CL511

Precision Calibrator

CE

OMEGA®

An OMEGA Technologies Company

Operator's Manual

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This instruction manual concerns the units having the C.xx program edition

Contents **Pages**

Summary of programming procedure (center pages)

1 - INTRODUCTION

The OMEGA ® CL511 is a digital calibrator for the generation and measurement of DC voltages and currents, for the simulation and measurement of thermocouple and RTD sensors in order to check and calibrate equipment in telemetry loops such as sensors, transmitters, positioners, converters, controllers, etc..

These units are self-contained, being powered by internal batteries. They are supplied in a carrying case with a charger.

They can be used in numerous ways thanks to their wide range of programmable functions and their ability to connect to the latest transmitters or receivers, depending on their configuration.

They include an alphanumeric display and a very comprehensive keyboard. These features and the provision of prompts in several languages make them very easy to program and use.

The CL511D has memory to store up to 1,000 measurements in one or more bursts and includes an RS 232 C interface through which the measurements can be transferred to a data acquisition and processing system.

UNPACKING AND INSPECTION

Remove the Packing list and verify that all equipment has been received. If there are any questions about the shipment, please call the OMEGA Customer Service at 1-800-622-2378.

Upon receipt of shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

Note : The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

2 - CHARACTERISTICS

2.1 - APPLICABLE STANDARDS

2.1.1 - Safety class

In accordance with IEC Publication 348 (harmonized standard HD 401, national standards NF C 42-020, DIN IEC 348). Class II.
Isolating voltage : 250 V max.
Note : The safety instructions for the unit are given in para. 6.1.

2.1.2 - Ambient conditions

In accordance with IEC Publication 359 (national standards NF C 42-600, DIN 43745) : operating category I.
Reference range : 23°C ± 1°C, relative humidity : 45 % to 75 %.
Normal operating range : 0°C to + 50°C, relative humidity : 20 % to 80 % non-condensing.
Operating range limits : - 10°C to + 55°C, relative humidity : 10 % to 80 % (70 % at 55°C).
Storage and transport range : - 30°C to + 60°C.
The unit can be used at altitudes below or equal to 2,200 m (7,218 ft.).

2.1.3 - Mechanical conditions

Protection according to IEC Publication 529 (harmonized standard HD 365 S3, national standard NF C 20-010).
- carrying case closed : IP 31.
- carrying case open : IP 30.

Vibration and shocks according to IEC Publication 348.

2.1.4 - Measurements at reference conditions

According to IEC Publication 485 (national standards NF C 42-630, DIN 43751).

2.1.5 - 100 Ω at 0°C RTDs (ITS 90)

Pt 100 Platinum RTD : according to IEC 751 Publication (harmonized standard HD 459, national standards NF C 42-330 and DIN IEC 751).
Ni 100 Nickel RTD : according to standard DIN 43760.
The ohmic values for Pt 200, Pt 500, Pt 1,000 and Ni 200, Ni 500, Ni 1,000 are multiples of those for Pt 100 and Ni 100 at the same temperature and in the specified measuring spans.

2.1.6 - Thermocouples (ITS 90)

K, T, J, N, E, R, S, B : according to IEC Publication 584-1 (harmonized standard HD 446-1, national standards NF C 42-321 and DIN IEC 584-1).
TDIN and JDIN : according to standard DIN 43710.
C : according to the HOSKINS curve.

2.2 - GENERAL SPECIFICATIONS

- Portable unit powered by internal batteries.
- Liquid crystal display, 16 alphanumeric characters 8 mm high with built-in lighting which can be programmed to stay on between 0.5 and 300 seconds.
- Choice of language for prompts and 24-key keyboard to program functions, ranges and parameters. Languages available : English, German, Italian, Spanish, French.
- Audible warning (beep) of any incorrect operation or, depending on programming, of certain measurement and emission/simulation functions.
- Automatic or manual ranging.
- Error messages displayed for various conditions of abnormal use.
- Permanent memory storage of 10 values of signals to be emitted.
- Power supply :
  - 6 Ni-Cd batteries, 0.5 Ah. Battery life : 3 to 20 hours depending on function(s) used.
  - Separate charger : 120 V, 60 Hz. Charging time : approx. 16 hours with unit switched off, consumption : < 1 VA.
- Case : Shoulder bag with strap and two-position buckles, one for carrying and the other for "hands-free" use.
- Dimensions : 285 mm x 170 mm x 100 mm.
- Weight : 1.5 kg.

For the CL511D :

- RS 232 C port for "simple RS" mode.
- Storage of the last 1,000 measurements in one or more bursts, with the average, minimum and maximum value of each burst (burst memory) with the corresponding measurements and values, as well as function and range being shown on the display and sent to the RS 232 C port.
- Permanent storage of 100 signals to be transmitted.

2.3 - "MEASUREMENT" FUNCTIONS

Stated accuracies are expressed in ± (n % rdg + C), with rdg = reading and C = Constant expressed, either as a practical unit or the number of units of the last digit. They apply to instruments situated in the reference conditions defined elsewhere after warning up for 15 minutes, without previous autocalibration of the MEASUREMENT functions during the periods indicated.

Autocalibration of MEASUREMENT functions (this procedure is described in chapter 8 - MAINTENANCE) results in the accuracies specified for emission/simulation subject to ± 1 count of the MEASUREMENT range in question.

Measurement rate : 2.5 per second.

2.3.1 - DC voltage

Range	Resolution	Accuracy 90 days 23°C ± 1°C	Accuracy 1 year 23°C ± 5°C	Input resistance
50 mV	10 µV	0.05 % + 1	0.1 % + 1	> 1,000 MΩ
500 mV	100 µV	0.05 % + 1	0.1 % + 1	> 1,000 MΩ
5 V	1 mV	0.05 % + 1	0.1 % + 1	10 MΩ
50 V	10 mV	0.05 % + 1	0.1 % + 1	10 MΩ

- Measuring range : from - 120 % to + 120 % of range.
- Input current : ≤ 100 pA (50 mV and 500 mV ranges).
- Response time to meet the specified accuracy :
  - without range changing : < 1 s.
  - with range changing : < 2 s.
- Max. permissible voltage on all ranges : 70 V DC or AC peak.
- Normal mode rejection (50 mV range) : > 70 dB at 60 Hz.
- Max. permissible common mode voltage : 250 V AC or 350 V peak, **(see safety instructions in para. 6.1).**
- Common mode rejection (50 mV range) : > 120 dB for DC and 60 Hz AC.
- Temperature coefficient : < (0.005 % + 0.1)/°C.

2.3.2 - DC current

Range	Resolution	Accuracy 90 days 23°C ± 1°C	Accuracy 1 year 23°C ± 5°C	Voltage drop
50 mA	10 µA	0.05 % + 1	0.1 % + 1	< 1.6 V

- Measuring range : from - 120 % to + 120 % of range.
- Response time : < 1 s.
- Electronic protection by PTC resistor (70 V DC or AC peak).
- Normal mode rejection : 90 dB at 60 Hz.
- Temperature coefficient : < (0.005 % + 0.1)/°C.

Note : When measuring current with a two-wire transmitter, the current loop can be supplied from an internal 24 V ± 10 % source with a 25 mA limit. This operating mode must be programmed.

2.3.3 - Resistance

Measurement with three-wire balanced circuit.

Range	Resolution	Accuracy 90 days 23°C ± 1°C	Accuracy 1 year 23°C ± 5°C	Measuring current
500 Ω	0.1 Ω	0.05 % + 1	0.1 % + 1	1 mA
5,000 Ω	1 Ω	0.05 % + 1	0.1 % + 1	0.1 mA

- Measuring range : from 0 % to + 120 % of range.
- Open circuit voltage across terminals : < 2.5 V.
- Permissible line resistance : ≤ 50 Ω per wire.
- Response time :
  - without range changing < 1 s.
  - with range changing < 2 s.
- Max. applicable voltage : 70 V DC or AC peak.
- Temperature coefficient : < (0.005 % + 0.1)/°C.

2.3.4 - Temperature by thermocouples

Sensor	Measuring range	Resolution	Accuracy 90 days 23°C ± 1°C	Accuracy 1 year 23°C ± 5°C
K Ni-Cr/Ni-Al	**- 250°C + 1,372°C** (- 418°F + 2,500°F)	- 250°C - 200°C: 0.5°C (1.0°F) - 200°C - 100°C : 0.2°C (0.5°F) - 100°C + 1,372°C : 0.1°C (0.2°F)	0.05 % + 1.0°C 0.05 % + 0.4°C 0.05 % + 0.2°C	0.1 % + 1.5°C 0.1 % + 0.6°C 0.1 % + 0.3°C
T Cu/Cu-Ni	**- 250°C + 400°C** (- 418°F + 752°F)	- 250°C - 200°C : 0.5°C (1.0°F) - 200°C - 100°C : 0.2°C (0.5°F) - 100°C + 400°C : 0.1°C (0.2°F)	0.05 % + 1.0°C 0.05 % + 0.4°C 0.05 % + 0.2°C	0.1 % + 1.5°C 0.1 % + 0.6°C 0.1 % + 0.3°C
TDIN Cu/Cu-Ni DIN	**- 200°C + 600°C** (- 328°F + 1,112°F)	- 200°C - 100°C : 0.2°C (0.5°F) - 100°C + 600°C : 0.1°C (0.2°F)	0.05 % + 0.4°C 0.05 % + 0.2°C	0.1 % + 0.6°C 0.1 % + 0.3°C
J Fe/Cu-Ni	**- 209°C + 1,020°C** (- 344°F + 1,868°F)	- 209°C - 120°C : 0.2°C (0.5°F) - 120°C + 1,020°C : 0.1°C (0.2°F)	0.05 % + 0.4°C 0.05 % + 0.2°C	0.1 % + 0.6°C 0.1 % + 0.3°C
JDIN Fe/Cu-Ni DIN	**- 200°C + 900°C** (- 328°F + 1,652°F)	- 200°C - 40°C : 0.2°C (0.5°F) - 40°C + 900°C : 0.1°C (0.2°F)	0.05 % + 0.4°C 0.05 % + 0.2°C	0.1 % + 0.6°C 0.1 % + 0.3°C
N Ni-Cr-Si/Ni-Si	**- 240°C + 1,300°C** (- 400°F + 2,372°F)	- 240°C - 200°C : 1.0°C (2.0°F) - 200°C + 400°C : 0.5°C (1.0°F) + 400°C + 1,300°C : 0.1°C (0.2°F)	0.05 % + 1.0°C 0.05 % + 0.4°C 0.05 % + 0.2°C	0.1 % + 1.5°C 0.1 % + 0.6°C 0.1 % + 0.3°C
E Ni-Cr/Cu-Ni	**- 250°C + 775°C** (- 418°F + 1,427°F)	- 250°C - 200°C : 0.5°C (1.0°F) - 200°C - 100°C : 0.2°C (0.5°F) - 100°C + 775°C : 0.1°C (0.2°F)	0.05 % + 1.0°C 0.05 % + 0.4°C 0.05 % + 0.2°C	0.1 % + 1.5°C 0.1 % + 0.6°C 0.1 % + 0.3°C
R Pt-13%Rh/Pt	**- 50°C + 1,768°C** (- 58°F + 3,214°F)	- 50°C + 450°C : 1.0°C (2.0°F) + 450°C + 1,767°C : 0.5°C (1.0°F)	0.05 % + 2.0°C 0.05 % + 1.0°C	0.1 % + 3.0°C 0.1 % + 1.5°C

2.3.4 - Temperature by thermocouples (continued)

Sensor	Measuring range	Resolution	Accuracy 90 days 23°C ± 1°C	Accuracy 1 year 23°C ± 5°C
S Pt-10%Rh/Pt	**- 50°C + 1,768°C** (- 58°F + 3,214°F)	- 50°C + 450°C : 1.0°C (2.0°F) + 450°C + 1,767°C : 0.5°C (1.0°F)	0.05 % + 2.0°C 0.05 % + 1.0°C	0.1 % + 3.0°C 0.1 % + 1.5°C
B Pt-30%Rh/Pt-6%Rh	**+ 400°C + 1,820°C** (+ 752°F + 3,308°F)	+ 400°C + 900°C : 1.0°C (2.0°F) + 900°C + 1,820°C : 0.5°C (1.0°F)	0.05 % + 2.0°C 0.05 % + 1.0°C	0.1 % + 3.0°C 0.1 % + 1.5°C
C W-5%Rh/W-26%Rh	**- 20°C + 2,320°C** (- 4°F + 4,208°F)	- 20°C + 300°C : 0.5°C (1.0°F) + 300°C + 1,830°C : 0.2°C (0.5°F) + 1,830°C + 2,320°C : 0.5°C (1.0°F)	0.05 % + 1.0°C 0.05 % + 0.5°C 0.05 % + 1.0°C	0.1 % + 1.5°C 0.1 % + 0.8°C 0.1 % + 1.5°C

• Accuracy is guaranteed for a 0°C (32°F) reference junction. When using the internal reference junction (except type B), add 0.2°C (0.5°F) for a measured temperature range from - 50°C up to the sensor full scale.
The inherent temperature error of the sensor used and its operating conditions must also be taken into account.
• A single keypress provides °F readings.
• Direct keyboard access to the sensor previously chosen by programming, with or without internal reference junction.
• Max. permissible voltage in normal mode : 70 V DC or AC peak.
• Normal mode rejection (10 mV, 60 Hz) :
- Type K : < 0.1°C.
- Type S : < 0.4°C.
• Max. permissible common mode mode voltage : 250 V AC or 350 V peak **(see safety instructions in para. 6.1).**
• Common mode rejection (10 V DC or 60 Hz) :
- Type K : < 0.3°C.
- Type S : < 1°C.
• Temperature coefficient : < 10 % of accuracy over 90 days per °C.
Except for thermocouple B, one of the following locations for the reference junction can be chosen by programming via the keyboard :
- external at 0°C (32°F),
- internal (compensation of the temperature at the terminals of the unit).

2.3.5 - Temperature by RTDs

Sensor	Measurement range	Resolution	Accuracy	
			90 days 23°C ± 1°C	1 year 23°C ± 5°C
Pt 100	**- 220°C + 1,200°C** (- 364°F + 2,192°F)	0.1°C (0.2°F)	0.05 % + 0.3°C	0.1 % + 0.4°C
Pt 200	**- 220°C + 550°C** (- 364°F + 1,022°F)	0.1°C (0.2°F)	0.05 % + 0.2°C	0.1 % + 0.3°C
Pt 500	**- 220°C + 1,200°C** (- 364°F + 2,192°F)	0.1°C (0.2°F)	0.05 % + 0.5°C	0.1 % + 0.7°C
Pt 1,000	**- 220°C + 1,200°C** (- 364°F + 2,192°F)	0.1°C (0.2°F)	0.05 % + 0.3°C	0.1 % + 0.4°C
Ni 100	**- 59°C + 180°C** (- 74°F + 356°F)	0.1°C (0.2°F)	0.05 % + 0.3°C	0.1 % + 0.4°C
Ni 200	**- 59°C + 180°C** (- 74°F + 356°F)	0.1°C (0.2°F)	0.05 % + 0.2°C	0.1 % + 0.3°C
Ni 500	**- 59°C + 180°C** (- 74°F + 356°F)	0.1°C (0.2°F)	0.05 % + 0.5°C	0.1 % + 0.7°C
Ni 1,000	**- 59°C + 180°C** (- 74°F + 356°F)	0.1°C (0.2°F)	0.05 % + 0.3°C	0.1 % + 0.4°C

• The accuracy above is given for a temperature sensor connected in a three-wire balanced circuit ; for Pt 100 and Ni 100, an unbalance of 40 mΩ causes an additional error of 0.1°C (0.2°F) . The inherent temperature error of the sensor used and its operating conditions must also be taken into account.

- Permissible line resistance : < 50 Ω per wire.
- Measuring current :
  - Pt 100, Pt 200 and Ni 100, Ni 200 : 1.0 mA ± 20 %.
  - Pt 500, Pt 1,000 and Ni 500, Ni 1,000 : 0.1 mA ± 20 %.
- Response time : < 1 s.
- A single keypress provides °F readings.
- Direct keyboard access to the sensor previously chosen by programming.
- Max applicable voltage : 70 V DC or AC peak.
- Temperature coefficient : < 10 % of accuracy over 90 days per °C.

2.3.6 - Additional characteristics in "MEASUREMENT" mode

2.3.6.1 - Manual or automatic ranging

For the mV, V and Ω functions, on autoranging, the unit switches on the higher range above 5,500 counts and to the lower range below 500 counts.

2.3.6.2 - Relative measurement

The unit reads the function L = M - R, with :
L = value read,
M = value measured with the chosen function and range,
R = reference value : value of a measurement stored by pressing a key and held in volatile memory.

2.3.6.3 - Conversion law - scaling

The unit reads the function P = aM + b, with :
P = value read,
M = value measured with the chosen function and range,
a and b are defined by the unit on the basis of the desired P1 and P2 values for corresponding values of M1 and M2, the data P1, M1 and P2, M2 having previously been entered on the keyboard and saved in permanent memory as well as the symbol of the unit to be displayed, selected by programming from the symbols available in memory.

2.3.6.4 - Method of triggering the measurement

Depending on how the unit is programmed, the following can be performed in triggered mode :
- a measurement with programmable triggering time between 0.5 and 3,480 seconds (58 minutes) from operation of a key on the keyboard.
- a burst of 2 to 1,000 consecutive measurements at intervals of 0.5 to 3,480 seconds by pressing the same key.

The minimum time of 0.5 s is raised to 2.5 s for resistance measurements, temperature measurements by RTD and thermocouple with internal reference junction.

The programming parameters for triggering are held in permanent memory.

2.3.6.5 - Storage of measurements (CL511D)

The unit can store in permanent memory up to 1,000 measurements made in triggered mode in one or several bursts (maximum 250 bursts).
In addition, this memory holds for each burst the average, maximum and minimum of the values held, together with the sensor type, range and unit in which measurements were made (where a scaling has been used for instance).

The unit can be used as a "notepad" by triggering measurements one by one and storing them in the memory.

The bursts and values in the bursts are organized so that, depending on how the unit is programmed, they can be :
- displayed on the unit,
- converted into analog signals (see below),
- sent to the RS 232 C port for processing in a computer or printing on a printer (see below).

2.3.6.6 - Analog output (CL511D)

The values of each burst contained in the permanent memory can be converted into 0 to 1 V or 4 to 20 mA analog signals.
The type of output signal is chosen by programming as are the displayed values that correspond to 0 and 1 V or 4 and 20 mA.
Burst content scan rate is programmable from 0.2 to 3,480 seconds per value (resolution 0.1 s).
Number of scan cycles is programmable from 1 to 65,000.
The characteristics of the signals delivered are those specified for 2,000 mV and 20 mA ranges of the emission-simulation function (see below).

2.3.6.7 - Output to RS 232 C interface (CL511D)

A three-contact socket enables the unit to be connected to a computer or a printer for the reading and processing of the values stored for the various bursts including the average, minimum and maximum values for each burst.

- Characteristics of the link : refer to para. 2.5.
- Connection to a computer :
  The measurements are sent to the computer, either by pressing the key on the CL511D, or by pressing a key on the computer to transmit the appropriate commands to the unit.
- Connection to a printer :
  Programming of the number of measurements per line (between 1 and 10) and the timing between each line (from 0 to 9,999 ms).

⚠ **WARNING : The RS 232 C port of the CL511D is at the same potential as its measurement terminals. For safety reasons, the port should not be used until the unit has been disconnected from all other external circuits.**

2.3.6.8 - Software for processing the measurement memory (CL511D)

Each CL511D comes with a disk containing the software for processing the content of the measurement memory on an IBM PC or compatible via the RS 232 C interface.

The software permits the following operations :

- Transfer of the measurement bursts contained in the memory of the unit.
- Comprehensive listing of all bursts, of the number of measurements per burst and the unit of the measurement used.
- Creation and saving of files for up to 16 bursts maximum.
- Display of the content of each burst in the form of an array of values or in graphics mode with fixed or moving cursor and zoom.
- Output for hard copy to printer of the selected graphics displays.

2.3.6.9 - Autocalibration

In order to improve performances of the unit and to facilitate maintenance operations, the MEASUREMENT functions can be recalibrated automatically with or without previous recalibration of the EMISSION/SIMULATION functions. The resulting characteristics are set out in para. 2.3 above.

2.4 - "EMISSION/SIMULATION" FUNCTIONS

The stated accuracies apply to a CL511 at the reference conditions defined and after 15 minutes warm up time. They are expressed in ± (n % rdg + C), where rdg = reading and C = a Constant expressed either in practical units or in a number of units of the last digit.

2.4.1 - DC voltage

Range	Emission range	Resolution	Accuracy	
			90 days 23°C ± 1°C	1 year 23°C ± 5°C
200 mV	**- 30 mV + 220 mV**	1 µV	0.03 % + 4 µV	0.05 % + 8 µV
2,000 mV	**- 300 mV + 2,200 mV**	10 µV	0.02 % + 20 µV	0.04 % + 40 µV
20 V	**- 2 V + 22 V**	100 µV	0.02 % + 0.2 mV	0.04 % + 0.4 mV

- Nominal load resistance : ≥ 100 kΩ.
- Source resistance : < 0.2 Ω.
- Output current : ≤ 1 mA (limited to 10 mA at short-circuit).
- Settling time : < 0.1 s.
- Temperature coefficient : < (0.0025 % + 0.2)/°C.
- The output circuits are protected against the application of a voltage ≤ 10 V DC or AC peak.

2.4.2 - DC current

Range	Emission range	Resolution	Accuracy 90 days 23°C ± 1°C	Accuracy 1 year 23°C ± 5°C
20 mA	**+ 0.1 mA + 24 mA**	0.1 µA	0.02 % + 0.3 µA	0.04 % + 0.5 µA

- Power supply available :
  - internal : 24 V DC, 4-wire circuit ; load resistance : < 900 Ω.
  - external : 10 V DC to 24 V DC, 2-wire circuit ; load resistance max. : from 200 Ω to 900 Ω depending on supply voltage.
- Settling time : < 0.1 s
- When the loop is open or the load resistance too high (voltage at terminals of the circuit above 18.5 V), there is a repetitive audible warning (beep).
- Temperature coefficient : < (0.003 % + 0.2)/°C.
- The output circuits are protected against the application of a voltage ≤ 10 V DC or AC peak.

2.4.3 - Resistance

Range	Simulation range	Resolution	Accuracy 90 days 23°C ± 1°C	Accuracy 1 year 23°C ± 5°C
500 Ω **5,000 Ω**	**26 Ω 501 Ω** **260 Ω 5,010 Ω**	1 mΩ 10 mΩ	0.02 % + 10 mΩ 0.02 % + 150 mΩ	0.04 % + 20 mΩ 0.04 % + 250 mΩ

- Nominal current flowing into the grey terminal (+), to the red terminal (-) for the accuracy indicated :
  - 500 Ω range : 1.0 mA ± 20 %.
  - 5,000 Ω range : 0.1 mA ± 20 %.
- Permissible measuring current : 0.5 mA to 3 mA on 500 Ω range or 0.05 mA to 0.3 mA on 5,000 Ω range.
- Max. permissible current or voltage :
  - 500 Ω range : 20 mA or 10 V (DC or AC peak).
  - 5,000 Ω range : 2 mA or 10 V (DC or AC peak).
- Settling time : < 0.1 s.
- Temperature coefficient : < 10 % of accuracy over 90 days per °C.

2.4.4 - Thermocouples

Sensor	Simulation range	Resolution	Accuracy 90 days 23°C ± 1°C	Accuracy 1 year 23°C ± 5°C
K Ni-Cr/Ni-Al	**- 240°C + 1,372°C** (- 400°F + 2,500°F)	0.1°C) (0.1°F)	- 240°C - 200°C : 1°C - 200°C 0°C : 0.15 % + 0.1°C 0°C + 1,372°C : 0.03 % + 0.1°C	- 240°C - 200°C : 2°C - 200°C 0°C : 0.3 % + 0.2°C 0°C + 1,372°C : 0.05 % + 0.2°C
T Cu/Cu-Ni	**- 240°C + 400°C** (- 400°F + 752°F)	0.1°C (0.1°F)	- 240°C - 200°C : 1°C - 200°C 0°C : 0.15 % + 0.1°C 0°C + 400°C : 0.03 % + 0.1°C	- 240°C - 200°C : 2°C - 200°C 0°C : 0.3 % + 0.2°C 0°C + 400°C : 0.05 % + 0.2°C
TDIN Cu/Cu-Ni DIN	**- 200°C + 600°C** (- 328°F + 1,112°F)	0.1°C (0.1°F)	- 200°C 0°C : 0.1 % + 0.1°C 0°C + 600°C : 0.02 % + 0.1°C	- 200°C 0°C : 0.2 % + 0.2°C 0°C + 600°C : 0.04 % + 0.2°C
J Fe/Cu-Ni	**- 210°C + 1,200°C** (- 346°F + 2,192°F)	0.1°C (0.1°F)	- 210°C 0°C : 0.15 % + 0.1°C 0°C + 1,200°C : 0.04 % + 0.1°C	- 210°C 0°C : 0.3 % + 0.2°C 0°C + 1,200°C : 0.08 % + 0.2°C
JDIN Fe/Cu-Ni DIN	**- 200°C + 900°C** (- 328°F + 1,652°F)	0.1°C (0.1°F)	- 200°C 0°C : 0.1 % + 0.1°C 0°C + 900°C : 0.03 % + 0.1°C	- 200°C 0°C : 0.2 % + 0.2°C 0°C + 900°C : 0.05 % + 0.2°C
N Ni-Cr-Si/Ni-Si	**- 240°C + 1,300°C** (- 400°F + 2,372°F)	0.1C (0.1°F)	- 240°C - 200°C : 1.5°C - 200°C 0°C : 0.15 % + 0.2°C 0°C + 1,300°C : 0.03 % + 0.2°C	- 240°C - 200°C : 3°C - 200°C 0°C : 0.3 % + 0.4°C 0°C + 1,300°C : 0.05 % + 0.4°C
E Ni-Cr/Cu-Ni	**- 240°C + 1,000°C** (- 400°F + 1,832°F)	0.1°C (0.1°F)	- 240°C - 200°C : 1°C - 200°C 0°C : 0.1 % + 0.1°C 0°C + 1,000°C : 0.03 % + 0.1°C	- 240°C - 200°C : 2°C - 200°C 0°C : 0.2 % + 0.2°C 0°C + 1,000°C : 0.05 % + 0.2°C

2.4.4 - Thermocouples (continued)

Sensor	Simulation range	Resolution	Accuracy 90 days 23°C ± 1°C	Accuracy 1 year 23°C ± 5°C
R Pt-13%Rh/Pt	**- 50°C + 1,768°C** (- 58°F + 3,214°F)	0.1°C (0.1°F)	- 50°C + 1,768°C : 0.8°C	- 50°C + 1,768°C : 1.5°C
S Pt-10%Rh/Pt	**- 50°C + 1,768°C** (- 58°F + 3,214°F)	0.1°C (0.1°F)	- 50°C + 1,768°C : 1°C	- 50°C + 1,768°C : 2°C
B Pt-30 %Rh/ Pt-6%Rh	**+ 400°C + 1,820°C** (+ 752°F + 3,308°F)	0.1°C (0.1°F)	+ 400°C + 1,820°C : 1°C	+ 400°C + 1,820°C : 2°C
C W-5%Rh/W-26%Rh	**- 20°C + 2,300°C** (- 4°F + 4,172°F)	0.1°C (0.1°F)	- 20°C 0°C : 0.3°C 0°C + 400°C : 0.03 % + 0.3°C + 400°C + 2,300°C : 0.06 % + 0.3°C	- 20°C 0°C : 0.5°C 0°C + 400°C : 0.05 % + 0.5°C + 400°C + 2,300°C : 0.1 % + 0.5°C

. The accuracy is guaranteed for a reference junction at 0°C (32°F) and a load resistance ≥ 100 kΩ. When using the internal reference junction (except type B), add 0.2°C (0.5°F) for a simulated temperature range from - 50°C up to the sensor full scale.

. Source resistance : 0.2 Ω.

. Output current : ≤ 1 mA.

. Settling time :
- External reference junction at 0°C : < 0.1 s.
- Internal reference junction : < 1 s.

. Temperature coefficient : < 10 % of the accuracy over 90 days per °C.

. The output circuits are protected against the application of a voltage ≤ 10 V DC or AC peak.

2.4.5 - RTDs

Sensor	Simulation range	Resolution	Accuracy 90 days 23°C ± 1°C	Accuracy 1 year 23°C ± 5°C
Pt 100	**- 180°C + 1,200°C** (- 292°F + 2,192°F)	0.01°C (0.01°F)	0.02 % + 0.1°C	0.04 % + 0.2°C
Pt 200	**- 210°C + 405°C** (- 364°F + 761°F)	0.01°C (0.01°F)	0.02 % + 0.05°C	0.04 % + 0.1°C
Pt 500	**- 120°C + 1,200°C** (- 184°F + 2,192°F)	0.01°C (0.01°F)	0.02 % + 0.2°C	0.04 % + 0.3°C
Pt 1,000	**- 180°C + 1,200°C** (- 292°F + 2,192°F)	0.01°C (0.01°F)	0.02 % + 0.1°C	0.04 % + 0.2°C
Ni 100	**- 60°C + 180°C** (- 76°F + 356°F)	0.01°C (0.01°F)	0.02 % + 0.1°C	0.04 % + 0.2°C
Ni 200	**- 60°C + 180°C** (- 76°F + 356°F)	0.01°C (0.01°F)	0.02 % + 0.05°C	0.04 % + 0.1°C
Ni 500	**- 60°C + 180°C** (- 76°F + 356°F)	0.01°C (0.01°F)	0.02 % + 0.2°C	0.04 % + 0.3°C
Ni 1,000	**- 60°C + 180°C** (- 76°F + 356°F)	0.01°C (0.01°F)	0.02 % + 0.1°C	0.04 % + 0.2°C

• Nominal current flowing into the grey terminal (+), to the red terminal (-) for the accuracy indicated :
- Pt 100, Pt 200 and Ni 100, Ni 200 : 1.0 mA ± 20 %.
- Pt 500, Pt 1,000 and Ni 500, Ni 1,000 : 0.1 mA ± 20 %.

• Permissible measuring current :
  - Pt 100, Pt 200, Ni 100, Ni 200 : 0.5 mA to 3 mA.
  - Pt 500, Pt 1,000, Ni 500, Ni 1,000 : 0.05 mA to 0.3 mA.
• Max. permissible current or voltage :
  - Pt 100, Pt 200, Ni 100, Ni 200 : 20 mA or 10 V (DC or AC peak).
  - Pt 500, Pt 1,000, Ni 500, Ni 1,000 : 2 mA or 10 V (DC or AC peak).
• Settling time : < 0.1 s.
• Temperature coefficient : < 10 % of the accuracy over 90 days per °C.
• The output circuits are protected against the application of a voltage ≤ 10 V DC or AC peak.

2.4.6 - Additional characteristics in "EMISSION/SIMULATION" mode

2.4.6.1 - Manual or automatic ranging

When a value to be emitted at an automatic ranging is entered on the keyboard, the unit sets itself to the setting that gives the highest output signal accuracy and displays the value under this setting.

Example : Where 0.255 V is requested, the unit displays 255.00 mV.

The range is changed :
- for the mV, V functions : above 220,000 counts and below 22,000 counts.
- for the Ω function : above 501,000 counts and below 50,100 counts.

2.4.6.2 - Conversion law - scaling

The keyboard can be used to enter a value conforming to the conversion law :
E = cP + d with :
P = value entered on the keyboard and read on the display.
E = value emitted or simulated after validation in the function and range chosen.
c and d are defined by the unit on the basis of the values E1 and E2 required for the corresponding values of P1 and P2, the data P1, E1 and P2, E2 having previously been entered on the keyboard and saved in the permanent memory with the symbol chosen by programming from those available.

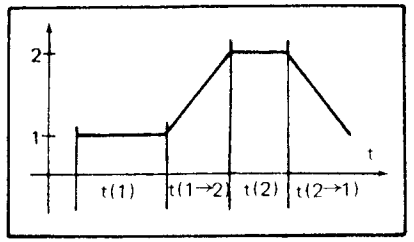
This law is applicable to all electrical functions (mV, V, mA, Ω) except temperature simulation functions, ramp generation and synthesizing functions.

2.4.6.3 - Step function

The emitted or simulated signal can be modified by a positive or negative step from 1 to 200,000 counts which is programmed and held in non-volatile memory.

Stepping is obtained by pressing two keys once or repetitively for all ranges and scaling programmed.

2.4.6.4 - Ramp generator



The emission signal can vary continuously between two programmed values 1 and 2 according to a cycle defined by the diagram opposite ; the durations of each part of the cycle and the number of cycles can be programmed separately and kept in non-volatile memory :

- duration of levels : from 0 to 3,480 s, i.e. 58 minutes, resolution 0.1 s.
- duration of transitions : from 0 to 9,999 s, i.e 2 h 45 min approx., resolution 1 s.
- number of cycles : from 1 to 65,000.
- output signal resolution : same as the resolution of the range of the level with the highest significant value or a multiple thereof if the rate of variation is greater than 18.8 counts/s.

Ramp generation is not possible under scaling or with °C or °F displayed signal (thermocouples or RTDs).

2.4.6.5 - Output signal programming

. CL511

Ten different output values can be be programmed from the keyboard. The values are held in permanent memory and can be re-instated on request on the keyboard.
They are expressed as any of the functions and ranges, with the corresponding unit or with the unit of a scaling.
The OMEGA CL511 automatically rejects the consecutive programming of two incompatible parameters, for example current followed by voltage.

. CL511D

This version of the OMEGA CL511 can store 100 different output values in permanent memory.
The values can be entered via the keyboard, or more conveniently, by means of the RS 232 C interface (remote loading).
Each unit comes with a disk containing software for an IBM PC or compatible.This can be used to create files of output values and to remoteload them to the unit via the RS 232 C interface.

Stored values are emitted from the keyboard, either one by one, or continuously (synthesizer function). In the latter case, the following must be programmed in advance :

- the addresses of the first and last value to be emitted (all ranges except scaling).
- the time between two consecutive values, from 0.2 s to 3,480 s, i.e. 58 minutes, resolution 0.1 s,
- the number of cycles to be performed from 1 to 65,000,
- the beep on or off each time a new value is emitted.

A single cycle must not include different quantities ; the "remote loading" and "synthesizer" functions will not accept scaling.
The characteristics of the RS 232 C interface are set out in para. 2.5.

⚠ **WARNING : The RS 232 C output of the CL511D is at the same potential as its measurement terminals. For safety reasons, the port should not be used until the unit has been disconnected from all other external circuits.**

2.5 - RS 232 C INTERFACE (CL511D)

The OMEGA CL511D has a three-way connector for a variety of functions described elsewhere and summarized below :

- To emit, from the keyboard to a printer, the values of a burst of measurements, as well as the average, minimum and maximum values, unit, etc .... The number of measurements per line and timing between two lines of characters can be programmed.

- To emit the above data from the keyboard to a data acquisition system (computer) operating in "Listen Only" mode.

- At the request of the controller, to perform the orders received and to output the data of one or more measurement bursts.

- Via the controller :
  - to remoteload the 100 values to be emitted in synthesizer mode.
  - to perform the automated calibration procedure.

Characteristics of the link :

- Transmission rate : 300 ; 600 ; 1,200 ; 2,400 ; 4,800 and 9,600 bauds.
- Character format : 7 or 8 bits with 1 or 2 "stop bits".
- Even or odd parity possible checking

All these parameters are programmable and stored in permanent memory.

2.6 - PROCESSING SOFTWARE

Each OMEGA CL511D unit comes with software that enables it to make use of the RS 232 port on an IBM PC or compatible (DOS 2 +).

The software is on a 5-1/4" disk, 360 ko format, and contains software for setting up and operating the link for the following functions :

- Measurement :
  - Capture of the bursts of measurements held in the unit.
  - Creation of files of measurement data (maximum 16 bursts).
  - Display of the values in array or graphic form, with facility for graphics hard copy to printer.

- Emission/simulation :
  - Creation of files of values to be emitted or simulated.
  - Remote loading of these files to the unit memories.

3 - MEASUREMENT ACCESSORIES

3.1 - DELIVERED WITH THE UNIT

- A carrying case with brief instructions.
- A battery charger.
- An instruction manual.

In addition, for CL511D :
- A male connector for RS 232 C interface.
- A 5-1/4" disk with the software to enable the unit to be used with a computer.

3.2 - DELIVERED IN EXTRA

Three-wire RS 232 C cable to connect the PRECICAL, version D, to an IBM PC or compatible, 2 meter long :
AN 8000 : cable equipped with a 9-pin female connector,
AN 8001 : cable equipped with a 25-pin female connector.

4 - THEORY OF OPERATION

The schematic diagrams and component location diagrams referred to this chapter can be found in chapter 10.

4.1 - GENERAL

The circuits of the CL511 are arranged on two main boards :

. the analog board (CA 40920),

. the logic board (CA 40915).

4.2 - ANALOG BOARD

The analog board (SP/CA 40920), which is located in the lower half-casing carries all the measuring circuits :

- input circuits and function and range switching circuits,

- analog to digital converter,

- voltage, current and resistance simulator.

4.2.1 - Input circuits and function and range switching circuits

They are mainly composed of bistable relays for function switching RL1 to RL3, voltage divider R32, R34 for DC voltage measurements, shunt R35 for DC current measurements and switching analog gates incorporated in the case of the analog to digital converter CI17.

4.2.2 - Analog to digital converter (ADC)

The analog to digital converter is of the "multi-ramp" type with auto-zero phase.

It consists mainly of :
- a high stability and low temperature coefficient reference source REF1, associated with divider RR1.
- an A/D converter circuit CI17 which also takes care of range switching, the activation of a preamplifier CI15 with a gain of 10 and the link with the micro-controller of the logic board.

4.2.3 - DC voltage measurement

The voltage to be measured is applied to the A/D converter, either directly for the 50 mV and 500 mV ranges, or via a 1/100 reducer for the 5 V and 50 V ranges.

In the 50 mV and 5 V ranges, a preamplifier with a gain of 10, consisting of CI15 and divider R36, R37, ensures that the A/D converter is driven at its nominal voltage.

4.2.4 - DC current measurement

The current to be measured is applied to a 10 Ω shunt R35. The voltage across the shunt is measured at the "potential" terminals.

4.2.5 - Resistance measurement

The resistance to be measured is supplied with a constant current by a current generator made up of a "MOS-FET" transistor T3, an error amplifier CI8 and a resistor network RR1 + R20.

The voltage appearing across the terminals of the resistor is measured by the A/D converter.

For temperature measurement, the reading in °C or °F is obtained by computation on the basis of measurement of the sensor resistance.

4.2.6 - Digital to analog converter (DAC)

This converter operates by chopping between two highly stable reference voltages obtained from REF1 and generated by means of RR1, CI2, CI1, R1 and R2.

For the emission ranges 2,000 mV, 20 V and 20 mA, these voltages are approximately equal to + 2.5 V and - 0.5 V. The 0.5 V voltage is supplied by the amplifier made up of CI1, R1 and R2 which has a gain of - 0.2.
For the 200 mV range, these voltage are equal to + 250 mV and - 50 mV and previously divided by 10 by means of RR1.

For the 500 Ω and 5,000 Ω ranges, the chopped voltage is the voltage at terminals of the standard resistor R17 (500 Ω range) or R16 (5,000 Ω range).

The voltage is chopped by an analog switch CI3 driven by two signals OC1 and OC2 generated by the micro-controller CI1. The cyclical ratios of these driving signals are proportional to the set point.

The reference voltages are switched by CI3.

4.2.7 - Voltage emission

For the 200 mV and 2,000 mV ranges, the output of the D/A converter is sent to the terminals of the unit via the unity-gain amplifier CI5.
For the 20 V range the gain of this amplifier is set to 10 by CI6 and RR10.

4.2.8 - Current emission

The output of the gain 10 amplifier is driven by RL6 to the voltage/current converter consisting of CI7, T1, T2, R10, R14 and R15.

4.2.9 - Resistance simulation

At the terminals of the standard resistance, the current supplied by the external circuit produces a reference voltage proportional to the current injected (Vref = Re x Iext).
The D/A converter gives a voltage Vs proportional to the set point and to this reference (Vs = k x Vref = k x Re x Iext) and thus simulates a resistance Rs = Vs/Iext = k x Re.

4.2.10 - Calibration coefficients

The analog board has no zero or FSD adjustment.
The scaling and compensation for offset voltages are achieved by computation (function y = ax + b).
The calibration coefficients of the various ranges are stored in a permanent memory CI4 on the logic board.
To ensure that these computations do not give rise to missing codes, the resolution of the A/D converter is eight times greater than that of the unit.

4.3 - LOGIC BOARD

The logic board (SP/CA 40915), which is located in the upper half-casing, provides the following functions :
- display,
- keyboard
- RS 232 C interface (CL511D),
- measurement memories.

It also carries the six Ni-Cd batteries.

The logic board is controlled by an HD 6303Y micro-controller (CI1), a 32 k x 8 CMOS EPROM (CI7) and an 8 k x 8 CMOS RAM (CI2).
The logic board is at the measurement potential.
It receives the measurement results from the mother board and sends orders via the micro-controller bus.

The RS 232 C interface is made up of integrated circuit CI3 which supplies the ± 10 V required for the operation of the interface thanks to the 5 V.
The calibration coefficients are stored in a permanent memory CI4 of EEPROM type.
This board is equipped with an automatic circuit-breaker, the purpose of which is to maximize the life of the batteries. This device is based on two voltage comparators CI6 which constantly monitor the battery voltage.

5 - INSTRUCTIONS BEFORE USE

5.1 - PRESENTATION

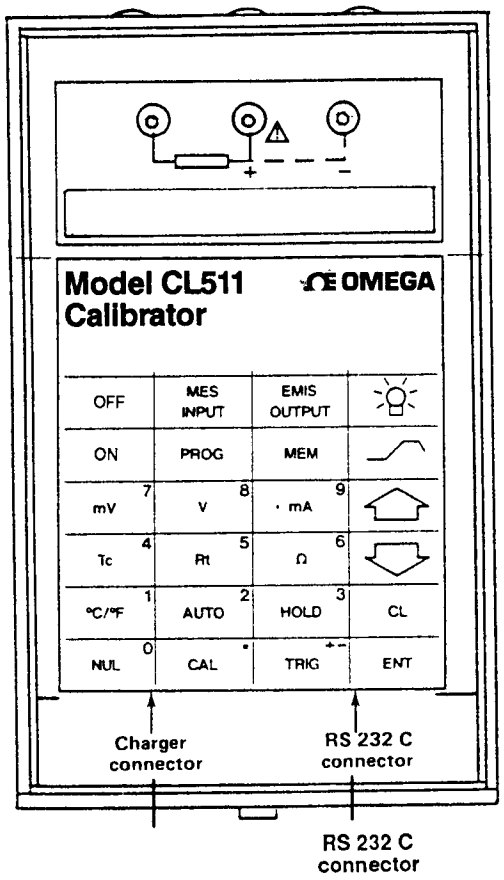
The unit comes in a carrying case with a strap.

5.1.1 - Carrying case

The carrying case is intended to protect the unit when using it on site.
When the lid is opened and the two press-studs at the rear are released, the lid can swivel through 180° and be placed under the carrying case.

With this arrangement, and with the two parts of the strap suitably adjusted, the unit can be suspended in front of the user with the strap around the back of the user's neck, for "hands-free" use.

5.1.2 - The unit



❶ The three measurement and emission/simulation terminals (grey, red and black).

❷ The 16-character liquid crystal display with built-in lighting.

❸ The frame fixing the unit in the case.

❹ The 24-key control keyboard.

❺ The compartment for the battery charger, where the charger connector and RS 232 C connector (CL511D) are also located.

5.1.2.1 - Allocation of the terminals - connections

Connections / Functions	G R+ B-	G R+ B-	G R+ B-
Measurement	- voltage - current - temperature of a thermo-couple	- resistance - temperature of an RTD	
Emission/ simulation	- voltage - current - emf of a thermo-couple		- resistance - RTD

5.1.2.2 - Keyboard functions

a)- Service keys

ON	Switches the unit on.
OFF	Switches the unit off.
☼	Display lighting.

b)- Main function keys

MES INPUT	Measurement function (input).
EMIS OUTPUT	Emission/simulation function (output).
PROG	Programming function.
MEM	Memory function in emission/simulation mode.

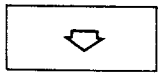
c)- Measurement or emission/simulation function keys

mV	
V	
mA	
Ω	
Rt	RTD.
Tc	Thermocouple.
°C/°F	Changing the unit for measurement and for simulation of temperature sensors.

d)- Operating mode keys

AUTO	Auto/manual ranging in measurement mode.
HOLD	Toggles between normal rate (free) measurement mode and "triggered" measurement mode.
TRIG	Triggers a measurement or a burst of measurement(s) after selection of "triggered" mode. (HOLD key).
CAL	Toggles scaling on/off.
NUL	Toggles relative measurements on/off.
⎍	In emission/simulation mode, toggles the "step" or "ramp" modes on/off (rotational selection).

e)- keys used in the various operating modes



or

- In the "manual ranging", selection of lower ⇩ or higher range.
- In "step" mode, emission/simulation of a negative ⇩ or positive ⇧ step.
- In "ramp" mode, activation of emission/simulation of one or several ramps as programmed.
- Other uses for these keys : in programming and/or when a menu is displayed, negative response to a prompt asked on the display and selection of next , or previous ⇧ item of the menu.

f)- Number keys

The number keyboard is used in emission/simulation and programming modes.

0	to	9	Input of the digits of the number to be entered.
.			Decimal point.
+ -			Sign.
CL			Deletion of a number in the event of an error ; in programming mode, return to menu items.
ENT			Confirmation of a number or affirmative response to a display prompt.

g)- Program call keys

Ten of the keys described above are used to call the ten available programs (14 for CL511D) after the **PROG** key has been pressed.

Most of the programs called correspond to the function of the key.

Example :

Tc	"Thermocouple" program.
☼	"Lighting" program, etc...

A list of program call keys is given in para. 7.2.

6 - OPERATION

6.1 - SAFETY PROVISIONS

6.1.1 - In accordance with safety standards

The OMEGA CL511 is constructed and tested according to IEC Publication 348 : safety rules for the electronic measuring instruments.

This instruction manual contains information and advice that users must follow to be protected against electrical shocks and to ensure the reliability of the unit in order to maintain it in a satisfactory state with regard to safety.

The unit may occasionally be exposed to temperatures between - 10°C and + 55°C without its safety features being compromised. It should not be used at altitudes above 2,200 m (7,218 ft.).

6.1.2 - Taking measurements

The test leads and measuring wires must be in good condition and should be changed if there is any evidence of deterioration (insulation split burnt, etc...).

When the unit is connected to a circuit under test, some of its terminals may be hazardous, therefore the hands should be kept away from any used or unused terminals. This precaution also applies to terminals of the battery charger and to the RS 232 C link which are directly or indirectly connected to the terminals of the unit. That is why, they are standing back in the carrying case and any operation on these circuits should be performed with the unit disconnected from all other external circuits.

Never exceed the safety limit values indicated elsewhere in this publication.

When the quantity to be measured is unknown, be sure that the measuring range used if the highest possible or select the autoranging mode.

Before changing function, disconnect the measuring wires from the external circuit. When measuring currents and/or voltages, even low, remember that circuits may show dangerous voltage regarding the ground.

Never perform resistance measurements on a live circuit.

6.1.3 - Faults and abnormal constraints

Should there be any indication that the protection of the unit has been compromised, it should be switched off and steps taken to prevent it being used inadvertently.

The protection may have been compromised in the following cases, for example :

- The unit is obviously damaged.
- The unit is no longer capable of taking accurate measurements,
- The unit has been stored under unfavourable conditions,
- The unit has been subject to severe stresses during transport.

6.1.4 - Maintenance

The unit must be disconnected from any form of measurement input before the casing is opened.

The unit should not be opened up for adjustment, maintenance or repair when live unless this is absolutely essential, in which case this work should be carried out only by qualified personnel advised of the risk entailed.

6.2 - USER ASSISTANCE

The OMEGA CL511 is a self-contained and portable unit well adapted to labs, site and factory purposes.

All the operations on keyboard are easy and any action on keys either displays a comprehensive message or emits a beep in case of error.

To make your task easier when operating on site, refer to the table headed "Short operating mode" and available in the cover of the carrying case.

This table, shown next page, resumes the operations to be performed in measurement and emission/simulation modes. It also indicates the position and meaning of the operating symbols displayed by the unit.

On the other hand, the whole set of menus available as well as procedures for changing the programming are clearly recalled in para. 7.4 headed "Summary of programming procedures" and in chapter 9 headed "Meaning of the displays".

At last and to better use all the unit possibilities or for a particular usage, we suggest you to read fully chapter 6 once.

6.3 - SHORT OPERATING MODE

OMEGA Stamford, CT USA

Model CL511 Calibrator
Short operating mode

Before any operation and for all the functions marked (▮), make sure that data stored in memory are suitable. If not, refer to chapter 7 of the operator's manual to change them.

1 - MEASUREMENT *(Input)*

⚠ **WARNING : Do not exceed 70 V DC or AC peak on terminals.**

How to :	Press keys :
Select the function	**MES**
Voltage	V or mV
Current (4 wires) (2 wires)	mA ENT mA ◇ ENT
Temperature (couple) ▮ (RTD) ▮	Tc Rt
Unit	°C/°F
Resistance (3 wires)	Ω
Change the range	
Manual ranging or autoranging	AUTO or ⌓ or ◇
	AUTO or V or mV or Ω
Perform	
• Relative measurements On	NUL
Return to normal mode	NUL or function key
• Scaling On ▮	CAL
Return to normal mode	CAL or function key
• Trig. measurements On	HOLD
Trig. order ▮	TRIG
Return to normal mode	HOLD or function key
Change the thermocouple type	PROG Tc ENT ◇... ◇ up to the desired couple, then ENT ENT

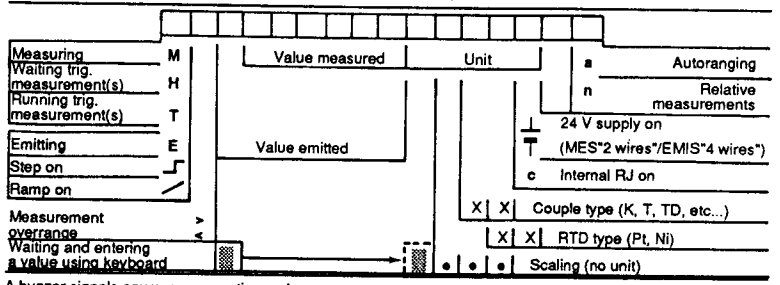
2 - EMISSION, SIMULATION *(output)*

⚠ **WARNING : Do not exceed 10 V DC or AC peak on terminals.**

How to :	Press keys :
● **Select the function**	
Voltage	EMIS V or EMIS mV
Current (4 wires) (2 wires)	EMIS mA ENT EMIS mA ◇ ENT
Temperature (couple) ▮ (RTD) ▮	EMIS Tc EMIS Rt
Resistance	EMIS Ω
■ **Select or change the value**	Digital keys, sign, decimal point ☛
◆ **Emit, simulate**	ENT
❑ **Other functions**	
• To change for Manual ranging Autoranging	⌓ or ◇ EMIS V or mV or Ω
• Scaling ▮ Return to normal mode	● CAL ■ ◆ CAL ■ ◆
• Step on ▮ (>0)	● ■ ◆ ⎍ ⌓...⌓
Step off (<0)	⌓...◇ ⎍ ⎍
• Ramp on ▮ Ramp off	● ■ ◆ ⎍ ⎍ ◇ or ⌓ ⎍
• To store a quantity in memories X_1, X_2, etc... (X = 0 to 9 or 0 to 99)	● ■ MEM X_1 ENT ■ MEM X_2 ENT etc ...
• To recall, emit the quantities stored in memories	EMIS MEM X_1 ENT ◆ MEM X_2 ENT ◆ etc ...

☛ CL if wrong value entered. For a decimal number n such as $-1 < n < 1$, enter 0 then the decimal point ⊡

Meaning of display



A buzzer signals any wrong operation on keys.
When you don't find a way out, press one of the three following keys :
ON = init ; **MES** *(input)* = to return to measurement ; **EMIS** *(output)* = to return to emission-simulation

6.4 - OPERATING GENERAL METHOD

Method employed is of "question and answer" type. **A question is clearly read on the display thanks to the interrogation mark.**

Three answers are possible as explained below :

a)- **yes** or **no**

These prompts are in a menu of the software.

- If **yes**, confirm with **ENT**.
- If **no**, change to the next prompt of the menu with ⇩ key or to the previous prompt of the menu with ⇧ key. Moving in the menu is made with these keys on rotational selection.

This general method enables you to scan and list the prompts of a menu, the quantities stored, etc...

b)- Using the keyboard

They are three in number :

- Which measurement function ? - Display of : **Meas. function?**
- Which emission/simulation function ? - Display of : **Emis. function ?**
- Which program ? - Display of **Program ?**

Pressing one of the keys, for example : mV or mA or Rt, etc..., determines the choice and answers to the question.

c)- Entering a numerical value

- In emission, this type of prompt is recognized by the blinking cursor ▒ . The value is entered with the number keys (see para. 6.8.1). Then, this value can be modified in the same way and at any time.
- In programming, the prompt is the textual parameter followed by the sign =.

  Example : **P1 = xx.x ?** If appropriate value, confirm it by pressing **ENT** key, if not, enter the new value using the number keys (see para. 6.8.1).

  Except the value Ro at 0°C (32°F) of the RTDs (see chapter 7).

In all cases and whatever the function used, a beep signals any wrong operation.

At last, if you don't find a way out, press one of the three following keys : **INPUT (MES)**, **OUTPUT (EMIS)** or **ON**.

6.5 - SWITCHING ON

The unit comes with the battery partially charged. It is advisable to charge the battery fully before using the unit for the first time (see para. 8.1).

- Disconnect the unit from any external circuit and press **ON** key. It performs an initialization procedure.
  It then reads English message : **Meas. function ?**.
  - To select the messages in any other language, press **PROG**, **0**, **ENT**, ⇩ or ⇧ and **ENT**.
  It is now ready for one of three main functions to be used in English language :
  - Measurement, the current operation of the unit (see para. 6.6),
  - Emission/simulation, which is requested by a keyboard command (see para. 6.8).
  - Programming, which is requested by a keyboard command (see chapter 7).

Note : If, during the initialization procedure, the unit displays **Memory empty** and gives a beep, this means that the programs are in the initialization state (see below).

To switch off the unit, press **OFF** key.

6.5.1 - State of memories when the unit is first switched on

The operation of the unit is to some extent determined by the presence of a certain amount of information in permanent memory.
The nature of this information when the unit is first switched on is set out briefly in the table below.
The complete list is given in the table in para. 7.2.

Program initialization, CL511	
Functions	**Information in memory**
RTD (para 6.6.4 and 6.8.5)	Pt 100 RTD
Thermocouple (para 6.6.5 and 6.8.6)	Type K with internal reference junction
Scaling (para 6.6.6.3 and 6.8.7.2)	No scaling except for current measurement and current emission (see table in para. 7.2).
Triggered measurement(s) (para. 6.6.6.4)	One measurement
Step (para. 6.8.7.4)	Fixed step : 1,000 counts
Ramp generation (para. 6.8.7.5)	Ramp from 0 to 2 V, all times programmed to 1 second
CL511D	
Synthesizer (para. 6.9.4)	The emission memories are at 0.00 mV
Measurement memories (para. 6.7)	The measurement memory is empty (no burst)
RS 232 C interface (para. 6.10.2)	The value of the parameters is given in the table in para. 7.2

This information can be modified using the programming function (see chapter 7).

6.5.2 - Battery maintenance

The power used by the unit, including that supplied to the external circuit in emission/simulation mode, comes from the internal battery which also keeps certain program parameters in memory even when the unit is switched off.

The unit comes with its battery partially charged and it is therefore advisable to check the state of charge before and during use (see para. 8.1.2).

A double safety feature is provided for this purpose :

- Regular appearance of the message **Low battery** for about one second indicating that **the battery must be recharged** (see para. 8.1). The operating autonomy and the unit characteristics are no more guaranteed.

- Automatic disconnection and switch off of the unit if the above warning has not been observed. In this case, the unit cannot be switched on again and **there is no alternative to recharging the battery**, even if you wish to use the unit immediately.

When the unit is in storage, the self discharging current of the batteries may discharge the battery completely within three to four months depending on the storage temperature. Although this does not harm the battery, the unit cannot be used until the battery has been recharged. If this has happened, the unit is in the program initialization state and **Mem. lost** will be displayed the first time it is switched on.

Note : Supplying the unit permanently from the battery charger only has a a very slight effect on battery life expectancy.

6.5.3 - Software edition

The software edition of the unit corresponds to that stated in this publication, page 1 and to check it, press the following keys in succession : **PROG**, **6** and **ENT**.
The software edition appears for one second, after which the unit returns to the initial state.

6.5.4 - Display lighting

- To illuminate the display for the programmed time **t**, press ☼ key.

- To change the time for which the lighting remains lit, use the **Lighting ?** program (**PROG** and ☼ keys) as described in chapter 7.

- To switch off the display lighting while it is on, press ☼ again.

WARNING : To avoid draining the battery, use the lighting when necessary.

6.6 - MEASUREMENT MODE

The MEASUREMENT mode can be used as soon as the unit is switched on. To return to MEASUREMENT mode after using one of the other main functions, press **MES**.

> ⚠ **WARNING : Do not exceed 70 V DC or AC peak on terminals.**

6.6.1 - DC voltage measurement

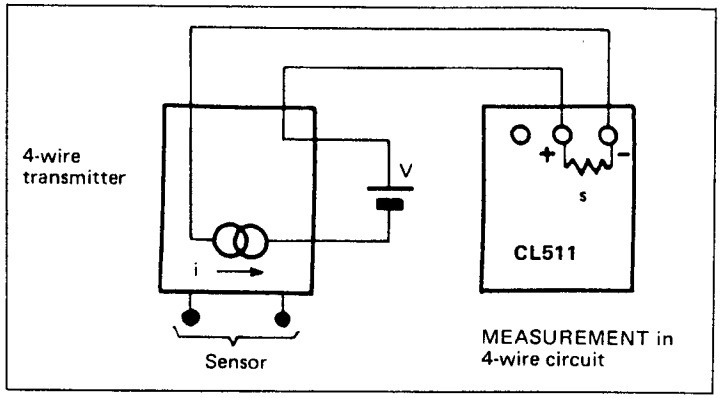
- Press **V** or **mV**.
  If the terminals are disconnected and the unit is set to autoranging (see para. 6.6.6.1), the display may alternate between **V**, **mV**, **V** etc.... This means it is searching for the correct range.
- Connect the leads to **+** and **-** terminals and to the voltage to be measured. When set to autoranging, the unit automatically selects the best range for the measurement.

6.6.2 - DC current measurement

- Press **mA**.
  The message **4 wire Tx ?** appears. You are now in a menu with two prompts : **4 wire Tx ?** or **2 wire Tx ?** (see below).
  To choose the latter prompt, select it with the ◊ key.
- In both cases, confirm the choice by pressing **ENT**.
- Connect the leads to **+** and **-** terminals and to the current loop.
  The ⏚ symbol coming on or off continuously indicates the type of circuit in use (see para. 9.3).

Four-wire circuit

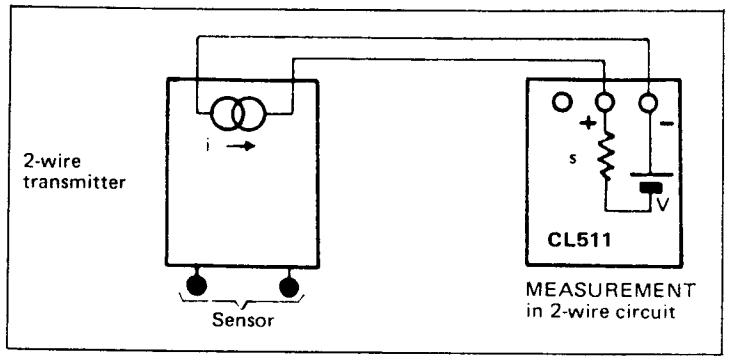
This is the usual arrangement when OMEGA CL511 is used as an ordinary milliammeter.
The current generator (i) in the transmitter is supplied by a voltage (V) in the transmitter or in the measurement loop.



The shunt **s** is used to measure the current in the loop.

2-wire circuit

When the OMEGA CL511 has been connected into the loop in 2-wire circuit, it provides a 24 V DC supply to the current generator (i) of the transmitter.



The shunt **s** is used to measure the current in the loop.

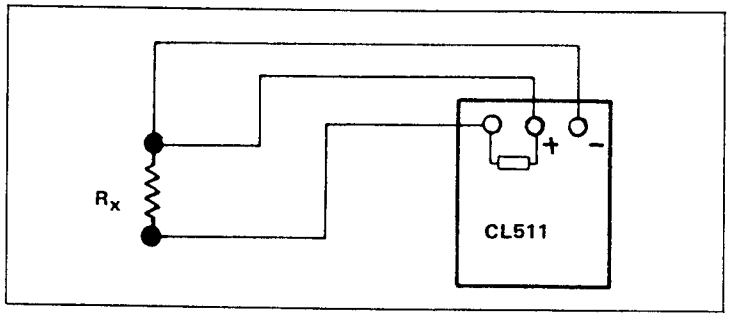
WARNING : When set for current measurement with 2-wire circuit, the CL511 displays the symbol ⎓ and the 24 V voltage remains at the terminals until one of the following operations is performed :
- the 4-wire configuration is confirmed,
- the measurement function is changed,
- an output program is executed (CL511D).

6.6.3 - Resistance measurement

- Press Ω.

- Connect the resistance to be measured as shown below in a balanced 3-wire circuit.

When the unit is set for autoranging, it always selects the best range for the measurement. When the terminals of the unit are not connected, the display will show **M > 600.0 Ω** or **M > 6000 Ω** depending on the range ; the **>** symbol is the overrange indicator.



6.6.4 - Temperature measurement with an RTD

This method of measurement involves measuring a resistance in a 3-wire circuit and then applying the Ω/°C conversion on the basis of the standard tables in order to display the temperature corresponding to the measured resistance, either in °C or in °F. The display permanently indicates the type of sensor used, Pt or Ni (see chapter 9).

- Press **Rt**.
  If the unit of measurement is not the one required, press **°C/°F**.

- If necessary, use the **RTD ?** program (**PROG** and **Rt** keys) as described in chapter 7 to check that the type of probe used (theoretical value at 0°C) is correct for the intended application. Modify this information if necessary.

- Connect the probe as indicated in para. 6.6.3, ensuring that the line resistances are balanced and are within the specified limits.

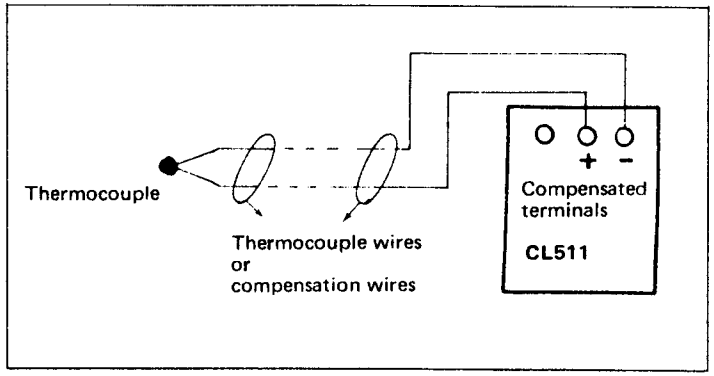
6.6.5 - Temperature measurement with a thermocouple

The unit measures the voltage supplied by the thermocouple, corrects the reading if necessary to take account of the temperature of the reference junction, then performs the mV/°C conversion on the basis of the standard tables before displaying the corresponding temperature either in °C or °F. The display permanently indicates the type of the thermocouple used and if the internal reference junction is in use (see chapter 9).

- Press **Tc**.
  If the unit of measurement is not the one required, press **°C/°F**.

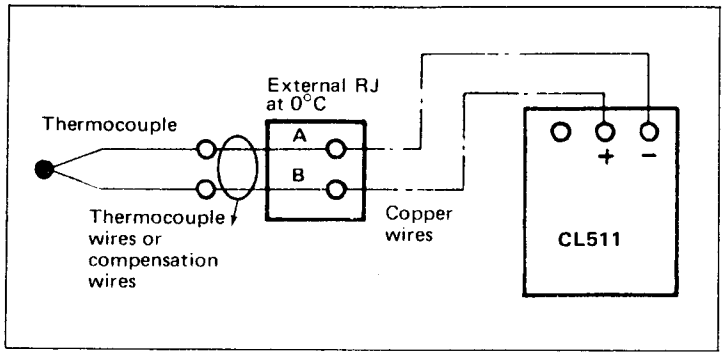
- Make the following connections :

Case 1 : Thermocouple connected directly to the unit



The internal reference junction of the unit should be used for compensation. The symbol **c** appears to the right on the display.

Case 2 : Thermocouple connected to an external reference junction assumed to be at 0°C



An external reference junction at 0°C should be used for compensation or the terminals **A** and **B** should be placed in room thermostatically controlled to 0°C.

- Check on the display (see chapter 9) that the type of thermocouple and the reference junction used are as required. If not, modify the information using the **Thermocouple ?** program (**PROG** and **Tc** keys) as described in chapter 7. Note that, for the thermocouple B, compensation by the internal reference junction is useless and not in use.

Note : When the unit has been subjected to a significant thermal shock, it is advisable to allow its temperature to stabilize for an hour so that the internal reference junction can be used with the specified accuracy.

6.6.6 - Operating modes in measurement

The four operating modes under MEASUREMENT can be identified by the following symbols on the display :

a	Autoranging. (blank for manual ranging).
n	Relative measurements.
. . .	Scaling. The unit is represented by . . . (no unit) or by the unit selected by programming from those available in the permanent memory of the unit.
	Triggered measurements :
H	- Holding position while awaiting triggering of the measurement.
T	- Triggering of a measurement or a series of measurements.

The positions of these symbols on the display are shown in the short operating mode.

When one of these operating modes is in use, another mode can be called for simultaneous use as indicated in the table below.

Mode in use / Mode called	Autoranging	Relative measure-ments	Scaling	Triggered measure-ment(s)
Autoranging	X	0	0	0
Relative measurements	0	X	1	0
Scaling	0	0	X	0
Triggered measure-ment(s)	0	1	1	X

0 = Simultaneous use not possible 1 = Simultaneous use possible

6.6.6.1 - Automatic or manual ranging

Only the mV, V, and Ω measurement functions can use this operating mode.

• To change to manual ranging :

- Press **AUTO**. The range remains the same or

- Press ⌂ or ⌄ to change to the higher or lower range respectively.

In all cases, if the message **M < ...** or **M > ...** appears, you must return to the range you just left (see chapter 9).

• To return to autoranging :

- Press **AUTO**. The unit switches automatically to the optimum measuring range. Autoranging is restored automatically, without the need to press the **AUTO** key, when one of the measurement function keys **mV**, **V**, or Ω is pressed.

6.6.6.2 - Relative measurements

In this operating mode, the unit uses the value of a measurement stored in memory as reference.

Let R be this reference.
For any measured value M, the reading will be : L = M - R.

All the measurement functions can use this feature.

• Starting the function :

- First measure the quantity to be used as a reference.
- Press **NUL**. The measured value at that instant is stored as a reference and the display indicates a zero value ; the symbol **n** appears. The unit locks on the stored measuring range.

• Return to normal measurement :

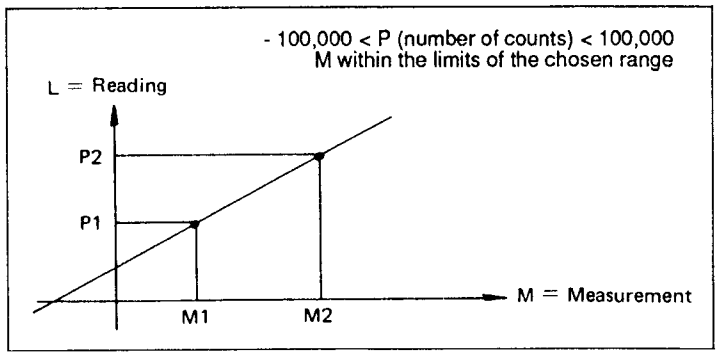
- Press **NUL** again. The reference value is removed from the memory. The display shows the normal measurement on the range in use. The same result is obtained by pressing one of the measurement function selection keys or after a manual or automatic ranging.
- If necessary, return to autoranging.

6.6.6.3 - Scaling

• Description of the operating mode :

The unit can display a reading P, expressed in the chosen quantity, according to the linear conversion law P = aM + b, where M is the measured value (see diagram below). The slope a and the constant b are computed by the unit on the basis of the co-ordinates of the two points P1, M1 and P2, M2 entered in the memory by means of the **Scaling ?** program (**PROG** and **CAL** keys) as described in chapter 7.

This operating mode can be used on all the measurement functions, **except temperature measurement**, since each range can have different conversion parameters and a different unit symbol selected from those available.



Example :

Assume a measurement of 4.00 mA (M1) to 20.00 mA (M2). We require a corresponding reading of 0 (P1) to 100 (P2), expressed, for example, in kW.

The 20 mA measuring range is chosen in the **Scaling ?** program.

The parameters entered in memory are :
P1 = 0.0 ; M1 = 4.0 ; P2 = 100.0 and M2 = 20.0.

The chosen unit is kW.

• Procedure :

- Using the **Scaling ?** program check if necessary that the parameters and unit stored for the function and the range to be used correspond to the required application.

- Select the measurement function and switch to the required range.

- Press **CAL**. The unit switches to (or remains in) manual ranging. The display conforms to the programmed conversion law.

- To exit from this operating mode, press **CAL** again.

The unit displays the measurement without scaling and in the unit of the measurement function used. The same result is obtained by pressing one of the measurement function selection keys or after a manual or automatic ranging.

- Return to autoranging if necessary.

List of symbols available in permanent memory

... (no unit)	(°F)	Hz
%	cmCE	kHz
bar	hPa	l/s
mbar	psi	m^3/h
(V)	cm/s	N
(mV)	m/s	daN
(mA)	tr/mn	kW
A	rpm	kVA
(°C)		

The symbols V, mV, mA, °C and °F already used outside the scaling are shown in brackets in scaling.

6.6.6.4 - Triggered measurement(s)

• Description of the operating mode :

Using the **TRIG** key on the keyboard, a measurement or a burst of 1 to 1,000 measurements at intervals of 0.5 s to almost one hour can be triggered at any moment.

All the measurement functions can use this operating mode.

The number of measurements N and time interval t between two measurements can be programmed and kept in permanent memory.

Taking the trigger command as the time origin, there are two possibilities :

- If N = 0 or 1 : every time **TRIG** is pressed one measurement will be triggered after a programmable time t.

- If $2 \leq N \leq 1{,}000$: every time **TRIG** is pressed one burst of N measurements will be triggered with an interval t between each measurement.

• Procedure :

Before performing any operation, it is useful to display parameters N and t currently in memory using the **Trig ?** program (**PROG** and **TRIG** keys) as described in chapter 7, so that they can be changed if necessary.

- With the unit in measurement mode, press **HOLD**. It switches to (or remains in) manual ranging and waits for measurements to be triggered, (symbol **H**).

- Press **TRIG**. The burst of measurement(s) is triggered (symbol **T**). For each measurement a beep sounds (if previously programmed). The last measurement remains on the display and the symbol **H** reappears (see para. 6.6.6).

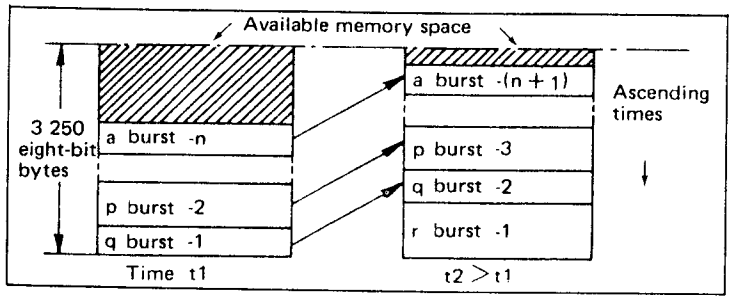
- To exit from this operating mode, after a cycle or during the course of a cycle, press **HOLD** again. The unit returns to measurement mode and free rate. The same result is obtained when pressing one of the measurement function selection keys, or after a manual or automatic ranging.

- If necessary return to autoranging.

6.7 - MEASUREMENT MEMORY (CL511D)

6.7.1 - Principle

The measurement memory or burst memory is a memory in which measurements performed in triggered mode are permanently stored (see para. 6.6.6.4) with the information relating to them : range, type of sensor, unit of measurement, etc... This memory can contain from 1 to 250 bursts.



A serial number is allocated to each burst.

Burst - 1 is the last recorded burst, the most recent one. The burst - n is the oldest burst. When a new burst is placed in memory, it becomes burst - 1, and all the others are shifted by one unit.

Since the memory is limited, the oldest burst (- n) can be "erased" by a new burst and can be lost if there is not sufficient memory space for it.

The diagram above shows two successive states of the content of the measurement memory (t2 to t1).

Number of bursts and/or measurements available :

The total number x of measurements contained in the y planned bursts should be such that the memory capacity of 3,250 eight-bit bytes is always sufficient :

$$3x + 10y \leq 3{,}250 \text{ where } y \leq 250$$

which works out between 250 bursts of one measurement and one burst of 1,000 measurements (leaving 240 eight-bit bytes available in this case for several bursts of a few measurements).

Note that the number of measurements may be different from one burst to another, if the relationship above is observed.

Each of the bursts stored in memory may be processed as follows :
- Simply displayed (see para. 6.7.3).
- Average, maximum and minimum values displayed (see para. 6.7.4).
- Output of measurements to RS 232 C interface for processing on a computer (see para. 6.10.3.1) or for printing on a printer (see para. 6.10.3.2).
- 4 to 20 mA or 0 to 1 V analog output (see para. 6.7.5).

The type of processing is selected using the **Meas. memory ?** program (**PROG** key followed by **HOLD** key) as described in chapter 7.

6.7.2 - Loading the measurement memory

The memory is loaded in triggered mode.
The operation and procedure are explained in para. 6.6.6.4.

The number of measurement N and the time interval t between two measurements can also be programmed using the **Trig ?** program (**PROG** key followed by **TRIG** key) as described in chapter 7, but with the option of an additional function :

- If N = 0 : Every keypress on **TRIG** triggers a measurement after the time t.
  The number of measurements in the burst is the same as the number of keypresses on **TRIG**.
  This is known as "notepad" method, where each measurement is written to memory manually in a single list (burst).

- If N ≥ 1 : Every keypress on **TRIG** opens a new list (burst) of N measurements.

6.7.3 - Recalling memory contents

If the prompt **Out:Display ?** of the **Meas. memory ?** program is chosen (**PROG** key followed by **HOLD** key) the selected burst and the corresponding measurements can be recalled to the display at anytime.

For each measurement recalled, the unit displays :
- the serial number of the measurement in the burst,
- its value,
- its unit of measurement and, for temperature measurements, the type of the sensor and, for thermocouples, whether or not the internal reference junction was used.

The first measurement displayed, **n° 000**, is the first of the burst. This is the oldest measurement and it is at the top of the list.

- To study the measurements of a burst, press ⇩ for the ascending way of times, or press ⇧ for the descending way of times as many times as there are measurements in the burst.

- To exit from the selected burst, press **CL**. This returns you to the options of the **Meas. memory ?** program (see chapter 7). To return to the initial state, simply confirm the **Exit ?** prompt which selects another burst by repeating the procedure (**PROG** key followed by **HOLD** key).

6.7.4 - Statistics on values in memory

In the prompt **Out:Stat. ?** in the **Meas. memory ?** program is chosen, the average, minimum or maximum value of the measurements of the selected burst can be displayed at anytime. The first value displayed is the average value.

- To display the minimum value, press , then ⇩ again to display the maximum value.

- Having studied the values, press **CL**. This returns you to the options of the **Meas. memory ?** program (see chapter 7). To return to the initial state, simply confirm the **Exit ?** prompt.

6.7.5 - Analog output

If the **Out:Analog.?** prompt in the **Meas. memory ?** program is selected (see chapter 7) the parameters to convert the measurements of the chosen burst into a proportional analog signal of 4 to 20 mA or 0 to 1 V can be selected for an analog recorder for example.
The analog signal is available at the terminals + and - of the unit.

The following information can be entered under the program :
- Choice of the 4 - 20 mA or 0 - 1 V analog signal.
  With 4 - 20 mA, the unit is regarded as a transmitter and can be programmed for 4-wire or 2-wire circuit.
- Choice of the minimum value of measurements of the chosen burst to obtain 4 mA or 0 V respectively at the analog output.
- Choice of the maximum value to obtain 20 mA or 1 V.
  The default minimum and maximum values are those displayed at **Out:Stat. ?** (see para. 6.7.4). **If other values are requested, they must be expressed in terms of the same range.**
- Choice of the time interval between the output of two consecutive measurements.
- Choice of the number of cycle(s) to output the measurements of the chosen burst.

After this information, the prompt **Exit ?** appears. At this point, you can :
- ask for the measurements to be output again, pressing ▽ ,
- return to the prompts of the **Meas. memory ?** program by pressing **CL**,
- return to measurement by pressing **ENT**.

Note : The electrical characteristics of the analog output are those of the 20 mA and 2,000 mV emission ranges.

6.7.6 - RS 232 C output (CL511D)

The method for transferring the contents of the measurement memories to a computer or a printer are explained in para. 6.10 - Using the RS 232 C interface.

6.8 - USE IN EMISSION/SIMULATION MODE

When used as a calibrator, the OMEGA CL511 is capable of emitting the electrical quantities and to simulate the physical quantities, same as those that it can measure.

Manual or automatic ranging is available on the same functions (mV, V and Ω) ; this makes it possible to emit or simulate a quantity with the best possible accuracy.
The scaling function can also be used. In certain cases, this makes it possible to enter the value of the physical quantity directly on the keyboard without having to perform the conversion computations in each case.

There are several possibilities for varying the emitted or simulated value :
- Use the number keys to enter a new value (see 6.8.1).
- Step the emitted or simulated value (see 6.8.7.4).
- Cause the value to increase or decrease in a linear continuous value (ramp) over one or several cycles according to the programmed parameters (see 6.8.7.5).

• To store a series of values in memory, either from the keyboard or automatically by **remote loading** (CL511D), and then to emit them or simulate them one by one by recalling the corresponding memories via the keyboard or automatically at regular time intervals by running the **synthesizer** program.

WARNING : After the unit has been switched on or initialized by pressing ON, there will be no signal at terminals of the unit unless a value has been entered on the keyboard in emission/simulation or execution of an output program has been confirmed (CL511D).
On the other hand, the signal generated remains present at the terminals of the unit until one of the above actions is repeated, until a measurement function is chosen or the unit is re-initialized.

⚠ **WARNING : Do not exceed 10 V DC or AC peak on terminals.**

6.8.1 - How to enter or change a numerical value

In the emission/simulation and program modes, the unit sometimes asks for a numerical value to be entered.

When the blinking cursor ▒ appears at the left of the display, enter the number on the keyboard using the 0 to 9 keys and the decimal point key, starting with the most significant digit. The cursor moves one character to the right for every digit entered.

NOTE :

The decimal point (•) can be placed anywhere provided it is preceded by at least one digit, in particular when the number entered is between - 1 and + 1.

If the decimal point (•) is entered as the first character, the unit switches to scaling which is the second function of the key. You should therefore enter 0.4 and not .4, for example.

Only the first decimal point (•) is observed.

If no decimal point (•) is entered, it is automatically placed after the last digit entered before the entry is confirmed ; the following digits become 0 by default.

- If the number is entered incorrect, delete it with **CL**. The cursor returns to the left. Start entering the number again.

- If the entered number on the display is acceptable, press **ENT**. The cursor disappears and the number has been confirmed.

- If the number to be confirmed is outside the specified limits, the message **Overrange** appears for about 0.5 s together with a beep. After this time, the cursor reappears and another number can be entered.

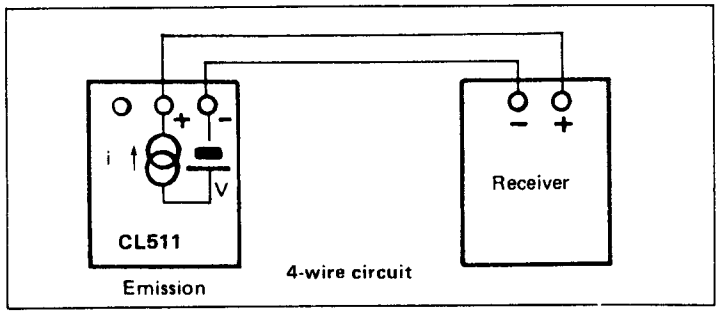
6.8.2 - Emission of a DC voltage

- Press **EMIS** then **V** or **mV**
- Enter the value on the keyboard observing the specified limits (see 6.8.1).
- Confirm the value by pressing **ENT**. The corresponding value appears at the terminals of the unit.
- Connect the leads to terminals **+** and **-** and to the external equipment.

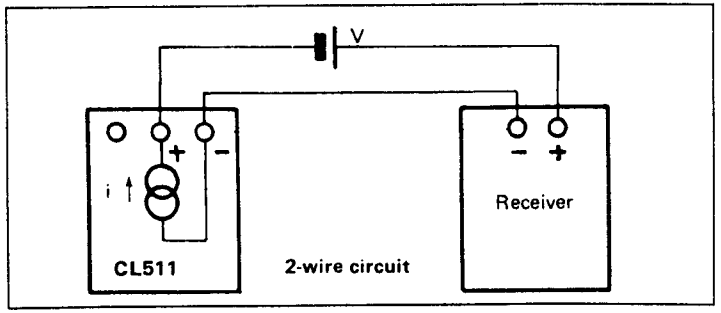
Note : With autoranging, when **ENT** is pressed, the unit goes to the range that gives the optimum display resolution (better accuracy of the emitted signal).

6.8.3 - Emission of a DC current

As in current measurement, the unit goes to a menu with two prompts : **4 wire Tx ?** or **2 wire Tx ?.** These correspond to the diagrams below :



In a 4-wire circuit, the OMEGA CL511 operates as a 4-wire transmitter, it has a 24 V DC voltage source in series with its current generator ; this enables it to accept a load resistance of up to 900 Ω.
To confirm this configuration, press **ENT**, the symbol ⏚ appears on the display.



In a 2-wire circuit, the current generator of the CL511 must be supplied by an external voltage source between 10 and 24 V DC located in the measurement loop or in the receiver. The resistance of the maximum permissible load is a function of this voltage value (200 Ω for 10 V, 900 Ω for 24 V).
Selecting the 4-wire or 2-wire circuit is made according to the procedure used in measurement mode (see para. 6.6.2).

- Enter on the keyboard the value of the current to be emitted (see para. 6.8.1).
- Confirm by pressing **ENT**.
- Connect the current loop to terminals + and - of the unit.
  The symbol ⏚ coming on or off continuously indicates the type of circuit in use (see para. 9.3).

6.8.4 - Simulation of a resistance

When a current i flows through the unit (grey and red terminals), confirmation of a resistance R programmed on the keyboard causes a potential difference V at the terminals, such that V = Ri.

- Press **EMIS** and Ω.
- Enter on the keyboard the value of the resistance to be simulated within the specified limits (see para. 6.8.1).
- Confirm by pressing **ENT**. The simulated value of the resistance programmed is available at the terminals.
- Make the connection to the grey and red terminals of the unit, 2-, 3- or 4-wire circuit may be used.

WARNING : The external current must enter via the grey terminal of the unit and must be within the specified limits.

6.8.5 - Simulation of an RTD

Depending on the temperature programmed via the keyboard, the unit applies a conversion on the basis of the standard tables, then simulates at its terminals the corresponding resistance value (see para. 6.8.4).

- Check by means of the program **RTD ?** (**PROG** and **Rt** keys) as described in chapter 7, that the type of sensor Pt or Ni and its theoretical value at 0°C are correct for the intended application. Modify this information if necessary.

- Press **EMIS**, then **Rt**.
- Enter on the keyboard the value of the temperature to be simulated within the specified limits and for the sensor used. The temperature unit °C or °F was previously chosen during measurement (see para. 6.6.4). To change it, return to the measurement function.
- Confirm by pressing **ENT**. The simulated resistance value corresponding to the temperature programmed is available at the terminals.
- Make the connection to the grey and red terminals of the unit, 2-, 3- or 4-wire circuits may be used.

WARNING : The external current must enter via the grey terminal of the unit and must be within the specified limits.

6.8.6 - Simulation of a thermocouple

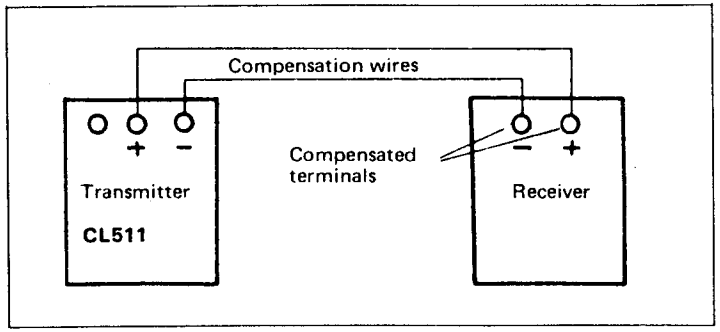
For a given type of thermocouple, the temperature programmed is converted into voltage on the basis of the standard tables. This voltage, which is available at terminals of the unit, is corrected to take account of the chosen reference junction temperature.

- Press **EMIS**, then **Tc**.
- Check on the display that the type of thermocouple and location of the reference junction are correct for the intended use (see chapter 9). To modify this information, enter and confirm a value (see para. 6.8.1), then use the program **Thermocouple ?** (**PROG** and **Tc** keys) as described in chapter 7.

WARNING : The modified information does not apply until the next time the function is called or the next value confirmed in the function.

- Enter on the keyboard the value of the temperature to be simulated within the specified limits for the thermocouple used (see para. 6.8.1). The unit of measurement °C or °F displayed is the unit chosen previously in measurement mode. To change it, return to measurement mode.
- Confirm by pressing **ENT**. The voltage corresponding to the chosen thermocouple for the programmed temperature is available at terminals of the unit.
- Connect the external equipment (receiver) in accordance with the program of the unit.

Case 1 : The receiver has input terminals which perform the function of a compensated reference junction



The OMEGA CL511 must be programmed for internal reference junction.

Case 2 : The receiver has no compensation of its input terminals (reference junction assumed to be at 0°C)

The connection wires must be of copper. The OMEGA CL511 must be programmed for an external reference junction.

6.8.7 - Operating modes in emission/simulation

When they are in service, the four operating modes in emission/simulation are indicated on the display by the following symbols :

a	Autoranging.
...	Scaling with unit symbol displayed or . . . indicating that there is no unit.
⌐	Stepping of the value emitted or simulated.
/	Ramp generation.

The position of these symbols on the display is shown in the short operating mode.

Only the scaling and step modes can be used simultaneously.

The unit switches automatically to manual ranging when one of the three other operating modes is called.

6.8.7.1 - Automatic or manual ranging

As in measurement mode, the mV, V and Ω functions are the only functions that use this operating mode. In emission/simulation mode, autoranging is the default setting ; it results in better accuracy of the emitted signal.

• To change to manual ranging :

- Having emitted or simulated a quantity (see para. 6.8.1 and 6.8.4) with autoranging, press ⇩ or ⇧ to switch to the lower or higher range.

• To return to autoranging :

- Press **EMIS** then call the desired function by pressing the corresponding **mV**, **V** or **Ω** key.
- Enter on the keyboard the value to be emitted or simulated (see para. 6.8.1).

Note : The* AUTO *key cannot be used in the same way as in measurement mode since, in emission/simulation mode it is treated as a number key giving digit 2.

6.8.7.2 - Scaling

• Description of the operating mode

The unit allows you to enter a value P expressed in the quantity chosen and according to the conversion law E = cP + d, where E is the value emitted or simulated. This operating mode, which is identical to that available in measurement (see para. 6.6.6.3) can be used in all the emission/simulation functions **except temperature simulation**. Each range may have different conversion parameters and different units chosen from those available.

The parameters are entered using the **Scaling ?** program (**PROG** then **CAL** keys) as described in chapter 7.

Example :

Assume a reading from 0.00 (P1) to 100.00 (P2) in kW.
We require to emit the corresponding values for 4 mA and 20 mA.
The 20 mA emission range is chosen in the **Scaling ?** program.

The parameters in memory are :
P1 = 0.00 E1 = 4.0000.
P2 = 100.00 E2 = 20.0000.
The unit is kW.

• Procedure

- Ensure that the parameters and unit in memory for the function and range to be used are correct for the required application.
- Select the required function and range.
- Press **CAL**. The symbol for the chosen unit appears.
- Enter the desired value on the keyboard. After confirmation by **ENT**, the quantity, meeting the conversion law programmed, is available at terminals of the unit.
- To exit from this operating mode, press **CAL** again. The unit symbol is replaced by the symbol for the function used.
- If necessary, return to autoranging.

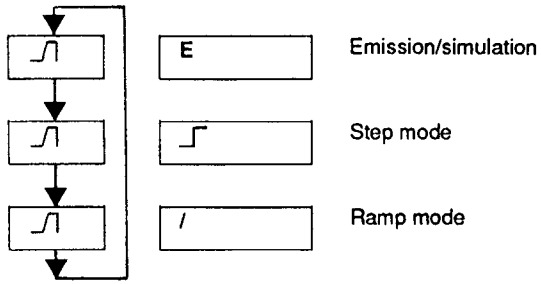
6.8.7.3 - Using the keys for step and ramp modes

In these two operating modes the following keys are used :

⎍	To call the required operating mode or return to normal mode.
⇧ or ⇩	To generate a positive or negative step or a ramp.

Starting from emission/simulation without using one of these two keys (symbol **E** on display) you can call each of these modes and return to the initial state on a rotational selection by repeatedly pressing the ⎍ key.

Symbols :



The fact that one of these two operating modes may have been called does not affect in any way the option to choose an emission/simulation function and a range and to enter on the keyboard all the required values in the specified units.

6.8.7.4 - Value stepping

In all the emission/simulation functions, a value that has been emitted or simulated can be stepped positively or negatively. The value of the step is programmable.

- Check by using the **Steps ?** program (**PROG** and ⇩ keys) as described in chapter 7 that the value of the step **expressed in number of count(s)** corresponds to the required application. Change the value if necessary.
- After a quantity has been emitted or simulated (see paras. 6.8.2 to 6.8.6), press ⎍⎍. The symbol ⎍ appears at the left of the display.
- To generate a positive step, press ⇧ .
- To generate a negative step, press ⇩ .

  A prolonged pressing of one of both keys enables continuous generation of steps (10 per second).

  In both cases, the unit switches to (or remains in) manual ranging and the new value emitted or simulated is available at the terminals of the unit.

- If necessary, continue positive or negative stepping by successive or continuous pressing of ⇧ or ⇩ keys until the range limits are reached.
- Change to another emission/simulation function if required. Stepping is still available (the symbol ⎍ is still at the left of the display).
- To return to emission/simulation without stepping, press ⎍⎍ twice.

6.8.7.5 - Ramp generation

In all the emission/simulation functions, **a ramp can only be generated if it has been programmed for the same function.**

- Emit or simulate a value **in the function** to be used (see paras. 6.8.2 to 6.8.6).
- Using the **Ramps ?** program (**PROG** and ⎍⎍ keys) as described in chapter 7, check that the ramp parameters and in particular **the function** are correct for the intended application. Change them if necessary.
- To call the ramp mode, press ⎍⎍ twice. The symbol / appears at the left of the display.
- To generate the ramp(s), press either of the key ⇧ or ⇩ . The ramp is emitted at the terminals of the unit.
- To stop generation of ramp, press **CL**. A new pressing on ⇩ or ⇧ triggers a new ramp from its origin.
- To return to emission/simulation, press ⎍⎍.

6.9 - EMISSION/SIMULATION MEMORIES

The emission/simulation memories are identified by an address from 0 to 9 (from 00 to 99 for CL511D).

All the values within the limits specified for the functions concerned can be stored in memory whatever the function. The function, symbol and value entered are stored at each address. The other information (type of sensor used, transmitter circuit, etc ...) are as programmed elsewhere.

Two memories with consecutive addresses may relate to different functions (thermocouple in °C, mA, mV, quantity in scaling, etc...)

When these memories are recalled, **the emission/simulation cannot take place unless the function stored is the same as the function that was being used before the call.**

The memories can be recalled manually, address by address, and automatically for the OMEGA CL511D by using the **Synthesizer ?** program (see 6.9.4).

6.9.1 - Manual storing of a quantity

- Select the desired function (see paras. 6.8.2 to 6.8.6).
- Enter the value to be stored (para. 6.8.1) **without validating the emission by pressing ENT** ; the cursor can still be seen on the display.
- Press **MEM**.
- Enter the memory address using the number keys from 0 to 9 or from 00 to 99 for CL511D.
- Confirm storage of the indicated address by pressing **ENT**. The value stored and the cursor can still be seen on the display.

At this point, there are two possibilities :

1 - Store, in the same function, a different value at another address. For this, enter the new value on the keyboard and proceed as described above ; there is no need to press **CL** first.

2 - Store the same quantity at another address. For this, press **MEM** and proceed in the same way as for the previous memory.

If you wish to emit or simulate the stored quantity, press **ENT**.

To store a quantity in another function, restart the procedure.

6.9.2 - Manual recall of the quantities stored

Proceed as follows :

- Emit or simulate a quantity (see paras. 6.8.2 to 6.8.6) or press **EMIS** only.
- Press **MEM**.
- Enter the address of the memory to be recalled using the number keys.
- Confirm the choice by pressing **ENT**. The content of the memory is displayed but the blinking cursor shows that the value displayed has not yet been emitted or simulated.

At this point, there are two possibilities :

1 - Recall another memory. For this, press **MEM** and proceed as above. The content of the memory is displayed only.

2 - Emit or simulate the content of the memory. For this, press **ENT**. The quantity is emitted or simulated.

Note 1 : If the quantity to be emitted is of a different type from that previously emitted, the content of the memory called is simply displayed for about one second and a beep signals that the functions are incompatible. After this time, the unit reads the quantity displayed before the call.

Note 2 : The current values stored in memory do not specify four-wire or two-wire circuit. At the first request for current emission, the unit displays **4 wire Tx ?**. If appropriate, press **ENT** to confirm or if **2 wire Tx ?** is required, press ◊ then **ENT** to confirm.

6.9.3 - Remote loading (automatic storing of quantities)

This possibility only exists for CL511D and makes use of the RS 232 C interface (see 6.10.4.4).

6.9.4 - Synthesizer (automatic recall of stored quantities)

This possibility only exists for CL511D.
The quantities must have been previously stored, either manually or automatically (see above) at the consecutive addresses that will be scanned.

Proceed as follows :

- Emit or simulate any value in the function and range chosen as described in paras. 6.8.2 to 6.8.6.
- Using the **Synthesizer ?** program (**PROG** and **MEM** keys) as described in chapter 7, check that the parameters are correct and in particular that all the memories to be recalled **are in fact in the function that was operating at emission.** If this condition is not satisfied, **Bad range** appears on the display.
- Start emission/simulation of the chosen memories by confirming the prompt **Execute ?** in the **Synthesizer ?** program.
- When the program has been executed, confirm the prompt **Exit ?** to return to emission/simulation or if you wish to start a new cycle, press ⌂ key and confirm the prompt **Execute ?**.

6.10 - USING THE RS 232 C INTERFACE (CL511D)

WARNING
Since the operating mode is a non-isolated RS 232 C, it is essential to insure that the measurement terminals of the unit are neither grounded nor connected to any voltage. Possible unit damage could occur if this happens.

The OMEGA CL511D uses the RS 232 C interface in two ways :

1 - In "Talk Only" mode : The unit only sends information to the equipment to which it is connected.

2 - In "Talk and Listen" mode : The units responds to the command sent by the equipment to which it is connected.

In both cases, the equipment uses a serial interface.

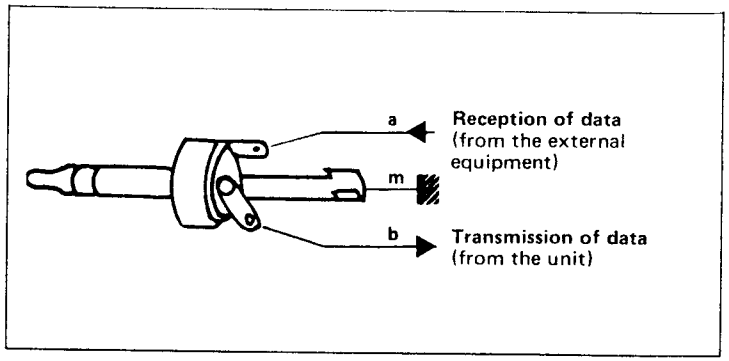
The format of the information messages is as follows :

Information	LF
1 to N ASCII characters	1 ASCII character

The LF character marks the end of the message.
The transmission format is programmable : 7 or 8 data bits and 1 or 2 stop bits.
There is a choice of odd, even or no parity.

6.10.1 - Connection

Connect the jack plug as shown below.



If the external equipment is a computer, type IBM PC or compatible, a, m and b correspond to pins 2, 7 and 3 respectively of the 25-pin connector of the computer.

6.10.2 - Programming the parameters of the RS 232 C interface

Before using the RS 232 C interface, it is advisable to check that parameters recorded (baud rate, character format, etc..) are correct for equipment being used. This is done with the **RS232 interface?** program (**PROG** key then **1**) described in chapter 7. Change the parameters if necessary.

6.10.3 - Operation in "Talk Only" mode

This operating mode involves the measurement memory.

When all connections have been made and the RS 232 C parameters are correctly set, run the **Meas. memory ?** program by pressing **PROG** then **HOLD**.

6.10.3.1 - Output of a burst of measurements to RS 232 C

- Select the burst to be processed (see chapter 7), then confirm the **Out:RS232 ?** prompt.
- Enter in decimal the "end of transmission" character that CL511D is to generate.
  The default value is 26 when programs are initialized.
- Confirm the **Execute ?** prompt. The list of measurements for the chosen burst is transmitted in the following format.

Header :	N = xxx	t = xx.x s	u = xxx	(CR,LF)
	Number of measurement(s)	Time between each measurement	Unit used	
	min = xx.x Minimum value	ave = xx.x Average value	max = xx.x Maximum value	(CR, LF)
Followed by :	xxx =	xx.x	(CR, LF)	
	Serial number of the measurement - - - - - - - - - - etc	Measured value		

All the measurements are arranged in one column. The number of the measurement at the top of the column (the oldest) is 000.
The "end of transmission" character is transmitted at the end of the list.

- When the complete list has been transmitted, the **Exit ?** prompt appears. Confirm to exit from **Meas. memory ?** program.

6.10.3.2 - Printing out of a burst of measurements

The differences between the printer port and the RS 232 C port have to do with the presentation format :
• Choice of number of measurements per line, this determines the number of columns.
• Choice of the timing between lines.
• 60 lines per page.
• No "end of transmission" character.

To start printing :
- Start the **Meas. memory ?** program by pressing **PROG** then **HOLD** and select the burst to be processed (see chapter 7) ; then confirm the **Out:Printer ?** prompt.
- Enter the number of measurements per line, then the timing between lines depending on the type of printer used.
- Confirm the **Execute ?** prompt. The list of measurements of the burst is transmitted to the printer.
- When the complete list has been transmitted, the **Exit ?** prompt appears. Confirm to exit from **Meas. memory ?** program.

6.10.4 - Operation in "Talk and Listen" mode

In this mode, the following programs can be run from a remote equipment :

• **Meas. memory ?**
• **Remote loading?**
• **Calibration ?**

To use the RS 232 C interface in dialog mode, this mode must be confirmed.
To do this, run the **RS232 interface?** and confirm the **Enabling ?** prompt.

WARNING :
Unless the system is reinitialized (by pressing the ON key), the RS 232 C link remains in this mode.
In that state, the battery consumption is significant and it is advisable to re-initialize the system after using this mode.

6.10.4.1 - Dialog commands

When programming, the only keys used to move among the various programs are **ENT**, **CL**, ⇩ and ⇧ , the number keys are used to enter numerical values.

The commands sent to the CL511D will therefore be :

ENT	For the **ENT** key.
CLR	For the **CL** key.
UP	For the ⇧ key.
DOWN	For the ⇩ key.
Digit, sign, decimal point	For the number keys.

The program access commands below must be added to the above commands which are used to select the CL511D programs accessible with the RS 232 C link :

MES:	For the **Meas. memory ?** program.
ETAL:	For the **Calibration ?** program.
MEM:	For the **Remote loading ?** program.

These three commands correspond respectively to the following keystrokes :

PROG, then **HOLD**, then **ENT**,
PROG, then **2**, then **ENT**,
PROG, then **7**, then **ENT**.

Every command sent to the CL511D must be followed by an LF. There is no need for numerical entries to be confirmed by the **ENT** key.

A group of commands can be sent together, provided that they are separated by commas. Note that program access commands include their own separator, a colon (:).

The commands may be entered in upper-case or lower-case ; blanks (spaces) are not significant.

Example : MES:UP,UP,ENT,ENT,DOWN,ENT (LF) causes the CL511D to transmit the average value of burst - 3.

When the CL511D has received a command or a group of commands it sends a NUL (00) to indicate that decoding has been performed.

6.10.4.2 - Using the Meas. memory ? program

This program works in just in the same way as when it is run from the CL511D keyboard (see chapter 7).

The command to access the program is **MES:** .

For each command sent, the unit displays the messages that appear in the table headed "Summary of programming procedures" in the middle of this manual and which are explained in chapter 9.

It also transmits this information or the requested lists of measurements in the format described above (see paras 6.10.3.1 and 6.10.3.2).

The disk supplied with the unit carries the processing software for performing these measurements on a computer (see para. 6.10.5).

6.10.4.3 - Using the remote loading ? program

The **Remote loading ?** program can only operate via the RS 232 C interface. It is used to automatically load one or more value(s) into emission/simulation memories using the processing software on the disk supplied with the device (see para. 6.10.5).

The **MEM:** command starts the program.

The CL511D returns and displays the message **Ready**.

The data are then sent to the unit in the following format :

xx = Memory address	xx.x Value to be stored	xxx Unit	(LF)

The following units are accepted : mV, V, mA, Ω or ohm, and °CTc or CTc, °FTc or FTc, °CRt or CRt, °FRt or FRt.

The CL511D then sends the information :

xx : OK Memory address	(CR, LF)	If the storage is correctly performed.

or

xx : ERR	(CR, LF)	If there is an error or incompatibility.

The 100 memories can be loaded in this way.

After remote loading, send the ^Z character (26) to indicate the "end of transmission".

The CL511D returns to the initial state.

6.10.4.4 - Using the Calibration ? program

This program is for maintenance purposes only.

Using the RS 232 C link, follow the procedure described in chapter 8.
To access the program, enter **ETAL:** command followed by commands identical to those described above.

6.10.5 - Processing software

The software is on 5-1/4" disk supplied with the CL511D.

It enables the user to exploit the potential of the RS 232 C interface described elsewhere in this manual, in particular :

- For measurement : Input and processing of bursts of measurements in array or graphics mode.
- For emission/simulation : creation of files of the values to be emitted or simulated and remote loading of these values into the unit memories.

The software runs on IBM PC or compatible (DOS 2 +).

OMEGA ENGINEERING, retaining title and ownership, grants to you a nonexclusive and untransferable right to use this software according to the terms, conditions and limited warranty contain in that license.

7 - PROGRAMMING

The programming function is used to enter and store a number of parameters in permanent memory and generally to handle the measurement and emission/simulation functions.

7.1 - USING THE KEYBOARD FOR PROGRAMMING

The following keys are used during programming procedures :

PROG	To call the programming function.
0 to 9	To enter figures of the numerical data.
.	When entering a decimal number.
±	To indicate the polarity.
ENT	To enter in the selected program or to confirm the programmed information.
CL	To delete an incorrect number before entering the correct one.
⇩ or ⇧	To scroll though the various programs and, within a program, through the various menu options.

All the other keys are inactive in programming mode, except those used to enter a given program.

7.2 - ACCESSING THE FUNCTION AND CHOOSING THE PROGRAM

The program menu is available when the initialization is complete, see para. 6.5.

- Press **PROG** to access the function.
- Select the required program by pressing the appropriate access keys, see table below. The table also sets the information that can be programmed for each of the 14 programs (10 basic programs + 4 for CL511D), as well as the initialization values of the programs (**Mem. lost** state).
- Confirm the choice of the program by pressing **ENT**. The default option of the first menu or the default value of the first parameter appears on the display. You can then modify these data or confirm them as described in para. 7.3.

Comments :

1 - When the **PROG** *key has been pressed, the* ☼ *key cannot be used to toggle the lighting on or off ; in this mode, it is used to program the timing of the lighting.*

2 - Any of the 14 programs of the program menu can also be selected by pressing **PROG** *followed by* ⇩ *or* ⇧ *until the name of the required program appears on the display. Although this method takes longer than pressing the direct access keys, it saves you have to refer to the table to check which function corresponds to which key.*

3 - You can exit from a procedure at any time by pressing the* INPUT *(MES), OUTPUT (EMIS) or* ON *key (for example, if you reach a "dead end"). Pressing one of these keys returns the unit to the measurement or emission/simulation or reinitializes it as the case may be. However, any modifications previously confirmed are still valid.

ACCESS KEYS AND PROGRAMS available after pressing PROG

Functions	Access keys	Programs	Programmable information (in permanent memory)	Initialization values
General use	6	**Edit. prog.?**	Plain display.	
	0	**Language ?**	Language used for display : English, German, Italian, Spanish, French.	English
	☼	**Lighting ?** (6.5.4)	Timing of display lighting.	t = 60.0 s.
Measurement and emission/ simulation	Rt	**RTD ?** (6.6.4 - 6.8.5)	Type of the RTD used (Pt or Ni) Theoretical value at 0°C	Pt 100 Ω
	Tc	**Thermocouple ?** (6.6.5 - 6.8.6)	Type of the thermocouple used Internal or external reference junction	Type = K Internal
	CAL	**Scaling ?** (6.6.6.3 - 6.8.7.2)	Display of the 1st count (P1) Measurement or emission for this count Display of the 2nd count (P2) Measurement or emission for this count Unit symbol	For all the ranges no scaling (conversion slope = 1). • • •
Measurement	TRIG	**Trig ?** (6.6.6.4)	Number of measurements of the burst Time between two consecutive measurements Beep on/off during the measurement	N = 1. t = 1.0 s. Off.

ACCESS KEYS AND PROGRAMS (CONTINUATION 1)

Functions	Access keys	Programs	Programmable information (in permanent memory)	Initialization values
Emission/ simulation	⇩ or ⇧	**Steps ?** (6.8.7.4)	Value of step (in number of display counts)	N = 1,000.
	⎍	**Ramps ?** (6.8.7.5)	Function used Value of 1st level Value of 2nd level Time of 1st level Time from 1st to 2nd level Time of 2nd level Time from 2nd to 1st level Number of cycle(s)	mV. 1 = 0.00. 2 = 2,000.00. t(1) = 1 s. t(1→2) = 1 s. t(2) = 1 s. t(1→2) = 1 s. N = 1.
Output (CL511D)	**MEM**	**Synthesizer ?** (6.9.4)	Memory start number Memory end number Time between two recalled memories Number of cycle(s) Beep on/off during call	Start mem: 0. End mem. : 9. t = 1.0 s. N = 1. off.
	HOLD	**Meas. memory ?** (6.7)	Plain display of quantity of bursts, content of bursts, etc ...	Memory empty.
			RS 232 C output : ASCII end-of-file character	End char. = 26.
			Printer output : Number of measurements per line Timing between lines	Meas./line = 1. t(CR) = 0 ms.

ACCESS KEYS AND PROGRAMS (CONTINUATION 2)

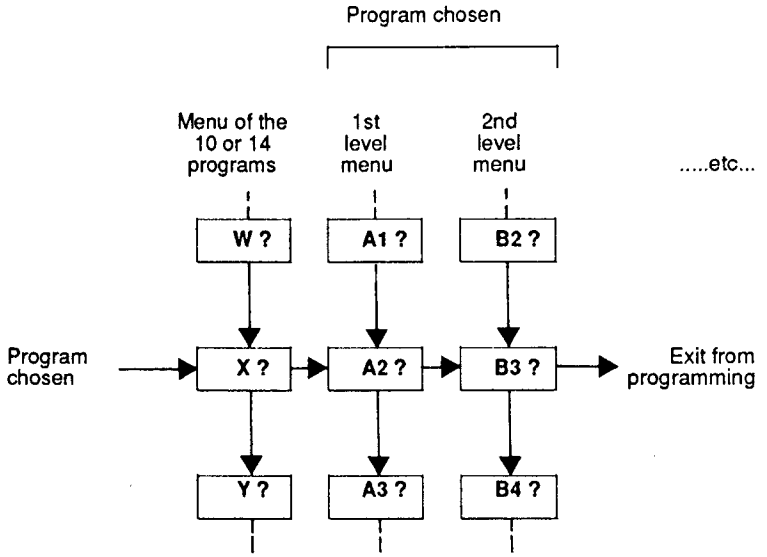
Functions	Access keys	Programs	Programmable information (in permanent memory)	Initialization values
Output (CL511D)	HOLD	**Meas. memory ?** (6.7)	Analog output : Value for 4 mA or 0 V Value for 20 mA or 1 V Time between two recalled measurements Number of cycle(s)	 I = (no meaning). h = (no meaning). t = 1.0 s. N = 1.
	7	**Remote loading?** (6.9.3 - 6.10.4.4)	No information to be programmed	
	1	**RS232 interface?** (6.10.2)	Transmission rate Binary "word" format Parity check Stop bit	9,600 bauds. 7 bits. Even parity. 1 stop bit.
Calibration	2	**Calibration ?**	Calibration coefficients entered at factory.	
	Warning : This program should only be used for maintenance. Any unconsidered uses may alter the performances of the unit.			

Measurement : 50 mA ; P1 = 0 ; M = 4 mA ; P2 = 100 ; M = 20.00 mA ; %.
Emission : 20 mA ; P1 = 0.00 ; M = 4.0000 mA ; P2 = 100.00 ; E = 20.0000 mA ; %.

7.3 - DISPLAY AND/OR MODIFICATION OF DATA

Each program (**X**) is made up of a succession of menus similar to the menu of the 10 or 14 available programs.

Each menu is made up of a succession of alphanumeric or numeric options (**A1 ?... An ?**).



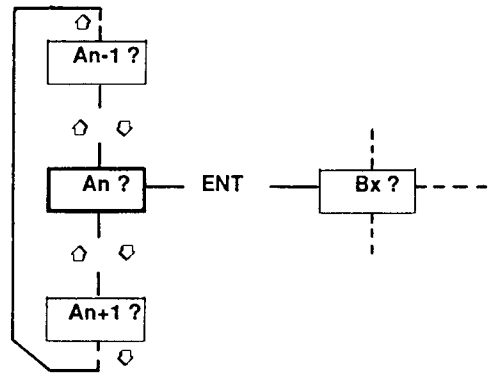
By following the general method explained in para. 6.4, and after having confirmed the chosen program (**X**), you can :

- either **display** the data currently in permanent memory (**A2**) then confirm them to move on to the option of the next menu (**B3**) for example and so on, until you exit from programming.

- or **change** the data in memory by selecting another option of the menu (replacing **A3** with **A2** for example) or by entering a new numerical value, followed by confirmation of the new data to move to the next menu and so on until you exit from programming.

In that manner and in the order shown schematically in the diagrams above, if **An ?** is a displayed option :

Rotational selection

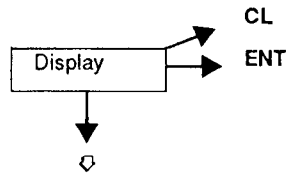


you can move through the program options using **only three keys** : , ⇧ and **ENT**.

Sometimes and when the program is ended, the key **CL** may also be used to return to first level menu.

7.4 - SUMMARY OF THE PROGRAMMING PROCEDURES

The diagram in the middle of this manual shows all the available menus, the messages that appear on the display and the flow direction you take when pressing ⇩ , **CL** or **ENT**.



Except in special cases, the direction of movement through the program menus and the 1st and 2nd level menus as a result of pressing the ⇧ key is not shown.

To use this diagram when programming, **refer to the pages in para. 9.4 headed "Meaning of displays"** which give all the necessary information.

8 - MAINTENANCE

In view of the necessary precautions and the risks involved, any maintenance operations, apart from those relating battery charging, should be left to qualified personnel.

This warning applies particularly to recalibration of the unit which should only be done under precise conditions.

8.1 - MAINTENANCE OF THE BATTERY

8.1.1 - Charging the battery

When **Low battery** appears on the display or when the battery protection switch has tripped (see 6.5.2), the battery should be recharged as soon as possible.

- **Make sure that all terminals of the unit are disconnected.** Plug the charger into the connector in the charger compartment of the carrying case (see 5.3.2).

- Connect the charger to the 120 V AC, making sure that the voltage is correct.

- Leave the battery on charge for approximately 14 to 16 hours. **The unit must not be used during this period.**

- When the time has elapsed, disconnect the charger.

8.1.2 - Storage

Even when not in use, the OMEGA CL511 holds any programmed information in RAM. This memory is constantly supplied by the battery and the information is maintained provided that the battery voltage does not fall below a value well below the voltage at which the battery protection switch trips.

The consumption of the RAM is negligible compared with the self-discharge current of the Ni-Cd batteries. In storage, a fully charged battery gradually loses its charge over 2 - 3 months depending on the storage temperature.

If it is important to preserve the programming information and the measurements in memory (CL511D), the batteries should therefore be recharged after every period of use and before storage. **Similarly, if the unit is to be stored for a long period, it is advisable to recharge the battery every two months.**

A fully discharged battery is completely restored after a normal charge (14 to 16 hours approx. or 24 hours if the unit has been stored several months with discharged battery). When the unit is first switched on, it will display **Mem. lost** and will be in the initialization configuration described in paras. 6.5.1 and 7.2.

Note : The calibration coefficients of the unit are not affected by the state of discharge of the battery thanks to the EEPROM memory.

8.2 - DISPLAY CONTRAST ADJUSTMENT

The contrast of the display is adjusted at the factory, but it can be modified if conditions require it.

- **Make sure all the terminals of the unit are disconnected.** Remove the unit from the carrying case by opening the fixing frame (see 5.3.2).

- Insert a screwdriver through the hole on the left-hand side of the unit and switch on the unit.

- Turn the adjustment potentiometer until the contrast of the display is satisfactory for the usual angle of vision.

- Switch off the unit before returning it to its carrying case.

8.3 - PERIODIC CHECKING OF CALIBRATION

The calibration has been checked at the factory before delivery.

The unit should **only** be recalibrated if one or more characteristics are **really outside** the specified tolerances.

8.4 - RECALIBRATION

8.4.1 - Principle

The correcting factors of each measurement and emission/simulation range are stored into the permanent memory (EEPROM) and automatically computed from a specific calibration program which is directly available either by the keyboard or the RS 232 C interface (CL511D).

For each range, the calibration is performed in two points :
- one point at zero (or close to zero),
- the other close to the max. measuring range.

According to the specified accuracies, procedures and precautions to take into account are quite different in emission/simulation and in measurement.

- **In emission/simulation :** Computation of the correcting factors is performed by comparison between the value of the signal displayed and the emitted value which is measured by means of a standard (voltmeter, ohmmeter, etc...) and entered using the keyboard of the unit or via the RS 232 C interface (CL511D).

- **In measurement :** The computation is performed by the unit which compares the value emitted or simulated and the value measured.
  This autocalibration which is performed automatically does not need measuring instruments.

8.4.2 - Measurement autocalibration

Generally, drift of performances in emission/simulation is lowest than the one observed in measurement.

If you take care to **check the accuracy of emission/simulation functions and to perform the required recalibrations** (see para. 8.4.3) **every year**, the measurement autocalibration can be performed several times in the year with no problems and specially, **each time a short term measurement accuracy, better than that specified, is requested** (see para. 2.3).

For that, proceed as follows :

- Press **PROG** key followed by **2** key to get in the calibration program.
- Confirm using **ENT**. The display indicates : **C:Meas.Autocal.?**

WARNING : To avoid any wrong measurements, the unit should be disconnected from any external circuit.

- Confirm using **ENT** . The display indicates **C:ADC precal.**

The unit starts the autocalibration phase and first precalibrates the analog to digital converter.

Then, each measurement range is displayed and **automatically** recalibrated. This phase takes about 3 minutes.

When autocalibration is completed, the display indicates : **C:Emission cal.?.**

- Press ⇩ to switch to the following prompt. The unit displays : **Exit ?**
- Confirm using **ENT**. The unit returns to measurement function.

8.4.3 - Emission/simulation autocalibration

This autocalibration can be performed if proved after checking the performances and provided that you have all the requested equipment at your disposal (see para. 8.3).

If not, return the unit to OMEGA ENGINEERING INC.

8.4.3.1 - Equipment required

The recalibration of emission/simulation functions must be performed in room with 23°C ± 1°C stable temperature and the following equipment at disposal :

- **For "voltage" and "current" functions :**
- A 2,000,000 counts - digital voltmeter, accuracy above 5.10^{-5}.
- A 10 Ω ± 10 % standard resistor known at 2.10^{-5}, temperature coefficient ≤ 20 ppm/°C.

• **For the "resistance" functions :**
- A 2,000,000 counts - digital ohmmeter, accuracy above 5.10^{-5}.
  Measuring current : 1 mA over 500 Ω range and 0.1 mA over 5,000 Ω range.

• **For the compensation of the internal reference junction :**
- A 0°C chamber regulated to ± 0.05°C.
- A standard thermocouple, type K plunged into this chamber.

WARNING : Recalibration should not be attempted if the above equipment is not available.

8.4.3.2 - Preliminary

Place the required equipment and the unit to be recalibrated in the regulated room **24 hours in advance**. The equipment should be switched on and **the unit should be set to OFF position**.

- Switch **ON** the unit for 2 hours before starting the procedure. The charger should be disconnected.

To recalibrate the unit using the RS 232 C interface (CL511D), refer to para. 6.10 to perform the required connections.

8.4.3.3 - Procedure

The complete procedure is shown in the diagram opposite.

As explained for programming procedures, press **ENT** key to confirm a prompt or press ◊ key to select another menu option.

To use this diagram, **also refer to para. 9.5 - "Meaning of the displays for recalibration"** which gives you all the needed information and operations to be performed.

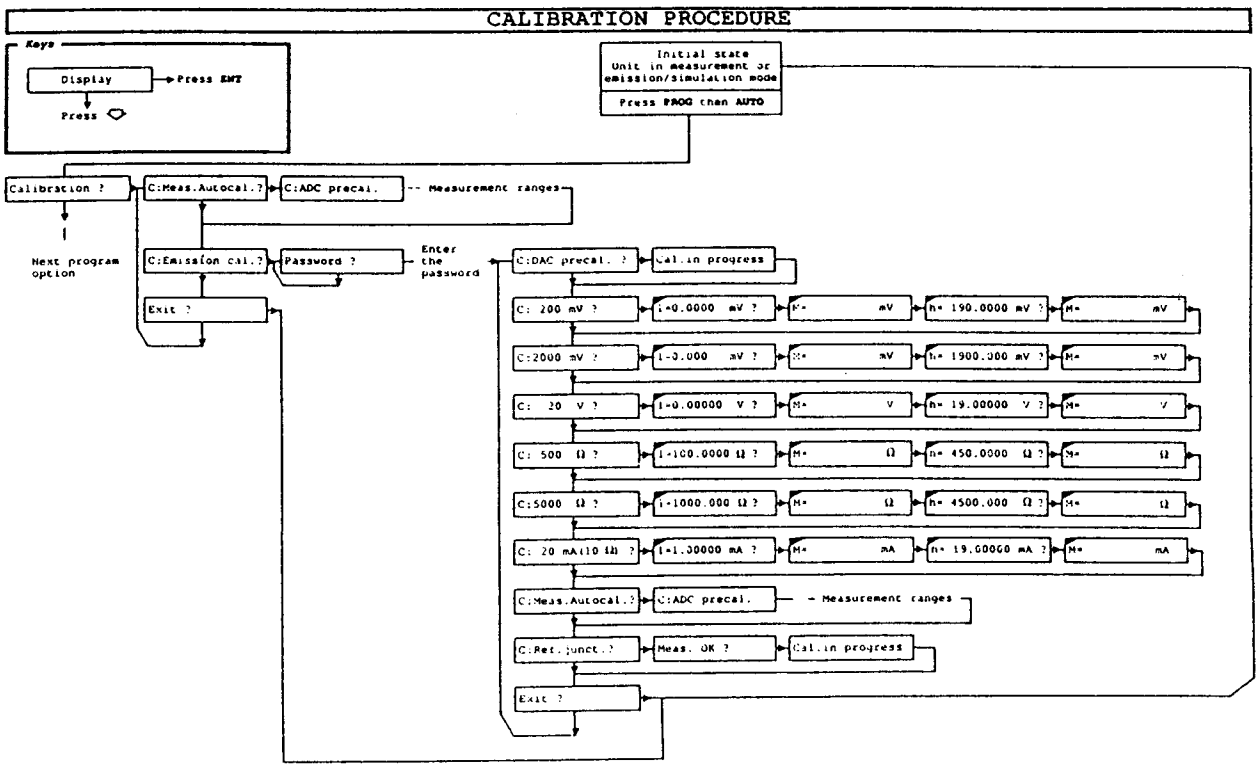
Note that you can only select the required range **but it is advisable to recalibrate the whole set of ranges by following the program order.**

Never recalibrate the reference junction alone. It must be strictly performed after an autocalibration.

When the recalibration of emission/simulation ranges is completed, the program asks for the measurement autocalibration, but as stated above, para. 8.4.2, it may be done later on.

The procedure concludes with the recalibration of the reference junction and the return to the initial state.

If the recalibration has been performed with the RS 232 C interface, never forget to reinitialize the unit by pressing the **ON** key, this avoiding a useless consumption of the battery (see para. 6.10.4).


CALIBRATION PROCEDURE
Keys
Display
Press ENT
Press
Initial state
Unit in measurement or emission/simulation mode
Press PROG then AUTO
Calibration ?
C:Meas.Autocal.?
C:ADC precal.
-- Measurement ranges
Next program option
C:Emission cal.?
Password ?
Enter the password
Exit ?
C:DAC precal. ?
Cal.in progress
C: 200 mV ?
i=0.0000 mV ?
M= mV
h= 190.0000 mV ?
C:2000 mV ?
i=0.000 mV ?
h= 1900.000 mV ?
C: 20 V ?
i=0.00000 V ?
h= 19.00000 V ?
C: 500 Ω ?
i=100.0000 Ω ?
h= 450.0000 Ω ?
C:5000 Ω ?
i=1000.000 Ω ?
h= 4500.000 Ω ?
C: 20 mA(10 Ω) ?
i=1.30000 mA ?
h= 19.60060 mA ?
C:Meas.Autocal.?
C:ADC precal.
- Measurement ranges
C:Ref.junct.?
Meas. OK ?
Cal.in progress
Exit ?

8.5 - OPENING THE UNIT

If you must open the unit, proceed as follows :

- **Disconnect the unit from any external circuit** and remove it from its casing by raising the fixing frame (see para. 5.3.2).

- Untighten the four screws at back of the casing.

- Set the unit to its operation position then remove the cover to the left.

  The boards are seen on the component sides with the logic board (CA 40915) at left and the analog board (CA 40920) at right.

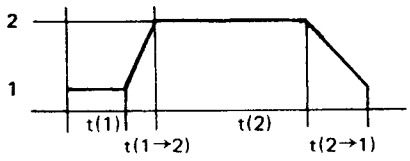
To reassemble the unit, perform steps in the reverse order.

9 - MEANING OF THE DISPLAYS

9.1 - General use	
Display	Meaning
Mem. lost for 0.5 s at switching on	Program initialization. The permanent memories no longer contain the information previously stored. (battery discharged). The calibration parameters are retained in EPROM.
Meas. function?	Specify the measurement function by pressing one of the keys **mV**, **V**, **mA**, **Tc**, **Rt** or Ω.
Emis. function ?	Specify which quantity is to be emitted or simulated by pressing one of the keys : **mV**, **V**, etc...
Program ?	Select a program from the 10 (or 14 for CL511D) programs available by pressing one of the access keys (see 7.2).
Low battery for 0.5 s every 6 seconds	**Recharge the battery** (see 8.1).
9.2 - Measurements	
M -------- a or **M --------**	Measurement with autoranging (a) or manual ranging.
M > -- or **M < --**	The measured value is outside the limits of the measuring range.
4 wire Tx ? or **2 wire Tx ?**	Select 4-wire circuit (see 6.6.2) or 2-wire circuit.
M -------- mA or **M -------- mA** ⏚	Measuring current of a 4-wire or 2-wire transmitter. In the latter case, the unit provides the transmitter current source with 24 V supply (⏚).
M xx.x °C Kc	Example of temperature measurement in °C by type K thermocouple with internal reference junction (c).
M xx.x °F K	As above but the unit is °F and the reference junction is external.

9.2 - Measurements (continued)	
M xx.x °C Pt	Example of a temperature measurement in °C with a platinum RTD.
M xx.x °F Ni	As above but with °F reading and Ni 100 RTD.
M -------- n	Relative measurements (n = NUL).
H --------	Holding a measurement (H = HOLD). The unit is ready to operate in triggered mode.
T --------	Measurements in triggered mode (T = TRIG).
t < 2.5 s for 0,5 s	With triggered temperature and resistance measurements, the time between two consecutive measurements (programmed time) should not be less than 2.5 seconds.
Memory empty	The measurement memory does not contain burst (CL511D).
M -------- ...	Measurement with scaling (no unit).

9.3 - Emission/simulation	
E ▒ →	Whenever the blinking cursor ▒ appears on the display, this means either that a number between the specified limits should be entered or that confirmation by **ENT** is required (see 6.8.1).
E xx.x	The entered value has been confirmed. It replaces the previous value that was present at the terminals of the unit (the cursor disappears).
⌐¬--------	The step mode is available.
/ --------	The ramp mode is available.
E -------- mA or **E -------- mA** ⏚	Simulation of a transmitter in a 2-wire circuit or in a 4-wire circuit (⏚ = 24 V supply from the internal current source is present).
E: mem n° ?	Enter the serial number of one of the 10 emission/simulation memories. (100 in CL511D).
Overrange	The number entered is outside the limits. It has not been confirmed.

9.4 - Programming		
It may be possible to modify the parameters whose programming limits are given below within these limits by means of the number keys (see 6.8.1).		
Display	Meaning	Programming limits
Steps ?	Programming of the step parameters.	
N = xxx ?	Value of the step as **number of counts**. Decimal numbers are not accepted. The sign is disregarded.	$0 \leq N \leq 200{,}000$.
Ramps ?	Programming of the ramp parameters.	The values of levels 1 and 2 may be positive or negative within the specified limits of ranges.
1 = xx.x u ?	**1** is the first level. If a new unit (**u**) is required : - enter value of level 1, then confirm with **ENT**, - choose the unit (function key), then confirm with **ENT**.	
4 wire Tx ? or **2 wire Rx ?**	In mA, the unit simulates a 4-wire transmitter or a 2-wire transmitter depending on the choice made before programming.	
2 = xx.x u ?	**2** is the second level. If a new value is required, enter it in terms of the unit displayed. *Example : 10,000 mV for 10 V.*  	

9.4 - Programming (continued)		
Display	Meaning	Programming limits
t(1) = xxx s ? **t(1→2) = xxx s ?** **t(2) = xxx s ?** **t(2→1) = xxx s ?**	For times, no decimals.	0 ≤ t(1) ≤ 3,480 s. 0 ≤ t(1→2) ≤ 9,999 s. 0 ≤ t(2) ≤ 3,480 s. 0 ≤ t(2→1) ≤ 9,999 s.
N = xxx ?	**N** is the whole number of ramp repetition cycles.	1 ≤ N ≤ 65,535.
Synthesizer ? (CL511D)	Programming of the parameters and execution of the output of the emission/simulation memories.	
Programming ?	Prompt to be confirmed if the parameters are to be displayed or modified.	
Execute ?	Prompt to be confirmed if the parameters are known and if output of the information is to be started.	
Exit ?	Prompt to be confirmed to exit from programming.	
Start mem: xxx ? **End mem. : xxx ?** **t = xx.x s ?**	**xxx** and **xxx** represent the serial numbers of the synthesizer cycle start memory and end memory. **t** is the time interval between calls to two memories with consecutive serial numbers.	00 ≤ xx < 99 (CL511D). 0.2 ≤ t ≤ 3,479.9 s.
N = xxx ?	**N** is the whole number of cycles. No decimals.	1 ≤ N ≤ 65,535.

9.4 - Programming (continued)		
Display	Meaning	Programming limits
Beep on ? **Beep off ?**	A beep will or will not sound after each automatic recall of a memory depending on which of these prompts is chosen.	
Bad range	For one or more of the memories chosen, the functions are not compatible.	
Meas. memory ? (CL511D)	Programming of the parameters and output of the contents of the measurement memory.	
Burst Qt = xxx or **Memory empty**	The quantity of bursts stored in memory is displayed for 0.5 s or no burst in memory.	
Burst - 1 ? . . . . **Burst - n ?**	If the prompt is confirmed, the most recent burst is processed. A previous burst is selected by repeatedly pressing the ⌂ key or by entering a negative number on the keyboard.	- n depending on quantity of bursts stored.
N = xxx , u	Plain display. **N** is the whole number of measurements in the selected burst. **u** is the unit of the measurement and for temperature measurement the type of the sensor.	
Out:Display ? **Out:Stat. ?** **Out:RS232 ?**	Confirm the choice of the output { Display of measurements. / Statistics. / For use with an external equipment.	

9.4 - Programming (continued)		
Display	Meaning	Programming limits
Out:Printer ? **Out:Analog ?**	Confirm the choice of the output { For use with printer. { For use with analog output.	
Exit ?	If confirmed, exit from program and return to initial state.	
000 = xx.x u . . . . **nnn = xx.x u**	List of measurements in the selected burst. **000** is the serial number of the 1st measurement in the list (the oldest). **xx.x** is the value of the measurement and **u** the unit of the measurement with, for temperature measurement the type of sensor. **nnn** is the last measurement in the list, i.e., the most recent. (nnn = Number of measurements - 1).	
Ave = xx.x u **Min = xx.x u** **Max = xx.x u**	Average value of the measurements in the burst. Minimum value of the measurements in the burst. Maximum value of the measurements in the burst.	
End char. = xxx?	Decimal ASCII value of the end of transmission character for the computer used (see the computer manual).	$0 \leq$ End char. ≤ 127.
Meas./line = xx ?	Number of measurements per line which defines page-setting on the printer paper.	$1 \leq$ Meas./line ≤ 10.
t(CR) = xxx ms ?	Timing before transmission to the printer of the characters of a new line (see printer manual).	$0 \leq t(CR) \leq 9{,}999$ ms.
4-20 mA ? **0-1 V?**	4 - 20 mA or 0 - 1 V analog output signal.	

9.4 - Programming (continued)		
Display	Meaning	Programming limits
4 wire Tx ? **2 wire Tx ?**	The current source available with analog output should simulate a 4 wire or 2 wire transmitter (see 6.8.3).	
I = xx.x u ? **h = xx.x u ?**	The value **I** displayed is the minimum value of the burst ; the value **h** is the maximum value. The reading will be 4 mA or 0 V for the value I and 20 mA or 1 V for the value h. I and/or h can be fixed at the desired value **provided that the decimal point is left at the same place** (same range).	h - I ≥ 245 display counts.
Error	The difference h - I is less than 245 display counts for these values.	
t = xx.x s ?	Time interval between recall of two consecutive measurements.	0.2 ≤ t < 3,479.9 s.
N = xxx ?	Whole number of cycle(s) to be performed.	1 ≤ N ≤ 65,535.
Execute ?	Prompt to be confirmed to output data.	
Exit ?	Prompt to be confirmed to exit from program and return to initial state.	
Remote loading ? (CL511D)	Program for loading emission/simulation memories from a computer.	
Ready	Remote loading can begin.	

9.4 - Programming (continued)		
Display	Meaning	Programming limits
RS232 interface? (CL511D)	Programming the parameters of the RS 232 interface.	
Enabling ?	Confirm the prompt to activate the RS 232 C output.	
Programming ?	Confirm the prompt to display or modify the parameters.	
9 600 bauds ? . . . . **300 bauds ?**	The data transmission rate on the RS 232 C line is from 9,600 bauds to 300 bauds. It must be compatible with the computer or printer used.	
8 bits ? **7 bits ?**	The binary information is in "words" of 8 bits or 7 bits.	
No parity ? **Even parity ?** **Odd parity ?**	Parity check.	
1 stop bit ? **2 stop bits ?**	The character includes one or two stop bits.	
Edit. prog.?	Display the edition of the program.	
Edit. prog.: xxx	The edition of the program is displayed for two seconds, followed by return to initial state.	

9.4 - Programming (continued)		
Display	Meaning	Programming limits
Language ? **English ?** . . . . **-------- ?**	Program the language used for display. Messages are displayed in one of the five available languages.	
Lighting ? **t = xx.x s ?**	Programming of the timing of the lighting. The display lighting goes out at a time **t** after activation.	 $0.5 \leq t \leq 300.0$ s.
Thermocouple ? **Type K ?** . . . . **Type C ?** **Ref.junct.:int.?** **Ref.junct.:ext.?**	Programming the thermocouple parameters (common to both measurement **and** simulation functions). The thermocouple used is type K, ... T, TD, J, JD, N, E, R, S, B ... or C. Measurement **and** simulation are performed with the internal reference junction of the unit or an external reference junction, except type B (see 6.6.5 and 6.8.6).	

9.4 - Programming (continued)		
Display	Meaning	Programming limits
RTD ?	Programming the RTD parameters (common to both measurement **and** simulation functions).	
Platinum ? **Nickel ?**	Choice of Platinum or Nickel RTD.	
R0= 100 Ω ? . . . . **R0=1000 Ω?**	The theoretical resistance of RTD at 0°C is 100 Ω, ... (200 Ω, 500 Ω) or 1,000 Ω.	
Scaling ?	Programming the scaling parameters for measurement or emission-simulation.	
M: 50 mV ? . . . . **M: 50 mA ?**	Measurement **M** under scaling is performed on 50 mV, ... 500 mV, 5 V, 50 V, 500 Ω, 5,000 Ω ... or 50 mA.	
E: 200 mV ? . . . . **E: 20 mA ?**	The emission-simulation **E** under scaling is performed on 200 mV, 2,000 mV, 20 V, 500 Ω, 5,000 Ω ... or 20 mA.	
P1 = xx.x ? **M = xx.x ?** **P2 = xx.x ?** **M = xx.x ?**	**P1** is the **quantity displayed** when the measurement **M** assumes the value **xx.x**. **P2** is the **quantity displayed** when the measurement **M** assumes the value **xx.x**.	- 99,999 ≤ P (No of counts) ≤ 99,999. M within the limits of the chosen range.

9.4 - Programming (continued)		
Display	Meaning	Programming limits
P1 = xx.x ? **E = xx.x ?** **P2 = xx.x ?** **E = xx.x ?**	**P1** is the **quantity displayed** when the emission **E** assumes the value **xx.x**. **P2** is the **quantity displayed** when the output **E** assumes the value **xx.x**.	- 999,999 ≤ P (No of counts) ≤ 999,999. For P1 and P2 the decimal point is in the same position. E is within the limits of the chosen range.
...?	Choose the unit symbol from those offered.	
Cal. error for 0.5 s	The conversion slope **a** has exceeded the limits. Since the parameters are expressed in numbers of counts displayed, the requirements are : For measurement : a < 72. For emission : a > .00025	
Trig ?	Programming of the parameters for operation in triggered mode.	
N = xxx ?	**N** is the number of measurements in the burst.	0 ≤ N ≤ 1,000.
t = xx.x s ?	**t** is the time between two consecutive measurements. Program 2.5 s ≤ t for triggered measurements of resistances or of temperatures by RTD or by thermocouples with internal reference junction.	0.5 ≤ t ≤ 3,479.9 s.
Beep on ? **Beep off ?**	A beep will or will not sound for each measurement of the burst depending on which of these prompts is chosen.	

9.5 - Recalibration	
Display	Meaning
C:Meas.Autocal.?	Confirm for autocalibration of the measurement functions. **Warning : Make sure the terminals of the unit are disconnected.**
C:Emission cal.?	Confirm to recalibrate the emission/simulation functions.
Exit ?	Confirm to return to measurement function.
C:ADC precal	Precalibration of the analog/digital converter. In measurement autocalibration mode, each measurement range appears consecutively on the display when that range is being recalibrated.
Password ?	The password to be entered on the keyboard is **9456**. Only this value is acknowledged.
C:DAC precal. ?	Precalibration of the digital/analog converter.
Cal.in progress	Waiting phase. Calibration is in progress.
C: 200 mV ?	Calibration of the 200 mV range. Connect the standard voltmeter to the red terminal (+) and black (-) of the unit. Wait 2 min for the unit to stabilize.
l = 0.0000 mV ? **M = ▒ mV**	Default value in emission mode for the low point of the 200 mV range. Another value may be entered. Wait for the reading on the standard voltage. Enter the reading via the keyboard.
h = 190.0000 mV ? **M = ▒ mV**	Default value in emission mode for the high point of the 200 mV range. Another value may be entered. As above.
Cal. error	The values entered are not plausible. The previous coefficients remain in memory.
C: 2000mV ?	Confirm for calibration of the 2,000 mV range. Standard voltmeter connected to terminals of the unit.
l = 0.000 mV ? **M = ▒ mV**	Default value in emission mode for the low point of the 2,000 mV range. As above.
h = 1900.000 mV ? **M = ▒ mV**	Default value in emission mode for the high point of the 2,000 mV range. As above.

9.5 - Recalibration (continued)	
Display	Meaning
C: 20 V ?	Confirm for calibration of the 20 V range. Standard voltmeter connected to terminals of the unit.
I = 0.00000 V ?	Default value in emission mode for the low point of the 20 V range.
M = ▒ V	As above.
h = 19.00000 V ?	Default value in emission mode for the high point of the 20 V range.
M = ▒ V	As above.
C: 500 Ω ?	Confirm for calibration of the 500 Ω range. Connect the standard ohmmeter to grey and red terminals, **the 1 mA measuring current enters via the grey terminal.**
I = 100.0000 Ω ?	Default value in simulation mode for the low point of the 500 Ω range.
M = ▒ Ω	As above.
h = 450.0000 Ω ?	Default value in simulation mode for the high point of the 500 Ω range.
M = ▒ Ω	As above.
C: 5000 Ω ?	Confirm for calibration of the 5,000 Ω range. Standard ohmmeter to grey and red terminals, **the 100 µA measuring current enters via the grey terminal.**
I = 1000.000 Ω ?	Default value in simulation mode for the low point of the 5,000 Ω range.
M = ▒ Ω	As above.
h = 4500.000 Ω ?	Default value in simulation mode for the high point of the 5,000 Ω range.
M = ▒ Ω	As above.
C: 20 mA (10 Ω) ?	Confirm for calibration of the 20 mA range. Connect the 10 Ω standard resistor and the standard voltmeter to red (+) and black (-) terminals of the unit.
I = 1.00000 mA ?	Default value in emission mode for the low point of the 20 mA range.
M = ▒ mA	• Wait for the reading on the standard voltmeter to stabilize. Um must be close to 10 mV. • Compute the exact value of the current flowing through the 10 Ω shunt. • Enter this value on the keyboard.

9.5 - Recalibration (continued)	
Display	Meaning
h = 19.00000 mA ? **M = ▒ mA**	Default value in emission mode for the low point of the 20 mA range. • Wait for the reading on the standard voltmeter to stabilize, it must be close to 190 mV. • Proceed as above.
C: Ref.junct.?	To calibrate the compensation of the internal reference junction, the standard thermocouple should be plunged in the 0°C reference for one hour.
Meas. OK ?	• Connect the thermocouple to red (+) and black (-) terminals of the unit. • Allow about 5 minutes for complete settling of temperatures at terminals of the unit. • Confirm.

9.6 - Maintenance	
Display	Meaning
Fault	There is faulty connection between logic and analog boards.

10 - PARTS LISTS AND DIAGRAMS

Designation	Parts lists Page	Component location diagrams Page	Schematic diagrams Page
Logic board	85	91	92
Analog board	87	93	94 and 95
Mechanical parts lists	90	-	-

10.1 - LOGIC BOARD

Designation	Item	Qty	Part number
Printed circuit equipped composed of :		1	CA 40915
. Common components :			
Resistors :			
Film :			
1/4 W, 5 % :			
2,2 kΩ	R21	1	ER 16567-058
4.7 kΩ	R14-R15	2	ER 16567-066
10 kΩ	R3	1	ER 16567-074
22 kΩ	R1-R2-R6		
	R9	4	ER 16567-082
47 kΩ	R10	1	ER 16567-090
100 kΩ	R4-R13	2	ER 16568-001
470 kΩ	R7	1	ER 16568-017
1 MΩ	R8-R11-R20	3	ER 16568-025
2,2 MΩ	R12	1	ER 16568-033
1/2 W, 5 % :			
20 Ω	R5	1	ER 33416-020
1/8 W, 1 % :			
61,9 kΩ	R16	1	ER 54016-077
162 kΩ	R17	1	ER 54017-021
232 kΩ	R19	1	ER 54017-036
1 MΩ	R18	1	ER 44017-100
Network : 22 kΩ	RR1-RR3	2	ER 44061-223

Designation	Item	Qty	Part number
Capacitors :			
Electrolytic :			
20 %, 10 V, 100 µF	C11-C18	2	ER 42073-101
Ceramic type I			
100 V, 22 pF	C1-C2	2	ER 52089-220
Tantalum 20 % :			
35 V, 1 µF	C5 to C9-C14		
	C16	7	ER 42031-105
16 V, 10 µF	C10	1	ER 42031-106
35 V, 4.7 µF	C4	1	ER 42031-475
16 V, 22 µF	C3	1	ER 42031-226
Metal polyester, 20 % :			
63 V, 0.1 µF	C13	1	ER 42036-104
63 V, 22 nF	C12	1	ER 42036-223
50 V, 0.22 µF	C15	1	ER 42036-224
63 V, 100 nF	C17	1	ER 42036-104
Diodes :			
signal, 1N4448	D1-D3 D4	3	ER 53002-005
rectifier, 1N4005	D2- D5 to D7		
	D10 to D12	7	ER 53019-005
1N5819	D9-D13	2	ER 43035-019
Transistors :			
BC 237	T1	1	ER 43505-002
MOSFET, P, VP1304	T2	1	ER 43521-000
Power MOSFET, 2N7000	T3 to T6	4	ER 43519-000
Quartz HC 18			
4.91520 MHz	QX1	1	ER 41918-001
Bistable **relays**			
2 coils	RL1	1	ER 45008-306
Miniature **potentiometer**			
± 10 %, 10 kΩ	P1	1	ER 41510-103
Integrated circuts :			
HD 63 A 0 3Y	CI1	1	ER 47598-001
PAL EP 320 programmed	CI5	1	PP 40048-000
EPROM 27C256			
programmed	CI7	1	PP 40049-001
EEPROM 64 x 16	CI4	1	ER 47565-000
ICL 7665 A	CI6	1	ER 47596-000
RAM 8 k x 8	CI2	1	ER 47583-010
LP 2950 C	RG1	1	ER 47145-000

Designation	Item	Qty	Part number
Miscellaneous :			
Connector	J3	1	ER 48262-012
	J5	1	ER 48273-000
HE 14, 15 pins	J1	1	ER 48283-115
Braid, 18 pins	1	1	ER 41021-418
Accumulator	A1 to A6	6	ER 41210-000
IC holder :			
8 contacts	XCI4	1	ER 49002-008
20 contacts	XCI5	1	ER 49002-020
64 contacts	XCI1	1	ER 49036-000
28 contacts	XCI7	1	ER 49002-028
18 contacts	XCI3	1	ER 49002-018
. Components used in CL511D :			
Integrated circuit :			
LT 1080 C	CI3	1	ER 47140-000
Jack	J4	1	ER 48274-000

10.2 - ANALOG BOARD

Designation	Item	Qty	Part number
Printed circuit equipped composed of :		**1**	**CA 40920-908**
Resistors :			
Film			
1/4 W, 5 % :			
47 Ω	R29	1	ER 16567-018
220 Ω	R30	1	ER 16567-034
1 kΩ	R11-R12-R19	3	ER 16567-050
10 kΩ	R47-R48-R28	3	ER 16567-074
22 kΩ	R4-R6-R41		
	R42	4	ER 16567-082
47 kΩ	R46-R18-R43	3	ER 16567-090
100 kΩ	R13	1	ER 16568-001
4.7 kΩ	R39	1	ER 16567-066
1 MΩ	R25-R45	2	ER 16568-025
Metal film			
1/4 W, 0.1 % :			
49.9 Ω	R15	1	ER 44099-010
527 Ω	R17	1	ER 44099-011
5.27 kΩ	R16	1	ER 44099-012
100 kΩ	R1-R14	2	ER 44099-013
20 kΩ	R2	1	ER 44099-014
10 kΩ	R10	1	ER 44099-015

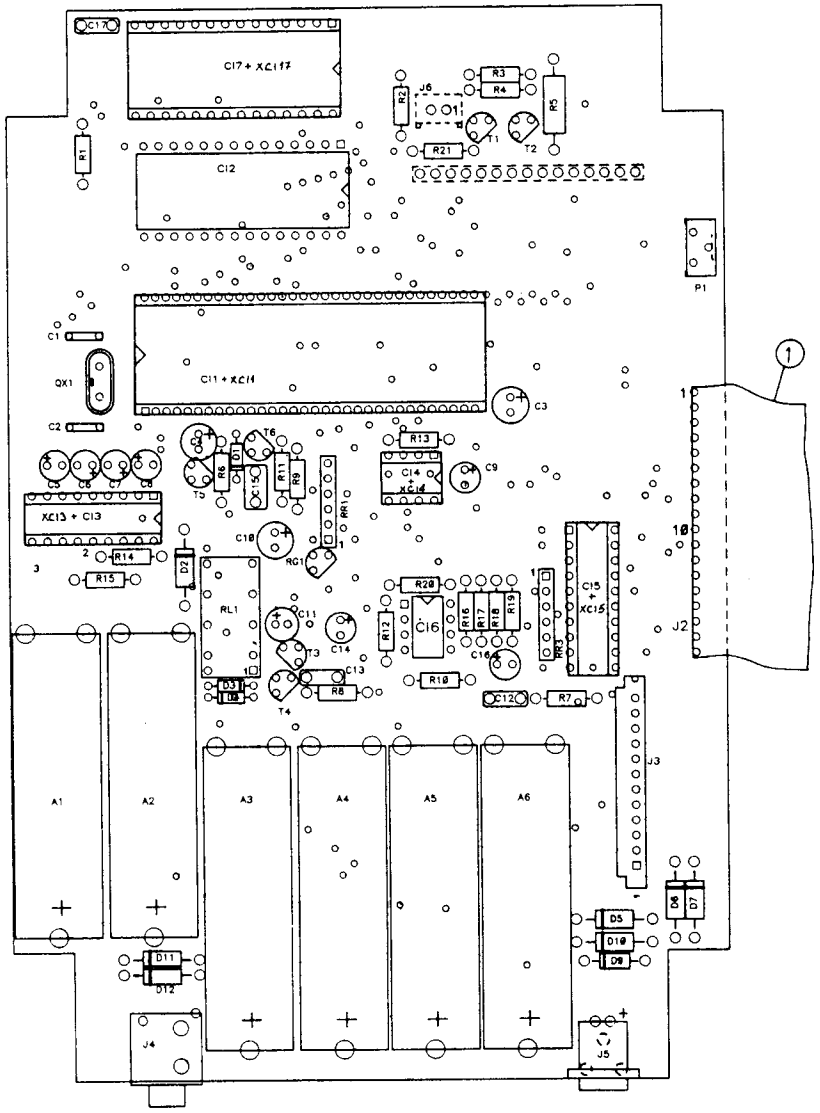
Designation	Item	Qty	Part number
1/8 W, 0.25 % :			
10 Ω	R35	1	ER 44021-100
1/8 W, 0.1 % :			
1 kΩ	R20	1	ER 44007-003
100 kΩ	R36	1	ER 44007-004
19.6 kΩ	R3	1	ER 44007-021
11.11 kΩ	R37	1	ER 44007-027
100 kΩ	R34	1	ER 44007-004
Film, 1/8 W, 1 % :			
124 Ω	R40	1	ER 54014-010
10 kΩ	R27	1	ER 54016-001
237 kΩ	R26	1	ER 54017-037
499 kΩ	R31	1	ER 54017-068
1/2 W, 1 % :			
10 MΩ	R5	1	ER 44030-100
1/2 W, 0.1 % :			
10 MΩ	R32	1	ER 44128-001
Wired, 2.6 W, 10 %, 0.22 Ω	R33	1	ER 44100-228
Networks :			
Thick film SIL06, 2 %			
100 kΩ	RR5	1	ER 44086-104
Thin film, SIL04, 0.1 %			
20 kΩ + 180 kΩ	RR10	1	ER 44054-000
Thick film SIL07	RR1	1	ER 44110-000
PTC resistor, 17 Ω	R44	1	ER 41111-001
Capacitors :			
Electrolytic 20 % :			
63 V, 10 µF	C45	1	ER 42077-100
35 V, 100 µF	C30	1	ER 42076-101
10 V, 100 µF	C33-C29	2	ER 42073-101
10 V, 220 µF	C31-C32-C52	3	ER 42073-221
Ceramic :			
Type I, 100 V, 2 % :			
100 pF	C16	1	ER 52089-101
22 pF	C38	1	ER 52089-220
33 pF	C53	1	ER 52089-330
10 pF	C55	1	ER 52089-100
Type II, 63 V, 10 % :			
1.5 nF	C50	1	ER 52090-152
Type II, 63 V, 20 % :			
22 nF	C 62	1	ER 42067-223
Tantalum 20 % :			
35 V, 1 µF	C3-C8-C9		
	C57	4	ER 42031-105
16 V, 10 µF	C34	1	ER 42031-106
16 V, 22 µF	C35	1	ER 42031-226
Metal polyester, 20 % :			
63 V, 10 nF	C44-C51-C10		
	C61	4	ER 42036-103
63 V, 33 nF	C54	1	ER 42036-333
50 V, 0.1 µF	C11-C14	2	ER 42036-104

Designation	Item	Qty	Part number
50 V, 1 µF	C15	1	ER 42036-105
63 V, 68 nF	C5	1	ER 42036-683
50 V, 330 nF	C41-C36 C39-C40	4	ER 42036-334
63 V, 100 nF	C58-C59-C60	3	ER 42036-104
Polystyrene, 1.25 %, : 63 V, 4 750 pF	C37	1	ER 52152-162
Diodes :			
regulation : D035, 0.4 W, 5 %, 2.1 V	D1	1	ER 43017-000
signal : D035, 75 V, 0.1 A, 1N4448	D5-D10 to D23 D4	16	ER 53002-005
low leak, T092, 35 V	D7-D8	2	ER 43014-020
rectifier, 1 A, 1N4005	D2-D3	2	ER 53019-005
current, T092, 4.7 mA, 50 V, J511	D24-D25	2	ER 43012-472
Rectifier bridge 100 V, 1 A	RD1	1	ER 53030-100
Transistors :			
JFET, N, T018, 40 V, 100 Ω	T1	1	ER 43515-000
MFET, P, T092	T3	1	ER 43521-000
NPN, 45 V, 0.1 A, T092, BC 237	T10	1	ER 43505-002
MFET, N, T092, 2N7000	T4-T5	2	ER 43519-000
DMOS, P	T2	1	ER 43545-000
Quartz, 40 kHz	X1	1	ER 41913-001
Bistable relays 1 RT, 5 V	RL1 to RL7	7	ER 45024-205
Self 100 µH	L1	1	ER 46297-101
Integrated circuits :			
Voltage regulator 4 V, CMOS, DIL16	CI18 CI3	1 1	ER 47160-000 ER 47550-052
Operational amplifier : LTC 1150 C	CI1-CI2-CI5 CI15	4	ER 47623-000
LT 1010	CI20	1	ER 47169-000
MC 34081	CI19	1	ER 47133-081
Double operational amplifier : 200GP	CI7	1	ER 47152-000
Simple inverser : DIL08,DG 419	CI6	1	ER 47594-000
2 V, DIL16	CI9	1	ER 47019-053
Operational bipolar amplifier : T099	CI8	1	ER 57043-308
Regulator : PWM, DIL08	CI11	1	ER 47148-000
T092, 5 V 160 mA	CI12	1	ER 47145-000

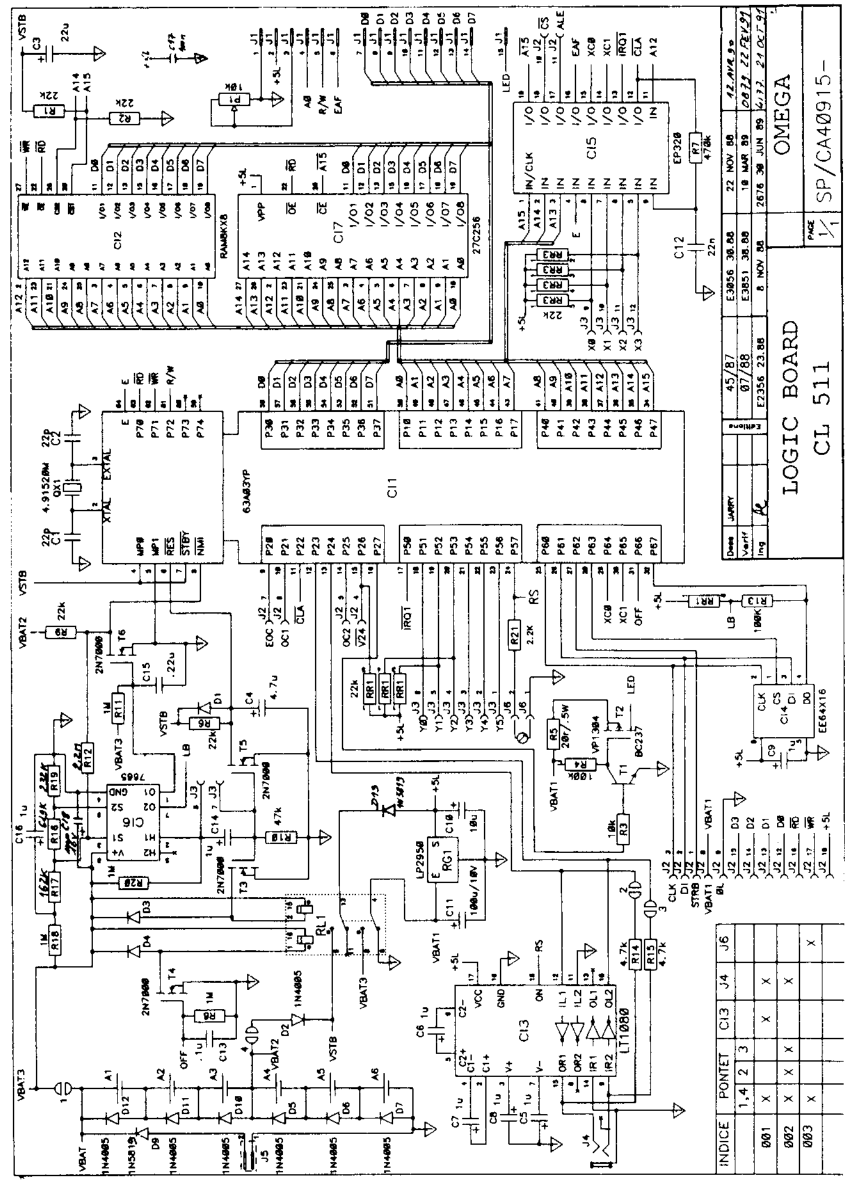
Designation	Item	Qty	Part number
Integrated circuits :			
CMOS, DIL08	CI13	1	ER 47536-000
A/D converter PLCC44	CI17	1	ER 47588-000
DIL28	CI14	1	ER 47590-000
2 V, CMOS, DIL16	CI4	1	ER 47550-053A
Reference :			
2.5 V, 1 %, DIL 08	REF1	1	ER 47046-002
Miscellaneous :			
Connectors :			
36 pins	J1	8/36	ER 48001-001
18 pins	J5	1	ER 49019-018
Buzzer, 4 kHz	X2	1	ER 40766-000
IC carrier	XCI17	1	ER 49038-044

10.3 - MECHANICAL PARTS LISTS

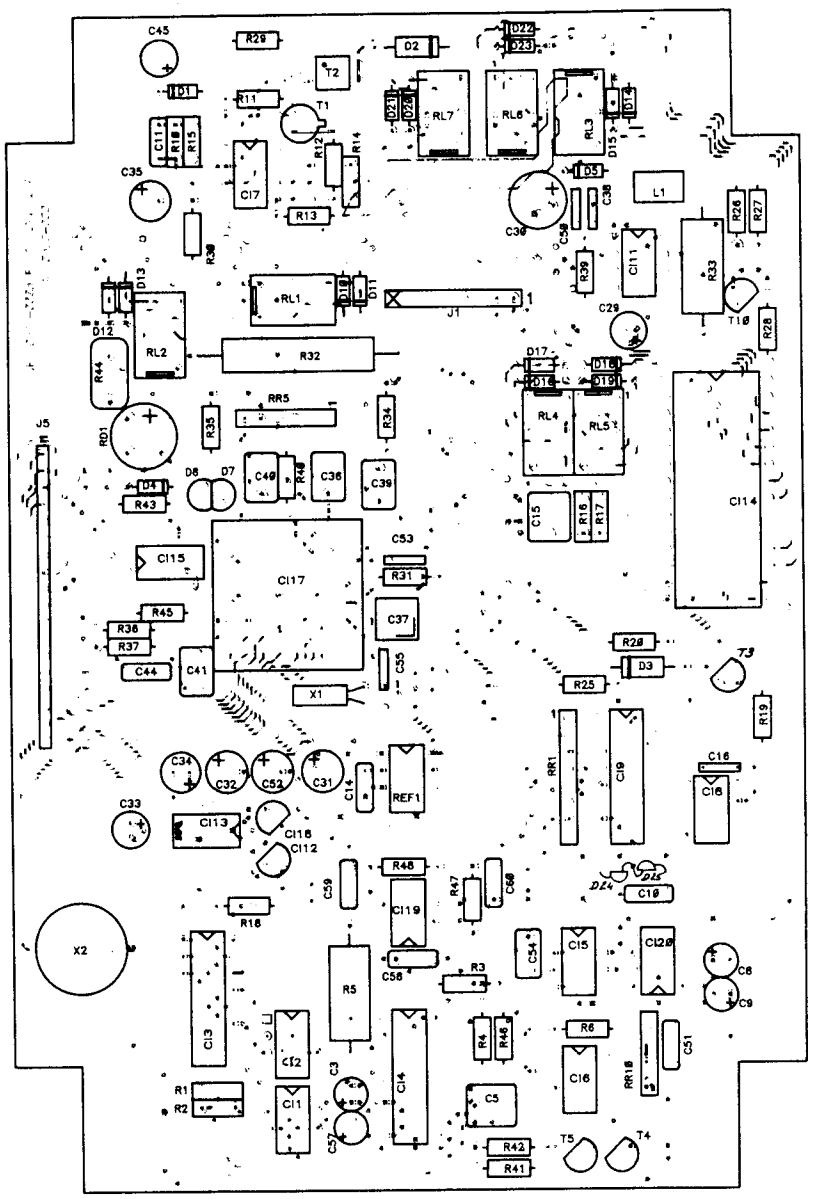
Description	Qty	Part number
Charger 120 V - 60 Hz	1	ER 40659-120
Display	1	ER 41410-000
Short operating mode (label)	1	DZ 40063-101
Black terminal	1	PEM 40060-004
Red terminal	1	PEM 40060-005
Grey terminal	1	PEM 40060-006
Temperature sensor	1	ER 47144-001



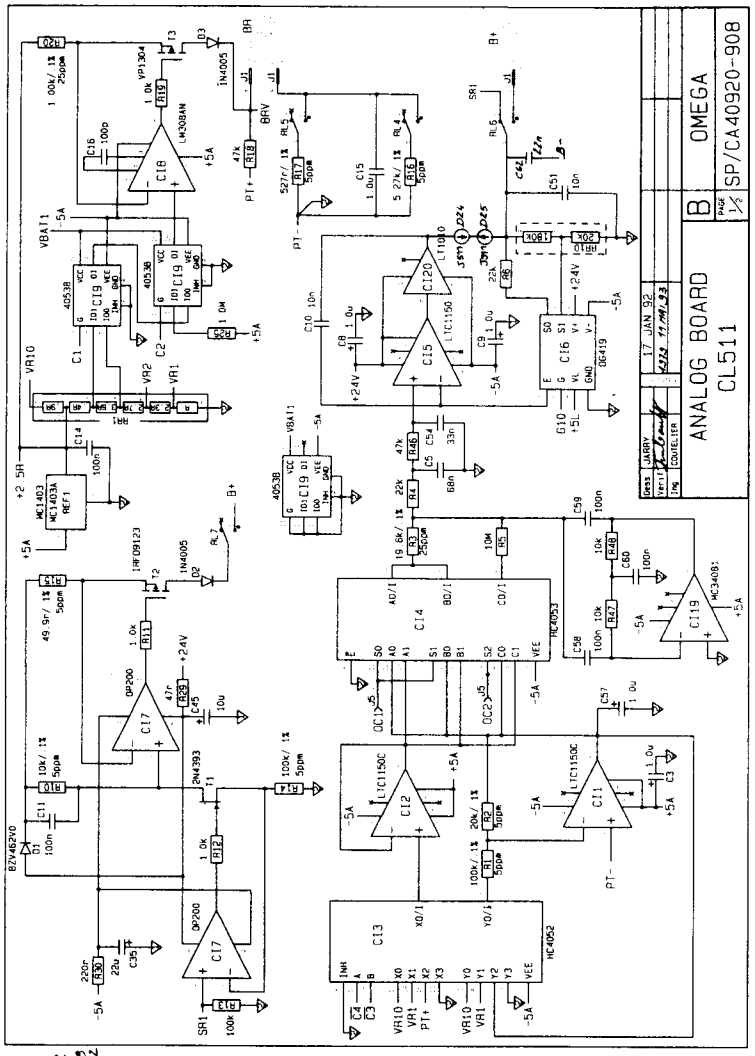
LOGIC BOARD CL511
Component location diagram



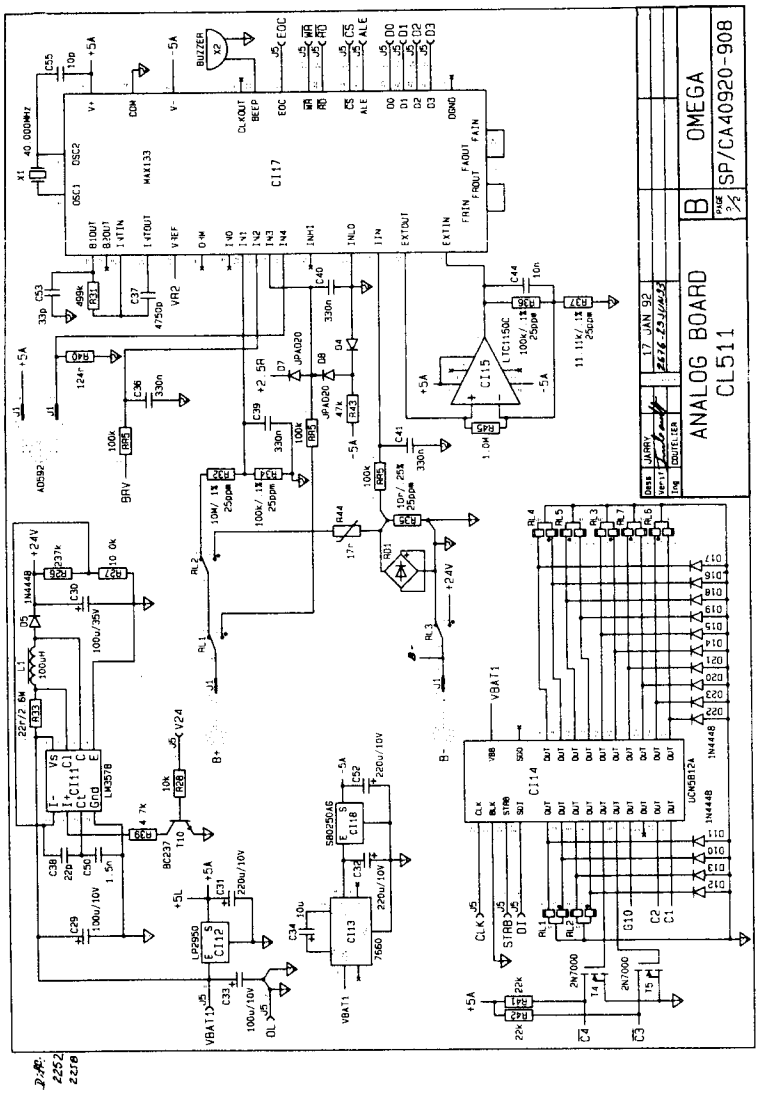
LOGIC BOARD CL511
Schematic diagram



ANALOG BOARD CL511
Component location diagram



ANALOG BOARD CL511
Schematic diagram 1/2



ANALOG BOARD CL511
Schematic diagram 2/2

Addendum to the CL511 precision calibrator.
Ed. 15 NOV 93

Precautions to take when calibrating MEASUREMENT functions

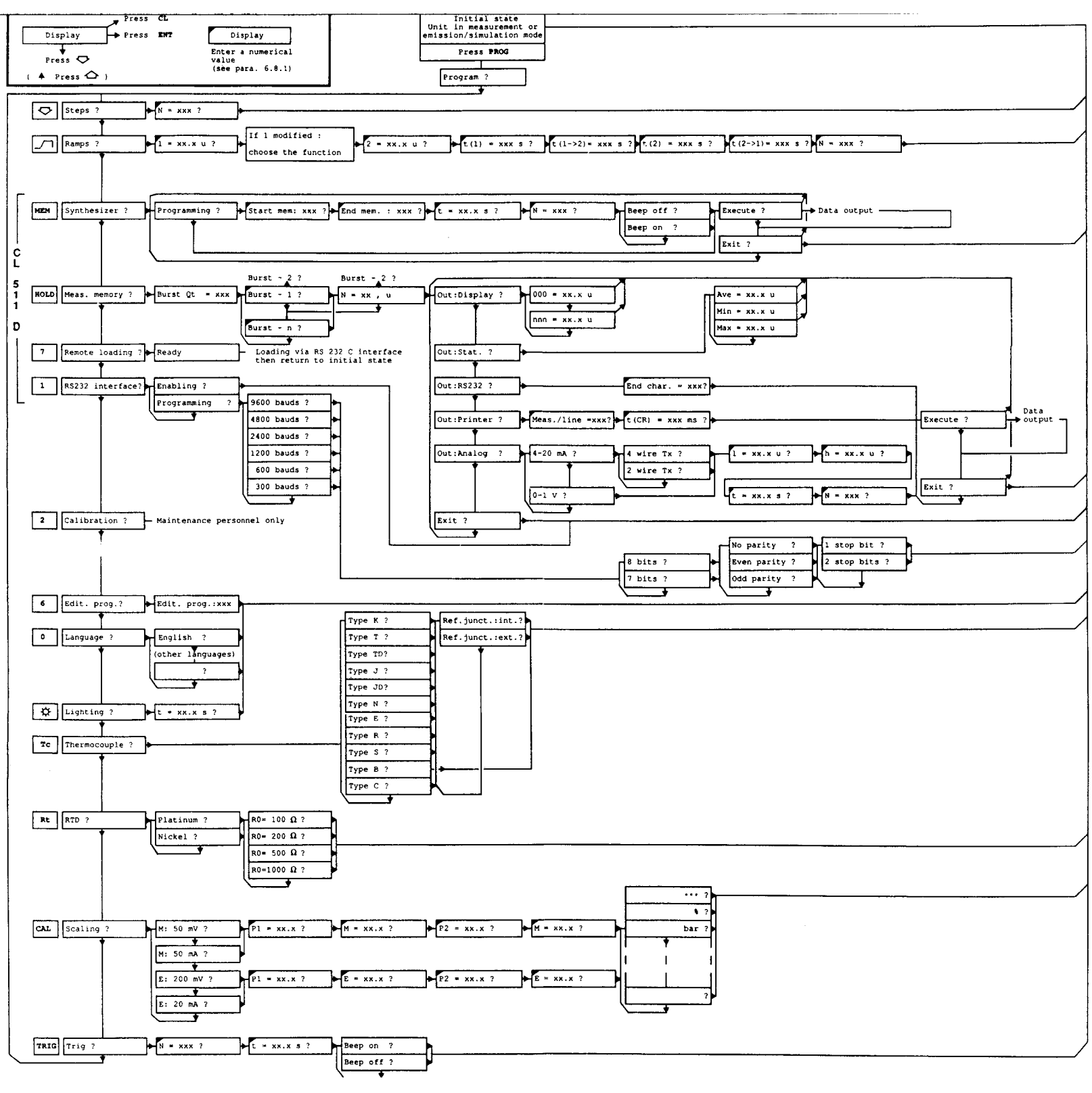
It is advisable to perform the "autocalibration" function (see § 2.3.6.9) before any connection to the standards and to repeat it periodically (at least every three months).
This operation resets the MEASUREMENT circuit to the internal references and then compensates the drifts.

Nevertheless, there is a counter-indication in using the "autocalibration" : if the connection to the standards has been performed before the "autocalibration" function has been done, the values indicated in the calibration certificate are not set to the unit internal references. In that case, using "autocalibration" leads to a loss of values corresponding to those stated on the calibration certificate.

WARNING : Readjusting the EMISSION function leads to an automatic readjustment when using the "autocalibration" function.

SUMMARY OF PROGRAMMING PROCEDURES

Also refer to page 73 for meaning of the displays


Press CL
Display
Press ENT
Press
(Press)
Display
Enter a numerical value (see para. 6.8.1)
Initial state
Unit in measurement or emission/simulation mode
Press PROG
Program ?
CL 511 D
Steps ?
N = xxx ?
Ramps ?
1 = xx.x u ?
If 1 modified : choose the function
2 = xx.x u ?
t(1) = xxx s ?
t(1->2)= xxx s ?
t(2) = xxx s ?
t(2->1)= xxx s ?
N = xxx ?
MEM
Synthesizer ?
Programming ?
Start mem: xxx ?
End mem. : xxx ?
t = xx.x s ?
N = xxx ?
Beep off ?
Beep on ?
Execute ?
Exit ?
Data output
HOLD
Meas. memory ?
Burst Qt = xxx
Burst - 2 ?
Burst - 1 ?
Burst - n ?
N = xx , u
Out:Display ?
000 = xx.x u
nnn = xx.x u
Ave = xx.x u
Min = xx.x u
Max = xx.x u
7
Remote loading ?
Ready
Loading via RS 232 C interface then return to initial state
Out:Stat. ?
1
RS232 interface?
Enabling ?
Programming ?
9600 bauds ?
4800 bauds ?
2400 bauds ?
1200 bauds ?
600 bauds ?
300 bauds ?
Out:RS232 ?
End char. = xxx?
Out:Printer ?
Meas./line =xxx?
t(CR) = xxx ms ?
Out:Analog ?
4-20 mA ?
4 wire Tx ?
2 wire Tx ?
0-1 V ?
1 = xx.x u ?
h = xx.x u ?
t = xx.x s ?
N = xxx ?
Execute ?
Exit ?
Data output
2
Calibration ?
Maintenance personnel only
Exit ?
8 bits ?
7 bits ?
No parity ?
Even parity ?
Odd parity ?
1 stop bit ?
2 stop bits ?
6
Edit. prog.?
Edit. prog.:xxx
0
Language ?
English ?
(other languages)
?
Type K ?
Type T ?
Type TD?
Type J ?
Type JD?
Type N ?
Type E ?
Type R ?
Type S ?
Type B ?
Type C ?
Ref.junct.:int.?
Ref.junct.:ext.?
Lighting ?
t = xx.x s ?
Tc
Thermocouple ?
Rt
RTD ?
Platinum ?
Nickel ?
R0= 100 Ω ?
R0= 200 Ω ?
R0= 500 Ω ?
R0=1000 Ω ?
CAL
Scaling ?
M: 50 mV ?
M: 50 mA ?
E: 200 mV ?
E: 20 mA ?
P1 = xx.x ?
M = xx.x ?
P2 = xx.x ?
M = xx.x ?
E = xx.x ?
E = xx.x ?
P2 = xx.x ?
E = xx.x ?
... ?
% ?
bar ?
?
TRIG
Trig ?
N = xxx ?
t = xx.x s ?
Beep on ?
Beep off ?

Where Do I Find Everything I Need for Process Measurement and Control? OMEGA...Of Course!

TEMPERATURE

- Thermocouple, RTD & Thermistor Probes, Connectors, Panels & Assemblies
- Wire: Thermocouple, RTD & Thermistor
- Calibrators & Ice Point References
- Recorders, Controllers & Process Monitors
- Infrared Pyrometers

PRESSURE, STRAIN AND FORCE

- Transducers & Strain Gauges
- Load Cells & Pressure Gauges
- Displacement Transducers
- Instrumentation & Accessories

FLOW/LEVEL

- Rotameters, Gas Mass Flowmeters & Flow Computers
- Air Velocity Indicators
- Turbine/Paddlewheel Systems
- Totalizers & Batch Controllers

pH/CONDUCTIVITY

- pH Electrodes, Testers & Accessories
- Benchtop/Laboratory Meters
- Controllers, Calibrators, Simulators & Pumps
- Industrial pH & Conductivity Equipment

DATA ACQUISITION

- Data Acquisition & Engineering Software
- Communications-Based Acquisition Systems
- Plug-in Cards for Apple, IBM & Compatibles
- Datalogging Systems
- Recorders, Printers & Plotters

HEATERS

- Heating Cable
- Cartridge & Strip Heaters
- Immersion & Band Heaters
- Flexible Heaters
- Laboratory Heaters

ENVIRONMENTAL MONITORING AND CONTROL

- Metering & Control Instrumentation
- Refractometers
- Pumps & Tubing
- Air, Soil & Water Monitors
- Industrial Water & Wastewater Treatment
- pH, Conductivity & Dissolved Oxygen Instruments

M1048/0299

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit should malfunction, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. P.O. number to cover the COST of the repair,
2. Model and serial number of product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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