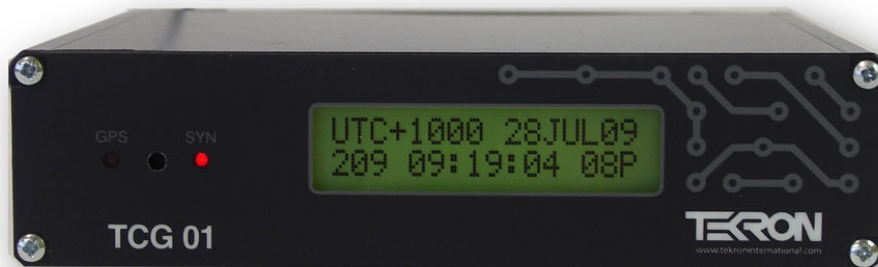




TCG 01



TIME CODE GENERATOR

User Manual

10th Edition

This document supports all TCG 01 with firmware revision D9



When you need to be certain.



TCG 01

Time Code Generator

User Manual

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10th Edition

July 2009

Revision History:

R4	For 0, A-B TCG-01
R5	For 0, A-B and C4-C7 TCG-01
R6	All C and D up to D1 version TCG-01
R7	All C and D up to D1 version TCG-01
R8	All C and D up to D4 version TCG-01
R9	All D up to D8 version TCG-01
R10	(This document) For D9 version TCG 01

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1 INTRODUCTION

The TCG 01 Time Code Generator produces precision time code signals, serial strings and pulses for use in synchronizing industrial control and SCADA equipment. The clock is ideally suited to providing time synchronization simultaneously to many different devices, such as Phasor Measurement Units (PMUs), Protection Relays, Remote Telemetry Units (RTUs) and other Intelligent Electronic Devices (IEDs) used in electrical sub-stations and industrial control installations.

The TCG 01 features one AM Modulated IRIG-B output, three programmable outputs and a serial port which is user-configurable to output serial strings and report event data for units fitted with event recording capability. Factory options include an embedded Network Time Server, and a choice of output connectors: BNC, 2-pin plug, or ST Fiber. Non-fiber outputs that can be ordered are TTL, RS422/ 485, or high voltage switching.

All TCG 01 units feature a front panel display (D09.010 and later are backlit) giving visual feedback about the time data being generated on the outputs. LED indicators provide “at a glance” status information.



Figure 1 – TCG 01 Front Panel

The optimized receiver/antenna system used by TCG 01 obtains time with similar to atomic clock precision from the GPS satellite constellation. The result is output timing accuracy similar to that normally seen only in laboratory instruments.

However, unlike laboratory instruments, TCG 01 is suited for hostile electromagnetic environments such as sub-stations and electrical switchyards. Each output of the TCG 01 is isolated from every other output, so that attached wiring can feed out to operating areas in different earth potential zones without compromising the overall site earthing security. Further isolation protects the internal electronics, and transient suppression devices protect I/O from both longitudinal and transverse high voltage events.

TCG 01 occupies less than half the width of a 1U rack space. It is supplied complete with all hardware and software required for installation, including rack-mount kit, connectors, antenna cable, and antenna.

2 FRONT PANEL



Figure 2 – TCG 01 Front Panel

TCG 01 features two LED indicators on the front panel, together with a 2-line by 16-character FSTN backlit LCD display.

LCD DISPLAY: The display unit updates every second, and by default displays local time and date, together with the offset of the local time from UTC. It also provides more information on the GPS receiver operation. A recessed push-button located on the front panel between the two indicator LED's is used to switch between display pages.

SYN LED: This LED operates in parallel with the Sync Relay, and is active at all times when the unit is operating with time code outputs accurately tracking the GPS time signals.

GPS LED: Flashing cadences indicate the status of the GPS receiver. Refer to section 2.2 for further details.

2.1 LCD Display

On initial power-up, the FSTN backlit LCD display shows a copyright message, along with the serial number and revision level of the unit (Figure 3[a]). Around 10 seconds after power-up, the display changes automatically to the operating default, (Figure 3[b]). Figures 3[c] and 3[d] show alternative time displays, that the user can access by pushing the recessed button on the front panel between the LED indicators. Successive button-pushes can be used to cycle through all the display screens in turn. The screen display examples below all show the same instant in time.

TCG01 D: 09. 010
(C)2009 Sn18748

[a] Start Up (Clock ID)

UTC+1200 17MAR09
076 11: 16: 53 87A

[b] Operating Default

LST: TUE 17MAR09
076 11: 16: 53 87A

[c] Local Time

UTC: MON 16MAR09
075 23: 16: 53 87A

[d] UTC Time

Figure 3 – LCD display screens

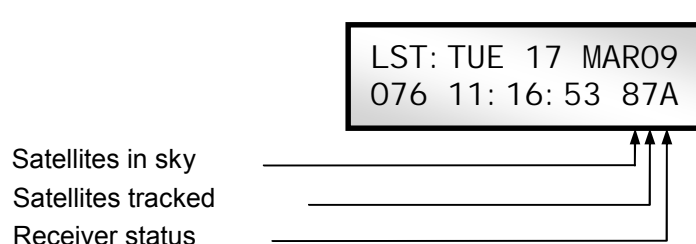
“UTC” denotes UTC time (similar to GMT). The top line of screen [b] shows the clock's current local time offset from UTC (hours & minutes), together with local date. The local time day-of-year and time-of-day are on the bottom line.

Screen [b] shows that the clock is operating with a local time offset of 12 hours ahead of UTC. The local date is 17th March 2009, and the local time is 11:16:53 in the morning.

Screen [c] shows the same time and date, but also indicates that the time displayed is Local Standard Time, and that the day is Tuesday. “LST” denotes Local Standard Time. If daylight savings time is active, the “LST” in screen [c] changes to “LDT”, denoting Local Daylight Time.

Screen [d] shows the UTC time and date which is 11:16:53 on the evening of Monday 16 March 2009.

Satellite Tracking Status



Display screens Figure 3: [b], [c] and [d] all show a three-character status field at the bottom right-hand side of the display. This three-character field provides feedback on the parameters that affect the operation of the GPS receiver.



Character	Values	Description
Satellites in sky	"0"=0 : "9"=9 "A"=10 "B"=11 "C"=12	Represents the total number of satellites currently present in the sky according to the GPS almanac. "0" in this position means that TCG 01 has lost its knowledge of the GPS satellites' orbit geometries. This occurs if the unit has been in storage for an extended period, or if the GPS receiver has been reset. It may take up to two hours for the TCG 01 to operate normally again.
Satellites Tracked	"0"=0 : "9"=9 "A"=10 "B"=11 "C"=12	This digit represents the number of satellites currently being used to compute the time solution. A "0" value means that no updated time solution is available, ("out of lock" condition). If this condition persists for the "Sync Hold" time (See section 5.3.1 for details) the clock will indicate the "out of sync" condition described under section 2.2 "Warning Status Indications" below.
Receiver status	"A"	TCG 01 in Acquisition mode - attempting to get satellite fixes
	"G"	"Poor satellite geometry": Satellites are positioned in almost a straight line so best accuracy cannot be obtained, but the unit will still sync to UTC.
	"2"	A 2D position is in use (no height). This may occur before Position Hold mode has been reached if only 3 satellites are tracked. Synchronisation is not compromised.
	"3"	A 3D position is in use, which includes height. A site survey begins next, so this mode is rarely seen.
	"S"	Site Survey in progress. TCG 01 is calculating an accurate position; once complete the mode will change to Position hold.
	"P"	"Position hold": Position is known accurately, and the GPS is providing its most accurate time, typically better than 40ns to UTC.

2.2 LED Indicators

The **GPS** LED shows the status of the GPS receiver, while the **SYN** LED shows the status of the time synchronization to UTC reference time derived from the GPS satellites.



Warning Status Indications (SYN LED = OFF)

When the SYN LED is off, TCG 01 is not guaranteed to be synchronized to UTC time. The sync relay is deactivated ("C" is connected to "NC").

GPS LED	SYN LED	Interpretation
 4 short flashes/second	OFF	Antenna fault: The GPS antenna is not connected, or is short or open circuited (faulty).
 2 short flashes/second	OFF	The GPS antenna is good, and the unit is searching the sky for satellites to begin the sync process.

Sync Status Indications (SYN LED = illuminated)

When the SYN LED is on, TCG 01 is synchronised to UTC time. All of the clock outputs are accurate and are usable for sync purposes and the sync relay output is activated.

GPS LED	SYN LED	Interpretation
 Long on – short off once every second	ON	Time accuracy is within 500ns of UTC time.
 Short on – long off once every second	ON	Time accuracy is certainly within 60ns and is typically within 40ns of UTC time

3 BACK PANEL



Figure 4 – Rear Panel of TCG 01, with BNC connectors (P2 and P3) and NTS output (P8)

3.1 P1: Power Input (2 pin connector [5.08mm])

Power is applied to the unit via this plug. Maximum steady state power consumption is 6W, and surge protection is provided. Despite the markings on P1, the polarity of the power connection is *not* important and the unit is fully isolated internally from the power source. A mating connector is supplied that is suitable for wiring up to 1.5mm².

The casing is isolated from the power supply inputs so that either (or neither) power supply polarity can be earthed to station earth.

The input voltage range is marked on the option label that is attached to the underside of TCG 01. Refer to section 6.1 for a list of orderable ranges.

■ **Check the label on the unit base for power supply voltage ratings!**

3.2 Ant: Antenna connector (SMA connector)

The “ant” antenna input provides an interface for an external active antenna via low-loss coaxial cable, 50Ω impedance. 5V DC @ 50mA max is supplied to power an active antenna. The total combined gain of the antenna system (antenna plus cable and connectors) should fall in the range of 10 to 35 dB, the optimum being 22dB.

TCG 01 is normally supplied complete with a timing-optimized narrow-band antenna and 30m of lead-in cable, this combination provides an overall gain near the optimum of 22dB. For lead-in lengths longer than 60m, amplification and/or larger diameter, lower loss cable can be supplied to order.

■ **Care should be taken to ensure that the connector is not cross-threaded when attaching the antenna lead-in cable. The connector should be tightened firmly by hand only. Do NOT over-tighten!**

A Lightning Protection device may be inserted into the antenna lead. A suitable device complete with additional cable connectors, a connector crimping tool and mounting hardware is available as an option (see Section 5.6 on page 29). Introduction of the Lightning protector does not degrade the performance of the antenna system.

3.3 P2, P3: Programmable Outputs (2 pin[3.81mm] / BNC / or ST Fiber)

3.3.1 Electrical and Physical Configuration

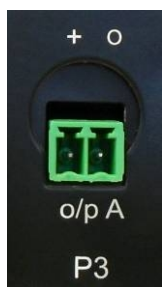


Figure 5 – 2pin connectors

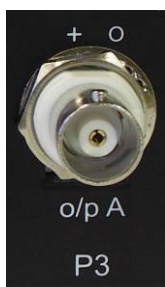


Figure 6 – BNC connectors



Figure 7 – Fibre connectors

Each output port may be fitted at the factory according to the following:

Electrical	Electrical Specification	Physical
TTL	CMOS/TTL (5V) logic level driver output ports, 150mA sink and source. The port is fully floating and has independent electrical isolation to 2.5kV	2-pin or BNC
RS422	High Speed RS422/ 485 (+/- 6V) output ports. The port is Fully floating and has independent electrical isolation to 2.5kV.	2-pin or BNC
HV MOSFET	Power MOSFET Switch, allowing switching of 300VA, 1A max. The port is fully floating and had independent electrical isolation to 2.5kV. Refer to Section 6.2 for suggested wiring configurations for use with Power MOSFET switching.	2-pin
Fibre	ST fibre transmitters, compatible with ST-terminated 62.5µm fibre diameter, 125µm jacket diameter multi-mode fibre optic cabling. The maximum length of fibre recommended is 750 metres.	ST Fibre

3.3.2 P2, P3 programmable output options

The user may configure P2 and P3 to output in either inverted or non-inverted polarity:

- A use- configurable number of pulses per second, minute, hour, day with adjustable pulse-width and offset.
- IRIG-B and DCF-77 time codes.

Refer to section 5.4 for further information.

3.4 P4: RS232 - Serial port and programmable output (DB9 Connector)



An RS232 port (+/-9V signal levels) is implemented via 9-way “D” male connector with signal lines: **pin 2** (serial data OUT from TCG 01), **pin 3** (serial data IN to TCG 01) and **pin 5** (signal ground) together with a programmable signal output on **pin 1**. The programmable output shares the **pin 5** (signal ground).

Do NOT over-tighten the securing screws of the connector!

TCG 01 is normally shipped as a DCE configuration, so that a “straight-wired” Socket-to-Socket 9-way data cable can be used to connect directly to a standard PC serial port. (A suitable 2m cable is included with each TCG 01.) The CTS and DSR lines are permanently asserted. As the serial outputs are usually precisely timed messages, there is no provision for either hardware or software flow control.

The RS232 signal lines are not HV-isolated from each other, but the port as a whole is isolated to a level of 2.5kV from all other ports.

3.4.1 P4 serial strings

The serial port can be configured to output any one of a number of different serial time messages on a broadcast basis. The serial port runs at a fixed baud-rate of 9600 baud. Message formats typically operate at 8-bit no parity, no flow control and 1 stop bit. Most are transmitted once per second.

A wide range of message strings and protocols can be output on this port. They include:

- NGTS protocol (transmits once per minute)
- IRIG J-17
- Six preset messages, String/Tekron A—F for compatibility with most IED.
- NMEA ZDA and RMC messages
- GPS Binary/Messages, these are subject to change without notice.

See Appendix B for details of each of the message string formats.

A common application for the programmable output on P4-pin1 (RS232 level) is to provide an independent drive to an RS232-Fibre converter unit for use in transporting the code signals to a distant location. (Tekron manufactures a range of interface devices (MOFRs) that include such converters.) In such cases, **pin 1** should be “broken out” of the normal 9-way cable optionally used to connect to an external PC, and used in conjunction with **pin 5** (signal return).

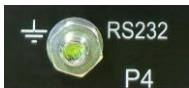
3.4.2 P4 pin 1 Programmable Output

The user may configure P4 pin 1 to output in with inverted or non inverted polarity:

- A user configurable number of pulses per second, minute, hour, day with adjustable pulse-width and offset.
- IRIG-B and DCF-77 time codes.

■ **N.B: P4-pin1 is not available on TCG 01's with DTE serial ports. If not specified, TCG 01 will ship with a DCE serial port.**

3.5 Earth stud (M4 nut)



An M4 bolt (to chassis) is provided for earthing of cable shields. This is located under the serial port to the left of the P4 designator.

3.6 P5: AM IRIG-B output (BNC connector)



P5 provides amplitude modulated IRIG-B (B12x) over a BNC connector.

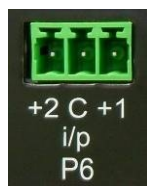
Use either coaxial cable or shielded twisted pair, to feed signal from P5 to any connected IED. When using shielded twisted pair, connect the shield to ground.

The mark/space amplitude modulation ratio is 10:3, and peak to peak output level is 9 volts (max), 100Ω impedance. The output is fully floating, and is transformer-isolated to a minimum of 2.5kV.

This output is *not* programmable for other types of signal, and the IRIG-B code is present whenever the unit is powered. The particular IRIG-B data content is as specified by the configuration program.

■ **Most devices with amplitude-modulated IRIG-B time sync inputs have an input impedance of between 4kΩ and 20kΩ, and maximum allowable peak- to-peak level of 6V or so. The P5 output on TCG 01 is designed to drive many of these devices all in parallel, with a terminating resistor (typically 100-180 ohms) fitted at the far end of the coax line feeding all of the attached loads. In this way P5 can drive at least 20, and typically 30 or more devices without any external amplification required. The terminating resistor is essential to ensure good noise immunity and correct voltage levels.**

3.7 P6: Event Recording/ Sync to IRIG-B Input (3 pin 3.81mm connector)



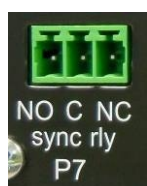
Two input channels with common return that may be driven by TTL logic levels. This port is implemented via a 2-pin plug-able connector. Wiring size is up to 1.0mm^2 and the input is isolated to 2.5kV.

“C” is the common reference (0V), and “+2” and “+1” are TTL inputs 2 and 1 respectively. Input burden is 7mA at 5V.

P6 is used for either:

- Event time tagging or “event recording” on units with this option fitted. For a full description, see B
- Synchronisation of TCG 01 to an external IRIG-B signal. See section 5.3.7 “Sync to IRIG-B Input (Master/ Slave function)” for further information on this feature.

3.8 P7: Sync Relay (3 pin 3.81mm connector)



A set of isolated changeover relay output via 3-pin plug-able connector – capable of switching up to 2A at 230V AC, or 300mA at 150V DC. Wiring size is to 1.0mm^2 using the supplied mating plug. Isolation is 2.5kV minimum.

This relay is active (“C” and “NO” connected) whenever the TCG 01 has established stable time sync from the GPS satellites. The active relay output indicates that all of the other output signals are operating within specification. The connector accommodates 1.0mm^2 cabling.

TCG 01 outputs maintain accuracy for a time after the loss of satellite sync, and the sync relay can be configured to remain active (indicating “in sync”) for a period following the loss of satellite signals. The default period is one minute, but this can be altered up to a maximum period of 42 minutes and 30 seconds (2550 seconds).

3.9 P8: NTS – network time-server (RJ45 connector)



TCG 01 units fitted with the network time-server option (NTS), feature an RJ45 connector supporting a 10/ 100Mbps Ethernet port (10/ 100baseT). A standard (i.e. non-crossover) drop lead should be used to connect the TCG 01 to a convenient port on a local network hub or switch.

Located adjacent to the time server port are four LEDs which convey multiple statii.

The green **lnk** LED indicator lights when a network cable (UTP drop lead) is correctly connected between the TCG 01 RJ45 port and the local network hub/switch. The other green LED, the **lck** indicator, lights up steadily when the NTS is correctly synchronized with UTC time. Provided that TCG 01 is already synced to UTC time from the GPS satellite constellation (Front Panel **SYN** led on), the **lck** indicator should stabilise and remain on. If the **lck** indicator does *not* stabilise “on”, even though TCG 01 is in sync with the GPS time, the most likely problem is that the NTS “satellites” parameter is set at too high a value.

The two lower indicators **err** and **sec** should remain off during normal operation. These indicators may flash for a few seconds immediately following power-on, and they can also flash continuously when the NTS sub-system is in “Set-Up” mode. However, after the NTS has completed initialization self-checks and has a valid network address, these indicators should go off and stay off.

4 INSTALLATION

4.1 Identification

Each TCG 01 unit is shipped with an identification label on the base. The label provides details of the particular options fitted to the unit, the power supply requirement, the serial number and firmware revision.

■✎ Check the identification label on the base of the unit to ensure that the correct model has been supplied before proceeding to install!

4.2 Packing list

Each TCG 01 kit is shipped with the following:

- TCG 01 Time code generator
- GPS Antenna optimized for stationary applications, with mounting plinth
- Antenna lead-in cable fitted with matching connectors
- 19" Rack mounting Plate
- RS232 Interface cable
- Configuration Software
- User Manual – this document

4.3 GPS Antenna and Cable Installation

GPS Antenna

The TCG 01-E unit's standard shipping configuration includes an active GPS antenna radome specifically designed for industrial/static timing environments, together with a pipe-mounting plinth. The mechanical diagram below shows the radome and pipe mounting plinth attached. Refer to Appendix A.1 for the complete antenna specifications.

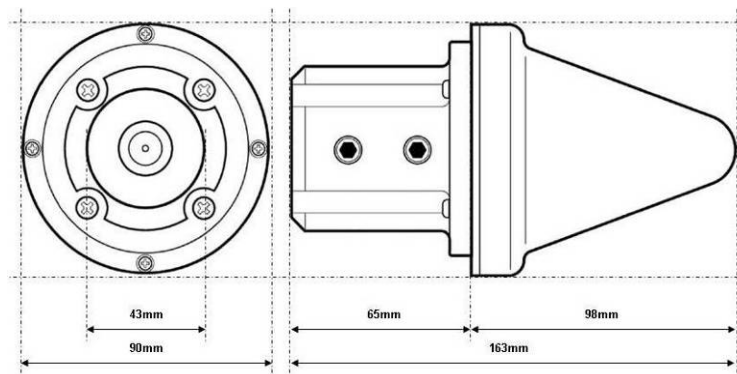


Figure 8 – Dimensions of antenna pipe-mounting plinth

The antenna pipe-mounting plinth (Figure 8) is designed to fit over the top of a pipe like a capping. The mount has an internal diameter of 43 mm, to fit a pipe with external diameter of between 40 and 42 mm (1¼ inch / 32 mm nominal ID galvanized pipe). The top end of the pipe should be cut flat, so that the rubber gasket inside the antenna mount sits flush against it, forming an effective weather seal. The mount is fixed to the pipe with two stainless steel M8 hexagon- socket setscrews (supplied).

Available Accessories

Antenna cable - Refer to Appendix A.3.

Adjustable antenna mounting bracket - Refer to Appendix A.2.

Lightning protection kit - Refer to Appendix A.6.

In-line amplifier - Refer to Appendix A.5.

Pre-installation

Prior to the acquisition and installation of a GPS Clock, ascertain where and how you will fix the antenna to ensure that the clock will perform nominally.

Step 1 - GPS Antenna placement

The GPS antenna should be installed in a position where it has a clear view of the satellites. When surveying a site prior to installation, consider any fixed or moving obstructions which may affect GPS reception (E.g. Terrain, Pylons, mobile obstructions...). Avoid close proximity to antennas from other services where possible. The antenna has excellent rejection characteristics to out-of-band signals, as does the GPS receiver, but high-powered RF signals in close proximity to the antenna may swamp the very low-level signals from the GPS satellites.

Reducing the risk of Lightning Strike

The first line of protection against the effects of lightning-induced surge events involves positioning the antenna in a “lightning-protected zone”. In practice, this means ensuring that there is at least one other earth-bonded structure located in the same rooftop area (e.g. another antenna, or a lightning rod) that reaches significantly higher than the top of the GPS antenna. The GPS Antenna should then be mounted so that it lies within a 45-degree angle from the top of the other earth-bonded structure. The GPS antenna mount itself should also be securely bonded directly to the building protection earth – and not connected via any of the other earthed structures.

By following the directions above you will reduce the risk of lightning strike. However, there is no fail-safe way of preventing lightning strike. A lightning arrestor should be installed to reduce the risk of damage caused in this instance.

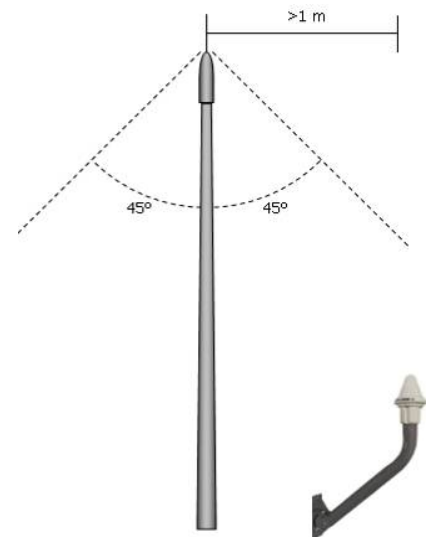
Lightning Protection

At installations where lightning frequently occurs, it is prudent to install a lightning arrestor between the antenna and clock. Tekron's antenna lightning protection kit LPK 01 provides additional protection through the use of an impulse suppressor. In the event of a lightning derived high voltage surge, the impulse suppressor activates, short-circuiting the cable directly to earth.

Step 2 - Antenna Mounting Bracket

The antenna pipe-mounting plinth is designed to fit over the top of a user-supplied pipe like a capping. Source a pipe that has an external diameter of between 40 and 42 mm (1¼ inch / 32 mm nominal ID galvanized pipe). The top end of the pipe should be cut flat, so that the rubber gasket inside the antenna mount sits flush against it, forming an effective weather seal.

Establish the mounting method for the pipe, such as strapping or bolting to a frame on the edge of the building, or strapping to an air conditioning exhaust or similar. The base of the pipe needs to be accessible for the cable entry, if this is not practical, then a hole or slot can be made in the side of the pipe to allow the cable to enter and be passed up to the top of the pipe.



An adjustable antenna mounting bracket can be procured from Tekron at the time of ordering. Refer to appendix A.2 for specifications.

Step 3 – Antenna Cable

Calculate the cable length required between the antenna and GPS Clock, allowing 5 – 10% extra for contingencies.

Tekron GPS Clocks can be ordered with 15, 30, or 60 meters of high performance RF cable factory-fitted with a TNC-type male connector at one end, and a SMA male connector at the other. The TNC-type connector mates with the connector on the antenna and provides a robust weather-resistant connection. The smaller SMA connector mates with the connector on the GPS clock rear panel and is only fractionally larger in diameter than the cable itself; this facilitates installation in conduit and through small apertures.

Custom lengths can be ordered upon request however additional costs may be incurred.

Where antenna cable distance exceeds 60 meters, either lower loss (e.g. LMR400UF) cable can be used or an in-line amplifier can be installed. Refer to Tekron for further advice.

Installation

Step 4 - Antenna Cable Installation

While the cable shielding is excellent, the cable should not be routed in close proximity to power cables or other RF cables carrying transmitter signals – in particular, parallel runs are to be avoided if possible. If such runs are absolutely unavoidable, a minimum separation of 300 mm may be used as a guideline.

The GPS receiver has excellent out of band rejection characteristics, as does the antenna itself. However, sound engineering practice should not rely on these factors alone to guarantee performance. Careful installation will enhance the long-term reliability and on-going stability of the Time Code Generator.

The absolute minimum bend radius for the antenna cable supplied is 40mm, but it is preferable to use a larger radius if possible. Caution should be taken at all times during the installation of the cable to avoid crushing or shorting the cable.

Step 5 - GPS Antenna Installation

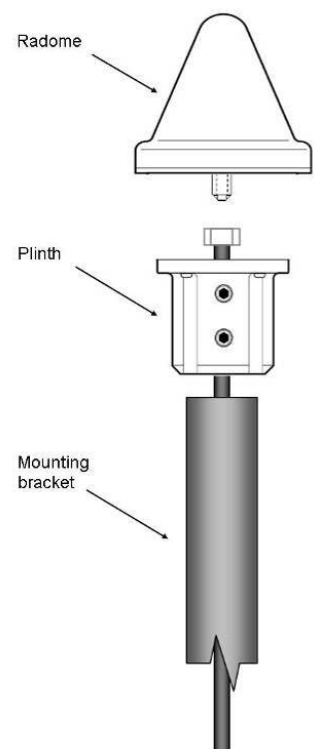
Feed the antenna cable up the mounting bracket/ pipe from the bottom end, through the plinth, and connect directly to the TNC connector on the base of the antenna. It is advisable to wrap self-amalgamating tape around the connector to seal the connection and provide protection against moisture ingress.

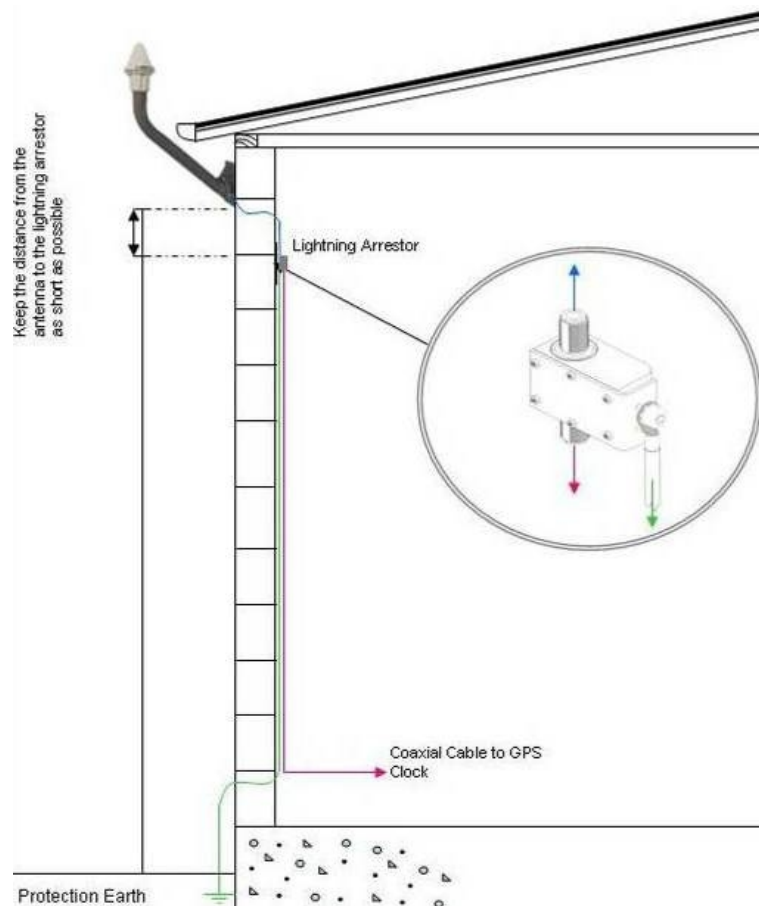
Fasten the antenna to the plinth using the four stainless screws supplied with the kit. The complete antenna assembly can then be placed on the mounting bracket/ pipe and secured by tightening the grub screws on the side of the plinth using the supplied Hex key.

Step 6 - Installing the Lightning Protection Kit (when applicable)

The lightning protector must be firmly mounted to a conductive metal surface that is itself bonded to the building protective earth. Ensure that a good electrical connection is made between the surge protector and the earthing system. All earthing connections should be as short as possible, should have no sharp bends or loops.

The preferred mounting position is on the inside of the building's exterior wall, adjacent to the antenna lead entry point.





Refer to the lightning protection installation guide for connection details.

Summary

Pre-installation steps:

Step 1 - GPS Antenna Placement

Locate a position to mount the GPS antenna where it has a clear view of the sky, away from RF transmitters, and in a lightning protected zone.

Step 2 - Antenna Mounting Bracket

Establish a mounting method and procure a suitable mounting pipe.

Step 3 – Antenna Cable

Calculate the cable length required between the antenna and GPS Clock, allowing 5 to 10 % extra for contingencies.

Installation steps:

Step 4 - Antenna Cable Installation

Run the cable from the antenna to the GPS clock. Where possible, allow a separation of 300 mm between the antenna cable and other cables including power or cables carrying other RF signals. Ensure that the cable bends are greater than 40 mm in radius.

Step 5 - GPS Antenna Installation

Feed the antenna cable up the mounting bracket from the bottom end, through the plinth, and connect directly to the TNC connector on the base of the antenna. It is advisable to wrap self-amalgamating tape around the connector to seal the connection and provide protection against moisture ingress.

Fasten the antenna to the mounting plinth using the four stainless screws supplied with the kit. The complete antenna assembly can then be placed on the mounting bracket/ pipe and secured by tightening the grub screws on the side of the plinth using the supplied hex key.

Secure the completed antenna assembly and mounting bracket to the previously prepared mounting structure.

Step 6 - Installing the Lightning Protection Kit (when applicable)

The lightning protector must be firmly mounted to a conductive metal surface that is itself bonded to the building protective earth. Ensure that a good electrical connection is made between the surge protector and the earthing system. All earthing connections should be as short as possible, should have no sharp bends or loops.

The preferred mounting position is on the inside of the building's exterior wall, adjacent to the antenna lead entry point.

Refer to the lightning protection installation guide for connection details.

■ All TCG 01-E antenna installations should follow the guidelines above.

4.4 Mounting the TCG 01

The clock is designed to be mounted in a 19" rack, but may be used on a bench. The unit is attached to the rack mount plate via the four screws shipped installed in the four corners of the front panel.



4.5 Operation

■ Check the label on the base for voltage requirements before switching on!

Connect the antenna lead and the antenna (with a good view of the sky). Then connect the power source to **P1**.

The time required that will achieve tracking and synchronization given a good "view" of the sky is typically within a minute. Although reactivating a unit that was previously synchronized 1000's of km away from the present position will take longer but not more than 45 minutes.

5 TCG 01 CONFIGURATION SOFTWARE

5.1 Introduction

A proprietary software configuration program ships with all TCG 01 units. It provides the user access to all of TCG 01's programmable system operating parameters as well as the programmable output options. If preferred, parameter set-up can be carried out ex factory to customer specification. In addition to the descriptions below, the various configurable parameters are also described within the program's on-line help. Clicking on the "?" icon in the top RH corner of the window brings up the help cursor. Moving the help-cursor over an option and clicking activates on-line help for that parameter. Pressing **F1** while over a parameter also activates online-help.



The configuration tool requires a Windows PC (95, 98, 2000, ME, XP, NT all supported) with a spare 9-pin serial port. The serial port of the TCG 01 must be connected to this PC with either a straight through DB9-DB9 plug, or for DTE TCG 01's a crossover cable. The correct cable for this is supplied with TCG 01. (The software also works with serial ports created using USB-to-Serial convertors. See the manufacturer's instructions for installing USB to Serial drivers.)

The configuration tool may be run without a clock attached; in this case it may view or alter a pre-saved configuration file.

When first loaded the configuration tool will bring up a small status window, and scan through available serial ports, to find a powered up TCG 01. If a TCG 01 is discovered a snapshot of the current clock settings will be shown in the "Clock Setup" and "Output Config" tabs, and a live time preview will be shown.

Once connected, the "GPS Setup" will also begin to show the status of the GPS including any satellites that are being tracked. The "Refresh Data" button is used to re-attempt connection to TCG 01 and will read in the current TCG 01's settings. The "Write" button is used to save and apply the changes to TCG 01.

What follows is a description of some of the TCG 01's configurable parameters. Due to continuous product improvement, these specifications are subject to change without notice.

5.2 Time Settings

5.2.1 Local Standard Time and Local Daylight Time offsets

The time offsets define the number of hours (and, in rare cases, minutes) that the local time differs from UTC time. A positive offset means that the local time is *ahead* of UTC. *If automatic Daylight Saving Time operation is not required, both of the offsets should be set to the same value.* For UTC operation, both values should be set to zero.

5.2.2 Local Time

When a TCG 01 is connected, this clock-face will be active, and is a preview of the current time according to the current daylight savings and local time rules shown in the configuration tool.

5.2.3 Choose City

The "Choose City" button provides a convenient way of automatically filling in time offset and daylight savings parameters simply by selecting a geographical location.

5.2.4 Set Daylight Time Using

This allows configuration of TCG 01's Automatic Daylight savings changes based either on a fixed date, or a fixed rule for calculating a date that will be different depending on what year it is. Use the "Choose City" button to access a list of presets.

5.3 General Options

5.3.1 Sync Hold Time

The “Sync Hold” parameter is used to control the period after loss of satellite sync that will be tolerated before TCG 01 will show loss of sync, and release the “sync” relay. Correct installation will make the loss of sync event rare, although in areas with poor GPS coverage there will be occasions where tracking is momentarily lost.

The accuracy of all outputs when there is a complete satellite “blackout” is maintained to within a few microseconds over short periods (a few minutes), and to within 200us for up to 40 minutes. A single satellite signal sufficiently recovers accuracy to within 1us.

■ In typical SCADA operations, time syncing to within 0.5ms is considered adequate. Setting Sync Hold to the maximum (2550 seconds) will prevent “loss of sync” alarms in the event that satellites are temporarily obstructed.

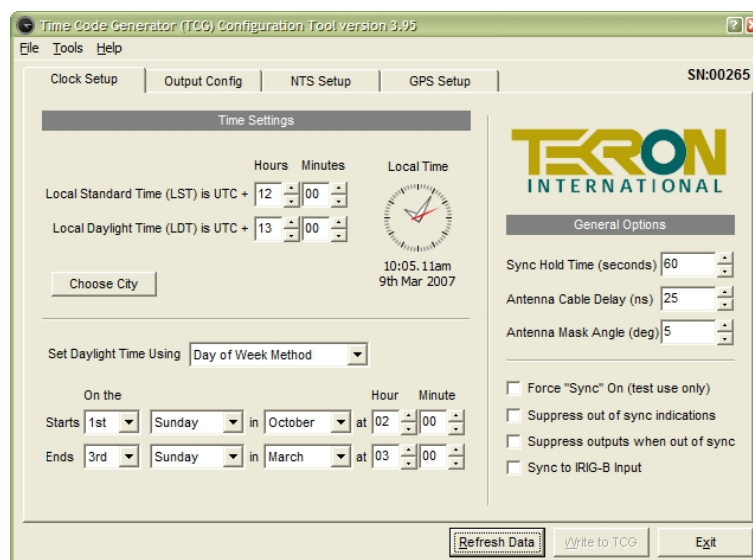


Figure 9 – “Clock Setup” Page

5.3.2 Antenna Cable Delay Compensation

All antenna systems introduce signal delay (depending on the cable length). To optimize the precision of the output signals enter the appropriate value in this field (4ns per meter of antenna cable). E.g. for a 30 meter antenna cable, enter “120”

5.3.3 Antenna Mask Angle

This is the elevation above the horizon below which satellites will not be used in time and position calculations. A good starting value is 5 degrees, and this may need to be increased in areas with land based obstacles to prevent time quality loss due to multi-pathing effects. Increasing this value will reduce the number of satellites in view.

5.3.4 Force “Sync” on (Test Mode)

Force “Sync” on forces TCG 01 to output time sync signals as if it were synced to GPS, even if this is not true (e.g. there is no antenna attached). In this mode the sync relay will be on at all times, and the TCG 01 display will flash a warning.

When the TCG 01 is in Force “Sync” on mode, the time can be arbitrarily set. This function allows the TCG 01 to be used as a signal source for testing the ability of externally attached equipment to correctly process received time codes through unusual time transitions such as the 28/29 Feb rollover during leap years, or daylight savings transitions. Refer to 6.8.1 for further details on setting the time.

■ Force “Sync” is typically used for testing in laboratory environments and should NEVER be used in time critical environments.

5.3.5 Suppress Out of Sync Indications

This makes TCG 01 operate as if it is in sync at all times, even if there is no antenna attached. The sync relay operation is unaffected by this option and will still indicate the true sync state of TCG 01.

5.3.6 Suppress Outputs When Out of Sync

This option suppresses the TCG 01’s outputs when the clock goes out of sync. The sync relay operation is unaffected by this option and will still indicate the true sync state of TCG 01.

5.3.7 Sync to IRIG-B Input (Master/ Slave function)

Selecting this option forces TCG 01 to get its synchronization from an external IRIG-B signal fed into the first input on the input plug P6 (terminals [+1, C]), overriding any information from the GPS antenna. This feature allows multiple time code generators to be slaved from a single IRIG-B source. The slave TCG 01 receives synchronization from a master TCG 01 that is producing IRIG-B, and will use the local time settings that are programmed into the master TCG 01. The sync algorithms used to achieve slave sync operation ensure that the outputs on the slave clocks maintain similar timing precision as those on the master clock.

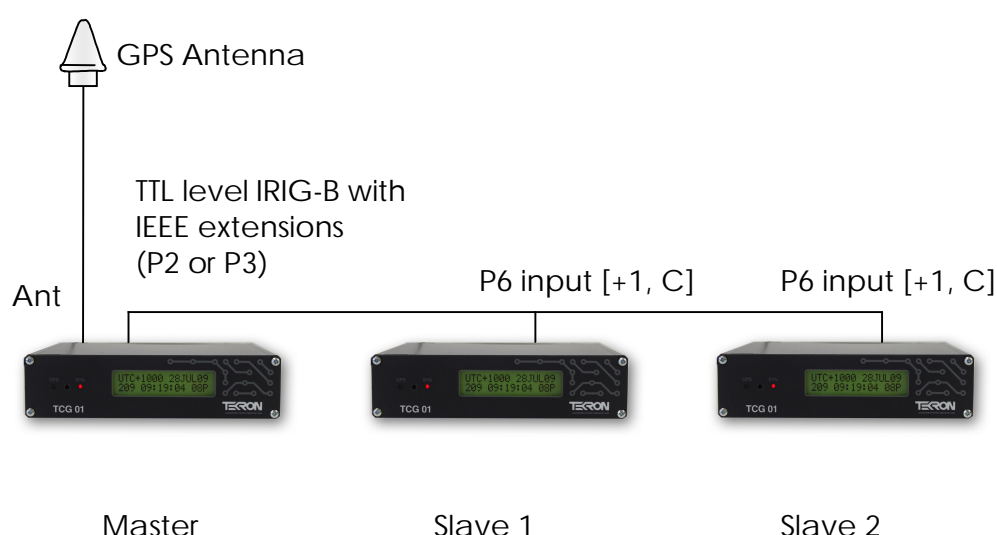


Figure 10 – Multiple Time Code Generators, with one GPS Antenna

5.4 Programmable Outputs

5.4.1 P2 / P3 / P4-pin 1

Each of the three outputs (**P2**, **P3** and **P4-pin 1**) can be programmed to give one of four different output waveforms. Selection between the four options is done via a drop-down menu. The options available **independently** for each output are:

- 1 DCF-77 output pulse simulation
- 2 IRIG-B DCLS (B000/B001 or B002/B003)
- 3 IRIG-B Modified Manchester Encoded (B220/B223 or B221/B222)
- 4 User Defined Pulse Sequence (separate definition stored for each output)

Each of the three programmable outputs can also be inverted in its operation.

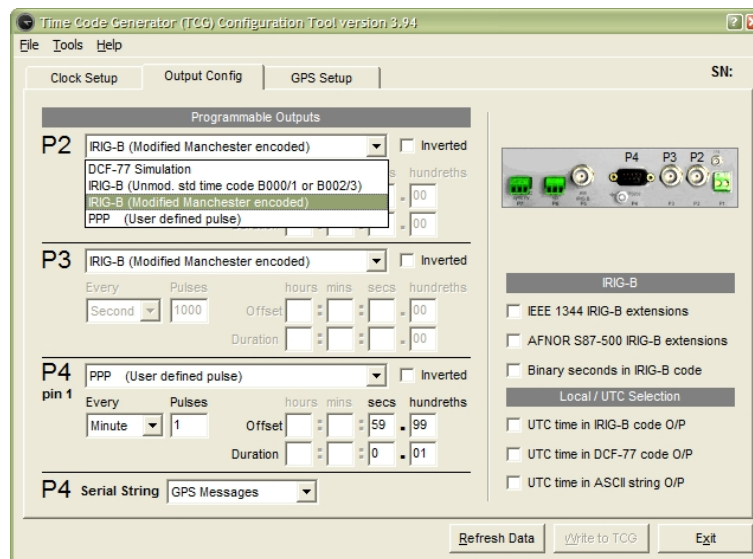


Figure 11 – “Output Config” Page

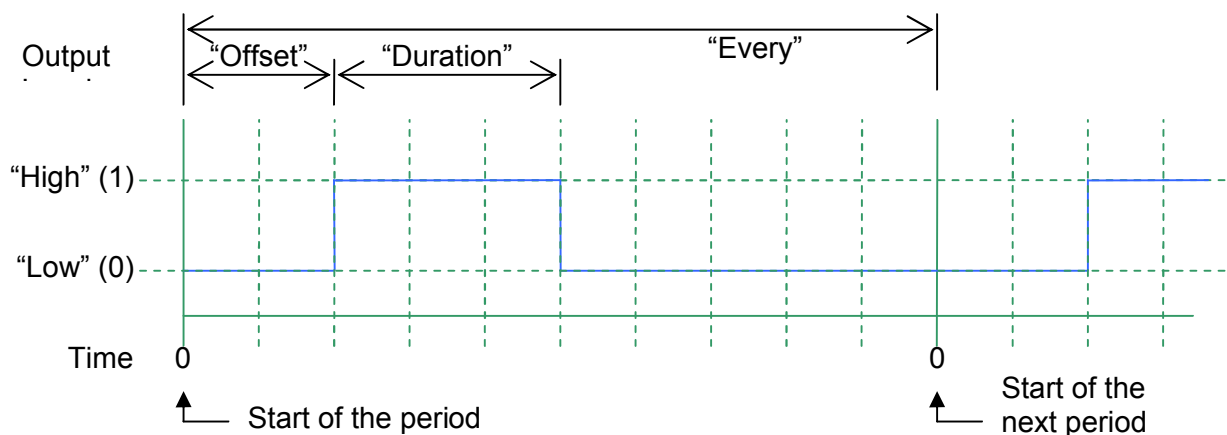
Figure 11 – “Output Config” Page shows the settings for a user-defined pulse on the P4-pin1 output. The values shown will result in a single pulse per minute. The pulse will begin 59.99 seconds after the start of the minute, and will last for 1/100th of a second (10ms). These settings of the pulse output on P4-pin1 are normally used in conjunction with the “NGTS ASCII” String on P4 to give an “NGTS synchronisation protocol”

In the case of the User-Defined Pulse option being selected for any outputs, further parameters are entered to define the pulse sequence. The parameters are as follows:-

- (1) A drop-down menu allows the user to choose to have pulses output every “second”, “minute”, “hour”, or “day”. Specify the frequency of pulses under the “Every” and “Pulses” fields: Use online help or press “F1” while over the pulses area to get a list of the available values that can be entered into the “Pulses” box. The table below shows what number of pulses per second are valid:

Period “Every”	Number of “Pulses”
Second	1, 2, 3, 4, 10, 20, 50, 1000
Minute	1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30
Hour	1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30
Day	1, 2, 3, 4, 6, 8, 12

- (2) Specify the “Offset” this is the interval from the start of the day, hour, minute, or second to the start of the pulse.
- (3) Specify the “Duration”; this is the time the pulse stays asserted.
- (4) Check “inverted” to swap the polarity of the pulse – that is “High” and “Low” levels are swapped.



5.4.2 Serial String

The serial port output P4 operates at the fixed data rate of 9600bd with no flow control and 8-bit, no parity format unless otherwise specified. The standard TCG 01 outputs are broadcast messages sent at regular intervals. The broadcast repetition rates, timings, and message content are all described in the Serial Output Strings B. Descriptions of each string are also built into the configuration tool; select the output string from the drop-down list in the configuration tool, and press F1.

5.5 IRIG-B

5.5.1 IEEE1344 IRIG-B extensions

Outputs programmed for IRIG-B code will output: year, impending leap second information, local time offset, impending daylight savings change, and time-quality information all in accordance with IEEE1344 specification.

5.5.2 AFNOR S87-500 IRIG-B extensions

If this option is checked, all of the outputs programmed for IRIG-B code will output: year, day of year, day of week, month, and day of month all in accordance with the European AFNOR S87-500 specification.

5.5.3 Binary Seconds in IRIG-B code

The “Binary Seconds” field is an option specified by IRIG standard 200-04. If this option is checked, all of the outputs programmed for IRIG-B code – including the amplitude-modulated output - will include the “Binary Seconds of Day” data.

5.6 Local/UTC Selection

5.6.1 UTC Time in IRIG-B Code O/P

When checked, UTC time will be output in this time code. Otherwise Local time using TCG 01's current Local Standard Time and Daylight Savings Time settings will be output.

5.6.2 UTC Time in DCF-77 Code O/P

When checked, UTC time will be output in this time code. Otherwise Local time using TCG 01's current Local Standard Time and Daylight Savings Time settings will be output.

5.6.3 UTC Time in ASCII String O/P

When checked, UTC time will be output in this time code. Otherwise Local time using TCG 01's current Local Standard Time and Daylight Savings Time settings will be output.

5.7 Network Time Server Configuration

The NTS Set-Up Page is displayed when the TCG 01 unit has the network time server option fitted. Click "Configure" to bring up a terminal and configure the time server.

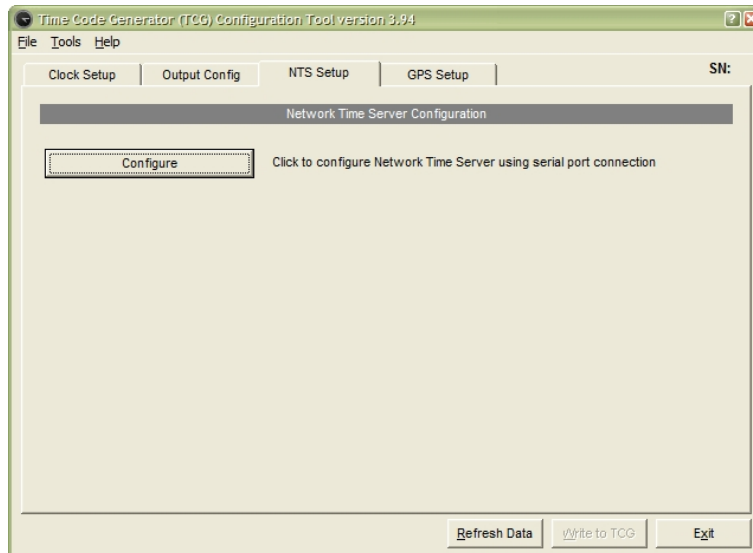


Figure 12 – "NTS Setup" Page

5.7.1 Configuration Requirements

Configuration of the NTS involves setting the unit's TCP/IP networking parameters (IP Address, Net-Mask and Gateway IP Address settings), the number of tracked satellites required to initiate the Server function, and optionally, the IP addressing data needed for SNMP status reporting. Although not strictly necessary, it is usual to assign a fixed IP address to the NTS module, even in network environments operating with a DHCP Server. This allows NTP client software on all work-stations to be permanently programmed to poll to the fixed address of the NTP Server.

■ It is beyond the scope of this document to discuss TCP/IP addressing concepts in detail. The configuration instructions below assume some familiarity with the TCP/IP networking environment and Network Operating System utilities such as "Ping", "Telnet" and "Arp".

The following TCP/IP information is required to configure the NTS properly:

- (a) The fixed local network address (IP address) to be assigned to the NTS.
- (b) The number of bits in the netmask that the local network assigns to hosts. The default setting of "0" results in automatic allocation.
- (c) The IP address of the gateway router (this is only necessary if the NTS is required to service clients on multiple sub-nets). The default is all null – service only to clients in the same sub-net as the server.
- (d) The IP addresses (up to 5) to which SNMP status information should be sent (should be set to null if no SNMP status reporting is required – this is the default setting.)
- (e) The name of the SNMP community to which the NTS is to belong (should be set to null if no SNMP status reporting is required – this is the default setting.)

5.7.2 Methods for Accessing Set-Up Mode

There are two ways to access the timeserver's configurable options:

Access Using Configuration Software:

Connect the TCG 01 to a Windows PC using a serial cable and, using the configuration tool, select the "Configure NTS" button in the "NTS Setup" tab of the configuration program. This method has the advantage of being always available. There is no need to know the network address of the unit, and there is no password protection using this configuration method.

Login using a "Telnet" connection

This method has the advantage of not requiring the operator to be present at the installed location. However the existing IP address of the NTS must be known before a Telnet connection can be made. Both methods access the same options and menus. A complete description of the NTS "Set-Up Mode" configuration menus and options starts on p24.

5.7.3 Using Telnet to access Set-Up Mode

Provided that the NTS IP address is already configured and known, then the time server can be configured using a Telnet Session to port 9999 on the known NTS IP address.

If the NTS IP address is *not* configured, an address must be temporarily assigned before network access can be gained. A temporary IP address can be assigned in one of two ways:

Assigning an IP address using DHCP addressing:

Networks that include a DHCP server offer automatic address allocation via **D**ynamic **H**ost **C**onfiguration **P**rotocol, (DHCP). The time server will automatically operate within a DHCP environment to fetch a dynamic address if it does not already have a fixed address configured. Each time server has a unique system name that will show up on the DHCP Server's active lease list within a few seconds of the DHCP Server granting an address to the NTS. Examination of the list will reveal the allocated address. The naming convention used by the time server is a "C" followed by the last six characters of the time server's permanent MAC address. For example: If the TCG 01 unit has a MAC Address of 00-20-4A-72-08-B7, then the DHCP name of the NTS is: C7208B7.

Each TCG 01 equipped with a time server has a label on its base that shows the permanent MAC address of the time server module..

Assigning an IP address using ARP addressing:

The ARP method is available under UNIX and Windows and can be used in systems where no DHCP server is present. The TCG 01 NTS will set its address from the first directed TCP/IP packet it receives.

On a Unix host, create an entry in the host's ARP table using the intended IP address and the hardware MAC address of the NTS (found on the label on the base of TCG 01). The UNIX command (for example addresses IP: 192.168.1.56 and MAC: 00-20-4A-72-08-B7) is:

```
arp -s 192.168.1.56 00:20:4A:72:08:B7
```

In order for the ARP command to work correctly in Windows, the ARP table on the PC must have at least one IP address defined other than its own. If the command **ARP -A** typed from the DOS prompt results in only the local IP address being shown, then "ping" any other known IP address on the network to establish a non-local entry. Once another entry is established, use the same command as above to ARP an IP address to the NTS.

Next, open a Telnet connection to port 1 using the command:

```
telnet 192.168.1.56 1
```

This Telnet connection will quickly fail (3 seconds) but the NTS will change its IP address to the one specified. Finally, open a new Telnet connection to port 9999 using the command:

```
telnet 192.168.1.56 9999
```

■ The IP address set above will revert to the default null address if the NTS is powered down or reset unless the full Set-Up procedure is completed and all of the changes stored permanently using option 9 on the Set-Up menu.

5.7.4 NTS Set-Up Mode Menu

The NTS Set-Up mode menu displays the configuration of the time server, followed by a menu. The menu display is similar for both configuration tool and network access.

```
Hardware: Ethernet Autodetect
IP addr – 0.0.0.0/DHCP/BOOTP/AutoIP, no gateway set
DHCP device name : not set
***** Tekron NTS parameters *****
SNTP Ref.Identifier : “GPS” Encryption is disabled
Visible Satellites : 1
***** Tekron NTS parameters *****
Community Name : public
Enter 1. Trap destination IP Address : --- not set ---
Enter 2. Trap destination IP Address : --- not set ---
Enter 3. Trap destination IP Address : --- not set ---
Enter 4. Trap destination IP Address : --- not set ---
Enter 5. Trap destination IP Address : --- not set ---
Syslog IP addr : --- not set --- --- not set ---
Syslog facility code: 0

Change Setup :
0 Basic parameters
1 NTS configuration
7 Factory defaults
8 Exit without save
9 Save and exit
Your choice ?
```

Figure 13 – NTS Set up mode, Main Menu

0 - Basic Parameters

This menu option allows permanent values to be assigned to the basic address parameters of the NTS module. As a minimum, the primary IP Address should be set. The other parameters that can be specified under this menu are:

- Gateway IP Address
- Number of bits in netmask

If the primary IP address is not changed from the default null value, then this menu will also included an option for setting the DHCP name. When operating with a DHCP-assigned address, the Tekron NTS has a permanently assigned DHCP name of Cxxxxxx where xxxxxx is the last 6 digits of the MAC address of the unit (shown on the label on base of the TCG 01 unit). Despite appearances, the DHCP name is *not* changeable under this menu option.

1 - NTS configuration

Selecting this option brings up prompts to set up the parameters required to operate the NTS function. For most applications, the default settings will be appropriate. The parameters that can be set are as follows:-

Broadcast Mode

Defaults to “N”. If “Y” is selected, the unit prompts for a poll interval. The unit will then broadcast time packets at the interval specified. Note that, while in broadcast mode, the unit will still respond to NTP/SNTP client requests in the usual manner. In most applications, Broadcast Mode is not used, so the default is the appropriate setting.

Encryption

Defaults to “N”. Most users will not use encryption. The TCG 01 NTS option supports fully encrypted requests from up to 6 clients simultaneously. If the answer “Y” is selected here, the unit then prompts for six encryption MAC strings. A good rule is – if you do not already know what MAC data to use – don’t attempt to use encryption at all, and leave the option at “N”.

No. of Satellites

Defaults to “1”. **Range 0-8.** If there are not this many GPS satellites being tracked for time, a SNMP message “low satellites” is generated. As TCG 01’s true clock accuracy when tracking just a single satellite is at least two orders of magnitude better than what can be practically handled on the network, the default value of “1 ” is sufficient for detection of this condition.

2 - SNMP configuration

The Tekron NTP server provides status monitoring to Network Management systems through the use of SNMP trap messages. The parameters that can be set are as follows:-

Community

The default value is “public”. This may be changed to suit the specific SNMP architecture on the network if required. If SNMP is not implemented for other purposes on the network, then the “public” setting allows the use of a simple SNMP trap display utility running on a remote monitoring PC to display the status messages sent from the NTS.

SNMP Trap IP Address

This parameter allows for up to five destination IP addresses to be entered. Machines on any or all of these IP addresses can then receive the status messages from the NTS unit. Even if there is no formal SNMP system running on the network, the messages can be received and displayed on the destination machines running “Windows NT” or higher using the freeware utility “SNMPTRAP.EXE” which is on the CD supplied with the kit.

Syslog IP Addr

One or two IP addresses may be entered to define destination machines running system logs. These parameters are really only useful in networks running full SNMP network management systems. Similarly, the following **Syslog facility code** parameter is only useful on full SNMP network systems.

Once configuration is complete, the set-up session may be terminated via option **9 Exit and Save**. The NTS will then reset and begin normal operation. (Note that the “HyperTerm” response on the PC may well go “strange” as soon as the NTS resets. This simply indicates that TCG 01 has reverted to normal operation on the serial port, transmitting whatever output options are programmed via the TCG 01 configuration program.)

5.8 Visible Satellites

Visible satellites are shown on a polar-display. The rings mark the 'elevation' and the sectors mark 'azimuth'. The centre of the display represents directly overhead and the elevation is 90° at this point. The edge of the display, elevation = 0°, represents the horizon. The 'azimuth' is a compass direction where 0° represents true north, 90° is east and 180° is south. Satellites being used are marked by a colored cross on the display, and a blue bar on the Satellite Signal Strength Indicator, otherwise it is gray on both.

Right clicking over the Visible Satellites area, brings up a menu where satellite trails (green lines), and a minimum elevation plot (the blue lines) can be turned on. Over time this minimum elevation plot will show the viewable horizon. An example of a minimum elevation plot is shown in Figure 16, which is from Wellington, New Zealand. This example shows there is poor satellite coverage in southern latitudes.

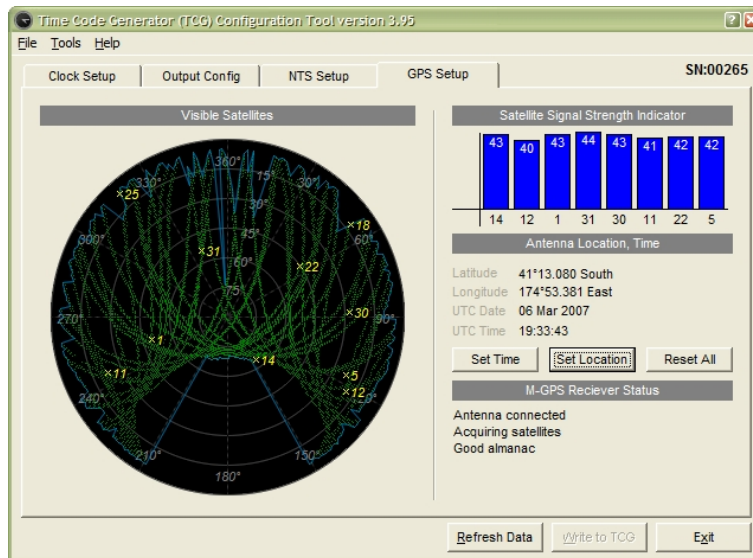


Figure 14 – GPS Setup Page, showing trails and minimum elevations turned on

■ To ensure reliable performance, when operating TCG 01 at extreme southern latitudes, ensure the antenna is positioned with a clear view of the northern sky. Similarly, when operating in extreme northern latitudes, the antenna must be able to “see” the southern sky.

5.8.1 Setting Position and Time

Time and position may be pre-set using the set time and set location buttons only if TCG 01 has no satellite tracking history. To clear tracking history, remove the antenna, then cycle power or use the “Reset GPS” button. Manual setting of the time in this way can be useful to assist in testing the behavior of synched equipment to Daylight Savings Time transitions. Note that, in order for the clock to transmit such as Daylight savings Note that, if When the clock is set in Force “Sync” on mode, the time in the TCG 01 can be arbitrarily set to output time sync signals. By left clicking on the set time button, a window will appear with time and date options

6 FACTORY HARDWARE OPTIONS

6.1 Power Supply Options

This table shows the three different power supply configurations that may be ordered with TCG 01.

Designator	DC Input Range
L (Low)	12 –36Vdc,
M (Medium)	20-72Vdc
H (High)	90-300Vdc

6.2 High Voltage (MOSFET) Output Option

TCG 01 may be ordered with either or both of the **P2** and **P3** outputs configured with a high voltage FET switching transistor instead of the standard 5V logic output. When so fitted, each output can switch an external load of up to 300VA, with a maximum “on” current rating of 1A, and a maximum rated Voltage of 300V DC.

External wiring should be arranged so that the external high voltage supply line (up to 300V DC max) is connected, via a fuse, to the load. The return connection from the load is then wired to one terminal of the **P2 (P3)** output, and the other terminal of the **P2 (P3)** output is then wired to complete the circuit back to the other side of the power supply. Do not connect the high voltage supply to P2 or P3 unless the high voltage option is fitted – check the label on the base of the TCG 01 unit.

IMPORTANT! It is the user’s responsibility to provide adequate protection in the form of an external fuse to protect the external power supply, the TCG 01 output switch and the load. **Note:** At all times, the polarity of the P2 (P3) connections should be such that conventional current flow is into the “+” terminal and out of the “0” terminal – i.e. “+” is at higher positive potential than “0”.

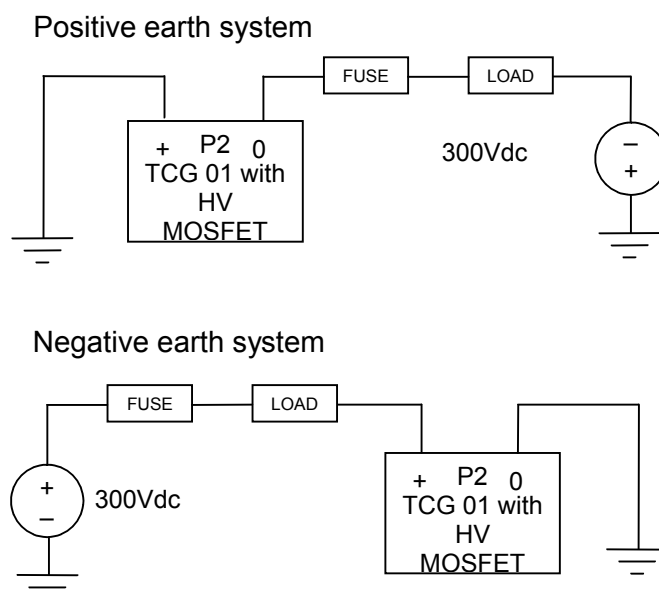


Figure 15 – High Voltage MOSFET output switch option: Suggested wiring arrangements

Output isolation (from chassis and other I/O) is still maintained when the HV option is fitted. This simplifies the external load/supply arrangements, particularly when operating with positive-earth systems – as in many utility facilities.

6.3 Network Time Server Option

Protocols supported by the TCG 01 NTS option are: ARP, UDP, TCP, ICMP, Telnet, TFTP, DHCP, SNMP and BOOTP. A TCG 01 unit equipped with the NTS option provides a complete Stratum-1 time-server function while still retaining all other output services. Specific time-sync client protocols supported are NTP and SNTP. SNMP trap support allows for status monitoring and NTS alarm reporting to 3rd party network management packages. Status reporting can be integrated with existing network management software to provide a complete package.

Provision is made for up to 5 different IP addresses to be specified for SNMP trap destinations, as well as two "Syslog" IP addresses. Accuracy of the NTS time stamps produced is to within 200 nanoseconds of UTC.

■ The RJ45 UTP port is not HV-isolated from the TCG 01 chassis, but complies with the standard balanced nature of a UTP connection for an office network

Each TCG 01 unit equipped with the NTS option is supplied complete with a 2M UTP cable. This cable is designed to connect directly between the TCG 01 unit and a network hub/switch/router. The cable is not suitable for direct connection to the network port on a PC. If such a connection is required, a cross-over cable must be obtained.

The NTS is configurable using the supplied configuration tool and a serial cable, or via a password protected telnet connection. Section 5.7 Network Time Server Configuration contains detail about how to install and configure the network time server option.

The time-server's operation is completely automatic once it is correctly configured for the network. Time-server configuration info is retained indefinitely when the unit is not powered (like all other TCG 01 configuration data). The time-server responds to time requests from multiple clients using either SNTP or NTP protocol. If the option is selected, the server will also broadcast time messages on a regular basis. The most common protocol in use is SNTP. A sample SNTP client (freeware) for use on Windows-based PC's (prior to Windows XP) is included with each TCG 01 equipped with the NTS option. Windows XP contains an NTP client as part of the operating system.

Correct operation of the Network Time Server can be verified by installing an SNTP client on any Windows-based PC attached to the network. A very simple and effective client, "Dimension 4" is included with the TCG 01 package (3 licenses are provided. Additional licenses may be purchased from Thinking Man Software: www.thinkman.com)

All that is required to use "Dimension 4" is, after the program is installed on the PC, add the IP address of the TCG 01 NTS to the list of Time Servers, and select it. "Dimension 4" will then use this address to fetch time information and sync the PC clock. "Dimension 4" installs complete with a list of internet time server addresses. To avoid any confusion, it is suggested that the user remove all of these addresses, leaving only the local NTS address.

6.4 Multi-port Hub Option



Figure 16 – The Multi-port Hub option adds seven additional I/O to TCG 01

The Multi-port Hub option consists of seven additional BNC I/O ports in a unit that matches and is mounted alongside TCG 01 in a 19" rack mount. TCG 01 with multi-port option ships with both TCG01 and Multi-port Hub units pre-installed in the rack-mount.

6.4.1 I/O Specification

Designator	Function	Description
P9, P10	Inputs 1 & 2	Share the same logical input channels as the TCG 01 P6 inputs, but are independently isolated.
P11	TTL 600ohm input impedance. Programmable output: TTL 5V 75mA sink & source	Outputs the same logical signal as the TCG 01's P4-pin1 output, and is isolated.
P12-P15	Four outputs, each independently switchable between the modulated or un-modulated form of IIRIG-B.	Un-modulated: TTL 5V 25mA sink & source, sharing a common ground between other outputs switched to un-modulated. Modulated: 8Vp-p, 100ohm, transformer-isolated.

6.5 Event Time-Tagging Option

6.5.1 Introduction

General Description & Specification

TCG 01's Event Time-Tagging Option provides for the time-stamping of rising edges seen at either channel of P6. This is a TTL level input with an input burden of 7mA.

Event time is deemed to be the rising edge of a pulse. The minimum pulse duration is 1us, and the maximum rate of time tag recording is 100 tags per second (aggregated over both inputs). In the event of pulses occurring simultaneously on both inputs, both events are captured and recorded independently with the same time data.

Tag Data

Time Tags use UTC time, and each tag includes the year, day of year, hour, minute and second, as well as fraction of second to a resolution and accuracy of 100ns. TCG 01 measures time internally in 40ns intervals, rounding to the nearest 100ns for time tag storage purposes, thus allowing accuracy to equate to resolution. Each tag record includes the input channel number, as well as the clock sync status as at the tag time.

Tag Storage

TCG 01 stores Time Tags in a data queue designed as a circular buffer. The maximum number of time tags that may be stored is 512. If further events occur when the buffer is full, TCG 01 sets an overflow status and continues storing tags, overwriting the oldest data first.

Tag Retrieval

The user can retrieve time tags from the buffer using a request/response protocol operating over TCG 01's serial port interface. Tags are retrieved from the buffer - oldest data first.

TCG 01 can be configured to broadcast either status or serial time strings over the serial port. Most users of the time tag option will want to suppress all broadcast outputs to simplify the task of time tag data collection. However, if output strings are programmed, then TCG 01 will still output time tag information when requested, timing the responses to avoid interference with the other traffic on the port.

6.5.2 TCG 01 Command / Response Message structure

Units equipped with the Time-Tagging (event recording) option provide four command/response message pairs that specifically support Time Tag management and retrieval.

All command and response messages used by TCG 01 have the same structure:-

Prefix: 2 bytes (ASCII "@" characters)
 Type: 2 bytes (ASCII alphabetic characters - case matters!)
 Data: n bytes (May be ASCII or binary data)

* The length of the "Data" field is determined by "Type". Command and Response commands, while sharing the same "Type" field, have different data content and length.

Checksum: 1 byte, Binary XOR over all bytes in the "Type" and "Data" fields
 Suffix: 2 bytes (ASCII <CR><LF>)

6.5.3 TCG 01 Commands related to Event Time Tagging

These commands and their responses contain ASCII characters only. A tool such as telnet provides a convenient way to explore the Time-Tagging command/retrieval functions manually. Note that the TCG01 native serial protocol does *not* include station addressing. In a network-connected system, the address of the Serial to Ethernet interface device can serve as the station address. Tekron International can supply such devices if required.

Ps command: Get Status

The Ps command invokes a **Ps** response that contains the clock status – which includes the number of tags currently in the time-tag event buffer.

Command (7 bytes [0-6]): Transmitted format: @@Ps#<CR><LF>
 Response: (33 bytes [0-32]): Received format: @@Ps{26 data bytes}{cs}<CR><LF>

Byte # Description (Data bytes only, bytes 4-29 in received message)

4	Antenna feed fault – [A] only if antenna line is short or open circuit *
5	No GPS Solutions – [T] only if no satellites are available for time calculations *
6	S/N level low – [S] only if S/N level is abnormally low for more than an hour *
7	Oscillator Error High – [X] only if Oscillator Control value is extreme *
8	Oscillator DAC out of range – [H] or [L] only if Oscillator Control tending towards extreme *
9	GPS Fail – [B] only if internal GPS receiver sub-system not operating properly *
10	Not implemented – ASCII [space] always
11	Tracking Satellites – [0-9] = # of satellites in time solution (see note 1 below)
12	Receiver Operating Mode – [0-5] see note 2 below
13 – 15	Time Tag Queue Indicator – [000-512, 999] # of tags in queue (999=overflow)
16 – 18	Outage Indicator – [000-999] Hours since receiver was last locked to GPS signals. Becomes non-zero one hour after loss of lock. Resets to zero when lock is re-acquired
19 – 20	Outage Indicator – [00-59] Minutes since receiver was last locked to GPS signals. Becomes non-zero one minute after loss of lock. Resets to zero when lock is re-acquired.
21	Oscillator Correction. Most significant 4 bits of 16-bit D/A converter used for oscillator control. Range is ASCII [@] to [O] (hex 40 to hex 4F)
22	Oscillator Correction. More significant 6 bits of 16-bit D/A converter used for oscillator control. Range is ASCII [@] to [del] (hex 40 to hex 7F)
23	Oscillator Correction. Least significant 6 bits of 16-bit D/A converter used for oscillator control. Range is ASCII [@] to [del] (hex 40 to hex 7F)

- 23 Frequency Error. Local Oscillator frequency offset as compared with GPS received signal. In ASCII, $\pm 00000-99999$ referenced to $1E-12$

Notes concerning the Ps command:

- * An ASCII [space] is transmitted if there is no alarm condition present
- 1. TCG 01 can track up to 12 satellites simultaneously. The message limitation of 9 is to retain compatibility with older equipment using this message format.
- 2. mode=1: satellite search, 2D/3D fix,
mode=2: GPS Automatic site survey,
mode=3: GPS position hold (most accurate time)

Pc command: Clear Time-Tag Buffer

The Pc command invokes a **Pc** response that returns the number of time-tags that were in TCG 01's event buffer when the **Pc** command was received. The event buffer is then cleared.

Command (7 bytes [0-6]): Transmitted format: **@@Pc3<CR><LF>**
 Response (10 bytes[0-9]): Received format: **@@Pc{3 data bytes}{cs}<CR><LF>**

Byte # Description (Data bytes only, bytes 4-6 in received message)

4 – 6 ASCII [000-512, 999] Number of time-tag entries in TCG 01 queue before reset.

Pt command: Get next Time-Tag

The Pt command invokes a **Pt** response that contains a single time-tag record – the oldest one in the data queue. Successive "Pt" commands will result in successive time tag data being retrieved. If the queue is empty, the **Pt** response is a null time tag. (ASCII [0] characters in all fields except delimiters).

Command (7 bytes [0-6]): Transmitted format: **@@Pt\$<CR><LF>**
 Response (33 bytes [0-32]): Received format: **@@Pt{26 data bytes}{cs}<CR><LF>**

Byte # Description (Data bytes only, bytes 4-29 in received message)

4 Day of Year in ASCII, 001 to 366
 7 Delimiter, ASCII [:] (hex 3A)
 8 – 9 Hour of Day in ASCII, 00-23
 10 Delimiter, ASCII [:] (hex 3A)
 11 –12 Minute of Hour in ASCII, 00-59
 13 Delimiter, ASCII [:] (hex 3A)
 14 – 15 Second of Minute in ASCII, 00-60
 16 Delimiter, ASCII [.] (hex 2E)
 17 – 23 Fraction of Second in ASCII (100's of nanoseconds), 0000000-9999999
 24 Quality Indicator. Codes are:
 ASCII [space] (hex 20) if receiver locked, sub-100nS Output accuracy
 ASCII [?] (hex 3F) if receiver unlocked for more than 1 minute
 ASCII [*] (hex 2A) if receiver in alarm mode – antenna fail
 25– 27 Outage Indicator – [000-999] Hours since receiver was last locked to GPS signals. Becomes non-zero one hour after loss of lock. Resets to zero when lock is re-acquired.
 28 Delimiter, ASCII [#] (hex 23)
 29 Number of Time-Tag Channel in ASCII, 1-2

Pr command: Repeat last Tag Sent

The Pr command invokes a Pr response that contains a single time-tag record – the same data that was sent in response to the last Pt command.

Command (7 bytes [0-6]): Transmitted format: @@Pr"<CR><LF>
Response (33 bytes [0-32]): Received format: @@Pr{26 data bytes}{cs}<CR><LF>

Data format is identical to **Pt** data format above

6.6 Lightning Protection Option

A lightning Protection kit may be fitted into the antenna lead-in cable. The kit contains a protection device, two coaxial cable connectors, a connector crimp tool, and mounting hardware. Refer to [Error! Reference source not found.](#) on page [Error! Bookmark not defined.](#) for specifications and installation information.

6.6.1 General

The first line of protection against the effects of lightning-induced surge events involves positioning the antenna in a "lightning-protected zone" as far as is possible. In practice, this means ensuring that there is at least one other earth-bonded structure located in the same rooftop area (e.g. another antenna, or a lightning rod) that reaches significantly higher than the top of the GPS antenna. The GPS Antenna should then be mounted so that it lies within a 45-degree angle from the top of the other earth-bonded structure. The GPS antenna mount itself should also be securely bonded directly to the building protection earth – and *not* connected via any of the other earthed structures.

However, this will *not* provide immunity from damage caused by a direct lightening strike, or voltages induced in the antenna lead-in cable due to side flashes or induction.

 **All Tekron antenna installations should follow the guidelines above – regardless of whether a separate lightning protection device is to be fitted to the antenna lead-in cable.**

In areas with a low incidence of electrical storms, careful attention to antenna positioning and earth connections may be all the protection deemed necessary. The antenna lightning protection kit LPK01 affords additional security through the use of an impulse suppressor installed in the antenna lead-in coax cable. In the event of a lightning-derived high voltage surge occurring on the coaxial cable, the impulse suppressor activates, short-circuiting the cable directly to the protection ground.

 **While the LP kit provides a high degree of protection, there is no guarantee of protection against all surge related events, including a direct lightning strike to the antenna. Careful antenna positioning is strongly advised!**

The performance of the antenna system under normal (non-surge) conditions is unaffected by the introduction of a correctly installed EMP Protector.

6.6.2 LPK01 Kit Contents

Quantity	Description
1	Polyphasor DGXZ+06NFNF-A Impulse Suppressor
2	N-type Male Crimp Style Coaxial cable connector set to match antenna cable
1	Crimp Tool to match the above connectors (RG59)
1	Roll Self-amalgamating Insulation tape

6.6.3 Installation

The impulse suppressor should be installed as per the instructions provided with the impulse suppressor.

For the lightning protector to be effective, it must be firmly mounted to a conductive metal surface that is itself bonded to the building protective earth. **Please ensure that a good electrical connection is made between the surge protector and the earthing system.**

All earthing connections should be as short as possible, should have no sharp bends or loops and should not be coiled to take up extra cable.

The preferred mounting position is on the inside of the building's exterior wall, adjacent to the antenna lead entry point.

■ **The absolute minimum bend radius for the antenna cable supplied is 40mm, but it is preferable to use a larger bending radius if possible. One way of achieving this is by positioning the protector so that the incoming antenna lead comes through the wall about 150mm away from the protector's connector. This provides some space to ease the incoming cable into a gentle arc back on to the connector.**

The antenna cable must be cleanly cut at the appropriate point and the resulting two ends terminated with the N-type connectors provided. The connectors are then attached to the protector assembly and tightened firmly by hand. Seal each of the connections by stretch-wrapping them with the self-amalgamating tape supplied in the kit. The seal provides protection against moisture ingress, and prevents the connections from loosening over time.

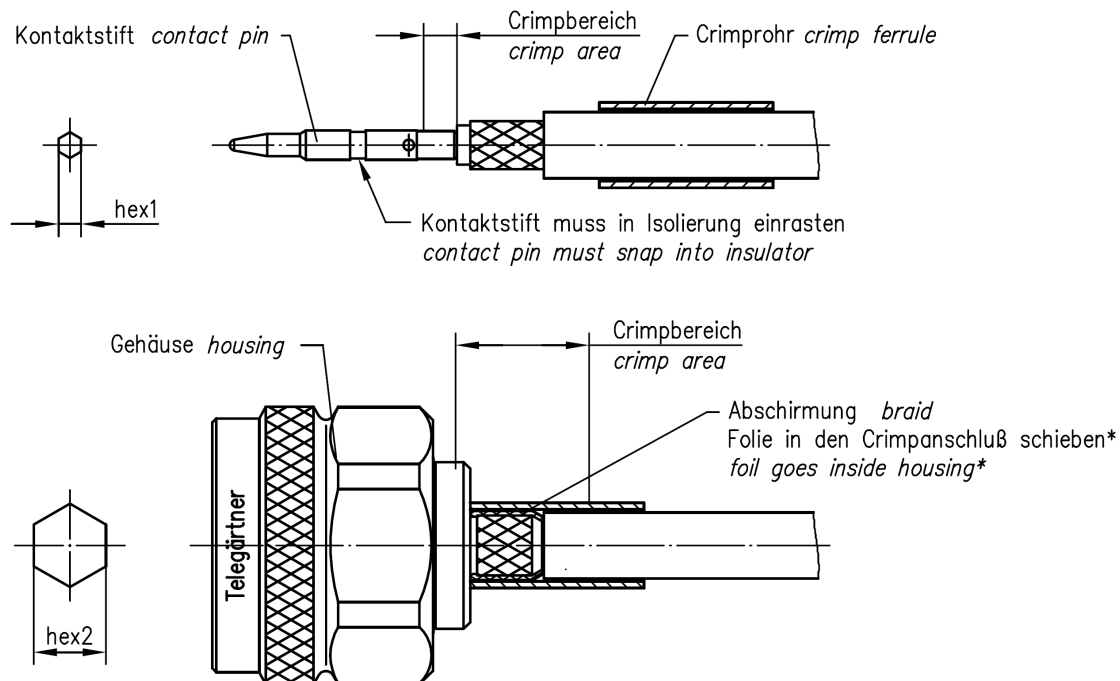
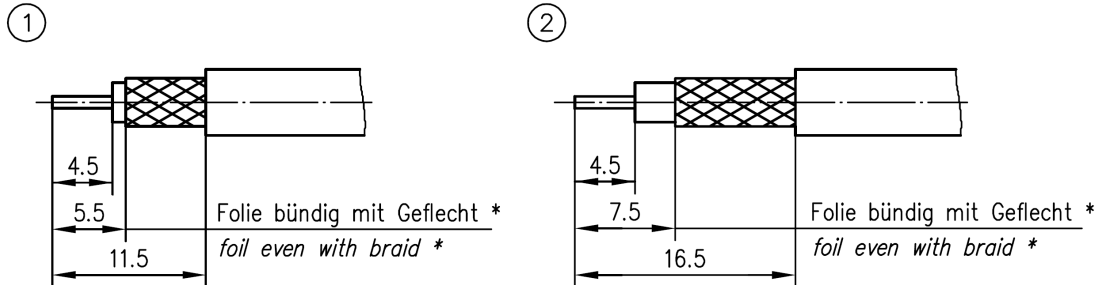
Care must be taken to mount the N-type connectors to the coax cable correctly according to Figure 10 (T00100B3300). As the GPS antenna operates at a frequency in excess of 1.5GHz, it is **essential** that the cable be prepared **exactly** as per the drawing (**Use Option 2 measurements shown** – all measurements in millimeters). A crimp tool is included in the kit – use the 0.68" die for the centre pin and the 0.256" die for the external hex housing.

Montagecode
B33XX
assembly code

Montageanweisung Assembly Instruction

Montagecode
B33XX
assembly code

Abisoliermaße *stripping instruction*



* nur für Kabel mit Folie / *only for cables with foil*

XX	Crimpeinsatz <i>crimp insert</i>	6kt.1 x Länge <i>hex1 x length</i>	6kt.2 x Länge <i>hex2 x length</i>	Abisoliermaße <i>stripping instruction</i>	
05	N01001A0005	1.69x2.5	5.41x8	①	
06	N01001A0007	1.69x2.5	6.48x8	②	

Index <i>index</i>	Änderung <i>modification</i>	Datum <i>date</i>	Name <i>name</i>

Datum <i>date</i>	Name <i>name</i>
Gez. <i>drawn</i>	29.09.00 HM
Gepr. <i>app'd</i>	11.10.00 GJ

**Serie N crimp
Series N crimp**

Unterl.-
Art R TG-Nr.
T00100B3300



Telegärtner

Original A4 Blatt 1/1

Maßstab 2:1

Ersatz für/replacement for

Alle Rechte vorbehalten/All rights reserved © by Telegärtner K. Gärtner GmbH D-71144 Steinenbronn Lerchenstr.35 Tel.: +49(0)7157/125-100 Fax: -120 URL: www.telegartner.com

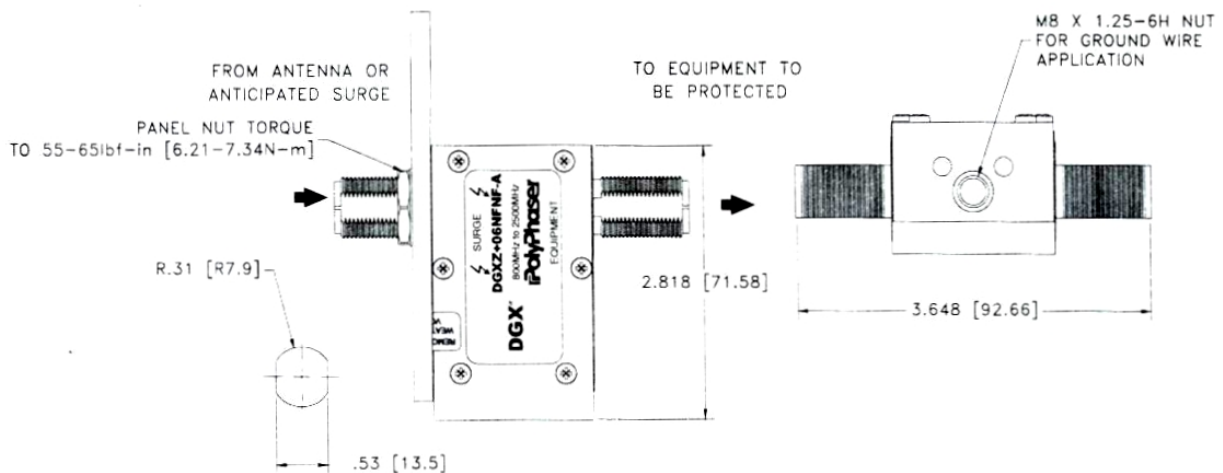
Figure 17 – N-Type connector cable preparation and termination

IMPULSE SUPPRESSOR INSTALLATION

PLEASE READ **DANGER** SHEET BEFORE INSTALLING

DGXZ+06NFNF-A

The DGXZ+06NFNF-A is used as a transmit and/or receive unit with dc voltage up to 6Vdc to power up a receive only Preamp generally located near the top of the tower at the antenna. Maximum average RF power use is 0.25 watts. Connect this unit in the direction it is labeled. The dc circuit has spike protection to suppress spikes over +6.5V to the dc Power Supply. This DGXZ+06NFNF-A is capable of 20,000 Amp maximum surges and has a frequency range of 800MHz to 2.5GHz.



IT IS VERY IMPORTANT THIS UNIT BE GROUNDED TO A LOW IMPEDANCE (LOW R AND LOW L) GROUND SYSTEM IN ORDER TO WORK PROPERLY. When attaching grounding stud (M8), use maximum of 88.5 lbf-in. [10 N-m] of torque. "N" mating connector torque is 15-20 lbf-in. [1.70-2.26 N-m]. We strongly recommend this ground be interconnected to the tower ground and power ground to form one system. To minimize the "in-air" interconnect inductance to the ground system since skin effect is present, use as straight and as large a surface area strap as possible. Keep bends to 8.0" [203.2mm] radius or larger.

The transmission line is only one means of having damaging impulse energy enter your equipment. We strongly recommend power line and telephone line protectors be used on the equipment.

LIMITED TEN YEAR WARRANTY

ENG-F-016 Rev. E 05/03

PolyPhaser Corporation warrants this product to meet or exceed the published specifications of the time of manufacturing and to be free of manufacturing defects for a ten year period after proven date of purchase. PolyPhaser Corporation makes no claims, nor extends any warranty to include an "IMPLIED WARRANTY OF MERCHANTABILITY OR IMPLIED WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE". PolyPhaser Corporation assumes no responsibility for personal injury, property damage, and any other losses. This warranty is limited to the repair, replacement or refund of purchased price of this product only and it will be PolyPhaser Corporation's decision as to whether this unit is defective and as to which of the above mentioned actions will be taken. PolyPhaser Corporation extends no obligation to update or modify any of its existing products as newly developed products are marketed.

Products may be covered under the following U.S. Patents: 5,986,869 6,061,223 6,115,227 6,236,551 6,243,247 other U.S. and Foreign Patents Pending

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6.6.4 Disclaimer

TEKRON INTERNATIONAL disclaims any liability or responsibility for the results of improper or unsafe installation practice including, but not limited to, any excessive performance degradation of the antenna system resulting from incorrect field installation of coaxial cable connectors.

7 FIRMWARE UPGRADE INSTRUCTIONS

TCG 01 clocks running D:09.XXX firmware or later is capable of being upgraded in the field. The latest firmware is available to be downloaded from the customer resources section on the Tekron International website:
www.tekroninternational.com.

The process requires a PC running Windows NT or later and equipped with a serial port. The serial port can be either a normal serial port or a USB serial port. Note that it is the user's responsibility to ensure that the port drivers are operational.

- 1 Place the two files: "TekronFWUpgrade.exe" and "xxxxxxx.FW" into a convenient directory.
- 2 Connect the Tekron clock requiring upgrade to the PC - use the Serial cable shipped with the clock. (Assuming a 9-pin connector on the PC, the wiring required is pins 2, 3 and 5 all wired straight thru).
- 3 Connect power to the clock.

To confirm that there is a good connection to the clock, run the Tekron Configuration program. If this program does not find the clock, then the upgrade process will not operate either! If the configuration program works OK, then close the configuration program and proceed as below.

- 4 From the directory noted above, run the executable "TekronFWUpgrade.exe" by double-clicking the filename.
- 5 When prompted "Choose a Firmware package", click on "Select".
- 6 In the selection Window, double-click on the appropriate .FW file. The filename will appear in the "Firmware File" box.
- 7 Click on "Perform Upgrade".

During the upgrade, the program will display the progress. On completion, the clock will automatically restart with the new firmware running.

In case of problems:-

Check the connection of the cable between the PC and the clock. If in doubt, run the Tekron configuration program.

If this does not work either, then either the PC port or the cabling arrangement is the most likely problem.

N.B. Do NOT attempt to carry out the upgrade with the clock configuration program running. Under these circumstances, the port is controlled by the configuration program, and the upgrade process cannot gain access.

In some cases, it may be necessary to trigger the process by cycling the power to the clock while the upgrade program is still searching.

APPENDIX

A SPECIFICATIONS

A.1 GPS Antenna

Physical Specifications

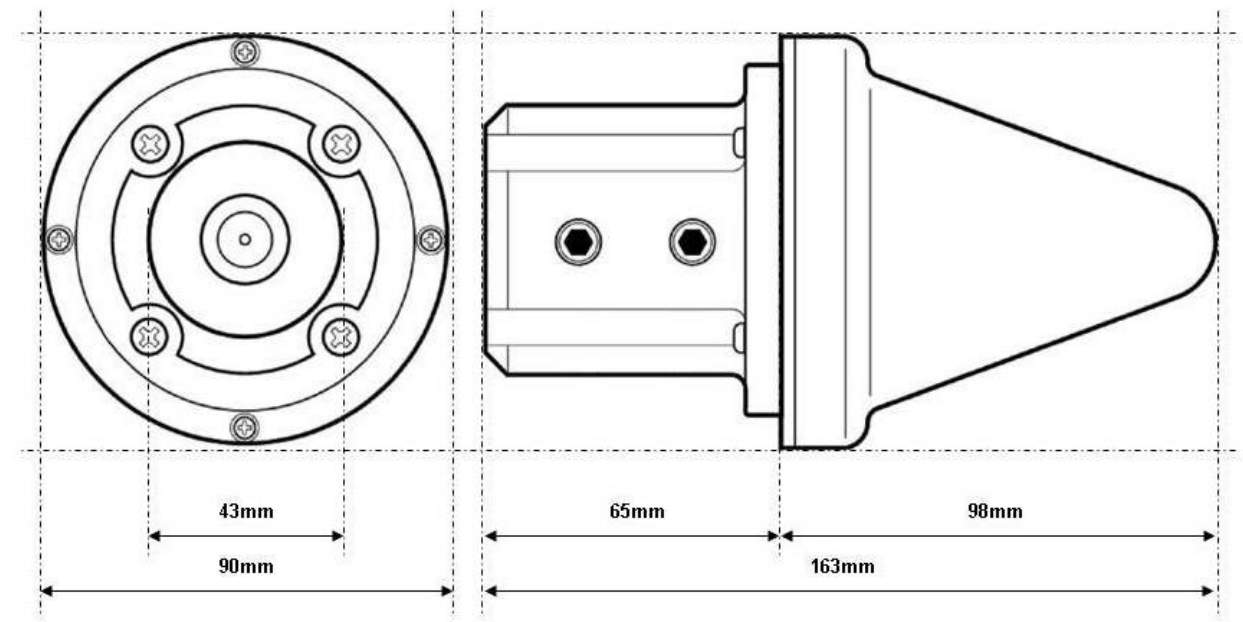
Property	Metric
Dimensions	Diameter 90mm
	Height 98mm (without connector or plinth)
Weight	200g

Environmental Specifications

Performance Property	° C
Operating Temperature Range	-40~+85

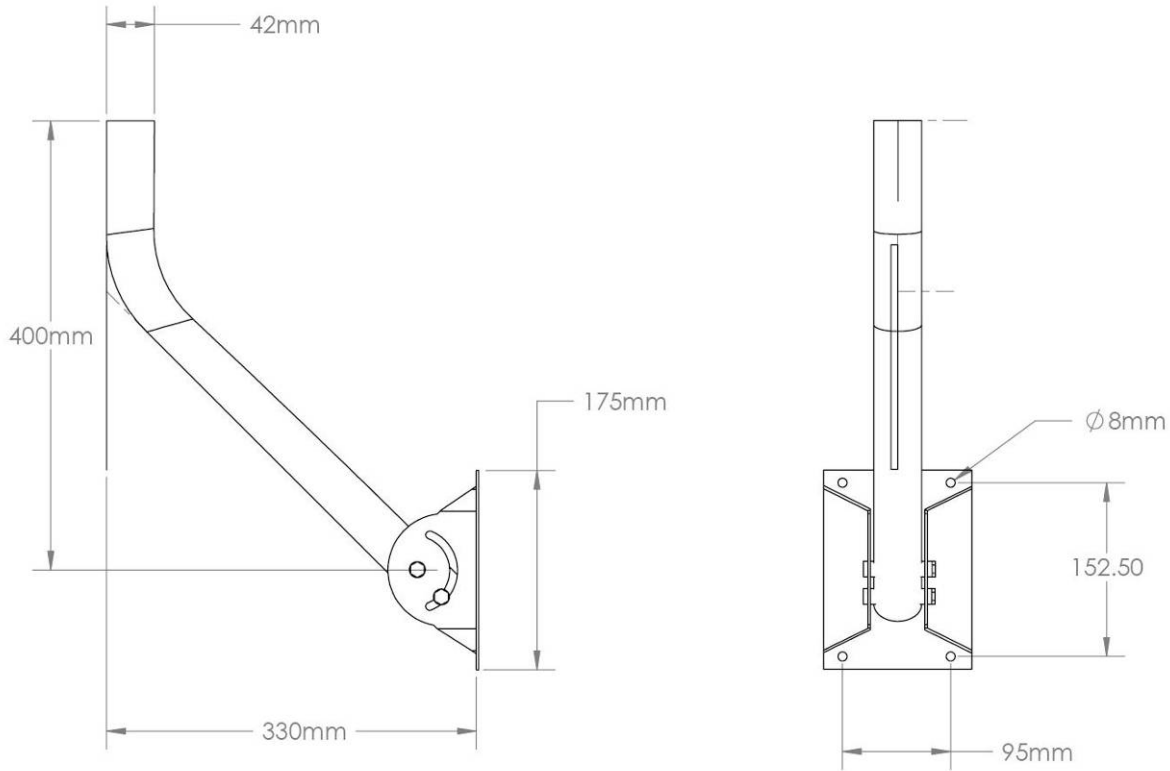
Electrical Specifications

Performance Property	Metric
Polarisation	Right hand circular polarisation
Bandwidth	1575.42MHz ± 1.023Mhz
Power Supply	5V dc ± 0.5V
Current Drain	20mA Typical
	27mA Maximum
Total Gain	38dBi Typical
	30dBi At 90° elevation
Attenuation	60dB at 1525MHz, 1625MHz (± 50MHz on centre frequency)
Output VWSR	1.5 Typical
Output VWSR	2.5 Maximum
Lightning Protection	80V for IEC1000-4-5 standard



A.2 Adjustable Antenna Mounting Bracket

The steel adjustable antenna mounting bracket will assist in the dissipation of energy should the antenna be struck by lightning. The mounting bracket should be securely bonded directly to the building protection earth – and not connected via any of the other earthed structures.



A.3 Antenna Cable

The TCG 01 can be ordered with 15, 30, or 60 meters of high performance LMR240 cable factory-fitted with a TNC-type male connector at one end, and a SMA male connector at the other. The TNC-type connector mates with the connector on the antenna and provides a robust and weather-resistant connection. The smaller SMA connector mates with the connector on the TCG 01 and is only fractionally larger in diameter than the cable itself; this facilitates installation in conduit and through small apertures.

Custom lengths can be ordered upon request (Additional charges may occur)

Where antenna cable distances exceed 60 meters, LMR400 can be used, or an in-line amplifier can be installed. Refer to Tekron for further advice.

Environmental Specifications

Performance Property	° C
Operating Temperature Range	-40~+85

Electrical Specifications

Performance Property	Metric
Attenuation (1575.42MHz)	38.9 dB/ 100m
Velocity of Propagation	84 %
Dielectric Constant	1.42 NA
Time Delay	3.97 nS/m
Impedance	50 Ω
Capacitance	79.4 pF/m
Inductance	0.20 uH/m
Shielding Effectiveness	>90 dB
DC Resistance Inner Conductor	14.1 Ω/1km
DC Resistance Outer Conductor	12.8 Ω/1km
Voltage Withstand	1500 VDC
Jacket Spark	5000 V RMS
Peak Power	5.6 kW

A.4 TCG 01 Unit

Physical Specifications

Property		Metric
Dimensions	Width	160mm
	Depth	155mm
	Height	40mm
Weight		800g

GPS Receiver

L1 (1575.42 MHz) Frequency, C/A Code, 12-Channel, parallel-tracking receiver.

Performance Property		Metric
Position Accuracy	Horizontal	<9m (90%)
	Altitude	<18m (90%)
Timing Accuracy		<15ns to UTC
Acquisition	Reacquisition	<2s (90%)
	Hot Start	<18s (90%)
	Warm Start	<45s (90%)
	Cold Start	<50s (90%)
Sensitivity	Acquisition	-136dBm
	Tracking	-140dBm
Voltage		3.0~5.5Vdc

Oscillator Specifications

Oscillator Type		Stability
Conventional Oscillator	XO	5 parts in 10 ⁸
Stability (Freewheeling stability, following tuning from at least 4 or more GPS satellites for at least 30 minutes.)		

Input and Output Specifications

Type	Electrical	Physical	Accuracy at the port
AM IRIG-B (modulated)	10V	BNC	≤1us of UTC
TTL	5V	2 pin Phoenix or BNC	≤100ns of UTC
RS422/ 485		2 pin Phoenix or BNC	≤100ns of UTC
RS232		DB9	≤1.5us of UTC
HV Switching (MOSFET)		2 pin Phoenix	≤100ns of UTC
Fiber	N/A	ST	≤100ns of UTC
NTP/ SNTP		RJ45	≤200ns of UTC

Environmental Specifications

Performance Property	° C
Operating Temperature Range	-10~+65

Electrical Specifications

Performance Property		Metric
Power Supply	Low Voltage	12-36Vdc
	Medium Voltage	20-72Vdc
	High Voltage	90-300Vdc
Power drain		6W max

Isolation & Protection

All inputs and outputs feature 2.5kV isolation from each other. In addition, the logic level outputs (**P2** and **P3**) are each protected against damage from transverse voltage events via a three-stage network of varistor, auto-resetting fuse, and transient suppressor diode.

■ Fuse and varistor protection is removed when the switching MOSFET factory option is fitted. The user must provide an external power supply and suitable fusing to use the MOSFET output option. (See 5.1 Power Supply Options. High Voltage (MOSFET) Output Option on page 14 for further information on the MOSFET Output option)

Varistor protection and current limiting (nominally 5mA) are employed for protection on the general-purpose input.

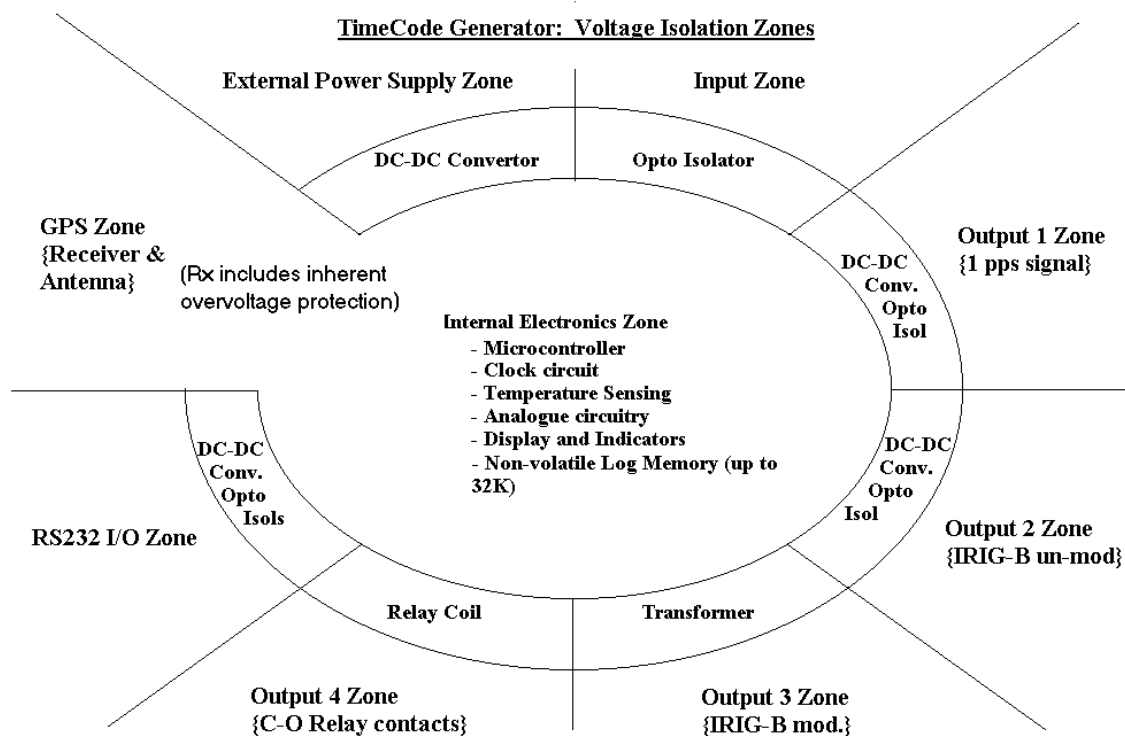


Figure 17 – TCG 01 Isolation Zones

Transformer isolation via DC-DC converter is used for the main power supply and for power to each of the logic output-drive circuits. The serial communications interface is also separately powered via isolating DC-DC converter. High-speed, fixed delay opto-isolators are used in each of the time-sensitive signaling paths. The isolation does not degrade the time accuracy of the output signals, as the fixed delays of the isolating components (together with the delay associated with the antenna lead-in) are all internally compensated.

A.5 In-line Amplifier

The Raven LA Series inline amplifier, filters and amplifies GPS signals to extend cable runs hundreds of feet.

Physical:

Length	95 mm (approximately)
Diameter	163 mm
Weight	420g
Connector type	N-Type Female (Both ends)

Electrical Specifications

Power Consumption	8mA
Input Voltage	3 – 8 Vdc
Operating Current	< 10 mA typical
Noise Figure	< 4 dB typical

Environmental:

Operating Temperature	-55 ~ 45 C
-----------------------	------------

A.6 Lightning Protection Kit

The Polyphaser GX™ Series is like no other DC-passing protector. It has separate circuits for RF-path protection and DC pass protection. This “extra” - filtering allows us to provide the lowest let through voltage in the industry. The GX™ Series is the protector to which all others are compared, and is the standard protector for GPS and tower mounted equipment.

Physical Specifications

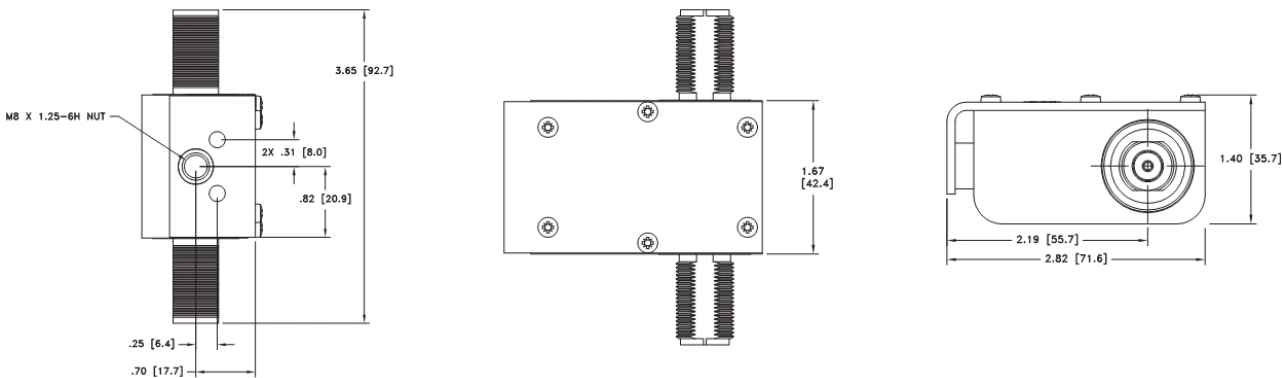
Property	Metric	
Dimensions	Width	93mm
	Depth	72mm
	Height	36mm
Weight	200g	
Connector type	N-Type Female (Both ends)	

Electrical Specifications

Operating Voltage	6.5Vdc
Maximum RF Power (@20°C)	300W
Frequency	800 – 2500 MHz
Insertion Loss	<0.1db (Typical)
Return Loss	>26 db
Surge (Max) Multi strike	20kA @ 8x20µs (IEC 61000-4-5)
Surge Throughput Energy:	<15µJ @ 6Vdc to 610µJ @ 60Vdc (4kV/2kA 8x20µs waveform)
User current	≤4A

Environmental:

Relative Humidity	0 to 95%
Vibration	1G @ 5Hz to 500Hz
DC Resistance	<0.1Ω Typical
Temperature	-50°C to +85°C
Fully weatherized housing meets IEC 60529 IP67	
Meets Bellcore #TA-NWT-00487 (Procedure 4.11) wind driven 120 MPH rain intrusion	



B SERIAL OUTPUT STRINGS

B.1 NGTS Time Code O/P on P4

Timing	Transmitted once per minute. Sent during the last second before the minute rollover to which the data in the string refers	
About	Normally used in conjunction with 10mS pulse on P4 pin 1 that finishes precisely on the minute. See the hint in Section 6.4.1 .	
Comms	9600bd, 8-bit ASCII, no parity	
Definition	TTYMMWhhmmx<CR><LF>	
	Placeholder	Content
	T	"T"
	YY	Last two digits of the year: e.g. "12" = the year 2012
	MM	Month: "00" = January ... "12" = December
	W	Day of week: "01"=Monday ... "07"=Sunday
	hh	Two digit hour
	mm	Two digit minute
	x	Time mode: "0" = Local time, "1" = UTC time
	<CR>	Carriage Return: HEX 0D
	<LF>	Line Feed: HEX 0A

Example	Interpretation
T020422112340<CR><LF>	Monday 22 April 2002 – 12:34 local time

B.2 IRIG J-17 Time Code O/P on P4

About	This code is compatible with IRIG Standard 212-00	
Timing	Transmitted once every second. The leading edge of the "start" bit of the first character <SOH> is exactly on the second that the message describes.	
Comms	9600bd, 7-bit ASCII, odd parity	
Definition	<SOH>DDD:hh:mm:ss<CR><LF>	
	Placeholder	Content
	<SOH>	HEX 01
	DDD	Day of year: range "001"—"365"
	:	HEX 3A
	hh	hour: "00"—"23"
	mm	minute: "00"—"59"
	ss	Seconds: "00"—"59"
	<CR>	HEX 0D
	<LF>	HEX 0A

Example	Interpretation
<SOH>112:12:34:36<CR><LF>	day 112, time 12:34:36

B.3 String-A Time Code O/P on P4

About	This code is very similar in data content to the IRIG J-17 code, but adds a two-character field containing the year, and uses 8-bit ASCII, no parity data format
Timing	Transmitted once every second. The leading edge of the "start" bit of the first character <SOH> is exactly on the second that the message describes.
Comms	9600bd, 8-bit ASCII, no parity
Definition	<SOH>DDD:hh:mm:ss:YY<CR><LF>
Placeholder	Content
<SOH>	HEX 01
DDD	Day of year: range "001"—"365"
:	HEX 3A
hh	hour: "00"—"23"
mm	minute: "00"—"59"
ss	seconds: "00"—"59"
YY	year: "00"—"99" representing the last two digits of the year
<CR>	HEX 0D
<LF>	HEX 0A

Example	Interpretation
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<SOH>112:12:34:36<CR><LF>	day 112, time 12:34:36
---------------------------	------------------------

B.4 String-B Time Code O/P on P4

About	This code substitutes a "Quality" indicator byte for the year field, but otherwise is identical in form, function and timing to String-A.
Timing	Transmitted once every second. The leading edge of the "start" bit of the first character <SOH> is exactly on the second that the message describes.
Comms	9600bd, 8-bit ASCII, no parity
Definition	<SOH>DDD:hh:mm:ssQ<CR><LF>
Refer to String-A table (above) for the definitions of the common digits:	
"Quality" Character (Q)	Meaning
HEX	ASCII
20	<Space> Clock in sync, timing accuracy is better than 60nS
2E	. (full stop) Clock is accurate to 1uS
2A	* Clock is accurate to 10uS
23	# Clock is accurate to 100uS
3F	? Clock accuracy may be worse than 100uS

Example	Interpretation
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<SOH>112:12:34:36?<CR><LF>	day 112, time: 12:34:36, >100uS sync error
----------------------------	--

B.5 String-C Time Code O/P on P4

About	This code is effectively a combination of String-A and String B. It provides both year information and a sync indicator field.
Timing	Transmitted once every second. The leading edge of the “start” bit of the first character, <CR>, is exactly on the second to which the message data refers.
Comms Definition	9600bd, 8-bit ASCII, no parity <CR><LF>Q★YY★DDD★hh★mm★ss.000★ ★ ★
Placeholder Content	
<CR><LF>	HEX 0D,0A
Q	Quality indicator: “ ” = in-sync, “?” = out-of-sync
★	HEX 20 (ASCII “ ”)
YY	Year: “00”—“99” representing the last two digits of the year
DDD	Day of year: range “001”—“365”
hh	hour: “00”—“23”
mm	minute: “00”—“59”
ss	seconds: “00”—“59”
.000	ASCII “.000”

Example	Interpretation
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<CR><LF>? 02 112 12:34:36.000	day 112 of year (20)02, time: 12:34:36, out-of-sync
-------------------------------	--

N.B. in the above example the three trailing spaces as described in the definition are invisible.

B.6 String-D Time Code O/P on P4

String-D is IDENTICAL in content to String-B, but the second mark is at the leading edge of the start-bit of the (<CR>).

Example	Interpretation
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<SOH>112:12:34:36?<CR><LF>	day 112, time: 12:34:36, >100uS sync error
----------------------------	--

B.7 String-E Time Code O/P on P4

About	This provides time, year information, and a sync indicator field.
Timing	The string is transmitted once every second, with the leading edge of the “start” bit of the <CR> exactly on the second.
Comms Definition	9600bd, 8-bit ASCII, no parity <SOH>YYY:DDD:hh:mm:ssQ<CR><LF>
Placeholder Content	
<SOH>	HEX 01
YYY	3-digit year, e.g. “012” = 2012
:	HEX 3A
DDD	Day of year: range “001”—“365”
hh	hour: “00”—“23”
mm	minute: “00”—“59”
ss	seconds: “00”—“59”
Q	Quality character, as defined in String-B (above)

Example	Interpretation
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<SOH>004:112:12:34:36?<CR><LF>	(2)004, day 112, 12:34:36pm, >100us sync error
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B.8 String-F Time Code O/P on P4

Timing	The string is transmitted once every second, with the leading edge of the “start” bit of the first carriage return (<CR>) exactly on the second.
Comms	9600bd, 8-bit ASCII, no parity
Definition	<CR><LF>1100<CR><LF>44hhmmss<CR><LF>54ddd<CR><LF> <CR><LF>45HHMMss<CR><LF>55DDD<CR><LF><BEL>
Placeholder	Content
<CR><LF>	HEX 0D, 0A
1100	ASCII “1100”
44	ASCII “44” (means local time follows)
54	ASCII “54” (means local day of year follows)
45	ASCII “45” (means UTC time follows)
55	ASCII “55” (means UTC day of year follows)
ddd	Local day of year: “001”—“365”
hh	Local hour of day: “00”—“23”
mm	Local minute of day: “00”—“60”
ss	seconds: “00”—“59”
DDD	UTC Day of year: “001”—“365”
HH	UTC hour: “00”—“23”
MM	UTC minute: “00”—“59”
<BEL>	HEX 07

B.9 NMEA ZDA Time Code O/P on P4

About	This string is compatible with and defined by the NMEA-0183 standard
Timing	Transmission is once every second. The leading edge of the “start” bit of the “\$” is exactly on the second.
Comms	9600bd, 8-bit ASCII, no parity
Definition	\$GPZDA,hhmmss.00,DD,MM,YYYY,xx,yy*CC<CR><LF>
Placeholder	Content
\$GPZDA	ASCII “\$GPZDA”
,	ASCII “,” (comma)
hh	UTC hour of day: “00”—“23”
mm	UTC minute of day: “00”—“60”
ss	UTC Seconds: “00”—“59”
.00	ASCII “.00”
DD	UTC day of month: “01”—“31” depending on which month
MM	UTC month: “01”—“12”, “01” = January
YYYY	UTC year, 4 digit.
xx	Local time zone offset from UTC in hours ¹
yy	Local time zone offset from UTC in minutes ¹
*	ASCII “*”
CC	2-digit hex representation of the result of XORing the 8 data bits of each character between, but not including the “\$” and “*”. (00-FF)
<CR><LF>	HEX 0D, 0A

¹set to zero when UTC time in ASCII string is selected

B.10 NMEA RMC Time Code O/P on P4

About	This string is compatible with and defined by the NMEA-0183 standard
Timing	Transmission is once every second. The leading edge of the "start" bit of the "\$" is exactly on the second.
Comms	9600bd, 8-bit ASCII, no parity
Definition	\$GPRMC,hhmmss.00,a,tt,tt.tttt,n,ggg,gg.gggg,w,0.0,0.0,DDMMYY,0.0,E*CC<CR><LF>
Placeholder	Content
\$GPZDA	ASCII "\$GPRMC"
,	ASCII "," (comma)
hhmmss	UTC hour of day, minute of day, seconds
.	ASCII "." (full stop)
0	ASCII "0"
a	Status: "A" = valid, "V" = invalid
tt,tt.tttt	Latitude (degrees, minutes): "00,00.0000"—"89,59.9999"
N	Latitude (north/south): "N" = north, "S" = south
ggg,gg.gggg	Longitude (degrees, minutes): "000,00.0000"—"359,59.9999"
W	Longitude (east/west): "E" = east, "W" = west
DDMMYY	UTC day of month, month, 2-digit year:
E*	ASCII "E*"
CC	2-digit hex representation of the result of XORing the 8 data bits of each character between, but not including the "\$" and "*".
<CR><LF>	HEX 0D, 0A

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