SECTION XIII

FREQUENCY AND TIME DEVIATION MONITOR OPTION

SECTION XIII-I - GENERAL INFORMATION

1-1   INTRODUCTION

The Frequency and Time Deviation Monitor III (FTM III) Option has been specifically designed for power utilities to aid in monitoring power line stability. When installed in a TrueTime Synchronized Clock host, this option will sample one phase of the 50 Hz or 60 Hz frequency supplied from the user's power line and provide frequency and time information on the host clock's front panel display, through the host clock's user RS-232C port, and through the FTM III Option RS-422 display driver port.

The FTM III Option provides the user with an accurate measurement of his local line frequency based on the Synchronized Clock reference frequency. The results of this measurement are reported as System Frequency and Frequency Deviation from nominal.

Additionally, by continual integration of the measured frequency error, time information is derived from the frequency measurement. From this integration, accumulated Time Deviation from nominal and System Time are calculated.

Accumulated Time Deviation represents the amount of time a clock would gain or lose if it used the measured line frequency as its timekeeping reference.

System Time represents the time that would be displayed by a clock using the line frequency as its timekeeping reference. System Time is calculated by adding Time Deviation plus a user entered constant, Time Deviation Preset, to the host clock's local time.

The beginning point of the Time Deviation calculation is when the Time Deviation Preset is initialized. Whenever a new Time Deviation Preset value is entered, the current accumulated value of Time Deviation is overwritten by the Time Deviation Preset value and the Time Deviation calculation is continued from this new value. Entering a value of zero (0) effectively resets the accumulated Time Deviation.

The FTM III is an intelligent option containing its own microprocessor. This processor allows the FTM III Option to process the incoming line frequency on a cycle by cycle basis, performing frequency comparison and calculations over single second periods continuously with no dead-time between measurements.

FTM III Option frequency and time measurements are directly traceable to UTC-USNO.

1-2   FTM III OPTION SPECIFICATIONS

1-3   INPUT

Voltage:	95 - 260 VAC
Frequency:	40 - 70 Hz
Input Connector:	MALE CEE-22 (Standard Electronic Equipment Power Connector)
Signal Conditions:	Corcom RFI Input Filter
	Line Fuse
	Varistor Protected
	2500 VAC RMS Isolation
	Transformer Coupled
Filter:	Multi-Stage Low Pass
Measurement Rate:	1 Measurement/Second

1-4   FREQUENCY DEVIATION

Range:	±9.999 Hz
Accuracy:	1 mHz
Resolution:	
Measurement	30 Hz
Display	1 mHz

1-5   TIME DEVIATION

Range:	±99.999 s
Accuracy:	1 ms
Resolution:	
Measurement	500 ns
Display	1 ms

1-6   SYSTEM FREQUENCY

Range:	40 - 70 Hz
Accuracy:	1 mHz
Resolution:	
Measurement	30 Hz
Display	1 mHz

1-7   SYSTEM TIME

System Time is defined as the user's time of day derived from the Line Frequency Under Test plus a user entered offset and is calculated as follows:

LOCAL TIME + USER ENTERED TIME DEVIATION PRESET + TIME DEVIATION

Range:	Local Time ±99.999 s
Accuracy:	1 ms + the absolute value of { (REF FREQ / FUT) -1} *1.5 e.g., at 60.05 Hz and 59.95 Hz, the accuracy is 1 ms + absolute value of {-0.833 ms} * 1.5 = 2.25 ms
Resolution:	1 ms

1-8   STANDARD USER I/O

Host Clock RS-232C
  User Port: FTM III Option Data Accessed via Function 27
Host Clock Front
  Panel Keypad: FTM Option Data Accessed via Keypad Function 27
FTM III Option Display
  Driver RS-422 PORT: Selectable Ranges (from Front Panel Keypad)
                                300 - 9600   baud rate
                                7   - 8   data bits
                                even, odd, none   parity
                                1, 2   stop bits

1-9   DATA AVAILABLE ONCE PER SECOND

System Frequency
Frequency Deviation
Time Deviation
System Time
Local Time

SECTION XIII-II - INSTALLATION

2-1   INTRODUCTION

No installation is required when the FTM III Option is purchased at the same time as the receiver. The following installation instructions apply only to an option acquired after the initial purchase of the receiver.

2-2   FIELD INSTALLATION

Supplied with this option are the following items:

1. Assembly 86-360
2. Mounting Hardware
3. Special Software

WARNING: Dangerous voltages are present which can cause electric shock that could result in severe injury or even death. **Disconnect all power before installing this option!**

The only equipment required for installation is a Phillips screwdriver and possibly an EPROM extraction tool.

Prior to installing the 86-360 Assembly, interrogate the host clock for the System Version Number "sys ver" via front panel Keypad Function 18. The version must be 012 or later for installation of the FTM III Option. If the System Version is 011 updated EPROMs must be installed into the clock prior to installation of the 86-360 FTM III Option.

If new EPROMs are required, consult the factory for EPROMs specific to your Synchronized Clock. Follow instructions included with the EPROMs for installation into the host clocks.

FTM III Option installation requires inserting the 86-360 Assembly into an empty double high option slot. Other existing options may be moved in order to gain access to two vacant slots, one above the other.

Remove the cover plate of two empty option slots and save the screws. Slide the option assembly into the guides on the side rails of the lower slot and firmly press the assembly connector into the Bus Backplane Assembly connector. Secure the option to the chassis with the previously saved screws.

The FTM-III Option hardware will be recognized and enabled by the software upon power-up. Attempting to access FTM-III Option functions from the front panel keypad without the FTM-III Option assembly installed will result in the "Function not implemented" message appearing on the front panel display.

SECTION XIII-III - OPERATION

3-1   INTRODUCTION

The Frequency and Time Deviation Monitor Option begins normal operation immediately after host clock power-up and runs continuously whether or not data is being accessed by the user. However, even though the FTM III Option starts operating on power-up, line frequency and time deviation measurements will not be in specification until the host clock has locked to its timing source.

The FTM III Option has several configurable parameters allowing the user to initialize and format the data output of both serial ports and the host clock front panel displays.

Configuration of the FTM III Option is a simple matter, described in detail in the following paragraphs. All configuration information is stored in non-volatile memory and is reloaded automatically on power-up.

After initial host clock power-up, it is suggested that the line frequency entry be checked to ensure it is set to the local line frequency. The default out-of-the-box line frequency setting is 60 Hz. The default line frequency value on subsequent power-ups will be that in use prior to the previous power-down.

A line voltage must be connected to the FTM III Male CEE-22 input connector. Refer to the input specifications for the acceptable voltage and frequency range before connecting to this input.

After the host clock has locked to its timing reference source and is in specification, it is suggested that a value of zero (0) be entered into the Time Deviation Preset to remove the time deviation accumulated during synchronization to the host clock's timing reference source.

The Frequency and Time Deviation Monitor Option can be accessed interactively via the host clock front panel keypad and RS-232C serial port.

A third transmit only Display port is available for driving multiple remote displays. This RS-422 (optionally RS-232C) serial port is located on the FTM III Option assembly and broadcasts Time Deviation, Frequency Deviation, System Frequency, Local Time and System Time to TrueTime addressable displays capable of displaying 12 or more characters.

An optional two-channel analog output is available. If ordered, this option attaches as a daughter-board to the FTM III Option and outputs Time Deviation and Frequency Deviation as analog voltages in user selectable ranges.

3-2   CONFIGURATION PARAMETERS OF THE FTM III OPTION

The following is a list of features that can be configured by the user. "Keypad" indicates the parameter may be set from the host clock's front panel keypad via Keypad Function 27. "RS-232C" indicates the parameter may be set from the host clock's user RS-232C serial port via the keypad Function 27 command.

Parameter:	Settable from:
Line Frequency	Keypad
Time Deviation Preset	Keypad, RS-232C
Front Panel Large LCD setup	Keypad
Front Panel Small LCD setup	Keypad
Display port RS-422 setup	Keypad
Display port Data Addresses	Keypad
User Serial Port Data Format	----------, RS-232C
Analog Option Range Setup (optional)	Keypad

The following paragraphs describe in detail how to configure and use the FTM III Option using the host clock front panel keypad.

3-3   KEYPAD FUNCTION 27 - THE FTM III OPTION

FTM III Keypad Function 27 has several entries in the scrolled selection list. The <up-arrow> <down-arrow> keys are used to scroll between the selections, and the <FUNC/ENTR> key is used to access the currently displayed selection (single keys are placed in <> brackets for clarity).

After accessing a particular selection, information can be entered by scrolling to a desired value via <up-arrow> <down-arrow> keys or by directly entering the desired value. The specific data entry method is dependent upon the particular selection.

If a data entry error is made on input, the <CLR> key may be used to restore the original value. Alternately, pressing the <TIME> or <STATUS> keys prior to pressing the <FUNC/ENTR> key will abort the keypad function without affecting the current entry value. Pressing the <FUNC/ENTR> key accepts the displayed data and returns operation to the FTM III scrolled selection list.

Operation of Keypad Function 27 is detailed in the following paragraphs.

Press Keypad keys <FUNC/ENTR> <2> <7> to access the FTM III Option. The front panel 2-line LCD will display the following title for approximately 2 seconds.

> Freq & Time
> Deviation Monitor

After the Introductory Title, the first selection will appear in the LCD display. The up down arrow keys can move between the list of settable parameters. The <FUNC/ENTR> key will access the displayed parameter.

The following is a list in order of appearance of the display screens with successive presses of the <up-arrow> key:

> Continue with   (Begin FTM-III Data Display)
> Current Setup
>
> Line Frequency
> Entry

Time Deviation
Entry

Front Panel
Large LCD Setup

Front Panel
Small LCD Setup

Display Port
RS-422 Setup

Display Port
Data Addr Setup

Analog Option
Range Setup

3-4   CONTINUE WITH CURRENT SETUP

If the <FUNC/ENTR> key is pressed at this time, the FTM III Option will begin displaying information using the current user configuration.

3-5   LINE FREQUENCY ENTRY

Pressing <FUNC/ENTR> at this point allows the user to scroll between 50 or 60 Hz for the Line Frequency to be measured. The selection process is performed by pressing the <up arrow> or <down arrow> until the desired frequency is displayed. At that time, pressing the <FUNC/ENTR> key selects the displayed frequency and returns to the Line Frequency Entry display.

3-6   TIME DEVIATION ENTRY

Pressing <FUNC/ENTR> at this display allows the user to input a Time Deviation Preset value. The range is +99.999 to -99.999 s. The number keys are used to enter the desired value, the <left-arrow> and <right-arrow> keys may be used to move the cursor, and the <up-arrow> and <down-arrow> keys are used to change the sign of the value. Pressing the <FUNC/ENTR> key will load the displayed Time Deviation Preset into the FTM III and reset the accumulated Time Deviation to the newly entered value. THIS FUNCTION PERFORMS A RESET OF ACCUMULATED TIME DEVIATION. If this function has been entered in error, simply press the TIME or STATUS buttons to exit the function without changing the preset value.

3-7   FRONT PANEL LARGE LCD SETUP

Pressing <FUNC/ENTR> at this display allows the user to select which data is to be displayed on the large front panel LCD display of the host clock. The three (3) selections are Time and Frequency Deviation, System Frequency, and Local Time. Scroll to display the desired data then press <FUNC/ENTR> to select.

3-8   FRONT PANEL SMALL LCD SETUP

Pressing <FUNC/ENTR> at this display allows the user to select which data is to be displayed on the two-line 32 character display of the host clock. The four (4) selections are Time and Frequency Deviation, System Frequency, Local Time and System Time. Scroll to display the desired data, then press <FUNC/ENTR> to select.

3-9   DISPLAY PORT RS-422 SETUP

Press <FUNC/ENTR> at this display to configure the FTM III RS-422 display port. The factory shipped default values are:

Baud Rate	-	9600
Data Bits	-	8
Parity	-	none
Stop Bits	-	1

The default values on subsequent power-ups will be those in use prior to the previous power-down. Using the <up-arrow> and <down-arrow> keys, scroll to the desired setting then press the <FUNC/ENTR> key to accept the currently displayed setting. When all parameters are entered, the display returns to Display Port RS-422 Setup.

NOTE: Only one stop bit is available when both 8 data bits and parity are selected.

3-10   DISPLAY PORT DATA ADDRESS SETUP

Pressing <FUNC/ENTR> at this display allows the user to set data addresses for all five (5) data values transmitted out the FTM III Display Port.

At each data value prompt, enter the desired address for that data value. A negative sign preceding the address indicates that the data value is not to be transmitted.

Disabling data transmission is a useful feature if a non-addressable display is connected to the display port. By placing a minus (-) sign in front of 4 of the 5 data value addresses, only one data value will be transmitted, thus allowing the user to select a value to be displayed on the non-addressable display.

The <up-arrow> or <down-arrow> key is used to change the sign of the address. The <left-arrow> and <right-arrow> keys may be used to move the cursor. Prior to accepting the displayed value, if the originally displayed value was the correct value, pressing the <CLR> button will restore it. Pressing the <FUNC/ENTR> button accepts the displayed value. The next data value address is then displayed until all five (5) addresses have been entered. The address range is from 0 to 255. Placing a (+) in front of the address enables the data for transmission, while placing a (-) in front of the address inhibits the data from being transmitted.

3-11   SELECT FREQUENCY 50/60

Pressing <FUNC/ENTR> at this display allows the user to select the line frequency to be measured. The <up-arrow> or <down-arrow> key is used to scroll to the desired frequency. Pressing the <FUNC/ENTR> key selects the displayed frequency.

3-12   ANALOG OPTION RANGE SETUP (OPTIONAL)

Pressing <FUNC/ENTR> at this display enables the user to change the full scale range of the Analog Option outputs without disturbing the full scale output voltage of these outputs. (Output voltage ranges are jumper selected.)

After the <FUNC/ENTR> key is pressed, the message "Set Analog ±Scale Ranges" is displayed momentarily, then the current range setting is displayed.

Scroll through the possible Full Scale Ranges by pressing the <up-arrow> <down-arrow> keys. The possible selections are:

Time Deviation ±Range	Frequency Deviation ±Range
1 s	1 Hz
5 s	1 Hz
10 s	1 Hz
1 s	5 Hz
5 s	5 Hz
10 s	5 Hz
1 s	10 Hz
5 s	10 Hz
10 s	10 Hz

When the desired range pair is displayed, press the <FUNC/ENTR> key to select the displayed values.

3-13   RS-232 USER SERIAL PORT FUNCTION 27

FTM-III Option data is accessible over the host clock's User RS-232C port via Function F27.

Available data which includes Local Time, Time Deviation, Frequency Deviation, System Frequency, and System Time can be output once per second or on demand. Additionally, the once per second data can be formatted by the user such that only selected data will be enabled for output.

The four (4) basic commands available on the serial port are listed here and explained in detail in the following paragraphs. In the following paragraphs <cr><lf> represents the carriage return and linefeed characters, and single ' and double " quotes are used to delimit character strings. The single ' and double " quotes are for text clarity and are not to be sent to the FTM-III Function 27.

To exit any FTM-III repeat mode command, such as Once Per Second output and Time On Demand Output, a <^C> (control C) character must be sent to the serial port. All other commands automatically exit after completion.

Serial Port Commands:

F27<cr><lf>	User formatted Once Per Second output.
F27FS<cr><lf>	Request user format string.
F27 FS X,X,X,X,X<cr><lf>	Set user format string.
F27 TD<cr><lf>	FTM-III data on demand output.
F27PS<cr><lf>	Request Time DeviationPreset value.
F27PS +99.999<cr><lf>	SetTime Deviation Preset value.

3-14   F27<cr><lf>   USER FORMATTED ONCE PER SECOND OUTPUT

When the string "F27<cr><lf>" is received by the host clock, the FTM-III Option begins sending user selected data at a once per second rate. The rising edge of the start bit of the last <CR> in the string is sent on time. If all information is enabled for transmission (see the "F27 FS" command for selection format details), the formatted string will be as follows:

DDD:HH:MM:SSQTsDS.thmFsU.thmSFDU.thmSTHH:MM:SS.thm<CR><LF>

e.g.,

068:12:17:55?T-01.537F+0.123SF+60.095ST12:17:53.463<CR><LF>

where:

Local Time of Day through seconds
DDD:HH:MM:SSQ TsDS.thmFsU.thmSFDU.thmSTHH:MM:SS.thm<CR><LF>
    e.g., 068:12:17:55?
Represents Local Time Day of Year through seconds with the host clock Time Quality Indicator
    appended.

Time Deviation Through milliseconds
DDD:HH:MM:SSQ**TsDS.thm**FsU.thmSFDU.thmSTHH:MM:SS.thm<CR><LF>
    e.g., T-01.537
'T' begins the accumulated Time Deviation in seconds.

Frequency Deviation through millihertz
DDD:HH:MM:SSQTsDS.thm**FsU.thm**SFDU.thmSTHH:MM:SS.thm<CR><LF>
    e.g., F+0.123
'F' begins Frequency Deviation in Hz from nominal, where a positive (+) value represents a
    frequency higher than nominal.

System Frequency through millihertz
DDD:HH:MM:SSQTsDS.thmFsU.thm**SFsDU.thm**STHH:MM:SS.thm<CR><LF>
    e.g., SF+60.095
"SF" begins the System Frequency, Hz. System frequency is measured over a 1 second
    period.

System Time through milliseconds
DDD:HH:MM:SSQTsDU.thmFsU.thmSFDU.thm**STHH:MM:SS.thm**<CR><LF>
    e.g., ST068:12:17:55.294
"ST" begins System Time, Day of Year through milliseconds. Recall that System Time
    represents the time a clock would display if the line voltage were used as its timing
    reference.

To exit F27 Once Per Second mode, transmit a <^C> (control C) character to the host clock.

3-15   F27 FS<cr><lf>   FORMAT SELECT ONCE PER SECOND DATA

The data that is transmitted once per second via the "f27<cr><lf>" command can be selected by the user. Using this command, all FTM-II and FTM-I formatted strings can be emulated.

Data transmitted out the serial port is in the following order: Local Time, Time Deviation, Frequency Deviation, System Frequency, and System Time. Each datum can be deselected for output using the format string (X,X,X,X,X). e.g.,

Local Time	Time Deviation	Frequency Deviation	System Frequency	System Time
X	,X	,X	,X	,X

Entering an "F27 FS<cr><lf>" requests the current format string in use by the FTM-III serial port. The serial port responds with the current format string. An example follows:

F27 FS<cr><lf>   user entry (requests current format)
F27 FS X,X,X,X,X<cr><lf>   FTM-III response

The X's represent data enabled for output. A format string with Local Time and System Time deselected would be:

",X,X,X,". Note the absence of X's in those positions.

To deselect all but Time Deviation and Frequency Deviation, the following command line and FTM-III Option response is as follows:

    "F27 FS ,X,X,<cr><lf>"
    "F27 OK<cr><lf>"

Note the commas are necessary placeholders and the X's are in the Time Deviation and Frequency Deviation positions.

Subsequently, when "F27<cr><lf>" is sent requesting the Once Per Second Mode, only Time Deviation and Frequency Deviation will be transmitted once per second.

    T-00.432F-0.003<cr><lf>
    T-00.432F-0.003<cr><lf>

3-16   F27PS<cr><lf>   REQUEST TIME DEVIATION PRESET VALUE

3-17   F27PS +99.999<cr><lf>   SET TIME DEVIATION PRESET VALUE

Accumulated Time Deviation can be preset to a given value in the range of +99.999 to -99.999 seconds. When executed, this command will preset the accumulated Time Deviation value to the entered value, all previously accumulated Time Deviation is lost. Example sessions follow:

    Preset accumulated Time Deviation to -1.0 seconds.
    F27 PS -1.00<cr><lf>
    OK<cr><lf>   response

    Request current Time Deviation Preset Value.
    F27 PS <cr><lf>   user entry
    F27 PS= -1.00<cr><lf>   response

    Preset accumulated Time Deviation to 0.0 seconds.
    F27 PS 0<cr><lf>   user entry
    OK<cr><lf>   response

    Preset accumulated Time Deviation to 100.0 seconds.
    F27 PS 100<cr><lf>   user entry
    ERROR 01 VALUE OUT
      OF RANGE<cr><lf>   response

3-18   F27 TD<cr><lf>   DATA ON DEMAND OUTPUT

The Data On Demand Output allows the user to request a single measurement by sending an upper case "T<cr><lf>" while in the "F27 TD" mode. Subsequent receipts of the letter T (without the carriage return linefeed combination) are responded to with the current data values.

Local Time of receipt of the 'T' to the millisecond is recorded, System Time is calculated from the recorded Local Time, and the complete FTM-III data string is transmitted back to the user. An example session follows:

F27 TD<cr><lf>

T
069:15:25:27.545QT+00.477F-0.011SF+59.989ST15:25:28.022

T
069:15:25:31.932QT+00.477F-0.013SF+59.987ST15:25:32.409

T
069:15:25:32.524QT+00.476F-0.012SF+59.988ST15:25:33.000

^C
OK<cr><lf>

The Time On Demand string contains an additional four (4) characters representing the decimal point and milliseconds of the Local Time at the time of receipt of the 'T'.

F27 TD mode is exited upon receipt of a ^C (control C) character.

3-19   RS-422 DISPLAY DRIVER OUTPUT PORT

The display driver is an RS-422 port located on the FTM-III Option rear panel. For the RS-232 Option Pin 3 is Transmit and Pin 5 is ground for the DB-9 connector. The RS-422 pinouts are as follows:

DB-9P PIN #	DATA DIRECTION	DB-25P ADAPTER SIGNAL	PIN #
1	OUT	TxD-	8
2	OUT	TxD+	3
3	IN	RxD+	2
4	IN	RxD-	20
5	--	GND	7
6	OUT	RTS-	6
7	OUT	RTS+	4
8	IN	CTS+	5
9	IN	CTS-	22

The port is a transmit only port. Transmitting characters to this port has no effect on port operation.

System Frequency, Frequency Deviation, Time Deviation, System Time, and Local Time data is transmitted once per second, with a terminating <etx> character on time with the second.

Each of the five (5) data items is preceded by a three-digit address for use by TrueTime addressable displays. These addresses can be entered via keypad Function 27 under the "Display Port Data Address Setup" selection.

The data transmitted is in a user selectable format as follows (the actual string length is too long to place on a single line of type, so it is broken into two lines here):

<stx>AAAdd.mmm<cr><lf>BBBsd.mmm<cr><lf>CCCsdd.mmm<cr><lf>
DDDHH MM SS.mmm<cr><lf>EEEDDD HH MM SS<tqf><cr><lf><etx>

AAA, BBB, CCC, DDD, and EEE represent the three-digit addresses for System Frequency, Frequency Deviation, Time Deviation, System Time, and Local Time, respectively. The lower case 's' represents the sign (±), lower case 'dd' and 'd' is the decimal portion of the value represented, and 'mmm' represents the fractional portion of the value represented.

All addresses entered with a negative value will not be transmitted out the Display Port. Thus, if a non-addressable display is to be used, setting only one address positive will cause that associated data to be transmitted alone.

Up to 10 displays may be connected to the RS-422 port in a multi-drop configuration.

3-20   OVER-RANGE CONDITIONS

If any displayed value exceeds its allowable limit, an over range condition occurs. An over range value is displayed as a sign character (+ or -) followed by 9____ where the <_> character represents a space, e.g., '+9   ' would follow +9.999 when incremented by 0.001.

3-21   ANALOG TWO CHANNEL OUTPUT OPTION

The Analog Two Channel Output Option adds a daughter-board to the FTM-III Option.

The Analog Two Channel Output Option outputs Time Deviation and Frequency Deviation in an analog format over six (6) voltage ranges selectable via three jumpers located on the 86-361 Analog Output PCB.

Referring to the 86-361 print set, Sheet 1, JP1 selects either unipolar or bipolar operation of the two analog output channels. When JP1 is installed, the outputs operate in a unipolar fashion, when removed, the outputs are bipolar.

JP2, selects the Frequency Deviation output voltage range. When installed in the JP2-1 position, the voltage range is 2.5 Vp-p, JP2-2 is 5 Vp-p, and position JP2-3 gives a 10 Vp-p range. With JP1 not installed, JP2-3 gives a -5 to +5 V range. With JP1 installed, the voltage range is 0 to +10 V.

JP3 selects the Time Deviation output voltage range, and performs identically to JP2 above.

Keypad Function 27 Analog Option Range Setup allows the user to set the full scale range of the analog outputs. The possible range selections are:

Time Deviation ± Range	Frequency Deviation ± Range
1 s	1 Hz
5 s	1 Hz
10 s	1 Hz
1 s	5 Hz
5 s	5 Hz
10 s	5 Hz
1 s	10 Hz
5 s	10 Hz
10 s	10 Hz

For example, with JP1 removed, JP2-3 and JP3-3 installed, both Time Deviation and Frequency Deviation outputs will range from -5 to +5 V.

After selecting the 10 s and 1 Hz ± range setting, +5 V on the Time Deviation output would represent +9.999 s and -5 V on the Time Deviation output would represent -9.999 Hz. Similarly, a +5 V output on the Frequency Deviation output would represent +0.999 Hz and -5 V would represent -0.999 Hz.

The Analog Option Range Setup values are stored in non-volatile memory. The default, out-of-the-box values are ±10 s and ±1 Hz.

SECTION XIII-IV - THEORY OF OPERATION

4-1   86-360 FTM III OPTION BOARD

The 86-360 board used in the FTM III option monitors incoming line frequency through its own power plug, and measures the Frequency, Frequency Deviation from nominal frequency, and accumulated Time Deviation, using the host Synchronized Clock as a reference.

The power line is connected to the board at connector P6. First it passes through transient protection circuitry consisting of fuse F1, and varistors V1 and V2. Isolation transformer T1 steps a 240 V RMS nominal input line voltage down to 12 V RMS. (When connected to a 120 V RMS line, the signal at the transformer secondary is reduced to about 6 V RMS.)

The voltage from the transformer secondary passes through voltage divider R14 and R17, with clipping for excessive transients provided by diodes D2 and D3. The quad op amp at U8 buffers and low pass filters the signal, then applies it to the comparator U9. The output of the comparator is a digital signal with the same frequency as the line, and with rising edges at the falling zero-crossing points of the original line input (ignoring phase shift through the filter).

The actual measurements are performed by 68HC11 microprocessor U6, under control of the program contained in EPROM U7. The microprocessor clock is 8 MHz, generated by PLL oscillator U2, which is locked to T-1 MHz from the backplane. The microprocessor clock drives edge capture counters in the microprocessor with a resolution of 500 ns. The microprocessor synchronizes with time from the host clock via backplane signals T-1 kHz and T-1 Hz, measures the timing of zero-crossings of the input line voltage, and counts the number of cycles in each second.

Dual port RAM U4 is used for communication between the microprocessor on the 86-360 board and the main processor in the host clock. PAL U1 decodes addresses from the backplane, and maps the dual port RAM into a section of address space of the host clock.

Soon after the beginning of every second, the microprocessor takes measurements from the prior second and passes them through a mailbox in the dual port RAM to the host clock. A program in the host clock handles the keyboard and user RS-232 interface to the FTM III and computes the Frequency, Frequency Deviation, Time Deviation, and System Time.

The computed values may be displayed on the host clock LCD displays, sent out through the user RS-232 port, or sent through the FTM III special display RS-422 port on the 86-360. In the latter case, the string to be sent is placed by the program in the host clock into a mailbox in the dual port RAM, and the 68HC11 handles sending out the characters through the 65C51 UART at U11.

The 86-360 board may be configured for either RS-422 operation with transceivers U17 and U19, or for RS-232 operation with transceivers U16 and U18. Serial port configuration information is passed from the keyboard handling code in the host clock through the dual port RAM to the microprocessor, which sets up the UART for the specified baud rate, parity, data bits, and stop bits.

4-2   86-361 ANALOG OUTPUT OPTION BOARD

The 86-361 Analog Output option board may be connected to the 86-360 FTM III board to drive strip chart recorders with data from Time Deviation and Frequency Deviation calculations. These outputs are designed to drive high impedance input loads. The calculations are performed by code in the host clock, then passed through the dual port RAM to the FTM III microprocessor, which handles updating serial DAC U13 on the 86-361 board.

The processor sends the Time Deviation value to the DAC, catching the analog value in Sample-and-Hold amp U6, then it sends the Frequency Deviation value to the DAC, catching it in Sample-and-Hold amp U7.   Alternating between the two channels is handled automatically by the FTM III microprocessor, once it has obtained the values for both channels from the main processor.

The DAC output, which varies between -3 V and +3 V, is amplified by op amp U12, with an optional offset added from reference U10 to shift it to a range of 0 V to +6 V. The output of U12 drives the two Sample-and-Hold amplifiers U6 and U7. The Sample-and-Hold outputs are amplified by op amps U8:1 and U8:2, with three gain selections available by jumpering JP2 and JP3. The gains are chosen to provide output ranges of 2.5 V, 5 V, and 10 V.

4-3   86-361-1 ISOLATED ANALOG OUTPUT OPTION BOARD

The 86-361-1 Isolated Analog Output option board isolates the ground of the analog outputs from the ground of the host clock and its ground connections. This is done by cutting the traces at R1, R3, R5, R6, R15, and R16, so that no direct connections exist between the main clock side and the isolated output side. DC to DC converter U4 generates isolated +12 V and -12 V for use on the isolated side. The Time and Frequency Deviation analog voltage is passed across the isolation line by isolation amp U5. The digital Sample-and-Hold control signals are passed across by opto-isolators U2 and U3, powered on the isolated side by regulator U9.

SECTION XIII-V - MAINTENANCE AND TROUBLESHOOTING

5-1   INTRODUCTION

This option has been designed to provide maintenance-free operation and requires no periodic servicing or calibration. There are no user serviceable components in the FTM-III Option. A qualified service technician may replace the surge protection fuse (pig-tail solder type) if it is determined to be faulty.

5-2   TROUBLESHOOTING

WARNING: Only a qualified technician should attempt troubleshooting of this option. Dangerous voltages are present which can cause electric shock that could result in severe injury or death.

Before proceeding, refer to SECTION XIII-III OPERATION for a description of normal operation and user configurations. Sometimes an apparent failure may simply be an incorrect user configuration entry (e.g., 50 Hz instead of 60 Hz).

Ensure the FTM-III Option configuration is correct.

Ensure that the line voltage to be measured is in the range of 95 - 260 VAC and that the power cord is properly seated into the AC line connector of the FTM-III Option rear panel (not the line cord used for host clock power).

Refer to SECTION VI DRAWINGS, ASSEMBLIES AND PARTS LISTS, sheets 86-360 1, 3, and 5.

If Frequency Deviation is reading "-9   " and Time Deviation is incrementing 1 second/second, then the problem might be that no line voltage signal is reaching U6 pin 41.

Turn off the power to the host clock and remove the power connector to the FTM-III Option.

Remove the lid of the host clock. Six (6) screws hold it in place.

Referring to assembly drawing 86-360 sheet 2. The lower left corner shows fuse F1. Note that the free end of the fuse is soldered into the 86-360 pcb.

Using an ohmmeter or continuity tester, test for continuity of the fuse.

If the fuse requires replacing, the FTM-III Option PCB must be removed from the host clock. Remove the FTM-III Option 4 rear panel holding screws.

To slide the pcb out, press on the rear panel and transformer T1 simultaneously until the board slides out of the host clock.

Use static sensitive component handling procedures when handling the FTM-III pcb.

Clear away the Electronic Grade RTV from the fuse ends. Remove the three screws holding the dielectric sheet protecting the A-C circuitry of the PCB and remove the sheet. De-solder and remove the fuse. CAUTION: DO NOT USE EXCESSIVE HEAT IN THE DESOLDERING PROCESS OR THE PCB MIGHT BE DAMAGED.

Place a new fuse sleeve (a piece of heat shrink tubing or spaghetti tube) onto the new fuse and solder the new fuse into place. If Electronic Grade RTV is available, apply to both ends of the fuse. CAUTION: DO NOT USE REGULAR RTV. ACETIC ACID RELEASED DURING THE CURING PROCESS OF REGULAR RTV WILL DAMAGE THE PRINTED CIRCUITS ON THE BOARD.

Clean all flux from the pcb before reassembly.

When replacing the dielectric sheet, the nuts are placed on the component side of the board. Use a nut driver to spin the nuts to tighten; do not turn the screws or the dielectric sheet might wrinkle, making it more difficult to reinstall the Option into the host clock.

Install the FTM-III Option board back into the host clock and replace the 4 rear panel retaining screws.

Replace the host clock lid and six retaining screws.

Replace the line cord into the FTM-III rear panel and re-apply power to the host clock. If Frequency Deviation is reading "-9   " and Time Deviation continues to increment 1 second/second, then the FTM-III Option assembly must be sent back to the factory for repair. If any "event" occurred coincidentally to a failure of the option, please relate the event to the factory. The information may be useful in repairing the Option, and allow for improvements in the design of the FTM-III Option.

If no information is being transmitted from the FTM-III Option display driver RS-422 Port, ensure that the baud rate, number of data bits, parity and number of stop bits is configured correctly. Refer to SECTION III "Display Port RS-422 Setup" for details.

Refer to SECTION III "RS-422 Display Driver Output Port" for pinouts and signal direction. NOTE that this is an RS-422 port, not RS-232C (unless specifically requested at time of order). The port will not transmit data unless the CTS+ line is at 0 V and the CTS- line is at +5 V; e.g., Clear To Send is true. If these lines are not connected, they are internally "pulled" to the proper voltage level, allowing the port to transmit data.

Please consult the factory for other problems, as it is not feasible to include all possible field failures in this section.