ENGINEERING
TOMORROW

Technical Information

PLUS+1®
XM100 Autonomous Controller

www.danfoss.com

Revision history

Table of revisions

Date	Changed	Rev
July 2025	Added CE mark and new cover photo	0203
July 2024	Added antenna illustration	0202
February 2022	Replaced schematic drawing	0201
November 2021	Corrected feature data	0102
October 2021	First edition	0101

Contents

XM100 literature references

Reference literature

Literature Title	Literature Type	Literature Number
PLUS+1® Function Block Library - Autonomous Control Function Blocks	User Manual	AQ295075513101
PLUS+1® GUIDE Software	User Manual	AQ152886483724
PLUS+1® XM100 Autonomous Controller	Data Sheet	AI379058006235
PLUS+1® XM100 Autonomous Controller	Technical Information	BC394784770000
PLUS+1® XM100 Reliability Data MTTF	Safety Manual	BH409064980476
XM100 HW Description - Application Interface*	API Specification	70493872v322

*Note that the most accurate API Specification is found within PLUS+1® GUIDE under **Project Manager** > **HWD** > **XM100** rather than the **Hardware** tab.

Technical Information (TI)

A TI is comprehensive information for engineering and service personnel to reference.

Data Sheet (DS)

A DS is summarized information and parameters that are unique to a specific model.

PLUS+1® GUIDE User Manual

The user manual details information regarding the PLUS+1® GUIDE tool used in building PLUS+1® applications.

This user manual covers the following broad topics:

- How to use the PLUS+1® GUIDE graphical application development tool to create machine applications
- How to configure module input and output parameters
- How to download PLUS+1® GUIDE applications to target PLUS+1® hardware modules
- How to upload and download tuning parameters
- How to use the PLUS+1® Service Tool

Latest version of technical literature

You can find technical literature online at *www.danfoss.com*

User liability and safety statements

The following topics describe OEM liability and user safety.

OEM responsibility

The OEM of a machine or vehicle in which Danfoss products are installed has the full responsibility for all consequences that might occur.

Danfoss has no responsibility for any consequences, direct or indirect, caused by failures or malfunctions.

- Danfoss has no responsibility for any accidents caused by incorrectly mounted or maintained equipment.
- Danfoss does not assume any responsibility for Danfoss products being incorrectly applied or the system being programmed in a manner that jeopardizes safety.
- All safety critical systems shall include an emergency stop to switch off the main supply voltage for the outputs of the electronic control system. All safety critical components shall be installed in such a way that the main supply voltage can be switched off at any time. The emergency stop must be easily accessible to the operator.

Safety statements

This topic lists warnings and cautions that users must be aware of.

Warning

Unintended movement of the machine or mechanism may cause injury to the technician or bystanders. Improperly protected power input lines against over current conditions may cause damage to the hardware. Properly protect all power input lines against over-current conditions. To protect against unintended movement, secure the machine.

Warning

At high ambient temperatures the metal housing can become hotter than 70°C. Please use caution when touching the metal housing of the display

Caution

Unused pins on mating connectors may cause intermittent product performance or premature failure. Be sure to plug all pins on mating connectors.

Machine wiring guidelines

Use the following wiring guidelines.

- Protect wires from mechanical abuse, run wires in flexible metal or plastic conduits.
- When using wire near hot surfaces, consider using 85° C (185° F) wire with abrasion resistant insulation and 105° C (221° F) wire.
- Use a wire size that is appropriate for the module connector.
- Separate high current wires such as solenoids, lights, alternators or fuel pumps from sensor and other noise-sensitive input wires.
- Run wires along the inside of, or close to, metal machine surfaces where possible. This simulates a shield which minimizes the effects of EMI/RFI radiation.
- Do not run wires near sharp metal corners, consider running wires through a grommet when rounding a corner.
- Do not run wires near hot machine members.
- Provide strain relief for all wires.

User liability and safety statements

- Avoid running wires near moving or vibrating components.
- Avoid long, unsupported wire spans.
- Ground electronic modules to a dedicated conductor of sufficient size that is connected to the battery (-).
- Power the sensors and valve drive circuits by their dedicated wired power sources and ground returns.
- Twist sensor lines about one turn every 10 cm (4 in).
- Use wire harness anchors that allow wires to float with respect to the machine rather than rigid anchors.

Machine welding guidelines

Use the following welding guidelines.

The following is recommended when welding on a machine equipped with electronic components:

- Turn the engine off.
- Remove electronic components from the machine before any arc welding.
- Disconnect the negative battery cable from the battery.
- Do not use electrical components to ground the welder.
- Clamp the ground cable for the welder to the component that will be welded as close as possible to the weld.

Overview

XM100 Autonomous Controller description

Powerful Data Processing

The XM100 Autonomous Controller provides the high processing power required for state-of-the-art autonomous mobile machines. This controller is designed to meet the needs of autonomous machines by interfacing with GNSS, LiDAR, Radar and inertial sensors and performing autonomous navigation tasks. Ethernet and CAN connectivity allow the controller to manage complex tasks and command machine sub-systems, such as propel, steering and work function.

Product Highlights

The controller includes a powerful quad-core i.MX 6 platform with a Linux OS operating at 1.0 GHz. It has 8GB of flash and 2GB of DDR3 RAM to execute large, complex autonomous applications. This central processing unit delivers the power that will drive the future of your autonomous machine development.

Application Development

Users develop applications with PLUS+1® platform that enables novice programmers to quickly develop advanced applications. The PLUS+1® Autonomous Control Library is designed to work seamlessly with the vehicle control unit to enable autonomous machine functionality. PLUS+1® GUIDE is a Microsoft® Windows® based development environment and features a user-friendly, field proven, icon-based graphical programming tool, application downloader, and service/diagnostic tool.

XM100 Features

- Programmable with PLUS+1® GUIDE
- 2 x 12-pin DEUTSCH DTP connectors
- Processor: i.MX 6 QuadPlus, 1.0 GHZ
- 8 GB flash, 2 GB DDR3 RAM
- 4 CAN ports
- 4-wire Ethernet port (10/100)
- Audio out
- 2 RGB LEDs
- 6-Axis Inertial Measurement Unit
- GNSS Receiver position accuracy 1.5m CEP50
- 5 Vdc sensor supply output
- 9 to 36 Vdc power supply, monitored internally
- Wake over digital input

Comprehensive technical literature is online at www.danfoss.com

PLUS+1® GUIDE

PLUS+1® GUIDE (Graphical User Integrated Development Environment) is a complete toolbox that generates downloadable applications for all programmable PLUS+1® Compliant products.

Caution

Unwanted system failure may occur.
Refer to the PLUS+1® GUIDE Software User Manual for best programming practices, AQ152886483724.

Overview

XM100 Related products part numbers

Product part number

11321919	XM100,ESSN Autonomous Controller
11321920	XM100, ADVN Autonomous Controller

Related products part numbers

Connector kit

10100944	DEUTSCH 12-pin Connector Kit (DTM06-12SA)

Connection tools

10100744	DEUTSCH stamped contacts terminal crimp tool, size 20
10100745	DEUTSCH solid contacts terminal crimp tool

Cable kit

11231512	Cable, M12 4-pin to USB device (2m)
11130713	Cable, M12 8-Pin to Lead Wires (1.5m)
11130712	Cable, M12 5-Pin to Lead Wires (1.5m)

Antenna

11283266	External GNSS Antenna (5m) Antenna supports L1/L2 bands and is an active antenna.

Software

11179523 (renew annually with 11179524 to keep software updates)	PLUS+1® GUIDE Professional Software (includes 1 year of software updates, a single user license, Service and Diagnostic tool and Screen Editor)

XM100 inputs and outputs

8 inputs

- 4 universal (DIN/AIN/FreqIn/Rheo/4-20 mA) that are user-defined as either:
  - Analog: with configurable ranges 0 to 5.25 Vdc (with over range protection) or 0 to 36 Vdc;
  - Digital: pull up (5 Vdc), pull down (0 Vdc), or pull to center (2.5 Vdc);
  - Frequency: (timing) 1 Hz to 10 kHz
  - Rheostat: (Resistance) from 0 to 1000 Ohm
  - Current: 4 to 20 mA
- 2 digital/analog (DIN/AIN) that are user-defined as either:
  - Analog: 0 to 5.25 Vdc or 0 to 36 Vdc
  - Digital: pull up (5 Vdc), pull down (0 Vdc), or pull to center (2.5 Vdc);
- Ignition Input (K15)
- Wake Input (DigIn)

Overview

5 outputs

- 4 digital (Sinking DOUT) 500 mA
- Sensor Supply (+5 Vdc)

Input types

Each PLUS+1® Module input pin supports one of the above functional types. For pins with multiple functions, input configurations are user programmable using PLUS+1® GUIDE templates.

When using inputs in digital mode, it is advised to use the software selectable pull-up or pull-down resistors.

XM100 Technical Information

Processor	i.MX6
Supply Voltage	9-36 Vdc
Connector	DEUTSCH DTM06-12SA
IP Rating	IP66 and IP67 front and back
Operating Temperature	-30°C to +70°C [-22°F to 158°F]
Storage Temperature	-40°C to +85°C [-40°F to 185°F]
Vibration/Shock	IEC 60068-2-64 (7.67g) /2-27 (50g)
EMI/RFI Rating	100 V/m
Humidity	IEC 60068-2-78, 60068-2-30
Transients	ISO 7637/1, 2, 3
Certifications	CE, FCC, IC, RCM, RoHS

Input/output types and specifications

Digital/analog

Digital inputs

Description	Values			Unit	Notes
	Min.	Typ.	Max.		
General:					
Input voltage range	0		36	V	Maximum Voltage at pin.
Rising Threshold Voltage			3.91	V	
Falling Threshold Voltage	0.85			V	
Input Impedance	14.8	15	15.2	kΩ	

Digital / Analog

Description	Values			Unit	Notes
	Min.	Typ.	Max.		
Input voltage range	0		36	V	Maximum Voltage at pin.
Low level digital input				V	Level adjustable in software
High level digital input				V	Level adjustable in software Voltage >= V_{inhigh} Digital Input = True
Time to change state in response to step input		---		ms	Depends on application (OS.ExecTime)
Minimum discernable voltage			0.03	V	
Maximum discernable voltage	5.64	5.78	5.92	V	
Resolution		1.4		mV	
Worst case offset and gain error			±0.14	V	@ $V_{Measure}$ = 5.78V
Non-linearity			±8.5	mV	
Input Impedance	230	233	236	kΩ	
This input can also be used as a CAN shield. It provides a 0.68uF capacitor to ground through a 1 ohm resistor.					

Multifunction inputs

Digital / Analog / Frequency / Rheostat / Current inputs

Description	Values			Unit.	Notes.
	Min.	Typ.	Max.		
General:					
Input voltage range	0		36	V	Maximum Voltage at pin
Frequency range	0		10,000	Hz	
Quad count or Phase shift	0		5,000	Hz	
Low level digital input				V	Level adjustable in software
High level digital input				V	Level adjustable in software Voltage >= V_{inhigh}, Digital Input = True
Time to change state in response to step input		---		ms	Depends on application (OS.ExecTime)
Low Range:					
Minimum discernable voltage			13	mV	
Maximum discernable voltage	379	404	430	mV	

Input/output types and specifications

Digital / Analog / Frequency / Rheostat / Current inputs (continued)

Description	Values			Unit.	Notes.
	Min.	Typ.	Max.		
Resolution		0.1		mV	
Worst case offset and gain error			±0.6	mV	@ $V_{Measure}$ = 404mV
Non-linearity			±26	mV	
Rising Voltage Threshold			314	mV	Voltage required for frequency input
Falling Voltage Threshold	55			mV	Voltage required for frequency input
Input Impedance	232	233	234	kΩ	No pull up or pull down
Input Impedance (5V/GND)	13.9	14.1	14.3	kΩ	Pull up or pull down
Input Impedance (2.5V)	7.1	7.3	7.4	kΩ	Pull up and pull down
Middle Range:					
Minimum discernable voltage			0.03	V	
Maximum discernable voltage	5.69	5.78	5.88	V	
Resolution		1.4		mV	
Worst case offset and gain error			±0.14	V	@ $V_{Measure}$ = 5.78V
Non-linearity			±8.5	mV	
Rising Voltage Threshold			4.25	V	Voltage required for frequency input
Falling Voltage Threshold	0.97			V	Voltage required for frequency input
Input Impedance	232	233	234	kΩ	No pull up or pull down
Input Impedance (5V/GND)	13.9	14.1	14.3	kΩ	Pull up or pull down
Input Impedance (2.5V)	7.1	7.3	7.4	kΩ	Pull up and pull down
High Range:					
Minimum discernable voltage			0.16	V	
Maximum discernable voltage	37.9	38.8	39.7	V	
Resolution		9.5		mV	
Worst case offset and gain error			±0.95	V	@ $V_{Measure}$ = 38.8V
Non-linearity			±56.8	mV	
Rising Voltage Threshold			28.71	V	Voltage required for frequency input
Falling Voltage Threshold	6.47			V	Voltage required for frequency input
Input Impedance	109.1	109.3	109.5	kΩ	No pull up or pull down (V_{in} < 5.7V)
Input Impedance (5V/GND)	13.0	13.2	13.4	kΩ	Pull up or pull down (V_{in} < 5.7V)
Input Impedance (2.5V)	6.9	7.0	7.1	kΩ	Pull up and pull down (V_{in} < 5.7V)
Input Impedance (V_{in} > 5.7V)					See chart below

Input/output types and specifications

Audio outputs

Audio outputs

Symbol	Description	Unit	Minimum	Typical	Maximum	Comment
	Output Power	mW		62.5		@1kHz

Right and left channel included - Stereo output

Ethernet

Ethernet

Symbol	Description	Unit	Minimum	Typical	Maximum	Comment
	Available Baud Rates	bps		10M 100M		10M is default
	Max Input Voltage Range	V	-25		25	Receiver Input

Inertial measurement unit

Inertial measurement unit

Description	Range		Accuracy percentage over full range
	Min.	Max.	
Accelerometer	±2g: 16384 LSB/g	±16 g:2048 LSB/g	±0.4%
Gyroscope	±125 dps: 262.1 LSB/dps	±2000 dps: 16.4 LSB/dps	±0.4% (with CRT)

For a directional drawing, please see *XM100 Autonomous Controller dimensions* on page 16.

Input/output types and specifications

CAN shield and analog input

CAN ports

Description	Unit	Minimum	Typical	Maximum	Comment
Available Baud Rates	kbps		50 100 125 250 500 1000		Default value
Max Input Voltage Range	V	-27		40	CAN HI & CAN LO

Digital output

500 mA Low-side DOUT (DOUT14)

Description	Unit	Minimum	Typical	Maximum	Comment
Output Voltage	V	0		$V_{Battery}$	I_{out} = 500mA
Output Current	mA	500			

Input/output types and specifications

USB communication

USB port

Description	Unit	Minimum	Typical	Maximum	Comment
Available Baud Rates	Mbps	12		480	USB 2.0 supported
Max Input Voltage Range	V	-0.3		7.3	
Vbus Voltage		4.4	5	5.25	
Vbus Current	mA			250	

RS232 communication

RS232 Port

Description	Unit	Minimum	Typical	Maximum	Comment
Available Baud Rates	bps	9600 11400 19200 28800 38400 57600 115200			19200 is default
Max Input Voltage Range	V	-25 -13.2		25 13.2	Receiver Input Transmitter Output

Sensor output

Sensor supply output 5V / 100mA

Description	Unit	Minimum	Typical	Maximum	Comment
Sensor Output Voltage	V	4.85	5	5.15	
Sensor Output Current	mA			100	

Product ratings

XM100 environmental testing criteria

Mechanical environment

Description	Applicable standard	Comment
Vibration	IEC 60068-2-64 test Fh	3.17g
Bump	IEC 60068-2-27 test Eb	
Shock	IEC 60068-2-27 test Ea	50g
Free fall	IEC 60068-2-31 test Ed	

Supply voltage/maximum current ratings

XM100 Autonomous Controllers are designed to operate with a nominal 9 to 36 Vdc power supply with reverse polarity protection.

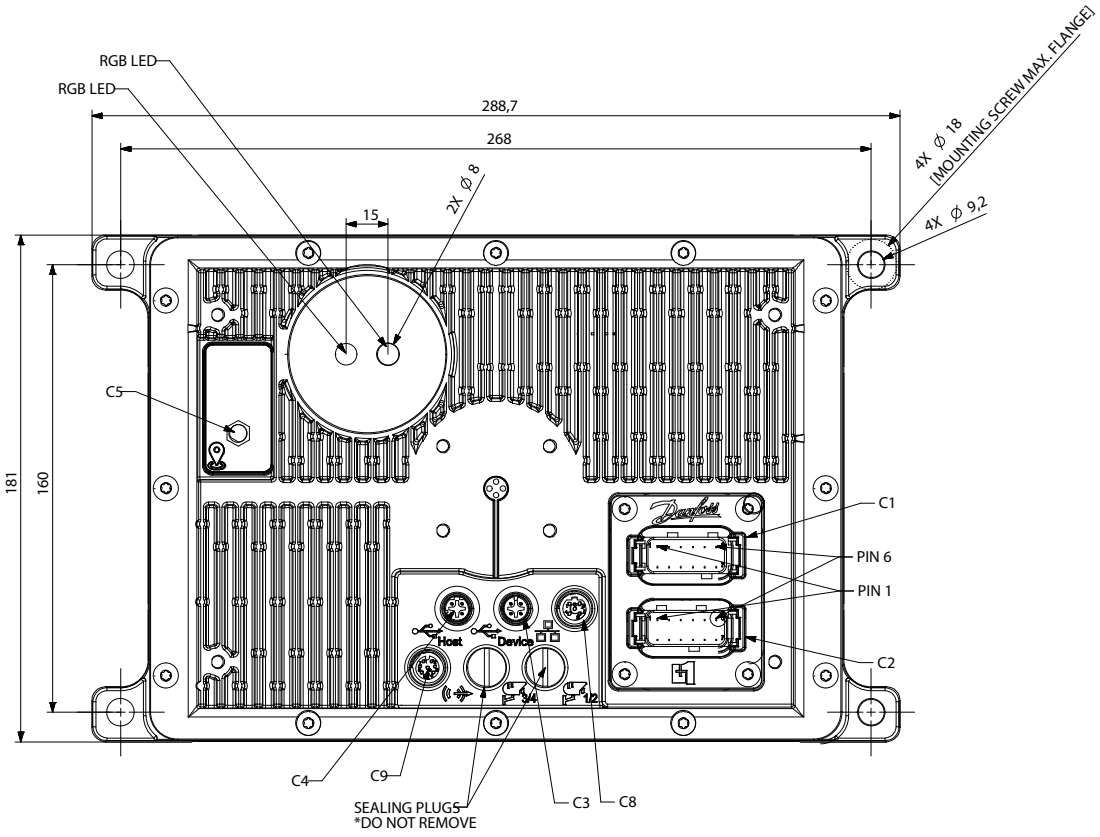
Battery power input

Description	Unit	Minimum	Typical	Maximum	Comment
Operating temperature	°C	-30	—	+70	
Storage temperature	°C	-40	—	+85	

Installation

XM100 Autonomous Controller dimensions

Pin locations and controller dimensions

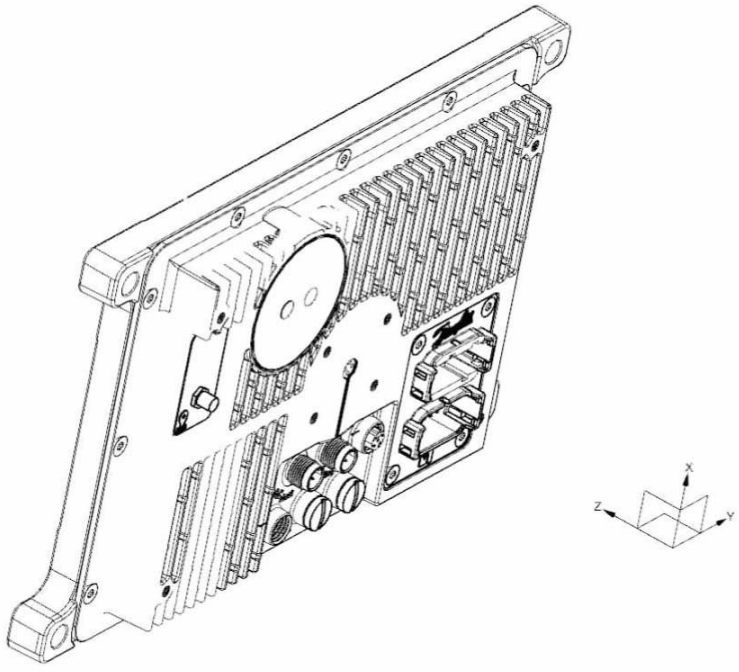


Warning

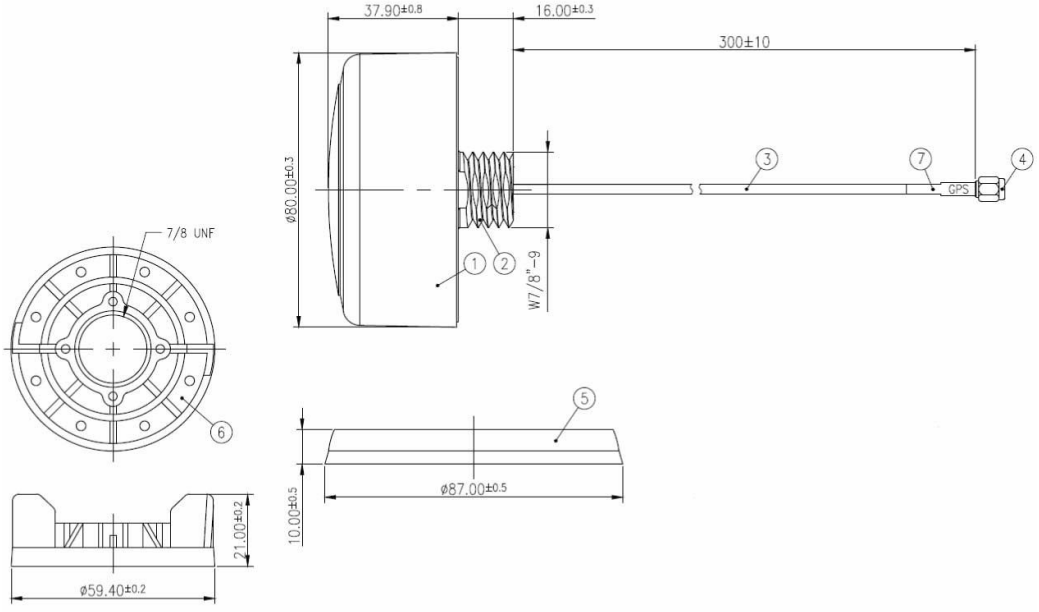
The XM100 needs to be rigidly mounted to a surface that has minimal vibration to avoid adding noise to the IMU. Additionally, mount the XM100 so the IMU axes align with the vehicle axes, or at 90° offset to the vehicle axes. The flat smooth side of the XM100 should face up to the sky and lie flat, with the connectors toward the ground. A positive x-axis goes toward the LED lights, and a positive y-axis goes toward the pins. If mounting it differently, adjust the code to get proper coordinates.

Installation

IMU Coordinate Frame



Antenna dimensions



No	NAME	MATERIAL	FINISH	QTY
7	Heat Shrink Tube	EVA	Black	1
6	Nut	PC+PBT	Black	1
5	Gasket	Silicone	Black	1
4	SMA(SP) Connector	Brass	Au Plated	1
3	Cable H100	PVC	Black	1
2	Bottom Base	Zinc Alloy	Ni Plated	1
1	Top Housing	PC+PBT	Black	1

Installation

Warning

Mount the antenna to a large metal surface to act as a ground plane. Also, mount the antenna with a 360° clear view of the sky, with no part of the vehicle blocking the antenna.

Install the antenna and gasket on the outside of the vehicle. Pass the wire through the hole in the vehicle, through the nut, and then screw the nut onto the threads of the antenna. The antenna supports L1/L2 bands and is an active antenna.

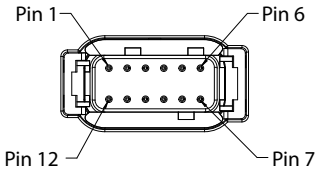
Pin assignments C1—C9

Connectors & mates

Connector Numbers	Description	Mate	Function	Rating	Max Wire Size
C1	Deutsch DTM04-12PA	Deutsch DT06-12SA	Main	7.5A	16 AWG
C2	Deutsch DTM04-12PB	Deutsch DT06-12SB	Main	7.5A	16 AWG
C3	Phoenix M12 1439939	Phoenix 1406189	USB Device		24 AWG
C4	Phoenix M12 1552214	Phoenix 1406130	USB Host		24 AWG
C8	Phoenix M12 1551451	Phoenix 1406131	Ethernet		24 AWG
C9	Phoenix M12 1551422	Phoenix 1406073	RS232 and Audio		24 AWG

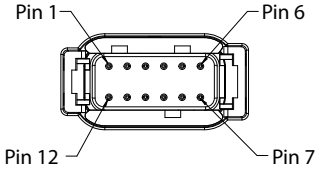
XM100 pin information

C1 - DEUTSCH DTM06-12SA, 12 pin



C1 pin	Function
1	Power ground -
2	Power supply +
3	CAN 0+
4	CAN 0-
5	Anin / CAN shield
6	CAN 1+
7	CAN 1-
8	Sensor supply out (+5 V)
9	Clamp15 (KL15) Power hold input / Digin
10	Multifunction input (Digin/Anin/Freq/4-20mA/Rheostat)
11	Multifunction input (Digin/Anin/Freq/4-20mA/Rheostat)
12	Digital out (0.5A sinking)

C2 - DEUTSCH DTM06-12SB, 12 pin, "B" key



C2 pin	Function
1	Sensor ground
2	Digital out (0.5A sinking)
3	CAN 2+
4	CAN 2-
5	Anin / CAN shield
6	CAN 3+
7	CAN 3-

Pin assignments C1—C9

C2 pin	Function
8	Multifunction input (Digin/Anin/Freq/4-20mA/Rheostat)
9	Multifunction input (Digin/Anin/Freq/4-20mA/Rheostat)
10	Clamp15 (KL15) Power hold input / Digin
11	Digital out (0.5A sinking)
12	Digital out (0.5A sinking)

C3 - M12 4 pin, USB Device, "A" key

C3 Pin	Function
1	Device data +
2	Device data -
3	Device Vbus
4	Ground

C4 - M12 4 pin, USB Host, "D" key

C4 Pin	Function
1	Host data +
2	Host data -
3	Host Vbus
4	Ground

C5 – GNSS antenna SMA coaxial

Antenna must be installed properly to the machine to avoid interference and to ensure the line of site to the sky.

C5 Pin	Function
Threads	Ground
Pin	Signal

C8 - M12 5 pin female, Ethernet, "D" key

Pin assignments C1—C9

C8 Pin	Function
1	TxD+
2	RxD+
3	TxD-
4	RxD-

C9 - M12 8 pin female, Stereo, "A" key

C9 Pin	Function
1	TxD
2	RxD
3	Ground
4	NC
5	Left channel
6	Right channel
7	Ground
8	NC

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