MAKING MODERN LIVING POSSIBLE

Technical Information

# PLUS+1®
# CSS1000 Slope Sensor

## Revision History

*Table of Revisions*

| Date | Page | Changed | Rev |
|---|---|---|---|
| 05 Nov 2013 | | Various | DA |
| 28 August 2012 | 14 | Mechanical specifications | CA |
| 22 August 2012 | 5 | Drawing and some minor corrections. | BA |
| 10 August 2012 | | | AA |

## Contents

## General Information

### Product Overview

The CSS1000 Slope Sensor is designed for use as a component in mobile machine control systems that require a measurement of deviation from a gravity reference.

This sensor uses MEMS (Micro Electro Mechanical System) technology combined with advanced signal processing to intelligently cancel out transverse machine motion, providing a high precision, fast responding, and stable slope signal.

### Features and Options

- State of the art MEMS technology
- PLUS+1® Compliant GUIDE function block available
- IP 67
- 12 Pin Deutsch® DTM connector
- CAN 2.0 B compliant
- Supports J1939 and Danfoss proprietary CAN message protocols
- Sensor parameters can be set via the PLUS+1 GUIDE Service Tool
- Input configuration pin for use of multiple sensors on a single CAN bus
- 9 to 36 Vdc power supply
- Measures slope and angle
- CE compliant

### User Liability and Safety Statements

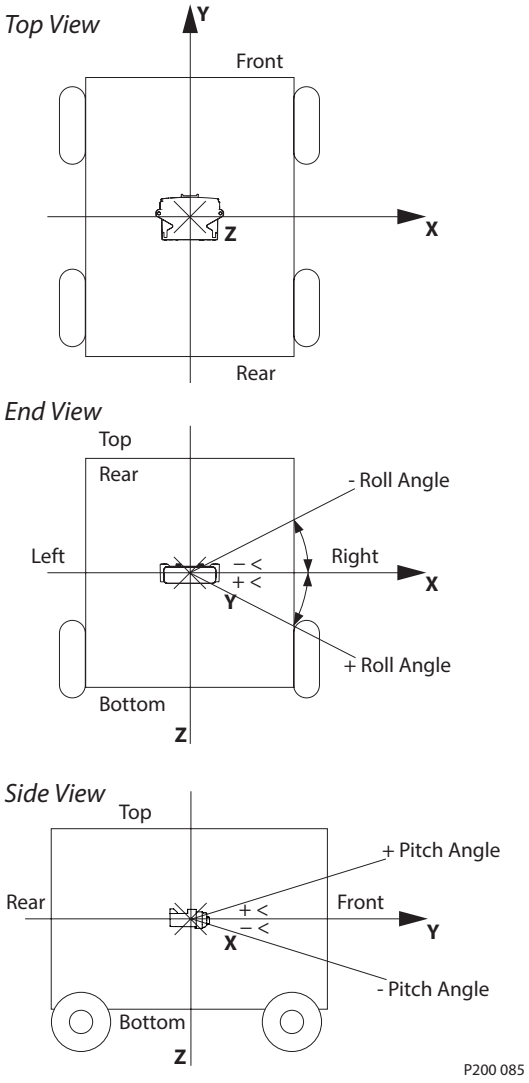
**OEM Responsibility**
The OEM of a machine or vehicle in which PLUS+1 electronic controls are installed has the full responsibility for all consequences that might occur. Danfoss has no responsibility for any consequences, direct or indirect, caused by failures or malfunctions.

- The Sensor is not intended to be used as a stand-alone safety device in safety critical applications.
- 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.

## General Information

### Theory of Operation

*Vehicle Roll Angle and Pitch Angle Definitions*

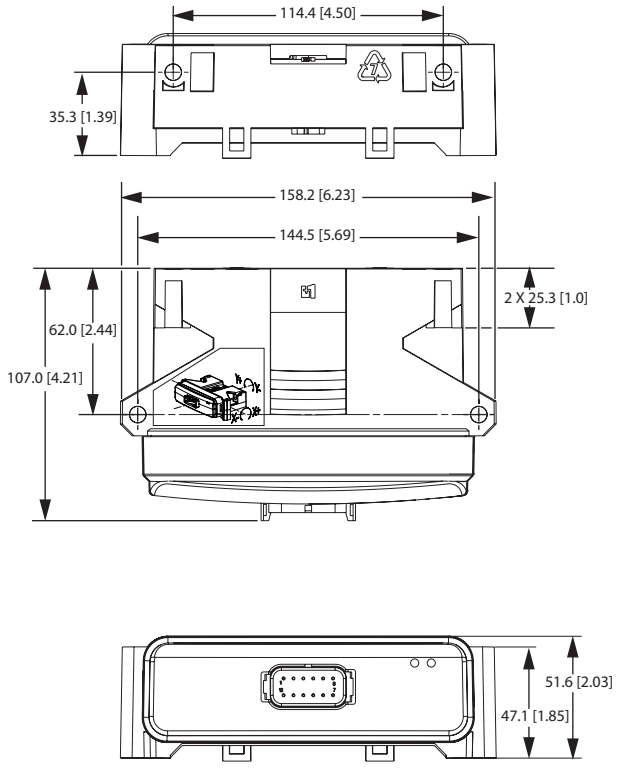



### Ordering Information

| Product | Danfoss part number | |
|---|---|---|
| CSS1000 | 11139794 | |
| CG150 CAN/USB Gateway | 10104136 | |
| Deutsch mating connector | 10102025<br>(16 to 20 AWG) | 101000944<br>(20 to 24 AWG) |
| PLUS+1 GUIDE single user license | 10101000 | |

## Product Installation

### Dimensions



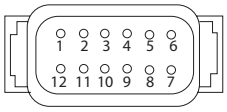

### Mechanical Installation

The sensor can be installed on any flat horizontal or vertical surface provided one takes care to align the sensor axes arrows parallel to the planes that will be sensed. It is suggested that 6.0 mm (.25 in) fasteners, torqued to 9.49 Nm (7 ft lb), be used. The wire harness to the sensor should be secured 4 to 5 inches from the sensor to help prevent any degraded performance of the sensor.

## Product Installation

### Connector Pin Assignments

*12 Pin Connector*




2200B

*Connector*

| Pin | Controller function |
|---|---|
| C1-P1 | Power ground - |
| C1-P2 | Power supply + |
| C1-P3 | CAN + |
| C1-P4 | CAN - |
| C1-P5 | CAN shield |
| C1-P6 | Config |
| C1-P7 | Config ground |
| C1-P8 | Not used |
| C1-P9 | Not used |
| C1-P10 | Not used |
| C1-P11 | Not used |
| C1-P12 | Not used |

Use care when wiring mating connector. Above pinouts are for device pins.

## Product Installation

### Recommended Wiring Practices

1. All wires must be protected from mechanical abuse. Wires should be run in flexible metal or plastic conduits.
2. Use 85° C (185° F) wire with abrasion resistant insulation. 105° C (221° F) rated wire should be considered near hot surfaces.
3. Use a wire size that is appropriate for the module connector.
4. Separate high current wires such as solenoids, lights, alternators or fuel pumps from sensor and other noise-sensitive wires.
5. Run wires along the inside of, or close to, metal machine surfaces where possible. This simulates a shield which will minimize the effects of EMI/RFI radiation.
6. Do not run wires near sharp metal corners. Consider running wires through a grommet when rounding a corner.
7. Do not run wires near hot machinery members.
8. Provide strain relief for all wires.
9. Avoid running wires near moving or vibrating components.
10. Avoid long, unsupported wire spans.
11. All analog sensors should be powered by the sensor power source from the PLUS+1 controllers and ground returned to the sensor ground pin on the PLUS+1 controller.
12. Sensor lines should be twisted about one turn every 10 cm (4 in).
13. It is better to use wire harness anchors that will allow wires to float with respect to the machine rather than rigid anchors.
14. Electronic modules should be grounded to a dedicated conductor of sufficient size that is connected to the battery (-).

### Recommended Welding Procedures for Machine Equipped with PLUS+1 Module

The following procedures are recommended when welding on a machine equipped with PLUS+1 modules.

- The engine should be off.
- 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.

## Parameter Set-Up

The sensor's source address may be configured in one of two ways: Configuration through the use of the configuration pin (C1-P6) or through the use of the PLUS+1 Service tool. All other adjustable parameters are serviced only through the PLUS+1 Service tool.

### Using the Sensor's Configuration Input Pin to Set the Source Address

The sensor is capable of achieving 256 distinct source addresses, 31 of which may be selected through the use of the configuration pin. The pin can be connected directly to ground (source address 129), left floating (last programmed source address) or connected to ground through one of thirty different resistor values. The table below defines the allowable source addresses and the required resistor value to achieve each address.

The source addresses are checked by the sensor's microprocessor each time it is powered up. In order to change the source address via the configuration pin, the sensor must be powered up with the configuration input pin connected to the appropriate value resistor. Any changes made to the source address while the sensor is powered are ignored until power has been cycled.

If, on power up, the source address configured by the resistor differ from the value currently stored in the sensor's non-volatile (NV) memory then the value in NV memory will be over written with the new source address, as long as the selected resistor value does not exceed 51,100 Ohms.

If a system has multiple sensors of the same type and the configuration input pins are used for setting the source addresses, it is recommended that all of these sensors use a unique resistance value. It is not recommended to leave one sensor in the open state.

| Source address | Resistor (Ohms) | Source address | Resistor (Ohms) |
|---|---|---|---|
| 129 | 0 | 145 | 2430 |
| 130 | 76.8 | 146 | 2740 |
| 131 | 162 | 147 | 3160 |
| 132 | 249 | 148 | 3570 |
| 133 | 340 | 149 | 4120 |
| 134 | 442 | 150 | 4750 |
| 135 | 562 | 151 | 5490 |
| 136 | 665 | 152 | 6490 |
| 137 | 806 | 153 | 7680 |
| 138 | 931 | 154 | 9310 |
| 139 | 1100 | 155 | 11,500 |
| 140 | 1270 | 156 | 14,700 |
| 141 | 1430 | 157 | 19,600 |
| 142 | 1650 | 158 | 28,700 |
| 143 | 1870 | 159 | 51,100 |
| 144 | 2150 | No change | Open |

## Parameter Set-Up

### Using the PLUS+1 Service Tool

All of the sensor's parameters can be set up using the PLUS+1 Service Tool. The source address can only be changed by the PLUS+1 Service Tool if the configuration pin is left open.

The table below defines the allowable values for each of the sensor's parameters that can be modified using the PLUS+1 Service Tool.

| PLUS+1 Service Tool signal (sensor parameter) | Allowable values | Comments |
|---|---|---|
| CANBaudRate | 100000, 250000, 500000, 1000000 | |
| CANID | 0- 536870911(0x00-0x1FFFFFFF) | The 8 Least Significant Bits are overwritten by the Source Address Value |
| UseExtendedID | 0,1 | 0=11 bit mode, 1=29 bit mode (factory default = 29 bit) |
| OutputMode | 0,1 | 0=degrees (factory default), 1=% slope |
| SourceAddress | 0-255 | Factory default=226 |
| TxPeriod | 0-255 ms | Factory default=15 |
| UseJ1939AddressClaim | 0,1 | Factory default=1 |

## Controller Area Network (CAN) Message Protocols

### J1939 Message Protocol

The sensor supports the SAE J1939 message protocol using a fixed addressing scheme. The source address is the LSB of the message identifier and is designated by the state of configuration pin or is set through the use of the PLUS+1 Service Tool. SAE J1939 PGN 45328 defines the data portion of the sensor's CAN message. The values in the X and Y axis message fields depend on the state of the OutputMode parameter set using the PLUS+1 Service Tool. The data format for both X and Y axis is 0.01 degree/bit or .01% slope/bit. The calibrated measurement range of the sensor is ±55.4% slope or ±29°.

*Sensor Message Structure*

| Priority | Base PGN | | PDU format | | PDU specific | | Source address | | Data field |
|---|---|---|---|---|---|---|---|---|---|
| | Dec | hex | Dec | hex | Dec | hex | Dec | hex | |
| 6 | 45328 | FFB1 | 255 | FF | 177 | B1 | 0-255 | 0-FF | 8 bytes |

- Message transmission rate: 15 ms
- CAN bus baud rate: 250 kbps

The resulting SAE J1939 message PGN on the CAN bus is: Ox18FFB1SA

- Data field

The data field contains the sensor's output information. SAE J1939 data fields contain 8 bytes of data.

*Information in the Data Field*

| Byte# | 0 | | | | | | | | 1 | | | | | | | | 2 and so on | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit# | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

## Controller Area Network (CAN) Message Protocols

### Sensor Message Data Field Descriptions

*Parameters and Data Field Locations*

| Start position byte/bit | Length (bits) | Parameter name |
|---|---|---|
| 1 | 8 | SD Byte |
| 2 | 8 | Slope Sensor |
| 3/1 | 2 | X Axis FOM |
| 3/3 | 2 | Output Mode |
| 4/1 | 2 | Y Axis FOM |
| 4/3 | 2 | Output Mode |
| 5 | 8 | X Axis LSB |
| 6 | 8 | X Axis MSB |
| 7 | 8 | Y Axis LSB |
| 8 | 8 | Y Axis MSB |

### Data Field Summary

*Data Field Examples*

| **Byte** | 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Bit** | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | SD Byte | | | | | | | |

***Fixed at 0 x 10**

| **Byte** | 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Bit** | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | Slope Sensor Byte | | | | | | | |

***Fixed at 0 x 81**

| **Byte** | 3 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Bit** | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | Not used | | | | Output Mode | | X axis FOM | |

*X Axis FOM Information in Data Field*

| Bit status | Remarks |
|---|---|
| 00 | Fully functional; data is within sensor specification. |
| 01 | Slope measurement has exceeded specified range.. |
| 10 | Hardware error |
| 11 | Not available |

*X Axis Output Mode Information in Data Field*

| Bit status | Remarks |
|---|---|
| 00 | Not used |
| 01 | % slope |
| 10 | Degrees |
| 11 | Not available |

| **Byte** | 4 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Bit** | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | Not used | | | | Output Mode | | Y axis FOM | |

## Controller Area Network (CAN) Message Protocols

### Data Field Summary (continued)

*Y Axis FOM Information in Data Field*

| Bit status | Remarks |
|---|---|
| 00 | Fully functional; data is within sensor specification. |
| 01 | Slope measurement has exceeded specified range.. |
| 10 | Hardware error |
| 11 | Not available |

*Y Axis Output Mode Information in Data Field*

| Bit status | Remarks |
|---|---|
| 00 | Not used |
| 01 | % slope |
| 10 | Degrees |
| 11 | Not available |

| Byte | 5 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bit | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | X axis LSB | | | | | | | |

| Byte | 6 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bit | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | X axis MSB | | | | | | | |

| Data range | Units | Resolution |
|---|---|---|
| -1500 to 1500 | Degrees | 0.01 Deg/bit |
| -28,600 to 26,800 | Percent Slope | 0.01% Slope/bit |

| Byte | 7 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bit | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | Y axis LSB | | | | | | | |

| Byte | 8 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bit | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | Y axis MSB | | | | | | | |

| Data range | Units | Resolution |
|---|---|---|
| -1500 to 1500 | Degrees | 0.01 Deg/bit |
| -28,600 to 26,800 | Percent Slope | 0.01% Slope/bit |

## Specifications

### Electrical

| | |
|---|---|
| **Supply voltage** | 9 to 36 Vdc |
| **Device maximum power consumption** | 2.0 Watts |

### Environmental

| | |
|---|---|
| **Operating temperature range** | -40° C to 70° C [-40° F to 158° F] |
| **Storage temperature range** | -40° C to 85° C [-40° F to 185° F] |
| **EMI/RFI rating** | 100 V/m |
| **Ingress Protection (IP) rating (with mating connector attached)** | IP 67 |

### Mechanical

| | |
|---|---|
| **Operation range, degrees/slope** | ±29° |
| **Operation range, percent slope** | 55.4% |
| **Resolution, degrees** | 0.00046° * |
| **Resolution, slope** | 0.0008% * |
| **Accuracy , degrees** | 0.15° |
| **Accuracy, slope** | 0.26% |
| **Temperature drift, degrees** | < 0.2° over temperature range |
| **Temperature drift, slope** | < 0.3° over temperature range |
| **Repeatability (hysteresis) degrees** | 0.02° |
| **Repeatability (hysteresis) slope** | 0.03% |
| **Accelerometer range** | 0.268 g |
| **Gyro rate** | ±100° per second |
| **Weight** | 0.34 kg (0.75 lbs) |
| **Vibration** | IEC 60068-2-64 |
| **Shock** | IEC 60068-2-27 test Ea |

* The standard protocol supports 0.01° and 0.01% resolution.

## Notes

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