User Manual

CED-10/CED-11 (J1939)

V1.0 November 2022

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Document History

Rev.	Date	Author	Details of Change
1.0	2022-11-03	Ian Chalinder Nathan Benjafield	Initial release. Valid for CED-10/CED-11 firmware V0.4.0.

1. The CED-10/CED-11 Module

Note: Unless specifically stated otherwise, any use of the term 'CED-10' in this manual gives information that is applicable to both the CED-10 and CED-11 modules.

1.1. Introduction

The CED-10 electronics module is a load cell digitiser with integral delta-sigma 24-bit analogue-to-digital converter for weighing and force measurements with strain gauge sensors used primarily in the automotive industry. The CED-10 includes a selection of standard weighing and calibration functions including the option for tilt compensation.

The CED-10 is Reg 10 approved and has been tested to meet the specifications set out in ISO 13766:2018 and ISO 14982:1998. These approvals allow the CED-10 to be used in multiple automotive industries including earth-moving machines and agricultural.

The device features a CAN interface with support for the J1939 protocol with a fixed data rate of 250 kbps.

The CED-10 can be switched from using the J1939 protocol to using the CANopen protocol as needed to suit the application. This document details the CED-10 operation and commands for the J1939 protocol only. To switch to using the CANopen protocol, see the Bus Protocol section of this manual (section 6.5.2) and refer to the CED-10/CED-11 CANopen User Manual (Flintec document 0100692) for details of its operation and command set.

1.2. Disclaimer

No patent liability is assumed with respect to the use of the information contained herein. While every precaution has been taken in the preparation of this Manual, Flintec assumes no responsibility for errors or omissions. Neither is any liability assumed for damages resulting from the use of the information contained herein.

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Flintec reserves the right to revise this manual and alter its content without notification at any time.

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Flintec shall not be liable against any damages or problems arising from the use of any options or any consumable products other than those designated as Original Flintec Products.

NOTICE: The contents of this manual are subject to change without notice.

1.3. Safety Instructions

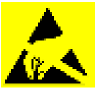
CAUTION: READ this manual BEFORE operating or servicing this equipment. FOLLOW these instructions carefully. SAVE this manual for future reference. DO NOT allow untrained personnel to operate, clean, inspect, maintain, service, or tamper with this equipment. ALWAYS DISCONNECT this equipment from the power source before cleaning or performing maintenance.

CALL Flintec for parts, information, and service.

WARNING: Only permit qualified personnel to service this equipment. Exercise care when making checks, tests and adjustments that must be made with power on. Failing to observe these precautions can result in bodily harm.

WARNING: Disconnect all power to this unit before removing the fuse or servicing.

WARNING: Before connecting/disconnecting any internal electronic components or interconnecting wiring between electronic equipment always remove power and wait at least thirty (30) seconds before any connections or disconnections are made. Failure to observe these precautions could result in damage to or destruction of the equipment or bodily harm.



CAUTION: Observe precautions for handling electrostatic sensitive devices.

2. Specification

CED10/CED-11	
Application	Automotive industry
Bridge excitation	5 V_{DC}
Load cell/sensor	4-wire or 6-wire
Accuracy	Single channel 24-bit delta-sigma ADC
Tilt resolution	14-bit
Weighing range	Single increment
Minimum input sensitivity	0.02 μV/count
Resolution (external)	±1000000 counts (non-approved)
Minimum load cell impedance	75 Ω (4x350 Ω)
Maximum load cell impedance	1100 Ω
Communication protocols	J1939 and CANopen
J1939 data rate	250 kbits/s
Power supply	+9 V_{DC} to +32 V_{DC}
Automotive protection voltage	≥38 V
Filter mode	Selectable FIR, IIR and averaging filters
Calibration	Electronic calibration in mV/V (eCal) or test weight(s)
Weight/measurement functions	Zero, gross, filter etc.
Operating temperature range	-20 °C to +85 °C
Storage temperature	-40 °C to +125 °C
Regulations/standards	REG 10, ISO 13766:2018, ISO 14982:1998
Enclosure dimensions	49.5 mm (diameter) x 41 mm (length) (Enclosure Only) For Loadcell Dimensions please check corresponding datasheet
Volume	78.9 cm^3
Weight	200 g approx.
Enclosure mounting options	Steel bracket 6.6mm drill holes
IP protection rating	IP68

3. Glossary of Terms and Abbreviations

The following is a list of terms and abbreviations used throughout this document, together with a brief explanation of their meaning.

Term / Abbreviation	Meaning
Broadcast message	Any message on the J1939 network that may be received and actioned by all devices simultaneously. Compare with **P2P message**.
CAN	Controller Area Network. A communications bus standard common in automotive and factory automation environments.
CANopen	A higher-layer communication protocol developed and supported by the **CAN** in Automation (CiA) organization. Website: www.can-cia.org
DLC	Data Length Code. A field within a CAN bus frame stating how many bytes of data are included in the frame.
ECU	Electronic Control Unit.
FDC	Flintec Device Configurator. A PC application to configure and calibrate a number of Flintec devices. Available on Flintec's website: www.flintec.com
Increment (Scale increment)	The smallest integer number by which a change of input signal can be represented.
J1939 (SAE J1939)	A higher-layer communication protocol developed and supported by the Society of Automotive Engineers. Website: www.sae.org
kbps	Kilobits per second. A data rate of 1000 **bps**.
LSB	Least Significant Byte. The byte in a multi-byte number which has the lowest value.
MSB	Most Significant Byte. The byte in a multi-byte number which has the highest value.
Node ID	The unique device identifier required by **CAN**-based higher-layer protocols to target messages to a specific recipient.
NVM	Non-Volatile Memory. A data-storage medium which retains information after the device is disconnected from its power source.
P2P message	Peer-to-peer message. A P2P message is any message on the J1939 network which is targeted at a device with a specific **Node ID**. Compare with **Broadcast message**.
PGN	Parameter Group Number. This identifies a message's function and its associated data. J1939 defines a large number of standard PGNs for a wide variety of purposes.
REG 10	Vehicle Type Approval Certificate. An internationally agreed EMC standard applicable to road vehicles

4. Getting Started

You will require:

- A USB to CAN Converter for J1939
- Load cell/scale with test weights or loadcell simulator.
- +12 V_{DC} to +24 V_{DC} power supply capable of delivering approximately 100 mA.
- A suitable software such as the Flintec Device Configuration (FDC) software. Download the latest copy of the FDC from the Flintec website: https://www.flintec.com/uk/downloads?id=493565

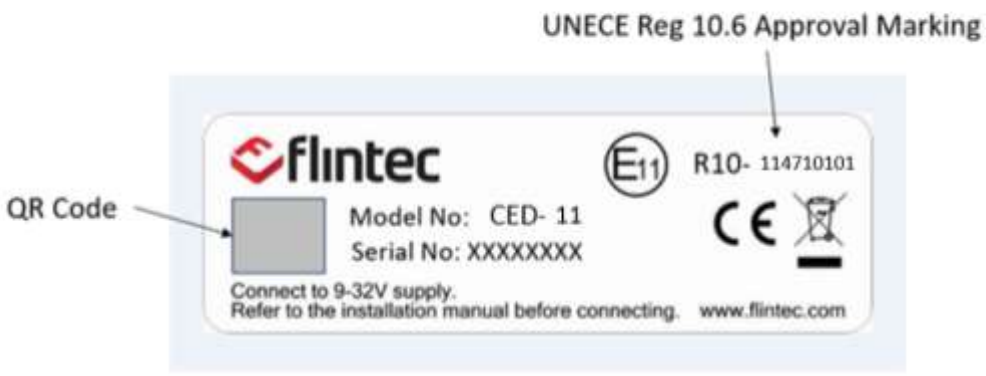
Note: The Flintec FDC application was developed with the Peak System USB-to-CAN adaptor. When using the Flintec FDC with CANopen or J1939 protocols, the Peak System adaptor should be used. Drivers, manuals and ordering information for the Peak System devices are located here:
https://www.peak-system.com/PCAN-USB.199.0.html?&L=1

4.1. Labelling

4.1.1. CED-11

The label for the CED-11 is located on the external wall of the inline enclosure and displays all required information to distinguish between models. The label also contains the Approval Certificate number for the REG 10 approvals.

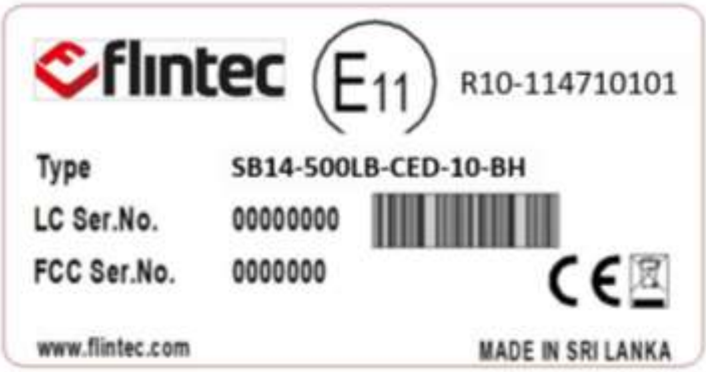
'Identification of Type' Label



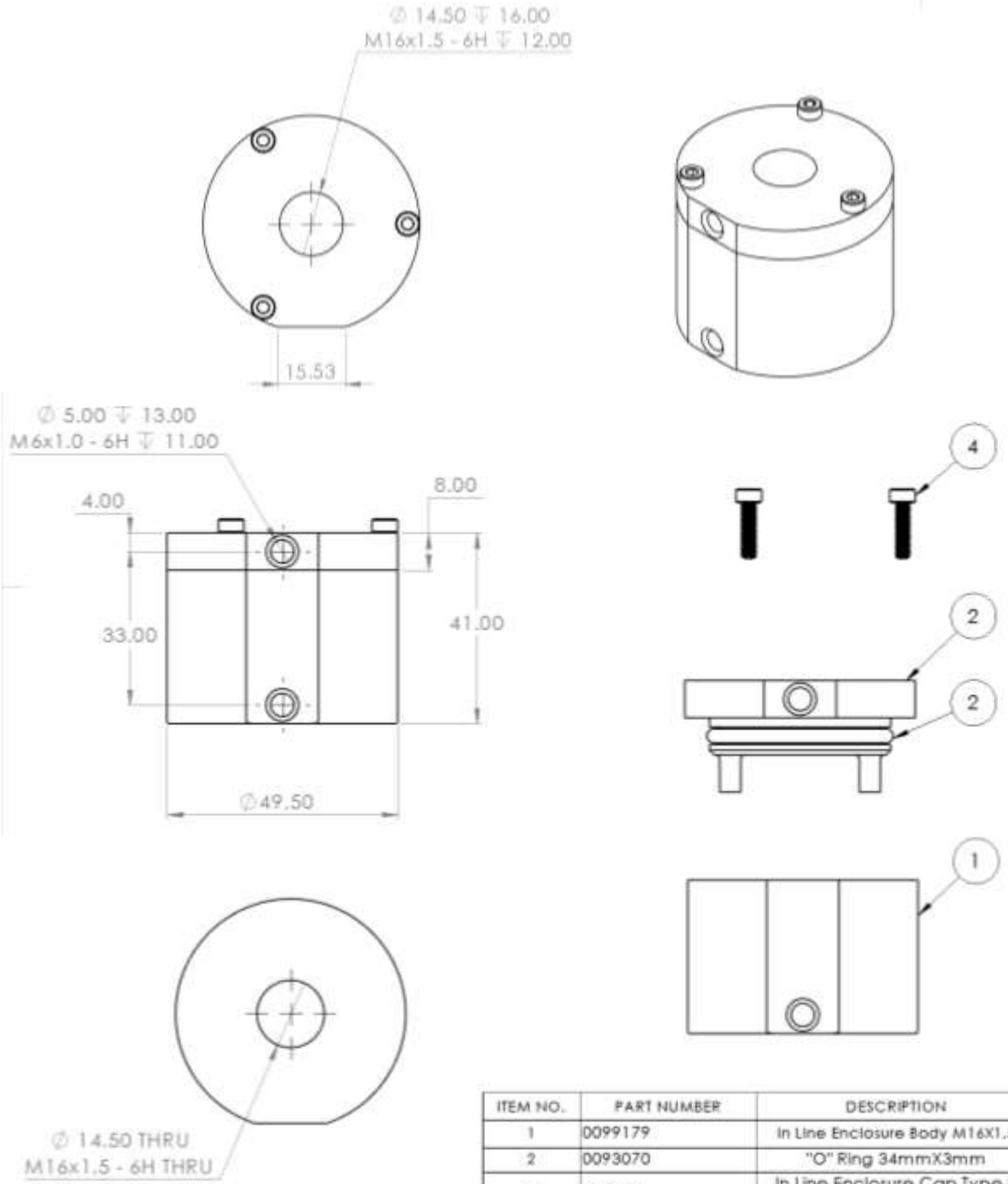
4.1.2. CED-10

The label for the CED-10 is located on the external wall of the load cell and displays all required information to distinguish between models. The label also contains the Approval Certificate number for the REG 10 Approvals.

Loadcell Self Adhesive Label

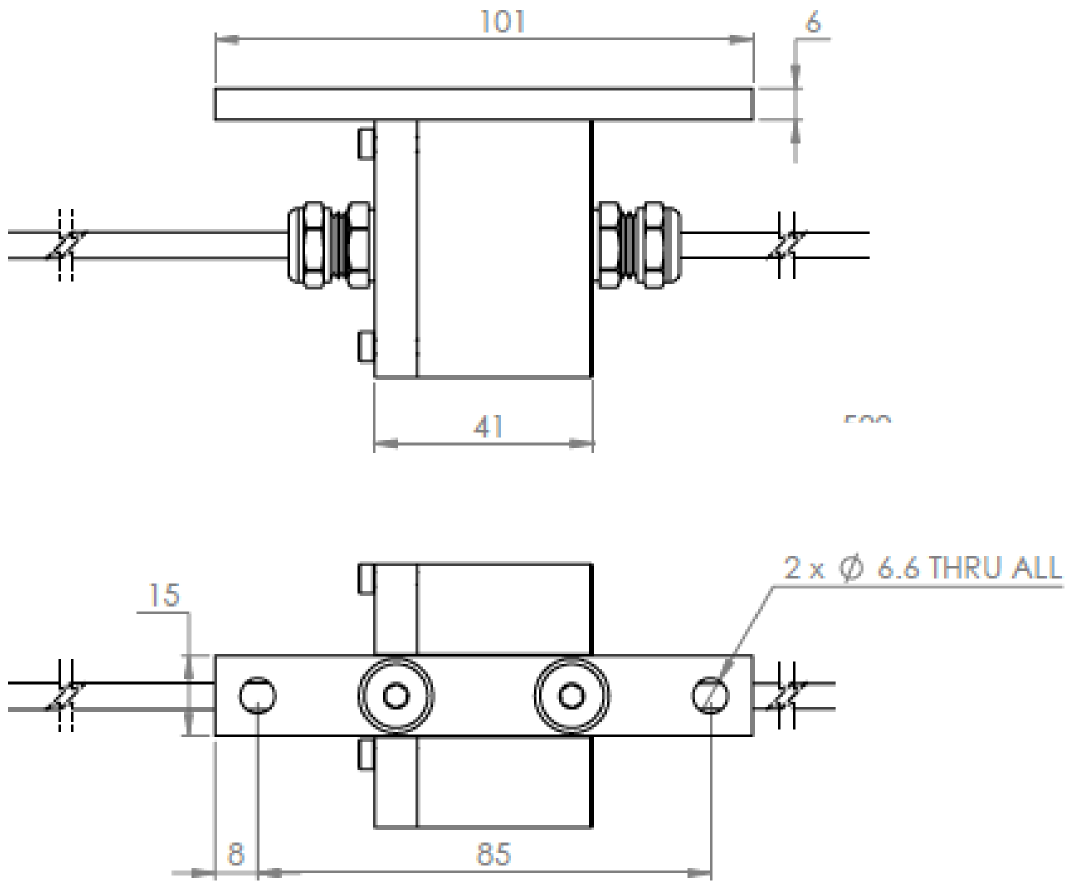


4.2. Inline Enclosure Dimensions

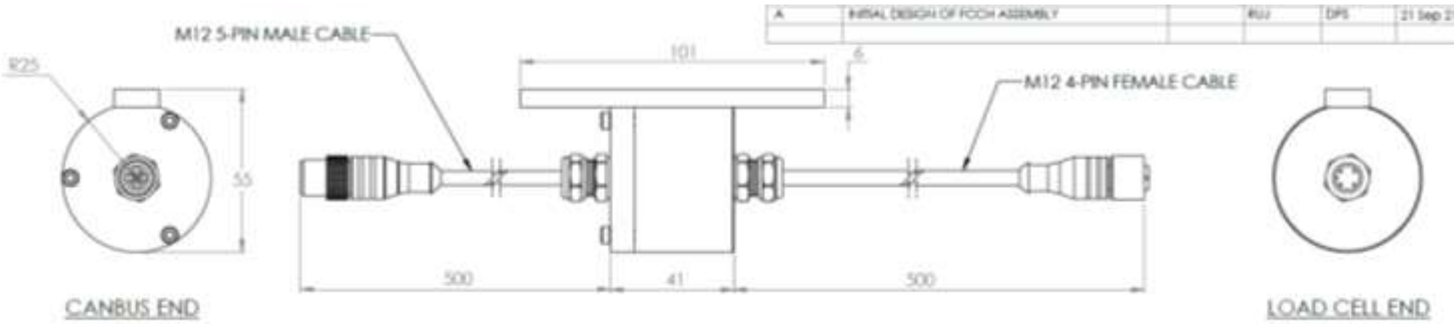


ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	0099179	In Line Enclosure Body M16X1.5	1
2	0093070	"O" Ring 34mmX3mm	1
2	099177	In Line Enclosure Cap Type 2 M16X1.5	1
4	0093076	M3X0.5X12	3

4.3. Enclosure Bracket Dimensions



4.4. Connections



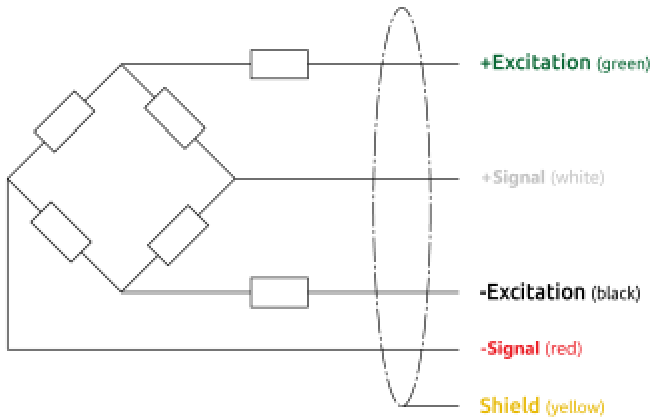
PIN NO.	CANBUS END
1	SHIELD
2	9-32 V
3	GND
4	CAN HIGH
5	CAN LOW

PIN NO.	Loadcell
1	+ EXCITATION
2	+ SIGNAL
3	- EXCITATION
4	- SIGNAL

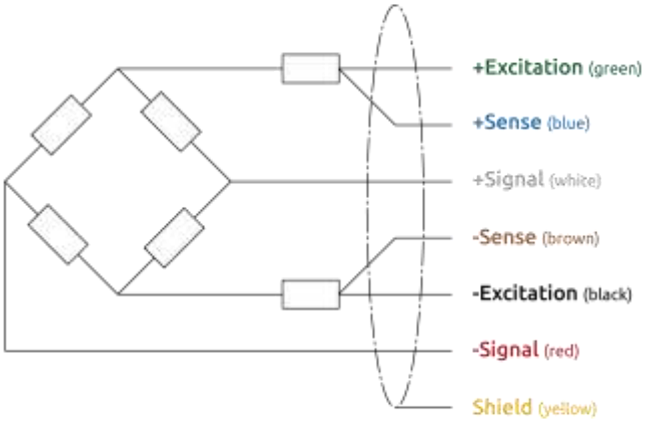
4.4.1. Load-Cell connections

If using a 6-wire load cell, tie the Excitation+ (***EXC+***) to the Sense+ (***S+***) & Excitation- (***EXC-***) to the Sense- (***S-***) for correct configuration, as shown below.

4-Wire Connection:

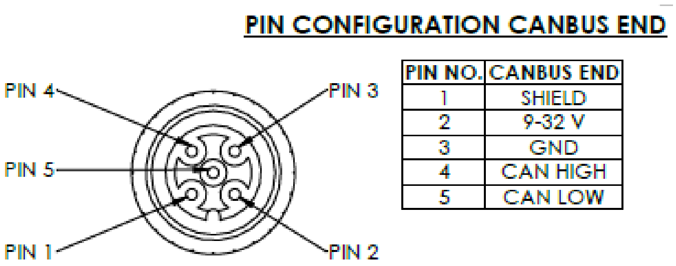


6-Wire Connection:



4.4.2. Power Connections

The power supply is designed to accept a +12 V_{DC} or +24 V_{DC} supply. The PCB will accept a voltage within the range of +9 V_{DC} to +32 V_{DC} input but optimised for +12 V_{DC} or +24 V_{DC}. The power supply ground is the same potential as the communications, but the chassis ground is isolated via a 1 MΩ resistor. Only use the appropriate power and return pins for the supply, all communications pins are to be referenced to the supply ground.

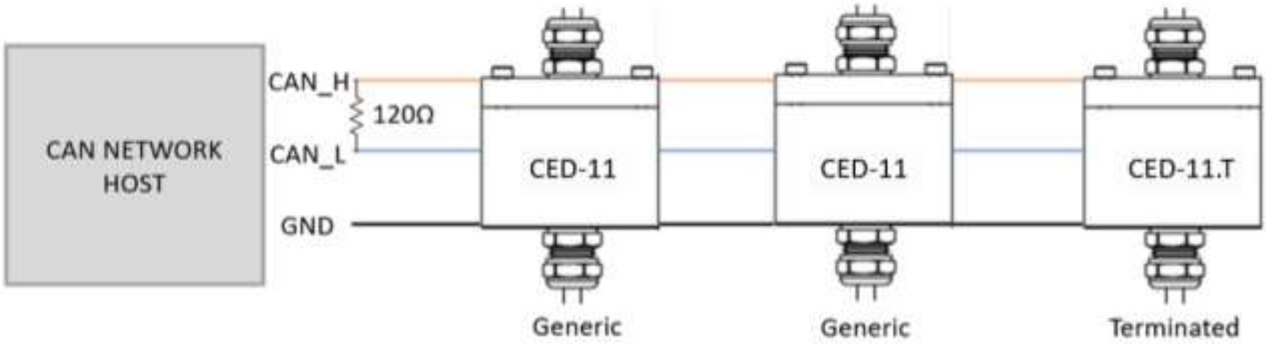


CED-10 Pins	Pin Name	Function
1	Shield	Chassis GND.
2	Vin	Power supply input (+9 V to +32 V).
3	GND	Power supply input GND.
4	CAN_H	CAN differential pin +
5	CAN_L	CAN differential pin -

4.4.3. CAN Bus Connection

For the CAN network to operate properly, it is necessary to place a 120 Ω termination resistor at both the host end and at the furthest point in the network. The CED-10.T/CED-11.T variant is available which has a termination resistor fitted that can be placed at the end of the network.

For more information on available variants, please refer to the CED-10/CED-11 datasheet.



5. The J1939 Interface

5.1. General Interface Description

The J1939 interface conforms to the CAN 2.0B standard, using 29-bit extended identifiers and runs at a fixed speed of 250 kbps. All data is sent in little-endian format; that is, least-significant byte first.

The CED-10 conforms to the requirements for an arbitrary address capable node as defined in the SAE International® J1939™ Network Management specification (J1939-81, March 2017). On first connection to the J1939 network, the CED-10 will negotiate a node address in accordance with the J1939 address claim process. A claimed address is stored in non-volatile memory (so will survive a power cycle) and will continue to be used until a higher-priority device claims that address, in which case a new address will then be negotiated.

Throughout this manual, hexadecimal values are written using the “0x” prefix (such as ‘0x99’); all un-prefixed numbers should be considered as decimal numbers.

5.2. Network Management and Address Management Messages

For the purposes of network management and node address management, the CED-10 will support the Parameter Group Numbers (PGNs) shown in the following sections. The PGNs given in these sections conform to those described in the SAE J1939 Network Management specification.

5.2.1. Node ID/Address

Each node (device) on the J1939 network must have a unique 8-bit node ID (address) in the range 0 to 253 (0xFD); node ID 255 (0xFF) is reserved as a broadcast address to send messages to all nodes simultaneously and ID 254 (0xFE) is the "null" address used by devices that have not yet successfully claimed an address. See section 6.5.1 for information on how to set the scale's node ID.

The node's ID is always included as part of the CAN ID when transmitting a message. This is referred to as the source address.

The node's ID *may* be part of the CAN ID when it is being specifically targeted by a request message from another device. This is referred to as the destination address.

5.2.2. Request for PGN (PGN 59904 [0xEA00])

All supported PGNs (address management and functional) can be requested using PGN 59904.

For example, to request the Tilt-Sensor Message from device 0x8C:

Controller 0xF9 sends:		CED-10 0x8C responds:	
CAN ID	CAN Data (DLC=3) Requested PGN	CAN ID	Data (DLC = 8) PGN Data
0x18EA8CF9	0x02 0xFF 0x00	0x18FF028C	0x15 0xFF 0x27 0x00 0xEE 0x22 0x00 0x00

5.2.3. Address Claimed (PGN 60928 [0xEE00])

When power is supplied to the CED-10, PGN 60928 will be sent as part of the address claim process. The J1939 standard defines a 64-bit NAME (which should be unique on the network) that will be sent in the data bytes of this PGN. For the CED-10, the 64-bit NAME parameter will contain the following data:

Field	Length	Value
Arbitrary address capable	1 bit	1 (Capable)
Industry group	3 bits	2 (Agricultural and forestry equipment)
Vehicle system instance	4 bits	0 (First and only instance)
Vehicle system	7 bits	5 (Fertilizers)
Reserved	1 bit	0
Function	8 bits	134 (Product level)
Function instance	5 bits	0 (First and only instance)
ECU instance	3 bits	Programmable. See section 6.1.4
Manufacturer code	11 bits	1031 (Flintec UK Ltd.)
Identity number	21 bits	21 least-significant digits of the Serial Number. See section 6.1.1.

Example: For a CED-10 with node ID 0x86, ECU Instance number 0 and Serial Number 2052999, the following CAN frame will be received when PGN 60928 is transmitted:

PGN	CAN-ID (hex)	Source (hex)	Data	
60928	18EEFF86	86h	87 53 FF 80 00 86 0A A0	
			IdentityNumber	= 2052999
			ManufacturerCode	= Flintec UK Ltd.
			ECUInstance	= 0
			FunctionInstance	= 0
			Function	= 134
			VehicleSystem	= 5
			VehicleSystemInstance	= 0
			IndustryGroup	= Agricultural and Forestry Equipment
			ArbitraryAddressCapable	= CA is capable

5.3. Broadcast Messages

The CED-10 supports three broadcast messages: the ADC Data Message, the Tilt-Sensor Message and the Tare Weight Message. Broadcast messages do not contain a destination address, so may be received by all nodes on the J1939 network.

The sections below describe each of these messages in detail.

5.3.1. The ADC Data Message (PGN 65281 [0xFF01])

The proprietary (manufacturer-defined) broadcast message PGN 65281 (0xFF01) sends the latest result read from the analogue-to-digital converter (ADC), or data calculated from it (such as gross weight).

The data format, data content and message trigger can be configured as detailed by the following parameters: ADC Output Data Select (6.6.1), ADC Sample Rate (6.3.1), ADC Output Data Rate Divisor (6.3.2) and Filter Type (6.3.3) parameters.

The ADC Output Data Select message determines the data content of the PGN. In summary, the PGN may contain 4 data bytes (ADC data only) or 7 data bytes (ADC data plus the ADC Output Data Select value and Scale Status).

The sections below detail the J1939 frame content for each of these configurations.

5.3.1.1. ADC Data Only

For configurations where ADC data only is selected (gross weight, net weight, ADC sample or mV/V), the ADC data is returned as a 32-bit signed integer or 32-bit floating-point value, as detailed in the ADC Output Data Select message in section 6.6.1 below. The message frame for these configurations is as follows.

CAN ID:	0x18FF0100 + Node ID
PGN:	65281
SAE J1939 acronym:	PropB_01
Message trigger:	Determined by configurations 6.6.1, 6.3.1, 6.3.2 and 6.3.3.
DLC:	4
Data type:	32-bit integer or 32-bit IEE 754 (defined by ADC Output Data Select).
Data byte 0:	ADC data, byte 0 (LSB)
Data byte 1:	ADC data, byte 1
Data byte 2:	ADC data, byte 2
Data byte 3:	ADC data, byte 3 (MSB)

5.3.1.2. ADC Data and Scale Status

For configurations where both ADC data and scale status transmission are selected (gross weight and status, net weight and status, ADC sample and status, mV/V and status), the ADC data is returned as described above, the ADC Output Data Select parameter is sent as an 8-bit unsigned integer and the Scale Status data is returned as a 16-bit bit-mapped value. The bit-values are defined in the Read Scale Status message in section 6.6.2 below.

The message frame for these configurations is as follows.

CAN ID:	0x18FF0100 + Node ID
PGN:	65281
SAE J1939 acronym:	PropB_01
Message trigger:	Determined by configurations 6.6.1, 6.3.1, 6.3.2 and 6.3.3.
DLC:	7
Data type:	32-bit integer or 32-bit IEE 754 (defined by ADC Output Data Select).
Data byte 0:	ADC data, byte 0 (LSB)
Data byte 1:	ADC data, byte 1
Data byte 2:	ADC data, byte 2
Data byte 3:	ADC data, byte 3 (MSB)
Data byte 4:	ADC Output Data Select (see section 6.6.1)
Data byte 5:	Scale Status, byte 0 (LSB) (see section 6.6.2)
Data byte 6:	Scale Status, byte 1 (MSB)

5.3.2. The Tilt-Sensor Message (PGN 65282 [0xFF02])

The proprietary (manufacturer-defined) broadcast message PGN 65282 (0xFF02) transmits pitch, roll and yaw angles calculated from the on-board accelerometer. The data is returned as 4 x 16-bit signed integers, as detailed in the Read Pitch and Roll Angles message (section 6.8.4.5) and the Read Yaw Angle and Axis message (section 6.8.4.6).

The message frame of the tilt-sensor PGN is as follows:

CAN ID:	0x18FF0200 + Node ID
PGN:	65282
SAE J1939 acronym:	PropB_02
Message trigger:	Determined by the Tilt Sensor Message Period parameter, detailed in section 6.8.1.
DLC:	8
Data byte 0:	Roll angle, byte 0 (LSB)
Data byte 1:	Roll angle, byte 1 (MSB)
Data byte 2:	Pitch angle, byte 0 (LSB)
Data byte 3:	Pitch angle, byte 1 (MSB)
Data byte 4:	Yaw axis angle, byte 0 (LSB)
Data byte 5:	Yaw axis angle, byte 1 (MSB)
Data byte 6:	Designated yaw axis
Data byte 7:	Tilt alarm status

5.3.3. The Tare Weight Message (PGN 65283 [0xFF03])

The proprietary (manufacturer-defined) broadcast message PGN 65283 (0xFF03) sends the latest tare weight.

The data content, data format and message trigger are determined by the options in the ADC Output Data Select parameter, so will always be the same as the ADC Data Message (with the ADC data replaced by tare weight).

The tare weight message may contain 4 data bytes (tare weight only) or 7 data bytes (tare weight plus the ADC Output Data Select value and Scale Status).

The sections below detail the J1939 frame content for each of these configurations.

5.3.3.1. Tare Weight Only

For configurations where tare weight only is selected, the tare weight is returned as a 32-bit signed integer or 32-bit floating-point value, as detailed in the ADC Output Data Select message in section 6.6.1 below. The message frame for these configurations is as follows.

CAN ID:	0x18FF0300 + Node ID
PGN:	65283
SAE J1939 acronym:	PropB_03
Message trigger:	On event: the Set Tare or Reset Tare command is executed
DLC:	4
Data type:	32-bit integer or 32-bit IEE 754 (defined by ADC Output Data Select).
Data byte 0:	Tare weight, byte 0 (LSB)
Data byte 1:	Tare weight, byte 1
Data byte 2:	Tare weight, byte 2
Data byte 3:	Tare weight, byte 3 (MSB)

5.3.3.2. Tare Weight and Scale Status

For configurations where both tare weight and scale status transmission are selected, the tare weight is returned as described above, the ADC Output Data Select is sent as an 8-bit unsigned integer and the Scale Status is returned as a 16-bit bit-mapped value. The bit-values are defined in the Read Scale Status message in section 6.6.2 below.

The message frame for these configurations is as follows.

CAN ID:	0x18FF0300 + Node ID
PGN:	65283
SAE J1939 Acronym:	PropB_03
Message trigger:	On-event or on-request (determined by the ADC Output Data Select)
DLC:	7
Data type:	32-bit integer or 32-bit IEE 754 (defined by ADC Output Data Select).
Data byte 0:	Tare weight, byte 0 (LSB)
Data byte 1:	Tare weight, byte 1
Data byte 2:	Tare weight, byte 2
Data byte 3:	Tare weight, byte 3 (MSB)
Data byte 4:	ADC Output Data Select (see section 6.6.1)
Data byte 5:	Scale Status, byte 0 (LSB) (see section 6.6.2)
Data byte 6:	Scale Status, byte 1 (MSB)

5.4. Peer-To-Peer Messages

J1939 peer-to-peer (P2P) messaging allows a CAN data frame to be targeted at a specific node on the network rather than being broadcast to all devices simultaneously. This is achieved by including the destination address as part of the CAN ID field. A given node will ignore all P2P messages in which the destination address does not match its own node ID.

CED-10 P2P messages include configuration messages, diagnostic messages and function-execution messages, and all use the proprietary (manufacturer-defined) P2P PGN 239 (0xEF).

Note: The J1939 specification does allow the use of the global destination address, 0xFF, to be used as the destination address in a P2P message, but this is discouraged. Given that PGN 239 is manufacturer-defined, the commands described in the following sections of this document are intended only for CED-10 devices. Other devices receiving these commands could interpret them in an unintended way, possibly causing harmful results.

5.4.1. Peer-To-Peer Requests

Each CED-10 P2P message has a unique command ID which, together with any command parameters, is contained in the data field of the message. The structure of a P2P request message is shown below:

CAN ID Field	**Data Field**	
0x18EF<dest.><source>	Command ID (8 bits)	Command parameters (0 to 56 bits)

In the CAN ID field above, “<dest>” and “<src>” are the 8-bit node addresses of the message receiver and message sender respectively.

5.4.2. Peer-To-Peer Responses

Every CED-10 P2P request will elicit a response from the CED-10 whose node ID matches the destination address of the request. As with the request, the response also uses PGN 239 (0xEF). The data bytes of the response message include a response code, the command ID of the request and any returned result(s). The structure of a P2P response message is shown below:

CAN ID Field	**Data Field**		
0x18EF<dest.><source>	Response code (8 bits)	Command ID (8 bits)	Result data (0 to 48 bits)

The response code will have one of the following values:

Response Code	Meaning
0xFF	Positive response (success)
0xFE	Negative response – invalid command ID
0xFD	Negative response – parameter(s) out of range
0xFC	Negative response – incorrect message length
0xFB	Negative response – conditions are not correct to execute the request at this time (e.g., the CED-10 is not in calibration mode).

Example:

A request by node 0xF9 to read the firmware part number from node 0x8C will be as follows.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x01	-	0x18EFF98C	0xFF	0x01	0xFD 0x78 0x01 0x00

In the above messages, the data bytes have the following meanings:

Request byte 0: Command ID 0x01 is "Read Firmware Part Number"

Response byte 0: 0xFF indicates a positive response (success).

Response byte 1: 0x01 is the command ID of the request.

Resp. bytes 2-5: 0xFD 0x78 0x01 0x00 is the firmware part number in 32-bit little-endian format (part number 96509 (decimal) is 0x000178FD).

5.4.3. Command Summary

The table below shows a summary of the P2P commands available in the CED-10. A **"(C)"** entry beside the description denotes that the CED-10 must be in calibration mode to *write* the parameter or access the operation (i.e., the correct value has been written to the passcode register).

Command ID	Description
0x00	Read serial number (section 6.1.1)
0x01	Read firmware part number (section 6.1.2)
0x02	Read firmware version (section 6.1.3)
0x08	Restore factory defaults (section 6.9.2)
0x09, 0x0A	Read the up-time counter (section 6.9.3)
0x0B – 0x0E	Reserved for Flintec use.

Command ID	Description
0x10	Read traceable access counter (section 6.2.1)
0x11	Write passcode register (section 6.2.2)
0x12	Save calibration or setup data (section 6.2.3) **(C)**
0x13, 0x14	Maximum weight (section 6.2.4) **(C)**
0x15, 0x16	Minimum weight (section 6.2.5) **(C)**
0x17, 0x18	Warm-up time (section 6.2.6) **(C)**
0x19, 0x1A	Zero range (section 6.2.7) **(C)**
0x1B, 0x1C	Initial zero range (section 6.2.8) **(C)**
0x1D, 0x1E	Zero-tracking range (section 6.2.9) **(C)**
0x1F, 0x20	Maximum tare weight (section 6.2.10) **(C)**
0x21, 0x22	Calibration weight / eCal span-point weight (section 6.2.11) **(C)**
0x23, 0x24	Absolute zero point (eCal) (section 6.2.12) **(C)**
0x25, 0x26	Absolute span point (eCal) (section 6.2.13) **(C)**
0x27	Read zero endpoint (section 6.2.14.1)
0x28	Calibrate zero endpoint (section 6.2.14.2) **(C)**
0x29	Read span endpoint (section 6.2.15.1)
0x2A	Calibrate span endpoint (section 6.2.15.2) **(C)**
0x30, 0x31	ADC sample rate (section 6.3.1)
0x32, 0x33	ADC output data rate divisor (section 6.3.2)
0x34, 0x35	Filter type (section 6.3.3)
0x36, 0x37	No-motion range (section 6.4.1)
0x38, 0x39	No-motion time (section 6.4.2)
0x3A, 0x3B	Last claimed address (section 6.5.1)
0x3C, 0x3D	ECU instance number (section 6.1.4)
0x3E, 0x3F	Bus protocol (section 6.5.2)
0x40, 0x41	ADC output data select (section 6.6.1)
0x42	Read scale status (section 6.6.2)
0x43	Read gross weight (section 6.6.3)
0x44	Read net weight (section 6.6.4)
0x45	Read tare weight (section 6.6.5)
0x47	Read raw (unfiltered) ADC sample (section 6.6.6)
0x48	Read filtered ADC sample (section 6.6.7)

Command ID	Description
0x49	Read filtered mV/V signal (section 6.6.8)
0x4A	Read fault flags (section 6.6.9)
0x50	Set system zero (section 6.7.1)
0x51	Reset system zero (section 6.7.2)
0x52	Set tare (section 6.7.3)
0x53	Reset tare (section 6.7.4)
0x54	Set mV/V tare (section 6.7.5)
0x55	Reset mV/V tare (section 6.7.6)
0x60, 0x61	Tilt sensor message period (section 6.8.1)
0x62, 0x63	Tilt sensor filter length (section 6.8.2) **(C)**
0x64, 0x65	Tilt alarm threshold (section 6.8.3)
0x66	Read pitch and roll sensor data (section 6.8.4.1)
0x67	Read yaw sensor data (section 6.8.4.2)
0x68	Read baseline pitch and roll sensor data (section 6.8.4.3)
0x69	Read baseline yaw sensor data (section 6.8.4.4)
0x6A	Read pitch and roll angles (section 6.8.4.5)
0x6B	Read yaw angle and axis (section 6.8.4.6)
0x6C, 0x6D	Tilt compensation status (section 6.8.5) **(C)**
0x6E	Set or reset tilt sensor baselines (section 6.8.5.3) **(C)**
0x6F	Restore factory default baselines (section 6.8.6) **(C)**
0x70	Read factory default pitch and roll baselines (section 6.8.7)
0x71	Read factory default yaw baseline (section 6.8.8)
0xF1	Read bootloader firmware version (section 6.1.5)
0xF2	Read bootloader part number (section 6.1.6)
0xF3	System reset (section 6.9.1)

6. Command Descriptions

The following sections describe the set of P2P commands that are available in the CED-10. As well as the command identifiers, this section defines the length, content and format of any expected parameters.

In the following sections, all multi-byte data is sent in little-endian format (least significant byte first). Unless stated otherwise, all request parameters and response data are sent as 32-bit signed integers, using 2's complement representation.

6.1. Device Identification Commands

6.1.1. Read Serial Number (0x00)

Command 0x00 returns the device-specific serial number as a 32-bit unsigned integer.

Controller 0xF9 sends:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 1)**		**CAN ID**	**Data (DLC = 6)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x00		0x18EFF98C	0xFF	0x00	0x87 0x53 0x1F 0x00

The data in the above response returns the serial number 2052999.

6.1.2. Read Firmware Part Number (0x01)

Command 0x01 returns the application firmware part number.

Controller 0xF9 sends:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 1)**		**CAN ID**	**Data (DLC = 6)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x01		0x18EFF98C	0xFF	0x01	0xFD 0x78 0x01 0x00

The data in the above response returns the application firmware part number 96509.

6.1.3. Read Firmware Version (0x02)

Command 0x02 returns the application firmware version number in the following format:

Data byte 2: Non-legal firmware version (minor)
Data byte 3: Unused (always 0x00)
Data byte 4: Non-legal firmware version (major)
Data byte 5: Legal firmware version.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x02		0x18EFF98C	0xFF	0x02	0x00 0x00 0x04 0x00

The data in the above response returns application firmware V0.4.0.

6.1.4. ECU Instance Number

Commands 0x3C and 0x3D read and set the ECU instance number. This is used as part of the NAME parameter in the J1939 address-claim process. If there is more than one CED-10 on a single J1939 network, each should be assigned a unique ECU instance number for easier identification.

The permitted values for the ECU instance number are from 0 to 7.

The factory default value is 0.

6.1.4.1. Read ECU Instance Number (0x3C)

Controller 0xF9 broadcasts:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x3C		0x18EFF98C	0xFF	0x3C	0x01 0x00 0x00 0x00

The result returned in the above response shows an ECU instance of 1.

6.1.4.2. Write ECU Instance Number (0x3D)

To set the ECU instance number to 2:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x3D	0x02 0x00 0x00 0x00	0x18EFF98C	0xFF	0x3D	

6.1.5. Read Bootloader Firmware Version (0xF1)

Command 0xF1 returns the bootloader firmware version number in the following format:

Data byte 2: Bootloader firmware version (minor)
Data byte 3: Bootloader firmware version (major)
Data byte 4: Bootloader compatibility number (LSB)
Data byte 5: Bootloader compatibility number (MSB)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0xF1		0x18EFF98C	0xFF	0xF1	0x01 0x02 0xC0 0x4B

The data in the above response returns bootloader firmware V2.1, compatibility number 19392.

6.1.6. Read Bootloader Part Number (0xF2)

Command 0xF2 returns the bootloader part number.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0xF2		0x18EFF98C	0xFF	0xF2	0x91 0x70 0x01 0x00

The data in the above response returns the bootloader part number 94353.

6.2. Calibration Commands

6.2.1. Read Traceable Access Counter (0x10)

Command 0x10 returns the current value of the traceable access counter.

The traceable access counter cannot be written directly but is incremented automatically whenever legally relevant parameters (calibration values) are saved to NVM (see section 6.2.3 for details of the "Save Calibration or Setup Data" command).

The traceable access counter is used in certified applications to check if legal parameters have been changed without re-verification.

The traceable access counter has a maximum value of 65535. When it reaches this value, it will latch and not go any higher.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x10		0x18EFF98C	0xFF	0x10	0x12 0x00 0x00 0x00

The data in the above response returns a traceable access counter value of 18.

6.2.2. Write Passcode Register (0x11)

Command 0x11 writes a 32-bit integer into the passcode register. The contents of this register must match the system passcode (default value 0x9A52F) to put the CED-10 into calibration mode (allowing changes to legally relevant parameters and access to restricted functions).

If the CED-10 is *not* in calibration mode and an incorrect code is entered, an error will be returned, and this command will become unavailable for a period of around 5 seconds.

The CED-10 will exit calibration mode if any of the following occur:

- The contents of the passcode register are *changed* when already in calibration mode (a success response will be returned in this case).
- No calibration commands are executed for around 10 minutes.
- A power cycle or System Reset is performed.

To write the passcode register, putting the CED-10 into calibration mode:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x11	0x2F 0xA5 0x09 0x00	0x18EFF98C	0xFF	0x11	

6.2.3. Save Calibrations or Setup Data (0x12)

When a change is made to any calibration parameter (those protected by calibration mode) or setup parameter (not protected by calibration mode), the new value is not committed to non-volatile memory until this save command is executed. Until committing to NVM, any unsaved parameter changes will be lost if a power cycle or System Reset occurs.

The parameter sent with this command determines which parameters are saved, and must have one of the following values:

Value	Meaning
0x01	Save only calibration parameters (legally relevant configurations).
0x02	Save only setup parameters.
0x03	Save all changed parameters.

If legally relevant parameters are to be stored (parameter is 0x01 or 0x03), the CED-10 must be in calibration mode. The traceable access counter will be automatically incremented each time the legally relevant parameters are stored.

The legally relevant parameters are: Maximum Weight, Minimum Weight, Warm-Up Time, Zero Range, Initial Zero Range, Zero-Tracking Range, Maximum Tare Weight, Span Point Weight, Absolute Zero Point (eCal), Absolute Span Point (eCal), Zero Endpoint, Span Endpoint, Tilt Sensor Filter Length, Tilt Compensation Status and Tilt Sensor Baselines.

The setup parameters are: ADC Sample Rate, ADC Output Data Rate Divisor, ADC Output Data Select, Filter Type, No-Motion Range, No-Motion Time, Last Claimed Address, ECU Instance Number, Bus Protocol, Tilt Alarm Threshold and Tilt Sensor Message Period.

Note: The data transfer to non-volatile memory may take up to 75 ms to complete. A successful response to this request signifies only that the request was valid, and that the memory transfer has begun. Any further communication sent to the CED-10 within 75 ms of this command may be lost, as all CPU activity is halted during the memory transfer process.

To save only setup parameters to non-volatile memory:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x12	0x02 0x00 0x00 0x00	0x18EFF98C	0xFF	0x12	

6.2.4. Maximum Weight

Commands 0x13 and 0x14 read and set the Maximum Weight parameter.

Maximum weight is the weight above which the over-range Scale Status flag will be set (see section 6.6.2).

As permitted by EN45501, the output weight value is limited to 9 divisions above maximum weight (9 increments in the case of CED-10). Any weight above this value will be reported as the over-range rogue value of 10^9 (0x3B9ACA00).

The permitted values for maximum weight are from 1 to 999999 increments.

For a CED-10, the factory default value for this parameter is the maximum capacity of the load cell itself.

For a CED-11, the factory default value is a unitless value of 100 increments.

The CED-10/CED-11 must be in calibration mode to write this parameter.

6.2.4.1. Read Maximum Weight (0x13)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x13		0x18EFF98C	0xFF	0x13	0x10 0x27 0x00 0x00

The data in the above response returns a maximum weight of 10000 increments.

6.2.4.2. Write Maximum Weight (0x14)

To set a maximum weight of 30000 increments:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x14	0x30 0x75 0x00 0x00	0x18EFF98C	0xFF	0x14	

6.2.5. Minimum Weight

Commands 0x15 and 0x16 read and set the Minimum Weight parameter.

Minimum weight is the lowest valid weight that will be reported by the scale. Any weight below this value will be reported as the under-range rogue value of -10^9 (0xC4653600) and the under-range Scale Status flag will be set.

The permitted values for minimum weight are from -999999 to 0 increments.

The factory default value is -999999.

The CED-10 must be in calibration mode to write this parameter.

6.2.5.1. Read Minimum Weight (0x15)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x15		0x18EFF98C	0xFF	0x15	0xEC 0xFF 0xFF 0xFF

The data in the above response returns a minimum weight of -20 increments.

6.2.5.2. Write Minimum Weight (0x16)

To set a minimum weight of -10 increments:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x16	0xF6 0xFF 0xFF 0xFF	0x18EFF98C	0xFF	0x16	

6.2.6. Warm-Up Time

Commands 0x17 and 0x18 read and set the system Warm-Up Time parameter.

The system warm-up time is the time, measured from power-on or System Reset, during which the weight output will be reported as the under-range value of -10^9, to avoid false readings while the system is stabilising.

The permitted values for warm-up time are from 0 to 3600 seconds.

The factory default value is 0 seconds.

The CED-10 must be in calibration mode to write this parameter.

6.2.6.1. Read Warm-Up Time (0x17)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x17		0x18EFF98C	0xFF	0x17	0x0F 0x00 0x00 0x00

The data in the above response returns a warm-up time of 15 seconds.

6.2.6.2. Write Warm-Up Time (0x18)

To set a system warm-up time of 30 seconds:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x18	0x1E 0x00 0x00 0x00	0x18EFF98C	0xFF	0x18	

6.2.7. Zero Range

Commands 0x19 and 0x1A read and set the Zero Range parameter.

Zero range is the weight, measured in scale increments, within which the scale can be manually zeroed. It is measured from the power-on zero position *after* any initial zero value has been applied.

The permitted values for zero range are from 0 to 999999 increments.

A value of zero indicates that the scale will use the default zero range of ±2% of the Maximum Weight value.

The factory default value is 0.

The CED-10 must be in calibration mode to write this parameter.

6.2.7.1. Read Zero Range (0x19)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x19		0x18EFF98C	0xFF	0x19	0x64 0x00 0x00 0x00

The data in the above response returns a zero range of ±100 increments.

6.2.7.2. Write Zero Range (0x1A)

To set a zero range of ±300 increments.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x1A	0x2C 0x01 0x00 0x00	0x18EFF98C	0xFF	0x1A	

6.2.8. Initial Zero Range

Commands 0x1B and 0x1C read and set the Initial Zero Range parameter.

The initial zero range is the weight (measured from the calibrated zero point) within which the scale will perform a Set System Zero command the first time the weight stabilises after power-on or a System Reset.

The permitted values for initial zero range are from 0 to 999999 increments.

The factory default value is 0 (no automatic zero will be performed at start-up).

The CED-10 must be in calibration mode to write this parameter.

6.2.8.1. Read Initial Zero Range (0x1B)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x1B		0x18EFF98C	0xFF	0x1B	0xFA 0x00 0x00 0x00

The data in the above response returns an initial zero range of ±250 increments.

6.2.8.2. Write Initial Zero Range (0x1C)

To set an initial zero range of ±500 increments:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x1C	0xF4 0x01 0x00 0x00	0x18EFF98C	0xFF	0x1C	

6.2.9. Zero-Tracking Range

Commands 0x1D and 0x1E read and set the Zero-Tracking Range parameter, which is measured in units of 0.5 increments.

The zero-tracking algorithm will zero the scale, when all of the following conditions are met:

- The gross weight (when the net weighing function is inactive) or the net weight (when the net weighing function is active) is within the zero-tracking range for at least 500 ms
- The rate of change of weight does not exceed 0.5 increments / second
- The overall effect of the automatic zeroing does not exceed the Zero Range value.

The permitted values for zero-tracking range are 0 (to disable zero-tracking) and 1 to 250 (≡ ±0.5 to ±125 increments).

The factory default value is 0 (zero-tracking is disabled).

The CED-10 must be in calibration mode to write this parameter.

6.2.9.1. Read Zero-Tracking Range (0x1D)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x1D		0x18EFF98C	0xFF	0x1D	0x02 0x00 0x00 0x00

The data in the above response returns a zero-tracking range of ±1 increment.

6.2.9.2. Write Zero-Tracking Range (0x1E)

To set a zero-tracking range of ±0.5 increments:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x1E	0x01 0x00 0x00 0x00	0x18EFF98C	0xFF	0x1E	

6.2.10. Maximum Tare Weight

Commands 0x1F and 0x20 read and set the maximum weight at which the Set Tare command can be executed; if the *gross* weight reading is outside the maximum tare range, the Set Tare command will return an error.

The permitted values for maximum tare weight are from -9999990 to 999999 increments.

A positive value of maximum tare weight indicates that negative tare weights are *not* allowed; any attempt to execute the Set Tare command when gross weight is below zero will return an error.

A negative value of maximum tare weight indicates that negative tare *is* allowed; the maximum negative tare weight will be the same as the maximum positive tare weight.

The factory default value is -999999 (±999999 increments).

The CED-10 must be in calibration mode to write this parameter.

6.2.10.1. Read Maximum Tare Weight (0x1F)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x1F		0x18EFF98C	0xFF	0x1F	0x88 0x13 0x00 0x00

The data in the above response returns a Maximum Tare Weight of 5000 increments (negative tare disallowed).

6.2.10.2. Write Maximum Tare Weight (0x20)

To set a maximum tare weight of ±5000 increments (negative tare allowed):

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x20	0x78 0xEC 0xFF 0xFF	0x18EFF98C	0xFF	0x20	

6.2.11. Calibration Weight / eCal Span-Point Weight

Commands 0x21 and 0x22 read and set the weight that corresponds to the load cell's mV/V signal at the span point. This weight value is unitless; it relies on the user to reference a weight system (e.g., imperial lb or metric kg) to provide real-world meaningful data.

The permitted values for span weight are from 1% to 100% of the Maximum Weight parameter.

For a CED-10, the factory default value for this parameter is the maximum capacity of the load cell itself.

For a CED-11, the factory default value is a unitless value of 100 increments. Before further calibration, this will give the weight output as a percentage of the range between the Absolute Zero Point and the Absolute Span Point.

The CED-10/CED-11 must be in calibration mode to write this parameter.

Note: To avoid a potentially untraceable change to the weight output when this legally relevant parameter is changed, all weight calculations are performed using the value last saved to the scale's *non-volatile* memory. Changes to this parameter will not affect the weight calculations until the 'Save Calibrations or Setup Data' command is executed to save the legally relevant parameters, as detailed in section 6.2.3.

6.2.11.1. Read eCal Span-Point Weight (0x21)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x21		0x18EFF98C	0xFF	0x21	0x98 0x3A 0x00 0x00

The data in the above response returns an eCal span-point weight of 15000 increments.

6.2.11.2. Write the eCal Span-Point Weight (0x22)

To set the eCal span-point weight to 12500 increments:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x22	0xD4 0x30 0x00 0x00	0x18EFF98C	0xFF	0x22	

6.2.12. Absolute Zero Point (eCal)

6.2.12.1. Read Absolute Zero Point (0x23)

Command 0x23 returns the load cell's mV/V signal level measured when the zero endpoint was calibrated (using the Calibrate Zero Endpoint command in section 6.2.14.2 or the Write Absolute Zero Point in section 6.2.12.2).

For increased precision, the value returned is 10000 times the mV/V value.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x23		0x18EFF98C	0xFF	0x23	0xC8 0x00 0x00 0x00

The data in the above response returns the eCal absolute zero point of 200 (≡ 0.0200 mV/V).

6.2.12.2. Write Absolute Zero Point (0x24)

Command 0x24 sets the eCal Absolute Zero Point parameter to the load cell's mV/V signal level specified in the parameter. For increased precision, the value transmitted should be 10000 times the actual mV/V value intended.

The permitted range for the eCal absolute zero point is ±33000 (≡ ±3.3 mV/V).

For a CED-10, the default value for this parameter is stored during factory testing and is unique to each load cell.

For a CED-11, the factory default value is 0 (0 mV/V).

The CED-10/ CED-11 must be in calibration mode to accept this command.

Note: To avoid a potentially untraceable change to the weight output when this legally relevant parameter is changed, all weight calculations are performed using the value last saved to the scale's *non-volatile* memory. Changes to this parameter will not affect the weight calculations until the 'Save Calibrations or Setup Data' command is executed to save the legally relevant parameters, as detailed in section 6.2.3.

To set the eCal absolute zero point to 196 (≡ 0.0196 mV/V):

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x24	0xC4 0x00 0x00 0x00	0x18EFF98C	0xFF	0x24	

6.2.13. Absolute Span Point (eCal)

6.2.13.1. Read Absolute Span Point (0x25)

Command 0x25 returns the load cell's mV/V signal level measured when the span endpoint was calibrated (using the Calibrate Span Endpoint command in section 6.2.15.2. or the Write Absolute Span Point command in section 6.2.13.2).

For increased precision, the value returned is 10000 times the mV/V value.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x25		0x18EFF98C	0xFF	0x25	0x20 0x4E 0x00 0x00

The data in the above response returns the eCal absolute span point of 20000 (≡ 2.0000 mV/V).

6.2.13.2. Write Absolute Span Point (0x26)

Command 0x26 sets the eCal Absolute Span Point parameter to the load cell's mV/V signal level specified in the parameter. For increased precision, the value transmitted should be 10000 times the actual mV/V value intended.

The permitted range for the absolute span point is ±33000 (≡ ±3.3 mV/V).

For a CED-10, the default value for this parameter is stored during factory testing and is unique to each load cell.

For a CED-11, the factory default value is 20000 (≡ 2m V/V).

The CED-10/ CED-11 must be in calibration mode to accept this command.

Note: To avoid a potentially untraceable change to the weight output when this legally relevant parameter is changed, all weight calculations are performed using the value last saved to the scale's *non-volatile* memory. Changes to this parameter will not affect the weight calculations until the 'Save Calibrations or Setup Data' command is executed to save the legally relevant parameters, as detailed in section 6.2.3.

To set the eCal absolute span point to 19970 (≡ 1.9970 mV/V):

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x26	0x02 0x4E 0x00 0x00	0x18EFF98C	0xFF	0x26	

6.2.14. Zero Endpoint

6.2.14.1. Read Zero Endpoint (0x27)

Command 0x27 returns the A/D converter value captured when the Zero Endpoint was calibrated.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x27		0x18EFF98C	0xFF	0x27	0x14 0x00 0x80 0x00

The data in the above response returns a zero endpoint of 8388628 ADC counts.

6.2.14.2. Calibrate Zero Endpoint (0x28)

Command 0x28 stores the current (filtered) A/D converter value into the scale's internal (**volatile**) memory as the Zero Endpoint calibration parameter. This command should be executed when the scale is unloaded.

The factory default value is the ADC count equivalent to the Absolute Zero Point factory default and is unique to each device.

The CED-10 must be in calibration mode to accept this command.

An error will be returned if this command is issued while the signal is not stable, as defined by the Motion Detection parameters in section 6.4.

Note: To avoid a potentially untraceable change to the weight output when this legally relevant parameter is changed, all weight calculations are performed using the value last saved to the scale's *non-volatile* memory. Changes to this parameter will not affect the weight calculations until the 'Save Calibrations or Setup Data' command is executed to save the legally relevant parameters, as detailed in section 6.2.3.

To calibrate the zero endpoint:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x28		0x18EFF98C	0xFF	0x28	

6.2.15. Span Endpoint

6.2.15.1. Read Span Endpoint (0x29)

Command 0x29 returns the A/D converter value captured when the Span Endpoint was calibrated.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x29		0x18EFF98C	0xFF	0x29	0x72 0xB3 0xC9 0x00

The data in the above response returns a span endpoint of 13218674 ADC counts.

6.2.15.2. Calibrate Span Endpoint (0x2A)

Command 0x2A stores the current (filtered) A/D converter value into the scale's internal (**volatile**) memory as the Span Endpoint calibration parameter. The current weight on the scale (in increments) must be provided as a parameter to this command.

For good accuracy, this command should be executed when the scale is loaded with a weight of at least 80% of the Maximum Weight parameter (see section 6.2.4).

The permitted values for span weight are from 1% to 100% of the Maximum Weight parameter.

The factory default value is the ADC count equivalent to the Absolute Span Point factory default and is unique to each device.

The CED-10 must be in calibration mode to accept this command.

An error will be returned if this command is issued while the signal is not stable, as defined by the Motion Detection parameters in section 6.4.

Note: To avoid a potentially untraceable change to the weight output when this legally relevant parameter is changed, all weight calculations are performed using the value last saved to the scale's *non-volatile* memory. Changes to this parameter will not affect the weight calculations until the 'Save Calibrations or Setup Data' command is executed to save the legally relevant parameters, as detailed in section 6.2.3.

To calibrate the span endpoint with a weight of 10000 increments:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x2A	0x10 0x27 0x00 0x00	0x18EFF98C	0xFF	0x2A	

6.3. ADC Control and Filtering

6.3.1. ADC Sample Rate

Commands 0x30 & 0x31 read and set the A/D converter Sample Rate parameter.

Note: Most filter settings (the FIR & IIR filters) have a fixed sample rate and cannot be changed. If the currently selected filter has a fixed sample rate, writing a new value with this command will have no effect. See section 6.3.3 below for details of the Filter Type parameter.

The permitted values for ADC sample rate are from 5 to 2500 samples/second.

The factory default value is 50 samples/second.

6.3.1.1. Read ADC Sample Rate (0x30)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x30		0x18EFF98C	0xFF	0x30	0x7D 0x00 0x00 0x00

The data in the above response returns a sample rate of 125 samples/second.

6.3.1.2. Write ADC Sample Rate (0x31)

To set the ADC sample rate at 250 samples/second:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x31	0xFA 0x00 0x00 0x00	0x18EFF98C	0xFF	0x31	

6.3.2. ADC Output Data Rate Divisor

Commands 0x32 and 0x33 read and set the Output Data Rate Divisor parameter.

The output data rate divisor is the number of samples over which the A/D converter output is averaged before entering it into the digital filter and/or sending the periodic ADC Data Message.

Example: an ADC sample rate of 50 SPS and an output data rate divisor of 10 will result in the scale entering the average of 10 ADC samples into the digital filter every 200 ms and (if the scale is configured to do so) transmitting the ADC data message every 200 ms.

The permitted values for output data rate divisor are from 1 to 250.

The factory default value is 1.

6.3.2.1. Read Output Data Rate Divisor (0x32)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x32		0x18EFF98C	0xFF	0x32	0x0A 0x00 0x00 0x00

The data in the above response returns an output data rate divisor of 10.

6.3.2.2. Write Output Data Rate Divisor (0x33)

To set the ADC output data rate divisor to 20:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x33	0x14 0x00 0x00 0x00	0x18EFF98C	0xFF	0x33	

6.3.3. Filter Type

Commands 0x34 and 0x35 read and set the ADC Filter Type parameter.

The permitted values of the filter type are as follows.

Value	Filter Type
0x00	No filtering
0x01	8-sample moving average
0x02	16-sample moving average
0x03	32-sample moving average
0x04	64-sample moving average
0x10	FIR filter, 40 SPS, 0.2 Hz cut-off
0x11	FIR filter, 40 SPS, 0.5 Hz cut-off
0x12	FIR filter, 40 SPS, 1 Hz cut-off
0x13	FIR filter, 40 SPS, 5 Hz cut-off
0x14	FIR filter, 40 SPS, 10 Hz cut-off
0x15	FIR filter, 75 SPS, 2.5 Hz cut-off
0x16	FIR filter, 85 SPS, 2.8 Hz cut-off
0x17	FIR filter, 100 SPS, 3.2 Hz cut-off

Value	Filter Type
0x18	FIR filter, 120 SPS, 3.9 Hz cut-off
0x19	FIR filter, 150 SPS, 4.9 Hz cut-off
0x1A	FIR filter, 200 SPS, 6.5 Hz cut-off
0x1B	FIR filter, 300 SPS, 9.8 Hz cut-off
0x1C	FIR filter, 600 SPS, 19.7 Hz cut-off
0x1D	FIR filter, 1200 SPS, 18 Hz cut-off
0x20	IIR filter, 40 SPS, 0.2 Hz cut-off
0x21	IIR filter, 40 SPS, 0.5 Hz cut-off
0x22	IIR filter, 40 SPS, 1 Hz cut-off
0x23	IIR filter, 40 SPS, 2 Hz cut-off
0x24	IIR filter, 40 SPS, 5 Hz cut-off
0x25	IIR filter, 40 SPS, 10 Hz cut-off
0x26	IIR filter, 600 SPS, 0.25 Hz cut-off
0x27	IIR filter, 600 SPS, 0.5 Hz cut-off
0x28	IIR filter, 600 SPS, 1 Hz cut-off
0x29	IIR filter, 600 SPS, 2 Hz cut-off
0x2A	IIR filter, 600 SPS, 3 Hz cut-off
0x2B	IIR filter, 600 SPS, 4 Hz cut-off
0x2C	IIR filter, 600 SPS, 8 Hz cut-off
0x2D	IIR filter, 600 SPS, 18 Hz cut-off

The factory default value is 2 (16-sample moving average).

The FIR and IIR filters above each have a fixed sample rate, but the moving average filters have a configurable sample rate. See section 6.3.1.2 above for details of how to set the ADC Sample Rate for the moving average filters.

6.3.3.1. Read Filter Type (0x34)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x34		0x18EFF98C	0xFF	0x34	0x03 0x00 0x00 0x00

The result returned in the above response shows that the 32-sample moving average filter is currently in use.

6.3.3.2. Write Filter Type (0x35)

To set the ADC digital filter to use a 600 SPS, IIR filter with 1 Hz cut-off:

Controller 0xF9 sends:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 5)**		**CAN ID**	**Data (DLC = 2)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x35	0x28 0x00 0x00 0x00	0x18EFF98C	0xFF	0x35	

6.4. Motion Detection

The motion detection facility provides a means of disabling certain functions whenever a condition of instability or motion is detected. The 'no-motion' or 'stable' condition is achieved whenever the weight does not fluctuate by more than the No-Motion Range parameter during a period defined by the No-Motion Time parameter.

The current stability status is reflected in the Scale Status data, as described in section 6.6.2 below).

6.4.1. No-Motion Range

Commands 0x36 and 0x37 read and set the value of the No-Motion Range parameter, which is a 16-bit unsigned value.

The no-motion range value is the range within the which the weight can fluctuate and still be considered as 'stable' and is in units of 0.1 scale increments.

The permitted values for no-motion range are from 0 to 60000 (±6000 increments).

The factory default value is 10 (±1 increment).

6.4.1.1. Read No-Motion Range (0x36)

Controller 0xF9 sends:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 1)**		**CAN ID**	**Data (DLC = 4)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x36		0x18EFF98C	0xFF	0x36	0x14 0x00

The result returned in the above response shows a no-motion range of 20 (±2 increments).

6.4.1.2. Write No-Motion Range (0x37)

To set the no-motion range parameter to 10 (±1 increment):

Controller 0xF9 sends:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 3)**		**CAN ID**	**Data (DLC = 2)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x37	0x0A 0x00	0x18EFF98C	0xFF	0x37	

6.4.2. No-Motion Time

Commands 0x38 and 0x39 read and set the No-Motion Time parameter, which is a 16-bit unsigned value.

The no-motion time value is the period (in milliseconds) over which the weight signal is checked for stability.

The permitted values for no-motion time are from 0 to 60000 ms.

The factory default value is 1000 ms.

6.4.2.1. Read No-Motion Time (0x38)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 4)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x38		0x18EFF98C	0xFF	0x38	0xE8 0x03

The result returned in the above response shows a no-motion time of 1000 ms.

6.4.2.2. Write No-Motion Time (0x39)

To set the no-motion time parameter to 750 ms:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 3)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x39	0xEE 0x02	0x18EFF98C	0xFF	0x39	

6.5. Communications

6.5.1. Last Claimed Address

Commands 0x3A and 0x3B read and set the last J1939 node address successfully claimed by the CED-10.

Writing a node address to the CED-10 is not mandatory as the scale will negotiate an address when it is powered-up or reset. Any address successfully claimed is stored in non-volatile memory and will be used as the first address claimed in all future power-on sessions.

If a *specific* node address is wanted, it can be written using this command and will take effect after the next power cycle or System Reset. However, any address written using this command is only a *preferred* address – this will be the first address *attempted* to be claimed by the CED-10 but may be overwritten by another (higher priority) device using the same address. Should this happen, the CED-10 will then attempt to negotiate another address and, when successful, will store this new address in its non-volatile memory.

The permitted values for last claimed address are 0 to 253 (0xFD). Any address in this range *can* be written, but the SAE J1939 standard recommends that arbitrary address-capable nodes use only addresses in the range 128 (0x80) to 247 (0xF7).

The factory default value is 128 (0x80).

6.5.1.1. Read Last Claimed Address (0x3A)

Controller 0xF9 broadcasts:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EFFFF9	0x3A		0x18EFF98C	0xFF	0x3A	0x8C 0x00 0x00 0x00

The result returned in the above response shows a node address of 140 (0x8C).

Note: The broadcast address of 0xFF (255) has been used here, as this command is useful if the node address is not yet known.

6.5.1.2. Write Last Claimed Address (0x3B)

To set the last claimed address to 202 (0xCA):

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x3B	0xCA 0x00 0x00 0x00	0x18EFF98C	0xFF	0x3B	

Note that the source address of the response is still the original node address (0x8C) since the new address (0xCA) will not be claimed until after the next power cycle or System Reset.

6.5.2. Bus Protocol

Commands 0x3E and 0x3F read and set the CAN bus protocol, allowing the CED-10 to switch between J1939 and CANopen.

The permitted values for the Bus Protocol parameter are 0x012D (CANopen) and 0x0793 (J1939).

When set (and written to NVM by the Save Setup Data command), the new bus protocol will be enabled after the next power cycle or system reset.

Note: After switching to the CANopen protocol and performing a power cycle/reset, the CED-10 will start up in CANopen mode, running at a bus speed of 250 kbps. The CAN bus speed cannot be changed whilst still running the J1939 protocol.

The CED-10 must be in calibration mode to write this parameter but the traceable access counter will *not* be incremented.

The Restore Factory Defaults command will not change the value of this parameter.

6.5.2.1. Read Bus Protocol (0x3E)

Controller 0xF9 broadcasts:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 1)**		**CAN ID**	**Data (DLC = 6)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x3E		0x18EFF98C	0xFF	0x3E	0x93 0x07 0x00 0x00

The result returned in the above response shows that the CED-10 will use the J1939 protocol after the next power cycle.

6.5.2.2. Write Bus Protocol (0x3F)

To set the CED-10 to use the CANopen protocol after the next power cycle:

Controller 0xF9 sends:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 5)**		**CAN ID**	**Data (DLC = 2)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x3F	0x2D 0x01 0x00 0x00	0x18EFF98C	0xFF	0x3F	

6.6. Data Access Commands

6.6.1. ADC Output Data Select

Commands 0x40 and 0x41 read and set the ADC Output Data Select parameter.

The Output Data Select parameter determines what ADC-related data is transmitted with the ADC Data Message and the data format and event triggers of the ADC Data Message and the Tare Weight Message.

This parameter is sent and received as an 8-bit unsigned integer.

The permitted values for the ADC output data select are derived from the table below.

Bit #	Value	Meaning
7..5		Unused, always 0.
4	0x10	Send-on-request flag. 0: The ADC Data Message will be sent each time a new ADC sample is received. The Tare Weight Message will be sent each time the Set Tare or Reset Tare command is executed. 1: The ADC Data Message and the Tare Weight Message will be sent only when requested using PGN 59904 (as described in section 5.2.2 above).
3	0x08	IEEE 754 flag. 0: ADC data in the ADC Data Message and tare weight in the Tare Weight Message are sent as 32-bit signed integers. 1: ADC data in the ADC Data Message and tare weight in the Tare Weight Message are sent as 32-bit floating-point numbers in IEEE 754 format.
2	0x04	Append scale status & output select flag. 0: The ADC Data Message sends only ADC data (determined by bits 1 & 0). The Tare Weight Message sends only tare weight data. 1: Scale Status information and the ADC Output Data Select value are appended to the data sent in the ADC Data Message and the Tare Weight Message.
1..0	0..3	Bits 1 & 0 make up a 2-bit number which determines what ADC-related data will be transmitted: 00: Gross weight 01: Net weight 10: Filtered ADC sample value 11: Filtered mV/V signal

Note: Regardless of the setting of the IEEE 754 flag, Scale Status information (if selected) is always sent as a 16-bit unsigned integer (as described in section 6.6.2 below).
When the Filtered mV/V option is selected and the IEEE 754 flag is *not* set, the mV/V value returned will be multiplied by 10000 to give increased precision.

The factory default value is 7 (event-triggered transmission of mV/V signal as a 32-bit integer, with status appended).

6.6.1.1. Read ADC Output Data Select (0x40)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 3)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x40		0x18EFF98C	0xFF	0x40	0x04

The result returned in the above response shows that the ADC data message will send the gross weight as a 32-bit integer with Scale Status appended.

6.6.1.2. Write ADC Output Data Select (0x41)

To set the ADC output data select parameter to transmit the load cell mV/V signal in IEEE 754 format by PGN request:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 2)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x41	0x1B	0x18EFF98C	0xFF	0x41	

6.6.2. Read Scale Status (0x42)

Command 0x42 returns the current status of the CED-10. The 16-bit unsigned integer returned represents a set of bit-mapped flags to indicate whether certain conditions are active. The values of each of these bit-mapped flags is as follows.

Bit #	Value	Condition
15	0x8000	Critical fault (non-recoverable, the CED-10 must be returned to Flintec).
14	0x4000	Scale h/w fault (non-recoverable, the CED-10 must be returned to Flintec).
13	0x2000	Scale configuration fault (recoverable by configuring all parameters).
12	0x1000	Unused
11	0x0800	Unused
10	0x0400	Unused
9	0x0200	Unused
8	0x0100	Tilt alarm is active (the tilt angle has exceeded the Tilt Alarm Threshold).
7	0x0080	Weight is within the Zero Range (scale can be manually zeroed).

Bit #	Value	Condition
6	0x0040	Over-range - weight is above maximum.
5	0x0020	Under-rage - weight is below minimum.
4	0x0010	Scale has been zeroed.
3	0x0008	The net weighing function is active.
2	0x0004	Scale warm-up is active (i.e., the Warm-up Time has not yet expired).
1	0x0002	Centre-of-zero.
0	0x0001	Weight signal is stable, as defined by the Motion Detection parameters.

To read the scale status:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 4)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x42		0x18EFF98C	0xFF	0x42	0x81 0x01

The result returned in the above response shows that the weight is stable, within the zero range and the tilt alarm is active.

6.6.3. Read Gross Weight (0x43)

Command 0x43 returns the last-calculated gross weight, measured in scale increments.

The overweight rogue value of 10^9 (0x3B9ACA00) will be returned if the gross weight is above the Maximum Weight, as defined in section 6.2.4.

The underweight rogue value of -10^9 (0xC4653600) will be returned under any of the following conditions:

- The scale has not been correctly calibrated.
- The gross weight is below the specified Minimum Weight defined in section 6.2.5.
- The Warm-Up Time defined in section 6.2.6 has not yet expired.
- Any of the Fault Flags defined in section 6.6.9 are set.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x43		0x18EFF98C	0xFF	0x43	0x94 0x0C 0x00 0x00

The result returned in the above response shows a gross weight of 3220 increments.

6.6.4. Read Net Weight (0x44)

Command 0x44 returns the last-calculated net weight, measured in scale increments.

The overweight rogue value of 10^9 (0x3B9ACA00) will be returned if the *gross* weight returns the overweight rogue value.

The underweight rogue value of -10^9 (0xC4653600) will be returned if the *gross* weight returns the underweight rogue value.

Controller 0xF9 sends:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 1)**		**CAN ID**	**Data (DLC = 6)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x44		0x18EFF98C	0xFF	0x44	0xDC 0x00 0x00 0x00

The result returned in the above response shows a net weight of 220 increments.

6.6.5. Read Tare Weight (0x45)

Command 0x45 returns the current tare weight, measured in scale increments. If the net weighing function is not currently active, a value of zero will be returned.

Controller 0xF9 sends:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 1)**		**CAN ID**	**Data (DLC = 6)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x45		0x18EFF98C	0xFF	0x45	0xB8 0x0B 0x00 0x00

The result returned in the above response shows a tare weight of 3000 increments.

6.6.6. Read Raw (Unfiltered) ADC Sample (0x47)

Command 0x47 returns the value of the last-received ADC sample, before any filtering or averaging is applied.

Controller 0xF9 sends:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 1)**		**CAN ID**	**Data (DLC = 6)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x47		0x18EFF98C	0xFF	0x47	0xC4 0xDA 0xA5 0x00

The result returned in the above response shows an unfiltered ADC sample value of 10869444 counts.

6.6.7. Read Filtered ADC Sample (0x48)

Command 0x48 returns the value of the last-calculated ADC signal after any selected filtering and averaging have been applied.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x48		0x18EFF98C	0xFF	0x48	0x9D 0x7B 0x9C 0x00

The result returned in the above response shows a filtered ADC sample value of 10255261 counts.

6.6.8. Read Filtered mV/V Signal (0x49)

Command 0x49 returns the latest value of the load cell signal in mV/V, after any selected filtering and averaging have been applied. The value returned is the net value, with any mV/V tare signal already subtracted.

For increased precision, the returned value is 10000 times the mV/V signal level.

The underweight rogue value of -10^9 (0xC4653600) will be returned under any of the following conditions:

- The mV/V signal level is outside the absolute limit of ±33000 (≡ ±3.3 mV/V).
- Any of the non-recoverable Fault Flags defined in section 6.6.9 have been set.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x49		0x18EFF98C	0xFF	0x49	0x4C 0x2B 0x00 0x00

The result returned in the above response shows a signal level of 11084 (≡ 1.1084 mV/V).

6.6.9. Read Fault Flags (0x4A)

Command 0x4A returns details of any faults logged by the scale's diagnostic functions and gives more information than is available from the Read Scale Status command in section 6.6.2.

The 32-bit integer returned represents a set of bit-mapped flags to indicate when specific faults have been detected. The values of each of these bit-mapped flags is as follows.

Bit #	Value	Condition
31..5	-	Currently unused
4	0x10	A non-recoverable fault has been detected in the tilt sensor. The CED-10 should be returned to Flintec.
3	0x08	A non-recoverable fault has been detected in the ADC. The CED-10 should be returned to Flintec.
2	0x04	An error has been detected in the calibration data memory. The scale can be recovered by reconfiguring all legal parameters and re-calibrating.
1	0x02	An error has been detected in the configuration data memory. The scale can be recovered by reconfiguring all user parameters.
0	0x01	A non-recoverable fault has been detected in the factory settings memory. The CED-10 should be returned to Flintec.

Note: If *any* of these fault flags is set, the scale will not output any meaningful weight data; only the underweight rogue value of -10^9 will be returned.

To read the fault flags:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x4A		0x18EFF98C	0xFF	0x4A	0x00 0x00 0x00 0x00

The result returned in the above response shows that no faults are set.

6.7. Taring and Zeroing

6.7.1. Set System Zero (0x50)

Command 0x50 defines a new scale system zero point which forms the basis of all subsequent weighing values until one of the following occurs:

- A new Set System Zero command is executed.
- A Reset System Zero command is executed.
- A power cycle or System Reset is performed.

The Set System Zero command will be rejected if any of the following conditions are true:

- The signal is not stable, as signified in the Scale Status message in section 6.6.2.
- The current gross weight is outside the Zero Range weight as measured from the power-on zero point (after any initial zero has been applied).
- The net weighing function is currently active.

To set a new system zero point:

<table>
<tr><th colspan="3">Controller 0xF9 sends:</th><th colspan="4">CED-10 0x8C responds:</th></tr>
<tr><th rowspan="2">CAN ID</th><th colspan="2">CAN Data (DLC = 1)</th><th rowspan="2">CAN ID</th><th colspan="3">Data (DLC = 2)</th></tr>
<tr><th>Cmd.</th><th>Parameters</th><th>Resp.</th><th>Cmd.</th><th>Result</th></tr>
<tr><td>0x18EF8CF9</td><td>0x50</td><td></td><td>0x18EFF98C</td><td>0xFF</td><td>0x50</td><td></td></tr>
</table>

6.7.2. Reset System Zero (0x51)

Command 0x51 returns the system zero point to the calibrated zero point.

To reset the system zero point:

<table>
<tr><th colspan="3">Controller 0xF9 sends:</th><th colspan="4">CED-10 0x8C responds:</th></tr>
<tr><th rowspan="2">CAN ID</th><th colspan="2">CAN Data (DLC = 1)</th><th rowspan="2">CAN ID</th><th colspan="3">Data (DLC = 2)</th></tr>
<tr><th>Cmd.</th><th>Parameters</th><th>Resp.</th><th>Cmd.</th><th>Result</th></tr>
<tr><td>0x18EF8CF9</td><td>0x51</td><td></td><td>0x18EFF98C</td><td>0xFF</td><td>0x51</td><td></td></tr>
</table>

6.7.3. Set Tare (0x52)

Command 0x52 activates the net weighing function by storing the current gross weight value as the tare weight.

The Set Tare command will be rejected if any of the following conditions are true:

- The scale has not been correctly calibrated.
- The weight signal is not stable, as signified in the Scale Status message in section 6.6.2.
- The gross weight is above the Maximum Weight, as defined in section 6.2.4.
- The gross weight is below the Minimum Weight, as defined in section 6.2.5.
- The current gross weight is outside the Maximum Tare Weight, as defined in section 6.2.10.
- The Warm-Up Time defined in section 6.2.6 has not yet expired.
- Any of the Fault Flags defined in section 6.6.9 have been set.

When the Set Tare command is executed, the 'net weighing function active' flag in the Scale Status message will be set and the Tare Weight Message will be broadcast (if enabled).

To set a new tare weight:

Controller 0xF9 sends:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 1)**		**CAN ID**	**Data (DLC = 2)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x52		0x18EFF98C	0xFF	0x52	

6.7.4. Reset Tare (0x53)

Command 0x53 resets the tare weight to zero and deactivates the net weighing function, returning the scale to gross mode.

When the Reset Tare command is executed, the 'net weighing function active' flag in the Scale Status message will be cleared and the Tare Weight Message will be broadcast (if enabled).

To reset the tare weight:

Controller 0xF9 sends:			**CED-10 0x8C responds:**			
CAN ID	**CAN Data (DLC = 1)**		**CAN ID**	**Data (DLC = 2)**		
	Cmd.	**Parameters**		**Resp.**	**Cmd.**	**Result**
0x18EF8CF9	0x53		0x18EFF98C	0xFF	0x53	

6.7.5. Set mV/V Tare (0x54)

Command 0x54 sets the current mV/V signal level as the mV/V tare value. All subsequent mV/V readings transmitted by the CED-10 will be offset from this value.

The Set mV/V Tare command will be rejected if any of the following conditions are true:

- The mV/V signal level is outside the absolute maximum range of ±3.3 mV/V.
- The weight signal is not stable, as signified in the Scale Status message in section 6.6.2.
- The Warm-Up Time defined in section 6.2.6 has not yet expired.
- Any of the Fault Flags defined in section 6.6.9 have been set.

Note: The Set mV/V Tare command is completely separate from the Set Tare command - it has no effect on the net weighing function, the net weight value or the 'net weighing function active' flag in the Scale Status message.

To set a new mV/V tare value:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x54		0x18EFF98C	0xFF	0x54	

6.7.6. Reset mV/V Tare (0x55)

Command 0x55 resets the mV/V tare value to zero. All subsequent mV/V readings transmitted by the CED-10 will be the true signal level from the load cell.

Note: The Reset mV/V Tare command is completely separate from the Reset Tare command - it has no effect on the net weighing function, the net weight value or the 'net weighing function active' flag in the Scale Status message.

To reset the mV/V tare value:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x55		0x18EFF98C	0xFF	0x55	

6.8. Tilt Detection and Compensation

As well as tilt measurement, reporting and alarm conditions, the CED-10 provides a tilt compensation function.

Tilt compensation attempts to counteract any loss in gain sensitivity due to the load cell being at an angle relative to the vertically acting gravity force rather than perpendicular to it, as in the ideal case.

Whilst tilt compensation works well in certain scenarios, there are limitations to its effectiveness - the tilt compensation function must be used as directed below.

- When tilted, the scale must be zeroed, using the Set System Zero command, *before* applying any load.
- Where this is not possible, changes to the zero-load indication will occur when the scale is tilted relative to the calibration position.
- Measurements taken as a difference between 2 readings at the same inclination (“before-and-after”) will not be affected by this change in zero reading.
- For the CED-11, the housing must be strongly coupled with the load cell and must *always* move at the same angles in all directions.
- Tilt compensation is applied to calculated weight values only; there will be no effect on the mV/V signal output.

Before using the tilt compensation function, the following scale functions must also be executed:

- The scale must be calibrated when on a flat surface (see section 7.1).
- The tilt sensor must be calibrated when on a flat surface (see section 7.2)
- Tilt compensation must be enabled (see section 6.8.5.2)

The following sections give details of the commands needed to setup and operate the tilt sensing, reporting and compensation functions of the CED-10.

6.8.1. Tilt Sensor Message Period

Commands 0x60 and 0x61 read and set the time interval (in milliseconds) between successive transmissions of the Tilt-Sensor Message.

The permitted values for the tilt sensor message period are from 10 to 60000 (milliseconds), or zero to disable the periodic transmission of the Tilt-Sensor Message.

The factory default value is 0 (disabled).

6.8.1.1. Read Tilt Sensor Message Period (0x60)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x60		0x18EFF98C	0xFF	0x60	0x88 0x13 0x00 0x00

The result returned in the above response shows a tilt sensor message period of 5000 ms.

6.8.1.2. Write Tilt Sensor Message Period (0x61)

To disable the tilt sensor periodic message:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x61	0x00 0x00 0x00 0x00	0x18EFF98C	0xFF	0x61	

6.8.2. Tilt Sensor Filter Length

Commands 0x62 and 0x63 read and set the number of entries in the tilt sensor’s moving-average filter.

The latest tilt sensor data is put into the averaging filter every 600 ms (approx.) and the running average value over the length of the filter is used to calculate the tilt angles.

The permitted values for the tilt sensor filter length are 1 to 32 samples.

The factory default value is 8.

The CED-10 must be in calibration mode to write this parameter.

6.8.2.1. Read Tilt Sensor Filter Length (0x62)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x62		0x18EFF98C	0xFF	0x62	0x10 0x00 0x00 0x00

The data in the above response returns a tilt sensor filter length of 16 samples.

6.8.2.2. Write Tilt Sensor Filter Length (0x63)

To set a tilt sensor filter length of 20 samples:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x63	0x14 0x00 0x00 0x00	0x18EFF98C	0xFF	0x63	

6.8.3. Tilt Alarm Threshold

Commands 0x64 and 0x65 read and set the angle above which the tilt alarm bit in the Scale Status word will be set.

The value sent to/read from the CED-10 is in units of 1/100 of a degree (0.01°).

The permitted values for the tilt alarm threshold are 1 to 9000 (≡ 0.01° to 90.00°) and 0 to disable the tilt alarm.

The factory default value is 0 (tilt alarm disabled).

6.8.3.1. Read Tilt Alarm Threshold (0x64)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x64		0x18EFF98C	0xFF	0x64	0xE8 0x03 0x00 0x00

The data in the above response returns a tilt alarm threshold of 10°.

6.8.3.2. Write Tilt Alarm Threshold (0x65)

To set a tilt alarm threshold of 5°:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x65	0xF4 0x01 0x00 0x00	0x18EFF98C	0xFF	0x65	

6.8.4. Read Tilt-Sensor Data

The on-board tilt sensor is a 3-axis accelerometer. For a consistent approach, the sensor's x, y and z axes are automatically assigned as the pitch, roll and yaw axes when the baselines are set (see section 6.8.5.3), depending on the orientation of the PCB / load cell at the time. The yaw axis is determined to be the axis closest aligned to the Earth's gravitational field (i.e., the vertical axis).

In the following sections, tilt sensor data can be read in one of two ways: as accelerometer data (measuring acceleration due to gravity) or as tilt angles.

Acceleration data is returned in units of $\frac{g}{1024}$ (approximating to milli-g), where g is the acceleration due to gravity.

Tilt angle data is returned in units of 1/100 of a degree (0.01°).

Due to the 48-bit data-length restriction of the CED-10 J1939 message, two messages are needed to send data for all three axes: one sends data for the pitch and roll axes and the other sends data for the yaw axis together with a byte to show which axis has been designated as the yaw axis. Where:

0: The PCB's x-axis was designated as the yaw axis
1: The PCB's y-axis was designated as the yaw axis
2: The PCB's z-axis was designated as the yaw axis.

6.8.4.1. Read Pitch and Roll Sensor Data (0x66)

Command 0x66 reads the filtered tilt sensor (accelerometer) data for the assigned pitch and roll axes and is returned in the following format:

Data byte 2: Roll axis accelerometer data in milli-g (LSB)
Data byte 3: Roll axis accelerometer data in milli-g (MSB)
Data byte 4: Pitch axis accelerometer data in milli-g (LSB)
Data byte 5: Pitch axis accelerometer data in milli-g (MSB)

The accelerometer data returned is measured from the current baseline data (i.e., already adjusted for baseline offset).

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x66		0x18EFF98C	0xFF	0x66	0x41 0x00 0x0A 0x00

The data in the above response returns a roll-axis acceleration of 65 milli-g and a pitch-axis acceleration of 10 milli-g.

6.8.4.2. Read Yaw Sensor Data (0x67)

Command 0x67 reads the filtered tilt sensor (accelerometer) data for the assigned yaw axis together with information on which axis has been designated as the yaw axis. Data is returned in the following format:

Data byte 2: Yaw axis accelerometer data in milli-g (LSB)
Data byte 3: Yaw axis accelerometer data in milli-g (MSB)
Data byte 4: Designated yaw axis
Data byte 5: Always 0x00

The accelerometer data returned is measured from the current baseline data (i.e., already adjusted for baseline offset).

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x67		0x18EFF98C	0xFF	0x67	0x14 0x00 0x02 0x00

The data in the above response returns a yaw-axis acceleration of 20 milli-g and shows the yaw axis is the PCB's z-axis.

6.8.4.3. Read Baseline Pitch and Roll Sensor Data (0x68)

Command 0x68 reads the baseline data for the assigned pitch and roll axes that was stored during the sensor baseline (calibration) process. The data is returned in the following format:

Data byte 2: Roll axis baseline data in milli-g (LSB)
Data byte 3: Roll axis baseline data in milli-g (MSB)
Data byte 4: Pitch axis baseline data in milli-g (LSB)
Data byte 5: Pitch axis baseline data in milli-g (MSB)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x68		0x18EFF98C	0xFF	0x68	0x41 0x00 0x0A 0x00

The data in the above response returns a roll-axis baseline of 65 milli-g and a pitch-axis baseline of 10 milli-g.

6.8.4.4. Read Baseline Yaw Sensor Data (0x69)

Command 0x69 reads the baseline data for the assigned yaw axis together with information on which axis has been designated as the yaw axis. Data is returned in the following format:

Data byte 2: Yaw axis baseline data in milli-g (LSB)
Data byte 3: Yaw axis baseline data in milli-g (MSB)
Data byte 4: Designated yaw axis
Data byte 5: Always 0x00

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x69		0x18EFF98C	0xFF	0x69	0x14 0x00 0x02 0x00

The data in the above response returns a yaw-axis baseline of 20 milli-g and shows the yaw axis is the PCB's z-axis.

6.8.4.5. Read Pitch and Roll Angles (0x6A)

Command 0x6A reads the current tilt angle for the assigned pitch and roll axes and is returned in the following format:

Data byte 2: Roll axis angle in units of 0.01º (LSB)
Data byte 3: Roll axis angle in units of 0.01º (MSB)
Data byte 4: Pitch axis angle in units of 0.01º (LSB)
Data byte 5: Pitch axis angle in units of 0.01º (MSB)

This is the same data that is returned in the Tilt-Sensor Message described in section 5.3.2.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x6A		0x18EFF98C	0xFF	0x6A	0x8A 0x02 0x14 0x05

The data in the above response returns a roll-axis angle of 6.5° and a pitch-axis angle of 13°.

6.8.4.6. Read Yaw Angle and Axis (0x6B)

Command 0x6B reads the current tilt angle for the assigned yaw axis together with information on which axis has been designated as the yaw axis. Data is returned in the following format:

Data byte 2: Yaw axis angle in units of 0.01º (LSB)
Data byte 3: Yaw axis angle in units of 0.01º (MSB)
Data byte 4: Designated yaw axis
Data byte 5: Tilt alarm status (= 1 when the yaw axis angle exceeds the Tilt Alarm Threshold).

This is the same data that is returned in the Tilt-Sensor Message described in section 5.3.2.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x6B		0x18EFF98C	0xFF	0x6B	0x3A 0x07 0x02 0x01

The data in the above response returns a yaw-axis angle of 18.5° and shows the yaw axis is the PCB’s z-axis and that the tilt alarm threshold has been exceeded.

6.8.5. Tilt Compensation Status

Commands 0x6C and 0x6D sets the status of tilt-compensation mode.

The permitted values for tilt compensation status are 0 (disabled) and 1 (enabled).

The factory default value is 0 (disabled).

The CED-10 must be in calibration mode to write this parameter.

6.8.5.1. Read Tilt Compensation Status (0x6C)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x6C		0x18EFF98C	0xFF	0x6C	0x01 0x00 0x00 0x00

The data in the above response indicates that tilt compensation is enabled.

6.8.5.2. Write Tilt Compensation Status (0x6D)

To disable tilt compensation:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x6D	0x00 0x00 0x00 0x00	0x18EFF98C	0xFF	0x6D	

6.8.5.3. Set or Reset Tilt Sensor Baselines (0x6E)

Command 0x6E sets or resets the tilt sensor baselines, depending on the value of the parameter sent with this command.

Valid values for the parameter are 0 (reset tilt baselines) and 1 (set tilt baselines).

The CED-10 must be in calibration mode to accept this command.

6.8.5.4. Reset Tilt Sensor Baselines

When command 0x6E is written with parameter value 0x00, the reference positions for each of the sensor's 3 axes are set to zero. When this command is executed, all subsequent data received from the sensor will be absolute values, referenced only to the accelerometer itself, and not necessarily to the load cell or PCB.

6.8.5.5. Set Tilt Sensor Baselines

When command 0x6E is written with parameter value 0x01, the reference positions for each of the sensor's 3 axes are set to the current values being read from the accelerometer. That is, the sensor will be calibrated. When this command is executed, all subsequent data received from the sensor will be relative to its position at the time of calibration.

This command will be rejected if any of the following conditions occur:

- Any 2 of the sensor's 3 axes are more than 30° from the horizontal
- The tilt sensor has not taken enough samples to calculate a reliable average value (which takes around 30 seconds after power-on).

To calibrate the tilt sensor:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 5)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x6E	0x01 0x00 0x00 0x00	0x18EFF98C	0xFF	0x6E	

6.8.6. Restore Factory Default Baselines (0x6F)

Before the CED-10 leaves the factory, the tilt sensor is calibrated on a flat surface and the baseline values stored in non-volatile memory. These factory default values can be restored by sending command 0x6F.

The CED-10 must be in calibration mode to accept this command.

When this command has been successfully executed, the restored baselines will be written to non-volatile memory and the traceable access counter will be automatically incremented.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x6F		0x18EFF98C	0xFF	0x6F	

6.8.7. Read Factory Default Pitch and Roll Baselines (0x70)

Command 0x70 reads the default baseline data for the assigned pitch and roll axes that was programmed in at the factory. The data is returned in the following format:

Data byte 2: Roll axis default baseline data in milli-g (LSB)
Data byte 3: Roll axis default baseline data in milli-g (MSB)
Data byte 4: Pitch axis default baseline data in milli-g (LSB)
Data byte 5: Pitch axis default baseline data in milli-g (MSB)

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x70		0x18EFF98C	0xFF	0x70	0x41 0x00 0x0A 0x00

The data in the above response returns a roll-axis baseline of 65 milli-g and a pitch-axis baseline of 10 milli-g.

6.8.8. Read Factory Default Yaw Baseline (0x71)

Command 0x71 reads the default baseline data for the assigned yaw axis together with information on which axis is the default yaw axis. Data is returned in the following format:

Data byte 2: Yaw axis default baseline data in milli-g (LSB)
Data byte 3: Yaw axis default baseline data in milli-g (MSB)
Data byte 4: Default designated yaw axis
Data byte 5: Always 0x00

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 6)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x71		0x18EFF98C	0xFF	0x71	0x14 0x00 0x02 0x00

The data in the above response returns a yaw-axis baseline of 20 milli-g and shows the yaw axis is the PCB’s z-axis.

6.9. Miscellaneous Commands

6.9.1. System Reset (0xF3)

Command 0xF3 instructs the CED-10 to perform a full firmware reset (warm start).

When successfully executed, the response will be returned *before* the device is reset. Initialisation after reset can take up to 250 ms. During initialisation, any messages transmitted on the CAN bus may not be received by the CED-10.

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0xF3		0x18EFF98C	0xFF	0xF3	

6.9.2. Restore Factory Defaults (0x08)

Command 0x08 over-writes both legally relevant parameters (calibration settings) and user setup parameters (except for the Bus Protocol parameter) with pre-defined factory default values.

When this command has been successfully executed, the restored parameters will be automatically written to non-volatile memory and the traceable access counter will be automatically incremented.

Note: The data transfer to non-volatile memory may take up to 75 ms to complete. A successful response to this request signifies only that the request was valid, and that the memory transfer has begun. Any further communication sent to the CED-10 within 75 ms of this command may be lost, as all CPU activity is halted during the memory transfer process.

The CED-10 must be in calibration mode to accept this command.

The parameters changed and their default values are as follows.

Parameter	Command(s)	Default Value
Maximum Weight	0x13, 0x14	Device-dependent.
Minimum Weight	0x15, 0x16	-999999 increments.
Warm-Up Time	0x17, 0x18	0 seconds.
Zero Range	0x19, 0x1A	0 (±2% of Maximum Weight_Maximum_Weight.)
Initial Zero Range	0x1B, 0x1C	0 (No initial zero.)
Zero-Tracking Range	0x1D, 0x1E	0 (Zero-tracking is disabled.)
Maximum Tare Weight	0x1F, 0x20	-999999
Calibration/eCal Span Weight	0x21, 0x22	Device-dependent. See the specific command description for details of the default value applied.
Absolute Zero Point (eCal)	0x23, 0x24	
Absolute Span Point (eCal)	0x25, 0x26	
Zero Endpoint (ADC counts)	0x27	
Span Endpoint (ADC counts)	0x29	
ADC Sample Rate	0x30, 0x31	50 samples/second.
ADC Output Data Rate Divisor	0x32, 0x33	1
Filter Type	0x34, 0x35	2 (16-entry running average.)
No-Motion Range	0x36, 0x37	10 (1 increment.)
No-Motion Time	0x38, 0x39	1000 ms.
Last Claimed Address	0x3A, 0x3B	128 (0x80)
ECU Instance Number	0x3C, 0x3D	0
ADC Output Data Select	0x40, 0x41	7 (mV/V & status, integer, event triggered.)
Tilt Sensor Message Period	0x60, 0x61	0 (Tilt Sensor Message is disabled.)
Tilt Sensor Filter Length	0x62, 0x63	8 samples
Tilt Alarm Threshold	0x64, 0x65	0 (Tilt alarm is disabled.)
Tilt Baseline Data	0x68	Device-dependent.
Tilt Compensation Status	0x6C, 0x6D	0 (Tilt compensation is disabled.)

To restore factory default values:

Controller 0xF9 sends:			CED-10 0x8C responds:			
CAN ID	CAN Data (DLC = 1)		CAN ID	Data (DLC = 2)		
	Cmd.	Parameters		Resp.	Cmd.	Result
0x18EF8CF9	0x08		0x18EFF98C	0xFF	0x08	

6.9.3. Read the Up-Time Counter

The CED-10 has a free-running internal timer which measures the timespan since the last power-on or System Reset event. The timespan can be requested as a coarse or fine value.

6.9.3.1. Read the Up-Time Counter in Seconds (0x09)

Command 0x09 returns the system up-time in seconds as a 32-bit unsigned integer.

<table>
<tr><th colspan="3">Controller 0xF9 sends:</th><th colspan="4">CED-10 0x8C responds:</th></tr>
<tr><th rowspan="2">CAN ID</th><th colspan="2">CAN Data (DLC = 1)</th><th rowspan="2">CAN ID</th><th colspan="3">Data (DLC = 6)</th></tr>
<tr><th>Cmd</th><th>Parameters</th><th>Resp</th><th>Cmd</th><th>Result</th></tr>
<tr><td>0x18EF8CF9</td><td>0x09</td><td></td><td>0x18EFF98C</td><td>0xFF</td><td>0x09</td><td>0x9C 0x72 0x00 0x00</td></tr>
</table>

The result returned in the above response shows a system up-time of 29340 seconds.

6.9.3.2. Read the Up-Time Counter in Milliseconds (0x0A)

Command 0x0A returns the system up-time in milliseconds as a 32-bit unsigned integer.

Given the returned data type, the up-time in milliseconds wraps around (resets) approximately every 50 days.

<table>
<tr><th colspan="3">Controller 0xF9 sends:</th><th colspan="4">CED-10 0x8C responds:</th></tr>
<tr><th rowspan="2">CAN ID</th><th colspan="2">CAN Data (DLC = 1)</th><th rowspan="2">CAN ID</th><th colspan="3">Data (DLC = 6)</th></tr>
<tr><th>Cmd</th><th>Parameters</th><th>Resp</th><th>Cmd</th><th>Result</th></tr>
<tr><td>0x18EF8CF9</td><td>0x0A</td><td></td><td>0x18EFF98C</td><td>0xFF</td><td>0x0A</td><td>0x4B 0xB2 0xBF 0x01</td></tr>
</table>

The result returned in the above response shows an up-time of 29340235 ms.

7. Calibration

7.1. Scale Calibration

Before scale calibration, the CED-10 will be unable to output any weight data; it will only output mV/V signal level or ADC counts.

To output weight data, the CED-10 scale must be calibrated using one of the following methods: manual calibration (using weights) or e-calibration (using load cell datasheet information). These methods are described in detail in the following sections.

7.1.1. Manual Calibration

7.1.1.1. Checklist

Before attempting the manual calibration, the following scale parameters should be checked and adjusted if necessary:

- Maximum weight.
  Ensure the Maximum Weight value is suitable for the load cell and weighing application. This is usually set to the maximum capacity of the scale.
- Warm-up time.
  Ensure the Warm-Up Time is long enough for the system to settle and to give reliable ADC readings, but not too high as to be impractical.
- Signal filtering and stability.
  Ensure that the No-Motion Time, No-Motion Range and Filter Type values are suitable for the application and environment. If these parameters are not set correctly, the weight signal may not stabilise, which will inhibit calibration.
- Calibration weight.
  For greater weighing accuracy, the Calibration Weight should be close to the Maximum Weight set for the application. For any successful calibration, the Calibration Weight must be at least 1% of the Maximum Weight and no more than this maximum.

7.1.1.2. Manual Scale Calibration Sequence

Assume a scale of 2000 kg capacity where the weight is to be displayed in increments of 1 kg. The calibration weight to be used is 1600 kg.

The sequence needed to calibrate the scale is as follows.

1. Ensure the load cell is on a flat, horizontal surface.
2. Put the scale into calibration mode by writing to the passcode register (section 6.2.2).
3. Switch off tilt compensation (section 6.8.5.2).

4. Set the Maximum Weight to 2000 (increments = kg in this case) (section 6.2.4.2).
5. Unload the scale to find the zero point and wait for the signal to settle.
6. Calibrate the zero endpoint (section 6.2.14.2)
7. Apply the 1600 kg load to the scale and wait for the signal to settle.
8. Calibrate the span endpoint, defining a weight of 1600 increments (section 6.2.15.2)
9. Save calibration data (section 6.2.3)
10. Exit calibration mode by writing to the passcode register (section 6.2.2).

The Maximum Weight, Zero Endpoint, Span Endpoint and Calibration Weight have now been saved to non-volatile memory. The traceable access counter has been automatically incremented and can be read back as described in section 6.2.1.

7.1.2. e-Calibration (eCal)

To calibrate the scale without using weights, information from the load cell manufacturer's test data is needed, which should accompany the load cell used.

The 2 items of information required are in mV/V (but descriptions can vary):

- Zero offset / zero balance / zero
- Span / output at rated load / ORL
- Load cell capacity / weight at rated load / rated load

7.1.2.1. Checklist

Before attempting the manual calibration, the following scale parameters should be checked and adjusted if necessary:

- Maximum weight.
  Ensure the Maximum Weight parameter is suitable for the load cell and weighing application. This is usually set to the maximum capacity of the scale.

7.1.2.2. eCal Scale Calibration Sequence

Assume a scale of 2000 kg capacity where the weight is to be displayed in increments of 1 kg.

The sequence needed to calibrate the scale is as follows.

1. Put the scale into calibration mode by writing to the passcode register (section 6.2.2).
2. Set the Maximum Weight to 2000 (increments = kg in this case) (section 6.2.4.2).
3. Set the Absolute Zero Point value to the zero offset value read from the load cell datasheet (section 6.2.12.2).
4. Set the eCal Span-Point Weight to the rated load of the load cell (section 6.2.11.2), 2000 increments in this case.

5. Set the Absolute Span Point value to the span value read from the load cell datasheet (section 6.2.13.2).
6. Save calibration data (section 6.2.3)
7. Exit calibration mode by writing to the passcode register (section 6.2.2).

The Maximum Weight, Zero Endpoint, Span Endpoint and Calibration Weight have now been saved to non-volatile memory. The traceable access counter has been automatically incremented and can be read back as described in section 6.2.1.

7.2. Tilt Sensor Calibration

Before using any of the tilt-measuring or tilt-compensation features of the CED-10, the sensor must first be calibrated to establish the baseline readings for each of its 3 axes. All subsequent calculations will use these baselined values and all sensor readings and angular output will be referenced from them.

7.2.1. Tilt Sensor Calibration Sequence

The sequence needed to calibrate the tilt sensor is as follows.

1. Ensure the load cell (or PCB housing) is on a near-horizontal surface.
2. Put the scale into calibration mode by writing to the passcode register (section 6.2.2).
3. Enable tilt compensation (section 6.8.5.2).
4. Set the Tilt Sensor Baselines (section 6.8.5.5).
5. Save calibration data (section 6.2.3)
6. Exit calibration mode by writing to the passcode register (section 6.2.2).

The new tilt sensor baselines have now been saved to non-volatile memory. The traceable access counter has been automatically incremented and can be read back as described in section 6.2.1.