TeraSync

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DATA SHEET

GPTiMe™

TS-369: Feature Rich, OEM Clock Synchronization Module for Cellular Base Stations and other Telecommunication applications

Complying with:

WiMAX (IEEE 802.16 d, e)
Telcordia: GR-1244-CORE
Telcordia: GR-253-CORE
ITU-T: G.812
ITU-T: G.813

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Revision history

Revision	Date	Description
1.00	01-02-2004	Preliminary
2.00	12-10-2009	New products added

1.0 Introduction

GPTiMe is an embedded OEM timing module handling timing and synchronization within the wireless base station (also: Node-B). It is designed to support several timing sources available within the base station, providing base stations manufacturers with flexible yet powerful synchronization management capabilities. It is a high performance feature rich timing unit, complying with:

WiMAX (IEEE 802.16 d, e)

Telcordia: GR-1244- CORE, GR-253 - CORE

ITU-T: G.812, ITU-T: G.813

W-CDMA

3GPP

The GPTiMe synchronization module is applying its capabilities to use multiple timing signals such as GPS satellite signal, and other telecommunication signals to provide the base station with the most accurate and reliable timing signal. The option to make use of an alternative reference when the active reference malfunctions provides the base station manufacturer with a robust and versatile timing source.

The GPTiMe can be equipped with an internal multi-channel parallel tracking GPS receiver. At power up, the GPTiMe internal GPS receiver will automatically track GPS satellites. After achieving lock to GPS, the GPTiMe is capable of synchronizing its output frequencies to the 1PPS signal derived from the GPS transmission. The GPTiMe is also capable of synchronizing itself to other external references signals such as 1PPS or inputs coming from the back-haul. In case of an interruption in the active reference signal, the GPTiMe is capable of deriving its timing from other available external references. When such references are not available, the module goes to holdover mode, deriving its outputs with an accuracy of the internal oscillator tuned to its last memorized output frequency.

GPTiMe is available as thru hole module, 2 types of SMT modules, or as an external box. It can be equipped with a wide range of oscillators, from low cost TCXO to Rubidium atomic clock, providing the customer with a maximum flexibility and helping him to achieve the most cost-effective solution for any application.

Option with a TCXO is available in full industrial temperature range (from –40 to +85º C).

The GPTiMe is also can be provided as a reference design, or separate IP core that can be embedded in the customer FPGA.

2.0 Description

GPTiMe is a self contained timing and synchronization module that can be embedded into Cellular Base stations equipment cards or other applications to provide the frequencies, functionality, performance and internal interfaces required in order to implement a modern telecommunications product.

2.1 The GPTiMe Block Diagram

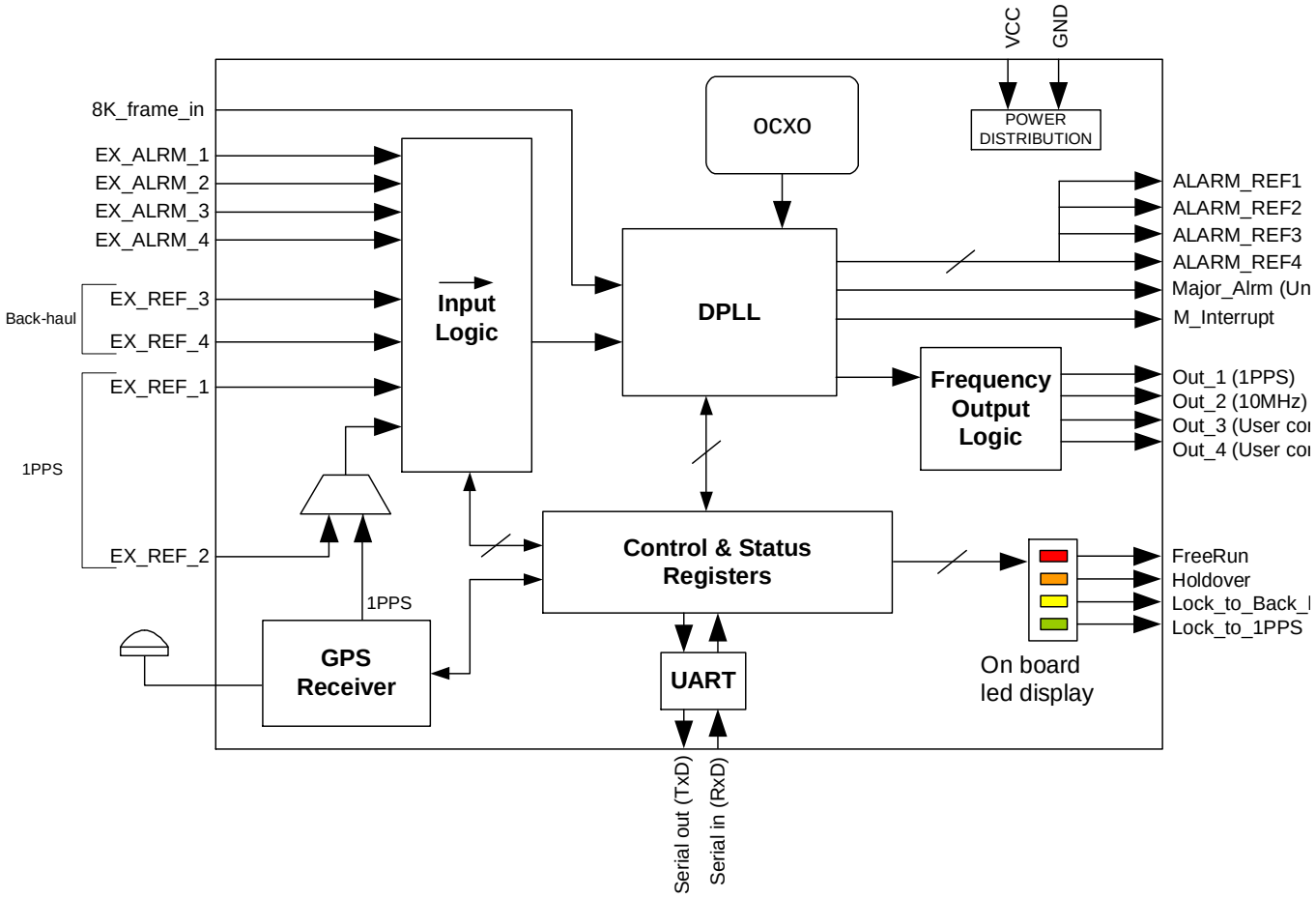


Figure 1: GPTiMe Block Diagram

2.2 GPTIME options

GPTIME is a highly customizable module, and virtually all parameters (including mechanical dimensions) can be modified in according to the customer requirements, way

beyong the scope of this data sheet. If such customization is required, just contact the manufacturer. Some standard off-the-shelf options are presented below.

2.2.1 Thru hole

This module size is 50.8x50.8mm (2x2”), with 2 thru-hole 2.54mm (0.1”) pitch headers. By default it is equipped with GPS receiver on-board, and main oscillator is placed off-board.

2.2.2 SMT

The size is 92x63mm, with 2 TYCO 517230-1 connectors. This module advantage is that it can be equipped with a GPS receiver and main oscillator (up to Stratum 3E SMT) on-board.

2.2.3 Miniature SMT

This module was especially designed to make a most cost-effective solution for the customers who don’t need the full set of GPTiMe features. It can be supplied with a basic functionality subset (default), for substantially lower price than the full-featured device, providing the lowest cost OEM module solution. This basic configuration includes on-board GPS receiver and low cost SMT TCXO, the module, when available, will automatically lock to 1PPS from the on-board receiver. In this configuration the RS232 host interface port is connected directly to the GPS receiver.

The module size is 40x60mm, it has one 30-pin female Samtec SFC-115-T2-F-D-A connector. It can be equipped with a miniature GPS receiver and 5x7mm TCXO as a main oscillator (others can be placed off-board).

2.2.4 Box

For laboratory testing, prototyping and other purposes GPTiMe can be supplied in a metal box, providing a complete closed GPS synchronization solution. The box can include any oscillator up to Rubidium atomic standard, and can be provided with a various power supply options (5V, 12V, -48V, etc.). The standard size is 150x83x50mm (excluding connectors).

3.0 Operation and performance

This chapter describes the GPTiMe module operating modes, features, performance and system architecture. Note that some functions described below are optional.

3.1 GPTiMe Operating Modes

The GPTiMe is capable of working in three operating modes. The operation modes relates directly to the source from which the GPTiMe is currently deriving its timing reference. The GPTiMe also provides the host with real time status indications according to the module's current operating mode. The three operation modes and the method of switching between them will be explained in details in the following sections.

3.1.1 Definitions of the GPTiMe Operating Modes

The GPTiMe operating modes are:

1. **Freerun Mode –** When operating in Freerun mode the GPTiMe output frequencies will be derived directly from the on board or off-board oscillator at its nominal accuracy (free running) without any frequency corrections. This mode is the initial for the the GPTiMe module and it is kept on until a lock is achieved.
2. **Locked Mode –** When operating in Locked mode the GPTiMe will be locked to an external reference signal received from an external source. The external source can be either a 1PPS signal derived from the GPS satellite signal or a back-haul reference coming from the telecom line or other external frequency source.
3. **Holdover Mode –** When operating in Holdover mode the GPTiMe module derives its timing from its internal oscillator tuned to its last memorized output frequency, prior to the moment the input reference was lost. In Holdover, the initial accuracy is derived from the lost signal accuracy and the long-term stability is derived from the characteristics of the on-board or off-board oscillator. The GPTiMe, when operating in holdover mode, will use its previously accumulated data to correct the OCXO's frequency.

   The GPTiMe can enter holdover mode only after it was locked to an external reference for 200 seconds - when locked to 1PPS reference or for 50 seconds – when locked to the back-haul references. In case that the GPTiMe was not locked to an external reference for sufficient time (either 50 sec or 200 sec) it will not be able to go into holdover mode and will go to freerun mode instead.

The following figure describes the GPTiMe transitions between operating modes:

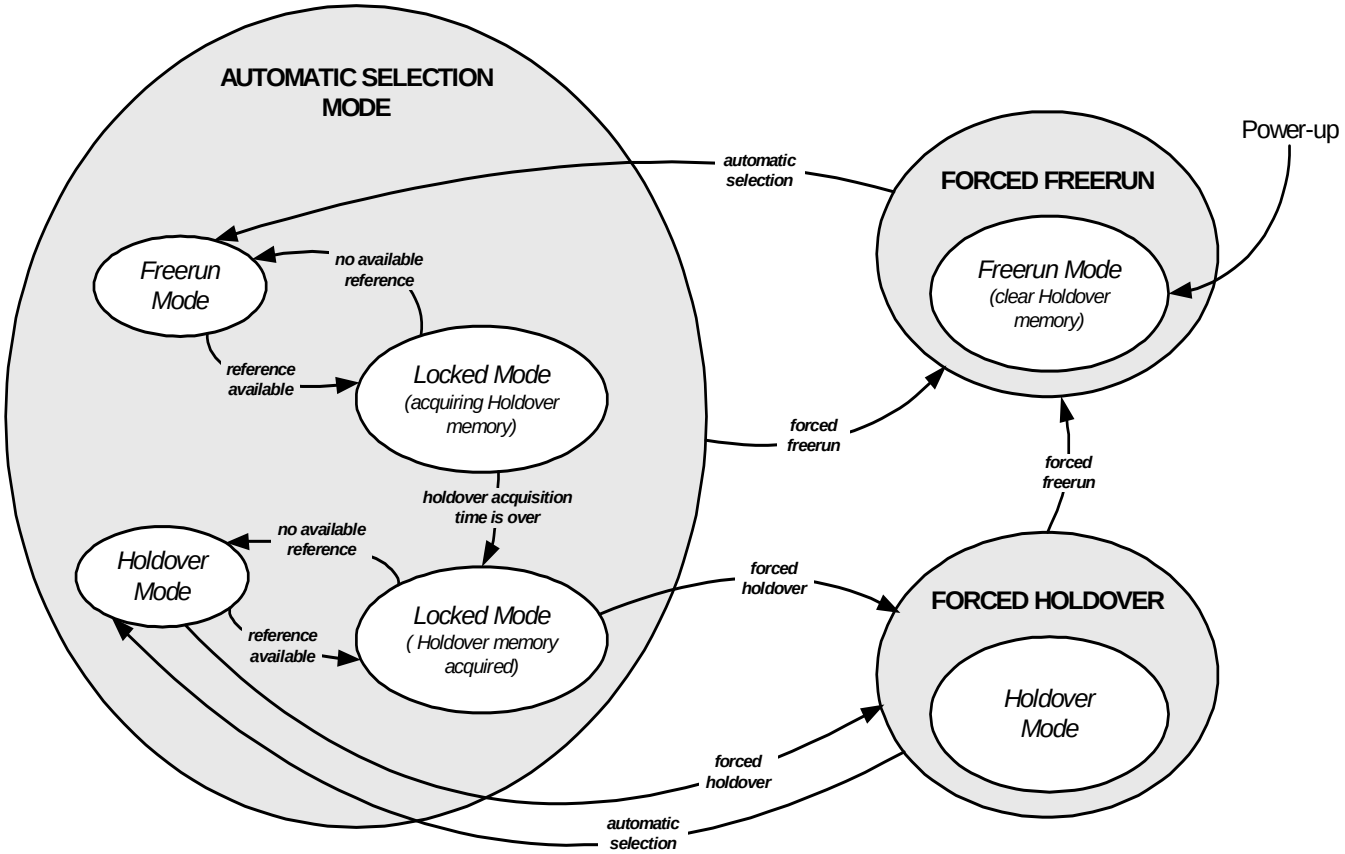


Figure 2: Transition Between Operating Modes

3.1.2 Switching Between Operating Modes

The GPTiMe provides two mechanisms to perform switching between operating modes. The two mechanisms (also: switching modes) are “Forced switching mode” and “Automatic switching mode”. The selection between the switching modes is to be made by the host according to the application requirements. Both forced and automatic switching modes are fully complying with the applicable standards.

3.1.2.1 Forced Switching Mode

The host can switch the module to the forced switching mode using the. In forced setting, one can direct the module to switch between all operating modes regardless of the status of the external references. For example, the user can set the operating mode to holdover while there are valid external references.

When operating in Forced switching mode the GPTiMe attempts to achieve lock to the forced reference as ordered. However, in case that the reference is not a valid one, the GPTiMe independently switches to holdover mode (if holdover history is available) or to freerun mode (when no history is available).

Note: Forced switching to Freerun mode erases the holdover history.

3.1.2.2 Automatic Switching Mode

When operating in automatic mode, switching between operating modes and external references inputs is performed automatically by the GPTiMe internal logic. In automatic settings the GPTiMe will automatically switch to a different external reference in case of a reference failure. In case that all external references are unavailable or unqualified the GPTiMe will change its operating mode to holdover mode or to freerun mode (when no holdover history is available).

When operating in automatic mode, switching between external references is performed either in a revertive or a non-revertive method. The following section details regarding these two possible methods.

3.1.2.2.1 Revertive Mode

When operating in automatic revertive mode, priority is pre-assigned to each of the external references inputs. In the revertive mode - the GPTiMe will always be locked to the reference with the higher priority - once qualified.

3.1.2.2.2 Non-Revertive Mode

When operating in automatic non-revertive mode, the GPTiMe module will remain locked to the active reference for as long as it's valid. In case that the active reference becomes invalid the GPTiMe will lock to the reference with the highest priority level.

3.1.2.3 Reference Selector's Configuration

The GPTiMe module is equipped with a reference selector that decides on the reference the GPTiMe will be locked to. The reference selector can operate either independently (Automatic mode) or manually (Forced mode).

When operating in automatic mode, the selection of an external reference is made according to the timing reference selector configuration. The reference selector can be configured to work in either Automatic-Revertive or Automatic-Non-Revertive mode. In addition, the user can configure the priority of each external reference input (see Table 1).

The priority level for each of the external references is configured using the "Priority level register". **The value '6' stands for the highest prioritized reference and '1' stands for the lowest one**. The user can manually disqualify a reference from the references list by setting its priority level to '0'. The GPTiMe module will not lock to a reference with a '0' priority level, however it will consider it as available and therefore continue performing all

the relevant tests (e.g. – frequency validation) on it. A situation of two (or more) references with the same priority level is invalid (except for the '0' value).

The user is capable of changing the priority level register settings during operation (for example, when a network rearrangement is taking place).

Although holdover and freerun are not actual external references, they are also assigned with constant priority level values and switching between them and the external references is always revertive. The freerun and holdover priority levels are '1' and '2', respectively.

Reference	Priority Level
EX_REF1	0, 3..6
EX_REF2	0, 3..6
EX_REF3	0, 3..6
EX_REF4	0, 3..6
HOLDOVER	2
FREERUN	1

Table 1: External references priority definition

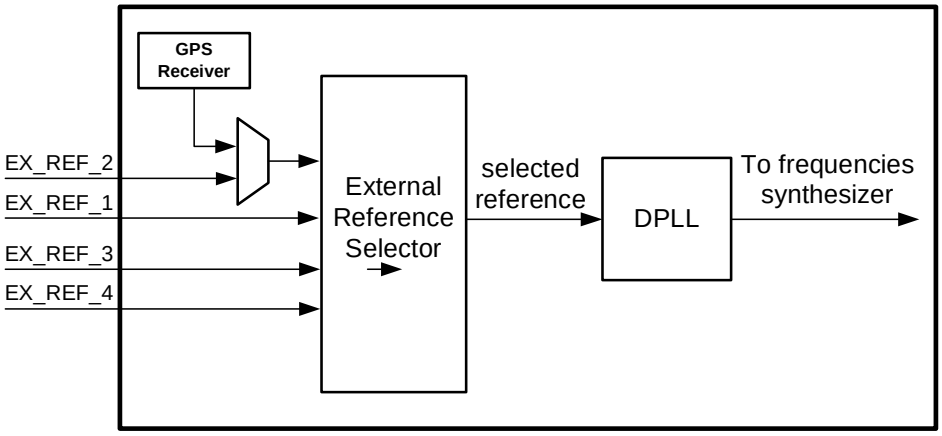


Figure 3: External Reference selector

3.2 External References Qualification

The GPTiMe module is continuously monitoring its external reference inputs for health and quality. This section relates to the various measurements, calculations and indications by which the GPTiMe determines the qualification of the signal as a possible external reference.

After it has been considered as invalid, a timing reference will be reconsidered as available if it is fault-free for a pre-defined validation time period. The validation time is user

configurable and it is in the range of 11 sec to 720 sec. The following sections detail regarding the qualification processes performed on the GPTiMe's external references.

3.2.1 Loss of Clock (LOC) Detection

The GPTiMe module is continuously examining the availability of all of its external reference signals (EX_REF1 to EX_REF4). When a signal becomes unavailable (lost), it is disqualified immediately. Such an event is referred to as a "LOC (Loss of Clock) event".

3.2.1.1 LOC conditions for the external reference inputs

Each of the different types of external references has its own LOC condition. The LOC conditions and their related times to detection and declaration are specified in the following lines:

1. **EX_REF1 and EX_REF2 inputs –** A signal is considered to be lost if there is no change in the signal logic level for 2 second. The maximum time for a LOC detection to occur is 2 seconds.
2. **EX_REF3 and EX_REF4 inputs -** A signal is considered to be lost if there is no change in the signal logic level for 250 microseconds. The maximum time for a LOC detection to occur is 250 microseconds.

3.2.1.2 LOC condition for Internal GPS Receiver 1PPS Signal

The GPTiMe module can be locked to its internal 1PPS signal derived from the GPS satellites via the module's internal GPS receiver. When locked to this reference, if the on-board receiver is managed by GPTIME module, the signal is considered lost in case that there are less than four available satellites for the GPS receiver. In this case no reliable position fixes can be done, and the 1PPS signal accuracy is below the permitted threshold. The maximum time for a LOC detection to occur (for a GPS signal) is 0.25 second.

3.2.2 Monitoring the external references frequencies

The GPTiMe module is continuously monitoring its external references coming from the back-haul (EX_REF3 and EX_REF4 inputs) relative the on board oscillator. When a reference frequency deviates from a pre-defined value, an internal alarm is issued and the signal is considered to be non-usable for synchronization (disqualified).

The frequency-monitoring feature is applicable only for EX_REF3 and EX_REF4 reference inputs. The frequency monitoring criteria consist of the following conditions:

Must reject condition - the monitoring process should consider a reference failed if it detects frequency-offset greater than a pre-defined value.

Must accept condition - the monitoring process should accept a reference if it detects frequency-offset lower than a pre-defined value.

Host interface command is used to configure the "must accept" and "must reject" values in according to the following table:

Option no.	Stratum level	Pull in Range	Accuracy of the on board OSC	Must Accept [max]	Must Reject [min]	Hysteresis [min]
1	3E	< ± 4.6	< ± 4.6	± 9.2	± 11.9	0.9
2	3	< ± 20	< ± 4.6	± 24.6	± 31.9	2.4
3	2	< ± 0.016	< ± 0.016	± 0.032	± 0.0416	0.0016

Table 2: Frequency Monitoring Values

Note 1: All parameters in Table 2 are in PPMs (Parts Per Million).

Note 2: Frequency monitoring parameters are applicable in according to Stratum level of GPTiMe oscillator.

Note 3: A hysteresis condition is applied preventing rapid changes between qualification conditions.

3.2.3 External Alarms inputs (EX_ALRM1 – EX_ALRM4)

Each of the external references inputs (EX_REFx, x =1 to 4) is assigned with an alarm input control (EX_ALRMx, x=1 to 4) indicating about its availability. When assigning '1' to the EX_ALRMx input the GPTiMe will refer to the relevant input (EX_REFx) as invalid.

The external alarm indication can be issued as follows:

Via hardware – the sources for the EX_ALRMx (x =1 to 4) signals are the module's pins of the same name.

Via software – the source for the EX_ALRMx (x =1 to 4) is an appropriate command.

A 'Wired-OR' condition is implemented on both the hardware and software sources (i.e. – If one of the two indications is set an alarm is issued).

3.2.4 Disqualifying an External Reference

The following section specifies the criteria by which the GPTiMe Reference will be considered as invalid/unavailable for synchronization. The back-haul reference inputs (EX_REF3 and EX_REF4) have different criteria from the one of the 1PPS reference inputs (EX_REF1 and EX_REF2). The host interface command is used to get the status (valid/invalid) of an individual external reference.

A 1PPS reference input will be considered to be unavailable in case that:

i. LOC detection has occurred.
ii. External alarm bit is set i.e. - EX_ALRM_X = '1' (X =1 or 2).

An back-haul reference input will be considered to be unavailable in case that:

i. Reference frequency is out of permitted range (must reject condition).
ii. LOC detection has occurred.
iii. External alarm bit is set i.e. - EX_ALRM_X = '1' (X =3 or 4).

3.3 GPTiMe I/O Timing Signals

3.3.1 GPTiMe Frequency Inputs

The GPTiMe module has four external references inputs; a fifth 'reference input' is the 1PPS signal derived from the module's on-board GPS receiver. A detailed description of the module's references inputs is given in the following sections.

3.3.1.1 GPS Satellite System Signal Input

This signal is received via the GPS L1 active antenna and provides the GPTiMe with a 1 pulse per second (1PPS) signal and GPS related data (e.g. – GPS time).

3.3.1.2 EX_REF1 – 1PPS First Input Signal

This is the first of two 1PPS reference inputs. This input should be supplied with a 1Hz signal. The GPTiMe when ordered to do so will be able to lock to this external reference.

3.3.1.3 EX_REF2 – 1PPS Second Input Signal

This is the second of two 1PPS reference inputs. This input goes into a 2-to-1 multiplexer (EX_REF2 Multiplexer) along with the 1PPS signal derived from the GPTiMe on-board GPS receiver (see Figure 4). The user selects which of the two inputs will be used as the source for the actual EX_REF2 signal and will be routed to the reference selector. The GPTiMe when ordered to do so will be able to lock to this external reference.

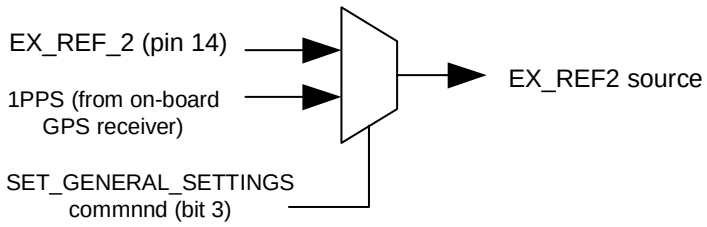


Figure 4: EX_REF2 Source Selection

Note: when the EX_REF2 source is configured to onboard GPS Receiver, than EX_ALRM2 bit (see **Error! Reference source not found.**) is determined only according to the Health of GPS Receiver (see 3.7.3).

3.3.1.4 EX_REF3 – Back-haul First Input Signal

This is the first of two back-haul reference inputs. By default this input should be supplied with 8 kHz signal but other frequencies are also available (see ordering information). The GPTiMe when ordered to do so will be able to lock to this external reference.

3.3.1.5 EX_REF4 – Back-haul Second Input Signal

This is the second of two back-haul reference inputs. In default this input should be supplied with 8 kHz signal but other frequencies are also available (see ordering information). The GPTiMe when ordered to do so will be able to lock to this external reference.

3.3.2 GPTiMe Frequency Outputs

GPTiMe offers a selection of output frequencies. There are up to four outputs and the customer can specify the desired frequencies for his application. The standard options are described below. Other frequencies are also available – see ordering information (section 8.0).

When the module is not locked to any of its external references, outputs accuracy will be equivalent to the GPTiMe internal oscillator accuracy (free run or holdover).

3.3.2.1 OUT1 – 1PPS Output

When the module is locked to one of its 1PPS references the 1PPS output signal will be phase aligned to the input reference. When the module is locked to one of the back-haul references (EX_REF3, EX_REF4) the phase of the 1PPS output will not change.

3.3.2.2 OUT2 – 10 MHz output

The phase of this 10MHz frequency output is the same as the OUT1 (1PPS) output phase.

There is an option to provide low phase noise 10 MHz at OUT2. The typical performance of this output is in according to the following table (HCMOS signal):

Offset (Hz)	Phase noise (dBc/Hz)
10	-80
1k	-130
10k	-140

Table 3 Typical phase noise of 10 MHz output

Better phase noise performance is also available; please contact the manufacturer for details.

3.3.2.3 OUT3 – User selectable output

OUT3 Frequency is user selectable, providing the user with the flexibility of configuring the module in according to his specific application. The output frequency can be one of the following:

T1 applications – OUT3 = 1.544MHz x N (N=1,2,4,8).

E1 applications – OUT3 = 2.048MHz x N (N=1,2,4,8).

The selection between E1 and T1 frequencies is made using an appropriate command. The selection of N (multiplying factor) is made when constructing the part number (see section 8.0).

OUT3 output signal is synchronized to the active external reference.

3.3.2.4 OUT4 – User selectable outputs

OUT4 frequency is user selectable and can be one the following three options:

Option 1 - Output frequency is:

T1 applications – OUT4 = 1.544MHz x N (N=1,2,4,8).

E1 applications – OUT4 = 2.048MHz x N (N=1,2,4,8).

The selection between E1 and T1 frequencies is made using an appropriate command. The selection of N (multiplying factor) is made when constructing the part number (see section 8.0).

Option 2 – the output is the main oscillator frequency output (Freerun).

Option 3 – the output is the 8 kHz frame sync signal.

OUT4 output signal is synchronized to the active external reference (except for option 2).

3.4 Master/Slave Functionality

The Master/Slave function is used to synchronize the module's frequency outputs between two or more GPTiMe modules set in redundant configuration. The GPTiMe module can be set to operate either as Master or Slave by the host card using the M/S control bit. The Master/Slave functionality is as follows:

i. The two modules feed each other with 8 kHz frame sync output.

ii. The Master module ignores the 8 kHz frame sync signal coming from the slave module.

iii. The Slave module - synchronizes the phase of its output signals with the phase of the 8 kHz input signal generated by the Master unit.

iv. When changing the status of the master – the role of the modules changes accordingly.

3.4.1 Switching between Master and Slave

When performing a Master-Slave functionality switching (i.e. – master becomes slave and slave becomes master) it is important to perform the following steps:

i. Set the slave module (e.g. module #1) to be master (using an appropriate command). After performing this step both modules will function as masters.

ii. Set the master module (e.g. module #2) to be slave (using an appropriate command).

Note: When working with composite clock output the configuration is different and it is fully described in AN#7 document.

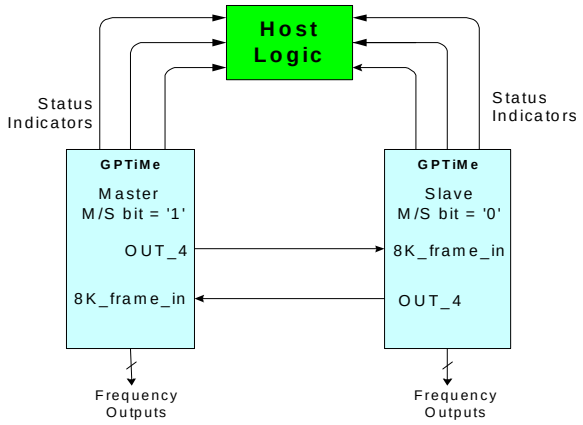


Figure 5: Master/Slave Configuration

3.4.2 Delays between Output Clocks in Master/Slave Configuration

The 8 kHz output is synchronized with the module's other outputs. The maximum phase difference is 5nsec maximum, in the same module. When working with composite clock output the delay is as specified in AN#7.

The phase difference between the master's 8 kHz output (always leads) and the slave's 8 kHz output is 30 nsec maximum (Typical 26 nsec). When working with composite clock output the delay is as specified in AN#7.

3.5 Monitoring the Output Frequency – Alerting OOR

The GPTiMe can continuously monitor the output frequency relative to the on board oscillator in order to detect effects such as:

i. Input frequency deviation.

ii. Abnormal Aging - can cause the natural clock frequency to eventually drift beyond the adjustment range of the DPLL circuitry.

iii. Inadvertent establishment of a synchronization loop (network-wise) - can drive the affected clocks off frequency to the limits of their control.

The Out Of Range (OOR) alarm alerts that these conditions are approaching, when the output frequency reaches = ± 1.1 * < Must accept value> as selected in Table 2 – the Out Of Range alarm is asserted. There is a host interface command that is used to read the OOR alarm status.

3.6 Phase Build-Out (PBO)

The PBO functionality enables the Digital PLL to be programmed not to pass phase transients higher than 3.5 microseconds over an interval of 0.1 second, to its output. This process of absorbing a phase hit is referred to as "Phase Build-out (PBO)". The GPTiMe performs this function (in default) according to the Telcordia standards.

The phase build-out mechanism is implemented only on the back-haul references inputs (EX_REF3 and EX_REF4) and can be activated and deactivated by the user request, via the serial interface.

3.7 On-Board GPS Receiver

The GPTiMe module can be equipped with a complete multi-channel parallel tracking GPS receiver designed to operate with the L1 frequency, standard position service, Coarse Acquisition code. The receiver when connected to a GPS antenna automatically begins to track available GPS satellite signals.

After the initialization process is ended, the GPS receiver starts doing its position fixes, therefore, a pulse per second signal (1Hz) synchronized to the GPS system signal will be available. The GPTiMe is capable of using this 1 PPS signal as a timing reference for its synchronization.

3.7.1.1 GPS Receiver Cold Start

The “Cold start” expression relates to the performance of the GPTiMe internal GPS receiver after the first power up. At first power up no navigation data such as almanac, satellite ephemeris or position are available so the receiver will automatically start searching for the required data.

When entering cold start state the receiver initiates its cold start algorithm. The receiver tries tracking the available satellites channels. After tracking the satellites the receiver starts downloading the almanac and ephemeris data. This process depends on the number of satellites available and the environmental conditions, and typically can take a few minutes.

3.7.2 GPS Time of Week (TOW)

The GPS receiver after it starts doing its position fixes can provide the user with an accurate Time of Week data. In order to get the GPS TOW data the user should send an appropriate command, a DATA SEND message will be sent in response.

The DATA SEND response message contains the following:

1. GPS Time of Week (seconds) – the number of seconds passed since Sunday morning at midnight.

2. Extended GPS week number – the number of weeks passed since the GPS count began (January 6, 1980).

3. GPS-UTC offset – the number of seconds by which the UTC time lags behind GPS time (leap seconds). UTC time = GPS time - GPS-UTC offset.

In order to obtain reliable GPS Time of Week data, first verify that the GPS receiver is doing position fixes.

3.7.3 Health of GPS Receiver

The GPTiMe is continuously testing out the status of its GPS receiver. In case that the receiver health is below the predefined value (e.g. – not enough satellites) the GPTiMe relates the GPS timing related data as invalid.

The user can test out the GPS receiver health by sending an appropriate command, the GPTiMe will reply with a DATA SEND message containing data regarding it's satellites tracking status and the antenna feed line.

3.7.4 Satellites Mask Settings

In order to comply with the minimal accuracy demands, the GPTiMe GPS receiver uses satellites masks for sieving out the satellites that do not comply with the minimum level of accuracy. The GPTiMe GPS receiver will calculate position fixes only when all of the satellites taken into considerations comply with the satellites masks.

The satellites masks are initialized with their default values. The default values are intended to suit most of the standard operating conditions. The user can change the satellites masks values using an appropriate command.

The satellites masks and their default initial values are described in the following sections.

3.7.4.1 Elevation Angle Mask

The default elevation criterion determines that satellites below 0.0873 radian (5º) elevation angle will not be taken under consideration when calculating position fix. It is assumed that signals from low elevation satellites are poorer in quality and are often arrive distorted. Another reason for disqualifying signals from low elevation satellites is to avoid multiple switching between satellites often caused by the terrain conditions.

3.7.4.2 SNR Mask (AMU)

The default SNR criterion determines that satellites signals with SNR (Signal/Noise Ratio) that is lower than 3 AMU will not be used when calculating position fix. This mask prevents the receiver from using poor quality satellite signals for its position fix calculations.

3.7.4.3 DOP Mask

The position DOP (Dilution of Precision) default mask value is 12. This criterion is set to fulfill both accuracy and GPS coverage demands.

3.7.5 GPS Antenna

The GPS antenna is used for receiving the GPS satellites signals and passing them to the GPS receiver. The antenna must be located outdoors and have a clear view of the sky in order to receive the signal properly. The available GPS antennas are described in details in section 7.3.

3.8 Off Board Main Oscillator Connection

When using off board GPTiMe main oscillator, it should be placed beside the module. The oscillator frequency output should be connected to "Ext_OSC" pin. A special consideration must be given for preserving the signal integrity of both the main oscillator frequency output signal (digital lines) and power supply lines.

The oscillator frequency output signal should be treated as a high frequency clock signal and therefore its trace should be routed in a noise-free area of the PCB. The power supply lines should be wide enough to enable the current flow (especially during warm-up time) and noise free (decoupling capacitors are needed). It is also highly recommended to mount the main oscillator as close as possible to the "Ext_OSC" input pin.

For proper functionality there should be no direct air flow on oscillator (from cooling fan, wind, etc.), and it should be mounted without excessive air gap between host PCB and its bottom.

3.9 Alarm and Status Indication Signals

The GPTiMe module is equipped with up to six alarm and status indication output signals, each output is assigned to a specific pin. The following section describes the signals functionality and pin allocation.

Major Alarm – goes high if the DPLL is not locked to any of its external reference.

ALARM_REFx (x = 1 to 4) – goes high in case that EX_REFx is disqualified. A reference is considered as disqualified in case that one of the following occurs:

i. A LOC condition is detected on the signal.

ii. External alarm is issued on the signal (EX_ALRMx).

iii. The signal's frequency deviates from the allowed pull-in range limit (only for EX_REF3 and EX_REF4).

Locked_to_1PPS – goes high in case that the module is locked to one of its 1PPS external references (i.e. – EX_REF1 or EX_REF2).

Locked_to_Back_haul – goes high in case that the module is locked to one of its back-haul external references (i.e. – EX_REF3 or EX_REF4).

3.10 On-Board LEDs

The GPTiMe module contains 4 on-board LEDs placed on its upper side. The following table relates to the LEDs and their functionality. These LEDs are used to assist the equipment designer during the R&D phase and Trouble-shoot during maintenance. The following table describes the LEDs and their functionality.

Name	Color	When lighted...
Freerun	Red	The unit is in Freerun mode
Holdover	Dark Orange	The unit is in Holdover mode
Locked to 1PPS	Green	The unit is enslaved to 1PPS reference
Locked to back-haul	Amber	The unit is enslaved to back-haul reference

Table 4: On board LEDs

3.10.1 The electrical interface of the control and indications inputs

The following figure depicts the actual electrical interface available on the GPTiMe.
The electrical characteristics of the input interface are defined by LVTTL / TTL electrical characteristics and the (added) 10 KOhm resistors are connected to the ground or VCC.

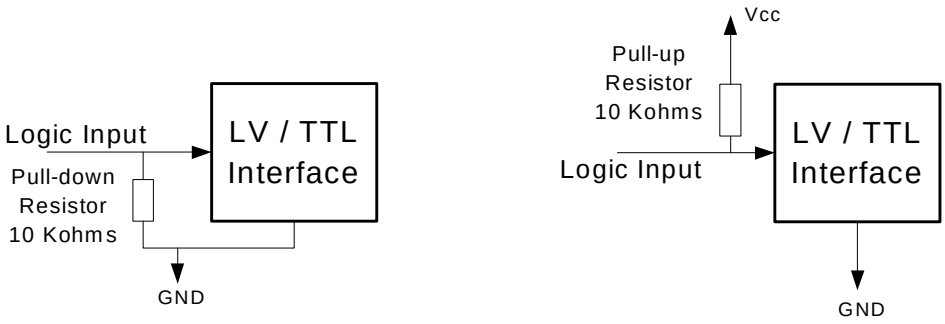


Figure 6 Electrical characteristics of input controls and indicators

Note: If the customer elects to add a resistor to change the default value, its value must be 1 kOhm or less.

4.0 Logical interface

The GPTiMe RS-232-based serial interface provides a means of communication with the host. This means of communication is used to configure the GPTiMe module as well as for obtaining status and alarm indications concerning the GPTiMe module's state of operation. The following section provides a description of the logical interface between the GPTiMe software and corresponding Host software. It describes the messages that can be transferred between the Host card and the GPTiMe.

4.1 Interfacing the GPTiMe Module

The physical interface between the host card and the GPTiMe module is accomplished via two connections:
Serial_Out – used for transmitting data (from the GPTiMe module to the host card).
Serial_In – used for receiving data (from the host card to the GPTiMe module).

4.1.1 GPTiMe RS232 TxD/RxD Electrical Specifications

The GPTiMe module logic levels are LVTTL compatible[1]. For SMT version there is an option that includes RS-232 voltage converter for direct interfacing with PC or another compatible device. See Ordering Information section for details.

4.1.2 RS-232 Port Settings

Baud rate: 115,200

Data bits: 8

Parity Bit: odd (default) or none

Stop bit: 1

For the GPTiMe that includes an option for software/firmware update via host interface the parity should be configured as none. If this option is not included, the parity is set to odd by default (can be set to none as option, see Ordering Information section for details).

[1] For thru hole version MAX232 transceiver or similar device is needed in order to translate voltage levels from RS-232 (when interfacing PC) to LVTTL levels of the GPTiMe-3/3E/2 module.

5.0 GPTiMe Electrical Specifications

5.1 Electrical Specifications

5.1.1 General Operating Condition

5.1.1.1 Absolute Maximum/Minimum Rating

Symbol	Parameter	Min.	Max.	Unit	Note
V_{cc}	Supply voltage	-0.5	3.6	VOLT	1
V_{cc}	Supply voltage (5V option)	-0.5	5.6	VOLT	1
V_{IN}	Dc input voltage	-0.5	3.6	VOLT	1
T_{STG}	Storage temperature	-40	85	^{0}C	1

Table 5: Absolute maximum rating

Note: Stresses beyond those listed under Absolute Max. Rating may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these, or any other condition beyond those listed under Recommended Operating Conditions, is not implied. Exposure to Absolute Max. Rating conditions for extended periods of time may affect device reliability.

5.1.1.2 Continuous Operation Conditions

The following table lists the modules operating conditions

Symbol	Parameter	Min.	Typ	Max.	Units
V_{cc}	Supply voltage	+3.13	+3.3	+3.47	VOLT
V_{cc}	Supply voltage (5V option)	+4.75	+5	+5.25	VOLT
V_{cc}	Supply voltage (48V option)	36	48	75	VOLT
T_{OP}	Operating temperature [1]	-5		65	^{o} C
I_{WU}	Current consumption during warm up time			1.2	A
I_N	Current consumption during normal operation			0.4	A
I_{OSF}	Current consumption with the main oscillator OFF board		0.6	0.8	A

Table 6: Operating conditions

Note: Following operating temperature ranges are available as options:

i. From -5 to +70 ^{o} C.

ii. From -40 to +85 ^{o} C (industrial temperature range) – for simple TCXO only.

See “Ordering Information” section for details.
If extended temperature range is desired, please contact the manufacturer.

5.1.2 DC Characteristics

5.1.2.1 LVTTL Interface characteristics

Symbol	Parameter	Min.	Typ	Max.	Units
V_{OH}	High level output voltage	+2.4		Vcc	Volts
V_{OL}	Low level output voltage		+0.3	+0.55	Volts
V_{IH}	High level input voltage	+2.0		+3.6	Volts
V_{IL}	Low level input voltage	-0.5		+0.8	Volts

Table 7: TTL output interface characteristics

5.1.2.2 LVTTL interfaces characteristics for the OUTx outputs

Symbol	Parameter	Min.	Typ	Max.	Units
V_{OH}	High level output voltage [I_{OH}= -100uA]	Vcc-0.2		Vcc	Volts
	High level output voltage [I_{OH}= -24mA]	2.4			Volts
V_{OL}	Low level output voltage [I_{OL}= 100uA]			+0.2	Volts
	Low level output voltage [I_{OL}= 16mA]			+0.4	Volts

Table 8: Buffered LVTTL output interface characteristics

5.2 Electrical Specifications for the Main Oscillator

This section contains the main electrical specification for both of the optional main oscillators. For custom oscillators see Appendix A - Custom oscillator options.

5.2.1 GPTiMe-3 main oscillator electrical specification

Symbol	Parameter	Min.	Typ.	Max.	Units
V_{cc}	Supply voltage	+3.135	3.3	+3.465	VOLT
T_{OP}	Operating temperature	-5		60	^{o}C
I_{WU}	Current consumption during warm up time			0.7	Amps
I_{N}	Current consumption during normal operation			0.4	Amps

Table 9: GPTiMe-3 main oscillator electrical specification

5.2.2 GPTiMe-3E main oscillator electrical specification

Symbol	Parameter	Min.	Typ.	Max.	Units
V_{cc}	Supply voltage	+4.75	+5	+5.25	VOLT
T_{OP}	Operating temperature	-5		65	^{o} C
I_{WU}	Current consumption during warm up time			1.2	Amps
I_{N}	Current consumption during normal operation			0.4	Amps

Table 10: GPTiMe-3E main oscillator electrical specification

5.2.3 GPTiMe-2 main oscillator electrical specification

Symbol	Parameter	Min.	Typ.	Max.	Units
V_{cc}	Supply voltage	+11.4	+12	+12.6	VOLT
T_{OP}	Operating temperature	-5		65	^{o}C
I_{WU}	Current consumption during			1.2	Amps

	warm up time				
I_N	Current consumption during normal operation			0.4	Amps

Table 11: GPTiMe-2 main oscillator electrical specification

5.3 Electrical interfaces of the frequency I/O Signals

The following section specifies the electrical interface for the GPTiMe-3/2 frequency I/O signals.

5.3.1 EX_REF1/2 input signal characteristics

Default frequency: 1 Hz

Signal level: LVTTL (TTL tolerable)

Signal shape: Square pulse wave

Duty cycle: 1 to 99 %.

Pulse width: more than 100 nSec

Rise time: less than 15 nSec

Width limitation: Pulse width > 2 * [rise time + fall time].

5.3.2 EX_REF3/4 input signal characteristics

Default frequency: 8 kHz

Signal level: LVTTL (TTL tolerable)

Signal shape: Square pulse wave

Duty cycle: 1 to 99 %.

Pulse width: more than 100 nSec

Rise time: less than 15 nSec

Width limitation: Pulse width > 2 * [rise time + fall time].

5.3.3 OUT1 to OUT4 output signal characteristics

Signal Shape: Square wave.

Signal level: Buffered LVTTL, for low phase noise option at OUT2 – HCMOS. For other options please contact the manufacturer.

Duty cycle:

For frequencies of 12.352MHz and 10MHz: from 20/80% to 80/20%

For other output frequencies (listed in paragraph 8.2): from 40/60% to 60/40%

Rise time: 5 nSec max.

6.0 GPTiMe Compliance with Standards

The GPTiMe is characterized by its standards compliance. This section details the GPTiMe-3, GPTiMe-3E and GPTiMe-2 modules standards compliance.

6.1 GPTiMe-3E Compliance with Stratum 3 standards

6.1.1 Applicable Standards

The applicable Standards are:

i. Telcordia: GR-1244-CORE- Stratum 3

ii. ITU-T G.812 Type IV

The following tables list the performance of the GPTiMe–3 module according to the applicable listed international standards.

6.1.2 Pull-In/Hold-In Range

Parameter	Specification	As per Standard	Notes
Minimum Pull-In/Hold-In Range	> ± 4.6 ppm	GR-1244-CORE 3.5	
		G.812 Type IV (Annex A)	

Table 12: GPTiMe-3 - Pull-In/Hold-In range

6.1.3 Holdover stability

Parameter	Specification	As per Standard	Notes
Free Run Frequency accuracy	< ± 4.6 x10^{-6}	GR-1244-CORE 5.1	
		G.812 Type IV (Annex A)	
Composite holdover stability	< ± 3.7 x10^{-7}	GR-1244-CORE 5.2	The stated stability is measured after warm up time less than 12 hours
		G.812 Type IV (Annex A)	
Initial offset	< ± 50 x10^{-9}	GR-1244-CORE 5.2 Table 5-1	
		G.812 Type IV (Annex A)	

Parameter		Specification	As per Standard	Notes
	Offset over the temperature	< ± 280 x10^{-9}	GR-1244-CORE 5.2 Table 5-1	
		< ± 300 x10^{-9}	G.812 Type IV (Annex A)	
	Drift	< ± 4.63 x10^{-13} / second	GR-1244-CORE 5.2 Table 5-1	
			G.812 Type IV (Annex A)	

Table 13: GPTiMe-3 - Holdover Stability Characteristics

6.1.4 Timing reference switching

Parameter	Specification	As per Standard	Notes
Timing reference failure –based on frequency offset	Specified in Section 3.2.2	GR-1244-CORE 3.4.1	
Performance during reference switching	MTIE < 30 ns	GR-1244-CORE 3.4.2 Figure 5.7	The standard req. is: MTIE < 1000 ns
		G.812 Type IV (Annex A)	

Table 14: GPTiMe-3 - Timing Reference Switching Characteristics

6.1.5 Input tolerance criteria

Parameter	Specification	As per Standard	Notes
Jitter tolerance	Jitter Amplitude: 0.3UI_{pp} to 10UI_{pp}	GR-1244-CORE 4.2	Mask definitions for line timing
		G.812 Type IV (Annex A)	
Wander tolerance		GR-1244-CORE 4.3	
		G.812 Type IV (Annex A)	

Parameter	Specification	As per Standard	Notes
Phase transient tolerance	MTIE: up to 1 uSec with max phase slope of 81 nSec For any measurement period up to 1.326 mSec	GR-1244-CORE 4.4	
		G.812 Type IV (Annex A)	

Table 15: GPTiMe-3 - Input Tolerance Characteristics

6.1.6 Output signal criteria

Parameter	Specification	As per Standard	Notes
Wander generation	-- Per figure 5.4 TDEV Between 2–10 ns -- Per figure 5.5 MTIE Between 40–100 ns	GR-1244-CORE 5.3	
		G.812 Type IV (Annex A)	
Wander transfer	Per figures 5.6 TDEV	GR-1244-CORE 5.4	
		G.812 Type IV (Annex A)	
Jitter generation and transfer	Less than or equal to $0.004UI_{pp}$	GR-1244-CORE 5.5	The required standard value is $0.05UI_{pp}$
		G.812 Type IV (Annex A)	
Phase changes during pull-in	As specified in the standard	GR-1244-CORE 5.7	

Table 16: GPTiMe-3 - Output Signal Characteristics

6.2 GPTiMe-3E Compliance with Stratum 3E standards

6.2.1 Applicable Standards

The applicable Standards are:

i. Telcordia: GR-1244-CORE- Stratum 3E

ii. ITU-T G.812 Type III

The following tables list the performance of the GPTiMe–3E module according to the applicable listed international standards.

6.2.2 Pull-In/Hold-In Range

Parameter	Specification	As per Standard	Notes
Minimum Pull-In/Hold-In Range	> ± 4.6 ppm	GR-1244-CORE 3.5	
		G.812 Type III 7	

Table 17: GPTiMe-3E - Pull-In/Hold-In range

6.2.3 Holdover stability

Parameter	Specification	As per Standard	Notes
Free Run Frequency accuracy	< ± 4.6 x10^{-6}	GR-1244-CORE 5.1	
		G.812 Type III 6	
Composite holdover stability	< ± 12 x10^{-9}	GR-1244-CORE 5.2	The stated stability is measured after warm up time less than 12 hours
		G.812 Type III 11.2	
Initial offset	< ± 1 x10^{-9}	GR-1244-CORE 5.2 Table 5-1	
		G.812 Type III 11.2	
Offset over the temperature	< ± 10 x10^{-9}	GR-1244-CORE 5.2 Table 5-1	
		G.812 Type III 11.2	
Drift	< ± 1.16 x10^{-14} / second	GR-1244-CORE 5.2 Table 5-1	
		G.812 Type III 11.2	

Table 18: GPTiMe-3E - Holdover Stability Characteristics

6.2.4 Timing reference switching

Parameter	Specification	As per Standard	Notes
Timing reference failure –based on frequency offset	Specified in Section 3.2.2	GR-1244-CORE 3.4.1	
Performance during reference switching	MTIE < 30 ns	GR-1244-CORE 3.4.2 Figure 5.7	The standard req. is: MTIE < 150 ns
		G.812 Type III 11.1	

Table 19: GPTiMe-3E - Timing Reference Switching Characteristics

6.2.5 Input tolerance criteria

Parameter	Specification	As per Standard	Notes
Jitter tolerance	Jitter Amplitude: $0.3UI_{pp}$ to $10UI_{pp}$	GR-1244-CORE 4.2	Mask definitions for line timing
		G.812 Type III 9.2	
Wander tolerance		GR-1244-CORE 4.3	
		G.812 Type III 9.1	
Phase transient tolerance	MTIE: up to 1 uSec with max phase slope of 81 nSec For any measurement period up to 1.326 mSec	GR-1244-CORE 4.4	
		G.812 Type III 11.4	

Table 20: GPTiMe-3E - Input Tolerance Characteristics

6.2.6 Output signal criteria

Parameter	Specification	As per Standard	Notes
Wander generation	-- Per figure 5.4 TDEV Between 2–10 ns -- Per figure 5.5 MTIE Between 40–100 ns	GR-1244-CORE 5.3	
		G.812 Type III 8.3, 8.1	
Wander transfer	Per figures 5.6 TDEV	GR-1244-CORE 5.4	
		G.812 Type III 10	
Jitter generation and transfer	Less than or equal to 0.004UI_{pp}	GR-1244-CORE 5.5	The required standard value is 0.05UI_{pp}
		G.812 Type III 10	
Phase changes during pull-in	As specified in the standard	GR-1244-CORE 5.7	

Table 21: GPTiMe-3E - Output Signal Characteristics

6.3 Model GPTiMe-2 Compliance with Stratum 2 standards

Performance specification in this section can be achieved only when working with a Stratum 2 oscillator.

6.3.1 Applicable Standards

The applicable Standards are:

i. Telcordia: GR-1244-CORE- Stratum 2

ii. ITU-T G.812 Type II

The following table lists the performance of the GPTiMe-2 unit according to the applicable listed international standards.

6.3.2 Pull-In/Hold-In Range

Parameter	Specification	As per Standard	Notes
Minimum Pull-In/Hold-In Range	> ± 16 ppb	GR-1244-CORE 3.5	
		G.812 Type II 7	

Table 22: GPTiMe-2 - Pull-In/Hold-In range

6.3.3 Holdover stability

Parameter	Specification	As per Standard	Notes
Free Run Frequency accuracy	< ± 16 ppb	GR-1244-CORE 5.1	
		G.812 Type II 6	
Composite holdover stability	< ± 22 x10^{-9}	GR-1244-CORE 5.2	The stated stability is measured after warm up time less than 12 hours
		G.812 Type II 11.2	
Initial offset	< ± 1 x10^{-10}	GR-1244-CORE 5.2	
		G.812 Type II 11.2	
Drift	< ± 1.16 x10^{-15} /	GR-1244-CORE 5.2	

Parameter	Specification	As per Standard	Notes
	second	G.812 Type II 11.2	

Table 23: GPTiMe-2 - Holdover Stability Characteristics

6.3.4 Timing reference switching

Parameter	Specification	As per Standard	Notes
Timing reference failure –based on frequency offset	Specified in Section 3.2.2	GR-1244-CORE 3.4.1	
Performance during reference switching	MTIE < 30 ns	GR-1244-CORE 3.4.2 Figure 5.7	The standard req. is: MTIE < 150 ns
		G.812 Type II 11.1	

Table 24: GPTiMe-2 - Timing Reference Switching Characteristics

6.3.5 Input tolerance criteria

Parameter	Specification	As per Standard	Notes
Jitter tolerance	Jitter Amplitude: 0.3UI_{pp} to 10UI_{pp}	GR-1244-CORE 4.2	Mask definitions for line timing
		G.812 Type II 9.2	
Wander tolerance		GR-1244-CORE 4.3	
		G.812 Type II 9.1	
Phase transient tolerance	MTIE: up to 1 uSec with max phase slope of 81 nSec For any measurement period up to 1.326 mSec	GR-1244-CORE 4.4	
		G.812 Type II 11.4	

Table 25: GPTiMe-2 - Input Tolerance Characteristics

6.3.6 Output signal criteria

Parameter	Specification	As per Standard	Notes
Wander generation	-- Per figure 5.4 TDEV Between 2–10 ns -- Per figure 5.5 MTIE Between 40–100 ns	GR-1244-CORE 5.3	
		G.812 Type II 8.3, 8.1	
Wander transfer	Per figures 5.6 TDEV	GR-1244-CORE 5.4	
		G.812 Type II 10	
Jitter generation and transfer		GR-1244-CORE 5.5	The required standard value is $0.05UI_{pp}$
		G.812 Type II 10	
Phase changes during pull-in	As specified in the standard	GR-1244-CORE 5.7	

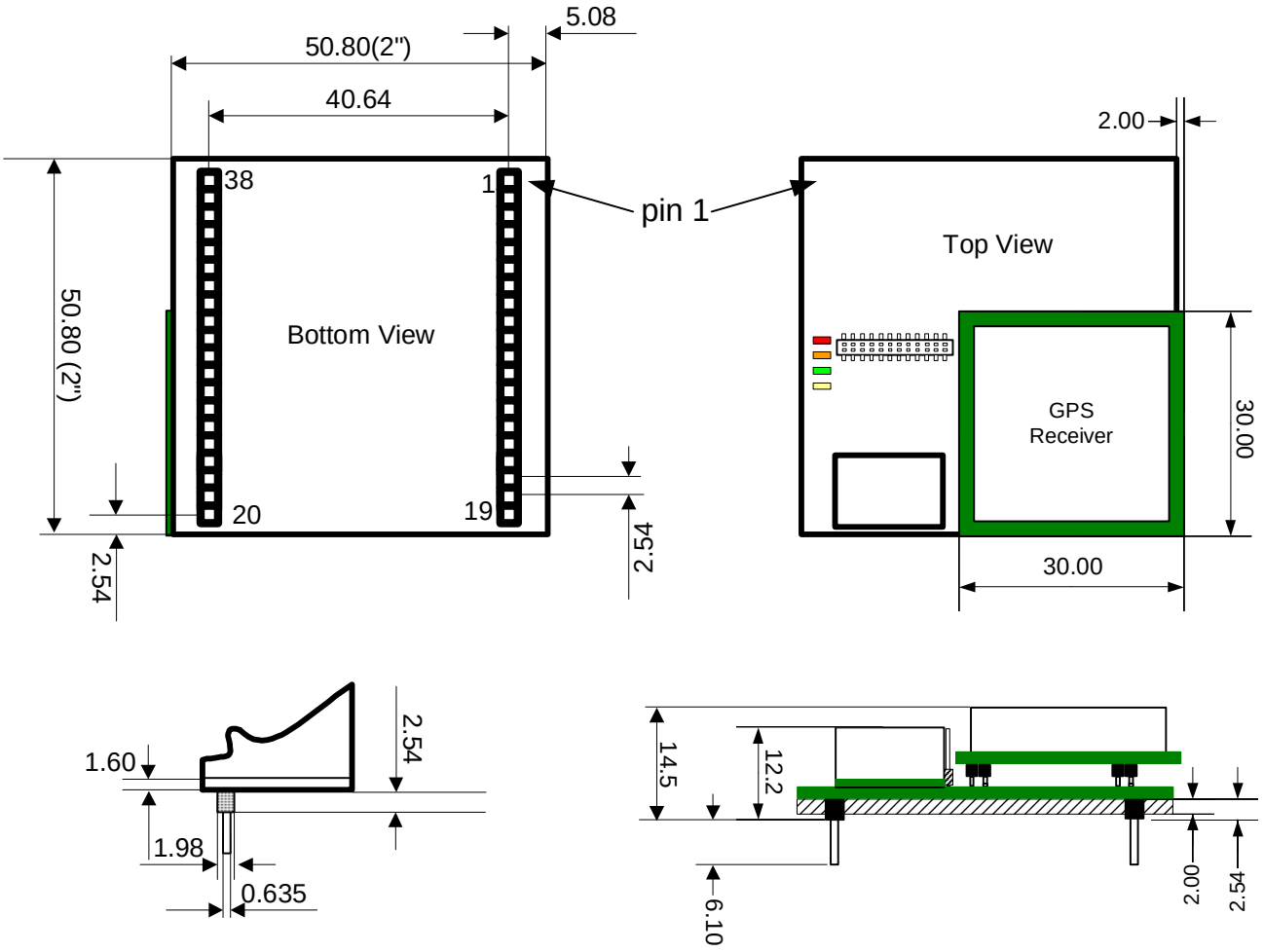
Table 26: GPTiMe-2 - Output Signal Characteristics

7.0 Mechanical Drawing and Measurements

The following drawing details the mechanical dimensions of the various GPTiMe modules.

7.1 GPTiMe Module Mechanical Characteristics

7.1.1 GPTiMe thru hole module



Note: all measurments are in mm

Figure 7 Mechanical drawing of the GPTiMe thru hole version

7.1.2 GPTiMe SMT module

The SMT version uses 2 TYCO 517230-1 connectors (see the drawing below). It mates with TYCO 517229-1 or equivalent connector. This version of GPTiMe can be equipped with GPS receiver and main oscillator (up to Stratum 3E) on-board, eliminating the need to place the oscillator or the GPS receiver off-board.

The main oscillator that is mounted on-board defines maximum height of the module. E.g., with Stratum 3 oscillator the maximum overall height is 14.82 mm (8.62mm oscillator+1.6mm PCB+4.6mm TYCO connector).

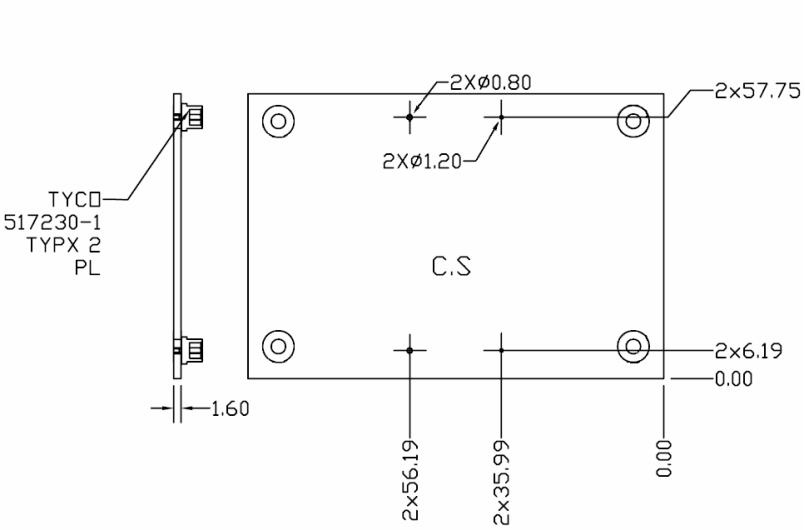


Figure 8 Mechanical drawing of the GPTiMe SMT version – top and side view

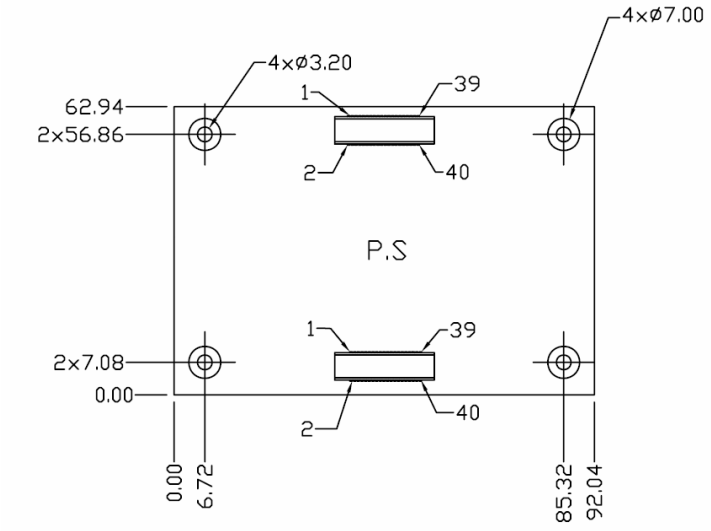


Figure 9 Mechanical drawing of the GPTiMe SMT version – bottom view

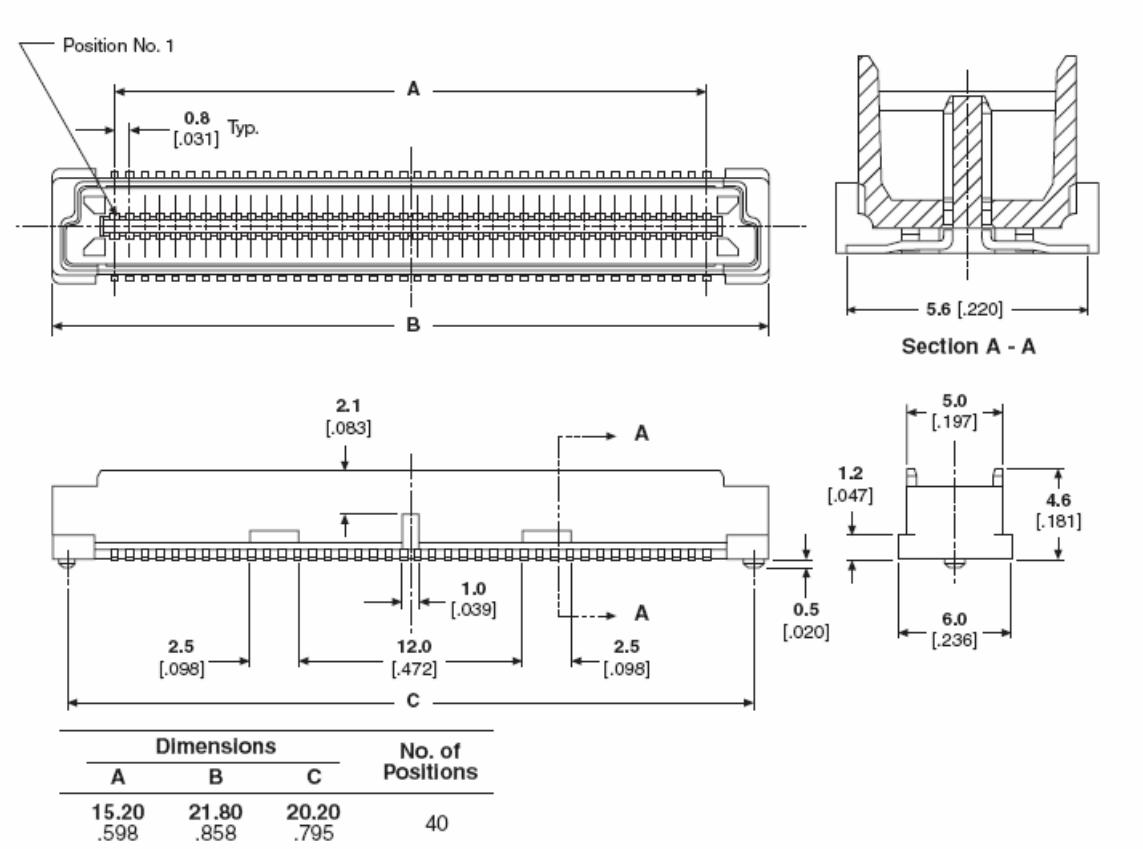


Figure 10 Mechanical drawing of TYCO 517230-1 connector

Note: tolerances are ±0.2mm unless shown otherwise.

7.1.3 Miniature SMT module

Miniature GPTiMe SMT module is equipped with 30 pin female Samtec SFC-115-T2-F-D-A connector (mates with TFM-115-02-S-D-LC or compatible). It can be equipped with on-board GPS receiver and 5x7mm TCXO (other types of oscillators can be placed off-board).

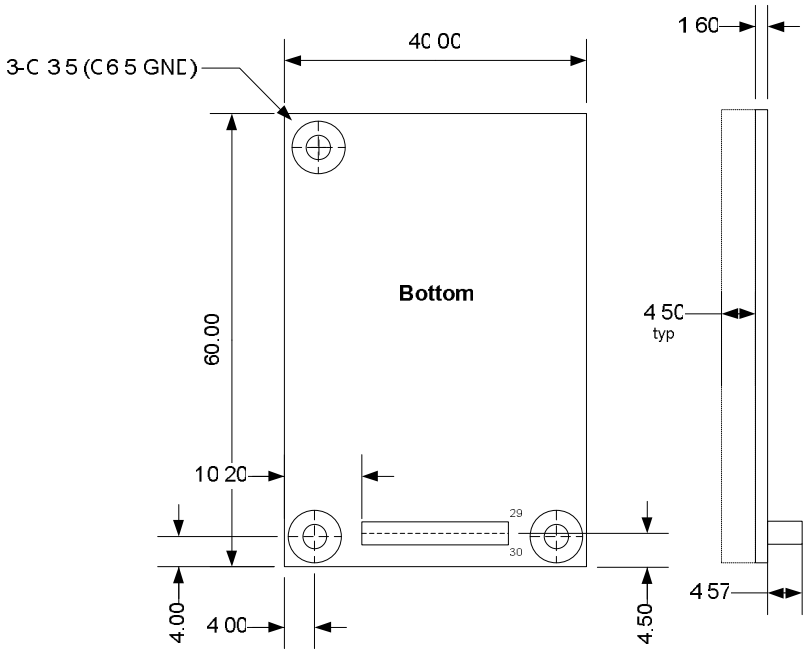


Figure 11 Mechanical drawing of the miniature GPTiMe SMT module

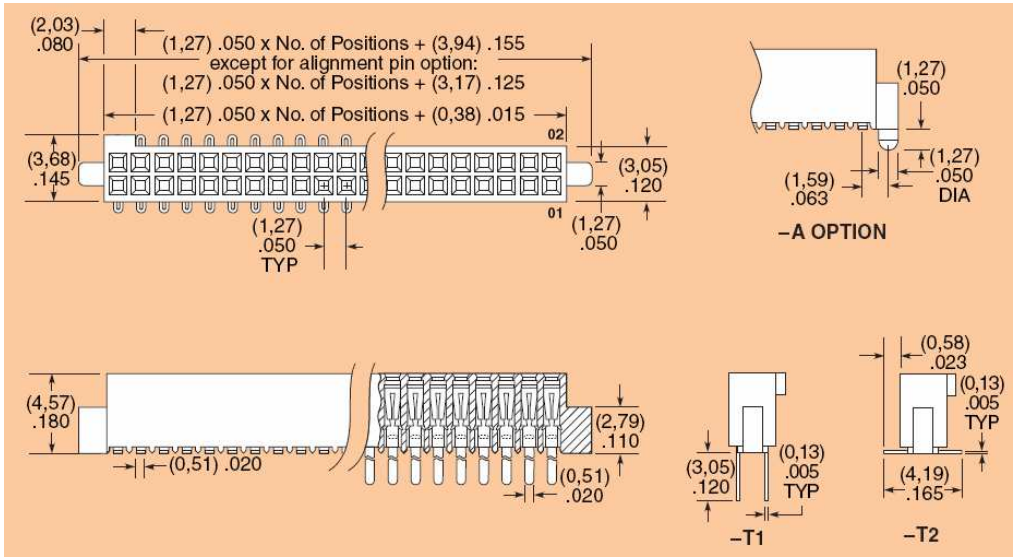


Figure 12 Mechanical drawing of the connector

7.1.4 Box

The box mechanical dimensions are shown below. The connectors for power, digital I/Os, references and outputs are customizable, below is one of the options.

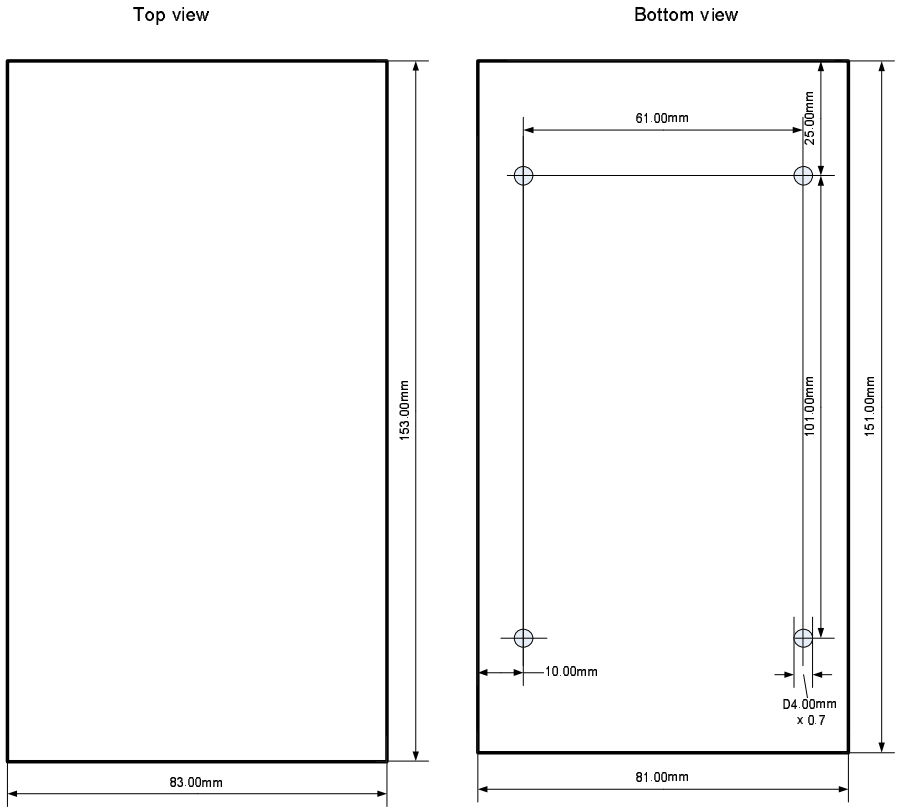


Figure 13 Top and bottom view of the box

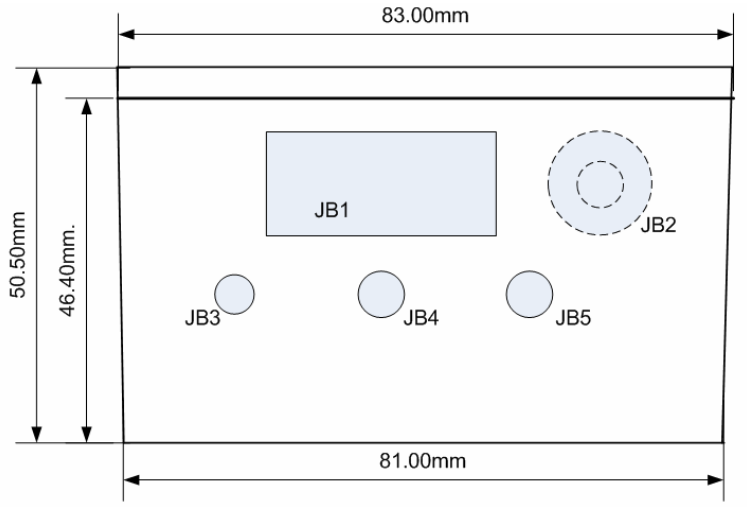


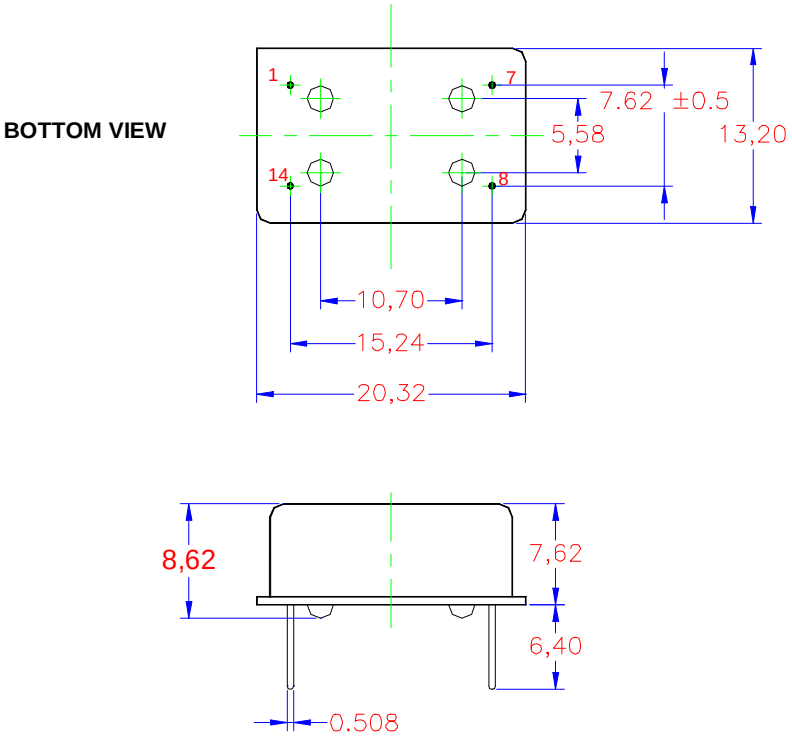
Figure 14 Side view - box panel

Name	Description
DB1	9 pin D-type (RS232)
DB2	2.1mm socket (power)
DB3	MCX female (GPS antenna)
DB4	SMA female (output 1)
DB5	SMA female (output 2)

Table 27 Connectors list

7.2 Main Oscillator Mechanical Characteristics

7.2.1 GPTiMe-3 Main Oscillator



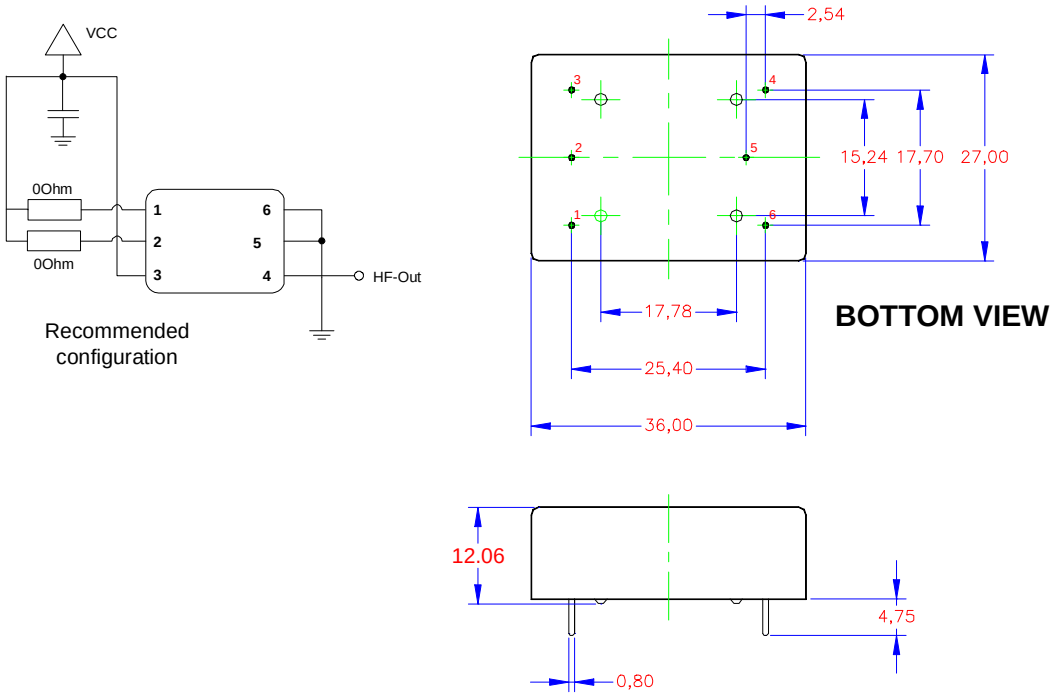
Notes:

1. All dimensions are in mm.
2. Tolerance ±0.2 , unless otherwise shown.

Pin assignments	
Pin no.	**Assignment**
1	NC
7	GND
8	HF-Out
14	Voltage supply

Figure 15: GPTiMe-3 Main Oscillator Mechanical Drawing

7.2.2 GPTiMe-3E Main Oscillator



Notes:

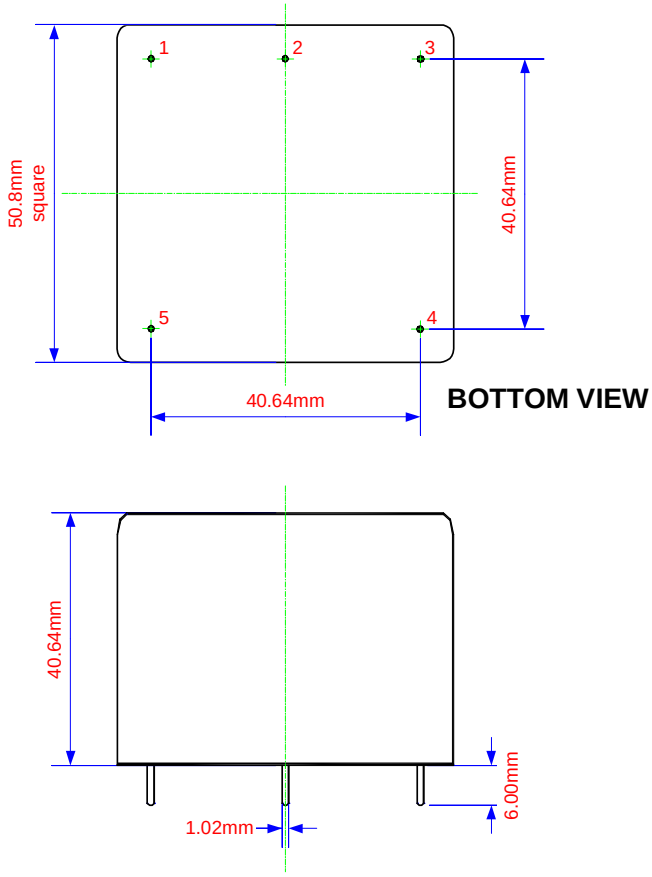
1. All dimensions are in mm.
2. Tolerance ±0.2 , unless otherwise shown.

Pin assignments	
Pin no.	**Assignment**
1	Voltage in / NC
2	Voltage in / NC
3	Voltage supply
4	HF-Out
5	GND
6	Heater Ground

Figure 16: GPTiMe-3E Main Oscillator Mechanical Drawing

SMT Stratum 3E oscillator is available – see Appendix A for details.

7.2.3 GPTiMe-2 Main Oscillator



Notes:

1. All dimensions are in mm.
2. Tolerance ±0.2 , unless otherwise shown.

Pin assignments	
Pin no.	**Assignment**
1	NC
2	NC
3	HF-Out
4	GND
5	Voltage supply

Figure 17: GPTiMe-2 Main Oscillator Mechanical Drawing

7.3 GPS Antenna Characteristics

7.3.1 Standard antennas

The GPTiMe module on board GPS receiver needs an active antenna for its proper operation. TeraSync offers the following GPS antennas for use:

Trimble's Bullet III 3.3V antenna (default) - active GPS antenna with TNC connector and RG-59 cable (length up to 22m).

Part number: 57861-00.

Trimble 3.3V Compact Magnetic mount antenna with a MCX connector and 5m cable.

Part number: 56237-50.

GPS Antenna complete characteristics can be found at www.trimble.com.

7.3.2 Antenna power supply

The GPS receiver provides 3.3V power supply for the antennas mentioned above via the same antenna cable. It is possible to use another active GPS antenna with equivalent or better characteristics. If the power supply for the antenna is not 3.3V (e.g. 5V) or there are increased power requirements, the antenna should be supplied from separate power source, and DC block should be placed on antenna cable to prevent the DC from getting back into the GPS receiver:

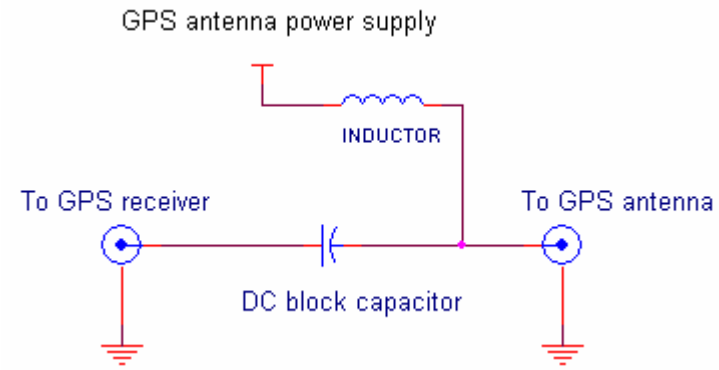


Figure 18 GPS antenna power connection

The typical value for the DC block capacitor is 47 pF (low inductance) and for the inductor is 3.9 nH. Special considerations may be needed for a specific antenna and power supply (e.g. finding a lower DC resistance inductor in order to comply with the antenna power requirements).

7.3.3 Surge protection

There is an option to add a surge protection (lightning protection) to GPTiMe. This protection is available on Bullet III and compact magnetic mount antennas with an additional device that is connected on the antenna line. It is also possible to order an

antenna that includes surge protection. The protection conforms to the max surge 20 kA IEC 61000-4-5 8/20 µsec waveform. Please contact the manufacturer for further details.

8.0 Ordering Information

8.1 Building the part number

The GPTiMe part number should be built according to the following table.

A	B	C	D	E*	F*	G	H	I	J**
Line Name	Oscillator Accuracy	OUT1 frequency	OUT2 frequency	OUT3 frequency	OUT 4 frequency	EX_REF3 frequency	EX_REF4 frequency	GPS Antenna	Other Options
TS-369	A For Stratum 3 E For Stratum 3E F For Stratum 2 C Custom oscillator	1P (Default) "NA" 1.5 2 12 16 19 77 Others	10 (Default) "NA" 1.5 2 12 16 19 77 Others	"NA" 1.5 2 12 16 19 32 38 77 Others	"NA" FR 1.5 2 10 12 16 19 32 38 77 Others	"NA" 8K 2K 1.5 2	"NA" 8K 2K 1.5 2	"NA" B C	"NA" RO XO NR ET SR Others
	See Section 8.5	See Section 8.2	See Section 8.2	See Section 8.2	See Section 8.2	See Section 8.3	See Section 8.3	See Section 8.4	See Section 8.5

* A combination of E1 oriented frequency (2.048MxN) on OUT3 and T1 oriented frequency (1.544MxN) on OUT4 (and vise versa) is not applicable.

** Default configuration – thru hole version, GPS receiver is mounted on-board and main oscillator is mounted off-board.

8.2 Output frequencies (Columns C-F)

The following table contains the available frequencies for the OUT3 and OUT4 output signals and their correlated codes.

Code	Frequency	Code	Frequency
1P	1Hz	1.5	1.544 MHz
2	2.048 MHz	10	10MHz
12	12.352 MHz	16	16.384 MHz
19	19.44 MHz	32	32.768 MHz
38	38.88 MHz	40	40 MHz
44.8	44.8 MHz	77	77.76 MHz

8.3 Input frequencies (Columns G-H)

The following table contains the available input frequencies for the EX_REF3 and EX_REF4 signals and their correlated codes.

Code	Frequency
8K	8 kHz
2K	2kHz
1.5	1.544MHz
2	2.048MHz

8.4 GPS Antenna (Column I)

The following table contains the available GPS antennas (when purchased from TeraSync) as listed under column G.

Code	GPS Antenna
B	Bullet III
C	Compact Magnetic mount

8.5 Other Options (Column J)

The following table contains the different options for the GPTiMe and their correlated codes as listed under column J.

Code	Description
RO	GPS Receiver off board
NR	No GPS receiver
XO	Main oscillator on-board
ET	Extended temperature (-5º to 70º)
ET1	Extended temperature – industrial range (Performance guarantee range is from -40º

	to +85º). Applicable only for simple TCXO versions.
SR	SRT-Special order (main oscillator ordered separately)
ST	Relevant for custom oscillator option – simple TCXO
LB	Relevant for custom oscillator option – low aging OCXO, basic option
L2	Relevant for custom oscillator option – low aging OCXO, form factor of GPTiMe-2 oscillator
L3E	Relevant for custom oscillator option – low aging OCXO, form factor of GPTiMe-3E oscillator
SMT	SMT version of GPTiMe
LP	Low phase noise option
RS	Option that includes RS-232 voltage level converter. Applicable for SMT version only.
UP	Option for software/firmware upgrade via the host interface
PAR	Option for host interface parity set to none
5V	5 Volt power supply
48V	48 Volt power supply (relevant for the box option)
MN	Miniature SMT module
BOX	GPTiMe in the box

Note: Default configuration – thru hole version, GPS receiver is mounted on-board and main oscillator is mounted off-board.

8.6 Part Number - Examples

To order a GPTiMe module with the following requirements:

i. Stratum 2 accuracy level
ii. OUT1 is 1PPS
iii. OUT2 is 10 MHz reference
iv. OUT3 is 16.384 MHz reference
v. OUT4 is 2.048 MHz reference
vi. EX_REF3 input reference frequency is 8 kHz
vii. EX_REF4 input reference frequency is 8 kHz
viii. Bullet III antenna.

ix. No others options

Column	A	B	C	D	E	F	G	H	I	J
	I	I	I	I	I	I	I			
Part Number	TS-369	F -	1P -	10 -	16 -	2 -	8K -	8K -	B	NA

Then, the part Number will be: **TS-369F-1P-10-16-2-8K-8K-B-NA**

Appendix A - Custom oscillator options

There is an option to equip GPTiMe with main oscillators that are different from the standard options in order to satisfy various customer performance requirements. A number of these options is listed below. More custom options are available; please contact the manufacturer for further details.

For structuring of the custom ordering part number, please contact the manufacturer.

1.0 Simple TCXO

1.1 Electrical specification

Symbol	Parameter	Min.	Typ.	Max.	Units
V_{cc}	Supply voltage	+3.135	3.3	+3.465	VOLT
T_{OP}	Operating temperature	-40		85	^{o}C
I_{WU}	Current consumption during warm up time (room temperature)			10	mA
I_N	Current consumption during normal operation (room temperature)			10	mA

Table 28: Simple TCXO electrical specification

1.2 Frequency stability and output characteristics

Parameter	Specification	Notes
Offset over the temperature	$< \pm 1.5 \times 10^{-6}$	
Stability vs. supply ±5%	< ±0.3 ppm	
Jitter generation	Less then or equal to $0.05UI_{pp}$	
Aging	$\leq \pm 1$ ppm/year	

Table 29: GPTiMe with simple TCXO - frequency stability and output characteristics

1.3 Mechanical drawing

The mechanical drawing is the same as for GPTiMe-3 Main Oscillator, SMT version is also available by request.

2.0 Low aging OCXO

Overall frequency accuracy of the low aging OCXO is $\leq \pm 0.9$ ppm in 10 years including initial tolerance, aging and frequency stability.

2.1 Electrical specification

Symbol	Parameter	Min.	Typ.	Max.	Units
V_{cc}	Supply voltage	+4.75	5.0	+5.25	VOLT
T_{OP}	Operating temperature	-20		65	^{o}C
I_{WU}	Current consumption during warm up time (room temperature)			1.2	A
I_N	Current consumption during normal operation (room temperature)			0.4	A

Table 30: Low aging OCXO electrical specification

2.2 Frequency stability and output characteristics

Parameter	Specification	Notes
Offset over the temperature	$< \pm 10 \times 10^{-9}$	
Stability vs. supply ±5%	$< \pm 5 \times 10^{-9}$	
Jitter generation	Less then or equal to $0.05UI_{pp}$	
Aging	80×10^{-9} per year	Typical

Table 31: GPTiMe with low aging OCXO - frequency stability and output characteristics

2.3 Mechanical drawing

The basic performance option:

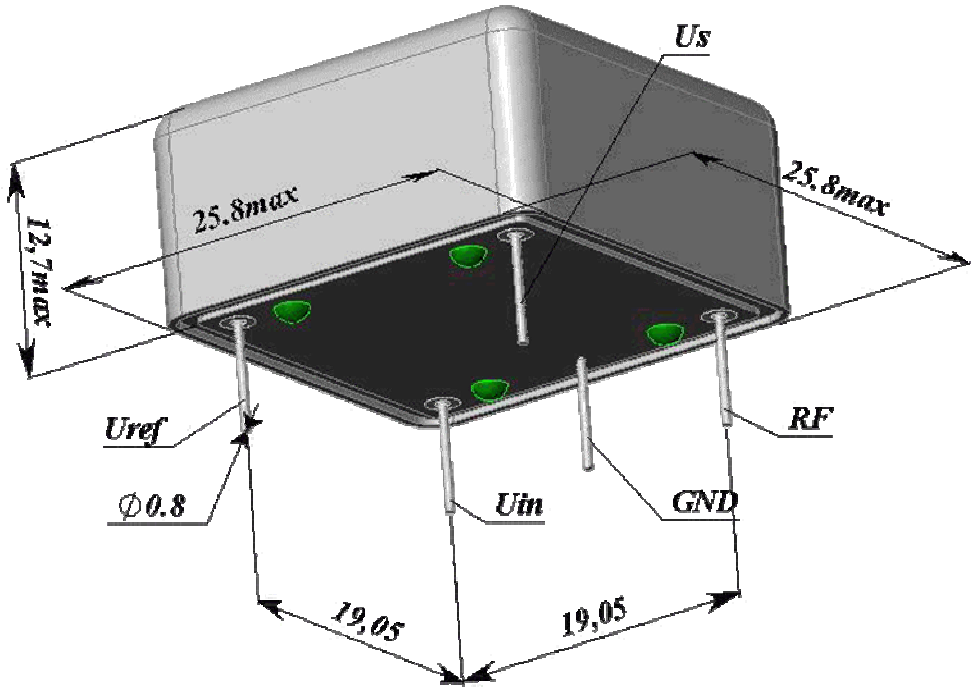


Figure 19 Mechanical drawing of the low aging OCXO

Pin name	Functionality
Uref	Not Connected
Us	Power supply input
RF	Frequency output
GND	Ground
Uin	Not Connected

If different performance is required (within the limits of ≤ ± 0.9 ppm in 10 years), these oscillators are also available in form factors of GPTiMe-3E and GPTiMe-2 Main Oscillators.

3.0 Stratum 3E SMT OCXO

3.1 Electrical specification

Symbol	Parameter	Min.	Typ.	Max.	Units
V_{cc}	Supply voltage	+3.135	3.3	+3.465	VOLT
T_{OP}	Operating temperature	-20		65	^{o}C
I_{WU}	Current consumption during warm up time (room temperature)			1.2	A
I_N	Current consumption during normal operation (room temperature)			0.4	A

Table 32 Electrical specification of Stratum 3E SMT OCXO

3.2 Frequency stability and output characteristics

Parameter	Specification	Notes
Offset over the temperature	$< \pm 10 \times 10^{-9}$	
Stability vs. supply ±5%	$< \pm 1 \times 10^{-9}$	
Jitter generation	Less then or equal to $0.05UI_{pp}$	
Aging	100×10^{-9} per year	Typical

Table 33 Frequency stability and output characteristics of Stratum 3E SMT OCXO

3.3 Mechanical drawing

Note: H=15mm.

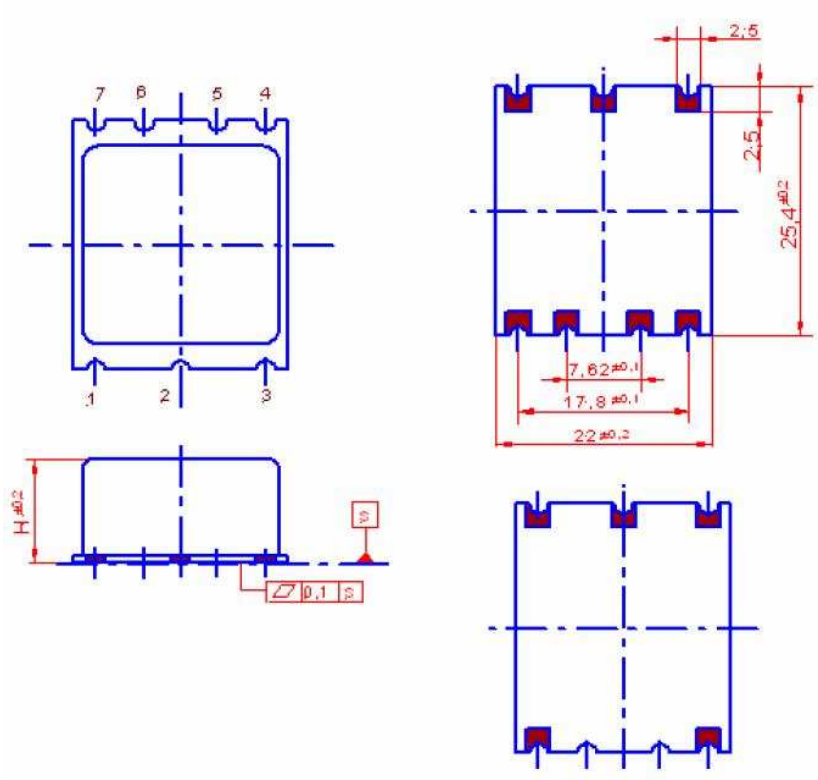


Figure 20 Mechanical drawing of Stratum 3E SMT OCXO