Mars-Energo

**Volt/mA Calibrator
CALMAR-S**

User's manual
Edition 3.1

2017

MARS-ENERGO

Table of contents

This User's Manual describes the Volt/mA Calibrators of Calmar-S type (the calibrator below).

1 Safety requirements

1.1 The calibrator is included in the product range of instruments compliant with the requirements of "Rules for Labor Safety When Operating Electrical Systems" (24 July 2013).

1.2 With respect to electric shock protection, the calibrator relates to class I equipment as stated in IEC 61140:2009 ("Protection against electric shock. Common aspects for installation and equipment").

1.3 The calibrator is compliant with the safety requirements of IEC 61010-1:2001 ("Safety requirements for electrical equipment for measurement, control and laboratory use"):

- Insulation category: basic
- Measurement category: I
- Degree of protection against pollution: 1

1.4 Electrical strength of insulation

1.4.1 For calibrators of Calmar-SS (stationary) modification, the insulation between the Power Adapter plug pins connected together from one side and the pins of the F_{IN}, $F_{(P)IN}$, F_{OUT}, SH, $0…10V$, ±10 V, $0…20mA$, and $\pm5mA$ connectors connected together from the other side provides for withstanding AC test voltage of 1690 V (rms), 50 Hz during 1 min.

1.4.2 For calibrators of Calmar-SL (laboratory) and Calmar-SP (portable) modifications, the insulation between the Power Adapter plug pins connected together from one side and the pins of the F_{IN}, $F_{(P)IN}$, F_{OUT}, SH, U_{IN}/U_{OUT}, and I_{IN}/I_{OUT} connectors connected together from the other side provides for withstanding AC test voltage of 1690 V (rms), 50 Hz during 1 min.

1.5 Insulation resistance

1.5.1 For calibrators of Calmar-SS (stationary) modification, the insulation resistance is at least 20 MOhm (under operating conditions):

- Between the Power Adapter plug pins connected together from one side and the pins of the F_{IN}, $F_{(P)IN}$, F_{OUT}, SH, $0…10V$, ±10 V, $0…20mA$, and $\pm5mA$ connectors connected together from the other side
- Between the pins of the F_{IN}, $F_{(P)IN}$, and F_{OUT} connectors connected together and the pins of the $0…10V$, ±10 V, $0…20mA$, and $\pm5mA$ connectors connected together.

1.5.2 For calibrators of Calmar-SL (laboratory) and Calmar-SP (portable) modifications, the insulation resistance is at least 20 MOhm (under operating conditions):

- Between the Power Adapter plug pins connected together and the pins of the F_{IN}, $F_{(P)IN}$, F_{OUT}, SH, U_{IN}/U_{OUT}, and I_{IN}/I_{OUT} connectors connected together
- Between the pins of the F_{IN}, $F_{(P)IN}$, and F_{OUT} connectors connected together and the pins of the U_{IN}/U_{OUT}, and I_{IN}/I_{OUT} connectors connected together.

1.6 IEC 60529 protection code: IP20.

2 Description and operation principle

2.1 Modifications and functionality

2.1.1 The calibrator's name consists of an instrument name (Volt/mA Calibrator Calmar-S) and modification name that reflects the available set of functions.

Volt/mA Calibrator Calmar-S<u>X</u>-<u>X</u>
1 2

1 – Calibrator's modification in terms of design and functionality (see Table 1):
    S – Stationary
    P – Portable design (powered from the battery or from the mains supply via the Power Adapter)
    L – Laboratory design (powered from the mains supply via the Power Adapter)

2 – Calibrator's modification in terms of accuracy (in accordance with the permissible intrinsic relative (in % of range) error in measurement of DC voltage and current):
    01 – with the permissible intrinsic relative error ±0.01 %
    02 – with the permissible intrinsic relative error ±0.02 %
    05 – with the permissible intrinsic relative error ±0.05 %

Table 2.1 Modifications vs. functionality

Function	Modifications (Calmar-SX)	
	S	P or L
DC voltage measurement	+	+
DC current measurement	+	+
Conversion of a DC voltage signal into a frequency (pulse repetition rate) signal	+	+
Conversion of a DC current signal into a frequency (pulse repetition rate) signal	+	+
Conversion of a frequency (pulse repetition rate) signal into a DC voltage signal	–	+
Conversion of a frequency (pulse repetition rate) signal into a DC current signal	–	+
Pulse repetition rate measurement	–	+
Generation of a DC voltage signal	–	+
Generation of a DC current signal	–	+
Generation of a pulse frequency signal	–	+
Division of input pulse signal frequency	+	+
Determining measurement errors of measurement instruments with pulse output	+	+
Determining measurement errors of electrical power transducers with standard DC current or voltage output	–	+
Note: Available functions are marked with "+"		

2.1.2 As a nationally recognized tool, the calibrator has been registered under N 34892-07 in the National Registry of Measuring Instruments and granted Type Approval Certificate of Measuring instruments RU.C.34.001.A № 27923.

Declaration of Conformity: № POCC.RU.ME48.088 of 10.04.2007.

2.1.3 The calibrator works as a component of test systems intended for testing measuring instruments with a pulse output (e.g. electric energy meters), measuring transducers with standard DC current or voltage outputs as well as multifunctional measuring instruments with DC current or voltage measurement channels.

2.1.4 Environmental conditions are specified in Table 2.2.

Table 2.2

Contributing parameter	Value (range of values)	
	Calibration conditions	Operating conditions
Ambient temperature, °C	20 ±5	0 to 35
Relative humidity, %	30 to 80	Up to 90 at 25 °C
Atmospheric pressure, kPa (mm Hg)	84 to 106 (630 to 795)	70 to 106.7 (537 to 800)
Power supply frequency, Hz	42 to 75	42 to 75
Power supply phase voltage, V	90 to 264	90 to 264

2.2 Scope of supply

2.2.1 The scope of supply for particular modifications is specified in:
Table 2.3 – Calmar-SS (stationary)
Table 2.4 – Calmar SL (laboratory)
Table 2.5 – Calmar SP (portable)

Table 2.3 Calmar -SS

Name and description	Q-ty
Volt/mA Calibrator Calmar-SS	1
Power Adapter (U_{OUT} = 12 V, $I_{OUT\,MAX}$ = 1.2 A)	1
Ethernet PC connection cable	1
Cable for connecting to the F_{OUT} connector	1
Cable for connecting to the "0…10V", "±10 V", "0…20mA", "±5 mA" connectors	1
Cable for connecting to the $F_{(P)IN}$ connector	1
Cable for connecting to the F_{IN} connector	1
User's manual	1
Package	1

Table 2.4 Calmar -SL

Name and description	Q-ty
Volt/mA Calibrator Calmar-SL	1
Power Adapter (U_{OUT} = 12 V, $I_{OUT\,MAX}$ = 1.2 A)	1
Ethernet PC connection cable	1
Cable for connecting to the F_{OUT} connector	1
Cable for connecting to the UI_{IN}/U_{OUT}, I_{IN}/I_{OUT} connectors	1
Cable for connecting to the $F_{(P)IN}$ connector	1
Cable for connecting to the F_{IN} connector	1
User's manual	1
Package	1

Table 2.5 Calmar-SP

Name and description	Q-ty
Volt/mA Calibrator Calmar-SP	1
Power Adapter (U_{OUT} = 12 V, $I_{OUT\,MAX}$ = 1.5 A)	1
AA type battery (1.2V, at least 1900 mA·h)	8
Ethernet PC connection cable	1
Cable for connecting to the F_{OUT} connector	1
Cable for connecting to the U_{IN}/U_{OUT}, I_{IN}/I_{OUT} connectors	1

Name and description	Q-ty
Cable for connecting to the $F_{(P)IN}$ connector	1
Cable for connecting to the F_{IN} connector	1
User's manual	1
Package	1

2.2.2 The scope of supply can contain accessories (if specified in the Supply Agreement) listed in Table 2.6 (the list of accessories may be extended).

Table 2.6 Accessories (included if specified in the Supply Agreement)

Name and description
Scanning head SH-E
Scanning head SH-I
Pulse former
Software

2.3 Specifications

2.3.1 The calibrator measures DC current and voltage within the ranges and with the limits of permissible intrinsic relative (in % of range) error specified in Table 2.7.

Table 2.7

Measured parameter	Measurement Ranges	Limits of permissible intrinsic error for modifications			Notes
		05	02	01 *	
DC voltage (U_{IN}), V	0 to $\pm1.5U_{NOM}$	Relative (in % of range)			U_{NOM}: 5V; 10V
	0 to $1.5U_{NOM}$	±0.05	±0.02	±0.01	U_{NOM}:0.2V*; 5V; 10V
DC current (I_{IN}), mA	0 to $\pm1.5I_{NOM}$				I_{NOM}: 5mA
	0 to $1.5I_{NOM}$				I_{NOM}: 5; 20mA
Pulse repetition rate (F_{IN}) on the F_{IN} input*, Hz	0 to 22500	Absolute, Hz $\pm(0.1 + 3\cdot10^{-5}\cdot F_{IN})$			
* Applicable for the Calmar-SP and Calmar SL modifications					

2.3.2 The calibrator measures DC voltage and DC current signals (the rated values of these signals U_{NOM} and I_{NOM} are specified in Table 2.7) and converts the measured values into a proportional frequency signal ($F_{P.\ OUT}$) generated on the F_{OUT} output of the calibrator. This frequency signal is a sequence of square pulses with the repetition rate $F_{P.\ OUT}$, which is proportional to the measured value and equals F_{NOM} when the measured input signal takes its nominal (rated) value I_{NOM} or U_{NOM}. The value of F_{NOM} can be programmed within the 0.1 to 15000 Hz range, where the recommended value is at least 4000 Hz.

The characteristics of the pulse sequence on the F_{OUT} output are as follows:

Amplitude: (4.5 ±0.5) V

Pulse period-to-duration ratio: from 2 to 3

The ranges and limits of permissible intrinsic error in converting DC voltage and current signals into a proportional frequency signal $F_{P.OUT}$ are listed in Table 2.8.

2.3.3 The Calmar-SP and Calmar-SL instruments provide for generating:

- DC voltage signal (U_{OUT}) within the (- 10.5 V to + 10.5 V) range and setting accuracy of 0.0001 V
- DC current signal (I_{OUT}) within the (- 24 mA to + 24 mA) range and setting accuracy of 0.0001 mA
- Frequency signal represented as a square pulse sequence with the repetition rate $F_{C.OUT}$ and characteristics as follows:
  - Range 0 to 22500 Hz
  - Amplitude 4 to 5.5 V
  - Pulse period-to-duration ratio: from 2 to 3
  - Setting accuracy 0.1 Hz

The ranges and limits of permissible intrinsic error in generating DC voltage, DC current and frequency signals along with the permissible values of load resistance are specified in Table 2.9.

2.3.4 The Calmar-SP and Calmar-SL instruments provide for measuring the repetition rate of square (3 to 15V amplitude) pulses and converting this frequency signal into a DC voltage or DC current signal.

The limits of permissible intrinsic error (absolute) in measuring the pulse repetition rate on the frequency input F_{IN} of the calibrator are given in Table 2.7.

The limits of permissible intrinsic error in converting the frequency signal into a DC voltage or DC current signal along with the permissible values of load resistance are listed in Table 2.10.

The lower value of the input signal range corresponds to $F_{IN}=0$ (no pulses on the input), and the upper value of the input signal range corresponds to $F_{IN}=F_{NOM}$.

2.3.5 The calibrator provides for frequency division of the input pulse signal by any even integer from 2 to 8192 provided that the input pulse signal has the following characteristics:

Pulse repetition rate 0.001 to 100000 Hz

Amplitude 3 to 15V

Pulse duration at least 10 microseconds

Pulses on the $F_{OUT:}$

Amplitude 4 to 5.5V

Pulse period-to-duration ratio 2 to 3.

Table 2.8 Ranges and limits of permissible intrinsic error in converting DC voltage and current signals into a frequency (pulse repetition rate) signal ($F_{P.OUT}$)

Converted parameters	Conversion ranges	Limits of permissible intrinsic error in converting input signals into a frequency ($F_{P.OUT}$) signal Relative (in % of range) for modifications			Notes
		05	02	01 *	
DC voltage (U_{IN}), V	From 0 to $\pm1.5U_{NOM}$	$\pm(0.05+10/F_{NOM})$	$\pm(0.02+10/F_{NOM})$	$\pm(0.01+10/F_{NOM})$	U_{NOM}: 5; 10V $F_{P.OUT} = 0$ Hz at $U_{IN} = 0$ V $F_{P.OUT} = F_{NOM}$ at $U_{IN} = U_{NOM}$ and at $U_{IN} = -U_{NOM}$
	From $-U_{NOM}$ to 1.5 U_{NOM}	$\pm(0.05+20/F_{NOM})$	$\pm(0,02+20/F_{HOM})$	$\pm(0.01+20/F_{NOM})$	U_{NOM}: 5; 10V $F_{P.OUT} = 0$ Hz at $U_{IN} = -U_{NOM}$ $F_{P.OUT} = F_{NOM}$ at $U_{IN} = U_{NOM}$
	From 0 to 1.5 U_{NOM}	$\pm(0.05+10/F_{NOM})$	$\pm(0.02+10/F_{NOM})$	$\pm(0.01+10/F_{NOM})$	U_{NOM}: 0.2*; 5; 10V $F_{P.OUT} = 0$ Hz at $U_{IN} = 0$ V $F_{P.OUT} = F_{NOM}$ at $U_{IN} = U_{NOM}$

Converted parameters	Conversion ranges	Limits of permissible intrinsic error in converting input signals into a frequency ($F_{P.OUT}$) signal Relative (in % of range) for modifications			Notes
		05	02	01 *	
DC current (I_{IN}), mA	From 0 to 1.5 I_{NOM}	$\pm(0.05+10/F_{NOM})$	$\pm(0.02+10/F_{NOM})$	$\pm(0.01+10/F_{NOM})$	$I_{NOM:}$ 5mA $F_{P.OUT} = 0$ Hz at $I_{IN} = 0$ A $F_{P.OUT} = F_{NOM}$ at $I_{IN} = I_{NOM}$ and at $I_{IN} = -I_{NOM}$
	From $-I_{NOM}$ to 1.5I_{NOM}	$\pm(0.05+20/F_{NOM})$	$\pm(0.02+20/F_{NOM})$	$\pm(0.01+20/F_{NOM})$	$I_{NOM:}$ 5mA $F_{P.OUT} = 0$ Hz at $I_{IN} = -I_{NOM}$ $F_{P.OUT} = F_{NOM}$ at $I_{IN} = I_{NOM}$
	From 0 to 1.5 I_{NOM}	$\pm(0.05+10/F_{NOM})$	$\pm(0.02+10/F_{NOM})$	$\pm(0.01+10/F_{NOM})$	$I_{NOM:}$ 5; 20mA $F_{P.OUT} = 0$ Hz at $I_{IN} = 0$ A $F_{P.OUT} = F_{NOM}$ at $I_{IN} = I_{NOM}$
* Applicable for the Calmar-SP and Calmar SL modifications					

Table 2.9 Ranges and limits of permissible intrinsic error (absolute) in generating DC voltage, DC current and frequency signals for the Calmar-SP and Calmar-SL modifications

Generated parameters	Ranges	Load resistance, Ohm	Limits of permissible intrinsic error (absolute) for modifications		
			05	02	01
DC voltage (U_{OUT}), V	from 0 to ±10.5	At least 2000	$\pm5.0 \cdot 10^{-3}$	$\pm2.0 \cdot 10^{-3}$	$\pm1.0 \cdot 10^{-3}$
DC current (I_{OUT}), mA	from 0 to ±24	Up to 500	±0.01	±0.004	±0.002
Frequency (pulse repetition rate $F_{C.OUT}$), Hz	from 0 to 22500	At least 5000	$\pm3 \cdot 10^{-5} \cdot F_{C.OUT}$		

Table 2.10 Ranges and limits of permissible intrinsic error (absolute) in converting a frequency signal into a DC voltage or DC current signal for the Calmar-SP and Calmar-SL modifications

Output signals	Output signal ranges	Load resistance, Ohm	Limits of permissible intrinsic error (absolute) for modifications		
			05	02	01
DC voltage (U_{OUT}), V	-10 to 10	At least 2000	$\pm5.0 \cdot 10^{-3}$	$\pm2.0 \cdot 10^{-3}$	$\pm1.0 \cdot 10^{-3}$
	0 to 10	At least 2000			
	0 to 5	At least 1000			
	-5 to 5	At least 1000			
	0 to 0.2	At least 1000	$\pm2 \cdot 10^{-4}$		
DC current (I_{OUT}), mA	0 to 20	Up to 500	±0.01	±0.004	±0.002
	4 to 20	Up to 500			
	0 to 5	Up to 2000	±0.0025	±0.001	±0.0005
	-5 to 5	Up to 2000			

8

2.3.6 The calibrator determines measurement errors for measuring instruments with a pulse output.

In this case, the relative measurement error of the device under test (the DUT below) is determined according to the formula:

$$\delta = [(N - N_{REF})/N_{REF}] \cdot 100\ \%,\ \text{where}$$

N_{REF} is the calculated number of pulses to be generated on the pulse output of the reference instrument (assuming that the measurement error of the DUT equals zero) within the measurement interval t_{MEAS}.

N is the actual number of pulses generated on the pulse output $F_{(P)IN}$ of the reference instrument within the measurement interval $t_{MEAS.}$

$T_{MEAS} = (1/f_2) \cdot K_2$, sec, where

f_2 is the frequency (pulse repetition rate) of the output pulses of the device under test (Hz) applied to the F_{IN} or SH inputs of the calibrator

K_2 is the division factor of the frequency f_2 (the specified number of the periods of the device-under-test output pulses making up the "measurement window").

2.3.6.1 For the Calmar-SS instruments, the limits of permissible error resulting from the method of determining the relative measurement error of the device under test do not exceed the values calculated from the formula:

$$\delta = \pm[f_2/(N_{TEST} \cdot f_1)] \cdot 100\ \%,\ \text{where}$$

f_1 is the frequency (repetition rate) of the pulses on the "$F_{(P)IN}$ input, Hz

f_2 is the frequency (repetition rate) of the pulses on the F_{IN} (or SH) input, Hz

N_{TEST} is the division factor of the frequency f_2 (the specified number of the periods of the device-under-test output pulses making up the "measurement window").

2.3.6.2 The Calmar-SP and Calmar-SL instruments provide the hardware-based preliminary division of the frequency of pulses applied to the F_{IN} (or SH) input and $F_{(P)IN}$ input by any integer (called the preliminary division factor K_{DIV}) within 1 to 65535.

For the Calmar-SP and Calmar-SL instruments, the limits of permissible error resulting from the method of determining the relative measurement error of the device under test do not exceed the values calculated from the formula:

$$\delta = \pm[(K_1 \cdot f_2/\ K_2 \cdot f_1)] \cdot 100\ \%,\ \text{where}$$

f_1 is the frequency (repetition rate) of the pulses on the "$F_{(P)IN}$ input, Hz

f_2 is the frequency (repetition rate) of the pulses on the F_{IN} (or SH) input, Hz

$K_1 = K_{DIV1}$ is the preliminary division factor for f_1

$K_2 = K_{DIV2} \cdot N_{TEST}$ is the division factor for f_2

K_{DIV2} is the preliminary division factor for f_2

N_{TEST} is the division factor for $f_2/\ K_{DIV2}$

$K_{DIV2} \cdot N_{TEST}$ is the number of the periods of the device-under-test output pulses making up the "measurement window"".

2.3.6.3 The values of N_{REF}, K_{DIV1}, K_{DIV2} and N_{TEST} are set from 1 to 65535 considering the pulse value and required accuracy:

- Via the dedicated software (controlled from PC)
- Via the keypad (off-line mode).

2.3.7 On changing the ambient temperature from 10 to 35 °C, the errors in measurement, conversion and generation of the parameters specified in Tables 2.7, 2.8, 2.9, and 2.10 do not exceed 50% of the corresponding limit of the permissible intrinsic errors.

2.3.8 Under normal and operating conditions, the calibrator sustains the current overload of up to $2I_{NOM}$ (when measuring DC current) and the voltage overload of up to $2U_{NOM}$ (when measuring DC voltage) during 0.5s and restores the declared accuracy characteristics in 15 minutes after the overload removal.

2.3.9 Under normal and operating conditions, the calibrator is considered set for stable operation in 15 minutes after applying power. From that point its technical characteristics are as declared.

2.3.10 Time of continuous operation of the calibrator powered from mains via the Power Adapter is unlimited.

Time of continuous operation of the Calmar -SP modification powered from the battery depends on the capacity of the accumulators in use. The current consumed from the battery does not exceed 0.2A.

2.3.11 Input impedance:

- Current measurement channel: 200 Ohm, or less
- Voltage measurement channel: 5 kOhm, or more
- Frequency measurement channel: 5 kOhm, or more

2.3.12 General specifications are given in Table 2.11.

Table 2.11

Parameter	Value	
	Calmar-SS, Calmar-SL	Calmar-SP
Power consumption from mains 220V (or less), VA	10	20
Overall dimensions (or less), mm	$185 \times 110 \times 60$	$230 \times 160 \times 90$
Overall dimensions of the Power Adapter (or less), mm	$90 \times 78 \times 62$	
Protection provided by the enclosure	IP 40	
Weight including the Power Adapter (or less), kg	1.0	2.0
Average lifetime (or more), years	15	
Mean time to failure (or more), hours	80000	

2.4 Design and operating principles

2.4.1 The calibrator consists of the functional module and power adapter module. The general block diagram of the functional module is shown in Fig. 2.1.
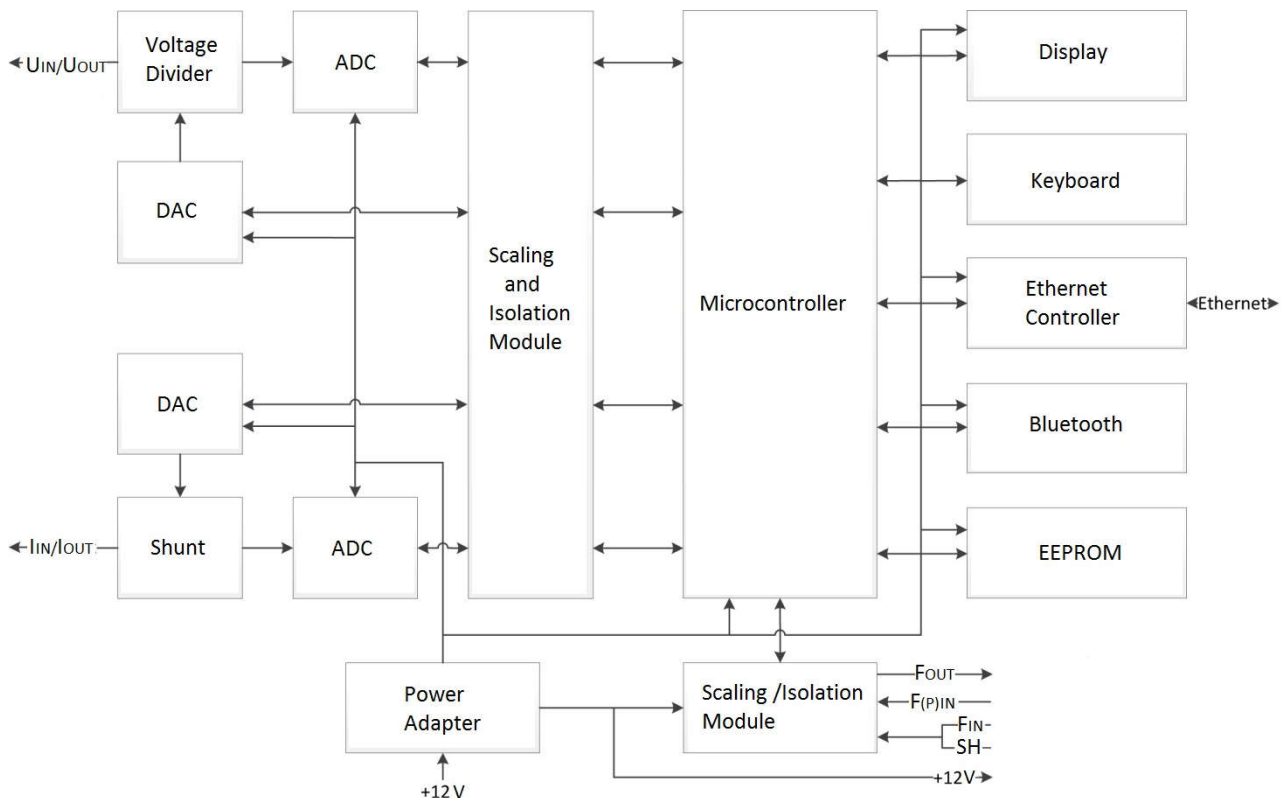

Fig 2.1 General Block diagram

2.4.2 Measurement and conversion of DC voltage into frequency is accomplished by applying the input signal to a 24-bit Analogue to Digital Converter (the ADC below) via the scaling (resistive divider) module.

Measurement and conversion of DC current into frequency is accomplished by applying the input signal to the ADC via the current-to-voltage converter (resistive shunt).

2.4.3 In the Calmar-SP and Calmar SL instruments, 16-bit Digital to Analogue Converters (the DACs below) produce DC current signals in 0 to ±24 mA range and DC voltage signals in 0 to ±10.5 V range.

DC current output signals are measured with the current-to-voltage converter (resistive shunt) and ADC and corrected on the basis of measurement results.

DC voltage output signals are measured with the scaling voltage converter (resistive divider) and ADC and corrected on the basis of measurement results.

2.4.4 The microcontroller controls the ADCs and DACs, generates output pulse signals and outputs measurement results to the display and PC via Ethernet, USB or Bluetooth ports (the Bluetooth and USB options are only available for the Calmar-SP and Calmar-SL modifications).

2.4.5 The calibrator can be controlled via the keyboard and built-in display or via the PC using the dedicated (e.g. EnForm-MTS) software.

2.4.6 Accessories

2.4.6.1 Pulse Former (PF) generates pulses applied to the SH input of the calibrator, so it can be used together with the calibrator to determine measurement errors of electronic or induction type energy meters (single- or three-phase) as well as to test (calibrate) electronic meters with a pulse output under on-site conditions.

2.4.6.2 Scanning heads SH-E and SH-I

SH-E and SH-I are used together with the calibrator to automatically test (calibrate) single- and three-phase active and reactive energy meters under on-site conditions.

SH-E is used to test electronic meters with an optical pulse output. The scanning head is mounted onto the meter and connected to the SH output of the calibrator.

SH-I is used to test induction-type (disk) meters. The scanning head is mounted onto the meter and connected to the SH output of the calibrator.

3 Preparing for operation

3.1 Notes on operating conditions

3.1.1 If the calibrator has been moved from a cold environment (with ambient temperature below 0° C) into a warm one, it shall be left to stand for at least 4 hours at room temperature before applying power to make sure that no condensation remains inside.

Caution! The calibrator shall not be used under the ingress of moisture inside its enclosure.

3.1.2 Input signals must be applied to the proper inputs of the calibrator. The values of the input signals must not exceed the measurement ranges set in the calibrator.

Caution! Negative polarity signals must NOT be applied to the unipolar inputs of the Calmar-SS instruments.

3.2 Unpacking

3.2.1 Check that the delivery package contains all items specified in Tables 2.3, 2.4 or 2.5 (depending on the modification). Check that the manufacturer's seals are intact. Should anything in the package be found damaged, contact the supplier immediately.

3.2.2 **For the Calmar-SP instruments:** Remove the rear cover, insert accumulators (8 pcs) into the battery compartment considering the polarity and set the cover into place.

3.3 Preparing for operation

3.3.1 Controls and connectors
The keys on the keypad are described in Table 3.1.

Table 3.1

Key	Function
⏻	Power ON/OFF (Calmar-SP)
⇓	Moving the cursor down through menu options Decreasing numeric values For Calmar-SS: in the "Ratio of frequencies" measurement mode (after pressing the F key), setting the number of reference (N_{REF}) and "device under test" (N_{TEST}) pulses
⇑	Moving the cursor up through menu options Increasing numeric values
⇐	Moving the cursor to the left
⇒	Moving the cursor to the right
ENT	Opening a selected menu option Entering data
ESC	Exit from a mode Return to the main menu
·	Restart of the "Error calculation" mode
F	For Calmar-SS: enabling the "Ratio of frequencies" mode For Calmar-SP and Calmar-SL: a service button

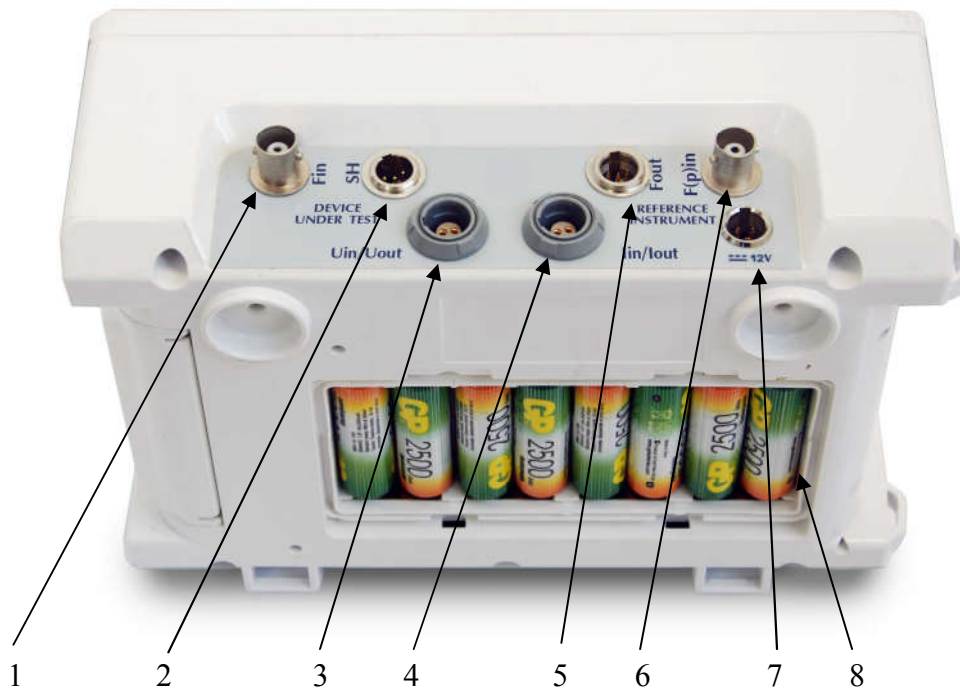Fig 3.1, 3.2 and 3.3 show controls and connectors on the Calmar-SP panels.
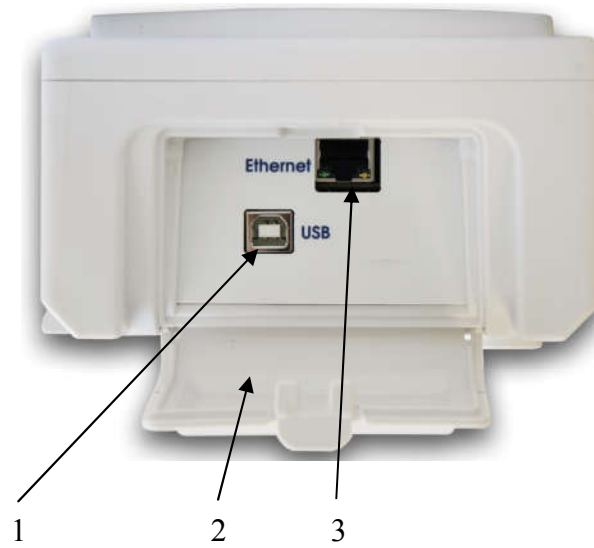
1 –USB port; 2 – Cover; 3 – Ethernet port

Fig 3.1 Calmar-SP side panel
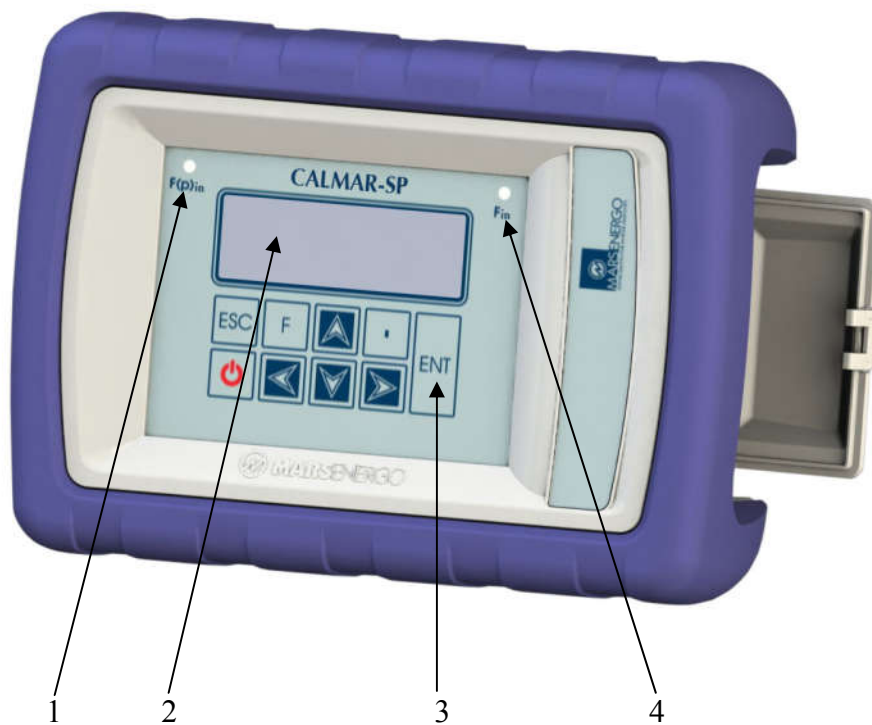
1 – LED showing pulses on the $F_{(P)IN}$ input; 2 – Display;
3 – Keypad; 4 – LED showing pulses on the F_{IN} input

Fig. 3.2 Calmar-SP front panel

1 – F_{IN} connector (for connection to the pulse output of the DUT); 2 – SH connector (for connection to the Scanning Head); 3 – U_{IN}/U_{OUT} connector (DC voltage input or output); 4 – I_{IN}/I_{OUT} connector (DC current input or output); 5 – F_{OUT} connector (for connection to the frequency input of the reference instrument); 6 – $F_{(P)IN}$ connector (for connection to the frequency output of the reference instrument); 7 – "=12 V" connector (for connection to the Power Adapter/Charger); 8 – Battery compartment

Fig.3.3 Calmar-SP upper panel

3.3.2 Turning on

Warning! To avoid electric shock, it is strongly recommended to connect (disconnect) the calibrator to the measured circuits when they are de-energized. Otherwise, connection (disconnection) to the measured circuits must be carried out by qualified personnel in compliance with the local safety regulations in force.

3.3.2.1 The Calmar-SS and Calmar-SL instruments are connected to mains via the Power Adapter.

3.3.2.2 Turning on Calmar-SP

Calmar-SP can be powered from mains (via the Power Adapter), from a USB power supply, or from the battery (8 Ni-MH or Ni-Cd AA accumulators). On connecting to mains, the accumulators start to charge.

Caution! You must not connect the Power Adapter to the calibrator if expendable (non-rechargeable) AA batteries are inside the battery compartment instead of rechargeable batteries (accumulators).

Note! The number of charge cycles of the accumulators is limited and substantially determined by their quality and operating conditions

Calmar-SP is turned on/off with the button ⏻:
ON: quickly press ⏻ three times
OFF: press ⏻ and hold at least 5 seconds

3.3.2.3 As it is powered up, the calibrator turns on the display backlight and performs warm-up, initialization and initial configuration procedures. During the initialization, performance of every unit

is checked and programs are loaded. At the conclusion, the screen containing manufacturer's name, firmware version and serial number of the calibrator will appear. On pressing ENT the calibrator goes to the main menu.

The table below contains the actual firmware versions for all modifications and metrologically significant (MS) checksums (for the Calmar-SP and Calmar-SL modifications).

Firmware	Calmar-S
Actual version for:	
Calmar-SS	1.2 or higher
Calmar -SL	1.4 or higher
Calmar -SP	2.1 or higher
Checksums for error calculation modules (CRC1) for:	
Calmar -SS	-
Calmar -SL	0x25E7
Calmar -SP	0x25E7

3.3.2.4 The calibrator is considered set for stable operation in 15 min after applying power. Its specifications are as declared from this point.

4 Operation

4.1 Operator interface

4.1.1 The calibrator is a menu driven instrument. To navigate to a desired screen or menu item, six keys are used: "ENT", "ESC", "⇓", "⇑", "⇐", "⇒". After power up and completion of initialization and self-test procedures, the calibrator opens the main menu on pressing the ENT key.

4.1.2 The main menu of the Calmar-SP and Calmar-SL instruments consists of 6 options reflecting the operation modes:

- **Converter**
- **Calibrator**
- **Comparator**
- **From PC** (PC controlled mode)
- **Settings**
- **Calibration** (not indicated)

Arrows (↓ or ↑) displayed in the right part of a screen mean that there are above or below menu items on the current level.

The first 3 options relate to the modes of operation when the calibrator is used independently (in the stand-alone mode).

The "From PC" item enables the PC controlled mode.

The "Settings" option is used to configure the communication ports (Ethernet or Bluetooth) and pulse inputs as well as to check the state of accumulators (for Calmar-SP only).

The "Calibration" item relates to the service mode used by the manufacturer.

4.1.3.1 The "**Converter**" option gives access to the following modes:

"$U_{IN} \rightarrow F_{OUT}$" – conversion of a DC voltage signal applied to the U_{IN}/U_{OUT} connector into the pulse (frequency) signal generated on the F_{OUT} output

"$I_{IN} \rightarrow F_{OUT}$" – conversion of a DC current signal I_{IN} into the pulse (frequency) signal generated on the F_{OUT} output

"$F_{IN} \rightarrow F_{OUT}$" – conversion of a pulse repetition rate (frequency) signal applied to the F_{IN} input into the pulse repetition rate (frequency) signal on the F_{OUT} output (frequency division)

"$F_{IN} \rightarrow U_{OUT}$" – conversion of the F_{IN} signal into the U_{OUT} signal

"$F_{IN} \rightarrow I_{OUT}$" – conversion of the F_{IN} signal into the I_{OUT} signal

4.1.3.2 The "**Calibrator**" menu has 3 options:

"$\rightarrow U_{OUT}$" – generation of DC voltage (from -10.5 to +10.5V) on the U_{OUT}

"$\rightarrow I_{OUT}$" – generation of DC current (from -24 mA to +24 mA) on the I_{OUT}

"$\rightarrow F_{OUT}$" – generation of frequency (pulse repetition rate) (from 0 to 22500 Hz) on the F_{OUT}

4.1.3.3 The "**Comparator**" menu has 3 options:

"$F_{IN}/F_{(P)IN}$" – comparison of two frequency signals: one is applied to the pulse output F_{IN} (from the device under test) and another one – to the $F_{(P)IN}$ (from the reference instrument) considering the pulse values

"$U_{IN}/F_{(P)IN}$" – conversion of an input DC voltage signal into the pulse repetition rate (frequency) signal and further comparison of this frequency with the frequency applied to the $F_{(P)IN}$ output considering the pulse values

"$I_{IN}/F_{(P)IN}$" – conversion of an input DC current signal into the pulse repetition rate (frequency) signal and further comparison of this frequency with the frequency applied to the $F_{(P)IN}$ output considering the pulse values

4.1.3.4 The "**From PC**" option makes it possible to select PC communication ports.

For the Calmar-SL modification these options are:

Ethernet
Bluetooth
For Calmar-SP:
Ethernet
Bluetooth
USB-COM

4.1.3.5 The "**Settings**" menu consists of 4 options:

"**Ethernet**" – settings for establishing Ethernet connection with your PC

"**Bluetooth**" – settings for Bluetooth connection with your PC

"**Mode F_{IN} & $F_{(P)IN}$**" – setting the operation modes for the frequency inputs

"**K_{DIV} F_{IN}**" – setting the division value for the repetition rate (frequency) of the pulses applied to the F_{IN} input (1 to 65535)

"**K_{DIV} $F_{(P)IN}$**" – setting the division value for the repetition rate (frequency) of the pulses applied to the $F_{(P)IN}$ input (1 to 65535

"**F_{NOM}**" – setting the value of nominal frequency, Hz (0.1 to 15000), the recommended value is 4000 Hz (at least), see section 2.3.2

"**Accumulators**" – checking the battery operation (present in the Calmar-SP menu)

"**Firmware info**" – displays the actual name, serial number, firmware version, metrologically significant (MS) checksum, and firmware checksum of the calibrator

"**Language**" – language selection

The detailed description of each item is given below.

"Ethernet"

"UDP-port" – to specify the port number

"IP-address" – to specify the IP-address

"Mask" – to specify the subnet mask

"Bluetooth"

On selecting the Bluetooth option, the user is requested to enter a pin-code.

"Mode F_{IN} & $F_{(P)IN}$"

The item includes 2 options:

"F_{IN}" – sets the mode of operation for the F_{IN} input

"$F_{(P)IN}$" – sets the mode of operation for the $F_{(P)IN}$ input

The modes of operation may be as follows:

"Pullup" – the frequency output of the connected device under test is powered from the calibrator, which means that the devices with the outputs of "open collector" type may be connected to the F_{IN} input

"No pull" – the calibrator does not supply power to the frequency output of the device under test connected to the F_{IN} input

The required mode is enabled by placing the symbol ">" on the left of the mode name.

"Accumulators"

"Temperature" – the temperature of accumulators, °C (displayed only if the calibrator is connected to mains via the Power Adapter)

"Charge" – charge current, mA (displayed only if the calibrator is connected to mains via the Power Adapter)

"Discharge" – discharge current, mA (displayed only if the calibrator is powered from the battery and the mains power supply is off)

"Health" – charge level of the battery in %

"Voltage max" – max output voltage of the battery, mV

"Voltage min:" – min output voltage of the battery, mV

"Firmware info"

displays the actual name, serial number, firmware version, metrologically significant (MS) checksum, and firmware checksum of the calibrator

"Name" – actual name of the calibrator

"Serial number" – self-explanatory

"Version" – actual firmware version

"MS Checksum" – Metrologically significant (measurement and calculation module) checksum

"Checksum" – firmware checksum

"**Language**" – language selection

4.2 Calmar-SP and Calmar-SL in standalone (off-line) mode

In the standalone (off-line) mode, the calibrator works independently. It is controlled from the keypad on the front panel. The first three options of the main menu relate to this mode:

Converter
Calibrator
Comparator

4.2.1 Converter

"$U_{IN} \rightarrow F_{OUT}$" – conversion of a DC voltage signal applied to the U_{IN}/U_{OUT} connector into the pulse (frequency) signal generated on the F_{OUT} output

"$I_{IN} \rightarrow F_{OUT}$" – conversion of a DC current signal I_{IN} into the pulse (frequency) signal generated on the F_{OUT} output

"$F_{IN} \rightarrow F_{OUT}$" – conversion of a pulse repetition rate (frequency) signal applied to the F_{IN} input into the pulse repetition rate (frequency) signal on the F_{OUT} output (frequency division)

"$F_{IN} \rightarrow U_{OUT}$" – conversion of the F_{IN} signal into the U_{OUT} signal

"$F_{IN} \rightarrow I_{OUT}$" – conversion of the F_{IN} signal into the I_{OUT} signal

4.2.1.1 $\mathbf{U_{IN} \rightarrow F_{OUT}}$

The mode is used for determining measurement errors of measuring transducers with standard DC voltage outputs:

0 to 0.3 V (**0 +0.2 V**)*
0 to 7.5 V (**0 +5 V**)*
0 to 15 V (**0 +10 V**)*
-5 to 7.5 V(**-5 +5 V**)* , -5 +5 V mode
-7.5 to 7.5 (**-5 +5 V**)* , -5 0 +5 V mode
-10 to 15 (**-10 +10 V**) , -10 +10 V mode *
-15 to 15 ("**-10 +10 V**) , -10 0 +10 V mode
* *How the range is indicated on the display*

a) Unipolar modes **"0 +0.2 V", "0 +5 V" or "0 +10 V"**
The calibrator measures voltage applied to the U_{IN}/U_{OUT} input
The display shows the values of measured DC voltage and frequency (pulse repetition rate) proportional to the measured voltage, where the zero value of voltage corresponds to the zero value of frequency (no pulses) and the nominal value of voltage (U_{NOM}) – to the nominal pulse repetition rate F_{NOM} (4 kHz).
The pulse sequence with a pulse period-to-duration ratio = 2 and frequency shown on the display is generated on the F_{OUT} output.
b) Bipolar modes **"-10 +10 V" and "-5 +5 V"**
In the bipolar modes, there will be 2 options reflecting the relationship between the output frequency (F_{OUT}) and measured voltage (U_{IN}):
1) "-5 +5 V" $\rightarrow F_{OUT} = 0$ at $U_{IN} = -5$ V; $F_{OUT} = F_{NOM}$ (4 kHz) at $U_{IN} = +5$ V
2) "-5 0 +5 V" $\rightarrow F_{OUT} = 0$ at $U_{IN} = 0$ V; $F_{OUT} = F_{NOM}$ either at $U_{IN} = +5$ V or at $U_{IN} = -5$ V

1) "-10 +10 V" $\rightarrow F_{OUT} = 0$ at $U_{IN} = -10$ V; $F_{OUT} = F_{NOM}$ at $U_{IN} = +10$ V
2) "- 10 0 +10 V"$\rightarrow F_{OUT} = 0$ at $U_{IN} = 0$ V; $F_{OUT} = F_{NOM}$ either at $U_{IN} = +10$ V and at $U_{IN} = -10$ V

The calibrator measures voltage applied to the U_{IN}/U_{OUT} input
The display shows the values of measured DC voltage and frequency (pulse repetition rate) proportional to the measured voltage according to the selected option 1) or 2).
The pulse sequence with a pulse period-to-duration ratio = 2 and frequency shown on the display is generated on the F_{OUT} output.
4.2.1.2 $\mathbf{I_{IN} \rightarrow F_{OUT}}$
The mode is used for determining measurement errors of measuring transducers with standard DC current outputs:

0 to 7.5 mA (**0 +5 mA**)*
0 to 30 mA (**0 +20 mA**)*
4 to 30 mA (**+4 +20 mA**)*
-5 to 7.5 mA (**-5 +5 mA**)*, -5 +5 mA mode
-7.5 to 7.5 (**-5 +5 mA**)*, -5 0 +5 mA mode
* *How the range is indicated on the display*
a) Unipolar modes "0 +5 mA", "0 +20 mA", "+4 +20 mA"
The calibrator measures current applied to the I_{IN}/I_{OUT} input

The display shows the values of measured DC current and frequency (pulse repetition rate) proportional to the measured current, where the zero value of current corresponds to the zero value of frequency (no pulses) and the nominal value of current (I_{NOM}) – to the nominal pulse repetition rate F_{NOM} (4 kHz).

The pulse sequence with a pulse period-to-duration ratio = 2 and frequency shown on the display is generated on the F_{OUT} output.

b) Bipolar mode "–5 +5 mA"

In this mode, you will find 2 options reflecting the relationship between the output frequency (F_{OUT}) and measured current (I_{IN}):

1) "-5 +5 mA" → F_{OUT} = 0 at I_{IN} = -5 mA; F_{OUT} = F_{NOM} (4 kHz) at I_{IN} = +5 mA

2) "-5 0 +5 mA" → F_{OUT} = 0 at I_{IN} = 0 mA; F_{OUT} = F_{NOM} either at I_{IN} = +5 mA or I_{IN} = -5 mA

The calibrator measures the current applied to the I_{IN}/I_{OUT} input

The display shows the values of measured DC current and frequency (pulse repetition rate) proportional to the measured current according to the selected option 1) or 2).

The pulse sequence with a pulse period-to-duration ratio = 2 and frequency shown on the display is generated on the F_{OUT} output.

4.2.1.3 $F_{IN} \rightarrow F_{OUT}$

The mode provides for the hardware-based division of the frequency of pulses applied to the F_{IN} input. Division factor is set programmatically in 2 to 8192 range.

To set the division factor, select the mode and press ENT to open the entry screen. The meander-like pulses of required frequency will be generated on the frequency output F_{OUT}.

4.2.1.4 $F_{IN} \rightarrow U_{OUT}$

The required output voltage range (0 +0.2 V, 0 +5 V, 0 +10 V, -5 +5 V, or -10 +10 V) is selected with the buttons ⇓ and ⇑.

The zero value of input frequency F_{IN} (no pulses) corresponds to the lower value of the voltage range, and the nominal value of frequency (F_{NOM} = 4 kHz) – to the upper voltage range value.

The display shows the values of input frequency in Hz and output voltage in V. The output voltage signal proportional to the input frequency signal will be generated on the U_{IN}/U_{OUT} output.

4.2.1.5 $F_{IN} \rightarrow I_{OUT}$

The required output current range (0 +5 mA, 0 +20 mA, 4 +20 mA, or -5 +5 mA) is selected with the buttons ⇓ and ⇑.

The zero value of input frequency F_{IN} (no pulses) corresponds to the lower value of the current range, and the nominal value of frequency (F_{NOM} = 4 kHz) – to the upper current range value.

The display shows the values of input frequency in Hz and output current in mA. The output current signal proportional to the input frequency signal will be generated on the I_{IN}/I_{OUT} output.

4.2.2 Calibrator

"→ U_{OUT}" – generation of DC voltage (from -10.5 to +10.5V) on the U_{OUT}
"→ I_{OUT}" – generation of DC current (from -24 mA to +24 mA) on the I_{OUT}
"→ F_{OUT}" – generation of frequency (pulse repetition rate) (from 0 to 22500 Hz) on the F_{OUT}
Select the required option and enter the setpoint value of the parameter to be generated on the corresponding output (use ⇐ ⇒ to select the position and ⇓ ⇑ to change the value or sign).
The calibrator starts to generate an output signal with the specified parameters.

The display shows the user specified value (U_{SET} or I_{SET}) and the value produced on the corresponding output (U_{OUT} or I_{OUT}).

In the "$\rightarrow F_{OUT}$" mode, only the preset value of frequency F_{SET} will be displayed.

4.2.3 Comparator

"$F_{IN}/F_{(P)IN}$" – comparison of two frequency signals: one is applied to the pulse output F_{IN} (from the device under test) and another one – to the $F_{(P)IN}$ (from the reference instrument) considering the pulse values

"$U_{IN}/F_{(P)IN}$" – conversion of an input DC voltage signal into the pulse repetition rate (frequency) signal and further comparison of this frequency with the frequency applied to the $F_{(P)IN}$ output considering the pulse values

"$I_{IN}/F_{(P)IN}$" – conversion of an input DC current signal into the pulse repetition rate (frequency) signal and further comparison of this frequency with the frequency applied to the $F_{(P)IN}$ output considering the pulse values

4.2.3.1 $F_{IN}/F_{(P)IN}$

The mode is used for determining measurement errors of measuring transducers (energy meters) with a pulse output.

Before you start measurements:

- Connect the pulse output of the device under test (DUT) to the F_{IN} input of the calibrator (when testing an induction meter, mount the SH-I scanning head onto the meter and connect its output cable to the SH input of the calibrator).
- Connect the pulse output of the reference instrument to the $F_{(P)IN}$ input of the calibrator.

To determine an error value, the calibrator compares pulse repetition rates of 2 signals: the DUT signal on the F_{IN} input (or on the SH input) and the reference signal on the $F_{(P)IN}$ input considering the pulse values or the instrument constants of the reference and tested instruments (for electrical energy meters).

After selecting the **$F_{IN}/F_{(P)IN}$** mode, specify the start conditions in the "N_{REF}, N_{TEST}" screen:

N_{REF} – the calculated number of pulses to be generated by the reference instrument considering the division factor preset for the $F_{(P)IN}$ input – this number of pulses will be expected from the reference instrument within the measurement interval ("measurement window") assuming a zero error value for the DUT.

N_{TEST} – the number of pulses to be received from the DUT considering the division factor preset for the F_{IN} input – this number of pulses determines the time interval ("measurement window") within which the number of reference pulses coming to the $F_{(P)IN}$ input will be calculated.

$K_{DIV} F_{IN}$ – division factor for the F_{IN} input

$K_{DIV} F_{(P)IN}$ – division factor for the $F_{(P)IN}$ input

N_{REF}, N_{TEST}, K_{DIV}, F_{IN} K_{DIV}, and K_{DIV} F_{IN} $F_{(P)IN}$ are set within 1 to 65535.

When the "Measurement" mode is activated, the calibrator starts to calculate the pulses coming to the F_{IN} and $F_{(P)IN}$ inputs. As soon as the number of the pulses from the DUT achieves the N_{TEST} value (considering the division factors), the calibrator determines the relative measurement error of the DUT, shows its value on the display and starts a new measurement.

The LEDs on the front panel indicate that the reference and DUT pulses are present on the measurement inputs of the calibrator.

4.2.3.2 $U_{IN}/F_{(P)IN}$

The mode is used for determining measurement errors of measuring transducers with a standard DC voltage output signal.

To determine an error value, the output DC voltage signal of the device under test is converted into a pulse repetition rate (frequency) signal, and then compared with the reference frequency signal coming to the $F_{(P)IN}$ input of the calibrator from the reference instrument (considering the pulse value).

The required input voltage range (0 +0.2 V, 0 +5 V, 0 +10 V, -5 +5 V, or -10 +10 V) is selected with the buttons ⇓ and ⇑.

If a bipolar mode (-5 +5 V, or -10 +10 V) is selected, there will be 2 options reflecting the relationship between the output frequency F_{OUT} and measured voltage U_{IN}.

1) "-5 +5 V" → F_{OUT} = 0 at U_{IN} = -5 V; F_{OUT} = F_{NOM} (4 kHz) at U_{IN} = +5 V

2) "-5 0 +5 V" → F_{OUT} = 0 at U_{IN} = 0 V; F_{OUT} = F_{NOM} either at U_{IN} = +5 V or at U_{IN} = -5 V

1) "-10 +10 V" → F_{OUT} = 0 at U_{IN} = -10 V; F_{OUT} = F_{NOM} at U_{IN} = +10 V

2) "- 10 0 +10 V" → F_{OUT} = 0 at U_{IN} = 0 V; F_{OUT} = F_{NOM} either at U_{IN} = +10 V and at U_{IN} = -10 V

After selecting the $U_{IN}/F_{(P)IN}$ mode, specify the start conditions in the "N_{REF}, N_{TEST}" screen:

N_{REF} − the calculated number of pulses to be generated by the reference instrument for the $F_{(P)IN}$ input − this number of pulses will be expected from the reference instrument within the measurement interval ("measurement window") assuming a zero error value for the DUT.

N_{TEST} − the number of pulses to be received from the DUT considering the division factor preset for the F_{IN} input − this number of pulses determines the time interval ("measurement window") within which the number of reference pulses coming to the $F_{(P)IN}$ input will be calculated.

$K_{DIV} F_{IN}$ − division factor for the F_{IN} input

$K_{DIV} F_{(P)IN}$ − division factor for the $F_{(P)IN}$ input

N_{REF}, N_{TEST}, K_{DIV}, $F_{IN} K_{DIV}$, and $K_{DIV} F_{IN} F_{(P)IN}$ are set within 1 to 65535.

When the "Measurement" mode is activated, the calibrator starts to calculate the pulses coming to the F_{IN} and $F_{(P)IN}$ inputs. As soon as the number of the pulses from the DUT achieves the N_{TEST} value (considering the division factors), the calibrator determines the relative measurement error of the DUT, shows its value on the display and starts a new measurement.

The LEDs on the front panel indicate that the reference and DUT pulses are present on the measurement inputs of the calibrator.

4.2.3.3 $I_{IN}/F_{(P)IN}$

The mode is used for determining measurement errors of measuring transducers with a standard DC current output signal.

To determine an error value, the output DC current signal of the device under test is converted into a pulse repetition rate (frequency) signal, and then compared with the reference frequency signal coming to the $F_{(P)IN}$ input of the calibrator from the reference instrument (considering the pulse value).

The required input current range (0 +5 mA, 0 +20 mA, +4 +20 mA, and -5 +5 mA) is selected with the buttons ⇓ and ⇑.

If the bipolar (-5 +5 mA) mode is selected, there will be 2 options reflecting the relationship between the output frequency F_{OUT} and measured current I_{IN}.

1) "-5 +5 mA" → F_{OUT} = 0 at I_{IN} = -5 mA; F_{OUT} = F_{NOM} (4 kHz) at I_{IN} = +5 mA

2) "-5 0 +5 mA" → F_{OUT} = 0 at I_{IN} = 0 mA; F_{OUT} = F_{NOM} either at I_{IN} = +5 mA or I_{IN} = -5 mA

After selecting the $I_{IN}/F_{(P)IN}$ mode, specify the start conditions in the "N_{REF}, N_{TEST}" screen:

N_{REF} − the calculated number of pulses to be generated by the reference instrument for the $F_{(P)IN}$ input − this number of pulses will be expected from the reference instrument within the measurement interval ("measurement window") assuming a zero error value for the DUT.

N_{TEST} − the number of pulses to be received from the DUT considering the division factor preset for the F_{IN} input − this number of pulses determines the time interval ("measurement window") within which the number of reference pulses coming to the $F_{(P)IN}$ input will be calculated.

$K_{DIV} F_{IN}$ − division factor for the F_{IN} input

$K_{DIV} F_{(P)IN}$ − division factor for the $F_{(P)IN}$ input

N_{REF}, N_{TEST}, K_{DIV}, $F_{IN} K_{DIV}$, and $K_{DIV} F_{IN} F_{(P)IN}$ are set within 1 to 65535.

When the "Measurement" mode is activated, the calibrator starts to calculate the pulses coming to the F_{IN} and $F_{(P)IN}$ inputs. As soon as the number of the pulses from the DUT achieves the N_{TEST} value (considering the division factors), the calibrator determines the relative measurement error of the DUT, shows its value on the display and starts a new measurement.

The LEDs on the front panel indicate that the reference and DUT pulses are present on the measurement inputs of the calibrator.

4.3 PC-controlled mode

4.3.1 To control the calibrator from a PC (on-line mode), the EnForm-MTS software package shall be installed on your computer (MS Windows 200, XP, 7).

When working with the EnForm-MTS program, it is recommended to use the calibrator as part of the test systems of MTS ME family.

The following PC configuration is recommended for proper functioning of the program:

Processor - Pentium III 700 MHz, or more powerful

At least 256 Mb RAM

At least 3Mb of disc space to install the program

At least 20 Mb of disc space, if Microsoft .NET Framework 2.0 library package has not been installed on your computer

Video adapter of 1024 × 768 resolution and 32-bit color depth

CD-ROM for installation

Mouse or compatible pointing device

Ethernet adapter (connector RJ-45)

Two free COM-ports (RS-232).

For more convenient work with large volumes of data, a more powerful computer may be required.

To work with several Calmar-S instruments, it is necessary to connect them to LAN via switches.

Ethernet communication can be provided via LAN, or the calibrator can be directly connected to the Ethernet port of a PC with a network cable.

For how to work with the EnForm-MTS program, see the corresponding user's manual.

4.3.2 **Calmar-SP and Calmar-SL in PC-controlled modes**

4.3.2.1 **Ethernet**

The calibrator features the same functionality, as in the standalone mode.

The UDP protocol is used for the Ethernet communication.

To disable the mode, open the **From PC → Ethernet** option and select OFF.

4.3.2.2 **Bluetooth**

The calibrator features the same functionality, as in the standalone mode. The Bluetooth communication channel works in the virtual COM port mode.

To disable the mode, open the **From PC → Bluetooth** option and select OFF.

4.3.2.3 **USB**

The calibrator features the same functionality, as in the standalone mode.

The data exchange rate is fixed (115200 bps).

The USB port of the calibrator can be used for charging the battery.

To disable the mode, open the **From PC → USB** option and select OFF.