TTM 01-G

USER MANUAL

Table of Contents

1 Introduction

The TTM 01-G – Tekron's powerful and cost effective synchronization solution for RTUs, Protection Relays and other Intelligent Electronic Devices used in electrical sub-stations and industrial control installations.

Utilizing state of the art technology, this compact unit locks onto atomic clock references from the GPS and GLONASS satellite constellations and produces time codes and pulses with sub-microsecond accuracy and precision.

The TTM 01-G clips onto a standard DIN rail. Its rugged compact design is suitable for noisy electrical environments, while built in electrical isolation combined with strong push pull drives on outputs simplify wiring schemes and enhances reliability.

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.

Figure 1 – TTM 01-G Front View

2 LED Indicators

The top of the TTM 01-G features two LED indicators. The **SYN LED** shows synchronization status, while the **ALM LED** shows the alarm status of the unit.

Outputs are synchronized to UTC time only when the SYN LED is fully illuminated.

The tables below provide information regarding the interpretation of the LEDs.

SYN LED	Meaning
Off	The TTM 01-G is not synchronized.
Slow Flash	The TTM 01-G is in hold-over mode.
Fast Flash	The TTM 01-G is out of sync and not in holdover.
On	The TTM 01-G is synchronized.

Table 1 – SYN LED Functionality

ALM LED	Meaning
Off	The TTM 01-G is operating normally and has no alarms.
Fast Flash	An alarm is active. To identify the alarm, use the configuration tool.

Table 2 – ALM LED Functionality

3 Inputs and Outputs

ANT: Antenna port (SMA connector)

The “ant” antenna input provides an interface for an external active antenna via low-loss cable. The unit can supply 5 Vdc @ 100 mA to power an active antenna. The antenna voltage will automatically fold back to limit the output current under fault condition. 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.

A Lightning Protection device should be inserted into the antenna cable. A suitable device, complete with additional cable connectors, a connector crimping tool and mounting hardware is available as an option (see accessories for details). Use of a Lightning Protector does not degrade the performance of the antenna system.

Care should be taken to ensure that the connector is not cross-threaded when attaching the antenna cable. The connector should be tightened by hand or with an appropriate SMA torque wrench only. Do not over tighten.

ETH: Ethernet Interface (ST Fiber / RJ45)

TTM 01-G units are fitted with either a RJ45 10/100 Ethernet interface or a ST multi-mode Fiber 100FX Ethernet interface. The unit can be configured over the LAN (Local Area Network) and can be upgraded with PTP or NTP / SNTP Licenses.

To the left of the Ethernet connector are two LEDs with the “LNK” LED above the “ACT” LED. 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.

TX: Fiber Output

The fiber output can be configured by the configuration tool to output an IRIG-B (B00x, B22x) signal, a DCF-77 signal or user defined pulse. The fiber transmitter is compatible with 50/125 µm, 62.5/125 µm and 100/140 µm multimode glass fiber.

TTL: TTL Output

The TTL output is a high drive, non-isolated TTL level driver which can be configured by the configuration tool to output an IRIG-B (B00x, B22x) signal, a DCF-77 signal or user defined pulse.

ALM: Alarm Output

The alarm output is a high voltage AC / DC isolated contact capable of switching up to 300 V at 100 mA. The contact is AC rated and normally-closed so that the alarmed state is the contacts open (i.e. the same as when the power is off). The alarm source is configurable by the configuration tool.

OPT: Optional Output

The TTM 01-G has a slot for one IO card to allow a variety of user interfaces. Each card is limited to one additional port with at least 3 kV isolation from the rest of the system to avoid current loops.

The table below shows the orderable options:

Output Type	Features
TTL	TTL (5 V, 150 mA) IRIG-B (B00x, B22x), DCF-77 or user defined pulse output.
Serial	RS232 level (9 V, 10 mA) output supporting serial strings.
AM IRIG-B	Analog IRIG-B (B12x) signal, typically 8 V with 3:1 mark space ratio. Output Impedance 120 Ω. Requires a 100 – 180 Ω terminator.

Table 3 – TTM 01-G Available Interface Modules

4 Power Supply Options

There are three different power supply options available for the TTM 01-G. Low, medium or high voltage supplies are available and feature similar maximum output ratings but different levels of isolation.

Power Supply	Features	
Low	14 – 36 Vdc.	Maximum 5 W, 1.6 kV Isolation
Medium	20 – 75 Vdc.	Maximum 5 W, 1.6 kV Isolation
High	90 – 300 Vdc.	Maximum 5 W, 3.75 kV Isolation

Table 4 – TTM 01-G Available Power Supplies Modules

5 Isolation & Protection

The GNSS Antenna input is earth referenced; care should be used when installing to prevent earth currents circulating in the antenna cable. The TTL output features an earthed, non-isolated driver and is designed for connection within the same rack. Since it is the only output with an earth reference, it is isolated from the power supply via the power supply isolation and from all other IO by their isolation. All the other outputs are galvanically isolated (including the optional TTL output card) from the internal electronics and power supply.

The Alarm port has a UL and VDE approved, 3.75 kV isolated contact and is protected by a 600 V, 175 mA self-resetting fuse and a 350 V transient suppressor diode.

The Copper Ethernet provides 1.5 kV isolation and includes ESD suppression on board.

All optional output cards feature at least 3 kV isolation from earth and have ESD suppression suitable for the interface type.

The power supply isolation varies from 1.6 kV for Low and Medium voltage power supplies to 3 kV for the High voltage power supply. In addition, a varistor protects the power supply against transverse voltages and transient suppressor diodes protect the internal electronics from longitudinal events.

6 Installation

Identification

Each TTM 01-G unit is shipped with an identification label on the side of the case. The label provides details of the optional output (if any) and power supply fitted to the unit as well as the unit serial number.

Check the identification label on the side of the unit to ensure that the correct output and voltage range has been supplied before proceeding to install.

The label on the side of TTM 01-G contains the voltage range: Do not apply power outside of this range!

Mounting the TTM 01-G

The TTM 01-G is designed to be mounted to a standard 'Top Hat' din rail mount using the supplied clips on the base (See Figure 2). The clips can also be used to screw mount the unit by extending them beyond the case edge.

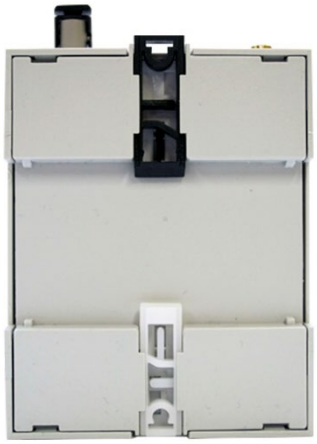

Figure 2 – Base of TTM 01-G

Connecting the TTM 01-G

The TTM 01-G has a SMA connector, RJ45 / 100Base FX connector and ST Fiber output on the top and a row of rising clamp screw terminals on the bottom. Any connection not required may be left unterminated. The screw terminals are designed for the following cables;

- 0.2-4.0mm² (30-12AWG) solid cable
- 0.2-2.5mm² (30-12AWG) stranded cable

The SMA **(ANT)** connector should be connected to the antenna lead-in cable. Care should be used to ensure that the cable bend radius is kept within the cable specification and the SMA connector is not placed under strain.

The Fiber TTM 01-G can have a ST multimode Fiber connector for the Ethernet and is labeled **ETH** on the case whereas the IRIG-B fiber out is simply labeled **TX**.

The connections from left to right along the bottom are optional output (**OPT**) '-' and '+'; Alarm (**ALM**) '-' and '+'; TTL '-' and '+'; Ground; Power Supply Negative; Power Supply Positive. If the optional output isn't fitted, then the unused terminals are covered.

Power Supply

Figure 3: Power Supply Connections

Note: The Power supply has polarity protection built in to prevent damage.

The label on the side of TTM 01-G indicates the type of output Option Card fitted: Do not apply voltages to output only interfaces!

The power supply should be connected to the PWR terminals at the bottom of the TTM01-G as shown by the red box in Figure 3: Power Supply Connections Figure 3 **above.**

The GND connection is located next to the power supply input terminals (highlighted in yellow above). This must be connected to earth for full protection of the TTM.

Figure 4 – TTM 01-G Top Connectors

Figure 5 – TTM 01-G Bottom Connectors

7 Product Configuration

Any configuration changes will need to be done via the Windows based Configuration Tool. The Configuration Tool is compatible with and version of Windows after Windows XP Service Pack 3, including Windows 7, 8, 8.1 and Windows 10. The latest version of the tool is available from the Tekron web site www.tekron.com/TTM01-G under the “Resources” tab.

8 Lightning Protection

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.

9 Appendix

TTM 01-G Specifications

Physical Specifications				
UL94-V0 polycarbonate flame retardant DIN rail enclosure with IP40 (Ingress Protection rating).				
Performance Property		**Metric**		
Dimensions	Width Depth Height	72 mm 60 mm 90 mm		
Weight		0.15 kg		
GNSS Receiver				
Performance Property		**Metric**		
Acquisition	Reacquisition Hot Start Warm Start Cold Start	< 2 s (90 %) < 8 s (90 %) < 45 s (90 %) < 50 s (90 %)		
Sensitivity	Acquisition Tracking	-160 dBm -155 dBm		
Input and Output Specifications				
Type		**Electrical**	**Physical**	**Accuracy at the port**
TTL		5 V (4.5 V @ 150 mA)	2 Pin	< 100 ns of UTC
Fiber (λ = 820 nm)[1]		-19 dB optical power	ST	< 100 ns of UTC
Alarm		265 Vac / 300 Vdc, 100 mA	2 Pin	
Ethernet (Copper)			RJ45	
Ethernet (Fiber)[2]		TX: -17 dB optical power RX: -33 dB sensitivity	Dual ST, ½ inch pitch	
Optional Output Specifications				
Type		**Electrical**	**Physical**	**Accuracy at the port**
TTL		5 V (4.5 V @ 150 mA)	2 Pin	< 100 ns of UTC
Serial		± 9 V	2 Pin	< 1 ms of UTC
AM IRIG-B		8 V	2 Pin	< 2 µs of UTC
Environmental Specifications				
Performance Property		**Metric**		
Operating Temperature Range		-10 to 65 °C		
Electrical Specifications				
Performance Property		**Electrical**	**Physical**	
Power Supply	Low Voltage	14 - 36 Vdc	2 Pin + common earth	
	Medium Voltage	20 - 75 Vdc	2 Pin + common earth	
	High Voltage	90 - 300 Vdc	2 Pin + common earth	
Power drain		4 W max		

10 Serial Output String (Serial Output Option)

General Key to Fields

Fields between brackets ('<' and '>') represent ASCII character codes. The used codes are in the following table:

[1] Fibre transmitter is compatible with 50/125 µm, 62.5/125 µm and 100/140 µm multimode glass fiber.

[2] Fibre Ethernet is compatible with 50/125 µm and 62.5/125 µm multimode glass fiber.

Placeholder	HEX	Content
<SOH>	01	ASCII Start of Header character
<STX>	02	ASCII Start of Text character
<ETX>	03	ASCII End of Text character
<BEL>	07	ASCII BEL character
<LF>	0A	ASCII Line Feed character
<CR>	0D	ASCII Carriage Return character
□	20	ASCII Space character

NGTS Time Code O/P

Timing Transmitted once per minute. Sent during the last second before the minute rollover to which the data in the string refers.

Timing	Transmitted once per minute. Sent during the last second before the minute rollover to which the data in the string refers.
Default Comms	9600 bps, 8-bit ASCII, no parity
Definition	TyyMMDDWhhmmx<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
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

Example Interpretation:

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

IRIG J-17 Time Code O/P

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.
Default Comms	9600 bps, 7-bit ASCII, odd parity
Definition	<SOH>ddd:hh:mm:ss<CR><LF>
Placeholder	**Content**
ddd	Day of year: range “001” – “366”
:	HEX 3A
hh	hour: “00” – ”23”
mm	minute: “00” – “2”
ss	Seconds: “00” – “59”

Example Interpretation:

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

String-A Time Code O/P

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

Placeholder	Content
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 since 2000

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

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

“Quality” Character (Q)		Content
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

*Refer to String-A table (above) for the definitions of the common digits

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

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

Placeholder	Content
Q	Quality indicator: ‘ ‘ = in-sync, ‘?’ = out-of-sync
□	HEX 20 (space)
yy	Year: “00” – “99” representing the last two digits of the year
ddd	Day of year: range “001” – “366”
Placeholder	**Content**
hh	hour: “00” – ”23”
mm	minute: “00” – “59”
ss	seconds: “00” – “59”
.000	ASCII “.000”

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

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

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.
Default Comms	9600 bps, 8-bit ASCII, no parity
Definition	<SOH>YYYY:ddd:hh:mm:ssQ<CR><LF>
Placeholder	**Content**
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)

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

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.
Default Comms	9600 bps, 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)
Placeholder	**Content**
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”

String-G Time Code O/P

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.
Default Comms	9600 bps, 8-bit ASCII, no parity
Definition	<STX>swhhmmssDDMMyy<LF><CR> <ETX>
Placeholder	**Content**
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”

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	
				0	No announcement for time change
				1	Announcement for time change – active for an hour before
			0		Local Standard Time (LST)
			1		Daylight Saving Time (DST)
	0	0			Time/date invalid – clock is out of sync
	0	1			Hold-over mode – running on local Oscillator
	1	0			GPS / IRIGB controlled mode
	1	1			GPS / 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	
	0				Local Time
	1				UTC time
		0	0	1	Monday
		0	1	0	Tuesday
		0	1	1	Wednesday
		1	0	0	Thursday
		1	0	1	Friday
		1	1	0	Saturday
		1	1	1	Sunday

Example Interpretation:

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

NMEA ZDA Time Code O/P

About	This string is defined by the NMEA-0183 standard and transmitted at 9600 bps.
Timing	Transmission is once every second. The leading edge of the “start” bit of the “$” is exactly on the second.
Default Comms	9600 bps, 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)
hhmmss.00	UTC hour of day, minute, seconds (millisecond = 0) (0 – 23 hour, 0 – 59)
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)

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

About	This string is defined by the NMEA-0183 standard and transmitted at 9600 bps.
Timing	Transmission is once every second. The leading edge of the “start” bit of the “$” is exactly on the second.
Comms	9600 bps, 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**
$GPRMC	ASCII “$GPRMC”
,	ASCII “,” (comma)
Hhmmss.00	UTC hour of day, minute, seconds (millisecond = 0) (0 – 23 hour, 0 – 59)
a	Status: “A” = valid, “V” = invalid
tttt.tttt	Latitude (degrees, minutes): “00” – “89” degrees; “00.0000” – “59.9999” minutes
N	Latitude (north/south): “N” = north, “S” = south
ggggg,gggg	Longitude (degrees, minutes): “000” – “180” degrees; “00.0000” – “59.9999” minutes
W	Longitude (east/west): “E” = east, “W” = west
ddmmyy	UTC day of month, month & 2-digit year
0.0	ASCII “0.0”
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 "*".

11 Warranty

For terms and conditions of Tekron’s Warrantee 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
The information in this manual may change without notice. The manufacturer assumes no responsibility for any errors that may appear in this manual.

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