GURALP SYSTEMS

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 Sensor is a well proven, established design since 1987.

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 ± 0.05 °
- Remote, automatic, electronic mass locking, unlocking and centring
- Adjustable feet allow for up to 5 ° of tilt
- Low power consumption (750 mW from 10 – 30V input power)
- CMG-3TD fully digital instrument available, combining the CMG-3T with our low-noise DM24 digitizer in a single package

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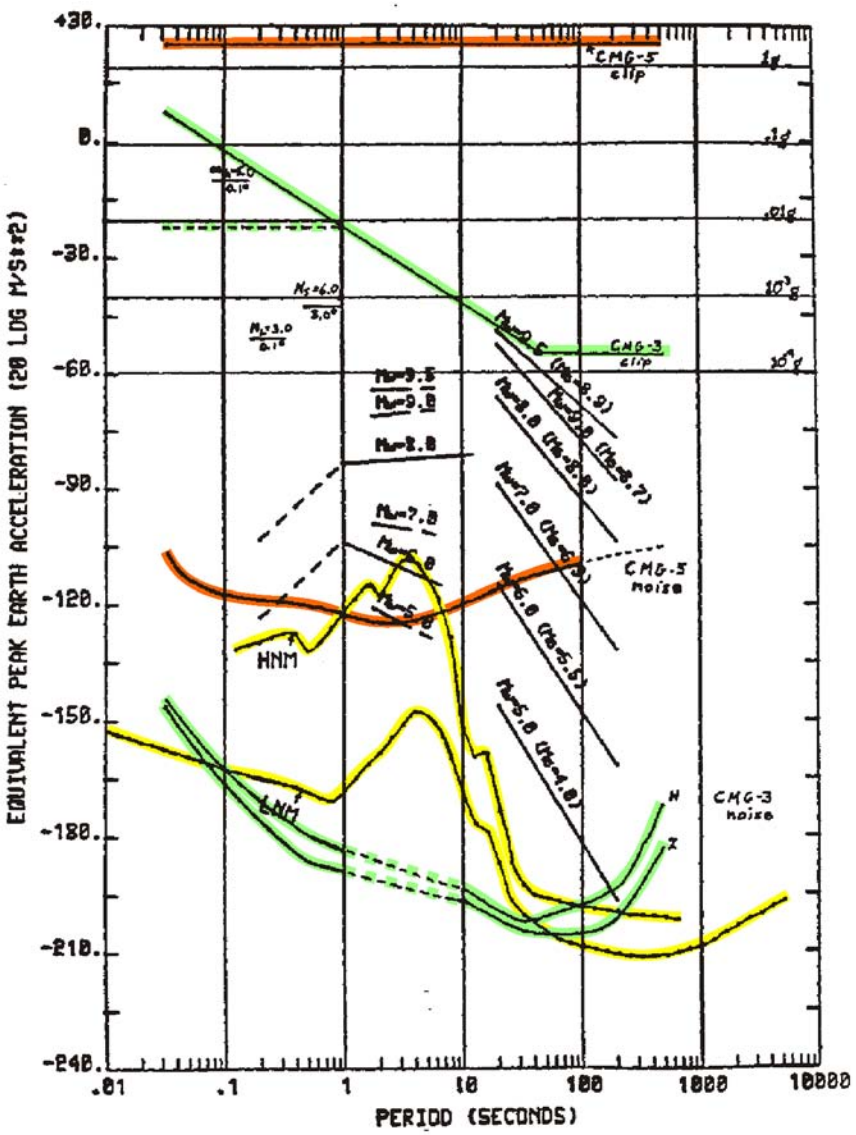
System noise and clip level

The noise equivalent input acceleration and Brownian noise of the CMG-3T is well below the background noise level encountered at the quietest site on earth. The noise level of the sensor transducer is at least 20 dB less than the Brownian noise of the instrument (set to –195 dB rel. 1 $m^2/s^4/Hz$ acceleration).



The figure describes the estimated system noise and clip level for CMG-3T (3V) weak-motion sensors and CMG-5T broadband accelerometers in terms of non-coherent power. Noise levels for the CMG-3T are shown separately for the vertical and horizontal sensors.

For reference, this graph also shows the Peterson NLNM (New Low Noise Model) and NHNM, as well as signal levels for seismic events of various magnitudes.

(Taken from *USGS Technical Summary*, US Geological Survey, 25 January 1990.)

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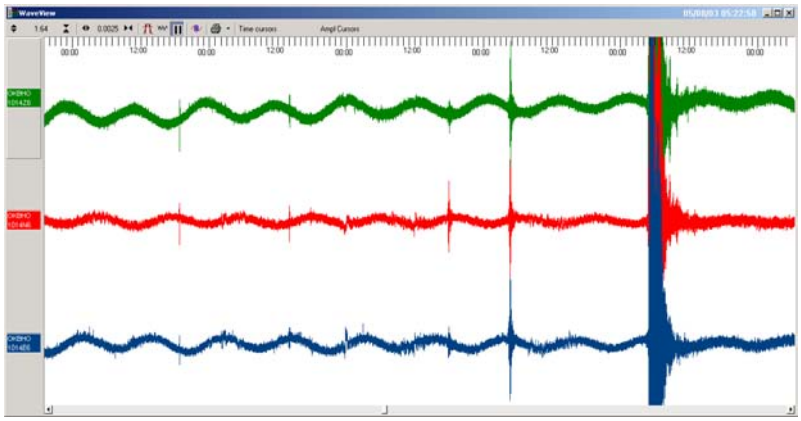
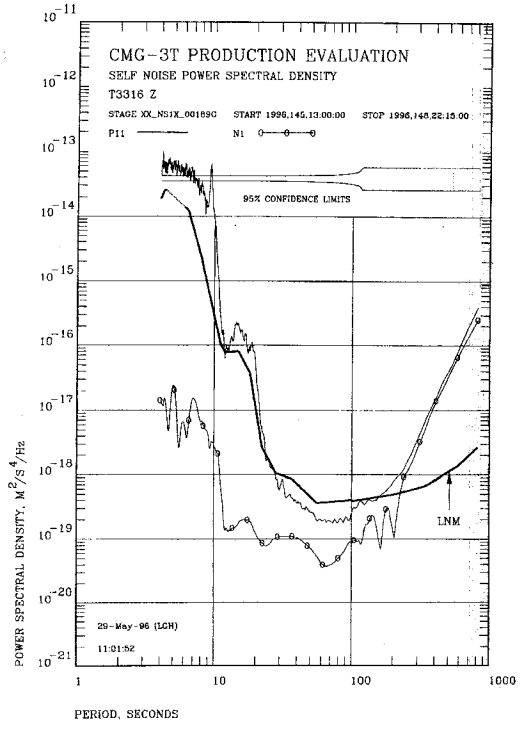
Low frequency performance

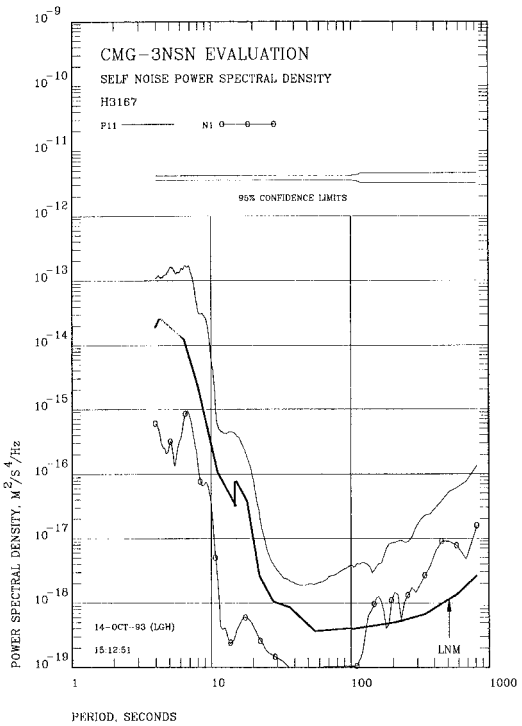


This plot shows earth tides and earth modes recorded by a 360 s CMG-3TB seismometer with 50 Hz high-frequency corner, outputting data at 1 sample/s to a downhole CMG-DM24 digitizer. The raw data has not been filtered or processed in any way.

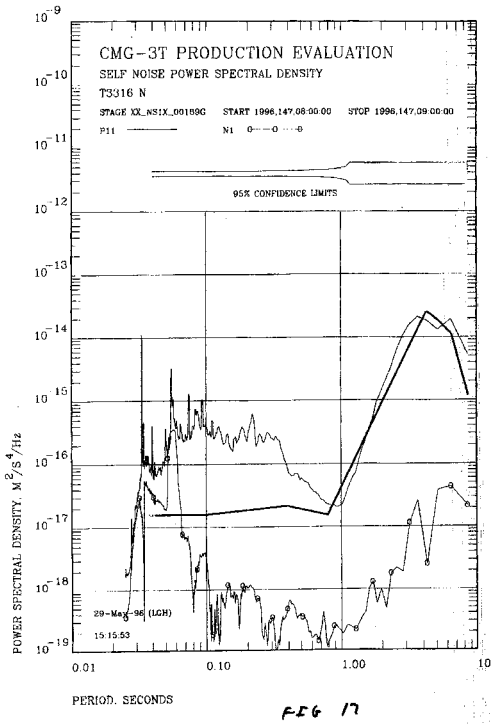
Earth modes are routinely observed at quiet stations using 3T sensors.

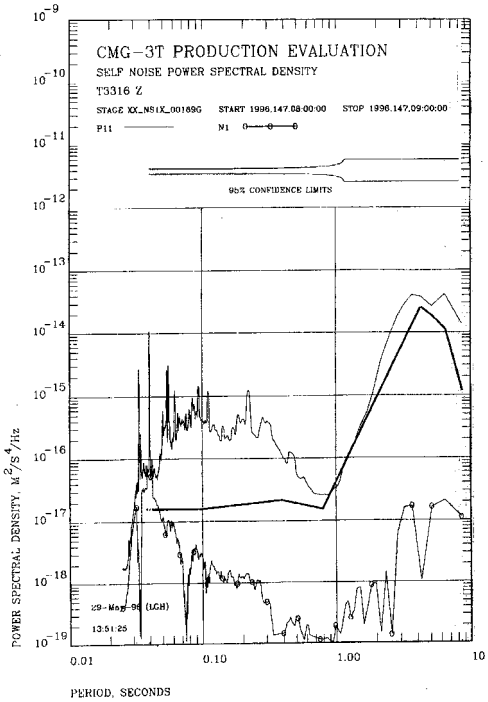
The plots below estimate the system noise power of the vertical component of the 3T conventional-response sensor (left) and the hybrid-response sensor (right) as used in the US National Seismic Network. The system noise power, corrected for system response and gain, is shown as a continuous thin line; the circled line is the raw non-coherent power spectrum. The thicker line is the NLNM.





High frequency performance





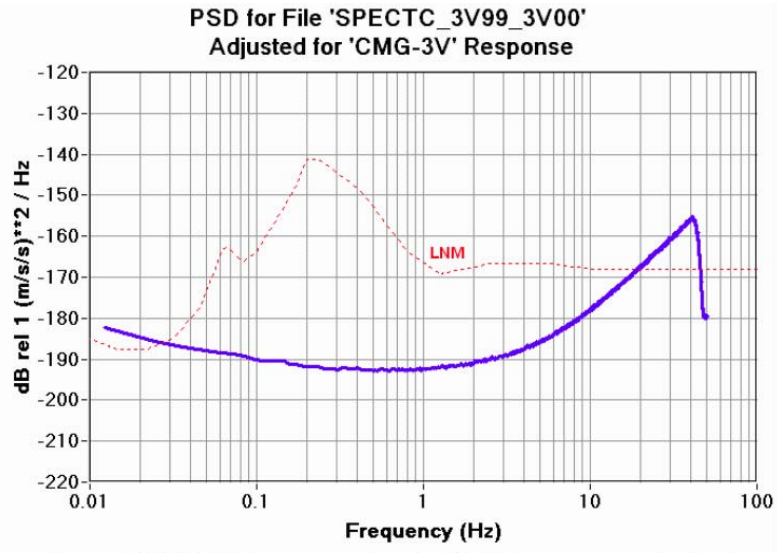
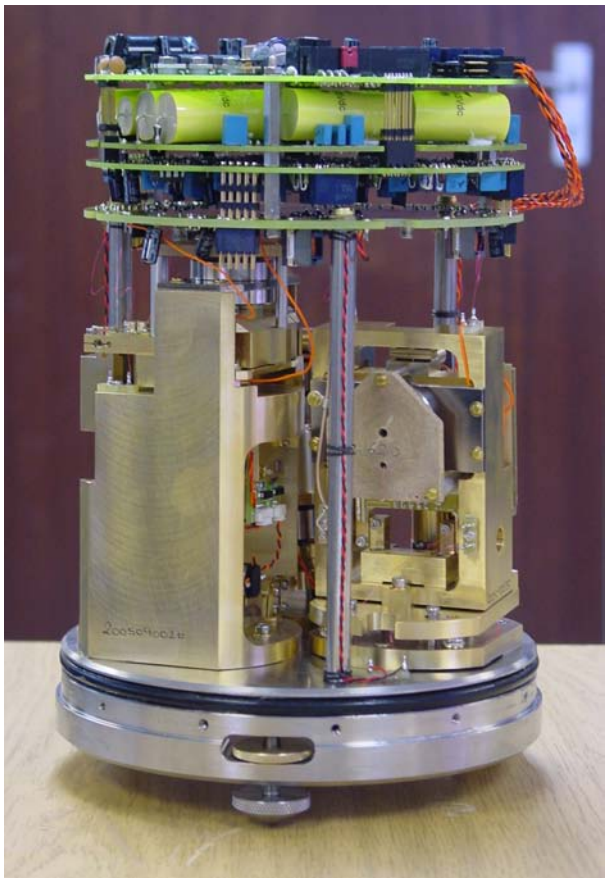


Figure 4 CMG3-V Noise corrected to CMG3-V Response (Acceleration)

The short-period performance of the CMG-3T is equally impressive, as can be seen from the PSD plots above.

The latest tests (left) conducted at the Sandia National Laboratories show a noise floor for the CMG-3T vertical component below 190 dB for much of the passband, cutting the NLNM at 20 Hz.

Inside the CMG-3T



The vertical and horizontal sensors in the CMG-3T are orthogonal to each other to an accuracy of better than +/- 0.05 °.

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 controlled 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.

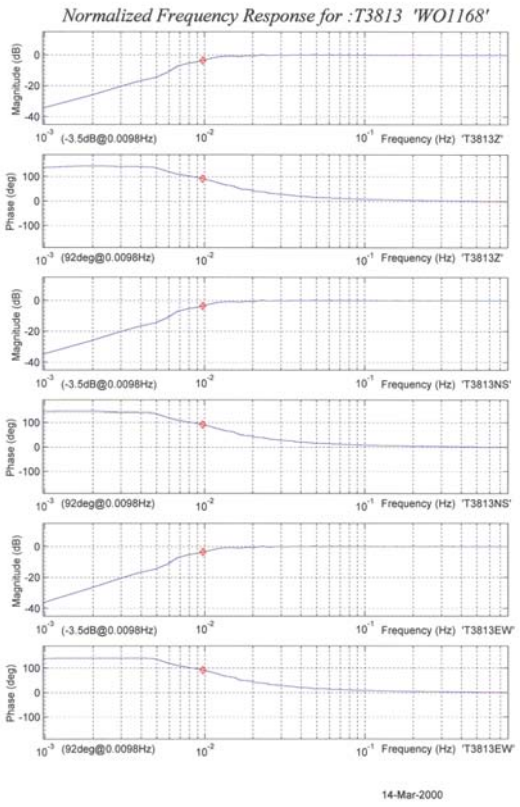
Response options

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 3T sensors output signals proportional to ground velocity over the full passband of the instrument.

The standard response is from 120 s to 50 Hz. Other low-frequency corner options are available from 360 s to 30 s, whilst the high frequency can be extended to 100 Hz.



Hybrid response

This is a new type of transfer function, used for the USGS National Seismic Network.

The standard CMG-3NSN hybrid response curve is flat to velocity from 50 Hz to 30 s and flat to acceleration between 30 s and 200 s.

Calibration

The frequency response of every 3T 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

Standard velocity output band	120 s – 50 Hz*
Mass position output band	DC – 120 s
Output sensitivity	2 × 750 V/ms^{-1} (1500 V/ms^{-1}) †
Peak output	±10 V differential
Lowest spurious resonance	> 140 Hz (vertical)
Linearity, vertical (USGS)	> 111 dB
Linearity, horizontal (USGS)	> 107 dB
Cross-axis rejection	> 65 dB
Remote control	Lock, unlock, centre
Operating temperature	–20 to +75 °C (–55 °C optional)
Temperature sensitivity	<0.8 V per 1 °C (<0.8 V per 50 °C optional)
Temp' range without re-centring	±10 °C standard (-20 °C to +50 °C optional)
Mass recentring range	± 2.5 ° from horizontal
Materials	Stainless steel case Mil-spec connector (1500 psi waterproof connector or user connector optional)
Case diameter	168 mm
Case height (with handle)	344 mm
Case height (sensor only)	274 mm
Isolating power supply	10 – 36 V DC
Optional low power sensor	5 V DC supply (output ±4.5 V)
Current at 12 V DC	62 mA
Calibration controls	Independent signal & enable lines exposed on sensor connector
Optional low pass corner	50 Hz, 100 Hz or 200 Hz

* Also available with 1 s, 30 s, 60 s, 100 s or 360 s long period corner frequency, or with hybrid response.

† Available with sensitivity in the range 2×500 V/ms^{-1} – 2×10,000 V/ms^{-1} (default is 2×750 V/ms^{-1})