CM2904
Instruction Book

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ENGINEERING YOUR SUCCESS.

Parker Hannifin Manufacturing Finland Oy
Electronic Controls Division
PO Box 86 (Tiilenlyöjänkatu 5)
FI-30101 Forssa, Finland
Office +358 3 412 4400
Fax +358 3 433 5157

http://www.parker.com/ecd
ECDinfo@parker.com

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Contents

1. Introduction

These instructions are meant as a reference tool for the vehicle manufacturer's design, production, and service personnel.

The user of this manual should have basic knowledge in the handling of electronic equipment.

1.1. Safety Symbols

Sections regarding safety, marked with a symbol in the left margin, must be read and understood by everyone using the system, carrying out service work or making changes to hardware and software.

The different safety levels used in this manual are defined below.

WARNING

Sections marked with a warning symbol in the left margin, indicate that a hazardous situation exists. If precautions are not taken, this could result in death, serious injury or major property damage.

CAUTION

Sections marked with a caution symbol in the left margin, indicate that a potentially hazardous situation exists. If precautions are not taken, this could result in minor injury or property damage.

NOTICE

Sections marked with a notice symbol in the left margin, indicate there is important information about the product. Ignoring this could result in damage to the product.

Contact the manufacturer if there is anything you are not sure about or if you have any questions regarding the product and its handling or maintenance.

The term "manufacturer" refers to Parker Hannifin Corporation

2. Precautions

2.1. General Safety Regulations

Work on the hydraulics control electronics may only be carried out by trained personnel who are well-acquainted with the control system, the machine and its safety regulations.

WARNING

Mounting, modification, repair and maintenance must be carried out in accordance with the manufacturer's regulations. The manufacturer has no responsibility for any accidents caused by incorrectly mounted or incorrectly maintained equipment. The manufacturer does not assume any responsibility for the system being incorrectly applied, or the system being programmed in a manner that jeopardizes safety.

WARNING

Damaged product may not be used. If the control system shows error functions or if electronic modules, cabling or connectors are damaged, the system shall not be used.

WARNING

Electronic control systems in an inappropriate installation and in combination with strong electromagnetic interference fields can, in extreme cases, cause an unintentional change of speed of the output function.

NOTICE

As much as possible of the welding work on the chassis should be done before the installation of the system. If welding has to be done afterwards, the electrical connections on the system must be disconnected from other equipment. The negative cable must always be disconnected from the battery before disconnecting the positive cable. The ground wire of the welder shall be positioned as close as possible to the place of the welding. The cables on the welding unit shall never be placed near the electrical wires of the control system.

2.1.1. Construction Regulations

CAUTION

The vehicle must be equipped with an emergency stop which disconnects the supply voltage to the control system's electrical units. The emergency stop must be easily accessible to the operator. The machine must be built if possible, so that the supply voltage to the control system's electrical units is disconnected when the operator leaves the operator’s station.

2.1.2. Safety During Installation

CAUTION

Incorrectly positioned or mounted cabling can be influenced by radio signals which can interfere with the functions of the system.

2.1.3. Safety During Start-up

WARNING

The machine's engine must not be started before the control system is mounted and its electrical functions have been verified.

Ensure that no one is in front, behind or nearby the machine when first starting up the machine.

Follow the instructions for function control in the Start-up section.

2.1.4. Safety During Maintenance and Fault Diagnosis

CAUTION

Ensure that the following requirements are fulfilled before any work is carried out on the hydraulics control electronics.

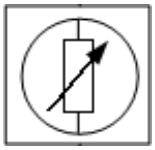
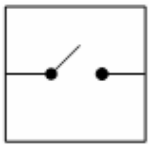
- The machine cannot start moving.
- Functions are positioned safely.
- The machine is turned off.
- The hydraulic system is relieved from any pressure.
- Supply voltage to the control electronics is disconnected.

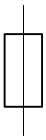
3. How to Use this Manual

This manual describes the CM2904 -module – hardware, - standard software, - module installation and gives examples of its use.

3.1. Diagram Conventions

There are many connection diagrams found throughout this manual. The following table provides meanings for the different symbols used in those diagrams:

Symbol	Meaning
	General input
	General output
	Frequency input
	Analog input
	Frequency sensor
	Resistive sensor
	General sensor
	Application switch
	Load
	Resistor

Symbol	Meaning
	Pull-down resistor
	Pull-up resistor
	Diode
	Battery
	Fuse
	Ground
	Chassis ground

3.2. 88CM2904 module revisions

HW Rev #	Description	Change log (changes made in relation to previous version)
1.0	Production version	

4. Product description

4.1. General

The CM2904 is a small module that has standard software for J1939 network (with proprietary CAN messages) for expanding the system I/O.

CM2904 can be utilized as interface to CAN bus. It takes measuring data from buttons, switches, potentiometers and/or joysticks- e.g. it provides interface for control elements and communication to terminal It can be used for indoor cabin –applications for example in tractors, forest machines, construction equipment's etc.

CM2904 I/O is usable in any application. Applications are mainly limited by mechanical construction.

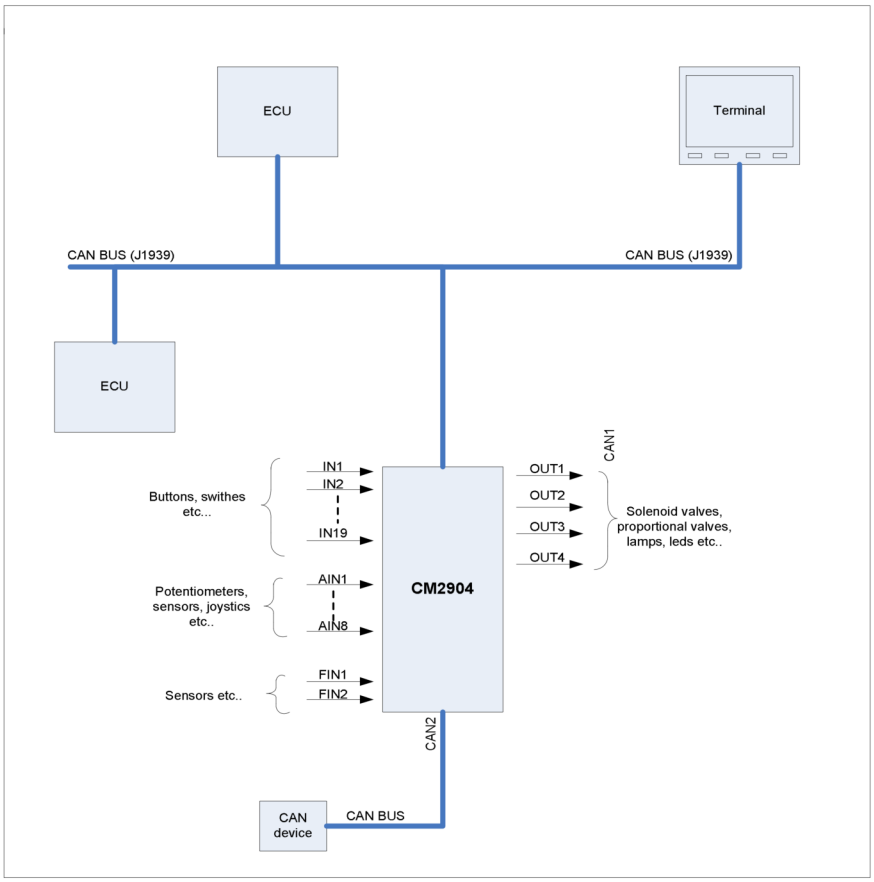


Figure 1: General system overview where CM2904 is operating

4.2. Product Characteristics Summary

Table 1: I/O & diagnostics capabilities

Symbol	Description	Total #	Notes
AIN	Analogue Inputs 0…8V	8	
MDIN	Digital inputs with analogue feedback	20	MDIN20 is optionally used for Itag addressing
FIN	Frequency inputs	2	
PWM	PWM outputs with current feedback	4	High Side outputs
+REFOut	Reference outputs, 5V and 8V	2	Sensor supply
CAN	CAN interface	2	
LED	LED-indicators	2	3 separate LEDs: - Yellow (SW controlled) - Red (SW controlled) - Green (power supply)

Table 2: General Product features

Characteristic	Value
Operating Temperature Range	-30℃…+85℃
IP rating	IP20
Protection	All I/O electronics withstand accidental connection to battery voltage or short to GND
Product Size	Outer dimensions 130 x 90 x 30 mm
Case Material	Polycarbonate
Weight	150g
Storage conditions	Continuous: 20ºC ± 20ºC Temporary: -40ºC …+85ºC Humidity: Non-condensing

4.3. Main Features & functionality

4.3.1. CM2904 basic architecture

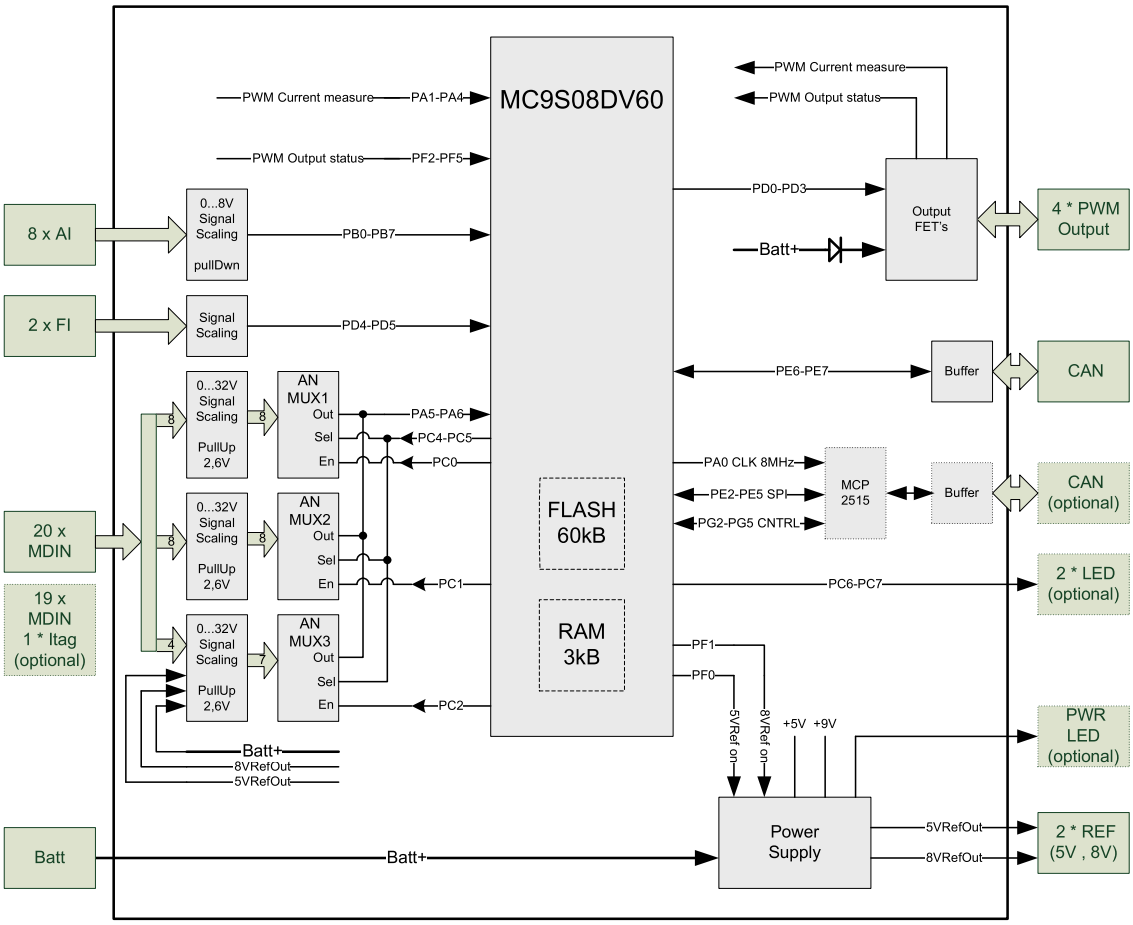


Figure 2: CM2904 architecture

4.3.2. CM2904 Product functions

- Measure and report digital input values.
- Measure and report frequency input values.
- Measure and report analog input values.
- Control PWM outputs in frequency, ramp or ON/OFF modes.
- J1939 compliant communication layer with CAN 2.0b protocol.
- Self-diagnostics and error reporting.
- Provide 5 V and 8 V reference voltages.

4.4. Mechanics, general view

Figure 3: Mechanical view of CM2904. LED's are visible through transparent gasket. LED's location are shown in the picture above with arrow.

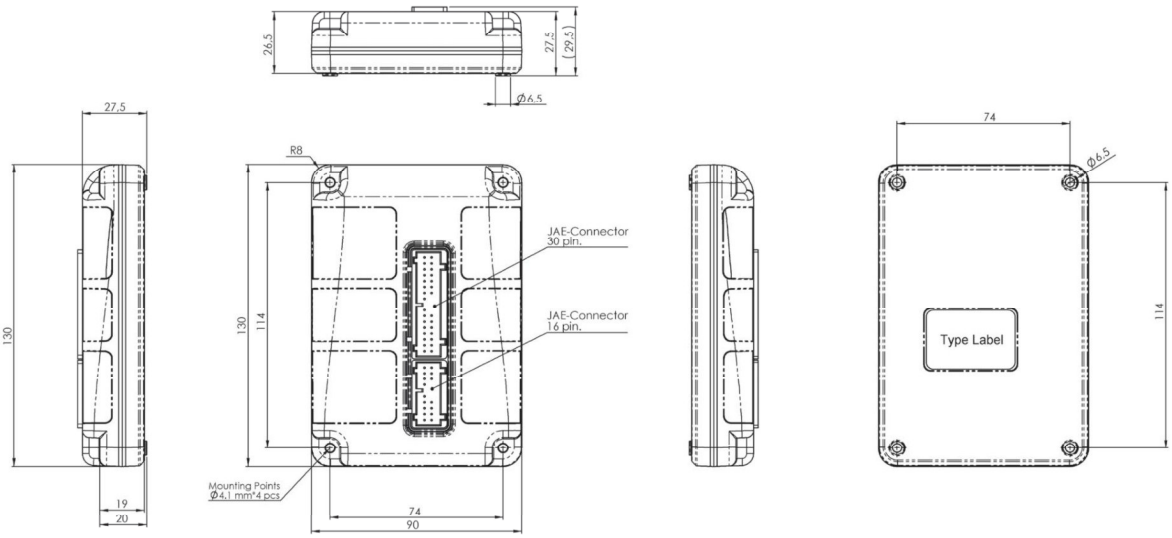


Figure 4: Dimensional drawing of CM2904

5. Hardware Specifications

5.1. Input / Output (I/O) List by Connector

The following tables list the I/O by connector:

NOTICE

Refer to the section 5.9 for more information on connectors.

Table 3: Connector X1 pins

Pin Number	Description
1	PWM_1
2	PWM_2
3	PWM_3
4	PWM_4
5	+8Vout
6	AIN_1
7	AIN_2
8	VBAT+
9	VBAT+
10	VBAT+
11	GND
12	+5Vout
13	MDIN_1
14	MDIN_2
15	MDIN_3
16	MDIN_4

Table 4: Connector X2 pins

Pin Number	Description
1	AIN_3
2	AIN_4
3	AIN_5
4	AIN_6
5	AIN_7
6	AIN_8
7	GND
8	FRQ_1
9	GND
10	FRQ_2
11	CAN_2_HI
12	CAN_1_HI
13	CAN_1_LO
14	CAN_2_LO
15	MDIN_5
16	MDIN_6

Pin Number	Description
17	MDIN_7
18	MDIN_8
19	MDIN_9
20	MDIN_10
21	MDIN_11
22	MDIN_12
23	MDIN_13
24	MDIN_14
25	MDIN_15
26	MDIN_16
27	MDIN_17
28	MDIN_18
29	MDIN_19
30	MDIN_20 or Itag

5.2. Input descriptions

5.2.1. Analog Input

The following table provides specific details for this analog input type:

Table 5: Analog input specifications

Element	Min	Nom	Max	Unit
Count		8		
Input voltage range	0		8,4	V
Pull-down resistance (24 V system)		20,7		kΩ
Cutoff frequency		50		Hz
Over-voltage			48	V
Resolution		2		mV
Accuracy	2			%
ADC reference voltage		5		V
Reference voltage tracking	0,2			%

5.2.2. Multifunction Digital Inputs (MDIN)

Multifunction digital input hardware specifications are described below. Usage of these inputs are decided in software.

MDIN 1…4 are actually used as analog inputs having measurement range from 0…32000mV, while MDIN5…19 are used as digital inputs having currently 3 states in use in the application software.

Refer to chapter 6.3.2 for use of MDIN 1..4 and to chapter 6.3.1 for use of MDIN 5…19.

The following table provides specific details for this digital input type:

Table 6: Digital multistage input specifications

Element	Min	Nom	Max	Unit
Count		20		pcs
Input voltage range	0		32	V
Pull-up voltage 24V system		2,6		V
Pull-up voltage 12V system		2,6		V
Short to ground	0		1	V
Open wire (no connection)	2,1		3,1	V
+5V reference	4,5		5,5	V
+8V reference	7,5		8,5	V
Short to battery	9			V
Cuttoff frequency		100		Hz
Over-voltage			38	V
Reverse protection	-26			V
Resolution	32			mV
Accuracy	2			%

NOTICE

Currently the states used for MDIN5...19 are following

Open = OFF or "0"

+5V reference = ON or "1"

Any other state = **+8Vreference / Short to battery/Short to ground = error**

5.2.3. Frequency inputs

- Input works in this configuration with NPN type sensors
- No open wire detection for sensor
- If used critical signals, normally closed - sensor type should be used

The following table provides specific details for this frequency input type:

Table 7: Frequency input specifications

Element	Min	Nom	Max	Unit
Count		2		
Input voltage range	-Vbat		Vbat	V
Pull-up resistance		2,8		kΩ
Pull-up voltage		0,72		*Vbat
Active low voltage	4,04		4,15	V
Cuttoff frequency		8		kHz
Frequency range	1		4000	Hz
Over-voltage			36	V
Resolution		0,5		% of reading

5.3. Output descriptions

The following sections provide detailed descriptions for each output pin-type. Refer also to previous section 5.1 for I/O –list.

5.3.1. PWM Outputs

In CM2904 these are High side -type of outputs with following features:

- Outputs can be used to control different types of loads:
  - ON/OFF type solenoids
    - Current feedback to µC ADC
  - Signaling light bulps / LED's (Open load detection option not in use)
  - Resistive loads (Open load detection option not in use)
- Open load detection is population option

Table 8 provides specific details for this high side output type:

Table 8: PWM output specifications

Element	Min	Nom	Max	Unit
Count		4		
Switchable voltage range	Bat+ - 1,5		Bat+	V
Output current			2	A
Over-voltage			40	V
Current sense Amp range	0		5	A
Current sense resolution		1,25		mA
Current sense accuracy	50			mA
PWM frequency	5		200	Hz
PWM resolution	1			Hz
Inductive pulse protection		YES		
Short circuit protection		THERMAL		
Digital feedback		YES		

INFORMATION

Inductive loads will create an average current flow that moves out of the high side output. When the output is on, the current flows through the output driver, and when the output is off, the current flows through the flyback diode. A duty cycle of 50% will produce the worst case average current flow through these two devices.

5.3.2. Reference Outputs

There is two sensor supply / reference outputs in CM2904: **+5V** and **+8V**

Table 9: Specifications for Sensor supply +5V

Element	Min	Nom	Max	Unit
Count		1		
Output voltage	4,975	5	5,025	V
Output current			200	mA
Resolution (feedback) *) NOTE				

Table 10: Specifications for Sensor supply +8V

Element	Min	Nom	Max	Unit
Count		1		
Output voltage	7,95	8	8,05	V
Output current			50	mA
Resolution (feedback) *) NOTE			2	%

Diagnostics and protection Diagnosable, protected against short circuit and battery.

NOTICE

Current feedback resolution based on feedback circuitry's component tolerance – Sensor supplies feedback circuitries tolerance is typically 1 %

5.4. Communication Mediums - CAN

The CM2904 has following communication features :

- 2 x extended CAN interfaces :
- 1st CAN is wired to microcontroller
- 2nd CAN implemented by using separate controller chip: MPC2515
- CAN 2.0B. Communication according to SAE J1939/71 communication layer
- Bit rate 250 kbps
- Overvoltage protection implemented by using 30V bi-directional TVS

5.5. Microcontroller

- Microcontroller:
  - Freescale MC9S08DV60
  - 8-bit (MCU supports 8-bit integer arithmetic)
- Frequencies:
  - 32 MHz system frequency
  - 16 MHz bus frequency
- Internal FLASH:
  - 60 Kbyte
  - Sector size 768 byte
  - Block protection
- Internal SRAM:
  - 3 Kbyte
- Diag -led's:
  - Yellow/red, Software controlled

5.6. Power Supply input

Table 11: Power supply input specifications

Power Supply				
	Min	**Nom**	**Max**	**Units**
Input voltage range	9	12	32	V
Over-voltage		37		V
Startup threshold		7		V
Input current	0,1		4,1	A
Diagnostic LED indicator		12		V

NOTICE

Even CM2904 can operate with 24V system voltage, its tested mainly with 12V system voltage. Refer to chapter 11- Design Verification Tests to check the compatibility against the environmental test requirements.

5.7. Power tree

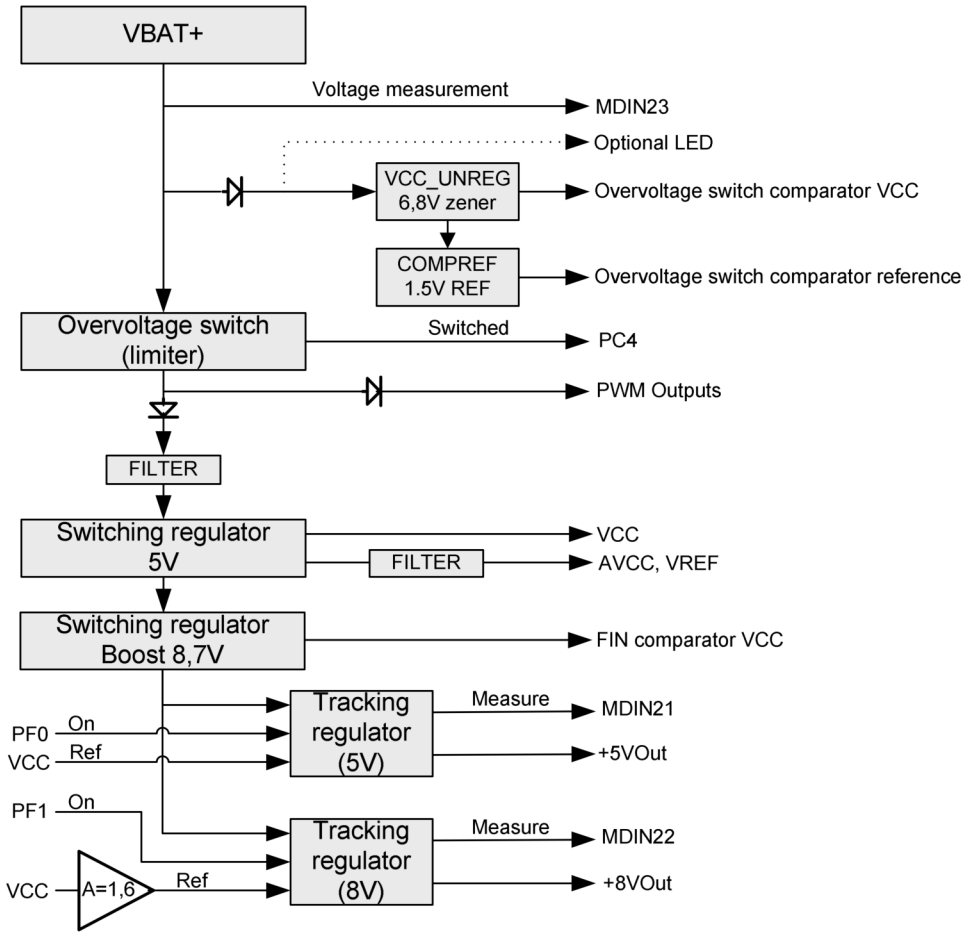


Figure 5: CM2904 power supply architecture - internal connections

5.8. Internal Functions

The following sections describe the internal functions for this product.

5.8.1. Reference Voltage Measurements

Implemented for both reference voltages

- Voltage range 0…32V
- Multiplexed with MDIN's

Voltage calculation:

V=ADINValue*31,5mV

5.8.2. Supply Voltage Measurement

- Voltage range 0…51V
- Multiplexed with MDIN's

Voltage calculation:

V=ADINValue*50mV

5.9. Connectors

5.9.1. Connector layout & signals

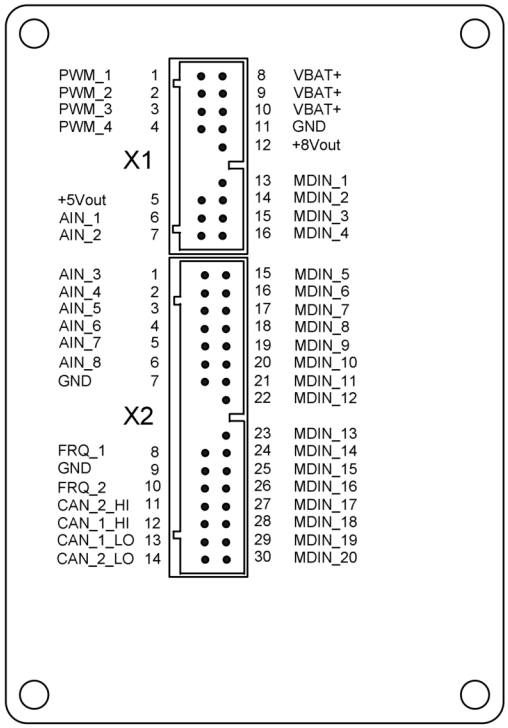


Figure 6: Connector layout of CM2904

5.9.2. Connector Types

The following table presents the CM2904 connector types:

Table 12: CM2904 connector types

Component	Part Number	Manufacturer
X1	IL-AG5-16P-D3T2	JAE
X2	IL-AG5-30P-D3T2	JAE

The following table lists the components, which forms the mating connectors for CM2904:

Table 13: CM2904 mating (Plug) connectors

Component	Part Number	Manufacturer
Plug connector chassis for X1	IL-AG5-16S-D3C1-A	JAE
Plug connector chassis for X2	IL-AG5-30S-D3C1	JAE

Component	Part Number	Manufacturer
Connector crimp	IL-AG5-C1-7500	JAE

NOTICE

Plug connectors (Table 13) are **not** part of the module delivery!

Connector kit for CM2904 is available separately from Parker, item: 88JCM2904K2- see. For more information, see “CM Accessories Catalogue HY33-4910_UK”.

6. CM2904 Standard software

The CM2904 has standard software, which is programmed into module in Parker production. Software follows the J1939 standard for vehicle communication network and the functionality comprehends following:

- Measure and report digital-, analog - and frequency input values
- Control PWM outputs in frequency, ramp or ON/OFF modes
- Self-diagnostics and error reporting

6.1. Messaging

6.1.1. General specifications and rules

- messages are sent repeatedly (if not otherwise defined)
- in case a message is late or lost (timeout) safety is to be considered
- CAN messaging is based on the parameter group number field (PGN) (18 bits)
    - Priority field (P) in the beginning of the identifier should not be considered by the receiver (3 bits)
    - Source address field (SA) in the end of the identifier – this should normally not be considered by the receiver, if not otherwise defined (8 bits)
- sender should make sure that the signal is in desired range
- Receiver should make sure that the signal is in valid range and all diagnostic functions of signal are in the application.
- receiver may have additional restrictions for operating range than the valid signal range in a case the command is outside the operating range
- signaling by the receiver should be defined if necessary
- There are two types of signals:
    - command: desired state for the receiver to take (state or set point)
    - measured: measured sensor or internal state, raw or normalized

6.1.2. Transmission

- single program cycle in this J1939 application is 10ms
- Signals are updated on every cycle
- Whenever the signal is changed, it will be sent latest on next cycle. This means that the regular transmission repetition rate for signal changes is 20ms (max 2 cycles)
- Signal states are to be sent latest in every 100ms, even there are no changes. This is called “Forced update” and it will tell that the module & its signaling is still alive in the case that there are no recent changes..

NOTICE

For more information refer to following standards:

Valid signal parameters s. ISO11783-7;

Signal characterization s. ISO 11783-7;

Message format s. ISO 11783-7;

6.2. CM2904 Message types

Table 14: Message types

Message	Description	Notes
MDIN	Multi-stage Digital input status	
ADC 1	MDIN1…MDIN4 measurements with 0 - 32V range	
ADC 2	ADC1…ADC4 measurements with 0 - 8V range	
ADC 3	ADC5…ADC8 measurements with 0 - 8V range	
FI & DIAG	Frequency Inputs and Diagnostics ○ FI 1: 0-1024 Hz ○ FI 2: 0-1024 Hz ○ 12 bit Quadrature encoder counter (default value 2048) ○ Diagnostics: ○ Vbat ○ +5V ref ○ +8V ref ○ PWM1…PWM4 diag	
PWM CONTROL	○ PWM 1 …PWM4 duty % ○ PWM Frequency (Hz) – common for all PWM channels.	
DM1	Diagnostic Message 1 = Active Diagnostic Trouble code	

6.3. Message definitions

Bytes: 1- 8; Bits: 0-7

6.3.1. MDIN

Transmission repetition rate: - Forced update period=100ms,
- Otherwise update period = 20ms on signal changes

Data length: 8 Bytes
Default priority: 6
Parameter group number: (FF04hex)

Table 15: MDIN

Byte	Bit / Bits	Description	Type	Values
1	1 2	MDIN5	Measurement	00=disabled (open) 01=enabled (conn. To +5V ref) 10=error (shorted) 11=Not available
1	3 4	MDIN6	Measurement	
1	5 6	MDIN7	Measurement	
1	7 8	MDIN8	Measurement	
2	1 2	MDIN9	Measurement	
2	3 4	MDIN10	Measurement	
2	5 6	MDIN11	Measurement	
2	7 8	MDIN12	Measurement	
3	1 2	MDIN13	Measurement	
3	3 4	MDIN14	Measurement	
3	5 6	MDIN15	Measurement	
3	7 8	MDIN16	Measurement	
4	1 2	MDIN17	Measurement	
4	3 4	MDIN18	Measurement	
4	5 6	MDIN19	Measurement	
4	7 8	Not used	Measurement	
5	1 : 8	Not used	Measurement	
6	1 : 8	Not used	Measurement	
7	1 : 8	Not used	Measurement	
8	1 : 8	Not used	Measurement	

6.3.2. ADC1

Transmission repetition rate: - Forced update period=100ms,
- Otherwise update period = 20ms on signal changes

Data length: 8 Bytes
Default priority: 6
Parameter group number: (FF01hex)

Table 16: Message description ADC1

Byte	Bit / Bits	Description	Type	Values
1	1 : 8	MDIN1	Measurement	0…32000mV
2	1 : 8			
3	1 : 8	MDIN2	Measurement	0…32000mV
4	1 : 8			
5	1 : 8	MDIN3	Measurement	0…32000mV
6	1 : 8			
7	1 : 8	MDIN4	Measurement	0…32000mV
8	1 : 8			

6.3.3. ADC2

Transmission repetition rate: - Forced update period=100ms,
- Otherwise update period = 20ms on signal changes

Data length: 8 Bytes
Default priority: 6
Parameter group number: (FF02hex)

Table 17: ADC2. 1 – 4; 0..8V range

Byte	Bit / Bits	Description	Type	Values
1	1 : 8	ADC 1 (mV) 0-8 V	Measurement	0 … 8000mV
2	1 : 8			
3	1 : 8	ADC 2 (mV) 0-8 V	Measurement	
4	1 : 8			
5	1 : 8	ADC 3 (mV) 0-8 V	Measurement	
6	1 : 8			
7	1 : 8	ADC 4 (mV) 0-8 V	Measurement	
8	1 : 8			

6.3.4. ADC3

Transmission repetition rate:

- Forced update period=100ms,
- Otherwise update period = 20ms on signal changes

Data length: 8 Bytes
Default priority: 6
Parameter group number: (FF03hex)

Table 18: ADC3. 5 – 8; 0..8V range

Byte	Bit / Bits	Description	Type	Values
1	1 : 8	ADC 5 (mV) 0-8 V	Measurement	0 … 8000mV
2	1 : 8			
3	1 : 8	ADC 6 (mV) 0-8 V	Measurement	

Byte	Bit / Bits	Description	Type	Values
4	1 : 8			
5	1 : 8	ADC 7 (mV) 0-8 V	Measurement	
6	1 : 8			
7	1 : 8	ADC 8 (mV) 0-8 V	Measurement	
8	1 : 8			

6.3.5. FI & DIAG

Transmission repetition rate:
- Forced update period=100ms,
- Otherwise update period = 20ms on signal changes

Data length: 8 Bytes
Default priority: 6
Parameter group number: (FF05hex)

Table 19: Message description for Frequency inputs and diagnostics

Byte	Bit	Description	Type	Values
1	1 LSB : 8	Frequency Input 1 signal FI1	Measurement	0…1021 Hz 1022=error 1023=Not available
2	1 2			
	3 LSB : 8	Frequency Input 2 signal FI2	Measurement	0…1021 Hz 1022=error 1023=Not available
3	1 : 4			
	5 LSB : 8	12 bit Quadrature encoder counter FI1 = Signal A, FI2 = Signal B	Measurement	default value 2048
4	1 : 8			
5	1 : 8	VBat Measurement	Measurement	0…255 Scale: mV = raw value x 200

Byte	Bit	Description	Type	Values
6	1 : 8	+5V ref Measurement	Measurement	0…255 Scale: mV = raw value x 126.4
7	1 : 8	+8V ref Measurement	Measurement	0…255 Scale: mV = raw value x 126.4
8	1 2	PWM 1 diagnostic	Measurement	00=OK 01=Open load 10=Over current 11=Not available
	3 4	PWM 2 diagnostic		
	5 6	PWM 3 diagnostic		
	7 8	PWM 4 diagnostic		

6.3.6. PWM Output Control

Timeout: 250 ms (DM1 message generated)
Data length: 8 Bytes
Default priority: 6
Parameter group number: (FECAhex)

Table 20: PWM CONTROL

Byte	Bit	Description	Type	Values
1	1 : 8	PWM 1 duty %	Command	0…250 Step = 0,4% Range = 0…100%
2	1 : 8	PWM 2 duty %	Command	
3	1 : 8	PWM 3 duty %	Command	
4	1 : 8	PWM 4 duty %	Command	
5	1 : 8	PWM Frequency Hz for all channels	Command	0…1000Hz
6	1 : 8		Command	
7		Not used		
8		Not used		

6.3.7. Diagnostic Message

Transmission repetition rate: 1000 ms
Data length: 8 Bytes
Default priority: 6
Parameter group number: (EFCAhex)

Message structure according to J1939 standard, message DM1.

6.3.8. Fault codes

Table 21: Fault codes

Fault Description	SPN	FMI
PWM1 Short circuit	697	6
PWM1 Open load	697	5
PWM2 Short circuit	698	6
PWM2 Open load	698	5
PWM3 Short circuit	701	6
PWM3 Open load	701	5
PWM4 Short circuit	702	6
PWM4 Open load	702	5
Output Command Timeout	629	9
Missing or invalid parameters	629	31

7. Module Identification on network

The following shows a typical CAN connection using the SAE J1939 standard:

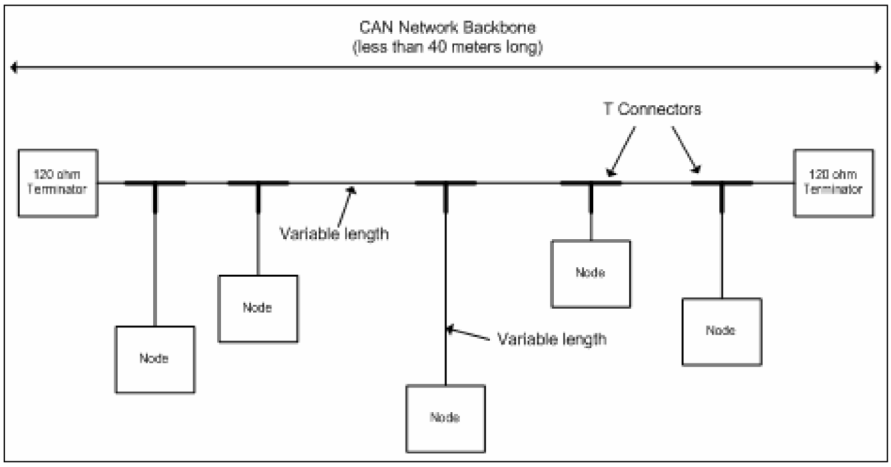


Figure 7: J1939 CAN connection

7.1. Module ID

The module can be configured by using an ID-Tag, which is connected to the connector mating the CM2904, between address high and low pins. The ID-Tag will enable a numeric input to the application which can be used to enable specific functions in the module. Each module can have a unique address. The maximum number of addresses is eight, denoted as addresses 0, 1, 2, 3, 4, 5, 6, 7 respectively. The ID-Tag can be used for CAN address selection.

For defining the module ID, the CM2904 has one module ID interface consisting of an analog module ID input:

- `MDIN 20 (ADDR_L)`

and +V reference voltage output:

- `+8VOut (ADDR_H)`

7.1.1. Module ID Installation Connections

The ID-Tag defining the address for the module shall be inserted to the CM2904 connector positions **MDIN20 (Idtag)** and **+8VOut**.

The following shows a typical module ID connection:

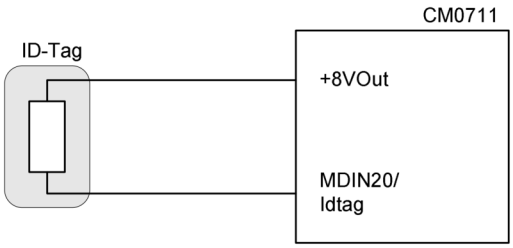


Figure 8: Module ID installation connections

7.1.2. Module ID Diagnostics and Fault Protection

Short or open circuit between ADDR-L and ADDR-H pins will generate a non-valid input voltage, as well as shorting either pin to ground or ADDR-L pin to battery voltage. However, depending on battery voltage and ID-tag value, shorting ADDR-H to battery voltage may generate an input voltage in acceptable range and thus an erratic ID value which cannot be detected.

7.1.3. ID-Tag Part Numbers

The following table provides part numbers for the ID-Tags with different addresses:

Table 22: Connector Contact Part Numbers

Address	Part No.	Ordering No. (10-pack)	Resistance (Ω)
0		UIDTAG10	294
1		UIDTAG11	590
2		UIDTAG12	976
3		UIDTAG13	1.5K
4		UIDTAG14	2.23K
5		UIDTAG15	3.36K
6		UIDTAG16	5.3K
7		UIDTAG17	9.53K

INFORMATION

The ID-Tags are available from Parker. Please consult your Parker Account Representative for specific details and pricing information.

8. Installation

INFORMATION

An I/O connection kit for building harnesses for the CM2904 is available from Parker. The kit includes mating connector plugs and socket contacts for connecting one CM2904 module. The part number for the kit is 88JCM2904K2. Please consult your Parker Account Representative for specific details and pricing information.

8.1. Installing into vehicle

Because every system is different, it is difficult for us to provide specific instructions on how to install a CM2904 into a vehicle. Instead, we have provided mechanical, environmental, and electrical guidelines and requirements that you should be aware of before installing the product.

The vehicle manufacturer is responsible for creating procedures for mounting the CM2904 in a vehicle during production assembly.

8.1.1. Selecting a Mounting Location

The CM2904 primary mounting location is in the vehicle's cab. If module is installed to chassis, then suitable outer enclosure shall be considered, depending on required IP classification.

Refer to section *11 Summary of Tests* for a complete list of environmental tests the CM2904 has been tested against.

Before mounting the CM2904, ensure you review the following environmental and mechanical requirements.

NOTICE

Do not install the CM2904 close to any significant heat sources, such as a turbo, exhaust manifold, etc. Also avoid installing the CM2904 near any drive-train component, such as a transmission or engine block.

8.1.1.1. Environmental Requirements

NOTICE

The CM2904warranty does not cover damage to the product when exposed to environmental conditions that exceed the design limitations of the product.

Review the following environmental specifications before selecting a mounting location for the CM2904:

- The CM2904 must be in an environment that is within its ambient temperature range.
  - Safe operating temperature range is **–30 °C to +85 °C**.
- The CM2904 must be in an environment that does not exceed its water or particle ingress rating.
  - The sealing standard for the CM2904 is **IP20 or IP54** depending on mounting direction.

CAUTION

IP54 only for module, which is installed upside down- direction. Use always suitable cabinet / outer enclosure when installing the module into chassis.

8.1.1.2. Mechanical Requirements

Review the following mechanical requirements before selecting a mounting location for the CM2904:

- The CM2904 should be positioned so moisture will drain away from it – E.g. a “upside-down” position would be the most preferable for this product.
- The harness should be shielded from harsh impact.
- The harness should connect easily to the connector and have adequate bend radius.
- The labels should be easy to read.
- The CM2904 should be easily accessible for service.

8.1.2. Mounting to a Vehicle

It is up to the original equipment manufacturer (OEM) to ensure the product is securely mounted to the vehicle.

The following guidelines are related to physically attaching the CM2904 to a vehicle:

- The CM2904 should be secured with bolts in both bolt holes using **M4 hexagonal socket cap screws** and **A4,3 washers**. The diameter of the fixing holes is **4.2 ± 0.1 mm**.
- An informational torque value for the bolts is **2,5Nm ± 10%**. Exact torque value must be found by tests and the fastener manufacturer's tightening torque specifications.
- Suggested fastening tool for bolts is 10 mm sleeve.

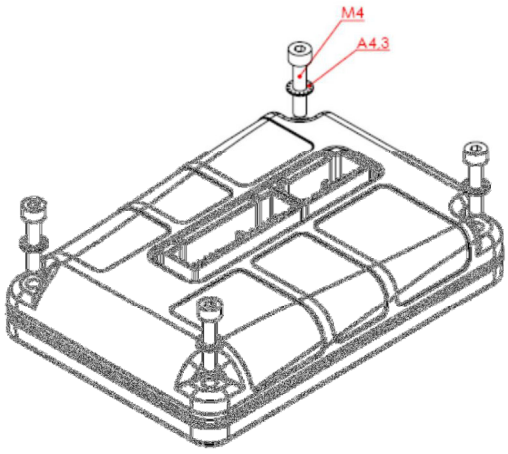


Figure 9: Mounting principle

8.2. Electrical Guidelines

The following sections provide electrical guidelines to install the CM2904 in a vehicle.

8.2.1. Designing the Vehicle Harness

The vehicle manufacturer is responsible for designing a vehicle harness, which mates with theCM2904 connector(s).

The vehicle harness design depends on the following:

- How the CM2904's inputs, outputs, communication, and power pins are configured.
- Other components on the vehicle and their physical locations.
- The routing of the harness.

For guidelines and recommendations on how to connect the different elements of the CM2904, refer to following sections:

- *5.9 Connectors* for details on the CM2904 connector types, pin-outs, and mating part numbers
- 8 *Installation* for general installation guidelines
- 9 Application Examples for guidance on how to connect sensors and actuators to CM2904

INFORMATION

An I/O connection kit for building harnesses for the product is available from Parker. The kit includes mating connector plugs and socket contacts for connecting one CM2904 module. The part number for the kit is **88JCM2904K2**. Please consult your Parker Account Representative for specific details and pricing information.

8.2.2. Connecting the Vehicle Harness

Once the vehicle harness is designed, it can be connected to the CM2904 simply by clicking the mating connector into the connector port on the CM2904.

9. Application Examples

The purpose of this section is to provide examples of how the CM2904 can be used for different purposes. The following examples are covered in this section:

- Controlling indicator lights
- Controlling actuators
- Connecting push-buttons
- Connecting sensors
- Connecting rotary encoder (pulse wheel)

INFORMATION

These examples are for illustrative purposes only.

NOTICE

As the CM2904 is mainly intended for **IO-extension**, it assumes to get the commands for performing the operations from the master module via CAN -bus. CM2904 also sends the measurement data through CAN –bus to master unit in pre-defined interval.

9.1. Controlling Indicator Lights

Multiple CM2904 can be used together in a system to control a vehicle's indicator lights.

The CM2904s would communicate over CAN, and be connected and wired to the rear indicator lights, front indicator lights, turn signal and hazard switches etc. Just to give an idea of what CM2904 could be utilized.

NOTICE

The CM2904 outputs has pull-up resistors for diagnostic purposes. This needs to be taken into account in application as the pull-up would mean small current to output, which may cause for example sensitive LED indicators to glow if connected directly to CM2904 output without pre-resistors.

You shall consider this when building your application and making connections to output devices for CM2904.

9.2. Controlling actuators with outputs

INFORMATION

You will need to write software to your main ECU/ Module that will be communicating with CM2904. CM2904 gets the commands for performing the operations from the master module via CAN -bus. CM2904 also sends the measurement data through CAN –bus to master unit.

NOTICE

If large inductive loads are used, and the high side output is providing a continuous PWM signal, then the PWM peak current must not be greater than the specified current for the output (in continuous mode, the average current flow through the diode at 50% duty cycle is approximately equal to ½ the peak current).

When connecting high side outputs, ensure you follow these best practices:

- High side outputs should not be connected to loads that will draw currents greater than the maximum peak current, or maximum continuous current.
- The grounds for the loads should be connected physically close to the CM2904 power grounds.

The following shows a typical high side output connection:

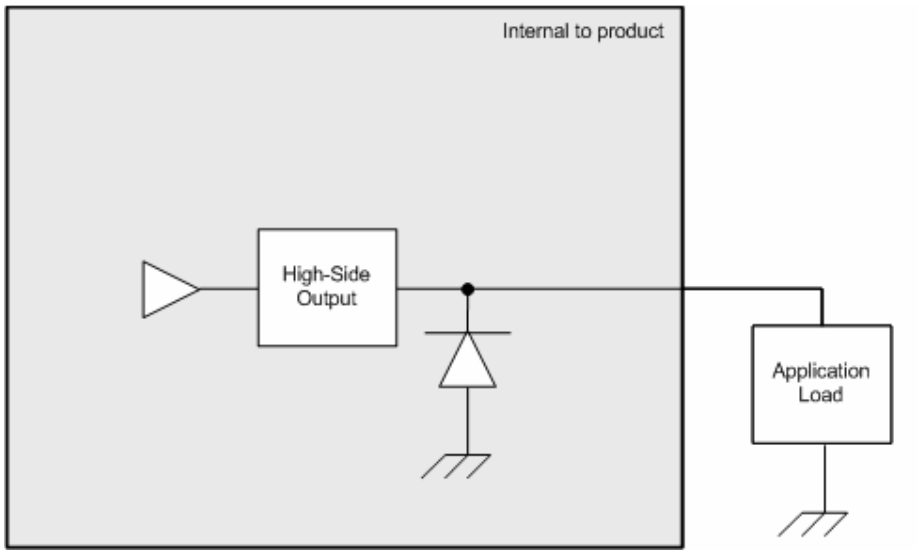


Figure 10: Typical high side output installation connections

9.3. Connecting Common Sensors

There are many types of sensors that can be connected to the CM2904, the most common are as follows:

- Open collector sensors
- Switch sensors
- Voltage sensors
- Potentiometer (ratiometric) sensors
- Rotary encoder (pulse wheel)

INFORMATION

When connecting sensors to the CM2904, refer to the sensor manufacturer's specifications to ensure the CM2904 is configured correctly for the sensor.

NOTICE

CM2904 supports many kind of sensors and switches. However, the sensor or switch type not mentioned in this manual may not be supported by CM2904. For example **common collector** –type of switches are not supported.

If you are uncertain of sensor type (whether it is supported or not), please contact your Parker representative to ensure this.

9.3.1. Open Collector Sensors

Open collector sensors are compatible with Frequency Inputs (refer to chapter 5.2.3), Analog Inputs (refer to chapter 5.2.1) and MDIN inputs 1…4 (refer to chapter 5.2.2) on the CM2904.

Open collector sensors are typically used in applications that require digital or frequency measurements. They work by pulling voltage down to ground or up to power when activated and are basically a switch that turns "on" and "off".

Open collector sensors need a pull-up or pull-down resistor to bias the state of the sensor when the sensor is not activated. Pull-up and pull-down resistors are internal to the CM2904.

The following shows a typical open collector sensor connection:

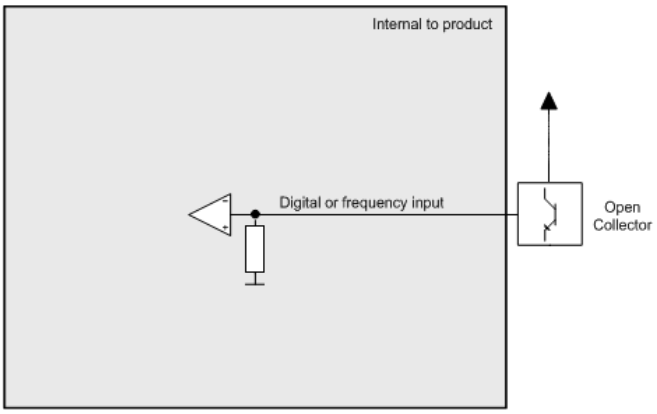


Figure 11: Open collector active high installation connection installation connection installation connection installation connection installation connection connection

9.3.2. Switch Sensors

A switch is a type of sensor that uses mechanical contacts in one of two states: open or closed. Sensor switches are used to turn sensors on and off, and can be wired directly to digital inputs.

Active-high sensor switches may be used by the product. For active-high switches use an input with internal pull-down resistor.

The following shows a typical sensor switch connection:

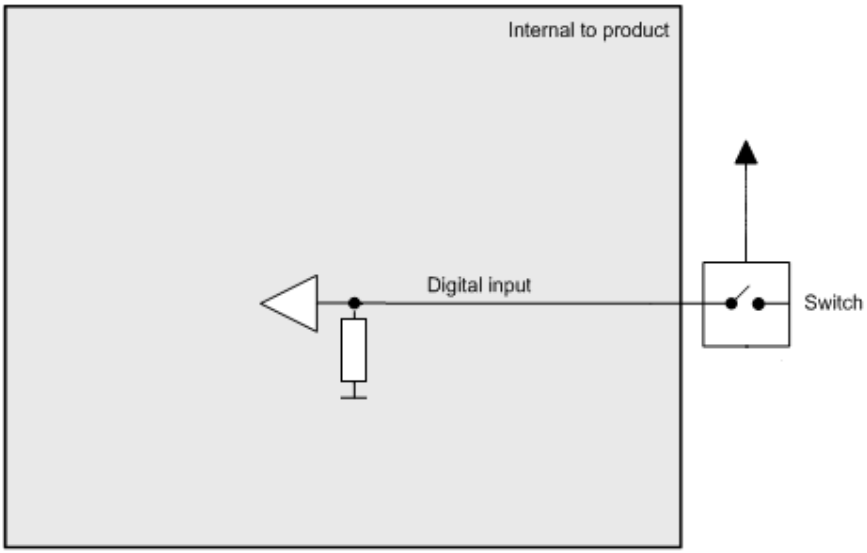


Figure 12: Switch sensor active high installation connection

9.3.3. Voltage Sensors

Voltage type sensors work by driving an analog voltage signal to report the sensor's measured value.

Voltage sensors are compatible with Analog Inputs (refer to chapter 5.2.1), and are typically used in applications that require variable voltage measurements.

Ensure that voltage range of the used sensor is within allowed range of CM2904 Analog Inputs measurement range (refer to chapter 5.2.1).

9.3.4. Potentiometer (Ratiometric) Sensors

Potentiometers and other ratiometric type sensors can be wired directly to Analog Inputs (refer to chapter 5.2.1).

Potentiometers are resistive devices that use a wiper arm to create a voltage divider. Changes to resistive measurements happen as the wiper arm moves along a resistive element.

When connecting potentiometer sensors, it is important to do the following:

- Connect one end of the sensor to CM2904 sensor supply pin:
  - Either +8VOut **or** +5VOut –pin
- Connect the other end to a sensor gnd:
  - X1/ Pin 11 for +8VOut **or** X2/pin 7 for +5VOut.
- Connect the sensor signal to an analog input.

The following shows a typical potentiometer sensor connection:

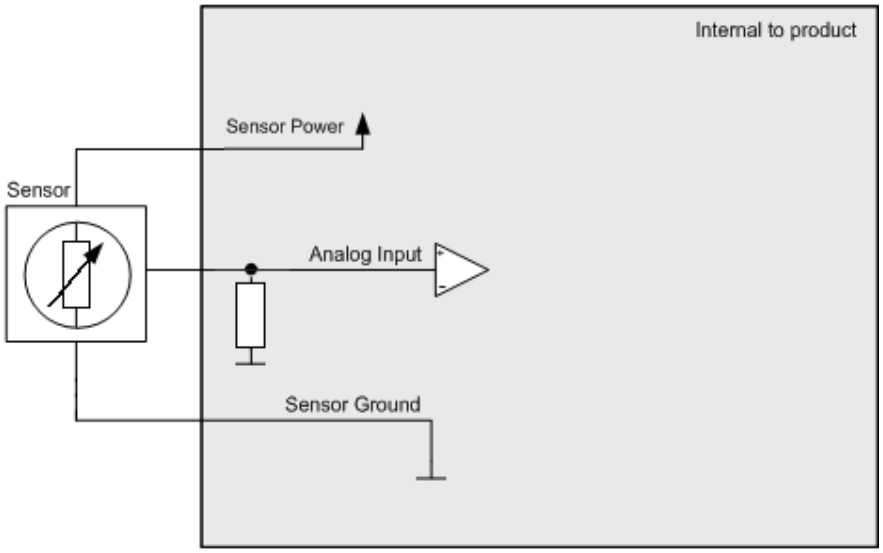


Figure 13: Potentiometer (ratiometric) sensor installation connection

9.4. Connecting rotary encoder

Frequency inputs can be used for connecting incremental rotary encoder (pulse wheel) into CM2904 by utilizing the quadrature feature of Frequency inputs.

These two signals are decoded to produce a count up pulse or a countdown pulse. FI1 & FI2 inputs are read by CM2904 software and to decode the direction.

NOTICE

When planning to use CM2904 for connecting quadrature encoder in motor application (servo motor or brushless motor), ensure first the requirement from your system point of view and take into account that quadrature mode in CM2904 is specified up to 4kHz.

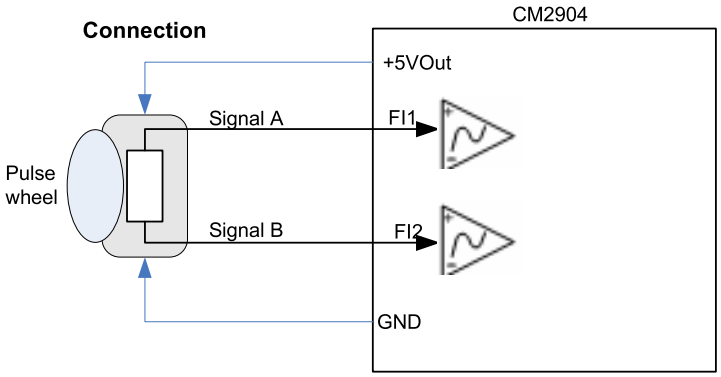
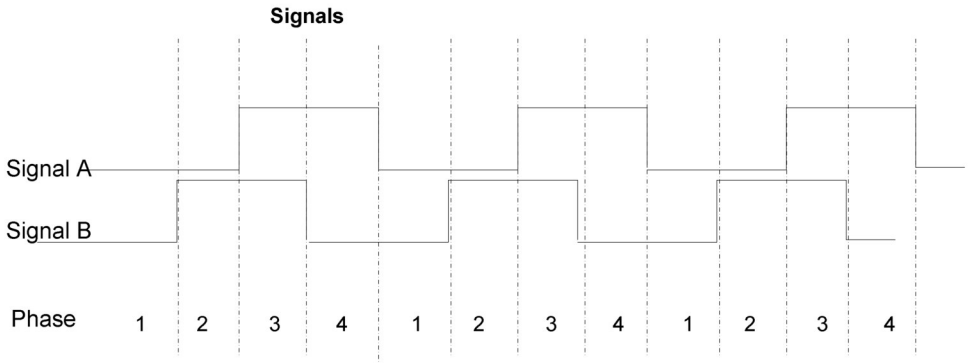


Figure 14: Rotary encoder (pulse wheel) connection



Clockwise rotation

Phase	Signal A	Signal B
1	0	0
2	0	1
3	1	1
4	1	0

Counter- Clockwise rotation

Phase	Signal A	Signal B
1	1	0
2	1	1
3	0	1
4	0	0

Figure 15: Quadrature signaling and rotation direction principles.

10. Start-Up

10.1. Start-Up Procedures

This chapter contains general instructions for action to be taken in connection with the initial start.

WARNING

Risk of injury!
If the control system is not fitted properly, the machine could move uncontrollably. The machine's engine shall not be started before the control system is completely fitted and its signals are verified.

10.1.1. Starting the Control System

Start the control system as follows:

- Prior to start, all modules and cables are to be fitted correctly.
- Check fuses, i.e. make sure that the supply voltage to the modules is equipped with the correct fuse.
- Make sure that connections for supply voltage and return lines are correct in the cable's conductor joint.
- Make sure the emergency stop works.
  - The emergency stop should disconnect the supply voltage to all modules.

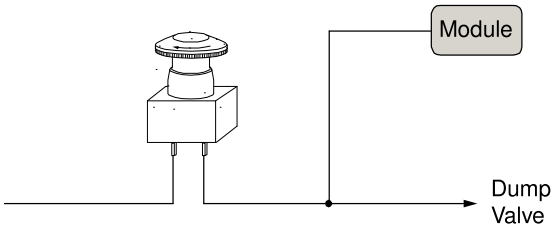


Figure 16: Emergency stop

Alternatively, the emergency stop may also shut off the diesel engine or a dump valve, and with that depressurize the hydraulic system.

10.1.2. Prepare for System Start

WARNING

Make sure no one is in dangerous proximity to the vehicle to avoid injuries when it starts.

Prepare for the initial system start as follows:

- The engine for the hydraulic system's pump shall be in off position.
- Make sure that all connectors are properly connected.
- Turn on the control system.

- Make sure that voltage is being supplied to all modules; the power-on LED’s shall be illuminated on all modules. Also make sure that master is in contact with all modules.
- Make sure the emergency stop is functioning properly.

10.1.3. Start the System

Start the system as follows:

- Start the engine for the hydraulic system's pump, assuming that the above mentioned inspections have been carried out and shown correct values.
- Calibrate and adjust input and output signals in your system according to the instructions and check each and every output function carefully.
- In addition to these measures, the machine shall also meet the machine directives for the country in question.

11. Summary of Tests

11.1. Design Verification Tests

The following table lists the design verification tests that were performed for the product.

Table 23: Design Verification Test Summary

Ref #	Test Specification	Test Description	Test Level
1	EP455 Section 5.1.1	Operating Temperature	Level 3: -30…+85 ℃ 9 cycles, 8h /cycle
2	EP455 Section 5.1.2	Storage Temperature	Level 2: -40…+85 ℃
3	IEC 60068-2-2 Bb	Storage High Temperature	+85 ℃, 16 hours
4	IEC 60068-2-1 Ab	Storage Low Temperature	-40 ℃, 16 hours
5	ISO 15003 Section 5.2.2	Thermal Shock	Level 3: -40…+85 ℃, 100 cycles
6	ISO 15003 Section 5.2.1	Thermal Cyclic	Level 3: -40…+85 ℃,
7	ISO 15003 Section 5.4	Damp Heat Cyclic Level 2	Level 2: 2 cycles, +55℃
8	ISO 15003 Section 5.10	Chemical Brush Exposure	Urea Nitrogen, Liquid Lime (Calcium), Fertilizers, Ammonium Hydroxide, Diesel fuel, Petrol, Hydraulic Oil, Ethylene Glycol
9 *)3	ISO 15003 Section 5.14.1	Operating Voltage	Test voltages: 9 V, 13.6 V, 16 V, 27,2 V, 36V; One cycle/voltage + 4 cycles in 27,2 V;
10	ISO 15003 Section 5.14.2	Over Voltage	48VDC, 5min
11	AGCO STD 6/2008 Section 2.2.3	Under Voltage	0…8VDC
12	ISO 15003 Section 5.14.3	Reverse Polarity	-26VDC, 5min
13	ISO 15003 Section 5.14.4	Short Circuit Protection	Voltage level = 26V; Test time = 5min/pin
14	EP455 Section 5.11.1	Accessory Noise	50 Hz…10 kHz, 5 min
15	ISO 15003 Section 5.14.5	Transient Batteryless Operation	

Ref #	Test Specification	Test Description	Test Level
16	ISO 7637-2 Section 5.6.5 Pulse 5a	Load Dump (FSC A)	Us= 70V, 5 pulses
17	ISO 7637-2 Section 5.6.5 Pulse 5a	Load Dump (FSC C)	Us= 70V, 5 pulses
18	ISO 7637-2 Section 5.6.1 pulse 1	Short Disconnection Of Power Supply (FSC C)	Us= -100V, 5000 pulses (12V systems)
19	ISO 7637-2 Section 5.6.2 pulse 2a	Short Disconnection Of Power Supply (FSC A)	Us= 50V, 5000 pulses
20	ISO 7637-2 Section 5.6.3 pulse 3a	Inductive Load Switching (FSC A)	Us= 150V, 36000 pulses (12V systems)
21	ISO 7637-2 Section 5.6.3 pulse 3b	Inductive Load Switching (FSC A)	Us= 100V, 36000 pulses (12V systems)
24	AGCO STD 6/2008 Section 2.2.12	Reset Test	T1, T2: 0.1ms … 1s
25	ISO 10605	Electrostatic Discharge During Handling	±8kV
26	ISO 10605 (probe according to IEC 60801-2)	Electrostatic Discharge During Operation	±15kV
27	ISO 15003 Section 5.5.2	Mechanical Shock	300m/s2, 12ms 140m/s2, 12ms
28	ISO 15003 Section 5.6.2	Mechanical Vibration	10…2000Hz, Dwell= 30min/ found resonance
29	ISO 15003 Section 5.6.1	Random Vibration	10…350Hz, Level 2, 8 hours/axis
30	ISO 15003 Section 5.13.1 ISO 11452-2 ISO 11452-4	EMC – Susceptibility	ISO 11452-2: 200…2700 MHz ISO 11452-4: 150 kHz …200MHz
32	ISO 14982 (2009), Annex D CISPR25	EMC – Radiated Emissions	0.15…2000 MHz

NOTICE

Above tests proceeded with 12V system voltage if not otherwise stated.

***)3** - synchronised cycle temperature/voltage test with test #1

12. Glossary of Terms

12.1. Glossary of terms

Table 24: Terms / Abbreviations used in this document.

Abbreviation	Description
CAN	Controller Area Network. 2-wire differential communication bus.
FMI	Fault Mode Identifier. Identifies fault mode in J1939 standard.
J1939	SAE J1939. Standard used for communication and diagnostics among vehicle components.
MCU	Microcontroller Unit. Core which runs the application.
PGN	Parameter group number. Identifies parameter group in J1939 standard.
PWM	Pulse Width Modulation. Way of providing intermediate amounts of electrical power between fully on and fully off
RAM	Random Access Memory. Volatile memory.
ROM	Read-Only Memory. Non-volatile memory.
SPN	Suspect Parameter Number. Identifies parameter in J1939 standard.
ADC	Analog to Digital Conversion (Abbreviation means also “Analog to Digital Converter”)
FLASH	Non Volatile memory for general storage & transfer of data. Flash memory is one type of “Read Only Memory” that can be re-programmed.
FET	Field Effect Transistor - an electronic device used either as a power switch, or amplifier in electronic circuitry. FETs are typically used as drivers.
MDIN	Multistage Digital Input. Analogue inputs that are used in manner of digital inputs. With MDIN inputs it is possible to assign more than 2 stages for the input.
AIN	Analogue Input - an input that allows a voltage level to be read and converted to discrete digital values within a microprocessor.
DIN	Digital Input - an input that is typically controlled by an external switch that makes the input either active “ON” or inactive “OFF”
FIN	Frequency Input - an input that allows a frequency value to be read from an oscillating input signal.
REF, REFOut	Reference Voltage Output. Supply that is intended to provide voltage for the sensors connected to this module’s inputs.
LED	Light Emitting Diode

ID-Tag	The module can be configured by using an ID-Tag, which is connected between the module's address high and low pins. The ID-Tag will enable a numeric input to the application.
High Side Output	An output that provides switched battery voltage to an external load.
Inductive Load	A load that produces a magnetic field when energized. Inductors are electrical components that store energy and are characterized by the following equation: $E_{\text{stored}} = \frac{1}{2} L I^2$

