FTI-10
OPERATING MANUAL
(10 Hz *Sampling Rate* version)
MAN-00007 R3

EPROM version 4.4.x

REV. 02/04/02

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SAFETY INFORMATION

The following safety instructions must be observed whenever the FTI-10 instrument is operated. Failure to comply with any of these instructions or with any precaution or warning contained in the FTI-10 Operating Manual is in direct violation of the standards of design, manufacture and intended use of the FTI-10 conditioner. FISO Technologies inc assumes no liability for the customer failure to comply with this safety requirments. This product is not designed with components of level of reliability suitable for use in life support or critical applications.

IN NO CASE WILL FISO TECHNOLOGIES INC BE LIABLE TO THE BUYER, OR TO ANY THIRD PARTIES, FOR ANY CONSEQUENTIAL DAMAGE OR INDIRECT DAMAGE WHICH IS CAUSED BY PRODUCT FAILURE, MALFUNCTION, OR ANY OTHER PROBLEM

IMPORTANT SAFETY INSTRUCTIONS

WARNING

When using any electrical appliance, basic safety precautions should be followed, including the following:

- **Use only the wall plug-in (or table top) power supply delivered with your FTI-10 instrument and verify that the voltage specifications indicated on the wall plug-in power supply are compatible with the AC voltage and frequency delivered at the power outlet**
- **Do not operate in wet/damp conditions**
- **Do not operate in an explosive atmosphere**
- **Keep product surfaces clean and dry**

DISCLAIMER

Information published in this manual is believed to be accurate and reliable. However, FISO Technologies assumes no responsibility for the use of such information. FISO Technologies reserves the right to make revisions or changes to any parts of this manual or to the software described herein at any time without obligation to notify of these changes

WARRANTY INFORMATION

FISO Technologies warrants the FTI-10 conditioner sold has been made in good workmanlike and proper manner; that it will perform according to the specifications if used in compliance with the guidelines provided; that when shipped, it will be in proper working order, free from any defects in either workmanship or material; and that, for a period of one year from the date of delivery, we will repair or replace without cost any part that may prove to be defective. This warranty does not apply to the transducers sold for use with the conditioner

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1.0 GETTING STARTED

1.1 PRODUCT AND FEATURE DESCRIPTION

The FTI-10 conditioner is a universal fiber-optic signal conditioner. It is used with FISO Technologies' fiber-optic transducers to perform Strain, Temperature, Force & Load, Displacement, and Pressure measurements in hostile locations that were formerly inaccessible with other measuring instruments. The FTI-10 conditioner has a 14-bit resolution (without averaging) with a relative dynamic range of 15 000:1. The resolution and the full-scale output depend on the type and sensitivity of the transducers used with the conditioner. Data averaging, data logging, direct and delayed acquisition, etc, are different features that come with the FTI-10 conditioner. The conditioner can be remotely controlled via a PC computer using the FISO*Commander*™ software. More details can be found in the following sections with instructions about installing and using your FTI-10 conditioner. Depending on the options you purchased with your FTI-10, you may not have access to all the functions and commands described next.

1.2 INSTALLATION

1.2.1 Installing the FTI-10

1) Connect the wall plug-in (or tabletop) power supply/battery charger to a power outlet. Connect the power cable to the FTI-10 power connector (Figure 2). The FTI-10 can be used without the power supply/battery charger. See Section 1.4.1

WARNING

VERIFY THAT THE VOLTAGE SPECIFICATIONS INDICATED ON THE WALL PLUG-IN POWER SUPPLY/BATTERY CHARGER COMPLY WITH THE AC VOLTAGE AND FREQUENCY DELIVERED AT THE POWER OUTLET.

1.2.2 Installing the transducers

1) Connect the transducer connector to the input connector of the FTI-10 (Figure 1)

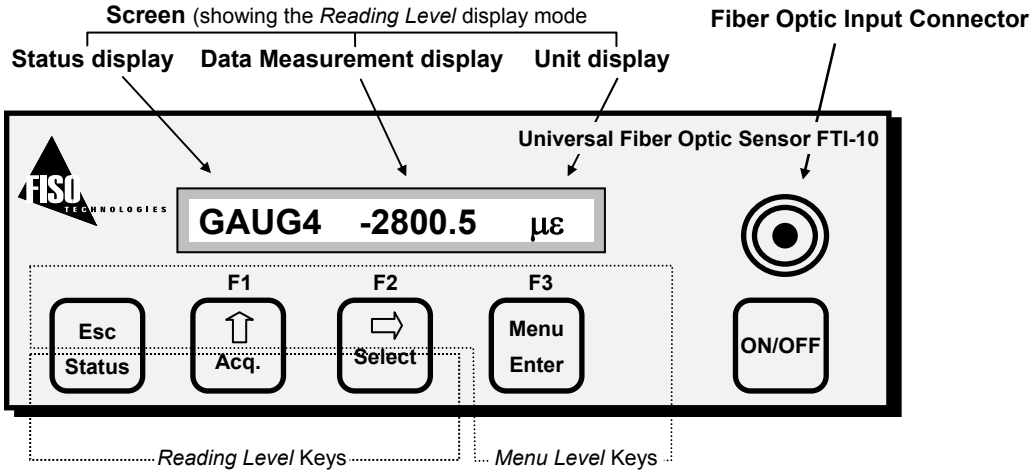
CAUTION

READ THE HANDLING PRECAUTIONS IN SECTION 1.6.1 BEFORE INSTALLING AND USING THE TRANSDUCERS FOR THE FIRST TIME

1.3 CONTROL PANEL

The front panel of the FTI-10 conditioner has a 16 characters alphanumeric liquid crystal backlight screen with 5 press-button control key pad and one fiber-optic input connector.

Figure 1: Front panel of FTI-10



The **ON/OFF** button is used to turn the conditioner ON and OFF. The use of the other buttons falls into two categories called the *Reading Level* display mode and the *Menu Level* display mode. The *Reading Level* is the default level when you turn ON the conditioner. At this level, the FTI-10 screen is divided in three different readings. The left shows the conditioner status or the acquisition status if you are proceeding to an *Acquisition Session* (Section 4.3.2). The center of the screen displays the data measurements whiles the right shows the current engineering unit of the measurements.

Using **Esc** (Status) button in the *Reading Level* display mode, one can scroll among the following conditioner status: 1) The assigned *Gauge Factor* and its associated *Gauge Name* (Section 3.1.2), 2) The analog output *Analog Scale Factor* (Section 3.3.1), and 3) The time of the conditioner; real-time clock. In addition, to display the conditioner status, one can select the H-*MAX Acquisition Mode* (Section 4.3.2.3) by scrolling until the H_MAX message appears. See also the diagram of Section 2.1 for more information.

In *Menu Level* display mode, menu functions are displayed on the screen and selected with **F1**, **F2**, or **F3** buttons. The **Esc** (Status) button is used to go one-step back in the menus or to access the *Reading Level* mode of the display. See Sections 2.0 and 3.0 for more information.

The screen back-light can be turned ON when the FTI-10 is powered ON by pressing simultaneously the **F3** button and the **ON/OFF** button. It is possible to turn the screen back-light OFF and ON while the FTI-10 is ON by pressing the **Esc** button twice (make a quick double press) at the *Display Level* mode.

1.3.1 Quick Start

Follow the instructions below to get ready for measurements with your FTI-10 conditioner:

1. **Save the *Gauge Factors* in the memory of the FTI-10**

   The *Gauge Factor* is a 7-digit number indicated near-by the fiber-optic connector of the transducer. This number provides the FTI-10 conditioner with the information related to the transducer (type, sensitivity, etc). Before using a transducer, its *Gauge Factor* must first be saved into the non-volatile RAM memory of the conditioner. See section 3.1 for more details.

   - From the *Reading Level* display mode, press the **F3** button to access the *Menu Level* display mode. Press the **F2** button to enter in the **Gauge** menu and then press **F1** to go to the **Add *Gauge Factor*** sub-menu (see also the diagram of section 2.2.2A) Use the arrow-equivalent buttons **F1** (↑↑↑) to select a digit at the insertion point and **F2** (→→→) to move the insertion point. Press **F3** to confirm your *Gauge Factor* entry.

   - Next, the conditioner prompts the user to enter a *Gauge Name*, which will be associated to the *Gauge Factor*. The *Gauge Name* is a 5-character word for mnemonic purpose only. This step is optional; pressing **F3** will skip this step and will immediately save the *Gauge Factor* (Note: the FTI-10 will automatically set a default name). Otherwise uses **F1** to select an alphanumeric character at the insertion point and **F3** to save the *Gauge Factor* and its associated *Gauge Name*.

   - Repeat the preceding steps for all the transducer that will be used with your FTI-10 conditioner in order to create the so-called *Gauge List*. This list can contain up to 50 different *Gauge Factors*. When finished, press **ESC** to return to the *Reading Level* display mode.

2. **Connect the transducer to the FTI-10**

   - If not already done, connect the transducer of your choice to the input connector of the FTI-10 conditioner.

3. **Assign the *Gauge Factor* to the measuring channel**

   To use a transducer with the FTI-10, you must first assign its *Gauge Factor* to the measuring channel in which the transducer is connected.

   - From the *Reading Level* display mode, press the **F2** button (press as many time as necessary) to scroll through the *Gauge List* and select a *Gauge Factor*. Your selection must correspond to the *Gauge Factor* of the transducer actually connected to the measuring channel.

4. **Zero adjustment of the transducer**

✓ **Go directly to the next point if you are using temperature transducer only.**

The zero adjustment, done with the aid of the **NULL** function, force the reading of the transducer to be equal to zero immediately after it is activated. The zero adjustment of the transducer is necessary when using for the first time a strain gauge, force & load, or a pressure transducer.

See section 3.1.3 for more details. The **NULL** function is available from the **Calibrate Gauge** sub-menu as described in the diagram of section 2.2.2B

- Press the **F3** button to switch to the *Menu Level* display mode. Then press **F2** (GAGE), followed by **F3** (CAL).

- Press the **F3** (NULL) button to make a zero adjustment of the transducer connected to the FTI-10 measuring channel. Note that the value of the *Gauge Zero* (section 3.1.3) will be associated to (and saved with) the *Gauge Factor* currently assigned to the measuring channel.

✓ **The zero adjustment function (NULL) is automatically disabled in case of a temperature transducer.**

5. Data measurement and various parameters

From this point, your FTI-10 conditioner is ready to display the data measurements taken with the fiber-optic transducer. For this purpose, the screen of the FTI-10 must be set to the *Reading Level* display mode. (Press the **ESC** button as many times as necessary to go back to this display mode)

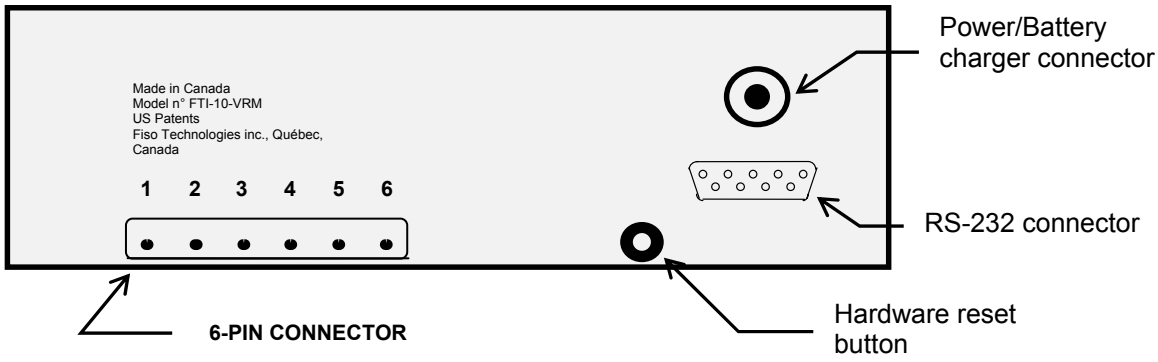
Different features of the FTI-10 conditioner allow the user to set specific parameters related to the data measurement. Among others, the *Averaging Time* parameter can be set to display an average value of the samples or data reading values collected by the transducers. See the menu diagram of section 2.2.1 as well as sections 3.2 and 4.3.2

The data measurements displayed on the screen are outputted as well through the analog output and the RS-232 serial output. For more details on these outputs, consult the diagram in section 2.2.3A as well as sections 3.3 and 4.0.

Other functions are available, for example, to set the time and date of the conditioner or to select the system of units displayed by the conditioner. Consult the menu diagram of section 2.2.3B as well as section 3.3.

1.4 BACK PANEL

The back panel of the FTI-10 conditioner comes with different connectors as described in this section.



Pin-1: Ground terminal for the voltage analog output or negative terminal for the 4-20 mA analog output

Pin-2: ± 10 Volts terminal for the voltage analog output or positive terminal for the 4-20 mA analog output

Pin-3: Reserved for future use

Pin-4: Reserved for future use

Pin-5: Ground terminal

Pin-6: Power/Battery charger terminal

Figure 2: Back panel of FTI-10

1.4.1 Power Supply/Battery charger

The FTI-10 conditioner comes with a wall plug-in or tabletop power supply/battery charger. It is used to power the conditioner and recharge the internal batteries. The FTI-10 autonomy with fully charged batteries is about 7 hours. However, the retention capacity of the batteries starts to reduce when approaching the lifetime expectancy as explained in the next paragraph. The **L.BAT** (Low Batteries) message appears in the Status Display every 2 minutes when the batteries remaining charge is below 25 %. In this case, the batteries should be recharged. The charging time is 7 hours or less. To use the power supply/battery charger, plug it into the power connector. You may also connect your own power supply/battery charger to Pin 5 and 6 of the 6-PINS Terminal. The required DC voltage is 9 V minimum and 14 V maximum with a minimum current capacity of 300 mA.

1.4.1.1 Batteries lifetime: cyclic and standby use

The battery lifetime, that is the maximum number of charge-discharge cycles before the batteries lose most of their retention capacity and must be replaced, depends of the capacity taken from the batteries. The following table gives the batteries lifetime as function of the depth of discharge of the batteries.

Depth of discharge	Number of cycles
100 %	200 to 300
50 %	800 to 1000
25 %	> 1500
0 % (standby use, always connected to the power supply/battery charger)	(4 to 5 years)

According to the above table, waiting for a complete discharge of the batteries before recharging strongly reduces the battery lifetime so it is not recommended. On the other hand, it is recommended during a long period storage of the FTI-10 to recharge the batteries once every six months in order to maintain their original capacity.

1.4.2 Analog Output

The voltage or current analog output is delivered at Pin-1 and Pin-2 of the 6-PIN connector. With the ±10 V analog output, Pin-1 is set as the ground terminal and Pin-2 is set as the ±10 V analog voltage terminal. With the loop-powered 4-20 mA analog output, Pin-1 is set as the negative terminal and Pin-2 is set as the positive terminal. In that case, the required driving voltage difference between Pin-1 and 2 is 9 V minimum and 40 V maximum and the floating potential should not exceed ± 500 Volts.

The ratio between the voltage or current variation measured at the output and the corresponding variation of the physical parameters measured by the transducer is given by the *Analog Scale Factor* (Section 3.3.1). This factor, expressed in Volts per physical unit (ex: 10 mV/ºC) or in Amperes per physical unit (ex: 100 µA/ºC), can be displayed by pressing the **Esc** (Status) Key at the *Display Level*. (See the menu diagram of Section 2.1).

The linear relationship between the analog voltage (or current) output and the measured value of the transducer depends on the type of the transducer and its own measuring range. Both the *Analog Offset* (given by the *ZERO* parameter) and the *Analog Scale Factor* (given by the *SCALE* parameter) of the analog output can be adjusted by the user or set to their defaults value. The *SCALE* and *ZERO* parameters allow the user to adjust the analog output so its ±10 V (or 4-20 mA) range fits with the full scale of the transducer measurements. These setting parameters are adjusted with the aid of the **Analog Output Setup** sub-menu functions. For more detail, consult the menu diagram of section 2.2.3A as well as section 3.3.1.

1.4.3 RS-232 Link

The FTI-10 conditioner can be remotely controlled via a PC computer (or other devices) with the aid of a RS-232 serial link. A set of *Remote Control Commands* emulates all the functions (and more) available from the front panel of the conditioner. For more detail about the remote control of the FTI-10, consult section 4.0

✓ **FISO Technologies suggests using its specially designed remote control software for the FTI-10 conditioner. This software, called the FISO*Commander*™, provides an effective and simple tool for remotely controlling your FTI-10 as well as for downloading and viewing in real-time the data measurements directly from your PC computer. Consult the FISO*Commander*™ user manual for more information.**

1.4.4 Hardware Reset Button

This button is used to reset the FTI-10 conditioner to its original configuration, as set at the factory.

✓ **For a full hardware reset, the power supply/battery charger must be connected to both a power outlet and your FTI-10 conditioner. Note that all the *Gauge Factors* of the *Gauge List* and their associated *Gauge Zero* will be erased from memory.**

1.5 MEMORY AND DATA LOGGER

The FTI-10 conditioner is equipped with a non-volatile RAM type memory where all the settings of the conditioner (*Gauge Factors*, analog output settings, etc.) are stored. Each time the FTI-10 conditioner is turned on; it is reset with the same settings that were used, just before the last time it was turned off. If for whatever reasons, the RAM memory contents has been damaged or lost, the message MEMORY LOST! will be displayed for few seconds and the conditioner will be reinitialized to its default factory settings. When this message appears, all the *Gauge Factor* and their associated *Gauge Zero* are lost. The user can reset the FTI-10 to its factory settings by using the **RST** function of the **More** sub-menu. (See the menu diagram of section 2.2.3B as well as section 3.3.3) The Hardware Reset Push Button located on the rear panel can be used as well for this purpose.

The FTI-10 conditioner has also a non-volatile memory buffer, which can store close to 50 000 data measurements. These stored data can be downloaded to a computer via the RS-232 serial link. See section 4.3.2.4 for more information.

1.6 USING THE TRANSDUCERS

1.6.1 Handling of the transducers

CAUTION

READ THE FOLLOWING PRECAUTIONS BEFORE INSTALLING AND USING THE TRANSDUCERS:

- **Avoid sharp radius turns in the fiber-optic cable (radius less than 10 mm)**
- **Temperature transducer: do not bend the rigid region at the end of the cable. The sensitive part of the transducer is located inside the rigid region, close to the tip.**
- **Strain Gauge transducer: do not touch the sensitive part of the transducer. This part must be kept clean until it is bonded.**
- **Avoid tension or twisting of the fiber-optic cable**
- **Avoid pinch points and "Scissors" when setting in place the transducers**
- **Do not pull on fiber-optic cable to clear tangles; carefully unwind instead**
- **Avoid allowing fiber-optic connectors to drop or scrape on hard surfaces**
- **Keep the surface of the fiber-optic connector clean**
- **Replace protector caps on the fiber-optic connectors when transducers are disconnected from the signal conditioner.**

1.6.2 Cleaning the transducer connectors

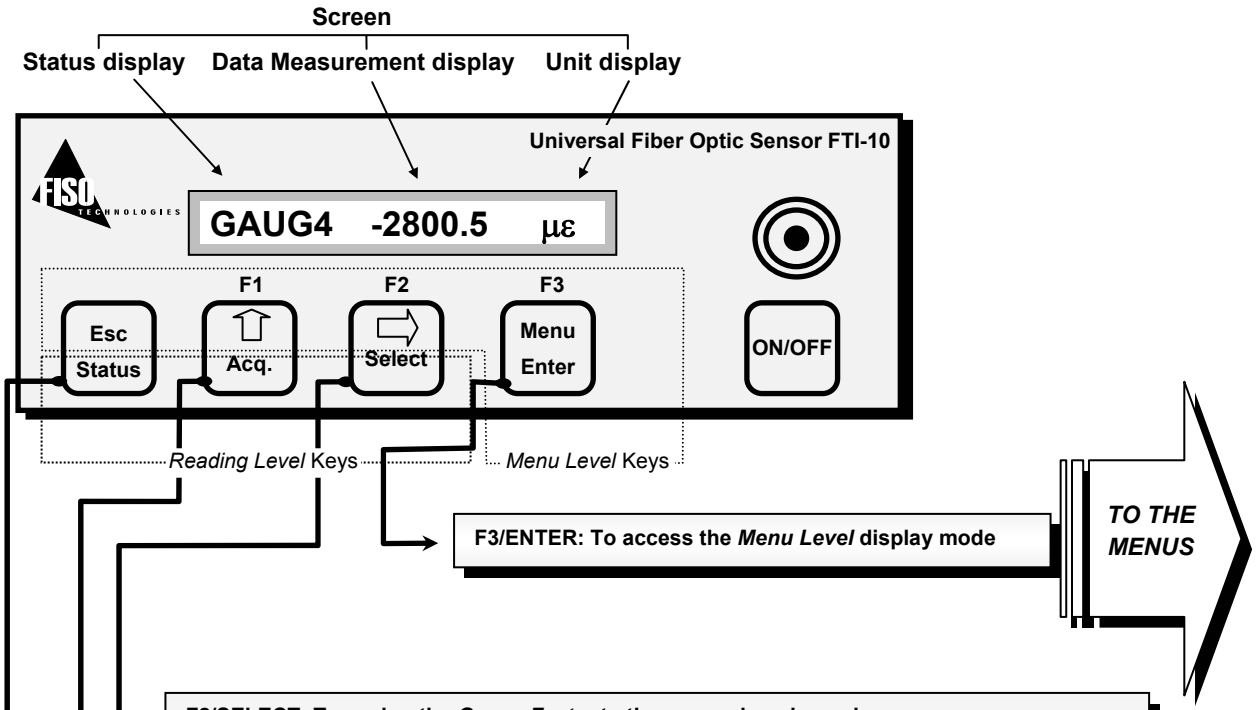
For proper use of the fiber-optic transducers, the fiber-optic connectors must be kept clean and free of dust at all times. Any dust may obstruct the light transmitted from one connector to the other, and reduce the signal-to-noise ratio to an unusable level. **IT IS A GOOD PRACTICE TO ALWAYS CLEAN THE TRANSDUCER CONNECTOR BEFORE MATING IT TO THE CONDITIONER**. Wiping the end with low lint tissue such as Kimwipes or lens cleaning tissues is a simple and easy way to clean transducer connectors. By keeping your transducer connectors clean you will also prevent the contamination of the FTI-10 input connector. However, we recommend cleaning the FTI-10 input connector occasionally. Use the specially designed 2.5-mm Mini Foam Swab provided with our cleaning kit (Part n° FTI-M) for cleaning the input connector of FTI-10.

1.6.3 Transducer Technical Notes

Additional information is available on specific fiber-optic transducers. Ask your local representative for FISO Technologies' specific Fiber-Optic Transducer Technical Note and Installation Guide such as our *Fiber-Optic Strain Gauge Installation Guide*.

2.0 CONTROL PANEL FUNCTIONS

2.1 *READING LEVEL* DISPLAY MODE



F2/SELECT: To assign the *Gauge Factor* to the measuring channel

- Press on **F2** button to assign the *Gauge Factor* to the measuring channel in which the corresponding transducer is connected. See Section 3.1.2.2 for more details

F1/ACQ: To start or stop a delayed *Acquisition Session*.

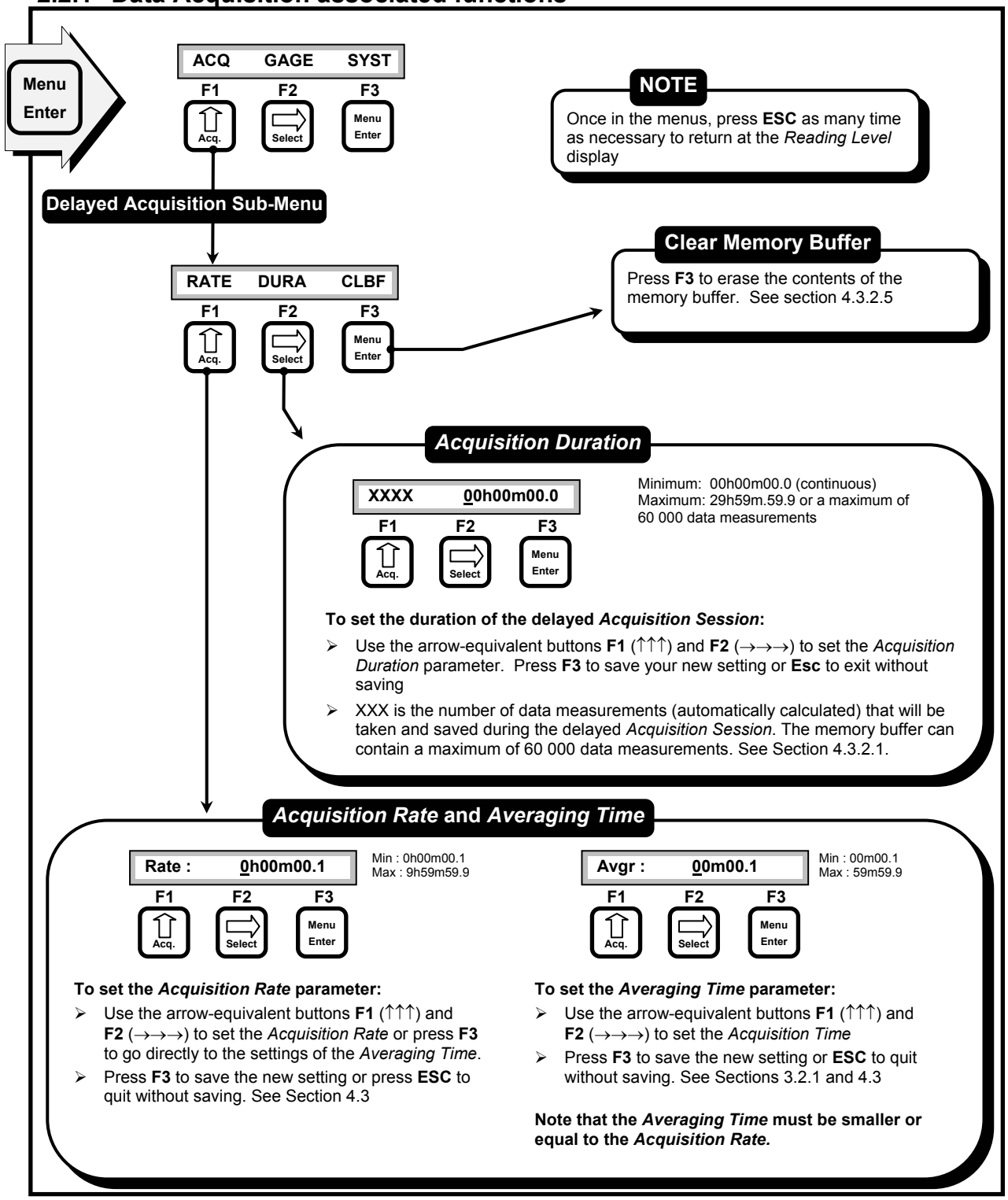
- Press once on **F1** button to start an *Acquisition Session*. Press twice on **F1** button to start the *Acquisition Programs*. Press **F1** again to stop the acquisition. See section 4.3.2 for more details.

ESC/STATUS: To display one of the conditioner status

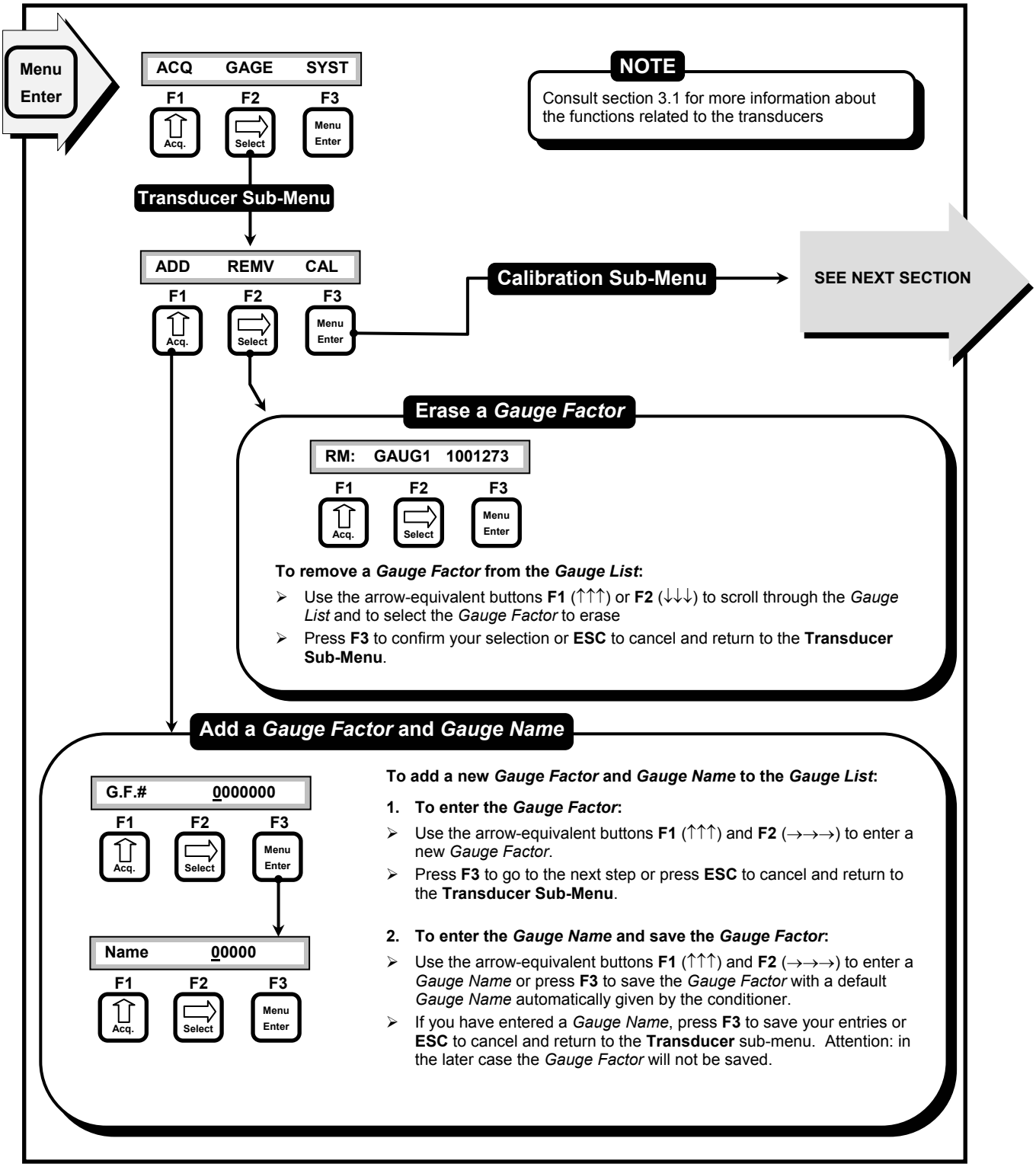
- Press the **ESC (Status)** button to scroll among the following conditioner status:
  1. Assigned *Gauge Factor* and its associated *Gauge Name*
  2. Analog output *Scale Factor*
  3. Time of the real time clock
  4. H_Max (see Section 4.3.2.3)
- Make a quick double-press on the **ESC (Status)** to turn ON or OFF the backlight

2.2 *MENU LEVEL* DISPLAY MODE

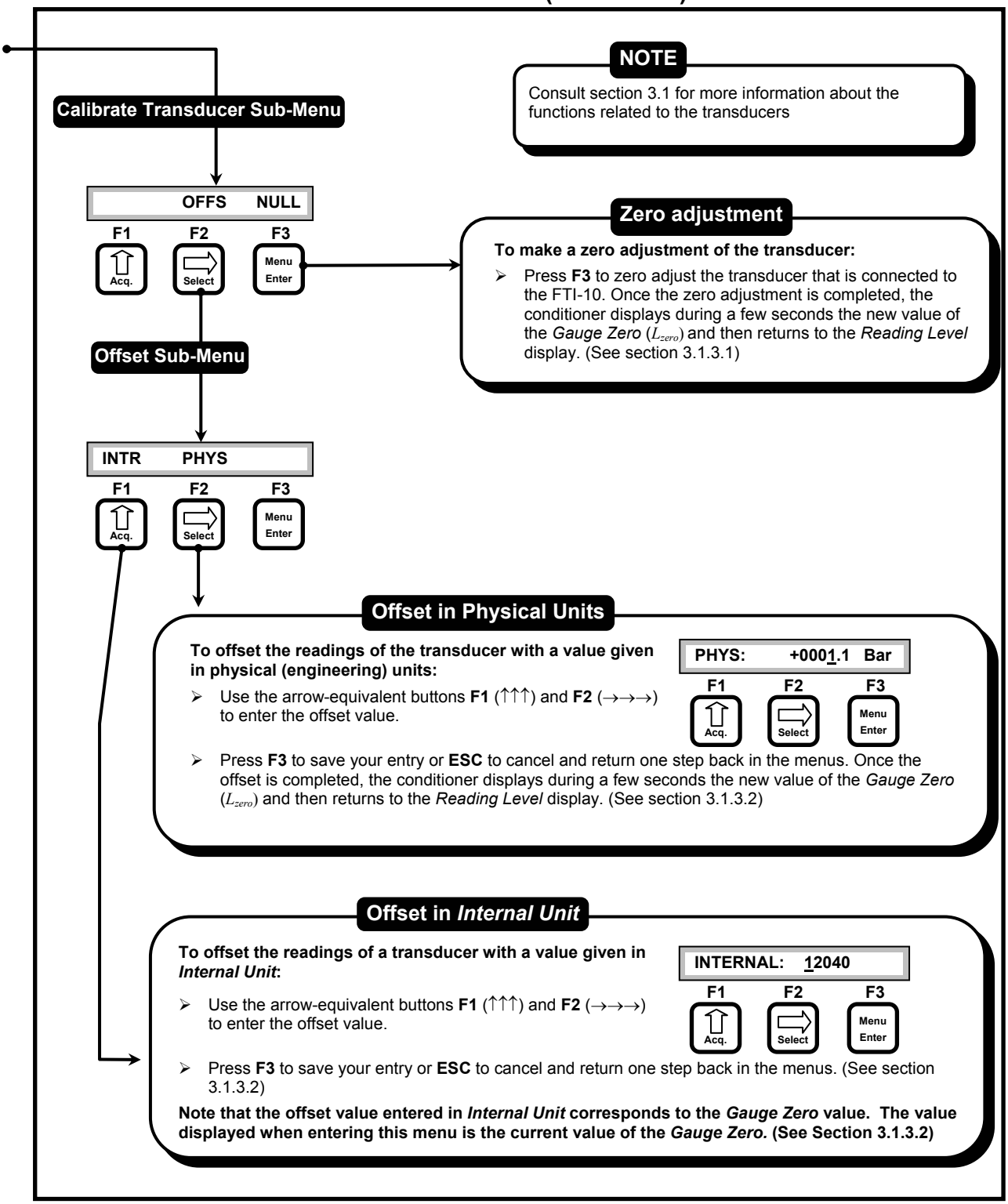
2.2.1 Data Acquisition associated functions



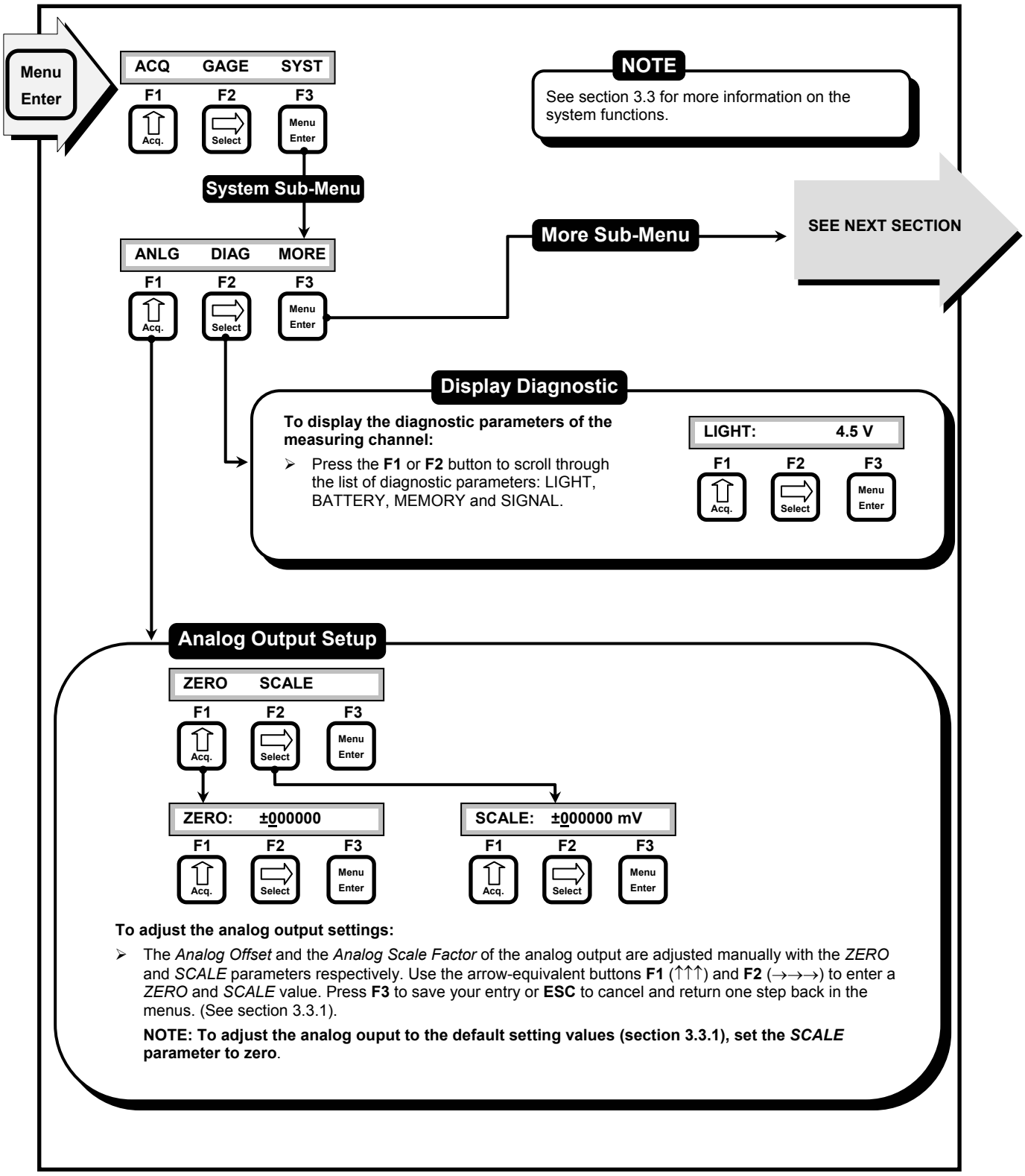
2.2.2A Transducer associated functions



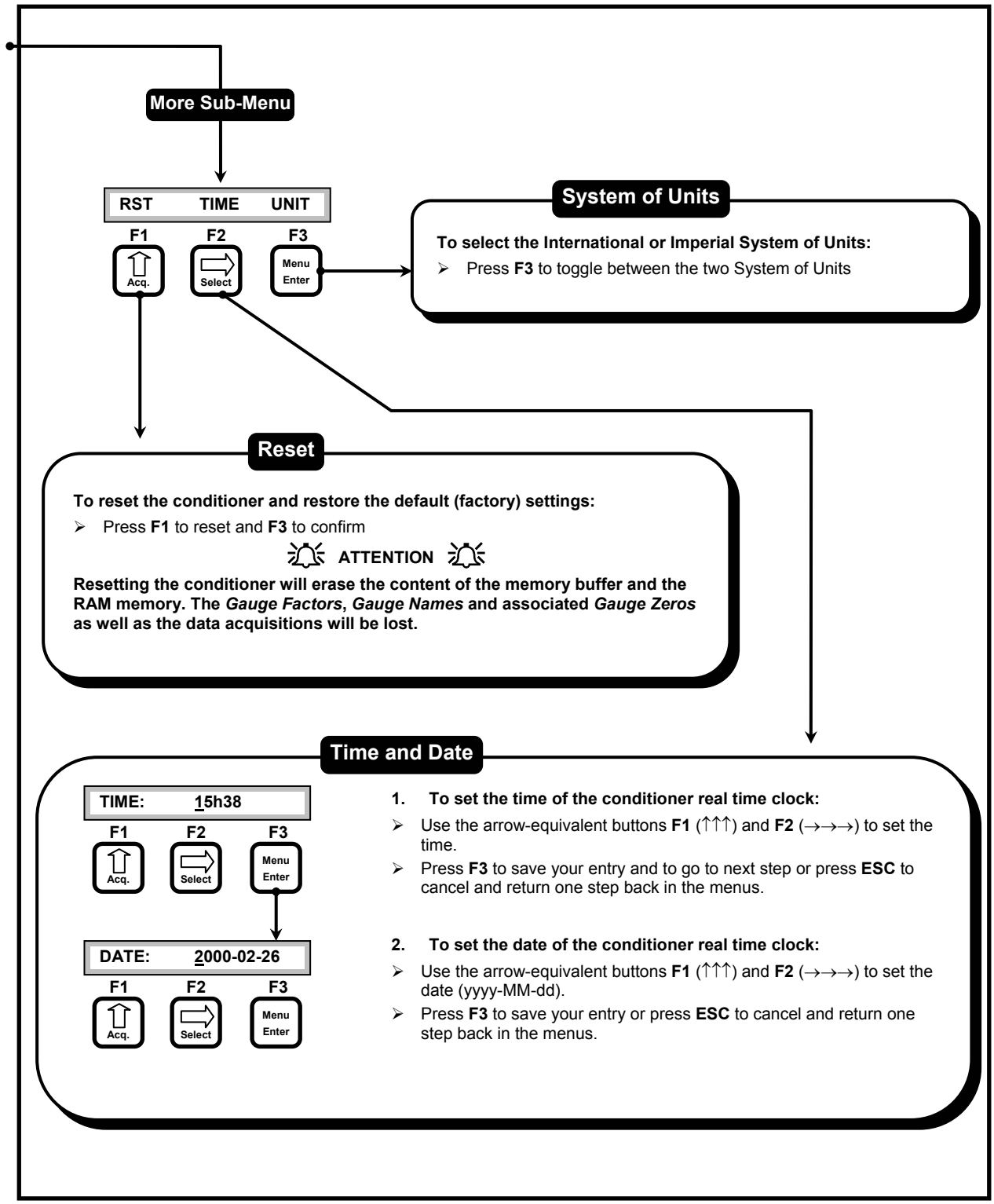
2.2.2B Transducers associated functions (calibration)



2.2.3A System associated functions



2.2.3B System associated functions (utility)



3.0 CONDITIONER ⇔ TRANSDUCERS OPERATION

3.1 TRANSDUCERS

3.1.1 Principle of operation

All the fiber-optic transducers made by FISO Technologies are of interferometric type. More specifically, the sensing element of the transducers is a miniature Fabry-Pérot interferometer. This sensing element is designed such that a stimulus (i.e. the physical parameter being measured: temperature, pressure, displacement, etc.…) produces a change in the cavity length (L_{cavity}) of the Fabry-Pérot interferometer. Therefore, the cavity length can be seen as the output signal[1] of the fiber-optic transducer. The output-stimulus relationship, which establishes the dependence between the output of the transducer, designated by L_{cavity}, and the stimulus, designated by M, is characterized by the following linear equation:

$$L_{cavity} = S \cdot M + L_{zero} \quad (1)$$

Where: *S* is the sensitivity of the transducer (in nanometers per physical unit),
and L_{zero} (*Gauge Zero*) is the output of the transducer when $M = 0$ (in nanometers).

The accurate factory-calibration of the sensitivity S and of the *Gauge Zero* (L_{zero}) provides all the necessary information to calculate, from the measurement of L_{cavity}, the true value of the stimulus M. The measure of L_{cavity} is the basic principle used in all the FISO Technologies' conditioners. The unit used to measure L_{cavity} is the nanometer — this is the *internal unit* of the conditioner used to represent the output signal of the transducer, as opposed to the physical units (ºC, Bar, etc…) used to represent the value of the stimulus.

✓ **It should be emphasized that the full scale (or the span) of the transducer output L_{cavity} does not begin at zero. In other words, FISO Technologies' fiber-optic transducers are made and delivered with an initial cavity length L_{cavity} not equal to zero.**

3.1.2 The Gauge Factor

Before using a transducer with the FTI-10 conditioner, its calibration factor, called the *Gauge Factor,* must be stored in memory and then assigned to the measuring channel of the conditioner. Up to fifty *Gauge Factors* can be stored in the non-volatile memory of the conditioner, which represent the so-called *Gauge List*. The *Gauge Factor* allows the conditioner to:

1. Identify the type of transducer connected
2. Know the sensitivity S of the transducer as determined by the factory calibration
3. Know the *Gauge Zero* (L_{zero}) of the transducer (temperature transducers only) as determined by the factory calibration.

The *Gauge List* contains a default *Gauge Factor* that is the number 0001000 (or 1000). The *Gauge Name* associated to this factor is FISO. This factor is permanently saved into the conditioner memory and cannot be erased.

[1] The physical signal measured from the fiber-optic transducer is a light signal. This light signal carries the information about the cavity length of the Fabry-Pérot interferometer.

The *Gauge Factor* is printed on a label close to the fiber-optic connector of the transducer. It is a 7-digit number where the first digit indicates the type of transducer, 0 being the default number value and is not associated with a specific type of transducer. The different numbers used to identify the transducer are listed next:

1: Is used for non-compensated strain gauge transducers
2: Is used for pressure transducers of type 1
3: Is used for force & load transducers of type 1
4: Is used for temperature transducers of type 1
5: Is used for compensated strain gauge transducers
6: Is used for pressure transducers of type 2
7: Is used for force & load transducers of type 2
8: Is used for linear displacement transducers
9: Is used for temperature transducers of type 2

In the case of force & load and pressure transducers, the second digit of the *Gauge Factor* is used to differentiate, within a transducer lot, the ones with same type and sensitivity. The third digit corresponds to a multiplying factor while the last four digits correspond to the sensitivity S of the transducer divided by the multiplying factor. It is the same for the strain gauge and the linear displacement transducer except that the last five digits correspond to the sensitivity S. In the case of the temperature transducers, the last six digits correspond to the sensitivity S and the *Gauge Zero* L_{zero}. See section 3.1.3 for more information.

3.1.2.1 To add (or remove) a *Gauge Factor* to the *Gauge List*

To add or remove a *Gauge Factor* from the *Gauge List*, simply follow the instructions given in the menu diagram of section 2.2.2A. Once you have entered a new *Gauge Factor*, the conditioner prompts you to enter a *Gauge Name* so to facilitate the identification of the corresponding transducer. You may enter a name with up to five alphanumeric characters: {0-9} {A-Z} {: ;}. If you do not want to assign yourself a *Gauge Name* just press **F3** button. The conditioner will then assign a default *Gauge Name*.

✓ **Attention: if you exit the *Gauge Name* menu with the Esc button, your new *Gauge Factor* will not be added to the *Gauge List*.**

3.1.2.2 To assign the *Gauge Factors* to the measuring channel

To use a transducer with the FTI-10, you must first assign its *Gauge Factor* to the measuring channel in which the transducer is connected.

From the *Reading Level* display mode, press **F2** button (press as many time as necessary) to scroll through the *Gauge List* and select a *Gauge Factor*. Your selection must correspond to the *Gauge Factor* of the transducer actually connected to the measuring channel. When finished, wait few seconds and the conditioner will return to the current *Reading Level* display mode.

✓ **The conditioner automatically assigns the default *Gauge Factor* "1000" and its corresponding *Gauge Name* "FISO" if no other *Gauge Factor* is assigned. Note that in that case, the conditioner displays the actual value of the output signal of the transducer that is the value of its cavity length L_{cavity}. This value is displayed in *Internal Units*, i.e. in nm. (See section 3.1.1)**

3.1.3 Calibration

As explained in section 3.1.1, FISO Technologies' fiber optic transducers are characterized by a linear relationship between the stimulus M, and the output signal produced by the transducer, that is the cavity length (L_{cavity}) of the Fabry-Pérot interferometer. The factory-calibration of the transducer is made by measuring, for a set of accurately-known values of *M*, the corresponding values of L_{cavity}. These measurements establish the calibration curve of the transducer by providing the value of the sensitivity S and the value of the *Gauge Zero* (L_{zero}). Once these two parameters are known, it is easy to assign to each measured value of L_{cavity} the corresponding value of the stimulus *M*. The conditioner uses the following equation to calculate and display the values of M as a function of the output values L_{cavity} of the transducer:

$$M\left(L_{cavity}\right) = \frac{\left(L_{cavity} - L_{zero}\right)}{S} \tag{2}$$

The factory-calibration varies depending of the type of the transducers as explained next.

Temperature Transducer: the *Gauge Factor* of the temperature transducer provides both the sensitivity S and the *Gauge Zero* (L_{zero}). Therefore, the temperature transducer is fully calibrated and ready to use.

Strain Gauge Transducer: the *Gauge Factor* of this transducer provides only the sensitivity S. The *Gauge Zero* is not included in the *Gauge Factor* because it would have no physical meaning at this point. Clearly, the *Gauge Zero* of the strain gauge transducer has, in general, a real signification only when it is installed, that is when it is bonded to the structure to be studied. At first, the FTI-10 conditioner fixes the default value of the *Gauge Zero* to zero (L_{zero} = 0 nm). However, the zero adjustment and offset functions of the conditioner allow the user to automatically define at any time a new value of the *Gauge Zero* — for example, after bonding the transducer (See sections 3.1.3.1 and 3.1.3.2).

Pressure Transducer: the *Gauge Factor* of this transducer provides only the sensitivity S. The *Gauge Zero* is not included in the *Gauge Factor* because in general these transducers are of gauge type (i.e. pressure measured relative to the ambient or atmospheric pressure). At first, the FTI-10 conditioner fixes the default value of the *Gauge Zero* to zero (L_{zero} = 0 nm). However, the zero adjustment and offset functions of the conditioner allow the user to automatically define at any time a new value of the *Gauge Zero* (See sections 3.1.3.1 and 3.1.3.2). Note that in the case of absolute pressure type of transducer, FISO Technologies provides separately a calibrated value of L_{zero}. The offset function in *Internal Unit* allows the user to enter this value and assign it to the *Gauge Factor* of that transducer. (See section 3.1.3.2).

Force & Load Transducer: the *Gauge Factor* of this transducer provides only the sensitivity S. At first, the FTI-10 conditioner fixes the default value of the *Gauge Zero* to zero (L_{zero} = 0 nm). However, the zero adjustment and offset functions of the conditioner allow the user to automatically define at any time a new value of the *Gauge Zero* (See sections 3.1.3.1 and 3.1.3.2).

Displacement Transducer: the *Gauge Factor* of this transducer provides only the sensitivity S. At first, the FTI-10 conditioner fixes the default value of the *Gauge Zero* such as to obtain 0 mm (or 0 inch) at the center position of the transducer. However, the zero adjustment and offset functions of the conditioner allow the user to automatically define at any time a new value of the *Gauge Zero* (See sections 3.1.3.1 and 3.1.3.2).

3.1.3.1 Zero adjustment of the transducer

The zero adjustment, done with the aid of the **NULL** function (see the menu diagram of section 2.2.2B), forces the data measurements of a given transducer to be equal to zero immediately after it is activated. The operating principle of this function is described next:

1. Immediately after pressing the button of the **NULL** function, the conditioner performs a measurement of L_{cavity} of the transducer.
2. Thereafter, the conditioner assigns this value of L_{cavity} to L_{zero}; that is $L_{cavity} \rightarrow L_{zero}$.
3. Next, the conditioner displays during a few seconds the new value of L_{zero} (in nm) and subsequently returns to the normal display of the data measurements. At this point, one can see that the displayed values of the data measurements are equal or close to zero. Indeed, if the value of the stimulus has not changed (or very little) since the zero adjustment, its calculated value *M* from equation 2 must be equal or close to zero knowing that $L_{cavity} \cong L_{zero}$

The zero adjustment function allows the user to specify or select the physical conditions at which the calculated value of the stimuli *M* must equal zero. It should be emphasized at this point that: 1) FISO Technologies' transducers are made and delivered with an initial cavity length L_{cavity} not equal to zero, 2) Except for temperature and displacement transducers, the default value of the *Gauge Zero* of the transducers is set to zero (L_{zero} = 0 nm). Consequently, when using for the first time the strain gauge, force & load, or pressure transducer, the conditioner will display a non-zero value of *M* even though there is no physical or real stimulus applied on the transducer (see equation 2). This situation will remain until the user redefines a new value of L_{zero}.

In the case of the strain gauge transducer, the zero adjustment is usually done after bonding the transducer to the structure. For pressure transducer of gauge type, the zero adjustment is done at atmospheric pressure or in vacuum (See next section for absolute pressure). The technical notes published by FISO Technologies for pressure and strain gauge transducers provide more information on this subject.

The principal characteristics of the zero adjustment that should be reminded are:

- ✓ **The measurement of the cavity length L_{cavity}, performed during the zero adjustment function, is done the same way as the data measurements (see section 3.2). Thus, parameters such as the *Averaging Time* will affect the results. Obviously, the value of the stimulus must be as stable as possible during the measurement of L_{cavity} in order to make an accurate zero adjustment.**
- ✓ **A new value of L_{zero} is redefined each time the zero adjustment function is activated. The new value replaces the preceding one and becomes the current value of L_{zero}. To look for the current value of L_{zero}, use the offset adjustment (OFFS) function with *Internal Unit* (see section 3.1.3.2).**
- ✓ **The zero adjustment function is transducer-specific, that is the resulting value of L_{zero} will be associated to the *Gauge Factor*, not to the measuring channel. In other words, the *Gauge Zero* is always saved with its associated *Gauge Factor*. When assigning another *Gauge Factor*, the conditioner will retrieve and use its associated *Gauge Zero*. Note that removing a *Gauge Factor* from the *Gauge List* will erase its *Gauge Zero* as well**
- ✓ **The zero adjustment function is automatically disabled in the case of a temperature transducer.**

- ✓ **The zero adjustment should be performed when the strain gauge, force & load, or gauge pressure transducers are being used for the first time (for absolute pressure, see section 3.1.3.2).**

- ✓ **It is recommended to take note of the current value L_{zero} when doing a zero adjustment. Knowing that it is possible to re-enter an arbitrary value of L_{zero}, it could be useful in the case the conditioner is reset or its memory content is lost.**

3.1.3.2 Offset adjustment of the transducer

The offset adjustment of the transducer, done with the aid of the **OFFS** function (see the menu diagram of section 2.2.2B), forces the data measurements of a given transducer to be equal to an arbitrary value immediately after it is activated. The operating principle of this function differs according to the selected unit.

Offset with physical units

With this option selected, the offset value is entered in the units that correspond to the transducer actually connected to the measuring channel (For example, the value is entered in psi or Bar in the case of a pressure transducer). The offset adjustment function in physical units is the same as the zero adjustment except that the entered value can be different from zero. The entered value will thus corresponds to the data measurements displayed right after the function is activated.

1. First, one must select the **PHY** option in the **Offset** sub-menu and then enter the offset value. (See the menu diagram of section 2.2.2B) Note that the conditioner displays the current physical units as given by the *Gauge Factor* that is assigned to the selected channel. Immediately after pressing the **F3** button, the conditioner performs a measurement of L_{cavity} of the transducer.
2. Thereafter, the conditioner recalculates a new value of L_{zero} from the measured value of L_{cavity} and the offset value just entered, the later being assigned to M in equation 2. In other words, the conditioner calculates a L_{zero} value that gives a value of M equal to the offset value: $L_{zero} = L_{cavity} - (S \times offset\ value)$
3. Next, the conditioner displays during a few seconds the new value of L_{zero} (in nm) and subsequently returns to the normal display of the data measurements. At this point, one can see that the displayed values of the data measurement are equal or close to the offset value. Indeed, if the value of the stimulus has not changed (or very little) since the offset, its calculated value M from equation 2 must be equal or close to the offset value knowing that $L_{cavity} \cong L_{zero} + (S \times offset\ value)$

Offset with *Internal Unit*

With this option selected, the offset value is entered in *Internal Unit* that is in nanometers. As opposed to the zero and physical units offset adjustment functions, there is no measurement of L_{cavity} since the entered value is directly assigned to L_{zero} without any other calculation.

1. First, one must select the **INTR** option in the **Offset** sub-menu (See the menu diagram of section 2.2.2B). When entering this function, the conditioner displays the current value of L_{zero}. It is recommended at this point to take note of this value. Thereafter the user can enter a new value and press **F3** to assign the entry to L_{zero} or press **Esc** to cancel. In the later case, the current value of L_{zero} will not be modified.
2. Next, the conditioner returns to the *Reading Level* display mode. The modification of the current value of L_{zero} will affect the displayed value of the data measurements according to equation 2.

The offset adjustment with *Internal Unit* is generally used to re-enter a given value of L_{zero}, for example, when the current value of L_{zero} is accidentally erased from the conditioner memory or when the transducer is to be used with another conditioner. This function can also be used to enter a calibrated value of L_{zero}, as for absolute pressure transducers.

The principal characteristics of the offset adjustment that should be reminded are:

- ✓ **The measurement of the cavity length L_{cavity}, performed during the offset adjustment in physical units, is done the same way as the data measurements (see section 3.2). Thus, parameters such as the *Averaging Time* will affect the results. Obviously, the value of the stimulus must be as stable as possible during the measurement of L_{cavity} in order to make an accurate offset adjustment.**

- ✓ **A new value of L_{zero} is redefined each time the offset adjustment function is activated. The new value replaces the preceding one and becomes the current value of L_{zero}. To look for the current value of L_{zero}, use the *Internal Unit* option.**

- ✓ **The offset adjustment function is transducer-specific, that is the resulting value of L_{zero} will be associated to the *Gauge Factor*, not to the measuring channel. In other words, the *Gauge Zero* is always saved with its associated *Gauge Factor*. When assigning another *Gauge Factor*, the conditioner will retrieve and use its associated *Gauge Zero*. Note that removing a *Gauge Factor* from the *Gauge List* will erase its *Gauge Zero* as well.**

- ✓ **The offset adjustment function is automatically disabled in the case of a temperature transducer.**

- ✓ **The offset adjustment function with Internal Unit can be useful to enter a calibrated value of L_{zero}. This is particularly the case with absolute pressure transducers.**

3.2 DATA MEASUREMENT

3.2.1 Data sampling and averaging

The signal conditioning of FISO Technologies' fiber-optic transducers consists of the following steps.

1. The FTI-10 conditioner samples the transducer signal, connected to one of the measuring channels, at a fix *Sampling Rate* of 10 Hz. Consequently, the conditioning process of the sampled signal from the transducer generates one data reading every 1/10 or 0.1 second.

2. The data readings generated at this 10 Hz *Sampling Rate* are averaged during an adjustable period of time as set with the *Averaging Time* parameter.

3. The average value of the data readings is thereafter displayed by the conditioner – this is the **data measurement**.

The *Averaging Time* is set from the **Acquisition** sub-menu of the control panel (See the menu diagram of section 2.2.1). The minimum value of the *Averaging Time* is 0.1 second where in this case there is no averaging since the data measurement is obtained from one data reading. To calculate the number of data readings that is used to produce one data measurement, simply multiply the *Averaging Time* by 10 Hz.

3.2.2 Refreshing rate of the screen and the analog output

The *Averaging Time* directly affects the rate at which the conditioner generates the data measurements to be displayed and directed toward the analog output. The screen of the conditioner cannot be refreshed faster than once every 0.5 s (2 Hz) whatever the setting of the *Averaging Time*. Clearly, the screen is refreshed at a rate given by the *Averaging Time* or once every 0.5 second, whichever is the slowest rate.

The refreshing rate of the analog output is not limited like with the screen so it is refreshed according to the *Averaging Time*.

3.3 SYSTEM FUNCTIONS

3.3.1 Analog Output

This section contains instructions about the analog output. Depending on the type of your FTI-10, you should refer to the different sections below. If you ordered the voltage analog output, that is the most common, refer to section 3.3.1.1. If you ordered the current analog output with internal supply, refer to section 3.3.1.2.

3.3.1.1 Voltage analog output

The FTI-10 conditioner comes standard with a voltage analog output. This output has a full scale range of ± 10 Volts with a resolution of approximately 1.22 mV. The analog output is updated at the same rate of the data measurements (see Section 3.2). The user has control of both the *Analog Scale Factor* (mV per Physical Unit) and the *Analog Offset* (the value of the data measurement M at which the analog output voltage is zero). The analog output voltage is proportional to the data measurement obtained from the transducer. It is given by the following equations:

$$V_{out} = SCALE \cdot (M - ZERO) \quad \text{(Volts)} \qquad (3)$$

where: *SCALE* is the *Analog Scale Factor* in mV/Physical Units
M is the data measurement displayed by the conditioner
ZERO is the *Analog Offset*

With the aid of the functions available in the **Analog Output Setup** sub-menu (see the menu diagram of section 2.2.3A), the user can adjust the values of the *SCALE* (*Analog Scale Factor*) and *ZERO* (*Analog Offset*) parameters so to cover the entire range of the instrument. However, for highest resolution, use the highest possible *Analog Scale Factor*. The voltage range of the output can be determined by using the above equation and substituting in the highest measured value of M, and lowest measured value of M. The analog output of the signal conditioner is adjusted at the factory with default setting values which depends of the type of the transducer. (The default value of the *Analog Offset* is always zero). The following table gives the analog output default setting values for different type of transducers along with the corresponding range and resolution.

DEFAULT SETTINGS OF THE ± 10 VOLTS ANALOG OUTPUT								
Transducer type	***Analog Scale Factor (SCALE)***		***Analog Offset (ZERO)***		Range		Resolution	
	SI	Imperial	SI	Imperial	SI	Imperial	SI	Imperial
Strain	2 mV/με	2 mV/με	0 με	0 με	± 5000 με	± 5000 με	0.6 με	0.6 με
Temperature	10 mV/°C	10 mV/°F	0 °C	0 °F	± 1000 °C	± 1000 °F	0.12 °C	0.12 °F
Pressure	75 mV/bar	5 mV/psi	0 bar	0 psi	± 133 bar	± 2000 psi	0.016 bar	0.24 psi
Load	2 mV/kg	1 mV/lb	0 kg	0 lb	± 5000 kg	± 10000 lb	0.6 kg	1.22 lb
Displacement	500 mV/mm	10000 mV/in	0 mm	0 in	± 20 mm	± 1 in	2.4 μm	0.12 μ-in
Internal unit (nm)	1 mV/nm		0 nm		± 10000 nm		1.22 nm	

- ✓ **To restore the *Analog Scale Factor* and the *Analog Offset* to their default value, set the *SCALE* parameter to zero.**
- ✓ **Assigning another *Gauge Factor* from the *Gauge List* (i.e. selecting another transducer) will restore the *Analog Scale Factor* and the *Analog Offset* to their default values only if this transducer is a different type than the previously assigned one. In other words, selecting another transducer but of same type, will not change the analog output settings**

3.3.1.2 Current analog output with internal supply

This output has a range of 4 to 20 milliamps with a resolution of approximately 1 μA. The analog output is updated at the same rate of the data measurements (see Section 3.2). The user has control of both the *Analog Scale Factor* (μA per Physical Unit) and the *Analog Offset* (the value of the data measurement M at which the analog output voltage is zero). The analog output current is proportional to the data measurement obtained from the transducer. It is given by the following equations:

$$I_{out} = SCALE \cdot (M - ZERO) + 4 \quad \text{(Milliamps)} \qquad (4)$$

where: *SCALE* is the *Analog Scale Factor* in μA/Physical Units
M is the data measurement displayed by the conditioner
ZERO is the *Analog Offset*

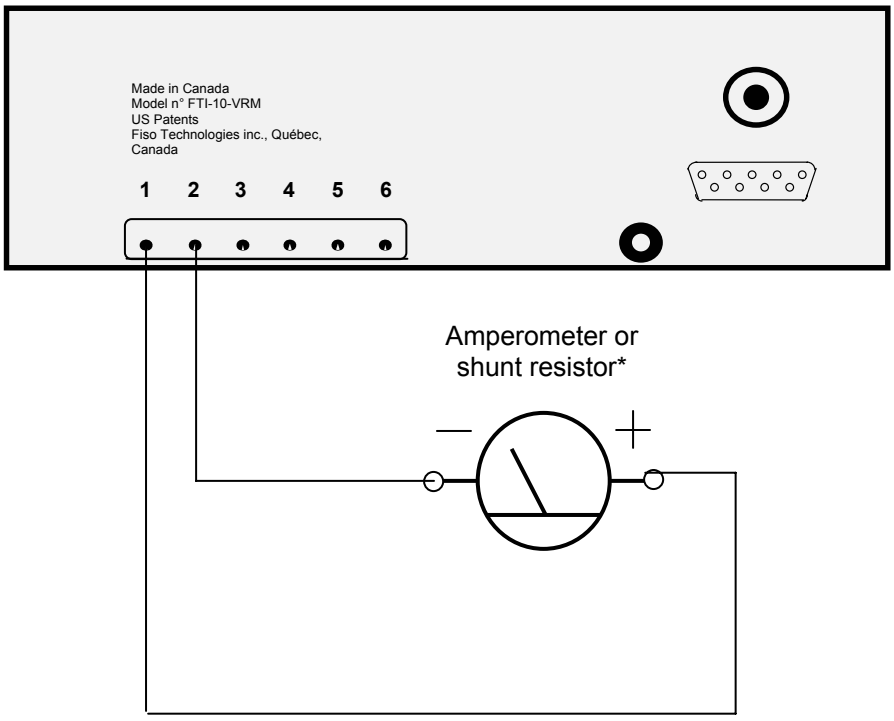
With the aid of the functions available in the **Analog Output Setup** sub-menu (see the menu diagram of section 2.2.3A), the user can adjust the values of the *SCALE* (*Analog Scale Factor*) and *ZERO* (*Analog Offset*) parameters so to cover the entire range of the instrument. However, for highest resolution, use the highest possible *Analog Scale Factor*. The current range of the output can be determined by using the above equation and substituting in the highest measured value of M, and lowest measured value of M. The analog output of the signal conditioner is adjusted at the factory with default setting values which depends of the type of the transducer. (The default value of the *Analog Offset* is always zero). The following table gives the analog output default setting values for different type of transducers along with the corresponding range and resolution.

- ✓ **Prior to use the current output, the user should double-check the application range to make sure that the *SCALE* factor setting is suitable for the application range and the sensor.**

DEFAULT SETTINGS OF THE 4-20 MILLIAMPS ANALOG OUTPUT				
Transducer type	***Analog Scale Factor (SCALE)***		***Analog Offset (ZERO)***	
	SI	Imperial	SI	Imperial
Strain Non-compensated	2 µA/µε	2 µA /µε	0 µε	0 µε
Pressure Type 1	75 µA /bar	5 µA /psi	0 bar	0 psi
Load Type 1	2 µA /kg	1 µA /lb	0 kg	0 lb
Temperature Type 1	10 µA /°C	10 µA /°F	0 °C	0 °F
Strain Compensated	1 µA/µε	1 µA /µε	0 µε	0 µε
Pressure Type 2	50 µA /bar	2 µA /psi	0 bar	0 psi
Load Type 2	2 µA /kg	1 µA /lb	0 kg	0 lb
Displacement	500 µA /mm	10000 µA /in	0 mm	0 in
Temperature Type 2	10 µA /°C	10 µA /°F	0 °C	0 °F
Internal unit (nm)	1 µA /nm		0 nm	

- ✓ **To restore the *Analog Scale Factor* and the *Analog Offset* to their default value, set the *SCALE* parameter to zero.**
- ✓ **Assigning another *Gauge Factor* from the *Gauge List* (i.e. selecting another transducer) will restore the *Analog Scale Factor* and the *Analog Offset* to their default values only if this transducer is a different type than the previously assigned one. In other words, selecting another transducer but of same type, will not change the analog output settings**

Wiring with internal supply:



*Note that the maximum loop impedance should not exceed 250 ohms.

3.3.2 Diagnostic and error messages

With the aid of the diagnostic function (**DIAG),** available from the **System** sub-menu (see menu diagram in section 2.2.3A), the user can obtain useful information for evaluating the performances of both the conditioner and the transducer. The diagnostic information is: the light intensity (in Volts), the signal (in Volts), the battery remaining capacity (%), and the memory in use (%). By comparing the diagnostic information with the following evaluation table, the user can make a diagnosis of its setup measurement.

DIAGNOSTIC:	Defective	Poor	Normal
Light	< 0.4 V	0.4 – 1.0 V	> 1.0 V
Signal	< 0.3 V	0.3 – 1.5 V	> 1.5 V
Battery	If < 25 %, batteries need to be recharged		
Memory	0 - 100 % of memory in use		

The FTI-10 conditioner has an auto-diagnosis feature that informs the user in case of defective or noisy measurement conditions. Depending of the conditions, the FTI-10 will display different messages:

MESSAGE	TYPE AND DESCRIPTION	POSSIBLE CAUSE & REMEDIES
« MEMORY LOST »	ERROR The content of the RAM memory has been erased.	✓ The RAM memory has been corrupted so the FTI-10 conditioner is automatically reset with the factory default settings. Contact factory if that problem persists.
« L.Bat »	INFORMATION Battery remaining capacity is below 25 % of its full capacity	✓ Recharge the batteries
« NO SIGNAL »	ERROR The conditioner detects a low level signal or no signal.	✓ No transducer connected to the FTI-10 or improper connection. Verify connections or clean transducer, cable, and/or FTI-10 input connector. ✓ Fiber optic extension cable is longer than the maximum length permitted. Use cable with shorter length. ✓ Cable or transducer is damaged. Replace damaged part. ✓ FTI-10 conditioner is defective. Contact factory.
« SYSTEM FAULT »	ERROR The conditioner has detected a faulty condition	✓ The FTI-10 conditioner has detected a faulty condition other than NO SIGNAL. Contact factory if that problem persists.
« SETTLING »	INFORMATION OR ERROR The conditioner is settling its electronic.	✓ This is not a defective condition if the message disappears, normally after 2 or 3 seconds. This message is displayed just after the FTI-10 conditioner is turned ON or just after a transducer is connected to the FTI-10.
« WAIT AVRG »	INFORMATION The conditioner is averaging the data readings of the transducer	✓ This message appears when the conditioner displays the first data measurement and the *Averaging Time* is greater than 2 s. Wait until the *Averaging Time* elapsed.
« WAITING FOR ACQUISITION »	INFORMATION During an *Acquisition Session*, the conditioner goes in Wait State between two successive data measurements	✓ This message appears only during a delayed *Acquisition Session*. It is displayed between two successive data measurements and when the *Acquisition Rate* is larger than 23 seconds.
« WAITING FOR STARTING TIME »	INFORMATION The programmed mode of acquisition is activated and the conditioner goes in Wait State until the activation of the *Acquisition Programs* at the preset date and time	✓ This message appears only when the programmed mode of acquisition is activated.

3.3.3 Utility functions

3.3.3.1 Reset

The **RST** function (see menu diagram of section 2.2.3B) erases the content of memory and resets the FTI-10 conditioner with its default factory settings. All the *Gauge Factors* of the *Gauge List* and associated *Gauge Zeros* as well as the acquisition data will be lost after a reset of the conditioner.

3.3.3.2 System of Units

The UNIT function (see menu diagram of section 2.2.3B) allows the user to select between the International and Imperial System of Units. When set to International System of Units (SI), the conditioner uses the following units: **°C** for temperature, **bar** for the pressure, **kg** for the force or load, **mm** for the displacement. The equivalent Imperial Units are: **°F, psi, lb, in**. The strain unit is the micro-strain $\mu\varepsilon$, that is 10^{-6} meter/meter or 10^{-6} inch/inch.

3.3.3.3 Date and Time

The **TIME** function is used to set the time and date of the conditioner real-time clock. Follow the instructions given in the menu diagram of section 2.2.3B for setting the clock.

4.0 REMOTE CONTROL & DATA ACQUISITION

The FTI-10 conditioner can be remotely controlled via a PC computer by using a RS-232 serial communication link. It can be done with the FISOCommander™ software which provides an effective and simple tool for remotely controlling your UMI as well as for downloading and viewing in real-time the data measurements directly from your PC computer. Consult the FISOCommander™ user manual for more information. Another way to remotely control the FTI-10 is with the *Remote Controls Commands*, which are already pre-programmed in the ROM memory of the FTI-10. See next sections for more information.

4.1 PRINCIPLE OF REMOTE CONTROL COMMANDS

The *Remote Controls Commands* allow the user to emulate from a PC computer all the control panel functions of the FTI-10 and more. All the *Remote Control Commands* are made of ASCII type characters, which can be sent to through the RS-232 link by using simple communication software (such as HyperTerminal on Windows 95® or Windows 98®). These commands can also be used with programs made with VISUAL BASIC, VISUAL C/C++ compilers, or with third party software such as LAB-VIEW® or LAB-WINDOWS®. With the aid of these commands, the user can create its own remote control software.

All *Remote Control Commands* begin with a two-capital letter identifier referred to as the prefix of that command. Commands without argument are composed solely of their prefix. All commands must start with a left bracket (**[**) and end with a right bracket (**]**) to be interpreted correctly. These two characters are the delimiters of a command. Everything typed inside the brackets is considered part of the command. Whenever a command must be followed by an argument, the command prefix and the argument are strung together. A command is not interpreted by the FTI-10 until the right delimiter is encountered in the incoming flow of characters. Everything between the brackets is sent back over the serial link as soon as the right delimiter is encountered. In other words, all the commands sent to the FTI-10 are echoed back to the computer. Each line of characters returned to the computer by the FTI-10 terminates with a line feed (\n) and carriage return (\r) character. Note also that each string of characters on same line is normally separated by a tab (\t) character or sometime by a space character identified by the ∨ character in this manual. Example: The command **[CB]** clears the FTI-10 memory buffer. Upon reception of the command, the FTI-10 returns the following over the serial link:

CB\n\r

The Table 1 gives the list of Remote Control Commands grouped by categories. For a complete description of each command, see Appendix A.

4.2 RS-232 SERIAL LINK

The RS-232 connection to the FTI-10 is made with the DB-9 connector located on the back panel of the conditioner. If your computer is equipped with a DB-9 serial port connector, then use a standard parallel cable for printer DB-9 to DB-9 (all wires straight through). If your computer is equipped with a DB-25 connector, use a DB-25 to DB-9 converter module with a standard parallel cable. **NOTE: do not use a null modem cable or adapter.** The serial link must be configured as follow.

BAUD RATE:	**9600**
PARITY:	**NONE**
DATA BITS:	**8**
STOP BIT:	**1**

The FTI-10 conditioner makes use of hardware flow control also called Handshaking or RTS/CTS control. When activated, the Request To Send (RTS) line of the serial link informs the FTI-10 that the UART of the host computer or controlling system is ready to exchange data. The Clear To Send (CTS) line indicates, when activated, that the FTI-10 is ready to exchange data. The RTS line corresponds to PIN 7 and the CTS corresponds to PIN 8 of the DB-9 connector.

TABLE 1 LIST OF *REMOTE CONTROL COMMANDS* (SEE APPENDIX A)

COMMAND NAME	SYNTAX
COMMUNICATION	
RS232 SHUTDOWN	**[RP**'X'**]**
DATA ACQUISITION	
ACQUISITION AVERAGE	**[TC**'mmss.s'**]**
ACQUISITION DURATION	**[DA**'hhmmss.s'**]**
ACQUISITION MODE	**[TM**'X'**]**
ACQUISITION RATE	**[SR**'hhmmss.s'**]**
ACQUISITION STATE	**[BU]**
DATA DOWNLOAD	**[DD**'XX'**]**
LIST TAG	**[LT**'X'**]**
PROGRAM# START TIME	**[SA**^X^hhmmss**]**
PROGRAM# START DATE	**[SF**^X^YYYYMMDD**]**
PROGRAM# AVERAGE	**[SD**^X^mmss.s**]**
PROGRAM# RATE	**[SC**^X^hhmmss.s**]**
PROGRAM# SHOW	**[SE**X 'D'**]**
PROGRAM# END TIME	**[SB**^X^hhmmss**]**
PROGRAM# END DATE	**[SG**^X^YYYYMMDD**]**
TRIGGER	**[TS'X']**
MEMORY	
BUFFER CLEAR	**[CB]**
SYSTEM RESET	**[RF]**
ANALOG OUTPUT	
ANALOG SCALE	**[AV**'XXXXX.XX'**]**
ANALOG ZERO	**[AZ**'XXXXX.YY'**]**

COMMAND NAME	SYNTAX
TRANSDUCER	
GAUGE ADD	**[AS**XXXXXXX**]** or **[AS**^YYYYY^XXXXXXX**]**
GAUGE ERASE	**[RS**XXXXXXX**]** or **[RS**^YYYYY**]**
GAUGE LIST	**[LG]**
GAUGE SELECT	**[GA**'XXXXXXX'**]** or **[GA**'^YYYYY'**]**
SYSTEM UNIT	**[SU**'X'**]**
ZERO DOWNLOAD	**[ZD]**
ZERO INTERNAL	**[ZP**XXXXXXXX**]**
ZERO PHYSICAL	**[ZO**XXXXX.XX**]**
MISCELLANEOUS	
DATE	**[SY**'^yyyy-MM-dd'**]**
DIAGNOSTIC REPORT	**[DR]**
SERIAL NUMBER	**[SN]**
SYSTEM OFF	**[WF]**
SYSTEM ON	**[WO]**
SYSTEM SHUTDOWN	**[WS]**
TIME	**[ST**'hhmm'**]**
VERSION DOWNLOAD	**[VR]**

Note: ^ = SPACE character
\t = TAB character
\n = LINE FEED character
\r = CARRIAGE RETURN character
\a = BELL character
Arguments within ' ' are optional

4.3 DATA ACQUISITION

4.3.1 Acquisition Modes

The FTI-10 conditioner offers different methods of making data acquisition through a selection of several *Acquisition Modes*. These modes are divided into two classes, that is the direct data acquisition and the delayed data acquisition, the later is subdivided into two other classes: data acquisition at set duration and programmable data acquisition. The direct data acquisition means that each data measurement is immediately sent to the RS-232 link of the conditioner without storage in the buffer memory. On the other hand, the data measurements taken during the delayed data acquisition (set duration or programmable) are stored into memory and must be downloaded with the **DATA DOWNLOAD [DD]** *Remote Control Command*. The *Acquisition Modes* are selected with the **ACQUISITION MODE [TM**X**]** (X=0-9) *Remote Control Command*. See Table 2 and the next sections for additional explanation on each *Acquisition Modes*.

TABLE 2: ACQUISITION MODES (See ACQUISITION MODE command in APPENDIX A)

NAME	COMMAND	DATA STORAGE	ACTIVATION / DEACTIVATION	START PARAMETER	STOP PARAMETER	OTHER SPECIFIC PARAMETERS AND FEATURES
NORMAL (Default mode)	**[TM0]**	Yes	**[TS1]/[TS0]** commands or **F1** button	None (Starts immediately after activation)	*Acquisition Duration* or deactivation	*Averaging Time* *Acquisition Rate*
SINGLE	**[TM1]**	Yes (single data)	**[TS1]/[TS0]** commands or **F1** button	None (Starts immediately after activation)	None (single data measurement)	*Averaging Time*
RS-232	**[TM2]**	No (Direct acquisition)	**[TS1]/[TS0]** commands or **F1** button	None (Starts immediately after activation)	*Acquisition Duration* or deactivation	*Averaging Time* *Acquisition Rate* "READY" string
PROGRAM/CONT	**[TM3]**	Yes	**[TS1]/[TS0]** commands or **F1** button	Starting Time (repeated every day)	Ending Time (repeated every day) or deactivation	See **PROGRAM #** commands in APPENDIX A
READY	**[TM4]**	Yes	**[TS1]/[TS0]** commands or **F1** button	None (Starts immediately after activation)	*Acquisition Duration* or deactivation	*Averaging Time* *Acquisition Rate* "READY" string
H_MAX	**[TM5]**	Yes (single data)	**[TS1]/[TS0]** commands or **F1** button	None (Starts immediately after activation)	*Acquisition Duration* or deactivation	*Averaging Time* *Acquisition Rate*
	[TM6]	RESERVED FOR MULTICHANNEL CONDITIONERS				
	[TM7]	RESERVED FOR INTERNAL USE				
	[TM8]	RESERVED FOR MULTICHANNEL CONDITIONERS				
PROGRAM/DATE	**[TM9]**	Yes	**[TS1]/[TS0]** commands or **F1** button	Starting Date and Starting Time	Ending Date and Ending Time or deactivation	See **PROGRAM #** commands in APPENDIX A

4.3.2 Delayed Data Acquisition

The FTI-10 conditioner has an integrated data logger (memory buffer) for real time storage of the data measurements. The process of making a delayed data acquisition and data storage in memory is called an *Acquisition Session.* The term "delayed" means that the data measurements are not available (i.e. ready to download to a computer) until the end of the *Acquisition Session*.

4.3.2.1 Data Acquisition at set duration

Use the **ACQUISITION MODE [TM**X**]** command to select the appropriate *Acquisition Mode* among the ones that have a set duration (see Stop parameter in Table 2). The duration of the *Acquisition Session* is adjusted with the *Acquisition Duration* parameter. Use the **ACQUISITION DURATION [DA]** command to set the value of this parameter or go at the **Acquisition** sub-menu of the control panel (See the menu diagram of section 2.2.1).

To activate the *Acquisition Session*, send the **TRIGGER [TS**1**]** command or press the **F1**/(Acq) button from the *Reading Level* display mode (See the menu diagram of section 2.1). To stop the *Acquisition Session*, press **F1** again or send the **TRIGGER [TS**0**]** command, otherwise *Acquisition Session* terminates when the elapsed time since the beginning of the session becomes equal to the *Acquisition Duration*. Note that the memory buffer cannot stores more than 60 000 data measurements — that may limit the maximum value of the *Acquisition Duration*. To use the full capacity of the memory, simply set the *Acquisition Duration* to 00h00m00.0. In that case, the *Acquisition Session* will terminate when the memory buffer is full.

The other time-based parameters of the *Acquisition Session* are the *Averaging Time* (**Avrg**) and the *Acquisition Rate* (**Rate**). These acquisition-setting parameters can be manually adjusted in the **Acquisition** sub-menu of the control panel (see the menu diagram of section 2.2.1) or with their remote control equivalent commands **ACQUISITION AVERAGE [TC]** and **ACQUISITION RATE [SR]**.

4.3.2.2 Programmable Data Acquisition

Up to five different *Acquisition Sessions* can be programmed and each one of them can be activated at a specific date and time. These programmed *Acquisition Session* are called the *Acquisition Programs*. To create an *Acquisition Program*, the user must download into the conditioner memory (from a PC computer) the program parameters: starting and ending date & time, *Averaging Time*, etc. Each *Acquisition Program* is numbered from one to five. This programmed mode of acquisition can be activated by different ways: 1) by pressing twice on the **F1** button, 2) with the **[TS**1**]** *Remote Controls Command* or, 3) with FISO Technologies' FISO*Commander* remote control software. When activated, the FTI-10 conditioner will start the *Acquisition Programs* in chronological order as given by their respective Starting Date & Time.

The user creates its own *Acquisition Programs* via the different **PROGRAM#** Remote Control Commands (see **PROGRAM#(command)** in Appendix A). An *Acquisition Program* consists of the following parameters:

1. Starting Time (0 to 23h59m59.9) — See **PROGRAM# STARTTIME** command
2. Starting Date (yyyyMMdd) — See **PROGRAM# STARTDATE** command
3. *Acquisition Rate* (0.1 to 09h59m59.9) — See **PROGRAM# RATE** command
4. *Averaging Time* (0.1 to 59m59.9) — See **PROGRAM# AVERAGE** command
5. Ending time (0.00 to 24h00m00.0) — See **PROGRAM# ENDTIME** command
6. Ending Date (yyyyMMdd) — See **PROGRAM# ENDDATE** command

An *Acquisition* Program is said enabled when its *Acquisition Rate* value is different from zero. One can disabled a given *Acquisition Program* by setting its *Acquisition Rate* to zero. To activate a set of enabled *Acquisition Programs,* first use the **ACQUISITION MODE [TM**3**]** or **[TM**9**]** command to select the appropriate programmable *Acquisition Mode*. Then send the **TRIGGER [TS**1**]** command or press twice the **F1**/(Acq) button. The FTI-10 will run the set of activated *Acquisition Programs* in chronological order as given by the Starting Time and Starting Date (TM9 mode only) of each program. In case of time and date overlap between different *Acquisition Programs*, the Starting time (or date) of a given *Acquisition Program* has priority over the Ending time (or date) of the preceding *Acquisition Program*. It means that the FTI-10 may jump to the next *Acquisition Program* while the actual *Acquisition Program* is not terminated yet.

Note: in TM3 mode, the *Acquisition Programs* are run again every 24 hours (the date is ignored) until the next **TRIGGER** command is received by the FTI-10 or until the user has pressed twice the **F1**/(Acq).

The following example show a list of the Remote Control Commands to sent to the FTI-10 for creating a TM9 *Acquisition Program*:

[SF˅2˅20001124]	Set the Starting Date of *Acquisition Program* # 2 to 2000-11-24
[SA˅2˅013000]	Set the Starting time of *Acquisition Program* # 2 to 01h30m00s
[SG˅2˅20001126]	Set the Ending Date of *Acquisition Program* # 2 to 2000-11-26
[SB˅2˅023000]	Set the Ending time of *Acquisition Program* #2 to 02h30m00s
[SC˅2˅000100.0]	Set the *Acquisition Rate* of *Acquisition Program* #2 to 1 minute
[SD˅2˅0010.0]	Set the *Averaging Time* of *Acquisition Program* #2 to 10 seconds

The listing of a given *Acquisition Program* # can be viewed with the **PROGRAM# SHOW** command. See Appendix A for more information.

4.3.2.3 H-*MAX* Acquisition

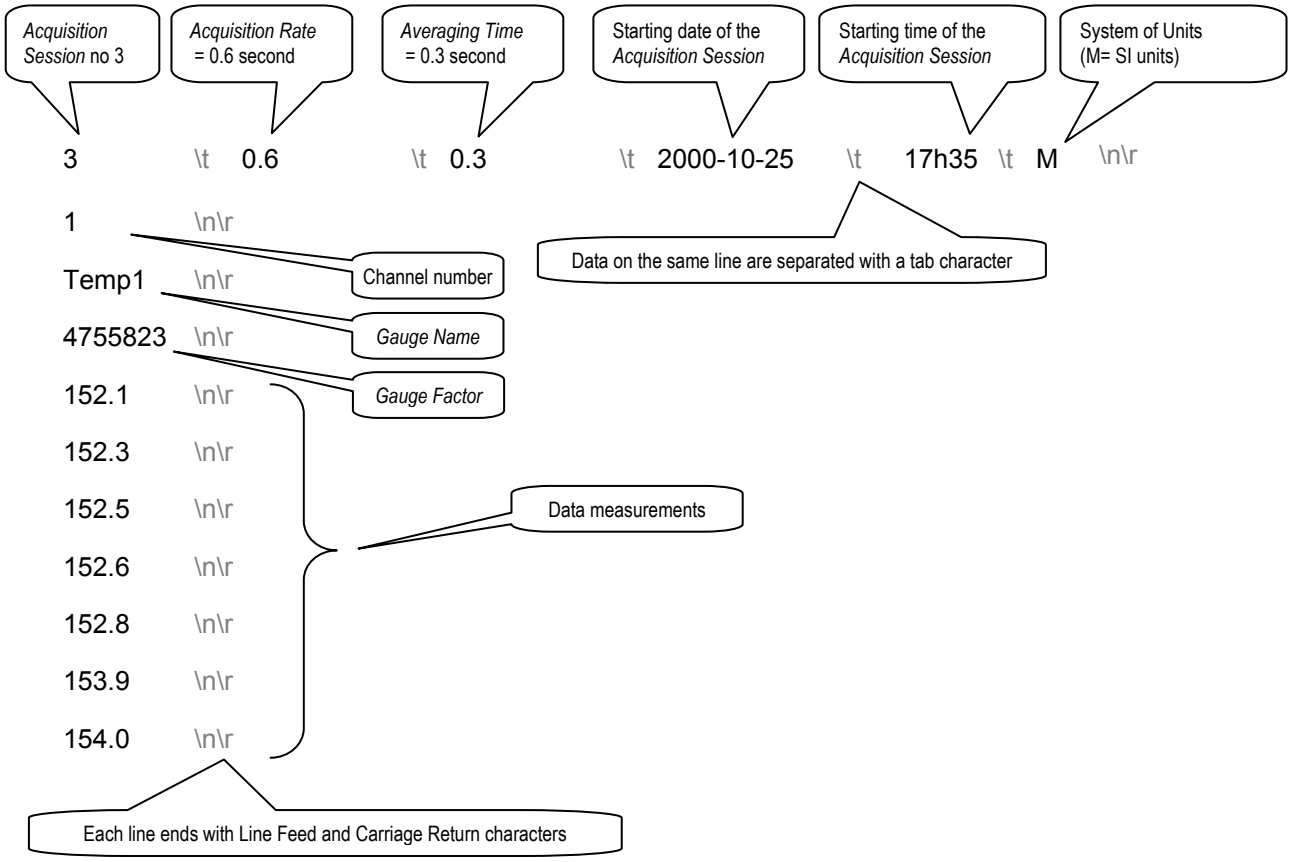
In H-*MAX Acquisition* mode, the FTI-10 records and displays only the highest measurement value taken. In other words, the actual transducer reading value is not refreshed until a higher value is read by the FTI-10. Use the **ACQUISITION MODE [TM**5**]** command to select the H-*Max Acquisition Mode* and then send the **TRIGGER [TS**1**]** command to activate the acquisition (or press the **F1**/(Acq) button). This mode can be selected at the *Reading Level* display as well. In that case, press the **Esc** (Status) button until the **H_MAX** message is displayed. Then start the *Acquisition Session* with the **F1**/(Acq) button. To terminate the *Acquisition Session*, press the **F1**/(Acq) button again. At the termination of the *Acquisition Session*, only the highest value of the data measurements acquired during the session will be stored in memory.

4.3.2.4 Data Logging and Downloading

Each time an *Acquisition Session* is started, a new data files is created and opened in the memory of the FTI-10 conditioner. The content of this file includes the data measurements and other useful information of the acquisition. The file (ASCII characters text file) is called the *Acquisition Series* and can be easily downloaded to a computer with the aid of the **DATA DOWNLOAD [DD]** command. The *Acquisition Series* file includes a four-line header and the data measurements taken during the duration of the *Acquisition Session*. First line of the header contains the *Acquisition Series* number, the value of the *Acquisition Rate*, the value of the *Averaging Time*, the date of the *Acquisition Session*, the time at which the *Acquisition Session* was started, and the system of Units. The *Acquisition Series* number indicates the chronological order of the *Acquisition Session*, i.e. 1 is the first *Acquisition Session*, 2 is the second

Acquisition Session, etc. The second line of the header indicates the channel numbers from which the data measurements are taken. Since the FTI-10 is a single channel conditioner, this number is always 1. The third line of the header indicates the *Gauge Name* and fourth line the *Gauge Factor*. It is then followed by the data measurements; each one of them placed on a separate line. Use the **LIST TAG [LT]** command to get a listing of all the *Acquisition Series* stored in the memory buffer without the data measurements. Figure 3 shows an example of the content of an *Acquisition Series* file.

Figure 3: CONTENT OF THE ACQUISITION SERIES FILE



4.3.2.5 Deleting the Memory Buffer

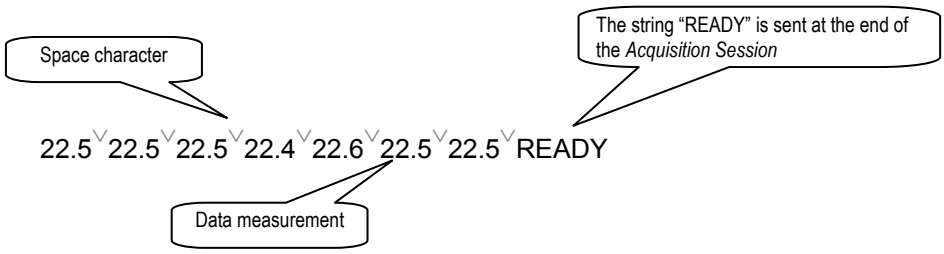
We recommend clearing the contents of the memory buffer once the data measurements have been downloaded. This ensures that the full capacity of the memory buffer is available for the next *Acquisition Sessions*. To delete the contents of the memory buffer, use the **CLBF** function of the **Acquisition** Sub-menu (see the menu diagram of section 2.2.1) or the equivalent remote command **CLEAR BUFFER [CB]**

4.3.3 Direct Data Acquisition

If a direct data acquisition mode is selected, each data measurement is immediately sent to the RS-232 link of the conditioner without storage in the memory. Use the **ACQUISITION MODE [TM**2**]** command to select the appropriate direct *Acquisition Mode* and then send the **TRIGGER [TS**1**]** command to activate the acquisition (or press the **F1**/(Acq) button). In that mode, a space character separates each data

measurement sent to the RS-232 output. The string READY is sent at the end of the last data measurement. No information is given on the acquisition parameters, the *Gauge Factor*, the unit of the measure, etc. Figure 4 shows an example of the direct data measurement output.

Figure 4: DATA MEASUREMENTS OUTPUT WITH RS-232 [TM2] DIRECT DATA ACQUISITION MODE



The time-based parameters of the direct data acquisition are the *Acquisition Duration* (**Dura**), *Averaging Time* (**Avrg**) and the *Acquisition Rate* (**Rate**). These acquisition-setting parameters can be manually adjusted in the **Acquisition** sub-menu of the control panel (See the menu diagram of section 2.2.1) or with their remote control equivalent commands **ACQUISITION DURATION [DA], ACQUISITION AVERAGE [TC]** and **ACQUISITION RATE [SR]** respectively.

4.3.4 Timing of the Data Acquisition

The data acquisition consists of storing (or directly outputting to RS-232 link) one data measurement at every interval of time given by the *Acquisition Rate* parameter. See Figure 4 for the timing diagram of the data acquisition. It should be noted that the data measurements are taken according to the *Averaging Time* initially set by the user (section 3.2.1). That is the averaging process is done on a 10 Hz sampling rate basis which means the FTI-10 conditioner calculates an average value of the data readings collected at every 1/10 s and during the period of time set with the *Averaging Time* parameter. The averaging process is always started at the beginning of the period as set with the *Acquisition Rate* parameters. For example, if the *Averaging Time* is set to 18 seconds and the *Acquisition Rate* is set to two minutes, the FTI-10 conditioner will take and store (or output) the average value of the first 180 data readings (10 Hz X 18 s) of the 1200 (10 Hz X 120s) available data readings (rounded to the closest integer). It should be noted that the *Acquisition Rate* parameter could not be smaller than the *Averaging Time*. If the user tries to set the *Averaging Time* larger than the *Acquisition Rate*, the later will be automatically reset (at the start of the *Acquisition Session*) to a value equal to the *Averaging Time.*

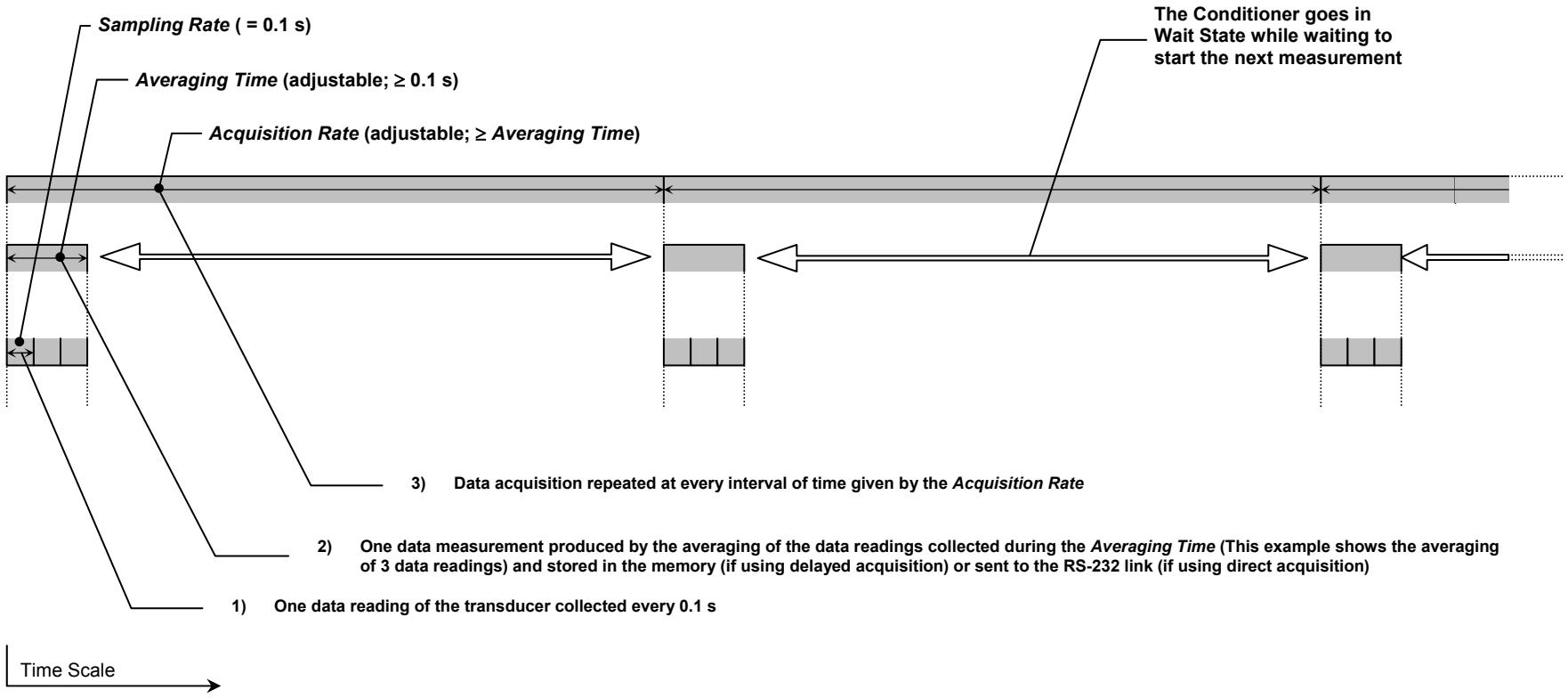
4.3.5 Refreshing rate of the screen and the analog output during acquisition

The screen of the conditioner cannot be refreshed faster than once every 0.5 s (2 Hz) whatever the setting of the acquisition parameters. During an *Acquisition Session*, the screen is refreshed at a rate given by the *Acquisition Rate* or once every 0.5 s*,* whichever is the slowest rate. The refreshing rate of the analog output is not limited like with the screen so it is refreshed at a rate given by the *Acquisition Rate*.

4.3.6 Wait State

When it goes in Wait State, the FTI-10 conditioner keeps the minimum hardware ON for remote communication and turns OFF all other non-necessary hardware (ex. Lamp). The user has still access to the *Remote Control Commands* such as, for example, downloading data or programming the conditioner. Use the **SYSTEM ON [WO]** command to put the conditioner ON again. The user can force the conditioner to go in Wait State with the **SYSTEM SHUTDOWN [WS]** command. See APPENDIX A.

Figure 4: Timing Diagram of Data Acquisition



4.4 ERROR MESSAGES WITH REMOTE CONTROL COMMANDS

4.4.1 No Signal

When the FTI-10 detects a defective or noisy measurement condition during an *Acquisition Session*, all the data in the *Acquisition Series* acquired during this condition are replaced by the error message NO SIGNAL. Note that the FTI-10 does not stop the *Acquisition Session* if that condition occurs. The following example shows the content of an *Acquisition Series* where a defective or noisy measurement condition occurred at the end of the *Acquisition Session*.

1\t1.0\t0.5\t1998-05-23\t10h30\tM\n\r
1\n\r
GAUG5\n\r
4229223\n\r
26\n\r
26\n\r
26\n\r
26\n\r
26\n\r
NO SIGNAL\n\r
NO SIGNAL\n\r
NO SIGNAL\n\r

The possible cause and remedies for a NO SIGNAL error message are:

- No transducer connected to the FTI-10 or improper connection. Verify connections or clean transducer, cable, and/or FTI-10 input connectors.
- Fiber optic cable is longer than the maximum length permitted. Use cable with shorter length.
- Fiber optic cable or transducer is damaged. Replace damaged part.
- FTI-10 light source is defective. Verify light condition with **DIAGNOSTIC REPORT** command.
- FTI-10 is defective. Contact factory.

4.4.2 Error Numbers

The following error messages are reported by sending through the RS-232 serial link a specific error number depending of the problem.

ERROR #	MEANING	REMARK OR EXAMPLE
01	MEMORY FULL	No more memory space for data acquisition or for adding a *Gauge Factor*
02	SYSTEM STOPPED	Command cannot be executed because the conditioner is in Wait State, is making a diagnosis, etc.
03	NO SIGNAL	Command cannot be executed because of no signal condition
10	INVALID PARAMETER	Command is send with an invalid parameter
11	COMMAND DENIED	Reserved for future use
12	ITEM NOT FOUND	Trying to erase or select a non existing *Gauge Factor* or *Gauge Name*

The error message is always sent in the following way:

\a ERR$^{\vee}$XX\n\r where \a is the BELL character and XX is the error number.

Ex.: The user sent the following **GAUGE SELECT** command: **[GA**9999999**]**. This *Gauge Factor* is not in the *Gauge List* so the FTI-10 returns the following:

GA9999999\n\r

\a ERR$^{\vee}$12\n\r

ERR 12 message means ITEM NOT FOUND. The possible errors that can occur while using the Remote Control Commands are listed by their corresponding error numbers in each command description of the Appendix A.

4.5 MISCELLANEOUS FUNCTIONS

See the Table 1 and Appendix A for a complete description off all the Remote Control Commands available.

APPENDIX A: LIST OF REMOTE CONTROL COMMANDS

NAME:	**ACQUISITION AVERAGE**
SYNTAX:	**[TC**mmss.s**], [TC]**
PARAMETERS:	If none: returns the current value of the *Averaging Time* Otherwise: mmss.s is a positive number that set the *Averaging Time* . mm = number of minutes and ss.s = number of seconds. Lowest permitted value: 00m00.1s Largest permitted value: 59m59.9s
REMARKS:	See Section 3.2.1
RETURN VALUE:	TCmmss.s\n\r (or) TC\n\r mmss.s\n\r (where mmss.s is the current *Averaging Time)*
ERROR NUMBER:	10 and 11

NAME:	**ACQUISITION DURATION**
SYNTAX:	**[DA**hhmmss.s**], [DA]**
PARAMETERS:	If none: returns the current value of the *Acquisition Duration* Otherwise: hhmmss.ss is a positive number that set the *Acquisition Duration* of the *Acquisition Session*. hh = number of hours; mm = number of minutes and ss.s = number of seconds. Lowest permitted value: 00h00m00.1s. Largest permitted value: 29h59m59.9s Special value: 00h00m00.0 for continuous acquisition (until memory buffer is full)
REMARKS:	See Section 4.3.4
RETURN VALUE:	DAhhmmss.s\n\r (or) DA\n\r hhmmss.s\n\r (where hhmmss.s is the current *Acquisition Duration*)
ERROR NUMBER:	10

NAME:	**ACQUISITION MODE**
SYNTAX:	**[TM**X**], [TM]**
PARAMETERS:	If none: returns the current *Acquisition Mode* (0, 1, 2, 3, 4, 5, 6, 7 8, or 9) If X = 0: set acquisition in NORMAL mode (default state) if X = 1: set acquisition in SINGLE mode if X = 2: set acquisition in RS232 mode if X = 3: set acquisition in PROGRAM/CONT mode if X = 4: set acquisition in READY mode if X = 5: set acquisition in H-*MAX* mode if X = 6: reserved for multichannel conditioners If X = 7: reserved for internal use if X = 8: reserved for multichannel conditioners if X = 9: set acquisition in PROGRAM/DATE mode
REMARKS:	See section 4.3.1
RETURN VALUE:	TMX\n\r (or) TM\n\r X\n\r (where X is the current *Acquisition Mode*)
ERROR NUMBER:	10

NAME:	**ACQUISITION RATE**
SYNTAX:	**[SR**hmmss.s**], [SR]**
PARAMETERS:	If none: returns the current value of the *Acquisition Rate* Otherwise: hmmss.ss is a positive number that set the *Acquisition Rate* of the *Acquisition Session*. h = number of hours; mm = number of minutes and ss.s = number of seconds. Lowest permitted value: 0h00m00.1s Largest permitted value: 9h59m59.9s
REMARKS:	See Section 4.3.4
RETURN VALUE:	SRhmmss.s\n\r (or) SR\n\r hmmss.s\n\r (where hmmss.s is the current *Acquisition Rate*)
ERROR NUMBER:	10

NAME:	**ACQUISITION STATE**
SYNTAX:	**[BU]**
PARAMETERS:	None, this command returns, during an *Acquisition Session*, the remaining number of data measurements to be acquired until the end of the session.
REMARKS:	This function is useful for knowing if an *Acquisition Session* is terminated or not. Two special cases: If 0 value is returned then Acquisition Session is completed; If -1 value is returned then the FTI-10 is in Wait State (see Figure 4).
RETURN VALUE:	BU\n\r (or) BU\n\r BUXXXX\n\r (where XXXX is equal to 0, -1, or the number of remaining data points to be acquired until the end of the *Acquisition Session*)
ERROR NUMBER:	10

NAME:	**ANALOG SCALE**
SYNTAX:	**[AV**XXXXX.XX**], [AV]**
PARAMETERS:	If none: returns the current *SCALE* (*Analog Scale Factor*) value from the analog output Otherwise: XXXXX.XX is a positive or negative number that set the *SCALE* (*Analog Scale Factor*) value on the analog output.
REMARKS:	See Section 3.3.1
RETURN VALUE:	AVXXXXX.XX\n\r (or) AV\n\r XXXXXX.XX\n\r (where XXXXX.YY is the current *SCALE* value)
ERROR NUMBER:	10

NAME:	**ANALOG ZERO**
SYNTAX:	**[AZ**XXXXX.XX**], [AZ]**
PARAMETERS:	If none: returns the current *ZERO* (*Analog Offset*) value from the analog output Otherwise: XXXXX.XX is a positive or negative number that set the *ZERO* (*Analog Offset*) on the analog output.
REMARKS:	See Section 3.3.1
RETURN VALUE:	AZXXXXX.XX\n\r (or) AZ\n\r XXXXX.XX\n\r (where XXXXX.XX is the current *ZERO* value)
ERROR NUMBER:	10

NAME:	**CLEAR BUFFER**
SYNTAX:	**[CB]**
PARAMETERS:	None, this command clears the contents of the memory buffer.
REMARKS:	We recommend to clear the memory buffer as soon as the data are downloaded to computer or are not needed anymore in order to release the memory space for the next *Acquisition Sessions.* See Section 4.3.2.5.
RETURN VALUE:	CB\n\r
ERROR NUMBER:	10

NAME:	**DATA DOWNLOAD**
SYNTAX:	**[DD**XX**], [DD]**
PARAMETERS:	If none: downloads the content of all the *Acquisition Series* stored in the memory Otherwise: downloads the content of the *Acquisition Series* number XX stored in the memory
REMARKS:	See Section 4.3.2.4 for information on the content of an *Acquisition Series*
RETURN VALUE:	DDXX\n\r --------- --------- (See Section 4.3.2.4 for the contents of the *Acquisition Series*) ---------- ----------
ERROR NUMBER:	

NAME:	**DATE**
SYNTAX:	**[SY**␣yyyy-MM-dd**], [SY]**
PARAMETERS:	If none: returns the current date of the FTI-10 real-time clock Otherwise: sets the date of the FTI-10 real-time clock, yyyy is the year (four digits), MM is the month (2 digits) and dd is the day (two digits)
REMARKS:	
RETURN VALUE:	SY␣yyyy-MM-dd\n\r (or) SY\n\r yyyy-MM-dd\n\r (where yyyy-MM-dd is the FTI-10 current date)
ERROR NUMBER:	10

NAME:	**DIAGNOSTIC REPORT**
SYNTAX:	**[DR]**
PARAMETERS:	None, used to download the diagnostic report
REMARKS:	See Section 3.3.2
RETURN VALUE:	DR\n\r BATTERY:^^^XXX%\n\r LIGHT:^^^^^XXXV\n\r SIGNAL:^^^^XXXV\n\r MEMORY:^^^^XXX%\n\r
ERROR NUMBER:	None

NAME:	**GAUGE ADD**
SYNTAX:	**[AS**XXXXXXX**]** or **[AS**^YYYYY^XXXXXXX**]**
PARAMETERS:	XXXXXXX is the 7-digits *Gauge Factor* YYYYY is the *Gauge Name* (5 characters maximum)
REMARKS:	This command adds a *Gauge Factor* (and *Gauge Name*) to the *Gauge List*. The *Gauge Name* is optional. See Section 3.1.2
RETURN VALUE:	ASXXXXXXX\n\r (or) AS^YYYYY^XXXXXXX\n\r
ERROR NUMBER:	1, 10

NAME:	**GAUGE ERASE**
SYNTAX:	**[RS**XXXXXXX**]** or **[RS**^YYYYY**]**
PARAMETERS:	XXXXXXX is the 7-digits *Gauge Factor* YYYYY is the *Gauge Name* (5 characters maximum)
REMARKS:	This command erases a *Gauge Factor* from the *Gauge List*. The *Gauge Factor* can be erased by mean of its associated *Gauge Name* as well. See Section 3.1.2
RETURN VALUE:	RSXXXXXXX\n\r (or) RS^YYYYY\n\r
ERROR NUMBER:	12

NAME:	**GAUGE LIST**
SYNTAX:	**[LG]**
PARAMETERS:	None, returns the content of the *Gauge List*
REMARKS:	An "END" string is added at the end of the list. The *Gauge Name* is sent as a five-character string, so space characters may be present. See Section 3.1.2
RETURN VALUE:	LG\n\r *GAUGE NAME*^*GAUGE FACTOR*\n\r *GAUGE NAME*^*GAUGE FACTOR*\n\r *GAUGE NAME*^*GAUGE FACTOR*\n\r --- --- *GAUGE NAME*^*GAUGE FACTOR*\n\r END\n\r
ERROR NUMBER:	None

NAME:	**GAUGE SELECT**
SYNTAX:	**[GA**XXXXXXX**]** or **[GA**^**YYYYY**], [GA]**
PARAMETERS:	If none: returns the *Gauge Name* YYYYY (five-character string format) and *Gauge Factor* XXXXXX currently assigned to the measuring channel Otherwise: assigns the *Gauge Factor* XXXXXXX to the measuring channel. The *Gauge Factor* can be assigned by mean of its associated *Gauge Name* YYYYY as well
REMARKS:	See Section 3.1.2.2
RETURN VALUE:	GAXXXXXXX\n\r (or) GA^YYYYY\n\r (or) GA\n\r *GAUGE NAME*^*GAUGE FACTOR*\n\r (currently assigned)
ERROR NUMBER:	10, 12

NAME:	**LIST TAG**
SYNTAX:	**[LT**XX**], [LT]**
PARAMETERS:	If none: returns a summarized list of all the *Acquisition Series*. For each of the series, the list provides the *Acquisition Series #*, the date, the time and the number of data measurements. The list ends with an "END" string. Otherwise: returns a summary of the *Acquisition Series #* XX. In that case, the summary consists of the four-line header of the *Acquisition Series #* XX
REMARKS:	See also the **DATA DOWNLOAD [DD]** command and Section 4.3.2.4
RETURN VALUE:	LT\n\r 1\tDATE\tTIME\tNUMBER OF DATA POINTS\n\r 2\tDATE\tTIME\tNUMBER OF DATA POINTS\n\r .....\n\r .....\n\r .....\n\r N\tDATE\tTIME\tNUMBER OF DATA POINTS\n\r END\n\r (or) LTXX\n\r XX\tRATE\tAVERAGE\tDATE\tTIME\tUNITS\n\r (See section 4.3.2.4) 1\n\r (Channel number 1) *GAUGE NAME*\n\r *GAUGE FACTOR*\n\r (Assigned *Gauge Factor* and its associated *Gauge Name* above)
ERROR NUMBER:	None

NAME:	**PROGRAM# AVERAGE**
SYNTAX:	**[SD**$^{\vee}$X$^{\vee}$mmss.s**]**
PARAMETERS:	mmss.s is the value that sets the *Averaging Time* of the *Acquisition Program* number X (X= 1 to 5) mm = number of minutes and ss.s = number of seconds. Lowest permitted value: 00m00.1s Largest permitted value: 59m59.9s
REMARKS:	See Sections 4.3.2.2 and 3.2.1
RETURN VALUE:	SD$^{\vee}$X$^{\vee}$mmss.s\n\r
ERROR NUMBER:	10

NAME:	**PROGRAM# ENDDATE**
SYNTAX:	**[SG**ᵛXᵛyyyyMMdd**]**
PARAMETERS:	yyyyMMdd is the value that sets the Ending Date of the *Acquisition Program* number X (X= 1 to 5). yyyy is the year (four digits), MM is the month (2 digits) and dd is the day (two digits).
REMARKS:	See Section 4.3.2.2
RETURN VALUE:	SGᵛXᵛyyyyDDdd\n\r
ERROR NUMBER:	10

NAME:	**PROGRAM# ENDTIME**
SYNTAX:	**[SB**ᵛXᵛhhmmss**]**
PARAMETERS:	hhmmss is the value that sets the Ending Time of the *Acquisition Program* number X (X= 1 to 5)
REMARKS:	See Section 4.3.2.2
RETURN VALUE:	SBᵛXᵛhhmmss\n\r
ERROR NUMBER:	10

NAME:	**PROGRAM# RATE**
SYNTAX:	**[SC**ᵛXᵛhmmss.s**]**
PARAMETERS:	hmmss.s is the value that sets the *Acquisition Rate* of the *Acquisition Program* number X (X= 1 to 5) h= number of hours, mm = number of minutes and ss.s = number of seconds. Lowest permitted value: 0h00m00.1s Largest permitted value: 9h59m59.9s
REMARKS:	See Section 4.3.2.2
RETURN VALUE:	SCᵛXᵛhmmss.s\n\r
ERROR NUMBER:	10

NAME:	**PROGRAM# SHOW**
SYNTAX:	**[SE**X^D**], [SE**^X**],**
PARAMETERS:	X is the *Acquisition Program* number for which the FTI-10 returns the program acquisition parameters. The "D" parameters includes the Starting and Ending Time in the returned values (see below)
REMARKS:	See Section 4.3.2.2
RETURN VALUE:	SEX^D\n\r STARTING DATE^STARTING TIME^ENDING DATE^ENDING TIME^RATE^AVERAGE (or) SEX\n\r STARTING TIME^ENDING TIME^RATE^AVERAGE
ERROR NUMBER:	10

NAME:	**PROGRAM# STARTDATE**
SYNTAX:	**[SF**^X^yyyyMMdd**]**
PARAMETERS:	yyyyMMdd is the value that sets the Starting Date of the *Acquisition Program* number X (X= 1 to 5). yyyy is the year (four digits), MM is the month (2 digits) and dd is the day (two digits).
REMARKS:	See Section 4.3.2.2
RETURN VALUE:	SF^X^yyyyDDdd\n\r
ERROR NUMBER:	10

NAME:	**PROGRAM# STARTTIME**
SYNTAX:	**[SA**^X^hhmmss**]**
PARAMETERS:	hhmmss is the value that sets the Starting Time of the *Acquisition Program* number X (X= 1 to 5)
REMARKS:	See Section 4.3.2.2
RETURN VALUE:	SA^X^hhmmss\n\r
ERROR NUMBER:	10

NAME:	**RS232 SHUTDOWN**
SYNTAX:	**[RP**X**], [RP]**
PARAMETERS:	If none: returns the current state of the conditioner RS-232 port (0 or 1) If X=0: set RS-232 port always ON If X=1: set RS-232 in auto shut-down (default state)
REMARKS:	This command enables or disables the automatic feature that turns OFF the RS-232 port when not in use. You should normally never disable this automatic feature. You may disable this feature if you continuously receive non-relevant characters when communicating with the FTI-10 conditioner
RETURN VALUE:	RPX\n\r (or) RP\n\r X\n\r (where X is the current state of the RS-232 port)
ERROR NUMBER:	None

NAME:	**SERIAL NUMBER**
SYNTAX:	**[SN]**
PARAMETERS:	None, this command returns the serial number of the FTI-10 conditioner
REMARKS:	
RETURN VALUE:	SN\n\r XXXXXX\n\r where XXXXXX is the serial number
ERROR NUMBER:	None

NAME:	**SYSTEM OFF**
SYNTAX:	**[WF]**
PARAMETERS:	None, this command turns OFF the FTI-10 conditioner
REMARKS:	See **SYSTEM ON [WO]** command
RETURN VALUE:	WF\n\r
ERROR NUMBER:	None

NAME:	**SYSTEM ON**
SYNTAX:	**[WO]**
PARAMETERS:	None, this command turns ON the FTI-10 conditioner
REMARKS:	See **SYSTEM OFF [WF]** and **SYSTEM SHUTDOWN [WS]** commands
RETURN VALUE:	WO\n\r
ERROR NUMBER:	None

NAME:	**SYSTEM RESET**
SYNTAX:	**[RF]**
PARAMETERS:	None, this command resets the FTI-10 conditioner to its default state
REMARKS:	See Section 3.3.3
RETURN VALUE:	RF\n\r
ERROR NUMBER:	None

NAME:	**SYSTEM SHUTDOWN**
SYNTAX:	**[WS]**
PARAMETERS:	None, this command shutdowns the FTI-10 conditioner
REMARKS:	When it is shutdown, the conditioner goes in Wait State. The Wait State keeps the minimum hardware ON for remote communication and turns OFF all other non-necessary hardware (ex. Lamp). The user has still access to all the *Remote Control Commands* such as, for example, downloading data or programming the conditioner. Use the **SYSTEM ON [WO]** command to put the conditioner ON again.
RETURN VALUE:	WS\n\r
ERROR NUMBER:	None

NAME:	**SYSTEM UNIT**
SYNTAX:	**[SU**X**], [SU]**
PARAMETERS:	If none: returns the current System of Units (0 or 1) If X=0: set the units to the International System of Units (default state) If X=1: set the units to the Imperial System of Units
REMARKS:	When set to the International System of Units (SI), the conditioner uses the following units: **°C** for temperature, **bar** for the pressure, **kg** for the force or load, **mm** for the displacement. The equivalent Imperial Units are: **°F, psi, lb, in**. The strain unit is the micro-strain με, that is 10^{-6} meter/meter or 10^{-6} inch/inch. See Section 3.3.3
RETURN VALUE:	SUX\n\r (or) SU\n\r X\n\r (where X is the current System of Units)
ERROR NUMBER:	None

NAME:	**TIME**
SYNTAX:	**[ST**hhmm**], [ST]**
PARAMETERS:	If none: returns the current time of the FTI-10 real-time clock Otherwise: sets the time of the FTI-10 real-time clock, hh =hours and mm = minutes
REMARKS:	See Section 3.3.3
RETURN VALUE:	SThhmm \n\r (or) ST\n\r hhmm \n\r (where hhmm is the FTI-10 current time)
ERROR NUMBER:	10

NAME:	**TRIGGER**
SYNTAX:	**[TS**X**]**
PARAMETERS:	If X=0: deactivates the *Acquisition Session* or the *Acquisition Programs* If X=1: activates the *Acquisition Session* or the *Acquisition Programs*
REMARKS:	See Section 4.3
RETURN VALUE:	TSX\n\r
ERROR NUMBER:	2

NAME:	**VERSION DOWNLOAD**
SYNTAX:	**[VR]**
PARAMETERS:	None, this command returns the EPROM version of the FTI-10 conditioner
REMARKS:	
RETURN VALUE:	VR\n\r VERSION$^{\vee}$X.XXX\n\r (where X.XXX is the EPROM version)
ERROR NUMBER:	None

NAME:	**ZERO DOWNLOAD**
SYNTAX:	**[ZD]**
PARAMETERS:	None, returns the *Gauge Zero* value of the *Gauge Factor* currently assigned to the measuring channel.
REMARKS:	This function is irrelevant for temperature transducer See Section 3.1.3
RETURN VALUE:	ZD\n\r XXXXXXX\n\r (where XXXXXXX is the *Gauge Zero* current value in nm)
ERROR NUMBER:	10, 12

NAME:	**ZERO INTERNAL**
SYNTAX:	**[ZP**XXXXXXX**]**
PARAMETERS:	XXXXXX is the value (in internal units) that offsets the transducer currently assigned to the measuring channel.
REMARKS:	This function is irrelevant for temperature transducer See Sections 3.1.3 and 3.1.3.2
RETURN VALUE:	ZPXXXXXXX\n\r
ERROR NUMBER:	10, 11

NAME:	**ZERO PHYSICAL**
SYNTAX:	**[ZO**XXXX.XX**]**
PARAMETERS:	XXXX.XX is the value (in physical units) that offsets (or zero adjust) the transducer currently assigned to the measuring channel.
REMARKS:	This function is irrelevant for temperature transducer See Sections 3.1.3 and 3.1.3.2. Use this function to make a zero adjustment as well (send **[ZO**0**]** command). See section 3.1.3.1
RETURN VALUE:	ZOXXXX.XX\n\r
ERROR NUMBER:	10, 11

APPENDIX B: REFRACTIVE INDEX TRANSDUCERS

The refractive index transducer is based on the variation of the optical Fabry-Perot cavity length that results from the refractive index properties of the liquid. The liquid filled cavity length, hereinafter called optical cavity length ($L_{optical}$), is given by the physical cavity length ($L_{physical}$) multiplied by the refractive index of the liquid (n_{liquid}):

$$L_{optical} = n_{liquid} \bullet L_{Physical} \quad (5)$$

Since Fiso signal conditioner has the capability to measure the absolute cavity length, there is no need for probe calibration. The user must first enter and specify a gage factor that indicates to the system that a refractive index transducer is being used. User is referred to the ADD and SELECT functions described in this manual. While still in air, the probe is zeroed (NULLing function). As a result of the zeroing, the conditioner memorizes the cavity length in air which corresponds to the physical cavity length described above. From there, any new cavity length will be divided by this memorized physical cavity length to give the refractive index. As with other probe types, displayed resolution can be increased by signal averaging.

The gage factor to be ADDed and SELECTed that corresponds to a refractive index transducer is:

***G.F.*: 08000XX**

The first 5 digits are specific to a refractive transducer. The last two digits are used to differentiate the probes that may be used simultaneously on the same conditioner. It is important for each probe connected to the same conditioner to be distinguishable since the physical cavity lengths are saved in the memory location that corresponds to the zero of the probe. Using the same last two digits would force the probes to use the same physical length and thus, inaccurate measurements will occur.

It is important to note that the refractive index measured by the system is not for one single wavelength as it is usually reported in the literature, but is the refractive index averaged over the wavelength covered by the internal light source. The light source extends from 650nm to 1000nm. As a rule of thumb, it is generally acceptable to consider that the refractive index is measured for a central wavelength of 800nm.