User Manual

CED-10 (CANopen)

V1.0 November 2022

CED-10/CED-11 CANopen User Manual

0100692

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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 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 CANopen protocol with several data rates from 10 kbps up to 1 Mbps.

The CED-10 can be switched from using the CANopen protocol to using the J1939 protocol as needed to suit the application. This document details the operation and commands for the CANopen protocol only. To switch to using the J1939 protocol, see the Bus Protocol section of this manual (6.5.3) and refer to the CED-10/CED-11 J1939 User Manual (Flintec document 0101581) 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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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

CED-10/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	CANopen and J1939
CANopen data rate	10k, 20k, 50k, 125k, 250k, 500k, 800k, 1Mbit/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 refer to corresponding loadcell 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
bps	Bits Per Second. A data rate equivalent to one binary digit per second.
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
Client-server	A communication system in which the client initiates the communication by a request to the server. The server will always send back a response to the client.
COB	Communication Object. One or more **CAN** messages with a specific functionality.
COB-ID	The object specifying the **CAN** message identifier and parameters.
Confirmed service	A confirmed service is a message (or group of messages) that requires the receiver to return an acknowledgement that the message has been successfully received. Compare with **unconfirmed service**.
DLC	Data Length Code. A field within a CAN bus frame stating how many bytes of data are included in the frame.
EDS	Electronic Data Sheet. A text file to describe the functionality and capabilities of a given CANopen device. The EDS is presented in a standardized format and layout to be both human- and machine-readable.
FDC	Flintec Device Configurator. A PC application to configure and calibrate several Flintec devices. Available on Flintec's website: www.flintec.com/uk/downloads
Heartbeat	A specific **CANopen** message transmitted periodically to show that a node (device) is still present on the network.
Index	A 16-bit address identifier to enable access to the **CANopen object dictionary**. For arrays and records, the address is extended by an 8-bit **sub-index**.
Increment (Scale increment)	The smallest integer number by which a change of input signal can be represented.
IP rating	Ingress Protection rating. Rates the degree of protection of an enclosure from external intrusions.
ISO	International Organization for Standardization. Standard-setting body

Term / Abbreviation	Meaning
	composed of representatives from various national standards organizations.
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.
Mbps	Megabits per second. A data rate of 1000000 **bps**.
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.
Object dictionary	A standardized listing which contains all communications and application parameters of a specific **CANopen** device.
PDO	Process Data Object. A communication object used for broadcasting high-priority control and status information. The **PDO** protocol is an **unconfirmed service**.
REG 10	Vehicle type approval certificate. An internationally agreed EMC standard applicable to road vehicles
RPDO	Receive Process Data Object. A **PDO** that is received by a **CANopen** device.
RTR	Remote Transmission Protocol. Setting the RTR bit in a CAN frame requests data from the node which would normally transmit the specified CAN ID.
SDO	Service Data Object. A protocol to provide access to all entries of the **object dictionary**. The SDO is a **client-server confirmed** service.
Sub-index	An 8-bit sub-address used to access array objects or records in the **object dictionary**.
TPDO	Transmit Process Data Object. A **PDO** that is transmitted by a **CANopen** device.
Unconfirmed service	An unconfirmed service is a message which will not be acknowledged by the receiver(s).
USB	Universal Serial Bus. An industry standard for communications between computers and peripherals.

4. Getting Started

You will require:

- A USB to CAN Converter for CANopen
- 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

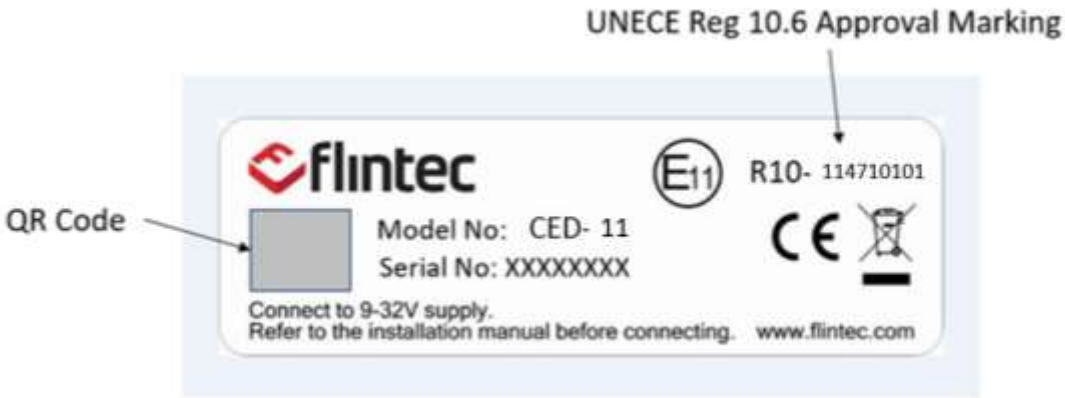
Note: The Flintec FDC application was developed with the Peak System USB-to-CAN adaptor. When using the Flintec FDC with CANopen or J1939 protocols, the Peak System adaptor should be used. Drivers and manuals for the Peak System devices are located here: https://www.peak-system.com/PCAN-USB.199.0.html?&L=1

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.

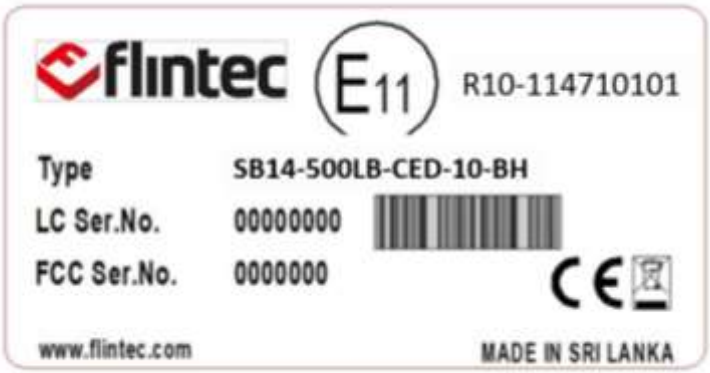
'Identification of Type' Label:



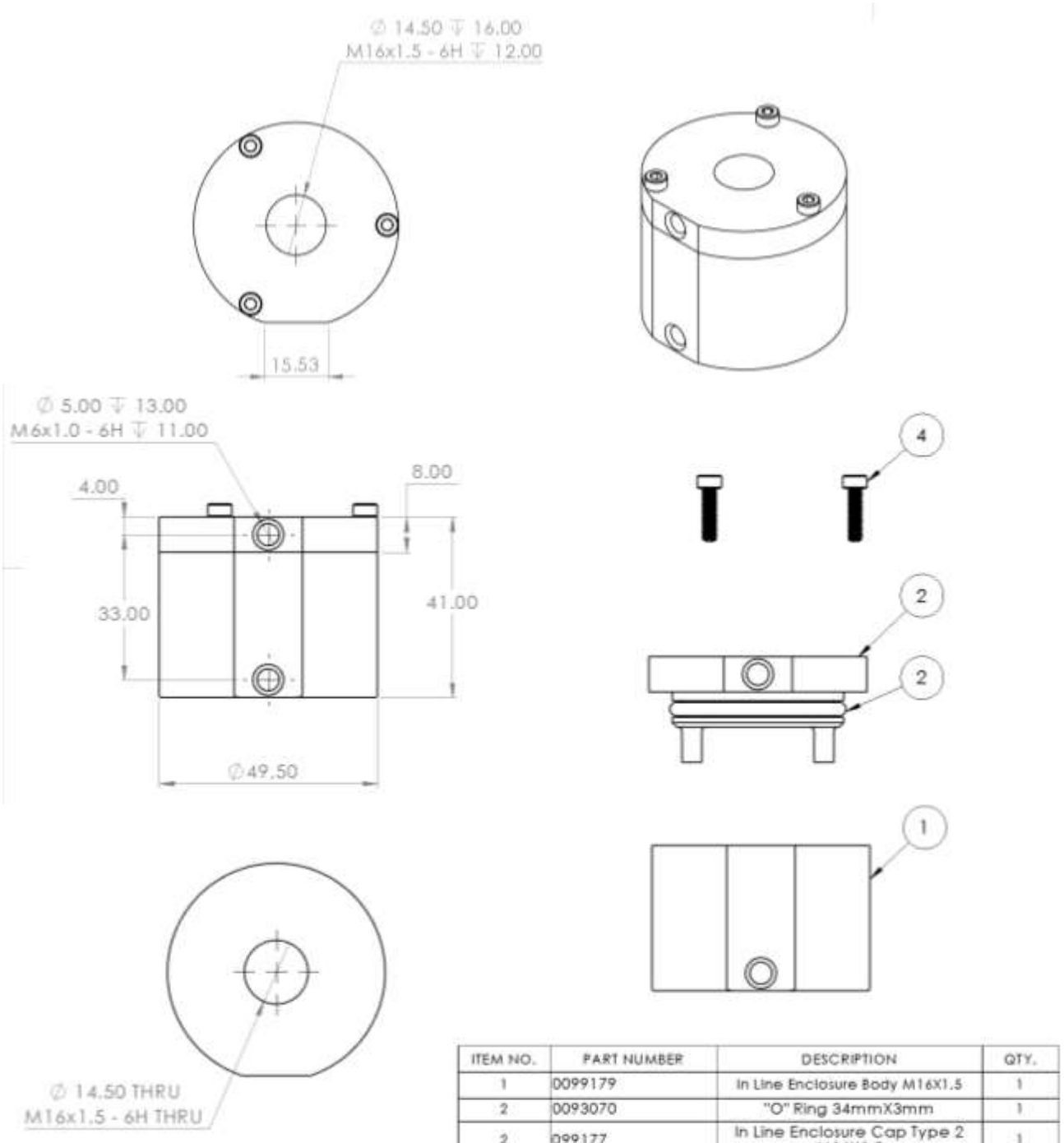
4.1.2. CED-10

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

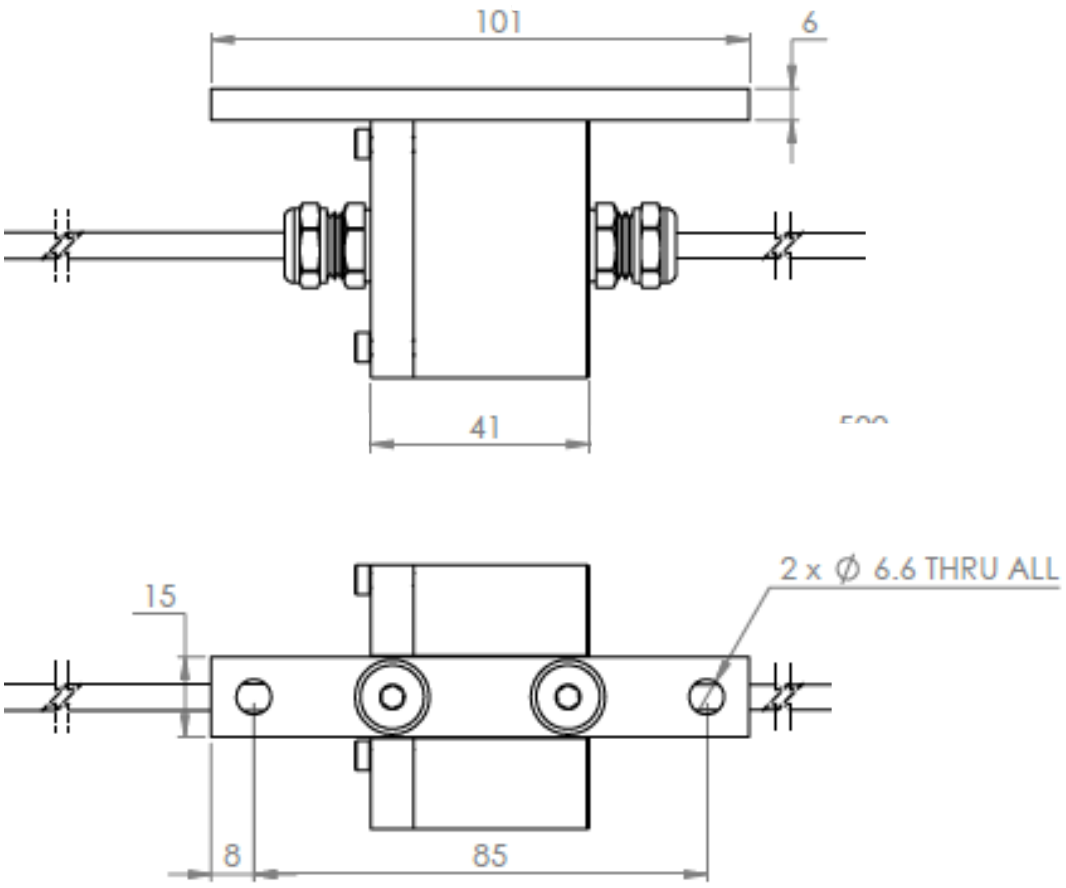


4.2. Inline Enclosure Dimensions

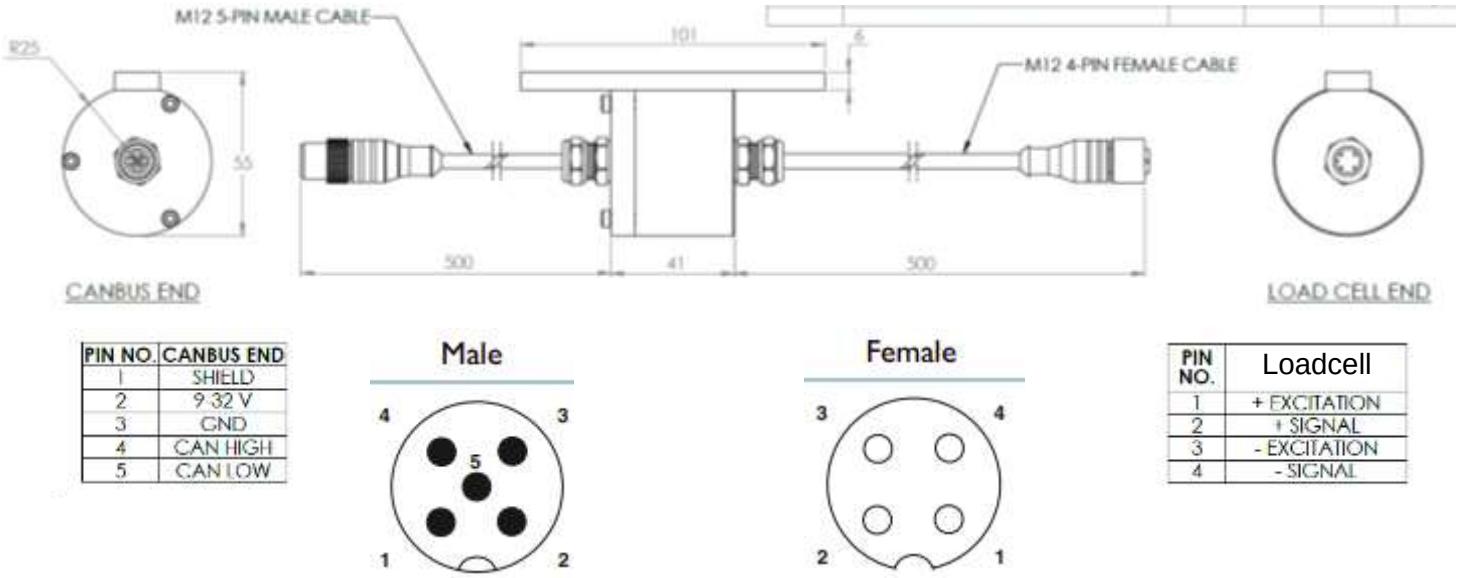


ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	0099179	In Line Enclosure Body M16X1.5	1
2	0093070	"O" Ring 34mmX3mm	1
2	099177	In Line Enclosure Cap Type 2 M16X1.5	1
4	0093076	M3X0.5X12	3

4.3. Enclosure Bracket Dimensions



4.4. Connections



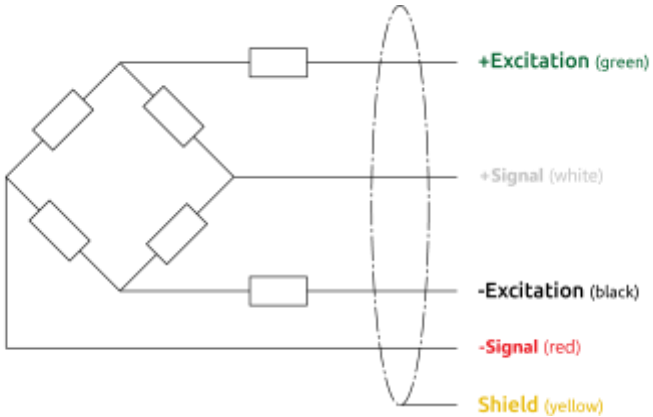
PIN NO.	CANBUS END
1	SHIELD
2	9-32 V
3	GND
4	CAN HIGH
5	CAN LOW

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

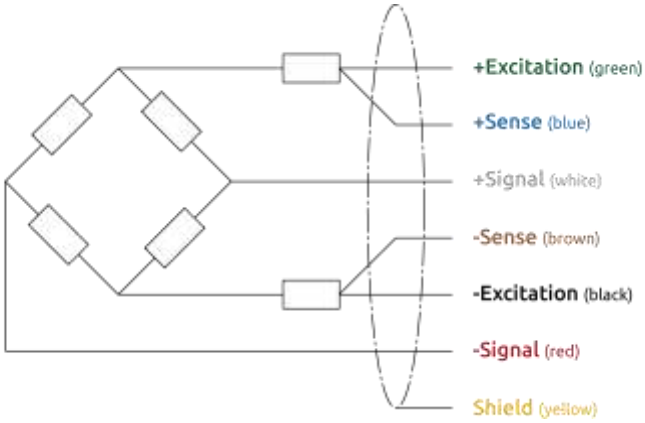
4.4.1. Load-Cell connections

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:

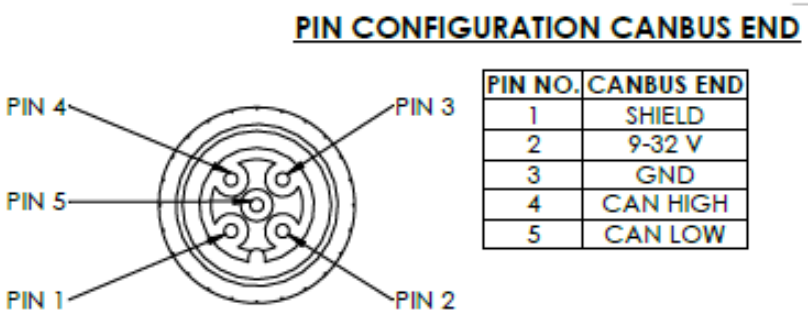


6-Wire Connection:



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.

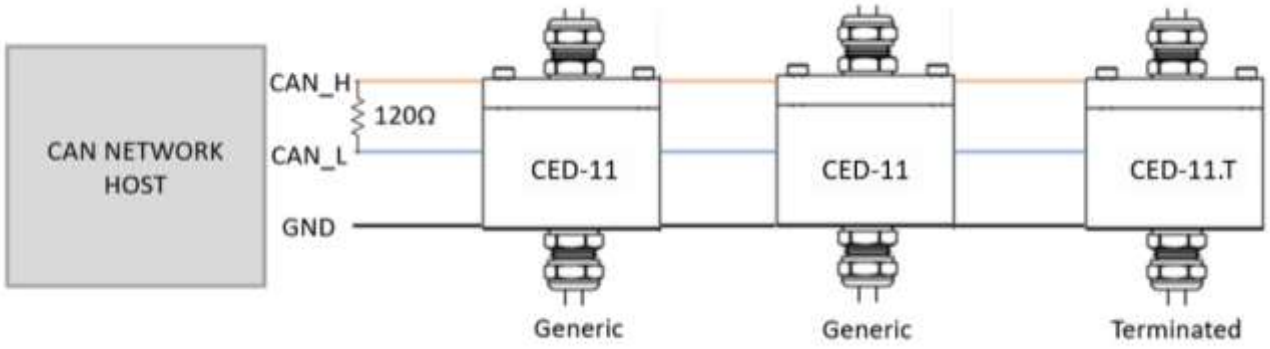


CED-10 Pins	Pin Name	Function
1	Shield	Chassis GND.
2	Vin	Power supply input (+9 V to +32 V).
3	GND	Power supply input GND.
4	CAN_H	CAN differential pin +
5	CAN_L	CAN differential pin -

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 CANopen Interface

5.1. General Information

The CANopen® interface conforms to the CAN 2.0B standard, using 11-bit identifiers and runs at a default speed of 500 kbps. All data is sent in little-endian format; that is, least-significant byte first.

The CED-10 conforms to the requirements for an NMT slave as defined in CiA® 302 DSP Part 2: Network Management (February 2009).

On first connection to the CANopen network, the CED-10 will send its boot-up message (a heartbeat message with a node state of 0), followed by periodic heartbeat messages (see section 5.2.2 and 6.5.4). If the node is configured to self-start, it will transition through the Pre-operational state into the Operational state. Otherwise, it will remain in the Pre-operational state, waiting for NMT messages or SDO requests (see sections 5.2.2. and 5.4)

The CED-10 implements static PDO mapping and a single, statically defined SDO server.

Throughout this manual, hexadecimal values are written using the “h” suffix (such as ‘9Ch’); all un-suffixed numbers should be considered as decimal numbers.

5.2. Network Management and Node Addressing

5.2.1. Node ID/Address

Each node on the CANopen network must have a unique 7-bit node ID (address) in the range 1 to 127 (7Fh); node ID 0 is reserved for use by the network management (NMT) master module. See section 6.5.2 and 6.5.6.3 for information on how to set the scale's node ID.

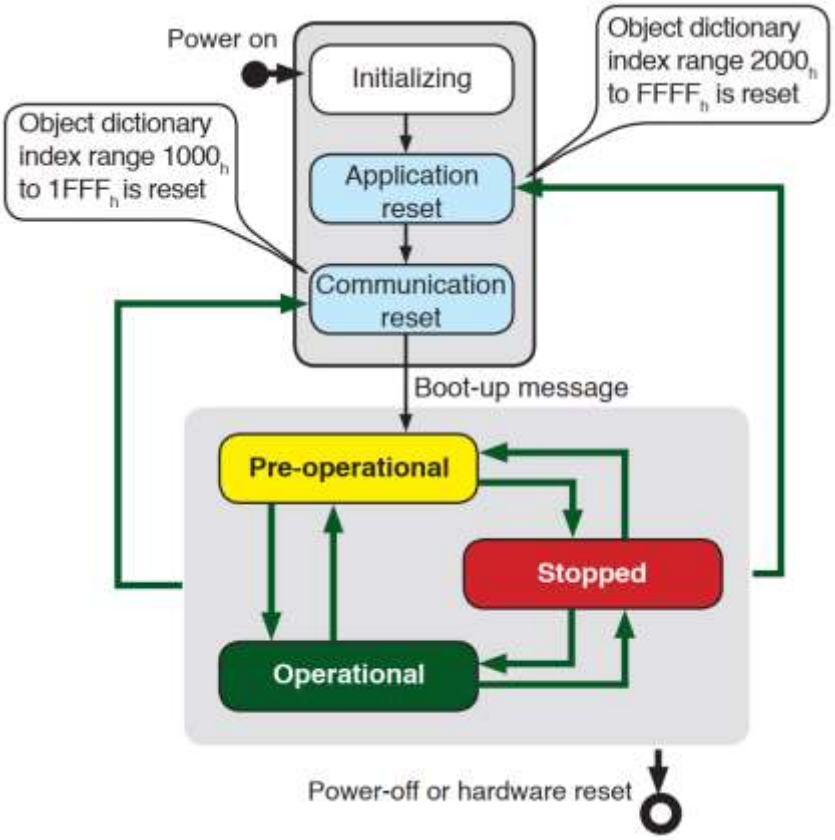
5.2.2. Network Management (NMT)

For the purposes of network management, the CED-10 supports the following dictionary objects.

Name	CAN ID / COB ID	DLC	CAN Data	
Boot-up protocol	700h + node ID	1	00h (Initialising)	
Heartbeat	700h + node ID	1	04h = Stopped 05h = Operational 7Fh (127) = Pre-operational	
NMT protocol	000h	2	00h = All nodes 01h..7Fh = Node ID	01h = Operational 02h = Stopped 80h (128) = Pre-operational 81h (129) = Reset node 82h (130) = Reset comms

NMT protocol is used to tell slaves to change state, to indicate device bootup and error conditions. The current node state dictates how that node communicates on the network.

The cycle of states is shown below.



5.3. Process Data Objects (PDOs)

Process data objects (PDOs) are messages which send real-time control and status information to and from the nodes on the CANopen network.

PDOs are unconfirmed transmissions and have a higher message priority than service data objects (SDOs), so will take precedence on the CAN bus.

The following sections detail the transmit PDOs (TPDOs) and receive PDOs (RPDOs) supported by the CED-10.

5.3.1. Transmit Process Data Objects (TPDOs)

Once set to the Operational state, the CED-10 will produce TPDOs on specific events or periodically at a rate defined by internal events (see the tables below). TPDOs may also be requested using a Remote Transmission Request (RTR), as described in the CANopen protocol.

When in the Operational state, a TPDO may be disabled by writing a '1' to bit-31 of its COB-ID (1800h:1 for TPDO1, 1801h:1 for TPDO2 and 1802h:1 for TPDO3).

The tables below detail the data content and format of the TPDOs implemented in the CED-10.

5.3.1.1. TPDO1: ADC/Weight Data

TPDO1	**Content**	ADC Data and scale status information.	
	COB ID	180h + Node ID	
	Trigger	On-event: Averaged ADC sample available.	
	CAN Data (DLC = 7)	Data 0	REAL32 or SIGNED32 (defined by ADC Output Data Select). ADC Event Data (see section 6.6.2), SDO 3004h:02h.
		Data 1	
		Data 2	
		Data 3	
		Data 4	UNSIGNED 8. ADC Output Data Select, SDO 3004h:01h.
		Data 5	UNSIGNED16. Scale Status, SDO 3004h:03h.
		Data 6	

Note: Depending on the data-rate set for the CANopen network, the higher sample rates (up to 2500 sample per second) can exceed what can be transmitted on the CAN bus. The output rate may also be affected when there are multiple nodes on the network and/or lower communication speeds are used. In these cases, lower sample rates or increased averaging can be used to reduce the network load (see sections 6.3.1 and 6.3.2 for more information).

5.3.1.2. TPDO2: Tilt Sensor Data

TPDO2	**Content**	Tilt sensor pitch & roll angles.	
	COB ID	280h + Node ID	
	Trigger	Periodic: As defined by the Tilt Sensor Message Period (section 6.8.1).	
	CAN Data (DLC = 8)	Data 0	SIGNED32. Pitch and Roll Angles (see section 6.8.4.5), SDO 3006h:08h.
		Data 1	
		Data 2	
		Data 3	
		Data 4	SIGNED32. Yaw Angle and Axis (see section 6.8.4.6), SDO 3006h:09h.
		Data 5	
		Data 6	
		Data 7	

5.3.1.3. TPDO3: Tare Weight

TPDO3	**Content**	Tare weight and scale status information.	
	COB ID	380h + Node ID	
	Trigger	On-event: Set Tare or Reset Tare command executed.	
	CAN Data (DLC = 7)	Data 0	REAL32 or SIGNED32 (defined by ADC Output Data Select). Tare Weight, SDO 3004h:06h.
		Data 1	
		Data 2	
		Data 3	
		Data 4	UNSIGNED 8. ADC Output Data Select, SDO 3004h:01h
		Data 5	UNSIGNED16 Scale Status, SDO 3004h:03h
		Data 6	

5.3.2. Receive PDOs (RPDOs)

Once set to the Operational state, the CED-10 will accept the following RPDOs to modify the output of TPDO1 or to execute certain key functions.

The tables below detail the data content and format of the RPDOs implemented in the CED-10.

5.3.2.1. RPDO1: Output Data Select

RPDO1	**Content**	ADC Output Data Select	
	COB ID	200h + Node ID	
	CAN Data (DLC = 1)	Data 0	UNSIGNED 8. ADC Output Data Select (see section 6.6.1), SDO 3004h:01h

5.3.2.2. RPDO2: Tare & Zero

RPDO2	**Content**	Taring and Zeroing commands	
	COB ID	300h + Node ID	
	CAN Data (DLC = 1)	Data 0	UNSIGNED8. Taring and Zeroing (see section 6.7), SDO 3005h:01h

5.4. Service Data Objects (SDOs)

Service data objects (SDOs) give access to all entries in the node's object dictionary, allowing reading of device-specific attributes, interrogation and writing of configuration parameters and execution of commands.

The SDO protocol is a confirmed service operating on a client-server basis. One SDO is made up of two CAN frames with different IDs: one for the client request and another for the server response. In this case, the CED-10 is the SDO server and supports both expedited (single-frame) and segmented (multi-frame) responses.

SDOs operate only in the Pre-operational and Operational states.

5.4.1. The SDO Message Frame

The message frame format of an SDO is as follows.

The SDO request frame (client to server):

CAN-ID (COB-ID)	CAN Data (DLC = 8)							
	D0	D1	D2	D3	D4	D5	D6	D7
600h + node ID	Command	SDO Index		Sub-Index	Data			

The SDO response frame (server to client):

CAN-ID (COB-ID)	CAN Data (DLC = 8)							
	D0	D1	D2	D3	D4	D5	D6	D7
580h + node ID	Command	SDO Index		Sub-Index	Data			

The command byte is split up further, as shown below.

Bit(s)	Symbol	Use	Meaning	
7..5	SP	Command specifier for client or server (only services supported by the CED-10 are shown).	**Client specifier**	**Server specifier**
			1: Initiate write 2: Initiate read 3: Read segment 4: Abort transfer.	0: Read segment response 2: Initiate read response 3: Initiate write response 4: Abort transfer.
4	T	Toggle bit	Toggles on each frame of a segmented transfer	
3..2	N	Unused data bytes (valid only if E=S=1)	0: Four data bytes are in the transfer 1: Three data bytes are in the transfer 2: Two data bytes are in the transfer 3: One data byte is in the transfer.	
1	E	Expedited transfer	0: Transfer is a segmented transfer (multi-frame) 1: Transfer is an expedited transfer (single frame).	
0	S	Size indication	0: Data size is not indicated 1: Data size is indicated by bits 3..2	

5.4.2. SDO Abort Codes

Since the SDO protocol is a confirmed service, all requests to the CED-10 will elicit a response. Where an SDO client request cannot be executed, an abort message will be sent. The command specifier of an SDO abort message is always 80h. The 32-bit abort code is sent in the data bytes of the SDO response frame to provide some detail as to why the request was not executed.

The table below lists all SDO abort codes supported by the CED-10.

Code	Description
05030000h	The toggle bit of a multi-frame request is not as expected.
05040001h	Invalid bit combination in the command specifier byte.
06010001h	Attempt to read a write-only object.
06010002h	Attempt to write a read-only object.
06020000h	The object does not exist in the object dictionary (the SDO index is invalid).
06070010h	The data length for an SDO write is incorrect.
06090011h	The sub-index does not exist for the given object.
06090030h	The value for an SDO write is out of range.
08000000h	General error (e.g., the request does not have 8 bytes or there is non-zero data in a read request).
08000022h	The conditions are not correct to execute the request at this time (e.g., the CED-10 is not in calibration mode).

5.5. Emergency Messages and the Emergency Object (EMCY)

On detection of certain errors in the CED-10 or on the CANopen bus itself, the CED-10 will send an unsolicited message containing details of the detected error; this is the Emergency Object (EMCY).

The EMCY message has the following format:

EMCY	**COB-ID**	80h + Node ID	
	Trigger	On-event: On detection of a new error *type*.	
	CAN Data (DLC = 8)	Data 0	UNSIGNED16. Error code (see the table of supported error codes below)
		Data 1	
		Data 2	UNSIGNED 8. Error register, SDO 1001h:00h.
		Data 3	Vendor-specific data
		Data 4	
		Data 5	
		Data 6	
		Data 7	

The following table shows all error codes which can be transmitted by the CED-10 EMCY object.

Code	Description
0000h	Error reset - transmitted when all errors are cleared.
5001h	An error has been detected in the A/D converter.
5002h	An error has been detected in the tilt sensor.
8110h	A CAN over-run error has occurred – a message has been lost.
8120h	The CED-10's CAN controller has entered the Error Passive state.
8140h	The CED-10's CAN controller has recovered from a Bus Off condition.
8150h	A COB-ID collision has been detected – another device on the CAN bus has the same node ID as the CED-10.
8210h	An RPDO1 message has been received with an incorrect data length.
8211h	An RPDO2 message has been received with an incorrect data length.
FF01h	A non-recoverable fault has been detected in the factory settings memory. The CED-10 should be returned to the factory.
FF02h	An error has been detected in the configuration data memory. The scale can be recovered by reconfiguring all user parameters.
FF03h	An error has been detected in the calibration data memory. The scale can be recovered by setting all legal parameters and re-calibrating.

5.6. The Object Dictionary

The following subsections detail the object dictionary entries needed for access to the CED-10 data.

The table below shows the abbreviations used for the various data types found in the object dictionary.

Abbreviation	Data Type	Range
UI8	Unsigned 8-bit integer	0 to 255
UI16	Unsigned 16-bit integer	0 to 65535
UI32	Unsigned 32-bit integer	0 to 4294967295
I32	Signed 32-bit integer	-2147483648 to 2147483647
REAL32	32-bit floating point number conforming to IEEE 754.	$\cong \pm 3.4028235 \times 10^{38}$
VS	Visible string	All bytes are ASCII characters in the range 20h to 7Eh.

5.6.1. Communication Segment

Index	Sub-Index	Name	Type	Access	Default Value	Information
1000h	0	Device type	UI32	RO	0	Non-standard device profile.
1001h	0	Error register	UI8	RO	0	Supported bits: Bit 0: Generic error Bit 4: Communication error Bit 7: Manufacturer-specific error.

Index	Sub-Index	Name	Type	Access	Default Value	Information
1003h	**Pre-defined error field**					
	0	Number of errors	UI8	RW	0	Reads the number of errors. Write 0 to erase error history.
	1 to 8	Standard error field	UI32	RO	-	A list of the most recent errors (EMCY objects sent).
100Ah	0	Manufacturer software version	VS	Const	Version specific	Bootloader version, application version and compatibility number.
1014h	0	Emergency COB-ID	UI32	Const	80h + node ID	CAN ID of the EMCY message.
1017h	0	Producer heartbeat time	UI16	RW	0	Heartbeat cycle time in milliseconds (see section 6.5.4).
1018h	**Identity object**					
	0	Number of entries	UI8	Const	4	
	1	Vendor ID	UI32	RO	044Ah	
	2	Product code	UI32	RO	96509	Application firmware part number (see section 6.1.2).
	3	Revision number	UI32	RO	Version specific	Application firmware version (see section 6.1.3).
	4	Serial number	UI32	RO	-	Device-specific serial number (see section 6.1.1).
1026h	**OS Prompt**					
	0	Number of entries	UI8	Const	2	
	1	StdIn	UI8	WO	-	Reserved for Flintec use.
	2	StdOut	UI8	RO	-	Reserved for Flintec use.

Index	Sub-Index	Name	Type	Access	Default Value	Information
1400h	**RPDO1 communication parameter**					
	0	Number of entries	UI8	Const	2	
	1	COB-ID of RPDO1	UI32	Const	200h + node ID	
	2	Transmission type	UI8	Const	FFh	Transmission type is asynchronous.
1401h	**RPDO2 communication parameter**					
	0	Number of entries	UI8	Const	2	
	1	COB-ID of RPDO2	UI32	Const	300h + node ID	
	2	Transmission type	UI8	Const	FFh	Transmission type is asynchronous.
1600h	**RPDO1 mapping**					
	0	Number of entries	UI8	Const	1	
	1	Mapping entry 1	UI32	Const	30040108h	Mapped to ADC Output Data Select (see section 6.6.2).
1601h	**RPDO2 mapping**					
	0	Number of entries	UI8	Const	1	
	1	Mapping entry 1	UI32	Const	30050108h	Mapped to the Taring & Zeroing commands (section 6.7).
1800h	**TPDO1 communication parameter**					
	0	Number of entries	UI8	Const	2	
	1	COB-ID of TPDO1	UI32	RW	180h + node ID	
	2	Transmission type	UI8	Const	FEh	Transmission type is manufacturer-specific.

Index	Sub-Index	Name	Type	Access	Default Value	Information
1801h	**TPDO2 communication parameter**					
	0	Number of entries	UI8	Const	2	
	1	COB-ID of TPDO2	UI32	RW	280h + node ID	
	2	Transmission type	UI8	Const	FEh	Transmission type is manufacturer-specific.
1802h	**TPDO3 communication parameter**					
	0	Number of entries	UI8	Const	2	
	1	COB-ID of TPDO3	UI32	RW	380h + node ID	
	2	Transmission type	UI8	Const	FEh	Transmission type is manufacturer-specific.
1A00h	**TPDO1 mapping**					
	0	Number of entries	UI8	Const	3	
	1	Mapping entry 1	UI32	Const	30040220h	Mapped to ADC Event Data (see section 6.6.2).
	2	Mapping entry 2	UI32	Const	30040108h	Mapped to ADC Output Data Select (see section 6.6.1).
	3	Mapping entry 3	UI32	Const	30040310h	Mapped to Scale Status (see section 6.6.3).
1A01h	**TPDO2 mapping**					
	0	Number of entries	UI8	Const	2	
	1	Mapping entry 1	UI32	Const	30060820h	Mapped to Pitch and Roll Angles (see section 6.8.4.5).
	2	Mapping entry 2	UI32	Const	30060920h	Mapped to Yaw Angle and Axis (see section 6.8.4.6).

Index	Sub-Index	Name	Type	Access	Default Value	Information
1A02h	**TPDO3 mapping**					
	0	Number of entries	UI8	Const	3	
	1	Mapping entry 1	UI32	Const	30040620h	Mapped to Tare Weight (see section 6.6.6).
	2	Mapping entry 2	UI32	Const	30040108h	Mapped to ADC Output Data Select (see section 6.6.1).
	3	Mapping entry 3	UI32	Const	30040310h	Mapped to Scale Status (see section 6.6.3).
1F80h	0	NMT start-up	UI32	RW	4 (no self-start)	NMT self-start capability (see section 6.5.5).

5.6.2. Manufacturer Segment

5.6.2.1. Device Identification (Index 3000h)

Index	Sub-Index	Name	Type	Access	Default Value	Information
3000h	0	Number of entries	UI8	Const	5	
	1	Serial number	UI32	Const	-	Device-specific serial number (see section 6.1.1).
	2	Firmware part number	UI32	Const	-	Application firmware part number (see section 6.1.2).
	3	Firmware version number	UI32	Const	-	Application firmware version (see section 6.1.3).
	4	Bootloader part number	UI32	Const	-	Bootloader firmware part number (see section 6.1.4).
	5	Bootloader f/w version	UI32	Const	-	Bootloader firmware version (see section 6.1.5).

5.6.2.2. Calibration and Calibration Parameters (Index 3001h)

Index	Sub-Index	Name	Type	Access	Default Value	Information
3001h	0	Number of entries	UI8	Const	15	
	1	Traceable access counter	I32	RO	-	Number of changes to legal parameters (see section 6.2.1).
	2	Write passcode register	I32	WO	-	Entry to calibration mode (see section 6.2.2).
	3	Save calibrations or setup	I32	WO	-	Store changed parameters (see section 6.2.3).
	4	Maximum weight	I32	RW	Device-specific	Maximum displayed weight (see section 6.2.4).
	5	Minimum weight	I32	RW	-999999	Minimum displayed weight (see section 6.2.5).
	6	Warm-up time	I32	RW	0	Time for system stabilization (see section 6.2.6).
	7	Zero range	I32	RW	0	Range for manual zero (see section 6.2.7).
	8	Initial zero range	I32	RW	0	Range for the power-up auto-zero (see section 6.2.8).
	9	Zero-tracking range	I32	RW	0	Range for automatic zero-setting (see section 6.2.9).
	10	Maximum tare weight	I32	RW	-999999	Maximum allowed tare weight (see section 6.2.10).
	11	Span-point weight	I32	RW	Device-specific	Read / set the calibration weight (see section 6.2.11).
	12	Absolute zero point	I32	RW	Device-specific	mV/V reading at the zero endpoint (see section 6.2.12).
	13	Absolute span point	I32	RW	Device-specific	mV/V reading at the calibrated weight (see section 6.2.13).
	14	Zero endpoint	I32	RW	Device-specific	Read / calibrate the zero endpoint (see section 6.2.14).
	15	Span endpoint	I32	RW	Device-specific	Read / calibrate the span endpoint (see section 6.2.15).

5.6.2.3. General Parameters (Index 3002h)

Index	Sub-Index	Name	Type	Access	Default Value	Information
3002h	0	Number of entries	UI8	Const	5	
	1	Sample rate	I32	RW	50 (Hz)	ADC sample rate (see section 6.3.1).
	2	Output data rate divisor	I32	RW	1	ADC averaging counter (see section 6.3.2).
	3	Filter type	I32	RW	2	ADC digital filter type (see section 6.3.3).
	4	No-motion range	UI16	RW	10 (1 increment)	Weight range for stability test (see section 6.4.1).
	5	No-motion time	UI16	RW	1000 (ms)	Stability test time (see section 6.4.2).

5.6.2.4. Communication Parameters (Index 3003h)

Index	Sub-Index	Name	Type	Access	Default Value	Information
3003h	0	Number of entries	UI8	Const	3	
	1	Baud rate	I32	RW	500000 (bps)	CAN bus speed (see section 6.5.1).
	2	Node ID	I32	RW	1	CANopen network address/ID (see section 6.5.2).
	3	Bus protocol	I32	RW	-	Switch between CANopen & J1939 (see section 6.5.3).

5.6.2.5. Data Access (Index 3004h)

Index	Sub-Index	Name	Type	Access	Default Value	Information
3004h	0	Number of entries	UI8	Const	11	
	1	ADC output data select	UI8	RW	7 (output mV/V)	ADC output data options for TPDOs (see section 6.6.1).
	2	ADC event data	I32	RO	-	Data output mapped to TPDO1 (see section 6.6.2).
	3	Scale status	UI16	RO	-	Scale status flags (see section 6.6.3).
	4	Gross weight	I32	RO	-	Latest calculated gross weight (see section 6.6.4).
	5	Net weight	I32	RO	-	Latest calculated net weight (see section 6.6.5).
	6	Tare weight	I32	RO	-	Latest calculated tare weight (see section 6.6.6).
	7	Dummy	I32	Const	0	
	8	Raw ADC sample	I32	RO	-	Latest unfiltered ADC output value (see section 6.6.7).
	9	Filtered ADC sample	I32	RO	-	Latest filtered ADC output (see section 6.6.8).
	10	Filtered mV/V signal	I32	RO	-	Latest filtered load cell signal level (see section 6.6.9).
	11	Fault flags	I32	RO	-	System fault flags (see section 6.6.10).

5.6.2.6. Scale Control (Index 3005h)

Index	Sub-Index	Name	Type	Access	Default Value	Information
3005h	0	Number of entries	UI8	Const	1	
	1	Taring and zeroing	UI8	WO	-	Taring & zeroing commands (see section 6.7).

5.6.2.7. Tilt Detection and Compensation (Index 3006h)

Index	Sub-Index	Name	Type	Access	Default Value	Information
3006h	0	Number of entries	UI8	Const	14	
	1	Tilt message period	UI32	RW	0 (disabled)	Output period of TPDO2 (see section 6.8.1).
	2	Tilt sensor filter length	UI32	RW	8 (samples)	Averaging filter for accelerometer data (see section 6.8.2).
	3	Tilt alarm threshold	UI32	RW	0 (disabled)	Threshold for tilt alarm flag (see section 6.8.3).
	4	Pitch & roll sensor data	UI32	RO	-	Read pitch & roll data from the sensor (see section 6.8.4.1).
	5	Yaw sensor data	UI32	RO	-	Read yaw data from the sensor (see section 6.8.4.2).
	6	Pitch & roll baseline data	UI32	RO	-	Baseline levels for pitch & roll axes (see section 6.8.4.3).
	7	Yaw baseline data	UI32	RO	-	Baseline level for the yaw axis (see section 6.8.4.4).
	8	Pitch & roll angles	UI32	RO	-	Read pitch & roll angles (see section 6.8.4.5).
	9	Yaw angle & axis	UI32	RO	-	Read yaw angle & axis (see section 6.8.4.6).
	10	Tilt compensation status	UI32	RW	0 (disabled)	Enable/disable tilt compensation (see section 6.8.5).

Index	Sub-Index	Name	Type	Access	Default Value	Information
	11	Set or reset tilt baselines	UI32	WO	-	Set or reset the tilt sensor baselines (see section 6.8.6).
	12	Restore default baselines	UI32	WO	-	Load the factory default tilt baselines (see section 6.8.7).
	13	Default pitch & roll baselines	UI32	Const	-	Read the factory default pitch & roll baselines (see 6.8.8).
	14	Default Yaw baseline	UI32	Const	-	Read the Factory default yaw baseline (see section 6.8.9).

5.6.2.8. Miscellaneous (Index 3007h)

Index	Sub-Index	Name	Type	Access	Default Value	Information
3007h	0	Number of entries	UI8	Const	5	
	1	System reset	I32	WO	-	System reset / warm start (see section 6.9.1).
	2	Factory default	I32	WO	-	Restore factory defaults (see section 6.9.2).
	3	Up-time in seconds	UI32	RO	-	Time since power-on / reset (see section 6.9.3.1).
	4	Up-time in milliseconds	UI32	RO	-	Time since power-on / reset (see section 6.9.3.2).
	5	Reserved	I32	WO	-	Reserved for Flintec use.

6. Command Descriptions

The following sections give a definitive list of the user commands supported by the SDOs making up the CED-10 object dictionary.

Unless stated otherwise, all data parameters and SDO results are transmitted as 32-bit signed integers in little-endian format.

6.1. System Identification Commands

6.1.1. Read Serial Number (Index 3000h, Sub-Index 01h)

Reading SDO 3000h:01h (and 1018h:04h) returns the device-specific serial number as a 32-bit unsigned integer.

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	00h 30h	01h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	00h 30h	01h	87h 53h 1Fh 00h

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

6.1.2. Read Application Firmware Part Number (Index 3000h, Sub-Index 02h)

Reading SDO 3000h:02h (and 1018h:02h) returns the application firmware part number.

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	00h 30h	02h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	00h 30h	02h	FDh 78h 01h 00h

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

6.1.3. Read Application Firmware Version (Index 3000h, Sub-Index 03h)

SDO 3000h:03h (and 1018h:03h) returns the application firmware version number in the following format:

Data byte 4: Non-legal firmware version (minor)
Data byte 5: Unused (always 00h)
Data byte 6: Non-legal firmware version (major)
Data byte 7: Legal firmware version.

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	00h 30h	03h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	00h 30h	03h	00h 00h 04h 00h

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

6.1.4. Read Bootloader Firmware Part Number (Index 3000h, Sub-Index 04h)

Reading SDO 3000h:04h returns the bootloader part number.

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	00h 30h	04h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	00h 30h	04h	91h 70h 01h 00h

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

6.1.5. Read Bootloader Firmware Version (Index 3000h, Sub-Index 05h)

Reading SDO 3000h:05h returns the bootloader firmware version number in the following format:

Data byte 4: Bootloader firmware version (minor)
Data byte 5: Bootloader firmware version (major)
Data byte 6: Bootloader compatibility number (LSB)
Data byte 7: Bootloader compatibility number (MSB)

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	00h 30h	05h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	00h 30h	05h	01h 02h C0h 4Bh

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

6.2. Calibration Commands

6.2.1. Read Traceable Access Counter (Index 3001h, Sub-Index 01h)

Reading SDO 3001h:01h 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 Calibrations 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 Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	01h 30h	01h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	01h 30h	01h	12h 00h 00h 00h

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

6.2.2. Write Passcode Register (Index 3001h, Sub-Index 02h)

SDO 3001h:02h writes a 32-bit integer into the passcode register. The contents of this register must match the system passcode (default value 09A52Fh) 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 when an incorrect code is entered, an error will be returned, and this command will become unavailable for 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 Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	01h 30h	02h	2Fh A5h 09h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	01h 30h	02h	00h 00h 00h 00h

6.2.3. Save Calibrations or Setup Data (Index 3001h, Sub-Index 03h)

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
01h	Save only calibration parameters (legally relevant configurations).
02h	Save only setup parameters.
03h	Save all changed parameters.

If legally relevant parameters are to be stored (parameter is 01h or 03h), 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, Baud Rate, Node ID, Producer Heartbeat Time, Self-Start, 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 Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	01h 30h	03h	02h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	01h 30h	03h	00h 00h 00h 00h

6.2.4. Maximum Weight (Index 3001h, Sub-Index 04h)

SDO 3001h:04h reads and sets the Maximum Weight parameter.

Maximum weight is the weight above which the over-range status flag will be set (see section 6.6.3).

As permitted by EN 45501, 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 (3B9ACA00h).

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.

For 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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	01h 30h	04h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	01h 30h	04h	10h 27h 00h 00h

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

6.2.4.2. Write Maximum Weight

To set a maximum weight of 30000 increments:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	01h 30h	04h	30h 75h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	01h 30h	04h	00h 00h 00h 00h

6.2.5. Minimum Weight (Index 3001h, Sub-Index 05h)

SDO 3001h:05h reads and sets 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 (C4653600h) and the under-range 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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	01h 30h	05h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	01h 30h	05h	ECh FFh FFh FFh

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

6.2.5.2. Write Minimum Weight

To set a minimum weight of -10 increments:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	01h 30h	05h	F6h FFh FFh FFh

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	01h 30h	05h	00h 00h 00h 00h

6.2.6. Warm-Up Time (Index 3001h, Sub-Index 06h)

SDO 3001h:06h reads and sets 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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	01h 30h	06h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	01h 30h	06h	0Fh 00h 00h 00h

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

6.2.6.2. Write Warm-Up Time

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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	01h 30h	06h	1Eh 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	01h 30h	06h	00h 00h 00h 00h

6.2.7. Zero Range (Index 3001h, Sub-Index 07h)

SDO 3001h:07h reads and sets 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 0 indicates the scale will use a 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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	01h 30h	07h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	01h 30h	07h	64h 00h 00h 00h

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

6.2.7.2. Write Zero Range

To set a zero range of ±300 increments:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	01h 30h	07h	2Ch 01h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	01h 30h	07h	00h 00h 00h 00h

6.2.8. Initial Zero Range (Index 3001h, Sub-Index 08h)

SDO 3001h:08h reads and sets 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 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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	01h 30h	08h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	01h 30h	08h	FAh 00h 00h 00h

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

6.2.8.2. Write Initial Zero Range

To set an initial zero range of ±500 increments:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	01h 30h	08h	F4h 01h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	01h 30h	08h	00h 00h 00h 00h

6.2.9. Zero-Tracking Range (Index 3001h, Sub-Index 09h)

SDO 3001h:09h reads and sets the Zero-Tracking Range parameter, which is measured in units of 0.5 increments.

The zero-tracking algorithm will zero the scale, when all 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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	01h 30h	09h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	01h 30h	09h	02h 00h 00h 00h

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

6.2.9.2. Write Zero-Tracking Range

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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	01h 30h	09h	01h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	01h 30h	09h	00h 00h 00h 00h

6.2.10. Maximum Tare Weight (Index 3001h, Sub-Index 0Ah)

SDO 3001h:0Ah reads and sets 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 -999999 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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	01h 30h	0Ah	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	01h 30h	0Ah	88h 13h 00h 00h

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

6.2.10.2. Write Maximum Tare Weight

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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	01h 30h	0Ah	78h ECh FFh FFh

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	01h 30h	0Ah	00h 00h 00h 00h

6.2.11. Calibration Weight / eCal Span-Point Weight (Index 3001h, Sub-Index 0Bh)

SDO 3001h:0Bh reads and sets 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 g) 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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	01h 30h	0Bh	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	01h 30h	0Bh	98h 3Ah 00h 00h

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

6.2.11.2. Write eCal Span-Point Weight

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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	01h 30h	0Bh	D4h 30h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	01h 30h	0Bh	00h 00h 00h 00h

6.2.12. Absolute Zero Point (eCal) (Index 3001h, Sub-Index 0Ch)

Reading SDO 3001h:0Ch 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 command in section 6.2.12.2).

Writing SDO 3001h:0Ch sets the eCal Absolute Zero Point parameter to the load cell's mV/V signal level specified in the parameter.

For increased precision, the values sent and received with this command are 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 specific 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 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.

6.2.12.1. Read Absolute Zero Point

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	01h 30h	0Ch	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	01h 30h	0Ch	C8h 00h 00h 00h

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

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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	01h 30h	0Ch	C4h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	01h 30h	0Ch	00h 00h 00h 00h

6.2.13. Absolute Span Point (eCal) (Index 3001h, Sub-Index 0Dh)

Reading SDO 3001h:0Dh 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).

Writing SDO 3001h:0Dh sets the eCal Absolute Span Point parameter to the load cell's mV/V signal level specified in the parameter.

For increased precision, the values sent and received with this command are 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 specific to each load cell.

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

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.

6.2.13.1. Read Absolute Span Point

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	01h 30h	0Dh	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	01h 30h	0Dh	20h 4Eh 00h 00h

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

6.2.13.2. Write Absolute Span Point

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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	01h 30h	0Dh	02h 4Eh 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	01h 30h	0Dh	00h 00h 00h 00h

6.2.14. Zero Endpoint (Index 3001h, Sub-Index 0Eh)

Reading SDO 3001h:0Eh returns the A/D converter value captured when the Zero Endpoint was calibrated.

Writing any value to SDO 3001h:0Eh 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 specific to each device.

The CED-10 must be in calibration mode to calibrate the endpoint.

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

6.2.14.1. Read Zero Endpoint

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	01h 30h	0Eh	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	01h 30h	0Eh	14h 00h 80h 00h

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

6.2.14.2. Calibrate Zero Endpoint

To calibrate the zero endpoint:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	01h 30h	0Eh	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	01h 30h	0Eh	00h 00h 00h 00h

6.2.15. Span Endpoint (Index 3001h, Sub-Index 0Fh)

Reading SDO 3001h:0Fh returns the A/D converter value captured when the Span Endpoint was calibrated.

Writing SDO 3001h:0Fh 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 specific to each device.

The CED-10 must be in calibration mode to calibrate the endpoint.

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

6.2.15.1. Read Span Endpoint

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	01h 30h	0Fh	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	01h 30h	0Fh	72h B3h C9h 00h

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

6.2.15.2. Calibrate Span Endpoint

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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	01h 30h	0Fh	10h 27h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	01h 30h	0Fh	00h 00h 00h 00h

6.3. ADC Control and Filtering

6.3.1. ADC Sample Rate (Index 3002h, Sub-Index 01h)

SDO 3002h:01h reads and sets 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 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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	02h 30h	01h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	02h 30h	01h	7Dh 00h 00h 00h

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

6.3.1.2. Write ADC Sample Rate

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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	02h 30h	01h	FAh 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	02h 30h	01h	00h 00h 00h 00h

6.3.2. ADC Output Data Rate Divisor (Index 3002h, Sub-Index 02h)

SDO 3002h:02h reads and sets the Output Data Rate Divisor parameter.

The ADC 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 TPDO1 every 200 ms.

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

The factory default value is 1.

6.3.2.1. Read ADC Output Data Rate Divisor

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	02h 30h	02h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	02h 30h	02h	0Ah 00h 00h 00h

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

6.3.2.2. Write ADC Output Data Rate Divisor

To set the ADC output data rate divisor to 20:

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	02h 30h	02h	14h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	02h 30h	02h	00h 00h 00h 00h

6.3.3. Filter Type (Index 3002h, Sub-Index 03h)

SDO 3002h:03h reads and sets the ADC Filter Type parameter.

The permitted values of the filter type are as follows.

Value	Filter Type
00h	No filtering
01h	8-sample moving average
02h	16-sample moving average
03h	32-sample moving average
04h	64-sample moving average
10h	FIR filter, 40 SPS, 0.2 Hz cut-off
11h	FIR filter, 40 SPS, 0.5 Hz cut-off
12h	FIR filter, 40 SPS, 1 Hz cut-off
13h	FIR filter, 40 SPS, 5 Hz cut-off
14h	FIR filter, 40 SPS, 10 Hz cut-off
15h	FIR filter, 75 SPS, 2.5 Hz cut-off
16h	FIR filter, 85 SPS, 2.8 Hz cut-off
17h	FIR filter, 100 SPS, 3.2 Hz cut-off
18h	FIR filter, 120 SPS, 3.9 Hz cut-off
19h	FIR filter, 150 SPS, 4.9 Hz cut-off
1Ah	FIR filter, 200 SPS, 6.5 Hz cut-off
1Bh	FIR filter, 300 SPS, 9.8 Hz cut-off
1Ch	FIR filter, 600 SPS, 19.7 Hz cut-off
1Dh	FIR filter, 1200 SPS, 18 Hz cut-off
20h	IIR filter, 40 SPS, 0.2 Hz cut-off
21h	IIR filter, 40 SPS, 0.5 Hz cut-off
22h	IIR filter, 40 SPS, 1 Hz cut-off
23h	IIR filter, 40 SPS, 2 Hz cut-off
24h	IIR filter, 40 SPS, 5 Hz cut-off
25h	IIR filter, 40 SPS, 10 Hz cut-off
26h	IIR filter, 600 SPS, 0.25 Hz cut-off
27h	IIR filter, 600 SPS, 0.5 Hz cut-off

Value	Filter Type
28h	IIR filter, 600 SPS, 1 Hz cut-off
29h	IIR filter, 600 SPS, 2 Hz cut-off
2Ah	IIR filter, 600 SPS, 3 Hz cut-off
2Bh	IIR filter, 600 SPS, 4 Hz cut-off
2Ch	IIR filter, 600 SPS, 8 Hz cut-off
2Dh	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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	02h 30h	03h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	02h 30h	03h	03h 00h 00h 00h

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

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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	02h 30h	03h	28h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	02h 30h	03h	00h 00h 00h 00h

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 value, as described in section 6.6.3).

6.4.1. No-Motion Range (Index 3002, Sub-Index 04h)

SDO 3002h:04h reads and sets 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 measured in units of 0.1 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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	02h 30h	04h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	4Bh	02h 30h	04h	14h 00h 00h 00h

The result returned in the above response shows a no-motion range of ±2.0 increments.

6.4.1.2. Write No-Motion Range

To set the no-motion range parameter to ±1.0 increment:

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	2Bh	02h 30h	04h	0Ah 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	02h 30h	04h	00h 00h 00h 00h

6.4.2. No-Motion Time (Index 3002h, Sub-Index 05h)

SDO 3002h:05h reads and sets 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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	02h 30h	05h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	4Bh	02h 30h	05h	E8h 03h 00h 00h

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

6.4.2.2. Write No-Motion Time

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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	2Bh	02h 30h	05h	EEh 02h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	02h 30h	05h	00h 00h 00h 00h

6.5. Communications

6.5.1. Baud Rate (Index 3003h, Sub-Index 01h)

SDO 3003h:01h reads and sets the CAN bus speed (baud rate) in bits per second.

The permitted values for baud rate are 10000, 20000, 50000, 125000, 250000, 500000, 800000 and 1000000 bps.

The factory default value is 500000 bps.

When set (and written to NVM by the Save Setup Data command), the new baud rate will be enabled after the next power cycle or System Reset.

The CAN bus speed may also be changed using the LSS protocol, as detailed in section 6.5.6.4.

6.5.1.1. Read Baud Rate

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	03h 30h	01h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	03h 30h	01h	20h A1h 07h 00h

The data in the above response returns a CAN bus speed of 500000 bps.

6.5.1.2. Write Baud Rate

To set a CAN bus speed of 1 Mbps:

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	03h 30h	01h	40h 42h 0Fh 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	03h 30h	01h	00h 00h 00h 00h

6.5.2. Node ID (Index 3003h, Sub-Index 02h)

SDO 3003h:02h reads and sets the device address used on the CANopen bus.

The permitted values for node ID are 01h to 7Fh.

The factory default value is 01h.

When set (and written to NVM by the Save Setup Data command), the new node ID will be active after the next power cycle or System Reset.

The node ID may also be changed using the LSS protocol, as detailed in section 6.5.6.3.

6.5.2.1. Read Node ID

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	03h 30h	02h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	03h 30h	02h	33h 00h 00h 00h

The data in the above response returns a node ID of 33h.

6.5.2.2. Write Node ID

To set a node ID of 0Fh:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	03h 30h	02h	0Fh 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	03h 30h	02h	00h 00h 00h 00h

6.5.3. Bus Protocol (Index 3003h, Sub-Index 03h)

SDO 3003h:03h reads and sets the CAN Bus Protocol parameter, allowing the CED-10 to switch between CANopen and J1939.

The permitted values for the Bus Protocol parameter are 012Dh (CANopen) and 0793h (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.

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.

6.5.3.1. Read Bus Protocol

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	03h 30h	03h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	03h 30h	03h	2Dh 01h 00h 00h

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

6.5.3.2. Write Bus Protocol

To set the CED-10 to use the J1939 protocol after the next power cycle:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	03h 30h	03h	93h 07h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	03h 30h	03h	00h 00h 00h 00h

6.5.4. Producer Heartbeat Time (Index 1017h, Sub-Index 00h)

The CED-10 implements the heartbeat protocol as a means of monitoring the CANopen network and ensuring the availability of all heartbeat producers.

Node-guarding is not supported by the CED-10.

SDO 1017h:00h reads or sets the period (in milliseconds) between successive heartbeat messages. Data is sent / received as a 16-bit unsigned integer.

The permitted values for the producer heartbeat time are 10 to 60000 (ms) and 0 to disable the output of the heartbeat message.

The factory default value is 0 (disabled).

6.5.4.1. Read Producer Heartbeat Time

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	17h 10h	00h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	4Bh	17h 10h	00h	FAh 00h 00h 00h

The result returned in the above response shows a producer heartbeat time of 250 milliseconds.

6.5.4.2. Write Producer Heartbeat Time

To disable the transmission of the heartbeat message:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	2Bh	17h 10h	00h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	17h 10h	00h	00h 00h 00h 00h

6.5.5. Self-Start / NMT Start-Up (Index 1F80h, Sub-Index 00h)

In the CANopen standard, dictionary object 1F80h:00h controls several aspects of the node's start-up behaviour. However, the CED-10 supports only the NMT Master Start flag, which determines whether the node will automatically switch to the Operational state as part of its start-up sequence.

The permitted values for the NMT Start-up are:

00h: The node automatically switches to the Operational state at start-up
04h: The node does *not* switch to the Operational state; it stays in the Pre-operational state.

The factory default value is 4 (self-start is disabled).

6.5.5.1. Read Self-Start / NMT Start-Up

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	80h 1Fh	00h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	80h 1Fh	00h	04h 00h 00h 00h

The result returned in the above response shows the node does *not* self-start.

6.5.5.2. Write Self-Start / NMT Start-Up

To enable the node's self-start capability:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	80h 1Fh	00h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	80h 1Fh	00h	00h 00h 00h 00h

6.5.6. Layer Setting Services (LSS)

As well as using the SDOs described above, the CED-10 also supports the CANopen Layer Setting Services (LSS) as a means of configuring the Node ID and Baud Rate parameters.

Unlike when using the SDO service, the current node ID of the CED-10 is not used in the protocol, so the LSS protocol can be used if the node ID is not known or two nodes on the bus share the same ID.

The following layer setting services are supported by the CED-10:

Service Code	Service Name
04h	Switch state global
11h	Configure node ID
13h	Configure bit timing
15h	Activate bit timing
17h	Store configuration
40h	Switch state selective, select vendor ID
41h	Switch state selective, select product code
42h	Switch state selective, select revision number
43h	Switch state selective, select serial number
5Ah	Inquire vendor ID
5Bh	Inquire product code
5Ch	Inquire revision number

Service Code	Service Name
5Dh	Inquire serial number
5Eh	Inquire node ID

In order to change the Node ID or Baud Rate of the CED-10, the specific device must first be selected for configuration. This can be done in one of two ways, as shown below.

6.5.6.1. Switch State Global

Using the Switch State Global service, all devices on the CANopen bus will be selected using a single command.

The permitted modes for the switch state global command are:

00h: Waiting – nodes in the waiting state will not be configured using LSS messages
01h: Configuration – nodes in the configuration state can be configured using LSS messages.

To select all devices on the CANopen bus for configuration:

Controller Sends 'Switch State Global':			
CAN ID	**CAN Data (DLC = 8)**		
	Command	**Mode**	**Reserved**
7E5h	04h	01h	00h 00h 00h 00h 00h 00h

The switch state global service is unconfirmed; there will be no response from any node receiving the message.

6.5.6.2. Switch State Selective

Using the Switch State Selective service, a specific node can be selected for configuration. To select a specific node, four messages must be sent, each identifying a different attribute of the node to be selected. Only when *all four* attributes of the node have been selected, will the node be in the configuration state.

The attributes to be matched and their CED-10 values are shown below.

LSS Attribute	CED-10 Value	CED-10 Attribute
Vendor ID	044Ah	Flintec vendor ID
Product code	96509	Application f/w part number
Revision number	Device-dependent	Application firmware version
Serial number	Device-dependent	Serial number

The switch state selective service is a confirmed service, but a response will only be sent when the node enters the configuration state (i.e., *all four* attributes are matched).

To select the CED-10 with serial number 202101999 and version 0.4.0:

Controller Sends 'Select Vendor ID':			
CAN ID	**CAN Data (DLC = 8)**		
	Command	**Vendor ID**	**Reserved**
7E5h	40h	4Ah 04h 00h 00h	00h 00h 00h

Controller Sends 'Select Product Code':			
CAN ID	**CAN Data (DLC = 8)**		
	Command	**Product Code**	**Reserved**
7E5h	41h	FDh 78h 01h 00h	00h 00h 00h

Controller Sends 'Select Revision Number':			
CAN ID	**CAN Data (DLC = 8)**		
	Command	**Revision Number**	**Reserved**
7E5h	42h	00h 00h 04h 00h	00h 00h 00h

Controller Sends 'Select Serial Number':			
CAN ID	**CAN Data (DLC = 8)**		
	Command	**Serial Number**	**Reserved**
7E5h	43h	EFh D4h 0Bh 0Ch	00h 00h 00h

When *all four* attributes are matched:

CED-10 Responds:		
CAN ID	**CAN Data (DLC = 8)**	
	Command	**Reserved**
7E4h	44h	00h 00h 00h 00h 00h 00h 00h

6.5.6.3. Configure Node ID

When a device has been selected for configuration, the Configure Node ID service can be used together with the NMT Reset Communications message and the LSS Store Configuration service.

The permitted values for node ID are 01h to 7Fh.

The message sequence needed to configure the selected device with node ID 3Bh is as follows.

Controller Sends 'Configure Node ID':			
CAN ID	**CAN Data (DLC = 8)**		
	Command	**New Node ID**	**Reserved**
7E5h	11h	3Bh	00h 00h 00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Error Code**	**Spec-Error**	**Reserved**
7E4h	11h	00h	00h	00h 00h 00h 00h 00h

Controller Sends 'Reset Communications':		
CAN ID	**CAN Data (DLC = 2)**	
	Command	**Node ID**
000h	82h	00h (all nodes)

CED-10 Responds:	
CAN ID	**CAN Data (DLC = 1)**
73Bh (= 700h + new node ID)	00h

Controller Sends 'Store Configuration':		
CAN ID	**CAN Data (DLC = 8)**	
	Command	**Reserved**
7E5h	17h	00h 00h 00h 00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Error Code**	**Spec-Error**	**Reserved**
7E4h	17h	00h	00h	00h 00h 00h 00h 00h

6.5.6.4. Configure Bit Timing

When a device has been selected for configuration, the Configure Bit Timing service can be used together with the LSS Activate Bit Timing service and the LSS Store Configuration service to set a new CAN bus speed.

Bit timing / bus speed is determined by means of a table selector and a table index. The CED-10 uses a manufacturer-specific bit timing table (table selector 80h) with indices defined as follows.

Table Index	CAN Bus Speed
0	1000000 bits/s (1 Mbps)
1	800000 bits/s (800 kbps)
2	500000 bits/s (500 kbps)
3	250000 bits/s (250 kbps)
4	125000 bits/s (125 kbps)
5	Reserved, do not use.
6	50000 bits/s (50 kbps)
7	20000 bits/s (20 kbps)
8	10000 bits/s (10 kbps)

The message sequence needed to configure the selected device with a bus speed of 125 kbps is as follows.

Controller Sends 'Configure Bit Timing':				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Table Selector**	**Table Index**	**Reserved**
7E5h	13h	80h	04h	00h 00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Error Code**	**Spec-Error**	**Reserved**
7E4h	13h	00h	00h	00h 00h 00h 00h 00h

Controller Sends 'Activate Bit Timing':			
CAN ID	**CAN Data (DLC = 8)**		
	Command	**Switch Delay**	**Reserved**
7E5h	15h	32h 00h	00h 00h 00h 00h 00h

Note: Switch delay is the time delay (UI16) in milliseconds which the slave nodes will wait before accepting the new bit rate. There is second delay of the same period before the slave sends messages.
This is an unconfirmed service; no response is sent.

Controller Sends 'Store Configuration':		
CAN ID	**CAN Data (DLC = 8)**	
	Command	**Reserved**
7E5h	17h	00h 00h 00h 00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Error Code**	**Spec-Error**	**Reserved**
7E4h	17h	00h	00h	00h 00h 00h 00h 00h

6.6. Data Access Commands

6.6.1. ADC Output Data Select (Index 3004h, Sub-Index 01h)

SDO 3004h:01h reads and sets the ADC Output Data Select parameter.

The Output Data Select parameter determines what ADC-related data is transmitted in the 'Read ADC Event Data' object, and the data format of TPDO1 and TPDO3.

The value of this parameter can also be changed using RPDO1.

This parameter is an 8-bit unsigned integer.

The permitted values for the ADC Output Data Select parameters are derived from the table below.

Bit #	Value	Meaning
7..4		Unused, always 0.
3	08h	IEEE 754 flag. 0: ADC data in TPDO1 and tare weight in TPDO3 are sent as 32-bit signed integers. 1: ADC data in TPDO1 and tare weight in TPDO3 are sent as 32-bit floating-point numbers in IEEE 754 format.
2	04h	Unused.
1..0	00h..03h	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: 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 (periodic transmission of mV/V signal as a 32-bit integer).

6.6.1.1. Read ADC Output Data Select

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	04h 30h	01h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	4Fh	04h 30h	01h	00h 00h 00h 00h

The result returned in the above response shows that TPDO1 will transmit the gross weight as a 32-bit integer.

6.6.1.2. Write ADC Output Data Select

To set TPDO1 to transmit mV/V signal in IEEE 754 format:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	2Fh	04h 30h	01h	0Bh 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	04h 30h	01h	00h 00h 00h 00h

6.6.2. Read ADC Event Data (Index 3004h, Sub-Index 02h)

Reading SDO 3004h:02h returns the value of the weight-related data that would normally be transmitted by TPDO1, as determined by the ADC Output Data Select parameter described in section 6.6.1. This dictionary object may be read even when TPDO1 is disabled, or when the system is in the Pre-operational state.

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	04h 30h	02h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	04h 30h	02h	9Dh 00h 00h 00h

The value (and data type) of the result returned is dependent on the value of the ADC Output Data Select object, as described in section 6.6.1.

6.6.3. Read Scale Status (Index 3004h, Sub-Index 03h)

Reading SDO 3004h:03h returns the 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 flags is as follows.

Bit #	Value	Condition
15	8000h	Critical fault (non-recoverable, the CED-10 must be returned to Flintec).
14	4000h	Scale h/w fault (non-recoverable, the CED-10 must be returned to Flintec).
13	2000h	Scale configuration fault (recoverable by configuring all parameters).
12	1000h	Unused
11	0800h	Unused
10	0400h	Unused
9	0200h	Unused
8	0100h	Tilt alarm is active (the tilt angle has exceeded the Tilt Alarm Threshold).
7	0080h	Weight is within the Zero Range (scale can be manually zeroed).
6	0040h	Over-range - weight is above maximum.
5	0020h	Under-range - weight is below minimum.
4	0010h	Scale has been zeroed.
3	0008h	The net weighing function is active.
2	0004h	Scale warm-up is active (i.e., the Warm-Up Time has not yet expired).
1	0002h	Centre-of-zero.
0	0001h	Weight signal is stable, as defined by the Motion Detection parameters.

To read the scale status:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	04h 30h	03h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	4Bh	04h 30h	03h	81h 01h 00h 00h

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

6.6.4. Read Gross Weight (Index 3004h, Sub-Index 04h)

Reading SDO 3004h:04h returns the last-calculated gross weight, measured in scale increments.

The overweight rogue value of 10^9 (3B9ACA00h) 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 (C4653600h) will be returned if any of the following are true:

- 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 6.6.10 have been set.

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	04h 30h	04h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	04h 30h	04h	94h 0Ch 00h 00h

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

6.6.5. Read Net Weight (Index 3004h, Sub-Index 05h)

Reading SDO 3004h:05h returns the last-calculated net weight, measured in scale increments.

The overweight rogue value of 10^9 (3B9ACA00h) will be returned if the *gross* weight returns the overweight rogue value.

The underweight rogue value of -10^9 (C4653600h) will be returned if the *gross* weight returns the underweight rogue value.

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	04h 30h	05h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	04h 30h	05h	DCh 00h 00h 00h

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

6.6.6. Read Tare Weight (Index 3004h, Sub-Index 06h)

Reading SDO 3004h:06h 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 Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	04h 30h	06h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	04h 30h	06h	B8h 0Bh 00h 00h

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

6.6.7. Read Raw (Unfiltered) ADC Sample (Index 3004h, Sub-Index 08h)

Reading SDO 3004h:08h returns the value of the last-received ADC sample, before any filtering or averaging is performed.

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	04h 30h	08h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	04h 30h	08h	C4h DAh A5h 00h

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

6.6.8. Read Filtered ADC Sample (Index 3004h, Sub-Index 09h)

Reading SDO 3004h:09h returns the value of the last-calculated ADC signal after any selected filtering and averaging have been applied.

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	04h 30h	09h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	04h 30h	09h	9Dh 7Bh 9Ch 00h

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

6.6.9. Read Filtered mV/V Signal (Index 3004h, Sub-Index 0Ah)

Reading SDO 3004h:0Ah returns the value of last-calculated 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 (C4653600h) 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 6.6.10 have been set.

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	04h 30h	0Ah	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	04h 30h	0Ah	4Ch 2Bh 00h 00h

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

6.6.10. Read Fault Flags (Index 3004h, Sub-Index 0Bh)

Reading SDO 3004h:0Bh 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 6.6.3.

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 flags is as follows.

Bit #	Value	Condition
31..5	-	Currently unused
4	10h	A non-recoverable fault has been detected in the tilt sensor. The CED-10 should be returned to Flintec.
3	08h	A non-recoverable fault has been detected in the ADC. The CED-10 should be returned to Flintec.
2	04h	An error has been detected in the calibration data memory. The scale can be recovered by reconfiguring all legal parameters and re-calibrating.
1	02h	An error has been detected in the configuration data memory. The scale can be recovered by reconfiguring all user parameters.
0	01h	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 Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	04h 30h	0Bh	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	04h 30h	0Bh	00h 00h 00h 00h

The result returned in the above response shows that no faults have been found.

6.7. Taring and Zeroing (Index 3005h, Sub-Index 01h)

Writing to SDO 3005h:01h controls the scale's zeroing operations depending on the value of the 8-bit unsigned integer parameter sent with the command.

Each bit in the parameter represents a specific command which will be executed only if that bit is set. The bits assignments are as shown below.

Bit #	Bit Value	Function
7..6		Unused, always 0.
5	20h	Reset mV/V tare (section 6.7.6)
4	10h	Set mV/V tare (section 6.7.5)
3	08h	Reset tare (section 6.7.4)
2	04h	Set tare (section 6.7.3)
1	02h	Reset system zero (section 6.7.2)
0	01h	Set system zero (section 6.7.1)

Note: All set bits in the data byte will execute the corresponding function, starting from the least-significant bit (bit 0). Thus, if the 'Reset System Zero' bit and the 'Set System Zero' are *both* set (parameter value is 03h), the Set System Zero command will be executed first, immediately followed by the Reset System Zero command.

Dictionary object 3005h:01h is mapped to RPDO2 for use as an unconfirmed service when in the Operational state. See section 5.3.2.2 for more information.

6.7.1. Set System Zero

Writing the value 01h to SDO 3005h:01h 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 6.6.3.
- 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:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	2Fh	05h 30h	01h	01h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	05h 30h	01h	00h 00h 00h 00h

6.7.2. Reset System Zero

Writing the value 02h to SDO 3005h:01h returns the system zero point to the calibrated zero point.

To reset the system zero point:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	05h 30h	01h	02h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	05h 30h	01h	00h 00h 00h 00h

6.7.3. Set Tare

Writing the value 04h to SDO 3005h:01h 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 6.6.3.
- 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 gross weight is outside the Maximum Tare Weight range 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 6.6.10 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 TPDO3 (tare weight) message will be broadcast (when in the Operational state).

To set a new tare weight:

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	2Fh	05h 30h	01h	04h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	05h 30h	01h	00h 00h 00h 00h

6.7.4. Reset Tare

Writing the value 08h to SDO 3005h:01h 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 Tare Active flag in the Scale Status message will be cleared and the TPDO3 (tare weight) message will be broadcast (when in the Operational state).

To reset the tare weight:

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	2Fh	05h 30h	01h	08h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	05h 30h	01h	00h 00h 00h 00h

6.7.5. Set mV/V Tare

Writing the value 10h to SDO 3005h:01h 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 6.6.3.
- The Warm-up Time defined in section 6.2.6 has not yet expired.
- Any of the Fault Flags defined in section 6.6.10 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 Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	2Fh	05h 30h	01h	10h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	05h 30h	01h	00h 00h 00h 00h

6.7.6. Reset mV/V Tare

Writing the value 20h to SDO 3005h:01h 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 Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	2Fh	05h 30h	01h	20h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	05h 30h	01h	00h 00h 00h 00h

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)

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 (Index 3006h, Sub-Index 01h)

SDO 3006h:01h reads and sets the time interval (in milliseconds) between successive transmissions of the tilt sensor message, TPDO2. See section 5.3.1.2 and 6.8.4.5 for details of the tilt sensor message itself.

The permitted values for the tilt sensor message period are from 10 to 60000 (milliseconds), or zero to disable the periodic transmission of TPDO2.

The factory default value is 0 (disabled).

6.8.1.1. Read Tilt Sensor Message Period

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	06h 30h	01h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	06h 30h	01h	88h 13h 00h 00h

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

To disable the tilt sensor periodic message:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	06h 30h	01h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	06h 30h	01h	00h 00h 00h 00h

6.8.2. Tilt Sensor Filter Length (Index 3006h, Sub-Index 02h)

SDO 3006h:02h reads and sets 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 samples.

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

6.8.2.1. Read Tilt Sensor Filter Length

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	06h 30h	02h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	06h 30h	02h	10h 00h 00h 00h

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

6.8.2.2. Write Tilt Sensor Filter Length

To set a tilt sensor filter length of 20 samples:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	06h 30h	02h	14h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	06h 30h	02h	00h 00h 00h 00h

6.8.3. Tilt Alarm Threshold (Index 3006h, Sub-Index 03h)

SDO 3006h:03h reads and sets the angle above which the tilt alarm bit in the Scale Status word will be set. See section 6.6.3 for details of the scale status word.

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

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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	06h 30h	03h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	06h 30h	03h	E8h 03h 00h 00h

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

6.8.3.2. Write Tilt Alarm Threshold

To set a tilt alarm threshold of 5°:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	06h 30h	03h	F4h 01h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	06h 30h	03h	00h 00h 00h 00h

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 6.8.6), 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 32-bit data-length restriction of an expedited SDO, two SDOs are needed to send data for all three axes: one SDO 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 (Index 3006h, Sub-Index 04h)

SDO 3006h:04h reads the filtered tilt sensor (accelerometer) data for the assigned pitch and roll axes and is returned in the following format:

Data byte 4: Roll axis accelerometer data in milli-g (LSB)
Data byte 5: Roll axis accelerometer data in milli-g (MSB)
Data byte 6: Pitch axis accelerometer data in milli-g (LSB)
Data byte 7: 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 Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	06h 30h	04h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	06h 30h	04h	41h 00h 0Ah 00h

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 (Index 3006h, Sub-Index 05h)

SDO 3006h:05h 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 4: Yaw axis accelerometer data in milli-g (LSB)
Data byte 5: Yaw axis accelerometer data in milli-g (MSB)

Data byte 6: Designated yaw axis
Data byte 7: Always 00h

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

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	06h 30h	05h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	06h 30h	05h	14h 00h 02h 00h

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 (Index 3006h, Sub-Index 06h)

SDO 3006h:06h 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 4: Roll axis baseline data in milli-g (LSB)
Data byte 5: Roll axis baseline data in milli-g (MSB)
Data byte 6: Pitch axis baseline data in milli-g (LSB)
Data byte 7: Pitch axis baseline data in milli-g (MSB)

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	06h 30h	06h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	06h 30h	06h	41h 00h 0Ah 00h

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 (Index 3006h, Sub-Index 07h)

SDO 3006h:07h 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 4: Yaw axis baseline data in milli-g (LSB)
Data byte 5: Yaw axis baseline data in milli-g (MSB)
Data byte 6: Designated yaw axis
Data byte 7: Always 00h

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	06h 30h	07h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	06h 30h	07h	14h 00h 02h 00h

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 (Index 3006h, Sub-Index 08h)

SDO 3006h:08h reads the current tilt angle for the assigned pitch and roll axes and is returned in the following format:

Data byte 4: Roll axis angle in units of 0.01º (LSB)
Data byte 5: Roll axis angle in units of 0.01º (MSB)
Data byte 6: Pitch axis angle in units of 0.01º (LSB)
Data byte 7: Pitch axis angle in units of 0.01º (MSB)

This is the same data that is returned in TPDO2.

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	06h 30h	08h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	06h 30h	08h	8Ah 02h 14h 05h

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 (Index 3006h, Sub-Index 09h)

SDO 3006h:09h 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 4: Yaw axis angle in units of 0.01º (LSB)
Data byte 5: Yaw axis angle in units of 0.01º (MSB)
Data byte 6: Designated yaw axis
Data byte 7: Tilt alarm status (= 1 when the yaw axis angle exceeds the tilt alarm threshold).

This is the same data that is returned in TPDO2.

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	06h 30h	09h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	06h 30h	09h	3Ah 07h 02h 01h

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 (Index 3006h, Sub-Index 0Ah)

SDO 3006h:0Ah reads and 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

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	06h 30h	0Ah	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	06h 30h	0Ah	01h 00h 00h 00h

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

6.8.5.2. Write Tilt Compensation Status

To disable tilt compensation:

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	06h 30h	0Ah	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	06h 30h	0Ah	00h 00h 00h 00h

6.8.6. Set or Reset Tilt Sensor Baselines (Index 3006h, Sub-Index 0Bh)

Writing to SDO 3006h:0Bh 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.

6.8.6.1. Reset Tilt Sensor Baselines

When SDO 3006h:0Bh is written with parameter value 00h, 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.

6.8.6.2. Set Tilt Sensor Baselines

When SDO 3006h:0Bh is written with parameter value 01h, 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 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 Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	06h 30h	0Bh	01h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	06h 30h	0Bh	00h 00h 00h 00h

6.8.7. Restore Factory Default Baselines (Index 3006h, Sub-Index 0Ch)

Before the CED-10 leaves the factory, the tilt sensor will be calibrated on a flat surface and the baseline values stored in non-volatile memory. These factory default values can be restored by writing to SDO 3006h:0Ch.

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 Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	06h 30h	0Ch	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	06h 30h	0Ch	00h 00h 00h 00h

6.8.8. Read Factory Default Pitch & Roll Baselines (Index 3006h, Sub-Index 0Dh)

SDO 3006h:0Dh 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 4: Roll axis default baseline data in milli-g (LSB)
Data byte 5: Roll axis default baseline data in milli-g (MSB)
Data byte 6: Pitch axis default baseline data in milli-g (LSB)
Data byte 7: Pitch axis default baseline data in milli-g (MSB)

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	06h 30h	0Dh	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	06h 30h	0Dh	41h 00h 0Ah 00h

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

6.8.9. Read Factory Default Yaw Baseline (Index 3006h, Sub-Index 0Eh)

SDO 3006h:0Eh 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 4: Yaw axis default baseline data in milli-g (LSB)
Data byte 5: Yaw axis default baseline data in milli-g (MSB)
Data byte 6: Default yaw axis
Data byte 7: Always 00h

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	06h 30h	0Eh	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	06h 30h	0Eh	14h 00h 02h 00h

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 (Index 3007h, Sub-Index 01h)

Writing any value to SDO 3007h:01h 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 Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	23h	07h 30h	01h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	60h	07h 30h	01h	00h 00h 00h 00h

6.9.2. Restore Factory Defaults (Index 3007h, Sub-Index 02h)

Writing any value to SDO 3007h:02h 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 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 execute this command.

The parameters changed and their default values are as follows.

Parameter	Index	Sub-Index	Default Value
Maximum Weight	3001h	04h	Device-dependent.
Minimum Weight	3001h	05h	-999999 increments.
Warm-Up Time	3001h	06h	0 seconds.
Zero Range	3001h	07h	0 (±2% of Maximum Weight.)
Initial Zero Range	3001h	08h	0 (No initial zero.)
Zero-Tracking Range	3001h	09h	0 (Zero-tracking is disabled.)
Maximum Tare Weight	3301h	0Ah	-999999
Calibration/eCal Span Weight	3001h	0Bh	Device-dependent. See the specific command description for details of the default value applied.
Absolute Zero Point (eCal)	3001h	0Ch	
Absolute Span Point (eCal)	3001h	0Dh	
Zero Endpoint (ADC counts)	3001h	0Eh	
Span Endpoint (ADC counts)	3001h	0Fh	
ADC Sample Rate	3002h	01h	50 samples / second.
ADC Output Data Rate Divisor	3002h	02h	1
Filter Type	3002h	03h	2 (16-entry running average.)
No-Motion Range	3002h	04h	10 (1 increment.)
No-Motion Time	3002h	05h	1000 ms
Baud Rate	3003h	01h	500000 bps.
Node ID	3003h	02h	1
Producer Heartbeat Time	1017h	00h	0 (Heartbeat is disabled.)
NMT start-up	1F80h	00h	04h (Self-start is disabled.)
ADC Output Data Select	3004h	01h	07h (Filtered mV/V, integer.)
Tilt Sensor Message Period	3006h	01h	0 (Tilt message is disabled.)
Tilt Sensor Filter Length	3006h	02h	8 samples
Tilt Alarm Threshold	3006h	03h	0 (disabled)
Tilt Baseline Data	3006h	06h	Device-dependent.
Tilt Compensation Status	3006h	0Ah	0 (disabled)

To restore factory default values:

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	23h	07h 30h	02h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	60h	07h 30h	02h	00h 00h 00h 00h

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 (Index 3007h, Sub-Index 03h)

Reading SDO 3007h:03h returns the system up-time in seconds as a 32-bit unsigned integer.

Controller Sends:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Parameters
600h + node ID	40h	07h 30h	03h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	CAN Data (DLC = 8)			
	Command	Index	Sub-Index	Result
580h + node ID	43h	07h 30h	03h	9Ch 72h 00h 00h

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 (Index 3007h, Sub-Index 04h)

Reading SDO 3007h:04h 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.

Controller Sends:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Parameters**
600h + node ID	40h	07h 30h	04h	00h 00h 00h 00h

CED-10 Responds:				
CAN ID	**CAN Data (DLC = 8)**			
	Command	**Index**	**Sub-Index**	**Result**
580h + node ID	43h	07h 30h	04h	4Bh B2h BFh 01h

The result returned in the above response shows a system 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 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 defined 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).
   CAN ID = 600h + node ID, data = 23h 01h 30h 02h 2Fh A5h 09h 00h

3. Switch off tilt compensation (section 6.8.5.2).
   CAN ID = 600h + node ID, data = 23h 06h 30h 0Ah 00h 00h 00h 00h
4. Set the Maximum Weight to 2000 (increments = kg in this case) (section 6.2.4).
   CAN ID = 600h + node ID, data = 23h 01h 30h 04h D0h 07h 00h 00h
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)
   CAN ID = 600h + node ID, data = 23h 01h 30h 0Eh 00h 00h 00h 00h
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)
   CAN ID = 600h + node ID, data = 23h 01h 30h 0Fh 40h 06h 00h 00h
9. Save calibration data (section 6.2.3)
   CAN ID = 600h + node ID, data = 23h 01h 30h 03h 01h 00h 00h 00h
10. Exit calibration mode by writing to the passcode register (section 6.2.2).
    CAN ID = 600h + node ID, data = 23h 01h 30h 02h 00h 00h 00h 00h

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 3 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).
   CAN ID = 600h + node ID, data = 23h 01h 30h 02h 2Fh A5h 09h 00h
2. Set the Maximum Weight to 2000 (increments = kg in this case) (section 6.2.4).
   CAN ID = 600h + node ID, data = 23h 01h 30h 04h D0h 07h 00h 00h
3. Set the Absolute Zero Point value to the zero offset value read from the load cell datasheet (section 6.2.12). Assuming a zero offset of 0 mV/V:
   CAN ID = 600h + node ID, data = 23h 01h 30h 0Ah 00h 00h 00h 00h
4. Set the eCal Span Point Weight to the rated load of the load cell (section 6.2.11), 2000 increments in this case.
   CAN ID = 600h + node ID, data = 23h 01h 30h 0Bh D0h 07h 00h 00h
5. Set the Absolute Span Point value to the span value read from the load cell datasheet (section 6.2.13). Assuming a span point of 2 mV/V:
   CAN ID = 600h + node ID, data = 23h 01h 30h 0Bh 20h 4Eh 00h 00h
6. Save calibration data (section 6.2.3)
   CAN ID = 600h + node ID, data = 23h 01h 30h 03h 00h 00h 00h 00h
7. Exit calibration mode by writing to the passcode register (section 6.2.2).
   CAN ID = 600h + node ID, data = 23h 01h 30h 02h 00h 00h 00h 00h

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 horizontal surface.
2. Put the scale into calibration mode by writing to the passcode register (section 6.2.2).
   CAN ID = 600h + node ID, data = 23h 01h 30h 02h 2Fh A5h 09h 00h
3. Switch on tilt compensation (section 6.8.5).
   CAN ID = 600h + node ID, data = 23h 06h 30h 0Ah 01h 00h 00h 00h
4. Set the tilt sensor baseline (section 6.8.6).
   CAN ID = 600h + node ID, data = 23h 06h 30h 0Bh 01h 00h 00h 00h
5. Save calibration data (section 6.2.3)
   CAN ID = 600h + node ID, data = 23h 01h 30h 03h 00h 00h 00h 00h
6. Exit calibration mode by writing to the passcode register (section 6.2.2).
   CAN ID = 600h + node ID, data = 23h 01h 30h 02h 00h 00h 00h 00h

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.