HORITA GPS-MTG

GPS Based SMPTE Time Code Generator
(NMEA Interface)

USER MANUAL

Doc. 073131-00
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HORITA®

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1 INTRODUCTION

1.1 Introduction

This manual provides installation, operation, and servicing information for the HORITA GPS Based Master Time Code Generator System (GPS-MTG).

The GPS-MTG consists of a SMPTE longitudinal time code generator and a Global Positioning System (GPS) receiver. The time code generator uses data from the GPS receiver to automatically acquire, monitor and maintain time synchronization with Coordinated Universal Time (UTC).

1.2 SMPTE Time Code

The Society of Motion Picture and Television Engineers (SMPTE) time code is an industry standard timing and control code that is widely used for computer control and automation in video production and broadcasting. The time code has an hours, minutes, seconds, and frames format and is a continuous serial digital signal designed to be recorded or distributed via an audio channel or time code channel.

1.3 Global Positioning System

The Global Positioning System is a position locating and time distribution system based on reception of signals from NAVSTAR satellites. GPS receivers provide highly accurate position and time data anywhere worldwide.

1.4 TAI, UTC, GMT, and GPS Time Relationship

The GPS-MTG is synchronized to Coordinated Universal Time (UTC). UTC is equal to International Atomic Time (TAI) but is adjusted for the slowing of the earth's rotation by adding “leap” seconds as needed to make it correspond to astronomical time or Greenwich Mean Time (GMT).

GPS system time is equal to TAI, but lagging by a constant exact 19 second offset. The difference between GPS time and UTC time is a small integer number of seconds which increases slowly over long periods of time.

2 GENERAL

2.1 System Components

The HORITA GPS-MTG Time Code Generator occupies 1/3 of a HORITA RM-50 1-3/4" by 19" rack-mount chassis. The GPS receiver is combined with the antenna in an assembly called a Smart Antenna.

Horita does not manufacture the GPS Smart Antenna used with the GPS-MTG. It is a commercially available GPS antenna/receiver manufactured by a company who specializes in GPS devices. Horita was, however, the first manufacturer of SMPTE time code equipment to synchronized SMPTE time code with the GPS system. Over the years since, Horita has used smart antennas from several manufactures, including Trimble, Marconi, Novatel, and Garmin. Horita puts its logo on the smart antenna so that it can be identified in situations where there are other devices using GPS antennas.

As of June 2013, Horita uses a Smart Antenna from Garmin. It is a self-contained GPS receiver and antenna designed for harsh environment (-30°c to +80°c) outdoor installation. It is contained in a 3.6" diameter round waterproof housing with a threaded base and sealed high impact plastic alloy cover. The Smart Antenna has an industry-standard 1"-14 UNS threaded hole in the base for mounting on a threaded antenna mast. Horita includes the manufactures installation instructions and accessory equipment that they provide with the antenna. Horita adds the correct connector interface to the GPS-MTG for that particular Smart Antenna and performs all testing with the smart antenna shipped with the GPS-MTG..

2.2 Time Acquisition

The GPS-MTG automatically acquires GPS time and outputs SMPTE longitudinal time code along with various one second and one minute timing pulses and RS-232 serial time data. The SMPTE time code is continuously monitored in relation to GPS time and maintained in exact synchronism within close limits.

The worldwide availability of exact UTC time allows precise coordination of widely separated equipment for automatic control according to a time schedule. Thus, the GPS-MTG provides a reliable unattended time reference for automatic control and initiation of programmed events.

2.3 Switches, Controls, and Displays

The GPS-MTG keys a time code "window" into an incoming composite video reference signal to display the time, date, and various conditions of the GPS-MTG.

The GPS-MTG also has a single LED which can be steady "on" or flashing at several distinct rates to provide positive indications of proper GPS-MTG operation.

The front panel switches and controls on the GPS-MTG allow the user to change operating modes and setup parameters, manually preset time code time and user bits, turn the video display on and off and change it's size.

2.4 SMPTE Time Code (with Date) Output

The SMPTE time code is locked to video and provides an exact UTC hours, minutes, seconds, and frame number time stamp for video recordings. The format of the SMPTE time code allows for the inclusion of additional information, along with the time information. The GPS-MTG takes advantage of this provision and allows the user to optionally select to receive the current date provided by the GPS system and include this with the time information. This date automatically advances to the next day at the local time midnight. Thus, the SMPTE time code provided by the GPS-MTG contains both time and date information.

2.5 RS-232 Serial Outputs

The GPS-MTG provides an RS-232 serial data output that can be used to provide exact time and date to a PC for logging or for control. The HORITA Standard Interface Protocol (HSIP) serial data format is used to output the time and date as well as other data used for monitoring operation of the GPS-MTG. *Ref. Appendix-1*

2.6 Automatic Time/Date Preset

The GPS-MTG receives serial data from the GPS receiver. The GPS data is used to preset the time code hours, minutes, seconds, and frame number to local time within +/- 1/2 video frame. The GPS date is also preset into the user bit portion of time code (user option).

2.7 UTC and Time Zone Offset

The GPS-MTG adjusts the received GPS time for the local time zone hour offset from UTC. For simplicity, UTC adjusted to the local time zone will be referred to as UTC.

2.8 Automatic Time Checks

Every second the GPS-MTG checks the time code frame count at the moment a UTC 1 PPS occurs. The frame count must be within limits of +/- 5 frames. If an error is detected and confirmed on the next second, the GPS-MTG is corrected to UTC. The +/- 5 frame range includes provision for a ± 2 frame drop frame peak error and a 3 frame (.1 sec.) maximum time error.

The GPS-MTG receives a new time message from the GPS receiver every second. When this message is received, the GPS-MTG checks the complete time code time in comparison to UTC. If an error is detected in either the hours, minutes, seconds, or frames and the error is confirmed by a second check, the GPS-MTG is corrected to UTC.

In normal operation the GPS-MTG runs continuously without the need to ever make a time correction. The time code is always equal to the exact UTC time and all the verification checks result in no corrective action. This condition can be monitored and verified by the status information available through the RS-232 output.

The GPS-MTG has an automatic daylight savings time mode which advances the local time by one hour at 2:00 A.M. on the second Sunday in March and removes the advance at 2:00 A.M. on the first Sunday in November.

2.9 Sources of Time Errors

The principle source of any small time error detected by the GPS-MTG is from the video frame rate. Two independent errors occur with regard to the video rate. The first is the error in oscillator frequency which controls the video frame rate. The second is the residual error in drop frame time code.

2.10 NTSC Color Video Standards

When developing the standards for generating NTSC color video, the scanning frequencies and color and sound subcarriers were selected so that they would "interleave" to produce a minimum of interference when the luminance and chrominance signals were eventually combined to form the composite video signal. This was necessary in order for the color signal to be compatible with the then current black and white television receivers.

2.11 Color Subcarrier Frequency Tolerance

The NTSC frequency selections resulted in a color subcarrier frequency of 3579545 Hz +/- 10 Hz, related to the horizontal scanning and picture frame rates such that the line scanning frequency is 2/455 times the color subcarrier frequency, and the video frame rate is equal to the line frequency / 525.

2.12 Video Frame Rate Tolerance

The end result is that the subcarrier frequency of 3579545 ± 10 Hz produces a video frame rate of 29.97002617 Hz ± .00008372 Hz. This tolerance can accumulate a maximum error of about ± 9.5 frames over 24 hours. In practice, the color subcarrier oscillator frequency is adjusted more accurately than ± 10 Hz., and typically much less than 9 frames of time error ever occur from this source over 24 hours.

2.13 Amount of Real Time Error

The time error between the 30 FPS black and white frame rate and the slightly slower 29.97 FPS color frame rate was so small that it was considered negligible at the time the color standards were adopted. However, when used as a time base, this small difference actually produces an error of 3.6 seconds per hour, and a clock counting video frames will fall behind by this amount of time each hour.

Because SMPTE time code has an hours, minutes, seconds, and frames format, and advances by one second time each time it counts 30 video frames, it will lag a real time clock by 3.6 seconds per hour, unless corrective action is taken.

2.14 Dropping Frames

The correction decided upon was to have the SMPTE time code numbers "skip ahead" by two frame numbers each minute to make up for falling behind. So, each time a new minute rolls around, instead of the normal numbering of the video frames starting from frame 00 on up to 27,28,29, then starting over at 00, 01, 02 etc., the frames are numbered 27, 28, 29, 02, 03, 04 etc., skipping frame numbers 00 and 01 once each minute and, thus, advancing the time readout by this amount.

Performing this two frame correction each minute advances the SMPTE time clock by 120 frames per hour, which actually overcorrects by 12 frames because the original error of 3.6 seconds is only 108 frames. This overcorrection is avoided by not skipping ahead two frames on every even ten minute boundary. That is, on minutes 00, 10, 20, 30, 40, 50, which there are six of, frame numbers 00 and 01 are not skipped, resulting in the desired correction of 108 frames per hour.

Because at each minute (except for the six exceptions) frame numbers 00 and 01 are "missing" or are "dropped" from the time code, the code produced is referred to as "drop frame" time code.

2.15 Residual Time Error After 24 Hours

The drop frame compensation of SMPTE time code still leaves a residual error of 2.26 video frames over a 24-hour period, and this error accumulates even if the subcarrier and resulting video frame rates are exactly at the specified frequency.

2.16 24-Hour Automatic Time Acquisition

The GPS-MTG makes a routine acquisition of GPS time at a selectable hour, such as local midnight, or 3:00 A.M., to eliminate the accumulated drop frame residual error and any additional error due to any small error in subcarrier frequency. The correction is made at "midnight" to minimize the possible effects which may result when the time code is re-synchronized.

When re-synchronization takes place, either frames are skipped or frames are repeated depending on the error (normally repeated). This discontinuity in the time code sequence occurs at a user selectable and predictable time, which normally happens only once per day.

2.17 Power or Video Loss Automatic Time Acquisition

If the power is interrupted and then restored, automatic acquisition and recovery is accomplished by the unattended GPS-MTG. Similarly, if video is interrupted and then restored an automatic acquisition occurs.

3 SYSTEM INSTALLATION AND CONNECTION

3.1 Introduction

The GPS-MTG consists of two major components, the GPS Antenna/Receiver (the GPS Receiver), and the RM-50 Rackmount chassis. It is unlikely that these two components will be located close to each other since the GPS receiver has to be where it gets a view of the sky, and the rackmount chassis will probably be mounted in a rackmount bay with other electronic equipment.

Installation and connection of the HORITA GPS-MTG is divided into separate instructions for the GPS receiver and for the rackmount chassis unit.

Figure-3.1 shows the connections between the various components of the GPS-MTG system, and should be referred to as necessary for installation and interconnection.

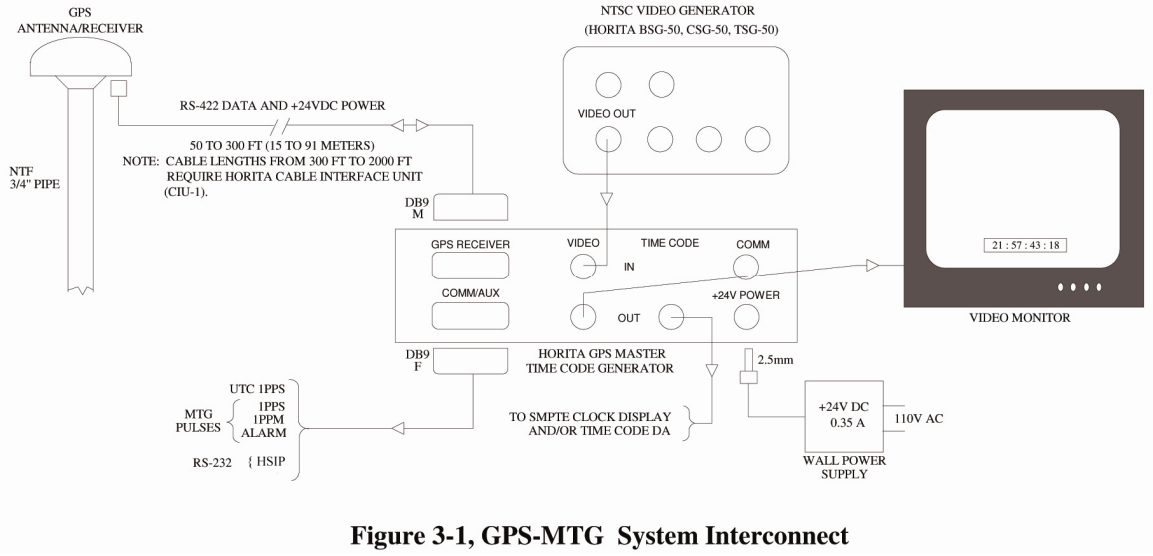


Figure 3-1, GPS-MTG System Interconnect

23.2 GPS Receiver Installation Selecting a Location

The GPS Receiver must be located where the 1.5 GHz satellite signals will not be blocked by a building or other structures. Generally this means placing it where there is an unobstructed view of a large area of the sky. A rooftop or skylight opening location is likely to be suitable. A thin layer of glass or plastic in a skylight does not significantly block the signal. A wood or composition roof strongly attenuates the signal.

3.3 GPS Receiver Exposure to RF Fields

An additional consideration is to avoid exposing the receiver to high levels of radio frequency energy. Exposure to high levels of electromagnetic radiation can cause receiver overload and in extreme cases receiver burnout.

The received signals from the satellites are extremely weak and must be amplified and correlated in order to detect the information they contain. High levels of radio frequency energy even at greatly different frequency can overload and block reception of the satellite signals.

Avoid locations near a transmitting antenna. If a transmitter is located nearby, it may be possible to locate the receiver in an area shielded from the emissions and still exposed to the sky.

3.4 GPS Receiver Exposure to Lightning

Finally, it should be recognized that cables from the receiver can conduct lightning induced transient voltages and may endanger equipment and personnel unless normal precautions are taken.

Locating the receiver in the sheltered zone below grounded metal structures will tend to avoid direct strikes. Avoid locating the receiver as the highest and most prominent point on a structure.

In areas where lightning is common, depending on the amount of shielding provided to the cable by building structure or grounded conduit, it may be necessary to purchase and install additional specialized lightning protection equipment.

Commercially available RS-232 signal line lightning protection devices are available from MCG Electronics Inc., Deer Park, N.Y. 11729 (1-800-851-1508) and from other suppliers.

3.5 Mounting the GPS Receiver

The receiver is mounted by means of a 1"-14 UNS (marine standard) pipe thread opening in the base of the enclosure. If PVC pipe is used, it may be possible to mount the antenna using ¾"-14 pipe thread

A location in a skylight slightly below rooftop level with exposure to a large area of sky may provide good protection from unwanted transmitter energy and at the same time, reduced chance of lightning damage.

3.6 GPS Receiver Cable Lengths

Connect the cable from the GPS receiver to the GPS-MTG 9-pin "D" GPS RECEIVER connector. The GPS receiver will operate directly with the GPS-MTG over a cable of up to 300 feet in length.

A standard 30 foot cable is provided with the basic system. Longer cables are available on special order.

3.7 Mounting the Rackmount Chassis

The HORITA RM-50/GPS-MTG installs into a standard 1-3/4" x 19" rackmount console opening. The GPS-MTG dissipates only a few watts of power so only minimal ventilation is required.

3.8 Connecting VIDEO IN and VIDEO OUT

After installation, connect the GPS-MTG rear panel VID IN BNC connector to a source of composite video such as color bars or black burst. The HORITA GPS-MSG, TSG-50/51, CSG-50 or BSG-50 can be used as the video reference for the GPS-MTG, and can mount on the same rack panel.

Connect the GPS-MTG Video Out to the input of a video monitor or video distribution amplifier. A video monitor is needed to view the information displayed by the GPS-MTG in a window, which is keyed into the video input signal.

NOTE:

The SMPTE time code is locked to this video as specified in the SMPTE reference document. The time code time is incremented by counting video frames from the VIDEO IN signal. It is important that an accurate and continuous uninterrupted signal is always present at this input. Interruptions or a large error in video rate will cause frequent GPS corrections to the time. Each correction is a jump in the frame number sequence. "Jumps" in the time code are undesirable for frame-accurate video search and edit applications.

3.9 Connecting Time Code Out

Connect the GPS-MTG TC OUT to the input of equipment which is to distribute, record, read, or display the SMPTE time code signal.

3.10 Connecting Power

Included with your GPS-MTG is an AC power adapter that provides a 24 volt, 350 ma. DC output. This adapter is equipped with a miniature coaxial DC power plug with the "+" positive voltage output connected to the center contact.

Insert the power plug into the GPS-MTG " + 24 V POWER" connector and plug the adapter into the 110-120 volt, 60-Hz AC power.

WARNING

ELECTRICALLY OPERATED PRODUCT

As with all electrical products, precautions should be observed during handling and use to prevent electrical shock.

NOTE:

Do not use an adaptor with AC output or an adaptor with DC output of more than 24 volts or damage to your GPS-MTG or GPS receiver may result.

The GPS receiver is powered from the GPS-MTG and no separate power supply is required.

3.11 Connecting the AUX/COMM Outputs

If any of the signals on the GPS-MTG 9-pin "D" AUX/COMM connector are to be used, fabricate a cable with the appropriate connections and plug it into that connector.

The AUX/COMM connector is a standard female DB9F and mates with a male DB9M connector.

PIN #	Signal Description
1	UTC 1 pulse per second (1PPS) from GPS rcvr.
2	RS-232 serial output from GPS-MTG (HSIP)
3	Reserved
4	GPS-MTG 1 pulse per second (100 microsec)
5	Ground
6	GPS-MTG 1 pulse per minute (100 microsec)
7	Reserved
8	RS-232 data from GPS receiver (NMEA)
9	GPS-MTG alarm output

3.12 UTC 1PPS

The UTC 1PPS output is a 20 millisecond nominal width pulse from a 5V quiescent level to 0V. The leading edge of this pulse coincides with the start of each UTC second.

The GPS receiver specifies a UTC 1 PPS accuracy of ± 1 microsecond. Additionally, a delay of about 1 microsecond is added in the GPS-MTG electronics and, nominally, 0.15 microseconds per 100 feet of cable between receiver and GPS-MTG.

3.13 GPS-MTG 1PPS

The GPS-MTG 1PPS is a 100 microsecond wide pulse from a quiescent 5V level to 0V. The leading edge of this pulse coincides with the end of frame 29 and the start of the next time code second.

The GPS-MTG 1PPS timing differs from the UTC 1PPS for the following reasons. As the drop frame time

code progresses, the GPS-MTG falls behind the UTC 1PPS at the rate of 1 millisecond per second (29.97 frames/sec. instead of 30.00).

After 1 minute, the time code is 60 milliseconds behind UTC. A drop (skip) of two frames in the time code advances the time code by 66.7 milliseconds putting it ahead of the UTC by 6.7 milliseconds.

The process is repeated 9 minutes in a row until at the 9th drop of two frames, the cumulative advance of the time code is approximately 60 milliseconds. By omitting the drop of two frames at the end of the 9th (start of the 10th) minute, nearly exact compensation is achieved.

The GPS-MTG 1 pulse per minute is the same in timing and duration as the 1PPS but occurs less frequently. The GPS-MTG 1PPS and 1PPM output pulses have provision inside the GPS-MTG for removing a jumper to make them open-collector outputs with no pull-up to 5V.

3.14 HSIP RS-232

The RS-232 serial output of the GPS-MTG is binary data at 9600 baud, providing the time code time and status information in a proprietary HORITA format (HSIP Ref. Appendix 1). This data can be received on a PC comm port with the use of HORITA or user-developed software to monitor GPS-MTG operation or preset time in your PC.

The GPS-MTG data output is multiplexed such that the user bits of a particular time code frame number contain certain GPS-MTG data, as well as certain test data. This is shown in the following table:

Frame No.		**User Bit Data**			
	UB Position =	U8/7	U6/5	U4/3	U2/1
02	Date	Zone	YR	MO	DY
03	DST/Test Data	DST	Test	Test	Test
04	Manual UB	U8/7	U6/5	U4/3	U2/1

DST (Daylight Savings Time) User Bit data meaning:
00 = DST disabled and not in DST time.
01 = DST disabled and not DST time.
d0 = DST enabled and not in DST time.
d1 = DST enable and in DST time.

NOTE: All other frame numbers not described above contain either zeros (00) or additional test data for the user bits. Consult HORITA Co. if further test data information is desired.

3.15 NMEA RS-232

The RS-232 data from the GPS receiver is National Marine Electronics Association (NMEA) data, received, buffered and retransmitted as RS-232 by the GPS-MTG.

3.16 GPS-MTG Alarm Output

The Alarm output from the GPS-MTG is an open-collector transistor output, which is normally conducting 0 volt output when there is no alarm. An external pull-up resistor to an external +5V DC voltage will provide a fail-safe +5V Alarm condition when:

a. Power input to the GPS-MTG is lost
b. Video input to the GPS-MTG is lost
c. 1PPS input to the GPS-MTG is lost
d. GPS serial data input to the GPS-MTG is lost

4 OPERATION

4.1 Introduction

The HORITA GPS-MTG can operate in either the GPS (automatic) time and date acquisition mode, or in a manual mode. The manual mode is used when desired to simply generate arbitrary SMPTE time code time and user bits, or non-drop frame time code. It can also serve as a backup to the GPS mode so that the GPS-MTG will still operate should there be a failure of the GPS receiver system.

4.2 Switches and Controls

Operation of the GPS-MTG switches and controls is summarized in the following table:

Switch/Control	Function
DISPLAY	Selects display vertical size and display on/off
SELECT	Selects TC UB or ZONE information displayed in the video as well as acted on by operation of the SETUP switch
SETUP	Initiates action as determined by SELECT switch position
H-POS	Moves display right/left
H-SIZE	Expands or shrinks width of display

Table 4-1, Front Panel Switches and Controls

4.3 DISPLAY Switch

The DISPLAY switch steps through a 3-step cycle of large display (48 horiz. lines), small display (24 horiz. lines), and display off. The latest display selection setting is written to non-volatile memory inside the GPS-MTG and restored as part of the power-on setup.

4.4 H-SIZE and H-POS Controls

The H-SIZE and H-POS controls can be operated to adjust the horizontal width of the display and the horizontal position. The display is at the bottom of the video screen.

4.5 SELECT Switch

The SELECT switch is used to select what information is displayed and acted upon by the SETUP switch.

When the SELECT switch is in the TC position, the information displayed is the GPS-MTG time code time. In the UB position the user bits are displayed and can be either the Zone/Date or manually entered user information, as selected by the SETUP switch. In the ZONE position the time zone, daylight savings time enable/disable, and selectable "midnight" hour preset values are displayed.

4.6 GPS Mode Automatic Time Acquisition Sequence

After installation and connection, operation of the GPS-MTG is basically automatic, and all that has to be done is to switch the POWER switch ON. To observe the SMPTE time code being generated, set the SELECT switch to the TC position. The GPS MTG time code display appears at the bottom of the video monitor screen.

When powered up, the GPS-MTG starts with a time code display of 00:00:00:00 in the video output with only the frames running. Both the LED and the dot above the colon between seconds and frames in the display are steady "ON" to indicate that GPS time acquisition is under way.

In a few minutes the GPS receiver will acquire satellite signals, determine UTC, and send this information to the GPS-MTG. The GPS MTG will preset the time code to UTC. The dot above the colon and the LED will begin to flash at a steady 1 flash per second.

Note that when the GPS time information is acquired, the GPS-MTG is preset to UTC time after first adjusting the hours according to the local time ZONE setting, including daylight savings if enabled and in effect. After this, local time appears in the display.

The dot above the colon is a UTC indicator. Whenever it (or the LED) is flashing once per second, UTC has been acquired and the GPS-MTG time is exactly equal to UTC. When a mismatch is detected and re-acquisition is in progress, the dot and the LED are steady "ON".

The presence of this UTC dot either flashing or steady "ON" also indicates that the GPS-MTG is not in the manual mode. The GPS-MTG manual mode is described in greater detail in a separate section.

4.7 Manually Starting A GPS Time Acquisition

Acquisition can be manually initiated at any time by operating the SETUP switch momentarily while TC is selected. When this occurs, the UTC dot and LED remain steady "ON" until another GPS time has been obtained and the preset operation is complete.

4.8 LED and Video Display Readouts

The GPS-MTG provides information to the user via the time code window video display and front panel LED indicator. The following two tables provide a summary of the LED and video displays.

MTG Status	LED Indication	1PPS Dot
GPS time acquisition	Steady on	Steady on
Normal running	1 PPS flash	1 PPS flash
Video loss	Alternating between "on" 1 second and "off" with flash	No display

Table 4-2, MTG GPS Mode LED and 1PPS Video Display

Displayed Video	Separator Characters	Display Example
Time code (drop frame)	2 colons, semicolon with 1PPS "dot"	23:59:59;29
Zone/Date user bits	1 dot, 2 colons, last with 1PPS "dot"	07 93:08:09
Manually set user bits	3 colons, last with 1pps "dot"	12:34:56:78
Zone/DST setup	2 dots, colon with 1pps "dot"	07 d0 03:00
Diagnostic display	2 blanks, colon with 1pps "dot"	00 00 00:C1

Table 4-3, MTG GPS Mode Video Displays

During time-acquisition the LED on the front panel just above the POWER ON switch provides visual indication of the acquisition-in-process status by remaining steady "ON".

When GPS time-acquisition has taken place and the time has been preset to UTC, the LED flashes at a steady 1 flash per second rate on frame 29, indicating that GPS time has been acquired and the time code is running in lock with the video input. The trailing edge of each flash marks the start of the next second.

If there is no video input, the GPS-MTG will automatically enter the acquisition mode causing the LED to remain continuously "ON" until video is again present and a new time setting has been acquired.

When a video input signal is present, and the time code has been preset to UTC, the LED again flashes once each second.

4.9 Time Zones

The GPS-MTG time zone setting adjusts the GPS time to local time. The time zone setting is stored in non-volatile memory for automatic setup following power off and power turn on.

The time zone selections are from 0 to 23. Zone 0 is Greenwich time. Time zone 1 is 1 hour later than (west of) Greenwich. Time zone 11 is 11 hours later than Greenwich (just east of the international dateline). Time zone 12 is 11 hours earlier than Greenwich (just west of the dateline). Time zone 23 is 1 hour ahead (east) of Greenwich time, and so forth. Reference locations and their time zone are shown in Table 4-3.

Zone	City
0	London (Greenwich)
1	Iceland
2	Azores
3	Rio de Janeiro
4	Buenos Aires (East. Daylight T.)
5	New York (Eastern Standard Time)
6	Chicago (Central Standard Time)
7	Denver (Mountain Standard Time)
8	Los Angeles (Pacific Standard. Time)
9	Whitehorse, Yukon Territory
10	Anchorage, Alaska
11	Nome, Alaska (UTC-11)

12	New Zealand (+1 day, UTC+12)
13	Kamchatka
14	Sydney
15	Tokyo
16	Manila
17	Djakarta
18	Igarka, Siberia
19	Omsk
20	Sverdlovsk
21	Baghdad
22	Moscow
23	Paris (UTC-1)

Table 4-4, Reference Locations For Time Zones

4.10 Time Zone Setup

To set up the time zone for local time, move the TC, UB, ZONE switch to the ZONE position. The output video will now have the current time zone setting in the left two (hours) digits of the display.

To change the time zone, operate the SETUP switch for one second until the zone display begins to alternate between its current setting and “88”. This indicates the zone setting is ready for change. To change the zone setting, release the SETUP switch and operate it again to advance the zone count. Holding the SETUP switch down will now cause the zone to count up at a slow rate.

When the local time zone has been selected and no further operation of the SETUP switch has occurred for 2 seconds, the zone setup mode is over.

Note that after the time zone preset operation is finished, the next digit, the automatic daylight savings mode enabled/disabled status, to the right of the time zone, will flash for a few seconds, then flashing stops. Enabling or disabling the automatic daylight savings time mode is described in later paragraphs. Similarly, the next two digits after daylight savings are the selectable hour (0="midnight") for automatic 24-hour GPS reacquisition. This is also described in later paragraphs.

If the time zone or daylight savings time status was changed, a new GPS time acquisition is automatically started when the SELECT switch is changed from ZONE to TC.

4.11 Automatic Daylight Savings Time Enable/Disable

The next two digits after the time zone are the automatic daylight savings time (DST) mode indication. The left digit is either 0 (disabled) or d (daylight savings enabled). The status can be changed from 0 (disabled) to d (enabled) or d to 0 by operating the set switch when this digit starts to flash.

If the current date is in the interval between the second Sunday in March and the first Sunday in November, the digit to the right of the d (or 0) will be a 1, indicating daylight savings will be in effect if enabled. Otherwise, this digit is a 0, indicating that it is not in the daylight savings time period. If the DST mode was enabled outside of that interval, the automatic change will take place at 2:00 A.M. on the second Sunday in March. Similarly, the change will be reversed at 2:00 A.M. on the first Sunday in November.

4.12 Automatic 24 Hour Acquisition Hour Selection

The next two digits after the DST display digits are the hour at which the 24 hour automatic reacquisition of GPS time will occur. This number can be set from 00 to 23 in the same way as the time zone.

For example, if the hour selection is set to 03, the 24 hour acquisition will occur at 3:00 A.M. every day. If the time zone is 00, the acquisition occurs at 3:00 A.M. UTC. If the time zone is set to the local zone number, then reacquisition will occur at 3:00 A.M. local time.

4.13 User Bit Setup

When the SELECT switch is in the UB position, the GPS-MTG display in the Video Output is the time code user bits. While displaying user bits, a momentary operation of the SETUP switch toggles the selection of either time-zone/date mode or manual user bit mode. The manual user bit mode allows the operator to manually enter user bit numbers. The user bit data is saved in non-volatile memory, along with the user bit mode selection, for automatic restoration at power up.

Each time the SETUP switch is operated, the user bit mode toggles between time-zone/date and manual preset modes. The display shows the information that is actually being put into the time code user bits. When the time-zone/date is displayed, the left most colon changes to a single dot.

The current user bit mode selection is apparent from the dots and from the user bit display. The time-zone/date being recognizable as zz • yy:mm:dd where zz = zone, yy = year, mm = month, and dd = day.

The manual user bits can be set to a number from 0 to 9, A to F in each digit position.

The user bits are manually preset by operating and holding-down the SETUP switch for 2 seconds or more. After 2 seconds, the left digit flashes between 0 and 8 indicating that this digit is now available for change. If held down for 4 seconds, all prior user bit setup data is set to zero.

If the SETUP switch is released while the digit is flashing and then operated again, the digit can be counted up either by operating the switch once for each count or by holding it down to count continuously until released. After the SETUP switch has been released for 2 seconds, the current digit becomes fixed and the next digit starts flashing.

Progressively all eight user bit digits enter the flashing state and may be preset as described above. After the last digit has been completed, the alternating 8 ceases to appear in the display.

Both the manually entered user bit setting and user bit time-zone/date selection are stored in non-volatile memory in the GPS-MTG for automatic setup following power off and power turn on.

4.14 Manual Mode

The manual mode provides an alternative way to preset and start the GPS-MTG without the GPS receiver operating, for example, in the event of a GPS receiver failure, or if some arbitrary time code number or user bits are desired to be generated. The manual mode also allows the generator to be set to generate non-drop frame time code, should the need arise.

Both the time code starting time and the user bits can be manually preset, and the generator manually stopped and started. None of the preset data entered when in the manual mode is saved in non-volatile memory, or affects any of the preset date entered when in the GPS-MTG mode.

The following two tables provide a summary of the LED and Video displays associated with the GPS-MTG manual mode of operation.

MTG Manual Status	LED Indication	Video Display
Generator stopped	Alternating "on/off" at 2 Hz	Colons flashing
Generator running	Alternating "on/off" at 15 Hz	Colons steady
Generator stopped, video loss	Alternating "on/off" at 0.5 Hz	No display
Generator running, video loss	Alternating between “on/off” "on/off" at 15 Hz and 1 second.	No display

Table 4-5, Manual Mode LED and Video Display

Displayed Video	Separator Characters	Typical Example
Time code, Drop frame	2 colons, semi colon	23:59:59;29
Time code, Non-drop frame	3 colons	23:59:59:29
User Bits	3 colons	12:34:56:78

Table 4-6, Manual Mode Video Displays

4.15 Entering the Manual Mode

To enter the manual mode of operation, turn POWER OFF, then hold the SETUP switch in the SET position while switching POWER ON. Release the SETUP switch and the GPS-MTG is ready to run, starting at time 00:00:00:00, with a single momentary actuation of the SETUP switch.

Note that the UTC dot above the colon is not present in the manual mode.

4.16 Presetting the Time Code

To preset the time code starting time and drop frame/non-drop frame mode, hold the SETUP switch down for two seconds until the hours digits start flashing between 00 and 88.

If the SETUP switch is released and again operated while the hours are flashing, each momentary actuation advances the hours count by 1 hour. Holding the SETUP switch down causes the hours to count up at a moderate rate.

After the SETUP switch has been released for 2 seconds, the minutes begin to flash. The minutes can be manually preset like the hours.

4.17 Presetting Drop Frame/Non-Drop Frame

After the minutes have been preset and the SETUP switch has been released for 2 seconds, the semicolon between seconds and frames will begin to alternate between a colon and semicolon. The colon indicates non-drop frame time code while the semicolon indicates drop frame. By operating the SETUP switch momentarily, the selection can be set for either drop or non-drop frame time code generation.

Note that only drop frame code is possible in the GPS mode. Non-drop frame code does not keep time accurately and is not suitable for automatic GPS-MTG operation.

When the drop frame/non-drop frame mode has been preset, the colons begin to flash again indicating the GPS-MTG is ready to be manually started when local time is approximately at the manually preset time.

4.18 Starting and Stopping the Generator

After all preset operations are complete, the LED and all of the colons in the time code display flash at a 0.5 second interval. At this time, alternate momentary operation of the SETUP switch will now start and stop the time code generator. If the SETUP switch is momentarily actuated while time code is running, the time code will stop and the colons will flash. The time code can be manually re-started or preset as described above.

4.19 Generator Run LED Indication

The LED indicates generator "run" operation in the manual mode by flashing at 15 Hz while generating time code locked to video. If time code is being generated in the manual mode without a video input, the LED alternates between 1 second "OFF" and 1 second of 15 Hz. as indication of loss of video.

4.20 User Bit Select and Preset

If the SELECT switch is placed in the UB position, the display will be user bits. If the SETUP switch is operated the user bits can be preset like the time, except that each of the 8 digits can be independently set.

The SELECT switch ZONE position has no function in the manual mode of operation. Selecting ZONE will display all zeros.

4.21 Changing from Manual to GPS Mode

Once the manual mode has been selected, the GPS automatic time acquisition mode cannot be selected except by turning POWER OFF and then back ON again on the GPS-MTG.

5 TROUBLESHOOTING

5.1 Introduction

Locating faults or problems with the GPS-MTG can be assisted by use of the front panel LED indicator and the time code video display window. There is also a GPS diagnostic mode that can be entered into which displays various codes showing the progress of communication from the GPS receiver to the GPS-MTG.

5.2 Front Panel LED

The GPS-MTG front panel LED is a good starting point for troubleshooting. The LED indications are:

- No lighted LED at all indicates no power input
- Steady "on" indicates GPS time acquisition in progress—if this condition continues for more than a few minutes see diagnostic mode below
- Steady "on" for 1 sec. and then "off" for 1 sec. with short flash "on" during "off" period indicates loss of video reference input

5.3 GPS Time Acquisition Diagnostic Mode

Serial communications from the GPS receiver is essential for setting the time in the GPS-MTG. Receiver status is verified by the GPS-MTG. The communication stages can be monitored in the Diagnostic mode. Normally this all happens automatically and need not be observed. If a problem occurs, the diagnostic mode may help to identify where things have gone wrong.

5.4 Selecting Diagnostic Mode

The diagnostic mode is activated by setting the SELECT switch to the ZONE position, then continuously holding the DISPLAY switch down until the left and center colons disappear from the display, which takes about two seconds.

5.5 Monitoring GPS Time Acquisition Codes

Upon entering the diagnostic mode, the GPS time acquisition process is automatically started and the GPS dot is steady "on". The right two digits of the display follow the progress of the communication sequence between the GPS-MTG and GPS receiver. The next two digits to the left show the “health” status of the GPS reception. Normally this is "41" when satellite signals are received.

5.6 Diagnostic Displays

When the system is operating normally, the display following initiation of the diagnostic mode is:

00:00:41:C2

Within about 100 sec. the C2 will change to 00. At that time the time code starts and the LED begins to flash once per second. Until then the LED has been steady on indicating time acquisition in progress.

If Satellites are not yet acquired the display will read:

00:00:00:C1

If there is no message from the GPS receiver the display will read:

00:00:00:C0

5.7 Communication Complete

When time data is received and the SMPTE time code is running, the GPS-MTG begins flashing the GPS dot in the display, and the right two digits are zero. The GPS-MTG remains in the diagnostic mode until the SELECT switch is moved from the ZONE position.

5.8 Communication Error Conditions

Following a lightning strike or some other extreme stress, which may have caused GPS-MTG internal parts to fail, two possible error conditions can be displayed in the diagnostic mode.

5.9 Interprocessor Communication Fail

The first error condition is failure of the two processors within the GPS-MTG to communicate with each other. This is indicated by the display of:

00:00:00:E1

5.10 UTC 1PPS Fail

The second error condition is failure to receive the 1 PPS signal from the GPS receiver. This condition is indicated as:

00:00:00:E2

5.11 Typical Communication Sequence

The following are typical sequences of diagnostic readings.

MTG/GPS Receiver Communication	Diag. Code
Start	00:00:00:C0
45 sec	
I-PPS verified	00:00:41:C1
1 sec.	
Satellites verified	00:00:41:C2
100 sec.	
Run	00:00:41:00
146 sec. total	

5.12 Summary of Communications Diagnostic Indications

Code	Meaning
C0	Start of Diagnostic sequence. Waiting for GPS receiver I-PPS to start.
C1	IPPS received.
C2	Satellite data received
00	Completion of diagnostic test. All OK.
E1	Communication between processors has failed. (GPS-MTG internal error)
E2	I-PPS from GPS receiver has failed

6 PC TIME/DATE SOFTWARE

6.1 MTG-TIME Program Overview

MTG-TIME is a MS Windows based program which keeps the PC's time and date synchronized to the HORITA GPS-MTG. MTG-TIME monitors the RS-232 "HSIP" format time code data applied to one of the PC's serial comm ports, and updates the PC's time and date once each second.

If the Time Code User Bits received from the GPS-MTG do not contain properly formatted zone and date information, the MTG-TIME program will not alter the PC's internal date value but will continue to update its time of day.

6.2 MTG-TIME Installation and Compatibility

The MTG-TIME program is contained on the CD that came with your GPS-MTG. Follow the installation instructions on the CD for installing MTG-TIME on your computer. Although Horita cannot guarantee that MTG-TIME will work on your specific computer, it was developed using the Windows XP operating system (OS) and should work with XP, as well as with the MS Vista and "7" OS's when those are run in XP "compliancy" mode.

7 SPECIFICATIONS

Power

Requirements	12 to 28 VDC 350 milliamperes
Connector	2.5mm coaxial power plug (center=+)
AC Adapter	24 VDC 400 milliamperes 12 VDC 1000 milliamperes can be used with cables up to 50' in length

Video System

Standard	NTSC color 525 line 60 field
Input	
Level	1 Volt p-p, negative sync
Impedance	75 Ohms
Output Level	
Power on	1 Volt p-p into 75 Ohms
Power off	Input switched to output (bypass)
Connectors	BNC

Time Code

Format	SMPTE 80-bit longitudinal drop frame Time code ANSI V98.12M
Output level	1.5 Volt p-p
Risetime	25 microseconds ± 5 microseconds
Impedance	2K Ohms
Connector	RCA-also on front panel

Serial GPS Data Input

Data Format	NMEA $GPRMC
Data Signal	RS-232 or RS-422 4800 baud
GPS 1PPS	approximately 2 microseconds wide from 5VDC to ground
Connector	DB9F female connector

AUX/COM Utility Outputs

UTC 1PPS	
Width	approximately 20 milliseconds
Level	+5 VDC quiescent, 0 VDC active
Leading-edge time accuracy	1 microsecond (2-3 min. after satellite lock-on) as specified by Marconi Navigation, delayed further by GPS-MTG electronics less than 1 microsecond plus approx. 1.5 ns per foot of cable
Time code 1PPS	100 microsecond pulse 5V to gnd
Time code 1PPM	100 microsecond pulse 5V to gnd
GPS-MTG Alarm Output	0V = no alarm, max. current = 10 millamperes open collector output=alarm condition +30V DC max. external supply voltage
Connector	DB9M male connector

Temperature Range

GPS-MTG	
Operating	5 degrees C to 40 degrees C
Non-operating	-10 degrees C to 60 degrees C
GPS Antenna/Receiver	
Operating	-30 degrees C to 80 degrees C

Dimensions

Rackmount panel	1-3/4" height by 19" wide
Chassis	5.75" deep
GPS Antenna/Receiver	3.6" diameter by 2.9" high

Weight

GPS-MTG	2.0 lb
GPS Antenna/Receiver	7.1 oz

Mounting

GPS Antenna/Receiver	1”-14 UNS (marine standard) female pipe thread in base of antenna

Specifications subject to change without notice.

APPENDIX - 1

HORITA MTG HSIP RS-232 SERIAL DATA FORMAT

Comm Data Format

RS232 serial data, 9600 baud, 1 start bit, 8 data bits, 1 stop bit, LSB first.

Byte Structure

Time Code:	Time	Packed BCD;	Tens/Units
User-Bits:	Date	Packed BCD;	Tens/Units

Message Structure

Continuously sent data stream of 10 bytes per video frame, requiring approximately 10Ms of real time, leaving about 23Ms of frame time remaining. Five byte time code packet is output during video Field-1, five byte user-bit packet is output during video Field-2, as follows:

Field-1; Time Code:	TC ID	T/U Frm	T/U Sec	T/U Min	T/U Hrs
Field-2; User-Bits:	UB ID	UB 21	UB 43	UB 65	UB 87

ID Bytes

The start of the time code and user-bit packets are preceded by a special "ID" byte. The time code ID byte can have one of four values, the user-bit ID byte has one value.

Time Code ID Byte

The time code ID byte is binary 111100XX, which in HEX is F0, F1, F2, or F3. The significance of the "X" bits of the time code ID byte is as follows:

Byte bits	7 6 5 4 3 2 1 0	
Binary value	1 1 1 1 0 0 XX	Bit Significance
	0	0=Reverse direction time code
	1	1=Forward direction time code
	0	0=Non-drop-frame time code
	1	1=Drop-frame time code

User-Bit ID Byte

The user-bit ID character is binary 11111111, or HEX FF

Supplement to GPS-MTG Manual
for Operation with GPS-MSG

Rev. 1 11-1-00

1 INTRODUCTION

The HORITA Master Time Code Generator System (GPS MTG) consists of an ANSI/SMPTE longitudinal time code generator and a Global Positioning System (GPS) receiver. The time code generator uses data from the GPS receiver to automatically acquire, to monitor and to maintain time synchronization with Coordinated Universal Time (UTC).

The HORITA Master Sync Generator (GPS MSG) is a multiple-output black-burst NTSC composite sync generator absolutely locked to UTC. The video output from each GPS-MSG is synchronized to UTC using signals from the GPS receiver.

The video signals from two independent GPS-MSGs are synchronous to each other through their common absolute reference to UTC. Field one on each video signal starts simultaneously regardless of physical separation between the systems. The timing difference between video signals from independent MSGs is typically less than 10 microseconds.

This supplement manual provides the additional information required when the MSG and MTG are operated together as a system. The operational changes affect the MTG only.

2 GENERAL

The MTG has two principal modes of operation, synchronous (with GPS-MSG video) and asynchronous (when operating with video from other sources).

The MTG has an internal jumper setting which is factory-set to select the mode of operation. Stand-alone MTGs are normally configured to operate in the asynchronous mode. When a MTG is combined with a MSG or known to be for use with a MSG, it is configured for synchronous operation. Reconfiguration is described in section 5 below.

The asynchronous mode of operation is covered in the basic MTG manual. The asynchronous mode allows a time code tolerance of +/-5 frames in relation to UTC time to accommodate the 24-hour build-up of time code error as a result of imperfect video source frequency.

This manual addendum covers the differences in MTG synchronous mode operation. In the synchronous mode, the MTG time code is frame-accurate. Two isolated MSG/MTG systems at different locations will generate video frames in unison with identical time code frame numbers.

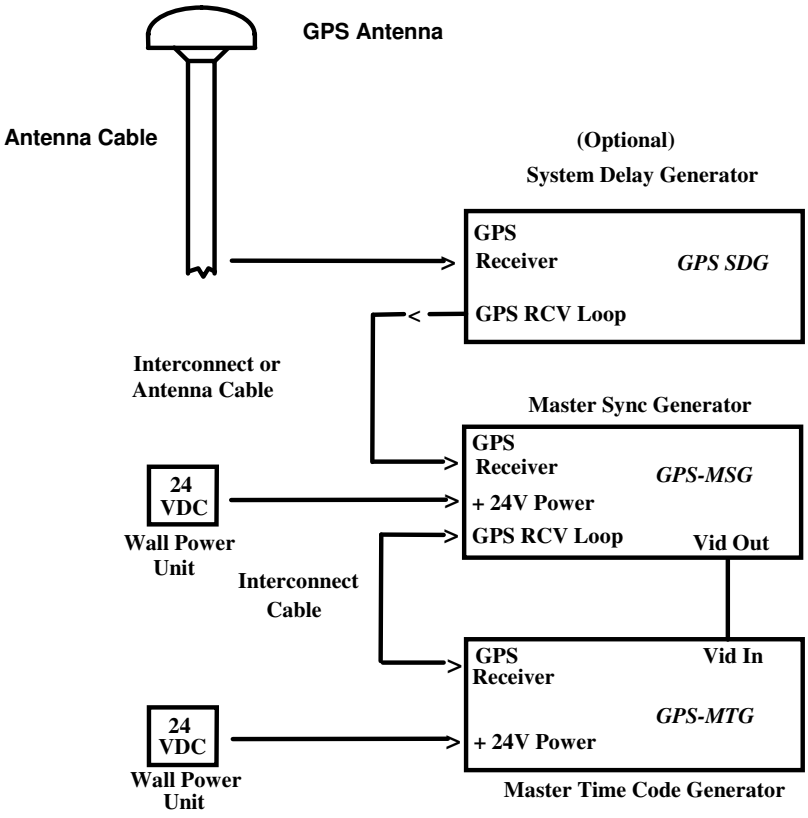
In the synchronous mode, the MTG time code does not drift away from the exact drop frame relationship to UTC. There is no 24-hour correction. The video and time code are maintained in continuous synchronization to UTC.

The MSG generates a video reference with a very precise relationship to UTC. The MSG circuits have an operating temperature range from 5 degrees centigrade to 40 degrees centigrade. The operational performance at any temperature in this range will be enhanced by maintaining a small temperature variation. The rate of change of temperature will increase the small phase difference in microseconds between UTC and MSG video sync. When the temperature change over several hours is small, the rate of change will be small and the tracking error will be minimal.

If the power is interrupted and then restored, automatic acquisition and recovery is accomplished by the unattended GPS MSG and MTG.

3 GPS MSG/MTG SYSTEM CONNECTION

3.1 GPS Antenna/Receiver and Power input diagram



Refer to MTG manual for further information on antenna location and connecting power.

4 Changes to MTG Operation in Synchronous Mode

4.1 Initial Startup

Following power-on, the MTG "POWER ON" LED is steady "on" indicating power is present and acquisition is in progress. Initial time-acquisition in the MTG synchronous mode is carefully sequenced and verified to assure a correct start. This process takes somewhat longer than the asynchronous MTG operation.

4.2 Time Zone Select Display:

When the time code window is selected to display the ZONE, the asynchronous mode shows:

zz:dx:hh:00

zz is the time zone, dx is daylight savings time status, hh is the 24 hr automatic time re-acquisition hour, and the 00 is unused.

When in the synchronous mode, the display is:

zz:dx:Ab:00

The "Ab" stands for "Acquisition bypass" since there is no 24 hour acquisition hour to select. The presence of "Ab" in this display is confirmation the mode jumper is in the position selecting the synchronous mode.

5 MTG SYNCHRONOUS/ASYNCHRONOUS MODE JUMPER

The jumper to select the “synchronous” or “asynchronous” operating mode is located inside the MTG chassis on the right-hand circuit board at J5. Disconnect power. Remove the 4 top cover mounting screws and take the cover off.

Looking down on the chassis with the front panel towards you, “J5” is located just behind the horizontal size (H-SIZE) control. Shorting “J5” selects “Synchronous mode; removing the jumper selects “asynchronous” mode.

Unless the GPS-MTG is to be installed with a HORITA GPS-MTG, the factory default is “asynchronous” mode.