SERVICE MANUAL

AC STANDARD VOLTAGE CURRENT STANDARD

Type 2858

YEW

YOKOGAWA ELECTRIC WORKS, LTD.

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1. OPERATING PRINCIPLE

1.1 Operating Principle

1.1.1 Introduction

Recently, a Field Effect Transistor abbreviated FET has been used for AC amplitude control. The AC Standard Voltage Current Generator described here is a practical AC power generating device with low distortion factor and high accuracy by FET control.

Up to now, a transformer (PT, CT) and accuracy-ensured instrument have been used in combination as standard instruments of test power supply to calibrate an AC voltmeter and ammeter. However, this generator can calibrate instruments besides calibrating or testing AC machines, by accurately generating power itself.

This generator produces any frequency from 40 to 500 Hz, any voltage from 1 to 1000 V and any current from 10 mA to 50 A within an accuracy of ±0.1% and distortion factor of 0.3% and can handle a load up to about 50 VA. Fig. 1-1 shows an external view of this generator.

1.1.2 Circuit Construction and Operation

1.1.2.1 Block Diagram

Fig. 1-2 shows a block diagram of the general circuit. The components include an oscillator, a resistance potential divider for DC reference voltage and output setting, a main amplifier, an FET control circuit, an AC-DC converter, a protective circuit and an output "ON-OFF" circuit. Output is always controlled by an FET connected to the input side of the main amplifier so that a preset fixed value will be taken out.

Each rated voltage and rated current is selected by the secondary winding tap of an output transformer connected to the output side of the main amplifier.

Any current in the large current range is taken out directly from the secondary winding of the output transformer sided to the main amplifier with terminals since a selector switch to be used requires large capacity, thus causing great contact resistance loss. Output can be cut off at any range by cutting off the control FET connected to the input side without using a mechanical relay or other mechanism. When abnormal condition is caused in output or the output is set wrongly, the protective circuit operates and then the FET is automatically formed into a cut-off state to cut off output.

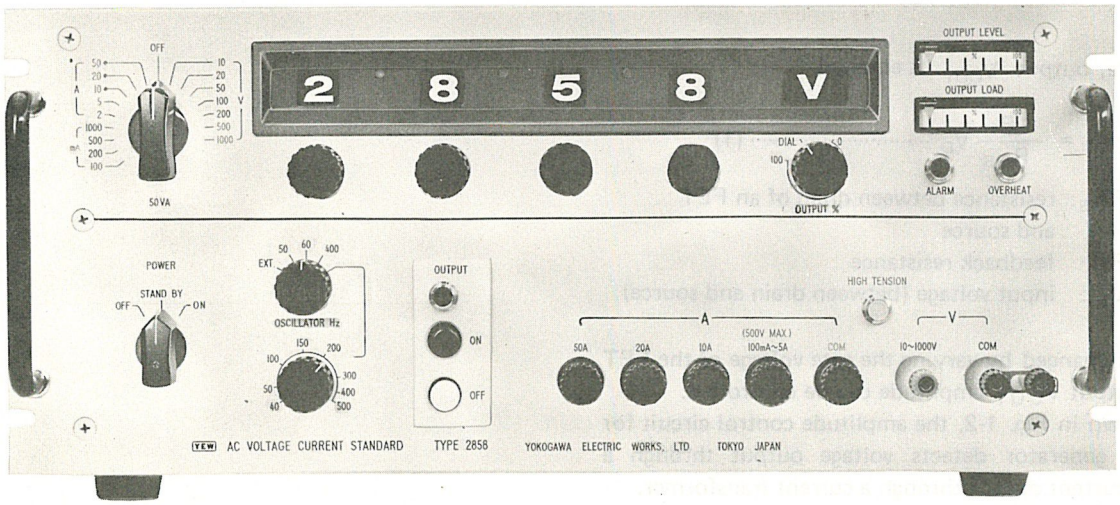


Fig. 1-1

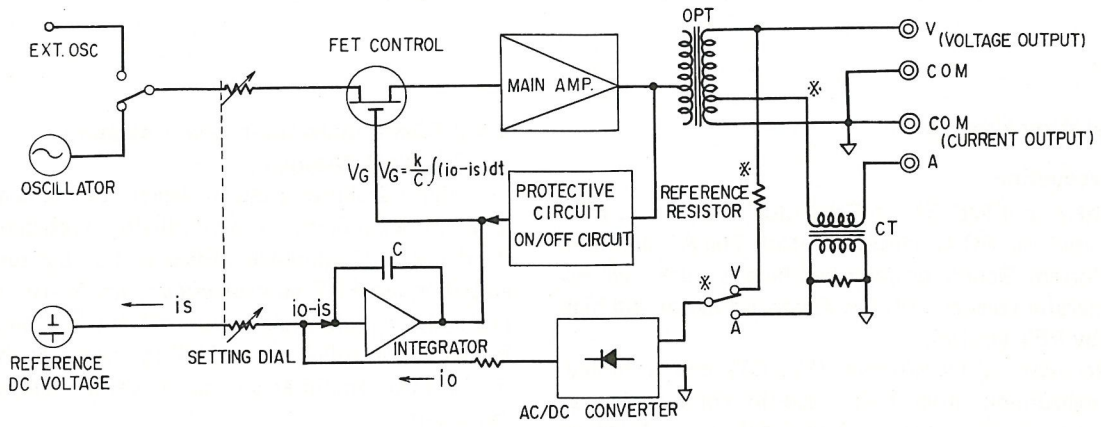


Fig. 1-2 Block Diagram

1.1.2.2 FET Control Circuit

Fig. 1-3 shows a basic circuit of amplitude control with a MOS type FET.

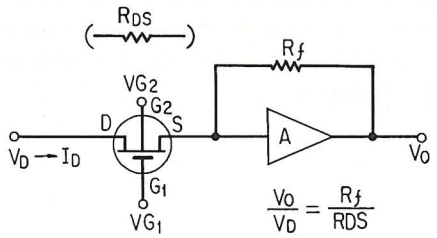


Fig. 1-3 MOS FET Amplitude Control Scheme

In the figure, output V_{OUT} is equated:

$$V_{OUT} = \frac{R_f}{R_{DS}} V_D \quad \cdots\cdots\cdots\cdots (1)$$

Where R_{DS}: resistance between drain of an FET and source
R_f: feedback resistance
V_D: input voltage (between drain and source)

R_{DS} is changed by varying the gate voltage of the FET whereby output V_{OUT} amplitude can be controlled.

As shown in Fig. 1-2, the amplitude control circuit for the whole generator detects voltage output through a resistor or current output through a current transformer.

Then the output is converted to DC current i_o by the AC-DC converter. After comparing it with DC reference current i_s determined by the preset value, the difference is applied to the integrator. It integrates the difference between i_o and i_s with time series. Its output voltage, i.e., the gate voltage of the FET, V_G has the following equation.

$$V_G = \frac{-k}{C} \int (i_o - i_s)\, dt \quad \cdots\cdots\cdots\cdots (2)$$

Where
k: integrating constant
C: integrating capacitor

V_G variation is controlled in amplitude by FET. The control system is constructed so that by comparing output with reference, the difference will be 0 at all times.

1.1.2.3 Reference Voltage and Setting Dial

A temperature-compensating constant voltage diode is employed for reference voltage. As in Fig. 1-4, the setting dial takes out DC preset voltage corresponding to each digit by dividing resistance by Kelvin Varley. In the figure, positions 1, 2 and 3 of selector switch SW are used to set the operating range of the amplifier at 100% for each of the maximum setting ranges.

Namely, position 1 is used to set the maximum setting range at 10 or 100 V. Position 2 is to set the maximum setting range at 50 or 500 V. Position 3 is to set the maximum setting range at 20 or 200 V.

To reduce FET operating resistance variation, the signal voltage provided by the oscillator is varied by linking the maximum digit 10^3 and the second 10^2 with corresponding ones of DC setting voltage circuit respectively.

Variation in FET operating resistance is at most ±5%. To change output continuously, switch the setting dial to a variable resistor and continuously change the DC setting voltage. In this case, FET operating resistance is greatly changed and so distortion is increased in the lower part of the output range since the AC voltage side is set at a fixed value.

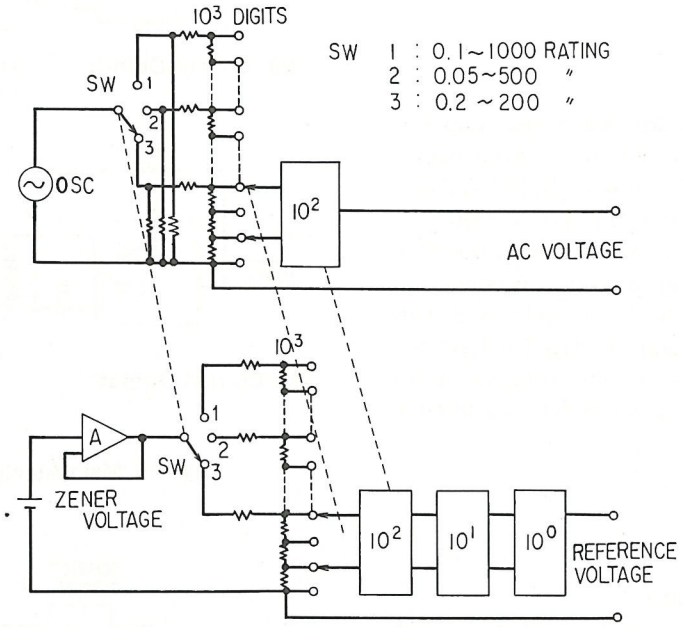


Fig. 1-4 Setting Dial

1.1.2.4 Oscillator

The built-in oscillator is a Wien bridge type by FET control and its circuit is composed as in Fig. 1-5. In the figure, A_1 is a Wien bridge amplifier, A_2 an output control amplifier and A_3 is FET control integrator. A_3 controls the FET by comparing the amplification ratio of A_1 with reference voltage Es so that the amplification ratio will be a value that satisfies oscillating condition at all times. In this case, voltage V_D applied to the FET requires a small value as well as that applied to the amplitude control FET and the value is maintained below 50 mV.

A fixed capacity and resistance selecting method is applied to oscillate frequency; fixed frequencies of 50, 60 and 400 Hz and variable frequencies from 40 to 500 Hz. Output is a sinusoidal wave of 3 V±0.1 V and its distortion factor is about 0.3%.

In Fig. 1-2, terminal EXT. OSC is used to obtain phase relation for each output (for example, AC electrical power calibrator) with two or more generators operated in parallel.

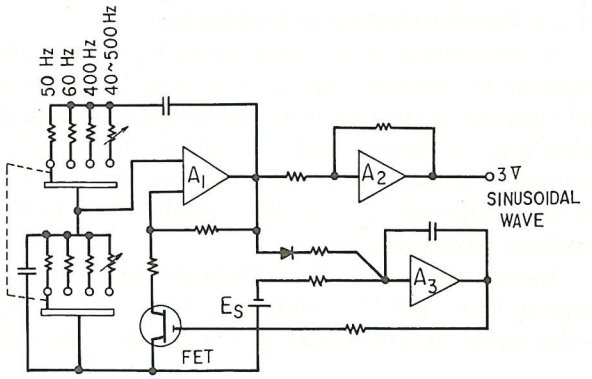


Fig. 1-5 Wien Bridge Oscillator

1.1.2.5 Main Amplifier

The main amplifier is a solid-state power amplifier employing an IC for its first stage and its maximum output is 50 VA. A wide choice of 1 V/50 A to 1000 V/50 mA provided by the output current transformer is allowed. Fig. 1-6 is a block diagram showing the negative feedback state of the main amplifier. With voltage output, it is connected as a voltage stabilizer negative feedback form, and with current output, as a current stabilizer negative feedback form. The main amplifier itself is also constructed to operate as a voltage or current stabilizer for load fluctuation.

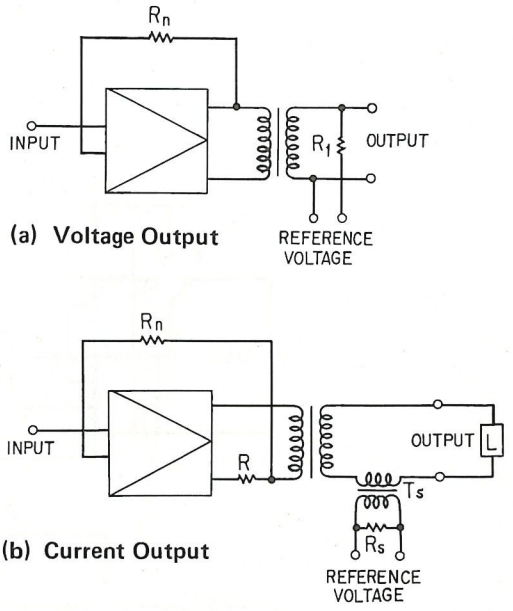


Fig. 1-6 Main Amplifier

1.1.2.6 Output "ON-OFF" Circuit

Since the FET has an extremely high resistance value in a cut-off state, the amplitude control FET allowing "ON-OFF" action of output is used. It is very convenient for "ON-OFF" action with high voltage and large current and allows compactness of the whole instrument, too. Fig. 1-7 is a LOGIC circuit to turn output "ON-OFF" and is combined with the circuit to protect the main amplifier from overload and overheat.

With power supply turned on, R-S FF is positioned at "OFF" by the "STAND-BY" switch connected in parallel to the "OFF" switch. By changing this level to develop "ON-OFF" signal and forming the amplitude control FET into a cut-off state, output reaches 0. Then with "ON" switch depressed, output is applied as pulse signal by CR and R-S FF is reversed to "ON". The "ON-OFF" signal is switched to "ON" through level conversion and the amplitude control FET is ready for operation.

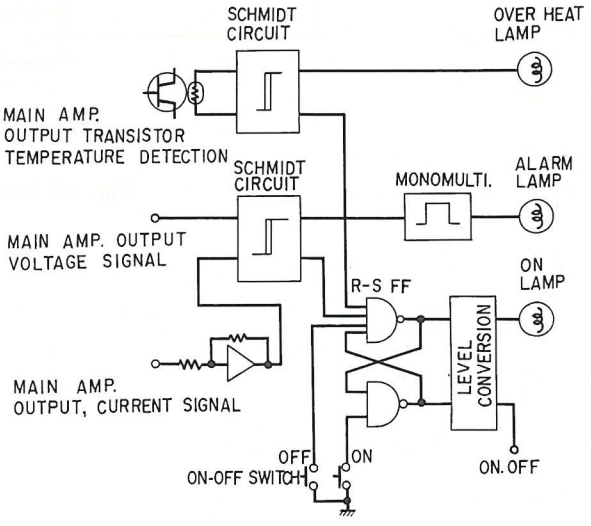


Fig. 1-7 "ON, OFF" Protective Circuit

If output is overloaded and thus overcurrent runs during operation, the output current signal provided by the main amplifier is increased above Schmidt level, then R-S FF is reversed to "OFF" and output is cut off. Operating time is on the order of μS in each circuit and the output is cut off within a half wave even at 500 Hz.

When ambient temperature is high or load is continuously taken out at near-rating, the output transistor is raised in temperature. The temperature detecting posistor senses output transistor temperature at all times and when temperature exceeds a fixed value, the Schmidt circuit operates to set R-S FF at "OFF".

This generator works to supply up to 50 VA output, high voltage and large current and generates high voltage at small current rating with an increase of load impedance. For example, with the rating of 100 mA, voltage reaches 500 V for rated 50 VA. Hence, great care must be taken in handling. Safety measures for overload and mistake in setting are described below.

(Overload)

When output terminal load exceeds the maximum value, output is automatically cut off and is not turned on unless load is restored to normal condition.

("OFF" position priority of "ON-OFF" switch)

With two "ON-OFF" switches depressed simultaneously or the Schmidt circuit turned "OFF" because of a rise in temperature, "OFF" is given priority by the LOGIC circuit and "ON" action is not performed.

(Protection of setting range)

With the setting dial turned above the setting range (105% or higher), output is automatically cut off.

(High voltage setting range)

With high voltage setting rating (500 V, 1000 V) and small current rating under conditions to allow high voltage generation (100 mA), a stop circuit is added to the "ON-OFF" circuit so that it will not be switched to "ON" unless the 1st dial is set at "O".

1.2 Printed Circuit Boards and Operation

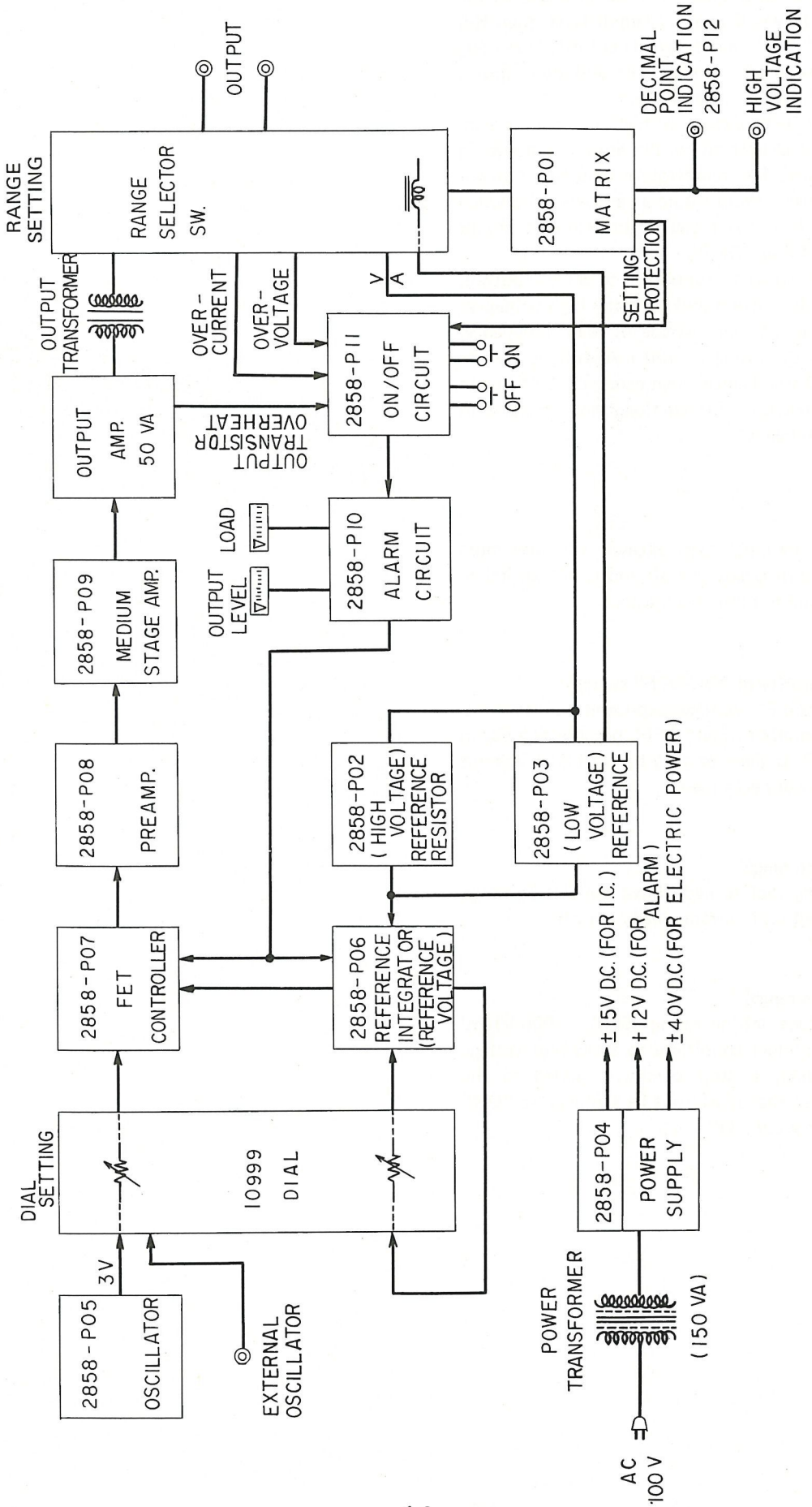


Fig. 1-8 Type 2858 Block Diagram

The general block diagram illustrating every circuit board as a block of Type 2858 AC voltage current generator is given in Fig. 1-8 and the following describes the operating principle.

The sinusoidal wave of 3 ±0.1 V AC oscillated by the Wien bridge is changed in level by setting the 1st and 2nd dials (3rd and 4th dials for DC reference voltage only) and then enters the FET control circuit. The FET control circuit always controls the amount of input by receiving control signal from the reference integrator according to accuracy of output. The FET control output passes through the preamplifier, midstage and output amplifiers and is taken out from the desired range (tap).

The range selector switch selects any of 1000 to 10 V and any of 100 mA to 5A. In case of 10, 20 and 50 A it is used for the detecting assembly. With voltage output, it is detected by reference resistors P_{02} and P_{03} and with current output, it is detected by P_{03} through the CT. The reference integrator compares the value converted from detected signal to DC with a fixed reference voltage value set by the dial, then integrates the difference and supplies integrated signal to FET as a control signal.

The "ON-OFF" circuit functions for "ON-OFF" action of output and is also a protective circuit to cut off output instantly when abnormal condition emerges. It operates in combination with the ALARM circuit.

(2858-P_{01}) MATRIX CARD

Various operation modes such as the position of a decimal point, high (500, 1000 V, 100 mA) or low voltage, current or voltage and a setting level value are changed by range selection. It is possible to select such modes by increasing the number of switch stages, but operation is troublesome when increased. This card accommodates only one stage of a mechanical switch and a diode matrix circuit to allow operation equivalent to that of multi-stage switches. Mode selections other than analog (reference resistance) selection are performed by this card.

(2858-P_{02}) REFERENCE RESISTOR (HIGH VOLTAGE) CARD

Accommodates the multiplying resistors for detecting 500 and 1000 V. They are attached in a zigzag pattern to reduce distribution capacity because of high voltage.

(2858-P_{03}) REFERENCE RESISTOR (LOW VOLTAGE) CARD

A multiplying resistor for detecting 10 to 200 V and a voltage conversion resistor inserted into the secondary winding of the CT are attached. Sensitivity of current range is adjusted by this card.

(2858-P_{04}) ±15 V-DC POWER CARD and power supply

Supplies the source voltage of ±15 V DC to the linear IC. In Type 2858, the source voltage of ±12 V is supplied by the P_{11} and lines of ±40 V DC for power amplification are wired directly to the chassis.

(2858-P_{05}) OSCILLATOR CARD

An oscillator operated by the Wien-bridge and allows any fixed oscillation of 50, 60 and 400 Hz and continuous oscillation from 40 to 500 Hz. Oscillator output is 3 ±0.1 V AC, with distortion factor of 0.3% which is down to about 0.2% after FET control. If distortion factor is reduced, it takes a few seconds after changing frequency until the output is stabilized. Frequency can be selected by changing R.

(2858-P_{06}) REFERENCE INTEGRATOR CARD

The heart of this generator and consists of the following circuits.

(1) DC reference voltage generator circuit
(2) AC-DC converter circuit
(3) Integrator circuit

The DC reference voltage generator circuit changes reference zener diode voltage to a fixed value.

The AC-DC converter circuit is a full wave rectifying type using an operational amplifier to compare detected AC output with DC. Linearity and drift in this circuit will adversely affect directly the accuracy of this generator.
The integrator circuit integrates the difference between DC voltage set by the dial and converted DC output and the system operates so that the difference will always result in 0.

(2858-P_{07}) FET CONTROL CARD

Controls oscillator AC voltage by FET control voltage provided by the reference integrator and supplies it to the post-stage amplifier. With output turned "OFF", the FET card is formed into a cut-off state in combination with the LOGIC circuit for cut-off.

(2858-P_{08}) PREAMPLIFIER CARD

Functions as a pre-stage amplifier of the power amplifier and mainly amplifies voltage.

Selection of voltage or current negative feedback must be performed according to the output—voltage or current, so a relay is incorporated in this card for selection.

(2858-P_{09}) MID-STAGE AMPLIFIER CARD

Functions as a mid-stage amplifier of the power amplifier and mainly amplifies current. It is intended to operate an SEPP output transistor.

(2858-P_{10}) ALARM CARD

Incorporates the monitor meter drive circuit, excessive-setting stop circuit, Schmidt circuit and ALARM automatic reset circuit.

(2858-P_{11}) ON-OFF CARD

Incorporates the LOGIC circuit to perform "ON-OFF" action of output, output transistor overheat detecting circuit, 12 V rectifier circuit and +5 V power circuit. It operates in combination with the P_{10} ALARM circuit.

(2858-P_{12}) DECIMAL POINT CARD

1.3 (A) Logic Circuit

Output "ON-OFF" Circuit

Fig. 1-9 is LOGIC circuit to turn ON or OFF output. It is combined with the circuit to protect the main amplifier and output from overload. When power supply is turned on, the R-S FF is switched to "OFF" by the delayed pulse provided by Schmidt circuit (2). The control signal is applied to the FET input side of main amplifier and output is 0 with the FET cut off. Simultaneously, the voltage to stop operation of the control circuit is also produced.

Then is it applied to the R-S FF through the CR as a pulse signal by depressing the ON switch, the R-S FF is reversed to "ON" and the "ON" lamp lights up. Simultaneously, the "ON-OFF" signal is switched to "ON" and the main amplifier and control circuit are ready for operation.

If output is overloaded and overcurrent flows on operation, the main amplifier output is cut off since the amount of output current signal provided by the main amplifier exceeds Schmidt level and the R-S FF is reversed to "OFF". Operating time is a few μs or so in each circuit and the output is cut off within a half wave even at 500 Hz.

When ambient temperature is high and load is continuously taken out nearly at rating, the output transistor is increased in temperature. The temperature detecting posistor always senses the output transistor temperature. If the temperature exceeds a fixed value. Schmidt circuit operates to switch the R-S FF to "OFF". In this case, a lamp lights up by a circuit exclusively for indicating overheat of the output transistor.

Overload

When load of the output terminals exceeds the maximum value, the output is automatically cut off and not set at "ON" unless load is restored to normal condition.

OFF priority of the ON-OFF Switch

With the ON-OFF switch depressed simultaneously, "OFF" is given priority by action of the LOGIC circuit.

Protection of Setting Range

When the setting dial is turned to any position (above 105%) above the setting range, the output is automatically cut off. This indicates that the main amplifier output exceeds Schmidt level of the protective circuit.

High Voltage Setting Range

The stop circuit is added to the ON-OFF and LOGIC circuits so as not to switch output to "ON" in the high voltage setting range (500, 1000 V) and small current setting range (100 mA) to develop high voltage unless the 1st dial is set at 0.

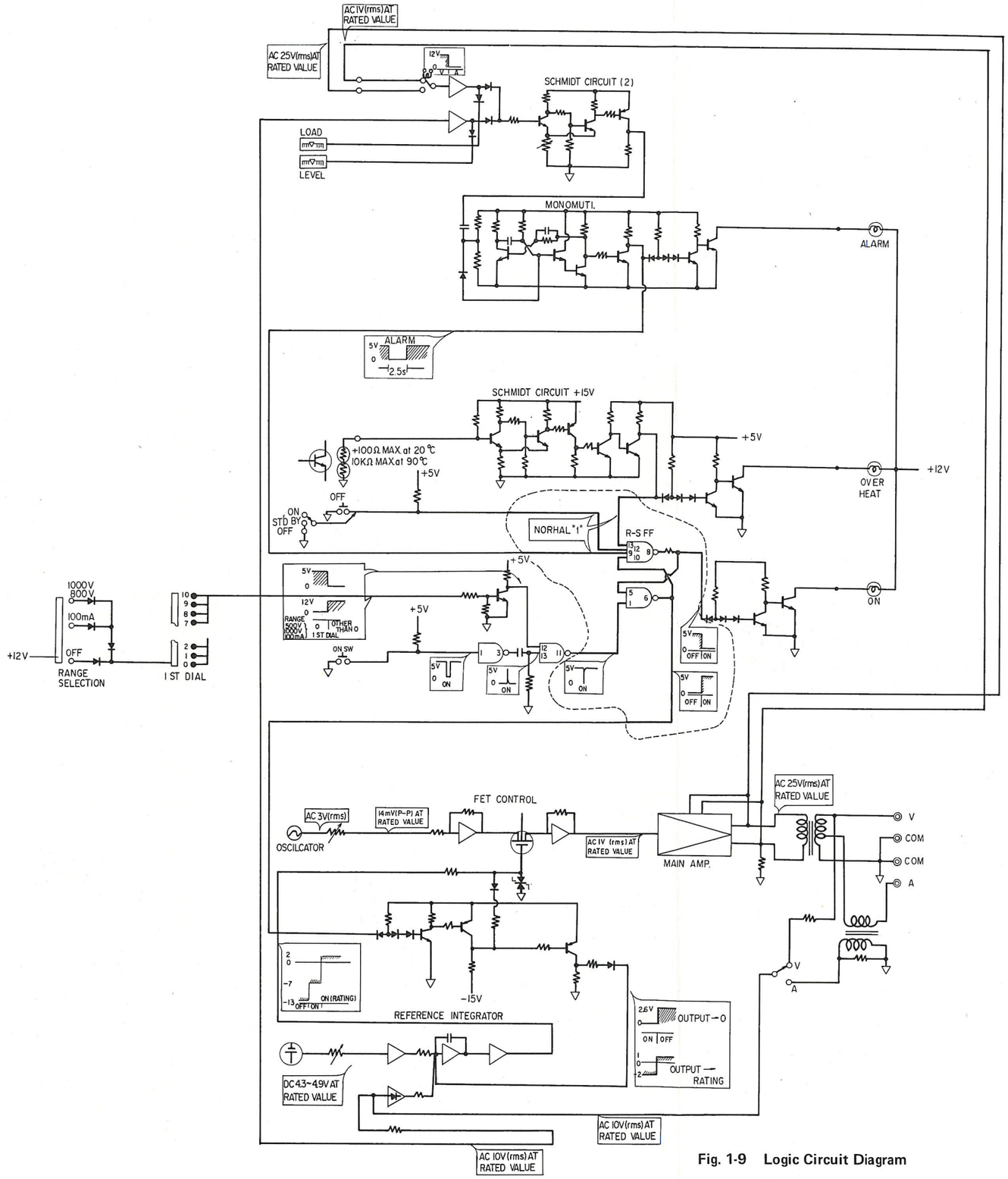


Fig. 1-9 Logic Circuit Diagram

(B) Logic Circuit

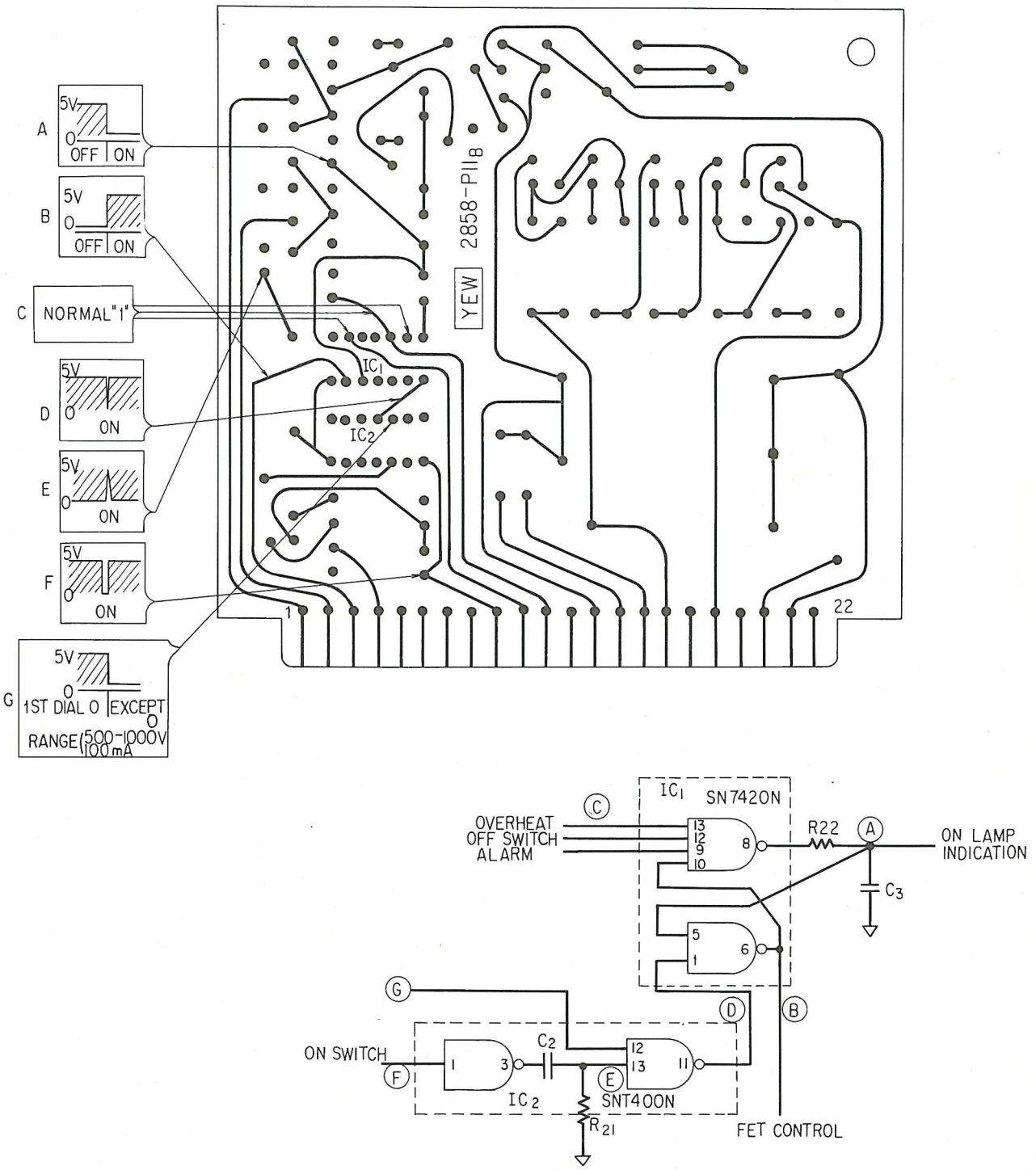


Fig. 1-10 Logic Circuit

2. TROUBLESHOOTING

2.1 Measuring Instruments and Tools

1) Tester (YEW Type 3201) or digital multimeter (YEW Type 2807)
2) Oscilloscope
3) Electronic counter (YHP Type 5326A)
4) Distortion analyzer (YHP Type 334A)
5) Differential voltmeter (Fluke Type 931B)
6) Single-core slidewire resistor, 200Ω 1 A (YEW Type 2791)
7) AC voltammeter (YEW Type 2014)
8) Standard resistor, 1Ω (YEW Type 2792)
9) DIL Soldering iron for IC
10) Extension cord (for Type 2802)
11) Lock nut
12) Insulated screwdriver

SINCE THE GENERATOR CAN SUPPLY HIGH VOLTAGE AND LARGE CURRENT UP TO 50 VA AS OUTPUT, GREAT CARE MUST BE TAKEN IN HANDLING.

2.2 Symptom and Remedy of Trouble

Output is not developed (by changing either frequency or range).

YES

→ Unplug all circuit boards (11 boards). (Preventing shock hazard)

→ With microswitch supported by lock nut, turn on power supply.
Check fan for operation

NO →POWER F_1 (5A) blown.
Faulty power transformer T_1.
Leads wired wrong.

→ Check if fuses TR_1 and TR_2 (4 A time lag type) blown.

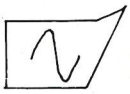
NO →Faulty Q_1 and Q_2 (2SD214),
faulty P09
$Q_1 \cdot Q_4$ (2SC696A),
$Q_2 \cdot Q_3$ (2SA546A)

Sequentially plug in circuit boards according to number of circuit board P indicated.

→ P04 DC power supply
Check to make sure +15V is developed between ⑳ – ㉑ and −15 V between ㉒ – ㉑.

NO→ Faulty + side
Faulty – side

→ P05 Oscillator
Check to make sure 3 V (RMS) is developed at (50, 60, 400 Hz).



NO →RV_3 (5kΩ) is faulty in adjustment or faulty oscillator card.

→ P07 Setting dial (AC side)

NO →Faulty 1st dial system

Check ①–㉑ for output with synchroscope.

Rated selecting range	1st dial	
100mA/1000mA/10A/10V/100V/1000V	10	140 mV (p-p)
200mA/2A/20A/20V/200V	2	
500mA/5A/50A/50V/500V	5	

→ P07 Setting dial (AC side)

Check ①–㉑ for output with synchroscope. Change 1st dial from 0 to 10 and 2nd dial from 0 to 9 at 100 mA range and check to make sure level is changed in proportion to change of dial position.

NO → Faulty dial system

→ P06 DC reference voltage
Check to make sure ⑱ – ㉑ develops about −7.8 V DC.

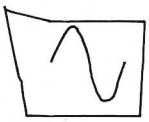
NO → Faulty DC reference voltage generating circuit.

→ P06 Setting dial (DC side)
Check ⑭ – ㉑ for output.

Rated selecting range	1st dial	
100 mA/1000 mA/10 A/10 V/100 V/1000 V	10	4.1 to 4.9 V DC
200 mA/2 A/20 A/20 V/200 V	2	
500 mA/5 A/50 A/50 V/500 V	5	

NO → Faulty 1st dial system

→ Setting dial (DC side) — P_{06}
Check to make sure DC voltage is changed stepwise between ⑭—㉑ when changing each of 1st, 2nd, 3rd and 4th dials from 0 to 10 or 0 to 9.
NO → Faulty dial system unless voltage change is noted in any dial.

→ FET control — P_{07}
Between ⑮—㉑ :

Waveform shown shall be 0 when switching ⑩ to ㉑.
NO → Faulty FET control assembly or P_{07}

→ ALARM — P_{10}

→ 5 V power supply — P_{11}
Between ⑯—㉑ : Make sure 5 V DC is developed.
NO → Faulty 5 V power supply or faulty 5 V load

→ ON-OFF — P_{11}
Between ③—㉑ : With 1st dial set at 0 and "ON" button depressed, make sure 5 V DC is developed.
NO → Faulty ON-OFF circuit

Be careful about high voltage after this service. Do not touch circuit.

YES

→ Plug in P_{01} to P_{03}.

→ +40V·—40 V power supplies
Check to make sure ±40 V power supplies are developed as specified.
NO → Faulty 40 V power supply

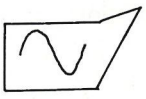
→ Check parts, especially transistor for condition. — P_{08} · $_{09}$
NO → Replace, if faulty.

→ Check Q_1·Q_2 (2SD214) for condition.
NO → Replace.

→ After such tests, make sure output is developed.
NO → Faulty transformer (T_2)

Output is not developed with any one of 50, 60 and 400 Hz.

YES

→ Oscillator — P_{05}
Connect synchroscope to ⑮—㉑ and check to make sure 4.242 V (peak) is developed.

NO → Faulty frequency selector switch or faulty resistors
R_1·R_4 (50 Hz)
R_2·R_5 (60 Hz)
R_3·R_5 (400 Hz)

Output is not developed by continuous frequency dial.

YES

→ Note: To use continuous frequency dial, turn off output, then change frequency and turn on output. If frequency is changed with output turned on, output is automatically cut off due to hunting of oscillator.
NO → Faulty frequency selector switch or faulty continuous frequency selecting variable resistor

Output is not developed at "EXT".

P_{07} Between ①–㉑ : Range of 100 mA

Check to make sure 140 mV (p-p) is developed with 1st dial set at 10.

NO → Faulty oscillator externally connected or improper level (3 V (RMS) ± 0.1 V)

Output is not developed only at 1000 and 500V range.

Check P_{02} for condition.

NO → Faulty P_{02} system or faulty T_2 and range selector switch.

Output is not developed at 200, 100, 50, 20 and 10 V ranges.

Check P_{03} for condition.

NO → Faulty P_{03} or faulty T_2 and range selector switch

Output is not developed at all current ranges.

Check P_{03} ($R_{5,6,7}$, RV_7, Z_1, Z_2) for condition.

NO → Faulty P_{03} or faulty T_3 and range selector switch.

Decimal point is not displayed.

P_{11} Check +12 V power supply ⑬–㉑ for condition.

NO → Replace, if faulty.

P_{01} Check diode for condition.

P_{12} Check lamp (9 V/35 mA, type ML#451) for condition.

Overheat lamp does not light up.

Check Q_1 .Q_2 (2SD214) for condition.

NO → Replace, if faulty.

Check to make sure Posistor (Pth) P_{11} ⑱–㉑ is about 200Ω at 20°C.

P_{11} Check Q1 to 7 for condition.

Check lamp (PLB-1320-12 V) for condition.

P_{04} Check DC power supply for condition. +15V between ⑳–㉑
-15V between ㉒–㉑

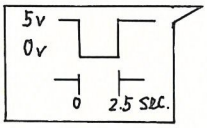
"ON" lamp does not light up.

→ P_{11} Between ③ - ㉑ : With output switch set at "ON", check 5 V — $Q_9 \cdot Q_{10}$ lamp for condition and 0 V — IC_1, IC_2, Q_8 for condition.

NO → Replace, if faulty.

"ALARM" lamp does not light up.

→ P_{10} Between ② - ㉑ : When voltage causes ALARM (instruction manual page 2), check to make sure it is formed as shown below for about 3 seconds.



The lamp does not light up at 0 V
The voltage does not reach 0V.

NO → Faulty lamps Q_8, Q_9

NO → Faulty one of any up to Q_7.

"HIGH VOLT" (1000, 500 V, 100 mA) lamp does not light up.

→ P_{11} Check +12 V power supply ⑬ –㉑ for condition.

NO → Replace, if faulty.

→ P_{01} Check diode for condition

→ Lamp (PLB-1320-12 V)

Monitor meter "LEVEL" does not operate.

→ P_{10} Check IC_2 for condition

→ Check meter (M_1) for condition

Monitor meter "LOAD" does not operate.

→ P_{10} Check IC_1 for condition

→ Check meter (M_2) for condition

Great error

- Allow 15-minute or longer warmup.
- Set range as high as possible.
- Check to make sure output continuous setting dial is set at "DIAL".
- Voltage drop of lead resistance (Use thick leads).
- Check to make sure load is linear (check load for waveform with oscilloscope).
- Oscillator output is greatly distorted.
- Output setting dial is burnt.
- Faulty reference DC voltage (P_{06}).
- Improper DC source voltage ($\pm 15V - P_{04}$).
- Check to make sure ambient temperature ranges from 0 to 40°C.

Unstable

- In service area of 50 Hz (60 Hz) line frequency, set output frequency of main unit at 60 Hz (50 Hz).

3. ADJUSTMENT

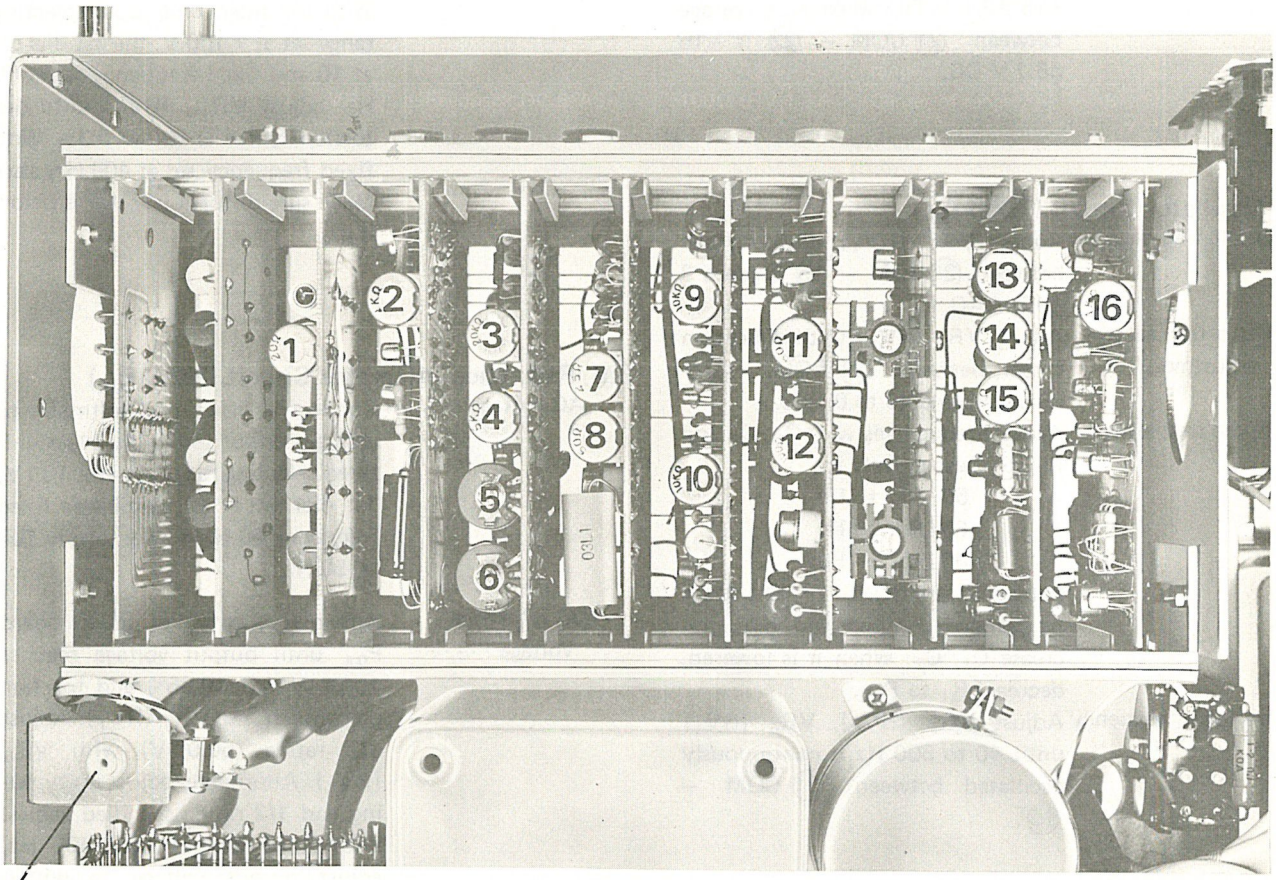


Fig. 3-1

Circuit Board No.	Control No.	Adjusting range	Resistance (Part No. on PCB)	Initial Position	Sequency of Adj.
P_{03}	VR_1	AC output current of 1/2 FS	20Ω (RV_1)	Center of range	13
P_{04}	VR_2	±15 V DC power supply	1 kΩ (RV_1)	Center of range	1
P_{05}	VR_3	Oscillator output of 3 V AC	20 kΩ (RV_4)	Center of range	2
	VR_4	Distortion factor of oscillator 3 V AC	5 kΩ (RV_3)	Center of range	3
	VR_5	Continuously variable oscillator to 40 Hz	500 kΩ x 2 (RV_3)	Center of range	4
	VR_6	Continuously variable oscillator to 500 Hz	5 kΩ x 2 (RV_1)	Center of range	5
P_{06}	VR_7	AC output voltage F.S.	25Ω (RV_1)	Center of range	11
	VR_8	AC output voltage of 1/2 FS	50Ω (RV_2)	Center of range	12
P_{07}	VR_9	FET control voltage of +2.0 V DC	10 kΩ (RV_2)	Center of range	9
	VR_{10}	Compensation of FET control output distortion	10 kΩ (RV_1)	Center of range	10
P_{08}	VR_{11}	Output transistor BIAS	50Ω (RV_2)	Minimum point of range	7
	VR_{12}	Feedback DC BIAS	100Ω (RV_1)	Center of range	8
P_{10}	VR_{13}	LOAD of AC output voltage range	1 kΩ (RV_2)	Center of range	14
	VR_{14}	LOAD of AC output voltage range	5 kΩ (RV_1)	Center of range	15
	VR_{15}	ALARM at 105 to 106% of AC voltage and AC current rated output	2 kΩ (RV_3)	Center of range	16
P_{11}	VR_{16}	5.00V DC	1 kΩ (RV_1)	Center of range	6

3.1 ±15 V Power Circuit (2858-P_{04})

Adjust VR_2 (RV_1) until voltage between ㉑ COM – ⑳ reaches +15 ±0.1 V DC. Make sure voltage between ㉑ COM – ㉒ is −15 ±0.1 V DC.

3.2 Oscillator Circuit (2858-P_{05})

Oscillating level · · Adjust VR_3 (RV_4) until voltage between ㉑ COM – ⑮ reaches 3 ±0.1 V AC.

Distortion factor adjustment · · · Adjust VR_4 (RV_3) until distortion factor between ㉑ COM – ⑮ ranges from 0.45 to 0.55%.

Fixed frequency · · Adjust frequencies with C_1, C_2 and R_1 to $_6$ respectively to:

50 Hz ± 1%
60 Hz ± 1%
400 Hz ± 1%

between ㉑ COM – ⑮. When frequency is raised too high, increase C_1, C_2. When it is lowered, decrease R_1 to R_6.

Variable frequency Adjust VR_5 (RV_2), VR_6 (RV_1) until 40 to 500 Hz is continuously oscillated between ㉑ COM – ⑮.

3.3 "ON-OFF" Circuit (2858-P_{11})

+ 5V Power supply · · · · · · Adjust VR_{16} (RV_1) until 5 V DC is developed between ㉑ COM – ⑯.

3.4 Preamplifier Circuit (2858-P_{08})

Set output transistor BIAS resistor VR_{11} (RV_2) at the minimum value.

DC BIAS · · · · · · Adjust VR_{12} (RV_1) until voltage registers 1 mV DC or less at both terminations of R_{91}=0.5Ω of the amplifier output side.

3.5 FET Control Circuit (2858-P_{07})

FET control input voltage Adjust VR_9 (RV_2) until voltage between ㉑ COM – ⑤ reaches 2.0 V DC.

With main unit rated selecting range set at x 100 V and 1st dial set at 10, turn on power supply and set output at "ON". With output set at "OFF", check to make sure about −13 V is developed.

Distortion factor of output voltage Connect a distortion factor meter to the main unit voltage output terminals.

With the main unit rated selecting range set at x 100 V, the 1st dial set at 10 and fixed frequency set at 60 Hz, adjust VR_{10} (RV_1) until distortion factor is below 0.3%. With fixed frequency set at 400 Hz, also, make sure distortion factor is below 0.3%.

3.6 Reference Integrator Circuit (2858-P_{06})

AC voltage · · · · · · Connect a differential voltmeter to voltage output terminals. Main unit rated selecting range set at x 100 V, 1st dial set at 10. Oscillator fixed frequency 60 Hz. Power supply 100 V, 50 Hz.

DC reference voltage · · · · · · Adjust R_{13} to $_{16}$ of circuit board P_{06} until output voltage reaches 100.0 V AC ±0.05% and for fine adjustment, use VR_7 (RV_1). Adjust 1/2 rating (50.0 V) with VR_8 (RV_2). Alternately adjust unity rating and 1/2 rating specified values. With fixed frequency of 400 Hz, adjust output voltage to within ±0.1% of the rated value.

3.7 Reference Resistor (Low Voltage) (2858-P_{03})

AC current · · · · · Connect a standard resistor (Type 2792) 1Ω to the "100 mA ~ 5A" current output terminals, and connect a differential voltmeter to both terminations of the resistor.

Main unit rated selecting range x	100 mA
1st dial	10
Oscillator fixed frequency	60 Hz
Power supply of 100 V,	50 Hz

Adjust VR_1 (RV_1) of circuit board P_{03} until output current reaches 100.0 mA AC ±0.05%.

With 1/2 rating (50.00 mA AC), also, adjust the current to within 0.05% of the rated value with VR_1 (RV_1). Alternately adjust full rating and 1/2 rating.

With fixed frequency of 400 Hz, adjust the current to within ±0.1% of the rated value.

3.8 Alarm (2858-P_{10})

Over ALARM Setting · · · · · · ·

With the main unit rated selecting range set at x 100 V, the 1st dial set at 10.
Turn on power supply and set output at "ON".
Set up the 2nd dial gradually until the "ALARM" lamp lights up. Adjust VR_{15} (RV_3) so that "ALARM" will operate at 105 to 106 V.
With the current range, also adjust so that "ALARM" will operate at 105 to 106% of the rated value.

"ALARM" operation for current load

With the main unit rated selecting range set at x 100 mA, and the 1st dial set at 10. Turn on power supply and set output at "ON". With an AC voltmeter registering 50 V by stepping up the variable resistor at 0, adjust VR_{14} (RV_1) until "ALARM" operates. Readout of the voltmeter must not exceed 50 V.

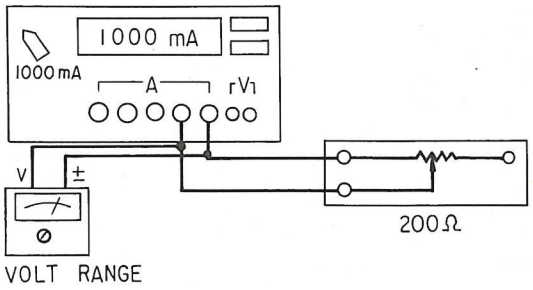


Fig. 3-2

"ALARM" operation for voltage load

With the main unit rated selecting range at x 100 V and the 1st dial set at 10.
Turn on power supply and set output at "ON". With an AC ammeter registering 0.5 A by stepping down the variable resistor at MAX, adjust VR_{13} (RV_2) until "ALARM" operates. The ammeter must not exceed 0.5 A.

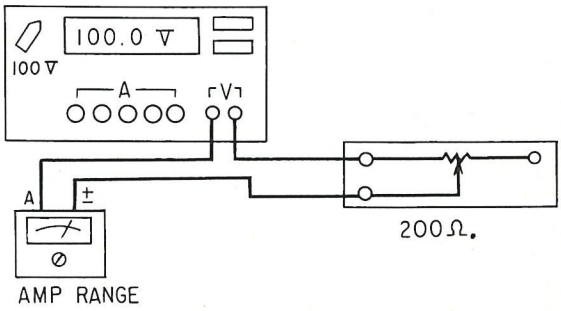


Fig. 3-3

4. CIRCUIT DIAGRAM

4.1 Overall Wiring Diagram Top and Bottom

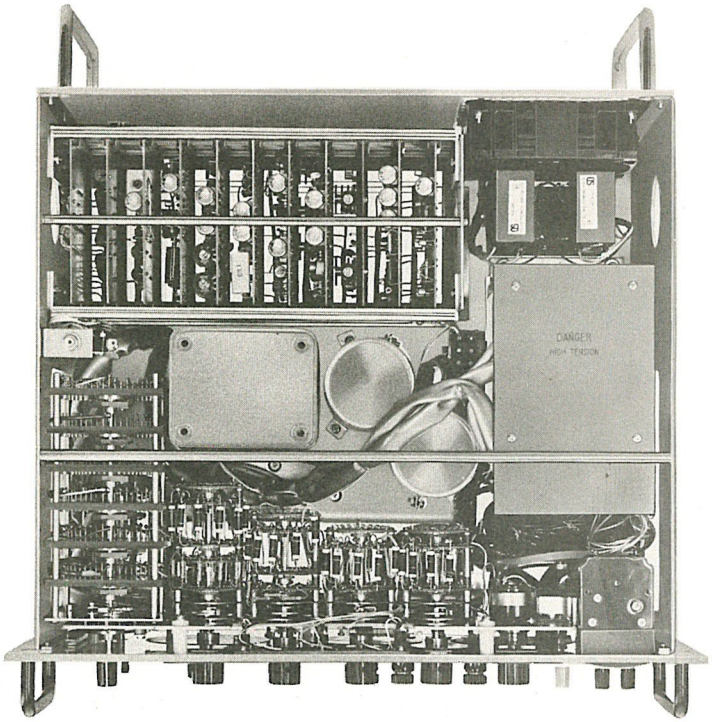


Fig. 4-1

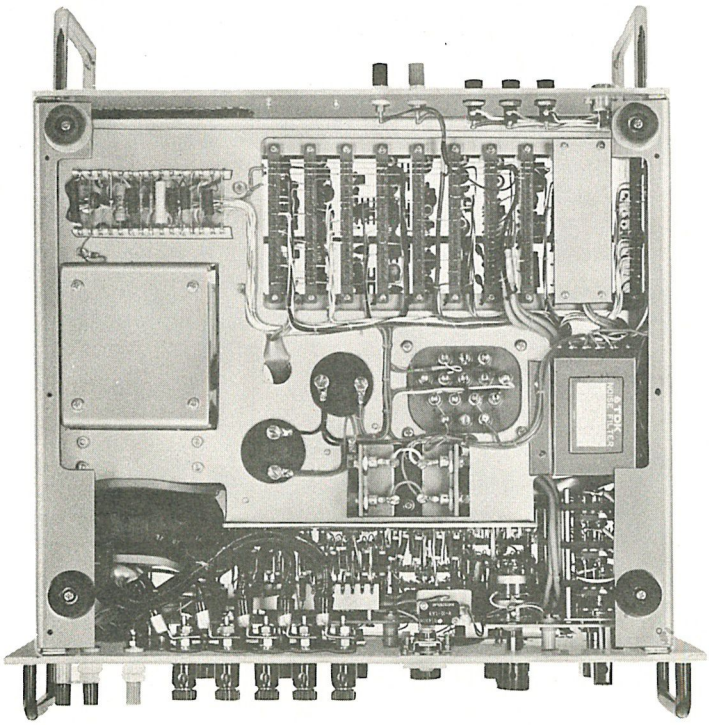
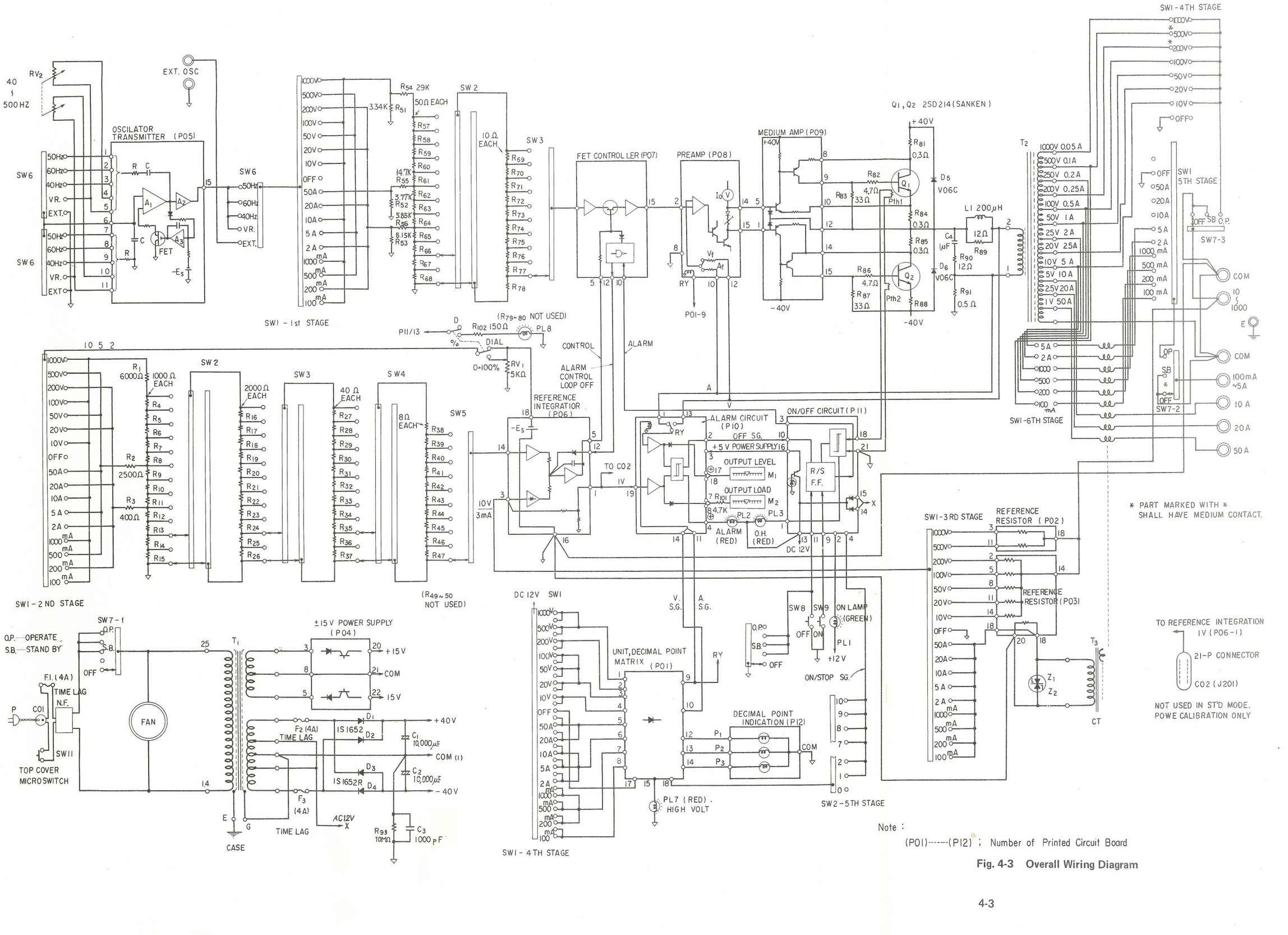


Fig. 4-2



Note :
(P01)------(P12) ; Number of Printed Circuit Board

Fig. 4-3 Overall Wiring Diagram

4.3 2858-P_{02} Reference Resistor (High Voltage) Circuit Card

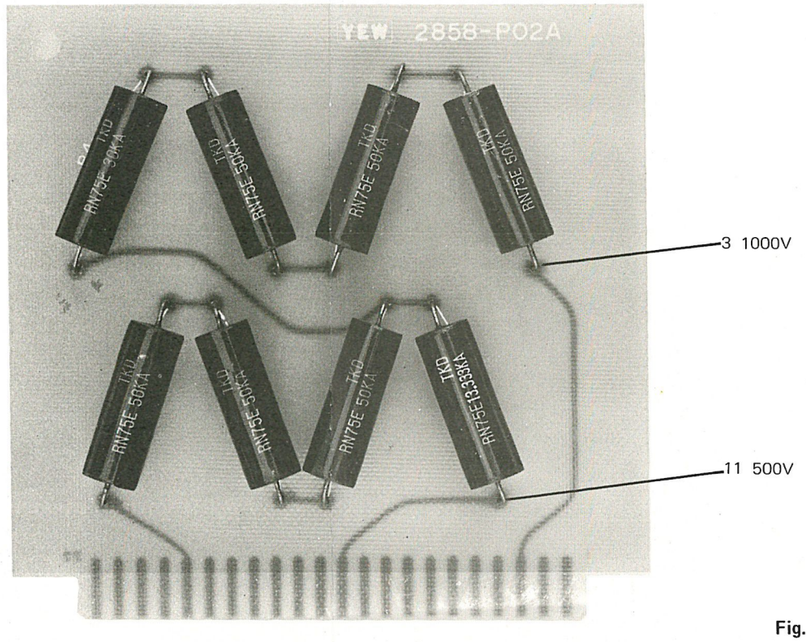


Fig. 4-6

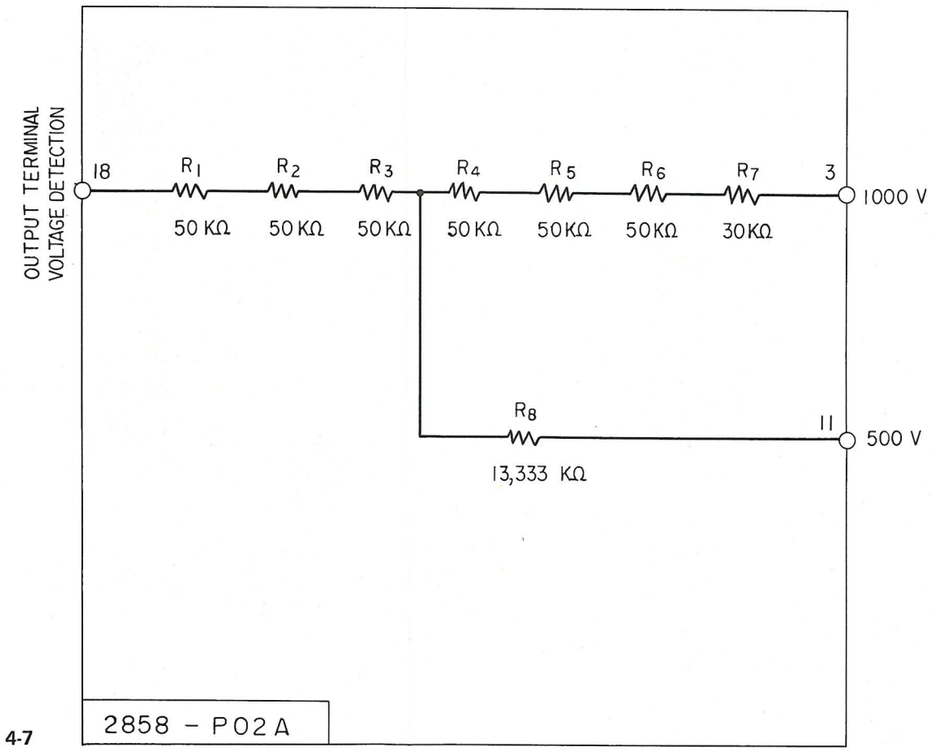


Fig. 4-7

4.4 5858-P_{03} Reference Resistor (Low Voltage) Circuit Card

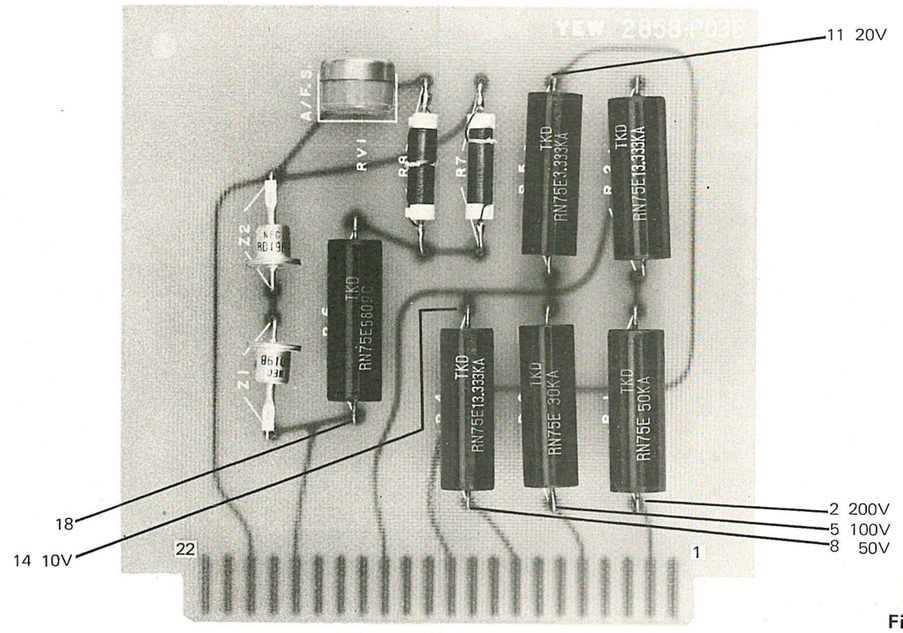


Fig. 4-8

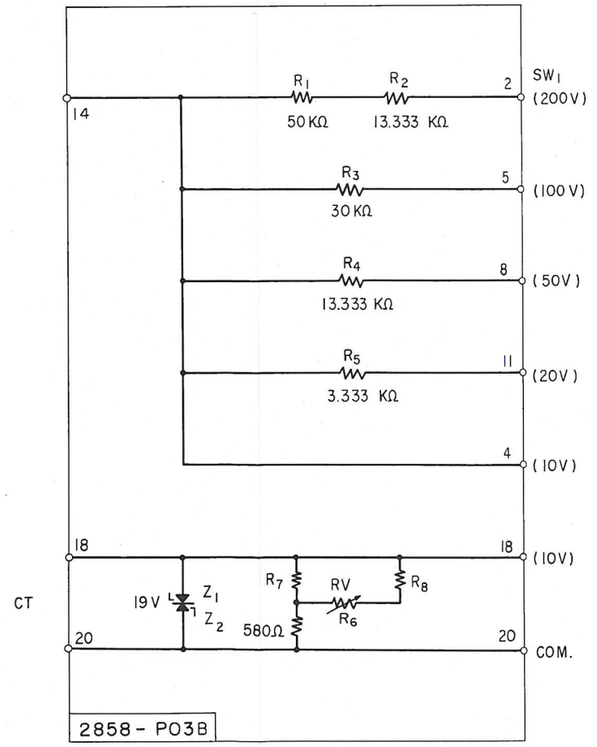


Fig. 4-9

4.5 2858-P_{04} ±15 V Power Circuit Card

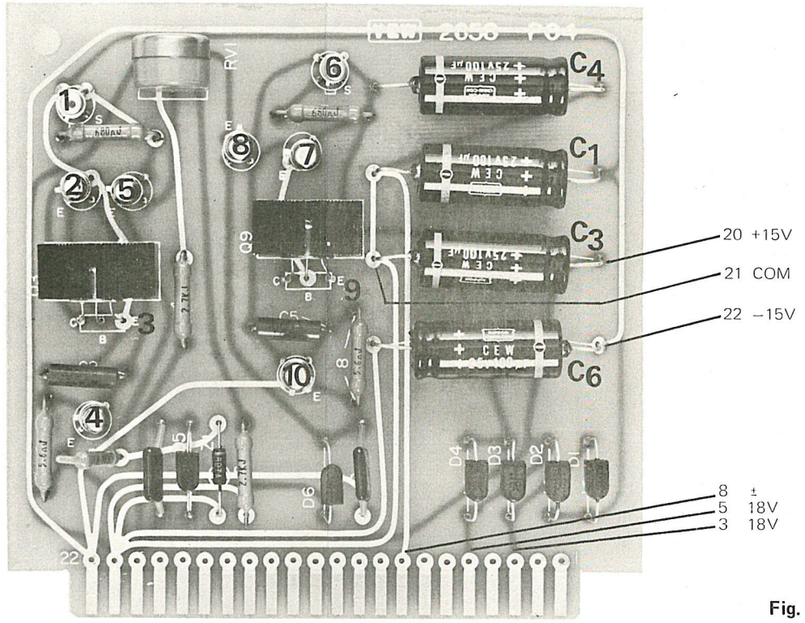


Fig. 4-10

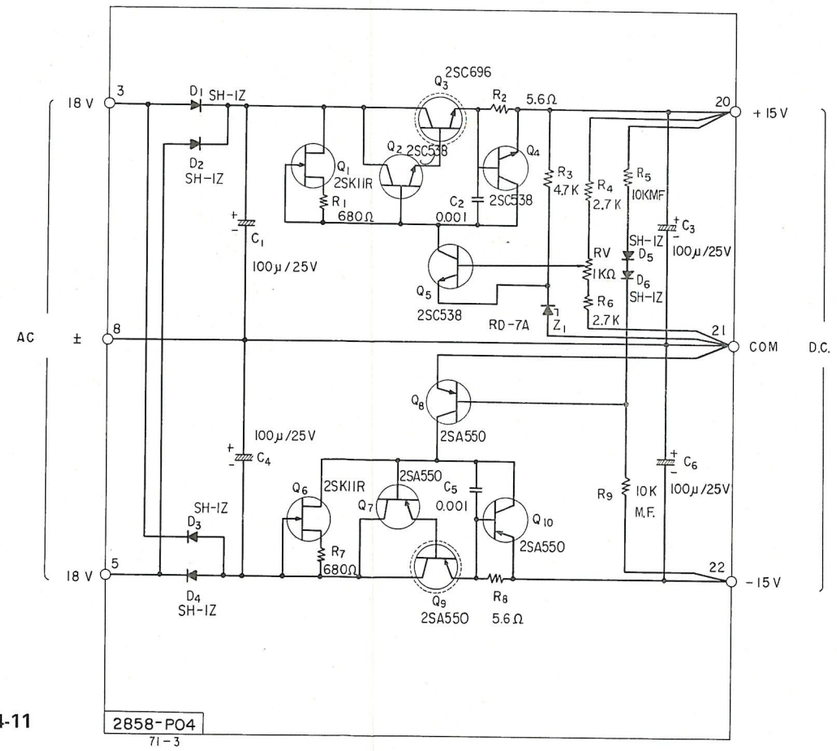


Fig. 4-11

4.6 2858-P_{05} Oscillator Circuit Card

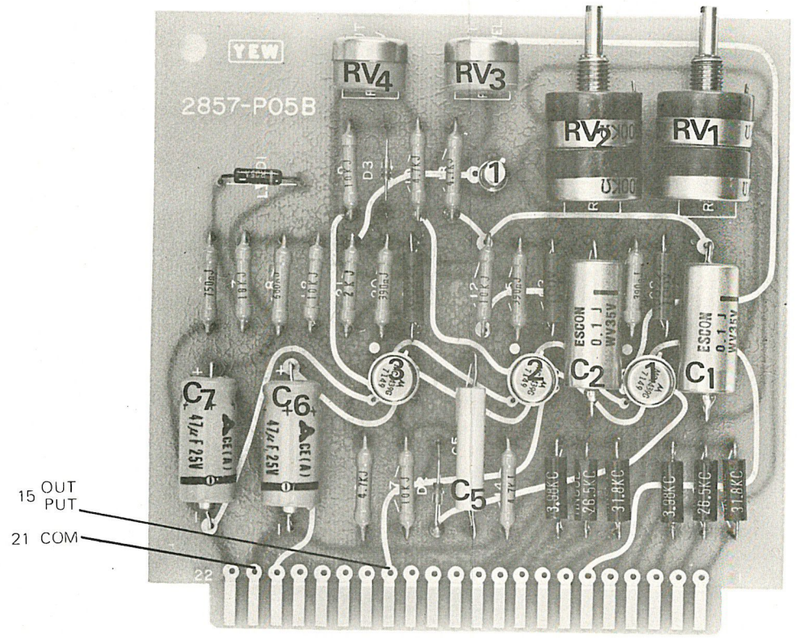


Fig. 4-12

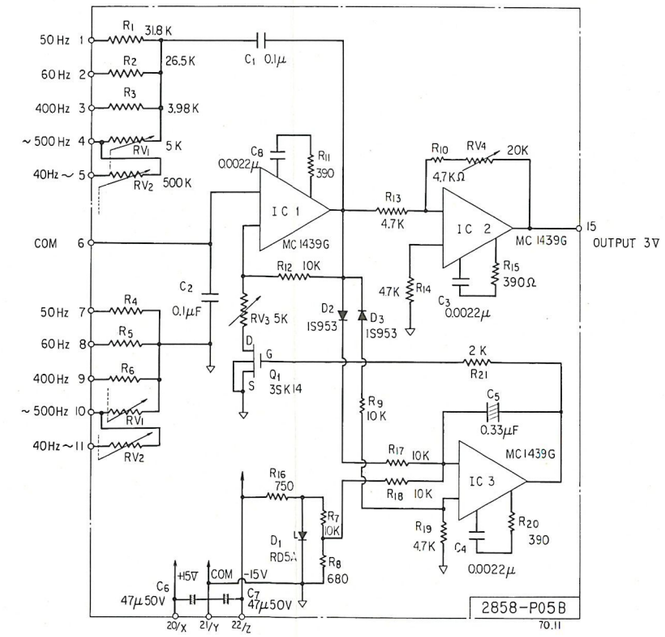


Fig. 4-13

4.7 2858-P_{06} Reference Integrator Circuit Card

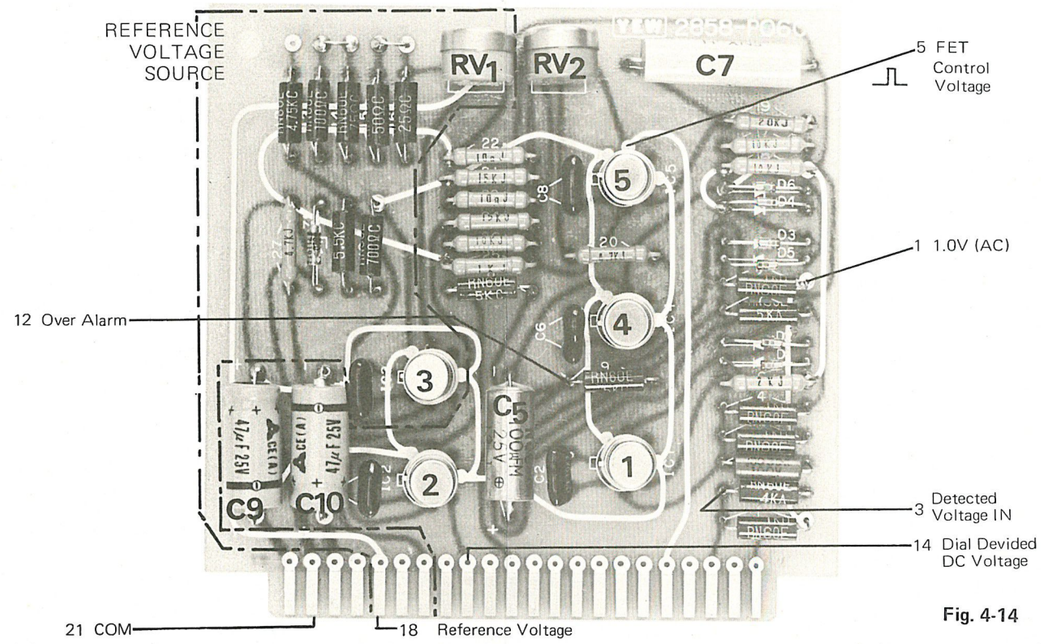


Fig. 4-14

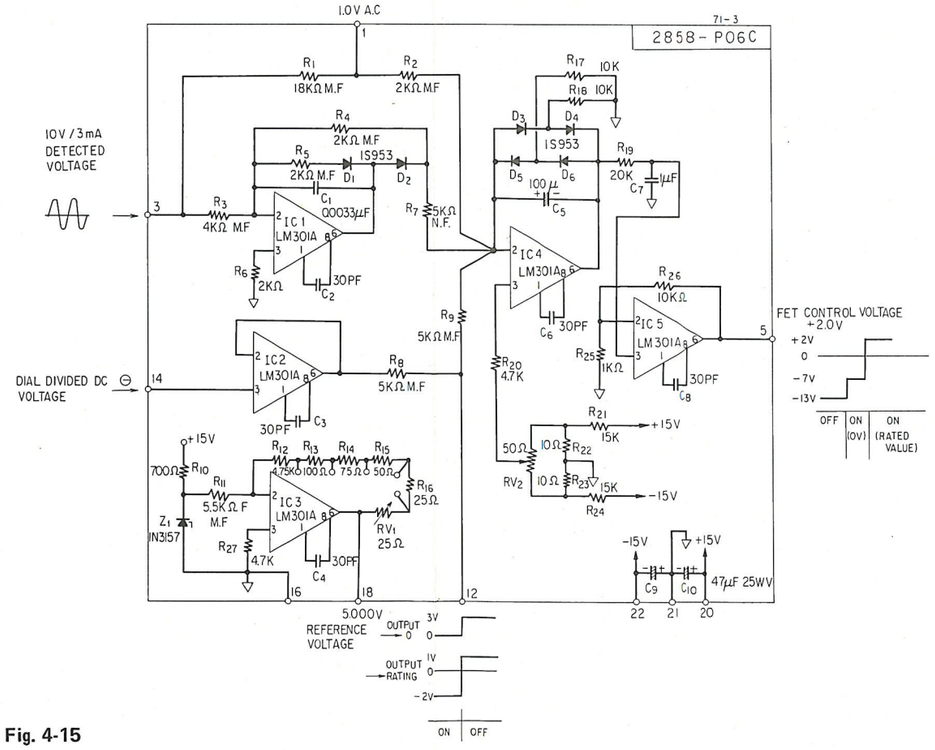


Fig. 4-15

4.8 2858-P_{07} FET Controller Circuit Card

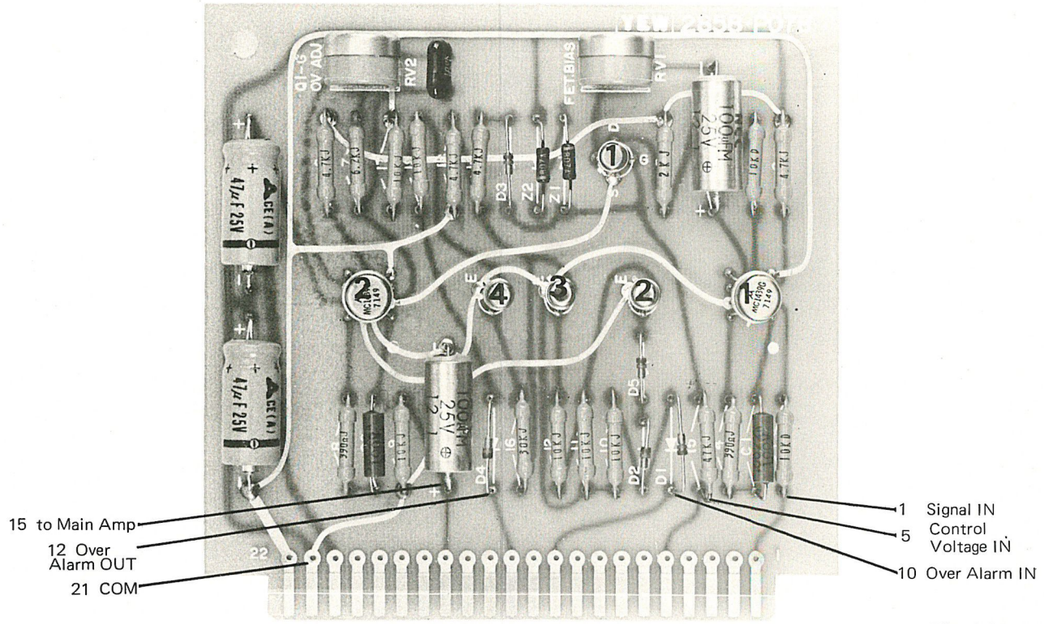


Fig. 4-16

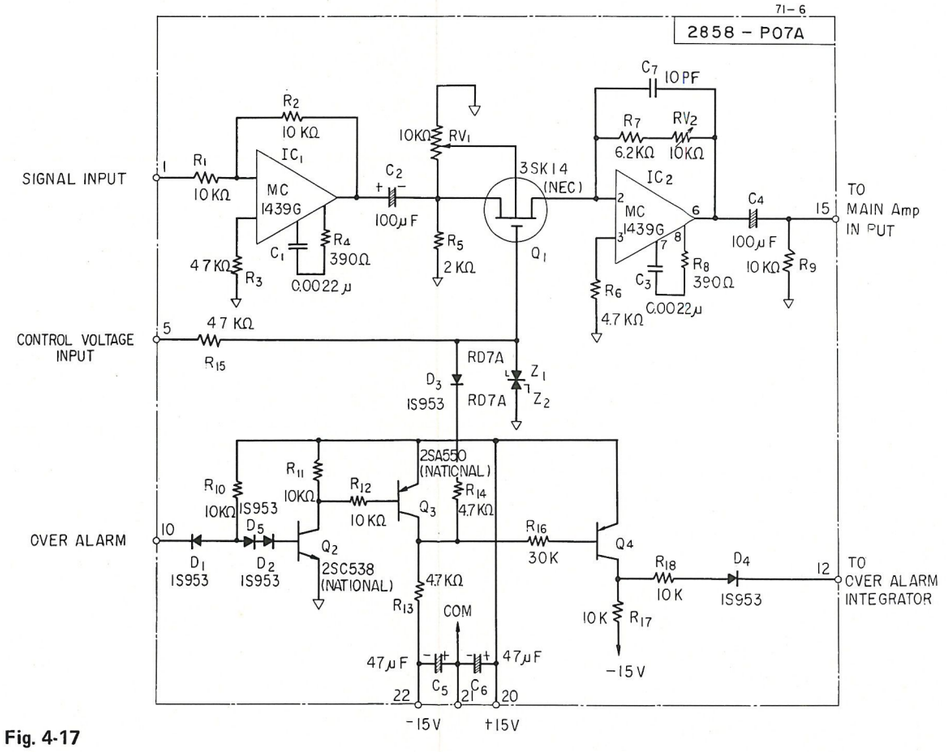


Fig. 4-17

4.9 2858-P_{08} Preamplifier Circuit Card

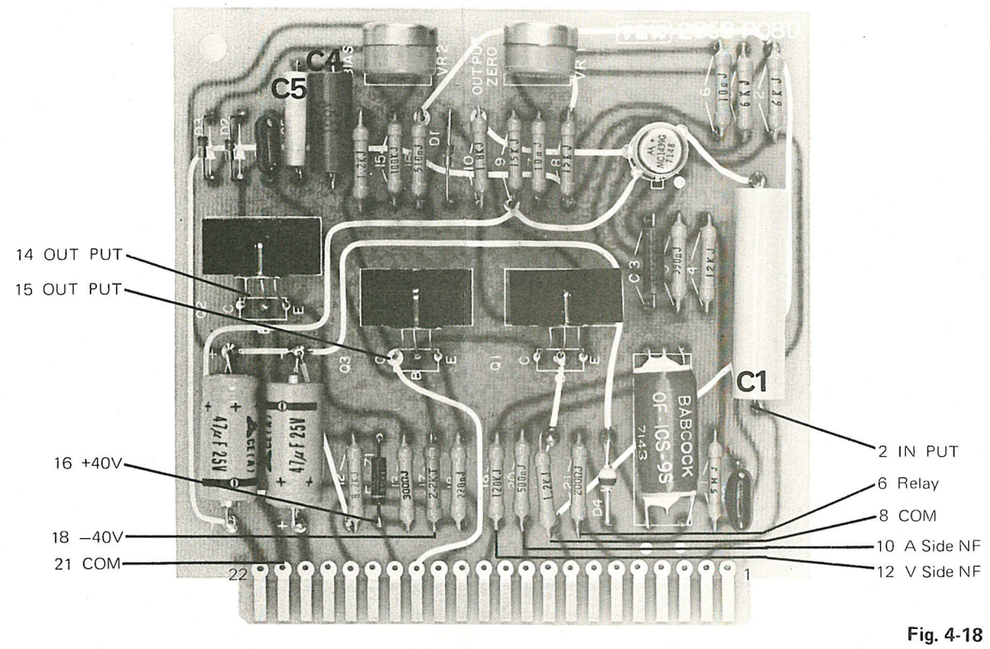


Fig. 4-18

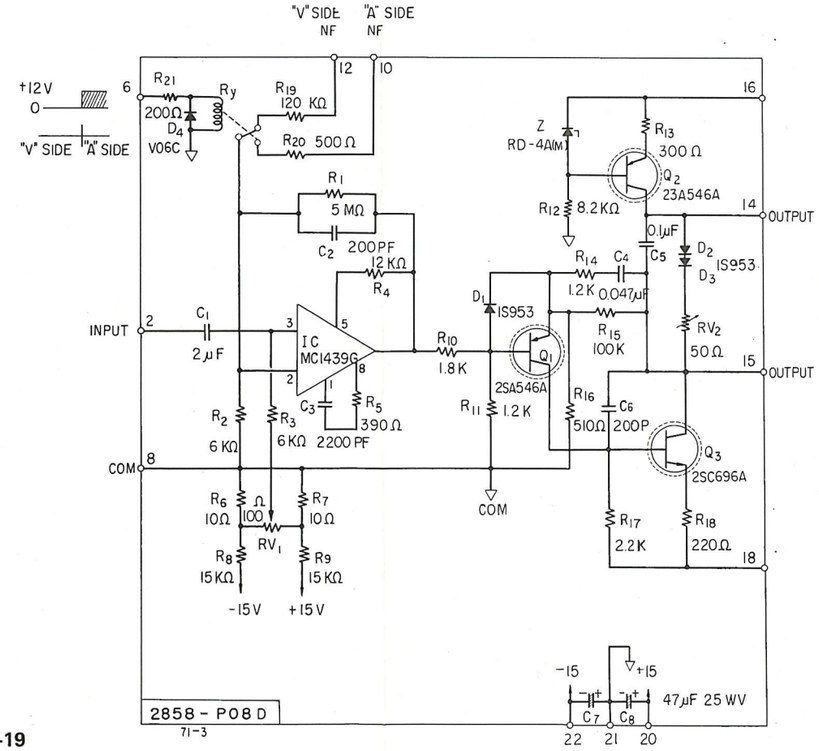


Fig. 4-19

4.10 2858-P_{09} Medium · Stage AMP · Circuit Card

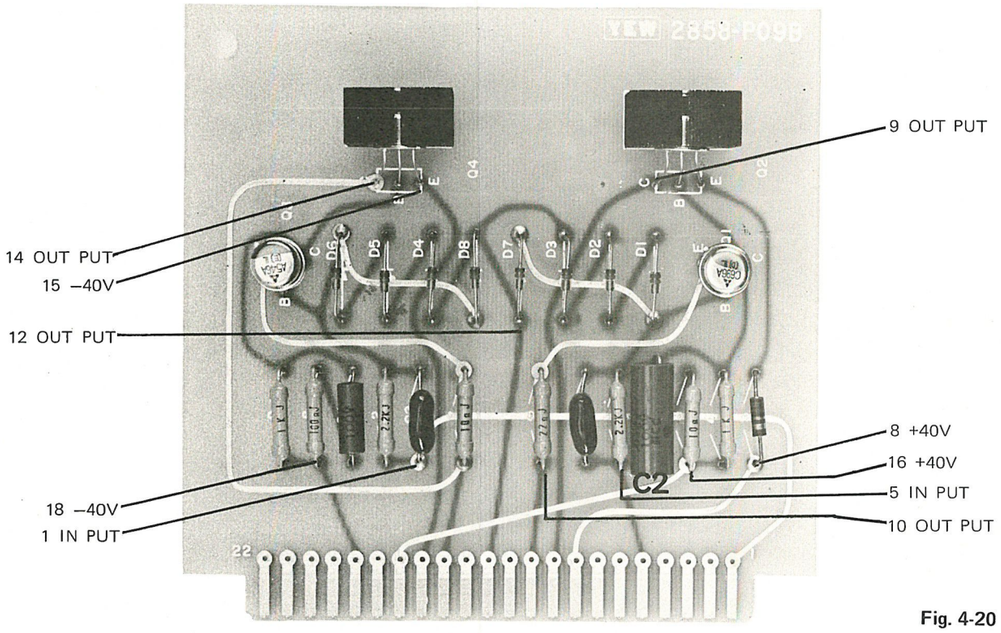


Fig. 4-20

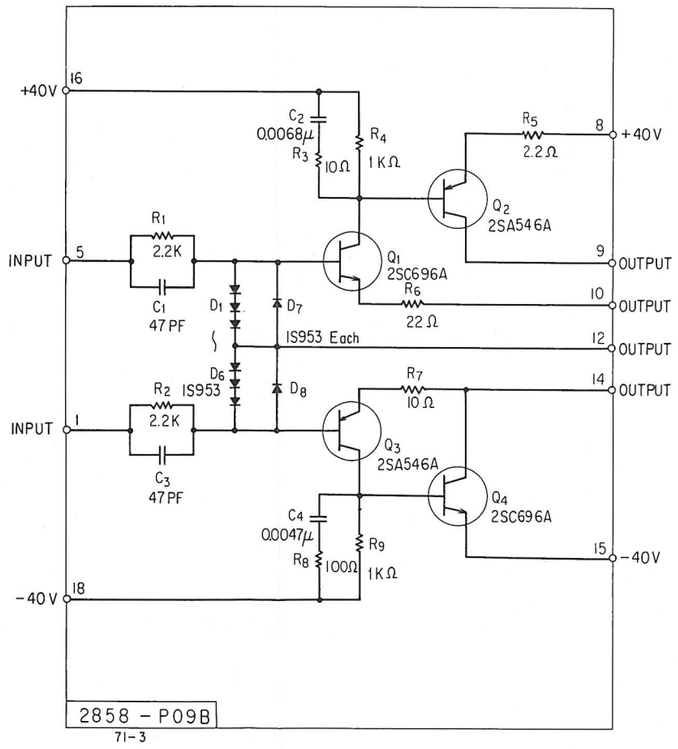


Fig. 4-21

4.11 2858-P_{10} ALARM Circuit Card

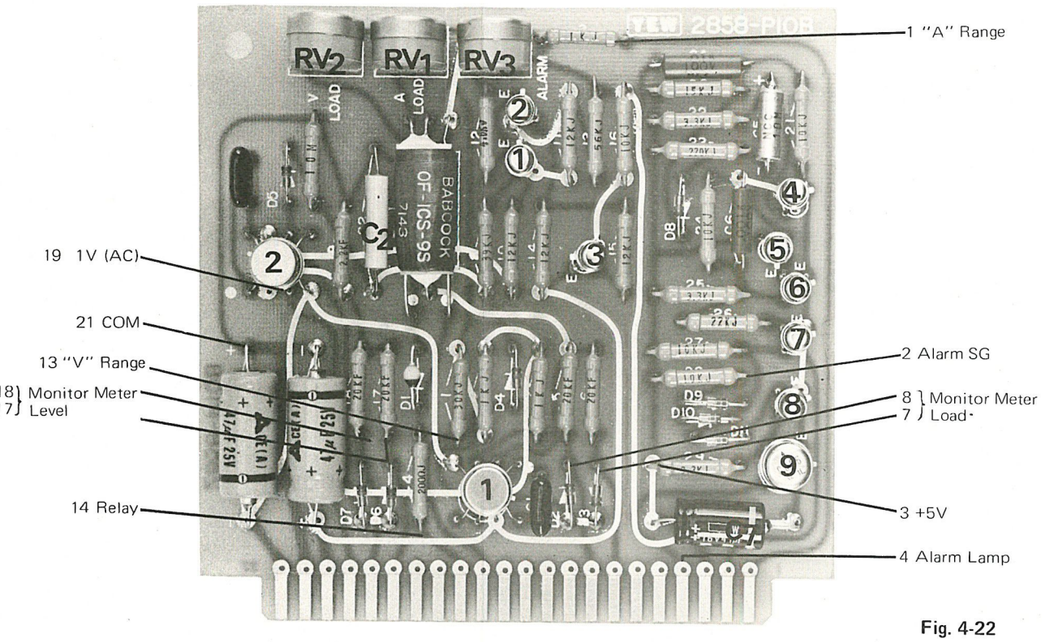


Fig. 4-22

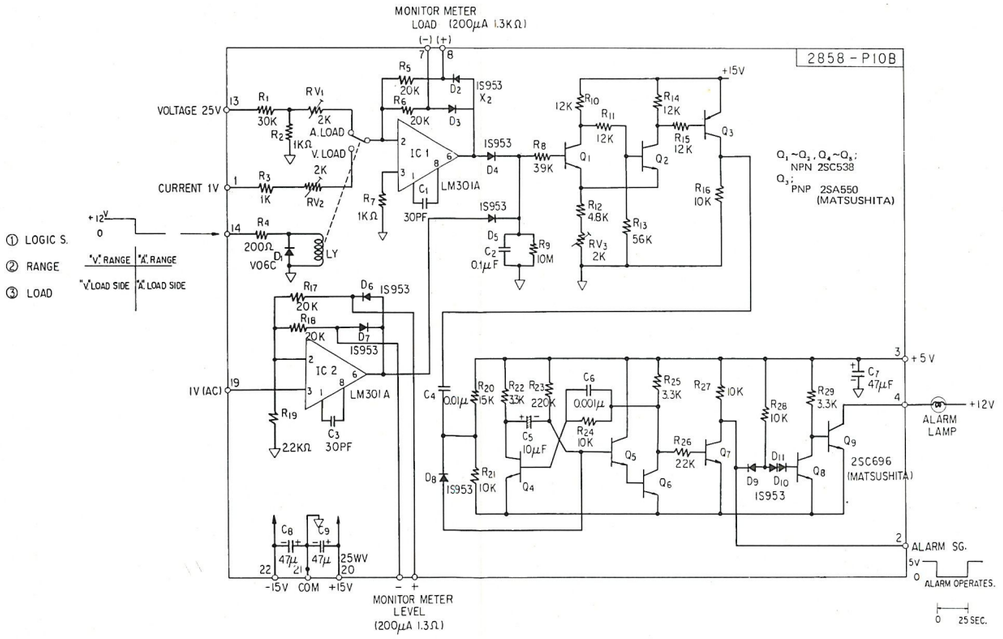


Fig. 4-23

4.12 2858-P_{11} ON/OFF Circuit Card

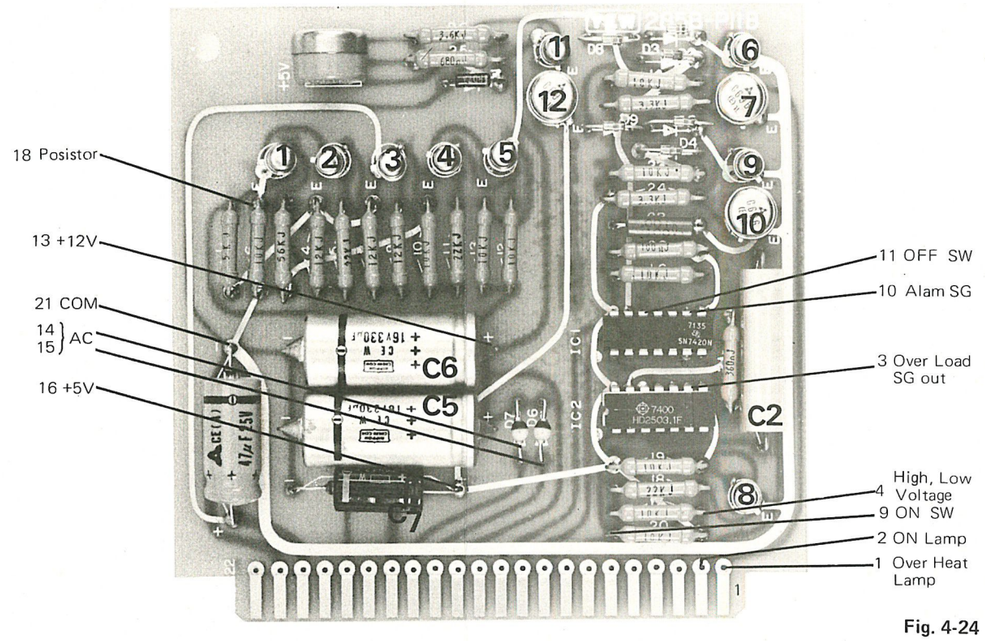


Fig. 4-24

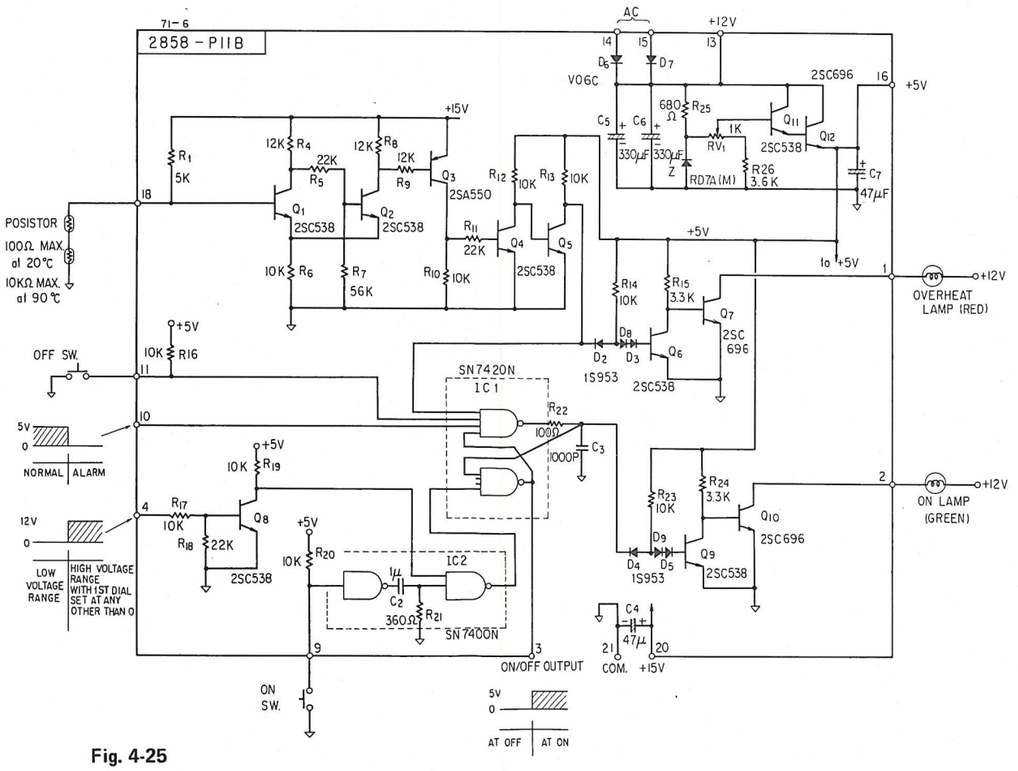


Fig. 4-25

4.13 Type 2858 Decimal Circuit Point Card

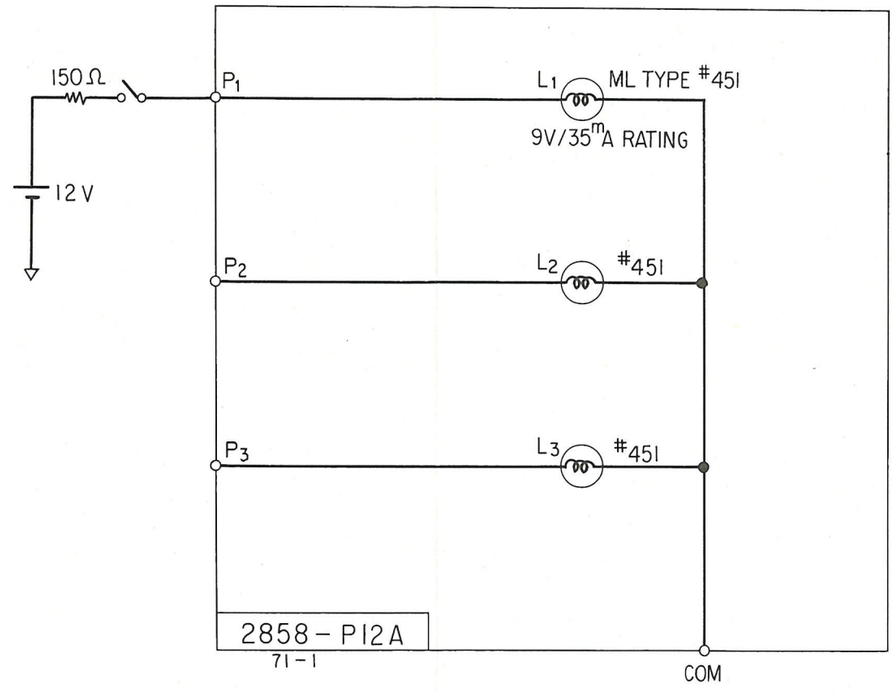


Fig. 4-26

5. PARTS LIST

Notes: Replace the item marked with ☆☆ as an assembly even when a part of it is damaged. Request the assembly to YEW.

5.1 Parts for Overall Wiring

72.4

Part No.	Description			Manufacturer	Remarks
R1	Wire Wound Resistor		6000Ω±0.5Ω	YEW	
R2	Wire Wound Resistor		2500Ω±0.3Ω	YEW	
R3	Wire Wound Resistor		400Ω±0.04Ω	YEW	
	Assembly of Rotary Switch SW2 and its Resistors				☆☆
	R_4~R_{15}: 12 pcs, Nominal Resistance 1000Ω each				
	R_{57}~R_{68}: 12 pcs, Nominal Resistance 50Ω each				
	SW2: Rotary Switch				
	Assembly of Rotary Switch SW3 and its Resistors				☆☆
	R_{16}~R_{26}: 11 pcs, Nominal Resistance 200Ω each				
	R_{69}~R_{78}: 10 pcs, Nominal Resistance 10Ω each				
	SW3: Rotary Switch				
	Assembly of Rotary Switch SW4 and its Resistors				☆☆
	R_{27}~R_{37}: 11 pcs, Nominal Resistance 40Ω each				
	SW4: Rotary Switch				
	Assembly of SW5 and its Resistors				☆☆
	R_{38}~R_{47}: 10 pcs, Nominal resistance 8Ω each				
	SW5: Rotary Switch				
R48	Not used				
R49	Not used				
R50	Not used				
R51	Wire Wound Resistor		3.34KΩ±10Ω	YEW	
R52	Wire Wound Resistor		3.77KΩ±10Ω	YEW	
R53	Wire Wound Resistor		6.15KΩ±10Ω	YEW	
R54	Wire Wound Resistor		29.45KΩ±10Ω	YEW	
R55	Wire Wound Resistor		14.70KΩ±10Ω	YEW	
R56	Wire Wound Resistor		5.85KΩ±10Ω	YEW	
R79	Not used				
R80	Not used				
R81	Wire Wound Resistor		0.3Ω±0.01Ω	YEW	
R82	Carbon Resistor	RD¼PX	4.7ΩJ		
R83	Carbon Resistor	RD¼PX	33ΩJ		
R84	Wire Wound Resistor		0.3Ω±0.01Ω	YEW	
R85	Wire Wound Resistor		0.3Ω±0.01Ω	YEW	
R86	Carbon Resistor	RD¼PX	4.7ΩJ		
R87	Carbon Resistor	RD¼PX	33ΩJ		
R88	Wire Wound Resistor		0.3Ω±0.01Ω	YEW	
R89	Carbon Resistor	RD1PX	12ΩJ		
R90	Carbon Resistor	RD1PX	12ΩJ		
R91	Wire Wound Resistor.		0.5Ω±0.01Ω	YEW	
R99	Carbon Resistor	RD¼PX	10MΩJ		
R101	Carbon Resistor	RD¼PX	4.7 KΩJ		
R102	Carbon Resistor	RD1PX	150ΩJ		
RV1	Variable Resistor	MF223N	5KΩ	Nippon Servo	
RV2	Variable Resistor	RV30YG40RC	50KΩ	Nippon Servo	
C1	Electrolytic Capacitor	63-LG-10000	10000μF 63V	Nippon Chemical	
C2	Electrolytic Capacitor	63-LG-10000	10000μF 63V	Nippon Chemical	
C3	Dipped Mica Capacitor	DM15C102K5	1000PF	Soshin	

5.1 Parts for Overall Wiring (continued)

72.4

Part No.	Description			Manufacturer	Remarks
C4	Polyester Film Capacitor	FNX-H-1W1K	1μF	Matsuo Denki	
PL1	Pilot Lamp	12V. 0.03A (Green)		Mitsuya Denki	
PL2	Pilot Lamp	12V. 0.03A (Red)		Mitsuya Denki	
PL3	Pilot Lamp	12V. 0.03A (Red)		Mitsuya Denki	
PL4~PL6	Not used				
PL7	Pilot Lamp	12V. 0.03A (White)		Mitsuya Denki	
PL8	Miniature Lead Lamp	ML Type #451 9V/35mA		Hamai	
SW1	Rotary Switch	R80-6-6-16 (14.4°)		TOSOKU	
SW6	Rotary Switch	OM25N-3-6-5 (30°)		TOSOKU	
SW7	Rotary Switch	R56-2-4-3 (30°)		TOSOKU	
SW8	Micro Switch	V-10-1A8		Tateishi	
SW9	Micro Switch	V-10-1A8		Tateishi	
SW10	Micro Switch	V-10-1A8		Tateishi	
SW11	Micro Switch	V-10-1A8		Tateishi	
Pth 1	Posistor	PTH-60BG	100Ω	Murata	
Pth 2	Posistor	PTH-60BG	100Ω	Murata	
Q1	Transistor	2SD214		Sanken	
Q2	Transistor	2SD214		Sanken	
D1	Diode	1SI652	150V 12A	Toshiba	
D2	Diode	1SI652	150V 12A	Toshiba	
D3	Diode	1SI652R	150V 12A	Toshiba	
D4	Diode	1SI652R	150V 12A	Toshiba	
D5	Diode	V06C	200V 1.2A	Hitachi	
D6	Diode	V06C	200V 1.2A	Hitachi	
Z1	Diode	RD-19B		Nippon Denki	
Z2	Diode	RD-19B		Nippon Denki	
L1	Inductance		150μH	YEW	
FAN	FAN	CT4B55	100V	Nippon Servo	
F1	Time Lag Fuse	F102-4A		Hamai	
F2	Time Lag Fuse	F102-4A		Hamai	
F3	Time Lag Fuse	F102-4A		Hamai	
M1	Meter	H04		YEW	
M2	Meter	H04		YEW	
N.F	Noise Filter	FCL-190-2	250V 3A	TDK	

5.2 Parts for Unit, Decimal Point, Matrix. (2858-P_{01})

71.3

Part No.	Description			Manufacturer	Remarks
P01-R_1	Carbon Resistor	RD¼PX	150ΩJ		
P01-R_2	Carbon Resistor	RD¼PX	150ΩJ		
P01-R_3	Carbon Resistor	RD¼PX	150ΩJ		
P01-V06C	Diode	V06C		Hitachi	22 pcs.

5.3 Parts for Reference Resistor (High Voltage) Circuit (2858-P_{02})

70.22

Part No.	Description			Manufacturer	Remarks
	Reference Resistor (High Voltage) PCB Assembly (2858-P02)			YEW	☆☆
P02-R_1~R_6	Metallized Film Resistor	RN75E	50KΩA		6 pcs.
P02-R_7	Metallized Film Resistor	RN75E	30KΩA		
P02-R_8	Metallized Film Resistor	RN75E	13,333KΩA		

5.4 Parts for Reference Resistor (Low Voltage) Circuit (2858-P_{03})

70.11

Part No.	Description			Manufacturer	Remarks
	Reference Resistor (Low Voltage) PCB Assembly (2858-P03)			YEW	☆☆
P03-R_1	Metallized Film Resistor	RN75E	50KΩA		
P03-R_2	Metallized Film Resistor	RN75E	13,333KΩA		
P03-R_3	Metallized Film Resistor	RN75E	30KΩA		
P03-R_4	Metallized Film Resistor	RN75E	13,333KΩA		
P03-R_5	Metallized Film Resistor	RN75E	3,333KΩA		
P03-R_6	Metallized Film Resistor	RN75E	580ΩC		
P03-R_7	Wire Wound Resistor		14.0Ω±0.1Ω	YEW	
P03-R_8	Wire Wound Resistor		18Ω±0.1Ω	YEW	
P03-RV	Variable Resistor	LAMBDA 13S	20Ω	Copal	
P03-Z_1	Diode	RD19B		Nippon Denki	
P03-Z_2	Diode	RD19B		Nippon Denki	

5.5 Parts for ±15V Power Supply Circuit (2858-P_{04})

70.11

Part No.	Description			Manufacturer	Remarks
P04-Q_1	Transistor	2SK11R		Toshiba	
P04-Q_2	Transistor	2SC538		Matsushita	
P04-Q_3	Transistor	2SC696		Matsushita	
P04-Q_4	Transistor	2SC538		Matsushita	
P04-Q_5	Transistor	2SC538		Matsushita	
P04-Q_6	Transistor	2SK11R		Toshiba	
P04-Q_7	Transistor	2SA550		Matsushita	
P04-Q_8	Transistor	2SA550		Matsushita	
P04-Q_9	Transistor	2SA550		Matsushita	
P04-Q_{10}	Transistor	2SA550		Matsushita	
P04-D_1	Diode	SH-1Z		Sanken	
P04-D_2	Diode	SH-1Z		Sanken	
P04-D_3	Diode	SH-1Z		Sanken	
P04-D_4	Diode	SH-1Z		Sanken	
P04-D_5	Diode	SH-1Z		Sanken	
P04-D_6	Diode	SH-1Z		Sanken	
P04-R_1	Carbon Resistor	RD¼PX	680ΩJ		
P04-R_2	Carbon Resistor	RD¼PX	5.6ΩJ		
P04-R_3	Carbon Resistor	RD¼PX	4.7KΩJ		
P04-R_4	Carbon Resistor	RD¼PX	2.7KΩJ		

5.5 Parts for ±15V Power Supply Circuit (2858-P_{04}) (continued)

70.11

Part No.	Description			Manufacturer	Remarks
P04-R_5	Metallized Film Resistor	RE50YR	10KΩJ	Susumu	
P04-R_6	Carbon Resistor	RD¼PX	2.7KΩJ		
P04-R_7	Carbon Resistor	RD¼PX	680ΩJ		
P04-R_8	Carbon Resistor	RD¼PX	5.6ΩJ		
P04-R_9	Metallized Film Resistor	RE50YR	10KΩJ	Susumu	
P04-C_1	Electrolytic Capacitor	25TH-100	100μF 25V	Nippon Chemical	
P04-C_2	Polyester Film Capacitor	MXT-101K	0.001μF	Matsuo Denki	
P04-C_3	Electrolytic Capacitor	25TH-100	100μF 25V	Nippon Chemical	
P04-C_4	Electrolytic Capacitor	25TH-100	100μF 25V	Nippon Chemical	
P04-C_5	Polyester Film Capacitor	MXT-101K	0.001μF	Matsuo Denki	
P04-C_6	Electrolytic Capacitor	25TH-100	100μF 25V	Nippon Chemical	
P04-Z_{10}	Zener Diode	RD-7A		Nippon Denki	

5.6 Parts for Oscillator Circuit (2858-P_{05})

70.11

Part No.	Description			Manufacturer	Remarks
	Oscillator PCB Assembly (2858-P05)			YEW	☆☆
P05-R_1	Metallized Film Resistor	RN60E	31.8KΩC		
P05-R_2	Metallized Film Resistor	RN60E	26.5KΩC		
P05-R_3	Metallized Film Resistor	RN60E	3.98KΩC		
P05-R_4	Metallized Film Resistor	RN60E	31.8KΩC		
P05-R_5	Metallized Film Resistor	RN60E	26.5KΩC		
P05-R_6	Metallized Film Resistor	RN60E	3.98KΩC		
P05-R_7	Carbon Resistor	RD¼PX	10KΩJ		
P05-R_8	Carbon Resistor	RD¼PX	680ΩJ		
P05-R_9	Carbon Resistor	RD¼PX	10KΩJ		
P05-R_{10}	Carbon Resistor	RD¼LX	4.7KΩJ		
P05-R_{11}	Carbon Resistor	RD¼PX	390ΩJ		
P05-R_{12}	Carbon Resistor	RD¼PX	10KΩJ		
P05-R_{13}	Carbon Resistor	RD¼PX	4.7KΩJ		
P05-R_{14}	Carbon Resistor	RD¼PX	4.7KΩJ		
P05-R_{15}	Carbon Resistor	RD¼PX	390ΩJ		
P05-R_{16}	Carbon Resistor	RD¼PX	750ΩJ		
P05-R_{17}	Carbon Resistor	RD¼PX	10KΩJ		
P05-R_{18}	Carbon Resistor	RD¼PX	10KΩJ		
P05-R_{19}	Carbon Resistor	RD¼PX	4.7KΩJ		
P05-R_{20}	Carbon Resistor	RD¼PX	390ΩJ		
P05-R_{21}	Carbon Resistor	RD¼PX	2KΩJ		
P05-RV_2	Variable Resistor	RVIGYG15S	5KΩB	Cosmos	
P05-RV_2	Variable Resistor	RVIGYG15S	500KΩB	Cosmos	
P05-RV_3	Variable Resistor	LAMBDA13S	5KΩ	Copal	
P05-RV_4	Variable Resistor	LAMBDA13S	20KΩ	Copal	
P05-C_1	Polystyrene Film Capacitor	CQ02MIV10002J01	0.1μF 35V	Fujitsu	
P05-C_2	Polystyrene Film Capacitor	CQ02MIV10002J01	0.1μF 35V	Fujitsu	
P05-C_3	Mica Capacitor	MXT-1D22K	0.0022μF	Matsuo	
P05-C_4	Mica Capacitor	MXT-1D22K	0.0022μF	Matsuo	
P05-C_5	Mica Capacitor	FNX-1P33-HK	0.33μF	Matsuo	

5.6 Parts for Oscillator Circuit (2858-P_{05}) (continued)

70.11

Part No.	Description			Manufacturer	Remarks
P05-C_6	Electrolytic Capacitor	25TB-47	47μF 25V	Nippon Chemical	
P05-C_7	Electrolytic Capacitor	25TB-47	47μF 25V	Nippon Chemical	
P05-D_1	Diode	RD-5A		Nippon Denki	
P05-D_2	Diode	1S953		Nippon Denki	
P05-D_3	Diode	1S953		Nippon Denki	
P05-Q_1	Transistor	3SK14			
P05-IC_1	IC	MC1439G		Motorola	
P05-IC_2	IC	MC1439G		Motorola	
P05-IC_3	IC	MC1439G		Motorola	

5.7 Parts for Reference Integrator Circuit (2858-P_{06})

71.3

Part No.	Description			Manufacturer	Remarks
	Reference Integrator PCB Assembly (2858-P06)				☆☆
P06-R_1	Metallized Film Resistor	RN60E	18KΩA		
P06-R_2	Metallized Film Resistor	RN60E	20KΩA		
P06-R_3	Metallized Film Resistor	RN60E	4KΩA		
P06-R_4	Metallized Film Resistor	RN60E	2KΩA		
P06-R_5	Metallized Film Resistor	RN60E	2KΩA		
P06-R_6	Carbon Resistor	RD¼PX	2KΩJ		
P06-R_7	Metallized Film Resistor	RN60E	5KΩA		
P06-R_8	Metallized Film Resistor	RN60E	5KΩA		
P06-R_9	Metallized Film Resistor	RN60E	5KΩA		
P06-R_{10}	Metallized Film Resistor	RN60E	700ΩC		
P06-R_{11}	Metallized Film Resistor	RN60E	5.5KΩC		
P06-R_{12}	Metallized Film Resistor	RN60E	4.75KΩC		
P06-R_{13}	Metallized Film Resistor	RN60E	100ΩC		
P06-R_{14}	Metallized Film Resistor	RN60E	75ΩC		
P06-R_{15}	Metallized Film Resistor	RN60E	50ΩC		
P06-R_{16}	Metallized Film Resistor	RN60E	25ΩC		
P06-R_{17}	Carbon Resistor	RD¼PX	10KΩJ		
P06-R_{18}	Carbon Resistor	RD¼PX	10KΩJ		
P06-R_{19}	Carbon Resistor	RD¼PX	20KΩJ		
P06-R_{20}	Carbon Resistor	RD¼PX	4.7KΩJ		
P06-R_{21}	Carbon Resistor	RD¼PX	15KΩJ		
P06-R_{22}	Carbon Resistor	RD¼PX	10ΩJ		
P06-R_{23}	Carbon Resistor	RD¼PX	10ΩJ		
P06-R_{24}	Carbon Resistor	RD¼PX	15KΩJ		
P06-R_{25}	Carbon Resistor	RD¼PX	1KΩJ		
P06-R_{26}	Carbon Resistor	RD¼PX	10KΩJ		
P06-R_{27}	Carbon Resistor	RD¼PX	4.7KΩJ		
P06-RV_1	Variable Resistor	LAMBDA13S	25Ω	Copal	
P06-RV_2	Variable Resistor	LAMBDA13S	50Ω	Copal	
P06-C_1	Polyester Film Capacitor	MXT-1D33K	0.0033μF	Matsuo	
P06-C_2	Dipped Mica Capacitor	DM15C330K5	33pF	Soshin	

5.7 Parts for Reference Integrator Circuit (2858-P06) (continued)

71.3

Part No.	Description			Manufacturer	Remarks
P06-C_3	Dipped Mica Capacitor	DM15C330K5	33pF	Soshin	
P06-C_4	Dipped Mica Capacitor	DM15C330K5	33pF	Soshin	
P06-C_5	Tantalum Capacitor	TAX-H-16V-101M	100μF 16V	Matsuo	
P06-C_6	Dipped Mica Capacitor	DM15C330K5	33pF	Soshin	
P06-C_7	Polyster Film Capacitor	FNX-H-1W1K	1μF	Matsuo	
P06-C_8	Dipped Mica Capacitor	DM15C330K5	33pF	Soshin	
P06-C_9	Electrolytic Capacitor	25TH-47	47μF 25V	Nippon Chemical	
P06-C_{10}	Electrolytic Capacitor	25TH-47	47μF 25V	Nippon Chemical	
P06-D_1	Diode	1S953			
P06-D_2	Diode	1S953			
P06-D_3	Diode	1S953			
P06-D_4	Diode	1S953			
P06-D_5	Diode	1S953			
P06-D_6	Diode	1S953			
P06-Z_1	Diode	IN3157		Motorola	8.4V ±5%
P06-IC_1	IC (OP Amp.)	LM301A		National Semiconductor	
P06-IC_2	IC (OP Amp.)	LM301A		National Semiconductor	
P06-IC_3	IC (OP Amp.)	LM301A		National Semiconductor	
P06-IC_4	IC (OP Amp.)	LM301A		National Semiconductor	
P06-IC_5	IC (OP Amp.)	LM301A		National Semiconductor	

5.8 Parts for FET Controller Circuit (2858-P_{07})

71.6

Part No.	Description			Manufacturer	Remarks
P07-R_1	Carbon Resistor	RD¼PX	10kΩD		
P07-R_2	Carbon Resistor	RD¼PX	10kΩD		
P07-R_3	Carbon Resistor	RD¼PX	4.7kΩD		
P07-R_4	Carbon Resistor	RD¼PX	390ΩJ		
P07-R_5	Carbon Resistor	RD¼PX	2kΩJ		
P07-R_6	Carbon Resistor	RD¼PX	4.7kΩJ		
P07-R_7	Carbon Resistor	RD¼PX	6.2kΩJ		
P07-R_8	Carbon Resistor	RD¼PX	390ΩJ		
P07-R_9	Carbon Resistor	RD¼PX	10kΩJ		
P07-R_{10}	Carbon Resistor	RD¼PX	10kΩJ		
P07-R_{11}	Carbon Resistor	RD¼PX	10kΩJ		
P07-R_{12}	Carbon Resistor	RD¼PX	10kΩJ		
P07-R_{13}	Carbon Resistor	RD¼PX	4.7kΩJ		
P07-R_{14}	Carbon Resistor	RD¼PX	4.7kΩJ		
P07-R_{15}	Carbon Resistor	RD¼PX	47kΩJ		
P07-R_{16}	Carbon Resistor	RD¼PX	30kΩJ		
P07-R_{17}	Carbon Resistor	RD¼PX	10kΩJ		
P07-R_{18}	Carbon Resistor	RD¼PX	10kΩJ		
P07-RV_1	Variable Resistor	LAMBDA 13S	10kΩ	Copal	
P07-RV_2	Variable Resistor	LAMBDA 13S	10kΩ	Copal	
P07-C_1	Polyester Film Capacitor	MXT-1D22K	0.0022μF	Matsuo	

5.8 Parts for FET Controller Circuit (2858-P_{07}) (continued)

71.6

Part No.	Description			Manufacturer	Remarks
P07-C_2	Tantalum Capacitor	TAX-H-16V-101M	100μF16V	Matsuo	
P07-C_3	Polyester Film Capacitor	MXT-1D22K	0.0022μF	Matsuo	
P07-C_4	Tantalum Capacitor	TAX-H-16V-101M	100μF16V	Matsuo	
P07-C_5	Electrolytic Capacitor	25TA-47	47μF 25V	Nippon Chemical	
P07-C_6	Electrolytic Capacitor	25TA-47	47μF 25V	Nippon Chemical	
P07-C_7	Dipped Mica Capacitor	DM15C100K5	10pF	Soshin	
P07-D_1	Diode	IS953		Nippon Denki	
P07-D_2	Diode	IS953		Nippon Denki	
P07-D_3	Diode	IS953		Nippon Denki	
P07-D_4	Diode	IS953		Nippon Denki	
P07-D_5	Diode	IS953		Nippon Denki	
P07-Z_1	Diode	RD-7A		Nippon Denki	
P07-Z_2	Diode	RD-7A		Nippon Denki	
P07-Q_1	FET Transistor	3SK14		Nippon Denki	
P07-Q_2	Transistor	2SC538		Matsushita Denki	
P07-Q_3	Transistor	2SA550		Matsushita Denki	
P07-Q_4	Transistor	2SA550		Matsushita Denki	
P07-IC_1	IC (OP Amp.)	MC1439G		Motorola	
P07-IC_2	IC (OP Amp.)	MC1439G		Motorola	

5.9 Parts for Preamp. Circuit (2858-P_{08})

71.3

Part No.	Description			Manufacturer	Remarks
P08-R_1	Carbon Resistor	RD¼PX	5MΩJ		
P08-R_2	Carbon Resistor	RD¼PX	6kΩJ		
P08-R_3	Carbon Resistor	RD¼PX	6kΩJ		
P08-R_4	Carbon Resistor	RD¼PX	12KΩJ		
P08-R_5	Carbon Resistor	RD¼PX	390ΩJ		
P08-R_6	Carbon Resistor	RD¼PX	10ΩJ		
P08-R_7	Carbon Resistor	RD¼PX	10ΩJ		
P08-R_8	Carbon Resistor	RD¼PX	15kΩJ		
P08-R_9	Carbon Resistor	RD¼PX	15kΩJ		
P08-R_{10}	Carbon Resistor	RD¼PX	1.8kΩJ		
P08-R_{11}	Carbon Resistor	RD¼PX	1.2kΩJ		
P08-R_{12}	Carbon Resistor	RD¼PX	8.2kΩJ		
P08-R_{13}	Carbon Resistor	RD¼PX	300ΩJ		
P08-R_{14}	Carbon Resistor	RD¼PX	1.2kΩJ		
P08-R_{15}	Carbon Resistor	RD¼PX	100kΩJ		
P08-R_{16}	Carbon Resistor	RD¼PX	510ΩJ		
P08-R_{17}	Carbon Resistor	RD¼PX	2.2kΩJ		
P08-R_{18}	Carbon Resistor	RD¼PX	220ΩJ		
P08-R_{19}	Carbon Resistor	RD¼PX	120ΩJ		
P08-R_{20}	Carbon Resistor	RD¼PX	500ΩJ		
P08-R_{21}	Carbon Resistor	RD¼PX	200ΩJ		
P08-RV_1	Variable Resistor	LAMBDA 13S	100Ω	Copal	
P08-RV_2	Variable Resistor	LAMBDA 13S	100Ω	Copal	
P08-C_1	Polyester Film Capacitor	FNX-H-100-2.2K	2μF	Matsuo	

5.9 Parts for Preamp. Circuit (2858-P_{08}) (continued)

71.3

Part No.	Description			Manufacturer	Remarks
P08-C_2	Dipped Mica Capacitor	DM15C221K5	220pF	Soshin	
P08-C_3	Polyester Film Capacitor	MXT-1D22K	0.0022μF	Matsuo	
P08-C_4	Polyester Film Capacitor	MXT-1S68K	0.068μF	Matsuo	
P08-C_5	Polyester Film Capacitor	FNX-1P1K	0.1μF	Matsuo	
P08-C_6	Dipped Mica Capacitor	DM15C221K5	220pF	Soshin	
P08-C_7	Electrolytic Capacitor	25TH-47	47μF 25V	Nippon Chemical	
P08-C_8	Electrolytic Capacitor	25TH-47	47μF 25V	Nippon Chemical	
P08-D_1	Diode	1S953		Nippon Denki	
P08-D_2	Diode	1S953		Nippon Denki	
P08-D_3	Diode	1S953		Nippon Denki	
P08-D_4	Diode	V06C		Hitachi	
P08-Z	Diode	RD-4A(M)		Nippon Denki	
P08-Q_1	Transistor	2SA546A		Matsushita	
P08-Q_2	Transistor	2SA546A		Matsushita	
P08-Q_3	Transistor	2SA546A		Matsushita	
P08-IC	IC (OP Amp.)	MC1439G		Motorola	
P08-RY	Micro Relay	OF-ICS-9S		Phillips	With Electro-magnetic & Electro-statis Shielded. Transfer. 9V/15mA

5.10 Parts for Medium Stage Amp. Circuit (2858-P_{09})

71.3

Part No.	Description			Manufacturer	Remarks
P09-R_1	Carbon Resistor	RD¼PX	2.2ΩJ		
P09-R_2	Carbon Resistor	RD¼PX	2.2ΩJ		
P09-R_3	Carbon Resistor	RD¼PX	10ΩJ		
P09-R_4	Carbon Resistor	RD¼PX	1kΩJ		
P09-R_5	Solid Resistor	RC¼GF	2.2ΩK		
P09-R_6	Carbon Resistor	RD¼PX	22ΩJ		
P09-R_7	Carbon Resistor	RD¼PX	10ΩJ		
P09-R_8	Carbon Resistor	RD¼PX	100ΩJ		
P09-R_9	Carbon Resistor	RD¼PX	1kΩJ		
P09-C_1	Dipped Mica Capacitor	DM15C471K3	47pF	Soshin	
P09-C_2	Polyester Film Capacitor	MXT-1S68HK	0.068μF	Matsuo	
P09-C_3	Dipped Mica Capacitor	DM15C471K3	47pF	Soshin	
P09-C_4	Polyester Film Capacitor	MXT-1D47K	0.0047μF	Matsuo	
P09-D_1	Diode	1S953		Nippon Denki	
P09-D_2	Diode	1S953		Nippon Denki	
P09-D_3	Diode	1S953		Nippon Denki	
P09-D_4	Diode	1S953		Nippon Denki	
P09-D_5	Diode	1S953		Nippon Denki	
P09-D_6	Diode	1S953		Nippon Denki	
P09-D_7	Diode	1S953		Nippon Denki	
P09-D_8	Diode	1S953		Nippon Denki	
P09-Q_1	Transistor	2SC696A		Matsushita Denki	

5.10 Parts for Medium Stage Amp. Circuit (2858-P_{09}) (continued)

71.3

Part No.	Description		Manufacturer	Remarks
P09-Q_2	Transistor	2SA546A	Matsushita Denki	
P09-Q_3	Transistor	2SA546A	Matsushita Denki	
P09-Q_4	Transistor	2SC946A	Matsushita Denki	

5.11 Parts for Alarm Circuit (2858-P_{10})

71.3

Part No.	Description			Manufacturer	Remarks
P10-R_1	Carbon Resistor	RD¼PX	30kΩJ		
P10-R_2	Carbon Resistor	RD¼PX	1kΩJ		
P10-R_3	Carbon Resistor	RD¼PX	1kΩJ		
P10-R4	Carbon Resistor	RD¼PX	200ΩJ		
P10-R_5	Carbon Resistor	RD¼PX	20kΩF		
P10-R_6	Carbon Resistor	RD¼PX	20kΩF		
P10-R_7	Carbon Resistor	RD¼PX	1kΩJ		
P10-R_8	Carbon Resistor	RD¼PX	39kΩJ		
P10-R_9	Carbon Resistor	RD¼PX	10MΩK		
P10-R_{10}	Carbon Resistor	RD¼PX	12kΩJ		
P10-R_{11}	Carbon Resistor	RD¼PX	12kΩJ		
P10-R_{12}	Carbon Resistor	RD¼PX	4.8kΩJ		
P10-R_{13}	Carbon Resistor	RD¼PX	56kΩJ		
P10-R_{14}	Carbon Resistor	RD¼PX	12kΩJ		
P10-R_{15}	Carbon Resistor	RD¼PX	12kΩJ		
P10-R_{16}	Carbon Resistor	RD¼PX	10kΩJ		
P10-R_{17}	Carbon Resistor	RD¼PX	20kΩF		
P10-R_{18}	Carbon Resistor	RD¼PX	20kΩF		
P10-R_{19}	Carbon Resistor	RD¼PX	2.2kΩF		
P10-R_{20}	Carbon Resistor	RD¼PX	15kΩJ		
P10-R_{21}	Carbon Resistor	RD¼PX	10kΩJ		
P10-R_{22}	Carbon Resistor	RD¼PX	3.3kΩJ		
P10-R_{23}	Carbon Resistor	RD¼PX	220kΩJ		
P10-R_{24}	Carbon Resistor	RD¼PX	10kΩJ		
P10-R_{25}	Carbon Resistor	RD¼PX	3.3kΩJ		
P10-R_{26}	Carbon Resistor	RD¼PX	22kΩJ		
P10-R_{27}	Carbon Resistor	RD¼PX	10kΩJ		
P10-R_{28}	Carbon Resistor	RD¼PX	10kΩJ		
P10-R_{29}	Carbon Resistor	RD¼PX	3.3kΩJ		
P10-RV_1	Variable Resistor	LAMBDA 13S	2kΩ	Copal	
P10-RV_2	Variable Resistor	LAMBDA 13S	2kΩ	Copal	
P10-RV_3	Variable Resistor	LAMBDA 13S	2kΩ	Copal	
P10-C_1	Dipped Mica Capacitor	DM15C330K5	33pF	Soshin	
P10-C_2	Polyester Film Capacitor	FNX-H-IPI-K	0.1μF	Matsuo	
P10-C_3	Dipped Mica Capacitor	DM15C330K5	33pF	Soshin	
P10-C_4	Polyester Film Capacitor	MXT-ISIK	0.01μF	Matsuo	
P10-C_5	Tantalum Capacitor	TAX-H-16V-100M	10μF 16V	Matsuo	
P10-C_6	Polyester Film Capacitor	MXT-IDIK	0.001μF	Matsuo	
P10-C_7	Electrolytic Capacitor	16TH-47	47μF 16V	Nippon Chemical	
P10-C_8	Electrolytic Capacitor	25TH-47	47μF 25V	Nippon Chemical	
P10-C_9	Electrolytic Capacitor	25TH-47	47μF 25V	Nippon Chemical	
P10-D_1	Diode	V06C		Hitachi	

5.11 Parts for Alarm Circuit (2858-P_{10}) (continued)

71.3

Part No.	Description		Manufacturer	Remarks
P10-D_2	Diode	1S953	Nippon Denki	
P10-D_3	Diode	1S953	Nippon Denki	
P10-D_4	Diode	1S953	Nippon Denki	
P10-D_5	Diode	1S953	Nippon Denki	
P10-D_6	Diode	1S953	Nippon Denki	
P10-D_7	Diode	1S953	Nippon Denki	
P10-D_8	Diode	1S953	Nippon Denki	
P10-D_9	Diode	1S953	Nippon Denki	
P10-D_{10}	Diode	1S953	Nippon Denki	
P10-D_{11}	Diode	1S953	Nippon Denki	
P10-Q_1	Transistor	2SC538	Matsushita Denki	
P10-Q_2	Transistor	2SC538	Matsushita Denki	
P10-Q_3	Transistor	2SA550	Matsushita Denki	
P10-Q_4	Transistor	2SC538	Matsushita Denki	
P10-Q_5	Transistor	2SC538	Matsushita Denki	
P10-Q_6	Transistor	2SC538	Matsushita Denki	
P10-Q_7	Transistor	2SC538	Matsushita Denki	
P10-Q_8	Transistor	2SC538	Matsushita Denki	
P10-Q_9	Transistor	2SC696	Matsushita Denki	
P10-IC_1	IC (OP Amp.)	LM301A	National Semiconductor	
P10-IC_2	IC (OP Amp.)	LM301A	National Semiconductor	

5.12 Parts for ON/OFF Circuit (2858-P_{11})

71.6

Part No.	Description			Manufacturer	Remarks
P11-R_1	Carbon Resistor	RD¼PX	5kΩJ		
P11-R_2	Not used				
P11-R_3	Not used				
P11-R_4	Carbon Resistor	RD¼PX	12kΩJ		
P11-R_5	Carbon Resistor	RD¼PX	22kΩJ		
P11-R_6	Carbon Resistor	RD¼PX	10kΩJ		
P11-R_7	Carbon Resistor	RD¼PX	56kΩJ		
P11-R_8	Carbon Resistor	RD¼PX	12kΩJ		
P11-R_9	Carbon Resistor	RD¼PX	12kΩJ		
P11-R_{10}	Carbon Resistor	RD¼PX	10kΩJ		
P11-R_{11}	Carbon Resistor	RD¼PX	22kΩJ		
P11-R_{12}	Carbon Resistor	RD¼PX	10kΩJ		
P11-R_{13}	Carbon Resistor	RD¼PX	10kΩJ		
P11-R_{14}	Carbon Resistor	RD¼PX	10kΩJ		
P11-R_{15}	Carbon Resistor	RD¼PX	3.3kΩJ		
P11-R_{16}	Carbon Resistor	RD¼PX	10kΩJ		
P11-R_{17}	Carbon Resistor	RD¼PX	10kΩJ		
P11-R_{18}	Carbon Resistor	RD¼PX	22kΩJ		
P11-R_{19}	Carbon Resistor	RD¼PX	10kΩJ		
P11-R_{20}	Carbon Resistor	RD¼PX	10kΩJ		
P11-R_{21}	Carbon Resistor	RD¼PX	360ΩJ		
P11-R_{22}	Carbon Resistor	RD¼PX	100ΩJ		
P11-R_{23}	Carbon Resistor	RD¼PX	10kΩJ		

5.12 Parts for ON/OFF Circuit (2858-P_{11}) (continued)

71.6

Part No.	Description			Manufacturer	Remarks
P11-R_{24}	Carbon Resistor	RD¼PX	3.3kΩJ		
P11-R_{25}	Carbon Resistor	RD¼PX	680ΩJ		
P11-R_{26}	Carbon Resistor	RD¼PX	3.6kΩJ		
P11-RV_1	Variable Resistor	λ 13S	1kΩ	Copal	
P11-C_1	Not used				
P11-C_2	Polyester Film Capacitor	FNX-H-1W1-K	1μF	Matsuo	
P11-C_3	Polyester Film Capacitor	MXT-1D1-K	0.001μF	Matsuo	
P11-C_4	Electrolytic Capacitor	25TH-47	47μF 25V	Nippon Chemical	
P11-C_5	Electrolytic Capacitor	16TH-330	330μF 16V	Nippon Chemical	
P11-C_6	Electrolytic Capacitor	16TH-330	330μF 16V	Nippon Chemical	
P11-C_7	Electrolytic Capacitor	16TH-47	47μF 16V	Nippon Chemical	
P11-D_1	Not used				
P11-D_2	Diode	1S953		Nippon Denki	
P11-D_3	Diode	1S953		Nippon Denki	
P11-D_4	Diode	1S953		Nippon Denki	
P11-D_5	Diode	1S953		Nippon Denki	
P11-D_6	Diode	60VC		Hitachi	
P11-D_7	Diode	60VC		Hitachi	
P11-D_8	Diode	1S953		Nippon Denki	
P11-D_9	Diode	1S953		Nippon Denki	
P11-Z	Diode	RD-7A(M)		Nippon Denki	
P11-Q_1	Transistor	2SC538		Matsushita Denki	
P11-Q_2	Transistor	2SC538		Matsushita Denki	
P11-Q_3	Transistor	2SA550		Matsushita Denki	
P11-Q_4	Transistor	2SC538		Matsushita Denki	
P11-Q_5	Transistor	2SC538		Matsushita Denki	
P11-Q_6	Transistor	2SC538		Matsushita Denki	
P11-Q_7	Transistor	2SC696		Matsushita Denki	
P11-Q_8	Transistor	2SC538		Matsushita Denki	
P11-Q_9	Transistor	2SC538		Matsushita Denki	
P11-Q_{10}	Transistor	2SC696		Matsushita Denki	
P11-Q_{11}	Transistor	2SC538		Matsushita Denki	
P11-Q_{12}	Transistor	2SC696		Matsushita Denki	
P11-IC_1	IC (4 input, 2 NAND)	SN7420N		Texas Inst.	
P11-IC_2	IC (4 input, 2 NAND)	SN7420N		Texas Inst.	

5.13 Parts for Decimal Point Circuit (2858-P_{12})

71.1

Part No.	Description			Manufacturer	Remarks
L_1	Miniature Lead Lamp	ML No. 451	9V 35mA	Hamai Denkyu	
L_2	Miniature Lead Lamp	ML No. 451	9V 35mA	Hamai Denkyu	
L_3	Miniature Lead Lamp	ML No. 451	9V 35mA	Hamai Denkyu	

MAIN PRODUCTS

Classification	Product Group	Name
Electrical Measuring and Recordihg Instruments	Electrical Indicating Instruments	Laboratory Standard & Portable Instruments, Panel & Switchboard Instruments, Electrostatic Voltmeters.
	Transducers	AC Voltage, AC Current, Watt, Reactive Power, Phase and Frequency Transducers.
	Tachometers	Photo Tachometeters, Panel & Switchboard Tachometers.
	Temperature Measuring Instruments	Thermocouple Thermometers, Thermistor Thermometers, Optical Pyrometers, Surface Temperature Indicators.
	Precision Measuring Instruments	DC Galvanometers, DC Potentiometers, DC & AC Bridges.
	Resistors	Standard Resistors, Dial Resistors, Slide Resistors.
	Digital Measuring Instruments	Digital Voltmeter, Digital Ohmmeter, Digital Multimeter. Digital LCR Meter, Precision Digital Meter.
	Standard Instruments	DC & AC Voltage & Current Standards, Standard Watt Converter.
	Oscillographs	Photocorders (Electromagnetic Oscillographs), Micro Pen-Oscillograph.
	Recorders	Direct-Acting Electrical Recorders, Laboratory Recorders, X-Y Recorders.
	Peripheral Equipment for Oscillographs and Recorders	Series Resistor, Shunt Resistor, DC Amplifiers, Strain Amplifiers, Logarithmic Converter, F-V Converter.
	Field Testers	Circuit Testers, Insulation Testers, Earth Resistance Testers, Portable Luxmeter, Sound Level Meter, Cycle Counter.
	Magnetic Material Testing Equipment	Gauss Meter, Electronic Fluxmeter, Epstein Iron Loss Test Sets, AC & DC Hysteresis Loop Tracers.
	Analog Computers	Analog Computers, Logic Assembly AC Network Analyzer.
Industrial Process Instruments	EBS Series Electronic Instruments, ERB Series Electronic Instruments, PCI Series Pneumatic Instruments	For measurement and control of Temperature, Pressure, Flow, Liquid Level, Density, Humidity, Dewpoint, Displacement, Velocity, Position, Speed, Electrical Quantity, etc.
Analytical Instruments	Instruments for Liquid Analysis	pH Meters, Turbidity Measuring Instruments, Liquid Density Measuring Instruments, Solution Conductivity Measuring Instruments, Viscosity Measuring Instruments, Process ORP Instrumentation, Petroleum Sulfur Analyzer.
	Instruments for Gas Analysis	Gas Chromatographs, SO_2 Measuring Instruments
	Radiation Instruments	β Ray Thickness Gauge, γ Ray Density Meter.
Digital Control Systems	Direct Digital Control Systems, Computer Control Systems, Digital Blending Control Systems	

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