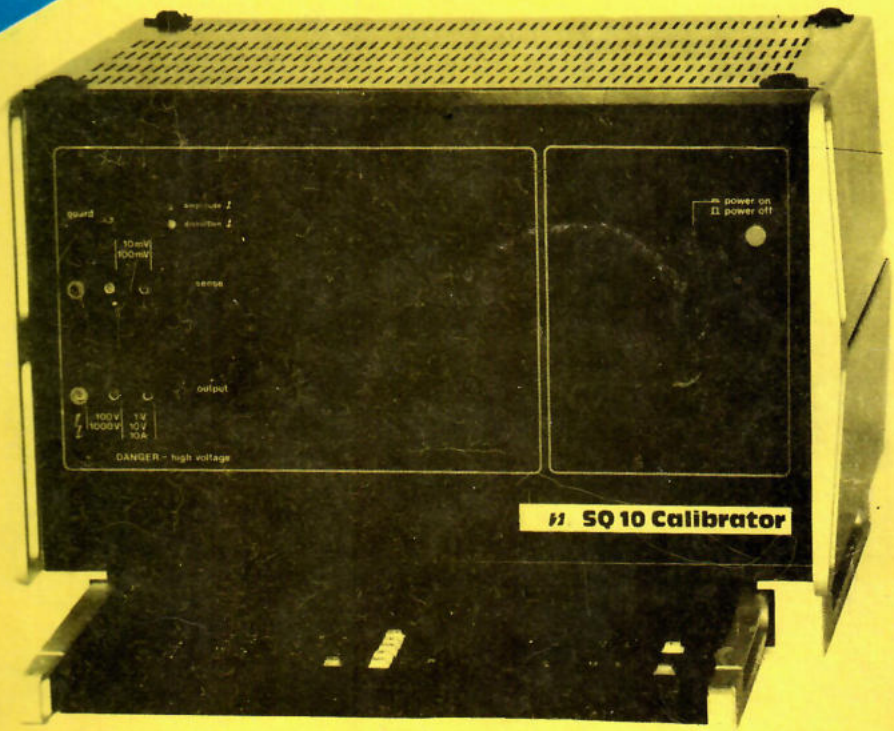
CALIBRATOR SQ 10



Przedsiębiorstwo Wdrożeniowe
INMEL

65-021 ZIELONA GÓRA, POLAND
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CALIBRATOR SQ10

OPERATING MANUAL

Nr. 90050100

MANUFACTURER:

PRZEDSIĘBIORSTWO WDROŻENIOWE
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METROLOGII ELEKTRYCZNEJ
"LUMEL"
Zielona Góra

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2. CALIBRATION RECORD BOOK

The Record Book should be filled in after incomplete tests, recalibrations and repairs

2.1. Calibrator test results

Table 2.1.

Range	Set point	Allowable basic error	Incomplete tests results			...recalibration			... recalibration		
			basic error	measuring error	PARD or distortion coefficient	basic error		measuring error	basic error		measuring error
						before recal.	after recal.		before recal.	after recal.	
1	2	3	4	5	6	7	8	9	10	11	12
10 mV	-0,00000 mV	10 µV	-2,4 µV	0,1 µV	0 µV						
	+0,00000 mV		-2,2 µV								
	+10,99999 mV	16 µV	0 µV	0,14 µV	10 µV						
	-10,99999 mV		5 µV								
	~0,10000 mV	50 µV	47 µV	7 µV	12 µV						
	~10,99999 mV	72 µV	-3 µV	9 µV	16 µV						
100 mV	-0,0000 mV	10 µV	-3 µV	0,1 µV	5 µV						
	+0,0000 mV		-4 µV								
	+109,9999 mV	65 µV	-6 µV	1,4 µV	30 µV						
	-109,9999 mV		-12 µV								
	~1,0000 mV	51 µV	11 µV	7 µV	0,025 mV						
	~109,9999 mV	270 µV	0 µV	24 µV	0,15 mV						
1 V	-0,000000 V	40 µV	11 µV	0,4 µV	0,1 mV						
	+0,000000 V		10 µV								
	+1,099999 V	260 µV	115 µV	13,4 µV	0,2 mV						
	-1,099999 V		100 µV								
	~0,010000 V	155 µV	20 µV	9 µV	0,3 mV						
	~1,099999 V	700 µV	-300 µV	200 µV	1,2 mV						
10 V	-0,00000 V	0,4 mV	0,2 mV	0,003 mV	0,1 mV						
	+0,00000 V		0,1 mV								
	+10,99999 V	3,7 mV	-0,9 mV	0,113 mV	0,3 mV						
	-10,99999 V		-1,1 mV								
	~0,10000 V	1,1 mV	0,5 mV	0,034 mV	1,2 mV						
	~10,99999 V	6,6 mV	2,5 mV	2,7 mV	11 mV						
100 V	+0,0000 V	4 mV	-0,1 mV	0,04 mV	0,05 mV						
	+109,9999 V	37 mV	3,7 mV	1,4 mV	5 mV						
	~1,0000 V	10,6 mV	1,3 mV	0,2 mV	9,2 mV						
	~109,9999 V	65 mV	27 mV	10 mV	110 mV						
1000 V	+0,000 V	40 mV	0,14 mV	0,3 mV	5 mV						
	+1099,999 V	370 mV	28 mV	13,3 mV	0,05 V						
	~10,000 V	105 mV	15 mV	2,7 mV	0,27 V						
	~1099,999 V	650 mV	300 mV	200 mV	0,4 V						

Table 2.1. cont.

1	2	3	4	5	6	7	8	9	10	11	12
1 mA	+0,000000 mA	0,1 μA	0,04 μA	0,01 μA	R_N=1kΩ						
	-0,000000 mA		0,06 μA		0,1 mV						
	+1,099999 mA	0,43 μA	0,2 μA	0,1 μA	0,2 mV						
	-1,099999 mA		0,13 μA								
	~0,010000 mA	2,1 μA	0,1 μA	0,03 μA	1,2 mV						
	~1,099999 mA	2,65 μA	0,3 μA	0,31 μA	3,2 mV						
10 mA	-0,00000 mA	0,5 μA	0,02 μA	0,1 μA	R_N=100Ω						
	+0,00000 mA		0,08 μA		0,03 mV						
	+10,99999 mA	3,8 μA	-0,1 μA	1,2 μA	0,05 mV						
	~10,99999 mA		0,4 μA								
	~0,10000 mA	3 μA	-0,1 μA	0,1 μA	0,4 mV						
	~10,99999 mA	8,5 μA	2,4 μA	3 μA	3,2 mV						
100 mA	-0,0000 mA	5 μA	3 μA	1 μA	R_N=10Ω						
	+0,0000 mA		2 μA		0,05 mV						
	+109,9999 mA	38 μA	6 μA	1,2 μA	0,05 mV						
	-109,9999 mA		6 μA								
	~1,0000 mA	12,5 μA	-0,4 μA	1 μA	0,3 mV						
	~109,9999 mA	67 μA	10 μA	30 μA	1,8 mV						
1 A	-0,000000 A	50 μA	16 μA	10 μA	R_N=1Ω						
	+0,000000 A		16 μA		0						
	+1,099999 A	380 μA	-30 μA	120 μA	0,3 mV						
	-1,099999 A		-70 μA								
	~0,010000 A	107 μA	-30 μA	10 μA	0,2 mV						
	~1,099999 A	652 μA	50 μA	300 μA	1,2 mV						
10 A	+0,00000 A	1 mA	0	0,2 mA	R_N=0,01Ω						
	+10,99999 A	5,4 mA	1 mA	1,2 mA	0,01 mV						
	~0,10000 A	1,05 mA	0,2 mA	0,7 mA	0,1 mV						
	~10,99999 A	6,52 mA	4,9 mA	3,4 mA	0,3 mV						

Calibrator serial number 90050100...

complies with the standard ZN-85/MERA-005/337

Kierownik Laboratorium
Pomiarów Elektrycznych
i Kontroli Jakości
inż. Jan Twaróg

90.06.15. .....
/date/ /signature/

....
/date/ /signature/

....
/date//signature/

1/ "~" - means alternating voltage or current of 60 cps

2.2. Instrument Service Card

/to be filled in by Service personnel/

Table 2.2.

Causes of malfunction or User's remarks	Specification of replacements and design changes	Date	Seal and signature
1	2	3	4

3. TECHNICAL DESCRIPTION

The SQ10 calibrator is a precision source of direct and alternating voltages and currents. It has been designed primarily for calibration and checking of measuring instruments and for calibration and checking of measuring instruments and for verification of the latter. It finds another application in laboratory measurments as a precision power supply.
Its operational features are enhanced by a set of programmable functions which facilitate measurment 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.

3.1. Design

The SQ10 calibrator is manufactured in two versions: the standard version and the version fitted with IEC-625 or RS232C interfac. The calibrator equipped with interface may be connected into automatic measuring systems through a bus complying with the standard.

3.2. Specifications

Specifications have been tabulated in tables 3.2.1. through 3.2.6. All notions defined according to the company standard ZN-05/MERA-005/337.

3.2.1. Direct voltage range specifications

Gleichspannungsbereichsbeschreibung

Table 3.2.1.

Parameter	Range					
	1000 V	100 V	10 V	1 V	100 mV	10 mV
1	2	3	4	5	6	7
Arbeitsbereich Usable setting range	0... +1099,999V	0... +109,9999V	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/ Grundfehler	±0,03% setting ±0,004% range			±0,02% set. ±0,004% range	0,05% setting ±10 µV	
Operating error 2/ Betriebsfehler	±0,05% setting ±0,007% range			±0,03% set. ±0,007% range	±0,07% setting ±16 µV	
15 minutes drift 3/ Abweichung	±0,002% setting ±0,001% range		±0,001% range		±3 µV	
7 h drift 3/ Abweichung	±0,01% setting ±0,005% range		±0,005% setting ±0,001% range		±0,01% range ±10 µV	
Additional error 2/ caused by ambient temperature change	±0,03% setting ±0,004% range			±0,02% set. ±0,004% range	±0,04% range ±10 µV	
Additional error 2/ caused by change of: - supply voltage	±0,006% setting ±0,0008% range			±0,004% set. ±0,0008% range	±0,01% setting ±2 µV	

Table 3.2.1. cont.

1	2	3	4	5	6	7
- load current	±0,002% range				caused by output resistance of 0,1Ω	
- load reactance	±0,001% range					
Linearity error	±0,01% range					
PARD 4/	0,15% set. +0,03% range		0,03% range	0,1% setting +0,1% range	0,1% setting +10 μV	
Common mode rejection ratio 6/ within frequency 0-50 Hz	80 dB	90 dB		100 dB	110 dB	
Short-circuit current	50 mA		1,8 A		1 A	100 mA
Open loop output voltage	2200 V	400 V	25 V	7 V	-	-
Feedback input impedance	210kΩ ±210Ω	21 kΩ ±21Ω	2,1kΩ ±2,1Ω	defined with current less than 500 nA	-	-
Transition process caused by the change of 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/	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	
max → 0A						

1/ in reference conditions according to table 3.2.5. within 12 months,
2/ in rated operating conditions according to table 3.2.5,
3/ after 1h pre-heating time,
4/ rms value of AC component in the 2 Hz to 10 kHz band,
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 settings greater than 0,1% range,

3.2.2. Alternating voltage range specifications

Table 3.2.2.

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 ±50µV 9/ ±0,1% setting ±0,02% range ±100µV				±0,2% setting ±50 µV 9/ ±0,4% setting ±100µV	
Operating error 2/	±0,08 % setting ±0,02 % range ±75 µV 9/ ±0,13% setting ±0,025% range ±128 µV				±0,24% setting ±60µV 9/ ±0,48% range ±120 µV	
15 minutes drift 3/	±0,005% setting ±0,002% range				±10 µV	
7 h drift 3/	±0,02% setting ±0,005% range				±0,02% setting ±20 µV	
Additional error caused by the change of: 2/ - 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					
Additional error 2/ caused by the change of: - load current	±0,02% setting ±0,003% range 9/ ±0,04% setting ±0,006% range				limited by output resistance of 0.1Ω	
- load reactance	±0,001% range					
Linearity error	±0,01% range					
Total harmonic distortion coefficient 4/ in the frequency band:						
40,00...48,00 Hz	2% setting 5/ 1% setting	0,4% setting ±0,05% range	0,2% setting ±0,05% range	0,2% setting ±0,2% range	0,2% setting ±0,1% range	50 µV
48,01...499,9 Hz	1% setting 5/ 0,5% setting ±0,05% range	0,05% range	0,3% setting ±0,05% range	0,2% setting ±0,3% range		
500,0...2000 Hz	0,5% setting ±0,1% range		0,4% setting ±0,06% range	0,3% setting ±0,4% range	0,3% setting ±0,1% range	
2001...4999 Hz	1,2% setting 5/ ±0,15% range 0,8% setting 0,1% range	0,5% setting ±0,1% range	0,5% setting ±0,1% range	0,4% setting ±0,4% range	0,8% setting ±0,1% range	
Common mode rejection ratio in the frequency range of 0-50 Hz	80 dB	90 dB		100 dB	110 dB	

Table 3.2.2. cont.

1	2	3	4	5	6	7
Short-circuit	50 mA		3,5 A		1 A	100 mA
Open loop output voltage	2200 V	400 V	25 V	7 V	-	-
Feedback input impedance	210kΩ ±210Ω	21kΩ ±21Ω	2,1kΩ ±2,1Ω	1,5MΩ	-	-
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			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 3.2.5. within 12 months,
2/ in rated operating conditions according to table 3.2.5,
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 output quantity value 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.

3.2.3. Direct current specifications

Table 3.2.3.

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% setting ±0,01% range	±0,03% setting ±0,005% range			±0,03% setting ±0,01% range
Operating error 2/	±0,07% setting ±0,02% range	±0,05% setting ±0,015% range	±0,05% setting ±0,009% range		±0,05% setting ±0,02% range

Table 3.2.3. cont.

1	2	3	4	5	6
15 minutes drift 3/	±0,005% range	±0,002% range			
7 h drift 3/	±0,02% setting ±0,005% range	±0,005% setting ±0,005% range			
Additional error 2/ caused by the change of:					
- ambient temperature	±0,04% setting ±0,01% range	±0,03% setting	±0,005% range		±0,03% setting ±0,01% range
- supply voltage	±0,008% setting ±0,002% range	±0,006% setting	±0,001% range		±0,006% setting ±0,002% range
- load voltage	±0,01% setting ±0,01% range	±0,01% range	±0,002% range		±0,01% range 4/
Additional error 2/ caused by the change of:					
- load reactance	±0,002% range	±0,001% range			±0,01% range
Linearity error	±0,01% range				
PARD 5/	0,2% setting +0,05 mV/Ro	0,1% setting +0,5 mV/Ro			0,1% setting +1 mV/Ro
Common mode rejection ratio 7/ in the frequency range 0-50 Hz	100 dB	90 dB			
Open circuit voltage	8 V	25 V			
Transition process caused by the change of:	transition process time/transition process amplitude				
- 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 0,1 V → max 6/	5 s/ 1% range	6 s/ 1% range		6 s/ 1% range	
max → 0,1 V	12 A-In	220% range		300% range	

1/ in reference conditions according to table 3.2.5. within 12 months,
2/ in rated operating conditions according to table 3.2.5,
3/ after 1 h pre-heating time,
4/ for settings 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 difference between the top and the bottom output value in the transition process and the steady-state output value,
9/ for settings over 0,1% range.

3.2.4. Alternating current range specifications

Table 3.2.4.

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 1/		±0,05% setting ±0,1% setting	±0,01% range ±0,02% range	±2µA 8/ 12/ ±4 µA	
Operating error 2/	±0,085% set. 8/ ±0,04% range ±0,13% setting ±0,045% range	±0,085% setting ±0,13% setting	±0,03% range ±0,055% range	8/ ±3,5 µA ±5,1 µA	±0,08% set. 8/ ±3,8 µA ±0,13% setting ±6,5 µA 12/
15 minutes drift 3/	±0,01% setting ±0,002% range	±0,005% setting	±0,001% range		
7 h drift 3/	±0,03% setting ±0,01% range	±0,02% setting	±0,005% range		
Additional error 2/ caused by the change of:					
- ambient temperature		±0,05% setting	±0,01% range	±2 µA	
- supply voltage		±0,01% setting	±0,002% range	±0,4 µA	
- load voltage	±0,01% setting ±0,01% range	±0,02% setting ±0,04% setting	±0,02% range ±0,04% range	8/	±0,15% range 8/ ±0,3% range 9/
- load reactance	±0,001% range C ±0,03% range L		±0,001% range /C/ 10/ ±0,01% range /L/		
Linearity error			±0,01% range		
Total harmonic distortion coefficient in the frequency band					
40,00...48,00 Hz	1,7% setting	0,4% setting +2 mV/Ro	0,2% setting +1,5 mV/Ro		0,3% setting +5 mV/Ro
48,01...499,9 Hz	0,8% setting		0,2% setting +2 mV/Ro		0,3% setting +6 mV/Ro
500,0...2000 Hz	1% setting		0,3% setting +2 mV/Ro		0,3% setting +8 mV/Ro
2001...4999 Hz	2% setting		0,4% setting +5 mV/Ro		0,5% setting +8 mV/Ro
Common mode rejection ratio in the frequency range of 0-50 Hz	100 dB	90 dB			
Open circuit voltage	5 V	25 V			
Transition process caused by the change of:	transition process time/transition process amplitude 7/				
- supply voltage	0,1 s/1% range				

Table 3.2.4. cont.

1	2	3	4	5	6
- setting	7 s/5% range				
- range	10 s/10% range				
- frequency of the output quantity	1,5s/20% range	1,5 s/20% range			
- load 0,1 V → max 5/	5 s/5% range	6 s/5% range	6 s/5% range		
max. → 0,1 V	5 s/12-In	6 s/220% range	6 s/300% range		

1/ in reference conditions according to table 3.2.5. within 12 months,
2/ in rated operating conditions according to table 3.2.5,
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 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 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 additionally 1% setting.

3.2.5. Reference conditions and rated operating conditions

Table 3.2.5.

Effect quantity or factor	Reference quantity or reference range	Rated usability range
1	2	3
Ambient temperature Lufttemp.	+23°C ±2°C	+5... +40°C
Atmospheric pressure Luftdruck	70 ... 106 kPa	
Relative humidity	20 ... 80%	
Supply voltage	220 V ±10%	
Supply voltage frequency	50 Hz ±5%	
Supply voltage shape	sinusoidal $\beta \leq 0,05$	
Preheating time Anwärmzeit	not less than 30 minutes	
Load resistance or load current or load voltage for range: 1000 V	over 1 MΩ	0... I fig. 3.1.

Table 3.2.5. cont.

1		2	3
	100 V	over 100 kΩ	0 ... 1 fig. 3.2.
	10 V, 1 V	over 0,1 kΩ	0 ... 1,1 A
	100 mV, 10 mV	over 100 kΩ	defined by output resistance 0.1Ω
	1 mA	1 kΩ ±50%	0 ... 11 V
	10 mA	100Ω ±50%	
	100 mA	10Ω ±50%	
	1 A	1Ω ±50%	
	10 A	0,01Ω ±50%	0 ... 1 fig. 3.3.
Load reactance.		zero	0 ... 10 mF 1/ 0 ... 10 mH
Alternating currents and voltages frequency		40 ... 4999 Hz 2/	
Position of calibrator		acc. to the design ±30°	
Air movement velocity Luftbew.		0 ... 0,5 m/s	
Ventilation		free	
Radio frequency interference		none /negligible/ Keine	
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. For the alternating currents 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

$$\frac{100}{I_N/A/ \cdot f_N/Hz/} \text{ /mH/ for } I_N = 0{,}1...10.99999 \text{ A and } f_n = 100...4999 \text{ Hz.}$$

2/ For currents over 5A - 40...2000 Hz.

Alternating voltages and currents output frequencies Table 3.2.6.

Range	Setting range /Hz/	Resolution /Hz/	Error in rated operating conditions
100 Hz	40 ... 99,9	0,01	0,01% of frequency range
1 kHz	100... 999,9	0,1	0,01% of frequency range
5 kHz	1000...2999	1	0,02% of frequency range
	3000...4999		0,05% of frequency range

3.2.6. General specifications

a/ Safety requirements,
class I acc. to PN-84/T-06500/05

b/ Highest common-mode voltage:
100 V in frequency band 0...50 Hz
for low-voltage terminals
1500 V in frequency band 0...50 Hz
for high-voltage terminals

c/ Casing protection grade
IP 20 acc. to PN-79/E-02031

d/ design requirements
acc. to PN-71/T-06500/03

e/ Mechanical requirements
group I acc. to PN-75/T-06500/07

f/ Climatic requirements
group I acc. to PN-75/T-06500/06

g/ Transport and storage
acc. to PN-85/T-06500/08

h/ Power consumption - 150 VA

i/ Dimensions: width 470 mm
height 310 mm
depth 370 mm, 560 mm
with the control board
pulled outwards

Weight 25 kg

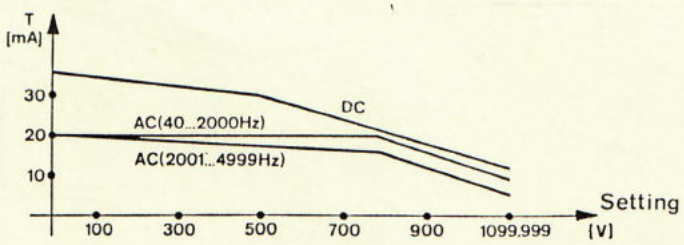

Fig. 3.1. Current limitation threshold for 1000 V range

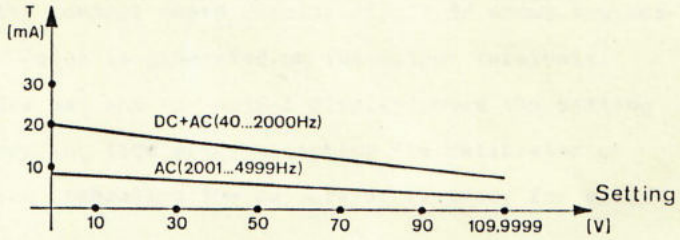

Fig. 3.2. Current limitation threshold for 100 V range

3.3. Programmable functions

- work with automatic range change at exceeding the range value by 109.9999% upwards or 11% downwards
- work in any selected range within the operational settings acc. to tables 3.2.1. ... 3.2.4.
- entering the amplitude limitation of the output signal
- incrementing or decrementing of the output quantity amplitude by declared value
- continuous incrementing or decrementing of the output quantity amplitude at two various velocities
- loading ten settings into ten memory cells
- loading the following sequence of settings into storage cells:

$$\frac{XW}{K} \times 1;\ \frac{XW}{K} \times 2;\ \ldots;\ \frac{XW}{K} \times K$$

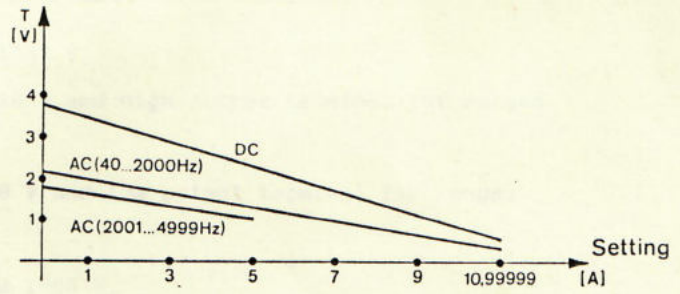

Fig. 3.3. Voltage limitation threshold for 10 A range

where:

XW - setting value loaded into the XW storage cell

K - number of division points $1 \leqslant K \leqslant 10$

- calculation of error expressed in /%/ in relation to the rated value /shown in the operational display/, and to the selected value /loaded into the XW storage cell/,
- read-out of storage cells,
- resetting the operational display,
- return to the initial state /resetting/.

4. OPERATING INSTRUCTIONS

4.1. Preparation to work

The acclimatization time of the calibrator should be longer than 24 h. Follow the requirements in table 3.2.5. when selecting the assembly place for the unit. The supply wire should be plugged to a network outlet supplying alternating current of rated voltage 220V/50Hz. The outlet should be 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. 4.1/ in the front panel, the control board display /fig.4.3/ shows the message "Hello SQ-10". Simultaneously, 0 mV $\pm$40 µV value is generated on the output terminals. After 5 - 10 seconds the operational display dies out and the output display shows the setting "+0.00000" 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.

4.2. Description of the front panel

Figure 1 shows the calibrator /with protracted board/ from the front side. The following elements ars marked:

1 - high output terminal for current and voltage ranges 1 V, 10 V,
2 - low output terminal for all ranges,
3 - high output terminal for ranges 100 V and 1000 V,
4 - high feedback terminal for ranges 1 V and 10 V and high output terminal for ranges 10 mV and 100 mV,
5 - low feedback terminal for ranges 1 V and 10 V and low output terminal for ranges 10 mV and 100 mV,
6 - high feedback terminal for ranges 100 V and 1000 V,
7 - internal screen terminal /guard/,
8 - power supply switch with indicator,
9 - control board,
10 - "amplitude error exceeded" - indicator,

11 - "distortion coefficient exceeded" indicator /only for alternating ranges/,

12 - high voltage switched on /100 V and 1000 V/x indicator.

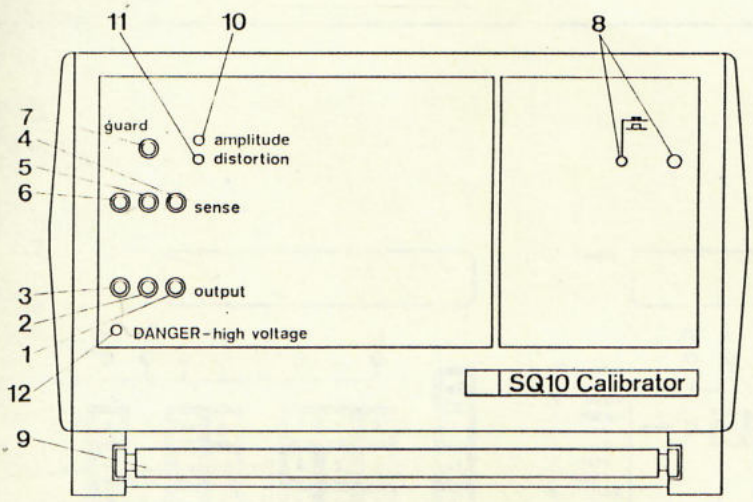

Fig. 4.1. View of the calibrator from the front panel side

4.3. Description of the rear panel.

Figure 4.2. presente the calibrator from the rear side.

The following elements have been marked:

1 - mains fuses 220 V/1 A,

2 - supply wire,

3 - ratings plate.

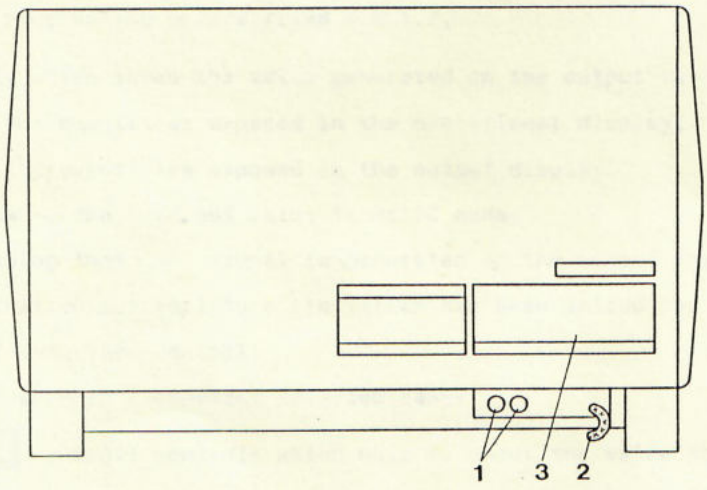

Fig. 4.2. View of the calibrator from the rear panel side

Description of the control board

Figure 4.3. shows the control board in which the following elements have been marked:

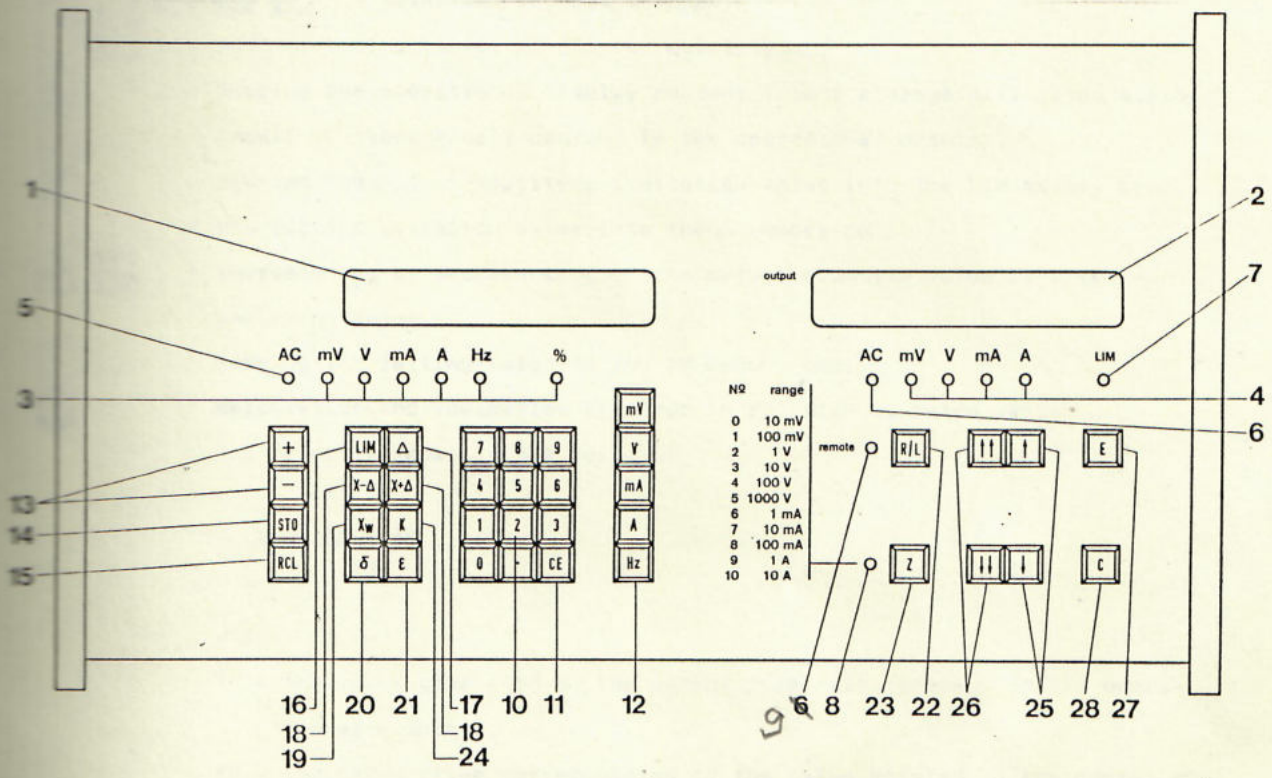

Fig. 4.3. View of the control board

1 - operational display which can show
- the currently enetered value,
- the read-out from storage cell /item 4.6.7./,
- the value of calculated error δ or ε ,
- signal frequency on output terminals in the case of operation on alternating voltages or currents /item 4.6.2./,
- message on programming errors /item 4.8.1./,

2 - output display which shows the value 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 - indicator showing the read-out value to be AC mode,

6 - indicator showing that AC signal is generated on the output terminals,

7 - indication that output amplitude limitation has been introduced,

8 - indication of interface control,

9 - indication of work in a constant selected range,

10 - [0] ... [9] [·] - digit controls which help to enter the value shown in the operational display, starting from the most significant item, with a coma after any item,

- resetting the operational display or return to the state before pressing the or /item 4.6.4./,

- selection of unit entered,

- selection of polarity of entered quantity,

- storing the operational display content into a storage cell /item 4.6.5./,

- recall of storage cell content to the operational display,

- storing the output amplitude limitation value into the LIM memory cell,

- storing the deviation value into the △ memory cell,

- incrementing or decrementing of the output quantity value by a set deviation value,

- storing the setting value to the XW memory cell,

- calculation and indication of error in relation to rated value.

The error is shown in the formula:

$$\delta = \frac{XN - XR}{XN} \qquad /4.1./$$

where:

XR - the value generated on the output terminals /exposed in the operational display/,

XN - the rated value corresponding to the value printed in the operational display or read out from a memory cell,

- calculation and indication of error in relation to the selected value.

The error is shown in the formula:

$$\varepsilon = \frac{XN - XR}{XW} \qquad /4.2./$$

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 a memory cell,

XW - selected value loaded into XW memory cell,

- 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.

- declaration of work on a selected range depending on the range number entered on the operational display.

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

24 - [E] - loading the number of division points into the memory cell K,

25 - [↑] [↓] - infinitely variable incrementing or decrementing of output quantity value with single movement by 0,00001 of range,

26 - [↑↑] [↓↓] - infinitely variable incrementing or decrementing of output value with single movement by 0,001 of range,

27 - [E] - rewriting of operational monitor indications onto the output monitor with aimultaneous generation of the rewritten value on the output terminals,

28 - [C] - resetting - return to the state after switching on /0 mV is generated on the output terminals/,

4.5. Terminating of load to the calibrator

The modes of terminating loads /e.g. a tested meter/ to the calibrator have been presented in the figures 4.4. - 4.8. /in fig. 4.8. a connection between terminals W increases the error/. Wiring of the "GUARD" terminal to the load presented in the diagrams is recommended by the manufacturer.

The following designations have been assumed in the drawings:

N - low terminal,

W - high terminal,

WV - high voltage high terminal,

E - internal screen terminal

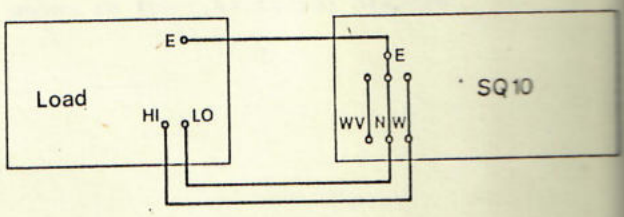

Fig.4.4a. Two-wire load termination for current ranges

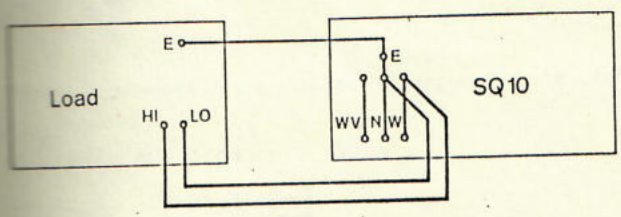

Fig.4.4b. Two-wire load termination for 1 V and 10 V ranges

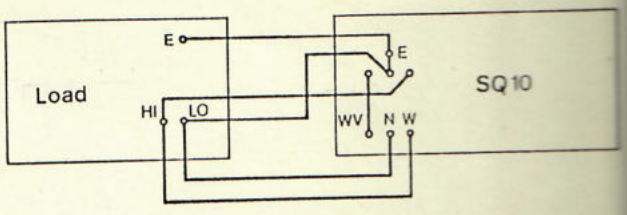

Fig.4.5. Four-wire load termination for 1 V and 10 V ranges

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

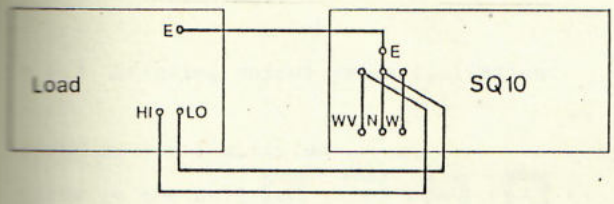

Fig. 4.6. Two-wire load termination for 100 V and 1000 V ranges.

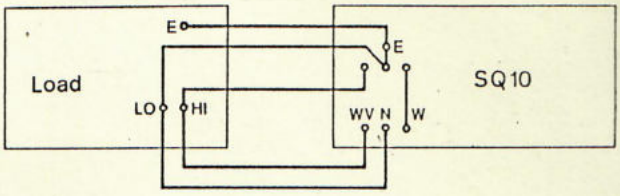

Fig. 4.7. Four-wire load termination for 100 V and 1000 V ranges.

For milivolt ranges the output resistance is 0,1Ω . In the case the load input impedance is higher than 10 kΩ , the calibrator output resistance entails a negligible error. If the load input impedance is lower than 10 k , a correction may be taken into account. The voltage on the calibrator output terminals is expressed in the formula:

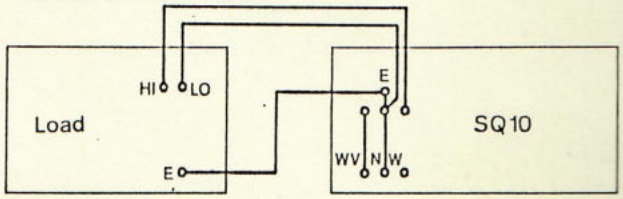

Fig. 4.8. Load termination for 10 mV and 100 mV ranges.

$$U_{wy} = U_N \frac{Ro}{0,1\Omega + Ro} \qquad /4.3./.$$

where: U_N - setting defined in voltage units

Ro - load input resistance expressed in ohms

4.6. Programming

The calibrator is programmed with the controls of the board /fig. 4.3./. A given value is printed with the digit keys /item dwg 4.3/ and shown in the operational display.

4.6.1. Generation of direct currents and voltages

Write in the setting value.

Write in polarity sign [+] or [−] .

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

Enter with pushbutton [E] - which is tantamount to generation of set value on the output terminals.

4.6.2. Generation of alternating currents and voltages

Write in the frequency value.

Write in the unit [Hz] .

Enter with pushbutton [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 so far.

4.6.3. Entering output value limitation.

Write in the limitation value.
Write in the unit [mV] , [V] , [mA] , [A] .
Enter with [LIM] button.
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.

4.6.4. Modyfication of output quantity value by set deviation value.

Write in the deviation value.
Write in the unit [mV] , [V] , [mA] , [A] .
Enter with [Δ] .
Use the [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] and [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] keys.

4.6.5. Storing signal value into memory.

Write in signal value.
Write in the polarity sign [+] or [-] .
Write in the unit [mV] , [V] , [mA] , [A]
Use the [STO] key to call the programme of writing into memory.
Give the storage cell number from [0] to [9] , which will automatically write the signal value to the selected 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 in the unit [Hz] .
With the [STO] key and the storage cell number write the frequence value into memory. This will replace the formerly stored direct signal value with the alternating signal value.

4.6.6. 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] .

Enter with the [Xw] key.

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

Enter with the [K] key.

Upon pressing the [X] key - values from the sequence

$$\frac{XW}{K} \times 1;\quad \frac{XW}{K} \times 2;\quad \ldots;\quad \frac{XW}{K} \times K$$

will be written into the storage cells 0 to K-1.

4.6.7. Memory read-out

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

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

a/ with [0] - [9] keys call the memory cell into the operationa 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 /lamp AC/.

Repeated 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.

b/ Pressing the keys [Xw] , [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 memory cell, an error will be indicated /table 4.8.1./.

4.7. Exemplary meter check-out procedure

Task: check whether 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.

Procedure	State of monitors			
	Operational and diodes		Output and diodes	
1	2	3	4	5
a/ get the calibrator ready for operation or press the key [C] /4.1./			+,000000	V
b/ declare work on 10 V range [3] [Z]	3	-	+,000000	V
	-	-	+,000000	V, Z
c/ write in the setting and alternating signal frequency /4.6.2/. [0] [.] [1] [V] [E] [5] [0] [Hz] [E]	0,1	-	+,000000	V, Z
	0,1	V	+,000000	V, Z
	-	-	+0,10000	V, Z
	5		+0,10000	V, Z
	50		+0,10000	V, Z
	50	Hz	+0,10000	V, Z
	50,00	Hz	0,10000	AC, Z, V
d/ enter the output voltage limitation 5.2 V to prevent meter defects /4.6.3/. [5] [.] [2] [V] [LIM]	5		0,10000	AC, V, Z
	5		0,10000	AC, V, Z
	5,2		0,10000	AC, V, Z
	5,2	V	0,10000	AC, V, Z
	-	-	0,10000	AC,V,Z,LIM
e/ wire the meter to the output terminals acc. to dwg 4.5.1.				
f/ write into the memory the points at which the meter will be checked /item 4.6.5./ [5] [V] [Xw] [5] [X]	5		0,10000	AC,V,Z,LIM
	5	V		
	-	-		
	5			
	-	-		
g/ write into the memory the value of deviation following the meter class - 0,1 V /4.6.4/ [0] [.] [1] [V] [Δ]	0			
	0		0,10000	AC,V,Z,LIM
	0,1			
	0,1	V		
	-	-		
h/ preset the first control point- reading out the set value from memory /4.6.8./ [RCL] [1] [E]			0,10000	AC,V,Z,LIM
	1,000000	AC, V		
	50,00	Hz	1,0000	AC,V,Z,LIM
i/ check whether the meter indications remain within the programmed error by changing the setting by set value of deviation [X+Δ] or [X-Δ]	0,10000		1,10000	AC,V,Z,LIM
			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 limite.				
j/ Additionally, you can calculate the error value for that point.				

1	2	3	4	5
In order to do so use the increment buttons to set the pointer to the scale mark [CE] [11] or [11] [1] or [1] Read the rated value from the memory [RCL] [1] Calculate the error [δ]	- 1.00000 xxxxxx error value	- - - - AC, V %	1,00000 1,XX000 1,XXXX0 1,XXXX0 1,XXXX0 1,XXXX0	AC,V,Z,LIM AC,V,Z,LIM AC,V,Z,LIM AC,V,Z,LIM AC,V,Z,LIM AC,V,Z,LIM
k/ repeat the procedures h, i for the remaining points [RCL] [2] [RCL] [3] [RCL] [4] [RCL] [5]	2.00000 3.00000 4.00000 5.00000	AC, V AC, V AC, V AC, V		

4.8. Specification of errors indicated by the calibrator.

The calibrator indicates:

a/ faulty programming writing a message on the operational display Err + error number. Using the 4.8.1. chart you can determine the cause of the error. Only two keys in the control board are accessible at that time: [CE] and [C]. The [CE] key resets the operational display and allows writing new data in, the [C] key returns the calibrator to the state just after the power was switched on /4.1./.

b/ 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 /items 10, 11, fig. 4.1./.

Return to normal working conditions /table 3.2.6./ automatically stops these indications.

NOTE! The overrun signalling for distortion coefficient pertains to work on alternating ranges only.

Table 4.8.1. Specification of programming errors.

Err 01 Usable settings range overrun,

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 △ , LIM, XW,

Err 10 Erroneous range selection.

Err 11 Incompatibility of the unit of generated value and the unit of deviation or lack of data in the deviation memory when pressing the X $\pm$ 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 errors.

Err 17 No XW value when calculating the δ error.

Err 19 δ error or ε error calculated value overrun over 100%.

5. ACCESSORIES

- warranty certificate	-	1 pc
- operating instruction	-	1 pc
- spare fuses WTA 250/1	-	2 pcs

6. OPERATING RECOMMENDATIONS

When using the SQ10 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 items 3.2.1., 3.2.2., 3.2.3., 3.2.4. of the Operating 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 current 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 ranges first requires you to terminate the load to the calibrator output terminals 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 rist of surge current occuring right at the moment you terminate the load of value many times above the highest setting on a given range.

Note: Operation of the processing system can be heard on the 10 A DC and 1000 V DC ranges /a 2 kHz tone/.

Load termination for milivolt ranges is presented in fig. 4.8. /armature between the output and feedback terminals enhances the error/.