INSTRUCTION MANUAL
FOR
MODEL NSD-515 TRANSMITTER

JRC

Japan Radio Co., Ltd.

The Model NSD-515 transmitter is the highest-class all-bands equipment, which has been designed with full application of the latest solid-state elements and digital circuit design technology concepts, based on the JRC's long-year technical achievements and experiences.
You are recommended to carefully read this technical instruction manual before operation of this transmitter and to be familiar with it. This equipment has been manufactured under rigorous quality control in the factory, however, if you should find any questionable point or defective section upon and during operation, immediately contact the sales store, where you bought the equipment or JRC Sales and Service Office.

CONTENTS

SECTION 1 SPECIFICATIONS

1.1 Frequency Range

1.8 – 2.0 MHz
3.5 – 4.0 MHz
7.0 – 7.3 MHz
*10.1 –10.15 MHz
14.0 –14.35 MHz
*18.068–18.168MHz
21.0 –21.45 MHz
*24.89 –24.99 MHz
28.0 –29.0 MHz
29.0 –29.7 MHz
*Optional new amateur bands approved by WARC '79

1.2 Rated Output power

NSD-515S ····· 10 watts
NSD-515D ····· 100 watts

1.3 Mode of Emission

A3J (USB/LSB), A1 (CW), F1 (RTTY)

1.4 Carrier Suppression

50dB or more with 1,500Hz modulation at rated output power

1.5 Undesired Sideband Suppression

50dB or more with 1,500Hz modulation

1.6 Spurious Suppression

50 dB or more

1.7 Third Order Intermodulation

Less than –31dB relative to peak envelope power

1.8 Occupied Bandwidth

A3J 3kHz or narrower
A1 0.5kHz or narrower at 25 bauds

1.9 Audio Response

Within 6dB at 400 to 2600Hz in A3J

1.10 Frequency Stability

Within ±500Hz 5 to 60 minutes from power-on,
Within ±50Hz per hour in more than 60 minutes after power-on

1.11 Antenna Impedance

50 ohms, unbalanced, nominal
Matching is available up to VSWR = 1:3 in use of CFG-515 Antenna Coupler, option.

1.12 Microphone Input Impedance

600 ohms, nominal

1.13 Microphone Input Level

–60dBm to –20dBm for rated output power

1.14 VFO Output Level

0.2V or more at 75 ohms, unbalanced, nominal

1.15 VFO Input Level

0.1V or more at 75 ohms, unbalanced, nominal

1.16 RTTY Frequency Deviation

–85Hz at MARK (with KEY GND)
+85Hz at SPACE (with KEY OPEN)

1.17 Power Supply

+13.6V DC ±10%, negative ground.
100/117/220/240V AC**; 50/60Hz, single phase
** Combined with NBD-515 optional power supply

1.18 Power Consumption

NSD-515S 2A (DC) or 60VA (AC)** at standby; 4A (DC) or 200VA (AC)** at rated output power
NSD-515D 2A (DC) or 60VA (AC)** at standby; 20A (DC) or 600VA (AC)** at rated output power
** Combined with NBD-515 optional power supply.

1.19 Dimensions, excluding projections

340(W) x 140(H) x 300(D)mm

1.20 Weight

NSD-515S 10.5kg, exclusive of options
NSD-515D 11.5kg, exclusive of options

REMARKS: Specifications, circuit parameters and used semiconductor elements subject to change for performance improvement etc., without notice.

SECTION 2 FEATURES

2.1 PLL Digital VFO

Digital VFO incorporated, combined with a photo type rotary encoder and PLL synthesizer. No mechanism is contained in the digital VFO, this eliminating the possibility of backlash.

The TUNE dial rotation causes a pulse signal to control the transmit frequency in step of 100Hz. The tuning rate is 10kHz per rotation of the dial and can be increased by means of UP/DOWN switch for quick OSY.

An electric locking function is provided to avoid deviation of a preset frequency due to vibration or misoperation. In addition, the PLL synthesizer is operating under the control of a high-stability reference crystal oscillator. This also avoids deviation of calibration and long-term change.

2.2 Transmit Band automatically changeable from receiver

When combined with the NRD-515 Receiver, the transmit band is automatically changeable with selection of a receive frequency. At the same time, the band of an optional built-in type antenna coupler is also automatically switched in this operation. In addition, above automatic switchings can be made with a frequency stored in the NDH-515 Memory Unit, option, connected to the NRD-515.

2.3 Powerful Final Stage Power Amplifier with sufficient margin

The final stage power amplifier and all other circuits have employed the latest semiconductor elements, based on the all-solid-state design policy.

The final stage power amplifier (PA) with sufficient margin is provided with an automatic power control (APC) circuit for controlling the output power at constant level. This assures a stable radiation of RF wave having a good quality with less distortion in a range from low power to rated power. In addition, large-size heat sinks are provided for both PA unit and power supply unit and hence allow a continuous transmission at 100W/10W, without any blower.

2.4 Protection of Final Stage Transistor from Mismatching

In the transistor type transmitter, SWR may abnormally rise due to mismatching or the antenna opened or shorted. This means the increase of the reflected power, which may cause the transistors at the final stage to be damaged. This equipment is capable of detecting an excessively high voltage and high reflected power due to mismatching of the antenna. In addition, a transistor protection circuit is provided to protect the final stage transistors against an abnormal increase of the collector current. Thus, the transistor are protected triply.

2.5 Exclusive Antenna Coupler (option) available

This transmitter can incorporate the optional CFG-515 built-in type antenna coupler, for matching with the antenna. It is able to preset the matching parameter for each band. In addition, the band selector switch of the coupler is interlocked with the MHz-switch at the transmitter. Therefore, there is no need for troublesome antenna adjustment when the working band is switched to another for QSY.

2.6 Tuning unnecessary for full band

A wide-band amplifier, lowpass filter and double-tuned bandpass filter have been employed in addition to the optional antenna coupler of a preset type. Therefore, there is no need for tuning operation, except for setting the frequency.

Any readjustment is not required when switching to other band.

2.7 Very effective Speech Processor

An RF limiter type speech processor is provided, so it is able to increase the talke power. The compression level of the processor is controllable at the front panel. The processor uses crystal filters identical to those for the SSB transmission. They substantially avoid spreading of splatters and hence prevent interference with nearby RF waves.

2.8 OVER MOD Indicator for avoiding overmodulation

When overmodulation is made, the OVER MOD indicator illuminates. If the microphone gain is reduced just before the indicator is going to illuminate, a clear RF wave can be radiated.

2.9 FSK Circuit incorporated

The shift width of frequency is ±85Hz, which is the international standard. Connection of a teletypewriter makes the equipment ready for the RTTY operation.

2.10 Open Ended to addition of new amateur bands

For the case of new 10MHz-, 18MHz- and 24MHz-bands of WARC approved, the equipment has been designed to cope with it only with addition of their units them.

2.11 Plug-in unit type structure

The circuits employ a full-modular structure with plug-in type printed circuit boards. Each circuit board is made of a high-quality epoxy resin excellent in high-frequency characteristics. This structure assures a high reliability and improves the serviceability for the maintenance.

2.12 Various Accessories filled up

Including band switching information outputs for control of peripheral equipment, terminals for external standby switches, ALC signal input terminals, BK signal output, CW side tone on-off switch, FSK keying signal input terminals, BF controller for frequency fine adjustment, etc.

2-13. Combinable with NRD-505

A combined operation with the JRC Model NRD-505 Receiver is available. For this operation, such functions are provided, as VFO input and output, side tone output, anti-trip input, BK (MUTE) signal output, antenna output for reception, VFO switching, etc.

SECTION 3 PREPARATION

OPERATIONAL PRECAUTIONS

(1) Carefully check the frequency before transmission. Never transmit at off-band.
(2) Do not rotate any semi-fixed resistor, trimmer or core of transformer, mounted on the printed circuit boards, unreasonably.
(3) Great care must be taken not to short circuit at the time of maintenance and checks; many semiconductor elements being used in this equipment.
(4) When turning on and off the power switch, always place the standby switch at the PTT position to avoid radiation of undesired RF power.
(5) Never turn the MHz-dial during transmission. If turning it, not only the power relays, final stage transistors, etc. may be damaged but also other communications may be influenced. When wishing to turn the MHz-dial, always return to the receiving state once.

3.1 ACCESSORIES

The following accessories are furnished; check the quantity.

ACCESSORIES LIST

	QTY.
(1) Instruction manual	1
(2) M-type coaxial plug (for antenna connection)	1
(3) 8 pin metal plug (for microphone connection)	1
(4) Plug, 2-pin (for key connection)	1
(5) Square plug, 28 pin (for RX connection)	1
(6) RCA type pin plug	6
(7) Power cable	1
(8) Fuse, 30A (100W) or 5A (10W)	1
(9) Pilot lamp (for meter illumination)	1

3.2 INSTALLATION LOCATION

Install the equipment at a place with good ventilation to fully perform the full functions and use for a long time.

Avoid such a place as those subject to the direct sunshine, hot wind from room heaters, vibration, etc. and moist places.

Reserve a space around the equipment, as wide as possible. In particular, a sufficient ventilation should be assured at the back of transmitter, since there are heat sink, radiating much heat.

3.3 INSTALLATION

Operation of the transmitter requires such preparations as the antenna installation, earthing work, connection of power source, connection of associated receiver, connection of the microphone, connection of the key, etc. Carefully install the equipment to fully perform its full functions.

3.3.1 Connection to Power Source

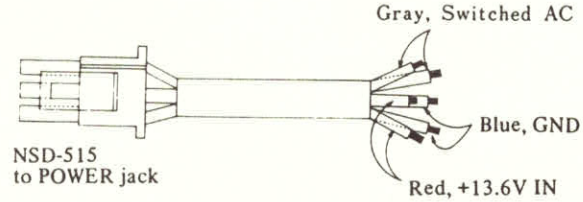
This equipment operates from +13.6V DC.

When operating from an AC power line, employ the optional Power Supply Unit for AC power line, NBD-515. Connect the NBD-515 to the POWER connector at the back of the NSD-515 by means of furnished power cable.

When using other power source, it is required +13.6V, 20A or more. First carefully check the current-handling capacity and voltage of the source, then cut off the connector of the furnished power cable at the power source side, and directly connect the cut end of the cable to the power source.

NOTE: The line voltage of +13.6V is always applied both the collectors of transistors at the final stage and the protection circuit of the transmitter, resulting in an uninterruptive current flow of about 10mA. Take care when operation with the battery.

(a) CONNECTION OF NBD-515 TO NSD-515



(b) CONNECTION OF OTHER POWER SUPPLY TO NSD-515

Figure 3.1 POWER CABLE CONNECTION

3.3.2 Connection to NRD-515 Receiver

For combination operation, connect this transmitter to the NRD-515 Receiver, as shown below.

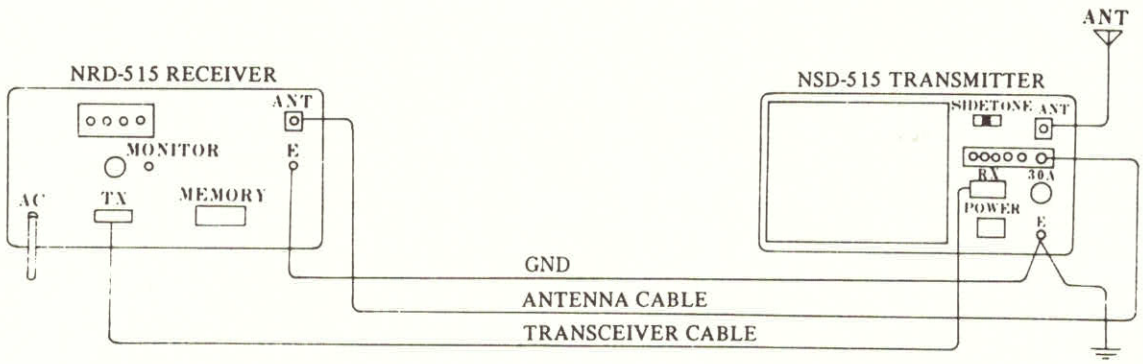
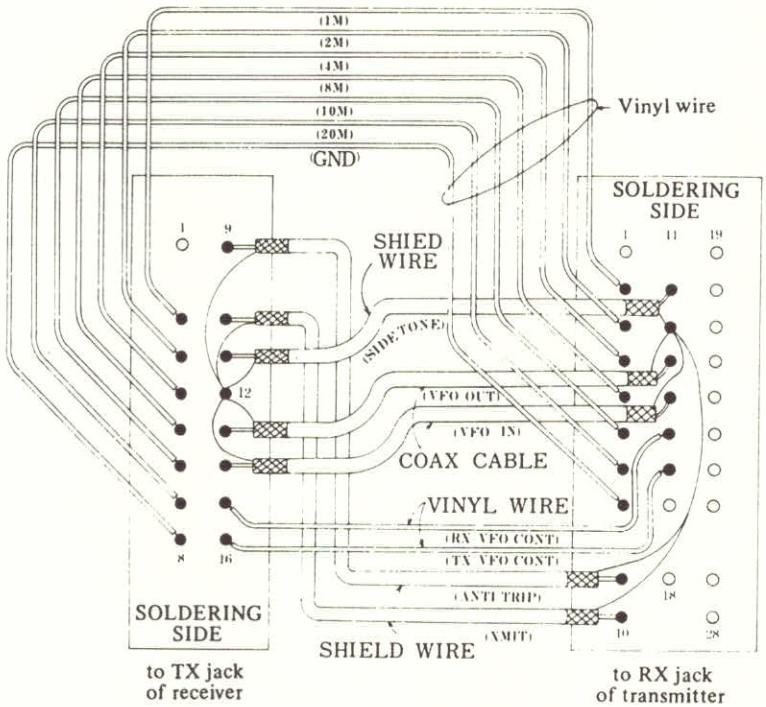
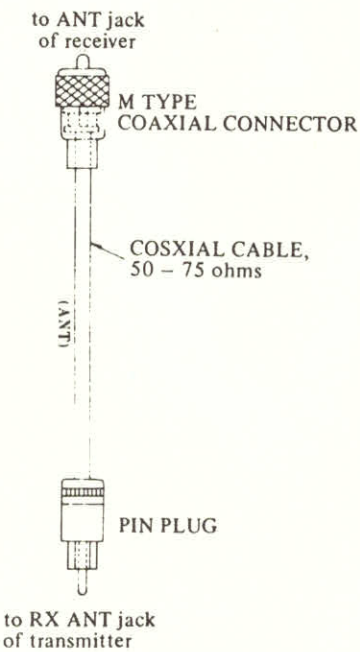


Figure 3.2 CONNECTION OF NSD-515 TRANSMITTER TO NRD-515 RECEIVER

NOTE: 1) Remove the "P35" shorting plug from the "J35" jack located on the receiver unit of the receiver. Without removing the plug, the receiver cannot be muted during transmission.
2) When connecting the antenna to the receiver through other antenna changer or the like, without observing Figure 3.2, avoid an excessive induction from the transmitted power to the antenna input of the receiver. Such induction tends to enter the antenna input because of undesired timing of the antenna changer.
3) When not performing either the transceive operation or cross operation, there is no need to connect VFO IN, VFO OUT, RX VFO CONT and TX VFO CONT.
4) When not performing the remote changing of band from the receiver, there is also no need to connect 1M through 20M.





NOTE: 1. Wiring as short as practicable.
2. Never forget to attach cover to connector.
3. Shield wire bundle to avoid induction from transmitter

(a) TRANSCEIVE CABLE (b) ANTENNA CABLE

Figure 3.3 CONNECTION CABLE ASSEMBLING

3.3.3 Connection to NRD-505 Receiver

For combination operation, connect this transmitter to the NRD-505 Receiver, as shown below.

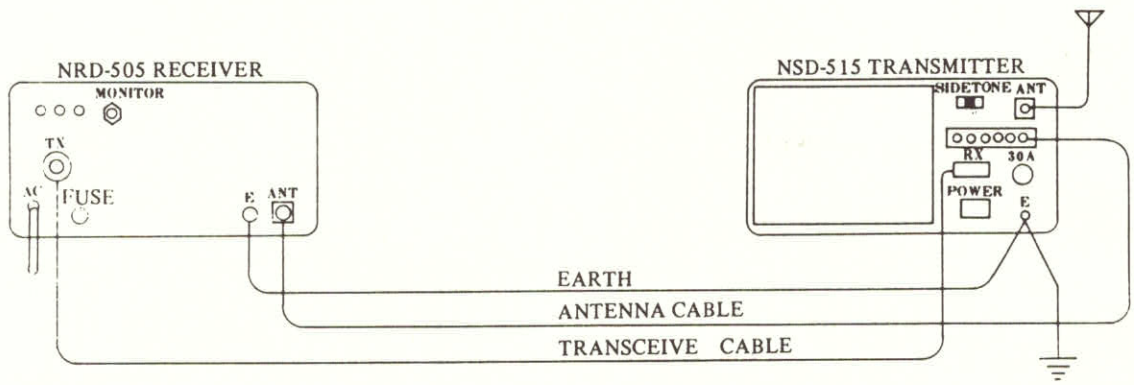


Figure 3.4 CONNECTION OF NSD-515 TRANSMITTER TO NRD-505 RECEIVER

NOTE: 1) The remote changing of band cannot be made from the receiver.
2) When connecting antenna to the receiver through other antenna changer or the like, without observing Figure 3.4, avoid an excessive induction from the transmitted power to the antenna input of the receiver. Such induction tends to enter the antenna input because of undesired timing of the antenna changer.

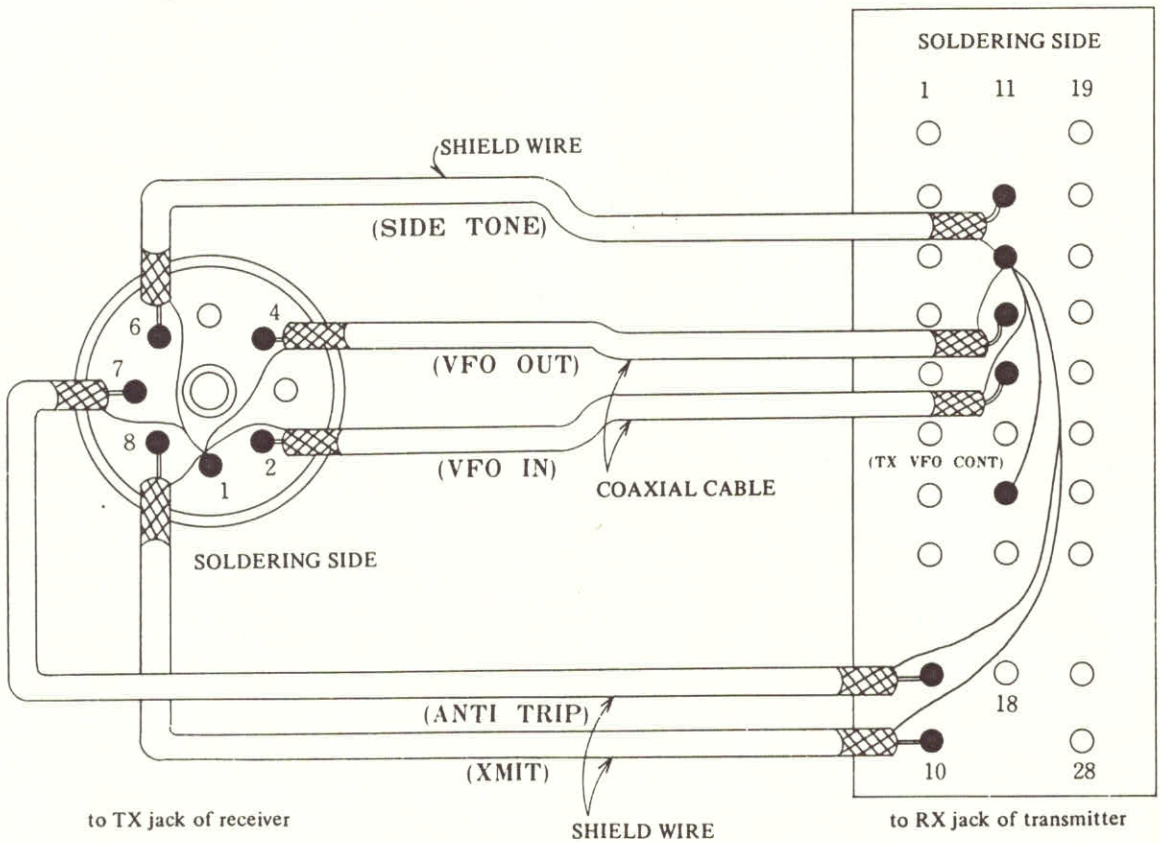


Figure 3.5 CONNECTION CABLE ASSEMBLING

3.3.4 Connection to Other Receiver

The NSD-515 Transmitter is provided with an VFO operative in a frequency range of 2.455 to 3.455MHz. If the VFO in the receiver has a different frequency range, neither transceive operation nor cross operation can be made. In this case, operate in the separate mode. When operating in the combination mode other than transceive or cross, connect in the same manner as denoted in Paragraph 3.3.3.

3.3.5 Antenna Connection

The NSD-515 matches with a load resistance of 50 ohms to assure the rated output power. Therefore, investigate both the antenna and feeder enough when selecting the antenna and installing it. Anyhow, the impedance of the transmitter must be 50 ohms, pure resistance, as seen from the antenna terminal.

If it cannot become 50 ohms, an impedance matching unit such as antenna coupler must be inserted between the ANT terminal and the feeder and adjusted to correctly match the load, the antenna, with the transmitter.

NOTE: When a balanced type antenna is used, while the load impedance is 50 ohms, a balance-unbalance converter circuit must be inserted.

So long as the antenna terminal of the transmitter is collectly matched with the feeder (, resulting in VSWR = 1), the transmitter provides an output power to the feeder, as specified. In this condition, undesired components of the output such as spurious components are sufficiently suppressed and a clear RF signal will be radiated.

In a poor matched condition (VSWR larger than 1), a part of the output power is reflected at the input end of the feeder. As the result, the output power is insufficiently applied to the feeder, and the rated power level cannot be assured since the load of the transmitter is no more 50 ohms, pure resistance. If the impedance is 75 ohms, for example, the output power will be reduced to 80 to 95% of the rated. If it is 100 ohms, the output power will be reduced to 70 to 90%.

Therefore, adjust the antenna, feeder, earth, antenna coupler, etc. so that SWR goes to unity (1.0) as near as practicable.

NOTE: The output power cannot still be transmitted sufficiently from the feeder to the antenna, if the antenna is not completely matched with the feeder, while the impedance between transmitter and feeder is forcibly matched by means of the antenna coupler.

Therefore, well design the extension of the antenna and sufficiently consider the power feed method, so that the antenna can be well matched with the feeder.

NOTE: The antenna coupler is not effective to improve the matching of the feeder to the antenna, but to adjust only the matching of the transmitter with the feeder.

To more efficiently feed the output power to the antenna, pay attension also to the earth as well as to the antenna. Make every effort to execute the earthing work. In particular, a grounded type antenna has an earth section or counterpoise for substitution of earth, or radial earth. Any of them must be regarded as an important part of the antenna system.

In addition, when using a balanced type antenna, connect the earth line to the E terminal of the transmitter for the purpose of suppressing undesired radiations such as spurious radiation, etc. and also for the safety.

3.3.6 Earth Connection

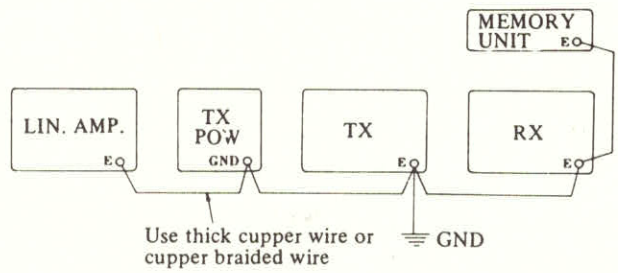


Figure 3.6 EARTHING

Ground all the transmitter, power supply unit, receiver, linear amplifier, etc., independent of the earth line of the antenna system, as shown in Figure 3.6. For grounding them, use a cupper wire, cupper braided wire, cupper tape, etc. as thick as practicable. The earthing wire should run at the shortest distance. These groundings will avoid the electric shock trouble, interference from other equipment, undesired spurious radiation, etc.

NOTE: Do not connect the ground wire to any gas feed or electrical feed pipe.

3.3.7 Microphone Connection

When operating in the SSB mode, connect a microphone to the MIC jack at the front panel. When using the optional microphone, CHG-43 of desk type or CHG-44 of hand type, insert the plug of its cord into the MIC jack as it is. When using other microphone, select a type having such an internal connection as shown in Figure 3.7, or otherwise, connect the microphone with use of the furnished 8-pin plug, as shown in Figure 3.7.

Use a dynamic type microphone having an impedance of 600 ohms and sensitivity of –70dB or better.

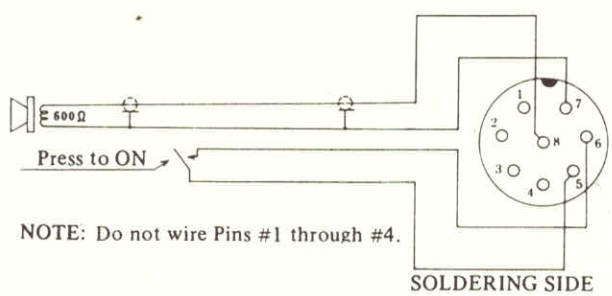


Figure 3.7 MICROPHONE CONNECTION

3.3.8 Key Connection

When operating in the CW mode, connect a key to the KEY jack on the front panel. When using the optional key, CCK-144, insert its plug into the KEY jack, as it is. When utilizing other key, connect with use of the furnished 2-pin plug, as shown in Figure 3.8.

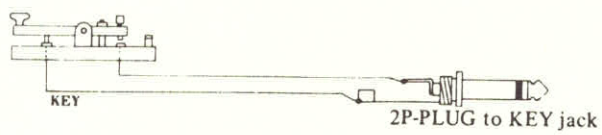


Figure 3.8 KEY CONNECTION

3.3.9 RTTY Connection

When operating in the RTTY mode, connect a teletypewriter to the RTTY-BK jack and RTTY MK/SP jack, by means of the furnished type pin plugs. Apply the mark/space keying signal to the RTTY MK/SP jack. A drain current of 10mA or less will flow. Earthing generates a mark and opening from the earth generates a space signal. The standby signal line is connected to the RTTY-BK jack. Earthing allows the transmitter to go into the transmitting state. A current of 200mA or lower flows out from this line. Send either open or earth signal from the RTTY by means of a relay or mechanical contact.

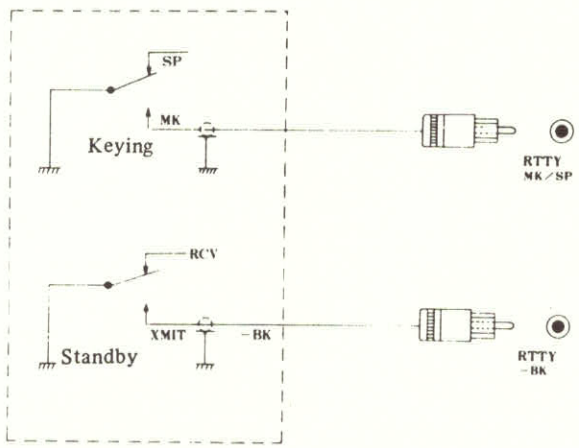


Figure 3.9 RTTY CONNECTION

3.3.10 Linear Amplifier Connection

When connecting a linear amplifier, connect the antenna line, stand-by line ($\overline{\text{XMIT}}$) and ALC line, as shown in Figure 3.10.

Employ a linear amplifier having an input impedance of 50 ohms. When using other linear amplifier having an input impedance of other than 50 ohms, connect an impedance matching coupler, CFG-515, between this transmitter and the linear amplifier, and adjust the coupler for matching, before operation.

The POWER CONT control is available for adjusting the exciting level. The exciting level will varies, during the adjustment of the linear amplifier. To avoid overdriving, connect the ALC line. The a negative voltage, which limits the output Power of NSD-515.

The following table are the ALC control voltage versus ort put power, nominal value Table 3.1

ALC VOLTAGE	POWER
0 V	100W
−1.0V	100W
−1.5V	100W
−2.0V	85W
−2.5V	30W
−3.0V	10W
−3.5V	5W
−4.0V	2W

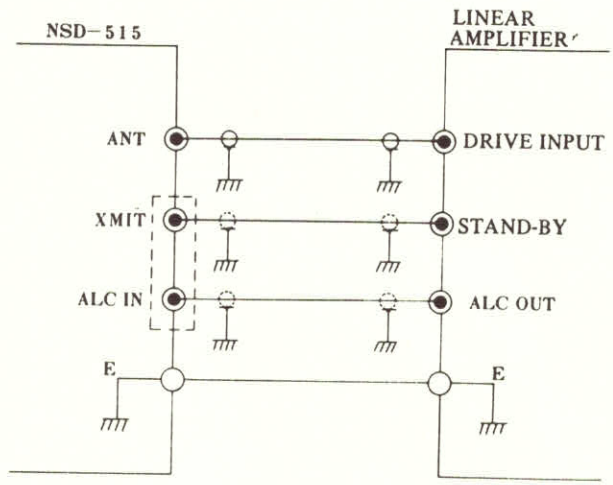


Figure 3.10 LINEAR AMPLIFIER CONNECTION

3.3.11 Electronics Key Connection

When using an electronics key in the CW mode, connect as shown in Figure 3.11. Noted that this equipment adopts the plus-keying system. If employing a minus-keying system, the electronics key must be slightly changed.

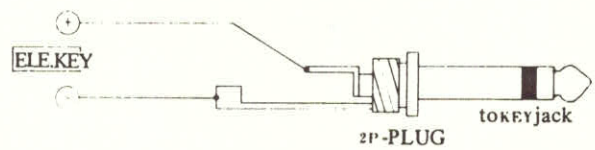


Figure 3.11 ELECTRONICS KEY CONNECTION

The voltage between the "+" and "−" lines connected to the electronics key should be kept, as follows:

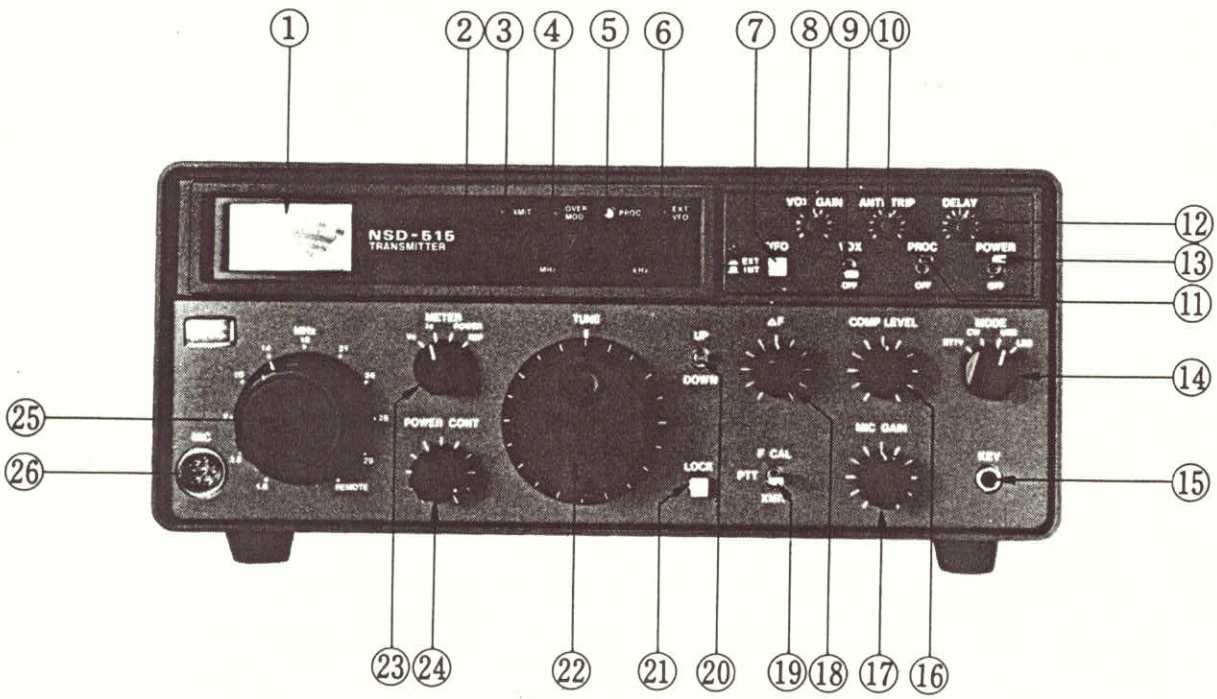
With KEY ON, voltage − less than 0.8V, at the current drain of 15mA, approx.

With KEY OFF, voltage − from 5V to 13.6V, or open-information (over 1 kilo-ohms)

The "−" line is grounded at the KEY jack.

SECTION 4 CONTROL PANEL

4.1 FRONT PANEL



(1) Check meter

For checking the operating conditions of the transmitter. The meter function is selected by the METER switch (23). It has the following positions.

Vc ..... For indication of the collector voltage of final stage transistors in the PA unit.
The normal reading on the meter is 13.6V at a green line on the 25V-scale.

Ic ..... For indication of the collector current of final stage transistors in the PA unit.
Utilize for measuring an final stage input power, etc.
The full scale of the meter is 25A, for the 100W-equipment, and 5A for the 10W-equipment.
In the normal operation, the meter reading is 15 to 20A for the 100W-equipment and 2 to 2.5A for the 10W-equipment.

POWER For indication of the transmitter output power. The rated power with the load resistance of 50 ohms corresponds to 100% on the scale of the check meter.
This position is available for checking the transmitter output power level.

REF ..... For indication of the reflected power.
Provided for adjustment of the antenna coupler.
The smaller reading on the check meter is better in operating condition; no deflection of the pointer indicates the load impedance is optimum to the transmitter. The condision is substantially normal, so long as a reading is less than Division 2 or 3 on the scale with the maximum position of the POWER CONT control.

(2) Frequency Display

Provided with light-emitting diodes for indicating the transmit frequency with minimum unit of 100Hz.

It is capable of indicating the frequencies in the following modes.

SSB ..... The display indicates the carrier frequency. The reading is automatically calibrated in the internal circuit, depending on the USB and LSB modes, either selected.

CW ..... The display indicates the transmitted carrier frequency.
The reading is automatically calibrated when the mode is switched from other mode to CW.

RTTY ...The display indicates the center frequency of mark and space signals.

NOTE: 1) The frequency display cannot indicate an external VFO frequency. The reading is of the internal VFO frequency only.
2) The 2 digits of MHz display will be invisible if the optional 3 band (WARC '79) is selected by the MHz exchange switch.

(3) XMIT Indicator

For indication of transmission. During the transmitting state, the LED illuminates in red.

CAUTION: Never transmit at off-band.

(4) OVER MOD Indicator

Illuminates to alarm, when the voice modulation level excessively rises. Adjust the MIC GAIN control (17) just before the OVER MODE indicator is going to illuminate.

If talking as loud as this indicator illuminates, an over modulation will be brough about to result in deterioration of the voice quality and the cause of spurious radiation. Therefore, such condition is undesirable.

(5) PROC Indicator

Illuminates in green, when the PROC switch (11) is set to the PROC position. This indicates the speech processor is operating.

(6) EXT VFO Indicator

Illuminates in green to indicate an external VFO is selected, when the VFO switch (7) is turned to the EXT position.

(7) VFO Switch

For selecting either the internal VFO or external VFO to be used, when operating in combination with the receiver. Having two positions:

INT .....for internal VFO operation.

EXT .....for external VFO operation.

The **EXT VFO** indicator (6) indicates which VFO is selected. With the EXT position of the VFO switch (7), the transmit frequency, including band, can be controlled from the receiver during the combined operation with the NRD-515 Receiver, while setting the MHz control (25) to the REMOTE position.

(8) VOX GAIN Control

For adjusting the voice level to turn the transmitter to transmition mode at VOX operation in the SSB mode. Clockwise rotation increases the VOX gain. Too high gain will cause miss transmission in response to the noise. Set the VOX GAIN for a stable operation.

(9) VOX Switch

For turning on and off the VOX circuit.

(10) ANTI TRIP Control

For adjusting the anti-trip level, when using the VOX. The anti-trip function is to prevent the mis-transmission in response to the sound from the speaker.

(11) PROC Switch

For turning on and off the RF speech processor for increasing the talk power level during transmission.

(12) DELAY Control

For adjusting the delay time provided for returning from transmission to reception, with use of VOX. Set so that no return to the reception is caused at any pause of speech or the like. Clockwise rotation increases the delay time.

(13) POWER Switch

For turning on and off the 13.6V-supply voltage.

CAUTION: Do set the STANDBY switch (19) to the PTT position, before turning on and off the POWER switch.

(14) MODE Switch

For selecting the type of emission. Having the positions of RTTY, CW, USB and LSB.

(15) KEY Jack

For connection of the key in the CW-operation.
Use the furnished 2-Pin plug.

(16) COMP LEVEL Control

For adjusting the compression level of the speech processor.

Clockwise rotation increases the compression level and the talk power goes up. Excessive compression may cause a distortion. Adjust with hearing own voice by means of the MONITOR at the receiver.

(17) MIC GAIN Control

For adjusting the signal level from the microphone. Clockwise rotation increases the gain. Set just before the OVER MOD indicator (4) is going to illuminate, while talking toward the microphone.

(18) ΔF Control

Closewise rotation increases the transmit frequency. Usually set to the mid position.

NOTE: This control has no effect upon the numerical value on the Frequency Display.

(19) STAND-BY Switch

For switching over the operation modes: transmission, stand-by (reception), and frequency calibration. Having three positions shown below.

PTT .....Stand-by mode. Set this position while operating with the PTT switch of microphone, with VOX circuits, or with an external.

F CAL ...The transmitter operates up to its driver stage.
At this position, the receiver is not muted. Available to calibrate the transmitting frequency to that of the partner station.

XMIT ....Transmission mode.

(20) UP/DOWN Switch

For quickly changing the operating frequency automatically.

Having two positions:

UP .....Increasing the frequency

DOWN ...Decreasing the frequency

(21) LOCK Button

For electrically locking the TUNE dial (22).

Once locked, the frequency is no more changed even by rotating the TUNE dia. Available for preventing the preset frequency from being changed due to vibration or mis-operation, and for calibration of the sub-dial scale.

(22) TUNE DIAL and SUB DIAL Scale

For setting the frequency to be transmitted. Full rotation of the dial covers 10kHz in step of 100Hz. The sub-dial scale has scale divisions, each per 500Hz.

Available and convenient for the UP-DOWN operation in QSY.

The sub-dial scale can be calibrated in steps of the following methods.

1) Set the TUNE dial so that a numerical value on the frequency display has "0" or "5" at its 100Hz-digit.
2) Depress the LOCK button (21) and rotate the TUNE dial. Set the sub-dial scale to an appropriate position relative to the dial. Then, release the LOCK button.

(23) METER Switch

For selecting the meter functions. For details, refer to the foregoing "Check meter" (1).

Usually, set to the POWER position, indicating the transmitter output power.

(24) POWER CONT Control

For adjustment of the output power level, with seeing the reading on the check meter. The variable range is from several watts to the rated power. Available for a near-range communication, for driving the linear amplifier, and for adjusting the antenna matching condition.

(25) MHz Switch

For selecting the amateur bands. Select one of 1.8MHz-, 3.5MHz-, 7MHz-, 14MHz-, 21MHz-, 28MHz- and 29MHz-bands.

Having positions for the 10MHz-, 18MHz- and 24MHz-bands, which will be newly approved by WARC. These positions will be available with associated optional units. When setting to the REMOTE position, the amateur band can be remotely controlled from the NRD-515 Receiver.

(26) MIC Jack

A 8-pin jack for connection of the microphone for the SSB mode operation. Use a microphone having a nominal impedance of 600 ohms.

4.2 BACK PANEL

(1) PA Unit

Integrated with heat sink.

(2) RX Connector

For connection of signal lines between the transmitter and the receiver, etc.

Having pins listed below.

(1) +13.6V OUT: +13.6V output line (max 0.5A)

(2)–(7) MHz-information: MHz-information input lines for remotely controlling the bands from the NRD-515 Receiver with the MHz switch (25) set to REMOTE .

(8), (12), (28) GND: earth lines.

(9) ANTI TRIP: input line of AF signal to be applied to the VOX circuit in the transmitter from the receiver.

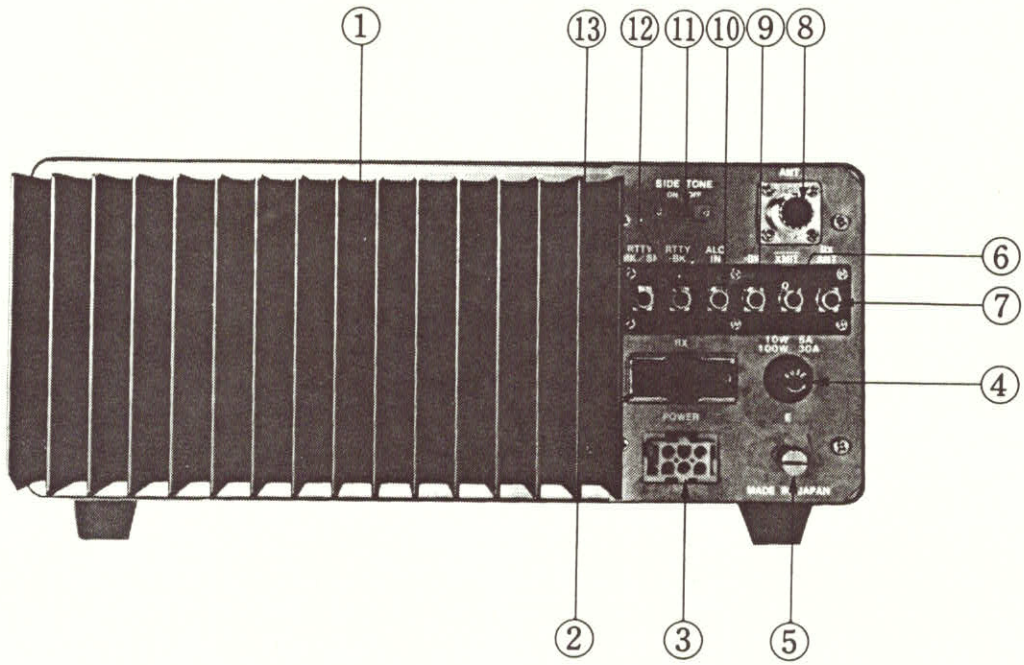
(10) XMIT: output line for muting the receiver during transmission. Opened from the earth during transmission to mute the receiver, and grounded during standby or waiting to allow the receiver to operate.

(11) SIDE TONE: output line of the side tone signal to the receiver. It is used for keying monitor at the CW mode.

The SIDE TONE switch (11) is provided for turning on and off the side tone.

(13) VFO OUT: output line of the VFO signal from the transmitter to the receiver.

(14) VFO IN: input line of the VFO signal from the receiver to the transmitter.



(15) RX VFO CONT: for controlling the VFO of the receiver from the transmitter.

(16) TX VFO CONT: for controlling the VFO of the transmitter from the receiver.

NOTE: Both (15) and (16) are effective for cross operation.

(17) Coupler-through: for bypassing the internal coupler, CFG-515, by externally grounding this pin.

(18)–(27) Operating band signals for external accessories, as follows:

(18) 1.8MHz-band	(19) 3.5MHz-band
(20) 7MHz-band	(21) 10MHz-band
(22) 14MHz-band	(23) 18MHz-band
(24) 21MHz-band	(25) 24MHz-band
(26) 28MHz-band	(27) 29MHz-band

(3) POWER Connector

For connection of the power input of +13.6V and external power source control signal output.

(4) FUSE HOLDER

For the 13.6V DC power from the power supply unit.

NOTE: If the fuse is blown, well investigate the cause and use specified fuse of 30A for 100W or 5A for 10W.

(5) E Terminal

For connection of the earth line.
Use for grounding the equipment.

(6) $\overline{\text{XMIT}}$ Connector

For transmit-receive switching of the linear amplifier. Provides the earth potential during transmission. Available as a standby signal output.

(7) RX ANT Jack

For connection of the antenna to the receiver.
Grounded by the ANT selector relay during transmission.

(8) ANT Connector

M-type coaxial connector for connecting the unbalanced antenna.

(9) –BK Jack

For connecting the –BK line for externally, controlling the transmitter, in the SSB or CW mode. Ground this line to transmit.
Available, combined with a foot siwthc, etc.

(10) ALC IN Jack

For connection of the ALC signal from a linear amplifier. Application of a negative voltage reduces the power level of the transmitter to protect the linear amplifier.

(11) SIDE TONE Switch

For turning on and off the side tone signal to be sent from the transmitter to the receiver during keying monitor in the CW mode.
Available for operation in the CW mode, combined with the receiver.

(12) RTTY –BK Jack

For connecting the –BK line in the RTTY mode.
Ground this line to transmit.

(13) RTTY MK/SP Jack

For connection of the keying signal of mark (MK) and space (SP) in the RTTY mode. Ground level for MK and open level for SP.

SECTION 5 OPERATION

CAUTION

Wrong operation may cause the transmitter to be in failure or damaged. Before switching on the power, carefully read through the instruction manual until becoming familiar with the operating procedure.

5.1 READING THE TRANSMIT FREQUENCY

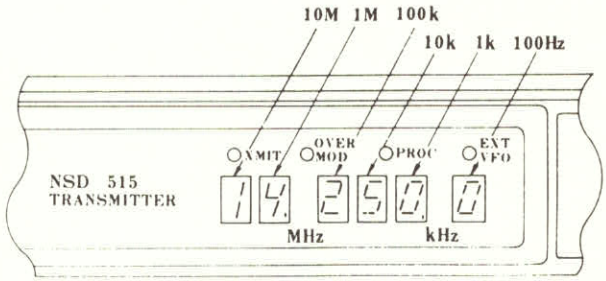


Figure 5.1 FREQUENCY DISPLAY

For direct reading the transmit frequency, six light-emitting diodes (LED) are arranged to provide its six digits: 10MHz-, 1MHz-, 100kHz-, 10kHz-, 1kHz- and 100Hz-digits, as shown in Figure 5.1.

The frequency display unit indicates the suppressed carrier frequency for the SSB mode, the carrier frequency for the CW mode, and the center frequency of mark and space for the RTTY mode.

In addition, the frequency display unit provides the frequency of the internal VFO only; providing no frequency of any external VFO.

NOTE: Never transmit other frequency than in the amateur band.

5.2 OPERATING PROCEDURE

Use a dummy load of 50 ohms in impedance, when adjusting the transmitter. If necessarily using an antenna, carefully watch a test frequency, before adjusting the transmitter. This prevents interference from being given to other communications.

5.2.1 Preparation

1) Set the POWER switch of the transmitter to OFF. Connect the power cord plug of the power supply unit to commercial AC line, 50/60Hz line.
2) Front panel control settings:
   STAND-BY switch ..... PTT
   MHz switch for band selection ..... desired band
   METER switch Vc
   POWER CONT control ..... fully counterclockwise
   MODE switch..... desired mode
   DELAY control ..... fully counterclockwise
   VOX switch ..... OFF
   PROC switch ..... OFF
   ΔF control ..... mid position
   COMP LEVEL control ..... fully counterclockwise
   MIC GAIN control ..... fully counterclockwise
   VOX GAIN control ..... fully counterclockwise
   ANTI TRIP control ..... fully counterclockwise
   VFO switch ..... INT

When completing the above settings, set the POWER switch ON and make sure the reading of Vc ranges 13V to 15V on the Check Meter. Then, set the TUNE dial to desired frequency.

5.2.2 Antenna Coupler Adjustment

1) In the procedure denoted in Paragraph 5.2.1, Preparation, change the settings as follows:
   METER switch Ic
   MODE switch ..... PTTY
2) This equipment is capable of transmitting the carrier in the RTTY mode. Set the STAND-BY switch to XMIT position to transmit.
3) Slowly rotate the POWER CONT control clockwise to drive the final stage, until the collector current reaches 5A for 100W-equipment or 1A for 10W-equipment.

   NOTE: If the matching condition is extremely poor, the final stage protection circuit may operate to reduce the driving. In such case, clockwise rotate the POWER CONT control by two or three divisions of scale and proceed to the next step.
4) Turn the METER switch to REF to check the strength of the reflected power. If the meter is in scale over, counterclockwise rotate the POWER CONT control unit a reading is reduced to 2/3 of full scale.
5) Adjust the antenna coupler so that the minimum reading is obtained at the REF position of the switch.
6) Turn the METER switch to Ic position to check the collector current, Ic. If it is less than the collector current of power data, about 18A for 100W-equipment or 2.2A for 10W-equipment, slightly turn the POWER CONT control to increase the Ic, and again adjust according to step 5.
7) The standard value of Ic is 18A (100W-equipment)/ 2.2A (10W-equipment). Refer to attached power data for details.
   Repeat steps 5) and 6) until the standard value is obtained.
   If the value of Ic exceeds the standard during adjustment, counterclockwise rotate the POWER CONT control until the standard value is obtained.

   CAUTION: An excessive Ic current may deteriorate the final stage to result in occurrence of the distortion and increase of the spurious and harmonics. Use with Ic of less than or equal to the standard value at any time.
8) If no reading is obtained on the check meter at the REF position with standard value of Ic, this suggests that the transmitter is completely matched with the antenna.
   If the reading ranges Division 3 to 5 at the REF position, the condition is not desirable. In this case, check the antenna, feeder, antenna coupler, earth, etc. and readjust them.

   NOTE: The sensitivity of the check meter is set near the critial point, only when the CHECK METER switch is set to REF position, so that the antenna coupler may be finely adjusted. As the result, the meter may response to a slight mismatched condition.

9) Scale-over on the check meter with its selector switch set to REF position may results from such a trouble as the antenna circuit being opened or shorted or heavy mismatch. Immediately check them.

   CAUTION: In this case, do not transmit, when allowable, though there is no fear that this equipment will be damaged owing to the protection circuit incorporated in it, against the antenna circuit being opened or shorted.

10) When using the CFG-515 antenna coupler, option, adjust it and preset the matching parameters for each band previously. The set parameters are changed, as the coupler is interlocked with the MHz switch. Therefore, there is no need to re-adjust each time the amateur band is switched.
    Well read the Instruction Manual attached to the CFG-515.

5.2.3 SSB Signal Emission

1) Change the settings denoted in Paragraph 5.2.1 Preparation, as follows:
   MODE switch .....USB or LSB
   NOTE: LSB for frequency less than 10MHz and USB for frequency of 10MHz or higher
   MIC jack ..... microphone connected
   METER switch ..... POWER
2) Set both MHz control and TUNE dial for desired transmit frequency.
3) Turn the STAND-BY switch to XMIT position, or turn it to PTT position before Press the PTT switch at the microphone, and talk.
4) Clockwise rotate the POWER CONT control. While applying a voice to the microphone, rotate the MIC GAIN control just before the OVER MOD LED is going to illuminate. Then, the check meter will suggest that the power is being radiated.
5) At the talking ends, return the STAND-BY switch to the PTT position or release the PTT switch of the microphone.
6) When the signal from own station is weak at the partner station in the DX communication, set the PROC switch to the PROC position and clockwise rotate the COMP LEVEL control. Then, the speech processor starts to increase the talk power.

   NOTE: Excessive complession may cause splatter.

7) For the operation with VOX, set the VOX switch to the VOX position and STAND-BY switch to the PTT position. While talking toward the microphone, clockwise rotate the VOX GAIN control and set to a position where the equipment automatically goes into the transmission. Too high gain may cause the VOX to maloperate in response to the ambinent noise. Use with the VOX GAIN control set to a position where no maloperation occurs.
   When using the speaker, The VOX may malfunction in response to the receiver tone from the speaker. To avoid this malfunction, clockwise rotate the ANTI TRIP control until no sound from the speaker cause the equipment to turn to the transmission. When the voice from the microphone is stopped, the equipment automatically returns to the reception. A time delay to return to the reception can be adjusted by means of the DELAY control. Clockwise rotation of this control increases the delay time. Set it so that the transmit state is kept during each pause of speech.

5.2.4 CW Signal Emission

1) Change the settings denoted in Paragraph 5.2.1 Preparation, as follows:
   MODE switch ..... CW
   KEY jack ..... key connected
   METER switch ..... POWER
2) Set both MHz switch and TUNE dial for desired transmit frequency.
3) Set the STAND-BY switch to the XMIT position and transmit with the key.
4) Rotate the POWER CONT control clockwise. Read the check meter to make sure the power is being radiated.
5) When the transmission ends, return the STAND-BY switch to the PTT position.
6) For the operation with VOX, set the VOX switch to the VOX position and the STAND-BY switch to the PTT position. The keying causes the equipment to automatically go into the transmission. Interruption of the keying causes the transmitter to return to the reception with a certain delay time. This recovery time can be adjusted also by means of the DELAY control, the same as in the SSB wave emission mode.

5.2.5 RTTY Signal Emission

1) Change the settings denoted in Paragraph 5.2.1 Preparation, as follows:
   MODE switch ..... RTTY
   METER switch ..... POWER
   Connect the teletypewriter as denoted in Paragraph 3.3.9.
2) Set both MHz switch and TUNE dial for desired frequency.
3) Set the STAND-BY switch to the XMIT position. Or set it PTT position and set the back panel RTTY –BK (standby signal) to the earth potential. Then, the equipment will go into the transmission.
4) When continuously transmitting in the RTTY mode for a long time, and PA unit may overheat. To avoid such situation, counterclockwise the POWER CONT control to reduce the output power.
5) VOX cannot be used in the RTTY mode.

5.2.6 Transmitted Signal Monitoring

When wishing to monitor the transmitted signal from own station, set the MONITOR switch of the receiver to ON position, and adjust the MONITOR control on the back of the receiver.

NOTE: If the frequency under transmission is different from that under reception, the monitor is impossible.

5.2.7 Frequency Zero-In at SSB Mode

The transmit frequency can be equalized to the receiving frequency, as follows: Set the STAND-BY switch to the F CAL position. Then, the transmitter is energized up to its driver stage. This allows the receiver to monitor the monitoring sound from the transmitter.

In the separate mode operation, while talking toward the microphone, adjust the TUNE dial of the transmitter so that the monitoring tone becomes natural tone. In addition, the ΔF control is available for fine adjustment in this setting. In the transceive mode operation, set the ΔF switch of the receiver to OFF and adjust the ΔF control of the transmitter to set the frequency.

5.2.8 KEYING Monitor

Set the SIDE TONE switch to ON. This switch is located at the back face of the transmitter. Then, the side tone generated according to the keying will be transmitted to the receiver from the transmitter and can be directly monitored.

When using the side tone signal, the CW monitor can be made, even if the frequencies are different between the transmitter and receiver. At this time, set the MONITOR switch of the receiver to OFF position.

5.2.9 Frequency Zero-In at CW Mode

The transmit frequency can be equalized to the receiving frequency, as follows: Set the STAND-BY switch to the F CAL position. Then, the continuous carrier can be directly monitored at the receiver.

In the separate mode operation, adjust the TUNE dial so that the tone of transmitting carrier coincides with that of receiving signal. In addition, the ΔF control of the transmitter is available for fine adjustment. In the transceive operation, set the ΔF switch of the receiver to the OFF position and adjust the ΔF control of the transmitter.

5.3 COMBINATION OPERATION WITH NRD-515

Connect the NSD-515 transmitter to the NRD-515 receiver, as described in Paragraph 3.3.2.

Set the VFO switches of the transmitter and receiver, and MANUAL/PRESET switch of the optional memory unit, as listed in Table 5.1.

Table 5.1

MEMORY UNIT MANU/PRE SW	RX VFO SW	TX VFO SW	REC. FREQ. SETTING	RX DISPLAY	TRA. FREQ. SETTING	TX DISPLAY	OPERATION MODE
MANUAL	INT	INT	RX VFO	RX freq.	TX VFO	TX freq.	Separate
	INT	EXT	RX VFO	TX/RX freq.	RX VFO	(Note 2)	Transceive with RX VFO
	EXT	INT	TX VFO	(Note 2)	TX VFO	TX/RX freq.	Transceive with TX VFO
	EXT	EXT	TX VFO	TX freq.	RX VFO	RX freq.	Cross
PRESET	INT	INT	Memory CH	RX freq.	TX VFO	TX freq.	Separate with fixed RX freq.
	INT	EXT	Memory CH	TX/RX freq.	Memory CH	(Note 2)	Transceive with memory CH
	EXT	INT	TX VFO	(Note 2)	TX VFO	TX/RX freq.	Transceive with TX VFO
	EXT	EXT	TX VFO	TX freq.	Memory CH	RX freq.	Cross with fixed TX freq.

NOTE: TX ..... Transmitter, RX ..... Receiver, CH ..... channel

1. This table includes the case where the NDH-515 memory unit is used. If not using the memory unit, refer to Column of MANUAL only.
2. Neither VFO frequency sent from outside to TX nor that to RX can be read on the TX and RX display units respectively. Each unit indicates only the frequency of its internal VFO.

NOTE: * When the VFO switch of RX is set to EXT , no frequency can be written in the memory unit from the external VFO.

* For fine adjustment of the frequency, use the ΔF control of RX at reception and the ΔF control of TX at transmission. In this case, numerical value remains unchanged on the FREQUENCY DISPLAY unit.
* With the REMOTE position of the MHz switch of TX, the band of TX can be remotely selected from RX.

In the combination operation of the NSD-515 transmitter with the NRD-515 receiver, both frequencies for transmission and reception are set by associated VFO and "ΔF" controls related as listed in Table 5.2.

Table 5.2

OPERATION MODE	TX TRA. FREQ. SETTING		RX REC. FREQ. SETTING	
	VFO	ΔF (TX)*	VFO	ΔF (RX)**
Separate	TX VFO	○	RX VFO	○
Transceive with RX VFO	RX VFO	○***	RX VFO	○
Transceive with TX VFO	TX VFO	○	TX VFO	X
Cross	RX VFO	○***	TX VFO	X

NOTE: TX ..... Transmitter, RX ..... Receiver

"○" ..... "ΔF" control available "X" ..... "ΔF" control not available

*) ΔF (TX) ..... ΔF control of NSD-515 transmitter

**) ΔF (RX) ..... ΔF control of NRD-515 receiver

***) With the F CAL position of the STAND-BY switch at TX, both ΔF controls of the transmitter and receiver are available for fine adjustment of the frequency. However, at the time of transmission, it follows that the ΔF switch of the receiver is set resultantly OFF. As the result, the set frequency may slightly shift.

5.4 COMBINATION OPERATION WITH NRD-505

Connect the NSD-515 transmitter to the NRD-505 receiver according to the method described in Paragraph 3.3.3.

The VFO switches of both transmitter and receiver and the MANUAL/PRESET switch of the optional memory unit are set, as listed in Table 5.3.

Table 5.3

MEMORY UNIT MANU/PRE SW	RX VFO SW	TX VFO SW	REC. FREQ. SETTING	RX DISPLAY	TRA. FREQ. SETTING	TX DISPLAY	OPERATION MODE
MANUAL	INT	INT	RX VFO	RX freq.	TX VFO	TX freq.	Separate
	INT	EXT	RX VFO	TX/RX freq.	RX VFO	(Note 2)	Transceive with RX VFO
	EXT	INT	TX VFO	TX/RX freq.	TX VFO	TX/RX freq.	Transceive with TX VFO
	EXT	EXT	TX VFO	RX freq.	RX VFO	RX freq.	Cross (Note 3)
PRESET	INT	INT	Memory CH	RX freq.	TX VFO	TX freq.	Separate with fixed RX freq.
	INT	EXT	Memory CH	TX/RX freq.	Memory CH	(Note 2)	Transceive with memory CH
	EXT	INT	TX VFO	TX/RX freq.	TX VFO	TX/RX freq.	Transceive with TX VFO
	EXT	EXT	TX VFO	RX freq.	Memory CH	RX freq.	Cross with fixed TX freq. (Note 3)

NOTE: TX ..... Transmitter, RX ..... Receiver, CH ..... channel

1. The above table includes the case where the CDD-48 frequency memory unit, option, is used. If not using the frequency memory unit, see Column MANUAL only.
2. No frequency of VFO sent from outside can be read on the TX display unit. It indicates the internal VFO frequency only.
3. In the cross operation mode, both TX and RX frequency display units provide the receive frequency at the time of reception; not the transmit frequency. If wishing to read the transmit frequency, set the VFO switch of RX to INT position and read the RX display. In addition, the RX frequency display unit does not provide a correct value of reading during the transmission; this being not in failure.

NOTE: * Use the TX and RX "MHz" switches for setting the MHz-digits of respective frequencies. When using the memory unit, the RX "MHz" switch is disabled.

* When wishing to transmit with use of the RX memory unit, no MHz-digit of desired frequency can be set, but the 100kHz-digit and lower digits of frequency can be set with only the frequency stored in the memory unit. In this case, manually set the TX "MHz" switch to desired band.

Table 5.4 tabulates the VFO's and associated "ΔF" controls for setting the transmit and receive frequencies in the combination operation of the NSD-515 transmitter with the NRD-505 receiver.

Table 5.4

OPERATION MODE	TX TRA. FREQ. SETTING		RX REC. FREQ. SETTING	
	VFO	ΔF (TX)*	VFO	ΔF (RX)**
Separate	TX VFO	○	RX VFO	○
Transceive with RX VFO	RX VFO	○	RX VFO	○
Transceive with TX VFO	TX VFO	○	TX VFO	○
Cross	RX VFO	○	TX VFO	○

NOTE: TX ..... Transmitter, RX ..... Receiver

"○" ..... "ΔF" control available

*) ΔF (TX) ..... ΔF control of NSD-515 transmitter

**) ΔF (RX) ..... ΔF control of NRD-515 receiver

SECTION 6 CIRCUIT DESCRIPTION

6.1 SYSTEM DIAGRAM AND CIRCUIT DIAGRAMS

The system diagram of this equipment is shown in Appendix 1 and the circuit connection diagrams shown in Appendix 2 through 18.

6.2 CIRCUIT DESCRIPTION

6.2.1 Front Panel Unit, CAE-240

The front panel mounts various operating switches, controls, check meter, MIC jack, KEY jack, etc. in addition to the MHz-switch for generating required BCD codes and TUNE dial, which incorporates a rotary photo type switch for generating 100 pulses per rotation, the same as the TUNE dial of the NRD-515.

The frequency display circuit converts the BCD code information of the set transmit frequency in IC1 through IC6 for code convertion and displays the numerical value of frequency on LED's of CD1 through CD6.

The signal from the microphone is applied to the MIC jack J1 located on the front panel and amplified in the MIC AMP pre-amplifier of IC1-1/2. Its output is further amplified in IC1-2/2 after passing through the AF GAIN control RV7. The amplified signal is applied to the balanced modulator in the AF-IF amplifier unit.

6.2.2 AF-IF Amplifier Unit, CAE-117

This unit contains the balanced modulator, IF amplifier, RF speech processor circuit, OVER MOD indicator circuit, VOX circuit, ANTI TRIP circuit and side tone circuit.

The local oscillator generates a signal of 8701.5kHz for USB or 8698.5kHz for LSB, which is amplified in the LOCAL-1 unit and then applied to the AF-IF amplifier unit. The circuit of IC1 in this unit modulate the local oscillator with AF signal and generates a DSB signal with suppressed carrier.

The DSB signal passes through a buffer amplifier TR1 to a crystal filter FL1 of 8.7MHz, which provides an output, SSB signal. It is amplified in TR12 when the RF speech processor is set OFF. The output of TR12 is connected to the mixer in the RF amplifier unit. When the speech processor is set ON, the SSB signal is amplified in TR10 and IC5. The amplification gain is varied in TR10 and the compression level is controlled at the same time. IC5 limits the excessive amplitudes of the signal. Its output is fed into another crystal filter FL2 for removing harmonics of the signal, and then amplified in TR12. Its output is fed to the mixer in the RF amplifier unit. Both TR13 and TR14 amplify an APC control voltage, which is applied to TR12 to control its amplification gain.

On the other hand, the AF signal amplified in IC2-1/2 is partly applied through the VOX GAIN control RV1 to TR7 for amplifying the signal. The AF signal is also partly detected and is amplified and applied to the OVER MOD light-emitting diode CD9.

The VOX amplifier-detector circuit consisting of TR7, IC3-2/2, CD26 and CD27 amplifies the AF signal and detects it to produce a trigger signal, which triggers a monostable multivibrator of IC4 to generate an automatic transmit-receive switching signal. Both TR5 and TR6 amplify the output of IC4, DC signal, to generate a standby signal, the −BK signal. This signal is used for turning on and off the antenna relay.

The anti-trip signal from the receiver passes through the ANTI TRIP control located on the front panel, to IC3-1/3 for amplification. Its output is detected by CD24 and CD25 into a DC signal, which is applied to IC4.

The anti-trip signal prevents to trigger the multivibrator. If, therefore, any sound from the speaker enters into the microphone, the equipment cannot turn to the transmit state in any way.

The delay time for returning to the receive phase from the transmit phase can be adjusted with use of the DELAY control, which determines the operation time of the multivibrator. It is noted that the relay K1 operates to cut off the anti-trip signal at the RTTY and CW modes.

The side tone is generated by keying on and off the key connected to the emitter of TR8 in the phase-shift type CR-oscillator. Its output is connected to the MONITOR control RV4 for adjusting the side tone level. It is followed by the SIDE TONE switch S1 located on the back panel. The side tone signal is finally connected to the RX connector, J3. It is also applied to the VOX amplifier of TR7 for driving the VOX circuit. The SIDE TONE control RV3 is to adjust the side tone frequency.

In case of CW mode, the carrier of 8700kHz generated in the LOCAL-1 unit is applied to TR1. The output of TR1 is also fed to the RF amplifier unit through FL1 and TR12 in the same manner as in the case of SSB mode, while the RF speech processor circuit is set OFF.

In case of RTTY mode, the signal of 8700kHz ±85Hz generated in the LOCAL-1 unit is applied also to TR1 and its output is fed to the RF amplifier unit in the same manner as in the case of CW.

6.2.3 RF Amplifier Unit, CAF-161

The RF amplifier unit contains a double-balanced mixer (DBM), double-tuned bandpass filters (BPF) for the respective bands, and wide-band RF amplifiers.

Both the IF signal of 8.7MHz from the AF-IF amplifier unit and the second local oscillator signal from the LOCAL-2 unit are applied to DBM followed by the BPF for taking out the difference between the frequencies of both signals. This is the transmit frequency. The output of the BPF is connected to amplifier stages of TR1, TR2 and TR3 and the final stage of them is connected to the PA unit.

Transistor TR4 swtiches on and off both TR2 and TR3 according to the CW keying signal.

6.2.4 POWER AMP (PA) Unit, CAH-154 for 100W and CAH-154S for 10W

The PA unit contains two or three stages of power amplifiers, temperature-compensated biasing circuit, and limiter circuit for limiting the collector current of transistors in the driver stage.

NOTE: Two stages of power amplifiers for the 10W-equipment, and three stages for the 100W-equipment.

The signal from the RF amplifier unit is A-class-amplified in TR1 and further amplifier in both TR2 and TR3, the final stage of amplifier of push-pull type. Its output is applied to the OUTPUT unit in the case of the 10W-equipment. In case of 100W-equipment, TR2 and TR3 are followed by TR4 and TR5 of a push-pull type, the final stage of power amplifier.

The biasing circuit contains TR9 combined with a temperature sensor consisting of TR11, CD1 and CD2 to form an automatic voltage regulator, AVR. TR9 gives TR1 biasing voltage. In addition, both TR7 and TR8 is combined with TR12 for temperature sensing, to form another automatic voltage regulator for biasing TR2 through TR5. A transistor circuit consists of TR6 and TR10, which lowers the base bias voltage of TR2 and TR3 when their collectors current abnormally increases. A negative feedback loop is contained in each power amplifier circuit to provide a good stability and linearity of amplification for every band.

6.2.5 OUTPUT-1 Unit, CMB-57 for 3.5MHz, 7MHz, 14MHz, 21MHz, 28MHz, and 29MHz bands

The OUTPUT-1 unit contains power lowpass filters (LPF) for respective bands, APC detector, amplifier circuit, power adjusting control, reflected power detector-amplifier circuit, etc.

The signal of 100W or 10W fed from the PA unit is applied to the power LPF for attenuating harmonics and spurious components of the signal to provide a clean RF signal to be fed to the antenna. Relays are used for switching over the power LPF's for the respective bands.

The output voltage of each power LPF is divided by R1 through R3, detected by CD1 and CD2, and amplified in a DC amplifier of IC1-1/2 to produce the PAC control voltage, which is applied to TR13 in the AF-IF amplifier unit. Controls RV6 through RV10 are provided for adjusting the bias voltage of IC1-1/2, which determines the output power level under the control of APC.

The reflected power is received with T1, C31 and C32. It is detected through CD12 and CD13 and then amplified in a DC amplifier of IC1-2/2. Its output is applied to TR13 in the AF-IF amplifier unit. If the reflected power is detected, resultant positive voltage is applied to TR13 in the AF-IF amplifier unit to lower its amplification gain. This causes the driver stage to lower its output level to the final stage, thus protecting the PA transistors.

6.2.6 Code Converter Unit, CHM-84

This unit contains a power lowpass filter (LPF), ALC circuit for the linear amplifier, and converter circuit for conventing the BCD code information fed from the MHz-switch, into each band information. The power LPF is for the 1.8MHz-band and identical to those in the OUTPUT-1 unit.

A comparator circuit consists of TR2 and IC9 for comparing the ALC level and is used in an external ALC input circuit of the linear amplifier.

The code converter circuit consists of IC1 through IC8, IC10 and IC11. A BCD code information is supplied to IC11 from the MHz-switch located on the front panel. Both IC2 and IC3 provide outputs of information about the bands of 1.8 through 29MHz.

The MHz-information from the NRD-515 is supplied to IC1, when the MHz-switch of the NSD-515 is set to REMOTE position in the combination with the NRD-515. As the result, the circuit of IC4 through IC8 provides an output for blanking the display of other than the amateur bands. Therefore, the MHz-indicator of the NSD-515 illuminates associated LED's with the amateur bands only.

Table 6.1

BAND (MHz)	CRYSTAL OSC. FREQ. (kHz)	MULTIPL.	PREMIXER INPUT FREQ. (kHz)	VFO FREQ. RANGE (kHz)	PREMIXER OUTPUT FREQ. (kHz)	TRANSMIT FREQ. (MHz)
1.8	7,245.0	x 1	7,245.0	3,255 – 3,455	10.5 – 10.7	1.8 – 2.0
3.5	9,245.0	x 1	9,245.0	2,955 – 3,455	12.2 – 12.7	3.5 – 4.0
7	13,245.0	x 1	13,245.0	2,455 – 2,755	15.7 – 16.2	7.0 – 7.3
10*	16,245.0	x 1	16,245.0	2,455 – 2,655	18.7 – 18.9	10.0 – 10.2
14	10,122.5	x 2	20,245.0	2,455 – 2,955	22.7 – 23.2	14.0 – 14.5
18*	12,122.5	x 2	24,245.0	2,455 – 2,655	26.7 – 26.9	18.0 – 18.2
21	13,622.5	x 2	27,245.0	2,455 – 2,955	29.7 – 30.2	21.0 – 21.5
24*	15,122.5	x 2	30,245.0	3,255 – 3,355	33.5 – 33.7	24.8 – 24.9
28	17,122.5	x 2	34,245.0	2,455 – 3,455	36.7 – 37.7	28.0 – 29.0
29	17,622.5	x 2	35,245.0	2,455 – 3,155	37.7 – 38.4	29.0 – 29.7

NOTE: 1. The 10MHz, 18MHz and 24MHz bands width * are new bands of WARC, and each option.

6.2.7 UP/DOWN Unit, CGH-58

This unit contains a reference frequency oscillator of TR3 to oscillate 10MHz and frequency dividers of IC23 and IC22 for generating a reference signal of 1kHz for the digital VFO.

The UP/DOWN counter consists of IC1, IC2, IC3, IC5, and IC13 through IC16. Both IC1 and IC2 are combined with IC29 to discriminate UP and DOWN pulses sent from the TUNE dial and control them. The output is sent to the UP/DOWN counter circuit.

This circuit consists of IC13 through IC16 for controlling the transmit frequency of 100Hz to 100kHz-digit. A frequency quick change circuit consists of IC3 and IC5. A gate circuit consists of IC26, IC27 and IC28 for controlling the frequency of the UP/DOWN counter.

Variable frequency dividers incorporated with VCO consist of IC17 through IC21.

6.2.8 VCO Unit, CGH-59

This unit consists of TR1 through TR6, TR9 through TR11, TR13 and IC1 through IC7. A VCXO of TR10 oscillates in 19MHz, which is then doubled into 38MHz and taken out through a tuned circuit of T1 and T2. Its output is applied to the mixer of TR4.

In this mixer, the frequency of 38MHz is mixed with the output frequency of VCO oscillable in a range of 24.55 to 34.55MHz to produce an output in a range of 13.45 to 3.451MHz. The output is amplified in IC2, TR2 and TR1 and then applied to the UP/DOWN unit.

The reference frequency of 1kHz from the UP/DOWN unit and the output frequency from the variable frequency divider are applied to a phase detector to detect the phase difference between them. This phase difference signal is applied to VCO to control its frequency.

When the VCO is out of phase lock, corresponding LED lamp of CD2 illuminates. The output signal of VCO is applied to an amplifier of TR6 followed by a 1/10-fixed frequency divider of IC7 and lowpass filter. Its output is a VFO signal of 2.455 to 3.455MHz.

A VFO switching relay of K1 is connected to the VFO switch located on the front panel to select the INT or EXT position.

A relay driver consists of TR13 for turning on and off the antenna relays K1 and K2, depending on the stand-by signal.

6.2.9 LOCAL-1 Unit, CGA-80

This unit contains a premix crystal oscillator circuit, ΔF circuit, frequency doubler circuit, local oscillator circuit of 8.7MHz, amplifier circuit, and FSK circuit for RTTY mode.

The crystal oscillator circuit consists of TR1 oscillates in one of frequencies listed in Table 6.1 and is followed by an amplifier of TR2. Its output is connected to the frequency doubler circuit consisting of T1 and CD21 through CD23.

When any of the 1.8MHz-band through 10MHz-band is selected, the frequency doubler circuit does not double the frequency but passes the signal to the next stage. On the other hand, when any of the 14MHz-band through 29MHz-band is selected, this circuit normally operates to provide the doubled frequency signal to be fed to a buffer of TR3.

The output of the buffer is connected to the premix circuit in the LOCAL-2 unit.

The ΔF circuit provides a control voltage to be fed to CD45 through CD54 under the control of the ΔF control located on the front panel. This circuit is used for fine adjustment of the transmit frequency for each band.

The 8700kHz-local oscillator circuit consisting of TR6 oscillates in a frequency of 8701.5kHz at the USB mode, 8698.5kHz at the LSB mode, and 8700.0kHz at the CW mode. An amplifier of TR7 amplifies the output of the oscillator circuit. The amplified signal is applied to the AF-IF amplifier unit through CD35 at the SSB mode and through CD36 through CD39 at the CW and RTTY modes.

On the other hand, both TR4 and TR5 are switched in response to the keying signal from RTTY to shift the oscillator frequency in X11.

Both CV11 and CV12 are provided for the shift setting.

The oscillation frequency is as follows:

MARK 8699.915kHz
SPACE 8700.085kHz

The radiated signal has a higher frequency for the MARK and lower frequency for the SPACE.

6.2.10 LOCAL-2 Unit, CGA-81

This unit contains a premixer, bandpass filters (BPF) for respective bands, and wide-band amplifier circuit. The premixer employs a double-balanced mixer IC, IC1. It mixed a premixer input frequency with a FVO frequency sent from the VCO unit. The premixer input signal is sent from the LOCAL-1 unit, as listed in Table 6.1. The output of the premixer is connected to the double-tuned BPF's for the respective bands. Each BPF picks out the sum frequency component from the premixer output. The output of each BPF is connected to the amplifier circuit consisting of TR1 through TR4. Its output is applied to the DBM in the RF amplifier unit.

SECTION 7 MAINTENANCE AND CHECKS

The equipment has been completely adjusted and inspected before delivery. However, the following maintenance and checks will assure a long life of the equipment in addition to its elevated performance for a long time.

7.1 PREPARATION BEFORE MAINTENANCE AND CHECKS

This equipment is composed of the chassis, back panel, front panel, and transmitter assembly.

The transmitter assembly consists of the AF-IF amplifier unit, RF amplifier unit, LOCAL-2 unit, LOCAL-1 unit, VCO unit, UP/DOWN unit, Code Converter unit, and OUTPUT-1 unit.

1) Removing the top cover and bottom cover from case

With referring to Figure 7.1, remove eight black screws at the right and left sides of top and bottom covers, and then uncover the case.

NOTE: a) Carefully handle each unit enough not to enter solder and wire cut pieces into it.

b) Do not rotate any core of transformer, trimmer capacitors, semifixed variable resistors, etc. unreasonably, unless necessary.

c) The UP/DOWN units and VCO units in the transmitter and synthesizer assemblies have been accurately adjusted already. They, therefore, necessitate suited measuring instruments and well-trained techniques for repair and adjustment.

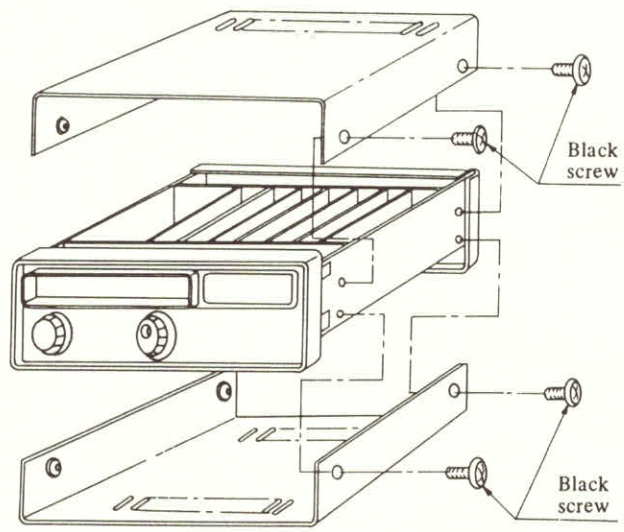


Figure 7.1 MAIN UNIT ASSEMBLY

7.2 MAINTENANCE

1) Cleaning

The panel surface, control knobs, top cover, bottom cover, etc. should be cleaned with use of soft cloth or which may be impregnated with silicone oil, for slightly wiping off dirts from them.

The inner surface of the equipment should be cleaned with use of brush and electric cleaner for removing dust and cut pieces.

There is no section requiring lubrication.

2) Circuit Units

Check the contact area, both ends of each circuit board, contacting with earth springs. If the contact area rusts because of long use, polish with a fine-mesh sand-paper or the like, until the unit completely contact with the earth springs, when inserted into the chassis.

3) Fuse

If the fuse is blown, thoroughly investigate the cause and then repair. Replace with a new glass type fuse of 30A for the 100W-equipment or 5A for the 10W-equipment.

4) Pilot lamp

If the pilot lamp is burnt out, replace with the furnished lamp of a BA7S/13 base-type; its rating is 18V, 0.11A.

5) Circuitry

CAUTION: Any IC and transistor may be damaged even by a very instantaneous shorting. Take care of this fact at the time of maintenance.

Check the resistors, capacitors, coils, transformers, etc. for being discolored or burnt out. If necessary, replace with a new circuit element having the same value, working voltage, tolerance, and temperature coefficient as the old element.

7.3 CHECKS, MAINTENANCE AND FREQUENCY CALIBRATION

For the checks and adjustment, each circuit unit needs an extension unit and printed circuit board pull-off tool.

7.3.1 UP/DOWN Unit, 10MHz-Reference Oscillator Circuit

Frequency calibration with frequency counter

(1) Connect a frequency counter to TP3.

(2) Set the trimmer CV1 just for a frequency of 10000.0000kHz.

7.3.2 VCO Unit, 38MHz-Oscillator Circuit

Frequency calibration by frequency counter

(1) Connect a frequency counter to TP4.

(2) Set the semi-fixed variable resistor RV1 just for a frequency of 38MHz. This resistor locates in the shield case below TP4.

7.3.3 LOCAL-1 Unit

1) Premix crystal oscillator frequency adjustment

(1) Set the front panel "ΔF" control to the mid position.

(2) Connect a frequency counter to either TP1 of the LOCAL-1 unit or TP2 of the LOCAL-2 unit.

(3) Set the MHz-switch on the front panel for the 1.8MHz-band through 29MHz-band one after another and set the trimmer capacitors CV1 through CV10 just for readings of frequencies on the counter, as listed in Table 6.1 Premix input frequencies.

2) 8.7MHz-First local oscillator adjustment

The 8.7MHz-first local oscillator must be adjusted for all the USB, LSB and CW modes, separately.

a) CW mode

(1) Connect a frequency counter to TP2.

(2) Set the trimmer capacitor CV14 just for a reading of 8700.000kHz. This capacitor is located in the shield case below TP2.

b) SSB mode

(1) Connect a frequency counter to TP2.

(2) Set the trimmer capacitor CV13 for a reading of 8701.500kHz on the counter for the USB mode. Set the trimmer capacitor CV15 for a reading of 8698.500kHz on the counter for the LSB mode. Both capacitors locate in the shield case below TP2.

c) RTTY mode

(1) Connect a frequency counter to TP2.

(2) Ground the back panel RTTY MK/SP jack J2. Set the trimmer capacitor CV11 (MARK) just for a reading of 8699.915kHz on the counter.

(3) Then, open the back panel RTTY MK/SP jack J2. Set the trimmer capacitor CV12 (SPACE) just for a reading of 8700.085kHz on the counter.

7.3.4 AF-IF Unit

1) Side Tone Frequency Adjustment

The SIDE TONE control RV3 is provided for setting the side tone frequency in a range of 650 to 950Hz. Set for desired tone.

The MONITOR control RV4 is available for adjusting the side tone output level to be fed to the receiver.

7.3.5 POWER Amplifier (PA) Unit

The PA unit must be connected to a dummy load of 50 ohms necessarily for checking the unit.

1) PA bias adjustment

NOTE: Before adjustment, execute the heat run of the PA unit enough to stabilize the temperatures at every point in the PA stages.

Set the power switch to OFF. Set the POWER CONT control to fully counterclockwise position, minimum position. Connect a well calibrated DC current meter to the +13.6V terminal J35 and P35, in such manner: the meter's positive terminal is to J35 and negative terminal to P35.

Then, turn the power switch to ON. Set for the CW mode and the standby switch to XMIT position. Adjust the BIAS ADJ control RV1 so that a reading of 0.5A is obtained on the current meter for the 100W-equipment and reading of 0.3A for the 10W-equipment.

WARNING: Never touch the key at this time.

2) Calibration of the check meter about IC

Connect the 30A DC current meter in the same manner as Paragraph 1), Turn the meter METER switch to Ic position. Key down and set the POWER CONT volume so that a reading of 10 A (100W) and reading of 2A (10W) is obtained on the 30A DC current meter. Then set the reading of the check meter to 10A (100W) or 2 A (10W) by RV2.

7.3.6 LOCAL-2 Unit

The double-tuned bandpass filters are composed of transformers T1 through T27 to cover the local oscillator frequency variable range for all the bands.

NOTE: Do not turn the core of any transformer; the adjustment is impossible, without using a measuring instrument capable of directly observing the filter characteristics, such as sweep generator, etc.

7.3.7 RF Amplifier Unit

The transformers T2 through T21 form double-tuned bandpass filters for the 1.8MHz-band through 29MHz-band.

NOTE: Do not turn the core of any transformer; the adjustment is impossible, without using a measuring instrument capable of directly observing the filter characteristics, such as sweep generator, etc.

7.3.8 OUTPUT Unit-1

Turn the MHz-switch, starting from the 3.5MHz-position up to 29MHz-position to make sure of the operation of corresponding relays K5 through K14. Set the STAND-BY switch to XMIT position. Be sure both relay K2 on the printed circuit board of the VCO

unit and the antenna relay K1 at the back panel of the equipment.

The output adjust controls RV6 through RV10 have been rigorously adjusted in the factory.

NOTE: Do not rotate RV6 through RV10.

If carelessly rotating any of the output controls, set with use of an accurate power meter of 50 ohms, as follows:

10W-equipment ..... set to output of 10W for every band

100W-equipment ..... set to output of 100W for every band

At this setting, mode – RTTY
POWER CONT – maximum

A protection circuit is provided for protecting the transistors in the final stage. It detects the increase of the reflected power to reduce the driving level. Controls RV1 through RV5 (REF) are provided for setting the control start levels of this protection circuit.

Controls associated with the 1.8MHz-band are contained in the Code Converter circuit unit. The adjustment is the same as those in the OUTPUT-1 unit. Use RV3 for adjusting the output level and RV4 (REF) for setting the control start level of the protection circuit.

CAUTION: Never rotate controls.

7.3.9 Lock Indicator

The VCO unit is provided with a lock indicator consisting of a light-emitting diode CD2. It illuminates, when the digital VFO circuit is out of phase lock. Locate the trouble according to Table 7.1.

Table 7.1

LOCK INDICATOR CD2	POSSIBLE TROUBLE
Illuminating	10MHz-reference frequency oscillator circuit defective
Illuminating	38MHz-oscillator circuit defective
Illuminating	UP/DOWN counter circuit defective

NOTE: 1. The indicator CD2 will momentarily flash when the operating frequency below the MHz-digit is changed from 999.9kHz to 000.0kHz or from 000.0kHz to 999.9kHz. This is, however, not a trouble.

7.3.10 Others

Check the pin plugs and connectors connected to each unit for incomplete connection and poor contact.

NOTE: Completely insert each unit into the mother board.

TROUBLESHOOTING

For a simple trouble, clear it according to the troubleshooting table below.

NO.	SYMPTOM		POSSIBLE TROUBLE	REMEDY
1	No display of frequency and no illumination of meter lamp with POWER switch being ON		1) Poor connection of AC power plug with AC power line connector. 2) Fuse blown 3) No connection of power cable of main unit with power supply unit.	1) Completely connect the AC power plug to power line connector. 2) Investigate the cause and repair. Then, replace the fuse. 3) Completely connect the power cable.
2	No change of transmit frequency display with rotation of TUNE dial		1) LOCK button remaining depressed.	1) Release the LOCK button.
3	No output power with STAND-BY switch set to XMIT		1) MODE switch etc. set to wrong positions. 2) POWER CONT control set to too low position.	1) Check if panel switches positions are correct. 2) Rotate POWER CONT volume to the counter-clockwide position.
4	No output power:	SSB mode	1) MIC GAIN control set to too low position. 2) Poor connection of MIC plug.	1) Clockwise rotate MIC GAIN control. 2) Check connection of the plug and completely insert it.
		CW mode	1) Poor connection of key plug.	1) Check connection of the key plug and completely insert it.
5	No switching to transmission		1) STAND-BY switch is being set to F CAL.	1) Set STAND-BY switch to PTT.
6	No MHz-display illuminating		1) MHz-switch set to REMOTE and receiver set for other than amateur bands.	1) Set MHz-switch for amateur band.

SECTION 8 OPTIONS

The following options are available for high performance operation of the transmitter.

8.1 CFG-515 BUILT-IN ANTENNA COUPLER

The CFG-515 antenna coupler is able to contain in the transmitter. The NSD-515 has been designed so as to incorporate this antenna coupler. It is available for presetting the matching data for each frequency band. The CFG-515 can not only be contained in the transmitter but also be controlled automatically by the MHz exchange switch on the front panel of the transmitter. This serves for quick QSY to the other band.

Specifications:

- Matching range – Up to about 3 to 1 in VSWR
- Power handling capacity – 150W at maximum
- Adjustment – Preset for every band
  (WARC new bands – option)

8.2 NBD-515 POWER SUPPLY UNIT

This power supply unit is a DC power source for the NSD-515 Transmitter with AVR suited to the Model NSD-515 and NRD-515 Series.

Specifications:

- Input voltage – 100/117/220/240V AC ±10%, 50/60Hz, single phase
- Output – +13.6V DC; 20A, intermittent

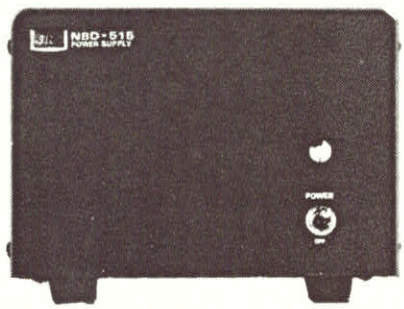


Figure 8.1 NBD-515 POWER SUPPLY UNIT

8.3 CHG-43 DESK TYPE MICROPHONE, DYNAMIC

This microphone is smart in the entire design. It consists of a microphone element mounted on a flexible pipe rooted to a mount having a heavy weight. Therefore, it is very easy to use and robust. The mount is provided with a light-touch PTT switch (standby switch). It is able to control the state of transmission/reception by the band.

specifications:

- Sensitivity – –73 ±3dB (0dB; 1V/μbar, 1000Hz)
- Directivity – Omni-directional
- Impedance – 600 ohms, nominal

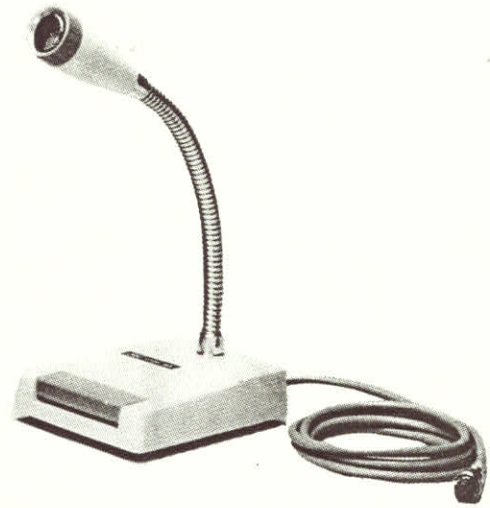


Figure 8.2 CHG-43 DESK TOP MICROPHONE

8.4 CHG-44 HAND TYPE MICROPHONE, DYNAMIC

This microphone is light in weight and handy and provided with a PTT switch easy to depress with a curled cord easy to use.

Specifications:

- Sensitivity – –73 ±3dB (0dB; 1V/μBar, 1000Hz)
- Directivity – Omni-directional
- Impedance – 600 ohms, nominal

Figure 8.3 CHG-44 HAND TYPE MICROPHONE

8.5 CCK-144 KEY (KY-3A WITH CORD)

This key is of a standard longitudinal keying type. The entire bottom face of the key base is covered by a rubber sheet to avoid slipping of the key base mounted on a desk during operation.

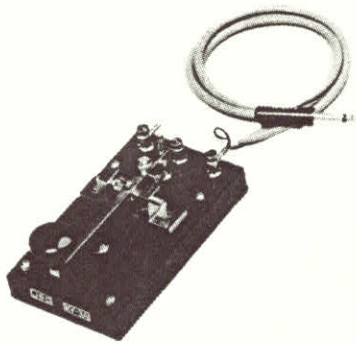
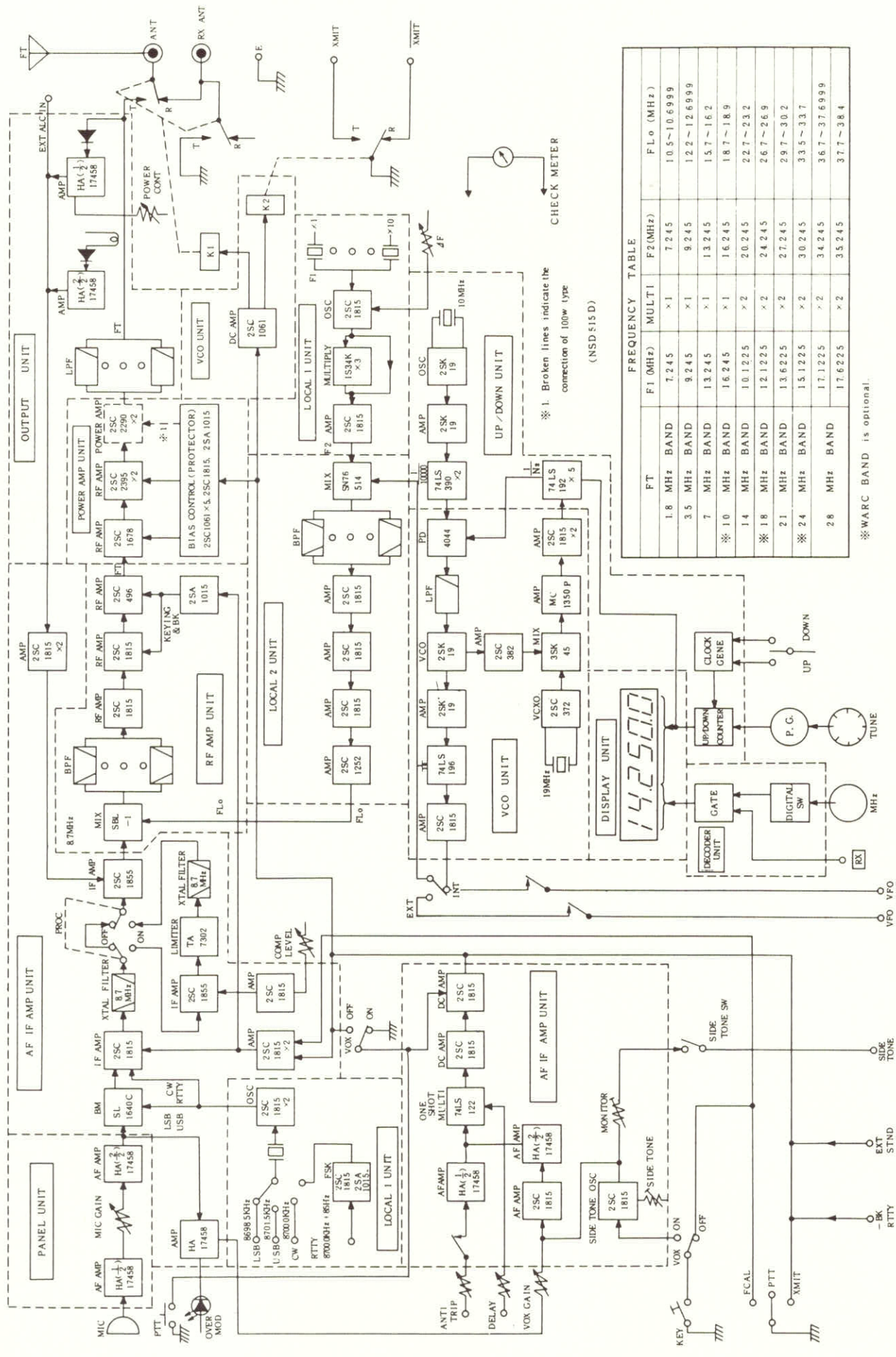


Figure 8.4 CCK-144 KEY

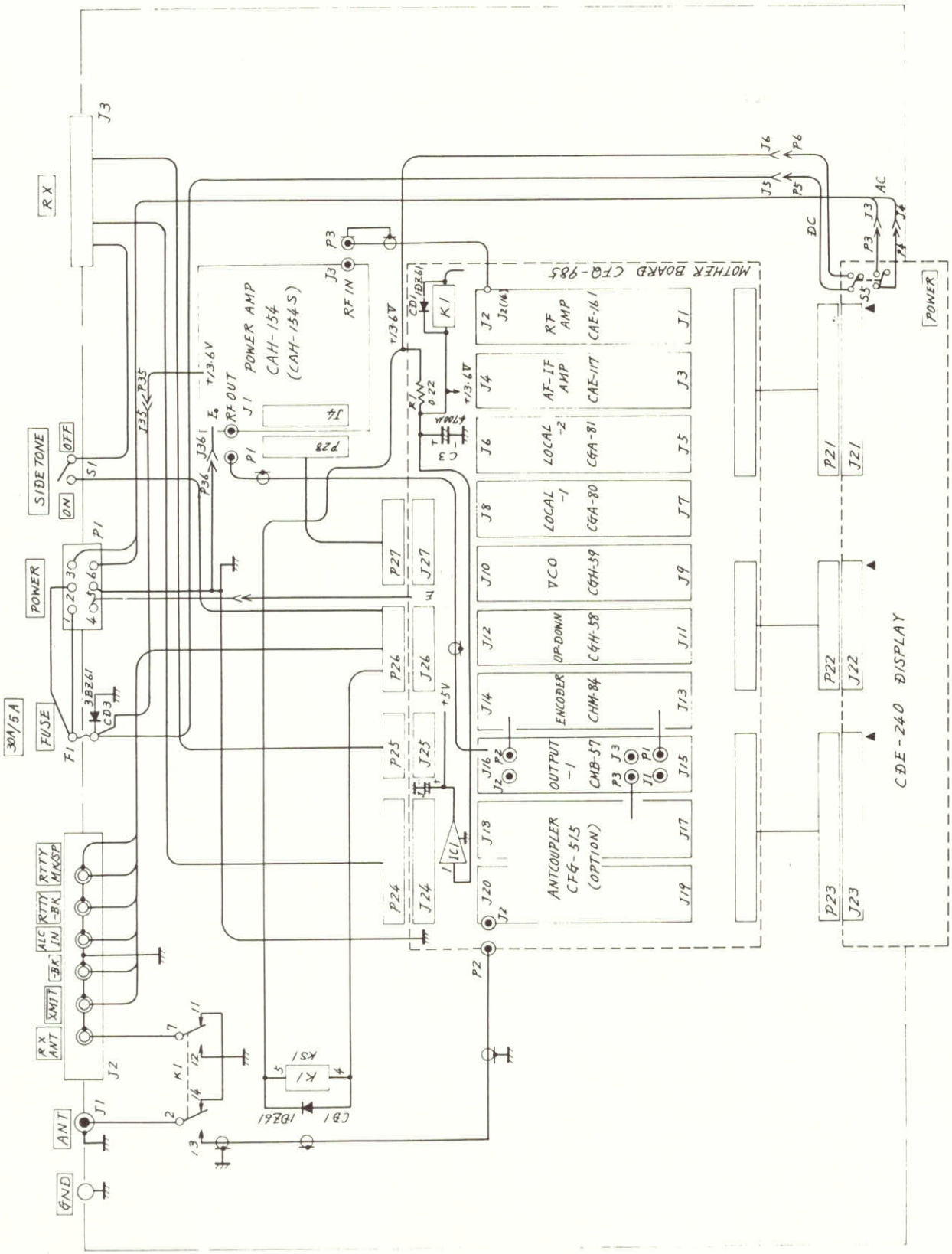
8.6 WARC NEW BANDS

For provision of permission of the WARC '79 new bands, corresponding options are provided for the NSD-515 transmitter.

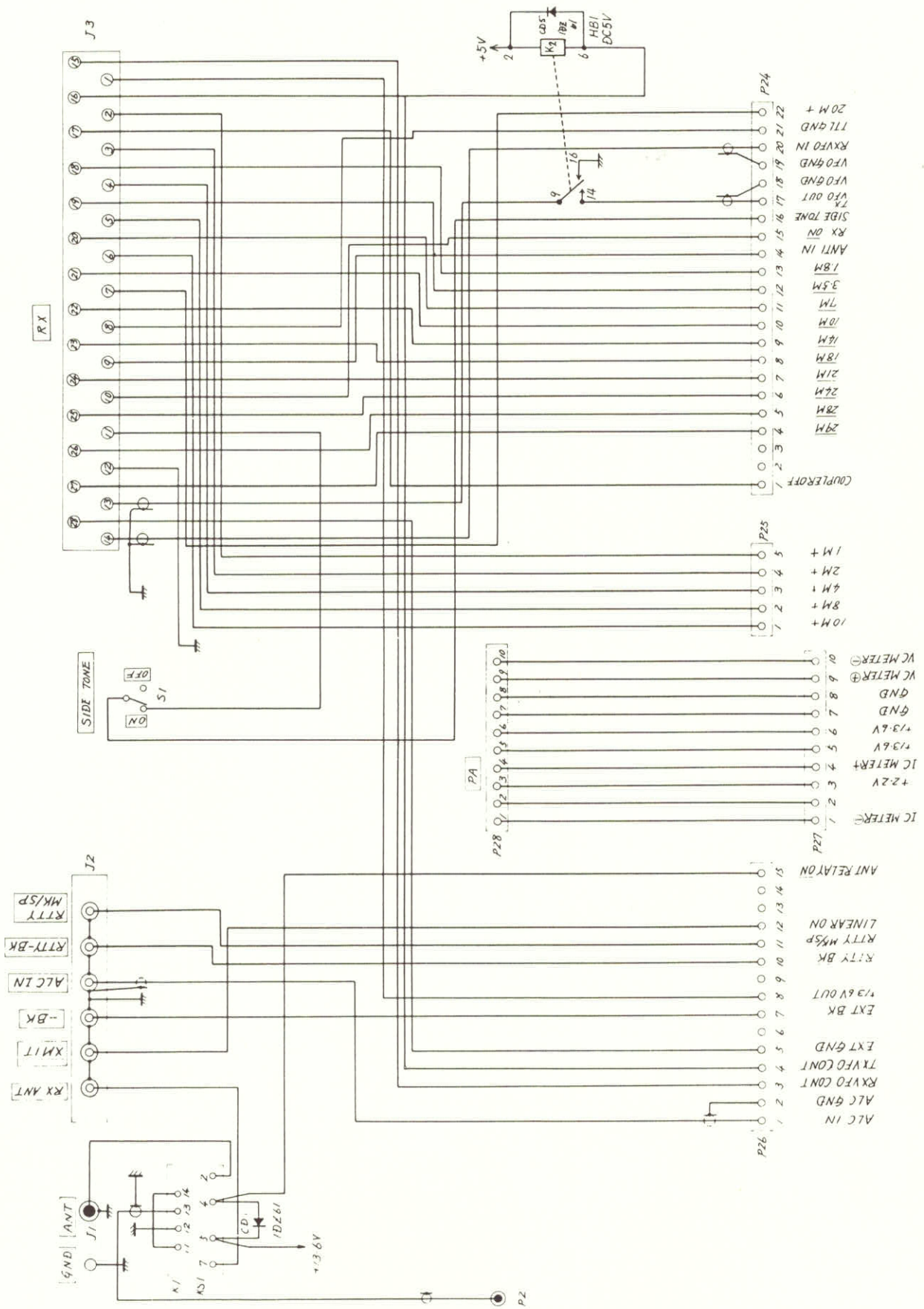
If these options will be equipped, the transmitter will be capable of operating in the new amateur bands. When using them, well read associated instruction manuals furnished with the options.



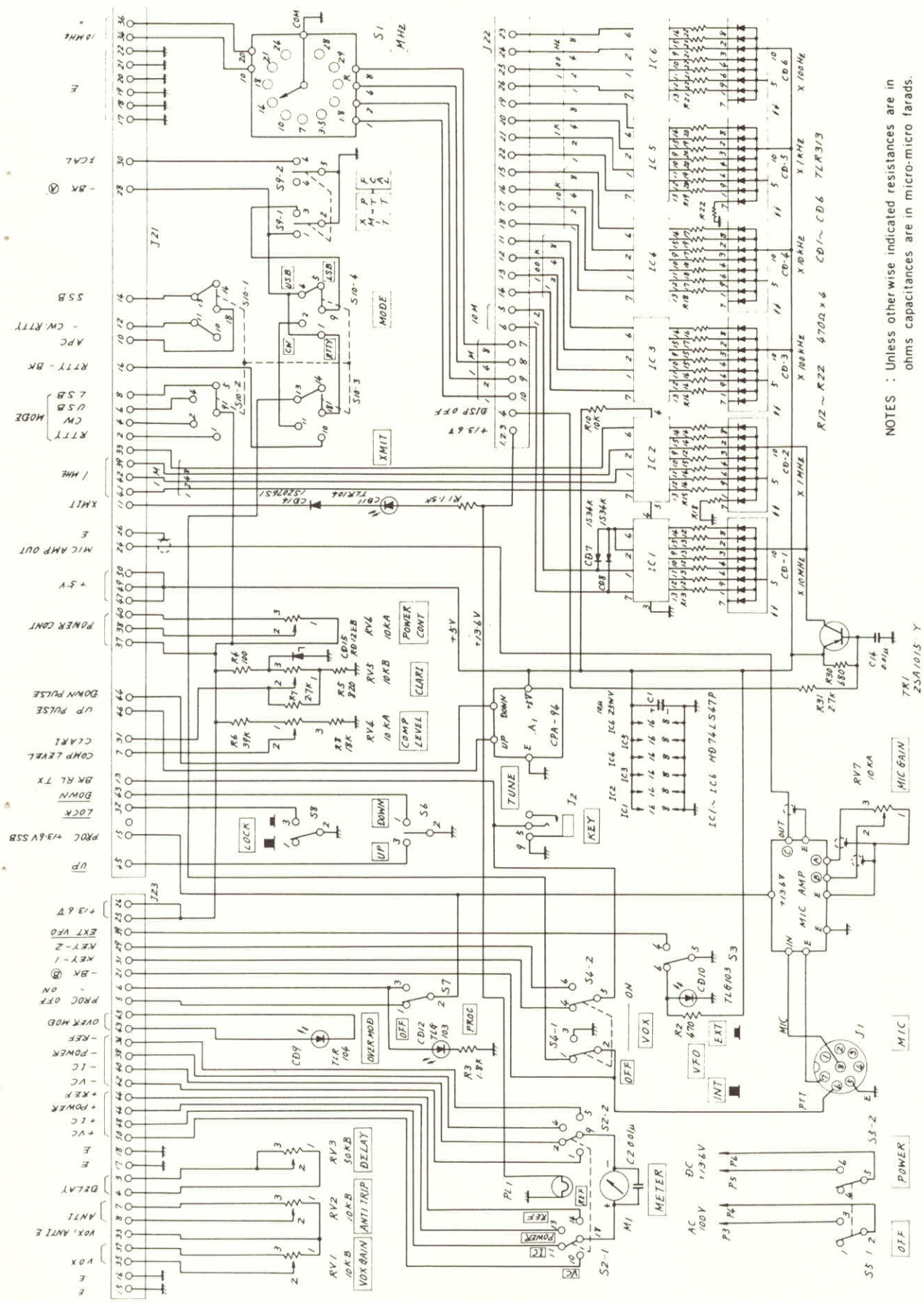
APPENDIX 1: NSD-515S(10W) NSD-515D(100W)
TRANSMITTER BLOCK DIAGRAM



APPENDIX 2. NSD-515 TRANSMITTER CONNECTION DIAGRAM

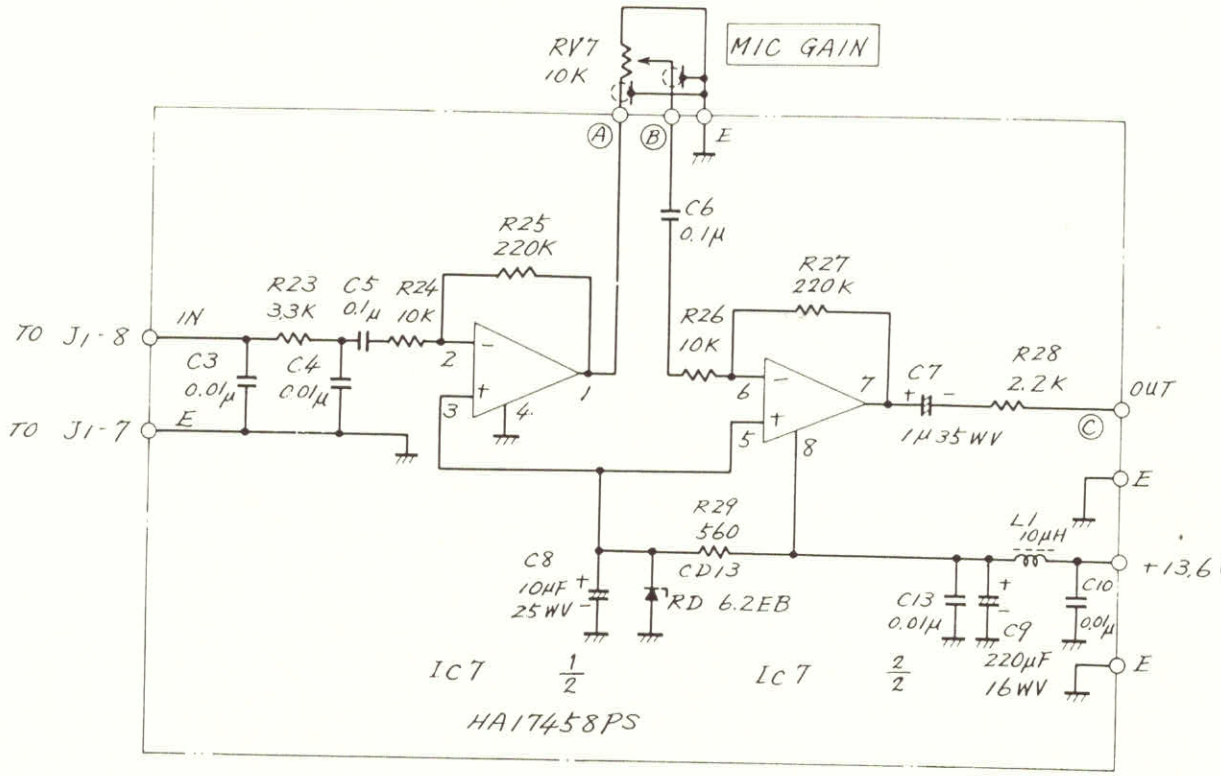


APPENDIX 3. REAR PANEL UNIT (CFQ-1099)



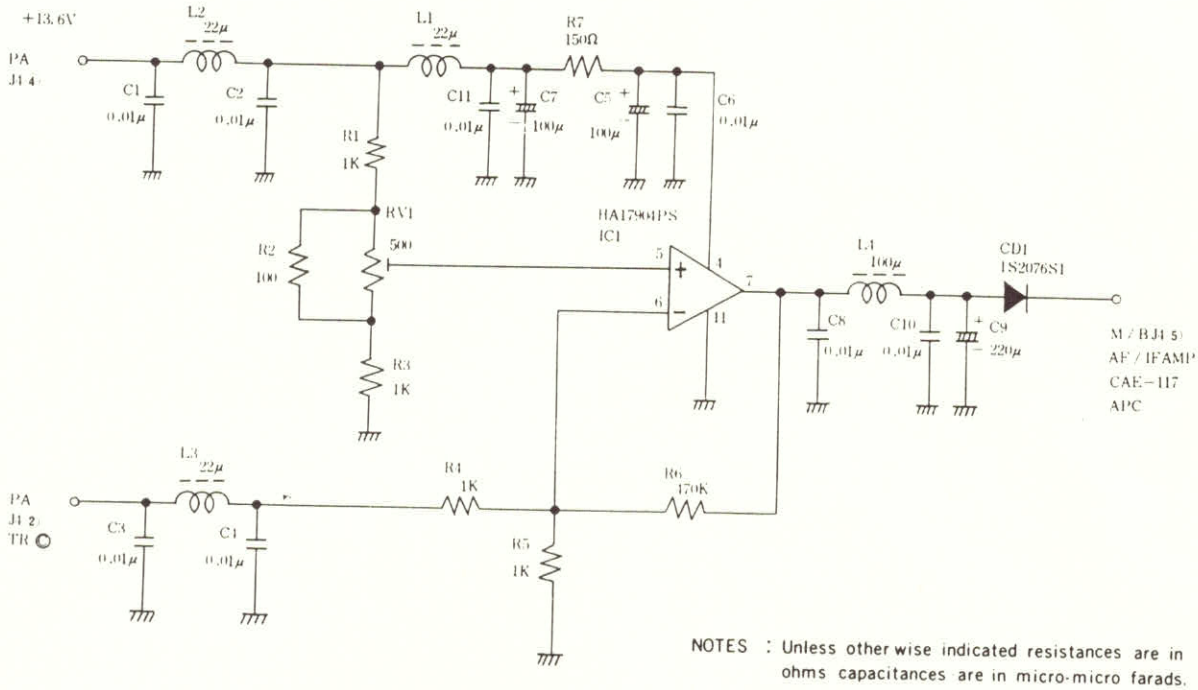
APPENDIX 4. FRONT PANEL UNIT (CDE-240)

NOTES : Unless otherwise indicated resistances are in ohms capacitances are in micro-micro farads.



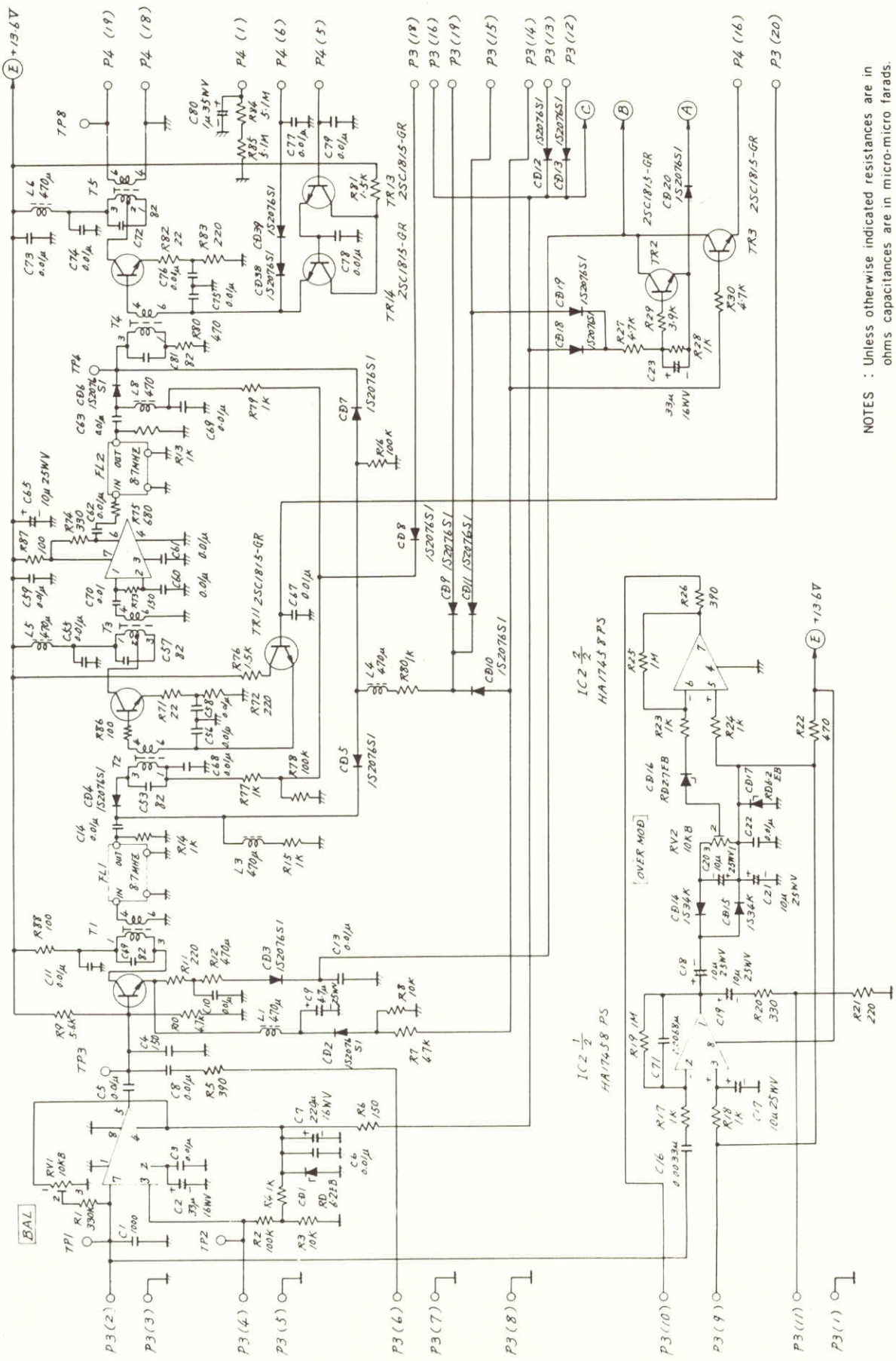
NOTES : Unless other wise indicated resistances are in ohms capacitances are in micro-micro farads.

APPENDIX 5. FRONT PANEL MIC AMP UNIT (CDE-240)



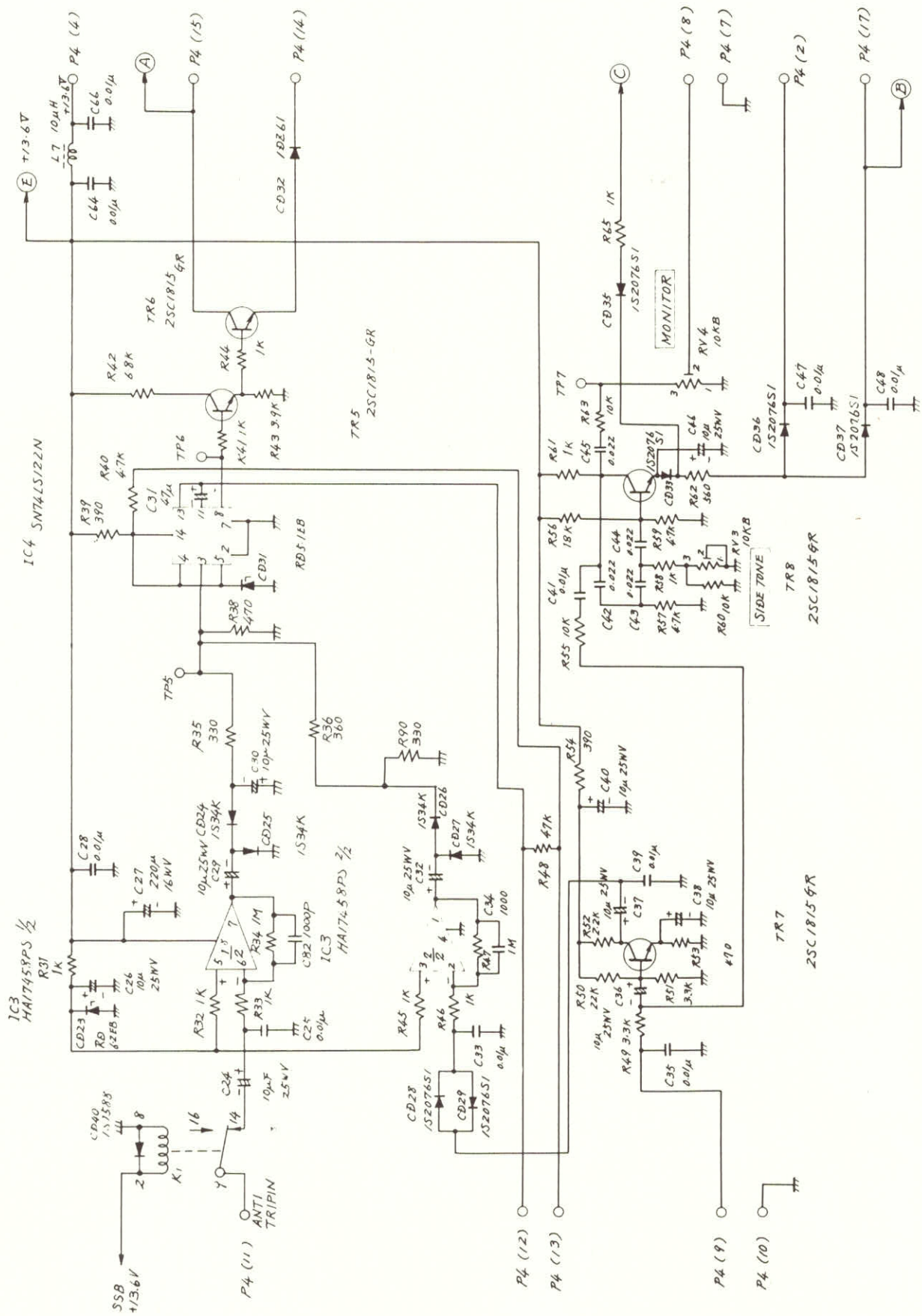
NOTES : Unless other wise indicated resistances are in ohms capacitances are in micro-micro farads.

APPENDIX 6. PROTECT UNIT (CCB-167)



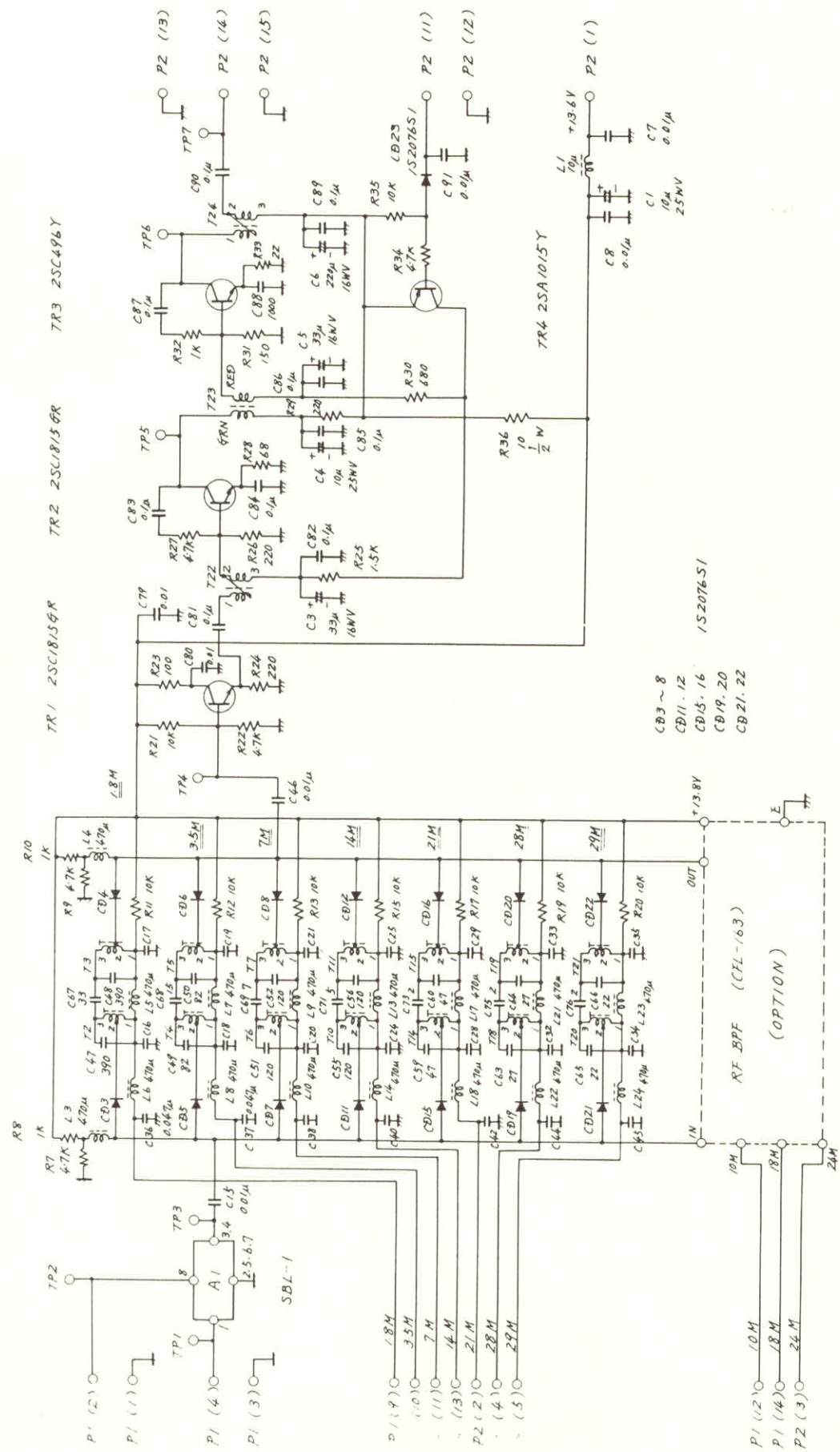
NOTES : Unless otherwise indicated resistances are in ohms capacitances are in micro-micro farads.

APPENDIX 7. AF·IFAMP UNIT (½) (CAE-117)



APPENDIX 8. AF·IFAMP UNIT (½) (CAE-117)

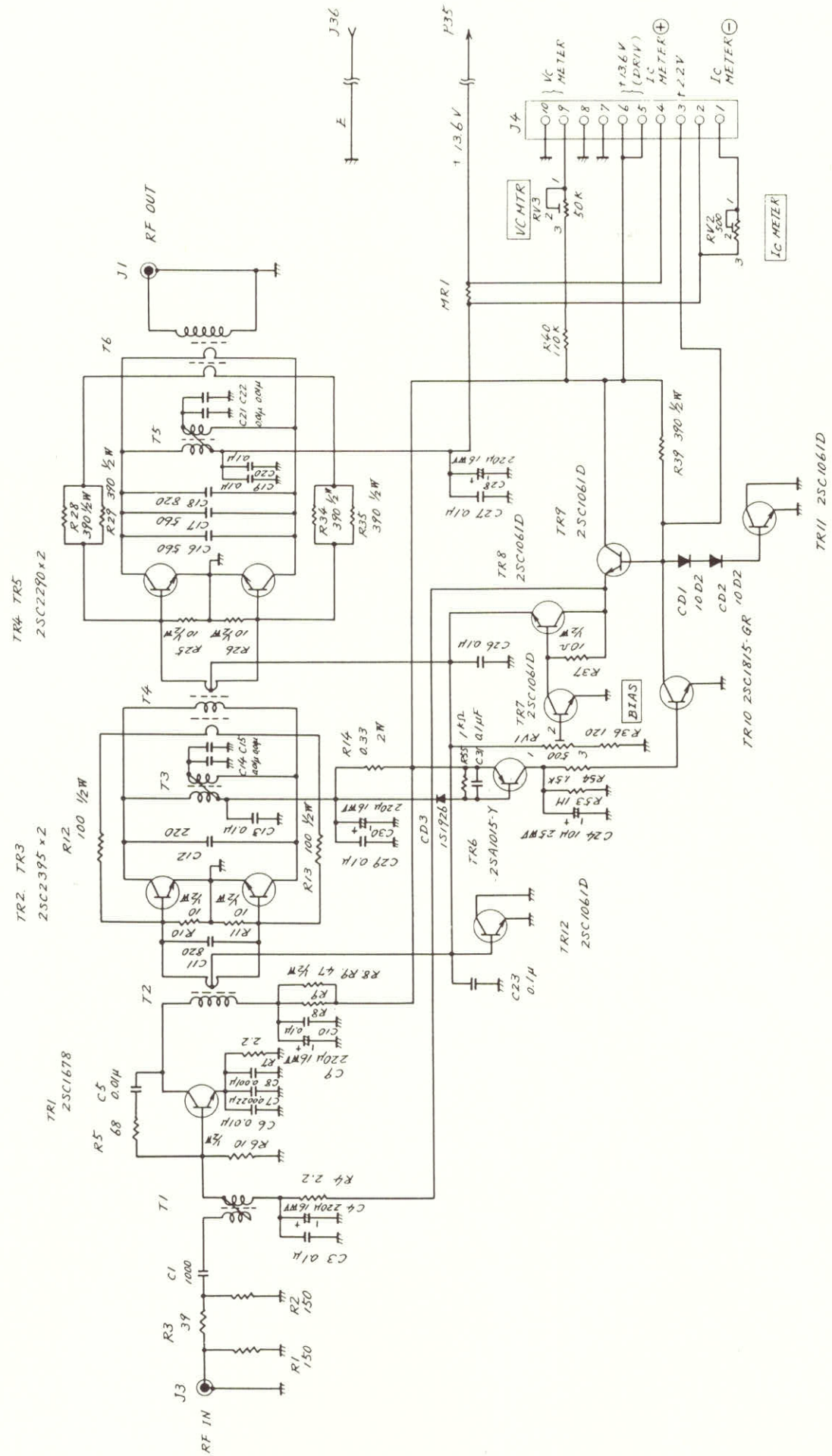
NOTES : Unless otherwise indicated resistances are in ohms capacitances are in micro-micro farads.



NOTES : Unless otherwise indicated resistances are in ohms capacitances are in micro-micro farads.

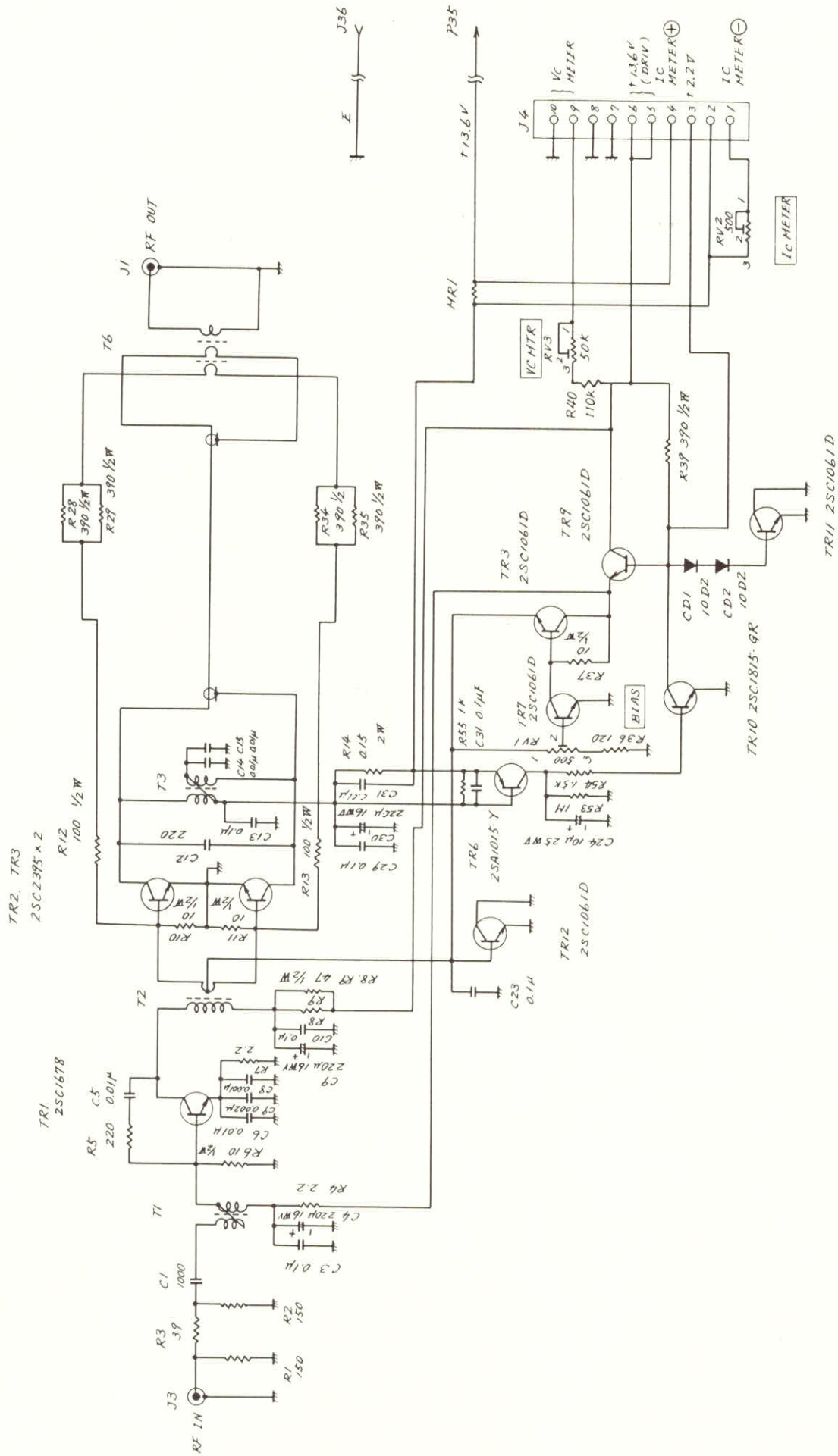
C16 ~ 21 0.01μ
C38 0.047μ
C40 . 24 . 25 0.01μ
C42 . 28 . 29 0.01μ
C44 . 32 . 33 0.01μ
C45 . 36 . 35 0.01μ

APPENDIX 9. RF AMP UNIT (CAF-161)



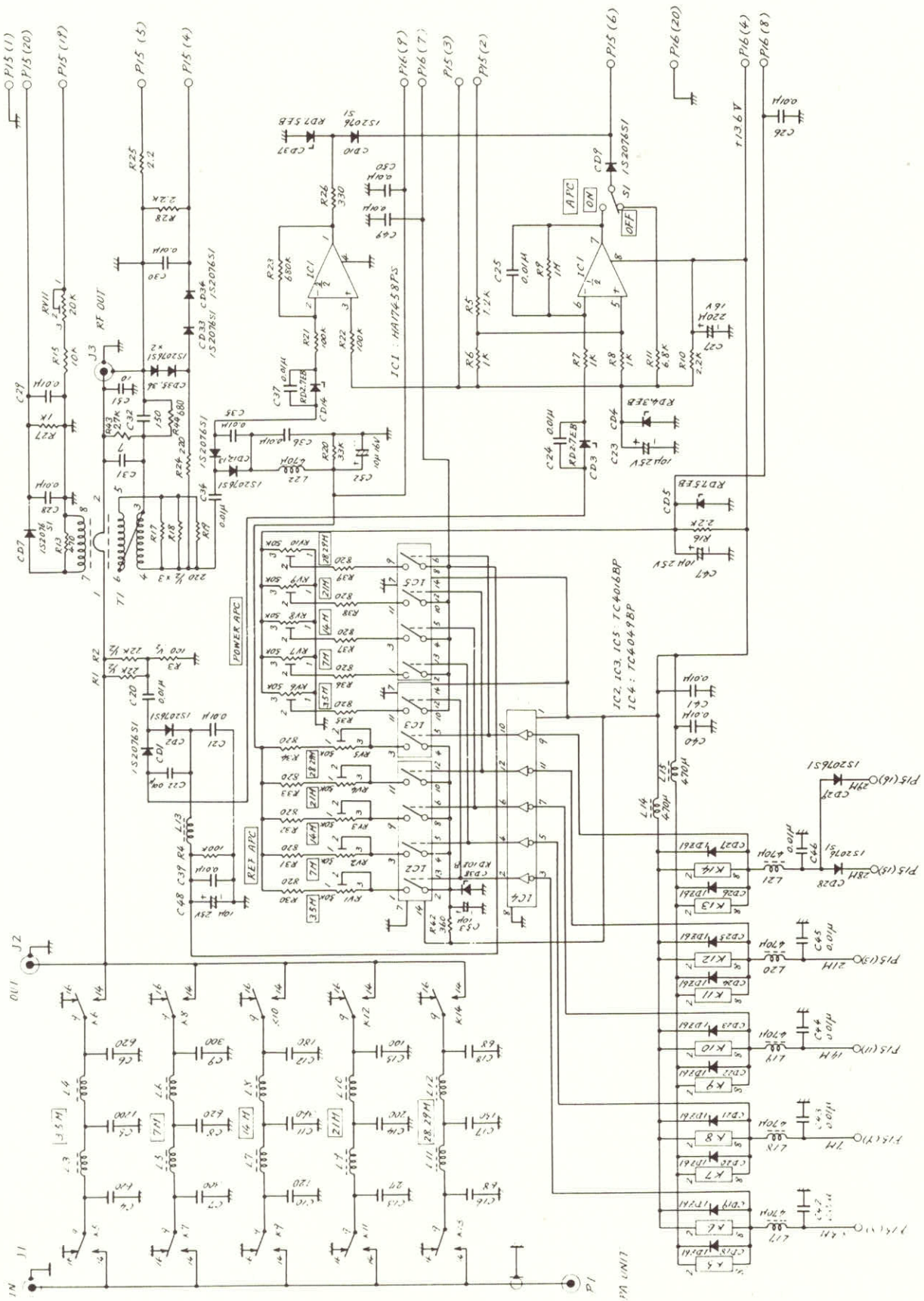
NOTES : Unless other wise indicated resistances are in ohms capacitances are in micro-micro farads.

APPENDIX 10. POWER AMP UNIT (100W) (CAH-154)



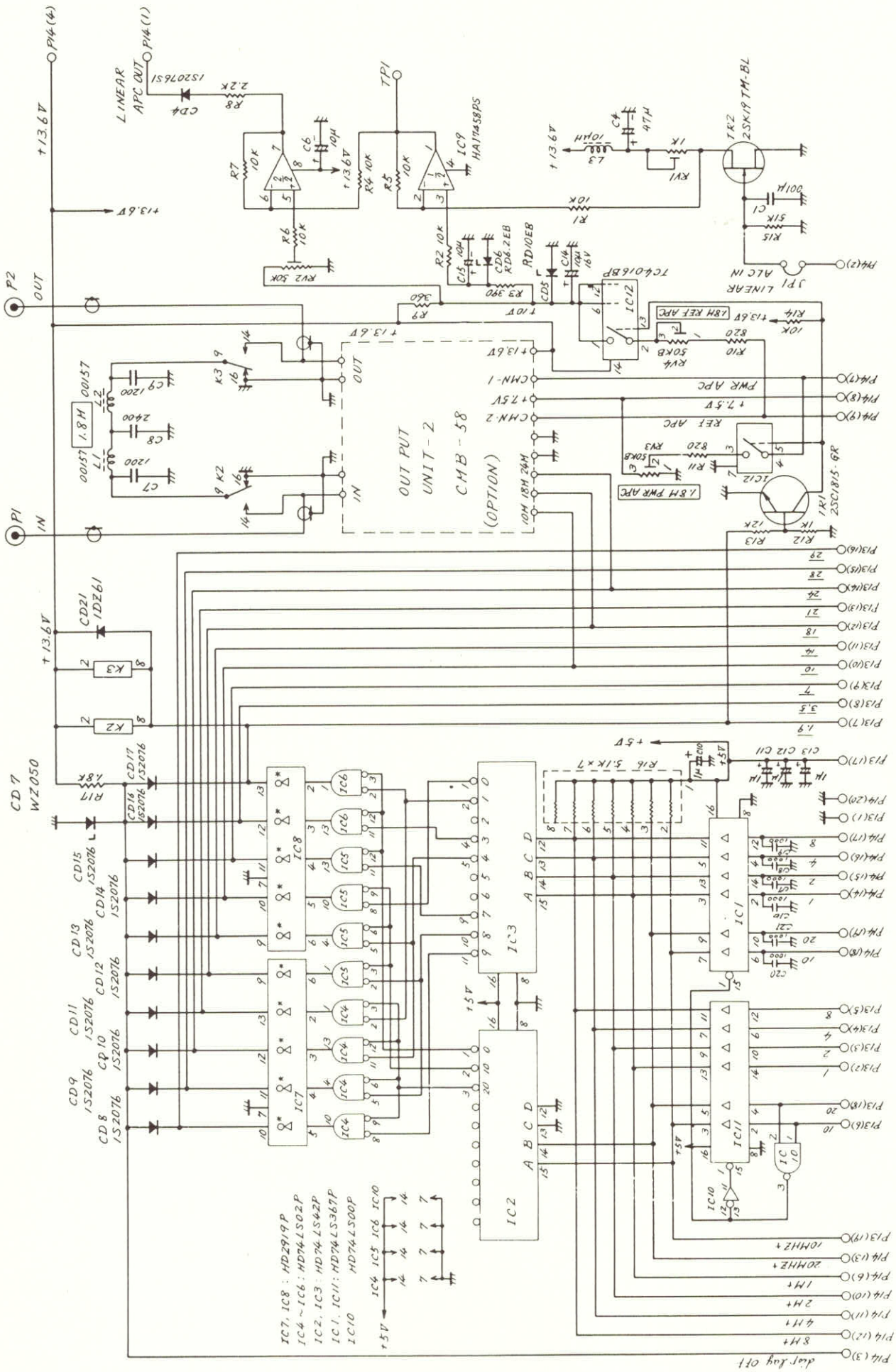
NOTES : Unless otherwise indicated resistances are in ohms capacitances are in micro-micro farads.

APPENDIX 11.POWER AMP UNIT (10W) (CAH-154S)



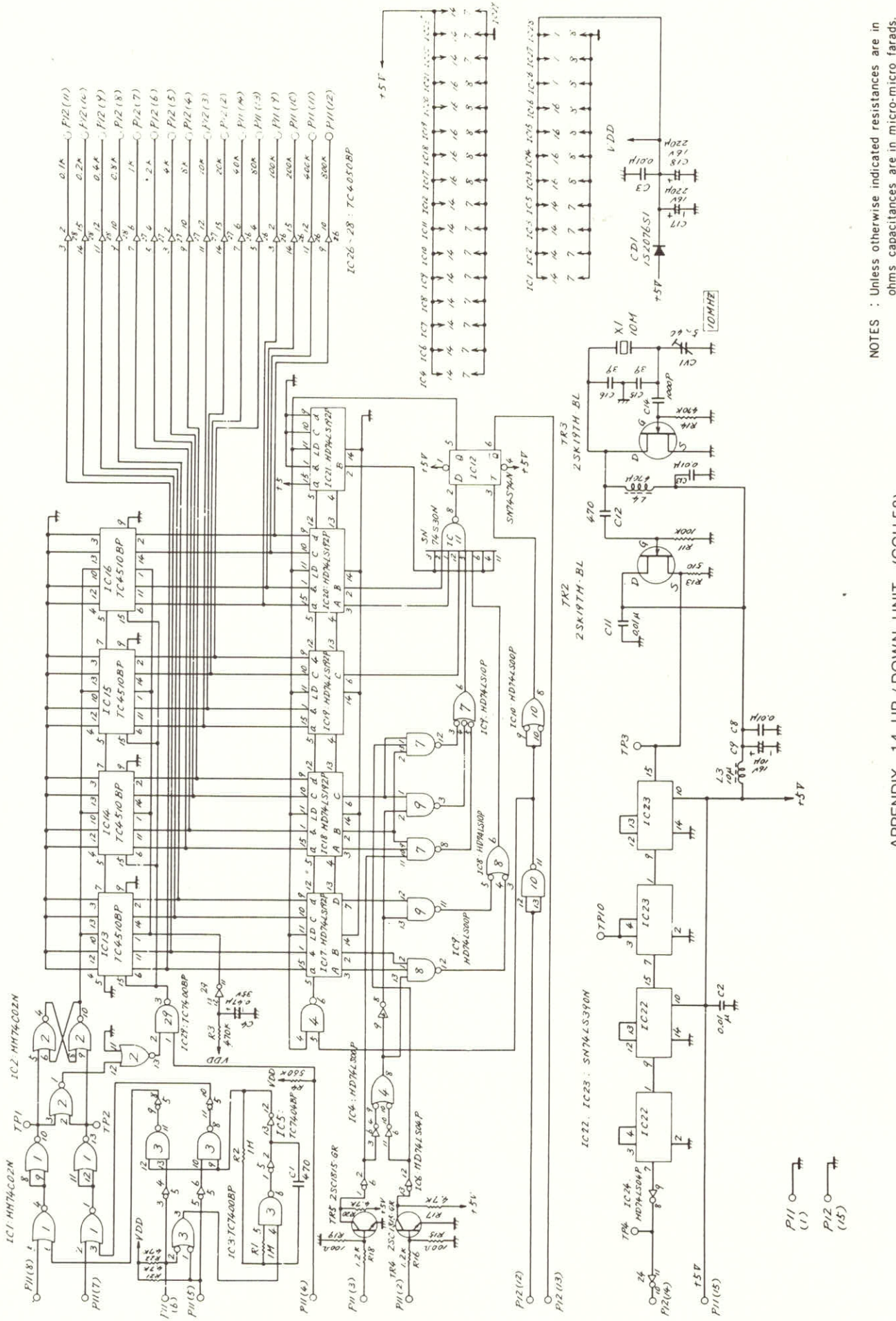
NOTES : Unless otherwise indicated resistances are in ohms capacitances are in micro-micro farads.

APPENDIX 12. OUT PUT-1 UNIT (CMB-57)



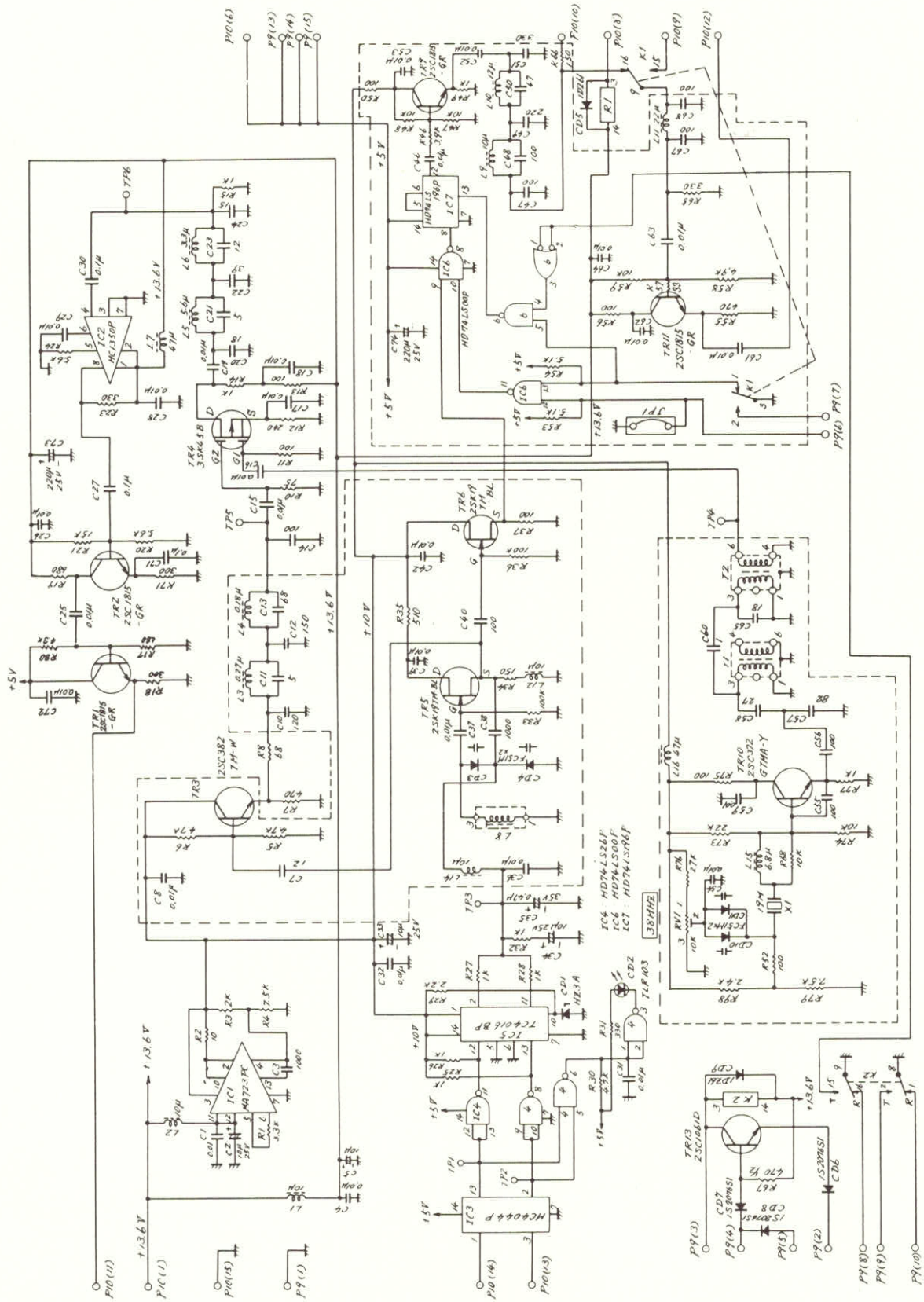
NOTES : Unless otherwise indicated resistances are in ohms capacitances are in micro-micro farads.

APPENDIX 13. ENCODER UNIT (CHM-84)



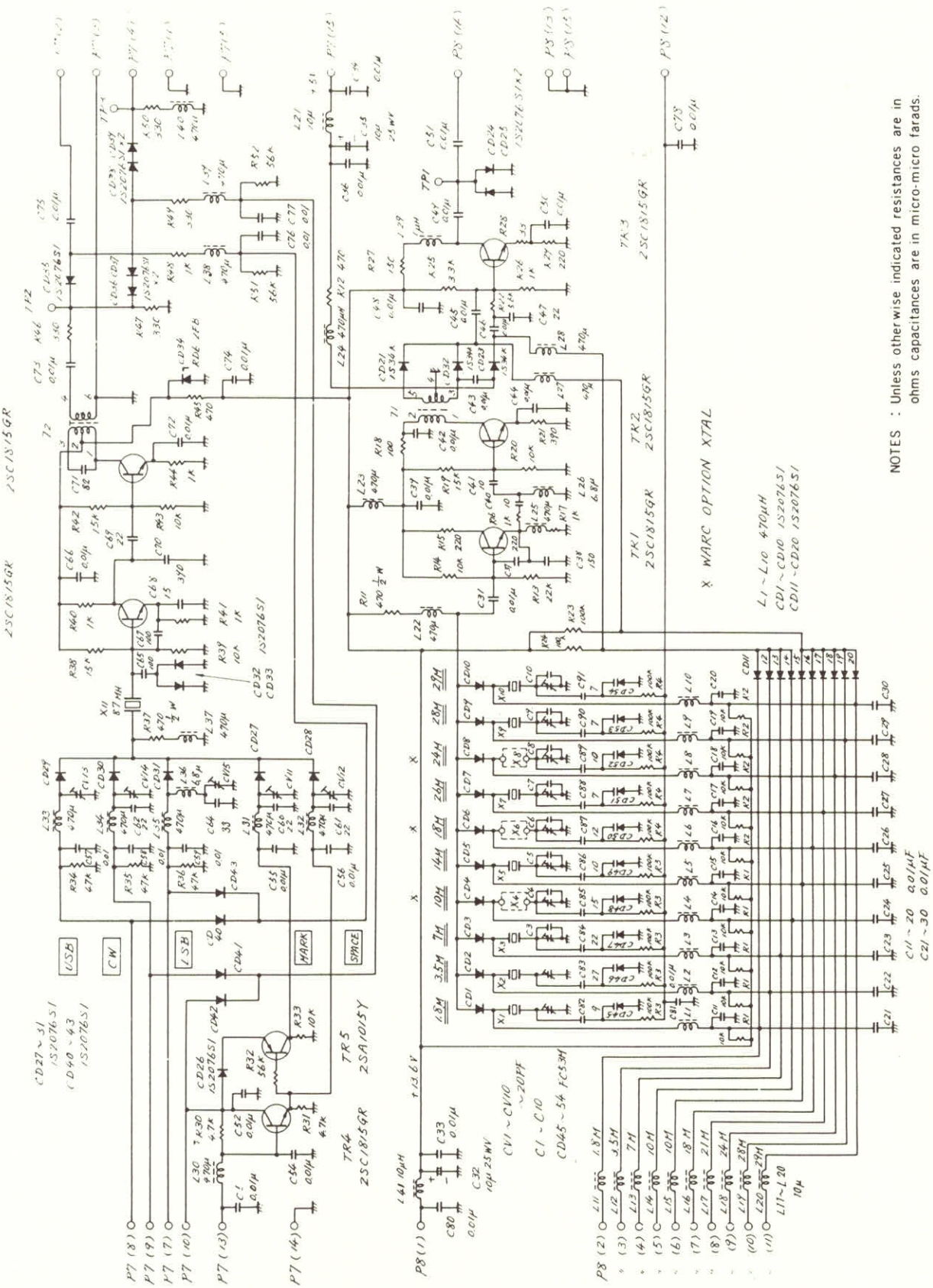
NOTES : Unless otherwise indicated resistances are in ohms capacitances are in micro-micro farads.

APPENDIX 14. UP / DOWN UNIT (CGH-58)

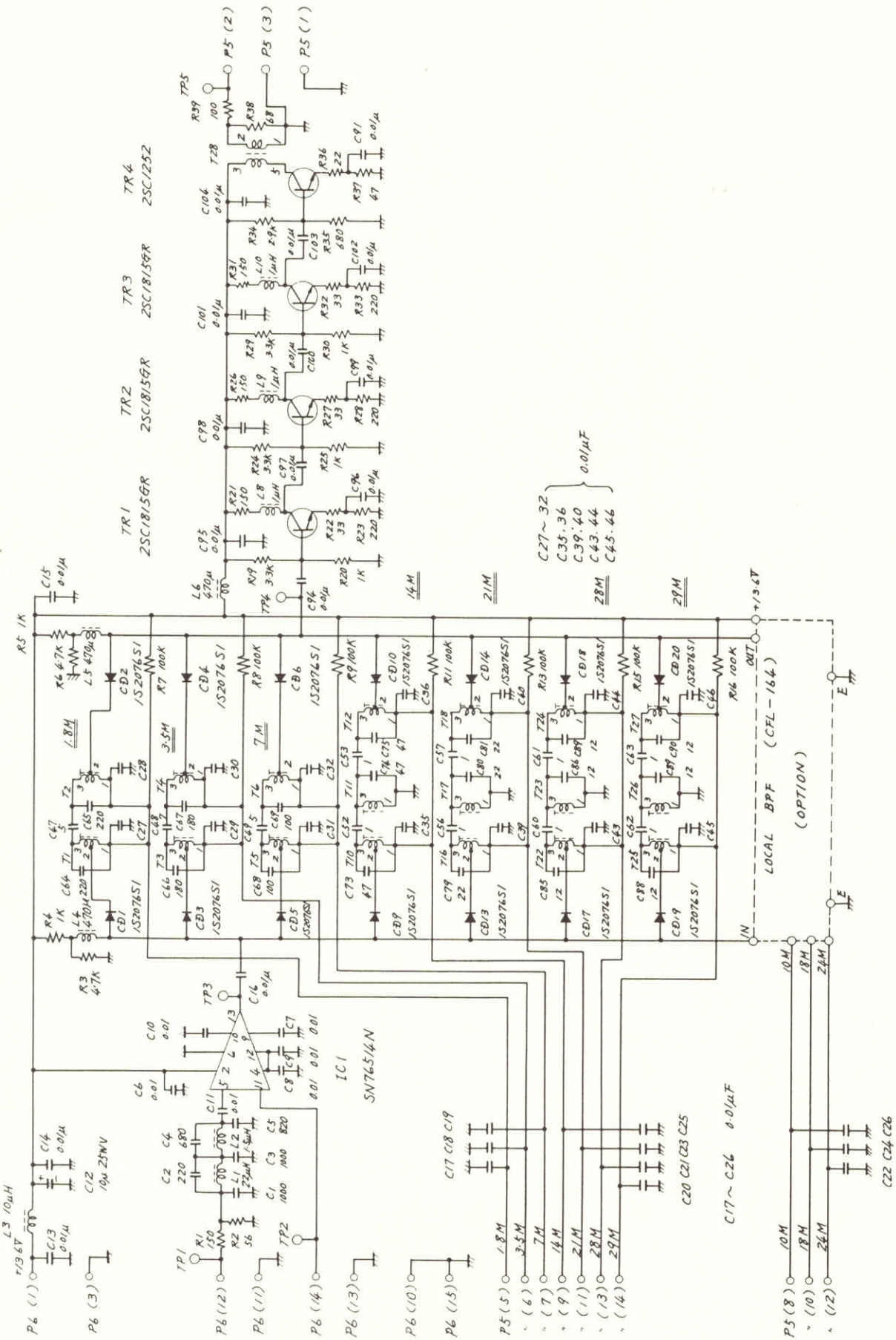


NOTES : Unless otherwise indicated resistances are in ohms capacitances are in micro-micro farads.

APPENDIX 15. VCO UNIT (CGH-59)

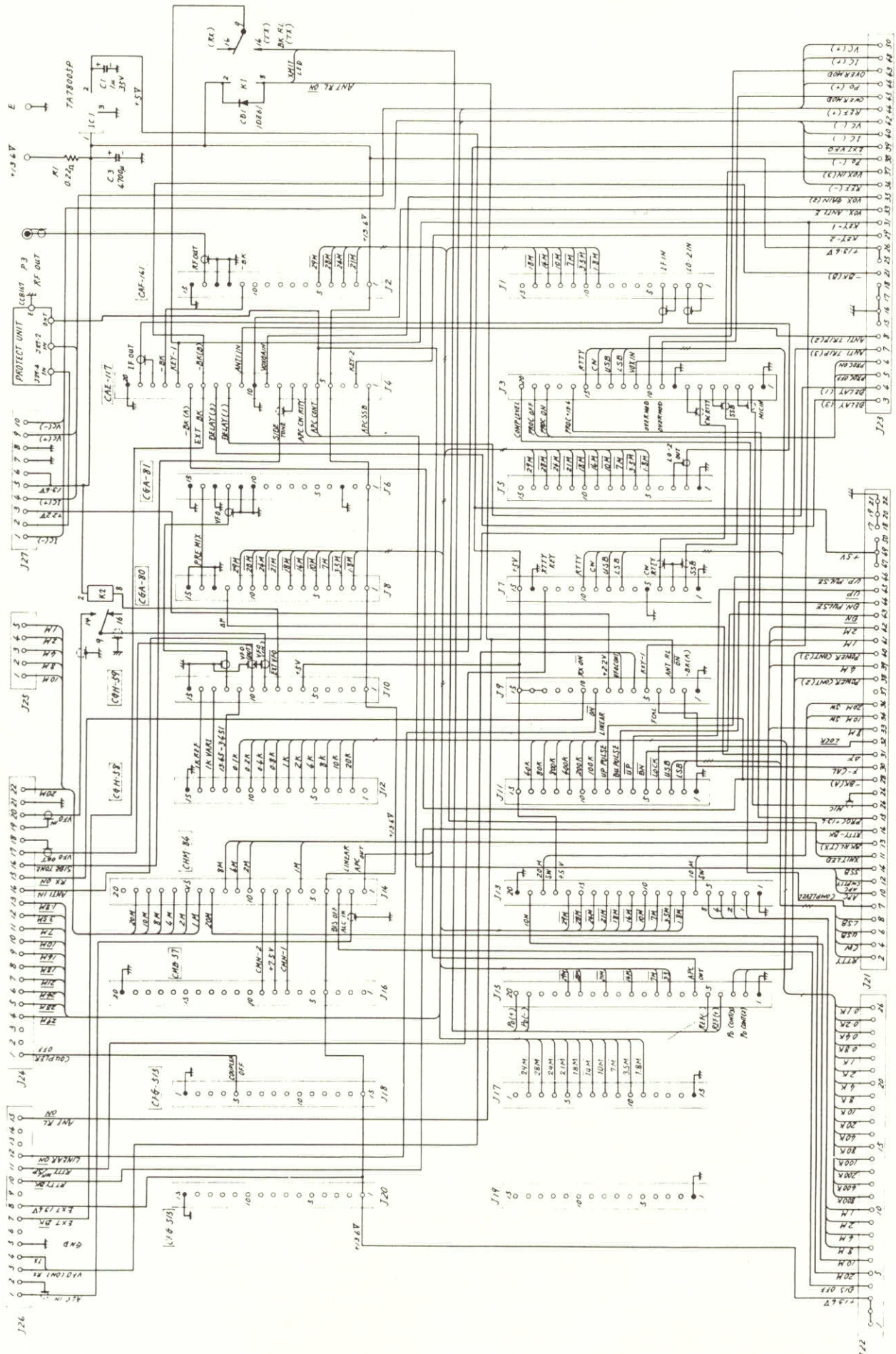


APPENDIX 16. LOCAL-1 UNIT (CGA-80)



APPENDIX 17. LOCAL-2 UNIT (CGA-81)

NOTES : Unless otherwise indicated resistances are in ohms capacitances are in micro-micro farads.



APPENDIX 18. MOTHER BOARD UNIT (CFQ-985)