RCA

Broadcast Equipment

BTR-30A Remote Control System

ES-561440

IB-8027562

Broadcast Equipment

Instructions

BTR-30A Remote Control System

ES-561440

Communications Systems Division/Front and Cooper Streets/Camden, New Jersey, U.S.A. 08102

BP75IM

IB-8027562

EQUIPMENT LOST OR DAMAGED IN TRANSIT

When delivering the equipment to you, the truck driver or carrier's agent will present a receipt for your signature. Do not sign it until you have (a) inspected the containers for visible signs of damage and (b) counted the containers and compared with the amount shown on the shipping papers. If a shortage or if evidence of damage is noted, insist that notation to that effect be made on the shipping papers before you sign them.

Further, after receiving the equipment, unpack it and inspect thoroughly for concealed damage. If concealed damage is discovered, immediately notify the carrier, confirming the notification in writing, and secure an inspection report. This item should be unpacked and inspected for damage WITHIN 15 DAYS after receipt. Report all shortages and damages to RCA, Commercial Electronic Systems Division – Camden, New Jersey 08102.

RCA will file all claims for loss and damage on this equipment so long as the inspection report is obtained. Disposition of the damaged item will be furnished by RCA.

FIELD ENGINEERING SERVICE

RCA Field Engineering Service is available at current rates. Requests for field engineering service may be addressed to your RCA Broadcast Field Representative or the RCA Service Company, Incorporated – Broadcast Service Division – Camden, New Jersey 08102. Telephone 609-963-8000.

WARRANTY ITEMS

Particular parts and/or equipment covered by warranty are specifically stated as such in the warranty or contract given to the customer at the time of sale. The warranty or contract also stipulates the conditions under which the warranty may be exercised.

To obtain a new replacement for such warranty items, contact your local RCA sales office and please supply Product Identification (including the Original Invoice Number, MI Number, Type Number, Model Number, and Serial Number) and Replacement Part Identification (including Stock Number and Description). Requests for warranty replacements may be unduly delayed if all this information is not supplied.

REPLACEMENT PARTS

When ordering replacement parts, please give Stock or Master Item (MI) Number, Description, and Symbol of each item ordered.

The part which will be supplied against an order for a replacement item may not be an exact duplicate of the original part. However, it will be a satisfactory replacement differing only in minor mechanical or electrical characteristics. Such differences will in no way impair the operation of the equipment.

Emergency Service:

For emergency service after working hours, contact RCA Parts and Accessories, Telephone 609-963-8000 or 609-848-5900.

LOCATION	ORDERING INSTRUCTIONS
Continental United States, including Alaska and Hawaii	Replacement Parts bearing a STOCK NUMBER should be ordered from RCA Parts and Accessories – 2000 Clements Bridge Road – Deptford, New Jersey 08096. Replacement Parts bearing a MASTER ITEM (MI) NUMBER should be ordered from RCA, Commercial Electronic Systems Division – Attention Commercial Service – Camden, New Jersey 08102 or your nearest RCA Regional Office. Replacement Parts with NO STOCK or MASTER ITEM (MI) NUMBER are standard components. They are not stocked by RCA and should be obtained from your local electronics distributor.
Dominion of Canada	Order from your local RCA Sales Representative or his office or from: RCA Victor Company Limited, 1001 Lenoir Street, Montreal, Quebec.
Outside of Continental United States, Alaska, Hawaii, and the Dominion of Canada	Order from your local RCA Sales Representative or from: RCA International Division, Clark, New Jersey – U.S.A. – Wire: RADIOINTER **Emergency:** Cable RADIOPARTS, DEPTFORD, N.J.

RETURN OF ELECTRON TUBES

If for any reason it is desired to return tubes, please return them through your local RCA tube distributor, RCA Victor Company Limited, or RCA International Division, depending on your location.

Please do not return tubes directly to RCA without authorization and shipping instructions.

It is important that complete information regarding each tube (including type, serial number, hours of service and reason for its return) be given. When tubes are returned, they should be shipped to the address specified on the Return Authorization form. A copy of the Return Authorization and also a Service Report for each tube should be packed with the tubes.

LOCATION	ORDERING INSTRUCTIONS
Continental United States, including Alaska and Hawaii	Local RCA Tube Distributor.
Dominion of Canada	Order from your local RCA Sales Representative or his office or from: RCA Victor Company Limited, 1001 Lenoir Street, Montreal, Quebec.
Outside of Continental United States, Alaska, Hawaii, and the Dominion of Canada	Local RCA Tube Distributor or from: RCA International Division, Clark, New Jersey, U.S.A., Wire: RADIOINTER **Emergency:** Cable RADIOPARTS, DEPTFORD, N.J.

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TECHNICAL SUMMARY

ELECTRICAL SPECIFICATIONS	
Metering	30 telemetry channels, plus calibration
Control Functions	30 ON/RAISE, 30 OFF/LOWER (60 total)
Meters	3, with provisions for 7 external meters
Metering Stability	Better than 1% with weekly checks
Telemetry Input Requirements	+ or - 1V to 10V dc for full scale deflection. All inputs fully isolated from ground. Maximum 350V potential to ground. Input impedance 20,000Ω.
Telemetry Frequencies	
Audible	1280 Hz
Subaudible	22 Hz – 36 Hz or 20 Hz – 30 Hz
Control Frequencies	
Failsafe	920 Hz
ON/RAISE	790 Hz
OFF/LOWER	670 Hz
Control Subcarrier Frequencies	26 kHz or 110 kHz, nominal
Interconnection Requirements	
Wire (BTR-30 AW)	Ordinary voice-grade two-way telephone line, 600Ω 20 dB allowable loss from 650 Hz – 1350 Hz (dc continuity not required).
Radio (BTR-30AR)	
Control Circuit	Control subcarrier generator and detector provided. Input and output 0.5V rms, 2000Ω nominal.
Telemetry Circuit	Telemetry return path capable of handling 22 Hz – 36 Hz or 20 Hz – 30 Hz, sinusoidal. Transmitter Control Unit output-0 dBm, 600Ω. Studio Control Unit input-0 dBm, bridging.
Calibration Reference	Zener diode
Semiconductor Devices	All silicon diodes, integrated circuits and JEDEC registered transistors.

POWER LINE REQUIREMENTS	
Power Supply	120 or 240 Vac
Line Frequency	50 – 60 Hz
Power Consumption	
Studio Control Unit (approx.)	15 watts
Transmitter Control Unit (approx.)	25 watts

PHYSICAL SPECIFICATIONS		
Ambient Temperature Range	-10° to +140°F	
Dimensions, Weight and Volume	Transmitter unit	Studio unit
Width	19" (48.26 cm)	19" (48.26 cm)
Height	8-3/4" (22.23 cm)	10-1/2" (26.67 cm)
Depth	10-1/2" (26.67 cm)	8-1/2" (21.59 cm)
Weight, Net (approx.)	36 lb. (16.33 kg)	27 lb. (12.25 kg)
Weight, Shipping (approx.)	47 lb. (21.32 kg)	38 lb. (17.24 kg)
Dimensions, Shipping (approx.)		
Width	24" (60.96 cm)	24" (60.96 cm)
Height	17" (43.18 cm)	17" (43.18 cm)
Depth	19" (48.26 cm)	19" (48.26 cm)

EQUIPMENT LIST

BTR-30A REMOTE CONTROL SYSTEM
ES-561440

Quantity	Description	Reference
1	Studio Unit	MI-561442
1	Transmitter Unit	MI-561441
1	Meter, M101, Studio	MI-561444-*
1	Meter, M102, Studio	MI-561444-*
1	Meter, M103, Studio	MI-561444-*
1	Transmission Kit	ES-561446-*
2	Instruction Book	IB-8027562

OPTIONAL AND ACCESSORY EQUIPMENT

Description	Reference
Meter Panel (1 meter)	MI-561445-1
Meter Panel (2 meter)	MI-561445-2
Meter Panel (3 meter)	MI-561445-3
Relay Panel, 5-1/4", and 8 Relay Sockets (less relays)	MI-561470
Relays for MI-561470	MI-561471-*
MI-561471-1 DPDT, 120 Vac coil, 10 A contacts	
MI-561471-2 DPDT, 24 Vdc coil, 10 A contacts	
Relay Panel, 3-1/2", (less relays and sockets)	MI-561449
Relays and Sockets for MI-561449	MI-561448-*
MI-561448-1 DPDT, 24 Vdc coil, 5 A contacts	
MI-561448-2 DPDT, 120 Vac coil, 5 A contacts	
MI-561448-3 Latching, 24 Vdc coil, 5 A contacts	
MI-561448-4 Time Delay, 24 Vdc coil, 5 A contacts	

TRANSMISSION KIT

ES-561446-*

Quantity	Description	Reference
	Telephone Circuit, Audible, ES-561446-1	
1	SCU Audible Metering Processor, Board 12	MI-561452
1	TCU Audible Metering Processor, Board 24	MI-561456
	STL Multiplex Control/TV Subcarrier Metering, ES-571446-2	
1	SCU Subaudible Metering Processor, Board 11	MI-561451
1	Subcarrier Generator, 26 kHz, Board 10	MI-561450-1
1	Subcarrier Generator, 39 kHz, Board 10	MI-561450-2
1	TCU Subaudible Metering Processor, Board 23	MI-561455
1	Subcarrier Filter, 26 kHz, Board 15	MI-561453-1
1	Subcarrier Demodulator, 26 kHz, Board 16	MI-561454-1
	STL Multiplex Control /SCA FM Generator Metering, ES-561446-3	
1	SCU Subaudible Metering Processor, Board 11	MI-561451
1	Subcarrier Generator, 26 kHz, Board 10	MI-561450-1
1	Subcarrier Generator, 67 kHz, Board 10	MI-561450-2
1	TCU Subaudible Metering Processor, Board 23	MI-561455
1	Subcarrier Filter, 26 kHz, Board 15	MI-561453-1
1	Subcarrier Demodulator, 26 kHz, Board 16	MI-561454-1
	STL Multiplex Control/FM External Subcarrier Generator Metering, ES-561446-4	
1	SCU Subaudible Metering Processor, Board 11	MI-561451
1	Subcarrier Generator, 26 kHz, Board 10	MI-561450-1
1	Jumper Board Connection, Board 26	MI-561457
1	TCU Subaudible Metering Processor, Board 23	MI-561455
1	Subcarrier Filter, 26 kHz, Board 15	MI-561453-1
1	Subcarrier Demodulator, 26 kHz, Board 16	MI-561454-1
	STL Multiplex Control/Audible Telephone Circuit Metering, ES-561446-5	
1	SCU Audible Metering Processor, Board 12	MI-561452
1	Subcarrier Generator, 26 kHz, Board 10	MI-561450-1
1	TCU Audible Metering Processor, Board 24	MI-561456
1	Subcarrier Filter, 26 kHz, Board 15	MI-561453-1
1	Subcarrier Demodulator, 26 kHz, Board 16	MI-561454-1
	STL Multiplex Control/AM Transmitter Subaudible Metering, ES-561446-6	
1	SCU Subaudible Metering Processor, Board 11	MI-561451
1	Subcarrier Generator, 26 kHz, Board 10	MI-561450-1
1	Jumper Board Connection, Board 26	MI-561457
1	TCU Subaudible Metering Processor, Board 23	MI-561455
1	Subcarrier Filter, 26 kHz, Board 15	MI-561453-1
1	Subcarrier Demodulator, 26 kHz, Board 16	MI-561454-1

TRANSMISSION KIT (Continued)

ES-561446-*

Quantity	Description	Reference
	STL Multiplex Control/TV Subcarrier Metering, ES-561446-7	
1	SCU Subaudible Metering Processor, Board 11	MI-561451
1	Subcarrier Generator, 110 kHz, Board 10	MI-561450-4
1	Subcarrier Generator, 39 kHz, Board 10	MI-561450-2
1	TCU Subaudible Metering Processor, Board 23	MI-561455
1	Subcarrier Filter, 110 kHz, Board 15	MI-561453-2
1	Subcarrier Demodulator, 110 kHz, Board 16	MI-561454-2
	STL Multiplex Control/FM SCA Generator Metering, ES-561446-8	
1	SCU Subaudible Metering Processor, 110 kHz, Board 11	MI-561451
1	Subcarrier Generator, 110 kHz, Board 10	MI-561450-4
1	Subcarrier Generator, 67 kHz, Board 10	MI-561450-3
1	TCU Subaudible Metering Processor, Board 23	MI-561455
1	Subcarrier Filter, 110 kHz, Board 15	MI-561453-2
1	Subcarrier Demodulator, 110 kHz, Board 16	MI-561454-2
	STL Multiplex Control/External Subcarrier Generator (FM) Metering, ES-561446-9	
1	SCU Subaudible Metering Processor, Board 11	MI-561451
1	Subcarrier Generator, 110 kHz, Board 10	MI-561450-4
1	Jumper Board Connection, Board 26	MI-561457
1	TCU Subaudible Metering Processor, Board 23	MI-561455
1	Subcarrier Filter, 110 kHz, Board 15	MI-561453-2
1	Subcarrier Demodulator, 110 kHz, Board 16	MI-561454-2
	STL Multiplex Control/Audible Telephone Circuit Metering, ES-561446-10	
1	SCU Audible Metering Processor, Board 12	MI-561452
1	Subcarrier Generator, 110 kHz, Board 10	MI-561450-4
1	TCU Audible Metering Processor, Board 24	MI-561456
1	Subcarrier Filter, 110 kHz, Board 15	MI-561453-2
1	Subcarrier Demodulator, 110 kHz, Board 16	MI-561454-2
	STL Multiplex Control/Subaudible AM Transmitter Metering, ES-561446-11	
1	SCU Subaudible Processor, Board 11	MI-561451
1	Subcarrier Generator, 110 kHz, Board 10	MI-561450-4
1	Jumper Board Connection, Board 26	MI-561457
1	TCU Subaudible Metering Processor, Board 23	MI-561455
1	Subcarrier Filter, 110 kHz, Board 15	MI-561453-2
1	Subcarrier Demodulator, 110 kHz, Board 16	MI-561454-2
	External Subcarrier Generator and Demodulation Control/TV Subcarrier Metering, ES-561446-12	
1	SCU Subaudible Metering Processor, Board 11	MI-561451
2	Jumper Board Connection, Board 26	MI-561457
1	Subcarrier Generator, 39 kHz, Board 10	MI-561450-2
1	TCU Subaudible Metering Processor, Board 23	MI-561455
	External Subcarrier Generator and Demodulation Control/FM SCA Generator Metering, ES-561446-13	
1	SCU Subaudible Metering Processor, Board 11	MI-561451
2	Jumper Board Connection, Board 26	MI-561457
1	Subcarrier Generator, 67 kHz, Board 10	MI-561450-3
1	TCU Subaudible Metering Processor, Board 23	MI-561455
	External Subcarrier Generator and Demodulation Control/External Subcarrier FM Generator Metering, ES-561446-14	
1	SCU Subaudible Metering Processor, Board 11	MI-561451
3	Jumper Board Connection, Board 26	MI-561457
1	TCU Subaudible Metering Processor, Board 23	MI-561455
	External Subcarrier and Demodulation Control/Audible Telephone Circuit Metering, ES-561446-15	
1	SCU Audible Metering Processor, Board 12	MI-561452
2	Jumper Board Connection, Board 26	MI-561457
1	TCU Audible Metering Processor, Board 24	MI-561456

TRANSMISSION KIT (Continued)

ES-561446-*

Quantity	Description	Reference
	External Subcarrier Generator and Demodulation Control/ Subcarrier AM Transmitter Metering, ES-561446-16	
1	SCU Subaudible Metering Processor, Board 11	MI-561451
2	Jumper Board Connection, Board 26	MI-561457
1	TCU Subaudible Metering Processor, Board 23	MI-561455

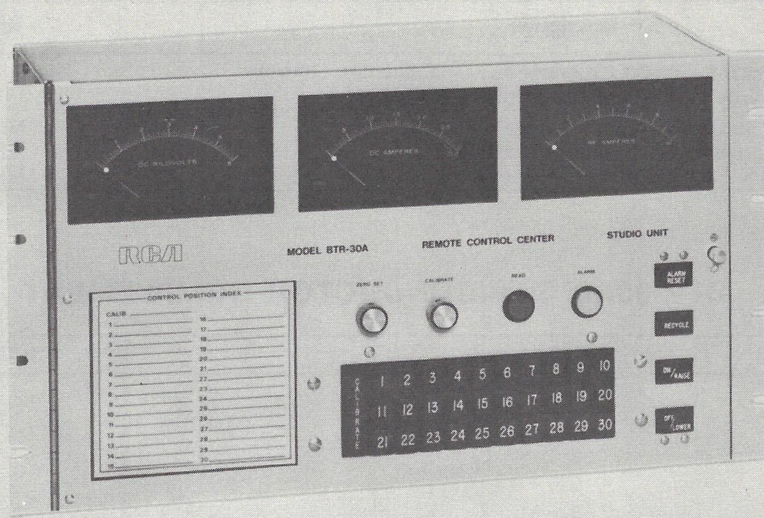
BTR-30AR SEMICONDUCTOR COMPLEMENT

TCU		SCU	
2N2924	31	2N2924	16
2N3053	4	2N3053	3
2N3054	2	2N3054	2
*2N3563	2	*2N3563	2
2N4058	2	2N3819	1
CA3018	3	**CA3028A	1
**CA3028A	1	MC824P	6
CA3030	1	MC829G	32
MC824P	1	MC889P	8
MC829G	1	MC890P	3
MC890P	1	MC899P	5
1N1588	1	1N4154	9
1N2974	4	10D2	4
1N4154	25	1ZC10T10	1
1N5240	1	1ZC16T10	1
10D2	20	1N4731A	1
1ZC10T10	3		
1ZC16T10	1		
1N4731A	1		
6RS20SP1B1	1		

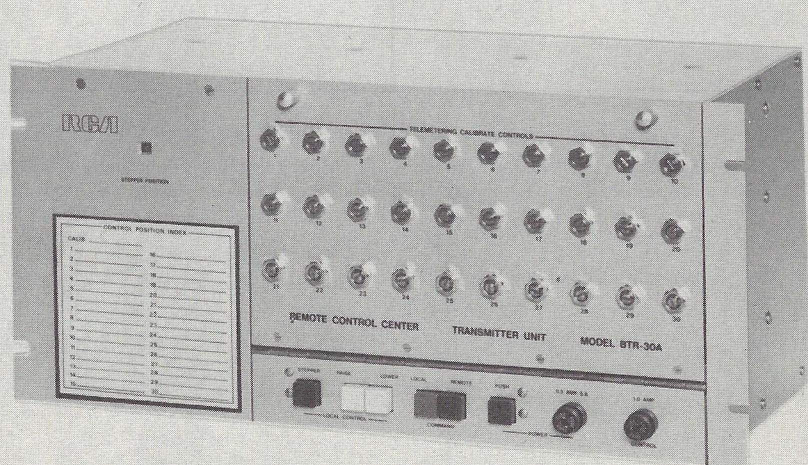
*Board 10a only

**Board 10 only

NOTE: In the BTR-30AW, the Audible Metering Processor (board 12) is utilized in place of the Subaudible Metering Processor (board 11), and the Subcarrier Generators (boards 10 or 10a) and the Subcarrier Demodulator (board 16) are replaced by the Input-Output Connector (board 26).



STUDIO UNIT



TRANSMITTER UNIT

1P039

Figure 1. BTR-30A Remote Control System

DESCRIPTION

GENERAL

The Model BTR-30A Remote Control System was designed specifically to remotely control television, FM, and standard broadcast transmitters. A total of 30 metering channels and 30 Raise/On and 30 Lower/Off control functions are provided by the system which requires only a single full-duplex telephone connection or similar full-time, two-way, communications-grade radio link. Control signals are sent to the transmitter in the form of audio tones. One of these is used to control the position of the stepping switch, and two are used to activate the Raise/On and Lower/Off circuitry. The stepping switch distributes the Raise and Lower outputs to a set of terminals on the rear of the Transmitter Unit and simultaneously selects a metering sample. The metering signals are returned from the transmitter to the studio in either the audible or subaudible spectrum.

Access to internal components is excellent. The mechanical design concept enables component testing, adjustment, and replacement to be accomplished with ease. The full-width, swing-away door on the Studio Unit provides full access from the front. The Transmitter Unit has both front and rear swing-down doors. All circuit modules are plug-in, and all transistors are socketed. All large capacitors except the computer-grade power supply filters are tantalum. The system functions well under wide temperature variations and other environmental extremes.

The BTR-30A is available in two basic versions: the BTR-30AW intended for wire-line service, and the BTR-30AR intended for radio (wireless) service. See figure 2. The BTR-30AR consists basically of the BTR-30AW with added plug-in subcarrier boards for simple interfacing with the studio transmitter link (STL) and radio receiving equipment. The BTR-30A is factory wired for either of the two basic operating modes.

WIRE SYSTEM (BTR-30AW)

The BTR-30A will be discussed first interconnected as a wire system (BTR-30AW). In this mode of operation the unit is designated as the BTR-30AW, and any two-way communications-grade telephone circuit can be used to interconnect the two units.

Considering the control portion first, a 920 Hz audio tone is sent from the Studio Unit (SCU) to the Transmitter Unit (TCU) at all times. This tone is keyed off briefly to advance the stepping switch. The number of positions the stepping switch advances is equal to the number of these brief interruptions. If the tone is keyed off for a half-second or longer, the stepping switch will seek its home or Calibrate position. The aforementioned interruptions are generated by the integrated circuitry located in the Studio Unit (SCU) and are controlled by the buttons located on the front panel of the unit. The short interruptions are generated by a 10 Hz oscillator while the longer half-second interruptions are generated by a reset circuit. Of interest at this point is that failure of this 920 Hz tone to be generated at the studio or to be received at the transmitter site will cause a failsafe relay in the Transmitter Unit (TCU) to become de-energized. The contacts of this relay can be used to remove the transmitter from the air in accordance with FCC regulations.

The stepping switch selects which voltage sample in the transmitter is to be returned to the studio for metering purposes. It also selects which terminals on the rear of the BTR-30A TCU are to be energized for control purposes. Each position of the stepper switch selects a metering sample, a Raise output, and a Lower output. These Raise and Lower outputs are not actually energized until either the Raise or Lower relay in the Transmitter Unit is energized. These relays are energized one at a time when either the RAISE or LOWER button at the studio is depressed. Depressing one of these buttons adds a second tone (670 Hz for Lower, 790 Hz for Raise) to the 920 Hz tone already going to the transmitter. Each button controls one oscillator, and since only one button at a time may be depressed, only one tone at a time may be added on to the normally present control tone going to the transmitter. No more than two tones are sent to the transmitter site at the same time. It should be noted that Raise and Lower signals may not be sent when the stepper switch is being advanced. The control tone actuating the stepper switch and failsafe relay is keyed electronically, and the Raise and Lower tones are keyed manually.

RADIO SYSTEM (BTR-30AR)

The preceding discussion concerned the operation of the BTR-30A when the two units are interconnected with an ordinary telephone line. Should radio remote control be used, certain options are available which allow the user to easily bypass the facilities of the telephone company. The first such option to be considered is the use of a subcarrier on a Studio-Transmitter Link (STL) to convey the control tones from the studio site to the transmitter site. This in itself, offers some relief from wire line unreliability. The subcarrier may be external, or preferably it should consist of a set of plug-in modules available as part of a radio remote control package available from RCA. In either case the subcarrier generator is frequency modulated by the summed control tones and delivers a subcarrier signal to the microwave Studio-Transmitter Link. The STL then conveys the subcarrier, containing control information, to the transmitter site. The subcarrier demodulator in the BTR-30AR consists of two boards; one a bandpass

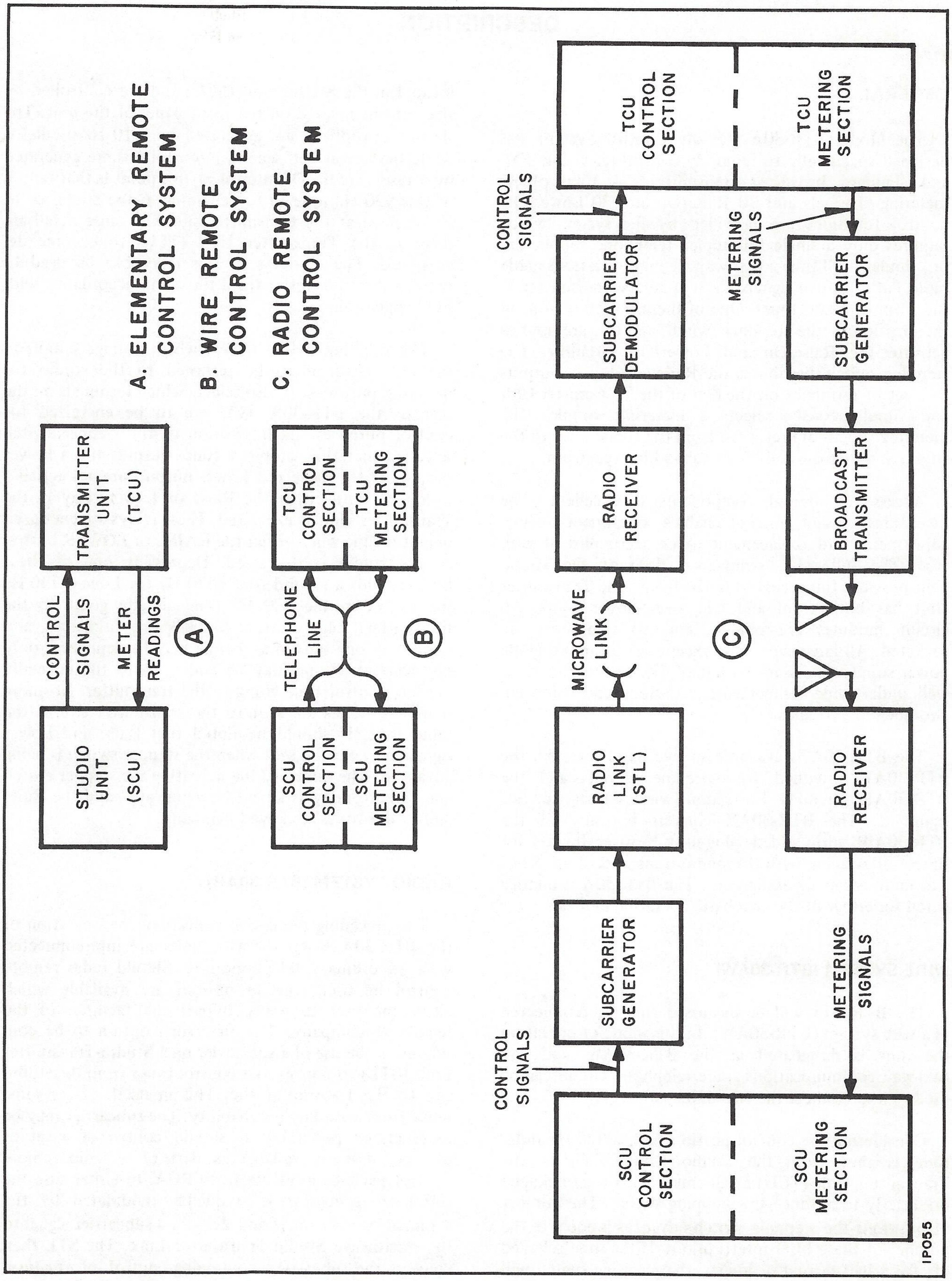


Figure 2. Remote Control Systems, Block Diagram

filter to extract the control subcarrier from the output of the STL receiver, and a second containing the actual subcarrier demodulator. The output of this demodulator is a replica of the control signal(s) sent from the Studio Unit.

Metering is returned, in the BTR-30AR via a subcarrier on the FM broadcast or television transmitter. In the case of standard broadcast transmitters, the metering tones are shifted to 20 Hz to 30 Hz and are applied to the transmitter. In all of these applications, the metering signal is sinusoidalized (filtered) and used intact. In the case of FM and TV transmitters, the signal is used to modulate an SCA subcarrier. In the case of AM, the signal is used to modulate the main carrier directly at a level of 5% to 6%. In FM and TV, either an internal or an external subcarrier generator may be used. The internal subcarrier generator does not have facilities for the addition of programming, nor does it have facilities for muting. The metering signal is received at the studio with an appropriate receiver, and the subaudible telemetry signal is extracted and directly demodulated to operate the studio metering system.

METERING

One pair of decks on the stepper switch selects a metering sample to be applied to the electronics in the BTR-30A Transmitter Unit (TCU). This metering sample, normally in the 1 volt dc range, is applied through gold-plated contacts on the stepper switch to a dc amplifier and then to a voltage-controlled oscillator. With no signal applied, this oscillator operates at a frequency of approximately 88 Hz. As the sample voltage increases to 1 volt, the oscillator frequency is shifted upward to 144 Hz. It is then counted down in an integrated circuit to a range of 22 Hz to 36 Hz. The reason for this counting process is twofold; one is to enable the use of reasonably-sized, high stability components in the oscillator, and the second is to eliminate any second-harmonic component in the metering signal. This is of importance in some methods of telemetry. In the wire system, however, the 22 Hz to 36 Hz signal is merely used to modulate a 1280 Hz carrier which is then sent back to the studio. Here it is detected and converted back to the original 22 Hz to 36 Hz tone. Application to a pulse-counting demodulator enables recovery of a current proportional to the original 0 to 1 volt sample. The frequency of the metering oscillator was proportional to the sample voltage; now the meter deflection is proportional to the oscillator frequency. The overall telemetry system is remarkably linear.

CIRCUITS

Control Circuitry

In the following discussion, occasional reference to the appropriate main frame schematic (figure 64 or 65) or to the appropriate block diagram (figure 3 or 4) will be helpful in understanding the BTR-30A operation.

The basic control circuit of the BTR-30A involves the continuous transmission from the studio to the transmitter of a 920 Hz audible tone. The oscillator which generates this tone is located on board 7 in the Studio Unit. See figure 43.

The oscillator utilizes transistor Q703 in a bridged-T RLC configuration. Components are selected for stable operation at the chosen frequency of 920 Hz, with a secondary winding on the inductor to provide an output for subsequent summing with other tones on another board.

If the base of transistor Q703 is held at ground potential, the circuit will not oscillate. Note the keying input at pin 19 of figure 43 (board 7). This point is normally positive, causing Q701 to conduct. This places the base of Q702 near ground, and it does not conduct, thereby allowing oscillation. Should the keying input drop to near ground, Q701 will not conduct, Q702 will conduct, and oscillation will stop. This is the method of keying the oscillator. The keying signal enters pin 19 of figure 43 (board 7) from pin 11 of figure 40 (board 4).

For maintenance purposes, notice that orange TP701 and yellow TP702 are both normally positive. Under this condition the control circuit is oscillating, and green TP703 shows the oscillator output at pin 5 which is fed to pin 20 of the output amplifier, figure 45 (board 9).

The output of the control oscillator is summed, along with other tones which will be discussed later, for subsequent application to either a telephone line or a subcarrier generator. For the moment a wire-line system (telephone interconnection) will be assumed. The output amplifier uses Q901 as a voltage amplifier and Q902 as a power amplifier. The output appears at pin 14. White TP902 will confirm satisfactory operation of the SCU output amplifier. The output of this amplifier is delivered to the telephone line matching transformer and then is connected to the line terminals.

At the transmitter site the signal from the telephone line is delivered to a 1 kHz low-pass filter and then to an input limiting amplifier on the TCU raise detector board, figure 53 (board 17). The circuitry around Q1701 forms a limiter enabling the incoming control tone to be extracted in the following circuitry in the presence of impulse noise. The input to this limiter is available for oscilloscopic observation at the orange TP1701, and the output of the limiter appears at pin 13, figure 53.

The remaining circuitry on this board will be discussed later.

Stepper Logic and Drive

Reference is made in the following material to schematic figures 56 and 57 and to the stepper circuit block diagram, figure 5. The limiter output from the input limiter, figure 53 (board 7) is fed to the stepper Control A, figure 56, pin 13 (board 20).

The amplitude-limited control tone is applied to a 920 Hz tone detector using a circuit similar to that used to generate the tone. This circuit uses Q2001 in a regenerative configuration, with R2004 as a regeneration control and C2001 as a tuning control. Q2002 provides buffering and power amplification to drive the voltage-doubling rectifier with diodes CR2001 and CR2002. The signal is smoothed and applied to a Schmitt level detector using Q2003 and Q2004.

Now refer to figure 5 which shows this area of the BTR-30A. The tone detector under discussion is shown at the left side of figure 5, and all circuitry mentioned is shown in the "920 Hz tone detector" block. The output signal from this block is positive (about 2 volts dc) when the tone is present, and zero when the tone is absent (during pulsing, homing, or system failure). It is fed to the Schmitt level detector, using Q2003 and Q2004. These transistors and associated components deliver a strong positive signal (about 8 volts dc) when the tone is above a certain level and a low-level signal (about 1 volt dc) when the tone is below the critical level. There is no middle ground; this is a so-called trigger circuit. Its output appears at pin 10 and is fed to a pulse-width detector using transistors Q2005 and Q2006. This circuit has a positive output (at figure 56, pin 4) only when a "pulse" (missing tone or keyed-off tone) is present for 0.3 second or more. The output of this pulse-width detector is processed with transistors Q2101 and Q2102. See figure 57. The output of Q2102 is near ground under normal conditions (920 Hz tone present) and about 15 volts positive when the pulse has been determined to be in excess of 0.3 second in width (home or failsafe).

The output of the first Schmitt trigger, Q2004, normally is positive but drops to ground when a stepping signal occurs. The output of the second Schmitt trigger, Q2102, normally is at ground. When both of these signals are at ground and when neither Q2004 nor Q2102 delivers a positive signal, then the "NOR" gate using Q2103 and Q2104 delivers a positive signal output. This is passed on to CR2102 and on to the power amplifier, using Q2106 and Q2107. The stepper is then actuated. This is the signal flow when the stepping switch is to be stepped one or more discrete steps at a time.

Consider now the action of the circuit when a reset or home signal (keying off of the 920 Hz tone for 0.5 second) is detected. The output of the Schmitt trigger Q2004 drops to zero immediately, as if a "step" signal were being detected. Since the output of Schmitt trigger Q2102 is at this instant near ground, both inputs of the NOR circuit, Q2103 and Q2104, are near ground, and it delivers a positive output to the stepper power amplifier. The stepper drive coil will be momentarily energized, and it will advance one step.

However, 0.3 second after this takes place, the pulse width detector Q2006 delivers sufficient signal to energize Schmitt trigger Q2101 and Q2102. Q2102 then applies a positive signal to the NOR circuit and prevents further discrete stepping action from taking place. The NOR circuit can deliver power to the stepper only if both inputs are near ground.

Q2101 of the pulse width Schmitt circuitry normally delivers a positive output. Upon receipt of the long pulse (home or reset), it drops to near ground. This signal is inverted in Q2105 so that the output of Q2105 goes to about 12 volts when a reset signal is detected. This is routed through the homing and pulsing contacts on the stepper to the input of the OR circuit, using CR2101. The stepper switch drive coil then pulses itself until it reaches the home position. At this time the homing contacts open up, removing drive to the OR circuit.

The type of circuit discussed is known in computer terminology as RTL (resistor-transistor logic), and it is reliable and rather elementary in its operation. However, should a failure occur somewhere in this system, it might be possible to apply power to the stepper switch drive coil continuously. To prevent this from happening, capacitor C2102 is used to ac couple the drive signals to the power amplifier. In this manner, the drive coil cannot be energized continuously and so it is prevented from over-heating. Another unique protective feature is the Zener diode and conventional diode-damping network across the stepping switch drive coil. This is shown on the schematic as the set of diodes CR2104 through CR2106. Finally, note that the drive transistor is easily capable of supplying the necessary power (in excess of 50 watts) to the drive coil.

Raise-Lower Generation

A pair of oscillators, each with circuitry similar to the control oscillator, is included in the BRT-30A System. These additional two oscillators are keyed on manually by depressing either the front panel RAISE or LOWER buttons. Refer to figure 6. When one of these buttons is depressed, its corresponding oscillator is turned on. These two oscillators are presented in figure 44 (board 8) and are identical except for the values of the tuning capacitors.

To key on one of these oscillators, the emitter circuit is connected to ground. Schematically, pin 20 of board 8 is grounded. Connecting the emitter circuit of Q801 to ground allows the stage to oscillate. On the tuning inductor, as in the control oscillator, there is a winding for extraction of the tone. This signal is summed with the control tone in the output amplifier, figure 45 (board 9).

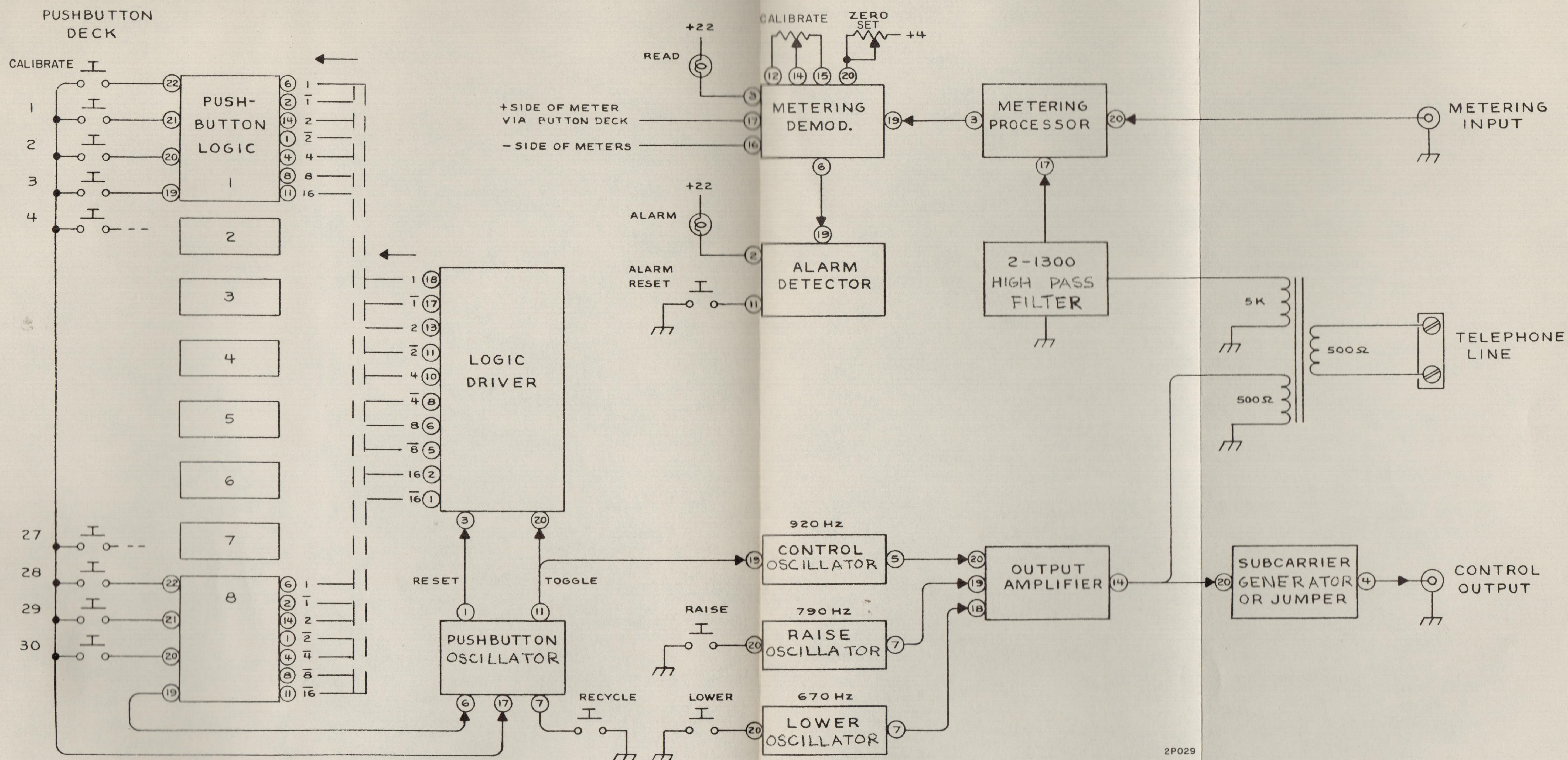


Figure 3. Studio Unit, Block Diagram

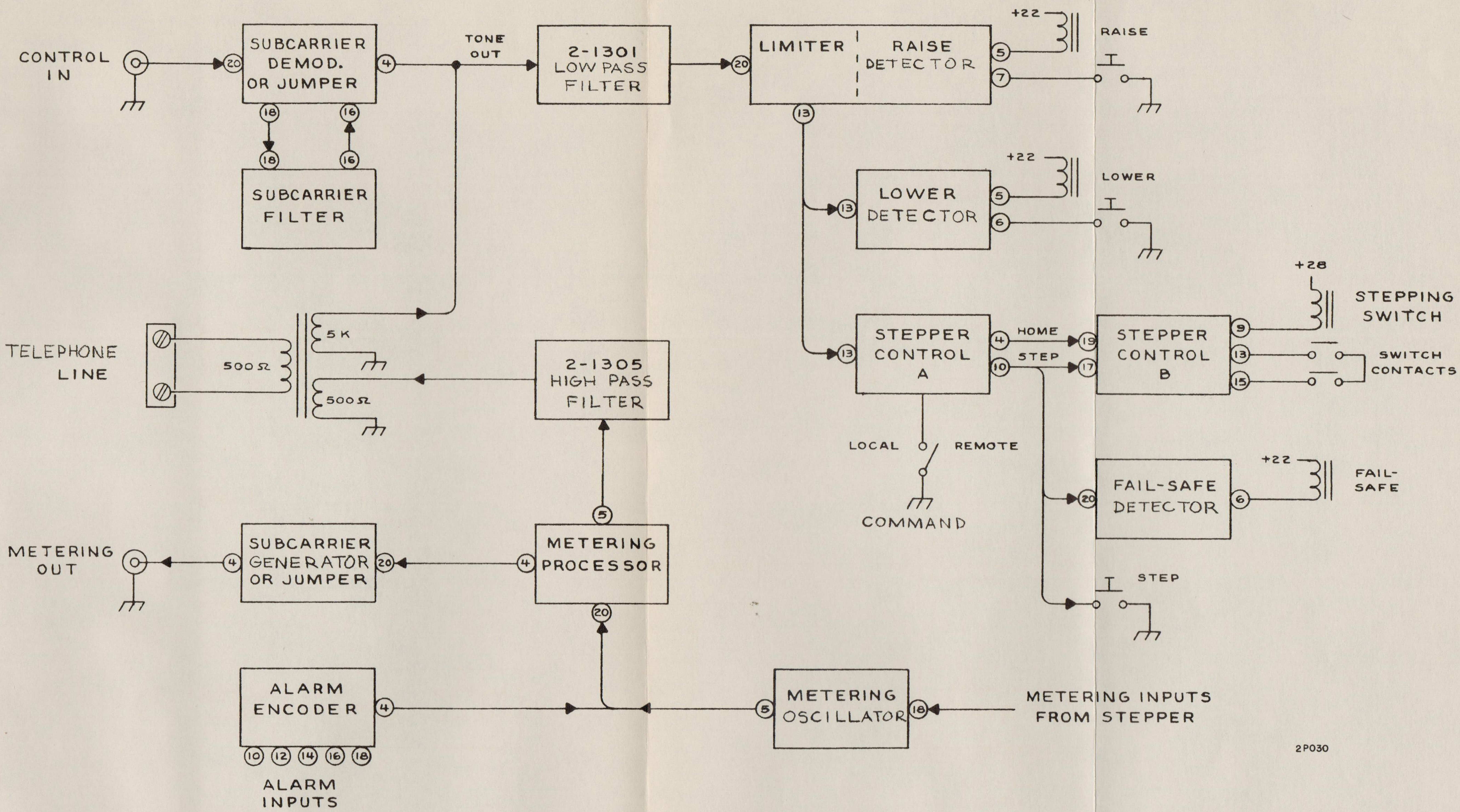


Figure 4. Transmitter Unit, Block Diagram

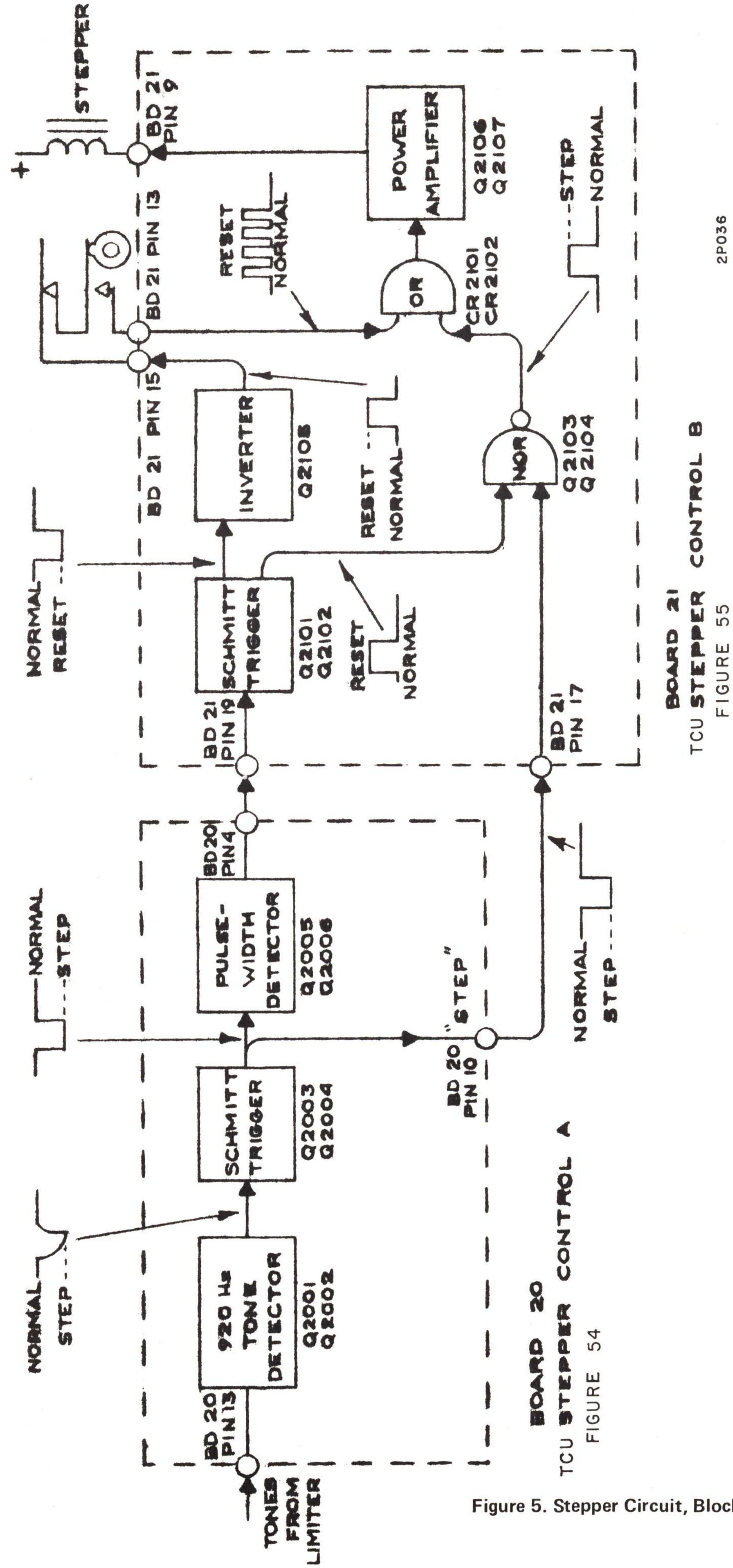


Figure 5. Stepper Circuit, Block Diagram

Note again that there are two oscillator boards and each is identical except for the values of tuning capacitors. One is to generate the Raise tone, and the other generates the Lower tone. They must be in their proper sockets, or the raise and lower functions will be interchanged. The Raise tone generator uses 0.047 microfarad tuning capacitors, and the Lower tone generator uses 0.068 microfarad capacitors.

Raise Detection

Once the Raise, or Lower, and the control tones are summed and sent to the transmitter site, they are processed identically. The tones are applied to the limiter circuit, board 17 in the Transmitter Unit. Refer to the schematic diagram, figure 53. Transistor Q1701 and associated circuitry accomplish limiting of the tone levels as previously discussed.

Also located on this board is the tone detector for the Raise channel. This detector, using transistors Q1702 through Q1705, operates in a manner similar to that of the control channel. The regenerative detector, buffer, and Schmitt trigger circuits are discussed for the control channel. The Schmitt trigger is coupled to a relay-driving transistor, and the Raise relay is driven upon receipt of a Raise tone.

Lower Detection

The output of the limiter of figure 53 (board 17) is also applied to the input of the Lower detector on pin 13, figure 54. This detector is essentially a duplicate of the Raise detector except that the input limiter is eliminated.

Failsafe

When reference to figure 56, observe that the Schmitt trigger output from Q2004 with the normal presence of the control tone is positive. This voltage is routed to, among other places, the failsafe circuitry located on board 19. See figure 55. The positive input is applied to pin 20, through CR1901 and R1902 and C1901 quickly charges substantially to the full value of the input signal. It is then passed through the buffer amplifier Q1901 to another Schmitt trigger used for level selection. The output of this circuit is positive when the control tone (used now for failsafe purposes) is present. The positive signal is used to drive transistor Q1904 and actuate the failsafe relay.

Failure of the control system will result in a loss of the positive input to the failsafe circuit, and capacitor C1901 will slowly discharge through R1901. The voltage present across C1901 is normally 8 volts. When this has discharged down to 1.5 volts, the failsafe relay will be de-energized. This will then cause the transmitter to be removed from the air. The time lag between control system failure and transmitter shut down is about 20 seconds.

Rise, Lower, and Failsafe Outputs

The Raise and Lower relays each distribute the applied "control" power to a specific deck of the stepper switch. The stepper switch, in turn, distributes this power to the barrier strip terminals on the rear of the Termination Unit. The control input power is applied to the terminals marked RAISE/LOWER DISTR. INPUT on the rear of the TCU. Normally, 117 Vac is used as the control voltage, but any convenient voltage less than this can be used. The maximum load to be switched should not exceed 50 watts and the maximum current should not exceed 1 ampere.

The failsafe output terminals are single-pole, double-throw and are not internally connected to any power. It is intended that these terminals go to the transmitter control circuitry in such a manner as to cause the transmitter to leave the air if the control signal is not present at the input to the TCU.

Studio Pushbutton Circuitry

The circuitry which keys the control oscillator (board 4) is shown schematically on figure 40. This circuit develops two types of signals; one is used to key (off) the control oscillator the required number of times for stepping purposes, while the second signal is a reset signal used to reset both the studio electronics and the stepper switch at the transmitter site. A simplified schematic of the 10 Hz keying oscillator, including the electronics inside the integrated circuits, is shown on figure 7. Observing the upper left portion of the schematic, it will be seen that a free-running multivibrator is the heart of this circuit. The connection from pin 3 to pin 13 forms a "self-completing" circuit so that only complete 10 Hz oscillations are developed. With the input to pin 6, the resultant output from pin 5 provides an isolated (buffered) output whose signal polarities are proper for operating the keyer on the 920 Hz control oscillator, figure 43.

The input to pin 9 at the left side of figure 7 is a "muting" input. When this point is driven with a positive signal, the oscillator cannot function.

The input to pin 1 at the right side of the schematic is a "keying" input. When this point is positive, the oscillator will function. The keying input signal is derived from a set of integrated circuits on another series of boards, and is positive if the button pushed does not agree with what the electronics has stored as the current stepper position. As soon as the electronics portion is in agreement with the button which has been depressed, the keying signal is switched off, and the 10 Hz oscillations cease.

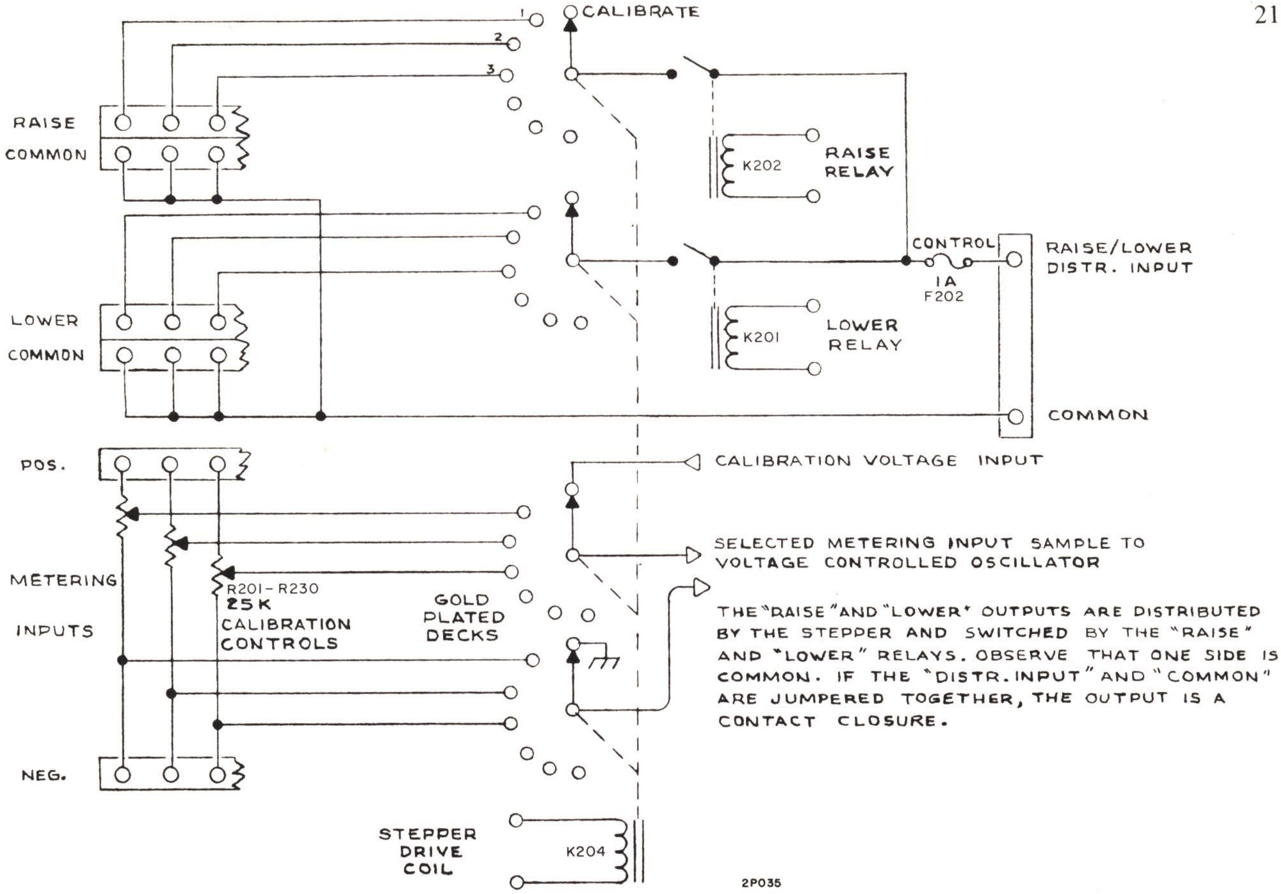


Figure 6. Raise-Lower Circuit, Simplified Schematic

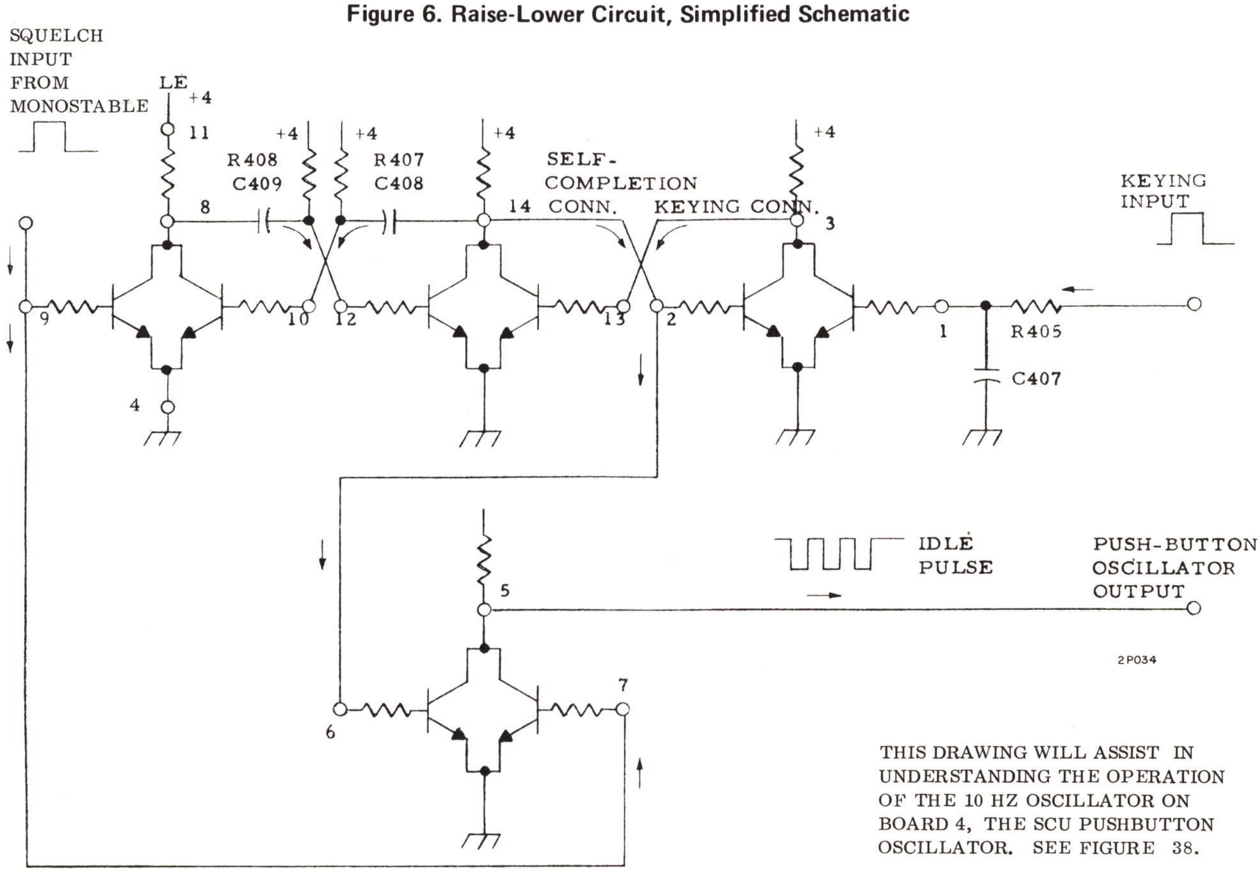


Figure 7. Pushbutton Oscillator, Simplified Schematic

It was mentioned that pin 9 of this integrated circuit was a "muting" input. When this point is driven positive, the oscillator cannot function. Further, the output buffer is also keyed into condition. The positive pulse which accomplishes this is derived from the monostable multivibrator. This circuit, when triggered any of three ways, will generate a single pulse whose amplitude is sufficient to operate the "muting" circuits and whose time length is sufficient to allow all the studio electronics as well as the transmitter stepper switch to go to home position.

The monostable multivibrator can be triggered by pushing the RECYCLE button on the front panel, by pushing the CALIBRATE button, or by allowing the integrated circuitry on other boards to signal the end of the counting process.

Refer to figure 8, which shows that the monostable multivibrator is triggered by pulling the collector at pin 3 down to near ground. This is accomplished by applying a positive signal to pin 1, by grounding pin 3, or by grounding pin 3 through a diode. This latter technique is the method by which the built-in electronic counter accomplishes the resetting of the system. Once this action has been started, the output pulse is applied to the remaining sections of this integrated circuit which operates as a buffer amplifier.

Both the 10 Hz oscillations and the reset pulses now appear at pin 5 of the oscillator integrated circuit. This signal is available for inspection at the green test point, TP403 on figure 40. It leaves the board at pin 11. Other signals on this board are indications of the monostable multivibrator output at orange TP401 and the 10 Hz oscillator keying input at yellow TP402. Waveforms are shown on this schematic to enable a better understanding of the circuitry.

The output of the 10 Hz oscillator keys the SCU control oscillator, figure 43, and it also drives the integrated circuit digit-counting chain. Note that the 10 Hz oscillator output is normally positive. This is the condition required to sustain a control-tone signal. When the 10 Hz oscillator is pulsing, the 920 Hz control-tone signal is pulsed *off* at a 10 Hz rate. When a reset signal is involved, the control-tone oscillator is keyed off for 1.8 seconds. This causes the stepper circuitry to home the stepper at the transmitter site. The reset signal also resets the digit-counting chain at the studio. This reset signal appears at pin 1 of figure 40.

Refer to figure 41, the schematic of the SCU logic driver. Observe the input at the left of the drawing labeled "toggle-input from PB oscillator" at pin 20. It is at this point that each of the 10 Hz oscillations are monitored, and in this circuit they are counted. The count is reset whenever a signal (from the reset monostable multivibrator) appears at the "reset input," pin 3.

The counting of the 10 Hz oscillations takes place in a binary manner; the number of cycles that have occurred are converted immediately to a binary form. At the bottom of the schematic, figure 41, note the pins numbered 18, 13, 10, 6 and 2. Immediately below each of these pins is a number. If the system has been reset and then five cycles of the 10 Hz oscillator have run, the "numbers" 4 and 1 (pins 10 and 18) will be positive. If six cycles have run, "numbers" 4 and 2 (pins 10 and 13) will be positive. The remaining terminals in this area will be near ground potential. This is an example of the manner in which the pulses are counted.

These voltages or signals (at the bottom of figure 41) are routed to a set of eight identical boards, each containing four decoding circuits. A total of 32 decoders is thus set up. One detects a count of zero (home or calibrate), another detects a count of 1, and so on up to 31. The 31st decoder is used to indicate that the system has gone past the 30th position, and electrically it applies a signal to the reset circuit. See figure 42. All eight boards are identical and they may be interchanged.

Depressing the manual RECYCLE button on the front of the Studio Unit will reset all of the integrated circuit electronics, and the process will reset the stepper switch at the transmitter site. The 10 Hz oscillator will then oscillate, producing a series of pulses equal in number to the button number which has been depressed. For example, if button 5 is depressed and the RECYCLE button is then depressed, the system will reset and then count out five pulses at a 10 Hz rate.

Refer to figure 9, the simplified block diagram of the decoding system. If a given pushbutton is depressed, it connects the "key-on" input on the 10 Hz oscillator to the output of a corresponding inverter. The output of this inverter will be positive; its input is near ground. The inverter input will rise to a positive value only when *all five* input lines to the corresponding decoder are at ground potential. This is the case only when sufficient pulses have been counted into the 5 stage binary counter to satisfy the decoder. Its inputs will one by one drop to ground, and when all five inputs are at ground, its output will be positive. This will bring the output of the inverter down to ground, removing excitation to the key-on input on the 10 Hz oscillator.

Should the binary chain for any reason count to position 31, the last decoder detects this immediately and automatically resets the system. Counting will then restart on its own accord.

Meanwhile the 920 Hz control tone oscillator is following this activity and keying (off) the control tone as necessary to allow the stepping switch to be continuously synchronized with the studio electronics.

Metering Generation

The metering or telemetry system operation in the BTR-30A is unusually flexible. The metering samples

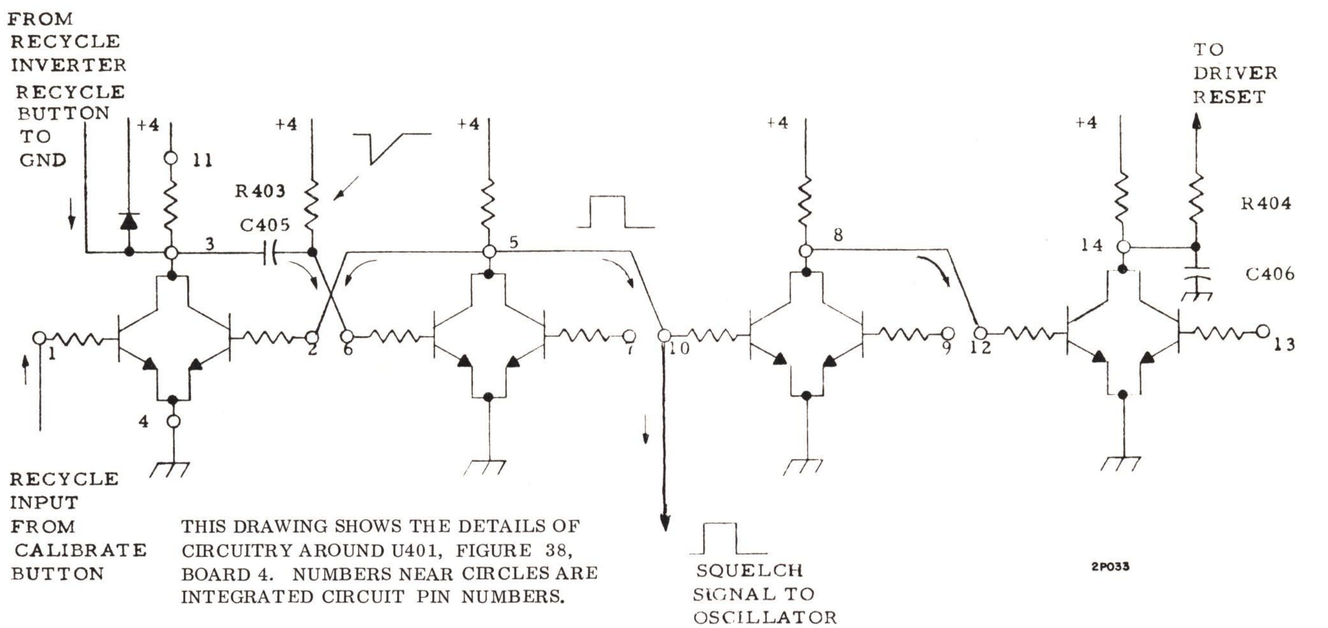


Figure 8. Reset Circuit, Simplified Schematic

from the transmitting equipment are applied to their individual calibration controls and then routed to contacts on the stepper switch.

One of these metering systems at a time is selected by the stepper switch for application to the metering system electronics. This is located in the Transmitter Unit on board 22. See figure 58.

The input from the stepping switch is routed to pin 18 of this board and applied to pin 3 of the integrated circuit dc amplifier. This amplifier provides for phase compensation and pre-emphasis. The pre-emphasis is in part responsible for the good meter ballistics as observed on the studio meters. This pre-emphasis provides a rising high-frequency response to the metering system, accelerating the meter movement and making it more responsive.

The dc amplifier is non-inverting and heavily gain-stabilized with negative feedback. A positive input from 0 through 0.7 volt dc yields an output from this stage of 0 through 7 volts dc.

The output of this dc amplifier is applied to the voltage-controlled oscillator. This is a multivibrator whose frequency is directly proportional to the voltage applied to it from the dc amplifier. The output waveform is a good approximation of a square wave.

In applications where the final metering waveform must be a good sine wave (sinusoid), it is important that all harmonic content be reduced far below the fundamental. Filtering of the metering signal can be simplified if it contains no second harmonic. This condition is met by dividing the metering signal (twice) from its original range of 88 Hz – 144 Hz down to 22 Hz – 36 Hz. An ideal square wave, it must be remembered, contains no even harmonics. This division process also results in the voltage-controlled oscillator using smaller components with better temperature coefficients than if the metering signal (22 Hz – 36 Hz) were generated "on frequency." Dividing the original metering signal down with bistable circuits also assures a constant output amplitude.

The metering signal leaves pin 5 of figure 58 (board 22), and it is applied to the metering processor. At this point an option is available; the basic 22 Hz – 36 Hz metering square-wave signal is either filtered and turned into a sine wave, or else it is used to key (amplitude modulate) a 1280 Hz tone. The first option is used when the metering signal is to be applied to an AM transmitter or to an FM SCA subcarrier with programming. The 1280 Hz option is used when the metering is returned from the transmitter to the studio via a communications-grade link such as a telephone line or other voice-quality system.

The output of the metering oscillator is a square wave of about 1 volt peak-to-peak amplitude in the range of 22 Hz to 36 Hz. In the case of metering return via modulation directly on the carrier of a standard AM broadcast carrier, the metering oscillator output frequency range is changed to 20 Hz to 30 Hz. Discussing first the subaudible processing, refer to figure 59 (board 23).

The input to the TCU subaudible metering processor appears at pin 20 of board 23 and is applied to a low-pass filter which removes significant harmonics to a level of 40 dB below the fundamental. Refer to figure 53. Note that because there are no even harmonics in the metering signal (because of the bistable processing), the filter does not need a sharp cutoff at the second

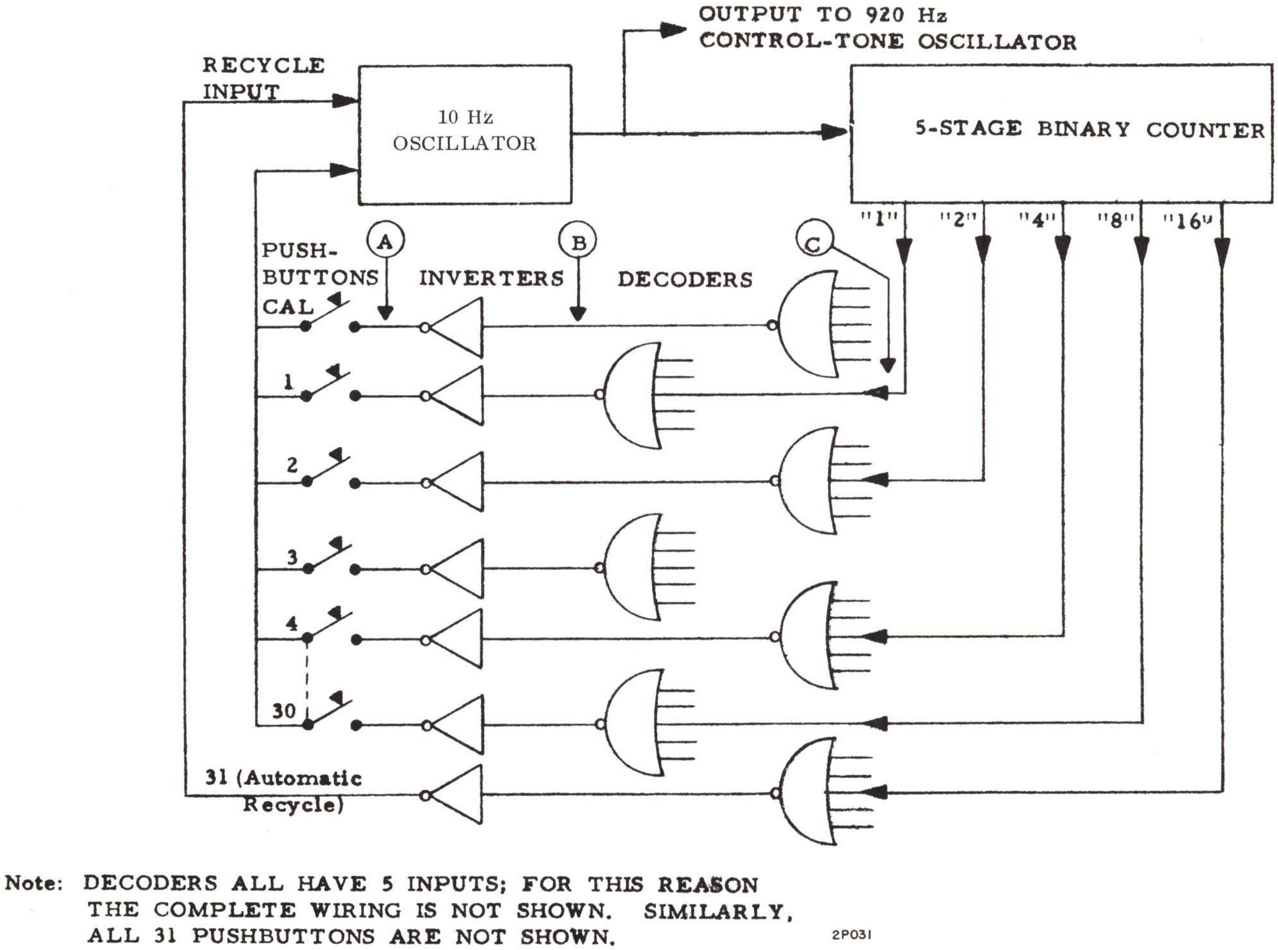


Figure 9. Pushbutton Logic, Simplified Schematic

harmonic of the lowest metering signal frequency. This would be required if the signal were not processed as it is. Following the low-pass filter is a voltage amplifier and a power amplifier. This latter has the ability to drive a subcarrier generator or an AM transmitter. Remember that in the case of AM broadcast, the metering oscillator output frequency is in the range of 20 Hz to 30 Hz.

Metering Detection

The metering signal is recovered at the studio from an AM receiver or modulation monitor. In the case of FM, a specially modified telemetry receiver is used. In either case, the metering signal is recovered and applied to the SCU subaudible metering processor at the studio. The schematic for this circuit is shown in figure 46. Again, the signal is applied to an emitter-follower for impedance-matching purposes and then to a low-pass filter. The purpose of this filter is to reject program material which may be present with the metering signals. Only the 22 Hz to 36 Hz (or 20 Hz to 30 Hz) signal will be passed by the filter.

In the case of the audible metering return (modulated 1280 Hz), the square-wave metering oscillator output is applied to pin 20 of board 24, the TCU audible metering processor at the transmitter. See figure 60. The metering oscillator output stage acts as a keyer for the 1280 Hz tone oscillator. The output from this oscillator is applied to a line-driving amplifier. The output connections are arranged in a manner such that the BNC connector for metering output is also brought into play. Metering signals appear at both the telephone line and at the "metering output" BNC connector.

At the studio, the input from the wire line (via the Type 2-1300 High-pass Filter) or from the BNC connector is applied to the SCU audible metering processor, board 12. Refer to figure 47. Here the metering signal is limited and applied to the 1280 Hz tone detector. This detector recovers the 22 Hz to 36 Hz modulation impressed on the tone at the transmitter site. Simple filtering and amplification follow this detection process.

The metering signal, whether it has been conveyed to the studio via audible (modulated 1280 Hz signal) or subaudible (22 Hz to 36 Hz) tones, is applied now to the

the additional circuitry to enable wireless (radio) operation will be presented. This system is designated the BTR-30AR.

Considering first the signals at the studio site, the control tones are summed in the SCU output amplifier, figure 45, and applied to the subcarrier generator. These control tones can be observed at the orange test point TP1001, on the subcarrier generator (board 10), figure 48 or 48a. Potentiometer R1001 sets the amount of control-tone signal applied to the voltage-controlled oscillator. The center frequency of the frequency-modulated control subcarrier oscillator is set with the frequency control, R1004. The oscillator is of the multivibrator type, using U1001. The signal at this point is a square wave and may be observed at the yellow test point, TP1003. It is applied to the filter-driving buffer amplifier Q1001. A low-pass filter removes unwanted harmonics of the carrier signal and leaves a sine wave. This is amplified in voltage amplifier Q1002 and is applied to the output power amplifier Q1003. The output level control R1028 sets the degree of injection into the microwave equipment.

The subcarrier generator produces a signal with a center frequency of 26 kHz (or other frequencies for special applications) which is deviated approximately plus and minus 5% of the carrier frequency. It is fed into the multiplex input of the STL equipment.

At the transmitter site, where the Transmitter Unit and the STL receiver are located, the subcarrier signal is extracted and demodulated by the subcarrier filter. See figure 52 (board 15). The extraction is accomplished with a bandpass filter consisting of five tuned circuits with sufficient bandwidth to pass the modulation sidebands of the control subcarrier and adequate skirt selectivity to reject unwanted subcarriers or other signals.

The output of the subcarrier filter is passed on to the subcarrier demodulator. See figure 51. The recovered control subcarrier is applied to pin 16 of board 16 and may be observed at the orange test point TP1601. It is then applied to the first transistor in the integrated circuit array U1601. This transistor then drives the voltage amplifier using the second transistor in this array. The output of this amplifier is symmetrically clipped by the back-to-back silicon diodes CR1601 and CR1602. Symmetrically limiting gives this demodulator good spurious signal rejection (capture ratio). Subsequent amplification in the third section and buffering in the fourth allows a high-level signal to be applied to the Schmitt trigger. The Schmitt trigger uses the first two sections in the second transistor array, U1602. The output of the Schmitt trigger is a square wave which is applied to the pulse-counting demodulator. This demodulator uses the third section of the array actively and the fourth section as a base-emitter protection diode. The output of the demodulator appears at pin 11 of U1602, and the waveform at this point consists of a series of pulses of equal pulse width and amplitude. The pulse rate, however, is the same as the input subcarrier frequency. The average voltage is proportional to the center frequency of the subcarrier.

This signal is applied to a buffer amplifier using the first section of the third array, U1603. This buffer drives a filter consisting of inductors L1601 and L1602 and capacitors C1607 through C1609 to remove the subcarrier frequency.

The voltage at the junction of C1609 and C1610 consists of two components; a dc voltage proportional to the subcarrier center frequency, and an ac voltage proportional to the subcarrier modulation. C1610 passes the ac (modulation) component on to the amplifier stages consisting of the last two sections in array U1603. The output of the last stage is a replica of the control tones impressed on the subcarrier generator at the studio or control site. This demodulated output is routed via the Type 2-1301 Low-pass Filter to the various tone detectors. From this point onward, operation of the BTR-30AR is identical to wire-line operation.

Metering Return, Wireless Operation

In radio remote control operation, the metering signals are normally returned to the studio in the subaudible spectrum. Should an AM transmitter be involved in this process, the metering subcarrier generator in the Transmitter Unit is replaced with a jumper board. See figure 62. In this manner, the subaudible signals are available directly at the "meter out" BNC connector on the rear of the TCU. It is intended in AM operation that this signal be applied to the transmitter with external equipment to modulate the carrier in the order of 5%.

In FM and TV operation, two possibilities exist. If only metering signals are to be returned to the studio on a subcarrier, then an internal subcarrier generator can be used in lieu of an external multiplex (SCA) generator. For FM this generator is normally supplied tuned to 67 kHz. For TV the subcarrier generator should be set to 39 kHz. In either case, the subcarrier generator is deviated about 5% with the subaudible metering signal, and the injection into the FM or TV aural transmitter is set to about 10%.

If, especially in the case of FM, an external subcarrier generator is employed, then the input-output connector, figure 62, is installed, and the metering output is taken at the subaudible rate from the BNC connector. It is then routed to the telemetry input on the rear of the subcarrier generator. The subaudible metering signals will then modulate the resultant SCA signal about 15 dB to 20 dB below program level and will be inaudible on a standard multiplex receiver.

In a radio remote control system, the subaudible

SCU metering demodulator. The schematic for this unit is shown in figure 48.

The processed input signal is applied to pin 19 of figure 48 and is used to actuate a Schmitt trigger circuit. This circuit produces a waveform of uniform amplitude with rapid rise and fall times. It is used to operate the monostable integrated circuit IC1301, which produces pulses of uniform width and amplitude at a rate equal to the metering signal frequency. After filtering by L1301, C1303, C1304 and C1305, the voltage is essentially free of metering-frequency ripple and is applied to the M101. R1311 is used as the meter multiplier and R1315 shunts the meter movement. C1306 and R1312 apply an accelerating signal to the meter to enable it to respond to transients. This acceleration component is in addition to the acceleration added at the transmitter site, and it is responsible for the exceptional operation of the BTR-30A metering system when measuring modulation of the remote transmitter.

R1313 and R1314 in conjunction with the external ZERO adjustment and R1316 provide a means of zeroing the meter when the input metering signal is at 22 Hz. It is normal for the meter to show a 0.5% peak-to-peak dither when reading at the left end of the scale. This is a by-product of the subaudible metering system and does not affect accuracy. Each of the meters has been by-passed at the factory with a 220 ufd capacitor to reduce this effect. Should ballistics be of greater importance than the dither reduction, remove this capacitor.

The output of the monostable circuit is also used to operate the alarm detector, the READ light, and a meter-muting circuit.

Metering Read

On the SCU metering demodulator, figure 48 (board 13) in the SCU, is a "metering presence" detector. Rectifying the output of the metering monostable multivibrator, diode CR1302 charges capacitor C1308 to about +2 volts. This keeps the collector of transistor Q1304 near ground potential. Should the metering signal disappear or be keyed off for any reason, the capacitor will discharge, and the collector of Q1304 will rise to a positive voltage. This voltage is coupled through R1321 to the base of Q1306. Q1306 then conducts, removing base drive to Q1307. Without drive, this transistor will not conduct and the front panel READ lamp will be extinguished.

Similarly, upon removal of metering signal, the positive voltage at the collector Q1304 is passed on as base drive to Q1305. The collector of Q1305 then drops to near-ground potential, removing the zero-adjustment voltage. This will prevent the meter needle from going off scale in a reverse direction upon cessation of metering signals.

The output of Q1304 is also passed on to the SCU alarm detector, figure 49 via resistor R1322 and pin 6.

Alarm Encoder

The BTR-30A System utilizes an alarm system based on momentary key-off of the metering signal. Basically, receipt of an alarm condition at the Transmitter Unit causes a brief interruption of the metering signal. This is accomplished electronically by the TCU alarm encoder, board 25. See figure 61.

If any of the input terminals (pins 10, 12, 14, 16, or 18) are connected to ground, then that terminal which has been held at -2 volts will suddenly go to ground potential. This positive-going signal is coupled through a capacitor (C2501 through C2505) to an input of U2501. This is a 5-input gate. If any of its inputs go positive, its output (pin 7) will go to ground. This negative-going signal is used to key a monostable multivibrator, U2502. The pulse width of the signal so generated is about 0.5 second in length. It is used to provide drive to transistor Q2501. When this transistor is conducting, it effectively shorts to ground the output of the metering oscillator board.

In summary, when any alarm input is connected to ground, the metering is removed from the system for a period of 0.5 second. This brief metering key-off is detected at the studio by the metering demodulator and alarm detector.

Alarm Detection

With reference to the SCU alarm detector schematic, figure 49, this positive-with-alarm signal enters the alarm detector circuit at pin 19 of board 14. This point is normally at near ground potential and rises to about +3 volts with metering cessation. Integrated circuit U1401 generates a 0.8 second pulse upon cessation of metering. At the end of this pulse, another pulse is generated by U1402, which is about 1 second in width. Should the metering return during the time of this second pulse ("window"), another pulse is generated which sets the set-reset bistable multivibrator U1403. This in turn will energize transistor Q1401 which illuminates the front-panel ALARM lamp. The lamp is turned off by manually resetting the bistable multivibrator using the front-panel ALARM RESET button. Note that in order to activate the alarm detector in its entirety, the metering signal must be keyed off for a period of time greater than 0.8 second but less than 1.8 seconds. Very brief or very long metering failures will not actuate the alarm circuitry.

Subcarrier Circuits

The discussion of the BTR-30A has been primarily limited to operation on a telephone line. At this point the additional circuitry to enable wireless (radio) operation will be presented. This system is designated the BTR-30AR.

Considering first the signals at the studio site, the control tones are summed in the SCU output amplifier, figure 45, and applied to the subcarrier generator. These control tones can be observed at the orange test point TP1001, on the subcarrier generator (board 10), figure 48 or 48a. Potentiometer R1001 sets the amount of control-tone signal applied to the voltage-controlled oscillator. The center frequency of the frequency-modulated control subcarrier oscillator is set with the frequency control, R1004. The oscillator is of the multivibrator type, using U1001. The signal at this point is a square wave and may be observed at the yellow test point, TP1003. It is applied to the filter-driving buffer amplifier Q1001. A low-pass filter removes unwanted harmonics of the carrier signal and leaves a sine wave. This is amplified in voltage amplifier Q1002 and is applied to the output power amplifier Q1003. The output level control R1028 sets the degree of injection into the microwave equipment.

The subcarrier generator produces a signal with a center frequency of 26 kHz (or other frequencies for special applications) which is deviated approximately plus and minus 5% of the carrier frequency. It is fed into the multiplex input of the STL equipment.

At the transmitter site, where the Transmitter Unit and the STL receiver are located, the subcarrier signal is extracted and demodulated by the subcarrier filter. See figure 52 (board 15). The extraction is accomplished with a bandpass filter consisting of five tuned circuits with sufficient bandwidth to pass the modulation sidebands of the control subcarrier and adequate skirt selectivity to reject unwanted subcarriers or other signals.

The output of the subcarrier filter is passed on to the subcarrier demodulator. See figure 51. The recovered control subcarrier is applied to pin 16 of board 16 and may be observed at the orange test point TP1601. It is then applied to the first transistor in the integrated circuit array U1601. This transistor then drives the voltage amplifier using the second transistor in this array. The output of this amplifier is symmetrically clipped by the back-to-back silicon diodes CR1601 and CR1602. Symmetrically limiting gives this demodulator good spurious signal rejection (capture ratio). Subsequent amplification in the third section and buffering in the fourth allows a high-level signal to be applied to the Schmitt trigger. The Schmitt trigger uses the first two sections in the second transistor array, U1602. The output of the Schmitt trigger is a square wave which is applied to the pulse-counting demodulator. This demodulator uses the third section of the array actively and the fourth section as a base-emitter protection diode. The output of the demodulator appears at pin 11 of U1602, and the waveform at this point consists of a series of pulses of equal pulse width and amplitude. The pulse rate, however, is the same as the input subcarrier frequency. The average voltage is proportional to the center frequency of the subcarrier.

This signal is applied to a buffer amplifier using the first section of the third array, U1603. This buffer drives a filter consisting of inductors L1601 and L1602 and capacitors C1607 through C1609 to remove the subcarrier frequency.

The voltage at the junction of C1609 and C1610 consists of two components; a dc voltage proportional to the subcarrier center frequency, and an ac voltage proportional to the subcarrier modulation. C1610 passes the ac (modulation) component on to the amplifier stages consisting of the last two sections in array U1603. The output of the last stage is a replica of the control tones impressed on the subcarrier generator at the studio or control site. This demodulated output is routed via the Type 2-1301 Low-pass Filter to the various tone detectors. From this point onward, operation of the BTR-30AR is identical to wire-line operation.

Metering Return, Wireless Operation

In radio remote control operation, the metering signals are normally returned to the studio in the subaudible spectrum. Should an AM transmitter be involved in this process, the metering subcarrier generator in the Transmitter Unit is replaced with a jumper board. See figure 62. In this manner, the subaudible signals are available directly at the "meter out" BNC connector on the rear of the TCU. It is intended in AM operation that this signal be applied to the transmitter with external equipment to modulate the carrier in the order of 5%.

In FM and TV operation, two possibilities exist. If only metering signals are to be returned to the studio on a subcarrier, then an internal subcarrier generator can be used in lieu of an external multiplex (SCA) generator. For FM this generator is normally supplied tuned to 67 kHz. For TV the subcarrier generator should be set to 39 kHz. In either case, the subcarrier generator is deviated about 5% with the subaudible metering signal, and the injection into the FM or TV aural transmitter is set to about 10%.

If, especially in the case of FM, an external subcarrier generator is employed, then the input-output connector, figure 62, is installed, and the metering output is taken at the subaudible rate from the BNC connector. It is then routed to the telemetry input on the rear of the subcarrier generator. The subaudible metering signals will then modulate the resultant SCA signal about 15 dB to 20 dB below program level and will be inaudible on a standard multiplex receiver.

In a radio remote control system, the subaudible metering signals are taken from the BNC connector and are applied to a multiplex processing amplifier. The metering signals then phase-modulate the subcarrier passing through the multiplex processing amplifier. They are subsequently detected at the studio in a phase-comparison system.

Metering Detection, Wireless Operation

In AM radio remote control, the subaudible metering signals modulating the AM transmitter at about 5% are detected on a modulation monitor, tuned to the station's carrier. They are then applied to the "metering input" J101, on the Studio Unit.

In TV remote control, the TV aural signal is detected on a receiver tuned to the TV aural carrier. The subcarrier at 39 kHz is extracted and demodulated from this composite signal. The resultant demodulated aural subcarrier modulation is applied to the "metering input," J101, on the Studio Unit.

Similarly, in FM radio remote control, the demodulated 67 kHz subcarrier is applied to the "metering input," J101.

In a radio remote control system, the metering signals are extracted from the SCA receiver *undemodulated* (intact at 67 kHz) and are routed directly to a subcarrier phase comparator. The output of the subcarrier phase comparator is then fed to the "metering input," J101, on the Studio Unit.

Power Supplies

The power supplies in the BTR-30A are elementary in their operation, and because rugged components are used, they should be of little concern. The rectifiers are plug in types as are the emitter follower regulators. The filter capacitors are not plug in because socketed capacitors may develop several ohms of contact resistance over several years' usage. In low-voltage applications this is undesirable. Should one of the plug in rectifiers need replacement, bear in mind that the diodes used can be replaced with any other silicon diode having a voltage rating in excess of 200 volts PIV and a current rating in excess of 1 ampere. Generally, diodes of this nature are available locally and purchasing them in this manner may expedite repair.

To operate low-powered external equipment, such as a temperature sensing kit, regulated plus and minus 10 volts have been brought out to terminals located on the rear of the TCU. Indiscriminate usage of this power for miscellaneous non-remote control purposes is not advised. These terminals are NOT for battery operation of the equipment. They are intended to supply power to accessory kits only.

INSTALLATION

GENERAL

Upon removing the units from the shipping cartons, they should be visually inspected for damage incurred during transit. One Studio Unit and one Transmitter Unit, each with an extension printed circuit board, and two Instruction Books are shipped with each system as standard items. The units should be checked out using the telephone line terminals if they are intended for wire line service, or they should be interconnected with short jumper coaxial cables with Type BNC connectors if the control system is for radio link service. With power applied to each unit, all operations should be confirmed. Operating the RECYCLE button on the Studio Unit should cause the stepper to cycle itself first to home and then on to whatever channel has been selected by the push-button assembly. Pressing the CALIBRATE bar will also cause the stepper to proceed directly to the home position. Pressing the ON/RAISE or OFF/LOWER buttons on the Studio Unit will cause the corresponding relays in the Transmitter Unit to operate. Turning off the power on the Studio Unit or otherwise disabling the system should cause the transmitter failsafe relay to de-energize after about 20 seconds.

When the stepping switch is at the home or Calibrate position, its gold-plated metering decks will select an internally regulated reference calibrating voltage. This is normally used to cause half-scale deflection on M101. Observe the two-point calibrating procedure. Pressing the OFF/LOWER button will remove the calibrating voltage, causing M101 to go to zero deflection. Adjust the ZERO SET control until M101 reads zero. Release the OFF/LOWER button. Adjust the CALIBRATE control until M101 reads midscale (between the arrows). Since these two controls tend to interact to some extent, this procedure may have to be repeated. Normally, the CALIBRATE control will need only occasional adjustment, perhaps weekly, and the only daily adjustment which may be required will be the ZERO SET adjustment.

Shorting to ground any of the "alarm" terminals on the back of the Transmitter Unit should cause the metering signal to be momentarily keyed off, and this in turn will cause the ALARM lamp on the Studio Unit to come on. Pressing the ALARM RESET button on the Studio Unit should then extinguish this lamp. It should be noted that the ALARM lamp may turn on when the power is first applied to the unit.

Pressing the LOCAL button on the Transmitter Unit will remove all control from the Studio Unit. All control can then be accomplished at the transmitter. Pressing the

STEPPER button briefly will now advance the stepper one step. Doing this repeatedly will advance the stepper as many steps as the button is depressed. Holding the STEPPER button down for about half a second will cause the stepper to home. Depressing the REMOTE button will return control to the SCU.

It is advisable at this time to have all personnel concerned with the operation of this equipment become familiar with the units while they are operating in this manner.

CONNECTIONS

The only connections required at the studio end of the system are connections to the power source and either the telephone line or the STL (radio) equipment. The Transmitter Unit requires these same connections plus connections to the control and metering circuits. Notice that the control power outputs are active only when the proper (raise or lower) relays are energized. The actual output will be that voltage fed into the Transmitter Unit at the terminals labeled RAISE/ LOWER DISTR. IN which is for control signals, *not* control *power* inputs. In addition, note that one side of all the control power outputs are connected together and labeled as COMMON. See figure 6.

The meter input samples should supply 1 volt dc or more. Either or neither side of this sample may be grounded, as desired. The metering input system on the BTR-30A is floating. The telemetry or remote metering samples can be derived from most older transmitters with little trouble, and most modern transmitters have the sampling points built in. With the addition of the proper metering kits, older transmitters can be easily monitored. A typical voltage to be measured via the metering circuit in the BTR-30A System might be power amplifier plate voltage. The usual method of sampling this voltage is to step it down (with a resistive voltage divider) from its normal value in the kilovolt range to a more convenient value of 0 to 1 volt dc and then connect it to an appropriate metering terminal of the BTR-30A Transmitter Unit. The point to remember is that the voltage or current to be measured must first be converted to a voltage of 0 to 1 volt dc. This signal is then fed into the metering input terminal selected on the rear of the BTR-30A Transmitter Unit. In effect, the studio meters of the BTR-30A are connected to the transmitter through a metering system that can operationally be disregarded at this time. Merely select from the studio the signal to be monitored, and the studio meter will give a replica of the transmitter reading.

At the Transmitter Unit, the FAILSAFE terminals should be inserted in series with the rear door interlock system or other control circuitry in the transmitter in order that the transmitter will go off the air in the event that the control system fails. When two or more transmitters are controlled by the BTR-30A, external failsafe repeating relays should be used.

SCU PUSHBUTTON SEQUENCE CHANGE

Unless otherwise specified, the pushbutton sequence of the BTR-30A Remote Control System is as follows. When the CALIBRATE bar is depressed, the calibration signal is routed to M101, which has the arrow marks for calibration. When button No. 1 is pushed, the meter signal is directed to the M103. This is generally used for filament control, with filament voltage being read on the logging scale. Button No. 2 and No. 3 route the meter information to M101, and M102 respectively, for power amplifier voltage and current readings. All of the remaining buttons direct the telemetry information to M103.

The sequence of the pushbutton assembly can be modified to suit individual applications by removing the cover over the pushbutton assembly in the Studio Unit and altering the jumpers on this assembly in accordance with figure 63. Note that this print shows the provisions which are included in the unit for the addition of five external meters. External meters No. 1 and No. 2 are shown connected to pushbuttons 29 and 30 respectively.

TUNING

STUDIO UNIT

The following paragraphs outline recommended procedures to be followed should internal adjustments be required on the BTR-30A System. These adjustments should not be performed routinely, but only if considered necessary.

The SCU control oscillator, figure 43 (board 7), is set on its frequency of 920 Hz by removing transistor Q702 and adjusting the trimmer capacitor C705. Set the frequency to 920 Hz using a counter connected to the green test point TP703. Reinsert Q702 to restore the unit to normal service.

The SCU tone oscillators (raise and lower oscillators), figure 44 (board 8), with 0.047 microfarad and 0.068 microfarad tuning capacitors. respectively, are set in a manner similar to the SCU control oscillator. First, remove the SCU control oscillator board. Then short the orange test point on the SCU tone (raise) oscillator board to ground. Observe the yellow test point TP802 with a counter. Set tuning capacitor C805 so that a 790 Hz tone is counted.

TABLE 1. SUBCARRIER GENERATOR, FIGURE 50, FREQUENCY DETERMINING PARTS

Frequency	26 kHz	41 kHz	67 kHz	110 kHz	135 kHz	185 kHz
C1002	1500	1000	560	330	270	220
C1003	1500	1000	560	330	270	220
C1006	1500	750	470	470	330	120
C1007	270	150	120	68	91	36
C1008	3300	1500	1000	680	620	270
C1009	680	1200	470	270	220	75
C1010	2000	1500	820	220	240	150
L1001	22,000	10,000	4700	3900	2200	2200
L1002	15,000	4700	3900	2200	2200	2200

Values shown in picofarads and microhenries, ±5% or better.

TABLE 2. SUBCARRIER GENERATOR, FIGURE 50A, FREQUENCY DETERMINING PARTS

Frequency	26 kHz	110 kHz	135 kHz
C1002	2700	560	560
C1003	2700	560	560
C1006	1500	470	220
C1007	270	68	33
C1008	3300	680	470
C1009	680	270	100
C1010	2000	220	150
L1001	22,000	3900	4700
L1002	15,000	2200	3900

Values shown in microhenries and picofarads, ±5% or better.

To set the lower oscillator, be sure the control oscillator is removed. Short the orange test point on the SCU tone (lower) oscillator board to ground. Observe the yellow test point TP802 with a counter. Set tuning capacitor C805 so that a 670 Hz tone is counted.

The subcarrier generator, figure 50 (or 50a), should this board be used, is first set on the correct frequency. See table 1 or table 2. Observe the white test point, TP1008, with a counter. Remove the SCU control oscillator, board 7. Adjust the center potentiometer, R1004, so that the correct frequency is generated. This will normally be 26 kHz but in special systems may be 110 kHz or 135 kHz. Then adjust the subcarrier output level control (top control) for 1.5 volts peak-to-peak as observed at the white test point TP1008. Reinstall the SCU control oscillator board. Adjust the modulation control (bottom control) until an oscilloscopic observation at TP1008 gives 5% deviation.

To adjust the SCU audible metering processor, figure 47, at the studio, remove the SCU output amplifier, board 9, any connection to the telephone line, and any connection to the metering input connector. Observe a voltmeter connected to the blue test point, TP1204.

Adjust the regeneration control, R1211, until the test point indicates a dc voltage. This indicates that the tone detector is oscillating. Set it to its assigned frequency of 1280 Hz by connecting the frequency counter to green TP1203. Adjust tuning capacitor C1205 until the counter reads 1280 Hz. Disconnect the counter, and back off the regeneration control R1211 until the dc signal at the blue test point TP1204 drops. This indicates the detector has dropped out of oscillation. Continue in this same direction for two more turns.

TABLE 3. SUBCARRIER FILTER, FREQUENCY DEPENDENT PARTS

Frequency	26 kHz	41 kHz	67 kHz	110 kHz	135 kHz	185 kHz
C1501	10,000	1500	1000	2400	3600	2400
C1502	470	160	110	75	33	27
C1503	12,000	4700	3300	2700	5100	3300
C1504	470	160	110	75	33	27
C1505	10,000	1500	1000	2400	3600	2400
L1501	3300	10,000	4700	820	330	330
L1502	100,000	100,000	47,000	33,000	47,000	33,000
L1503	3300	3300	1500	680	330	220
L1504	100,000	100,000	47,000	33,000	47,000	33,000
L1505	3300	10,000	4700	820	330	330

Values shown in picofarads and microhenries, ±5% or better.

TRANSMITTER UNIT

The control subcarrier filter in the TCU must be sweep-aligned. If the subcarrier generator at the studio has been set on frequency, this sweep process is simply a matter of tuning the inductors for maximum output signal coincident with minimum ripple. This filter will neither drift or vary to a significant extent with temperature variations, so field adjusting this filter is not advised.

The three tone detectors may eventually require checking. Bearing in mind that these devices are intended to receive signals generated at the studio, the following procedure may be used. Turn off power at the studio to insure that no signals are sent to the transmitter site. Connect a voltmeter between green TP1703 and ground on the TCU raise detector, figure 53. Adjust the regeneration control, R1711, until the voltmeter indicates a dc voltage. This indicates that the tone detector is oscillating.

On the TCU lower detector, figure 54, connect the voltmeter between yellow TP1802 and ground. Adjust the regneration control, R1804, until the meter indicates a dc voltage.

The regeneration control, R2004, for the TCU stepper control A, figure 56, is best adjusted by turning it clockwise several turns, then slowly turning it counterclockwise until the stepper homes. Turn counterclockwise two more turns.

Should adjustment of the *tuning* controls be deemed necessary, simply transmit from the studio to the transmitter site the tone in question and adjust the tuning control for maximum recovered dc out of the corresponding rectifier. For the TCU raise detector, adjust C1705 for maximum dc as observed at the green test point TP1703. This will require that the RAISE pushbutton at the studio be depressed. In the case of the lower detector, C1801 is adjusted for maximum dc as measured at the yellow test point TP1802. In the case of the TCU stepper control A, C2001 is tuned for maximum dc voltage at the yellow test point TP2002.

In all cases, a voltage near +1.8 volts dc at each rectifier output is to be expected when the proper tone is present. Setting the tuning control midway between the points where the amplitude falls off due to mistuning will be satisfactory. For a more precise tuning adjustment, remove the transistor following the rectifier. This will unload the rectifier circuit and allow a precise tuning adjustment. Because the tuning circuits are composed of temperature-stabilized inductors and stable (metalized polycarbonate) capacitors, tuning should seldom, if ever, be required.

The TCU metering oscillator, figure 58, has three adjustments. R2204 is used to set the integrated circuit dc amplifier to its proper operating point. R2220 is used to set the frequency of the oscillator (after the countdown process) to a frequency of 22 Hz without input signal and R2216 is used to set the oscillator to a frequency of 29 Hz when the calibration voltage is being read. Note that for AM broadcast applications these frequencies are 20 Hz and 25 Hz instead of 22 Hz and 29 Hz.

With no input signal applied, adjust R2204 (middle) for zero volts dc as measured with a voltmeter connected between the yellow and black test points on the metering oscillator board. Then set R2220 (top) for a frequency of 22 Hz as measured at the violet test point, TP2208. Then apply the calibration voltage by advancing the stepper to the home position. Adjust R2216 (bottom) for a frequency of 29 Hz. This completes the metering oscillator adjustment procedure.

Should the metering be returned to the studio via the audible metering processor, this oscillator must be set to its asigned frequency of 1280 Hz. See figure 60. Remove the metering oscillator board to allow sustained oscillations of the 1280 Hz oscillator. Connect a frequency counter to yellow TP2402. Adjust the tuning control C2404 for a frequency of 1280 Hz. Restore the system to normal.

Remember that the end result to be expected in any tone oscillator/tone detector combination is that the tone detector satisfactorily receive its mating generator. Other techniques may very well prove quite satisfactory if the individual station has trustworthy specialized equipment.

OPERATION

NOTE: It is advisable to HOME the remote control system before making any function selections. This will insure synchronism between the Studio Control Unit and the Transmitter Control Unit.

STUDIO UNIT

When the CALIBRATE bar on the Studio Unit is depressed, the calibrate signal is routed to M101, which has the arrow marks for calibration. Unless the SCU pushbutton sequence has been changed, as covered under SCU Pushbutton Sequence Change in the INSTALLATION section, power amplifier plate voltage may be read on M101 when pushbutton No. 2 is depressed. Depressing pushbutton No. 3 directs the power amplifier current reading to M102. When pushbutton No. 1 is depressed, the meter signal is routed to M103. This is usually used for filament control, with filament voltage being read on the logging scale. All the remaining pushbuttons direct the telemetry information to M103.

Depressing the RECYCLE button on the Studio Unit should cause the stepper to cycle itself first to home, then to whatever channel has been selected by the pushbutton assembly. Pressing the CALIBRATE bar will cause the stepper to proceed to the home position. Pressing a numbered pushbutton will cause the stepper to advance to the selected position. Depressing the RAISE or LOWER buttons will cause the corresponding relays in the Transmitter Unit to operate. Turning off the power to the Studio Unit will cause the transmitter failsafe relay to de-energize after about 20 seconds.

Shorting any of the "alarm" terminals on the back of the Transmitter Unit to ground should cause the amber ALARM lamp on the studio unit to come on. Pressing the ALARM RESET button on the SCU should extinguish this lamp. The ALARM lamp may light when power is first applied to the unit.

TRANSMITTER UNIT

The transmitter can be controlled locally through the Transmitter Unit by depressing the LOCAL control button. Depressing the STEPPER button briefly will now advance the stepper one step. Doing this repeatedly will advance the stepper as many steps as the button is depressed. Holding the STEPPER button down for about half a second will cause the stepper to home. Depressing the RAISE or LOWER button will increase or decrease the power output of the transmitter. Depressing the REMOTE button will return control to the Studio Unit. Panel meters are not required on the Transmitter Unit, since the transmitter meters may be used to monitor circuit adjustments or measurements.

CALIBRATION

Turn the BTR-30A Remote Control System on by depressing the POWER button on the TCU and turning the SCU power switch, S101, located inside the front panel, to the ON position. Depress the CALIBRATE bar and a calibrating voltage will be applied to M101. Adjust the CALIBRATE control for midscale deflection (between the arrow marks) of M101. Depress the OFF/LOWER pushbutton and adjust the ZERO SET control for zero reading on M101. Release the OFF/LOWER pushbutton. Adjust the CALIBRATE control until M101 reads midscale. Since these two controls interact to some extent, this procedure may have to be repeated.

TABLE 4. PRINTED CIRCUIT BOARD LOCATION

TRANSMITTER SITE*	
Subcarrier Filter (Radio only)	Stepper Control A
Subcarrier Demodulator (Radio only)	Stepper Control B
Raise Detector	Failsafe
Lower Detector	Metering Oscillator
Metering Processor (Audible, except radio is normally subaudible).	Alarm Encoder
Input-Output Connector (If Subcarrier Filter and Subcarrier Generator boards are not used).	Subcarrier Generator (Radio, if and only if external subcarrier not used; install Input-Output Connector if external subcarrier is used).
STUDIO SITE**	
Pushbutton Oscillator	Logic Driver
Pushbutton Logic (8 boards)	Output Amplifier
Control Oscillator (.033 uf capacitor)	Subcarrier Generator (Radio only)
Raise Oscillator (.047 uf capacitor)	Alarm Detector
Lower Oscillator (.068 uf capacitor)	Metering Demodulator
Metering Processor (Audible, except radio is normally subaudible).	Input-Output Connector (If Subcarrier Generator is not used).

*These boards are all marked TCU. Components are located on left side of board.

**These boards are all marked SCU. Components are located on right side of board.

MAINTENANCE

GENERAL

The transmitter should be visited periodically as specified by FCC regulations and the remote meter readings checked against the transmitter site meter readings.

Be sure to observe the correct polarity if any rectifiers are replaced and the correct telephone line polarity if lines are disconnected from the terminals.

CARE AND SERVICING OF RELAYS AND SWITCHES

Trouble free relay and switch operation depends upon keeping contacts clean and free of dust, lint, grease, paint, oil or similar materials. Contamination from sources such as these is the most common cause of contacts arcing, pitting and burning.

Relays and switches should be inspected periodically, and at such times contacts should be cleaned and adjusted as necessary. Relay contacts should be cleaned with Chlorothene applied with a soft brush after which they should be burnished with a tool such as the RCA Stock No. 22963 Contact Cleaning Tool. Finally, contacts should be wiped clean with a clean piece of bond paper.

The stepper switch should be lubricated with Automatic Electric Rotary Switch Lubrication Kit No. PD-9100-1 only. This lubricant is available from Automatic Electric Company, Northlake, Illinois.

The following is a list of conditions to watch for when making routine relay maintenance checks.

- Improperly adjusted residual screws on relays.
- Arcing contacts caused by a defective spark suppressor.
- Spring and contact assemblies which show evidence of tampering.
- Contacts out of alignment more than 1/3 of their diameter at the base of the contact points.
- Loose screws and nuts.
- Insecurely mounted coils, contacts, and other parts.
- Mutilated or defective screws, nuts, or other parts.
- Sharp bends or kinks in springs. The free length of relay spring can have only a normal bow.
- Bushings not in the approximate center of the springs they strike.

PRINTED CIRCUITS

An extension printed circuit board is supplied to permit easy access to test points and ease of maintenance of circuit boards. In general, the same techniques used in servicing wired chassis work equally well in servicing printed circuit boards. Circuit analysis and troubleshooting procedures remain the same, as does the test equipment normally utilized for this purpose. When replacing components, however, techniques applicable to printed circuit board repairs should be used.

EMERGENCY FIRST AID INSTRUCTIONS

WARNING

VOLTAGES THAT ARE DANGEROUS TO LIFE ARE INVOLVED IN THE OPERATION OF THIS ELECTRONIC EQUIPMENT. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE THE EQUIPMENT WITH VOLTAGES APPLIED. DANGEROUS CONDITIONS MAY EXIST IN CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS, ETC. ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM TO AVOID PERSONAL INJURY OR LOSS OF LIFE.

Personnel engaged in the installation, operation, or maintenance of this equipment or similar equipment are urged to become familiar with the following rules both in theory and practice. It is the duty of all operating personnel to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

RESCUE BREATHING

GENERAL INFORMATION

A. START IMMEDIATELY, SECONDS COUNT

Do not move victim unless absolutely necessary to remove from danger. Do not wait or look for help or stop to loosen clothing. Warm the victim or apply stimulants. The main purpose is to GET AIR INTO THE VICTIM'S LUNGS.

B. WIPE OUT VICTIM'S MOUTH

Wipe out quickly any mucus, food, or any foreign matter in the victim's mouth using your fingers or a cloth wrapped around your fingers.

C. LOOSEN CLOTHING - KEEP WARM

Do this when the victim is breathing by himself or help is available. Keep him quiet as possible and from becoming chilled. Otherwise, treat him for shock.

D. DON'T GIVE UP

Continue emergency rescue breathing without interruption until victim is breathing without help or until all hope of reviving him as determined by a physician is gone.

E. CALL A PHYSICIAN

Have someone summon medical aid since respiratory and other disturbances may develop as a aftermath. A physician is necessary during the recovery period.

PROCEDURE

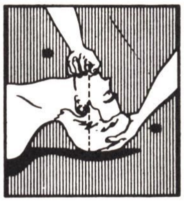


FIG. A

FIG. B

FIG. C

TILT HEAD BACK - Lift neck and point chin up to open air passage.

EXTEND JAW - Pull or push jaw into jutting out position (Fig. A).

PINCH NOSE - Close nostrils to prevent air leakage, or close mouth when using mouth-to-nose breathing.

BLOW - Seal victim's mouth or nose with your mouth. (Fig. B) Blow until chest rises.

REMOVE MOUTH - Listen for exchange of air; if none, check throat for obstruction. To remove it, place victim in position shown in Fig. C, and slap sharply between shoulder blades.

REPEAT - 12 times per minute for adults; at least 20 times per minute for children.

BURNS

SKIN REDDENED: Apply ice cold water to burned area to prevent burn from going deeper into skin tissue. Cover area with clean sheet or cloth to keep away air. Consult a physician.

SKIN BLISTERED OR FLESH CHARRED: Apply ice cold water to burned area to prevent burn from going deeper into skin tissue. Cover area with clean sheet or cloth to keep away air. Treat victim for shock and take to Hospital.

EXTENSIVE BURN-SKIN BROKEN: Cover area with clean sheet or cloth to keep away air. Treat victim for shock and take to hospital.

PARTS IDENTIFICATION INFORMATION

GENERAL

The components listed in the parts list are identified by one of two methods depending on whether the component is a mechanical or electrical part. Mechanical parts are assigned a numerical symbol (TP401, XV102, etc.) that corresponds to the item number on the mechanical assembly drawing where that particular part is located. Electrical parts are assigned a standard electrical symbol and are listed in an alphanumerical sequence by electrical assemblies or subassemblies (TCU Main Frame, SCU Logic Driver, Subcarrier Filter, etc.) The illustrations in this book are keyed so that electrical and mechanical parts that are "called out" in the illustrations should always be consulted so that positive identification of the part can be made before referring to the parts list.

ELECTRICAL PARTS

In order to locate an electrical part in the parts list the following procedure is recommended:

a. Determine in which electrical assembly the part is physically located.

b. With the use of the illustrations, positively identify the part and note its symbol designation.

c. In the parts list, find the heading for the electrical assembly.

d. Under the heading in "c" above, find the symbol designation in the Symbol column of the parts list. All pertinent ordering information and a brief description of the item will be found to the right of the symbol designation.

MECHANICAL PARTS

In order to locate a mechanical part in the parts list the following procedure is recommended:

a. Determine in which major electrical assembly the part is physically located (SCU Main Frame, Subcarrier Generator, etc.).

b. With the use of the illustrations, identify the part and note its numerical symbol designation.

c. In the parts list, find the heading for the major electrical assembly.

d. Under the heading in "c" above, find the numerical symbol designation in the Symbol column of the parts list. All pertinent ordering information and a brief description of the item will be found to the right of the symbol designation.

TABLE 5. COMPONENT SUFFIX NUMBERS

Symbol Suffix	Item	Example
100	SCU Main Frame	C106
200	TCU Main Frame	CR207
400	SCU Pushbutton Oscillator	U402
500	SCU Logic Driver	C501
600	SCU Pushbutton Logic	U605
700	SCU Control Oscillator	T701
800	SCU Tone Oscillator (Raise, Lower)	C803
900	SCU Output Amplifier	Q901
1000	Subcarrier Generator	R1025
1100	SCU Subaudible Metering Processor	TP1103
1200	SCU Audible Metering Processor	Q1204
1300	SCU Metering Demodulator	CR1302
1400	SCU Alarm Detector	R1405
1500	Subcarrier Filter	L1503
1600	Subcarrier Demodulator	U1602
1700	TCU Raise Detector	R1701
1800	TCU Lower Detector	Q1804
1900	TCU Failsafe	TP1902
2000	TCU Stepper Control "A"	L2002
2100	TCU Stepper Control "B"	CR2106
2200	TCU Metering Oscillator	C2211
2300	TCU Subaudible Metering Processor	Q2301
2400	TCU Audible Metering Processor	R2416
2500	TCU Alarm Encoder	TP2502

REPLACEMENT PARTS

Symbol	Stock No.	Drawing No.	Description
			BTR-30A REMOTE CONTROL SYSTEM ES-561440
			STUDIO UNIT, MAIN FRAME
C101	421031		CAPACITOR W/BASE 1500 MFD 50V
C102	421031		CAPACITOR W/BASE 1500 MGD 50V
C103	421031		CAPACITOR W/BASE 1500 MFD 50V
C104	248371		CAPACITOR W/BASE 1000 MFD/500MFD 50V
C105	222954		CAPACITOR 220/10V
C106	222954		CAPACITOR 220/10V
C107	222954		CAPACITOR 220/10V
CR101	245128		DIODE-TYPE 1ZC16T10
CR102	421810		DIODE-TYPE 1N4731A
F101	300123		FUSE-1/4 AMP
F102	300151		FUSE-1 AMP
F103	300151		FUSE-1 AMP
FL101	421872		FILTER, HIGH PASS, 1100 HZ
I101	236278		LAMP-28V
I102	236278		LAMP-28V
J101	223973		CONNECTOR-METERING INPUT
J102	223973		CONNECTOR-CONTROL OUTPUT
J103	223973		CONNECTOR-AUXILIARY INPUT
M101			METER-100 MICROAMP NOTE MI-561444 SERIES
M102			METER-100 MICROAMP NOTE MI-561444 SERIES
M103			METER-100 MICRO AMPNOTE MI-561444 SERIES
Q101	262116		TRANSISTOR-TYPE 2N3054
Q102	262116		TRANSISTOR-TYPE 2N3054
R101	206913		RESISTOR-1000 OHMS-ZERO SET
R102	208677		RESISTOR-5000 OHMS-CALIBRATE
R103	522122		RESISTOR- 220 OHMS 10% 2 W
R104	522122		RESISTOR-100 OHMS 10%, 2W
R105	502247		RESISTOR-4700 OHMS 10%, 1/2W
R106	502110		RESISTOR-100 OHMS 10%, 1/2W
S101	421873		SWITCH-POWER
	421898		SWITCH ASSEMBLY S102 TO S105 CONSISTING OF
S102			SWITCH-ALARM RESET
S103			SWITCH-RECYCLE
S104			SWITCH-ON/RAISE
S105			SWITCH-OFF/LOWER
S106	421899		SWITCH-PUSHBUTTON DECK
T101	421042		TRANSFORMER
T102	421037		TRANSFORMER-LINE
Z101			DIODE RECTIFIER, FULL WAVE
	234552		DIODE ONLY-TYPE 10D2
	101748		CONNECTOR
Z102			DIODE RECTIFIER, FULL WAVE
	234552		DIODE ONLY-TYPE 10D2
	101748		CONNECTOR
	421039		SOCKET-PILOT LIGHT
	248369		SOCKET-TRANSISTOR
	421041		LENS-PILOT LIGHT GREEN
	421040		LENS-PILOT LIGHT AMBER
	240676		BLOCK-FUSE BLOCK DUAL
	101749		SOCKET
	101748		CONNECTOR-BRIDGE DIODE
			TRANSMITTER UNIT, MAIN FRAME
C201	421031		CAPACITOR 1500 MFD 50V
C202	421031		CAPACITOR 1500 MFD 50V
C203	421031		CAPACITOR 1500 MFD 50V
C204	421031		CAPACITOR 1500 MFD 50V
C205	421031		CAPACITOR 1500 MFD 50V
C206	421867		CAPACITOR 1000 MFD 15V
C207	421867		CAPACITOR 1000 MFD 15V
C208	421867		CAPACITOR 1000 MFD 15V

Symbol	Stock No.	Drawing No.	Description
C209	421867		CAPACITOR 1000 MFD 15V
C210	245142		CAPACITOR .005 600V
C211	245142		CAPACITOR .005 600V
C212	245142		CAPACITOR .005 600V
C213	245142		CAPACITOR .005 600V
C214	267703		CAPACITOR CERAMIC .01 DISC.
C215	267703		CAPACITOR CERAMIC .01 DISC.
C216	421031		CAPACITOR 1500 MFD 50V
C217	421031		CAPACITOR 1500 MFD 50V
CR201	248128		DIODE TYPE 1ZC16T10
CR202	421034		DIODE TYPE 1N2974
CR203	421034		DIODE TYPE 1N2974
CR204	421033		DIODE TYPE 1N1588
CR205	421810		DIODE TYPE 1N4731A
CR206	421032		SUPPRESSOR-TRANSIENT SUPPRESSOR
CR207	421034		DIODE TYPE 1N2974
CR208	421034		DIODE TYPE 1N2974
F201	300151		FUSE 1/2 AMP
F202	300218		FUSE 1 AMP
F203	300123		FUSE 1/4 AMP
F204	300123		FUSE 1/4 AMP
FL201	421868		FILTER 1KHZ LPF
FL202	421869		FILTER HPF
I201	265029		LAMP 28V
I202	265029		LAMP 28V
I203	265029		LAMP 28V
J201	223973		CONNECTOR-BNC METER OUT
J202	223973		CONNECTOR-BNC CONTROL IN
J203	223973		CONNECTOR-BNC AUXILIARY OUTPUT
J204	223973		CONNECTOR-BNC AUXILIARY INPUT
K201	246420		RELAY-LOWER
K202	246420		RELAY-RAISE
K203	246420		RELAY-FAILSAFE
K204	422039		RELAY-STEPPING SWITCH
L201	245132		CHOKE-RF 2.4UH
L202	245132		CHOKE-RF 2.4UH
Q201	262116		TRANSISTOR-TYPE 2N3054
R201 TO R230	421035		POTENTIOMETER 25K 10TURN
R231	210528		RESISTOR 25 OHMS 10W
RI32	522147		RESISTOR 470 OHMS 2W 10%
R233	242107		RESISTOR 100 OHMS 10W
R234	242107		RESISTOR 100 OHMS 10W
R235	502268		RESISTOR 6800 OHMS 10% 1/2W
R236	502182		RESISTOR 820 OHMS 10% 1/2 W
R237	522122		RESISTOR 220 OHMS 10% 2 W
R238	208207		RESISTOR 50 OHMS 10W
R239	208207		RESISTOR 50 OHMS 10W
	502310		RESISTOR 10000 OHMS 10% 1/2W
	421900		SWITCH ASSEMBLY S201 TO S205 CONSISTING OF
S201			SWITCH-POWER
S202			SWITCH-STEPPER
S203			SWITCH-RAISE
S204			SWITCH-LOWER
S205			SWITCH-COMMAND
T201	421036		TRANSFORMER
T202	421037		TRANSFORMER-LINE
Z201			DIODE BRIDGE
	234552		DIODE ONLY-TYPE 10D2
Z202			DIODE BRIDGE
	234552		DIODE ONLY-TYPE 10D2
Z203			DIODE BRIDGE
	234552		DIODE ONLY-TYPE 10D2
Z204			DIODE BRIDGE
	234552		DIODE ONLY-TYPE 10D2
	248369		SOCKET-TRANSISTOR
	101749		SOCKET
	101748		CONNECTOR-PLUG
	048894		HOLDER-FUSE POST
	240676		BLOCK-FUSE BLOCK-DUAL

Symbol	Stock No.	Drawing No.	Description
			STUDIO CONTROL UNIT PLUG-IN BOARDS MI-561442
01			BOARD 4 PUSHBUTTON OSCILLATOR 20A2109
02			BOARD 5 LOGIC DRIVER 20A2110
03			BOARD 6 PUSHBUTTON LOGIC 20A2111
04			BOARD 7 CONTROL OSCILLATOR 20A2117
05			BOARD 8 TONE OSCILLATOR RAISE 20A21118
06			BOARD 8 TONE OSCILLATOR LOWER 20A2118
07			BOARD 9 OUTPUT AMPLIFIER 20A2120
08			BOARD 10A SUBCARRIER GENERATOR 20A2121 OR BOARD 26 JUMPER BOARD 51A5206 OR FILLER BOARD 5A1645
09			BOARD 11 SUBAUDIBLE METER 20A2123 OR BOARD 12 AUDIBLE METER 20A2122
10			BOARD 14 ALARM DETECTOR 20A2124
11			BOARD 13 METER DEMOD 20A2125
12			EXTENSION BOARD 20A2114
			TRANSMITTER CONTROL UNIT PLUG-IN BOARDS MI-561441
01			BOARD 15 SUBCARRIER FILTER 20A2134 OR FILLER BOARD 5A1645
02			BOARD 16 SUBCARRIER DEMOD 20A2132 OR BOARD 26 JUMPER BOARD 51A5206 OR FILLER BOARD 5A1645
03			BOARD 17 RAISE DET 20A2131
04			BOARD 18 LOWER DET 20A2130
05			BOARD 20 STEPPER CONTROL A 20A2138
06			BOARD 21 STEPPER CONTROL B 20A2136
07			BOARD 19 FAILSAFE 20A2129
08			BOARD 10,A SUBCARRIER GENERATOR 20A2121 OR BOARD 26 JUMPER BOARD 51A5206 OR FILLER BOARD 5A1645
09			BOARD 23 SUBAUDIBLE METER 20A2139 OR BOARD 24 AUDIBLE METER 20A2135
10			BOARD 22 METER OSCILLATOR 20A2133
11			BOARD 25 ALARM ENCODER 20A2137
12			EXTENSION BOARD 20A2114
245851			**SCU PUSHBUTTON OSCILLATOR, BOARD 4, 20A2109**
			CAPACITORS
C401	227444		.1/25
C402	420340		2.2/35
C403	227444		.1/25
C404	245142		.005/600
C405	222954		220/10
C406	227444		.1/25
C407	227444		.1/25
C408	226673		47/6
C409	226673		47/6
C410	227444		.1/25
CR401 TO CR405	242220		DIODE, 1N4154
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R401	502122		220 OHM 10% 1/2 W
R402	502210		1 K 10% 1/2 W
R403	502282		8.2 K 10% 1/2W

Symbol	Stock No.	Drawing No.	Description
R404	502122		220 OHM 10% 1/2 W
R405	502122		220 OHM 10% 1/2 W
R406	502168		580 OHM 10% 1/2 W
R407	502210		1 K 10% 1/2 W
R408	502210		1 K 10% 1/2 W
R409	502168		680 OHM 10% 1/2 W
R410	502210		1 K 10% 1/2 W
U401	418834		INTEGRATED CIRCUIT, MC824P
U402	418834		INTEGRATED CIRCUIT, MC824P
XV401	245851		SOCKET INTEGRATED CIRCUIT
XV402	245851		SOCKET INTEGRATED CIRCUIT
TP401			TEST JACK ORANGE
TP402			TEST JACK YELLOW
TP403			TEST JACK GREEN
			SCU LOGIC DRIVER, BOARD 5, 20A2110
C501	227444		0.1 MF 25 V
U501	420547		CIRCUIT - INTEGRATED, TYPE MC890P
U502	420547		CIRCUIT - INTEGRATED, TYPE MC890P
U503	420547		CIRCUIT - INTEGRATED, TYPE MC890P
U504 TO U508	420546		CIRCUIT - INTEGRATED, TYPE MC899P
XV501 TO XV508	245851		SOCKET - INTEGRATED CIRCUIT
TP501			TEST JACK - ORANGE
TP502			TEST JACK - YELLOW
			SCU PUSHBUTTON LOGIC, BOARD 6, 20A2111
U601	420548		INTEGRATED CIRCUIT MC 829 G
U602	420548		INTEGRATED CIRCUIT MC 829 G
U603	420548		INTEGRATED CIRCUIT MC 829 G
U604	420548		INTEGRATED CIRCUIT MC 829 G
U605	419890		INTEGRATED CIRCUIT MC889 P
XV601 TO XV605	245851		SOCKET INTEGRATED CIRCUIT
			SCU CONTROL OSCILLATOR, BOARD 7, 20A2117
			CAPACITORS
C701	240846		.001/1KV
C702	420340		2.2/35
C703	240846		.001/1KV
C704	420549		.033 3%
C705	219845		VARIABLE
C706	420549		.033 3%
Q701	248024		TRANSISTOR, TYPE 2N2924
Q702	248024		TRANSISTOR, TYPE 2N2924
Q703	248024		TRANSISTOR, TYPE 2N2924
Q704	248024		TRANSISTOR, TYPE 2N2924
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R701	502210		1 K 10% 1/2 W
R702	502247		4700 OHMS 10% 1/2 W
R703	502110		100 OHMS 10% 1/2 W
R704	502222		2200 OHMS 10% 1/2 W
R705	502215		1500 OHMS 10% 1/2 W
R706	502310		10 K 10% 1/2 W
R707	502310		10 K 10% 1/2 W

Symbol	Stock No.	Drawing No.	Description
R708	502310		10 K 10% 1/2 W
R709	502247		4700 OHMS 10% 1/2 W
R710	502247		4700 OHMS 10% 1/2 W
R711	502210		1 K 10% 1/2 W
T701	421871		COIL 1.6 HY W/SEC
XV701	420550		SOCKET TRANSISTOR
XV702	420550		SOCKET TRANSISTOR
XV703	420550		SOCKET TRANSISTOR
XV704	420550		SOCKET TRANSISTOR
TP701			TEST JACK ORANGE
TP702			TEST JACK YELLOW
TP703			TEST JACK GREEN
			SCU TONE OSCILLATOR, RAISE, LOWER, BOARD 8, 20A2118
			CAPACITORS
C801	420340		2.2/35
C802	240846		.001/1KV
C803	240846		.001/1KV
C804	420552		.068 3% :LOWER 670 HZ
C805	219845		CAPACITOR VARIABLE
C806	420553		.047 3% :RAISE 790 HZ
Q801	248024		TRANSISTOR, TYPE 2N2924
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R801	502310		10 K 10% 1/2 W
R802	502110		100 OHM 10% 1/2 W
R803	502222		2200 OHM 10% 1/2 W
R804	502215		1500 OHMS 10% 1/2 W
R805	502310		10 K 10% 1/2 W
R806	502310		10 K 10% 1/2 W
R807	502310		10 K 10% 1/2 W
R808	502247		4700 OHMS 10% 1/2 W
T801	421871		COIL 1.6 HY W/SEC
XV801	420551		TRANSISTOR SOCKET
TP801			TEST JACK ORANGE
TP802			TEST JACK YELLOW
			SCU OUTPUT AMPLIFIER, BOARD 9, 20A2120
			CAPACITORS
C901	227444		0.1 MF 25 V
C902	420340		2.2 MF 35 V
C903	420340		2.2 MF 35 V
Q901	248024		TRANSISTOR - TYPE 2N2924
Q902	248024		TRANSISTOR - TYPE 2N2924
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R901	502410		CARBON, 100,000 OHMS 10% 1/2 W
R902	502322		CARBON, 22,000 OHMS 10% 1/2 W
R903	502247		CARBON, 4700 OHMS 10% 1/2 W
R904	502215		CARBON, 1500 OHMS 10% 1/2 W
R905	502133		CARBON, 330 OHMS 10% 1/2 W
R906	502047		CARBON, 47 OHMS 10% 1/2 W
R907	502010		CARBON, 10 OHMS 10% 1/2 W
R908	502147		CARBON, 470 OHMS 10% 1/2 W
R909	502147		CARBON, 470 OHMS 10% 1/2 W
XV901	420551		SOCKET - TRANSISTOR
XV902	420551		SOCKET - TRANSISTOR

Symbol	Stock No.	Drawing No.	Description
TP901			TEST JACK - ORANGE
TP902			TEST JACK - WHITE
			SUBCARRIER GENERATOR, BOARD 10, 20A2121
			CAPACITORS
C1001	245163		2.2 MF 20 V
C1004	245163		2.2 MF 20 V
C1005	245142		.005 MF 600 V
C1011	245142		.005 MF 600 V
C1012	245142		.005 MF 600 V
C1013	227444		0.1 MF 10% 25 V
CR1001 TO CR1004	242220		DIODE - TYPE 1N4154
CR1005	245151		DIODE, ZENER, TYPE 1ZC10T10
L1001			CHOKE - FREQ. DET. PARTS
L1002			CHOKE - FREQ. DET. PARTS
Q1001	248024		TRANSISTOR - TYPE 2N2924
Q1002	248024		TRANSISTOR - TYPE 2N2924
Q1003	248024		TRANSISTOR - TYPE 2N2924
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R1001	243416		POTENTIOMETER, 100,000 OHMS
R1002	502233		CARBON, 3300 OHMS 10% 1/2 W
R1003	502310		CARBON, 10,000 OHMS 10% 1/2 W
R1004	232646		POTENTIOMETER, 5000 OHMS
R1005	502156		CARBON, 560 OHMS 10% 1/2 W
R1006	502210		CARBON, 1000 OHMS 10% 1/2 W
R1007	502222		CARBON, 2200 OHMS 10% 1/2 W
R1008	502310		CARBON, 10,000 OHMS 10% 1/2 W
R1009	502322		CARBON, 22,000 OHMS 10% 1/2 W
R1010	502322		CARBON, 22,000 OHMS 10% 1/2 W
R1011	502310		CARBON, 10,000 OHMS 10% 1/2 W
R1012	502222		CARBON, 2200 OHMS 10% 1/2 W
R1013	502210		CARBON, 1000 OHMS 10% 1/2 W
R1014	522122		CARBON, 220 OHMS 10% 2 W
R1015	502322		CARBON, 22,000 OHMS 10% 1/2 W
R1016	502322		CARBON, 22,000 OHMS 10% 1/2 W
R1017	502110		CARBON, 100 OHMS 10% 1/2 W
R1018	502222		CARBON, 2200 OHMS 10% 1/2 W
R1019	502233		CARBON, 3300 OHMS 10% 1/2 W
R1020	502347		CARBON, 47,000 OHMS 10% 1/2 W
R1021	502247		CARBON, 4700 OHMS 10% 1/2 W
R1022	502222		CARBON, 2200 OHMS 10% 1/2 W
R1023	502122		CARBON, 220 OHMS 10% 1/2 W
R1024	502322		CARBON, 22,000 OHMS 10% 1/2 W
R1025	502322		CARBON, 22,000 OHMS 10% 1/2 W
R1026	502110		CARBON, 100 OHMS 10% 1/2 W
R1027	502122		CARBON, 220 OHMS 10% 1/2 W
R1028	261883		POTENTIOMETER, 1000 OHMS
U1001	305551		CIRCUIT - INTEGRATED, TYPE CA3028 A
			26 KHZ FREQUENCY DETERMINING PARTS
L1001	420556		CHOKE, 22 MH
L1102	420555		CHOKE, 15 MH
C1002	218469		CAPACITOR, 2700 PF
C1003	218469		CAPACITOR, 2700 PF
C1006	218777		CAPACITOR, 1500 PF
C1007	300188		CAPACITOR, 270 PF
C1008	921660		CAPACITOR, 3300 PF
C1009	300193		CAPACITOR, 680 PF
C1010	300201		CAPACITOR, 2000 PF

Symbol	Stock No.	Drawing No.	Description
			110 KHZ FREQUENCY DETERMINING PARTS
L1001	245147		CHOKE, 3.9 MH
L1002	420557		CHOKE, 2.2 MH
C1002	300192		CAPACITOR, 560 PF
C1003	300192		CAPACITOR, 560 PF
C1006	238220		CAPACITOR, 470 PF
C1007	215197		CAPACITOR, 68 PF
C1008	300193		CAPACITOR, 680 PF
C1009	300188		CAPACITOR, 270 PF
C1010	300187		CAPACITOR, 220 PF
			135 KHZ FREQUENCY DETERMINING PARTS
L1001	245146		CHOKE, 4.7 MH
L1002	245147		CHOKE, 3.9 MH
C1002	300192		CAPACITOR, 560 PF
C1003	300192		CAPACITOR, 560 PF
C1006	300187		CAPACITOR, 220 PF
C1007	215198		CAPACITOR, 33 PF
C1008	238220		CAPACITOR, 470 PF
C1009	300237		CAPACITOR, 100 PF
C1010	300185		CAPACITOR, 150 PF
			SUBCARRIER GENERATOR, BOARD 10A, 20A2121
			CAPACITORS
C1001	227444		0.1 MF 10% 25 V
C1004	227444		0.1 MF 10% 25 V
C1005	261542		.01 MF 100 V
C1011	245142		.005 MF 600 V
C1012	245142		.005 MF 600 V
C1013	227444		0.1 MF 10% 25 V
C1014	261542		.01 MF 100 V
CR1001	242220		DIODE - TYPE 1N4154
CR1002	242220		DIODE - TYPE 1N4154
CR1003	245151		DIODE - ZENER, TYPE 1ZC10T10
Q1001	241778		TRANSISTOR - TYPE 2N3563
Q1002	241778		TRANSISTOR - TYPE 2N3563
Q1003	248024		TRANSISTOR - TYPE 2N2924
Q1004	248024		TRANSISTOR - TYPE 2N2924
Q1005	248024		TRANSISTOR - TYPE 2N2924
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R1001	243416		POTENTIOMETER, 100,000 OHMS
R1002	502310		CARBON, 10,000 OHMS 10% 1/2 W
R1003	502247		CARBON, 4700 OHMS 10% 1/2 W
R1004	232646		POTENTIOMETER, 5000 OHMS
R1005	502318		CARBON, 18,000 OHMS 10% 1/2 W
R1006	502227		CARBON, 2700 OHMS 10% 1/2 W
R1007	420554		THERMISTER, 5000 OHMS
R1008	502315		CARBON, 15,000 OHMS 10% 1/2 W
R1009	502210		CARBON, 1000 OHMS 10% 1/2 W
R1010	502147		CARBON, 470 OHMS 10% 1/2 W
R1011	502247		CARBON, 4700 OHMS 10% 1/2 W
R1012	502315		CARBON, 15,000 OHMS 10% 1/2 W
R1013	502315		CARBON, 15,000 OHMS 10% 1/2 W
R1014	522122		CARBON, 220 OHMS 10% 2 W
R1015	502322		CARBON, 22,000 OHMS 10% 1/2 W
R1016	502322		CARBON, 22,000 OHMS 10% 1/2 W
R1017	502110		CARBON, 100 OHMS 10% 1/2 W
R1018	502222		CARBON, 2200 OHMS 10% 1/2 W

Symbol	Stock No.	Drawing No.	Description
R1019	502233		CARBON, 3300 OHMS 10% 1/2 W
R1020	502347		CARBON, 47,000 OHMS 10% 1/2 W
R1021	502247		CARBON, 4700 OHMS 10% 1/2 W
R1022	502222		CARBON, 2200 OHMS 10% 1/2 W
R1023	502122		CARBON, 220 OHMS 10% 1/2 W
R1024	502322		CARBON, 22,000 OHMS 10% 1/2 W
R1025	502322		CARBON, 22,000 OHMS 10% 1/2 W
R1026	502110		CARBON, 100 OHMS 10% 1/2 W
R1027	502122		CARBON, 220 OHMS 10% 1/2 W
R1028	261883		POTENTIOMETER, 1000 OHMS
R1029	502222		CARBON, 2200 OHMS 10% 1/2 W
R1030	502233		CARBON, 3300 OHMS 10% 1/2 W
XV1001 TO XV1005	420551		SOCKET - TRANSISTOR
TP1001			TEST JACK - ORANGE
TP1004			TEST JACK - RED
TP1005			TEST JACK - GREEN
TP1006			TEST JACK - BLUE
TP1007			TEST JACK - BROWN
TP1008			TEST JACK - WHITE
TP1009			TEST JACK - BLACK
			26 KHZ FREQUENCY DETERMINING PARTS
L1001	420556		CHOKE, 22 MH
L1002	420555		CHOKE, 15 MH
C1002	218777		CAPACITOR, 1500 PF
C1003	218777		CAPACITOR, 1500 PF
C1006	218777		CAPACITOR, 1500 PF
C1007	300188		CAPACITOR, 270 PF
C1008	079191		CAPACITOR, 3300 PF
C1009	300193		CAPACITOR, 680 PF
C1010	300201		CAPACITOR, 2000 PF
			41 KHZ FREQUENCY DETERMINING PARTS
L1001	420570		CHOKE, 10 MH
L1002	245146		CHOKE, 4.7 MH
C1002	219195		CAPACITOR, 1000 PF
C1003	219195		CAPACITOR, 1000 PF
C1006	218091		CAPACITOR, 750 PF
C1007	300185		CAPACITOR, 150 PF
C1008	218777		CAPACITOR, 1500 PF
C1009	218249		CAPACITOR, 1200 PF
C1010	218777		CAPACITOR, 1500 PF
			67 KHZ FREQUENCY DETERMINING PARTS
L1001	245146		CHOKE, 4.7 MH
L1002	245147		CHOKE, 3.9 MH
C1002	300192		CAPACITOR, 560 PF
C1003	300192		CAPACITOR, 560 PF
C1006	238220		CAPACITOR, 470 PF
C1007	300184		CAPACITOR, 120 PF
C1008	219195		CAPACITOR, 1000 PF
C1009	238220		CAPACITOR, 470 PF
C1010	300194		CAPACITOR, 820 PF
			110 KHZ FREQUENCY DETERMINING PARTS
L1001	245147		CHOKE, 3.9 MH
L1002	420557		CHOKE, 2.2 MH
C1002	079191		CAPACITOR, 330 PF
C1003	079191		CAPACITOR, 330 PF

Symbol	Stock No.	Drawing No.	Description
C1006	238220		CAPACITOR, 470 PF
C1007	215197		CAPACITOR, 68 PF
C1008	300193		CAPACITOR, 680 PF
C1009	300188		CAPACITOR, 270 PF
C1010	300187		CAPACITOR, 220 PF
			135 KHZ FREQUENCY DETERMINING PARTS
L1001	420557		CHOKE, 2.2 MH
L1002	420557		CHOKE, 2.2 MH
C1002	300188		CAPACITOR, 270 PF
C1003	300188		CAPACITOR, 270 PF
C1006	079191		CAPACITOR, 330 PF
C1007	300183		CAPACITOR, 91 PF
C1008	300444		CAPACITOR, 620PF
C1009	300187		CAPACITOR, 220 PF
C1010	300443		CAPACITOR, 240 PF
			185 KHZ FREQUENCY DETERMINING PARTS
L1001	420557		CHOKE, 2.2 MH
L1002	420557		CHOKE, 2.2 MH
C1002	300187		CAPACITOR, 220 PF
C1003	300187		CAPACITOR, 220 PF
C1006	300184		CAPACITOR, 120 PF
C1007	220259		CAPACITOR, 36 PF
C1008	300188		CAPACITOR, 270 PF
C1009	228718		CAPACITOR, 75 PF
C1010	300185		CAPACITOR, 150 PF
			SCU SUBAUDIBLE METERING PROCESSOR, BOARD 11, 20A2123
			CAPACITORS
C1101	245163		2.2/20
C1102	237802		6.8/35
C1103	240161		1.5/20
C1104	240161		1.5/20
C1105	237797		15/20
C1106	237802		6.8/35
C1107	420340		2.2/35
C1108	245163		2.2/20
C1109	237797		15/20
C1110	420340		2.2/35
C1111	237797		15 MF 20 V
C1112	420340		2.2/35
CR1101	242220		DIODE 1N4154
CR1102	242220		DIODE 1N4154
L1101	421875		COIL 4.3 HY
L1102	421874		COIL 3.3 HY
Q1101	248024		TRANSISTOR, TYPE 2N2924
Q1102	248024		TRANSISTOR, TYPE 2N2924
Q1103	248024		TRANSISTOR, TYPE 2N2924
Q1104	420558		TRANSISTOR, TYPE 2N3819
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R1101	502347		47 K 10% 1/2 W
R1102	502322		22 K 10% 1/2 W
R1103	502322		22 K 10% 1/2 W
R1104	502110		100 OHM 10% 1/2 W
R1105	502215		1500 OHMS 10% 1/2 W
R1106	502215		1500 OHMS 10% 1/2 W

Symbol	Stock No.	Drawing No.	Description
R1107	502410		100 K 10% 1/2 W
R1108	502422		220 K 10% 1/2 W
R1109	502310		10 K 10% 1/2 W
R1110	502310		10 K 10% 1/2 W
R1111	502110		100 OHMS 10% 1/2 W
R1112	502310		10 K 10% 1/2 W
R1113	502347		47 K 10% 1/2 W
R1114	502247		4700 OHMS 10% 1/2 W
R1115	502122		220 OHMS 10% 1/2 W
R1116	502247		4700 OHMS 10% 1/2 W
R1117	502322		22 K 10% 1/2 W
R1118	502347		47 K 10% 1/2 W
R1119	502110		100 OHMS 10% 1/2 W
XV1101	420551		TRANSISTOR SOCKET
TO			
XV1104	420551		TRANSISTOR SOCKET
TP1101			TEST JACK ORANGE
TP1102			TEST JACK YELLOW
TP1103			TEST JACK GREEN
			SCU AUDIBLE METERING PROCESSOR, BOARD 12, 20A2122
			CAPACITORS
C1201	245163		2.2/20
C1202	245163		2.2/20
C1203	245163		2.2/20
C1204	247837		.10/35
C1205	219845		CAPACITOR VARIABLE
C1206	420559		.015 3%
C1207	420559		.015 3%
C1208	240846		.001/1 KV
C1209	237802		6.8 MF 35V
C1210	242035		10 MF 20 V
C1211	245163		2.2/20
C1212	245163		2.2/20
C1213	242035		10/20
C1214	242035		10/20
CR1201	242220		DIODE, 1N4154
CR1202	242220		DIODE, 1N4154
CR1203	242220		DIODE, 1N4154
CR1204	242220		DIODE, 1N4154
CR1205	242220		DIODE, 1N4154
L1201	421870		COIL 1.6 HY
Q1201	248024		TRANSISTOR, TYPE 2N2924
Q1202	248024		TRANSISTOR, TYPE 2N2924
Q1203	248024		TRANSISTOR, TYPE 2N2924
Q1204	248024		TRANSISTOR, TYPE 2N2924
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R1201	502247		4700 OHMS 10% 1/2 W
R1202	502310		10 K 10% 1/2 W
R1203	502310		10 K 10% 1/2 W
R1204	502368		68 K 10% 1/2 W
R1205	502347		47 K 10% 1/2 W
R1206	502310		10 K 10% 1/2 W
R1207	502310		10 K 10% 1/2 W
R1208	502322		22 K 10% 1/2 W
R1209	502310		10 K 10% 1/2 W
R1210	502268		6800 OHMS 10% 1/2 W
R1211	259322		10 K TRIMPOT
R1212	502310		10 K 10% 1/2 W
R1213	502222		2200 OHMS 10% 1/2 W
R1214	502215		1500 OHMS 10% 1/2 W
R1215	502115		150 OHMS 10% 1/2 W

Symbol	Stock No.	Drawing No.	Description
R1216	502110		100 OHMS 10% 1/2 W
R1217	502222		2200 OHMS 10% 1/2 W
R1218	502222		2200 OHMS 10% 1/2 W
R1219	502222		2200 OHMS 10% 1/2 W
R1220	502147		470 OHMS 10% 1/2 W
R1221	502347		47 K 10% 1/2 W
R1222	502310		10 K 10% 1/2 W
R1223	502247		4700 OHMS 10% 1/2 W
R1224	502122		220 OHMS 10% 1/2 W
R1225	502247		4700 OHMS 10% 1/2 W
R1226	502368		68 K 10% 1/2 W
XV1201	420551		SOCKET, TRANSISTOR
XV1202	420551		SOCKET, TRANSISTOR
XV1203	420551		SOCKET, TRANSISTOR
XV1204	420551		SOCKET, TRANSISTOR
TP1201			TEST JACK ORANGE
TP1202			TEST JACK YELLOW
TP1203			TEST JACK GREEN
TP1204			TEST JACK BLUE
TP1205			TEST JACK VIOLET
			SCU METERING DEMODULATOR, BOARD 13, 20A2125
			CAPACITORS
C1301	227444		.1/25
C1302	420340		2.2/35
C1303	420340		2.2/35
C1304	226673		47/6
C1305	226673		47/6
C1306	226673		47/6
C1307	223777		47/20
C1308	237802		6.8/35
CR1301	242220		DIODE, 1N4154
CR1302	242220		DIODE, 1N4154
L1301	245179		TRANSFORMER
Q1301	248024		TRANSISTOR - TYPE 2N2924
Q1302	248024		TRANSISTOR - TYPE 2N2924
Q1303	232841		TRANSISTOR 2N3053
Q1304	248024		TRANSISTOR - TYPE 2N2924
Q1305	248024		TRANSISTOR - TYPE 2N2924
Q1306	248024		TRANSISTOR - TYPE 2N2924
Q1307	232841		TRANSISTOR 2N3053
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R1301	052347		47 K 10% 1/2 W
R1302	502210		1 K 10% 1/2 W
R1303	502110		100 OHMS 10% 1/2 W
R1304	502310		10 K 10% 1/2 W
R1305	502222		2.2 K 10% 1/2 W
R1306	502210		1 K 10% 1/2 W
R1307	502222		2.2 K 10% 1/2 W
R1308	502268		6.8 K 10% 1/2 W
R1309	502147		470 OHMS 10% 1/2 W
R1310	502210		1 K 10% 1/2 W
R1311	502268		6.8 K 10% 1/2 W
R1312	502210		1 K 10% 1/2 W
R1313	502222		2.2 K 10% 1/2 W
R1314	502239		3.9 K 10% 1/2 W
R1315	502210		1 K 10% 1/2 W
R1316	502215		1.5 K 10% 1/2 W
R1317	502322		22 K 10% 1/2 W
R1318	502247		4.7 K 10% 1/2 W
R1319	502247		4.7 K 10% 1/2 W
R1320	502247		4.7 K 10% 1/2 W
R1321	502247		4.7 K 10% 1/2 W

Symbol	*Stock No.*	*Drawing No.*	*Description*
R1322	502222		2.2 K 10% 1/2 W
R1323	502222		2.2 10% 1/2 W
U1301	418834		INTEGRATED CIRCUIT, MC824P
XV1301	420551		SOCKET-TRANSISTOR
XV1302	420551		SOCKET-TRANSISTOR
XV1303	420551		SOCKET-TRANSISTOR
XV1304	420551		SOCKET-TRANSISTOR
XV1305	420551		SOCKET-TRANSISTOR
XV1306	420551		SOCKET-TRANSISTOR
XV1307	420551		SOCKET-TRANSISTOR
XV1308	245851		SOCKET I C
TP1301			TEST JACK ORANGE
TP1302			TEST JACK YELLOW
TP1303			TEST JACK GREEN
TP1304			TEST JACK BLUE
			SCU ALARM DETECTOR, BOARD 14, 20A2124
			CAPACITORS
C1401	227444		.1/25
C1402	420340		2.2/35
C1403	222954		220/10
C1404	237797		15/20
C1405	222954		220/10
C1406	420340		2.2/35
Q1401	232841		TRANSISTOR, TYPE 2N3053
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R1401	502222		2200 OHMS 10% 1/2 W
R1402	502222		2200 OHMS 10% 1/2 W
R1403	502247		4700 OHMS 10% 1/2 W
R1404	502222		2200 OHMS 10% 1/2 W
R1405	502310		10 K 10% 1/2 W
R1406	502222		2200 OHMS 10% 1/2 W
R1407	502110		100 OHMS 10% 1/2 W
U1401	418834		INTEGRATED CIRCUIT, MC824P
U1402	418834		INTEGRATED CIRCUIT, MC824P
U1403	418834		INTEGRATED CIRCUIT, MC824P
XV1401	245851		SOCKET I C
XV1402	245851		SOCKET I C
XV1403	245851		SOCKET I C
XV1404	420551		SOCKET-TRANSISTOR
TP1401			TEST JACK ORANGE
			SUBCARRIER FILTER, BOARD 15, 20A2134
R1501	502247		RESISTOR, 4700 OHMS 10% 1/2W
TP1501			TIP JACK, ORANGE
TP1502			TIP JACK, YELLOW
			26 KHZ FREQUENCY DETERMINING PARTS
L1501	421950		COIL, 3.3 MH
L1502	421951		COIL, 100 MH
L1503	421950		COIL, 3.3 MH
L1504	421951		COIL, 100 MH
L1505	421950		COIL, 3.3 MH
C1501	248387		CAPACITOR, .01 MF 100V 5%
C1502	238220		CAPACITOR, 470 PF
C1503	248381		CAPACITOR, .012 MF 100V 5%
C1004	238220		CAPACITOR, 470 PF
C1005	248387		CAPACITOR, .01 MF 100V 5%
			41 KHZ FREQUENCY DETERMINING PARTS
L1501			COIL, 10 MH
L1502	421951		COIL, 100 MH
L1503	421950		COIL, 3.3 MH

Symbol	*Stock No.*	*Drawing No.*	*Description*
L1504	421951		COIL, 100 MH
L1505			COIL, 10 MH
C1501	218777		CAPACITOR, 1500 PF
C1502	238230		CAPACITOR, 160 PF
C1503	921661		CAPACITOR, 4700 PF
C1504	238230		CAPACITOR, 160 PF
C1505	218777		CAPACITOR, 1500 PF
			67 KHZ FREQUENCY DETERMINING PARTS
L1501			COIL, 4.7 MH
L1502	421955		COIL, 47 MH
L1503			COIL, 1.5 MH
L1504	421955		COIL, 47 MH
L1505			COIL, 4.7 MH
C1501	219195		CAPACITOR, 1000 PF
C1502	270629		CAPACITOR, 110 PF
C1503	921660		CAPACITOR, 3300 PF
C1504	270629		CAPACITOR, 110 PF
C1505	219195		CAPACITOR, 1000 PF
			110KHZ FREQUENCY DETERMINING PARTS
L1501	421952		COIL, 820 UH
L1502	421953		COIL, 33 MH
L1503	421954		COIL, 680 UH
L1504	421953		COIL, 33 MH
L1505	421952		COIL, 820 UH
C1501	300198		CAPACITOR, 2400 PF
C1502	228718		CAPACITOR, 75 PF
C1503	218469		CAPACITOR, 2700 PF
C1504	228718		CAPACITOR, 75 PF
C1505	300198		CAPACITOR, 2400 PF
			135 KHZ FREQUENCY DETERMINING PARTS
L1501	421955		COIL, 330 UH
L1502	421949		COIL, 47 MH
L1503	421955		COIL, 330 UH
L1504	421949		COIL, 47 MH
L1505	421955		COIL, 330 UH
C1501	224554		CAPACITOR, 3600 PF
C1502	215198		CAPACITOR, 33 PF
C1503	300481		CAPACITOR, 5100 PF
C1504	215198		CAPACITOR, 33 PF
C1505	224554		CAPACITOR, 3600 PF
			185 KHZ FREQUENCY DETERMINING PARTS
L1501	421949		COIL, 330 UH
L1502	421953		COIL, 33 MH
L1503			COIL, 220 UH
L1504	421953		COIL, 33 MH
L1505	421949		COIL, 330 UH
C1501	300198		CAPACITOR, 2400 PF
C1502	218098		CAPACITOR, 27 PF
C1503	921660		CAPACITOR, 3300 PF
C1504	218098		CAPACITOR, 27 PF
C1505	300198		CAPACITOR, 2400 PF
			SUBCARRIER DEMODULATOR, BOARD 16, 20A2132
			CAPACITORS
C1601	267703		.01 DISC
C1602	227444		.1/25V
C1603	267703		.01 DISC
C1604	227444		.1/25V

Symbol	Stock No.	Drawing No.	Description
C1605	227444		.1/25V
C1606	300194		820PF 26KHZ
C1606	300191		510PF 41KHZ
C1606	79191		330PF 67KHZ
C1606	300186		180PF 135KHZ
C1606	300184		120PF 185KHZ
C1607	248374		.022/100 2%
C1608	420582		.033/100 2%
C1609	248374		.022/100 2%
C1610	245163		2.2/20
C1611	420340		2.2/35
C1612	267703		.01 DISC
C1613	267703		.01 DISC
C1614	245163		2.2/20
C1615	245163		2.2/20
CR1601	242220		DIODE 1N4154
CR1602	242220		DIODE 1N4154
L1601	245182		CHOKE 100 MH
L1602	245182		CHOKE 100 MH
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R1601	502322		22K 10% 1/2 W
R1602	502268		6.8K 10% 1/2 W
R1603	502222		2.2 K 10% 1/2 W
R1604	502247		4.7 K 10% 1/2 W
R1605	502047		47 OHMS 10% 1/2 W
R1606	502210		1K 10% 1/2 W
R1607	502247		4.7 K 10% 1/2 W
R1608	502347		47 K 10% 1/2 W
R1609	502310		10K 10% 1/2 W
R1610	502247		4.7 K 10% 1/2 W
R1611	502147		470 OHMS 10% 1/2 W
R1612	502327		27K 10% 1/2 W
R1613	502247		4.7 K 10% 1/2 W
R1614	502110		100 OHMS 10% 1/2 W
R1615	502210		1K 10% 1/2 W
R1616	502247		4.7 K 10% 1/2 W
R1617	502222		2.2 K 10% 1/2 W
R1618	502122		220 OHMS 10% 1/2 W
R1619	502310		10K 10% 1/2 W
R1620	502222		2.2 K 10% 1/2 W
R1621	502222		2.2 K 10% 1/2 W
R1622	502322		22K 10% 1/2 W
R1623	502310		10K 10% 1/2 W
R1624	502122		220 OHMS 10% 1/2 W
R1625	502210		1K 10% 1/2 W
R1626	502233		3300 OHMS 10% 1/2 W
R1627	502368		68 K 10% 1/2 W
R1628	502247		4.7 K 10% 1/2 W
R1629	502310		10K 10% 1/2 W
R1630	502210		1K 10% 1/2 W
R1631	502368		68 K 10% 1/2 W
R1632	502310		10K 10% 1/2 W
R1633	502222		2.2 K 10% 1/2 W
R1634	502133		330 OHMS 10% 1/2 W
R1635	502310		10K 10% 1/2 W
U1601	244345		INTEGRATED CIRCUIT CA3018
U1602	244345		INTEGRATED CIRCUIT CA3018
U1603	244345		INTEGRATED CIRCUIT CA3018
TP1601			TEST JACK ORANGE
TP1602			TEST JACK YELLOW
TP1603			TEST JACK GREEN
TP1604			TEST JACK BLUE
TP1605			TEST JACK VIOLET
TP1606			TEST JACK GREY
TP1607			TEST JACK BLACK

Symbol	Stock No.	Drawing No.	Description
TP1608			TEST JACK RED
TP1609			TEST JACK WHITE
	248370		PAD INTEGRATED CIRCUIT WHITE
			TCU RAISE DETECTOR, BOARD 17, 20A2131
			CAPACITORS
C1701	245163		2.2/20
C1702	245163		2.2/20
C1703	245163		2.2/20
C1704	247837		.10/35
C1705	219845		VARIABLE
C1706	420553		.047 3%
C1707	420553		.047 3%
C1708	240846		.001/1KV
C1709	245163		2.2/20
C1710	245163		2.2/20
C1711	245163		2.2/20
C1712	245163		2.2/20
CR1701	242220		DIODE, 1N4154
CR1702	242220		DIODE, 1N4154
CR1703	242220		DIODE, 1N4154
CR1704	242220		DIODE, 1N4154
CR1705	242220		DIODE, 1N4154
CR1706	242220		DIODE, 1N4154
CR1707	234552		DIODE, 10D2
CR1708	242220		DIODE, 1N4154
L1701	421870		REACTOR 1.6 HY
Q1701	248024		TRANSISTOR TYPE 2N2924
Q1702	248024		TRANSISTOR TYPE 2N2924
Q1703	248024		TRANSISTOR TYPE 2N2924
Q1704	248024		TRANSISTOR TYPE 2N2924
Q1705	248024		TRANSISTOR TYPE 2N2924
Q1706	232841		TRANSISTOR TYPE 2N3053
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R1701	502247		4700 10% 1/2W
R1702	502310		10,000 10% 1/2W
R1703	502310		10,000 10% 1/2W
R1704	502368		68,000 10% 1/2W
R1705	502347		47,000 10% 1/2W
R1706	502310		10,000 10% 1/2W
R1707	502310		10,000 10% 1/2W
R1708	502322		22,000 10% 1/2 W
R1709	502310		10,000 10% 1/2W
R1710	502247		4700 10% 1/2W
R1711	259322		TRIM POT 10K
R1712	502310		10,000 10% 1/2W
R1713	502222		2200 10% 1/2W
R1714	502215		1500 10% 1/2W
R1715	502122		220 OHMS 10% 1/2W
R1716	502110		100 OHMS 10% 1/2W
R1717	502222		2200 10% 1/2W
R1718	502247		4700 10% 1/2W
R1719	502210		1,000 10% 1/2W
R1720	502210		1,000 10% 1/2W
R1721	502110		100 OHMS 10% 1/2W
R1722	502310		10,000 10% 1/2W
R1723	502222		2200 10% 1/2W
R1724	502210		1,000 10% 1/2W
R1725	502247		4700 10% 1/2W
R1726	502147		470 OHMS 10% 1/2W
R1727	502368		68,000 10% 1/2W
XV4701	420551		SOCKET, TRANSISTOR
XV1702	420551		SOCKET, TRANSISTOR
XV1703	420551		SOCKET, TRANSISTOR

Symbol	Stock No.	Drawing No.	Description
XV1704	420551		SOCKET, TRANSISTOR
XV1705	420551		SOCKET, TRANSISTOR
XV1706	420551		SOCKET, TRANSISTOR
TP1701			TEST JACK ORANGE
TP1702			TEST JACK YELLOW
TP1703			TEST JACK GREEN
TP1704			TEST JACK BLUE
TP1705			TEST JACK VIOLET
			TCU LOWER DETECTOR, BOARD 18, 20A2130
			CAPACITORS
C1801	219845		VARIABLE
C1802	420552		.068 3%
C1803	420552		.068 3%
C1804	240846		.001/1KV
C1805	420340		2.2/35
C1806	420340		2.2/35
C1807	420340		2.2/35
C1808	420340		2.2/35
CR1801	242220		DIODE, 1N4154
QR1802	242220		DIODE, 1N4154
CR1803	234552		DIODE, 1N4154
CR1804	242220		DIODE, 1N4154
L1801	421870		CHOKE 1.6HY
Q1801	248024		TRANSISTOR TYPE 2N2924
Q1802	248024		TRANSISTOR TYPE 2N2924
Q1803	248024		TRANSISTOR TYPE 2N2924
Q1804	248024		TRANSISTOR TYPE 2N2924
Q1805	232841		TRANSISTOR TYPE 2N3053
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R1801	502322		22,000 10% 1/2W
R1802	502310		10,000 10% 1/2W
R1803	502247		4700 10% 1/2W
R1804	259322		TRIMPOT 10.000
R1805	502310		10,000 10% 1/2W
R1806	502222		2200 10% 1/2W
R1807	502215		1500 10% 1/2W
R1808	502122		220 OHMS 10% 1/2W
R1809	502110		100 OHMS 10% 1/2W
R1810	502222		2200 10% 1/2W
R1811	502247		4700 10% 1/2W
R1812	502210		1,000 10% 1/2W
R1813	502210		1,000 10% 1/2W
R1814	502110		100 OHMS 10% 1/2W
R1815	502310		10,000 10% 1/2W
R1816	502222		2200 10% 1/2W
R1817	502210		1,000 10% 1/2W
R1818	502247		4700 10% 1/2W
R1819	502147		470 OHMS 10% 1/2W
XV1801	420551		SOCKET - TRANSISTOR
XV1801	420551		SOCKET - TRANSISTOR
XV1803	420551		SOCKET - TRANSISTOR
XV1804	420551		SOCKET - TRANSISTOR
XV1805	420551		SOCKET - TRANSISTOR
TP1801			TEST JACK ORANGE
TP1802			TEST JACK YELLOW
TP1803			TEST JACK GREEN
TP1804			TEST JACK BLUE
			TCU FAILSAFE, BOARD 19, 20A2129

Symbol	*Stock No.*	*Drawing No.*	*Description*
C1901	223777		CAPACITOR, 47 MF 20 V
CR1901	242220		DIODE, 1N4154
CR1902	234552		DIODE, 10D2
Q1901	248024		TRANSISTOR TYPE 2N2924
Q1902	248024		TRANSISTOR TYPE 2N2924
Q1903	248024		TRANSISTOR TYPE 2N2924
Q1904	232841		TRANSISTOR TYPE 2N3053
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R1901	502447		470,000 10% 1/2W
R1902	502247		4700 10% 1/2W
R1903	502310		10,000 10% 1/2W
R1904	502310		10,000 10% 1/2W
R1905	502210		1,000 10% 1/2W
R1906	502110		100 OHMS 10% 1/2W
R1907	502310		10,000 10% 1/2W
R1908	502222		2200 10% 1/2W
R1909	502210		1,000 10% 1/2W
R1910	502247		4700 10% 1/2W
R1911	502147		470 OHMS 10% 1/2W
XV1901	420551		SOCKET
XV1902	420551		SOCKET
XV1903	420551		SOCKET
XV1904	420551		SOCKET
TP1901			TEST JACK ORANGE
TP1902			TEST JACK YELLOW
TP1903			TEST JACK GREEN
			TCU STEPPER CONTROL "A", BOARD 20, 20A2138
			CAPACITORS
C2001	219845		VARIABLE
C2002	420549		.033 MF 3%
C2003	420549		.033 MF 3%
C2004	240846		.001 MF 1000 V
C2005	420340		2.2 MF 35 V
C2006	237797		15 MF 20 V
C2007	420340		2.2 MF 35 V
C2008	420340		2.2 MF 35 V
C2009	237797		15 MF 20 V
CR2001 TO CR2004	242220		DIODE, 1N4154
L2001	421870		COIL - TOROID, 1.6 HY
Q2001 TO Q2006	248024		TRANSISTOR - TYPE 2N2924
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R2001	502322		22,000 OHMS 10% 1/2 W
R2002	502310		10,000 OHMS 10% 1/2 W
R2003	502247		4700 OHMS 10% 1/2 W
R2004	259322		TRIMPOT, 10,000 OHMS
R2005	502310		10,000 OHMS 10% 1/2 W
R2006	502222		2200 OHMS 10% 1/2 W
R2007	502215		1500 OHMS 10% 1/2 W
R2008	502122		220 OHMS 10% 1/2 W
R2009	502110		100 OHMS 10% 1/2 W
R2010	502222		2200 OHMS 10% 1/2 W
R2011	502247		4700 OHMS 10% 1/2 W
R2012	502210		1000 OHMS 10% 1/2 W

Symbol	Stock No.	Drawing No.	Description
R2013	502210		1000 OHMS 10% 1/2 W
R2014	502110		100 OHMS 10% 1/2 W
R2015	502310		10,000 OHMS 10% 1/2 W
R2016	502222		2200 OHMS 10% 1/2 W
R2017	502210		1000 OHMS 10% 1/2 W
R2018	502247		4700 OHMS 10% 1/2 W
R2019	502147		470 OHMS 10% 1/2 W
R2020	502247		4700 OHMS 10% 1/2 W
R2021	502347		47,000 OHMS 10% 1/2 W
R2022	502110		100 OHMS 10% 1/2 W
R2023	502222		2200 OHMS 10% 1/2 W
R2024	502247		4700 OHMS 10% 1/2 W
XV2001 TO XV2006	420551		SOCKET - TRANSISTOR
TP2001			TEST JACK - ORANGE
TP2002			TEST JACK - YELLOW
TP2003			TEST JACK - GREEN
TP2004			TEST JACK - BLUE
			TCU STEPPER CONTROL "B", BOARD 21, 20A2136
			CAPACITORS
C2101	225842		4.7 MF 35 V
C2102	222954		220 MF 10 V
CR2101	242220		DIODE, 1N4154
CR2102	242220		DIODE, 1N4154
CR2103	242220		DIODE, 1N4154
CR2104	245151		DIODE - ZENER, 1ZC10T10
CR2105	245128		DIODE - ZENER, 1ZC16T10
CR2106	234552		DIODE, 10D2
Q2101 TO Q2105	248024		TRANSISTOR - TYPE 2N2924
Q2106	232841		TRANSISTOR - TYPE 2N3053
Q2107	262116		TRANSISTOR - TYPE 2N3054
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R2101	502210		1000 OHMS 10% 1/2 W
R2102	502110		100 OHMS 10% 1/2 W
R2103	502310		10,000 OHMS 10% 1/2 W
R2104	502222		2200 OHMS 10% 1/2 W
R2105	502210		1000 OHMS 10% 1/2 W
R2106	502247		4700 OHMS 10% 1/2 W
R2107	502147		470 OHMS 10% 1/2 W
R2108	502210		1000 OHMS 10% 1/2 W
R2109	502247		4700 OHMS 10% 1/2 W
R2110	502147		470 OHMS 10% 1/2 W
R2111	502247		4700 OHMS 10% 1/2 W
R2112	502147		470 OHMS 10% 1/2 W
R2113	502210		1000 OHMS 10% 1/2 W
R2114	502222		2200 OHMS 10% 1/2 W
R2115	502410		100,000 OHMS 10% 1/2 W
R2116	502033		33 OHMS 10% 1/2 W
R2117	502010		10 OHMS 10% 1/2 W
R2118	502110		100 OHMS 10% 1/2 W
XV2101 TO XV2107	420551		SOCKET - TRANSISTOR
TP2101			TEST JACK - ORANGE
TP2102			TEST JACK - BLUE
TP2103			TEST JACK - GREEN
TP2104			TEST JACK - YELLOW

Symbol	Stock No.	Drawing No.	Description
			TCU METERING OSCILLATOR, BOARD 22, 20A2133
			CAPACITORS
C2201	227444		0.1 MF 25 V
C2202	227444		0.1 MF 25 V
C2203	227444		0.1 MF 25 V
C2204	240846		.001 MF 1000 V
C2205	245163		2.2 MF 20 V
C2206	267703		.01 MF 600 V
C2207	420561		0.47 MF 3% 100 V
C2208	420561		0.47 MF 3% 100 V
C2209	267703		.01 MF 600 V
C2210	227444		0.1 MF 25 V
C2211	227444		0.1 MF 25 V
CR2201	242220		DIODE - TYPE 1N4154
CR2202	246975		DIODE - TYPE 1N5240, ZENER
Q2201	248024		TRANSISTOR - TYPE 2N2924
Q2202	277487		TRANSISTOR - TYPE 2N4058
Q2203	277487		TRANSISTOR - TYPE 2N4058
Q2204	248024		TRANSISTOR - TYPE 2N2924
Q2205	248024		TRANSISTOR - TYPE 2N2924
Q2206	248024		TRANSISTOR - TYPE 2N2924
Q2207	248024		TRANSISTOR - TYPE 2N2924
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R2201	502333		33,000 OHMS 10% 1/2 W
R2202	502322		22,000 OHMS 10% 1/2 W
R2203	502247		4700 OHMS 10% 1/2 W
R2204	259322		TRIMPOT, 10,000 OHMS
R2205	502247		4700 OHMS 10% 1/2 W
R2206	502422		220,000 OHMS 10% 1/2 W
R2207	502347		47,000 OHMS 10% 1/2 W
R2208	502222		2200 OHMS 10% 1/2 W
R2209	502356		56,000 OHMS 10% 1/2 W
R2210	502347		47,000 OHMS 10% 1/2 W
R2211	502510		1 MEGOHM 10% 1/2 W
R2212	502410		100,000 OHMS 10% 1/2 W
R2213	502147		470 OHMS 10% 1/2 W
R2214	502415		150,000 OHMS 10% 1/2 W
R2215	502322		22,000 OHMS 10% 1/2 W
R2216	259322		TRIMPOT, 10,000 OHMS
R2217	502322		22,000 OHMS 10% 1/2 W
R2218	502210		1000 OHMS 10% 1/2 W
R2219	502315		15,000 OHMS 10% 1/2 W
R2220	259322		TRIMPOT, 10,000 OHMS
R2221	502315		15,000 OHMS 10% 1/2 W
R2222	502233		3300 OHMS 10% 1/2 W
R2223	502210		1000 OHMS 10% 1/2 W
R2224	502310		10,000 OHMS 10% 1/2 W
R2225	502210		1000 OHMS 10% 1/2 W
R2226	502247		4700 OHMS 10% 1/2 W
R2227	502133		330 OHMS 10% 1/2 W
R2228	502147		470 OHMS 10% 1/2 W
R2229	502210		1000 OHMS 10% 1/2 W
R2230	502222		2200 OHMS 10% 1/2 W
R2231	502233		3300 OHMS 10% 1/2 W
T2201	420562		TRANSFORMER
U2201	418813		INTEGRATED CIRCUIT, CA3030
U2202	420547		INTEGRATED CIRCUIT, MC890P
XV2201 TO XV2207	420551		SOCKET - TRANSISTOR
XV2208	245851		SOCKET - INTEGRATED CIRCUIT
XV2209	245851		SOCKET - INTEGRATED CIRCUIT
TP2201			TEST JACK - RED

Symbol	Stock No.	Drawing No.	Description
TP2202			TEST JACK - ORANGE
TP2203			TEST JACK - BLACK
TP2204			TEST JACK - GREY
TP2205			TEST JACK - YELLOW
TP2206			TEST JACK - GREEN
TP2207			TEST JACK - BLUE
TP2208			TEST JACK - VIOLET
TP2209			TEST JACK - WHITE
			TCU SUBAUDIBLE METERING PROCESSOR, BOARD 23, 20A2139
			CAPACITORS
C2301	237802		6.8/35
C2302	240161		1.5/20
C2303	240161		1.5/20
C2304	237797		15/20
C2305	237802		6.8/35
C2306	420340		2.2/35
C2307	226673		47/6
C2308	223777		47/20
L2301	421875		REACTOR 4.3 HY
L2302	421874		REACTOR 3.3 HY
Q2301	248024		TRANSISTOR 2N2924
Q2302	248024		TRANSISTOR-2N2924
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R2301	502310		10 K 10% 1/2 W
R2302	502210		1 K 10% 1/2 W
R2303	502210		1K 10% 1/2W
R2304	502410		100K 10% 1/2 W
R2305	502268		6.8K 10% 1/2 W
R2306	502368		68 K 10% 1/2 W
R2307	502322		22K 10% 1/2 W
R2308	502247		4.7K 10% 1/2 W
R2309	502122		2.2 K 10% 1/2 W
R2310	502168		220 OHMS 10% 1/2 W
R2311	502047		47 OHMS 10% 1/2 W
R2312	502110		100 OHMS 10% 1/2 W
R2313	502147		470 OHM 10% 1/2 W
XV2301	420551		SOCKET TRANSISTOR
XV2302	420551		SOCKET TRANSISTOR
TP2301			TEST JACK ORANGE
TP2302			TEST JACK YELLOW
TP2303			TEST JACK GREEN
			TCU AUDIBLE METERING PROCESSOR, BOARD 24, 20A2135
			CAPACITORS
C2401	420340		2.2/35
C2402	240846		.001/1KV
C2403	420559		.015 3%
C2404	219845		VARIABLE
C2405	420559		.015 3%
C2406	227444		.1/25
C2407	420340		2.2/35
C2408	420340		2.2/35
Q2401	248024		TRANSISTOR, TYPE 2N2924
Q2402	248024		TRANSISTOR, TYPE 2N2924
Q2403	248024		TRANSISTOR, TYPE 2N2924
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R2401	502122		220 OHMS 10% 1/2 W
R2402	502222		2200 OHMS 10% 1/2 W

Symbol	Stock No.	Drawing No.	Description
R2403	502215		1.5 K 10% 1/2 W
R2404	502310		10 K 10% 1/2 W
R2405	502310		10 K 10% 1/2 W
R2406	502310		10 K 10% 1/2 W
R2407	502410		100000 OHM 10% 1/2 W
R2408	502322		22 K 10% 1/2 W
R2409	502247		4700 OHMS 10% 1/2 W
R2410	502215		1.5 K 10% 1/2 W
R2411	502147		470 OHMS 10% 1/2 W
R2412	502047		47 OHMS 10% 1/2 W
R2413	502010		10 OHMS 10% 1/2 W
R2414	502147		470 OHMS 10% 1/2 W
R2415	502147		470 OHMS 10% 1/2 W
R2416	502247		4700 OHMS 10% 1/2 W
T2401	421871		TRANSFORMER 1.6 HY W/SEC
XV2401	420551		SOCKET TRANSISTOR
XV2402	420551		SOCKET TRANSISTOR
XV2403	420551		SOCKET TRANSISTOR
TP2401			TEST JACK ORANGE
TP2402			TEST JACK YELLOW
TP2403			TEST JACK GREEN
			TCU ALARM ENCODER, BOARD 25, 20A2137
			CAPACITORS
C2501	420340		2.2/35
C2502	420340		2.2/35
C2503	420340		2.2/35
C2504	420340		2.2/35
C2505	420340		2.2/35
C2506	222954		220/10
C2507	227444		.1/25
C2508	237797		2.2/35
C2509	227444		.1/25
C2510	227444		.1/25
Q2501	248024		TRANSISTOR, TYPE 2N2924
			RESISTORS - FIXED COMPOSITION, UNLESS NOTED
R2501	502210		1 K 10% 1/2 W
R2502	502210		1 K 10% 1/2 W
R2503	502310		10 K 10% 1/2 W
R2504	502210		1 K 10% 1/2 W
R2505	502210		1 K 10% 1/2 W
R2506	502310		10 K 10% 1/2 W
R2507	502210		1 K 10% 1/2 W
R2508	502210		1 K 10% 1/2 W
R2509	502310		10 K 10% 1/2 W
R2510	502210		1 K 10% 1/2 W
R2511	502210		1 K 10% 1/2 W
R2512	502310		10 K 10% 1/2 W
R2513	502210		1 K 10% 1/2 W
R2514	502210		1 K 10% 1/2 W
R2515	502310		10 K 10% 1/2 W
R2516	502310		10 K 10% 1/2 W
R2517	502222		2.2K 10% 1/2 W
U2501	420548		INTEGRATED CIRCUIT, MC829G
U2502	418834		INTEGRATED CIRCUIT, MC824P
XV2501	245851		SOCKET I C
XV2502	420551		SOCKET-TRANSISTOR
TP2501			TEST JACK ORANGE
TP2502			TEST JACK YELLOW
			EXTENSION, BOARD 26
02	420672		CONNECTOR, PC FEMALE

RECOMMENDED STATION SPARES

Description	Symbol/Location	Quantity	Stock No.
Capacitor, 1500 MF, 50 V	C101-C103, C201-C205, C216, C217	2	421031
Capacitor, 1000 MF, 15V	C206-C209	1	
Diode, 1N1588	CR204	1	421033
Diode, 1N2974	CR202, CR203, CR207, CR208	1	421034
Diode, 1ZC16T10	CR101, CR201, CR2105	1	245128
Diode, 1N4731A	CR102, CR205	1	421810
Diode, 10D2	Z101, Z102, Z201-Z204, CR1707, CR1803, CR1902, CR2106	4	234552
Integrated circuit, MC824P	U401, U402, U1301, U1401-1403, U2502	2	418834
Integrated circuit, MC829G	U601-U604, U2501	4	420548
Integrated circuit, MC890P	U501-U503, U2202	2	420547
Integrated circuit, MC899P	U504-U508	2	420546
Integrated circuit, CA3018	U1601-1603	1	244345
Integrated circuit, CA3028A	U1001	1	305551
Integrated circuit, CA3030	U2201	1	418813
Transistor, 2N2924	Q701-Q704, Q801, Q901, Q902, Q1001-Q1003, Q1101-Q1103, Q1201-Q1204, Q1301, Q1302, Q1304-Q1306, Q1701-Q1705, Q1801-Q1804, Q1901-Q1903, Q2001-Q2006, Q2101-Q2105, Q2201, Q2204-Q2207, Q2301, Q2302, Q2401-Q2403, Q2501	4	248024
Transistor, 2N3053	Q1303, Q1307, Q1401, Q1706, Q1805, Q1904, Q2106	2	232841
Transistor, 2N3054	Q101, Q102, Q201, Q2107	1	262116
Transistor, 2N4058	Q2202, Q2203	1	277487
Transformer	T101	1	421042
Transformer	T102, T202	1	421037
Transformer	T201	1	421036

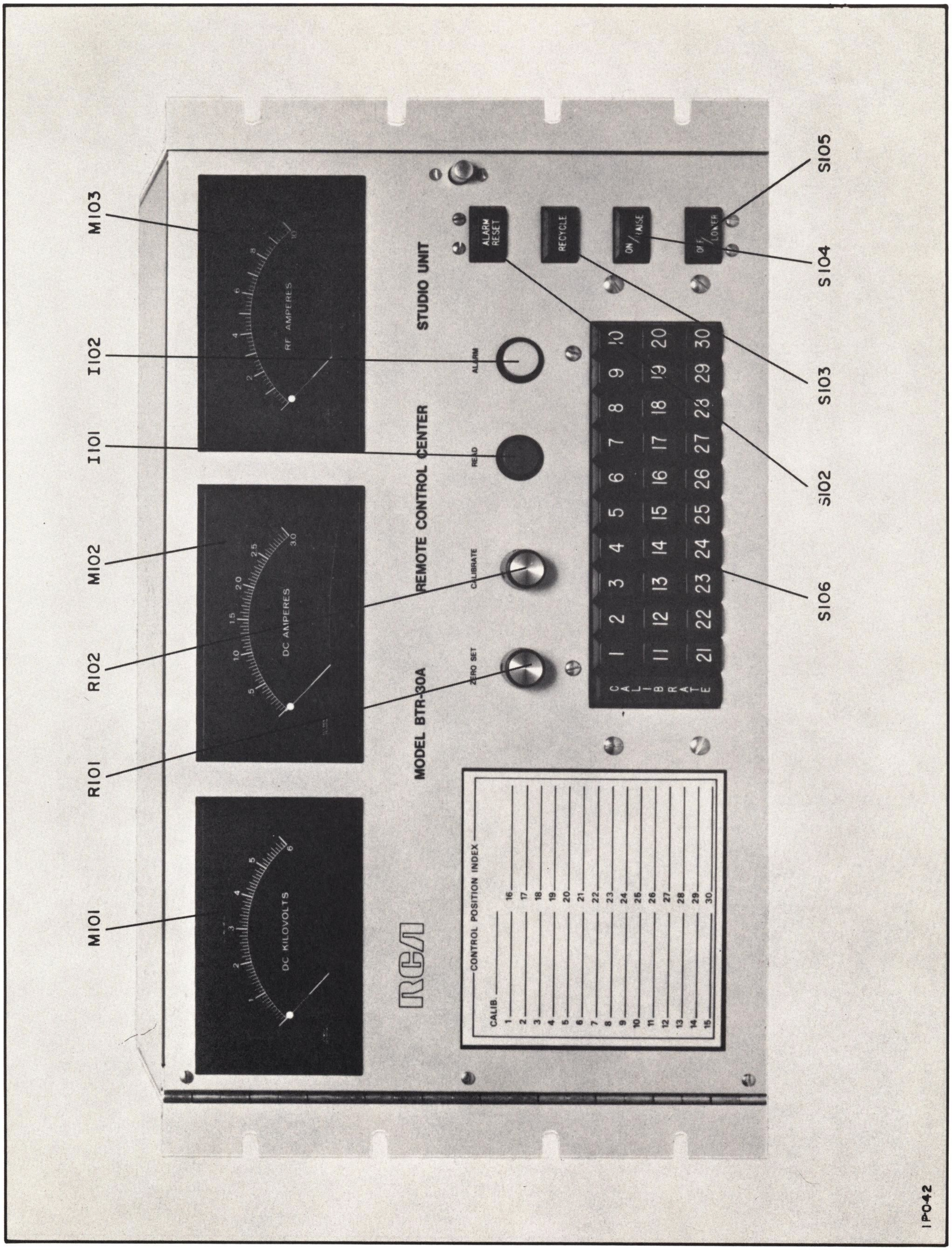


Figure 10. Studio Unit, Front View

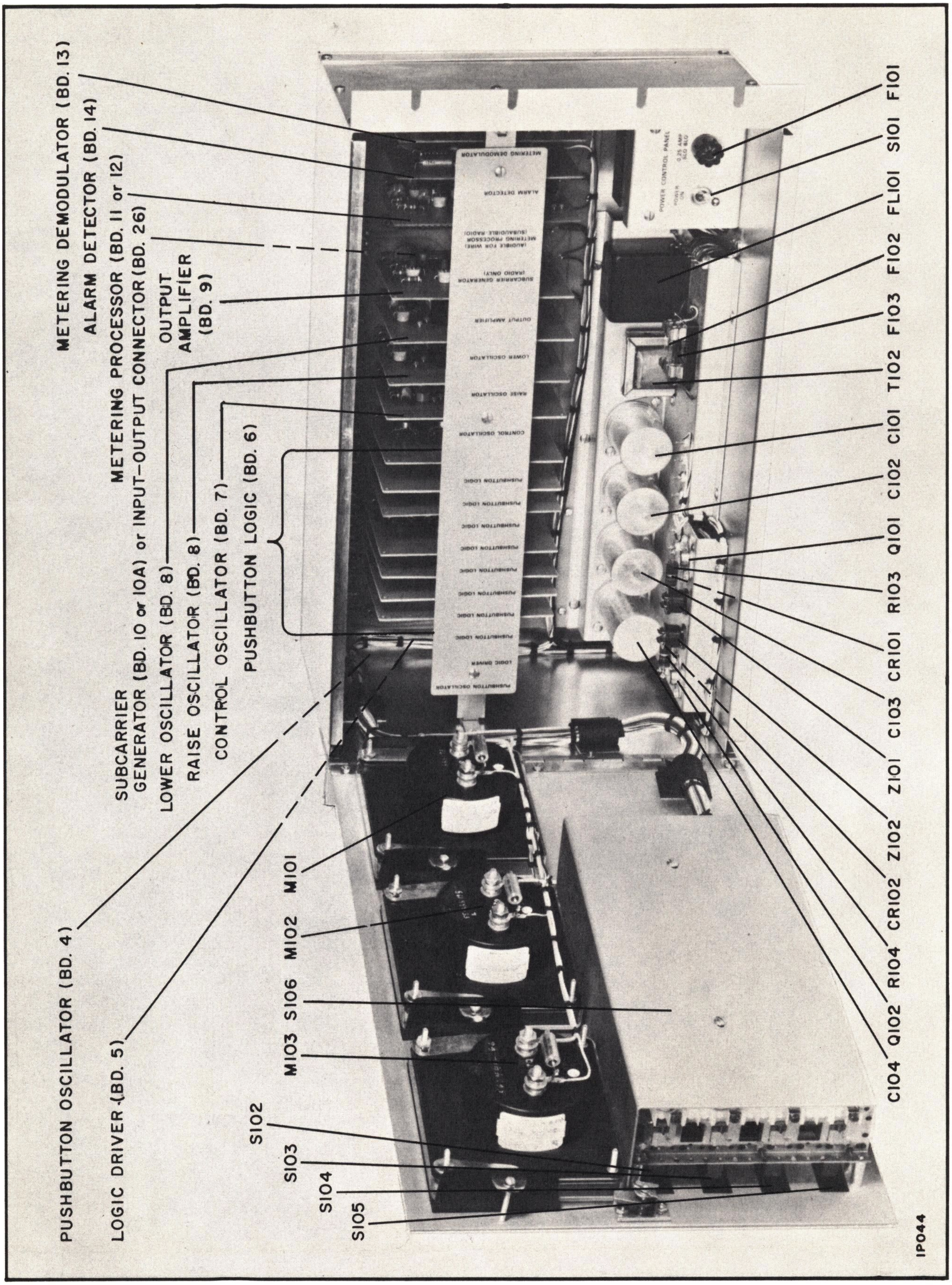


Figure 11. Studio Unit, Front Door Open

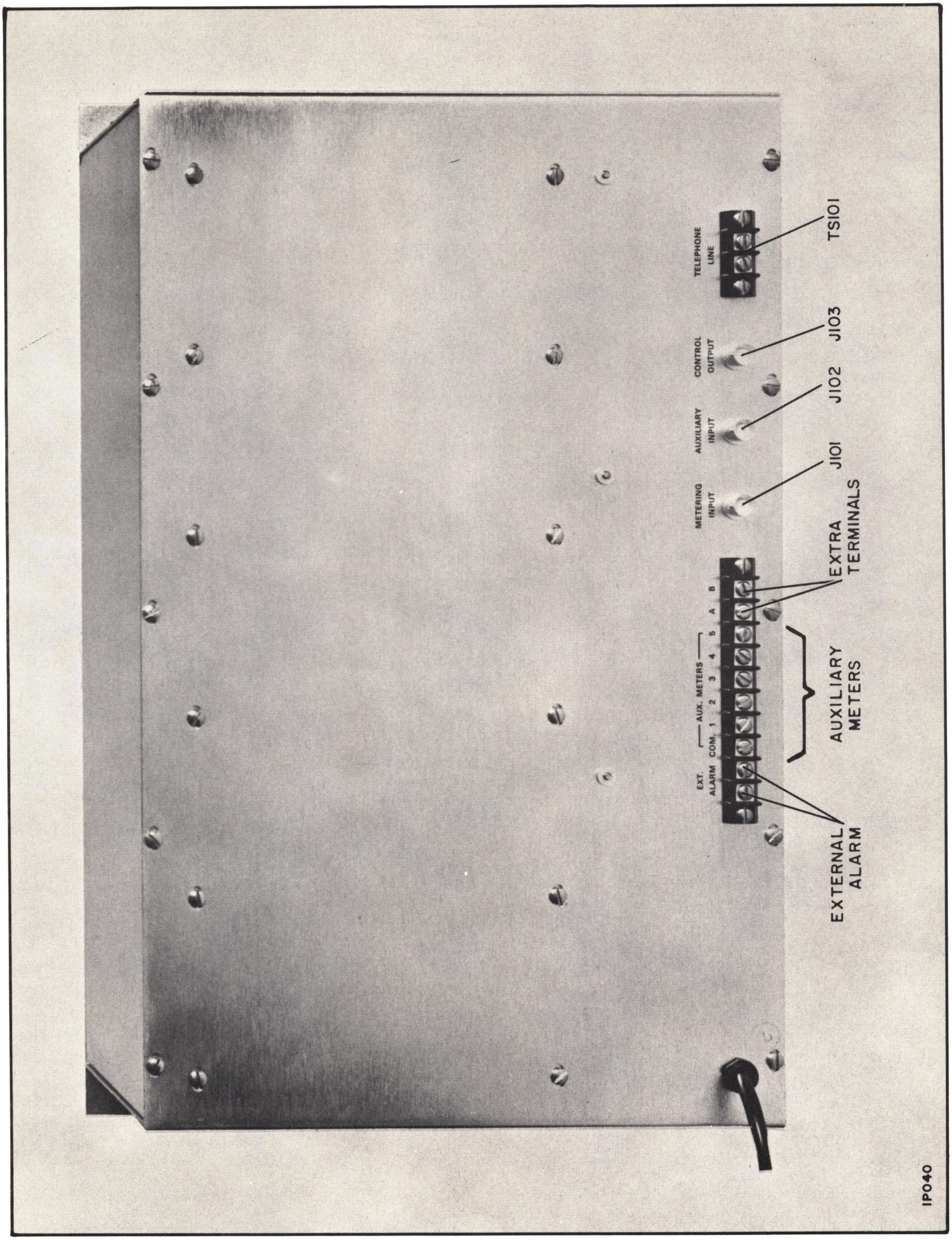


Figure 12. Studio Unit, Rear View

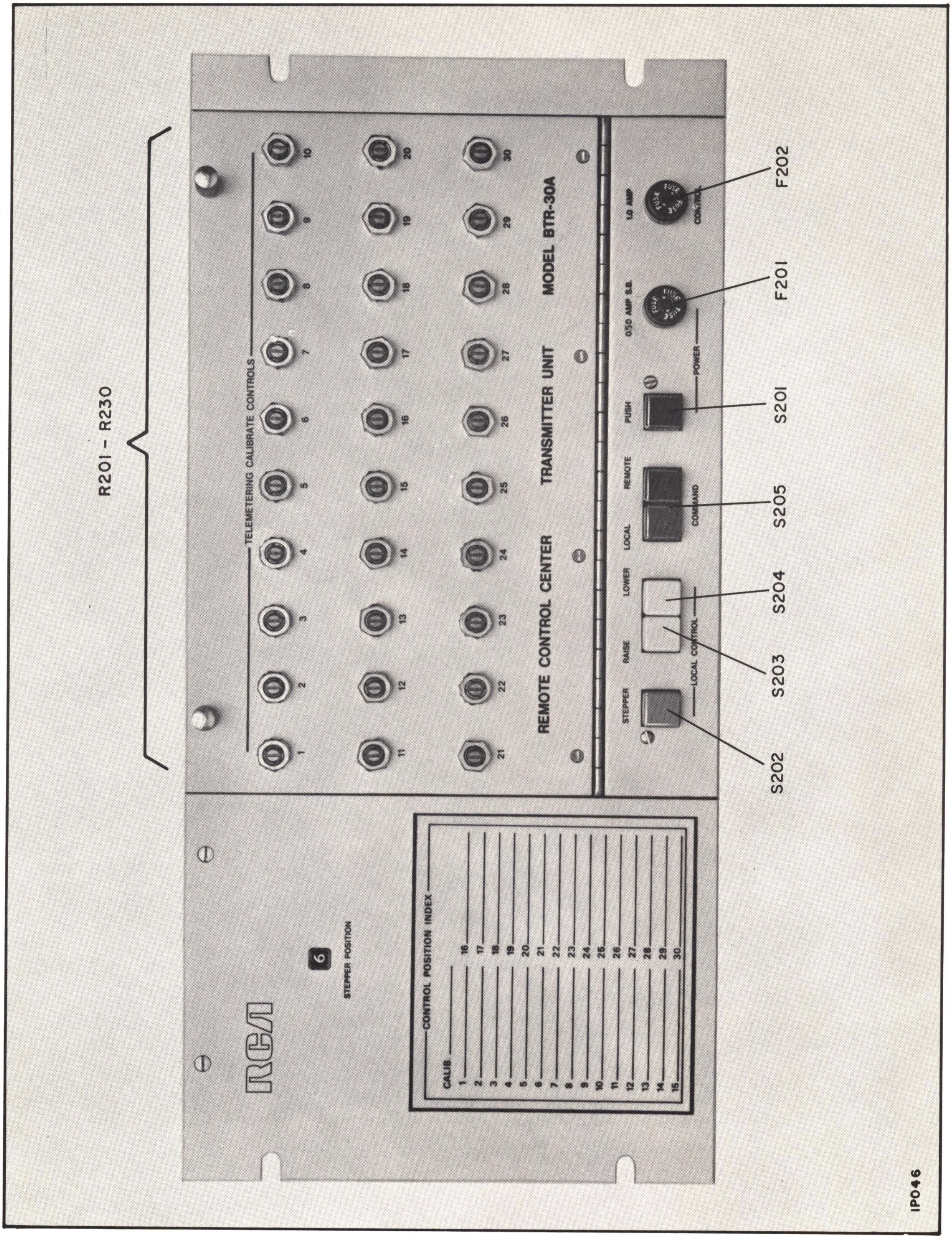


Figure 13. Transmitter Unit, Front View

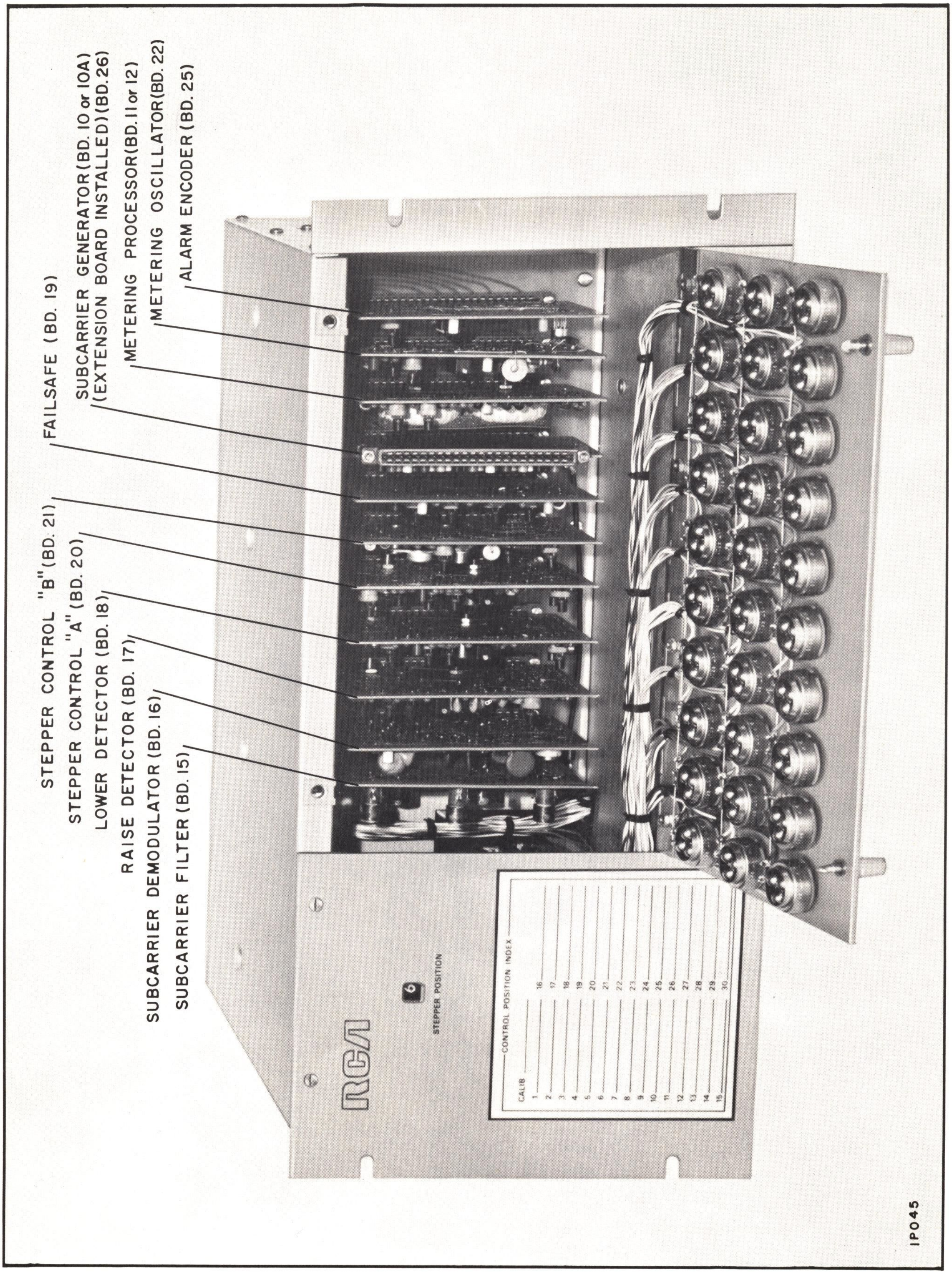


Figure 14. Transmitter Unit, Front Panel Open

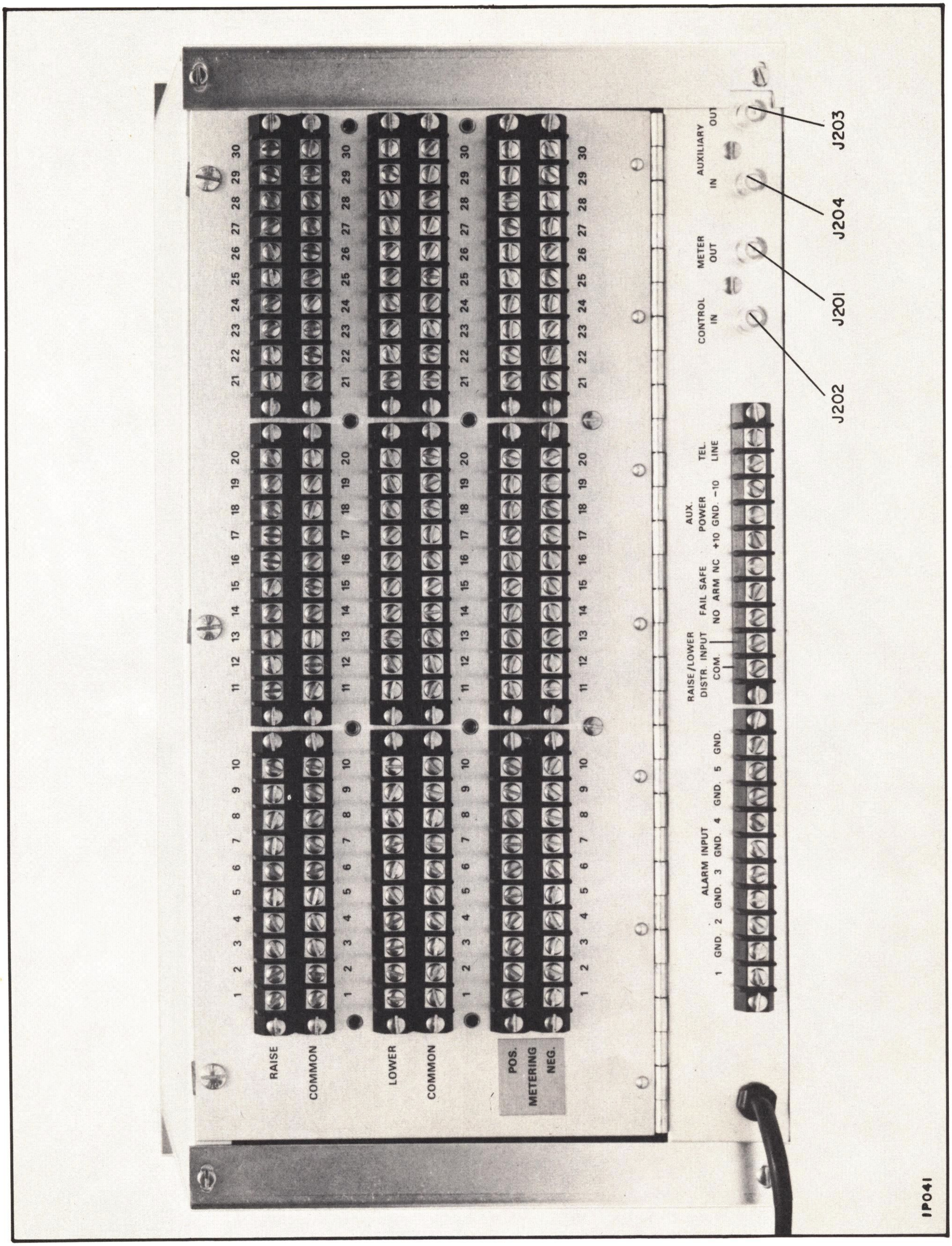


Figure 15. Transmitter Unit, Rear View

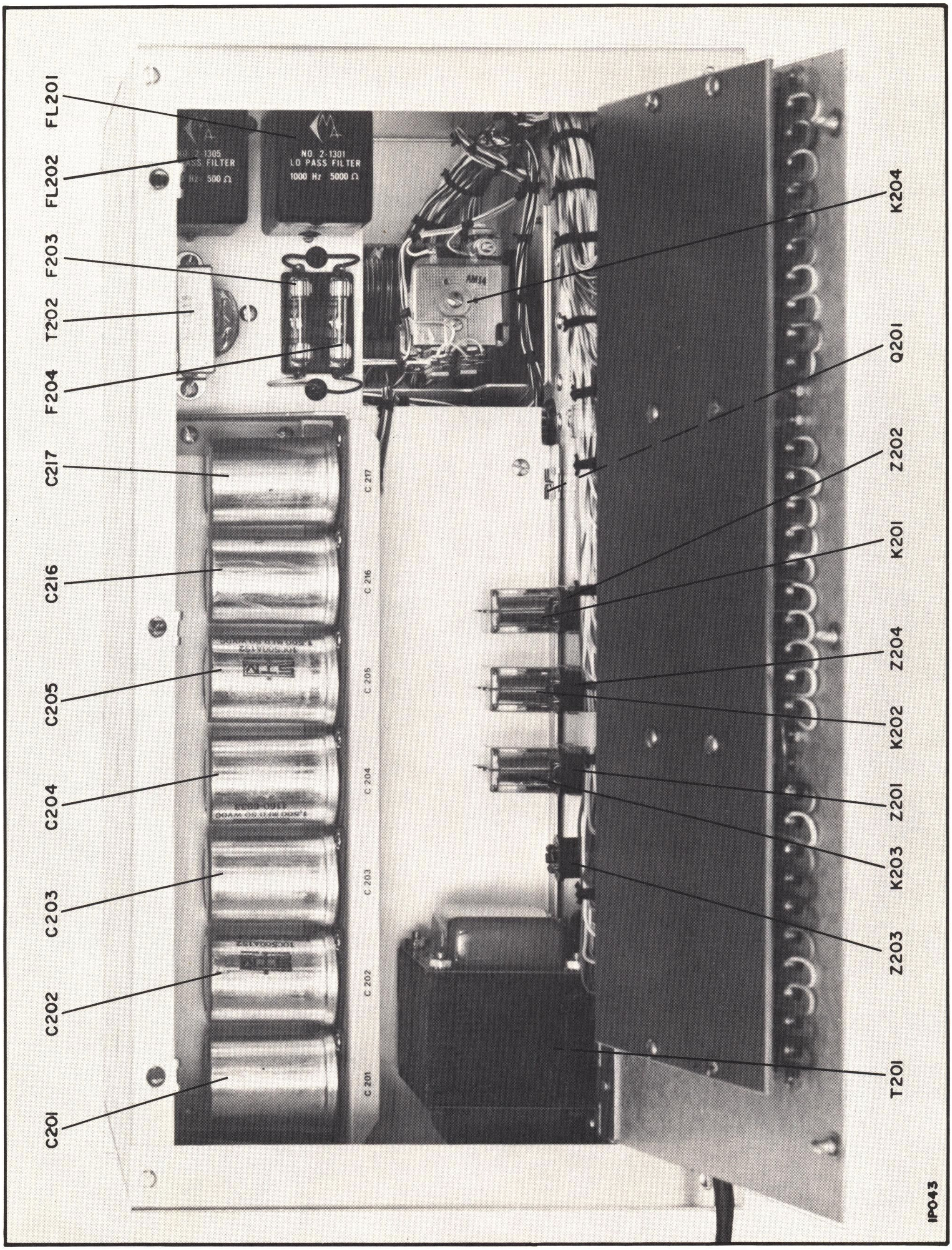


Figure 16. Transmitter Unit, Rear Panel Open

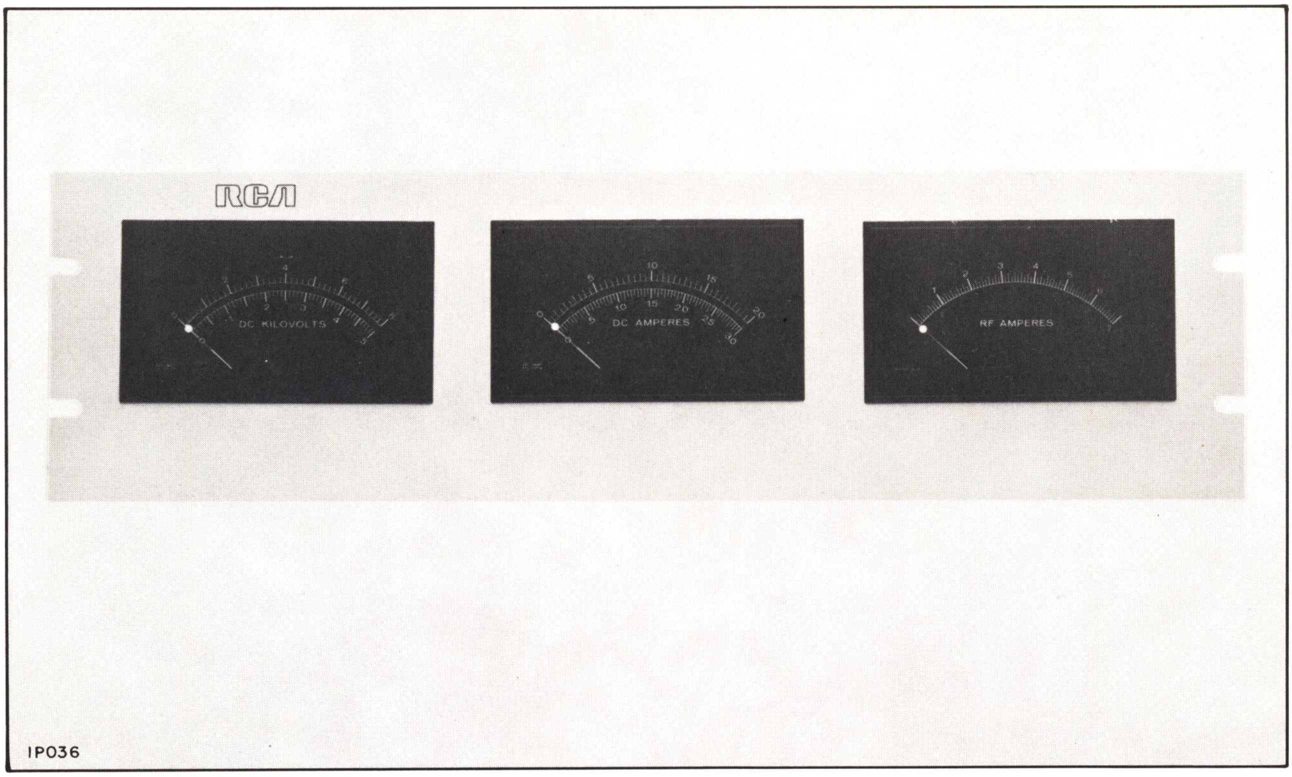


Figure 17. Remote Control Meter Panel (Optional)

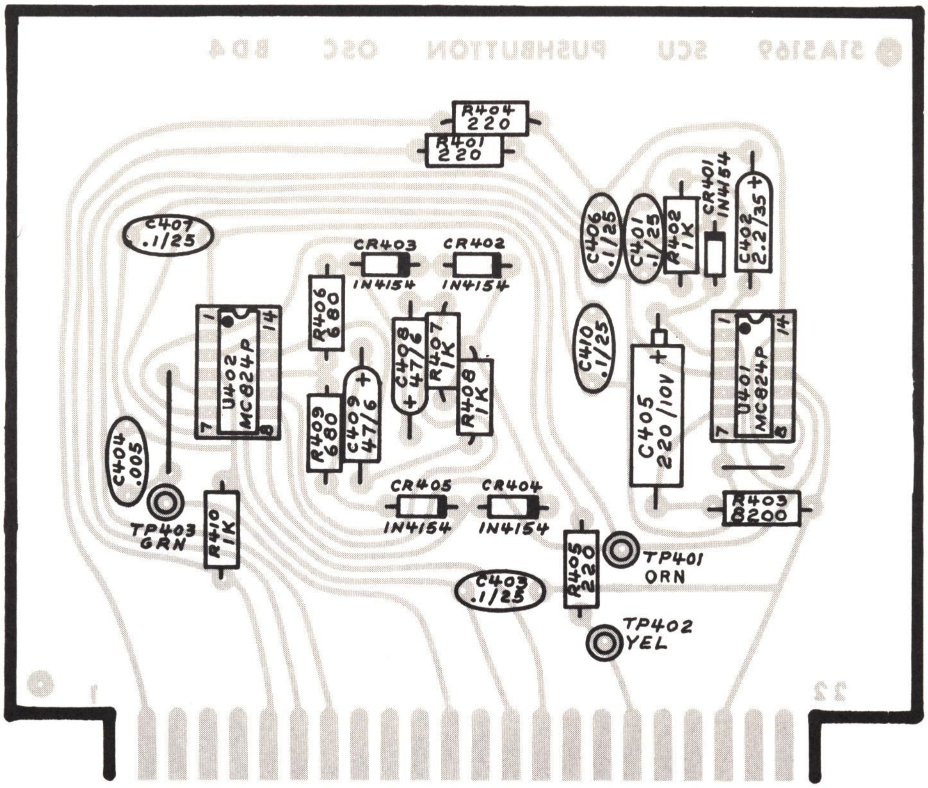
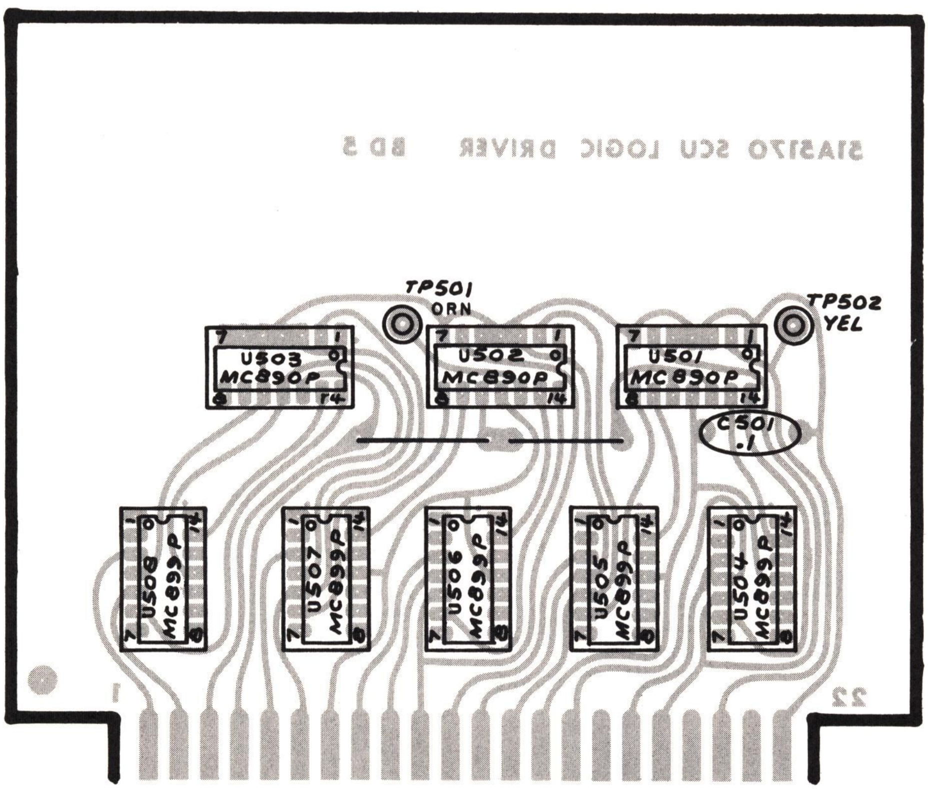


Figure 18. SCU Pushbutton Oscillator (Board 4), Parts Location



IP005

Figure 19. SCU Logic Driver (Board 5), Parts Location

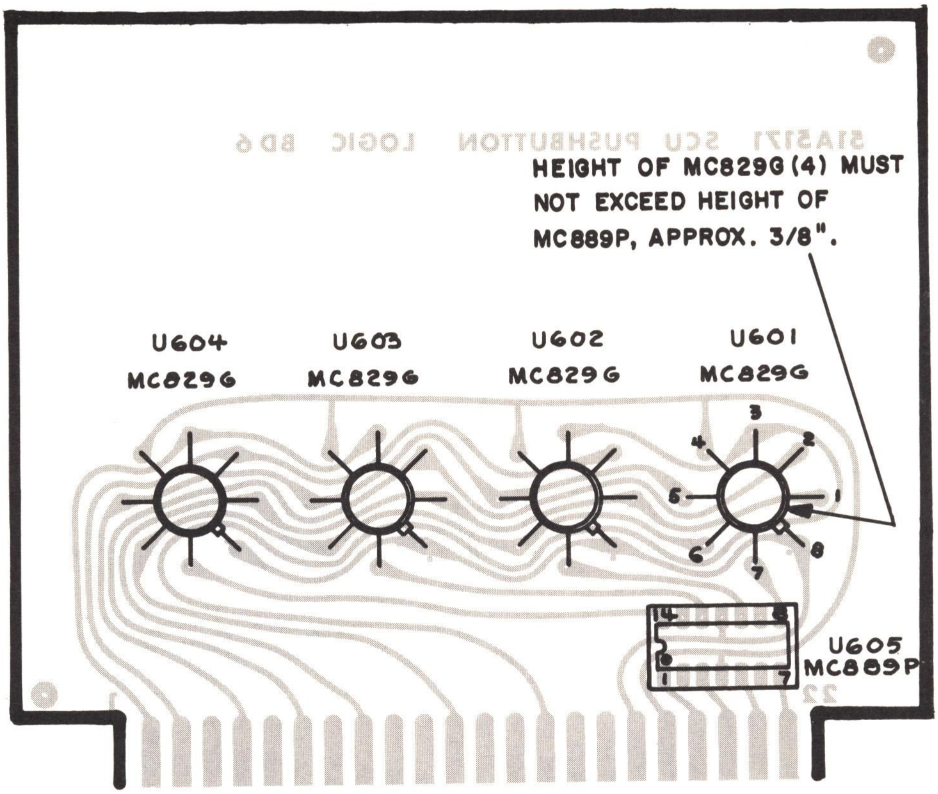
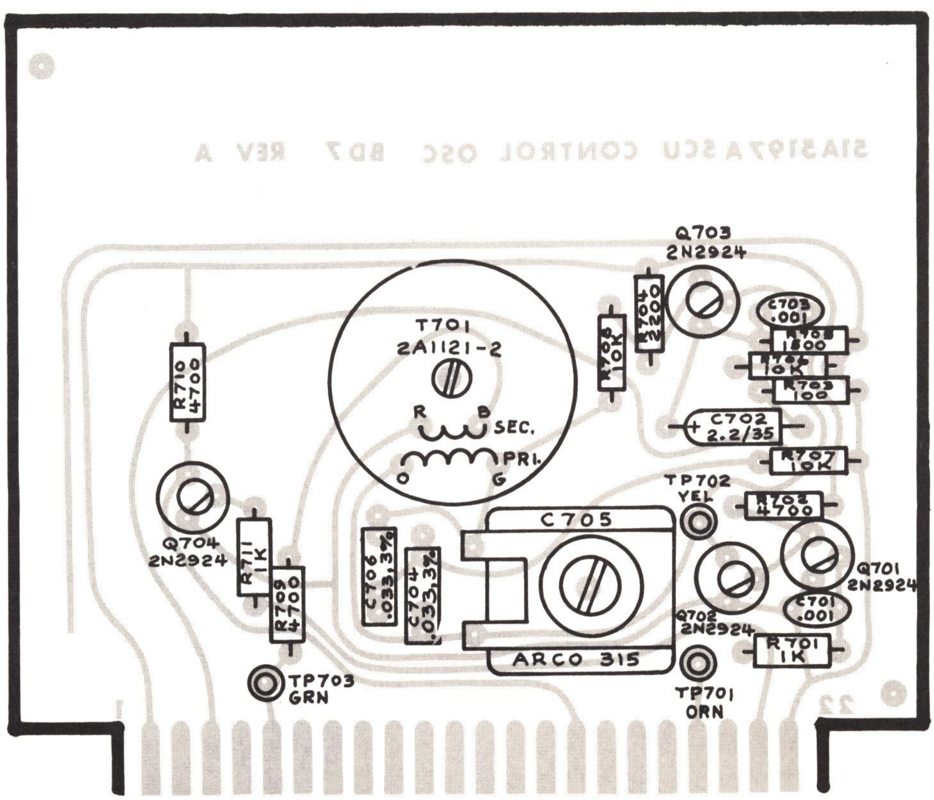


Figure 20. SCU Pushbutton Logic (Board 6), Parts Location



IP007

Figure 21. SCU Control Oscillator (Board 7), Parts Location

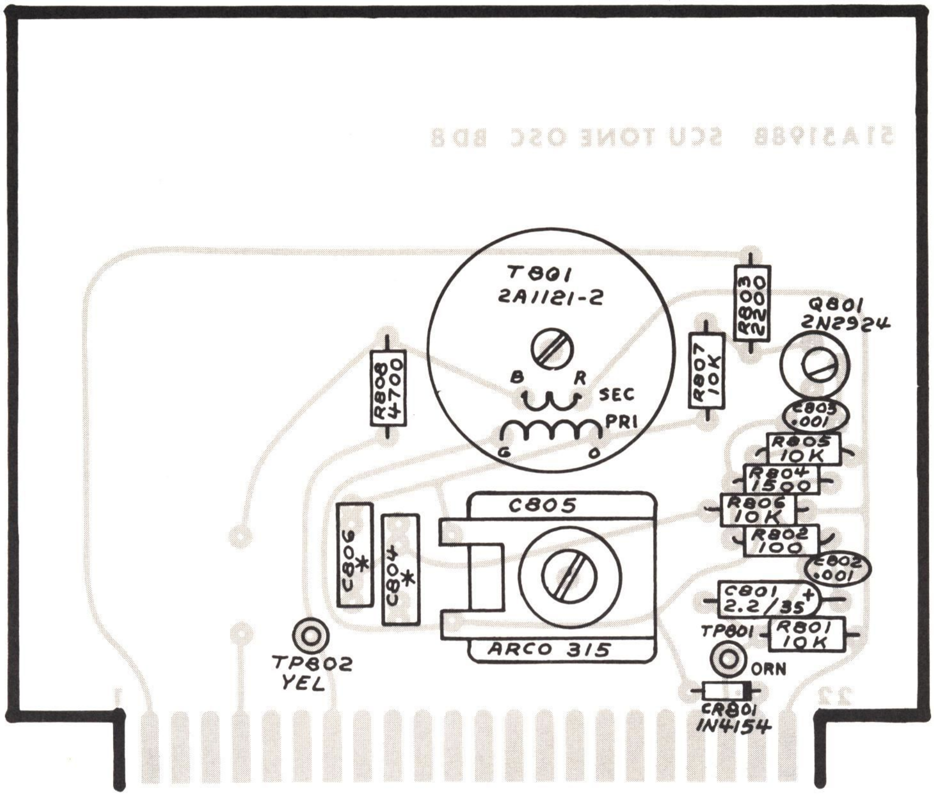
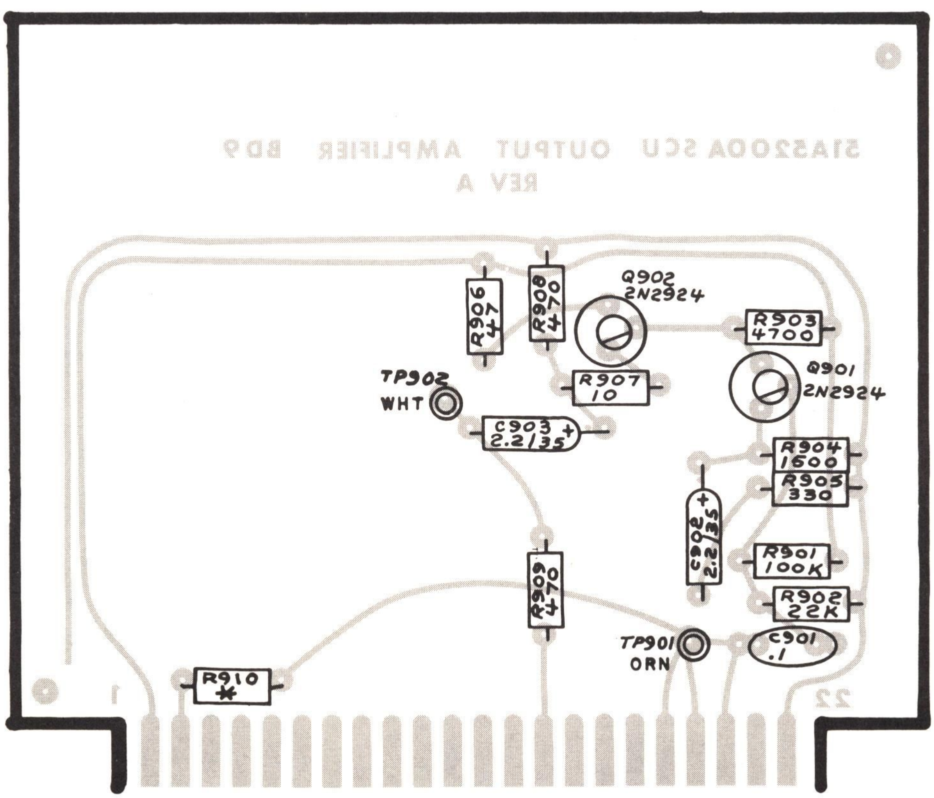


Figure 22. SCU Tone Oscillator (Board 8), Parts Location



IP009

Figure 23. SCU Output Amplifier (Board 9), Parts Location

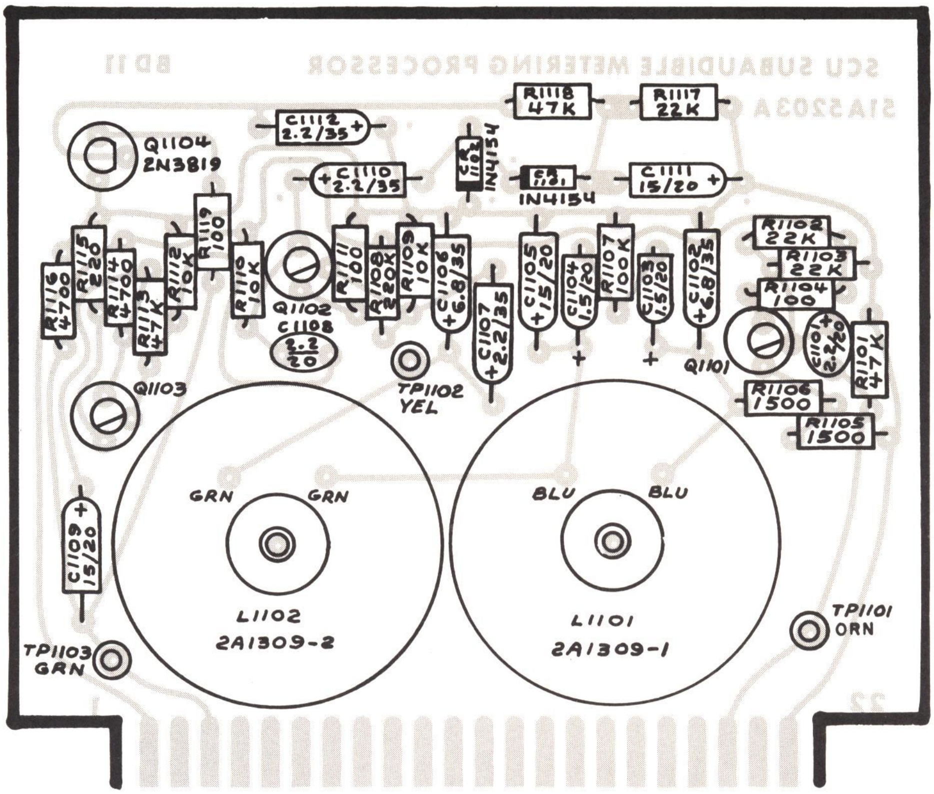
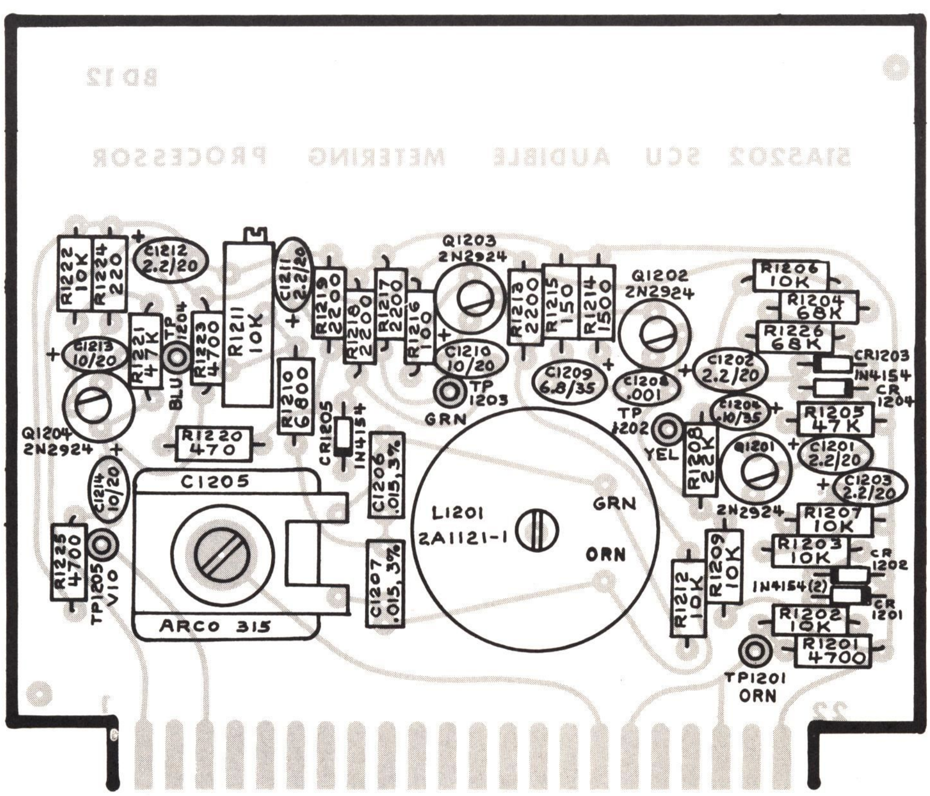


Figure 24. SCU Subaudible Metering Processor (Board 11), Parts Location



IP011

Figure 25. SCU Audible Metering Processor (Board 12), Parts Location

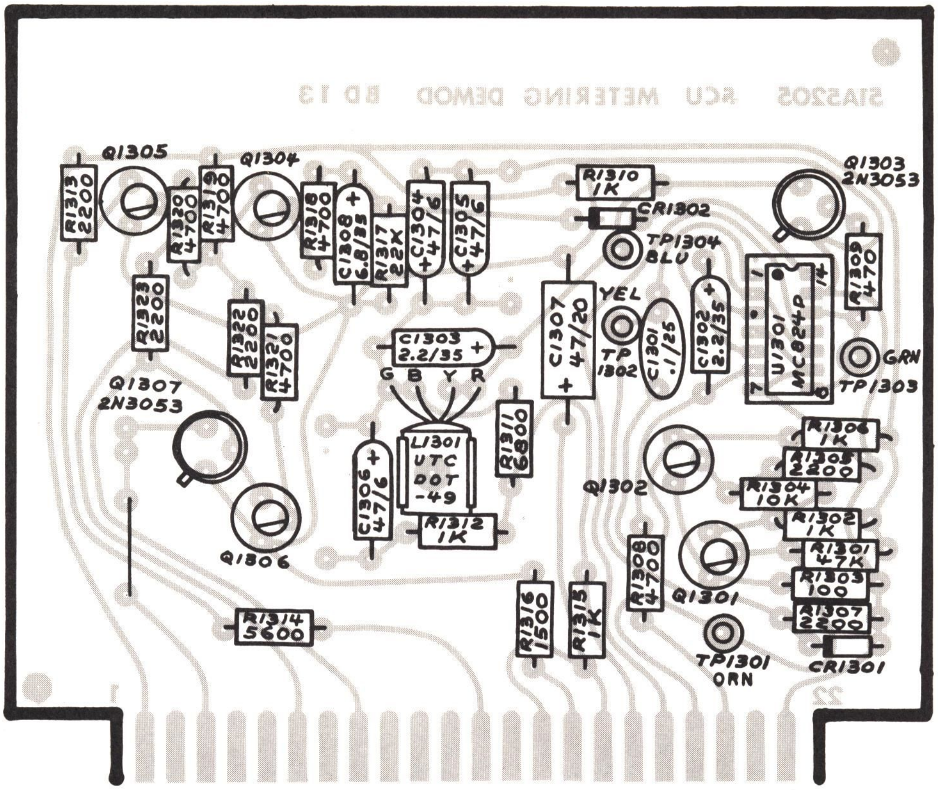


Figure 26. SCU Metering Demodulator (Board 13), Parts Location

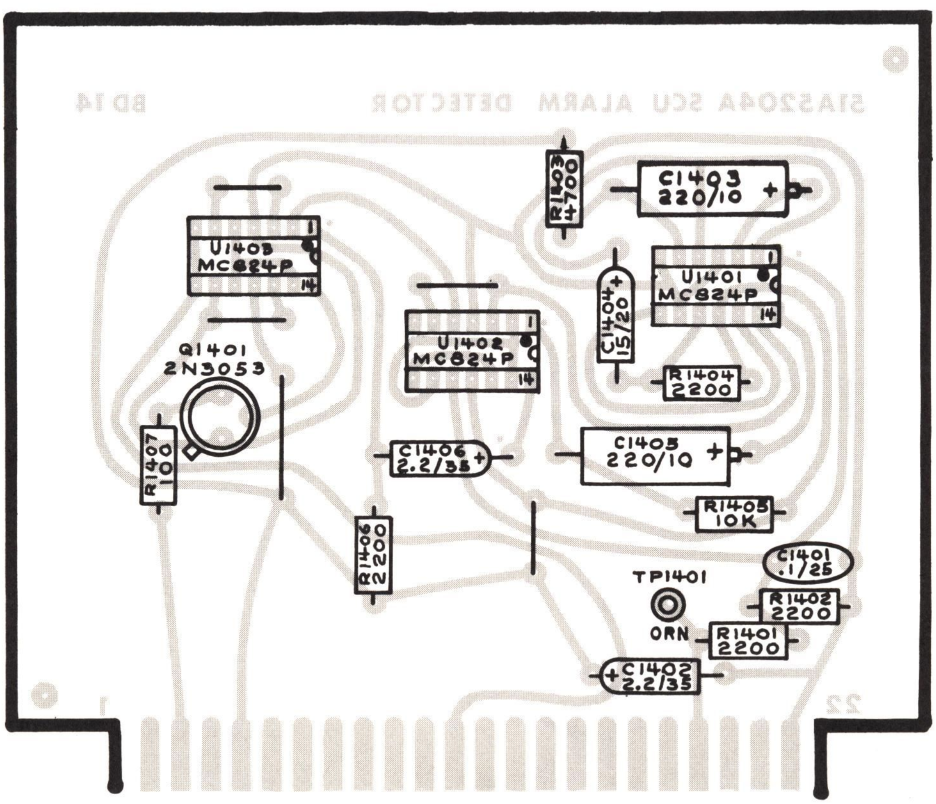


Figure 27. SCU Alarm Detector (Board 14), Parts Location

IP013

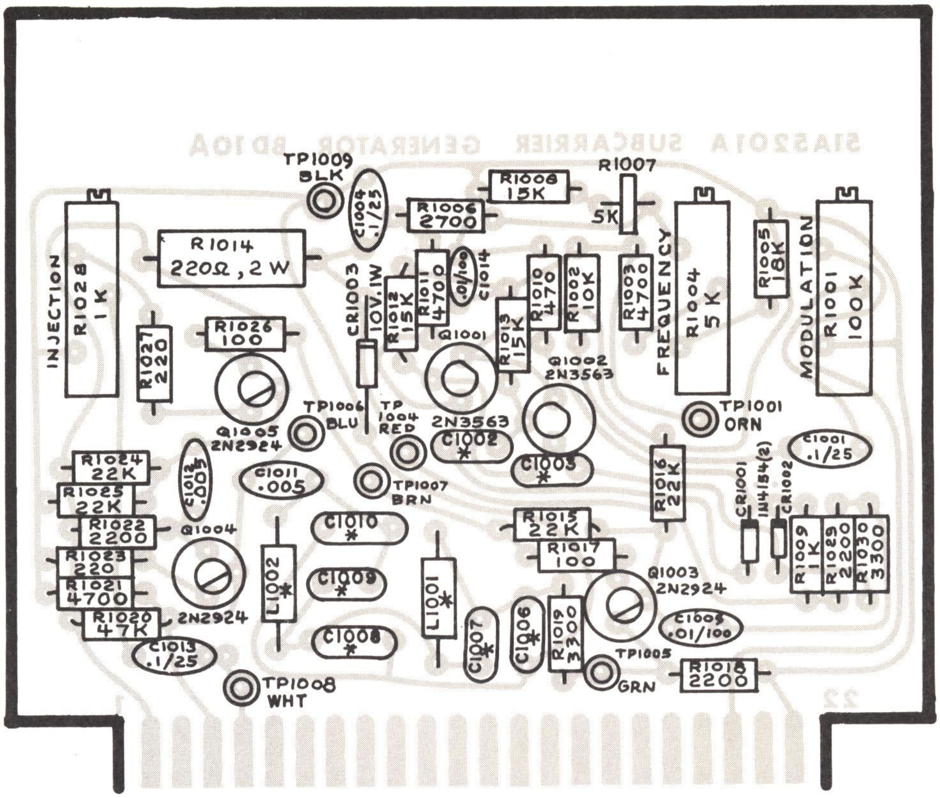
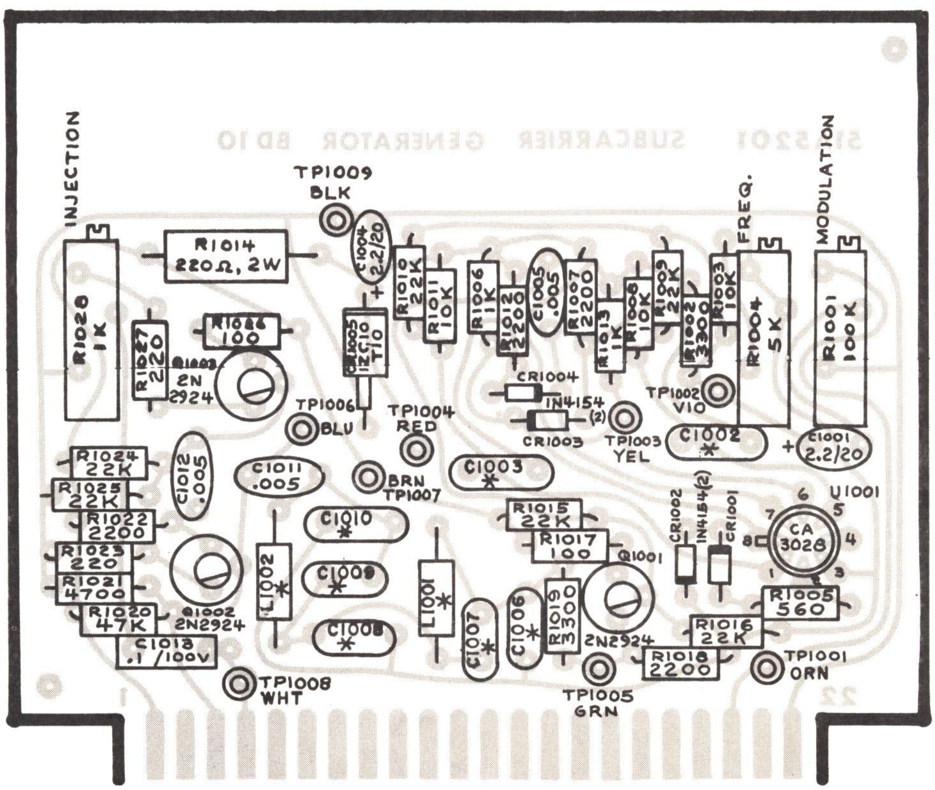


Figure 28. Subcarrier Generator (Board 10A), Parts Location



1P015

Figure 28a. Subcarrier Generator (Board 10), Parts Location

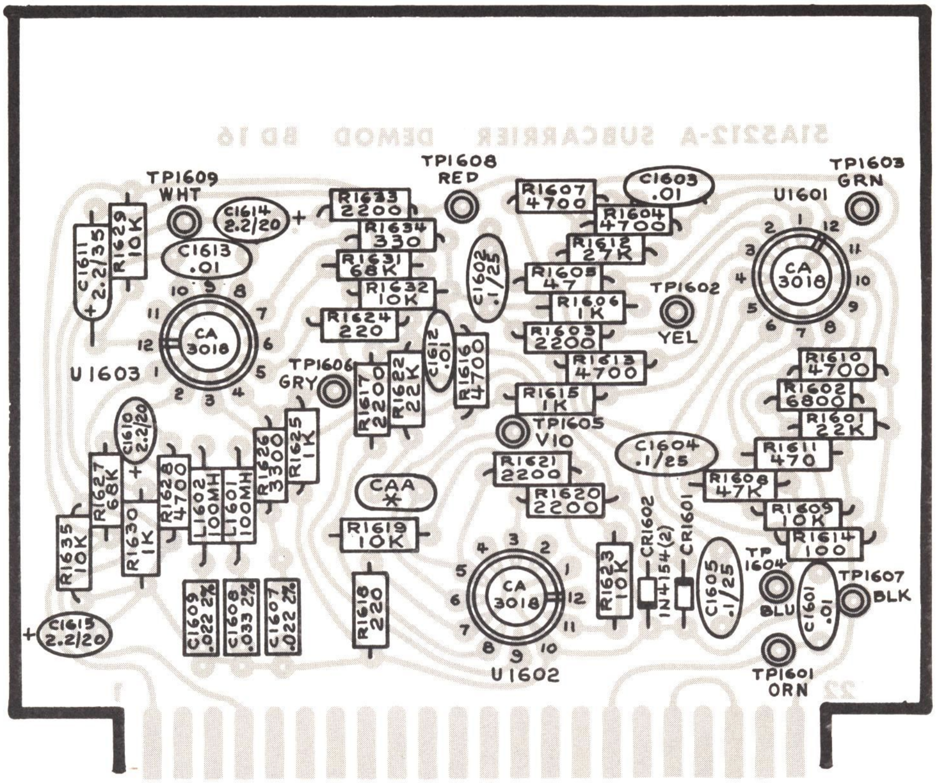
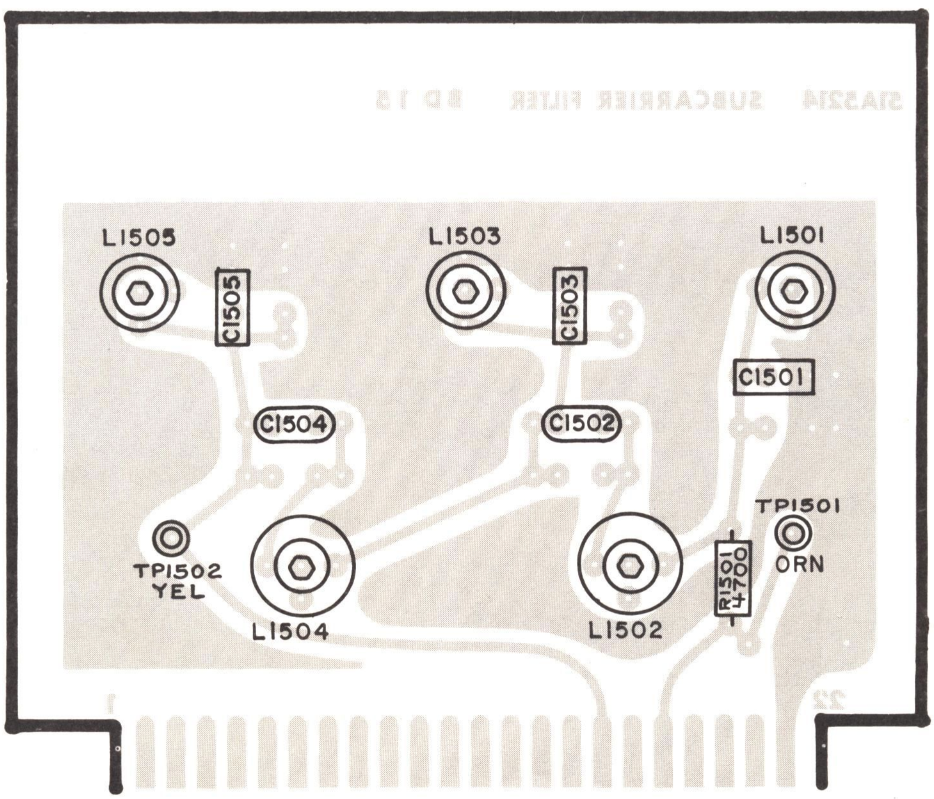


Figure 29. Subcarrier Demodulator (Board 16), Parts Location



IP017

Figure 30. Subcarrier Filter (Board 15), Parts Location

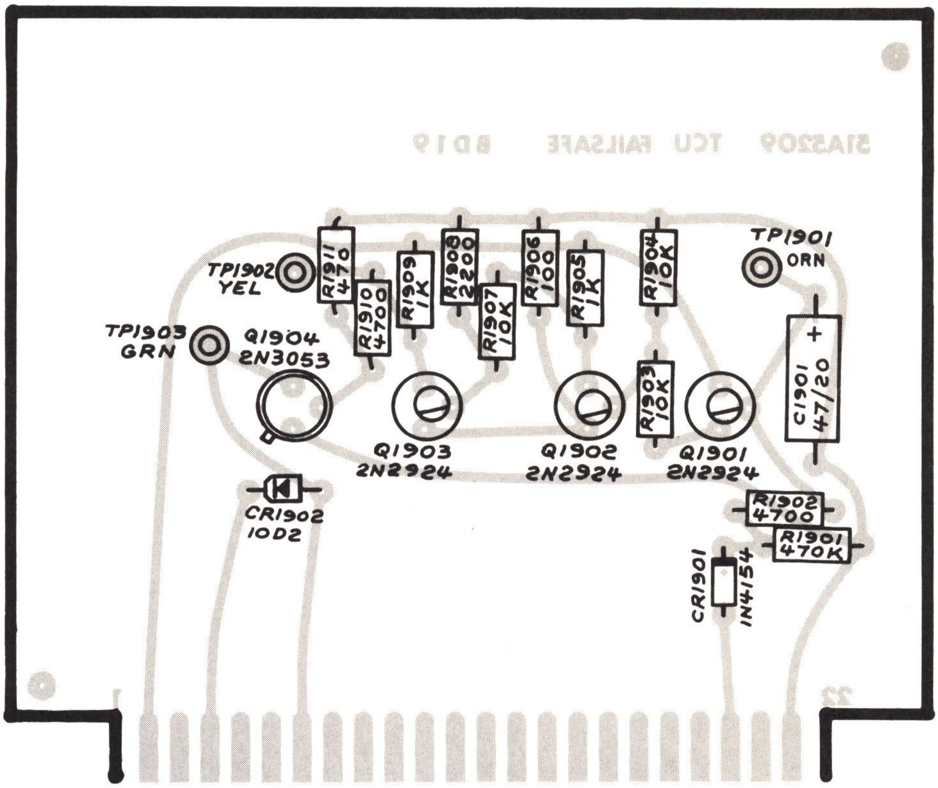
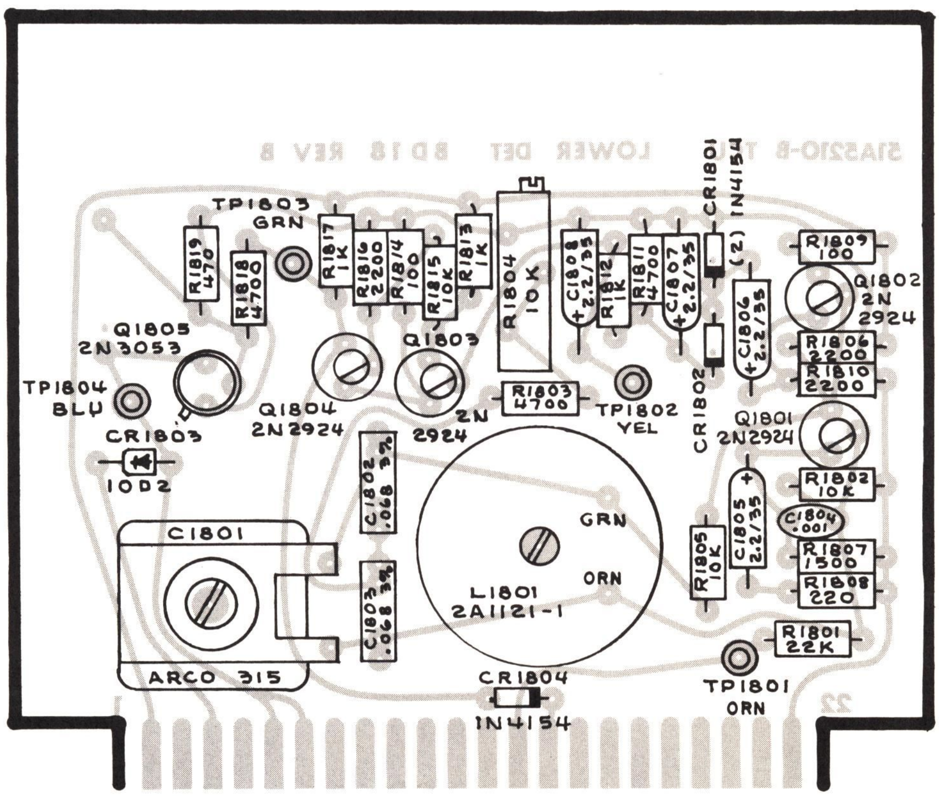


Figure 31. TCU Failsafe (Board 19), Parts Location



1P019

Figure 32. TCU Lower Detector (Board 18), Parts Location

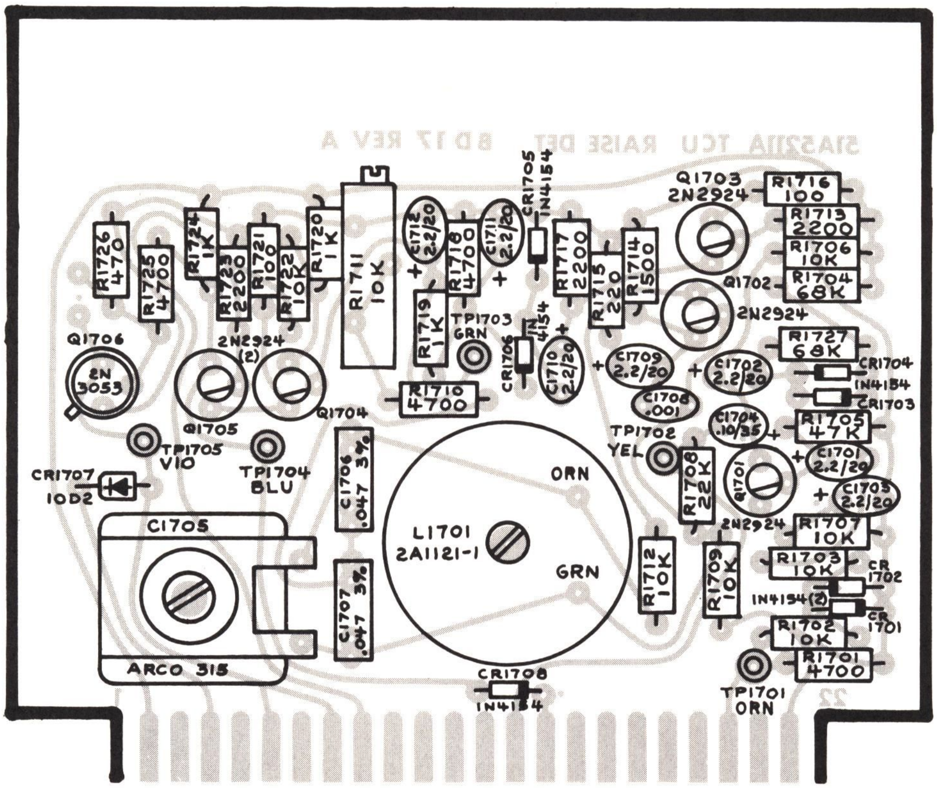
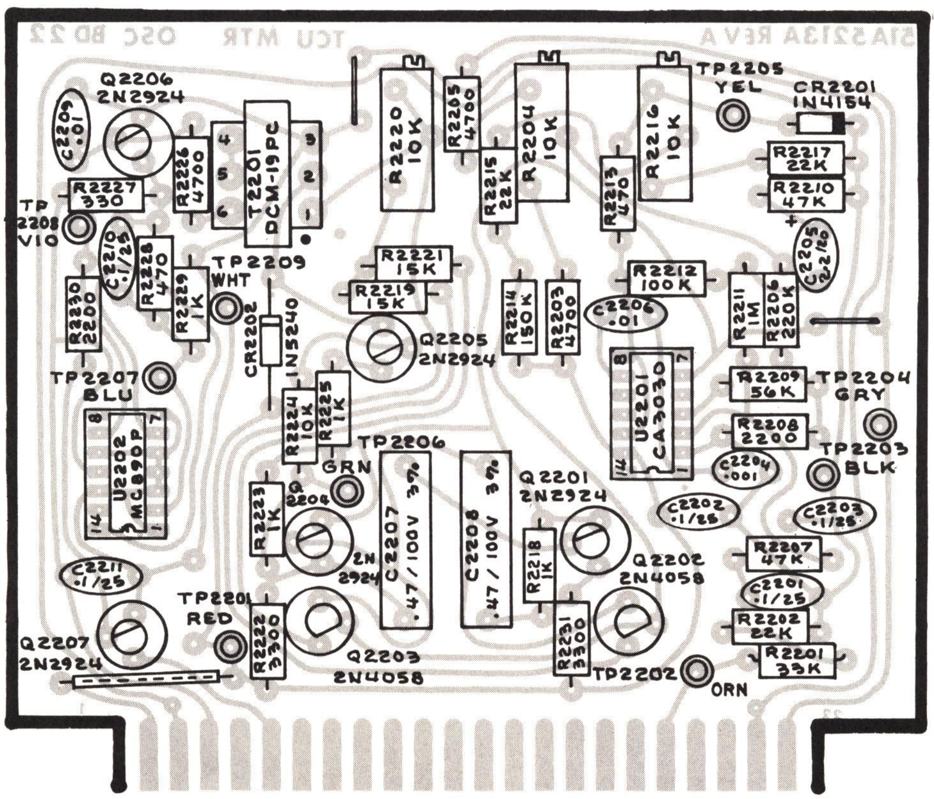


Figure 33. TCU Raise Detector (Board 17), Parts Location



IP021

Figure 34. TCU Metering Oscillator (Board 22), Parts Location

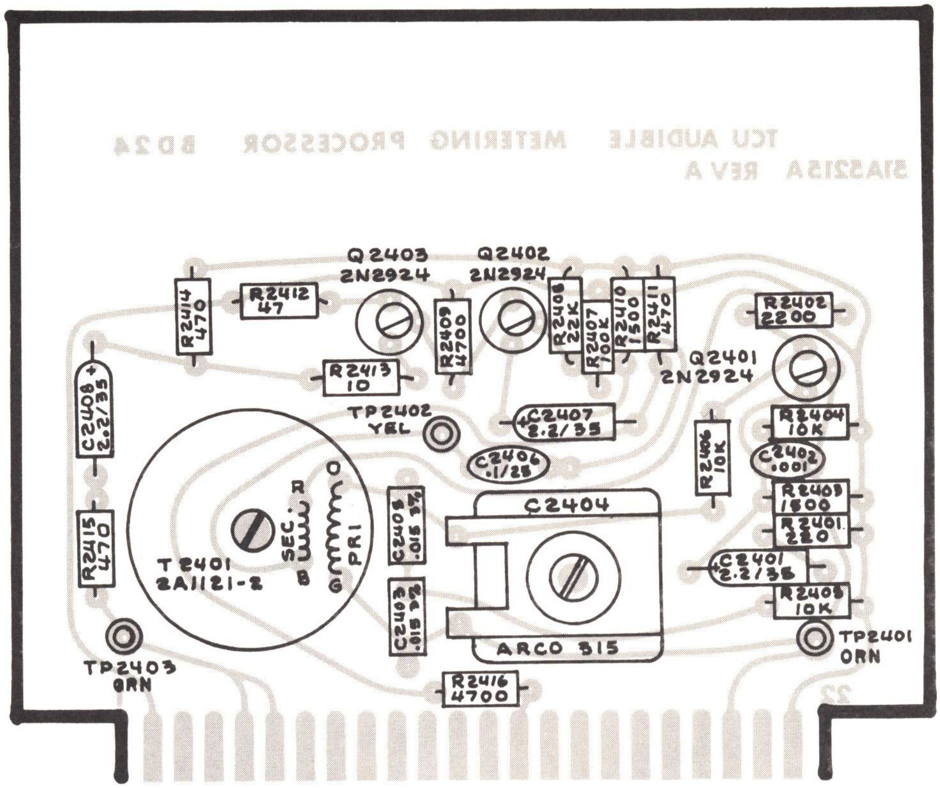
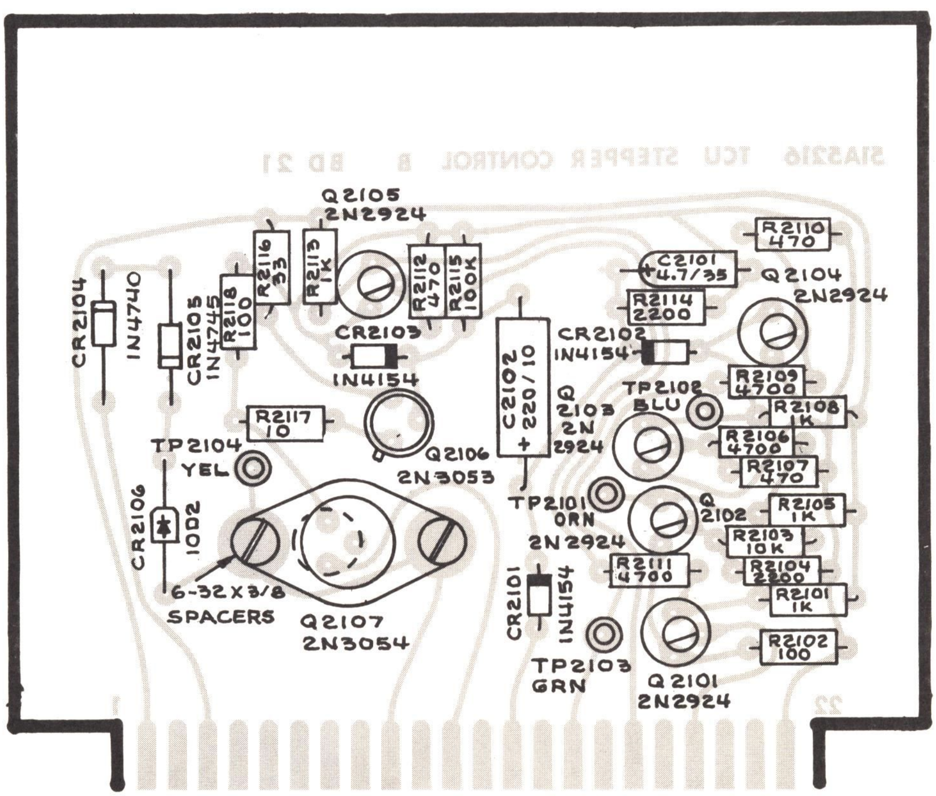


Figure 35. TCU Audible Metering Processor (Board 24), Parts Location



IP023

Figure 36. TCU Stepper Control B (Board 21), Parts Location

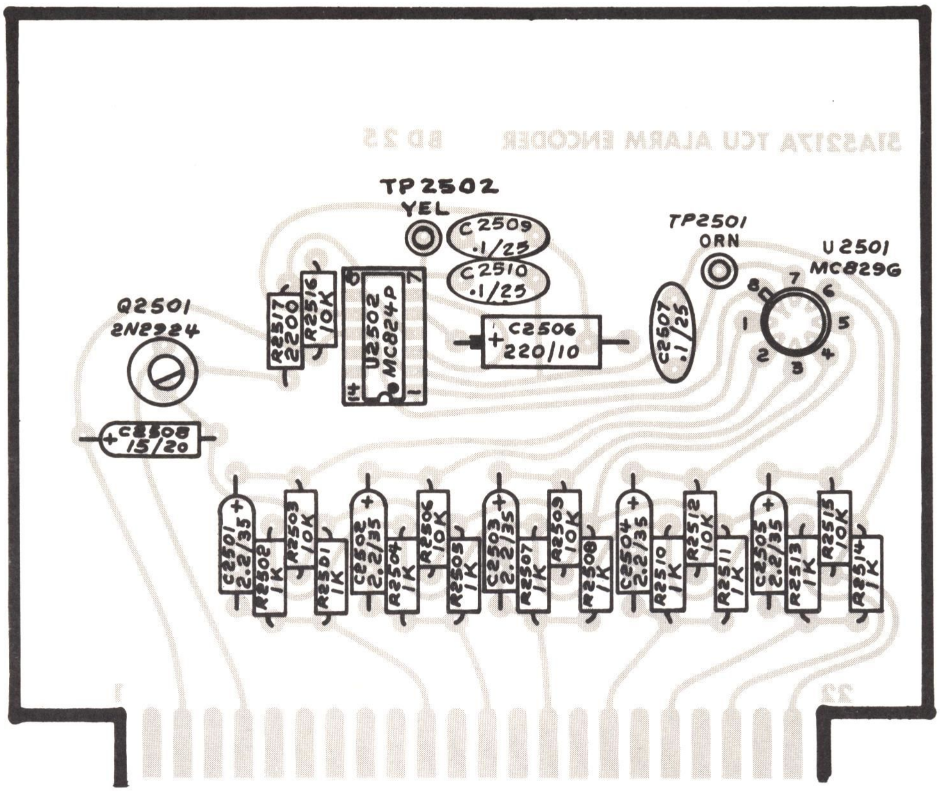


Figure 37. TCU Alarm Encoder (Board 25), Parts Location

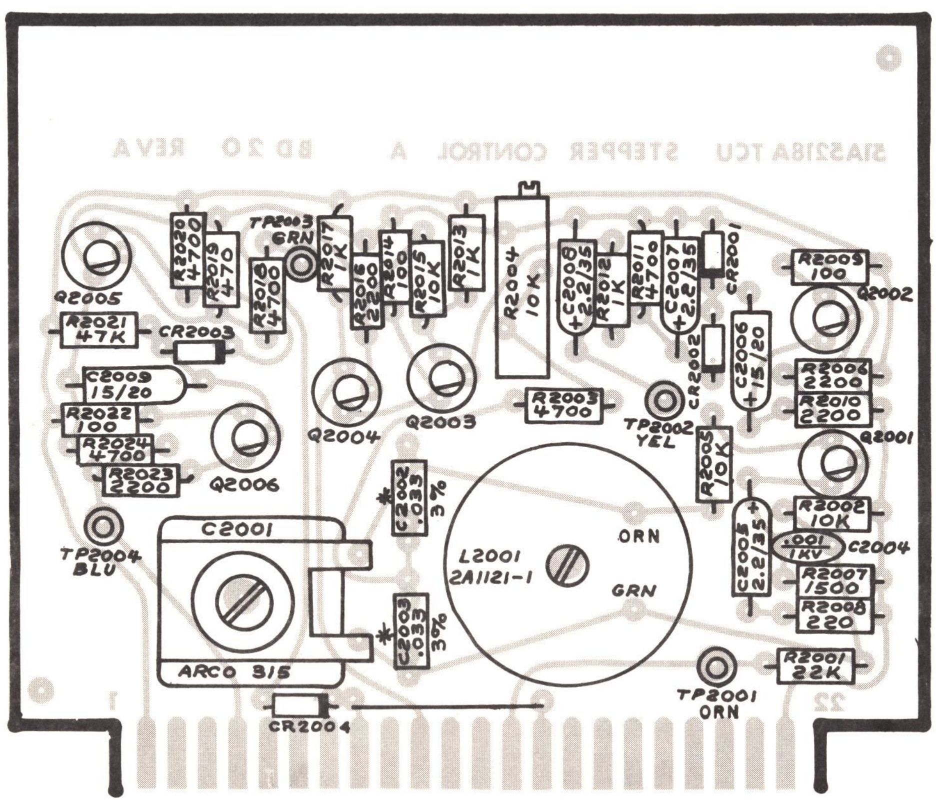
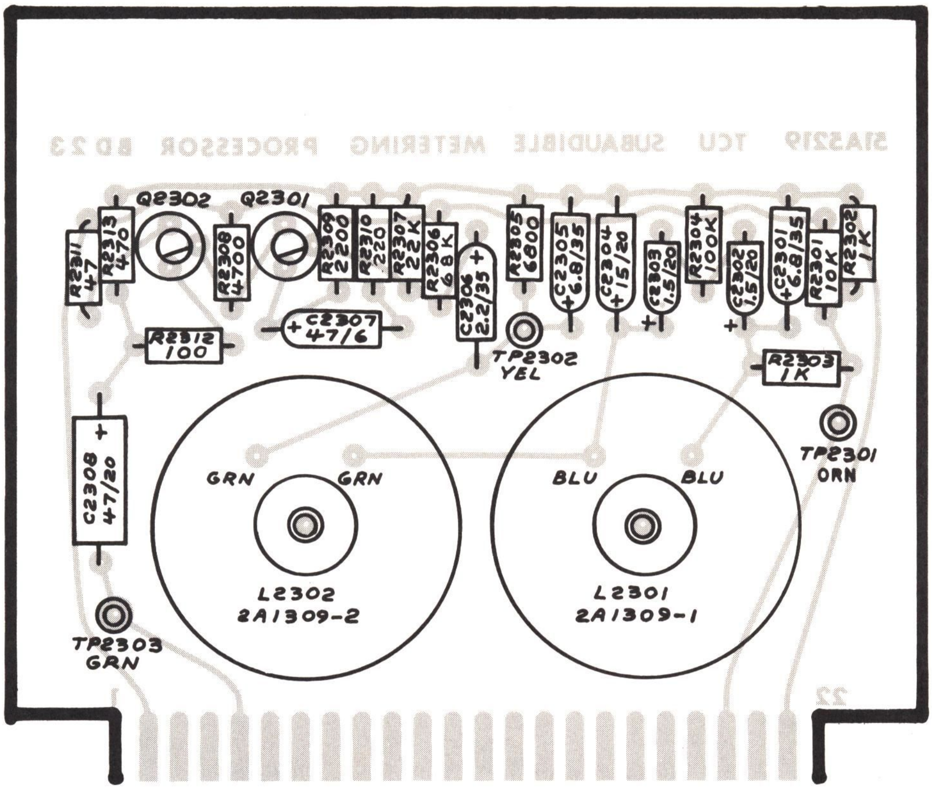
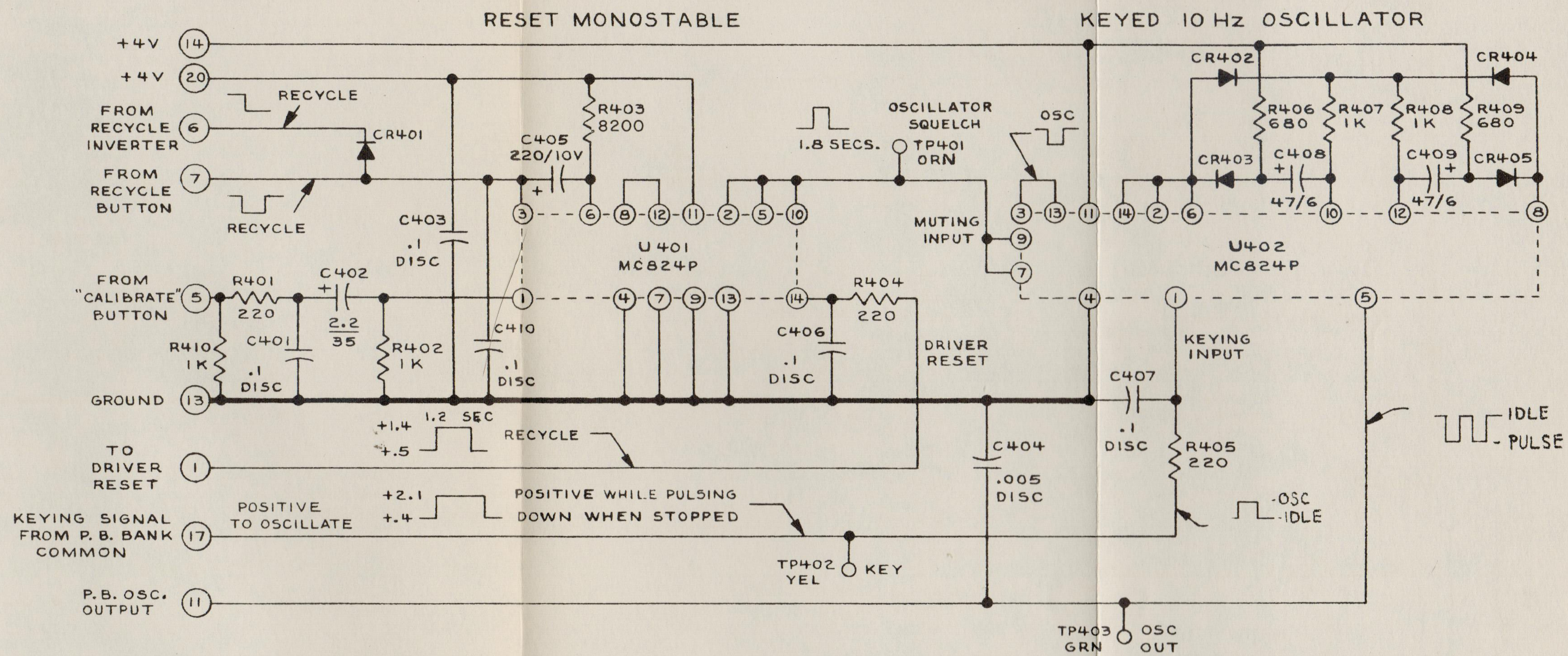


Figure 38. TCU Stepper Control A (Board 20), Parts Location



IP027

Figure 39. TCU Subaudible Metering Processor (Board 23), Parts Location

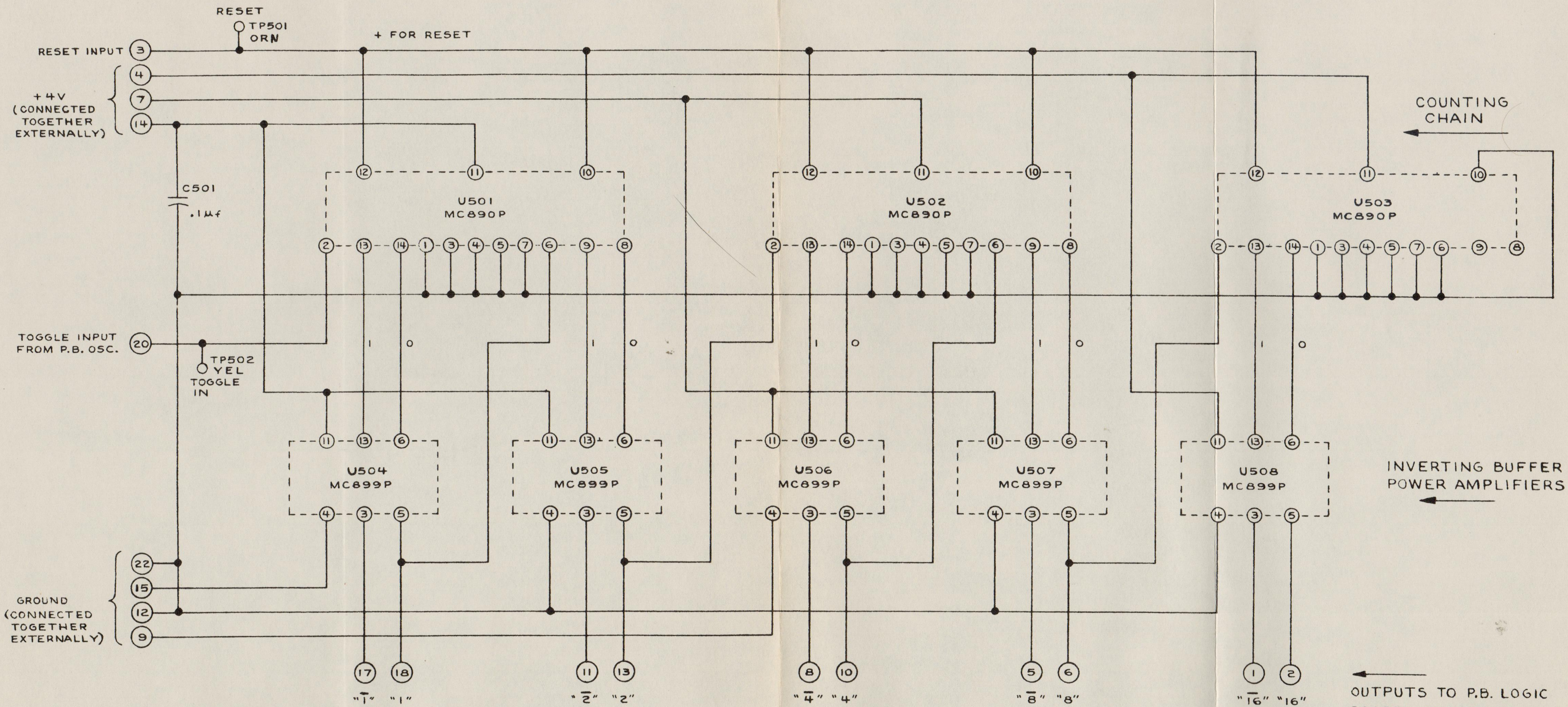


NOTES:

1 UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2W, 10%.
CAPACITOR VALUES ARE IN MICROFARADS.
DIODES ARE IN4154 OR EQUIVALENT.

2P004

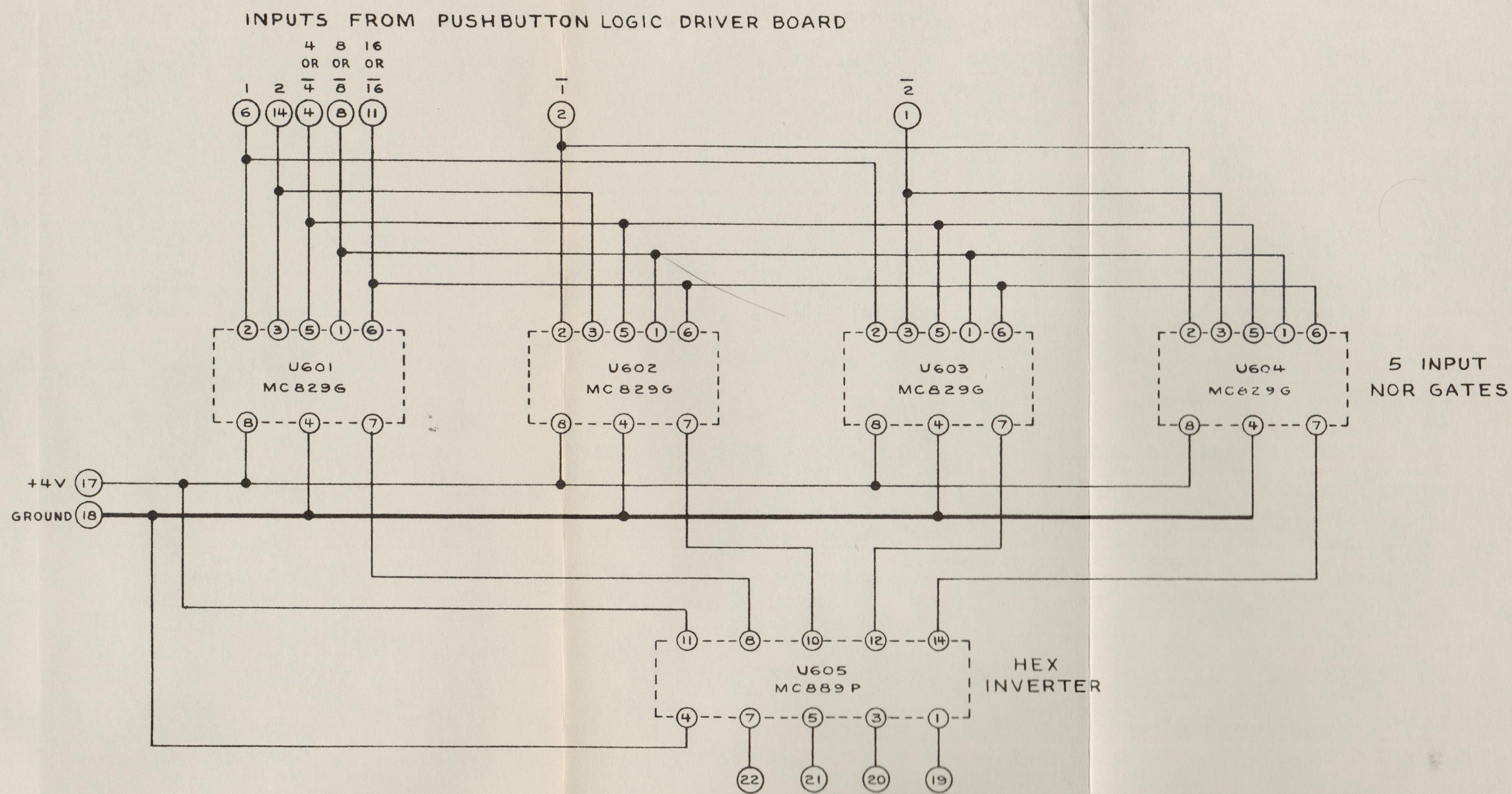
Figure 40. SCU Pushbutton Oscillator (Board 4), Schematic Diagram



NOTES:

1. P.C. BOARD 51A5170
2. MC890P PINS 9 & 13 GO TO GROUND POTENTIAL WHEN 10 OR 12 GO POSITIVE.
3. MC899P INVERTS: 3 IS HIGH WHEN 13 IS LOW.

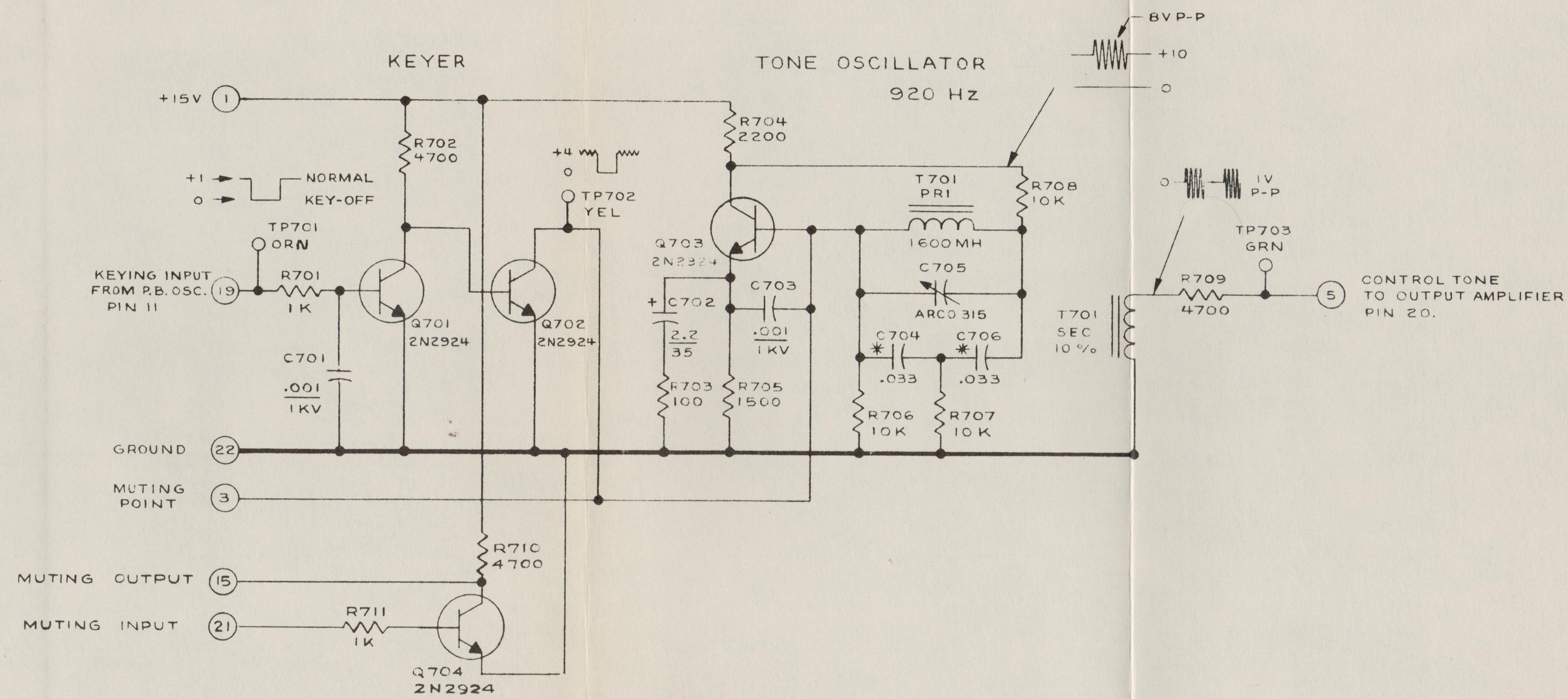
Figure 41. SCU Logic Driver (Board 5), Schematic Diagram



NOTES:

1 P.C. BOARD 51A5171

Figure 42. SCU Pushbutton Logic (Board 6), Schematic Diagram



NOTES:

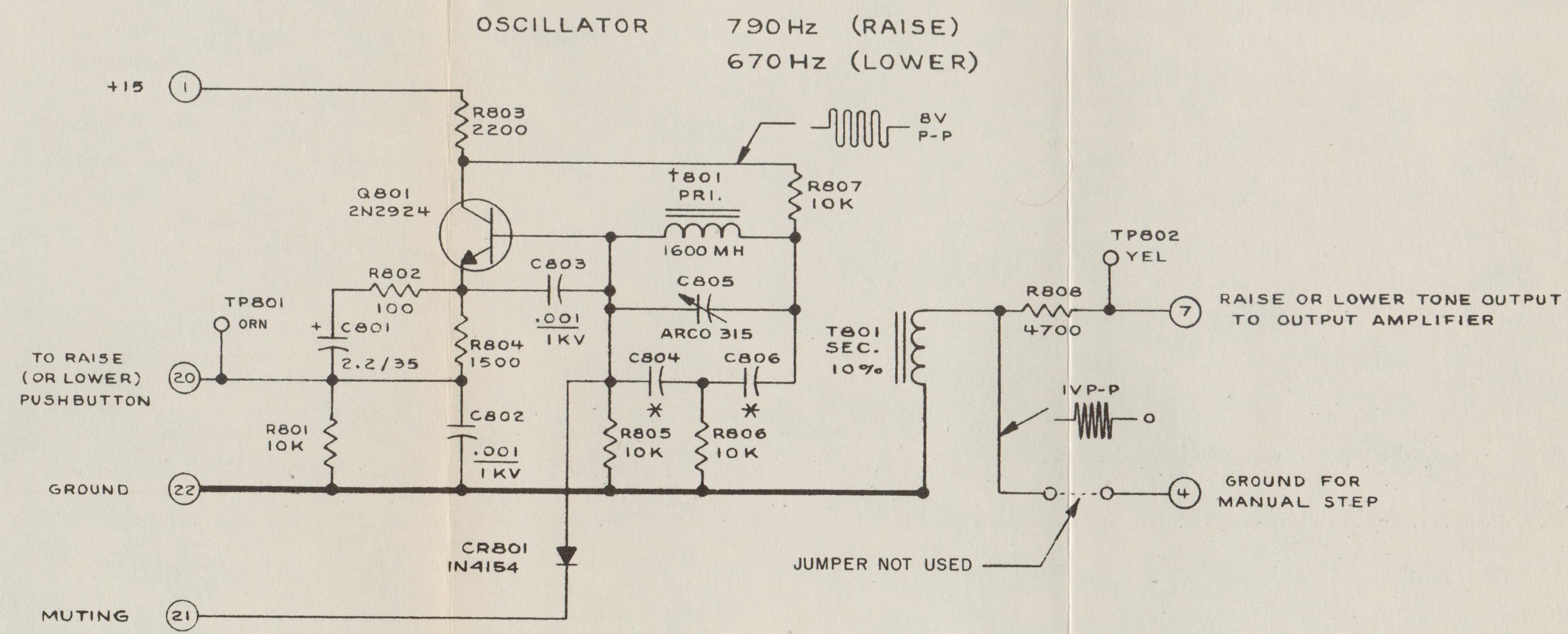
1 UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS, 1/2W, 10%. CAPACITOR VALUES ARE IN MICROFARADS.

2 P.C. BOARD 51A5197.

3 * C704 & C706 ARE METALIZED POLYCARBONATE ±3%.

2P007

Figure 43. SCU Control Oscillator (Board 7), Schematic Diagram



NOTES:

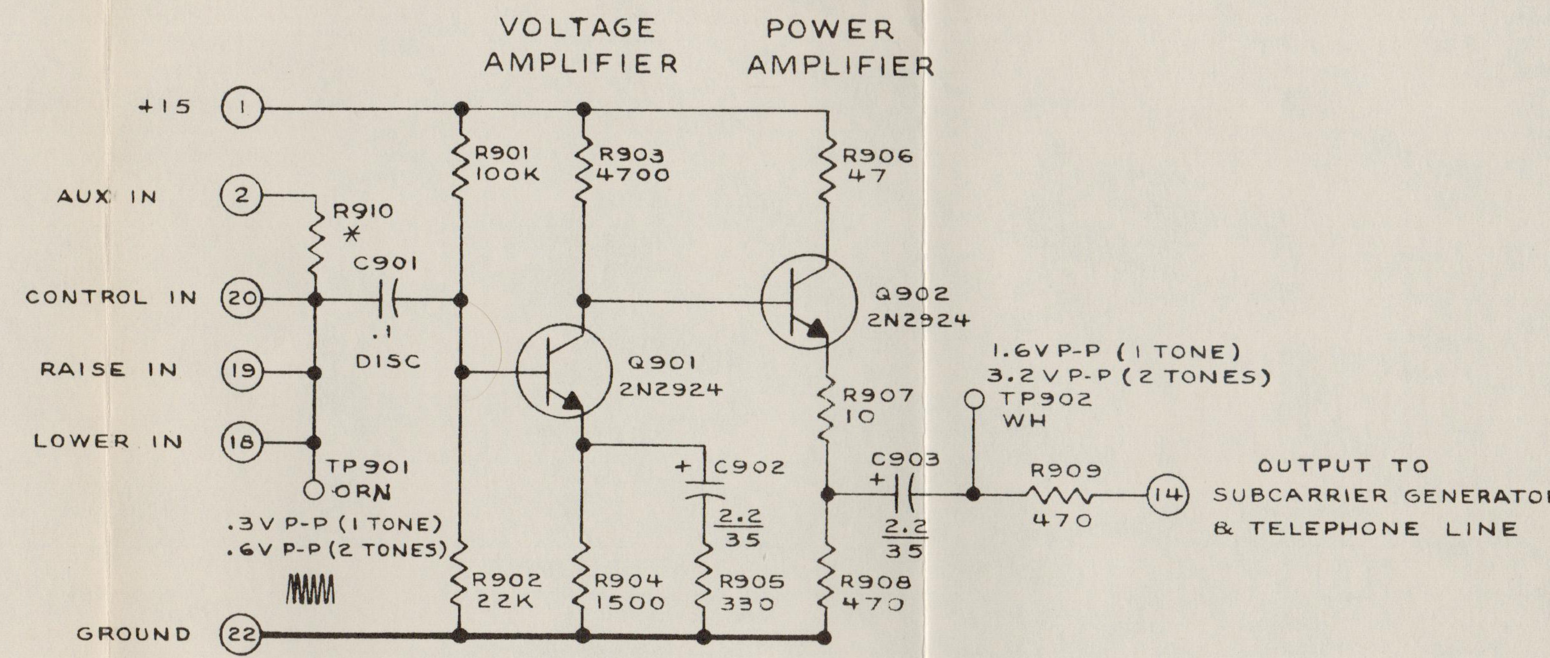
1 UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%.
CAPACITOR VALUES ARE IN MICROFARADS.

2 ✳ TUNING CAPACITORS C804 & C806 ARE
METALIZED POLYCARBONATE ± 3%.
.068 μF FOR "LOWER" (670 HZ)
.047 μF FOR "RAISE" (790 HZ)

3 P.C. BOARD 51A5198.

2P008

Figure 44. SCU Tone Oscillator (Board 8), Schematic Diagram



NOTES:

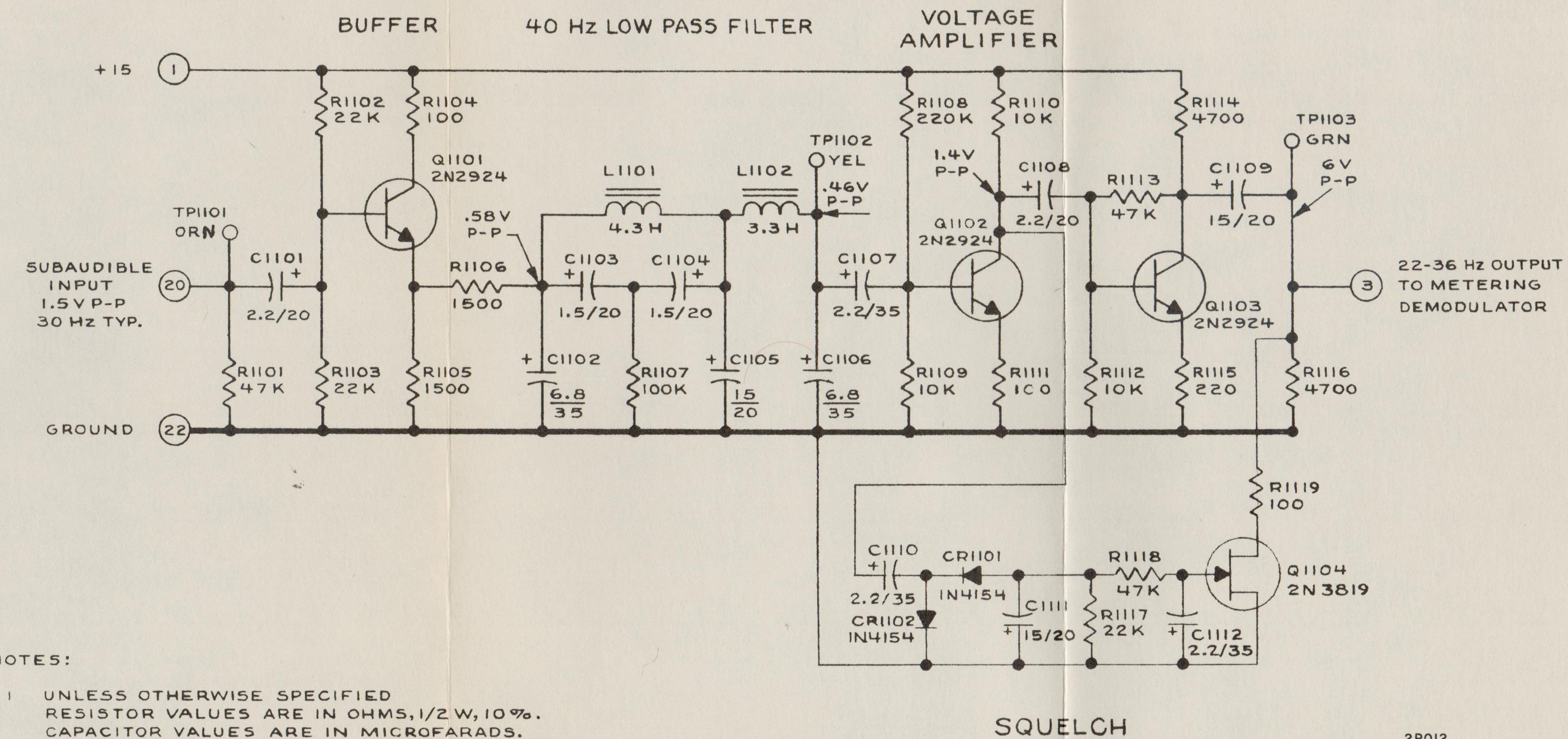
1 UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%.
CAPACITOR VALUES ARE IN MICROFARADS.

2 P.C. BOARD 51A5200.

3 * DENOTES SELECTED VALUE.

2P010

Figure 45. SCU Output Amplifier (Board 9), Schematic Diagram

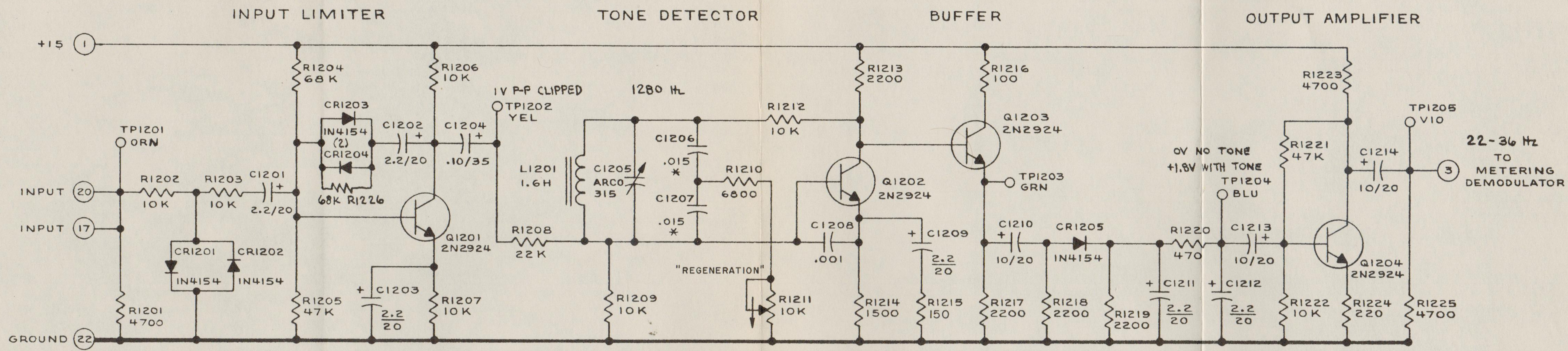


NOTES:

1. UNLESS OTHERWISE SPECIFIED
   RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%.
   CAPACITOR VALUES ARE IN MICROFARADS.

2. P.C. BOARD 51A5203.

Figure 46. SCU Subaudible Metering Processor (Board 11), Schematic Diagram



NOTES:

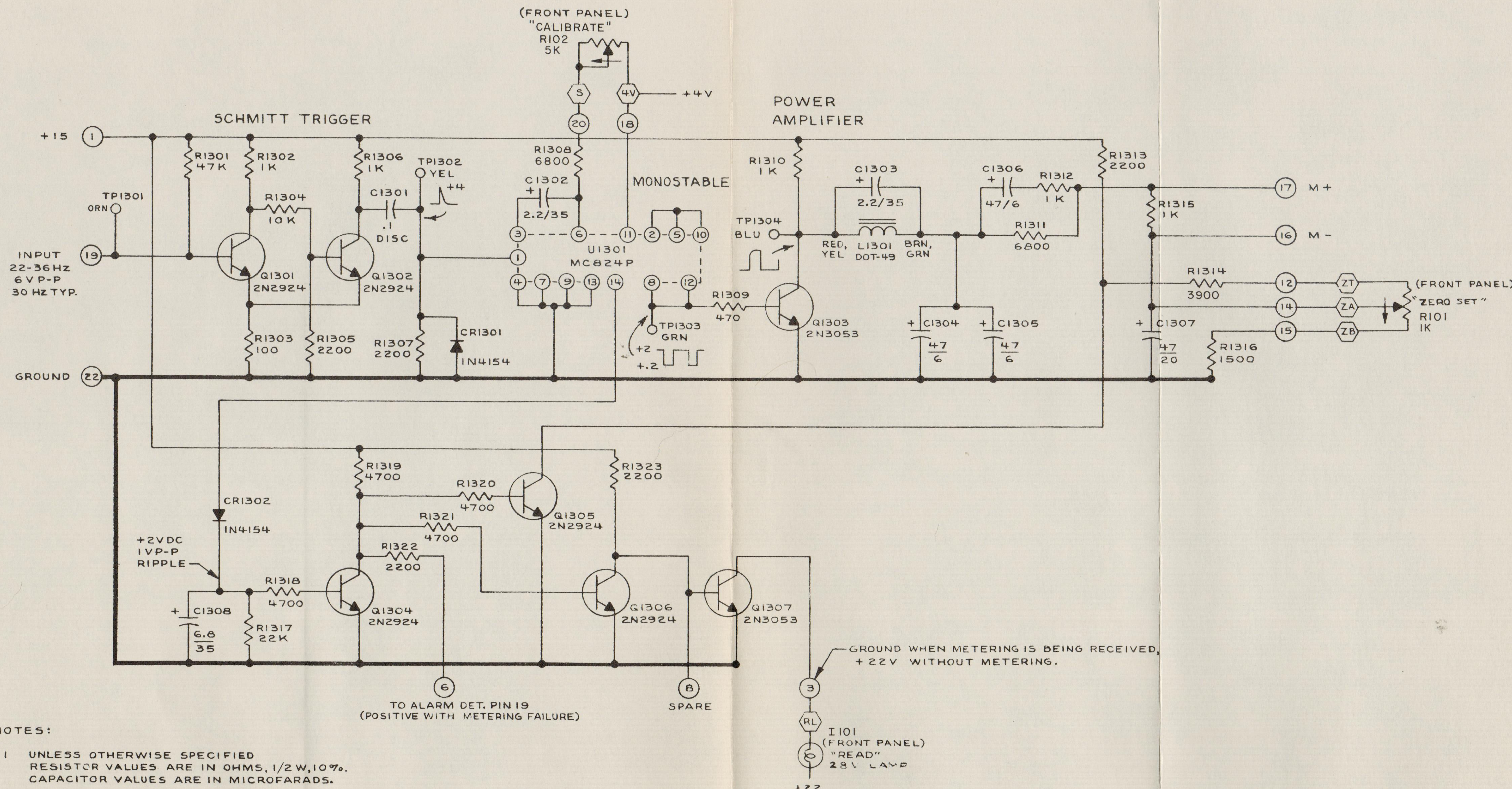
1 UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%.
CAPACITOR VALUES ARE IN MICROFARADS.

2 * C1206 & C1207 ARE METALIZED POLYCARBONATE, ± 3%.

3 P.C. BOARD 51A5202.

2P013

Figure 47. SCU Audible Metering Processor (Board 12), Schematic Diagram



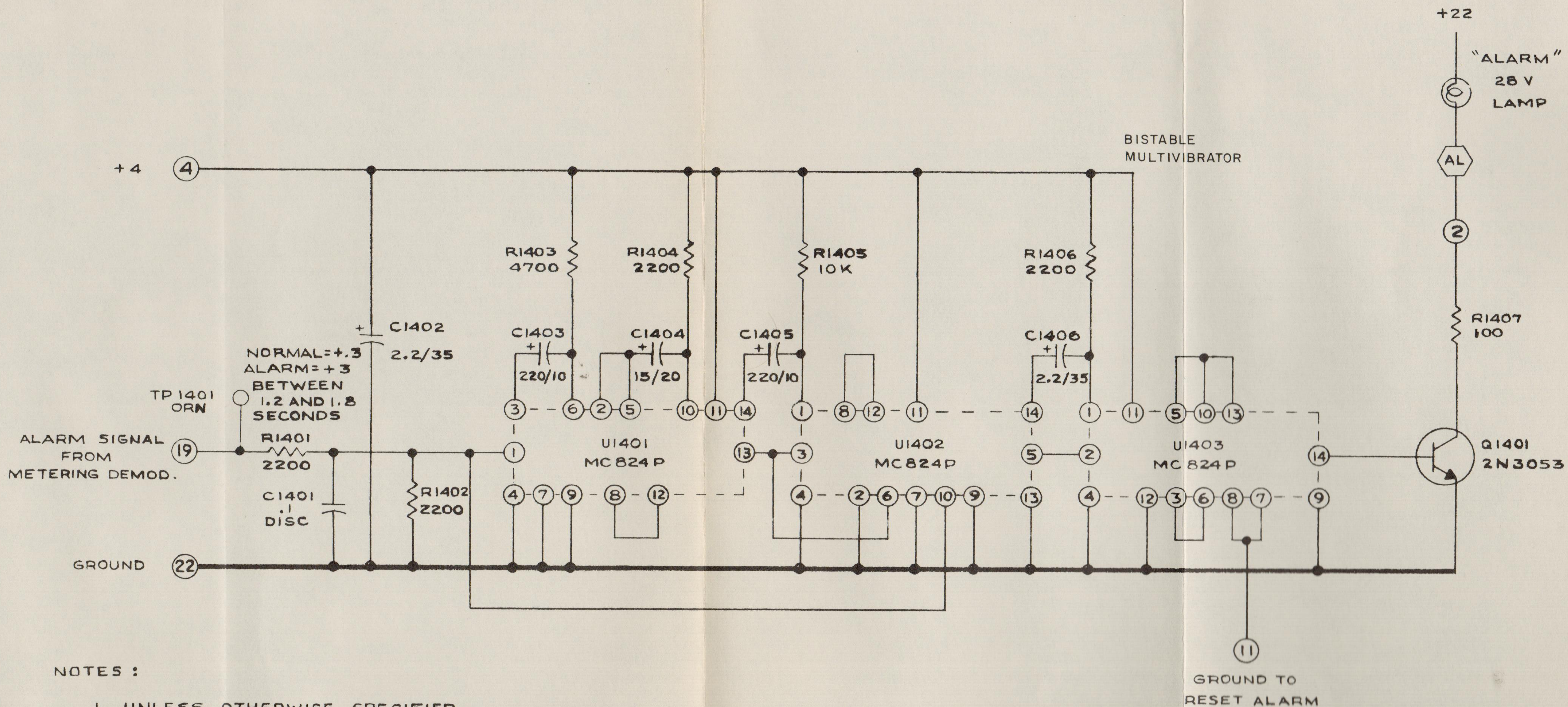
NOTES:

1 UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%.
CAPACITOR VALUES ARE IN MICROFARADS.

2 P.C. BOARD 51A5205.

3 ⬡ DENOTES TERMINAL ON MOTHER BOARD.

Figure 48. SCU Metering Demodulator (Board 13), Schematic Diagram

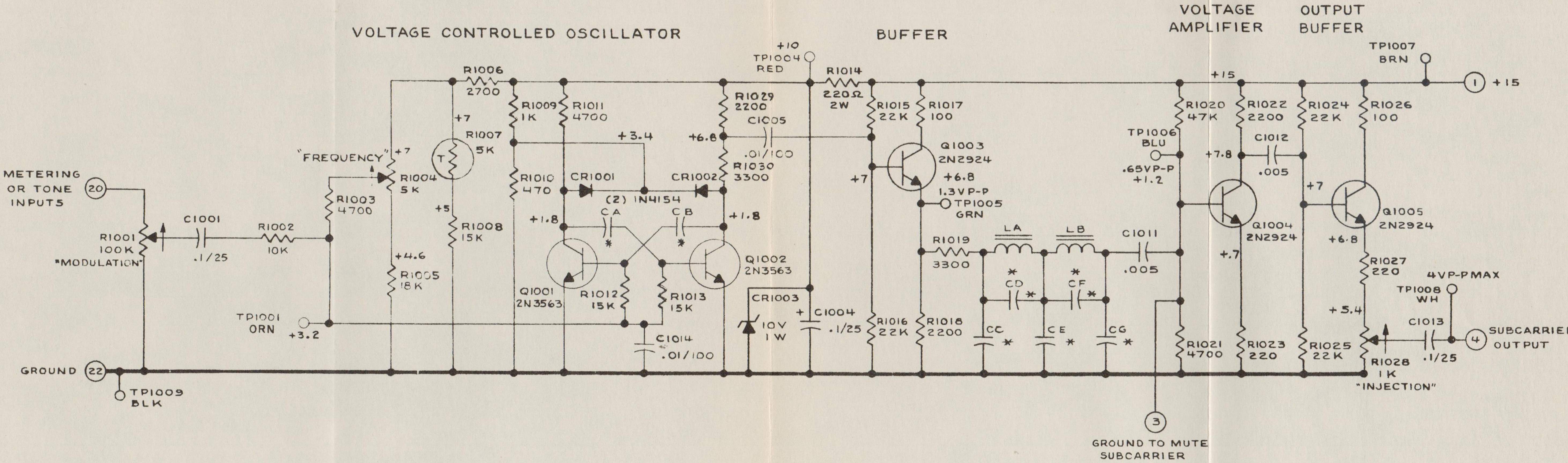


NOTES:

1 UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%.
CAPACITOR " " " MICROFARADS
2 ⬡ DENOTES TERMINAL ON MOTHER BD.
3 C1402 AND R1403 DETERMINE WINDOW DELAY.
4 C1404 AND R1405 " " WIDTH.
5 P.C. BOARD 51A5204A.

2P015

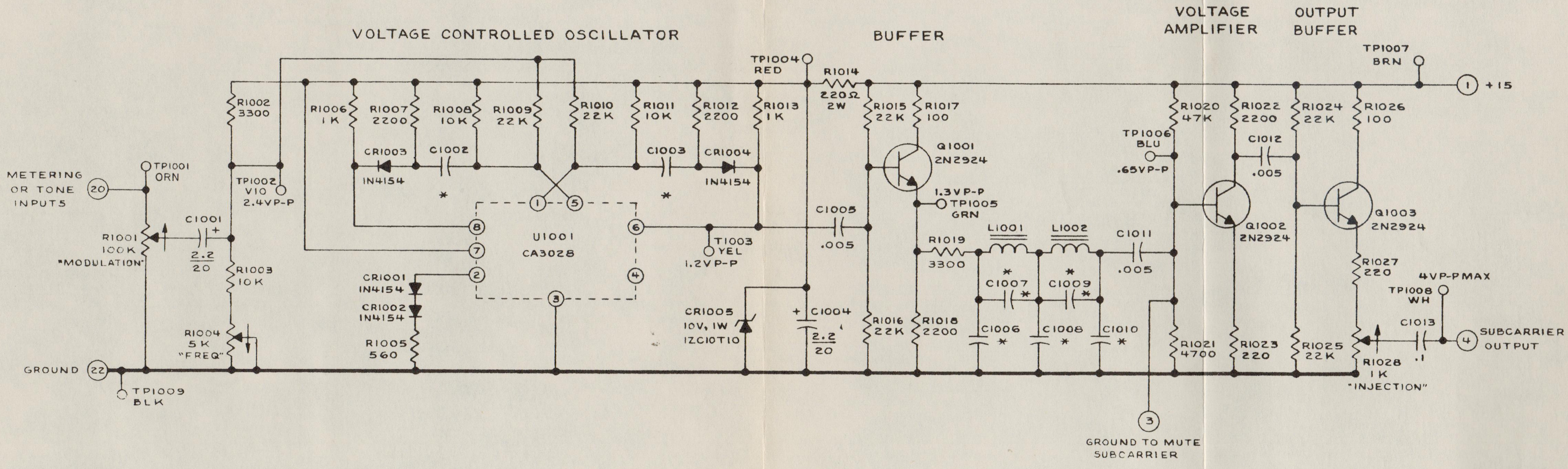
Figure 49. SCU Alarm Detector (Board 14), Schematic Diagram



NOTES:

1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%. CAPACITOR VALUES ARE IN MICROFARADS.
2. P. C. BOARD 51A5201A.
3. COMPONENT LAYOUT 20A2121.
4. * DENOTES FREQUENCY DETERMINING COMPONENT. VALUES SHOWN IN TABLE I.

Figure 50. Subcarrier Generator (Board 10A), Schematic Diagram

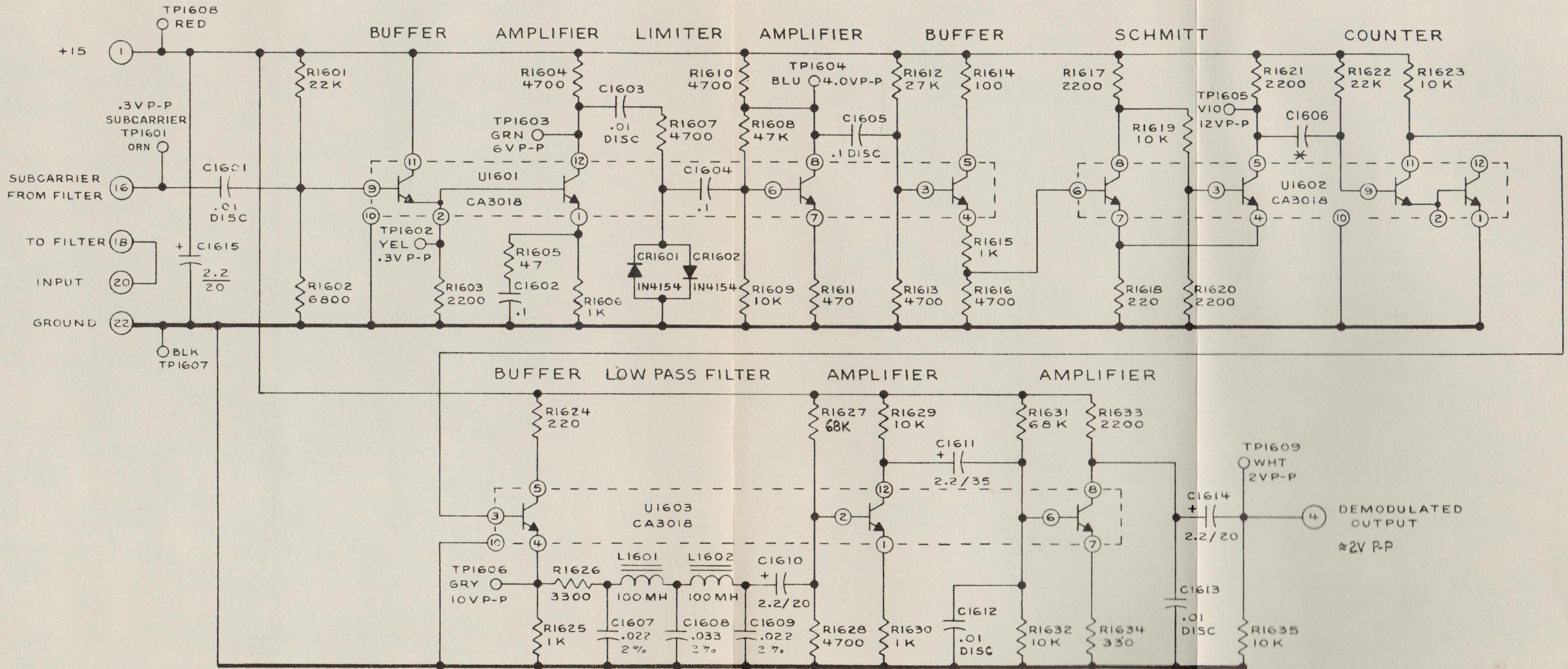


NOTES:

1. UNLESS OTHERWISE SPECIFIED
   RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%.
   CAPACITOR VALUES ARE IN MICROFARADS.
2. P. C. BOARD 51A5201.
3. * DENOTES FREQUENCY DETERMINING COMPONENT.
   VALUES SHOWN IN TABLE 2.

2P009

Figure 50a. Subcarrier Generator (Board 10), Schematic Diagram



NOTES:

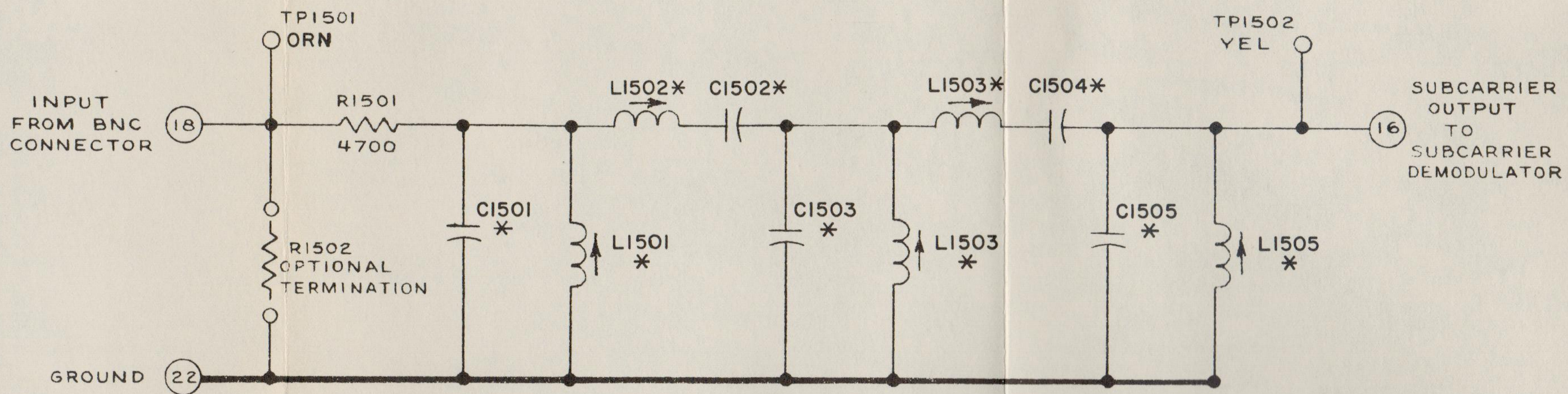
1. UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2W, 10%.
CAPACITOR VALUES ARE IN MICROFARADS.

2. * DENOTES FREQUENCY DEPENDENT VALUE.
C1606 IS 820Pf FOR 26KHz.

3. P.C. BOARD 51A5212.

2P017

Figure 51. Subcarrier Demodulator (Board 16), Schematic Diagram



NOTES:

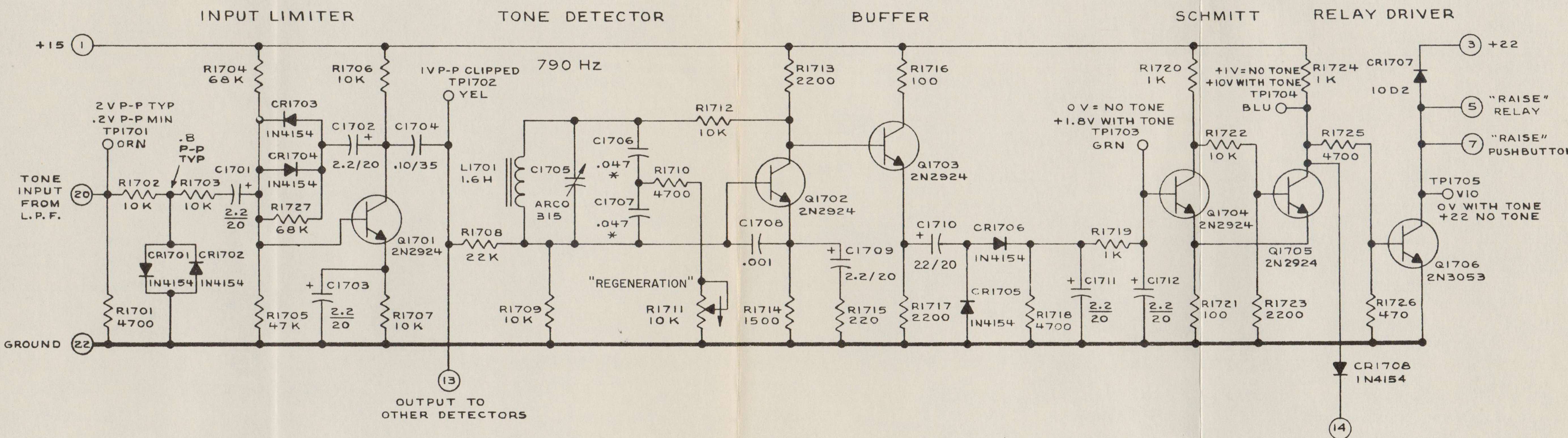
1 UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%.
CAPACITOR VALUES ARE IN MICROFARADS

2 * FREQUENCY DEPENDENT VALUES PRESENTED IN TABLE 3

3 P.C. BOARD 51A5214.

2P016

Figure 52. Subcarrier Filter (Board 15), Schematic Diagram



NOTES:

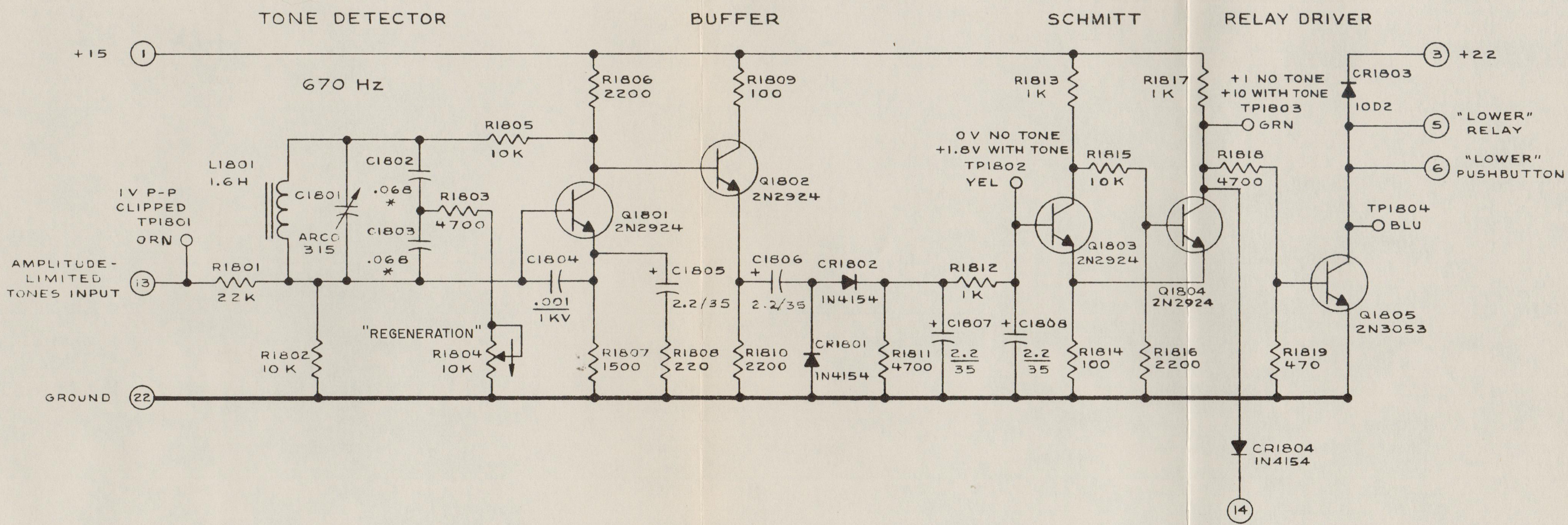
1 UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2W, 10%.
CAPACITOR VALUES ARE IN MICROFARADS.

2 * C1706 & C1607 ARE METALIZED POLYCARBONATE ±3%.

3 P.C. BOARD 51A5211.

2P018

Figure 53. TCU Raise Detector (Board 17), Schematic Diagram



NOTES:

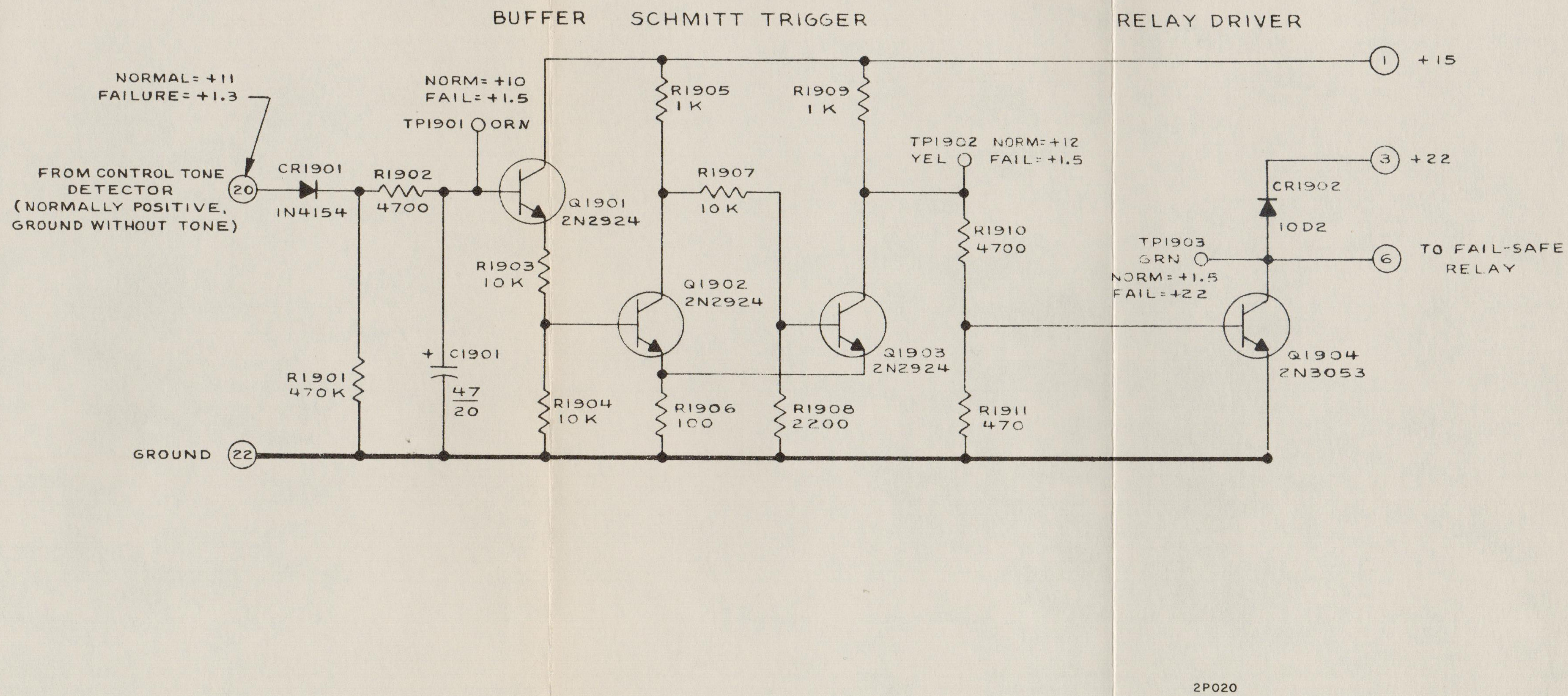
1 UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2W, 10%.
CAPACITOR VALUES ARE IN MICROFARADS.

2 * C1802 & C1803 ARE METALIZED POLYCARBONATE ± 3%.

3 P.C. BOARD 51A5210.

2P019

Figure 54. TCU Lower Detector (Board 18), Schematic Diagram

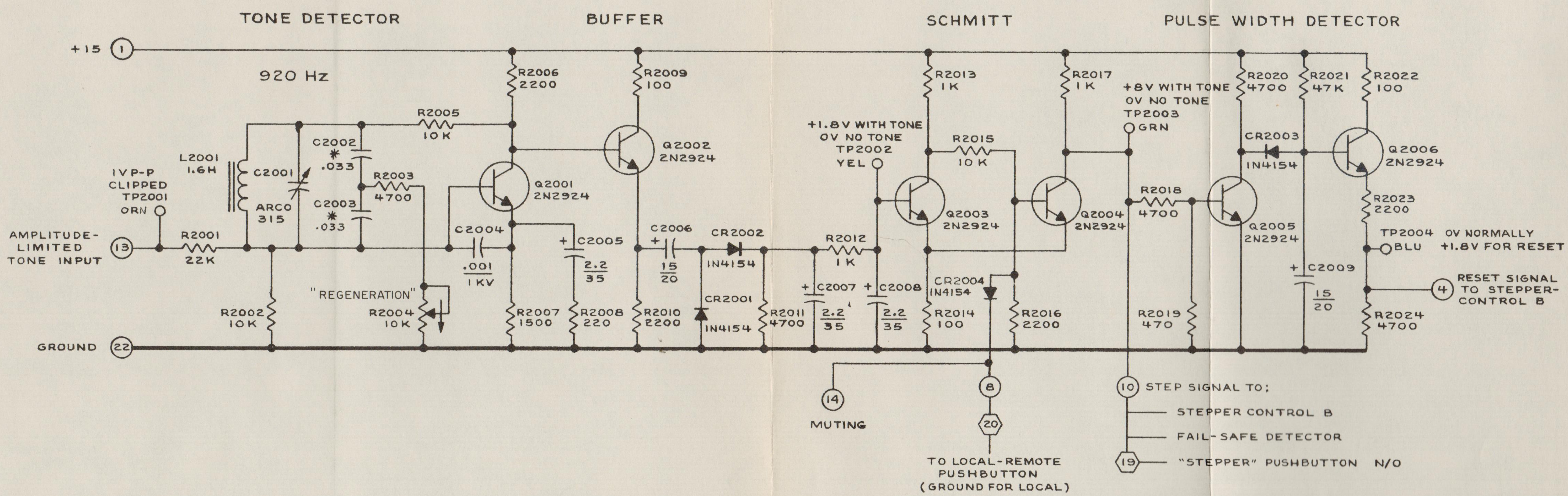


NOTES:

1 UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%.
CAPACITOR VALUES ARE IN MICROFARADS.

2 P.C. BOARD 51A5209.

Figure 55. TCU Failsafe (Board 19), Schematic Diagram

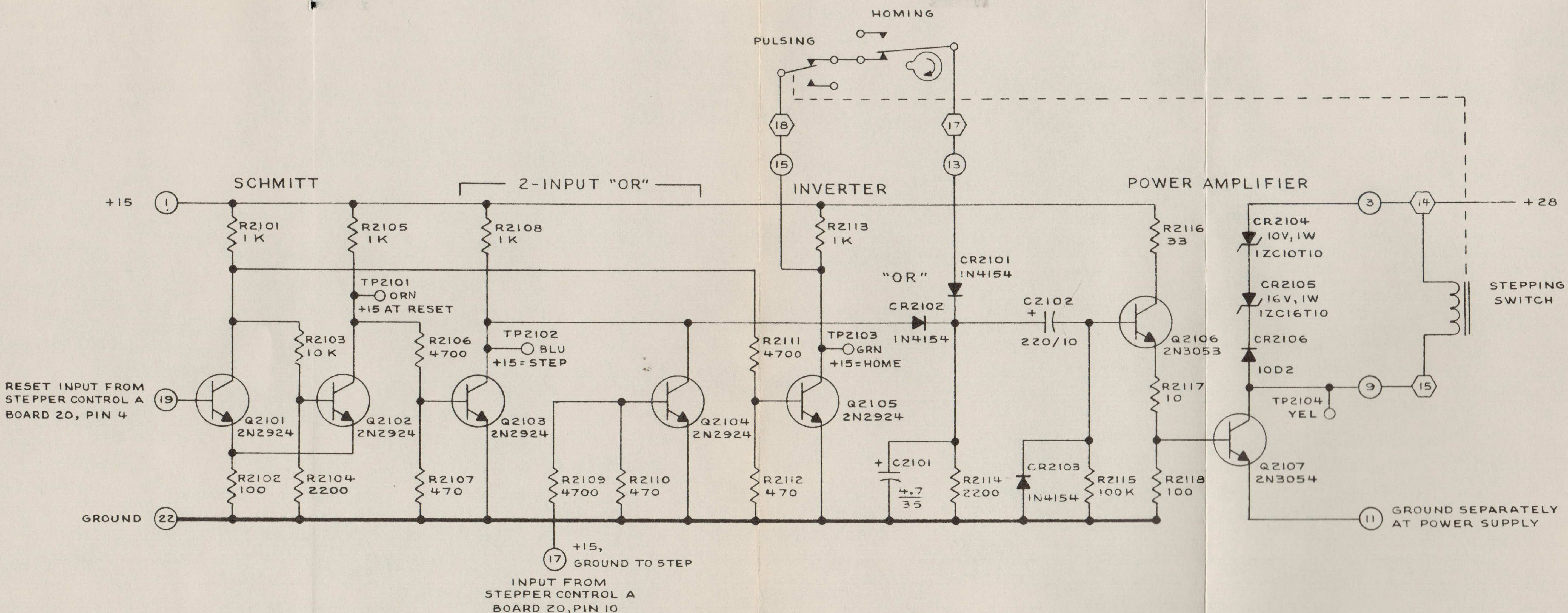


NOTES:

1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS, 1/2W, 10% CAPACITOR VALUES ARE IN MICROFARADS.
2. ⬡ DENOTES TERMINAL ON MOTHER BOARD.
3. P.C. BOARD 51A5218.
4. * C2002 AND C2003 ARE METALIZED POLYCARBONATE ± 3%

2P021

Figure 56. TCU Stepper Control A (Board 20), Schematic Diagram



NOTES:

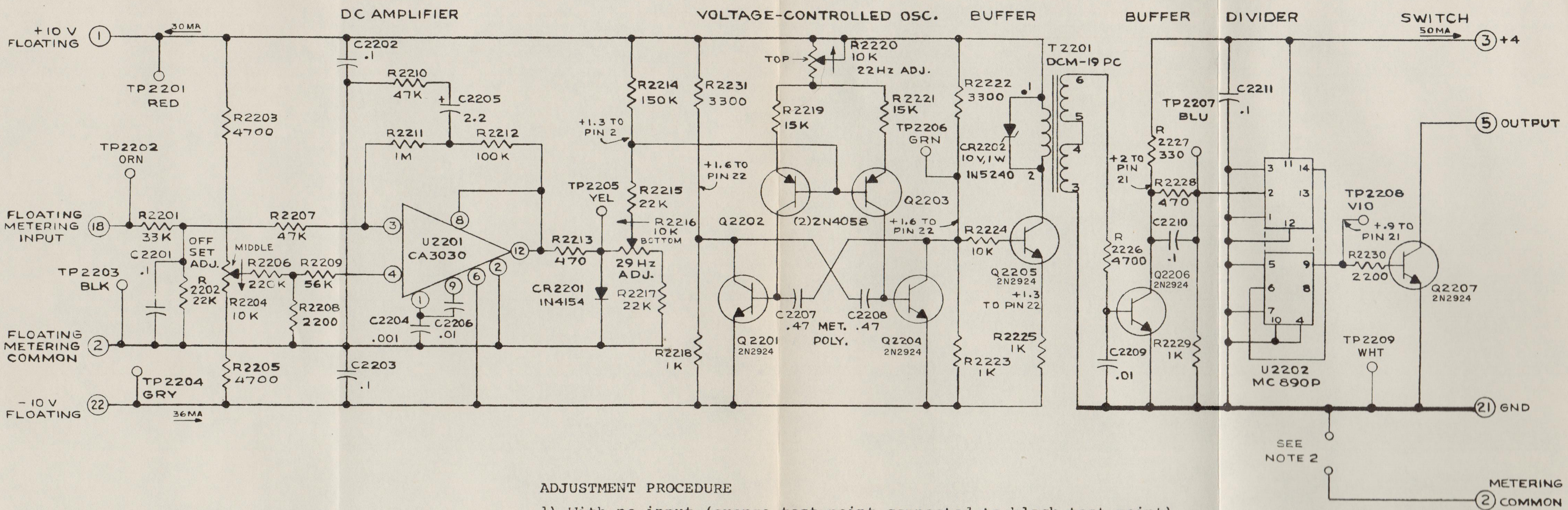
1 UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%. CAPACITOR VALUES ARE IN MICROFARADS.

2 ⬡ DENOTES TERMINAL ON MOTHER BOARD.

3 P. C. BOARD 51A5216.

2P022

Figure 57. TCU Stepper Control B (Board 21), Schematic Diagram



NOTES:

1 UNLESS OTHERWISE SPECIFIED
RESISTOR VALUES ARE IN OHMS, 1/2 W, 10 %
CAPACITOR " " " MICROFARADS

2 JUMPER NOT USED ON BTR-30A

3 P.C. BOARD 51A5213 A

ADJUSTMENT PROCEDURE

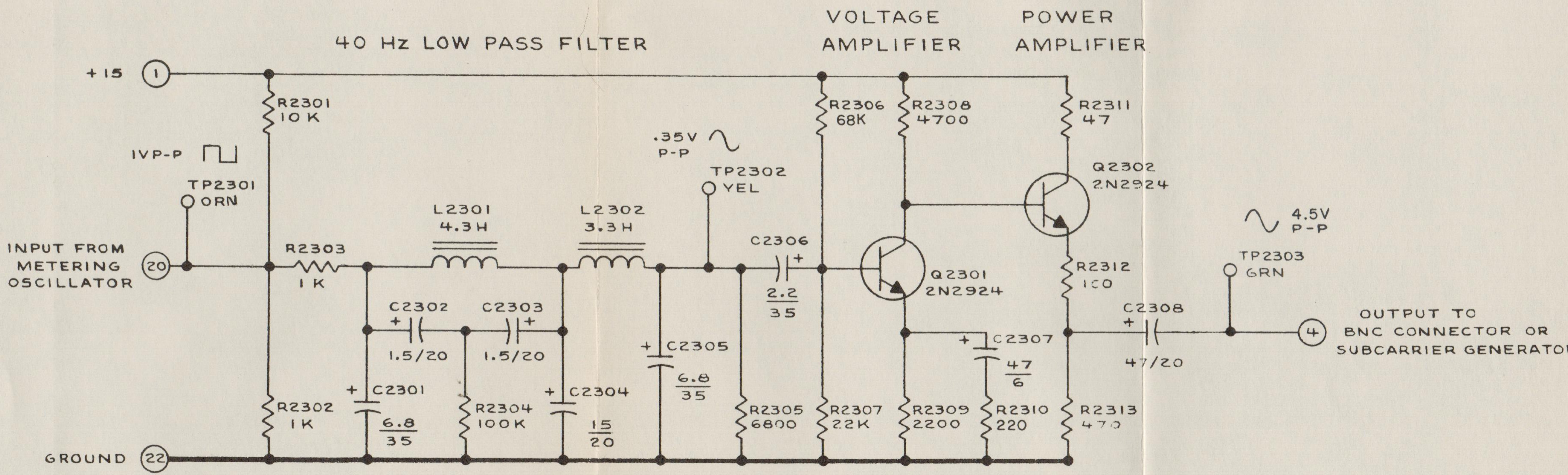
1) With no input (orange test point connected to black test point), adjust the middle potentiometer for zero volts DC as measured between the black and the yellow test points.

2) At that time, adjust the top potentiometer (R-2220) for an output frequency of 22 Hz as measured at the violet test point. For standard AM broadcast transmitters, adjust for a frequency of 20 Hz.

3) Remove the connection between the orange and black test points. Home the stepping switch to the Calibrate position and adjust the bottom potentiometer (R-2216) for an output frequency of 29 Hz as measured at the violet test point. For standard AM broadcast transmitters, adjust for a frequency of 25 Hz.

2P023

Figure 58. TCU Metering Oscillator, (Board 22), Schematic Diagram



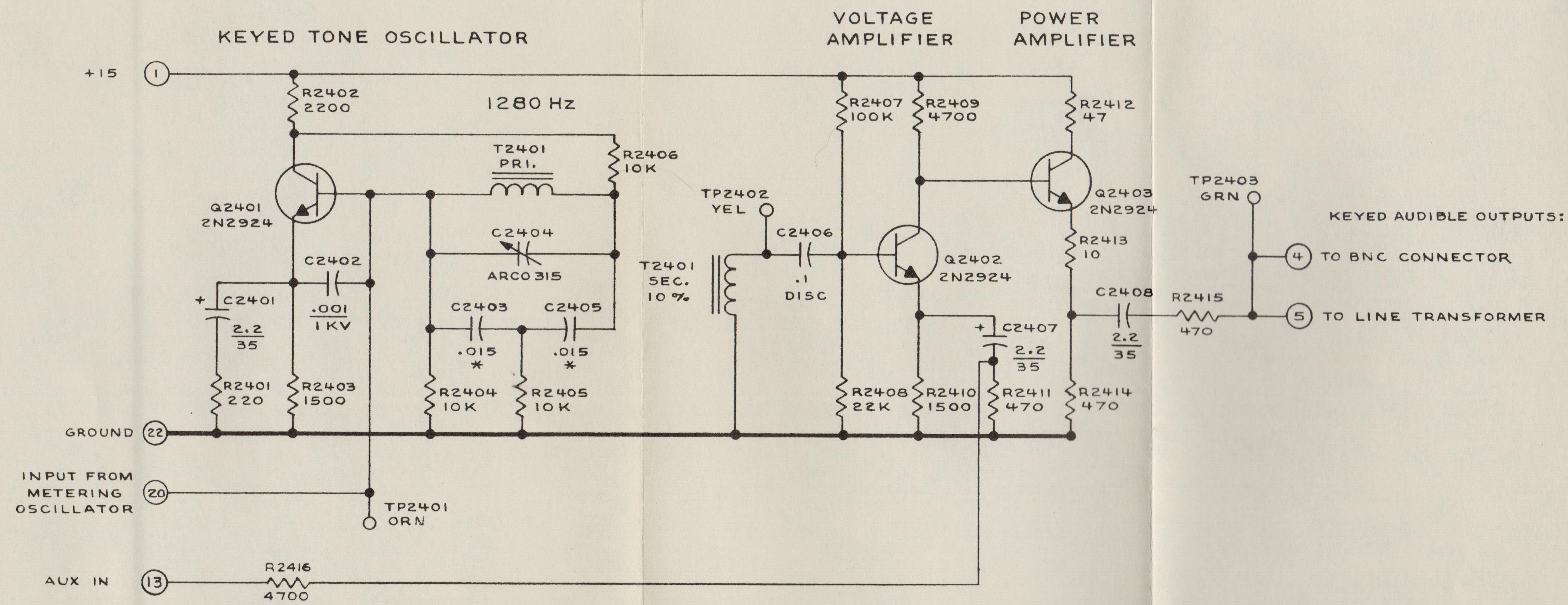
NOTES:

1 UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS, 1/2 W, 10%. CAPACITOR VALUES ARE IN MICROFARADS.

2 P.C. BOARD 51A5219.

2P024

Figure 59. TCU Subaudible Metering Processor, (Board 23), Schematic Diagram



NOTES:

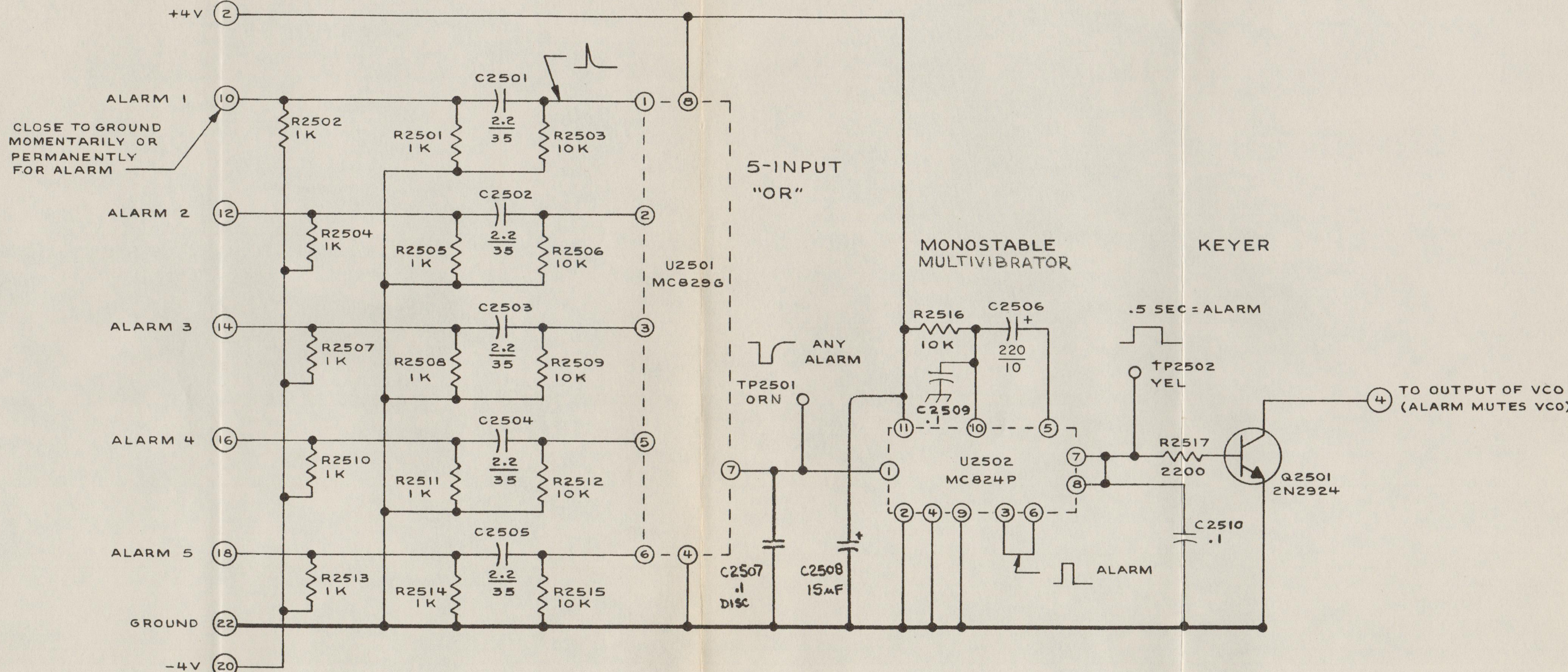
1 UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS, 1/2, 10% CAPACITOR VALUES ARE IN MICROFARADS.

2 * C2403 & C2405 ARE METALIZED POLYCARBONATE, ± 3%.

3 P.C. BOARD 51A5215.

2P025

Figure 60. TCU Audible Metering Processor, (Board 24), Schematic Diagram



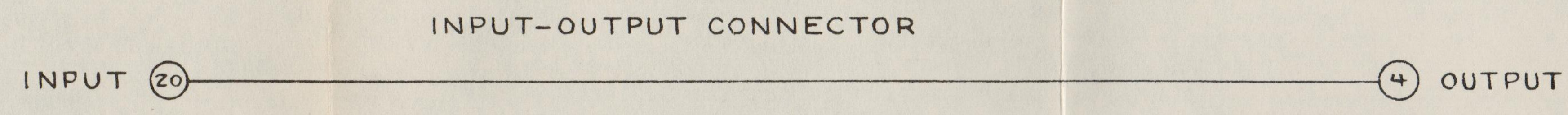
NOTES:

1 UNLESS OTHERWISE SPECIFIED,
RESISTOR VALUES ARE IN OHMS, 1/2W, 10%
CAPACITOR VALUES ARE IN MICROFARADS.

2 P.C. BOARD 51A5217.

2P026

Figure 61. TCU Alarm Encoder (Board 25), Schematic Diagram



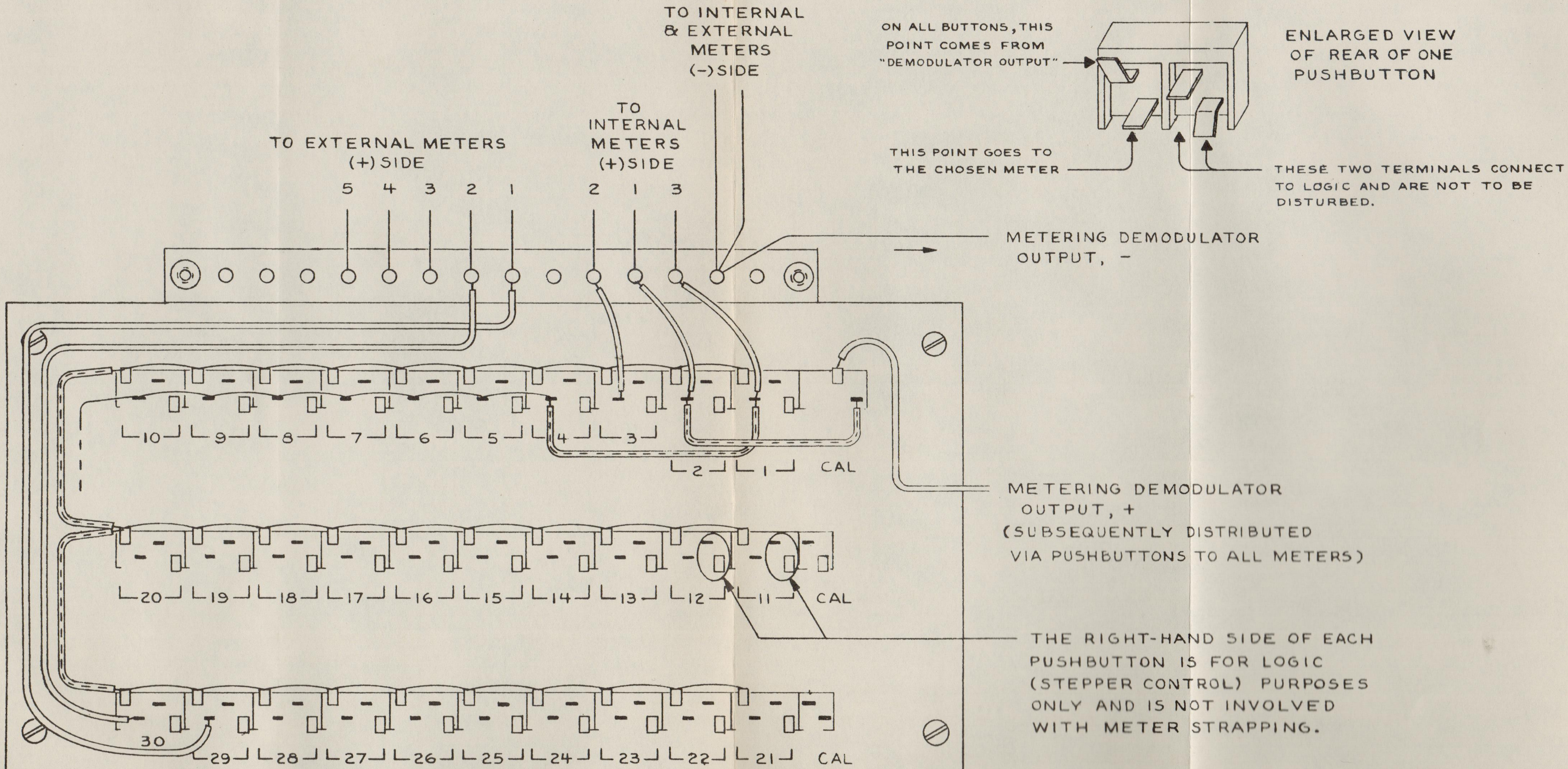
NOTES

1. THIS BOARD SUBSTITUES FOR A SUBCARRIER GENERATOR OR DEMODULATOR WHEN BNC CONNECTORS ARE USED IN A NON-SUBCARRIER APPLICATION.

2. P.C. BOARD 51A5206.

2P027

Figure 62. Input-Output Connector (Board 26), Schematic Diagram



IN THIS PARTIAL DRAWING, "CALIBRATE" AND BUTTON 2 GO TO METER 1. 1 AND 4 THRU 28 GO TO METER 3. BUTTON 3 GOES TO METER 2. BUTTON 29 GOES TO EXTERNAL METER 1. BUTTON 30 GOES TO EXTERNAL METER 2.

2P028

Figure 63. Pushbutton Switch Function Guide

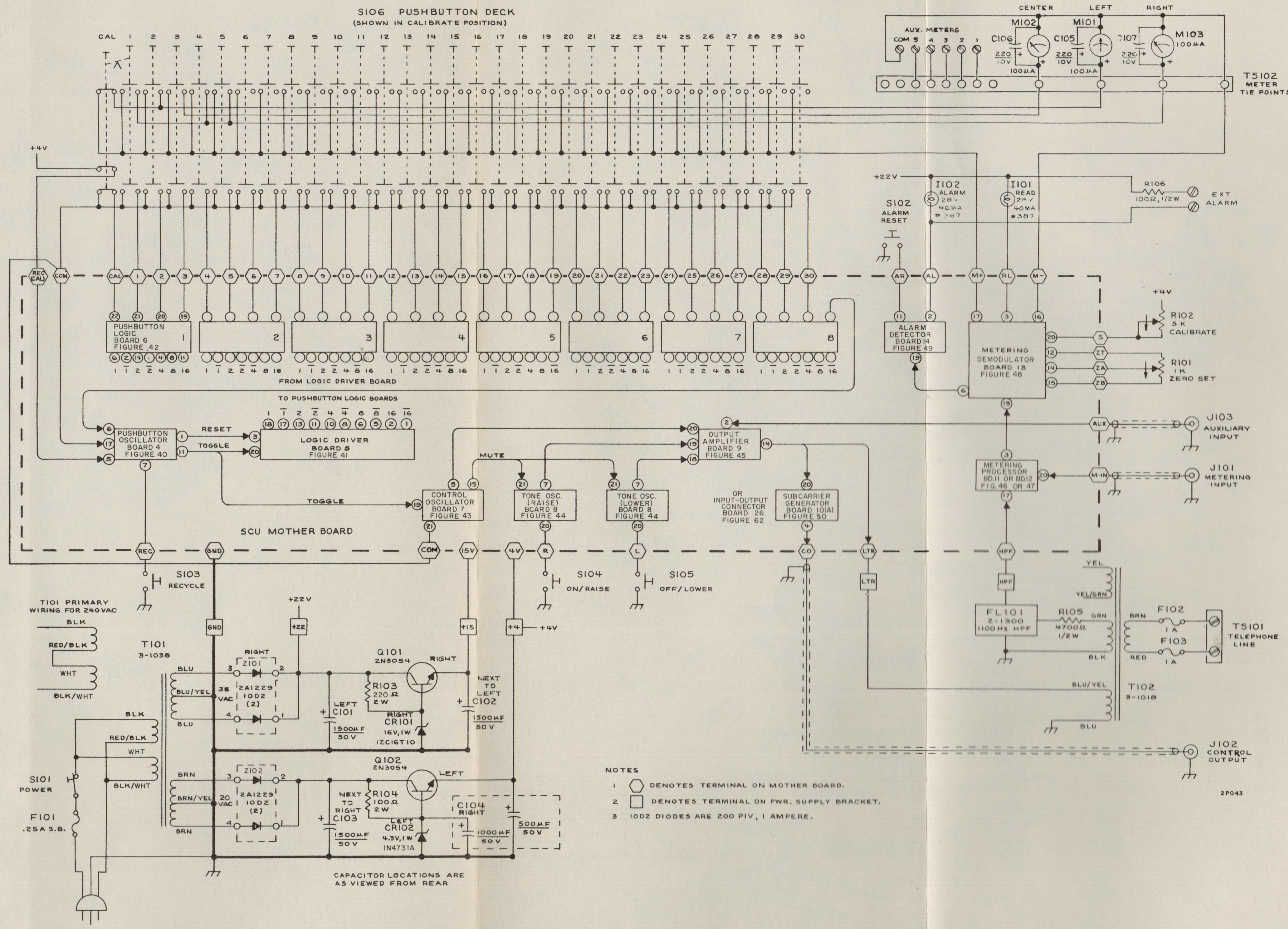


Figure 64. SCU Main Frame, Schematic Diagram

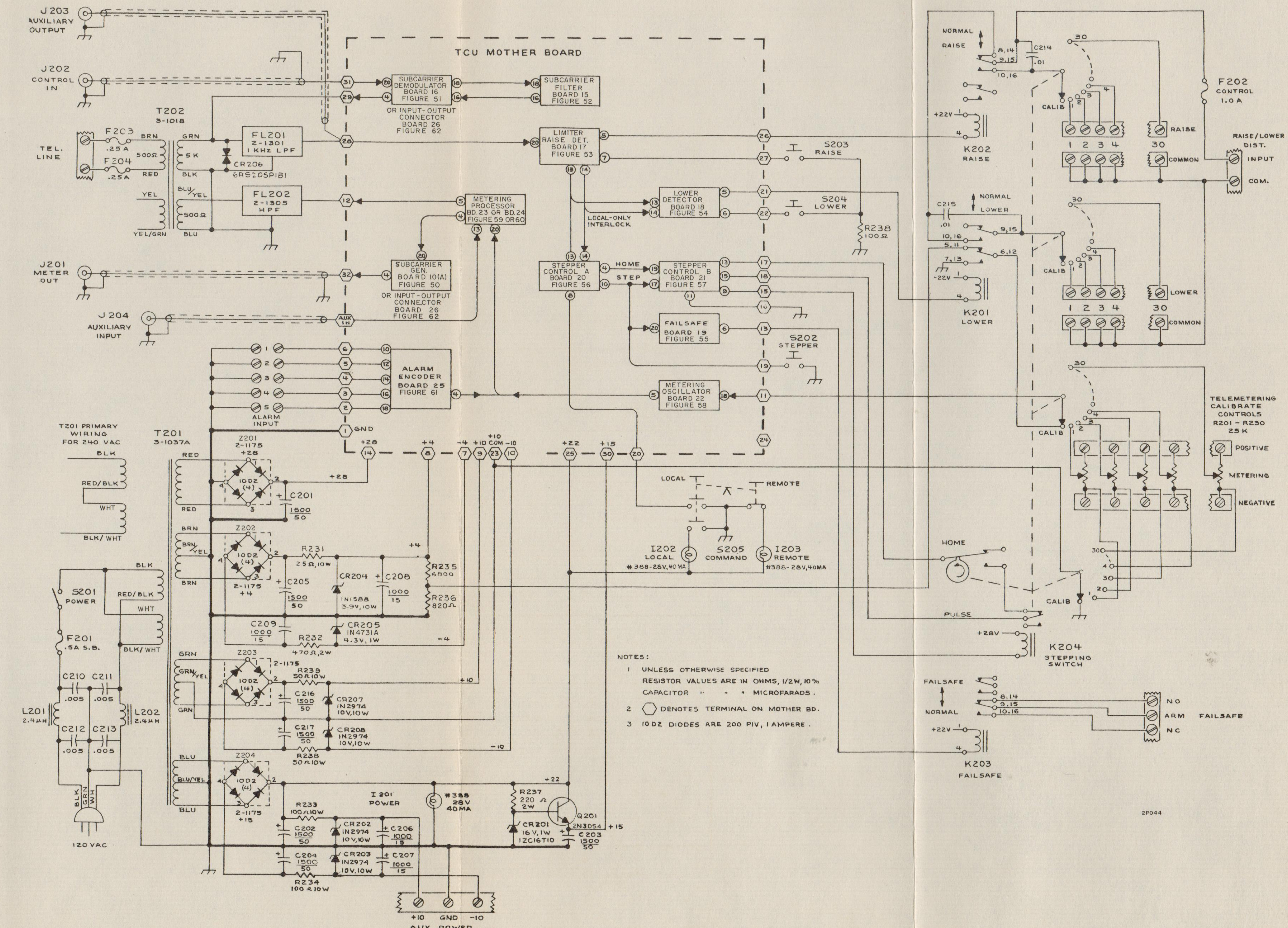
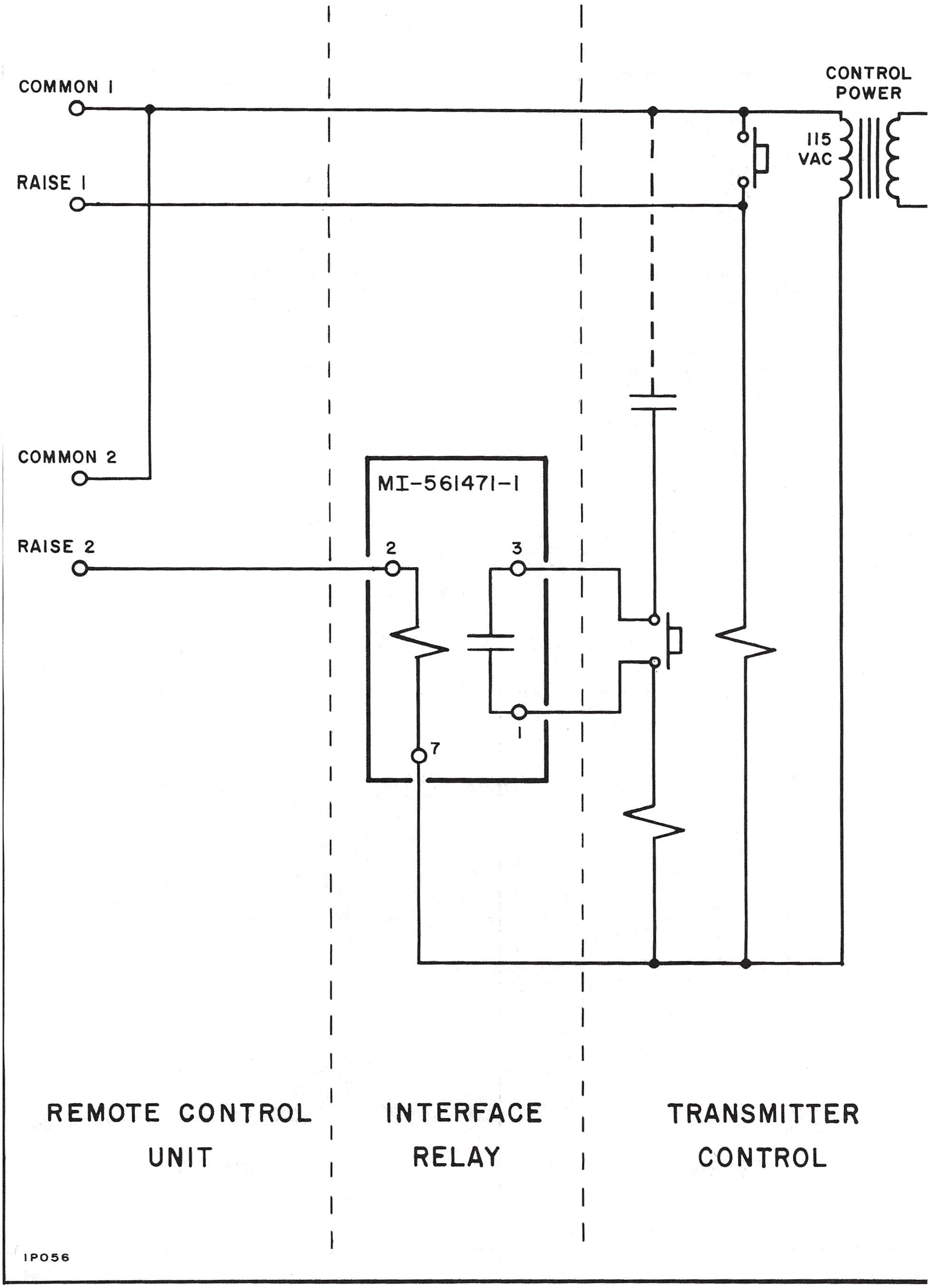
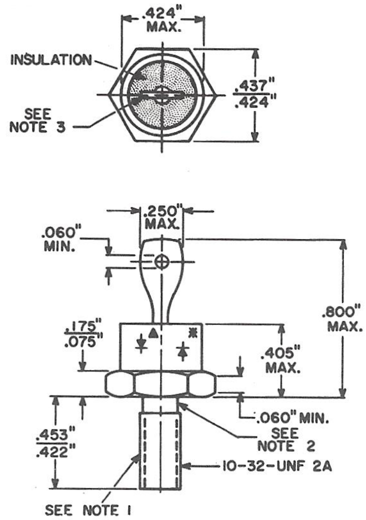
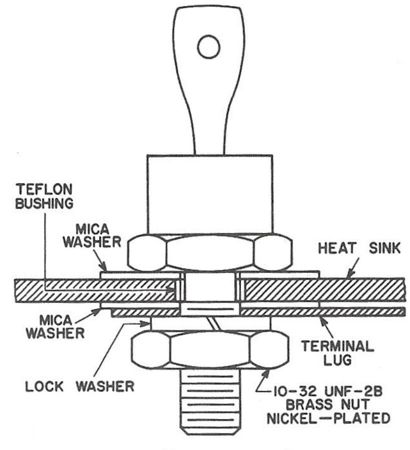


Figure 65. TCU Main Frame, Schematic Diagram


COMMON 1
RAISE 1
COMMON 2
RAISE 2
CONTROL POWER
115 VAC
MI-561471-1
2
3
1
7
REMOTE CONTROL UNIT
INTERFACE RELAY
TRANSMITTER CONTROL
1P056

DIMENSIONAL OUTLINE (JEDEC DO-4)





Suggested
Mounting Arrangement.

ote 1: The recommended installation torque is 5 to 20 inch-pounds applied to a 10/32 UNF-2B ex nut assembled on stud thread. The applied orque during installation should not exceed 25 nch-pounds.

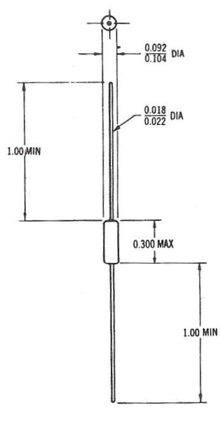
Note 2: Diameter of unthreaded portion: 0.189" max., 0.163" min.

Note 3: Angular orientation of this terminal is undefined.

Note 4: This device may be operated in any position.

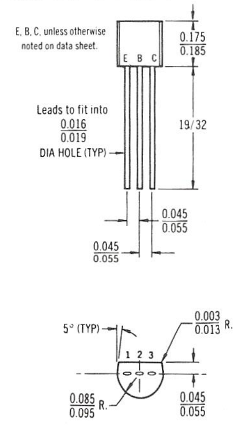
IN1588 AND IN2974

CASE 51 DO-7 PACKAGE

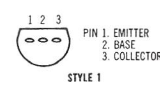


IN5240

CASE 29 TO-92 PACKAGE
PLASTIC TRANSISTOR



CASE 29 STYLES

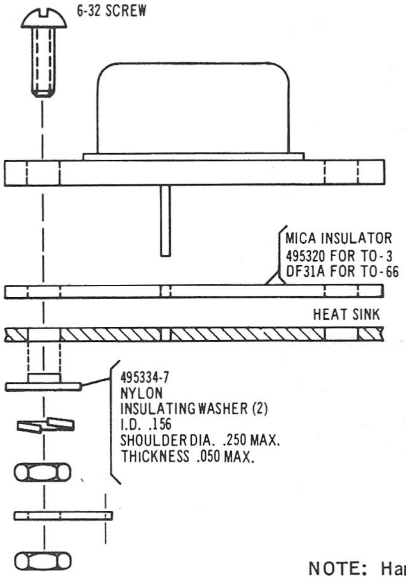


IN2924

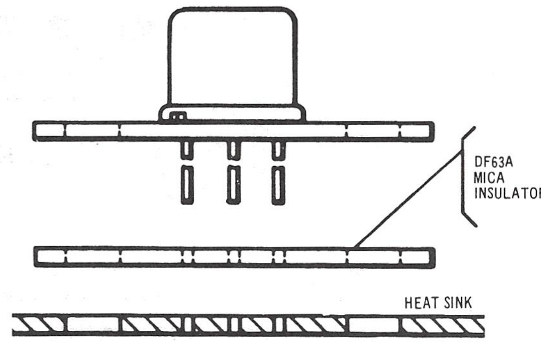
P071

SUGGESTED HARDWARE

FOR TO-3 & TO-66 PACKAGES
(2N3054 & 2N3055)

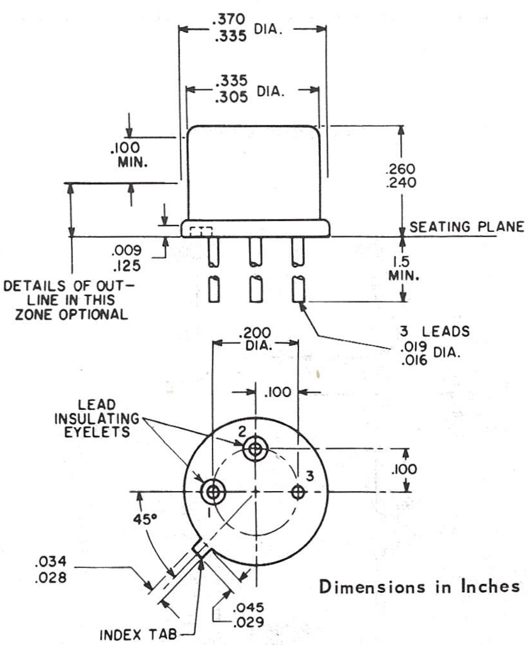


FOR FLANGE TO-5 PACKAGE



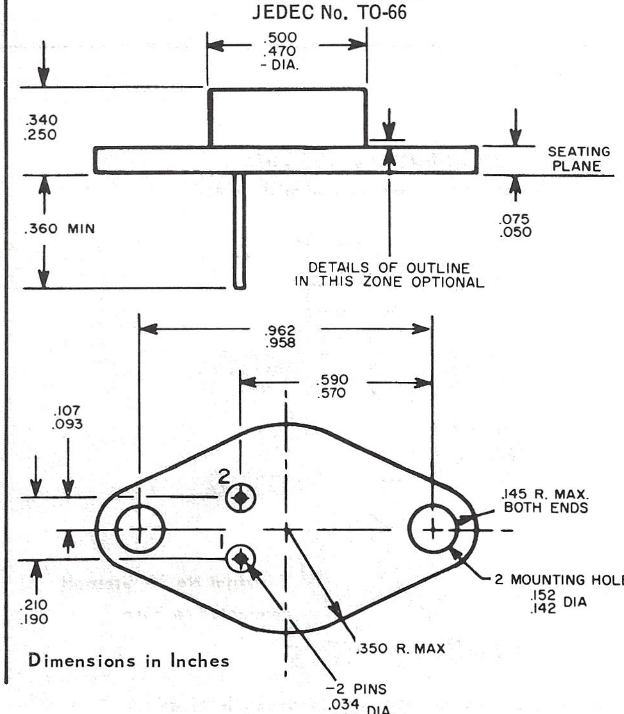
NOTE: Hardware With Part Numbers Supplied.

FOR TYPE 2N3053
JEDEC No. TO-5



Dimensions in Inches

FOR TYPE 2N3054
JEDEC No. TO-66



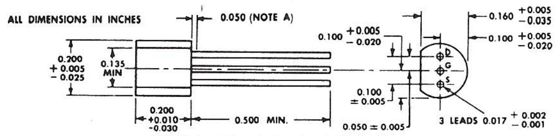
Dimensions in Inches

TERMINAL CONNECTIONS

FOR TYPE 2N3053	FOR TYPE 2N3054
Lead 1 - Emitter	Pin 1 - Base
Lead 2 - Base	Pin 2 - Emitter
Case, Lead 3 - Collector	Case, Flange - Collector

IP072

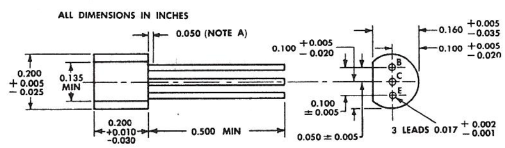
*ALL JEDEC TO-92 DIMENSIONS AND NOTES ARE APPLICABLE



NOTE A: Lead diameter is not controlled in this area.

2N3819

*ALL JEDEC TO-92 DIMENSIONS AND NOTES ARE APPLICABLE

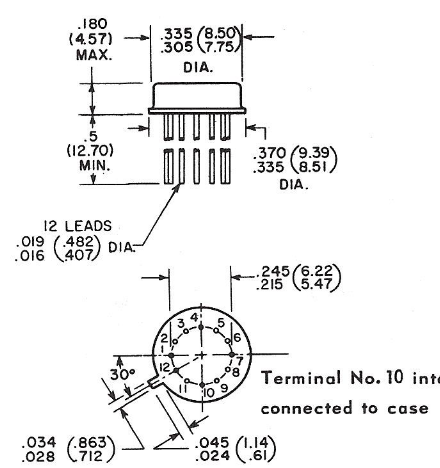


NOTE A: Lead diameter is not controlled in this area.

2N4058

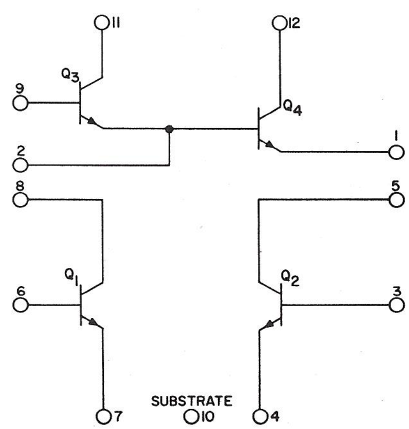
DIMENSIONAL OUTLINE

Dimensions In Inches and millimeters



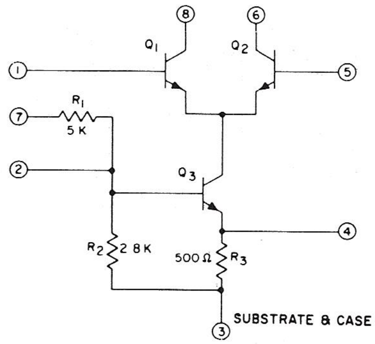
Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.

Schematic Diagram

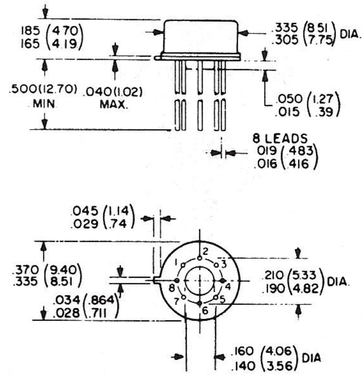


CA3018

Schematic diagram



DIMENSIONAL OUTLINE

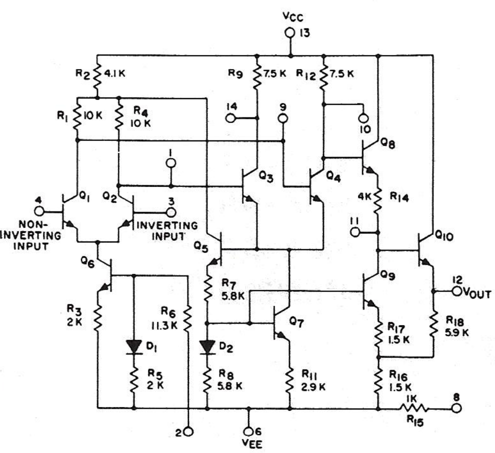


Dimensions in Inches and Millimeters

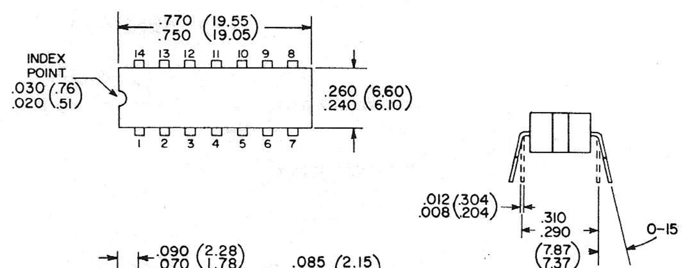
NOTE: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

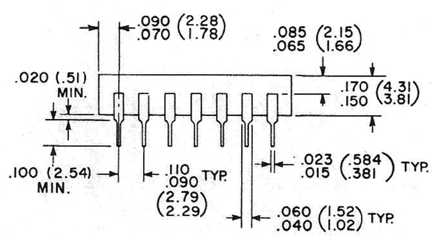
CA3028

SCHEMATIC DIAGRAM



DIMENSIONAL OUTLINE





14-Lead Dual In-Line Plastic Package JEDEC-TO-116

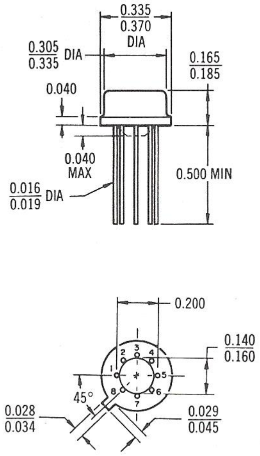
Dimensions in Inches and Millimeters

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.

CA3030

1P074

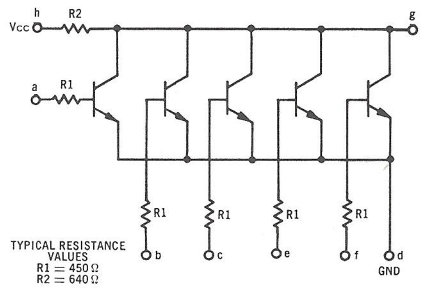
DIMENSIONAL OUTLINE

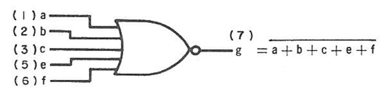


Pin 4 connected to case.

TO-99

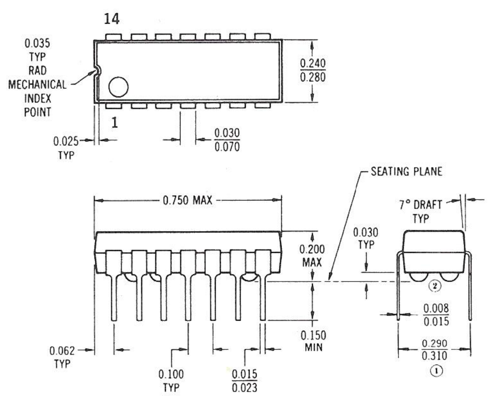
SCHEMATIC DIAGRAM





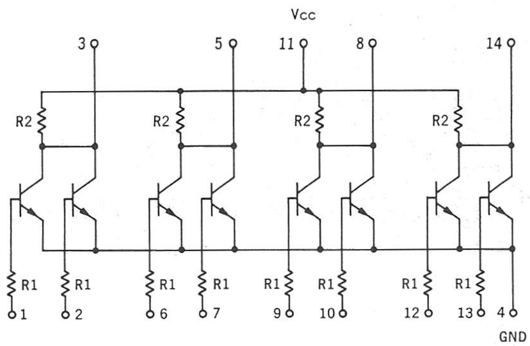
MC829G

DIMENSIONAL OUTLINE

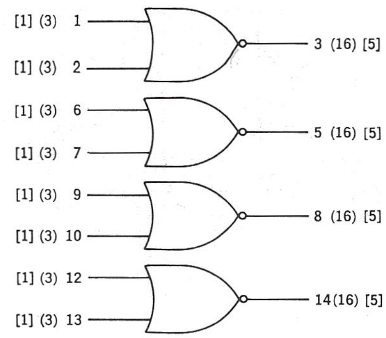


① This dimension is measured at the seating plane.
② 4 insulating stand-offs are provided.

MC824P
MC889P
MC890P
MC899P



TYPICAL RESISTANCE VALUES
R1 = 450 Ω
R2 = 640 Ω

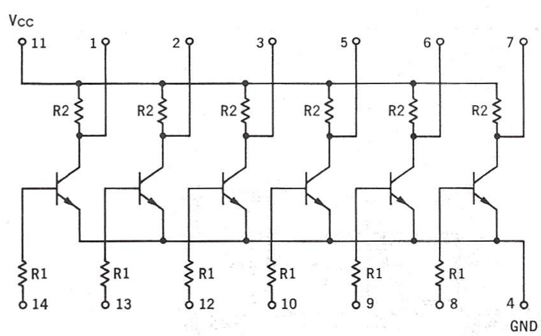


$3 = \overline{1 + 2}$

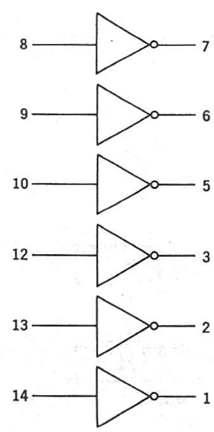
NUMBER IN PARENTHESIS INDICATES mW MRTL LOADING FACTOR

NUMBER IN BRACKETS INDICATES MRTL LOADING FACTOR

MC824P



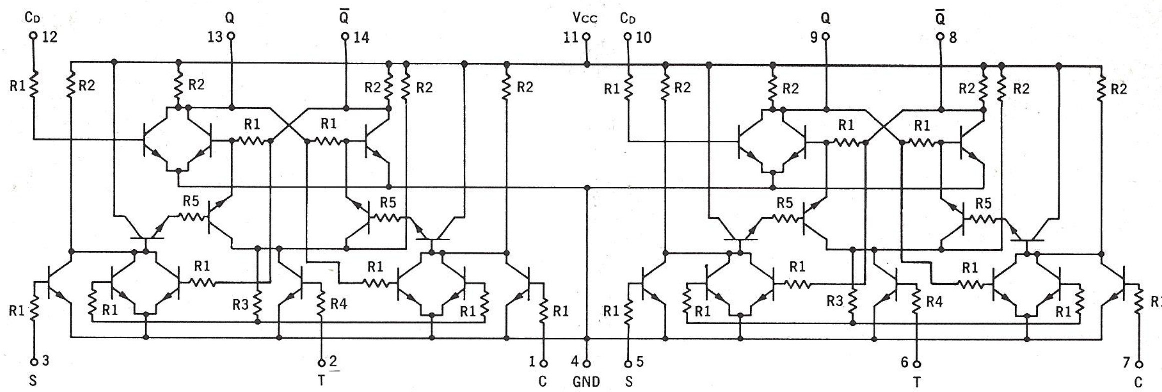
TYPICAL RESISTANCE VALUES
R1 = 450 Ω
R2 = 640 Ω



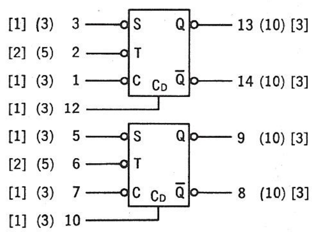
$7 = \overline{8}$

MC889P

IP076



TYPICAL RESISTANCE VALUES
R1 = 450 Ω   R3 = 510 Ω
R2 = 640 Ω   R4 = 225 Ω
R5 = 300 Ω

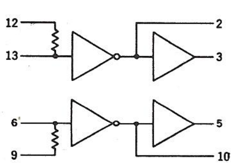


CLOCKED INPUT OPERATION ①

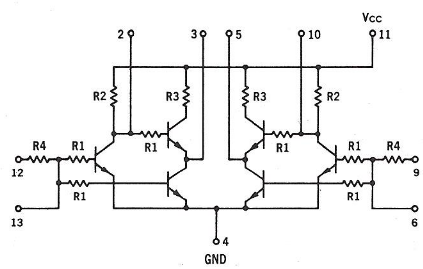
t_n②		t_{n+1}②	
S	C	Q	$\overline{Q}$
1	1	Q_n③	$\overline{Q}_n$
1	0	1	0
0	1	0	1
0	0	$\overline{Q}_n$	Q_n③

NUMBER IN PARENTHESIS INDICATES LOADING FACTOR FOR mW MRTL.
NUMBER IN BRACKETS INDICATES LOADING FACTOR FOR MRTL.

MC890P



$2 = \overline{13}$
$3 = \overline{13}$



TYPICAL RESISTANCE VALUES
R1 = 450 Ω   R3 = 100 Ω
R2 = 640 Ω   R4 = 1.0 k

MC899P

'07T