Twido Extreme Programmable Controller

Hardware Guide

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www.schneider-electric.com

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Table of Contents

Safety Information

Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

CAUTION

CAUTION, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** equipment damage.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

About the Book

At a Glance

Document Scope

This manual describes the hardware for a Twido Extreme programmable controller base.

It provides a description of the different parts, explains mounting operations and gives wiring instructions.

Validity Note

The information in this manual applies only to a Twido Extreme programmable controller base. This documentation is valid for TwidoSuite Version 2.3

User Comments

We welcome your comments about this document. You can reach us by e-mail at techcomm@schneider-electric.com.

Twido Extreme Overview

1

Introduction

This chapter gives an overview of Twido Extreme: it describes its configurations, its functions and the communication system.

What's in this Chapter?

This chapter contains the following topics:

Twido Extreme Controller Description

Introduction

The Twido Extreme controller can be powered by an external battery with voltage:

- either 12 VDC (%Q0.10 to %Q017 are available when nominal voltage ranges from 9 to 16 VDC),
- or 24 VDC (nominal voltage ranging from 18 to 32 VDC).

NOTE: The length of the power supply cable must not exceed 30 m (98.4 ft).

Low voltage electrical installations, Fundamental principles : IEC60364 series

The shield terminals (CANopen shield (40), CANJ1939 shield (51)) are not directly connected to the chassis.

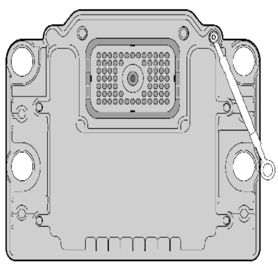
For the installer claimant an equipotentiality shield-chassis, add connection shield-chassis upstream of the controller.

The Twido Extreme has the ability to locally control machinery in its own severe environment and to use communication bus for more distant components.

For application in machinery, use EN/IEC 60204-1 (Safety of machinery - Electrical equipement of machines - General requirements),UL 508, CSA C22.2 N°142.

The Twido Extreme is well suitable for automotive application.

Twido Extreme Controller Model

Model Reference	Illustration
TWD LEDC K1	The nominal battery power supply voltage is either 12 VDC or 24 VDC. Both systems handle 22 inputs and 19 outputs. **Note**: Twido Extreme has no internal battery.  Twido Extreme is protected for 1 hour against reverse voltage.

For more information on the accessories and options available, see *Options, page 16* and *Accessories, page 19*.

Battery

Twido Extreme has no internal battery. A specific input, the key switch input, is used to turn the controller ON and OFF and to put it in standby mode.

Twido Extreme must continuously be connected to the battery (Steady State Voltage) to avoid loss of SRAM memory and operate properly.

For more information on this feature, see *Key Switch Input, page 68*.

Input/Output Extensions

The number of inputs and outputs can be extended through the CANopen communication bus.

To carry out an extension, use IP67 distributed I/O interfaces such as Advantys FTB or FTM splitter boxes. They allow distributed connection of sensors and actuators on machines through CANopen.

For more information on Advantys FTB or FTM splitter boxes, see the guides available on Schneider Electric website (http://www.schneider-electric.com).

Communication Capabilities

The Twido Extreme Controller communication capabilities are based on the 3 following communication ports.

- Serial line RS485
- CANopen port
- CANJ1939 port

Associated Software

To perform operations on Twido Extreme, you can use the following software tools:

- TwidoSuite
  TwidoSuite *1.20 or later* is used to create, configure, operate and maintain applications for Twido programmable controllers with a PC.
- TwidoAdjust
  TwidoAdjust *3.0* is used to manage and monitor a Twido application with a Pocket PC.

For more information on these tools, see the guides available on Schneider Electric website (http://www.schneider-electric.com).

Controller Features

Introduction

By default, all I/Os on the base are configured as discrete I/Os. However, dedicated I/Os can be assigned to specific functions during configuration such as:

- RUN/STOP input
- Latching inputs
- Fast counter: single up/down counter 10 kHz
- Controller status output
- Pulse Width Modulation (PWM)
- Pulse (PLS) generator output

Twido Extreme controllers are programmed using TwidoSuite which enables the following functions to be used:

- PWM
- PLS
- Fast counter

Main Features

The following table lists the main features of the base:

Feature	Description
Scanning	Normal (cyclical) or periodic (constant) (2 ms to 150 ms).
Execution time	0.14 μs to 0.9 μs for a list instruction.
Memory capacity	Data: 3000 memory words. Program: 22 inputs and 19 outputs, 3000 instruction lists.
Modbus communication	Non-isolated EIA RS-485 type, maximum length limited to 30.5 m (100 ft). ASCII or RTU mode.
ASCII communication	Half-duplex protocol to a device.
Dedicated functions	• 1 fast counter • 3 PLS/PWM outputs • 1 PWM/analog input • 1 PWM input
Programmable input filter	Input filter time can be changed by configuration. Filtering at 3 m by default, no filtering or 12 ms by configuration.

Feature	Description		
Special inputs	RUN/STOP	Up to 13 discrete inputs	I0.0 to I0.12
	Latching	Up to 4 memorized inputs	I0.0 to I0.3
	Fast counter	10 kHz maximum	-
	Interrupt/catch inputs	4 switch to ground	-
	PWM/analog input	1 configurable input 90-600 Hz	IW0.7
	PWM input	1 PWM input 0.005-15 kHz	IW0.8
Special outputs	Controller status output	1 dedicated status output	Q 0.3
	PLS/PWM	3 PLS/PWM outputs • 2 outputs with a frequency ranging from 10 Hz to 1 kHz	Q0.0 Q0.1
		• 1 output with a frequency ranging from 10 Hz to 5 kHz	Q0.2
	Reverse logic	1 current sinking discrete output working with a reverse logic	Q0.18
Terminal block	70-contact connector.		
Standby mode	Performed using the key switch input. The controller remains on power but no process is executed, there is no communication, no output and no user code execution, the RAM remains alive and the RTC active. In standby mode, the power used by the controller is 310 mA for a 12 V system and 160 mA for a 24 V system.		
Programming port	Programming in Modbus communication with a RS485 port using cable TSX CUSB485, through the PC serial port using cable VW3 A8106 or with Bluetooth.		
Input/output extension	Performed using CANopen communication.		
Calendar function	Performed through an internal process.		
Analog functions	Provided with the base and the CANopen bus.		
Motion functions	Performed through CANopen or Modbus.		
Operator display	Available through Modbus or CANJ1939 buses.		
Application update software	Performed with the TwidoSuite or TwidoAdjust software tools.		

Options

Introduction

This section describes the options compatible with Twido Extreme that can be combined to set up an application.

An example of application set up for mobile vehicles is described in the appendices.

Sensors

The following sensors are compatible with Twido Extreme.

Characteristic	Description
Sensor type	Twido Extreme allows the connection of standard ON/OFF sensors.
Voltage requirements	5 V or 8 V analog sensors are to be used.
Specific input	Twido Extreme PWM (Pulse With Modulation) input is used to connect devices in extremely harsh environments that require proportional information, such as a single axis lever or a joystick.
Specific output	Twido Extreme PWM (Pulse With Modulation) output is used to connect devices in extremely harsh environments that require proportional information, such as hydraulic valves.

NOTE: Sensors are connected by means of standard M12 connectors for Advantys FTB and M12/M8 connectors for Advantys FTM.

Actuators and Relays

Actuators must comply with the following discrete outputs of the controller:

- 1 A: 1 output
- 50 mA: 1 output
- 300 mA: 14 outputs (8 have a 150 V protection limit and 6 have a 85 V protection limit)

NOTE: Actuators are connected by means of standard M12 connectors for Advantys FTB and M12/M8 connectors for Advantys FTM.

To command high power actuators, use:

- Static relays on the PWM output for precise control.
  For example, a PWM output can be used with hydraulic valves that require up to 3 A.
- Normal relays as indicated in the table below:

Reference	Relays
RPF2ABD	Power relay 2 NO/24 VDC

Reference	Relays
RPF2AJD	Power relay 2 NO/12 VDC
RPF2BBD	Power relay 2 CO/24 VDC
RPF2BJD	Power relay 2 CO/12 VDC

Cables and Adapters

The following table lists the optional cables.

Reference	Cables
TWD XCAFJ010	RS485 connection cable equipped with a RJ45 plug and wires at the other end.
FTX CN32..	CANopen bus cables equipped with a M12 plug, the following lengths are available: ● FTX CN3203 for 0.3 m (0.98 ft) ● FTX CN3206 for 0.6 m (1.97 ft) ● FTX CN3210 for 1 m (3.28 ft) ● FTX CN3220 for 2 m (6.56 ft) ● FTX CN3230 for 3 m (9.84 ft) ● FTX CN3250 for 5 m (16.4 ft)
TSX CANCA..	CANopen and CANJ1939 network cable, the following lengths are available: ● TSX CANCA50 for 50 m (164 ft) ● TSX CANCA100 for 100 m (328 ft) ● TSX CANCA300 for 300 m (984 ft)
VW3 A8106	PC to controller programming cable for RS485-RS232 conversion Cable equipped with SUB-D 9 and RJ45 at the other end, 2 m (6.56 ft)
TSX CUSB485	PC to controller programming cable powered by the PC through a USB plug **Note:** Position the rotary switch on 0 (TER - MULTI function).
VW3 A8114	PC to controller Bluetooth Modbus adapter
VW3 A8115	PC Bluetooth USB key

NOTE: For more details on RJ45 plug and Twido Extreme contacts connection see *RS485 Modbus Plug Connection, page 58*

Display Interfaces

Two types of interfaces can be connected to Twido Extreme.

- A control and operations dialog display
  This display communicates with Twido Extreme using the Modbus protocol on a serial link RS485.
  It can be any type of XBT supporting a Modbus protocol, a XBT N or a XBT GT display for example.

ex.: XBT N410

ex.: XBT GT

- A camera
  A camera can be connected to a XBT GT display.

Accessories

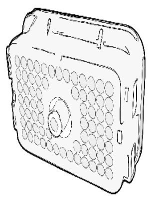
Introduction

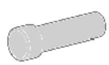
This section describes the Twido Extreme controller accessories and their characteristics.

Twido Extreme can be associated:

- with connector kit (reference TWD FCN K70) that you must assemble,
- with an already mounted IP67 connector (reference TWD FCWK70L015) equipped with a 1.5 m (4.92 ft) long cable.

Connector Kit

<table>
<tr><th>Reference</th><th>Description</th></tr>
<tr><td>TWD FCN K70</td><td>The connector kit includes the following parts:
• A 70-contact connector

• 80 sockets to crimp the wires to the connector

• 80 stoppers

• A protection end bell
</td></tr>
</table>

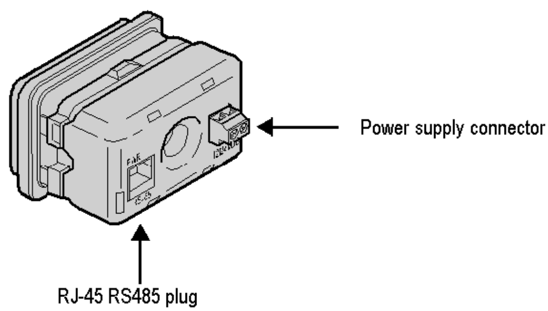
IP67 Mounted Connector

Reference	Description
TWD FCW K70L015	The IP67 connector is already equipped. It includes the 70 contact positions equipped with a 1.5 m (4.92 ft) long cable with free wires at the other end.

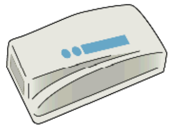
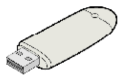
Contact Crimping Tool

Reference	Description
TWD XMT CT	The contact crimping tool to use is the following. 

Programming Connector

Reference	Description
TWD NADK70P	The programming connector has the 2 following plugs: ● a plug for the connector power supply (0-12 VDC or 0-24 VDC) ● a RJ45 plug to connect a serial cable, a USB key or a Bluetooth adapter. 

Bluetooth Dongle

Reference	Description
VW3 A8114	The Bluetooth dongle provides wireless connection for the programming phase. This dongle manages D0 and D1 signal (Tx Rx), the ground and the 5 VDC power supply (D0 signal is connected to contact 5 and D1 signal is connected to contact 4). 
VW3 A8115	The Bluetooth USB key is used for PC not equipped with Bluetooth. 

Mounting Kit

The mounting kit provides compatible mounting parts to mount the controller.

Reference	Description
TWD XMT K4	The mounting kit includes parts for 4 holes: ● 8 shock mounts ● 8 washers ● 4 spacers 4 8 mm (0.31 in) bolts are required for the mounting kit.

Communication Overview

Introduction

Twido Extreme has one serial port used for application management and data animation.

5 types of communications can be used with a Twido Extreme system:

- CANopen fieldbus connection
- CANJ1939 fieldbus connection
- Ethernet Network connection, possible through the Modbus Ethernet box OSITRACK XGS Z33ETH
- Modem connection
- Bluetooth connection

The communication services provide data distribution functions for exchanging data with I/O devices and messaging functions for communicating to external devices.

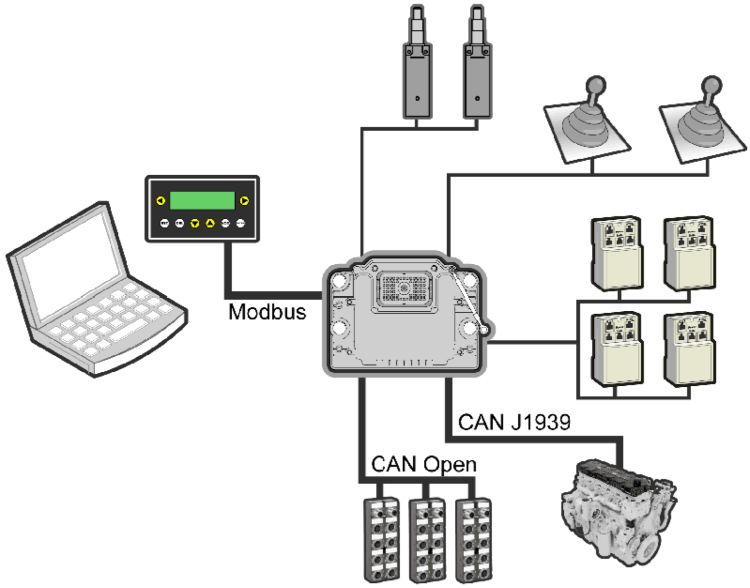
The application management services manage and configure the base through TwidoSuite software.

To provide these services, 2 protocols are available:

- Modbus
  Note that Ethernet communications implement the Modbus TCP/IP protocol.
- ASCII

Communication Architecture

The following illustration gives an overview of the typical architecture including the 3 protocols.



NOTE: The different buses must be configured with the TwidoSuite software.

CANopen Communication

Introduction

This section describes the CANopen communication.

CANopen Capabilities

The Twido Extreme Controller can be connected to a CANopen fieldbus.

The CANopen fieldbus functions in master mode only, with the following characteristics:

- 16 PDOs in emission
- 16 PDOs in reception
- 100 SDOs
- 125 kbits/s, 250 kbits/s and 500 kbits/s transmission speed
- No synchronization mode
- Heartbeat and node guarding supervision mode

On the CANopen bus, the syntax used for exchanged data is as follows:

`IWCx,y,z, QWCx,y,z`

where:

- x represents the channel number,
  - x=1 for the CANopen bus
  - x=0 for the CAN J1939 bus.
- y represents the object number from the object list,
- z represents the sub-object number.

CANopen Fieldbus Description

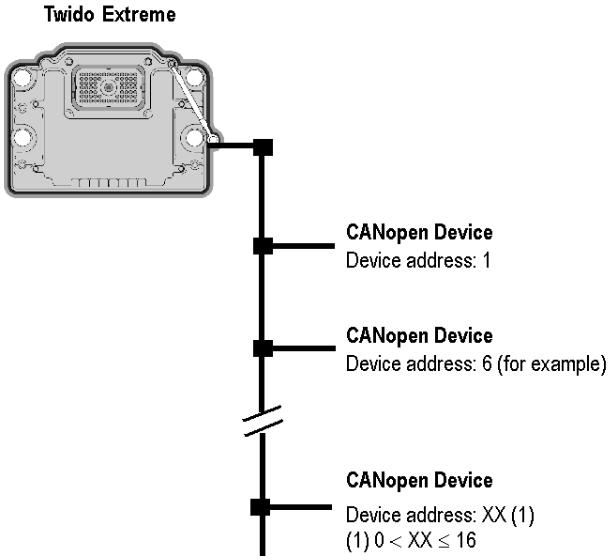
The CANopen architecture of a Twido Extreme system consists of:

- Twido Extreme controller as master port,
- Up to 16 CANopen PDOs exchanged on the bus, with addresses ranging from 1 to 16.

NOTE: The baud rate of the bus depends on its length and on the cable type used. See "Cable Length and Transmission Speed" in the Communication Guide.

CANopen Fieldbus Topology

The following figure shows the Twido CANopen fieldbus topology:



Communication Interface

The communication interfaces are Advantys FTB and FTM distributed I/Os.

The TwidoSuite software provides the CANopen configuration tool necessary to setup the CANopen bus.

ATV Drives Interface

The Twido Extreme Controller manages the ATV CANopen drives family to allow control of powerful engines.

The drives can be configured with TwidoSuite.

CANJ1939 Communication

Introduction

Twido Extreme is designed to provide direct communication with devices such as engines, using the CANJ1939 protocol particularly defined to allow the interconnection of different devices on the same bus.

When the CANJ1939 bus is configured using TwidoSuite programming software, the controller executes communication exchanges.

On the CANJ1939 bus, the syntax used for exchanged data is as follows:

`IWCx,y,z, QWCx,y,z`

where:

- x represents the channel number,
  - x=1 for the CANopen bus
  - x=0 for the CAN J1939 bus.
- y represents the object number from the object list,
- z represents the sub-object number.

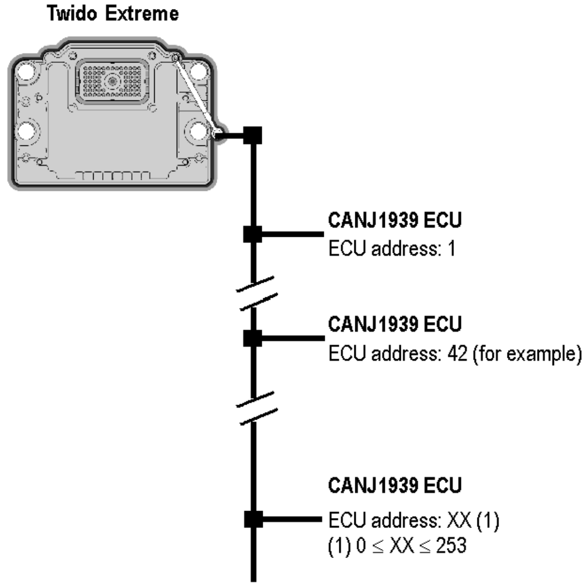
CANJ1939 Fieldbus Connection

The CANJ1939 architecture of a Twido Extreme system consists of:

- A Twido Extreme controller,
- A CANJ1939 fieldbus port installed on Twido Extreme controller,
- Up to 32 CANJ1939 objects exchanged on the bus, with addresses ranging from 0 to 253.

CANJ1939 Fieldbus Topology

The following figure shows the Twido CANJ1939 fieldbus topology:



Modbus RTU and ASCII Communication

Introduction

The Modbus RTU and ASCII protocols are used for:

- programming Twido Extreme with the TwidoSuite available on a PC (with a modem or a Bluetooth connection),
- operating Twido Extreme using the display interface.

Programming Protocols Characteristics

The programming protocol uses a RS485 line and RS485 half duplex terminal port.

It is based on Modbus at 19200 bauds, no parity and 1 stop bit.

To use a protocol other than the programming protocol on the controller serial RS485 port (to use ASCII for example), you must apply 0 V to contact 22 (DPT) on the connector.

The ASCII and RTU Modbus characteristics are as follows:

Characteristics	Modbus and ASCII Value
Speed	1200 to 38400 bauds
Parity	None, odd or even
Stop Bit	1 or 2
Data Bits	7 (ASCII) or 8 (RTU)

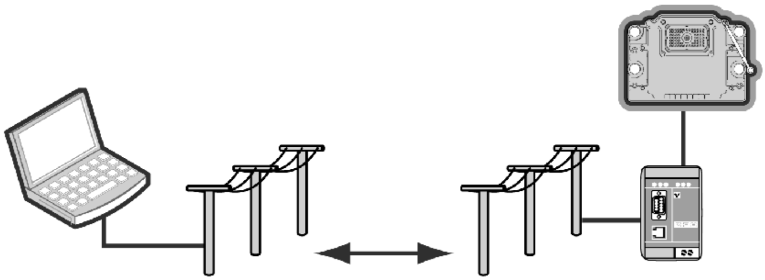
Communication with a PC

A PC executing TwidoSuite can be connected to a Twido controller to transfer applications, animate objects and execute operator mode commands.

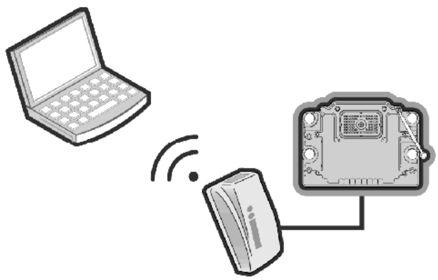
Note that it is also possible to connect a Twido controller to other devices, such as another Twido controller to establish communication with the application process.

The 2 following modes enable the communication between Twido Extreme and the programming suite on a PC:

- Communication with a modem

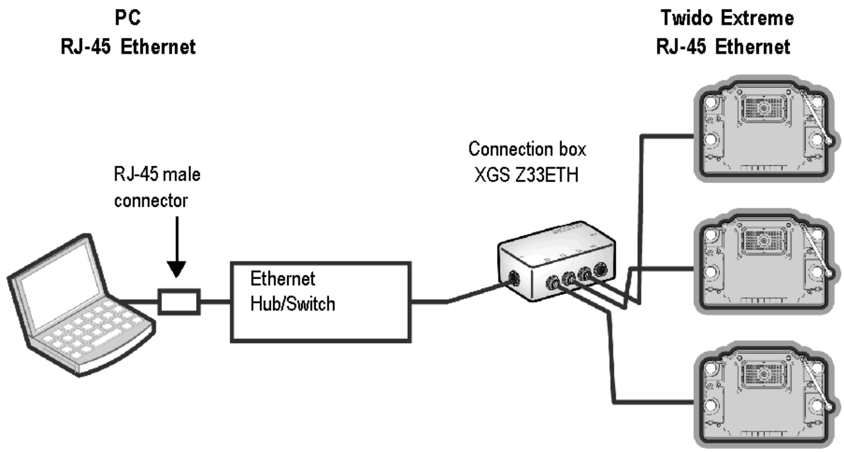


- Communication with a Bluetooth dongle



Ethernet Network Connection

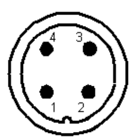
It is possible to connect up to 3 Twido Extreme Controllers on an Ethernet network using the connection box XGS Z33ETH.



NOTE: The PC running the TwidoSuite application must be Ethernet-capable.

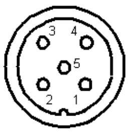
To set up an application with a connection box (XGS Z33ETH for example), use the wires as recommended down below.

Power supply connection using the XGS Z33ETH connection box.

Description		
Male M12 4-contact connector 	**Contact number**	**Signal**
	1	24 VDC
	2	24 VDC
	3	V -
	4	V -
	Connector Wrap	Shielding
Power supply cable 		

NOTE: The connection must be made using a shielded cable with the strands connected to the chassis.

RS485 wiring information for Modbus and ASCII protocols using the XGS Z33ETH connection box

<table>
<tr><th colspan="3">Description</th></tr>
<tr><td rowspan="7">Female M12 5-contact connector for Modbus OUT wiring

</td><td>Contact number</td><td>Signal</td></tr>
<tr><td>1 NC</td><td>Drain (1)</td></tr>
<tr><td>2 NC</td><td>24 VDC (1)</td></tr>
<tr><td>3</td><td>0V/MODBUS-GND</td></tr>
<tr><td>4</td><td>D0</td></tr>
<tr><td>5</td><td>D1</td></tr>
<tr><td>Connector Wrap</td><td>Shielding</td></tr>
<tr><td colspan="3">(1)
Any other network equipment, supplied with connection box XGS Z33ETH can be powered on 24VDC by connecting contacts 1 and 2.
Connecting contact 1 and 2 when the connector power supply is 12 VDC will result in equipment damages.</td></tr>
<tr><td colspan="3">Shielded cable, M12 female 5 contacts with wires for Modbus OUT connection
</td></tr>
</table>

NOTE: To force the use of the modbus port configuration in the application, apply 0 V to contact 22 (DPT signal) on the connector. Thus you can handle other addresses than adress 1 (default address if the contact 22 (DPT signal) is not connected).

Installation

2

Introduction

This chapter provides installation safety information, installation and mounting instructions for the Twido Extreme Controller and its options.

What's in this Chapter?

This chapter contains the following topics:

Power Supply Requirements

Introduction

This section gives the voltage and current information required for a correct use of the controller and of the associated sensors.

Controller Power Supply Requirements

The controller must comply with the following electric requirements:

Power	Requirements
Power supply voltage	from 9 VDC to 32 VDC
Power supply voltage in standby mode	310 mA for a 12 V system and 160 mA for a 24 V system
Battery voltage	12 VDC or 24 VDC: • For a 12 VDC battery, ranging from 9 to 16VDC (%Q0.10 to %Q0.17 are available for power supply 9 to 16VDC) • For a 24 VDC battery, ranging from 18 to 32VDC

The voltages listed below are the steady state voltage ranges required between the +Battery and –Battery input contacts on the controller, whatever the temperature is:

Description	Symbol	Limit for a 12 V System	Limit for a 24 V System
Normal operating voltage range The controller operates in normal conditions and during cranking.	V_{op}	minimum: 9 V maximum: 16 V	minimum: 18 V maximum: 32 V
Non-operating voltage range The controller does not need to boot or to function with the vehicle battery voltage. The voltage level depends on the system voltage (12 V or 24 V).	V_{nop}	minimum: -32 V 24 V maximum: 9 V	minimum: -32 V 48 V maximum: 18 V
Non-destructive voltage range The controller must not be damaged when exposed to any voltage for up to two minutes at 25° C (77° F). The voltage level depends on the system voltage (12 V or 24 V).	V_{nd}	minimum: -32 V maximum: 24 V	minimum: -32 V maximum: 48 V

Reverse Voltage Range

The controller is protected against reverse voltage conditions.

NOTE: The controller does not function if reverse battery voltage is applied.

Sensors Power Supply Requirements

The sensors can either be 5 V or 8 V sensors. They must comply with the following electric requirements:

Description	Symbol	Limits		
		Minimum	**Nominal**	**Maximum**
5 V sensor current output	I_o	-	-	200 mA
5 V sensor voltage output	V_o	4.75 V	5 V	5.25 V
8 V sensor current output	I_o	-	-	70 mA
8 V sensor voltage output	V_o	7.5 V	8.0 V	8.5 V

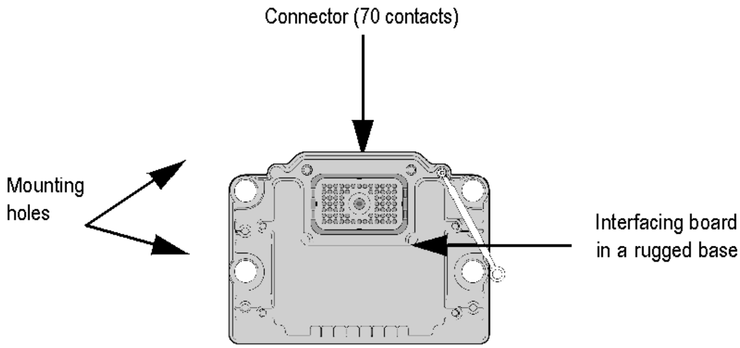
NOTE: Moreover in stanby mode, the %Q0.18 output can be set and then to increase the power supply voltage of the controller.

Twido Extreme Controller Dimensions

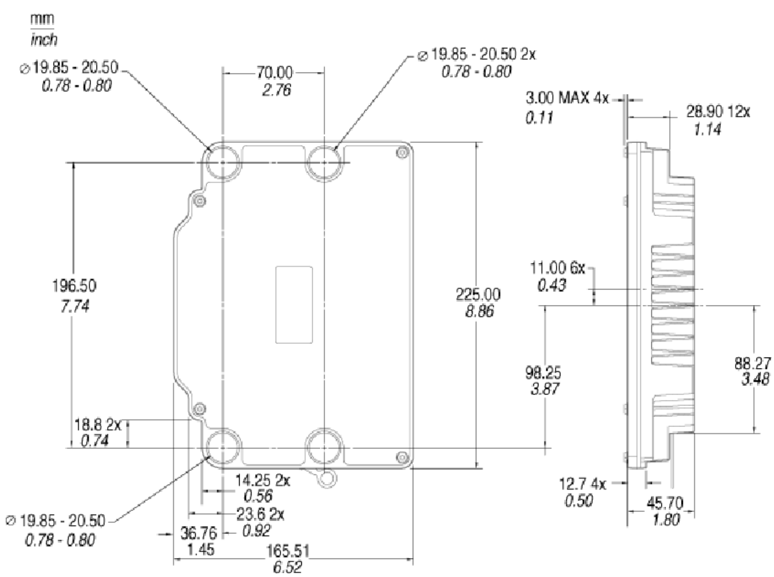
Introduction

This section gives the dimensions of the Twido Extreme Controller.

Base Overview



Base Dimensions



Environment Characteristics

Introduction

This section provides the controller environmental operating conditions.

Environment Conditions

The operating environmental characteristics are as follows:

Characteristic	Description
Operating temperature range	-40° C to +110° C (-40° F to +230° F)
System voltage	12 V and 24 V
Radiated immunity	20 MHz to 2.0 GHz at 30V/m
Storage temperature range	-55° C to +155° C (-67° F to +311° F)
Output shortage tolerance	75% to 133% NSV (Nominal System Voltage)
Input shortage tolerance	Between Input and Batt +/Batt-
Humidity tolerance	112% NSV, 90% relative humidity over operating temperature range
Salt spray tolerance	112% NSV with 5% salt spray for 48 hours at 38° C (100° F)
Chemical splash immunity	Diesel fuel, engine and machine oil, SAE J1455 chemical agents, washer solvent, anti-freeze and degreaser
Vibration (shock isolated components tolerance)	9.45 Grms random vibration from 24-2000 Hz in three orthogonal planes, for six hours per plane
Moisture leakage (sealant pressure tolerance)	+/- 35 kPa (+/- 5.1 psi) against water and water vapor
Electrostatic environment	Zero damage during exposure to electrostatic painting process
Shock resistance	• Vertical Max. acceleration 50 G 10 shock pulses 5 ms • Horizontal Max. acceleration 20 G 10 shock pulses 5 ms

Mounting Instructions

Introduction

This section provides information to mount a Twido Twido Extreme Controller.

It includes safety information and mounting instructions:

- to connect the battery,
- to seal a connector kit,
- to mount Twido Extreme.

Installation Safety Information

⚠ DANGER

RISKS OF ELECTRIC SHOCK

- Turn power off before installing, removing, wiring, or maintaining.
- Do not repair or modify the controller.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines.[1]
- Each implementation of this equipment must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1] For additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems" or their equivalent governing your particular location.

⚠ CAUTION

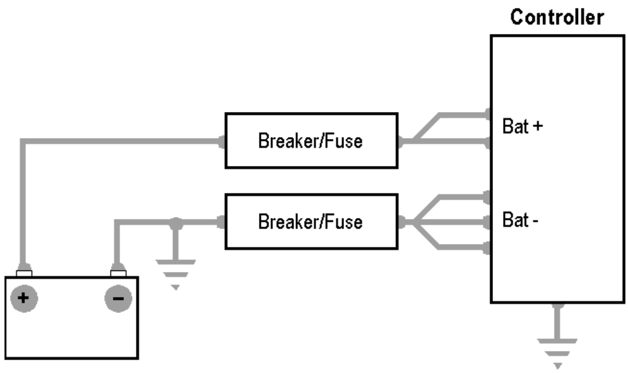
INOPERABLE EQUIPMENT

- Install the controller in the operating environment conditions described.
- Use the sensor power supply only for supplying power to sensors connected to the controller.
- For power line, use a fuse 32V with a maximum of 10 A for the input current and 10 s for fuse/breaker blow time.

Failure to follow these instructions can result in injury or equipment damage.

How to Connect the Battery

The battery must be connected as follows:



⚠ CAUTION

INOPERABLE EQUIPMENT

Ground the Controller as indicated in the figure above and connect the battery to the appropriate contacts on the connector.

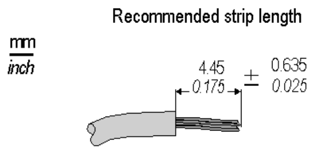
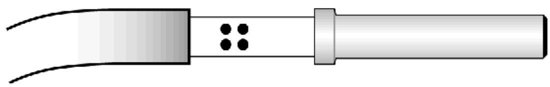
Failure to follow these instructions can result in injury or equipment damage.

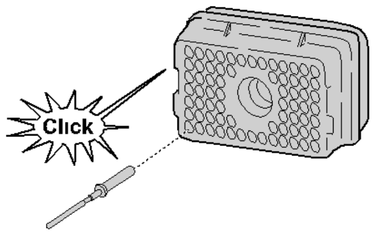
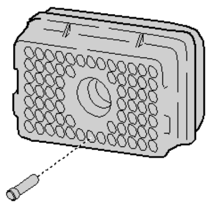
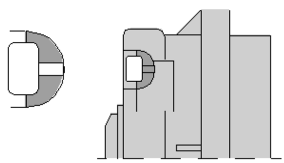
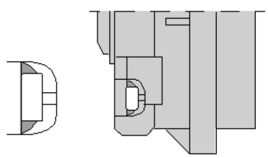
How to Connect the Power Supply

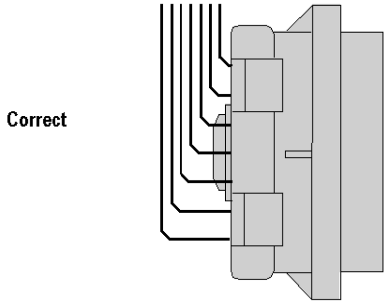
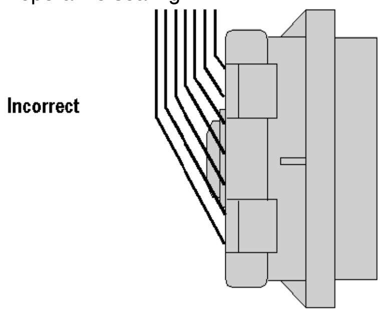
The controller automatically manages the power supply while respecting the voltage and current limits.

How to Seal a Connector Kit

To seal a connector, comply with the following recommendations and instructions.

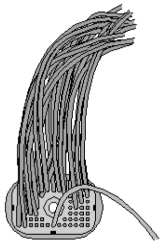
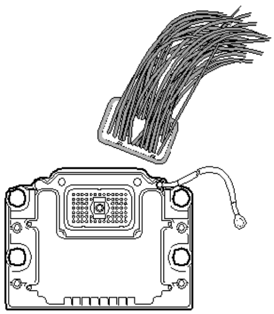
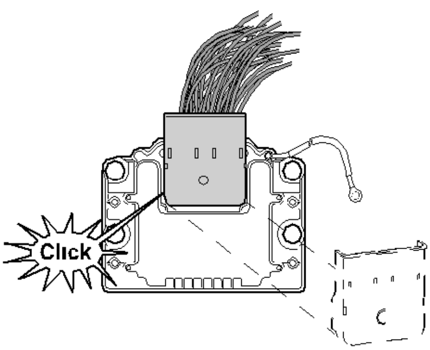
Step	Description
1	Strip the wires following the strip length recommendations indicated in the figure below: 
2	Inspect wire stripping as follows.  Check that: ● All strands are captivated. ● The bare wire strands are extended from the conductor crimp. ● Insulation is spaced from the conductor crimp area. For more information on the crimp dimensions for each contact-wire combination, refer to Wiring Rules *(see page 47)*. Use only the recommended type of socket terminals with the appropriate wire size and check that you secured the socket and the wire into the crimping tool, otherwise, adjust it.
3	Crimp the socket terminals using the connector Allen screw torque. The torque specification for the connector Allen screw is 6 +/- 1 N-m (53 +/-9 lb-in).

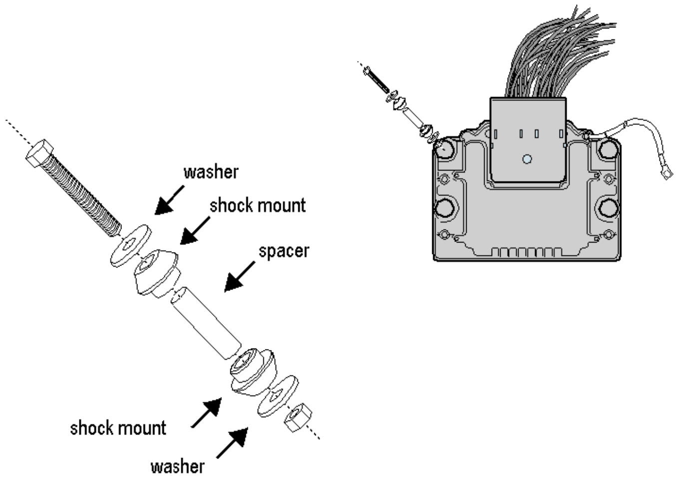
Step	Description
4	Plug all socket terminals that you need in the connectors as indicated in the figure below. Push the socket terminal until to hear a click: 
5	Fill all unused connector socket slots with plugs. Sealing integrity can only be provided with a correct installation of the cavity plugs in unused sockets:  For a correct installation, the plug cap must rest against the seal as indicated in the figure that follows. Correct  Avoid inserting the plug cap in the hole Incorrect 

Step	Description
6	To install the routing harness, check that the connector seals are not stressed as this will cause the harness curve to be too close to the connector. To avoid seal distortion, place the wires perpendicular to the connector with a 90° bend radius curve, as shown in the following figure.  Wires must not bend close to the connector wire seal as they may cause inoperative sealing. 

How to Mount a Twido Extreme Controller

To mount a Twido Extreme controller, proceed as follows.

Step	Description
1	If the connector is a kit to assemble (TWD FCN K70), fix the sockets as indicated in the section above to mount a sealed connector.  Add a cable duct if necessary.
2	Fix the connector into the base.  Fix the bolt at the center of the connector. The torque specification for the mounting bolt is 28 +/- 7 N-m (248 +/- 62 lb-in).
3	Fix the end bell to protect the connector. 

Step	Description
4	Mount the wired base on a panel, fixing the mounting kit components in the 4 holes in the correct order, as indicated in the following figure. 

For more information on the connection of Twido Extreme with other components, refer to Application Example Appendix *(see page 116)*.

Wiring Rules and Recommendations

3

Introduction

This chapter provides wiring rules, recommendations and wiring schematics.

What's in this Chapter?

This chapter contains the following sections:

3.1 Wiring Overview

Introduction

This section gives general information on wiring.

What's in this Section?

This section contains the following topics:

Wiring Rules and Recommendations

Introduction

Several rules must be followed when wiring a controller. Recommendations are provided to help you to comply with the rules.

⚠ DANGER

RISKS OF ELECTRIC SHOCK

Remove all power from all devices before connecting or disconnecting inputs or outputs to any terminal or installing or removing the controller.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines.[1]
- Each implementation of this equipment must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1] For additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems" or their equivalent governing your particular location.

⚠ CAUTION

LOSS OF IP67 RATING

Strictly follow the routing and wiring rules indicated below. Not strictly following these rules can lead to poor seal protection against liquids or damaged wires produced by system vibration.

Failure to follow these instructions can result in injury or equipment damage.

Routing Rules

The rules for harness routing are as follows:

- Clamp a wiring harness to both the controller and the metal support. Clamping reduces vibrations on the wire harness connector and provides routing control to prevent rubbing against other machine components and to limit motion in high vibration areas.
  The only points of contact are clamps and connectors.
- Use insulated P clips for wire harness support, as they are permanent.
- Use preformed bends for any bend beyond the controller clamp point.
- To avoid seal distortion of the wires entering the connector, the wire should exit perpendicular to the connector before curving. The harness bundle should have a bend radius greater than twice the harness diameter. Wires must not bend close to the connector wire seal as they may cause inoperative sealing.
- Unused connector socket slots must be filled with a sealing plug for ensure proper sealing against water/chemicals.

Sockets Rules

The sockets required to mount the connector are provided with the connector kit.

I/O Wiring Rules

Wires must be used with the recommended sockets in the paragraph above.

If the recommended wire is not used, parts may not be correctly sealed, moisture can affect the contacting pins and cause corrosion and/or crosstalk between pins.

The ground lines for I/O signals must be terminated as close to the controller as possible (max length 1m - 3.28ft).

When using auxiliary equipment with a distance longer than 3m (9.84ft) from the PLC, use CAN fieldbus for improved EMC immunity and easier cabling.

It is recommended that you use a connection terminal for the return I/O connections.

Connector Allen Screw Torque Specification

The recommended Allen screw torque is:

Characteristic	Value
Final tightening	6 N/m (53 lb-in)
Tolerance	+/- 1 N/m (+/- 9 lb-in)

Connector Wire Gauge Size

The battery positive and negative connections must be made with a 14 AWG SAE J1128 type GXL wire for stamped and formed terminal and for machined gold socket contacts or 14 AWG GXL. All other connections may be a 16 or 18 AWG SAE J1128 type GXL.

Insulation material is cross-linked polyethylene.

The table below provides insulation diameter range for each gauge.

Wire Gauge (AWG)	Insulation Diameter $(mm)^2$	Insulation Diameter $(in)^2$
14	2.08	0.00327
16	1.31	0.00202
18	0.82	0.00127

Contacts Location on the Connector

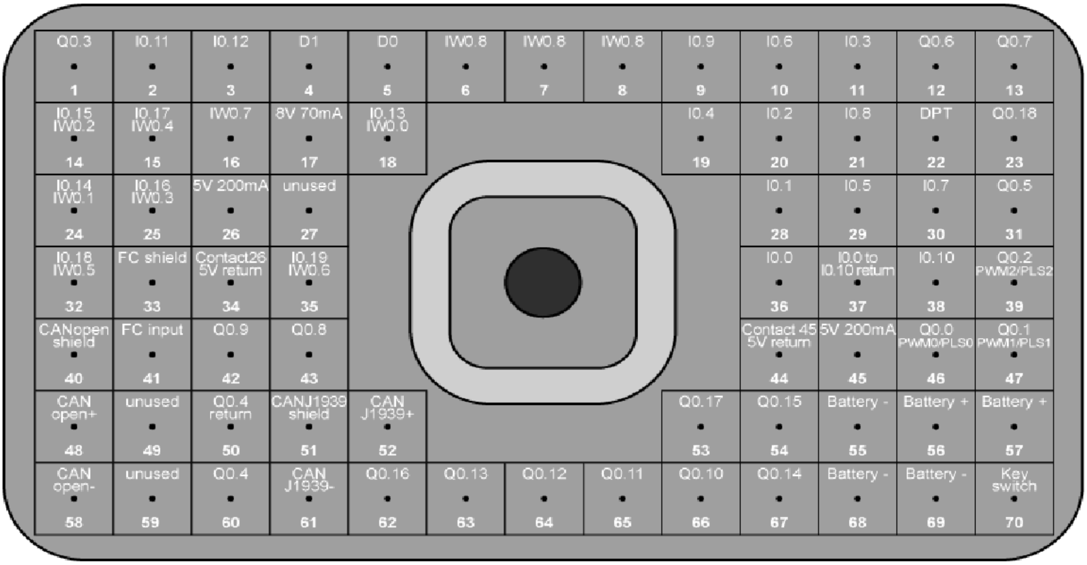
Introduction

Twido Extreme manages 22 inputs and 19 outputs for 24 VDC and 12 VDC systems.

Contact	Types	Number
Inputs	**Key switch input**	Specific input
	Discrete inputs	
	Switch to ground inputs	11
	Switch to battery inputs	2
	Analog inputs	
	Active analog sensor inputs	4
	Passive analog sensor inputs	3
	Active analog/Pulse width modulation input	1
	Pulse width modulation inputs	1
Outputs	**Discrete outputs**	
	1 A discrete output	1
	50 mA discrete output	1
	300 mA discrete outputs	14
	Pulse width modulation/Pulse generator outputs	3

Connectors Location

The following figure illustrates the contacts and their location on the connector.



Inputs and Outputs List Sorted by Type

Introduction

This section lists the contacts according to their type and function.

Inputs/Outputs List

Function	I/O Identifier	Contact Number
Key switch input	Key switch	70
Communication strap	DPT	22
Discrete input 0	I0.0	36
Discrete input 1	I0.1	28
Discrete input 2	I0.2	20
Discrete input 3	I0.3	11
Discrete input 4	I0.4	19
Discrete input 5	I0.5	29
Discrete input 6	I0.6	10
Discrete input 7	I0.7	30
Discrete input 8	I0.8	21
Discrete input 9	I0.9	9
Discrete input 10	I0.10	38
I0.0 to I0.10 return	I0.0 to I0.10 return	37
Discrete input 11	I0.11	2
Discrete input 12	I0.12	3
Analog input 0	I0.13/IW0.0	18
Analog input 1	I0.14/IW0.1	24
Analog input 2	I0.15/IW0.2	14
Analog input 3	I0.16/IW0.3	25
Analog input 4	I0.17/IW0.4	15
Analog input 5	I0.18/IW0.5	32
Analog input 19	I0.19/IW0.6	35
Non configurable active analog sensor/PWM	IW0.7	16
PWM input 1 +	IW0.8	6
PWM input 1 -	IW0.8	7
PWM input 1 shield	IW0.8	8

Function	I/O Identifier	Contact Number
D1	D1	4
D0	D0	5
5 V sensor power supply	5 V 200 mA	26
Contact 26 5 V return	Contact 26 5 V return	34
5 V sensor power supply	5 V 200 mA	45
Contact 45 5 V return	Contact 45 5 V return	44
8 V sensor power supply	8 V 70 mA	17
35 mA discrete sink/source output 0	Q0.0/PWM0/PLS0	46
35 mA discrete sink/source output 1	Q0.1/PWM1/PLS1	47
40 mA discrete sink/source output 2	Q0.2/PWM2/PLS2	39
50 mA discrete source output 3	Q0.3	1
1 A discrete source output 4	Q0.4	60
1 A discrete source output 4 return	1 A RETURN - Q0.4	50
300 mA discrete sink output 5	Q0.5	31
300 mA discrete sink output 6	Q0.6	12
300 mA discrete sink output 7	Q0.7	13
300 mA discrete sink output 8	Q0.8	43
300 mA discrete sink output 9	Q0.9	42
300 mA discrete sink output 10	Q0.10	66
300 mA discrete sink output 11	Q0.11	65
300 mA discrete sink output 12	Q0.12	64
300 mA discrete sink output 13	Q0.13	63
300 mA discrete sink output 14	Q0.14	67
300 mA discrete sink output 15	Q0.15	54
300 mA discrete sink output 16	Q0.16	62
300 mA discrete sink output 17	Q0.17	53
300 mA discrete sink output 18	Q0.18	23
CANopen network shield	CANopen shield	40
CANopen+ network	CANopen+	48
CANopen- network	CANopen-	58
CANJ1939 network shield	CANJ1939 shield	51
CANJ1939+ network	CANJ1939+	52
CANJ1939- network	CANJ1939-	61
Fast counter return	FC Shield	33

Function	I/O Identifier	Contact Number
Fast counter input	Fast counter input	41
Battery+	Battery+	56
Battery+	Battery+	57
Battery-	Battery-	55
Battery-	Battery-	68
Battery-	Battery-	69
Unused	Unused	27
Unused	Unused	49
Unused	Unused	59

Inputs and Outputs List Sorted by Number

Introduction

This section lists the contacts according to their number.

Inputs/Outputs List

Contact Number	Function	I/O Identifier
1	50 mA discrete source output 3	Q0.3
2	Discrete input 11	I0.11
3	Discrete input 12	I0.12
4	D1	D1
5	D0	D0
6	PWM input 1 +	IW0.8
7	PWM input 1 -	IW0.8
8	PWM input 1 shield	IW0.8
9	Discrete input 9	I0.9
10	Discrete input 6	I0.6
11	Discrete input 3	I0.3
12	300 mA discrete sink output 6	Q0.6
13	300 mA discrete sink output 7	Q0.7
14	Analog input 2	I0.15/IW0.2
15	Analog input 4	I0.17/IW0.4
16	Non configurable active analog sensor/PWM	IW0.7
17	8 V sensor power supply	8 V 70 mA
18	Analog input 0	I0.13/IW0.0
19	Discrete input 4	I0.4
20	Discrete input 2	I0.2
21	Discrete input 8	I0.8
22	Communication strap	DPT
23	300 mA discrete sink output 18	Q0.18
24	Analog input 1	I0.14/IW0.1
25	Analog input 3	I0.16/IW0.3
26	5 V sensor power supply	5 V 200 mA
27	Unused	Unused

Contact Number	Function	I/O Identifier
28	Discrete input 1	I0.1
29	Discrete input 5	I0.5
30	Discrete input 7	I0.7
31	300 mA discrete sink output 5	Q0.5
32	Analog input 5	I0.18/IW0.5
33	Fast counter return	FC Shield
34	Contact 26 5 V return	Contact 26 5 V return
35	Analog input 19	I0.19/IW0.6
36	Discrete input 0	I0.0
37	I0.0 to I0.10 return	I0.0 to I0.10 return
38	Discrete input 10	I0.10
39	40 mA discrete sink/source output 2	Q0.2/PWM2/PLS2
40	CANopen network shield	CANopen shield
41	Fast counter input	Fast counter input
42	300 mA discrete sink output 9	Q0.9
43	300 mA discrete sink output 8	Q0.8
44	Contact 45 5 V return	Contact 45 5 V return
45	5 V sensor power supply	5 V 200 mA
46	35 mA discrete sink/source output 0	Q0.0/PWM0/PLS0
47	35 mA discrete sink/source output 1	Q0.1/PWM1/PLS1
48	CANopen+ network	CANopen+
49	Unused	Unused
50	1 A discrete source output 4 return	1 A RETURN - Q0.4
51	CANJ1939 network shield	CANJ1939 shield
52	CANJ1939+ network	CANJ1939+
53	300 mA discrete sink output 17	Q0.17
54	300 mA discrete sink output 15	Q0.15
55	Battery-	Battery-
56	Battery+	Battery+
57	Battery+	Battery+
58	CANopen- network	CANopen-
59	Unused	Unused
60	1 A discrete source output 4	Q0.4
61	CANJ1939- network	CANJ1939-

Contact Number	Function	I/O Identifier
62	300 mA discrete sink output 16	Q0.16
63	300 mA discrete sink output 13	Q0.13
64	300 mA discrete sink output 12	Q0.12
65	300 mA discrete sink output 11	Q0.11
66	300 mA discrete sink output 10	Q0.10
67	300 mA discrete sink output 14	Q0.14
68	Battery-	Battery-
69	Battery-	Battery-
70	Key switch input	Key switch

RS485 Modbus Connection

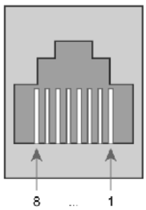
Introduction

This section indicates how to connect the 70 contact connector on Schneider standard Modbus RJ45 plugs.

RS485 Modbus Plug Description

The connection is possible using the RJ45 plug with a RS232/RS485 converter described hereafter.

The RJ45 plug is as follows:



RS485 Modbus Plug Connection

The following table describes the RJ45 plug and the Twido Extreme contacts to which it must be connected.

RJ45 Plug Contact Number	RJ45 Plug Contact Description	Corresponding Twido Contact
1	DPT	22
2	NC	
3	NC	
4	D1	4
5	D0	5
6	NC	
7	+5 V	26 (45)
8	0 V	34 (44)

NOTE: For more cable and adapter references, see *Cables and Adapters, page 17*

NOTE: The connection must be made using a shielded cable with the strands connected to the chassis.

Network Wiring

Introduction

The controller is equipped with the following buses:

- 2 CAN buses (CANopen and CANJ1939) with a 10 kΩ slope control resistor
- 1 Modbus network

CAN network locations on the connector are as follows.

Function	Contact number
CANopen+	**48**
CANopen-	58
CAN_GND	55
CANopen shield	40
CANJ1939+	52
CANJ1939-	61
CANJ1939 shield	51

CANopen Network Specifications

CANopen is designed with 120 Ω termination resistor.

To set up a network, it is recommended to use Schneider CANopen cable:
TSX CANCA50 for a 50 m (164 ft) cable, TSX CANCA100 for 100 m (328 ft) and TSX CANCA300 for 300 m (984 ft).

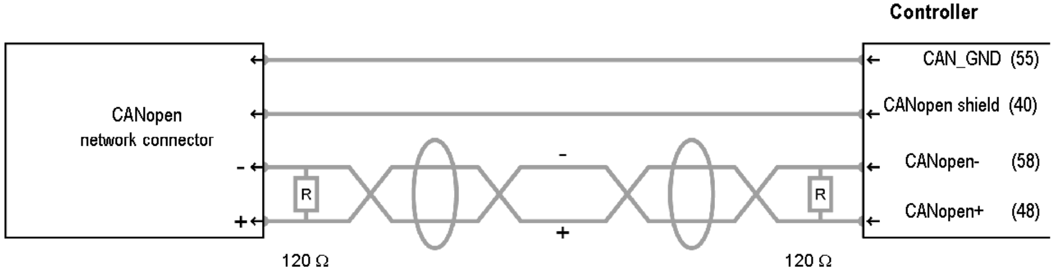
The CANopen bus can communicate at a maximum bit rate of 500 kbit/s.

An external120 Ω terminating resistor is required for CAN connection next to the controller (see the figure down below).Another terminating resistor is required at the opposite end of the CANopen cable.

NOTE: The CAN_GND wire must be connected to the BAT- controller contact.

The high-speed connection for this interface is controlled by software.

CANopen Wiring Example



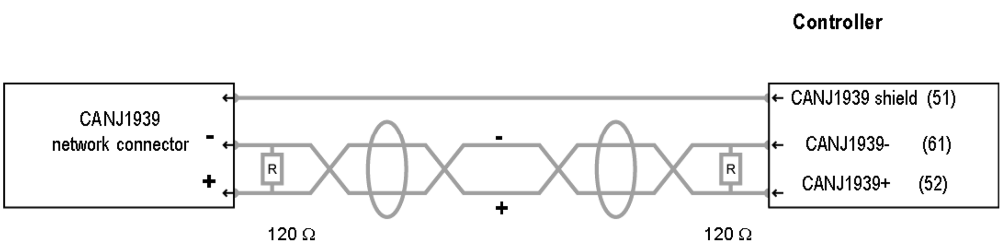
CANJ1939 Network Specifications

CANJ1939 must have a twisted cable complying with SAE J1939-11 or J1939-15 wiring standards. It is recommended to use Schneider CANopen cable:
TSX CANCA50 for a 50 m (164 ft) cable, TSX CANCA100 for 100 m (328 ft) and TSX CANCA300 for 300 m (984 ft).

The SAE J1939 CAN bus operates at 250 kbit/s.

It requires an external terminating resistor pair to work properly. This bus has a dedicated AC-coupled shielding connection. Any twisted cable that meets SAE J1939-11 or J1939-15 can be used with this bus.

CANJ1939 Wiring Example



Modbus Network

The Modbus network is used for programming and operating.

It has the following wiring specifications:

Characteristics	**Limit**
Wire (unshielded-Twisted Pair)	16 or 18 AWG
Twist	0.33 to 1 Twist/inch
Wire capacitance	22 pF/foot
Max total length (total cable length of bus including stubs)	100 Ft (30.5 m)
Operational temperature	-40° C to +105° C (-40° F to +221° F)
+ Network line load to ground	5 kΩ
- Network line load to ground	1 kΩ

Inputs and Outputs Special Functions

Introduction

This section provides information on inputs and outputs dedicated to special functions.

Turning the Controller ON/OFF

Twido Extreme has no internal battery. The key switch input is used to turn the controller ON and OFF.

- When the key switch is turned ON, the controller applies standard operating modes.
  When the key switch is turned ON for a restart, the controller starts, calculates the checksum and restarts on WARM start if the checksum is equal to the value calculated when it was turned OFF or it executes a cold start.
- When the key switch is turned OFF, the controller runs the run time clock update, executes a checksum of the RAM and turns off the micro-controller.
  Note that if the controller is in a RUN state, it remains in the RUN state without executing the code.

For detailed information, see *Key Switch Input, page 68*.

RUN/STOP Input

The RUN/STOP input is a special function that can be assigned to one of the controller 13 first inputs. This function is used to start or to stop a program.

At power up, if configured, the controller state is set by the RUN/STOP input:

- if RUN/STOP input is at state 0, the controller is in STOP mode.
- if RUN/STOP input is at state 1, the controller is in RUN mode.

While the controller is powered, a rising edge on the RUN/STOP input state sets the controller to RUN.

The controller is stopped if the RUN/STOP input is set to 0.

If the RUN/STOP input is set to 0, the controller ignores any RUN command from a connected PC.

The optional status output gives the result of the state transition.

Status Output

The controller status output is a special function assigned to Q0.3.

At power up, the controller status output is set to 1 if the controller is in RUN mode without errors.

This function can be used in circuits external to the controller to control, for example, the power supply to the output devices.

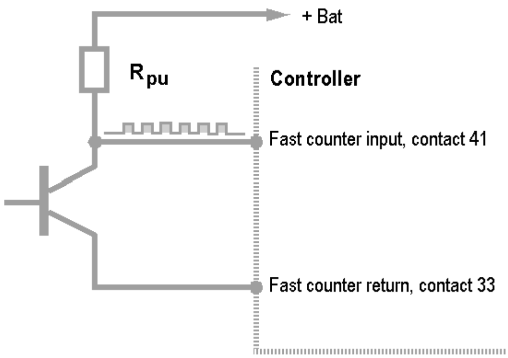
For detailed information, see *50 mA Discrete Output, page 87*

Fast Counting

The extreme base controller has 1 fast counter including a single up and down counter function with a maximum frequency of 10 kHz.

The single up and single down counter functions enable up-counting or down-counting of pulses (rising edges) on a digital I/O. These functions enable counting of pulses from 0 to 65535 in single-word mode and from 0 to 4294967295 in double-word mode.

Example of fast counter wiring



Fast Counting input electrical requirements are as follows.

Symbol	Description	Limits		
		Minimum	Nominal	Maximum
V_{IL}	Input low voltage (single-ended)			1 V
V_{IH}	Input high voltage (single-ended)	4 V		
R_L	Sensor resistance	60 Ω		1950 Ω
	Low pass cutoff filter			4000 Hz
f_{IN}	Input frequency range	50 Hz ± 0.5 Hz		10 kHz
H_L	Sensor inductance	40 mH		550 mH
t_d	Single end time delay	20 µs	25 µs	30 µs
Z_{DEL}	Zero crossing output delay	25 µs	35 µs	45 µs

Pulse Width Modulation (PWM) Outputs

The PWM is a special function that can be assigned to 3 outputs (Q0.0, Q0.1 or Q0.2).

A user-defined function block generates a signal on output Q0.0, Q0.1 or Q0.2. This signal has a constant period with the possibility of varying the duty cycle.

PWM outputs can be used in hydraulic mode to handle proportional valves

The controller supports 3 PWM generators in single-word and double-word functions.

NOTE: IW0.7 and IW0.8 are PWM inputs.

Pulse (PLS) Generator Outputs

The PLS is a special function that can be assigned to 3 outputs (Q0.0, Q0.1 or Q0.2).

A user-defined function block generates a signal on output Q0.0, Q0.1 or Q0.2. This signal has a variable period and a constant duty cycle

The controller supports 3 PLS generators in single-word and double-word functions.

3.2 Inputs Description

Introduction

This section provides detailed information on the inputs: their features, the electrical requirements and the connection.

What's in this Section?

This section contains the following topics:

Introduction to Inputs

Overview

The 22 inputs are as follows:

- 13 discrete inputs protected against short circuit
- 7 analog inputs
- 1 analog or PWM input
- 1 PWM input

Discrete Inputs

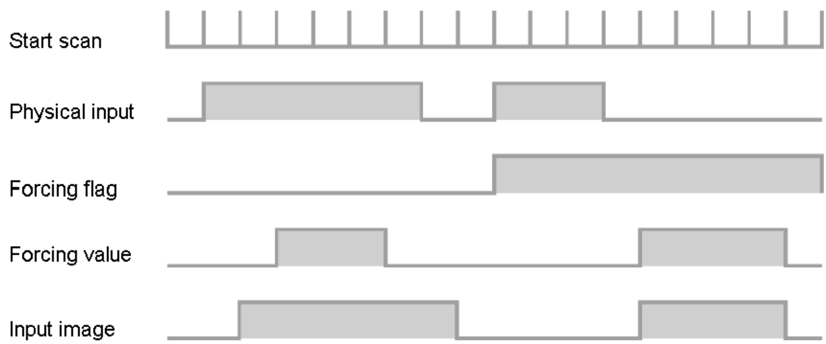
Twido Extreme manages 13 discrete inputs.

The discrete inputs consist of input values, rising edge values and falling edge values. The rising and the falling edge values are computed from an image (i) and the preceding image (i-1) every scan.

The dynamically changing memory images of the inputs and edges are stored in the run-time input object.

There are 2 types of discrete inputs:
- Switch to ground input (source)
- Switch to battery input (sink)

Discrete inputs can have the following 3 programmable states:
- **Forcing**
  Forcing allows to update the value of an input. The input is disabled so that its value can be forced.



- **Filtering**
  Filtering allows to reject input noises and chatter in limit switches. All inputs provide a level of input filtering using the hardware. Additional filtering using the software is also configurable through TwidoSuite. Filtering input can be assigned to "No filter, 3ms, 12ms" of the controller 13 first inputs.

- **Latching**
  Latching allows to memorize pulses with a duration inferior to the controller scan time.
  When a pulse is shorter than a scan and has a value greater than or equal to 1 ms, the controller latches the pulse which is then updated in the next scan.
  Latching input can only be enabled for the first 4 inputs (I0.0 to I0.3).

Analog Inputs

Twido Extreme manages 7 analog inputs (0-5 VDC). There are 2 types of analog inputs:

- Active analog sensor inputs
- Passive analog sensor inputs

Analog/PWM Input

Twido Extreme manages 1 input which is either an active analog input or a PWM input.

PWM Input

Twido Extreme manages 1 input used only as a PWM input.

Key Switch Input

Features

The key switch input is used to:

- turn the controller ON and OFF,
- set the controller in standby mode.

NOTE: Power supply must not be turned off to proceed to these operations so that the controller can automatically execute a WARM restart. If power supply is turned off, the controller proceeds to a COLD restart, date and time are not maintained.

The input must be set to1 to start the controller and to 0 to place it in standby mode provided that power supply has not been turned off.

Description

Type	**Discrete**
Number	**1**
Identifier	Key switch
Contact position	70

Electrical Characteristics

Key switch input electrical requirements are as follows.

Symbol	**Description**	**Limits**		
		Minimum	Nominal	Maximum
V_{IN}	Input signal voltage (DC)	-1 V	0 to 32 V	48 V
V_{IL} (1)	Low-level input voltage Logic 0 = V_{IN} inferior or equal to V_{IL}			0.65 V_{BAT}
V_{IH} (1)	High-level input voltage Logic 1 = V_{IN} superior or equal to V_{IH}	0.8 V_{BAT}		
R_{PD}	Pull-down resistance to controller ground	9.5 kΩ	10 kΩ	10.5 kΩ
τ_{SWK_O}	Noise filter time constant at 25° C (77° F), single pole RC type		600 µs	

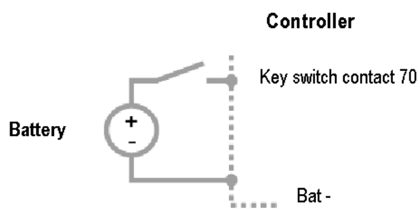
NOTE: (1): Level input is unspecified for voltage between 0.65 V_{BAT} and 0.8 V_{BAT}.

Protection

The key switch input is protected from inductive load fly back current on the machine battery line.

The controller can tolerate a 1 hour short circuit.

Connection Diagram



Switch to Ground Inputs

Features

The switch to ground (source) inputs are discrete inputs.

The return must be connected to the controller discrete ground. This polarity is used for compatibility with existing applications.

Description

Type	**Discrete**
Number	**11**
Identifier	I0.0 to I0.10
Contact position	I0.0 to contact 36 I0.1 to contact 28 I0.2 to contact 20 I0.3 to contact 11 I0.4 to contact 19 I0.5 to contact 29 I0.6 to contact 10 I0.7 to contact 30 I0.8 to contact 21 I0.9 to contact 9 I0.10 to contact 38
Return	Return to contact 37

Electrical Characteristics

Switch to ground input electrical requirements are as follows.

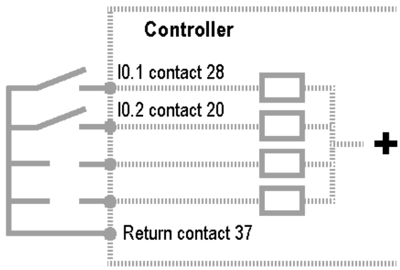
Symbol	**Description**	**Limits**		
		Minimum	Nominal	Maximum
V_{IN}	Input signal voltage (DC)	-1 V	0 to 32 V	32 V
V_{IH}	High-level input voltage Logic 0 = V_{IN} superior or equal to V_{IH}	3.75 V		
V_{IL}	Low-level input voltage Logic 1 = V_{IN} inferior or equal to V_{IL}			0.8 V
R_{PU}	Pull-up resistance to	1.9 kΩ	2 kΩ	2.1 kΩ
τ_{SWG}	Noise filter time constant at 25° C (77° F), single pole RC type	149.8 µs	198.9 µs	248.6 µs

NOTE: [(1)]: Level input is unspecified for voltage between 0.8 V and 3.75 V.

Protection

The controller can tolerate a 1 hour short circuit.

Connection Diagram



Switch to Battery Inputs

Features

The switch to battery (sink) inputs are discrete inputs. They are pulled-down to the controller ground.

There must be 2 switches to +Bat inputs on the controller. This polarity is used for compatibility with existing applications.

Description

Type	**Discrete**
Number	**2**
Identifier	I0.11 and I0.12
Contact position	I0.11 to contact 2 I0.12 to contact 3

Electrical Characteristics

Switch to battery input electrical requirements are as follows.

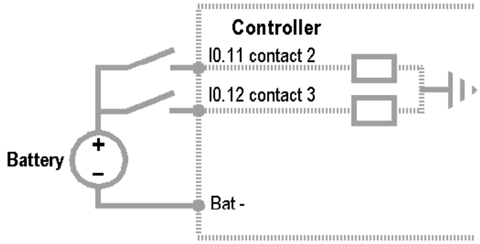
Symbol	**Description**	**Limits**		
		Minimum	Nominal	Maximum
V_{IH} (1)	High-level input voltage Logic 1 = V_{IN} superior or equal to V_{IH}	0.85 V_{BAT}		
V_{IL} (1)	Low-level input voltage Logic 0 = V_{IN} inferior or equal to V_{IL}			0.65 V_{BAT}
V_{IN}	Input signal voltage (DC)	-1 V	0 to 32 V	48 V
R_{PD}	Pull-down resistance to the controller ground	9.5 kΩ	10 kΩ	10.5 kΩ
τ_{SWB}	Noise filter time constant at 25° C (77° F), single pole RC type		600 µs	

NOTE: (1): Level input is unspecified for voltage between 0.65 V_{BAT} and 0.85 V_{BAT}.

Protection

The controller can tolerate a 1 hour short circuit.

Connection Diagram



Active Analog Sensor Inputs

Features

Active sensors use an external power supply to provide measure signals. The sensors behave as active dipoles with a current, tension or load type.

Active sensors function as generators. They are scaled at 1 without adaptation.

The analog to discrete converter takes the controller components obsolescence into account.

These inputs can function as switch to ground (source) inputs, however the noise filter and pull-up values do not meet the switch to ground (source) inputs specifications.

Analog inputs can be used for current sensors (0-20 mA) with a resistor plugged between the common reference point and the input.

Description

Type	**Analog**
Number	**4**
Identifier	IW0.0 to IW0.3
Contact position	IW0.0/I0.13 to contact 18 IW0.1/I0.14 to contact 24 IW0.2/I0.15 to contact 14 IW0.3/I0.16 to contact 25

Electrical Characteristics

Active analog sensor input electrical requirements are as follows.

Symbol	**Description**	**Limits**		
		Minimum	Nominal	Maximum
E_{ADC}	ADC error	0	-	+/- 125 mV
V_{IN}	Input signal voltage (DC)	-1 V	0 V to 5 V	32 V
V_{RD}	Nominal reading voltage range	0 V	-	5 V
V_{PU}	Pull-up voltage	-	13 V	-
R_{PU}	Pull-up resistance, internal at 25°C (77°C)	20.9 kΩ	22 kΩ	23.1 kΩ
τ_{AIN_ACT}	Noise filter time constant at 25°C (77°C), single pole RC type	3.87 ms	5.10 ms	6.43 ms
	Value (QADC) refresh time	-	700 µs	-

Data Characteristics

The application objects are as follows.

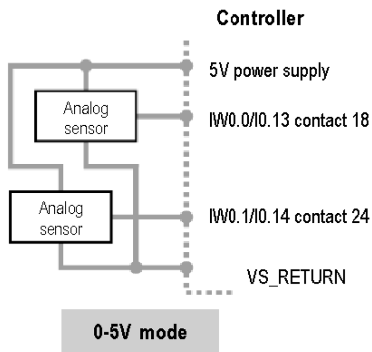
Description	Limits		
	Minimum	Nominal	Maximum
ADC type		10 bits	
ADC bit range	0		5120

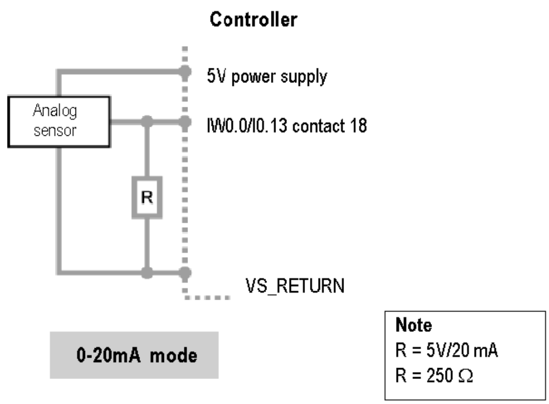
Protection

The controller can tolerate a 1 hour short circuit.

The active analog sensor inputs detect short circuits to battery and ground. They are protected against reverse voltage.

Connection Diagram





Passive Analog Sensor Inputs

Features

Passive sensors take a part of energy of the signal to measure. The sensors behave as passive dipoles which are resistive. The passive sensor must have a load of between 0.018KOhms to 36KOhms that is connected to the input.

They are scaled at 1 without adaptation.

The analog to discrete converter takes the controller components obsolescence into account.

All passive analog sensor inputs are scaled at 1.

These inputs can function as switch to ground (source) inputs, however the noise filter and pull-up values do not meet the switch to ground (source) inputs specifications.

Description

Type	**Analog**
Number	**3**
Identifier	IW0.4 to IW0.6
Contact position	IW0.4/I0.17 to contact 15 IW0.5/I0.18 to contact 32 IW0.6/I0.19 to contact 35

Electrical Characteristics

Passive analog sensor input electrical requirements are as follows.

Symbol	**Description**	**Limits**		
		Minimum	Nominal	Maximum
E_{ADC}	ADC error	0	-	+/- 125 mV
V_{IN}	Input signal voltage (DC)	-1 V	0 V to 5 V	32 V
V_{RD}	Nominal reading voltage range	0 V		5 V
V_{OC}	Open circuit voltage (voltage from pin to ground)	4.75 V	5 V	5.25 V
R_{PU}	Pull-up resistance, internal at 25° C (77° F)	494 Ω	499 Ω	504 Ω
R_L	Sensor output resistance	0.018 kΩ		36kΩ
	Value (QADC) refresh time		700 µs	
	Input impedance		7300 Ω	
τ_{AIN_ACT}	Noise filter time constant at 25° C (77° F), single pole RC type	3.87 ms	5.10 ms	6.43 ms

Data Characteristics

The application objects are as follows.

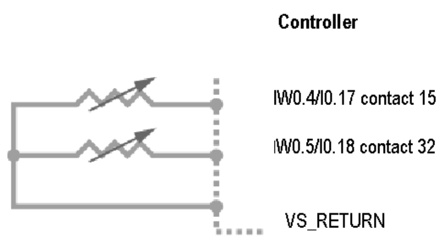
Description	Limits		
	Minimum	Nominal	Maximum
ADC type		10 bits	
ADC bit range	0		5120

Protection

The controller can tolerate a 1 hour short circuit.

The active analog sensor inputs detect short circuits to battery and ground as well as open circuit. They are protected against reverse voltage.

Connection Diagram



$$\text{Resistor} = \frac{((\text{Measure - Configuration min value}) \times 500)}{(\text{Measure Configuration max value - Measure})}$$

Measure represents the value of %IW0.4, %IW0.5,%IW0.6

Configuration min value = 0 by default

Configuration max value = 5120 by default

Analog or PWM Input

Features

This input is either an active analog input or it can be configured as a PWM (pulse width modulation) input.

The channel cannot be both simultaneously.

Description

Type	**Analog or PWM**
Number	**1**
Identifier	IW0.7
Contact position	IW0.7 to contact 16

Electrical Characteristics

Pulse width modulation input electrical requirements are as follows.

Symbol	**Description**	**Limits**		
		Minimum	Nominal	Maximum
E_{ADC}	ADC error	0	-	+/- 125 mV
V_{IN}	Input signal voltage (DC)	-1 V	0 V to 5 V	32 V
V_{PU}	Pull-up voltage		13 V	
V_{RD}	Nominal reading voltage range	0 V		5 V
R_{PU}	Pull-up resistance, internal at 25°C (77° F)	4.8 kΩ	5.1 kΩ	5.4 kΩ
ACC_{PWM}	PWM measurement accuracy	1 %		
D_I	Input PWM duty cycle	5 %		95 %
f_{IN}	Input frequency range	90 Hz		600 Hz
τ_{AIN_ACT}	Active analog input noise filter time constant at 25° C (77° F), single pole RC type	3.87 ms	5.10 ms	6.43 ms
τ_{PWM_I}	PWM noise filter time constant at 25° C (77° F), single pole RC type	50 µs	60 µs	70 µs

Data Characteristics

The application objects are as follows.

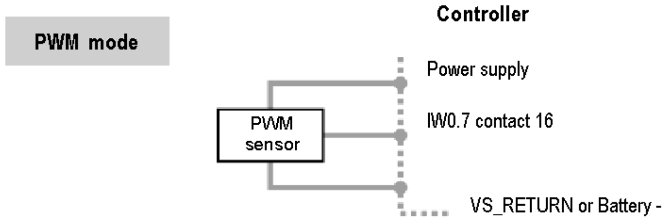
Description	Limits		
	Minimum	Nominal	Maximum
ADC type		10 bits	
ADC bit range	0		5120

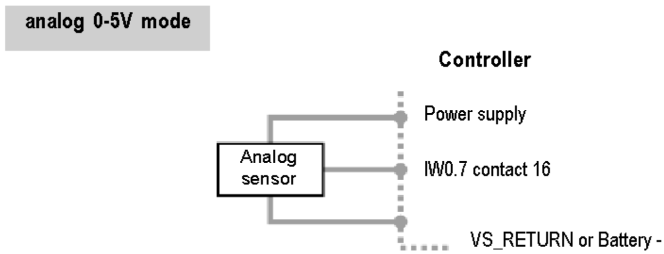
Protection

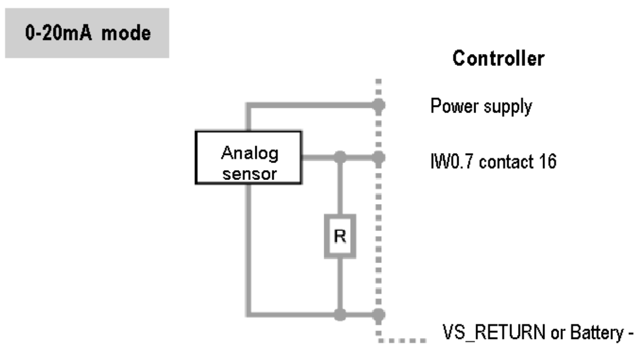
The controller can tolerate a 1 hour short circuit.

The active analog sensor inputs detect short circuits to battery and ground. They are protected against reverse voltage.

Connection Diagram







Note
R = 5V/20 mA
R = 250 Ω

PWM Input

Features

The input described in this section is a PWM input and cannot be assigned to any other function.

Description

Type	**PWM**
Number	**1**
Identifier	IW0.8
Contact position	IW0.8 to contacts 6, 7 or 8 PWM input 1 + to contact 6 PWM input 1 - to contact 7 (not connected in single ended mode) PWM input 1 shield to contact 8

Electrical Characteristics

PWM input electrical requirements are as follows.

Symbol	**Description**		**Limits**		
			Minimum	Nominal	Maximum
V_{IL}	Input low voltage (single-ended)				1 V
V_{IH}	Input high voltage (single-ended)		4 V		
V_{IN}	Input signal voltage (differential)		0.4 V_{P-P}		120 V_{P-P}
R_L	Sensor resistance		60 Ω		1950 Ω
	Low pass cutoff filter				4000 Hz
f_{IN}	Input frequency range		50 Hz ± 0.5 Hz		10 kHz
H_L	Sensor inductance		40 mH		550 mH
PW_{ON}	Input duty cycle		30 %		70 %
t_d	Single end time delay		20 µs	25 µs	30 µs
Z_{DEL}	Zero crossing output delay		25 µs	35 µs	45 µs
	Frequency measure accuracy for signal inferior to 10 KHz				1%
	Duty cycle measure accuracy	signal inferior to 1 KHz			2 %
		signal between 1 KHz and 3 KHz			6 %
		signal between 3 KHz and 5 KHz			10 %

	Pulse width measure accuracy	signal inferior to 1 KHz			2 %
		signal between 1 KHz and 3 KHz			8 %
		signal between 3 KHz and 5 KHz			15 %

NOTE: (1): Level input is unspecified for voltage between 1 V and 4 V.

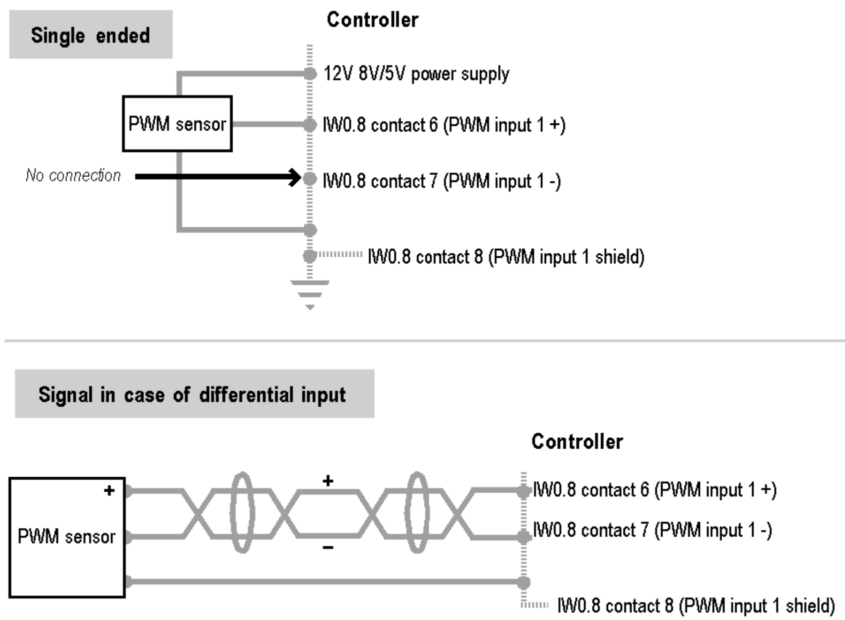
Protection

The controller can tolerate a 1 hour short circuit.

Zero crossing falling edge is triggered.

Maximum 1% frequency distortion is measured between the controller contact to the CPU contact.

Connection Diagram



3.3 Outputs Description

Introduction

This section provides detailed information on the outputs: their features, the electrical requirements and the connection.

What's in this Section?

This section contains the following topics:

Introduction to Outputs

Overview

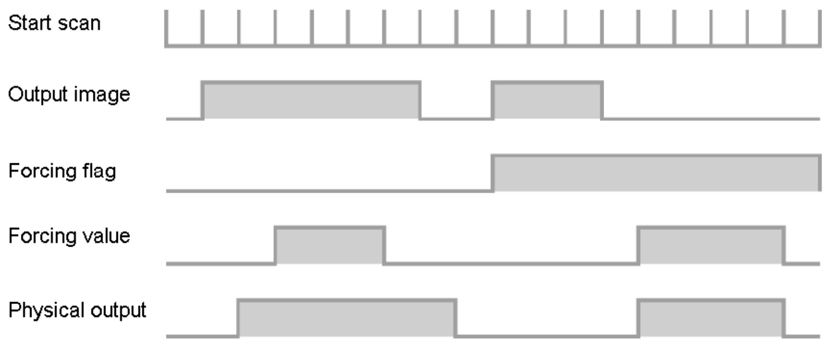
The 19 outputs are as follows:

- 16 discrete outputs protected against short circuit:
  - 1 A driver: 1 output,
  - 50 mA driver: 1 output
  - 300 mA driver: 14 outputs with either a 85 V load dump or a 150 V load dump
- 3 PWM/PLS outputs

Output State

Outputs can have a forcing programmable state.

Forcing allows to update the value of an output. The output is disabled so that its value can be forced.



When unforcing occurs, the value of the bit remains the same as the last forced value until such time as a forcing operation or user logic instruction overwrites that image bit. Output scanning does not happen unless the controller is in a RUN or NO_CONFIG (test) state with no application download started.

The NO_CONFIG state allows wiring tests. To perform wiring tests in a non configured mode, set bit S8 to 0 and use TwidoAdjust to change the output object value. The system copies this value to the physical output. If you set bit S8 to 1, physical outputs will be at 0.

NOTE: Forcing overrides any output except the status output

NOTE: Risks of breaking may occur when the relay coil connected to the controller output opens. To avoid overvoltage, you are recommended to connect a protection module to the relay coil.

1 A Discrete Output

Features

The 1 A discrete current sourcing channel output functions during cranking and load dump.

To use this output, connect the load between the output contact and the 1 A discrete output contact.

Description

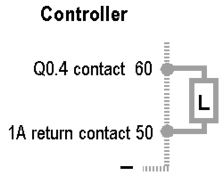
Number	**1**
Identifier	Q0.4
Contact position	Q0.4 to contact 60
Return	Return to contact 50

Electrical Characteristics

The output electrical requirements are as follows.

Symbol	**Description**	**Limits**		
		Minimum	Nominal	Maximum
I_O	Current output			1 A
I_I	Leakage current (24 VBAT)			1 mA
H_L	Load inductance			175 mH
R_L(12V)	Load resistance	0.015 kΩ		5 kΩ
R_L(24V)	Load resistance	0.025 kΩ		5 kΩ
T_{ON}	Turn on delay (propagation delay from CPU command transition to output state transition. Tested with purely resistive load.)		5 ms	
T_{OFF}	Turn off delay (propagation delay from CPU command transition to output state transition. Tested with purely resistive load.)		18 ms	

Connection Diagram



Protection

The 1 A discrete current sourcing output can detect load dumps and short circuits between +battery and ground and can provide protection.

Channel Fault

In case of short to ground fault, the channel is turned off within 2 ms of a valid fault feedback signal.

A new connection attempt will occur every 769 ms. Trying the output connection earlier than specified may damage the channel.

The feedback signal for this is valid 5 ms after the channel is set to ON and 30 ms after the channel is set to OFF.

Load Dump

The 1A discrete current sourcing channel operates through a load dump event, using a 4.27 A expected load dump.

After a the load dump condition, the channel is activated and reset to the state before to the load dump event.

	Supply Voltage 12 V	**Supply Voltage 24 V**
Minimum load resistance	15 Ω	25 Ω
Voltage load dump clamp	64 V	64 V
Current load dump	4.27 A	2.56 A

50 mA Discrete Output

Features

This channel can source at least 50 mA when used with other loads.

To use this output, connect the load between the output contact and the 1 A discrete return.

NOTE: The 50 mA discrete current sourcing channel output is used to set the status feature of the controller.

Description

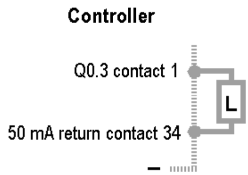
Number	**1**
Identifier	Q0.3
Contact position	Q0.3 to contact 1
Return	return to contact 34

Electrical Characteristics

The output electrical requirements are as follows.

Symbol	**Description**	**Limits**		
		Minimum	Nominal	Maximum
V_O	Voltage output			60 V
V_{OH}	Channel output high	0.55 V_{BAT}		
V_{OL}	Channel output low			0.45 V_{BAT}
I_O	Current output			50 mA
T_{ON}	Turn on delay (propagation delay from CPU command transition to output state transition. Tested with purely resistive load.)		20 μs	
T_{OFF}	Turn off delay (propagation delay from CPU command transition to output state transition. Tested with purely resistive load.)		20 μs	
R_L (12 V)	Load resistance	0.25 kΩ		5 kΩ
R_L (24 V)	Load resistance	0.5 kΩ		7 kΩ

Connection Diagram



Protection

The 50 mA discrete current sourcing channel output can detect load dumps and short circuits between +battery and ground and can provide protection.

Channel Fault

In case of short to ground fault, the channel is turned off within 20 ms of a valid fault feedback signal.

A new connection attempt will occur every 77 ms. Trying the output connection earlier than specified may damage the channel.

Load Dump Conditions

Ignoring the short circuit fault before a load dump allows to check that no erroneous short faults are flagged, if the fault line goes active before the load dump interrupt sets the output as disabled.

The short circuit fault is ignored.

300 mA Discrete Outputs

Features

The 300 mA current sinking discrete channels are available for 12 V and 24 V systems.

NOTE: 6 of the 300 mA outputs have a 85 V protection limit and 8 have a 150 V protection limit.

NOTE: Contact Q0.18 works with a reverse logic. It is activated by default.

NOTE: Contacts Q0.10...Q0.17 are not available for 24 V systems.

Description

Number	**14**
Identifier	Q0.5 to Q0.18
Contact position	Q0.5 to contact 31 Q0.6 to contact 12 Q0.7 to contact 13 Q0.8 to contact 43 Q0.9 to contact 42 Q0.10 to contact 66 Q0.11 to contact 65 Q0.12 to contact 64 Q0.13 to contact 63 Q0.14 to contact 67 Q0.15 to contact 54 Q0.16 to contact 62 Q0.17 to contact 53 Q0.18 to contact 23

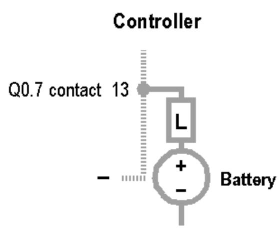
Electrical Characteristics

The output electrical requirements are as follows.

Symbol	**Description**	**Limits**		
		Minimum	Nominal	Maximum
I_L	Leakage current 24 VBAT			1 mA
I_O	Current output			300 mA

R_{LSS}	Steady state load resistance (Resistance for incandescent lamps or other dynamic devices are typically 0.1 RLSS for up to 15 ms. Under these conditions, the channel pulse ON and OFF or current limit until the load reaches the RLSS range.	0.05 kΩ	0.1 kΩ	12 kΩ
T_{ON}	Turn on delay (propagation delay from CPU command transition to output state transition. Tested with purely resistive load.)		20 µs	
T_{OFF}	Turn off Delay (propagation delay from CPU command transition to output state transition. Tested with purely resistive load.)		20 µs	
V_{OL}	Flash frequency			3 Hz

Connection Diagram



Protection

The 300 mA current sinking discrete channel output can detect load dumps and short circuits between +battery and ground and can provide protection.

Channel Fault

The channels have different fault condition characteristics.

Fault conditions for channels Q0.5, Q0.6, Q0.7 and Q0.18

In case of short to battery fault, the channel is turned off within 100 ms of a valid fault feedback signal.

A new connection attempt will occur every 1.5 s. Trying the output connection earlier than specified may damage the channel.

The feedback signal for this channel is valid 100 ms after the channel state changes.

Fault conditions for channels Q0.8 and Q0.9

In case of short to battery fault, the channel is turned off within 10 ms of a valid fault feedback signal.

A new connection attempt will occur every 1.12 s. Trying the output connection earlier than specified may damage the channel.

The feedback signal for this channel is valid 100 ms after the channel state changes.

Fault conditions for channels Q0.10 to Q0.17

In case of a short to battery fault, the channels can go into thermal shutdown.

Disable any shorted channel within 100 ms so that the other channels can continue to operate.

Re-connection to the output after a short has been cleared can be attempted after 100 ms. The number of attempts is limited to 10 per ignition cycle.

Load Dump Conditions

The channels have different load dump condition characteristics.

Load dump conditions for channels Q0.5, Q0.6, Q0.7 and Q0.18

During a load dump condition, channels Q0.5, Q0.6, Q0.7 and Q0.18 are disabled. To allow logging a fault, the short circuit fault is ignored during the load dump event and during 10 ms preceding the event.

Load dump conditions for channels Q0.8 and Q0.9

The outputs must operate through a load dump event. For this, the channel is allowed to sink the expected load dump current of 2.16 A without flagging a fault.

	12 V Supply Voltage	24 V Supply Voltage	Unit
Minimum load resistance	40	80	Ω
Voltage load dump clamp	86.50	150	V
Current load dump	2.163	1.875	A

Load dump conditions for channels Q0.10 to Q0.17

During a load dump condition, the channels must be disabled and the short circuit fault ignored.

NOTE: During a load dump event, the loads connected to the channels depends on a voltage equal to the difference between the 12 V load dump and the 12 V 300 mA channel’s clamp voltage. The channels clamp at 36 V and the 12 V load dump can reach 85 V.

NOTE: Contacts Q0.10...Q0.17 are not available for 24 V systems.

PWM/PLS Outputs

Features

3 outputs can produce a square wave or a pulse wave as follows:

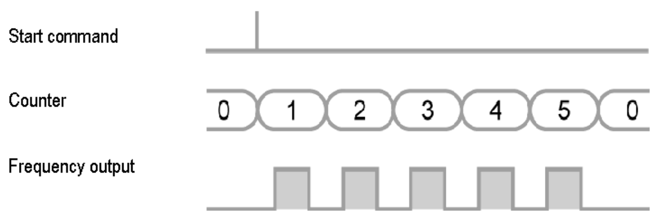
Output	Frequency range	Duty cycle range
Q0.0 and Q0.1	10 Hz to 1 kHz	5% to 95%
Q0.2	10 Hz to 5 kHz	20% to 80%

Used as a PWM function, the output produces a square or a rectangular wave and an undefined pulse number.

PWM Chronogram (with a 50% duty cycle)

Used as a PLS function, the output produces a square wave with a predefined pulse number.

PLS Chronogram



Description

Output number	3
Output name	Q0.0, Q0.1 and Q0.2
Controller contact position	Q0.0 to contact 46 Q0.1 to contact 47 Q0.2 to contact 39

Electrical Characteristics for Q0.0 and Q0.1

The output electrical requirements for Q0.0 and Q0.1 are as follows.

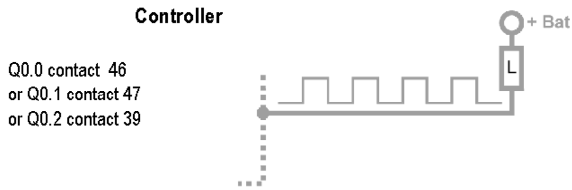
Symbol	Description	Limits		
		Minimum	Nominal	Maximum
	Frequency accuracy		1 %	
	Duty cycle accuracy		2 %*	
V_{OL}	Channel output low (OFF)			1.2 V
V_{OH}	Channel output high (ON)	4.3 V	4.6 V	4.9 V
I_{SI}	Channel sinking current			35 mA
D_O	Channel output duty cycle	5 %		95 %
f_o	Channel output frequency	10 Hz		1000 Hz
R_L (12 V)	Load resistance	0.3 kΩ		
R_L (24 V)	Load resistance	0.7 kΩ		
*maximum of the full scale				

Electrical Characteristics for Q0.2

The output electrical requirements for Q0.2 are as follows.

Symbol	Description		Limits		
			Minimum	Nominal	Maximum
	Frequency accuracy			1 %	
	Duty cycle accuracy	signal inferior to 1 KHz		2 %*	
		signal between 1 KHz and 3 KHz		4 %*	
		signal between 3 KHz and 5 KHz		25 %*	
V_{OL}	Channel output low (OFF)				1.2 V
V_{OH}	Channel output high (ON)		12.3 V	12.6 V	12.9 V
f_O	Channel output frequency		10 Hz		5000 Hz
I_{SI}	Channel sinking current				40 mA
D_O	Channel output duty cycle		20 %		80 %
R_L (12 V)	Load resistance		0.3 kΩ		
R_L (24 V)	Load resistance		0.6 kΩ		
*maximum of the full scale					

Connection Diagram



Channel Fault

For Q0.0 and Q0.1

In case of a short to battery condition, the channel is disabled within 4 ms of valid fault feedback signal. The outputs can be tried again after 10 ms.

Under a short to ground condition, the channel is turned off.

A new connection attempt can occur every 10 ms provided that the driver has been turned off after 4 ms.Trying the output connection earlier than specified may damage the channel.

The feedback signal for this driver is valid 100 s after a change in the driver output state has been required.

For Q0.2

In case of a short to ground fault, the channel is turned off.

A new connection attempt can occur every 65.6 ms. Trying the output connection earlier than specified may damage the channel.

Controller Operation

4

Introduction

This chapter provides information about the controller operating modes.

What's in this Chapter?

This chapter contains the following topics:

Cyclic Scan

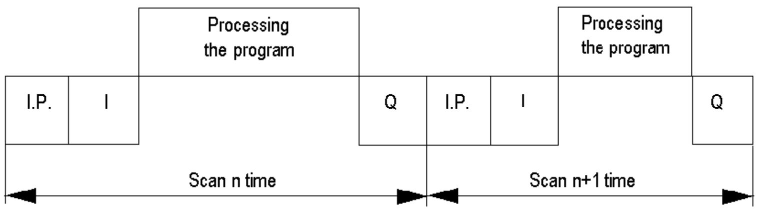
Introduction

Cyclic scanning involves linking controller cycles together one after the other. After having performed an output update (task cycle third phase), the system executes its own tasks and immediately triggers another task cycle.

NOTE: The controller watchdog timer monitors the scan time of the user program. The scan time must not exceed 500 ms otherwise a fault appears and causes the controller to stop immediately in HALT mode. Outputs in this mode are forced to their default fallback state.

Operation

The following diagram shows the running phases of the cyclical scan time.



Cycle Phases Description

The following table describes the phases of a cycle.

Address	Phase	Description
I.P.	Internal processing	The system implicitly monitors the controller (managing system bits and words, updating current timer values, updating status lights, detecting RUN/STOP switches, etc.) and processes requests from TwidoSuite (modifications and animation).
I, IW	Acquiring input	Writing to the memory the status of discrete and application specific module inputs.
-	Program processing	Running the application program written by the user.
Q, QW	Updating outputs	Writing output bits or words associated with discrete and application specific modules.

Operating Modes

Controller in RUN mode

in RUN mode, the processor carries out:

- Internal processing
- Acquiring inputs
- Processing the application program
- Updating outputs

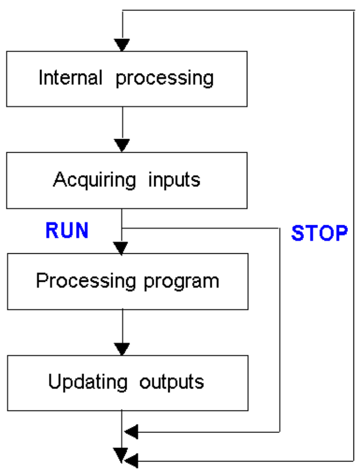
Controller in STOP mode

In STOP mode, the processor carries out:

- Internal processing
- Acquiring inputs

Illustration

The following illustration shows the operating cycles.



Check Cycle

The check cycle is performed by the watchdog.

Periodic Scan

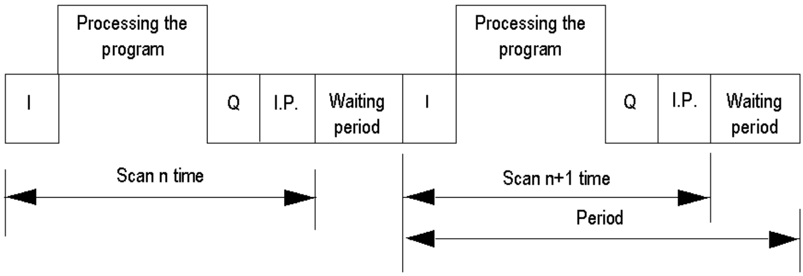
Introduction

In this operating mode, acquiring inputs, processing the application program and updating outputs are done periodically according to the time defined at configuration (from 2-150 ms).

When the controller starts to scan, a timer starts to count down, the value of this timer is initialized at the period defined at configuration. The controller scan must end before the timer has finished and launches a new scan.

Operation

The following diagram shows the running phases of the periodic scan time.



Description of Operating Phases

The table below describes the operating phases.

Address	Phase	Description
I.P.	Internal processing	The system implicitly monitors the controller (managing system bits and words, updating current timer values, updating status lights, detecting RUN/STOP switches, etc.) and processes requests from TwidoSuite (modifications and animation).
I, IW	Acquiring inputs	Writing to the memory the status of discrete and application specific module inputs.
-	Processing program	Running the application program written by the user.
Q, QW	Updating outputs	Writing output bits or words associated with discrete and application specific modules.

Operating Modes

Controller in RUN mode

In RUN mode, the processor carries out:

- Internal processing
- Acquiring inputs
- Processing the application program
- Updating outputs

If the period has not finished, the processor completes the operating cycle until the end of the internal processing period.

If the operating time is longer than the time allocated to the period, the controller sets the system bit S19 to 1 to indicate that the period has been exceeded.The process continues until the end. However, it must not exceed the watchdog time limit.

The next scan starts after writing the outputs of the scan in progress.

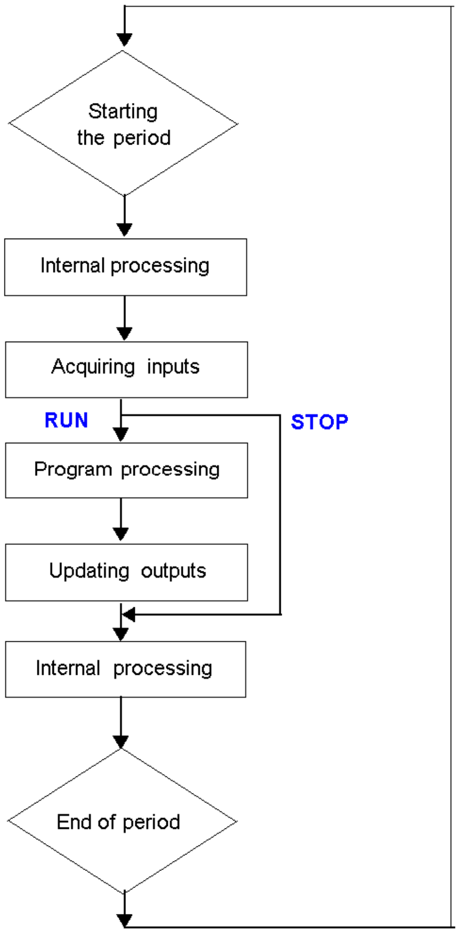
Controller in STOP mode

In STOP mode, the processor carries out:

- Internal processing
- Acquiring inputs

Illustration

The following illustration shows the operating cycles.



Check Cycle

Two checks are carried out:

- Period overflow
- Watchdog

Checking Scan Time

General

The task cycle is monitored by a watchdog timer called Tmax (maximum duration of the task cycle). It indicates the application errors (infinite loops for example) and gives a maximal duration for output refreshing.

Software WatchDog (Periodic or Cyclic Operation)

In periodic or cyclic operation, triggering the watchdog causes a software error. The application goes into a HALT state and sets the system bit S11 to 1. Relaunching the task requires a connection to TwidoSuite in order to:

- analyze the cause of the error,
- modify the application to correct the error,
- reset the program to RUN.

NOTE: The HALT state occurs when the application immediately stops because of an application software error such as a scan overrun. The data retains the current values, which allows for an analysis of the cause of the error. The program stops on the instruction in progress. Communication with the controller is set.

Check on Periodic Operation

In periodic operation, an additional check is used to detect the period that is exceeded:

- **S19** indicates that the period has been exceeded. It is set to:
  - 1 by the system when the scan time is greater that the task period,
  - 0 by the user.
- **SW0** contains the period value (0-150 ms). It is:
  - Initialized when starting from a cold start by the value selected on the configuration,
  - Able to be modified by the user.

Using Master Task Running Time

The following system words are used for information on the controller scan cycle time:

- **SW11** initializes to the maximum watchdog time (10 to 500 ms).
- **SW30** contains the execution time for the last controller scan cycle.
- **SW31** contains the execution time for the longest controller scan cycle since the last cold start.
- **SW32** contains the execution time for the shortest controller scan cycle since the last cold start.

NOTE: The information can also be accessed from the configuration editor.

Operating Modes

Introduction

TwidoSuite is used to take into account the 3 main operating mode groups:
- Checking
- Running or production
- Stopping

Starting through Grafcet

These different operating modes can be obtained either starting from or using the following Grafcet methods:
- Initializing Grafcet
- Presetting steps
- Maintaining a situation
- Freezing charts

Preliminary processing and use of system bits ensure effective operating mode management without complicating and overburdening the user program.

Grafcet System Bits

Use of bits S21, S22 and S23 is reserved for preliminary processing only. These bits are automatically reset by the system. They must be written by Set Instruction **S** only.

The following table provides Grafcet-related system bits:

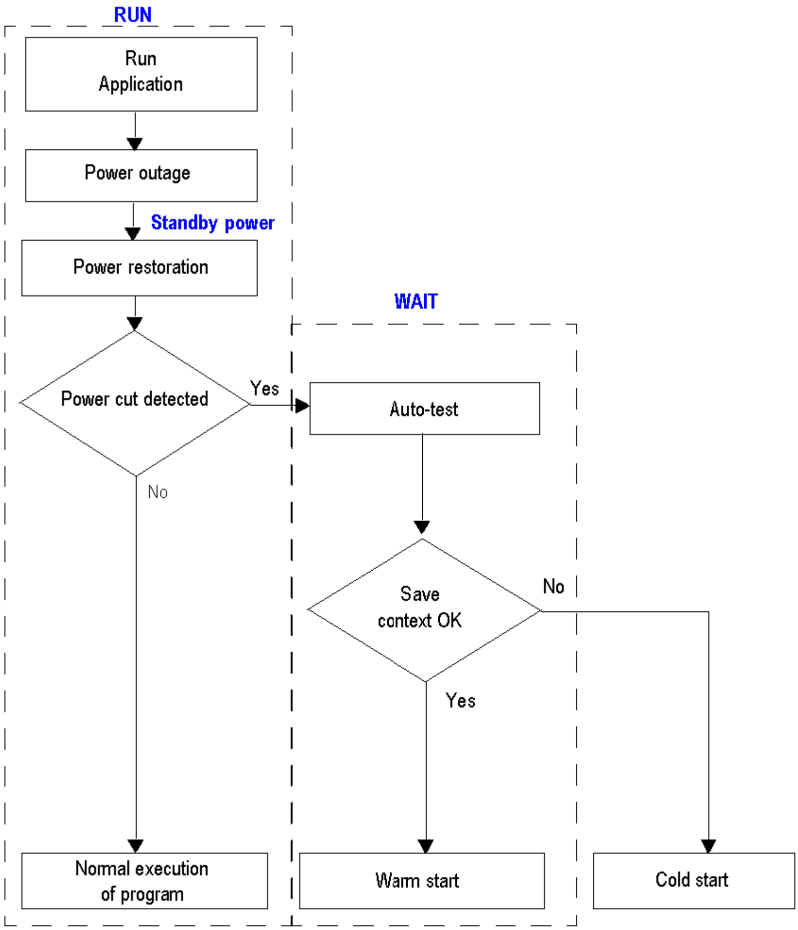
Bit	Function	Description
S21	GRAFCET initialization	Normally set to 0, it is set to 1 by: • A cold-start: **S0=1**. • The user: in the pre-processing program part only, using a Set Instruction **S S21** or a set coil **-(S)-S21**. Consequences: • Deactivation of all active steps. • Activation of all initial steps.
S22	GRAFCET RESET	Normally set to 0, it can only be set to 1 by the program in pre-processing. Consequences: • Deactivation of all active steps. • Scanning of sequential processing stopped.

Bit	Function	Description
S23	Preset and freeze GRAFCET	Normally set to 0, it can only be set to 1 by the program in pre-processing. ● Prepositioning by setting S22 to 1. ● Preposition the steps to be activated by a series of S Xi instructions. ● Enable prepositioning by setting S23 to 1. Freezing a situation: ● In initial situation: by maintaining S21 at 1 by program. ● In an "empty" situation: by maintaining S22 at 1 by program. ● In a situation determined by maintaining S23 at 1.

Dealing with Power Cuts and Power Restoration

Illustration

The following diagram shows the various power restarts detected by the system. The program notices when the power cut lasts less than the power supply filtering time (about 10 ms for an alternating current supply or 1 ms for a direct current supply), it runs normally



RUN/STOP Input Bit Versus Auto Run

The RUN/STOP input bit has priority over the ‘Automatic Start in Run’ option available from the Scan Mode dialog box. If the RUN/STOP bit is set, then the controller will restart in the RUN Mode when power is restored.

The mode of the controller is determined as follows:

Run/Stop Input Bit	Auto Start in Run	Resulting State
Zero	Not configured	Stop
Zero	Configured	Stop
Rising edge	No effect	Run
One	No effect	Run
Not configured in software	Not configured	Stop
Not configured in software	Configured	Run

NOTE: If the controller was in RUN mode when power was interrupted and the "Automatic Start in Run" flag was not set from the Scan Mode dialog box, the controller will restart in STOP mode in case a Cold start is performed.

NOTE: If the key switch is turned off while power is supplied, the controller performs a warm restart.

Operation

The table below describes the processing phases for power cuts.

Phase	Description
1	In case of power cut, the system stores the application context and the time of the power cut.
2	All outputs are set to fallback status (0).
3	When the power is restored, the context saved is compared with the one in progress which defines the type of start to run: • If the application context has changed (loss of system context or new application), the controller initializes the application: COLD restart (systematic for extreme). • If the application context is the same, the controller restarts without initializing data: WARM restart.

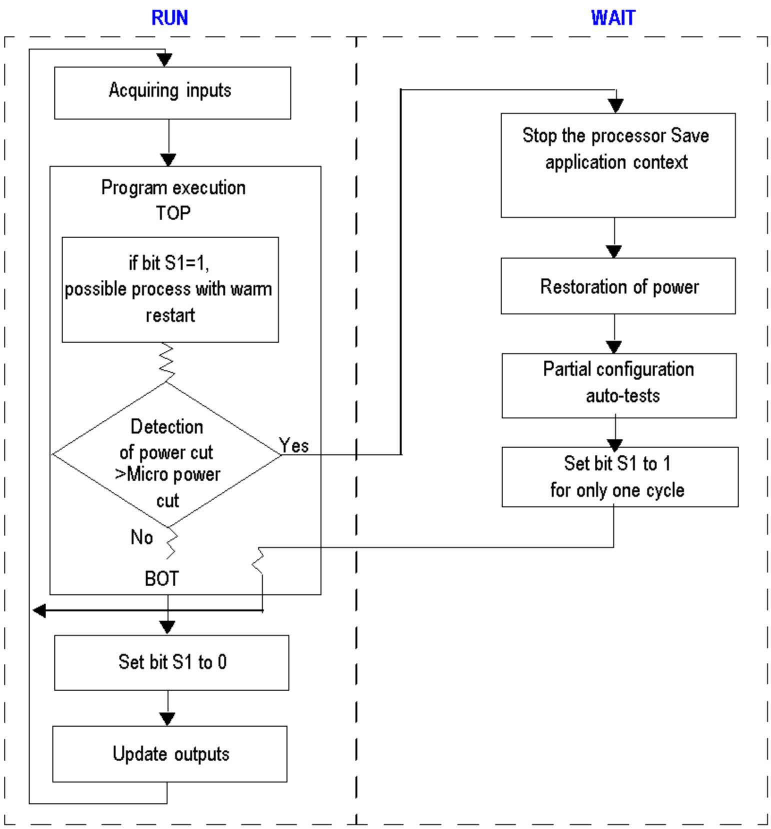
Dealing with a Warm Restart

Cause of a Warm Restart

A warm restart occurs only when the key switch is used while maintaining the power supply on the automate.

Illustration

The drawing below describes a warm restart operation in RUN mode.



Restart of the Program Execution

The table below describes the restart phases for running a program after a warm restart.

Phase	Description
1	The program execution resumes from the same element where it was prior to the power cut, without updating the outputs. **Note:** Only the same element from the user code is restarted. The system code (for example, the updating of outputs) is not restarted.
2	At the end of the restart cycle, the system: ● Unreserves the application if it was reserved. ● Reinitializes the messages.
3	The system carries out a restart cycle in which it: ● Relaunches the task with bits **S1** (warm-start indicator) and **S13** (first cycle in RUN) set to 1. ● Resets bits **S1** and **S13** to 0 at the end of the first task cycle.

Processing of a Warm Start

In the case of a warm start, if a particular application process is required, bit **S1** must be tested at the start of the task cycle, and the corresponding program called up.

Outputs after Power Failure

Once a power outage is detected, the outputs are set to (default) fallback status (0).

When the power is restored, the outputs are in the last state they were until they are updated again by the task.

Dealing with a Cold Start

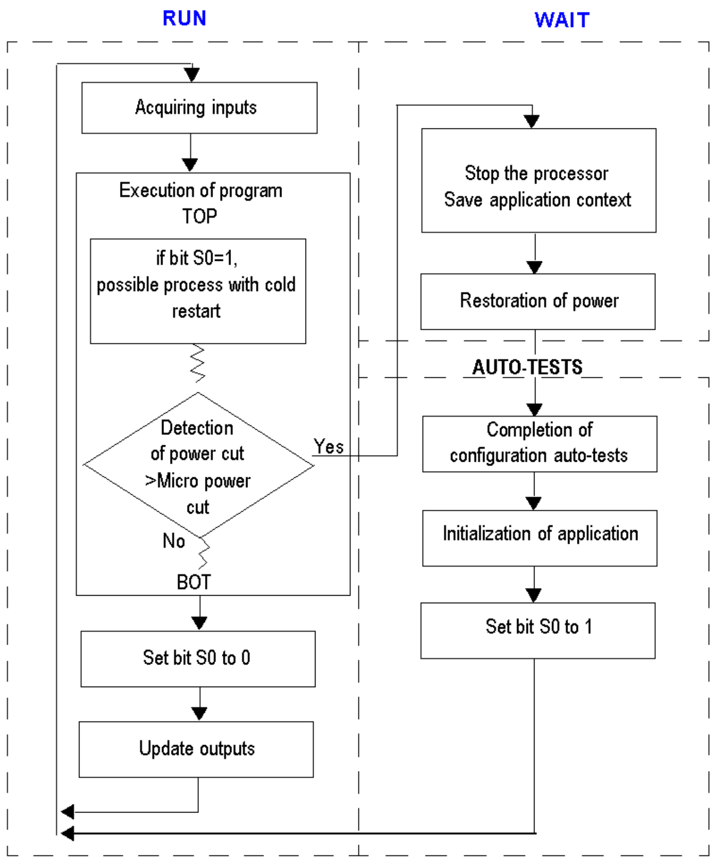
Cause of a Cold Start

A cold-start can occur:

- When loading a new application into RAM
- When power is restored with loss of application context
- When system bit **S0** is set to state 1 by the program
- From the Operator Display when the controller is in STOP mode

Illustration

The diagram below describes a cold restart operation in RUN mode.



Operation

The table below describes the restart phases for running a program after a cold restart.

Phase	Description
1	At start up, the controller is in RUN. At a cold restart after a stop due to an error, the system forces a cold restart. The program execution restarts at the beginning of the cycle.
2	The system: ● Resets internal bits and words and the I/O images to 0. ● Initializes system bits and words. ● Initializes function blocks from configuration data.
3	For this first restart cycle, the system: ● Relaunches the task with bits **S0** (cold-start indicator) and **S13** (first cycle in RUN) set to 1. ● Resets bits **S0** and **S13** to 0 at the end of this first task cycle. ● Sets bits **S31** and **S38** (event control indicators) to their initial state 1. ● Resets bits **S39** (event control indicator) and word **SW48** (counts all events executed except periodic events).

Processing of a Cold Start

In the event of a cold-start, if a particular application process is required, bit **S0** (which is at 1) must be tested during the first cycle of the task.

Outputs after Power Failure

Once a power outage is detected, outputs are set to (default) fallback status (0).

When power is restored, outputs are at zero until they are updated again by the task.

Initialization of objects

Introduction

The controllers can be initialized by TwidoSuite by setting system bits **%S0** (a cold restart) and **%S1** (a warm restart).

Cold Start Initialization

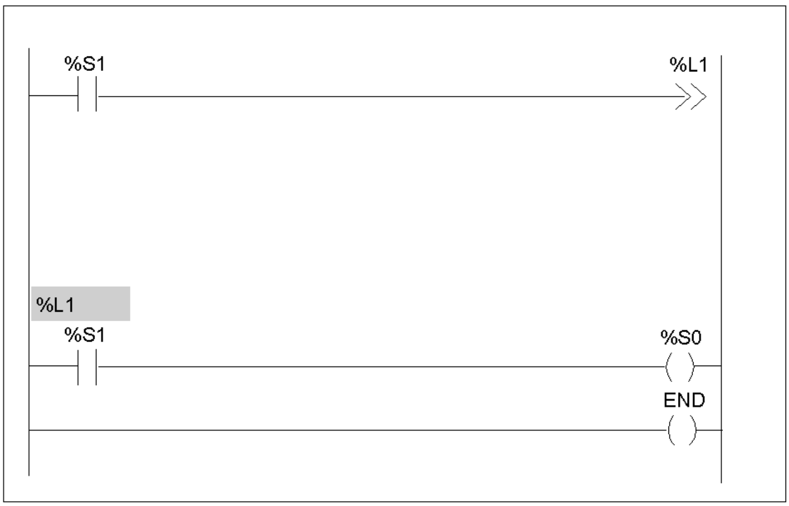
For a cold start initialization, system bit **%S0** must be set to 1.

Initialization of objects (identical to cold start) on power-up using S0 and S1

To initialize objects on power-up, system bit **%S1** and **%S0** must be set to 1.

Ladder Language

The following example shows how to program a warm restart object initialization using system bits.



Instruction List Language

```
 LD %S1
 JMPC %L1
%L1:
 LD %S1
 ST %S0
 END
```

LD %S1 If %S1 = 1 (warm restart), set %S0 to 1 to initialize the controller.

ST S These two bits are reset to 0 by the system at the end of the following scan.

NOTE: Do not set %S0 to 1 for more than one controller scan.

Appendices

Appendices

A

Introduction

This chapter provides an example of application and the associated functions.

What's in this Chapter?

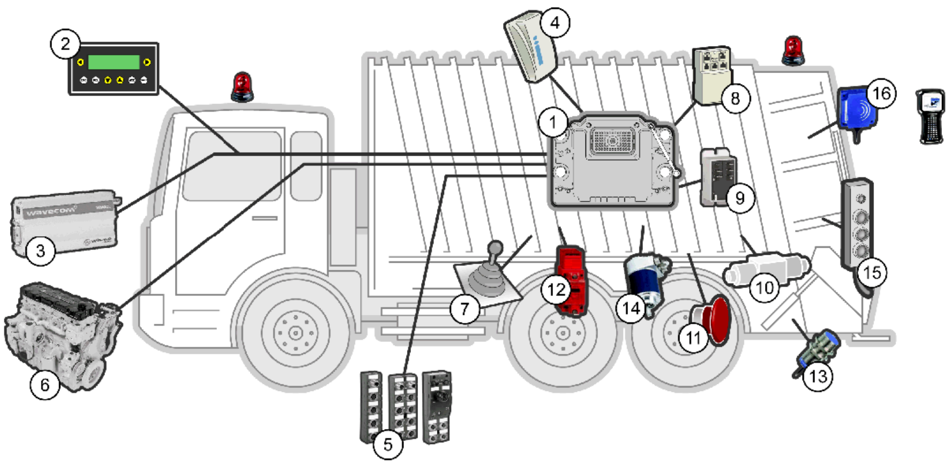
This chapter contains the following topics:

Application Example for Mobile Vehicles

Introduction

This appendix provides an example of application with Twido Extreme for mobile vehicles.

Illustration



The components used with Twido Extreme for the application are as follows:

Number	Component	Comments
1	Twido Extreme Controller	
Components used to set up the network		
2	XBT products supporting Modbus protocol, e.g. XBT GT	Used on Modbus network (RS485 line)
3	Modem	Used on Modbus network (RS485 line)
4	Bluetooth dongle	Used on Modbus network (RS485 line)
5	I/O Advantys FTB, FTM CANopen splitter boxes	Used on CANopen network
6	Engine	Used on CANJ1939 network
Components connected as inputs		
7	Joystick	Used for PWM control

Number	Component	Comments
8	Normal relays	
9	Static Relays	
10	Hydraulic valve	Used for PWM control
Components connected as outputs		
11 12	Preventa module (11) with an emergency stop button (12)	Handles security with the emergency stop button
13	Proximity sensor	
14	Pressure sensor	
15	Push button station	
16	RFID sensor and the associated command	

Single Axis Lever

Introduction

This appendix gives the characteristics, operations and performance of the single axis lever you can connect to the PWM input.

Description

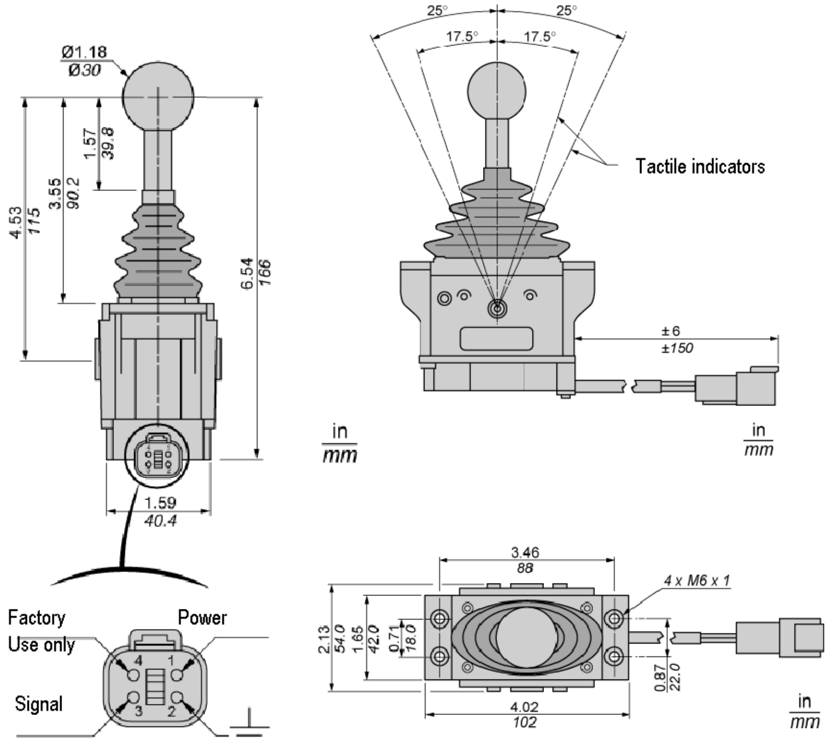
This is a single-axis spring-return-to-center model with a tactile detent at +/-17.5° deflection.The narrow housing design allows for side by side mounting of the joysticks for multiple control functions.

The joystick base utilizes a specific technology that allows for stable operation over the full deflection range, as well as a no-hysteresis line a output signal that is proportional to the operator input.

This joystick is designed to withstand the temperatures, shock, vibration and EMI/RFI conditions normally encountered in mobile equipment applications. In tests up to 6 million cycles, this joystick has shown no signs of bearing or boot wear, and no reduction of electrical performance.

Dimensions

The single axis lever has the following dimensions.



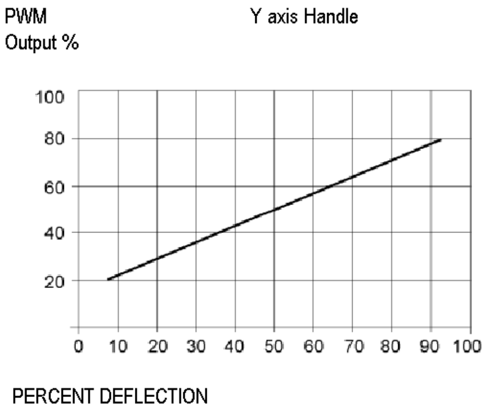
⚠ DANGER

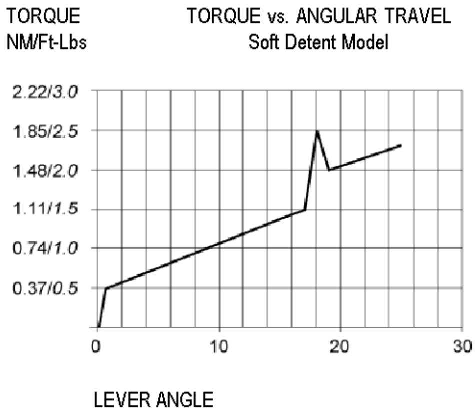
HAZARDOUS VOLTAGE

Disconnect power before wiring or assembling/disassembling the equipment

Failure to follow these instructions will result in death or serious injury.

Performances





Operation

The joysticks operate as low level control signal output devices only. With a supply voltage of 9...32 VDC to the connector of the joystick, a PWM output control signal will be available to act as the input to a valve amplifier/controller.

This PWM signal from the joystick is at 50 % duty cycle when the joystick is centered. When the joystick is deflected off-center, the PWM duty cycle output changes proportionally within the range of +/-40 %.

This joystick PWM output cannot be used to directly control a proportional valve.

An additional controller is required to convert the joystick PWM output signal to a stable output current which can drive the proportional coils. Duty cycles above and below the suggested range of 50 % +/-40 % are used for system diagnostics.

Features

The single axis lever has the following features:

- Single-function implement control
- Pulse width modulated (PWM) output to the controller.
- Tactile indicators for float (detent) return-to-dig and bucket leveling functions.
- Can be ganged in sets of two or three units for lift, tilt, and auxiliary control.
- Mounting in Armrest, typically.
- Two units can be used in place of one two-axis joystick.
- Advanced ASIC technology for reliability and accuracy.
- Reliable operation in extreme temperature conditions from –40° C +85° C.
- Rugged diecast metal housing.

- Chemical resistant to diesel fuel, water, engine oil, tri-sodium phosphate cleaners.
- PWM > 10% and < 90% for diagnostic testing and noise immunity.
- Spring return-to-center.
- Long-life, reliable operation–tested up to 6 million cycles.
- Rugged, low-part-count design with diecast metal frame.
- No hysteresis, and stable null for smooth, predictable control.
- Compact size for convenient application design.
- Protected against EMI/RFI, and +80 V for 2 minutes, –32 V for 1 hour.
- Factory calibrated.
- Low power consumption.

Electrical Specifications

Electrical specifications are as follows:

Characteristics	Value
Base supply requirements	9...32 VDC at 100 mA maximum.
Base signal PWM fixed frequency	500 Hz +/- 80 Hz
Base duty cycle center	50 % +/- 3 %
Base duty cycle range	10...90 % +/- 1.5 %
Electrical connector	DT04-4P
Mating base	DT06-4S

Materials

Material specifications are as follows:

Characteristics	Description
Grip	Thermoplastic
Boot	Neoprene rubber
Base	Aluminum alloy
Harnesses	PVC insulated copper wire with fiberglass woven loom and plastic connector

Mechanical Specifications

Mechanical specifications are as follows:

Characteristics	Value
Maximum handle travel	25° +/- 1° on axis
Force required to deflect handle	See figures above
Maximum horizontal load	> 200 lbs

Environmental Specifications

Environmental specifications are as follows:

Characteristics	Value
Operating temperature	- 40° C...+ 85° C (- 40° F...185° F)
Storage temperature	- 40° C...+ 85° C (- 40° F...185° F)
EMI/RFI (SAE J1113-21 level 6)	100 V/M, 15 KHz...1 GHz
Sealing	+/- 0.35 bar (5 psi); 0.1 bar (1.5 psi) water spray
Housing classifications	IP 67
Vibration	9.8 G random three axis, 8 grms (24 Hz...2 KHz)
Short circuit protection	All inputs and outputs are protected from short to battery and ground.

Glossary of Symbols

Introduction

This section contains illustrations and definitions of common IEC symbols used in describing wiring schematics.

Symbols

Common IEC symbols are illustrated and defined in the table below:

	Fuse
	Load
	Resistance
	Digital sensor/input, for example, contact, switch, initiator, light barrier, and so on.
	Battery

Agency Requirements

Introduction

This section provides agency standards for this product.

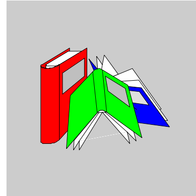
Standards

Twido Extreme controller complies with the main national and international standards concerning electronic industrial control devices.

The following are specific controller requirements:

- European "Automotive" Directive 2004/104/CE and Rules ECE N°10 (ECE R10) (e and E marks)
- European "Low Voltage" Directive 73/23/CEE (CE mark):
  Standards: EN(IEC) 61131-2
- European "EMC" Directive 89/336/CEE (CE mark).
  Standards:EN(IEC) 61131-2, EN(IEC) 61000-6-2, EN(IEC) 61000-6-4
- Certification UL 508
- Certification CSA C22.2 N°142

Glossary



A

analog input

A module containing circuits that enable analog DC (Direct Current) input signals to be converted into digital values that can be handled by the processor. This implies that the analog inputs are generally direct values — in other words: a value in the data table is a direct reflection of the analog signal value.

analog output

A module containing circuits that transmit an analog DC (Direct Current) input signal proportional to a digital input value to the processor module. This implies that the analog outputs are generally direct values — in other words: a value in the data table directly governs the analog signal value.

C

CAN

Controller Area Network. The CAN protocol (ISO 11898) for serial bus networks is designed to connect a series of intelligent devices (from different manufacturers) together into intelligent systems for real-time industrial applications. Multi-master CAN systems provide a high level of data integrity, by implementing message broadcast mechanisms and a strict error checking procedure. Initially developed for the automotive industry, the CAN protocol is now used in a wide range of automation environments.

CANJ1939

A protocol for automobile applications allowing communication with engines.

CANopen

An open standard industrial protocol used on the internal communication bus. This protocol can be used to connect any CANopen standard-compliant device to the island bus

D

discrete input/output

Another expression used is digital input/output. Designates an input or an output featuring an individual circuit connection to the module corresponding directly to a bit or word of the data table storing the value of the signal on this I/O circuit. A digital I/O gives the control logic discrete access to I/O values

DTP

Data Protocol Transfer. When the DPT signal is used, the controller sets the connection according to the communication port configuration defined in the application (see also *Programming Protocol*).

E

ECU

Electronic Control Unit. An embedded system used to control one or several electrical subsystems in the vehicle.

F

fast counting

A special function available as a single up counter and single down counter.

These functions allow counting pulses up or down (rising edges) on a digital I/O.

Extreme controllers are equipped with 1 fast counter.

I

IEC

International Electrotechnical Commission. Commission officially founded in 1906 and devoted to the advancement of theory and practice in the following sciences: electrical engineering, electronic engineering, information technology and computer engineering. The IEC 1131 standard covers industrial automation equipment.

IEEE

Institute of Electrical and Electronics Engineers, Inc. An international association for the standardization and evaluation of compliance in all areas of electro-technology, including electricity and electronics.

input filtering

A special function that rejects input noises. This function is useful for eliminating input noises and chatter in limit switches. All inputs provide a level of input filtering using the hardware. Additional filtering using the software is also configurable through TwidoSuite.

L

latching input

A special function used to memorize pulses with a duration less than the controller scan time. When a pulse is shorter than one scan and has a value greater than or equal to 100 μs, the controller latches the pulse, which is then updated in the next scan.

M

master/slave model

In a network using a master/slave model, the direction of control is always from the master to slave devices.

Modbus master mode

A communication mode that allows the controller to initiate a Modbus query transmission, with a response expected from a Modbus slave.

Modbus slave mode

A communication mode that allows the controller to respond to Modbus queries from a Modbus master and is the default communications mode if no communication is configured.

O

operator display module

An optional module that can be attached to the controller to display program information.

P

PDO, object

Process Data Object. On networks based on CAN technology, PDOs (Process Data Objects) are transmitted as broadcast messages without confirmation or are sent from a producer device to a consumer device. The transmitted PDO (TxPDO) from the producer device has a specific identifier corresponding to the PDO (RxPDO) received from client devices.

PLC

Programmable Logic Controller. Programmable Logic Controller. The PLC is the kernel of the industrial manufacturing process. A controller allows to automate a process compared to a relay control system. The PLCs are computers designed to survive under harsh conditions of an industrial environment.

PLS

Pulse Generator Output. A special user-defined function block that generates a signal on output Q0.0 or Q0.1. This signal has a variable period but has a constant duty cycle, or on to off ratio of 50% of the period.

programming protocol

The controller uses the Modbus protocol (slave address 1, 19 200 bauds, 8 data bits, no parity, 1 stop bit) to communicate when no DTP signal is detected (see also *DPT*).

PWM

Pulse Width Modulation. A special user-defined function block that generates a signal on output Q0.0 or Q0.1. This signal has a constant period with the possibility of varying the duty cycle, or on to off ratio.

R

RTC

Real Time Clock. A serially readable/writable device that maintains the current time and date without the system CPU running.

S

SDO, object

Service Data Object. On CAN networks, the fieldbus master (CANopen) uses SDO messages for (read/write) access to the network node object dictionaries.

Status output

A special function assigned to Q0.3. At power up, the controller status output is set to 1if the controller is in RUN mode without errors.This function can be used in circuits external to the controller to control, for example, the power supply to the output devices.

Index

G

H

I

L

M

N

O

P

R

S

T

W