CMG-6TC

Operators' Guide

Document No. MAN-060-0005

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Issue C February 2015

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

Note: A 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.

1.4 Conventions

Throughout this manual, examples are given of command-line interactions. In these examples, a fixed-width typeface will be used:

```
Example of the fixed-width typeface used.
```

Commands that you are required to type will be shown in bold:

`Example of the fixed-width, bold typeface.`

Where data that you type may vary depending on your individual configuration, such as parameters to commands, these data are additionally shown in italics:

`Example of the fixed-width, bold, italic typeface.`

Putting these together into a single example:

`System prompt:` **`user input with`** ***`variable parameters`***

2 Equipment Overview

2.1 Introduction

The CMG-6TC is an ultra-lightweight seismometer consisting of three sensors in a sealed case, which can measure simultaneously the North/South, East/West and vertical components of ground motion over a wide frequency range. This frequency response is made possible by advanced force-balance feedback electronics. It is ideally suited for rapid, temporary installations in locations with medium noise.

The robust sensor elements are designed so that no mechanical clamping is required. Because of this, the 6TC is ready to record ground movements as soon as you provide it with power and the processor has booted-up. The instrument will operate with up to 20° of tilt (if buried; up to 10° if free-standing) but better results will be obtained if the base is within 3° of the horizontal and installed on a hard surface, well coupled to the bedrock.

Each instrument is delivered with a detailed calibration sheet showing its serial number, measured frequency response (in both the long period and short period sections of the seismic spectrum), sensor output calibration figures and the instrument's transfer function, specified in “poles and zeroes” notation.

2.2 Features

- Compact size: 89mm x 160mm
- True broadband, three-component, force-feedback instrument
- Direct velocity outputs

- Lightweight (1.2kg) and waterproof to 1 metre submersion
- No mass clamping required – plug in and go
- High sensitivity and dynamic range (>135 dB)
- Orthogonal instrument with high cross-axis rejection (>65 dB)
- The sensor response is completely flat across the entire passband. Its high-gain feedback loop eliminates mechanical non-linearity (the overall measured linearity exceeds 95 dB) and minimizes resonances in the spring system.
- Low-frequency vibration modes are carefully avoided in the design. The lowest spurious vibration mode of the 6TC is a barely measurable resonance at 440Hz.

Refer to Appendix B on page 14 for full specifications.

2.3 Build options

The CMG-6TC is supplied in two standard build versions:

Selectable 1, 10, 30 and 60 second low frequency corner, flat to 100Hz

Selectable 1, 30, 60, 120 second low frequency corner, flat to 100Hz

A 50Hz option is available on request.

The responses for each build version are user-configurable. See section 4 on page 8 for instructions for configuring the responses.

2.4 Ports and Connections

Note: Refer to Appendix A on page 13 for information on connector pin-outs.

2.4.1 Ports

A single 26-pin connector provides power to the instrument and supplies analogue data from the sensors. A TTL-level serial interface is also exposed on the same connector.

The supplied cable has a 26-pin instrument connector at one end and either a 26 way connector or free pigtails at the other (depending on customer requirements).

2.4.2 Breakout box

An optional breakout box is available and comes with all necessary cables to connect the instrument to a power supply, digitiser and hand-held control unit, as required.

3 Setting up the CMG-6TC

3.1 Introduction

The CMG-6TC is delivered in a single transportation case. The packaging is specifically designed and should be reused whenever you need to transport the instrument.

Note any damage to the packaging when you receive the equipment and then unpack, ensuring the following are present:

- The seismometer;
- The thermal insulation jacket;
- The calibration and installation sheet.
- The connection cable (which contains a DC-DC power converter); and
- The attachable North/South alignment tool, if ordered

The instrument is factory set to the customer-specified response mode. To change the response mode before deployment, carry out the procedure detailed in section 4 on page 8.

3.2 Handling notes

- Avoid bumping or jolting the instrument when handling or unpacking.
- Do not kink or walk on the cables (especially on rough surfaces such as gravel) or allow any cable to bear the weight of the instrument.
- Do not connect the instrument to power sources, except where instructed.
- Do not ground any of the signal lines from the sensors.

3.3 Deployment

Note: Refer to Appendix A on page 13 for information on connector pin-outs.

1. Stand the instrument on bedrock where possible or, at least, deep in well-compacted subsoil. Remove all loose material from the mounting surface as this will ensure good contact between the instrument and the surface.

2. Align the instrument along the North/South axis using the indicators engraved on the top cover or the optional alignment tool (an extended pointer which locates into the two recesses in the top cover).

3. For best results, level the instrument using the adjustable feet and bubble level. The instrument can stand unsupported and function on a surface tilted by up to 10°. If buried, the instrument will still function with a tilt of up to 20° but the quality of the output signals will be compromised.

4. Lock the adjustable feet in position using the knurled brass locking nuts. The feet are locked when the knurled nuts are tight against the base of the instrument.

5. Install the thermal jacket to protect against temperature fluctuations.

6. Referring to the instrument pin-outs in Appendix A on page 13:

   a. Connect the instrument to suitable digitiser, such as a CMG-CD24 or CMG-DM24.

   b. Connect the instrument to a 9-36 VDC power supply.

7. Allow a few seconds for the instrument's processor to boot

8. The instrument is now operational and transmitting data.

9. Allow 4 minutes for the instrument to auto-centre.

Note: Güralp systems can supply breakout boxes, cables, digitisers and software for data conversion and analysis.

Note: If you are using a Güralp Systems digitiser, refer to the digitiser manual for details on how to set up the digitiser to receive data.

10. If installed in a hole, the instrument can be sealed in a plastic bag (to keep it clean) prior to infilling.

11. After installation, the instrument and mounting surface will slowly adjust to the local temperature, and settle in their positions. This typically takes around four hours from the time installation is completed.

3.4 Re-centring

The CMG-6TC automatically centres its masses at power up and should not normally require re-centring. If however, the sensor's position changes due to earth movement or if the ambient temperature changes dramatically, re-centring can be triggered by connecting pin U to pin Y:

- If pin U is connected to pin Y *for between one and five seconds*, the processor will switch temporarily to one-second response mode and check the mass positions. If they average more than 25% of full-scale, automatic re-centring is initiated.
- If pin U is connected to pin Y *for between five and ten seconds*, the processor will check the mass positions in the currently selected response mode and initiate automatic re-centring if they average more than 25% of full-scale.

4 Configuring the response mode

The CMG-6TC is available in two versions. Each version has a set of four different frequency response modes, from which the operator can choose. The four response modes are referred to as SP (short period), SMP (short-medium period), LMP (long-medium period) and LP (long period).

Response Mode	Build Version A pass-band	Build Version B pass-band
SP	1 second to 100 Hz*	1 second to 100 Hz*
SMP	10 seconds to 100 Hz*	30 seconds to 100 Hz*
LMP	30 seconds to 100 Hz*	60 seconds to 100 Hz*
LP	60 seconds to 100 Hz*	120 seconds to 100 Hz*

* Versions with 50Hz low-pass corners are also available.

The response mode can be changed at any time using either of the following methods:

1. Using the serial console menu (see section 5.2 on page 11).
2. By connecting specific pins on the connector to digital ground (see section 4.2 on page 8).

In order to use the first method (serial console menu), connector pins S and T should be left open circuit (not connected).

In order to use the second method (connector pins), the serial console menu should first be used to set the response mode to “LP” (option 0).

4.1 Setting the response mode using the serial console

To configure the 6TC response mode using the serial console menu, follow the instructions given in section 5 on page 10. Note that pins S and T on the connector should be left open circuit when relying on the menu to set the response mode.

4.2 Setting the response mode using the connector pins

Note: Refer to Appendix A on page 13 for information on connector pin-outs.

In order to set the response mode using the connector pins, the serial menu should first be used to set the response mode to “LP” (option 0). If any other mode is selected via the serial menu, only that mode and “SP” mode can be enabled using the connector pins.

1. Identify pins S, T and Y on the instrument connector.
2. Connect pin S and/or pin T to pin Y (digital ground) as required, according to the following table:

Response mode	Pin configuration	
	Pin S	Pin T
SP	Connect to pin Y	Connect to pin Y
SMP	Leave unconnected	Connect to pin Y
LMP	Connect to pin Y	Leave unconnected
LP	Leave unconnected	Leave unconnected

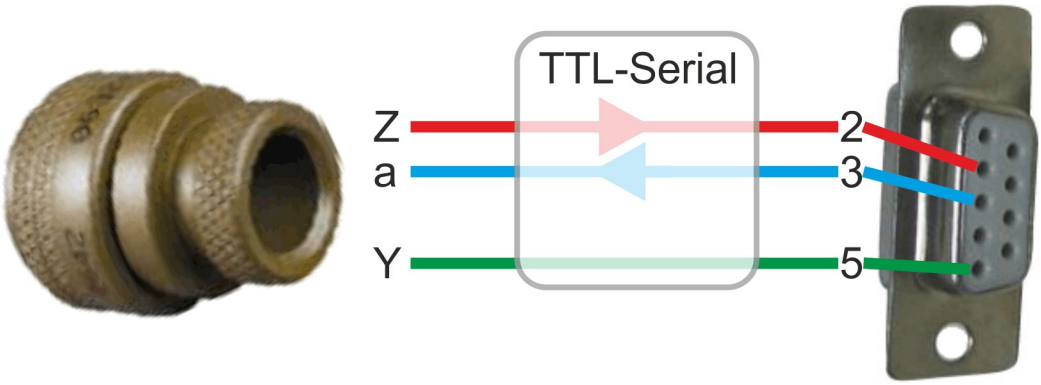
Note: If a mode other than “LP” has been selected using the serial console menu, it is still possible to select “SP” mode using the connector pins by connecting both pin S and pin T to pin Y.

5 The 6TC control menu

Note: Refer to Appendix A on page 13 for information on connector pin-outs.

The CMG-6TC has a serial console, which can be accessed via pins Y (ground), Z (console output) and a (console input) of the connector. This is a TTL-level interface (rather than RS232) so a suitable adaptor is required before it can be interfaced directly to, say, a PC or laptop.

1. Using a suitable TTL-to-USB or TTL-to-Serial adaptor, connect pins Y, Z and a on the instrument connector to a PC.



2. Connect the instrument to a power supply as follows:
   - If using the optional Güralp supplied cable, a DC supply of between 9V and 36V is required.
   - If you are connecting directly to the instrument, a ±5V DC supply is required.
3. Open a connection from the PC to the instrument using terminal emulator software such as: minicom or picocom (Linux); or Hyperterminal or PuTTY (Windows). Configure the connection to 38,400 baud, 8 data bits, no parity bits, 1 stop bit (“8-N-1”) and no hardware or software flow-control.
4. Once a connection has been established, disconnect and re-connect the instrument's power supply to re-boot it.
5. The boot sequence should look something like this:

```
Guralp Systems Ltd 6TC SoH v1.0 mgs 29/06/11 (Build 07f)
Built 29 Jun 2011, 15:44:16
Red Amber
W6461 T6E90 Green
System Test Passed
ESC for manual control 5 4 3 2 1 0
```

6. To access the control menu press the Esc key before the figures indicated in red count down to zero.

   The control menu looks like this:

```
SENSORS : A_ll, V_ertical, N_orth, E_ast – centre
MODE : S_hortperiod, B_roadband, R_esponse
M_ass positions : I_inclination : O_ffset null ADXL : e_X_it
:- KEY ?
```

   To exit the control menu and continue with a normal system start, press the X key. For explanation of all other keys, please see the following sections.

   After any control menu operation is completed, the control menu will re-display.

5.1 Sensor centring

To centre the sensors, press the A, V, N or E keys as required.

Keying A will centre all components while V, N or E will centre the vertical, North/South or East/West masses, respectively.

The sensors will auto-centre during start up: manual centring is only required for diagnostic or testing purposes.

5.2 Response mode

Option R displays the following menu, used for selecting the response mode:

```
Select System Bandwidth 0=LP, 1=LMP, 2=SMP, 3=SP
```

The response mode options are given in the following table:

Required Response (in seconds)		Menu Key	Designation
Build Version A	Build version B		
1	1	3	***SP***
10	30	2	***SMP***
30	60	1	***LMP***
60	120	0	***LP***

In addition to configuring the mode for normal operations, it is also possible to set the instrument temporarily into short-period mode, in order to assess the effects of adjustments to the instrument's inclination during installation.

Option S (***S***hort-period mode) over-rides any selected response mode (whether hardware or software configured) and temporarily changes the response mode to one second (SP) for as long as the control menu is active – i.e. until the system is allowed to boot normally or “broadband mode” is selected (see option B, below).

Option B (Broadband mode) cancels the temporary short-period mode and restores the configured response mode. Note that, when the instrument boots, it will always revert to the normally configured response mode.

5.3 Other controls

Option M displays the current mass positions.

Option I returns the internally measured inclination.

Option O resets the offset-null. This can be used when the internally-measured inclination appears to be different to the actual inclination. Resetting the offset should result in an internally measured inclination reading of 0°, regardless of the actual, physical inclination.

Option X exits the control menu and continues with the normal boot process.

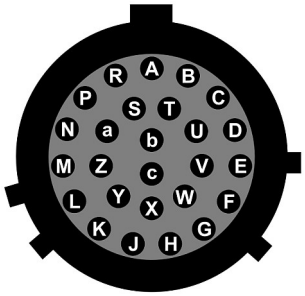
6 Appendices

6.1 Appendix A - 26 pin Connector pin-outs

This is a standard 26-pin “mil-spec” plug, conforming to MIL-DTL-26482 (formerly MIL-C-26482). A typical part-number is 02E-16-26P although the initial “02E” varies with manufacturer.

Suitable mating connectors have part-numbers like ***-16-26S and are available from Amphenol, ITT Cannon and other manufacturers.

Pin	Function	Pin	Function
A	Velocity +ve, vertical channel	P	Calibration signal
B	Velocity –ve, vertical channel	R	Calibration enable
C	Velocity +ve, N/S channel	S	Response mode selection
D	Velocity –ve, N/S channel	T	Response mode selection
E	Velocity +ve, E/W channel	U	Centre
F	Velocity –ve, E/W channel	V	*not connected*
G	Mass position, vertical channel	W	*not connected*
H	*not connected*	X	*not connected*
J	Mass position, N/S channel	Y	Data ground
K	*Factory use only*	Z	Console Output (TTL-level)
L	Mass position, E/W channel	a	Console Input (TTL-level)
M	Power -5 Volts	b	Power ground
N	Signal ground	c	Power +5 Volts



Wiring details for the compatible socket, ***-16-26S, as seen from the cable end (*i.e.* when assembling).

6.2 Appendix B - Specifications

Parameter	Specification
Velocity output bandwidth	1, 10, 30, 60 seconds at 100Hz *or* 1, 30, 60, 120 seconds at 100Hz
Velocity output sensitivity	2 x 1,200 V/ms^{-1} (standard), 2 x 750 V/ms^{-1} (optional) 2 x 2,000 V/ms^{-1} (optional) 2 x 4,000 V/ms^{-1} (optional)
Peak output	±5V (20V peak-to-peak) – standard output ±10V (40V peak-to-peak) – high-power output
Linearity	> 95 dB
Cross-axis rejection	> 65 dB
Electronics self-noise	-172 dB (relative to 1 m^{2}s^{-4}Hz^{-1})
Operating temperature	-20 to +60°C
Temperature sensitivity	< 0.6 V per 10 °C
Horizontal tilt tolerance	±20° from horizontal
Construction	Hard anodised aluminium case, gold plated contacts, O-ring seals throughout, exceeding IP67
Case diameter	89mm
Case height (with handle)	160mm
Weight	1.20 kg
Power supply	9 - 36 VDC / ±5V
Power consumption	140mW (without cable and standard output) 200mW (with cable)
Calibration controls	common signal and enable lines exposed on sensor connector
Optional accessories	Break-out box Combined power/signal cable Right angled connector

6.3 Appendix C - Revision history

2015-02-09	C	Corrected serial line description
2013-07-08	B	Added auto-centring information
2010-04-28	A	New document