OBSERVATOIRE CANTONAL DE NEUCHATEL
BEAUREGARD 3, CORMONDRÈCHE
CH-2036, SWITZERLAND

EFOS Monitoring System
User's and Interfacing Manual

1.0 Software Version

The last release of the monitoring software is named **MONIT7** and the executable file is dated **11-4-92**.

2.0 How to Load the Software

The monitoring software runs on the **Toshiba T1000SE** portable computer that is delivered with the EFOS frequency standard as its monitoring terminal. Previously the **Toshiba T1000** model was used.

Normally the monitoring software is stored on the **Hard RAM Disc** of the Toshiba T1000SE computer. The Hard RAM Disc is accessed on volume **D:** which contains both the **MONIT7** executable file and its associated **AUTOEXEC.BAT** batch file. When the computer is switched on, the AUTOEXEC file is executed which loads and starts automatically the MONIT7 monitoring program. When the computer is switched off, the RAM memory is continuously powered as long as there is battery power and its content is not lost.

Note

On the Toshiba T1000 portable computer, a Hard RAM Disc can be created but it is destroyed as soon as the computer is switched off because the RAM memory is not continuously powered.

On this computer the software must be run from the disc in the standard DOS fashion. Another solution is to copy the monitoring software, together with the AUTOEXEC.BAT file and the DOS system on the same floppy disc. The computer is then booted using this system disc and the monitoring software is automatically loaded by the AUTOEXEC batch file.

3.0 How to Store the Software on Hard RAM Disc volume D:

If the Hard RAM Disc of volume D: doesn't exist, the monitoring software cannot run. The Hard RAM Disc is created by running the **SETUP10** program stored in **ROM volume C:**. The

program displays a menu offering the option of creating a Hard RAM Disc. This option must be selected. A capacity of **128kb** must also be selected for the Hard RAM Disc and is sufficient to store both MONIT7 and its associated AUTOEXEC.

The Hard RAM Disc must first be formatted using the following DOS command:

Format D:

The monitoring software is then copied from the floppy disc to the Hard RAM Disc volume D: by the following DOS commands:

D:

sets the directory to volume D:

Copy A: *.*

copies the content of floppy disc volume A: to the Hard RAM Disc volume D:. Of course, the monitoring floppy disc must first be inserted into the Toshiba T1000SE 3 1/2" floppy drive (volume A:).

The above initialization procedure is necessary only after a loss of battery power. Under normal circumstances the RAM memory is continuously powered and Hard RAM Disc volume D: is never erased.

4.0 Setting the Keyboard

If the Toshiba T1000SE unit has a **F**rench **S**wiss keyboard, it may be necessary to initialize also the keyboard by the DOS command

Keyb SF

5.0 Running the Monitoring Software

Normally the MONIT7 program is started automatically at switch- on by the AUTOEXEC batch file. If the program was previously stopped, it can be started again from the volume **D:** by typing the program name **MONIT7** followed by the **Return** key. Once the MONIT7 program is started, the main menu window appears on the screen. The title **MONITOR MASER** is displayed on the upper left corner. The main menu is as follows.

F1:	MONITOR	**D:**	DATA	**F10:** END
F2:	RECORD	**F:**	FREQUENCY	

Function Key **F1**   Stops the continuous sampling and display of the 34 monitoring channels.

```
Function Key F2          Calls the menu with record functions


Function key F10         Stops the MONIT7 program and produces
                         the DOS prompt.

Alpha Key D              Starts the continuous sampling and
                         display of the 34 monitoring channels.

Alpha Key F              Calls the synthesizer control display
                         window.
```

Once the function key F2 in the main menu is pressed, the menu window with the record functions appears on the screen. The title **RECORD PARAMETERS** is displayed on the upper left corner. The record menu is as follows.

```
Numeric Key 1            START RECORD
                         Enables the recording process.

Numeric Key 2            STOP RECORD
                         Disables the recording process.

Numeric Key 3            SET TIME INTERVAL
                         Sets the time interval. This is a
                         integer number of seconds. Default
                         value is 10 s. Return confirms the new
                         value. Escape restore the previous
                         value.


Numeric Key 4            SET NEW FILENAME
                         Defines the name of the record file.
                         Default value is MASER.DAT. Return
                         confirms the new value. Escape restore
                         the previous value.

Numeric Key 5            SHOW 1 RECORD
                         Diagnostic function

Numeric Key 6            SHOW RECORD
                         Starts the display single record mode.
                         In this mode the individual records
                         stored in the record file are
                         displayed. Space Bar calls the next
                         record. Escape calls back the main
                         menu.
```

5.1 Note About the Use of Record Floppy Discs

Once the MONIT7 program is started, the excutable program is loaded in memory and the program disc may be removed.

The record floppy disc must be inserted in the driver before
calling the record menu. The available disc space displayed in
the record menu window is valid only for the disc that was
present in the driver at the time the record menu is called.

The **record interval** and the **record file name** must be specified
first. Pressing the **numeric key 1** only enables the recording
process. It is necessary to press the **Escape** key in order to
go back to the main menu and then to press the alpha key **D** in
order to actually start the recording process. It is only then
that the program either creates a new record file of the
specified name, if it does not already exists, or appends the
new data to the existing file.

The 34 monitoring channels are as follows:

Title	*Meaning*
U (input A) [V]	Voltage dc input connector A
I (input A) [A]	Current dc input connector A
U (input B) [V]	Voltage dc input connector B
I (input B) [A]	Current dc input connector B
T(source) [C°]	Temperature of dissociator
Set H press. [V]	Desired hydrogen pressure
Read H press. [V]	Measured pressure on pirani gauge
Palladium heat. [V]	Voltage applied on palladium valve heater
LO heat. [V]	Voltage on LO heater
UO heat. [V]	Voltage on UO heater
Dalle heat. [V]	Voltage on Dalle heater
LI heat. [V]	Voltage on LI heater
UI heat. [V]	Voltage on UI heater
Cavity heat. [V]	Voltage on microwave cavity heater
T (cavity) [C°]	Temperature of cavity relative to nominal
T(ambient) [C°]	Ambient temperature
Cavity var. [V]	Voltage on cavity varactor freq. control
C field [µA]	DC current in C-field coil
int. N°2 HT U [kV]	Voltage of internal ion pump N°2
int. N°2 HT I [µA]	Current of internal ion pump N°2
int. N°1 HT U [kV]	Voltage of internal ion pump N°1
int. N°1 HT I [µA]	Current of internal ion pump N°1
ext. HT U [kV]	Voltage of external ion pump
ext HT I [µA]	Current of external ion pump
RF U [V]	Voltage of RF oscillator DC power supply
RF I [A]	Current of RF oscillator DC power supply

+24 VDC [V]	Voltage of +24 V DC to DC converter
+15 VDC [V]	Voltage of +15 V DC to DC converter
-15 VDC [V]	Voltage of -15 V DC to DC converter
+5 VDC [V]	Voltage of +5 V DC to DC converter
+15 VDC [V]	Voltage of +15 V DC to DC converter
-15 VDC [V]	Voltage of -15 V DC to DC converter
OCXO var. [V]	PLL error signal on OCXO varactor control
Ampl. 5.7 kHz [V]	Amplitude of maser signal at 5.7 kHz
Lock	PLL lock flag, 1 = lock, 0 = unlock

The monitor display window also shows the synthesizer absolute frequency and the associated relative frequency offset. See next section.

6.0 Theoretical Background of Synthesizer Action

The synthesizer control enables to fine tune the frequency of the maser 5 MHz reference output with respect to a primary standard.

The action of the synthesizer setting on the maser output frequency is as follows. The output of the synthesizer is phase compared with the maser signal that comes out from the 5.7 kHz last IF stage in the maser coherent receiver. The PLL error signal is applied to the 5 MHz OCXO frequency control varactor and, in the lock condition, forces the last IF frequency to be exactly equal to the synthesizer frequency.

The first IF frequency in the coherent receiver is at 19.594 MHz using a 1440 MHz local oscillator derived from the 5 MHz reference OCXO.

$$IF_1 = 288\ \nu_{ref} - \nu_0$$

ν_{ref} is the frequency of the reference 5 MHz OCXO and ν_0 the frequency of the maser signal which nominal value is 1420'405'751 Hz.

The second IF frequency is 405 kHz using a 20 MHz local oscillator derived from the 5 MHz reference OCXO.

$$IF_2 = 4\ \nu_{ref} - IF_1$$

The third IF frequency is 5'751 Hz using a 400 kHz local oscillator derived from the 5 MHz reference OCXO.

$$IF_3 = IF_2 - \frac{2}{25}\ \nu_{ref}$$

Under the PLL lock condition we have

$$\nu_{synth} = IF_3 = \nu_0 - \left(288 - 4 + \frac{2}{25}\right)\nu_{ref}$$

The OCXO reference output frequency of the maser is therefore

$$\nu_{ref} = \frac{\nu_0 - \nu_{synth}}{288 - 4 + \frac{2}{25}}$$

An offset of +1 Hz of the 5.7 kHz synthesizer frequency produces an offset of -3.521 mHz of the maser signal at 1'420'405'751 Hz. Therefore the relative frequency offset _y of the 5 MHz maser reference output produced by an offset ν_{synth} of the synthesizer is

$$y = \frac{\nu_{ref}\ [Hz]}{5\ MHz} = \frac{-\ \nu_{synth}\ [Hz]}{1420'405'751\ Hz}$$

7.0 Programming the Synthesizer

The synthesizer has 7 programmable digits

57xx.xxxxx Hz.

The hardware reset frequency of the microprocessor controller on the synthesizer card is

5'751.68900 Hz.

The nominal frequency of the MONIT7 software is

5'751.68930 Hz.

The relative offset _y displayed by MONIT7 is -211×10^{-15} when the synthesizer frequency is set at the synthesizer hardware reset setting of 5'751.68900 Hz. The displayed offset _y is 0 for the nominal synthesizer frequency 5'751.68930 Hz.

The smallest frequency step that can be programmed, i.e. the **resolution** determined by the synthesizer least significant programmable digit, is

$$\nu_{synth} = 10^{-5}\ \mathbf{Hz}$$

which is equivalent to

$$\_y = \mathbf{7x10^{-15}}.$$

The synthesizer control window is called by pressing key **F**. Both the absolute synthesizer frequency and the relative frequency offset _y are displayed. However it is the absolute frequency that can be programmed.

The synthesizer frequency can be modified as follows:

1) The digit to be modified is selected using the horizontal arrow cursor keys **->** and **<-** on the keyboard. The blinking underline cursor _ indicates the selected digit.

2) The selected digit is modified by entering a new digit using the keyboard.

3) Every time a new digit is entered, the new relative frequency offset _y is automatically computed and displayed.

4) The new synthesizer frequency becomes effective **only** if the **RETURN** key is pressed.

5) Pressing the **ESCAPE** key dismisses the synthesizer control display window.

6) Note that if the ESCAPE key is pressed without first pressing the ENTER key, then the program goes back to the monitoring display window without changing the original setting of the synthesizer frequency.

8.0 Serial Interface on the Monitoring Card Front Panel

There are 2 DB9 male connectors on the front panel of the monitoring card. The latter is found at the upper right of the 19" electronics rack of the EFOS maser.

The monitoring card can interface the EFOS maser monitoring system with 2 computers simultaneously.

The interface is a standard RS232 serial interface. The interface chip is a MAX233. The MAX233 output uses standard [-12V, +12V] RS232 signal levels. The voltage comparator at the input of the MAX233 is set at +2 V. Therefore it is compatible with [0, 5V], [-5V, +5V] and [-12V, +12V] input RS232 signal levels.

The pin-out of the male DB9 connector is shown below.

DB9 Connector on EFOS maser RS232 serial interface

Pin N°	Signal
2	Transmit RS232
3	Receive RS232
5	GND RS232
1	+15 V for optical fiber translator

Caution

The + 15 VDC power connection on pin #1 does not comply to the RS232 standard. This voltage is there to power the Olink optical fiber translator only.

A 3 wire serial connection between the monitoring card and a computer is not recommended because it can produce ground loop problems. If a 3 wire serial connection is used despite our recommendation, care must be taken so that the + 15 VDC pin is not wired. Otherwise the serial interface on the computer side can be damaged.

9.0 Optical Fiber to Serial Conversion

The RS232 serial to optical fiber translator modules delivered with the EFOS maser are **OLINK APF-11TR25** modules manufactured by KONTINITRO. One module is required at each end of the duplex optical fiber cable with HP standard optical fiber connectors. The exact type of the optical duplex connector is **HFBR 4506.**

The **OLINK APF-11TR25** can be powered by a +12 V "signal" RS232 level (300 _, ± 10 mA) using pins #4 or #20 of the DB25 connector. It can also be powered by a +12 VDC power supply using pin #9.

Either a +12 VDC "signal" or a +12 VDC power supply voltage is present on the serial interface of most computers. If these voltages are not present, an external power supply can be used.

Caution

Note that the old **OLINK APF-11TR25** module uses [0, +5V] RS232 signal levels at the output. These levels are compatible with many RS232 line receivers but do not comply to the true RS232 standard. The new model **OLINK APF-11TR25F** uses [-5V, +5V] signal levels and is compatible with all RS232 line receivers. The EFOS maser monitoring card is compatible with both models as well as the Toshiba **T1000** and **T1000SE** computers.

DB25 Connector on OLINK APF-11TR25 Module

Pin N°	Signal
2	Transmit RS232 of serial device

3	Receive RS232 of serial device
7	GND RS232
4	RTS +12 V "signal" DC power input
20	DTR +12 V "signal" DC power input
9	+12 V DC power supply input (+15 V from maser monitoring card is ok)
10	-12 V DC power supply input for long optical link > 50 m

10.0 Serial connection to the Toshiba T1000SE Computer

The serial connection to the Toshiba computer is as follows. Connection to the Toshiba T1000 is the same.

DB9 Connector on Toshiba T1000SE serial interface

Pin N°	Signal
2	Receive RS232
3	Transmit RS232
5	GND RS232
4	DTR

Note
The DTR line is configured by software to a + 10 V "signal" level and is used to power the Olink APF-11TR25 Module through the #9 pin on the DB25 connector.

11.0 Communication Protocol for Reading the Monitoring Channels

The EFOS monitoring card RS232 serial interface uses the following parameters:

RS232 parameters

9600 baud
8 bits data
1 stop bit
no parity

The 34 analog monitoring channels and the lock flag are read as follows:

1) The character **D** is transmitted from the computer to the monitoring card, immediately followed by the **2 decimal digits** of the address of the selected channel.

2) The monitoring card sends back to the computer each received character as an echo. The computer must wait for each echo character before sending the next character. The timeout of the computer must be set to 2 seconds.

3) After receiving and echoing the 3 characters of the reading command, the monitoring card executes the analog to digital conversion for the selected channel and then transmits the **2 hexadecimal digits** of the reading followed by a **return** and a **linefeed** characters.

4) The hexadecimal reading is finally translated into an actual value using the parameters found in table below.

Address	Signed	Offset	Scale factor	Title
00	yes	0	0.230	**U (input A) [V]**
01	yes	0	0.096	**I (input A) [A]**
02	yes	0	0.230	**U (input B) [V]**
03	yes	0	0.096	**I (input B) [A]**
04	yes	−1.1	0.960	**T(source) [C°]**
05	yes	0	0.096	**Set H press. [V]**
06	yes	0	0.096	**Read H press. [V]**
07	yes	0	0.192	**Palladium heat. [V]**
08	yes	0	0.192	**LO heat. [V]**
09	yes	0	0.192	**UO heat. [V]**
10	yes	0	0.192	**Dalle heat. [V]**
11	yes	0	0.192	**LI heat. [V]**
12	yes	0	0.192	**UI heat. [V]**
13	yes	0	0.192	**Cavity heat. [V]**
14	yes	0	0.010	**T (cavity) [C°]**
15	yes	26	0.096	**T(ambient) [C°]**
16	yes	0	0.096	**Cavity var. [V]**
17	yes	0	1.920	**C field [µA]**
18	yes	0	0.048	**int. N°2 HT U [kV]**
19	yes	0	19.00	**int. N°2 HT I [µA]**
20	yes	0	0.048	**int. N°1 HT U [kV]**
21	yes	0	19.00	**int. N°1 HT I [µA]**
22	yes	0	0.048	**ext. HT U [kV]**
23	yes	0	19.00	**ext HT I [µA]**
24	yes	0	0.298	**RF U [V]**
25	yes	0	0.010	**RF I [A]**
26	yes	0	0.240	**+24 VDC [V]**
27	yes	0	0.148	**+15 VDC [V]**
28	yes	0	0.148	**-15 VDC [V]**
29	yes	0	0.048	**+5 VDC [V]**
30	yes	0	0.148	**+15 VDC [V]**
31	yes	0	0.148	**-15 VDC [V]**
32	no	0	0.078	**OCXO var. [V]**
33	no	0	0.078	**Ampl. 5.7 kHz [V]**
34	no	0	1	**Lock**

The translation operations are as follows. The original reading is a pair of hexadecimal digits.

reading := 'XX'

This must be translated into a decimal number in the range [0, 255].

reading := Decimal(reading);

If the value of the channel is "signed" then 128 must be subtracted.

IF signed = TRUE THEN reading := reading - 128;

The final value is obtained using the offset and the scale factor parameters of the channel to be found in table above.

value := reading*factor + offset;

12.0 Communication Protocol for Reading and Setting the Synthesizer

The synthesizer frequency is read and set as follows.

1) The character **F** is send by the computer to the monitoring card.

2) The monitoring card echoes back the **F** character and then transmits the **7 decimal characters** corresponding to the 7 programmable digits of the synthesizer frequency setting. The most significant digit is transmitted first. The character string is terminated by a **return** and a **linefeed** characters.

3) After this, the monitoring card is ready to receive a string of 7 decimal digits if a new frequency is to be programmed into the synthesizer card. The monitoring card stays in this state until it receives either 7 decimal digits (for programming the frequency) or a D or F characters (this would initiate the reading of a monitoring channel or another reading of the synthesizer frequency).

4) If 7 decimal digits are sent by the computer, each character is echoed back by the monitoring card. The computer must wait for the echo before sending the next character. The most significant digit is sent first.

5) After receiving the 7 decimal characters, the monitoring card programs the synthesizer card with the new frequency and, if the operation is successful, acknowledges the new setting by sending to the computer a **return** and **linefeed** characters.