TCG 01-G

USER MANUAL

Contents

1. INTRODUCTION

The TCG 01-G 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-G features one amplitude modulated (AM) IRIG-B output and three user-programmable outputs, including a serial port. The serial port is user-configurable to output serial strings and report event data for units fitted with event recording capability. Factory options include a choice of physical connectors: BNC, 2-pin plug and socket, or ST Fiber. Non-fiber outputs can be ordered as TTL, RS422/485, or high voltage switching.

All TCG 01-G units feature a front panel display (Figure 1) giving visual feedback about the time data being generated on the outputs. LED indicators provide "at a glance" status information.

Figure 1 – TCG 01-G chassis and front panel

The optimized receiver/antenna system used by TCG 01-G obtains time with near-atomic clock precision from the available Global Navigation Satellite Systems (GNSS). The result is output timing accuracy similar to that normally seen only in laboratory instruments.

However, unlike laboratory instruments, TCG 01-G is suited for hostile electromagnetic environments such as sub-stations and electrical switchyards. Each output of the TCG 01-G 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. In addition, isolation protects the internal electronics from longitudinal transient voltages and transient suppression devices protect from transverse transient voltages.

The TCG 01-G features a 10/100Mb Ethernet port through which the unit can be configured. Firmware license options include a stratum 1 NTP server and IEEE 1588 V2 functionality. When the IEEE 1588 (PTP V2) option is enabled, the unit can operate as a PTP Grand Master, an ordinary PTP clock, or a Slave-Only Clock.

The TCG 01-G has automatic IRIG-B slave functionality which allows the TCG 01-G to accept two DCLS IRIG-B signals for synchronizing purposes. This function provides automatic selection of the synchronization source.

It comes complete with Ethernet cables to allow for customization and easy setup from the Windows™ Configuration software which is available to download from www.tekron.com. Optional accessories include antenna, low loss antenna cable, antenna pipe mounting components and lightning protection kit.

2. FRONT PANEL

Figure 2 – TCG 01-G front panel

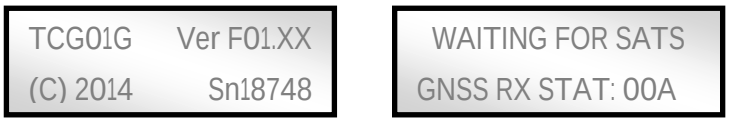
TCG 01-G features two LED indicators on the front panel (Figure 2), together with a 2-line by 16-character backlit LCD display.

SYN LED: This LED shows the status of the current sync source.

ALM LED: This LED shows the alarm status of the TCG 01-G.

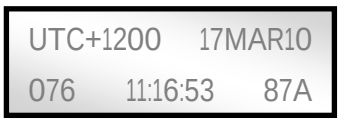
LCD Display

On initial power-up, the LCD display shows a copyright message, along with the serial number and revision level of the unit (Figure 3a). Approximately 10 seconds after power-up, the display changes automatically to indicate that it is waiting for satellites (Figure 3b). Once one or more satellites have been discovered, it transitions to the operating default display (Figure 3c). After which, the user can access alternative time displays by pushing the button on the front panel between the LED indicators, as shown in Figure 3d and Figure 3e. 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.

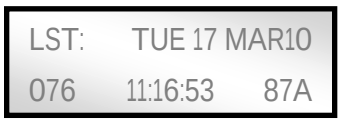


3a – Start Up (Clock ID)

3b – Waiting for Satellites



3c – Operating Default



3d – Local Time

3e – UTC Time

3f – Alarm

Figure 3 – LCD display screens

"UTC" denotes Universal Time Coordinated (approximately equivalent to GMT). The top line of screen in Figure 3c 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.

Figure 3c shows that the clock is operating with a local time offset of 12 hours ahead of UTC. The local date is 17th March 2010, and the local time is 11:16:53 in the morning.

Figure 3d 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 3d changes to "LDT", denoting Local Daylight Time.

Figure 3e shows the UTC time and date which is 11:16:53 on the evening of Monday, 17th March 2010.

The display screens in Figure 3b, 3c, 3d and 3e each 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 GNSS receiver and are explained in Figure 4.

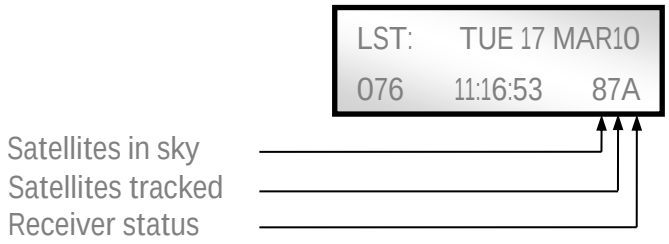


Figure 4 – Satellite tracking status

Character	Values	Description
Satellites in the sky	"0 - 9": 0 - 9 "A - E": 10-14 "F": >14	This character represents the total number of satellites currently present in the sky according to the GNSS almanac. "0" in this position means that TCG 01-G has lost its knowledge of the GNSS satellites' orbit geometries. This occurs if the unit has been in storage for an extended period, or if the GNSS receiver has been reset. It will typically take 20 minutes (worst case two hours) for the unit to gain sufficient GNSS synchronization for the TCG 01-G to recommence normal operation (Position hold).
Satellites tracked	"0 - 9": 0 - 9 "A - E": 10-14 "F": >14	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 the clock will indicate the "out of sync" condition.
Receiver status	"A"	TCG 01-G 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. Synchronization is not compromised.

Character	Values	Description
	"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-G is calculating an accurate position; once complete the mode will change to Position hold.
	"P"	"Position hold": Position is known accurately, and the GNSS is providing its most accurate time, typically better than 40 ns to UTC.

Display Status Table 1a – GNSS Status

Character	Values	Description
Alternate Sync Source	"SL1"	Clock is synchronized to an IRIG-B source on P6A input "Slave: Copper"
	"SL2"	Clock is synchronized to an IRIG-B source on P6B input "Slave: Copper"
	"SLF"	Clock is synchronized to an IRIG-B source on the Fiber input "Slave: Fiber"
	"PTP"	Clock is synchronized to a Precision Time Protocol (PTP) master clock.
	"NTP"	Clock is synchronized to a Network Time Protocol (NTP) server.
	"TST"	Clock is operating with manually set time. Please refer to configuration tool "Set Time" function for further details

Display Status Table 1b – Alternative Sync Source

If the clock is configured to synchronize to IRIG-B only (ignore GNSS) then "SL?" will be displayed in the status field if there is no IRIG-B signal input.

Contrast Adjustment Mode

The LCD contrast can be adjusted by entering the Contrast Adjustment Mode. This mode is entered by double pressing the button on the front panel.

Once in Contrast Adjustment Mode, pressing the button will lighten the contrast and decrease the contrast by one level. There are five different contrast levels and the LCD will cycle from the lightest to darkest if the button is pressed when on the lightest setting.

To exit the Contrast Adjustment Mode, simply double-press the button on the front panel again. The button will return to normal operations after this.

LED Indicators

The **SYN LED** shows the status of the sync source. The various states are shown as follows:-

State	Description
off	The TCG 01-G has no power
on	The TCG 01-G is synchronized to the source indicated by the LCD display
Slow Flash (1 per second)	The TCG 01-G is operating in the "hold-over" state (Sync Hold timer running)
Fast Flash (5 per second)	The TCG 01-G is not synchronized. "Out of Sync" condition

LED Indicators Table 2 – SYN LED

The ALM LED indicates the internal alarm status of the TCG01-G. It has only two operating states:-

State	Description
off	The TCG 01-G is operating normally. i.e., there are no alarms
Fast Flash (5 per second)	Alarms are active. In this case, the actual alarm state is shown on the top line of the LCD display, replacing the normal date information (see example in Figure 3f above).

LED Indicators Table 3 – ALM LED

Alarm Messages

When an alarm condition is active, a four-character message is shown on the top line of the LCD, replacing the normal date information (see example in Figure 3f above). The possible alarm messages are shown below:

Message	Description
Sync	The TCG 01-G is not synchronized. "Out of Sync" condition.
Hold	The TCG 01-G is operating in the "hold-over" state (Sync Hold timer running).
AntL	The current being drawn from the antenna connector is lower than expected. This is usually caused by the antenna being disconnected, or a break in the antenna cable.
AntH	The current being drawn from the antenna connector is higher than expected. This is usually caused by a short-circuit in the antenna cable.
IRIG	IRIG-B monitoring is enabled on the P6A and/or P6B input, and a valid IRIG-B signal is not present on that input.
IPe1	IP error, port ETH1. The clock has failed to obtain an IPv4 address via DHCP, and has adopted an ARP tested Link-Local address (169.254.xxx.xxx). When this alarm occurs, the user may need to update their network adaptor settings to a Link-Local address to gain access to the clock. The alarm will persist until the IPv4 address settings are changed or the clock is connected to a DHCP enabled network.

Display Status Table 4 – Alarm Messages

3. BACK PANEL

An example TCG 01-G back panel is shown in Figure 5 below. Its appearance may vary, as different connector types can be fitted at the factory to suit your requirements.

Figure 5 – Rear panel of TCG 01-G, configured with 2-pin connectors (P2 and P3)

P1: Power Input (2-pin Connector [5.08 mm])

Power is applied to the unit via this plug. Maximum steady state power consumption is 6 W, and surge protection is provided. A mating connector is supplied that is suitable for wiring up to 1.5 mm^2.

Note that the DC input is protected against incorrect power supply polarity.

The power supply inputs are isolated from earth so that any earthing system is acceptable (PEN, positive earth, negative earth or non-earthed low voltage supply).

Check the label on the unit base for power supply voltage rating!

Earth Stud (M4 Nut)

Located under the serial port, to the left of the P4 designator is a M4 bolt provided for earthing. An external ground connection must be connected to ensure appropriate grounding for the unit.

4. BACK PANEL – INPUTS AND OUTPUTS

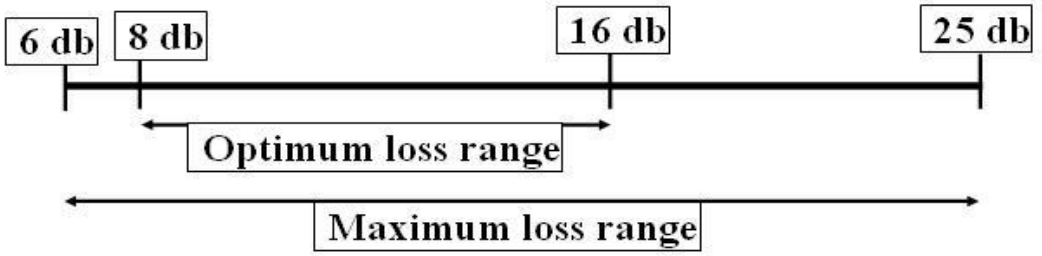
ANT: Antenna Connector (SMA Connector)

The "ANT" is the GNSS antenna input port. The antenna port provides an interface for an external active antenna via low-loss coaxial cable: 50 Ω impedance. 5 V DC @ 50 mA 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 22 dB.

If the Fiber-Slave option is ordered, the antenna is replaced by a fiber input port.

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!

Antenna Cable Considerations:



Note: The following figures are based on an average GNSS signal strength of -130dBm at sea level.

CNT-240	32.8 dB/100 m (10dB/100ft). Plus 1 dB/connector
	Approx. Optimum Length Range: 18 to 42 meters
	Approx. Maximum Length Range: 12 to 70 meters
CNT-400	16.73 dB/100 m. Plus 1 dB/connector
	Approx. Optimum Length Range: 34 to 79 meters
	Approx. Maximum Length Range: 23 to 129 meters

A lightning protection device should 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 (FACTORY HARDWARE OPTIONS). Introduction of the lightning protector does not degrade the performance of the antenna system.

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

Electrical and Physical Configuration

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

Electrical	Electrical Specification	Physical
TTL	CMOS/TTL (5 V) logic level driver output ports, 150 mA sink and source. The port is fully floating and has independent electrical isolation to 2.5 kV.	2-pin or BNC
RS422	High Speed RS422/485 (5 V differential) output ports. The port is fully floating and has independent electrical isolation rated to 2.5 kV.	2-pin
HV MOSFET	Power MOSFET Switch, allowing switching of 300 VA, 1 A max. The port is fully floating and had independent electrical isolation rated to 2.5 kV. Refer to Figure 11 for suggested wiring configurations for use with Power MOSFET switching.	2-pin
Fiber	ST fiber transmitters, compatible with ST-terminated 62.5 µm fiber diameter, 125 µm jacket diameter multi-mode fiber optic cabling. The maximum length of fiber recommended is 750 m. (λ=820 nm)	ST Fiber

Examples of the three connector types are given in (**Figure 6**) to (**Figure 8**);

Figure 6 – 2-pin connector

Figure 7 – BNC connector

Figure 8 – Fiber connector

P2, P3 Programmable Output Options

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

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

P4: Serial Port and Programmable Output (DB9 Connector)

If not requested otherwise, the TCG 01-G 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. As the serial outputs are usually precisely timed messages, there is no provision for either hardware or software flow control.

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

The following signals are present on P4 (DCE configuration only):

- Pin 1: RS232 level (-9V to +9V) programmable output.
- Pin 2: RS232 level serial string.
- Pin 5: RS232 signal ground.
- Pin 4 & Pin 6: RS422 level 5V) differential programmable output.
- Pin 8 & Pin 9: RS422 level serial string.

The RS232/RS422 signal lines are not isolated from each other, but the port as a whole has an isolation rating of 2.5 kV from all other ports.

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 user configurable data rate between 1200 and 38400 bps (available rates are 1200, 2400, 4800, 9600, 19200 and 38400 bps). Message formats typically operate at 9600 baud, 8-bit with no parity, no flow control and 1 stop bit. Most messages 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
- Eight pre-set messages, String/Tekron A – H for compatibility with most IED.
- NMEA ZDA and RMC messages
- GNSS Binary/Messages, these are subject to change without notice.

See Appendix (SERIAL OUTPUT STRINGS) for details on each of the message string formats.

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

P4 pin 1 Programmable Output

The user may configure the P4 pin 1 output to operate with inverted or non-inverted polarity, and:

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

P4 pin 1 is not available on TCG 01-G with DTE serial ports. If not specified, TCG 01-G will ship with a DCE serial port.

P5: AM IRIG-B Output (BNC Connector)

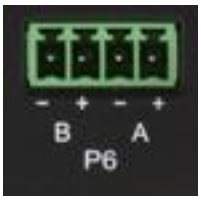
P5 provides AM IRIG-B (B12x) over a BNC connector. This output is not programmable for other types of signal and a 1 kHz carrier is present whenever the unit is powered. The particular IRIG-B data content is as specified by the configuration program.

Use either a coaxial cable or a 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 3:1, and peak to peak output level is 8 V (max), 120 Ω impedance. The output is fully floating, and is transformer-isolated to 3.75 kV.

Most devices with amplitude-modulated IRIG-B time sync inputs have an input impedance of between 4 kΩ and 20 kΩ, and a maximum allowable peak-to-peak level of approximately 6 V. The P5 output on the TCG 01-G is designed to drive multiple devices in parallel, with a terminating resistor (typically 100-180 Ω) 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 (dependent upon layout, device input impedance, etc.), without any external amplification. The terminating resistor is essential to ensure good noise immunity and correct voltage levels.

P6: Event Recording / IRIG-B Sync Inputs (4-pin 3.81 mm Connector)



The pluggable connector provides two input channels that may be driven by TTL sources. The input can be either a pulse for event recording or un-modulated IRIG-B (B004 + IEEE1344 extensions) for GNSS sync backup. The input type is software configurable. If both event recording and IRIG-B sync input functions are selected, then channel 'A' is the Event Input and channel 'B' is the IRIG-B sync input.

The expected input is 5 V, 7 mA however; inputs up to 10 V, 20 mA may be applied, and the '+' and '-' symbols represent the positive and negative terminals respectively. Wiring size is up to 1.00 mm².

The two ports are isolated from the rest of the system by a 2.5 kV barrier and the ports have a 60 VDC isolation from each other. Each input is protectively clamped to 25 V and uses a 470 Ω resistor to limit the current.

P7: Sync Relay (4-pin 3.81 mm Connector)

P7 provides two alarm output channels.

P7 A is GNSS signals receive fail (Antenna fail) alarm. The antenna alarm only occurs after a continuous 5 seconds with the antenna disconnected.

P7 B is a synchronization fail alarm. This alarm is triggered if the TCG 01-G is unable to synchronize to any incoming time source. TCG 01-G will synchronize to UTC time derived from GNSS, if GNSS reception is available. In the absence of GNSS, the unit will then attempt to sync to an IRIG-B time source connected via the P6A and/or P6B inputs (P6A takes

priority over P6B). If the unit is optioned for PTP operation, it can also sync to time from a distant PTP Master clock.

If all sync is lost, the TCG 01-G will operate in "Sync Hold" mode for a period defined by the "Sync Hold time" parameter (configurable in the Configuration Tool). At the expiry of the "Sync Hold time", the alarm condition is signaled. When sync is restored, the alarm condition is retained for 5 seconds before being cancelled.

The alarm outputs are Type A (*normally-open*) dry contact types (implemented using solid state relays). Note: the *"Normally-Open"* descriptor refers to the de-energized state of the relay. The convention used in the TCG 01-G is to have the alarm relays energized during normal operation, and de-energized in the alarm state. In the case of all power to the clock being lost, all of the alarm relays then default to the "alarm" state (open contact). The '+' and '-' symbols represent the positive and negative terminals respectively. The wiring size is up to 1.00 mm^2; contact rating: 200 V, 150 mA DC or 150 V, 100 mA AC.

ADMIN/ETH1: Ethernet Communication Port (RJ45 Connector)

The Ethernet port (ETH1), features a RJ45 connector and supports 10/100 Mbps, Auto MDX & Auto Negotiate. The LEDs convey Link (**LNK**) and Activity (**ACT**) status for the port.

The LNK LED will be on when the unit is connected to a valid Ethernet port whilst the ACT LED will be on when there is activity on either the transmit or receive pair.

This port is also used to configure the clock via the Tekron Configuration Tool which is available for download on the TCG 01-G page on the Tekron website at https://tekron.com/power/gnss-timing-generator-tcg01g/#resources.

5. INSTALLATION

Identification

Each TCG 01-G unit is shipped with identification labels on the base and side. 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!

Mounting the TCG 01-G

The clock can be used free-standing or mounted in a 19" rack. Each unit ships with a rack-mount bracket which can be attached by removing the 4 corner front panel screws and attaching the plate as illustrated in Figure 9.

Figure 9 – TCG 01-G with rack-mount bracket

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. Reactivating a unit that was previously synchronized thousands of kilometers away from the present position will take longer but not more than 45 minutes.

As described in LCD Display, the button on the front panel will toggle the display on the LCD and can also enter the Contrast Adjustment Mode.

Once powered up, the operator can determine correct operation of the TCG 01-G by observing the LEDs. The ALM LED should be off and the SYN LED should be on solid. If the LEDs are flashing, refer to

LED Indicators for an explanation of the status.

To reset the unit, the power must be cycled. To cycle the power, it is recommended that the external power source switch that the device the TCG 01-G is connected to; is turned OFF, wait a full ten seconds, and then turned ON again. This will result in the TCG 01-G having to resynchronize with the GNSS satellites.

Event Recording Function

General Description & Specification

TCG 01-G clocks can provide event recording channels on each channel of **P6**. The P6 inputs A and B are TTL level inputs with an input burden of 7 mA.

Recorded time tags contain timestamps corresponding to the rising edge of a pulse. The minimum pulse duration is 1 µs, 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.

The event recording option makes use of the same input connector (P6) as the external IRIG-B input function.

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 100 ns. TCG 01-G measures time internally in 40 ns intervals, rounding to the nearest 100 ns 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-G 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-G 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-G's serial port interface. Tags are retrieved from the buffer - oldest data first.

TCG 01-G 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* selected, then TCG 01-G will still output time tag information when requested, timing the responses to avoid interference with the other traffic on the port.

TCG 01-G Command / Response Message structure

Units equipped with the 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-G 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>)

TCG 01-G Commands related to Event Time Tagging

These commands and their responses contain ASCII characters only. A general serial communications program can be used to explore the event recording command/retrieval functions manually. Note that the TCG 01-G 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 GNSS 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	GNSS Fail – [B] only if internal GNSS 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 GNSS 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 GNSS 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)

Byte #	Description (Data bytes only, bytes 4-29 in received message)
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 GNSS received signal. In ASCII, ±00000-99999 referenced to 1E-12

Notes concerning the Ps command:

* An ASCII [space] is transmitted if there is no alarm condition present

1. The TCG 01-G can track up to 14 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: GNSS Automatic site survey.
   Mode = 3: GNSS 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-G'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-G 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

Byte #	Description (Data bytes only, bytes 4-29 in received message)
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-100 ns 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 GNSS 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

P6 Input Function (IRIG-B / Event Recording)

This feature provides a means to monitor /control signal activity on the two input channels of **P6**. The TCG 01-G clock supports both IRIG-B and event input functions on the two **P6** input lines (Figure 10). If one IRIG-B input function and one Event input function are selected, then P6A should be connected to the Event input source, and P6B connected to the IRIG-B signal source. As described on Table 1b, when synced to IRIG-B, on the bottom right of the LCD will show SL1 or SL2 to indicate synchronization with a source from P6A or P6b respectively.

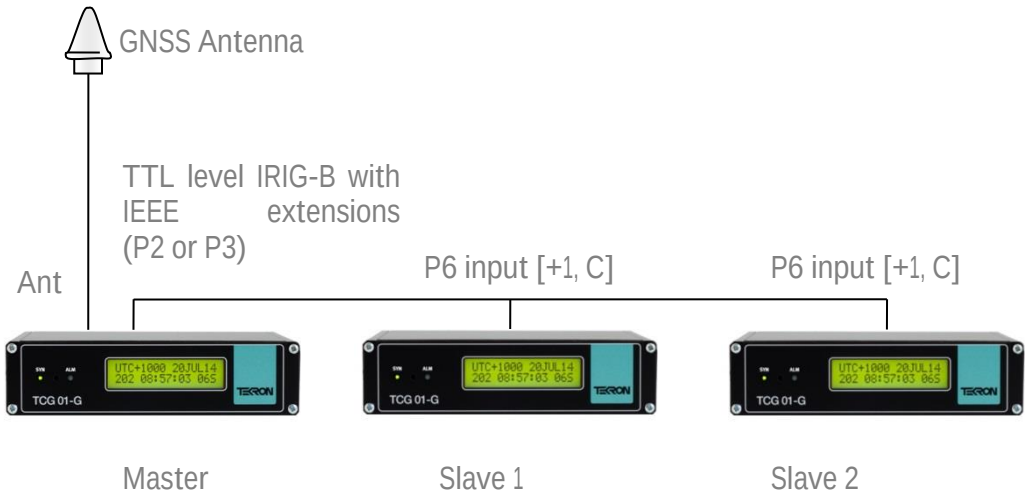


Figure 10 – Multiple Time Code Generators with one GNSS antenna

6. FACTORY HARDWARE OPTIONS

Power Supply Options

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

Designator	DC Input Range
L (Low)	14 - 36 Vdc
M (Medium)	20 - 75 Vdc
H (High)	90 - 300 Vdc

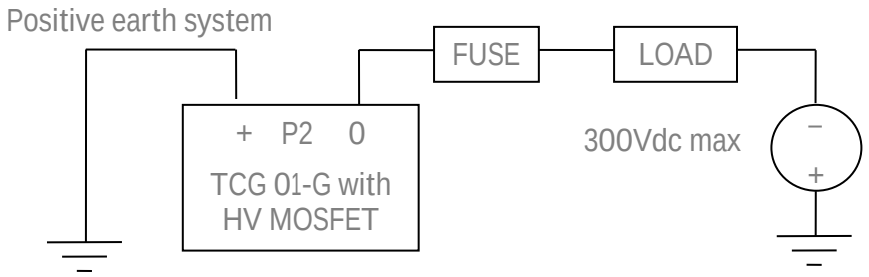
High Voltage (MOSFET) Output Option

TCG 01-G 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 5 V logic output. When fitted in this manner, each output can switch a 300 V DC, 1 A external load.

External wiring should be arranged so that the external high voltage supply line (up to 300 V DC max) is connected, via a fuse, to the load (Figure 11). 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-G unit.

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.

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-G 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". Failure to observe the polarity will result in the output being permanently on, regardless of the state of the output.



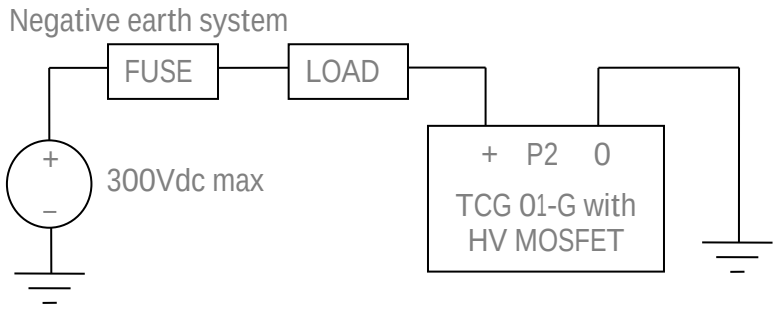


Figure 11 – High voltage MOSFET output switch option: Suggested wiring arrangements

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.

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 GNSS antenna. The GNSS antenna should then be mounted so that it lies within a 45-degree angle from the top of the other earth-bonded structure. The GNSS 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 lightning 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 LPK 01 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 Lightning Protector 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 Lightning Protector.

Installation

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

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. APPENDIX

TCG 01-G Specifications

Physical Specifications

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

GNSS Receiver

L1/GLONASS (1575.42 / 1598 MHz) Frequency, C/A Code, 32 Channel, parallel-tracking receiver

Performance Property		Metric
Position Accuracy	Horizontal	<9 m (90%)
	Altitude	<18 m (90%)
Timing Accuracy		15 ns (1 sigma) to UTC
Acquisition	Reacquisition	<2 s (90%)
	Hot Start	<18 s (90%)
	Warm Start	<45 s (90%)
	Cold Start	<50 s (90%)
Sensitivity	Acquisition	-155 dBm
	Tracking	-160 dBm

Input and Output Specifications

Type	Electrical	Physical	Accuracy at the port
AM IRIG-B (modulated)	8 V_{p-p}	BNC	<2 µs of UTC
TTL	5 V	2 pin Phoenix or BNC	<100 ns of UTC
RS422/485		2 pin Phoenix or BNC	<100 ns of UTC
RS232/RS422 (Pulse)		DB9	<1.5 µs of UTC
RS232/RS422 (String)		DB9	Baud rate dependent
HV Switching (MOSFET)		2 pin Phoenix	<100 ns of UTC
Fiber (λ=820 nm)	N/A	ST	<100 ns of UTC

Type	Electrical	Physical	Accuracy at the port
NTP / SNTP/PTP		RJ45	<100 ns of UTC

Environmental Specifications

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

Electrical Specifications

Performance Property		Metric
Power Supply	Low Voltage	14 ~ 36 Vdc
	Medium Voltage	20 ~ 75 Vdc
	High Voltage	90 ~ 300 Vdc
Power drain		6 W max

ISOLATION & PROTECTION

All inputs and outputs feature 2.5 kV isolation from earth and 5 kV 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 FACTORY HARDWARE OPTIONS for further information).

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

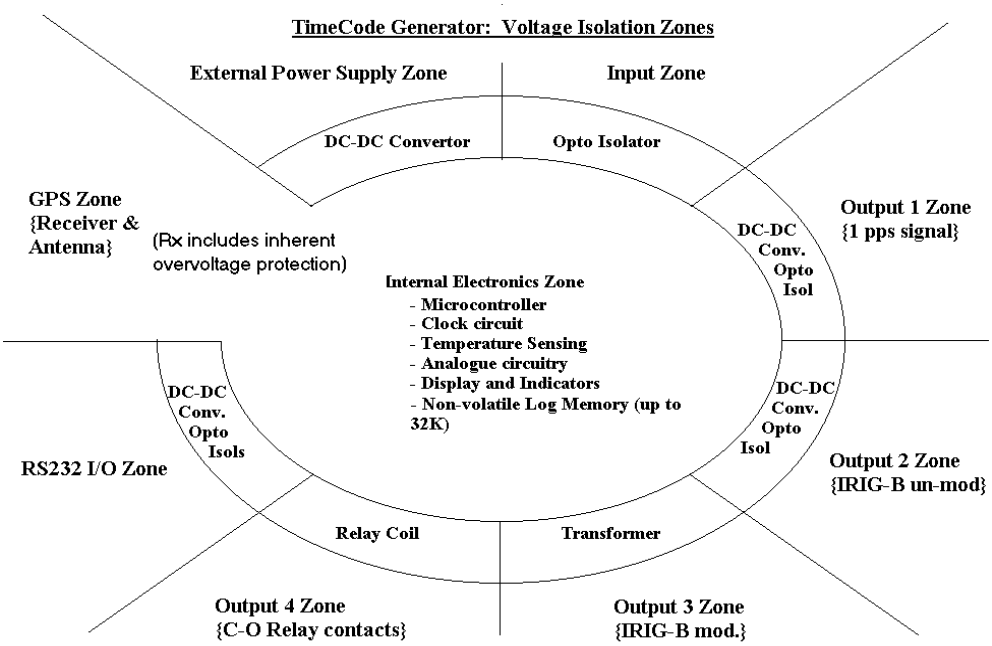


Figure 12 – TCG 01-G isolation zones

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.

NGTS Time Code O/P on P4

About	Normally used in conjunction with 10 ms pulse on P4 pin 1 that finishes precisely on the minute.
Timing	Transmitted once per minute. Sent during the last second before the minute rollover to which the data in the string refers.
Comms	9600bps, 8-bit ASCII, no parity
Definition	TyyMMDDwhhmmx<CR><LF>

Placeholder	Content
T	ASCII "T"
yy	Last two digits of the year: e.g."12" = the year 2012
MM	Month: "00" = January … "12" = December
DD	Day of Month: 01…31
w	Day of week: "1"=Monday … "7"=Sunday
hh	Two digit hour
mm	Two digit minute
x	Time mode: "0" = Local time, "1" = UTC time
<CR><LF>	Carriage Return Line Feed Pair: HEX 0D 0A

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

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	9600bps, 7-bit ASCII, odd parity
Definition	<SOH>ddd:hh:mm:ss<CR><LF>

Placeholder	Content
<SOH>	Start of Header: HEX 01
ddd	Day of year: range “001” – “366”
:	HEX 3A
hh	hour: “00” – ”23”
mm	minute: “00” – “2
ss	Seconds: “00” – “59”
<CR><LF>	Carriage Return Line Feed Pair: HEX 0D 0A

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

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	9600bps, 8-bit ASCII, no parity
Definition	<SOH>ddd:hh:mm:ss:yy<CR><LF>

Placeholder	Content
<SOH>	Start of Header: HEX 01
ddd	Day of Year: range "001" – "366"
:	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><LF>	Carriage Return Line Feed Pair: HEX 0D 0A

Example	Interpretation
<SOH>112:12:34:36:10<CR><LF>	day 112, time 12:34:36, year (20)10

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	9600bps, 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 60 ns
2E	'.' (full stop)	Clock is accurate to 1 µs
2A	'*'	Clock is accurate to 10 µs
23	'#'	Clock is accurate to 100 µs
3F	'?'	Clock accuracy may be worse than 100 µs

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

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	9600bps, 8-bit ASCII, no parity
Definition	<CR><LF>Q␣yy␣ddd␣hh␣mm␣ss.000␣␣␣

Placeholder	Content
<CR><LF>	Carriage Return Line Feed Pair: HEX 0D 0A
Q	Quality indicator: " " = in-sync, "?" = out-of-sync
␣	HEX 20 (space)
yy	Year: "00" – "99" representing the last two digits of the year
␣	HEX 20 (space)
ddd	Day of year: range "001" – "366"
␣	HEX 20 (space)
hh	hour: "00" – "23"
mm	minute: "00" – "59"
ss	seconds: "00" – "59"
.000	ASCII ".000"
␣	HEX 20 (space)
␣	HEX 20 (space)
␣	HEX 20 (space)

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

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
<SOH>112:12:34:36?<CR><LF>	day 112, time: 12:34:36, >100 µs sync error

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	9600bps, 8-bit ASCII, no parity
Definition	<SOH>YYYY:ddd:hh:mm:ssQ<CR><LF>

Placeholder	Content
<SOH>	Start of Header: HEX 01
YYYY	4-digit year
:	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)
<CR><LF>	Carriage Return Line Feed Pair: HEX 0D 0A

Example	Interpretation
<SOH>2004:112:12:34:36?<CR><LF>	2004, day 112, 12:34:36pm, >100us sync error

String-F Time Code O/P on P4

About	This string complies with the protocol required to drive Vorne type Time Displays.
Timing	The string is transmitted once every second, with the leading edge of the "start" bit of the last <BEL> exactly on the second.
Comms	9600bps, 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
1100	ASCII "1100"
44	ASCII "44" (means local time follows)
hh	Local hour of day: "00" – "23"
mm	Local minute of day: "00" – "60"
ss	seconds: "00" – "59"
54	ASCII "54" (means local day of year follows)
ddd	Local day of year: "001" – "365"
45	ASCII "45" (means UTC time follows)
HH	UTC hour: "00" – "23"
MM	UTC minute: "00" – "59"
55	ASCII "55" (means UTC day of year follows)
DDD	UTC Day of year: "001" – "365"
<BEL>	HEX 07
<CR><LF>	Carriage Return Line Feed Pair: HEX 0D 0A

String-G Time Code O/P on P4

About	This general time string is used predominantly in Europe.
Timing	The string is transmitted once every second, with the leading edge of the "start" bit of the last <ETX> exactly on the second.
Comms	9600bps, 8-bit ASCII, no parity
Definition	<STX>swhhmmssddMMyy<LF><CR> <ETX>

Placeholder	Content
<STX>	Start of Text: HEX 02
s	Clock Status (see below)
w	Day of Week (see below)
hh	hour of day: "00" – "23"
mm	minute of day: "00" – "60"
ss	seconds: "00" – "59"
dd	day of month: "01" – "31"
MM	month of year: "01" – "12"
yy	year: "10" – "99"
<CR><LF>	Carriage Return Line Feed Pair: HEX 0D 0A
<ETX>	End of Text: HEX 03

Clock Status

The s "Clock Status" is an ASCII character in the range 0-9, A-F representing a single hex digit (nibble)

Bits: 3	2	1	0	
X	X	X	0	No announcement for time change
X	X	X	1	Announcement for time change – active for an hour before
X	X	0	X	Local Standard Time (LST)
X	X	1	X	Daylight Saving Time (DST)
0	0	X	X	Time/date invalid – clock is out of sync
0	1	X	X	Hold-over mode – running on local Oscillator
1	0	X	X	GNSS / IRIGB controlled mode
1	1	X	X	GNSS / IRIGB controlled mode (high accuracy)

DAY OF WEEK

The w "Day of Week" is an ASCII character in the range 1-7, 9, A-F representing a single hex digit (nibble)

Bits:	3	2	1	0	
	1	X	X	X	UTC time
	X	0	0	1	Monday
	X	0	1	0	Tuesday
	X	0	1	1	Wednesday
	X	1	0	0	Thursday
	X	1	0	1	Friday
	X	1	1	0	Saturday
	X	1	1	1	Sunday

Example	Interpretation
<STX>E3123456170410<LF><CR><ETX>	High Accuracy Mode, DST, Wed, 12:34:56, 17/4/2010

String-H 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 character <STX> exactly on the second that the message describes.
Comms	9600bps, 8-bit ASCII, no parity
Definition	<STX>D:dd.MM.yy;T:w;U:hh.mm.ss;uvxy<ETX>

Placeholder	Content
<STX>	Start of Text (HEX 02)
D	ASCII "D"
:	HEX 3A (colon)
dd	Day of month: "01" – "31"
.	HEX 2E (full stop)
MM	Month of year: "01" – "12"
yy	year: "10" – "99" representing the last two digits of the year
:	HEX 3B (semicolon)
T	ASCII "T"
w	Day of Week "1" to "7", "1" = Monday
U	ASCII "U"
hh	Hour: "00" – "23"
mm	Minute: "00" – "60"
ss	Second: "00" – "59"
u	ASCII "#" (hash) if not synchronised since last reset, or space (HEX 20) if synchronised since last reset
v	ASCII "*" (asterisk) if clock is running on local oscillator, or space (HEX 20) if clock is currently synchronised
x	ASCII "U" if UTC time, or ASCII "S" if DST, or space (HEX 20) if standard time
y	ASCII "!" (exclamation) if DST change pending, or ASCII "A" if leap second pending, or space (HEX 20) otherwise
<ETX>	End of Text (HEX 03)

Example	Interpretation
<STX>D:17.04.10;T:6;U:12.34.56;#*S!<ETX>	17 April 2010, Saturday, 12:34:56, out of sync, DST, DST change pending

NMEA ZDA Time Code O/P on P4

About	This string is in accordance with the NMEA-0183 standard in content, but is transmitted at 9600bps.
Timing	Transmission is once every second. The leading edge of the "start" bit of the "$" is exactly on the second.
Comms	9600bps, 8-bit ASCII, no parity
Definition	$GPZDA,hhmmss.00,dd,mm,yyyy,s,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 digits.
s	Local time zone offset sign (positive means local time leads UTC)
xx	Local time zone offset from UTC in hours
yy	Local time zone offset from UTC in minutes
*	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>	Carriage Return Line Feed Pair: HEX 0D 0A

Example	Interpretation
$GPZDA,123456.0023042010+1200*	UTC time is 12:34:56, 23 April 2010, the local time offset is +12:00

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	9600bps, 8-bit ASCII, no parity
Definition	$GPRMC,hhmmss.00,a,tttt.tttt,N,ggggg.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
tttt.tttt	Latitude (degrees, minutes): “0000.0000” – “8959.9999”
N	Latitude (north/south): “N” = north, “S” = south
ggggg,gggg	Longitude (degrees, minutes): “00000.0000” – “35959.9999”
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>	Carriage Return Line Feed Pair: HEX 0D 0A

8. WARRANTY

For terms and conditions of Tekron's Warranty see the Web Site

http://tekron.com/about-tekron/warranty

WARNING

This product has been designed to comply with the limits for a Class A digital device pursuant to Part 15 of FCC rules. These limits are designed to provide reasonable protection against such interference when operating in a commercial environment.

Notes

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