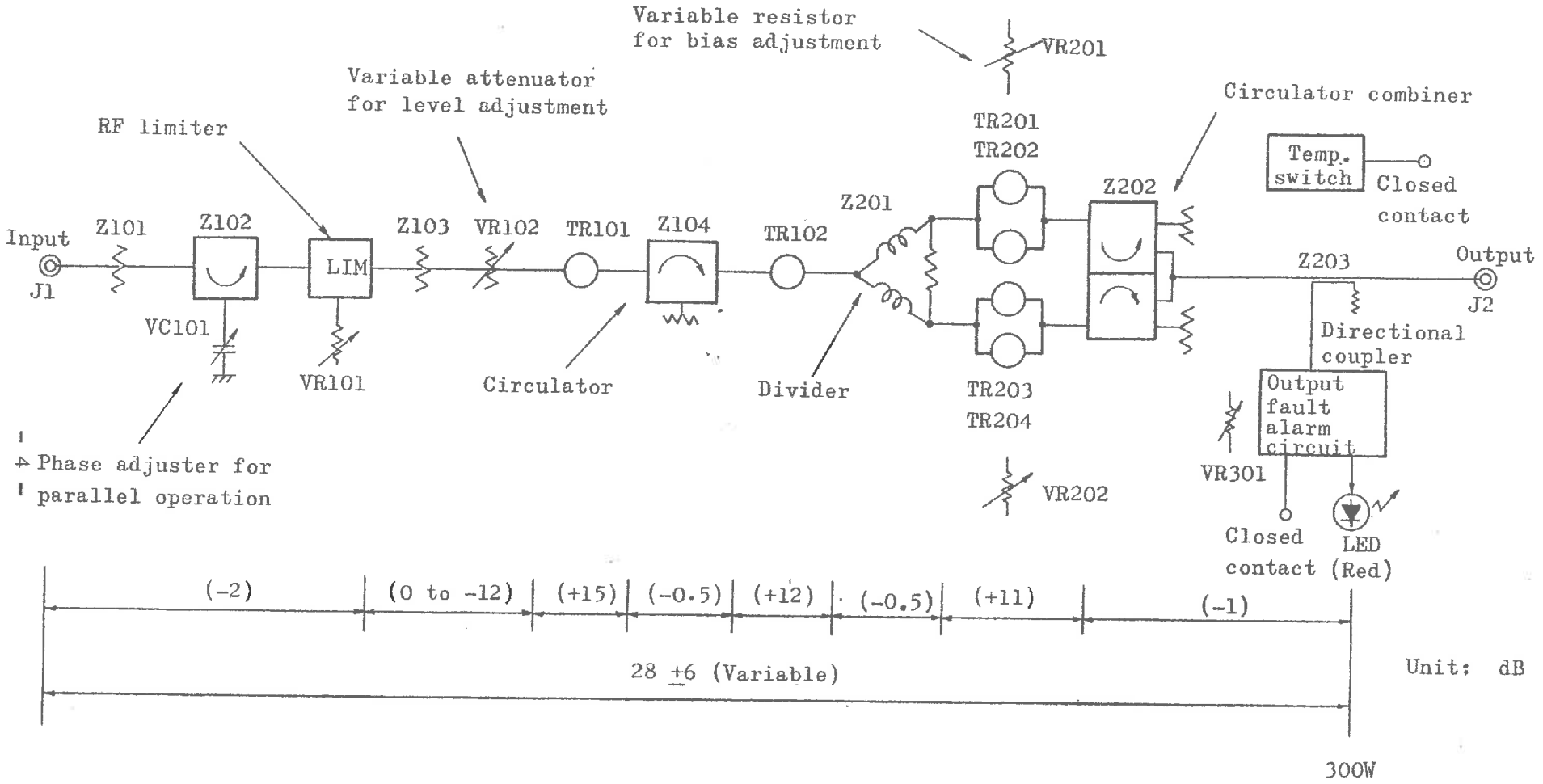


Block diagram of V360CL (130150) TR PA

The VHF signal from the input coaxial connector (J1) is fed to TR101 (B12-28) via a phase adjuster (Z102, VC101), RF limiter and variable attenuator (VR102).

The signal amplified by TR101 (B12-28) passes through the circulator (Z104) and is then amplified by TR102 (BM100-28).

Next, the signal is divided and fed into two ways by a divider (Z201). They are led to each parallel-connected amplifier circuit consisting of TR201, 202 and TR203, 204 (BM100-28).

The respective outputs amplified by the final transistors are combined by a special circulator combiner (Z202) and they are taken out from output coaxial connector (J2).

The net gain of the V360CL TR PA is approximately 28 dB or more and its gain can continuously be varied to the extent of $\pm$6 dB by input variable attenuator LEVEL ADJ.

The maximum output of this amplifier is 300W with visual sync. peak power or aural mean power.

For abnormal indications of this amplifier, the output fault alarm circuit and temperature switch are provided. When the abnormal temperature rise of heat sink or no output power of amplifier circuit is detected, the fault signal is sent out from the corresponding fault circuit as a closed contact, and the LED (light emitting diode) for output fault circuit is lit at the same time.

3. Functions

3.1 Level Adjuster

A 12 dB variable attenuator (VR102) is inserted in the input side of amplifier unit to adjust the RF output level. This attenuator can be adjusted using an adjustment rod from the front panel of the unit to the extent of ±6 dB in the frequency range of Band I and Band II. The maximum rated power of this attenuator is 200 mW.

The Level Adjuster may be set to the position in which the output power is at desired level when the input power of amplifier unit is 100 mW. ("LEVEL ADJ." is marked on the front panel of TR PA.)

3.2 Phase Adjuster

For easy phase adjustment in the parallel operation of several TR PA units, a phase adjuster using a circulator (Z102) and a variable capacitor (VC101) is provided at the input end of the V360CL TR PA.

The phase of RF signal can be varied to the extent of approx ±30 degrees at 50 MHz, and ±50 degrees or more at 100 MHz frequency, by tuning the variable capacitor using adjusting rod from front of TR PA. ("PHASE SHIFT" is marked on the front panel of the TR PA.)

3.3 RF Limiter

The RF limiting circuit is provided to prevent a transistor from being broke due to an overdrive input of the V360CL TR PA.

This RF limiter is effective against overdriving of TR PA due to mis-level-adjustment of driver PA or VHF MIXER unit, or mis-gain-control of automatic gain control circuit.

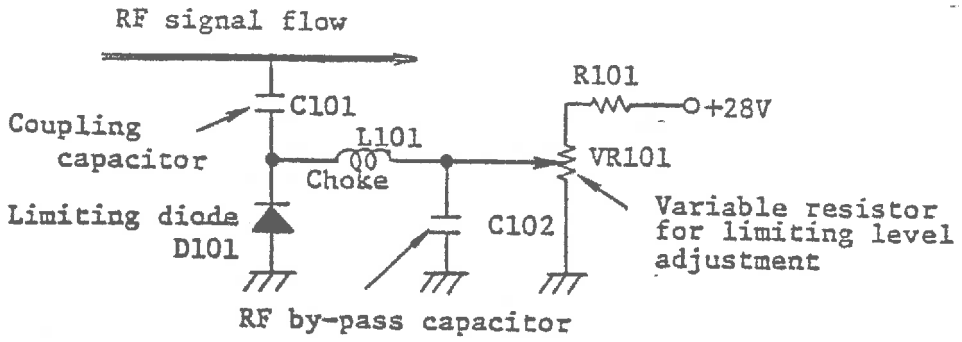


Fig. 2 RF Limiting Circuit

The RF limiter is so set that its limiting function is performed at 0.5 dB higher than the operating level of TR PA, and is capable of protecting TR PA against overdriving up to approximately 10 dB higher.

3.4 Circulator

The circulator is employed to prevent operational transistors from being damaged due to changing of RF impedance between the amplifier stages and to assure stable operation by bringing the effects of other unwanted oscillation and spurious radiations than these in desired frequency band to the minumum.

(1) Ordinary circulator

The input and output terminals of the circulator are designed to have 50 ohms, and they are isolated from each other in more than 15 dB to permit the independent adjustment of each power amplifier stage.

The absorbing port of circulator is terminated with a 50-ohm dummy load. When the output end of circulator is short-circuited or is

open during operation, the reflected power is entirely absorbed into the dummy load, thereby preventing transistors from being damaged.

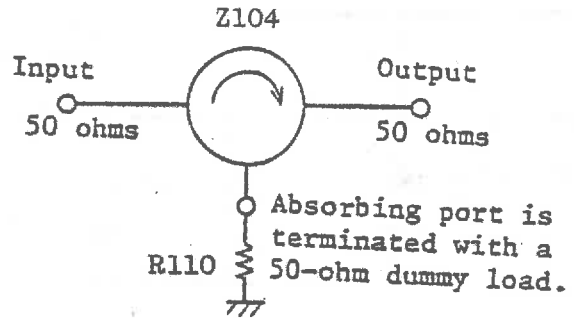


Fig. 3 Ordinary Circulator

The insertion loss of the circulator (Z104) is 1 dB and V.S.W.R. of each terminal is less than 1.2 in specified frequency rang. The maximum power rating is 10 W. As for dummy load characteristics of R110, V.S.W.R. is 1.1 or less in D.C. to 250 MHz and 1.2 or less between 250 and 1,000 MHz frequencies. Maximum power rating of it is 10W with the heatsink mounted.

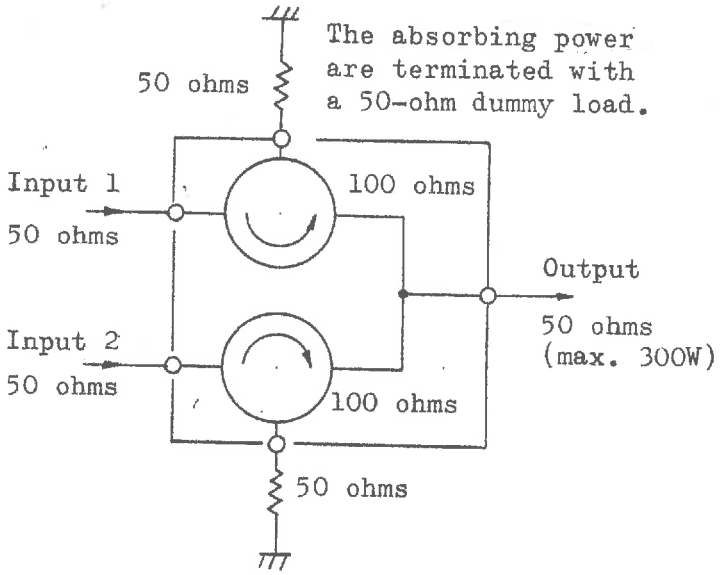
(2) Special circulator

For the power combiner in the V360CL TR PA, the special circulator is provided.

The combiner is composed of two circulators as in a case, but the rated input impedance of the circulator is 50 ohms and output impedance is 100 ohms. Therefore, the impedance of each port for paired circulator as a combiner, is designed to be 50 ohms.
(Refer to Fig. 4).

The maximum power rating of the Combiner is 300W.

If one of the input power of the combiner goes down to zero, the output will be decreased to 1/4 from normal combining output. The two inputs in the Combiner are approximately 30 dB electrically isolated from each other.



Combiner

Fig. 4 Combiner Adopting Paired Special Circulator

3.5 Power Amplifier Circuit

The power amplifier circuit of the V360CL TR PA consists of four amplifier sections; they are one pre-amplifier stages, one mid-amplifier stage, and two final-amplifier stages. Since each stage is connected to the circulator, each amplifier circuit can independently be adjusted.

Each power amplifier section requires no adjustment of RF matching networks by adoption of the wideband transformer, stipline circuit system, high gain transistors and other special circuit techniques.

(1) Pre-amplifier circuit

In the pre-amplifier circuit, a RF transistors TR101 (B12-28) is class A operated for realization of excellent video characteristics.

The gain of TR101 is about 15 to 20 dB which is varied in accordance with the operational frequencies.

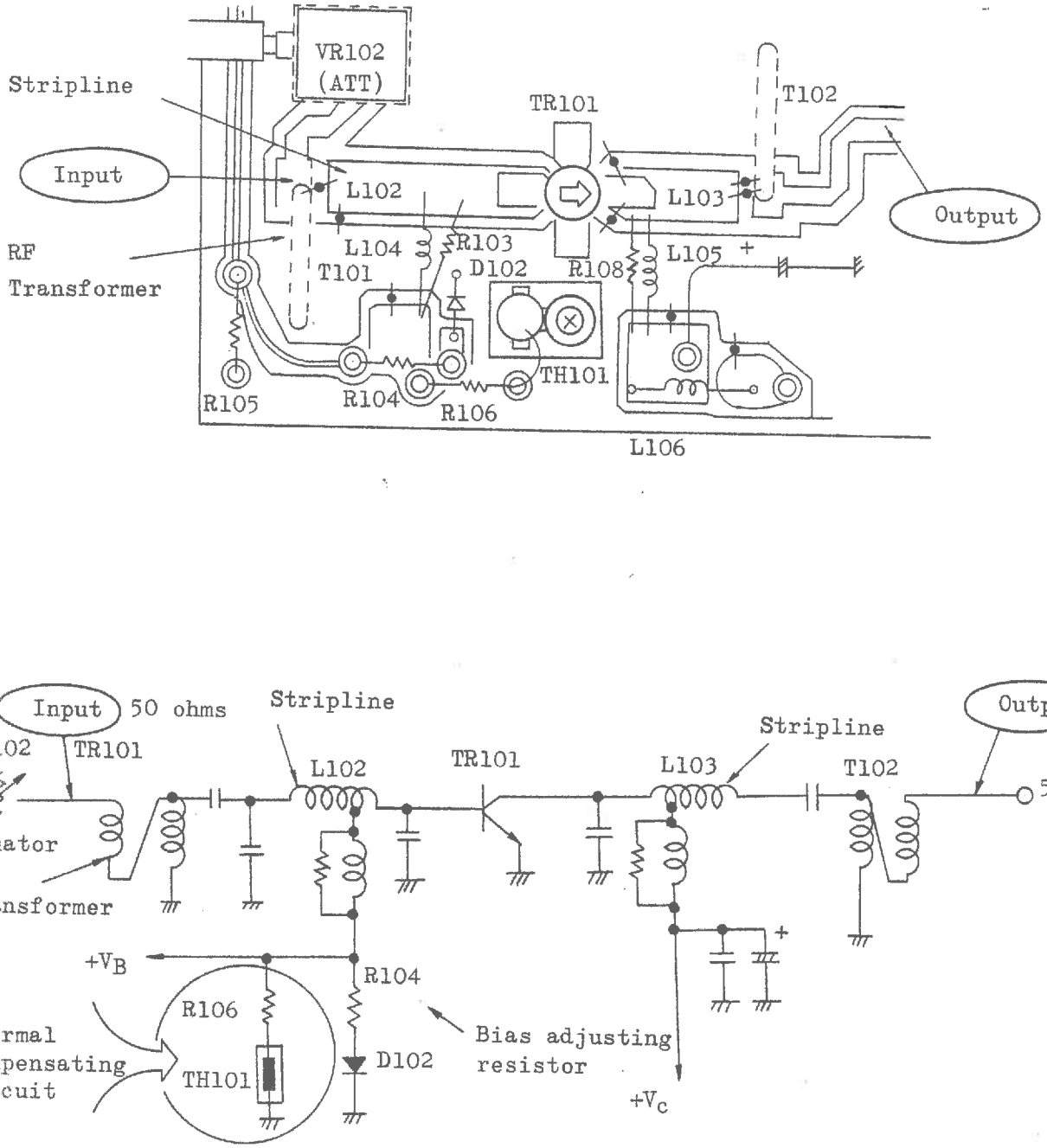


Fig. 5 Pre-amplifier circuit

A RF transformer made of 25-ohm semirigid coaxial cable is used at each of the input and output ends of this pre-amplifier circuit. See Fig. 6.

The impedance Zo of the semirigid coaxial cable is given by $Zo = \sqrt{Zin\ Zout}$ (ohms) and the impedance transforming ratio between input and output is 50 ohms: 12.5 ohms.

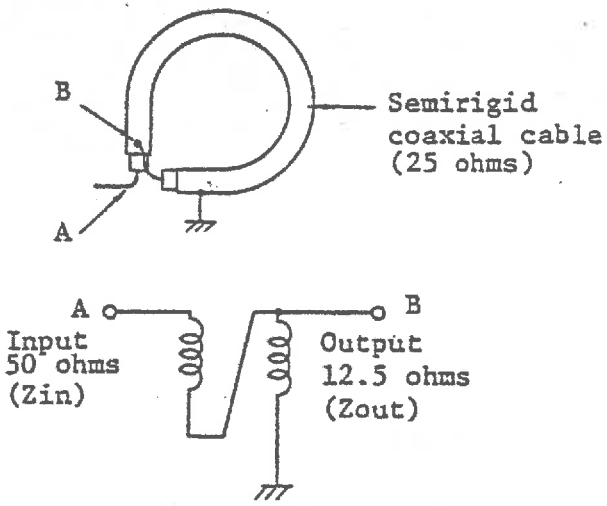


Fig. 6 RF Transformer

With this RF transformer, it is now possible not only to facilitate matching to the low-impedance transistors, but also to estalbish a broad frequency tuning circuit easily.

The fixed base bias circuit which is thermally compensated for class A amplifier requires no adjustment of idle current (static collector current with no RF drive) for a constant linearity.

When the output power of V360CL TR PA is 300W, the output level of the transistor in the pre-amplifier stage is approximately 0.5W to 2.4W for TR101.

(2) Mid-amplifier circuit

The Mid-amplifier stage is a class A operating circuit using a RF transistor BM100-28.

The gain of this amplifier is about 12 to 17 dB and its operating level is at 21W to 33W as the rated power output.

Also, the RF transformer made of semirigid cable is used at each of the input and output ends of this Mid-amplifier circuit for an easy matching.

This amplifier requests no adjustment of idle current the same as pre-amplifier requests no it.

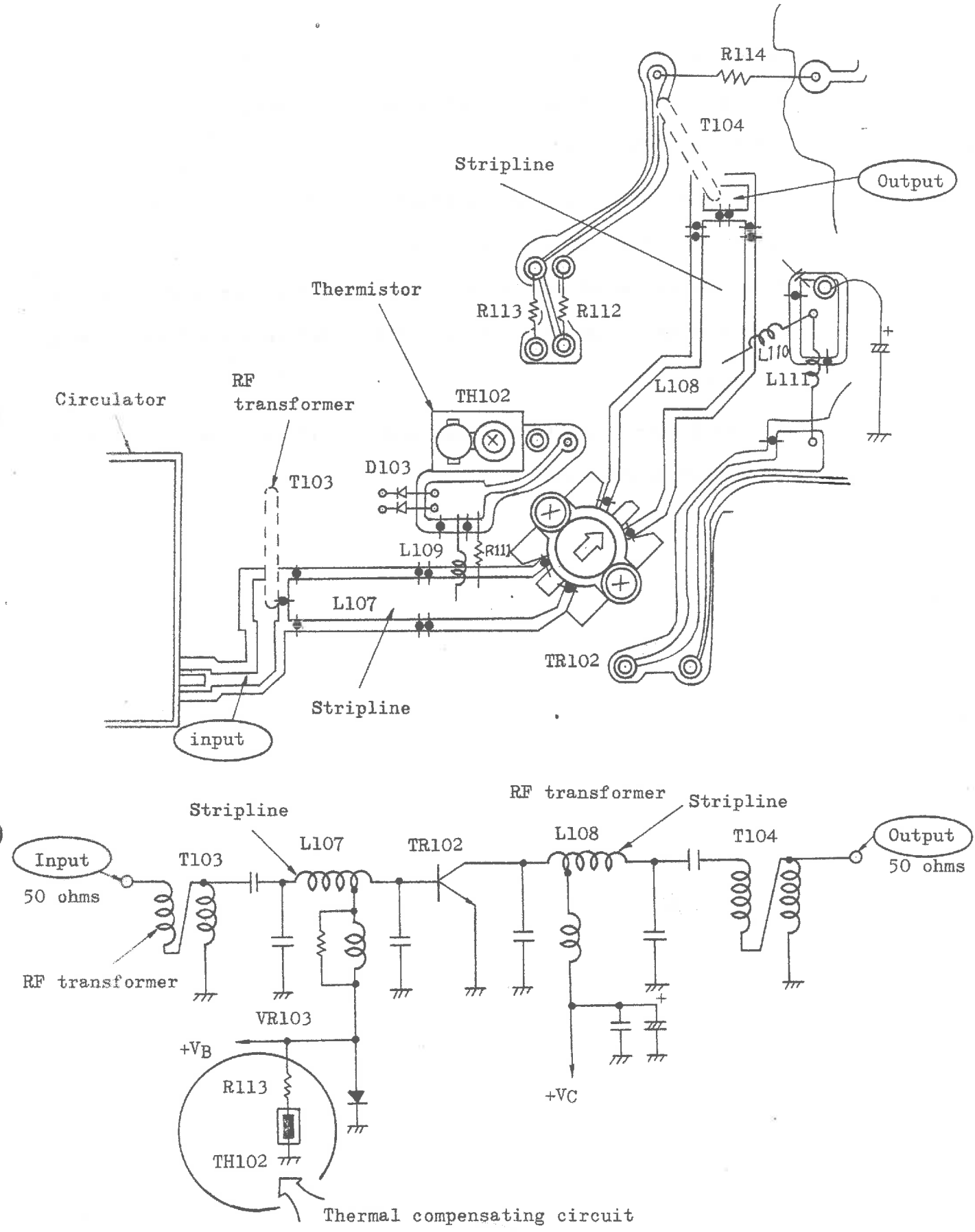


Fig. 7 Mid-amplifier Circuit

(3) Final amplifier circuit

In this amplifier stage, two paralleled amplifier circuits in which RF transistors (BM100-28) are used are parallely operated to obtain the combined output of 300W as maximum power rating. The gain of each paralleled amplifier circuit is approximately 11 to 13 dB.

This amplifier circuit is designed to provide a maximum output with a minimum number of transistors and is engineered for visual transmitting applications. For this reason the output matching impeadance is set to low, thereby obtaining chracteristics close to the inherent linearity of the transistors. The RF transformer made of 25-ohm semirigid coaxial cable is used for impedance transformation of 50 ohms to 12.5 ohms for easy matching.

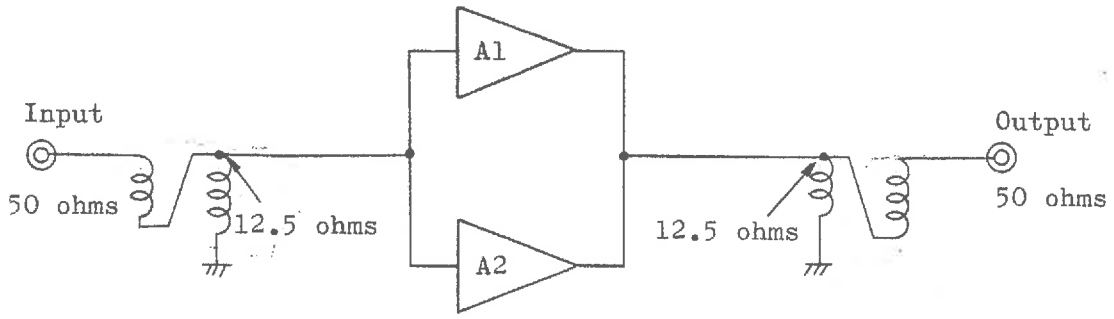


Fig. 8 Paralleled amplifier circuit

The idle collector current of TR201 and TR202 (TR203 and TR204) can be adjusted by means of variable resistor VR201 (VR202), and the base bias voltage is thermally controlled by the thermistor TH201 (TH202) and attached resistor R207 (R214).

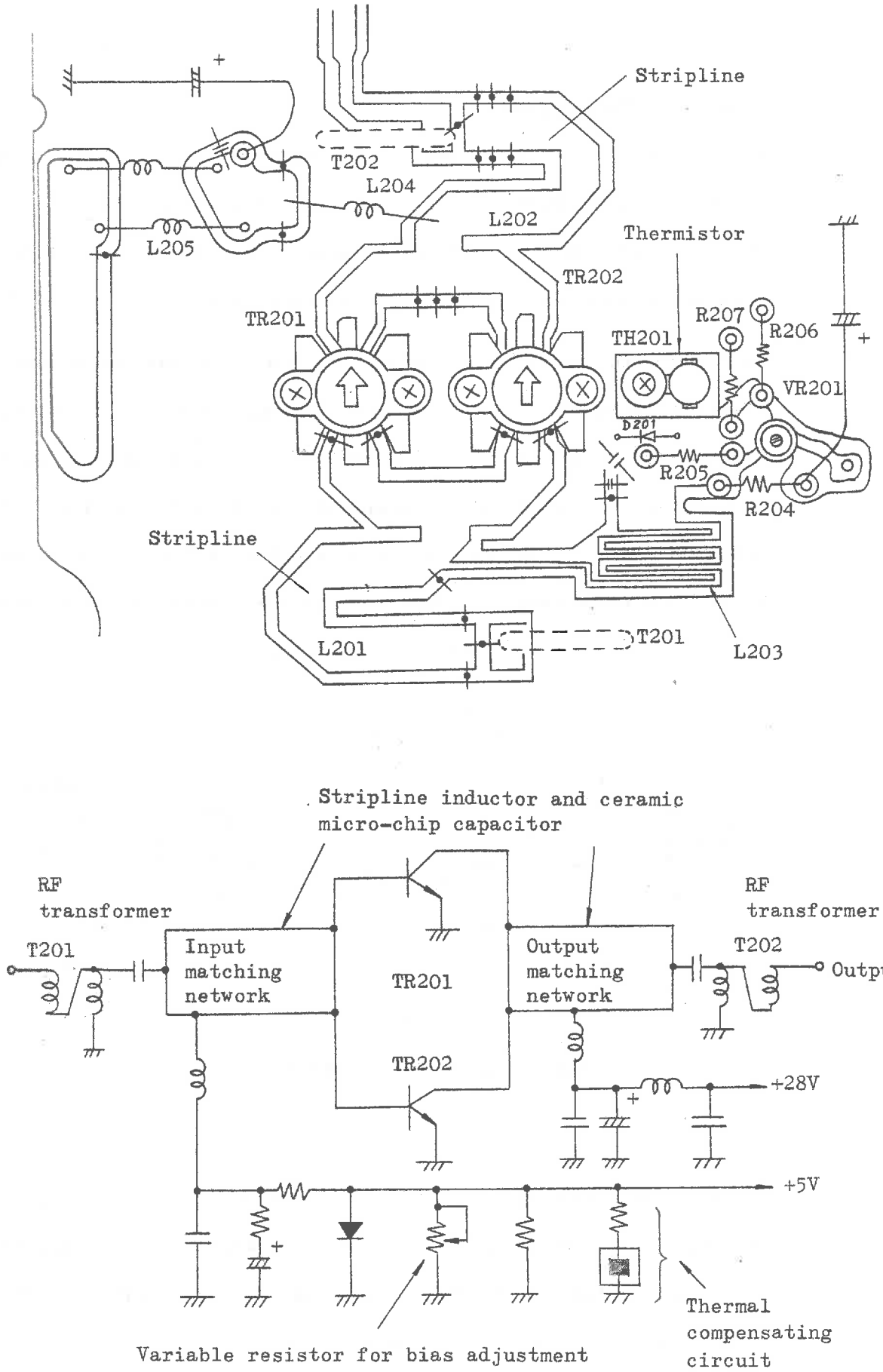


Fig. 9 Final amplifier circuit

3.6 Output Fault Alarm Circuit

The Output Fault Alarm Circuit is provided in output side of V360CL TR PA to indicate an abnormally decreased power output or absence of RF output signal.

The RF signal picked up by a directional coupler is fed to diodes (1SS16) D301 and D302 through a coupling capacitor C301, and it is detected by these diodes.

The operational level of output fault alarm circuit can be adjusted by means of a variable resistor VR301. When the detected signal is decreased compared with the set level, the relay (RL301) is driven by an Integrated Circuit (IC301) to sent out a closed contact signal for a fault information. LED (D1) mounted on the front panel of TR PA is lit at the same time.

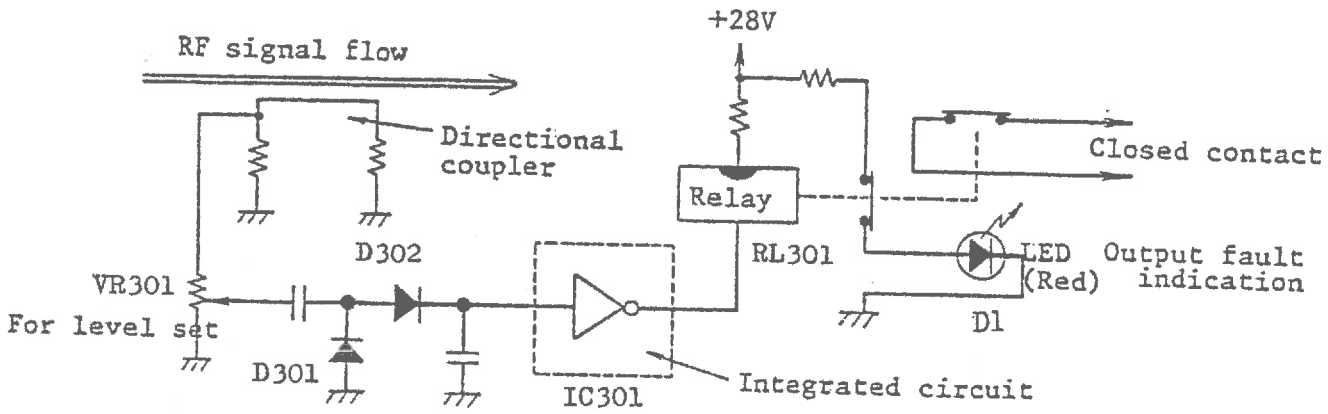


Fig. 10 Output Fault Alarm Circuit

Usually, the operational level of the output fault alarm circuit should be set to the desired level at which the output power of the TR PA drops to the extent of 3 dB from normal operating power.

When the +28V D.C. power is not supplied to the TR PA, the closed contact signal for an output fault alarm is sent out.

3.7 Temperature Fault Alarm Device

The V360CL TR PA provides a temperature switch called the Thermal Lead Switch, for a direct sensing of the abnormal temperature rise of the heatsink. The Thermal Lead Switch consists of thermally sensitive ferrite, magnet and lead switch.

This Thermal Lead Switch is of TRS-90MKR type. It operates at temperature of 90 degrees centigrade with accuracy of $\pm$2.5 degrees centigrade.

One closed contact is incorporated in it. The contact is used for temperature alarm indication and protection of TR PA in the event of trouble by sending this information into the control circuit of the transmitter.

4. Operating Instruction

The V360CL TR PA is designed for use on +28V D.C. power, and negative grounded. So it is necessary to properly set the supply voltage before operating the TR PA. If the D.C. supply voltage is higher than specified, damage to the transistors may occur or a shorter life may result. If the unit is operated at the voltage lower than specified, not only the linearity but also various characteristics may be affected. Therefore, attention should be paid to this point.

Specified supply voltage: +28V $^{+0V}_{-0.5V}$ D.C.

Check to ensure that the output coaxial cable is connected to the output connector before flowing an input signal into the TR PA.

When the level setting of TR PA is not completed, the attenuator "LEVEL ADJ" may fully be turned counterclockwise to avoid overdriving.

In case the TR PA is used for an aural amplification, the idle collector current of final transistors may be reduced, which is a better way for safety operation.

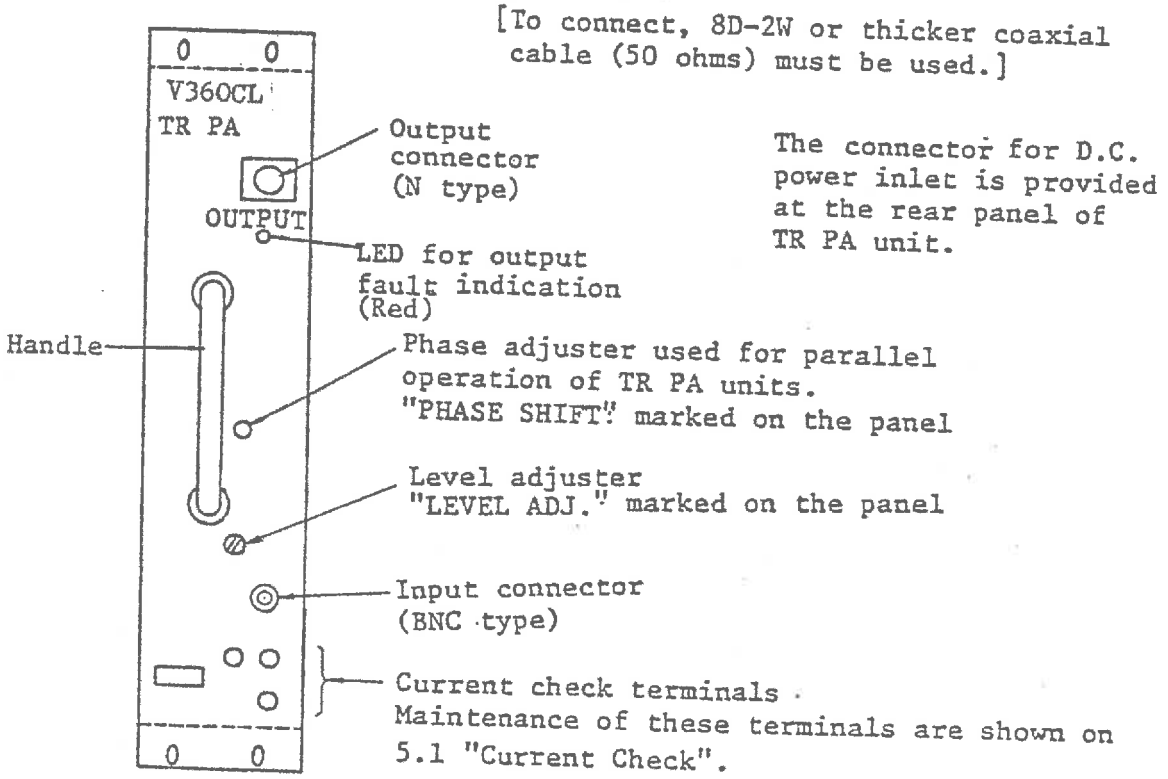


Fig. 11 Front of V360CL TR PA

5. Maintenance and Adjustment

The V360CL TR PA is basically designed for a non-adjustment operation. So the idle collector current of each transistor excluding pre-amplifier and mid-amplifier stages, output level, the phase of RF signal and the RF limiting level may only be adjusted for basic operation.

The RF matching network and the D.C. feeding circuit do not require the adjustment and highly satisfactory characteristics can be obtained.

The idle current of each transistor is properly set at the factory before shipment.

In the RF matching network, printed circuit boards with microstripline inductors and ceramic micro-chip capacitors are employed to constitute L matching sections by the fixed distributed constant. The impedance matching networks of input and output circuits for RF transistor are usually composed of L matching sections.

In addition, L matching sections provide a low-pass filter for input and output to keep harmonics down.

If the Q of each matching step is kept low, the frequency bandwidth of the resulting amplifier will be wider.

The Q referred to here is not the unloaded Q of any individual component but the loaded Q of the matching network. Keep the component Q high, of course, to minimize loss.

The low Q matching networks can form a low loss amplifier circuit, as circulating currents are lower.

Thanks to less critical component value required and the avaialbility of wideband frequency characteristics, operation without tuning for extended

period of time may be performed. The ideal matching construction of the transistor amplifier circuit is as shown in Fig. 13 when the operating bandwidth is f_L to f_H.

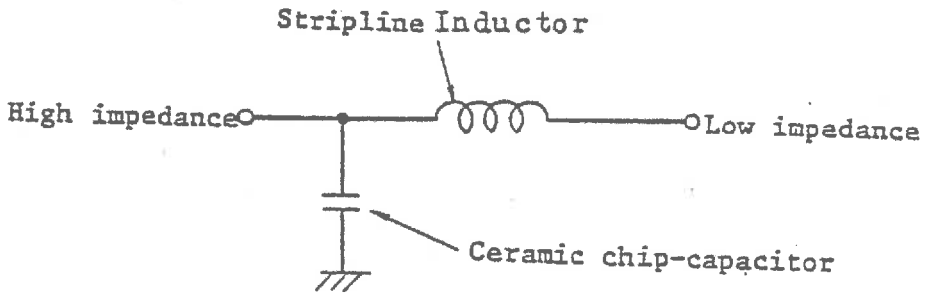


Fig. 12 L Section Matching Network

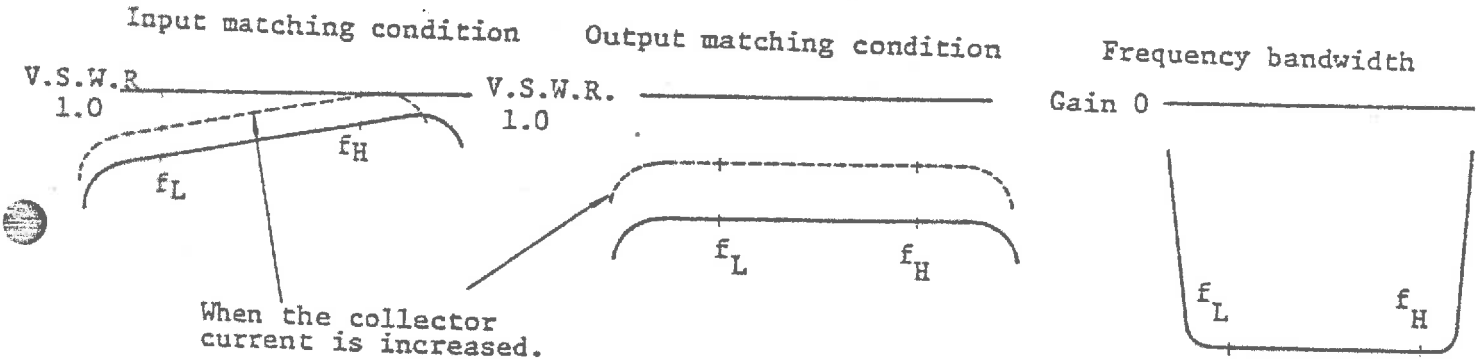


Fig. 13 Ideal Matching Construction of RF Amplifier Circuit

The adjustment procedure is described below.

5.1 Current Check

A shunt resistor is inserted in the D.C. power source line of each amplifier stage for independent checking of transistor's collector current.

The current is measured from the check terminal mounted on the front panel of TR PA unit using a check meter with 60 mV sensitivity.

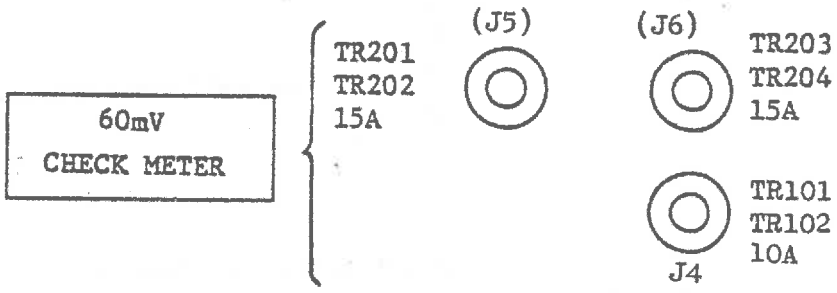


Fig. 14 Arrangement of Check Terminals on Front Panel of TR PA

Check terminal J4 is used to measure the total collector current of transistors TR101 and TR102, and the full-scale range of the check meter is 10A.

Similarly, J5 is used for TR201 and TR202 and the full-scale range of the check meter is 15A; J6 for TR203 and 204, full-scale range being 15A.

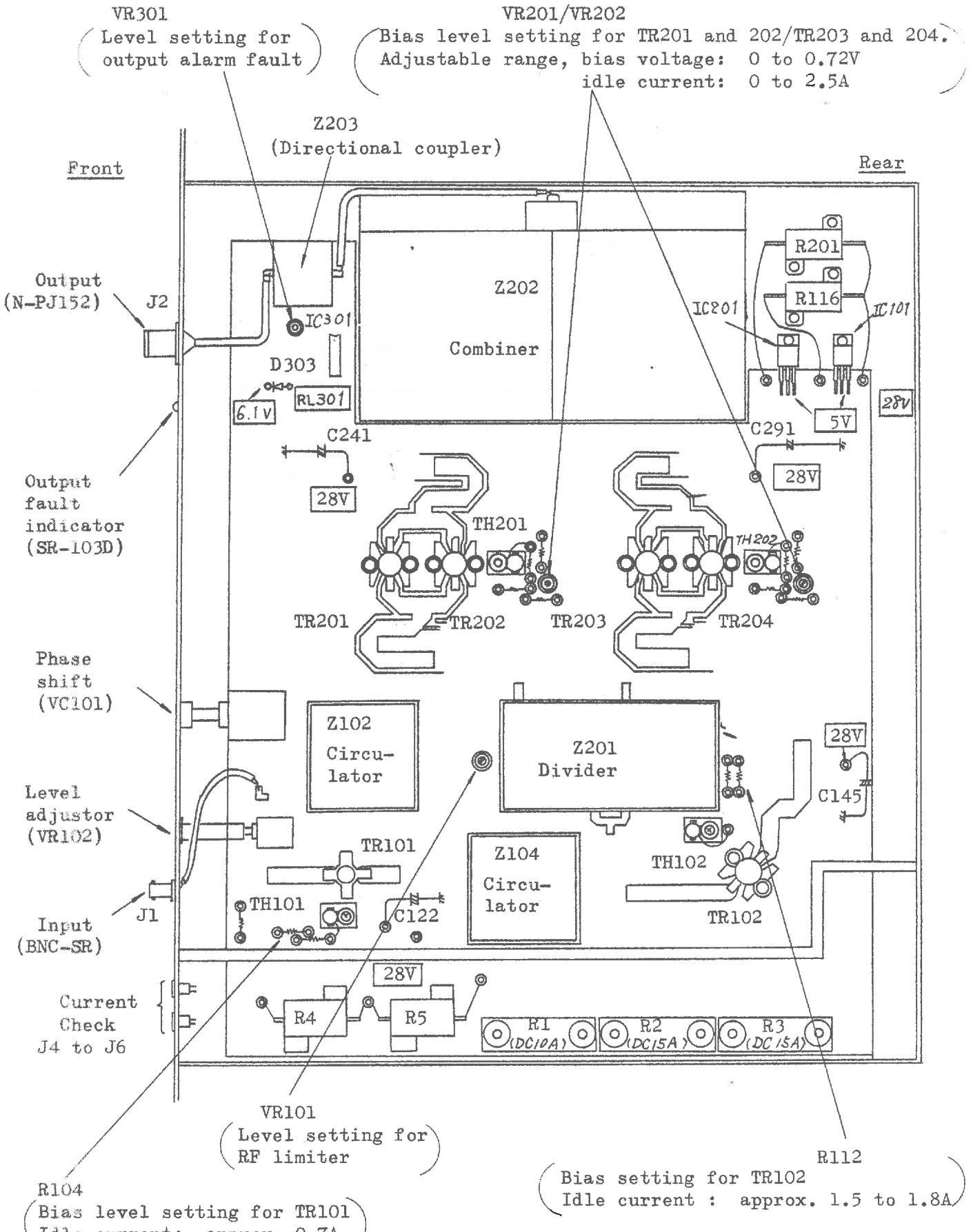
The idle collector current of each transistor should be adjusted to the following range while checking the D.G. (Differential Gain) by means of corresponding base bias adjusting variable resistor.

Transistor	Adjusting point	Check terminal	Check meter	Recommended idle current	Maximum idle current
TR101 TR102	R104 R112	J4	10A range	2.5 to 2.7	3A
TR201, 202	VR201	J5	15A range	0.8 to 1.5A	3A
TR203, 204	VR202	J6	15A range	0.8 to 1.5A	3A

Note: When the D.G. is good enough, the idle current may be allowed to differ from the recommended value. For adjustment procedure for the D.G., refer to paragraph 5.6.(1) below. For the caution of idle current setting for each transistor, the idle current should be kept to less than the maximum value shown above to prevent transistors from being broken.

5.2 Normal Circuit Voltage

The normal circuit voltages without input RF drive are shown in Fig. 15, when +28V D.C. is supplied.


VR301
Level setting for output alarm fault
VR201/VR202
Bias level setting for TR201 and 202/TR203 and 204.
Adjustable range, bias voltage: 0 to 0.72V
idle current: 0 to 2.5A
Z203
(Directional coupler)
Front
Rear
Output
(N-PJ152)
J2
IC301
Z202
Combiner
D303
RL301
6.1V
R201
R116
IC201
IC101
28V
5V
C241
C291
28V
28V
Output
fault
indicator
(SR-103D)
TH201
TH202
TR201
TR202
TR203
TR204
Phase
shift
(VC101)
Z102
Circu-
lator
Z201
Divider
28V
C145
Level
adjustor
(VR102)
TR101
Z104
Circu-
lator
TH102
TR102
Input
(BNC-SR)
J1
TH101
C122
Current
Check
J4 to J6
28V
R4
R5
R1
(DC10A)
R2
(DC15A)
R3
(DC15A)
VR101
Level setting for
RF limiter
R112
Bias setting for TR102
Idle current : approx. 1.5 to 1.8A
R104
Bias level setting for TR101
Idle current: approx. 0.7A