FEI-Zyfer

AccuSync
Model 373-100-01
Model 373-100-02
Model 373-100-11
Model 373-100-12

GPS Synchronized
Time and Frequency Instrument
User's Manual

Document 373-8001
Rev C

ALL SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

WARRANTY

FEI-Zyfer, Inc's standard warranty is for one year unless otherwise agreed upon by contract or purchase order. Warranty terms and conditions are explained in the Standard Terms and Conditions of Sale provided with the quotation.

TRADEMARKS

All brand names and product names used in this document are trademarks, registered names of their respective holders. FEI-Zyfer, Inc. is not associated with any referenced product or manufacturer mentioned in this document.

DISCLAIMER

This document reflects the specifications and features of the equipment that were current at the time of release of this manual. FEI-Zyfer, Inc. disclaims responsibility for any errors contained herein, and reserves the right to make changes to this manual and related equipment without notice or obligation.

THIS PRODUCT IS NOT AUTHORIZED FOR USE AS A CRITICAL COMPONENT IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESSED WRITTEN CONSENT OF THE CHIEF EXECUTIVE OFFICER OFFEI-ZYFER, INC.

DATE	AMENDMENTS
3/18/200	Rev A: Changer “Odetics” and “Odetics Telecom” to “Zyfer”, and changed “Coasting” to “Holdover” throughout the document.
10/31/2000	Rev B: Changed panel color from Pantone 425 C to Fed Std 595 27038.
01/05/2005	Rev C: Changed “Zyfer” to “FEI-Zyfer”. Deleted contact address in Europe. Modified to reflect operation with firmware starting at V1.12.00.

CONTACT INFORMATION

FEI-Zyfer, Inc (North America)

Technical Support:	Phone	(714) 780-7642
		(888) 886-7465 (USA only)
	Fax	(714) 780-7649
	Email	techsupport@fei-zyfer.com
Sales:	Phone	(714) 780-7685
	Fax	(714) 780-7649
	Email	sales@fei-zyfer.com
Data Sheets:	http://www.fei-zyfer.com/	
RMA Numbers:	Phone	(714) 780-7685
	Fax	(714) 780-7649

Shipping Address for Repairs/Returns:

FEI-Zyfer, Inc.
Attention: RMA -####
1515 S. Manchester Ave., Dock 5
Anaheim, CA 92802-2907
USA

Please obtain a Return Material Authorization (RMA) number prior to returning a product to FEI-Zyfer, Inc.

Table of Contents

Section 1 General Information

Section 2 Getting Started

Table of Contents (continued)

Section 1 General Information

1.1 DESCRIPTION

This document contains information pertaining to AccuSync Time and Frequency source Model 373. The unit is configured with SMA type output connectors (373-100-01 and 373-100-11), or with SMB output connectors (373-100-02 and 373-100-12). The required type of input power is also configuration dependent: AC input of 85 to 265 VAC (373-100-01 and 373-100-02), and wide range DC input source of 20 to 60 VDC (373-100-11 and 373-100-12).

The instrument is packaged in a 1U high 19-inch rack mount chassis that provides highly accurate frequency and timing and output signals, synchronized to the UTC.

Operation is automatic and self-calibrating. Methods of controlling and monitoring the performance are provided via a RS-232 I/O interface. The instrument consists of:

- A Global Positioning System (GPS) receiver
- A GPS disciplined ovenized Quartz oscillator
- A Universal Input AC power supply or wide input range DC power supply
- Five front panel LED status indicators

The instrument provides:

- A flash ROM to simplify firmware upgrades
- Two 1 PPS pulse rate output signals
- Five 10 MHz sinusoid frequency output signals
- One RS-232 I/O control and monitor computer interface port
- One Time-Of-Year and Status message output port
- Two "hardware" status signals

All connectors are located on the instrument’s rear panel

Available Accessories:

- GPS antenna kit: FEI-Zyfer stock number 0810384
  (Note: Antenna kit FEI-Zyfer stock number 0810137 can also be used)
- Long length and low loss antenna cable

1.2 FUNCTIONS

The following paragraphs describe the functions of the instrument's input/output signals and the front panel indicators.

1.2.1 1 PPS Outputs

Two high accuracy 1 PPS (One Pulse Per Second) output ports are provided. The signals are derived from a GPS disciplined oscillator. When locked to GPS, the signals are traceable to Coordinated Universal Time (UTC) through GPS. In the event GPS lock is lost the signals continue to be generated by the internal oscillator, operating in a coasting mode. However, the oscillator frequency, and consequently the 1 PPS output, will degrade as the coasting period increases in duration.

1.2.2 10 MHz Outputs

Five 10 MHz sinusoid output ports are provided, that are traceable to UTC (USNO) through GPS. If GPS lock is lost, the oscillator enters a coasting mode and will maintain the frequency outputs in the same way as the 1 PPS outputs described above.

1.2.3 Serial Control Port

A serial interface control port allows for communication with the instrument. This is accomplished by connecting an external device with suitable software to send and receive the proper commands for transmitting and receiving data. The port allows customizing the instrument's position solution, change the operating status, and retrieve operating status and data.

1.2.4 Serial Output Port

A serial "output-only" port is provided to retrieve TOD (Time Of Day) and operation status data. The user can select the output rate of the message.

1.2.5 Antenna Input

A TNC type connector allows connection of a antenna system to the instrument. A +5Vdc source is provided on the center conductor, which is intended to provide power to an external "active" antenna containing a low noise amplifier, such as the antenna optionally available from FEI-Zyfer.

1.2.6 Power Input

The instrument's universal AC input power is connected through an IEC 320 inlet connector. Instruments configured for wide input range DC input operation are configured with a 3-contact connector (supplied with a mating connector).

1.2.7 Front Panel Indicators

Five front panel LED indicators provide visual status of internal DC power, GPS lock, time accuracy, and fault conditions.

- **POWER** - This indicator illuminates when the internal power supplies are operating within tolerance.

- **GPS LOCK** - When this indicator is illuminated the instrument's timing and frequency signals are locked to GPS. The disciplining of the internal oscillator is in progress, and the characteristics of the internal oscillator are being learned.

- **TFOM >4** - This indicator is illuminated when the instrument has determined that the difference between the instrument's 1 PPS output signals and the GPS 1 PPS reference exceeds 1.0 µs.

- **HOLDOVER** - This indicator is illuminated when the instrument is not locked to GPS. Time is kept using the output of the internal ovenized oscillator, that is being corrected for aging and temperature effects through a special algorithm using data obtained during GPS Lock. The indicator is also illuminated during the recovery mode, when the instrument is adjusting its internal timing or the frequency of the internal oscillator.

  Note: If the HOLDOVER indicator illuminates before the instrument has been able to fully learn the aging and temperature effect characteristics of the internal oscillator, the accuracy specification during holdover may not be fully met. The specification is valid only after the instrument has operated for a period sufficiently long to characterize the oscillator.

- **ALARM** - This indicator illuminates at application of input power, and remains illuminated until the instrument's timing and frequency signals are locked to GPS. The indicator will flash on and off If the instrument's signals are not locked to GPS within 30 minutes after application of input power. The indicator also illuminates when the instrument's internal GPS receiver does not provide a useable reference signal for disciplining the instrument's oscillator, and when the instrument has detected an internal error condition that requires attention. Some errors are receiver communication fault, receiver 1 PPS output fault, internal oscillator fault, and internal power supply out of tolerance.

1.3 DETAILS OF OPERATION

1.3.1 Warm-Up

When power is applied, the instrument enters the Warm-Up mode. During this period the internal GPS receiver initializes in the *Position Averaging* mode (also referred to as *Survey* mode). When the receiver has acquired a minimum of four satellites with good satellite geometry, it resolves the initial position of the antenna connected to the instrument and downloads current satellite almanac data. At this point the instrument verifies that the existing position data stored in non-volatile memory is correct. If the position is verified, the receiver automatically switches to the *Known* position mode. The position verification process and automatic switch over takes a few minutes

If the position data indicates that the antenna position has changed, or is otherwise incorrect, the receiver continues to operate in the *Position Averaging* mode using data from the receiver to calculate a new accurate position. After this process is finished, the receiver automatically switches to the *Known* position mode, storing the new antenna position in non-volatile memory. The duration of the position averaging process can take from approximately 3 hours to 24 hours, depending on the type of installed receiver and the satellite visibility.

The disciplining of the instrument's oscillator starts as soon as the receiver's timing locks to GPS and the oscillator is determined to be stable. It is not necessary for the instrument to have finished its position survey.

As soon as the instrument has locked to satellites, has enough information, and the internal oscillator has stabilized, the oscillator disciplining process and the alignment of the internal timing starts. When the internal timing is aligned with GPS 1PPS, the instrument's operation mode switches to the *Time Locked* mode,

1.3.4 Time Locked

In the *Time Locked* mode the instrument's major and minor time is synchronized to UTC. The 1 PPS output from the internal GPS receiver is used as reference to discipline the internal oscillator and the phase of the instrument's 1 PPS output pulse. The accuracy of the 1 PPS output signals is indicated by the Time Figure Of Merit, TFOM. Normally, the TFOM is 4 while operating in the *Known* position mode, and 4 or 5 when operating in the *Dynamic* or *Position Averaging* mode. The TFOM value is available through the RS-232 interface. A front panel LED indicator illuminates when the TFOM exceeds 4.

1.3.5 Holdover

The *Holdover* (Coasting) mode is entered after out of range inconsistencies in the major time (days through seconds) or 1 PPS have been detected, or if the internal receiver has lost lock with satellites. This mode can only be entered from the *Time Locked* mode.

In the first stage of this mode, the internal oscillator is coasting (i.e. -not being disciplined) to retain the accuracy of the output signals. The timing output accuracy is indicated by the Time Figure Of Merit (TFOM). In the first stage of this mode, the TFOM is the same value as that while operating in the *Time Locked* mode.

Time is kept using the output of the internal ovenized oscillator, that is being corrected for aging and temperature effects through a special algorithm using data obtained during GPS Lock

When operating in the *Holdover* mode for extended periods, the TFOM value is changed according to the estimated time error computed from the following formula: Time Error = nf; where n = number of seconds since time lock was lost, and f = frequency error at the moment time lock was lost.

In the last stage of the mode, when the conditions needed to start the disciplining and synchronization process are met and then started, the instrument will automatically change to the *Recovering* mode if the timing error is greater than 10 µs or, if the timing error is less than 10 µs, directly to the *Time Locked* mode.

At the moment the last stage of the mode is entered, the TFOM available via the serial interface indicates the actual measured accuracy of the timing output.

1.3.6 Recovering

In the *Recovering* mode the internal timing or the frequency of the internal oscillator is adjusted until the *Time Locked* mode criteria is met. Expect an eventual transition to the *Time Locked* mode (unless changing conditions prevent this; for instance: loss of tracked satellites or change of antenna cable delay selection).

1.3.7 Disciplining Period

When the *Time Locked* mode is entered for the first time after power is applied, the time and frequency output signals are synchronized to GPS, and are phase and frequency corrected as needed to maintain the specified accuracy of the output signals. A hardware/firmware estimator continuously compares the GPS receiver 1 PPS output with the internally generated 1 PPS derived from the internal oscillator to determine the correction necessary to discipline the oscillator. The estimator filters out the short-term variations inherent in the GPS 1 PPS.

.

This page left blank intentionally

Section 2 Getting Started

2.1 INTRODUCTION

This section contains the step-by-step procedures to place the AccuSync in operation.

2.2 GETTING ASSISTANCE

If you need assistance or have any questions relating to setup or operation, contact Technical Support. Please refer to the CONTACT INFORMATION page for detailed information.

2.3 PREPARING FOR USE

Install the instrument into the equipment cabinet (rack) as follows:

- Set the rear panel AC power switch, if supplied, to the OFF position.
- If not already installed, fasten the two rack-mount brackets to the instrument using the screws supplied in the shipping kit.
- Place the instrument in the desired cabinet (rack) location.

CAUTION!

Always locate heavy equipment towards the bottom of the cabinet (rack) to avoid accidental tip-over of the cabinet (rack).

Make certain the maximum operating ambient temperature does not exceed 55º C.

Never restrict the airflow through the instrument's vents, located on each side of the instrument.

- Fasten the rack-mount brackets to the equipment cabinet (rack).

Prior to use, the instrument must be connected to an antenna, ac or dc power source, and to a compatible serial interface.

If the instrument is configured to operate from an ac power source, pay special attention to the following:

- *Connect the instrument only to a properly rated supply circuit.*
- *The supplied 3-prong power cord provides safety grounding. Do not defeat this feature. The user must comply with all applicable national and local electrical regulations regarding grounding and safety.*

2.3.1 Installing the Antenna System

The optional FEI-Zyfer antenna is to be to be mounted on a pole with the supplied hardware.

Note: Special care must be taken when routing the antenna cable near sources of potential interference, such as a power bus, high frequency antenna couplers, and other transmitting equipment.

The mounting location should be free of any objects that might obstruct satellite visibility within 10º of the horizon. Obstructions that obscure significant areas of the sky will result in degraded performance of the instrument. The antenna should be located at least 50 cm away from any other GPS antenna. The antenna must be mounted with the connector side down.

Mount the antenna in the desired location. At the antenna, connect one end of the antenna cable to the antenna connector. Application of a weatherproofing compound to the antenna/cable connection is recommended to impede corrosion.

2.3.1.1 Antenna Cable

The antenna available from FEI-Zyfer has a minimum gain of 30 dB. This allows for a maximum antenna cable loss of 15 dB 1575 MHz.

Other lengths and types of cable can be used as long as the signal loss at 1575 MHz does not exceed 15 dB.

Caution: Not all coaxial cable exhibits the same amount of attenuation or shielding quality. These parameters can vary between manufacturers as well as manufacturer's type.

FEI-Zyfer has evaluated several manufactures and types of cable, and has found that Belden® type 9311 (RG-58), Belden® type 8267 (RG-213), Belden® type 9913 (RG-8), Belden® type 9104 (RG-59), and Times Microwave LMR type cable provide good performance.

The following table indicates the maximum length of recommended cable type when used with the antenna available from FEI-Zyfer.

Cable Type	Max. Length	Comments
RG-58 (Belden® 9311)	75 ft (23 m)	Loss 20 dB per 100 ft (30 m)
RG-213 (Belden® 8267)	125 ft (38 m)	Loss 12 dB per 100 ft (30 m)
RG-59 (Belden® 9104)	150 ft (46 m)	Loss 10 dB per 100 ft (30 m)
RG-8 (Belden® 9913)	250 ft (75 m)	Loss 6 dB per 100 ft (30 m)
LMR400 (Times Microwave)	275 ft (84 m)	Loss 5.4 dB per 100 ft (30 m)

For long runs it is necessary to use an In-Line Amplifier or low loss foam dielectric cable such the Heliax series manufactured by Andrew Corporation, Orland Park, IL, USA.

For extremely long runs a special up/down converter system can be used, such as the downconverter/upconverter system manufactured by Raven Industries (formerly Starlink Incorporated), Austin, TX, USA. Versions are available for use with coaxial cable and also for use with fiber optic cable.

2.3.1.2 In-Line Amplifier

In some cases it may be more cost effective to place an amplifier in the antenna cable system to make up for the signal attenuation caused by long cable runs.

Amplifiers are available from several manufacturers including Raven Industries (formerly Starlink Incorporated), Austin, TX, USA, and FEI-Zyfer. The following tables list the characteristics of the amplifier available from FEI-Zyfer.

Amplifier 0810402 is configured with a male TNC connector at the input side and a female TNC connector at the output side. This allows the amplifier to screw directly on to the GPS antenna without the need for additional cables. It also provides protection from the environment when the antenna is installed using a pipe that also surrounds the amplifier. This configuration allows for a cable loss between the output of the amplifier and the input of the GPS receiver up to 35 dB.

Parameter	P/N 0810402 Characteristics
GPS Band	L1 (Fc = 1575.42 MHz)
Gain	20 +/- 2.0 dB @ Fc
Filter	-20 dB Attenuation @ 20 MHz from Fc
Input Power	4.0 VDC @ 10 ma/28 VDC at 20 ma with voltage pass-through
NF	< 3.0 dB
Connector	TNC Male Input/TNC Female Output

Amplifier 0810398 is configured with a female TNC connector at both the input side and the output side. This allows the amplifier to be installed in-line with the antenna cable. The optimum location for the amplifier is at a point in the antenna cable where the cable loss is approximately 15 dB. This configuration allows for up to 15 dB cable loss between the output of the antenna and the input of the in-line amplifier, and for up to 20 dB cable loss between the output of the in-line amplifier and the input of the GPS receiver

Parameter	P/N 0810398 Characteristics
GPS Band	L1 (Fc = 1575.42 MHz)
Gain	20 +/- 2.0 dB @ Fc
Filter	-20 dB Attenuation @ 20 MHz from Fc
Input Power	4.0 VDC @ 10 ma/28 VDC at 20 ma with voltage pass-through
NF	< 3.0 dB
Connector	TNC Female Input/TNC Female Output

2.3.1.3 Lighting Protection

In areas where lightning is present, it is recommended to install a surge protector in the antenna system. Surge protectors are available from several manufacturers such as: Part number 095-0518C-A from PolyPhaser Corporation, Minden, Nevada, USA, and part number P8AX09TNCWFF from Citel, Miami, Florida, USA. In order to be effective, the arrestor must be connected to earth ground using a very low-inductance conductor. The arrestor should be connected as close as possible to the point where the antenna cable enters the building. Contact the manufacturers for installation details.

2.3.1.4 Weather Proofing

The antenna enclosure is designed to be exposed to all-weather conditions. However, care should be taken with the connectors and cable couplers, if used. These components should be shielded from the elements, or weather protected using butyl rubber tape. Weather proofing kit P/N 221213 is available from Andrew Corporation. This kit includes butyl rubber and plastic tape. Instructions are included with the kit.

2.3.2 Connecting the Antenna Input

Connect the antenna system cable to the instrument's rear panel TNC connector labeled *Antenna*.

2.3.3 Connecting the AC Input Power

When installing an instrument configured for AC input power, verify that the rear panel power switch is set to the off position before installing the supplied power cord. Insert one end of the power cord into the instrument's rear panel AC power inlet connector, and insert the other end into the facility power outlet.

2.3.4 Connecting the DC Input Power

When installing an instrument configured for DC input power it is necessary to assemble the dc power cable using 18 AWG connecting wires and the three-pin mating connector, supplied in the unit's shipping kit. Connect the DC input as follows:

DC INPUT POWER CONNECTOR PIN DESIGNATION	
PIN	FUNCTION
1	DC Supply (+)
2	Chassis Ground
3	DC Supply Return (-)

2.3.5 Connecting the Serial Control/Monitor Port

The control and monitor of the instrument's operation is accomplished through an RS-232 interface. Connect the remote control/monitor device to the instrument's rear panel connector labeled *Cntrl* as follows:

CONTROL INTERFACE CONNECTOR PIN DESIGNATION		
PIN	SIGNAL	DESCRIPTION
1,5,9	GROUND	SIGNAL RETURN, GROUND POTENTIAL
2	OUTPUT (TXD)	RS-232 INTERFACE OUTPUT
3	INPUT (RXD)	RS-232 INTERFACE INPUT
4,8	NO CONNECTION	
6	AUX INPUT (RXD)	AUXILIARY RS-232 INPUT – NOT ACTIVE
7	AUX OUTPUT (TXD)	AUXILIARY RS-232 OUTPUT – NOT ACTIVE

Note: The required mating connector is a DE-9S "D-Subminiature" connector (not supplied with the instrument).

2.3.6 Connecting the Time of Day Output Port

To monitor the Time Of Day (TOD) and Status message, connect a compatible RS-232 device to the instrument's rear panel connector labeled *TOD* as follows:

TIME OF DAY (TOD) CONNECTOR PIN DESIGNATION		
PIN	SIGNAL	DESCRIPTION
1,5,9	GROUND	SIGNAL RETURN, GROUND POTENTIAL
2, 3	NO CONNECTION	
4	TOD OUTPUT	RS-232 LEVEL SIGNAL TIME/STATUS/ERROR MESSAGE
6	/TIME LOCK	TIME LOCK STATUS (Open = Not Locked, Ground = Locked)
7	/ALARM	ALARM STATUS (Open = Alarm, Ground = OK)
8	SPARE INPUT (RXD)	SPARE RS-232 INPUT - NOT ACTIVE

Note: The required mating connector is a DE-9S "D-Subminiature" connector (not supplied with the instrument).

2.4 POWERING-UP THE INSTRUMENT

On a unit configured to operate from an AC power source, set the rear panel power switch to the ON position. On a unit configured to operate from a DC power source, apply DC power to the instrument. The following sequence of events takes place:

- When power is applied, only the front panel PWR indicator illuminates.
- After a moment, the instrument runs through its self-test diagnostics.
- After the completion of the self-test, only the PWR and TFOM >4 indicators are normally illuminated. If the ALARM indicator is illuminated, a failure may have occurred during the self-test or the instrument has detected an abnormal condition.
- At the application of power, the instrument's internal receiver defaults to the *Position Averaging* mode, the receiver begins to search the sky for all available satellites, and then starts to acquire and track satellites.

  When the receiver has acquired a minimum of four satellites with good satellite geometry, it resolves the initial position of the antenna connected to the instrument and downloads current satellite almanac data. At this point the instrument verifies that the existing position data stored in non-volatile memory is correct. If the position is verified, the receiver automatically switches to the *Known* position mode. The position verification process and automatic switch over takes a few minutes

  If the position data indicates that the antenna position has changed, or is otherwise incorrect, the receiver continues to operate in the *Survey* mode using data from the receiver to calculate a new accurate position. After this process is finished, the receiver automatically switches to the *Known* position mode, storing the new antenna position in non-volatile memory. The duration of the position averaging process can take from approximately 3 hours to 24 hours, depending on the type of installed receiver and the satellite visibility.

  The disciplining of the instrument’s oscillator starts as soon as the receiver’s timing locks to GPS and the oscillator is determined to be stable. It is not necessary for the instrument to have finished its position survey.

  As soon as the instrument has locked to satellites, has enough information, and the internal oscillator has stabilized, the oscillator disciplining process and the alignment of the internal timing starts.
- Further operation is automatic. After the instrument's internal timing and oscillator frequency have been adjusted sufficiently to provide accurate output signals, the front panel GPS LOCK indicator illuminates, and the TFOM >4 indicator extinguishes.

  The elapsed time for each step varies, depending on the satellite visibility. When operating in the *Position Averaging* mode at power-up and with many satellites visible, the internal receiver requires at least 8 minutes and at most 30 minutes to calculate the coarse antenna position. The antenna position solution improves over a period of time through further averaging.

2.5 COMMUNICATING WITH THE INSTRUMENT

Any computer with an RS-232 serial interface and suitable terminal emulation software (such as PROCOM PLUS) can be used to communicate with the instrument. Most computers have a terminal program installed, especially computers with Windows.

The instrument's operation can be monitored and changed via the commands listed in FEI-Zyfer Document 365-8005, RS-232 Communication Protocol. In that document, the commands that can be used to communicate with this instrument are referred to as *Compatibility: AccuSync*.

2.5.1 Configuring the Control Port

In order to communicate with the instrument, the computer's serial communication port configuration must be set the same as the instrument's settings. The instrument's settings can not be altered. The default settings are:

Parameter	Default Setting
Baud Rate	19200
Parity	NONE
Data Bits	8
Stop Bits	1

2.6 CUSTOMIZING THE OPERATION

After the instrument is installed and operating, the user may elect to customize the installation as described below.

2.6.1 Set Antenna Cable Delay Compensation

For the most accurate timing, it is necessary to compensate for the signal delay caused by the antenna system. The delay is the sum of all signal delays between the antenna and the receiver. The major contributor is the delay caused by the antenna cable length. The typical amount of error is on the order of a few hundred nanoseconds.

Delay values for recommended cable types are listed in the following table.

CABLE TYPE	DELAY VALUE
Belden® 9311 (RG-58)	4.36 ns/m (1.33 ns/ft)
Belden® 8267 (RG-213)	4.99 ns/m (1.52 ns/ft)
Belden® 9104 (RG-59)	4.00 ns/m (1.22 ns/ft)
Belden® 9913 (RG-8)	3.90 ns/m (1.19 ns/ft)

Calculate the systems cable delay by multiplying the actual cable length and the delay value from the above table.

For example, if the antenna system includes 15 meters of RG-58 cable, the total cable delay is: 15 m x 4.36 ns/m = 65.4 ns. When entering the data, round off the delay value to the nearest nanosecond.

Set the antenna cable delay compensation using RS-232 command:
$ANTD,65*<cr/lf><cr/lf>

Note: It is normal for the instrument to momentarily go to the Holdover mode after a change is made in the antenna cable delay compensation value.

Note: This command can also be used to compensate for system offsets external to the instrument. The maximum offset is 999,999 ns. Any programmed offset causes the timing outputs to occur sooner in time.

2.6.2 Select TOD Output Message Rate

The transmission rate of the instrument's Time Of Day (TOD) output message can be selected by the user as either every second or every even second.

Select the TOD message format using RS-232 command:
$TODS,2*<cr/lf>

In this command, *2* selects TOD message format and rate: *ASCII, even second*. Refer to FEI-Zyfer Document 365-8005, Generic RS-232 Communication Protocol, for additional format/rate selection commands.

2.6.3 Set Local Time Rather than UTC or GPS Time

The instrument's output time can be expressed in UTC or GPS time, and can be adjusted for local time zone offset. The default setting is UTC without local offset.

UTC is offset from GPS time by the number of accumulated leap seconds that have occurred since midnight of January 6, 1980 UTC. When operating in the GPS (or Local GPS) time mode, the instrument's current output time is in referenced to GPS time. When operating in the UTC (or Local UTC) mode, the output time is referenced to UTC.

Set the local time offset from UTC time using RS-232 command:
$TIMM,*3*,*h,m**<cr/lf>

In this command, *3* selects local UTC time mode, *h* is the sign and hours of local hours of offset from UTC, and *m* is the minutes of local time offset from UTC. The offset value can range from -14.30 to +14.30 hours, in selectable 30-minute increments.

Set the local time offset from GPS time using RS-232 command:
$TIMM,*4*,*h,m**<cr/lf>

In this command, *4* selects local GPS time mode, *h* is the sign and hours of local hours of offset from UTC, and *m* is the minutes of local time offset from UTC. The offset value can range from -14.30 to +14.30 hours, selectable in 30-minute increments.

Note: Up to a 30 second delay exists between the time offset entry and the actual instrument time output change.

Daylight Saving Time - When the instrument is configured to display Local UTC or Local GPS time, the local time offset must changed by the user to compensate for Daylight Saving time.

2.6.4 Reset Internal GPS Receiver

In the rare case that it is suspected that the receiver's memory has been corrupted, causing erroneous results or no operation at all, the receiver should be reset. One reset mode is available: *Cold Start*.

- *Cold Start* – Re-initializes the receiver, resulting in a "search the sky" mode until sufficient data has been collected from the satellites. To complete the collection of new data requires from 12 to 30 minutes, depending on satellite visibility conditions. *Cold Start should be performed only when necessary*. Cold Start the receiver through the Windows User Application program's *Setup* pull down menu *Mode*, or:

  Set the receiver to Cold Start using RS-232 command:
  $RSTG,C*<cr/lf>

2.7 MONITORING THE OPERATION STATUS

The operation status can be monitored (and changed) via the serial interface control/status port by commands listed in FEI-Zyfer Generic RS-232 Communication Protocol Document 365-8005. In that document, the instrument is referred to as *AccuSync*. The *TIME* query command is one of the most commonly used commands. The following paragraphs describe in detail the data field of the query command return message.

TIME Query Command - This command returns the following information: *Time* (Julian format), *Time Mode* (UTC, Local UTC, GPS, Local GPS), *Time Figure Of Merit* (TFOM), and *Operation Mode* (Warm-up, Time Locked, Holdover, or Recovering).

- ***Time*** - When the instrument is powered up, the time stored in the instrument may not be correct. The actual time will be valid after one satellite has been tracked by the instrument's GPS receiver.

- ***Time Mode*** - There are two basic ways to express time: GPS or UTC. GPS time is offset from UTC by the number of accumulated leap seconds that have occurred since midnight of January 6, 1980 UTC. It is possible to offset the GPS or UTC time to adjust for local time zone offset from UTC. When operating in the GPS (or Local GPS) mode, the instrument's current output time is in referenced to GPS time. When operating in the UTC (or Local UTC) mode, the output time is referenced to UTC. (To change the Time Mode selection, refer to command TIMM).

  FEI-Zyfer recommends using the UTC or GPS mode without local offset to prevent temporary loss in time synchronization between systems operating in different time zones, caused by the daylight saving event.

- ***TFOM (Time Figure Of Merit)*** - Indicates the accuracy of the instrument's time and timing output. The following table lists the TFOM values with the corresponding Time Error.

TFOM Value	Time Error	TFOM Value	Time Error
4	to $\leq$ 1 µs	7	**>** 100 µs to $\leq$ 1 ms
5	**>** 1 µs to $\leq$ 10 µs	8	**>** 1 ms to $\leq$ 10 ms
6	**>** 10 µs to $\leq$ 100 µs	9	**>** 10 ms

  Normally, the TFOM is 4 while operating in the *Known* position mode, and 4 or 5 when operating in the *Dynamic* or *Position Averaging* mode.

- ***Operation Mode*** - There are four operating modes: Warm-up, Time Locked, Holdover, and Recovering

  - *Warm-up* - Indicates that the instrument has not achieved initial GPS lock since it was powered. During the first ten minutes after power-up, the internal oscillator is warming up and the internal receiver is acquiring satellites.

  - *Time Locked* - Indicates that the instrument's major and minor time (days through seconds) is locked to GPS, and the internal oscillator is being disciplined.

  - *Holdover* - Indicates that the instrument is waiting for conditions needed to allow

the recovery process from Holdover to Time Locked.

This mode is entered after out of range inconsistencies in the major time (days through seconds) or 1 PPS have been detected, or if the internal receiver has lost lock with satellites. This mode can only be entered from the *Time Locked* mode.

In the first stage of this mode, the internal oscillator is coasting (i.e. -not being disciplined) to retain the accuracy of the output signals. The timing output accuracy is indicated by the Time Figure Of Merit (TFOM). In the first stage of this mode, the TFOM is the same value as that while operating in the *Time Locked* mode.

Time is kept using the output of the internal ovenized oscillator, that is being corrected for aging and temperature effects through a special algorithm using data obtained during GPS Lock

When operating in the *Holdover* mode for extended periods, the TFOM value is changed according to the estimated time error computed from the following formula: Time Error = nf; where n = number of seconds since time lock was lost, and f = frequency error at the moment time lock was lost.

In the last stage of the mode, when the conditions needed to start the disciplining and synchronization process are met and then started, the instrument will automatically change to the *Recovering* mode if the timing error is greater than 10 µs or, if the timing error is less than 10 µs, directly to the *Time Locked* mode.

- *Recovering* - Indicates that the instrument is adjusting its internal timing or the frequency of the oscillator until the conditions for time lock are met. Expect an eventual transition to the *Time Locked* mode (unless changing conditions prevent this; for instance: loss of tracked satellites or change of antenna cable delay selection).

2.8 MODIFYING THE OPERATION STATUS

The operation status can also be changed (and monitored) via the serial interface control/status port by commands listed in FEI-Zyfer Generic RS-232 Communication Protocol Document 365-8005. In that document the instrument is referred to as *AccuSync*. Some examples are:

TIMM Command - Allows the user to set the status of the time mode (*UTC, Local UTC, GPS, or Local GPS*). The user can also set the local time offset. The default mode is *UTC* (local time offset defaults to 00 hrs and 00 min). The setting is not normally changed to *GPS*.

TRMO Command - Enables changing the antenna position solution mode (*Position Averaging* or *Dynamic*).

Normally, the mode is automatically set by the instrument, and should not be changed unless required by system conditions, such as limited satellite visibility or unexpected satellite conditions.

During normal operation, the antenna position solution mode is *Known.* In this mode the highest accuracy is obtained (assuming the position data is correct). During warm-up after the initial application of power, the antenna position solution mode is *Position Averaging.* After the instrument completes its position survey, the mode automatically switches to *Known*. The *Dynamic* position solution mode is normally not used.

Section 3 Specifications

3.1 INTRODUCTION

The following paragraphs contain the specifications for the AccuSync.

3.2 MECHANICAL

Height ..... 1.74" (44.2 mm) maximum
Width (without rack mount brackets) ..... 16.52 (420 mm) maximum
Depth (excluding protrusions) ..... 11.86" (301 mm) nom
Weight ..... 9 lb (4.1 kg) maximum
Panel Color ..... Fed Std 595 27038 light texture finish

3.3 ENVIRONMENTAL

Operating Altitude ..... -60 m to 4000 m
Storage Altitude ..... -60 m to 9000 m
Operating Temperature ..... 0º C to +55º C
Temperature Rate of Change ..... ±15º C/Hour
Storage Temperature. ..... -40º C to +85º C
Relative Humidity ..... 5% to 95%, non-condensing

3.4 POWER REQUIREMENTS

- AC Input Power (Part Number Suffix -01 and -02)

Voltage ..... 85 to 264 VAC (CE rating: 100 to 240 VAC)
Current ..... 0.4 A maximum
Frequency ..... 50/60 Hz
Input Over-current Protection ..... External and internal fuses
Isolation Voltage, Input to chassis ..... 1500 VAC
Connector ..... IEC 320
On/Off Control ..... On rear panel power entry module

CAUTION!

Replace fuse(s) with same type and rating as marked

- DC Input Power Version (Part Number Suffix -11 and -12)

Voltage ..... 20 to 53 VDC
Current (20 VDC input) ..... 1.2 A
Input Over-current Protection ..... Internal fuses
Isolation Voltage, Input to ground and output ..... 500 VDC
Connector ..... 3 Pin metal shell, circular
Mating Connector ..... Supplied
Input Power Connector Pin Designation
Pin 1 ..... + DC Input
Pin 2 ..... Chassis ground
Pin 3 ..... - DC Input

3.5 ELECTRICAL SIGNALS

3.5.1 10 MHz Output

Five (5) separate 10 MHz sources are provided. Unless otherwise stated, the specifications apply when the instrument is operating in the *Known* position time solution mode, the antenna's geodetic position is known within 25 meters, the antenna is in a fixed location, and the internal oscillator has been disciplined for at least three days.

Number of Outputs 5
Wave Shape ..... Sinusoid
Distortion
- Harmonic ..... < 50 dBc
- Non-Harmonic ..... < 60 dBc

Amplitude ..... 16 +1, -2 dBm
Coupling ..... AC
Protection
- Applied Voltage ..... ±50 Vdc maximum
- Terminating Impedance ..... Infinity to short circuit

Accuracy Error
- Time Locked ..... $< 1 \times 10^{-12}$ (1-day average)
- Holdover ..... $< 1 \times 10^{-10}$ / day at 95% probability (at ambient temperature change $\leq \pm 10^{o}$ C)

Short Term Stability (Time locked or Holdover)
- 100 Sec tau ..... $< 1 \times 10^{-10}$

Phase Noise ..... < -85 dBc/Hz @ 1 Hz
< -115 dBc/Hz @ 10 Hz
< -135 dBc/Hz @ 100 Hz
< -145 dBc/Hz @ 1 kHz through 100 kHz

Source Impedance ..... 50 Ω nominal
Output to Output Isolation ..... > 60 dB
Connector Type
- Part Number Suffix -01 and -11 ..... SMA male
- Part Number Suffix -02 and -12 ..... SMB male

3.5.2 1 PPS Output

Two (2) separate 1 PPS sources are provided. Unless otherwise stated, the specification apply when the instrument is operating in the *Known* position time solution mode, the antenna's geodetic position is known within 25 meters, the antenna is in a fixed location, the proper antenna/cable delay has been selected. and the internal oscillator has been disciplined for at least three days.

Number of Outputs 2
Rate ..... 1 PPS
Wave Shape ..... Pulse
Pulse Width ..... 2 ms
Synchronization Reference ..... GPS or UTC, user selected (Default to previous selection)
Synchronization ..... Rising edge on-time (Leading edge)

Accuracy Error
- Time Locked (TFOM 4) ..... < 0.3 µs with respect to UTC (< 0.1 µs at 95% probability)
- Holdover ..... < 7 µs / day at 95% probability (at ambient temperature change ≤ ±10º C)

Output Jitter
- Time Locked ..... ≤ 1 ns
- Re-sync after Holdover ..... ≤ 5 ns steps between pulses for timing error < 10 µs
  100 ns steps between pulses for timing error ≥ 10 µs, < 100 µs
  Single step correction timing error ≥ 100 µs

Output Drive
- High Level ..... ≥ +2.0 V into 50 Ω load (≥ 3.0 V open circuit)
- Low Level ..... ≤ +0.5 V into 50 Ω load

Coherency between 1 PPS outputs ..... ≤ 10 ns

Connector Type
- Part Number Suffix -01 and -11 ..... SMA male
- Part Number Suffix -02 and -12 ..... SMB male

3.5.3 Control Interface Port

A bi-directional DCE RS-232 interface port is provided for remote control and monitor of the instrument. The interface port is fixed to a baud rate of 19200, 8 data bits, 1 stop bit and no parity. FEI-Zyfer Generic RS-232 Communication Protocol Document 365-8005 describes the functions and controls available through the control port. The control interface port is accessible at the rear panel DE-9S (female) connector labeled *Cntrl* as follows:

CONTROL INTERFACE CONNECTOR PIN DESIGNATION		
PIN	SIGNAL	DESCRIPTION
1,5,9	GROUND	SIGNAL RETURN, GROUND POTENTIAL
2	OUTPUT (TXD)	RS-232 INTERFACE OUTPUT
3	INPUT (RXD)	RS-232 INTERFACE INPUT
4,8	NO CONNECTION	
6,7	AUX INPUT/OUTPUT	AUXILIARY RS-232 INPUT/OUTPUT - NOT ACTIVE

3.5.4 Time Of Day Output Port

A unidirectional serial Time of Day and Status message with RS-232 levels is provided. The Time of Day port is accessible at the rear panel DE-9S (female) connector labeled *TOD* as follows:

TIME OF DAY (TOD) CONNECTOR PIN DESIGNATION		
PIN	SIGNAL	DESCRIPTION
1,5,9	GROUND	SIGNAL RETURN, GROUND POTENTIAL
2, 3	NO CONNECTION	
4	TOD OUTPUT	RS-232 LEVEL SIGNAL TIME/STATUS/ERROR MESSAGE
6	/TIME LOCK	TIME LOCK STATUS (Open = Not Locked, Ground = Locked)
7	/ALARM	ALARM STATUS (Open = Alarm, Ground = OK)
8	SPARE INPUT (RX)	SPARE RS-232 INPUT - NOT ACTIVE

3.5.4.1 ASCII TOD Message

The ASCII TOD message is generated every second or every even second, as selected by the user. The selection is stored in non-volatile memory. The message contains the time of the previously generated 1 PPS. The message begins with an "On-Time" ASCII character "!". The rising edge of the first "On-Time" character bit is synchronized to the 1 PPS Output pulse.

3.5.4.1.1 ASCII TOD Message Signal Specifications

Port Designation	TOD
Signal Levels	RS-232 compatible
Baud Rate	9600
Data Bits	8
Stop Bits	1
Parity	None
Transmit Rate	Every second or every even second (as selected by user)
Time Tag	Previous 1 PPS
Synchronism of "On-Time" Character	< 1 ms after 1 PPS Output
Time Contents	Days through seconds
Time Mode Reference	Same as unit

3.5.4.1.2 ASCII TOD Message Structure

The structure of the Time Of Day output message is as follows:
!TIME,YYYY,DDD,HH,MM,SS,M,T,O<cr/lf>

Where: !		"On-Time" character
YYYY		Year
DDD	001 - 366	Day into the year
HH	00 - 23	Hours into the day
MM	00 - 59	Minutes into the hour
SS	00 - 59	Seconds into the minute
M	1 - 5	Time Mode, where: 1 = GPS Time 2 = UTC Time
T	4 - 9	TFOM (Time Figure Of Merit), where the Estimated Time Error (ETE) is: TFOM — ETE 4 — ≤ 1 µs 5 — > 1 µs to ≤ 10 µs 6 — > 10 µs to ≤ 100 µs 7 — > 100 µs to ≤ 1 ms 8 — > 1 ms to ≤ 10 ms 9 — > 10 ms
O	0 - 4	Operation Mode, where: 0 = Warm Up 1 = Time Locked 2 = Holdover 3 = Recovering 4 = Manual Time Set

3.5.5 Hardware Output

Two open drain hardware output signals are provided to indicate a failure and time lock status. These signals require an external pull up resistor, and are pulled to ground potential when no alarms are present, and when operating in the time lock mode. They become high impedance when there is an alarm condition, and when operating in the Holdover mode. The hardware output signals are accessible at the rear panel *TOD* connector, pin 6 and pin 7.

Circuit Type ..... Open drain TMOS FET
Pin 6 Function..... Time Locked to GPS = "On"
Holdover = "Open Circuit"
Pin 7 Function..... No Alarm = “On”
Alarm = “Open Circuit”
Internal Limiting Resistor ..... 100 Ω
Total On Resistance ..... 120 Ω
Open Circuit Voltage ..... +55 VDC maximum
Reverse Voltage ..... -2 VDC maximum

3.6 ANTENNA INTERFACE

The circuitry of the instrument’s internal GPS receiver is protected from damage if the antenna interface connector is shorted to ground for an indefinite period.

3.6.1 Optional Antenna Kit

The system requires one external antenna. Optional antenna kit (P/N 0810384) includes a 50 ft (15 m) RG-59 coaxial cable, an antenna with an internal low noise pre-amplifier, and a 1-inch pipe adapter.

Connector Type ..... TNC female
Connector Type ..... TNC female
Gain at 1575 Mhz ..... 38 dBi typical
30 dBi minimum at 90° elevation angle
Operating Temperature. ..... -40º C to +85º C
Storage Temperature. ..... -45º C to +90º C
Humidity ..... Outdoors / All-weather
Power Requirements ..... +5 VDC, +/-10% at 30 ma maximum
(Supplied by the instrument)