2-1974

Macromodular Computer Design, Part 2, Volume 02, Electronic Package Assembly

Computer Systems Laboratory, Washington University

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MACROMODULAR
COMPUTER DESIGN
PART 2
MANUFACTURING DESCRIPTION

VOLUME II
ELECTRONIC PACKAGE ASSEMBLY

Technical Report No. 31

FINAL REPORT - FEBRUARY, 1974
CONTRACT SD-302 (ARPA)
COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI
This work has been supported by the Advanced Research Projects Agency of the Department of Defense under Contract SD-302 and by the Division of Research Facilities and Resources of the National Institutes of Health under Grant RR-00396. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies either expressed or implied, of the Advanced Research Projects Agency or the U.S. Government.

Computer Systems Laboratory
Washington University
St. Louis, Missouri
ABSTRACT

Manufacturing documents, including parts lists, assembly pictorials, and adjustment procedures for the LOGIC, ARITHMETIC, SHIFT, COMPARE and REGISTER macro-module electronic subassemblies are given.
INDEX

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**COMPUTER SYSTEMS LABORATORY**
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

**MACROMODULAR PROJECT**

**COMPONENT IDENTIFICATION**

**TITLE**
POWER SUPPLY BOARD ASSEMBLY

**DRAWING NO.**
200.5D1

**APPROVED**

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TWO REQUIRED
TYPE LOCATION
MPS-T1 T1
MPS-T2 T2

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TYPE LOCATION
SPRAGUE ALUMINUM
600D 256 6060 DD4 C1
SPRAGUE TANTALUM
150D 475X 0050 BZ C2
SPRAGUE TANTALUM
150D 19X 0056 R2 C4

INDUCTORS
TWO REQUIRED
TYPE LOCATION
MPS-L1 L1
MPS-L2 L2

TRANSISTORS
TWO REQUIRED
TYPE LOCATION
RCA 40374 Q1

DIODES
SIX REQUIRED
TYPE LOCATION
MOTOROLA MR810 D1
D2
D3
D4
MOTOROLA SR1922A D5
D6

RESISTORS
THREE REQUIRED
5% CARBON COMP.
TYPE LOCATION
13 K OHM 1/2 W R1
75 OHM 1/2 W R2

CONNECTORS
17 REQUIRED
AMPMODU 85863-4

PRINTED CIRCUIT BOARD
ONE REQUIRED
PTV 0081-0

NOTE:

MPS-T2-78 USED IN FOLLOWING MODULES:
LOGIC
ADDITION
SHIFT
COMPARE
DECODE

MPS-T2-79 USED IN FOLLOWING MODULES:
REGISTER
LOAD
FUNCTION CALLER

MPS-T2-81 USED IN FOLLOWING MODULES:
CALL
MERGE/RENDEZVOUS
DATA BRANCH
INTERLOCK

COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

TITLE PARTS LIST
POWER SUPPLY BOARD

APPROVED ENGR. DRAWING NO.
BY FOR DATE
Comm MANUF. 245670 200.502

CHECKED DATE 3/23/70
INDUCTOR DESCRIPTION AND SPECIFICATION

Part Number MPS-L1
Inductor Description:

The inductor is a single layer coil of 35 ±1 turns of number 24 magnet wire wound on a *Magnetics Incorporated permalloy power toroidal core number 55118-A2. The magnet wire is insulated with polyurethane (sodereze or equal) for 90°C operation.

The wound inductor is potted in a **Milton Ross shell 50071 and header 60200 with Scotcheast number 222 polyurethane resin. The two leads of the wound inductor extend through the header as shown in the figure. The leads extend through the header a minimum of 0.25 inches and, beginning at a distance of 0.05 inch from the package, are tinned.

The characters "MPS-L1" in white at least 0.1 inch high appear on the top of the package.

Finished Inductor Specifications:

I. Identification: The characters "MPS-L1" in white at least 0.1 inch high will appear on the top of the inductor package and shall remain readable after hard rubbing with thumb.

II. Inductance: The inductance of the inductor shall be \( L_p > 100 \mu \text{H} \) and \( Q > 8 \) when measured on a General Radio type 1650-A impedance bridge. The bridge controls are set to: OSC LEVEL control adjusted for maximum output; the function switch to INT 1 KC; the CRL SELECTOR to \( L_p \); and the CRL MULTIPLIER to 100\( \mu \text{H} \).

---

*Magnetics Incorporated
Butler, Pa. 16001

**Milton Ross Company
511 Second Street Pike Box 158
Southampton, Pa. 18966
PSS-2

COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY

INDUCTOR DESCRIPTION AND SPECIFICATION

Part Number MPS-L2
Inductor Description:

The inductor is a single layer coil of 20 ±1 turns of number 20 magnet wire wound on a *Magnetics Incorporated permalloy power toroidal core number 55118-A2. The magnet wire is insulated with polyurethane (sodereze or equal) for 90°C operation.

The wound inductor is potted in a **Milton Ross shell 50071 and header 60200 with Scotchest number 222 polyurethane resin. The two leads of the wound inductor extend through the header as shown in the figure. The leads extend through the header a minimum of 0.25 inches and, beginning at a distance of 0.05 inch from the package, are tinned.

The characters "MPS-L2" in white, at least 0.1 inch high, appear on the top of the package.

Finished Inductor Specifications:

I. Identification: The characters "MPS-L2" in white at least 0.1 inch high will appear on the top of the inductor package and shall remain readable after hard rubbing with thumb.

II. Inductance: The inductance of the inductor shall be Lp>30µH and Q>8 when measured on a General Radio type 1650-A impedance bridge. The bridge controls are set to: OSC LEVEL control adjusted for maximum output; the function switch to INT 1 KC; the CRL SELECTOR to Lp; and the CRL MULTIPLIER to 100µH.

*Magnetics Incorporated
Butler, Pa. 16001

**Milton Ross Company
511 South Street Pike Box 158
Southampton, Pa. 18966

200.5D2D
PSS-3

COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY

TIMING TRANSFORMER DESCRIPTION AND SPECIFICATION
Part Number MPS-T1
Transformer Description:

The transformer core is an *Indiana General toroidal ferrite core number CF-102-C2 that has been coated with paint to reduce scratching of the wire wound on the core. Windings T1 and T2 of Figure 1 form an 16 turn bifilar winding of number 30 copper wire which is uniformly distributed around core. Windings T3 and T4 form a second bifilar winding of 3 turns of number 30 copper wire which is uniformly distributed around the core. The copper wire insulation will be polyurethane-nylon cover coat (Nyleze or better for 125°C operation).

The wound transformer is installed in a **Epoxy Products Company shell 173-02-10-43A and header 068-02-10-43A. Two of the 9 pins in the header 068-02-10-43A are cut off above and below the header per Figure 2. A piece of number 3 mylar tape or equivalent is placed over the cut pins to protect the transformer windings from scratches. The transformer leads are soldered to the header pins per Figures 1 and 3. The pin numbers used in Figure 3 are the same as the lead numbers of Figure 1. The assembled transformer is filled with Scotcheast number 212 red potting compound.

A sample of 5 Indiana General cores from each shipment received by the vendor shall be forwarded to the Computer Components Laboratory for tests before the transformers are assembled.

Finished Transformer Specifications:

I. Identification: The characters "MPS-T1" at least 0.1 inches high will appear on the transformer and shall remain readable after hard rubbing with thumb.

II. Turns: The number of turns on each winding must be exact:

a. T1 = 16 turns
b. T2 = 16 turns
c. T3 = 3 turns
d. T4 = 3 turns

*Indiana General
Electronics Div/Ferrites
Keasbey, New Jersey

**Epoxy Products Company
Div of Allied Products Corp
119 Coit Street
Irvington, New Jersey
III. High Voltage Breakdown: Less than 0.1 milliampere shall flow when 200 $V_{RMS}$ AC is applied for one minute across:

a. pins 1, 2 and 3 shorted together and pins 4 and 5 shorted together.

b. pins 1, 2 and 3 shorted together and pins 6 and 7 shorted together.

c. pins 4 and 5 shorted together and pins 6 and 7 shorted together.

![Figure 1](image-url)
Figure 2

Figure 3
POWER TRANSFORMER DESCRIPTION AND SPECIFICATION

Part Number MPS-T2-78
Transformer Description:

The coil form is a *Ferroxcube type number 2616PCB1 printed circuit bobbin.

Windings T1 and T2 are first wound on the bobbin as a 78 turn bifilar winding of number 30 copper wire uniformly covering the length of the bobbin. Next, windings T3 and T4 are wound on the bobbin as a 6 turn bifilar winding of number 30 copper wire. A single layer of tape (Mylar or equivalent) less than 0.007 inch thick is then placed over the windings. Windings T5 and T6 are then wound on the bobbin as a 9 turn bifilar winding of number 20 copper wire. The wire insulation shall be polyurethane nylon overcoat (Nyleze) or better for 120°C operation.

Windings T1, T2, T3 and T4 are connected to the bobbins' pins as shown in Figures 1 and 2. The ends of windings T5 and T6 extend out the side shown in Figure 2 and are 0.7 to 1.0 inch long. Wires 8A and 8B must be identified together. Wires 7 and 9 need not be individually identified.

The wound bobbin is then placed inside two *Ferroxcube number 2616P-L00-3B7 flat ground half-pot cores. The cores are then cemented together, with the center posts of the cores aligned, using Biggs R-312 epoxy cement. The two slits in the side of the transformer are both completely filled with a rigid epoxy such as **Mista Pox 103. The completed transformer is then sprayed with a light coat of clear varnish.

Finished Transformer Specifications:

I. Identification: The characters "MPS-T2-78" at least 0.1 inches high will appear on the transformer and shall remain readable after hard rubbing with thumb.

*Ferroxcube Corporation
Saugerties, New York

**M and R Plastics and Coatings, Inc.
11460 Dorsett Road
Maryland Heights, Mo. 63042

200.5D2J
II. Turns: The number of turns on each winding must be exact:
   a. T1 = 78 turns
   b. T2 = 78 turns
   c. T3 = 6 turns
   d. T4 = 6 turns
   e. T5 = 9 turns
   f. T6 = 9 turns

III. Inductance: The inductance between pins 1 and 2 shall be \( L_p > 16 \, \text{mhy} \) and \( Q > 15 \) with all other windings open circuited when measured on a General Radio type 1650-A impedance bridge. The bridge controls are set to: OSC LEVEL control adjusted for maximum output; the function switch to INT 1 KC; the CRL SELECTOR to \( L_p \); and the CRL MULTIPLIER to 10 mH.

IV. High Voltage Breakdown: Less than 0.1 milliampere shall flow when 200 V\(_{\text{RMS}}\) AC is applied for one minute across pins 1, 2 and 3 shorted together and pins 4, 5 and 6 shorted together.

Less than 0.1 milliampere shall flow when 500 V\(_{\text{RMS}}\) AC is applied for one minute across:
   a. pins 1, 2, 3, 4, 5 and 6 shorted together and wires 7, 8A, 8B and 9 shorted together.
   b. pins 1, 2, 3, 4, 5 and 6 with wires 7, 8A, 8B and 9 all shorted together and the core.
Figure 1

T1 = 78 Turns of #30 Wire

T2 = 78 Turns of #30 Wire

T3 = 6 Turns of #30 Wire

T4 = 6 Turns of #30 Wire

T5 = 9 Turns of #20 Wire

T6 = 9 Turns of #20 Wire

Note Tab

Top View

Figure 2

200.5D2L
Transformer Description:

The coil form is a *Ferroxcube type number 2616PCB1 printed circuit bobbin. Windings T1 and T2 are first wound on the bobbin as a 79 turn bifilar winding of number 30 copper wire uniformly covering the length of the bobbin. Next, windings T3 and T4 are wound on the bobbin as a 6 turn bifilar winding of number 30 copper wire. A single layer of tape (Mylar or equivalent) less than 0.007 inch thick is then placed over the windings. Windings T5 and T6 are then wound on the bobbin as a 9 turn bifilar winding of number 20 copper wire. The wire insulation shall be polyurethane nylon overcoat (Nyleze) or better for 120°C operation.

Windings T1, T2, T3 and T4 are connected to the bobbins' pins as shown in Figures 1 and 2. The ends of windings T5 and T6 extend out the side shown in Figure 2 and are 0.7 to 1.0 inch long. Wires 8A and 8B must be identified together. Wires 7 and 9 need not be individually identified.

The wound bobbin is then placed inside two *Ferroxcube number 2616P-L00-3B7 flat ground half-pot cores. The cores are then cemented together, with the center posts of the cores aligned, using Biggs R-312 epoxy cement. The two slits in the side of the transformer are both completely filled with a rigid epoxy such as **Mista Pox 103. The completed transformer is then sprayed with a light coat of clear varnish.

Finished Transformer Specifications:

I. Identification: The characters "MPS-T2-79" at least 0.1 inches high will appear on the transformer and shall remain readable after hard rubbing with thumb. The style "9" used shall be easily distinguished from an "8".

*Ferroxcube Corporation
Saugerties, New York

**M and R Plastics and Coatings, Inc.
11460 Dorsett Road
Maryland Heights, Mo. 63042

200.5D2N
II. Turns: The number of turns on each winding must be exact:
   a. T1 = 79 turns
   b. T2 = 79 turns
   c. T3 = 6 turns
   d. T4 = 6 turns
   e. T5 = 9 turns
   f. T6 = 9 turns

III. Inductance: The inductance between pins 1 and 2 shall be \( L_p > 16 \text{mH} \) and \( Q > 15 \) with all other windings open circuited when measured on a General Radio type 1650-A impedance bridge. The bridge controls are set to: OSC LEVEL control adjusted for maximum output; the function switch to INT 1 KC; the CRL SELECTOR to \( L_p \); and the CRL MULTIPLIER to 10 mH.

IV. High Voltage Breakdown: Less than 0.1 milliampere shall flow when 200 V\(_{\text{RMS}}\) AC is applied for one minute across pins 1, 2 and 3 shorted together and pins 4, 5 and 6 shorted together.

Less than 0.1 milliampere shall flow when 500 V\(_{\text{RMS}}\) AC is applied for one minute across:
   a. pins 1, 2, 3, 4, 5 and 6 shorted together and wires 7, 8A, 8B and 9 shorted together.
   b. pins 1, 2, 3, 4, 5 and 6 with wires 7, 8A, 8B and 9 all shorted together and the core.
Figure 1

Note Tab

Top View

Figure 2
PSS-8

COMPUTER SYSTEMS LABORATORY

WASHINGTON UNIVERSITY

POWER TRANSFORMER DESCRIPTION AND SPECIFICATION

Part Number MPS-T2-81
Transformer Description:

The coil form is a *Ferroxcube type number 2616PCB1 printed circuit bobbin. Windings T1 and T2 are first wound on the bobbin as an 81 turn bifilar winding of number 30 copper wire uniformly covering the length of the bobbin. Next, windings T3 and T4 are wound on the bobbin as a 6 turn bifilar winding of number 30 copper wire. A single layer of mylar tape 0.003 to 0.007 inch thick is then placed over the windings. Windings T5 and T6 are then wound on the bobbin as a 9 turn bifilar winding of number 22 copper wire. The wire insulation shall be polyurethane nylon overcoat (Nyleze) for 120°C operation.

Windings T1, T2, T3, and T4 are connected to the bobbins' pins as shown in Figures 1 and 2. The ends of windings T5 and T6 extend out the side shown in Figure 2 and are 0.7 to 1.0 inch long. Wires 8A and 8B must be identified together. Wires 7 and 9 need not be individually identified.

The wound bobbin is then placed inside two *Ferroxcube number 2616-L00-3B7 flat ground half-pot cores. The cores are then cemented together, with the center posts of the cores aligned, using Biggs R-312 epoxy cement. The two slits in the side of the transformer are both completely filled with a rigid epoxy such as **Mista Pox 103. The completed transformer is then sprayed with a light coat of clear varnish.

Finished Transformer Specifications:

I. Identification: The characters "MPS-T2-81" at least 0.1 inches high will appear on the transformer and shall remain readable after hard rubbing with thumb. The style "8" used shall be easily distinguished from a "9".

*Ferroxcube Corporation
Saugerties, New York

**M and R Plastics and Coatings, Inc.
11460 Dorsett Road
Maryland Heights, Mo. 63042

200.5D2R
II. Turns: The number of turns on each winding must be exact:
   a. $T_1 = 81$ turns
   b. $T_2 = 81$ turns
   c. $T_3 = 6$ turns
   d. $T_4 = 6$ turns
   e. $T_5 = 9$ turns
   f. $T_6 = 9$ turns

III. Inductance: The inductance between pins 1 and 2 shall be $L_p > 16\text{mhy}$ and $Q > 15$ with all other windings open circuited when measured on a General Radio type 1650-A impedance bridge. The bridge controls are set to: OSC LEVEL control adjusted for maximum output; the function switch to INT 1 KC; the CRL SELECTOR to $L_p$; and the CRL MULTIPLIER to 10 mH.

IV. High Voltage Breakdown: Less than 0.1 milliampere shall flow when $200\ V_{\text{RMS}}$ AC is applied for one minute across pins 1, 2 and 3 shorted together and pins 4, 5 and 6 shorted together.

   Less than 0.1 milliampere shall flow when $500\ V_{\text{RMS}}$ AC is applied for one minute across:
   a. pins 1, 2, 3, 4, 5 and 6 shorted together and wires 7, 8A, 8B and 9 shorted together.
   b. pins 1, 2, 3, 4, 5 and 6 with wires 7, 8A, 8B and 9 all shorted together and the core.
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**NOTE**
R0 = JUMPERS ZERO OHM
R1 = 15K OHM 1% FILM RESISTOR
R3 = 121 OHMS 1% FILM RESISTOR
R4 = 15K OHMS 5% CARBON COMP.

---

**COMPUTER SYSTEMS LABORATORY**
**WASHINGTON UNIVERSITY**
**ST. LOUIS, MISSOURI**

**MACROMODULAR PROJECT**

**PARTS LIST**
**TRANSFER CONTROL BOARD**
**PART NO. 200.9**

**APPROVED**
**ENQ.**
**DRAWING NO.**
**200.902**

**CHECKED**
**DATE:**
**7-15-71**
NOTE: INSTALL FEMALE AMP MODU CONNECTORS EXACTLY AS SHOWN ON DRAWING 200.5002.
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**CONNECTORS**
- AMPMODU NO. 85863-4
- 57 REQUIRED

**JUMPERS**
- R0 15K 1% FILM RESISTOR
- R1 150 OHM 1% FILM RESISTOR
- R2 121 OHM 1% FILM RESISTOR
- R4 15K OHM 5% CARBON COMP.
200.1
ONE CELL CASE
ASSEMBLY

201.8
PTT0057-1

201.5
PTL0056-1

201.9
201.9
200.9
201.2
200.13
200.5
PTV086-1
PTV025-0
PTV025-0
PTV025-0
PTV086-1

201.6
PTF0055-1

201.7
PTB0059-1

KEY STOP
LEFT HAND SHROUD

MACROMODULAR PROJECT

THE ASSEMBLY SCHEMATIC & PARTS LIST
LOGIC FUNCTION UNIT
PART NO. 201

COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

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APPROVED BY
NTK

WAC 201.0D
PLL

DECLARED IN

11/16/73

3-28-70
NOTE: INSTALL FEMALE AMPMODU CONNECTORS EXACTLY AS SHOWN ON Dwg. 200.5002.
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<tr>
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NOTE:
- R9 - JUMPER
- R1 = 1.5K OHM 1% FILM RESISTOR
- R2 = 750 OHM 1% FILM RESISTOR
- R3 = 12K OHM 1% FILM RESISTOR
- R5 = 57.6 OHM 1% FILM RESISTOR
- 18 pf DIPPED SILVER MICA 5%

COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI
MACROMODULAR PROJECT

PARTS LIST
LOGIC MODULE CONTROL BOARD
PART NUMBER 201.2

<table>
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DATE: 7-27-71
E.C.O. 0207
Test Procedure

Logic Module Control Board #201.2

This board contains one critical delay whose proper value must be checked on each board prior to assembly into a Logic Module.

The delay value must be longer than a specified minimum value. If the delay value is excessively large, the operation of the module will be needlessly slowed down. If the delay value is excessively short, the module may perform incorrectly under certain conditions.

Procedure

Tie pins L3 and T31 high and tie pins F2, F3, F4 and F5 to -5.2 volts. Apply a square wave signal with a period of 300 nanoseconds or greater to pin T31. The signal should have a rise and fall time not greater than 10 nanoseconds. Observe the waveform at pin T31 with channel one of a 454 oscilloscope. Observe the waveform at pin L2 with the second channel. The delay between the two waveforms, measured from mid-point of each transition, should be 56 nanoseconds or greater. The delay should be observed for both positive and negative going transitions, and both should be 56 nanoseconds or greater. If the smaller of the two delays is less than 56 ns, increase the value of C9 and C38. If the smaller of the two delays is greater than 65 nanoseconds the value of C9 and C38 should be reduced.

The final capacitor values and the measured delays for each board should be recorded on the test sheet provided for that board, along with the serial number of the board.

The circuit board should be carefully inspected to insure that the foregoing procedure has not resulted in damage to the circuit board, particularly in the areas where fresh soldering has taken place. All flux residues should be thoroughly removed.

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<td>11-16-73</td>
<td>11/5</td>
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201.2D4
METALCRAFT "AUTOGRAPH" OR EQUIVALENT:
BLANK SIZE: 4" X 2" SHEARED WITH
SQUARE CORNERS, BLACK LETTERS,
VOGUE BOLD 12 POINT BOLD FACE TYPE
CENTERED TOP, BOTTOM AND SIDES WITH 6
POINT SPACING ON LIGHT BROWN PMS 466
BACKING. MANUFACTURED FROM .016
THICK ALUMINUM WITH SOLVENT ACTIVATED
PERMANENT ADHESIVE BACKING.

NOTE: PANTONE MATCHING SYSTEM (PMS)

| COMPUTER SYSTEMS LABORATORY |
| WASHINGTON UNIVERSITY |
| ST. LOUIS, MISSOURI |

**MACROMODULAR PROJECT**

<table>
<thead>
<tr>
<th>TITLE</th>
<th>IDENTIFICATION LABEL</th>
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<tr>
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<td>MWAR</td>
<td>6-16-70</td>
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By F. DATE NTK W. 20 4D KM I.CHEKED DATE _I,_ 6-16-70
NOTE: AMPMODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DRAWINGS 200.50D1 AND 200.50D2. (35 PINS)

NOTE: SEE DRAWING NUMBER 200.50D28 FOR CONNECTOR MOUNTING ORIENTATION.
JUMPERS
SIX REQUIRED
R05
R06
R07
R08
R09
R10

RESISTOR 250K OHM 1% FILM
R12

FUSE BUSSMAN GFA 1/4 AMP
ONE REQUIRED
R11

AMP CONNECTOR
563 464-1
ONE REQUIRED

CONNECTORS
AMPMODU NO. 85931-1
FIFTY-FOUR REQUIRED

CIRCUIT BOARD
PTL0005-1
ONE REQUIRED
NOTE:
MALE AMPMODU PINS MUST BE INSTALLED FROM THIS SIDE
IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DRAWINGS
200.50D1 AND 200.50D2.
(85 PINS)

NOTE:
SEE DRAWING NUMBER 200.50D29 FOR
CONNECTION MOUNTING ORIENTATION.

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ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

TITLE
LOGIC FACEPLATE MOTHERBOARD CONNECTOR ASSEMBLY
PART NO. 201.6

COMPONENT IDENTIFICATION

DRAWN BY
C. M. RYK
2-7-71

CHECKED
N. K.
11-17-70

APPROVED
C. M. RYK
2-7-71

DATE
2-7-71

DLS
201.50D1

E. C. O. 0082
11-13-70

CHANGE NO.
2

DATE
11-13-70

DESCRIPTION
**AMP CONNECTOR**
533 464-1
ONE REQUIRED

**RESISTORS 15K OHM 5% 1/4WATT CARBON**
TWO REQUIRED
R01
R02

**SPRAGUE NETWORK LTN-2**
SEVEN REQUIRED
N01
N02
N03
N04
N05
N06
N07

**CIRCUIT BOARD**
PTF0058-1
ONE REQUIRED

**CONNECTOR**
AMPMODU NO. 85331-5
EIGHTY-FIVE REQUIRED

---

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**MACROMODULAR PROJECT**

**COMPUTER SYSTEMS LABORATORY**
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

**PARTS LIST**
FACEPLATE MOTHERBOARD CONNECTOR ASSEMBLY
PART NO. 201.5

---

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**CHECKED**
10/14/70
NOTE: MALE AMP/3019 PINs MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DWGS.
200.5001 AND 200.5002.
(88 Pins)

NOTE: SEE DRAWING NUMBER 200.50027 FOR CONNECTOR MOUNTING ORIENTATION.
AMP CONNECTOR
1-202845-5
ONE REQUIRED

CONNECTORS
AMPMODU NO. 85331-5
EIGHTY EIGHT REQUIRED

CIRCUIT BOARD
PTB0093-1
ONE REQUIRED
NOTE: SEE DRAWING NUMBER 200.50D26 FOR CONNECTOR MOUNTING ORIENTATION.

NOTE: MALE AMPMODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DWGS. 200.50D1 AND 200.50D2.
(106 PINS)
AMP CONNECTOR
1-202845-5
ONE REQUIRED

CONNECTORS
AMPMODU NO. 85931-5
ONE HUNDRED SIX REQUIRED

JUMPERS
TWO REQUIRED
R00
R01

CIRCUIT BOARD
PTT0057-1
ONE REQUIRED

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WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

PARTS LIST
LOGIC TOP MOTHERBOARD ASSEMBLY
PART NO. 201.8

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10/23/70
10/14/70
NOTE:
INSTALL FEMALE AMPMODU CONNECTORS EXACTLY AS SHOWN ON DWG. 200.5002.
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<td>R0 2 R21</td>
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<td>R2 27 R28 R29 R30</td>
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<td>M20 2 P15 P17</td>
<td>R3 16 R01 R02 R03</td>
<td>ONE REQUIRED</td>
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**CAPACITORS**

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*SPRAGUE TYPE CK-103 CERAMIC DISC 50WVDC

NOTE:

RO = JUMPERS
R1 = 1.5K OHM 1% FILM RESISTOR
R3 = 121 OHM 1% FILM RESISTOR
INSTALL FEMALE AMPMODU
CONNECTORS EXACTLY AS
SHOWN ON DRAWING 200.502
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<td>1</td>
<td>P9</td>
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<tr>
<td>M31</td>
<td>1</td>
<td>P14</td>
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</table>

**NOTE:**
- R0 = JUMPERS
- R1 = 1.5K OHM 1% FILM RESISTOR
- R3 = 121 OHM 1% FILM RESISTOR

**Computer Systems Laboratory**
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

**Macromodular Project**

**Title:** Parts List
**Addition Data Board**
**Part No. 202.1**

**Approved:**
- MANUF. 2/24/70
- ENG. 3/24/70
- DRAWN BY 4/23/70

**Checked:**
- MF 6/24/70
### Integrated Circuits

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### Resistors

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### Capacitors *

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<td>820 pf</td>
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<td>C3</td>
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</table>

* Dipped silver mica 5% - 50 VDC

---

**Note:**
- **R0**: Jumpers
- **R1**: 1.5K Ohm 1% Film Resistor
- **R2**: 750 Ohm 1% Film Resistor
- **R3**: 121 Ohm 1% Film Resistor
- **R5**: 57.6 Ohm 1% Film Resistor

---

**Change Log:**
- **3**: 11-16-73 E.C.O. 030
- **2**: 6-17-73 E.C.O. 022
- **1**: 10-6-70 E.C.O. 004

**Computer Systems Laboratory**

**Washington University**

**St. Louis, Missouri**

**Macromodular Project**

**Title**: Parts List Addition Control Board

**Part No**: 202 2

**Approved**

**Manuf.** 4/7/70

**Drawn By** 202.202

**Checked** 6/24/70
Test Procedure

Addition Module Control Board #202.2

This board contains two critical delays whose proper value must be checked on each board prior to assembly into an Addition Module.

Both delay values must be longer than a specified minimum value. If the delay value is excessively large, the operation of the module will be needlessly slowed down. If the delay value is excessively short, the module may perform incorrectly under certain conditions.

Procedure

Test 1: Tie pins L3 and T88 high and tie pins L5 and T30 low. Apply a square wave signal with a period of 300 nanoseconds or greater to pin T31. The signal should have a rise and fall time not greater than 10 nanoseconds. Observe the waveform at pin T31 with channel one of a 454 oscilloscope. Observe the waveform at pin T82 with the second channel. The delay between the two waveforms, measured from mid-point of each transition, should be 157 nanoseconds or greater. The delay should be observed for both positive and negative going transitions, and both should be 157 nanoseconds or greater. If the smaller of the two delays is less than 157 nanoseconds, the value of capacitors C1 and C2 should be increased. If the value of the smaller of the delays is greater than 175 nanoseconds, the value of C1 and C2 should be reduced.

Test 2: Tie pin T31 high and pins L5, T30 and T88 low. Apply a square wave signal with a period of 300 nanoseconds or greater to pin L3. The signal should have a rise and fall time not greater than 10 nanoseconds. Observe the waveform at pin L3 with channel one of a 454 oscilloscope and observe the waveform at pin T82 with the second channel. The delay between the two waveforms, measured from mid-point of each transition, should be 133 nanoseconds or greater for the positive going output. There is no delay specification for a negative going output, but the delay will be much less than the positive transition delay. If the positive going delay is less than 133 nanoseconds, increase the value of C3 to increase the delay. If the positive going delay is greater than 150 nanoseconds, reduce the value of C3.

The final capacitor values and the measured delays for each board should be recorded on the test sheet provided for that board, along with the serial number of the board.
The circuit board should be carefully inspected to insure that the foregoing procedure has not resulted in damage to the circuit board, particularly in the areas where fresh soldering has taken place. All flux residues should be thoroughly removed.
NOTE: 1
MALE AMPMODU PINS MUST BE
INSTALLED FROM THIS SIDE IN
LOCATIONS MARKED X PRECISELY
AS SHOWN IN DRG. 200.5001 AND
200.5002.

NOTE: 2
SEE DRAWING NUMBER 200.50029 FOR
CONNECTOR MOUNTING ORIENTATION.
RESISTORS 15K OHM 1/4WATT CARBON
TWO REQUIRED
R01
R02

SPRAGUE NETWORK LTN-2
FOUR REQUIRED
N01
N02
N04
N06

AMP CONNECTOR
S83 464-1
ONE REQUIRED

CONNECTOR
AMPHD NO. 85931-5
FIFTY SEVEN REQUIRED

CIRCUIT BOARD
PTF0058-1
ONE REQUIRED

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COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

TITLE
PARTS LIST
ADDITION FACEPLATE MOTHER BOARD
PART NO. 202.3

APPROVED
MANUF: 4/7/70
DRAWN BY: MBP
CHECKED: 6/24/70

ENG.
DRAWING NO.
202.3D2
NOTE:
MALE AMP MODU PINS MUST BE INSTALLED FROM THIS SIDE
IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DWG.
200.50D1 AND 200.50D2
NOTE: SEE DRAWING NUMBER
200.50D26 FOR CONNECTOR MOUNTING ORIENTATION.

COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

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JUMPERS
ONE REQUIRED
R01

AMP CONNECTOR
1-202-645-5
ONE REQUIRED

CONNECTORS
AMP/MODU NO. 05931-5
ONE HUNDRED TEN REQUIRED

CIRCUIT BOARD
PTT0031-1
ONE REQUIRED

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COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

PARTS LIST
ADDITION UNIT TOP MOTHER BOARD
PART NO. 202.4

APPROVED BY
MANUF. DATE
4/10/70

ENGINEER DRAWN BY CHECKED
MBP DATE
6/24/70
METALCRAFT "AUTOGRAPH" OR EQUIVALENT:
BLANK SIZE: ⅛" X 2" SHEARED WITH
SQUARE CORNERS, BLACK LETTERS, VOGUE
BOLD 12 POINT BOLD FACE TYPE CENTERED
TOP, BOTTOM AND SIDES WITH 6 POINT
SPACING ON GREY GREEM PMS 557 BACKING,
MANUFACTURED FROM .016 THICK ALUMINUM
WITH SOLVENT ACTIVATED PERMANENT
ADHESIVE BACKING.

NOTE: PANTONE MATCHING SYSTEM (PMS)

COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

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<td>PART #202.5</td>
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NOTE:
AMP MODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DRAWINGS 200.5011 AND 200.5012.

NOTE: SEE DRAWING NUMBER 200.50D28 FOR CONNECTOR MOUNTING ORIENTATION.
JUMPERS
SIX REQUIRED
R05
R06
R07
R08
R09
R10
RESISTOR 25.5K OHM 1% FILM
R12
AMP CONNECTOR
S33 464-1
ONE REQUIRED
CONNECTORS
AMPMODU 85931-5
FIFTY THREE REQUIRED
FUSE BUSSMAN GFA 3/4 AMP
ONE REQUIRED
R11
CIRCUIT BOARD
PTL0556-1
ONE REQUIRED

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COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

TITLE
LATERAL MOTHER BOARD ASSY
PART NO. 202.6

APPROVED
MANUF. 6/8/70  DRAWN BY 202.6D3

REV.
MANUF. 6/8/70  DRAWN BY 5/18/70
NOTE:
MALE AMP MODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DRAWING 200.5001 AND 200.5002.

NOTE: SEE DRAWING NUMBER 200.5002 FOR CONNECTOR MOUNTING ORIENTATION.
AMP CONNECTOR
1-202845-5
ONE REQUIRED

CONNECTORS
AMPMODU NO 85931-5
ONE HUNDRED ELEVEN REQUIRED

CIRCUIT BOARD
PTB0059-1
ONE REQUIRED

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COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

TITLE
PARTS LIST
BOTTOM MOTHER BOARD ASSEMBLY
PART NO. 200.11

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CHECKED: 6/16/70
ONE CELL CASE ASSEMBLY

KEY STOP

LEFT HAND SHROUD

MACROMODULAR PROJECT

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2 7-27-71 E.C.O.0209 TK

1 10-10-70 E.C.O.0051 NTK

WAC 203.0D

PLL NTK 3-28-70
NOTE: INSTALL FEMALE AMPMODU CONNECTORS EXACTLY AS SHOWN ON DWG. 200-500Z.
## Integrated Circuits

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## Resistors

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<td>R02, R03, R04, R05, R06, R08, R10, R12, R15, R17</td>
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## Connectors

- **Type**: AMPMODU NO. 85863-4
- **Quantity**: 39 Required
- **Type**: PTV0067-1
- **Quantity**: 1 Required

## Notes:
- R0 = jumpers
- R1 = 1.5K ohm 1% film resistor
- R3 = 121 ohm 1% film resistor
# Integrated Circuits

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# Resistors

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*Dipped Silver Mica 5% 50VDC

# Capacitors

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# Connectors

- AMPMODU No. 85863-4
- CIRCUIT BOARD

**NOTE:**

- R0 = Jumpers
- R1 = 1.5k Ohm 1% Film Resistor
- R2 = 750 Ohm 1% Film Resistor
- R3 = 121 Ohm 1% Film Resistor
- R5 = 57.6 Ohm 1% Film Resistor

---

**Change No.**

<table>
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**Computer Systems Laboratory**

Washington University

St. Louis, Missouri

**Macromodular Project**

**Title:** Parts List

**Shift Control Board**

**Part No. 203.2**

**Approved By:**

**Manuf.:** 4/1/70

**Drawn By:** MBP

**Checked By:** 6/24/70
Test Procedure

Shifter Control Board Part #203.2

This board contains two critical delays whose proper value must be checked on each board prior to assembly into a Shifter Module.

Both delay values must be longer than a specified minimum value. If the delay value is excessively large, the operation of the module will be needlessly slowed down. If the delay value is excessively short, the module may perform incorrectly under certain conditions.

Procedure

Test 1: Tie pin T83 low and apply one phase of a 200 nanosecond square wave to pin L3 and apply the opposite phase of the square wave to pin T31. Observe the waveform at pin L2 with the second channel of a 454 oscilloscope. Observe the waveform at pin L3 with the first channel. The delay between the two waveforms, measured from mid-point of each transition, should be 17 nanoseconds or greater. The delay should be observed for both positive and negative going transitions, and both should be 17 nanoseconds or greater. If the smaller of the two delays is less than 17 nanoseconds, add a capacitor in location C16 to increase the delay.

Test 2: Tie pins L3 and T83 high. Apply a square wave signal with a period of 240 nanoseconds or greater to pin T31. The signal should have a rise and fall time not greater than 10 nanoseconds. Observe the waveform at pin T31 with one channel of 454 oscilloscope. Observe the waveform at pin L2 with the second channel. The delay between the two waveforms, measured from mid-point of each transition, should be 40 nanoseconds or greater. The delay should be observed for both positive and negative going transitions, and both should be 40 nanoseconds or greater. If the smaller of the two delays is less than 40 nanoseconds, the value of capacitor C32 should be increased. If the value of the smaller of the delays is greater than 50 nanoseconds, the value of C32 should be reduced.
The final capacitor values and the measured delays for both directions of transition should be recorded, along with the serial number of the board.

The circuit board should be carefully inspected to insure that the foregoing procedure has not resulted in damage to the circuit board, particularly in the areas where fresh soldering has taken place. All flux residues should be thoroughly removed.
NOTE 1:
MALE AMPMODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DUGS 200.50D1 AND 200.50D2. (29 PINS)

NOTE 2:
SEE DRAWING NUMBER 200.50D29 FOR CONNECTOR MOUNTING ORIENTATION.
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**COMPUTER SYSTEMS LABORATORY**
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

**MACROMODULAR PROJECT**

**Title**
PARTS LIST
SHIFT FACEPLATE MOTHER BOARD
PART NO. 203.3

**Approved by**
KEO

**Drawn by**
203.302

**Checked by**
6/24/70
NOTE: AMPMODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DRAWINGS 200.50D1 AND 200.50D2.

NOTE: SEE DRAWING NUMBER 200.50D28 FOR CONNECTOR MOUNTING ORIENTATION.
JUMPERS
SIX REQUIRED
R01
R02
R03
R04
R09
R10
RESISTOR 33.2K OHM 1/8 WATT 1%
ONE REQUIRED
R12
AMP CONNECTOR
583 464-1
ONE REQUIRED
CONNECTORS
AMPMODU NO. 85931-5
FORTY SEVEN REQUIRED
FUSE, BUSMAN GFA 3/4 AMP
ONE REQUIRED
R11
CIRCUIT BOARD
PTL0056-1
ONE REQUIRED

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COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

TITLE
PARTS LIST
SHIFT LATERAL MOTHER BOARD
PART NO. 203.4

APPROVED
KEO

DRAWING NO.
203.4D3

MANUF.
4/7/70

CHECKED
MAY

DATE
6/24/70
NOTE: MALE AMPMODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DWGS. 200.50D1 AND 200.50D2.

NOTE: SEE DRAWING 200.50D26 FOR CONNECTOR MOUNTING ORIENTATION.

MACROMODULAR PROJECT
### JUMPERS
**ONE REQUIRED**
RO2

**AMP CONNECTOR**
1-202845-5
**ONE REQUIRED**

**CONNECTOR**
AMPMODU 85931-5
109 REQUIRED

**CIRCUIT BOARD**
PTT0857-1
**ONE REQUIRED**

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**COMPUTER SYSTEMS LABORATORY**
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

**MACROMODULAR PROJECT**

**TITLE**
PARTS LIST
SHIFT TOP MOTHER BOARD
PART NO. 203.5

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METALCRAFT "AUTOGRAF" OR EQUIVALENT
BLANK SIZE: 4" X 2" SHEARED WITH
SQUARE CORNERS, WHITE LETTERS,
VOGUE BOLD 12 POINT BOLD FACE TYPE CENTERED
TOP, BOTTOM AND SIDES WITH 6 POINT
SPACING ON RUST PMS 152 BACKING,
MANUFACTURED FROM .016 THICK ALUMINUM
WITH SOLVENT ACTIVATED PERMANENT
ADHESIVE BACKING.

NOTE: PANTONE MATCHING SYSTEM (PMS)

COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

TITLE
IDENTIFICATION LABEL
SHIFT MODULE
PART #203.6

APPROVED
ENG
DRAWING NO.

BY
FOR
DATE
NTK
DRAWN BY
CHECKED
Maw Prod. 7/28/70
Maw

203.6D

DATE

6-16-70
NOTE: MALE AMPMODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN ON DWGS. 200.50D1 AND 200.50D2.

(104 PINS)

NOTE: SEE DRAWING NUMBER 200.50D27 FOR CONNECTOR MOUNTING ORIENTATION.
AMP CONNECTOR
1-202845-5
ONE REQUIRED

CONNECTORS
AMPMODU NO. 8931-5
ONE HUNDRED FOUR REQUIRED

CIRCUIT BOARD
PTB053-1
ONE REQUIRED
ONE CELL CASE ASSEMBLY

KEY STOP

LEFT HAND SHROUD

MACROMODULAR PROJECT

ASSEMBLY SCHEMATIC & PARTS LIST
COMPARATOR UNIT MOD. 2
PART NO. 204

COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

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WAC 204.0D
MOD. 2

DRAWN BY
NOK 6-3-71
NOTE: INSTALL FEMALE AMP MODU CONNECTORS EXACTLY AS SHOWN ON DRAWING 200.5002
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### Capacitors

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*Dipped Silver Mica 5%*

### Connectors

- AMPMODU No. 85863-4
- 47 Required

- Circuit Board
- PTV0073-1
- 1 Required

**Note:**

- R1 = 1.5K OHM 1% Film Resistor
- R2 = 750 OHM 1% Film Resistor
- R3 = 121 OHM 1% Film Resistor
- R4 = 15K OHM 5% Carbon Comp.
Test Procedure

Compare Module Transfer Control Board #204.3 MOD 2

This board contains 3 critical delays whose proper value must be checked on each board prior to assembly into a Compare Module.

All delay values must be longer than a specified minimum value. If the delay value is excessively large, the operation of the module will be needlessly slowed down. If the delay value is excessively short, the module may perform incorrectly under certain conditions.

Procedure

Test 1: Tie pin L9 high. Apply one phase of a square wave signal with a period of 300 nanoseconds or greater to pin L10 and apply the opposite phase to pin T82. The signal should have a rise and fall time not greater than 10 nanoseconds. Observe the waveform at pin L10 with channel one of a 454 oscilloscope. Observe the waveform at pin L11 with the second channel. The delay between waveform at L10 and L11, measured from mid-point of each transition, should be 17 nanoseconds or greater. The delay should be observed for both positive and negative going transitions, and both should be 17 nanoseconds or greater. If the smaller of the two delays is less than 17 nanoseconds, increase the value of C39. If the smaller of the two delays is greater than 22 nanoseconds, the value of C39 should be reduced.

Test 2: Next observe the signal at pin T84 with channel two of the oscilloscope. The delay for both positive and negative transitions should be 22 nanoseconds or greater. If the smaller of the two delays is less than 22 nanoseconds, increase the value of C34 and C36. If the smaller of the two delays is greater than 30 nanoseconds, decrease the value of C34 and C36.

Test 3: Tie pins L9 and L10 low. Apply a square wave signal with a period of 300 nanoseconds or greater to pin T82. The signal should have a rise and fall time not greater than 10 nanoseconds. Observe the waveform at pin
T82 with channel one of a 454 oscilloscope and observe the waveform at pin T84 with the second channel. The delay between the two waveforms, measured from midpoint of each transition, should be 133 nanoseconds or greater for both the positive and negative transition. If the shorter of the two delays is less than 133 nanoseconds, increase the value of C25 and C27 to increase the delay. If the shorter of the two delays is greater than 145 nanoseconds, reduce the value of C25 and C27, to decrease the delay.

The final capacitor values and the measured delays for each board should be recorded on the test sheet provided for that board, along with the serial number of the board.

The circuit should be carefully inspected to insure that the foregoing procedure has not resulted in damage to the circuit board, particularly in the areas where fresh soldering has taken place. All flux residues should be thoroughly removed.
NOTE:
AT TIME OF INSTALLATION OF BOARD,
MODIFY AS FOLLOWS:
MOD 1: REMOVE R31
MOD 3: REMOVE R33

NOTE: INSTALL FEMALE AMPMODU CONNECTORS EXACTLY AS SHOWN ON DRAWING 200.5002.
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**NOTE:**
- R0 = JUMPERS
- R1 = 1.5K OHM 1% FILM RESISTOR
- R2 = 750 OHM 1% FILM RESISTOR
- R3 = 121 OHM 1% FILM RESISTOR
- R4 = 15K OHM 5% WATT CARBON COMP.

*CX-103 SPRAGUE CERAMIC DISC. 50 WDC*

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**COMPUTER SYSTEMS LABORATORY**
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

**MACROMODULAR PROJECT**

**TITLE**
PARTS LIST
COMPARATOR DATA BOARD
PART NO. 204.4

**APPROVED**

**DRAWN BY** MBP

**CHECKED**

**DATE** 10-30-70

**DRAWING NO.** 204.4D2
NOTE: AMPMODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DRAWINGS 200.50D1 AND 200.50D2.

NOTE: SEE DRAWING NUMBER 200.50D28 FOR CONNECTOR ORIENTATION.
JUMPERS
FOUR REQUIRED
R01
R02
R09
R10

RESISTOR 25.5K OHM 1/8WATT 1%
ONE REQUIRED
R12

AMP CONNECTOR
583 464-1
ONE REQUIRED

CONNECTOR
AMPMODU NO. 85931-5
FORTY-SEVEN REQUIRED

FUSE BUSSMAN GFA-3AMP
ONE REQUIRED
R11

CIRCUIT BOARD
PTL 0055-1
ONE REQUIRED
METALCRAFT "AUTOGRAPH" OR EQUIVALENT:
BLANK SIZE: 4" X 2" SHEARED WITH
SQUARE CORNERS, BLACK LETTERS,
VOGUE BOLD 12 POINT BOLD FACE TYPE CENTERED
TOP, BOTTOM AND SIDES WITH 6 POINT
SPACING ON YELLOW PMS 109 BACKING,
MANUFACTURED FROM .016 THICK ALUMINUM
WITH SOLVENT ACTIVATED PERMANENT
ADHESIVE BACKING.

NOTE: PANTONE MATCHING SYSTEM (PMS)

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MACROMODULAR PROJECT

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MALE AMPMODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DRAWINGS 200.50D1 AND 200.50D2.

NOTE:
SEE DRAWING NUMBER 200.50D29 FOR CONNECTOR ORIENTATION.
RESISTORS 1.5K OHM 5% 1/8 WATT CARBON
TWO REQUIRED
R01
R02
SPRAGUE NETWORK LTN-2
SEVEN REQUIRED
N01
N02
N03
N04
N05
N06
N07

AMP CONNECTOR
SS3 464-1
ONE REQUIRED

CONNECTOR
AMPMODU NO. 83931-5
EIGHTY-THREE REQUIRED

CIRCUIT BOARD
PTF0058-1
ONE REQUIRED

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ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

TITLE: COMPARATOR FACEPLATE MOTHERBOARD
PART NO: 204.7

APPROVED: N/A
DRAWN BY: MBP
CHECKED: N/A
DATE: 11/12/70
NOTE 1:
MALE AMPMODU PLUGS MUST BE INSTALLED FROM THIS SIDE
IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DRGS.
200.5001 AND 200.5002.

NOTE 2:
SEE DRAWING NUMBER 200.50026
FOR CONNECTOR ORIENTATION.
AMP CONNECTOR
1-202045-5
ONE REQUIRED

CONNECTORS
AMPMODU NO. 85931-5
ONE HUNDRED FOUR REQUIRED

CIRCUIT BOARD
PTT0057-1
ONE REQUIRED
NOTE 1:
SEE DRAWING NUMBER 200.50D2 FOR CONNECTOR ORIENTATION.

NOTE 2:
MALE AMPMODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DWGS. 200.50D1 AND 200.50D2.
AMP CONNECTOR
1-202845-5
ONE REQUIRED

CONNECTORS
AMPMODU NO. 05931-5
ONE HUNDRED FOURTEEN REQUIRED

CIRCUIT BOARD
PTB0099-1
ONE REQUIRED

MACROMODULAR PROJECT

PARTS LIST
BOTTOM MOTHERBOARD ASSEMBLY
PART NO. 204.9

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DRAWING NO. 204.902

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CHECKED: 11/24/70

ENGINEER: MBP

DATE

APPROVED

DRAWN BY

DATE

FOR
NOTE: INSTALL FEMALE AMPMODU CONNECTORS EXACTLY AS SHOWN ON DRAWING 200.5002.
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**CONNECTORS**
- AMMPDU NO. 85863-4
- S5 REQUIRED

**CIRCUIT BOARD**
- PTV0072-2
- ONE REQUIRED

**NOTE:**
- R0 = JUMPERS
- R1 = 1.5K OHM 1% FILM RESISTOR
- R2 = 750 OHM 1% FILM RESISTOR
- R3 = 121 OHM 1% FILM RESISTOR
- R5 = 57.6 OHM 1% FILM RESISTOR

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**MACROMODULAR PROJECT**

**TITLE**
- PARTS LIST
- COMPARATOR CONTROL BOARD
- PART NO. 204.10

**DRAWING NO.**
- 204.10D2

**DATE**
- 10-30-70

**MANUFACTURER**
- MANUF. [Signature]

**CHECKED**
- [Signature]

**DRAWN BY**
- [Signature]
200.1
ONE CELL CASE
ASSEMBLY

KEY STOP
LEFT HAND SHROUD

MACROMODULAR PROJECT

TITLE ASSEMBLY SCHEMATIC & PARTS LIST
REGISTER UNIT
PART NO. 205

COMPUTER SYSTEMS LABORATORY
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NOTE:
INSTALL FEMALE AMPMODU CONNECTORS
EXACTLY AS SHOWN ON DRAWING NUMBER
200.5002.
### Integrated Circuits

<table>
<thead>
<tr>
<th>TYPE</th>
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<td></td>
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<td>P8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P9</td>
</tr>
</tbody>
</table>

| M04 | 1        | P1       |
| M10 | 2        | P2       |
|     |          | P3       |

| M16 | 2        | P4       |
|     |          | P5       |

### Resistors

<table>
<thead>
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<td>R06</td>
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<td>R10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R12</td>
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</table>

| M0   | 1        | R02      |
| M10  | 2        | R03      |
|      |          | R05      |
|      |          | R07      |
|      |          | R09      |
|      |          | R11      |

| M16  | 2        | R01      |
|      |          | R05      |
|      |          | R07      |
|      |          | R09      |
|      |          | R11      |

|      | 5        | R13      |
|      |          | R14      |
|      |          | R15      |
|      |          | R16      |
|      |          | R17      |
|      |          | R18      |
|      |          | R19      |
|      |          | R20      |
|      |          | R21      |
|      |          | R22      |
|      |          | R23      |
|      |          | R24      |
|      |          | R25      |
|      |          | R26      |
|      |          | R27      |
|      |          | R28      |

### Connectors

- AMPMODU NO. 85863-4
- 4S REQUIRED
- CIRCUIT BOARD
- PT0074-1
- ONE REQUIRED

### NOTE:

- R1 = 1.5 K OHM 1% FILM RESISTOR
- R3 = 121 OHM 1% FILM RESISTOR
- R5 = 51.6 OHM 1% FILM RESISTOR

### Change Log

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<tr>
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</table>

### Computer Systems Laboratory

Washington University
St. Louis, Missouri

### Macromodular Project

Title: Parts List
Register Data Board
Part No. 205.1
NOTE:
INSTALL FEMALE AMPMODU CONNECTORS
EXACTLY AS SHOWN ON DRAWING NUMBER
200.5002.
INTEGRATED CIRCUITS

<table>
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<td>M08</td>
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<td>M10</td>
<td>6</td>
<td>P1 P8 P10 P12 P13 P16</td>
</tr>
<tr>
<td>M11</td>
<td>4</td>
<td>P2 P3 P11 P14</td>
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<tr>
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<td>1</td>
<td>P17</td>
</tr>
<tr>
<td>M30</td>
<td>1</td>
<td>P6</td>
</tr>
<tr>
<td>M31</td>
<td>1</td>
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RESISTORS

<table>
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<tr>
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<tr>
<td>R0</td>
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<td>R08 R11 R12 R27 R29 R34 R1 R15 R01 R04 R06 R10</td>
</tr>
<tr>
<td>R1</td>
<td>1</td>
<td>R14 R15 R16 R17 R19 R21 R22 R25 R32 R33</td>
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<tr>
<td>R2</td>
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<td>R21</td>
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<tr>
<td>R3</td>
<td>14</td>
<td>R02 R03 R05 R07 R09 R15 R18 R20 R23 R24 R26 R30 R31 R47</td>
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<td>R4</td>
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RESISTORS (cont)

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<tr>
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<td>R36 R37 R38 R39 R40 R41</td>
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DIODES 1N3504

| TWO REQUIRED | D42 | D45 |

CONNECTORS

| AMPMODU NO. 8563-4 |
| 96 REQUIRED |

CIRCUIT BOARD

| PTY0076-1 |
| ONE REQUIRED |

NOTE:

R0 = JUMPERS
R1 = 1.5 K OHM 1% FILM RESISTOR
R3 = 120 OHM 1% FILM RESISTOR
R4 = 15K 5% CARBON COMP.
R5 = 57.6 OHM 1% FILM RESISTOR
NOTE:
INSTALL FEMALE AMPMODU CONNECTORS
EXACTLY AS SHOWN ON DRAWING NUMBER
200.5002.
## Integrated Circuits

<table>
<thead>
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<td>4</td>
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<td>M11</td>
<td>4</td>
<td>P2, P3, P10, P12</td>
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<tr>
<td>M16</td>
<td>1</td>
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<td>P18</td>
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## Resistors

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<td>R09</td>
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<td>11</td>
<td>R01, R02, R05</td>
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<td>R2</td>
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<td>R03, R04, R06, R07, R08, R12, R14, R15, R20, R22, R24</td>
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<tr>
<td>R3</td>
<td>20</td>
<td>R03</td>
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<tr>
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### Connectors
- AMPMODU NO. 8S063-4
- 52 Required
- Circuit board: PTV007-1
- One required

### Note:
- R0 = Jumpers
- R1 = 1.5 kΩ 1% film resistor
- R2 = 121 kΩ 1% film resistor
- R4 = 15k Ω 5% carbon comp.

---

**Computer Systems Laboratory**

**Washington University**

**St. Louis, Missouri**

**MACROMODULAR PROJECT**

---

**Parts List**

- Register Control Board No. 2
- Part No. 205.3

---

**Approved**

- MANUF.: 5/15/70
- DRAWN BY: MBP

**Drawing No.**

- 205.3D2

---

**Change No.**

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---

**Check:**

- 6/17/70
METALCRAFT "AUTOGRAF" OR EQUIVALENT:
BLANK SIZE: ¼" X 2" SHEARED WITH
SQUARE CORNERS, BLACK LETTERS,
VOGUE BOLD 12 POINT BOLD FACE TYPE
CENTERED TOP, BOTTOM AND SIDES WITH
6 POINT SPACING ON IVORY PMS 134
BACKING, MANUFACTURED FROM .016
THICK ALUMINUM WITH SOLVENT ACTIVATED
PERMANENT ADHESIVE BACKING.

NOTE: PANTONE MATCHING SYSTEM (PMS)

COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

<table>
<thead>
<tr>
<th>TITLE</th>
<th>IDENTIFICATION LABEL</th>
<th>REGISTER MODULE</th>
<th>PART #205.4</th>
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<td>McFarland Ped.</td>
<td>FOR</td>
<td>DRAWN BY</td>
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<td>6-16-70</td>
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NOTE:
AMPMODU PINS MUST BE INSTALLED
FROM THIS SIDE IN LOCATIONS MARKED
X PRECISELY AS SHOWN IN DRAWINGS
200.50D1 AND 200.50D2.

NOTE:
SEE DRAWING NUMBER 200.50D28
FOR CONNECTOR ORIENTATION.
JUMPERS
THREE REQUIRED
R1
R2
R4

RESISTOR 34K OHM 1% FILM
ONE REQUIRED
R03

CONNECTOR AMP 583 454-1
ONE REQUIRED

CONNECTOR
AMPMODU NO. 85931-5
SIXTEEN REQUIRED

FUSE BUSSMAN GFA THREE-QUARTER AMP
ONE REQUIRED
R11

CIRCUIT BOARD
PTL0062-1
ONE REQUIRED
NOTE:
MALE AMP MODU MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DRAWINGS 200.50D1 AND 200.50D2.

NOTE:
SEE DRAWING 200.50D29 FOR CONNECTOR ORIENTATION.
JUMPER
ONE REQUIRED
R1
RESISTOR 15K OHM 1/4WATT 5% CARBON COMP.
TWO REQUIRED
R2
R3
NETWORK LTN-2
TWO REQUIRED
N1
N2
CONNECTOR AMP 583 464-1
ONE REQUIRED
CONNECTOR
AMPMODU NO. 85931-5
EIGHTY-TWO REQUIRED
CIRCUIT BOARD
PTF0063-1
ONE REQUIRED
NOTE 1:
SEE DRAWING 200.50027 FOR
CONNECTOR ORIENTATION.

NOTE 2:
MALE AMPMODU PINS MUST BE INSTALLED FROM
THIS SIDE IN LOCATIONS MARKED "X" PRECISELY
AS SHOWN IN DRAWINGS 200.5001 AND 200.5002.
(73 PINS)
JUMPER
ROL
ONE REQUIRED

CONNECTOR
AMP 1-202845-5
ONE REQUIRED

CONNECTOR
AMP NO. 85951-5
SEVENTY-THREE REQUIRED

CIRCUIT BOARD
FY8028-1
ONE REQUIRED

COMPUTER SYSTEMS LABORATORY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI

MACROMODULAR PROJECT

PARTS LIST
REGISTER BOTTOM MOTHER BOARD
PART NO. 205.8

DRAWING NO.
205.803

CHECKED
SP
DATE
9-10-71
**NOTE:** SEE DRAWING NUMBER 200.50D1 FOR CONNECTOR ORIENTATION.

**NOTE:** MALE AMP MODU PINS MUST BE INSTALLED FROM THIS SIDE IN LOCATIONS MARKED X PRECISELY AS SHOWN IN DRAWINGS 200.50D1 AND 200.50D2.

---

**COMPONENT IDENTIFICATION**

**REGISTER TOP MOTHER BOARD ASSEMBLY**

**PART NO.** 205.9

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**MACROMODULAR PROJECT**

**COMPUTER SYSTEMS LABORATORY**

WASHINGTON UNIVERSITY

ST. LOUIS, MISSOURI

**TITLE**

**DESIGNATED**

DLS

**APPROVED BY**

P. L.

**CHECKED BY**

NTK

**DATE**

4-18-70

**DRAWN BY**

MANUF.

9-16-71

**MANUF.**

205.9D1
CONNECTOR AMP 1-202845-5
ONE REQUIRED

CIRCUIT BOARD
PTT060-1
ONE REQUIRED

CONNECTOR
AMPMODU NO. 85931-5
EIGHTY-SEVEN REQUIRED
ELECTRONIC PACKAGE ASSEMBLY

Final Report 4/1/65 through 12/31/73

Mishell J. Stucki, Editor

February, 1974

Volume II of Part 2

Technical Report No. 31

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ARPA - Information Processing Techniques, Washington, D.C.

Manufacturing documents, including parts lists, assembly pictorials, and adjustment procedures for the LOGIC, ARITHMETIC, SHIFT, COMPARE and REGISTER macromodule electronic subassemblies are given.
<table>
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