

**Beckman Industrial™**

**CIRCUITMATE™ MODEL CM20A  
DIGITAL CAPACITANCE METER**

**Operator's Manual**

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INSTRUMENTATION PRODUCTS DIVISION  
BECKMAN INDUSTRIAL CORPORATION  
A SUBSIDIARY OF EMERSON ELECTRIC CO.  
BREA, CA 92621

Beckman Industrial Corp. Brea, CA 92621  
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# WARRANTY

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## 90-Day Limited Warranty

Circuitmate™ Model CM20A Digital Capacitance Meters are warranted in entirety against any defects of material or workmanship which develop for any reason whatsoever, except abuse, within a period of 90 days following the date of purchase of the capacitance meter by the original purchaser. This warranty is extended by Beckman Industrial Corp. only to the original purchaser or original user of the capacitance meter, who must, as a CONDITION PRECEDENT TO WARRANTY COVERAGE AND PERFORMANCE THEREUNDER BY BECKMAN INDUSTRIAL CORP., complete and return the Warranty Registration Card, received on purchase of the capacitance meter.

In the event a defect develops during the warranty period, Beckman Industrial Corp. will, at Beckman Industrial Corporation's election, repair or replace the capacitance meter with a new or reconditioned model of equivalent quality. In order to obtain performance of any obligation of Beckman Industrial Corp. under the warranty, the original purchaser or original user must return the defective capacitance meter, postage prepaid, along with a handling charge of \$3.00\* to:

Beckman Industrial Corp.  
630 Puente Street  
Brea, CA 92621  
Attention: Customer Service

In the event of replacement with a new or reconditioned model, the replacement unit will continue the warranty period of the original capacitance meter. The turnaround time for replacement units at the Service Center is typically only two (2) working days.

ANY IMPLIED WARRANTIES ARISING OUT OF THE SALE OF A CIRCUITMATE CAPACITANCE METER INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE ABOVE-STATED 90-DAY PERIOD. BECKMAN INDUSTRIAL CORP. SHALL NOT BE LIABLE FOR LOSS OF USE OF THE CAPACITANCE METER, OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, OR ECONOMIC LOSS, OR FOR ANY CLAIM OR CLAIMS FOR SUCH DAMAGE, EXPENSES, OR ECONOMIC LOSS.

*\*Prices are subject to change without notice*

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Some states do not allow limitations on how long implied warranties last or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

BECKMAN INDUSTRIAL CORP.  
Brea, California

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# Section One

## INTRODUCTION

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The Circuitmate™ Model CM20A is a 3½-digit handheld capacitance meter designed for use by technicians, servicemen, production workers, and quality control personnel as well as engineers. The LCD display design allows longer battery life than comparable LED designs. The meter can operate either on batteries or from an optional AC/DC adaptor, making it usable almost anywhere.

Standard features are:

1. Recessed 3½-Digit LCD Display
2. Overload Protection
3. Nine Ranges — 200pF to 20 mF
4. Front Panel Zero Adjust
5. Over-Range Indicator
6. Low Battery Indicator
7. Single Range Selector Switch
8. Banana Jacks as well as Lead Insertion Slots
9. Tilt Bail
10. AC/DC Adaptor Provisions

## **Section Two**

# **UNPACKING/SETUP**

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Remove the capacitance meter from the container. The box should contain following items:

1. Capacitance Meter.
2. Test lead set (one red, one black).
3. Operator's Manual.
4. 9-volt battery (located in battery compartment).
5. Two fuses (one installed and one spare).

### **CAUTION**

*Failure to turn off the instrument before installing the battery could result in damage to the instrument if it is connected to the battery with polarities reversed.*

Unpack the battery, which was placed in the battery compartment, and connect it to the battery snap. See Paragraph 5.1, Page 8.

# Section Three

## INSTRUMENT FEATURES

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For features described in this section, refer to Figure 1. It is strongly recommended that the user read and become familiar with the contents of this section before operating the device.

1. Digital LCD Display

Digital display has 3½ -digit readout (maximum reading 1999) with decimal point, over-range, and low battery indicators.

2. Power Switch

Use this switch to turn the instrument on and off.

3. Zero Adjust

Thumbwheel adjustment for zeroing out the test lead capacitance.

4. Range Switch

Selects the desired one of the eight available ranges.

5. Lead Insertion Slots

Spring contacts spaced for convenient insertion of capacitance leads. Make sure of correct polarity when measuring polarized capacitors.

6. Banana Jacks

For use with test leads; polarized for use with polarized capacitors.

7. Tilt Bail

The bail may be removed from its standard position by squeezing the two sides of the bail together and then reinserting the tips in the top holes, thus permitting the capacitance meter to hang in a vertical position.

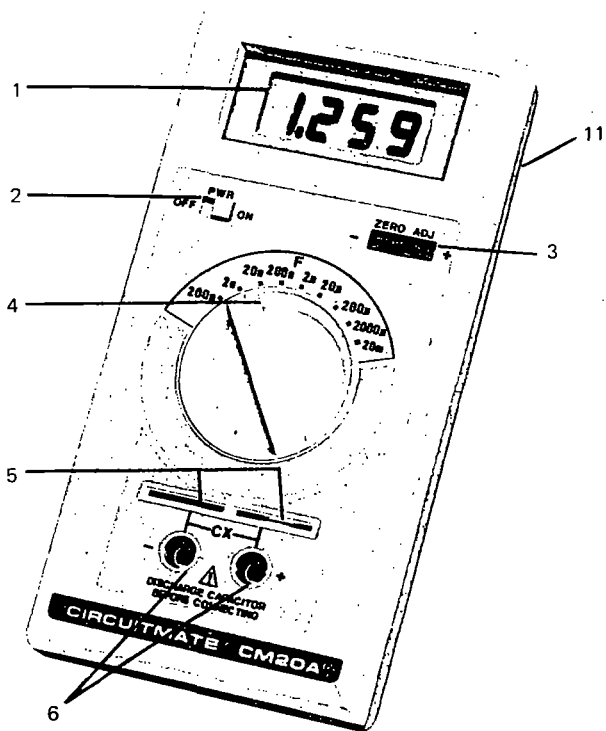


Figure 1. Circuitmate Model CM20A Digital Capacitance Meter



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8. Low Battery Indicator  
"LO BAT" displayed when battery voltage drops to 7.0VDC  $\pm 0.5$ VDC.
  9. Over-Range Indicator  
Most significant digit of "1" will be displayed, with trailing digits blanked.
  10. Anti-Skid Pads  
Provide anti-skid protection when the meter is either lying flat or standing with the bail.
  11. AC/DC Adaptor Jack  
Allows plug-in of the optional AC/DC adaptor so the meter can be powered from a mains voltage outlet .

# Section Four

## OPERATION

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### 4.1 MEASUREMENT PROCEDURE

1. Set Power Switch to "ON."
2. Select the range for the maximum expected capacitance. If the capacitance value is unknown, start with the 200pF range and keep increasing until the Over-Range Indicator goes off and a reading is obtained.
3. If test leads are to be used, insert them into the banana jacks and use the thumbwheel Zero Adjust to obtain a zero reading on the display.

#### CAUTION

*Discharge any capacitors **before** taking any measurements.*

*Never apply a voltage to the test lead input jacks or the capacitor lead insertion slots; failure to observe this precaution can result in serious damage to the meter.*

*Do **not** short test leads together; this will cause heavy consumption of battery power.*

4. Connect the capacitor to be measured to the test leads or insert the capacitor leads into the insertion slots. Make sure of correct polarities when measuring polarized capacitors.
5. Read the display. If the Over-Range Indicator comes on, select the next higher range. If the display has one or more leading zeros, shift to the next lower range to improve the resolution of the measurement.

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## 4.2 DISPLAY PATTERNS

1. After power to the meter is turned off, it may take a few seconds for disappearance of one or more of the following displays:

    "LO BAT" Indicator

    Erratic Readings

    Minus Sign (" - ")

All of the above displays are normal. The phenomenon is caused by internal filtering capacitors which were charged when power was on.

2. A shorted capacitor will read over-range on all ranges.
3. A capacitor with low voltage leakage will read over-range, or an abnormally high value.
4. An open capacitor will read zero on all ranges except possibly a few pF on the 200pF range.
5. A leaky capacitor is indicated by a significant change in the indicated capacitance when the range is changed.
6. Capacitors, especially electrolytics, often have notoriously wide manufacturing tolerances. Unless the capacitor is of a close-tolerance type, do not be surprised if the measured value is greater than the value marked on the capacitor. However, the actual value is seldom drastically below the rated value.

# Section Five

## SERVICING INSTRUCTIONS

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### 5.1 BATTERY/FUSE REPLACEMENT

#### WARNING

*To prevent electrical shock hazard, turn off capacitance meter and disconnect test leads before removing battery cover. To prevent fire, use only 0.25A/250V fuse.*

1. Remove battery cover by pressing down on it and pushing in the direction of the arrows.
2. Replace battery with a standard 9-volt transistor battery.  
Replace fuse with spare furnished with instrument.
3. Replace battery cover.

### 5.2 CASE AND WINDOW CLEANING

The case and window should be cleaned with a mild solution of detergent and water. Apply sparingly with a soft cloth and allow to dry completely before using.

#### CAUTION

*Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These chemicals will react with plastics used in instrument construction.*

### 5.3 RECALIBRATION

1. Perform calibration at an ambient temperature of  $23 \pm 2^{\circ}\text{C}$  and a relative humidity of 75% or less.  
Allow instrument to stabilize at this temperature for at least thirty minutes.
2. Remove the back cover from the instrument by removing the screws and then lifting off cover. **DO NOT** remove the shield.

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Set up the meter with the lead configuration to be used in the recalibration. Insert any test fixture (Kelvin clip, for example) or connect any leads to be used later. (Remember that even very short leads may have a significant effect.)

4. Turn the Range Switch on the Capacitance Meter to the 200pF position.
5. Adjust the front-panel zero adjust control for 000 display.
6. Connect a standard capacitor whose value is near fullscale on one of the higher ranges, and is known to within  $\pm 0.1\%$ . Suggested value is 19 nF.
7. Turn the Range Switch to the appropriate range scale.
8. Adjust VR1 (Figure 2) for a display equal to the known capacitance.
9. Remove the standard capacitor. Replace back cover.

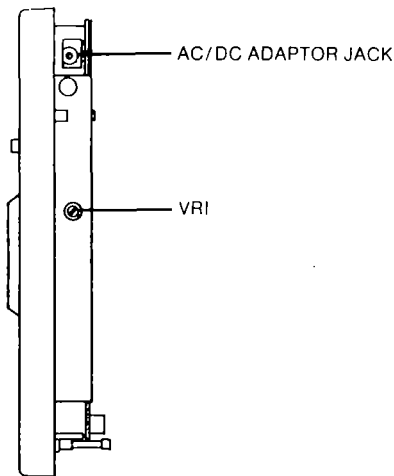


Figure 2. Right-hand Side View of Meter

#### 5.4 PARTS LIST FOR CIRCUITMATE CM20A LARGE BOARD ASSEMBLY

Item No.	Reference Designation	Beckman Industrial Part No.	Description	Qty
1	R1	3001-050-121	Metal Film Resistor 900K ohms $\pm 0.5\%$ $\frac{1}{8}W$ Select much $\pm 0.25\%$	1
2	R2	3001-050-120	Metal Film Resistor 90K ohms $\pm 0.5\%$ $\frac{1}{8}W$ Select much $\pm 0.25\%$	1
3	R3	3001-050-119	Metal Film Resistor 9K ohms $\pm 0.5\%$ $\frac{1}{8}W$ Select much $\pm 0.25\%$	1
4	R4	3001-050-118	Metal Film Resistor 900 ohms $\pm 0.5\%$ $\frac{1}{8}W$ Select much $\pm 0.25\%$	1
5	R5	3001-050-117	Metal Film Resistor 90 ohms $\pm 0.5\%$ $\frac{1}{8}W$ Select much $\pm 0.25\%$	1
6	R6	3001-050-116	Metal Film Resistor 9 ohms $\pm 1\%$ $\frac{1}{8}W$ Select much $\pm 0.5\%$	1
7	R7, 18	3001-010-102	Carbon Film Resistor 10K ohms $\pm 5\%$ $\frac{1}{8}W$	2
8	R8, 10, 11, 23, 25	3001-010-104	Carbon Film Resistor 100K ohms $\pm 5\%$ $\frac{1}{8}W$	5
9	R9	3001-010-223	Carbon Film Resistor 22K ohms $\pm 5\%$ $\frac{1}{8}W$	1
10	R12	3001-050-112	Metal Film Resistor 200K ohms $\pm 1\%$ $\frac{1}{8}W$	1
11	R13, 24	3001-050-113	Metal Film Resistor 100K ohms $\pm 1\%$ $\frac{1}{8}W$	2

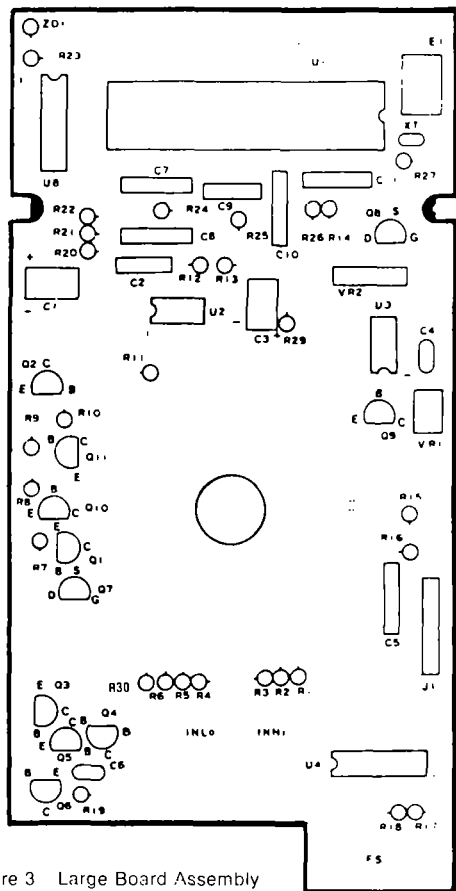


Figure 3 Large Board Assembly

Item No.	Reference Designation	Beckman Industrial Part No.	Description	Qty
12	R15	3001-050-114	Metal Film Resistor 79.6K ohms $\pm 1\%$ $\frac{1}{8}W$	1
13	R16	3001-050-115	Metal Film Resistor 9.09K ohms $\pm 1\%$ $\frac{1}{8}W$	1
14	R17, 20, 21, 22	3001-010-105	Carbon Film Resistor 1M ohms $\pm 5\%$ $\frac{1}{8}W$	4
15	R26	3001-010-824	Carbon Film Resistor 820K ohms $\pm 5\%$ $\frac{1}{8}W$	1
16	R19	3001-030-100	Carbon Film Resistor 10 ohms $\pm 5\%$ $\frac{1}{2}W$	1
17	R27	3001-050-131	Metal Film Resistor 1M ohms $\pm 2\%$ $\frac{1}{8}W$	1
18	R29	3001-010-473	Carbon Film Resistor 47K ohms $\pm 5\%$ $\frac{1}{8}W$	1
19	VR1	3001-090-103	Potentiometer 5K ohms $\pm 10\%$ 100ppm	1
20	VR2	3001-090-104	Variable Resistor 1M ohms $\pm 20\%$	1
21	C1, 3	3001-160-100	Electrolytic Capacitors $10\mu F$ $\begin{matrix} +80\% \\ -20\% \end{matrix}$ 16V	2
22	C2	3001-130-111	MPE Capacitor $0.1\mu F \pm 10\%$ 100V	1
23	C5, 7, 8, 10, 11	3001-130-112	MPE Capacitor $0.22\mu F \pm 10\%$ 100V	5



Item No.	Reference Designation	Beckman Industrial Part No.	Description	Qty
24	C9	3001-130-113	MPE Capacitor 0.47 $\mu$ F $\pm$ 10% 100V	1
25	C4	3001-100-106	Ceramic Capacitor 1000pF $\pm$ 10% 50V	1
26	C6	3001-100-108	Ceramic Capacitor 68pF $\pm$ 5% 50V	1
27	Q7	3001-250-107	JFET J305	1
28	Q8	3001-250-108	JFET J113	1
29	Q1, 4, 5, 6	3001-250-106	Transistors 8050	4
30	Q2, 3	3001-250-104	Transistors 8550	2
31	Q9, 11	3001-250-105	Transistors 1402	2
32	Q10	3001-250-109	Transistor 9015	1
33	U1	3001-270-125	I.C. 7106CPL	1
34	U2, 3	3001-270-118	I.C. TL062CP	2
35	U4	3001-270-119	I.C. HD14016	1
36	U8	3001-270-120	I.C. HD14070	1
37	ZD1	3001-230-100	Diode, Zener	1
38	X'TAL	3001-360-100	Quartz Crystal	1
39	E1	3001-350-100	Battery Eliminator	1
40	R30		<b>Metal Film Resistor 1 Ohm</b> $\pm$ 0.5% 1/8W, Sorting From 1%.	1

## 5.5 PARTS LIST FOR CIRCUITMATE CM20 SMALL BOARD ASSEMBLY

Item No.	Reference Designation	Beckman Industrial Part No.	Description	Qty
1	D1	3001-200-101	Diode, 1N4001	1
2	C12, 14	3001-160-100	Electrolytic Capacitors $10\mu\text{F}$ $\begin{matrix} +80 \\ -20 \end{matrix} \%$ 16V	2
3	R28	3001-010-104	Carbon Film Resistor 100K $\pm 5\%$ $\frac{1}{8}\text{W}$	1
4	C13	3001-100-105	Ceramic Capacitor $100\text{pF} \pm 5\%$ 50V	1
5	U5, 6	3001-270-121	I.C. CD4518	2
6	U7	3001-270-122	I.C. CD4017	1
7		3001-370-105	Cable, Flex 7 pins	
8	C14	3001-160-101	Electrolytic Capacitor $1\mu\text{F}$ $\begin{matrix} +80 \\ -20 \end{matrix} \%$ 16V	1

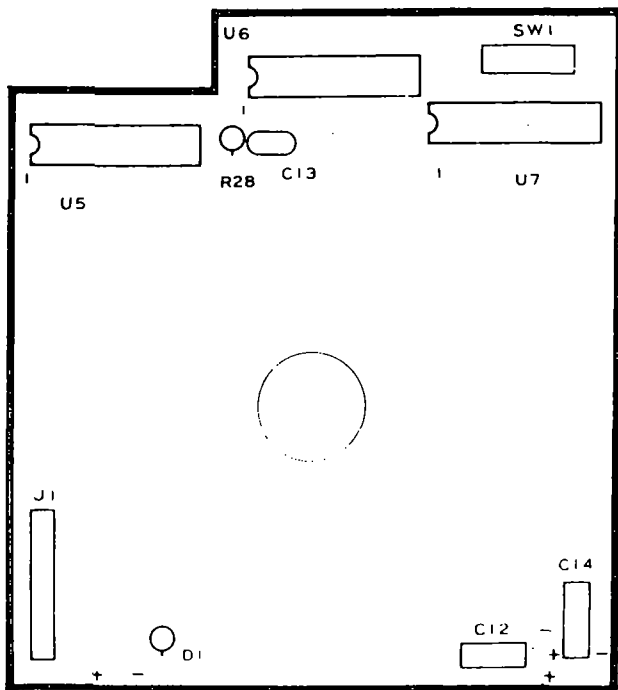


Figure 4. Small Board Assembly

# Section Six

## SPECIFICATIONS

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**Specifications are subject to change without notice.**

### 6.1 GENERAL SPECIFICATIONS

- |                        |   |
|------------------------|---|
| Display                | • 3½ -digit liquid crystal display (LCD) with a maximum reading of 1999.                            |
| Overload indication    | • Most significant digit of "1" displayed, with all trailing zeros blanked.                         |
| Low battery indication | • "LO BAT" displayed when battery voltage drops below 7.0VDC $\pm$ 0.5VDC.                          |
| Measurement rate       | • 2.5 measurements per second, nominal.   |
| Operating temperature  | • 0°C to +35°C 0-80% RH<br>+35°C to +50°C 0-70% RH  |
| Storage temperature    | • -20°C to +65°C 0-90% RH with battery removed.   |
| Accuracy               | • Accuracy specified at 23 $\pm$ 5°C, less than 75% RH.   |
| Power                  | • Single, standard 9-volt transistor battery, NEDA 1604, JIS 006P, IEC 6F22.                        |
| Battery Life           | • Approximately 100 hours on alkaline battery or 75 hours on carbon-zinc battery with normal usage. |
| Dimensions             | • 6.85 inches (17.4 cm) long<br>× 3.55 inches (9.0 cm) wide<br>× 1.4 inches (3.6 cm) high.          |
| Weight                 | • 12 ounces (355 grams) including battery.  |
| Accessories            | • Test leads (pair), spare fuse (0.25A), battery, operator's manual, AC/DC adaptor (optional).      |

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## 6.2 ELECTRICAL SPECIFICATIONS

(At 23°C ±5°C, 75% RH maximum.)

Range accuracy	200pF	±0.5% reading, plus 1 count plus 0.5pF
	2nF	±0.5% reading, plus 1 count plus 0.5pF
	20nF	±0.5% reading, plus 1 count plus 0.5pF
	200nF	±0.5% reading, plus 1 count plus 0.5pF
	2 $\mu$ F	±0.5% reading, plus 1 count plus 0.5pF
	20 $\mu$ F	±0.5% reading, plus 1 count plus 0.5pF
	200 $\mu$ F	±1.0% reading, plus 1 count
	2000 $\mu$ F	±2.0% reading, plus 1 count
	20mF	±2.0% reading, plus 1 count
Range resolution	200pF	0.1pF
	2nF	1pF
	20nF	10pF
	200nF	100pF
	2 $\mu$ F	1000pF
	20 $\mu$ F	0.01 $\mu$ F
	200 $\mu$ F	0.1 $\mu$ F
	2000 $\mu$ F	1 $\mu$ F
	20mF	10 $\mu$ F
Battery current	3.0 mADC max.	if no capacitor load
	25.0 mADC max.	if max. capacitor load
Zero adjust range	20pF minimum	
Excitation voltage	3.2VAC maximum	

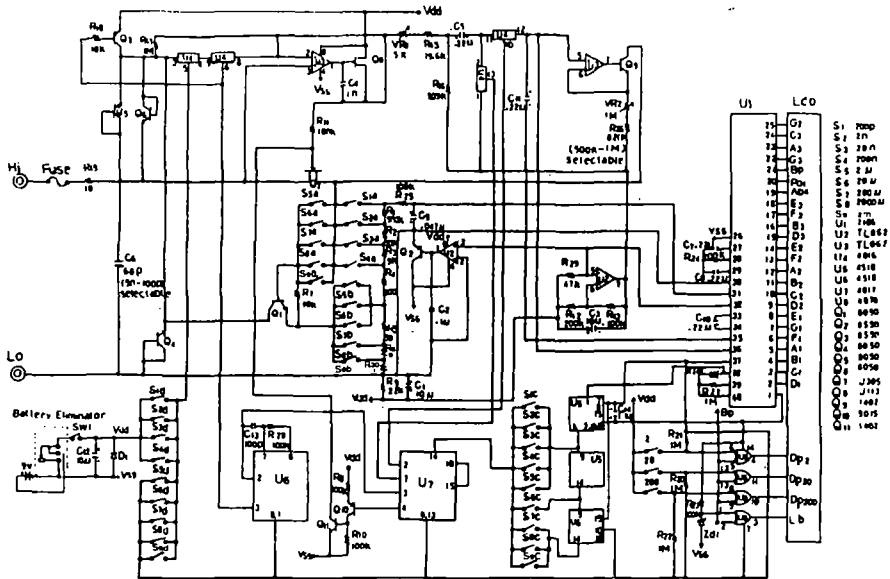


Figure 5. Schematic Wiring Diagram of CM20A

