A RAMI TECHNOLOGY Company

Time and Frequency Reference Module

SY-GSC10S

High-Performance GPS Time and Frequency Reference Module
Designed for incorporation into integrated systems

- High spectral-purity 10 MHz sine wave output
- Standard one pulse-per-second (1 PPS) timing pulse output
- Industry standard NMEA 0183 format serial output messages
- MTIE Stratum-1 compliance with frequency accuracy of $1x10^{-12}$ (long-term)
- Sawtooth-corrected timing pulse accuracy
- GPS-disciplined ovenized oscillator with very low phase noise
- Unit-to-Unit Phase Coherency optimization
- High-sensitivity GPS/SBAS receiver, with automatic WAAS differential corrections
- Time, Date, Position, Altitude, Heading, Velocity Information
- Fast Time-To-First-Fix offers high accuracy within just minutes of start-up
- Intelligent compensation algorithm provides exceptional stability during GPS Holdover/Coast

DESCRIPTION

The SY-GSC10S Time and Frequency Reference Module provides a GPS-based precise time reference (1PPS) for synchronizing to UTC time, and a precise frequency reference (10 MHz) for maintaining calibration of frequency-related instrumentation. In addition, the Module provides GPS position, velocity and time (PVT) information as well as auxiliary time and frequency outputs. Capable of autonomous operation without connection to a host computer, the Module requires no intervention to acquire GPS satellites and provide the basic time and frequency functions based on factory default settings.

A GPS-disciplined ovenized crystal oscillator (OCXO) is incorporated to provide a very precise and stable frequency reference. After a few hours of tracking GPS signals, the accuracy of this source in the frequency domain approaches that of the Cesium clocks on the GPS satellites in the time domain. The output frequency of 10 MHz is presented both as a sine-wave and as a TTL or LVTTL square-wave.

The high-sensitivity, timing-optimized GPS receiver is effective even in challenging signal environments. The timing outputs are maintained by the internal reference oscillator (OCXO) if the GPS is in Holdover/Coast. The switch-over between tracking and Holdover is seamless to the output signal. The Module provides the bias voltage of either +5.0 or +3.3 VDC for an active GPS antenna. GPS antennas are sold separately.

LVTTL logic level asynchronous serial communications provide information in NMEA 0183 format. A DIP switch changes the polarity if desired to be compatible with RS-232. A breakout board accessory is available that provides true RS-232 conversion, along with DC power connector, serial connector, and access to signal outputs. Contact the factory for information.

CONNECTIONS

The Module has two vertical MCX jacks that are used for the primary timing and frequency reference outputs, a third vertical MCX jack that is used for the input from the GPS Antenna, and a dual-row, 16-pin (2x8) 0.100”-pitch header connector that is used for all other input/output, plus power and serial communications (System Interface).

The **Primary Timing Output** is a One-Pulse-Per-Second (1PPS) that is synchronized to UTC. The positive pulse is rising edge on-time, TTL levels into 50 , 1ms nominal pulse-width, 2.5 ns typical rise-time. An additional 1PPS output appears on Pin 2 of the System Interface connector. Both of the 1PPS signals are sawtooth-corrected in real-time and are derived directly from the timing-optimized GPS receiver. A filtered 1PPS that is generated from the primary reference oscillator appears on Pin 11 of the System Interface connector and is coherent with the zero-crossing of the 10 MHz frequency reference output. The filtered 1PPS is practically jitter-free.

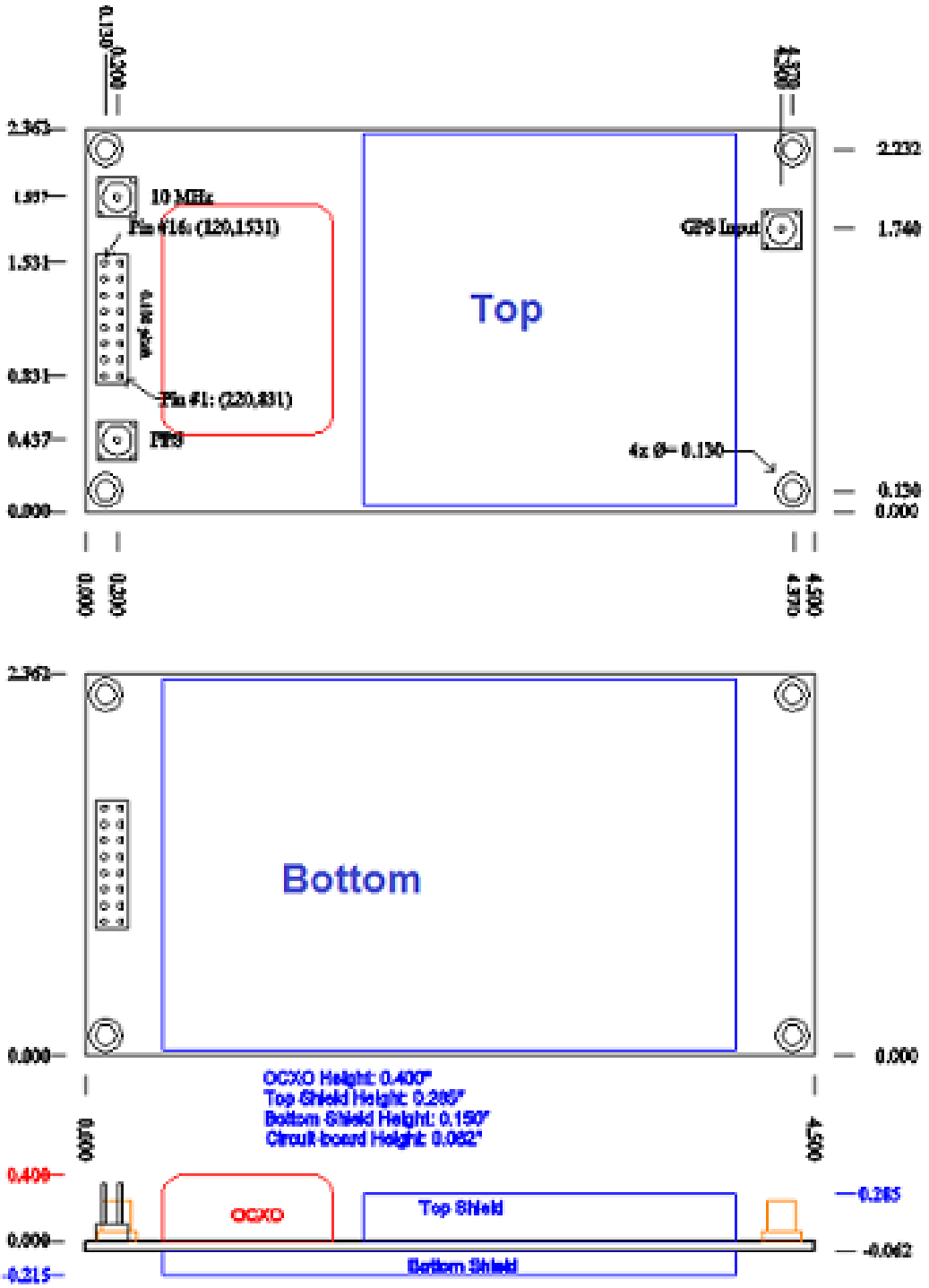
The **Primary Frequency Output** is a high spectral purity 10 MHz sine wave that is phase-locked to GPS. It is a +10dBm signal into 50 2dBm). A 10 MHz TTL version (square-wave) of the primary frequency output is available on the Multiplexer outputs. This signal is derived from the same source. Only the waveform is different.

An **External PPS Input** can be supplied to Pin 1 of the System Interface connector as an alternative source for tuning and synchronization.

INDICATORS

The best way to monitor the status of the GPS receiver and progress in tuning the oscillator is to observe the status messages that are output from the serial communications port. However, there are three LED indicators that can provide insight into the information without reading the messages. The three-color LED indicators relate the status of the power, the GPS time validity, and the frequency tuning algorithm.

LAYOUT DRAWING



DIMENSIONS

The dimensions of the module are 2.362" x 4.500". The circuit-board is 0.062". The bottom shield height is 0.150". The top shield height is 0.285". The tallest component on the top is the OCXO. It is available in different height options. The minimum height for the OCXO is 0.400". This results is an overall bottom-to-top height of 0.620". The height of the double-oven DOCXO Option 4 oscillator is 0.630", as shown on the drawing above. This results in an overall bottom-to-top height of 0.850". The mounting holes are 0.130" in diameter and are centered 0.130" in from the edges on each corner. The mounting holes are plated and grounded.

PIN ASSIGNMENTS

The Pin Assignments of the **System Interface** connector are

1 - External PPS Input (when enabled by command) or reserved for Custom I/O
2 - 1PPS Out (TTL or LVTTL into 50)
3- GND
4- GND
5- Rx – Serial interface Receive (LVTTL logic levels)
6- Tx – Serial interface Transmit (LVTTL logic levels)
7- Reserved for Custom I/O
8- MUX1 Output [Selected with $PTFR009 command] (TTL or LVTTL into 50)
9- "LOCKED" Hardware Logic Indicator for Locked to GPS
10- "FAULT" Hardware Logic Indicator for Hardware Malfunction
11- MUX2 Output [Selected with $PTFR014 command] (TTL or LVTTL into 50)
12- "RESET" Hardware Reset
13- GND
14- GND
15- Vcc (12 to 26 VDC)
16- Vcc (12 to 26 VDC)

COMMUNICATIONS

The NMEA 0183-format information output messages are as follows:

Message Name	Message Description	Information Provided
$GPGGA	**GPS Fix Data**	Time, Latitude, Longitude, Altitude, Status
$GPGSV	**Detail Satellite Data**	Detail Satellite Data, Signal Strength
$GPRMC	**Minimum Recommended Data**	Time, Date, Position, Speed, Course, Status
$GPZDA	**Date and Time**	Time, Date
$PTFR006	**User Time Bias**	Adjustment for cable length and system delays
$PTFR007	**Timing Mode**	Dynamic Mode (mobile), Static Mode (Fixed Location)
$PTFR008	**Master Reset**	
$PTFR009	**Multiplexer #1 Output Selection**	Select TTL Output: 10, 5, 1MHz; 100, 10, 1kHz; or PPS
$PTFR010	**Baud Rate**	9600, 19200, 38400, higher rates on request
$PTFR014	**Multiplexer #2 Output Selection**	Select TTL Output: 10 MHz square-wave or PPS
$PTFR017	**Query Mode**	Polling request for individual messages
$PTFR023	**Miscellaneous Information**	Antenna Alarm, Output Enable, External Input Enable
$PTFR024	**Select PPS Output Source**	GPS PPS or Filtered PPS
$PTFR025	**Status Indicators**	Status and Timers
$PTFR024	**Tuning Algorithm Control Parameters**	Optimize for phase coherency or frequency stability

SPECIFICATIONS

PHYSICAL

HEIGHT: 0.850 in. (15.75 mm) minimum, depending upon oscillator selection
WIDTH: 2.362 in. (60 mm) Optional Rack-mount Extension Brackets for 19-inch Rack Mounting
DEPTH: 4.500 in. (114 mm), excluding connectors
WEIGHT: 3.5 ozs. (100 g)

ENVIRONMENTAL

STORAGE TEMPERATURE: -40 to +85^{o}C.
OPERATING TEMPERATURE: -30 to +70^{o}C.
HUMIDITY: Up to 95% RH, non-condensing

PERFORMANCE (GPS)

RECEIVER TYPE: High Sensitivity 50 - channel GPS/SBAS Timing Receiver. CA code, L1 carrier.
TIME TO FIRST FIX:
Hot Start: <2 seconds, typical (valid Almanac, time, date, position and Ephemeris)
Warm Start: <5 seconds, typical (valid Almanac, time, date, and position)
Cold Start: <30 seconds, typical (no information)
POSITION UPDATE RATE: Once per second, nominal.
SENSITIVITY - ACQUISITION: -148 dBm
SENSITIVITY - TRACKING: -162 dBm
MAXIMUM VELOCITY: 1000 knots (515 m/s)
MAXIMUM ACCELERATION: 2 g
POSITION ACCURACY: Better than 2.5 m CEP

PERFORMANCE (FREQUENCY)

GPS-DISCIPLINED 10 MHz SINE WAVE FREQUENCY OUTPUT:
(Conditions: Time Valid, Static Mode, Phase-Locked to GPS)
Long-term Stability (tracking)**:** 1x10^{-12} after 24 hours of tracking (t=24 hours)

	High Performance	Highest Performance
Primary Reference Oscillator:	**OCXO "Option 1" (or 18)**	**DOCXO "Option 4"**
Short-term Stability: (t=1 second)	1x10^{-11}	7x10^{-12}
Accuracy (while coasting): (after stabilization)	<5x10^{-10}	<2x10^{-10}
Phase Noise, 1 Hz Bandwidth: @ 1 Hz:		< -90 dBc
10 Hz:	<-124 dBc	<-120 dBc
100 Hz:	<-139 dBc	<-140 dBc
1 kHz:	<-149 dBc	<-150 dBc
10 kHz:	<-151 dBc	<-155 dBc
100 kHz:	<-155 dBc	<-155 dBc

Harmonic Outputs: <-50 dBc
Spurious Outputs: <-70 dBc
Level: +10 dBm nominal into 50 ohms (±2dB)

PPS Holdover while coasting: 1.8 μsec 0.72 μsec
(Max. drift over 1 hr., stable conditions)

PERFORMANCE (TIME)

1 PPS OUTPUT ACCURACY, triggered by **GPS**, referenced to UTC**:** ±10 ns with real-time sawtooth correction
(Conditions: Time Valid, Static Mode)
JITTER, pulse-to-pulse**:** <±5 ns

1 PPS FILTERED OUTPUT ACCURACY, coherent with 10MHz**:** ±10 ns with additional jitter reduction
(Conditions: Time Valid, Static Mode, Phase-Locked to GPS)
JITTER, pulse-to-pulse**:** <±2 ns
COHERENCY TO 10MHz: <±1 ns

HOLDOVER STABILITY: Determined by Frequency Performance
1 PPS TIME MESSAGE: NMEA 0183 format ($GPZDA)

INPUTS & OUTPUTS

1 PPS OUTPUTS:
CONNECTOR: MCX standard. (SMA, SMB, MMCX available for special order)
DRIVE: TTL levels into 50
SOURCE: Low-jitter sawtooth-corrected GPS.
PULSE WIDTH: Positive pulse, 1 ms nominal. Rising edge on-time
RISE TIME: 2.5 ns typical, 5.0 ns maximum

10 MHz OUTPUTS:
CONNECTOR: MCX standard. (SMA, SMB optional)
DRIVE: High spectral purity sine wave, +10 dBm into 50 ±2dB

OTHER DIGITAL I/O:
CONNECTOR: 16-pin (2x8) IDC-compatible Header
INDICATORS: Indicator pins of Hardware Fault conditions, GPS Lock/Holdover, and Reset
MULTIPLEXER OUTPUTS: TTL levels into 50 ,rise time 10 ns maximum
Signal Selections: 1 kHz, 10 kHz, 100 kHz, 1 MHz, 5 MHz, 10 MHz, PPS, 1PP2S (even seconds), and Custom
GENERAL PURPOSE I/O: TTL levels into 50 for custom modification capability
EXTERNAL PPS INPUT: For synchronizing to external PPS source**,** including SAASM GPS receiver

COMMUNICATIONS:
SERIAL CONTROL I/O: LVTTL logic levels, 9600 bps, 8-N-1. Selectable baudrate to 38400 bps. Higher baudrates

available to 115200 bps. DIP switch changes polarity for compatibility with RS-232

NMEA 0183-FORMAT MESSAGES: $GPZDA, $GPRMC, $GPGGA, $GPGSV plus proprietary specialty messages. Messages can be streamed (every second) or individually polled

ANTENNA INPUT

Active GPS antenna required: Maximum gain 50 dB with noise figure less than 3 dB
Selectable Antenna Bias Voltage provided – either 5.0 or 3.3-Volts
Antenna should only be connected when the Module is not powered to allow for noise calibration on power-up

CONNECTOR: MCX standard. (SMA, SMB, MMCX available for special order)

EXTERNAL PPS REFERENCE INPUT

The Module will synchronize to an external 1PPS signal and maintain stability during Holdover/Coast stability

INPUT PULSE: 0 to +2 V min/+5 V max. Pulsewidth: 1µs – 400ms

POWER

INPUT SUPPLY VOLTAGE: +12 to +26 VDC. Power conditioning is provided internally. Contact factory for lower voltage requirements
POWER CONNECTOR: Included in System Interface 16-pin (2x8) IDC-compatible Header

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