ENGINEERING
TOMORROW

Technical Information

PLUS+1® Connect
CS500 IoT Gateway

Revision history

Table of revisions

Date	Changed	Rev
September 2023	Updated compliance information	0201
October 2021	First edition	0101

Contents

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Document Overview

About this manual

This document is part of the product and provides important information on the intended use, safety, installation and operation of the device(s) described below. The manual is intended for qualified personnel and electricians with advanced knowledge in electrical engineering and fieldbus systems, allowing them to estimate the risks and hazards of operating the device and to integrate it into systems with components of other manufacturers.

CS500 literature references

Reference literature

Literature title	Literature type	Literature number
PLUS+1® Connect CS500	Technical Information	
PLUS+1® Connect CS500	Data Sheet	AI384967975537
PLUS+1® GUIDE Software	User Manual	AQ152886483724

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.

Device Elements

This chapter gives an overview of the device elements and functions and describes the intended use.

It further lists the available device variants and the product certifications.

Device information

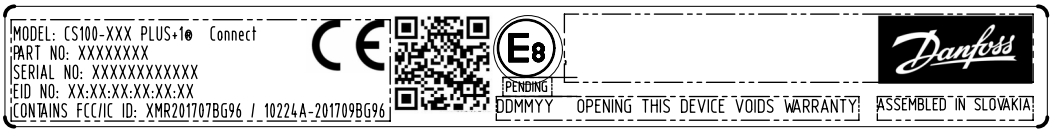
The device elements of the CS500 are shown in the figure below:

1	Mounting Holes
2	GPS connector
3	Cellular/4G connector
4	LEDs
5	Power/CAN/MFIO connector
6	Label

Type label

The CS500 type label is located on the side of the enclosure.

CS500 type label information



- Model
- Part number
- Serial number
- E-mark certification number
- CE mark
- Country of origin
- Traceability code in data matrix code

Device Elements

Do not remove device type label caution warehouse topic

Caution

The device type label contains important information and should not be removed. Solvents can destroy the label imprint.
Do not contact the type label with any solvent-containing substance.

Intended use

Danger

The CS500 operates using radio signals and cellular networks and is not authorized for use in safety-related applications due to possible deficient data transmission.

Deficient network coverage, failure, or malfunction of the device may lead to deficient data transmission. Due to this, connection cannot always be guaranteed under all conditions.

- Do not operate the device in machines and applications where life depends on the proper operation of this piece of equipment.
- Never rely solely upon any wireless device for essential communications.
- This device is designed to be used in systems which must be checked for conformity with legal requirements prior to placing into operation. The integrator of this device is responsible to check and comply with regional directives and requirements.

The OEM of a machine or vehicle in which PLUS+1® or other electronic controls are installed has the full responsibility for all consequences that may 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 PLUS+1® 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.
- A system FMEA should be performed on all applications.

The CS500 is designed for transmitting data that is available within a CAN network via 4G/3G/2G.

The CS500 is suitable for use in mobile and stationary systems for industrial, agricultural, construction and forestry machinery.

CS500 devices are IP 67-rated: They are protected against ingress of dust and against water jets against the enclosure (tested under defined conditions of pressure and time). IP 67 protection is only ensured when all connectors are plugged in and unused connector pin positions have sealing plugs installed.

Service and support

Contact PLUS+1® Support and Services:

https://www.danfoss.com/en/products/software/dps/plus1-software-services-support-and-training/plus1-support-and-services/#tab-overview

The most recent driver, firmware, tools and documentation versions are available for download from *https://www.danfoss.com/en/products/software/?sort=default_sort*

Device Elements

Caution

Warranty will be voided if device is opened.
Device is not field serviceable. Do not open the device.

Product Conformity

CS500

Compliance with CE

CE	This device complies with the directives, standards, and normative documents. Directive 2014/30/EC on Radio equipment and telecommunications terminal equipment Directive 2004/108/EC on Electromagnetic compatibility Immunity and Emission standard Earth moving and building construction machinery ISO13766-1:2018

Compliance with ECE R-10

Ex	This device has been approved to comply with Regulation No. 10. ECE Regulation No. 10 Revision 6, 11/20/2019 Approval No.: 10R-06 11848

PTCRB

PTCRB PCS Type Certification Review Board	This device has been certified for use on PTCRB Mobile Network Operator networks. For more information, see the certified device section http//ptcrb.com

PLUS+1® Compliance

+1®	Danfoss CS500 is compliant with PLUS+1® System Control Platform. Danfoss Telematics features are added in the Remote Interface (Machine information, signal strength, geographical position linked to Google Maps, CAN Status).

IC

IC	Industry Canada certification for use of wireless devices in Canada

RCM

	Australian and New Zealand certification for use of wireless devices

Product Conformity

IMDA

Complies with IMDA Standards DB107243	IMDA certification for use of wireless devices in Singapore

Safety information

In this chapter, you will find important information on how to avoid life-threatening situations and injuries and how to prevent product damage.

General information

These instructions are part of the device.

They contain text and illustrations for the correct handling of the module and must be read before installation or use.

Before deploying the device described in this document, read the entire Technical Information and the User Manual document, including all safety information.

Non-observance of the notes, operation that is not in accordance with use as prescribed below, wrong installation or handling can result in serious harm concerning the safety of people and plant.

Keep this manual for future use and make all information available to anyone deploying the device, even after installation.

Tampering with the device can lead to considerable risks for the safety of people and plant. It is not permitted and leads to an exclusion of any liability and warranty claims.

The device must be installed, connected and put into operation by a qualified electrician.

In the event of malfunctions or uncertainties, please contact the manufacturer.

This device is designed to be used in systems which must be checked for conformity with legal requirements prior to placing into operation. The integrator of this device is responsible to check and comply with regional directives and requirements.

⚠ Warning

Danfoss strongly recommends that initialization and provisioning of CS500 IoT Gateways be completed outside of machine production processes. It is best practice to de-couple this initialization and provisioning from machine production processes.

Safety advice

General

Danger due to possibly deficient data transmission.

CS500 unit operates using radio signals and cellular networks and is not authorized for use in safety-related applications.

Deficient network coverage, failure or malfunction of the device may lead to deficient data transmission. Because of this, connection cannot be guaranteed at all times under all conditions.

- Do not operate the device in machines and applications where life depends on the proper operation of this piece of equipment.
- Never rely solely upon any wireless device for essential communications.

Health care

Danger of interference caused by RF energy.

Medical equipment may be sensitive to RF energy.

Safety information

- When in a hospital or other health care facility, observe the restrictions on the use of cellular communication equipment. Switch CS500 unit off, if instructed to do so by the guidelines posted in sensitive areas.

The operation of cardiac pacemakers, other implanted medical device and hearing aids can be affected by interference from CS500 unit's antennas placed close to the device.

- If in doubt about potential danger, contact a physician or the manufacturer of the implanted medical device to verify that it is properly shielded. Pacemaker patients are advised to keep CS500 unit and its antennas away from the pacemaker while it is on.

Air traffic

Danger of interference caused by RF energy.

The operation of wireless appliances in an aircraft is forbidden to prevent interference with communications systems. Failure to observe these instructions may lead to the suspension or denial of cellular services to the offender, legal action, or both.

- Switch the unit off before boarding an aircraft.
- Make sure it cannot be switched on inadvertently.

Explosives

Danger of explosion.

Operation of any electrical equipment in potentially explosive atmospheres can constitute a safety hazard.

- Observe the applicable regulations and precautions when you are near explosive areas (i.e. petrol stations, fuel depots, chemical plants or where blasting operations are in progress).
- Do not mount the antenna in the close environment of fuel tanks, vessels with explosives and insufficiently shielded electronic devices.

Antennas

Danger due to absorption of RF energy.

Mobile communication devices may pose a health risk when operated in close proximity of persons.

- Install the device with integrated antenna(s) used for the CS500 to provide a separation distance of at least 20 cm / 8 inches from all persons.
- Do not operate them in conjunction or co-locate them with any other antenna or transmitter.

Electronic equipment

Danger of interference caused by RF energy

The unit receives and transmits radio frequency energy while switched on. Interference may occur if it is used close to TV sets, radios, computers or inadequately shielded equipment.

Follow any special regulations and always switch off the unit wherever use is forbidden, or when you suspect that it may cause interference or danger.

Avoid property damage

Warning

Property damage may occur, and unintended movement of machine or mechanism may cause injury to the technician or bystanders. Before any installation of the Control system, turn ignition lock off and disconnect the battery. Before handling the device disconnect externally. Also, disconnect independently supplied output load circuits.

Safety information

Connecting the supply voltage

The supply voltage must be within the operating range. Connect the supply voltage to power supply. Protect the module by using a fuse with requisite fuse level: 2 amps. To avoid damage, switch off power to the device when connecting/disconnecting the main connector to the device.

The CS500 and control system must be connected to the same power supply and ground connection to ensure trouble free communication.

Polarity reversal

Polarity reversal can damage the unit. Protect the CS500 module against power supply polarity reversal by using an external fuse, maximum 2 amps.

IP protection rating

IP 67 rating is ensured only with the following guidelines:

- Do not expose the device to dust and water if the connectors are not plugged in.
- Do not immerse the device in water or other liquids.
- Do not operate the device unless temperature is between -40 °C and +75 °C (-40 °F and +167 °F).
- Do not store and/or transport the device unless it is kept at a temperature between -40 °C and +85 °C (-40 °F and +185 °F).

Welding guidelines

Welding should be done before the installation of the control system.

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.

Warranty and liability

Danfoss assumes no liability for defects caused by normal wear, external influences, and errors of installation, operating or maintenance. This also applies if the customer itself or third parties without our approval modify the components of our products (such as devices, elements or additional hardware facilities; programs or program elements of the software).

Servicing the CS500

Warning

The device can only be repaired by the manufacturer, it is not field serviceable. Opening the device housing will void the Warranty.

Warning

To prevent misuse, immediately inform Danfoss in case of loss or theft of the device or the related SIM card that is factory pre-installed on it.

Ordering information

Device and part number

CS500 IoT Gateway	11247194
CS500 BR	11301188

Related products

Related product and part numbers

Product	Part Numbers
CS500 IoT Gateway and Antenna Kit	11247193
Replacement CS500 IoT Gateway	11247192
Replacement Antenna	11247194
DEUTSCH mating connector bag assembly	10102025 (16 to 20 AWG) 10100944 (20 to 24 AWG)

Device functions

Variant	GNSS	CAN Bus Interface	Local MFIO	Local MFIN	RTC	Service Tool	Data Logging	Power Management
CS500	Yes	2	2	2	Yes	Yes	Yes	Yes

Operations

CS500 devices support Data Logging and Service Tool functionality.

Data logging

The CS500 unit logs specific CAN messages, GNSS position data and internal variables according to its configuration and sends them to the Danfoss PLUS+1® Connect portal.

CS500 devices have an internal non-volatile memory which allows the CS500 to store the logged data in case of a cellular outage. When the cellular connection is recovered the logged data is sent to the Danfoss PLUS+1® Connect portal automatically.

Service Tool

All PLUS+1® Service Tool functionalities may be executed remotely with the CS500.

GNSS (Global Navigation Satellite System)

The GNSS enables the devices to determine their position using the Global Positioning System (GPS). The position data can then be transmitted via the cellular connection to the Danfoss PLUS+1® Connect portalor make it available to the connected CAN bus system.. The device includes a GNSS receiver for determining position data: the receiver can process signals from GPS, GLONASS, BeiDou and Galileo satellites. It can process data from multiple navigation systems simultaneously: this increases the accuracy.

The CS500 uses GNSS as a time source. When GNSS sync is not available, the local timing accuracy is ±2 seconds per day.

Wireless Solution

CS500 devices transmit data available on a CAN bus via 4G LTE, 3G UMTS/HSPA+, and 2G GSM/GPRS/EDGE telecommunication services.

Beyond the 4G LTE, 3G UMTS/HSPA+, and 2G GSM/GPRS/EDGE functionality, these services allow for communication with web servers at high data rates. The communication is based on the TCP/IP protocol, the communication is encrypted and secure (TLS). Using these services requires a connection to a Danfoss PLUS+1 Connect portal.

SIM card

Factory installed into the device there is a network operator SIM card.

Inserting generic SIM card is not possible because the housing cannot be opened.

The functionality depending on the ambient temperature can be assured for the maximum transfer rate only between -38 °C to 55 °C (36.4 °F to 131 °F).

Input/output functions (I/O)

CS500 features four multifunction input/output (2 DIN/AIN/ResIN/FreqIN/CrntIN/DOut and 2 DIN/AIN/ResIN/FreqIN/CrntIN) configurable with several options similar to the type of pins available on PLUS+1®

Device functions

ECUs. The input function can be used, for example, to read and log status information from devices or machines as well as to directly determine and monitor switch and key states. The data can be sent from the input/output function via the CAN bus or via the mobile radio network.

CAN interfaces

The device features 2 CAN bus interfaces. The CAN interfaces meet the specifications CAN 2.0 A/B protocol and the physical layer according to ISO 11898-2 high-speed up to 1 Mbit / s. The CAN interfaces are operational only when existing power supply is energized. A support for CAN-FD is not possible.

Device configuration

The CS500 can be remotely configured from the Danfoss PLUS+1® Connect portal, PLUS+1® Service Tool, or programmatically with PLUS+1® GUIDE to monitor the machine state, performance, and position. Both position and machine data are periodically transmitted and stored to the Danfoss Data Portal.

CS500 firmware update

A firmware update to the CS500 can be loaded via the Danfoss PLUS+1® Connect portal. The firmware update may reset the saved configuration to default. After the firmware update, load your configuration to the device through the PLUS+1® Connect portal.

Secure connection to the PLUS+1® Connect portal

CS500 always establishes a secure encrypted TLS connection to the PLUS+1® Connect portal. If, for specific reasons, the encryption is a problem, please contact a Danfoss representative for possible solutions.

Connector

CS500 is equipped with: 1x Main connector (CAN bus, I/O, Power).

Main connector

The connector functions:

- Connecting the device to the CAN bus network
- Supplying the device with power
- Local multifunction Inputs/Outputs

To avoid damage to the device, connect/disconnect the main connector only if the power supply to the device is switched off.

To maximize the performance of the GPS receiver, mount the GPS antenna in a place where it is level with the local geographic horizon and has full view of the sky above.

Power Supply / CAN Bus / I/O Connector 1

Pin	Designation	Description
1	Ground	Power supply
2	9 to 36 VDC	Power supply
3	CAN 1 High	CAN bus 1
4	CAN 1 Low	CAN bus 1
5	DIGIN1/CL15	Multifunction Input / Ignition
6	DIGIN2	DIN / Sensor Power
7	CAN 2 High	CAN bus 2
8	CAN 2 Low	CAN bus 2
9	MFIO1	Multifunction Input / Output
10	MFIO2	Multifunction Input / Output
11	MFIN1	Multifunction Input
12	MFIN2	Multifunction Input

CS500 Technical Data

Electrical Data

Electrical data

DC supply voltage	9 to 36 V_{DC}
Memory buffering capacity	256 MB Min
EMI/RFI rating	100 V/M
Current consumption	Typical: TBD mA Low-power mode: 5mA Max

Mechanical Data

Mechanical data

Dimension L x W x D	107 x 1588 x 51.5 mm [4.2 x 6.25 x 2 in]
Housing	Tamper resistant
Color	Black
Operating temperature	-40 to 75°C [-40 to 167°F]
Storage temperature	-40 to 85°C [-40 to 185°F]
IP rating	IP67 (with connector mated)
Weight	350 g
Status LED	2 red / green

Interface/Protocol/Certification

Interface/Protocol/Certification

CAN bus network	2 (ISO 11898-2 High Speed, 2.0A/B)
Multifunction Input	2 (DIN/AIN/ResIN/FreqIN/CrntIN/CL15/DOUT)
Radio Module	Cat 1 TE with 3G Fallback
Cat 1LTE Throughput (UL/DL)	Max 5 Mbps / Max 10 Mbps
3G HSPA Throughput (UL/DL)	Max5.76 Mbps / Max 42 Mbps
Cat M1 LTE FDD Bands	TBD
3G – EGPRS Bands	TBD
GNSS Constellations	GPS, GLONASS, BeiDou, Galileo
Antennas	Cellular (External) and GNSS (External)
SIM Card	Factory Installed
Certifications	FCC, CE, E-Mark, PTCRB, IC, RCM
Vibrations	IEC 60068-2-64
Shock	IEC 60068-2-27 test Ea

CS500 Technical Data

Multifunction inputs

Middle range analog

Description	Unit	Minimum	Typical	Maximum	Comment
Minimum discernible voltage	mV	—	—	20	—
Maximum discernible voltage	V	5.18	5.26	5.33	—
Resolution	mV	—	1.3	—	—
Worst case offset and gain error	mV	—	—	71	VMeasure = 5.26 V
Non-linearity	mV	—	—	±7.8	—
Input impedance	kΩ	232	233	234	No pull up or pull down
Input impedance (5V/GND)	kΩ	13.9	14.1	14.3	Pull up or pull down
Input impedance (2.5V)	kΩ	7.1	7.3	7.4	Pull up and pull down

High range analog

Description	Unit	Minimum	Typical	Maximum	Comment
Minimum discernible voltage	mV	—	—	145	—
Maximum discernible voltage	V	34.5	35.3	36.1	—
Resolution	mV	—	8.6	—	—
Worst case offset and gain error	V	—	—	.79	VMeasure = 35.5 V
Non-linearity	mV	—	—	±53	—
Input impedance	kΩ	109.1	109.3	109.5	No pull up or pull down (Vin < 5.7 V)
Input impedance (5V/GND)	kΩ	13.0	13.2	13.4	Pull up or pull down (Vin < 5.7 V)
Input impedance (2.5V)	kΩ	6.9	7.0	7.1	Pull up and pull down (Vin < 5.7 V)

Frequency input middle range

Description	Unit	Minimum	Typical	Maximum	Comment
Range	Hz	0	—	10000	In steps of 1 Hz
Range (phase and quad)	Hz	0	—	5000	In steps of 1 Hz
Rising voltage threshold	V	—	—	3.89	Voltage required for frequency input
Falling voltage threshold	V	0.85	—	—	Voltage required for frequency input
Input impedance	kΩ	232	233	234	No pull up or pull down
Input impedance (5V/GND)	kΩ	13.9	14.1	14.3	Pull up or pull down
Input impedance (2.5V)	kΩ	7.1	7.3	7.4	Pull up and pull down

Frequency (PPU) High Range

Description	Unit	Minimum	Typical	Maximum	Comment
Range	Hz	0	—	10000	In steps of 1 Hz
Range (phase and quad)	Hz	0	—	5000	In steps of 1 Hz
Rising voltage threshold	V	—	—	23.6	Voltage required for frequency input
Falling voltage threshold	V	5.6	—	—	Voltage required for frequency input
Input impedance	kΩ	109.1	109.3	109.5	No pull up or pull down
Input impedance (5V/GND)	kΩ	13	13.2	13.4	Pull up or pull down
Input impedance (2.5V)	kΩ	6.9	7.0	7.1	Pull up and pull down

CS500 Technical Data

Resistance input

Description	Unit	Minimum	Typical	Maximum	Comment
Range	Ω	5.2	—	10000	In steps of 1 Ω
Measurement error	%	—	—	6.4	100Ω
		—	—	1.9	1kΩ
		—	—	4.9	10kΩ
Input impedance	kΩ	1.32	1.32	1.33	Input impedance to 5V

Outputs

Digital output

Description	Unit	Minimum	Maximum	Comment
Output Voltage range	V	0	36	
Current	mA	0	3000	

Do not connect a digital output to battery+ (back drive) without a series diode.

PLUS+1® Connect portal

The CS500 is produced with a pre-installed SIM card and with a default configuration that allows the direct connection of the device to the PLUS+1® Connect portal.

The visibility of the device on the PLUS+1® Connect portal is linked to the activation of the device, if not activated with a specific data plan the device is not visible on the portal.

Connect the device and ensure the device turns on.

The LED light correct sequence:

- The LED lights up green constantly during the first second.
- The LED starts to flash.

Problem with connection to PLUS+1® Connect portal

After connecting to power supply, the LED should follow the correct sequence. If the LED lights up green and the red LED begins flashing, there is a problem.

- 1 Hz – Operation error
- 2 Hz – Configuration error
- 4 Hz – CAN Fault

If contacting the helpdesk or your CS PAE, EID number is required in order to receive assistance.

Packaging and Transport

IP protection rating

IP 67 rating is ensured only with the following guidelines:

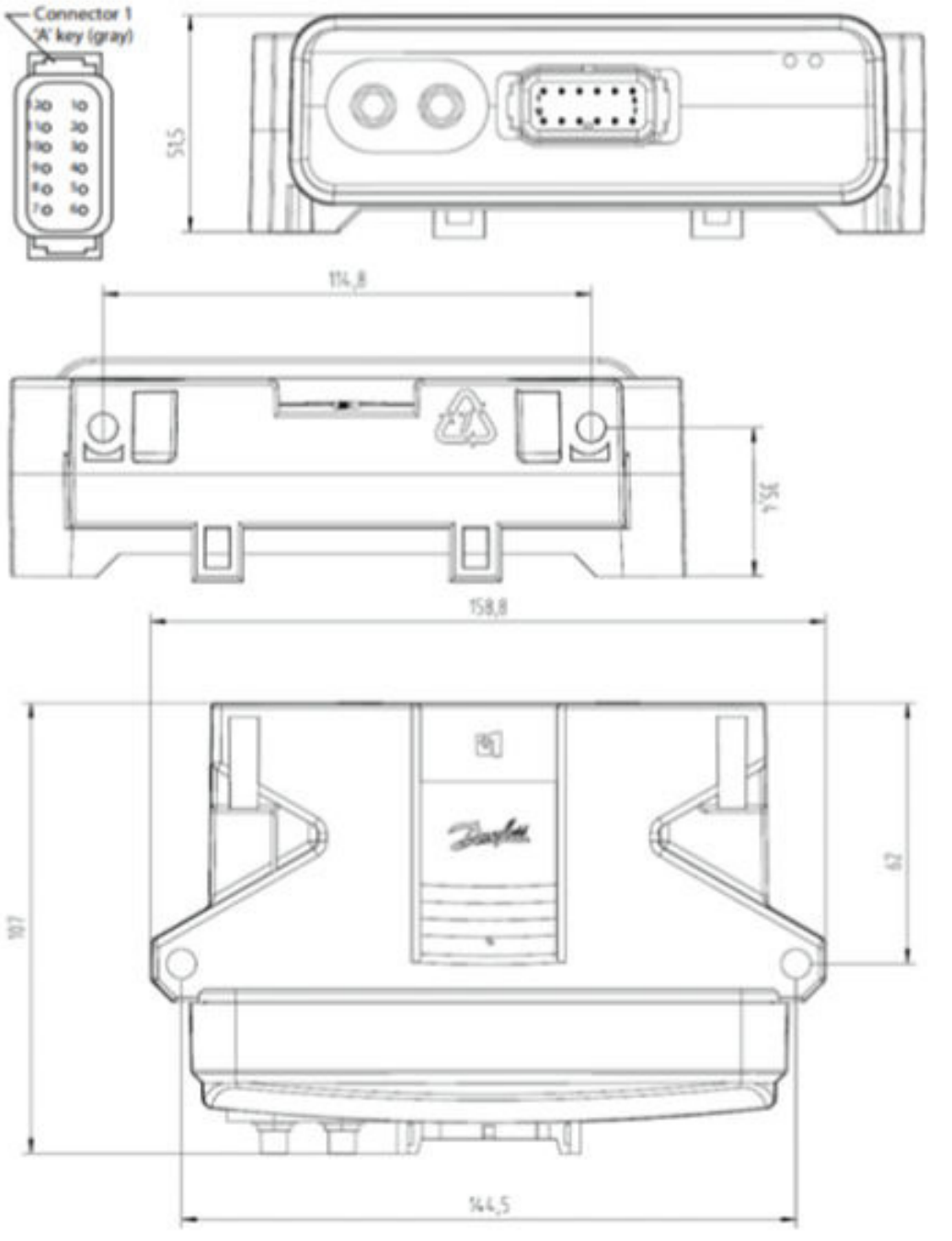
- Do not expose the device to dust and water if the connectors are not plugged in.
- Do not immerse the device in water or other liquids.
- Do not operate the device unless temperature is between -40 °C and +75 °C (-40 °F and +167 °F).
- Do not store and/or transport the device unless it is kept at a temperature between -40 °C and +85 °C (-40 °F and +185 °F).

Disposal

Observe national regulations when disposing the device, accessories and its package.

CS500 Technical Drawings

CS500 Dimensions



Mounting

The CS500 can be mounted in one of three ways:

- End (bulkhead) installation
- Up to three units stacked on one another
- Individually side mounted

Care must be taken to ensure that the device's connector is positioned so that moisture drains away from the connector.

If the device is side or stack mounted, provide a drip loop in the harness. If the device is mounted vertically, the connector should be on the bottom of the module.

Provide strain relief for mating connector wires.

Antenna must be mounted on external surface with a view to the sky.

Caution

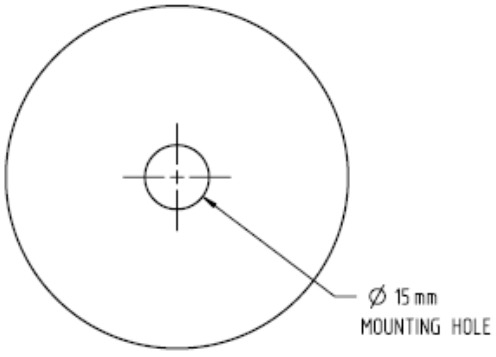
Device damage may occur. Use caution when installing CS500. Due to the size of the mating connector wire bundle, it is possible to twist off the end cap of the module if excessive pressure is applied during the installation of harness strain relief.

Fasteners

Recommended outer diameter (OD)	Recommended torque
6.0 mm [0.25 in]	2.26 N•m [20 in•lbs]

Antenna

Connector(s) and nuts	Recommended torque
Cellular & GNSS	0.5 N•m [4.5 in•lbs]
18mm nut	2.94 N•m [26 in•lbs]



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