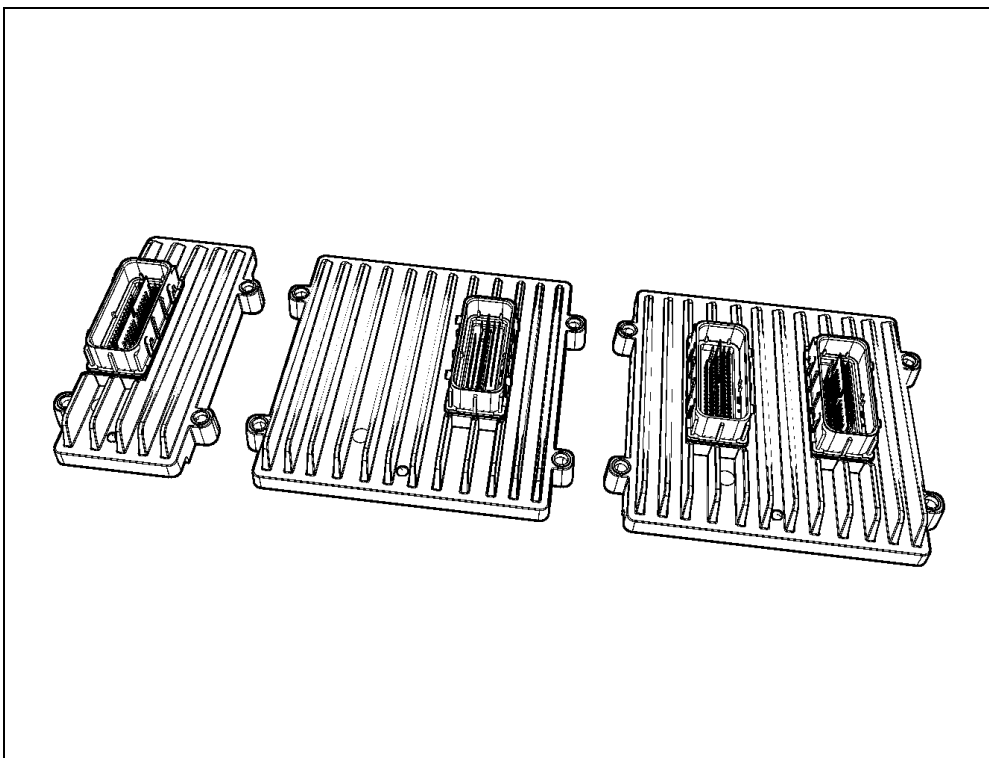


IQAN-MC4x

Instruction book

Publ no MSG18-8413-IB/UK

Edition 2018-03-27



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Publication history

The following table provides an overview of the changes made to this document over the course of its publication history.

Revision / date	Description of change
Rev. 001 / 2017-03-14	Added PWMIN section.
Rev. 002 / 2017-03-29	Added max. current to busbar section, updated Appendix A to match latest <i>Summary of Product Characteristics</i> .
Rev. 003 / 2017-07-27	Added PWM HS+LS to proportional output section Revised LS output section Depiction of inputs with internal pull-ups fixed Changed declaration of conformity to July 2017 version
Rev. 004 / 2017-09-25	Fixed pin naming MC42, C1 table (PWMouts)
Rev. 005 / 2017-12-08	Added MC4xFS information and history table
Rev. 006 / 2018-03-27	New publication number. Updated CAN pin naming to match software, blink code footnote b in Appendix B, and information on Digital out under current

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	Publication history	ii
1	Introduction	1
	Warnings	1
	Mandatory Safety Requirements	1
	Overview of relevant documentation	2
2	Precautions	3
	Read This	3
	Design of control system	3
	Start-up, maintenance, and diagnostics	4
3	Product description	5
	IQAN-MC4x, -MC4xFS	5
	Capability and I/O overview	5
	IQAN-MC4xFS I/O use in safety functions	6
	Communication	7
	Markings/Approvals	8
4	Safety	13
	Safety concept	13
	Safe state	13
	Maximum achievable SIL and PL	13
	System boundaries	14
	IQAN software support tools	15
	Run time diagnostics and startup tests	16
	Application dependent input diagnostics	17
	Safety related CAN bus communication	17
	MC4xFS internal diagnostics	18
	Architecture for a complete safety function	19
5	Mounting	23
	Mounting the module	23
6	Installation and I/O	25
	Connector, MC43, C1	25
	Connector C1 pin assignments	25
	Connector, MC43, C2	28
	Connector C2 pin assignments	28
	Connector, MC42, C1	31
	Connector C1 pin assignments	31
	Connector, MC41, C1	34
	Connector C1 pin assignments	34
	Supply voltage	37
	Emergency stop	37
	Connecting of Supply Voltage	37
	Polarity reversal	38
	Addressing/terminating	39
	IQAN-MC4x use of an ID-Tag	39
	Terminating	39
	Diagnostic interfaces	40
	CAN diagnostics connection	40
	Reference voltage, VREF	41
	Voltage inputs	42
	Connecting sensors to the VIN voltage inputs	42
	VIN (IN_1 to IN_26) circuit block	43

VIN usage in safety functions	43
Connecting sensors to the VIN32 voltage inputs	44
VIN32 (IN_27, IN_28) circuit block	45
VIN32 usage in safety functions	45
Current loop inputs	47
Connecting sensors to the current loop inputs	47
Current loop IN_29 to IN_32 circuit block	48
Using current inputs to monitor voltage inputs	49
Connecting analogue sensors as monitored voltage inputs	49
CIN usage in safety functions	49
Frequency inputs	51
Connecting to push-pull type frequency sensors	51
Connecting NPN sensors to the pull-up frequency inputs	52
Connecting NPN sensors with pull-ups to the frequency inputs	53
Connecting PNP sensors to the pull-down frequency inputs	54
Connecting directional frequency sensors to the frequency inputs	55
Connecting directional pulse sensors to the frequency inputs	56
Pull-up IN_33 to IN_36 input circuit block	57
Pull-down IN_37, IN_38 input circuit block	57
FIN/PCNT/DFIN/DPCNT usage in safety functions	57
PWM inputs	58
Connecting PWM sensors to the PWM inputs	58
Pull-up IN_33 to IN_36 input circuit block	59
Pull-down IN_37, IN_38 input circuit block	59
PWMIN usage in safety functions	59
Digital inputs	60
Connecting switches to the digital inputs	60
Digital inputs IN_39 to IN_50 circuit block	60
Connecting switches to the digital inputs with internal pull-up	61
Digital input IN_33 to IN_36 input circuit block	61
DIN usage in safety functions	62
Proportional current outputs	63
Connecting bi-directional valve to proportional outputs	63
Connecting single valve to proportional outputs	65
COUT (HS) output OUT_1 to OUT_10 circuit block	66
COUT (LS) output OUT_11 to OUT_30 circuit block	66
COUT usage in safety functions	66
Proportional PWM out HS+LS	67
Connecting bi-directional valve to PWM out HS+LS	68
Connecting single valve to PWM out HS+LS	68
PWM out HS OUT_1 to OUT_10 circuit block	68
PWM out LS OUT_11 to OUT_30 circuit block	69
High side PWM outputs	70
Connecting loads to PWM outputs	70
PWM out (HS) output OUT_31 to OUT_38 circuit block	71
High side digital outputs	72
Connecting loads to high side digital outputs	72
Connecting loads to high side digital outputs in parallel	73
Digital outputs HS+LS	74
Connecting loads to DOUT HS+LS	74
Digital outputs HS+LS OUT_11 to OUT_30 circuit block	76
DOUT HS+LS usage in safety functions	77
Digital out LS outputs, (MC43)	78

	Connecting LEDs to low-side low current outputs	78
	Connecting relays to low-side on-off outputs	79
	Connecting a PLC to low-side low current outputs	80
	Low current Digital out (LS) outputs OUT_39 to OUT_46 circuit block	81
	Busbar pins (MC41)	82
	Connecting wires to busbars to create splices	82
7	Start-up	83
	Start-up procedures	83
	Starting the control system	83
	Prepare for system start	83
	Start the system	83
8	System Diagnostics	84
	Bypass application	85
	Appendix A	86
	IQAN-MC4x Technical Overview	86
	Appendix B	95
	Error codes, messages and actions	95
	Failure modes, external faults on power drivers	96
	Appendix C	99
	Dimensioning of the IQAN-MC41 module	99
	Dimensioning of the IQAN-MC42 module	100
	Dimensioning of the IQAN-MC43 module	101
	Appendix D	102
	Safety manual requirements	102
	SMR: Safety Manual Requirement	102

1 Introduction

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

The user of these instructions should have basic knowledge in the handling of electronic equipment.

Warnings

Sections 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 symbols used in this manual are defined below.



WARNING

Sections labeled *WARNING* with a caution symbol in the left margin, indicate that a hazardous situation exists. We use warnings, marked with the warning symbol, in two ways.

- As a strong recommendation about work practices when using the product in the machine (e.g. routines when updating an application). This use is common to the term 'hazardous situation', that a person is exposed to a hazard.
- As a way of pointing out important information for the machine designer that in some way relates to safety. This includes the design of the physical machine, and also the application program being developed for the control system.

Not all document sections that contain information about safety are marked with a warning symbol (there would be warnings everywhere). Failure to comply with the recommendations can cause unintentional, and unexpected behavior of the control system. This can potentially cause death, serious injury or property damage.



NOTICE

Sections labeled *NOTICE* with a notice symbol in the left margin, indicate there is important information about the product. Ignoring this could result in less than optimal performance, or damage to the product.

Mandatory Safety Requirements

The requirements shown in boxes, and labeled SMR, contain important information about the use of the product in safety related applications. If these requirements are not fulfilled, the safety integrity level on the product is not valid. The Safety Manual Requirements are applicable to the product variants designed for use in safety function, denoted MC4xFS.

These requirements serve as assumptions of use and are focused on handling internal faults that may arise in the MC4xFS. If these requirements are not fulfilled, the safety integrity level on the product is not valid.

MC4xFS-SMR-00x:A Safety Manual Requirement

Boxed sections labeled as SMR contain important safety information. All SMR's are tagged and numbered for easy access.

In some cases, a safety manual requirement, a warning or notice in this manual may be of use for handling faults in external components, but faults in external components are beyond the scope of this manual.

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.

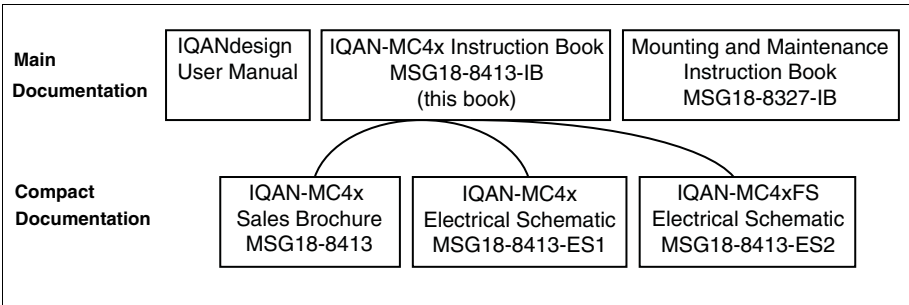
The term "manufacturer" refers to Parker Hannifin Corporation.

Overview of relevant documentation

The following publications are relevant for users of this product.

The main documentation contains information that is not found elsewhere.

The additional documentation contains product information in a compact format, for details on the information found in those documents, consult this manual.



The IQAN-MC4x module documentation system.

2 Precautions

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

Make sure that you have sufficient knowledge before designing, modifying or servicing the control system.

Read the relevant sections of this document before conducting any work on the control system.

MC4xFS-SMR-001:A Use within specification

The product shall only be used within its specified range.



WARNING

This product is not field repairable.

MC4xFS-SMR-002:A No field repair

A damaged product shall not be used, and may only be repaired by the manufacturer.



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.

Read This

Design of control system



WARNING

Risk of injury may be introduced by design of control system!

This product is designed to control hydraulic outputs. The control application must be designed using basic safety principles so that unintentional movement is avoided.

The machine must be equipped with an emergency stop that stops all movement. Please refer to section Emergency stop, on page 37.

Before you start

Read this document, as a minimum sections 1-7

Read the IQANdesign software user manual section on 'application safety'.

Start-up, maintenance, and diagnostics

For all personnel carrying out installation, commissioning, maintenance or troubleshooting.



WARNING

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.

Before you start,

Read section Start-up, on page 83.

Additional information for service

Mounting and maintenance instruction book.

Additional information for diagnosing the system

Read section System Diagnostics, on page 84, and see Appendix B, on page 51, in this document.

Use the IQANrun software user manual as a reference.

3 Product description

IQAN-MC4x, -MC4xFS

The IQAN-MC4 series of controllers are designed for controlling hydraulic systems in vehicles and machinery, using 12/24 Vdc power supply.

There are 2 types of controllers:

- The *Performance* versions, optimized for calculation speed
- The *Functional Safety* versions, for use in safety functions

The controllers intended for use in safety functions are denoted FS, Functional Safety.

The IQAN-MC4xFS controllers are designed to IEC 61508 SIL2.

This document is covering IQAN-MC4 product variants that are designed for use in safety functions, and product variants that are not intended for use in safety functions..

MC4xFS-SMR-003: Use FS version in safety functions

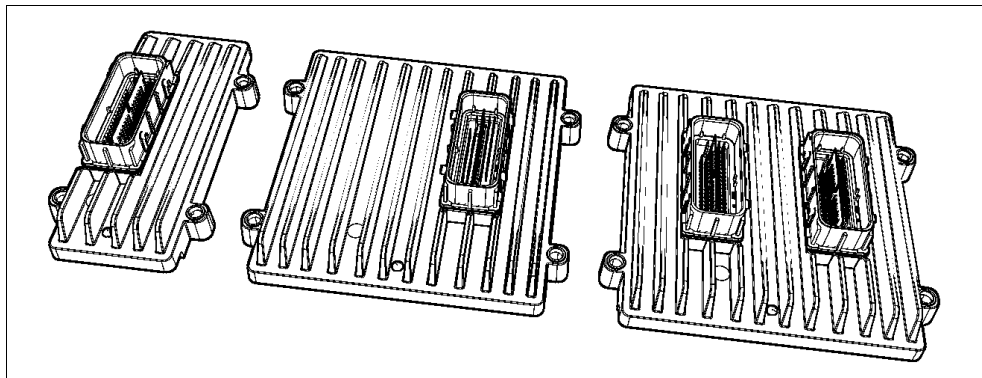
Safety functions shall use one of the following MC4x modules:

- IQAN-MC41FS
- IQAN-MC42FS
- IQAN-MC43FS.

Each IQAN-MC4x or IQAN-MC4xFS is a master unit capable of running applications created by IQANdesign. The MC4x controllers have varying amounts of local I/O for input/output use and multiple CAN buses that support ICP (IQAN CAN Protocol), SAE J1939 and Generic CAN.

By supporting SAE J1939 and Generic CAN the MC4x can act as a sub-master when there is a need of higher performance in a sub-circuit or when there is an OEM supplied overall machine master.

This product is designed for the outdoor environment and comes with an IP6K9K protection for applications where high-pressure water and steam jet cleaning is used.



The IQAN-MC4x controller family.

Capability and I/O overview

The IQAN-MC4x family of controllers has a wide range of input and output types for the monitoring and control of hydraulic systems. Common pin numbering is used between controllers to match type of I/O.

Capabilities	MC41	MC42	MC43
MCU triple core 300 MHz	✓	✓	✓
Program memory (Flash/SRAM)	0.5 MB/0.5 MB	1 MB/1 MB	1.5 MB/1.5 MB
Data log memory (Dflash)	2 MB	2 MB	2 MB
Settings and counter memory (FRAM)	32 KB	32 KB	32 KB
Inputs, total	18	18	50
Voltage inputs: 0–5 V	8	8	26
Voltage inputs: 0–32 V	2	2	2
Current-loop inputs: 0–20 mA	2	2	4
Timer inputs (Freq., PWM, Pulse): 0–50 KHz	6	6	6
Digital inputs	6	6	18
Outputs, total	8	16	36
COU _T (HS)*: 0-2500 mA high-side	2x2	6x2	10x2
PWM/Digital outputs: 4 A high-side	4	4	8
COU _T /Digital output (LS)*: 2.5 A low-side	4	12	20
Digital outputs: 300 mA low-side	-	-	8
Network			
CAN	2	3	5
Ethernet	-	✓	✓

The inputs and outputs can have different functionality depending on software configuration.

* denotes pins that are always used in combination with another pin



NOTICE

For inputs and outputs specifications and connection examples, see section Installation and I/O, on page 25.

IQAN-MC4xFS I/O use in safety functions

Inputs

For the IQAN-MC4xFS, all of the input pins can be used in safety functions, under the assumption that the designer considers the applicable Safety Manual Requirements. For several input types, e.g. digital inputs the use of redundant input pins is mandatory, for other input types the use of single input pins is sufficient to ensure the integrity of the MC4xFS. See section Installation and I/O, on page 25.

Outputs

For the outputs that may be used in safety functions, the output pins are always combined so that the MC4xFS can control both the load supply (high-side) and the load ground (low-side). The pin combinations along with the automatic error detection makes it possible for the MC4xFS to both detect and take action in case of external wiring faults and the more unlikely case of internal faults.

All COUT channels consists of one high-side combined with one or two returns (low-sides), and any COUT can be used in safety functions.

For the digital outputs, DOUT, the DOUT HS +LS outputs can be used in safety functions when there is exactly one high-side combined with one low-side. For detailed instruction on how these outputs may be used, see section Installation and I/O, on page 25.

Communication

The communication interfaces are used for uploading/downloading applications or diagnostics and typically are connected to a computer.

CAN

The IQAN-MC4x controllers have multiple CAN buses. Any of the CAN buses may be used for communication and diagnostics. A CAN communication adapter is required to be installed in your PC to use this feature.

Ethernet

The MC43 and MC42 also have pins to wire in an Ethernet communication port.

The Ethernet port is used for uploading/downloading applications and diagnostics and is designated for computer communication.

Markings/Approvals

The markings/approvals reflect the state of the products at the time of publishing.



EC Type Examination Certificate

SC1402-17

Issued by Notified Body No. 0402 according to 2006/42/EG, the Machinery Directive, annex IX, regarding:

Electrohydraulic Control System IQAN-MC4xFS

Issued to
Parker Hannifin Manufacturing Sweden AB
Mölnlycke Fabriker 14, SE-435 35 Mölnlycke, Sweden
Reg.number: 556045-9470

Product description and product name
Electrohydraulic Control System IQAN-MC41FS, IQAN-MC42FS and IQAN-MC43FS, programmable controller for use in mobile machinery applications intended for implementation of safety functions. Hardware version 20085121 (MC41FS), 20085122 (MC42FS) and 20085123 (MC43FS). Software version vmAC 5.01.

Technical documentation
The manufacturer's technical file, latest dated 2017-12-04

Certificate
RISE Research Institutes of Sweden AB, Notified Body No. 0402, hereby certifies that the manufacturer's technical file and the product have been inspected in accordance with the procedure described in Directive 2006/42/EG, the Machinery Directive, annex IX and found to fulfil the requirements, in respect of products listed in annex 4, paragraph 21 (Logic units to ensure safety functions).
The certification is verified by a type test in accordance with EN 61508 (SIL 2). According to EN 62061, the design of complex programmable electronic subsystems shall conform to the relevant requirements of EN 61508. By using Table 3 in EN ISO 13849-1:2015 it can be shown that this corresponds to PL d.

The Council Directive 2006/42/EC is implemented in Swedish Law by the national regulation AFS 2008:3. RISE Certification Rule SPCR 305 has been applied.

Miscellaneous
The manufacturer's information, in English, on installation and safety, has been inspected and found to fulfil the relevant requirements of the Directive.

Validity
This certificate was first issued on 2017-12-06 and remains valid as long as the conditions laid down in the specification(s) in reference are not modified significantly or at the latest until 2022-12-06.



Lennart Aronsson



Jan Jacobson

Certificate No. SC1402-17 | issue 1 | 2017-12-06

RISE Research Institutes of Sweden AB |
Box 857, SE-501 15 Borås, Sweden
Phone: +46 10-516 50 00
certifiering@ri.se | www.ri.se



2017-10-27 7P03370

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Page 1 (1)



TYPE EXAMINATION CERTIFICATE

SC1403-17

Parker Hannifin IQAN-MC4xFS control system

Issued to

Parker Hannifin Manufacturing Sweden AB,

Mölnlycke Fabriker 14, SE-435 35 Mölnlycke, Sweden

Reg.number: 556045-9470

Product name and description

IQAN-MC41FS

IQAN-MC42FS

IQAN-MC43FS

Programmable controller for use in mobile machinery applications intended for implementation of safety functions.

Certification

The product described above fulfils the requirements for SIL 2 of the standard IEC 61508:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems, part 1-7 for a safety related control system:

Safety integrity level	SIL 2
Systematic capability	SC2
Element complexity	Type B
Hardware Fault Tolerance	HFT=0
Safe Failure Fraction	
MC41FS	SFF= 98,7%
MC42FS	SFF= 98,8%
MC43FS	SFF=98,7%
PFH _D	
MC41FS	7,61E-08
MC42FS	7,90E-08
MC43FS	9,28E-08
Diagnostic Coverage	
MC41FS	DC=98,5%
MC42FS	DC=98,6%
MC43FS	DC= 98,4%
Diagnostic test interval	< 100 ms
Lifetime	10 years or 40.000 hours
Periodic proof test	No

Certificate No. SC1403-17 | issue 1|2017-12-06

RISE Research Institutes of Sweden AB | Certification

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Page 1 (2)



TYPE EXAMINATION CERTIFICATE

The certification is based on a functional safety assessment according to IEC 61508 described in RISE report 7P03370:A dated 21st November 2017 supplemented by a separate evaluation of Parker Hannifins development tool IQANdesign and service tool IQANrun, for use together with MC4xFS control system, described in RISE report 7P03370:B dated 21st November 2017 and instruction book IQAN-MC4 in the currently valid revision.

Marking


Each product that conforms in all respects with the original item certified may display the text 'Type-examined by RISE'. When this marking is applied the marking shall also contain reference to the standard IEC 61508:2010, the reached SIL (Safety Integrity Level) of the item, the number of this certificate and the serial number or equivalent of the item.

Validity


This certificate is valid until not later than 2022-12-06.

Miscellaneous

Other terms and conditions are set out in RISE certification rules for type-examination, SPCR 123.



Lennart Aronsson



Jan Jacobson

Certificate No. SC1403-17 | issue 1|2017-12-06
RISE Research Institutes of Sweden AB | Certification

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Page 2 (2)



Declaration of Conformity

EC Machinery directive 2006/42/EC

We: Parker Hannifin Manufacturing Sweden AB
Mobile Hydraulic Systems Division

Located at: Mölnlycke Fabriker 14
S-435 35 Mölnlycke, SWEDEN

Declare that the products declared herein fulfil all relevant safety component requirements of EC Machinery Directive 2006/42/EC.

Trade Name	Products	since year of manufacture
Electrohydraulic Control System	IQAN-MC41FS	2017
	IQAN-MC42FS	
	IQAN-MC43FS	

Harmonized standard:

EN 62061:2005/AC:2010/A1/A2

Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems

Other standards:

IEC 61508 edition 2

Functional safety of electrical/electronic/programmable electronic safety-related systems

EC Type examination:

RISE Research Institutes of Sweden AB, Notified body no. 0402
Certificate no: SC1402-17

The products referred in this declaration of conformity also fulfil the relevant provisions of EMC Directive 2014/30/EU and RoHS Directive 2011/65/EU.

Signature:

Printed name:

Håkan Jisland

Position:

Business Unit Manager

Executed on December 6th 2017, at Mölnlycke, Sweden

Publ.no: HY33-8413-DC/UK
Ed. 12/2017



Declaration of Conformity

We: Parker Hannifin Manufacturing Sweden AB
Mobile Hydraulic Systems Division

Located at: Mölnlycke Fabriker 14
S-435 35 Mölnlycke, SWEDEN
Tel. +46 31 750 44 00

Declare that the products identified herein comply with the essential requirements of the following EU directives:

2014/30/EU **EU EMC Directive**

2011/65/EU **EU RoHS II Directive**

Harmonized standards:

ISO 14982:2009	Agricultural and forestry machines - Electromagnetic compatibility - Test methods and acceptance criteria
EN 13309:2010	Construction machinery - Electromagnetic compatibility of machines with internal electrical power supply
EN 50581:2012	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Trade Name: Electrohydraulic Control Systems

Products:	IQAN-MC41	IQAN-MC42	IQAN-MC43
	IQAN-MC41FS	IQAN-MC42FS	IQAN-MC43FS

Signature of responsible party:

Printed name of responsible party: Håkan Jisland
Position of responsible party: Business Unit Manager

Executed on December 6th 2017, at Mölnlycke, Sweden

4 Safety

Safety concept

All IQAN modules are designed for controlling hydraulic implements on mobile machines, and when basic safety principles are observed, IQAN modules such as the performance versions of IQAN-MC4 can be used for normal machine functions.

The IQAN-MC4xFS is designed in accordance with IEC 61508 for use in applications with higher demands on functional safety. When there is a need to prove the safety integrity of each implemented safety function, the IQAN-MC4xFS can be used for functions with a maximum safety integrity of SIL2.

The performance versions of IQAN-MC4 are also covered in this manual, and are not intended for use in safety functions.

Safe state

The safety analysis of all IQAN modules, including the IQAN-MC4xFS is done under the assumption that the system is in a safe state when the controller is off.



WARNING

System design must not allow any unintentional movement when the unit is off.

MC4xFS-SMR-004:A Safe state

The MC4xFS shall only be used in systems that are in a safe state when the controller is off; and where a transition to the critical stop state can be an immediate action for maintaining safe state.

If any critical fault within the IQAN-MC4xFS is detected by its internal checks, the controller will shut down all outputs, including CAN.

- If a fault on an output is detected, that output and adjacent outputs affected by the fault will be shut off.
- If this occurs, the stop ramps on the outputs will have no effect, the outputs will shut off immediately.

Therefore, the application must be designed so that a sudden stop on the outputs does not in itself lead to a hazardous situation.

Maximum achievable SIL and PL

The IQAN-MC4xFS is designed for use in safety functions of up to SIL2 (IEC 61508). The IQAN-MC4xFS in itself does not come with any safety function; it needs to be put into a system and loaded with an application file. It is recommended for the developer of the safety function to apply a standard written specifically for machine manufacturers when designing safety functions with the IQAN-MC4xFS. Suitable standards for machinery are EN ISO 13849-1, or IEC/EN 62061.

The following table shows the relationship between Performance Level (PL) and Safety Integrity Level (SIL), and also the corresponding average probability of dangerous failure per hour (PFHd). The PL and SIL are based both on quantifiable aspects and on non-quantifiable aspects such as the development process used and the safety related software.

Average probability of dangerous failure per hour [1/h]	EN 13849-1 PL	EN 62061 SIL	IEC61508 SIL
$\geq 10^{-5}$ to $< 10^{-4}$	a	-	-
$\geq 3 \cdot 10^{-6}$ to $< 10^{-5}$	b	1	1
$\geq 10^{-6}$ to $< 3 \cdot 10^{-6}$	c	1	1
$\geq 10^{-7}$ to $< 10^{-6}$	d	2	2
$\geq 10^{-8}$ to $< 10^{-7}$	e	3	3
	-	-	4

For the IQAN-MC4xFS, the maximum achievable Performance Level and Safety Integrity Level is shown in the following table.

Maximum achievable Performance Level, EN ISO 13849-1	PLd
Maximum achievable Safety Integrity Level, EN IEC 62061	SIL2
Maximum achievable Safety Integrity Level, EN IEC 61508	SIL2

System boundaries

The safety integrity of the IQAN-MC4xFS is covering the following elements of the module:

- Local I/O, installed and used in accordance with this manual
 - All input channels (VIN, VIN32, DIN, FIN/PCNT/DFIN/DPCNT, PWMIN, CIN)
 - Sensor supplies (VREF)
 - Outputs allowed in safety functions (COUT, DOUT HS+LS)
- Core electronics (processor, memory, power supply)
- CAN, when information sent is protected by a high level protocol

The following internal diagnostic information is used for keeping the IQAN-MC4xFS within the specified range, and may not be used for implementation of safety functions:

- Measurement of module supply voltage
- Measurement of module temperature

The following functionality of the IQAN-MC4xFS is seen as non-safety related:

- Logs
- LED diagnostics
- Single pin outputs

The IQAN-MC4xFS provides some diagnostic features related to the interface with sensors and actuators (valves). However, sensors, actuators, and wiring must be analyzed separately for their suitability to be used in safety functions.



NOTICE

The IQAN-MC4xFS does not come with any pre existing safety function implemented. An application file must always be created in IQANdesign before the module can be used.

The IQAN-MC4xFS provides some diagnostic features related to the interface with sensors and actuators (valves). However, sensors, actuators, and wiring must be analyzed separately for their suitability to be used in safety functions.

The internal diagnostics of the IQAN-MC4xFS as well as built in diagnostics on I/O are dependent on the system cycle time, a longer system cycle will in some cases delay the diagnostics.

IQAN software support tools

The hardware and embedded software of the IQAN-M4xFS allows it to be used to implement safety functions of up to SIL2 or PLd. In order to achieve this, the application software must be designed up to the same level. The application software may be designed using the generic standard for functional safety, IEC 61508, or a standard for functional safety of machinery, e.g. EN ISO 13849-1 or EN/IEC 62061. Both development of safety related application software and software based parameterization is considered when working with the IQAN software support tools. IQANdesign is the tool used for developing the application software. An IQANdesign application is built up from of pre-existing application specific building blocks (e.g. channels), that run on the application interpreter on the IQAN master module. With this approach, the user never re-compiles any code, which allows the embedded software including the application interpreter to be extensively tested by Parker before each IQANdesign release.

MC4xFS-SMR-005:A Only use an official release of IQANdesign

The application shall be built using an officially released version of IQANdesign.

It is not necessary for all development of the application to be made using an official release of IQANdesign; a beta version may be used for prototyping. However, before the safety integrity of the module can claimed, the application must be upgraded to an official release of IQANdesign.

It is possible to implement both safety-related and non-safety related functionality on the IQAN-MC4xFS, the separation of safety functions from other application logic is done by organizing the application with function groups marked as safety.

MC4xFS-SMR-006:A Safety related function groups in IQANdesign

The IQANdesign application shall be structured so that safety functions are organized in function groups marked as safety related.

Safety related function groups do not change the run-time execution of an MC4xFS application, it is at design-time that it helps by separating and highlighting the safety functions and aids in identifying constructs that are not suitable in safety functions.

See IQANdesign user manual for further details.

For safety related software based parameterization, the IQAN configuration tools (e.g. IQANrun) have functionality for handling the integrity of the parameters and the access to these parameters.

MC4xFS-SMR-007:A Configuration tools

The application shall not incorporate functions that would make it possible to alter safety related parameters through other tools than the IQAN configuration tools.

IQAN configuration tools include: IQANrun (PC), IQANrun for tablets, IQANsync and IQAN master displays that are part of the same project file as the MC4xFS.

When implementing safety functions, it is important that the functions for protecting settings are used.

MC4xFS-SMR-008:A Access protection of safety related parameters

The IQANdesign application shall be designed so that adjust items for safety related parameters are protected with passwords and limits.

All settings in the IQAN master (includes adjust items and values stored using application logic) are individually checksum protected. In case of a fault, the application default values will be used.

MC4xFS-SMR-009:A Safe default values on safety related parameters

The IQANdesign application shall be designed so that the application default values set on safety related parameters are always safe to use.

See IQANdesign user manual for further detail.

Run time diagnostics and startup tests

The IQAN-MC4xFS hardware and software diagnostics is designed to run continuously and detect dangerous failures within the diagnostic test interval, see Appendix A. Detected errors will be indicated with one of the blink codes in Appendix B.

Diagnostic functions implemented in the IQANdesign application is dependent on the application cycle time (see IQANdesign user manual). When determining the maximum reaction time of a safety function, it is important that the application cycle time is not exceeded.

MC4xFS-SMR-010:A Application cycle utilization

The application cycle utilization shall be considered during development; the application shall be designed so that cycle utilization cannot exceed 100%.

If the application cycle time has been set so low that the application is not calculated within this fixed time, the effect on the module is that the effective cycle time is doubled. This will delay the reaction time on safety functions. If the application cycle utilization is so high that the watchdog timeout is exceeded, the module will enter the critical error state.

In addition to the run-time diagnostics methods for detecting dangerous faults, the IQAN-MC4xFS is also has testing of the diagnostics functions. Some of these tests of the diagnostic functions can only be performed on startup. It is assumed that the

MC4xFS is used in an application where the module is being restarted at regular interval, e.g. by key-off by the machine operator at the end of a shift.

MC4xFS-SMR-011:A Expected restart interval

The module shall only be used in application where it is expected to be shut down or restated within 48 hours after startup.

Application dependent input diagnostics

The IQAN-MC4xFS provides a flexible way of selecting and combining inputs to meet the requirements of different safety functions.

Some input diagnostics is provided entirely by the lower level firmware, some is provided on the input channel when the application designer sets certain properties, and for some diagnostics the application designer needs to combine redundant inputs to fulfil the requirements. Safety Manual Requirements for the different input types are found in chapter 6, Installation and I/O.

When an error is detected on an input channel, it will fall back to using its error value (set in IQANdesign) and the type of error will be indicated as the channel status.

MC4xFS-SMR-012:A Safe error values on input channels

The error values set in IQANdesign on input channels shall be selected so that the application is in a safe state if an error detection.

It is recommended to also make use of the channel status when designing the conditions for restart after faults.

When pairs of channels are used in a safety function, it is recommended to use the IQANdesign compare-channels for cross monitoring of the channels. In addition to properties for cross monitoring the compare channels also provide functionality for setting startup- and restart conditions.

Safety related CAN bus communication

High-speed CAN in itself is a very robust protocol with a low risk of faults, and is suited for many machine control applications, but without additional checks in place regular CAN is not considered suitable for IEC 61508 SIL2 safety functions.

To bridge this gap, an IQAN multi-master system consisting of e.g. IQAN-MC4xFS can be designed so that safety-related real-time data is sent over CAN with a higher-layer protocol providing additional diagnostics. This is done using the IQANdesign APPOUT/APPIN channels.

MC4xFS-SMR-013:A Safety related real-time CAN communication between IQAN masters

A safety function allocated on multiple IQAN masters shall use the IQANdesign APPOUT/APPIN channels for exchange of safety related real-time data.

This IQAN protocol for exchange of safety related data is designed so that it can coexist with other non-safety related communication on the same physical bus.

The IQAN-MC4xFS could also be connected to sensor subsystems over CAN, assuming that the CAN protocol is suitable for safety related communication and that the diagnostic functions of that protocol are handled by the application design.

MC4xFS-SMR-014:A Safety related real-time CAN communication with 3rd party nodes

For safety functions that depend on CAN communication with 3rd party nodes, the high-level protocol used must provide the diagnostic methods, and these diagnostic methods shall be implemented in the IQANdesign application.

MC4xFS internal diagnostics

The IQAN-MC4xFS is based on a safety-certified lock-step microcontroller, where the lock-step core is calculating the IQAN application twice on diverse processors and compare the results each clock-cycle in hardware. The use of this safety-certified microcontroller also includes hardware supported run-time monitoring of all microcontroller peripherals, run-time monitoring of RAM and Flash memories using ECC (error correcting code) and isolation between software parts using memory protection in hardware. The MC4xFS runs on a safety certified Real Time Operating System.

A key component is also the Safety Power Manager that provides monitoring of all voltages and also an additional external windowed watchdog. If any non-isolatable fault occurs, the separate safety power manager will switch off the SSP, *Secondary Shutdown Path* that provides, cutting the power to all high-side drivers and disabling all low-side drivers.

In addition to the run-time diagnostics of dangerous faults, the MC4xFS also performs even more extensive start-up tests covering also the diagnostic functions.

Depending on the criticality of a fault detected by internal diagnostics, the action of the IQAN-MC4xFS will be one of the following:

- Prevention of startup
- Isolated detection and shutdown of the affected function while continuing to run the application
- Complete stop by shutting down all power drivers and the application, while continuing to run diagnostic communication via IQAN software tools
- Complete stop by shutting down all power drivers and stopping all software execution, only blink codes are shown.

See Appendix B for blink codes describing these states

IQAN-MC4x and IQAN-MC4xFS

The enclosures and pin-layout for the IQAN-MC4x performance versions and the corresponding size IQAN-MC4xFS are identical, the modules are based on similar hardware. IQAN-MC4xFS is an evolution of the earlier MC4x versions, with a vast amount of monitoring added to meet the requirements for IEC 61508 SIL2.

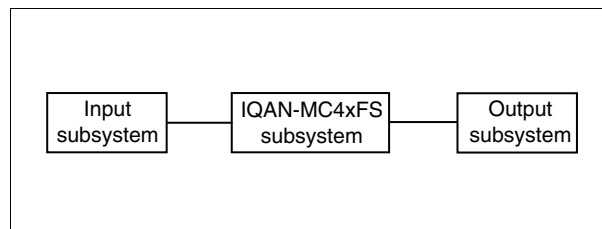
IQANdesign distinguishes between all variants, an IQAN-MC4xFS firmware and application can never be sent to IQAN-MC4x performance hardware and vice versa.

- IQAN-MC4x performance only runs a sub-set of the MC4xFS functions for internal diagnostics. Because of reduced diagnostics, DC and thus SFF and PFHd is not available for these modules.
- In a given IQANdesign version, the IQAN-MC4x performance may support new software features not yet available on IQAN-MC4xFS

- Safety certification only applies to IQAN-MC4xFS variants, the IQAN-MC4x performance is considered as a unit without safety rating by the manufacturer.

Architecture for a complete safety function

When analyzing a safety function, the IQAN-MC4xFS can be modeled as a safety related sub-system. With this approach, there would also be at least one safety related input subsystem (e.g. sensors), and a safety related output subsystem (e.g. valves). In EN 13849-1, this method for combining subsystems is titled combination of SRP/CS.



The IQAN-MC4xFS module as a subsystem in a complete safety application.

Input subsystem

The input subsystem consists of the sensors or operator controls that initiate the safety function.

IQAN-MC4xFS place requirements on how to connect and use its local inputs, this serves to fulfil the requirements on diagnosing the IQAN-MC4xFS input hardware. See section Installation and I/O, on page 25. By meeting these requirements, the application will also achieve diagnostics on the input subsystem elements (e.g. sensors) and may also achieve redundant use of subsystem elements.

Because diagnostics is always required, and redundancy may be required, the EN ISO 13849-1 categories 2, 3 or 4 are suitable for designing input subsystems used together with the IQAN-MC4xFS.

If a single sensor output signal meets the MC4xFS requirements without achieving diagnostic coverage of the sensor itself, the EN 13849-1 category B might be used for the input subsystem, but such designs would significantly limit the Performance Level PL on the complete safety function.

EN 13849-1 category 1 is not a suitable design of input subsystems for the IQAN-MC4xFS, as the DIN channel must always be used in pair with a redundant input channel.

Alternatively, if the input subsystem for the safety function is designed in accordance with EN/IEC 62061, the subsystems type C (zero fault tolerance with a diagnostic function) or type D (single fault tolerance with a diagnostic function) are suitable.



WARNING

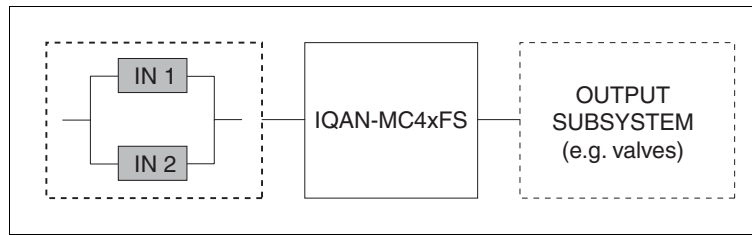
Although the IQAN-MC4xFS with a maintained safety integrity can accept a single input signal for some channels, the application must also consider faults in the source of the signal (e.g. sensor), and systematic failures such as loss of ground.

Pairs of inputs

It is always recommended, and in several cases required, to use inputs for safety functions in pairs.

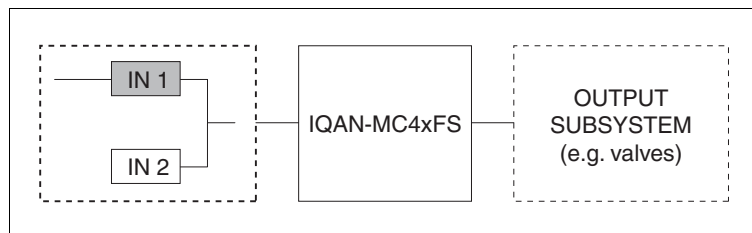
Pairs of signals may be used either:

- as a fully redundant structure



Fully redundant structure.

- or, as a single channel that performs the safety function combined with a monitoring channel.



Single structure with monitoring by separate signal.

It is important to understand that in order to achieve true redundancy; the application software must use the input signals in such a way that a single failure that is not detected by diagnostics is still safe. It is also important to consider measures against common cause failures as well as systematic faults that would affect both channels.

EXAMPLE

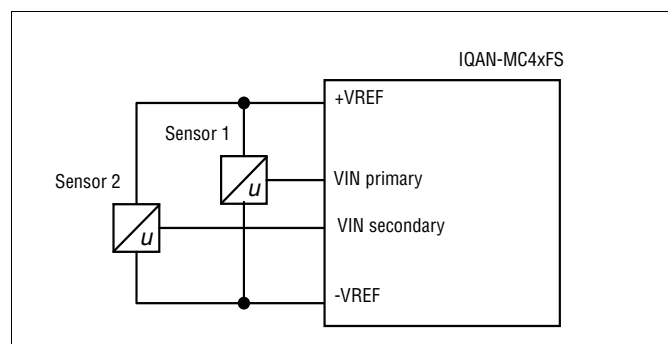
An overload safety function for stopping hazardous movement when the pressure exceeds a set threshold may be implemented using two separate pressure sensors with opposing signals.

This may be a redundant structure if the overload safety function always picks the highest measured pressure value of the two, and the two signals are also compared for diagnostics.

- Implemented in IQANdesign with 2 range limited VIN channels, the method 'MaxOf' and with AAC (Analog-Analog Comparator)

If the same overload function only uses one of the signals, and compares with the other for diagnostics that lead to a safe state, that is not true redundancy, but may be interpreted as a single structure with monitoring by separate signal.

- Implemented in IQANdesign with 2 range limited VIN channels and with AAC



Connecting pairs of signals.

The wiring is the same for both alternatives. In case the sensor signals are identical (instead of opposing), full separation in wiring may be necessary to handle faults such as loss of ground.

Input subsystem connected on CAN

Alternatively, an 3rd party input device may be communicating over CAN, to use this in a SIL2 or PLd safety function the 3rd party device needs to be rated to this level. See section Safety related CAN bus communication, on page 17.

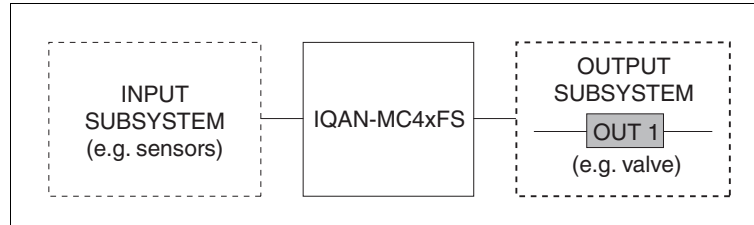
Logic subsystem, IQAN-MC4xFS and application software

The logic subsystem consists of the IQAN-MC4xFS hardware, embedded software and the application software. The hardware and embedded software of the IQAN-MC4xFS allows it to be used to implement safety functions of up to SIL2 or PLd. In order to achieve this, the application software must be designed up to the same level. The application software can be designed using the generic standard for functional safety, IEC 61508. However, it is recommended that a standard for the functional safety of machinery is applied, either EN ISO 13849-1 or EN/IEC 62061. IQANdesign is used for developing the application software.

Output subsystem

The output subsystem is the output power elements, e.g. valves, which control the machine actuators. In applications with output monitoring, e.g. spool position sensors, such sensors are also included in the output subsystem.

The power driver outputs on the module control the valves. The IQAN-MC4xFS outputs intended for controlling potentially hazardous movement in a safety function are the Current out and Digital out HS +LS. With these outputs, the IQAN-MC4xFS has continuous monitoring and redundant shutdown paths for the loads, and does not place any restriction on the possible architecture for the output subsystem.



The IQAN-MC4xFS module connected to output subsystem.

The IQAN-MC4xFS is suitable for connection to output subsystems of category B, 1, 2, 3 or 4 in accordance with EN ISO13849-1.

For requirements on output connections, section Installation and I/O, on page 25.

For a description of external failure modes detected by module outputs, see Appendix B, on page 95.

5 Mounting

Mounting the module

The IQAN-MC4x module should be mounted according to the following instructions:

- Locate the module eliminating the risk for the cabling to be folded, crushed or damaged in any way. Ensure the cabling cannot pull, twist or induce side load on the connector.



NOTICE

Maximum recommended distance from the Molex MX123 connector to the first cabling anchor point is 300 mm.

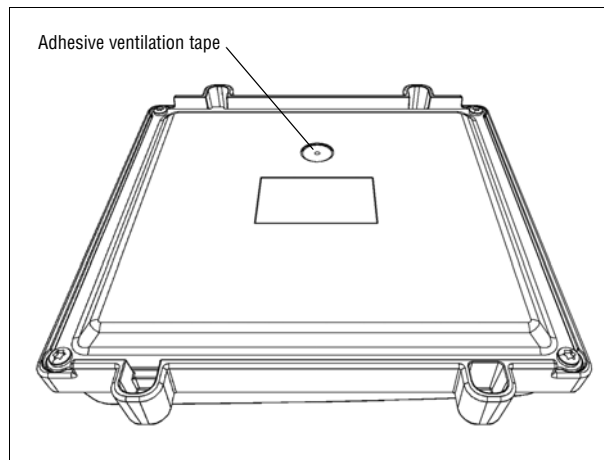
- Locate the module so that severe physical impact is avoided, e.g. impact from falling objects or the module being used as a step.
- Locate the module so that air can circulate to eliminate excess heat. Ensure that no external heat, e.g. from the engine or heater, is transferred to the module.
- Locate the module to protect it from high pressure washing or similar.



NOTICE

Protect the ventilated tape on the back of the housing.

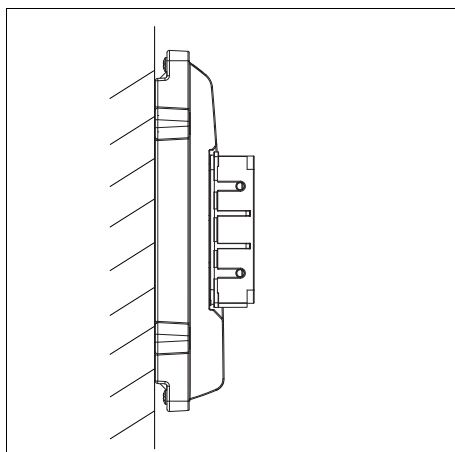
The IQAN-MC4x must be installed so that the ventilated hole is protected against direct water pressure and mechanical exposure.



Location of ventilation tape on IQAN-MC43.

- Locate the module so the status LED is visible.

- For maximum cooling, mount the module on a vertical surface.



Recommended placing.



NOTICE

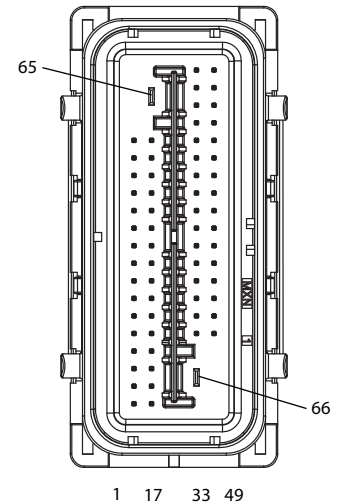
The IQAN-MC4x module must not be placed in any marine related or similar continuously damp, salt-spray environment without external protection.

6 Installation and I/O

Connector, MC43, C1

Connector C1 pin assignments

Connector kit	Parker no. 20085114
Housing	Molex no. 34822-0013
Cover	Molex no. 34565-0003
Pin types	Molex 33467-0024 (0.64 mm) Yazaki 7116-4152-02 (2.8 mm)
Seal	Yazaki 7158-3113-40 (2.8 mm)
Cables	0.75 mm ² / 18 AWG (0.64 mm) 1.50-2.50 mm ² / 14 AWG (2.8 mm)
Plugs (empty pos.)	Molex no. 34586-0001 (0.64 mm)
Crimping tools (all pins)	Parker no. 20085120
Prototype cable	Parker no. 20085116



Pin	Symbol	Primary Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function
1	CAN_L_A	CAN low, bus 1					
2	CAN_L_B	CAN low, bus 2					
3	CAN_L_C	CAN low, bus 3					
4	ADDR_L	IdTag, low side.					
5	NC	No connect.					
6	NC	No connect.					
7	VREF+_A	+5 Vdc supply power					
8	IN_1	VIN-A	DIN-M				
9	IN_2	VIN-B	DIN-N				
10	IN_3	VIN-C	DIN-O				
11	IN_33	FIN-A w/pull-up.	DFIN-A	PCNT-A	DPCNT-A+	PWMIN-A	DIN-AM
12	IN_34	FIN-B w/pull-up.	DFIN-A	PCNT-B	DPCNT-A-	PWMIN-B	DIN-AN
13	IN_35	FIN-C w/pull-up.	DFIN-B	PCNT-C	DPCNT-B+	PWMIN-C	DIN-AO
14	OUT_1	COUT-A (HS)*	PWM-A (HS)*				
15	OUT_2	COUT-B (HS)*	PWM-B (HS)*				
16	OUT_3	COUT-C (HS)*	PWM-C (HS)*				
17	CAN_H_A	CAN high, bus 1					

Pin	Symbol	Primary Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function
18	CAN_H_B	CAN high, bus 2					
19	CAN_H_C	CAN high, bus 3					
20	ADDR_H	IdTag, high side.					
21	NC	No connect.					
22	NC	No connect.					
23	VREFGND	+5 Vdc supply GND					
24	IN_4	VIN-D	DIN-P				
25	IN_5	VIN-E	DIN-Q				
26	IN_6	VIN-F	DIN-R				
27	IN_36	FIN-D w/pull-up.	DFIN-B	PCNT-D	DPCNT-B-	PWMIN-D	DIN-AP
28	IN_37	FIN-E w/ pull-down.	DFIN-C	PCNT-E	DPCNT-C+	PWMIN-E	DIN-AQ
29	IN_38	FIN-F w/ pull-down.	DFIN-C	PCNT-F	DPCNT-C-	PWMIN-F	DIN-AR
30	OUT_4	COUT-D (HS)*	PWM-D (HS)*				
31	OUT_5	COUT-E (HS)*	PWM-E (HS)*				
32	OUT_6	COUT-F (HS)*	PWM-F (HS)*				
33	ETHRD-	Ethernet RD-					
34	ETHTD-	Ethernet TD-					
35	VREFGND	+5 Vdc supply GND					
36	IN_7	VIN-G	DIN-S				
37	IN_29	CIN-A					
38	IN_27	VIN32-A					
39	OUT_11	COUT-A (LS+)*	PWM-A (LS+)*	DOUT-I (LS)*			
40	OUT_13	COUT-B (LS+)*	PWM-B (LS+)*	DOUT-K (LS)*			
41	OUT_15	COUT-C (LS+)*	PWM-C (LS+)*	DOUT-M (LS)*			
42	OUT_17	COUT-D (LS+)*	PWM-D (LS+)*	DOUT-O (LS)*			
43	OUT_19	COUT-E (LS+)*	PWM-E (LS+)*	DOUT-Q (LS)*			
44	OUT_21	COUT-F (LS+)*	PWM-F (LS+)*	DOUT-S (LS)*			
45	OUT_31a	PWM-K (HS)	DOUT-A (HS)	DOUT-I (HS)*	DOUT-J (HS)*	DOUT-K (HS)*	DOUT-L (HS)*
46	OUT_32a	PWM-L (HS)	DOUT-B (HS)	DOUT-M (HS)*	DOUT-N (HS)*	DOUT-O (HS)*	DOUT-P (HS)*
47	OUT_33a	PWM-M (HS)	DOUT-C (HS)	DOUT-Q (HS)*	DOUT-R (HS)*	DOUT-S (HS)*	DOUT-T (HS)*
48	OUT_34a	PWM-N (HS)	DOUT-D (HS)				
49	ETHRD+	Ethernet RD+					
50	ETHTD+	Ethernet TD+					
51	VREF+_B	+5 Vdc supply power					

Pin	Symbol	Primary Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function
52	IN_8	VIN-H	DIN-T				
53	IN_30	CIN-B					
54	IN_28	VIN32-B					
55	OUT_12	COUT-A (LS-)*	PWM-A (LS-)*	DOUT-J (LS)*			
56	OUT_14	COUT-B (LS-)*	PWM-B (LS-)*	DOUT-L (LS)*			
57	OUT_16	COUT-C (LS-)*	PWM-C (LS-)*	DOUT-N (LS)*			
58	OUT_18	COUT-D (LS-)*	PWM-D (LS-)*	DOUT-P (LS)*			
59	OUT_20	COUT-E (LS-)*	PWM-E (LS-)*	DOUT-R (LS)*			
60	OUT_22	COUT-F (LS-)*	PWM-F (LS-)*	DOUT-T (LS)*			
61	OUT_31b	PWM-K (HS)	DOUT-A (HS)	DOUT-I (HS)*	DOUT-J (HS)*	DOUT-K (HS)*	DOUT-L (HS)*
62	OUT_32b	PWM-L (HS)	DOUT-B (HS)	DOUT-M (HS)*	DOUT-N (HS)*	DOUT-O (HS)*	DOUT-P (HS)*
63	OUT_33b	PWM-M (HS)	DOUT-C (HS)	DOUT-Q (HS)*	DOUT-R (HS)*	DOUT-S (HS)*	DOUT-T (HS)*
64	OUT_34b	PWM-N (HS)	DOUT-D (HS)				
65	+BAT	Power supply 12/24 Vdc					
66	-BAT	Power supply GND					

Notes:

1. Voltage inputs, frequency and digital inputs may also be configured as digital inputs.
2. High side outputs OUT-31 to OUT-34 have 2 pins (a/b) per output.
3. Shaded pin numbers are 2.8 mm terminals.
4. If marked with *, channel combines high-side(HS) and low-side(LS) pins



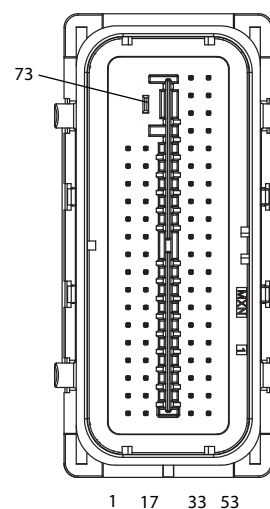
NOTICE

Sealing plugs must be used in all open pin positions. Failure to follow this instruction will cause the module to not meet the environmental specification.

Connector, MC43, C2

Connector C2 pin assignments

Connector kit	Parker no. 20085115
Housing	Molex no. 34566-0103
Cover	Molex no. 34565-0003
Pin types	Molex 33467-0024 (0.64 mm) Yazaki 7116-4152-02 (2.8 mm)
Seal	Yazaki 7158-3113-40 (2.8 mm)
Cables	0.75 mm ² /18 AWG (0.64 mm) 1.50-2.50 mm ² / 14 AWG (2.8 mm)
Plugs (empty pos.)	Molex no. 34586-0001 (0.64 mm)
Crimping tool (all pins)	Parker no. 20085120
Prototype cable	Parker no. 20085117



Pin	Symbol	Primary Function	Alt. Function	Alt. Function	Alt. Function	Alt. Function
1	CAN-L_D	CAN low				
2	CAN_L_E	CAN low				
3	IN_9	VIN-I	DIN-U			
4	IN_10	VIN-J	DIN-V			
5	IN_11	VIN-K	DIN-W			
6	IN_12	VIN-L	DIN-X			
7	VREF+_A	+5 Vdc supply power				
8	VREF+_A	+5 Vdc supply power				
9	IN_39	DIN-A				
10	IN_40	DIN-B				
11	IN_41	DIN-C				
12	IN_42	DIN-D				
13	OUT_23	COUT-G (LS+)*	PWM-G (LS+)*	DOUT-U (LS)*		
14	OUT_25	COUT-H (LS+)*	PWM-H (LS+)*	DOUT-W (LS)*		
15	OUT_27	COUT-I (LS+)*	PWM-I (LS+)*	DOUT-Y (LS)*		
16	OUT_29	COUT-J (LS+)*	PWM-J (LS+)*	DOUT-AA (LS)*		
17	CAN_H_D	CAN high				
18	CAN_H_E	CAN high				
19	IN_13	VIN-M	DIN-Y			
20	IN_14	VIN-N	DIN-Z			
21	IN_15	VIN-O	DIN-AA			
22	IN_16	VIN-P	DIN-AB			
23	VREFGND	+5 Vdc supply GND				

Pin	Symbol	Primary Function	Alt. Function	Alt. Function	Alt. Function	Alt. Function
24	VREFGND	+5 Vdc supply GND				
25	IN_43	DIN-E				
26	IN_44	DIN-F				
27	IN_45	DIN-G				
28	IN_46	DIN-H				
29	OUT_24	COUT-G (LS-)*	PWM-G (LS-)*	DOUT-V (LS)*		
30	OUT_26	COUT-H (LS-)*	PWM-H (LS-)*	DOUT-X (LS)*		
31	OUT_28	COUT-I (LS-)*	PWM-I (LS-)*	DOUT-Z (LS)*		
32	OUT_30	COUT-J (LS-)*	PWM-J (LS-)*	DOUT-AB (LS)*		
33	IN_31	CIN-C				
34	IN_17	VIN-Q	DIN-AC			
35	IN_18	VIN-R	DIN-AD			
36	IN_19	VIN-S	DIN-AE			
37	IN_20	VIN-T	DIN-AF			
38	IN_21	VIN-U	DIN-AG			
39	VREFGND	+5 Vdc supply GND				
40	VREFGND	+5 Vdc supply GND				
41	IN_47	DIN-I				
42	IN_48	DIN-J				
43	OUT_39	DOUT-AC (LS)				
44	OUT_41	DOUT-AE (LS)				
45	OUT_43	DOUT-AG (LS)				
46	OUT_45	DOUT-AI (LS)				
47	OUT_7	COUT-G (HS)*	PWM-G (HS)*			
48	OUT_8	COUT-H (HS)*	PWM-H (HS)*			
49	OUT_35a	PWM-O (HS)	DOUT-E (HS)	DOUT-U, -V, -W, -X (HS)*		
50	OUT_36a	PWM-P (HS)	DOUT-F (HS)	DOUT-Y, -Z, -AA, -AB (HS)*		
51	OUT_37a	PWM-Q (HS)	DOUT-G (HS)			
52	OUT_38a	PWM-R (HS)	DOUT-H (HS)			
53	IN_32	CIN-D				
54	IN_22	VIN-V	DIN-AH			
55	IN_23	VIN-W	DIN-AI			
56	IN_24	VIN-X	DIN-AJ			
57	IN_25	VIN-Y	DIN-AK			
58	IN_26	VIN-Z	DIN-AL			
59	VREF+_B	+5 Vdc supply power				
60	VREF+_B	+5 Vdc supply power				
61	IN_49	DIN-K				

Pin	Symbol	Primary Function	Alt. Function	Alt. Function	Alt. Function	Alt. Function
62	IN_50	DIN-L				
63	OUT_40	DOUT-AD (LS)				
64	OUT_42	DOUT-AF (LS)				
65	OUT_44	DOUT-AH (LS)				
66	OUT_46	DOUT-AJ (LS)				
67	OUT_9	COUT-I (HS)*	PWM-I (HS)*			
68	OUT_10	COUT-J (HS)*	PWM-J (HS)*			
69	OUT_35b	PWM-O (HS)	DOUT-E (HS)	DOUT-U (HS)*	DOUT-V (HS)*	
70	OUT_36b	PWM-P (HS)	DOUT-F (HS)	DOUT-W (HS)*	DOUT-X (HS)*	
71	OUT_37b	PWM-Q (HS)	DOUT-G (HS)	DOUT-Y (HS)*	DOUT-Z (HS)*	
72	OUT_38b	PWM-R (HS)	DOUT-H (HS)	DOUT-AA (HS)*	DOUT-AB (HS)*	
73	+BAT	Power supply 12/24 Vdc				

Notes:

1. Voltage inputs may also be configured as digital inputs.
2. High side outputs OUT-35 to OUT-38 have 2 pins (a/b) per output.
3. Shaded pin numbers are 2.8 mm terminals.
4. If marked with *, channel combines high-side(HS) and low-side(LS) pins



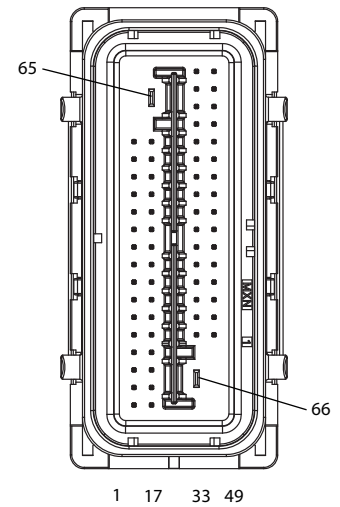
NOTICE

Sealing plugs must be used in all open pin positions. Failure to follow this instruction will cause the module to not meet the environmental specification.

Connector, MC42, C1

Connector C1 pin assignments

Connector kit	Parker no. 20085114
Housing	Molex no. 34822-0013
Cover	Molex no. 34565-0003
Pin types	Molex 33467-0024 (0.64 mm) Yazaki 7116-4152-02 (2.8 mm)
Seal	Yazaki 7158-3113-40 (2.8 mm)
Cables	0.75 mm ² / 18 AWG (0.64 mm) 1.50-2.50 mm ² / 14 AWG (2.8 mm)
Plugs (empty pos.)	Molex no. 34586-0001 (0.64 mm)
Crimping tools (all pins)	Parker no. 20085120
Prototype cable	Parker no. 20085116



Pin	Symbol	Primary Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function
1	CAN_L_A	CAN low, bus 1					
2	CAN_L_B	CAN low, bus 2					
3	CAN_L_C	CAN low, bus 3					
4	ADDR_L	IdTag, low side.					
5	NC	No connect.					
6	NC	No connect.					
7	VREF+_A	+5 Vdc supply power					
8	IN_1	VIN-A	DIN-A				
9	IN_2	VIN-B	DIN-B				
10	IN_3	VIN-C	DIN-C				
11	IN_33	FIN-A w/pull-up.	DFIN-A	PCNT-A	DPCNT-A+	PWMIN-A	DIN-I
12	IN_34	FIN-B w/pull-up.	DFIN-A	PCNT-B	DPCNT-A-	PWMIN-B	DIN-J
13	IN_35	FIN-C w/pull-up.	DFIN-B	PCNT-C	DPCNT-B+	PWMIN-C	DIN-K
14	OUT_1	COUT-A (HS)*	PWM-A (HS)*				
15	OUT_2	COUT-B (HS)*	PWM-B (HS)*				
16	OUT_3	COUT-C (HS)*	PWM-C (HS)*				
17	CAN_H_A	CAN high, bus 1					
18	CAN_H_B	CAN high, bus 2					
19	CAN_H_C	CAN high, bus 3					

Pin	Symbol	Primary Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function
20	ADDR_H	IdTag, high side.					
21	NC	No connect.					
22	NC	No connect.					
23	VREFGND	+5 Vdc supply GND					
24	IN_4	VIN-D	DIN-D				
25	IN_5	VIN-E	DIN-E				
26	IN_6	VIN-F	DIN-F				
27	IN_36	FIN-D w/pull-up.	DFIN-B	PCNT-D	DPCNT-B-	PWMIN-D	DIN-L
28	IN_37	FIN-E w/ pull-down.	DFIN-C	PCNT-E	DPCNT-C+	PWMIN-E	DIN-M
29	IN_38	FIN-F w/ pull-down.	DFIN-C	PCNT-F	DPCNT-C-	PWMIN-F	DIN-N
30	OUT_4	COUT-D (HS)*	PWM-D (HS)*				
31	OUT_5	COUT-E (HS)*	PWM-E (HS)*				
32	OUT_6	COUT-F (HS)*	PWM-F (HS)*				
33	ETHRD-	Ethernet RD-					
34	ETHTD-	Ethernet TD-					
35	VREFGND	+5 Vdc supply GND					
36	IN_7	VIN-G	DIN-G				
37	IN_29	CIN-A					
38	IN_27	VIN32-A					
39	OUT_11	COUT-A (LS+)*	PWM-A (LS+)*	DOUT-I (LS)*			
40	OUT_13	COUT-B (LS+)*	PWM-B (LS+)*	DOUT-K (LS)*			
41	OUT_15	COUT-C (LS+)*	PWM-C (LS+)*	DOUT-M (LS)*			
42	OUT_17	COUT-D (LS+)*	PWM-D (LS+)*	DOUT-O (LS)*			
43	OUT_19	COUT-E (LS+)*	PWM-E (LS+)*	DOUT-Q (LS)*			
44	OUT_21	COUT-F (LS+)*	PWM-F (LS+)*	DOUT-S (LS)*			
45	OUT_31a	PWM-G (HS)	DOUT-A (HS)	DOUT-E (HS)*	DOUT-F (HS)*	DOUT-G (HS)*	DOUT-H (HS)*
46	OUT_32a	PWM-H (HS)	DOUT-B (HS)	DOUT-I (HS)*	DOUT-J (HS)*	DOUT-K (HS)*	DOUT-L (HS)*
47	OUT_33a	PWM-I (HS)	DOUT-C (HS)	DOUT-M (HS)*	DOUT-N (HS)*	DOUT-O (HS)*	DOUT-P (HS)*
48	OUT_34a	PWM-J (HS)	DOUT-D (HS)				
49	ETHRD+	Ethernet RD+					
50	ETHTD+	Ethernet TD+					
51	VREF+_B	+5 Vdc supply power					
52	IN_8	VIN-H	DIN-H				
53	IN_30	CIN-B					

Pin	Symbol	Primary Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function
54	IN_28	VIN32-B					
55	OUT_12	COUT-A (LS-)*	PWM-A (LS-)*	DOUT-F (LS)*			
56	OUT_14	COUT-B (LS-)*	PWM-B (LS-)*	DOUT-H (LS)*			
57	OUT_16	COUT-C (LS-)*	PWM-C (LS-)*	DOUT-J (LS)*			
58	OUT_18	COUT-D (LS-)*	PWM-D (LS-)*	DOUT-L (LS)*			
59	OUT_20	COUT-E (LS-)*	PWM-E (LS-)*	DOUT-N (LS)*			
60	OUT_22	COUT-F (LS-)*	PWM-F (LS-)*	DOUT-P (LS)*			
61	OUT_31b	PWM-G (HS)	DOUT-A (HS)	DOUT-E (HS)*	DOUT-F (HS)*	DOUT-G (HS)*	DOUT-H (HS)*
62	OUT_32b	PWM-H (HS)	DOUT-B (HS)	DOUT-I (HS)*	DOUT-J (HS)*	DOUT-K (HS)*	DOUT-L (HS)*
63	OUT_33b	PWM-I (HS)	DOUT-C (HS)	DOUT-M (HS)*	DOUT-N (HS)*	DOUT-O (HS)*	DOUT-P (HS)*
64	OUT_34b	PWM-J (HS)	DOUT-D (HS)				
65	+BAT	Power supply 12/24 Vdc					
66	-BAT	Power supply GND					

Notes:

1. Voltage inputs, frequency and digital inputs may also be configured as digital inputs.
2. High side outputs OUT-31 to OUT-34 have 2 pins (a/b) per output.
3. Shaded pin numbers are 2.8 mm terminals.
4. If marked with *, channel combines high-side(HS) and low-side(LS) pins



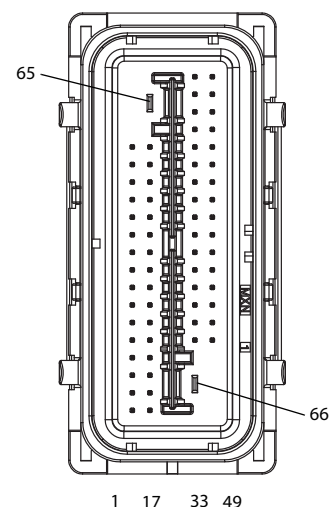
NOTICE

Sealing plugs must be used in all open pin positions. Failure to follow this instruction will cause the module to not meet the environmental specification.

Connector, MC41, C1

Connector C1 pin assignments

Connector kit	Parker no. 20085114
Housing	Molex no. 34822-0013
Cover	Molex no. 34565-0003
Pin types	Molex 33467-0024 (0.64 mm) Yazaki 7116-4152-02 (2.8 mm)
Seal	Yazaki 7158-3113-40 (2.8 mm)
Cables	0.75 mm ² /18 AWG (0.64 mm) 1.50-2.50 mm ² / 14 AWG (2.8 mm)
Plugs (empty pos.)	Molex no. 34586-0001 (0.64 mm)
Crimping tool (all pins)	Parker no. 20085120
Prototype cable	Parker no. 20085124



Pin	Symbol	Primary Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function
1	CAN_L_A	CAN low					
2	CAN_L_B	CAN low					
3	NC	No connect.					
4	ADDR_L	IdTag, low side.					
5	NC	No connect.					
6	NC	No connect.					
7	VREF+_A	+5 Vdc supply power					
8	IN_1	VIN-A	DIN-A				
9	IN_2	VIN-B	DIN-B				
10	IN_3	VIN-C	DIN-C				
11	IN_33	FIN-A w/pull-up.	DFIN-A	PCNT-A	DPCNT-A+	PWMIN-A	DIN-I
12	IN_34	FIN-B w/pull-up.	DFIN-A	PCNT-B	DPCNT-A-	PWMIN-B	DIN-J
13	IN_35	FIN-C w/pull-up.	DFIN-B	PCNT-C	DPCNT-B+	PWMIN-C	DIN-K
14	OUT_1	COUT-A (HS)*	PWM-A (HS)*				
15	OUT_2	COUT-B (HS)*	PWM-B (HS)*				
16	BB_1	Busbar 1					
17	CAN_H_A	CAN high					
18	CAN_H_B	CAN high					
19	NC	No connect					

Pin	Symbol	Primary Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function
20	ADDR_H	IdTag, high side.					
21	NC	No connect.					
22	NC	No connect.					
23	VREFGND	+5 Vdc supply GND					
24	IN_4	VIN-D	DIN-D				
25	IN_5	VIN-E	DIN-E				
26	IN_6	VIN-F	DIN-F				
27	IN_36	FIN-D w/pull-up.	DFIN-B	PCNT-D	DPCNT-B-	PWMIN-D	DIN-L
28	IN_37	FIN-E w/ pull-down.	DFIN-C	PCNT-E	DPCNT-C+	PWMIN-E	DIN-M
29	IN_38	FIN-F w/ pull-down.	DFIN-C	PCNT-F	DPCNT-C-	PWMIN-F	DIN-N
30	BB_2	Busbar 2					
31	BB_3	Busbar 3					
32	BB_4	Busbar 4					
33	NC	No connect.					
34	NC	No connect.					
35	VREFGND	+5 Vdc supply GND					
36	IN_7	VIN-G	DIN-G				
37	IN_29	CIN-A					
38	IN_27	VIN32-A					
39	OUT_11	COUT-A (LS+)*	PWM-A (LS+)*	DOUT-E (LS)*			
40	OUT_13	COUT-B (LS+)*	PWM-B (LS+)*	DOUT-G (LS)*			
41	BB_1	Busbar 1					
42	BB_2	Busbar 2					
43	BB_3	Busbar 3					
44	BB_4	Busbar 4					
45	OUT_31a	PWM-C (HS)	DOUT-A (HS)	DOUT-E (HS)*	DOUT-F (HS)*	DOUT-G (HS)*	DOUT-H (HS)*
46	OUT_32a	PWM-D (HS)	DOUT-B (HS)				
47	OUT_33a	PWM-E (HS)	DOUT-C (HS)				
48	OUT_34a	PWM-F (HS)	DOUT-D (HS)				
49	NC	No connect.					
50	NC	No connect.					
51	VREF+_B	+5 Vdc supply power					
52	IN_8	VIN-H	DIN-H				
53	IN_30	CIN-B					

Pin	Symbol	Primary Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function	Alternate Function
54	IN_28	VIN32-B					
55	OUT_12	COUT-A (LS-)*	PWM-A (LS-)*	DOUT-F (LS)*			
56	OUT_14	COUT-B (LS-)*	PWM-B (LS-)*	DOUT-H (LS)*			
57	BB_1	Busbar 1					
58	BB_2	Busbar 2					
59	BB_3	Busbar 3					
60	BB_4	Busbar 4					
61	OUT_31b	PWM-C (HS)	DOUT-A (HS)	DOUT-E (HS)*	DOUT-F (HS)*	DOUT-G (HS)*	DOUT-H (HS)*
62	OUT_32b	PWM-D (HS)	DOUT-B (HS)				
63	OUT_33b	PWM-E (HS)	DOUT-C (HS)				
64	OUT_34b	PWM-F (HS)	DOUT-D (HS)				
65	+BAT	Power supply 12/24 Vdc					
66	-BAT	Power supply GND					

Notes:

1. Voltage inputs and frequency inputs may also be configured as digital inputs.
2. OUT-31 to OUT-34 have 2 pins (a/b) per output.
3. Shaded pin numbers are 2.8 mm terminals.
4. If marked with *, channel combines high-side(HS) and low-side(LS) pins



NOTICE

Sealing plugs must be used in all open pin positions. Failure to follow this instruction will cause the module to not meet the environmental specification.

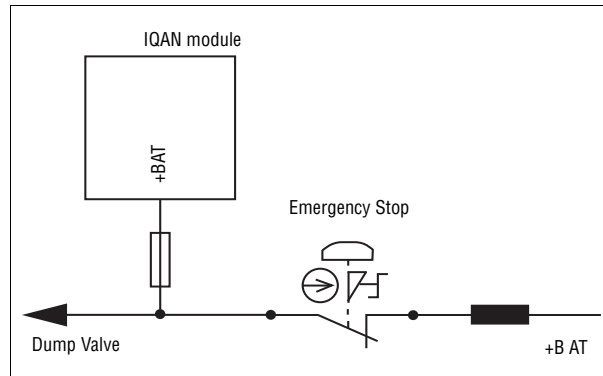
Supply voltage

Before any installation of the IQAN system can take place, make sure the ignition lock is turned off and the battery is disconnected.

Emergency stop

The machine must always be equipped with an *Emergency stop* that stops all potentially hazardous movements by cutting the power supply to the actuators.

The recommended way of implementing this is by cutting the power to all IQAN modules, and also to the actuators directly, e.g. via a dump valve. See below:

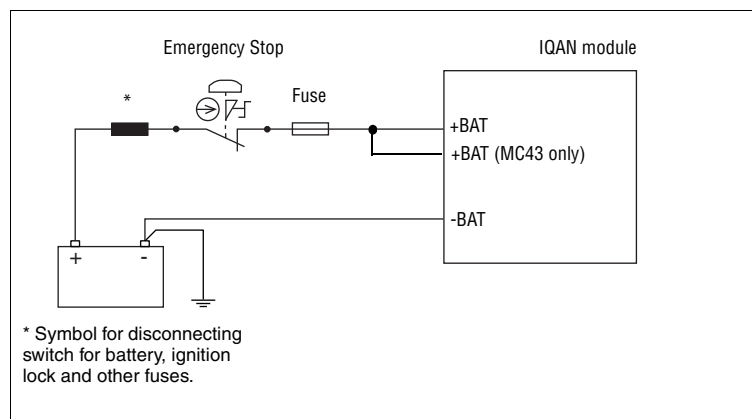


Emergency stop.

Since the IQAN-MC4xFS is capable of implementing safety functions, it may in some applications be tempting for the designer to implement the emergency stop as a function in the IQAN-MC4xFS. The IQAN-MC4xFS does not have any built in emergency stop function, but if it is implemented anyway, it must be done with extreme caution. Especially when application updates are performed, e.g. during service or commissioning.

Connecting of Supply Voltage

The supply voltage, should be within the operating interval, see Appendix A. Connect the supply voltage to +BAT and -BAT. Protect the module by using a fuse. For recommended fuse level, see Appendix A.



Connecting the emergency stop and voltage supply.



NOTICE

Do not use the chassis as the negative terminal.

Polarity reversal

The module is protected against power supply polarity reversal and over-voltage, provided an external fuse is being used.

If this fuse is not used, polarity reversal can damage the unit.

Addressing/terminating

IQAN-MC4x use of an ID-Tag

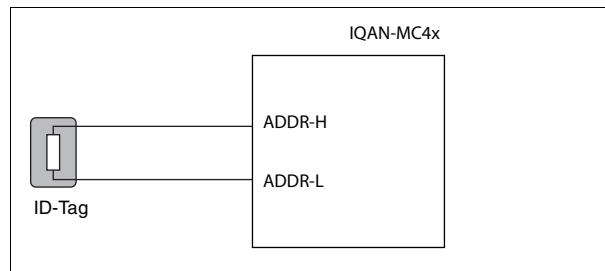
In IQANdesign software, more than one IQAN master module can be used together in a multi-master system. The master modules are each given a unique address by using an ID-Tag. The value of the ID-Tag identifies the master and will enable a single project application to be loaded into more than one master module over the PC connection. The functionality needed for each master is loaded based on the ID-tag address.

Identification of an IQAN-MC4x by address

The ID-Tag is needed when the IQAN-MC4x is used as a single master or in a multi-master system. The connection of an ID-Tag between ADDR-H and ADDR-L will assign an address to the IQAN-MC4x master module. The desired functionality based on address is built into the project file using IQANdesign software. For more information, please refer to the IQANdesign user manual.

It is the combination of *address* and *type* that gives each master module a unique identification. For each MC4x module, there are up to 8 addresses, denoted as addresses 0, 1, 2, 3, 4, 5, 6, 7 respectively.

In order to assign any IQAN-MC4x a unique address, an *ID-Tag* will have to be connected to the positions ADDR-H and ADDR-L.



Connecting of Id-Tag.

Terminating

To eliminate interference in the communications through the CAN bus, the CAN bus must be terminated. By default, the MC4x is terminated internally on all of its CAN buses. When an IQANdesign application is loaded, it can set individual buses to be non-terminated.

To give an IQAN-MC4x a unique address, you may use an addressing ID-tag, or an ID-tag having a combined address and terminating function. The 'T' values of ID-tags are ignored, i.e. an ID-tag 3T is equivalent to ID-tag 3.

If the module is located at the end of the CAN-bus, then leave the bus default terminated in the MC4x.



NOTICE

The CAN-bus is not typically terminated at the MC4x using an external regular terminating resistor, due to the fact that terminating is made from within the MC4x module by default.

If an external 120 ohm resistor will be used to terminate the bus, then set the bus to be non-terminated in the MC4x using IQAN software.

Diagnostic interfaces

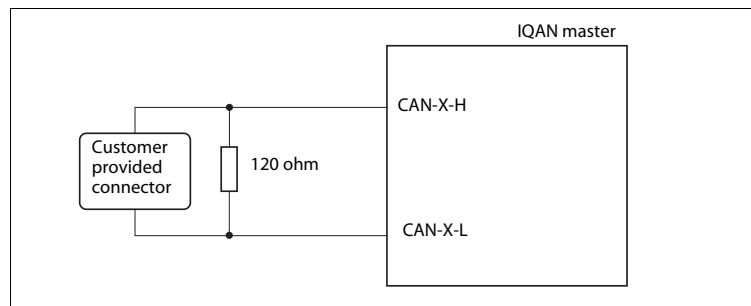
IQAN software includes many tools for tuning, measuring, accessing logs and otherwise checking the performance or troubleshooting your control system. To use the diagnostic tools with an IQAN master module you may choose between different ways to connect to the unit.

CAN diagnostics connection

One of the CAN buses of the IQAN master module may be dedicated for diagnostics. Reserving a bus for diagnostics ensures that signals are not interrupted by other bus traffic. A high-speed CAN interface is needed to use this feature. Contact Parker for information about supported CAN interfaces.

A termination resistor is usually required at the CAN interface on the PC. Parker part number 5030082 or 5030182, or an equivalent 120 ohm resistor may be used. A flying lead cable may be connected to the IQAN master to provide a connector interface. The connection from IQAN master module to diagnostic CAN interface can then be made quite easily. It is recommended that the connector be a sealed, automotive type. When not being used this connector should be protected from the environment with a cover or mating blank plug.

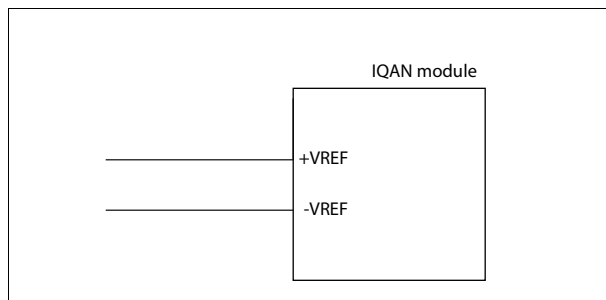
The recommended wiring to the IQAN master module connector is shown below.



Connecting for CAN communication.

Reference voltage, V_{REF}

The IQAN module is internally equipped with a voltage regulator to generate the reference voltage V_{REF} . The standard reference voltage will feed different kinds of sensors and potentiometers.



V_{REF} positions.



NOTICE

It is strongly recommended to use the module's $-V_{REF}$ and $+V_{REF}$ to all sensors and potentiometers that are connected to the module inputs. This will reduce bad measurement based on potential fault (i.e. different ground points for other supplies in relation to the IQAN module ground, -BAT).

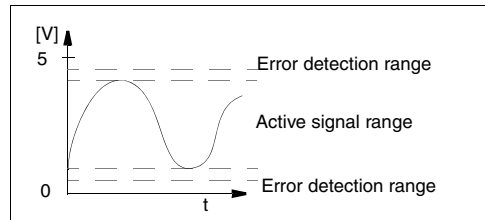
Maximum load for the V_{REF} , see "Appendix A".

Voltage inputs

There are 2 types of voltage inputs. VIN is for measuring 0-5 Vdc analogue signals and VIN32 is for measuring 0-32 Vdc analogue signals.

Connecting sensors to the VIN voltage inputs

The sensor signal range must be 0-5 Vdc. To detect signal errors such as short circuits or interruptions the active signal range should be within 0.5-4.5 Vdc.

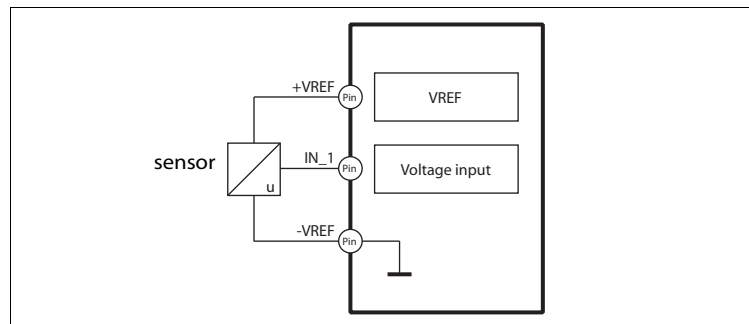


Active signal range.

The current consumption related to the voltage input is negligible.

The positive terminal of the sensor is connected to the +VREF position and the corresponding negative terminal to the -VREF position. The sensor signal is connected to an appropriate VIN position.

EXAMPLE



Possible combinations

IN_1 ... IN_26

Function

Voltage input from analogue sensor.

Monitoring

Signal is monitored with limits in application

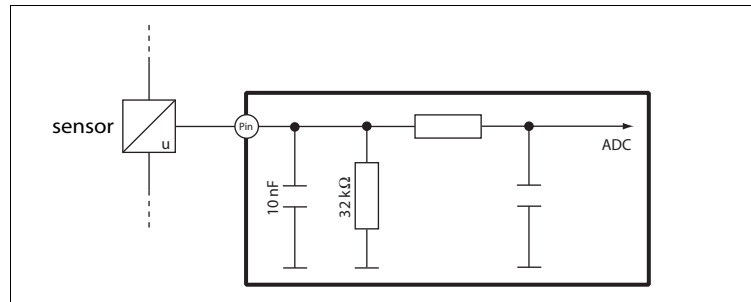


NOTICE

The negative terminal of the sensor must not be connected to the chassis.
Maximum load for VREF position: see Appendix A.

VIN (IN_1 to IN_26) circuit block

The VIN voltage inputs have high impedance and an internal pull-down resistor.



VIN inputs.

VIN usage in safety functions

The following additional information applies when the inputs are used in safety functions where an incorrect input signal can lead to an immediate increase of the risk.

MC4xFS-SMR-015:A Limits on VIN signal range

When a safety function depends on VIN (voltage input), the signal range shall be limited and the limitations shall be implemented in IQANdesign.

The limits shall be selected so that the application as a minimum detects open circuit, short to ground and short to reference.

It is highly recommended to select and test the input devices (e.g. sensors) and limits so that loss of ground is also detected. In cases where this is not possible, a redundant sensor should be used for detection.

For sensors connected to VIN, suitable calibration limits are usually within the range

- Min voltage: ≥ 200 mV
- Max voltage: ≤ 4800 mV

For description of error detection on VIN channels, see IQANdesign user manual.

MC4xFS-SMR-016:A Tolerances on single or identical VIN

When a safety function depends on a single VIN, or on a pair of voltage inputs reading identical signals, the following requirement on application tolerances apply:

- The application shall be designed so that it can tolerate a gain error of 10% on the voltage inputs and still be in a safe state.

MC4xFS-SMR-017:A VIN combined with redundant and diverse channel

When a safety function depends on a VIN combined with a redundant and diverse channel, the tolerances on the safety functions may instead be based on the normal input accuracy found in Appendix A.

The second channel shall be considered redundant and diverse when the IQANdesign application is selecting the safest value from the two channels, and the redundant channels also meet one of the following criteria:

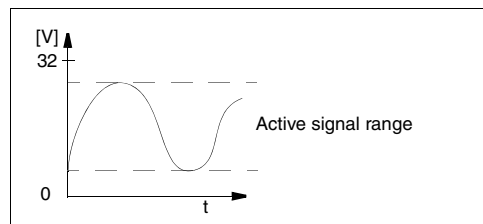
- The signals to the two redundant channels are crossed
- The second channel is reading frequency, pulse width or pulse count
- The second channel is located on a separate module and sent on CAN

When using redundant channels, the two channels values shall also be compared in order to detect faults.

A voltage input combined with a current loop input is not sufficiently diverse if the two signals are following each, in such cases the higher gain error has to be considered.

Connecting sensors to the VIN32 voltage inputs

The sensor signal range must be 0-32 Vdc.

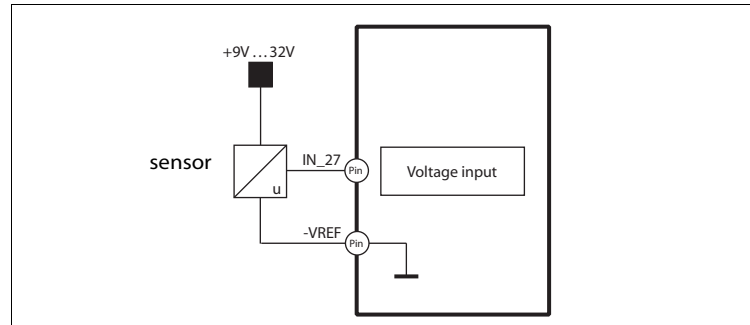


Active signal range.

The current consumption related to the voltage input is negligible.

The positive terminal of the sensor is connected to the +BAT position and the corresponding negative terminal to the -VREF position. The sensor signal is connected to an appropriate voltage input HVIN position.

EXAMPLE



Possible combinations

IN_27 ... IN_28

Function

Voltage input from analogue sensor.

Monitoring

Signal is monitored with limits in application

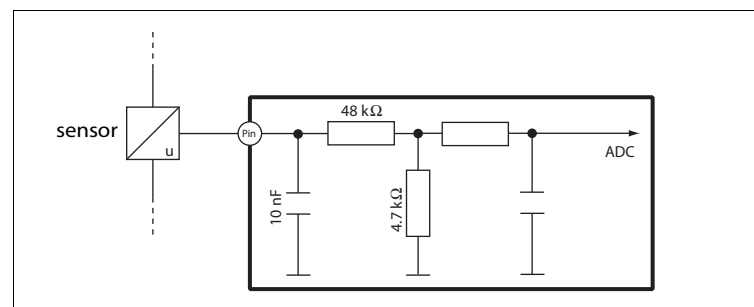


NOTICE

The negative terminal of the sensor must not be connected to the chassis. Use -VREF instead.

VIN32 (IN_27, IN_28) circuit block

The VIN32 voltage inputs have high impedance and an internal pull-down resistor.



VIN32 inputs.

VIN32 usage in safety functions

MC4xFS-SMR-018:A Limits on VIN32 signal range

When a safety function depends on VIN32 (voltage input), the signal range shall be limited and the limitations shall be implemented in IQANdesign.

The limits shall be selected so that the application as a minimum detects open circuit, short to ground and short to battery.

It is highly recommended to select the input devices (e.g. sensors) and limits so that also loss of ground and short to sensor supply is detected. In cases where this is not possible, a redundant sensor should be used for detection.

For description of error detection on VIN32 channels, see IQANdesign user manual.

MC4xFS-SMR-019:A Tolerances on single or identical VIN32

When a safety function depends on a VIN32(voltage input), or on a pair of voltage inputs reading identical signals, the following requirement on application tolerances apply:

- The application shall be designed so that it can tolerate a gain error of 10% on the voltage inputs and still be in a safe state.

MC4xFS-SMR-020:A VIN32 combined with redundant and diverse channel

When a safety function depends on a VIN32 combined with a redundant and diverse channel, the tolerances on the safety functions may instead be based on the normal input accuracy found in Appendix A.

The second channel shall be considered redundant and diverse when the IQANdesign application is selecting the safest value from the two channels, and the redundant channels also meets one of the following criteria:

- The signals to the two redundant channels are crossed
- The second channel is reading frequency, pulse width or pulse count
- The second channel is located on a separate module and sent on CAN

When using redundant channels, the two channels values shall also be compared in order to detect faults.

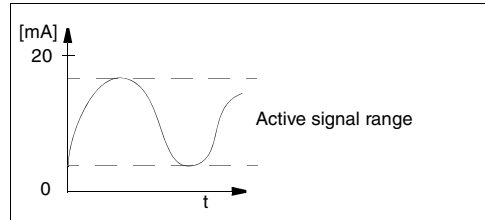
Note that for the MC4xFS, a voltage input combined with a current loop input is not sufficiently diverse if the two signals are following each, the higher gain error has to be considered.

Current loop inputs

The current loop inputs on the MC4x are for measuring 0-20 mA signals.

Connecting sensors to the current loop inputs

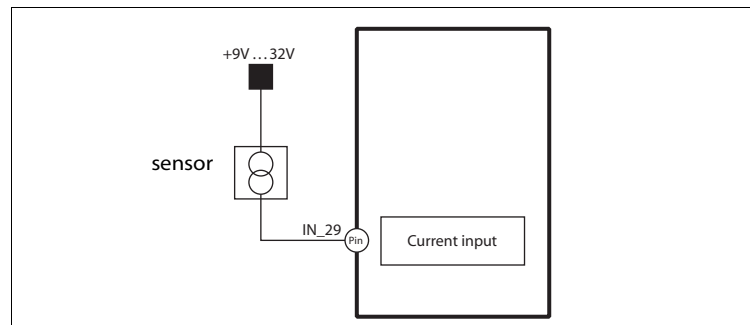
The sensor signal range must be 0-20 mA.



Active signal range.

The positive terminal of the sensor is connected to the +BAT position and the corresponding negative terminal (sensor signal) is connected to an appropriate current input CIN position.

EXAMPLE



Possible combinations

IN_29 ... IN_32

Function

Current input from 2 wire analogue sensor. Current must be within 0 ... 20 mA range

Monitoring

Signal is monitored with limits in application

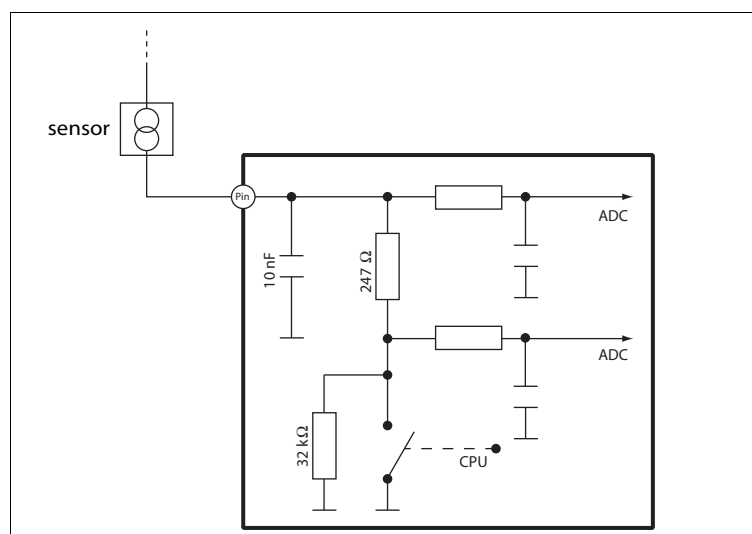


NOTICE

The negative terminal of the sensor must not be connected to the chassis.

Current loop IN_29 to IN_32 circuit block

The current loop inputs have high impedance and an internal pull-down resistor plus a CPU switched signal conditioning circuit.



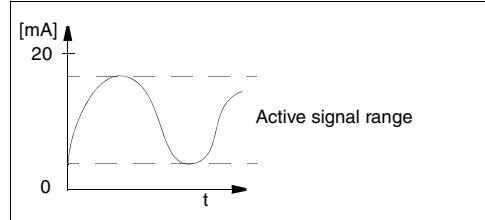
Current loop inputs.

Using current inputs to monitor voltage inputs

Another use for current inputs is for error monitoring of analogue voltage inputs.

Connecting analogue sensors as monitored voltage inputs

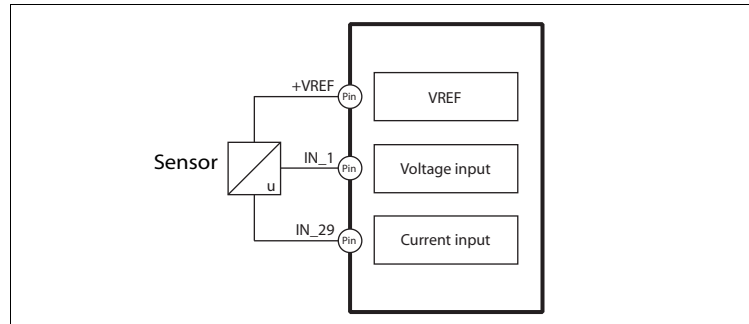
The current range through the sensor must be 0-20 mA.



Active signal range.

The positive terminal of the sensor is connected to the +VREF position and the sensor signal is connected to an appropriate voltage input VIN position. The negative terminal of the sensor is connected to an appropriate current input CIN position.

EXAMPLE



Possible combinations

IN_1 ... IN_26

In combination with

IN_29 ... IN_32

Function

Voltage input from analogue sensor with monitoring of current through the sensor.
Current must be within 0 ... 20 mA range

Monitoring

Signal is monitored with limits in application

CIN usage in safety functions

The following additional information applies when the inputs are used in safety functions where an incorrect input signal can lead to an immediate increase of the risk.

MC4xFS-SMR-021:A Limits on CIN signal range

When a safety function depends on CIN (current loop input), the signal range shall be limited and the limitations shall be implemented in IQANdesign.

The limits shall be selected so that the application as a minimum detects open circuit and short to ground.

For sensors connected to CIN, a 4-20 mA with correct calibration limits set in IQANdesign is able to meet the requirement on detection of input open circuit and input short to ground.

The IQAN-MC4 CIN inputs are designed to detect overcurrent and switch off to protect the input.

It is highly recommended to check the effect that other wiring faults have on the sensor output.

MC4xFS-SMR-022:A Tolerances on single or identical CIN

When a safety function depends on either a single CIN (current loop input) or a pair of CIN, the following requirement on application tolerances apply:

- The application shall be designed so that it can tolerate a gain error of 10% on the current inputs and still be in a safe state.

MC4xFS-SMR-023:A CIN combined with redundant and diverse channel

When a safety function depends on a CIN combined with a redundant and diverse channel, the tolerances on the safety functions may instead be based on the normal input accuracy found in Appendix A.

The second channel shall be considered redundant and diverse when the IQANdesign application is selecting the safest value from the two channels, and the redundant channels also meets one of the following criteria:

- The signals to the two redundant channels are crossed
- The second channel is reading frequency, pulse width or pulse count
- The second channel is located on a separate module and sent on CAN

When using redundant channels, the two channels values shall also be compared in order to detect faults.

Note that for the MC4xFS, a voltage input combined with a current loop input is not sufficiently diverse if the two signals are following each other, so the higher gain error has to be considered.

Frequency inputs

Frequency inputs can operate in 2 modes. *Speed* which is frequency and *position* which is a pulse count. For the frequency ranges and trigger levels, see Appendix A.

The MC4x has 2 types of frequency inputs. There are 6 types of frequency sensor signals that can be measured by the MC4x. The signals can be push-pull, NPN (open collector), NPN with pull-up, PNP, directional frequency and directional pulse.



NOTICE

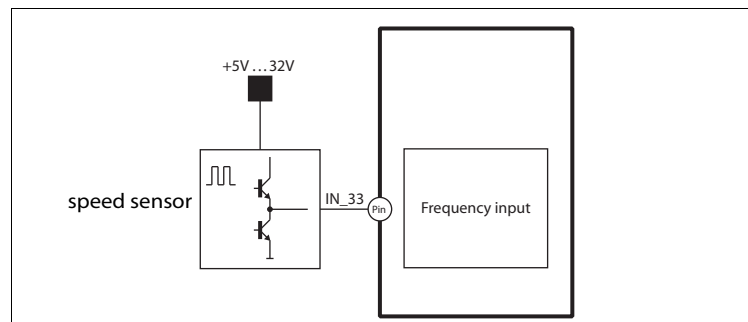
For signal trigger limits for frequency inputs, see Appendix A.

Connecting to push-pull type frequency sensors

This type of sensor can be used with either type of frequency input configuration, having pull-up or pull-down resistors. Push-pull sensors are preferred because they constantly provide a signal (either to power or ground) and do not 'float' which can cause errors in reading the signal.

The positive terminal of the sensor is connected to power. The sensor signal is connected to an appropriate frequency input FIN position.

EXAMPLE



Possible combinations

IN_33 ... IN_38

Function

Frequency (or pulse) measurement with push-pull signal.

This signal will minimize modulation errors due to better symmetry of the signal.

Monitoring

Signal is monitored with limits in application

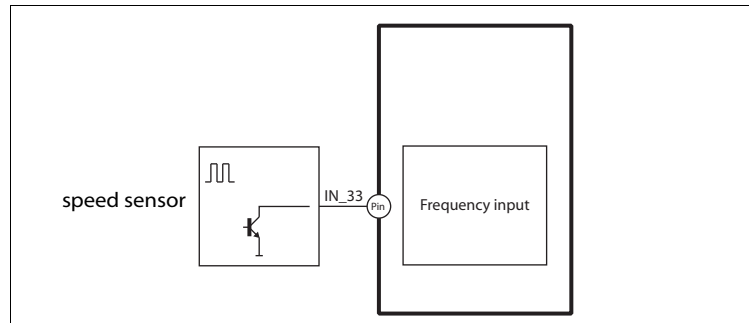


NOTICE

The negative terminal of the sensor must not be connected to the chassis.

Connecting NPN sensors to the pull-up frequency inputs

NPN sensors are used with frequency input positions that have pull-up resistors. The sensor signal is connected to an appropriate frequency input FIN position.

EXAMPLE**Possible combinations**

IN_33 ... IN_36

Function

Frequency (or pulse) measurement with NPN-type (open collector) output.

Monitoring

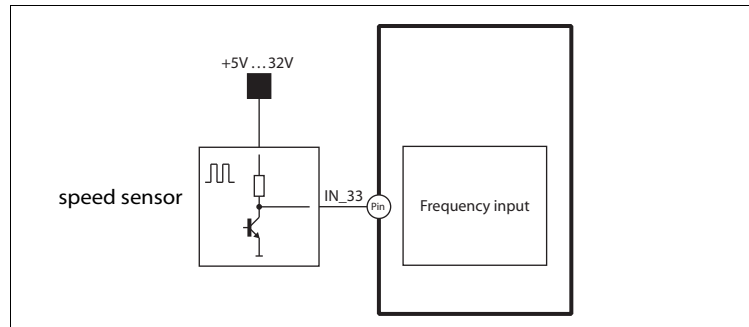
Signal is monitored with limits in application

Connecting NPN sensors with pull-ups to the frequency inputs

NPN sensors with their own internal pull-up resistors, can be used with either type of frequency input configuration, having pull-up or pull-down resistors.

The positive terminal of the sensor is connected to power. The sensor signal is connected to an appropriate frequency input FIN position.

EXAMPLE



Possible combinations

IN_33 ... IN_38

Function

Frequency (or pulse) measurement with NPN-type (open collector) output and pull-up.

If input position with pull-down is used, the signal level will be reduced due to the voltage divider created by external/internal resistor. Rise time of signal can also be reduced.

Monitoring

Signal is monitored with limits in application

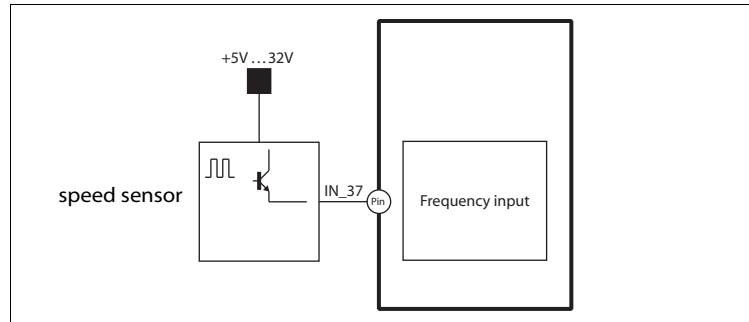


NOTICE

Extra care should be taken using NPN sensors with pull-up resistors on the pull-down frequency inputs (internal pull-down resistor). A voltage divider is created between external pull-up and internal pull-down and will affect the trigger limits.

Connecting PNP sensors to the pull-down frequency inputs

PNP sensors are used with frequency input positions that have pull-down resistors. The positive terminal of the sensor is connected to power. The sensor signal is connected to an appropriate frequency input FIN position.

EXAMPLE**Possible combinations**

IN_37, IN_38

Function

Frequency (or pulse) measurement with PNP-type output.

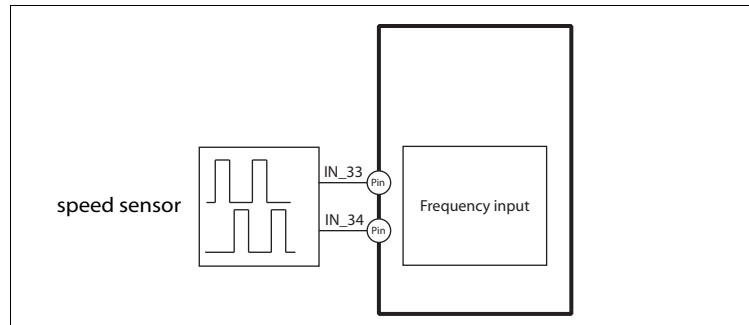
Monitoring

Signal is monitored with limits in application

Connecting directional frequency sensors to the frequency inputs

Directional frequency sensors can be used with either type of frequency input configuration, having pull-up or pull-down resistors.

The positive terminal of the sensor is connected to power. The sensor signals are connected to the appropriate frequency input FIN positions.

EXAMPLE**Possible combinations**

IN_33, IN_34

IN_35, IN_36

IN_37, IN_38

Function

Frequency measurement with phase detection.

First input (lower number) will be the leading edge and second input (higher number) the trailing edge.

Monitoring

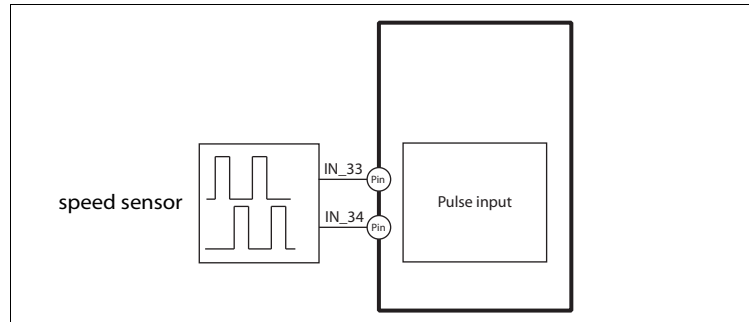
Signal is monitored with limits in application

Connecting directional pulse sensors to the frequency inputs

Directional pulse sensors can be used with either type of frequency input configuration, having pull-up or pull-down resistors.

The sensor signals are connected to the appropriate frequency input FIN positions.

EXAMPLE



Possible combinations

IN_33, IN_34

IN_35, IN_36

IN_37, IN_38

IN_39, IN_40

Function

Pulse count measurement with phase detection.

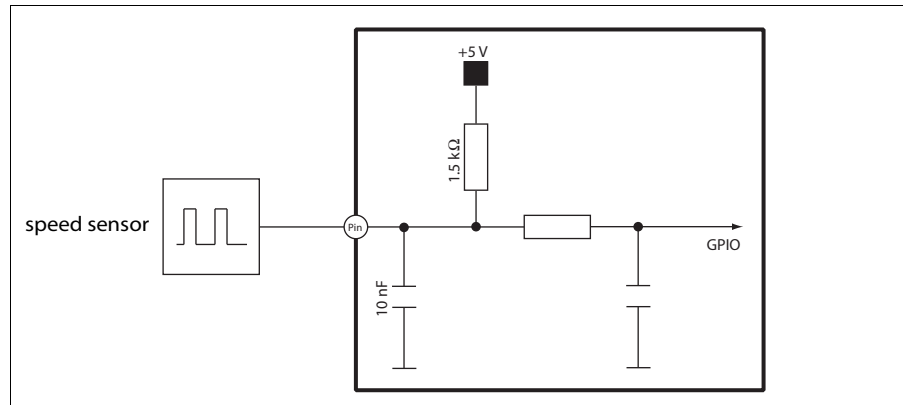
First input (lower number) will be the leading edge and second input (higher number) the trailing edge.

Monitoring

Signal is monitored with limits in application

Pull-up IN_33 to IN_36 input circuit block

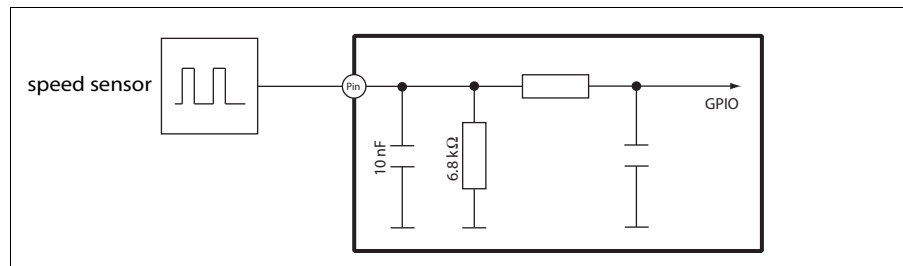
These frequency inputs have high impedance and an internal pull-up resistor.



Pull-up frequency inputs.

Pull-down IN_37, IN_38 input circuit block

These frequency inputs have high impedance and an internal pull-down resistor.



Pull-down frequency inputs.

FIN/PCNT/DFIN/DPCNT usage in safety functions

The following additional information applies when the inputs are used in safety functions where an incorrect input signal can lead to an immediate increase of the risk.

MC4xFS-SMR-024:A Frequency input redundancy

When a safety function depends on frequency or pulse count channel, FIN/PCNT/DFIN/DPCNT, the channel shall be combined with a redundant channel reading a separate input signal, and the values shall be compared.

To be considered redundant, the application may either be designed to use the safest of the two channel values, or by setting the channel difference check limit within the tolerances for the safety function.

The redundant channel may be identical or diverse.

PWM inputs

PWM inputs are used with sensors that have a PWM output signal at a fixed frequency. The most commonly used sensors that transmit PWM signals are pressure and temperature measurement devices. PWM is used to encode and digitally transmit the sensor's internal analog value. A PWM signal has good noise immunity and is suitable for transmission over longer distances than analog signals.

The MC4x has 2 types of PWM inputs. IN_33 to IN_36 have internal pull-up resistors and IN_37 to IN_38 have internal pull-down resistors.



NOTICE

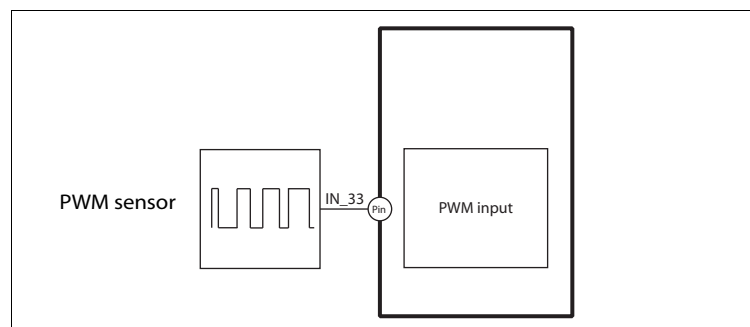
For the frequency range and minimum pulse width for PWM inputs, see Appendix A.

Connecting PWM sensors to the PWM inputs

PWM sensors can be used with either type of PWM input configuration, having pull-up or pull-down resistors.

The positive terminal of the sensor is connected to +VREF and the negative terminal is connected to -VREF. If the current consumption for the sensor exceeds the maximum load for the VREF, the sensor could be connected to the +BAT/-BAT positions. The sensor signal is connected to an appropriate PWM input PWMIN position.

EXAMPLE



Possible combinations

IN_33 ... IN_38

Function

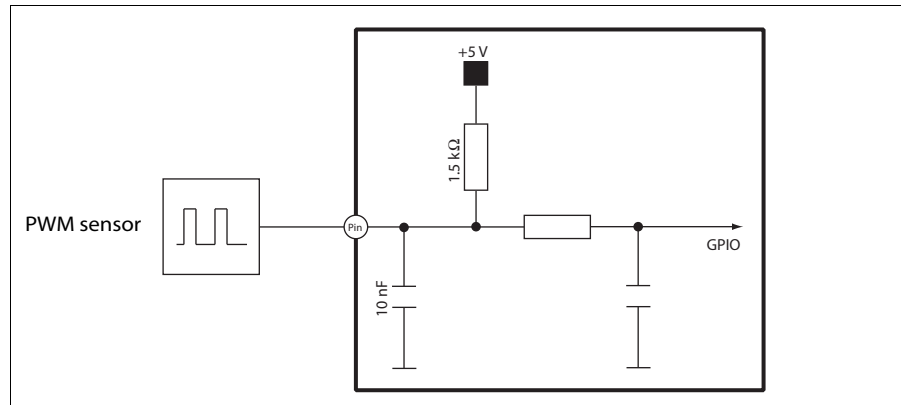
PWM measurement of MR (modulation ratio).

Monitoring

Signal is monitored with limits in application

Pull-up IN_33 to IN_36 input circuit block

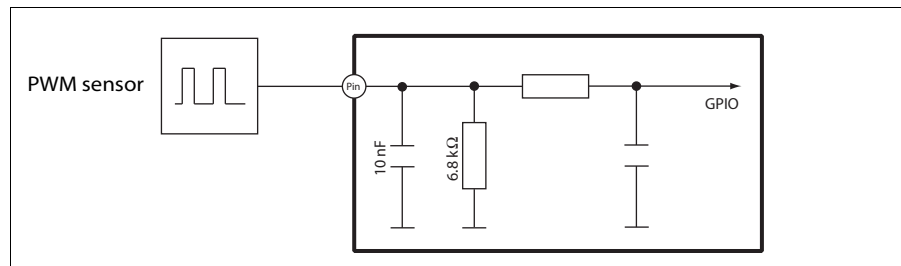
These PWM inputs have high impedance and an internal pull-up resistor.



Pull-up PWM inputs.

Pull-down IN_37, IN_38 input circuit block

These PWM inputs have high impedance and an internal pull-down resistor.



Pull-down PWM inputs.

PWMIN usage in safety functions

The following additional information applies when the inputs are used in safety functions where an incorrect input signal can lead to an immediate increase of the risk.

MC4xFS-SMR-025:A Limits on PWMIN signal range

When PWM inputs are used in safety functions, the modulation ratio range shall be limited and the limitations shall be implemented in IQANdesign.

For a description of how the PWMIN channel error detection is based on the calibration values, see IQANdesign user manual. Calibration limits too close to 0% or 100% are prevented in IQANdesign.

The IQAN-MC4x also has a function for detecting if the PWM frequency is too far below the specified range.

Digital inputs

The digital inputs are typically used for on-off signals from switches.



NOTICE

For digital input trigger levels, see Appendix A.

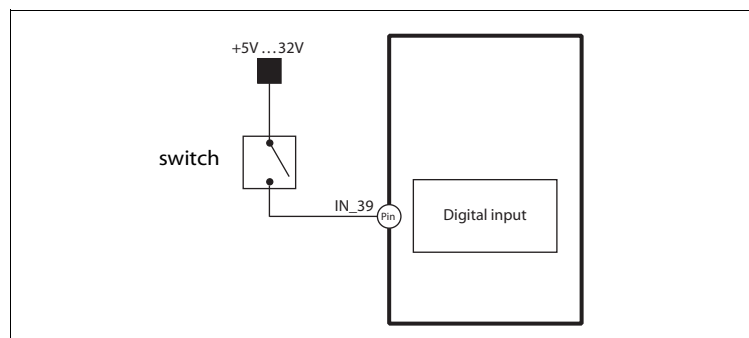
DIN that share pins with VIN and FIN

These digital inputs, IN_1 ... IN_36, share pins with the module voltage inputs and frequency inputs. They also have high impedance characteristics.

Connecting switches to the digital inputs

One terminal of the switch is connected to the +BAT position and the other terminal is connected to an appropriate digital input DIN position.

EXAMPLE



Possible combinations

IN_39 ... IN_50

(IN_1 ... IN_32, IN_37, IN_38)

Function

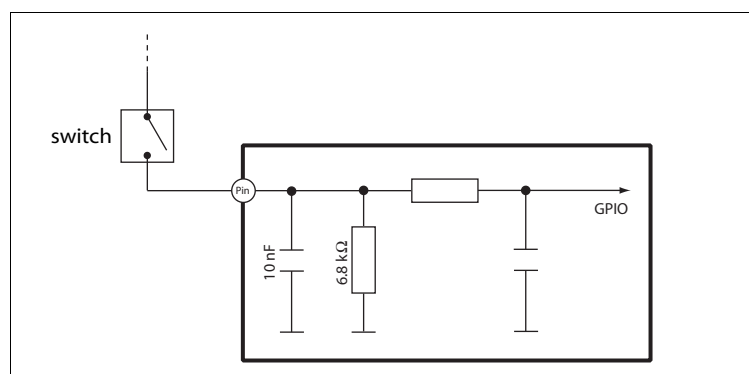
Digital input from switch

Monitoring

Signal is monitored in application

Digital inputs IN_39 to IN_50 circuit block

The digital voltage inputs have high impedance and an internal pull-down resistor. This circuit block also represents IN_1 to IN_32, IN_37, IN_38.

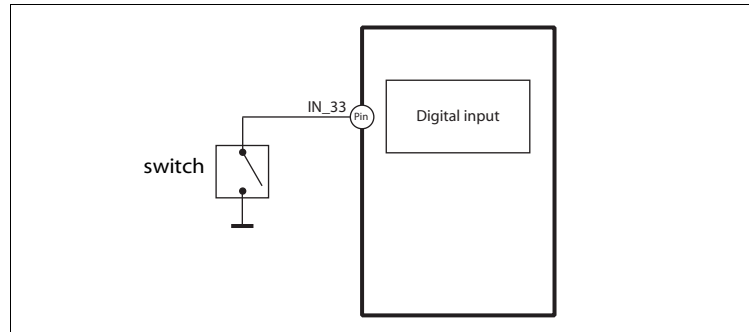


Digital inputs.

Connecting switches to the digital inputs with internal pull-up

One terminal of the switch is connected to the -BAT (ground) position and the other terminal is connected to an appropriate digital input DIN position.

EXAMPLE



Possible combinations

(IN_33 ... IN_36)

Function

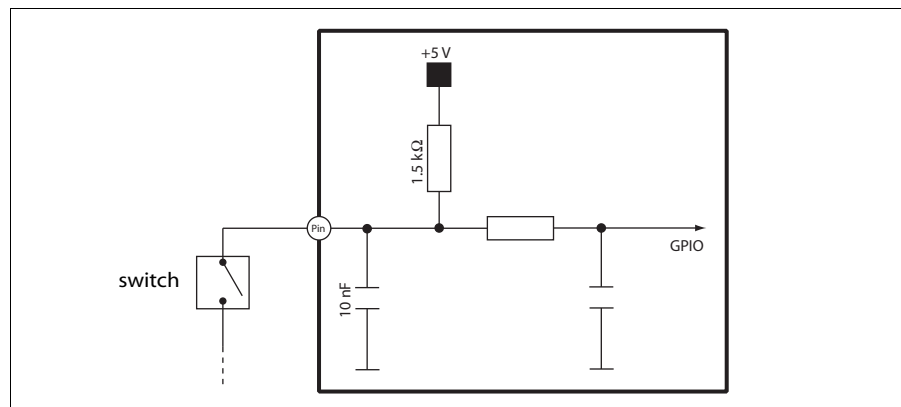
Digital input from switch

Monitoring

Signal is monitored in application

Digital input IN_33 to IN_36 input circuit block

These inputs have high impedance and an internal pull-up resistor. This is because they may also be configured as pull-up frequency inputs.



Pull-up frequency input position used as DIN.

DIN usage in safety functions

The following additional information applies when the inputs are used in safety functions where an incorrect input signal can lead to an immediate increase of the risk.

MC4xFS-SMR-026:A DIN redundancy

When a safety function depends on a DIN, the DIN shall be combined with a second redundant channel, the IQANdesign application shall be created so that it selects the safest of the two channels.

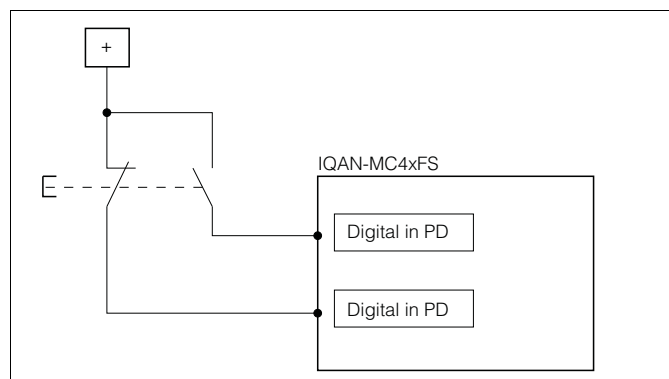
The values of the two channels shall also be compared to detect errors.

When the redundant channel is another DIN, the signals may be designed to be either identical or opposite.

The function shall be designed so that open circuit on at least one of the inputs leads to a safe-state without waiting for an input signal change.

EXAMPLE

A safety function where movement is initiated by pressing a button, could be implemented using a button with two mechanically linked NO and NC contacts could be connected to two of the Digital inputs with pull-down.



Connecting pairs of signals.

In this example, open circuit of the wire from the NO contact is safe, while open circuit of the wire from the NC contact is dangerous if it is not handled. It is important that the function is built up so that movement is started only when both inputs indicate that the button is pressed, stops if any of the signals indicates that it is not pressed, and that a Digital-Digital Compare channel is used for cross-monitoring.

Proportional current outputs

The Parker COUT outputs are current regulated PWM outputs used for control of proportional valves and devices. An IQAN COUT channel is a combination of high-side and low-side switch with CAM (Current Arithmetic Mean) measurement of current that enables fast and accurate closed loop current control.

One COUT can control a bi-directional valve section with 2 coils. MC4xFS current outputs may be used in safety functions when the requirements in "COUT usage in safety functions" are met. For the current range and loads, see Appendix A.

Connecting bi-directional valve to proportional outputs

Connecting a load, e.g. one proportional valve section, to the COUT outputs is done by using the COUT (HS)/COUT (LS) paired positions.

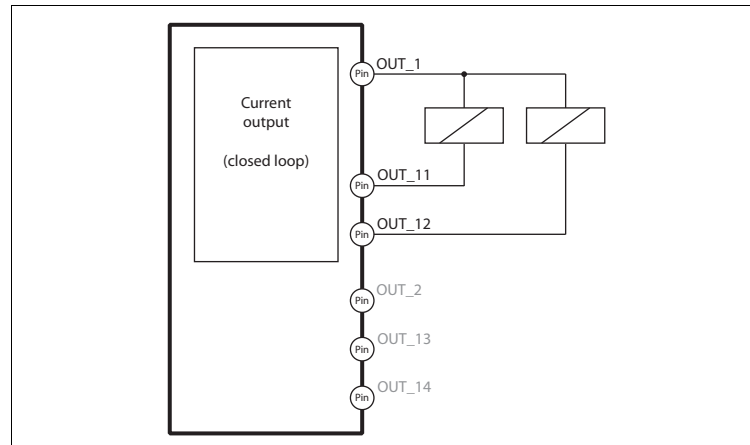
EXAMPLE

Positive direction:

Connect the proportional valve to the **COUT (HS)** OUT_1, and the **COUT(LS+)** OUT_11.

Negative direction:

Connect the proportional valve to the **COUT (HS)** OUT_1, and the **COUT (LS-)** OUT_12.

**Possible combinations**

OUT_1, OUT_11/OUT_12

OUT_2, OUT_13/OUT_14

OUT_3, OUT_15/OUT_16

OUT_4, OUT_17/OUT_18

OUT_5, OUT_19/OUT_20

OUT_6, OUT_21/OUT_22

OUT_7, OUT_23/OUT_24

OUT_8, OUT_25/OUT_26

OUT_9, OUT_27/OUT_28

OUT_10, OUT_29/OUT_30

Function

Closed-loop control of solenoid type of proportional valves with two directions (two solenoids). COUTs are grouped in pairs where adjacent channels have separate low-side switches and CAM feedback circuits, but share the same high-side switch used for shutdown. See section COUT (HS) output OUT_1 to OUT_10 circuit block, on page 66.

Monitoring

The COUT is monitored for external and internal faults, see Appendix B and section, *COUT usage in safety functions*

Detected critical errors will lead to shutdown of adjacent COUT channels also.

Thermal management

Low-side switches are grouped in clusters of 4. Max current and power dissipation is limited to each group.

**NOTICE**

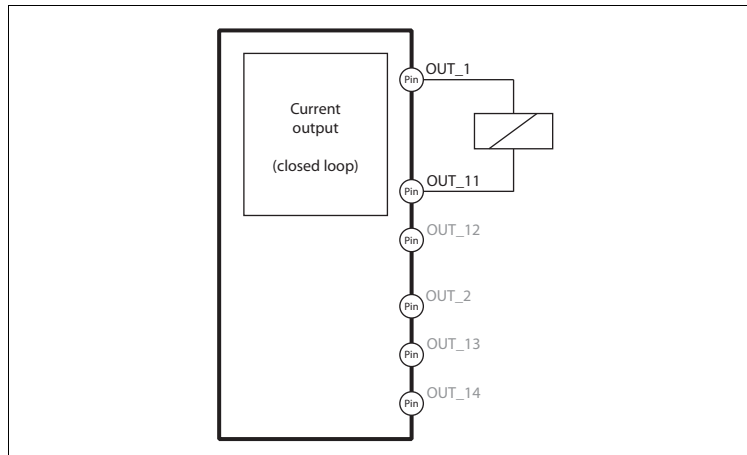
DO NOT install diodes across coils for COUT outputs.

Connecting single valve to proportional outputs

Connecting a load, e.g. one proportional valve coil, to the COUT outputs is done by using the COUT (HS) and one of the COUT (LS) paired positions.

EXAMPLE

Connect the proportional valve to the COUT (HS), and the COUT (LS), respectively.



Possible combinations

OUT_1, OUT_11
 OUT_2, OUT_13
 OUT_3, OUT_15
 OUT_4, OUT_17
 OUT_5, OUT_19
 OUT_6, OUT_21
 OUT_7, OUT_23
 OUT_8, OUT_25
 OUT_9, OUT_27
 OUT_10, OUT_29

Function

Closed-loop control of solenoid type of proportional valves with one direction (one solenoid). The unused low-side switch COUT (LS-) becomes available for use as Digital out HS +LS

COUTs are grouped in pairs where adjacent channels have separate low-side switches and CAM feedback circuits, but share the same high-side switch used for shutdown.

Restriction

The COUT is monitored for external and internal faults, see Appendix B and COUT usage in safety functions

Detected errors will lead to shutdown of adjacent COUT channels.

Thermal management

Power driver Low-side is grouped in cluster of 4. Max current and power dissipation is limited to each group.



NOTICE

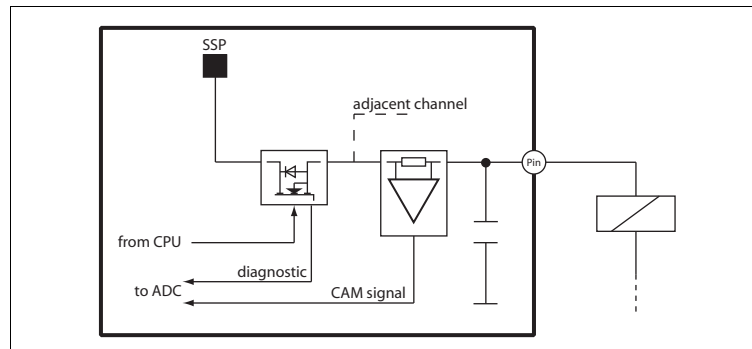
DO NOT install diodes across coils for COUT outputs.

Frequency

To obtain the best performance from proportional valves the MC4x controller produces a CAM (current mode closed loop) output signal with PWM. The module has an adjustable PWM frequency which can be changed using IQAN software. For the possible frequencies, see Appendix A.

COUT (HS) output OUT_1 to OUT_10 circuit block

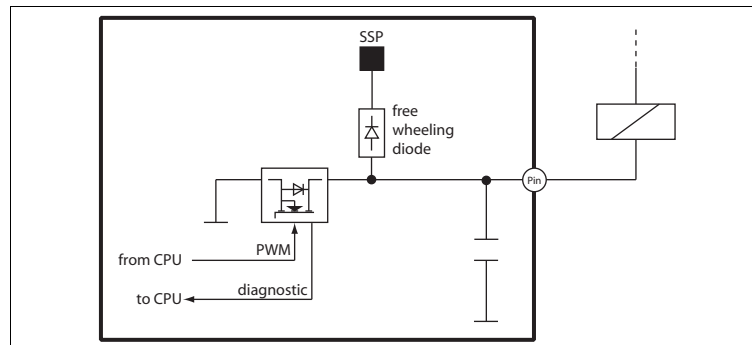
The current outputs have a CPU controlled frequency and a measuring circuit.



Current output high-side, COUT (HS).

COUT (LS) output OUT_11 to OUT_30 circuit block

The current outputs have a low side switch and free wheeling diode for proportional coils.



Current output low-side, COUT (LS).

COUT usage in safety functions

When the COUT is off, the output current is only the specified leakage current. In this state, the COUT high-side is kept active which enables rapid detection of wiring faults. For description of external faults detected by COUT, see Appendix B.

Minimum current

There are several diagnostics methods that are active, one of these methods is based on measuring current. The threshold for detection has been selected based on the assumptions that currents below specified minimum current does not cause movement.

MC4xFS-SMR-027:A Minimum current when using COUT

Safety related output functions controlled by COUT shall be designed so that movement can only be activated if the output current is $> 100 \text{ mA}$.

Error detection limits and delay

The COUT has two separate measurements of current, and is capable of detecting drift faults on the closed loop control of the output. To avoid spurious trips, it is designed to tolerate some deviation. The worst-case detection time for the most severe type of faults are listed in the table below:

COUT off	Faults that cause unintentional coil activation are detected within 50 ms. The action taken is to de-energized the coil by opening both high-side and low-side switch.
COUT on	Faults that cause unintentional increase in current with >30% above commanded value are detected within 500 ms. The action taken is to de-energized the coil by opening both high-side and low-side switch.
COUT on->off	Faults that cause delay in de-activation are detected within 250 ms. The action taken is to de-energized the coil by opening both high-side and low-side switch.

Since the MC4xFS COUT channels are grouped in pairs sharing an internal high-side driver channel, shutdown of one COUT will cause shutdown of both COUT channels in the pair. Restart conditions are controlled by the application.

Appendix B has detailed lists of failure modes focused on output wiring faults.

MC4xFS-SMR-028:A COUT error detection

When COUT outputs are used in safety functions, the error detection thresholds, the diagnostics delay time and any application specific delays shall be considered when determining the response time of the safety function.

All types of wiring faults must be considered to ensure that the failures are safe in the application. There are for example, wiring errors that can only be detected on start-up of the unit.

Note that accumulation of wiring faults can lead to loss of control of the load, e.g. if the COUT high-side pin shorted to battery and the COUT return pin is then shorted to ground.

Limits on COUT adjustable parameters

The COUT current range and slopes must be limited in the application. Due to the risks involved with modifying these adjustable values, it is recommended that these limits are kept narrow. The access to modifying these parameters must also be restricted.

See **MC4xFS-SMR-008:A Access protection of safety related parameters** and IQANdesign user manual.

Proportional PWM out HS+LS

Proportional outputs that are configured for open control of PWM Modulation Ratio are called PWM outputs in IQAN.

PWM out HS+LS is an alternative configuration of the pins used for COUT, configuring them as PWM out HS+LS can be used when there no need for closed loop current control, but instead a need to disable some of the error detection, e.g. when driving smaller currents. For the signal range and loads, see Appendix A.

Connecting bi-directional valve to PWM out HS+LS

Connecting a load, e.g. one proportional valve section, to the PWM outputs is done by using the PWM (HS)/PWM (LS) paired positions. The connection is done in the same way as shown in the examples for the bi-directional COUT outputs.



NOTICE

PWM out HS+LS has an internal free wheeling diode.

Because of the internal diode, this output is not suitable for Pulsar® 33 Hz or 75 Hz digital poppet style pilot operated valves.

Connecting single valve to PWM out HS+LS

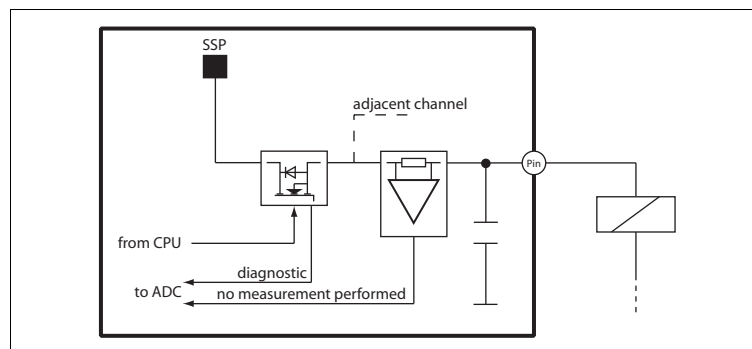
Connecting a load, e.g. one proportional valve coil, to the PWM outputs is done by using the PWM (HS) and one of the PWM (LS) paired positions. The connection is done in the same way as shown in the example for the single valve CAM outputs

Frequency

To match the recommended PWM frequency of the valve, the PWM output frequency can be changed using IQAN software. For the possible frequencies, see Appendix A.

PWM out HS OUT_1 to OUT_10 circuit block

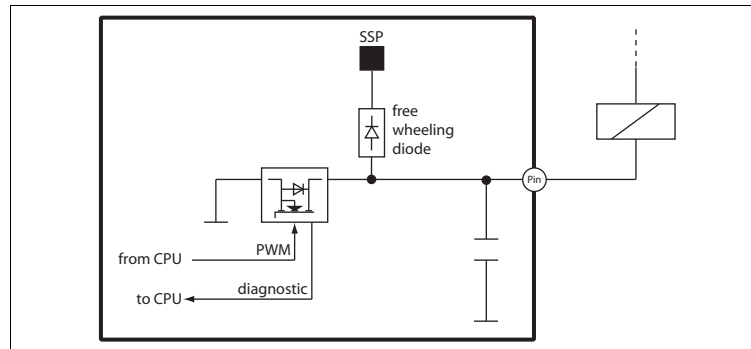
The PWM outputs have a CPU controlled frequency. Current measurement is not performed.



PWM output high-side, PWM (HS).

PWM out LS OUT_11 to OUT_30 circuit block

The PWM outputs have a low side switch and free wheeling diode for proportional coils.



PWM output low-side, PWM (LS).

High side PWM outputs

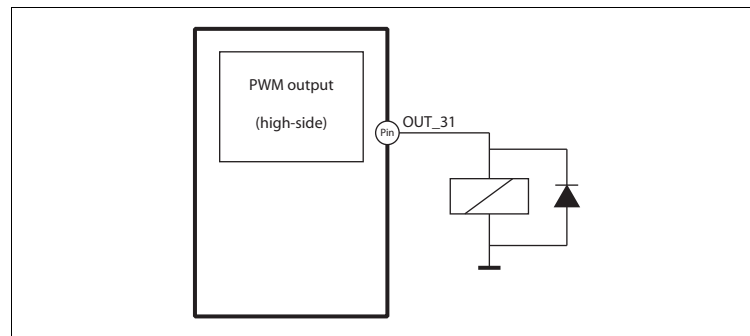
The high side PWM outputs are voltage open loop outputs used to control proportional valves and devices by varying *MR*, modulation ratio (duty cycle). One of this type output can control a single direction proportional valve. For the output range and loads, see Appendix A.

Connecting loads to PWM outputs

Connecting a load, e.g. one proportional valve coil, to the PWM outputs is done by using the PWM out (HS) positions.

EXAMPLE

Connect the proportional load to the PWM out (HS), and to GND, respectively.



Possible combinations

OUT_31
OUT_32
OUT_33
OUT_34
OUT_35
OUT_36
OUT_37
OUT_38

Function

PWM output with open loop control. External flyback diode for a proportional control of the load.

Clamping diode is mandatory if running in PWM mode!

Thermal management

PWM output driver is grouped in cluster of 2. Max current and power dissipation is limited to each group.



NOTICE

YOU MUST install diodes across coils for PWM out (HS) outputs.

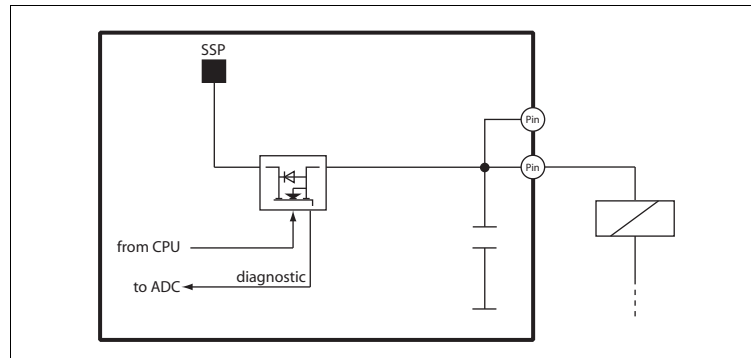
Because external diodes must be used, this output is not suitable for Pulsar® 33 Hz or 75 Hz digital poppet style pilot operated valves.

Frequency

To match the recommended PWM frequency of the valve, the PWM output frequency can be changed using IQAN software. For the possible frequencies, see Appendix A.

PWM out (HS) output OUT_31 to OUT_38 circuit block

The PWM outputs have a CPU controlled frequency.



PWM out (HS) outputs.

High side digital outputs

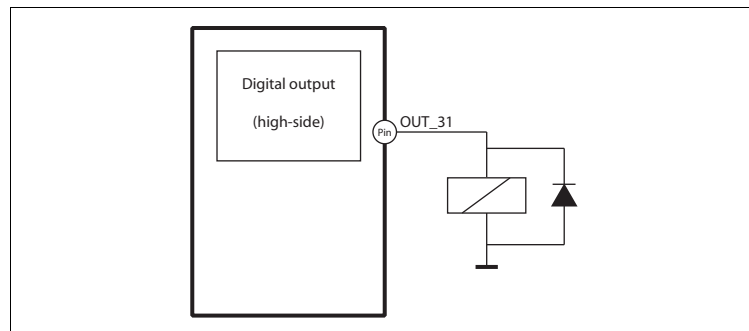
The high side digital outputs are switched digital outputs used to control on-off valves and devices. High side digital outputs share pins with the PWM outputs. More than 1 output can be combined to supply higher amperage to the loads. For the output specifications and loads, see Appendix A.

Connecting loads to high side digital outputs

Connecting a load, e.g. one on-off valve coil, to the digital outputs is done by using the DOUT positions.

EXAMPLE

Connect the load to the DOUT, and to GND, respectively.



Possible combinations

OUT_31
OUT_32
OUT_33
OUT_34
OUT_35
OUT_36
OUT_37
OUT_38

Function

On/off output with current sense (open loop).

Clamping diode is recommended if running in ON/OFF mode!

Drive capability

Power driver high-side is connected to drive single load current.

Thermal management

Power driver High-side is grouped in cluster of 2. Max current and power dissipation is limited to each group.



NOTICE

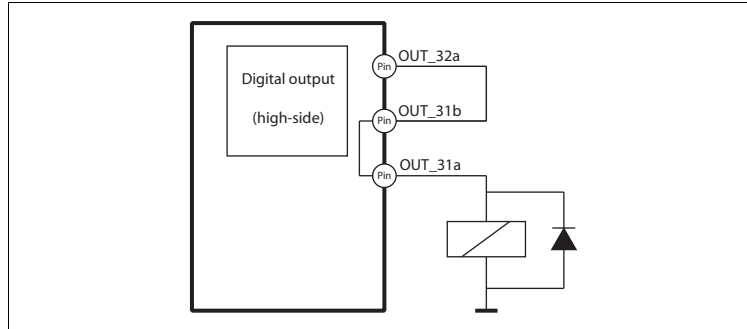
YOU SHOULD install diodes across coils for on-off outputs.

Connecting loads to high side digital outputs in parallel

Connecting a load, e.g. one on-off valve coil, to the digital outputs in parallel is done by using the DOUT positions and available a/b pin connections.

EXAMPLE

Connect the load to the DOUT, and to GND, respectively.



Possible combinations

OUT_31 in parallel with OUT_32

OUT_33 in parallel with OUT_34

OUT_35 in parallel with OUT_36

OUT_37 in parallel with OUT_38

Function

On/off output with current sense (open loop).

Clamping diode is recommended if running in ON/OFF mode!

Increased drive capability

Power driver high-side is connected in parallel with adjacent output to drive double load current.

Thermal management

Power driver High-side is grouped in cluster of 2. Max current and power dissipation is limited to each group.



NOTICE

YOU SHOULD install diodes across coils for on-off outputs.

Digital outputs HS+LS

Digital out HS + LS combines one Digital out high-side pin and one or more DOUT(LS) pins for control of on-off valves and devices. The DOUT(LS) share pins with COUT(LS).

On MC4xFS, this combination may be used in safety functions when the requirements in "DOUT HS+LS usage in safety functions" are met. For the maximum load per output see Appendix A.

Connecting loads to DOUT HS+LS

Connecting of loads to the low-side digital outputs such as on-off valves is done by using the DOUT(LS) positions and associated Digital out high-side pin as supply. The output functionality is configured using IQAN software.

Protection against voltage transients

A clamping diode must be placed between the source and low-side output, as close to the load as possible. This protects the output against high voltage transients.

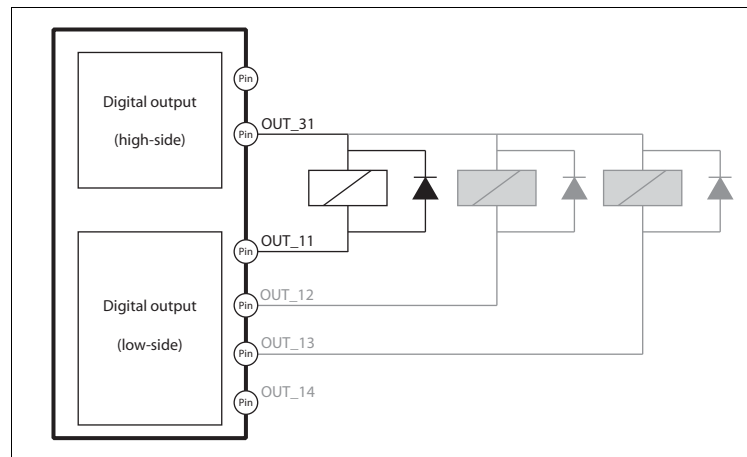
For example, use diode: 1N5408 (3A/1000V).

Depending on the load, other clamping diodes might be used instead.

EXAMPLE

Connect the on-off valve to the low-side outputs using one of the DOUT (LS) positions, and the DOUT (HS), as supply.

A clamping diode must be placed as close to the load as possible, see figure below.

**Possible combinations**

OUT_31, OUT_11/OUT_12/OUT_13/OUT_14
 OUT_32, OUT_15/OUT_16/OUT_17/OUT_18
 OUT_33, OUT_19/OUT_20/OUT_21/OUT_22
 OUT_35, OUT_23/OUT_24/OUT_25/OUT_26
 OUT_36, OUT_27/OUT_28/OUT_29/OUT_30

Function

Low-side control of loads with common high-side on/off.

Clamping diode is mandatory!

Restriction

See "DOUT HS+LS usage in safety function"

Thermal management

Power driver Low-side is grouped in cluster of 4. Max current and power dissipation is limited to each group.

**NOTICE**

YOU MUST install diodes across coils for low-side switch outputs.

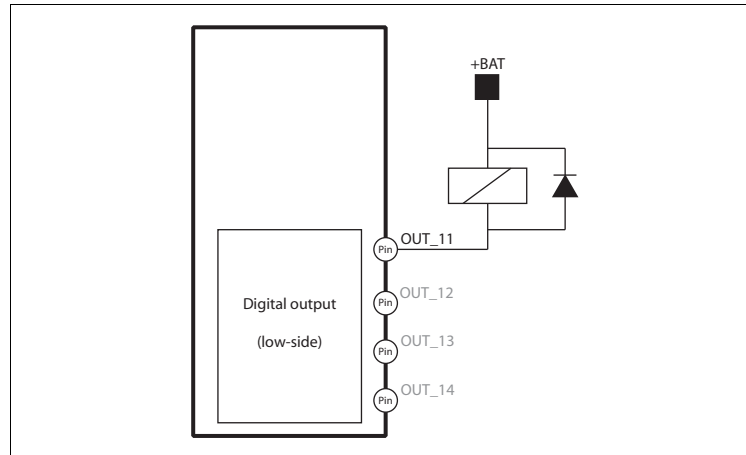
**WARNING**

Safe function!

Loads on DOUT with Low-Side switch DOUT(LS), must always be controlled on the high-side by connection to a digital output with High-Side switch DOUT (HS), for safe function.

Avoid unsafe connections

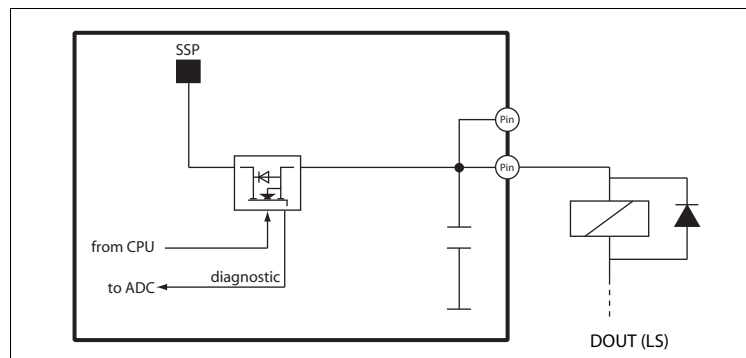
The connection shown below is NOT SUPPORTED. The power driver will be sourced (back-ended) by the external power supply. This connection will be detected as a critical error by the MC4x at power-on.



Example of unsafe connection that is not supported.

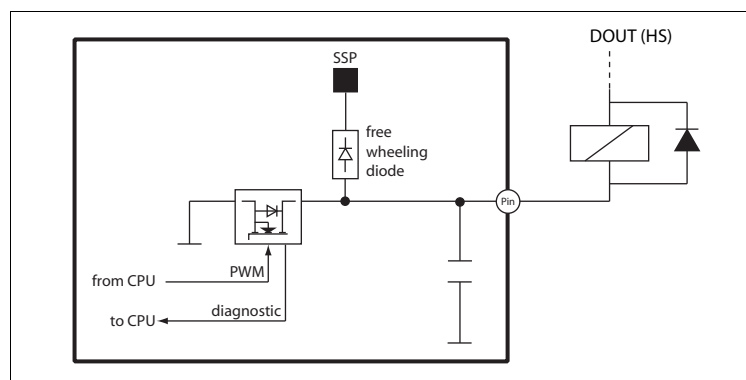
Digital outputs HS+LS OUT_11 to OUT_30 circuit block

High-side switch is shown for reference.



DOUT (HS) output circuit block.

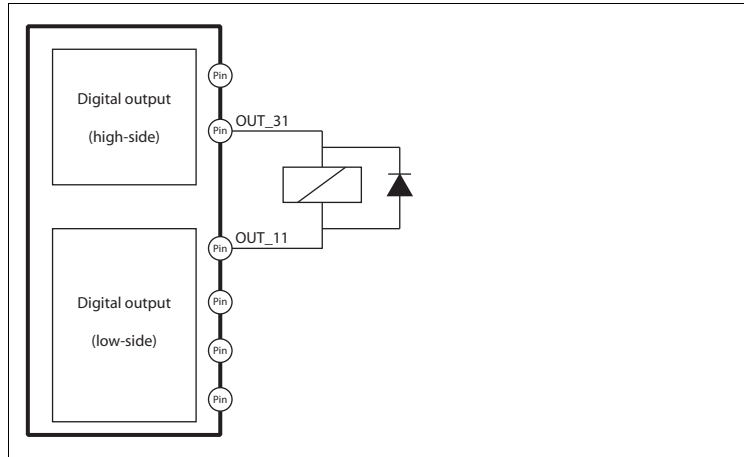
Status in low-side switch is monitored by CPU.



DOUT (LS) output circuit block.

DOUT HS+LS usage in safety functions

MC4xFS digital out HS+LS configured as a single low side connected to the high side may be used in safety functions, if the following requirements are met.



DOUT HS+LS connection in safety function.

MC4xFS-SMR-029:A DOUT HS+LS in safety functions

When the load connected to the DOUT is capable of initiating a hazardous movement, the DOUT used shall be of type DOUT HS+LS, and there shall be exactly one high-side supplying one low-side.

MC4xFS-SMR-030:A Minimum current when using DOUT HS+LS as power driver

Safety related output functions controlled by DOUT HS+LS shall be designed so that movement can only be activated if the output current is > 60 mA.

The worst-case detection time for the most severe type of faults are listed in the table below:

DOUT HS+LS off	Faults that cause unintentional coil activation are detected within 60 ms. The action taken is to de-energized the coil by opening both high-side and low-side switch.
DOUT HS+LS on->off	Faults that cause delay in de-activation are detected within 250 ms. The action taken is to de-energized the coil by opening both high-side and low-side switch.

MC4xFS-SMR-031:A DOUT HS+LS error detection

When DOUT HS+LS outputs are used in safety functions, the diagnostics delay time and any application specific delays shall be considered when determining the response time of the safety function.

For listings of external faults, see Appendix B.

Digital out LS outputs, (MC43)

The IQAN-MC43 has low-current low side digital outputs that may be used to control LEDs, relays or provide on-off signals to an external PLC.

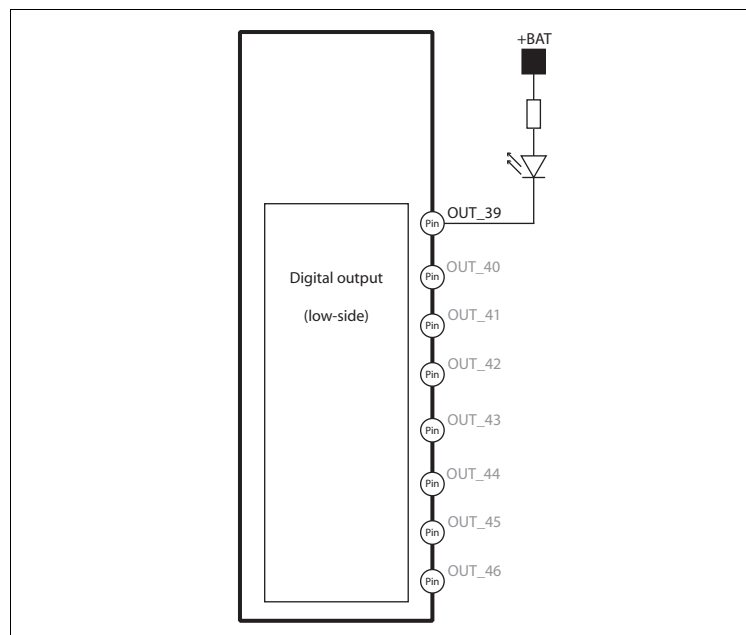
For the maximum load per output see Appendix A.

Connecting LEDs to low-side low current outputs

Connecting of loads to the low-side digital outputs such as LEDs is done by using the DOUT(LS) positions.

EXAMPLE

Connect the LED to the low-side output using one of the DOUT(LS) positions.



Possible combinations

OUT_39
OUT_40
OUT_41
OUT_42
OUT_43
OUT_44
OUT_45
OUT_46

Function

Low-side control of LED with current limiting resistor.

Monitoring

Load is monitored for open load (or short circuit to ground) and over load.

Connecting relays to low-side on-off outputs

Connecting of loads to the low-side digital outputs such as relays is done by using the DOUT(LS) positions.

Protection against voltage transients

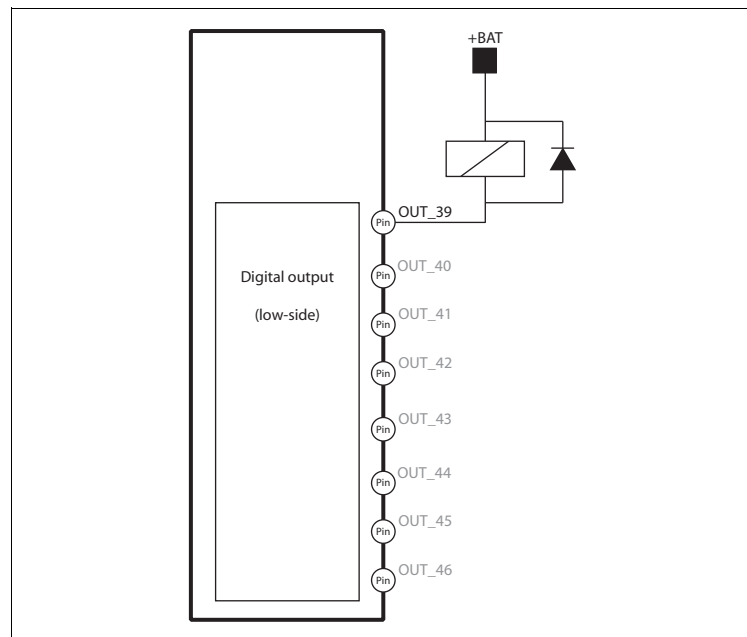
A clamping diode must be placed between the source and low-side output, as close to the load as possible. This protects the output against high voltage transients.

For example, use diode: 1N5408 (3A/1000V).

Depending on the load, other clamping diodes might be used instead.

EXAMPLE

Connect the relay to the low-side output using one of the DOUT(LS) positions.



Possible combinations

OUT_39
OUT_40
OUT_41
OUT_42
OUT_43
OUT_44
OUT_45
OUT_46

Function

Low-side control of relay.

External clamping diode is recommended

Monitoring

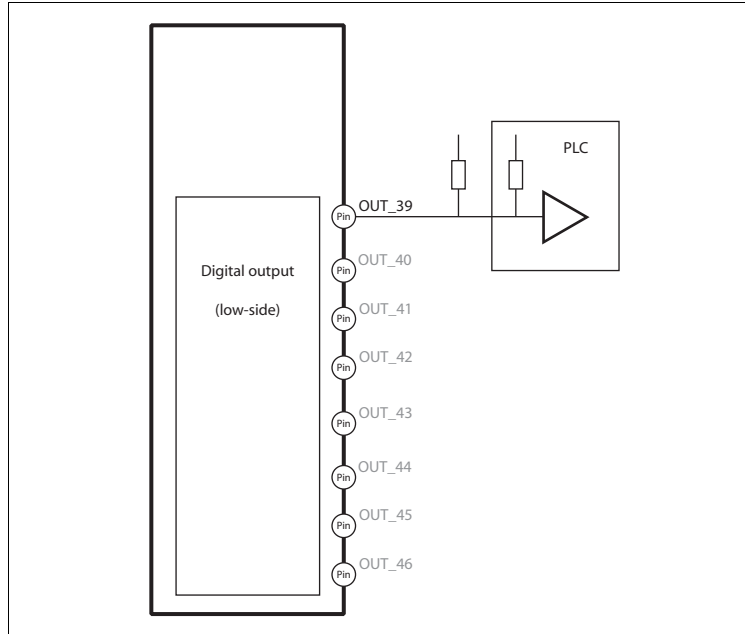
Load is monitored for open load (or short circuit to ground) and over load.

Connecting a PLC to low-side low current outputs

Connecting of PLC inputs to the low-side digital outputs is done by using the DOUT(LS) positions.

EXAMPLE

Connect the PLC input to the low-side output using one of the DOUT(LS) positions.



Possible combinations

OUT_39
OUT_40
OUT_41
OUT_42
OUT_43
OUT_44
OUT_45
OUT_46

Function

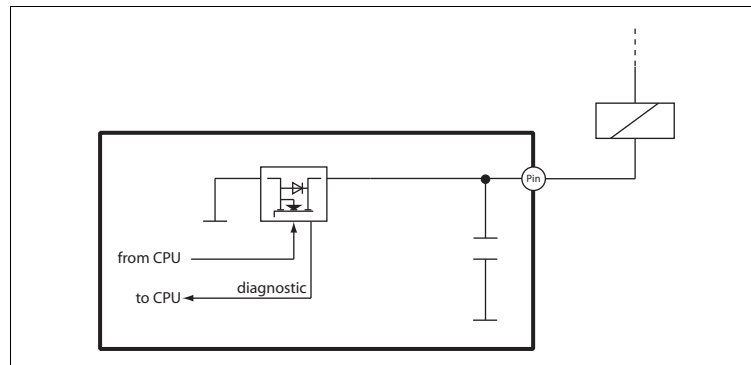
Signal interface to external PLC with internal or external pull-up resistor.

Monitoring

Load is monitored for open load (or short circuit to ground) and over load.

Low current Digital out (LS) outputs OUT_39 to OUT_46 circuit block

The low-side outputs are monitored by the CPU.



Digital out (LS) outputs (low current).

Busbar pins (MC41)

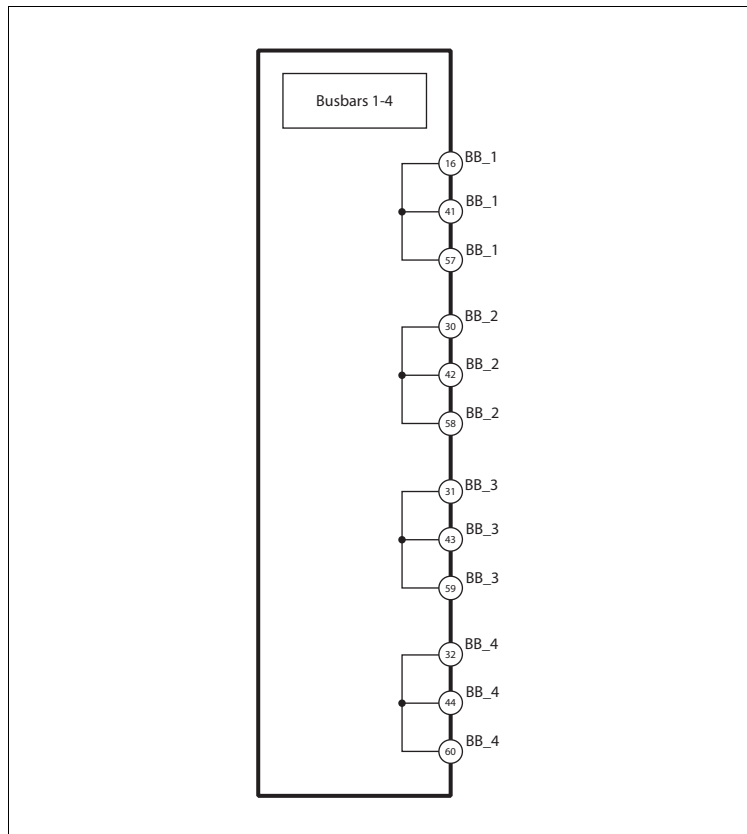
The IQAN-MC41 has 4 sets of pins that are internally connected to 4 busbars, *BB_1* to *BB_4*. There are 3 common pins per busbar. The internal bussed pins are intended to be used for jumper, splice or tap functions.

Connecting wires to busbars to create splices

To splice wires in the MC41 connector instead of externally in the harness, use the *BB_x* positions.

EXAMPLE

Connect the wires that need to be spliced to the busbar.



Possible combinations

BB_1
BB_2
BB_3
BB_4

Function

Jumper, splice or tap connections.



NOTICE

Maximum current for any of the busbars is 8 A.

7 Start-up

Start-up procedures

This chapter contains 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.

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 an emergency stop is installed.
The emergency stop should disconnect the supply voltage to all modules. Alternatively, the emergency stop may also shut off the diesel engine or a dump valve, and with that, depressurize the hydraulic system.

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/status diode shall be illuminated on all modules. Also, make sure that the master is in contact with all modules by reading the master's display.
- Make sure the emergency stop is functioning properly.

Start the system

Start the system as follows:

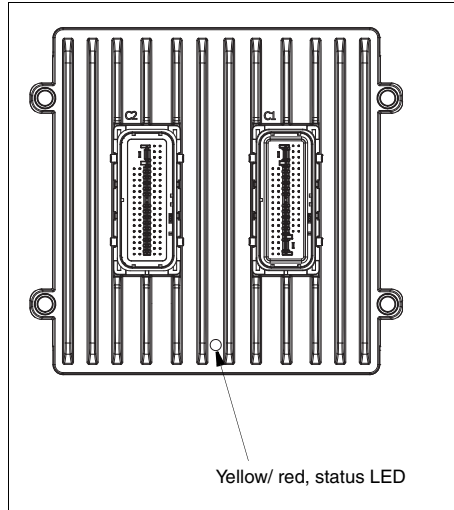
- Start the engine for the hydraulic system's pump, assuming that the above mentioned inspections have been carried out and shown correct values.

Calibrate and adjust input and output signals according to the instructions related to the master menu system and check each and every output function carefully.

8 System Diagnostics

The yellow blinking LED on the top of the module indicates normal status. If there is an error detected, the IQAN module will indicate *error status* through the red blinking LED.

This gives an immediate diagnosis as to the nature of the error that has occurred.



The location of the LED indicators on the IQAN-MC43.

The yellow/red LED, will be blinking red when an error has been detected. To get further information about the error messages, see Appendix B.

Bypass application

This is a special start-up mode that is used for master modules and puts the unit in a safe state without starting any application. You may bypass loading the application in the MC4x on start up in two ways.

- 1 If the ADDR_L voltage $> 3.00V$ (ADDR_L pin shorted to ADDR_H) is detected when the module starts (during power up) the application will not be loaded. When starting in a safe state with no application is desired, a jumper is put across pins 4 and 20 on the C1 connector, in place of an ID-Tag.
- 2 The MC4x will also bypass application on start up if the ID-Tag is absent. This is an easier method since you can just remove 1 wire of the ID-Tag.

Appendix A

IQAN-MC4x Technical Overview

System

Operating temperature	-40 to +85 °C ambient
Absolute maximum temperature	-40 to +85 °C ambient
Storage temperature	-40 to +105 °C ambient
Voltage supply on +BAT	9 to 32 Vdc
Power on threshold	typ. 6.5 Vdc
Over voltage on any pin	36 Vdc with respect to -BAT
Reverse polarity protection on +BAT	with external 40 A fuse
Power driver load	total load < 2 x 20 A (MC43) / 1 x 20A (MC41, MC42)
Current supply -MC41, $V_{BAT}=14V$ -MC41, $V_{BAT}=28V$ -MC43, $V_{BAT}=14V$ -MC43, $V_{BAT}=28V$	typ. 250 mA typ. 180 mA typ. 320 mA typ. 190 mA
Start up time	typ. 500 ms (with a small application)
System cycle time, T_{SC}	1 ms to 100 ms
Application memory (flash/RAM) -MC41 -MC42 -MC43	0.5MB / 0.5 MB 1.0MB / 1.0 MB 1.5MB / 1.5 MB
Data logging	typ. 80,000 records
Weight -MC41 -MC42 -MC43	350 g 700 g 750 g

MC4xFS safety integrity

Safety Integrity	Up to SIL2
Systematic capability	SC2
Element complexity	Type B
PHFd -MC41FS -MC42FS -MC43FS	7.61 x10 ⁻⁸ 7.90 x10 ⁻⁸ 9.98 x10 ⁻⁸
SFF -MC41FS -MC42FS -MC43FS	0.987 0.988 0.987
HFT	0
Diagnostic test interval	< 100 ms
Lifetime	10 years or 40,000 hours
Periodic proof test	No

Environmental ratings

Climate environment Enclosure, water & dust protection Salt mist Damp heat, cyclic Damp heat, steady state Heat, operation Heat, storage Cold Change of temperature	IEC 60529:2001, IP65; DIN 40050 Part 9:1993, IP6K9K IEC 60068-2-52:1996 Kb, 72 h IEC 60068-2-30:2005 Db, +55°C, 95% RH, 6 cycles IEC 60068-2-78:2001 Cab, +40°C, 93% RH, 21 days IEC 60068-2-2:2007 Bb, +85°C, 72 hours IEC 60068-2-2:2007 Bb, +105°C, 240 hours IEC 60068-2-1:1993 Ab, -40°C, 16 hours IEC 60068-2-14:1984 Nb, - 30°C to +70°C, 100 x 4 hours
Mechanical environment Random vibration Bump	IEC 60068-2-64: 2008 Fh, 15 - 1000 Hz, 11.6 Grms, 3 x 10 h IEC 60068-2-27:2008 Ea, 40 g, 6 ms, 1000 * 6 dir
EMC Radiated emission Conducted emission Conducted susceptibility Radiated susceptibility Conducted transients susceptibility Power supply ramp ESD, operation ESD, handling	ISO 13766:2010/ISO 14982:2009 EN 55025:2008, 0.15-108 MHz, Class 1 ISO 11452-4:2005, 1 - 200 MHz, 1 kHz, 80% AM, 150 mA ISO 11452-2:2004, 200-2000 MHz, 1kHz, 80% AM, 100 V/m ISO 11452-2:2004, 800-2000 MHz, PM 577 us/4.6 ms, 60 V/m ISO 7637-2:2004, Pulse 1,2a,2b,3a,3b,4,5, Level 3 ISO 7637-3:2007, Level 3 SAE J1455:2011, Section 4.13.1 ISO 10605:2008, 8kV (contact), 15kV (air) ISO 10605:2008, 8kV (contact)

Markings/Approvals

CE <i>MC43FS, MC42FS, MC41FS</i>	2014/30/EU, EMC directive 2011/65/EU, RoHS 2 2006/42/EG, Machinery directive
E-mark <i>MC43 / MC43FS</i> <i>MC42 / MC42FS</i> <i>MC41 / MC41FS</i>	ECE regulation No. 10.05:2014, Approval number E5 10 R - 05295 Approval number E5 10 R - 05322 Approval number E5 10 R - 05313

Sensor supply, VREF

Number of VREF	2
Output voltage	5 V ±150 mV, -40 to 85 °C
Output voltage temperature drift	0.50 mV/°C, -40 to 85 °C
Maximum load current	150 mA on each VREF
Protection	overload, SCB, SCG
Diagnostics	over/under voltage
Under/over voltage threshold	±500 mV from nominal value

Voltage inputs, 5 Vdc

Number of inputs -MC43 -MC42 -MC41	(configuration may reduce number) 26 8 8
Signal full scale	5000 mV \pm 100 mV
Signal resolution	1.3 mV (12 bits)
Input impedance	36 kohm in parallel with 10 nF
Accuracy with external sensor supply with VREF sensor supply	\pm (0.5 % + 6 mV), -40 to 85 °C \pm (0.3 % + 6 mV), -40 to 85 °C
Sample rate	same as system cycle time T _{SC}
Maximum continuous voltage	32 V
Protection	SCB, SCG
Diagnostics	defined in application

Voltage inputs, 32 Vdc

Number of inputs -MC43 -MC42 -MC41	(configuration may reduce number) 2 2 2
Signal full scale	32 V \pm 350 mV
Signal resolution	10 mV (12 bits)
Input impedance	52 kohm in parallel with 10 nF
Accuracy	\pm (0.8 % + 60 mV), -40 to 85 °C
Sample rate	same as system cycle time T _{SC}
Maximum continuous voltage	32 V
Protection	SCB, SCG
Diagnostics	defined in application

Current loop inputs

Number of inputs -MC43 -MC42 -MC41	(configuration may reduce number) 4 2 2
Signal full scale	20 mA \pm 0.15 mA
Signal resolution	3 μ A (13 bits)
Input impedance	247 ohm in parallel with 10 nF
Accuracy	\pm (0.9 % + 30 μ A), -40 to 85 °C
Sample rate	same as system cycle time T _{SC}
Maximum continuous voltage	5.5 V
Protection Over current limit	SCB, SCG typ. 23 mA
Diagnostics	defined in application

Digital inputs

Dedicated digital inputs	
Number of inputs -MC43 -MC42 -MC41	12 0 0
Logic levels <i>low</i> <i>high</i> <i>hysteresis</i>	<1 V >4 V >150 mV
Input impedance	6.8 kohm in parallel with 10 nF
Sample rate	same as system cycle time T_{SC}
Maximum continuous voltage	32 V
Diagnostics	Defined in application
Digital inputs from Voltage in (0-5V)	
Number of inputs -MC43 -MC42 -MC41	26 8 8
Logic levels <i>low</i> <i>high</i> <i>hysteresis</i>	<1 V >4 V >150 mV
Input impedance	36 kohm in parallel with 10 nF
Sample rate	same as system cycle time T_{SC}
Maximum continuous voltage	32 V
Diagnostics	Defined in application
Digital inputs from Frequency in pull-ups	
Number of inputs -MC43 -MC42 -MC41	4 4 4
Logic levels <i>low</i> <i>high</i> <i>hysteresis</i>	<1 V >4 V >150 mV
Input impedance	1.5 kohm pull-up to internal 5V, 10 nF
Sample rate	same as system cycle time T_{SC}
Maximum continuous voltage	32 V
Diagnostics	Defined in application

Digital inputs

Digital inputs from Frequency in pull-downs	
Number of inputs	
-MC43	2
-MC42	2
-MC41	2
Logic levels	
low	<1 V
high	>4 V
hysteresis	>150 mV
Input impedance	6.8 kohm in parallel with 10 nF
Sample rate	same as system cycle time T_{SC}
Maximum continuous voltage	32 V
Diagnostics	Defined in application

Frequency inputs

Number of inputs (FIN / DFIN)	(configuration may reduce number)
-MC43	6 / 3
-MC42	6 / 3
-MC41	6 / 3
Frequency range	5 to 50.000 Hz, 50% duty cycle
Frequency timeout	200 ms
Resolution	31 ns
Logic levels	
low	<1 V
high	>4 V
hysteresis	>150 mV
Input impedance	
Pull-up type	1.5 kohm pull-up to internal 5V, 10 nF
Pull-down type	6.8 kohm in parallel with 10 nF
Maximum continuous voltage	32 V
Diagnostics	Defined in application

Pulse-count inputs

Number of inputs (PCNT / DPCNT)	(configuration may reduce number)
-MC43	6 / 3
-MC42	6 / 3
-MC41	6 / 3
Frequency range	0 to 50.000 Hz, 50% duty cycle
Resolution	31 ns
Logic levels	
low	<1 V
high	>4 V
hysteresis	>150 mV
Input impedance	1.5 kohm pull-up to internal 5V, 10 nF
Maximum continuous voltage	32 V
Diagnostics	Defined in application

PWM inputs

Number of inputs (PWMIN) -MC43 -MC42 -MC41	(configuration may reduce number) 6 6 6
Frequency range	100 to 500 Hz
MR range	3 to 97 %
Resolution	31 ns
Logic levels <i>low</i> <i>high</i> <i>hysteresis</i>	<1 V >4 V >150 mV
Input impedance <i>Pull-up type</i> <i>Pull-down type</i>	1.5 kohm pull-up to internal 5V, 10 nF 6.8 kohm in parallel with 10 nF
Maximum continuous voltage	32 V
Diagnostics	Defined in application

Current outputs

Number of outputs -MC43 -MC42 -MC41	(configuration may reduce number) 10 dual/single 6 dual/single 2 dual/single
Load restriction <i>max load total</i> <i>max load per group</i> <i>max load per output</i>	20 A (MC43) / 12 A (MC42) / 4 A (MC41) 4.0 A (Groups: OUT_1, 2 / OUT_3, 4 / OUT_5, 6 / OUT_7, 8 / OUT_9, 10) 2.5 A
Leakage current in OFF state	<1 mA
Output range	100 to 2500 mA
Output resolution	1 mA
Absolute accuracy	±(2 % + 15 mA), -40 to 85 °C
Supply rejection	±2 mA, V _{BAT} change 9 to 18V or 18 to 32V
Load rejection	±2 mA, load change ±50 %
PWM frequency, F _{DITH} (Hz)	71, 77, 83, 90, 100, 111, 125, 167, 200, 250, 333, 500
Maximum load V _{BAT} = 14V and F _{DITH} ≥ 200 Hz V _{BAT} = 14V and F _{DITH} ≤ 167 Hz V _{BAT} = 28V and F _{DITH} ≥ 200 Hz V _{BAT} = 28V and F _{DITH} ≤ 167 Hz	5 ohm + 10 mH 5 ohm + 20 mH 10 ohm + 30 mH 20 ohm + 60 mH
Protection	SCB, SCG
Diagnostics	open load, over load, saturation

PWM outputs, HS+LS

Number of outputs -MC43 -MC42 -MC41	(configuration may reduce number) 10 dual / single 6 dual / single 2 dual / single
Load restriction <i>max load total</i> <i>max load per group</i> <i>max load per output</i> <i>min load</i>	20 A (MC43) / 12 A (MC42) / 4 A (MC41) 4 A (Groups: OUT_1, 2 / OUT_3, 4 / OUT_5, 6 / OUT_7, 8 / OUT_9, 10) 2.5 A 60 mA
Leakage current in OFF state	<1 mA
PWM frequency, F_{DITH} (Hz)	71, 77, 83, 90, 100, 111, 125, 167, 200, 250, 333, 500
PWM max pulse width	$1/PWM_{freq} - 20 \mu s$
PWM resolution	1 μs
Protection	SCB, SCG
Diagnostics	open load, over load

Digital outputs, HS+LS

Number of outputs -MC43 -MC42 -MC41	(configuration may reduce number) 20 12 4
Load restriction <i>max load total</i> <i>max load per group</i> <i>max load per output</i> <i>min load</i>	20 A (MC43) / 12 A (MC42) / 4 A (MC41) 4 A 2.5 A 60 mA
Leakage current in OFF state	<2 mA
Maximum allowable load inductance $V_{BAT} = 14V$ single pulse $V_{BAT} = 28V$ single pulse	(without external clamping diode) 14 Ohm / 80 mH, 7 ohm / 50 mH 28 Ohm / 70 mH, 14 ohm / 46 mH
Protection	SCB, SCG
Diagnostics <i>Open load, output OFF</i> <i>Under current detection threshold</i> <i>Over current threshold, output ON</i>	> 50 Kohm @ $V_{BAT} = 9V$, > 140 Kohm @ $V_{BAT} = 18V$ typ. 60 mA(can be disabled) >3000 mA

Digital outputs HS

Number of outputs -MC43 -MC42 -MC41	(configuration may reduce number) 8 4 4
Load restriction <i>max load total</i> <i>max load per group</i> <i>max load per output</i> <i>min load</i>	20 A (MC43) / 12 A (MC42, MC41) 6 A (Groups: OUT_31, 32 / OUT_33, 34 / OUT_35, 36 / OUT_37, 38) 4 A 60 mA
Leakage current in OFF state	<2 mA
Maximum allowable load inductance <i>V_{BAT} = 14V, single pulse</i> <i>V_{BAT} = 28V, single pulse</i>	(without external clamping diode) 14 Ohm / 366 mH, 9.3 ohm / 126 mH, 7 ohm / 50 mH 5.6 ohm / 30 mH, 4.7 ohm / 20 mH, 3.5 ohm / 9 mH 28 Ohm / 334 mH, 19 ohm / 114 mH, 14 ohm / 46 mH 11 ohm / 28 mH, 9.3 ohm / 18 mH, 8 ohm / 12 mH
Protection	SCB, SCG
Diagnostics <i>Open load, output OFF</i> <i>Under current threshold, output ON</i> <i>Over current threshold, output ON</i>	> 17 Kohm @ VBAT = 9V, > 48 Kohm @ VBAT = 18V typ. 60 mA (can be disabled) >4200 mA

PWM outputs HS

Number of outputs -MC43 -MC42 -MC41	(configuration may reduce number) 8 4 4
Load restriction <i>max load total</i> <i>max load per group</i> <i>max load per output</i> <i>min load</i>	20 A (MC43) / 12 A (MC42, MC41) 6 A (Groups: OUT_31, 32 / OUT_33, 34 / OUT_35, 36 / OUT_37, 38) 4 A 60 mA
PWM frequency (Hz)	71, 77, 83, 90, 100, 111, 125, 167, 200, 250, 333, 500
PWM max pulse width	1/PWMfreq - 100 µs
PWM resolution	1 µs
PWM inductive load	external clamping diode is mandatory
Leakage current in OFF state	<2 mA
Protection	SCB, SCG
Diagnostics <i>Open load, output OFF</i> <i>Over current threshold, output ON</i>	> 17 Kohm @ VBAT = 9V, > 48 Kohm @ VBAT = 18V thermal shut-off

Digital outputs LS

Number of outputs -MC43 -MC42 -MC41	8 - -
Leakage current in OFF state	<200 µA
Minimum load	1 mA
Load restriction <i>max load total</i> <i>max load per output</i>	1.6 A 300 mA
Maximum allowable load inductance <i>V_{BAT} = 14V, single pulse</i> <i>V_{BAT} = 28V, single pulse</i>	(without external clamping diode) 45 Ohm / 220 mH 95 Ohm / 183 mH
Protection	SCB, SCG
Diagnostics	open load

CAN

Number of CAN buses -MC43 -MC42 -MC41	5 3 2
CAN specification	2.0A and 2.0B
CAN bus speed	125 kbit/s to 1 Mbit/s
Protection	SCB, SCG

Ethernet

Number of Ethernet ports -MC43 -MC42 -MC41	1 1 0
Network interface	100 Base-TX, 10 Base-T, Auto-MDIX (auto crossover)
Network protocol	TCP/IP, UDP Dynamic IP (DHCP/link-local auto-IP)
Communication rates	10/100 Mbps, auto-negotiated

Appendix B

Error codes, messages and actions

If one of the following error is detected, a message will be presented with an error code on the module. In some cases, the module will turn off or at least shut down the outputs, to increase safety.



WARNING

Don't use the machine if an error message or error code is activated.

LED indicator showing different MC4x modes

Status		Flash (yellow)	
Normal operation			
Application not loaded			
No application available			
Waiting for restart			

Error code	Error	Primary Flash (red) Error category	Secondary Flash (yellow) Error description
1:1	Output		
1:2	Input		
1:3	VREF		
2:1	Power supply		
2:2	Temperature		
3:1	CAN, no contact		
3:2	IDtag error		
3:3	System mismatch		
3:4	CAN error (bus off)		
4:1 ^a	Stopped, critical		
4:2 ^b	Stopped, critical		
4:3 ^c	Stopped, critical		

- Followed by a longer sequence of flashes, contact Parker.
- Followed by a longer sequence of flashes. Possible causes include reverse feed on startup, critical under-voltage and critical temperature.
- Followed by a longer sequence of flashes, contact Parker.

Failure modes, external faults on power drivers

The following table has information about the actions taken by the IQAN-MC4xFS when certain failure causing conditions occur. Failure modes for internal faults are included in the total PFHd for the module.

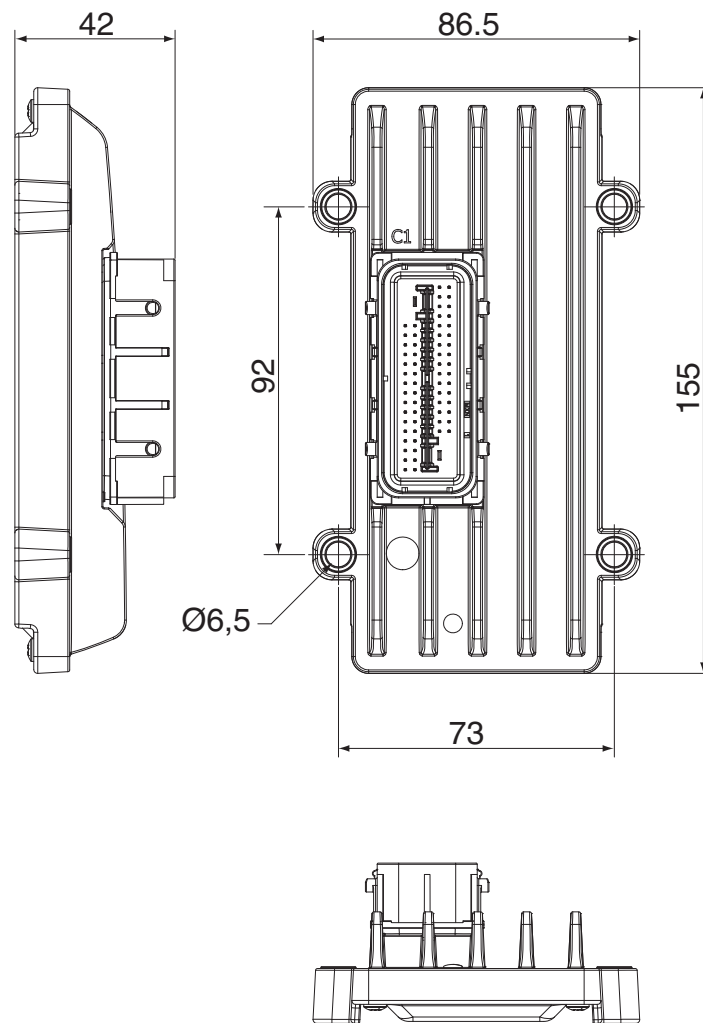
Output pin configuration	Failure mode	Expected channel status ^a			Comment
		Start up	On	Off	
Current out	Broken wire		open load	open load	
	Short to GND (HS)	critical error	overload	overload	
	Short to GND (LS)	critical error	overload	overload	SCG while off: coil is energized for ≤ 50 ms before detection
	Short to Battery (HS)	(no contact)	open load	-	Prevents module startup => LED showing Stopped, Critical
	Short to Battery (LS)	(no contact)	overload	-	Prevents module startup => LED showing Stopped, Critical
	Short LS+ to LS-		overload	-	
	Overload		overload	n/a	
	Insufficient voltage on +BAT		saturated	n/a	
	Insufficient voltage on +BAT, current saturated < 70%		open load	n/a	
PWM out HS+LS	Broken wire		open load	open load	
	Short to GND (HS)	critical error	overload	overload	
	Short to GND (LS)	critical error	overload	overload	SCG while off: coil is energized for ≤ 50 ms before detection
	Short to Battery (HS)	(no contact)	-	-	Prevents module startup => LED showing Stopped, Critical
	Short to Battery (LS)	(no contact)	overload	-	Prevents module startup => LED showing Stopped, Critical
	Overload		overload	n/a	

Output pin configuration	Failure mode	Expected channel status ^a			Comment
		Start up	On	Off	
Digital out HS+LS	Broken wire		open load*	open load	*with multiple low sides, open load while on is detected only when combined load is showing undercurrent. Can be disabled in IQANdesign
	Short to GND (HS)		overload	overload	
	Short to GND (LS)		-	overload	
	Short to Battery (HS)	(no contact)	*	-	Prevents module startup => LED showing Stopped, Critical *SCB while on can be detected as undercurrent (open load) in configurations with one low-side
	Short to Battery (LS)	(no contact)	overload	-	Prevents module startup => LED showing Stopped, Critical
	Overload		overload	n/a	
	Under current		open load	n/a	See under current threshold. Can be disabled in IQANdesign
Digital out HS	Broken wire		open load*	open load	*Open load while on is detected by under current. Can be disabled in IQANdesign
	Short to GND (HS)	critical error	overload	-	
	Short to Battery (HS) coil energized	(no contact)	*	open load	Prevents module startup => LED showing Stopped, Critical *SCB while on can be detected as undercurrent (open load)
	Overload		overload	n/a	
	Under current		open load	n/a	See under current threshold. Can be disabled in IQANdesign
PWM out HS	Broken wire		-	open load	
	Short to GND (HS)		-		
	Short to Battery (HS) coil energized	(no contact)	-	open load	Prevents module startup => LED showing Stopped, Critical
	Overload		overload	n/a	Power driver thermal protection shut down

- a. Only the resulting status from the test expected to find the error first is listed, different status is possible as several failure modes are detected by multiple test.
Failures not detected by in this state are indicated with -

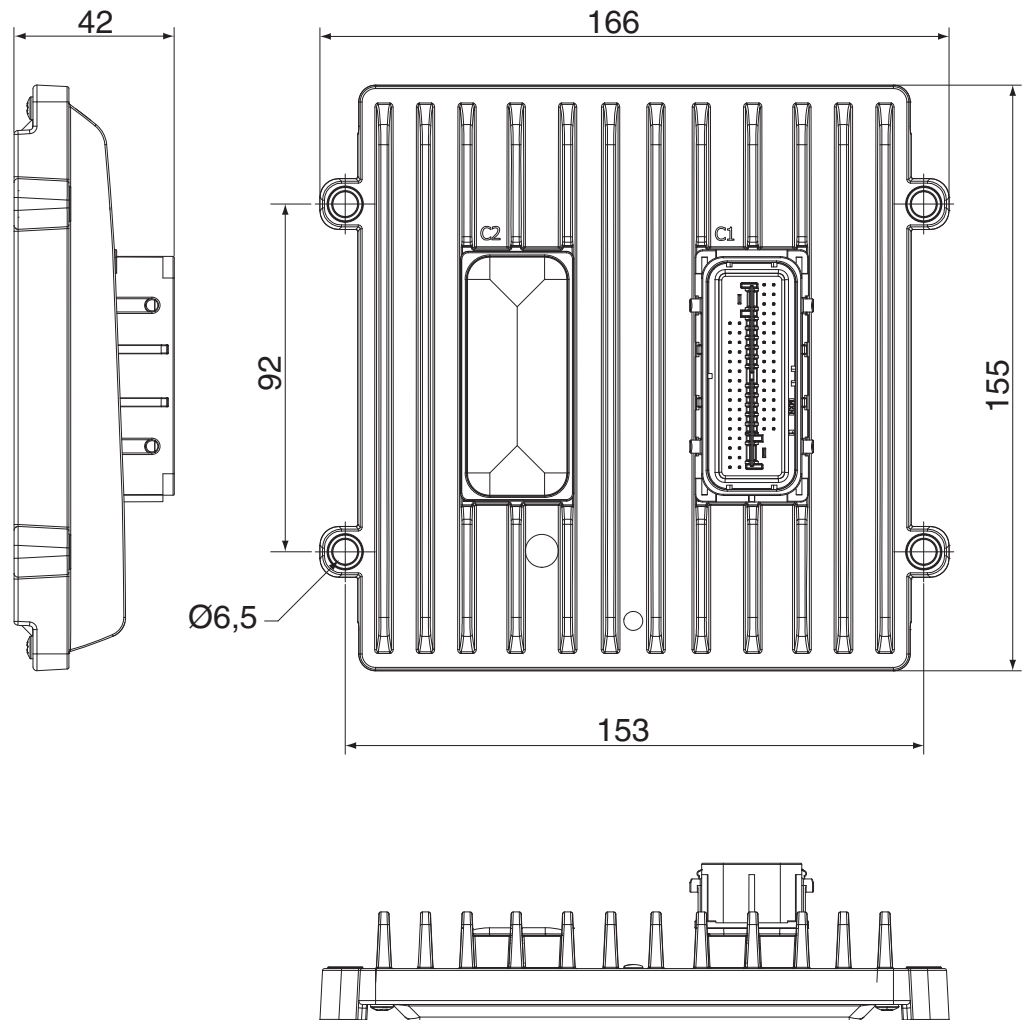
Appendix C

Dimensioning of the IQAN-MC41 module



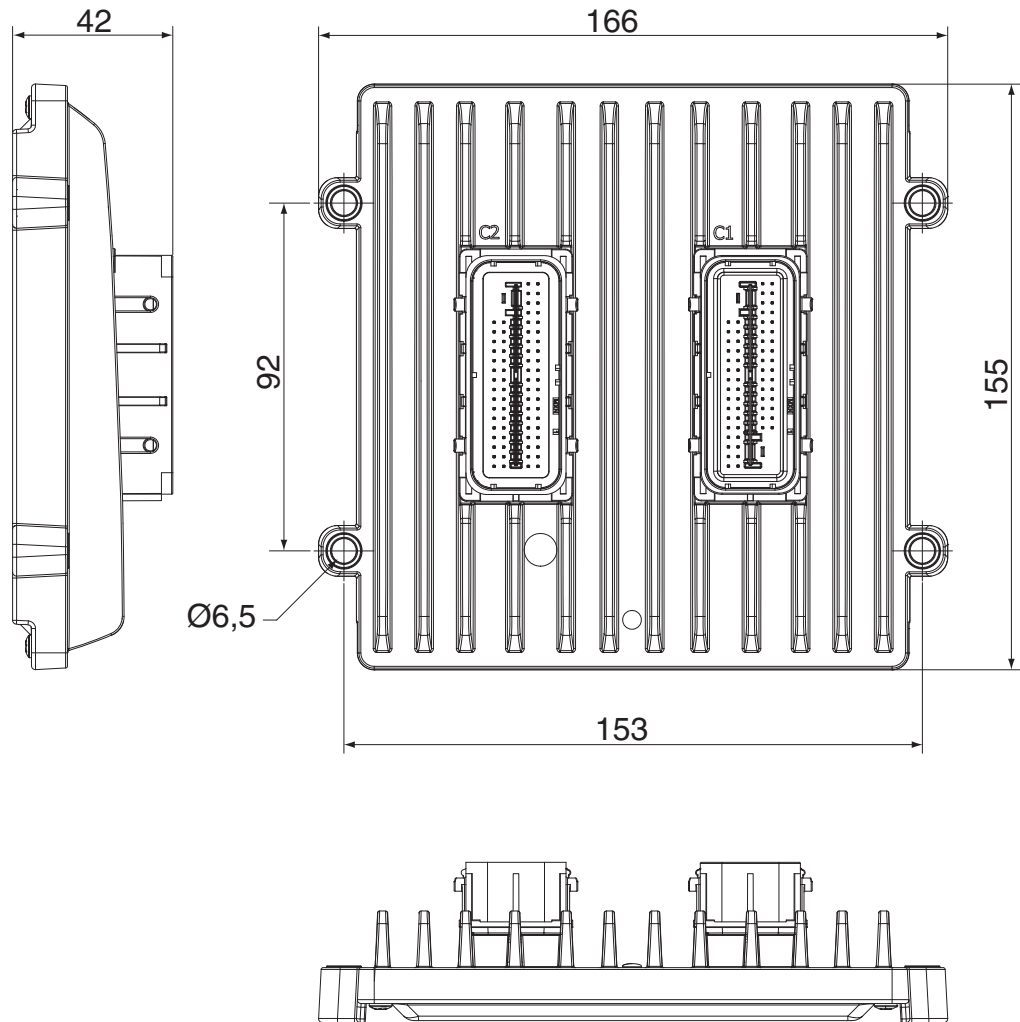
Unit = mm

Dimensioning of the IQAN-MC42 module



Unit = mm

Dimensioning of the IQAN-MC43 module



Unit = mm

Appendix D

Safety manual requirements

This appendix contains a list of the mandatory safety requirements that must be fulfilled in order for the unit to be used up to its specified safety integrity level.

SMR: Safety Manual Requirement

MC4xFS-SMR-001:A Use within specification	3
MC4xFS-SMR-002:A No field repair	3
MC4xFS-SMR-003:A Use FS version in safety functions	5
MC4xFS-SMR-004:A Safe state	13
MC4xFS-SMR-005:A Only use an official release of IQANdesign.....	15
MC4xFS-SMR-006:A Safety related function groups in IQANdesign	15
MC4xFS-SMR-007:A Configuration tools	16
MC4xFS-SMR-008:A Access protection of safety related parameters	16
MC4xFS-SMR-009:A Safe default values on safety related parameters	16
MC4xFS-SMR-010:A Application cycle utilization.....	16
MC4xFS-SMR-011:A Expected restart interval.....	17
MC4xFS-SMR-012:A Safe error values on input channels.....	17
MC4xFS-SMR-013:A Safety related real-time CAN communication between IQAN masters	17
MC4xFS-SMR-014:A Safety related real-time CAN communication with 3rd party nodes	18
MC4xFS-SMR-015:A Limits on VIN signal range	43
MC4xFS-SMR-016:A Tolerances on single or identical VIN.....	43
MC4xFS-SMR-017:A VIN combined with redundant and diverse channel....	44
MC4xFS-SMR-018:A Limits on VIN32 signal range	45
MC4xFS-SMR-019:A Tolerances on single or identical VIN32.....	46
MC4xFS-SMR-020:A VIN32 combined with redundant and diverse channel	46
MC4xFS-SMR-021:A Limits on CIN signal range	49
MC4xFS-SMR-022:A Tolerances on single or identical CIN.....	50
MC4xFS-SMR-023:A CIN combined with redundant and diverse channel....	50
MC4xFS-SMR-024:A Frequency input redundancy.....	57
MC4xFS-SMR-025:A Limits on PWMIN signal range	59
MC4xFS-SMR-026:A DIN redundancy	62
MC4xFS-SMR-027:A Minimum current when using COUT	66
MC4xFS-SMR-028:A COUT error detection.....	67
MC4xFS-SMR-029:A DOUT HS+LS in safety functions.....	77
MC4xFS-SMR-030:A Minimum current when using DOUT HS+LS a power drive.....	77
MC4xFS-SMR-031:A DOUT HS+LS error detection	77

For the latest information visit our website www.iqan.com

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