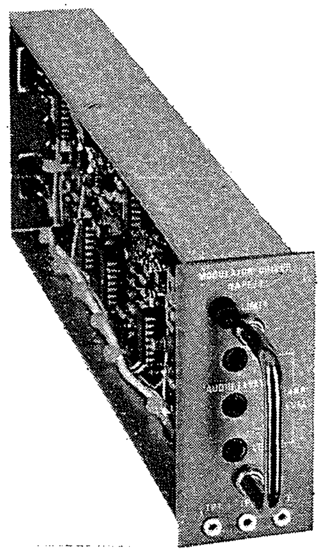
SERVICE INSTRUCTION

NAPE19A & NAPE19A/1

MODULATOR DRIVER MODULE



NAUTICAL ELECTRONIC LABORATORIES LIMITED

RR1 TANTALLON, HACKETT'S COVE

HALIFAX COUNTY, NOVA SCOTIA, CANADA

B0J 3J0

LIST OF EFFECTIVE PAGES

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INTRODUCTION

1. The NAPE19A modulator driver module is used in AMPFET 1 thru AMPFET 10 transmitters to provide the pulse width modulated drive for the transmitters' NASM1A modulator(s). Minor variations of the modulator driver module accommodate different power levels of their associated transmitters. A variation applicable to a specific transmitter is identified in the instruction manual for that transmitter. Variations are identified by a (/#) after the NAPE19A identifier. Troubleshooting and repair of a module is performed on a work bench independent of it's associated transmitter. This document provides information required for a competent technician to understand the operation of the electrical circuits and the procedures to restore defective modules to a serviceable status, using tools and test equipment normally available at an AM radio station workshop. An alternative to procedures provided in this document is to utilize Nautel's module exchange/repair service facilities.

FACTORY EXCHANGE/REPAIR SERVICE

2. Nautel provides a factory, module exchange/repair service for users of Nautel's AMPFET transmitters. Users who do not have repair facilities or who are unable to repair a module may utilize this service for a nominal fee.

MECHANICAL CONFIGURATION

3. The NAPE19A modulator driver module utilizes a formed, metal chassis. Two electrical connectors and a guide pin are installed on the rear of the chassis; a stamped panel containing a handle, a warning lamp, three adjustment access holes and three test points are installed on the front. All electrical components, except a fuse mounted on the chassis, are mounted on printed circuit boards A1 and A2 and are interconnected by the circuit boards' printed patterns. Interconnecting wires are soldered to standoff terminals on the circuit boards. Refer to figure FO-4 for modulator driver module assembly detail.

MODULATOR DRIVER OVERVIEW

4. Figure FO-1 depicts a block diagram of the NAPE19A modulator driver module. The following overview description is based on that illustration. Refer to paragraph 5 for a detailed description based on the electrical schematics shown in figures FO-2 and FO-3.

4.1 LOW-PASS FILTER OVERVIEW: The 'audio input', from an unbalanced 600 ohm source, is passed through the low-pass filter, an L/C filter that filters any rf on the audio input to ground. An AUDIO LEVEL potentiometer, accessible through the front panel, is adjusted to pass the desired audio signal level to the high-pass filter. The low-pass filter also contains a diode surge arrestor to shunt any spurious voltage spikes to ground.

4.2 HIGH-PASS FILTER OVERVIEW: The high-pass filter is an active filter with a nominal cutoff frequency of 50 Hz. Installation of links A-B-C modifies the cutoff frequency to 20 Hz. The filtered output of the high-pass filter is applied to the input of audio limiter U8.

4.3 AUDIO LIMITER OVERVIEW: The audio limiter is a variable gain, wide band, linear amplifier. Two balance potentiometers are adjusted during calibration to ensure the audio limiter's output is balanced and linear. When peaks and troughs of the audio signal do not exceed preset thresholds, the 'audio gain control' dc bias voltage from the audio limiter control will bias the audio limiter for a fixed gain. The filtered audio will be passed through the audio limiter and then applied to the audio amplifier. When peaks and troughs of the audio signal exceed preset peak/trough thresholds, the 'audio gain control' dc bias voltage will change and reduce the gain of the audio limiter and linearily attenuate the filtered audio signal. The gain of the audio limiter will be reduced to, and maintained at, the level required to restrict the peaks and troughs of its audio output to the preset threshold levels.

4.4 AUDIO AMPLIFIER OVERVIEW: The audio amplifier amplifies the audio signal by a factor of 3.3 and superimposes the amplified audio signal on an adjustable dc reference voltage, which is provided by a voltage divider. The dc reference voltage is adjusted to obtain a fixed pulse width from the variable pulse width generator that will result in the desired rf carrier, output level from the associated transmitter. On transmitters that utilize single phase ac power as their power source, the -72 dc voltage which is applied to the transmitter's rf power stage is applied to a hum balancing circuit in the audio amplifier. The ac ripple, which is present on the -72 dc voltage, is applied to the audio signal in the appropriate phase and level to cancel any ripple that is present on the transmitter's rf output. The level of the ac ripple applied to the audio amplifier is adjusted during calibration of the transmitter. On transmitters using a 3-phase ac power source, it is not necessary to use this hum balancing circuit to reduce the ripple; however, it may be used to improve the distortion at 50 Hz audio.

4.5 AUDIO PEAK/TROUGH DETECTOR OVERVIEW: The audio peak/trough detector comprises an adjustable voltage divider and two comparators. The voltage divider provides a 'peak' threshold reference voltage to one comparator; a 'trough' threshold reference voltage to the other. The 'peak' threshold reference voltage is set for the voltage that represents the maximum desired positive modulation peaks (adjustable from 100 percent to 135 percent) on the modulated rf output of the transmitter. The 'trough' threshold reference voltage is set for the voltage that represents the maximum desired negative modulation troughs (90 percent to 105 percent) on the modulated rf output of the transmitter. The output of the audio amplifier is monitored by the comparators. When audio peaks or troughs exceed the applicable threshold voltage(s), the peak/trough detector will produce control pulses to activate the audio limiter control.

4.6 AUDIO LIMITER CONTROL OVERVIEW: The audio limiter control consists of a voltage divider that applies an 'audio gain control' dc bias voltage to the audio limiter. A field-effect transistor is employed as a variable resistor in the voltage divider to control the level of the dc bias voltage. When control pulses from the peak/trough detector are not being applied, the 'audio gain control' dc voltage will bias the audio limiter for a fixed gain. When control pulses are being applied, the audio limiter control's field-effect transistor's resistance will be changed to the value required to provide the 'audio gain control' dc bias voltage that will reduce the gain of the audio limiter. The audio limiter's gain will be reduced to the level that will result in the peaks and troughs of the audio amplifier's output being within the peak/trough threshold limits. If the peak or trough thresholds are exceeded when the audio amplifier's output has been decreased by 3dB, an 'audio attenuated 3dB' signal will be applied to the LIMIT lamp on the front panel for the period of time the thresholds are exceeded.

4.7 CUTBACK CONTROL OVERVIEW: The cutback control consists of two comparators connected in parallel. One of the comparators clamps an 'attenuate drive' reference dc voltage to a near-ground potential when an 'alarm cutback' command is applied. The second comparator compares the 'reflected power' input from the associated transmitter's rf power probe and clamps the 'attenuate drive' reference voltage to a near ground potential when the reflected power exceeds the preset reflected power threshold.

4.8 LOW LEVEL/CUTBACK ATTENUATOR OVERVIEW: The low level/cutback attenuator is a voltage controlled, linear, resistance element which is connected between the output of the audio amplifier and an adjustable reference voltage. In the absence of an 'attenuate drive' signal, the atteunator is a high resistance and the audio amplifier's output is not attenuated. When a 'select low power' command is applied to the low level control, the pulse width modulation (PWM) control at the output of the audio amplifier will be attenuated to a level determined by the setting of LOW CARR potentiometer. When an 'alarm cutback' command or a 'reflected power' signal that exceeds the acceptable limits, is applied to the cutback control, the resultant near ground potential 'attenuate drive' dc reference voltage will reduce the resistance of the low level/cutback attenuator to a low value. The portion of the audio amplifier's output that will be applied to the variable pulse width generator will be reduced to a level that will result in 200 nanosecond pulses.

4.9 70 KHZ SQUARE-WAVE GENERATOR OVERVIEW: The 70 kHz square wave generator is a programmable timer connected as an oscillator. It produces a square wave output at a nominal 70 kHz. A variable capacitor is adjusted to obtain the precise frequency output.

4.10 LINEAR RAMP GENERATOR OVERVIEW: The linear ramp generator is an integrating circuit that converts the 70 kHz square wave input to a linear sawtooth waveform.

4.11 VARIABLE PULSE WIDTH GENERATOR OVERVIEW: The variable pulse width generator compares the PWM control from the audio amplifier to the output of the linear ramp generator to produce the PWM signal to drive the modulators of the associated transmitter. For carrier only, the PWM signal will be 70 kHz pulses with a constant duty cycle. When the PWM control contains modulating audio, the PWM signal will be 70 kHz pulses whose duty cycle will vary as the modulation index varies.

4.12 PULSE WIDTH FAULT DETECTOR OVERVIEW: The pulse width fault detector monitors the output of the variable pulse width generator and generates a 'drive inhibit' signal when no pulse is present or when the average pulse width exceeds 50 percent.

4.13 MOD DRIVE ENABLE OVERVIEW: The mod drive enable circuit is a gate that provides a 'drive enable' signal when a high level 'mod drive enable' signal is applied to it.

4.14 BALANCED DRIVE OVERVIEW: The balanced drive is effectively a double-throw, single pole switch that switches the 'modulator drive' output to 15 volts dc during the period a pulse is present and switches it to ground when a pulse is not present. The variable pulse width input, from the variable pulse width generator, is inhibited by gates if a 'drive enable' signal from the mod drive enable circuit is not present or if a 'drive inhibit' signal is being applied by the pulse width fault detector. The positive logic, 15 volt dc, pulses are applied to the modulator module of the associated transmitter.

DETAILED THEORY OF OPERATION

5. The following description expands on the overview presented in paragraph 4 and provides a detailed description of each function in the NAPE19A modulator driver module based on the electrical schematics depicted in figures FO-2 and FO-3.

NOTE

Reference designations not prefixed with A2 are located on modulator driver pcb A1, and should be read as if they were prefixed with A1.

5.1 LOW-PASS FILTER DESCRIPTION: The 'audio input' signal is applied to low-pass filter C8/L2/C9 through P2-1, from an unbalanced 600 ohm source. The low-pass filters remove any spurious rf from the audio signal. AUDIO LEVEL potentiometer R8 is adjusted to apply the desired level of audio signal to the high-pass filter. Surge suppressor diodes CR6/CR7 shunt any spurious voltage spikes to ground.

5.2 HIGH-PASS FILTER DESCRIPTION: The high-pass filter is an active filter, comprising C22/C23, C24/C25, R47 and U7A that attenuates low audio frequencies. When links are connected between A/B and B/C, C24 is placed in parallel with C22 and C25 in parallel with C23. Frequencies below 20 Hz will be attenuated. When links are not connected between A/B and B/C, C24 and C25 are removed from the circuit. Frequencies below 50 Hz will be attenuated.

5.3 AUDIO LIMITER DESCRIPTION: The audio limiter comprises wideband monolithic four-quadrant multiplier U8, connected as a variable gain, wide band, linear amplifier and its associated components. The filtered audio signal is applied to U8-9 (X-input). The voltage on the wiper of BAL 1 potentiometer R53, of voltage divider R49/R53/R52, sets the dc operating level of U7A and therefore the X-input of U8 at the appropriate dc reference level. The voltage at the junction of R50/R51, of voltage divider R49/R50/R51/R52, is applied to U8-12 as the 'X' offset voltage. BAL 1 potentiometer R53 is adjusted for zero voltage shift while momentarily grounding the output of the audio peak/trough detector. The voltage at the junction of R70/R71 is applied to U8-8 as the 'Y' offset voltage. The voltage at the junction of R68/R69 is applied to U8-4 as the Y-input dc reference voltage. BAL 2 potentiometer R67 is adjusted for maximum attenuation of the audio signal at U8-14 when Q11 is conducting. When Q11 is conducting, the 'Y' offset voltage on U8-8 will decrease and reduce the gain of U8 by an amount proportional to the current flow through Q11. Transistor Q10/R79/C27 forms a capacitor multiplier to decouple any audio voltage present on the +15 VDC (B) dc supply before it is applied to U8 or other sensitive circuits in the module. This filtered dc voltage is a nominal 13.3 volts labelled 15 VDC (C).

5.4 AUDIO AMPLIFIER DESCRIPTION: The audio signal is applied through C10 and R10 to the inverting input of operational amplifier U2A. The voltage on the wiper of HIGH CARR LEVEL potentiometer R16, from voltage divider R14/R16/R15, is applied to U2A's non-inverting input and provides its operating dc reference level. HIGH CARR LEVEL potentiometer R16 is adjusted to set the dc output level of U2A at the level required to obtain a dc reference voltage at carrier reference output that will result in the desired, unmodulated, rf carrier output level from the associated transmitter. Operational amplifier U2A inverts and amplifies the audio signal by a factor of 3.3 and superimposes the amplified audio signal on the audio amplifiers dc reference voltage. On transmitters that utilize single phase ac power as their power source, -72 volts dc is applied through P1-3 to hum balancing circuit L3/C7. An ac ripple is present on the -72 dc voltage. A portion of this ac ripple, as determined by the setting of HUM BAL potentiometer R9, is applied through C11 and R11 to the audio input signal. The ac ripple is the appropriate phase and is adjusted for the amplitude that will reduce any ripple that is present to an acceptable level. This circuit may also be used on transmitters with a 3-phase ac power source to reduce distortion at 50 Hz audio.

5.5 AUDIO PEAK/TROUGH DETECTOR DESCRIPTION: Comparators U9B, U9A and voltage divider R14/R64/R63/R62/R61 form an audio peak/trough detector. The dc voltage on the wiper of TROUGH potentiometer R64 is applied to the non-inverting input of U9B and is adjusted to the voltage that represents the maximum desired/permissible modulation troughs on the rf output of the associated transmitter. The dc voltage on the wiper of PEAK potentiometer R62 is applied to the inverting input of U9A and is adjusted to the voltage that represents the maximum desired/permissible modulation peaks on the rf output of the associated transmitter. U2A's output, a dc voltage with superimposed audio, is applied to the inverting input of U9B and the non-inverting input of U9A. When U2A's output does not go more positive than the threshold voltage from R64 or does not go less positive than threshold voltage from R62, the outputs of U9B and U9A will be a high impedance to ground and the output of the peak/trough detector will be 15 volts dc. If U2A's output goes more positive than the threshold voltage from R64, the output of U9B will be switched to a low impedance (forward diode resistance) to ground during the period of time its threshold is exceeded. If U2A's output goes less positive than the threshold provided by R62, the output of U9A will be switched to a low impedance (forward diode resistance) to ground during the period of time its threshold is exceeded. The output of the peak/trough detector will be a series of low level pulses that occur when either threshold is exceeded.

5.6 AUDIO LIMITER CONTROL DESCRIPTION: Field-effect transistor Q11 is employed as a variable impedance to ground for the junction of R70/R71. When the junction of CR5 and CR4 is held at 15 volts dc, Q11 gate is reverse biased by the voltage at the junction of R74/R75. Capacitors C29 and C28 will be charged to this voltage. Q11 will appear to be a high resistance and the voltage at the junction of R70/R71 will be held at the dc level that will provide maximum gain from linear amplifier U8. When modulation peak and/or trough thresholds are exceeded, low level pulses will be applied to the cathodes of diodes CR5 and CR4, causing C29 and C28 to partially discharge and reduce the reverse bias on the gate of Q11, which will reduce its apparent resistance. The voltage at the junction of R70/R71 will be reduced, causing the gain of U8 to be reduced and linearily attenuate its audio output. C28/R72 and C29/R73 form relatively long time constant integrating circuits which will attempt to return to the original bias level after each pulse. If the audio is being overdriven and the peak/trough thresholds are continuously being exceeded, the bias voltage on the gate of Q11 will stabilize at a lower level. The bias voltage level will be maintained at the level required to reduce the gain of linear amplifier U8 until the peak/trough thresholds are no longer exceeded. The voltage drop across the source/drain junction of Q11 is applied to the non-inverting input of comparators U9C and U9D. This voltage is compared to the threshold voltage, from the junction of R76/R77, on their input. When the voltage drop across Q11 has reached the level that will cause the gain of linear amplifier U8 to be reduced 3dB, any additional pulses through CR5/CR4, will cause the voltage on the non-inverting inputs to go less positive than the voltage on their inverting inputs. The outputs of U9C and U9D will switch to a low impedance (forward diode resistance) and turn on LIMIT lamp DS1. LIMIT lamp DS1 will turn on (flash) whenever the gain of the audio limiter is reduced by more than 3 dB.

5.7 CUTBACK CONTROL DESCRIPTION: Comparators U6C, U6D and their associated components form the cutback control circuit. This circuit provides the 'attenuate drive' signal to the 'cutback attenuator' (see paragraph 5.8). Whenever the voltage on the anode of CR2 is less than that at U3B-5, current will flow through R26 activating the cutback attenuator.

5.7.1 The 'alarm cutback' input at P1-4 is applied to U6C-8 where it is compared with the reference voltage established by R22 and R23 on U6C-9. When the alarm cutback is present, at the normal +15 volt logic level, the output of U6C-14 will be zero and Q9 will be turned on. The voltage on the anode of CR2 will be a nominal 1 volt which will activate the cutback attenuator via R26. When the 'alarm cutback' signal is removed, Q9 will be turned off and the voltage on the anode of CR2 will rise to the level of that on U3B-5 at a time constant determined by R26 and C13. This results in a deactivation of the 'cutback attenuator' and a return to normal output power in approximately 0.5 seconds.

5.7.2 The 'reflected power' signal at P2-3 is a dc voltage proportional to the reflected power sensed by the associated transmitter's rf power probe. This is applied to the inverting input, pin 10 of U6D, where it is compared to the reference voltage established by R22 and R23 on pin 11 of U6D.

NOTE

The values of R22 and R23 differ in the NAPE19A and NAPE19A/1 to accommodate the differences in their associated transmitters.

When the 'reflected power' signal exceeds the reference voltage, the output of U6D-13 goes low causing Q9 to conduct and the 'cutback attenuator' to become active. This results in a reduction in the output power of the associated transmitter which results in a reduction in the 'reflected power' signal. In the presence of a mismatched load (VSWR) at the output of the associated transmitter, the output power will be cutback until an acceptable reflected power level is established. As a result of varying modulation present in the normal transmitted signal, it is not possible for an automatic cutback in carrier level to be achieved. By reducing the output carrier level, it is possible to operate, at reduced power, into a mismatched load.

5.8 LOW LEVEL/CUTBACK ATTENUATOR DESCRIPTION: To attenuate the transmitter output in a manner such that the modulation index remains constant with output level, the signal at the output of the audio amplifier (paragraph 5.4) is attenuated to a reference dc voltage just below the peak of the linear ramp generator output (paragraph 5.10). This reference voltage is established by MOD BAL potentiometer A1R12 in conjunction with A1U3B and A1Q4. To ensure a modulator driver fault alarm (paragraph 5.12) does not occur during a cutback cycle, the MOD BAL potentiometer is adjusted to give a nominal 200 nanosecond pulse at the output of the variable pulse width generator in the cutback condition (paragraph 6.3.5).

5.8.1 When an excessive 'reflected power' has been sensed or an 'alarm cutback' command is present, A1U3A turns A2Q1 on as a result of the current flowing through A1R26 and A1R27. A2Q1 acts as a linear resistor which attenuates the signal at the junction of A1R18/L4 to reduce the transmitter output until an acceptable reflected power is obtained, or a nominal zero output while the 'cutback command' is present. A2Q2 provides an offset that balances the 'cutback' attenuator circuit with that of the low level attenuator circuit (paragraph 5.8.2).

5.8.2 When the associated transmitter is operating in its low power mode, A2Q4 is turned on by the 'select low power' signal on P1-2. This allows the signal at the junction of A1R18/L4 to be attenuated to the voltage on MOD BAL potentiometer A1R12 by low carrier level control A1R25. A2Q3 compensates for the offset of A1Q4.

5.9 70 KHZ SQUARE-WAVE GENERATOR DESCRIPTION: Programmable timer U1 and its associated components are connected to form a 70 kHz square-wave generator. The oscillating frequency is adjusted to nominally 70 kHz by variable capacitor C4.

5.10 LINEAR RAMP GENERATOR DESCRIPTION: Operational amplifier U2B and its associated components form the linear ramp generator. The relatively long time constant of integrator C5/R5 ensures the input to U2B is a linear, sawtooth waveform. The voltage at the junction of R16/R15 is applied to U2B as its operating dc reference level. U2B's output is a constant amplitude, linear, sawtooth waveform superimposed on the dc reference level.

5.11 VARIABLE PULSE WIDTH GENERATOR DESCRIPTION: Transistors Q1, Q2, Q3, gate U4C and associated components form the variable pulse width generator. The constant amplitude, linear, sawtooth waveform from the linear ramp generator is applied to the base of Q2 and the PWM control signal from the audio amplifier is applied to the base of Q1. Transistors Q1 and Q2 form an emitter coupled comparator circuit.

5.11.1 The output of U4C-10 is a 70 kHz digital waveform with the width of the individual pulses determined by the instantaneous differential voltage between 'linear ramp generator output' and the 'PWM control'. When the instantaneous voltage at the base of Q1 is less than that at the base of Q2, Q1 will be on, Q2 off and, hence, Q3 will be off resulting in a high (logic level 1) voltage at U4C-10. Conversely, when the instantaneous voltage at the base of Q1 is greater than that at the base of Q2, a low (logic level zero) voltage appears at U4C-10. The width of the pulses at the output of the 'variable pulse width generator' have an average value which is the function of the preset carrier level, while the width of the individual pulses will vary with the level of the audio modulation.

5.12 PULSE WIDTH FAULT DETECTOR DESCRIPTION: Comparators U5D, U5C and associated components form the pulse width fault detector. Integrator C17/R34 provides a dc voltage to the inverting input of U5D and the non-inverting input of U5C which is the average dc level of U4C's output. Voltage divider R35/R36/R37 provides dc reference voltages as the fault detector thresholds. The voltage at the junction of R35/R36, which represents the highest acceptable average dc voltage, is applied to the non-inverting input of U5D. The voltage at the junction of R36/R37, which represents the average dc voltage of the longest permissible pulse width, is applied to the inverting input of U5C. If the output of U4C is held high, indicating a defect in the modulator driver, the inverting input of U5D will be more positive than its non-inverting input. The output of U5D will switch to a low impedance (forward diode resistance) to ground. If the output of U4C is held low, indicating a defect in the modulator driver, the non-inverting input of U5C will be less positive than its inverting input. The output of U5C will switch to a low impedance (forward diode resistance) to ground. When either U5C or U5D's output is a low impedance, gate U4B will be inhibited and the modulator drive will be inhibited. When U5C or U5D's output is a low potential, the non-inverting input of comparator U5A will be less positive than its inverting input. U5A's output will switch to a low impedance (forward diode resistance) to ground. The base/emitter junction of Q8 will be forward biased and it will turn on. If links 13/14 are connected (NAPE19A/1), a ground potential 'modulator driver alarm' signal will be applied to P2-4 to turn on the associated transmitter's MOD DRIVE ALARM lamp. If links 12/14 are connected, 15 volts dc will be applied through Q8 to P2-4 as the 'modulator driver alarm' signal to turn on the associated transmitter's MOD DRIVE ALARM lamp. The 'modulator driver alarm' signal will also cause the standby modulator driver module to be activated on transmitters that have a main/standby feature.

5.13 MOD DRIVE ENABLE DESCRIPTION: Gate U4D and its associated components form the mod drive enable circuit. When a high logic level 'mod drive enable' command is applied to the junction of R39/R45, through P1-1, gate U4D is enabled and applies a high level signal to gate U4A. When a high level 'mod drive enable' command is not applied to the junction of R39/R45, through P1-1, gate U4D is inhibited and applies a low logic level signal to gate U4A. When a low level signal is applied to U4A, U4A will be inhibited and the variable width pulses will not be passed. Upon initial application of the 15 volts dc, capacitor C20 will inhibit gate U4D until it is charged via R44. This delays the modulation drive enable for approximately 500 milliseconds. The delay is required to allow the bias voltages within the NAPE19A module to stabilize after switch-on.

5.14 BALANCED DRIVE DESCRIPTION: Gates U4B, U4A; transistor Q6, Q7 and associated components form the balanced drive circuit. Q6 and Q7 act as switches between 15 volts dc and ground to charge and discharge the capacitive load presented by the cabling to the modulator(s) of the associated transmitter. When a pulse width fault has not been detected and U4B-5 is held high, gate U4B will be enabled and the positive going pulses from U4C-10 will be applied to U4A-2. When a 'mod drive enable' command is applied and U4D-11 is held high, gate U4A will be enabled and the positive going pulses from U4B-4 will be passed to the base of Q6 and Q7. When a positive going pulse is present, the base/emitter junction of Q6 will be forward biased and it will turn on. Q7 will be reverse biased and it will be turned off. 15 volts dc will be applied through R40, Q6, R43 and P2-5 to the capacitive load of the modulator cabling. The capacitive load will charge to 15 volts dc. When a positive-going pulse is not present, the base/emitter junction of Q6 will be reverse biased and it will be turned off. The base/emitter junction of Q7 will be forward biased, since the voltage on its base is near ground potential and the voltage on the capacitive load will be applied through P2-5 and R43 to its emitter. Q7 will turn on and discharge the capacitive load through P2-5, R43 and Q7 to ground.

TROUBLESHOOTING

6. Troubleshooting of modulator drive modules that are defective, or are suspected of being defective, consists of performing a visual inspection and then conducting a functional test to isolate the defective components.

6.1 TEST EQUIPMENT AND SPECIAL TOOLS: The test equipment required is listed in table 1. There are no special tools required.

6.2 VISUAL INSPECTION: It is recommended that a visual inspection be performed on the monitor module prior to applying power. Inspect the module for the following:

(a) Inspect all electrical components for evidence of overheating or physical damage.

(b) Verify fuse F1 is the correct value and is not defective.

(c) Inspect all solder connections for good mechanical bond and adequate solder.

(d) Verify connectors P1 and P2 do not contain damaged or loose pins and that they are securely fastened to the chassis.

(e) Verify the guide pin is present and securely fastened.

(f) Verify all wiring insulation is not pinched, frayed, broken or otherwise damaged.

(g) Verify wire strands of wiring conductors are not broken or otherwise damaged.

(h) Verify chassis and printed circuit board is free from solder slivers and other conductive foreign objects.

(i) Verify all integrated circuit devices are installed and firmly seated in their sockets.

(j) Verify all fastening hardware is securely tightened.

6.3 CALIBRATION/FUNCTIONAL TEST: Functional testing and calibration of the modulator driver module is the recommended first step in troubleshooting a defective module and also verifies the module is operating within design limits after corrective action has been taken. Modules that meet the requirements of the functional test may be considered to be operating satisfactorily and returned to service.

NOTE

Final testing and adjustment of the modulator driver module is performed with the module installed in the transmitter. Instructions are provided in the associated transmitter's instruction manual.

6.3.1 PREPARATION FOR TEST/CALIBRATION: Prepare the modulator driver module for test as follows:

(a) Verify the visual inspection has been completed.

(b) Connect the modulator driver module to be tested to test setup depicted in figure 2, with test setup's REFLECTED POWER potentiometer set for zero volts on P2-3.

(c) Set test setup's audio signal generator to 1000 Hz and its output to zero volts.

(d) Switch on test setup's 15 volt dc power supply and set its output to a nominal 14.3 volts dc.

(e) 15 volt dc power supply's current indication should be 55 $\pm$10 milliamperes.

6.3.2 70 KHZ SAWTOOTH WAVEFORM TEST/CALIBRATION: Test 70 kHz square wave generator and linear ramp generator circuits and recalibrate if necessary as follows:

(a) Connect test setup's oscilloscope test leads between test point TP1 and chassis ground.

(b) Oscilloscope waveform should be a linear, constant amplitude, 3 volt peak-to-peak, sawtooth waveform, with the lower peak approximately 4.0 volts above ground potential (see figure 1A).

(c) Connect test setup's frequency counter test leads between test point TP1 and chassis ground.

NOTE

If a frequency counter is not available, the frequency may be determined by measuring the waveform period on an oscilloscope with a calibrated time base. The period of a 70 kHz waveform is 14.3 microseconds.

(d) Frequency counter's indication should be 70 ±0.5 kHz.

(e) If requirements of step (d) are not met, adjust trimmer capacitor C4 to obtain a frequency indication of 70 ±0.5 kHz.

(f) Disconnect oscilloscope.

6.3.3 AUDIO AMPLIFIER TEST/CALIBRATION: Test audio limiter and audio amplifier circuits and recalibrate, if necessary, as follows:

(a) Set test setup's audio signal generator to 1000 kHz and its output to zero volts.

(b) Set test setup's digital multimeter to measure dc voltage and connect its test leads between U8-14 and ground.

(c) Record digital multimeter indication.

(d) Connect a shorting jumper between CR4's cathode and ground.

(e) Digital multimeter indication should be the same as that obtained in step (c) after indication has stabilized.

(f) If requirements of step (e) are not met, adjust BAL 1 potentiometer R53 for required indication.

(g) Remove shorting jumper installed in step (d).

(h) Repeat steps (c) thru (g) until requirements of step (e) are met without further adjustment of BAL 1 potentiometer.

(i) Connect test setup's oscilloscope test leads between test point TP2 and ground.

(j) Set PEAK potentiometer R62 fully clockwise and TROUGH potentiometer R64 fully counterclockwise.

(k) Adjust audio signal generator for a 2.5 volts rms output at a frequency of 1000 Hz.

(l) Oscilloscope indication should be an undistorted, 2.5 volts peak-to-peak audio waveform (see figure 1B).

(m) If requirements of step (l) are not met, adjust AUDIO LEVEL potentiometer R8 for a 2.5 volts peak-to-peak audio waveform.

(n) Simultaneously observe oscilloscope waveform amplitude and adjust audio signal generator frequency from 50 Hz to 10,000 Hz while maintaining output at 2.5 volts rms.

(o) Difference between the highest amplitude and minimum amplitude of waveform observed in step (n) shall be no more than 0.25 volts peak-to-peak.

(p) Adjust audio signal generator for a 2.5 volts rms output at a frequency of 1000 Hz.

(q) Connect a shorting jumper between CR4's cathode and ground.

(r) Oscilloscope indication should be an undistorted, audio waveform with a maximum amplitude of 20 millivolts peak-to-peak.

(s) If requirements of step (r) are not met, adjust BAL 2 potentiometer R67 for minimum amplitude waveform (20 millivolts peak-to-peak or less).

(t) Remove shorting jumper installed in step (q) and disconnect oscilloscope.

6.3.4 PULSE WIDTH GENERATOR TEST/CALIBRATION: Test the variable pulse width generator circuits and perform initial calibrations as follows.

(a) Set test setup's audio signal generator to zero.

(b) Connect test setup's oscilloscope test probe between Q3 collector (case) and ground.

(c) Adjust HIGH CARR LEVEL potentiometer A1R16 to verify the pulse width at Q3 collector can be adjusted from zero to 7.1 microseconds.

(d) Perform initial calibration of variable pulse width generator by determining the positive, square wave pulse duration for the associated transmitter to produce the desired unmodulated, rf carrier output using the following equation. Note that a pulse duration of 6.2 microseconds will produce the reference, unmodulated, rf carrier output from the associated AMPFET 1 (1.25 kW); AMPFET 2.5 (2.5 kW); AMPFET 5 (5.0 kW); AMPFET 10 (10.0 kW).

$$t = 6.2 \times \sqrt{\frac{P_{desired}}{P_{reference}}}$$

Where: t = The duration of the positive, square wave pulse in microseconds

$P_{desired}$ = Desired, unmodulated, rf carrier output from the associated transmitter.

$P_{reference}$ = Reference, unmodulated, rf carrier output from the associated transmitter

1.25 kW for AMPFET 1 transmitters
2.5 kW for AMPFET 2.5 transmitters
5.0 kW for AMPFET 5 transmitters
10.0 kW for AMPFET 10 transmitters

(e) Adjust HIGH CARR LEVEL potentiometer for an indication of positive going square wave pulses with the duration determined in step (d) and amplitude of approximately 15 volts as depicted in figure 1C.

NOTE

Final calibration of the HIGH CARR LEVEL adjustment must be performed when operating in its associated transmitter.

6.3.5 LOW LEVEL/CUTBACK FUNCTIONS TEST/CALIBRATION: Test the low level/cutback control and attenuator circuits and recalibrate, if necessary, as follows:

(a) Set or verify the test setup's audio signal generator output is set to zero.

(b) Connect test setup's oscilloscope test leads between Q3 collector (case) and ground.

(c) Connect a 10K ohm resistor between P1-4 and the +15 volt dc supply.

(d) Oscilloscope indication should be a positive-going 70 kHz pulse with a duration of 0.15 to 0.20 microseconds (see figure 1D).

(e) If requirements of step (d) are not met, adjust MOD BAL potentiometer R12 for positive going square waves with a duration of 0.15 to 0.20 microseconds.

(f) Remove resistor connected in step (c).

(g) Oscilloscope indication should return to positive going square waves with the duration determined in paragraph 6.3.4(d).

(h) Simultaneously monitor oscilloscope and slowly increase output of test setup's REFL POWER potentiometer until oscilloscope's waveform just switches from positive going pulses with the duration noted in step (d), to a duration as noted in step (e).

(i) Voltage applied to P2-3 from wiper of test setup's REFLECTED POWER potentiometer should be 1.04 ± 0.05 volts dc for NAPE19A modulator driver modules and 2.4 ± 0.1 volts dc for NAPE19A/1 modulator driver modules.

(j) Set test setup's REFLECTED POWER potentiometer for zero volts to P2-3.

(k) Oscilloscope indication should return to positive going square waves with the duration noted in step (g).

(l) Connect a 10K ohm resistor from P1-2 to 15 volt power supply to select low power.

NOTE

Counterclockwise adjustment of LOW CARR LEVEL potentiometer A1R25 will result in maximum pulse width output from NAPE19A modulator driver modules.

(m) Oscilloscope indication should be positive going square waves with a duration of less than 6.0 microseconds and more than 0.22 microseconds.

(n) Verify adjustment of LOW CARR LEVEL potentiometer R25 will change the duration (width) of the square waves and then adjust LOW CARR LEVEL potentiometer R25 for positive going square waves with the duration required for the associated transmitter to produce the desired low level, unmodulated rf carrier output using the equation shown in paragraph 6.3.4(d).

(o) Remove resistor connected in step (l).

(p) Oscilloscope indication should return to positive going square waves with the duration determined in paragraph 3.6.4(d).

(q) Disconnect oscilloscope test leads.

6.3.6 MOD DRIVE ENABLE TESTS: Test the modulator drive enabling circuit as follows:

(a) Set test setup's audio signal generator to 1000 kHz and its output to zero volts.

(b) Connect test setup's oscilloscope test leads between TP3 and chassis ground.

(c) Oscilloscope indication should be a straight trace (no signal).

(d) Connect a 10K ohm resistor between P1-1 and the +15 volt dc supply.

(e) Oscilloscope indication should be positive going square waves with the duration determined in paragraph 6.3.4(d).

6.3.7 PULSE WIDTH FAULT DETECTOR TEST: Test the pulse width fault detector circuitry as follows:

(a) Connect a 100K ohm resistor from P2-4 to ground and monitor P2-4 with voltmeter. This should be zero volts for an NAPE19A or a nominal +10 volts for an NAPE19A/1.

(b) Monitor waveform on TP3 with oscilloscope. The waveform should be as in 6.3.4(e).

(c) Turn carrier level control R16 counterclockwise until the waveform on TP3 goes to a continuous zero.

(d) Check that the voltage on P2-4 goes to high (14 volts) on an NAPE19A or to a low (zero volts) on an NAPE19A/1.

(e) Readjust R16 for the same waveform as in 6.3.4(e).

(f) Hold a 10K ohm resistor from L4 to ground and check that the waveform on TP3 goes to a continuous zero while the voltage on P2-4 goes to the level given in 6.3.7(d).

(g) Remove the resistor [step (f)] and check waveforms return to normal as in 6.3.7(e).

6.3.8 MODULATION TEST: Test that an audio signal modulates the PWM output pulse width in the appropriate manner as follows:

(a) Set or verify PEAK potentiometer R62 is fully clockwise and TROUGH potentiometer R64 is fully counterclockwise.

(b) With setup as above, set audio input P2-1 to +4 dBm at 1 kHz.

(c) Monitor the signal on TP3 and adjust the audio level control to give a variation in the pulse width of ± 3 microseconds (a nominal 50 percent modulation).

(d) Varying the input frequency from 50 Hz to 10 Khz, check that no significant change in the variation of pulse width occurs.

(e) Reset frequency to 1 kHz and increase input level until the variation in pulse width remains constant. Maximum pulse width should be between 12.5 and 13 microseconds.

(f) Reduce the input signal level to -10 dBm and check that the audio level control can be adjusted to give full modulation as in step (e).

6.3.9 LIMITER CALIBRATION: If the audio limiter of the NAPE19A is to be used as the final system limiter, it is necessary to perform the setup and calibration of PEAK and TROUGH limit controls. R62 and R64 should be adjusted to give the desired peak and trough limiting with the NAPE19A in the operational transmitter. To make adjustments of R62 and R64 while the module is in the transmitter, it is necessary to utilize a modulator driver extender module, Nautel part number 139-8229.

NOTE

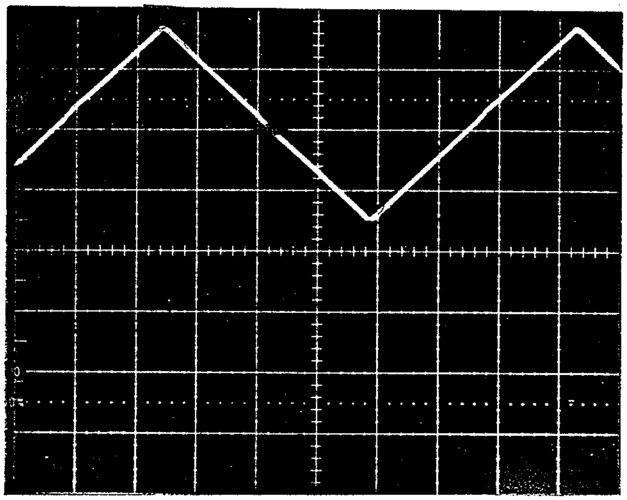
Use of the limiter in the NAPE19A for the final system limiter is not normally recommended. However, it will serve as an adequate limiter in an emergency. Normally, this limiter is used only to protect the transmitter from overdrive. Flashing of the limiter lamp indicates audio input is exceeding the level required for full modulation by at least 3 dB.

6.3.10 COMPLETION OF TESTS: Modulator driver modules that meet all the requirements of 6.3 may be considered to be satisfactory and returned to service. Switch off the test setup's 15 volt dc power supply and disconnect the modulator driver module from the test setup.

REPAIR

7. There are no special repair procedures for the modulator driver other than the normal precautions to be observed when handling CMOS devices. Gain access to the printed wiring side of printed circuit board A1 by removing six fastening screws and swinging the printed circuit board on its cable harness without removing the interconnecting wires. Upon reassembly, ensure the interconnecting wires are not pinched when the screws are tightened.

A



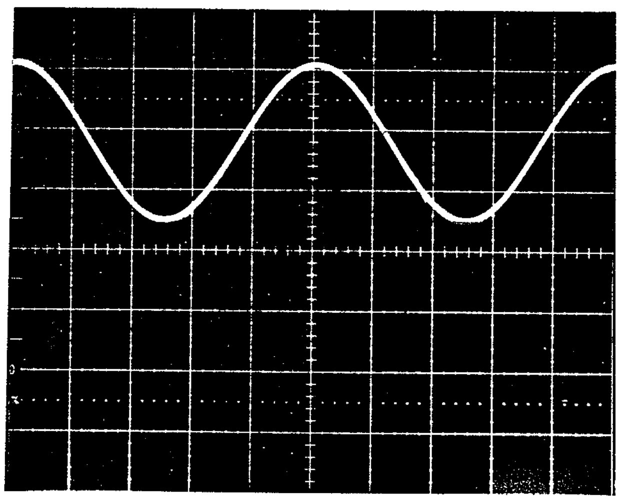
LINEAR SAWTOOTH WAVEFORM

(TP1)

1 volt/division
2 usec/division
0 volts dc at bottom of screen

Scale centered at +4.0 vdc

B



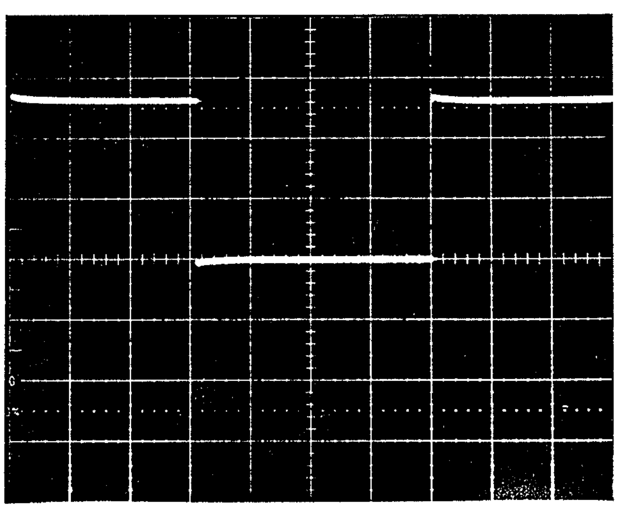
PWM CONTROL SIGNAL
(1 kHz audio)
(Amplitude for 100% mod)

TP2

1 volt/division
0.2 msec/division

Scale centered at +4.0 vdc

C



PULSE DURATION (NO MOD)

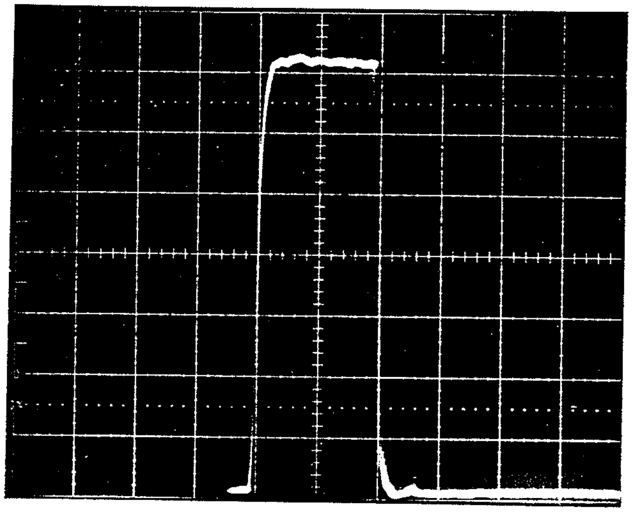
Q3 collector case

5 volts/division
2 usec/division

Scale centered at zero vdc

Figure 1 Modulator Driver Waveforms (Sheet 1)

D



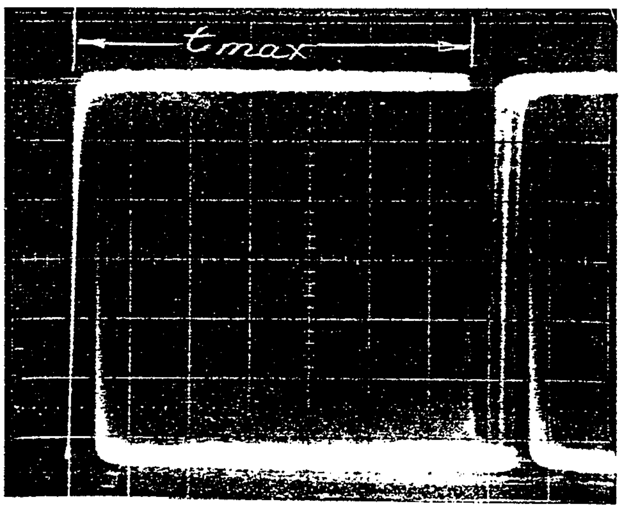
PULSE DURATION (CUTBACK)

Q3 collector case

2 volts/division
0.1 usec/division

Scale centered at +6.0 vdc

E



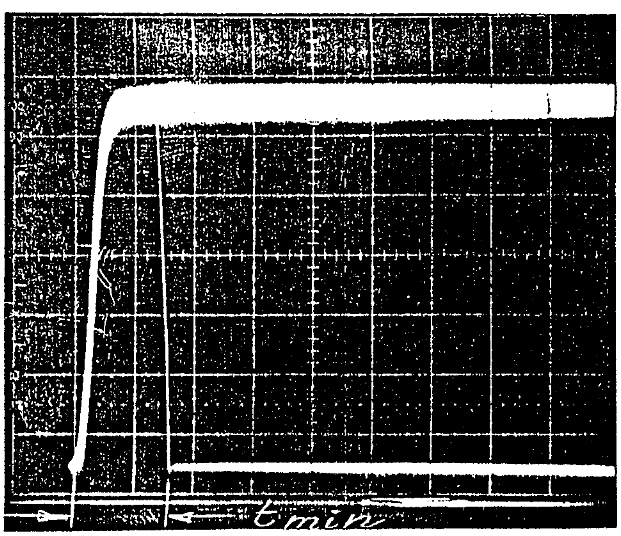
PULSE DURATION (t_{max})
(130% positive modulation)

Q3 collector case

2 volts/division
2 usec/division

Scale centered at +8.0 vdc

F



PULSE DURATION (t_{min})
(95% negative modulation)

Q3 collector case

2 volts/division
2 usec/division

Scale centered at +8.0 vdc

Figure 1 Modulator Driver Waveforms (Sheet 2)

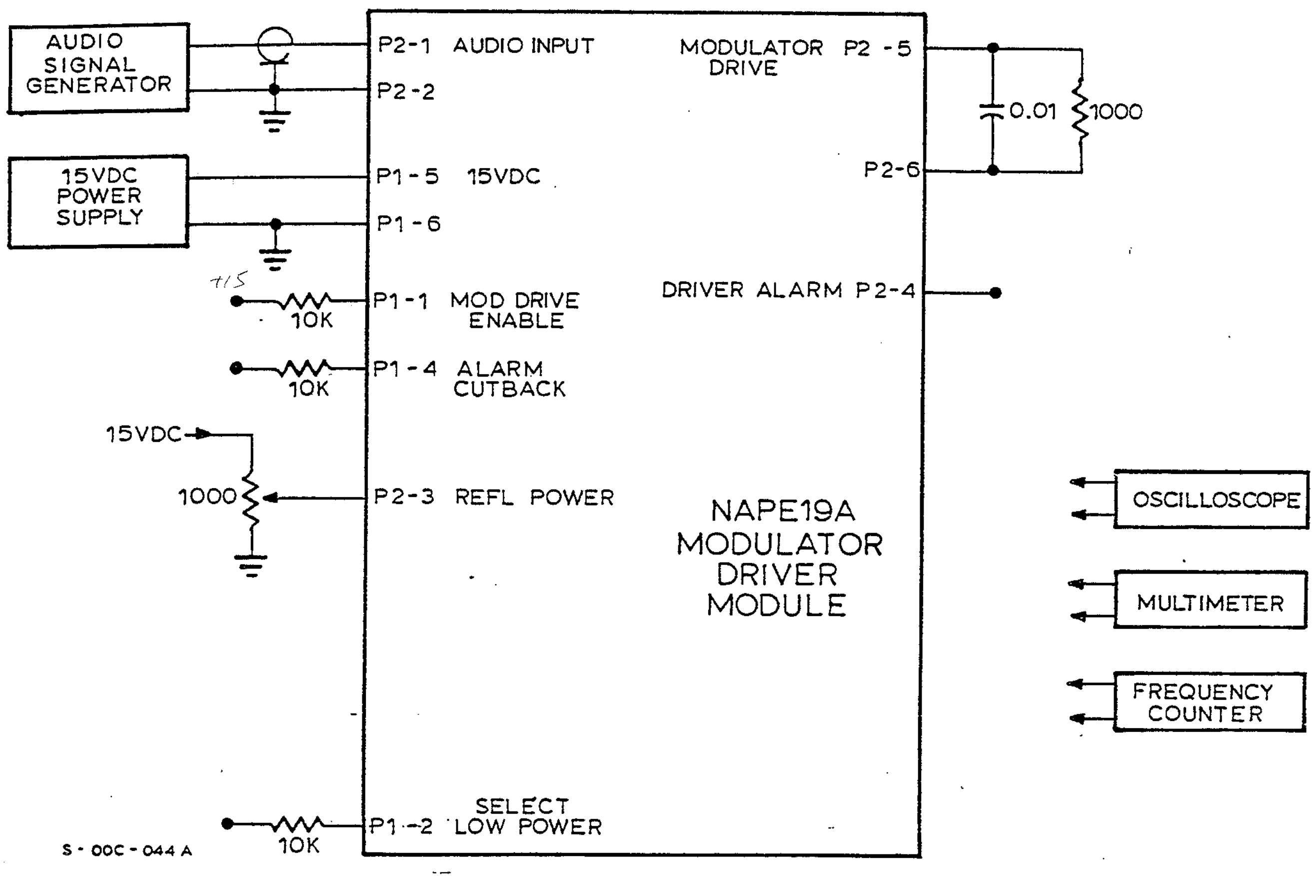


Figure 2 Test Setup NAPE19A Modulator Driver Module

Table 1 - Test Equipment

NOMENCLATURE	PART, MODEL, OR TYPE NUMBER (EQUIVALENTS MAY BE USED)
Digital Multimeter	3 1/2 digit, ac and dc volts, ohms and amps, $\pm$0.5% accuracy. Beckman 3010
Oscilloscope	15 MHz. Tektronix Model T922
Audio Signal Generator	10 Hz to 10 MHz, 600 ohms, 0 to +15 dBm. Hewlett Packard model 651B
DC Power Supply	15 Volts 1 Amp
Frequency Counter	5ppm up to 10 MHz, Fluke 1900A

Table 2 Wiring List - NAPE19A Modulator Driver Module

SOURCE	DESTINATION	CODE		SIZE	FUNCTION
P1-2	Ground	Resistor	RAP17	100K ohms	R1
P1-1	A1-1	1	White	22	
-	-	2	Not Used		
P1-3	A1-4	3	Blue	22	
P1-4	A1-8	4	White	22	
P1-5	F1-1	5	Red	22	
F1-2	A1-2	6	Red	22	
P1-6	A1-3	7	Black	22	
P2-1	A1-5	8	Core	RG188A/U	WE38
P2-2	A1-6	-	Shield	-	
P2-3	A1-9	9	White	22	
P2-4	A1-14	10	White	22	
P2-5	A1-10	11	Core	RG188A/U	WE38
P2-6	A1-11	-	Shield	-	
P1-6	Ground	12	Black	22	
DS1(Cathode)	A1-15	13	White	22	
F1-2	DS1(Anode)	14	Red	22	
TP1(-)	A1-16	15	White	22	
TP2(-)	A1-17	16	White	22	
TP3(-)	A1-18	17	White	22	
A1-23	A2-2	18	White	22	Twisted
A1-24	A2-6	19	White	22	Pair
P1-2	A2-3	20	White	22	
A2-1	A1-22	-	Red	22	Jumper
A2-4	A1-19	-	White	22	Jumper
A2-5	A1-20	-	White	22	Jumper
A2-6	A1-21	-	White	22	Jumper

Table 3 NAPE19A Reference Designation Index

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL's PART NO.	JAN, MIL OR MFR PART NO.
A -	Modulator Driver	NAPE19A	139-3084-2
B -	Modulator Driver	NAPE19A/1	139-3084-3
A A1	Modulator Driver PCB Assembly	139-3085-4	139-3085-4
B A1	Modulator Driver PCB Assembly	139-3085-5	139-3085-5
A A1C 1	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
B A1C 1	Capacitor, Tantalum, 150uF 10%, 15V	CCP13	CSR13D157KM
A1C 2	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C 3	Capacitor, Mica, 100pF 2%, 500V	CB25	CM05FD101G03
A1C 4	Capacitor, Variable, 7-25pF, 350V	CY23	538-011-B7-25
A1C 5	Capacitor, Ceramic, 0.01uF 10%, 100V	CCG04	CKR05BX103KL
A1C 6	Capacitor, Mica, 150pF 2%, 500V	CB27	CM05FD151G03
A1C 7	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C 8	Capacitor, Ceramic, 0.0047uF 10%, 100V	CCG03	CKR05BX472KL
A1C 9	Capacitor, Ceramic, 0.0047uF 10%, 100V	CCG03	CKR05BX472KL
A1C10	Capacitor, Ceramic, 0.47uF 10%, 50V	CCG09	CKR06BX474KL
A1C11	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C12	Capacitor, Tantalum, 1.0uF 10%, 50V	CCP24	CSR13G105KM
A1C13	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C14	Capacitor, Ceramic, 0.0022uF 10%, 100V	CCG02	CKR05BX222KL
A1C15	Capacitor, Ceramic, 0.0022uF 10%, 100V	CCG02	CKR05BX222KL
A1C16	Capacitor, Tantalum, 1.0uF 10%, 50V	CCP24	CSR13G105KM
A1C17	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A1C18	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C19	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A1C20	Capacitor, Tantalum, 1.0uF 10%, 50V	CCP24	CSR13G105KM
A1C21	Capacitor, Ceramic, 0.001uF 10%, 200V	CCG01	CKR05BX102KL
A1C22	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C23	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C24	Capacitor, Ceramic, 0.22uF 10%, 50V	CCG08	CKR06BX224KL
A1C25	Capacitor, Ceramic, 0.22uF 10%, 50V	CCG08	CKR06BX224KL
A1C26	Capacitor, Tantalum, 22uF 10%, 35V	CCP20	CSR13F226KM
A1C27	Capacitor, Tantalum, 6.8uF 10%, 35V	CCP19	CSR13F685KM
A1C28	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C29	Capacitor, Ceramic, 0.22uF 10%, 50V	CCG08	CKR06BX224KL
A1C30	Capacitor, Ceramic, 0.1uF 10%, 100V	CCG07	CKR06BX104KL
A1C31	Capacitor, Ceramic, 0.01uF 10%, 100V	CCG04	CKR05BX103KL
A1CR1	Not Used		
A1CR2	Diode, General Purpose, Small Signal	QAP29	1N4938
A1CR3	Diode, General Purpose, Small Signal	QAP29	1N4938
A1CR4	Diode, General Purpose, Small Signal	QAP29	1N4938
A1CR5	Diode, General Purpose, Small Signal	QAP29	1N4938
A1CR6	Diode, General Purpose, Small Signal	QAP29	1N4938
A1CR7	Diode, General Purpose, Small Signal	QAP29	1N4938
A1L1	Inductor, Moulded, Shielded, 1000uH	LAP39	SWD1000
A1L2	Inductor, 360uH	139-8119	139-8119
A1L3	Inductor, Moulded, Shielded, 4700uH	LAP40	SWD4700
A1L4	Inductor, Moulded, Shielded, 560uH	LAP38	SWD560
A1L5	Inductor, Moulded, Shielded, 10000uH	LAP41	SWD10000

Table 3 NAPE19A Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL's PART NO.	JAN, MIL OR MFR PART NO.
A1L6	Bead, Small	LXP20	21-030-B
A1Q 1	Transistor, PNP	QAP09	2N2907
A1Q 2	Transistor, PNP	QAP09	2N2907
A1Q 3	Transistor, NPN, Switch	QE10	2N3227
A1Q 4	Transistor, PNP	QAP09	2N2907
A1Q 5	Not Used		
A1Q 6	Transistor, NPN	QAP06	2N2222
A1Q 7	Transistor, PNP	QAP09	2N2907
A1Q 8	Transistor, PNP	QAP09	2N2907
A1Q 9	Transistor, PNP	QAP09	2N2907
A1Q10	Transistor, NPN	QAP06	2N2222
A1Q11	Transistor, Field Effect, P Channel	QB34	2N5268
A1R 1	Resistor, Film, 56 ohms, 2% 1/2W	RAP04	RL20S560G
A1R 2	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A1R 3	Resistor, Film, 22K ohms, 2% 1/2W	RD11	RL20S223G
A1R 4	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A1R 5	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A1R 6	Resistor, Comp, 3.3M ohms, 5% 1/2W	RF37	RC20GF335J
A1R 7	Resistor, Film, 1200 ohms, 2% 1/2W	RC38	RL20S122G
A1R 8	Resistor, Variable, 1000 ohms, 1/2W	RV36	3339W-1-102
A1R 9	Resistor, Variable, 100K ohms, 1/2W	RW01	3339P-1-104
A1R10	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A1R11	Resistor, Comp, 3.3M ohms, 5% 1/2W	RF37	RC20GF335J
A1R12	Resistor, Variable, 100 ohms, 1/2W	RW24	63P101T000
A1R13	Resistor, Film, 330 ohms, 2% 1/2W	RAP07	RL20S331G
A1R14	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R15	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R16	Resistor, Variable, 1000 ohms, 1/2W	RV36	3339W-1-102
A1R17	Resistor, Film, 330K ohms, 2% 1/2W	RAP19	RL20S334G
A1R18	Resistor, Film, 330 ohms, 2% 1/2W	RAP07	RL20S331G
A1R19	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A1R20	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A1R21	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A A1R22	Resistor, Film, 39K ohms, 2% 1/2W	RD14	RL20S393G
B A1R22	Resistor, Film, 47K ohms, 2% 1/2W	RD15	RL20S473G
A A1R23	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
B A1R23	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R24	Not Used		
A1R25	Resistor, Variable, 1000 ohms, 1/2W	RV36	3339W-1-102
A1R26	Resistor, Comp, 3.3M ohms, 5% 1/2W	RF37	RC20GF335J
A1R27	Resistor, Film, 180K ohms, 2% 1/2W	RAP18	RL20S184G
A1R28	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A1R29	Resistor, Film, 330 ohms, 2% 1/2W	RAP07	RL20S331G
A1R30	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R31	Resistor, Film, 270 ohms, 2% 1/2W	RC30	RL20S271G
A1R32	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R33	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R34	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G

Table 3 NAPE19A Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL's PART NO.	JAN, MIL OR MFR PART NO.
A1R35	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R36	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R37	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
A1R38	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R39	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A1R40	Resistor, Film, 56 ohms, 2% 1/2W	RAP04	RL20S560G
A1R41	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A1R42	Resistor, Film, 18K ohms, 2% 1/2W	RAP14	RL20S183G
A1R43	Resistor, Film, 56 ohms, 2% 1/2W	RAP04	RL20S560G
A1R44	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A1R45	Resistor, Film, 33K ohms, 2% 1/2W	RAP15	RL20S333G
A1R46	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R47	Resistor, Film, 27K ohms, 2% 1/2W	RD12	RL20S273G
A1R48	Resistor, Film, 68K ohms, 2% 1/2W	RD17	RL20S683G
A1R49	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A1R50	Resistor, Film, 10 ohms, 2% 1/2W	RAP01	RL20S100G
A1R51	Resistor, Film, 10 ohms, 2% 1/2W	RAP01	RL20S100G
A1R52	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R53	Resistor, Variable, 1000 ohms, 1/2W	RW07	63P102
A1R54	Resistor, Film, 3900 ohms, 2% 1/2W	RD02	RL20S392G
A1R55	Resistor, Film, 15K ohms, 2% 1/2W	RD09	RL20S153G
A1R56	Resistor, Film, 15K ohms, 2% 1/2W	RD09	RL20S153G
A1R57	Resistor, Film, 4700 ohms, 2% 1/2W	RD03	RL20S472G
A1R58	Resistor, Film, 4700 ohms, 2% 1/2W	RD03	RL20S472G
A1R59	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R60	Resistor, Film, 1800 ohms, 2% 1/2W	RAP10	RL20S182G
A1R61	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
A1R62	Resistor, Variable, 10K ohms, 1/2W	RW08	63P103T000
A1R63	Resistor, Film, 68K ohms, 2% 1/2W	RD17	RL20S683G
A1R64	Resistor, Variable, 10K ohms, 1/2W	RW08	63P103T000
A1R65	Resistor, Film, 6800 ohms, 2% 1/2W	RD05	RL20S682G
A1R66	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A1R67	Resistor, Variable, 10K ohms, 1/2W	RW08	63P103T000
A1R68	Resistor, Film, 39K ohms, 2% 1/2W	RD14	RL20S393G
A1R69	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A1R70	Resistor, Film, 39K ohms, 2% 1/2W	RD14	RL20S393G
A1R71	Resistor, Film, 56K ohms, 2% 1/2W	RAP16	RL20S563G
A1R72	Resistor, Comp, 3.3M ohms, 5% 1/2W	RF37	RC20GF335J
A1R73	Resistor, Comp, 1.8M ohms, 5% 1/2W	RF34	RC20GF185J
A1R74	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R75	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R76	Resistor, Film, 10K ohms, 2% 1/2W	RAP13	RL20S103G
A1R77	Resistor, Film, 1000 ohms, 2% 1/2W	RAP09	RL20S102G
A1R78	Resistor, Film, 2200 ohms, 2% 1/2W	RC41	RL20S222G
A1R79	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A1R80	Resistor, Film, 330K ohms, 2% 1/2W	RAP19	RL20S334G
A1R81	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A1R82	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G

Table 3 NAPE19A Reference Designation Index (Continued)

REF DES	NAME OF PART AND DESCRIPTION	NAUTEL's PART NO.	JAN, MIL OR MFR PART NO.
A1R83	Resistor, Film, 3300 ohms, 2% 1/2W	RAP11	RL20S332G
A A1R84	Resistor, Film, 10 ohms, 2% 1/2W	RAP01	RL20S100G
B A1R84	Resistor, Film, 100 ohms, 2% 1/2W	RAP05	RL20S101G
A1U1	IC, CMOS, Programmable Timer	UL42	MC14536BAL
A1U2	IC, Operational Amplifiers, Dual	UL12	TL082IJG
A1U3	IC, Operational Amplifiers, Dual	UL12	TL082IJG
A1U4	IC, CMOS, Quad, 2-input AND Gates	UB20	MC14081BAL
A1U5	IC, Comparator, Quad	UL02	MC3302L
A1U6	IC, Comparator, Quad	UL02	MC3302L
A1U7	IC, Operational Amplifiers, Dual	UL12	TL082IJG
A1U8	IC, Multiplier, Four Quadrant	UL21	MC1595L
A1U9	IC, Comparator, Quad	UL02	MC3302L
A1XU1	Socket, Integrated Circuit, 16-pin	UC03	640358-1
A1XU2	Socket, Integrated Circuit, 8-pin	UC01	640463-1
A1XU3	Socket, Integrated Circuit, 8-pin	UC01	640463-1
A1XU4	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A1XU5	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A1XU6	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A1XU7	Socket, Integrated Circuit, 8-pin	UC01	640463-1
A1XU8	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A1XU9	Socket, Integrated Circuit, 14-pin	UC02	640357-1
A2	Low Power Stability PCB Assembly	139-3136	139-3136
A2C1	Capacitor, Ceramic, 0.047uF 10%, 100V	CCG06	CKR06BX473KL
A2Q1	Transistor, PNP	QAP09	2N2907
A2Q2	Transistor, NPN	QAP06	2N2222
A2Q3	Transistor, NPN	QAP06	2N2222
A2Q4	Transistor, Field Effect, N Channel	QAP18	IRFF130
DS1	Diode, Light Emitting, Red	QK13	5082-4693
F1	Fuse, 0.25A, 250V, Slo-Blo, Type 3AB	FB11	323.250
P1	Connector, Plug, 6-pin	JD09	P-3306-AB
P2	Connector, Plug, 6-pin	JD09	P-3306-AB
R1	Resistor, Film, 100K ohms, 2% 1/2W	RAP17	RL20S104G
TP1	Jack, Tip, White, Teflon	J021	450-4355-1-0319
TP2	Jack, Tip, White, Teflon	J021	450-4355-1-0319
TP3	Jack, Tip, White, Teflon	J021	450-4355-1-0319
XDS1	Socket, LED	QK25	PS-200-B
XF1	Fuse Block, 1 Pole, Type 3AG	FA26	357001

A Denotes used in NAPE19A
B Denotes used in NAPE19A/1

Table 4 NAPE19A Parts Per Unit Index

NAUTEL's PART NO.	NAME OF PART AND DESCRIPTION	JAN, MIL OR MFR PART NO.	OEM CODE	TOTAL IDENT PARTS
NAPE19A	Modulator Driver	139-3084-2	37338	- A
NAPE19A/1	Modulator Driver	139-3084-3	37338	- B
139-3085-4	Modulator Driver PCB Assembly	139-3085-4	37338	1 A
139-3085-5	Modulator Driver PCB Assembly	139-3085-5	37338	1 B
139-3136	Low Power Stability PCB Assembly	139-3136	37338	1
139-8119	Inductor, 360uH	139-8119	37338	1
CB25	Capacitor, Mica, 100pF 2%, 500V	CM05FD101G03	14655	1
CB27	Capacitor, Mica, 150pF 2%, 500V	CM05FD151G03	14655	1
CCG01	Capacitor, Ceramic, 0.001uF 10%, 200V	CKR05BX102KL	56289	1
CCG02	Capacitor, Ceramic, 0.0022uF 10%, 100V	CKR05BX222KL	56289	2
CCG03	Capacitor, Ceramic, 0.0047uF 10%, 100V	CKR05BX472KL	56289	2
CCG04	Capacitor, Ceramic, 0.01uF 10%, 100V	CKR05BX103KL	56289	2
CCG06	Capacitor, Ceramic, 0.047uF 10%, 100V	CKR06BX473KL	56289	1
CCG07	Capacitor, Ceramic, 0.1uF 10%, 100V	CKR06BX104KL	56289	9
CCG08	Capacitor, Ceramic, 0.22uF 10%, 50V	CKR06BX224KL	56289	3
CCG09	Capacitor, Ceramic, 0.47uF 10%, 50V	CKR06BX474KL	56289	1
CCP13	Capacitor, Tantalum, 150uF 10%, 15V	CSR13D157KM	56289	1 B
CCP19	Capacitor, Tantalum, 6.8uF 10%, 35V	CSR13F685KM	56289	1 A
CCP19	Capacitor, Tantalum, 6.8uF 10%, 35V	CSR13F685KM	56289	4
CCP20	Capacitor, Tantalum, 22uF 10%, 35V	CSR13F226KM	56289	1
CCP24	Capacitor, Tantalum, 1.0uF 10%, 50V	CSR13G105KM	56289	3
CY23	Capacitor, Variable, 7-25pF, 350V	538-011-B7-25	72982	1
FA26	Fuse Block, 1 Pole, Type 3AG	357001	75915	1
FB11	Fuse, 0.25A, 250V, Slo-Blo, Type 3AB	323.250	75915	1
JD09	Connector, Plug, 6-pin	P-3306-AB	13150	2
J021	Jack, Tip, White, Teflon	450-4355-1-0319	71279	3
LAP38	Inductor, Moulded, Shielded, 560uH	SWD560	00213	1
LAP39	Inductor, Moulded, Shielded, 1000uH	SWD1000	00213	1
LAP40	Inductor, Moulded, Shielded, 4700uH	SWD4700	00213	1
LAP41	Inductor, Moulded, Shielded, 10000uH	SWD10000	00213	1
LXP20	Bead, Small	21-030-B	02114	1
QAP06	Transistor, NPN	2N2222	04713	4
QAP09	Transistor, PNP	2N2907	04713	7
QAP18	Transistor, Field Effect, N Channel	IRFF130	81483	1
QAP29	Diode, General Purpose, Small Signal	1N4938	01295	6
QB34	Transistor, Field Effect, P Channel	2N5268	04713	1
QE10	Transistor, NPN, Switch	2N3227	04713	1
QK13	Diode, Light Emitting, Red	5082-4693	50434	1
QK25	Socket, LED	PS-200-B	15513	1
RAP01	Resistor, Film, 10 ohms, 2% 1/2W	RL20S100G	36002	1 A
RAP01	Resistor, Film, 10 ohms, 2% 1/2W	RL20S100G	36002	2
RAP04	Resistor, Film, 56 ohms, 2% 1/2W	RL20S560G	36002	3
RAP05	Resistor, Film, 100 ohms, 2% 1/2W	RL20S101G	36002	1
RAP05	Resistor, Film, 100 ohms, 2% 1/2W	RL20S101G	36002	1 B
RAP07	Resistor, Film, 330 ohms, 2% 1/2W	RL20S331G	36002	3
RAP09	Resistor, Film, 1000 ohms, 2% 1/2W	RL20S102G	36002	8
RAP10	Resistor, Film, 1800 ohms, 2% 1/2W	RL20S182G	36002	1
RAP11	Resistor, Film, 3300 ohms, 2% 1/2W	RL20S332G	36002	1 A

Table 4 NAPE19A Parts Per Unit Index

NAUTEL's PART NO.	NAME OF PART AND DESCRIPTION	JAN, MIL OR MFR PART NO.	OEM CODE	TOTAL IDENT PARTS
RAP11	Resistor, Film, 3300 ohms, 2% 1/2W	RL20S332G	36002	6
RAP13	Resistor, Film, 10K ohms, 2% 1/2W	RL20S103G	36002	1 B
RAP13	Resistor, Film, 10K ohms, 2% 1/2W	RL20S103G	36002	8
RAP14	Resistor, Film, 18K ohms, 2% 1/2W	RL20S183G	36002	1
RAP15	Resistor, Film, 33K ohms, 2% 1/2W	RL20S333G	36002	3
RAP16	Resistor, Film, 56K ohms, 2% 1/2W	RL20S563G	36002	3
RAP17	Resistor, Film, 100K ohms, 2% 1/2W	RL20S104G	36002	10
RAP18	Resistor, Film, 180K ohms, 2% 1/2W	RL20S184G	36002	1
RAP19	Resistor, Film, 330K ohms, 2% 1/2W	RL20S334G	36002	2
RC30	Resistor, Film, 270 ohms, 2% 1/2W	RL20S271G	36002	1
RC38	Resistor, Film, 1200 ohms, 2% 1/2W	RL20S122G	36002	1
RC41	Resistor, Film, 2200 ohms, 2% 1/2W	RL20S222G	36002	1
RD02	Resistor, Film, 3900 ohms, 2% 1/2W	RL20S392G	36002	1
RD03	Resistor, Film, 4700 ohms, 2% 1/2W	RL20S472G	36002	2
RD05	Resistor, Film, 6800 ohms, 2% 1/2W	RL20S682G	36002	1
RD09	Resistor, Film, 15K ohms, 2% 1/2W	RL20S153G	36002	2
RD11	Resistor, Film, 22K ohms, 2% 1/2W	RL20S223G	36002	1
RD12	Resistor, Film, 27K ohms, 2% 1/2W	RL20S273G	36002	1
RD14	Resistor, Film, 39K ohms, 2% 1/2W	RL20S393G	36002	1 A
RD14	Resistor, Film, 39K ohms, 2% 1/2W	RL20S393G	36002	2
RD15	Resistor, Film, 47K ohms, 2% 1/2W	RL20S473G	36002	1 B
RD17	Resistor, Film, 68K ohms, 2% 1/2W	RL20S683G	36002	2
RF34	Resistor, Comp, 1.8M ohms, 5% 1/2W	RC20GF185J	36002	1
RF37	Resistor, Comp, 3.3M ohms, 5% 1/2W	RC20GF335J	36002	4
RV36	Resistor, Variable, 1000 ohms, 1/2W	3339W-1-102	80294	3
RW01	Resistor, Variable, 100K ohms, 1/2W	3339P-1-104	80294	1
RW07	Resistor, Variable, 1000 ohms, 1/2W	63P102	02111	1
RW08	Resistor, Variable, 10K ohms, 1/2W	63P103T000	02111	3
RW24	Resistor, Variable, 100 ohms, 1/2W	63P101T000	02111	1
UB20	IC, CMOS, Quad, 2-input AND Gates	MC14081BAL	04713	1
UC01	Socket, Integrated Circuit, 8-pin	640463-1	00779	3
UC02	Socket, Integrated Circuit, 14-pin	640357-1	00779	5
UC03	Socket, Integrated Circuit, 16-pin	640358-1	00779	1
UL02	IC, Comparator, Quad	MC3302L	04713	3
UL12	IC, Operational Amplifiers, Dual	TL082IJG	01295	3
UL21	IC, Multiplier, Four Quadrant	MC1595L	04713	1
UL42	IC, CMOS, Programmable Timer	MC14536BAL	04713	1

A Denotes used in NAPE19A
B Denotes used in NAPE19A/1

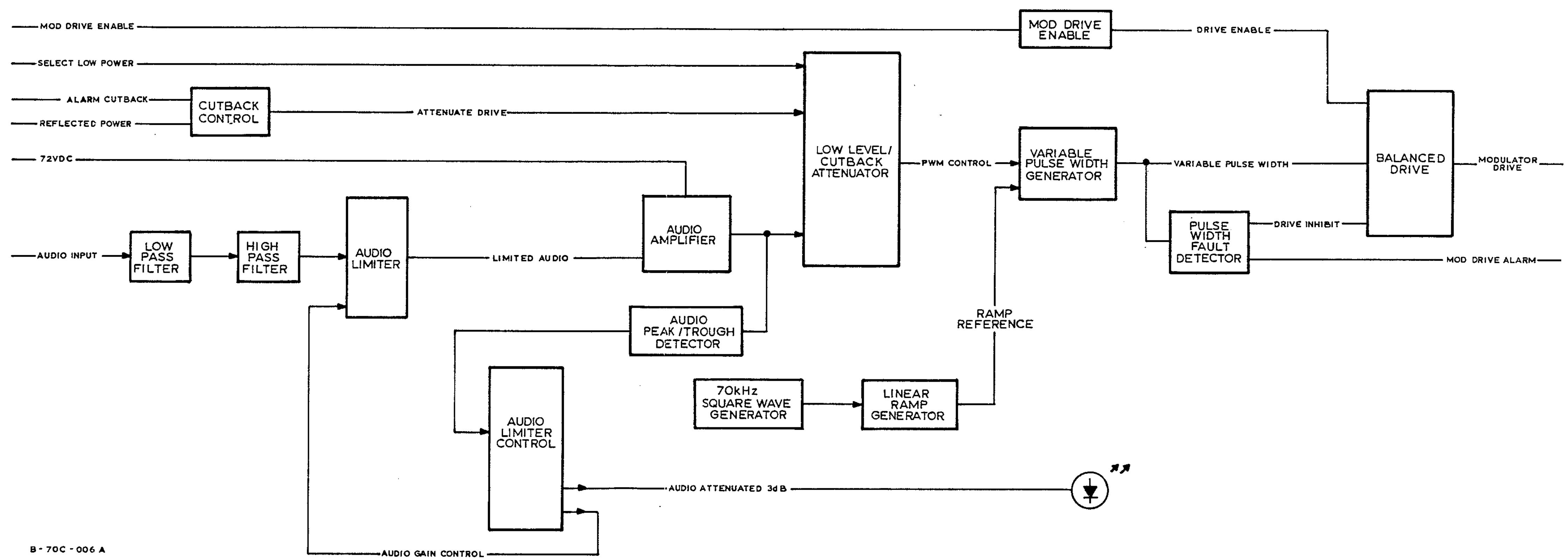
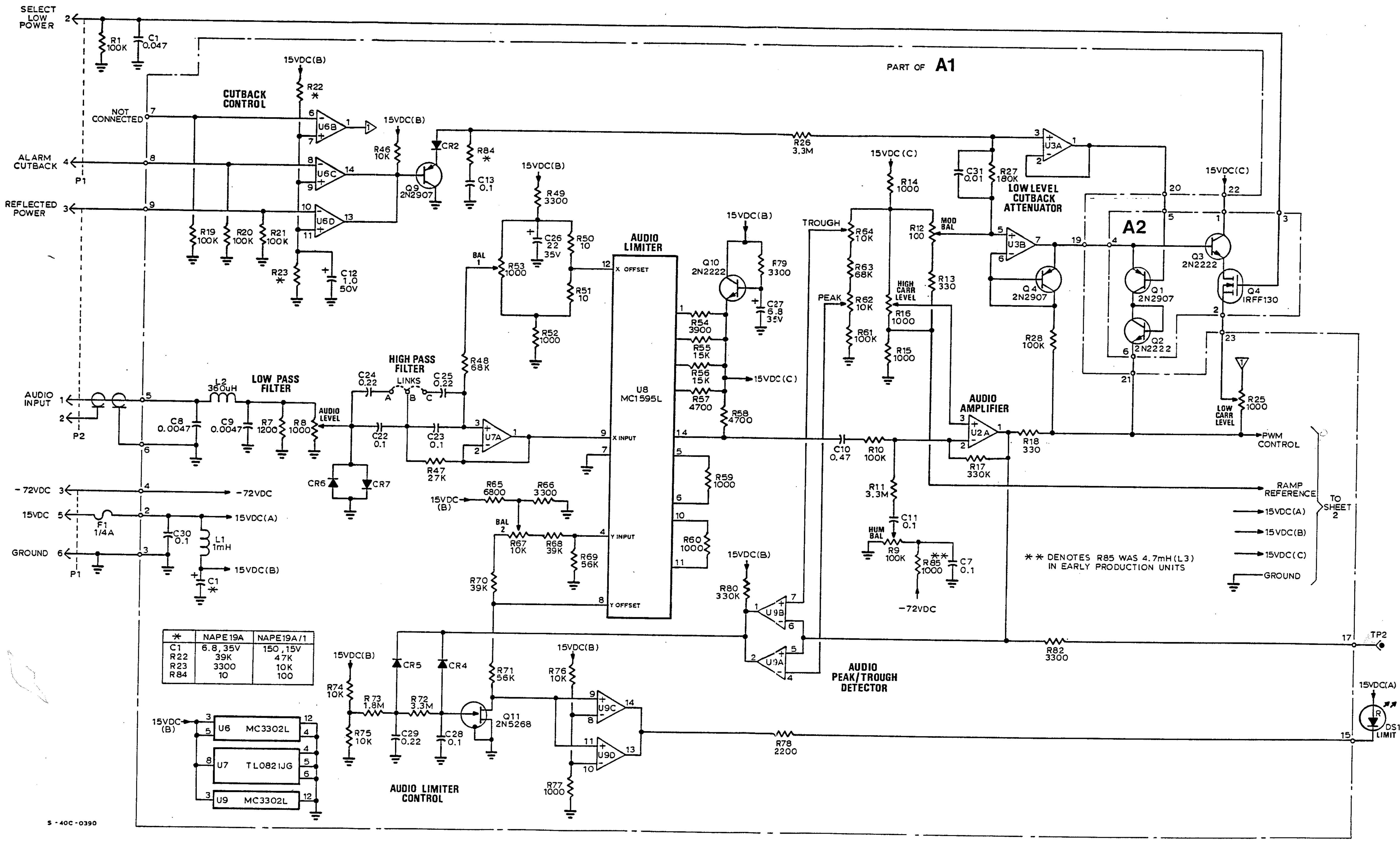
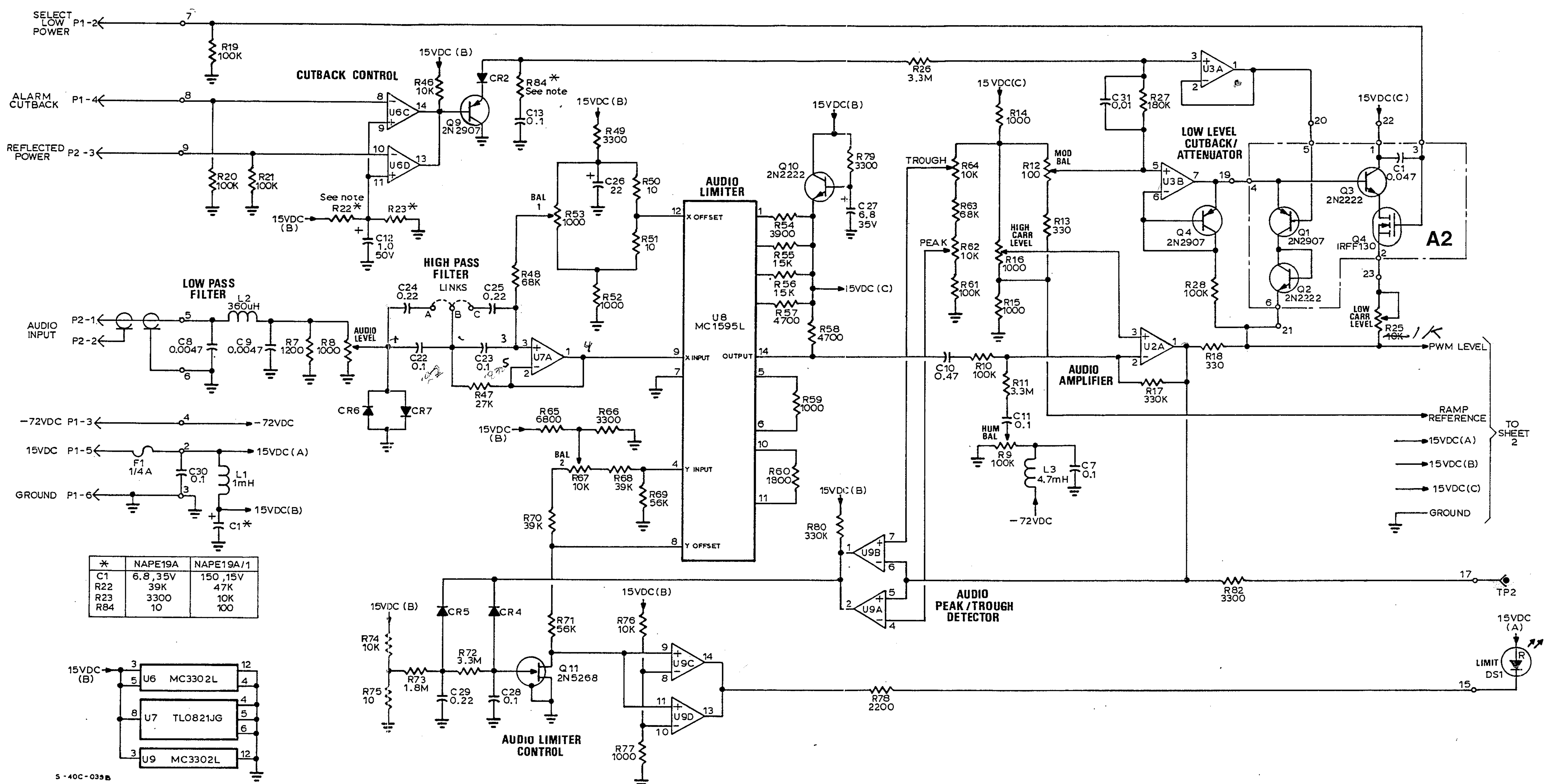


Figure FO-1 Block Diagram - NAPE19A Modulator Driver Module



*	NAPE19A	NAPE19A/1
C1	6.8, 35V	150, 15V
R22	39K	47K
R23	3300	10K
R84	10	100

Figure FO-2 Electrical Schematic - NAPE19A Modulator Driver Module (Sheet 1 of 2)



*	NAPE19A	NAPE19A/1
C1	6.8,35V	150,15V
R22	39K	47K
R23	3300	10K
R84	10	100

Figure FO-2 Electrical Schematic - NAPE19A Modulator Driver Module (Sheet 1 of 2)

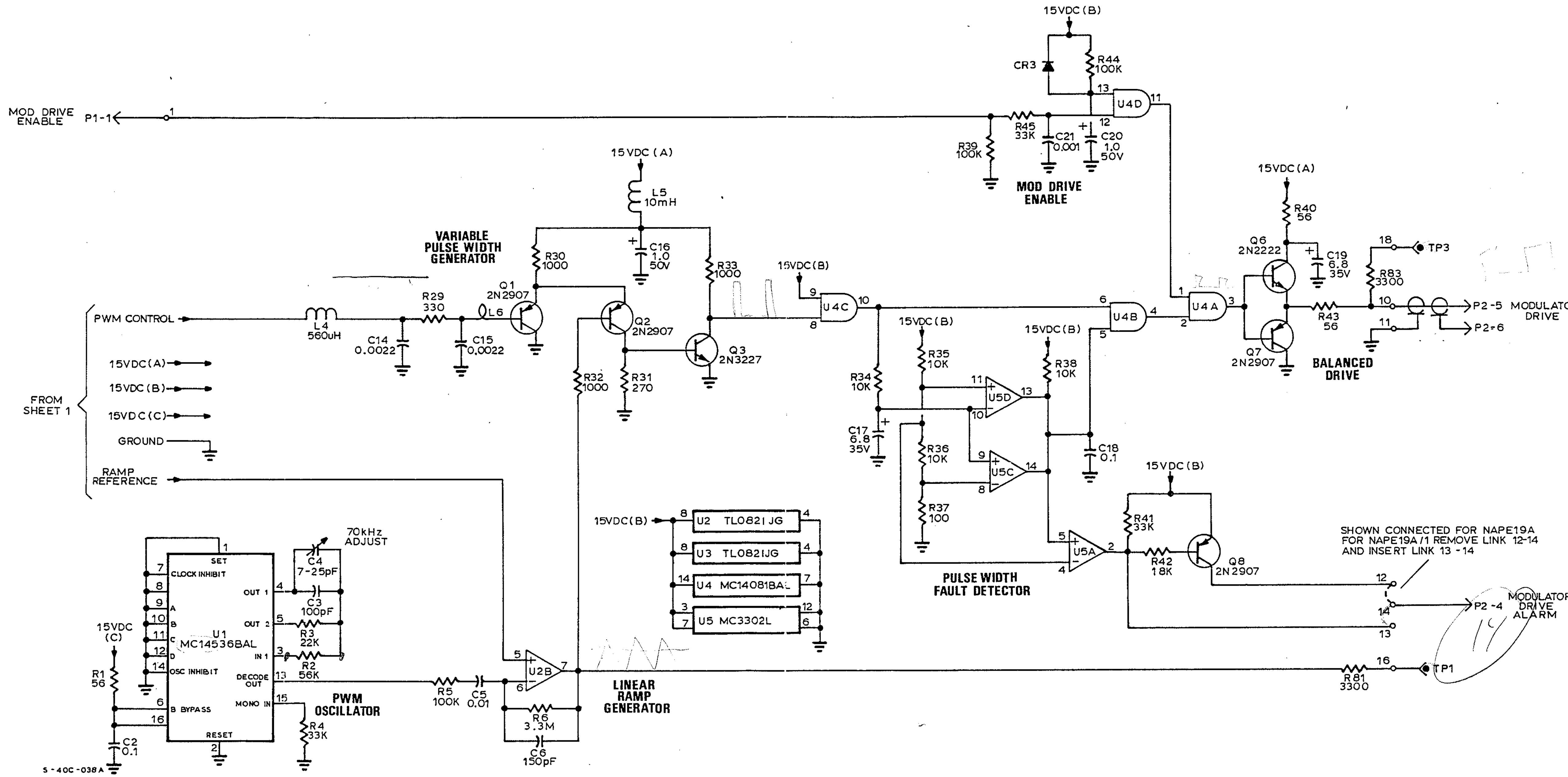


Figure FO-3 Electrical Schematic - NAPE19A Modulator Driver Module (Sheet 2 of 2)

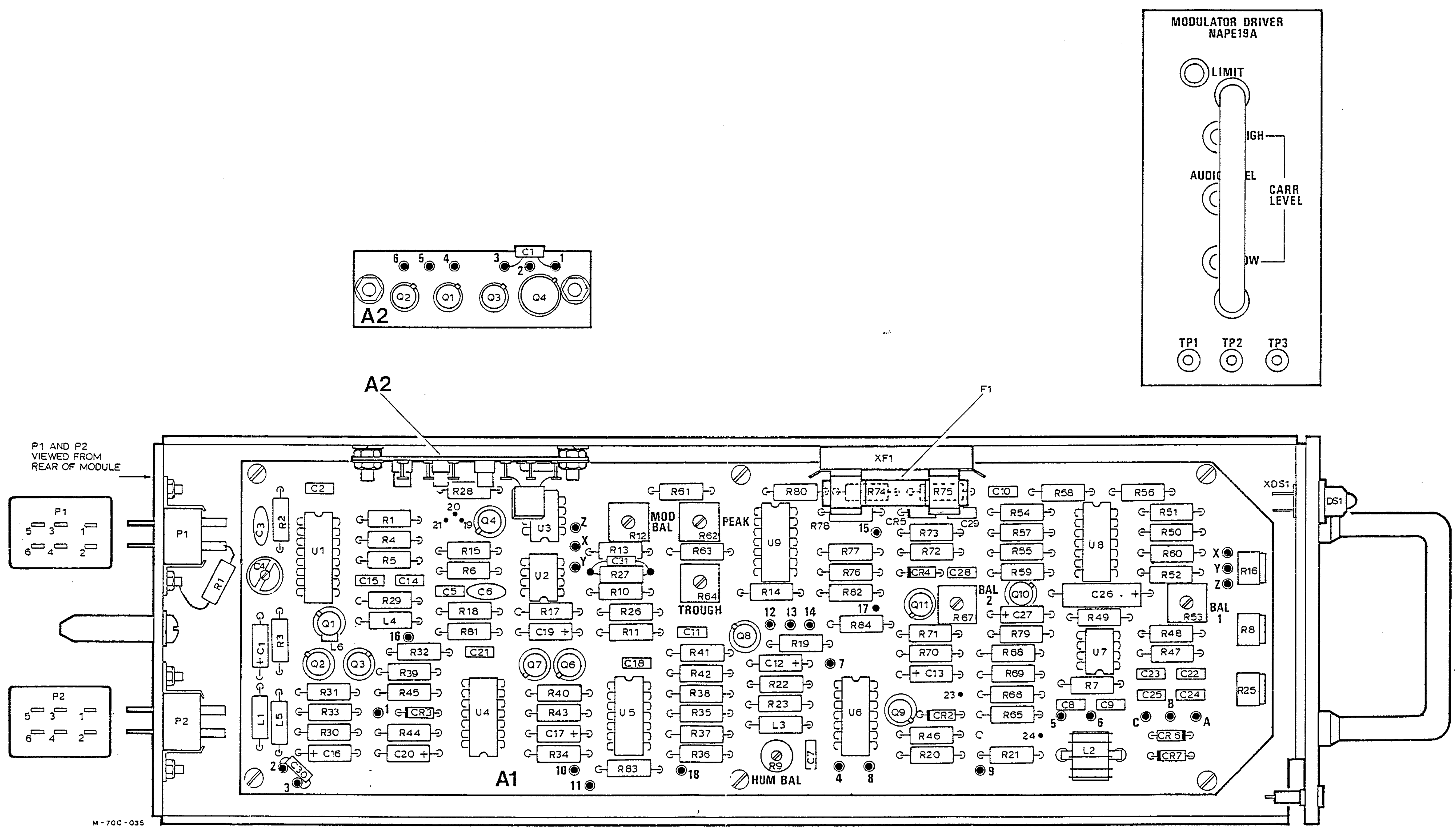


Figure FO-4 Assembly Detail - NAPE19A Modulator Driver Module