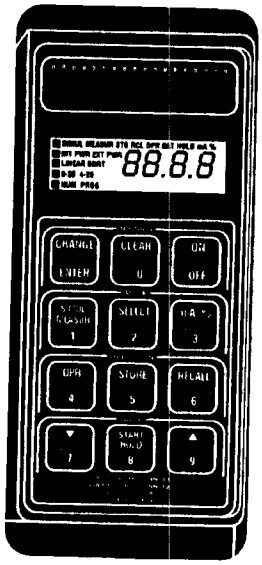
CL28MA

Loop Calibrator



OMEGA®
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Operator's Manual

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GENERAL INFORMATION

This manual provides operating instructions and maintenance information for the OMEGA® CL28MA Loop Calibrator. It is recommended that you read this manual, in particular the sections on safety, prior to operating this instrument.

The CL28MA is a combination milliamp simulator and meter. Numerous pre-programmed operating modes make this a versatile and time-saving instrument. In addition, it has user programmable setups backed up with non-volatile memory for repeated special tests.

Both simulate and measure modes operate with external loop power supplies or with an internal 24 volt power source.

The CL28MA can be programmed with either mA or percent-of-scale data. When operating, the CL28MA can toggle between mA or percent modes with the touch of one button.

Instead of fuses, the CL28MA is protected with PTC resistors. These devices automatically reset when a fault condition is corrected. Protection is provided between any combination of terminations in the input and output connectors.

SPECIFICATIONS

SIMULATOR OUTPUT CONNECTOR: Female SMP

MEASURE INPUT CONNECTOR: Female SMP

SIMULATOR OUTPUT CURRENT: 0.00 TO 21.00 mA

MEASURE INPUT CURRENT: 0.00 TO 21.00 mA

ACCURACY (64°F to 82°F ambient, 1 year): ±0.05 % of range

TEMPERATURE COEFFICIENT: 64°F to 82°F; included in accuracy specification.
From 14°F to 64°F and 82°F to 122°F; ±0.0015% of range per °F.

SIMULATOR SELECTIONS:

1.	RANGE	0.00 to 21.00 mA/0.0% to 105.0% 4.00 to 21.00 mA/0.0% to 106.3%
2.	LOOP POWER SOURCE	External (56 VDC max.) Internal (24 VDC nom.)
3.	FIXED OUTPUTS	Keypad entered Value/Power Source Memory recalled Value/Power Source (5 locations)
4.	PRESET RAMP/STEP OUTPUTS	
	4.1 Linear Steps:	4, 8, 12, 16, 20 mA (4-20 mA) 0, 5, 10, 15, 20 mA (0-20 mA)
	4.2 Square-Root Steps:	4, 5, 8, 13, 20 mA (4-20 mA) 0, 1.25, 5, 11.25, 20 mA (0-20 mA)

5. USER PROGRAMMED RAMP/STEP OUTPUTS
   5 memory locations store ramp/step parameters:
   - Step Size
   - Start Point
   - High Limit
   - Low Limit
   - Dwell Time
6. RAMP STEPPING Manual
   Automatic

MEASURE SELECTIONS;

1. RANGE 0.00 to 21.00 mA / 0.0% to 105.0 %
   4.00 to 21.00 mA / 0.0% to 106.3 %
2. LOOP POWER SOURCE External (56 VDC max.)
   Internal (24 VDC nom.)
3. STORE/RECALL MEASUREMENTS 5 memory locations
4. RUN/HOLD

SIMULATOR DRIVE CAPABILITY: 900 ohms max.

MEASURE INPUT RESISTANCE: 10 ohm shunt in series with 1Ω (nom.) PTC resistor for overload protection.

POWER: 9 volt alkaline (NEDA 1604A), lithium, or NiCd (rechargeable) battery.

BATTERY LIFE, CONTINUOUS:

Alkaline:	External Loop Power, 30 hrs typ. Internal Loop Power (12 mA), 7 hrs typ. Internal Loop Power (20 mA), 4 hrs. typ.
Lithium:	Approx. twice life of alkaline battery.
NiCd:	Approx. 1/4 life of alkaline battery.

BATTERY INDICATOR: Display indicates BAT when less than 10% of alkaline battery life remains. (Less than 3% of lithium, or NiCd battery life).

ERROR MESSAGES:

LO	Under range current.
HI	Over range current.
-POL	Input current reversed.
OL	Output loop overload.

ENVIRONMENTAL LIMITS FOR OPERATING: 14°F to 122°F, less than 90% relative humidity (R.H.) up to 95°F; reduce R.H. limit by 1.7% / °F from 95°F to 122°F.

ENVIRONMENTAL LIMITS FOR STORAGE (NiCd battery removed): –30°F to 140°F, less than 95% R.H. up to 95°F; reduce R.H. limit by 1.7% / °F from 95°F to 140°F.

DIMENSIONS, NET WEIGHT: 7.0" x 2.9" x 1.1", 10 oz.

MANUAL ADDENDA

Improvements or changes to this manual will be explained on an addendum included with the instrument. All change information should be incorporated immediately into the appropriate places in the manual.

UNPACKING AND INSPECTION

Each instrument is inspected both mechanically and electrically before shipment. Upon receiving your instrument, unpack all items from the shipping container and check for any obvious damage that may have occurred during transit. Report any damage to the shipping agent. Retain and use the original packing materials if reshipment is necessary.

The following items are included with every shipment:

1. CL28MA Loop Calibrator
2. Calibration Cable
3. Instruction Manual
4. 9 volt Battery
5. Carrying Case

SAFETY SYMBOLS AND TERMS

The symbol ⚠ on the instrument denotes that the user should refer to the operating instructions.

The **CAUTION** term used in this manual and on the instrument explains hazards that could damage the instrument.

The **WARNING** term used in this manual and on the instrument explains dangers that could result in personal injury or death.

SAFETY PRECAUTIONS

WARNING

This instrument is intended for use by qualified personnel trained in the safe operation of electronic testing equipment. Read the instruction manual thoroughly before using to become familiar with the instrument's operations and capabilities.

WARNING

The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30VRMS or 42VDC are present. Exercise caution when working around hazardous voltages.

WARNING

Do not substitute a metal part for the nylon screw in the rear case. Doing so will degrade electrical isolation of the case.

WARNING

The battery is accessible through a cover on the back of the instrument. To avoid electrical shock hazard, disconnect all cables and turn the unit off before removing the cover.

BATTERY INSTALLATION AND REPLACEMENT

WARNING

Turn the unit off and disconnect any input/output connections before replacing the battery. Put the cover back into place on the battery compartment before resuming use of the instrument.

1. Remove the cover from the battery compartment by sliding it off in the direction of the arrow located on the battery cover.
2. Remove the old battery by lifting the battery extractor loop.
3. Place the new battery in the battery compartment with the extractor loop around the battery. Be sure to observe proper polarity.
4. Re-install the battery cover before resuming use of the instrument.

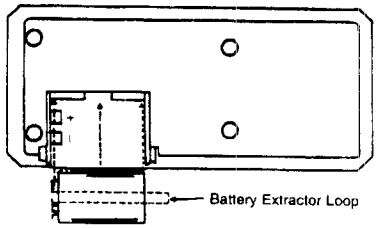


Figure 1. Battery Installation

NOTES:

- Less than 10% of battery life remains when the BAT annunciator turns on.
- When the battery is excessively discharged, the display is blanked.
- If the instrument is going to be stored for a long period of time or in a high temperature environment, remove the battery to prevent leakage damage.
- After a new battery is installed, press the ON/OFF key (Figure 2) once or twice to verify operation. The unit should momentarily turn on all segments and annunciators (Figure 3) of the display.

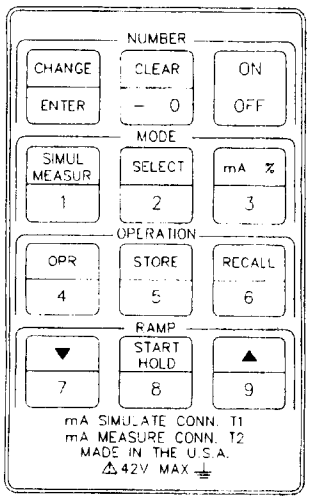


Figure 2. Keypad

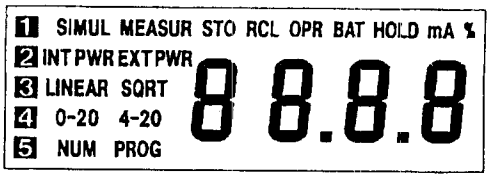


Figure 3. Display Test

MEMORY BACKUP

The contents of user-programmed memory (data, operating modes, etc.) can be saved during battery replacement. Be sure that the unit is turned OFF prior to battery removal, and install the new battery within 10 seconds of removing the old.

OPERATION WITH RECHARGEABLE BATTERY

The HH22-AC provides a 9-volt NiCd battery and recharger suitable for use with the unit. Depending on the application, this battery provides 1 to 7 hours of continuous operation.

Turn off the instrument to recharge the battery. Allow 7 hours to fully recharge the battery. Then unplug the recharger to avoid overcharging.

OPERATING INSTRUCTIONS

1. ERROR MESSAGES

Fault conditions and instrument misapplications are displayed by the following error messages:

PROBLEM:	LIKELY CAUSE:
Blank LCD	– Battery is dead, or installed backwards.
BAT (annunciator)	– Low battery voltage. Install a new battery.
Er.1 (momentary)	– Invalid keypad entry.
LO	– Under-range input current eg. 2mA input on 4-20 mA range.
HI	– Over-range input current or keypad-entered simulator output >21.00 mA.
–POL	– Reversed input leads (negative polarity current)
OL	– Loop overload. Simulator unable to source current due to open circuit, excessive loop resistance, or lack of loop excitation (internal or external power).

2. TURN ON

Turn on the instrument by depressing the ON/OFF keyswitch once. At power-up, the unit first performs a display test. All segments and annunciators of the liquid crystal display (LCD) are momentarily turned on for visual confirmation by the user (Figure 3).

After display test, the instrument resumes operation in the mode last active at turn-off.

NOTE: • Instruments turned on for the first time with a new battery default to MEASURE mode.

• Operating mode (etc.) can be retained during battery changes. Refer to Memory Backup section.

3. KEYPAD OPERATION

The keypad of the CL28MA serves two purposes:

1. Function selection (grey background)
2. Number entry (blue background)

The CHANGE/ENTER key selects between function selection and number entry operation in the simulator mode.

When function selection is active, the numeric readout of the LCD is displayed continuously and the NUM (number) annunciator is blanked. Number entry operation is indicated by the NUM annunciator and a flashing numeric readout.

4. MEASURE MODE OPERATION

In the measure mode, the CL28MA functions as a milliamp meter with a built-in 24 volt power supply.

Use the SIMUL-MEASURE key to select this mode. When this mode is selected, the MEASURE annunciator turns on.

mA Set-Ups:

The SELECT key is used to select one of 4 possible measurement setups.

The sequence of measurement setups is shown in Table 1. Annunciators identify the range selection (0-20mA, 4-20mA) and loop power source (external, internal).

Table 1: Measurement Setups (mA Readout)

Setup	Range (mA)	Under-Range	Over-Range	Loop Power
1	0 - 20	< 0 mA	> 21 mA	External
2	4 - 20	< 4 mA	> 21 mA	External
3	0 - 20	< 0 mA	> 21 mA	Internal
4	4 - 20	< 4 mA	> 21 mA	Internal

After pressing the SELECT key 4 times, the setup sequence is repeated.

Setups 1 and 2 are used to measure loop currents where an external power supply provides excitation (see Figure 4).

In setups 3 and 4, the CL28MA provides 24 volts for loop excitation (see Figure 5). In this manner the CL28MA is able to power up and measure transmitters by itself.

% Set-Ups:

Instead of measuring milliamps, the CL28MA can display percent-of-range readings. Use the mA - % key to make this choice. Table 2 shows the 4 setups configured for % readings.

Table 2: Measurement Setups (% Readout)

Setup	Range (mA)	Under-Range	Over-Range	Loop Power
1	0 - 20	< 0%	> 105.0%	External
2	4 - 20	< 0%	> 106.2%	External
3	0 - 20	< 0%	> 105.0%	Internal
4	4 - 20	< 0%	> 106.2%	Internal

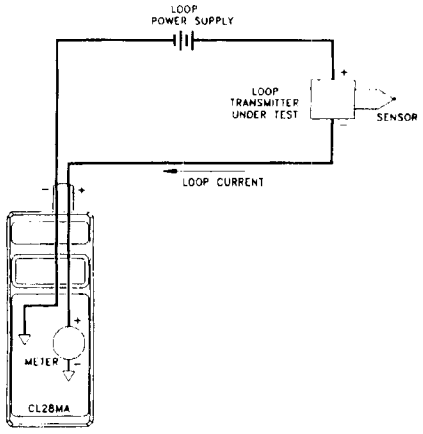


Figure 4. Measurement of Loop Current (External Power)

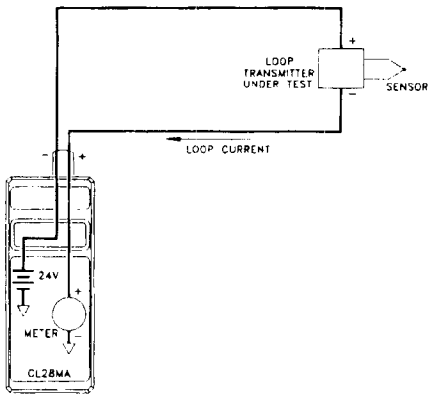


Figure 5. Measurement of Loop Current (Internal Power)

Hold:

Meter readings can be put on hold at any time by depressing the HOLD key. At this time, the HOLD annunciator turns on, the reading is frozen, and all keys (except ON/OFF and HOLD) are locked out. Depress the HOLD key again to return to real-time readings, and re-enable the keypad.

5. DATA LOGGING AND RECALL

While operating in the measure mode (MEASURE and OPR annunciators on), the CL28MA can save and recall up to 5 measurements (each with independent parameters; range, loop power source, and mA or % units).

To Save Readings:

1. Press the STORE key. Note that the OPR annunciator is replace by STO.
2. Press one of the memory location numbers (keys 1, ... 5). The corresponding memory annunciator turns on and the unit returns to the OPR mode.

   e.g. STORE 4

NOTES:

- The enabled location annunciator indicates that the meter reading at the instant that the location number key was pressed was stored in memory.
- When data is stored in a location already loaded with data, the new data replaces the old.
- Saved readings are retained during power-off.

To Recall Readings:

1. While in the MEASURE OPR mode, readings saved earlier can be displayed by first depressing the RECALL key. Note that the OPR annunciator is replaced by RCL, and all memory location annunciators are blanked.
2. Next, depress the keypad number corresponding to the desired location. Note that the annunciator for this location turns on, and the memory contents are displayed.

3. Several stored readings can be randomly recalled by a key sequence such as:

   e.g. RECALL 3
   RECALL 5
   RECALL 2
   etc.

4. To return the unit to the operate mode, depress OPR after recalling the last reading. All active location annunciators will turn on again, together with the OPR annunciator.

NOTE: • Recalling data from unused (i.e., empty) locations will give a zero reading.

• Readings can be saved and recalled from memory locations 1 through 5 only.

To Erase Data Locations

1. Individual data locations can be erased by recalling the location to be cleared, followed by a CLEAR key input. Note that the annunciator for the cleared location is turned off, and the unit returns to OPR.

   e.g. RECALL 3
   CLEAR

NOTE: There is no need to clear a location if new data is ready for saving in this location. Just STORE the new data. It will write over and delete the old.

6. SIMULATOR MODE OPERATION

In the simulator mode, the CL28MA functions as a current source. This current source functions with either external power supplies, or an internal 24 volt power supply.

Use the SIMUL-MEASURE key to select this mode. When this mode is selected, the SIMUL annunciator turns on.

NOTE: The simulator will indicate OL (loop overload) when attempting to operate with an open output, or without loop-excitation. Although this does not prevent programming of the CL28MA, this task is easier with normal display functioning. The overload condition is removed by plugging the supplied calibration cable into the simulator output connector, and connecting the alligator clips to an external power source such as a 9 volt transistor battery. Connect the red lead to the negative battery terminal, and black to positive.

mA Set-Ups:

The SELECT key can now be used to select 1 of 10 possible setups.

The sequence of simulator setups is shown in Table 3. Annunciators identify range selection, (0 - 20 mA, 4 - 20 mA), loop power source (internal, external), and ramp/step values (linear, square root, programmed).

Table 3: Simulator Setups (mA Outputs)

Setup	Range (mA)	Under-Range	Over-Range	Loop Power	Ramp/Step Values (mA)
1	0 - 20	< 0 mA	> 21 mA	External	Linear; 0, 5, 10, 15, 20
2	4 - 20	< 4 mA	> 21 mA	External	Linear; 4, 8, 12, 16, 20
3	0 - 20	< 0 mA	> 21 mA	External	SqRt; 0, 1.25, 5, 11.25, 20
4	4 - 20	< 4 mA	> 21 mA	External	Sq.Rt; 4, 5, 8, 13, 20
5	PROG	< 0 mA	> 21 mA	External	User Programmed*
6	0 - 20	< 0 mA	> 21 mA	Internal	Linear; 0, 5, 10, 15, 20
7	4 - 20	<4 mA	> 21 mA	Internal	Linear; 4, 8, 12, 16, 20
8	0 - 20	< 0 mA	> 21 mA	Internal	SqRt; 0, 1.25, 5, 11.25, 20
9	4 - 20	< 4 mA	> 21 mA	Internal	SqRt; 4, 5, 8, 13, 20
10	PROG	< 0 mA	>21 mA	Internal	User Programmed*

* Refer to Section 8 of Operating Instructions

Setups 1 through 5 are used where an external power supply provides loop excitation (see Figure 6). In setups 6 through 10, the CL28MA provides 24 volts for loop excitation (see Figure 7).

In any of these 10 simulator setups, the CL28MA can be configured to output a fixed continuous output, or output the ramp/step values shown in Table 3. Fixed outputs and ramp/step outputs are explained below.

Fixed Outputs:

A fixed output is an arbitrary value (e.g. 18.47 mA) entered via the keypad. Fixed outputs can be obtained in any of the 10 setups. The only restriction is that values must be within the under-range and over-range limits of the selected setup.

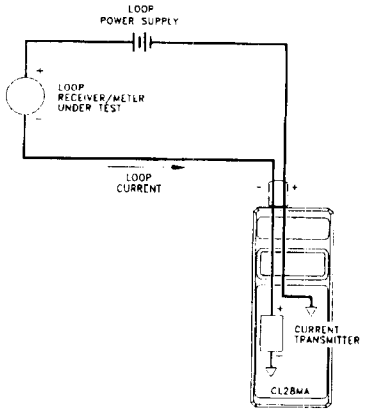


Figure 6. Simulation of Current Transmitter (External Power)

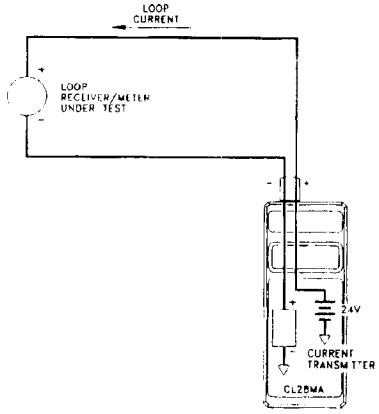


Figure 7. Simulation of Current Transmitter (Internal Power)

To enter a fixed output, first change the keypad to its number-entry mode. Do this by depressing the CHANGE/ENTER key once. When this done, the OPR annunciator turns off, and the NUM annunciator turns on to indicate that the keypad is ready for numeric entries. Meanwhile, the numeric display will flash indicating that the previous calibrator output will remain unchanged until the new value has been keyed in and entered.

Key in the desired mA value, most significant digit first. For example, a value of 15.47 would be keyed in by pressing the key sequence 1, 5, 4, 7. The numbers will shift into LCD with each keystroke. After the desired value has been keyed in, hit the CHANGE/ENTER key one more time. The OPR annunciator will return, NUM turns off, and the LCD numerics stop flashing. At this time, the output updates to the new value.

To summarize, the keystroke sequence for the above example is:

CHANGE, 1, 5, 4, 7, ENTER.

NOTES:

- Out-of-range entries will cause a momentary LO or HI error code.
- To correct a numeric entry while in the NUM mode, hit the CHANGE/ENTER key twice. This will return number entry to the beginning of a new number.
- While in the OPR mode, the simulator output can be reset to range-zero (0mA or 4mA, depending on setup) by pressing the CLEAR key.

Ramp/Step Outputs (Factory Set):

Ramp and step outputs go up and down defined current staircases. Ramp outputs move up and down automatically, while step outputs are manually stepped.

Simulator setups 1 thru 4, and 6 thru 9 provide factory set values for ramp and step outputs (refer to Table 3). Setups 1, 2, 6 and 7 provide linear steps, while setups 3, 4, 8 and 9 provide square-root steps. (Setups 5 and 10 have user-defined steps. This feature is discussed in Section 8 of the Operating Instructions). To activate a specific step/ramp setup, for example setup #2, use the SELECT key to access the setup (i.e., 4-20, EXT.PWR, LINEAR annunciators are indicated by display). Next press the START-HOLD key twice. The display will show current ramping automatically 4, 8, 12, 16, 20, 16, 12, ..., etc.

NOTE: The duration (or dwell time) of each current level is factory set at 2 seconds. This value can be changed by the user (refer to Section 8, User-Programmed Ramp/Step Outputs).

While ramping is in progress, pressing either the up-arrow key or down-arrow key activates manual stepping.

A third press of the START-HOLD key turns off ramp and step outputs.

% Setups:

Instead of milliamps, the CL28MA can output percent-of-range currents. Use the mA-% key to use this feature. Table 4 shows the 10 simulator setups configured for % operation.

Table 4: Simulator Setups (% of Range Outputs)

Setup	Range (mA)	Over-Range	Loop Power	Ramp/Step Values (%)
1	0 - 20	>105.0%	External	Linear; 0, 25, 50, 75, 100
2	4 - 20	>106.3%	External	Linear; 0, 25, 50, 75, 100
3	0 - 20	>105.0%	External	SqRt; 0, 6.2, 25, 56.2, 100
4	4 - 20	>106.3%	External	Sq.Rt; 0, 6.2, 25, 56.2, 100
5	0 - 20	>105.0%	External	User Programmed*
6	0 - 20	>105.0%	Internal	Linear; 0, 25, 50, 75, 100
7	4 - 20	>106.3%	Internal	Linear; 0, 25, 50, 75, 100
8	0 - 20	>105.0%	Internal	SqRt; 0, 6.2, 25, 56.2, 100
9	4 - 20	>106.3%	Internal	Sq.Rt; 0, 6.2, 25, 56.2, 100
10	0 - 20	>105.0%	Internal	User Programmed*

* Refer to Section 8 of Operating Instructions

All the features of mA Setups apply to % Setups, i.e., fixed, ramped, and stepped outputs.

7. STORAGE AND RECALL OF FIXED OUTPUTS

While operating in the simulator mode (SIMUL and OPR annunciators on), the CL28MA can store and recall up to 5 outputs, each with independent setup parameters.

NOTE: The simulator will indicate OL (loop overload) when attempting to operate with an open output, or without loop-excitation. Although this does not prevent programming of the CL28MA, this task is easier with normal display functioning. The overload condition is removed by plugging the supplied calibration cable into the simulator output connector, and connecting the alligator clips to an external power source such as a 9 volt transistor battery. Connect the red lead to the negative battery terminal, and black to positive.

To Store Fixed Outputs:

1. Press the STORE key. Note that the OPR annunciator is replaced by STO.
2. Next, press one of the memory location numbers (keys 1 ..., 5). The corresponding memory annunciator turns on, and the unit returns to the OPR mode.

   e.g. STORE 2

NOTES:

- The enabled memory annunciator shows that the output setup has been stored.
- When a setup is stored in a location already in use, the new setup replaces the old.
- Stored setups are retained during power-off.

To Recall Fixed Outputs

1. While in the SIMUL OPR mode, setups saved earlier in memory can be recalled to program the calibrator output. First depress the RECALL key to recall a set-up.

   Note that the RCL annunciator turns on, OPR turns off, and all memory locations annunciators are blanked.
2. Next, press the key with the number corresponding to the desired memory location. The corresponding annunciator turns on, and the LCD updates to show the new calibrator setting.

   e.g. RECALL 2

3. Several stored setups can be randomly recalled by a key sequence such as:

   e.g. RECALL 5
   RECALL 3
   RECALL 4
   etc.

4. To return the unit to the SIMUL OPR mode after recalling the last setup, hit the OPR key.

   NOTE: While in the SIMUL mode, the down-arrow key will recall the contents of loaded memory locations. Recall is in numerical order, and does not require use of the RECALL key.

To Erase Setup Locations:

1. Individual setup locations can be erased by recalling the location followed by pressing the CLEAR key.

   e.g. RECALL 5
   CLEAR

8. USER-PROGRAMMED RAMP/STEP OUTPUTS

NOTE: The simulator will indicate OL (loop overload) when attempting to operate with an open output, or without loop-excitation. Although this does not prevent programming of the CL28MA, this task is easier with normal display functioning. The overload condition is removed by plugging the supplied calibration cable into the simulator output connector, and connecting the alligator clips to an external power source such as a 9 volt transistor battery. Connect the red lead to the negative battery terminal, and black to positive.

Tables 3 and 4 show that setups 5 and 10 have user programmed ramp/step values. In these setups, users can define a custom staircase function for ramp and step outputs.

A custom staircase is defined with 5 parameters. These parameters are saved in 5 dedicated memory locations for use at any time. To activate a user programmed output, select setup 5 or 10 (choice based on external or internal loop power). Next press the START-HOLD key once. All five memory annunciators will start flashing, while the numeric readout remains fixed).

These flashing annunciators represent the memory locations into which the above 5 staircase parameters are loaded. Table 5 describes these parameters.

Table 5: User Programmed Ramp/Step Parameters

Parameter	Factory-Default Value	User Entered Value (example)	Memory Location
Step Size	1.00 mA	1.50 mA	1
Start Point	12.00 mA	6.00 mA	2
High Limit	20.00 mA	9.00 mA	3
Low Limit	4.00 mA	0.00 mA	4
Dwell Time*	2.00 sec.	5.00 sec.	5

* Times are approximate, per step, in seconds.

The user entered values shown in Table 5 will generate the following sequence of staircase milliamps once the ramp is started:

6.00, 7.50, 9.00, 7.50, 6.00, 4.50, 3.00, 1.50, 0.00, 1.50, etc.

While the memory annunciators are flashing, new values can be entered and stored, or old values can be recalled for review.

The following procedure loads a 1.50mA step size into memory location 1:

1. Enter step size with key sequence:

   CHANGE, 1, 5, 0, ENTER (numeric display flashes during entry)

2. Store in memory:

   STORE, 1

3. Verify memory contents:

   RECALL, 1, OPR (1.50 mA displayed)

Use this procedure to review, load or verify each of the 5 parameters of Table 5.

Once the appropriate parameter values have been stored, automatic ramping is initiated by pressing the START-HOLD key once more. The user can now take manual control of the ramp by pressing either the up-arrow key or down-arrow key.

One more press of the START-HOLD key will turn off the user-programmed ramp, and lock out access to the corresponding memory locations. Additional presses of the START-HOLD key will make the unit recycle through the ramp-program, ramp-start, and ramp-stop sequence.

NOTES:

- User programmed dwell-time is used in all simulator setups (1-10).
- Ramp-step parameters should be programmed in a mA setup only.
- Ramp function can be operated in either mA or percent-of-scale modes.
- Dwell times should be integer values between 2 seconds and 21 seconds (i.e. 2.00, 3.00, ..., 21.00)
- While in the ramp-program mode, the down-arrow key will recall the contents of the ramp-parameter memory. Recall is in numerical order, and does not require use of other keys.

SERVICE INFORMATION

WARNING

All service information is intended for qualified electronic maintenance personnel only.

1. CALIBRATION

Test Equipment Required:

1. Current Source (CL8300, or equivalent).
2. DMM (OM7560, or equivalent).
3. Shunt Resistor, 10 ohm, 0.01%.
4. Loop Power Source (9 volt transistor battery).
5. Transistor, 2N7000.
6. Calibration cables per Figures 8 and 9.

Ambient Conditions:

Units should be calibrated at an ambient temperature of 23°C ±2°C with relative humidity less than 80%

Preparation for Calibration:

1. Remove battery from CL28MA. Refer to Battery Installation and Replacement Instructions in the manual.
2. Remove bottom-cover. Refer to Disassembly Instructions.

3. Re-install battery.
4. Hook up test-equipment, cables, and CL28MA per Figure 8.

NOTE: With its internal loop power-source enabled, the CL28MA can output a higher voltage than the compliance rating of many general-purpose current calibrators. For this reason a 2N7000 transistor is included in the loop to hold-off excess voltage. The 10 ohm resistor ensures loop stability.

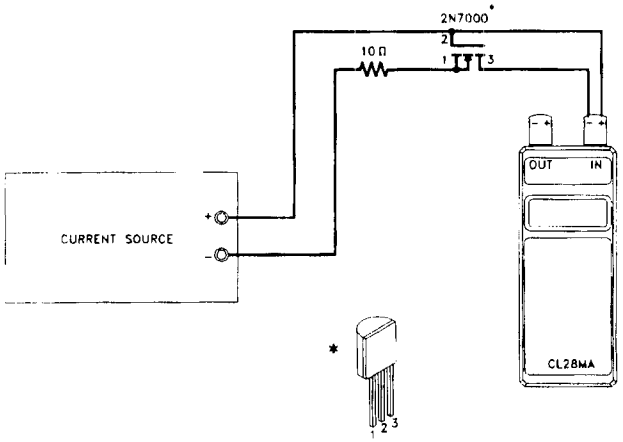


Figure 8. Calibration Setup, Measure Input

5. Set the CL28MA to measure mode, with the following annunciators turned on:

   MEASURE
   OPR
   EXT PWR
   0-20
   mA

6. Input 20.00 mA to CL28MA from current source.
7. Adjust potentiometer P3 for a display reading of 20.00 mA.

8. Verify reading of 20.00 mA ± 0.01 mA as other measure setups are selected:

   ie. 4-20 EXT PWR
   0-20 INT PWR
   4-20 INT PWR

9. Hook up test-equipment, cables, and CL28MA per Figure 9.

   NOTE: When the internal loop power-source of the CL28MA is turned off, the 9 volt battery provides loop power. This battery need not be disconnected when the internal power-source is enabled.

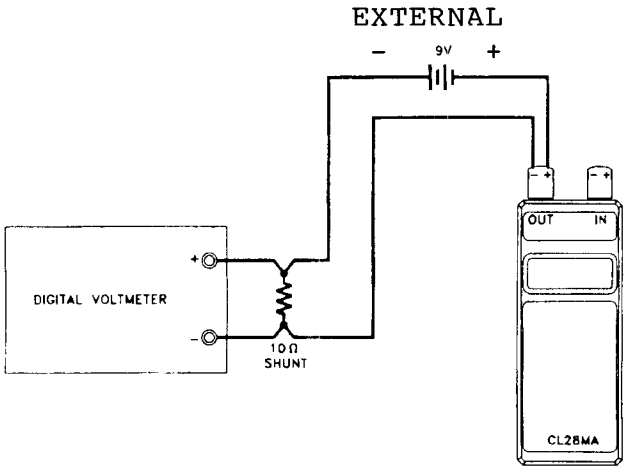


Figure 9. Calibration Setup, Simulator Output

10. Set the CL28MA to simulator mode, with the following annunciators turned on:

    SIMUL
    OPR
    EXT PWR
    0-20
    mA
    LINEAR

11. Enter an output value of 0.00 mA into the CL28MA keypad.
12. Adjust potentiometer P2 for a voltmeter reading of 0.0 mV.

    NOTE: Leave the potentiometer set as clockwise as possible, without losing the zero-reading.

13. Enter an output value of 20.00 mA.
14. Adjust potentiometer P1 for a voltmeter ready of 200.0 mV.
15. Verify mid-scale output (ie. 10.00 mA output measures 100.0 mV on voltmeter).
16. Re-enter output of 20.00 mA.
17. Use the SELECT key to scroll through all 10 simulator setups (Refer Table 3 in Operating Instructions). Verify voltmeter reading of 200.0 mV ± 0.1 mV in each setup.
18. Calibration is complete. Re-install back cover.

2. DISASSEMBLY INSTRUCTION

Before opening the case, remove all input/output connections. This includes connectors, cables, and the optional battery charger. Next slide the battery cover off, and remove the battery (see Battery Installation/Replacement).

Turn the instrument face down, and remove the three Phillips head screws from the rear cover. Lift off the rear cover. The circuit board can be lifted from the front case after removal of the hexagonal-standoff.

NOTE: Be sure to keep the face down during this last step. Otherwise, the LCD and its associated hardware may fall free and break.

Re-assemble the instrument by following the reverse of the above procedure.

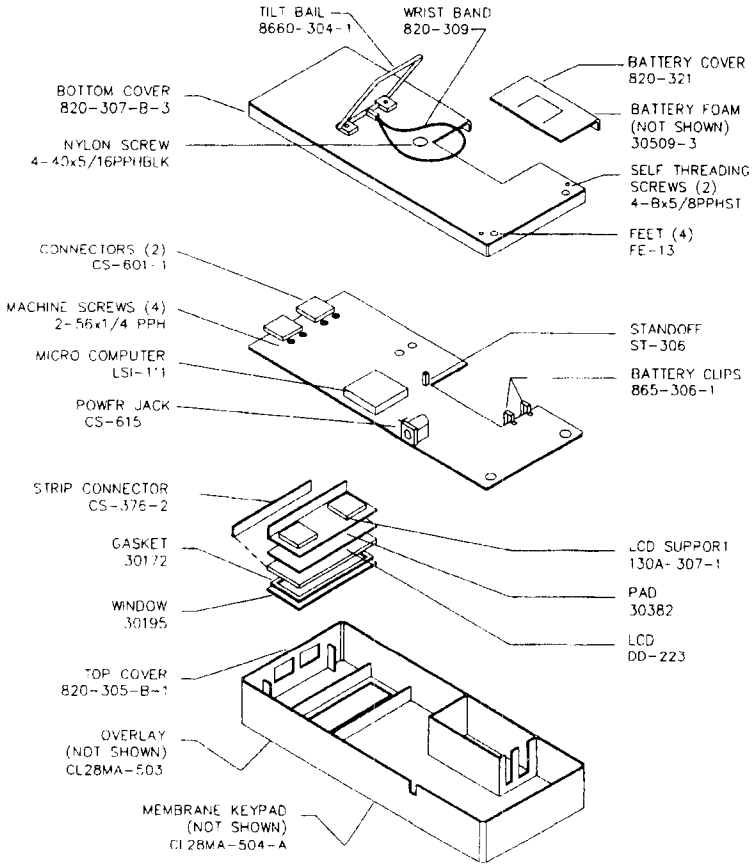
CAUTION

Do not use excessive torque when re-installing the nylon machine-screw into the rear case. Excess torque will damage the part.

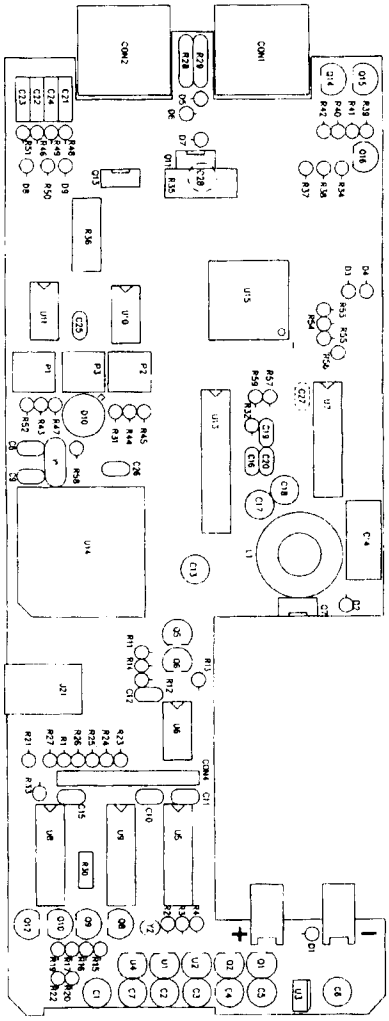
WARNING

Do not substitute a metal part for the nylon machine screw. Doing so will degrade the electrical isolation of the instrument.

3. MECHANICAL PARTS DIAGRAM



4. COMPONENT LAYOUT



5. PARTS LIST

Schematic Designation	Description	Part Number
C1, 13	Capacitor, Aluminum	C-513-100
C2, 3, 7, 28	Capacitor, Aluminum	C-513-1
C4, 5, 6	Capacitor, Aluminum	C-513-33
C8, 9, 10, 11	Capacitor, Ceramic	C-237-33P
C12	Capacitor, Ceramic	C-237-1000P
C14	Capacitor, Aluminum	C-551-100
C15, 16, 19, 20, 26, 27	Capacitor, Ceramic	C-237-.1
C17, 18	Capacitor, Aluminum	C-513-10
C21, 22	Capacitor, Polyester	C-344-.1
C23	Capacitor, Polyester	C-344-.22
C24	Capacitor, Polyester	C-344-.047
C25	Capacitor, Ceramic	C-237-220P
CON1, 2	Connector	CS-601-1
CON4	Connector, Right Angle	CS-614
D1	Diode, Zener	DZ-213
D2	Diode, Schottky	RF-55
D3, 5, 6, 7, 9	Diode, Rectifier	RF-38
D4	Diode, Zener	DZ-202
D8	Diode, Signal	RF-28
D10	Diode, Band-Gap	845-602
DS1	Display, Liquid Crystal	DD-223
J21	Jack, Charger	CS-615
L1	Inductor	TM-35-1
P1	Potentiometer	RP-97-1K
P2	Potentiometer	RP-97-2K
P3	Potentiometer	RP-97-500
Q1, 6, 9, 10, 14, 15	Transistor, PNP	TG-84
Q2, 5, 8, 12, 16	Transistor, NPN	TG-47
Q7, 11, 13	Transistor, FET	TG-325
R1	Resistor, Carbon	R-76-330
R2, 3, 4, 20, 21, 22, 23, 24, 25, 39, 40, 42	Resistor, Carbon	R-76-47K
R11, 30	Resistor, Carbon	R-76-10M
R12	Resistor, Carbon	R-76-470K
R13	Resistor, Metal Film	R-88-20K
R14, 26	Resistor, Carbon	R-76-2.2M

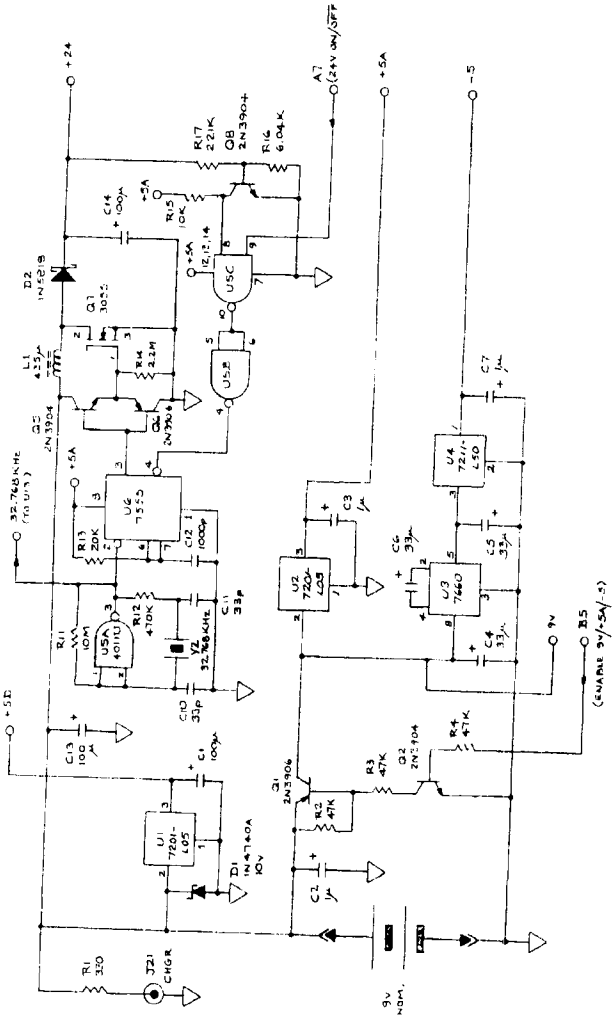
5. PARTS LIST (cont'd)

Schematic Designation	Description	Part Number
R15, 27, 54, 55, 56	Resistor, Carbon	R-76-10K
R16	Resistor, Metal Film	R-88-6.04K
R17	Resistor, Metal Film	R-88-221K
R19, 41	Resistor, Metal Film	R-88-22.1
R28, 29	Resistor, PTC	RT-10
R31	Resistor, Metal Film	R-88-9.09K
R32, 38	Resistor, Metal Film	R-88-10
R33	Resistor, Metal Film	R-88-49.9K
R34, 37	Resistor, Metal Film	R-88-1K
R35	Resistor, Wirewound	R-518-10
R36	Resistor, Wirewound	R-518-61.9
R43, 46, 48, 49,	Resistor, Metal Film	R-88-200K
R44	Resistor, Metal Film	R-88-8.66K
R45	Resistor, Metal Film	R-88-59.0
R47	Resistor, Carbon	R-76-6.8K
R50	Resistor, Carbon	R-76-1K
R51	Resistor, Carbon	R-76-100
R52	Resistor, Metal Film	R-88-715
R53	Resistor, Carbon	R-76-220K
R57, 59	Resistor, Carbon	R-76-100K
R58	Resistor, Carbon	R-76-4.7M
U1, 2	I.C., Regulator	IC-837
U3	I.C., Inverter	IC-809
U4	I.C., Regulator	IC-838
U5	I.C., NAND	IC-836
U6	I.C., Timer	IC-760
U7	I.C., Mux	IC-764
U8	I.C., Schmitt	IC-834
U9	I.C., D-Flop	IC-103
U10, 11	I.C., Op. Amp.	IC-842
U13	I.C., A/D	IC-827
U14	I.C., μC	LSI-111-CL28
U15	I.C., LCD Controller	IC-761
Y1	Ceramic Resonator, 4MHz	CR-53

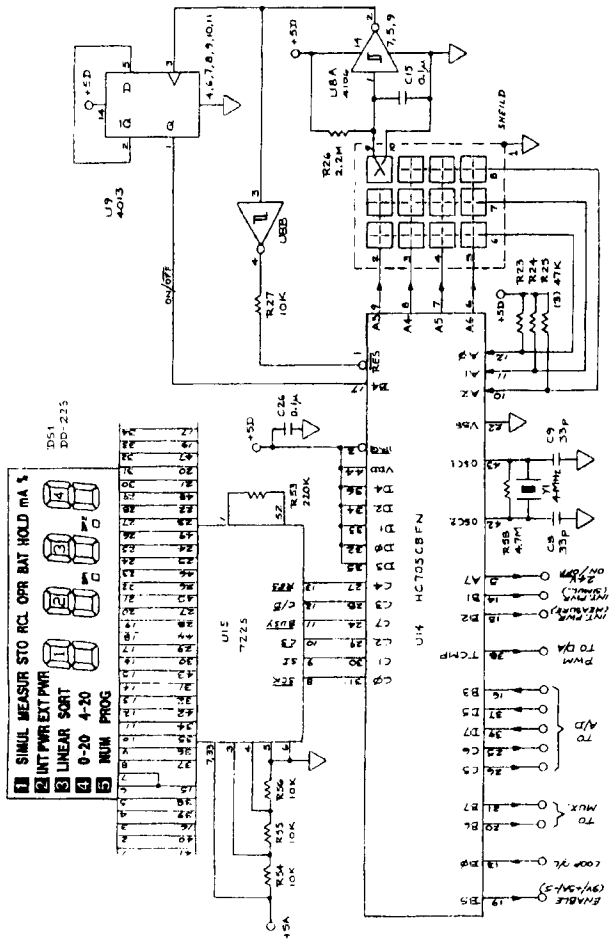
5. PARTS LIST (cont'd)

Schematic Designation	Description	Part Number
Y2	Crystal, 32.768 KHz	CR-54
—	Keypad	CL28MA-504
—	Socket, μC	SO-207
—	Connector, LCD	CS-376-2
—	Battery Clips	865-306-1
—	Fastener, Toroid	FA-146
—	Washer, Nylon	WA-245
—	Transistor, 2N7000 (For calibration setup, Fig. 8)	TG-95

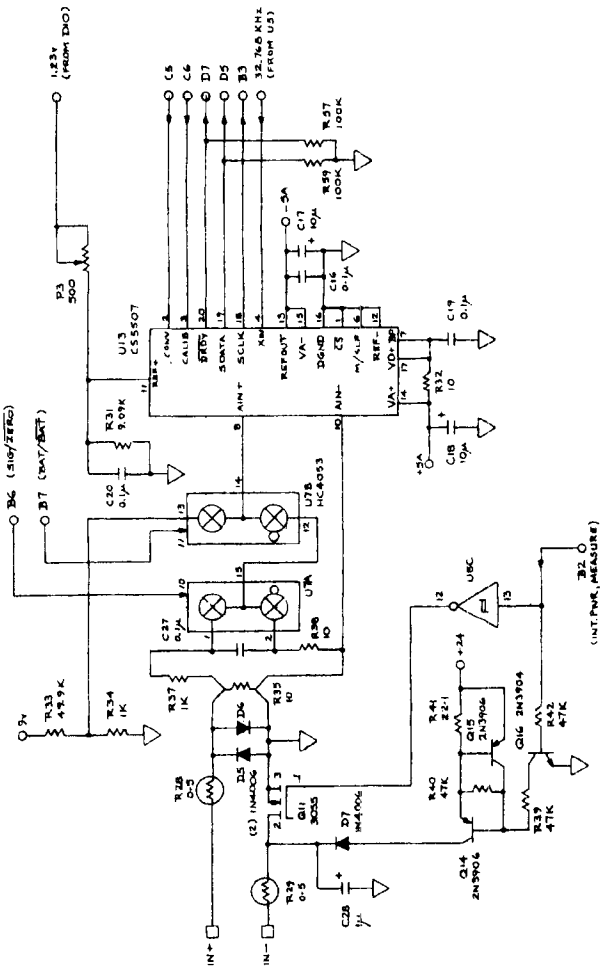
6. SCHEMATIC DIAGRAMS



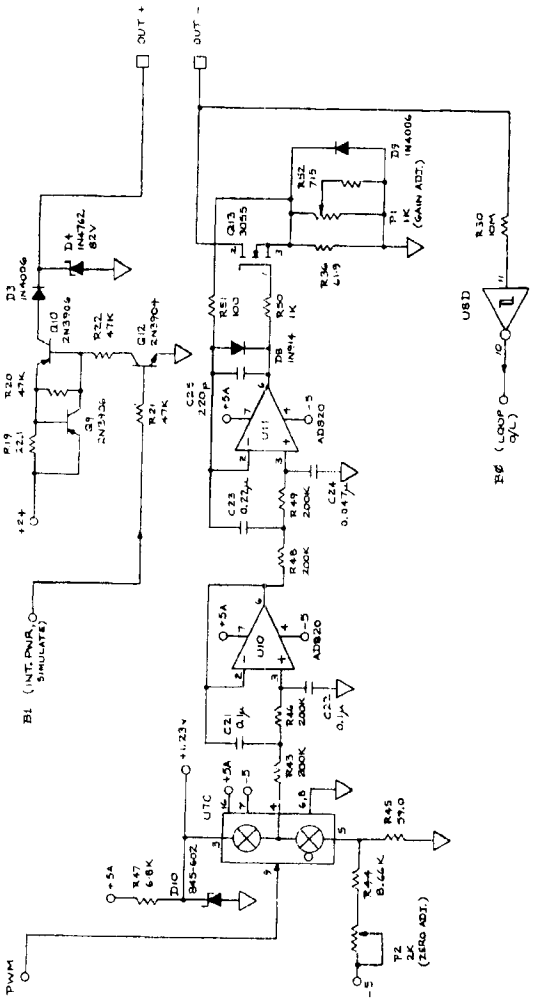
1. Power Supply



2. Microcomputer



3. Measure Signal Conditioning



4. Simulate Signal Conditioning

MADE IN USA

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3. Repair instructions and/or specific problems relative to the product.

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2. Model and serial number of product, and
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