

**GURALP**



**SYSTEMS**

# CMG-1T



## Very broadband seismometer

The CMG-1T is a modern development of a very broadband seismometer. It is a compact three-component very broadband sensor, suitable for observatory grade surface vault, subsurface vault and posthole installations. The seismometer is based on a well proven, established design of the CMG-3 sensors first introduced in 1985.

### Key Features:

Covers the complete seismic spectrum with a single transfer function

Response from 360 s to 50 Hz  
Option of 100 HF corner

Self noise below the USGS NLNM from >500s to 20Hz (Vertical)

Truly portable with lifting handle and convenient access to connectors

High linearity: >107 dB horizontal, 111 dB vertical

Over 140 dB dynamic range over the entire passband

Cross-axis rejection over 65 dB; sensor axes orthogonal to within +/- 0.05 °

Remote, automatic electronic mass locking, unlocking and centring

- Adjustable feet allow for up to 5 ° tilt



# System noise and clip level



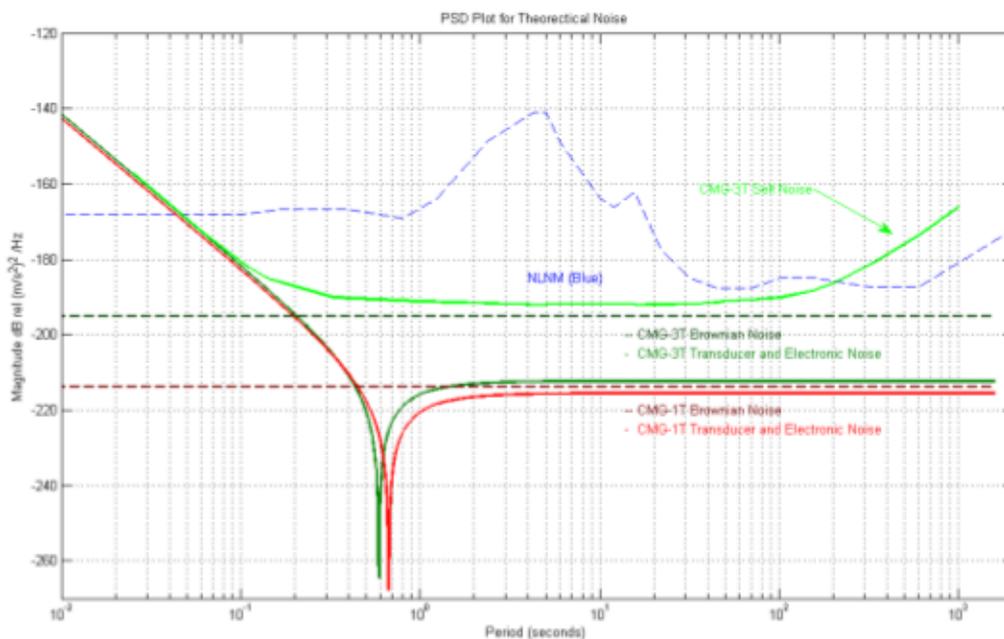
CMG-1T



Discrete component pre-amplifier circuitry with a high responsivity capacitive transducer sets the sensor electronics noise level at least 20 dB (factor of 10) below Brownian noise level. This is well below the background noise level encountered at the quietest site on earth.

The CMG-1T sensor housing can be evacuated to reduce sensor Brownian noise further however it is well known that the main practical problems in the long period instruments arise from thermal, magnetic field and pressure effects in the mechanical system. The heat effect of the sensor electronics is negated due to separate mechanical and electronic housings.

In ideal installations the self noise of the CMG-1T is well below the USGS NLNM for in excess of 500 seconds to better than 20Hz. A Granite, thermal, pressure and magnetic shielded installation case can be provided on request.



The above plot shows the theoretical noise<sub>1</sub> of the CMG-1T with the theoretical and actual achieved self noise for the CMG-3T as reference.

Note 1: The theoretical calculated Brownian noise level (Ref. C.M. Guralp PhD thesis, Reading University 1980) of the sensor is set at - 205 dB relative to  $1\text{m}^2\text{s}^{-4}\text{Hz}^{-1}$  of input ground acceleration.

# Response options



## CMG-1T

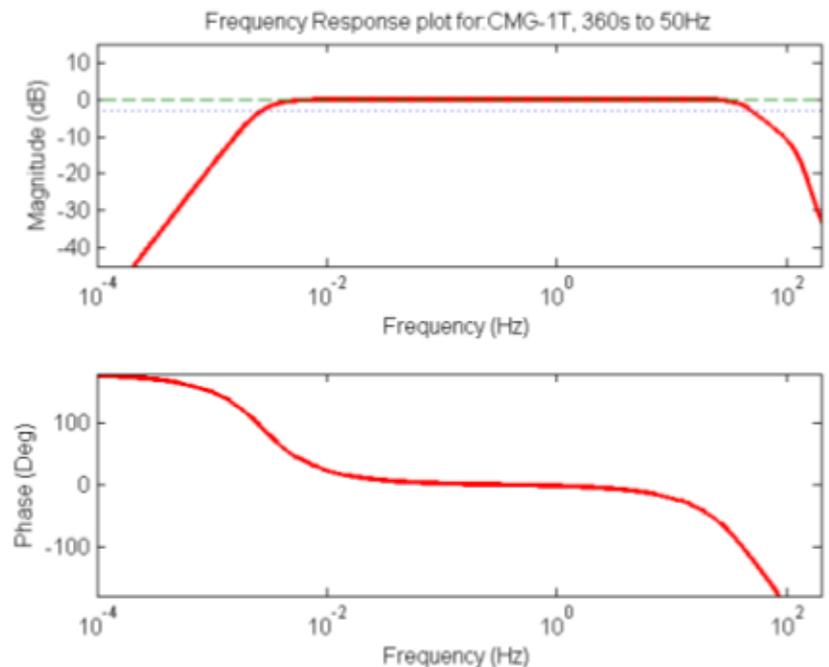


Since the response of a modern broadband feedback seismometer is completely determined by the feedback electronics, which supply a force to the mass opposing any motion, the feedback loop can be designed to provide practically any desired frequency response.

### Conventional response

Conventional-response 1T sensors output signals proportional to ground velocity over the full passband of the instrument.

The standard response is from 360s to 50Hz. Other low-frequency corner options are available from 360s to 30s, whilst the high frequency can be extended to 100Hz.



### Hybrid response

This is a new type of transfer function, used for the USGS National Seismic Network. The standard CMG-NSN hybrid response curve is flat to velocity from 50Hz to 30s, and to acceleration between 30 and 200 s. Other options are available.

### Calibration

The frequency response of every 1T sensor is measured at the factory with a frequency analyser. Comprehensive calibration documentation is provided, including measured frequency plots in the long and short period sections of the seismic spectrum. The poles and zeroes of the instrument's single transfer function are also provided.

# Specifications



CMG-1T



Standard velocity output band	360s – 50Hz*
Mass position output band	DC – 360s
Output sensitivity	$2 \times 750\text{Vm}^{-1}\text{s}^{-1}$ ( $1500\text{Vm}^{-1}\text{s}^{-1}$ ) **
Peak output	$\pm 10\text{V}$ differential
Lowest spurious resonance	> 140Hz (vertical)
Linearity, vertical (USGS)	> 111dB
Linearity, horizontal (USGS)	> 107dB
Cross-axis rejection	> 65dB
Remote control	Lock, unlock, centre
Operating temperature	-30 to +65°C (-55°C option)
Temperature sensitivity	< 0.6V per 10°C
Mass recentring range	$\pm 2.5^\circ$ from horizontal
Materials	Stainless steel case Mil-spec connector (1500psi waterproof connector or user connector option)
Case diameter	168mm
Case height (with handle)	270 mm
Case height (sensor only)	220mm
Isolating power supply	10 – 36VDC
Optional low power sensor	5VDC supply (output $\pm 4.5\text{V}$ )
Current at 12 V DC	75mA
Calibration controls	Independent signal & enable lines exposed on sensor connector
Optional low pass corner	50Hz, 100Hz or 200Hz

\* Also available with 1s, 30s, 60 , 100s or 360s long period corner frequency, or with hybrid response. 100Hz Low pass option

\*\* Available with sensitivity in the range  $2 \times 750\text{Vm}^{-1}\text{s}^{-1}$  to  $2 \times 10000\text{Vm}^{-1}\text{s}^{-1}$ .

# CMG-3T



## Weak motion broadband seismometer

The CMG-3T is a compact three-component broadband sensor, suitable for surface vault, subsurface vault and posthole installations. The instrument is a well proven, established design and has been in continuous production since 1987. The CMG-3T is widely used on many National Seismic Networks, with in excess of 3000 triaxial sensors deployed worldwide.

### Key Features:

Covers the complete seismic spectrum with a single transfer function

Response from 360 s to 50 Hz (120 s – 50 Hz standard)  
Options of 1, 30, 60 and 100 s LP corners  
Options of 100 and 200 Hz HF corners

Measured Self noise below the USGS NLNM from >200s to 20Hz (Vertical)

Truly portable with lifting handle and convenient access to connectors

High linearity: >107 dB horizontal, 111 dB vertical (USGS figures)

Over 140 dB dynamic range over the entire passband (USGS figure)

Cross-axis rejection of over 65 dB; sensor axes orthogonal to within  $\pm 0.05^\circ$

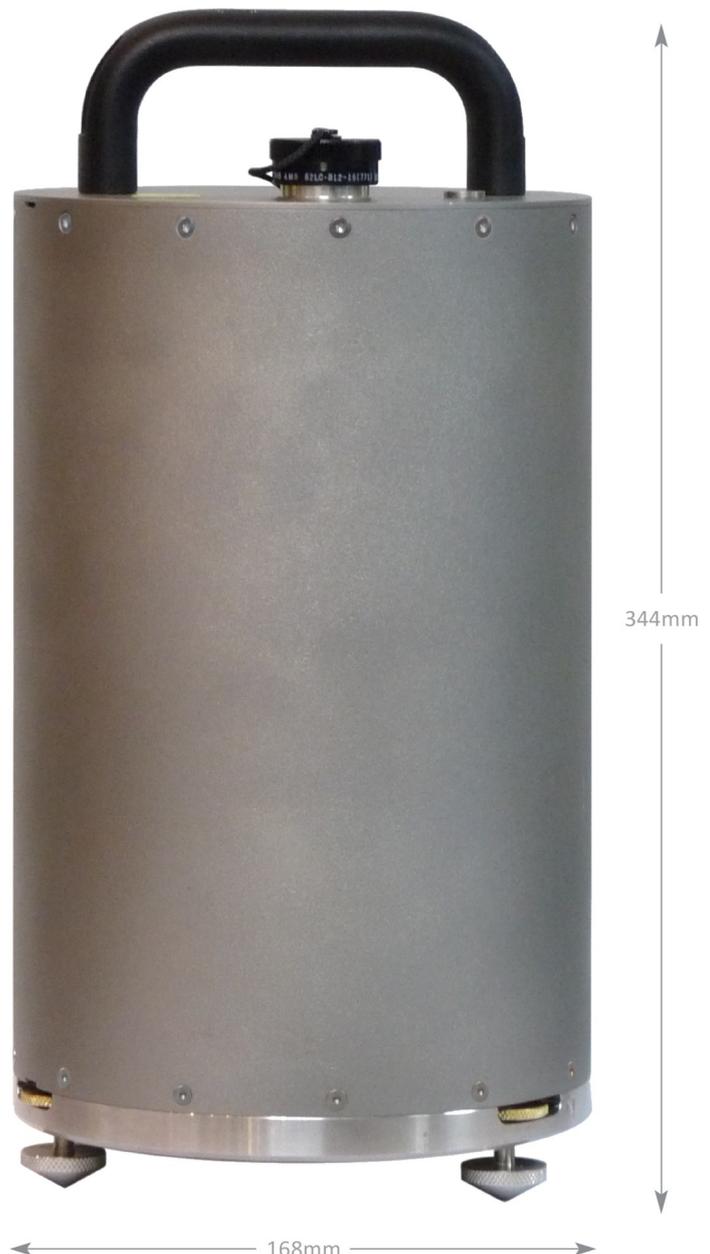
Remote, automatic, electronic mass locking, unlocking and centring

Adjustable feet allow for up to  $5^\circ$  of tilt

Low power consumption (750 mW from 10 – 30V supply)

A fully digital instrument, the CMG-3TD is also available. It combines the CMG-3T with our low-noise DM24 digitizer in a single package

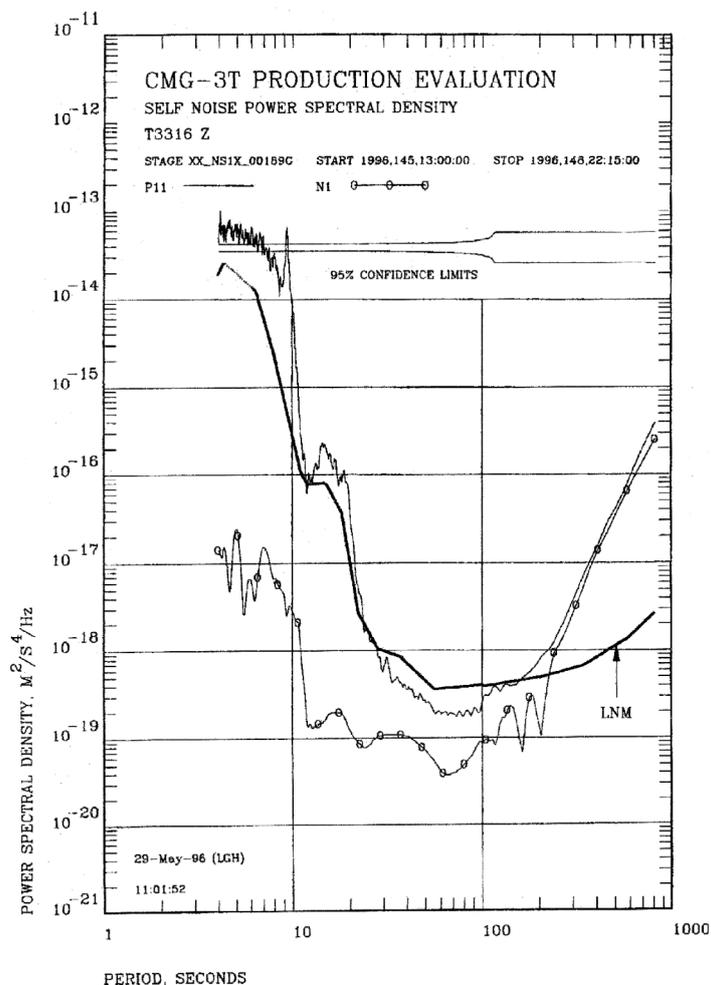
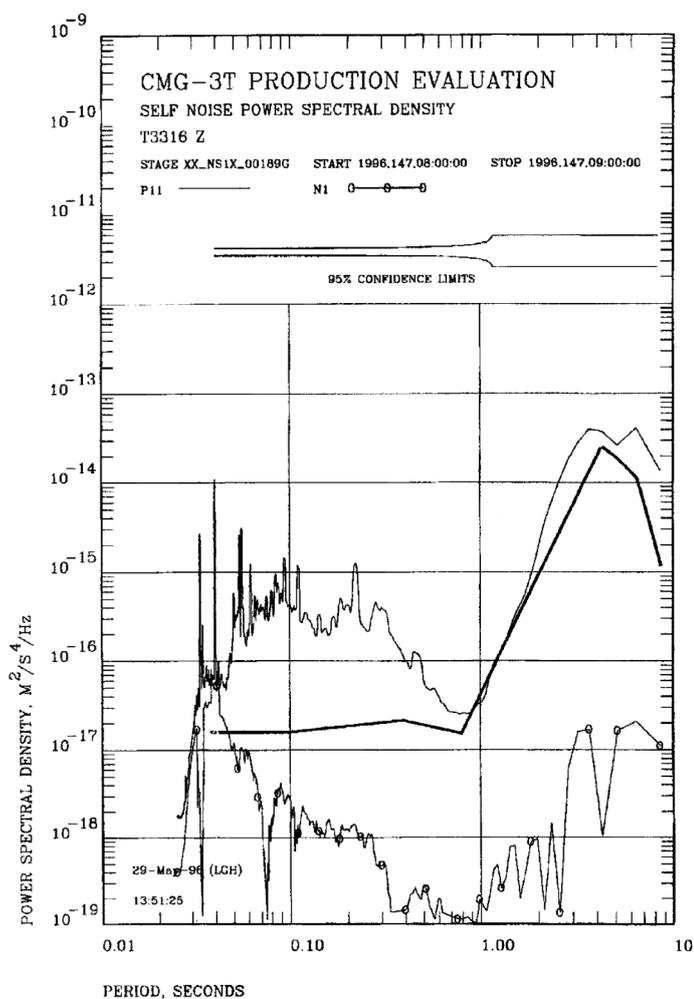
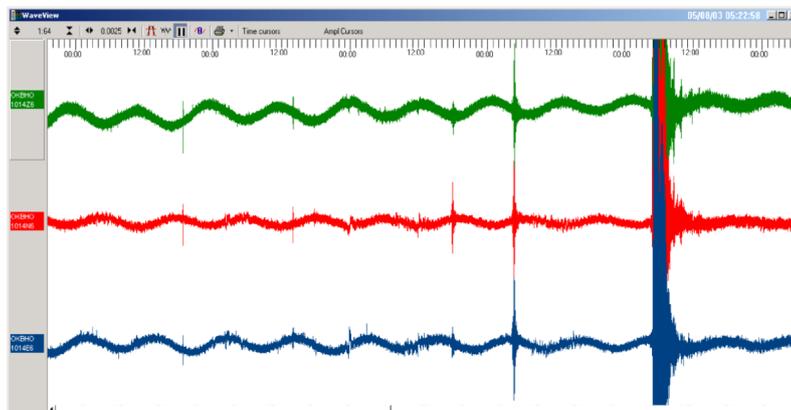
Optional hybrid response models are available, e.g. flat to velocity from 50 Hz to 30 s and flat to acceleration between 30 s and 200 s, offering unrivalled dynamic range





## Noise Performance

This plot shows earth tides and earth modes recorded by a 360 s CMG-3TB seismometer with 50 Hz high-frequency corner, outputting data at 1 sample/s to a downhole CMG-DM24 digitizer. The raw data has not been filtered or processed in any way. Earth modes are routinely observed at quiet stations using 3T sensors.



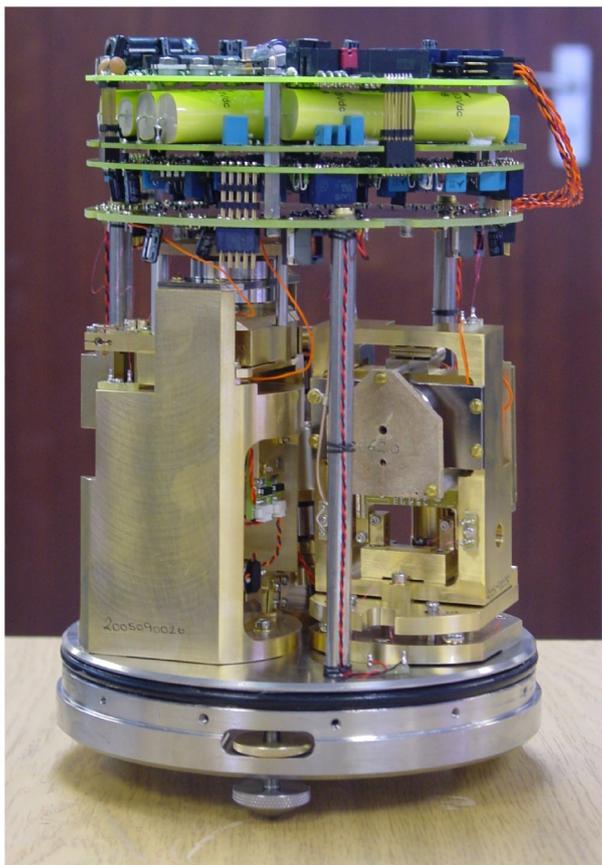
These plots estimate the system noise power of the vertical component of the 3T conventional-response sensor at long period (left) and short period (right).

The system noise power, corrected for system response and gain, is shown as a continuous thin line; the circled line is the raw non-coherent power spectrum. The thicker line is the Peterson NLNM (New Low Noise Model). The CMG-3T's self-noise typically remains below the NLNM between 200 seconds and 18 Hertz (vertical).



## Inside the 3T

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The vertical and horizontal sensors in the CMG-3T are orthogonal to each other to an accuracy of better than  $\pm 0.05^\circ$ .

Vertical and horizontal components use identical, symmetrical beam-type booms with a single degree of freedom, capacitive displacement transducers and constant-flux feedback transducers. The masses are supported using leaf springs with a natural period around 0.9 s.

The lowest parasitic resonance of the complete sensor system is above 140 Hz.

When locked for transportation, the mass clamping mechanism presses the mass into precisely-machined cavities under a control-led spring force, restraining movement in all 6 degrees of freedom. This ensures that the sensor pivots cannot be damaged under normal operation.

The vertical component is centred with a stable, motorised, precision micrometer, which moves the end of the load-bearing spring under electronic control. The horizontal component uses a similar electronic arrangement to tilt the sensor base.

The CMG-3T sensor housing is completely sealed with “O”-rings, and all external components are manufactured from durable stainless steel. It can be provided with an optional waterproof connector and cabling, allowing the instrument to be immersed continuously under water down to a depth of 25 m. Other depth options are available.

# Specifications

CMG-3T



Standard velocity output band	<i>120 seconds – 50 Hertz standard (The instrument is also available with 1 s, 30 s, 60 s, 100 s or 360 s long period corner frequency, or with hybrid response)</i>	
Mass position output band	<i>DC – 120 seconds</i>	
Output sensitivity	<i>2 × 750 V/ms<sup>-1</sup> (1500 V/ms<sup>-1</sup>) standard The CMG-3T is available with any user-specified sensitivity in the range 2 × 500 V/ms<sup>-1</sup> to 2 × 10,000 V/ms<sup>-1</sup></i>	
Peak output	<i>±10 V differential</i>	
Lowest spurious resonance	<i>&gt; 140 Hz (vertical)</i>	
Linearity, vertical	<i>&gt; 111 dB (USGS figures)</i>	
Linearity, horizontal	<i>&gt; 107 dB (USGS figures)</i>	
Cross-axis rejection	<i>&gt; 65 dB</i>	
Remote control	<i>Lock, unlock, centre</i>	
Operating temperature	<i>–20 to +75 °C</i>	<i>(–55 °C optional)</i>
Temperature sensitivity	<i>&lt;0.8 V per 1 °C</i>	<i>(&lt;0.8 V per 50 °C optional)</i>
Temp' range without re-centring	<i>±10 °C standard</i>	<i>(–20 °C to +50 °C optional)</i>
Mass recentring range	<i>± 2.5 ° from horizontal</i>	
Materials	<i>Stainless steel case Mil-spec connector (1500 psi waterproof connector or user connector optional)</i>	
Case diameter	<i>168 mm</i>	
Case height (with handle)	<i>344 mm</i>	
Case height (sensor only)	<i>274 mm</i>	
Isolating power supply	<i>10 – 36 V DC</i>	
Optional low power sensor	<i>5 V DC supply (output ±4.5 V)</i>	
Current at 12 V DC	<i>62 mA</i>	
Calibration controls	<i>Independent signal &amp; enable lines exposed on sensor connector</i>	
Optional low pass corner	<i>50 Hz, 100 Hz or 200 Hz</i>	

# CMG-3ESP



## Weak motion broadband seismometer

The CMG-3ESP is a compact and cost-effective three-component broadband sensor, suitable for surface vault (observatory), sub-surface vault and posthole installations. The latest incarnation offers numerous improvements over its predecessor whilst retaining the best features of the original, proven 1989 design.

### Key Features:

Reduced case height and diameter; reduced power consumption; new, single-piece sensor bodies; improved electronics (now surface-mount) and improved mass-locking mechanisms

Covers the complete seismic spectrum with a single transfer function

Response from 120 seconds to 50 Hertz (30s to 50Hz standard)

Options of 1s, 60s and 100s long period corners  
Optional 100Hz high frequency corner

Truly portable with lifting handle and convenient access to connector

High linearity: >107 dB horizontal, 111 dB vertical (independent test results)

Over 140 dB dynamic range (independent testing)

Cross-axis rejection of over 62 dB

Self noise below USGS NLNM from >40s to >16Hz

Sensor axes orthogonal to within  $\pm 0.05^\circ$

Manual mass locking and unlocking; electronic centring

Adjustable feet allow for up to  $2.5^\circ$  of tilt

Low power consumption (48 mA from 12 V supply)

The CMG-3ESPD fully digital instrument is also available, combining the CMG-3ESP and DM24 digitizer in a single package

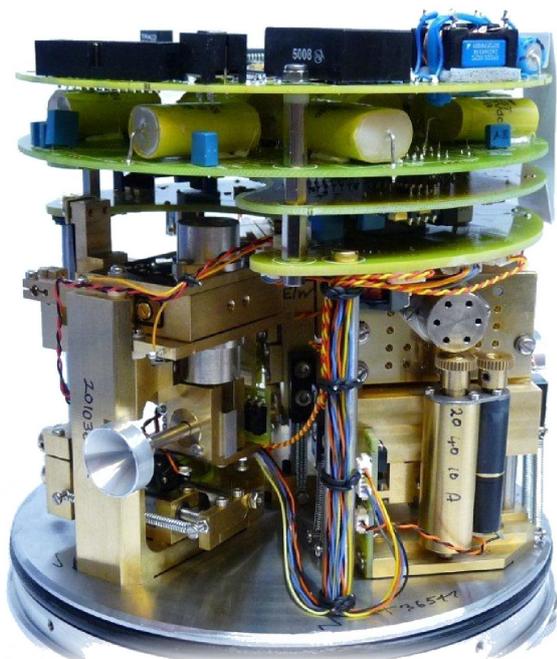






## Inside the 3ESP

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The vertical and horizontal sensors in the CMG-3ESP are orthogonal to each other to an accuracy of better than  $0.1^\circ (\pm 0.05^\circ)$ .

Vertical and horizontal components use identical, symmetrical beam-type booms with a single degree of freedom, capacitive displacement transducers and constant-flux feedback transducers. The compound masses are supported using leaf springs with a natural period around 0.9 seconds.

The lowest parasitic resonance of the complete sensor system is above 140 Hertz.

When locked for transportation, the mass clamping mechanisms press the masses into precisely-machined cavities under a control-led spring force, restraining movement in all 6 degrees of freedom. This ensures that the sensor pivots cannot be damaged under normal operation.

The vertical component is centred with a stable, motorised, precision micrometer, which moves the end of the load-bearing spring under electronic control. The horizontal components use a similar electronic arrangement to tilt the sensor base, allowing the mass to come to rest at one end of its travel.

The CMG-3ESP sensor housing is completely sealed with “O”-rings, and all external components are manufactured from durable stainless steel. It can be provided with an optional waterproof connector and cabling, allowing the instrument to be immersed continuously under water down to a depth of 25 m. Other depth options are available.

## Improved version

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The latest CMG-3ESPs use surface-mount electronics for increased reliability, smaller PCBs and reduced power consumption. The motors and motor assemblies have all been redesigned, resulting in a significant improvement in locking, unlocking and centring operations, as well as a smaller casing - the new and old versions are shown here, side by side. The height has been reduced by 50mm to 315mm (including handle), the weight by 2.6kg to 9.3kg and the power consumption by 15mA to 50mA. The use of new, single-part sensor bodies, as used in the CMG-3T, has increased the frequency of the lowest spurious resonance to above 140Hz. The performance of the redesigned instrument is, in all respects, equivalent to or better than that of the original CMG-3ESP.



# Specifications

CMG-3ESP



Standard velocity output band	<i>30 s – 50 Hz. Also available with 1 s, 60 s, 100 s or 120 s long-period corner frequency, 100Hz high-frequency corner, or with hybrid response.</i>
Mass position output band	<i>DC – 30 s</i>
Output sensitivity	<i>2 × 1000 V/m/s. Also available with and user-specified sensitivity in the range 2 × 750 V/m/s – 2 × 10000 V/m/s.</i>
Peak output	<i>±10 V differential</i>
Lowest spurious resonance	<i>&gt; 140 Hz (vertical)</i>
Linearity, vertical (USGS)	<i>&gt; 111 dB</i>
Linearity, horizontal (USGS)	<i>&gt; 107 dB</i>
Cross-axis rejection	<i>&gt; 62 dB</i>
Dynamic range	<i>&gt; 140 dB (see plots)</i>
Self-noise below NLNM	<i>40 s to 16 Hz</i>
Operating temperature	<i>–20 to +65 °C (–55 °C optional)</i>
Temperature sensitivity	<i>&lt; 0.6 V per 10 °C (standard response)</i>
Operating pressure	<i>200 kPa (equivalent to 10m of water)</i>
Mass recentring range	<i>± 2.5 ° from horizontal</i>
Materials	<i>Stainless steel case Mil-spec connector (1500 psi waterproof connector or user-specified connector optional)</i>
Case diameter	<i>168 mm</i>
Case height (with handle)	<i>315 mm</i>
Case height (sensor only)	<i>245 mm</i>
Weight	<i>9.3 kg</i>
Isolating power supply	<i>9 – 36 V DC</i>
Optional low power sensor	<i>5 V DC supply (output ±4.5 V)</i>
Current at 12 V DC	<i>50 mA</i>
Mass control	<i>Manual lock, unlock; automatic centre</i>
Optional remote mass lock	<i>Automatic lock, unlock and centre</i>
Calibration controls	<i>Independent signal &amp; enable lines exposed on sensor connector</i>

# CMG-3ESP Compact



## Portable weak motion seismometer

The CMG-3ESP Compact from Guralp Systems is a development from the well-proven CMG-3ESP seismometer. It is a small, lightweight, broadband, triaxial, weak-motion instrument, offering weak-motion performance for the price and size of a medium-motion instrument.

### Key Features:

Covers the complete seismic spectrum with a single transfer function

Response from 120s to 50 Hz (60s to 50Hz Standard)

- \* Options of 1s, 30s and 100s LP corners
- \* Option of 100Hz HF corner

Truly portable: under 9 kg, with lifting handle and convenient access to connectors

Highly compact form factor

High linearity: >107 dB horizontal, 111 dB vertical

Over 140 dB dynamic range; low self-noise over a wide frequency band

Cross-axis rejection over 62 dB; sensor axes orthogonal to within  $\pm 0.05^\circ$

Robust automatic mass locking, unlocking and centring

Adjustable feet allow for up to  $4^\circ$  tilt ( $8^\circ$  optional)

Low power consumption (750 mW from 10 – 30 V input power)

- \* Optional integrated DM24 digitizer with up to 8 Gb storage

Also available in single-component form



# Specifications

## CMG-3ESP Compact



Standard velocity output band	<i>60 seconds – 50 Hertz standard. Also available with 1 s, 30 s, 100 s or 120 s corner frequency, or with a hybrid response.</i>
Mass position output band	<i>DC – 60 seconds</i>
Output sensitivity	<i><math>2 \times 1000 \text{ V/ms}^{-1}</math>. Also available with any sensitivity in the range <math>2 \times 750 \text{ V/m}^{-1}</math> to <math>2 \times 10,000 \text{ V/m}^{-1}</math>.</i>
Peak output	<i><math>\pm 10 \text{ V differential}</math></i>
Lowest spurious resonance	<i><math>&gt; 300 \text{ Hz (vertical)}</math></i>
Linearity, vertical (USGS)	<i><math>&gt; 111 \text{ dB}</math></i>
Linearity, horizontal (USGS)	<i><math>&gt; 107 \text{ dB}</math></i>
Cross-axis rejection	<i><math>&gt; 62 \text{ dB}</math></i>
Dynamic range	<i><math>&gt; 140 \text{ dB (see plots)}</math></i>
Self-noise below NLNM	<i><math>&gt; 30 \text{ s to } 16 \text{ Hz}</math></i>
Operating temperature	<i><math>-20 \text{ to } +65 \text{ }^\circ\text{C}</math> (<math>-55 \text{ }^\circ\text{C}</math> optional)</i>
Temperature sensitivity	<i><math>&lt; 0.6 \text{ V per } 10 \text{ }^\circ\text{C}</math> (standard response) <i>* Optional <math>-20 \text{ to } +50 \text{ }^\circ\text{C}</math> range without recentring</i></i>
Mass recentring range	<i><math>\pm 2.5 \text{ }^\circ</math> from horizontal</i>
Materials	<i>Hard anodised aluminium case Mil-spec connector (1500 psi waterproof connector or user-specified connector optional)</i>
Case diameter	<i>168 mm</i>
Case height (with handle)	<i>258 mm</i>
Case height (sensor only)	<i>187 mm</i>
Weight	<i>8.3 kg</i>
Isolating power supply	<i>10 – 36 V DC</i>
Optional low power sensor	<i>5 V DC supply (output <math>\pm 4.5 \text{ V}</math>)</i>
Current at 12 V DC	<i>50 mA</i>
Mass control	<i>Automatic, remotely operable</i>
Calibration controls	<i>Independent signal &amp; enable lines exposed on sensor connector</i>
Optional low pass filter	<i>100 Hz corner frequency</i>

# CMG-3T Portable



## Weak motion compact broadband seismometer

The Guralp Systems CMG-3T portable is a compact, three-component, broadband instrument suitable for rapid deployment in surface and subsurface vaults and posthole installations. The instrument is based on a well proven, established design that has been in continuous production since 1987 and used on many National Seismic Networks with in excess of 3000 instruments deployed worldwide.

### Key Features:

Covers the complete seismic spectrum with a single transfer function

Standard response of 120s to 50Hz or 100Hz  
Options of 1, 30, 60, 100 or 360s LP corners  
Option of 200 Hz HF corners

Measured Self noise below the USGS NLNM from >60s to 20Hz (Vertical)

Truly portable with lifting handle and convenient access to connectors

Connector options of horizontal, vertical or waterproof mil-spec

High linearity: >107 dB horizontal, 111 dB vertical (USGS figures)

Over 140 dB dynamic range over the entire passband (USGS figure)

Cross-axis rejection of over 65 dB; sensor axes orthogonal to within  $\pm 0.05^\circ$

Remote, automatic, electronic mass locking and unlocking

No mass centring required (between  $\pm 45^\circ\text{C}$ )

Low power consumption (750 mW from 10 – 30V supply)

A fully digital instrument, the CMG-3TCD is also available. It combines the CMG-3TC with our low-noise DM24 digitizer in a single package

Optional hybrid response models are available, e.g. flat to velocity from 50 Hz to 30 s and flat to acceleration between 30 s and 200 s, offering unrivalled dynamic range



# Specifications

## CMG-3T Portable



Standard velocity output band	<i>120 seconds – 50 Hertz standard (The instrument is also available with 1s, 30s, 60s, 100s or 360s long period corner frequency, or with hybrid response)</i>
Mass position output band	<i>DC – 120 seconds</i>
Output sensitivity	<i>2 × 750 V/ms<sup>-1</sup> (1500 V/ms<sup>-1</sup>) standard Available with any user-specified sensitivity in the range 2 × 500 V/ms<sup>-1</sup> to 2 × 10,000 V/ms<sup>-1</sup></i>
Peak output	<i>±10 V differential</i>
Lowest spurious resonance	<i>&gt; 140 Hz (vertical)</i>
Linearity, vertical	<i>&gt; 111 dB (USGS figures)</i>
Linearity, horizontal	<i>&gt; 107 dB (USGS figures)</i>
Cross-axis rejection	<i>&gt; 65 dB</i>
Remote control	<i>Lock, unlock, centre</i>
Operating temperature	<i>–20 to +75°C (–55°C optional)</i>
Temperature sensitivity	<i>&lt;0.8 V per 1°C (&lt;0.8 V per 50°C optional)</i>
Temperature range without re-centring	<i>±45°C standard</i>
Materials	<i>Stainless steel case</i>
Case diameter	<i>168mm</i>
Case height (with handle)	<i>289mm</i>
Case height (instrument only)	<i>232mm</i>
Isolating power supply	<i>10 – 36 VDC</i>
Optional low power sensor	<i>5 VDC supply (output ±4.5 V)</i>
Current at 12 VDC	<i>62 mA</i>
Calibration controls	<i>Independent signal &amp; enable lines exposed on sensor connector</i>
Optional low pass corner	<i>50 Hz, 100 Hz or 200 Hz</i>

# CMG-40T



## Broadband seismometer

The Guralp CMG-40T is a rugged and robust three-component broadband seismometer ideally suited for installation in vaults with moderate noise.

### Key Features:

True broadband force-feedback instrument

Direct velocity outputs

Self-contained in a waterproof steel case

Fully adjustable levelling feet

No mass clamping required – plug in and go

High sensitivity and dynamic range

The 40T has a standard response of 30 seconds to 50 Hertz but can be supplied with response options of 1, 10, 30 or 60 seconds for the long period corner and 50 or 100 Hertz for the high frequency corner

Its high-gain feedback loop eliminates mechanical non-linearity (the overall measured linearity exceeds 90 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 40T is a barely measurable resonance at 440 Hz.

Single-component vertical and horizontal sensors (CMG-40V and CMG-40H) are also available.

The CMG-40T can be supplied as the CMG-40TD, which consists of CMG-40T sensors in the same case as an integrated digitiser.



# Specifications

CMG-40T



Velocity output bandwidth	<i>30 seconds – 50 Hertz (Standard) 1s, 2s, 10s or 60s long period options 100Hz high frequency option</i>
Velocity output sensitivity	<i>2 × 400 V/ms<sup>-1</sup> (Standard) Options for 2 × 1000 or 2 × 1600 V/ms<sup>-1</sup> Optional high-gain output (× 10)</i>
Peak output	<i>±10 V (20 V peak-to-peak)</i>
Optional high gain sensitivity	<i>2 × 10000 V/ms<sup>-1</sup> (adjustable)</i>
Lowest spurious resonance	<i>450 Hz</i>
Linearity	<i>&gt; 90 dB</i>
Cross-axis rejection	<i>&gt; 65 dB</i>
Electronics noise level	<i>-172 dB (relative to 1m<sup>2</sup>s<sup>-4</sup>Hz<sup>-1</sup>)</i>
Operating temperature range	<i>-20 to +75 °C</i>
Temperature sensitivity	<i>&lt; 0.6 V per 10 °C</i>
Mass recentring range	<i>±3 ° from horizontal</i>
Materials	<i>Stainless steel case Gold plated contacts O-ring seals throughout</i>
Case diameter	<i>154 mm</i>
Case height (with handle)	<i>207 mm</i>
Weight	<i>2.49 kg</i>
Power supply	<i>10 – 36 V DC</i>
Optional low power sensor	<i>5 V DC supply (output ±4.5 V)</i>
Current at 12 V DC	<i>38 mA</i>
Calibration controls	<i>Common signal &amp; enable lines exposed on sensor connector</i>
Offset zeroing	<i>Adjustable through case</i>
Optional remote control	<i>Offset zeroing with DC motors</i>
Optional accessories	<i>Handheld Control Unit</i>

# CMG-6T



## Seismometer and Digitiser

The Guralp Systems CMG-6T is an ultra-lightweight three-component seismometer ideally suited for rapid installation in medium-noise sites.

### Key Features:

True broadband force-feedback instrument

Direct velocity outputs

Lightweight, waterproof and self-contained

Quick and easy, one-person installation

Easy access to electrical connections

No mass clamping required – plug in and go

High sensitivity and dynamic range

Orthogonal instrument with high cross axis rejection (>65 dB)

The 6T can be supplied with response options of 1s to 100Hz (Model CMG-6T-1)

10 s – 100 Hz

30 s – 100 Hz

Its high-gain feedback loop eliminates mechanical non-linearity (the overall measured linearity exceeds 90 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 6T is a barely measurable resonance at 440 Hz.

Single-component vertical and horizontal sensors (CMG-6V and CMG-6H) are also available.



# Specifications

CMG-6T



Velocity output bandwidth	<i>1 s – 100 Hz (Model CMG-6T-1), 10 s – 100 Hz (Standard) or 30 s – 100 Hz</i>
Velocity output sensitivity	<i>2 × 1200 V/m/s, (Standard) 2 × 2000 V/m/s or 2 × 1000 V/m/s</i>
Peak output	<i>±10 V (20 V peak-to-peak)</i>
Optional high gain sensitivity	<i>2 × 10000 V/m/s (adjustable)</i>
Lowest spurious resonance	<i>450 Hz</i>
Linearity	<i>&gt; 90 dB</i>
Cross-axis rejection	<i>&gt; 65 dB</i>
Electronics noise level	<i>–172 dB (rel. 1m2s-4Hz-1)</i>
Operating temperature	<i>–40 to +75 °C</i>
Temperature sensitivity	<i>&lt; 0.6 V per 10 °C</i>
Mass recentring range	<i>±3 ° from horizontal</i>
Materials	<i>Hard anodised aluminium case Gold plated contacts O-ring seals throughout</i>
Case diameter	<i>154 mm</i>
Case height (with handle)	<i>207 mm</i>
Weight	<i>2.49 kg</i>
Power supply	<i>10 – 36 V DC</i>
Optional low power sensor	<i>5 V DC supply (output ±4.5 V)</i>
Current at 12 V DC	<i>38 mA</i>
Calibration controls	<i>Common signal &amp; enable lines exposed on sensor connector</i>
Offset zeroing	<i>Adjustable through case</i>
Optional remote control	<i>Offset zeroing with DC motors</i>
Optional accessories	<i>Handheld Control Unit</i>

# CMG-5T



## Strong motion feedback accelerometer

The Guralp CMG-5T is a three-axis strong motion force feedback accelerometer with a large dynamic range, suitable for seismology, hazard mitigation and civil engineering applications.

The standard 5T includes an amplifying filter which provides additional output lines at a nominal gain of  $\times 10$ . An instrument ordered with 2 g full-scale sensitivity will, therefore, have both 2 g and 0.2 g outputs. As an option, the high-gain outputs can be replaced with high-pass filtered outputs with a corner frequency to your specification.

### Key Features:

- Low-noise components for high precision and extended dynamic range
- Full-scale sensitivity from 0.1 to 4.0 g
- Additional high gain outputs or optional high-pass filter
- Low pass corner from 50 to 100 Hz
- Simple installation with a single fixing bolt
- No sensor levelling required
- Isolated power supply for 10 – 36 V operation
- Robust and waterproof



# Specifications



## CMG-5T



The CMG-5T accelerometer is supplied with a double-ring mounting system incorporating levelling screws, allowing the instrument to be attached with a single bolt to any suitable surface that is within  $\pm 5^\circ$  of the horizontal.

The CMG-5T is particularly suited to in situ structural analysis applications. Using CMG-5T sensors connected to a CMG-DM24S12 digitiser system, experiments are easy to set up with minimal disruption to working buildings. For example, signals from CMG-5T instruments distributed throughout a building can be compared in real time with earth movements

Standard acceleration output band	<i>DC – 100 Hz</i>
Output sensitivity	<i>4 g, 2 g, 1 g, 0.5 g or 0.1 g</i>
Corresponding high gain outputs	<i>0.4 g, 0.2 g, 0.1 g 0.05 g or 0.01 g</i>
Peak output	<i><math>\pm 10</math> V differential</i>
Nominal output impedance	<i>47 <math>\Omega</math></i>
Lowest spurious resonance	<i>&gt; 450 Hz</i>
Linearity	<i>0.1 % full scale</i>
Cross-axis rejection	<i>0.001 g/g</i>
Dynamic range	<i>&gt; 165 dB &gt; 140 dB for 0.005 – 0.05 Hz; &gt; 127 dB for 3 – 30 Hz (see plot)</i>
Operating temperature	<i>–20 to +70 °C</i>
Materials	<i>Hard anodized aluminium case Mil-spec connectors</i>
Case diameter	<i>176 mm</i>
Case height (with feet / handle)	<i>97 mm</i>
Case height (sensor only)	<i>83 mm</i>
Weight	<i>2.7 kg</i>
Isolating power supply	<i>10 – 36 V DC</i>
Current at 12 V DC	<i>9 mA</i>
Calibration controls	<i>Independent signal &amp; enable lines exposed on sensor connector</i>
Optional output controls	<i>Remote offset zeroing</i>
Optional low pass corner	<i>50, 100 or 200 Hz</i>

# CMG-5U



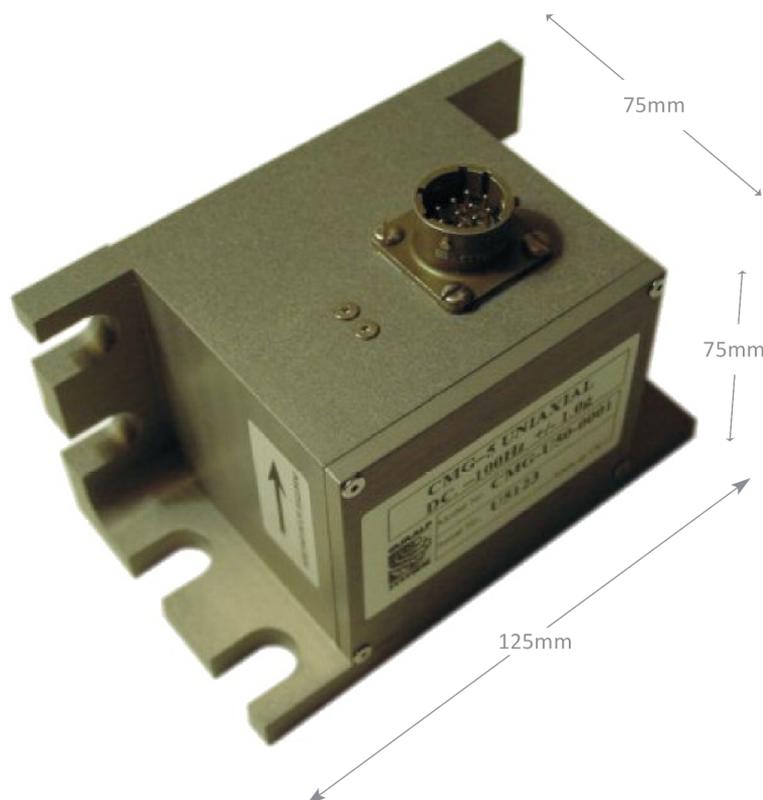
## Single axis feedback accelerometer

The CMG-5U is an ultra-compact strong motion force feedback accelerometer with a large dynamic range, suitable for hazard mitigation, modal analysis and civil engineering applications.

The small size of the 5U accelerometer means that it is particularly suited to in situ structural analysis applications. Using 5U sensors connected to a CMG-DM24S12 digitiser system, experiments are easy to set up with minimal disruption to working buildings. For example, signals from 5U instruments distributed throughout a building can be compared in real time with earth movements measured using a buried 5TD sensor.

### Key Features:

- Low-noise components for extra precision and higher dynamic range (greater than 140 dB)
- Install to any surface, horizontal or vertical, with no mechanical adjustment required
- Full-scale sensitivity from 0.1 to 2.0 g
- Additional high-gain outputs or optional high-pass filter
- Operates directly from 12 V DC
- Detailed calibration information provided with every instrument
- Output offsets adjustable to within < 1 mV without exposing the sensor internal components
- Optional low-pass filter with 50, 100 or 200 Hertz corner frequency



# Specifications

CMG-5U



Full-scale, low-gain sensitivity is available from 4.0g down to 0.1g. The standard frequency pass band is flat to acceleration from DC to 100 Hz (although other low-pass corners from 50 Hz to 100 Hz can be ordered). A high frequency option provides flat acceleration from DC to 200 Hz.

Low gain output options	<i>2g, 1g, 0.5g, 0.1g</i>
Corresponding high gain outputs	<i>0.2g, 0.1g, 0.05g, 0.01g</i>
Dynamic range at 2 g	<i>standard</i>
Dynamic range, 0.005 – 0.05 Hz	<i>&lt; 140 dB</i>
Dynamic range, 3 – 30 Hz	<i>&lt; 127 dB</i>
Standard frequency band	<i>DC – 100 Hz (–3dB point)</i>
Optional low-pass corner	<i>50, 100 or 200 Hz</i>
Linearity	<i>0.1 % of full scale</i>
Cross-axis rejection	<i>0.001g / g</i>
Open-loop response	<i>pin on connector</i>
Closed-loop response	<i>pin on connector</i>
Step function response	<i>may be added to open- and closed-loop calibrations</i>
Lowest spurious resonance	<i>450 Hz</i>
Operating temperature range	<i>–20 to +70 °C</i>
Pressure jacket material	<i>hard anodised aluminium</i>
Power / signal connector	<i>Mil-spec connector on sensor housing (02E-14-19P)</i>
Dimensions	<i>75 × 75 × 125 mm</i>
Weight	<i>908 g</i>
Current at 12 V DC	<i>8 mA</i>

# CMG-5T Compact



## Strong motion feedback accelerometer

The new CMG-5T is Guralp Systems' smallest ever triaxial instrument: a low-noise force feedback accelerometer with a large dynamic range, suitable for seismology, hazard mitigation and civil engineering applications.

### Filter options:

The 5T has two sets of outputs. The standard instrument provides both unity gain and 10 × gain outputs. As an alternative to the 10x gain outputs, a high-pass filter can be installed with a corner frequency set to the customer's specification.

### Key Features:

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Low-noise components for extra precision and enhanced dynamic range

50% smaller footprint than the original CMG-5T

Full-scale sensitivity from 0.1 to 4.0 g

Low-pass corner from 50 to 200 Hz

Simple installation with a single M8 fixing bolt; robust and waterproof

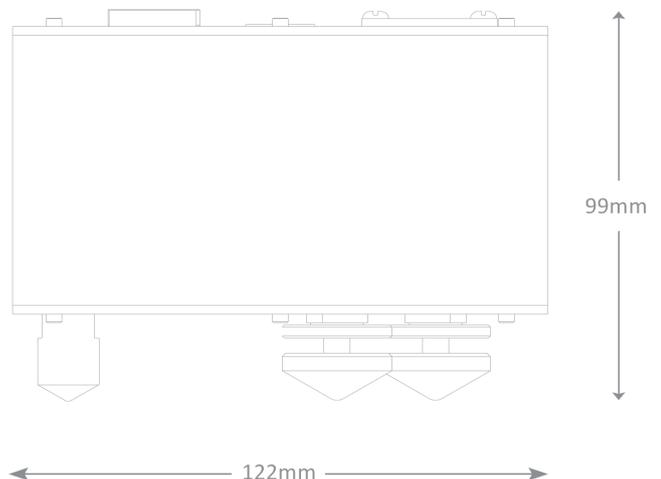
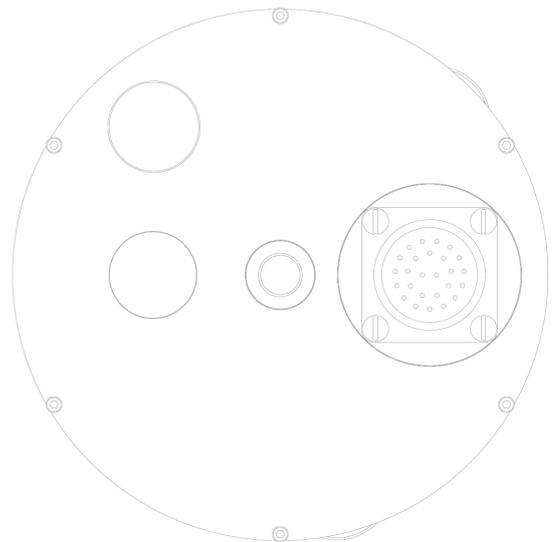
No sensor levelling required

Isolated power supply for 10 – 36 V operation

Acceleration offsets adjustable to <1 mV precision

Connector compatible with CMG-3T and 40T; breakout box identical to original 5T

Automatic open-loop calibration with built-in timer



# Specifications

## CMG-5T Compact



Standard acceleration output band	<i>DC – 100 Hz</i>
Optional low pass corner	<i>50, 100 or 200 Hz</i>
Output sensitivity	<i>4 g, 2 g, 1 g, 0.5 g or 0.1 g</i>
Corresponding high gain outputs	<i>0.4 g, 0.2 g, 0.1 g 0.05 g or 0.01 g</i>
Clip level (4 g)	<i>4.2 g</i>
Peak output	<i>±10 V differential</i>
Nominal output impedance	<i>47 Ω</i>
Lowest spurious resonance	<i>&gt; 450 Hz</i>
Linearity	<i>0.1 % full scale</i>
Cross-axis rejection	<i>0.001 g/g</i>
Dynamic range	<i>&gt; 165 dB &gt; 145 dB for 0.005 – 0.05 Hz; &gt; 127 dB for 3 – 30 Hz</i>
Operating temperature	<i>–20 to +70 °C</i>
Materials	<i>Hard anodized aluminium case with mil-spec connectors</i>
Calibration controls	<i>Signal and enable lines Built-in, timer-activated, open-loop calibration</i>
Case diameter	<i>122 mm</i>
Case height (with feet and ports)	<i>99 mm</i>
Case height (sensor only)	<i>66 mm</i>
Weight	<i>1.3 kg</i>
Isolating power supply	<i>10 – 36 V DC</i>
Current at 12 V DC	<i>41 mA</i>
Power consumption at 12 V DC	<i>0.50 W</i>
Three-way power option:	
Current at ±12 V DC	<i>±15 mA</i>
Power consumption at ±12 V DC	<i>0.36 W</i>



# GURALP SYSTEMS

## CMG-55T

triaxial strong motion accelerometer

The CMG-55T is an extremely compact, robust accelerometer based on MEMS technology, suitable for civil engineering, hazard mitigation and structure monitoring applications.



### Features

Three axes of acceleration with high dynamic range

Compact, hard anodized aluminium case

Full-scale sensitivity from 2 to 10 g

High frequency corner from 200 to 1000 Hz

Highly robust, with no moving parts

Response to DC as standard; optional high-pass filter option with user-specified corner frequency

Isolated power supply for 10 – 36 V operation

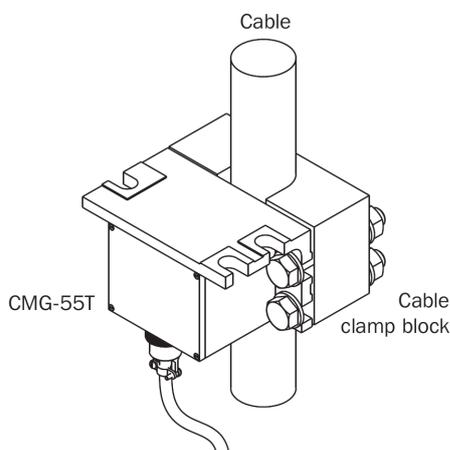
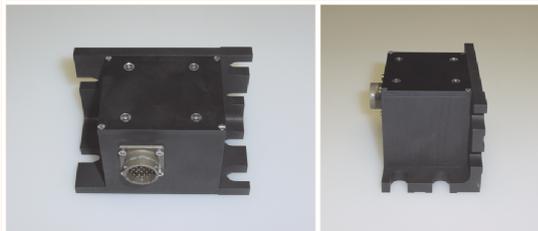
19-way mil-spec connector compatible with original 5T

Cables provided for connection to all Guralp Systems digitizers

Combine with Guralp Systems feedback accelerometers for high-density, high performance arrays

Simple installation with fixing bolts; two mounting orientations provided

Clamps available for secure attachment to cables or rods of any diameter



# Specifications

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Output sensitivity	10 g, 5 g, 2 g
Acceleration output low corner	DC
Acceleration output high corner	2 g: 200, 400 Hz 5 g: 200, 400, 600 Hz 10 g: 200, 400, 600, 1000 Hz
Peak output	±10 V differential
Maximum shock	2000 g (1 ms)
Nominal output impedance	47 Ω
Lowest spurious resonance	> 1000 Hz
Nonlinearity	0.5 % full scale
Cross-axis rejection	0.02 g/g
Dynamic range	105 dB
Noise level	2 μg Hz <sup>-1/2</sup>
Operating temperature	-55 to +85 °C
Temperature shift	300 ppm / °C
Materials	Hard anodized aluminium case Mil-spec connector
Case depth/height	51 mm (square cross-section)
Case width	76 mm
Weight	0.8 kg
Isolating power supply	10 – 36 V DC
Current at 12 V DC	60 mA
Power consumption at 12 V DC	0.72 W

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# CMG-54T



## Triaxial strong motion accelerometer

The Guralp Systems CMG-54T is an extremely compact, robust accelerometer based on MEMS technology, suitable for civil engineering, hazard mitigation and structure monitoring applications.

### Key Features:

Three axes of acceleration with high dynamic range

Compact, hard anodized aluminium case

Full-scale sensitivity from 2 g to 6 g

282Hz high frequency corner

Highly robust, with no moving parts

Response to DC as standard

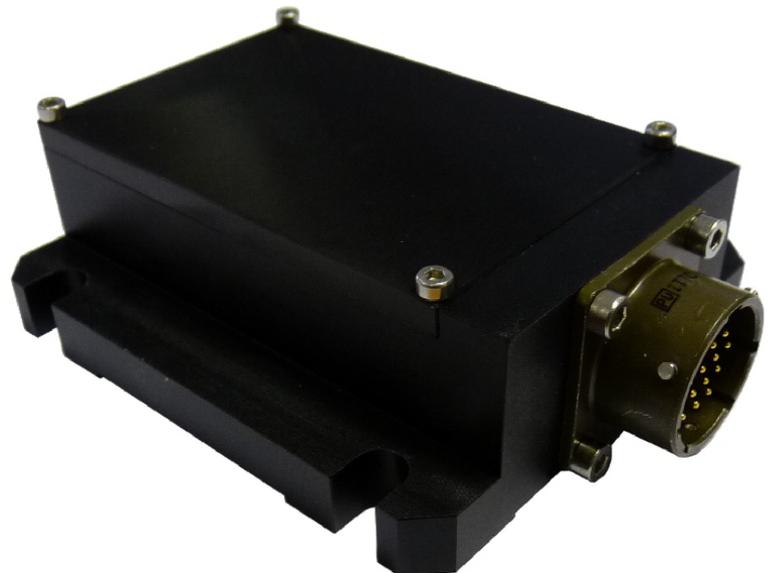
19-way mil-spec connector

Cables provided for connection to all Guralp Systems digitizers

Combine with Guralp Systems feedback accelerometers for high-density, high performance arrays

Simple installation - bolts directly to any flat surface

Clamps available for secure attachment to cables or rods of any diameter



# Specifications

CMG-54T



Output sensitivity	$\pm 2g$ to $\pm 6g$
Acceleration output low corner	DC
Acceleration output high corner	100 to 1000Hz
Peak output	0-5V single ended (separate reference voltage)
Maximum shock	10 000g
Nominal output impedance	47 $\Omega$
Lowest spurious resonance	> 1000Hz
Nonlinearity	0.5 % full scale
Cross-axis rejection	0.02 g/g (or $\pm 2\%$ )
Dynamic range	3 to 30Hz Vertical: 72dB Horizontal: 76dB
Noise level	Vertical: 17 $\mu\text{g}/\text{Hz}^{1/2}$ Horizontal: 11 $\mu\text{g}/\text{Hz}^{1/2}$
Operating temperature	-40 to +85 °C
Temperature shift	100 ppm / °C
Materials	Hard anodized aluminium case Mil-spec connector
Case depth/height	102.5mm
Case width	80mm
Case depth	33mm
Weight	< 0.5kg
Power supply	7 – 14VDC
Current at 12 V DC	7.5mA
Power consumption at 12 V DC	90mW

# CMG-3TB



## Broadband borehole seismometer

Güralp Systems' CMG-3TB weak-motion broadband seismometer and 5TB strong-motion accelerometer can be supplied in a single package. The CMG-3T/5T (89mm OD) is available for boreholes up to 229mm in diameter using either single-jaw or three-jaw hole lock units.

Güralp analogue borehole instruments can be combined with CMG-DM24 borehole digitizers and EAM borehole data modules. Using these, you can build a fully networked, authenticating digital instrument inside a single borehole.

If a downhole digitizer is not utilised, the instrument is supplied with a strain relief mechanism to physically decouple the sensors from any vibrations in the load-bearing cable.

### Key Features:

Flat velocity output from 360s (0.0027 Hz) to 50Hz

120s, 60s and 1s long period options (120s standard)  
100Hz HF corner option (50Hz standard)

Hybrid response option—sensitivity at low frequency for teleseisms combined with high clip threshold at high frequency for local events

Single- or three-jaw hole lock for 89 – 229 mm diameter boreholes, or backfill with sand to minimise convection

Waterproof and durable with 'O'-ring seals throughout

Built-in inclinometer option for attitude checking

Optional levelling gimbals extend tilt tolerance from  $\pm 3^\circ$  to  $\pm 10^\circ$

Optional rotational mounts for horizontal components allows true alignment

Optional "Bishop's Hat" alignment mechanism

Also available with 3ESP or 40T components for a cost-effective borehole sensor

**The flexible, modular design offers a huge range of installation possibilities. For a full assessment of your options, please contact Güralp Systems, quoting the exact dimensions of your borehole and any special requirements.**



# Specifications

CMG-3TB



Velocity output bandwidth	<i>120 s – 50 Hz standard. (Also available with 30, 60, 100 or 360 second corner frequencies, or with a hybrid response.)</i>
Optional low pass corner	<i>50 Hz, 100 Hz or 200 Hz</i>
Mass position output	<i>DC – 120 s</i>
Output sensitivity	<i>2000 V/ms<sup>-1</sup> (Optional sensitivity from 2 × 750 V/ms<sup>-1</sup> to 2 × 10kV/ms<sup>-1</sup>)</i>
Peak output	<i>±20 V peak to peak</i>
Lowest spurious resonance	<i>&gt; 140 Hz</i>
Linearity, vertical (USGS)	<i>&gt; 111 dB</i>
Linearity, horizontal (USGS)	<i>&gt; 107 dB</i>
Cross-axis rejection	<i>&gt; 62 dB</i>
Self Noise	<i>&gt;200s (0.005Hz) to 20Hz (vertical)</i>
Remote control	<i>Lock, unlock, centre</i>
Operating temperature	<i>–25 to +75 °C (–55 °C Polar Version available)</i>
Temperature sensitivity	<i>&lt; 0.6 V per 10 °C</i>
Mass recentring range	<i>±10 ° from horizontal Hard anodised aluminium case</i>
Materials	<i>Gold plated contacts O-ring seals throughout 89 – 229 mm</i>
Borehole diameter	<i>1422 mm (single-jaw hole lock)</i>
Case height (with lifting loop)	<i>1354 mm (three-jaw hole lock)</i>
Power supply	<i>11 – 30 V DC (24V DC recommended) 5 V DC supply (output ±4.5 V)</i>
Optional low power sensor Current at 12 V DC	<i>95 mA</i>
Calibration controls	<i>Common signal &amp; enable lines exposed on sensor connector</i>
Optional hole-lock mechanism	<i>Spring-loaded jaw with passive skids or studs (&gt;60 kg force)</i>

# CMG-5TB



## Borehole accelerometer

The Guralp Systems CMG-5TB accelerometer is a low-noise triaxial force-feedback instrument, equivalent to the CMG-5T vault accelerometer, designed for strong-motion borehole studies..

### Key Features:

Flat acceleration output from DC top 100Hz (200Hz optional)

76mm outer diameter

Optional single-jaw lock for boreholes of 82-178mm diameter

Waterproof and durable with 'O' ring seals fitted.

Suitable for installation with sand backfill to minimise convection

Dual output (high and low gain) and optional high/low pass filters

Optional electronic compass module to determine downhole attitude

Remote DC offset zeroing

Guralp analogue borehole instruments can be combined with CMG-DM24 borehole digitizers and DCM/AM borehole data modules. Using these you can build a fully networked, authenticating digital instrument inside a single borehole.

If a downhole digitizer is not present the instrument is supplied with a strain relief mechanism to isolate the sensors from motions in the load bearing cable.

Guralp Systems can provide tripods winches and other equipment designed specifically for borehole installations. We also offer civil works, installation and seismic station operation services.



# Specifications

CMG-5TB



Acceleration output bandwidth	<i>DC - 100 Hz</i>
Dynamic range	<i>156 Db</i>
Dynamic range 20 - 200 s	<i>140 Db</i>
Dynamic range 3 - 30 Hz	<i>127 Db</i>
Output sensitivity	<i>0.1 - 4g</i>
Peak output	<i>±10 V differential</i>
Output options	<i>2 g + 0.2 g, 1 g + 0.1 g, 0.5 g + 0.05 g, 0.1 g + 0.01 g</i> <i>50 Hz, 100 Hz or 200 Hz</i>
Lowest spurious resonance	<i>&gt; 400 Hz</i>
Linearity, vertical (USGS)	<i>&gt; 77 dB</i>
Linearity, horizontal (USGS)	<i>&gt; 66 dB</i>
Cross-axis rejection	<i>0.001 g / g</i>
Remote control	<i>DC offset zero</i>
Operating temperature	<i>-20 to +65 °C (-55 °C optional )</i>
Temperature sensitivity	<i>&lt; 0.6 V per 10 °C</i>
Materials	<i>Hard anodised aluminium case</i> <i>Gold plated contacts</i> <i>O-ring seals throughout</i>
Borehole diameter	<i>82 – 120 mm</i>
Install depth	<i>to 250 m (other options available)</i>
Case height (with lifting loop)	<i>431 mm</i>
Power supply	<i>11 – 30 V DC</i>
Current at 12 V DC	<i>24 mA</i>
Calibration controls	<i>Common signal &amp; enable lines exposed on sensor connector</i>
Hole-lock mechanism	<i>Spring-loaded jaw with passive skids or studs (&gt;60 kg force)</i>
Optional low pass corner	<i>50 Hz, 100 Hz or 200 Hz</i>

# CMG-3T/5T Borehole



## Complete borehole seismic station

Güralp Systems' CMG-3TB weak-motion broadband seismometer and 5TB strong-motion accelerometer can be supplied in a single package. The CMG-3T/5T (89mm OD) is available for boreholes up to 229mm in diameter using either single-jaw or three-jaw hole lock units.

### Key Features:

Total realised dynamic range of over 200 dB

Exceptionally low noise floor

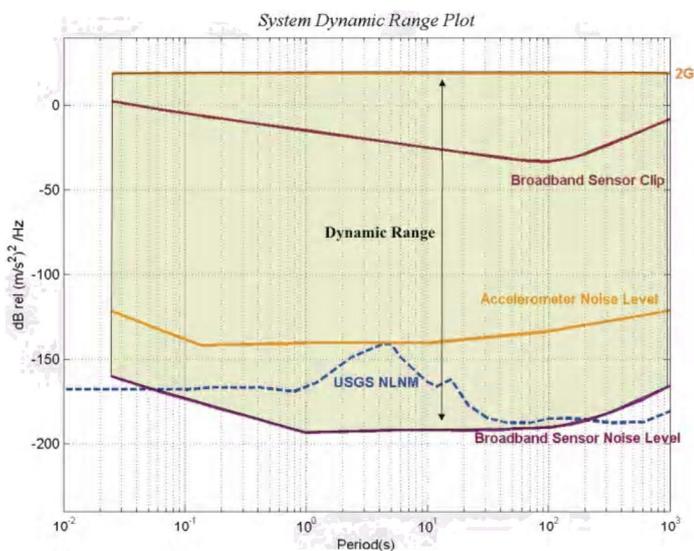
89mm diameter x 1480mm high (excluding connector)

Hole lock units with cable pass-through available, allowing installation in boreholes already containing an instrument

Optional down-hole digitiser

Optional down-hole data acquisition module

Strain relief mechanism fully isolates the sensors from any motions in the load-bearing cable



# Specifications

CMG-3T/5T



	<i>3T Sensor</i>	<i>5T Sensor</i>
Velocity output bandwidth	<i>120 s* – 50 Hz</i>	
Acceleration output bandwidth		<i>DC – 100 Hz</i>
Output sensitivity	<i>2 x 10,000 V/ms<sup>-1</sup></i>	<i>0.1 – 4 g</i>
Peak output	<i>±10 V differential</i>	<i>±10 V differential</i>
Lowest spurious resonance	<i>&gt; 140 Hz</i>	<i>&gt; 400 Hz</i>
Linearity	<i>&gt; 107 dB</i>	<i>&gt; 70 dB</i>
Cross-axis rejection	<i>&gt; 62 dB</i>	<i>0.003 g/g</i>
Remote control	<i>Lock, unlock, centre</i>	<i>Offset zeroing</i>
Operating temperature	<i>–20 to +65 °C (–55 °C optional)</i>	
Temperature sensitivity	<i>&lt; 0.6 V per 10 °C</i>	
Mass recentring range	<i>±12 ° from horizontal</i>	
Materials	<i>Stainless Steel case Gold plated contacts O-ring seals throughout</i>	
Sensor diameter	<i>89 mm</i>	
Case height	<i>1480 mm (excluding connector)</i>	
Power supply	<i>11 – 30 V DC (24V DC recommended)</i>	
Optional low power sensor	<i>5 V DC supply (output ±4.5 V)</i>	
Current at 12 V DC	<i>165 mA</i>	
Calibration controls	<i>Common signal &amp; enable lines exposed on sensor connector</i>	
Hole lock mechanism	<i>Spring-loaded jaw with passive skids or studs (&gt;60 kg force)</i>	
Optional low pass corner	<i>50 Hz, 100 Hz or 200 Hz</i>	

# CMG-40T-B



## Borehole seismometer

The Guralp Systems CMG-40T borehole seismometer uses the CMG-40T transducers stacked vertically in a waterproof 3.5-inch (89mm) outside diameter stainless steel sonde.

The sonde can be installed easily in 4-inch or larger steel-cased holes. The velocity response can be flat from 60s to 100 Hz, and the output sensitivity is 2x1200 V/m/s.

Response options include 0.033Hz (30s), 0.1Hz (10s) and 0.5 Hz (2s) to 100 Hz. Output sensitivity options range from 2x1000 V/m/s up to and including 2x10000 V/m/s.

### Key Features:

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Levelling from +/- 8 degrees

3 Jaw holelock option

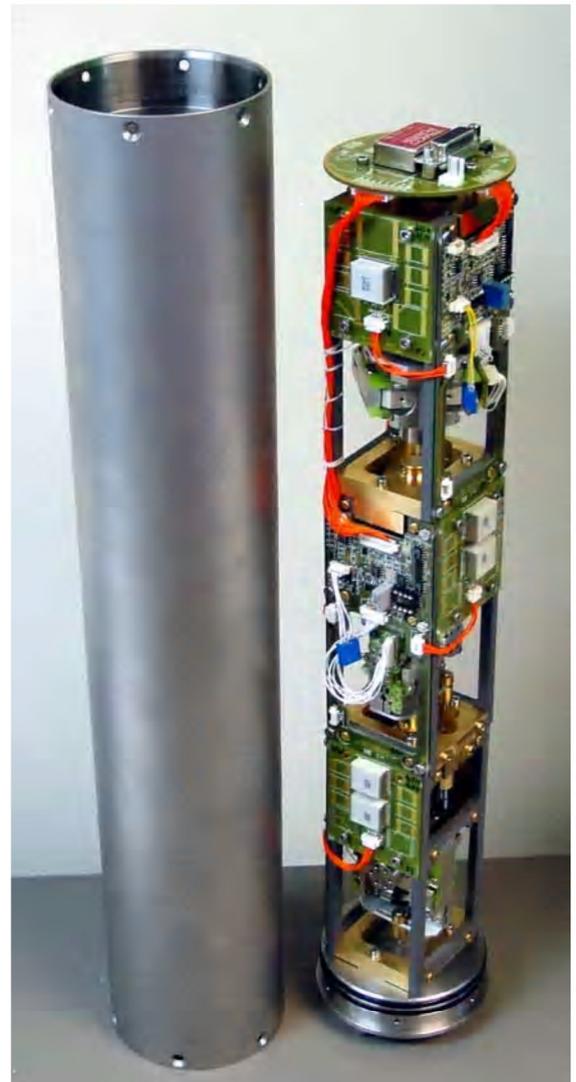
60s, 30s, 10s, 2s and 1s LP corner options

50Hz to 100Hz High frequency options

Greater than 136 dB dynamic range at 1 Hz

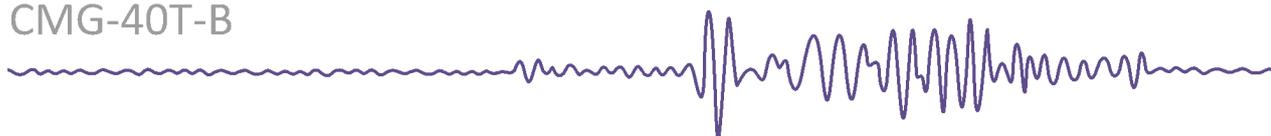
High Linearity

Orthogonal design giving >- 65 dB cross axis rejection



# Specifications

CMG-40T-B



Velocity output bandwidth	<i>30 s* - 100 Hz</i>
Acceleration output bandwidth	<i>-</i>
Mass position output	<i>DC -30 s*</i>
Velocity sensitivity	<i>2 x 1200 V/m/s*</i>
Lowest spurious resonance	<i>&gt; 200 Hz</i>
Linearity, vertical	<i>&gt; 91 dB</i>
Linearity, horizontal (USGS)	<i>&gt; 91 dB</i>
Cross-axis rejection	<i>&gt; 65 dB</i>
Standard low pass corne	<i>100 Hz</i>
Self Noiser	<i>Below USGS NLNM &gt;8s to 5Hz</i>
Levelling	<i>+/- 8 degrees</i>
Storage temperature	<i>-60 to +75 °C</i>
Operating temperature	<i>-20 to +65 °C</i> <i>(-55 °C optional: low temperature testing facilities available)</i>
Power supply	<i>10 - 36 V DC</i>
Current at 12 V DC	<i>65 mA</i>
Hole lock mechanism	<i>Spring-loaded 3 jaw skids or studs (&gt;60kg force)</i>
Borehole diameter	<i>89 - 229 mm</i>
Calibration controls	<i>Open- and closed-loop response</i>
External inputs	<i>Sine, step or pseudo-random</i>
Optional low pass corner	<i>50 Hz, 100 Hz or 200 Hz</i>

# CMG-FLUTE



## Ultra-slimline borehole broadband seismometer



The Guralp Flute sensor is a slimline, three-component borehole seismometer ideally suited for rapid installation in medium-noise sites. The sensor has an outer diameter of just 51mm. The Sensor is available with an optional, single-jaw holelock and the unit also comes with Guralp Systems 1500 PSI water-proof connector for installation into wet holes.

### Key Features:

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51mm outer diameter

True broadband, three-component, force-feedback instrument

Direct velocity outputs

Lightweight, waterproof and self-contained

No mass clamping required – plug in and go

High sensitivity and dynamic range (>135 dB)

Orthogonal instrument with high cross-axis rejection (>65 dB)

Single jaw holelock option

The Flute can be supplied with response options of 1s, 10s, 30s, 60s\* or 120s for the long period and 50Hz, 100Hz\* or 200Hz for the short period (\* standard)

Optional Smart Sensor interface (IEEE 1451.4 TEDS Compliant)

The sensor response is completely flat and linear across the entire passband. Its high-gain feedback loop eliminates mechanical non-linearity (overall measured linearity exceeding 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 sensor is a barely measurable resonance at 440 Hz.



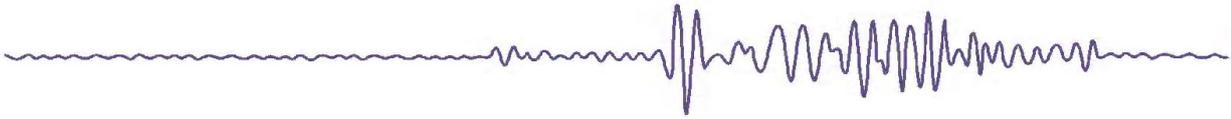
# Specifications

## CMG-FLUTE

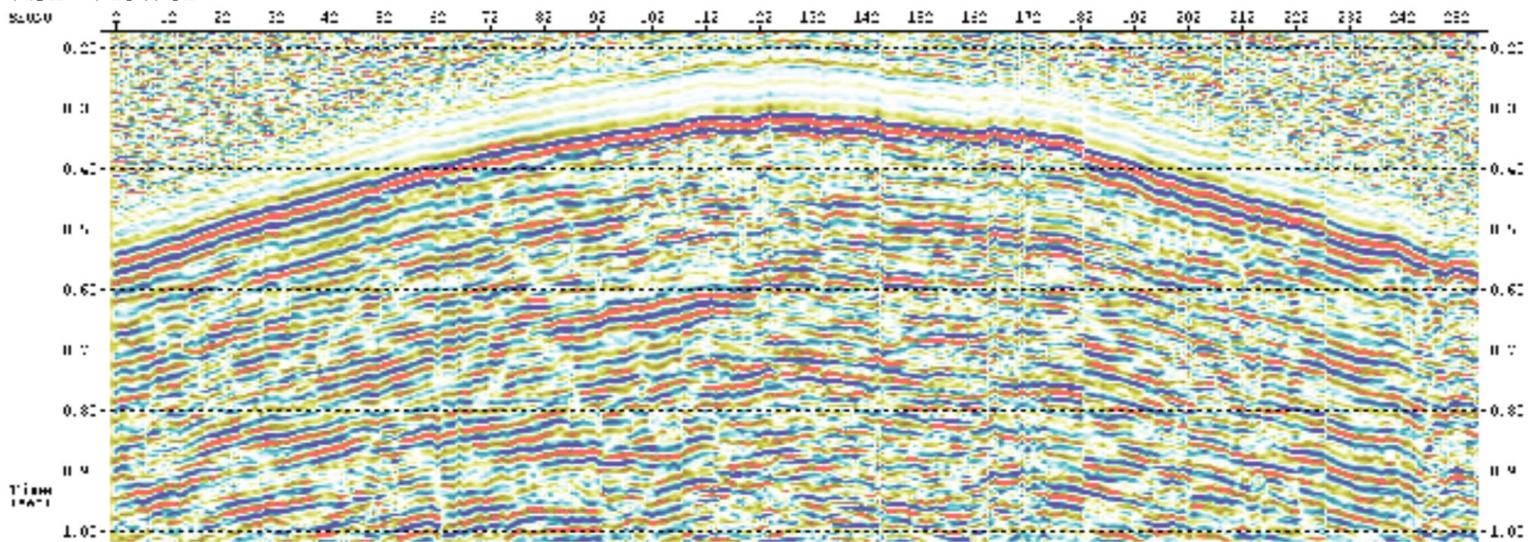


Velocity output bandwidth	<i>60 seconds – 100 Hertz (Standard), Long-period options: 1, 10, 30, 40 or 120 seconds Short-period options: 50 or 200 Hertz</i>
Velocity output sensitivity	<i>2 × 1200 V/ms<sup>-1</sup>, (Standard) 2 × 2000 V/ms<sup>-1</sup> or 2 × 4000 V/ms<sup>-1</sup></i>
Peak output	<i>±10 Volts (20 Volts peak-to-peak)</i>
Optional high gain sensitivity	<i>2 × 10000 V/ms<sup>-1</sup> (adjustable)</i>
Lowest spurious resonance	<i>450 Hertz</i>
Linearity	<i>&gt; 95 dB</i>
Cross-axis rejection	<i>&gt; 65 dB</i>
Electronics noise level	<i>−172 dB (rel. 1m2s-4Hz-1)</i>
Operating temperature range	<i>−30 to +60 °C</i>
Temperature sensitivity	<i>&lt; 0.6 Volts per 10 °C</i>
Mass recentring range	<i>±12 ° from horizontal</i>
Materials	<i>Hard anodised aluminium case Gold plated contacts O-ring seals throughout</i>
Case diameter	<i>51 mm</i>
Length, including connector	<i>690 mm</i>
Power supply	<i>10 – 28 Volts DC</i>
Optional low power sensor	<i>5 Volts DC supply (output ±4.5 Volts)</i>
Current at 12 V DC	<i>@40 mA</i>
Calibration controls	<i>Common signal &amp; enable lines exposed on sensor connector</i>
Offset zeroing	<i>Adjustable through case</i>
Optional accessories	<i>Handheld Control Unit</i>

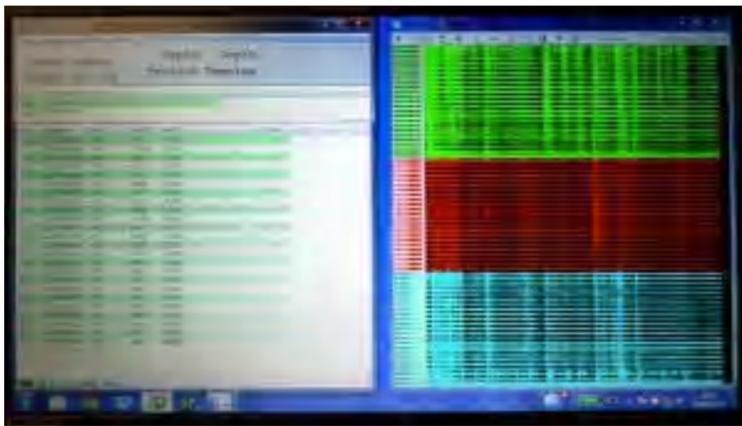
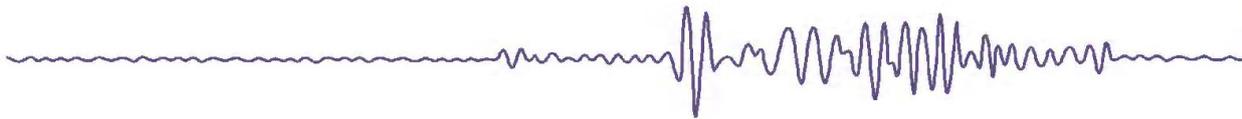
# CMG-SADI



VSP Viewer



# CMG-SADI



This new borehole tool has several major advantages over the classic VSP technology:

- The newly developed miniature broadband sensors have a flat frequency response to acceleration between 5 sec and up to 2000 Hz
- The downhole digitization allows for a much higher dynamic range and a fundamental reduction in signal distorting noise
- It also allows for operation in a highly sensitive trigger mode
- The tool can be used in hot environments, as the sensors can operate with nominal performance specs in temperatures of up to 125 degrees Celsius
- The length of the tool and the spacing between its elements can be easily varied just by changing the length of the cables between each element.
- The system is versatile, as it can be used in wellbores on land or offshore. We can guarantee nominal performance in water pressure of up to 2000 m.
- We have also developed a winch system, which is designed to control the operation of the downhole tool.



## Portable Freefall OBS



obs-floating

### Key features

- Rigid HDPE cradles containing glass spheres and the sensor. The spheres contain the batteries, a digitiser, storage media and other electronics.
- Sacrificial concrete weights jetisoned on receipt of an acoustic signal when the sensor is to be recovered.
- Acoustic transponder system is used to obtain an accurate location for the sensor when deployed.
- GPS receiver, AIS radio broadcast and strobe aid location for recovery
- Can be supplied with a range of sensors, including the CMG-6TC OBS, a true triaxial, broadband, force-feedback seismometer mounted on dual, gravity-driven, microprocessor-controlled, electrically-braked gimbals. Other transducers, such as pressure gauges and hydrophones can be incorporated



## Cabled OBS



cabled-obs

## Key features

- Rugged sensors in direct contact with ocean bottom.
- Concrete dome to push sensor into mud on ocean floor and protect against: noise due to current, fluctuations, fish trawlers
- Optical fibre connection to single ground station, cable lengths in excess of 60km
- Pressure tested to 6000m depth
- Cheaper and easier to install because no ROV
- Options for single node and multinode connections
- No wet mating techniques necessary
- Real time monitoring
- Additional optional sensors: hydrophone, differential pressure gauge, acoustic doppler profiler, thermometer, magnetometer for orientation, tiltmeter

# CMG-DM24



## 3 to 12 channel broadband digitisers



The Guralp Systems CMG-DM24 is a high-quality digitiser with full 24-bit resolution, designed for data quality and durability with models available for 3, 6, 9, or 12 channel recording.

### Key Features:

- 4 low-noise 24-bit ADCs (expandable to 7, 14)
- Fourth channel for user signals and calibration
- 8 environmental channels with 20-bit resolution (3 × mass position, 5 user)
- Low power 32-bit DSP and ARM processor (<1W recording 4 channels at 100 sps)
- Multiple concurrent data rates, up to 1000 sps

- STA/LTA, level, external and software triggering
- Simultaneous output of triggered and continuous streams
- Event selection and download over data port

- Full control of Guralp broadband sensors including remote lock, unlock and centre
- Calibration using on board sinewave, impulse or broadband signal generators
- Remotely configurable using Guralp data modules and software

- UTC time-stamped data using low power GPS
- Up to 8 Gb Flash storage (64 Mb standard)
- USB Flash drive memory storage option
- Optional LCD panel with status information
- Optional FireWire interface for external disk storage
- Ethernet and USB interface options
- Multiple storage and transmission modes
- Built-in modem support
- Available in surface, borehole and integrated packages or as a retro-fit to existing sensors for instant digital seismic stations



# Specifications

CMG-DM24



Signal channels	3, 6, 9, 12 @ 24 bits
Auxiliary / calibration channels	1, 1, 2, 2 @ 24 bits
Input voltage range (surface)	$\pm 10$ V ( $\pm 20$ V optional) differential
Input impedance (surface)	33 k $\Omega$ / 10 nF
Input impedance (cylindrical)	113 k $\Omega$ / 10 nF
Inputs (borehole and integrated)	matched to sensor
Environmental channels	8 @ 4 samples/s, 16-bit resolution
Environmental channel range	$\pm 10$ V single-ended
ADC converter type	5th-order single-bit low pass $\Delta$ - $\Sigma$
Output format	24-bit (32-bit low-noise option)
Dynamic range	137dB (141dB) @ 40 samples/s
Absolute accuracy	0.5% (0.1 %)
Common-mode rejection	120 dB @ 10 Hz
DSP sampling rate	32 kHz
Output rates available	1000 .. 1 samples/s
Highest output capability	3 channel: 3 $\times$ 1000 + 1 $\times$ 500 6 channel: 3 $\times$ 1000 + 4 $\times$ 500
Decimation filters	2, 4, 5, 2 $\times$ 4, 2 $\times$ 5
Anti-alias filters	3-pole
Low pass filters	FIR (other options available)
Out-of-band rejection	140 dB
In-band ripple	-140 dB
DSP trigger modes	STA/LTA, level, external, software
Timing source precision	$8 \times 10^{-7}$
Optional precision RTC	$1.7 \times 10^{-8}$ (30 mW power cost)
Calibration signal generator	Amplitude/frequency adjustable sine wave, step or broadband noise
Flash storage	64 Mb (options to 8 Gb), external flash memory stick option
Sensor control commands	Remote lock, unlock, centre
Optional smart sensor interface	SSI I2C/1-wire interface
Operating temperature	-40 to +60 $^{\circ}$ C
Power supply	10 – 28 V DC
Current at 12 V DC	3 channel: 77 mA = 0.92 W 6 channel: 120 mA = 1.44 W GPS: 35 mA = 0.42 W

# Scream!



## Seismic network monitoring software

Scream! is a freely-available software application, developed by Güralp Systems, which allows you to monitor, configure and record data from an entire seismic network.

### Key Features:

Receive data over serial or dialup links, TCP/IP, UDP/IP or other file transfer protocols, or any combination of these

Low-overhead GCF format for data transfer

Real-time conversion to miniSEED, GSE 2.0, sac, P-SEgy, SUDS, PEPP or UFF format

Display any number of incoming streams with real-time spectrogram calculation

User-friendly interface to Güralp instruments including full mass control, calibration, digitizer output configuration and triggering

Extension modules available for calibration, noise calculations and data analysis

Diagnostic tools including data integrity checks, at-a-glance GPS and mass position status, and direct access to the digitizer console

Advanced networking facilities (see over)

Windows and Linux versions



Reset All	TIMING	MASS	AGE	ERRORS	TRIGS
BH0LE-DA62	■	■	■	■	0
D0012-DT12	■	■	■	■	0
D0511-3A20	■	■	■	■	0
GURALP-3E75	■	■	■	■	0
GURALP-6TD	■	■	■	■	2
GURALP-CMG6	■	■	■	■	0
GURALP-DM24	■	■	■	■	0
GURALP-S156	■	■	■	■	0
MK3PW-DEMO	■	■	■	■	0
SENTESS-ISD1	■	■	■	■	0
SENTESS-ISD2	■	■	■	■	0
SENTESS-ISD3	■	■	■	■	0
SENTESS-ISD4	■	■	■	■	0

# Network capabilities



Scream!



Scream! includes extensive support for TCP/IP and UDP/IP networks. It is designed to be effectively network-transparent, so users can contact and configure digitizers at remote sites as easily as those directly connected to the computer.

## Networking Features:

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Full IP networking support, including multicast groups

Robust real-time network transmission protocol

Support for polling autonomous stations over dial-up links

Network summary window monitors the status of data streams, mass positions, and GPS timing for every instrument

Automated e-mail alert facility

The Scream! network protocol is supported by Earthworm's `scream2ew` and Antelope's `guralp2orb` extension modules. Both modules are part of the standard distribution.

Stand-alone Scream! network clients are also available for converting data streams into (unauthenticated) CD1.0 and SEISLOG SFS format. Contact Guralp Systems for more information.

## **CONTATTI**

La nostra azienda si propone di assisterti nella scelta e fornirti la migliore soluzione tecnica alle tue applicazioni che coinvolgono misure meccaniche. Il personale tecnico, altamente qualificato, vanta esperienza in svariati settori, con particolare attenzione alle misure meccaniche come acustica, vibrazioni, estensimetria, monitoraggi strutturali, etc... Effettuare una buona acquisizione dei dati è la prima e più importante caratteristica per una buona misura: nessuna analisi, per quanto sofisticata, potrà mai restituire risultati utili se è basata su rilievi non corretti.

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