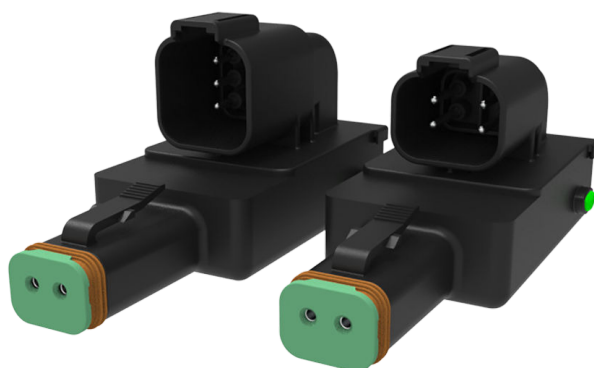


Technical Information

CAN to Current C2C



Revision history

Table of revisions

Date	Changed	Rev
September 2025	Added C2C to file name	0103
August 2025	Corrected typo	0102
June 2025	First edition	0101

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C2C overview

CAN to Current (C2C) is a compact solenoid-mounted microcontroller that communicates using CANBus protocols and provides closed-loop current-control on one or two outputs.

The C2C can be used with on-off and proportional solenoids and is available as either a single or dual channel device.

The single channel device commands only one coil.

To command two coils continuously, two single channel C2C devices are required.

The dual channel commands two coils from one C2C, but not simultaneously.

Technical data

C2C electrical specifications

Specification	Data
Supply voltage	9-36 VDC
Peak output current	3A
Continuous output current	2A
Idle consumption	65mA
Ambient temperature	-40° C to 90° F

C2C CAN specification and ratings

CAN specifications

ISOBus and J1939 compliant.

- Auxiliary Valve Command is used to command current
- Auxiliary Valve Estimated Flow is used to provide current feedback

Ratings

- IP Rating 67
- Clamped load dump (ISO 16750-2:2012 CLASS C)

C2C temperature performance

The steady state current error is dependent on the temperature. In turn, the error range is bound by the temperature range as seen in the table below.

± Variation (A)	Ambient temperature range
0.2	-20 °C to 90 °C
0.16	-10 °C to 90 °C

The part-to-part variation is $\pm 70\text{mA}$ at a given temperature. In turn, it is recommended to tune the C2C to the coil/valve setup at the expected ambient temperature. C2C to C2C tuning is only necessary if less than $\pm 70\text{mA}$ accuracy is necessary.

C2C vibration performance

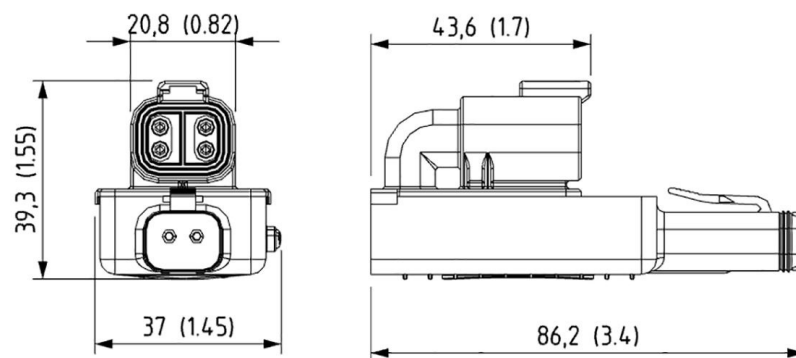
The C2C is rated for 8 Gs of vibration.

[If the C2C is to be mounted in a high vibration environment, such as directly to a pump or engine, please consider remote mounting the C2C.](#)

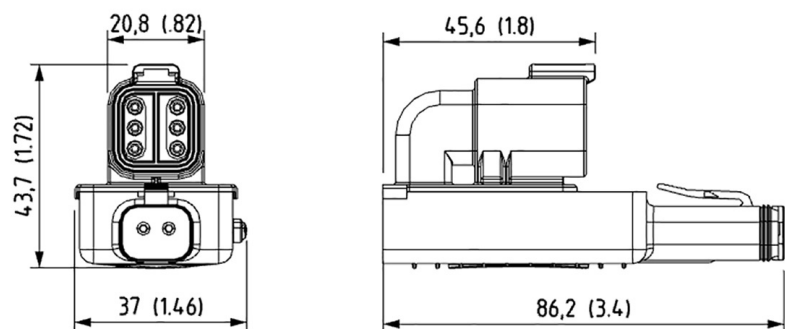
Technical data

C2C dimensions

Single channel



Dual channel



Installation

Integrating with PVG

The C2C is intended to be used on the same CANbus as PVG valves.

The command and feedback messages match PVG messages for ease of integration; however, C2C and PVEs (or other CAN devices) must have different Node-IDs.

Daisy chaining specifications are different for PVE, so it is important to review the current ratings of the PVE when determining the layout of the daisy chaining. For example, it might be beneficial to wire C2Cs before the PVEs so the current for the C2Cs does not travel through the PVE daisy chaining connector.

Wiring information

DEUTSCH connectors

The C2C uses DEUTSCH connectors. The two-pin coil connector is the same for both variants but the cable connector is different to accommodate the second coil.

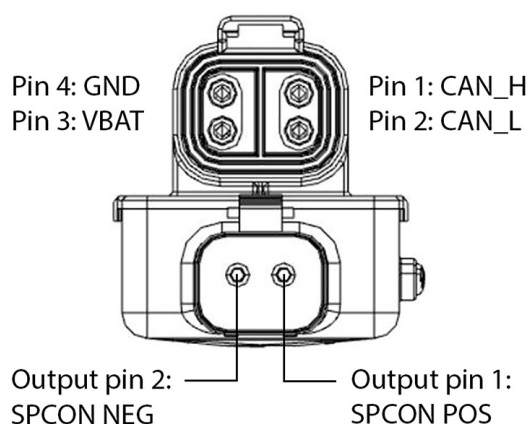
Variant	Coil Connector	Cable Connector
Single Channel	DT06-2S	DT04-4P
Dual Channel	DT06-2S	DT04-6P

Pin-out

The following images detail the pin-out for both C2C variants.

Single channel cable connector

Connector pin out

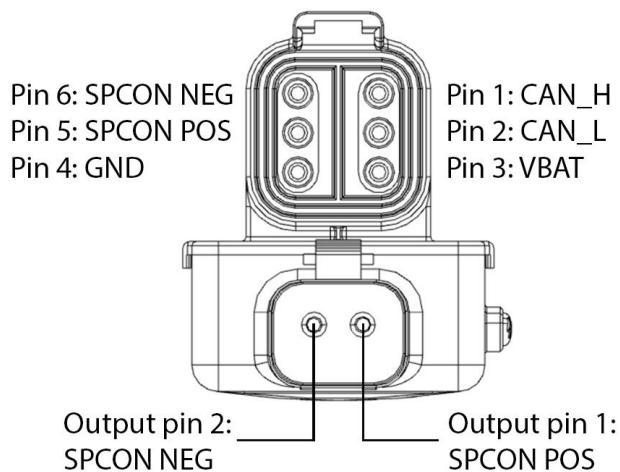


The single channel variant cable connector only has 4 pins.

Installation

Dual channel cable connector

Connector pin out



The dual channel variant cable connector has 6 pins to accommodate the second coil shown by SPCON POS and SPCON NEG.

[The pin numbers for power, ground, CAN_H, CAN_L match the single channel, but the pin locations do not match.](#)

Daisy chaining

The C2C is designed to be a single stub on a CANbus. In turn, the external wiring must be designed to handle the full current of the whole chain and follow CANbus wiring recommendations.

Installation

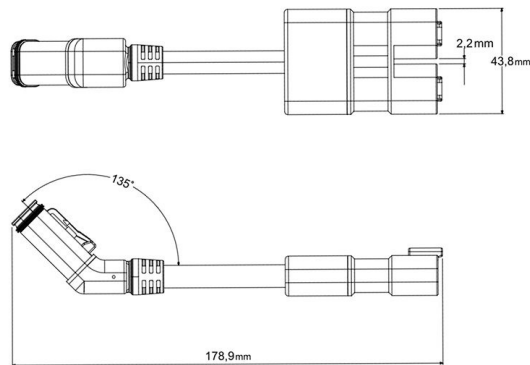
Y cable

The Y cable can be used to daisy chain multiple single channel C2Cs. The connector has one DT06-4S and two DT04-4P.

Y cable specifications

Specification	Data
Maximum current	15A
Part number	11329381

Y cable dimensions



Coil

The coil and wiring connected to the outputs of the C2C must be rated for full battery voltage.

The C2C is designed to work with hydraulic solenoids with a resistance above 1 ohm and inductance above 3mH.

The C2C may not control the current correctly if either the resistance or the inductance is out of range.

Internal protections and warnings

The C2C automatically protects and provides warnings for common situations.

C2C fault handling

The C2C categorizes the faults into levels of severity. It uses the categories to define a fixed set of actions for fault activation and deactivation. These actions are internal and external to the C2C adapter.

The C2C adapter manages the response and resolution of faults based on their severity and categories as either internal or external. A fault is classified as internal when the cause is internal and external when the cause is external to the adapter. The fault handling keeps count of fault occurrence for each fault and preserves it over power cycles/resets.

All faults are transmitted to the CANbus according to the protocol configurations.

Fault severity levels

All C2C adapter errors detected by the software are grouped into three levels based on the fault severity.

In order of least to most severe:

- Information
- Warning
- Severe

Fault handling type

The C2C adapter can be configured as one type of fault handling through the Fault Handling Type parameter.

- | | |
|--------------------|--|
| Active | The C2C will go into a fault state if a warning or severe fault occurs. The protocol specific procedure will have to be followed to clear the fault. Power cycling always clears a fault. |
| Passive | The C2C will only go to a fault state if a severe fault occurs. In turn, in passive mode the C2C does not go into a fault state for warnings so the user is responsible to react accordingly. |
| Fault state | The C2C stops commanding current and changes LED to state described in C2C LED indicator on page 38. Fault handling type and protocol determine how to remove the fault state. |

Clamped load dump

The C2C is designed to handle a clamped load dump (ISO 16750-2:2012 CLASS C).

The C2C will automatically turn off during a clamped load dump to protect itself and downstream components. The C2C will automatically turn back on once the load dump condition is over. No warnings are sent during this condition.

This feature does not remove the necessity for proper fusing.

Output short protection

The C2C hardware has current limit protection on shorted output conditions. This feature limits input power to less than 4 watts if the output is being commanded with a high enough current. If the C2C is commanded for a low current output, it is possible the current limit protection will not be active. Under this condition, the C2C could draw up to 20 watts.

The C2C should send fault conditions for either of these situations. The user software should remove the commanded output if these faults are detected or configure the C2C to Active mode (Active mode automatically commands zero during faults). Failure to remove the commanded output to a C2C with a shorted output could cause damage to the C2C if left on too long.

Internal protections and warnings

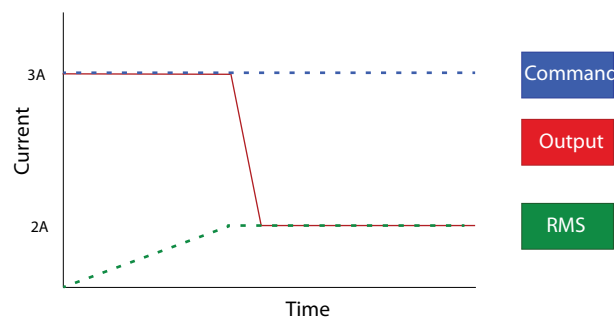
This feature does not remove the necessity for proper fusing.

RMS output current limiting

The C2C software limits the output current to protect the internal components from overheating.

The C2C will automatically limit the output current to 2A once the RMS current over the previous 10 seconds exceeds 2A. A warning is provided via CANbus to notify of the intervention.

The figure below illustrates how limiting might occur. At first the output is not limited, but once the RMS current gets to 2A the output is limited to keep the RMS below 2A. Once the output is limited to 2A limiting stops.



This feature does not remove the necessity for proper fusing.

Incorrect current warning

The C2C will provide a warning if it is unable to achieve the current requested.

This fault is likely due to either insufficient supply voltage or no load connected to the output pins. It is recommended to check the wiring and coil if this warning occurs.

Configuration

The C2C is configured through the CANbus using the PLUS+1® Service Tool.

Boot Node-ID

The Boot Node-ID is configurable between 0x80 and 0x8F.

It is important to configure each C2C and PVE (or other CAN devices) on the bus to a different Boot Node-ID. By default, C2Cs are configured to 0x80.

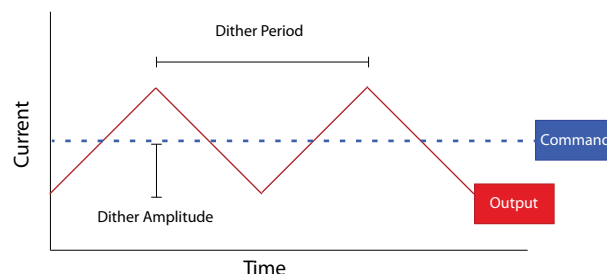
AVC timeout

The AVC timeout determines the maximum amount of time between two commands.

If a command is not received fast enough, the C2C enters an error state. To remove the error state, two neutral commands must be sent or the C2C is power cycled. By default, this feature is turned off (a setting of 0).

Dither

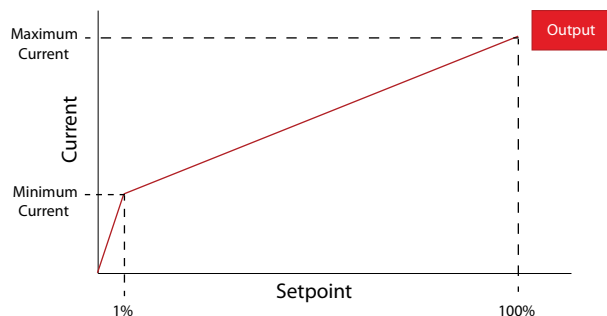
Dither frequency and dither amplitude are configurable up to 250Hz and 25% of maximum current setting (max of 3A) respectively. By default, dither is off.



Proportional

Proportional control is enabled through the Control Mode parameter. Minimum and maximum currents are configurable and the setpoint is interpolated in-between.

The minimum output current is provided at the smallest non-zero setpoint that can be provided over the CANbus. For brevity, 1% is used in the example figure below.

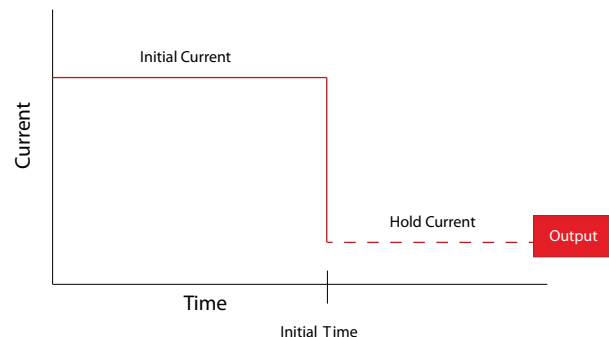


Configuration

On-off

On-off control is enabled through the Control Mode parameter. The C2C device can automatically implement a “peak-and-hold” control scheme.

A high current level can be used to shift the solenoid and then the current can be reduced to a lower level to hold the valve in-place, optimizing electrical power consumption. Initial current, initial time, and hold current determine the behavior of an on-off valve. Whenever 100% command is provided, the device will command the Initial Current for Initial Current Time, then command Hold Current until turned off or receiving a non 100% command. Initial Current parameter cannot be set above 3A.



Coil resistance

The coil resistance parameter is used to provide faster closed loop current control (as a feed forward term). For most cases an estimate of the coil resistance will suffice. However, tuning the coil resistance can provide better performance. A higher resistance will cause the current to raise more quickly but tend to overshoot more. A lower resistance will cause the current to raise less quickly but tend to overshoot less.

Port configuration

The port configuration parameter determines which coil gets commanded for extend and retract states.

For both types of C2C, “Coil 1” is the coil connected to the 2-pin DEUTSCH connector.

C2C type	Port configuration	Extend	Retract
Single	Normal	Coil 1	Neither
	Inverted	Neither	Coil 1
Dual	Normal	Coil 1	Coil 2
	Inverted	Coil 2	Coil 1

J1939 application protocol

DM1 PGN (active diagnostic trouble codes)

The C2C adapter support DM1 PGN as per J1939-73 (02 June 2006 version) specification.

The C2C adapter sends out DM1 frame at every 1 second, as well as event-based (on occurrence or disappearance of faults) as per specifications.

DM1 frame

Message ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18FECAxx	8	Lamp status	Flash status	1-8 bits of SPN SPN	9-16 bits of SPN SPN	Higher 3 bits of SPN; lower 5 bits of FMI SPN/FMI	Occurrence count	Reserved 0xFF	Reserved 0xFF

"xx" in Message ID is the Boot Node ID of the adapter sending DM1 message.

DM1 message description

Frame description for DM1 message

Byte	Description
Byte 1	Lamp status 0x04 - AMBER LAMP (For warning and info errors) 0x10 - RED LAMP (For severe errors) 0x00 - DEFAULT STATE (No error)
Byte 2	Flash status - (0xFF)
Byte 3-5	SPN/FMI (contributes 19 bits SPN and 5 bits FMI) Bits 24 - 6 SPN Bits 5 - 1 FMI
Byte 4	Occurrence count / conversion method Bit 8 - conversion method Bits 7-1 - occurrence count
Byte 5-8	Reserved - 0xFF

Transmission rate: sent immediately at detection of a fault and every second.

DM1 message IDs are configured as following:

DM1 message IDs

C2C #	Node-ID	Message-ID
0	0x80	0x18FECA80
1	0x81	0x18FECA81
2	0x82	0x18FECA82
3	0x83	0x18FECA83
4	0x84	0x18FECA84
5	0x85	0x18FECA85
6	0x86	0x18FECA86
7	0x87	0x18FECA87
8	0x88	0x18FECA88
9	0x89	0x18FECA89
10	0x8A	0x18FECA8A
11	0x8B	0x18FECA8B
12	0x8C	0x18FECA8C
13	0x8D	0x18FECA8D

J1939 application protocol

DM1 message IDs (continued)

C2C #	Node-ID	Message-ID
14	0x8E	0x18FECA8E
15	0x8F	0x18FECA8F

DM1 scenarios

DM1 for only one active error

If there is only one active error present in system then C2C adapter will send out DM1 as follows: Here, DTC with SPN 0x048FE9, FMI 0x13 of WARNING type is Active.

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
DM1 PGN	8	Lamp status	Reserved	SPN1	SPN2	SPN3 FMI	OC	Reserved	Reserved
0x18FECA81	8	0x04	0xFF	0xE9	0x8F	0x93	0x03	0xFF	0xFF

DM1 for no active errors

If no active error is present in the system, then the C2C adapter will send out the following DM1.

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18FECA81	8	0x00	0xFF	0x00	0x00	0x00	0x00	0xFF	0xFF

J1939 application protocol

DM1 for multiple active errors

If there are multiple active errors present in the system, the C2C will send out DM1 in the format of BAM messages as: "following errors are active in the system."

1. DTC with SPN 0x048FD7, FMI 0x00 of WARNING type
2. DTC with SPN 0x048FEF, FMI 0x07 of SEVERE type
3. DTC with SPN 0x048FED, FMI 0x07 of SEVERE type
4. DTC with SPN 0x048FE9, FMI 0x13 of WARNING type

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
BAM	8	BAM	No. of bytes	No. of bytes	No. of packets	Res	DM1 PGN	DM1 PGN	DM1 PGN
0x1CECFFxx	8	0x20	0x12	0x00	0x03	0xFF	0xCA	0xFE	0x00

DT1 frame

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
DT1	8	Seq	Lamp status	Res	EC1 (SPN2)	EC1 (SPN2)	EC1 (SPN3)	EC1 (OC)	EC2 (SPN1)
0x1CEBFFxx	8	0x01	0xFF	0xFF	0xD7	0x8F	0x80	0x01	0xEF

DT2 frame

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
DT2	8	Seq	EC2 (SPN2)	EC2 (SPN3)	EC2 (OC)	EC3 (SPN1)	EC3 (SPN2)	EC3 (SPN3)	EC3 (OC)
0x1CEBFFxx	8	0x02	0x8F	0x87	0x06	0xED	0x8F	0x87	0x06

DT3 frame

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
DT3	8	Seq	EC4 (SPN1)	EC4 (SPN2)	EC4 (SPN3)	EC4 (OC)	Res	Res	Res
0x1CEBFFxx	8	0x03	0xE9	0x8F	0x93	0x06	0xFF	0xFF	0xFF

"xx" in Message ID is the Node ID of the adapter sending DM1 message.

EC1	Error code 1
EC2	Error code 2
EC3	Error code 3
EC4	Error code 4
Res	Reserved
OC	Occurrence count

J1939 application protocol

Toggle DM1 message transmission

The C2C adapter supports the option of turning off DM1 message in case the system is in no-error condition.

To turn on or off continuous DM1 messages when the system is not in error state, follow the below instruction.

Set the parameter DM1 Status Transmission of data type UNSIGNED8, stored in EEPROM sector Protocol Data.

Value	Description
0x00	DM1 is only transmitted at boot-up in case of an error, and once when errors are cleared.
0xFF	DM1 is continuously transmitting in no-error condition.

When the value is set to 0xFF, the C2C adapter will send DM1 messages in both normal and fault state.

When the value is set to 0x00, the C2C adapter will send continuous DM1 messages only when the system is in fault state and only one message when in normal state.

At bootup, the adapter reads DM1 Status Transmission from EEPROM.

J1939 application protocol

DM2 PGN (previously active diagnostic trouble codes)

On requesting DM2 PGN (via request PGN), the C2C adapter responds with previously active DTCs information through BAM session.

Both destination-specific and global requests will receive a BAM response.

DM2 frame

Message ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18FECBxx	8	Lamp status	Flash status	1-8 bits of SPN	9-16 bits of SPN	Higher 3 bits SPN; lower 5 bits of FMI	OC/ Conversion method	Reserved	
				SPN/FMI				0xFF	

"xx" in Message ID is the Boot Node ID of the adapter sending DM2 message.

DM2 message description

Frame description for DM2 message

Byte	Description
Byte 1	Lamp status 0x04 - AMBER LAMP (For warning and info errors) 0x10 - RED LAMP (For severe errors) 0x00 - DEFAULT STATE (No error)
Byte 2	Flash status - (0xFF)
Byte 3-5	SPN/FMI (contributes 19 bits SPN and 5 bits FMI) Bits 24 - 6 SPN Bits 5 - 1 FMI
Byte 6	Occurrence count / conversion method Bit 8 - conversion method (default: 0) Bits 7-1 - occurrence count (0 to 126)
Byte 7-8	Reserved - 0xFF (ignored in C2C adapter)

DM2 PGN is transmitted by the adapter, only if it is requested by master or some other device with 'Request PGN' frame.

Transmission rate: sent immediately at detection of a fault and every second.

Frame format for DM2 message

Message-ID	DLC	Byte 1	Byte 2	Byte 3
0x18EAxxyy (request PGN)	3	Requested PGN (LSB)	Requested PGN (MSB)	0x00
		0xCB	0xFE	

Where xx is the Node-ID of the adapter and yy is the sender's Node-ID.

DM2 scenarios

DM2 for only one previously active error

If there is only one active error present in system then C2C adapter will send out DM2. Here, a DTC with 0x048FE9 SPN (FMI 0x13) was previously active.

Request PGN: send request for DM2

Message-ID	DLC	Byte 1	Byte 2	Byte 3
0x18EA8105	3	0xCB	0xFE	0x00

J1939 application protocol

DM2 frame for C2C adapter

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
DM2 PGN	8	Lamp status	Reserved	SPN1	SPN2	SPN3/FMI	OC	Reserved	-
0x18FECBxx	8	0x04	0xFF	0xE9	0x8F	0x93	0x01	0xFF	0xFF

xx in Message-ID is the Node-ID of the adapter sending the DM2 message.

DM2 for no previously active errors

If no previously active error is present in the system, then ISOBUS adapter will send out DM2 as:

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18FECBxx	8	0x00	0xFF	0x00	0x00	0x00	0x00	0xFF	0xFF

xx in Message-ID is the Node-ID of the adapter sending the DM2 message.

DM2 for multiple previously active errors

Currently, there are NO errors Active in the system (hence, current lamp-status is 0). The Following are the previously Active errors in the system.

1. DTC with SPN 0x048FED, FMI 0x07 of CRITICAL type
2. DTC with SPN 0x048FEF, FMI 0x07 of CRITICAL type
3. DTC with SPN 0x048FD7, FMI 0x00 of WARNING type
4. DTC with SPN 0x048FE9, FMI 0x13 of WARNING type

If there are more than one previously active errors present in system then ISOBUS adapter will send out DM2 in the format of BAM messages as:

Format	Message-ID	DLC	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BAM	0x1CECFFxx	8	BAM	No. of bytes	No. of bytes	No. of packets	Reserved	DMS PGN (0x00FECB)		
			0x20	0x12	0x00	0x03	0xFF	0xCB	0xFE	0x00
DT1	0x1CEBFFxx	8	-	SPN1		SPN2	SPN3 / FMI	OC	SPN1	
			Seq.	Lamp status	Reserved	Error code 1				EC 2
			0x01	0x10	0xFF	0xED	0x8F	0x87	0x01	0xEF
DT2	0x1CEBFFxx	8	-	Error code 2			Error code 3			
			Se1.	SPN2	SPN3 / FMI	OC	SPN1	SPN2	SPN3 / FMI	OC
			0x02	0x8F	0x87	0x06	0xD7	0x8F	0x80	0x06
DT3	0x1CEBFFxx	8	-	SPN1	SPN2	SPN3 / FMI	OC	Reserved		
			Seq.	Error code 4				Reserved		
			0x03	0xE9	0x8F	0x93	0x06	0xFF	0xFF	0xFF

xx in Message-ID is the Node-ID of the adapter sending the DM2 message. EC2 = error code 2; OC = occurrence count.

DM2 when BAM session is unavailable

If there are more than one previously active error present in the system and BAM session is unavailable (may be busy with transmission of DM1/DM2), then the ISOBUS adapter will send out busy acknowledgement message globally as follows:

J1939 application protocol

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18E8FFxx (Ack PGN)	8	BAM busy (control byte)	0x00	Reserved	Reserved	Reserved	Requested PGN		
		0x03	0x00	0xFF	0xFF	0x05	0xCB	0xFE	0x00

xx in Message-ID is the Node-ID of the adapter sending the DM2 message.

J1939 application protocol

DM3 PGN (reset of previously active DTCs)

On invoking the DM3 PGN (via Request PGN), the C2C adapter resets the error occurrences to zero and erases error history in EEPROM. The error activeness or any other status remains unchanged.

Below information is set to default values in EEPROM upon invoking the DM3 PGN.

- Diagnostics data sector 1
 - Error occurrence counters: set to default value 0
 - DM3_Counter: increments when a DM3 command is processed successfully
- Diagnostics data sector 3
 - Error history FIFO index: set to default value 0
 - Error history number of valid error records: set to default value 0
 - Error history FIFO size: set to default value 16
 - All error history records: set to default value 255 (0xFF)
- Diagnostics data sector 5
 - First and last error occurrence timestamps: set to default value 4294967295 (0xFFFFFFFF)

The adapter does not increment the DM3_COUNTER value upon reaching the max value. Only the diagnostic information clearing is performed upon receiving DM3 request when the DM3_COUNTER value is at max value. However, the adapter clears the diagnostic data for previously active DTCs and currently active DTCs upon receiving the DM3 request.

Frame format for request PGN message

Message-ID	DLC	Byte 1	Byte 2	Byte 3
0x18EAxxyy	3	Requested PGN (LSB)	Requested PGN (MSB)	0x00
		0xCC	0xFE	0x00

"xx" in Message-ID is the destination node for the request (ex. Node-ID or global).

"yy" in Message-ID is sender's Node-ID, (either master or another tool).

DM3 scenarios

DM3 send request

The send request for DM3 is as follows:

Message-ID	DLC	Byte 1	Byte 2	Byte 3
0x18EAxx05 (Request PGN)	3	0xCC	0xFE	0x00

After clearing the error log history, the C2C adapter will send a positive acknowledgement as:

Message-ID	DLS	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18E8FFxx (Ack PGN)	8	Ack (control byte)	0x00	Reserved			Requested PGN		
		0x00	0x00	0xFF	0xFF	0x05	0xCC	0xFE	0x00

"xx" in Message-ID is the Node-ID of the adapter.

Busy acknowledgement for multiple DM3 operations

The C2C adapter will send a busy acknowledgement if it receives a new DM3 request while already processing a DM3 operation.

C2C adapter will send busy acknowledgement as:

J1939 application protocol

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18E8FFxx (Ack PGN)	8	DM3 busy (control byte)	0x00	Reserved			Requested PGN PGN		
		0x03	0x00	0xFF	0xFF	0x05	0xCC	0xFE	0x00

"xx" in Message-ID is the Node-ID of the adapter.

DM3 clear error log history

The C2C adapter clears the error history even if active errors present in the system. Send request for DM3 with active errors in it.

After clearing error log history, the C2C adapter will send positive acknowledgement as:

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18E8FFxx (Ack PGN)	8	Ack (control byte)	0x00	Reserved			Requested PGN		
		0x00	0x00	0xFF	0xFF	0x05	0xCC	0xFE	0x00

"xx" in Message-ID is the Node-ID of the adapter.

The C2C adapter clears error occurrence counters of active errors in Diagnostics Data Sector 1 of EEPROM to 0.

J1939 application protocol

DM11 PGN (reset of active DTCs)

The DM11 command instructs the C2C adapter to clear the active status of critical errors if FAULT_HANDLING_TYPE (EEPROM parameter) is configured for active.

There are two important notes about the DM11 command:

- The DM11 command does not affect the status of severe errors. These remain unchanged.
- The DM11 command is sent only after the critical error condition has been fully resolved. If the error is still present when the DM11 command is sent, the error will be triggered again.

The DM11 command only clears the active status of critical errors. All other error-related information (including error counters, timestamp, previously active errors, etc.) remains unchanged.

On both destination specific and global requests, the C2C adapter responds with an acknowledgment response (ACK). After clearing the critical error activeness, the adapter sends positive acknowledgement. If there are any active non-critical (severe, warning and info) errors after the clearing of the critical error activeness, the adapter sends negative acknowledgement.

Since the warning and info type of errors are auto-recovered, clearing them via DM11 is unnecessary.

Message-ID	DLC	Byte 1	Byte 2	Byte 3
0x18Eaxxyy (Request PGN)	3	Requested PGN - DM11 (LSB)	Requested PGN - DM11 (MSB)	0x00
		0xD3	0xFE	0x00

"xx" is the destination node for the request, either Node-ID of the C2C adapter or global.

"yy" is the sender's Node-ID.

DM11 scenarios

DM11 no active severe error in valve

No severe error is active in the valve. After the successful transmission of the DM11, the C2C adapter will send out a positive acknowledgement.

Send request for DM11

Message-ID	DLC	Byte 1	Byte 2	Byte 3
0x18Eaxx05 (Request PGN)	3	0xD3	0xFE	0x00

If there are no severe errors present, the C2C adapter sends a positive response, as follows:

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18E8FFxx (Ack PGN)	8	Ack (control byte)	0x00	Reserved		Address Ack	Requested PGN		
		0x00	0x00	0xFF	0xFF	0x05	0xD3	0xFE	0x00

"xx" in Msg-ID is the Node-ID of the valve.

DM11 present active severe error

If a severe error is active within the valve, the C2C adapter will respond with a negative acknowledgement.

Send request for DM11

Message-ID	DLC	Byte 1	Byte 2	Byte 3
0x18Eaxx05 (Request PGN)	3	0xD3	0xFE	0x00

J1939 application protocol

As there is a severe error active in the system, the C2C adapter will respond with a negative response, as follows:

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18E8FFxx (Ack PGN)	8	Ack (control byte)	0x00	Reserved		Address Ack	Requested PGN		
		0x01	0x00	0xFF	0xFF	0x05	0xD3	0xFE	0x00

"xx" in Msg-ID is the Node-ID of the valve.

J1939 application protocol

DM13 PGN

Implementation of `start diagnostic DM13` will make C2C adapter ignore all warning and info type of faults, which are generated due to unstable voltage levels at power up.

All warning and info level DTCs are ignored by C2C adapter and not communicated on CAN bus until the `start diagnostic DM13` command is received. The C2C adapter will stay in inactive control state after power-on till they receive the `start diagnostic DM13` command.

`Start diagnostic DM13` can be enabled or disabled based on the boolean parameter `Support DM13` value stored in EEPROM in Protocol sector. If this boolean is `TRUE`, `start diagnostic DM13` will be activated.

Frame format for DM13 message

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
DM13	8	Bit 2-1: start broadcasting on reception of DM13	Ignored	Ignored	Ignored	Ignored	Ignored	Ignored	Ignored
0x18DFxx05		0xFD	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Where xx is the Node-ID of the adapter.

J1939 application protocol

DM13 scenarios

Start diagnostic DM13 is on

If boolean parameter Support DM13 from EEPROM is **TRUE**, the `start diagnostic DM13` command is activated. The C2C adapter will return to normal fault-handling state and communicate all active DTCs on CAN bus but positive acknowledgment will not be sent.

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18DFFF05	8	0xFD	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Start diagnostic DM13 is off

If boolean parameter Support DM13 from EEPROM is **FALSE**, the `start diagnostic DM13` command is disabled. The C2C adapter will send negative acknowledgment. All active DTCs, including warning and info level DTCs, will be acknowledged and communicated on CAN bus.

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Ack PGN	8	Ack (control byte)	0x00	Reserved	Reserved	Reserved	Requested PGN	Requested PGN	Requested PGN
0x18E8FFxx	8	0x01	0x00	0xFF	0xFF	0xFF	0xFF	0xDF	0x00

["xx" in Message-ID is the Boot Node-ID of the adapter.](#)

Address claim

The device must log in to the network with a valid address before it can send CAN messages. Upon a successful boot-up procedure, the C2C adapter will transmit an "Address Claimed" message to signal its operational status on the network.

The adapter must first send the address claim message before it can send other CAN messages.

The SPN NAME should be configured using the EEPROM parameter Valve Name x, where 'x' represents the adapter number, ranging from 1 to 8. If the EEPROM parameter Node ID Address Claim is set to 0xFF, the adapter will utilize its own Node ID source address, overriding the value in Valve Name x.

[The J1939-81 network management is not supported.](#)

Address claimed message

The address claimed message is a predefined message format (dummy address claim) and is configurable from EEPROM config tool parameter VALVE_NAME_1 - VALVE_NAME_8. The value represents the valve name.

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x18EEFFyy	8	0x01	0x00	0x20	0x07	0x08	0xFF	0x02	0x20
		NAME							

[yy in Msg-ID is claimed source address \(sender's Node-ID \(i.e. Node-ID of the C2C adapter\)\).](#)

ISOBUS application protocol

PGN: auxiliary valve command

The C2C adapter uses the `auxiliary valve command (AVC)` message as the current setpoint information from the master ECU, also referred as the setpoint message. The following information describes the `auxiliary valve command frame`.

The received AVC message includes the following signals.

AVC frame

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE3xyy	8	Port flow	Reserved	Bits 8, 7: fail safe mode Bits 6, 5: reserved Bits 4-1: valve state	Reserved	Reserved	Reserved	Reserved	Reserved

The C2C adapter utilizes the *port flow* and *valve state* signals to ascertain the current setpoint.

"x" in Message-ID is the destination node for the command, within range of 0x0 to 0xF.

"yy" in Message-ID is sender's node-ID, (either master or another tool).

AVC message description

AVC frame bitwise description

Byte	Description
Byte 1	Port flow 0% ⇒ 100% of the max current 250 or 0xFA ⇒ 100% of the max current
Byte 2	Reserved - 0xFF
Byte 3	Bits 8, 7: fail safe mode Device support only 'block (0x00) as fail-safe mode Bits 6, 5: ignored Bits 4, 1: state 0000 block 0001 extend 0010 retract 1010 hand operation 1110 emergency stop
Byte 4-8	Reserved - 0xFF

AVC source addresses are configure according to the table below.

AVC frame message IDs

C2C #	Boot Node-ID	AVC message-ID
0	0x80	0x0CFE3005
1	0x81	0x0CFE3105
2	0x82	0x0CFE3205
3	0x83	0x0CFE3305
4	0x84	0x0CFE3405
5	0x85	0x0CFE3505
6	0x86	0x0CFE3605
7	0x87	0x0CFE3705
8	0x88	0x0CFE3805

ISOBUS application protocol

AVC frame message IDs (continued)

C2C #	Boot Node-ID	AVC message-ID
9	0x89	0x0CFE3905
10	0x8A	0x0CFE3A05
11	0x8B	0x0CFE3B05
12	0x8C	0x0CFE3C05
13	0x8D	0x0CFE3D05
14	0x8E	0x0CFE3E05
15	0x8F	0x0CFE3F05

AVC monitoring

The C2C adapter receives periodic AVC messages, and time guarding is performed on AVC PGN messages. On timeout event, it raises ERR_VALVE_FLOW_CMD_TIMGURD (0x48FE9, 0x13) error.

The timeout period is an EEPROM parameter AVC Timeout and thus, configurable to user.

AVC validation

The C2C adapter validates the data received in the AVC message based on certain conditions.

- Any SPN signal data has an invalid value
- Invalid DLC

If invalid data is received, the C2C adapter raises error ERR_INVALID_DATA_RECV_IN_AVC_CMD (0x7F1E4, 0x13).

ISOBUS application protocol

AVC scenarios

AVC command for different state with different current setpoint. The following scenarios are with Boot Node ID 0x81.

Set 0% current for extend coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE3105	8	0x00	0xFF	0x31	0xFF	0xFF	0xFF	0xFF	0xFF

Set 50% current for extend coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE3105	8	0x7D	0xFF	0x31	0xFF	0xFF	0xFF	0xFF	0xFF

Set 100% current for extend coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE3105	8	0xFA	0xFF	0x31	0xFF	0xFF	0xFF	0xFF	0xFF

Set 0% current for retract coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE3105	8	0x00	0xFF	0x32	0xFF	0xFF	0xFF	0xFF	0xFF

Set 50% current for retract coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE3105	8	0x7D	0xFF	0x32	0xFF	0xFF	0xFF	0xFF	0xFF

Set 100% current for retract coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE3105	8	0xFA	0xFF	0x32	0xFF	0xFF	0xFF	0xFF	0xFF

Set block

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE3105	8	0x00	0xFF	0x30	0xFF	0xFF	0xFF	0xFF	0xFF

Set hand operation

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE3105	8	0x00	0xFF	0x3A	0xFF	0xFF	0xFF	0xFF	0xFF

Set emergency stop

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE3105	8	0x00	0xFF	0x3E	0xFF	0xFF	0xFF	0xFF	0xFF

ISOBUS application protocol

PGN: auxiliary valve estimated flow

The auxiliary valve estimated flow (AVEF) serves as feedback from the C2C adapter to the master ECU, also referred as a current feedback message. The following information describes the AVEF.

AVEF message frame

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE1xyy	8	Extend port estimated flow	Retract port estimated flow	Bits 8, 7: fail safe mode Bits 6, 5: reserved Bits 4-1: state	Reserved	Reserved	Reserved	Reserved	Reserved

Byte 1/2 describe the extend/retract port estimated flow, which is the estimated value of current flowing through the coil mapped to port.

"x" in Message-ID is the destination node for the command, within range of 0x0 to 0xF.

"yy" in Message-ID is Boot Node ID, (i.e. Boot Node ID of the C2C).

AVEF message description

AVEF frame bitwise description

Byte	Description
Byte 1	Extend port estimated flow 125 or 0x7D $\Rightarrow$ 0% of the max current 225 or 0xE1 $\Rightarrow$ 100% of the max current
Byte 2	Retract port estimated flow 125 or 0x7D $\Rightarrow$ 0% of the max current 225 or 0xE1 $\Rightarrow$ 100% of the max current
Byte 3	Bits 8, 7: fail-safe mode Device support only 'block' (0x00) as fail-safe mode Bits 6, 5: reserved Bits 4, 1: state 0000 block 0001 extend 0010 retract 1110 error
Byte 4-8	Reserved - 0xFF

When the AVEF C2C state indicates error, the estimated Current in AVEF message is not reliable for determining actual estimated Current.

The C2C adapter periodically transmits the AVEF message. Users can configure the repetition rate of the AVEF PGN through an EEPROM parameter AVEF Transmission Time. Message transmission is disabled when AVEF Transmission Time is set to 0.

AVEF message IDs

C2C #	Boot Node ID	AVEF message-ID
0	0x80	0x0CFE1080
1	0x81	0x0CFE1181
2	0x82	0x0CFE1282
3	0x83	0x0CFE1383
4	0x84	0x0CFE1484
5	0x85	0x0CFE1585

ISOBUS application protocol

AVEF message IDs (continued)

C2C #	Boot Node ID	AVEF message-ID
6	0x86	0x0CFE1686
7	0x87	0x0CFE1787
8	0x88	0x0CFE1888
9	0x89	0x0CFE1989
10	0x8A	0x0CFE1A8A
11	0x8B	0x0CFE1B8B
12	0x8C	0x0CFE1C8C
13	0x8D	0x0CFE1D8D
14	0x8E	0x0CFE1E8E
15	0x8F	0x0CFE1F8F

ISOBUS application protocol

AVEF scenarios

AVEF command for different state with different coil Current with reserved bits as 1. The following scenarios are with Boot Node ID 0x81.

AVEF message when device is in block state

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE1181	8	0x7D	0x7D	0x30	0xFF	0xFF	0xFF	0xFF	0xFF

AVEF message when current is 0% in extend coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE1181	8	0x7D	0x7D	0x31	0xFF	0xFF	0xFF	0xFF	0xFF

AVEF message when current is 50% in extend coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE1181	8	0xAF	0x7D	0x31	0xFF	0xFF	0xFF	0xFF	0xFF

AVEF message when current is 100% in extend coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE1181	8	0xE1	0x7D	0x31	0xFF	0xFF	0xFF	0xFF	0xFF

AVEF message when current is 0% in retract coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE1181	8	0x7D	0x7D	0x32	0xFF	0xFF	0xFF	0xFF	0xFF

AVEF message when current is 50% in retract coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE1181	8	0x7D	0xAF	0x32	0xFF	0xFF	0xFF	0xFF	0xFF

AVEF message when current is 100% in retract coil

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE1181	8	0x7D	0xE1	0x32	0xFF	0xFF	0xFF	0xFF	0xFF

AVEF message when device is in error state

Message-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x0CFE1181	8	0x7D	0x7D	0x3E	0xFF	0xFF	0xFF	0xFF	0xFF

ISOBUS application protocol

Master node ID configuration

The C2C adapter can be enabled to listen to specific PGNs only from a configured source node address using the Master Node ID configuration feature, thus avoiding the interference from other nodes.

The Master Node ID is a configurable parameter stored in EEPROM sector protocol data.

Master Node ID value	Description
0x00 to 0xFD	The adapter listens to the PGN only from a source address specified by Master Node ID value and ignores the PGN from other source addresses.
0xFF	The adapter listens to the PGN from all source addresses.

If the Master Node ID value is set to 0xFE, the adapter shall use default node ID set in EEPROM configurations, since 0xFE is reserved for J1939-81 Network Management.

The Master Node ID configuration feature is applicable only to below PGNs:

- PGN: [Auxiliary Valve Command](#)

Master node ID scenarios

Scenario 1

Master Node ID value is set to 0x05 in EEPROM. In this case, the adapter will accept AVC and PD message PGNs only from the source address 0x05. AVC and PD message from source address other than 0x05 will not be

Scenario 2

Master Node ID value is set to 0xFF in EEPROM. In this case, the adapter will accept AVC and PD message PGNs from all source addresses (i.e., source addresses in the range 0x00 to 0xFD).

Diagnostic features

Debug messages

The C2C adapter will send debug information which provides the user with signals that are not available on any CAN messages. This feature assists the user in tuning the control loop parameters based on the specific application.

The transmission rate of debug message is configurable through EEPROM. A Byte is reserved in protocol data sector named Debug Msg Period. The range of Debug Msg Period is 0 to 255 (0ms to 2550ms).

- If Debug Msg Period is 0 then C2C adapter will not transmit debug message.
- If Debug Msg Period is 1 then C2C adapter will transmit debug message with transmission rate 10 ms.
- If Debug Msg Period is 2 then C2C adapter will transmit debug message with transmission rate 20 ms and so on.
- The Debug Message includes the following signals:
 - Instantaneous Current
 - RMS Current
 - Saturated Integrated Error
 - Control State
 - PWM Duty Cycle
 - Battery Voltage
 - PCB Temperature
 - Active Coil

Debug message frame

- CAN Msg-ID: the 11bit identifier of CAN Msg-ID will be 0x740 + Application Node-ID.
- DLC: 8 bytes
- Transmission rate: 0 ms (default)

Bytes	Bits							
	7	6	5	4	3	2	1	0
0	Instantaneous current (0-7 bits)							
1	RMS current (0 - 3 bits)				Instantaneous current (8-11 bits)			
2	RMS current (4-11 bits)							
3	Saturated integral error (0-7 bits)							
4	Control state (0-2 bits)			Saturated integral error (8-12 bits)				
5	PCB temperature (0-7 bits)							
6	Battery voltage (0-5 bits)						Active coil (0-1 bits)	
7	PWM duty cycle (0-6 bits)							Reserved

Diagnostic features

Debug message example

The debug message contains the Node ID and the respective Debug Msg-ID for each valve.

Valve #	0	1	2	3	4	5	6	7
Node-ID	0x80	0x81	0x82	0x83	0x84	0x85	0x86	0x87
Debug Msg-ID	0x7C0	0x7C1	0x7C2	0x7C3	0x7C4	0x7C5	0x7C6	0x7C7

8	9	10	11	12	13	14	15
0x88	0x89	0x8A	0x8B	0x8C	0x8D	0x8E	0x8F
0x7C8	0x7C9	0x7CA	0x7CB	0x7CC	0x7CD	0x7CE	0x7CF

In the example given below physical values are as follows:

Signals	Actual value (dec)	Offset values	Debug message value (hex)
Instantaneous current (mA)	1494	0	5D6
Root mean square (RMS) current	1494	0	5D6
Integral error (saturated)	0	3000	BB8
Control state indicator	1	0	1
Pulse width modulation (PWM)	70%	0	46
Battery voltage (V)	12	0	C
PCB temperature (°C)	28	50	4E
Active coil indicator	1	0	1

Msg-ID	DLC	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0x7C0	8	0xD6	0x65	0x5D	0xB8	0x2B	0x4E	0x31	0x8C

Diagnostic features

C2C error codes

DTC is bytes 3-5 of the DM1 message. Refer to section *DM1 PGN (active diagnostic trouble codes)* on page 15.

All C2C errors

Error code	Name	DTC (hex)	FMI (dec)	SPN (dec)	Type	Active	Passive
0	ERR_SW_INITIALIZATION	FD8F8B	11	299005	Internal	Severe	Severe
1	ERR_DIVISION_BY_ZERO	FC8F8B	11	299004	Internal	Severe	Severe
2	ERR_VARIABLE_TRUNCATION	FA8F8B	11	299002	Internal	Severe	Severe
3	ERR_INTERPOLATION_FAULT	D88F8B	11	298968	Internal	Severe	Severe
4	ERR_VBAT_ABOVE_UPPER_LIMIT	730203	3	627	External	Warning	Info
5	ERR_VBAT_BELOW_LOWER_LIMIT	730204	4	627	External	Warning	Info
6	ERR_5V_OUT_OF_RANGE	86F1E2	1	520582	Internal	Severe	Severe
7	ERR_RAM_TEST_FAILURE	15060C	12	1557	Internal	Severe	Severe
8	ERR_EEPROM_VAL_OUT_OF_RANGE	83F1E2	2	520579	Internal	Severe	Severe
9	ERR_FLASH_TEST_FAILURE	74020C	12	628	Internal	Severe	Severe
10	ERR_I2C_COMMUNICATION_FAIL	F98F8C	12	299001	Internal	Severe	Severe
11	Undefined	000000	0	0	Internal	Severe	Severe
12	ERR_VERIFIED_EEPROM_WRITE_FAIL	15908C	12	299029	Internal	Severe	Severe
13	ERR_EEPROM_CONF_DATA_INTEGRITY_FAIL	82F1E2	2	520578	Internal	Severe	Severe
14	ERR_OUT_OF_RANGE_LIFE_TIME_TEMPR	84F1F0	16	520580	External	Warning	Info
15	ERR_INST_TEMPR_ABOVE_UPPER_LIMIT	85F1E0	0	520581	External	Warning	Info
16	ERR_INST_TEMPR_BELOW_LOWER_LIMIT	8EF1E1	1	520590	External	Warning	Info
17	ERR_SPI_COMMUNICATION_FAILURE	0D9082	2	299021	Internal	Severe	Severe
18	ERR_CAN_BUS_OFF	D78F93	19	298967	External	Warning	Info
19	ERR_VALVE_FLOW_CMD_TIMGURD	E98F93	19	298985	External	Warning	Info
20	ERR_INVALID_DATA_RECV_IN_AVC_CMD	E4F1F3	19	520676	External	Warning	Info
21	ERR_STACK_USAGE_ABOVE_LIMIT	F48F82	2	298996	Internal	Severe	Severe
22	ERR_INVALID_HW_VERSION	00F1E2	2	520448	Internal	Severe	Severe
23	ERR_INSTANT_CUREENT_ABOVE_LIMIT	B6F2E0	0	520886	Internal	Warning	Info
24	ERR_RMS_CURRENT_ABOVE_LIMIT	B7F2EF	15	520887	External	Info	Info
25	ERR_CURRENT_DRIVER_FAULT	B9F2E0	0	520889	Internal	Severe	Severe

Fault activations and deactivation

On fault activation, the C2C adapter will follow a set of actions.

1. The C2C adapter broadcasts the Diagnostics Message 1 (DM1), which contains information on active faults.
2. The C2C adapter transitions from fault-state to a safe-state.
3. Adapter updates the fault diagnostics data.

Diagnostic features

C2C LED indicator

When the C2C adapter is enters fault-state, it displays whether the fault is internal or external with an LED light.

When the LED displays a constant red, the C2C detects an internal fault. The LED will blink red when the fault is external.

The LED indicator uses color and blinking frequency to indicate different system states described in the below table

The table below details the C2C LED signals.

LED characteristic

Color	LED characteristic	Description
Green constant		No error – actuating
Green flashing @ 1.5 Hz		Neutral – power save
Red constant		Internal error
Red flashing @ 1.5 Hz		External or float error

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- Hoses and fittings
- Hydraulic power units and packaged systems
- Hydraulic valves
- Industrial clutches and brakes
- Motors
- PLUS+1® software
- Pumps
- Steering
- Transmissions

Danfoss Power Solutions designs and manufactures a complete range of engineered components and systems. From hydraulics and electrification to fluid conveyance, electronic controls, and software, our solutions are engineered with an uncompromising focus on quality, reliability, and safety.

Our innovative products makes increased productivity and reduced emissions a possibility, but it's our people who turn those possibilities into reality. Leveraging our unsurpassed application know-how, we partner with customers around the world to solve their greatest machine challenges. Our aspiration is to help our customers achieve their vision — and to earn our place as their preferred and trusted partner.

Go to www.danfoss.com or scan the QR code for further product information.

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