Models 2533 11 and 2533 21 Digital Power Meter (Single-Phase AC and DC/AC)

IM 2533-01E
4th Edition

= For Reference =

Safety precausions are subject to change due to amandements made in laws and ordinaces.
Please operate the device at your own risk.
If you have any inquiries regarding the safety operation, please do not hesitate to contact your local Yokogawa sales office.

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	• **Model 2533 Digital Power Meter Service Manual**	IM2533-01Es

FD No. 1007N (CID: 5770A)/T and M E0003-N-J(UP)

NOTE

- To ensure safety, turn off power of the measured device before connecting an input signal.
- Models 2533 11 and 2533 21 is intended for AC signal only. Do not apply DC or DC-superposed signal. Otherwise, the DC component would be ignored in measurement and an excessive DC input might adversely affect the instrument itself. Full wave or half wave rectification which has asymmetrical waves on positive and negative sides would superpose a DC component.
- Reactive power (var), apparent power (VA) and power factor (PF) of the instrument are obtained by digital computation from voltage, current, effective power, etc.
  When distorted waveshapes are measured, differential in measured values using this instrument and other instrument with different principle of measurement may occur.

HOW TO USE INSTRUCTION MANUAL

This instruction manual describes the functions, specifications and operations of the single-phase digital power meters 2533 11 and 2533 21.

For optional GP-IB Interface /GP-IB, RS-232C Interface /RS232C,Frequency Measurement /FRQ and Integrator Function /INTEG, refer to a separate manual.

Instrument Name	Model or Option Code	Instruction Manual No.
Digital Power Meter (Single-phase, AC and DC/AC)	2533 11 and 2533 21	IM 2533-01E
Digital Power Meter (Three-phase Three-wire, AC and DC/AC)	2533 12 and 2533 22	IM 2533-03E
Digital Power Meter (Three-phase Four-wire, AC and DC/AC)	2533 13 and 2533 23	
Frequency Measurement	/FRQ	IM 2533-50E
Integrator Function	/INTEG	
GB-IB Interface	/GP-IB	IM 2533-51E
RS-232C Interface	/RS232C	IM 2533-70E

The manual consists of five chapters given below.

Chapter 1. OUTLINE OF PRODUCT

This chapter describes the outline, features, functions and specifications of the Model 2533. Read it through before use to get an overview of the functions of the instrument.

Chapter 2. HANDLING

The wiring procedure and operation methods are explained here. By reading the manual and operating the instrument together, increases the speed of learing and shows proper handling and operation.

Chapter 3. MAINTENANCE

Chapter 4. REFERENCES

"Error codes" and other useful information are explained.

WHEN THE INSTRUMENT HAS ARRIVED

The instrument is strictly factory inspected. After it has arrived, however, check the quantities of accessories, etc. and appearance and operation of the instrument to make sure nothing is wrong.

If some accessories are missing or the operation is poor, contact the nearest service agent given on the back cover of the manual.

1. ACCESSORIES

The instrument is furnished with accessories given in Figure 1 and Table 1. Check the quantities, etc. against them.

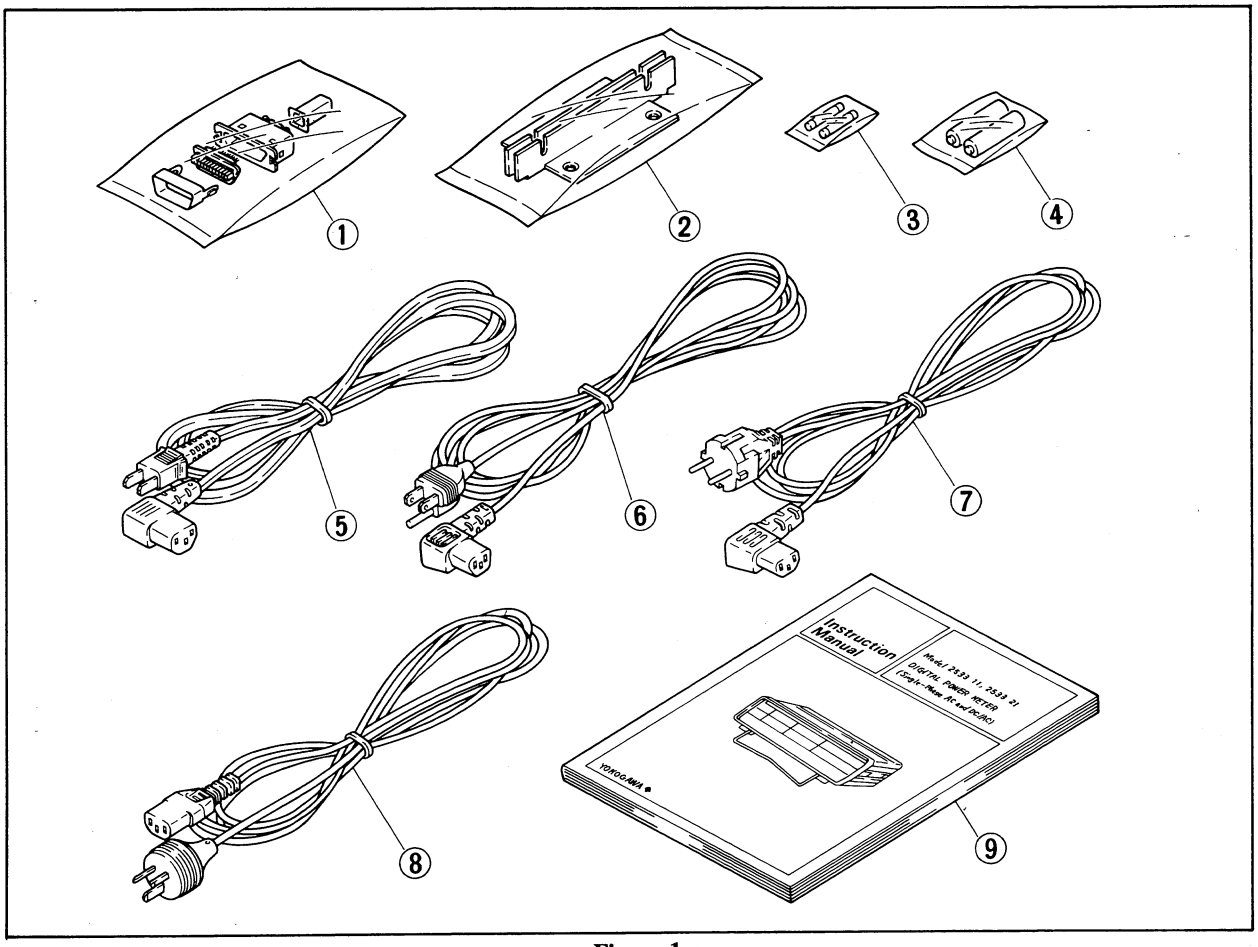


Figure 1.

Table 1.

No.	Part Name	Part No.	Q'ty	Remarks
①	Connector	A9026KC	1	For analog output
②	Rack mount adapter	B9564EL	2	
③	Fuse	A9050KF	2	1 A time lag type (100 V series) } select
	Fuse	A9049KF	2	0.5 A time lag type (200 V series) } select
④	Dry cell	A9005ED	2	SUM-3D
⑤	Power Cord	A9009WD	1	Other than below } select
⑥	Power Cord	A9008WD	1	UL standard
⑦	Power Cord	A9011WD	1	VDE standard
⑧	Power Cord	A9015WD	1	SAA standard
⑨	Instruction manual	B9278AM	1	Japanese } select
	Instruction manual	B9278AN	1	English } select

2. SELF-TEST WHEN TURNING ON POWER

The instrument incorporates a self-test function. It is performed automatically by on power up. Examine the unit for shipping damage or failures during self-test.

<Self-test procedure>

(1) Connecting Power

1) Make sure the power switch of the instrument is turned OFF, and engage the furnished power cord with the power connector on the rear panel of the instrument shown in Figure 2.
2) Plug the unit into a power receptacle.

NOTE

If the power voltage is wrong, the instrument will be damaged. Be sure to use power in the range specified on the right of the power connector.

Ensure the power voltage change switch located on the right of the connector shown in Figure 2 is in the proper position, down when power voltage is 100 V (200 V) according to the label, or up when 115 V (230 V).

(2) Turning ON Power Switch

Turning ON the power switch starts the incorporated test program.

The tested items are RAM memory check (write, read) and ROM sum check. The time required is about 1 second.

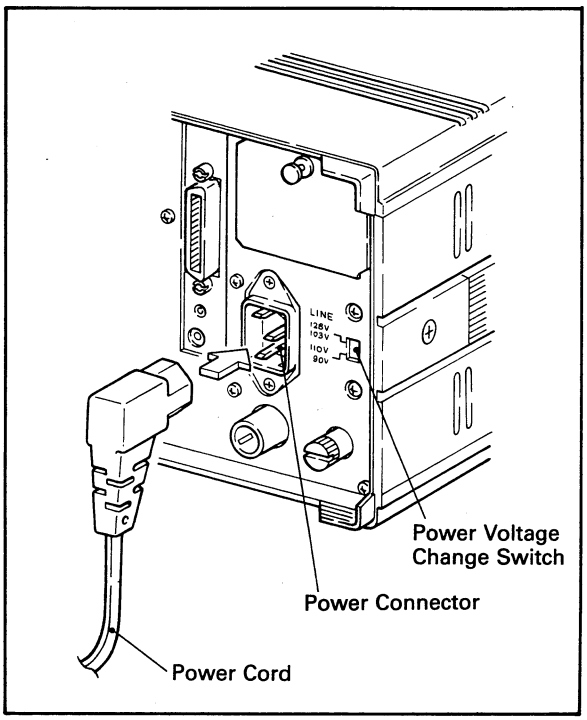


Figure 2.

(3) Judging Results of Self-Test

1) If Test Results are Normal

When the aforementioned RAM and ROM self test complete successfully, the model, system configuration and version No. are displayed for several seconds in a format shown in Figure 3, thereby readying the instrument for measurement.

From the display of this system configuration, the number of input elements mounted on the instrument and types of options are shown in section **4-1 2. Hardware Configuration**.

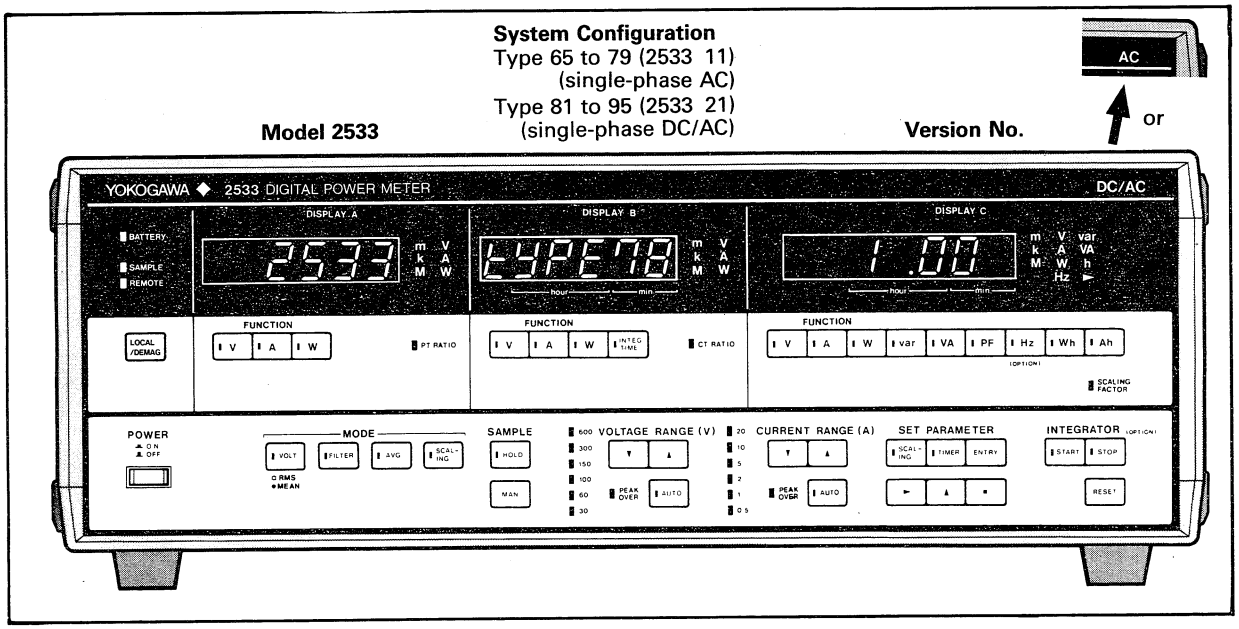
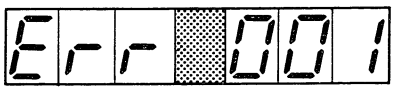


Figure 3.

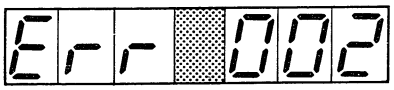
2) If Test Results are Abnormal

If results of the self tests are abnormal, the test is suspended, and the following error code is displayed on DISPLAY C.

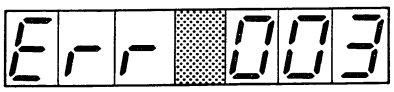
- **When RAM is faulty**



- **When ROM0 is faulty**



- **When ROM1 is faulty**



NOTE

If any of the above code is displayed, the instrument will not work properly. Immediately turn OFF the power switch, and contact the service agent specifying the model name, serial number and displayed error code.

1. OUTLINE OF PRODUCT

1-1. General

The manual describes how to operate the Digital Power Meters 2533 11 (single-phase AC) and 2533 21 (Single-phase DC/AC).

Two types of meters are available which measure AC and DC/AC. AC meters measure AC voltage/current and AC power in a single-phase circuit. DC/AC meters measure DC current and AC current in a single-phase circuit. Voltage, current and power—that AC is superimposed on DC—are also measured. Computation functions are included to totalize apparent power, reactive power, power factor and frequency. The frequency ranges 10 Hz to 20 kHz, and distorted wave of inverter can be measured accurately.

1-2. Features

◎ **Simultaneous Display of 3 Measured Values**

Three valves among measured or computed values are simultaneously displayed: voltage, current, and power or apparent power and reactive power of single phase.

◎ **High Precision**

The voltage, current and power can be measured with high accuracy: ±(0.1% of rdg+0.1% of range) (for AC meter 2533 11) ±(0.1% of rdg+ 0.2% of range) (for DC/AC meter 2533 21).

◎ **Wide Band of DC 10 Hz to 20 kHz**

Having a DC range and frequency range of 10 Hz to 20 kHz, DC/AC meters measure DC current and AC current in a single-phase circuit, voltage, current and power—that AC is superimposed on DC—are also measured, the instrument is best suited for measuring power of distorted wave and different inverters.

◎ **Abundant Computing Functions are Incorporated**

Apparent power, reactive power, power factor, etc. can be computed.

◎ **PT and CT Scaling**

Even when PT or CT is externally mounted, the voltage, current, power, etc. can directly be read through scaling.

◎ **Analog Output Is Standard Equipped**

Analog output can output simultaneously with up to five signals.

◎ **GP-IB and RS-232C Interfaces (Option)**

For data communications, the GP-IB or RS-232C interface is available. Full remote control is available for data output and range, function, etc. from external.

◎ **Integration and Frequency Measuring Function (Option)**

Current and power integrating function, and source frequency measuring function can be provided.

1-3. Designations and Functions

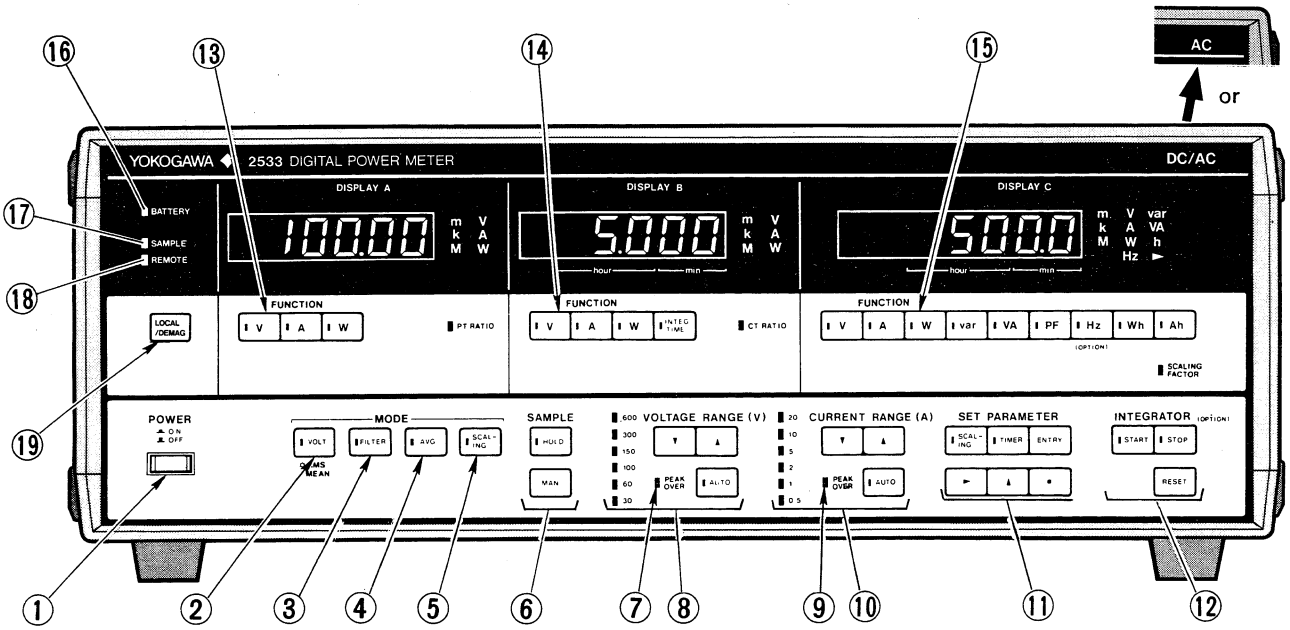


Figure 1-1. Front Panel

① **Power ON/OFF switch**
Turn ON/OFF power.
ON at ▬ and OFF at ▙ .

② **Voltage Mode Change Key:** [VOLT]
Determines whether to display the measured voltage in RMS or average value in MEAN.
With a value displayed, the key lamp is lit.

③ **Filter ON (SLOW)/OFF (FAST) Key:** [FILTER]
When a low frequency voltage or current is measured and noise is superposed or the display fluctuates, turn ON the filter. When ON, the key lamp is lit. Turning ON the filter permits a stable measurement even if low frequency ripples are superposed.

④ **Averaging Key:** [AVG]
By digital computation of A-D converted value, an input filter effect is obtained. When averaging is ON, the key lamp is lit.

⑤ **Scaling Key:** [SCAL-ING]
Turns ON/OFF a scaling function. When the scaling function is on, the key lamp is lit.

⑥ **Hold and Manual Keys:** [HOLD] [MAN]
Pressing the hold key stops a measurement action and, on the digital display, the value measured just before the pressing is held. If the display function is changed when in hold mode, specified data are displayed when data is present or, when data is absent, "(–) – – – – – – " is displayed. The analog output is a value proportional to input regardless of the hold.
When in hold mode, every press of the manual key updates the measured value.

⑦ **Voltage Peak Over Display Lamp**
If the peak value of a voltage wave has exceeded about 250% of the set range, PEAK OVER display lamp located on the left of [AUTO] key comes on.

⑧ **Voltage Range Change Keys**
The voltage range is changed over.
Pressing [▼] key changes to the next lower voltage range, and pressing [▲] key changes to the next upper range. By pressing [AUTO] key, the voltage range is automatically changed. At this time, AUTO key lamp is lit. When in automatic range, [▼] and [▲] keys are overridden. Voltage ranges are 30/60/100/150/300/600 V.

⑨ Current Peak Over Display Lamp

If the current peak value has exceeded about 350% of the set range, PEAK OVER display lamp comes on.

⑩ Current Range Change Keys

Function of [▲], [▼] and [AUTO] keys is the same as for voltage range. The current ranges are 0.5*/1/2/5/10/20 A.

*DC/AC meters do not cover 0.5A range.

⑪ Parameter Setting Keys

[SCALING] key allows to set PT ratio, CT ratio, SCALING FACTOR. In case of an optional integration function, the [TIMER] key can set the integration time.

Pressing [SCALING] key lights up the key lamp. DISPLAY A, B and C display the PT ratio, CT ratio and SCALING FACTOR, respectively.

The most significant digit of DISPLAY A flashes, thereby indicating data in that place is changeable.

The flashing digit can be moved to the right by [►] key. The flashing digit displayed can be changed by [▲] key to 1 → 2 → ... → 9 → 0 → 1 ...

[■] key moves the decimal point to the right. The displayed value is set by [ENTRY] key. Pressing [TIMER] key lights the lamp, whereby the integrated time is settable on DISPLAY C. The keys are overridden for a model not provided with the optional function.

⑫ Integrator Key (option)

Used for power or current integration. The keys are overridden for a model not provided with the optional function.

Pressing [START] key lights up the lamp, commencing an integration.

Pressing [STOP] key lights the lamp, stopping the integration.

[RESET] key clears the integrated value when the integration has stopped.

⑬ Function Keys (DISPLAY A)

[V] key selects voltage, [A], current, and [W], power. The lamp of the selected function comes on.

⑭ Function Keys (DISPLAY B)

[V] key selects voltage, [A] key, current, and [W], power.

[INTEG TIME] key is used for displaying integrated time in case of an optional integration function. The lamp for the selected function key comes on. The keys are overridden for a model not provided with the optional function.

⑮ Function Keys (DISPLAY C)

[V] key selects voltage, [A], current, [W], power, [var], reactive power, [VA], apparent power, [PF], power factor, [Hz], frequency, [Wh], integrated power, and [Ah], integrated current. The lamp of a selected function key comes on. But, [Hz], [Wh] and [Ah] keys are overridden for a model not provided with the optional function.

⑯ Battery Display Lamp

Comes on when the memory backup battery is exhausted.

⑰ Sample Display Lamp

The lamp comes on about every 0.4 second. Every time it lights, the displayed data is updated. It remains off at a hold mode.

⑱ Remote Control Display Lamp

Lit in remote control mode with GP-IB interface (option).

⑲ Local/Demag Key: [LOCAL /DEMAG]

In remote mode with GP-IB, pressing this key cancels the remote mode.

For DC/AC models, in local mode, use this key before starting measurement to demagnetize the DC-CT core if an excessive input was applied. To demagnetize the core correctly, use this key without applying a DC input.

Rear panel

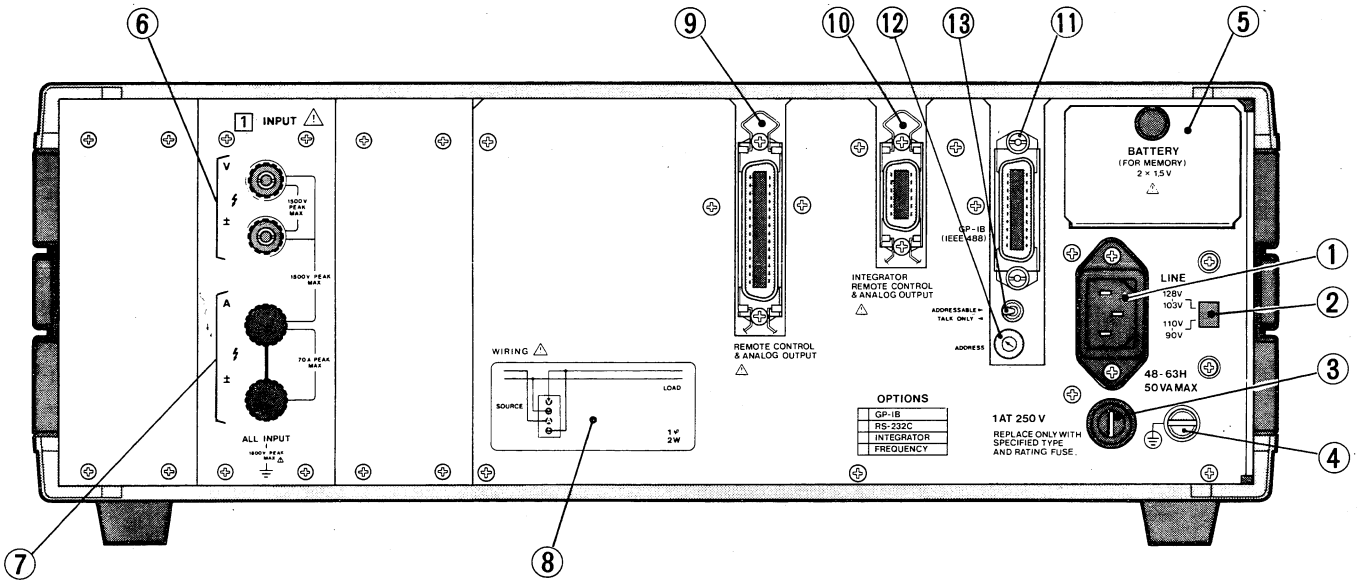


Figure 1-2.

① Power Connector

The furnished power cord is connected.

② Power Voltage Change Switch

The switch is changed to 100 V or 115 V according to the power voltage. With 200 V series, 200 V and 230 V are changed over.

③ Power Fuse

When the power voltage is 100 V series, a time lag fuse of 250 V, 1 A (A9050KF) is used. With 200 V series, a time lag fuse of 250 V, 0.5 A (A9049KF) is used.

④ Ground Terminal

For the mainframe case. Be sure to connect it to ground to ensure safety. When a power cord with ground cable is connected to a power outlet (wall receptacle), it is not necessary to connect the ground terminal to ground separately.

The common potential for all analog output, GP-IB, RS-232C and remote control connectors is the same as the case potential.

⑤ Panel Set Data Protecting Battery

Two SUM-3D battery are used. New cells protect panel set operating conditions for about one year.

⑥ Voltage Input Terminal

⑦ Current Input Terminal

Voltage and current input terminals are provided. Once the voltage and current input terminals are connected, voltage and current ranges may be changed by the front panel keys, after power up.

⑧ Wiring Instruction Plate

A wiring diagram is shown for each to a particular model.

⑨ Remote Control/Analog Output Connector

A connector for starting measurement by an external contact closure command and taking out input voltage, current waveform, and voltage, current and effective power analog output.

⑩ Integrator/Remote Control/Analog Output Connector (Option/INTEG)

An external contact closure command performs start/stop and reset control of integrator. Also used for taking out integrated value and VA, PF var, Hz and D-A converter.

⑪ GP-IB Connector

⑫ Address Setting Switch } /GP-IB* option.

⑬ Mode Setting Switch

(TALK, ONLY/ADDRESSABLE).

*For RS-232C option, RS-232C connector and DIP switches—for data mode, data format and transfer rate settings—are added.

1-4. Specifications

Display: LED (light-emitting diode)
Display Mode (3 displayes):

Mode	Max. Display	Display Item
A	±99999	V, A, W
B	±99999	V, A, W, integration lapse (option)
C	±99999 (±999999 Wh, Ah)	V, A, W, VA, var, PF (Hz, Wh, Ah ... option)

Unit: m, k, M, V, A, W, VA, var, Hz h, ►
Function Change: display A, B, C can be changed independently (except VA, var, PF)
(mode is changed by GP-IB or RS-232C interface option)
Sample Rate: approx. 2.5 samples/s
Range Changeover: manual, auto and external control (GP-IB ... option) change for V and A independently
Auto Range Change: by RMS or MEAN value in case of V, RMS value in case of A
Demagnetizing: Demagnetizes DC-CT core by pressing the [LOCAL /DEMAG] key in local mode, or receiving a DM command in remote or local mode. Demagnetizing time is approximately 5 seconds.
Effective Input Range: 10 to 110% of rated value (range)
Response Time: approx. 0.4 s (time required for analog value to reach specified accuracy at change of 30→100% or 100→30% when filter is OFF). Approx. 2 s (when filter is ON.)
Data Output: wave output; *v*, *i* (for monitor)
Analog output: V, A, W
D-A output: one of VA, var, PF, Wh, Ah, Hz (Data indicated on display C)
GP-IB or RS-232C interface (option): display data and measurement data
External Control: measurement sample start, A-D BUSY (standard), integrator (option) start, stop and reset
Operating temperature and humidity ranges: 5 to 40°C (23 to 104°F), 20 to 80% R.H.
Storage Temperature Range: −10 to 50°C (14 to 122°F) (non-condensing)
Warmup Time: approx. 30 min (until all specifications are satisfied)
Insulation Resistance: Use a 500 V insulation resistance tester. At least 50 MΩ between: (input terminal and case, input and output terminals, voltage and current terminals, input terminal, output terminal, case and power supply terminal)
Dielectric Strength: 3,000 V AC, 50/60 Hz, 1 min (input terminal and case, input and output terminals, voltage and current terminals).
1,500 V AC, 50/60 Hz, 1 min. (input and output terminals, case and power supply terminal)
Source: 100 or 115 V±10% AC, 48 to 63 Hz (200 series to be specified)
Power Consumption: approx. 35 VA
External Dimensions: approx. 149×444×364 mm (5-7/8″×17-1/2″×14-5/16″)
Weight: approx. 12 kg (26 lbs.)(for AC meter)
approx. 14 kg (31 lbs.)(for DC/AC meter)
Accessories: power cord ... 1. Fuse ... 2 (1 A for 100 V series, 0.5 A for 200 series). Connector ... 1. Mounting fixture ... 1 set. Dry cells (SUM-3D) ... 2. Instruction manual ... 1 copy (separate manual for options).
Input section

Item \ Input		Voltage	Current
Type of input	AC	Direct input (CT isolation after changing range)	CT isolation (secondary switching)
	DC/AC	Direct input (DC-CT isolated after changing range)	DC-CT isolated (secondary switching)
Rated value (range)	AC	30/60/150/300/600 V	0.5/1/2/5/10/20 A
	DC/AC		1/2/5/10/20 A
Frequency range	AC	10 Hz to 20 kHz	10 Hz to 20 kHz
	DC/AC	DC, 10 Hz to 20 kHz	DC, 10 Hz to 20 kHz
Max. allowable input for 1 s		Peak 3.5 times range or 1,400 V whichever smaller	Peak 10 times range or 70 A, whichever smaller
Max. continuous allowable input (at 50/60 Hz)		Peak 1,000 V or rms value 2 times range, whichever smaller	Peak 50 A or rms value 3 times range, whichever smaller
Instrument loss	AC DC/AC	Input resistance approx. 1 MΩ (all ranges)	At 50 Hz, 2 mΩ in all ranges
Max. continuous common mode voltage, 50/60 Hz		1,000 Vrms	1,000 Vrms
Influence by common mode voltage at 50/60 Hz		Less than ±0.025% of range (input terminals shorted, 1,000 V applied to input-case)	Same as voltage (input terminal open)

*DC/AC meters do not cover 0.5A range.

Measurement Functions

Item \ Measurement Functions		Voltage	Current	Power
Principle		Change of mean value rectification and true RMS by LOG-anti LOG	True RMS by LOG-anti LOG	PWM time division multiplication
Measurement frequency	AC	10 Hz to 20 kHz	10 Hz to 20 kHz	10 Hz to 20 kHz
	DC/AC	DC, 10 Hz to 20 kHz	DC, 10 Hz to 20 kHz	DC, 10 Hz to 20 kHz
Crest factor	AC	Max. 2	Max. 3	Same as these described in voltage and current column.
	DC/AC		Max. 3 or 50 A (peak)	
Accuracy At ambient temperature: 23 ±3°C Humidity: 45 to 75% R.H., Source voltage: 100 v ±1%, Input waveform: sinusoidal, Calibration cycle: 90 days same phase voltage 0 V, and after demagnetization (only for DC/AC model)	AC	45 to 66 Hz ±(0.1% of rdg +0.1% of range) 20 to 45 Hz, 66 Hz to 2 kHz ±(0.2% of rdg +0.2% of range) 10 to 20 Hz, 2 to 10 kHz ±1% of range 10 to 20kHz, ±2% of range (at input 10 to 110%)	45 to 66 Hz ±(0.1% of rdg +0.1% of range) 20 to 45 Hz, 66 Hz to 2 kHz ±(0.2% of rdg +0.2% of range) 10 to 20 Hz, 2 to 10 kHz ±1% of range 10 to 20kHz, ±2% of range (at input 10 to 110%)	At cos ϕ= 1, 45 to 66 Hz ±(0.1% of rdg +0.1% of range) 20 to 45 Hz, 66 Hz to 2 kHz ±(0.2% of rdg +0.2% of range) 10 to 20 Hz, 2 to 10 kHz ±1% of range 10 to 20 kHz ±2% of range
	DC/AC	DC: ±(0.1% of rdg +0.2% of range) AC: 45 to 66 Hz ±(0.1% of rdg +0.2% of range) 20 to 45 Hz, 66 Hz to 2 kHz ±(0.2% of rdg +0.4% of range) 10 to 20 Hz, 2 to 10 kHz ±1% of range 10 to 20kHz, ±2% of range (at 10 to 110% input)	DC: ±(0.1% of rdg +0.2% of range +3 mA) AC: 45 to 66 Hz ±(0.1% of rdg +0.2% of range) 20 to 45 Hz, 66 Hz to 2 kHz ±(0.2% of rdg +0.4% of range) 10 to 20 Hz, 2 to 10 kHz ±1% of range 10 to 20kHz, ±2% of range (at 10 to 110% input)	DC: ±(0.1% of rdg +0.3% of range) when cos ϕ= 1, AC: 45 to 66 Hz ±(0.1% of rdg +0.2% of range) 20 to 45 Hz, 66 Hz to 2 kHz ±(0.2% of rdg +0.4% of range) 10 to 20 Hz, 2 to 10 kHz ±1% of range 10 to 20 kHz ±2% of range
Influence by power factor		———	———	Within 50/60 Hz ±0.5% of rdg at cos ϕ=0.5
Accuracy (analog output) at same conditions as for display		Add 0.05% of range to display accuracy shown above.		
Temperature coefficient 5 to 20°C (41 to 68°F), 26 to 40°C (79 to 104°F)		Less than ±0.03% of range/°C (Less than ±0.02% of range/°F)	Same as voltage	Same as voltage

Computing Functions

Apparent Power, Reactive Power and Power Factor Computations

Item \ Computing Function	Apparent Power (VA)	Reactive Power (var)	Power Factor (PF)
Arithmetic expression	V×A	$\sqrt{(V\times A)^2-W^2}$	$\frac{W}{V\times A}$
Computation range	Rated value depends on V; A ranges (F.S. resolution same as corresponding W range)	Same as apparent power	−1 to 0 to +1 (10 to 110% of rating for V and A)
Computation accuracy with respect to value calculated from measured value (V, A, W)	±0.05% of rated value (VA)	±0.05% of rated value (var)	±0.001

*When distorted waveshapes are mesured, differential in measured values using this instrument and other instrument with different principle of measurement may occur.

Scaling Function

Each measured value multiplied by PT ratio, CT ratio, SCALING FACTOR or others is displayed (unit is changed automatically)

Effective Digit: selected automatically according to effective digit of voltage and current ranges

Setting Range: 0.0001 to 10000

Set Value: DISPLAY A settable for PT ratio, DISPLAY B for CT ratio, DISPLAY C for scaling factor

Averaging Function

Principle: exponential averaging with attenuation factor K=8

Optional Specifications

■ GP-IB Interface (/GP-IB)

Electrical, Mechanical Specifications: conform to IEEE Std 488-1978

Functional Specifications: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, C0 (ADDRESSABLE/TALK ONLY)

■ /RS-232C Interface Option

Data Transmission System: Start-stop system

Data Transmission Rate: 75, 150, 300, 600, 1200, 2400, 4800, 9600 bps.

■ Frequency Measurement (/FRQ)

Measurement Principle: reciprocal

Measurement Frequency Range: 8 Hz to 200 kHz (filter OFF), 2 to 200 Hz (filter ON)

Accuracy: ±(0.1% +1 digit)

Min. Voltage and Current Input Sensitivity: ±10% of F.S.

Display Range: 2.000 Hz to 240.0 kHz (4 digits)

Sampling Rate: 400 ms (filter OFF), 1.6 s (filter ON)

Measurement Input: V or A

■ Integrator Function (/INTEG)

Max. Display: ±999999 (6 digits)

Integration Time: 999 h

Display: Ah or Wh by DISPLAY C

Timer: integration can automatically be stopped by timer setting. Set value ... 000 h:01 min to 999 h:00 min (timer OFF at 000 h:00 min).

Lapse of Time: lapse of time after integration start can be indicated as 0 to 999 h:00 min by display B

Count Over: if integrated value over ranges, lapse of time is held and control stops

Accuracy: ± (mainframe accuracy +0.02% of rdg +1 digit)

Temperature Characteristics: ±0.025% of range/°C (±0.045 of range/°F)

Timer Accuracy: ±0.02%

Remote Control: start, stop and reset control are made by external contact closure command

■ D-A Converter Function

Principle: 16 bit PWM system, D-A converter

Output Range: (−7.5 to +7.5V) rating: 5V/F.S.

Accuracy: mainframe accuracy +0.1% of F.S.

Temperature Characteristics: ±0.02%/°C (±0.036%/°F)

Output Contents: one of Wh, Ah, var, VA, PF and Hz (data specified at DISPLAY C)

Sampling Rate: 400 ms

1-5. Operating Principle

Figure 1-3 is a block diagram for the digital power meter of single-phase system. It consists of input section, RMS board, A-D board, CPU board, etc.

In the voltage input circuit adopted for the input section, the input voltage is changed to a constant current by voltage divider and preamp and is then isolated by a CT. In the current input circuit, the CT primary winding is fixed and the secondary load and preamp gain are changed over. With this, changing the current range does not open the primary current circuit, permitting safe changes, and remote control can be attained by using GP-IB or RS-232C interface.

On RMS board, the voltage output is subjected to true rms computation by log-antilog method or mean value rectification rms value computation. The current output is subjected to true rms computation by log-antilog. For power measurement, the multiplier circuit resorts to a PWM (pulse width modulation) time division system. To ensure wide bandwidth and high accuracy, the clock frequency adopted is 125 kHz and, for a switching element, a high speed MOS device is used.

Output from RMS board enters A-D converter of 16 bit PWM system, where it is converted to a digital value.

CPU board is centered around an 8 bit 8085. Here, A-D converter control, display section control and also apparent power, reactive power, power factor, PT ratio, CT ratio scaling and other computations are carried out.

Analog output, voltage and current waveform from different input sections as well as voltage, current and power converted into DC voltages are available.

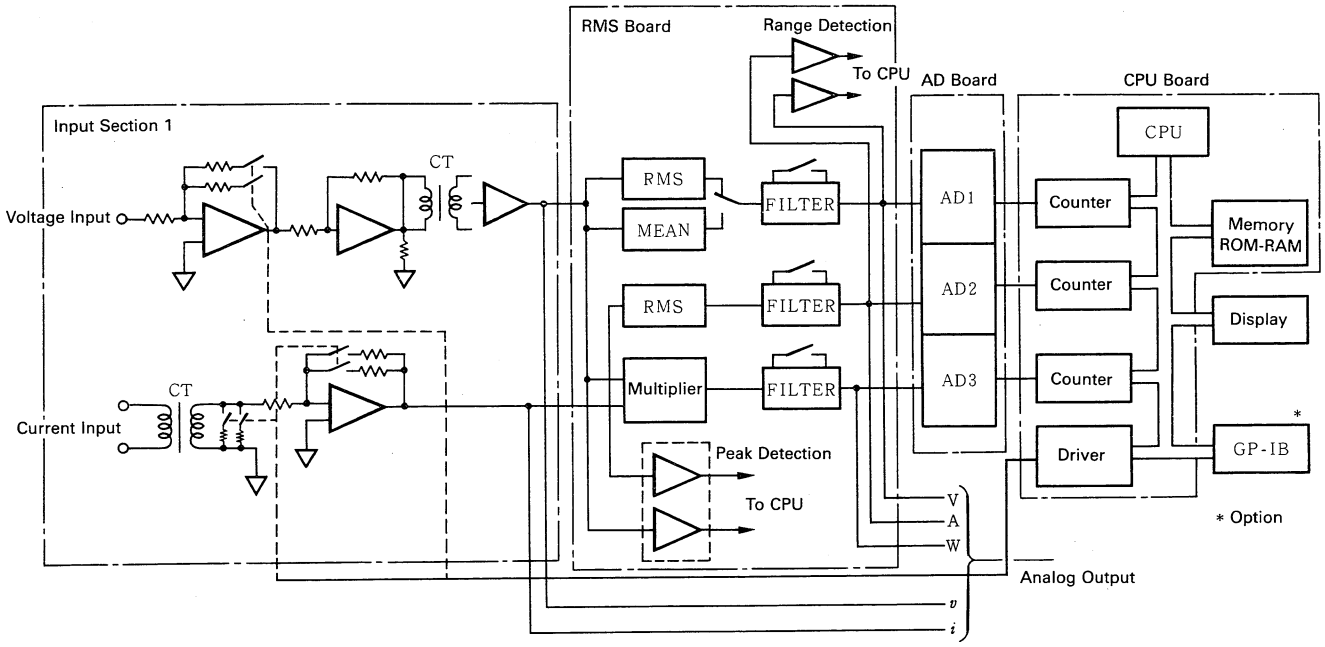
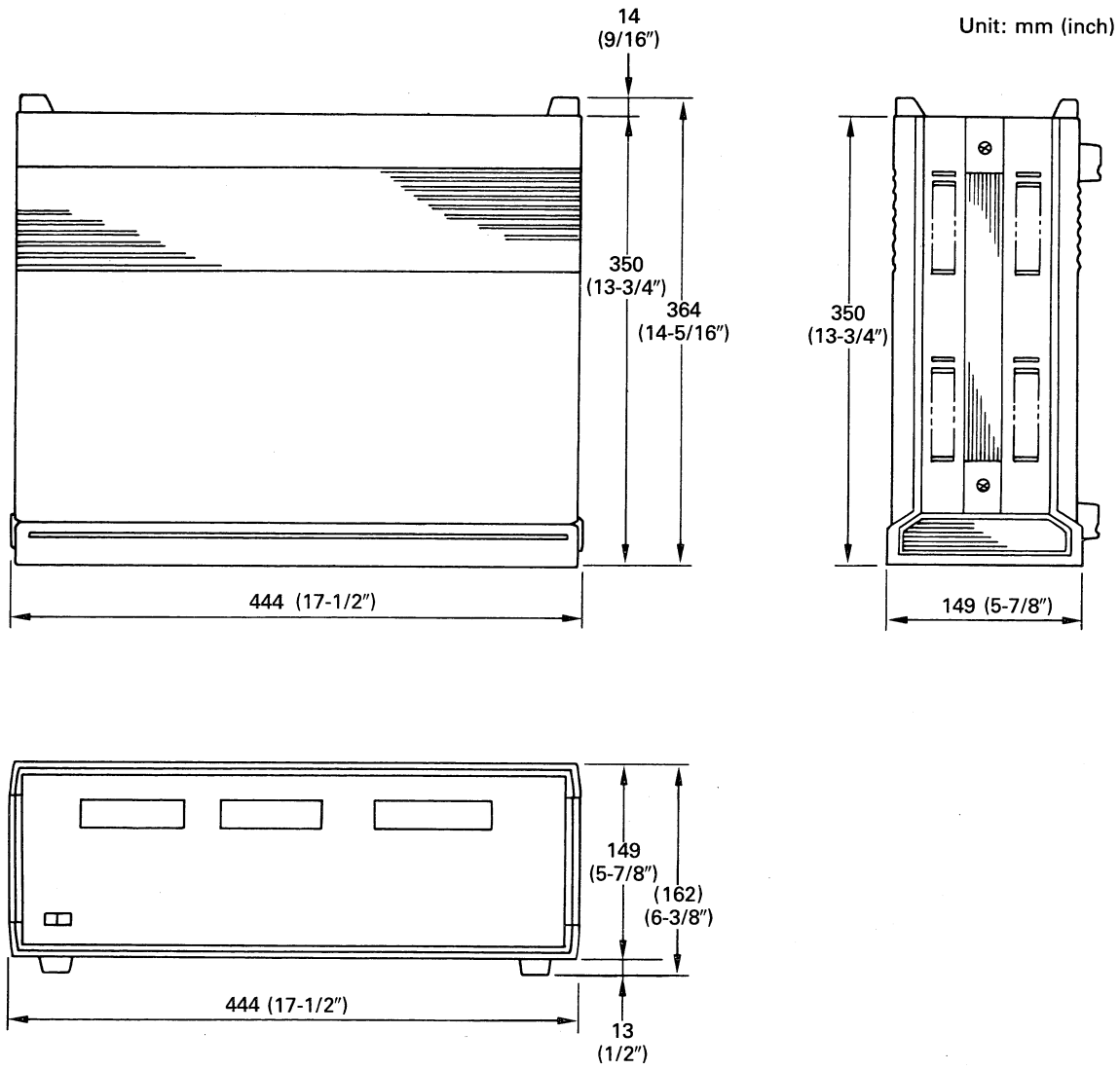


Figure 1-4. Block Diagram of Single-Phase System

1-6. External Dimensions

Unit: mm (inch)



2. HANDLING

2-1. General Operating Procedure

A general operating procedure of the instrument is illustrated in the form of a flow chart. The description is made almost in the illustrated sequence.

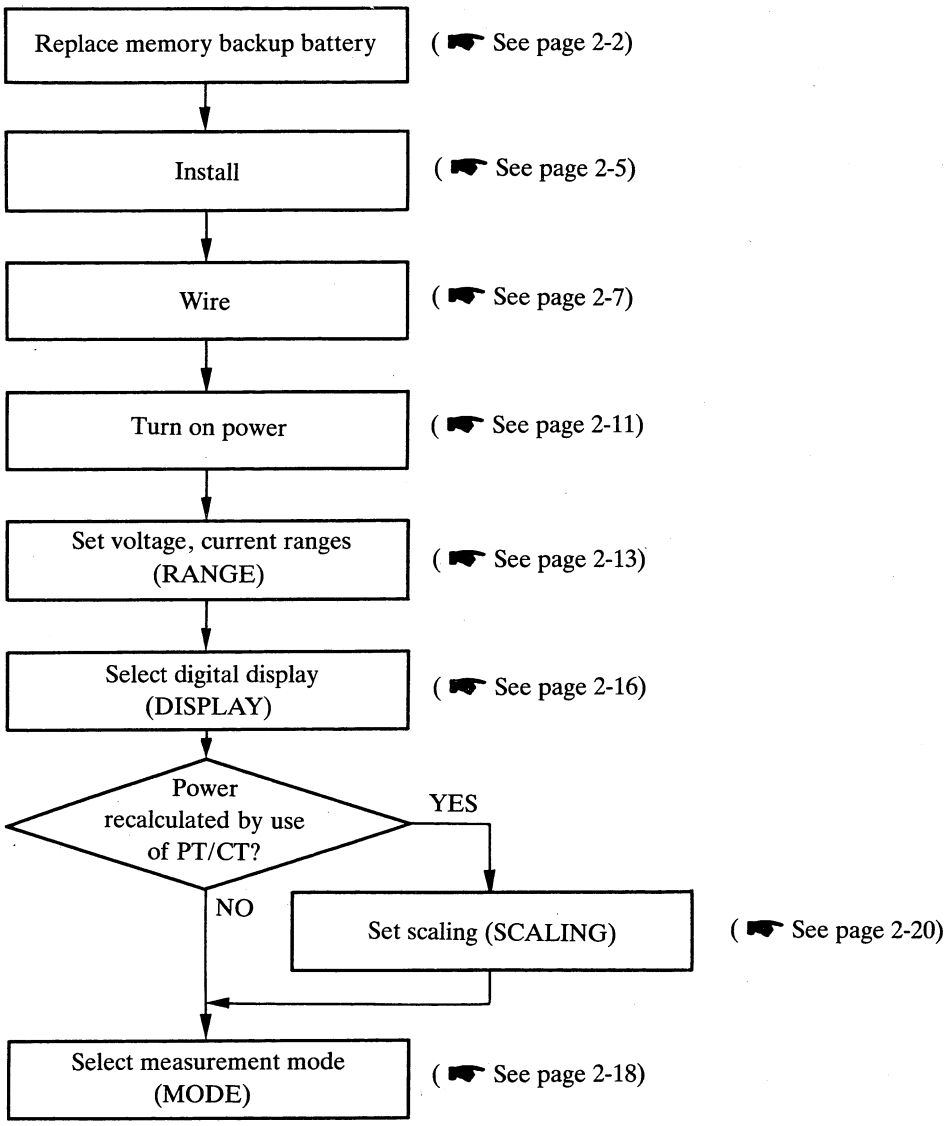


Figure 2-1.

2-2. Installing and Replacing Battery

(1) Installing Battery (First Time)

1) On the instrument, "panel setting information protective dry cells" are installed for backup of setting information in case of a power failure or when the power switch is turned OFF. The battery is housed at the upper right corner on the rear of the mainframe as depicted in Figure 2-2.

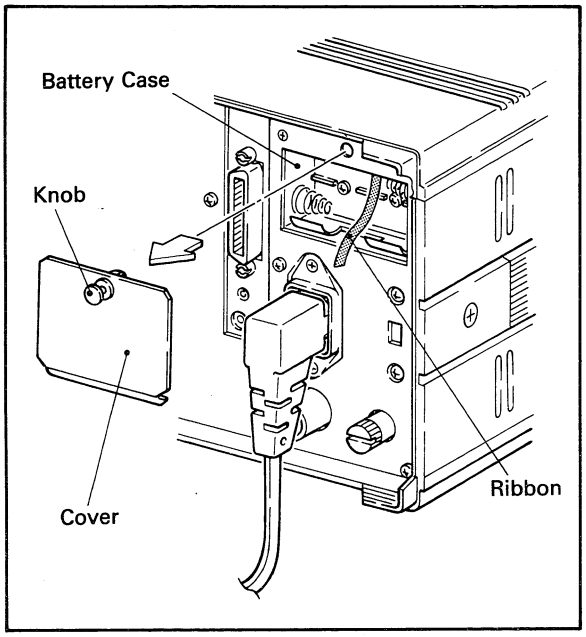


Figure 2-2.

2) By pulling the knob located at the upper middle of the battery cover shown in Figure 2-2, the cover is unlocked and can be taken out of the mainframe.

3) In the middle of the internal battery case, a red ribbon is mounted. As shown in Figure 2-3, mount two furnished dry cells (SUM-3D) on top of the ribbon.

Observe proper polarity when installing the batteries.

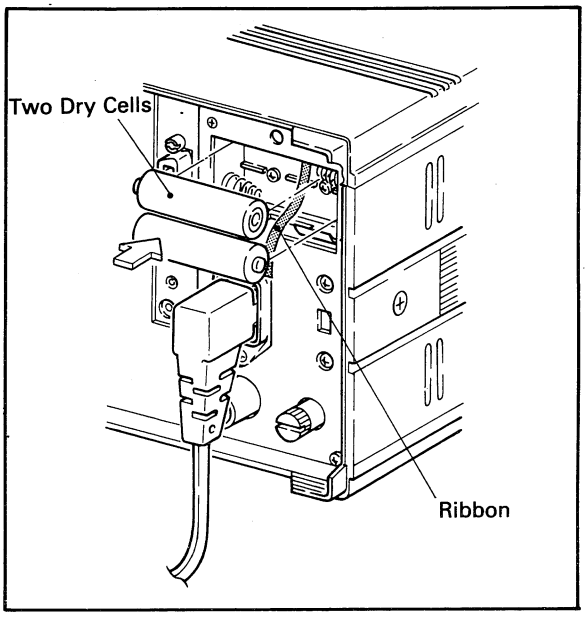


Figure 2-3.

4) As depicted in Figure 2-4, fold back the excess of ribbon upward, put the cover in place and push the knob to lock.

Take care so the ribbon end does not show outside the case.

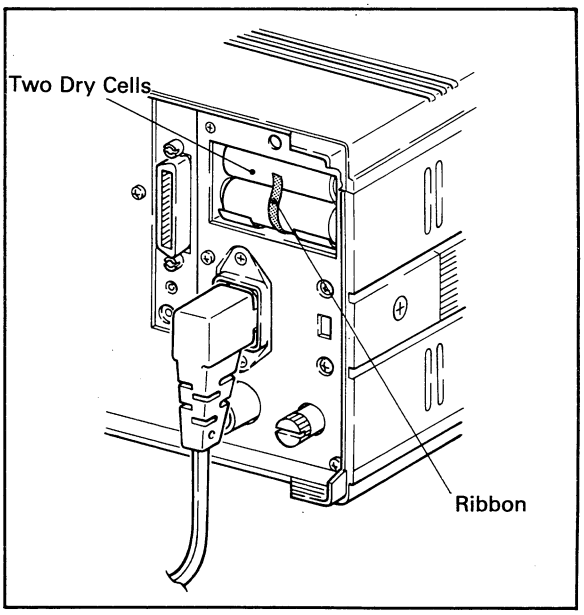


Figure 2-4.

5) The battery life is about one year at a normal operating status. When the battery voltage becomes lower than specified, BATTERY indicator lamp on the upper left corner of the front panel comes on, thereby indicating the battery must be replaced.

(2) Replacing Battery

1) If BATTERY indicator lamp stated in 5) above is lit, immediately prepare two new dry cells.
2) Refering (1) 2), remove the cover from the housing.
3) Pull the red ribbon and remove the old cells.
4) Thereafter, replace the cells in the procedure given in (1) 3) and 4).
5) **Replace the cells with 2533 turned ON so as not to lose the setting information.**

If the cells are replaced with power OFF, the set data is destroyed and the control return to a default mode to be described in section 2-5.

Note, however, that in the default mode, the voltage and current ranges are maximum with 600 V and 20 A. Therefore, turning ON does not damage the instrument.

NOTES

1. Replace with cells of the same manufacturer, where possible.
2. Replace two cells at a time and refrain from using new and old cells together.
3. Refrain from using cells whose history is unknown.
4. Do not discard old cells together with ordinary garbage.

(3) Setting Information Backed Up By Battery

Table 2-1 shows setting information backed up by the "panel setting information protective dry cells" installed as explained in (1).

Table 2-1.

Display Mode	DISPLAY A	V A W	Setting item
	DISPLAY B	V A W INTEG TIME	Setting item
	DISPLAY C	V A W var VA PF Hz Wh Ah	Setting item
Measurement Mode	VOLT		Voltage section (RMS/MEAN)
	FILTER AVG SCAL-ING		Each section (ON/OFF)
Sampling Mode	HOLD		Sampling section (ON/OFF)
Measurement Range	VOLTAGE RANGE (V)		Setting range
	AUTO		Range section (ON/OFF)
	CURRENT RANGE (A)		Setting range
	AUTO		Range section (ON/OFF)
Scaling Value	DISPLAY A	SCAL-ING	PT ratio set value
	DISPLAY B		CT ratio set value
	DISPLAY C		Set value
Timer Setting	TIMER		

Notes: 1. In the display mode, Hz of DISPLAY C is effective only when the frequency measurement function (option code: /FRQ) installed.

2. In the display mode, Wh and Ah of DISPLAY C and TIMER of the timer setting are effective only when the integrator function (option code: /INTEG) is installed.

3. When GP-IB or RS-232C interface option is installed, the following interface-related parameters are not backed up:
   - service request mask: IM✻✻ and
   - BLOCK output time delimiter: DS✻ (GP-IB only)

2-3. Installation

The instrument is available as a desk top type, or the like or a rack mount type with the furnished adapter.

(1) Desk Top Type

The instrument can be installed horizontal or tilted on a table.

To tilt the instrument, lift the front and pull the stand located on the instrument bottom. It is locked in a position almost perpendicular with respect to the bottom surface. To unlock, push back the stand while pushing inward on the right and left legs of the stand.

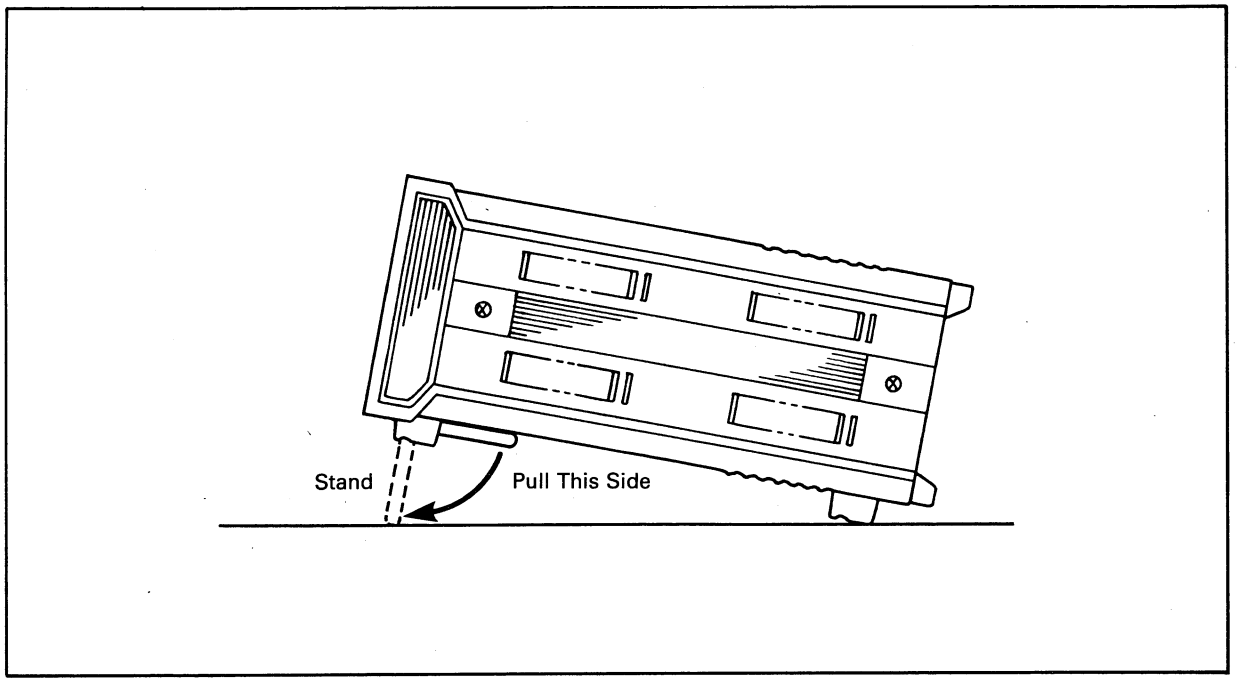


Figure 2-5.

(2) Rack Mount Type

For use as a rack mount type, the supplied adapter must be mounted.

<Mounting Procedure>

① Remove the rubber covers from the sides of the mainframe shown in Figure 2-6.
② Loosen each right and left 2 countersunk screws from the locations where the rubber covers were removed.
③ Attach the adapter with the countersunk screws loosened in ②.
④ Remove the four legs from the mainframe sides with a flathead screwdriver.
⑤ Mount the mainframe on the rack.
◎ When installing, be sure to add a support from underneath.

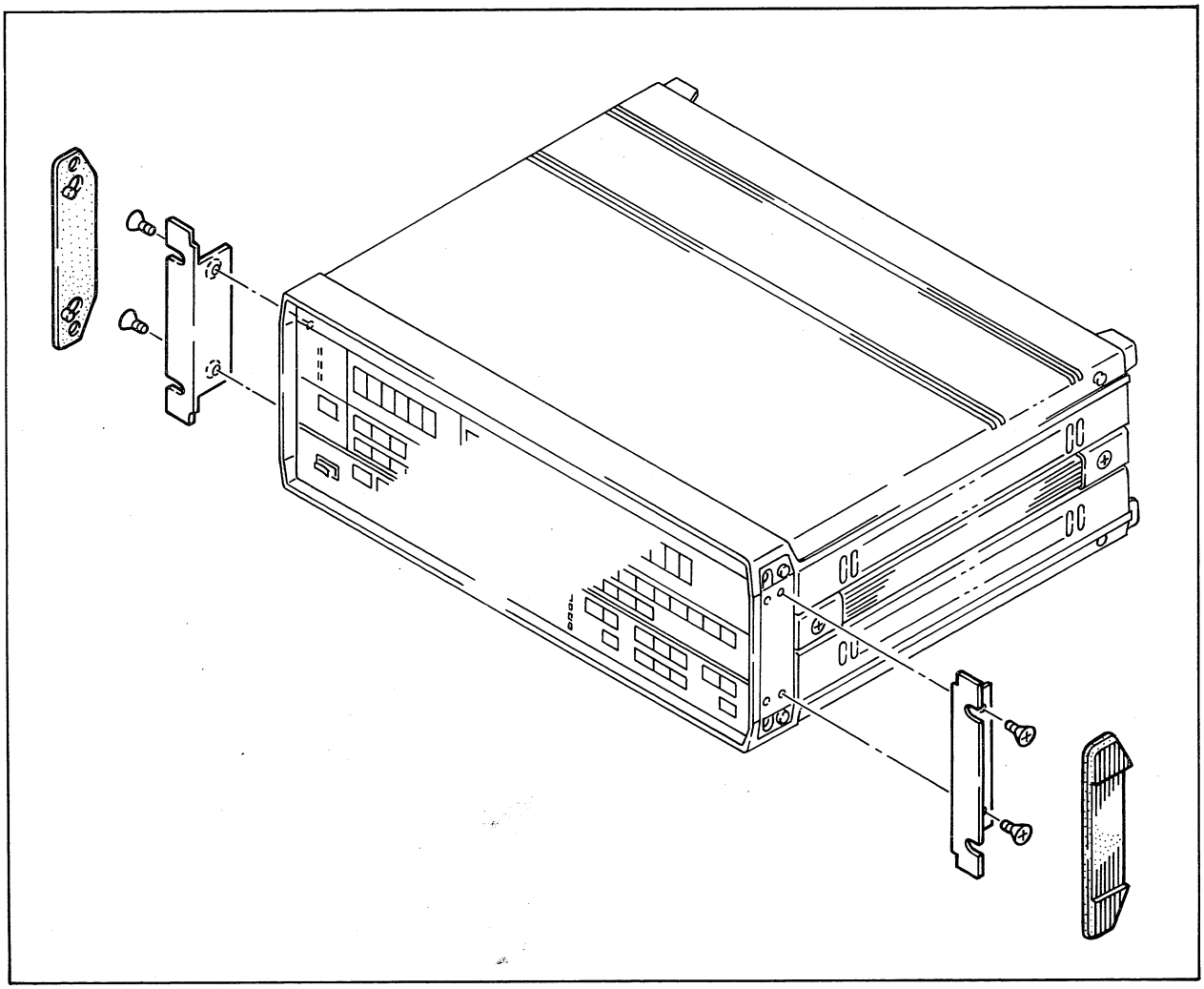


Figure 2-6.

2-4. Wiring Procedure

This section describes the wiring method for single-phase power models 2533 11 and 2533 21.

On the wiring diagram, both voltage and current sides are connected for a power measurement. When measuring voltage or current only, connecting of the voltage or current only, will suffice.

CAUTION

- Before connecting the power cord and line under test to this instrument, connect to ground of a good quality (ground resistance: under 100Ω) the ground terminal ⏚ located on the lower right corner of the rear panel to avoid danger.
  When a power code with ground cable is connected to a power outlet (wall receptacle), it is not necessary to connect the ground terminal to ground separately.

- **Before connecting the line under test to the instrument, turn OFF the power switch of the load.** Take utmost care not to connect a voltage circuit to the current input terminal, or a current circuit to the voltage input terminal. Wrong connection is not only dangerous to the human body but also might burn the instrument.

- Use connecting wires of proper size and gage with respect to the voltage and current to be measured.

- Although the rear panel, etc. of the input element used on the instrument are so designed as to ensure safety, **it is very dangerous to remove the connecting wires with SOURCE side turned on. Be sure to turn OFF the input signal before removing the connecting wires.**

- Whether the power switch is turned ON or OFF, applying voltage or current beyond the maximum continuous or momentary allowable input indicated in the Specifications might damage the instrument.

- In a power measurements, large current and voltage and current containing high frequency components are handled. Wire inputs with regard to about their mutual interference and countermeasure for noise.
  As required, separate, twist or shield the wiring.

- Influence by a residual current may occur if the wiring resistance is lower than 40 mΩ when a high sensitivity range is used for current measurement.

2-4-1. Power Measurement of Single-Phase Two-Wire (1φ2W) System

(1) When both Voltage and Current are Within Specified Measurement Ranges

When both voltage and current are within the specified measurement renges for the instrument, securely connect SOURCE and LOAD side wires to the voltage and current terminals on the rear of the input element as shown in the wiring diagram in the middle of the rear panel, or in Figure 2-7. The thicker line indicates the current circuit, and the thinner line indicates the voltage circuit.

With this wiring, the digital display shows the measured value as it is.

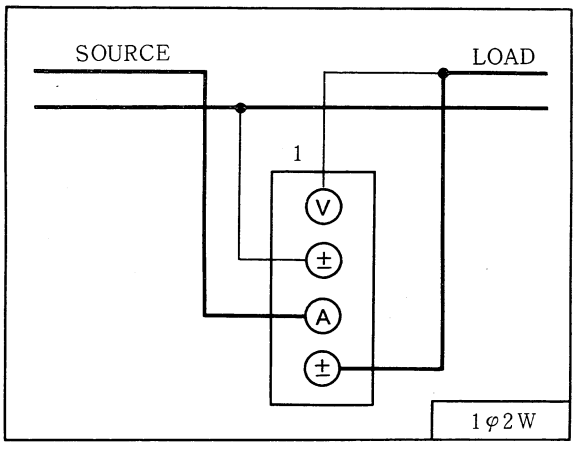


Figure 2-7.

(2) When both Voltage and Current Exceed Specified Measurement Ranges

The maximum measurement ranges of the input element are 600 V for voltage, and 20 A for current.

When it is desired to measure a greater voltage or current, connect an external potential transformer (PT) and current transformer (CT) as shown in Figure 2-8.

Note: The frequency characteristics and phase characteristics of the external PT and CT influence the measured value.

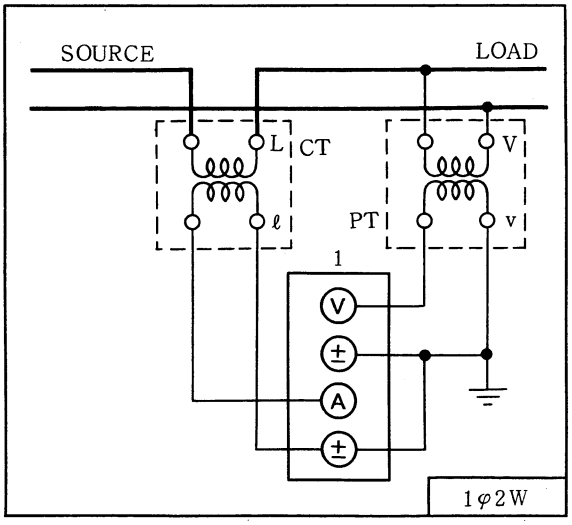


Figure 2-8.

Generally, PT secondary is 110 V or 150 V, and CT secondary is 5 A. Select appropriate primary ranges according to the voltage and current to be measured. PTs and CTs in Tables 2-3 and 2-4 (related products) are available from us. Their use combined with this instrument considerably widens the voltage and current measurement ranges.

<Examples of Calculation When Using PT and CT>

(1) Voltage Measurement (instrument's voltage reading×PT ratio)

Example: Instrument's voltage reading ..... 100.00 V
PT ratio ..... 3300/110=30
Measured voltage .. 100 V×30=3kV

(2) Current Measurement (instrument's current reading×CT ratio)

Example: Instrument's current reading ..... 4.000 A
CT ratio ..... 50/5=10
Measured current .. 4 A×10=40 A

(3) Power Measurement (instrument's power reading×PT ratio×CT ratio)

Example: Instrument's power reading ..... 350.0 W
PT ratio ..... 3300/110=30
CT ratio ..... 50/5=10
Measured power ... 350 W×30×10=105 kW

- When it is desired to directly read on the display the values measured as shown above, set the PT and CT transformation ratios by scaling.
  For details of scaling, refer to section **2-10 Setting Scaling (SCALING) Factor.**

NOTE

- When using an external current transformer, its secondary must not be opened at an energized mode. If opened, a high voltage would appear on the current transformer secondary which is very dangerous.

- The instrument is so designed that, by changing the range by the range change key [▲] or [▼] on the front panel, the secondary of the incorporated current transformer is not opened. Therefore, the range may be changed in an energized mode.

- When measuring low power factor wattage, a slight phase error from a potential or current transformer influences the measured power considerably. Be aware of it when the power must be measured accurately.

2-4-2. Correction for Self-Consumed Power

The measured power indicated by the instrument is load power plus power consumed by the input circuit of the instrument connected to the load side.

When it is desired to measure the load power more accurately, the power cinsumption of the instrument itself must be deducted from the measured value.

(1) When Voltage Terminal is Connected to Load Side

When the source impedance is low and the voltage fluctuation is small, or the load power is relatively small, connect the voltage terminal to the load side. In the wiring diagrams on the instrument's rear panel and this manual, the "voltage terminal is connected to load side".

The loss on the voltage terminal side is almost the same as the instrument's reading when the load is detached. By deducting this value from the value measured when the load is connected, a true load power is obtained.

Since the input resistance of the voltage terminal of the instrument is about 1 MΩ (constant) over the entire voltage measurement ranges, correction of self-consumed power may hardly be necessary.

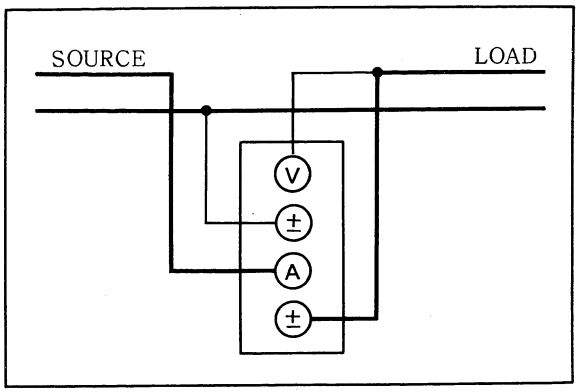


Figure 2-9.

(2) When Current Terminal is Connected to Load Side

For power measurement, the current terminal may be connected to the load side besides the wiring stated in (1) above. In this case, by changing the voltage connecting point from P to Q with the load kept connected as shown in Figure 2-10, the power measured by the instrument is the loss on the current terminal side. By deducting this value from the power measured when the voltage connecting point is at P, a true load power is obtained.

The self-consumed power (instrument loss) on the current terminal side is 2 mΩ×current (squared) at 50 Hz. When the instrument loss is sufficiently smaller than the load power, the instrument loss may be ignored.

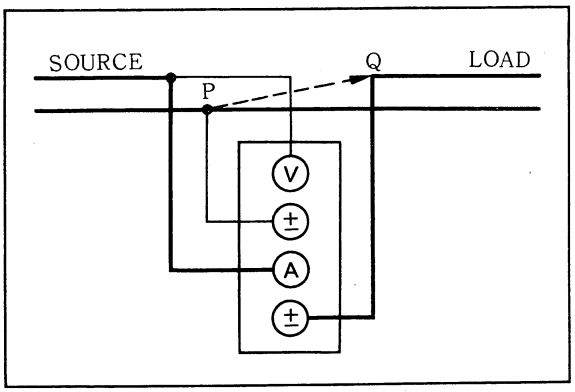


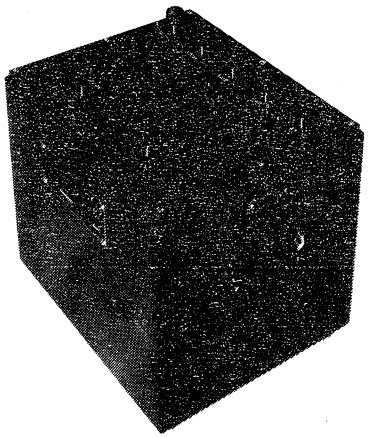
Figure 2-10.

Related Products

(1) Potencial Transformers: 2261, 2262
Class: 0.2, JIS C 1731
Rated Burden: 15 VA

Table 2-3.

Model	Primary	Secondary
226101	220/440/2,200/3,300 V	110 V
226102	15/30/50/75 V	150 V
226103	100/200/300/500 V	150 V
226200	3,300/6,600 V	110 V

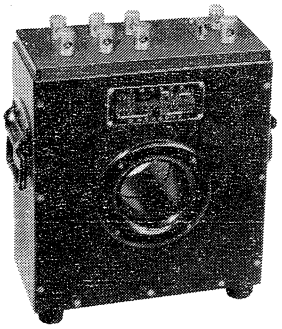


226101 Potential Transformer

(2) Current Transformers: 2241 to 2244
Class: 0.2

Table 2-4.

Model	Primary	Secondary
224100	10/15/30/60/100/250/ 300/500/750/1,500 A	5 A
224200	10/15/30/50/100/250/ 300/500/750/1,500 A	5 A
224300	0.5/0.75/1/1.5/2/3/5/ 7.5/10/15/20/30/50/ 75/100 A	5 A
224400	500 A (500 AT)	5 A



224100 Current Transformer (through type)

2-5. Turning on Power

(1) Setting Status of Keys when Turning on Power

Install the backup batteries according to section 2-2. Before any settings have been made with the front panel keys, the settings of the keys shown in Figure 2-11 when turning on power are at a default status given below. For a DC/AC meters, when the power turns on, its DC-CT core is demagnetized.

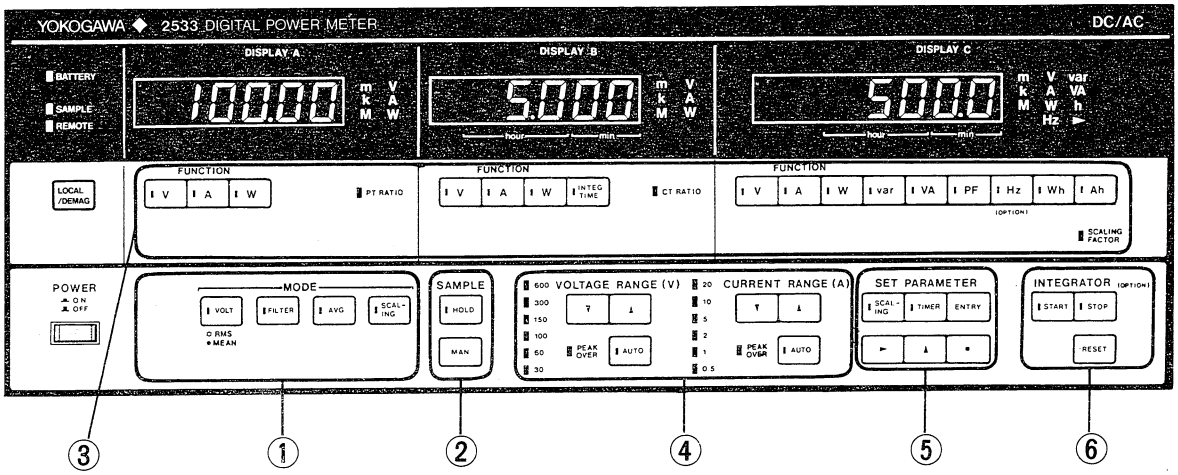


Figure 2-11.

1) Measurement Mode

A measurement mode is selected by MODE keys shown by ① in Figure 2-11. The initial status of the keys are given in Table 2-5.

Table 2-5.

Key	Initial Setting	Display
VOLT	RMS	Key lamp lit
FILTER	OFF	Key lamp extinguished
AVG	OFF	
SCAL-ING	OFF	

2) Sampling Mode

The sampling hold status is turned ON or OFF by SAMPLE keys indicated by ② in Figure 2-11. The initial settings are given in Table 2-6.

Table 2-6.

Key	Initial Setting	Display
HOLD	OFF	Key lamp extinguished

At this time, SAMPLE display lamp located near the upper left corner of the front panel flashes at a sampling cycle of about 400 ms. Confirm this.

3) Display Mode

A display mode is selected by FUNCTION and ELEMENT keys corresponding to DISPLAY A, B and C shown by ③ in Figure 2-11. The initial settings of the keys are given in Table 2-7.

Table 2-7.

Corresponding Display	Initial Setting	Display
DISPLAY A	V1	Lamps lit on V keys. Others extinguished.
DISPLAY B	A1	Lamps lit on A keys. Others extinguished.
DISPLAY C	W1	Lamps lit on W keys. Others extinguished.

4) Measurement Range

Each measurement range is selected by VOLTAGE RANGE (V) and CURRENT RANGE (A) keys shown by ④ in Figure 2-11. The initial settings are given in Table 2-8.

Table 2-8.

Measurement Range	Initial Setting	Display
VOLTAGE	600 V	600 lamp lit. Others extinguished.
CURRENT	20 A	20 lamp lit. Others extinguished.

5) Scaling Value

Press [SCALING] key, shown by ⑤ in Figure 2-11. The key lamp comes on and, at the same time, PT ratio, CT ratio and scaling factor initial set value are indicated on DISPLAY A, B and C, as shown in Table 2-9.

At this time, the most signification digit of DISPLAY A flashes, indicating the value in this place is ready to be changed by setting. It is not due to trouble in the instrument.

Table 2-9.

Display	Initial Scaling Item	Initial Setting and Display
DISPLAY A	PT ratio	1.0000
DISPLAY B	CT ratio	1.0000
DISPLAY C	SCALING FACTOR	1.0000

6) Timer Setting (Only When/INTEG is Added)

Press [TIMER] key, shown by ⑤ in Figure 2-11. The key lamp comes on, DISPLAY A and B disappear as shown in Table 2-10, and initial timer setting is indicated on DISPLAY C.

At this time, 0 the most signification digit of DISPLAY C flashes, indicating the value in this place is ready to be changed. It is not due to trouble in the instrument.

Table 2-10.

Display	Initial Setting	Initial Setting and Display
DISPLAY A		
DISPLAY B		
DISPLAY C	Timer (h, min)	00000 (hour, min)

At the same time, INTEGRATOR Keys shown by ⑥ in Figure 2-11 give initial settings shown in Table 2-11.

Table 2-11.

Key	Initial Setting	Display
[START]	OFF	Key lamp extinguished
[STOP]	ON	Key lamp lit

Note: When the integrator function is not added, [STOP] key lamp is also extinguished.

(2) Others

Make sure BATTERY indicator lamp on the upper left corner of the front panel is extinguished.

This lamp is lit when "panel setting information protective dry cells" are not installed or are exhausted.

NOTE

When setting information is backed up by the batteries, key setting statuses when turning on power are set in last setting when power was turned OFF. When GP-IB or RS-232C interface (option code:/GP-IB or/RS-232C) is installed, service request mask: IM✻✻ and delimiter: DS✻ (GP-IB interface only) setting at BLOCK output are not protected. If power is turned OFF while integrating when an integrator function is added, turning on power again does not resume the integration.

2-6. Setting Voltage and Current Ranges (RANGE)

The voltage and current ranges are set by operating the keys in the shaded area of Figure 2-12. The selected ranges are known by the range indicator lamps located at left of the keys.

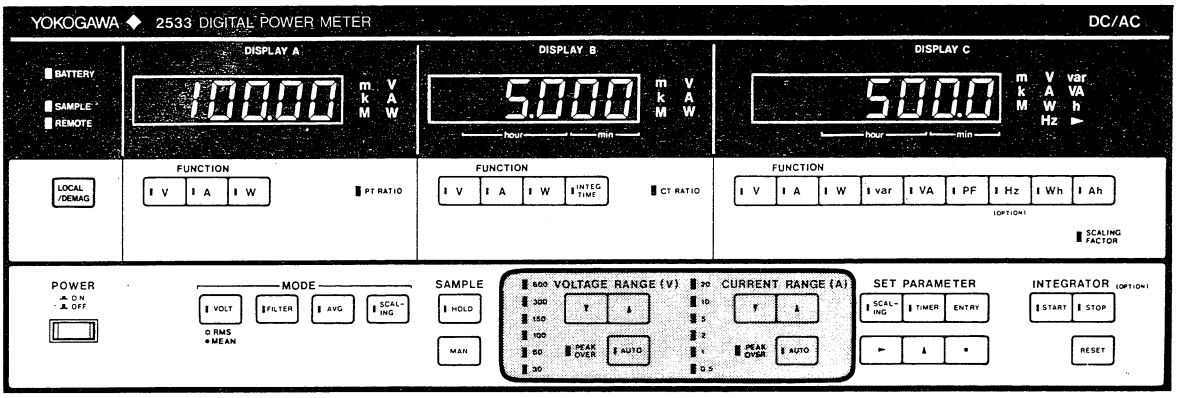


Figure 2-12.

Setting is carried out in either automatic range setting mode or fixed range mode.

[AUTO] : Pressing this key selects the automatic range setting mode or fixed range mode alternately.
The automatic range mode is selected when the key lamp is lit. In this mode, a range appropriate for an input signal level is automatically selected.

[▼] ([▲]): Effective in the fixed range mode (overridden in automatic range setting mode). Each press lowers, (raises) the measurement range down to the minimum or up to the maximum range.
Six ranges each are provided for voltage and current.
Voltage range; 600 V/300 V/150 V/100 V/60 V/30 V
Current range; 20 A/10 A/5 A/2 A/1 A/0.5 A*
*DC/AC meters do not cover 0.5 A range.

PEAK OVER : The lamp comes on when the input signal peak level has exceeded 250% of range for voltage or 350% of range for current, indicating the peak value is exceeded.

- A combination of voltage and current ranges determines the power range as follows.
(Power range)=(voltage range)×(current range)
Example: Combination of 100 V range and 5 A range makes a power range of 500 W.
- For an automatic range mode, the range is changed as follows.

(1) The Range Rises
- The measured value of the measurement range has exceeded 110% of the range (overrange).
- The peak level has exceeded 250% of the range for voltage or 350% for current.

(2) The Range Lowers
All the measured values has dropped to about 30% or less (underrange).

NOTES

◎ When measuring a wave of a high crestfactor (3.5 min.) at auto range, or when measuring a signal of 5 Hz or less, the range may be indefinite. In such cases, use the fixed range.
◎ In the auto range mode, the range is changed over as explained in (1) and (2) above. The range may be different for the same input.
◎ In the auto range mode, the time required for changing the range is:
1 s/step with FILTER ON or
0.2 s/step with FILTER OFF.

2-7. Digital Display (DISPLAY)

The instrument has three digital display sections DISPLAY A, B and C surrounded by ☐ in Figure 2-13, and three parameters or voltage, current and power can be indicated simultaneously.

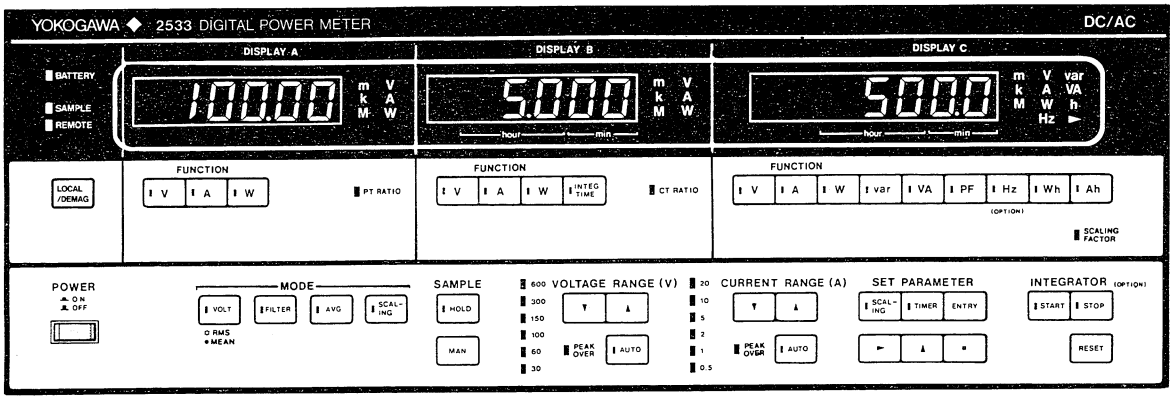


Figure 2-13.

They display scaling factor setting, hardware configuration when turning ON power and version No.

Their details are as follows.

Display Range: 0.0000 to ±99999 for DISPLAY A and B, 0.0000 to ±99999 for DISPLAY C

Mode	Max. Display	Display Item
A	±99999	V, A, W
B	±99999	V, A, W, integration lapse (option)
C	±99999 (±999999 Wh, Ah)	V, A, W, VA, var, PF (Hz, Wh, Ah ... option)

Measured Value Overrange Indication: 999999

Computed Value Overflow Indication: 888888

No Data: - - - - - -

<Measured and Computed Value Display>

By setting the internal switches, the display resolution can be selected between 20000 and 60000 (see section **2-12 Setting Internal Switches**). They are factory set at 20000.

This action changes the display resolution and the resolution of A-D converter remains at 20000.

In case of 60000 display, the minimum resolution is greater than 1 digit.

(1) Voltage (V) Display

Display / Voltage Range	20000 Display		60000 Display	
	Rating Display	Max. Display	Rating Display	Max. Display
30 V	30.00	42.00	30.000	42.000
60 V	60.00	84.00	60.000	84.000
100 V	100.00	140.00	100.00	140.00
150 V	150.00	210.00	150.00	210.00
300 V	300.0	420.0	300.00	420.00
600 V	600.0	840.0	600.00	840.00

- The input is 10% to 110% of the range but display is available up to 140% of the range (max. display). 0.1% or less of the range gives zero display.

(2) Current (A) Display

Display / Current Range	20000 Display		60000 Display	
	Rating Display	Max. Display	Rating Display	Max. Display
0.5 A*	0.5000	0.7000	500.00 m	700.00 m
1 A	1.0000	1.4000	1.0000	1.4000
2 A	2.0000	2.8000	2.0000	2.8000
5 A	5.000	7.000	5.0000	7.0000
10 A	10.000	14.000	10.000	14.000
20 A	20.000	28.000	20.000	28.000

*DC/AC meters do not cover 0.5 A range.

- The input is 10% to 110% of the range but display is available up to 140% of the range (max. display). 0.1% or less of the range gives zero display.

(3) Effective Power (W), Reactive Power (var) and Apparent Power (VA) Display

Combinations of voltage and current ranges make the following rating ranges.

20000 Display Resolution

Voltage Range \ Current Range	0.5 A*	1 A	2 A	5 A	10 A	20 A
30 V	15.000	30.00	60.00	150.00	300.0	600.0
60 V	30.00	60.00	120.00	300.0	600.0	1200.0
100 V	50.00	100.00	200.00	500.0	1000.0	2000.0
150 V	75.00	150.00	300.0	750.0	1500.0	3.000k
300 V	150.00	300.0	600.0	1500.0	3.000k	6.000k
600 V	300.0	600.0	1200.0	3.000k	6.000k	12.000k

*DC/AC meters do not cover 0.5 A range.

60000 Display Resolution

Voltage Range \ Current Range	0.5 A*	1 A	2 A	5 A	10 A	20 A
30 V	15.000	30.000	60.00	150.00	300.0	600.00
60 V	30.000	60.000	120.00	300.0	600.0	1200.0
100 V	50.00	100.00	200.00	500.00	1000.0	2000.0
150 V	75.00	150.00	300.0	750.0	1500.0	3000.0
300 V	150.00	300.0	600.0	1500.0	3000.0	6000.0
600 V	300.0	600.0	1200.0	3000.0	6000.0	12.000k

*DC/AC meters do not cover 0.5 A range.

- Overrange occurs when 140% of the rated range is exceeded and 99999 is displayed.

(4) Power Factor (PF) Display

Display Range: 0.000 to ±1.000

When the measured value of W or VA is beyond the measurement extent (10% or less, 110% or more of FS), the computed power factor may exceed 1. Therefore, the following processing is carried out.

- 1.000 is displayed when the computed power factor is 1.000 to 2.000 or 888888 is displayed when over 2.000.

Display of Scaling Factor

Display Range: 0.0001 to 10000

- Values of 0.0000 and 10001 or less cannot be input. In this case, the display flashes, indicating that input is unavailable.
- By MODE's SCALING Key [SCALING], the measured value can be multiplied by a scaling factor for display.
- If a set combination is such that the display value of 100% of rating exceeds 99999 M by setting a scaling factor, measured and computed data are not displayed but "(8) 888888 " is displayed.

2-8. Selecting Digital Display (DISPLAY)

Measured and computed values to be indicated on the digital display sections DISPLAY A, DISPLAY B and DISPLAY C are selected by combinations of FUNCTION keys in the shaded area of 2-14.

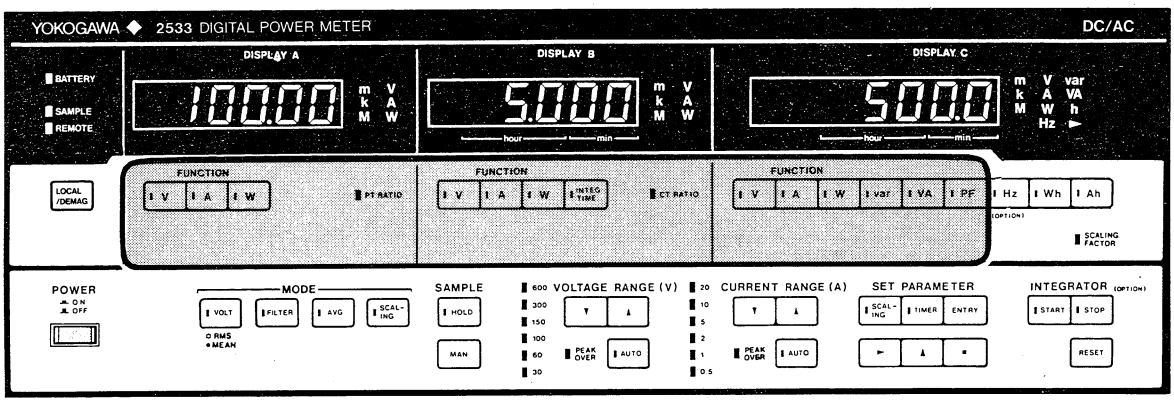


Figure 2-14.

<FUNCTION keys>

[V] : for display of voltage.
By [VOLT] key of measurement mode (MODE), rms value measurement and rms value display, and mean value rectified rms value calibration display can be selected.

[A] : for display of current.
Rms current intensity is displayed.

[W] : for display of effective power.

Above keys are common to DISPLAY A, DISPLAY B and DISPLAY C.

[INTEG TIME] : effective for Model 2533/INTEG provided with an integrating function (option) and applies to DISPLAY B only.
(☛ IM 2533-50E).
This key is overridden for a model which has no integrating function.

The following keys apply to DISPLAY C only.

[var] : for display of reactive power.
Reactive power var is calculated by:
$\sqrt{(\text{apparent power VA})^2-(\text{effective power W})^2}$

[VA] : for display of apparent power.
Apparent power VA is computed by V × A.

[PF] : for display of power factor (Power Factor).
The power factor is computed by effective power W ÷ apparent power VA.

[Hz] : effective for a Model 2533/FRQ provided with a frequency measuring function (option) (☛ IM 2533-50E).

[Wh] and [Ah] keys are effective for a model provided with an integrating function (option) (☛ IM 2533-50E).
The keys are overridden for a model not provided with the above optional function.

- Display mode settable on DISPLAY A
  V, A, W

- Display mode settable on DISPLAY B
  V, A, W
  INTEG TIME (effective only for model equipped with the optional integrating function: /INTEG)

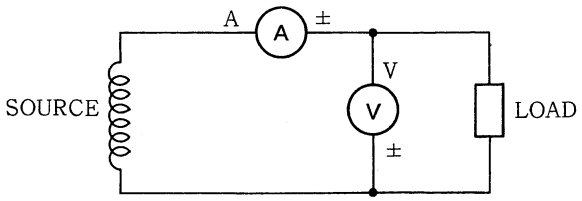
- Display mode settable on DISPLAY C
  V, A, W, var, VA, PF
  Hz(V), Hz(A) (effective only for model equipped with the optional frequency measuring function /FRQ)
  Wh, Ah (effective only for model equipped with the optional integrating function: /INTEG)

Table 2-12.

Indicated Item \ Wiring	Single Phase 2-Wire (1φ2W)
Voltage V	V
Current A	A
Effective power W	W
Reactive power var	$\sqrt{(VA)^2 - W^2}$
Apparent power V A	V × A
Power factor P F	$\frac{W}{V A}$

The reactive power, apparent power, and power factor are computed as effective values or as average value, rectified effective value, and calibrated value.

Single Phase (2-wire) System



2-9. Selecting Measurement Mode (MODE)

Operation of keys in the shaded area of Figure 2-15 selects a response time and determines whether to perform averaging or scaling.

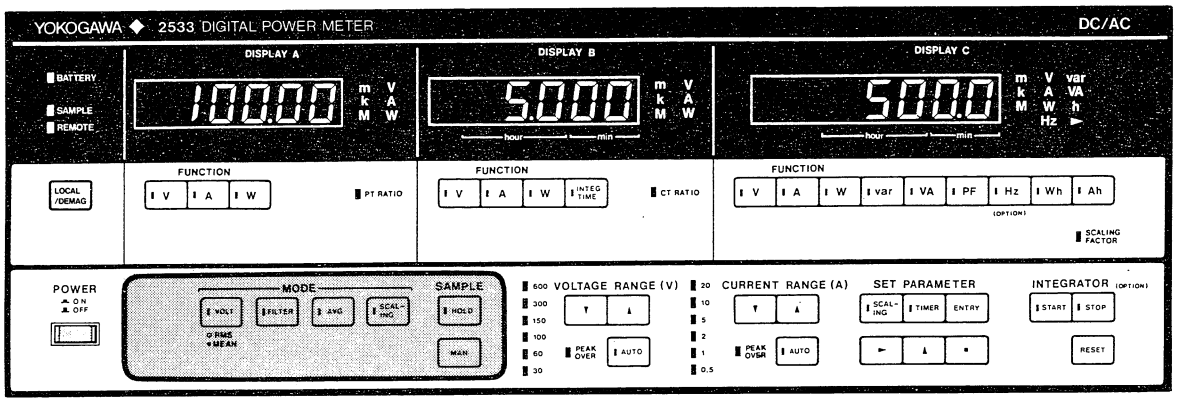


Figure 2-15.

[VOLT] ☼ RMS ● MEAN : rms value measurement/rms value display (RMS) or mean value rectification/rms value calibration display (MEAN) is selected.
RMS mode is selected when the lamp is lit, or MEAN mode is selected when the lamp is extinguished.

[FILTER] : the response for analog computation results of voltage, current and power is changed over.
When the lamp is lit (FILTER ON), the response is 2 seconds (when changing from 30% to 100% of range). When the lamp is extinguished (FILTER OFF), the response is 400 ms. When FILTER is ON, the display is stabilized in case the measured value is fluctuating at 2 to 10 Hz.

[AVG] : When voltage, current and effective power are measured, whether to display after exponential averaging or not is determined.
When the lamp is lit, averaging is ON or, when extinguished, averaging is OFF.
*: Exponential averaging is carried out by the expression:

$$A_n = A_{n-1} + \frac{1}{K}(M_n - A_{n-1})$$

Where A_{n-1}: exponential averaging data
A_{n-1}: preceding exponential averaging data
M_n: measured data
K: attenuation factor. K=8 on this instrument.

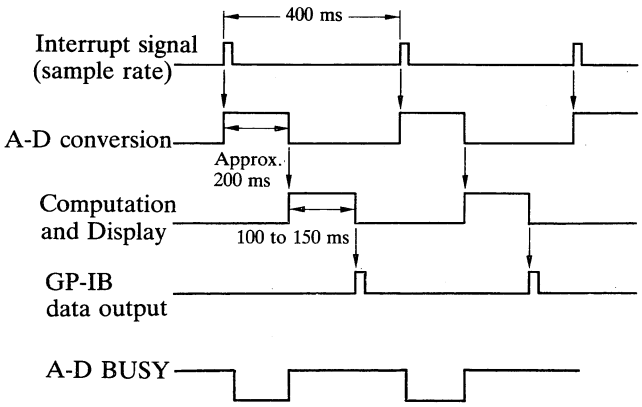
When [AVG] key is turned ON, measured data are displayed for the first time, and thier value constitutes the preceding exponential averaging data A_{n-1} in the second computation.

[SCAL-ING] : determines whether to multiply the measured value by a scaling factor (SCALING ON) or not (SCALING OFF).
When the lamp is lit, SCALING is ON or, when extinguished, SCALING is OFF.
SCALING ON, the unit display changes accordingly.

[HOLD] : selects free run (FREE RUN: 400 ms) or hold sampling (display cycle). When the key lamp is lit, sample hold mode is selected and SAMPLE display lamp is extinguished. When that key lamp is extinguished, a free run mode is selected and SAMPLE display lamp flashes at 400 ms cycle.

[MAN] : effective in sample hold mode.
Pressing [MAN] key actuates a measurement once and updates the display. At this time, SAMPLE display lamp flashes once.

■ **Timing chart**
FREE RUN (sample hold OFF)



- With an internal interrupt signal of 400 ms cycle, A-D converter is activated for computation and display and data is sent to GP-IB interface.
- Pressing [MAN] key or inputting a signal to the EXT A-D START, activates the A-D converter once for computation and display and sends data to GP-IB interface. At this time, SRQ of A-D END is generated.
- Computation and display are performed with an internal interrupt signal of 400 ms even without pressing [MAN] key or inputting a signal to EXT A-D START. Therefore, when the display mode (FUNCTION) is changed in sample hold mode, data which is ready to be displayed is displayed. If display is impossible, – – – – – – is indicated, indicating an absence of data.

2-10. Setting Scaling (SCALING) Factor

Measured voltage, current and power multiplied by a scaling factor can be displayed. When measuring an input beyond the measurement range, an external potential transformer (PT) or current transformer (CT) is used. This function provides a direct reading in terms of the primary side value. Power scaling (SCALING FACTOR) can be converted to calorie (CAL) or other physical quantities conveniently. When scaling, parameter setting keys in the shaded area of Figure 2-16 are used.

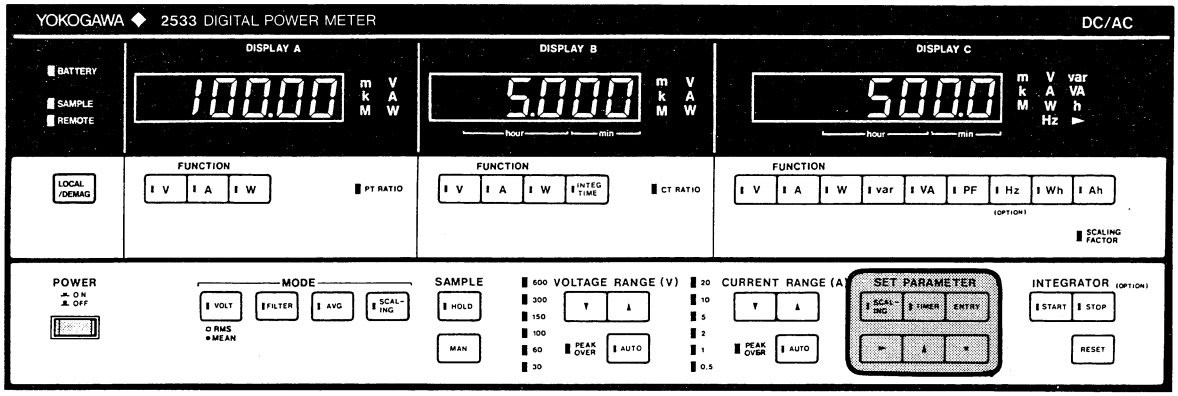


Figure 2-16.

Given K_v is the scaling factor of voltage (PT RATIO), K_i is the scaling factor of current (CT RATIO), and K_w is the scaling factor of power (SCALING FACTOR), the displayed value of each function is as follows.

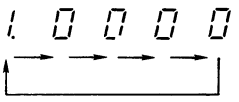
	<Measured data>	<Scaling data>
Voltage	V	$K_v \times V$
Current	A	$K_i \times A$
Effective power	W	$K_v \times K_i \times K_w \times W$
Reactive power	var	$K_v \times K_i \times K_w \times var$
Apparent power	VA	$K_v \times K_i \times K_w \times VA$

- Scaling factor setting range 0.0001 to 10000.
- By [SCAL-ING] key of MODE, the digital display can be changed over to scaling ON/OFF.
- When the power scaling factor Kw is other than 1.0000, turning ON scaling of digital display clears the units of W, VA and var and lights up ► mark on display C.
  At this time, k, m and M are indicated as they are.
  If, by setting a scaling factor, the displayed value of 100% of rating exceeds 99999M, measured data are not displayed but " 8888888 " is indicated.
- Measured and computed data can be displayed so long as the measured data do not exceed 140% of rating. In case of computation of VA consisting of two measured values, for example, up to 196% of rating can be displayed as a computed value.

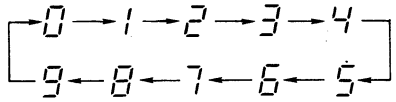
Function of Scaling Factor Setting Keys

[SCAL-ING] : pressing the key selects a scaling factor setting mode.
At this time, the key lamp comes on and, on DISPLAY A, B and C, PT ratio, CT ratio and SCALING FACTOR are displayed, respectively. The initial value is 1.0000. All units disappear and the lamps of PT RATIO, CT RATIO and SCALING FACTOR come on. The most significant digit on DISPLAY A flashes.

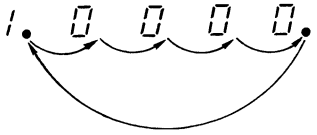
[►] : moves the digit which flashes indicating it is changeable. Every time it is pressed, the changeable digit is moved in the sequence given below. Holding it down can move it automatically in the same sequence.



[▲] : changes a value. Every time this key is pressed, the displayed value can be changed in the following sequence. Holding down the key permits change in the same sequence.



[■] : moves the decimal point position. Every time the key is pressed, the decimal point position is moved in the following sequence. Holding it down moves the position in the same way.



[ENTRY] : enters a scaling factor. Pressing the key performs an entry.

- When the scaling factor is within the specified range(0.0001 to 10000),the control transfers to the next display (DISPLAY B or DISPLAY C).
  Pressing [ENTRY] key for DISPLAY C terminates scaling factor setting, and the measured and computed value display mode resumes.
- Pressing [ENTRY] key for DISPLAY C terminates scaling factor setting, and the measured and computed value display mode is resumes.
  By pressing key when the specified range is exceeded, all digits of the relevant display flash. Pressing any of [►], [▲] and [■] keys at this time can recall the display where an error has occurred. Pressing [SCALING] key again can set the scaling factor of DISPLAY A to start with. Pressing FUNCTION and ELEMENT keys resumes an ordinary measurement and computation display mode from scaling factor setting mode.

Setting Examples

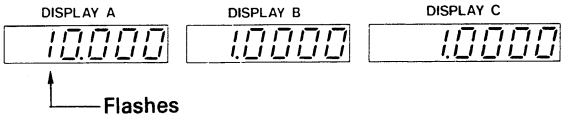
Let us carry out a measurement using a potential transformer (PT) of 3,300 V (primary)/110 V (secondary) and a current transformer (CT) of 100 A (primary)/5 A(secondary) and set a scaling factor for direct digital reading.

First obtain PT and CT ratios.

PT ratio: 3,300 V/ 110 V=30

CT ratio: 100 A/5 A=20

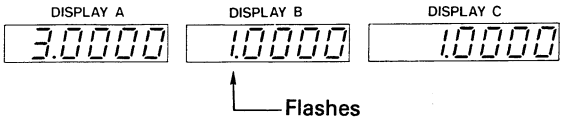
(1) Press [SCALING] key in SET PARAMETER to select a scaling factor setting mode.



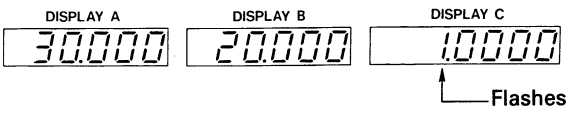
(2) [▲], [▼] : set the flashing digit to 3.

(3) [■] : move the decimal point and enter the PT ratio 30.000

(4) [ENTRY] : enter the PT ratio. At this time the most significant disgit of DISPLAY B flashes.



(5) [▲], [■], [ENTRY] : in the same way, set the CT ratio to 20.000 and enter.



(6) [ENTRY] : in the example shown, the power scaling factor need not be set. Just press the ENTRY key to resume the measured and computed value display mode. Thus the scaling factor has been set.

(7) In sample hold mode, press [SCALING] key, and make sure the scaling ON value is 30 times ±1 digit for voltage, 20 times ±1 digit for current, and 600 times ±1 digit for power, with respect to the SCALING OFF value.

2-11. How to Use Connector

The following is available by REMOTE CONTROL & ANALOG OUTPUT connector depicted in Figure 2-17.

1) A-D converter start by external signal
2) Observation of input voltage and current waveform
3) Taking out analog outputs proportional to voltage and current rms values and effective power.
   Tables 2-13 show pin numbers of analog output and signal names.

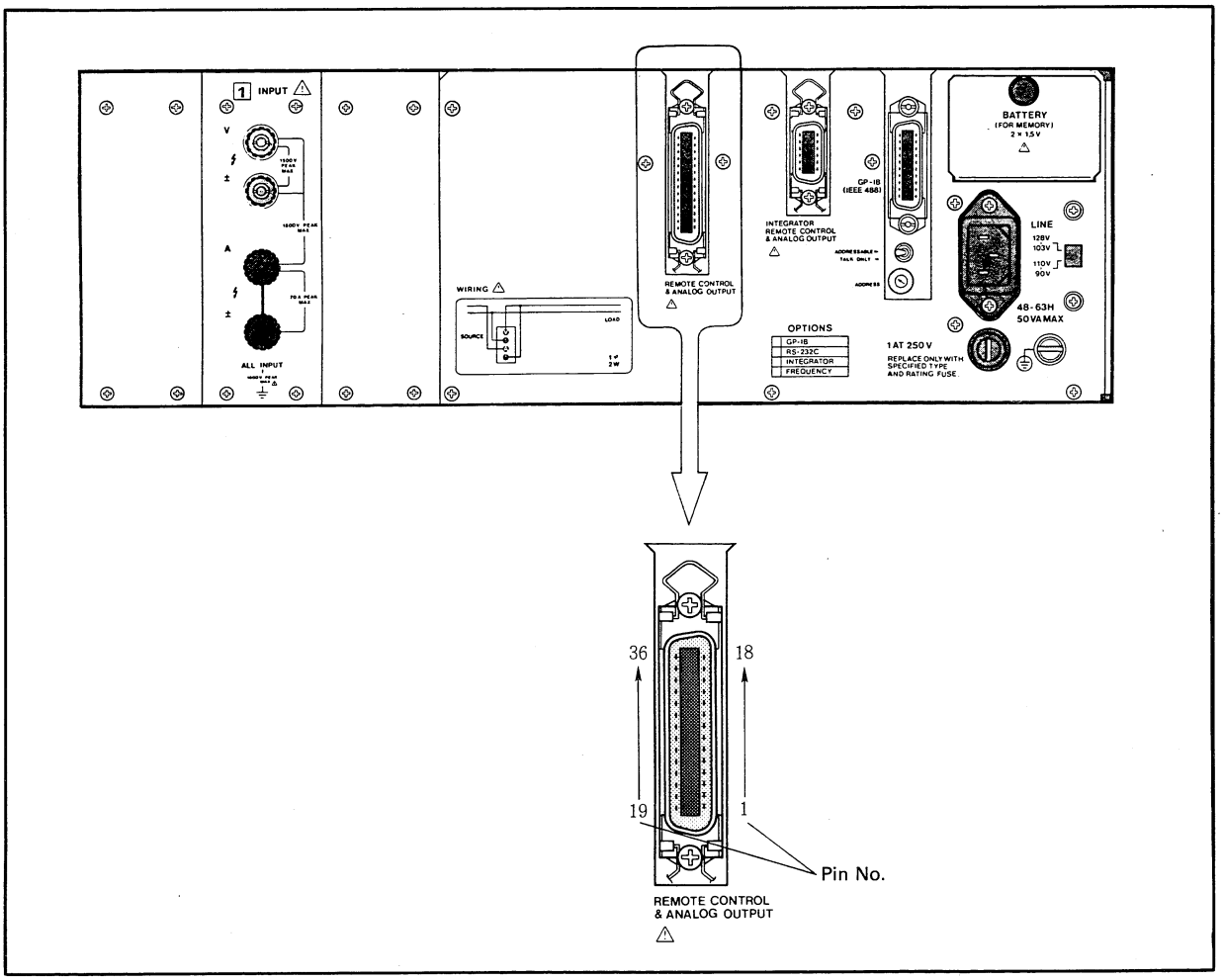


Figure 2-17.

Table 2-13.

Pin No.	Signal Name
1	DIG.COM
2	DIG.COM
3	A-D BUSY
4	
5	
6	
7	
8	
9	
10	ANALOG COM
11	A (rms)
12	
13	
14	
15	ANALOG COM
16	A Input wave output
17	
18	
19	+5V
20	
21	EXT A-D START
22	
23	ANALOG COM
24	W
25	
26	
27	
28	ANALOG COM
29	V (rms or mean)
30	
31	
32	
33	ANALOG COM
34	V Input wave output
35	
36	

- The input wave output is an AC waveform of approximately 1 V rms at rated input. The maximum load current is 0.1 mA, the maximum load capacitance is 100 pF, and the output resistance is 20 Ω.
- Each analog output V (rms), A (rms), W is 5 V DC at rated input with maximum load current of 0.1 mA and maximum load capacitance of 1000 pF.

(1) EXT A-D START and BUSY Signal

In sample hold mode, the A-D converter can be started and synchronized with an external signal. It is also effective in remote mode with GP-IB interface.

To start with an external signal, the pulse width must be 20 ms or more, and the sampling interval must be 400 ms or more.

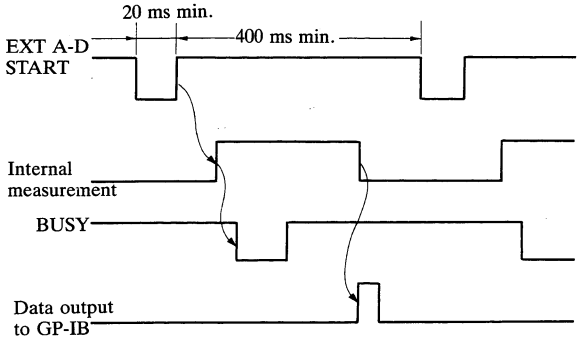


Figure 2-18.

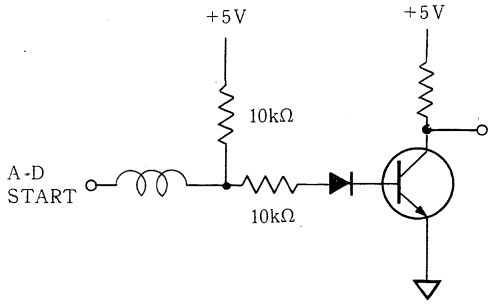


Figure 2-19. EXT A-D START

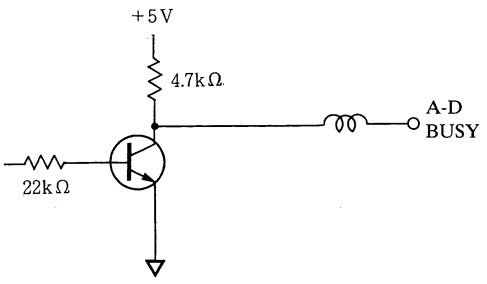


Figure 2-20. A-D BUSY

(2) Input Wave Output

Input wave isolated from voltage and current input signal can be observed.

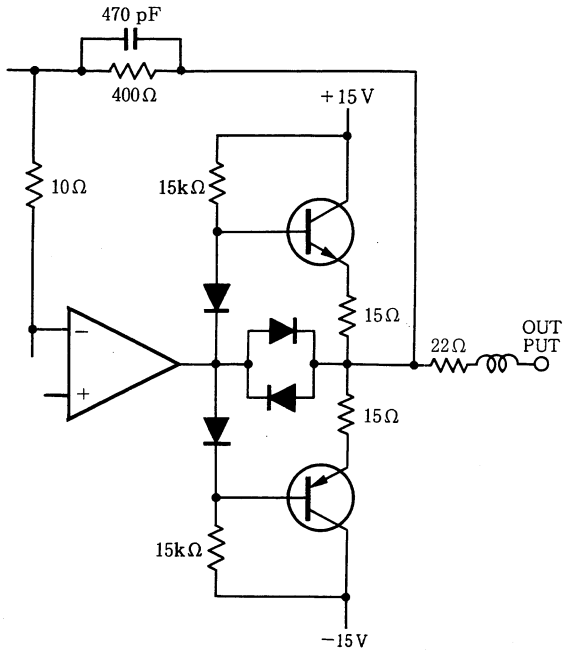


Figure 2-21. Voltage (V) Input Monitor Circuit

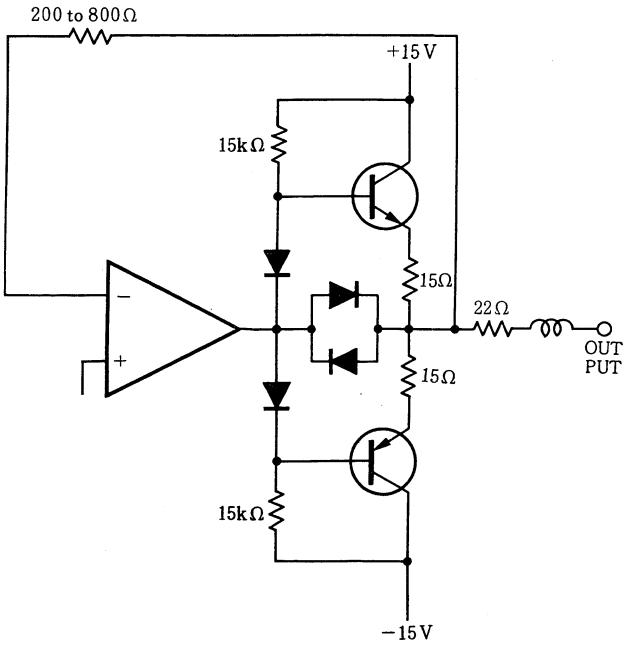


Figure 2-22. Current (A) Input Monitor Circuit

(3) Analog Output

DC voltages proportional to measured voltage, current and effective power are output simultaneously.

When the analog outputs are combined with a multipen recorder, measured values can be continuously recorded, or the instrument can be used as a transducer.

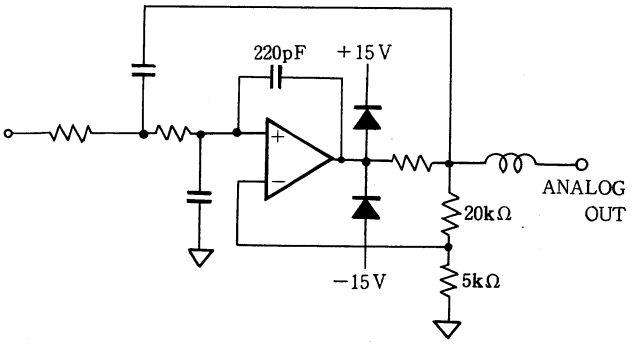


Figure 2-23. V, A and W Output Circuit

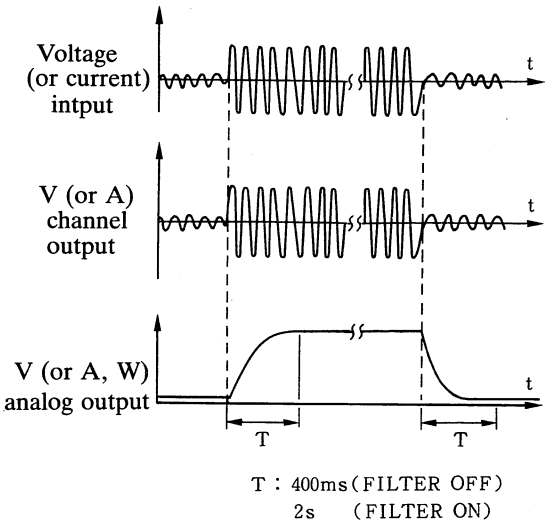


Figure 2-24. Analog Output Response

2-12. Setting Internal Switches

The display resolution can be changed and the wiring system can be designated by setting DIP switches in 2533.

Switch Setting Procedure

(1) Disconnect the Power Cord from 2533.
Remove the rubber cover located on the right or left side of the 2533. If a rack mount adapter is installed, remove it with a screwdriver.

(2) With a screwdriver, loosen four screws from the upper case.

(3) Remove the upper case.

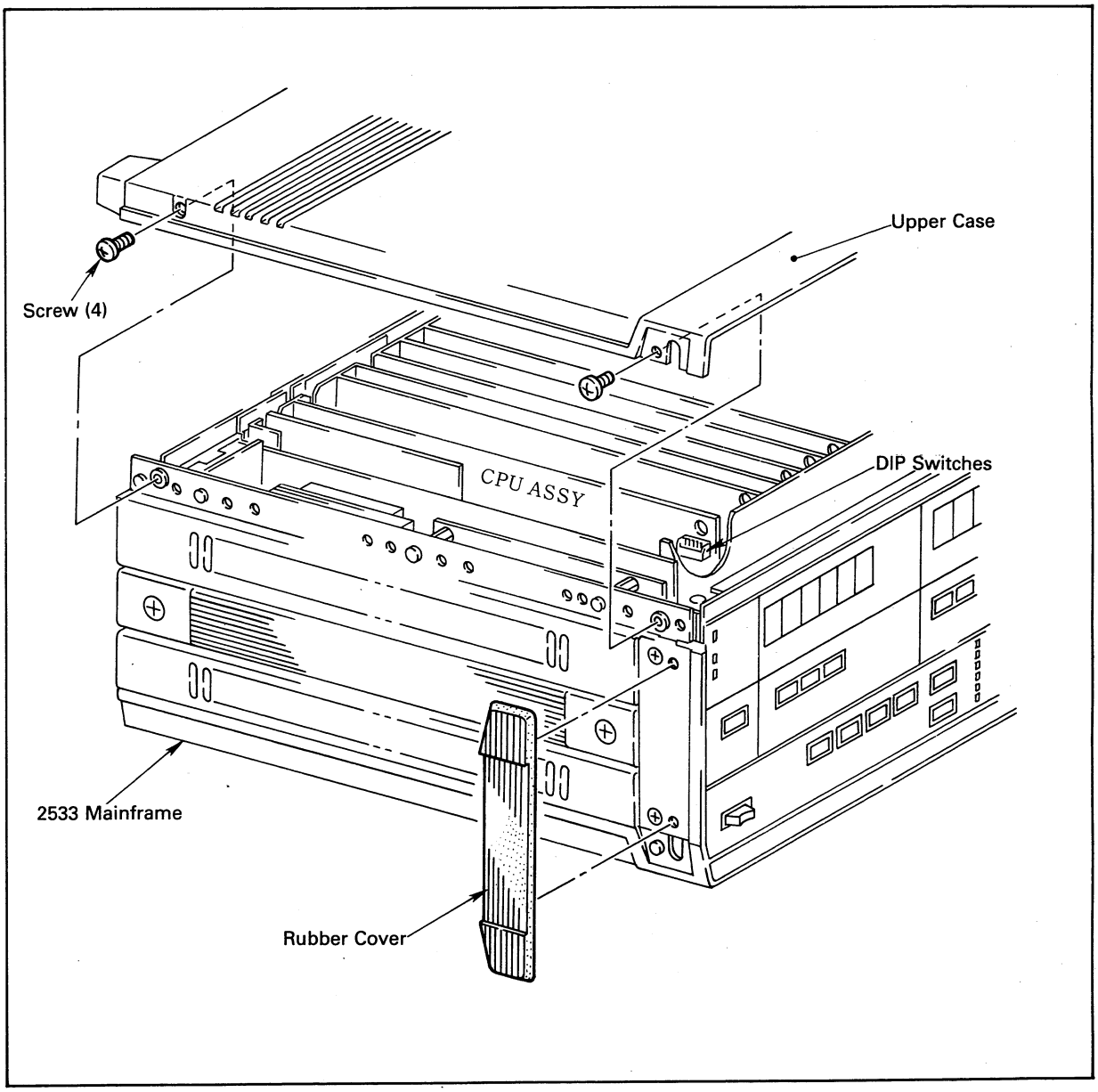


Figure 2-25.

(4) Referring to Figure 2-26, set CPU ASS'Y DIP switches as desired. Do not tamper with other parts to avoid a malfunction.
Do not drop foreign matter into the mainframe.

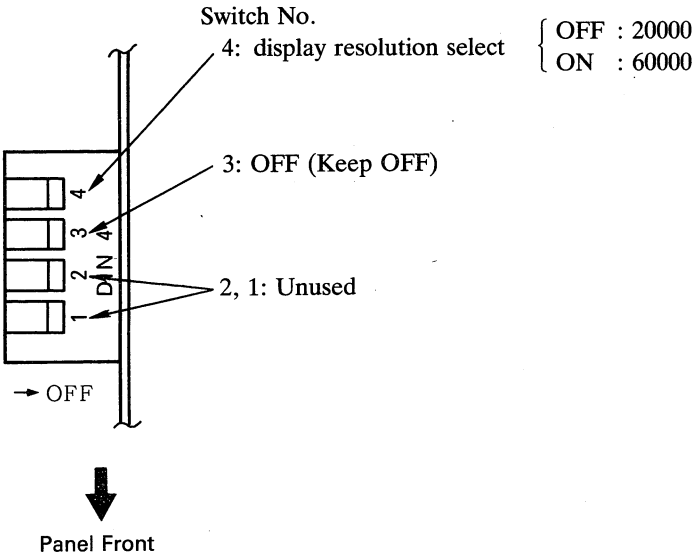


Figure 2-26.

● All the switches are factory set at OFF.
Display resolution: 20000

(5) After the setting the switches, replace the upper case, tighten the screws, and mount the rubber cover or rack mount adapter. The internal switches have now been set.

3. MAINTENANCE

3-1. Storage

When storing the instrument, avoid the following locations.

- Place containing excessive humidity
- Place exposed to direct sunshine or where temperature is high
- Near heat source
- Place subjected to excessive vibration
- Place filled with dust, corrosive gases or salty air

If the operation is abnormal and repair is necessary, contact the sales representative.

When the repair is billable, contact the service center given on the back cover.

3-2. Replacing Fuse

(1) If the power fuse has blown, replace it with a furnished fuse: 1 A time lag type (parts number: A9050KF) for 100 V series or 0.5 A time lag type (parts number: A9049KF) for 200 V series.
(2) When replacing the fuse, disengage the power cord from the rear panel and turn the fuse holder counterclockwise.

4. REFERENCES

4-1. Error Code and Hardware Configuration Lists

Given below are a list for error codes displayed by self-test when turning ON power or output by GP-IB interface, and a corresponding list between hardware configuration and codes displayed when turning ON power.

1. Error Code List

Error Code	Description	Operation of 2533
Self-test and Initial Setting when Turning ON Power		
001	RAM (U4) is faulty	Err001 is indicated on DISPLAY C and hold mode is set
002	ROM (U2) is faulty	Err002 is indicated on DISPLAY C and hold mode is set
003	ROM (U3) is faulty	Err003 is indicated on DISPLAY C and hold mode is set
004	Board combination error (A-D converter board is absent or input section board combination is erroneous)	Err004 is indicated on DISPLAY C and hold mode is set
005	Internal switch setting error	Err005 is indicated on DISPLAY C and hold mode is set
Related to GP-IB		
100	Command error (undefined command is received)	● Service request SRQ is generated (syntax error) ● "ERR 100 CR LF" is sent when OE command is received
101	Parameter (● Parameter is beyond specified range ● DISPLAY and mode combination error)	● Service request SRQ is generated (syntax error) ● "ERR 101 CR LF" is sent when OE command is received ● Lamp of designated function flashed for combination errors
107	● While message (setting information, error code) is being output, A-D conversion is started from GP-IB controller in sample HOLD mode ● A-D conversion is started by "ST", "TRG" while not in HOLD mode	● Service request SRQ is generated (syntax error) ● "ERR 107 CR LF" is sent when OE command is received

Error Code	Description	Operation of 2533
Processing error		
103	Result of scaling factor computation overflows display digits	● "(8) 888888 "is indicated on relevant display ● Service request SRQ is generated (OVER) ● "ERR 103 CR LF"is sent when OE command is received
104	Measured data overflow (input of A-D converter exceeds 140% of range rating)	● " 999999 " is indicated on relevant display ● Service request SRQ is generated (OVER) ● "ERR 104 CR LF" is sent when OE command is received
105	Measured data is absent	● "(-) - - - - - - " is indicated on relevant display ● Service request SRQ is generated (OVER) ● "ERR 105 CR LF" is sent when OE command is received
106	Voltage peak value overflow (voltage peak value exceeds 250% of range rating)	● Voltage PEAK OVER display lamp comes on ● Service request SRQ is generated (OVER) ● "ERR 106 CR LF" is sent when OE command is received
108	Current peak value overflow (current peak value exceeds 350% of range rating)	● Current PEAK OVER display lamp comes on ● Service request SRQ is generated (OVER) ● "ERR 108 CR LF" is sent when OE command is received
Hardware error		
200	A-D converter error	Err200 is indicated on DISPLAY C
Data setting error		
	Scaling factor set value is beyond setting range (0.0001~10000)	Entire set value flashes as 888888

2. Hardware Configuration and Error Codes

Model	Interface	INTEG	FRQ	Code No.
AC Model (Single-phase)	RS-232C	○	○	TYPE65
		○	×	TYPE67
		×	○	TYPE69
		×	×	TYPE71
	GP-1B	○	○	TYPE72
		○	×	TYPE74
		×	○	TYPE76
		×	×	TYPE78
	—	○	○	TYPE73
		○	×	TYPE75
		×	○	TYPE77
		×	×	TYPE79
DC/AC Model (Single-phase)	RS-232C	○	○	TYPE81
		○	×	TYPE83
		×	○	TYPE85
		×	×	TYPE87
	GP-1B	○	○	TYPE88
		○	×	TYPE90
		×	○	TYPE92
		×	×	TYPE94
	—	○	○	TYPE89
		○	×	TYPE91
		×	○	TYPE93
		×	×	TYPE95

- Optional function provided (○), not provided (×).

5. SCHEMATIC DIAGRAMS AND ELECTRONIC PARTS LIST

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Note: Unless otherwise specified, board assemblies are common to the Model 253311 and 253321.

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List of abbreviations

AC	alternating current	**IC**	integrated circuit	**RTD**	resistance temperature detector
ADPTR	adapter	**IND**	inductance, induction		
Aℓ	aluminum	**ISLN**	isolation	**RTRY**	rotary
AMP	amplifier	**ISOL**	isolator		
ASSY	assembly			**SEG**	segment
		JIS	Japanese industrial standard	**SHLD**	shielded
BAT	battery			**Si**	silicon
BFR	buffer	**JUMP**	jumper	**SKT**	socket
BUZ	buzzer			**SNSR**	sensor
		L	inductor	**SPLY**	supply
CAP	capacitor	**LCD**	liquid crystal display	**STAB**	stabilizer
CAR	carbon	**LED**	light-emitting diode	**STD**	standard
CBL	cable	**LSI**	large-scale integrated circuit	**STEPG**	stepping
CCT	circuit			**SVO**	servo
CER	ceramic			**SW**	switch
CHP	chopper	**MDL**	module	**SYN**	synchronous
CNTR	counter	**MET**	metal (lized)		
COAX	coaxial	**MOD**	modulator	**Ta**	tantalum
COM	common			**TC**	thermocouple
COMP	composition	**NOM VAL**	nominal value	**TEMP**	temperature
CONN	connector			**TERM**	terminal
CONV	converter	**OPT**	optical	**TGL**	toggle
CT	current transformer	**OSC**	oscillator	**THERMO**	thermostat
				THMS	thermistor
DC	direct current	**PB**	printed board		
DET	detector	**PBA**	printed board assembly	**UJT**	unijunction transistor
DSPL	display	**PEC**	photoelectric cell		
		POLYE	polyester	**VAR**	variable
ELECT	electrolytic	**POLYS**	polystyrene		
EXT	external, extension	**POT**	potentiometer	**WW**	wire wound
		PT	potential transformer		
FET	field effect transistor	**PWR**	power	**XDCR**	transducer
FLEX	flexible			**XFMR**	transformer
FLM	film	**RAM**	random access memory	**XSTR**	transistor
FLTR	filter	**RBN**	ribbon	**XTAL**	crystal
FXD	fixed	**RECP**	receptacle		
		RECT	rectifier	**ZNR**	zener
Ge	germanium	**RES**	resistor		
GEN	generator	**RGLTR**	regulator		
GND	ground	**ROM**	read only memory		

Example

CONN : multi = multi connector
CAP : fxd Al elect = Fixed aluminum electrolytic capacitor
CAP : fxd polye flm = Fixed polyester film capacitor
RES : fxd car flm = Fixed carbon film resistor
RES : var ww = Wirewound variable resistor
SW : rtry = rotary switch

NOTES

1. **Components — especially ICs — which are equivalent to components shown in the schematic diagrams and parts list, but manufactured by other manufacturers, can in general be used in the instrument.**

2. **Subject to change without notice; changes may be made to improve the instrument's performance.**

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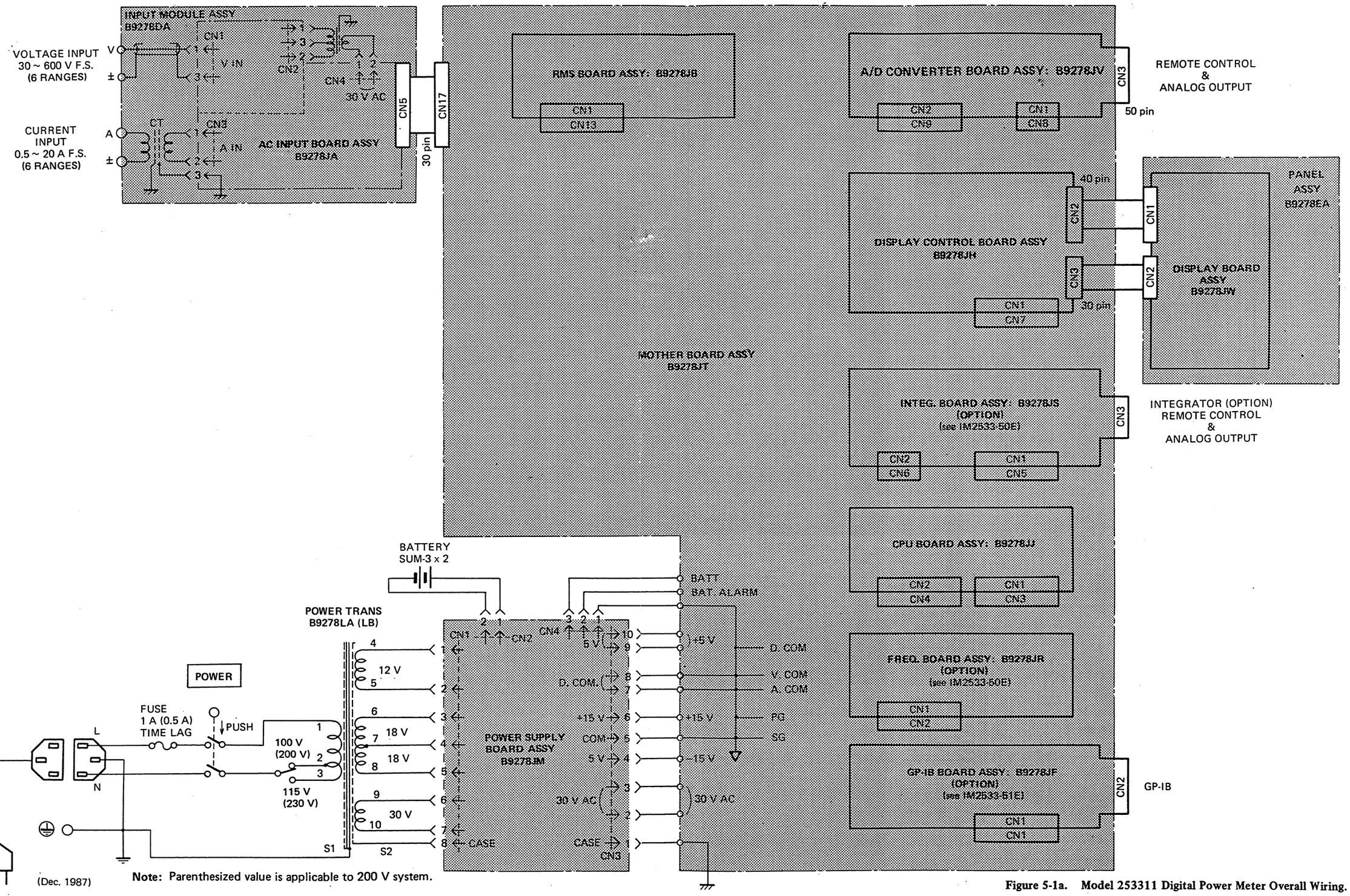

(Dec. 1987)

Note: Parenthesized value is applicable to 200 V system.

Figure 5-1a. Model 253311 Digital Power Meter Overall Wiring.

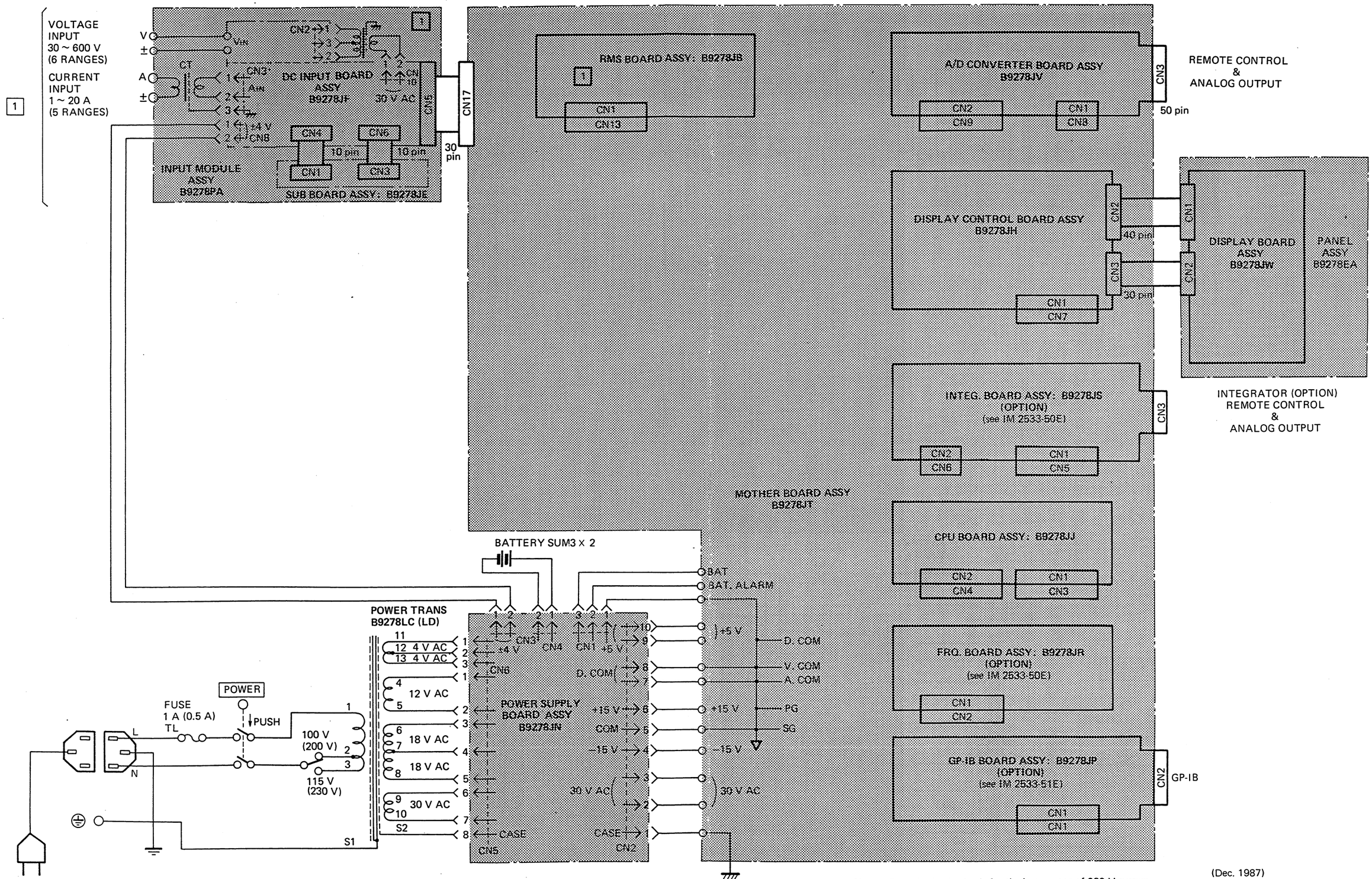

Figure 5-1b. Model 253321 Digital Power Meter Overall Wiring.

Note: Parenthesized value is for the instrument of 200 V system.

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ASSY	B9278JA
PWB	B9278KA

(Dec. 1987)

Figure 5-2a. AC Input Board Ass'y (for Model 253311): B9278JA Schematic Diagram.

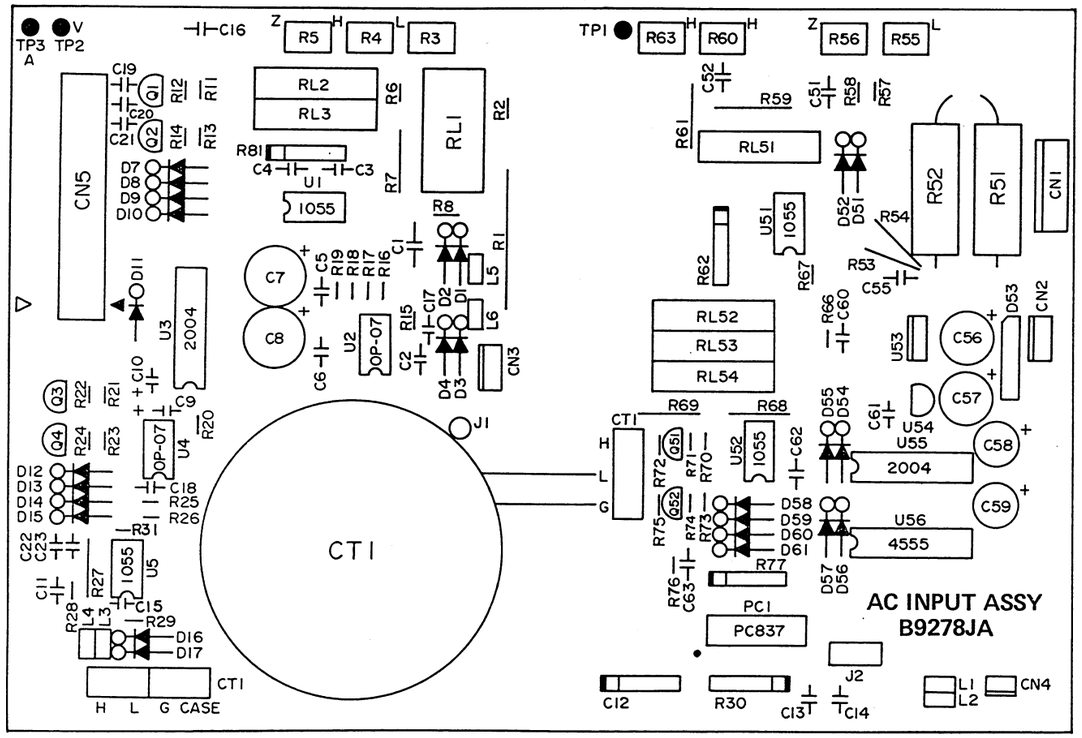

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Figure 5-2b. AC Input Board Ass'y (for Model 253311): B9278JA Components Location Diagram.

5-2. AC Input Board Ass'y (for Model 253311): B9278JA.

(Dec. 1987)

Item	Part No.	Part Name and Description	Remarks
R1	A9346RQ	Res: fxd met flm 11Ω ±0.1% ½W RN70S 11ΩB	
R2	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R3	A9362RV	Res: var cermet 100kΩ ±20% ¼W GF06X1 100kΩ	
R4	A9383RV	Res: var cermet 5kΩ ±20% ¼W GF06X1 5kΩ	
R5	A9362RV	Res: var cermet 100kΩ ±20% ¼W GF06X1 100kΩ	
R6	A9071RG	Res: fxd met flm 8.2kΩ ±1% ¼W LF¼ 8.2kΩF	
R7	A9178RK	Res: fxd met flm 100Ω ±0.1% ¼W CFA 100ΩBT1	
R8	A9001RG	Res: fxd met flm 10Ω ±1% ¼W LF¼ 10ΩF	
R9, R10			not assigned
R11	A9077RG	Res: fxd met flm 15kΩ ±1% ¼W LF¼ 15kΩF	
R12	A9005RG	Res: fxd met flm 15Ω ±1% ¼W LF¼ 15ΩF	
R13	A9077RG	Res: fxd met flm 15kΩ ±1% ¼W LF¼ 15kΩF	
R14	A9005RG	Res: fxd met flm 15Ω ±1% ¼W LF¼ 15ΩF	
R15, R16	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R17	A9001RG	Res: fxd met flm 10Ω ±1% ¼W LF¼ 10ΩF	
R18	A9104RG	Res: fxd met flm 200kΩ ±1% ¼W LF¼ 200kΩF	
R19	A9017RG	Res: fxd met flm 47Ω ±1% ¼W LF¼ 47ΩF	
R20	A9080RG	Res: fxd met flm 20kΩ ±1% ¼W LF¼ 20kΩF	
R21	A9077RG	Res: fxd met flm 15kΩ ±1% ¼W LF¼ 15kΩF	
R22	A9005RG	Res: fxd met flm 15Ω ±1% ¼W LF¼ 15ΩF	
R23	A9077RG	Res: fxd met flm 15kΩ ±1% ¼W LF¼ 15kΩF	
R24	A9005RG	Res: fxd met flm 15Ω ±1% ¼W LF¼ 15ΩF	
R25	A9025RG	Res: fxd met flm 100Ω ±1% ¼W LF¼ 100ΩF	
R26	A9087RG	Res: fxd met flm 39kΩ ±1% ¼W LF¼ 39kΩF	
R27	A9650RK	Res: fxd met flm 400Ω ±0.1% ¼W CFA 400ΩBT1	
R28	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R29	A9001RG	Res: fxd met flm 10Ω ±1% ¼W LF¼ 10ΩF	
R30	A9109RL	Res: module 470Ω ±5% 1/8 W RKC1/8 B4 470ΩJ	4 elements
R31	A9075RG	Res: fxd met flm 12kΩ ±1% ¼W LF¼ 12kΩF	
R51, R52	A9345RQ	Res: fxd met flm 480kΩ ±0.1% ½W RN70E 480kΩB	
R53	A9660RK	Res: fxd met flm 120kΩ ±0.1% ¼W CFA 120kΩBT1	
R54	A9658RK	Res: fxd met flm 60kΩ ±0.1% ¼W CFA 60kΩBT1	
R55	A9270RV	Res: var cermet 500Ω ±20% ¼W GF06X1 500Ω	
R56	A9362RV	Res: var cermet 100kΩ ±20% ¼W GF06X1 100kΩ	
R57	A9001RG	Res: fxd met flm 10Ω ±1% ¼W LF¼ 10ΩF	
R58	A9087RG	Res: fxd met flm 39kΩ ±1% ¼W LF¼ 39kΩF	
R59	A9660RK	Res: fxd met flm 120kΩ ±0.1% ¼W CFA 120kΩBT1	
R60	A9384RV	Res: var cermet 100Ω ±20% ¼W GF06X1 100Ω	
R61	A9661RK	Res: fxd met flm 13.3kΩ ±0.1% ¼W CFA 13.3kΩBT1	
R62	A9183RL	Res: module MRP1487	
R63	A9383RV	Res: ver cermet 5kΩ ±20% ¼W GF06X1 5kΩ	
R64, R65			not assigned
R66, R67	A9035RG	Res: fxd met flm 270Ω ±1% ¼W LF¼ 270ΩF	
R68	A9652RK	Res: fxd met flm 9.9kΩ ±0.1% ¼W CFA 9.9kΩBT1	
R69	A9178RK	Res: fxd met flm 100Ω ±0.1% ¼W CFA 100ΩBT1	
R70	A9077RG	Res: fxd met flm 15kΩ ±1% ¼W LF¼ 15kΩF	
R71, R72	A9005RG	Res: fxd met flm 15Ω ±1% ¼W LF¼ 15ΩF	
R73	A9077RG	Res: fxd met flm 15kΩ ±1% ¼W LF¼ 15kΩF	
R74, R75	A9005RG	Res: fxd met flm 15Ω ±1% ¼W LF¼ 15ΩF	

5-2. AC Input Board Ass'y (for Model 253311): B9278JA. (continued)

Item	Part No.	Part Name and Description	Remarks
R76	A9041RG	Res: fxd met flm 470Ω ±1% ¼W LF¼ 470ΩF	
R77	A9029RL	Res: module 10kΩ ±5% 1/8W RK1/8B4 10kΩJ	4 elements
R78~R80			not assigned
R81	A9182RL	Res: module MRP1486	
C1	A9229CY	Cap: fxd polye flm 0.1μF ±10% 100V ECQ-E 1104KZ	
C2	A9250CY	Cap: fxd polye flm 0.01μF ±10% 50V MFL5002-103K	
C3	A9068CN	Cap: fxd mica 470pF ±10% 100V DM15C 471K1	
C4	A9244CY	Cap: fxd polye flm 1000pF ±10% 50V MFL5002-102K	
C5, C6	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C7, C8	A9360CA	Cap: fxd Al elect 47μF 35V ECEA1VS470R	
C9, C10	A9106CT	Cap: fxd Ta elect 22μF ±20% 35V 221M3502-226M5	
C11	A9029CN	Cap: fxd mica 220pF ±10% 100V DM15C 221K1	
C12	A9009CL	Cap: module 1000pF EXF-P4102ZW	4 elements
C13, C14	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C15	A9069CN	Cap: fxd mica 560pF ±10% 100V DM15C 561K1	
C16	A9068CN	Cap: fxd mica 470pF ±10% 100V DM15C 471K1	
C17	A9250CY	Cap: fxd polye flm 0.01μF ±10% 50V MFL5002-103K	
C18~C20	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C21~C23	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C51	A9002CN	Cap: fxd mica 1.2pF ±10% 100V DM05C 1R2K1	
C52	A9017CN	Cap: fxd mica 22pF ±10% 100V DM05C 220K1	
C53, C54			not assigned
C55	A9009CN	Cap: fxd mica 4.7pF ±10% 100V DM05C 4R7K1	
C56, C57	A9373CA	Cap: fxd Al elect 220μF 35V ECEA1VS221R	
C58, C59	A9360CA	Cap: fxd Al elect 47μF 35V ECEA1VS470R	
C60	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C61	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C62	A9013CN	Cap: fxd mica 10pF ±10% 100V DM05C 100K1	
C63	A9249CY	Cap: fxd polye flm 6800pF ±10% 50V MFL5002-682K	
L1~L6	A9100MC	Inductor ZBF253D-01	
D1, D2	A9249HD	Diode: Si 1S954	
D3, D4	A9248HD	Diode: Si 1S953	
D5, D6			not assigned
D7~D10	A9248HD	Diode: Si 1S953	
D11~D17	A9248HD	Diode: Si 1S953	
D51, D52	A9248HD	Diode: Si 1S953	
D53	A9146HL	Diode: module 1B4B41	
D54~D60	A9248HD	Diode: Si 1S953	
D61	A9248HD	Diode: Si 1S953	
Q1	A9340HQ	XSTR: Si NPN 2SC1815-Y	
Q2	A9338HQ	XSTR: Si PNP 2SA1015-Y	

5-2. AC Input Board Ass'y (for Model 253311): B9278JA. (continued)

Item	Part No.	Part Name and Description		Remarks
Q3	A9340HQ	XSTR: Si NPN	2SC1815-Y	
Q4	A9338HQ	XSTR: Si PNP	2SA1015-Y	
Q51	A9452HQ	XSTR: Si NPN	2SC2235-O, Y	
Q52	A9477HQ	XSTR: Si PNP	2SA965-Y	
U1	A9235LA	IC: analog	LT1055CN8	
U2	A9200LA	IC: analog	OP-07CN	
U3	A9096HL	IC: NPN Darlington XSTR array	μPA 2004C	7 elements
U4	A9200LA	IC: analog	OP-07CN	
U5	A9235LA	IC: analog	LT1055CN8	
U51, U52	A9235LA	IC: analog	LT1055CN8	
U53	A9104LA	IC: +12 V voltage regulator	μPC14312H	
U54	A9213LA	IC: −12 V voltage regulator	NJM79L12	
U55	A9096HL	IC: NPN Darlington XSTR array	μPA2004C	7 elements
U56	A9148LM	IC: digital	TC4555BP	MOS
PC1	A9073HL	Photo coupler	PC837	
CT1	B9278LR	Trans: CT		
RL1	A9260MR	Relay	DS2E-S-DC 5V	
RL2, RL3	A9241MR	Relay	HFS-1A-05	
RL51~RL54	A9241MR	Relay	HFS-1A-05	
CN1	A9460KP	Conn.	5281-3A	3P
CN2, CN3	A9244KP	Conn.	5045-03A	3P
CN4	A9246KP	Conn.	5045-02A	2P
CN5	A9159KP	Conn.	PS-30PA-D4LT1-PN1-K	30P
TP1~TP3	A9574KP	Test point	VTC-1-1	
	A9051KP	Feed through (2 pcs)	FT-E-15	
	A9177KH	Heat sink (1 pc)	TYPE SB-7	for U53
	B9278KA	PWB (1 pc)		
	A9799KP	Edge saddle (1 pc)	EDS-1208U	
	B9278DL	Plate (1 pc)		
	B9278DM	Gasket (2 pcs)		
	B9278DR	Cover (1 pc)		
	B9278DS	Cover (1 pc)		
	B9278DT	Plate ass'y (1 pc)		
	A9599XK	Heat shrinkable tube		
	Y9305LB	Screw: M3 X 5 (7 pcs)		
	Y9435LB	Screw: M4 X 35 (1 pc)		
	Y9401BB	Nut: M4 (1 pc)		

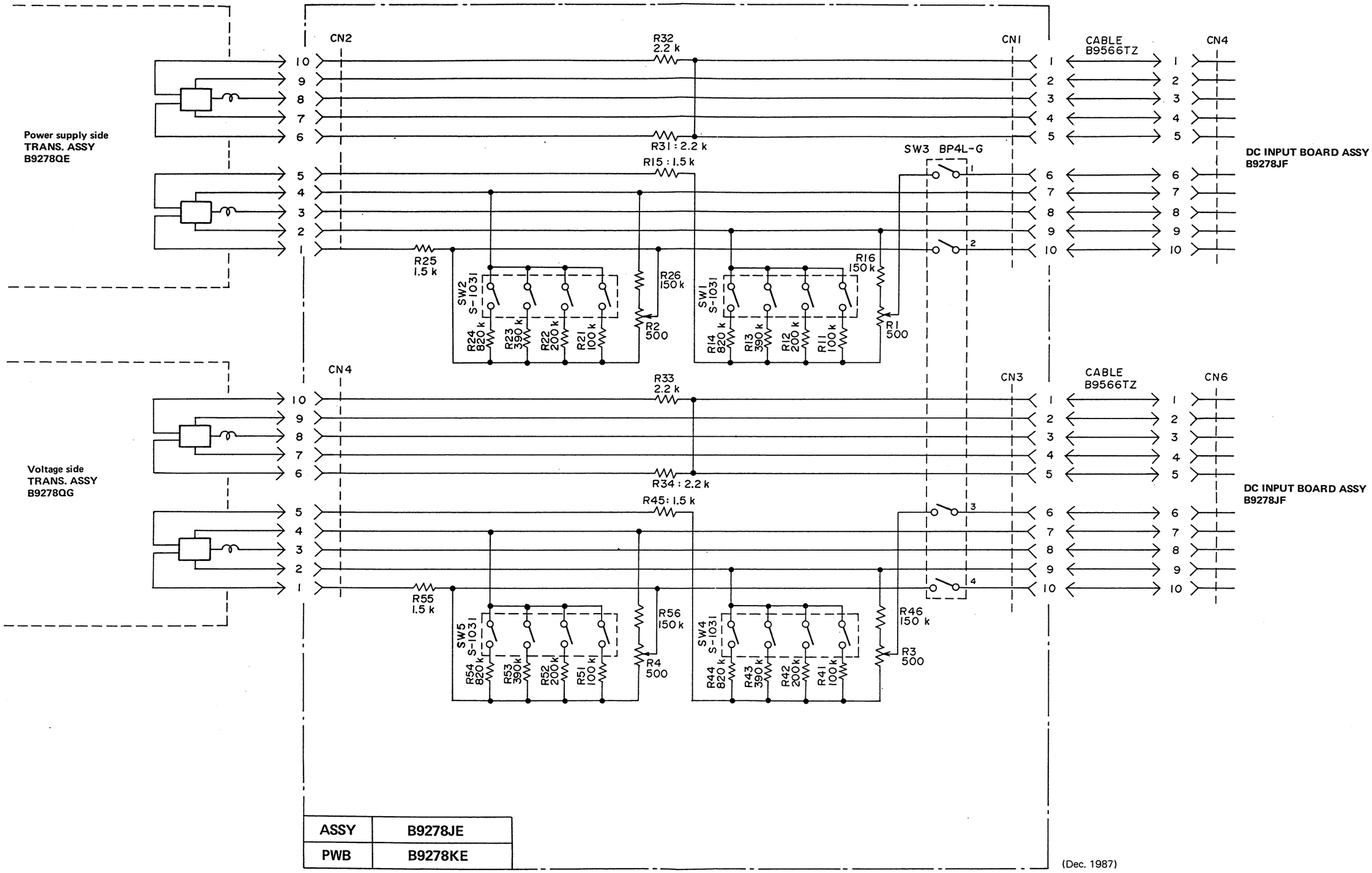
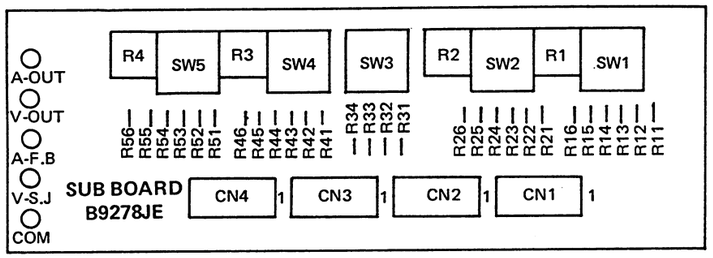


Figure 5-3a. Sub Board Ass'y (for Model 253321): B9278JE Schematic Diagram.



(Dec. 1987)

Figure 5-3b. Sub Board Ass'y (for Model 253321): B9278JE Components Location Diagram.

5-3. Sub Board Ass'y (for Model 253321): B9278JE.

(Dec. 1987)

Item	Part No.	Part Name and Description	Remarks
R1~R4	A9270RV	Res: var cermet 500Ω ±20% ¼W GF06X1 500Ω	
R5~R10			not assigned
R11	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R12	A9104RG	Res: fxd met flm 200kΩ ±1% ¼W LF¼ 200kΩF	
R13	A9111RG	Res: fxd met flm 390kΩ ±1% ¼W LF¼ 390kΩF	
R14	A9119RG	Res: fxd met flm 820kΩ ±1% ¼W LF¼ 820kΩF	
R15	A9053RG	Res: fxd met flm 1.5kΩ ±1% ¼W LF¼ 1.5kΩF	
R16	A9101RG	Res: fxd met flm 150kΩ ±1% ¼W LF¼ 150kΩF	
R17~R20			not assigned
R21	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R22	A9104RG	Res: fxd met flm 200kΩ ±1% ¼W LF¼ 200kΩF	
R23	A9111RG	Res: fxd met flm 390kΩ ±1% ¼W LF¼ 390kΩF	
R24	A9119RG	Res: fxd met flm 820kΩ ±1% ¼W LF¼ 820kΩF	
R25	A9053RG	Res: fxd met flm 1.5kΩ ±1% ¼W LF¼ 1.5kΩF	
R26	A9101RG	Res: fxd met flm 150kΩ ±1% ¼W LF¼ 150kΩF	
R27~R30			not assigned
R31~R34	A9057RG	Res: fxd met flm 2.2kΩ ±1% ¼W LF¼ 2.2kΩF	
R35~R40			not assigned
R41	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R42	A9104RG	Res: fxd met flm 200kΩ ±1% ¼W LF¼ 200kΩF	
R43	A9111RG	Res: fxd met flm 390kΩ ±1% ¼W LF¼ 390kΩF	
R44	A9119RG	Res: fxd met flm 820kΩ ±1% ¼W LF¼ 820kΩF	
R45	A9053RG	Res: fxd met flm 1.5kΩ ±1% ¼W LF¼ 1.5kΩF	
R46	A9101RG	Res: fxd met flm 150kΩ ±1% ¼W LF¼ 150kΩF	
R47~R50			not assigned
R51	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R52	A9104RG	Res: fxd met flm 200kΩ ±1% ¼W LF¼ 200kΩF	
R53	A9111RG	Res: fxd met flm 390kΩ ±1% ¼W LF¼ 390kΩF	
R54	A9119RG	Res: fxd met flm 820kΩ ±1% ¼W LF¼ 820kΩF	
R55	A9053RG	Res: fxd met flm 1.5kΩ ±1% ¼W LF¼ 1.5kΩF	
R56	A9101RG	Res: fxd met flm 150kΩ ±1% ¼W LF¼ 150kΩF	
SW1, SW2	A9370SR	Sw: rtry S-1031	
SW3	A9130SS	Sw: toggle BP4L-G	
SW4, SW5	A9370SR	Sw: rtry S-1031	
CN1~CN4	A9800KP	Conn HLEM 10R-1	10P
	B9278KE	PWB (1 pc)	

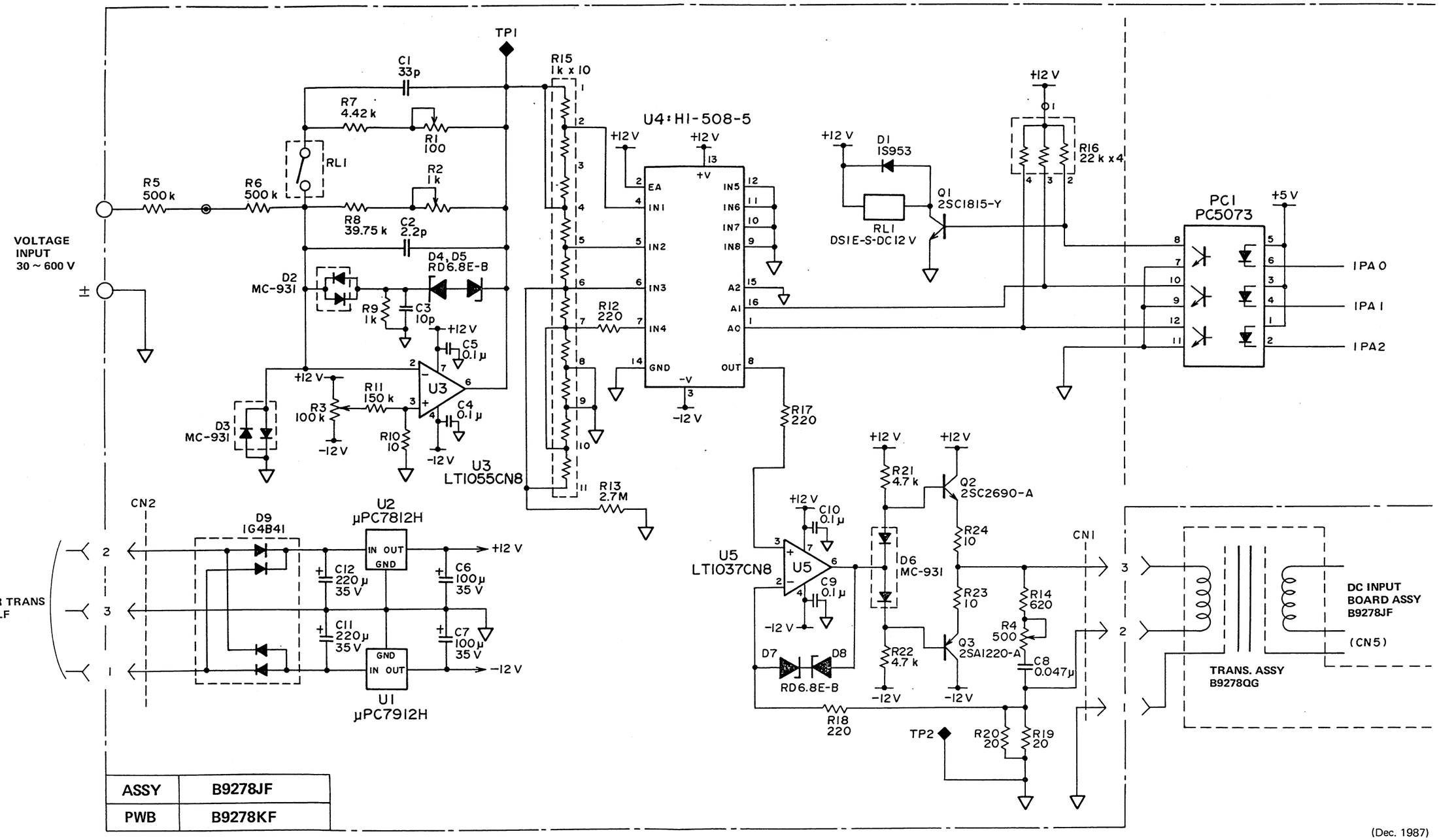


Figure 5-4a. DC Input Board Ass'y (for Model 253321): B9278JF Schematic Diagram (1/2).

ASSY	B9278JF
PWB	B9278KF

CURRENT INPUT 1 ~ 20A

TRANS ASSY B9278QE

TRANS ASSY B9278QG

SUB BOARD ASSY B9278JE

SUB BOARD ASSY B9278JE

MOTHER BOARD ASSY B9278JT

POWER SUPPLY BOARD ASSY B9278JN

U21:HI-508-5

U22 LT1007CN8

U23 LT1037CN8

U11 LT1007CN8

U12:LT1013CN8

U13 LT1037CN8

U14:LT1013CN8

U15 LT1037CN8

U16 TL317LP

U17 TL317LP

U18 TL317LP

U19 TL317LP

U24 μPA2004C

U25 OP-07CN8

U26 TC4047BP

U27 LA6393D

RL2 DSIE-S-DC5V

C21 1000p x 4

C22~C27,C29,C53,C54 0.1μ

L1, L2 ZBF-253D-01

IPA 0 IPA 1 IPA 2

D-COM

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Figure 5-4b. DC Input Board Ass'y (for Model 253321): B9278JF Schematic Diagram (2/2).

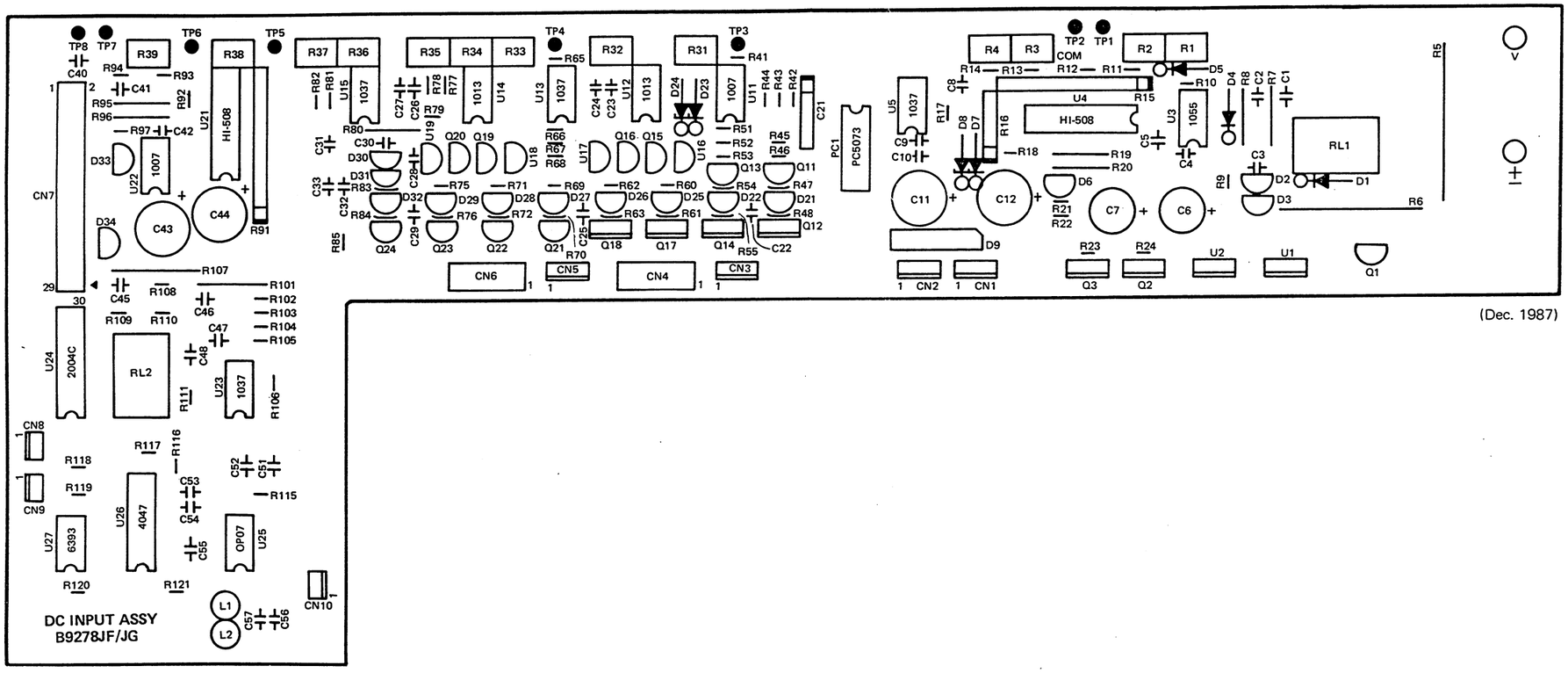

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Figure 5-4c. DC Input Board Ass'y (for Model 253321): B9278JF Components Location Diagram.

5-4. DC Input Board Ass'y (for Model 253321): B9278JF.

(Dec. 1987)

Item	Part No.	Part Name and Description	Remarks
R1	A9384RV	Res: var cermet 100Ω ±20% ¼W GF06X1 100Ω	
R2	A9387RV	Res: var cermet 1kΩ ±20% ¼W GF06X1 1kΩ	
R3	A9362RV	Res: var cermet 100kΩ ±20% ¼W GF06X1 100kΩ	
R4	A9270RV	Res: var cermet 500Ω ±20% ¼W GF06X1 500Ω	
R5, R6	A9563RP	Res: fxd met film 500kΩ ±0.1% ½W RN70E 500kΩB	
R7	A9737RK	Res: fxd met film 4.42kΩ ±0.1% ¼W CFA 4.42kΩBT1	
R8	A9738RK	Res: fxd met film 39.75kΩ ±0.1% ¼W CFA 39.75kΩBT1	
R9	A9049RG	Res: fxd met film 1kΩ ±1% ¼W LF¼ 1kΩF	
R10	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R11	A9101RG	Res: fxd met film 150kΩ ±1% ¼W LF¼ 150kΩF	
R12	A9033RG	Res: fxd met film 220Ω ±1% ¼W LF¼ 220ΩF	
R13	A9131RG	Res: fxd met film 2.7MΩ ±2% ¼W LF¼ 2.7MΩG	
R14	A9044RG	Res: fxd met film 620Ω ±1% ¼W LF¼ 620ΩF	
R15	A9157RL	Res: module 1kΩ X 4 MRP1361	4 elements
R16	A9041RL	Res: module 22kΩ ±5% 1/8W RKC1/8B4 22kΩJ	4 elements
R17, R18	A9033RG	Res: fxd met film 220Ω ±1% ¼W LF¼ 220ΩF	
R19, R20	A9735RK	Res: fxd met film 20Ω ±0.1% ¼W CFA 20ΩBT1	
R21, R22	A9065RG	Res: fxd met film 4.7kΩ ±1% ¼W LF¼ 4.7kΩF	
R23, R24	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R25~R30			not assigned
R31	A9362RV	Res: var cermet 100kΩ ±20% ¼W GF06X1 100kΩ	
R32	A9383RV	Res: var cermet 5kΩ ±20% ¼W GF06X1 5kΩ	
R33	A9836RV	Res: var cermet 500kΩ ±20% ¼W GF06X1 500kΩ	
R34	A9383RV	Res: var cermet 5kΩ ±20% ¼W GF06X1 5kΩ	
R35	A9543RV	Res: var cermet 200Ω ±20% ¼W GF06X1 200Ω	
R36	A9348RV	Res: var cermet 10kΩ ±20% ¼W GF06X1 10kΩ	
R37	A9387RV	Res: var cermet 1kΩ ±20% ¼W GF06X1 1kΩ	
R38	A9272RV	Res: var cermet 50kΩ ±20% ¼W GF06X1 50kΩ	
R39	A9348RV	Res: var cermet 10kΩ ±20% ¼W GF06X1 10kΩ	
R40			not assigned
R41	A9063RG	Res: fxd met film 3.9kΩ ±1% ¼W LF¼ 3.9kΩF	
R42~R44	A9041RG	Res: fxd met film 470Ω ±1% ¼W LF¼ 470ΩF	
R45	A9097RG	Res: fxd met film 100kΩ ±1% ¼W LF¼ 100kΩF	
R46	A9073RG	Res: fxd met film 10kΩ ±1% ¼W LF¼ 10kΩF	
R47	A9065RG	Res: fxd met film 4.7kΩ ±1% ¼W LF¼ 4.7kΩF	
R48	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R49, R50			not assigned
R51	A9085RG	Res: fxd met film 33kΩ ±1% ¼W LF¼ 33kΩF	
R52	A9063RG	Res: fxd met film 3.9kΩ ±1% ¼W LF¼ 3.9kΩF	
R53	A9073RG	Res: fxd met film 10kΩ ±1% ¼W LF¼ 10kΩF	
R54	A9065RG	Res: fxd met film 4.7kΩ ±1% ¼W LF¼ 4.7kΩF	
R55	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R56~R59			not assigned
R60	A9073RG	Res: fxd met film 10kΩ ±1% ¼W LF¼ 10kΩF	
R61	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R62	A9073RG	Res: fxd met film 10kΩ ±1% ¼W LF¼ 10kΩF	
R63	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	

5-4. DC Input Board Ass'y (for Model 253321): B9278JF. (continued)

Item	Part No.	Part Name and Descritption	Remarks
R64			not assigned
R65	A9063RG	Res: fxd met film 3.9kΩ ±1% ¼W LF¼ 3.9kΩF	
R66	A9085RG	Res: fxd met film 33kΩ ±1% ¼W LF¼ 33kΩF	
R67	A9063RG	Res: fxd met film 3.9kΩ ±1% ¼W LF¼ 3.9kΩF	
R68	A9105RG	Res: fxd met film 220kΩ ±1% ¼W LF¼ 220kΩF	
R69	A9077RG	Res: fxd met film 15kΩ ±1% ¼W LF¼ 15kΩF	
R70	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R71	A9077RG	Res: fxd met film 15kΩ ±1% ¼W LF¼ 15kΩF	
R72	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R73, R74			not assigned
R75	A9077RG	Res: fxd met film 15kΩ ±1% ¼W LF¼ 15kΩF	
R76	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R77	A9029RG	Res: fxd met film 150Ω ±1% ¼W LF¼ 150ΩF	
R78	A9069RG	Res: fxd met film 6.8kΩ ±1% ¼W LF¼ 6.8kΩF	
R79	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R80	A9178RK	Res: fxd met film 100Ω ±0.1% ¼W CFA 100ΩBT1	
R81	A9025RG	Res: fxd met film 100Ω ±1% ¼W LF¼ 100ΩF	
R82	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R83	A9077RG	Res: fxd met film 15kΩ ±1% ¼W LF¼ 15kΩF	
R84, R85	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R86~R90			not assigned
R91	A9157RL	Res: module 1kΩ X 10 MRP1361	10 elements
R92	A9041RG	Res: fxd met film 470Ω ±1% ¼W LF¼ 470ΩF	
R93	A9111RG	Res: fxd met film 390kΩ ±1% ¼W LF¼ 390kΩF	
R94	A9061RG	Res: fxd met film 3.3kΩ ±1% ¼W LF¼ 3.3kΩF	
R95	A9264RK	Res: fxd met film 4kΩ ±0.1% ¼W CFA 4kΩBT1	
R96	A9331RQ	Res: fxd met film 2.4kΩ ±0.1% ¼W CFA 2.4kΩBT1	
R97	A9025RG	Res: fxd met film 100Ω ±1% ¼W LF¼ 100ΩF	
R98~R100			not assigned
R101	A9827RK	Res: fxd met film 1.044kΩ ±0.1% ¼W CFA 1.044kΩBT1	
R102	A9025RG	Res: fxd met film 100Ω ±1% ¼W LF¼ 100ΩF	
R103, R104	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R105, R106	A9025RG	Res: fxd met film 100Ω ±1% ¼W LF¼ 100ΩF	
R107	A9828RK	Res: fxd met film 116Ω ±0.1% ½W CFB 116ΩBT1	
R108	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R109	A9053RG	Res: fxd met film 1.5kΩ ±1% ¼W LF¼ 1.5kΩF	
R110	A9076RG	Res: fxd met film 13kΩ ±1% ¼W LF¼ 13kΩF	
R111	A9001RG	Res: fxd met film 10Ω ±1% ¼W LF¼ 10ΩF	
R112~R114			not assigned
R115	A9112RG	Res: fxd met film 430kΩ ±1% ¼W LF¼ 430kΩF	
R116	A9042RG	Res: fxd met film 510Ω ±1% ¼W LF¼ 510ΩF	
R117	A9088RG	Res: fxd met film 43kΩ ±1% ¼W LF¼ 43kΩF	
R118~R120	A9073RG	Res: fxd met film 10kΩ ±1% ¼W LF¼ 10kΩF	
R121	A9103RG	Res: fxd met film 180kΩ ±1% ¼W LF¼ 180kΩF	
C1	A9019CN	Cap: fxd mica 33pF ±10% 100V DM05C 330K1	
C2	A9005CN	Cap: fxd mica 2.2pF ±10% 100V DM05C 2R2K1	

5-4. DC Input Board Ass'y (for Model 253321): B9278JF. (continued)

Item	Part No.	Part Name and Description	Remarks
C3	A9013CN	Cap: fxd mica 10pF ±10% 100V DM05C 100K1	
C4, C5	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C6, C7	A9444CA	Cap: fxd Al elect 100μF ±20% 35V ECEA1VU101	
C8	A9254CY	Cap: fxd polye flm 0.047μF ±10% 50V MFL5002-473K	
C9, C10	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C11, C12	A9445CA	Cap: fxd Al elect 220μF ±20% 35V ECEA1VU221	
C13~C20			not assigned
C21	A9009CL	Cap: module 1000pF X 4 EXF-P4102ZW	
C22~C27	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C28	A9367CY	Cap: fxd polye flm 0.22μF ±10% 63V 553M6302-224K	
C29	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C30	A9244CY	Cap: fxd polye flm 1000pF ±10% 50V MFL5002-102K	
C31	A9365CY	Cap: fxd polye flm 0.068μF ±10% 63V 553M6302-683K	
C32, C33	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C34~C39			not assigned
C40	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C41	A9365CY	Cap: fxd polye flm 0.068μF ±10% 63V 553M6302-683K	
C42	A9026CN	Cap: fxd mica 120pF ±10% 100V DM05C 121K1	
C43, C44	A9445CA	Cap: fxd Al elect 220μF ±20% 35V ECEA1VU221	
C45	A9248CY	Cap: fxd polye flm 4700pF ±10% 50V MFL5002-472K	
C46	A9069CN	Cap: fxd mica 560pF ±10% 100V DM15C 561K1	
C47	A9249CY	Cap: fxd polye flm 6800pF ±10% 50V MFL5002-682K	
C48	A9365CY	Cap: fxd polye flm 0.068μF ±10% 63V 553M6302-683K	
C49, C50			not assigned
C51, C52	A9369CY	Cap: fxd polye flm 0.47μF ±10% 63V 553M6302-474K	
C53, C54	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C55	A9254CY	Cap: fxd polye flm 0.047μF ±10% 50V MFL5002-473K	
C56, C57	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
L1, L2	A9100ML	Inductor ZBF-25D-01	
D1	A9248HD	Diode: Si 1S953	
D2, D3	A9150HL	Diode: array MC-931	
D4, D5	A9302HD	Diode: zener RD6.8E-B	
D6	A9150HL	Diode: array MC-931	
D7, D8	A9302HD	Diode: zener RD6.8E-B	
D9	A9092HL	Diode: module 1G4B41	
D10			not assigned
D11~D20			not assigned
D21, D11	A9150HL	Diode: array MC-931	
D23, D24	A9306HD	Diode: zener RD10E-B	
D25~D30	A9150HL	Diode: array MC-931	
D31~D34	A9150HL	Diode: array MC-931	

5-4. DC Input Board Ass'y (for Model 253321): B9278JF. (continued)

Item	Part No.	Part Name and Description		Remarks
Q1	A9340HQ	XSTR: Si NPN	2SC1815-Y	
Q2	A9454HQ	XSTR: Si NPN	2SC2690-A	
Q3	A9455HQ	XSTR: Si PNP	2SA1220-A	
Q4~Q10				not assigned
Q11	A9477HQ	XSTR: Si PNP	2SA965-Y	
Q12	A9454HQ	XSTR: Si NPN	2SC2690-A	
Q13	A9452HQ	XSTR: Si NPN	2SC2235-Y	
Q14	A9455HQ	XSTR: Si PNP	2SA1220-A	
Q15, Q16	A9477HQ	XSTR: Si PNP	2SA965-Y	
Q17	A9454HQ	XSTR: Si NPN	2SC2690-A	
Q18	A9455HQ	XSTR: Si PNP	2SA1220-A	
Q19, Q20	A9477HQ	XSTR: Si PNP	2SA965-Y	
Q21	A9452HQ	XSTR: Si NPN	2SC2235-Y	
Q22	A9477HQ	XSTR: Si PNP	2SA965-Y	
Q23	A9452HQ	XSTR: Si NPN	2SC2235-Y	
Q24	A9477HQ	XSTR: Si PNP	2SA965-Y	
U1	A9105LA	IC: −12V voltage regulator	μPC7912H	
U2	A9104LA	IC: +12V voltage regulator	μPC7812H	
U3	A9235LA	IC: analog	LT1055CN8	
U4	A9201LA	IC: analog	HI-508-5	
U5	A9218LA	IC: analog	LT1037CN8	
U6~U10				not assigned
U11	A9229LA	IC: analgo	LT1007CN8	
U12	A9259LA	IC: analog	LT1013CN8	
U13	A9218LA	IC: analog	LT1037CN8	
U14	A9259LA	IC: analog	LT1013CN8	
U15	A9218LA	IC: analog	LT1037CN8	
U16~U19	A9261LA	IC: analog	TL317LP	
U20				not assigned
U21	A9201LA	IC: analog	HI-508-5	
U22	A9229LA	IC: analog	LT1007CN8	
U23	A9218LA	IC: analog	LT1037CN8	
U24	A9096HL	IC: NPN Darlington XSTR array	μPC2004C	
U25	A9200LA	IC: analog	OP-07CN8	
U26	A9058LM	IC: digital	TC4047BP	MOS
U27	A9192LA	IC: analog	LA6393D	
PC1	A9073HL	Photo coupler	PC5073	
RL1	A9251MR	Relay	DS1E-S-DC12V	
RL2	A9259MR	Relay	DS1E-S-DC5V	
CN1~CN3	A9244KP	Conn	5045-03A	3P
CN4	A9641KP	Conn	HLEM-10S-1	10P
CN5	A9244KP	Conn	5045-03A	3P
CN6	A9641KP	Conn	HLEM-10S-1	10P
CN7	A9159KP	Conn	PS-30PA-D4LT1-PN1-K	30P
CN8~CN10	A9246KP	Conn	5045-02A	2P

5-4. DC Input Board Ass'y (for Model 253321): B9278JF. (continued)

Item	Part No.	Part Name and Description	Remarks
TP1~TP8	A9574KP	Test point VTC-1-1	
	B9278TF	Sheet ass'y (1 pc)	
	B9278TR	Plate ass'y (1 pc)	
	B9278TS	Plate (1 pc)	
	B9278TT	Plate (1 pc)	
	B9278TU	Plate (1 pc)	
	B9278TW	Bracket (1 pc)	
	B9278TX	Bracket (1 pc)	
	Y9304LS	Screw: M3 X 4 (18 pcs)	
	Y9720YA	Spacer (4 pcs)	
	B9278KF	PWB (1 pc)	

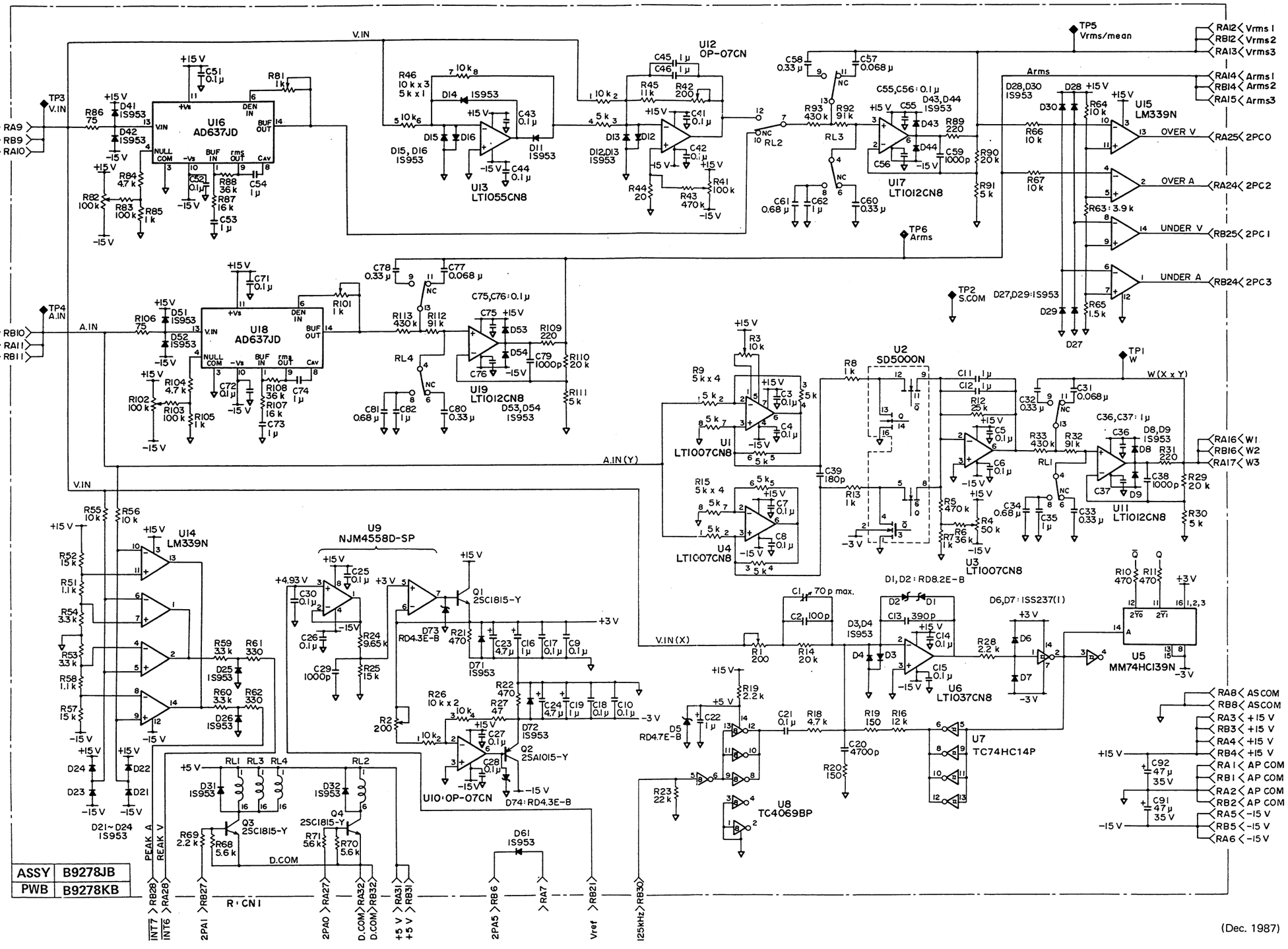

Figure 5-5a. RMS Board Ass'y: B9278JB Schematic Diagram.

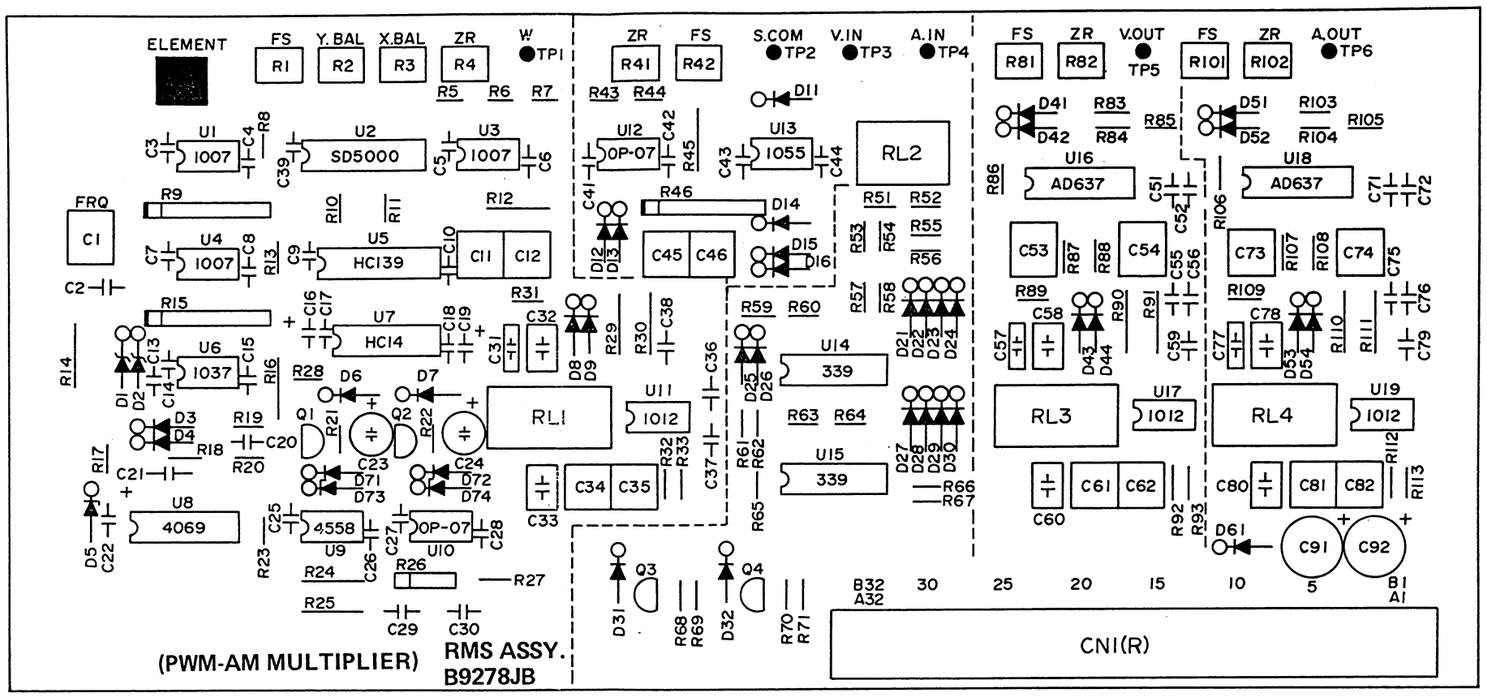

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Figure 5-5b. RMS Board Ass'y: B9278JB Components Location Diagram.

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5-5. RMS Board Ass'y: B9278JB.

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Item	Part No.	Part Name and Description	Remarks
R1, R2	A9543RV	Res: var cermet 200Ω ±20% ¼W GF06X1 200Ω	
R3	A9348RV	Res: var cermet 10kΩ ±20% ¼W GF06X1 10kΩ	
R4	A9272RV	Res: var cermet 50kΩ ±20% ¼W GF06X1 50kΩ	
R5	A9113RG	Res: fxd met flm 470kΩ ±1% ¼W LF¼ 470kΩF	
R6	A9086RG	Res: fxd met flm 36kΩ ±1% ¼W LF¼ 36kΩF	
R7, R8	A9049RG	Res: fxd met flm 1kΩ ±1% ¼W LF¼ 1kΩF	
R9	B9278LZ	Res: module 5kΩ X 4 MRP1492	4 elements
R10	A9041RG	Res: fxd met flm 470Ω ±1% ¼W LF¼ 470ΩF	
R11	A9041RG	Res: fxd met flm 470Ω ±1% ¼W LF¼ 470ΩF	
R12	A9310RN	Res: fxd met flm 25kΩ ±0.1% 1/8W RN60E 25kΩB	
R13	A9049RG	Res: fxd met flm 1kΩ ±1% ¼W LF¼ 1kΩF	
R14	A9123RQ	Res: fxd met flm 20kΩ ±0.1% 1/8W RN60R 20kΩB	
R15	B9278LZ	Res: module 5kΩ X 4 MRP1492	4 elements
R16	A9142RQ	Res: fxd met flm 12kΩ ±0.1% 1/8W RN60R 12kΩB	
R17	A9057RG	Res: fxd met flm 2.2kΩ ±1% ¼W LF¼ 2.2kΩF	
R18	A9065RG	Res: fxd met flm 4.7kΩ ±1% ¼W LF¼ 4.7kΩF	
R19, R20	A9029RG	Res: fxd met flm 150Ω ±1% ¼W LF¼ 150ΩF	
R21, R22	A9041RG	Res: fxd met flm 470Ω ±1% ¼W LF¼ 470ΩF	
R23	A9081RG	Res: fxd met flm 22kΩ ±1% ¼W LF¼ 22kΩF	
R24	A9662RK	Res: fxd met flm 9.65kΩ ±0.1% 1/8W SFA 9.65kΩBT11	
R25	A9133RQ	Res: fxd met flm 15kΩ ±0.1% 1/8W SFA 15kΩBT11	
R26	A9178RL	Res: module 10kΩ X 2 MRP1436	2 elements
R27	A9017RG	Res: fxd met flm 47Ω ±1% ¼W LF¼ 47ΩF	
R28	A9057RG	Res: fxd met flm 2.2kΩ ±1% ¼W LF¼ 2.2kΩF	
R29	A9656RK	Res: fxd met flm 20kΩ ±0.1% ¼W CFA 20kΩBT1	
R30	A9651RK	Res: fxd met flm 5kΩ ±0.1% ¼W CFA 5kΩBT1	
R31	A9033RG	Res: fxd met flm 220Ω ±1% ¼W LF¼ 220ΩF	
R32	A9096RG	Res: fxd met flm 91kΩ ±1% ¼W LF¼ 91kΩF	
R33	A9112RG	Res: fxd met flm 430kΩ ±1% ¼W LF¼ 430kΩF	
R34~R40			not assigned
R41	A9362RV	Res: var cermet 100kΩ ±20% ¼W GF06X1 100kΩ	
R42	A9543RV	Res: var cermet 200Ω ±20% ¼W GF06X1 200Ω	
R43	A9113RG	Res: fxd met flm 470kΩ ±1% ¼W LF¼ 470kΩF	
R44	A9008RG	Res: fxd met flm 20Ω ±1% ¼W LF¼ 20ΩF	
R45	A9654RK	Res: fxd met flm 11kΩ ±0.1% ¼W CFA 11kΩBT1	
R46	A9176RL	Res: module 5k, 10k X 3 MRP1434	4 elements
R47~R50			not assigned
R51	A9050RG	Res: fxd met flm 1.1kΩ ±1% ¼W LF¼ 1.1kΩF	
R52	A9077RG	Res: fxd met flm 15kΩ ±1% ¼W LF¼ 15kΩF	
R53, R54	A9061RG	Res: fxd met flm 3.3kΩ ±1% ¼W LF¼ 3.3kΩF	
R55, R56	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R57	A9077RG	Res: fxd met flm 15kΩ ±1% ¼W LF¼ 15kΩF	
R58	A9050RG	Res: fxd met flm 1.1kΩ ±1% ¼W LF¼ 1.1kΩF	
R59, R60	A9061RG	Res: fxd met flm 3.3kΩ ±1% ¼W LF¼ 3.3kΩF	

5-5. RMS Board Ass'y: B9278JB. (continued)

Item	Part No.	Part Name and Description	Remarks
R61, R62	A9037RG	Res: fxd met flm 330Ω ±1% ¼W LF¼ 330ΩF	
R63	A9063RG	Res: fxd met flm 3.9kΩ ±1% ¼W LF¼ 3.9kΩF	
R64	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R65	A9053RG	Res: fxd met flm 1.5kΩ ±1% ¼W LF¼ 1.5kΩF	
R66, R67	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R68	A9067RG	Res: fxd met flm 5.6kΩ ±1% ¼W LF¼ 5.6kΩF	
R69	A9057RG	Res: fxd met flm 2.2kΩ ±1% ¼W LF¼ 2.2kΩF	
R70	A9067RG	Res: fxd met flm 5.6kΩ ±1% ¼W LF¼ 5.6kΩF	
R71	A9067RG	Res: fxd met flm 5.6kΩ ±1% ¼W LF¼ 5.6kΩF	
R72~R80			not assigned
R81	A9387RV	Res: var cermet 1kΩ ±20% ¼w GF06X1 1kΩ	
R82	A9362RV	Res: var cermet 100kΩ ±20% ¼W GF06X1 100kΩ	
R83	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R84	A9065RG	Res: fxd met flm 4.7kΩ ±1% ¼W LF¼ 4.7kΩF	
R85	A9049RG	Res: fxd met flm 1kΩ ±1% ¼W LF¼ 1kΩF	
R86	A9022RG	Res: fxd met flm 75Ω ±1% ¼W LF¼ 75ΩF	
R87	A9078RG	Res: fxd met flm 16kΩ ±1% ¼W LF¼ 16kΩF	
R88	A9086RG	Res: fxd met flm 36kΩ ±1% ¼W LF¼ 36kΩF	
R89	A9033RG	Res: fxd met flm 220Ω ±1% ¼W LF¼ 220ΩF	
R90	A9656RK	Res: fxd met flm 20kΩ ±0.1% ¼W CFA 20kΩBT1	
R91	A9651RK	Res: fxd met flm 5kΩ ±0.1% ¼W CFA 5kΩBT1	
R92	A9096RG	Res: fxd met flm 91kΩ ±1% ¼W LF¼ 91kΩF	
R93	A9112RG	Res: fxd met flm 430kΩ ±1% ¼W LF¼ 430kΩF	
R94~R100			not assigned
R101	A9387RV	Res: var cermet 1kΩ ±20% ¼W GF06X1 1kΩ	
R102	A9362RV	Res: var cermet 100kΩ ±20% ¼W GF06X1 100kΩ	
R103	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R104	A9065RG	Res: fxd met flm 4.7kΩ ±1% ¼W LF¼ 4.7kΩF	
R105	A9049RG	Res: fxd met flm 1kΩ ±1% ¼W LF¼ 1kΩF	
R106	A9022RG	Res: fxd met flm 75Ω ±1% ¼W LF¼ 75ΩF	
R107	A9078RG	Res: fxd met flm 16kΩ ±1% ¼W LF¼ 16kΩF	
R108	A9086RG	Res: fxd met flm 36kΩ ±1% ¼W LF¼ 36kΩF	
R109	A9033RG	Res: fxd met flm 220Ω ±1% ¼W LF¼ 220ΩF	
R110	A9656RK	Res: fxd met flm 20kΩ ±0.1% ¼W CFA 20kΩBT1	
R111	A9651RK	Res: fxd met flm 5kΩ ±0.1% ¼W CFA 5kΩBT1	
R112	A9096RG	Res: fxd met flm 91kΩ ±1% ¼W LF¼ 91kΩF	
R113	A9112RG	Res: fxd met flm 430kΩ ±1% ¼W LF¼ 430kΩF	
C1	A9024CV	Cap: var cer 70pF max. ECE-1ZW70P40	
C2	A9025CN	Cap: fxd mica 100pF ±10% 100V DM05C 101K1	
C3~C10	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C11, C12	A9371CY	Cap: fxd polye flm 1μF ±10% 50V 553M5002 105K	
C13	A9033CN	Cap: fxd mica 390pF ±10% 100V DM05C 391K1	
C14, C15	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C16	A9233CT	Cap: fxd Ta elect 1μF 35V CS90E-1V-1R000-R58	
C17, C18	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	

5-5. RMS Board Ass'y: B9278JB. (continued)

Item	Part No.	Part Name and Description	Remarks
C19	A9233CT	Cap: fxd Ta elect 1μF 35V CS90E-1V-1R000-R58	
C20	A9248CY	Cap: fxd polye flm 4700pF ±10% 50V MFL5002-472K	
C21	A9229CY	Cap: fxd polye flm 0.1μF ±10% 100V ECQ-E 1104KZ	
C22	A9233CT	Cap: fxd Ta elect 1μF 35V CS90E-1V-1R000-R58	
C23, C24	A9290CA	Cap: fxd Al elect 4.7μF 35V ECEA1VS4R7R	
C25~C28	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C29	A9244CY	Cap: fxd polye flm 1000pF ±10% 50V MFL5002-102K	
C30	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C31	A9256CY	Cap: fxd polye flm 0.068μF ±10% 50V MFL5002-683K	
C32, C33	A9368CY	Cap: fxd polye flm 0.33μF ±10% 63V 553M6302 334K	
C34	A9370CY	Cap: fxd polye flm 0.68μF ±10% 50V 553M5002 684K	
C35	A9371CY	Cap: fxd polye flm 1μF ±10% 50V 553M5002 105K	
C36, C37	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C38	A9244CY	Cap: fxd polye flm 1000pF ±10% 50V MFL5002-102K	
C39	A9028CN	Cap: fxd mica 180pF ±10% 100V DM05C 181K1	
C40			not assigned
C41~C44	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C45, C46	A9371CY	Cap: fxd polye flm 1μF ±10% 50V 553M5002 105K	
C47~C50			not assigned
C51, C52	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C53, C54	A9371CY	Cap: fxd polye flm 1μF ±10% 50V 553M5002 105K	
C55, C56	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C57	A9256CY	Cap: fxd polye flm 0.068F ±10% 50V MFL5002-683K	
C58	A9368CY	Cap: fxd polye flm 0.33μF ±10% 63V 553M6302 334K	
C59	A9244CY	Cap: fxd polye flm 1000pF ±10% 50V MFL5002-102K	
C60	A9368CY	Cap: fxd polye flm 0.33μF ±10% 63V 553M6302 334K	
C61	A9370CY	Cap: fxd polye flm 0.68μF ±10% 50V 553M5002 684K	
C62	A9371CY	Cap: fxd polye flm 1μF ±10% 50V 553M5002 105K	
C63~C70			not assigned
C71, C72	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C73, C74	A9371CY	Cap: fxd polye flm 1μF ±10% 50V 553M5002 105K	
C75, C76	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C77	A9256CY	Cap: fxd polye flm 0.068μF ±10% 50V MFL5002-683K	
C78	A9368CY	Cap: fxd polye flm 0.33μF ±10% 63V 553M6302 334K	
C79	A9244CY	Cap: fxd polye flm 1000pF ±10% 50V MFL5002-102K	
C80	A9368CY	Cap: fxd polye flm 0.33μF ±10% 63V 553M6302 334K	
C81	A9370CY	Cap: fxd polye flm 0.68μF ±10% 50V 553M5002 684K	
C82	A9371CY	Cap: fxd polye flm 1μF ±10% 50V 553M5002 105K	
C83~C90			not assigned
C91, C92	A9335CA	Cap: fxd Al elect 33μF 35V ECEA1VS330R	
D1, D2	A9304HD	Diode: zener RD8.2E-B	
D3, D4	A9248HD	Diode: Si 1S953	
D5	A9229HD	Diode: zener RD4.7E-B	

5-5. RMS Board Ass'y: B9278JB. (continued)

Item	Part No.	Part Name and Description	Remarks
D6, D7	A9362HD	Diode: Schottky 1SS237(1)	
D8, D9	A9248HD	Diode: Si 1S953	
D10			not assigned
D11~D16	A9248HD	Diode: Si 1S953	
D17~D20			not assigned
D21~D30	A9248HD	Diode: Si 1S953	
D31, D32	A9248HD	Diode: Si 1S953	
D33~D40			nota ssigned
D41~D44	A9248HD	Diode: Si 1S953	
D45~D50			not assigned
D51~D54	A9248HD	Diode: Si 1S953	
D55~D60			not assigned
D61	A9248HD	Diode: Si 1S953	
D62~D70			not assigned
D71, D72	A9248HD	Diode: Si 1S953	
D73, D74	A9180HD	Diode: zener RD4.3E-B	
Q1	A9340HQ	XSTR: Si NPN 2SC1815-Y	
Q2	A9338HQ	XSTR: Si PNP 2SA1015-Y	
Q3, Q4	A9340HQ	XSTR: Si NPN 2SC1815-Y	
U1	A9229LA	IC: analog LT1007CN8	
U2	A9173LA	IC: analog SD5000N	
U3, U4	A9229LA	IC: analog LT1007CN8	
U5	A9027LN	IC: digital MM74HC139N	CMOS
U6	A9218LA	IC: analog LT1037CN8	
U7	A9086LN	IC: digital TC74HC14P	CMOS
U8	A9075LM	IC: digital TC4069BP	MOS
U9	A9195LA	IC: analog NJM4558D-SP	
U10	A9200LA	IC: analog OP-07CN	
U11	A9188LA	IC: analog LT1012CN8	
U12	A9200LA	IC: analog OP-07CN	
U13	A9235LA	IC: analog LT1055CN8	
U14, U15	A9019LA	IC: analog LM339N	
U16	A9026LE	IC: RMS-DC converter AD637JD	
U17	A9188LA	IC: analog LT1012CN8	
U18	A9026LE	IC: RMS-DC converter AD637JD	
U19	A9188LA	IC: analog LT1012CN8	
RL1	A9260MR	Relay DS2E-S-DC5V	
RL2	A9259MR	Relay DS1E-S-DC5V	
RL3, RL4	A9260MR	Relay DS2E-S-DC5V	
CN1	A9708KP	Conn. PCN10A-64P-2.54DS	64P
TP1~TP6	A9574KT	Test point VTC-1-1	
	B9278KB	PWB (1 pc)	

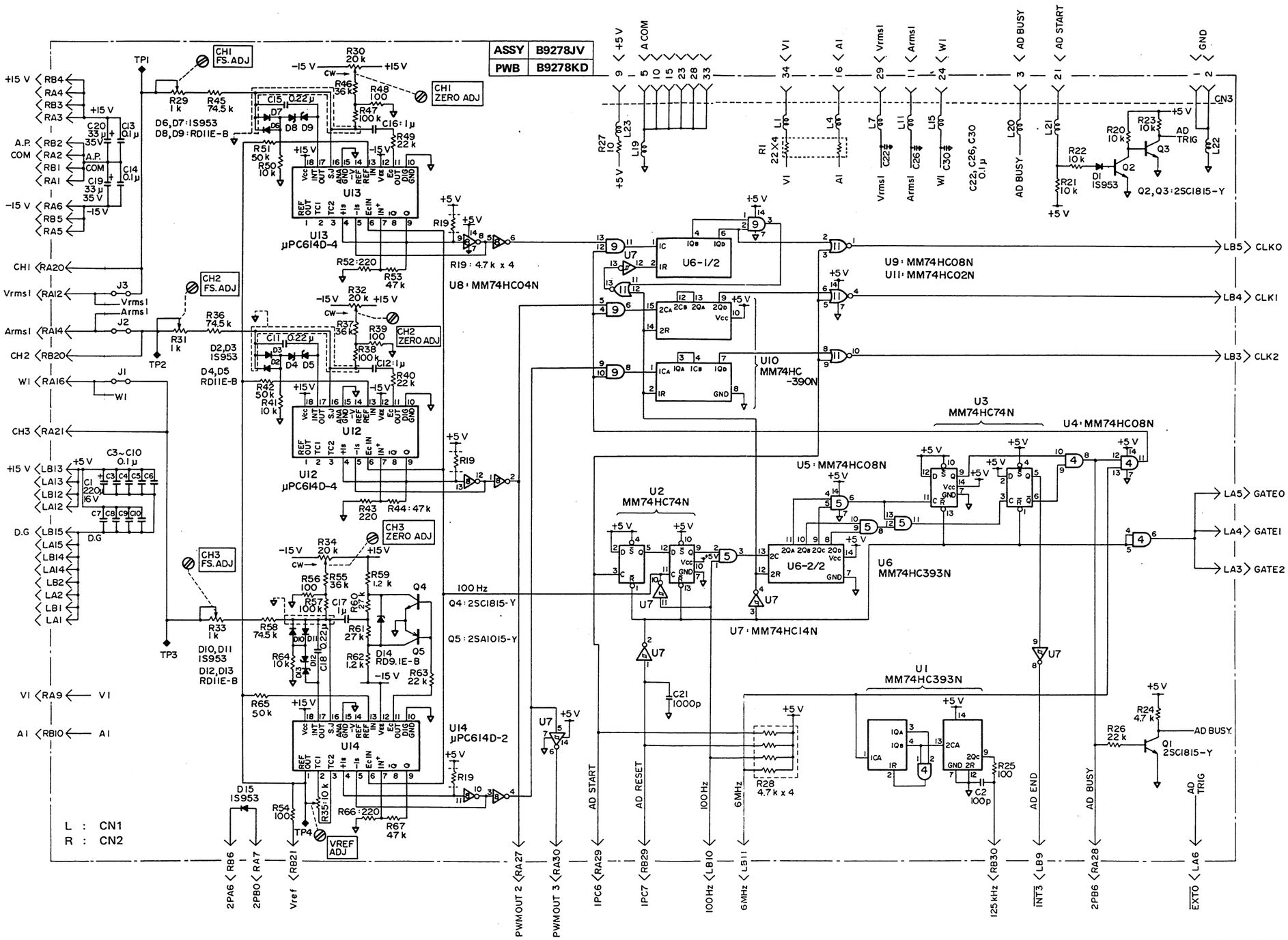

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Figure 5-6a. A/D Converter Board Ass'y: B9278JV Schematic Diagram.

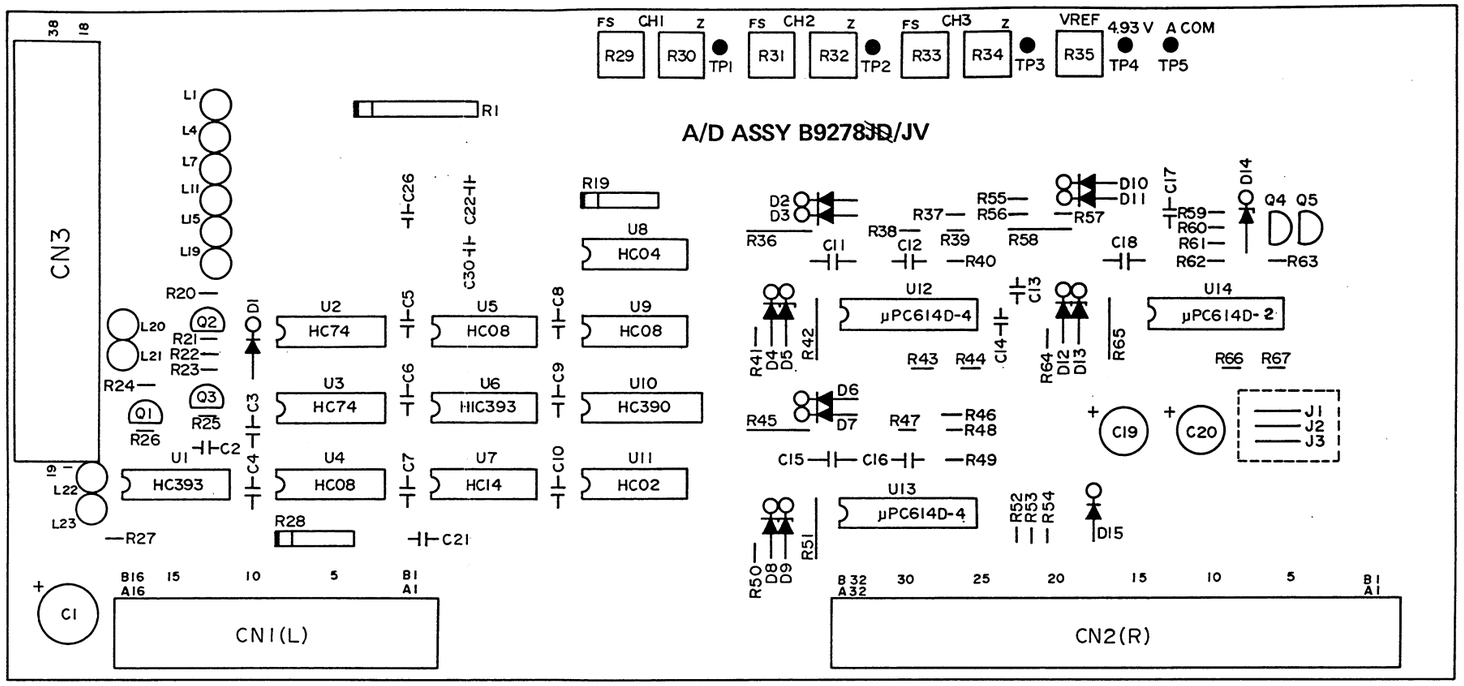

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Figure 5-6b. A/D Converter Board Ass'y: B9278JV Components Location Diagram.

5-6. A/D Converter Board Ass'y: B9278JV.

(Dec. 1987)

Item	Part No.	Part Name and Description	Remarks
R1	A9130RL	Res: module 22Ω ±5% ¼W RKC¼B4S 22ΩJ	4 elements
R2~R10			not assigned
R11~R18			not assigned
R19	A9043RL	Res: module 4.7kΩ ±5% 1/6 W RKC1/6 B4 4.7kΩJ	4 elements
R20	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R21~R23	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R24	A9065RG	Res: fxd met flm 4.7kΩ ±1% ¼W LF¼ 4.7kΩF	
R25	A9025RG	Res: fxd met flm 100Ω ±1% ¼W LF¼ 100ΩF	
R26	A9081RG	Res: fxd met flm 22kΩ ±1% ¼W LF¼ 22kΩF	
R27	A9001RG	Res: fxd met flm 10Ω ±1% ¼W LF¼ 10ΩF	
R28	A9043RL	Res: module 4.7kΩ ±5% 1/6 W RKC1/6 B4 4.7kΩJ	4 elements
R29	A9387RV	Res: var cermet 1kΩ ±20% ¼W GF06X1 1kΩ	
R30	A9271RV	Res: ver cermet 20kΩ ±20% ¼W GF06X1 20kΩ	
R31	A9387RV	Res: ver cermet 1kΩ ±20% ¼W GF06X1 1kΩ	
R32	A9271RV	Res: ver cermet 20kΩ ±20% ¼W GF06X1 20kΩ	
R33	A9387RV	Res: ver cermet 1kΩ ±20% ¼W GF06X1 1kΩ	
R34	A9271RV	Res: ver cermet 20kΩ ±20% ¼W GF06X1 20kΩ	
R35	A9348RV	Res: ver cermet 10kΩ ±20% ¼W GF06X1 10kΩ	
R36	A9659RK	Res: fxd met flm 74.5kΩ ±0.1% ¼W CFA 74.5kΩBT1	
R37	A9086RG	Res: fxd met flm 36kΩ ±1% ¼W LF¼ 36kΩF	
R38	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R39	A9025RG	Res: fxd met flm 100Ω ±1% ¼W LF¼ 100ΩF	
R40	A9081RG	Res: fxd met flm 22kΩ ±1% ¼W LF¼ 22kΩF	
R41	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R42	A9725RK	Res: fxd met flm 50kΩ ±0.1% ¼W CFA 50kΩBT1	
R43	A9033RG	Res: fxd met flm 220Ω ±1% ¼W LF¼ 220ΩF	
R44	A9089RG	Res: fxd met flm 47kΩ ±1% ¼W LF¼ 47kΩF	
R45	A9659RK	Res: fxd met flm 74.5kΩ ±0.1% ¼W CFA 74.5kΩBT1	
R46	A9086RG	Res: fxd met flm 36kΩ ±1% ¼W LF¼ 36kΩF	
R47	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R48	A9025RG	Res: fxd met flm 100Ω ±1% ¼W LF¼ 100ΩF	
R49	A9081RG	Res: fxd met flm 22kΩ ±1% ¼W LF¼ 22kΩF	
R50	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R51	A9725RK	Res: fxd met flm 50kΩ ±0.1% ¼W CFA 50kΩBT1	
R52	A9033RG	Res: fxd met flm 220Ω ±1% ¼W LF¼ 220ΩF	
R53	A9089RG	Res: fxd met flm 47kΩ ±1% ¼W LF¼ 47kΩF	
R54	A9025RG	Res: fxd met flm 100Ω ±1% ¼W LF¼ 100ΩF	
R55	A9086RG	Res: fxd met flm 36kΩ ±1% ¼W LF¼ 36kΩF	
R56	A9025RG	Res: fxd met flm 100Ω ±1% ¼W LF¼ 100ΩF	
R57	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R58	A9659RK	Res: fxd met flm 74.5kΩ ±0.1% ¼W CFA 74.5kΩBT1	
R59	A9051RG	Res: fxd met flm 1.2kΩ ±1% ¼W LF¼ 1.2kΩF	
R60	A9083RG	Res: fxd met flm 27kΩ ±1% ¼W LF¼ 27kΩF	
R61	A9083RG	Res: fxd met flm 27kΩ ±1% ¼W LF¼ 27kΩF	
R62	A9051RG	Res: fxd met flm 1.2kΩ ±1% ¼W LF¼ 1.2kΩF	
R63	A9081RG	Res: fxd met flm 22kΩ ±1% ¼W LF¼ 22kΩF	

5-6. A/D Converter Board Ass'y: B9278JV. (continued)

Item	Part No.	Part Name and Description	Remarks
R64	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R65	A9725RK	Res: fxd met flm 50kΩ ±0.1% ¼W CFA 50kΩBT1	
R66	A9033RG	Res: fxd met flm 220Ω ±1% ¼W LF¼ 220ΩF	
R67	A9089RG	Res: fxd met flm 47kΩ ±1% ¼W LF¼ 47kΩF	
C1	A9355CA	Cap: fxd Al elect 220μF 16V ECEA1CS221R	
C2	A9025CN	Cap: fxd mica 100pF ±10% 100V DM05C 101K1	
C3~C10	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C11	A9231CY	Cap: fxd polye flm 0.22μF ±10% 100V ECQ-E 1224KZ	
C12	A9371CY	Cap: fxd polye flm 1μF ±10% 50V 553M5002 105K	
C13, C14	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C15	A9231CY	Cap: fxd polye flm 0.22μF ±10% 100V ECQ-E 1224KZ	
C16, C17	A9371CY	Cap: fxd polye flm 1μF ±10% 50V 553M5002 105K	
C18	A9231CY	Cap: fxd polye flm 0.22μF ±10% 100V ECQ-E 1224KZ	
C19, C20	A9335CA	Cap: fxd Al elect 33μF 35V ECEA1VS330R	
C21	A9244CY	Cap: fxd polye flm 1000pF ±10% 50V MFL5002-102K	
C22	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C23~C25			not assigned
C26	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C27~C29			not assigned
C30	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
L1	A9100MC	Filter ZBF253D-01	
L2, L3			
L4	A9100MC	Filter ZBF253D-01	not assigned
L5, L6			
L7	A9100MC	Filter ZBF253D-01	not assigned
L8~L10			not assigned
L11	A9100MC	Filter ZBF253D-01	not assigned
L12~14			
L15	A9100MC	Filter ZBF253D-01	not assigned
L16~L18			
L19, L20	A9100MC	Filter ZBF253D-01	
L21~L23	A9100MC	Filter ZBF253D-01	
D1~D3	A9248HD	Diode: Si 1S953	
D4, D5	A9307HD	Diode: zener RD11E-B	
D6, D7	A9248HD	Diode: Si 1S953	
D8, D9	A9307HD	Diode: zener RD11E-B	
D10	A9248HD	Diode: Si 1S953	
D11	A9248HD	Diode: Si 1S953	
D12, D13	A9307HD	Diode: zener RD11E-B	
D14	A9305HD	Diode: zener RD9.1E-B	
D15	A9248HD	Diode: Si 1S953	
Q1~Q4	A9340HQ	XSTR: Si NPN 2SC1815-Y	
Q5	A9338HQ	XSTR: Si PNP 2SA1015-Y	
U1	A9069LN	IC: digital MM74HC393N	CMOS
U2, U3	A9014LN	IC: digital MM74HC74N	CMOS

5-6. A/D Converter Board Ass'y: B9278JV. (continued)

Item	Part No.	Part Name and Description		Remarks
U4, U5	A9004LN	IC: digital	MM74HC08N	CMOS
U6	A9069LN	IC: digital	MM74HC393N	CMOS
U7	A9007LN	IC: digital	MM74HC14N	CMOS
U8	A9003LN	IC: digital	MM74HC04N	CMOS
U9	A9004LN	IC: digital	MM74HC08N	CMOS
U10	A9068LN	IC: digital	MM74HC390N	CMOS
U11	A9002LN	IC: digital	MM74HC02N	CMOS
U12, U13	A9033LE	IC: PWM A/D converter	μPC614D-4	MOS
U14	A9032LE	IC: PWM A/D converter	μPC614D-2	MOS
CN1	A9709KP	Conn.	PCN10A-32P-2.54DS	32P
CN2	A9708KP	Conn.	PCN10A-64P-2.54DS	64P
CN3	A9637KC	Conn.	57LE-40360-7700-D12	36P
TP1~TP5	A9574KP	Test point	VTC-1-1	
	B9278DX	Plate (1 pc)		
	Y9308LB	Screw: M3 X 8 (2 pcs)		
	Y9310JB	Screw: M3 X 10 (2 pcs)		
	B9278KD	PWB		

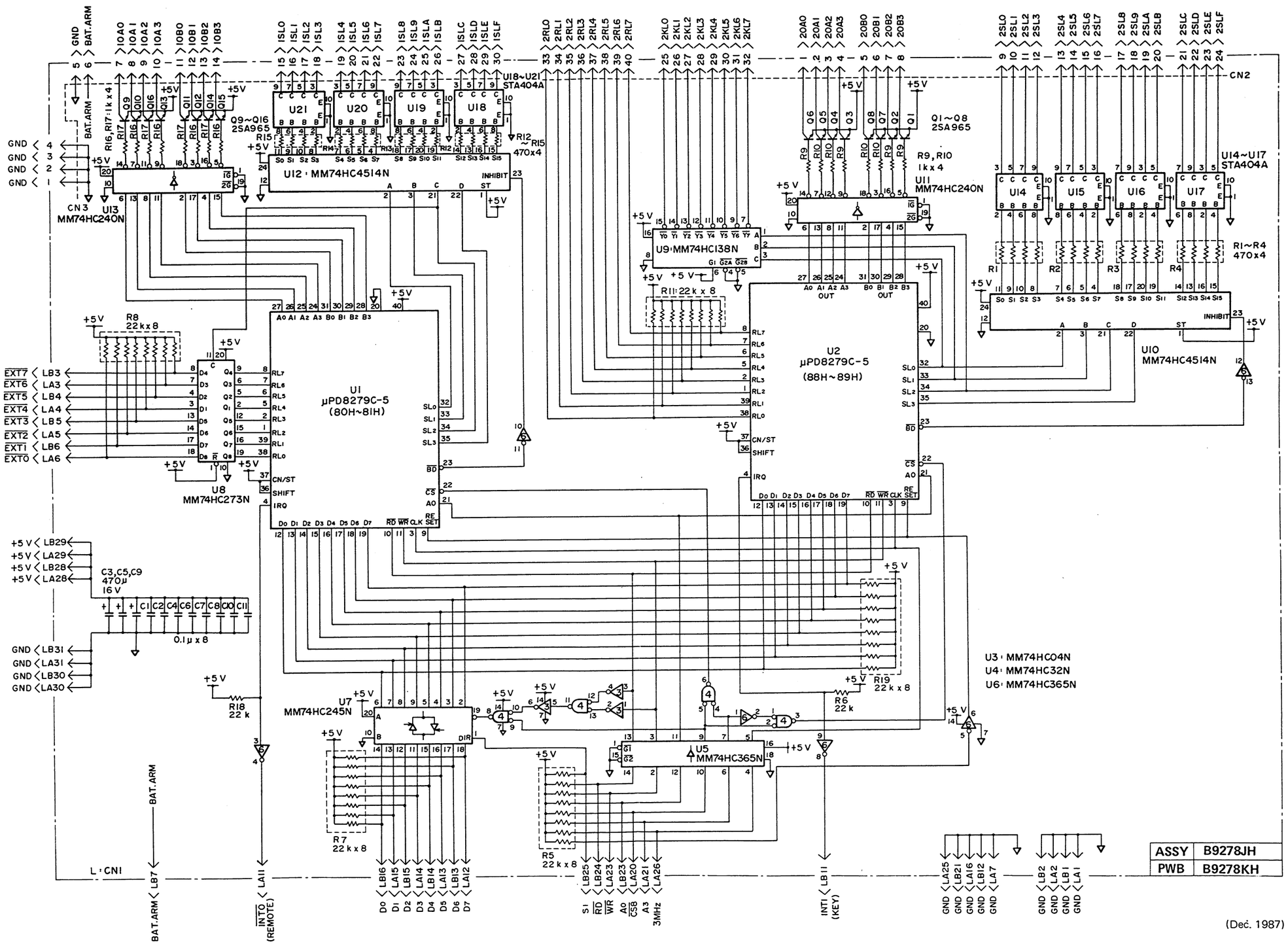

Figure 5-7a. Display Control Board Ass'y: B9278JH Schematic Diagram.

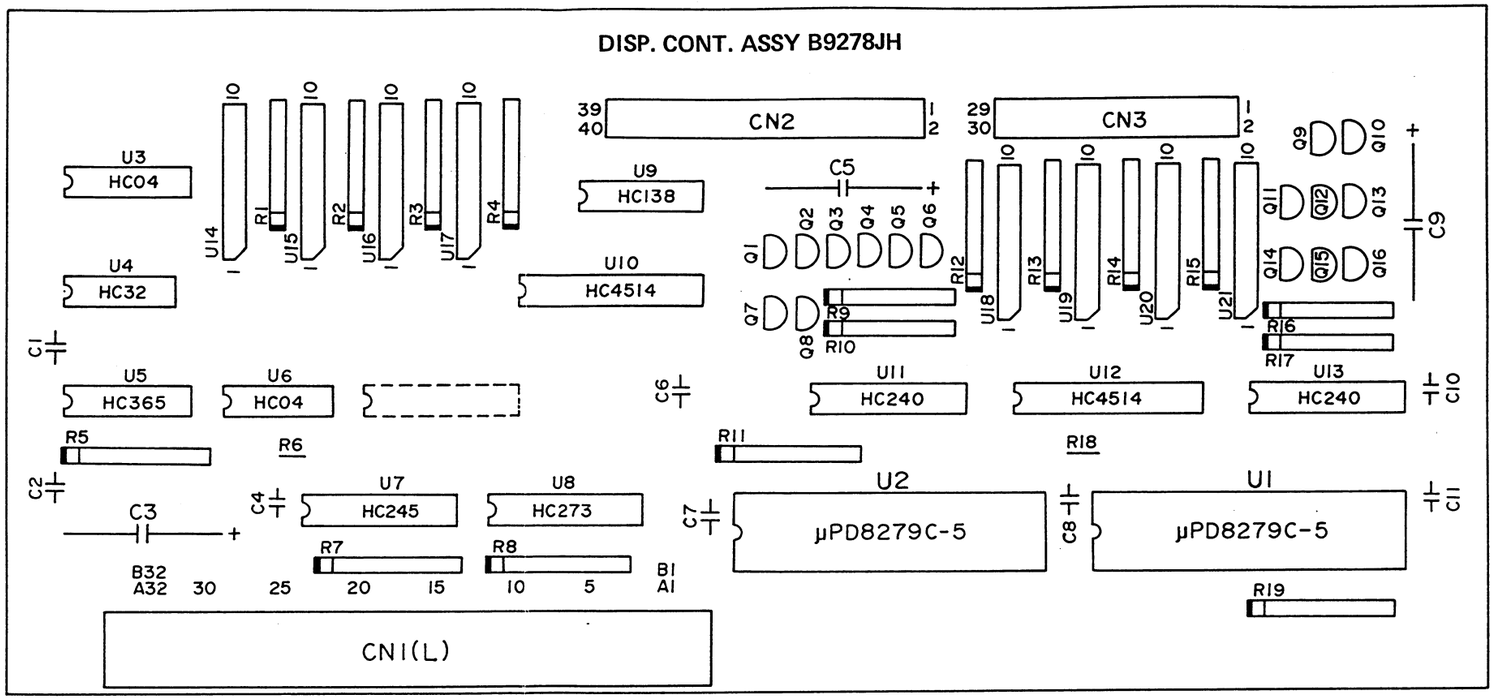

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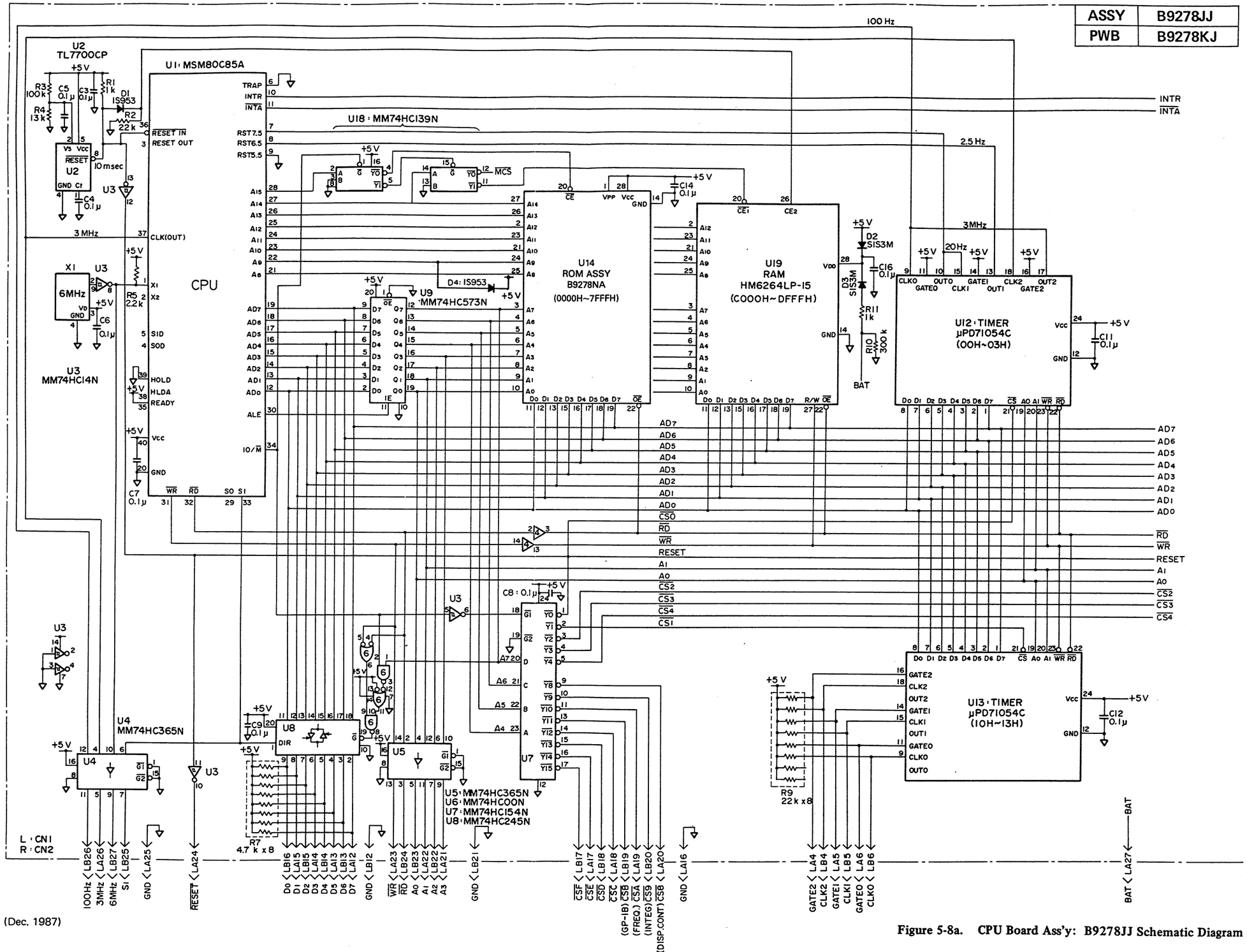
Figure 5-7b. Display Control Board Ass'y: B9278JH Components Location Diagram.

5-7. Display Control Board Ass'y: B9278JH.

(Dec. 1987)

Item	Part No.	Part Name and Description	Remarks
R1~R4	A9118RL	Res: module 470Ω ±5% ¼W RKC¼B4S 470ΩJ	4 elements
R5	A9071RL	Res: module 22kΩ ±5% 1/8W RK1/8 B8 22kΩJ	8 elements
R6	A9081RG	Res: fxd met flm 22kΩ ±1% ¼W LF¼ 22kΩF	
R7, R8	A9071RL	Res: module 22kΩ ±5% 1/8W RK1/8 B8 22kΩJ	8 elements
R9, R10	A9111RL	Res: module 1kΩ ±5% ¼W RKC¼B4S 1kΩJ	4 elements
R11	A9071RL	Res: module 22kΩ ±5% 1/8W RK1/8 B8 22kΩJ	8 elements
R12~R15	A9118RL	Res: module 470Ω ±5% ¼W RKC¼B4S 470ΩJ	4 elements
R16, R17	A9111RL	Res: module 1kΩ ±5% ¼W RKC¼B4S 1kΩJ	4 elements
R18	A9081RG	Res: fxd met flm 22kΩ ±1% ¼W LF¼ 22kΩF	
R19	A9071RL	Res: module 22kΩ ±5% 1/8W RK1/8 B8 22kΩJ	8 elements
C1, C2	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C3	A9343CA	Cap: fxd Al elect 470μF 16V ECEB1CS471R	
C4	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C5	A9343CA	Cap: fxd Al elect 470μF 16V ECEB1CS471R	
C6~C8	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C9	A9343CA	Cap: fxd Al elect 470μF 16V ECEB1CS471R	
C10	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C11	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
Q1~Q10	A9477HQ	XSTR: Si PNP 2SA965	
Q11~Q16	A9477HQ	XSTR: Si PNP 2SA965	
U1, U2	A9145LM	LSI: programmable display controller μPD8279C-5	MOS
U3	A9003LN	IC: digital MM74HC04N	CMOS
U4	A9011LN	IC: digital MM74HC32N	CMOS
U5	A9062LN	IC: digital MM74HC365N	CMOS
U6	A9003LN	IC: digital MM74HC04N	CMOS
U7	A9052LN	IC: digital MM74HC245N	CMOS
U8	A9081LN	IC: digital MM74HC273N	CMOS
U9	A9026LN	IC: digital MM74HC138N	CMOS
U10	A9084LN	IC: digital MM74HC4514N	CMOS
U11	A9047LN	IC: digital MM74HC240N	CMOS
U12	A9084LN	IC: digital MM74HC4514N	CMOS
U13	A9047LN	IC: digital MM74HC240N	CMOS
U14~U20	A9131HL	XSTR: array STA404A	
U21	A9131HL	XSTR: array STA404A	
CN1	A9708KP	Conn. PCN10A-64P-2.54DS	64P
CN2	A9114KP	Conn. PS-40PA-D4LT1-PN1-K	40P
CN3	A9159KP	Conn. PS-30PA-D4LT1-PN1-K	30P
	B9278KH	PWB (1 pc)	

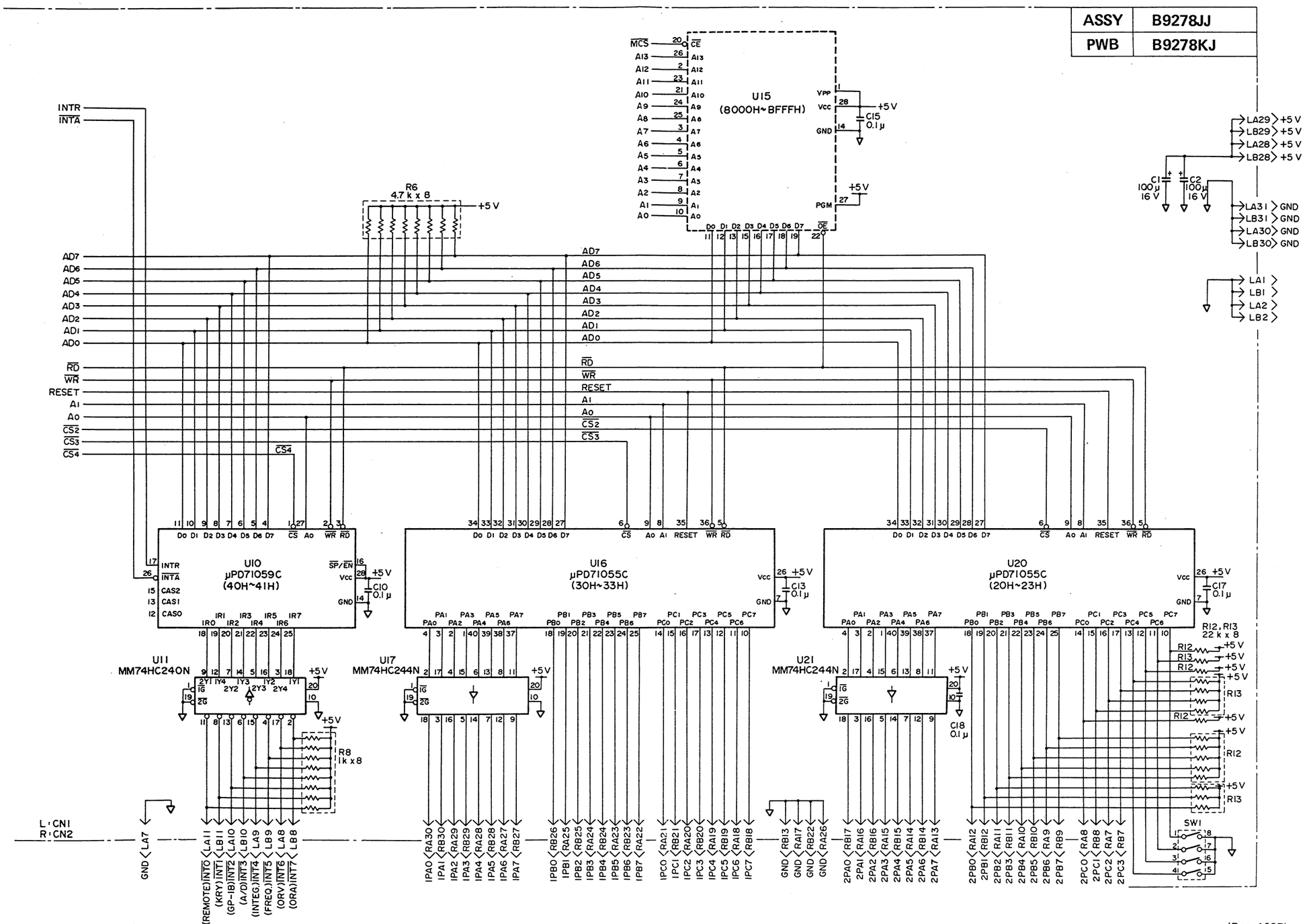
ASSY	B9278JJ
PWB	B9278KJ



(Dec. 1987)

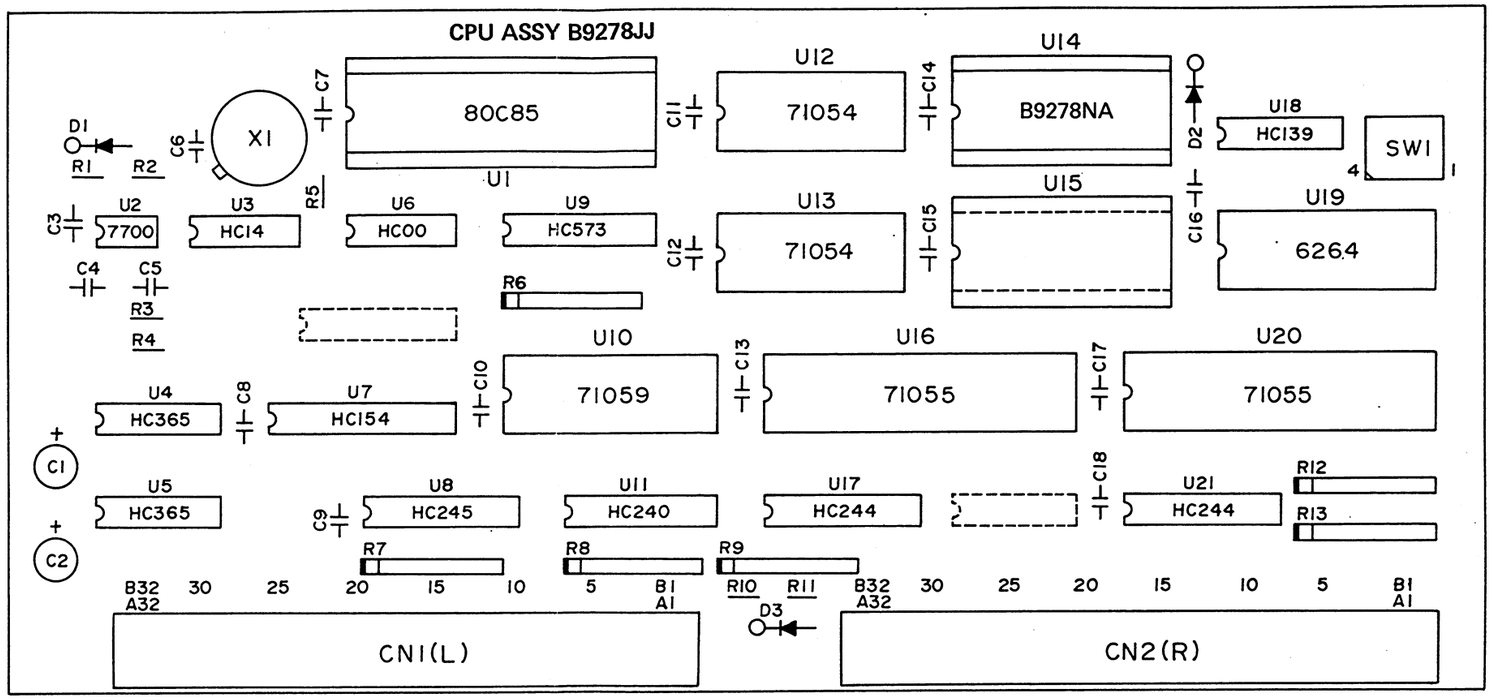
Figure 5-8a. CPU Board Ass'y: B9278JJ Schematic Diagram (1/2).

ASSY	B9278JJ
PWB	B9278KJ



(Dec. 1987)

Figure 5-8b. CPU Board Ass'y: B9278JJ Schematic Diagram (2/2).



(Dec. 1987)

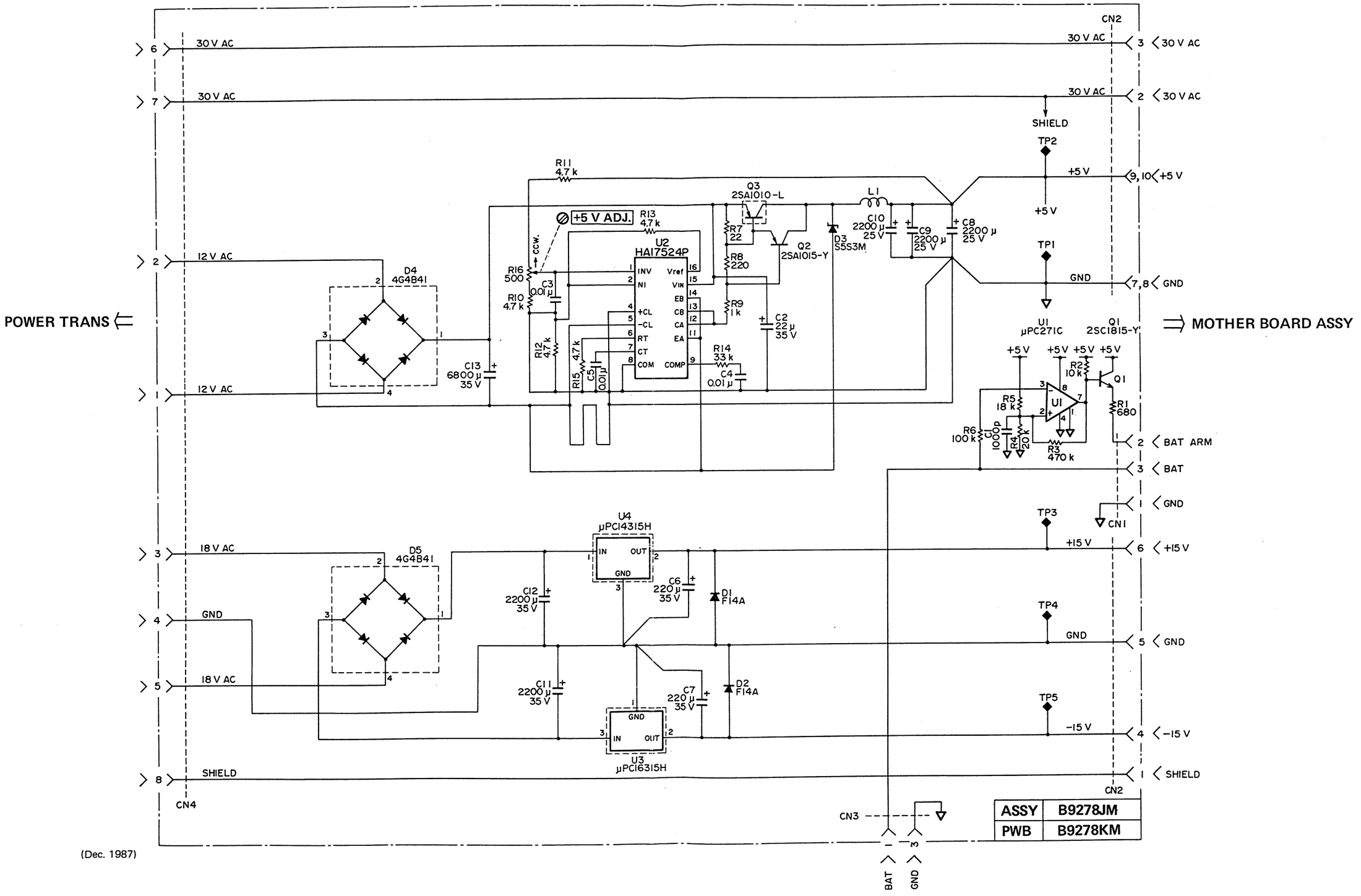
Figure 5-8c. CPU Board Ass'y: B9278JJ Components Location Diagram.

5-8. CPU Board Ass'y: B9278JJ.

(Dec. 1987)

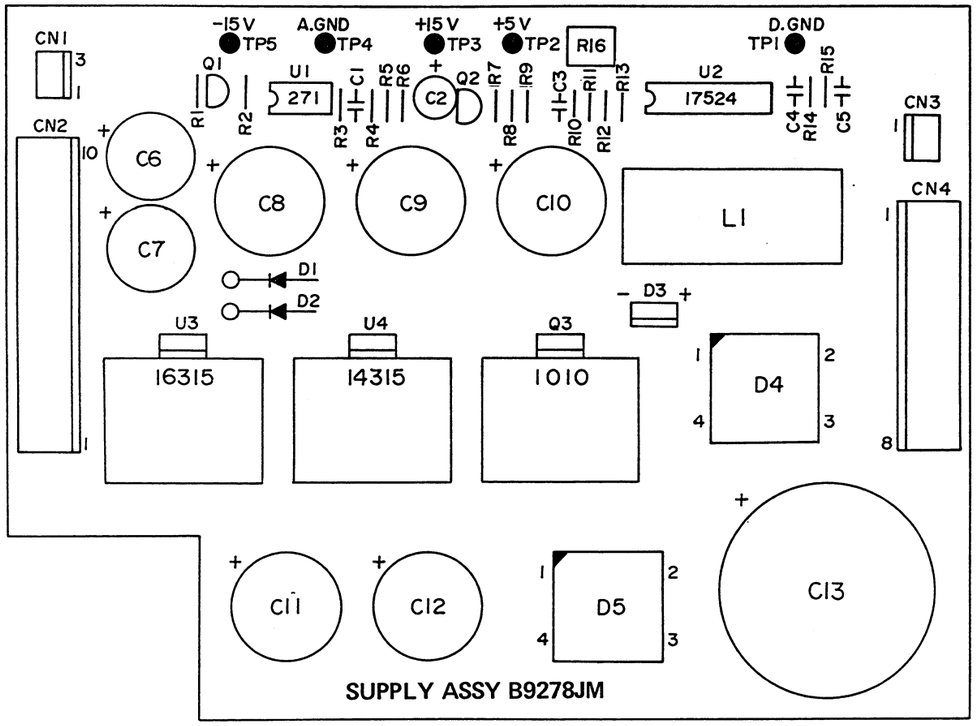
Item	Part No.	Part Name and Description	Remarks
R1	A9049RG	Res: fxd met flm 1kΩ ±1% ¼W LF¼ 1kΩF	
R2	A9081RG	Res: fxd met flm 22kΩ ±1% ¼W LF¼ 22kΩF	
R3	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R4	A9076RG	Res: fxd met flm 13kΩ ±1% ¼W LF¼ 13kΩF	
R5	A9057RG	Res: fxd met flm 2.2kΩ ±1% ¼W LF¼ 2.2kΩF	
R6, R7	A9070RL	Res: module 4.7kΩ ±5% 1/8W RK1/8 B8 4.7kΩJ	8 elements
R8	A9022RL	Res: module 1kΩ ±5% 1/8W RK1/8 B8 1kΩJ	8 elements
R9	A9071RL	Res: module 22kΩ ±5% 1/8W RK1/8 B8 22kΩJ	8 elements
R10	A9108RG	Res: fxd met flm 300kΩ ±1% ¼W LF¼ 300kΩF	
R11	A9049RG	Res: fxd met flm 1kΩ ±1% ¼W LF¼ 1kΩF	
R12, R13	A9071RL	Res: module 22kΩ ±5% 1/8W RK1/8 B8 22kΩJ	8 elements
C1, C2	A9354CA	Cap: fxd Al elect 100μF 16V ECEA1CS101R	
C3~C10	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
C11~C18	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
D1	A9248HD	Diode: Si 1S953	
D2, D3	A9392HD	Diode: Schottky S1S3M	
D4	A9248HD	Diode: Si 1S953	
U1	A9030LC	LSI: CPU MSM80C85A	
U2	A9577LB	IC: digital TL7700CP	
U3	A9007LN	IC: digital MM74HC14N	CMOS
U4, U5	A9062LN	IC: digital MM74HC365N	CMOS
U6	A9001LN	IC: digital MM74HC00N	CMOS
U7	A9031LN	IC: digital MM74HC154N	CMOS
U8	A9052LN	IC: digital MM74HC245N	CMOS
U9	A9075LN	IC: digital MM74HC573N	CMOS
U10	A9055LC	LSI: interrupt control unit μPD71059C	
U11	A9047LN	IC: digital MM74HC240N	CMOS
U12, U13	A9052LC	LSI: programmable timer, counter μPD71054C	
(U14)	B9278NA	LSI: ROM ass'y (μPD27C256D-20)	PGM'd
U15			not assigned
U16	A9051LC	LSI: parallel interface μPD71055C	
U17	A9051LN	IC: digital MM74HC244N	CMOS
U18	A9027LN	IC: digital MM74HC139N	CMOS
U19	A9031LD	LSI: memory (SRAM) HM6264LP-15	
U20	A9051LC	LSI: parallel interface μPD71055C	
U21	A9051LN	IC: digital MM74HC244N	CMOS
CN1, CN2	A9708KP	Conn. PCN10A-64P-2.54DS	
SW1	A9130SS	Sw: DIP DNP-4	4 elements
X1	A9105EX	Quartz resonator 6MHz LQV6M00-02CG	
	A9575KC	IC socket (2 pcs) DICF-28A	for U14, U15
	A9576KC	IC socket (1 pc) DICF-40A	for U1
	B9278KJ	PWB (1 pc)	

Note: U14 is not included in the components of this ass'y.



(Dec. 1987)

Figure 5-9a. Power Supply Board Ass'y (for Model 253311): B9278JM Schematic Diagram.



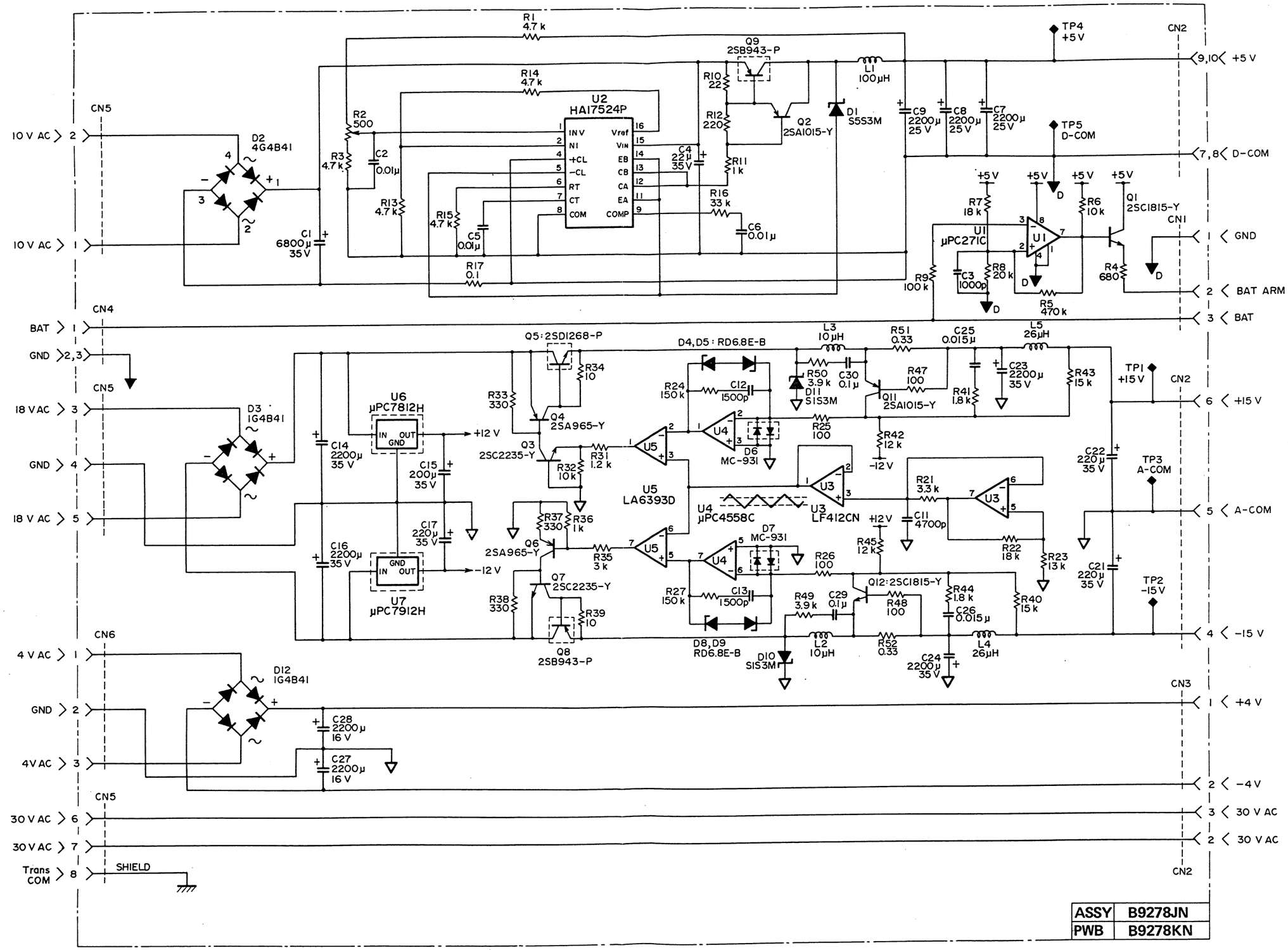
(Dec. 1987)

Figure 5-9b. Power Supply Board Ass'y (for Model 253311): B9278JM Components Location Diagram.

5-9. Power Supply Board Ass'y (for Model 253311): B9278JM.

(Dec. 1987)

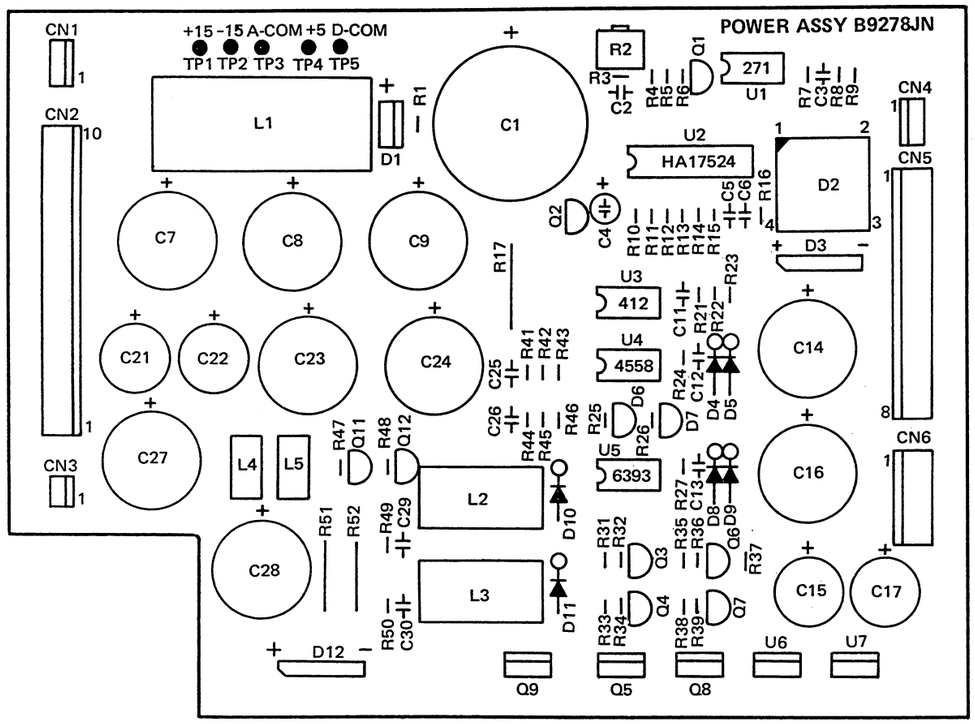
Item	Part No.	Part Name and Description	Remarks
R1	A9045RG	Res: fxd met flm 680Ω ±1% ¼W LF¼ 680ΩF	
R2	A9073RG	Res: fxd met flm 10kΩ ±1% ¼W LF¼ 10kΩF	
R3	A9113RG	Res: fxd met flm 470kΩ ±1% ¼W LF¼ 470kΩF	
R4	A9080RG	Res: fxd met flm 20kΩ ±1% ¼W LF¼ 20kΩF	
R5	A9079RG	Res: fxd met flm 18kΩ ±1% ¼W LF¼ 18kΩF	
R6	A9097RG	Res: fxd met flm 100kΩ ±1% ¼W LF¼ 100kΩF	
R7	A9009RG	Res: fxd met flm 22Ω ±1% ¼W LF¼ 22ΩF	
R8	A9033RG	Res: fxd met flm 220Ω ±1% ¼W LF¼ 220ΩF	
R9	A9049RG	Res: fxd met flm 1kΩ ±1% ¼W LF¼ 1kΩF	
R10	A9065RG	Res: fxd met flm 4.7kΩ ±1% ¼W LF¼ 4.7kΩF	
R11~R13	A9065RG	Res: fxd met flm 4.7kΩ ±1% ¼W LF¼ 4.7kΩF	
R14	A9085RG	Res: fxd met flm 33kΩ ±1% ¼W LF¼ 33kΩF	
R15	A9065RG	Res: fxd met flm 4.7kΩ ±1% ¼W LF¼ 4.7kΩF	
R16	A9270RV	Res: var cermet 500Ω ±20% ¼W GF06X1 500Ω	
C1	A9244CY	Cap: fxd polye flm 1000pF ±10% 50V MFL5002-102K	
C2	A9351CA	Cap: fxd Al elect 22μF 35V ECEA1VS220R	
C3~C5	A9250CY	Cap: fxd polye flm 0.01μF ±10% 50V MFL5002-103K	
C6, C7	A9373CA	Cap: fxd Al elect 220μF 35V ECEA1VS221R	
C8~C10	A9425CA	Cap: fxd Al elect 2200μF 25V KME25VB2200	
C11, C12	A9353CA	Cap: fxd Al elect 2200μF 35V ECEA1VS222R	
C13	A9406CA	Cap: fxd Al elect 6800μF 35V ECES1VU682M	
L1	A9084EC	Inductor SKC-103	
D1, D2	A9236HD	Diode: Si F14A	
D3	A9385HD	Diode: zener S5S3M	
D4, D5	A9115HL	Diode: module 4G4B41	400V, 4A
Q1	A9340HQ	XSTR: Si NPN 2SC1815-Y	
Q2	A9338HQ	XSTR: Si PNP 2SA1015-Y	
Q3	A9401HQ	XSTR: Si PNP 2SA1010-L	
U1	A9085LA	IC: analog μPC271C	
U2	A9115LA	IC: analog HA17524P	
U3	A9074LA	IC: −15V voltage regulator μPC16315H	
U4	A9073LA	IC: +15V voltage regulator μPC14315H	
CN1	A9244KP	Conn 5045-03A	
CN2	A9447KP	Conn 5281-10A	
CN3	A9244KP	Conn 5045-03A	
CN4	A9462KP	Conn 5281-8A	
TP1~TP5	A9574KP	Test point VTC-1-1	
	A9168KH	Heat sink (3 pcs) MC 245A-2M3	for Q3, U3, U4
	Y9410XH	Stud (2 pcs)	
	Y9406LB	Screw : M4x6 (2 pcs)	
	B9278KM	PWB (1 pc)	



ASSY	B9278JN
PWB	B9278KN

(Dec. 1987)

Figure 5-10a. Power Supply Board Ass'y (for Model 253321): B9278JN Schematic Diagram.



(Dec. 1987)

Figure 5-10b. Power Supply Board Ass'y (for Model 253321): B9278JN Components Location Diagram.

5-10. Power Supply Board Ass'y (for Model 253321): B9278JN.

(Dec. 1987)

Item	Part No.	Part Name and Description					Remarks
R1	A9065RG	Res: fxd met flm	4.7kΩ	±1%	¼W	LF¼ 4.7kΩF	
R2	A9270RV	Res: var cermet	500Ω	±20%	¼W	GF06X1 500Ω	
R3	A9065RG	Res: fxd met flm	4.7kΩ	±1%	¼W	LF¼ 4.7kΩF	
R4	A9045RG	Res: fxd met flm	680Ω	±1%	¼W	LF¼ 680ΩF	
R5	A9113RG	Res: fxd met flm	470kΩ	±1%	¼W	LF¼ 470kΩF	
R6	A9073RG	Res: fxd met flm	10kΩ	±1%	¼W	LF¼ 10kΩF	
R7	A9079RG	Res: fxd met flm	18kΩ	±1%	¼W	LF¼ 18kΩF	
R8	A9080RG	Res: fxd met flm	20kΩ	±1%	¼W	LF¼ 20kΩF	
R9	A9097RG	Res: fxd met flm	100kΩ	±1%	¼W	LF¼ 100kΩF	
R10	A9009RG	Res: fxd met flm	22Ω	±1%	¼W	LF¼ 22ΩF	
R11	A9049RG	Res: fxd met flm	1kΩ	±1%	¼W	LF¼ 1kΩF	
R12	A9033RG	Res: fxd met flm	220Ω	±1%	¼W	LF¼ 220ΩF	
R13~R15	A9065RG	Res: fxd met flm	4.7kΩ	±1%	¼W	LF¼ 4.7kΩF	
R16	A9085RG	Res: fxd met flm	33kΩ	±1%	¼W	LF¼ 33kΩF	
R17	A9506RA	Res: fxd ww	0.1Ω	±10%	2W	ERW-2PKR10	
R18~R20							not assigned
R21	A9061RG	Res: fxd met flm	3.3kΩ	±1%	¼W	LF¼ 3.3kΩF	
R22	A9079RG	Res: fxd met flm	18kΩ	±1%	¼W	LF¼ 18kΩF	
R23	A9076RG	Res: fxd met flm	13kΩ	±1%	¼W	LF¼ 13kΩF	
R24	A9101RG	Res: fxd met flm	150kΩ	±1%	¼W	LF¼ 150kΩF	
R25, R26	A9025RG	Res: fxd met flm	100Ω	±1%	¼W	LF¼ 100ΩF	
R27	A9101RG	Res: fxd met flm	150kΩ	±1%	¼W	LF¼ 150kΩF	
R28~R30							not assigned
R31	A9051RG	Res: fxd met flm	1.2kΩ	±1%	¼W	LF¼ 1.2kΩF	
R32	A9073RG	Res: fxd met flm	10kΩ	±1%	¼W	LF¼ 10kΩF	
R33	A9037RG	Res: fxd met flm	330Ω	±1%	¼W	LF¼ 330ΩF	
R34	A9001RG	Res: fxd met flm	10Ω	±1%	¼W	LF¼ 10ΩF	
R35	A9060RG	Res: fxd met flm	3kΩ	±1%	¼W	LF¼ 3kΩF	
R36	A9049RG	Res: fxd met flm	1kΩ	±1%	¼W	LF¼ 1kΩF	
R37, R38	A9037RG	Res: fxd met flm	330Ω	±1%	¼W	LF¼ 330ΩF	
R39	A9001RG	Res: fxd met flm	10Ω	±1%	¼W	LF¼ 10ΩF	
R40							not assigned
R41	A9055RG	Res: fxd met flm	1.8kΩ	±1%	¼W	LF¼ 1.8kΩF	
R42	A9075RG	Res: fxd met flm	12kΩ	±1%	¼W	LF¼ 12kΩF	
R43	A9077RG	Res: fxd met flm	15kΩ	±1%	¼W	LF¼ 15kΩF	
R44	A9055RG	Res: fxd met flm	1.8kΩ	±1%	¼W	LF¼ 1.8kΩF	
R45	A9075RG	Res: fxd met flm	12kΩ	±1%	¼W	LF¼ 12kΩF	
R46	A9077RG	Res: fxd met flm	15kΩ	±1%	¼W	LF¼ 15kΩF	
R47, R48	A9025RG	Res: fxd met flm	100Ω	±1%	¼W	LF¼ 100ΩF	
R49, R50	A9063RG	Res: fxd met flm	3.9kΩ	±1%	¼W	LF¼ 3.9kΩF	
R51, R52	A9206RK	Res: fxd met flm	0.33Ω	±5%	½W	ERX-12ANJ 0.33Ω	
C1	A9406CA	Cap: fxd Al elect	6800μF	±20%	35V	ECES1VU682M	
C2	A9250CY	Cap: fxd polye flm	0.01μF	±10%	50V	MFL5002-103K	
C3	A9244CY	Cap: fxd polye flm	1000pF	±10%	50V	MFL5002-102K	
C4	A9441CA	Cap: fxd Al elect	22μF	±20%	35V	ECEA1VU220	
C5, C6	A9250CY	Cap: fxd polye flm	0.01μF	±10%	50V	MFL5002-103K	

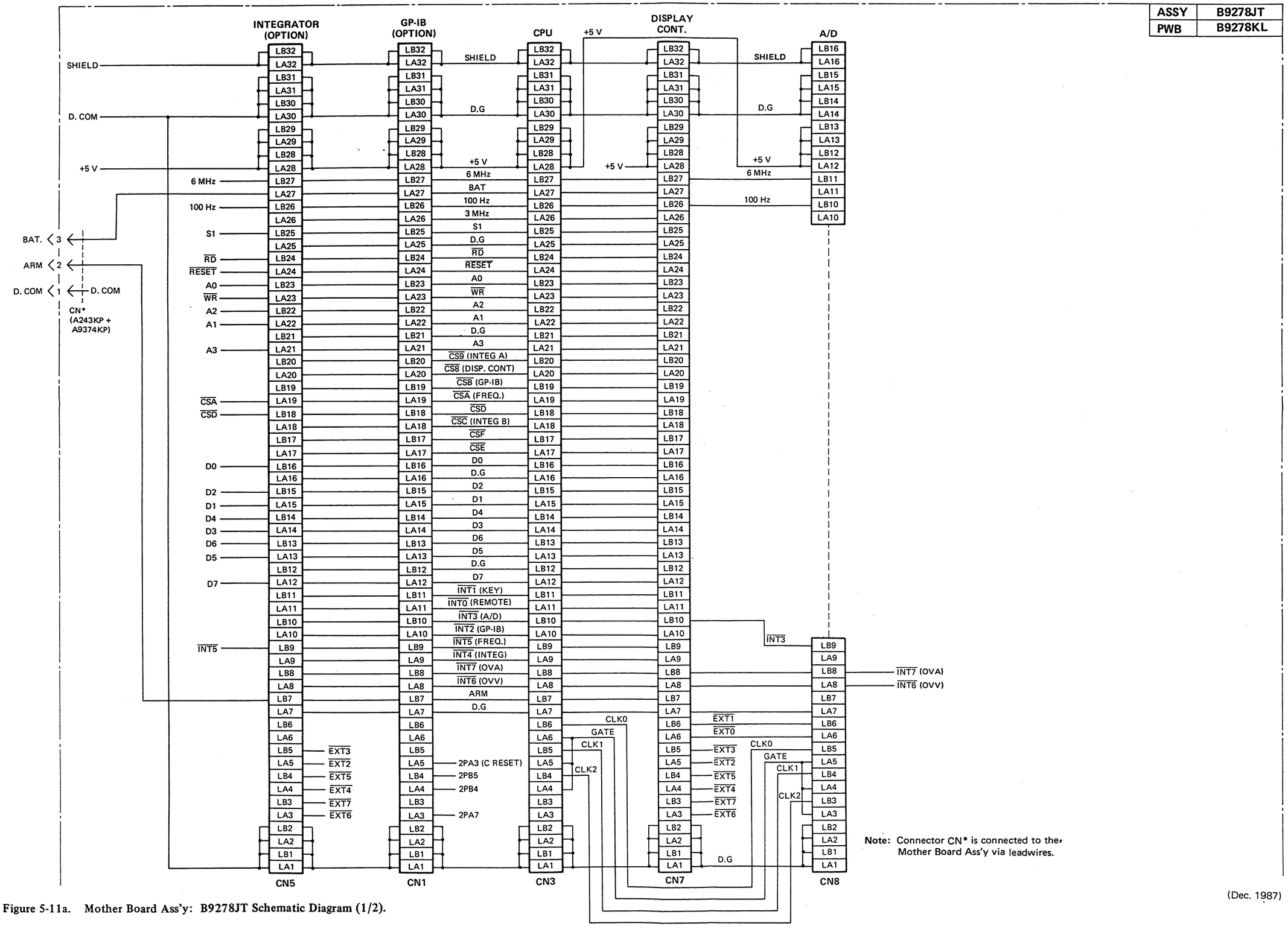
5-10. Power Supply Board Ass'y (for Model 253321): B9278JN. (continued)

Item	Part No.	Part Name and Description	Remarks
C7~C9	A9425CA	Cap: fxd Al elect 2200μF ±20% 25V KME25VB2200	
C10			not assigned
C11	A9248CY	Cap: fxd polye flm 4700pF ±10% 50V MFL5002-472K	
C12, C13	A9245CY	Cap: fxd polye flm 1500pF ±10% 50V MFL5002-152K	
C14	A9449CA	Cap: fxd Al elect 2200μF ±20% 35V ECEA1VU222	
C15	A9445CA	Cap: fxd Al elect 220μF ±20% 35V ECEA1VU221	
C16	A9449CA	Cap: fxd Al elect 2200μF ±20% 35V ECEA1VU222	
C17	A9445CA	Cap: fxd Al elect 220μF ±20% 35V ECEA1VU221	
C18~C20			not assigned
C21, C22	A9445CA	Cap: fxd Al elect 220μF ±20% 35V ECEA1VU221	
C23, C24	A9449CA	Cap: fxd Al elect 2200μF ±20% 35V ECEA1VU222	
C25, C26	A9251CY	Cap: fxd polye flm 0.015μF ±10% 50V MFL5002-153K	
C27, C28	A9418CA	Cap: fxd Al elect 2200μF ±20% 16V KME16VB2200	
C29, C30	A9114CC	Cap: fxd cer 0.1μF 50V RPE132-305F104Z50	
L1	A9084EC	Inductor 100μH 5A SKC-103	
L2, L3	A9043ML	Inductor 10μH 1A AF-012	
L4, L5	A9013ML	Inudctor 26μH 2A SN-8S-300	
D1	A9385HD	Diode: zener S5S3M	5A/30 V
D2	A9115HL	Diode: module 4G4B41	
D3	A9092HL	Diode: module 1G4B41	
D4, D5	A9302HD	Diode: zener RD6.8E-B	
D6, D7	A9150HL	Diode: array MC-931	
D8, D9	A9302HD	Diode: zener RD6.8E-B	
D10	A9392HD	Diode: zener S1S3M	1A/30 V
D11	A9392HD	Diode: zener S1S3M	1A/30 V
D12	A9092HL	Diode: module 1G4B41	
Q1	A9340HQ	XSTR: Si NPN 2SC1815-Y	
Q2	A9338HQ	XSTR: Si PNP 2SA1015-Y	
Q3	A9452HQ	XSTR: Si NPN 2SC2235-Y	
Q4	A9477HQ	XSTR: Si PNP 2SA965-Y	
Q5	A9287HQ	XSTR: Si NPN 2SD1268-P	
Q6	A9477HQ	XSTR: Si PNP 2SA965-Y	
Q7	A9452HQ	XSTR: Si NPN 2SC2235-Y	
Q8, Q9	A9334HQ	XSTR: Si PNP 2SB943-P	
Q10			not assigned
Q11	A9338HQ	XSTR: Si PNP 2SA1015-Y	
Q12	A9340HQ	XSTR: Si NPN 2SC1815-Y	
U1	A9085LA	IC: analog μPC271C	
U2	A9115LA	IC: analog HA17524P	
U3	A9219LA	IC: analog LF412CN	
U4	A9082LA	IC: analog μPC4558C	
U5	A9192LA	IC: analog LA6393D	
U6	A9104LA	IC: +12 V voltage regulator μPC7812H	
U7	A9105LA	IC: −12 V voltage regulator μPC7912H	

5-10. Power Supply Board Ass'y (for Model 253321): B9278JN. (continued)

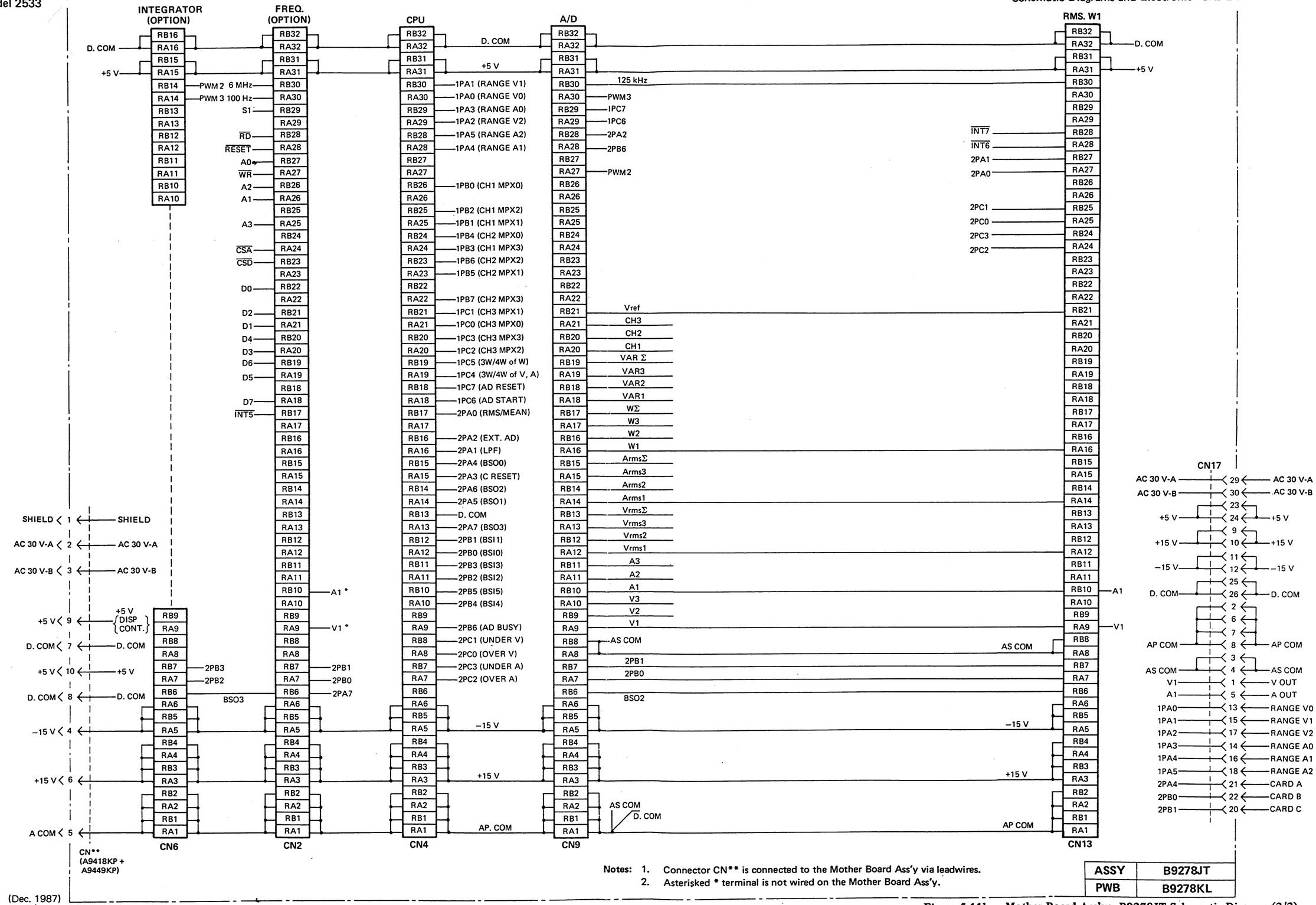
Item	Part No.	Part Name and Description	Remarks
CN1	A9244KP	Conn 5045-03A	3P
CN2	A9447KP	Conn 5281-10A	10P
CN3	A9246KP	Conn 5045-02A	2P
CN4	A9244KP	Conn 5045-03A	3P
CN5	A9462KP	Conn 5281-08A	8P
CN6	A9460KP	Conn 5281-03A	3P
TP1~TP5	A9574KP	Test point VTC-1-1	
	B9278UA	Plate (1 pc)	
	B9278UB	Plate (1 pc)	
	Y9304LS	Screw: M3 X 4 (10 pcs)	
	B9278KN	PWB (1 pc)	

ASSY	B9278JT
PWB	B9278KL



(Dec. 1987)

Figure 5-11a. Mother Board Ass'y: B9278JT Schematic Diagram (1/2).



Notes: 1. Connector CN** is connected to the Mother Board Ass'y via leadwires.
2. Asterisked * terminal is not wired on the Mother Board Ass'y.

ASSY	B9278JT
PWB	B9278KL

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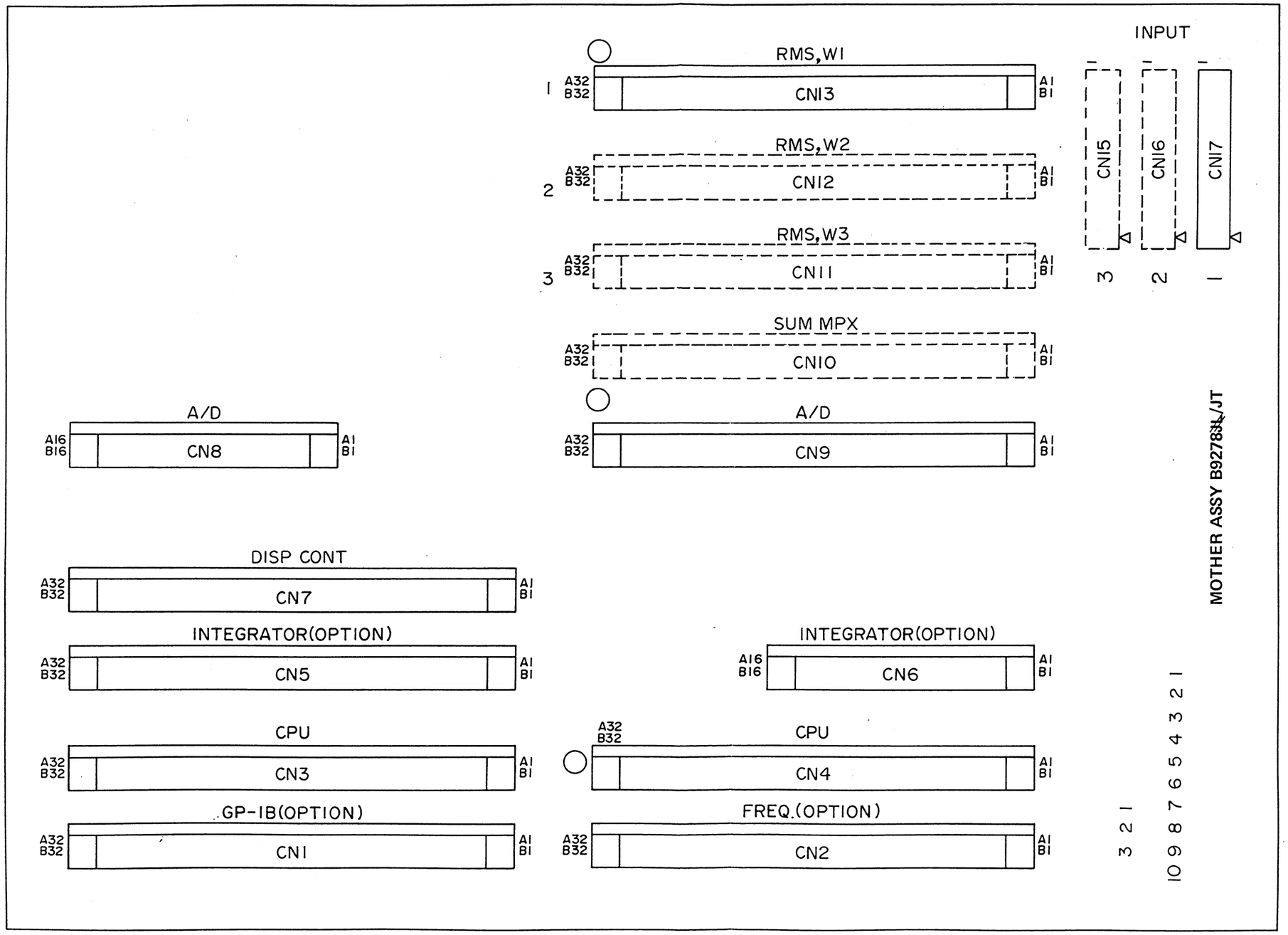
Figure 5-11b. Mother Board Ass'y: B9278JT Schematic Diagram (2/2).



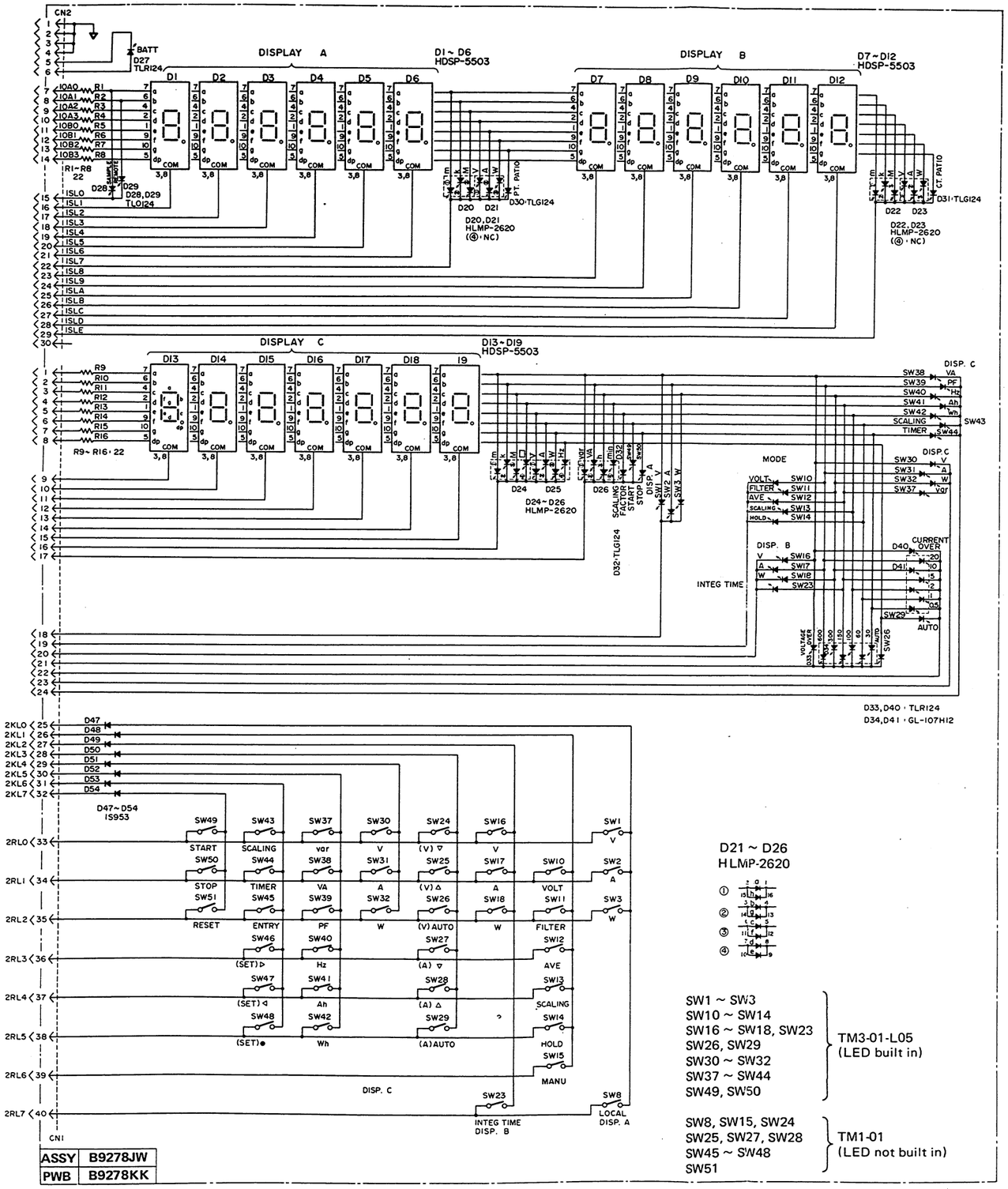
(Dec. 1987)

Figure 5-11c. Mother Board Ass'y: B9278JT Components Location Diagram.

5-11. Mother Board Ass'y: B9278JT.

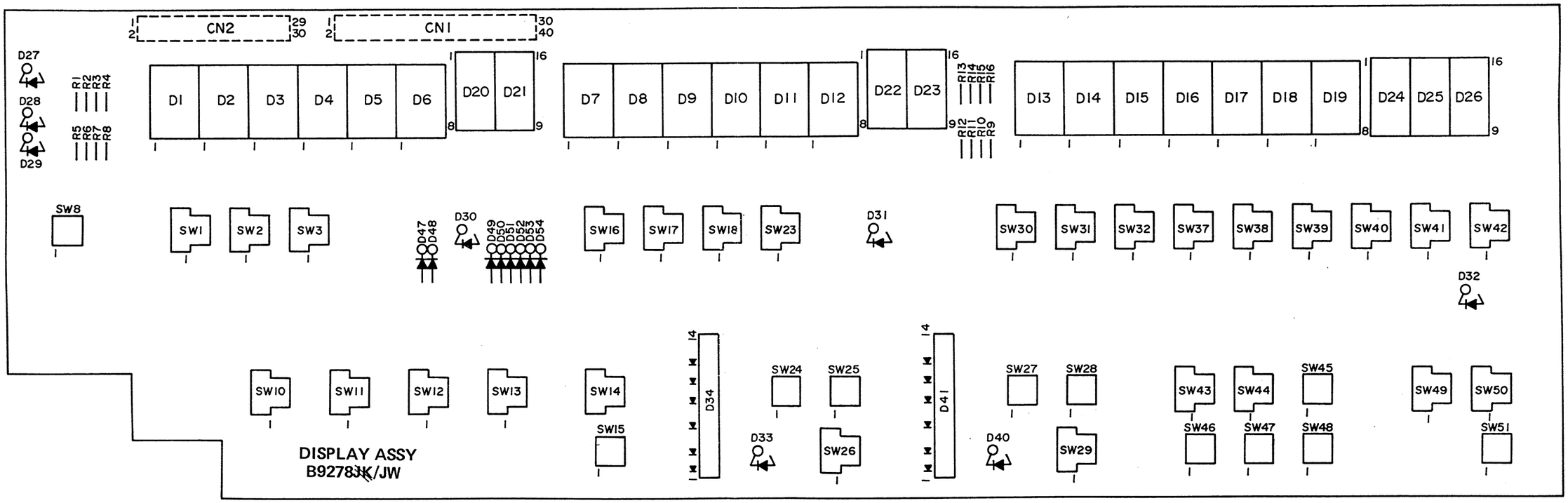
(Dec. 1987)

Item	Part No.	Part Name and Description			Remarks
CN1~CN5	A9710KP	Conn.		PCN10C-64S-2.54DSA	64P
CN6	A9711KP	Conn.		PCN10C-32S-2.54DSA	32P
CN7	A9710KP	Conn.		PCN10C-64S-2.54DSA	64P
CN8	A9711KP	Conn.		PCN10C-32S-2.54DSA	32P
CN9	A9710KP	Conn.		PCN10C-64S-2.54DSA	64P
CN10					not assigned
CN11, CN12					not assigned
CN13	A9710KP	Conn.		PCN10C-64S-2.54DSA	64P
CN14~CN16					not assigned
CN17	A9134KP	Conn.		PS-30PA-D4T1-PN1-K	30P
	A9418KP	Housing	(1 pc)	5197-10	
	A9243KP	Housing	(1 pc)	5051-03	
	A9374KP	Contact	(3 pcs)	5159T	for A9243KP
	A9449KP	Contact	(10 pcs)	5149T	for A9418KP
	B9278KL	PWB	(1 pc)		



(Dec. 1987)

Figure 5-12a. Display Board Ass'y: B9278JW Schematic Diagram.



(Dec. 1987)

Figure 5-12b. Display Board Ass'y: B9278JW Components Location Diagram.

5-12. Display Board Ass'y: B9278JW.

(Dec. 1987)

Item	Part No.	Part Name and Description	Remarks
R1~R10	A9009RG	Res: fxd met flm 22Ω ±1% ¼W LF¼ 22ΩF	
R11~R16	A9009RG	Res: fxd met flm 22Ω ±1% ¼W LF¼ 22ΩF	
D1~D10	A9120HP	Diode: 7 seg. LED HDSP-5503	
D11~D19	A9120HP	Diode: 7 seg. LED HDSP-5503	
D20	A9100HP	Diode: module HLMP-2620	
D21~D26	A9100HP	Diode: module HLMP-2620	
D27	A9099HP	Diode: LED TLR124	red
D28, D29	A9075HP	Diode: LED TLO124	orange
D30	G9037HL	Diode: LED TLG124	green
D31, D32	G9037HL	Diode: LED TLG124	green
D33	A9099HP	Diode: LED TLR124	red
D34	A9119HP	Diode: module GL-197H12	yellow
D35~D39			not assigned
D40	A9099HP	Diode: LED TLR124	red
D41	A9119HP	Diode: module GL-107H12	yellow
D42~D46			not assigned
D47~D50	A9248HD	Diode: Si 1S953	
D51~D54	A9248HD	Diode: Si 1S953	
SW1~SW3	A9204SP	Sw: push TM3-01-L05	
SW4~SW7			not assigned
SW8	A9203SP	Sw: push TM1-01	
SW9			not assigned
SW10	A9204SP	Sw: push TM3-01-L05	
SW11~SW14	A9204SP	Sw: push TM3-01-L05	
SW15	A9203SP	Sw: push TM1-01	
SW16~SW18	A9204SP	Sw: push TM3-01-L05	
SW19, SW20			not assigned
SW21, SW22			not assigned
SW23	A9204SP	Sw: push TM3-01-L05	
SW24, SW25	A9203SP	Sw: push TM1-01	
SW26	A9204SP	Sw: push TM3-01-L05	
SW27, SW28	A9203SP	Sw: push TM1-01	
SW29, SW30	A9204SP	Sw: push TM3-01-L05	
SW31, SW32	A9204SP	Sw: push TM3-01-L05	
SW33~SW36			not assigned
SW37~SW40	A9204SP	Sw: push TM3-01-L05	
SW41~SW44	A9204SP	Sw: push TM3-01-L05	
SW45~SW48	A9203SP	Sw: push TM1-01	
SW49, SW50	A9204SP	Sw: push TM3-01-L05	

5-12. Display Board Ass'y: B9278JW. (continued)

Item	Part No.	Part Name and Description	Remarks
SW51	A9203SP	Sw: push TM1-01	
CN1	A9266KP	Conn PS-40PA-D4T1-PN1-K	40P
CN2	A9134KP	Conn PS-30PA-D4T1-PN1-K	30P
	B9278FP	Spacer (2 pcs)	
	B9278FQ	Spacer (1 pc)	
	B9278KK	PWB (1 pc)	

Instruction Manual

Model 2533
Digital Power Meter
Service Manual

Supplement

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YOKOGAWA
Yokogawa Electric Corporation

FD No. T and M 10003-R-J(UP)

IM 2533-01Es

WARNING

These servicing instructions are for use by trained service personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

SELF TEST

Refer to the Instruction Manual (Self Test on Power ON and Item 4 References) for the information of system architecture, version number of software and error code on power ON.

ROM VERSION

		April 4 1986	July 24 1986
Mount CPU A'ssy (B9278KJ)	Part No. U14 (B9278NA)	VER 1.01	___
	Part No. U14 (B9278NB)	___	VER 2.00
	Part No. U15 (B9278NC)	___	VER 2.00
Instrument Code		25331□	25331□
Optional features	/GP-IB	○	○
	/FRQ	×	○
	/INTEG	×	○
	/RS232C	×	×
Display of version		1.01	2.00

		October 30 1987
Mount CPU A'ssy (B9278KJ)	Part No. U14 (B9278NH)	VER 1.00
	Part No. U1 (B9278NJ)	VER 1.00
	___	___
Instrument Code		25332□
Optional features	/GP-IB	○
	/FRQ	○
	/INTEG	○
	/RS232C	○
Display of version		1.00

Note : Version 2.00 is due to the addition of optional features (/FRQ & /INTEG).

1. ADJUSTMENT MANUAL

1.1 Scope

This manual covers the adjustment of Digital Power Meters
253311, 253312 and 253313 (AC input type).
253321, 253322 and 253323 (DC/AC input type).

1.2 Standard Conditions

Overall adjustment and inspection should be conducted under the following conditions :

- **Temperature** : 23±3°C (73±5°F)
- **Humidity** : 45 to 75% (Relative Humidity)
- **Power** : 115V±3 V (50/60 Hz) (sine wave input)
- **Heat run** : In order to stabilize the temperature inside the equipment, adjustment shall be carried out after a warm-up of at least 30 minutes.

All adjustments are made in the TEST MODE. This setting is to be made when main power is OFF. Remove cover of unit, locate CPU Card - Switch 1. Turn Bit 3 ON, all others off until instructed otherwise.

1.3 Standard Equipment for Adjustments

- **AC voltage standard** : FLUKE Model 5200A ±0.01%
- **Booster** : FLUKE Model 5215
- **AC current standard** : FLUKE Model 5200A ±0.01%
- **Booster** : FLUKE Model 5220
- **Standard wattmeter** : YOKOGAWA Model 288520 ; (10 to 3 kHz) ±0.02%
- **2-phase oscillator** : HP Model 3326A ; FRQ accuracy: Less than 0.01%
  Resolution: 0.01 deg.
- **Digital multimeter** : YOKOGAWA Model 2502 ; ±0.01%
- **DC voltage standard** : YOKOGAWA Model 2552 ; ±50 ppm

2. DISPLAY, KEYBOARD, AND DIGITAL FUNCTION INSPECTIONS

2.1 Conditions

Tests and adjustments should only be conducted when the following assemblies are installed:

Power Supply	:	B9278CE (AC input type)
Do.	:	B9278CN (DC/AC input type)
Mother Assembly	:	B9278JL
CPU Assembly	:	B9278JJ
Display Controller	:	B9278JH
A/D Assembly	:	B9278JD or JV
Display Assembly	:	B9278JK or JW

If unit is equipped with Integrator Board (B9278JS), this board must be removed for the following tests.

Display controller assembly and display assembly are connected with 2 cables.

Use TEST MODE. Turn power OFF, locate CPU Board and Switch 1. Turn Bit 3 ON, all others off, and turn main power ON.

2.2 Items to be Checked

(a) Keyboard Switches
(b) LED
(c) Battery Lamp
(d) Battery Back-up
(e) A/D Start
(f) DIP Switches

(a) Check Keyboard Switch

Press LOCAL switch once to display 2 Dash Marks in Display C. Ignore Display A and B. See Drawing of Front Panel - Page 3a of this manual. As you press each key, the corresponding number will appear in Display C.

(b) Check LED

Press LOCAL switch again. All LED's in all displays will be illuminated and will count up from 0-9. Decimals will sequence right to left. Indicator lamps for keyboard switches will sequence. When all LED's, lamps, have been verified in operating condition, press LOCAL again to continue with procedure.

(c) Check Battery Lamp

With main powr ON, remove battery from rear compartment and check to see that battery LED lights. Reinstall battery and verify that battery LED extinguishes.

(d) Check Battery Back-up for Panel Settings

In normal operation this unit has various DEFAULT settings when power is turned on. These DEFAULT settings are :

Sample light - flashing
Display A - Function V Element 1
Display B - Function A Element 1
Display C - Function W Element 1
Mode - Wiring 3 phase 3 wire Volt RMS
Voltage Range - 600 V - Auto Range OFF
Current Range - 20 A - Auto Range OFF

To verify battery backed-up panel settings, change any of these DEFAULT settings and turn main power OFF. Wait a few seconds, turn main power ON and verify the changes you made are still valid.

(e) Check A/D Start

Push LOCAL to show all zero in Display B and two dashes in Display C.

For this test, prepare a 36 pin mating connector for the Remote Control/Analog Output connector on the rear panel.

Ground the A/D Start terminal (pin 21) to ANALOG COM. (pin 10). Check that Display B changes from 000000 to 000001.

(f) Check for DIP Switch Operation

Locate Switch 1 on CPU Board. Verify all Bits are <u>off</u> except Bit 3 which is <u>on</u>.

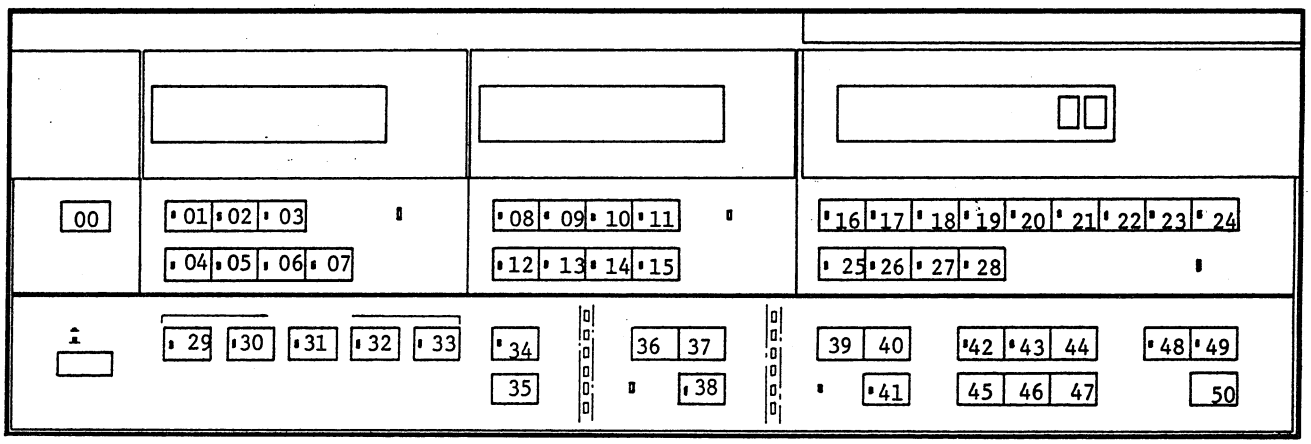
Read DISPLAY A, left most LED as each Bit is turned on, then off, as in following chart.

Bit Number	Display A
1	1XXX
2	2XXX
3	4XXX
4	8XXX

XXX don't care

(3)

To Use in Case of DIP Switch Setting, etc.



This completes Front Panel Function TEST.

Restore Bit 3 Switch 1 on CPU Board to off.

3. POWER SOURCE ADJUSTMENT AND CHECK

This test is made on the Power Supply Assembly (B9728JM) which is located on the left side (from front) behind Display board. MAIN power switch ON.

3.1 Check for ±15 V Power (AC input type)

(1) Connect DMM "L" side to the A. GND (TP4) and the DMM "H" side to +15 V (TP3) and read the display +15 V ± 0.5 V.
(2) Connect the DMM "H" side to −15 V (TP5), "L" side to A. GND (TP-4) and read the display −15 V ± 0.5 V.

3.2 Power +5.03 V Adjustment

(1) Connect DMM "L" side to the D.GND (TP1), and the DMM "H" side to +5 V (TP2). Adjust R16 and read 5.030 V ± 0.005 V.

3.3 Check for ±15 V (for both AC and DC/AC Models)

(1) Connect digital multimeter (DMM) "L" (low) terminal to A-COM (TP3) and "H" (High) terminal to +15 (TP1). Check that the DMM displays +15 ±0.5V.
(2) Connect DMM "H" (High) terminal to −15 V (TP2) and check that the DMM displays −15 ± 0.5 V.

3.4 Power +5 V Adjustment

Connect DMM L (Low) terminal to D-COM (TP5) and H (High) terminal to +5 V (TP4), and adjust R2 so that DMM displays +5,000 ± 0.005 V.

4. A/D ASSEMBLY ADJUSTMENT

Turn power OFF, remove MPX Board (B9278JC) and all RMS Boards (up to 3 depending on model) (B9278JB) and all ribbon cables which connect AC inputs to Mother Board (B9278JL) at connectors CN15, CN16, CN17.

4.1 Sample Lamp Check

Turn on MAIN Power and check to see that Sample light flashes on upper left front panel. Make sure the **SAMPLE HOLD SWITCH** on front panel is **OFF**. Using a stop watch, verify the flashes on the SAMPLE light occur every 0.4 seconds.

4.2 Reference Voltage Adjustment

Test is performed on A/D Board B9278JD.

Using DMM, connect "L" side to A.COM (TP5) and Ref. voltage (TP4) (4.93V) and turn adjuster R35 (V Ref) so that the display indicates 4.980 V ± 0.001 V.

4.3 Zero Adjustment (A/D Board B9278JD)

With main power ON, and using jumper leads, connect A.COM (TP5) to CH1 (TP1), CH2 (TP2) and CH3 (TP3). Reading results in the Display A, B, and C of the Power Meter (2533), turn adjuster R30 (zero) for CH1, adjuster R32 (zero) for CH2, and adjuster R34 (zero) for CH3 to read 0 ± 1 digit in Display A (CH1), Display B (CH2), and Display C (CH3) respectively.

4.4 Full Scale Adjustment (A/D Board B9278JD)

Connect the DC Calibrator output ("H" side) to CH1 (TP1), CH2 (TP2), and CH3 (TP3) in parallel. Connect "L" side of calibrator to A.COM (TP5). Set output to 5.000 V DC and turn adjuster (s) R29 (F.S.) for CH1, R31 for CH2, and R33 for CH3 to show +20000 ± 2 digits in Display A, B and C respectively.

5. RMS ASSEMBLY ADJUSTMENT INSTRUCTIONS

5.1 Preparation

Turn main power OFF and install RMS Board(s) into their appropriate slots. In the case of ; Model 253311, only one RMS Board is used, Model 253312, two boards, and Model 253313, three boards. For polyphase you must also install MPX Board.

RMS Board B9278JB-1, 2, 3 in slots right to left respectively.

MPX Board B9278JC in respective slot.

Do not connect ribbon cables from AC Input at this time.

Adjustment is to be carried out in the TEST MODE. Locate CPU Board Switch 1 and turn **on** Bit 3.

All readings are displayed on POWER METER Display A.

The following steps 5.2 (1) thru (12) refer to the adjustment of **one** RMS Board. You must repeat these steps according to the number of RMS Boards in your unit.

When adjusting RMS Board #1, DISPLAY A Element 1 must be used. For RMS Boards 2, and 3, select Display A, Elements 2, and 3, respectively.

5.2 A RMS, V RMS, and V MEAN Adjustment

(1) Connect AC Calibrator output"L" to S.COM (TP2) and output "H" to V.IN (TP3) and A.IN (TP-4). Use jumper between TP3 and TP4. Turn main power ON.

(2) Set AC Calibrator to 0.1 Vrms (60Hz).

NOTE :For all following adjustments refer to Board Components Layout Figure 5-36 - RMS Assembly B9278JB in your Operators Manual.

(3) Arms Zero (ZR) Adjustment.

Set Display A to Function AMPS, turn adjuster R102 to show 2000 ± 5 digits in display.

(4) Vrms Zero (ZR) Adjustment

Set Display A to Function VOLTS and **MODE** to **RMS**.

Turn adjuster R82 to show 2000 ± 5 digits on the display.

(5) Vmean Zero (ZR) Adjustment

Select **MODE - MEAN** and turn adjuster R41 to show 2000 ±5 digits on the display.

(6) Set AC Calibrator output to1.0 Vrms (60Hz).

(7) Arms Full Scale (FS) Adjustment

Set Display A for function AMPS.

Turn adjuster R101 to show 20000 ±4 dights on the display.

(8) Vrms Full Scale (FS) Adjustment

Set Display A for Function VOLTS, **Mode - RMS**.

Turn adjuster R81 to show 20000 ±4 digits on the display.

(9) Vmean Full Scale (FS) Adjustment

Set Display A for Function VOLTS, **Mode - MEAN**. Turn adjuster R42 to show 20000 ± 4digits on the display.

(10) Set AC Calibrator output to 0.1 Vrms (60Hz).

(11) Zero (ZR) Re-Adjustment

Using function/mode keys, read Vrms, Vmean and Arms in Display A, one at a time, and verify that all read 2000 ±2 digits for each setting. If not, refer to steps (3), (4) and (5) and readjust as needed.

(12) If re-adjustment of zero (ZR) in Step (11) was performed, repeat full scale (FS) adjustment as shown in steps (6) to (11). Readings must be as follows:

INPUT	ARMS	VRMS	VMEAN
0.1 Vrms	2000 ± 2	2000 ± 2	2000 ±2
1.0 Vrms	20000 ± 4	20000 ± 4	20000 ± 4

5.3 Watt (W) Adjustment - RMS Boards

These adjustments are performed on RMS Board(s) B9278JB.

(1) Connect **DC** Calibrator output "L" to S.COM (TP2) and output "H" to V.IN (TP3). Jumper S.COM (TP2) to A.IN (TP4).

(2) Zero (ZR) Adjustment

When DC calibrator output is ZERO, turn adjuster R4 (ZR) to show 00000 ±2 digits on Display A, Function W (Watts), Element 1 for RMS Board 1. Repeat for elements (RMS Boards 2 and 3).

(3) A Balance Adjustment

Set A.BAL (R3) to approximately 00000 on Display A, Function W (watts), Element 1. Select DC Calibrator outputs of +1.5 V DC and −1.5 V DC alternately. Turn adjuster A.BAL (R3) to raes ± digit on display according to polarity of DC calibrator output. Repeat on other RMS Boards and Elements 2 and 3 respectively.

(4) Connect DC Calibrator output "L" to S.COM (TP2) and output "H" to A.IN (TP4). Jumper S.COM (TP2) to V.IN (TP3).

(5) V. Balance (BAL) Adjustment

Set V.BAL (R2) so that Display A Function W, Element 1 reads 00000. Select DC Calibrator outputs of +1.5 V DC and −1.5 V DC alternately and turn adjuster V.BAL (R2) to show a change of ±1 digit on the display. Also check the **absolute** value on the display is less than ±20 digits. Repeat for all RMS Boards/Elements in your unit.

(6) Connect AC Calibrator output "L" to S.COM (TP2) and "H" output to V.IN (TP3). Jumper V.IN (TP3) and A.IN (TP4) together.

(7) Full scale (FS) Adjustment

Set AC Calibrator output to 1 Vrms (60Hz) and turn adjuster FS (R-1) to show 20000 ±4 digits on Display A, Function W, Element 1. Repeat for other RMS Boards/Elements.

(8) Frequency (F) characteristics adjustment

Set AC Calibrator output to 1Vrms, 20KHz, and turn adjuster Cl to show 20000 ± 10 digits on Display A, Function W, Element 1. Repeat for RMS Boards/Elements in your unit. When finished, turn Bit 3, Switch 1 on CPU OFF.

6. AC INPUT ASSEMBLY ADJUSTMENT INSTRUCTIONS

6.1 Preparation

Turn off main power - disconnect all leads. Connect AC Input assembly(s) to the Mother Board with Ribbon Cables disconnected earlier. Green Trace on Ribbon corresponds with △ index on Mother Board connector. Remove black plastic guard covering AC Input Modules.

6.2 Current Input Zero Adjustment

(1) Turn on main power to unit. Connect DMM "H" input to A (TP3) and "L" input to S.COM (TP2). Set Power Meter Range (AMPS) to 5 A. Turn adjuster R5 to set voltage between TP2 and TP3 to be within ± 0.05 mV DC.

(2) Holding that state select each range from 0.5 A to 20 A in order to check that the voltage is less than ± 0.0 5mV DC.

(3) Repeat steps (1) and (2) for each remaining AC Input Assemblies.

6.3 Voltage Input Zero Adjustment

(1) With the Voltage Input Terminals shorted (rear panel of 2533) and the Voltage Range set to 100 V, connect the DMM input "H" to TP1 and input "L" to input voltage terminals. Turn adjuster R56 to set voltage to be less than 0.1 mV DC.

(2) Holding that state select Input Ranges 30 V-600 V to check that the voltage reading on DMM is less than 0.5 mV DC in each range.

(3) Repeat steps (1) and (2) for each additional AC Input Assembly. When finished remove short from voltage terminals.

6.4 Voltage Input Full Scale (FS) Adjustment

This adjustment is carried out in TEST MODE ; Bit 3 of Switch 1 on CPU is turned ON.
Read results in Display A. Set Function to V and Element 1.

(1) Set Range to 60 Volt Range apply 60 V (60 Hz) to Voltage input terminals - Element 1 - (rear input connections). Turn adjuster "L" (R55) to show 20000 ±1 on Display A.

(2) Set Range to 100 Volt Range. Apply 100 V (60 Hz) and turn adjuster "H" (R60) to show 20000 ± on Display A.

6.5 Voltage Input Frequency Adjustment

(1) 100 Volt Range : Apply 100V (20 kHz) and turn adjuster R61 to show 20000 +50 digits on Display A.

(2) Leave range set to 100V and set input to 100V (6 kHz) and verify the value is 20000 +50 digits on Display A.

6.6 Repeat For Each Additional Element

Repeat Steps 6.4 and 6.5 for each additional element in your unit. Read results on DISPLAY A, Function V and Elements 2 and 3 according to which element is being adjusted.

6.7 Current Range Adjustment

Connect AC Current Standard to current Input Terminals of Element 1. Set Display A for Function A (AMPS) and Element 1.

(1) Apply 2 A (60 Hz) on 2 A Range and turn adjuster R3 (L) of the AC Input Assembly to show 20000 ±4 digits in display A.

(2) Apply 5 A (60 Hz) on 5A Range and turn adjuster R4 (H) of AC Input Assembly to show 20000 ±4 digits on Display A.

(3) Repeat steps (1) and (2) for each element in your unit remembering to select Display A, Element 2 or 3 depending on which one is under test.

7. POWER RANGE ADJUSTMENT

(1) Set Display A to W1, Display B to W2, and Display C to W3. Set measuring ranges to 100 V and 1 A. Verify the displays read 00000 ±3 digits. If not, turn adjuster R4 (ZR) of the appropriate RMS Assembly to show 00000 ±3 digits.

(2) Leave W1, W2, W3 settings in Displays A, B and C respectively, apply 100V, 1A (60Hz) and $\cos\phi = 1$ with ranges set at 100 V, 1 A and turn adjuster R1 (FS) of each RMS Assembly to show 20000 ±4 digits on the display. If your unit is a multiple element version (−12, −13), the single phase voltage and current standards should be connected with voltage elements in parallel and current elements in series. (See drawing - page 13 of this manual.)

Note : This concludes all adjustments for the measuring and display of Volts, Amps and Watts. If your unit contains one or more of the following options, proceed with steps 8, 9, and 10.;

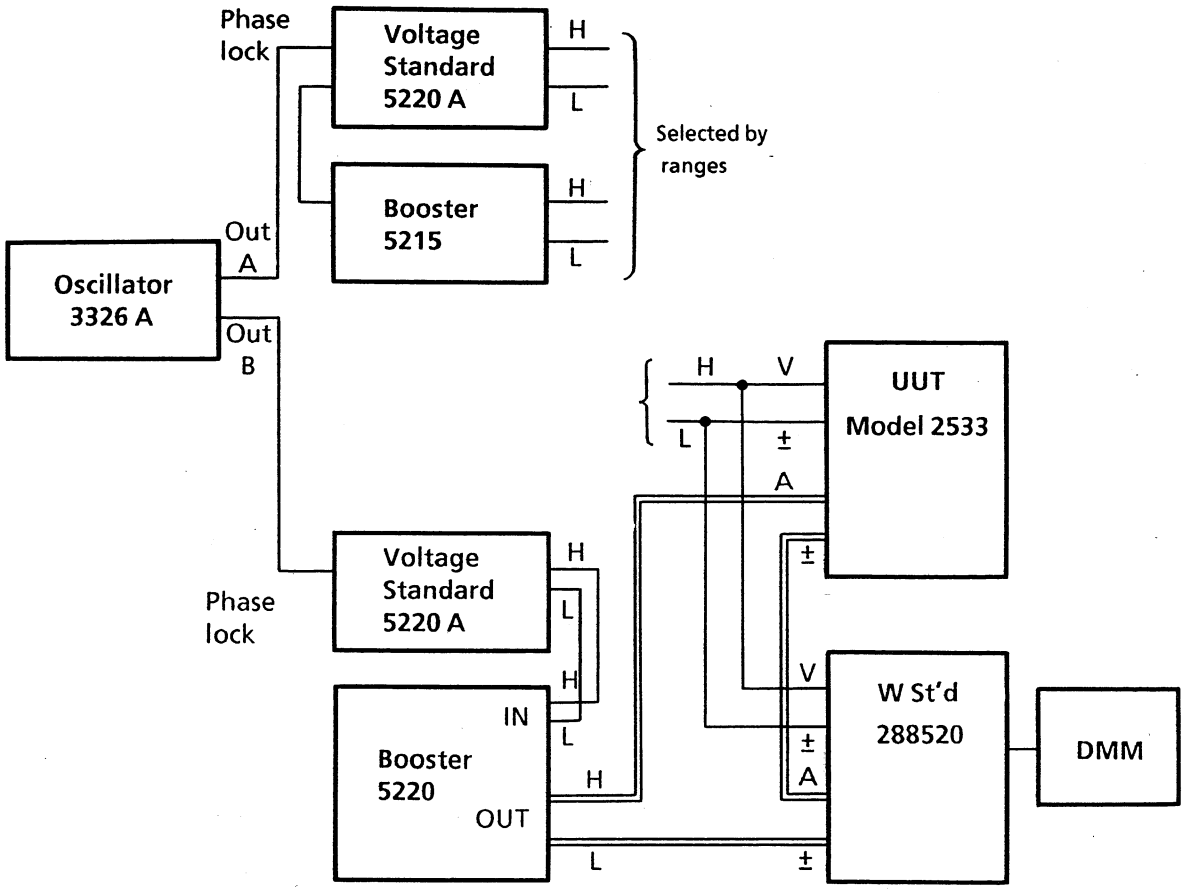
(1) Frequency Measuring Option

(2) Integrator

(3) GP-IB

If none of the above options are present, locate switch 1 on CPU Board and turn BIT 3 **OFF**. Proceed to step 11 to complete ranging and linearity tests on the unit.

- **Standard Equipment Connection Method AC Characteristics**

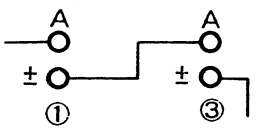


3-phase Type Connection

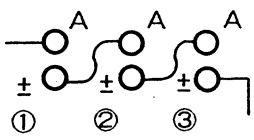
For voltage : (V) parallel each other

(±) parallel each other

For current,
3-phase 3 wire



3-phase 4 wire



8. DC INPUT ASSEMBLY ADJUSTMENT PROCEDURES

8.1 Preparation

To adjust the DC input assembly, use the digital power meter that its RMS assembly is already adjusted. Adjust the Meter DC input assembly in TEST mode (DIP switch 3 ON on CPU assembly, B9278CM).

8.2 Initial Setting

(1) Before turning ON the power, turn ON SW3 on the sub-board (B9278JE).

(2) Set trimmer and rotary switch in the center of rotary switch.

8.3 Voltage Input Assembly and Preamplifier Zero Adjustment

With the meter range set to 60 V and input in short-circuited status, turn R11 until the voltage between COM (TP2) and TP1 is within ±20 μV.

8.4 Current Output Amplifier Zero Adjustment

Set the meter range 5 A and leave input terminals disconnected, turn R38 to obtain that the voltage between COM (TP8) and TP6 is ±50 μV.

8.5 Transformer Damping Adjustment

Set the meter to 60 mV range and the input voltage to 6 V (at 300 kHz), adjust R12 so that the meter displays 2800 ±50 digits.

8.6 Linearity Adjustment

Set the meter to 60 V range, apply a 60 V input signal and observe the display. Next apply a 30 V input signal and observe whether the display is 1/2 ±1 digit of that when the 60 V input signal was applied. If the display is beyond the limits specified, adjust R33 so that the desired voltage linearity is obtained.

8.7 Voltage Characteristics

Set the meter to 60 V AC range and apply a 60 V AC input signal whose frequency is 1 kHz to the meter. Observe the display. Next apply a 60 V AC input signal whose frequency is 60 Hz and observe the display. Adjust R35 so that the display when 1 kHz input was applied is within ±1 digit of that when 60 Hz input was applied.

8.8 Voltage Span Adjustment

(1) Set the meter to 60 V range and apply a 60 V input signal whose frequency is 60 Hz. Adjust R8 so that the meter displays 20000 ±1 digits.

(2) Set the meter to 100 V range and apply a 100 V input signal whose frequency is 60 Hz. Adjust R7 so that the meter displays 20000 ±1 digits.

8.9 Current Characteristics

(1) Set the meter to 5 A range and apply a 5 A input signal whose frequency is 60 Hz. Next apply a 5 A input signal whose frequency is 2 kHz and observe the display. Adjust R31 so that the display when the input whose frequency is 60 Hz was applied is −10 ±1 digits of that when the input whose frequency was 2 kHz.

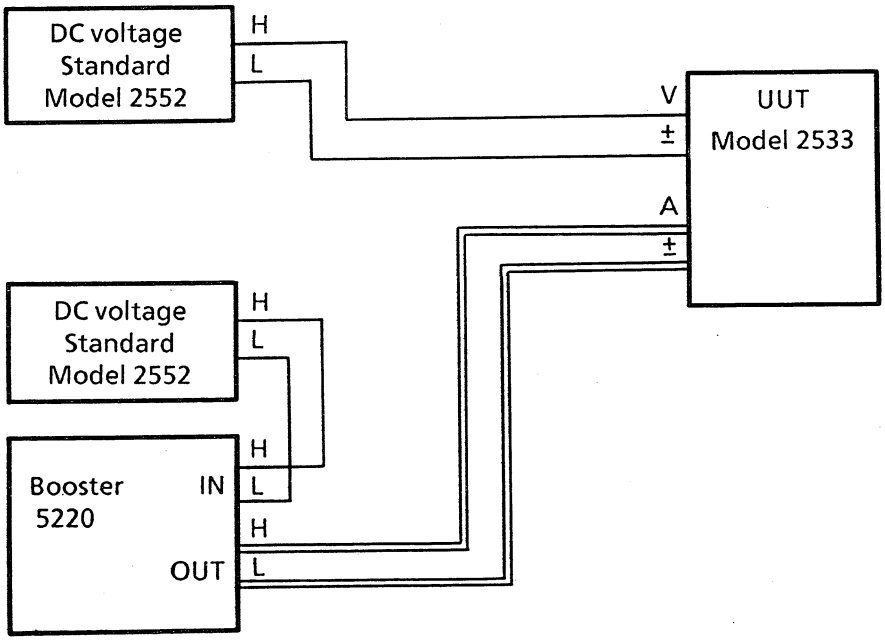
(2) Set the meter to 5 A range, apply a 5 A input signal whose frequency is 300 Hz, and observe the display. Next apply a 5 A input signal whose frequency is 60 Hz, and observe the display. Adjust R39 so that the display when the input whose frequency is 300 Hz was applied is within ±1 digit of that when the input whose frequency is 60 Hz was applied.

8.10 Current Span Adjustment

(1) Set the meter to 2 A range and apply a 2 A input signal whose frequency is 60 Hz. Adjust R36 so that the meter displays 20000 ±1 digits.

(2) Set the meter to 20 A range and apply a 20 A input signal whose frequency is 60 Hz. Adjust R37 so that the meter displays 20000 ±1 digits.

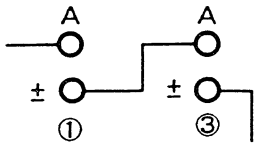
- DC/AC Characteristics



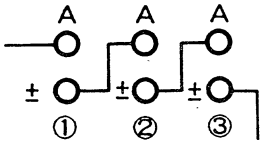
3-phase type connection

For voltage : (V) parallel each other
(±) parallel each other

For current: 3-phase 3-wire



3-phase 4-wire



9. CHECK FREQUENCY ASSEMBLY DIP SWITCH (OPTIONAL)

If your unit is equipped with the Frequency Option, proceed with this step.

(1) Disconnect AC Voltage and Current Standards.

(2) Verify Bit 3 on CPU Board. Switch 1 is ON.

(3) Press LOCAL key for Key Test Mode. If your unit contains the Integrator Option Board, you must press LOCAL key once, wait till Display C stops counting then press LOCAL key again to read Display B.

(4) Locate Dip Switch on Frequency Board. Turn each Bit ON and verify reading in Display B according to the following chart;

Bit Number	Display B
1	01XXXX
2	02XXXX
3	04XXXX
4	08XXXX

Note : X ... don't care

Note: If your unit is equipped with the Optional Integrator or GP-IB, proceed with steps 9 and 10. If not, set Bit 3 on CPU Board. Switch 1 to OFF and proceed to step 11.

10. INTEGRATOR ASSEMBLY ADJUST-MENT METHOD (OPTIONAL)

10.1 Internal Counter Test

Verify that Bit 3 on CPU Switch 1 is ON.

If your unit is a polyphase, then set W1 in display C. With V and A inputs at zero, and input ranges set to 100 V, 2 A, check to see that Display C shows −00005 to +00005.

Press LOCAL key for the Counter Test Mode. Verify that the value in Display C increases by one digit per second to show the following displays.

DISPLAY	DESCRIPTION	DISPLAYED VALUE
A	Upcounter	16E5XX (16) to 16E1XX (16)
B	Downcounter	16E5XX (16) to 16E1XX (16)
C	Timer Counter	00010

10.2 Dip Switch Check

Press LOCAL key for the Key Test Mode.

Turn each Bit on the Dip Switch-Integrator Board- ON then OFF and check the following chart with the values in Display B.

Bit Number	Display B
1	XX01XX
2	XX02XX
3	XX04XX
4	XX08XX

Note : X ... don't care

10.3 D/A Converter Adjustment

The test results for this procedure are measured at the rear connector for the Integrator Board. Connect the DMM "H" side to PIN 7 (analog OUT) and "L" side to PIN 6 (Analog Common).

Switch 1 Bit 1	Switch 1 Bit 2	D/A Output	Note
OFF	OFF	0.000 V ± 0.5 mV	Turn R23
OFF	ON	5.000 V ± 1 mV	Turn R24 (FS)
ON	OFF	−5.000 V ± 2 mV	Check − (FS)

Integrator Test is complete. Return all BITS on Switch 1 (Integrator Board) to OFF. Disconnect DMM. If you **do not** have the GP-IB Option, return BIT 3 on CPU Switch 1 to OFF position and proceed to Step 11.

11. GP-IB FUNCTION (OPTIONAL)

If you have completed the Frequency and Integrator Tests, your unit is in the proper test mode. If not, verify that BIT 3 of CPU Switch 1 is **ON**. Press LOCAL switch on front panel to put unit is TEST MODE:

Display A should read 40XX

Display B should read 000000

Display C should read XXXX− −

Read all results of this test in Display A.

Address-rotate switch on rear panel to read 0 − F in Display A.

XXXX0__

Addressable Address 0 − F

Talk only: 2

Addressable/Talk Only − move toggle switch on and off to indicate 0 or 2 in Display A.

The address for GP-IB is held "1" at shipment and the mode is held ADDRESSABLE (0).

This concludes function tests of GP-IB.

Set Bit 3 on CPU Switch 1 to **OFF**.

12. RANGING PERFORMANCE CHECK

12.1 Automatic Range Switching (Check Voltage Range Only)

When the Vrms/Vmean ratio, expressed as a percentage exceeds approximately 110, the measured range switches automatically to the next highest range.

When the Vrms/Vmean ratio, expressed as a percentage falls below approximately 30, the measuring range switches automatically to the next lowest range.

12.2 Peak Over

Check to confirm that the voltage peak indicator lamp lights when the input voltage peak value exceeds approximately 250 % of range.

Check to confirm that the current peak indicator lamp lights when the current peak value exceeds approximately 350 % of range.

13. ANALOG OUTPUT CHECK

(1) Prepare Analog Output Connector with leads for:

V , V , V
A , A , A
W , W , W

(2) Connect AC Voltage and Current Standards according to the number of measuring elements in your unit and apply 100 V, 5 A, cosø = 1 to unit and fix ranges at 100 V, 5 A.

(3) Using DMM, verify analog outputs to be:

5 V DC ± 0.25 % (± 0.0125 V DC)

(4) This concludes test of Analog Output.

14. OPTIONAL FUNCTION CHECKS

(1) GP-IB Interface Function Check

Use a controller with GP-IB control functions to confirm that function setting and range selection by remote control can be carried out correctly for each function.

(2) Frequency Measurement

Measure the input voltage and frequency. The accuracy must be ±(0.1 % +1 digit).

(3) Integrator Function Check

Use a standard AC voltage/current to apply 100 V AC to the voltage input terminals and 1 A AC to the current input terminals. After setting the timer to six minutes, press the "Wh" pushubutton switch, then press the integrator pushbutton switch to start integration. Confirm that the value displayed after six minutes is 10 Wh.

Integration accuracy must be ± (instrument accuracy + 0.02 % of measurement value +1 digit)

15. VOLTAGE TESTS

(1) Range and Frequency Characteristic Tests

(a) Test set Vrms mode

Apply a standard AC voltage, at the four frequencies of 10 Hz, 60 Hz, 2 kHz and 20 kHz, as listed in the following table read the display to the voltage input terminals and on each voltage range. Input voltage and reading accuracy must be as listed in the following table.

Range		30 V	60 V	100 V	150 V	300 V	600 V
Input Voltage		30 V	60 V	100 V	150 V	300 V	600 V
Accuracy	25331□	10 Hz : ± 1 % of range 60 Hz : ± (0.1 % of rdg + 0.1 % of range) 2 kHz : ± 1 % of range 20 kHz : ± 2 % of range					
	25332□	DC : ± (0.1 % of rdg + 0.2 % of range) 10 Hz : ± 1 % of range 60 Hz : ± (0.1 % of rdg + 0.2 % of range) 2 kHz : ± 1 % of range 20 kHz : ± 2 % of range					

(b) Test set Vmean mode

Using a standard AC voltage, apply 100 V AC at four frequencies of 10 Hz, 60 Hz, 2 kHz, and 20 kHz to the voltage input terminals and read the display for each frequency. Accuracy must be as listed in the following table:

Frequency		10 Hz	60 Hz	2 kHz	20 kHz
Input Voltage		100 V fixed		Range 100 V	
Accuracy	25331□	10 Hz : ± 1 % of range 60 Hz : ± (0.1 % of rdg + 0.1 % of range) 2 kHz : ± 1 % of range 20 kHz : ± 2 % of range			
	25332□	DC : ± (0.1 % of rdg + 0.2 % of range) 10 Hz : ± 1 % of range 60 Hz : ± (0.1 % of rdg + 0.2 % of range) 2 kHz : ± 1 % of range 20 kHz : ± 2 % of range			

(2) Linearity Test

The 100 V range shall be selected, and using a standard AC voltage apply an AC voltage at 60 Hz as listed in the following table to the voltage input terminals and read the display. The test points and accuracy must be as listed in the following table:

Input Voltage		10 V	20 V	60 V	110 V
Accuracy	25331□	60 Hz : ± (0.1 % of rdg + 0.1 % of range)			
	25332□	DC : ± (0.1 % of rdg + 0.2 % of range)			

16. AC CURRENT TEST

The following tests shall be carried out for each test point in the CURRENT mode selected by the function selector switch.

(1) Range and Frequency Characteristic Tests

Using AC current standard apply an AC current at frequencies of 10 Hz, 60 Hz, 2 kHz and 20 kHz to the current input terminals and read the display on each range. The input current and accuracy for each range must be as listed in the following table:

Range		0.5 A	1 A	2 A	5 A	10 A	20 A
Input Current		0.5 A	1 A	2 A	5 A	10 A	20 A
Accuracy	25331□	10 Hz : ± 1 % of range 60 Hz : ± (0.1 % of rdg + 0.1 % of range) 2 kHz : ± 1 % of range 20 kHz : ± 2 % of range					
	25332□	DC : ± (0.1 % of indicated value + 0.2 % of range + 3 mA) 10 Hz : ± 1 % of range 60 Hz : ± (0.1 % of rdg + 0.2 % of range) 2 kHz : ± 1 % of range 20 kHz : ± 2 % of range					

(2) Linearity Test

The 1 A range shall be selected and, using AC current standard apply an AC (or DC) current at 60 Hz as listed in the following table to the current input terminals and read the display. The test points and accuracy must be as listed in the following table:

Input Current		0.1 A	0.2A	0.6 A	1 A
Accuracy	25331□	60 Hz : ± (0.1 % of rdg + 0.1 % of range)			
	25332□	DC : ± (0.1 % of rdg + 0.2 % of range + 3 mA) 60 Hz : ± (0.1 % of rdg + 0.2 % of range)			

17. POWER MEASUREMENT TESTS

The following tests shall be carried out for each point in the WATT and Σ modes.

(1) Range and Frequency Characteristic Tests

Using standard AC (or DC) power apply AC (or DC) voltage and currents at power factor 1 to the input terminals and read the displayed power.

Voltage and current range setting, input voltage and current, frequency and accuracy shall be as in the table below.

<table>
<tr><th colspan="2">Frequency, Factor</th><th>Voltage Range and Input Voltage</th><th>Current Range and Power Input Current</th></tr>
<tr><td colspan="2" rowspan="6">(D.C)
10 Hz

50/60 Hz</td><td rowspan="5">100 V fixed</td><td>0.5 A</td></tr>
<tr><td>2 A</td></tr>
<tr><td>5 A</td></tr>
<tr><td>10 A</td></tr>
<tr><td>20 A</td></tr>
<tr><td colspan="2" rowspan="6">2 kHz

20 kHz

cosø: 1</td><td>30 V</td><td rowspan="6">1 A fixed</td></tr>
<tr><td>60 V</td></tr>
<tr><td>100 V</td></tr>
<tr><td>150 V</td></tr>
<tr><td>300 V</td></tr>
<tr><td>600 V</td></tr>
<tr><td rowspan="2">Accuracy</td><td>25331□</td><td colspan="2">10 Hz : ± 1 % of range
60 Hz : ± (0.1 % of rdg + 0.1 % of range)
2 kHz : ± 1 % of range
20 kHz : ± 2 % of range</td></tr>
<tr><td>25332□</td><td colspan="2">DC : ± (0.1 % of rdg + 0.3 % of range)
10 Hz : ± 1 % of range
60 Hz : ± (0.1 % of rdg + 0.2 % of range)
2 kHz : ± 1 % of range
20 kHz : ± 2 % of range</td></tr>
</table>

(2) Linearity Test

Using AC power standard, apply the input voltages and currents listed in the following tables to each inpt terminal and read the displayed power. The current range, voltage range and accuracy must be as follows:

Item	Input Current and Voltage
Current range (1 A)	1 A fixed
Voltage range (100 V)	10 V, 20 V, 60 V, 110 V

Item	Input Voltage and Input Current
Voltage range (100 V)	100 V fixed
Current range (1 A)	0.1 A, 0.2 A, 0.6 A, 1.1 A

Power factor: 1, Frequency : 60 Hz

Accuracy	25331□	± (0.1 % of rdg + 0.1 % of range)
	25332□	± (0.1 % of rdg + 0.2 % of range)

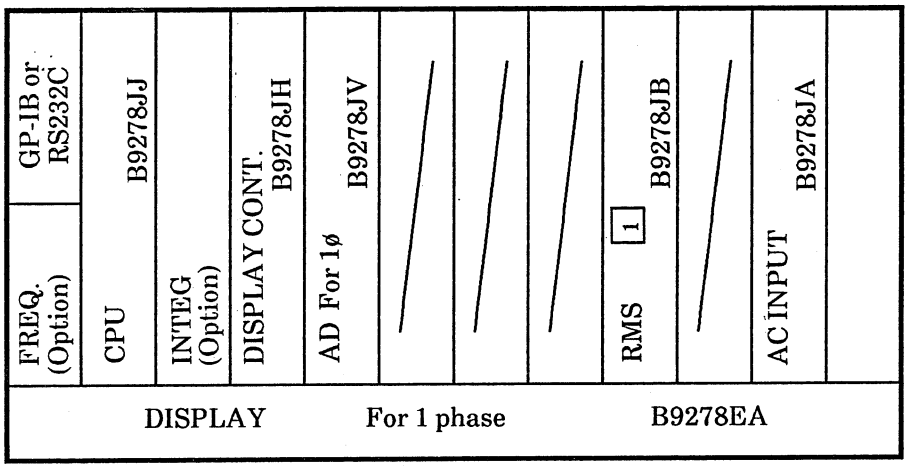
(3) Power Factor Influence Test

With each phase power and Σ power, AC voltage and current at power factor zero (for both LEAD and LAG) listed in the following table shall be applied to each input terminals and the displayed power read.

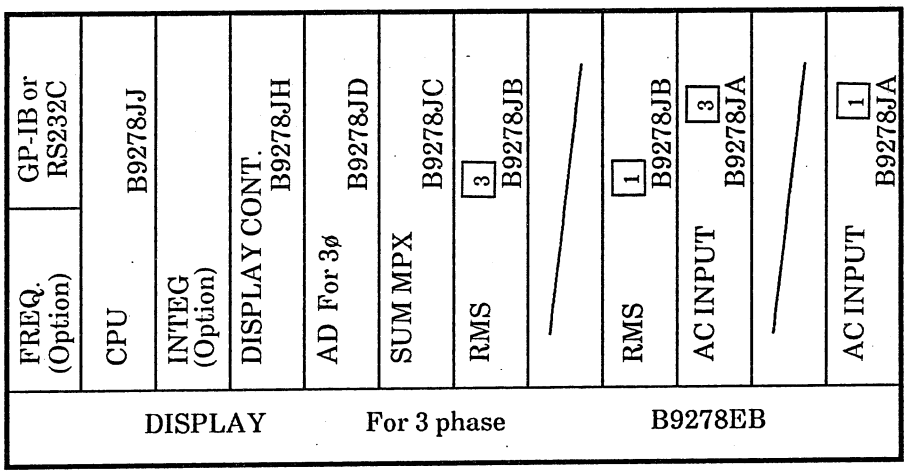
Voltage Range and Input Voltage	Current Range and Input Current	Frequency	Accuracy
30 V	1 A fixed	60 Hz	± (0.39 % of range)
60 V			
100 V			
150 V			
300 V			
600 V			

18. VARIATIONS AND KEYBOARD LOCATIONS

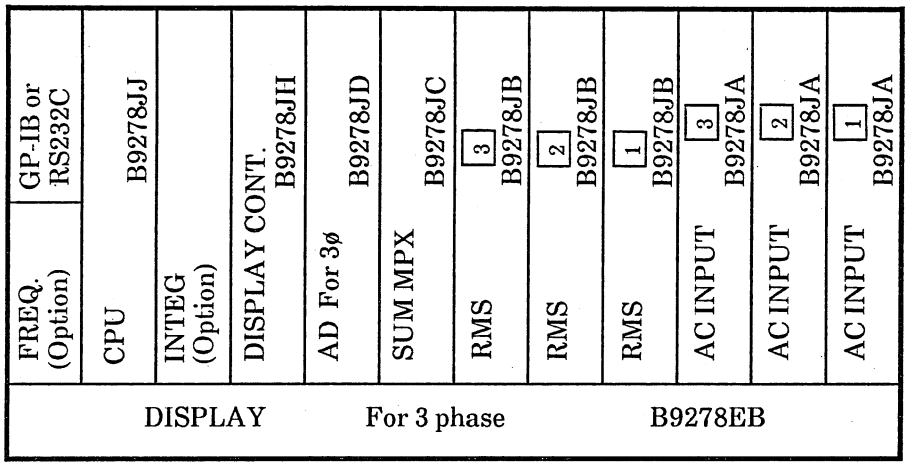
(1) 1 Phase (Model 253311)



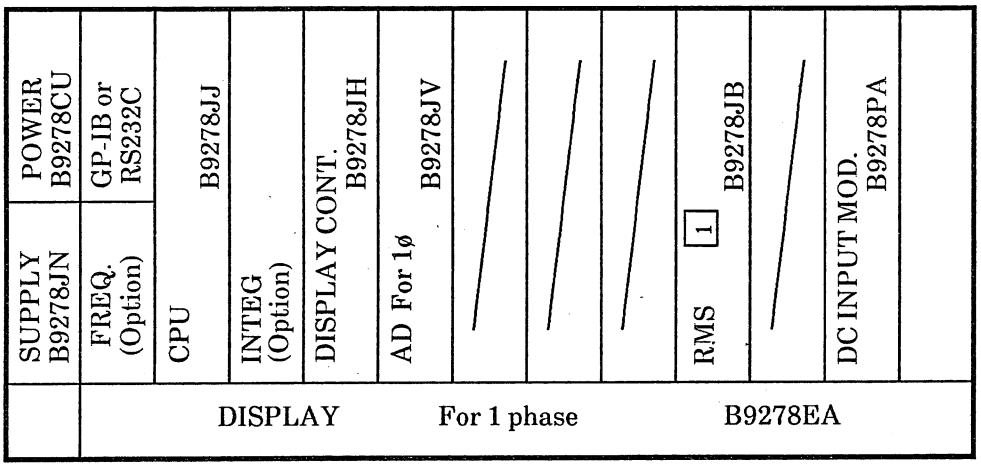
(2) 3 Phase 3 Wire (Model 253312)



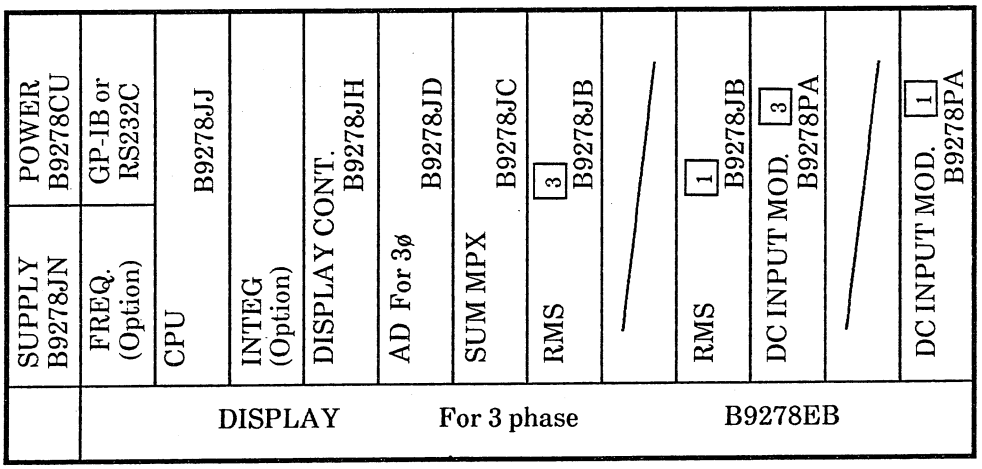
(3) 3 Phase 4 Wire (Model 253313)



(4) 1 Phase (Model 253321)



(5) 3 Phase 3 Wire (Model 253322)



(6) 3 Phase 4 Wire (Model 253323)