DMI

Universal Multichannel Instrument

User Guide
MAN-00018 R5

If the equipment described herein bears the CE symbol, the said equipment complies with the applicable European Union Directive and Standards mentioned in the Declaration of Conformity.

SAFETY INFORMATION

The following safety instructions must be observed whenever the DMI instrument is operated. Failure to comply with any of these instructions or with any precaution or warning contained in the DMI Operating Manual is in direct violation of the standards of design, manufacture and intended use of the DMI 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 power supply or the power cord delivered with your DMI instrument and verify that the voltage specifications indicated on the wall plug-in power supply (or indicated near by the panel power connector) 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 DMI 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 DMI.

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1.0 GETTING STARTED

1.1 PRODUCT AND FEATURE DESCRIPTION

The DMI signal conditioner is a universal multichannel fiber optic signal conditioner. It is used with FISO Technologies' fiber optic transducers to perform Strain, Temperature, Force & Load, Displacement, Refractive index and Pressure measurements in hostile locations that were formerly inaccessible with other measuring instruments. The DMI 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 DMI.

Data averaging, data logging, direct and delayed acquisition, etc, are different features that come with the DMI. The DMI signal 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 DMI conditioner.

1.2 INSTALLATION

1.2.1 Installing the DMI

- The DMI may be powered by an external power supply or with the provided battery (see section 1.4.1). Whenever it is possible, use the provided external power supply to operate the DMI. Connect the wall plug-in (or tabletop) power supply to a power outlet. Connect the power cable to the DMI power connector (Figure 1).

WARNING

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

THE FRONT PANEL OF THE DMI SIGNAL CONDITIONER IS DISPLAYED IN FIGURE 1. PRIOR TO USE THE SYSTEM, THE USER SHOULD MAKE SURE TO HAVE ALL CONNECTIONS MADE. REFER TO SECTIONS 1.4 AND

1.5 for more information about the front panel connections.

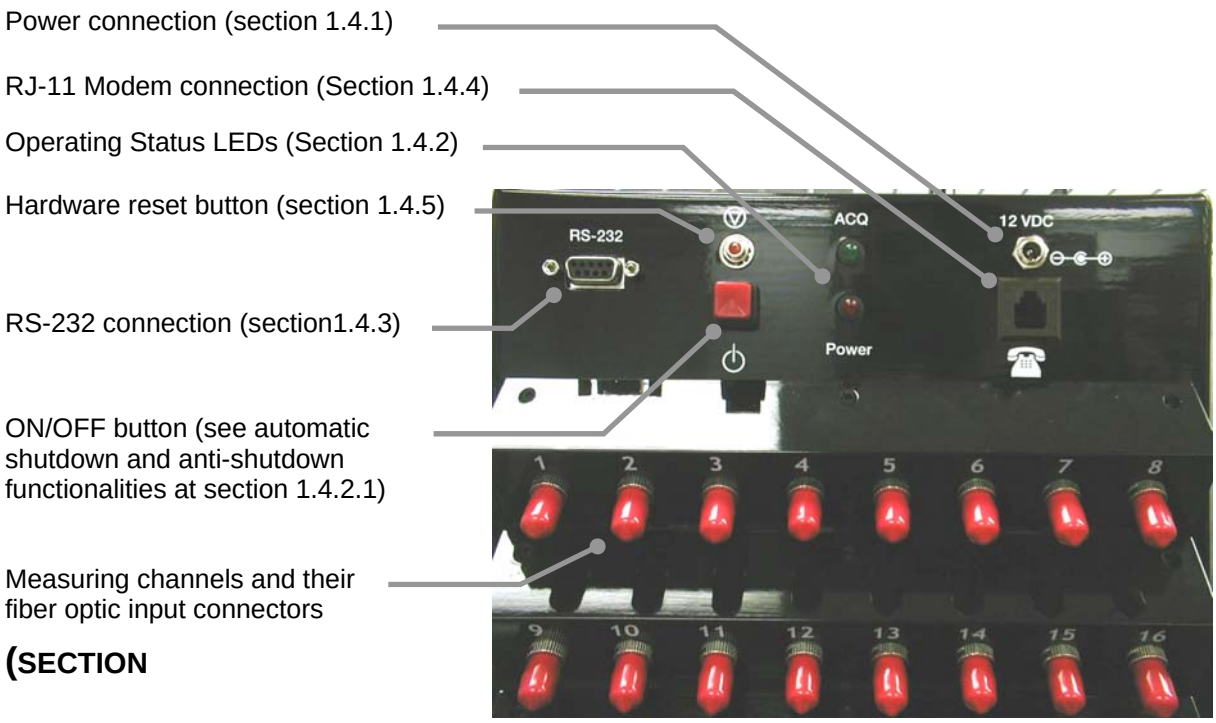


Figure 1: Front panel of DMI

1.2.2 Installing the transducers

1) Connect the transducer connectors to the input connectors of the DMI (Figure 1)

CAUTION

READ THE HANDLING PRECAUTIONS IN SECTION 1.5.1 BEFORE INSTALLING AND USING THE TRANSDUCERS FOR THE FIRST TIME.

1.3 GETTING STARTED

Follow the next instructions to make your first measurements with the DMI conditioner:

1. Installation of FISO*Commander*™ software

The FISOCommander™ software is easy to use and provides an access to all the signal conditioner parameters. For more information about the software functionalities, please refer to the FISO*Commander* ™ user's manual.

Here are the steps to install the software using Windows™ operating system:

1. Insert the CD-ROM in the CD-ROM drive.
2. If your computer is handling automatic loading, will prompt you the installation menu automatically.
3. If not, press "Start" and select "Run".
4. Type d:\Setup.exe (where d:\ is your CD-ROM drive location) and press "Enter".
5. Once completed, launch the software.

2. Save the *Gage Factors* in the memory of the DMI

The *Gage Factor* is a 7-digit number located near-by the fiber optic connector of the transducer. This number provides the DMI signal conditioner with the information related to the transducer (type, sensitivity, etc). Before using a transducer, its *Gage Factor* must first be saved into the non-volatile RAM memory of the conditioner. See section 2.1 for more details.

- In FISO*Commander*™ software, go to the **Configuration Transducer** tab. In the **Transducer: Gage Factor** box, click on «**Add**» button.
- Enter the transducer *Gage Factor* written on a tag close by its connector. If you are reading the *Gage Factor* from the clear plastic box, pay attention to do not confuse the *Gage Factor* with the identification number. Once completed, click on «OK».
- For easier *Gage Factor* management, you may enter a mnemonic name, called a *Gage Name*, for every *Gage Factor* stored. This entry is optional. If you do not want to save a *Gage Name*, click on «**OK**». The *Gage Factor* will then be stored and will remain in the memory buffer even if it is not assigned to any channel.
- Repeat the preceding steps for all the transducers that will be used with your DMI signal conditioner in order to create the so-called *Gage List*. This list can contain up to 50 different *Gage Factors*. This list is stored in a non-volatile memory so it will not be erased when turning off the DMI.
- If not already done, connect each transducer to the corresponding channel input connectors of the DMI signal conditioner.

3. Assign the *Gage Factors* to the measuring channels

To use a transducer with the DMI, you must first assign its *Gage Factor* to the corresponding channel.

- Select a DMI channel by moving the mouse pointer into the **Transducer: assignment** box. Double click on the desired channel. Make sure that your pointer is located on the channel no. The selected channel will then appears in bold.

- In the **Transducer: assignment** box, click on the selected channel cell located in the **Gage Name and Gage Factor** column. A drop down menu will appear and propose you all the *Gage Factor* stored in the *Gage List*. According to the transducer, select the corresponding transducer *Gage Factor*. Note: the default assigned *Gage Name* and *Gage Factor* is FISO1000 (for internal use only).

- Repeat the preceding steps for all the transducers that will be used with your DMI conditioner. **Turn off all unused channels by selecting the «OFF» option in the *Gage List***

4. Zero adjustment of the transducers

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

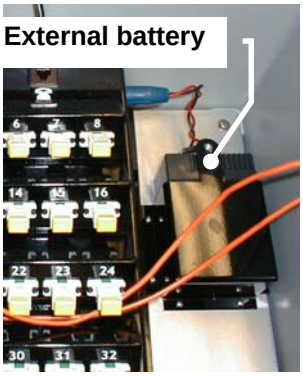
The zero adjustment forces the reading of the transducer to be equal to zero immediately after it is activated. The zero adjustment of the transducer is necessary when using for the first time a strain gage, force & load, refractive index or a pressure transducer. The zero adjustment function is automatically disabled in case of a temperature transducer. See section 2.1.3 for more details. To zero adjust a selected transducer with the FISO*Commander*™ software, click on the "**NULL"** button in the **Config Transducer** tab.

5. First acquisition and graphical display

From this point, your DMI signal conditioner is ready to display the data measurements taken with the fiber optic transducers. For this purpose, we recommend the step by step procedure describe in the FISO*Commander* ™ software user's manual.

1.4 OPERATING FUNCTIONALITIES

1.4.1 Power supply and external battery operation



The DMI conditioner comes with a wall plug-in or tabletop power supply/battery charger and with an external battery already connected to the conditioner (The battery is located inside the NEMA enclosure). The former is used to power the conditioner and recharge the external battery. The allowed power supply DC operating voltage is 9 to 15 Volts with a minimum current capacity of 500 mA.

The external battery is a 6 Volts 4.5 A-hour capacity. The operating temperature is from 0°C to 40°C. The external battery is mainly used as a back-up power supply during a shutdown of the external power. It can also be used as a main power supply in remote location where no external power is available. In the later case, the DMI autonomy depends of course on the remaining charge in the battery but it also depends on the operating conditions of the DMI. The next table provides information about the DMI autonomy during battering operation for different type of operating conditions.

DMI AUTONOMY DURING BATTERY OPERATION (@ 25°C; BATTERY FULLY CHARGED)	
DATA ACQUISITION CONDITIONS	**DMI AUTONOMY**
Data acquisition of 32 channels with maximum speed of data measurements (no averaging)	12 hours
Data acquisition of 32 channels with data acquisition rate of 5 data measurements (no averaging) per hour and per channel	350 hours
Data acquisition of 32 channels with data acquisition rate of 1 data measurements (no averaging) every 6 hours and per channel	900 hours

1.4.1.1 External battery lifetime: cyclic and standby use

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

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 DMI to recharge the battery once every six months in order to maintain its original capacity.The time to recharge the external battery can vary from 2 to 8 hours depending on the remaining charge of the battery.

1.4.2 Operating status

The red and green LEDs provide information to the user about the operating status of the DMI as explained in the following table.

Red LED	Green LED (ACQ)	Status
ON	OFF	• DMI is ON; *Acquisition Mode* not activated
ON	ON	• *Acquisition Mode* activated • Data measurements going on
OFF	ON	• *Acquisition Mode* activated • DMI is in the *Sleep State* (i.e. waiting for the next data measurement)
OFF	OFF	• The DMI is off

✓ **The DMI can be remotely turned on by sending a string character over the RS-232 serial link or by calling the DMI internal modem. See next sections.**

1.4.2.1 Automatic shutdown

The DMI goes completely off automatically after 15 minutes of inactivity unless it is in *Sleep Mode*. The DMI can be remotely turned off at any time with the aid of **SYSTEM OFF [WF]** remote control command (see REMOTE CONTROL COMMANDS MANUAL) or with FISO*Commander*™ software. The automatic shutdown feature can be disabled and enabled (default state) with the aid of the **POWER MANAGEMENT [GP**X**]** remote control command (See REMOTE CONTROL COMMANDS MANUAL).

Note: this function is irrelevant for NON BATTERY POWERED SYSTEM

1.4.2.2 Anti-Shutdown protection

The DMI is equipped with an anti-shutdown protection that prevent against unattended shutdown that could happen by pushing the ON/OFF button while a DMI *Acquisition Modes* (section 4.4.1) is still active. In this case, the user must hold down the ON/OFF button during at least 5 seconds and then release the button to turn off the conditioner.

Note: this function is irrelevant for NON BATTERY POWERED SYSTEM

RS-232 Link

The DMI signal conditioner is remotely controlled via a PC computer (or other computer device) with the aid of the RS-232 serial link or the modem connection (see next section). A set of *Remote Control Commands* provides all the functions to operate the conditioner. For more details about the RS-232 remote control of the DMI, consult the REMOTE CONTROL COMMANDS MANUAL. If the DMI is off or in *Sleep State*, a string character must be sent to the DMI in order to turn it on.

- ✓ **FISO Technologies suggests using its specially designed remote control software for the DMI conditioner. This software, called the FISO*Commander*™, provides an effective and simple tool for remotely controlling your DMI as well as for downloading and viewing in real-time the data measurements directly from your PC computer (see section 3.1) using either an RS-232 or modem connection.**

1.4.4 Modem connection

The DMI is equipped with a V.90 standard internal modem that allows the user to remotely control the DMI through a telephone connection. The internal modem supports communication speed from 300 bps to 56 kbps.

To use the modem communication, simply connect the DMI to your telephone line using a standard RJ-11-to-RJ-11 cable. The DMI internal modem answers automatically immediately after receiving the second telephone ring signal even if the DMI is off or in *Sleep State*. Indeed, the modem automatically turns on the DMI. Once connected via the internal modem, the remote operation of the DMI is the same as with an RS-232 link. After the remote user hangs up, the internal modem needs approximately one minute to shut off itself after which, 15 minutes later, the DMI will turn off or goes back in *Sleep State*.

The FISO*Commander*™ software can be used with a modem connection. Simply select in FISO*Commander*™ software the COM port on which the computer modem is installed and the modem initialization window will pop-up. Enter the telephone number. For long distance call, it may be necessary to enter pauses in the dialing sequence of numbers. The easiest way to accomplish this is by using the standard modem dialing string character "," which causes dialing to pause for each occurrence (ex.: 1,222,111,3333). When ready, click on “OK” to have your computer modem call the DMI internal modem. Once the communication is established with the DMI, the FISO*Commander*™ software will bring its standard user-interface window.

1.4.5 Hardware Reset Button

This button is used to reset the DMI signal conditioner to its original configuration as set at the factory.

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

1.4.6 Memory

The DMI signal conditioner is equipped with a non-volatile RAM type memory where all the settings of the conditioner (*Gage Factors*, *Gage Zero*, etc.) are stored. Each time the DMI conditioner is turned on; it is reset with the same settings in use just before the last time it was turned off.

The DMI signal 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 or modem link. See section 4.4.4 for more information.

1.5 USING THE TRANSDUCERS

1.5.1 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 probe: 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 Gage: 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

1.5.2 Cleaning the transducer connectors (ST type)

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 DMI input connectors. However, we recommend cleaning the DMI input connectors occasionally. Use the specially designed 2.5-mm Mini Foam Swab provided with our cleaning kit for cleaning the input connector of DMI.

1.5.3 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 Gage Installation Guide*.

2.0 TRANSDUCER ⇔ CONDITIONER

2.1 TRANSDUCERS

2.1.1 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:

$$L_{cavity} = S \cdot M + L_{zero}$$

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

The accurate factory-calibration of the sensitivity S and of the *Gage 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.**

2.1.2 The Gage Factor

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

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

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

The *Gage 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:

0: Is used for non-specific type transducers
08: Is used for refractive index transducers
0X: is reserved for future use
1: Is used for non-compensated strain gage 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 gage 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 *Gage 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 gage 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 *Gage Zero* L_{zero}. See section 2.1.3 for more information.

2.1.2.1 To add (or remove) a *Gage Factor* to the *Gage List*

To add or remove a transducer *Gage Factor*, use the **GAGE ADD** remote control command described in REMOTE CONTROL COMMANDS MANUAL or go in the **Config Transducer** tab of the FISO*Commander*™ software. You may enter with the *Gage Factor* a *Gage Name* to facilitate the identification of the corresponding transducer. The *Gage Name* can be composed of up to five alphanumeric characters: {0-9} {A-Z} {: ;}. If you do not want to assign yourself a *Gage Name* just enter the *Gage Factor*. The conditioner will then assign a default *Gage Name*.

2.1.2.2 To assign the *Gage Factors* to the measuring channels

To use a transducer with the DMI, you must first assign its *Gage Factor* to the corresponding channel, that is the one to which the transducer is connected.

Use the **GAGE SELECT [GA**"Gage Factor"**]** or **[GA**"Gage Name"**]** remote control command as described in REMOTE CONTROL COMMANDS MANUAL or go in the **Config Transducer** tab of the FISO*Commander*™. Your selection must correspond to the *Gage Factor* of the transducer actually connected to the measuring channel. Repeat the preceding steps for all the measuring channels that will be used. Select the "OFF" option to deactivate the unused channels (**[GA**0**]** remote control command).

- ✓ **It is strongly recommended to deactivate all unused channels ("OFF" option), otherwise the conditioner automatically assign the default *Gage Factor* "1000" and its corresponding *Gage Name* "FISO".**

- ✓ **Note that when the *Gage Factor* 1000 (or 0001000) is assigned, the conditioner gives the actual value of the output signal of the transducer that is the value of its cavity length L_{cavity}. This value is given in *Internal Units*, i.e. in nm. (See section 2.1.1)**

2.1.3 Calibration

As explained in section 2.1.1, 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 *Gage 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 output the values of M as a function of the output values L_{cavity} of the transducer:

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

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

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

Strain Gage Transducer: the *Gage Factor* of this transducer provides only the sensitivity S. The *Gage Zero* is not included at the factory because it would have no physical meaning at this point. Clearly, the *Gage Zero* of the strain gage 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 DMI conditioner fixes the default value of the *Gage Zero* to zero (L_{zero} = 0 nm). However, the zero and offset adjustment functions of the conditioner allow the user to automatically define at any time a new value of the *Gage Zero* — for example, after bonding the transducer (See sections 2.1.3.1 and 2.1.3.2).

Pressure Transducer: the *Gage Factor* of this transducer provides only the sensitivity S. The *Gage Zero* is not included at the factory because in general these transducers are of gage type (i.e. pressure measured relative to the ambient or atmospheric pressure). At first, the DMI conditioner fixes the default value of the *Gage Zero* to zero (L_{zero} = 0 nm). However, the zero and offset adjustment functions of the conditioner allow the user to automatically define at any time a new value of the *Gage Zero* (See sections 2.1.3.1 and 2.1.3.2). 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 *Gage Factor* of that transducer. (See section 2.1.3.2).

Force & Load Transducer: the *Gage Factor* of this transducer provides only the sensitivity S. At first, the DMI conditioner fixes the default value of the *Gage Zero* to zero (L_{zero} = 0 nm). However, the zero and offset adjustment functions of the conditioner allow the user to automatically define at any time a new value of the *Gage Zero* (See sections 2.1.3.1 and 2.1.3.2).

Displacement Transducer: the *Gage Factor* of this transducer provides only the sensitivity S. At first, the DMI conditioner fixes the default value of the *Gage Zero* such as to obtain 0 mm (or 0 inch) at the center position of the transducer. However, the zero and offset adjustment functions of the conditioner allow the user to automatically define at any time a new value of the *Gage Zero* (See sections 2.1.3.1 and 2.1.3.2).

Refractive index gauge : the Gage Factor of this transducer provides only the optical cavity length. After a simple zeroing, which corresponds to the physical cavity length, then the gage is ready to use. (See APPENDIX A)

2.1.3.1 Zero adjustment of the transducer

The zero adjustment forces the data measurements of a given transducer to be equal to zero immediately after it is activated. This is achieved with the aid of the **ZERO PHYSICAL** remote control command (REMOTE CONTROL COMMANDS MANUAL) or with the FISO*Commander*™ software (<<**NULL**>> button in the **Config Transducer** tab). The operating principle of this function is described next:

1. Immediately after receiving the **ZERO PHYSICAL [ZO0]** remote control command or after pressing the <<**NULL**>> button in the **Config Transducer** tab of the FISOCommander™ software, 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. At this point, one could see that the values of the data measurement taken right after the zero adjustment 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 *Gage Zero* of the transducers is set to zero (L_{zero} = 0 nm). Consequently, when using for the first time the strain gage, force & load, or pressure transducer, the conditioner will output 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 gage transducer, the zero adjustment is usually done after bonding the transducer to the structure. For pressure transducer of gage 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 gage 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 4.0). 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 ZERO DOWNLOAD (REMOTE CONTROL COMMANDS MANUAL) remote control command or go in the Config Transducer tab of the FISO*Commander*™ software.**
- ✓ **Despite the fact that the zero adjustment is only active with the selected measuring channel, this function is transducer-specific: the resulting value of L_{zero} will be associated to the *Gage Factor* currently assigned to the selected channel. That means the *Gage Zero* will always stick to its associated *Gage Factor* even though the later is re-assigned to another channel. Note that removing a *Gage Factor* from the *Gage List* will erase its associated *Gage 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 gage, force & load, refractive index or gage pressure transducers are being used for the first time (for absolute pressure, see section 2.1.3.2).**
- ✓ **It is recommended to take note of the current value of 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. See the ZERO DOWNLOAD remote control command in REMOTE CONTROL COMMANDS MANUAL.**

2.1.3.2 Offset adjustment of the transducer

The offset adjustment of the transducer, done with the aid of the **ZERO PHYSICAL** or **ZERO INTERNAL** remote control command, or with the FISO*Commander*™ software (in the **Config Transducer** tab), 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.

A. Offset with physical units

The offset adjustment function in physical units is the same as the zero adjustment except that the entered value is different from zero. The entered value will thus correspond to the data measurements displayed right after the function is activated. Using the **ZERO PHYSICAL [ZO**"Offset value"**]** remote control command or with FISO*Commander*™ software (<<**PHYSICAL**>> button in the **Config Transducer** tab), the offset value is entered in the units that correspond to the transducer actually connected to the selected channel (For example, the value is entered in psi or Bar in the case of a pressure transducer).

1. Immediately after receiving the **ZERO PHYSICAL [ZO**"Offset value"**]** remote control command or after confirming your offset entry in the **Physical** dialog box of the FISO*Commander*™ software, 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. At this point, one could see that the values of the data measurement taken right after the offset adjustment are equal or close to the offset value. Indeed, if the value of the stimulus has not changed (or very little) since the offset adjustment, its calculated value M from equation 2 must be equal or close to the offset value knowing that $L_{cavity} \cong L_{zero} + (S \times offset\ value)$

B. Offset with Internal Unit

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. Using the **ZERO INTERNAL [ZP**"Offset value"**]** remote control command or with FISO*Commander*™ software (<<**INTERNAL**>> button in the **Config Transducer** tab), the offset value is entered in *Internal Unit* that is in nanometers.

1. Immediately after receiving the **ZERO INTERNAL [ZP**"Offset value"**]** remote control command or after confirming your offset entry in the **Internal** dialog box of the FISO*Commander*™ software, the conditioner assigns the entry to L_{zero} and it becomes the new current value.
2. At this point, the new current value of L_{zero} will affect the values of the data measurement 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.

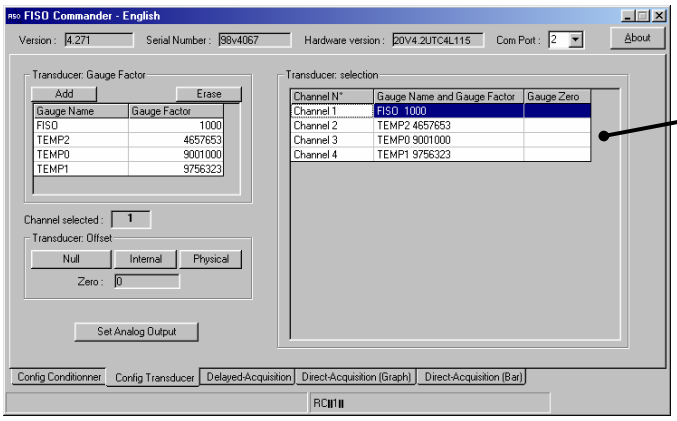
The principal characteristics of the offset adjustment that should be reminded are:

- ✓ **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 4.0). 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 ZERO DOWNLOAD (SEE REMOTE CONTROL COMMANDS MANUAL) remote control command or go in the Config Transducer tab of the FISOCommander™ software.**
- ✓ **Despite the fact that the offset adjustment is only active with the selected measuring channel, this function is transducer-specific: the resulting value of L_{zero} will be associated to the *Gage Factor* currently assigned to the selected channel. That means the *Gage Zero* will always stick to its associated *Gage Factor* even though the later is re-assigned to another channel. Note that removing a *Gage Factor* from the *Gage List* will erase its associated *Gage 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.**

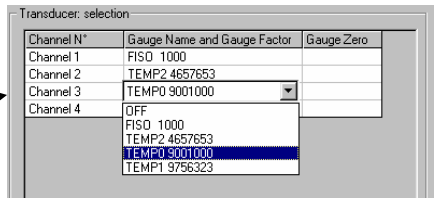
3.0 CONDITIONER REMOTE CONTROL

3.1 FISO*COMMANDER*™ SOFTWARE

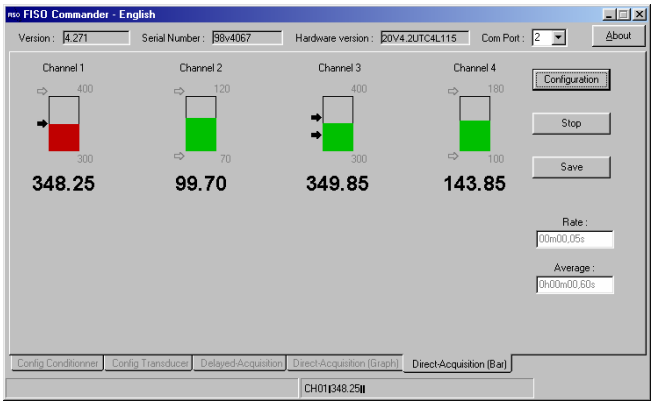
FISO Technologies offers specially designed remote control software for the DMI conditioner. This software, called the FISO*Commander*™, provides an effective and simple tool for remotely controlling your DMI as well as for downloading and viewing in real-time the data measurements directly from your PC computer. The figures below show few of the many features offered by this software. FISO*Commander*™ is offered in a free demonstration version (Lite version) or is sold in Full version. For more information about the FISO*Commander*™, please refer to the software user's manual.



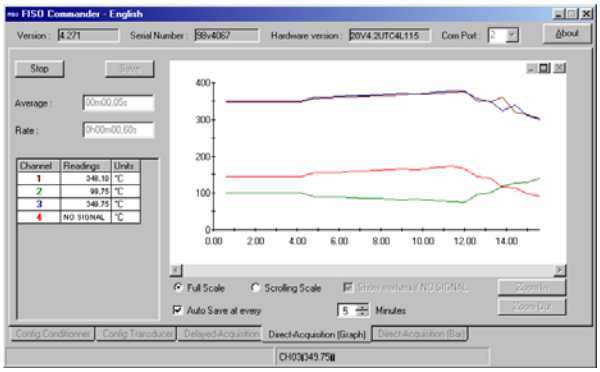
Transducer Configuration Menu



Transducer Assignment dialog box



Direct Data Acquisition window
(Bar Graph with alarms)



Direct Data Acquisition window
(Line Graph)

4.0 THE DATA MEASUREMENT & ACQUISITION

4.1 DATA SAMPLING AND AVERAGING

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

1. The DMI conditioner samples the transducer signal, connected to one of the measuring channels, at a fix *Sampling Rate* of 20 Hz. Consequently, the conditioning process of the sampled signal from the transducer generates one data reading every 1/20 or 0.05 second.

2. The data readings generated at this 20 Hz *Sampling Rate* are averaged during an adjustable period of time as set by the user with the *Averaging Time* parameter.

3. The average value of the data readings, referred as the **data measurement,** is thereafter available for memory storage or outputting to the RS-232 (or modem) port depending on the *Acquisition Mode* selected.

4. During data acquisition (see section 4.4), the three preceding steps will be repeated at every interval of time given by the *Acquisition Rate* if manual scan mode is selected. If the automatic scan mode is selected, the conditioner will first switch to the next channel and repeat the preceding steps. The complete scan of the channels will be repeated at every interval of time given by the *Acquisition Rate.* See section 4.4, the timing diagrams of Figure 2 and Figure 3 for more information.

The *Averaging Time* is set with the **ACQUISITION AVERAGE** remote control command or in the **Config Conditioner** tab of FISO*Commander*™ software. The minimum value of the *Averaging Time* is 0.05 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 20 Hz.

The *Acquisition Rate* is set with the **ACQUISITION RATE** remote control command or in the **Config Conditioner** tab of FISO*Commander*™ software. The meaning and permitted values of *Acquisition Rate* depends of the scanning mode; see sections 4.4.2, 4.4.3, Figure 2 and Figure 3.

✓ **The default value of *Averaging Time* for the DMI Long Range version is factory preset at 1.0 second and should not be decreased when using transducer with long length of fiber optic cable. Whenever it is possible, it is recommended to set the *Averaging Time* to a value larger or at least equal to 1.0 second.**

4.2 AUTOMATIC SCAN

The measuring channels of the DMI conditioner can be scanned in two ways: automatic and manual scan. The scanning method is selected by mean of the *Acquisition Modes*. See section 4.4.1

When set to automatic scan mode, the data measurements are sequentially taken on each of the activated DMI channels. The conditioner switches from one active channel to the next active one in ascending order (ex: channel no 1→2→3→4→….). This scanning cycle is continuously repeated: →1→2→3→4→…→1→2→….

The *Scanning Time* is defined as the time required for switching to a channel a get a data measurement of that channel. This time varies with the *Averaging Time* and with a stabilization time fixed at 0.1 second.

Note: The stabilization time is fixed at 0.4 seconds for a DMI Long Range version.

$$\textbf{\textit{Scanning Time}} = \textbf{\textit{Averaging Time}} + \textbf{0.1 second} \quad (\textit{seconds/channel}) \qquad (3)$$

The smallest and default value of the *Scanning Time* is 0.15 second/channel, that is when the *Averaging Time* is set to its minimum value of 0.05 second. It should be emphasized that the conditioner skips the deactivated channels (i.e. channels turned OFF). Consequently, it is recommended to set the non-used channels to OFF to minimize the time required for a complete scan of the channels.

4.3 MANUAL SCAN

When set to manual scan mode, the data measurements are taken with one measuring channel. This mode gives the fastest means of measurement that is up to 20 data measurements per second.

✓ **In manual scan, the amount of time between two consecutive data measurement is equal to the *Averaging Time* since there is no stabilization time.**

4.4 DATA ACQUISITION

4.4.1 Acquisition Modes

The DMI 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 (or modem) 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** remote control command or with the aid of FISO*Commander*™ software (**Delayed-Acquisition** tab).

Each *Acquisition Mode* offers other options such as data acquisition in automatic or manual scan of the measuring channels. The DMI switches immediately to manual or automatic scan depending on the *Acquisition Mode* that is selected.

The *Acquisition Modes* are selected with the **ACQUISITION MODE** remote control command. See Table **2** and the next sections for additional explanation on each *Acquisition Mode*. When using the FISO*Commander*™ software, the selection of the proper *Acquisition Mode* is done automatically by the software.

4.4.2 Data Acquisition in Manual Scan

When the conditioner is set to manual scan, the data acquisition consists of storing (or directly outputting to RS-232 or modem link) one data measurement at every interval of time given by the *Acquisition Rate* parameter. See Figure 2 for the timing diagram of the data acquisition when in manual scan. It should be noted that the data measurements are taken according to the *Averaging Time* initially set by the user (section 4.1). That is the averaging process is done on a 20 Hz sampling rate basis which means the DMI conditioner calculates an average value of the data readings collected at every 0.05 second 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 40 seconds and the *Acquisition Rate* is set to two minutes, the DMI conditioner will store (or output) the average value of the first 800 data readings (20 Hz X 40 s) of the 2400 (20 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) to a value equal to the *Averaging Time.*

4.4.3 Data Acquisition in Automatic Scan

When the conditioner is set to automatic scan, the data acquisition is performed by storing (or by directly outputting to the RS-232 or modem link), at every interval of time given by the *Acquisition Rate,* the data measurements taken during one scanning cycle. See Figure 3 for the timing diagram of the data acquisition when in automatic scan. It should be noted that the data measurements are taken according to the *Averaging Time* initially set by the user (section 4.1). That is the averaging process is done on a 20 Hz sampling rate basis which means the DMI conditioner calculates an average value of the data readings collected at every 0.05 second 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, a DMI-32 with its thirty-two channel activated has the *Averaging Time* set to 1.90 second and the *Acquisition Rate* set to 120 seconds. The conditioner starts the acquisition on channel no 1 with the averaging of 38 data readings (20 Hz x 1.90 s). The resulting data measurement is then stored in memory or outputted to the RS-232 link. Thereafter, the conditioner switches to channel no 2 and performs the same steps. These steps are repeated for each channel until the end of the scanning cycle (total duration of 64 seconds, including stabilization period of 0.1 second per channel), that is at channel no 32. This cycling process is repeated at every interval of time given by the *Acquisition Rate* that is 56 seconds after the last data measurement taken on the channel no 32.

The lowest possible value of the *Acquisition Rate* is equal to the *Scanning Time* multiply by the number of activated channels that is the time of a scanning cycle. If the user tries to enter a lower value, the *Acquisition Rate* will be automatically reset (at the start of the *Acquisition Session*) to this limiting value.

TABLE 2: ACQUISITION MODES (See ACQUISITION MODE command in REMOTE CONTROL COMMANDS MANUAL)							
NAME	COMMAND	SCAN MODE *	DATA STORAGE	ACTIVATION / DEACTIVATION	START PARAMETER	STOP PARAMETER	OTHER SPECIFIC PARAMETERS AND FEATURES
NORMAL	[TM0]	Manual	Yes	[TS1]/[TS0] commands	None (Starts immediately after activation)	*Acquisition Duration* or deactivation	*Averaging Time* *Acquisition Rate*
SINGLE	[TM1]	Manual	Yes	[TS1]/[TS0] commands	None (Starts immediately after activation)	None (single data measurement)	*Averaging Time*
RS-232	[TM2]	Manual	No (Direct acquisition)	[TS1]/[TS0] commands	None (Starts immediately after activation)	*Acquisition Duration* or deactivation	*Averaging Time* *Acquisition Rate* "READY" string
PROGRAM/CONT	[TM3]	Automatic	Yes	[TS1]/[TS0] commands	Starting Time (repeated every day)	Ending Time (repeated every day) or deactivation	See PROGRAM # commands in REMOTE CONTROL COMMANDS MANUAL
READY	[TM4]	Manual	Yes	[TS1]/[TS0] commands	None (Starts immediately after activation)	*Acquisition Duration* or deactivation	*Averaging Time* *Acquisition Rate* "READY" string
	[TM5]	RESERVED FOR INTERNAL USE					
SCAN	[TM6]	Automatic	Yes	[TS1]/[TS0] commands	None (Starts immediately after activation)	*Acquisition Duration* or deactivation	*Averaging Time* *Acquisition Rate*
	[TM7]	RESERVED FOR INTERNAL USE					
RS-232/SCAN	[TM8]	Automatic	No (Direct acquisition)	[TS1]/[TS0] commands	None (Starts immediately after activation)	None (continuous), deactivation only	*Averaging Time* *Acquisition Rate*
PROGRAM/DATE	[TM9]	Automatic	Yes	[TS1]/[TS0] commands	Starting Date and Starting Time	Ending Date and Ending Time or deactivation	See PROGRAM # commands in REMOTE CONTROL COMMANDS MANUAL

* Note: the DMI switches immediately to manual or automatic scan according to the *Acquisition Mode* selected

Figure 2: Timing Diagram of Data Acquisition in Manual Scan Mode

(Example given with channel no 1 selected)

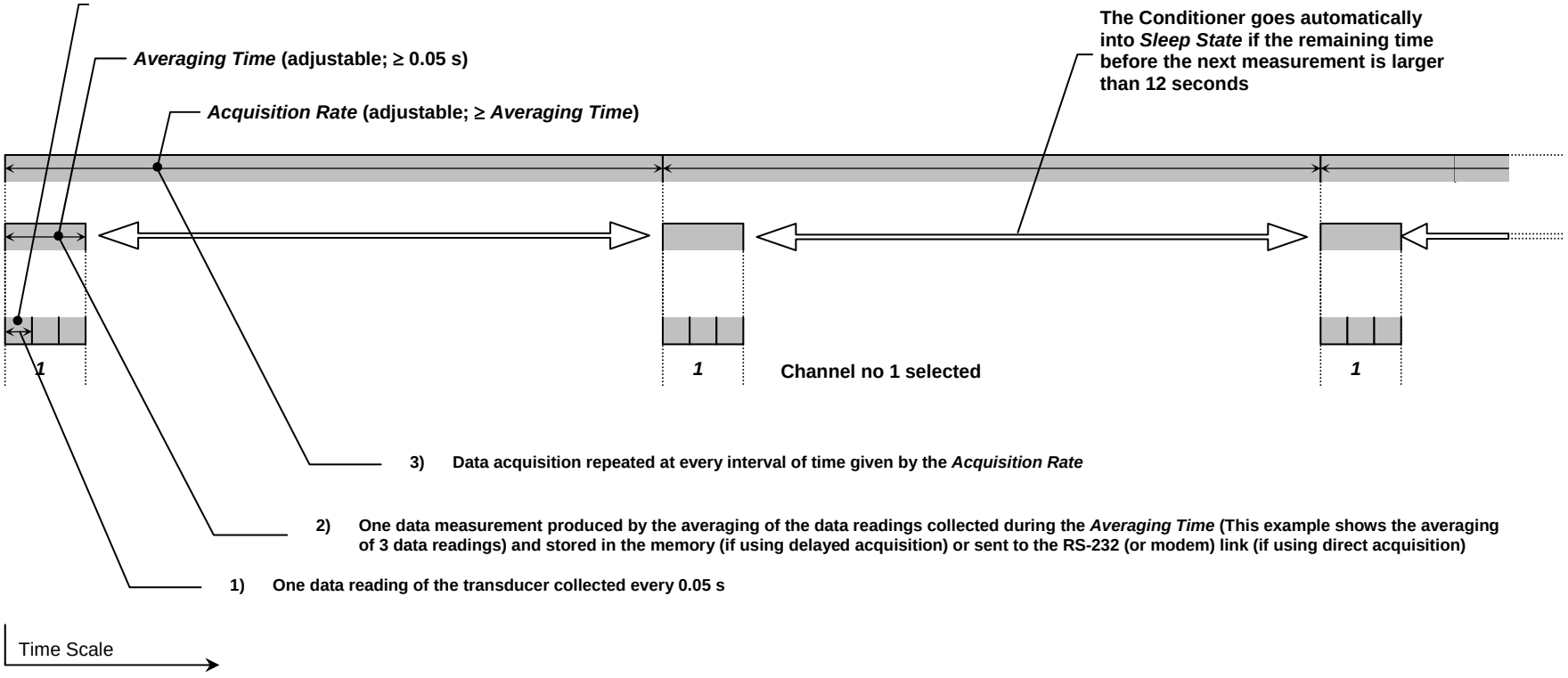
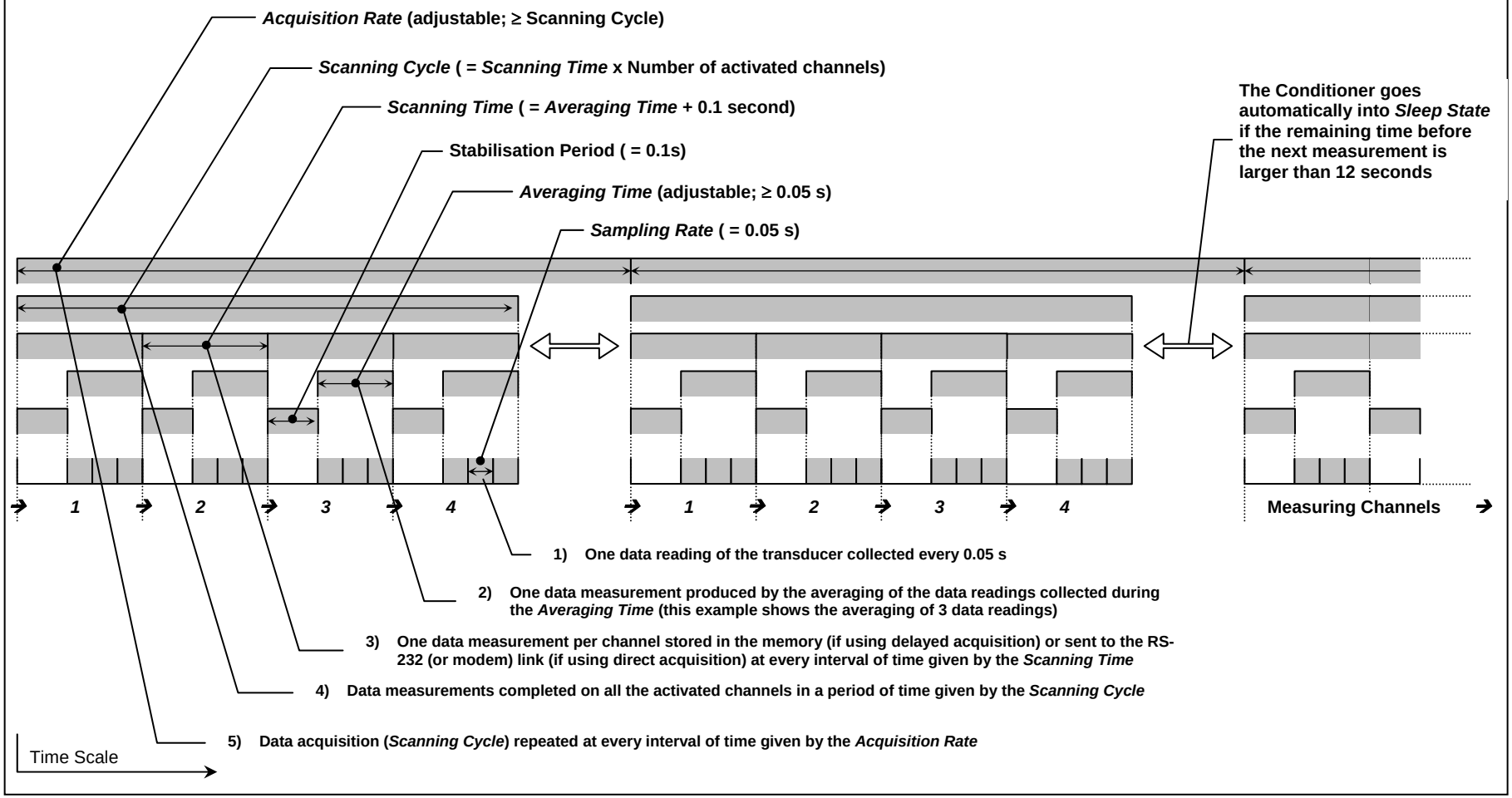


Figure 3: Timing Diagram of Data Acquisition in Automatic Scan Mode

(Example given with channels no 1 to 4 activated)



4.4.4 Delayed Data Acquisition

The DMI signal 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 will be available as soon as the acquisition session has begun logging.

4.4.4.1 Data Acquisition at set duration

Use the **ACQUISITION MODE** 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** remote control command to set the value of this parameter or go in the **Config Conditioner** tab of FISO*Commander*™ software.

To activate the *Acquisition Session*, send the **TRIGGER [TS**1**]** command (Note: The data acquisition at set duration can be done with the FISO*Commander*™ software as well). To stop the *Acquisition Session*, 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 store close to 50 000 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 00h00m00.00. 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* and the *Acquisition Rate*. These acquisition-setting parameters can be adjusted with the remote control commands **ACQUISITION AVERAGE** and **ACQUISITION RATE** respectively. See preceding sections.

4.4.4.2 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 Sessions* 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 with the **TRIGGER [TS**1**]** remote control command or with FISO*Commander*™ software in the **Delayed-Acquisition** tab. When activated, the DMI 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 REMOTE CONTROL COMMANDS MANUAL) or with the aid of FISO*Commander*™ software (**Delayed-Acquisition** tab). 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* (0.05 to 09h59m.95)	See **PROGRAM# RATE** command
4. *Averaging Time* (0.05 to 54m36.75)	See **PROGRAM# AVERAGE** command
5. Ending time (0.05 to 23h59m59.95)	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. These steps can be done as well in the **Delayed-Acquisition** tab of FISO*Commander*™ software. The DMI 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 DMI 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 sent to the DMI.

The following example shows a list of the *Remote Control Commands* to send to the DMI for creating a TM9 *Acquisition Program*:

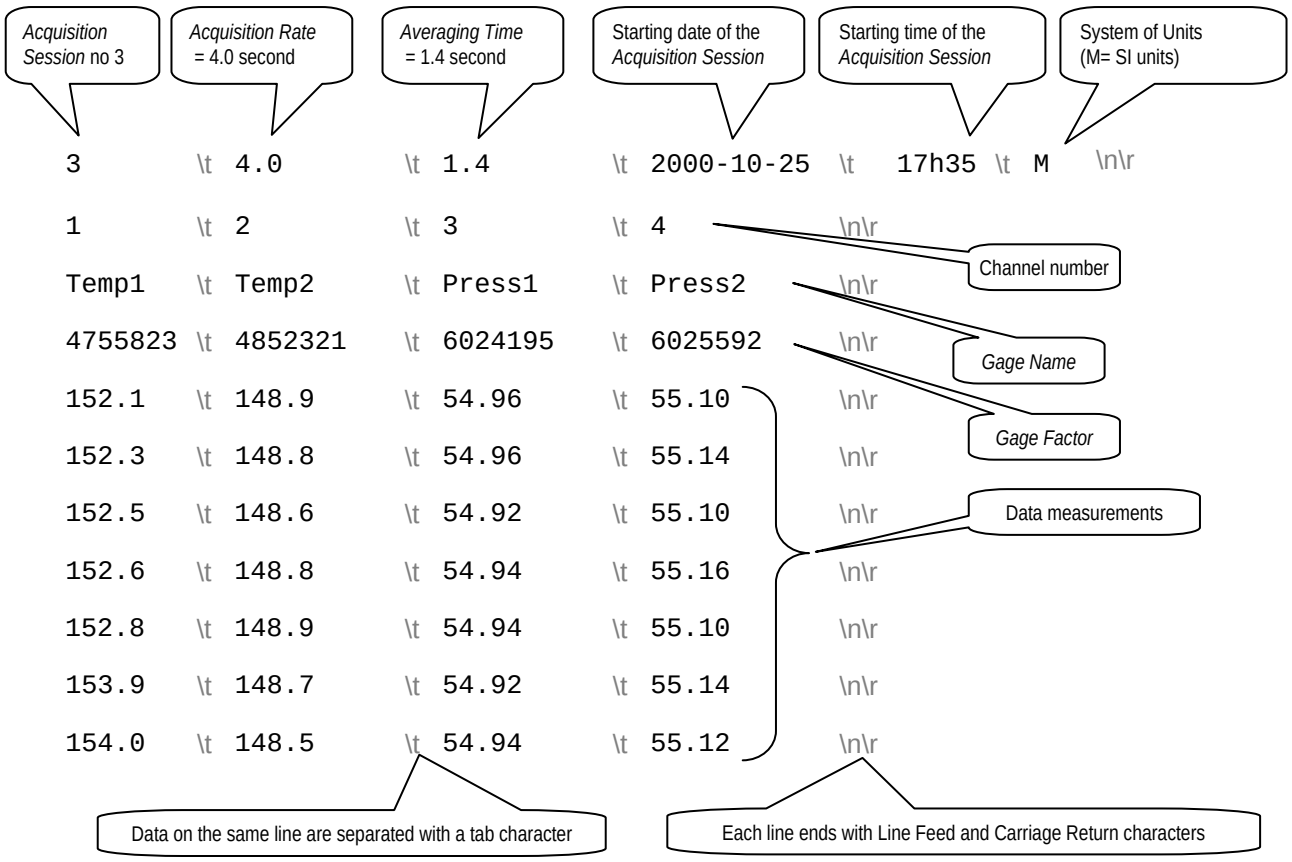
[SF$^{\vee}$2$^{\vee}$20001124]	Set the Starting Date of *Acquisition Program* # 2 to 2000-11-24
[SA$^{\vee}$2$^{\vee}$013000]	Set the Starting time of *Acquisition Program* # 2 to 01h30m00s
[SG$^{\vee}$2$^{\vee}$20001126]	Set the Ending Date of *Acquisition Program* # 2 to 2000-11-26
[SB$^{\vee}$2$^{\vee}$023000]	Set the Ending time of *Acquisition Program* #2 to 02h30m00s
[SC$^{\vee}$2$^{\vee}$000100.00]	Set the *Acquisition Rate* of *Acquisition Program* #2 to 1 minute
[SD$^{\vee}$2$^{\vee}$0010.00]	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** remote control command. Refer to the REMOTE CONTROL COMMANDS MANUAL for more information.

4.4.4.3 Data Logging and Downloading

Each time an *Acquisition Session* is started, a new data file is created and opened in the memory of the DMI conditioner. The content of this file includes the data measurements and other useful information on 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 or using the FISO*Commander*™ software. 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. Each channel number defines a row under which is written the *Gage Name* (third line of the header), followed by the *Gage Factor* (fourth line of the header.) and then next by the data measurements, each line of data corresponding to a scanning cycle (if in automatic scan mode). Use the **LIST TAG [LT]** command or FISO*Commander*™ software to get a listing of all the *Acquisition Series* stored in the memory buffer without the data measurements. FIGURE 4 shows an example of the content of an *Acquisition Series* file.

FIGURE 4: CONTENT OF THE *ACQUISITION SERIES* FILE
(This example shows the acquisition made on channel 1 to 4)



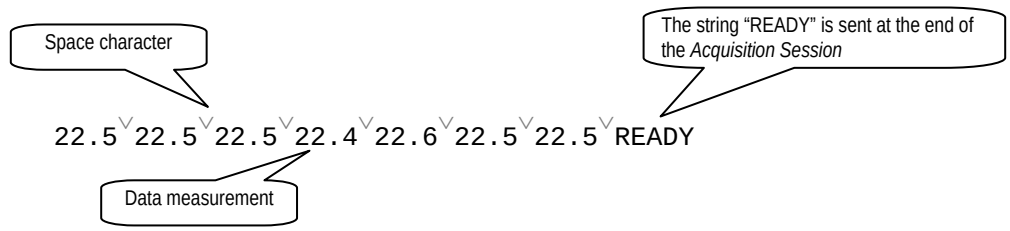
4.4.4.4 Deleting the Memory Buffer

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 **CLEAR BUFFER [CB]** remote control command or go in the **Delayed-Acquisition** tab of the FISO*Commander*™ software.

4.4.5 Direct Data Acquisition

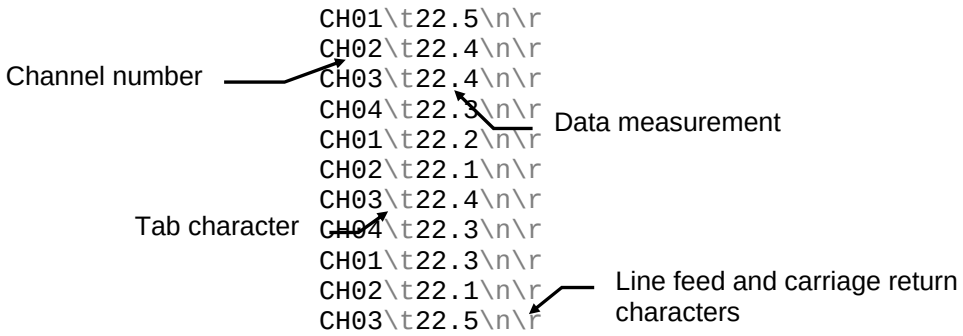
If a direct data acquisition mode is selected, each data measurement is immediately sent to the RS-232 or modem link of the conditioner without storage in the memory. Use the **ACQUISITION MODE [TM**2**]** or **[TM**8**]** remote control command to select the appropriate direct *Acquisition Mode* and then send the **TRIGGER [TS**1**]** command to activate the acquisition. When the direct data acquisition is set in manual scan (RS-232 **[TM**2**]** mode), a space character separates each data measurement (taken on a single channel) that is 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 *Gage Factor*, the unit of the measure, etc. The next figure shows the output of seven data measurements taken on a single channel:

FIGURE 5: DATA MEASUREMENTS OUTPUT FOR DIRECT DATA ACQUISITION WITH RS-232 [TM2] MODE



When the direct data acquisition is set in automatic scan (RS-232/SCAN **[TM**8**]** mode), each data measurement collected on the different channels are placed on separate lines. The line begins with the channel number (ex.: CH01) followed by a tab character, then the data measurement and it terminates with a line feed (\n) and carriage return (\r) character. No information is given on the acquisition parameters, the *Gage Factor*, the unit of the measure, etc. The example below shows the output of data measurements when in automatic scan mode:

FIGURE 6: DATA MEASUREMENTS OUTPUT FOR DIRECT DATA ACQUISITION WITH RS-232/SCAN [TM8] MODE (example shows channels 1 to 4)



The duration of the direct data acquisition (set with the *Acquisition Duration* parameter) can be adjusted only in the RS-232 **[TM**2**]** mode. The RS-232/SCAN **[TM**8**]** mode is continuously running and stops with the **TRIGGER [TS**0**]** remote control command. The other time-based parameters of the direct data acquisition are the *Averaging Time* and the *Acquisition Rate*. These acquisition-setting parameters can be adjusted with the remote control commands **ACQUISITION AVERAGE** and **ACQUISITION RATE** respectively.

The direct data acquisition can be performed with the aid of FISO*Commander*™ software as well. See **Direct-Acquisition** tabs in the software.

4.4.6 Sleep State

Note : the sleep state is irrelevant for NON BATTERY POWERED SYSTEM

When it goes in *Sleep State,* the DMI signal conditioner turns off most of its hardware so to reduce its power consumption. By doing so, the system will preserve the battery power. If the user wants to communicate with the DMI while in *Sleep State*, a wake up signal must be send first to the DMI.

This can be done by three different ways: pushing once the ON/OFF button, sending a string character via the RS-232 link, or by way of modem communication, i.e. calling the DMI internal modem (section 1.4.4).

The red LED off with the green LED on the front panel indicates that the DMI is in the *Sleep State*. This state means that one of the DMI *Acquisition Modes* is activated and still active (for example an *Acquisition Program* is to be started at a set date and time), but no data measurements is being taken nor is being planned for at least the next 12 seconds.

Low power state (using system without battery)

When it goes in *low power state,* the DMI-rackmount signal conditioner keeps the minimum hardware ON for remote communication and turns OFF all other non-necessary hardware (ex. Lamps). The user has still access to the *Remote Control Commands* such as, for example, downloading data or programming the conditioner. This state means that one of the DMI-rackmount *Acquisition Modes* is activated and still active (for example an *Acquisition Program* is to be started at a set date and time), but no data measurements is being taken nor is being planned for at least the next 2m30s. The lower power state will be set automatically by the system.

Since the system has no display, this event will be transparent for the user.

APPENDIX A: 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}):

$$L_{optical} = n_{liquid} \bullet L_{Physical} \quad (4)$$

Since FISO Technologies' 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 index transducer. The last two digits are used to differentiate the refractive index transducers 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.