



CMG-RTM Real-time Clock/GPS Emulator

Operator's Guide

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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:



Warning: A black cross indicates a chance of injury or death if the warning is not heeded.



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-RTM is a battery backed, high-precision, thermally-compensated, real-time clock module with simulated GPS output. It obtains its initial synchronisation from a GPS receiver and, once locked, starts generating NMEA sentences and a PPS (pulse per second) signal, making it suitable for use as a time-source for GPS-synchronised equipment in situations where GPS receivers are impractical. A large liquid crystal display provides status information.



Once the initial synchronisation source is removed, the CMG-RTM continues to run under battery power, maintaining timing through the use of a high-precision, thermally-compensated, crystal-controlled oscillator. The CMG-RTM can then be transported to the deployment site and connected to a digitiser, from which it subsequently draws power. Once powered, it will generate the NMEA and PPS signals which are required to synchronise the connected digitiser.

Each unit is individually factory-trained to calculate a temperature compensation table with 0.1°C granularity, ensuring stability of operation in a wide range of environments.

3 Operation

The CMG-RTM has two 10-pin bayonet connectors: one, on the right, for attachment to a power supply (during synchronisation) or to a digitiser (during operation) and one, on the left, for attachment to a GPS receiver.

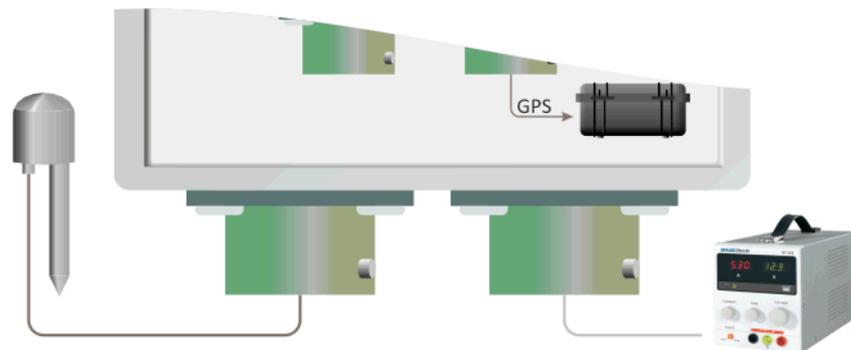
If the unit has been disconnected from power for some time, the internal battery will be discharged. The unit automatically shuts down under these circumstances.

The unit should first be connected to either a digitiser or power supply, using the right-hand connector. The following screen will be displayed:



The second line shows the date and time, according to the internal clock. The third line shows that no GPS data are currently being received.

A GPS receiver should then be attached to the left-hand connector.



The third line of the display will change to show that GPS signals are being received.



The GPS receiver produces two sets of outputs: a stream of textual data known as the NMEA (because it is in NMEA 0183v1.5 format) and a one-Hertz pulse train known as the PPS. The NMEA provides coarse timing (to the nearest second) and the PPS provides accurate sub-second timing.

Both signals are required for correct operation. If either is missing, there is a problem with the receiver, the cable or the CMG-RTM itself.

If the NMEA is missing, the following screen is displayed:



If the PPS is missing, the following screen is displayed:



If you see either of these screens, please check the GPS cable and connections. If no fault is apparent, please contact GSL technical support for advice.

While the GPS receiver is looking for satellite signals, the display will change:



In the illustration above, the receiver does not know where it is (No Fix) and it can see no satellites (SVs stands for "Space Vehicles", which is standard GPS terminology for the satellites used by the GPS system). As a result, the system is not synchronised (Not Sync).

Over the next minute or so, the receiver will start to receive data from more satellites. It will first calculate an automatic two-dimensional fix (2D). This is not sufficient for synchronisation purposes and if this condition persists, the receiver should be moved to obtain a better view of the sky. For more information about the GPS system and optimum receiver placement, please see our GPS installation guide at <http://www.guralp.com/howtos/setting-up-gps-equipment.shtml>.

When sufficient satellites have been in view for enough time, the GPS receiver will establish a full three-dimensional fix (3D) and the display will change to the following:



Here, five satellites are in view (5 SVs).

After a minute or so with a stable three-dimensional fix, the clock control system will start the synchronisation process and the display will change to the following:

```

3D Fix 5 SVs Train
GURALP SYSTEMS RTM3
Clock Sync
2015/03/09 12:34:56

```

The internal clock will be coarsely adjusted until it is in line with the GPS time, and then the offset (the difference between internal clock time and GPS time) and drift (the first derivative of the offset) are monitored while the pulse width modulation value is altered to minimise both. This process is known as training.

```

3D Fix 5 SVs -5E-8
GURALP SYSTEMS RTM3
0d00:03 12.3uS GPS
2015/03/09 12:34:56

```

In the display above, the first line gives the drift, or frequency error ($-5E-8$) as -5×10^{-8} . Note that the drift value is unit-less, representing seconds per second. The third line shows the elapsed time since synchronisation (0d00:03), which is zero days, zero hours and three minutes, and the current offset from PPS, which is 12.3µs. The last line shows the date and time.

The CMG-RTM should now be left until both offset and drift reach sensibly small values. In a thermally stable environment with good satellite visibility, this process should take less than an hour.

The GPS receiver and power supply (or digitiser) can then be disconnected. The display will change to show that GPS data are no longer being received:

```

GURALP SYSTEMS RTM3
0d01:23 2.3uS EST
2015/03/09 13:56:23
██████████ 75% 234mA

```

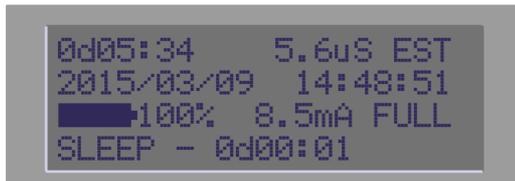
The second line shows the elapsed time since synchronisation (0d01:23) and the offset from GPS time, which is now an estimate (EST). The bottom line shows the state of charge of the internal battery. If the battery were fully charged, the display would look like this:

```

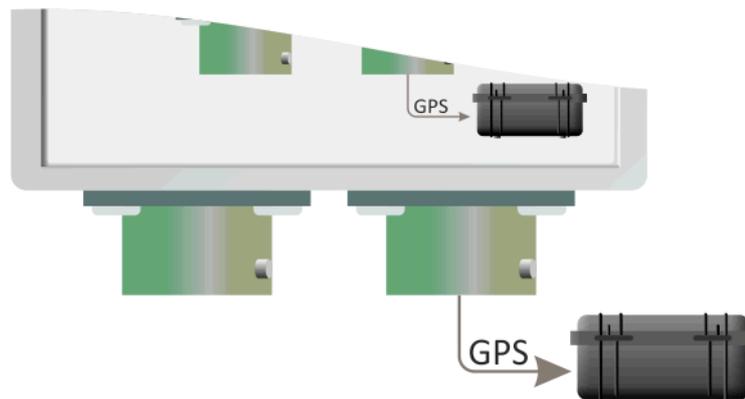
GURALP SYSTEMS RTM3
0d00:03 12.3uS GPS
2015/03/09 12:34:56
██████████100% 2.3mA FULL

```

The unit can now be completely disconnected from external power. It enters a low-power sleep mode, turns off the display back-light and stops transmitting GPS signals.



The display shows the time since synchronisation and the estimated offset from GPS time; the date and time from the internal clock; the battery status; the sleep indicator and the time during which it has been sleeping. If the battery is fully charged, the unit will run for approximately eight days in this mode.



The unit is now free-running under battery power and can be transported to the deployment site, where the target digitiser should be plugged into the right-hand connector, which will then provide power. The CMG-RTM will provide accurate timing to the digitiser.



Note: The CMG-RTM will not provide positional information to the digitiser. Only timing information is generated.

4 Connector pin-outs

4.1 GPS Output, Power Input (right-hand connector)

This is a standard 10-pin, military-specification, bayonet plug, conforming to MIL-DTL-26482 (formerly MIL-C-26482). A typical part-number is 02E-12-10P although the initial "02E" varies with manufacturer.

Suitable mating connectors have part-numbers like ***-12-10S and are available from Amphenol, ITT Cannon and other manufacturers.



| Pin | Function |
|-----|--|
| A | Power 0 V input |
| B | Power +5 V to +36 V DC input |
| C | 1pps signal output to digitiser |
| D | <i>not connected</i> |
| E | Console RS232 TxD (for factory use only) |
| F | Console RS232 RxD (for factory use only) |
| G | Ground (for factory use only) |
| H | <i>not connected</i> |
| J | <i>not connected</i> |
| K | NMEA RS232 transmit to digitiser |



Wiring details for the compatible socket, ***-12-10S, as seen from the cable end.

4.2 GPS Input (left-hand connector)

This is a standard 10-pin, military-specification, bayonet plug, conforming to MIL-DTL-26482 (formerly MIL-C-26482). A typical part-number is 02E-12-10P although the initial "02E" varies with manufacturer.

Suitable mating connectors have part-numbers like ***-12-10S and are available from Amphenol, ITT Cannon and other manufacturers.



| Pin | Function |
|-----|-----------------------------|
| A | Power 0 V output |
| B | Power +V output |
| C | 1pps signal input |
| D | <i>not connected</i> |
| E | <i>not connected</i> |
| F | <i>not connected</i> |
| G | Ground |
| H | <i>not connected</i> |
| J | <i>not connected</i> |
| K | NMEA RS232 receive from GPS |



Wiring details for the compatible socket, ***-12-10S, as seen from the cable end.

5 Specifications

| | |
|--|---|
| Physical | |
| Length (casing) | 150 mm |
| Length (including connectors) | 162 mm |
| Width | 80 mm |
| Depth | 45 mm |
| Material | Polystyrene |
| Display | 21 character, 4 line |
| Weight | 305 g |
| Electrical | |
| Power supply input voltage | 5 V to 36 V DC |
| Power supply input current (without receiver connected) | 20 mA at 12 V DC |
| Battery capacity | 1.84 Ah |
| Battery backup | 7 – 10 days |
| Timing | |
| NMEA output sentences | \$GPGSA and \$GPZDA |
| Trained Temperature range | -10 °C to +50 °C in 1 °C increments (extrapolated for out-of-range values). |
| Operating Temperature range | -10 °C to +60 °C * <i>* Battery and display performance are both compromised at the extremes of this range but timing performance is unaffected.</i> |
| Accuracy | $<3 \times 10^{-8}$ (<100 ms per month) |

6 Revision history

| | | |
|------------|---|--|
| 2015-03-31 | A | New document |
| 2015-04-15 | B | Revised graphics and improved specifications |
| 2016-03-10 | | Facelift with no significant content changes |