

**Advanced Measurement Solutions**

Laser Torque Meters

**LTM2214**

**LASER TORQUE METER**

Rugged Mounting version (RM) – (HW Rev.1.1/FW Rev.2.0)

**USER MANUAL Rev.2.0**

(English version)

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## Patents

The laser torque metering technique used by the LTM2214 is patented

Notice: Product characteristics are subject to modifications without notice. Drawings and photographs may differ from the actual product / scope of supply.

## FOREWORD

This manual is an abridged version of the “Installation, Calibration and User Manual” of the LTM2214 laser torque meter system. The chapters and paragraphs numbering is the same of the “Installation, Calibration and User Manual” in order to speed up cross reference to this document.

This manual describes only the most common features which are used and/or modified more frequently. It contains the description of the configuration, setup, manipulation of the parameters and various operating modes of the LTM2214 electronic unit.

This manual does not describe the installation, calibration, maintenance and troubleshooting of the system (relevant chapters were omitted).

For installation and calibration procedures, electrical connections, maintenance and troubleshooting, dimensional and layout drawings of the LTM2214 system refer to the “Installation, Calibration and User Manual” of the LTM2214 laser torque meter system which is delivered with the system to purchasers only.

The “User Manual” is supplied with the equipment and is also freely downloadable from the [www.AdvancedMeasurementSolutions.com](http://www.AdvancedMeasurementSolutions.com) website.

## 0. Introduction

Thank you for purchasing a LTM2214 laser torque meter system.

The LTM2214 laser torque meter system uses the most recent digital electronic technology and contains a powerful 32 bits ARM7 microcontroller which provides torque/power calculations and the real time management of the system.

The LTM2214 laser torque meter system is not only a torque meter, but a complete measurement and analysis system of the working parameters of the prime mover-shaft assembly, which provides the following performance and characteristics:

- 1) RPM and shaft rotation direction measurement
- 2) Shaft revolution counter
- 3) Shaft torque measurement
- 4) Shaft power measurement
- 5) Vibrotorsional analysis (option)
- 6) Fuel oil consumption (FOC) measurement (option)
- 7) Specific fuel oil consumption (SFOC) measurement (option)
- 8) LCD data display
- 9) Display of system time and date
- 10) Data logging on a PC readable (FAT32) SD Card (SDSC and SDHC)
- 11) Output of measured data on two serial ports (RS232 and RS422) for remote processing (in NMEA0183 and custom formats) and for remote management by means of the supplied software remote control utility.
- 12) Possibility of setting, for each measured parameter, an alarm threshold. When the threshold is reached, an alarm can be generated and output via serial ports and/or potential free (NO/NC) contacts. Moreover when 90% of the threshold value is exceeded, a warning message is generated and transmitted via serial ports.
- 13) Up to 3 digital outputs (NC/NO relays) user assigned alarm outputs.

For additional information, document updates, software downloads and news please visit our website: [www.AdvancedMeasurementSolutions.com](http://www.AdvancedMeasurementSolutions.com)

You can also contact us at the email address: [info@AdvancedMeasurementSolutions.com](mailto:info@AdvancedMeasurementSolutions.com)

### Introductory note for system installation and startup

To ensure the correct functionality, the system must be installed following the prescriptions contained in this manual.

Only commonly used tools are required for the installation.

The instrument is delivered with all the accessories needed (bolts, mounting templates, alignment tools, etc..).

The system is CE marked (see chapter 10 – Certifications, CE marking and quality system)

## 0.1 Manufacturer responsibility

The user must read carefully the following legal note. The usage of the system implies the complete acceptance of all the terms of the legal note. Should the user not agree, even partially, with it, he/she must not proceed to install and use the system.

**IMPORTANT NOTICE:** LTM2214 torque meter system (in the following text referred to as “system”) is a measurement system and, as such, must be used only to obtain measurements, store and analyze them.

All applications of the system which, directly, indirectly, incidentally, consequentially, fraudulently can cause damage to things, menace human life and/or cause physical injuries to persons, even if the system is only part of a more complex one, are expressly forbidden.

Should the user wish to use the system in one of the above mentioned applications, he/she must obtain the written permission from the manufacturer beforehand.

The manufacturer shall not be liable for any direct, indirect, special, incidental, consequential, fraudulent damage, of material and non material nature, caused by correct or improper usage of the system. Moreover the manufacturer shall not be liable for any economical and/or financial damage (loss of profits or business) caused by the usage of the system.

The manufacturer shall not be liable for any expenses, claims, or suits arising out of or relating to any of the foregoing.

See also the “Contractual Terms and Conditions” signed and accepted at the order.

## 0.2 Safety prescriptions and warnings

### Electrical risk:

The user must be fully aware of the potential risks of the voltage used to supply the instrument. The LTM2214 system is designed and manufactured in order to fulfil the electrical protection standards (and directives) in force. Despite this, the user must pay the greatest attention in the usage of the instrument in order to avoid possible accidents.

### Mechanical risk:

Depending on the type of the installation, the rotating shaft, and the slitted discs mounted on it, can be a serious danger for the safety of the personell close to them.

In these cases the user should install mechanical protections (e.g. fences similar to the ones preventing contact with the shaftline) to avoid contact with the moving parts.

In any case the user must pay the greatest attention when working on the parts of the system mounted on the shaft and on the LTM2214 frame.

**SAFETY WARNING:** Due to the risk of electric shock, special care must be taken when connecting the system, opening the enclosures, accessing internal parts. The installation of the system must be carried out by authorized personell only. Power supply MUST be disconnected before working on the instrument.

**WARNING:** Before supplying the system, make sure that the supply voltage is equal to the rated voltage marked on the electronic unit. Wrong supply voltage will damage the system.

**DANGER:** Before working on the mechanical parts of the system (frame, shaft, slitted discs, etc...), the shaft MUST be stopped and locked in this state (start interlocks must be engaged if present). All the personell MUST be informed beforehand that the shaft MUST NOT be rotated or started prior to further notice. Clearly readable warning plates MUST be placed in all the locations from which it is possible to start the shaft, and these locations must be surveilled to prevent unauthorized starting of the shaft. The installation of the mechanical parts MUST be carried out by authorized and specialized personell only. Prior to proceed to the installation, the personell MUST carefully read, and understand, the installation instructions. Before working on the frame power supply must be removed.

**SAFETY WARNING:** After finishing to work on the mechanical parts of the system (frame, shaft, slitted discs, etc.), the earth connection of the frame must also be checked.

**SAFETY WARNING:** The laser unit contains a class II, 1mW 670nm, laser source. Do not stare directly into the beam or view it directly using optical instruments.

**SAFETY WARNING:** Both the electronic unit and the frame mounted on the shaft **MUST** be earthed.  
The electronic unit supply cable, must have an earth conductor (yellow/green).

### 0.3 Configuration emergency restore procedure

In case the system hangs up due to a wrong eeprom parameters setup, or due to a power supply black out during eeprom writing, it is always possible to restore the default configuration of the system keeping pressed the UP and DOWN keys at the same time and pressing the reset pushbutton (or removing and restoring the power supply to the electronic unit after few seconds). The UP and DOWN keys must be kept pressed till the LCD displays:

writing sector xx

where xx is the eeprom sector number (that is the number of the user configuration) to be restored (xx varies from 0 to 7).

At the end of the emergency restore procedure the default parameters are loaded in all the user configurations of the system (the default parameters are listed at chapter 5 – Menu mangement – menu26 – User configuration selection). Moreover the Remote control mode OFF is set. As a consequence of this the modification of some parameters with client customized parameters could be necessary.

Note: The system is delivered to the client with the default parameters loaded in users configurations from 2 to 7, while in user configurations 0, 1 the client customized parameters (specified by the client at the order) are loaded. As a consequence of this, the system is immediately usable (normally it is only necessary to adjust the Discs angle parameter – menu25 to set the actual value of their overlap, see chapter 3 – Initial setup).

The default parameters are listed at chapter 5 – Menu description – menu26 – User configuration selection (moreover Remote control OFF mode is set).

## 0.4 SD Card insertion and extraction

### SD Card insertion

The SD Card must be inserted in the slot of the LTM2214 electronic unit and then pressed inside gently till a “click” is heard which indicates that the card is correctly inserted and blocked in position.

### SD Card extraction

The card must be pressed inside gently till a “click” is heard which indicates that the card is unblocked. The spring will then push the card out of the slot permitting its extraction.

#### Note:

The SD card must NOT be removed from the slot while data storage is in progress as this could cause an unrecoverable data loss.

To remove the SD card safely, press the MENU (▶) pushbutton prior to extract the SD card to block pending write cycles. Once the card is extracted, press again the MENU (▶) pushbutton to return to normal operating mode.

#### **Notice:**

The SD Card must be preformatted (e.g. using a PC disk management utility) in FAT32 format. Other older formats are not recognized by LTM2214. SDSC and SDHC cards are supported.

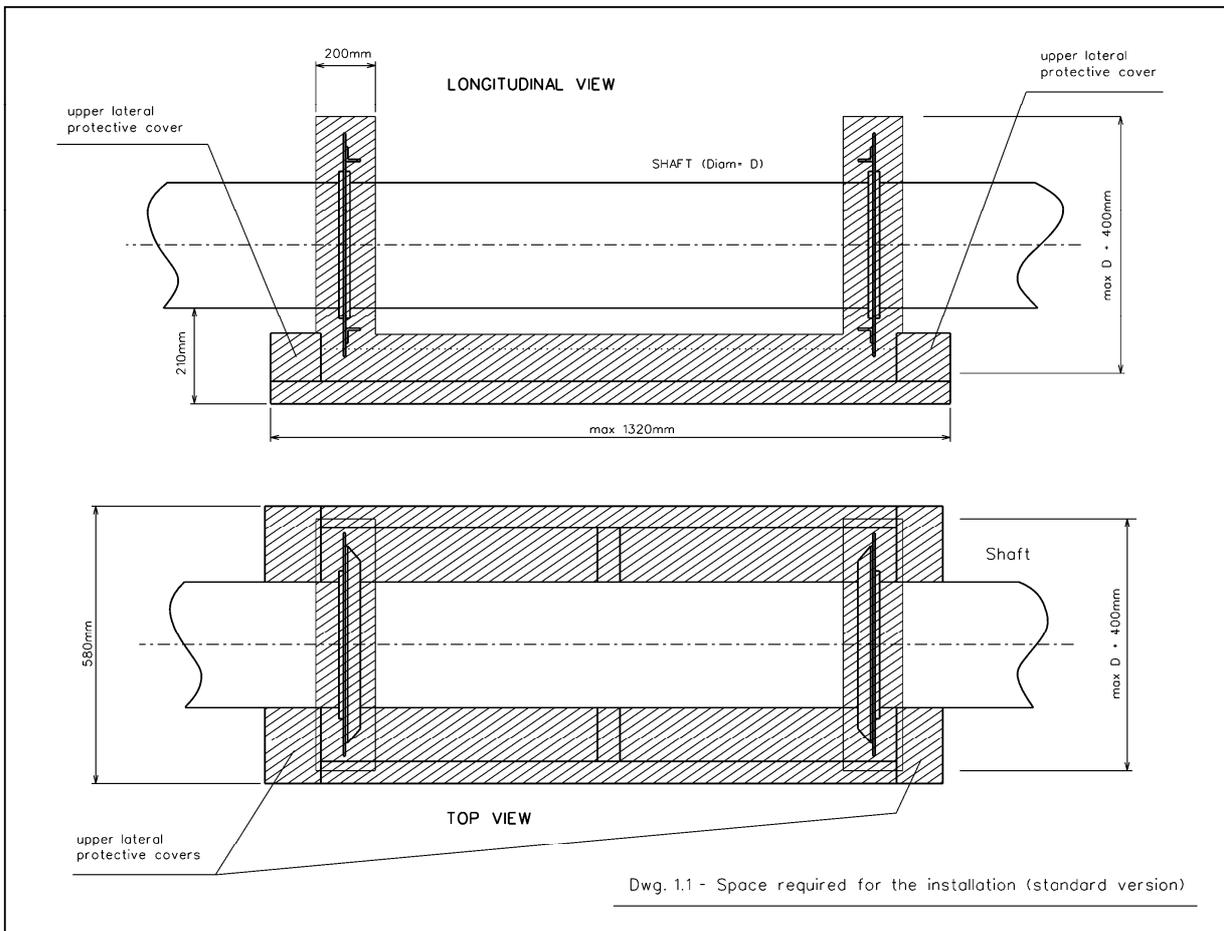
# 1. Ordering instructions

At the order the following data must be specified:

- 1) External shaft diameter (with 0.1mm accuracy)
- 2) Internal shaft diameter and shaft typology (only in case of hollow shafts, with 0.1mm accuracy)
- 3) Characteristics of shaft material
- 4) Minimum and maximum shaft RPM
- 5) Maximum shaft power
- 6) Length of the interconnection cables between the frame and the electronic unit (standard length 12m)
- 7) Dimensions of obstacles which may limit the maximum slitted discs diameter

Space required for the installation (see dwg. 1.1, hatched areas):

In order to be able to install the LTM2214, two short cylindrical free areas coaxial with the shaft of about  $D+400\text{mm}$  in diameter (where  $D$  is the shaft diameter) and 200mm in length in correspondence of each of the two discs, and a parallelepiped shaped free area under the shaft of about 580mm transversally, 210mm vertically and 1320mm in length along the shaft must be available.



## 4. Operating modes

The system has the following operating modes which can be selected by the user:

- 1) Configuration mode
- 2) Calibration mode
- 3) Torque meter mode
- 4) Engine performance monitor mode (FOC and SFOC display)
- 5) Vibrotorsional sampling mode

### 4.1 Configuration mode

**Note:** The LTM2214 is delivered to the client with the frame factory focused, collimated and calibrated and with the electronic unit already set with the client custom setup table parameters (see chapter 11). As a consequence of this no modification to menu preset parameters is normally necessary, apart from the adjustment of “discs angle” (menu25) parameter, and of “L” (menu11) parameter, in case the distance between the two discs is different from the design one.

The custom setup table (see chapter 11) is enclosed to this manual and varies from system to system.

Should modifications to the monitored shaftline system be made afterwards, the setup parameters will have to be modified accordingly. If necessary our technical assistance service can confirm you via email the parameters to set.

LTM2214 can be configured by means of the keypad (see chapter 5 – Menu description).

At power on the system enters one of the three presettable operating modes (torque meter, vibrotorsional sampling, engine performance monitor). To enter the configuration mode it is necessary to press once the pushbutton MENU (▶). At this point the menu management functions are accessible (see chapter 5 – Menu description). Select the desired submenu and set the parameters.

**Note:** Some functions are protected to prevent inadvertent modification of critical parameters. To unprotect the keypad select Keypad Unprotect (menu35) and press OK. After this the keypad will remain unprotected for 30 minutes. After this period has elapsed the unprotect sequence must be repeated again. Display mode selection functions are always enabled.

Once parameters setup is finished another pressure of MENU (▶) pushbutton permits to return to the preset display mode.

### 4.2 Torque meter mode

It is the mode normally used, and it is set as default.

In this mode the system displays, depending on the set LCD display mode, the values of RPM, shaft rotation direction, torque, power, percentages, hour in HH:MM:SS format, and of the date in the DD/MM/YYYY format.

To select the torque meter mode it is necessary that in menu22 (LCD refresh, Operating mode) the menu226 (System calibration) or menu227 (Vibrotorsional data sampling) are not set. On

the contrary one of the options ranging from menu220 (0.1sec) to menu225 (5sec) must be set. The options from menu220 to menu225 select the refresh period of the data displayed on the LCD and sent to the serial ports. Moreover in menu30 (LCD display setting) menu312 (LCD ON) must be set.

Measured values normally vary because of the fluctuations of prime mover RPM, of the torque, and power delivered to the shaft which depend on the loading capability of the driven machinery (e.g. a ship propeller may sometime cavitate or have power absorption pulsations). In case load fluctuations are wide and quick, LCD displayed data will change quickly and continuously. This is the evidence of the quality of the instrument and of the fact that it can discriminate even small and quick variations of the measured values. If the LCD refresh rate is too quick and become difficult to read, it is possible to select a longer refresh period (1 second or higher).

Moreover if a serial port is used to download measured data to a PC for data logging to be used for long term trend analysis, it is advisable to set an even longer refresh period (e.g. 5 seconds). In fact at every LCD data refresh serial data is sent on the enabled serial lines. In this case a short refresh period will fill quickly the PC (or automation system) memory.

Note: The serial lines must be enabled to transmit data.

Several display modes are available and can be selected with menu30 (LCD display setting). Available display modes in torque meter mode are menu331, menu332, menu333 (menu312 - LCD ON must always be active).

Note: In order to achieve the best measurement resolution it is suggested to set in menu21 (Counter period selection) to the value determined by the manufacturer and listed in the custom setup table (see chapter 11). In some special cases the setting of parameters different from the ones suggested by the manufacturer for the specified mechanical system can lead to malfunctioning and to wrong measurement.

The custom setup table is determined by the manufacturer taking into account the mechanical parameters of the system as shaft diameter, distance between the discs, angular aperture of the single slit, discs overlap percentage, maximum and minimum shaft RPM, optical radius of the discs. For example the setting of parameters different from the suggested ones could lead to the overflow of the counter which determines the collimation time of the laser beam causing errors in torque and power calculation.

For the above mentioned reasons each LTM2214 system is delivered with a custom setup table which is enclosed to this manual (see chapter 11 – Custom setup table).

Moreover, if alarms and warnings output is enabled, when the preset threshold is exceeded, the signalling via serial lines and dedicated clean contacts are activated (up to 3 alarm channels assignable by the user with 1 pole changeover contacts relays). The warning threshold is automatically set to 90% of the corresponding alarm threshold. The warning is transmitted only via serial lines.

### 4.3 Engine performance monitor mode

This mode permits to monitor, on the LCD display, the overall performance of the system, composed by shaft – prime mover, taking into account the fuel consumption and the specific fuel oil consumption (SFOC) of the prime mover itself.

This mode actually is a particular torque meter display mode.

So all the considerations made for the torque meter mode are valid, with the only difference that in menu30 (LCD display setting) menu334, which enables the mode in question, must be set.

LCD display is as follows:

RPM= xxxx	VS
P(kW)= xxxxx	
FOC(l/h)= xx.x	
SFOC(l/kWh)= x.xxx	

where: RPM: shaft speed in RPM  
 VS: direction of rotation of the shaft  
 P: shaft power in kW or W  
 FOC: instantaneous fuel oil consumption of the prime mover in liters/hour  
 SFOC: specific fuel oil consumption of the prime mover (variable between 0.000 and 1.000) in liters/kWh

Alternatively if menu335 is selected the LCD displays:

RPM= xxxx	VS
P(kW)= xxxxx	
FOC(kg/h)= xx.x	
SFOC(g/kWh)= x.xxx	

where: RPM: shaft speed in RPM  
 VS: direction of rotation of the shaft  
 P: shaft power in kW or W  
 FOC: instantaneous fuel oil consumption of the prime mover in kg/hour  
 SFOC: specific fuel oil consumption of the prime mover (variable between 0.0 and 1000.0) in g/kWh

**Note:** If menu335 is selected the actual fuel density value must be set in the menu66.

In both cases measured data are transmitted on the serial lines (if enabled).  
 Moreover, if the output of alarms and warnings is enabled, when the preset thresholds are reached the signalling is activated.

#### 4.4 Vibrotorsional sampling mode

This operating mode is used to monitor the torsional vibrations to which the shaft is subject during its operation. To enhance the reliability of the system, UPS supply is recommended.

In a real dynamic system, torsional vibrations are caused by the continuous fluctuations of the torque applied to the shaft and cause an applied torque variation, around its mean value. So, if a constant torque is applied to the shaft, torsional vibrations are an oscillatory component superimposed to the applied torque.

Torsional vibrations are caused by the instantaneous variations of the power absorbed by the load and by the variations of the power delivered by the prime mover (e.g. due to the pulsations which, in an internal combustion engine, are generated by the combustion of the fuel in each cylinder which are not completely damped by the flywheel inertia).

In ship propulsion case also the non uniform power absorption of shaft delivered power by the propeller can produce torsional vibrations.

As high intensity torsional vibrations can stress excessively the system, wearing it untimely and causing failures, it is very useful to monitor periodically the intensity of torsional vibrations at the various reference working conditions.

LTM2214 permits vibrotorsional sampling and their post processing using a PC and the supplied software.

Torsional vibration data must first be sampled and stored in the torque meter memory and/or on the SD card, then downloaded via serial link to the PC (alternatively data can be downloaded to the PC using the SD Card), and then postprocessed on the PC.

This approach is preferable as real time vibrotorsional analysis (with data processing and display on the torque meter itself) would require many additional megabytes of memory and an hardware dedicated only to vibrotorsional monitoring. All these features would not be used in the other operating modes. Moreover the limited LCD display dimensions would not allow an adequate graphical display of the measured values. It is also to be considered that vibrotorsional analysis is carried out only in particular circumstances (e.g. shaft alignment, after machinery overload and/or failures, etc...) and not continuously. Usually this analysis is carried out with expensive laboratory instruments and only time windows of few seconds (or minutes) are considered.

An instrument for real time vibrotorsional analysis is very expensive and really redundant compared to the normal monitoring requirements of an already aligned and up and running shaftline.

Despite this LTM2214 can carry out an accurate vibrotorsional analysis using a standard PC for data postprocessing.

To set vibrotorsional sampling it is necessary to enter the menu management, select menu 20 (Miscellaneous parameters), select menu21 (Counter period selection) and then set menu210 (0.0166666usec) option pressing OK (◀) pushbutton, to allow the maximum measurement resolution possible. Then it is necessary to exit the menu management pressing again the MENU (▶) pushbutton.

Then activate vibrotorsional sampling mode: enter again menu management, select menu227 (Vibrotorsional data sampling) option and press the OK (◀) pushbutton. Then exit the menu management pressing again the MENU (▶) pushbutton.

After this the LCD will display:

```
Vibrotorsional
sampling
Array: 0%
DOWN=Start sampling
```

to indicate that the sampling is enabled.

To start the sampling it is sufficient to press the DOWN (▼) pushbutton. During the sampling the percentage of filled memory is shown.

```
Vibrotorsional
sampling
Array: x%      RUNNING
UP=stop
```

In case the memory is completely filled, the LCD will display "Array full". At this point the sampling stops automatically and the system waits for other comands.

The sampling time duration is variable and depends on the shaft speed. The higher the speed, the quicker the samples are generated and the quicker the memory is filled. Typically memory filling time varies between 5 and 30 minutes depending on the shaft speed.

To stop the sampling it is sufficient to press the UP (▲) pushbutton and the LCD will display:

Vibrotorsional sampling Array: x% DOWN=start	HALTED OK=reset
---	--------------------

At this point to start again the sampling it is sufficient to press the DOWN (▼) pushbutton and the new samples will be appended to the already stored ones.

It is possible to reset the samples array pressing the OK (◀) pushbutton after having stopped the sampling in progress pressing the UP (▲) pushbutton (actually the OK (◀) pushbutton is enabled even before the sampling is started, even if, in this case, the samples array is automatically reset and so it does not need manual intervention). After resetting the LCD will display:

Vibrotorsional sampling Array: x% DOWN=start	RESET
---	-------

To download the data to a remote PC it is sufficient to connect the serial cable of the PC to the RS232 port (port 0) of the electronic unit (or to the RS422 port (port 1) if the PC has an RS422 port), start a terminal emulation software or the remote management utility supplied with the LTM2214 on the PC in file capture mode. To speed up the download it is suggested to use the highest baud rate available (equal or higher than 115200 baud).

**Note:** Make sure that the electronic unit is set to the same baud rate (menu50, menu55/menu56, menu555-menu558/menu565-menu568).

Start the file capture on the remote PC.

Enter the menu management and select menu50 (Serial ports setting), select menu57 (Vibrotorsional data download for PC postprocessing) or menu58 (Vibrotorsional data download for Perc\_slot calibration).

Wait the completion of the data download. During the process the LCD displays the progress percentage. At the end of the process the LCD displays "Download completed".

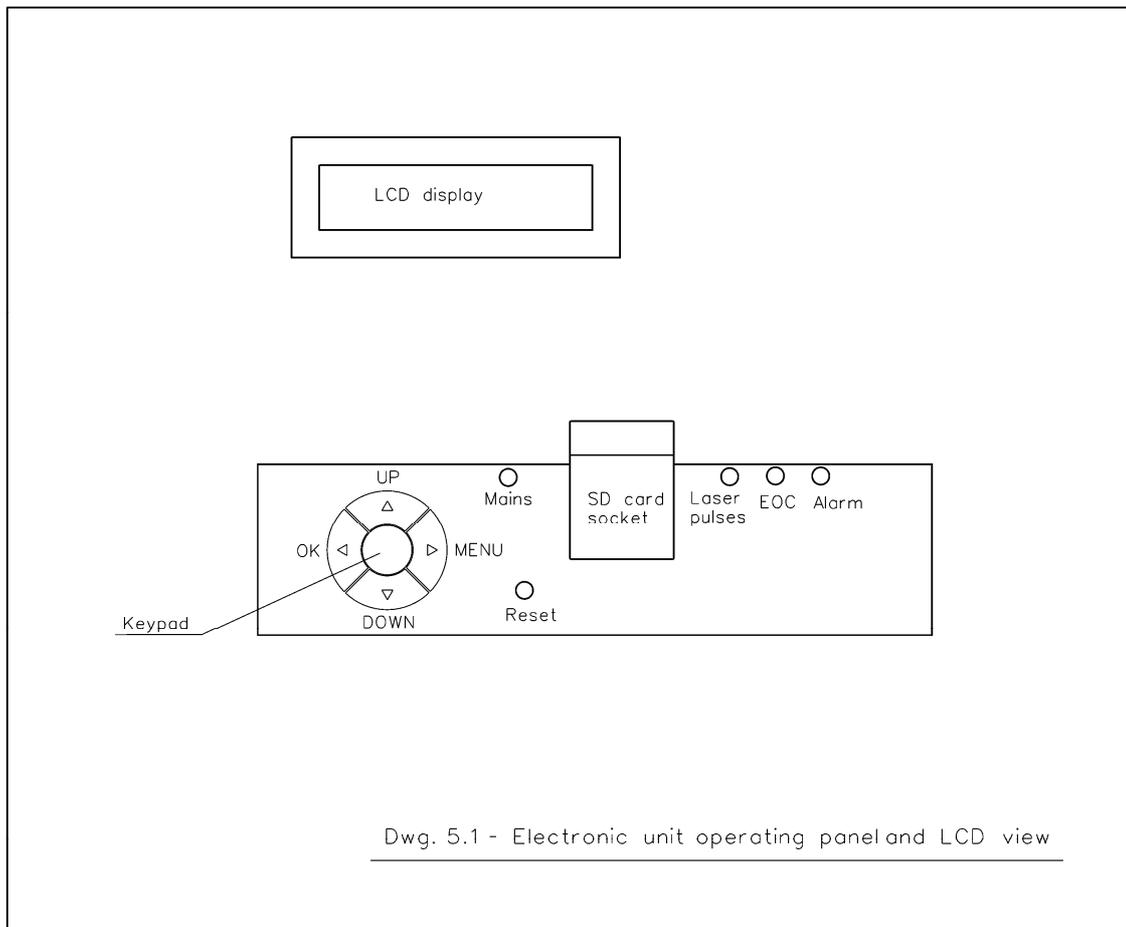
At this point the PC capture file can be closed.

If no other vibrotorsional sampling must be carried out, it is possible to go back to torque meter mode or to engine performance monitor mode.

The data stored in the remote PC can be processed with the supplied analysis utility.

## 5. Menu description

All system parameters (mechanical, electrical, interfacing, alarms, etc..) are set by means of four pushbuttons MENU (▶), OK (◀), UP (▲), DOWN (▼) of the keypad located inside the electronic unit panel (see Dwg. 5.1). These pushbuttons allow an easy and simple navigation in the menu structure.



Note: The system is delivered with the parameters specified by the client at the order already set in user configuration 1 and in the default configuration (eeprom sector 0). The table with the list of these parameters is enclosed at chapter 11 (Custom setup table). If necessary in every moment it is possible to load the default values via keypad.

**Note:** Some functions are protected to prevent inadvertent modification of critical parameters. To unprotect the keypad select Keypad Unprotect (menu35) and press OK. After this the keypad will remain unprotected for 30 minutes. After this period has elapsed the unprotect sequence must be repeated again. Display mode selection functions are always enabled.

### MENU (▶) pushbutton

The menu management mode is entered (at menu10 – Mechanical parameters), pressing the MENU (▶) pushbutton, from all the display modes. At the end of the setting process, pressing

the MENU (▶) pushbutton again will exit the menu management mode and put the system in the previously selected display mode.

#### OK (◀) pushbutton

The OK (◀) pushbutton is used to store the value of the selected parameter or to navigate inside the menu management (entering/exiting menus).

#### UP (▲) pushbutton

The UP (▲) pushbutton is used to navigate between the selectable options of a menu, or to increment the value of a parameter with the preset step.

Pressing the UP (▲) pushbutton in correspondence of the first item of a menu sends (in a circular manner) to the last item of the same menu. With an additional pressure of the UP (▲) pushbutton the various items of the menu are sequentially visited navigating upwards.

#### DOWN (▼) pushbutton

The DOWN (▼) pushbutton is used to navigate between the selectable options of a menu, or to decrement the value of a parameter with the preset step.

Pressing the DOWN (▼) pushbutton in correspondence of the last item of a menu sends (in a circular manner) to the first item of the same menu. With an additional pressure of the DOWN (▼) pushbutton the various items of the menu are sequentially visited navigating downwards.

#### ON/OFF (central) pushbutton

The ON/OFF pushbutton, when pressed for more than two seconds, turns on or turn off the system, toggling its state.

Note: The system actually does not turn off but enters the idle mode, a low consumption mode (the electronic unit absorbs about 650mW with respect to the 15W of the on mode). In idle mode all the stored data are maintained. In idle mode the frame mounted on the shaft remains powered and absorbs about 600mW.

The system menu has a tree structure which is listed below.

The two or three digits number preceding each tag is the menu page code.

**Note:** Depending on the purchased system configuration, some menu items may be unavailable. Available system configurations are:

- Basic (vibrotorsional and fuel menu items unavailable)
- Basic+Vibrotorsional (fuel menu items unavailable)
- Basic+SFOC (vibrotorsional menu items unavailable)
- Basic+Vibrotorsional+SFOC (all menu items available)

**Note:** In the following text the (P) denotes a protected menu, the (U) an unprotected one. To unprotect the keypad select Keypad Unprotect (menu35) and press OK.

### MENU STRUCTURE:

10: Mechanical Parameters (P)

11: L(mm) (P)

12: D(mm) (P)

121: Dext(mm) (P)

122: Dint(mm) (P)

123: Exit (P)

13: G(mm) (P)

14: RPMmax (P)

- 15: kWmax (P)
- 16: Power Coefficient(+/-) (P)
- 17: Power Distorsion(+/-) (P)
- 18: Rotation direction (P)
  - 180: Clockwise (P)
  - 181: Counterclockwise (P)
- 19: Exit (P)
  
- 20: Miscellaneous Parameters (P)
  - 21: Counter period selection (P)
    - 210: 0.01666666 usec (P)
    - 211: 0.03333333 usec (P)
    - 212: 0.05000000 usec (P)
    - 213: 0.06666666 usec (P)
    - 214: 0.08333333 usec (P)
    - 215: 0.10000000 usec (P)
    - 216: 0.11666666 usec (P)
    - 217: 0.13333333 usec (P)
    - 218: 0.15000000 usec (P)
    - 219: Exit (P)
  - 22: LCD refresh / Operating mode (P)
    - 220: 0.1 sec (P)
    - 221: 0.2 sec (P)
    - 222: 0.5 sec (P)
    - 223: 1.0 sec (P)
    - 224: 2.0 sec (P)
    - 225: 5.0 sec (P)
    - 226: System calibration (P)
    - 227: Vibrotorsional data sampling (P)
    - 228: LD/RO\*100 (P)
    - 229: Exit (P)
  - 23: Slits number (P)
  - 24: Slit aperture (P)
  - 25: Discs angle (P)
  - 26: User configuration selection (P)
    - 260: User 1/2/3/4 (P)
    - 261: User 5/6/7 (P)
    - 262: Restore / Exit (P)
  - 27: Calculation algorithm (P)
    - 271: Calculation from Dt (P)
    - 272: Calculation from cubic equation (P)
    - 273: Coefficient A ( $x^3$ ) (P)
    - 274: Coefficient B ( $x^2$ ) (P)
    - 275: Coefficient C ( $x^1$ ) (P)
    - 276: Coefficient D ( $x^0$ ) (P)
    - 277: Filter coefficient (1-120) (P)
    - 278: Exit (P)
  - 28: Backup battery operation (P)
    - 281: Backup battery present (P)
    - 282: Backup battery not present (P)
  - 29: Exit (P)
  
- 30: LCD display setting (U)
  - 31: LCD visualization (P)
    - 311: LCD OFF (P)
    - 312: LCD ON (P)
    - 313: Metric system (SI system) (P)
    - 314: Imperial system (P)
    - 315: Scaling factor x1 (P)
    - 316: Scaling factor x1000 (P)
    - 317: Exit (P)
  - 32: LCD language (P)

- 321: English / Italiano / Deutsch / Francois (P)
- 33: Display mode (U)
  - 331: RPM, % | VS | kW, % | kNm, % (U)
  - 332: RPM , VS | kW | RxTemp | TxTemp (U)
  - 333: Date, Time | RPM, VS | kW | kNm (U)
  - 334: RPM, VS | kW | l/h | l/kWh (U)
  - 335: RPM, VS | kW | kg/h | g/kWh (U)
  - 336: Timing debug (U)
  - 337: Exit (U)
- 34: Backlight (U)
- 35: Keypad unprotect (U)
- 39: Exit (U)
  
- 40: SD card setting (P)
  - 41: SD Card log OFF (P)
  - 42: SD Card log ON (P)
  - 43: SD Tsample (P)
  - 44: SD RPM min (P)
  - 45: SD card free space (kB) / space used (kB) / number of files (P)
  - 46: Download of vibrotorsional sampling to SD Card (P)
  - 47: Download of SD Card files to serial ports (P)
    - 470: Download SD card files to serial ports (P)
    - 471: SD card raw dump to serial ports (P)
    - 472: Exit (P)
  - 48: SD Card recovery (P)
  - 49: Exit (P)
  
- 50: Serial ports setting (P)
  - 51: Serial RTx OFF (P)
  - 52: Port 0 /Port 1 ON (P)
    - 520: Port 0 ON (P)
    - 521: Port 1 ON (P)
    - 522: Port 0,1 ON (P)
    - 523 : Exit (P)
  - 53: NMEA0183 (P)
  - 54: Custom format (P)
    - 541: Custom 1 (P)
    - 542: Custom 2 (P)
    - 543: Custom 3 (P)
    - 544: Exit (P)
  - 55: Serial port 0 baud rate (P)
    - 550: 4800baud (P)
    - 551: 9600baud (P)
    - 552: 19200baud (P)
    - 553: 38400baud (P)
    - 554: 56600baud (P)
    - 555: 115200baud (P)
    - 556: 230400baud (P)
    - 557: 460800baud (P)
    - 558: 921600baud (P)
    - 559: Exit (P)
  - 56: Serial port 1 baud rate (P)
    - 560: 4800baud (P)
    - 561: 9600baud (P)
    - 562: 19200baud (P)
    - 563: 38400baud (P)
    - 564: 56600baud (P)
    - 565: 115200baud (P)
    - 566: 230400baud (P)
    - 567: 460800baud (P)
    - 568: 921600baud (P)
    - 569: Exit (P)

- 57: Vibrotorsional data download for PC postprocessing (P)
- 58: Vibrotorsional data download for Perc\_slot calibration (P)
- 59: Exit (P)
  
- 60: Fuel meter setting (P)
  - 61: Fuel input OFF (P)
  - 62: Fuel input ON (P)
  - 63: Pulse/liter (P)
  - 64: V/l per l/h (P)
  - 65: Input type (P)
    - 651: Pulse (P)
    - 652: 4/+20mA (P)
    - 653: 0-3.3V/0-20mA (P)
    - 654: Exit (P)
  - 66: Fuel density g/dm<sup>3</sup> (kg/m<sup>3</sup>) (P)
  - 67: Exit (P)
  
- 70: Real Time Clock setting (P)
  - 71: RTC OFF (P)
  - 72: RTC ON (P)
  - 73: Day (P)
  - 74: Month (P)
  - 75: Year (P)
  - 76: Day of week (S,M,T,...,F,S) (P)
    - 761: Sunday (P)
    - 762: Monday (P)
    - 763: Tuesday (P)
    - 764: Wednesday (P)
    - 765: Thursday (P)
    - 766: Friday (P)
    - 767: Saturday (P)
    - 768: Exit (P)
  - 77: Hour (P)
  - 78: Minutes (P)
  - 79: Exit (P)
  
- 80: Alarms setting / ETC (Embedded Temperature Control) setup (P)
  - 81: RPM alarm (P)
    - 810: RPM alarm OFF (P)
    - 811: DOUT 1 ON (P)
    - 812: DOUT 2 ON (P)
    - 813: DOUT 3 ON (P)
    - 814: Buzzer OFF (P)
    - 815: Buzzer ON (P)
    - 816: Set point (P)
    - 817: Exit (P)
  - 82: Torque alarm (P)
    - 820: Torque alarm OFF (P)
    - 821: DOUT 1 ON (P)
    - 822: DOUT 2 ON (P)
    - 823: DOUT 3 ON (P)
    - 824: Buzzer OFF (P)
    - 825: Buzzer ON (P)
    - 826: Set point (P)
    - 827: Exit (P)
  - 83: Power alarm (P)
    - 830: Power alarm OFF (P)
    - 831: DOUT 1 ON (P)
    - 832: DOUT 2 ON (P)
    - 833: DOUT 3 ON (P)
    - 834: Buzzer OFF (P)
    - 835: Buzzer ON (P)

- 836: Set point (P)
- 837: Exit (P)
- 84: FOC alarm (P)
  - 840: FOC alarm OFF (P)
  - 841: DOUT 1 ON (P)
  - 842: DOUT 2 ON (P)
  - 843: DOUT 3 ON (P)
  - 844: Buzzer OFF (P)
  - 845: Buzzer ON (P)
  - 846: Set point (P)
  - 847: Exit (P)
- 85: SFOC alarm (P)
  - 850: SFOC alarm OFF (P)
  - 851: DOUT 1 ON (P)
  - 852: DOUT 2 ON (P)
  - 853: DOUT 3 ON (P)
  - 854: Buzzer OFF (P)
  - 855: Buzzer ON (P)
  - 856: Set point (P)
  - 857: Exit (P)
- 86: Total revolution alarm (P)
  - 860: Total revolution alarm OFF (P)
  - 861: DOUT 1 ON (P)
  - 862: DOUT 2 ON (P)
  - 863: DOUT 3 ON (P)
  - 864: Buzzer OFF (P)
  - 865: Buzzer ON (P)
  - 866: Set point (P)
  - 867: Exit (P)
- 87: Energy alarm (P)
  - 870: Energy alarm OFF (P)
  - 871: DOUT 1 ON (P)
  - 872: DOUT 2 ON (P)
  - 873: DOUT 3 ON (P)
  - 874: Buzzer OFF (P)
  - 875: Buzzer ON (P)
  - 876: Set point (P)
  - 877: Exit (P)
- 88: Buzzer global enable / ETC (P)
  - 880: Buzzer enabled (P)
  - 881: Buzzer disabled (P)
  - 882: ETC enabled (P)
  - 883: ETC disabled (P)
  - 884: Exit (P)
- 89: Exit (P)

90: Exit (U)

In the following paragraph all the menus are described in detail.

**Note:** The character '?' displayed on the LCD immediately following a menu item means that that item is of ON/OFF type and that, to activate it, or to enter the submenu it is sufficient to press the OK (◀) pushbutton. The characters '=?' displayed on the LCD immediately following a menu item mean that that item is a parameter which can be varied continuously. In this case to modify the parameter value it is necessary to press OK (◀) pushbutton to enter the edit mode (the current parameter value will be displayed) and then edit the parameter with UP (▲) and/or DOWN (▼) pushbuttons as necessary. A prolonged pressure UP (▲) or DOWN (▼) pushbuttons will activate the fast mode which

will vary the parameter value exponentially as the pushbutton is kept pressed. If the pushbutton is released and pressed again, fast mode switches off and the increment/decrement will be slow. To store the value of a modified parameter it is sufficient to press the OK (◀) pushbutton and wait that the LCD displays the following:

Parameter upload  
completed .....  
Press MENU to exit

### 10: Mechanical parameters (P)

This menu is used to set the dimensional mechanical parameters of the system. The selectable items are the following:

#### 11: L(mm)=? (P)

This is the value of the distance (in mm) at which the two discs are spaced. The distance to set is the internal one between the faces of the two discs, measured along the shaft. The value can be varied with 0.1mm steps. The default value is 830.0mm.

#### 12: D(mm)? (P)

This submenu used to set shaft diameter. The selectable items are:

#### 121: Dext(mm)=? (P)

This is the value of shaft external diameter (in mm). The value can be varied with 0.1mm steps. The default value is 460.0mm.

#### 122: Dint(mm)=? (P)

This is the value of shaft internal diameter (in mm) to be used in case of hollow shafts. The value can be varied with 0.1mm steps. In case the shaft is not hollow, set this parameter to 0. The default value is 0.0mm.

#### 123: Exit (P)

Used to return to the higher level menu.

#### 13: G(N/sqmm)=? (P)

This is the value of the torsional elasticity module (in N/mm<sup>2</sup>) of the shaft material. For carbon steel shaft this value ranges between 79000N/mm<sup>2</sup> and 88000N/mm<sup>2</sup>. If the G value is not known, it can be calculated from Young module (E) using the known formula:

$$G = E / (2 \times (1 + \mu))$$

where:

E = Young module in N/mm<sup>2</sup> (usually varying between 205000N/mm<sup>2</sup> and 220000N/mm<sup>2</sup>)

μ = adimensional parameter (usually varying between 0.25 and 0.3)

This formula is often used in the following form:

$$G = E \times 2 / 5 = E \times 0.4$$

where μ = 0.25

The value can be varied with 1N/mm<sup>2</sup> steps. The default value is 84000N/mm<sup>2</sup>.

14: RPMmax=? (P)

This is the value of the maximum shaft speed (in RPM). The value can be varied with 1RPM steps. The default value is 650RPM.

15: kWmax=? (P)

This is the value of the maximum shaft power (in kW). The value can be varied with 1kW steps. The default value is 20000.0kW.

16: PCoeff(+/-)=? (Power Coefficient) (P)

This is the value of the coefficient which multiplies the time variation measured with respect to the nominal zero torque period. The value can be varied with 0.001 steps. Power Coefficient value can be positive or negative. The default value is 1.000sec.

17: PDist(+/-)=? (Distorsion Coefficient) (P)

This is the value of the coefficient by which the total collimation time is multiplied. The value can be varied with 0.001 steps. Distorsion Coefficient value can be positive or negative. The default value is 1.000mm.

18: Rotation direction (P)

This submenu used to set shaft rotation direction.  
The default value is clockwise direction.  
The selectable items are:

180: clockwise (P)

Selects clockwise rotation direction.

181: counterclockwise (P)

Selects counterclockwise rotation direction.

19: Exit (P)

Used to return to the higher level menu.

20: Miscellaneous parameters (P)

This menu is used to set parameters of different types (mechanical, dimensional and electrical) of the system.

The selectable items are the following:

21: Conunter period selction (P)

This submenu is used to set the counter period selection. The default value is 0.0166666usec.  
The selectable items are the following:

210: 0.0166666usec (P)

211: 0.0333333usec (P)

212: 0.0500000usec (P)

213: 0.0666666usec (P)

214: 0.0833333usec (P)

215: 0.1000000usec (P)

216: 0.1166666usec (P)

217: 0.1333333usec (P)

218: 0.1500000usec (P)

219: Exit (P)

Used to return to the higher level menu.

22: LCD refresh / Operating mode (P)

This submenu is used to set data refresh frequency and system operating mode. The default value is 0.5sec.

The selectable items are the following:

220: 0.1sec (P)

Updates data every 0.1sec.

221: 0.2sec (P)

Updates data every 0.2sec.

222: 0.5sec (P)

Updates data every 0.5sec.

223: 1sec (P)

Updates data every 1sec.

224: 2sec

Updates data every 2sec.

225: 5sec

Updates data every 5sec.

226: System calibration (P)

Depending on the value of the Filtering coefficient (menu277), this mode is used to carry out the laser beam power calibration or to determine Disc angle (menu25) value using the shaftline turning gear.

**Note:** The Filtering coefficient value (menu277) must be set before entering system calibration mode.

a) Laser beam power calibration

If the Filtering coefficient (menu277) value is higher than 1 laser beam power calibration mode is entered (normally a value between 2 and 6 should be used).

**Note:** This mode is intended to be used with the calibration tool mounted on the receiver (see chap. 2.2.4).

In this mode the LCD displays:

RPM=x.xxx	d=x.xx%
Ang.=x.xxxx	d=x.xx%
PDist.=x.xxxx	
AC=x.xxxx	N=xxx

This mode measures the calibration disc RPM and its percentage variation (d=x.xx%), the calculated slit aperture angle (Ang.) of the calibration disc and its percentage variation (d=x.xx%) and the correction coefficient (PCoeff.) to be set in the system to compensate the aberration of the laser optics. Moreover the calculated value of the corrected angle (AC) and the number of slits (N) of the calibration disc is displayed.

The measurement can be considered reliable if the percentage variations are less than 1.5%. It is normally sufficient to wait for the calibration disc speed to stabilize to obtain acceptable percentage variations (an appropriate value for the filtering coefficient (menu277) is 6).

This mode is used to determine the coefficient (PDist.) which must be set in the Distorsion coefficient parameter (menu17).

To restore the torque meter mode it is sufficient to select an option ranging from menu220 to menu225.

**Important note:**

Before setting this mode make sure that:

- 1) the slit number parameter (menu23) is set to the number of slits of the calibration disc (usually 1)
- 2) the slit aperture parameter (menu24) is set to the value punched on the calibration disc
- 3) the filtering coefficient (menu277) value is between 2 and 6 otherwise the settling time is too long (at least 6 revolutions of the calibration disc are necessary to obtain a steady reading).

After completing the laser beam power calibration process remember to restore the slit number (menu23) and the slit angle (menu24) of the slitted discs mounted on the shaft and the filtering coefficient (menu277) parameters previously set and to carry out a new disc alignment (see Chapter 2.3.2).

b) Disc angle (overlap) determination

If the Filtering coefficient (menu277) is equal to 1, the Disc angle value determination mode is entered.

**Note:** This mode is intended to be used only with shaft rotated at very low speed using a turning gear. At speeds higher than 0.5RPM this procedure should not be used.

In this mode the LCD displays:

RPM=x.xx	N=xxx
min%=x.xx	max%=x.xx
PS=x.xxxx (x.xxxx)	
Reliability:--/--	xx

It measures the RPM, the number of slits counted, RPM minimum and maximum percentage variations (min%=, max%=), the calculated PS parameter (discs overlap percentage), and gives an indication of the overall reliability of the calculated PS value. In the right bottom corner of the LCD is displayed the number of grouped counts (this value is incremented whenever the number of slit counts between two subsequent LCD updates is higher than one). If the shaft speed is lower than 0.5RPM no value should be displayed in this area indicating that all slit counts are displayed one by one.

The measurement can be considered reliable if the RPM percentage variations are less than 1.5%. The values are displayed only after the first 18 slits are counted (that is only after N=17 is displayed).

When the shaft rotates, the N value is incremented from 1 to the total number of slits of the discs (Slits No. – menu23). The higher the value of N displayed, the higher the accuracy of the calculated PS value.

This mode is used to determine the slitted discs overlap coefficient (PS) which must be set in the Disc angle parameter (menu25).

Read the PS value in the brackets (calculated taking into consideration all the slits of the discs, so that the tolerances of all the slits are compensated).

The other PS value (on the left side of the LCD) varies continuously, as it is calculated on a slit by slit basis, and is displayed only for reference.

**Note:** After N reaches the maximum value (and PS is calculated with the samples of all the slits), N rolls over to 1 again and the PS value calculated is less reliable. As a matter of fact the value of PS smoothens as N gets higher. This is the reason why the PS value inside the brackets (which is calculated on the total number of slit and is updated only after the revolution is completed) must be used.

Wait for at least three complete rotations of the shaft to take place to read the value of PS. Use the value of PS with the highest reliability value. Possible values are: very high (HH), high(H), low (L), very low (LL), unreliable (--).

To restore the torque meter mode it is sufficient to select an option ranging from menu220 to menu225 and to set the filtering coefficient (menu277) to its original value.

#### Important note:

Before setting this mode make sure that:

- 1) the slit number (menu23) and the slit aperture (menu24) parameters are set to the value of the slitted discs mounted on the shaft.
- 2) the filtering coefficient (menu277) is equal to 1.

After completing the disc angle value determination process remember to restore the filtering coefficient (menu277) to the value previously set.

#### 227: Vibrotorsional data sampling (P)

Selects vibrotorsional data sampling mode.

For vibrotorsional sampling UPS supply is recommended.

For an exhaustive description of this mode see paragraph 4.4 (Vibrotorsional sampling).

**Note:** The sampling period is set in menu21 (see above). To restore torque meter mode it is sufficient to select an option ranging from menu220 to menu225.

#### 228: Ld/Ro\*100 (P)

Selects the compensation parameter for non dot like (circular) and/or focusable laser beams.

Note: Normally it is not necessary to set this parameter which must be left to its default value (0.0).

If the laser beam has a transversal profile (from the laser transmitter to the optical receiver) of cylindrical/elliptical type and its pattern on the receiver disc has an appreciable dimension, a measurement error which must be compensated, is induced.

Ld/Ro\*100 parameter takes care of this. If the beam is dot like or perfectly focused on the receiver disc, this parameter must be set to zero. On the contrary, if the beam is not focusable and has a cylindrical/elliptical longitudinal profile, the value to set for this parameter is given by the laser beam diameter Ld (measured at the receiver disc) divided by the optical radius Ro (that is the distance from the shaft center to the laser beam) multiplied by 100.

For example if the laser beam diameter (Ld) is equal to 6mm and the optical radius (Ro) is equal to 115mm, the parameter to set is equal to  $6/115*100=5.2$

The value can be varied with 0.1 steps. The default value is 0.0.

229: Exit (P)

Used to return to the higher level menu.

23: Slits number (P)

It is used to set the slits number of one disc. The value can be varied with unitary steps. The default value is 180.

24: Slit aperture (P)

It is used to set the angle, in degrees and tenths of degrees of the aperture of a single slit. The value can be varied with 0.001 degree steps. The default value is 1.000 degrees.

25: Discs angle (P)

It is used to set the discs overlap percentage with respect to the angular aperture of a single slit. A value of 0% means that the slits are completely overlapped and so the laser beam can not pass through the two discs, while a value of 100% means that the slits are perfectly aligned and so the laser beam can pass through the two discs for all the aperture of each single slit. The value ranges from 0.0000 to 1.0000.

The value can be varied with 0.0001 steps. The default value is 0.5000.

26: User configuration selection (P)

This menu is used to load the user parameters configurations of the system. Seven sets of freely configurable user parameters are available. Moreover a default parameter set is present (loaded in eeprom 0 sector) which is the one loaded at system startup in SRAM. To use and/or modify a particular set of the seven available, the user must simply select the required set navigating in menu260, menu261, and menu262. Doing so the selected set is copied into the default sector (0) and becomes the current set (the active one) in SRAM.

The modifications done to the current set (SRAM) are stored in the default set (0) and in the selected set (e.g. if set n.3 is selected, the modifications are stored in the current set (SRAM), in the default set (0) and in set n.3).

**Note:** If menu262 item 9) (Restore) is selected, the default parameters listed below will overwrite ALL parameters sets (from 1 to 7) previously modified and also the current sector (SRAM), and the default sector (0), so maximum attention must be paid before proceeding with this operation, which is normally used to completely reconfigure the system. Moreover the Remote control OFF mode is set.

Default parameters are listed below:

<b>10: Mechanical parameters</b>	11: L(mm)=890mm
	121: Dext(mm)=400mm
	122: Dint(mm)=0mm
	13: G(mm)=84000N/mm <sup>2</sup>
	14: RPMmax=650RPM
	15: kWmax= 22000kW
	16: PCoeff(+/-)=1.0000
	17: PDist(+/-)=1.0000
18: Rotation direction=clockwise	
<b>20: Miscellaneous parameters</b>	210: Counter period selection=0.0166666usec
	222: LCD refresh=0.5sec
	228: Ld/Ro=0.0
	23: Slits number=180
	24: Slit aperture=1.0degrees
	25: Discs angle=0.5000
	260: User configuration selection: User 0

	271: Calculation from Dt
	273: Coefficient $A(x^3)=0.0$
	274: Coefficient $B(x^2)=0.0$
	275: Coefficient $C(x^1)=0.0$
	276: Coefficient $D(x^0)=0.0$
	277: Filter coefficient=6
	281: Backup battery present (UPS supply)
<b>30: LCD display setting</b>	312: LCD ON
	313: Metric system
	316: Scaling factor x 1000
	321: Language= English
	331: RPM, %   VS   kW, %   kNm, %
	34: Backlight= 500
	35: Keypad protected
<b>40: SD Card setting</b>	41: log OFF
	43: SD Tsample=5sec
	44: SD RPMmin= 50RPM
<b>50: Serial ports setting</b>	522: Port 0=ON, Port 1=ON
	541: Data format=Custom 1
	555: Port 0 baud rate= 115200baud
	565: Port 1 baud rate= 115200baud
<b>60: Fuel meter setting</b>	62: Fuel input= ON
	63: Pulse/liter=1000pulse/l
	64: V/l for l/h= 1.000 l/(Vh) or l/(mAh)
	652: Input type= 4-20mA
	66: Fuel density=850kg/m <sup>3</sup> (g/l)
<b>70: Real Time Clock setting</b>	72: RTC ON
	73: Day=01
	74: Month=01
	75: Year=2011
	761: Day of week=Sunday
	77: Hour=12
	78: Minutes=00
<b>80: Alarms setting / ETC setup</b>	810: RPM alarm= OFF
	814: Buzzer OFF
	816: Set point= 10000
	820: Torque alarm= OFF
	824: Buzzer OFF
	826: Set point= 100000
	830: Power alarm= OFF
	834: Buzzer OFF
	836: Set point= 10000000
	840: FOC alarm= OFF
	844: Buzzer OFF
	846: Set point= 1000
	850: SFOC alarm= OFF
	854: Buzzer OFF
	856: Set point= 0.600
	860: Total revolutions alarm= OFF
	864: Buzzer OFF
	866: Set point= 1000000000
	870: Energy alarm= OFF
	874: Buzzer OFF

876: Set point= 1000000000
881: Buzzer global enable= disabled
882: ETC enabled

Note: It is possible to load the default parameters, even without accessing the menu management, keeping pressed contemporarily UP (▲) and DOWN (▼) pushbutton during system reset (for the details see chapter 0 – Introduction – electronic unit configuration emergency restore procedure).

27: Calculation algorithm (P)

This menu is used to select the calculation algorithm and its coefficient. The selectable items are the following:

271: Calculation from Dt (P)

Selects torque and power calculation starting from the variation of the collimation time of the laser beam on the target with respect to the zero torque one. This is the normal operating mode and the default setting.

272: Calculation form cubic equation (P)

Selects torque and power calculation starting from the RPM information only using the cubic equation  $A \cdot x^3 + B \cdot x^2 + C \cdot x^1 + D \cdot x^0$ , whose coefficients (A, B, C, D) are defined by the user. The coefficients are set with menu items menu273, menu374, menu275, menu276.

Note: This mode is used only in case the frame is not correctly aligned and calibrated and so it is not possible to carry out the calculation starting from Dt. In this mode the system uses for the calculation the cubic equation which normally approximates the load curve of the mechanical system, as a consequence of this there can be differences with respect to the actual torque and power values. This mode should be used only as a backup of the main mode (menu271).

273: Coefficient A ( $X^3$ ) (P)

Sets A coefficient value. The value can be varied with  $10^{-7}$  steps. The default value is 0.0.

274: Coefficient B ( $X^2$ ) (P)

Sets B coefficient value. The value can be varied with  $10^{-7}$  steps. The default value is 0.0.

275: Coefficient C ( $X^1$ ) (P)

Sets C coefficient value. The value can be varied with  $10^{-7}$  steps. The default value is 0.0.

276: Coefficient D ( $X^0$ ) (P)

Sets D coefficient value. The value can be varied with  $10^{-7}$  steps. The default value is 0.0.

277: Filter coefficient (1-120) (P)

Sets the filter coefficient which is used to damp the fluctuations of the calculated values.

The value can be varied between 1 and 120 with 1 unit steps. The default value is 4.

Values ranging from 1 to 20 can be used for very smooth mechanical systems for which torque and RPM ripple is very low (less than 5%), values ranging from 21 to 60 can be used for systems with average ripple (between 5% and 20%), and values ranging from 61 to 120 can be used for systems with high ripple (bigger than 20%) or in those cases in which the poor quality of the alignment between the prime mover and the shaft generates shaft flexions and vibrations. The higher the filter coefficient value, the higher the measurement parameters accuracy. This value anyway increases also the delay, in numbers of shaft rotations, after which the first valid measured parameters are obtained.

Note: The usage of a filter coefficient value which is an integer multiple or submultiple of the number of slits of one disc gives the best results (e.g. for a disc with 80 slits, values such as 4, 8, 16, 20, 40, 80).

278: Exit (P)

Used to return to the higher level menu.

28: Backup battery/UPS operation (P)

This menu is used to set the operation of the system with backup battery or UPS supply (in case the ETC circuitry is installed, the backup battery can not be installed). The selectable items are the following:

281: Backup battery present/UPS power supply (P)

Used to set system operation with backup battery or UPS supply.

Select this mode if a SD Card is used as, in case of a sudden power blackout while the storing of SD data is in progress, all the stored files can become unreadable.

Power supply from an UPS system is required.

If the battery can be installed, it must be present and adequately charged. The complete charging of the battery requires about 10 hours. A completely charged battery can supply the system in idle state for about 12-15 hours, and for more than one hour in the on state.

282: Backup battery not present/Normal power supply (P)

Used to set system operation without backup battery or with normal power supply (non UPS).

In this mode the shutdown of the system is not carried out and the system turns off just because of the lack of supply voltage. Moreover in case SD Card is used, a power blackout can cause SD Card data loss. This mode is suggested only if measurements whose loss can be tolerated is carried out.

29: Exit (P)

Used to return to the higher level menu.

30: LCD display setting (U)

31: LCD visualization (P)

This menu is used to set the LCD display visualization mode. The selectable items are the following:

311: LCD OFF (P)

Disable LCD data display.

Note: Because of the importance of LCD data display (also for the setup of the instrument) this option has no effect.

312: LCD ON (P)

Enables LCD data display. This is the default setting.

313: Metric system (P)

Displays data in N, m, etc.. . This is the default setting.

314: Imperial system (P)

Displays data in lb, ft, etc...

315: Scaling factor x1 (P)

Displays data in Nm or lbft, W.

316: Scaling factor x1000 (P)

Displays data in kNm, klbft, kW. This is the default setting.

317: Exit (P)

Used to return to the higher level menu.

32: LCD language (P)

Selects the language used for LCD data display. The selectable languages are: english, italian, german, french.

33: Display Mode (P)

Select the display mode of the LCD.

331: RPM, % | VS | kW, % | kNm, % (U)

The submenu enables the display of speed (in RPM), direction of rotation (ahead or astern), power (in kW) and torque (in kNm) on the LCD display. The relevant percentages, calculated on the alarm thresholds (see menu816, menu826, menu836), are also displayed.

The LCD will display:

RPM=xxx.x	x.x%
DIR.=xxx	
P(kW)=xxx.x	x.x%
T(kNm)=xxxx.x	x.x%

332: RPM, VS | kW | RxTemp | TxTemp (U)

The submenu enables the display of speed (in RPM), direction of rotation (ahead or astern), power (in kW), laser receiver and laser transmitter enclosures temperature on the LCD display.

The LCD will display:

RPM=xxx.x	VS
P(kW)=xxx.x	
RxTemp=xx	
TxTemp=xx	

333: Date/Time | RPM, VS | kW | kNm (U)

The submenu enables the display of the date (DD/MM/YYYY), hour (HH:MM:SS), speed (in RPM), direction of rotation (ahead/astern), power (in kW) and torque (in kNm) on the LCD display.

The LCD will display:

DD/MM/YYYY	HH:MM:SS
RPM=xxx.x	VS
P(kW)=xxx.x	
T(kNm)=xxx.x	

334: RPM, VS | kW | l/h | l/kWh (U)

The submenu enables the display of speed (in RPM), direction of rotation (ahead or astern), power (in kW), fuel consumption (FOC) (in l/h) and specific fuel consumption (SFOC) (in l/kWh) on the LCD display.

The LCD will display:

RPM=xxx.x	VS
P(kW)=xxx.x	
FOC(l/h)=xxx.x	
SFOC(l/kWh)=xxx.xxx	

### 335: RPM, VS | kW | kg/h | g/kWh (U)

The submenu enables the display of speed (in RPM), direction of rotation (ahead or astern), power (in kW), fuel consumption (FOC) (in kg/h) and specific fuel consumption (SFOC) (in g/kWh) on the LCD display.

The LCD will display:

RPM=xxx.x	VS
P(kW)=xxx.x	
FOC(kg/h)=xxx.x	
SFOC(g/kWh)=xxx.xxx	

### 336: RPM, PS | T\_teor | T\_eff | deltaT (Timing debug) (U)

The submenu enables the LCD display of data for system calibration.

The LCD will display:

RPM=xxx.x	PS=0.xxxx
T_teor=0.xxxxx	
T_eff= 0.xxxxx	
Delta_T=0.xxxxx	

where:

RPM=shaft speed (in RPM)

PS=Discs overlap angle (menu25) measured value);

T\_teor = theoretical collimation time at zero torque, set in the system (in sec);

T\_eff = actual, instantaneously measured, collimation time (in sec);

Delta\_T = T\_eff - T\_teor difference (in sec)

Note: All the data is calculated considering as a reference a 1sec. cycle period.

### 34: Backlight (U)

The submenu is used to set the LCD display backlight intensity. The value ranges between 0 and 999. The value can be varied with one unit steps. The default value is 650.

### 35: Keypad unprotect (U)

The submenu is used to unprotect the keypad for 30 minutes. After this period of time has elapsed, the unprotect procedure must be repeated again. The keypad is normally protected to avoid inadvertent modification of sensible parameters.

### 36: Exit (U)

Used to return to the higher level menu.

### 40: SD Card setting (P)

#### 41: SD Card log OFF (P)

Disables data logging on the SD Card.

42: SD Card log ON (P)

Enables data logging on the SD Card. When a SD Card is inserted in the slot a new log file called HHMM\_XXX.LOG is automatically created, where HHMM are the hour and the minutes of file creation and xxx a progressive number ranging from 001 to 999. Data storing starts automatically.

**Note:** The SD Card must be preformatted in FAT32 format. SDSC and SDHC card types are supported.

**Note:** To enhance the reliability of SD card data logging, UPS supply is recommended.

43: SD Tsample (P)

Sets the sampling period, that is the time (in sec) which passes between two consecutive measurements stored on the SD Card.

To use the SD Card as a “black box” a 5 seconds period is suggested (enough for a sufficiently detailed reconstruction of events evolution), while if the SD log is used to diagnose the system a period even longer than 40-50 seconds can be acceptable.

The value can be varied with 1sec steps. The default value is 5sec.

44: SD RPM min (P)

Sets the minimum value (the threshold) of the shaft speed which triggers SD Card logging.

This function is particularly useful to avoid to store data referring to non interesting working conditions of the system (e.g. with engine stopped, at low speed and at very low load). For this purpose a RPM threshold higher than the non interesting speed range can be set.

It must be clear anyway that setting an excessively high threshold value there is the risk of losing significant data (e.g. in case the engine is frequently used at low load).

The value can be varied with 1RPM steps. The default value is 30RPM.

45: SD Card free space (kB) / space used (kB) / number of files (P)

The submenu displays the SD Card situation. The LCD will display:

```
free(kB)= xxxxxxxx
used(kB)=xxxxxxx
file(s)=xx
press MENU to exit
```

If no SD Card is inserted in the slot , the LCD will display:

```
SD Card error:
SD Card not present

press MENU to exit
```

46: Download of vibrotorsional sampling to SD Card (P)

Stores on the SD Card the data stored in the vibrotorsional sampling array. The file created is called HHMM\_XXX.VBT, where HHMM are the hour and the minutes at which the file was created and xxx is a progressive number ranging from 001 to 999. In no SD Card is inserted in the slot the LCD will display the following error message:

```
SD Card error:
SD Card not present

press MENU to exit
```

While the storage of the file on the SD Card is in progress, the LCD will display:

Valid FAT32 SD Card

Downloaded: xx%  
press MENU to exit

If the sampling file is empty (because for example no sampling took place) the LCD will display:

No file to store!

press MENU to exit

While the storage of the file on the SD Card is in progress, the stored percentage of the file is shown. At the end of the storage process the LCD will display:

Valid FAT32 SD Card

Downloaded: 100%  
press MENU to exit

Note: The SD Card must be preformatted in FAT32 format. SDSC and SDHC card types are supported.

#### 47: Download of SD Card data to serial ports (P)

This menu is used to download the contents of the SD card to the serial ports. Two submenus are available.

#### 470: Download of SD Card files to serial ports (P)

Transmits on the enabled serial ports the selected file (stored on the SD Card).  
The LCD will display:

No.

1

Filename

xxxx\_001.yyy

zzz kB

where xxxx is the filename in HHMM format, yyy is the extension (.VBT or .LOG) and zzz is the file dimension in kB.

Pressing the DOWN (▼) pushbutton (or the UP (▲) pushbutton as well) the files stored on the SD Card will be listed. When the file to be sent is found press the OK (◀) pushbutton to start downloading it. The LCD will display the percentage of the progress of the operation:

Downloaded: xx%  
press MENU to exit

At the end of the download the LCD will go back to its normal display mode (out of menu management).

If the SD Card is not inserted in the slot the LCD will display:

SD Card error:  
SD Card not present

And after few seconds the display will go back to its normal display mode (out of the menu management).

#### 471: SD Card raw dump to serial ports (emergency only) (P)

This function downloads to the enabled serial ports all the data stored on the SD Card in a raw byte stream.

This function is intended to be used only in emergency, if the FAT structure of the SD card is damaged and the card can not be read by a PC. The downloaded data must then be analyzed with a forensic software for data retrieval.

At the beginning of the download the LCD will display:

FAT32 - MBR SD card  
Please wait

during the download:

SD Card raw dump  
Please wait

At the end of the download the LCD will display:

SD Card raw dump  
Press MENU to exit

#### 472: Exit (P)

Used to return to the higher level menu.

#### 48: SD Card recovery (P)

Recovers a SD Card whose FAT got damaged (e.g. because of a power blackout during FAT writing) and that can not be formatted by a PC (normally the PC supplied SD Card management utilities do not permit low level formatting and so, in these cases, the PC can not "see" the SD Card).

Insert the SD Card in the slot and select this option. A minimal FAT will be rebuilt. Now the SD Card is readable even by the PC.

Note: After this procedure it is necessary to carry out a complete format with the standard PC utilities. The FAT type to be used is FAT32 only. LTM2214 does not manage older types of FAT.

49: Exit (P)

Used to return to the higher level menu.

50: Serial ports setting (P)

Note: If the "Remote control ON" mode is set, the transmission to the remote PC is made with Xon/Xoff software handshake protocol (see chapter 6 - Remote PC control).

Note: If the "Remote control ON" mode is set, interrupt based serial reception is enabled; while if "Remote control OFF" is set, serial reception is disabled.

51: Serial RTx OFF (P)

Disables data output on serial ports (RS232 and RS422).

52: Port 0 / Port 1 ON (P)

Enables data output on serial ports (RS232 and RS422). The selectable items are the following:

520: Port 0 ON (P)

Enables data output on serial port 0 (RS232).

521: Port 1 ON (P)

Enables data output on serial port 1 (RS422).

522: Port 0, 1 ON (P)

Enables data output on serial ports 0 (RS232) and 1 (RS422).

523: Exit (P)

Used to return to the higher level menu.

53: NMEA (P)

Enables the output on serial ports in NMEA0183 standard format using \$IILMA sentence formatter.

Note: If NMEA0183 format is used it can be necessary to set the standard baud rate requested by NMEA0183 standard (4800baud - see menu55/menu56: Baud rate). If NMEA0183 standard baud rate is not necessary, set always a higher baud rate (at least 115200baud or higher).

54: Custom format (P)

Enables the output on serial ports in custom format.

Note: The custom format is much more readable than the NMEA0183 format and can be visualized with all terminal emulation softwares (e.g. Smarterm, Microsoft Hyperterminal, Foxterm, etc...). Moreover the custom 1 format is used by the PC remote management utility supplied with LTM2214.

The selectable items are the following:

541: Custom 1 (P)

In this format data are transmitted by the serial ports with the following format:

\$xxx.xRPM xxx.xxxkNm xxx.xxxkW xxx.xml/h x.xml/kWh xxxxxxxxRPM(T) xxxxxx.xkWh  
xxx.x°C xxx.xCst xx.x%R xx.x%T xx.x%P xxxxxxxx x xx.x°C xx.x°C

The '\$' character is always present at the beginning of the string. In case of reverse rotation the sign '-' is interposed between \$ and the RPM value.

Note: This format is used by the PC remote management utility LTM2214-RCU.

#### 542: Custom 2 (P)

In this format data are transmitted by the serial ports with the following format:

\$xxx.xRPM, xxx.xxxkNm, xxx.xxxkW, xxx.xml/h, x.xml/kWh, xxxxxxxxRPM(T), xxxxxx.xkWh

The '\$' character is always present at the beginning of the string. In case of reverse rotation the sign '-' is interposed between \$ and the RPM value:

\$-xxx.xRPM, xxx.xxxkNm, xxx.xxxkW, xxx.xml/h, x.xml/kWh, xxxxxxxxRPM(T), xxxxxx.xkWh

Upon request Custom 2 format can be customized as specified by the client.

#### 543: Custom 3 (P)

In this format data are transmitted by the serial ports with the same format of Custom 2 case.

Upon request Custom 3 format can be customized as specified by the client.

#### 544: Exit (P)

Used to return to the higher level menu.

#### 55: Serial port 0 baud rate (P)

The submenu is used to to set the baud rate of serial port 0.

Note: A low baud rate uses a lot of system resources. It is suggested to use always the higher baud rate possible compatibly with the performance of the remote PC used.

Note: To download vibrotorsional sampling data use only high baud rates (115200baud or higher) which permit to download the data quickly. Using low baud rates prolongs too much the download time.

The selectable items are the following:

#### 550: 4800baud (P)

Selects a baud rate of 4800baud.

#### 551: 9600baud (P)

Selects a baud rate of 9600baud.

#### 552: 19200baud (P)

Selects a baud rate of 19200baud.

#### 553: 38400baud (P)

Selects a baud rate of 38400baud.

#### 554: 56600baud (P)

Selects a baud rate of 56600baud.

#### 555: 115200baud (P)

Selects a baud rate of 115200baud.

#### 556: 230400baud (P)

Selects a baud rate of 230400baud.

#### 557: 460800baud (P)

Selects a baud rate of 460800baud.

#### 558: 921600baud (P)

Selects a baud rate of 921600baud.

559: Exit (P)

Used to return to the higher level menu.

56: Serial port 1 baud rate (P)

The submenu is used to to set the baud rate of serial port 1.

Note: A low baud rate uses a lot of system resources. It is suggested to use always the higher baud rate possible compatibly with the performance of the remote PC used.

Note: To download vibrotorsional sampling data use only high baud rates (115200baud or higher) which permit to download the data quickly. Using low baud rates prolongs too much the download time.

The selectable items are the following:

560: 4800baud (P)

Selects a baud rate of 4800baud.

561: 9600baud (P)

Selects a baud rate of 9600baud.

562: 19200baud (P)

Selects a baud rate of 19200baud.

563: 38400baud (P)

Selects a baud rate of 38400baud.

564: 56600baud (P)

Selects a baud rate of 56600baud.

565: 115200baud (P)

Selects a baud rate of 115200baud.

566: 230400baud (P)

Selects a baud rate of 230400baud.

567: 460800baud (P)

Selects a baud rate of 460800baud.

568: 921600baud (P)

Selects a baud rate of 921600baud.

569: Exit (P)

Used to return to the higher level menu.

57: Vibrotorsional data download for PC postprocessing (P)

Downloads, on the enabled serial ports, the vibrotorsional sampling data currently stored in the system in the format:

n. of interslot counts,

n. of aperture counts

CR LF

The first 100 rows have the following format:

n. of interslot counts,

n. of aperture counts,

Perc\_slot value

CR LF

Note: This mode is used to download vibrotorsional sampling data for subsequent postprocessing on a remote PC.

58: Vibrotorsional data download for Perc\_slot calibration (P)

Downloads, on the enabled serial ports, the vibrotorsional sampling data currently stored in the system in the format:

array index,

n. of interslot counts,

n. of aperture counts,

instantaneous Perc\_slot,

average Perc\_slot calculated on immediately preceding total number of slits of one disc (moving average),

instantaneous RPM

CR LF

Note: This mode is used to download vibrotorsional sampling data for the subsequent calculation of Perc\_slot (discs angle) value by means a remote PC. Data are transmitted in reversed order (first is transmitted the last sample).

59: Exit (P)

Used to return to the higher level menu.

60: Fuel meter setting (P)

61: Fuel input OFF (P)

Disables fuel consumption input and calculation.

62: Fuel input ON (P)

Enables fuel consumption input and calculation.

63: Pulse/liter (P)

Sets the number of pulse per liter of fuel. The value can be varied with one unit steps. The default value is 1000.

64: V/l per l/h (P)

Sets the constant equivalent to the fuel consumption full scale value (20mA or 3.48V) measured in l/h. The value can be varied with 0.001l/(Vh) (l/mAh) steps. The default value is 1.000 which corresponds to a full scale value of 34.8l/h.

The value to set is given by:

$$\text{value to set} = \text{full scale flow (in l/h)} / 34.8$$

where the full scale flow is the flow at 20mA, in the case of current input (0-20mA or 4-20mA), or at 3.48V, in the case of voltage input (0-3.3V).

Warning: The maximum input voltage to be measured must not exceed 3.3V. To ensure the accuracy of the measure, the user must adjust the flow meter output in order not to exceed this voltage value at 100% of the measurement (a resistive voltage divider can be used if necessary). The input can withstand input voltages up to 5V without damage.

65: Input type (P)

Sets the type of fuel consumption input signal.

The selectable items are the following:

651: Pulse (P)

Selects pulse input type.

652: 4/+20mA (P)

Selects 4/+20mA input type.

653: 0-3.3V/0-20mA (P)

Selects 0-3.3V/4-20mA input type.

654: Exit (P)

Used to return to the higher level menu.

66: Fuel density g/dm<sup>3</sup> (kg/m<sup>3</sup>) (P)

This submenu is used to input manually the fuel density value in order to transform the l/h values in kg/h ones. The default value is 850 g/dm<sup>3</sup>.

67: Exit (P)

Used to return to the higher level menu.

70: Real Time Clock setting (P)

71: RTC OFF (P)

Disables RTC operation and RTC data display.

72: RTC ON (P)

Enables RTC operation and RTC data display.

73: Day (P)

Sets the day of the month in the DD format.  
The variation step is 1. The default value is 1.

74: Month (P)

Sets the month in the MM format.  
The variation step is 1. The default value is 1.

75: Year (P)

Sets the year in the AAAA format.  
The variation step is 1. The default value is 2011.

76: Day of week (S,M,T,...,F,S) (P)

Sets the day of the week from Sunday to Saturday.  
The default value is Sunday.

The selectable items are the following:

761: Sunday (P)

Selects Sunday as the day of the week.

762: Monday (P)

Selects Monday as the day of the week.

763: Tuesday (P)

Selects Tuesday as the day of the week.

764: Wednesday (P)

Selects Wednesday as the day of the week.

765: Thursday (P)

Selects Thursday as the day of the week.

766: Friday (P)

Selects Friday as the day of the week.

767: Saturday (P)

Selects Saturday as the day of the week.

768: Exit (P)

Used to return to the higher level menu.

77: Hour (P)

Sets the hour in the HH (24 hours) format.  
The variation step is 1. The default value is 12.

78: Minutes (P)

Sets the minutes in the MM format.  
The variation step is 1. The default value is 00.

79: Exit (P)

Used to return to the higher level menu.

80: Alarms setting / ETC (Embedded System Control) setup (P)

Note: The alarms setting menu is composed of several submenus all organized in the same way.

Note: More than one output can be set at the same time for the same or more alarms. In this case the output will behave as the logical OR of each single setting. If ETC is enabled DOUT2 (relay2) and DOUT3 (relay3) are not available.

81: RPM alarm (P)

The submenu sets RPM alarm features.

810: RPM alarm OFF (P)

Disables RPM alarm. It does not modify the set point value.

811: DOUT 1 ON (P)

Enables RPM alarm on digital output 1 (relay 1). The set point value must be set.

812: DOUT 2 ON (P)

Enables RPM alarm on digital output 2 (relay 2). The set point value must be set.

813: DOUT 3 ON (P)

Enables RPM alarm on digital output 3 (relay 3). The set point value must be set.

814: Buzzer OFF (P)

Disables buzzer RPM alarm.

815: Buzzer ON (P)

Enables buzzer RPM alarm. The set point value must be set.

816: Set point (P)

Sets the RPM alarm set point value. The value can be varied with 1RPM steps. The default value is 10000. The warning set point is automatically set at 90% of this value.

817: Exit (P)

Used to return to the higher level menu.

82: Torque alarm (P)

The submenu sets torque alarm features.

820: Torque alarm OFF (P)

Disables torque alarm. It does not modify the set point value.

821: DOUT 1 ON (P)

Enables torque alarm on digital output 1 (relay 1). The set point value must be set.

822: DOUT 2 ON (P)

Enables torque alarm on digital output 2 (relay 2). The set point value must be set.

823: DOUT 3 ON (P)

Enables torque alarm on digital output 3 (relay 3). The set point value must be set.

824: Buzzer OFF (P)

Disables buzzer torque alarm.

825: Buzzer ON (P)

Enables buzzer torque alarm. The set point value must be set.

826: Set point (P)

Sets the torque alarm set point value. The value can be varied with 1Nm steps. The default value is 1000000. The warning set point is automatically set at 90% of this value.

827: Exit (P)

Used to return to the higher level menu.

83: Power alarm (P)

The submenu sets power alarm features.

830: Power alarm OFF (P)

Disables power alarm. It does not modify the set point value.

831: DOUT 1 ON (P)

Enables power alarm on digital output 1 (relay 1). The set point value must be set.

832: DOUT 2 ON (P)

Enables power alarm on digital output 2 (relay 2). The set point value must be set.

833: DOUT 3 ON (P)

Enables power alarm on digital output 3 (relay 3). The set point value must be set.

834: Buzzer OFF (P)

Disables buzzer power alarm.

835: Buzzer ON (P)

Enables buzzer power alarm. The set point value must be set.

836: Set point (P)

Sets the power alarm set point value. The value can be varied with 1W steps. The default value is 10000000. The warning set point is automatically set at 90% of this value.

837: Exit (P)

Used to return to the higher level menu.

84: FOC alarm (P)

The submenu sets FOC alarm features.

840: FOC alarm OFF (P)

Disables FOC alarm. It does not modify the set point value.

841: DOUT 1 ON (P)

Enables FOC alarm on digital output 1 (relay 1). The set point value must be set.

842: DOUT 2 ON (P)

Enables FOC on digital output 2 (relay 2). The set point value must be set.

843: DOUT 3 ON (P)

Enables FOC on digital output 3 (relay 3). The set point value must be set.

844: Buzzer OFF (P)

Disables buzzer FOC alarm.

845: Buzzer ON

Enables buzzer FOC alarm. The set point value must be set.

846: Set point (P)

Sets the FOC alarm set point value. The value can be varied with 11/h steps. The default value is 1000. The warning set point is automatically set at 90% of this value.

847: Exit (P)

Used to return to the higher level menu.

85: SFOC alarm (P)

The submenu sets SFOC alarm features.

850: Specific consumption alarm OFF (P)

Disables SFOC alarm. It does not modify the set point value.

851: DOUT 1 ON (P)

Enables SFOC alarm on digital output 1 (relay 1). The set point value must be set.

852: DOUT 2 ON (P)

Enables SFOC alarm on digital output 2 (relay 2). The set point value must be set.

853: DOUT 3 ON (P)

Enables SFOC alarm on digital output 3 (relay 3). The set point value must be set.

854: Buzzer OFF (P)

Disables buzzer SFOC alarm.

855: Buzzer ON (P)

Enables buzzer SFOC alarm. The set point value must be set.

856: Set point (P)

Sets the SFOC alarm set point value. The value can be varied with 0.001/kwh steps. The default value is 0.600. The warning set point is automatically set at 90% of this value.

857: Exit (P)

Used to return to the higher level menu.

86: Total revolutions alarm (P)

The submenu sets total revolutions alarm features.

860: Total revolutions alarm OFF (P)

Disables total revolutions alarm. It does not modify the set point value.

861: DOUT 1 ON (P)

Enables total revolutions alarm on digital output 1 (relay 1). The set point value must be set.

862: DOUT 2 ON (P)

Enables total revolutions alarm on digital output 2 (relay 2). The set point value must be set.

863: DOUT 3 ON (P)

Enables total revolutions alarm on digital output 3 (relay 3). The set point value must be set.

864: Buzzer OFF (P)

Disables buzzer total revolutions alarm.

865: Buzzer ON (P)

Enables buzzer total revolutions alarm. The set point value must be set.

866: Set point (P)

Sets the total revolutions alarm set point value. The value can be varied with 1 rotation steps. The default value is 1000000000. The warning set point is automatically set at 90% of this value.

867: Exit (P)

Used to return to the higher level menu.

87: Energy alarm (P)

The submenu sets energy alarm features.

870: Energy alarm OFF (P)

Disables energy alarm. It does not modify the set point value.

871: DOUT 1 ON (P)

Enables energy alarm on digital output 1 (relay 1). The set point value must be set.

872: DOUT 2 ON (P)

Enables energy alarm on digital output 2 (relay 2). The set point value must be set.

873: DOUT 3 ON (P)

Enables energy alarm on digital output 3 (relay 3). The set point value must be set.

874: Buzzer OFF (P)

Disables buzzer energy alarm.

875: Buzzer ON (P)

Enables buzzer energy alarm. The set point value must be set.

876: Set point (P)

Sets the energy alarm set point value. The value can be varied with 1kWh steps. The default value is 1000000000. The warning set point is automatically set at 90% of this value.

877: Exit (P)

Used to return to the higher level menu.

88: Buzzer global enable / ETC (P)

The submenu selects buzzer and ETC (Embedded Temperature Control) operation. The selectable items are the following:

880: Buzzer enabled (P)

Enables the buzzer.

881: Buzzer disabled (P)

Disables the buzzer. Default value.

882: ETC enabled (P)

Enables the ETC (Embedded Temperature Control). The laser temperature is controlled by the torque meter main board (DOUT2 and DOUT3 outputs are used for this feature and therefore are not available for alarm output when the ETC is enabled). Default value.

**Note:** If ETC external circuitry is present, it is connected to DOUT2 and DOUT3. In this case the ETC must always be enabled, otherwise incorrect laser temperature control may occur due to DOUT2 and DOUT3 outputs behaving as alarms.

883: ETC disabled (P)

Disables the ETC. Laser temperature is not controlled by the torque meter main board (all the alarm outputs are available).

884: Exit (P)

Used to return to the higher level menu.

90: Exit (U)

Exits menu management and goes back to the normal display mode.

## 6. PC remote control

### 6.1 Remote control protocol via RS422/RS232 serial ports

The LTM2214 can transmit and receive data with a PC used for the remote management of the system. From the remote PC it is possible to perform all the functions available from the front panel of the instrument.

If properly programmed, the LTM2214 can transmit on the serial ports the value of all the measurements. These data can then be displayed on a remote PC using a standard terminal emulation software or the remote management utility supplied with LTM2214.

Note: The utility supplied with the system manages automatically, and transparently to the user, all the commands recognized by the LTM2214. For this reason its usage is highly recommended.

When the torque meter is in keypad control mode ("Remote control OFF") it can neither receive commands nor it is possible to modify its setup from a remote PC.

It is anyway always possible to use a standard terminal emulation software or the remote management utility supplied with LTM2214 only to display data.

In order to command and modify the LTM2214 setup remotely it is necessary that the instrument is set in "Remote control ON" mode.

Note: The default mode is "Remote control OFF", so "Remote control ON" mode must be expressly set by the user.

Data transmission is made via RS422/RS232 ports.

Data reception is interrupt driven, while the transmission is always polling driven.

#### 1) Data transmission from the remote PC to the LTM2214

The data transmitted from the remote PC to the LTM2214 simulate the pressure of the five pushbuttons located on the front panel of the instrument. The five pushbuttons send to the LTM2214 the following ASCII characters:

- a) the MENU (▶) pushbutton corresponds to the character 'M'
- b) the OK (◀) pushbutton corresponds to the character 'K'
- c) the UP (▲) pushbutton corresponds to the characters 'u' or 'U'
- d) the DOWN (▼) pushbutton corresponds to the characters 'd' or 'D'
- e) the ON/OFF pushbutton corresponds to the character 'F'

The characters can be sent one after the other, or in sequence (with a text string). The characters are transmitted in 8 bit ASCII coding.

E.g. the string "ddddd" corresponds to 5 subsequent pressures of DOWN (▼) pushbutton. The 'U' and 'D' characters correspond respectively to a prolonged pressure of UP (▲) and DOWN (▼) pushbutton and cause a fast increment or decrement.

Moreover the LTM2214 decodes the following commands (ASCII characters) received via serial port:

- a) 'Q' requests the transmission of SRAM loaded parameters
- b) 'W' requests the transmission of eeprom 0 (default) sector loaded parameters
- c) 'E' requests the transmission of eeprom User 1 loaded parameters
- d) 'R' requests the transmission of eeprom User 2 loaded parameters

- e) 'T' requests the transmission of eeprom User 3 loaded parameters
- f) 'Y' requests the transmission of eeprom User 4 loaded parameters
- g) 'I' requests the transmission of eeprom User 5 loaded parameters
- h) 'O' requests the transmission of eeprom User 6 loaded parameters
- i) 'P' requests the transmission of eeprom User 7 loaded parameters

## 2) Data transmission from the LTM2214 to the remote PC

The transmission from the LTM2214 to the remote PC is made in several formats:

- a) measured values datagram (outside menu management)
- b) menu management data transmission
- c) alarm and warning messages transmission
- d) numerical values modification message transmission
- e) miscellaneous message transmission (configuration, status, etc..)

- a) Measured value datagrams start always with the '\$' symbol and terminate with CR+LF and have the following format:

Custom 1 format:

```
$xxx.xRPM xxx.xxxkNm xxx.xxxkW xxx.xxl/h x.xxl/kWh xxxxxxxxRPM(T) xxxxxx.xkWh
xxx.x°C xxx.xCst xx.x%R xx.x%T xx.x%P xxxxxxxx x xx.x°C xx.x°C CR LF
```

Custom 2 and Custom 3 formats:

```
$xxx.xRPM, xxx.xxxNm, xxx.xxxkW, xxx.xxl/h, xxx.xl/kWh, xxx.xRPM(T), xxx.xkWh CR LF
```

a terminal emulation software displays the string "as it is", while the LTM2214 remote management utility (LTM2214-RCU) extracts the data from the string and displays them in the selected video page in a user friendly format.

Note: For LTM2214-RCU to work properly, only Custom 1 format must be used.

- b) Menu management data transmission strings start always with the character '|' and have the following standard format:

```
|menuxxx: xxxxxxxxxxxxxxxxxxxx CR LF
```

They start always with the string "|menu" followed by the code of the entered menu. After receiving and decoding the menu code, the remote management utility act as required. Other messages that start with the '|' character but are not followed by the "menu" string must in any case be considered as menu management messages and must be treated as such.

- c) Alarm and warning messages transmission strings start always with the '>>' character and have the following format:

```
>>"alarm or warning message" CR LF
```

At reception and decoding of the alarm/warning, the PC remote management utility action depends on the current display mode.

- d) Numerical values modification message transmission strings start always with the '>' character, terminate with "< CR LF" string and have the following standard format:

>xxxxxxx.xxx< CR LF

- e) Miscellaneous message transmission strings never start with the characters '\$', '|', '>>', '>' and do not have a standard format. These strings are used to transmit miscellaneous information (e.g. instrument configuration). These strings are decoded by LTM2214 PC remote management utility and are displayed in the selected video page in a user friendly format.

### 6.2 "Remote control ON" mode activation

To enable the "Remote control ON" mode, the DOWN (▼) pushbutton must be kept pressed and then the system must be reset with the reset pushbutton located on LTM2214 rear panel (or the power supply must be switched off for at least 2 seconds and then turned on again). The DOWN (▼) pushbutton must be kept pressed till the LCD displays:

Remote control ON

At this point the pushbutton can be released. From this moment on interrupt driven reception is enabled. Moreover also the Xon/Xoff software handshake protocol for the transmission to the remote PC is activated.

Note: For high speed file transfer (115200baud or higher) the Xon/Xoff protocol must always be enabled to avoid remote PC receive buffer overflow and subsequent transmitted data loss.

### 6.3 "Remote control OFF" mode activation

To disable the remote control mode, that is to enable the "Remote control OFF" mode, the UP (▲) pushbutton must be kept pressed and then the system must be reset with the reset pushbutton located on the LTM2214 rear panel (or the power supply must be switched off for at least two seconds and then turned on again). The UP (▲) pushbutton must be kept pressed till the LCD displays:

Remote control OFF

At this point the pushbutton can be released. From this moment on data reception is disabled. Moreover also the Xon/Xoff software handshake protocol for the transmission to the remote PC is disabled. The default mode is "Remote control OFF".

## 6.4 PC remote management utility

A utility which allows the remote management of the system using a normal PC is supplied with the LTM2214. This utility uses one PC serial port to communicate with LTM2214. For a better performance it is suggested to set the highest possible baud rate (at least 115200baud or higher). The same baud rate must be set both on the PC and on the LTM2214. The PC can be connected to LTM2214 port 0 (RS232) or 1 (RS422). In order to have a reliable data link over distances higher than 15-20m, it is advisable to use port 1 (RS422). If the RS422 port is used, the PC must have a RS422 card or an external RS232-RS422 adapter.

LTM2214 serial ports pin out, to be used to manufacture the communication cable, is described at paragraphs 3.7 c) e d).

The communication parameters used by LTM2214 are the following:

- 1) Data length= 8bit
- 2) Parity= None
- 3) Stop bit= 1
- 4) Software handshake (Xon/Xoff)= enabled in "Remote control ON",  
disabled in "Remote control OFF"

The remote management utility has three operating modes: Log mode, Console mode and Configuration mode.

### 6.4.1 Main menu description (command bar)

The command bar menu is tree structured with the following structure:

```
File ----- Connect (activates serial link)
              Disconnect (deactivates serial link)
              Exit (exits from the utility)

Terminal ----- Clear (cleans the main window)
                 Flow Control setting -----
                   Xon/Xoff input control (activates/deactivates
                                           Xon/Xoff protocol)
                   Xon limit (Xon send delay)
                   Xoff limit (Xoff send delay)
                   OK (exits storing the settings)
                   Cancel (exits without storing the settings)

Transfer ----- Send File (Text)    F5    (sends a text file)
                 Receive File (Text) F6    (capture a text file)
                 Abort sending      F7    (aborts text file sending)

Help ----- Help (online help)
            About LTM2214 Utility (informations about the utility)
```

The option Transfer—Receive File (Text) allows to store on a text file the data received from LTM2214. This option can be used to store the files downloaded and received from LTM2214 (e.g. vibrotorsional samplings, log files, SD Card files, etc...).

Note: During the storing of the file, the button "Close Capture", used to close the file and to go back to normal log mode, appears above the main windows.

## 6.4.2 Log mode

In Log Mode the utility behaves as a terminal emulator with some additional features which facilitates LTM2214 usage.

The main window (white background) displays the received data strings as they are (raw data). The event window (grey background) signals if particular events take place (measurement datagram reception, alarm/warning reception, etc..).

### 6.4.2.1 Functions description

“Connect” button: activates PC serial port connection  
“Disconnect” button: deactivates PC serial port connection

“Port” edit box: selects, with the scroll down menu, the communication port  
“Baud Rate” edit box: selects, with the scroll down menu, the communication port baud rate  
Note: The “Port” and “Baud Rate” edit boxes are disabled after the port is connected (pressing “Connect” button). To be able to modify these settings, first it is necessary to disconnect the port (pressing “Disconnect” button).

“datagram” check box: if active it disables the display of measurement datagrams reception in the event window  
“alarms” check box: if active it disables the display of alarm/warning messages reception in the event window

“Console Mode” button: enters the Console mode. This is the normal working mode  
“Configuration Mode” button: enters the Configuration mode

“Exit” button: exits from the program

Note: “Datagram” and “Alarms” check boxes default state is not set thus, normally, the respective events are displayed

Advanced Measurement Solutions - LTM2214 Laser Torque Meter Remote Control Utility

File Terminal Transfer Help

Port: COM1 Baud: 115.2kbps

Connection state: Connect Disconnect

LOG MODE

126.5RPM	751.2kNm	9950.4kθ	0.0017/h	0.00017/kWh	860URPM(T)	11286.3kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	46.8C	33.5C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8604RPM(T)	11291.5kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	69.4C	34.1C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8608RPM(T)	11296.8kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	72.2C	31.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8612RPM(T)	11302.0kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	48.6C	33.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8616RPM(T)	11307.2kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	54.6C	33.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8620RPM(T)	11312.5kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	70.3C	31.4C
126.5RPM	751.2kNm	9950.3kθ	0.001/h	0.0001/kWh	8624RPM(T)	11317.7kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	59.1C	31.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8628RPM(T)	11323.0kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	47.6C	34.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8632RPM(T)	11328.2kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	69.8C	34.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8636RPM(T)	11333.5kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	72.0C	30.6C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8640RPM(T)	11338.7kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	47.9C	32.0C
126.5RPM	751.2kNm	9950.3kθ	0.001/h	0.0001/kWh	8644RPM(T)	11344.0kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	56.0C	34.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8648RPM(T)	11349.2kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	72.3C	32.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8652RPM(T)	11354.4kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	59.9C	32.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8656RPM(T)	11359.7kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	49.6C	33.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8660RPM(T)	11364.9kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	66.4C	33.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8664RPM(T)	11370.2kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	68.7C	31.0C
126.5RPM	751.2kNm	9950.3kθ	0.001/h	0.0001/kWh	8668RPM(T)	11375.4kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	50.3C	32.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8672RPM(T)	11380.7kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	56.5C	34.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8676RPM(T)	11385.9kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	73.0C	32.0C
126.5RPM	751.2kNm	9950.3kθ	0.001/h	0.0001/kWh	8680RPM(T)	11391.2kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	60.7C	31.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8684RPM(T)	11396.4kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	46.4C	33.0C
126.5RPM	751.2kNm	9950.3kθ	0.001/h	0.0001/kWh	8688RPM(T)	11401.6kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	65.3C	34.0C
126.5RPM	751.2kNm	9950.3kθ	0.001/h	0.0001/kWh	8692RPM(T)	11406.9kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	71.4C	31.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8696RPM(T)	11412.1kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	50.8C	32.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8700RPM(T)	11417.4kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	50.7C	33.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8704RPM(T)	11422.6kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	71.5C	32.0C
126.5RPM	751.2kNm	9950.4kθ	0.001/h	0.0001/kWh	8708RPM(T)	11427.9kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	66.5C	31.0C
126.5RPM	751.2kNm	9950.3kθ	0.001/h	0.0001/kWh	8712RPM(T)	11433.1kWh	0.0C	0.0Cst	79.13R	75.13T	82.98P	XXXXXXXXXX	46.4C	33.0C

40> Datagram received  
41> Datagram received  
42> Datagram received  
43> Datagram received  
44> Datagram received  
45> Datagram received

Filter events:  
 Datagram  
 Alarms

Console Mode  
Config Mode  
Exit

Start Advanced Measurement... 0.20

### 6.4.3 Console mode

Console Mode video page is very similar to the layout of LTM2214 electronic unit front panel, thus it is very easy to use once operation on the front panel of the instrument is learnt.

As in Log mode, an event window with check boxes to filter events is present. In addition to this a number of radio buttons for decoded alarms/warnings signalling are present. Moreover the EOC (end of cycle) and SD log radio buttons, to signal respectively a measurement cycle data reception and data logging on SD Card, are present.

As in Log mode “Connect”, “Disconnect”, “Config Mode”, and “Exit” buttons are present. Moreover the “Log Mode” button, which returns to the Log mode, is present.

Note: “Datagram” and “Alarms” check boxes default state is set thus, normally, the respective events are not displayed.

# Advanced Measurement Solutions

## LTM2214 Laser Torque Meter

CONSOLE MODE

Connection state

Main data  
 Speed= 126.7 RPM 79.2 % AHEAD  
 Torque= 757.8 kNm 75.8 %  
 Power= 10053.4 kW 83.8 %

Fuel data  
 FOC= 0.00 l/h Temp.= 0.0 °C  
 SFOC= 0.000 l/kWh Visc.= 0.0 Cst

Miscellaneous data  
 Total revs= 2568  
 Energy= 3376.2 kWh

Laser data  
 Rx Temp= 39.1 °C  
 Tx Temp.= 36.7 °C

EVENT WINDOW

[Empty Event Window]

EOC  
 SD log

Filter Events  
 Datagram  
 Alarms

RPM  Warn  Alarm  
 Torque  Warn  Alarm  
 Power  Warn  Alarm  
 FOC  Warn  Alarm  
 SFOC  Warn  Alarm  
 F.Temp.  Warn  Alarm  
 F.Visc.  Warn  Alarm  
 RPM Total  Warn  Alarm  
 Energy  Warn  Alarm

#### 6.4.4 Configuration mode

Config Mode is used to display the configuration parameters stored in the various user parameters sets of the electronic unit eeprom.

As in Log and Console modes “Connect”, “Disconnect”, “Log Mode”, “Console Mode”, and “Exit” buttons are present.

“RAM loaded configuration”, “User 0 (default)”, “User 1”, “User 2”, “User 3”, “User 4”, “User 5”, “User 6”, “User 7” buttons select the user parameters set to display in the various fields. Displayed parameters are the one which are set in the menu management (see chapter 5 – Menu description).

Note: Configuration mode allows only to display the parameters, but not their modification.

# Advanced Measurement Solutions

## LTM2214 Laser Torque Meter

CONFIGURATION MODE

**Mechanical parameters**

Distance between discs (mm)= 890.1 / 0.0

Shaft diam. ext / int(mm)= 400.0 / 0.0

Young module (Nsqmm)= 84000

Maximum shaft speed (RPM)= 160

Maximum engine power (kW)= 22000

Power Coefficient= 1.0000

Distorsion Coefficient= 1.0000

Sense of rotation: Counter-clockwise

**SD Card setup**

SD Card off  SD Card on

Sampling interval (sec)= 5

Min RPM threshold (RPM)= 50

**Fuel input setup**

Fuel input off  Fuel input on

Input type: 4+20mA

Pulse/l= 1000

Volt, mA for l/h= 1.0000

Fuel density (kg/l)= 850.0000

**RTC setup**

RTC off  RTC on

Date (DD/MM/YYYY): 1/01/2011

Day of week: Sunday

Time (HH:MM:SS)= 12:01:30

**Serial ports setup (do not modify)**

Port 0 off  Port 0 on

Port 0 speed (kb/sec)= 115200

Port 1 off  Port 1 on

Port 1 speed (kb/sec)= 115200

Serial format: Custom1

**Connection state**

**Config. selection**

RAM loaded configuration

User 0 (Default)

User 1

User 2

User 3

User 4

User 5

User 6

User 7

**Miscellaneous parameters**

Counter period (usec)= 0.0166666

Cycle time (sec.)= 0.5

Laser diameter / Optical diameter \*100= 0.0

Number of slits= 180

Slit aperture (degr.)= 1.000

Angle between discs (degr.)= 0.5000

Calculation from measured values

Calculation from cubic equation

Filter coefficient (1-120)= 6

**LCD display setup**

LCD off  LCD on

LCD mode: R,D,P,T

Backlight intensity (%)= 500

LCD language: English

System: Metric

Scale factor: x1000

**Miscellaneous info**

Backup battery present

Backup battery NOT present

Selected configuration: 0 SRAM

**Alarms setup**

	OFF	Relay1	Relay2	Relay3	Buzzer	Set point
RPM:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	150 RPM
Torque:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1000000 Nm
Power:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	120000000 kW
Fuel:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1000 l/h
Specific consum.:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0.600 l/kWh
Total revolutions:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1000000000
Energy:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1000000000 kWh

Buzzer overall enable

Embedded Temperature Control

## 11. Custom setup table

The custom setup, determined by our technical department for your application, is listed below.

The custom parameters are already stored in the system and need not to be set by the user via keypad (or remote PC).

Note: The only parameters which normally require adjustment are “discs angle” (menu25) parameter and “L” (menu11) parameter.

Please note that, usually, a large number of custom parameters coincide with the default ones and so, in case later on a system setup modification were necessary, it is possible to load default parameters first and then modify them to match user needs.

Note: The system is delivered to the client with “Remote control OFF” mode set.

<b>10: Mechanical parameters</b>	11: L(mm)=890mm
	121: Dext(mm)=400mm
	122: Dint(mm)=0mm
	13: G(mm)=84000N/sqmm
	14: RPMmax=650RPM
	15: kWmax= 22000kW
	16: PCoeff(+/-)=1.0000
	17: PDist(+/-)=1.0000
18: Direction of rotation=clockwise	
<b>20: Miscellaneous parameters</b>	210: Counter period selection=0.0166666usec
	222: LCD refresh= 0.5sec
	228: Ld/Ro=0.0
	23: Slits number=180
	24: Slit aperture=1.0degrees
	25: Discs angle=0.5000
	271: Calculation from Dt=YES
	273: Coefficient A ( $x^3$ )=0.0
	274: Coefficient B ( $x^2$ )=0.0
	275: Coefficient C ( $x^1$ )=0.0
	276: Coefficient D ( $x^0$ )=0.0
	277: Filter coefficient=6
281: Backup battery/UPS supply= present	
<b>30: LCD display setting</b>	311: LCD ON
	313: Metric system
	316: Scaling factor x1000
	32: Language=: English
	331: RPM, %   VS   kW, %   kNm, %
	34: Backlight=500
	35: Keypad unprotect= protected
<b>40: SD Card setting</b>	41: SD Card OFF
	43: SD Tsample=5sec
	44: SD RPM min>50RPM
<b>50: Serial ports setting</b>	523: Port 0 ON, Port1 ON
	541: Custom 1
	555: Port 0 baud rate= 115200baud
	565: Port 1 baud rate= 115200baud
<b>60: Fuel meter setting</b>	62: Fuel input ON

	63: Pulse/liter=1000pulse/l
	64: V/l for I/h=1,000 I/(Vh) or I/(mAh)
	652: Input type= 4-20mA
	66: Fuel density=850g/dm <sup>3</sup> (kg/m <sup>3</sup> )
<b>70: Real Time Clock setting</b>	72: RTC ON
	73: Day= 01
	74: Month= 01
	75: Year= 2011
	761: Day of week= Sunday
	77: Hour= 12 (24h based)
	78: Minutes= 00
<b>80: Alarms setting</b>	810: RPM alarm= OFF
	814: Buzzer OFF
	816: Set point= 10000
	820: Torque alarm= OFF
	824: Buzzer OFF
	826: Set point= 100000
	830: Power alarm= OFF
	834: Buzzer OFF
	836: Set point= 10000000
	840: FOC alarm= OFF
	844: Buzzer OFF
	846: Set point= 1000
	850: SFOC alarm= OFF
	854: Buzzer OFF
	856: Set point= 0.600
	860: Total revolution alarm= OFF
	864: Buzzer OFF
	866: Set point= 1000000000
	870: Energy alarm= OFF
	874: Buzzer OFF
	876: Set point= 1000000000
	880: Global buzzer enabled= OFF
	882: ETC= ON

System design parameters:

Ro= xxxmm (optical radius)  
Dd= xxxmm (slitted discs external diameter)  
Hb= 68mm (laser beam – frame distance)  
Lfs= xxxmm (frame – shaft distance)  
Lf= 580mm (frame width)  
Lt= 312mm (template half width)

where:

$Lfs + D/2 = Ro + Hb$   
 $Lt = Lf / 2 + 22$

Model: LTM2214-RM

Serial Number: