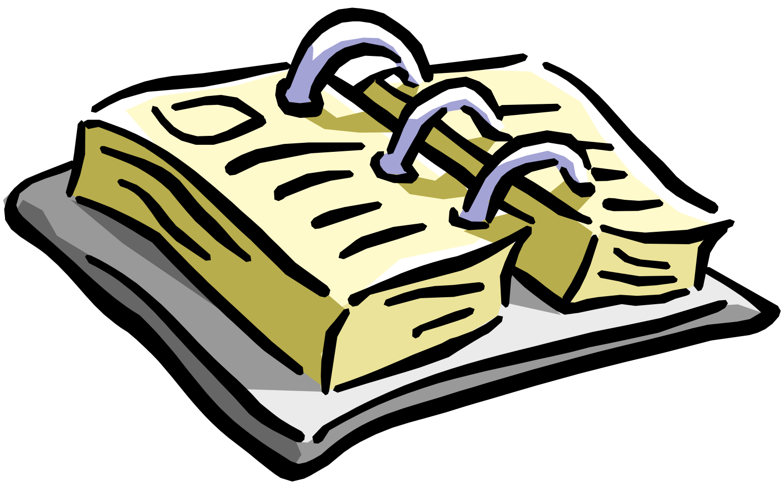
CALIBRATOR PRODUCER

SERVICE MANUAL
VOLTAGE AND CURRENT CALIBRATOR
TYPE
INMEL 10



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1. TECHNICAL DESCRIPTION

The INMEL 10 calibrator is a precision source of direct and alternating voltages and currents. It has been designed primarily for calibration and checking of measuring instruments. It finds another application in laboratory measurements as a precision power supply.

Its operational features are enhanced by a set of programmable functions which facilitate measurement procedures. Entering set values of programmed functions is handled by the operator who uses the keys in the control board retractable from the calibrator casing. The output and feedback terminals are on the front panel.

1.1. Technical parameters of calibrator INMEL 10

Specifications have been tabulated in tables 1.1.1.-1.1.6.

Tabl. 1.1.1. Direct voltages ranges parameters.

Parameter	Range					
	1000 V	**100 V**	**10 V**	**1 V**	**100 mV**	**10 mV**
1	**2**	**3**	**4**	**5**	**6**	**7**
Useable setting range	0... +1099.999V	0... +109.9999 V	0... ±10.99999V	0... ±1.099999V	0.. ±109.9999mV	0... ±10.99999mV
Resolution	1000 μV	100 μV	10 μV	1 μV	0.1 μV	0.01 μV
Basic error [1]	± 0.03% setting ± 0.004% range			± 0.02% setting ± 0.004% range	± 0.05% setting ± 10 μV	
Operating error [2]	± 0.05% setting ± 0.007% range			± 0.03% setting ± 0.007% range	± 0.07% setting ± 16 μV	
15 minutes drift. [3]	± 0.002% setting ± 0.001% range		± 0.001% range		± 3 μV	
7 h drift [3]	± 0.01% setting ± 0.005% range		± 0.005% setting ± 0.001% range		± 0.01% range ± 10 μV	

→

Parameter	**Range**					
	1000 V	**100 V**	**10 V**	**1 V**	**100 mV**	**10 mV**
1	**2**	**3**	**4**	**5**	**6**	**7**
Additional error caused by change: - ambient temperature	± 0.03% setting ± 0.004% range			± 0.02% setting ± 0.004% range	±0.04% setting ±10 μV	
- supply voltage	± 0.006% setting ± 0.0008% range			± 0.004% setting ± 0.0008% range	± 0.01% setting ± 2 μV	
- load current	± 0.002% range				caused by output resistance of 0,1 Ω	
- load reactance	± 0.001% range					
Linearity error	± 0.01% range					
PARD [4)]	0.15% setting +0.03% range		0.03% range	0.1% setting +0.1% range	0.1% setting + 10 μV	
Common mode rejection ratio [6)] within frequency 0...50Hz	80 dB	90 dB		100 dB	110 dB	
Short-circuit current	50 mA		1.8 A		1 A	100 mA

Parameter	**Range**					
	1000 V	**100 V**	**10 V**	**1 V**	**100 mV**	**10 mV**
1	**2**	**3**	**4**	**5**	**6**	**7**
Transition process caused by the change:[2]	transition process time/transition process amplitude [7]					
- supply voltage	0.1 s / 1% range					
- set value	7 s / 1% range [8]			4 s / 1% range		
- polarity	-			6 s / 1% range		
- range	10 s / 10% range					
- load 0A→max[5] max→0A	6 s 1% range 100% range	6 s 1% range 200% range	3 s 1% range 50% range	3 s 1% range 150% range	0.1 s 1% range	

1) in reference conditions according to table 1.1.5. within 12 months,
2) in rated operating conditions according to table 1.1.5.,
3) after 1 h pre-heating time,
4) rms value of AC component in the 2 Hz...10 kHz,
5) maximum load current in rated operating conditions,
6) the ratio of common-mode voltage (external source voltage generated between insulated output terminals of the calibrator and the casing screen or earthing terminals)to the change of the output quantity value caused by the common-mode voltage, expressed in decibels,
7) the difference between the top or bottom output value in the transition process and the steady-state output value,
8) for setting greater than 0.1% range

Tabl. 1.1.2. Alternating voltage range specifications.

Parameter	**Range**					
	1000 V	**100 V**	**10 V**	**1 V**	**100 mV**	**10 mV**
1	**2**	**3**	**4**	**5**	**6**	**7**
Usable setting range	10... 1099.999 V	1... 109.9999 V	0.1... 10.99999 V	0.01... 1.099999 V	1... 109.9999 mV	0.1... 10.99999 mV
Resolution	1000 µV	100 µV	10 µV	1 µV	0.1 µV	0.01 µV
Basic error	± 0.05% setting ± 0,01% range ± 50 µV [9] ± 0.1% setting ± 0.02% range ± 100 µV				± 0.2% setting ±50 µV[9] ± 0.4% setting ±100 µV	
Operating error [2]	± 0.08% setting ± 0.02% range ± 75 µV [9] ± 0.13% setting ± 0.025% range ± 128 µV				±0.24% setting ±65µV[9] ±0.48% setting ±120µV	
15 minutes drift [3]	± 0.005% setting ± 0.002% range				± 10 µV	
7 h drift [3]	± 0.02% setting ± 0.005% range				± 0.02% range ± 20 µV	
Additional error [2] caused by the change:						
- ambient temperature	± 0.05% setting ± 0.01% range ± 50 µV				± 0.04% setting ±10 µV	
- supply voltage	± 0.01% setting ± 0.002% range ± 10 µV					
- load current	± 0.02% setting ± 0.003% range [9] ± 0.04% setting ± 0.006% range				limited by output resistance 0,1 Ω	
- load reactance	± 0.001% range					
Linearity error	± 0.01% range					

<table>
<tr><th rowspan="2">Parameter</th><th colspan="6">Range</th></tr>
<tr><th>1000 V</th><th>100 V</th><th>10 V</th><th>1 V</th><th>100 mV</th><th>10 mV</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th></tr>
<tr><td>Total harmonic distortion coefficient.[4] in the frequency band:
40.00...
48.00Hz</td><td>[5)]
2% setting
1% setting</td><td rowspan="3">0.4%
setting
0.05%
range</td><td>0.2%
setting
+ 0.05%
range</td><td>0.2%.
setting
+ 0.2%
range</td><td rowspan="2">0.2%
setting
+ 0.1%
range</td><td rowspan="4">50 μV</td></tr>
<tr><td>48.01...
499.9 Hz</td><td>[5)]
1% setting
0.5% set.
+0.05%ran.</td><td>0.3% set.
+ 0.05%
range</td><td>0.2% set.
+ 0.3%
range</td></tr>
<tr><td>500.0...
2000 Hz</td><td>0.5% set.
+0.1%
range</td><td>0.4% set.
+0.06%
range</td><td>0.3% set.
+0.4%
range</td><td>0.3% set.
+0.1%
range</td></tr>
<tr><td>2001...
4999 Hz</td><td>[5)]
1.2% set.
+0.15%ran.
0.8% set.
0.1% ran.</td><td>0.5% set. +
0.1% range</td><td>0.5% set.
+0.1%
range</td><td>0.4%. set.
+0.4%
range</td><td>0.8% set.
+0.1%
range</td></tr>
<tr><td>Common mode rejection ratio in the frequency range of 0...50Hz</td><td>80 dB</td><td colspan="2">90 dB</td><td>100 dB</td><td colspan="2">110 dB</td></tr>
<tr><td>Short-circuit</td><td colspan="2">50 mA</td><td colspan="2">3.5 A</td><td>1 A</td><td>100 mA</td></tr>
</table>

Parameter	Range					
	1000 V	**100 V**	**10 V**	**1 V**	**100 mV**	**10 mV**
1	**2**	**3**	**4**	**5**	**6**	**7**
Transition process caused by the change of:	transition process time/transition process amplitude [8)]					
- supply voltage	0.1 s / 1% range					
- setting	7 s / 5% range					
- range	10 s / 10% range					
- output value frequency	1.5 s / 20% range					
- load 0A→max [6)] max→0A	6 s 5% range 100% range	6 s 5% range 200% range	5 s 5% range 50% range	5 s 5% range 150% range	0.1 s 1% range	

1) in reference conditions according to table 1.1.5. within 12 months,
2) in rated operating conditions according to table 1.1.5.,
3) after pre-heating for 1 h,
4) in rated operating conditions in the 2 Hz...200 kHz band,
5) the lower THD coefficient pertains to voltages lower than 800 V,
6) maximum load current at rated operating conditions,
7) the ratio of common-mode voltage (external source voltage generated between insulated output terminals of the calibrator and the casing, screen or earthing terminals) to the change of the calibrator and the caused by the common-mode voltage, expressed in decibels,
8) the difference between the top or bottom output value in the transition process and the steady-state output value,
9) the higher value for frequency over 500 Hz.

Tabl. 1.1.3. Direct current specifications.

Parameter	**Range**				
	10 A	**1 A**	**100 mA**	**10 mA**	**1 mA**
1	**2**	**3**	**4**	**5**	**6**
Usable setting range	0... 10.99999 A	0... ±1.099999 A	0... ±109.9999 mA	0... ±10.99999 mA	0... ±1.099999 mA
Resolution	10 μA	1 μA	100 nA	10 nA	1 nA
Basic error[1]	± 0.04 % set. ± 0.01 % rang.	± 0.03% setting ± 0.005% range			± 0.03 % set. ± 0.01% range
Operating error[2]	± 0.07% set. ± 0.02% rang.	± 0.05% set. ± 0.015% rang.	± 0.05% setting ± 0.009% range		± 0.05% set. ± 0.02% range
15 minute drift[3]	± 0.005%set.	± 0.002% range			
7 h drift [3]	± 0.02% set. ± 0.005%rang.	±0.005% set. ±0.005% rang.	± 0.005% setting ± 0.005% range		
Additional error caused by the change:					
- ambient temperature	± 0.04% set. ± 0.01% rang.	± 0.03% setting ± 0.005% range			± 0.03% set. ± 0.01% range
- supply voltage	± 0.008% set. ± 0.002% rang.	± 0.006% setting ± 0.001% range			± 0.006%set ± 0.002%rang
- load voltage	± 0.01% set ± 0.01% rang.	± 0.01% rang.	± 0.002% range		± 0.01%range [4]
- load reactance	±0.002% rang.	±0.001% range			±0.01% rang.
Linearity error	± 0.01% range				
PARD [5]	0.2% setting + 0.05 mV/Ro	0.1% setting + 0.5 mV/Ro			0.1% setting + mV
Common mode rejection ratio[7] in the frequency 0...50 Hz	100 dB	90 dB			

Parameter	**Range**				
	10 A	**1 A**	**100 mA**	**10 mA**	**1 mA**
1	**2**	**3**	**4**	**5**	**6**
Open circuit voltage	8 V	25 V			
Transition process caused by the change :	transition process time/transition process amplitude [7]				
- supply voltage	0.1 s / 1% range				
- setting	7 s / 1% range [9]	4 s / 1% range			
- polarity	-	6 s / 1% range			
- range	10 s / 10% range				
- load 0.1V→max [6]	5 s / 1% range.	6 s / 1%range	6 s / 1% range		
max →0.1V	5 s / 12 A-I_n	6 s / 220%ran.	6 s / 300% range		

1) in reference conditions according to table 1.1.5. within 12 months,
2) in rated operating conditions according to table 1.1.5.
3) after 1 h pre-heating time,
4) for setting over 0.1 mA,
5) rms value of AC component in the band 2 Hz...10 kHz, Ro-load resistance,
6) maximum load voltage at rated operating conditions,
7) the ratio of common-mode voltage (external source voltage generated between insulated output terminals of the calibrator and the casing, screen or earthing terminals) to the change of the output quantity value caused by the common-mode voltage, expressed in decibels,
8) the differences between the top and the bottom output value in the transition process and the steady-state output value,
9) for setting over 0.1% range.

Tabl. 1.1.4. Alternating current range specifications.

Parameter	Range				
	10 A	**1 A**	**100 mA**	**10 mA**	**1 mA**
1	**2**	**3**	**4**	**5**	**6**
Usable setting range	0.1...10.99999 A	0.01...1.099999 A	1...109.9999 mA	0.1...10.99999 mA	0.01...1.099999 mA
Resolution	10 μA	1 μA	100 nA	10 nA	1 nA
Basic error)	± 0.05% setting ± 0.01% range ± 2μA [8)] [12)] [13)] ± 0.1% setting ± 0.02% range ± 4μA				
Operating error)	[8)] ± 0.085%set. ± 0.04%rang. ± 0.13% set. ± 0.045%rang.	[8)] ± 0.085% setting ± 0.03% range ± 3.5 μA ± 0.13% setting ± 0.055% range ± 5.1 μA			[8)] ± 0.08% set. ± 3.8 μA ± 0.13% set. ± 6.5 μA [12)]
15 minutes drift.[3)]	± 0.01%set. ± 0.002%rang.	± 0.005% setting ± 0.001% range			
7 h drift [3)]	± 0.03% set. ± 0.01% rang.	± 0.02% setting ± 0.005% range			
Additional error caused by the change:					
- ambient temperature	± 0.05% setting ± 0.01% range ± 2 μA				
- power supply	± 0.01% setting ± 0.002% range ± 0.4 μA				
- load voltage	± 0.01% set. ± 0.01% rang.	± 0.02% setting ± 0.02% range [8)] ± 0.04% setting ± 0.04% range			± 0.15%range.[8] ± 0.3% range.[9)]
- load reactance	± 0.001%rangeC ± 0.03%rangeL	± 0.001% range (C) [10)] ± 0.01% range (L)			
Linearity error	± 0.01% range				

<table>
<tr><th rowspan="2">Parameter</th><th colspan="5">Range</th></tr>
<tr><th>10 A</th><th>1 A</th><th>100 mA</th><th>10 mA</th><th>1 mA</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th></tr>
<tr><td>Total harmonic distortion coefficient in the frequency band
40.00...48.00Hz</td><td>1.7% setting</td><td rowspan="4">0.4% setting + 2 mV/Ro</td><td colspan="2">0.2% setting + 1.5 mV/Ro</td><td>0.3% setting + mV/Ro</td></tr>
<tr><td>48.01...4999.9Hz</td><td>0.8% setting</td><td colspan="2">0.2% setting + 2 mV/Ro</td><td>0.3% setting + 6 mV/Ro</td></tr>
<tr><td>500.0...2000Hz</td><td>1% setting</td><td colspan="2">0.3% setting + 2 mV/Ro</td><td>0.3% setting + 8 mV/Ro</td></tr>
<tr><td>2001...4999Hz</td><td>2% setting</td><td colspan="2">0.4% setting + 5 mV/Ro</td><td>0.5% setting + 8 mV/Ro</td></tr>
<tr><td>Common mode rejection ratio in the frequency range of 0...50 Hz</td><td>100 dB</td><td colspan="4">90 dB</td></tr>
<tr><td>Open circuit voltage</td><td>5 V</td><td colspan="4">25 V</td></tr>
<tr><td>Transition process caused by the change of:</td><td colspan="5">transition process time / transition process amplitude [7]</td></tr>
<tr><td>- supply voltage</td><td colspan="5">0.1 s / 1% range</td></tr>
<tr><td>- setting</td><td colspan="5">7 s / 5% range</td></tr>
<tr><td>- range</td><td colspan="5">10 s / 10% range</td></tr>
<tr><td>- frequency of the output quantity</td><td>1.5 s / 20% range</td><td colspan="4">1.5 s / 20% range</td></tr>
<tr><td>- load
0,1V→max [5]
max→0,1V</td><td>5 s / 5% rang.
5 s / 12 A-I_n</td><td>6 s / 5% rang.
6s / 220%rang</td><td colspan="3">6 s / 5% range
6 s / 300% range</td></tr>
</table>

1) in reference conditions according to table 1.1.5. within 12 months,
2) in rated operating conditions according to table 1.2.5.
3) after 1 h pre-heating time,
4) in rated operating conditions within the frequency band of 2 Hz...200 kHz,
5) maximum load voltage in rated operating conditions,
6) the ratio of common-mode voltage (external source voltage generated between insulated output terminals of the calibrator and casing, screen or earthing terminals) to the change of the output quantity value caused by the common-mode voltage, expressed in decibels,
7) the difference between the top and bottom output value in the transition process and the steady-state output value,
8) higher value for frequency over 500 Hz,
9) for settings over 0.1 mA,
10) L – inductive load, C – capacity load,
11) Ro – load resistance,
12) for the 1 mA range at frequency above 2000 Hz aditionally1% setting.
13) for 10 A range valid for setting 0.1...5 A in all frequency range, for setting above 5 A for frequency ≤ 2000 Hz.

Tabl. 1.1.5. Reference conditions and rated operating conditions.

Influential quantity or influential factor	**Reference quantity or reference range**	**Rated usability range**
1	**2**	**3**
Ambient temperature	+23°C ± 2°C	+5...+40°C
Atmospheric pressure	70...106 kPa	
Relative humidity	20...80 %	
Supply voltage	230 / 110 V ± 10 %	
Supply voltage frequency	50 / 60 Hz ± 5 %	
Supply voltage shape	sinusoidal β ≤ 0.05	
Preheating time	not less than 30 minutes	
Load resistance or load current or load voltage for range:		
1000 V	over 1 MΩ	fig. 1.2.1.
100 V	over 100 kΩ	fig. 1.2.2.
10 V, 1 V	over 0.1 kΩ	0...1.1 A
100 mV, 10mV	over 100 kΩ	defined by output resistance 0.1 Ω
1 mA	1 kΩ ± 50%	0...11 V
10 mA	100 Ω ± 50%	0...11 V
100 mA	10 Ω ± 50%	0...11 V
1 A	1 Ω ± 50%	0...11 V
10 A	0.1 Ω ± 50%	fig. 1.2.3.
load reactance	zero	0...10 nF [1)] 0...10 mH
Alternating currents and voltage frequency	40...4999 Hz [2)]	
Position of calibrator	according with instruction ± 30°	
Air movement velocity	0...0.5 m/s	
Ventilation	free	
Radio frequency interference	none /negligible/	
Vibration and shocks	none /negligible/	
Magnetic and electric fields	none/ Earth field/	
Insolation	none	
Content of sand, dust, salt, water and aggressive gases in air	none /negligible/	

1) For the alternating voltages range the allowable load capacity is additionally limited by the current limitation threshold. Foe the alternating current range the allowable load inductance is additionally limited by the voltage limitation threshold. For the alternating voltage range the allowable load inductance is 2 mH for f_N=100...4999 Hz. For the alternating current range the allowable load inductance follows from the formula $\frac{100}{I_N / A /* f_N / Hz /} / mH /$ for I_N=0.1...10.99999 A and f_N=100...4999 Hz.
2) For currents over 5 A – 40...2000 Hz.

Tabl. 1.1.6. Parameters of alternating voltages and currents output frequencies.

Range	Setting range (Hz)	Resolutions (Hz)	Error in rated operating conditions
100 Hz	40...99.9	0.01	0.01% frequency range
1 kHz	100...999.9	0.1	0.01% frequency range
5 kHz	1000...2999 3000...4999	1	0.02% frequency range 0.05% frequency range

1.2. General specifications

a) safety requirements class I acc. to IEC 1010-1

highest common-mode voltage:100V in frequency band 0...50Hz for low-voltage terminals, 1500V in frequency band 0...50Hz for high-voltage terminals

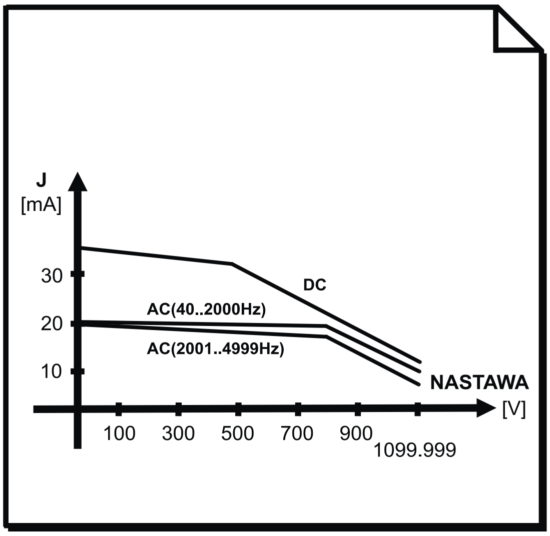

Fig. 1.2.1. Current limitation threshold for 1000V range

b) casing protection grade IP 20 acc. to PN-79/E-08106
c) design requirements acc. to PN-71/T-06500/03
d) mechanical requirements group I acc. to PN-75/T-06500/07
e) climatic requirements group I acc. to PN-75/T-06500/06
f) transport and storage acc. to PN-85/T-06500/08
g) power consumption – 150 V * A
h) cassette dimensions:
   width – 430 mm
   height – 360 mm
   depth – 350 mm
   weight - 25 kg
i) control board dimensions:
   width– 340 mm
   height – 50 mm
   weight – 240 mm

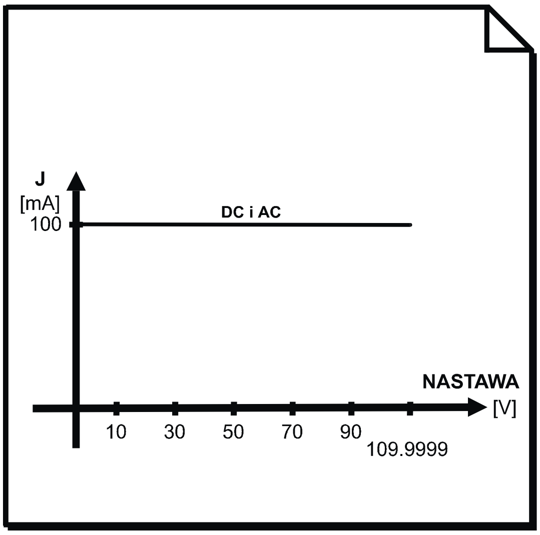

Fig. 1.2.2. Current limitation threshold for 100V range

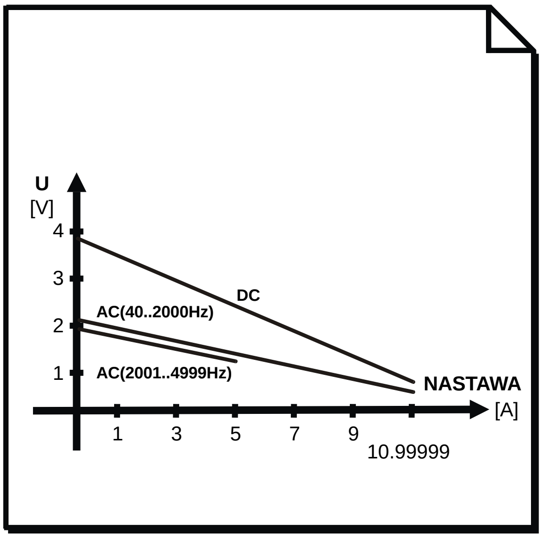

Fig. 1.2.3. Voltage limitation threshold for 10A range

1.3. Programmatic functions

- work with automatic range change at exceeding the range value by 109.9999% or down 11% contractual value of range
- work in any selected range within the operational setting acc. to table 1.1.1... 1.1.4,
- entering the amplitude limitation of the output signal,
- increasing or decreasing of the output quantity amplitude by declared value,
- continuous increasing and decreasing of the output quantity amplitude at two various velocities,
- recording ten settings into ten memory cells,
- recording the following sequence of settings into memory cells:

$$\frac{XW}{K}*1;\frac{XW}{K}*2;\ldots;\frac{XW}{K}*K \qquad (1.4.1)$$

  where:
  XW – setting value loaded XW memory
  K – number of division points $1 \leq K \leq 10$,
- calculation of error expressed in (%) in relation to the rated value: principal shown in the operational display) and contractual (loaded into the XW memory cell),
- read-out of storage cells,
- resetting the operational display,
- return to the initial state (resetting).

2. Working instruction

2.1. Preparation to work

The acclimatization time of the calibrator should be longer than 24 h. Follow the requirements in table 1.2.5. when selecting the assembly place for the unit. The supply wire should be plugged to a network outlet supplying alternating current of rated voltage 230/110V/50/60Hz after previously connect joint of this wire to outlet in back part this device. The outlet should equipped with a nulling pin to ensure neutralization of the calibrator casing.

Before starting the calibrator slide the control board out of the casing. Upon pressing the „POWER” button (fig. 2.2.1.) in the front panel, the control board display (fig.2.3.1.) shows the massage **HELLO** Simultaneously **0mV±40µV** value is generate on the output terminals. After 5...10 seconds the operational display dies out and the output display shows the setting **+,000000** and lights up the unit **V**. The preheating time after switching the calibrator on should not be shorter than 30 minutes. After such preheating the calibrator is ready for operation.

2.2. Description of the front panel

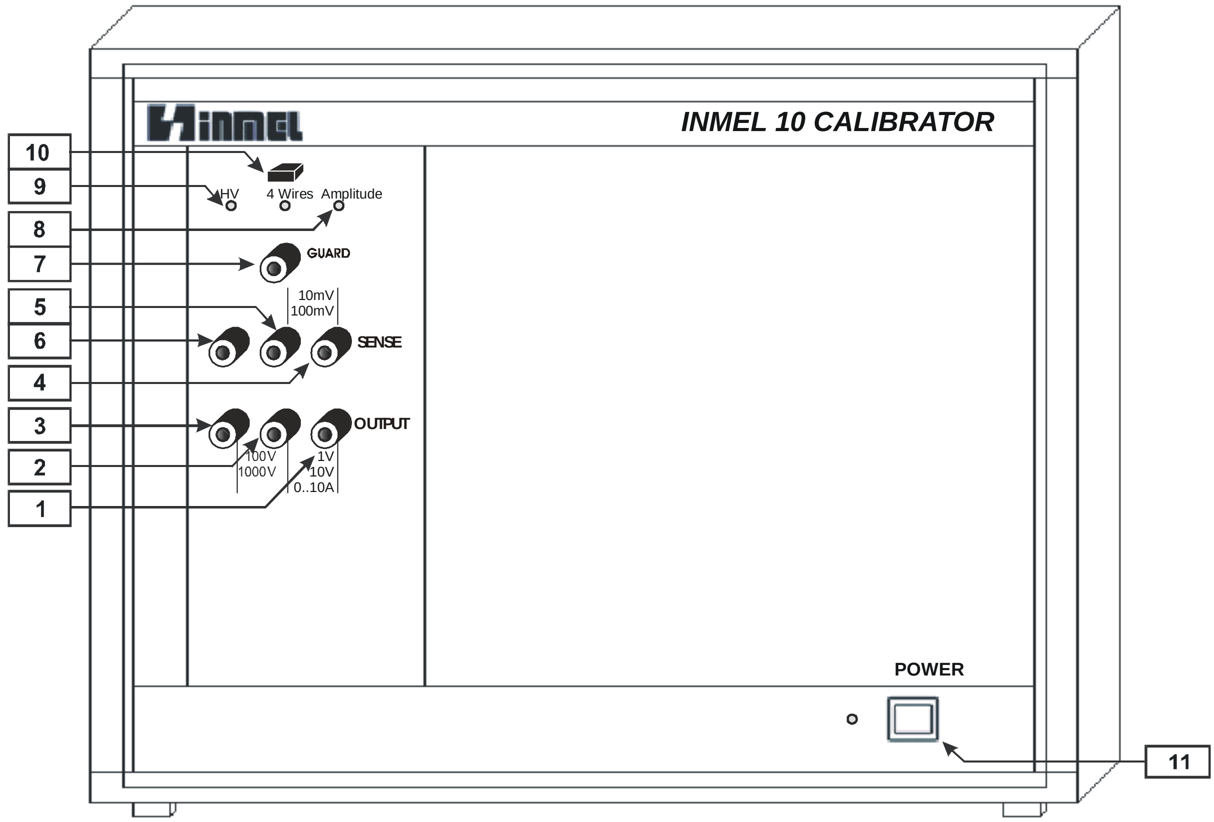

Fig. 2.2.1. View of the calibrator from the front panel.

Figure 2.2.1. shows front panel layout where the designators means

1. high output terminal for current and voltage range 1V, 10V.
2. low output terminal for all ranges.
3. high output terminal for ranges 100V i 1000V.
4. high feedback terminal for ranges 1V and 10V and high output terminal for ranges 10mV i 100mV.
5. low feedback terminal for ranges 1V i 10V and low output terminal for ranges 10mV i 100mV.
6. high feedback terminal for ranges 100V i 1000V.
7. internal screen terminal.
8. „amplitude error exceeded" - indicator.
9. Signaling of switch on high voltages ranges 100V i 1000V.
10. 4 wires switch with signaling
11. power supply switch with signaling,

2.3. Description of the rear panel.

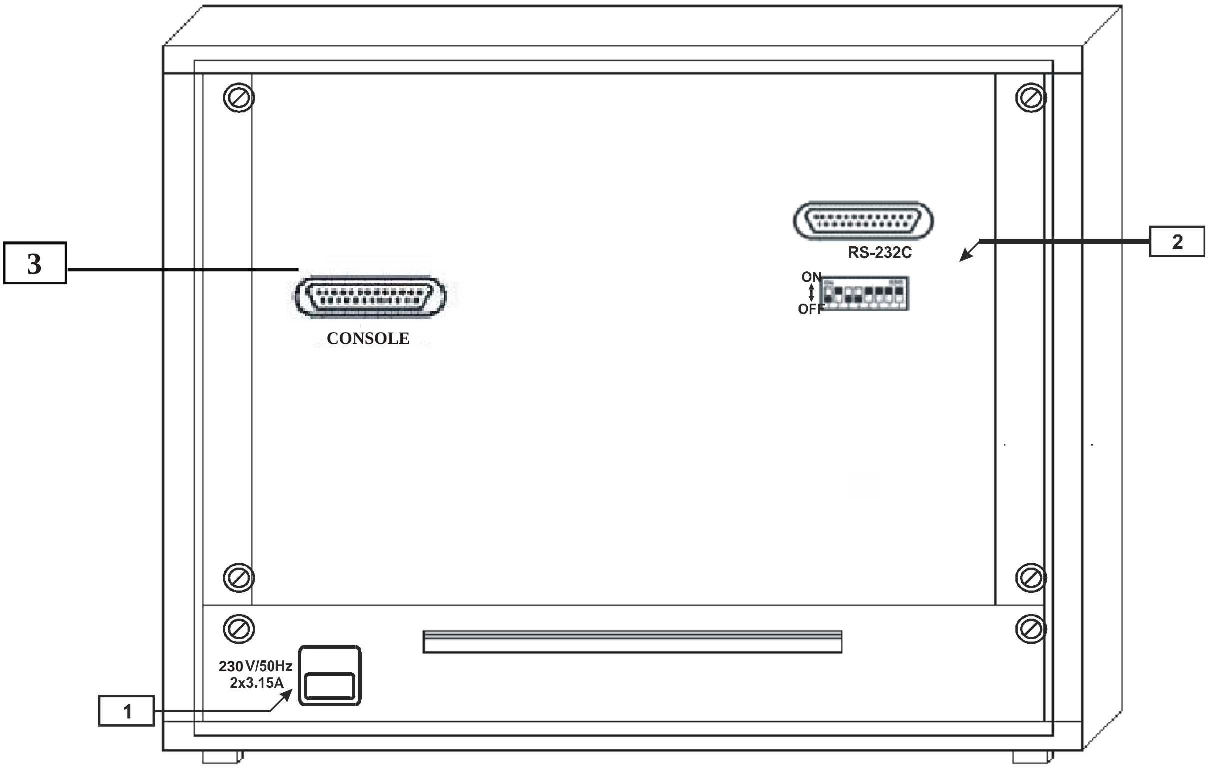

Fig. 2.3.1. View of the calibrator from the rear panel side.

Figure 2.3.1. shows rear panel layout where the designators means:

1. Power outlet.
2. Serial interface joint and code switch (DIP switch).
3. Console connection.

2.4. Description of the control board

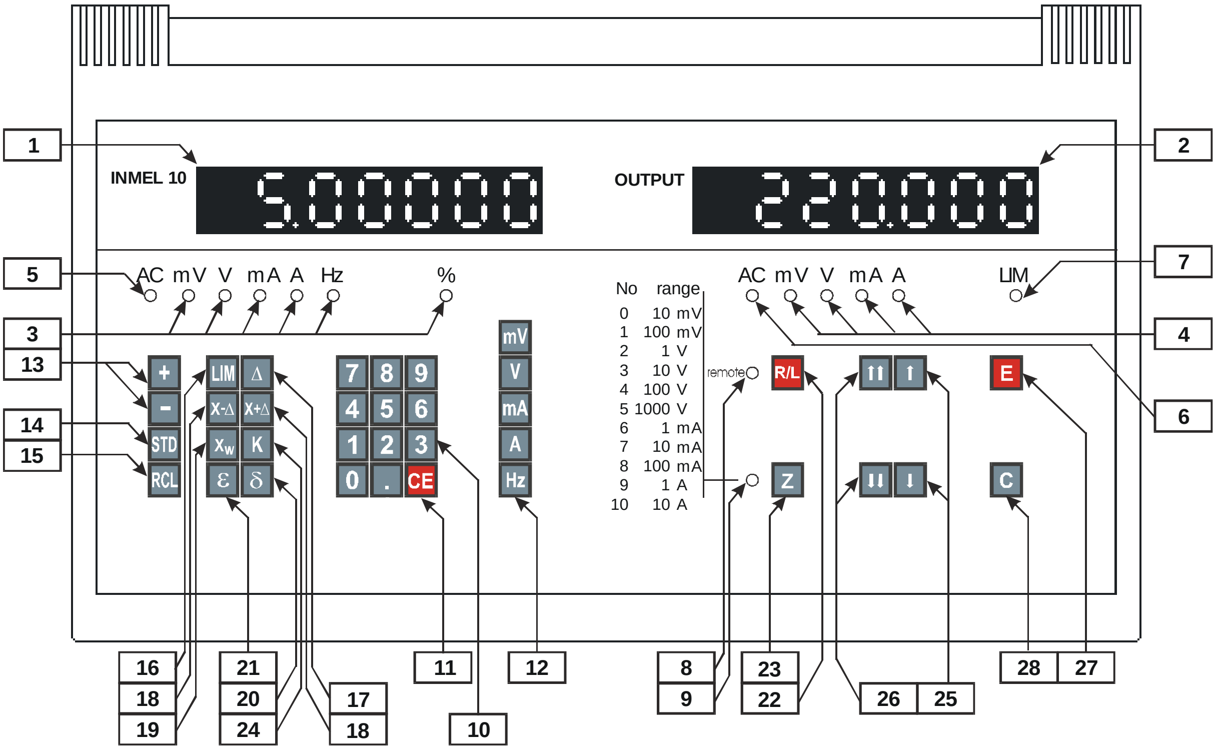

Fig. 2.4.1. View of the control board

Fig. 2.4.1. shows control board layout where the designator mean:

1. operational display which can show
   - the currently entered value,
   - the read-out value from storage cell (item 2.6.7.),
   - the value of calculated error δ or ε,
   - signal frequency on output terminals in the case of operation on alternating voltages or currents (item 2.6.2.)
   - programming error massage (item 2.8.1.)
2. output display; it shows value being generated on the output terminals,
3. the units of the quantities exposed in the operational display,
4. the units of the quantities exposed in the output display,
5. Signaling that read-out value from storage cell is parameter of alteranting signal,
6. Signaling that on output terminals is generating alternating signal,
7. Signaling that output amplitude limitation has been introduced,
8. signaling of interface control,
9. signaling of work in a constant selected range,
10. [0] ... [9] [CE] - numerical button which help to enter the value shown in the operational display, starting from the most significant item, with a coma after any item,
11. [CE] - resetting the operational display or return to the state before pressing the [X+Δ] or [X-Δ] (item 2.6.4).

12. [Hz] [mV] [V] [mA] [A] - selection of unit entered,
13. [-], [+] - selection of polarity of entered quantity,
14. [STD] - storing the operational display content into a storage cell (item 2.6.5.).
15. [RCL] - recall of storage cell content to the operational display (item 2.6.7.).
16. [LIM] - storing the output amplitude limitation value into the LIM memory cell.
17. [Δ] - storing the deviation value into the. Δ memory cell,
18. [X+Δ] [X-Δ] - increase or decrease output value by set deviation value,
19. [X_W] - storing the setting value to the X_W memory cell,
20. [δ] - calculation and indication of error in relation to rated value.
    The error is shown in the formula:

$$\delta = \frac{XN - XR}{XN} \qquad (2.4.1.)$$

    where:
    XR – the value generated on the output terminals ,
    XN – the rated value corresponding to the value printed in the operational display or read out from a memory cell,
21. [ε] - calculation and indication of error in relation to the selected value.
    The error is shown in the formula:

$$\varepsilon = \frac{XN - XR}{XW} \qquad (2.4.2.)$$

    where:
    XR – the value generated on the output terminals (exposed in the output display),
    XN – rated value corresponding to the value printed on the operational display or read out from memory cell,
    XW – selected value loaded into XW memory cell.
22. [R/L] - switching of calibrator control from the board (local) to interface (remote) or the other way round.
    In the calibrator without interface pressing the button does not change the control mode.
23. [Z] - declaration of work on a selected range depending on the range number entered on the operational display .
24. [K] - loading the number of division points into the memory cell K.
25. [↑] [↓] - infinitely variable increase and decrease 0.00001 of range,
26. [↑↑] [↓↓] - infinitely variable increase and decrease of output value with signal movement by 0.001 of range,
27. [E] - rewriting of operational monitor indications into the output monitor with simultaneous generation of the rewritten value on the output terminals.
28. [C] - resetting- return to the state after switching on (0mV is generated on the output terminals).

Number of range	Selected range value
0 1 2 3 4 5	10 mV 100 mV 1 V 10 V 100 V 1000 V
6 7 8 9 10	1 mA 10 mA 100 mA 1 A 10 A

2.5. Connection load to calibrator

The ways of load connecting (e.g. checked meter) to calibrator was shown on fig. 2.5.1.-2.5.6. The way connecting terminal „GUARD” to load shown on schemes, should treat as recommended by producer.

The following designation have been assumed in the drawings:

N – low terminal,
W – high terminal,
WN – high terminal of high voltage,
E – internal screen terminal.

The four-wire connection reduces the series resistance impact on the voltage on load terminals.

For milivolt range the output resistance is 0.1Ω. In the case the load input impedance is higher than 10kΩ, the calibrator output resistance entails a negligible error. If the load input impedance is lower than 10kΩ, a correction may be taken into account.

The voltage on the calibrator output terminals is expressed in the formula:

$$U_{wy} = U_N \frac{R_o}{0.1\Omega + R_o}$$

(2.5.1.)

where:

U_N – setting defined in voltage units.

R_O – load input resistance expressed in ohms

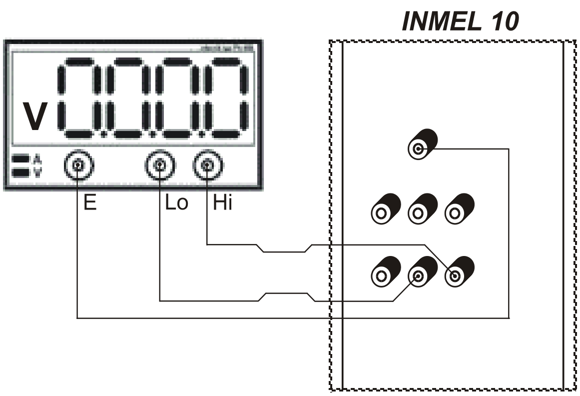

Fig. 2.5.1. Two-wire load connecting for current ranges.

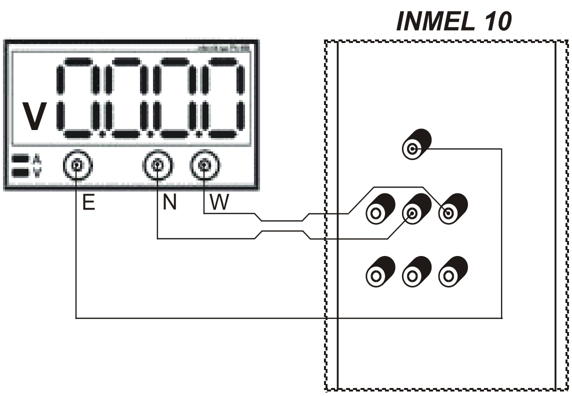

Fig. 2.5.2. Two-wire load connecting 1V and 10V ranges.

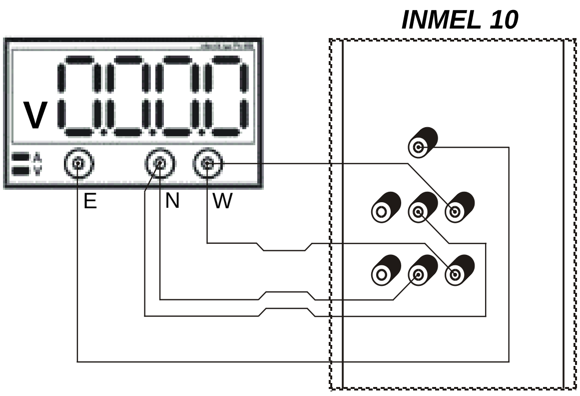

Fig. 2.5.3. Four-wire load connecting for 1V and 10V ranges

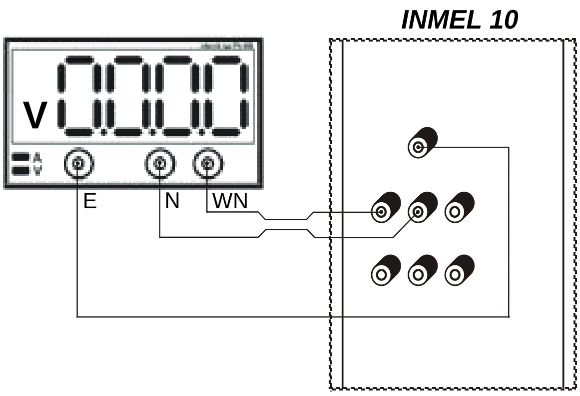

Fig. 2.5.4. Two- wire load connecting for 100V and 1000V ranges.

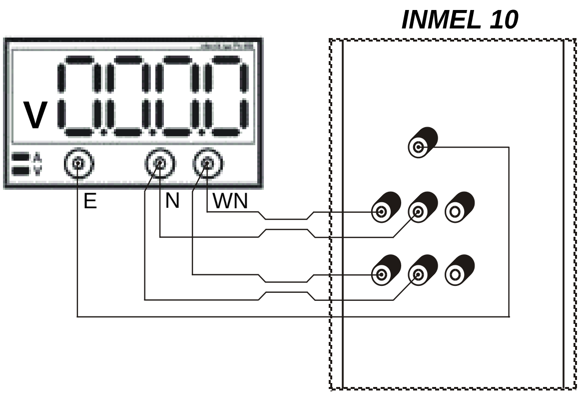

Fig. 2.5.5. Four-wire connecting for 100V and 1000V ranges.

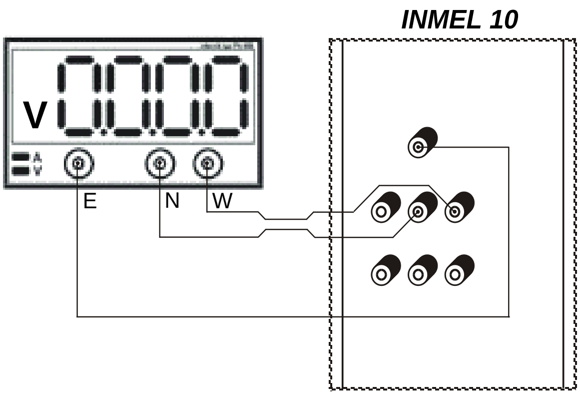

Fig. 2.5.6. Load connecting for 10mV and 100mV ranges.

2.6. Programming the calibrator

The calibrator is programmed with the controls of the board (fig. 2.4.1.). A given value is printed with the digit keys (item. fig. 2.4.1.) and shown in the operational display.

2.6.1. Generation of direct currents and voltages.

Write setting value.

Write polarity sign + or -.

Write the unit mV, V, mA, A.

Accept by key E - which is tantamount to generation of set value on the output terminals

2.6.2. Generatinon of alternating currents and voltages

Write frequency value.

Write unit Hz.

Accept by key E - which is tantamount to breakover to alternating current or voltage range indicated by AC diode.
The rms of the alternating signal equals the direct signal generated up to now.

2.6.3. Entering output value limitation.

Write in the limitataion value.

Write in unit [mV]; [V]; [mA]; [A].

Accept by key [LIM].

Limitation entered is indicated with the **LIM** diode. Any attempt at writing on the output display of a signal value higher than the limitation value results in the message **Err 08**.

2.6.4. Modification of output quantity value by set deviation value.

Write in deviation value.

Write in unit [mV]; [V]; [mA]; [A].

Accept by key [Δ].

Use the keys [X+Δ], [X-Δ] keys to call the written in deviation value. The latter will be shown on the operational display and will simultaneously modify the output value by the set deviation value which will entail a change in the output display.

Repeated pressing of the keys [X+Δ], [X-Δ] will result in multiple modification of the output value.

Pressing the [CE] will result in automatic return to the state before the first pressing of the [X+Δ] or [X-Δ].

2.6.5. Writing signal value into memeory.

Write in signal value.

Write in the polarity sign [+] or [-].

Write in the unit [mV]; [V]; [mA]; [A].

Use the [STD] key to cell the programme of writting into memory [0] to [9], which will automatically write the signal value to the indicate cell. If any other value had been stored in the same cell it will be reset and replaced with the new value.

In the case of storing the alternating parameters, the procedure has to be continued.

Write in the signal frequency value.

Write the unit [Hz].

With the [STD] key and the storage cell number write the frequency value into memory. This replace the formerly stored direct signal value with the alternating signal value.

2.6.6. Writing value sequence into memory.

Write in the maximum value of the sequence.

When working on direct ranges- write in the polarity sign [+] or [-].

Write in the unit [mV]; [V]; [mA]; [A].

Accept by key [X_W].

Write in the number of division points from 1 to 10.

Accept by the key [K].

Upon pressing the [K] key – values from the sequence will be written into the storage cells 0 to K-1

$$\frac{XW}{K}*1;\frac{XW}{K}*2;\ldots;\frac{XW}{K}*K. \qquad (2.6.6.1)$$

2.6.7. Memory read-out

Use the [RCL] key to recall the memory read-out procedure.

Depending on the type of memeory cell to be read-out you should:

- with [0] - [9], - keys call the memory cell into the operation display. If no value had been stored in the cell, the error **Err 06** will be indicated.
  If an alternating signal had been stored in the memory cell, such a signal will be indicated simultaneously (light **AC**).
  Reapeated pressing of the key with the same cell number will result in showing the signal frequency value

Pressing a key of another number will result in showing a respective storage cell content in the operational display.

- Pressing the keys X_W K Δ LIM Z Hz will result in showing the following cells contents in the operational display

XW – selected value,
K – number of division points,
Δ – deviation value,
LIM – limitation value,
Z – number of range,
Hz – signal frequency generated on the output (when working on the alternating ranges).
If no value had been stored in the memeory cell, an error will be indicated (table 2.8.1.).

2.7. Examplary meter check-out procedure

Task: check wheter the basic error of the meter does not exceed 0.1 V on the 5 V range of alternating voltage.

The check has to be carried out at five points: 1 V, 2 V, 3 V, 4 V, 5 V.

Tabl. 2.7.1.

Procedure	State of monitors			
	Operational and diodes		Output and diodes	
1	2	3	4	5
1) Proper calibrator (item.2.1.) or press the key [C].			.000000	V
2) Declared work on 10 V range				
[3]	3	-	.000000	V
[Z]	-	-	.000000	V, Z
3) Write in setting of value or frequency alternating signal (item.2.6.2.)				
[0] [.] [1]	0.1	-	.000000	V, Z
[V]	0.1	V	.000000	V, Z
[E]	-	-	0.10000	V, Z
[5]	5		010000	V, Z
[0]	50		0.10000	V, Z
[Hz]	50	Hz	0.10000	V, Z
[E]	50.00	Hz	0.10000	AC, Z, V
4) Enter the output voltage limitation 5.2V to prevent meter defects (item.2.6.3.)				
[5]	5		0.10000	AC, V, Z
[.]	5		0.10000	AC, V, Z
[2]	5.2		0.10000	AC, V, Z
[V]	5.2	V	0.10000	AC, V, Z
[LIM]	-	-	0.10000	AC, V, Z, LIM
5) Connect the meter to the output terminals acc.(item 2.5.1.)				

Tabl. 2.7.1.

Procedure	**State of monitors**			
	Operational and diodes		**Output and diodes**	
1	**2**	**3**	**4**	**5**
6) write into the memory the points at which the meter will be checked (item.2.6.5.)				
[5]	5		0.10000	AC, V, Z, LIM
[V]	-	V		
[X_W]	5	-		
[5]	5			
[K]	-	-		
7) write into the memory the value of deviation following the meter class– 0.1 V (item.2.6.4.)				
[0]	0			
[.]	0		0.10000	AC, V, Z, LIM
[1]	0.1			
[V]	0.1	V		
[Δ]	-	-		
8) preset the first control point-reading out the set value from memory (item2..6.8.)				
[RCL]			0.10000	AC, V, Z, LIM
[1]	1.000000	AC, V		
[E]	50.00	Hz	1.0000	AC, V, Z, LIM

Tabl. 2.7.1.

Procedure	State of monitors			
	Operational and diodes		Output and diodes	
1	**2**	**3**	**4**	**5**
9) check whether the meter indications remain within the programmed error by changing the setting by set value of deviation				
<X+Δ>	0.10000		0.10000	AC, V, Z, LIM
or <X-Δ>			0.90000	AC, V, Z, LIM
If the meter pointer moves above 1 V on the scale, the meter remains within the allowable basic error limit. additionally can: calculate error value for this point. In this case use increase keys and set pointer to the scale mark				
[CE]	-	-	1.00000	AC, V, Z, LIM
[⇈] or [⇊]		-	1.XX000	AC, V, Z, LIM
[↑] or [↓]		-	1.XXXX0	AC, V, Z, LIM
Read out the rated value from the memory				
[RCL]		-	1.XXXX0	AC, V, Z, LIM
[1]	1.00000	AC, V	1.XXXX0	AC, V, Z, LIM
Calculate the error [δ]	xxxxxx	%	1.XXXX0	AC, V, Z, LIM
	error value			

Tabl. 2.7.1.

Procedure	State of monitors			
	Operational and diodes		Output and diodes	
1	2	3	4	5
10) repeat the procedures item 8-10 for the remaining points				
RCL 2	2.00000	AC, V		
RCL 3	3.00000	AC, V		
RCL 4	4.00000	AC, V		
RCL 5	5.00000	AC, V		

2.8. Specification of error indicated by the calibrator

The calibrator indicates:

faulty programming writing a message on the operational display Err + error number. Using the 3.8.1. chart you can the cause of the error.

Only two keys in the control board are accessible at that time: <CE> and <C>.

The <CE> key reset the operational display and allows writing new data in, the <C> returns the calibrator to state just after the power was switched on (2.1.).

- overrun of amplitude error limit or distortion coefficient, caused by overload or opening of contact of the output and feedback terminals, is indicated with diodes in the calibrator front panel (item. 8 fig. 2.2.1.).

Return to normal working conditions automatically stops these indications..

Tabl. 2.8.1. Specification of programming errors..

Err 01	Exceed operation setting range,
Err 02	Incompatibility of selected range unit with the unit of introduced setting,
Err 03	Memory storage without entering the value or unit,
Err 04	Erroneous sequence of pressing the keys,
Err 06	No data in the storage cell or input incomplete (e.g. polarity sign not specified),
Err 07	No division point K given in the storage cell,
Err 08	Limitation value LIM overrun,
Err 09	No data in the memory cells Δ, LIM, XW,
Err 10	Erroneous range selection,
Err 11	Incompatibility of the unit of generated value and the unit of deviation or lack of date in the deviation memory when pressing the X ± Δ keys,
Err 12	Wrong number of division K,
Err 15	Incompatibility of units: XW value, generated value, rated value.
Err 16	No polarity sign for rated or maximum value when calculating the δ, or ε,
Err 17	No XW value when calculated the δ error,
Err 19	δ error or ε error calculated value overrun over 100%.

3. ACCESSORIES

Warranty certificate	1 pc.
Service Manual	1 pc.
Spare fuse	2 pcs.

4. OPERATING RECOMMENDATIONS

When using the INMEL 10 calibrator as a precision source of direct or alternating voltages and currents in calibration and checking of measuring instruments you should take into account the transition processes which occur when changing the range or the settings of voltage, current and frequency. The quantities of the transition states, i.e. the response time and the transition amplitude have been presented in table. 1.2.1., 1.2.2., 1.2.3. i 1.2.4. of Service Manual.

The following recommendations have to be adhered to in order to minimize the quantities of transition processes:

1. Declare operation on constant range. Working on constant range you avoid overshoots following from the change of range.
2. Load termination and disconnection to the calibrator should be affected on settings close to zero for voltage ranges and precisely zero for ranges.
   If you terminate load to the calibrator at the time the voltage of 500 V or higher is generated it may interfere with the work of the microprocessor controller, e.g. the setting may be reset and the calibrator may return to ready-to- work state at the 1 V range.

Operation on the current and then to generate the set current value. If you do not adhere to this sequence of operations, you have to take into account the rest of surge current occurring right at the moment you terminate the load of value many times the highest setting on a given range.

<u>Note</u>:

Operation of the processing system can be heard on the 10A DC and 1000 ranges (2 kHz tone).

Load termination for milivolt ranges is presented in fig.2.5.6.(armature between the output and feedback terminals enhances the error).