CMG-3EX-EAM

Digital Broadband Seismometer

Operator's Guide

Part No. MAN-C3E-0004

Designed and manufactured by
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1 Preliminary Notes

1.1 Proprietary Notice

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1.2 Warnings, Cautions and Notes

Warnings, cautions and notes are displayed and defined as follows:



Caution: A yellow triangle indicates a chance of damage to or failure of the equipment if the caution is not heeded.



Note: A blue circle indicates indicates a procedural or advisory note.

1.3 Manuals and Software

All manuals and software referred to in this document are available from the Güralp Systems website: www.guralp.com unless otherwise stated.

2 Introduction

The CMG-3ESPCD is a full-featured three-axis digital seismometer consisting of three sensors in a lightweight case, which can measure the North/South, East/West and vertical components of ground motion simultaneously, a built-in CMG-CD24 digitizer and a built-in CMG-EAM embedded acquisition module.

Each sensor is sensitive to ground vibrations in the frequency range 120 seconds to 50 Hz, a broadband frequency response made possible by advanced force-balance feedback electronics. Because of this wide response range, the 3ESPCD can replace many of the instruments conventionally used in a seismic observatory; it also produces true pulse-shape records suitable for modern earthquake mechanism analysis. Its small size and low weight make it an ideal choice for rapid deployment of low-noise installations.

The seismometer unit is self-contained apart from its 12 V DC power supply. Once levelled and centred, it will begin operating automatically. Its output is digitized within the sensor by the internal CD24 digitizer, which provides data streams to the embedded acquisition module. The instrument can be connected to a PC over a serial port or Ethernet network. The text- or web-based configuration interface provides complete control over the storage and transmission of data, as well as the instrument's centring and mass locking processes. Data stored in the internal memory can be written to an external USB drive at the touch of a button.



Each seismometer is delivered with a detailed calibration sheet showing its serial number, measured frequency response in both the long period and the short period sections of the seismic spectrum, sensor DC calibration levels, and the transfer function in poles/zeros notation.

3 Internal Modules

The CMG-3EX-EAM is composed of three internal modules:

- The triaxial sensor assembly;
- The analogue-to-digital converter (digitiser); and
- The embedded acquisition module.

Each of these modules is described in detail in a separate manual. The sensor itself is described in MAN-C3E-0001, the analogue-to-digital converter module is described in MAN-C24-0001 and the embedded acquisition module is described in MAN-EAM-0003. If you wish to transmit data in CD1.1 format, you will also need MAN-EAM-1100.

Many common tasks can be performed in more than one way. For example, mass locking and unlocking can be initiated from the digitiser's command line, from the web interface of the embedded acquisition module, using a copy of Scream! software or by using the push-button controls on the top of the instrument.

This document provides additional information specific to the CMG-3EX-EAM and refers the reader, where necessary, to the manuals mentioned above for operational details which are not peculiar to this instrument.

4 External Connectors and Controls.



On the top of the instrument, you will find:

- An Ethernet connector, labelled NET;
- A general purpose input/output connector, labelled GPIO;
- A universal serial bus connector, labelled USB;
- The handle, with an arrow indicating “North”;
- A bubble-level;
- A “breather” screw, to allow the instrument to be assembled without a build-up of pressure internally.

- A power and data connector, labelled DATA;
- A GPS receiver connector, labelled GPS;
- Five coloured push-buttons (described below);
- A red LED (next to the yellow push-button) to indicate when data are being flushed to storage (described below); and
- Two LEDs, one red, one green, next to the black push-button, to indicate the progress of locking, unlocking and centring operations.

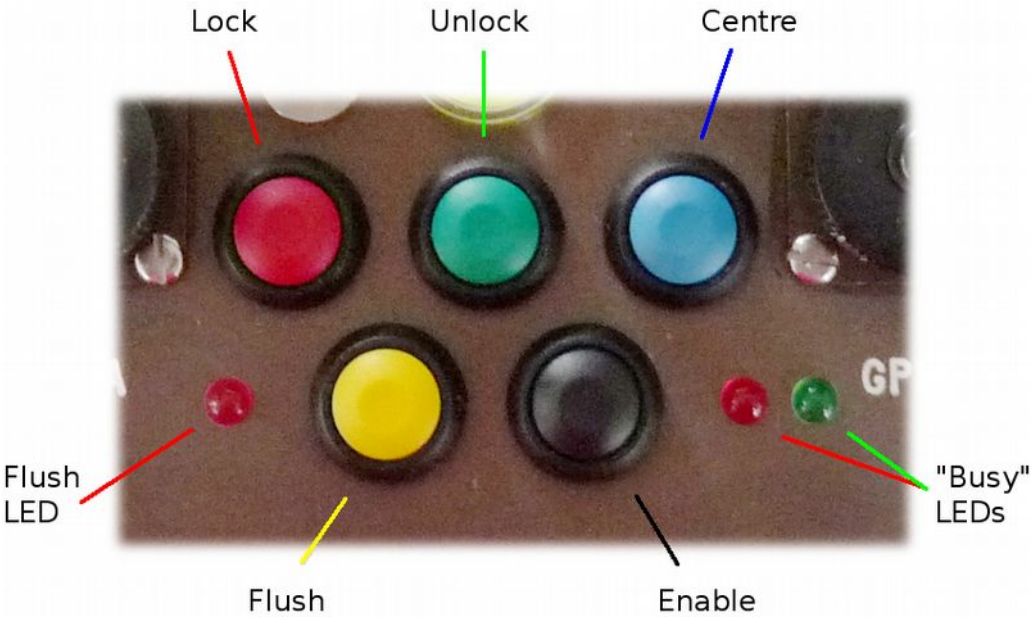
The five connectors, NET, GPIO, USB, DATA and GPS, are connected internally to the embedded acquisition module and are described in MAN-EAM-0003.

The use of the “North” indication and the bubble level are described in MAN-C3E-0001.

The use of the push-buttons and LEDs are described in the following section.

4.1 Mass Control

The sensors' masses can be locked, unlocked and centred using the digitiser's command line, the EAM's command line or the web interface, Scream! software or the push-buttons on the top of the instrument. This section describes how to use the push buttons.



The two LEDs, on the right in the illustration above, provide an indication of the instruments status.

4.1.1 Unlock

To initiate the unlock function, hold down the green unlock button, then press the black enable button and release both after approximately 10 seconds. The internal processor will now perform the task of unlocking the sensor. There are several stages to this and the green LED shows the progress. If an error is encountered during the unlock process, the red LED will flash at the end of the operation. The precise pattern of flashing indicates the fault encountered. Details of LED states can be found in section 4.2 on page 9.

4.1.2 Centre

To initiate the centre function, hold down the blue centre button, then press the black enable button and release both after approximately 10 seconds. The internal processor will now perform the task of centring the sensor. The green LED flashes during the centre process and then stays on once the centre is successful. If an error is encountered during the centring process, the red LED will illuminate at the end of the operation. The precise pattern of flashing indicates the fault encountered. Details of LED states can be found in section 4.2 on page 9.

4.1.3 Lock

To initiate the lock function, hold down the red lock button, then press the black enable button and release both after approximately 10 seconds. The internal processor will now perform the task of locking the sensor. There are several stages to this and the green LED shows the progress. If an error is encountered during the locking process, the red LED will illuminate at the end of the operation. The precise pattern of flashing indicates the fault encountered. Details of LED states can be found in section 4.2 on page 9.

4.1.4 Auto Lock

The sensor has an automatic lock feature to ensure that the sensor is always locked when transported. If power is removed from the sensor for more than thirty seconds, an internal NiMH battery provides enough energy to initiate an automatic locking sequence.



Caution: If the sensor has been left standing powered off for expended periods of time (>3months) the sensor should be left powered for at least 48 hours before deployment to ensure that the internal battery is charged. Failure to do this may result in the auto lock function failing and damage to the sensor.

The auto-lock feature is enabled at the factory but can be disabled if desired.

To disable or re-enable the auto lock function, hold down both the blue centre and green unlock button, then press the black enable button until the red LED illuminates continuously. This sequence toggles the sensor between auto-lock enabled and disabled. Both busy LEDs blink together continuously to indicated the sensors' mode. The sensor should not be in a fault state prior to enabling this function. Details of LED states can be found in section 4.2 on page 9.

4.1.5 Auto Centre

The instrument has an automatic centre function that will centre the sensor masses if their position exceeds a set threshold.

To enable and disable the auto centre function, hold down both the blue centre and the red lock buttons, then press the black enable button until the red LED illuminates continuously. This sequence toggles the sensor between auto-centre enabled and disabled. Both busy LEDs blink together continuously to indicated the sensors' mode. The sensor should not be in a fault state prior to enabling this function. Details of LED states can be found in section 4.2 on page 9.

When Auto centre is enabled the sensor will initiate a centre operation if the mass position of any component exceeds the threshold continuously, for a set Delay period.

The default threshold is set to +/-1000 counts which is ±50% full scale. The delay period is set to 10 which equates to around 10 minutes.

4.2 Busy LEDs

The busy LEDs show the various states of the instrument. To do this they illuminate and flash in different sequences. The status LED sequence is based on 8 time segments that are repeated Either LED can be on or off during each time segment. The table below explains

the LED states. A series of symbols are used to show when the LED is on or off.

LED sequence	Description of status
Red: ○○○○○○○○ Green: ○○○○○○○○	Sensor is locked or powered off and no automatic functions are selected.
Red: ○○○○○○○● Green: ○○○○○○○●	Only auto-centre is enabled.
Red: ○○○○○●○● Green: ○○○○○●○●	Only auto-lock is enabled.
Red: ○○○●○●○● Green: ○○○●○●○●	Both auto-lock and auto-centre are enabled.
Red: ○○○○○○○○ Green: ●●●●●●●●	Sensor is centred: auto-lock and auto-centre are both disabled.
Red: ○○○○○○○● Green: ●●●●●●●●	Sensor is centred and only auto-centre is enabled.
Red: ○○○○○●○● Green: ●●●●●●●●	Sensor is centred and only auto-lock is enabled.
Red: ○○○●○●○● Green: ●●●●●●●●	Sensor is centred and both auto-lock and auto-centre are enabled.
Red: ○○○○○○○○ Green: ○○○○○○○●	Sensor is locking.
Red: ○○○○○○○○ Green: ○○○○○●○●	Sensor is unlocking
Red: ○○○○○○○○ Green: ○○○●○●○●	Sensor is centring
Red: ○●○●○●○● Green: ●○●○●○●○	Power failure waiting for auto-lock delay to time out (alternating red/green flashes).
Red: ●●●●●●●● Green: ○○○○○○○○	Catastrophic failure: the sensor has a fault that has made it impossible to complete the last operation.
Red: ○○○○○○○● Green: ○○○○○○○○	Locking system limit switch fault.
Red: ○○○○○●○● Green: ○○○○○○○○	Horizontal tilt base limit. This could be a result of a poorly levelled sensor.
Red: ○○○●○●○● Green: ○○○○○○○○	The current operation timed out. This could indicate a fault or, in the case of centring, the sensor may need to be re-centred.

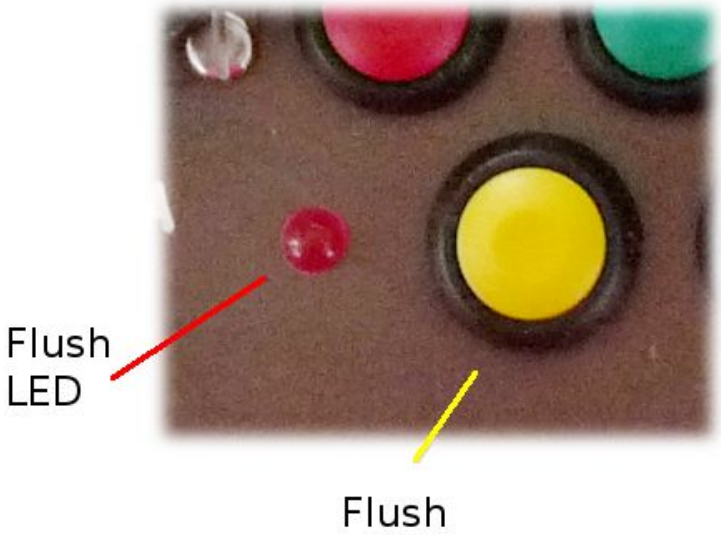
Here the symbol ○ indicates that the led is off during a time segment and the symbol ● or ● indicates that the red or green LED is on. So, for example, the sequence of symbols ○○○○○●○● indicates that the green LED is off for a long period of time (5 segments) then flashes twice.

5 Data flush control

The CMG-3EX-EAM has an internal ring-buffer for storing seismic data. If an external storage device is connected and configured for data storage, the CMG-3EX-EAM will leave it powered down for most of the time, in order to conserve energy. Periodically, the CMG-3EX-EAM will power up the external storage device and flush the data from the ring buffer to it. (To configure an external storage device for use in this way, see Section 11.1 of MAN-EAM-0003.)

When data need to be retrieved, e.g. at a site visit or at the end of a deployment, a manual flush to storage should be initiated in order to ensure that the most recent data are written to the external device. This process can be initiated using the yellow “flush” button on the instrument's lid.

To start a flush, hold down the yellow flush button then press the black enable button for approximately 10 seconds. The flush LED should now illuminate to indicate that the transfer is in progress.



If the LED remains illuminated for only a few seconds, the flush has failed; the EAM module will retry after 60 seconds (and will retry up to three times before aborting).

When the flush is complete, the LED will extinguish. It is now safe to remove the external storage device.

Flushing data using the lid controls it identical to the web interface's 'flush' command and transfers (from flash to external storage) all data that have been recorded since the last transfer was carried out.

6 USB Operations

The CMG-3EX-EAM can function as both a storage device, available for access from a USB connected PC, and as a USB host, writing to external USB storage devices such as memory sticks and USB disks.

When used as a USB storage device, the GPIO connector is employed. When acting as a host, the USB connector is used. The pin-outs of both these connectors are given in the appendices of MAN-EAM-0003.

6.1 USB device mode

The CMG-3EX-EAM is fitted with an internal Flash memory device which is accessible via USB. It can be written to by selecting “Internal USB storage” from the “Recording destination” drop-down menu on the “Disk recording” menu (see section 11.2 of MAN-EAM-0003).

When a USB host, such as a laptop or PC, is connected to the GPIO port, internal circuitry detects the USB power and automatically connects the Flash memory to the USB socket, causing it to behave identically to a standard USB memory stick.

When no power is detected at the USB port, the Flash memory is available to the system as if it were a standard removable disk. All of the disk recording options described in section 11 of MAN-EAM-0003 will apply to this device.

6.2 USB host mode

If a USB storage device is connected to the USB port, it will be mounted under /media. It can be used to store seismic data by selecting “External USB drive on mil-spec connector” from the “Recording destination” drop-down menu on the “Disk recording” menu, described in section 11.2 of MAN-EAM-0003.

7 What to read next...

- To connect to your instrument over a serial or Ethernet link, see Sections 3 and 7 of MAN-EAM-0003.
- To prepare a site and install your instrument, see Section 2 of MAN-C3E-0001.
- To calibrate your instrument, see Section 3 of MAN-C3E-0001.
- To configure sample rates and triggering, see Section 8 of MAN-EAM-0003.
- To record and retrieve data, see Section 11 of MAN-EAM-0003.
- For connector pin-out details, see Section 16.5 of MAN-EAM-0003: Use the versions marked “Cylinder”.

8 Revision history

2010-03-26	A	New document
2014-01-27	B	Updated for post-10,000 build Platinum