	U16	Write	Sets the time to debounce the digital input. 0…100 [ms]	**Note1, Note4** The input signal will be delayed for that time. Only valid, if .PinConfig = 2. (fixed sample time 1 ms)
.DigIn	BOOL	Read	Digital input High = True	
.PinStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .PinConfig Bit1 0 = OK 1 = ConfigError at .DebounceConfig Bit2 0 = OK 1 = invalid value at .OutputValue Bit3 0 = OK 1 = Overload / output shorted to +I/O supply / transistor damaged Bit4 0 = OK 1 = Output disconnected / output shorted to –I/O supply / transistor shorted Bit5 0 = OK 1 = switched off because overload Bit6 0 = OK	A shorted output to +I/O supply (.PinStatus Bit3 = TRUE) can only be detected: if .PinConfig = 0 ➔ .DigOut need to be 1 if .PinConfig = 1 ➔ .OutputValue need to be > 500 A disconnected/shorted to -I/O supply output (.PinStatus Bit4 = TRUE) can only be detected: if .PinConfig = 0 ➔ .DigOut need to be 0 if .PinConfig = 1 ➔ .OutputValue need to be 0 “switched off because overload” indicates that the output is switched off because overload of this pin was detected. This bit is

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			General purpose Inputs/Outputs	
			1 = switch on protection after overload error Bit 7 0 = OK 1 = Hardware Watchdog error	acknowledged with a switch off/on sequence at .DigOut (in Digital output mode or .OutputValue (in PWM output mode). "switch on protection after overload error" indicates that the pin is not retrigger able after a overload switch off. "Hardware Watchdog error" indicates an error of the ext. HW watchdog of the unit.

2.4. General purpose Inputs/Outputs with Safety Switch

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			General purpose Inputs/Outputs with Safety Switch	
C1p13	-			
Elements				
.PinConfig	U16	Write	Config 0 = Digital output 1 = PWM output 2 = Digital input (default value = 0)	**Note1, Note3** Sinking output
.DigOut	BOOL	Write	Digital out False = off (inactive) True = on (active)	**Note2** For .PinConfig = 0
.OutputValue	U16	Write	Set point value 0…10000 [0.01%]	**Note2, Note4** For .PinConfig = 1; PWM frequency = 100 Hz; Resolution = 10 %; .OutputValue will be rounded internally to the nearest 10% value;
.DebounceConfig	U16	Write	Sets the time to debounce the digital input. 0…100 [ms]	**Note1, Note4** The input signal will be delayed for that time. Only valid, if .PinConfig = 2. (fixed sample time 1 ms)
.DigIn	BOOL	Read	Digital input High = True	
.PinStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .PinConfig Bit1 0 = OK 1 = ConfigError at .DebounceConfig Bit2 0 = OK 1 = invalid value at .OutputValue	A shorted output to +I/O supply (.PinStatus Bit3 = TRUE) can only be detected: if .PinConfig = 0 ➔ .DigOut need to be 1 if .PinConfig = 1 ➔ .OutputValue need to be > 500

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			General purpose Inputs/Outputs with Safety Switch	
			Bit3 0 = OK 1 = Overload / output shorted to +I/O supply / transistor damaged Bit4 0 = OK 1 = Output disconnected / output shorted to –I/O supply / transistor shorted Bit5 0 = OK 1 = switched off because overload Bit6 0 = OK 1 = switch on protection after overload error Bit 7 0 = OK 1 = Hardware Watchdog error	A disconnected/shorted to -I/O supply output (.PinStatus Bit4 = TRUE) can only be detected: if .PinConfig = 0 ➔ .DigOut need to be 0 if .PinConfig = 1 ➔ .OutputValue need to be 0 "switched off because overload" indicates that the output is switched off because overload of this pin was detected. This bit is acknowledged with a switch off/on sequence at .DigOut (in Digital output mode or .OutputValue (in PWM output mode). "switch on protection after overload error" indicates that the pin is not retriggerable after a overload switch off. "Hardware Watchdog error" indicates an error of the ext. HW watchdog of the unit.
.SafetyStatus	U16	Read	0 = OK 1 = SafetyError	If .SafetyStatus = 1 and .PinStatus Bit3 = 0 and Bit4 = 0 the output will work in unsafe mode (the PWM signal can be 10 % wider than commanded).

2.5. Main contactor output

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Main contactor output	
C1p24	-			
Elements				
.PinConfig	U16	Write	Config 0 = Digital output 1 = PWM output (default value = 0)	**Note1, Note3** Sinking output
.Locked	BOOL	Read	False = unlocked True = permanently locked	
.DigOut	BOOL	Write	Digital out False = off (inactive) True = on (active)	**Note2** For .PinConfig = 0
.OutputValue	U16	Write	Set point value 0…10000 [0.01%]	**Note2, Note4** For .PinConfig = 1; PWM frequency = 100 Hz; Resolution = 10 %; .OutputValue will be rounded internally to the nearest 10%
.PinStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .PinConfig Bit1 0 = OK 1 = invalid value at .OutputValue Bit2 0 = OK 1 = Overload / output shorted to +I/O supply / transistor damaged Bit3 0 = OK 1 = Output disconnected / output shorted to –I/O supply / transistor shorted Bit4 0 = OK 1 = switched off because overload Bit5 0 = OK 1 = switch on protection after overload error Bit 6 0 = OK 1 = Hardware Watchdog error	A shorted output to +I/O supply (.PinStatus Bit2 = TRUE) can only be detected: if .PinConfig = 0 ➔ .DigOut need to be 1 if .PinConfig = 1 ➔ .OutputValue need to be > 500 A disconnected/shorted to -I/O supply output (.PinStatus Bit3 = TRUE) can only be detected: if .PinConfig = 0 ➔ .DigOut need to be 0 if .PinConfig = 1 ➔ .OutputValue need to be 0 “switched off because overload” indicates that the output is switched off because overload of this pin was detected. This bit is acknowledged with a switch off/on sequence at .DigOut (in Digital output mode or .OutputValue (in PWM output mode). “switch on protection after overload error” indicates that the pin is not retrigger able

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Main contactor output	
				after a overload switch off. “Hardware Watchdog error” indicates an error of the ext. HW watchdog of the unit.

2.6. General purpose proportional Inputs/Outputs

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			General purpose proportional Inputs/Outputs	
C1p16	-			
Elements				
.PinConfig	U16	Write	Config 0 = Digital output 1 = PWM output 2 = Digital input 3 = Proportional output, closed loop current controlled (init value = 3) (default value = 3)	**Note1, Note3**
.DitherAmp	U16	Write	Set point Dither Amplitude 0…2500 [0.1mA]	**Note2, Note4** For .PinConfig = 3 Square wave signal symmetrically to current set point with a fixed frequency of 62.5 Hz
.DigOut	BOOL	Write	Digital out False = off (inactive) True = on (active)	**Note2** For .PinConfig = 0
.OutputValue	U16	Write	Set point value 0…10000 [0.01%] (for .PinConfig = 1) 0…20000 [0.1mA] (for .PinConfig = 3)	**Note2, Note4** For .PinConfig = 1; PWM frequency = 100 Hz; Resolution = 10 %; .OutputValue will be rounded internally to the nearest 10%
.DebounceConfig	U16	Write	Sets the time to debounce the digital input. 0…100 [ms]	**Note1, Note4** The input signal will be delayed for that time. Only valid, if .PinConfig = 2. (fixed sample time 1 ms)
.DigIn	BOOL	Read	Digital input High = True	If .PinConfig = 2

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			General purpose proportional Inputs/Outputs	
.PinStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .PinConfig Bit1 0 = OK 1 = ConfigError at .DebounceConfig Bit2 0 = OK 1 = invalid value at .OutputValue Bit3 0 = OK 1 = invalid value at .DitherAmp Bit4 0 = OK 1 = Output disconnected / output shorted to –I/O supply / transistor shorted Bit 5 0 = OK 1 = Hardware Watchdog error	A disconnected/shorted to -I/O supply output (.PinStatus Bit4 = TRUE) can only be detected: if .PinConfig = 0 ➔ .DigOut need to be False if .PinConfig = 1 or 3 ➔ .OutputValue need to be 0 "Hardware Watchdog error" indicates an error of the ext. HW watchdog of the unit.

2.7. General purpose proportional Inputs/Outputs with Safety Switch

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			General purpose proportional Inputs/Outputs with Safety Switch	
C1p27	-			
Elements				
.PinConfig	U16	Write	Config 0 = Digital output 1 = PWM output 2 = Digital input 3 = Proportional output, closed loop current controlled (init value = 3) (default value = 3)	**Note1, Note3**
.DitherAmp	U16	Write	Set point Dither Amplitude 0…2500 [0.1mA]	**Note2, Note4** For .PinConfig = 3 Square wave signal symmetrically to current set point with a fixed frequency of 62.5 Hz
.DigOut	BOOL	Write	Digital out False = off (inactive) True = on (active)	**Note2** For .PinConfig = 0

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			General purpose proportional Inputs/Outputs with Safety Switch	
.OutputValue	U16	Write	Set point value 0…10000 [0.01%] (for .PinConfig = 1) 0…20000 [0.1mA] (for .PinConfig = 3)	**Note2, Note4** For .PinConfig = 1; PWM frequency = 100 Hz; Resolution = 10 %; .OutputValue will be rounded internally to the nearest 10%
.DebounceConfig	U16	Write	Sets the time to debounce the digital input. 0…100 [ms]	**Note1, Note4** The input signal will be delayed for that time. Only valid, if .PinConfig = 2. (fixed sample time 1 ms)
.DigIn	BOOL	Read	Digital input High = True	If .PinConfig = 2
.PinStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .PinConfig Bit1 0 = OK 1 = ConfigError at .DebounceConfig Bit2 0 = OK 1 = invalid value at .OutputValue Bit3 0 = OK 1 = invalid value at .DitherAmp Bit4 0 = OK 1 = Output disconnected / output shorted to –I/O supply / transistor shorted Bit 5 0 = OK 1 = Hardware Watchdog error	A disconnected/shorted to -I/O supply output (.PinStatus Bit4 = TRUE) can only be detected: if .PinConfig = 0 ➔ .DigOut need to be False if .PinConfig = 1 or 3 ➔ .OutputValue need to be 0 "Hardware Watchdog error" indicates an error of the ext. HW watchdog of the unit.
.SafetyStatus	U16	Read	0 = OK 1 = SafetyError	If .SafetyStatus = 1 and .PinStatus Bit4 = 0 the output will work in unsafe mode (the PWM signal can be 10 % wider than commanded)

2.8. Analog inputs

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Analog inputs	
C1p10	-			
Elements				
.AnIn	U16	Read	Analog input 0…32760 (2728 = 0 V, 30024 = 10 V)	AD Count
.Volt	S32	Read	Analog in 0…10000[mV]	
.PinStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .FilterConfig Bit1 0 = OK 1 = Input out of range Bit2 0 = OK 1 = Hardware error	If PinStatus Bit1 = TRUE .AnIn and .Volt are undefined
.FilterConfig	U16	Write	Sets the filter time constant. The filter can be bypassed by setting 0 ms at .FilterConfig. Adjustable time constants: 0 [ms] 10…200 [ms] (init value = 10)	**Note1, Note4**
C1p11	-			
C1p22	-			
Elements				
.AnIn	U16	Read	Analog input 0…32760 (2728 = -10 V, 30024 = 10 V)	AD Count
.Volt	S32	Read	Analog in -10000…+10000[mV]	
.PinStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .FilterConfig Bit1 0 = OK 1 = Input out of range Bit2 0 = OK 1 = Hardware error	If PinStatus Bit1 = TRUE .AnIn and .Volt are undefined
.FilterConfig	U16	Write	Sets the filter time constant. The filter can be bypassed by setting 0 ms at .FilterConfig. Adjustable time constants: 0 [ms] 10…200 [ms] (init value = 10)	**Note1, Note4**

2.9. Auxiliary supply voltages

2.9.1. Sensor supply

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Auxiliary supply voltages	
C1p23	-		Sensor supply	Selectable auxiliary supply voltage with voltage feedback, typically used for potentiometers, foot pedals, throttles or minilevers.
Elements				
.PinConfig	U16	Write	Set Value 0 = 5 V 1 = 10 V 2 = 12 V (default value = 0)	**Note1, Note3**
.AnIn	U16	Read	Analog input 0…32760 (0 = 0 V, 32760 = 18 V)	AD Count
.Volt	S32	Read	Actual supply voltage feedback value 0…15000 [mV]	
.PinStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .PinConfig Bit1 0 = OK 1 = Supply voltage feedback value out of range	Supply voltage feedback value out of range will be set for voltage values higher than 15000 mV. In this case the provided value is limited to 15000 mV.

2.9.2. Encoder supply

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Auxiliary supply voltages	
C1p28	-		Encoder supply	Fixed auxiliary supply voltage with current feedback, typically used for motor encoder supply
Elements				
.AnIn	U16	Read	Analog input 0…32760 (0 = 0 mA, 32720 = 110 mA)	AD Count
.FeedbackValue	U16	Read	Encoder supply current 0 …1000 [0.1mA]	
.PinStatus	U16	Read	Bit0 0 = OK 1 = current feedback out of range	

2.10. Power Stage

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Power Stage	
PowerStage	-			
Elements				
.PWMFreq	U8	Write	PWM frequency 1 = 4 kHz 2 = 8 kHz 3 = 12 kHz 4 = 16 kHz (init value = 2)	**Note1, Note4**
.Enable	BOOL	Write	False = disabled True = enabled	**Note2, Note3** .Enable can be set after all self tests are finished and if no error was found during the self test. A 1-0 sequence receipts the PowerStage.Status bits and clears the bits of these errors, which are not longer present. A 0 – 1 sequence at .Enable is necessary to enable the power stage.
.EnableStatus	BOOL	Read	False = disabled True = enabled	In case of an error .EnableStatus can be disabled even if .Enable is enabled.
.Unprotected	BOOL	Write	False = Unprotected mode disabled True = Unprotected mode enabled	**Note3** If the Power Stage is switched off because of a temperature sensor error, it is possible to switch on the Power Stage also if this error is actually present.
.ResetErrStatus	BOOL	Write	False = disabled True = enabled	**Note2, Note3** A 0 – 1 sequence receipts the PowerStage.Status bits and clears the bits of these errors, which are not longer present.
.Temp	S16	Read	Actual temperature at power stage -60…170 [°C]	
.TempLimit	S16	Read	Upper temperature limit of power stage [°C]	A constant value, specified by the inverter type (production data)
.HWCurrLimit	U32	Read	Current limit of the power stage hardware – corresponds with boost current of data sheet 0…2900000 [mArms]	**Production data**

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Power Stage	
.Locked	U16	Read	0 = unlocked 1 = temporary locked 2 = permanently locked	"temporary locked" means the power stage is in initialization phase. "permanently locked" means, the power stage is switched off due to an error while self test or run time.
.Status	U16	Read	Bit0 0 = OK 1 = wrong value at PWMFreq Bit1 0 = OK 1 = Overtemperature Bit2 0 = OK 1 = Temperature sensor error Bit3 0 = OK 1 = Overvoltage Bit4 0 = OK 1 = Overcurrent Bit5 0 = Unprotected mode inactive 1 = Unprotected mode active Bit6 0 = OK 1 = Power Stage permanently locked because wrong motor data Bit7 0 = OK 1 = Power Stage permanently locked because HW watchdog error Bit8 0 = OK 1 = Power Stage permanently locked because current sensor error Bit9 0 = OK 1 = Power Stage permanently locked because undervolt detection	

2.11. Monitoring

2.11.1. DC link voltage, Power supply

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Monitoring – DC link voltage, Power supply	
V_DC_Link	-		DC link voltage (at power connector)	.
C1p02	-		Power Supply (typically used as key switch input)	
Elements				
.AnIn	U16	Read	Analog input 0…32760	AD Count
.Volt	S32	Read	Actual voltage [mV]	

2.11.2. Hour counters

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Monitoring – Hour counters	
HourCounter	-		Hour counters [0.001h], not resettable	
Elements				
.Inverter	U32	Read	Counts, when the inverter is power supplied by C1p02 [0.001h]	
.Power	U32	Read	Counts, when the power stage is enabled (PowerStage.EnableStatus = True). [0.001h]	

2.11.3. Selftest

Variable Name	**Variable Type**	**Variable Direction**	**Function, Scaling**	**Miscellaneous**
			Monitoring – Selftest	
Selftest	-		Shows the results of the self test routines at power-on	
Elements				
.Error	U16	Read	Bit0 0 = OK 1 = Error DC-Link circuit Bit1 0 = OK 1 = Error in watchdog circuit, operation impossible Bit2 0 = OK 1 = Short circuit to –V_DC_Link Bit3 0 = OK 1 = Short circuit to +V_DC_Link Bit4 0 = OK 1 = Error in motor wiring or power stage Bit5 0 = OK 1 = Shorted power output (motor output) Bit6 0 = OK 1 = Test not passed, because of hardware overvoltage protection Bit7 0 = OK 1 = Corrupted production data in EEPROM detected	
.Warning	U16	Read	Bit0 0 = OK 1 = Error in watchdog circuit, limited operation possible Bit1 0 = OK 1 = Watchdog not tested, because low voltage at DC-Link or VKey Bit2 0 = OK 1 = Corrupted user data in EEPROM detected Bit3 0 = OK 1 = Corrupted error history data in EEPROM detected	

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Monitoring – Selftest	
.Status	U16	Read	0 = Selftest finished 1 = DCLink selftest in progress 2 = Watchdog selftest in progress 3 = PowerStage selftest in progress	

2.11.4. Error history

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Monitoring – Error history	
ErrorHistory	-			
.Number[0..7]	U8	Read	Error history (the last 8 errors) 1 = Overtemperature 2 = Overvoltage 3 = Overcurrent 4 = Temperature sensor error 5 = Unprotected Mode used 6 = DC_Link error 7 = Watchdog error, limited operation possible 8 = Watchdog error, operation impossible 9 = Power Stage error, short circuit to –V_DC_Link 10 = Power Stage error, short circuit to +V_DC_Link 11 = Error in motor wiring or power stage 12 = Shorted power output 13 = wrong production data in EEPROM detected 14 = Current sensor error 15 = Undervoltage 16…255 = reserved	
.Counter[0..7]	U8	Read	If the occurred error is the same as last entry in .Number[0], the .Counter[0] will be incremented and the .Hour[0] will be overwritten with the actual time.	
. Hour[0..7]	U32	Read	Value of HourCounter.Inverter when the error occurred	
.AbsOTErrors	U16	Read	Shows absolute number of detected over temperature errors while lifetime of the inverter.	
. AbsOVErrors	U16	Read	Shows absolute number of detected over voltage errors while lifetime of the inverter.	
. AbsOCErrors	U16	Read	Shows absolute number of detected over current errors while lifetime of the inverter.	
. AbsTSensErrors	U16	Read	Shows absolute number of detected temperature sensor errors while lifetime of the inverter.	

2.12. Analog Input (Rheo)

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Analog Input (Rheo)	
C1p34	-			
Elements				
.AnIn	U16	Read	Analog input 0…32760	AD Count
.Ohm	U16	Read	Resistance between C1p34 and GND 0…12000[Ohm]	If resistance > 12000 Ohm C1p34.Ohm shows 12000 Ohm
.FilterConfig	U16	Write	Sets the filter time constant. The filter can be bypassed by setting 0 ms at .FilterConfig. Adjustable time constants: 0 [ms] 10…2000 [ms] (init value = 10)	**Note1, Note4**
.PinStatus	U16	Read	Bit0 0 = OK 1 = ConfigError at .FilterConfig Bit1 0 = OK 1 = Input out of range Bit2 0 = OK 1 = Hardware Error	ConfigError indicates wrong values at .FilterConfig Input out of range shows, that the measured resistance at this input is higher than 12000 Ohm.

2.13. Non volatile RAM Area for User specific data

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Non volatile RAM Area for User specific data	
NVRam	-			
Elements				
.UserData[0..7]	U16	Bi-Directional		At run time this data are stored at RAM. The RAM will be automatically stored to EEPROM at power down and restored at power up.

2.14. Motor Control interface

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Motor Control interface	
MotorControl				
Elements				
.RPMSetPoint	S32	Write	Motor speed set value -80000…+80000 [0.1rpm]	**Note2, Note4**
.SpeedKP	U32	Write	Proportional gain of speed controller 50…10000000 [0.00001Nm/rpm] (init value = 50)	**Note2, Note4**
.SpeedKI	U32	Write	Integral gain of speed controller 0…10000000 [0.00001Nm/rpm/s]	**Note2, Note4**
.TorqueFF	S32	Write	Torque which is added as feed forward part to the speed controller output. -1000000…1000000 [0.001Nm]	**Note2, Note4**
.UserTorqueLimit	U16	Write	User torque limit as percentage of Motor.TorqueMax 0…10000 [0.01%] (init value = 10000)	**Note2, Note4**
.UserCurrLimit	U16	Write	User current limit as percentage of hardware current limit. 0…10000 [0.01%] (init value = 10000)	**Note2, Note4**
.EncErrThreshold	U16	Write	Number of bad encoder pulses in a row to detect a disconnected signal line. 2…65535 (init value = 65535)	**Note1, Note4**
.PartLoadReduc	U16	Write	Lower limit of rated flux to reduce current at partial load. 2000…10000 [0.01%] (init value = 10000)	**Note1, Note4**
.ActSpeed	S32	Read	Actual motor speed -100000 … +100000 [0.1 rpm]	
.ActStatFreq	S32	Read	Actual stator frequency -1000000…+1000000 [0.001Hz]	
.ActSlipFreq	S32	Read	Actual slip frequency -1000000…+1000000 [0.001Hz]	
.ActTorque	S32	Read	Actual motor torque set value -1000000 …+1000000 [0.001 Nm]	
.ActQCurrent	S32	Read	Actual Q-axis current -4000000…4000000 [mA]	
.ActDCurrent	S32	Read	Actual D-axis current -4000000…4000000 [mA]	
.ActCurrent	U32	Read	Actual motor current 0…2900000 [mArms]	
.ActVoltage	U32	Read	Actual motor voltage (line to line) 0…150000 [mVrms]	
.ActTorqueLimit	U32	Read	Actual torque limit (minimum of calculated physical limit , user torque limit and motor torque limit) 0…1000000 [0.001 Nm]	

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Motor Control interface	
.ActCurrLimit	U32	Read	Actual current limit (minimum of hardware current limit, user current limit and motor current limit) 0…2900000 [mArms]	
.Gen_Mode	BOOL	Read	Operation mode: 0 = motor mode 1 = generator mode	
.Status	U16	Read	Bit0 0 = OK 1 = invalid value at .RPMSetPoint Bit1 0 = OK 1 = invalid value at .SpeedKP Bit2 0 = OK 1 = invalid value at .SpeedKI Bit3 0 = OK 1 = invalid value at .TorqueFF Bit4 0 = OK 1 = invalid value at .UserTorqueLimit Bit5 0 = OK 1 = invalid value at .UserCurrLimit Bit6 = reserved Bit7 = reserved Bit8 = reserved Bit9 0 = OK 1 = invalid value at .EncErrThreshold Bit10 0 = OK 1 = One encoder line disconnected Bit11 0 = OK 1 = invalid value at .PartLoadReduc	

2.15. Motor Identification Data

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Motor Identification Data	
Motor	-			
Elements				
.PolePairs	U8	Write	Pole pairs 1…6 (init value = 0xFF)	**Note4, Note5**
.SpeedMax	U32	Write	Maximum motor speed 0…100000 [0.1 rpm] (init value = 0xFFFFFFFF)	**Note4, Note5**
.FluxRated	U32	Write	Rated rotor flux 0…1000000 [0.01mWb] (init value = 0xFFFFFFFF)	**Note4, Note5**
.CurrentMax	U32	Write	Maximum motor current 0…2900000 [mArms] (init value = 0xFFFFFFFF)	**Note4, Note5**
.TorqueMax	U32	Write	Torque at maximum current (Motor.CurrentMax) 0…1000000 [0.001Nm] (init value = 0xFFFFFFFF)	**Note4, Note5**
.LmRated	U32	Write	Main inductance at rated rotor flux level 0…10000000 [0.1 µH] (init value = 0xFFFFFFFF)	**Note4, Note5**
.Llr_Min	U32	Write	Minimum leakage inductance of rotor 0…10000000 [0.1 µH] (init value = 0xFFFFFFFF)	**Note4, Note5**
.Llr_Max	U32	Write	Maximum leakage inductance of rotor 0…10000000 [0.1 µH] (init value = 0xFFFFFFFF)	**Note4, Note5**
.Lls_Min	U32	Write	Minimum leakage inductance of stator 0…10000000 [0.1 µH] (init value = 0xFFFFFFFF)	**Note4, Note5**
.Lls_Max	U32	Write	Maximum leakage inductance of stator 0…10000000 [0.1 µH] (init value = 0xFFFFFFFF)	**Note4, Note5**
.Lm100	U32	Write	Main inductance (100% value for Lm lookup table) 0…10000000 [0.1 µH] (init value = 0xFFFFFFFF)	**Note4, Note5**
.Im100	U32	Write	Magnetization current (100% value for Lm lookup table) 0…2900000 [mArms] (init value = 0xFFFFFFFF)	**Note4, Note5**
.LmTable[0..9]	U16	Write	Main inductance lookup table (Im array) 0…10000 [0.01%] (init value = 0xFFFF for all elements)	**Note4, Note5** Take care for increasing values LmTable[i] < LmTable[i+1]
.LmTable[10..19]	U16	Write	Main inductance lookup table (Lm array) 1000…10000 [0.01%] (init value = 0xFFFF for all elements)	**Note4, Note5**
.RrBase	U32	Write	Rotor resistance value measured at Tbase_r transformed to stator side	**Note4, Note5**

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Motor Identification Data	
			0…10000000 [1µOhm] (init value = 0xFFFFFFFF)	
.TBase_r	U8	Write	Temperature at which RrBase was measured 0…150 [°C] (init value = 0xFF)	**Note4, Note5**
.Tcoeff_r	U16	Write	Temperature coefficient of rotor resistance 0…10000 [10^{-6}/K] (init value = 0xFFFF)	**Note4, Note5**
.RsBase	U32	Write	Stator resistance value measured at Tbase_s 0…10000000 [1µOhm] (init value = 0xFFFFFFFF)	**Note4, Note5**
.Tbase_s	U8	Write	Temperature at which RsBase was measured 0…150 [°C] (init value = 0xFF)	**Note4, Note5**
.ActTemp	S16	Write	Actual motor temperature -50…200 [°C] (init value = 0x7FFF)	**Note2, Note4**
.CC_Gain	U16	Write	Adjustment factor for current controller parameter 5000…15000 [0.01%] (init value = 0xFFFF)	**Note4, Note5**
.EncPulses	U16	Write	Number of encoder pulses per revolution 32…1024 [pulses/rev] (init value = 0xFFFF)	**Note4, Note5**
.EncCounter	S32	Read	Actual encoder counter -32768…32767 [Counts per loop]	Counts up at positive speed
.EncA	BOOL	Read	Actual state of the hardware input pin of encoder line A High = True	For test purposes
.EncB	BOOL	Read	Actual state of the hardware input pin of encoder line B High = True	For test purposes
.ReInit	BOOL	Write	Trigger variable to reinitialize the motor and encoder parameters. A 0 – 1 sequence will reinitialize the motor control as soon as (PowerStage.EnableStatus = FALSE) and (abs(MotorControl.ActSpeed) <= 10 rpm)	**Note5**
.DataStructVersion	U16	Write	Version of the motor data structure 0…65000 (init value = 100) (default value = 100)	**Note3, Note5**
.Status	U32	Read	Bit0 0 = OK 1 = invalid value at .PolePairs Bit1 0 = OK 1 = invalid value at .SpeedMax	

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Motor Identification Data	
			Bit2 0 = OK 1 = invalid value at .FluxRated Bit3 0 = OK 1 = invalid value at .CurrentMax Bit4 0 = OK 1 = invalid value at .TorqueMax Bit5 0 = OK 1 = invalid value at .LmRated Bit6 0 = OK 1 = invalid value at .Llr_Min Bit7 0 = OK 1 = invalid value at .Llr_Max Bit8 0 = OK 1 = invalid value at .Lls_Min Bit9 0 = OK 1 = invalid value at .Lls_Max Bit10 0 = OK 1 = invalid value at .Lm100 Bit11 0 = OK 1 = invalid value at .Im100 Bit12 0 = OK 1 = invalid value in Im array of .LmTable[0…9] Bit13 0 = OK 1 = invalid value in Lm array of .LmTable[10…19] Bit14 0 = OK 1 = invalid value at .RrBase Bit15 0 = OK 1 = invalid value at .Tbase_r Bit16 0 = OK 1 = invalid value at .Tcoeff_r Bit17 0 = OK 1 = invalid value at .RsBase Bit18 0 = OK 1 = invalid value at .Tbase_s Bit19 0 = OK	

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Motor Identification Data	
			1 = invalid value at .ActTemp Bit20 0 = OK 1 = invalid value at .CC_Gain Bit21 0 = OK 1 = invalid value at .EncPulses Bit22 0 = OK 1 = invalid value at .DataStructVersion Bit23 0 = no ReInit in progress 1 = ReInit in progress	

2.16. Device Info Block

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Device Info Block	
DeviceInfo	-			
Elements				
.DeadTime	U16	Read	Dead time of power stage 0…6400 [ns]	Production data
.MinTemp	S16	Read	Specified minimum temperature where the unit will work proper. -60…200 [°C]	Production data
.MinVolt	S32	Read	Specified minimum voltage. [mV]	Production data
.MaxVolt	S32	Read	Specified maximal voltage where the unit will work proper. [mV]	Production data
.SerialNoA	U32	Read	First part of the Serial number.	Production data
.SerialNoB	U32	Read	Second part of the Serial number.	Production data
.PartNo0	U32	Read	Defines the hardware assembly with software loaded.	Production data
.PartNo1	U32	Read	Is a S-D part number and is set when customer-specific software and/or parameter settings are loaded from production cell (part number that the customer is ordering).	Production data
.InvFrameSize	U32	Read	Inverter frame size of the unit (i.e. 6 for MI06 unit)	Production data

2.17. OS

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			OS	
OS				
Elements				
.Start	BOOL	Read	Set during the first processing time.	
.LoopCnt	U32	Read	Counter that increment with 1 every processing time.	
.ExecTime	U16	Read	processing time [ms]	
.ExecTimeOut	U16	Write	Requested processing time [ms]	**Note1**
.ExecTimeWork	U16	Read	Actual work time during processing time [ms]	
.ETime	U32	Read	Time since power on [10ms]	

2.18. LED

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			LED	
Led				
Elements				
.Red	BOOL	Write	Red LED, True = On	
.Green	BOOL	Write	Green LED, True = On	

2.19. NVMem

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			NVMem	
NVMem				
Elements				
.Status	U16	Read	Status of Non Volatile memory after reset. The status code is bit coded. Bit 0 Set = The NVMem was restored to a previous state. This may happen when a store operation was aborted. For example due to power off. Bit 1 Set = The NV Memory checksums are not correct. This may for instance occur the first boot up after a new application is downloaded, if the NV Memory usage is changed. Bit 2 Set = The reset routine could not access the NV memory. For instance due to a hardware problem. Bit3..15 is reserved	

2.20. Service Tool Access

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Service Tool Access	
ServiceTool	-			
Elements				
.DisableRead	BOOL	Write	True = The Service Tool has no read access to the unit.	
.DisableWrite	BOOL	Write	True = The Service Tool has no write access to the unit.	
.DisableDownload	BOOL	Write	True = The Service Tool has no access to download any file to the unit.	
.Connect	BOOL	Read	True = The unit has received a Service Tool Command during the last execution loop.	
.MasterPassword.-Read	U32	Write	This value can be read by the Service Tool even if .DisableRead is True.	
.MasterPassword.-Write	U32	Read	This value can be written to by the Service Tool even if .DisableWrite is True. It can also be read by the Service Tool even if .DisableRead is True.	

2.21. IDENTITY

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			Identity	
ID				
Elements				
.Node				
Elements				
.ServerAddr	U8	Write	The node number of this unit.	**Note1**
.ClientAddr	U8	Read	The node number of the diagnostic tool.	
.Net[n]				
Elements				
.Addr	U8	Write	The net number, n=0…1	**Note1**

2.22. CAN INTERFACE

CAN-Controller internal in CPU is used for CAN bus. Following CAN-signals are implemented.

Variable Name	Variable Type	Variable Direction	Function, Scaling	Miscellaneous
			CAN[0]	
CAN[0]				
Elements				
.Baudrate	U32	Write	Default 250000 baud Supported Baud rates: 50000 baud 100000 baud 125000 baud 250000 baud 500000 baud 1000000 baud	**Note2**
.BussOff	BOOL	Read	Set ⇒ If the CAN controller is in Bus Off mode	
.Reset	BOOL	Write	Set ⇒ Resets the CAN controller and Bus of f mode	
.DriverError	BOOL	Read	Set ⇒ The CAN driver could not be initialized and the whole CAN functionality is shut down. For CAN[0] this flag could be set if other CAN-Nodes already communicate during initialization phase.	
.DriverReset	BOOL	Write	Set ⇒ Reinitialize the CAN driver if DriverError is Set.	
.Overflow	BOOL	Read	Set ⇒ The internal CAN message queue have was full during the last execution loop. A message may have been lost.	
.Port	PORT	Read	A handler for the CAN port x, used as an input to a CAN symbol to select which CAN port to use.	

3. Notes

3.1. Note1:

This signal must use the symbol “Initialize Hardware Output”.
This means that this output will be updated before the application starts.

3.2. Note2:

This signal can use both symbols “Initialize Hardware Output” and “Hardware Output”.
“Initialize Hardware Output” means that this output will be updated before the application starts.
“Hardware Output” means that this output will be updated every loop in the application.

3.3. Note3:

For invalid values the default value is taken.

3.4. Note4:

The input value will be limited to the valid range. For invalid values the minimum or maximum value is taken.
(If invalid value is less than the minimum allowed value the minimum allowed value is taken, if invalid value is bigger than the maximum allowed value, the maximum allowed value is taken.)

3.5. Note5:

To reinitialize the APL with the new variables given by the API, the special variable .ReInit inside the structure need to be triggered.

4. Miscellaneous

All Scaling for inputs and outputs are theoretical values, for exact data see engineering specification for hardware.
More technical details can be found in "Plus+1 Controller Family Technical Information"
The engineering specification can be found, Sauer-Danfoss internally, in the EDMS system.

Maximum nested levels are 10

The Data types; BOOL, S8 and U8 will allocate 2 bytes (16bit) each in this hardware.

If the PLUS+1 GUIDE Service Tool version < 2.2 the PLUS+1 GUIDE Service Tool size of the downloadable file will be 20000H.

PLUS+1 GUIDE 4.0 or higher is required.

4.1. Supported GUIDE Components

The following GUIDE components which needs support from the SYS are allowed

- Initialize Hardware Output
- Integer Sine
- Integer Cosine
- Integer Tangent
- Integer Arc Sine
- Integer Arc Cosine
- Integer Arc Tangent
- Integer Square Root
- Module Input
- Module Bus Input
- Module Bus Output
- Hardware Input/Output
- Hardware Input
- Read Output from Hardware
- Open Parameter Set
- Close Parameter Set
- Read-only Parameter Input with Namespace
- Read-only Parameter Input
- Access App Log Enable
- Disable Raw Applog data Readout
- Accessrights App Log Diagnostics
- Accessrights App Log Errors
- Accessrights App Log Others
- Accessrights History
- Accessrights Read
- Accessrights Write
- Transmit CAN
- Receive CAN with Filter
- Receive CAN with ID Mask
- Receive CAN Basic
- Non Volatile memory Dynamic with Default
- Non Volatile memory Dynamic

- Non Volatile memory Dynamic Input
- Set Pulse
- Repeat
- Until
- Get Time us

4.2. Diagnostic Data (PLG) In Target

Diagnostic Data (PLG file) is dynamic allocated in target FLASH memory,

4.3. ToolKey

"LOGKEY" Supported.

4.4. TimeBase

The following time bases are supported
T1M
T10M
T100M
T1S
T60S
T1H
TLOOP

4.5. Unit History

Unit History is supported. The 20 latest activities are logged.

4.6. Read Only Parameters Support

This software supports Read Only Parameters.

This SYS have a parameter named ReadOnlyParameters which enables or disables this function.. The parameter can have the values ENABLE or DISABLE where DISABLE is the default value. The value can be set in the GUIDE. Select this SYS in the Project manager and Edit the Parameter in the Inspector.
NOTE: The memory calculation would not be correct, when the ReadOnlyParameters is in ENABLE mode. The Total amount of ROM should be reduced with 8192 to get the correct calculation.

Needed information for csv file:

ADDRESSMODE:	LSBFIRST
DEFAULTTYPEDATA:	1
MIN_DATASIZE:	16

4.7. HOST-settings

In General the PLUS1 Setup program does this.

This setting use TI Compiler v 4.1.3, Key is;
```
TMS320C2000 C/C++ v4.1.3 –BEGIN
```

Data Sheet

PLUS+1™ GUIDE

Graphical User Integrated Development Environment

Take Control of Your Applications with GUIDE!

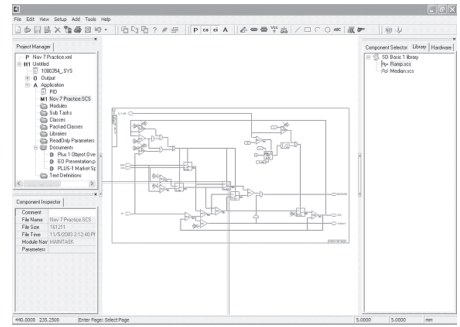
GUIDE (Graphical User Integrated Development Environment) is a member of the PLUS+1 family of products that provide complete vehicle control solutions. Other PLUS+1 products include controllers, displays, and electrohydraulic products.

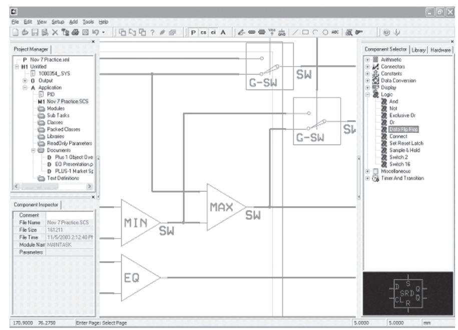
GUIDE allows graphical development of machine management applications, downloading of software via CAN, and development of user specific service and diagnostic tools. GUIDE maximizes OEM engineering productivity and protects intellectual property

GUIDE Development Tool

GUIDE uses graphic symbols and components to create application drawings that are easily understood by inexperienced programmers. The drawing represents the software application which is then automatically coded and serves as the documentation for the program.

Local Address:





GUIDE Screens

GUIDE Features

- Rapid production of applications enabled by dragging and dropping proven graphical software objects
- Built on reliable, robust field-proven tools
- Assures protection of proprietary intellectual property
- Graphical editor allows easy development of applications by inexperienced programmers
- Service tool has multiple access protection levels to protect against unauthorized use and tampering
- PLUS+1 compliant function blocks increase productivity by allowing rapid set-up of Sauer-Danfoss compliant sensor, pump, motor, and valve products

SAUER DANFOSS

PLUS+1™ GUIDE Graphical User Integrated Development Environment

GUIDE Development Tool

- Symbols and components are selected from a palette and dropped onto the drawing space.
- Sauer-Danfoss developed function blocks are available for common control requirements such as PID control, ramp, filter, and command signal profiles.
- GUIDE compliance blocks allow rapid integration of input and output signals from Sauer-Danfoss electrohydraulic products through the use of predetermined signal types and parameter default settings.
- Graphical programming reduces the number of steps required to develop an application; source code is generated directly from the application drawing to reduce coding errors.
- On-line and context-sensitive help allows easy comprehension of product features.
- Application data logging aids machine diagnostics.

Downloader

GUIDE includes an easy to use download tool. Application files are downloaded to the target controller via CAN. The download tool allows PLUS+1 users to access all of the controllers and intelligent devices on the PLUS+1 network. Simple, fast, reliable communications between a controller, or network of controllers, and a PC USB port is accomplished with the CG150 CAN/USB gateway.

Service Tool

GUIDE includes a Service Tool that provides the ability to monitor and tune the operation of all devices on a PLUS+1 network. The application developer can use basic Service Tool building blocks to develop a custom look and feel Service Tool. Standard features of the Service Tool include bar graph displays, oscilloscope displays for trending and tuning, and data export to spreadsheet tools. User-defined graphics allow the Service Tool to have a proprietary look and feel.

The Service Tool allows:

- OEM customization of the Service Tool look and feel
- Importation of user-defined graphics in JPEG, TIFF, GIF, or BMP format
- Access to any device on PLUS+1 network via CAN, using the CG150 CAN/USB gateway
- Data logging
- Read and write access to tuning parameters
- Protection for determining the level of access to PLUS+1 device data
- Viewing of history logs maintained in the PLUS+1 device

Specifications

PLUS+1 GUIDE Minimum System Requirements
1.5 GHz processor
Microsoft® Windows® XP
Local administrator access on used PC
1 GB of system memory
355 MB of available hard disk space
1024 x 768 or higher resolution graphics card/monitor with 16 bit color
Access to e-mail for license registration
Adobe Acrobat Reader v7.0 or higher

PLUS+1 Service Tool Minimum System Requirements
1.0 GHz processor
Microsoft® Windows® XP
Local administrator access on used PC
1 GB of system memory
125 MB or available hard disk space
1024 x 768 or higher resolution graphics card/monitor with 16 bit color
USB 2.0 for use with CAN/USB gateway
Access to e-mail for license registration
Adobe Acrobat Reader v7.0 or higher

Ordering Information

PLUS+1 GUIDE

Short Term and Single Seat Packages	Sauer-Danfoss part number
28 day single seat short term license	10101078
Full capability single seat license	10101000

Related Product

Type	Sauer-Danfoss part number
CG150 CAN/USB gateway	10104136

Comprehensive technical information: *PLUS+1 GUIDE Software User Manual*, **10100824**
Sauer-Danfoss product literature on line at: www.sauer-danfoss.com

MCP2551

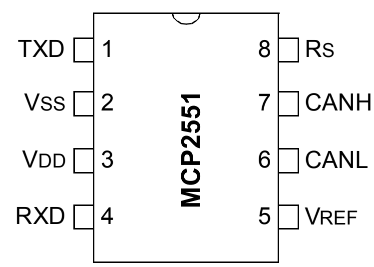
High-Speed CAN Transceiver

Features

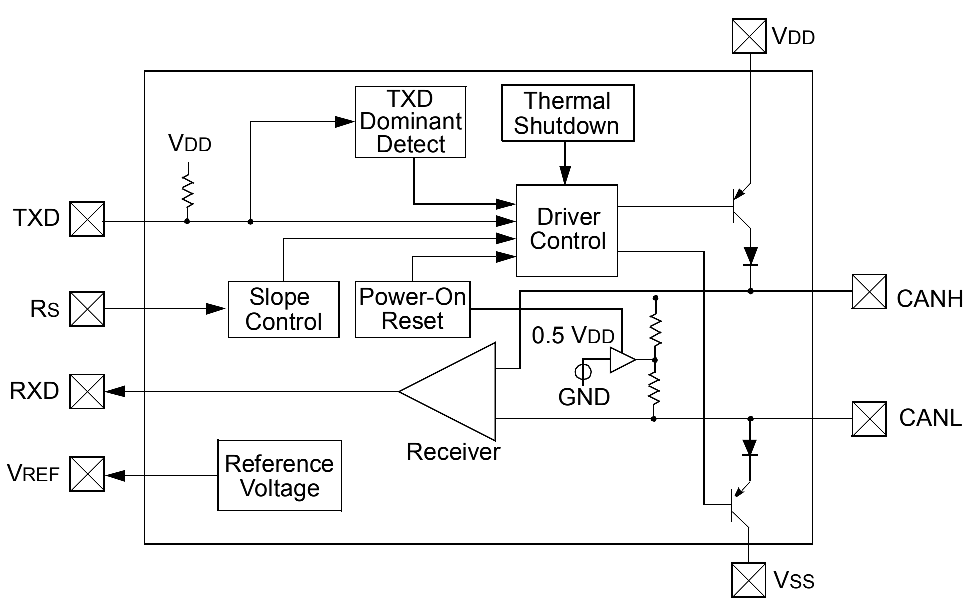
- Supports 1 Mb/s operation
- Implements ISO-11898 standard physical layer requirements
- Suitable for 12V and 24V systems
- Externally-controlled slope for reduced RFI emissions
- Detection of ground fault (permanent dominant) on TXD input
- Power-on reset and voltage brown-out protection
- An unpowered node or brown-out event will not disturb the CAN bus
- Low current standby operation
- Protection against damage due to short-circuit conditions (positive or negative battery voltage)
- Protection against high-voltage transients
- Automatic thermal shutdown protection
- Up to 112 nodes can be connected
- High noise immunity due to differential bus implementation
- Temperature ranges:
  - Industrial (I): -40°C to +85°C
  - Extended (E): -40°C to +125°C

Package Types

PDIP/SOIC



Block Diagram



NOTES:

1.0 DEVICE OVERVIEW

The MCP2551 is a high-speed CAN, fault-tolerant device that serves as the interface between a CAN protocol controller and the physical bus. The MCP2551 provides differential transmit and receive capability for the CAN protocol controller and is fully compatible with the ISO-11898 standard, including 24V requirements. It will operate at speeds of up to 1 Mb/s.

Typically, each node in a CAN system must have a device to convert the digital signals generated by a CAN controller to signals suitable for transmission over the bus cabling (differential output). It also provides a buffer between the CAN controller and the high-voltage spikes that can be generated on the CAN bus by outside sources (EMI, ESD, electrical transients, etc.).

1.1 Transmitter Function

The CAN bus has two states: Dominant and Recessive. A dominant state occurs when the differential voltage between CANH and CANL is greater than a defined voltage (e.g.,1.2V). A recessive state occurs when the differential voltage is less than a defined voltage (typically 0V). The dominant and recessive states correspond to the low and high state of the TXD input pin, respectively. However, a dominant state initiated by another CAN node will override a recessive state on the CAN bus.

1.1.1 MAXIMUM NUMBER OF NODES

The MCP2551 CAN outputs will drive a minimum load of 45Ω, allowing a maximum of 112 nodes to be connected (given a minimum differential input resistance of 20 kΩ and a nominal termination resistor value of 120Ω).

1.2 Receiver Function

The RXD output pin reflects the differential bus voltage between CANH and CANL. The low and high states of the RXD output pin correspond to the dominant and recessive states of the CAN bus, respectively.

1.3 Internal Protection

CANH and CANL are protected against battery short-circuits and electrical transients that can occur on the CAN bus. This feature prevents destruction of the transmitter output stage during such a fault condition.

The device is further protected from excessive current loading by thermal shutdown circuitry that disables the output drivers when the junction temperature exceeds a nominal limit of 165°C. All other parts of the chip remain operational and the chip temperature is lowered due to the decreased power dissipation in the transmitter outputs. This protection is essential to protect against bus line short-circuit-induced damage.

1.4 Operating Modes

The R_S pin allows three modes of operation to be selected:

- High-Speed
- Slope-Control
- Standby

These modes are summarized in Table 1-1.

When in High-speed or Slope-control mode, the drivers for the CANH and CANL signals are internally regulated to provide controlled symmetry in order to minimize EMI emissions.

Additionally, the slope of the signal transitions on CANH and CANL can be controlled with a resistor connected from pin 8 (R_S) to ground, with the slope proportional to the current output at R_S, further reducing EMI emissions.

1.4.1 HIGH-SPEED

High-speed mode is selected by connecting the R_S pin to V_{SS}. In this mode, the transmitter output drivers have fast output rise and fall times to support high-speed CAN bus rates.

1.4.2 SLOPE-CONTROL

Slope-control mode further reduces EMI by limiting the rise and fall times of CANH and CANL. The slope, or slew rate (SR), is controlled by connecting an external resistor (R_{EXT}) between R_S and V_{OL} (usually ground). The slope is proportional to the current output at the R_S pin. Since the current is primarily determined by the slope-control resistance value R_{EXT}, a certain slew rate is achieved by applying a respective resistance. Figure 1-1 illustrates typical slew rate values as a function of the slope-control resistance value.

1.4.3 STANDBY MODE

The device may be placed in standby or “SLEEP” mode by applying a high-level to R_S. In SLEEP mode, the transmitter is switched off and the receiver operates at a lower current. The receive pin on the controller side (RXD) is still functional but will operate at a slower rate. The attached microcontroller can monitor RXD for CAN bus activity and place the transceiver into normal operation via the R_S pin (at higher bus rates, the first CAN message may be lost).

TABLE 1-1: MODES OF OPERATION

Mode	Current at R_S Pin	Resulting Voltage at R_S Pin
Standby	$-I_{RS}$ < 10 µA	V_{RS} > 0.75 V_{DD}
Slope-control	10 µA < $-I_{RS}$ < 200 µA	0.4 V_{DD} < V_{RS} < 0.6 V_{DD}
High-speed	$-I_{RS}$ < 610 µA	0 < V_{RS} < $0.3V_{DD}$

TABLE 1-2: TRANSCEIVER TRUTH TABLE

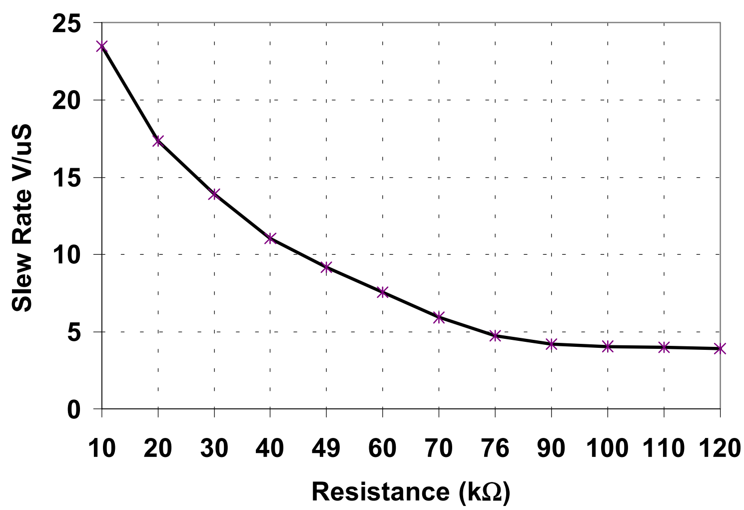
V_{DD}	V_{RS}	TXD	CANH	CANL	Bus State[1]	RXD[1]
4.5V ≤ V_{DD} ≤ 5.5V	V_{RS} < 0.75 V_{DD}	0	HIGH	LOW	Dominant	0
		1 or floating	Not Driven	Not Driven	Recessive	1
	V_{RS} > 0.75 V_{DD}	X	Not Driven	Not Driven	Recessive	1
V_{POR} < V_{DD} < 4.5V (See **Note 3**)	V_{RS} < 0.75 V_{DD}	0	HIGH	LOW	Dominant	0
		1 or floating	Not Driven	Not Driven	Recessive	1
	V_{RS} > 0.75 V_{DD}	X	Not Driven	Not Driven	Recessive	1
0 < V_{DD} < V_{POR}	X	X	Not Driven/ No Load	Not Driven/ No Load	High Impedance	X

Note 1: If another bus node is transmitting a dominant bit on the CAN bus, then RXD is a logic ‘0’.

2: X = “don’t care”.

3: Device drivers will function, although outputs are not ensured to meet the ISO-11898 specification.

FIGURE 1-1: SLEW RATE VS. SLOPE-CONTROL RESISTANCE VALUE



1.5 TXD Permanent Dominant Detection

If the MCP2551 detects an extended low state on the TXD input, it will disable the CANH and CANL output drivers in order to prevent the corruption of data on the CAN bus. The drivers are disabled if TXD is low for more than 1.25 ms (minimum). This implies a maximum bit time of 62.5 µs (16 kb/s bus rate), allowing up to 20 consecutive transmitted dominant bits during a multiple bit error and error frame scenario. The drivers remain disabled as long as TXD remains low. A rising edge on TXD will reset the timer logic and enable the CANH and CANL output drivers.

1.6 Power-on Reset

When the device is powered on, CANH and CANL remain in a high-impedance state until V_{DD} reaches the voltage-level V_{PORH}. In addition, CANH and CANL will remain in a high-impedance state if TXD is low when V_{DD} reaches V_{PORH}. CANH and CANL will become active only after TXD is asserted high. Once powered on, CANH and CANL will enter a high-impedance state if the voltage level at V_{DD} falls below V_{PORL}, providing voltage brown-out protection during normal operation.

1.7 Pin Descriptions

The 8-pin pinout is listed in Table 1-3.

TABLE 1-3: MCP2551 PINOUT

Pin Number	Pin Name	Pin Function
1	TXD	Transmit Data Input
2	V_{SS}	Ground
3	V_{DD}	Supply Voltage
4	RXD	Receive Data Output
5	V_{REF}	Reference Output Voltage
6	CANL	CAN Low-Level Voltage I/O
7	CANH	CAN High-Level Voltage I/O
8	R_S	Slope-Control Input

1.7.1 TRANSMITTER DATA INPUT (TXD)

TXD is a TTL-compatible input pin. The data on this pin is driven out on the CANH and CANL differential output pins. It is usually connected to the transmitter data output of the CAN controller device. When TXD is low, CANH and CANL are in the dominant state. When TXD is high, CANH and CANL are in the recessive state, provided that another CAN node is not driving the CAN bus with a dominant state. TXD has an internal pull-up resistor (nominal 25 kΩ to V_{DD}).

1.7.2 GROUND SUPPLY (V_{SS})

Ground supply pin.

1.7.3 SUPPLY VOLTAGE (V_{DD})

Positive supply voltage pin.

1.7.4 RECEIVER DATA OUTPUT (RXD)

RXD is a CMOS-compatible output that drives high or low depending on the differential signals on the CANH and CANL pins and is usually connected to the receiver data input of the CAN controller device. RXD is high when the CAN bus is recessive and low in the dominant state.

1.7.5 REFERENCE VOLTAGE (V_{REF})

Reference Voltage Output (Defined as $V_{DD}/2$).

1.7.6 CAN LOW (CANL)

The CANL output drives the low side of the CAN differential bus. This pin is also tied internally to the receive input comparator.

1.7.7 CAN HIGH (CANH)

The CANH output drives the high-side of the CAN differential bus. This pin is also tied internally to the receive input comparator.

1.7.8 SLOPE RESISTOR INPUT (R_S)

The R_S pin is used to select High-speed, Slope-control or Standby modes via an external biasing resistor.

NOTES:

2.0 ELECTRICAL CHARACTERISTICS

2.1 Terms and Definitions

A number of terms are defined in ISO-11898 that are used to describe the electrical characteristics of a CAN transceiver device. These terms and definitions are summarized in this section.

2.1.1 BUS VOLTAGE

V_{CANL} and V_{CANH} denote the voltages of the bus line wires CANL and CANH relative to ground of each individual CAN node.

2.1.2 COMMON MODE BUS VOLTAGE RANGE

Boundary voltage levels of V_{CANL} and V_{CANH} with respect to ground, for which proper operation will occur, if up to the maximum number of CAN nodes are connected to the bus.

2.1.3 DIFFERENTIAL INTERNAL CAPACITANCE, C_{DIFF} (OF A CAN NODE)

Capacitance seen between CANL and CANH during the recessive state when the CAN node is disconnected from the bus (see Figure 2-1).

2.1.4 DIFFERENTIAL INTERNAL RESISTANCE, R_{DIFF} (OF A CAN NODE)

Resistance seen between CANL and CANH during the recessive state when the CAN node is disconnected from the bus (see Figure 2-1).

2.1.5 DIFFERENTIAL VOLTAGE, V_{DIFF} (OF CAN BUS)

Differential voltage of the two-wire CAN bus, value $V_{DIFF} = V_{CANH} - V_{CANL}$.

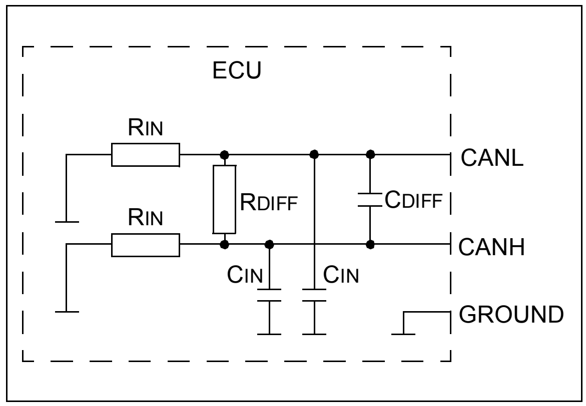
2.1.6 INTERNAL CAPACITANCE, C_{IN} (OF A CAN NODE)

Capacitance seen between CANL (or CANH) and ground during the recessive state when the CAN node is disconnected from the bus (see Figure 2-1).

2.1.7 INTERNAL RESISTANCE, R_{IN} (OF A CAN NODE)

Resistance seen between CANL (or CANH) and ground during the recessive state when the CAN node is disconnected from the bus (see Figure 2-1).

FIGURE 2-1: PHYSICAL LAYER DEFINITIONS



Absolute Maximum Ratings†

V_{DD}	7.0V
DC Voltage at TXD, RXD, V_{REF} and V_S	-0.3V to V_{DD} + 0.3V
DC Voltage at CANH, CANL (**Note 1**)	-42V to +42V
Transient Voltage on Pins 6 and 7 (**Note 2**)	-250V to +250V
Storage temperature	-55°C to +150°C
Operating ambient temperature	-40°C to +125°C
Virtual Junction Temperature, T_{VJ} (**Note 3**)	-40°C to +150°C
Soldering temperature of leads (10 seconds)	+300°C
ESD protection on CANH and CANL pins (**Note 4**)	6 kV
ESD protection on all other pins (**Note 4**)	4 kV

Note 1: Short-circuit applied when TXD is high and low.

2: In accordance with ISO-7637.

3: In accordance with IEC 60747-1.

4: Classification A: Human Body Model.

† NOTICE: Stresses above those listed under “Maximum ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

2.2 DC Characteristics

DC Specifications			Electrical Characteristics: Industrial (I): T_{AMB} = -40°C to +85°C V_{DD} = 4.5V to 5.5V Extended (E): T_{AMB} = -40°C to +125°C V_{DD} = 4.5V to 5.5V			
Param No.	**Sym**	**Characteristic**	**Min**	**Max**	**Units**	**Conditions**
Supply						
D1	I_{DD}	Supply Current	—	75	mA	Dominant; V_{TXD} = 0.8V; V_{DD}
D2			—	10	mA	Recessive; V_{TXD} = +2V; R_S = 47 kΩ
D3			—	365	µA	-40°C ≤ T_{AMB} ≤ +85°C, Standby; **(Note 2)**
			—	465	µA	-40°C ≤ T_{AMB} ≤ +125°C, Standby; **(Note 2)**
D4	V_{PORH}	High-level of the power-on reset comparator	3.8	4.3	V	CANH, CANL outputs are active when V_{DD} > V_{PORH}
D5	V_{PORL}	Low-level of the power-on reset comparator	3.4	4.0	V	CANH, CANL outputs are not active when V_{DD} < V_{PORL}
D6	V_{PORD}	Hysteresis of power-on reset comparator	0.3	0.8	V	**Note 1**
Bus Line (CANH; CANL) Transmitter						
D7	$V_{CANH(r)}$; $V_{CANL(r)}$	CANH, CANL Recessive bus voltage	2.0	3.0	V	V_{TXD} = V_{DD}; no load.
D8	$I_{O(CANH)(reces)}$ $I_{O(CANL)(reces)}$	Recessive output current	-2	+2	mA	-2V < $V_{(CAHL,CANH)}$ < +7V, 0V < V_{DD} < 5.5V
D9			-10	+10	mA	-5V < $V_{(CANL,CANH)}$ < +40V, 0V < V_{DD} < 5.5V
D10	$V_{O(CANH)}$	CANH dominant output voltage	2.75	4.5	V	V_{TXD} = 0.8V
D11	$V_{O(CANL)}$	CANL dominant output voltage	0.5	2.25	V	V_{TXD} = 0.8V
D12	$V_{DIFF(r)(o)}$	Recessive differential output voltage	-500	+50	mV	V_{TXD} = 2V; no load
D13	$V_{DIFF(d)(o)}$	Dominant differential output voltage	1.5	3.0	V	V_{TXD} = 0.8V; V_{DD} = 5V 40Ω < R_L < 60Ω **(Note 2)**
D14	$I_{O(SC)(CANH)}$	CANH short-circuit output current	—	-200	mA	V_{CANH} = -5V
D15			—	-100 (typical)	mA	V_{CANH} = -40V, +40V. **(Note 1)**
D16	$I_{O(SC)(CANL)}$	CANL short-circuit output current	—	200	mA	V_{CANL} = -40V, +40V. **(Note 1)**
Bus Line (CANH; CANL) Receiver: [TXD = 2V; pins 6 and 7 externally driven]						
D17	$V_{DIFF(r)(i)}$	Recessive differential input voltage	-1.0	+0.5	V	-2V < $V_{(CANL, CANH)}$ < +7V **(Note 3)**
			-1.0	+0.4	V	-12V < $V_{(CANL, CANH)}$ < +12V **(Note 3)**
D18	$V_{DIFF(d)(i)}$	Dominant differential input voltage	0.9	5.0	V	-2V < $V_{(CANL, CANH)}$ < +7V **(Note 3)**
			1.0	5.0	V	-12V < $V_{(CANL, CANH)}$ < +12V **(Note 3)**
D19	$V_{DIFF(h)(i)}$	Differential input hysteresis	100	200	mV	see **Figure 2-3**. **(Note 1)**
D20	R_{IN}	CANH, CANL common-mode input resistance	5	50	kΩ	
D21	$R_{IN(d)}$	Deviation between CANH and CANL common-mode input resistance	-3	+3	%	V_{CANH} = V_{CANL}

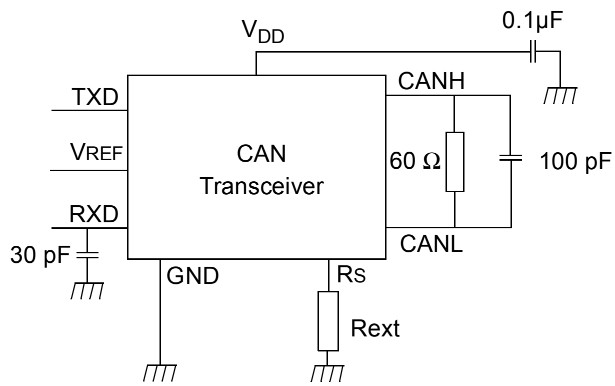
Note 1: This parameter is periodically sampled and not 100% tested.
2: I_{TXD} = I_{RXD} = I_{VREF} = 0 mA; 0V < V_{CANL} < V_{DD}; 0V < V_{CANH} < V_{DD}; V_{RS} = V_{DD}.
3: This is valid for the receiver in all modes; High-speed, Slope-control and Standby.

2.2 DC Characteristics (Continued)

DC Specifications (Continued)			Electrical Characteristics: Industrial (I): T_{AMB} = -40°C to +85°C V_{DD} = 4.5V to 5.5V Extended (E): T_{AMB} = -40°C to +125°C V_{DD} = 4.5V to 5.5V			
Param No.	**Sym**	**Characteristic**	**Min**	**Max**	**Units**	**Conditions**
Bus Line (CANH; CANL) Receiver: [TXD = 2V; pins 6 and 7 externally driven]						
D22	R_{DIFF}	Differential input resistance	20	100	kΩ	
D24	I_{LI}	CANH, CANL input leakage current	—	150	µA	$V_{DD} < V_{POR}$; $V_{CANH} = V_{CANL}$ = +5V
Transmitter Data Input (TXD)						
D25	V_{IH}	High-level input voltage	2.0	V_{DD}	V	Output recessive
D26	V_{IL}	Low-level input voltage	V_{SS}	+0.8	V	Output dominant
D27	I_{IH}	High-level input current	-1	+1	µA	$V_{TXD} = V_{DD}$
D28	I_{IL}	Low-level input current	-100	-400	µA	V_{TXD} = 0V
Receiver Data Output (RXD)						
D31	V_{OH}	High-level output voltage	0.7 V_{DD}	—	V	I_{OH} = 8 mA
D32	V_{OL}	Low-level output voltage	—	0.8	V	I_{OL} = 8 mA
Voltage Reference Output (V_{REF})						
D33	V_{REF}	Reference output voltage	0.45 V_{DD}	0.55 V_{DD}	V	-50 µA < I_{VREF} < 50 µA
Standby/Slope-Control (Rs pin)						
D34	V_{STB}	Input voltage for standby mode	0.75 V_{DD}	—	V	
D35	I_{SLOPE}	Slope-control mode current	-10	-200	µA	
D36	V_{SLOPE}	Slope-control mode voltage	0.4 V_{DD}	0.6 V_{DD}	V	
Thermal Shutdown						
D37	$T_{J(sd)}$	Shutdown junction temperature	155	180	°C	**Note 1**
D38	$T_{J(h)}$	Shutdown temperature hysteresis	20	30	°C	-12V < V(CANL, CANH) < +12V **(Note 3)**

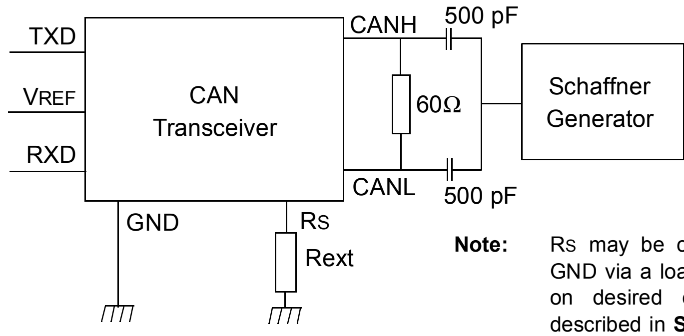
Note 1: This parameter is periodically sampled and not 100% tested.
2: $I_{TXD} = I_{RXD} = I_{VREF}$ = 0 mA; 0V < V_{CANL} < V_{DD}; 0V < V_{CANH} < V_{DD}; $V_{RS} = V_{DD}$.
3: This is valid for the receiver in all modes; High-speed, Slope-control and Standby.

FIGURE 2-1: TEST CIRCUIT FOR ELECTRICAL CHARACTERISTICS



Note: RS may be connected to VDD or GND via a load resistor depending on desired operating mode as described in **Section 1.7.8, "Slope Resistor Input (Rs)"**.

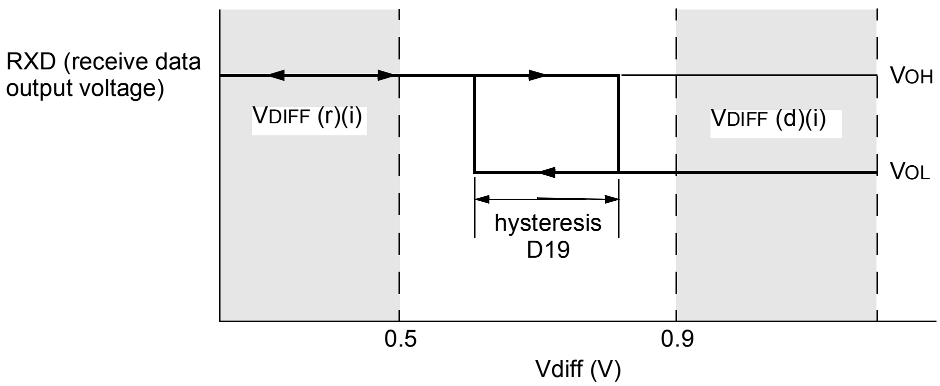
FIGURE 2-2: TEST CIRCUIT FOR AUTOMOTIVE TRANSIENTS



Note: RS may be connected to VDD or GND via a load resistor depending on desired operating mode as described in **Section 1.7.8, "Slope Resistor Input (Rs)"**

The wave forms of the applied transients shall be in accordance with "ISO-7637, Part 1", test pulses 1, 2, 3a and 3b.

FIGURE 2-3: HYSTERESIS OF THE RECEIVER



2.3 AC Characteristics

AC Specifications			Electrical Characteristics: Industrial (I): T_{AMB} = -40°C to +85°C V_{DD} = 4.5V to 5.5V Extended (E): T_{AMB} = -40°C to +125°C V_{DD} = 4.5V to 5.5V			
Param No.	**Sym**	**Characteristic**	**Min**	**Max**	**Units**	**Conditions**
1	t_{BIT}	Bit time	1	62.5	µs	V_{RS} = 0V
2	f_{BIT}	Bit frequency	16	1000	kHz	V_{RS} = 0V
3	TtxL2bus(d)	Delay TXD to bus active	—	70	ns	-40°C ≤ T_{AMB} ≤ +125°C, V_{RS} = 0V
4	TtxH2bus(r)	Delay TXD to bus inactive	—	125	ns	-40°C ≤ T_{AMB} ≤ +85°C, V_{RS} = 0V
			—	170	ns	-40°C ≤ T_{AMB} ≤ +125°C, V_{RS} = 0V
5	TtxL2rx(d)	Delay TXD to receive active	—	130	ns	-40°C ≤ T_{AMB} ≤ +125°C, V_{RS} = 0V
			—	250	ns	-40°C ≤ T_{AMB} ≤ +125°C, R_S = 47 kΩ
6	TtxH2rx(r)	Delay TXD to receiver inactive	—	175	ns	-40°C ≤ T_{AMB} ≤ +85°C, V_{RS} = 0V
			—	225	ns	-40°C ≤ T_{AMB} ≤ +85°C, R_S = 47 kΩ
			—	235	ns	-40°C ≤ T_{AMB} ≤ +125°C, V_{RS} = 0V
			—	400	ns	-40°C ≤ T_{AMB} ≤ +125°C, R_S = 47 kΩ
7	SR	CANH, CANL slew rate	5.5	8.5	V/µs	Refer to Figure 1-1; R_S = 47 kΩ, (**Note 1)**
10	t_{WAKE}	Wake-up time from standby (Rs pin)	—	5	µs	see Figure 2-5
11	TbusD2rx(s)	Bus dominant to RXD Low (Standby mode)	—	550	ns	V_{RS} = +4V; (see **Figure 2-2**)
12	$C_{IN(CANH)}$ $C_{IN(CANL)}$	CANH; CANL input capacitance	—	20 (typical)	pF	1 Mbit/s data rate; V_{TXD} = V_{DD}, **(Note 1)**
13	C_{DIFF}	Differential input capacitance	—	10 (typical)	pF	1 Mbit/s data rate **(Note 1)**
14	TtxL2busZ	TX Permanent Dominant Timer Disable Time	1.25	4	ms	
15	TtxR2pdt(res)	TX Permanent Dominant Timer Reset Time	—	1	µs	Rising edge on TXD while device is in permanent dominant state

Note 1: This parameter is periodically sampled and not 100% tested.

2.4 Timing Diagrams and Specifications

FIGURE 2-4: TIMING DIAGRAM FOR AC CHARACTERISTICS

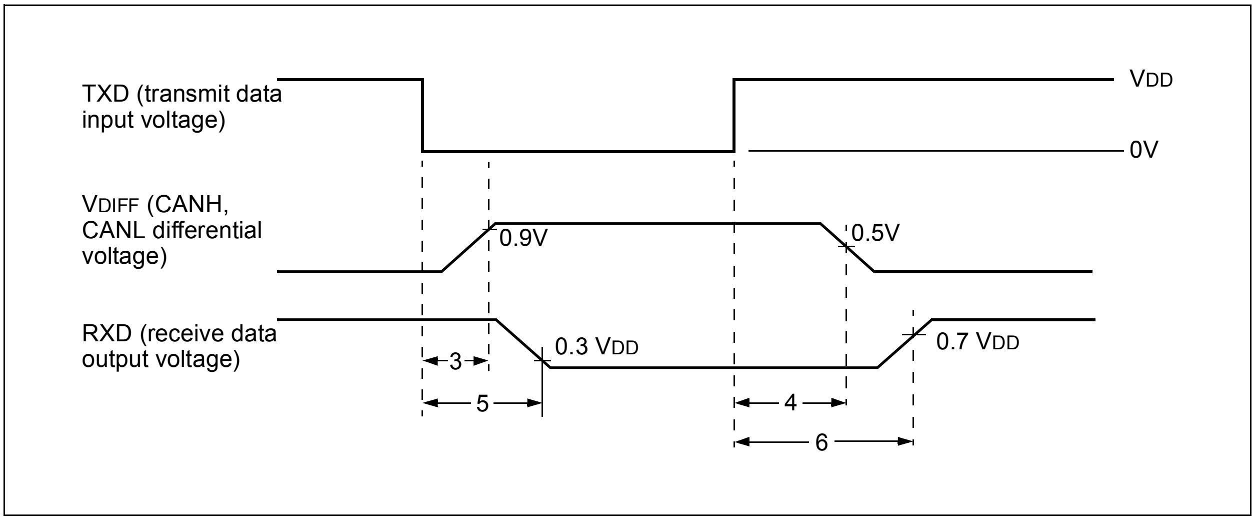


FIGURE 2-5: TIMING DIAGRAM FOR WAKE-UP FROM STANDBY

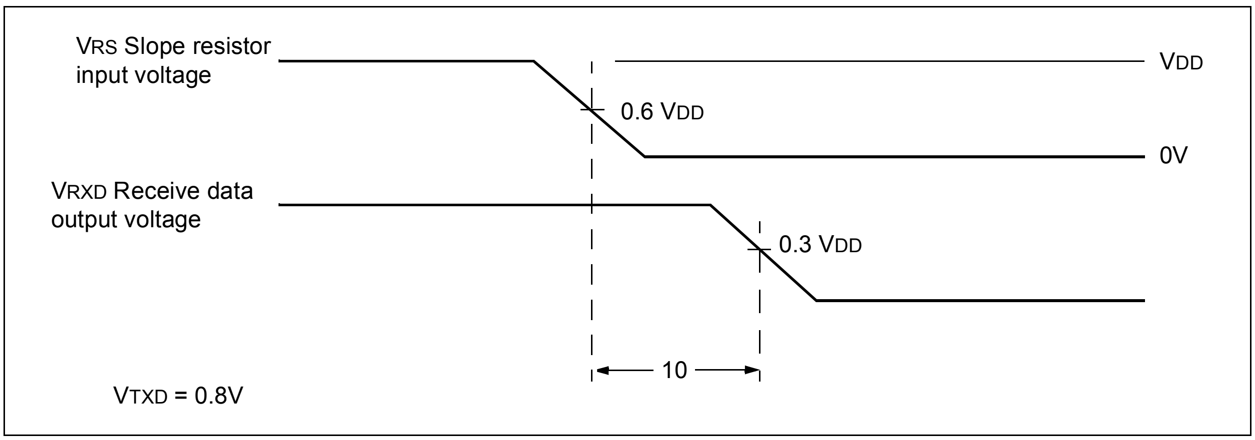
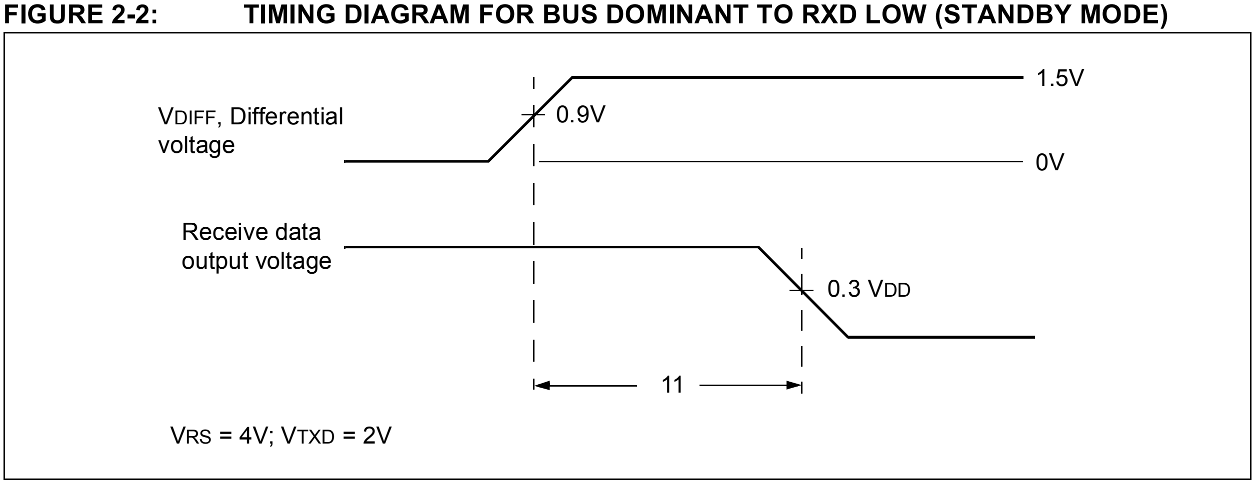


FIGURE 2-2: TIMING DIAGRAM FOR BUS DOMINANT TO RXD LOW (STANDBY MODE)

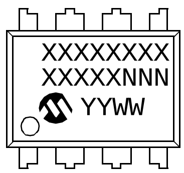


NOTES:

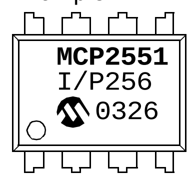
3.0 PACKAGING INFORMATION

3.1 Package Marking Information

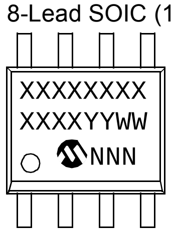
8-Lead PDIP (300 mil)



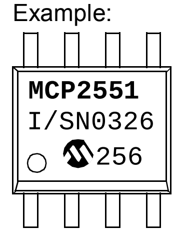
Example:



8-Lead SOIC (150 mil)



Example:

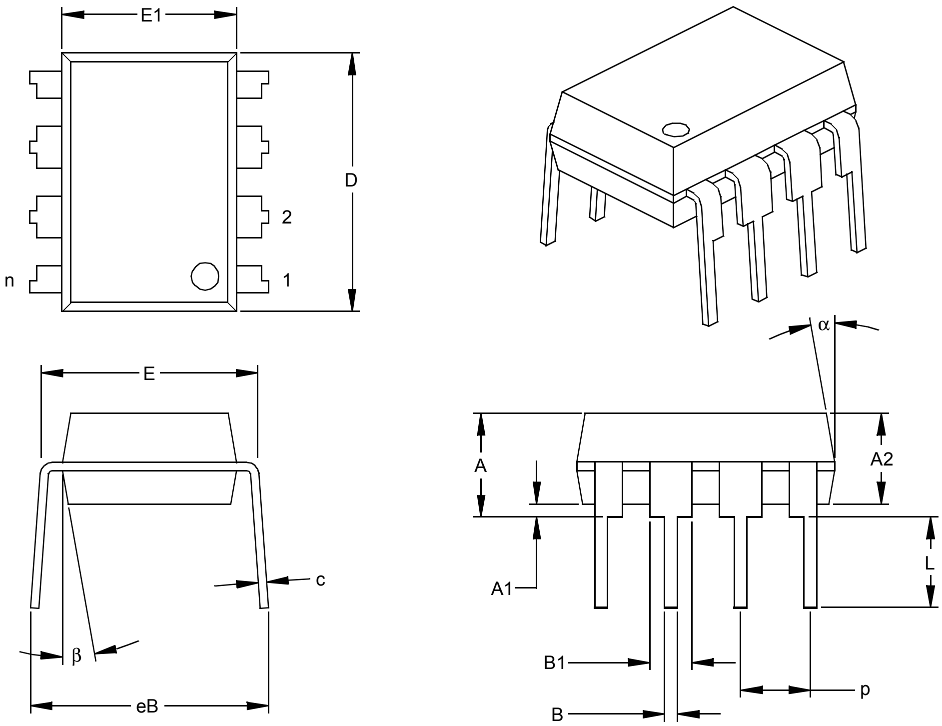


Legend:	XX...X	Customer specific information*
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line thus limiting the number of available characters for customer specific information.

* Standard marking consists of Microchip part number, year code, week code, traceability code (facility code, mask rev#, and assembly code). For marking beyond this, certain price adders apply. Please check with your Microchip Sales Office.

8-Lead Plastic Dual In-line (P) – 300 mil (PDIP)

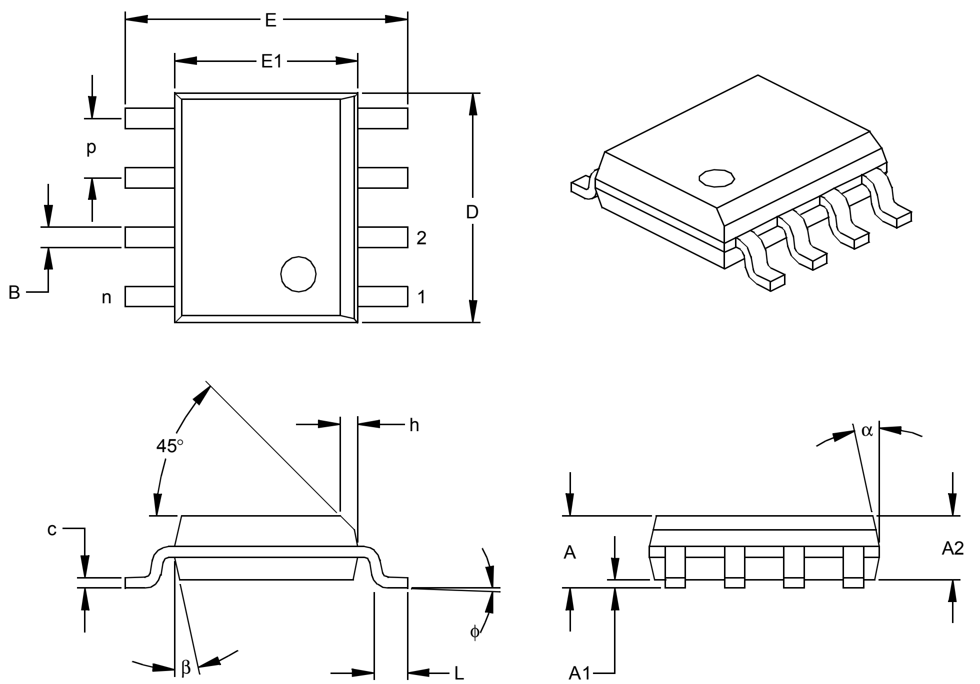


Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.140	.155	.170	3.56	3.94	4.32
Molded Package Thickness	A2	.115	.130	.145	2.92	3.30	3.68
Base to Seating Plane	A1	.015			0.38		
Shoulder to Shoulder Width	E	.300	.313	.325	7.62	7.94	8.26
Molded Package Width	E1	.240	.250	.260	6.10	6.35	6.60
Overall Length	D	.360	.373	.385	9.14	9.46	9.78
Tip to Seating Plane	L	.125	.130	.135	3.18	3.30	3.43
Lead Thickness	c	.008	.012	.015	0.20	0.29	0.38
Upper Lead Width	B1	.045	.058	.070	1.14	1.46	1.78
Lower Lead Width	B	.014	.018	.022	0.36	0.46	0.56
Overall Row Spacing §	eB	.310	.370	.430	7.87	9.40	10.92
Mold Draft Angle Top	α	5	10	15	5	10	15
Mold Draft Angle Bottom	β	5	10	15	5	10	15

* Controlling Parameter
§ Significant Characteristic

Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010” (0.254mm) per side.
JEDEC Equivalent: MS-001
Drawing No. C04-018

8-Lead Plastic Small Outline (SN) – Narrow, 150 mil (SOIC)



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.050			1.27	
Overall Height	A	.053	.061	.069	1.35	1.55	1.75
Molded Package Thickness	A2	.052	.056	.061	1.32	1.42	1.55
Standoff §	A1	.004	.007	.010	0.10	0.18	0.25
Overall Width	E	.228	.237	.244	5.79	6.02	6.20
Molded Package Width	E1	.146	.154	.157	3.71	3.91	3.99
Overall Length	D	.189	.193	.197	4.80	4.90	5.00
Chamfer Distance	h	.010	.015	.020	0.25	0.38	0.51
Foot Length	L	.019	.025	.030	0.48	0.62	0.76
Foot Angle	φ	0	4	8	0	4	8
Lead Thickness	c	.008	.009	.010	0.20	0.23	0.25
Lead Width	B	.013	.017	.020	0.33	0.42	0.51
Mold Draft Angle Top	α	0	12	15	0	12	15
Mold Draft Angle Bottom	β	0	12	15	0	12	15

* Controlling Parameter
§ Significant Characteristic

Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010” (0.254mm) per side.
JEDEC Equivalent: MS-012
Drawing No. C04-057

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	X	/XX
Device	Temperature Range	Package

Device:	MCP2551= High-Speed CAN Transceiver	
Temperature Range:	I =	-40°C to +85°C
	E =	-40°C to +125°C
Package:	P =	Plastic DIP (300 mil Body) 8-lead
	SN =	Plastic SOIC (150 mil Body) 8-lead

Examples:

a) MCP2551-I/P: Industrial temperature, PDIP package.

b) MCP2551-E/P: Extended temperature, PDIP package.

c) MCP2551-I/SN: Industrial temperature, SOIC package.

d) MCP2551T-I/SN: Tape and Reel, Industrial Temperature, SOIC package.

e) MCP2551T-E/SN: Tape and Reel, Extended Temperature, SOIC package.

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Products supported by a preliminary Data Sheet may have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

1. Your local Microchip sales office
2. The Microchip Corporate Literature Center U.S. FAX: (480) 792-7277
3. The Microchip Worldwide Site (www.microchip.com)

Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

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07/28/03

SAUER DANFOSS

Data Sheet

CG150 CAN/USB Gateway Interface Communicator

CG150 CAN/USB Gateway Interface Communicator

INTRODUCTION

The Sauer-Danfoss CG150 CAN Interface is an element of the PLUS+1™ family of mobile machine management products. The CG150 provides a compact and cost effective gateway interface between PLUS+1 compliant modules on the PLUS+1 Controller Area Network (CAN) and a personal computer (PC) USB port.

The CG150 communicator provides the application download of programs to PLUS+1 compliant devices on the PLUS+1 CAN network and upload/download of application tuning parameters.

Device drivers are imbedded in the PLUS+1 GUIDE (Graphical User Integrated Development Environment) service and diagnostic tool software.

The CG150 is compatible with Bosch CAN standard 2.0 A & B (standard and extended data frames) and USB standard 1.1 & 2.0.

Features

- USB powered
- Supports CAN bit rates up to 1000 kb per second
- CAN messages are time-stamped in 100 ms increments.
- Supports both 11-bit (CAN 2.0A) and 29-bit (CAN 2.0B) identifiers.
- Supports data and remote frames.
- Equipped with 110 cm [44 in] length USB cable and 30 cm [12 in] length CAN cable.
- Interface the CAN bus with 9-pin D-SUB connector.
- Designed for USB 2.0, backward compliant with USB 1.1
- Microsoft Windows XP® & Windows 2000® platforms.
- Plug and Play installation
- CAN bus monitor software available on the Sauer-Danfoss PLUS+1 website: www.sauer-danfoss-plus1.com

520L0945 Rev.B 02/06

CG150 CAN/USB Gateway Interface Communicator

Technical data

Technical Data

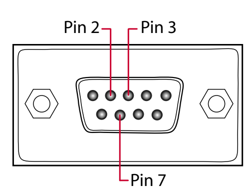
Dimensions	100 x 25 x 20 mm [4 x 1 x 0.75 in]
Power supply	USB
Current consumption	(approximately) 70 mA@5V
Operating temperature range	0° C – 70° C [32° F – 158° F]
Storage temperature range	-40° C – 85° C [-40° F – 185° F]
USB version	2.0.1.1
Clock accuracy	100 µs
LED indicators	2
Bit rate (kb/sec)	5 – 1000 Kbits/sec
CAN physical layer	High speed (ISO 11898-2)
Galvanic Isolation	No
Clock syncronization of multiple devices	No
Maximum message rates msgs/sec	8000
Time stamp (bits)	32
Error counters reading	No
Mix 11/29 bit messages	Yes
Error frame detection	Yes
Error frame generation	No
Silent mode	No
Sound indicator	No
CAN connector	9-pin male D-SUB
USB cable length	110 cm [44 in]
CAN cable length	30 cm [12 in]
Auto transmit buffers	No
Auto response buffers	No
Load dump protection	Yes
Polyurethane cabling	No

Status Lights

CAN pin configuration

CAN pin configuration

Pin	Function
1	–
2	CAN -
3	Shield/ Ground
4	–
5	–
6	–
7	CAN +
8	–
9	–



9-pin male connector, front-side view

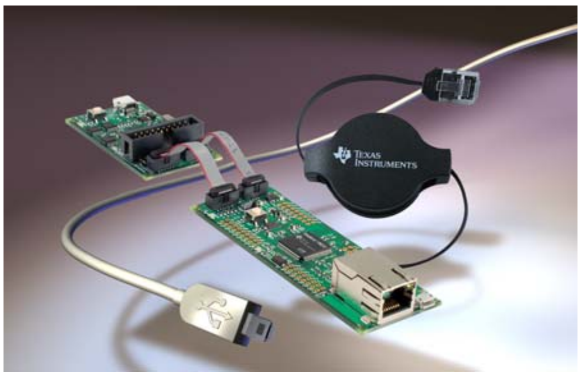
Ordering information

Ordering Information

CG150 CAN/USB Gateway Interface Communicator	Part Number 10104136

Stellaris® LM3S9B92 Ethernet+USB-OTG Evaluation Kit

The Stellaris® LM3S9B92 Ethernet+USB-OTG Evaluation Kit provides a low-cost evaluation platform for the LM3S9B92 ARM® Cortex™-M3-based microcontroller. The kit includes two boards: the EK-LM3S9B92 evaluation board, and the BD-ICDI In-Circuit Debug Interface board.The evaluation board design highlights the LM3S9B92 microcontroller's 10/100 Mbit Ethernet port, full-speed USB-OTG port, In-Circuit Debug Interface (ICDI) board, and easy connection to the GPIO ports.



Features

The evaluation board uses the LM3S9B92 microcontroller which features advanced motion control including eight PWM outputs for motion and energy and two Quadrature Encoder Inputs (QEI) modules.The LM3S9B92 microcontroller also features an external 16 MHz crystal that provides the main oscillator clock which can directly drive the ARM core clock or an internal PLL to increase the core clock up to 80 MHz. A 25 MHz crystal is used for the Ethernet clock. The LM3S9B92 microcontroller also has an internal LDO voltage regulator that supplies power for internal use.

The Stellaris EK-LM3S9B92 evaluation board includes the following features:

- Stellaris LM3S9B92 high-performance microcontroller with large memory
  - 32-bit ARM® Cortex™-M3 core
  - 256 KB main Flash memory, 96 KB SRAM, and 23.7 KB ROM
- Ethernet 10/100 port with two LED indicators
- USB 2.0 Full-Speed OTG port
- Virtual serial communications port capability
- Oversized board pads for GPIO access
- User pushbutton and LED
- Detachable In-Circuit Debug Interface (BD-ICDI) board can be used for programming and debugging other Stellaris® boards

Kit Contents

The EK-LM3S9B92 evaluation kit includes:

- EK-LM3S9B92 Evaluation Board (EVB)
- BD-ICDI In-Circuit Debug Interface Board
- Cables
  - USB cable
  - 10-pin ribbon cable for JTAG
  - 8-pin ribbon cable for power/UART connection
- Evaluation Kit CD containing:
  - Complete documentation
  - StellarisWare® Peripheral Driver Library and example source code
  - A supported evaluation version of one of the following:
    - Keil™ RealView® Microcontroller Development Kit (MDK-ARM)
    - IAR Embedded Workbench® development tools
    - Code Sourcery GCC development tools
    - Code Red Technologies Red Suite
    - Texas Instruments' Code Composer Studio™ IDE

Ordering Information

Product Number	Description
EKK-LM3S9B92	Stellaris® LM3S9B92 Low-Cost Evaluation Kit for Keil™ RealView® MDK-ARM (32 KB code-size limited)
EKI-LM3S9B92	Stellaris® LM3S9B92 Low-Cost Evaluation Kit for IAR Systems Embedded Workbench® (32 KB code-size limited)
EKC-LM3S9B92	Stellaris® LM3S9B92 Low-Cost Evaluation Kit for CodeSourcery G++ GNU (30-day limited)
EKT-LM3S9B92	Stellaris® LM3S9B92 Low-Cost Evaluation Kit for Code Red Technologies Red Suite (90-day limited)
EKS-LM3S9B92	Stellaris® LM3S9B92 Low-Cost Evaluation Kit for Code Composer Studio™ IDE (board-locked)

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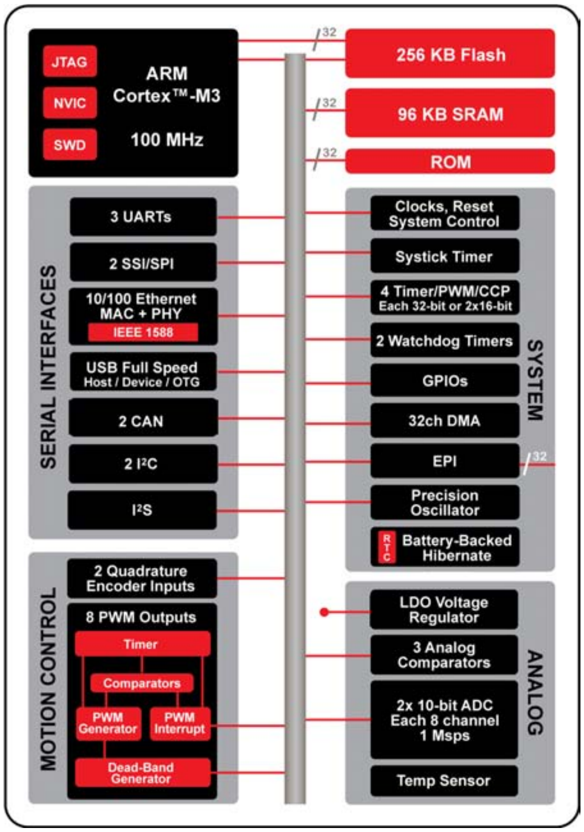
LM3S9B92 Microcontroller



LM3S9000 Series Block Diagram. This block diagram shows the superset of features for the LM3S9000 series of microcontrollers.

Product Features

- ARM® Cortex™-M3 Processor Core
  - 80-MHz operation; 100 DMIPS performance
  - ARM Cortex SysTick Timer
  - Nested Vectored Interrupt Controller (NVIC)
- On-Chip Memory
  - 256 KB single-cycle Flash memory up to 50 MHz; a prefetch buffer improves performance above 50 MHz
  - 96 KB single-cycle SRAM
  - Internal ROM loaded with StellarisWare® software:
    - Stellaris® Peripheral Driver Library
    - Stellaris® Boot Loader
    - Advanced Encryption Standard (AES) cryptography tables
    - Cyclic Redundancy Check (CRC) error detection functionality
- External Peripheral Interface (EPI)
  - 8/16/32-bit dedicated parallel bus for external peripherals
  - Supports SDRAM, SRAM/Flash memory, FPGAs, CPLDs
- Advanced Serial Integration
  - 10/100 Ethernet MAC and PHY
  - Two CAN 2.0 A/B controllers
  - USB 2.0 OTG/Host/Device
  - Three UARTs with IrDA and ISO 7816 support (one UART with full modem controls)
  - Two I^{2}C modules
  - Two Synchronous Serial Interface modules (SSI)
  - Integrated Interchip Sound (I^{2}S) module
- System Integration
  - Direct Memory Access Controller (DMA)
  - System control and clocks including on-chip precision 16-MHz oscillator
  - Four 32-bit timers (up to eight 16-bit)
  - Eight Capture Compare PWM pins (CCP)
  - Real-Time Clock
  - Two Watchdog Timers
    - One timer runs off the main oscillator
    - One timer runs off the precision internal oscillator
  - Up to 65 GPIOs, depending on configuration
    - Highly flexible pin muxing allows use as GPIO or one of several peripheral functions
    - Independently configurable to 2, 4 or 8 mA drive capability
    - Up to 4 GPIOs can have 18 mA drive capability
- Advanced Motion Control
  - Eight advanced PWM outputs for motion and energy applications
  - Four fault inputs to promote low-latency shutdown
  - Two Quadrature Encoder Inputs (QEI)
- Analog
  - Two 10-bit Analog-to-Digital Converters (ADC) with sixteen analog input channels and sample rate of one million samples/second
  - Three analog comparators
  - 16 digital comparators
  - On-chip voltage regulator
- JTAG and ARM Serial Wire Debug (SWD)
- 100-pin LQFP and 108-ball BGA package
- Industrial (-40°C to 85°C) Temperature Range

Target Applications

- Motion control
- Factory automation
- Fire and security
- HVAC and building control
- Power and energy
- Transportation
- Test and measurement equipment
- Medical instrumentation
- Remote monitoring
- Electronic point-of-sale (POS) machines
- Network appliances and switches
- Gaming equipment

LM3S9B92 Microcontroller

STELLARIS® microcontrollers

High-performance ARM Cortex-M3 microcontroller for real-time embedded applications

Ordering Information

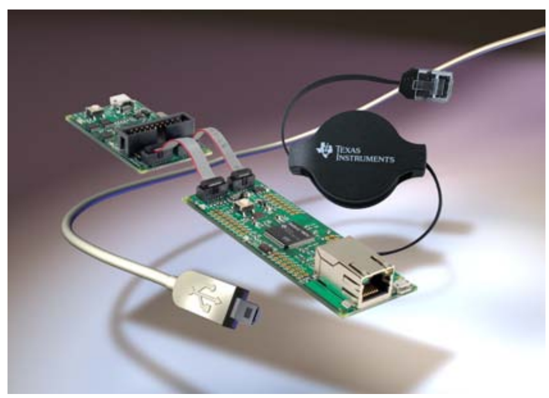
Orderable Part Number	Description
LM3S9B92-IQC80-C1	Stellaris® LM3S9B92 Microcontroller Industrial Temperature 100-pin LQFP
LM3S9B92-IBZ80-C1	Stellaris® LM3S9B92 Microcontroller Industrial Temperature 108-ball BGA
LM3S9B92-IQC80-C1T	Stellaris® LM3S9B92 Microcontroller Industrial Temperature 100-pin LQFP Tape-and-reel
LM3S9B92-IBZ80-C1T	Stellaris® LM3S9B92 Microcontroller Industrial Temperature 108-ball BGA Tape-and-reel

Development Kit

The Stellaris® LM3S9B96 Development Kit provides the hardware and software tools that engineers need to begin development quickly. Ask your distributor for part number DK-LM3S9B96. See the website for the latest tools available.

Evaluation Kit

The Stellaris® LM3S9B90 and LM3S9B92 Ethernet and USB-OTG Evaluation Kits provide the hardware and software tools to speed development using the LM3S9B90 and LM3S9B92 microcontrollers' integrated USB Full-Speed OTG port and 10/100 Ethernet controllers. Ask your distributor for part number EKK-LM3S9B90 or EKK-LM3S9B92 (ARM RealView® MDK tools), EKI-LM3S9B90 or EKI-LM3S9B92 (IAR Embedded Workbench® tools), EKC-LM3S9B90 or EKC-LM3S9B92 (CodeSourcery Sourcery G++ tools), EKT-LM3S9B90 or EKT-LM3S9B92 (Code Red Technologies Red Suite tools), or EKS-LM3S9B90 or EKS-LM3S9B92 (Texas Instruments' Code Composer Studio™ IDE). See the website for the latest tools available.



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