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MC MARTIN

TBM 2200A

STEREO MONITOR

INSTRUCTION MANUAL

McMartin Industries Inc. ■ 4500 South 76th Street ■ Omaha, Nebraska 68127 ■ (402) 331-2000 ■ Telex 484485

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19KHZ CAL = CARD A3
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McMartin®

TBM—2200A

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TBM-2200A

I

TECHNICAL SPECIFICATIONS

Composite Input

Impedance	5K ohms
Sensitivity	0.9 to 1.5 volts peak to peak

Outputs - Left and Right:

Audio Output for Monitoring Circuits

Source Impedance	600 ohms balanced
Level	+2 dBm at 100% modulation at 400 Hz
Distortion	Less than 0.5%, 50-15,000 Hz

Audio Output for Distortion Measurement

Impedance	10K ohms or greater
Level	5 volts at 100% at 400 Hz
Frequency Response	± 0.5 dB, 30-15,000 Hz

Distortion

Stereo	0.35%, 30-15,000 Hz
Stereo Noise Level	-66 dB below 100% modulation at 400 Hz

Composite Output

Source Impedance	1000 ohms
Level	0.3 volts rms
Frequency Response	± 0.2 dB, 50-75,000 Hz

Pilot Injection Circuit

Accuracy	± 0.5%
Meter Indication	6-12% (pilot injection scale)
Indicator	Pilot Lamp (operates at 5% or greater injection level)

Internal Pilot Calibrate

Accuracy	± 0.5%

Modulation Meters, Left or Right

Accuracy	± 0.5 dB
Frequency Response	± 0.5 dB, 30-15,000 Hz

Meter characteristics meet FCC requirements.

TECHNICAL SPECIFICATIONS (continued)

Separation

Left and Right Channels	-45 dB or better, 50-10,000 Hz -40 dB or better, 10,000-15,000 Hz

NOTE: Separation can be measured internally down to 70 dB

Measurement of Suppressed 38 kHz Carrier

Modulated 100% with frequencies above 5 kHz	Better than 50 dB
No modulation	Better than 60 dB

Crosstalk

Main into Stereo Sub Channel	50 dB or better
Stereo Sub Channel into Main Channel	50 dB or better
67 kHz into Main or Stereo Channel	66 dB or better

Pilot Carrier Frequency Meter

Deviation Range	$\pm$ 2.5 Hz
Accuracy	$\pm$ 0.25 Hz

Remote Monitoring Facilities

Modulation	Optional RM-22 T/R kit available. Left and right meter may be remotely monitored with 2500 ohm external loop resistance plus remote meter resistance. Remote meters are completely independent of internal meters.
Pilot Carrier Frequency	Frequency deviation may be remotely monitored with 2500 ohms external loop resistance including remote meter resistance.

Power Requirements	105-125 volts AC
Fuse	0.5 amp SLO BLO
Ambient Temperature Range	10-50 degrees C

Dimensions

Width	EIA Standard 19" rack (48.3 cm)
Height	7" (17.8 cm)
Depth	13" overall (33 cm) overall
Weight	15 lbs. (6.8 Kg)
Finish	Beige with wood grain trim

II

GENERAL DESCRIPTION

The McMartin TBM-2200A solid state stereo modulation and frequency monitor is designed to operate in conjunction with McMartin base band monitors, TBM-3700, TBM-4000A, or TBM-3500A, to provide all the stereo monitoring requirements. Three meters are used for simultaneously monitoring the left and right stereo channels and the center frequency deviation of the 19 kHz pilot carrier. The right and left meters are also used as audio voltmeters, which serve a secondary function of measuring separation between right and left channels, and cross-talk between main and sub channels, 38 kHz carrier suppression and stereo S/N of each channel. These functions are controlled by the dual range separation S/N switch calibrated in decibels. When the voltmeter section is used, the meters are highly damped to provide average measuring ballistics more suitable for noise and crosstalk measurement.

The various meter functions are incorporated in one switch. These functions read on the left meter are as follows: calibrate level, pilot injection level, operate, L+R, 19-38 kHz phasing, 38 kHz suppression and stereo signal-to-noise ratio. L-R information is read on the right meter. When the function switch is in the stereo S/N position the audio is automatically de-emphasized. The left meter is highly damped in the pilot injection position to prevent meter jitter with high levels of stereo modulation. The audio voltmeter is automatically locked out when the function switch is in the pilot injection position thereby eliminating any change of pilot level error. When in the "operate" position, the meter ballistics conform to the FCC requirement.

A precise 19 kHz calibrate signal and additional circuitry are used to accurately calibrate the 19 kHz pilot injection measuring circuits. This allows daily verification of the accuracy of the monitor and the frequency of the 19 kHz pilot.

The metering circuits used in the TBM-2200A are peak-indicating devices capable of accurately measuring composite signals. The meter driving circuits are de-

GENERAL DESCRIPTION (continued)

signed to go into saturation slightly above full scale deflection to protect the meters against severe overload.

An indicator light located above the pilot frequency deviation meter displays the presence of the 19 kHz pilot carrier when the level exceeds 3% main channel modulation. A phasing control, located on the front panel allows adjustments of the 19 and 38 kHz circuits for exact phase coincidence (necessary for proper operation of the TBM-2200A monitor). In the absence of a stereo signal (mono operation), internal circuitry automatically maintains the audio at a constant level.

A BNC connector on the front panel is available to allow viewing the composite signal fed to the monitoring circuits on an oscilloscope. This output is switched permitting viewing of the pilot carrier, L+R and L-R signals. Almost all of the circuits are on plug-in cards, easily removed from the rear of the chassis for easy servicing. Each plug-in card is isolated from the power supply so in case of failure it will not short-circuit the power supply, disabling the rest of the monitoring functions. The power supply is also protected against accidental short circuit. A separate 20 Volt regulated supply is used for the lower voltage, higher current plug-in cards.

The pilot center frequency deviation indicator used in the TBM-2200A is not a zero center meter, thus in case of malfunction of the frequency measuring circuitry, the meter indicator will not remain on zero frequency but will return to the left side of the meter. This is also the normal position in the absence of a pilot carrier. A squelch circuit is used to disable the frequency metering circuits in the absence of the pilot carrier.

The TBM-2200A has complete facilities for remote monitoring of the 19 kHz pilot carrier level, left and right stereo modulation and frequency deviation of the pilot carrier.

III

INSTALLATION

Upon receipt of your TBM-2200A, remove it from the shipping carton and inspect it carefully for any damage caused in transit due to rough handling. If any damage is found, notify the shipping agency and advise McMartin Industries of such action.

The top cover of the TBM-2200A should be removed. An inspection of the plug-in cards should be made to insure that they are firmly seated in their proper sockets.

The TBM-2200A should be mounted where there is adequate ventilation. The unit should not be mounted above high heat-producing equipment.

CAUTION: Ambient temperature should not exceed 110° F (43°C).

Check the mechanical zero setting of the frequency and modulation meters before applying AC power.

Connect the AC cord to a 117 volt AC source. Connect a low capacity cable from the composite output of the base band monitor to the input jack marked "Composite Input" on the rear of the chassis.

The TBM-2200A has been thoroughly checked and calibrated prior to shipment and should require no adjustment. Turn power on. The monitor has extensive filtering and requires some time for stabilization.

CAUTION: The recessed front panel "Level Set" control must be properly adjusted to the base band monitor. Refer to "Normal Operation".

IV

NORMAL OPERATION

IT IS IMPERATIVE THAT THE "LEVEL SET", "INTERNAL CAL" AND "PILOT INJ" ARE PROPERLY ADJUSTED FOR ACCURATE MONITORING OF THE STEREO SIGNAL.

Level Set Adjustment

This is not a factory set control.

1. Turn the function switch of the TBM-2200A to the "Cal." position.
2. Modulate the transmitter (mono) 100% with a 400 Hz signal as verified with the total modulation meter in the base band monitor.
3. Adjust the recessed "Level Set" control located on the lower left side of the TBM-2200A with a small screwdriver, for a reading of exactly 100% on the left meter.

NOTE: If a TBM-3700 base band monitor is used, the internal calibrate signal may be used for this adjustment. Turn the function switch of the TBM-3700 to the "+" or "-" position. Depress the "Mod-Push to Cal" switch on the TBM-3700 and use this accurate signal for calibration of the TBM-2200A.

"Internal Cal" Adjustment

This has been factory adjusted, but should be verified during installation.

1. Turn the function switch to the "Cal" position.
2. Depress the "Injection Push to Cal" switch.
3. Adjust the recessed "Internal Cal" control with a small screwdriver, located on the left side of the TBM-2200A for a reading of exactly 100% on the left meter.

Pilot Injection Calibrate Adjustment

This has been factory adjusted, but should be verified during installation.

1. The "Internal Cal" adjustment must be properly adjusted for exactly 100% on the left meter as described above.
2. Turn the function switch to "Pilot Injection" position.
3. Depress the "Injection Push to Cal" switch. If the pilot injection does not read exactly 10% on the top scale of the left meter, adjust the recessed "Injection" control with a small screwdriver, located above the

NORMAL OPERATION (continued)

Pilot Injection Calibrate Adjustment, Item # 3, (continued)

BNC connector on the front panel for a reading of exactly 10% injection. NOTE: After initial adjustment of the "Internal Cal" and "Injection Cal" controls, these should rarely have to be adjusted, unless a malfunction occurs in the monitor.

It is recommended that the "Internal Cal" and "Injection Cal" be checked occasionally to verify proper operation of the TBM-2200A.

Monitoring Pilot Carrier Frequency

1. Insure that a 19 kHz pilot is present at a level of at least 5% injection.
2. Depress the "Freq. - Push to Cal" switch.
3. Adjust "Meter Zero" control to exact zero center on frequency deviation meter.
4. Release "Push to Cal" switch to measure frequency. NOTE: Frequency meter indicates the error frequency of the 19 kHz carrier.

Monitoring Pilot Injection

If the station is transmitting stereo, place the function switch in the "Pilot Injection" position. Adjust the pilot injection of the transmitter to obtain the desired percent injection level (8-10% as required by the FCC). This is read on the upper scale of the left meter of the TBM-2200A. This signal may be viewed on the oscilloscope by connecting to the BNC composite output jack located on the front panel of the monitor.

Internal 19 kHz Phase Calibration

With a 19 kHz pilot carrier present, adjust the transmitter to approximately 10 percent injection. Turn the function switch to "+" phase and note the reading on the left meter. Switch the function switch to "-" phase position. If the two readings are not identical, adjust the "Phase" control, located on the front panel switching between the "+" and "-" positions until the two readings are equal. This indicates perfect phase coincidence.

Pilot Phase Adjustment of the Transmitter

The internal 19 and 38 kHz phasing of the monitor must be adjusted before making any phase adjustment in the transmitter. Apply equal out-of-phase 80-100 Hz signals (L=-R) to the left and right input of the transmitter. Adjust the pilot phase of the transmitter for maximum reading on either the left or right meter. If a good wide-band oscilloscope is available, the adjustment may be verified by connecting a low capacity cable to the BNC connector labelled composite output on the front panel. The display should resemble Figure 6A*. The two points in the diamond must coincide. NOTE: It is very important that correct phase be maintained at all times.

Operation of the Separation S/N Switch

The separation S/N switch is, in effect, an audio voltmeter calibrated in 10 dB steps. Turning the switch to either the left or right increases the gain 10 dB in each position. A high gain amplifier is automatically switched to the appropriate left or right meter. An example for reading signal-to-noise ratio: If the meter reads -3 dB in the 50 dB position, the noise ratio would be -53 dB below 100 percent modulation.

Measurement of L into R Channel Separation

Modulate the left channel of the transmitter until the left meter reads 90 percent (80 percent if SCA is being transmitted). The right meter should now read near zero, if everything is functioning properly. The separation can be measured by rotating the separation switch to the right, (L into R) until a reading is obtained on the right meter. For example: If the meter reads -6 dB with the separation switch in the -30 dB position, the channel separation would be -36 dB. This procedure is used for any frequency from 50 to 15,000 Hz.

Return the separation switch to the "Operate" position.

Measurement of R into L Channel Separation

Modulate the right channel of the transmitter until the right meter reads

*waveform figures found on page 32.

Measurement of R into L Channel Separation (continued)

90 percent (80 percent if SCA is being transmitted). The left meter should read near zero. The separation can be measured by rotating the separation switch to the left (R into L) until a reading is obtained on the left meter. This procedure is identical to the measurement of L into R.

Return the separation switch to the "Operate" position.

If the separation between the left and right channel is inadequate, (30 dB minimum is required by FCC) the following procedures are recommended:

Connect a wide-band oscilloscope to the composite output BNC jack located on the front panel of the TBM-2200A. The display should look like Figure 1*. Any departure from this will reduce separation. Figure 2* indicates the amplitude of the L-R is too low, and Figure 3* shows the L-R amplitude is too high. Figure 4*, indicates excessive time delay. Figure 5* indicates both time delay and amplitude error. Again adjust transmitter for the straightest base line at all frequencies. The pilot phase must also be correct for good separation. If an oscilloscope is not available, adjust transmitter for best overall separation at all frequencies as read on the separation meter of the TBM-2200A. The amount of separation in decibels is the ratio of the peak-to-peak value of the composite signal to the base line variation. See Figure 7*.

In actual practice, separation losses are attributable to a combination of both amplitude and phase errors that exist somewhere in the system.

Measurement of Crosstalk - Stereo Sub Channel into Main Channel

1. Modulate the transmitter 90 percent (as read on the left and right modulation meters) with 400 Hz L=-R (equal in phase signals) applied to the left and right inputs of the transmitter.
2. Turn the function switch to the "L+R" position. (Residual L-R signal may be viewed on an oscilloscope through the BNC connector on the front panel of the TBM-2200A).
3. Turn the separation switch to the left to read the crosstalk of the

*waveform figures found on page 32.

Measurement of Crosstalk - Stereo Sub Channel into Main Channel, Item # 3 (continued)

double side band subcarrier into the main channel. (Refer to "Operation of Separation Switch"). This will be read on left meter.

4. Return separation switch to the "Operate" position.
5. Return function switch to the "Operate" position.

Measurement of Crosstalk - Main Channel into Stereo Subchannel

1. Modulate the transmitter 90 percent (as read on the left and right modulation meters) with 400 Hz L=+R (equal in phase signals) applied to left and right inputs of the transmitter.
2. Turn the function switch to the "L-R" position. (Residual L+R signal may be viewed on an oscilloscope through the BNC connector on the front panel of the TBM-2200A.)
3. Turn the separation control to the right to read crosstalk of the main channel into the stereo subchannel This will be read on the right meter.
4. Return separation switch to the "Operate" position.
5. Return function switch to the "Operate" position.

NOTE: If poor crosstalk readings are obtained, it may be necessary to check the amplitude and phase relationship of the input signals. The amplitude and phase relationship of the left and right audio signals feeding the stereo modulation must be precisely equal at all frequencies, 50-15,000 Hz, to meet the crosstalk requirements.

Measurement of the 38 kHz Suppressed Carrier Without Modulation

1. Remove all signals from both channels of the transmitter.
2. Turn the function switch to "38 kHz" position.
3. Turn the separation switch to the left and read the residual 38 kHz carrier on the left meter. (Refer to operation of separation switch.)
4. Adjust transmitter for the null of the 38 kHz carrier.
5. Return the function switch to "Operate" position.

NORMAL OPERATION (continued)

Measurement of the 38 kHz Suppressed Carrier Without Modulation (continued)

6. Return the separation switch to "Operate" position.

NOTE: FCC requires that the 38 kHz suppressed carrier must be suppressed 40 dB, equal to 1 percent modulation.

Measurement of the 38 kHz Suppressed Carrier with Modulation (5 kHz to 15 kHz)

1. Modulate the transmitter 90 percent (as read on the left or right modulation meters) with any frequency between 5 kHz and 15 kHz.
2. Turn the function switch to "38 kHz" position.
3. Turn the separation switch to the left and read the residual 38 kHz carrier on the left meter. (Refer to "Operation of Separation Switch").
4. Return the separation and function switches to "Operate" position.

Measurement of Distortion of the Left and Right Channel

1. Modulate the left channel of the transmitter 90 percent as read on the left modulation meter.
2. Remove the jumper between the "HI-Z" terminals on the rear terminal board on the left channel.
3. Connect a distortion analyzer to the terminals marked "Ground" and "HI-Z".
4. Measurement of the right channel is identical to above.
5. The de-emphasis switch should be in the "out" position when distortion measurements are taken.

Measurement of the Stereo Signal-to-Noise Ratio of the Transmitter

1. Remove all audio modulation from the transmitter.
2. Turn the function switch to "S/N" position.
3. Turn the separation switch to the left and read the S/N of the left channel on the left meter (refer to "Operation of Separation Switch").
4. Turn the separation switch to the right and read the S/N of the right channel on the right meter (refer to "Operation of Separation Switch").

Measurement of the Stereo Signal-to-Noise Ratio of the Transmitter (continued)

5. Return the function switch and separation switch to "Operate" positions.

Remote Monitor Operation

Remote left and right meters.

1. Connect the remote modulation meter lines to the respective "Left RM Mod" and "Right RF Mod" terminals on the rear chassis. NOTE: Remote meter lines resistance must not exceed 2500 ohms.
2. Refer to remote monitoring under the maintenance section for calibration.

Remote Pilot Frequency Deviation Meter

1. Connect the remote frequency meter to the two terminals marked "RM Freq." on the terminal strip located on rear chassis. NOTE: Remote line resistance must not exceed 2500 ohms.
2. Refer to remote monitoring under maintenance section for calibration.

DETAILED CIRCUIT DESCRIPTION

The stereo composite signal from the base band monitor is fed to the "Level Set" recessed front panel control, R-2. The composite signal from R-2 is routed through two sections of the "Injection - Push to Cal." switch, SW-1 to the Internal Gain Calibrate control, R-5, located on top of chassis. The composite signal from R-5 is routed through section #5 of the function switch, SW-2. With SW-2 in the "Calibrate" position, the composite signal is routed through to the modulation meter circuitry. Properly adjusted, a meter reading of 100% indicates the correct level of the composite signal from the base band monitor.

Depressing the "Injection - Push to Cal." switch, SW-1, blocks the composite signal from the base band monitor. This also activates the 19 kHz reference crystal oscillator on plug-in Card A-3. This injection calibrate signal is routed to the "Internal Cal." recessed front panel control, R-6. This signal is now fed through SW-1 to the modulation meter circuitry. R-6 adjusts the level of the reference oscillator signal for a meter reading of 100%, thus adjusting the internal 19 kHz calibrate voltage to precisely equal the 100% composite signal from the base band monitor. This 100% reference signal, through SW-1 is also fed to a precision voltage divider, R-3 and R-3A, which gives a precise 10% pilot injection calibrate voltage.

The injection calibrate Card A-3 utilizes a 190,000 Hz crystal oscillator. This signal is fed to IC-1 (SN7490) which divides the signal by 10, producing a stable and accurate 19 kHz signal for internal calibration.

With the function switch, SW-2 in the "Injection" position and the "Injection - Push to Cal." switch depressed, the precise 10% pilot injection voltage is fed through the composite amplifier Card A-4 and into the highly selective 19 kHz amplifier on the 19 - 38 kHz amplifier Card A-5. The amplified 19 kHz signal is fed to the recessed front panel control, R-14, which allows pilot injection calibration of the left meter to precisely 10% injection.

DETAILED CIRCUIT DESCRIPTION (continued)

The composite amplifier Card A-4 consists of two separate amplifiers with low output impedance suitable for driving the L+R, L-R, and the 38 kHz filters. Each filter is terminated with a potentiometer to allow accurate level adjustment of each function. Function switch SW-2 selects the desired output signal from the filters and is routed to the left modulation meter.

The 19-38 kHz amplifier Card A-5 fed from composite amplifier Card A-4 utilizes two amplifier stages with high-Q coils L1 and L2 which remove all modulation products from the desired 19 kHz pilot carrier. This signal appears at the emitter of Q-3, feeding the injection potentiometer R-14 and transistor Q-4. This stage further amplifies the 19 kHz signal feeding transformer T-1. The secondary of T-1 is center-tapped and diodes D1 and D2 are used as full wave rectifiers to double the frequency and produce 38,000 Hz positive pulses, eliminating the undesired 19 kHz carrier from the stereo demodulator. Capacitor C-11 (4700 pf) is used in conjunction with the front panel "Phase" control to delay or advance the phase of the 19 kHz signal to precisely match the zero crossing of the 19 and 38 kHz signal in the stereo demodulator.

The positive 38 kHz pulses are fed to the stereo demodulator Card A-6. Diodes D1, D2, D3, and D4 and resistor R-6 are used as a limiter to hold the input to Q-1 constant. Changes in pilot level will have little effect on the performance of the stereo demodulator.

The 38 kHz positive pulses turn on Q-1 which amplifies the 38 kHz signal fed to transformer T-1. The "Q" of the primary and secondary windings of T-1 being high, produces a very clean 38 kHz switching voltage.

The 38 kHz positive pulses turn on Q-1 causing a positive voltage to appear across R-8 which turns on Q-2, short circuiting the center tap of transformer T-1 to ground. This produces the 38 kHz switching voltage required for stereo demodulation. When the pilot carrier is removed, transistor Q-2 turns off, removes the short circuit and a DC voltage is applied to the center tap of of the secondary of transformer T-1 and to the diodes. This allows a mono signal to pass without clipping. Transistors Q-2, Q-5, and Q-6 are used as switches and are turned on and off by transistor Q-1.

Transistor Q-5 is turned on by the voltage across R-8. In the presence of a stereo signal Q-5 turns on, short circuits the mono calibration control R-19 (on top of chassis) and increases the gain by 6 dB. The absence of a stereo signal turns off Q-5. The mono level can be adjusted by the mono calibration control R-19 to precisely equal the level of the stereo signal. Transistor Q-6 turns on and activates the pilot indicating light.

In the presence of a stereo signal wide band stereo composite signal is fed through R-3 to the junction of D6 and D9 and through R-5 to the junction of diodes D7 and D8. These diodes are in effect, switches. The diode switches are alternately turned on and off at a 38,000 Hz rate to allow the left and right channel to pass at the prescribed time.

The left and right outputs of the demodulator are applied to the amplitude correction amplifiers, transistors Q-3 and Q-4. The original stereo signal consists of equal amplitude (L+R) and (L-R) signals with no odd-harmonic components of the 38 kHz switching pulses as these were filtered out in the stereo modulator. Square wave switching in the demodulator of the TBM-2200A adds an L-R component which is not present in the original. This difference in amplitude must be corrected in the amplitude correction amplifier by cross-coupling the outputs through resistor R-17 and the "Separation" control, R-20 on top of the chassis.

The left and right audio channels are amplified and feed two 15 kHz low pass filters, FL-4 and FL-5. These filters remove all frequencies above 15 kHz present on the demodulated left and right channels. The outputs of the two filters are terminated with 1000 Ohm potentiometers. R-21 is used for calibrating the level of the left audio channel. R-22 is used for calibrating the right audio channel. The two audio outputs are routed through the function switch SW-2 to the right and left modulation meters. Right and left channel audio is also fed to the dual audio amplifier Card, A-10, where the signal is amplified to a level of approximately 5 volts rms suitable for driving a distortion analyzer. A dual deemphasis switch is mounted on the A-10 card and is used for test purposes when making distortion measurements. This switch must be operated in the deemphasized (out) position.

The audio voltmeter consists of the high gain dB amplifier Card A-9 which drives the separation S/N switch which provides 10 dB attenuation steps for the metering circuits. The normal position of the separation S/N switch is in the center. Turning the switch to the left increases the gain of the left channel functions and to the right the right channel functions.

The right and left meter drive circuits Card A-8 consists of two IC amplifiers, one for each meter. The output impedance is extremely low (0.2 Ohms) and is capable of charging capacitors C-3 and C-11 to the peak value of modulation. The capacitors across R-5 and R-15 control the rise time of the meters. R-4 and R-14 control the decay time with little or no interaction with the rise time. A DC balancing voltage is fed through diodes D1 and D2. This compensates for the temperature characteristics of the peak rectifier diodes, and provides excellent temperature stability of the metering circuits. Trimpots R-9 and R-19 are used to electrically zero the meters. The remote meter Card A-7 is identical to the A-8 card except for changes in the values of; R-5, R-10, and the capacitor values across those resistors used to control the rise time. Resistors R-1 and R-11 are trimpots for calibration.

Detailed Description of the Pilot Frequency Measuring Circuit

The selected 19 kHz signal from Card A-5 is fed through isolation resistor R-17 to the frequency multiplier and mixer Card A-1A. The 19 kHz signal is again fed through a selective amplifier which insures that the monitor will not respond to signals other than the pilot carrier. The 19 kHz signal is

DETAILED CIRCUIT DESCRIPTION (continued)

Detailed Description of the Pilot Frequency Measuring Circuit, (continued)

multiplied 12 times by quadrupler and tripler stages. Four high-Q coils are used to insure a clean 228,000 Hz sine wave. A stable 228,060 Hz crystal controlled local oscillator frequency is mixed with 228,000 Hz signal to produce a 60 Hz IF frequency. One Hz deviation of the 19 kHz pilot carrier will produce a 12 Hz change in the IF frequency.

The 60 Hz IF signal from Card A-1A is fed to the IF amplifier, limiter and frequency counter type discriminator Card A-2. The front panel "Freq. - Push to Cal." switch, SW-4, controls the signal feed to Card A-2A. When the switch is in the "Normal" position a DC voltage is applied to diode switches D1 and D2. This allows the 60 Hz signal from the mixer in Card A-1A to pass through to the IF system.

When the front panel switch SW-4 is depressed the voltage is removed from D-1 and D-2 which blocks the 60 Hz IF from the mixer. The DC voltage is now applied to diode D-3 turning it on and a sample of the 60 Hz line frequency is fed to the IF system for calibration. A 1 Hz error of the line frequency will produce only 1/12 Hz error in the frequency discriminator.

The IF signal is fed to the first symmetrical limiter Q-1. This device is a dual unit on one chip and is matched as to temperature, gain, and other parameters to give symmetrical limiting. The square wave output of Q-1 drives the second symmetrical limiter Q-2. The output of the second limiter drives the first half of the dual unit Q-3 alternately to complete saturation and cut-off. This output drives the second half of Q-3 to complete cut-off and saturation producing a very stable 27 volt Peak to Peak square wave signal. Temperature, transistors, and other components have no effect on the amplitude or shape of the square wave.

Large coupling capacitors are used so that hard limiting occurs down to 25 Hz. The IF frequency will shift from 36 Hz to 84 Hz when the 19 kHz carrier is shifted ± 2 Hz.

Detailed Description of the Pilot Frequency Measuring Circuit (continued)

The negative going 27 volt square wave pulses are intergrated by diodes D-4 and D-5 and filtered by resistor R-23 and capacitor C-11 producing a negative voltage at the negative meter terminal. A positive voltage is fed through resistor R-31, the "Coarse Frequency Calibrate" potentiometer, R-24 (on top of chassis), and the front panel zero control to the junction of the negative meter terminal. The resultant voltage is fed through the 50 microampere frequency meter, the rear chassis remote switch and a precision 3010 Ohm resistor to ground. Whenever the voltage changes in either direction, resulting from a change in carrier frequency, the current through the meter causes a like deviation of the frequency meter. The frequency meter is not affected by injection levels of 2% to 12%.

Capacitor C-10 and resistor R-31 have been chosen so that the negative produced voltage and the positive produced voltage change equally when the 27 volt supply is varied. This produces a very stable frequency measuring circuit.

A relay circuit, Q-4 and Q-5, is used on Card A-2A to short circuit the negative meter terminal to ground in the absence of a 19 kHz carrier. This protects the frequency meter from overload and causes the frequency meter to return to the left side of the scale as it is not a zero-center meter. When a remote meter is used to read frequency, the rear chassis remote switch must be in the remote position. The external loop resistance must equal 2500 Ohms for accurate frequency reading of the remote meter.

VI

MAINTENANCE

This section contains maintenance and calibration information for the TBM-2200A Stereo Monitor. The unit utilizes separate circuitry for stereo modulation functions and frequency measurements. The stereo functions will be described first.

Before performing calibration, check to see that all plug-in cards are properly seated in their respective sockets. Also, definitely determine that the monitor is at fault (injection levels, internal phasing, modulation levels, and S/N, are self-checking) before performing recalibration. It is sometimes possible to create an error in the monitor and compensate for a transmission error by midadjustment of the monitor giving excellent meter readings; however, this is most undesirable. The following calibration may be made if appropriate test equipment is available. CAUTION: Do not remove or insert cards with power on!

Injection Calibrate Oscillator

NOTE: This precision 19 kHz signal is used for calibrating the injection measuring circuits and several functions of the stereo demodulator system.

1. Remove plug-in Card A-3 and insert into extender card.
2. Connect a frequency counter to the junction of R-6 and R-7 on Card A-3.
3. Depress "Injection - Push to Cal." switch on the front panel, this activates the 190,000 Hz crystal oscillator.
4. Adjust variable capacitor C-1 for exactly 190,000 Hz as measured with the frequency counter.
5. Connect the frequency counter to pin "K" on Card A-3. The frequency at this point should be precisely 19,000 Hz.
6. Replace plug-in Card A-3.

DC Meter Balance Card A-8

1. Short circuit the meter terminals and adjust for mechanical zero.
2. Remove all input signals.
3. Turn the function switch to "Operate" position.

DC Meter Balance Card A-8 (continued)

4. Adjust trimpot R-19 located on the lower rear of Card A-8 for exact zero on the left meter.
5. Adjust trimpot R-9 located on the top rear of Card A-8 for exact zero on the right meter.

NOTE: The zero balance control may have to be adjusted occasionally due to aging of components.

DC Meter Balance - Optional Remote Card A-7

The same procedure is used for adjusting the optional remote card.

Calibration of Internal Gain Control

1. Turn function switch to "Cal" position.
2. The recessed front panel "level set" control must be turned fully clockwise.
3. Feed a 400 Hz signal (0.30 volts rms) into the composite input jack on the rear of the chassis. The accuracy of this voltage is critical as it determines the accuracy of the monitor.
4. Adjust R-5 internal gain control on top of chassis for a reading of 100% on left meter.

Calibration of Internal Calibrate (recessed front panel control)

1. Turn function switch to "Cal" position.
2. Depress the "Internal Cal - Push to Cal" switch.
3. Adjust recessed control with a small screwdriver for a reading of exactly 100% on left meter. This adjusts the internal 19 kHz signal to the exact level of 100% modulation.

Pilot Injection Calibration (recessed front panel control)

1. Turn the front panel function switch to the "Inj" position.
2. Position the 19-38 kHz plug-in Card A-5 into the extender card.
3. Depress the front panel "Injection - Push to Cal." switch and tune L-1 and L-2 located on Card A-5, for maximum reading on the left meter.

MAINTENANCE (continued)

Pilot Injection Calibration (recessed front panel control)

4. With the "Injection - Push to Cal." switch depressed, adjust recessed front panel control "Injection Cal" for a reading of exactly 10% injection read on the top (pilot) scale of the left meter.
5. Connect a wide band oscilloscope to pin "K" of plug-in Card A-5.
6. With the "Push to Cal." switch depressed, tune T-1 on Card A-5 for maximum output, as viewed on scope. NOTE: These are 38 kHz positive pulses.
7. Replace plug-in Card A-5.

Calibration of 19 kHz Phasing Amplifier Card A-4

1. Position phasing and composite amplifier Card A-4 on extender card.
2. Turn the front function switch to the "+" or "-" phase position.
3. Connect an oscilloscope to pin 9 on same Card A-4.
4. Depress "Injection - Push to Cal." switch.
5. Adjust L-1 and L-2 on Card A-4 for maximum amplitude as read on the oscilloscope.

Calibration of Internal 19 and 38 kHz Phasing

NOTE: Pilot injection calibration (steps 1 through 5) must be correct before attempting the internal phase adjustment.

1. Adjust the front panel phasing control to approximately the 10 o'clock position.
2. Turn the front panel function switch to the "+" phase position.
3. Position stereo demodulator Card A-6 in the extender card.
4. Connect a wide band oscilloscope between the junction of diodes D-6, D-7, and ground on the stereo demodulator cards.
5. Depress the "Injection - Push to Cal." switch.
6. Adjust transformer T-1 on stereo demodulator Card A-6 for maximum 38 kHz signal as viewed on the oscilloscope. This should be approximately 10 volts peak to peak.
7. Place the stereo demodulator card A-6 into the monitor.

MAINTENANCE (continued)

Calibration of Internal 19 and 38 kHz Phasing (continued)

8. Position 19 and 38 kHz Card A-5 in the extender card.
9. Depress the "Injection - Push to Cal." switch.
10. Switch the function switch from positive "+" phase to negative "-" phase and note the difference in readings. If they are not identical, adjust the phasing transformer T-1 Card A-5 clockwise or counter-clockwise, while switching from positive "+" to negative "-" phase until the readings are identical. NOTE: The front panel phasing control is a vernier adjustment used for normal daily calibration of monitor.
11. Adjust phasing amplifier calibration control located directly back of left meter for a reading of 100 percent on the left meter with the function switch in either "+" or "-" position.

Stereo Demodulator Calibration

1. Modulate the transmitter 100 percent in the monaural mode as read on the base band monitor and adjust level set control on front panel of the TBM-2200A for a reading of 100% on left meter.
2. Place the stereo demodulator Card A-6 on the extender card.
3. Place a jumper between the two red dots connecting the outside of the balance control. (R-14 on A-6). NOTE: These red dots are on the foil side of the stereo demodulator card.
4. Turn the function switch to "Operate" position.
5. Adjust right meter control located on the chassis for a reading of 100 percent on the right meter.
6. Adjust the left meter control, located on the chassis for a reading of 100 percent on the left meter.
7. Remove jumper described above (step 3).
8. Modulate the transmitter in the stereo mode with in-phase signal (L=+R) to the left and right input with equal amplitude.
9. Adjust the stereo balance control R-14 for equal meter readings.
10. Modulate the transmitter in the stereo mode with equal out-of-phase signals (L=-R) and equal amplitude.
11. Adjust the separation control located on the top of the chassis for equal meter reading of the out-of-phase signal above.

Stereo Demodulator Calibration (continued)

12. Repeat steps 7, 8, 9, 10, and 11 until all readings are identical. The signal amplitude into the transmitter must be kept constant for these adjustments.
13. Modulate the transmitter with a "left only" signal 100 percent as indicated on the total modulation meter of the main channel monitor.
14. Adjust the separation control on the chassis for maximum separation on the right meter providing that the composite input signal is know to be correct. (See Figure 1*.)
15. Modulate the right channel 100 percent and check the separation on the left channel. The same separation should be read on each channel. If not, check steps 7 through 11 until the same performance is achieved. on both channels. This completes the stereo demodulator calibration.

Monaural Calibration of Left and Right Meter

1. Modulate the transmitter 100 percent (400 Hertz) as indicated on the total modulation meter on the main channel monitor.
2. Adjust monaural calibration control located on the chassis for exactly 100 percent modulation as read on both left and right meter.

Stereo Calibration of Left and Right Meter

1. Modulate the transmitter 100 percent stereo (10 percent 19 kHz pilot and 90 percent left channel) as indicated on the total modulation meter of the main channel monitor.
2. Adjust left meter potentiometer located on the chassis for a reading of 90 percent on left meter.
3. Modulate the transmitter 100 percent stereo (10 percent pilot 90 percent right channel) as indicated on the total modulation meter of the main channel monitor.
4. Adjust right meter potentiometer located on the chassis for a reading of 90 percent on right meter.
5. Recheck monaural calibration of left and right meter.

*waveform figures found on page 32.

Calibration of Main Channel (L+R)

1. Modulate the transmitter (400 Hertz) to 100 percent as read on total modulation meter of main channel monitor.
2. Turn the function switch to the (L+R) position on the TBM-2200A.
3. Adjust L+R meter calibration control, located on the chassis, for exactly 100 percent modulation as read on the left meter.
4. Return function switch to "Operate" position.

Calibration of Stereo Subchannel (L-R)

1. Disconnect the TBM-2200A from the main channel monitor.
2. Inject a 38 kHz signal (±2 Hz) (0.30 volts rms) into the composite input jack on rear of chassis.
3. Turn the function switch to "L-R" position.
4. Adjust L-R meter calibration control, located on the chassis, for exactly 104 percent modulation as read on the right meter.
5. Return function switch to "Operate" position.

Calibration of the 38 kHz (Suppressed Carrier)

1. Disconnect the TBM-2200A from the main channel monitor.
2. Inject a 38 kHz signal (± 2 Hz) (0.30 volts rms) into the composite input jack on rear chassis.
3. Turn the function switch to 38 kHz position.
4. Adjust 38 kHz calibration control located on the chassis, for exactly 100 percent modulation as read on the left meter.
5. Return function switch to "Operate" position.

Calibration of Audio Voltmeter Amplifier

1. Inject a 400 Hz (0.30 volts rms) into the composite input on rear chassis. NOTE: Both meters should read exactly 100 percent modulation. If left and right meters do not read 100 percent, refer back to monaural calibration.
2. Reduce the input signal by exactly 10 dB.
3. Turn separation S/N switch to "-10 dB" position (either left or right).
4. Adjust dB amplifier calibration control located on chassis, for 100 percent modulation reading on the respective meter.

Calibration of Audio Voltmeter Amplifier (continued)

5. Reduce the input signal another 10 dB.
6. Turn the separation switch to "-20 dB" and the meter should again read 100 percent modulation. This verifies proper operation.
7. Return separation S/N switch to "Operate" position.
8. Return function switch to normal position.

Pilot Frequency Reference Oscillator

1. Remove Card A-1A and insert into extender card.
2. Connect an oscilloscope to the base of Q-3 on Card A-1A.
3. Depress "Injection - Push to Cal." switch and tune coils L-1 and L-2 for a maximum 19 kHz output as displayed on oscilloscope.
4. Connect the oscilloscope to the emitter of Q-6.
5. Depress "Injection - Push to Cal" switch and tune quadrupler coils L-3 and L-4 and tripler coils L-5 and L-6 for maximum output as displayed on the oscilloscope. NOTE: The output frequency must be 228 kHz at the emitter of Q-6.
6. Connect a frequency counter at the junction of R-24 and C-20. NOTE: The counter must be adjusted to 1 ppm (parts per million) base accuracy.
7. Short circuit the junction of R-18 and C-14 to ground.
8. Adjust variable capacitor C-18 for an exact frequency of 228,060 Hz.
9. Reinsert Card A-1A.

Frequency Meter Calibration

1. Short circuit the frequency meter terminals and check the mechanical zero.
2. Turn the front panel meter zero control to its mid-position.
3. Depress the "Freq. - Push to Cal." switch.
4. Turn the frequency deviation calibrate control located between plug-in Cards A-1A and A-2A fully clockwise.
5. Adjust the coarse frequency centering control located between plug-in Cards A-1A and A-2A for exact zero center on meter.

MAINTENANCE (continued)

Frequency Deviation Calibrate

1. Remove Card A-1A from its socket.
2. Remove Card A-2A and insert into extender card.
3. Feed an accurate 60 Hz (± 1 Hz) signal at 0.3 volts rms into terminal "B" of plug-in Card A-2A. Frequency meter should read "zero" deviation.
4. Feed a 36 Hz (± 1 Hz) at 0.3 volts rms signal into terminal "B" of plug-in Card A-2A.
5. Adjust deviation control located between plug-in Card A-1A and A-2A for an exact + 2 Hz deviation of the frequency meter.
6. Recheck the meter zero with a 60 Hz signal (±1 Hz).
7. Again recheck the +2 Hz deviation with a 36 Hz signal (± 1 Hz). Repeat the two steps until the correct deviation and meter zero occur as there is slight interaction between the deviation and coarse meter zero controls.
8. Feed an accurate 84 Hz (± 1 Hz) signal into terminal "B" and verify the opposite 2 Hz deviation.
9. Reinsert Card A-1A.

Remote Monitoring

Remote modulation meters.

1. Connect the two remote modulation meter lines to the respective terminals, "Left RM" and "Right RM" to the respective terminal barrier strips located on the rear chassis.
2. Turn the front panel function switch to the "Operate" position.
3. Tone modulate the transmitter 100 percent as read on the left and right modulation meters.
4. Adjust the two rear chassis remote modulation meter calibrate controls (R-29 and R-39) located on the rear chassis. Turn each control counterclockwise until the respective remote meter agrees with the internal meters of the monitor. These controls will compensate for external loop resistance of 2,500 ohms. NOTE: If remote meters read backwards, reverse meter leads. NOTE: The left remote meter will indicate pilot injection or left modulation depending on the position of the function switch. The right meter will indicate right channel modulation.

Remote 19 kHz Frequency Deviation Meter

1. Connect the remote frequency meter line to the two terminals marked "Freq. Meter Rem" on the rear chassis.
2. Depress the front panel "Freq. - Push to Cal." switch and adjust the frequency deviation meter on the monitor for a reading of +1 Hz deviation.
3. Switch the rear chassis "Remote Freq. Meter" switch to the remote position.
4. Depress the front panel "Freq. - Push to Cal." switch and the remote meter should be adjusted to read +1 Hz frequency. NOTE: Reverse line if meter reads -1 Hz. The circuitry will compensate to up to 2500 ohm line resistance.
5. Return the front panel meter calibration to zero.

VII

PARTS LIST

The majority of components used in the TBM-2200A are of standard values and tolerance and are readily available from local electronic parts jobbers. Those parts which are of critical value or tolerance or of McMartin manufacture are listed below.

Card A-1A (19 kHz Amplifier/Reference Oscillator and Mixer, P/N 550154)

SYMBOL	PART NUMBER	DESCRIPTION
Xtal	090033	228.060 Hz local oscillator
L-1, 2	930062	19 kHz band pass filter
L-3, 4, 5, 6	930165	Multiplier coil
Q-1, 2, 3, 7	201022	Type SE-4001 silicon transistor
Q-4, 5, 6	201050	Type SE-4010 silicon transistor
Q-8	201074	2N2060 Balanced Mixer

Card A-2A (60 Hz Amplifier, Limiter, and Frequency Meter, P/N 552063)

SYMBOL	PART NUMBER	DESCRIPTION
Q-1, 2, 3	201074	Type 2N2060 dual silicon transistor
Q-4	201050	Type SE-4010 silicon transistor
Q-5	201056	Type 2N3569 silicon transistor
RY-1	470026	PC Board relay
R-19	540021	4.75K 1% metal film resistor
R-22	540026	34K 1% metal film resistor
R-23	540013	1.5K 1% metal film resistor
R-31	540023	1% metal film resistor
C-10	116115	N type 47000 pf capacitor

Card A-3 (Injection Calibrate Oscillator P/N 554019)

SYMBOL	PART NUMBER	DESCRIPTION
Xtal	090034	190,000 Hz cal. crystal
Q-1	201022	Type SE-4001 silicon transistor
Q-2, 3	201050	Type SE-4010 silicon transistor
IC-1	230007	Type SN-7490 decade divider
CH-1, 2	932012	19 kHz coil

Card A-4 (Composite Amplifier and 19 kHz Amplifier P/N 552066)

SYMBOL	PART NUMBER	DESCRIPTION
L-1, 2	932012	19 kHz coil
Q-1	201022	Type SE-4001 silicon transistor

PARTS LIST (continued)

Card A-4 (continued)

SYMBOL	PART NUMBER	DESCRIPTION
Q-2, 4, 6, 7, 8	201049	Type SE-4002 silicon transistor
Q-3, 5	201033	Type 2N2102 silicon transistor
R-14	540011	40.2K, 1/2W, 1% resistor

Card A-5 (19-38 kHz Amplifier P/N 552067)

SYMBOL	PART NUMBER	DESCRIPTION
L-1, 2	932012	19 kHz coil
Q-1, 2, 3, 4	201049	Type SE-4002 silicon transistor
R-3, 4	540018	549K 1% resistor
R-7, 13	540021	4.75K 1% resistor
R-16	540006	2.162K, .25% resistor
R-10	540001	10K, 1% resistor

Card A-6 (Stereo Demodulator P/N 554020)

SYMBOL	PART NUMBER	DESCRIPTION
R-3, 5, 9, 10, 17	540021	4750, 1/2W, 1% resistor
R-12, 16	540022	1 meg, 1/2W, 1% resistor
R-13, 15	540010	7500, 1/2W, 1% resistor
R-14	400041	1K trimpot (P. C. Miniature) resistor
T-1	922014	Transformer
D-1 through 10	220005	Type 1N-3604 diode
D-11	220004	Type 1N-542 diode
Z-1	220008	36V, 1W, zener diode
Q-1	201022	Type SE-4001 silicon transistor
Q-2, 5	201056	Type 2N3569, silicon transistor
Q-3, 4, 7, 8	201050	Type SE-4010 silicon transistor
Q-6, 9, 10	201033	Type 2N2102 silicon transistor
R-18, 19	540012	12.1K, 1% resistor

Card A-7 (Optional) (Remote Dual Meter Amplifier P/N 559022)

SYMBOL	PART NUMBER	DESCRIPTION
IC-1, 2	230037	Type LM-380 meter amplifier
R-1, 11	400043	100K trimpot
R-6, 17	540016	6838 1% metal film resistor
R-7, 18	540021	4750 1% metal film resistor
R-8, 16	540013	1.5K 1% metal film resistor
R-9, 19	400050	250 ohm trimpot (meter zero)
R-10, 20	540015	316.2 ohm, .1% metal film resistor

PARTS LIST (continued)

Card A-8 (Local Dual Meter Amplifier P/N 551048)

SYMBOL	PART NUMBER	DESCRIPTION
IC-1, 2	230037	Type LM-380 meter amp
R-6, 17	540016	6838 1% metal film resistor
R-7, 18	540021	4750 1% metal film resistor
R-8, 16	540013	1.5K 1% metal film resistor
R-9, 19	400050	250 ohm trimpot (meter zero)
R-10, 20	540015	316.2 1% metal film resistor

Card A-9 (dB Amplifier P/N 552068)

SYMBOL	PART NUMBER	DESCRIPTION
Q-1	201022	Type SE-4001 silicon transistor
Q-2	201033	Type SE-2102 amplifier

Card A-10 (Dual Audio Amplifier P/N 552069)

SYMBOL	PART NUMBER	DESCRIPTION
C-7, 13	650048	7500 pf, dipped Mica 5% capacitor
Q-1, 3	201022	Type SE-4001 silicon transistor
Q-2, 4	201033	Type 2N2102 silicon transistor
R-11, 22	540012	12.1K 1/2W, 1% resistor
SW-1	484004	Push button switch

Chassis

SYMBOL	PART NUMBER	DESCRIPTION
R-2	401015	2500 ohm potentiometer (level set)
R-2A	540010	7.5K 1%
R-3	540016	6838 ohm 1% resistor
R-3A	540024	750 ohm 1% resistor
R-5, 11, 31	401016	10K potentiometer
R-6, 8, 19, 20	401012	5K potentiometer
R-9, 13, 14, 21, 22	401013	1K potentiometer
R-4	540021	4.75K 1%
R-12	540015	316.2 1% resistor
R-16	402003	5K potentiometer (phase cal.)
R-24	402008	500K potentiometer
R-25	402009	100K potentiometer
R-26	402014	25K potentiometer
R-27	540019	3010 1% resistor
R-28	540006	2168 1% resistor
R-29, 30	402004	2.5K potentiometer
T-1	900062	Power transformer
T-2, 3	910003	Audio output transformer
FL-1, 4, 5	935022	0-15 kHz low pass filter

PARTS LIST (continued)

CHASSIS (continued)

SYMBOL	PART NUMBER	DESCRIPTION
FL-2	930047	38 kHz bandpass filter
SW-1	484027	4 pole, 2 pos. push switch
SW-2	492027	10 pole, 9 pos. rotary switch
SW-3	492028	6 pole, 11 pos. rotary switch
SW-4	484026	2 pole, 2 pos. push switch
Q-1, 2	201034	Type 40328 silicon transistor
Q-3	201050	Type SE-4010 silicon transistor
M-1	700023	Right modulation meter
M-2	700045	19 kHz frequency meter
M-3	700024	Left modulation meter

Attenuator and Isolation Amplifier B-1658 (mounted on dB switch assembly)

SYMBOL	PART NUMBER	DESCRIPTION
R-1	540007	6.838K, 1/2W, 1% resistor
R-2	540006	2.162K, 1/2W, 1% resistor
R-3	540005	683.8 ohm, 1/2W, 1% resistor
R-4	540004	216.2 ohm, 1/2W, 1% resistor
R-5	540003	100 ohm, 1/2W, 1% resistor
R-6	502168	2.2 Meg, 1/2W, 5% resistor
C-1	670004	2.2 mf, 20V tantalum capacitor
Q-1	201032	Type SF 4863 silicon transistor
Q-2	201033	2N2102 transistor

Composite Output B-1659 (mounted on function switch assembly

SYMBOL	PART NUMBER	DESCRIPTION
Q-1	201032	Type SF-4863 silicon transistor

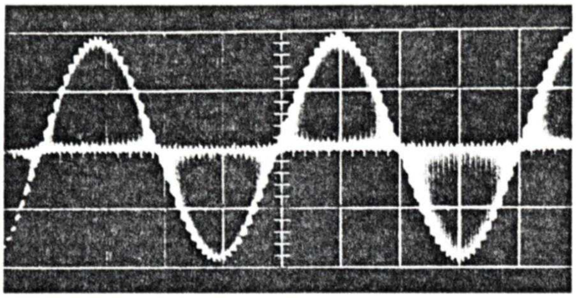


FIG. 1
IDEAL COMPOSITE SIGNAL

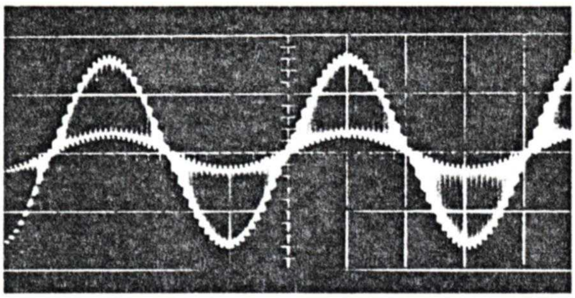


FIG. 2
L-R SIGNAL TOO LOW

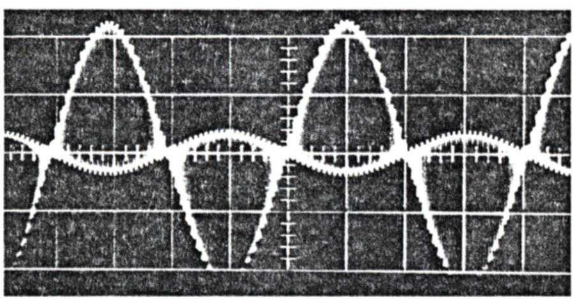


FIG. 3
L-R SIGNAL TOO HIGH

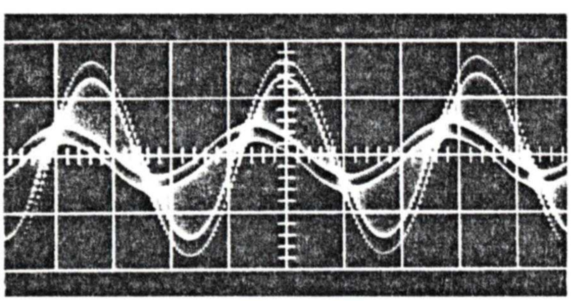


FIG. 4
EXCESSIVE TIME DELAY

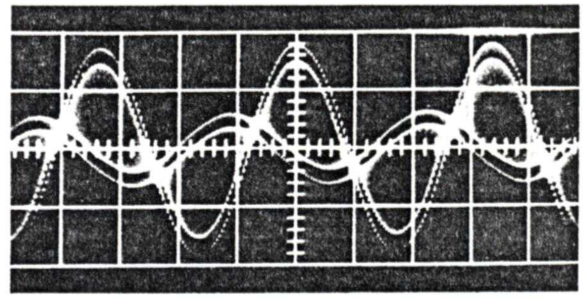


FIG. 5
TIME DELAY AND AMPLITUDE ERROR

FIG. 6A
PILOT PHASE ON COMPOSITE SIGNAL

FIG. 6B
PILOT PHASE ERROR ON COMPOSITE SIGNAL

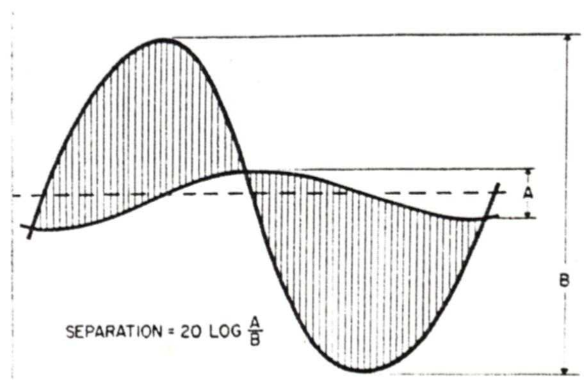
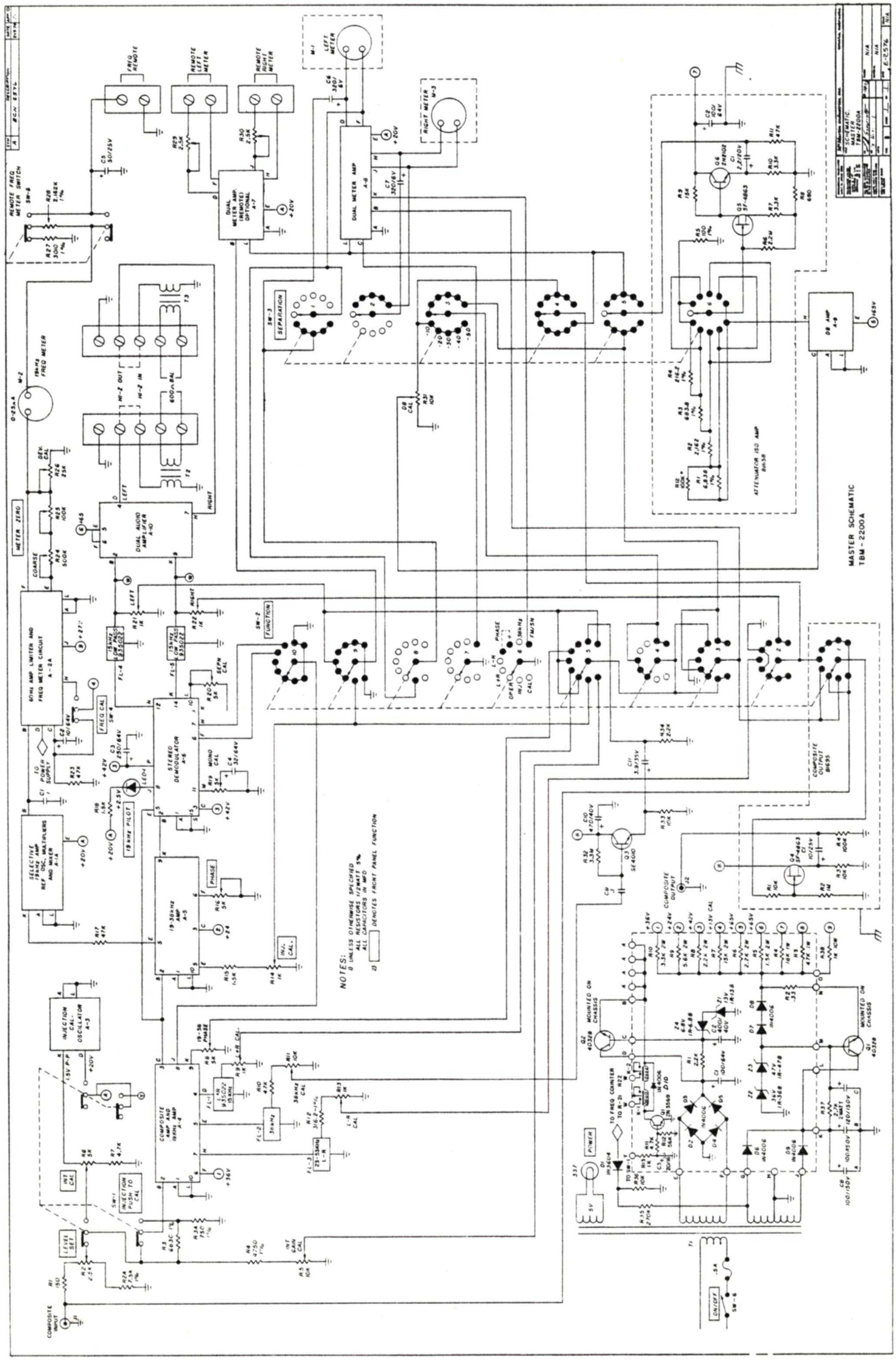
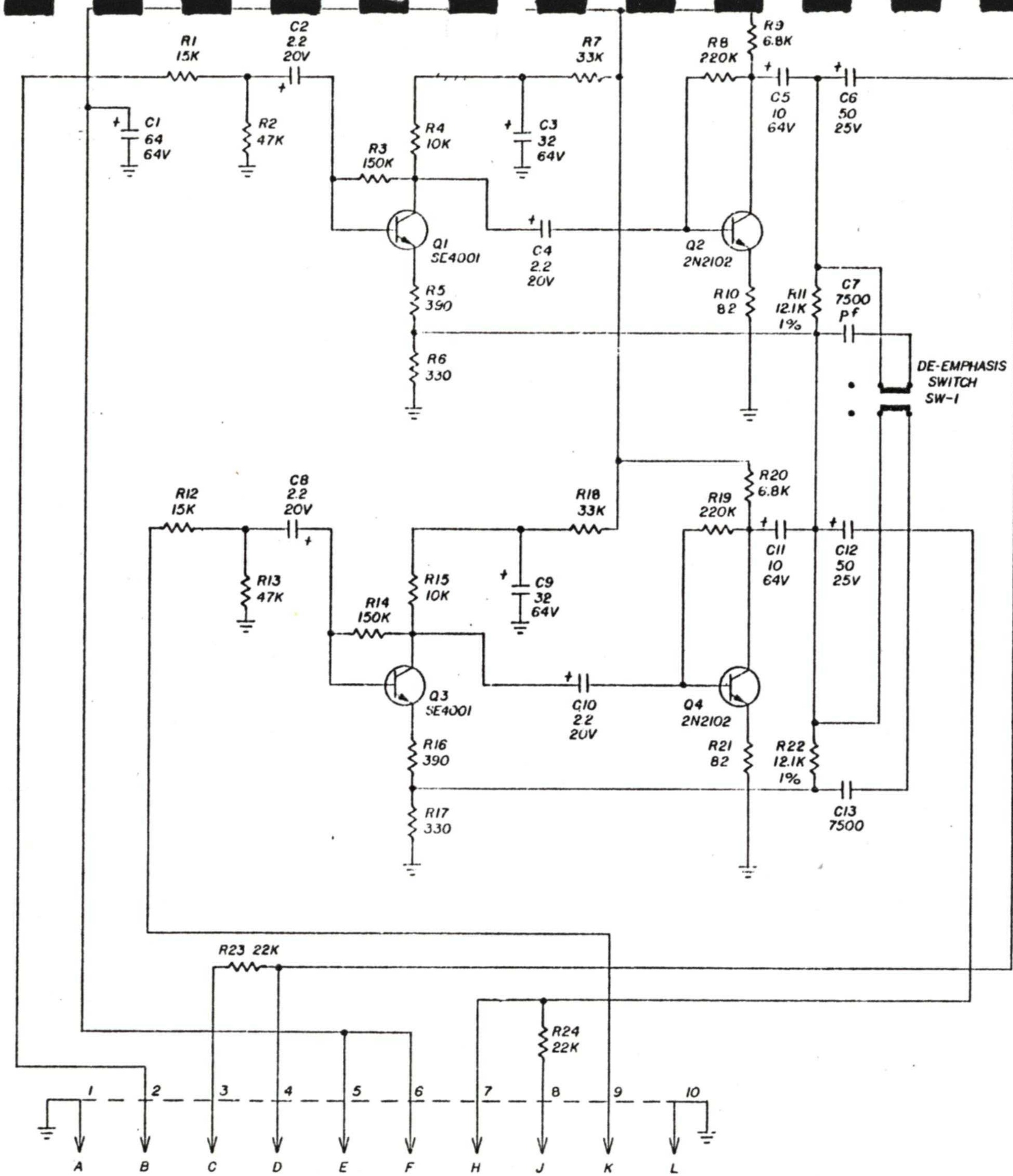


FIG. 7
SEPARATION MEASUREMENT WITH SCOPE

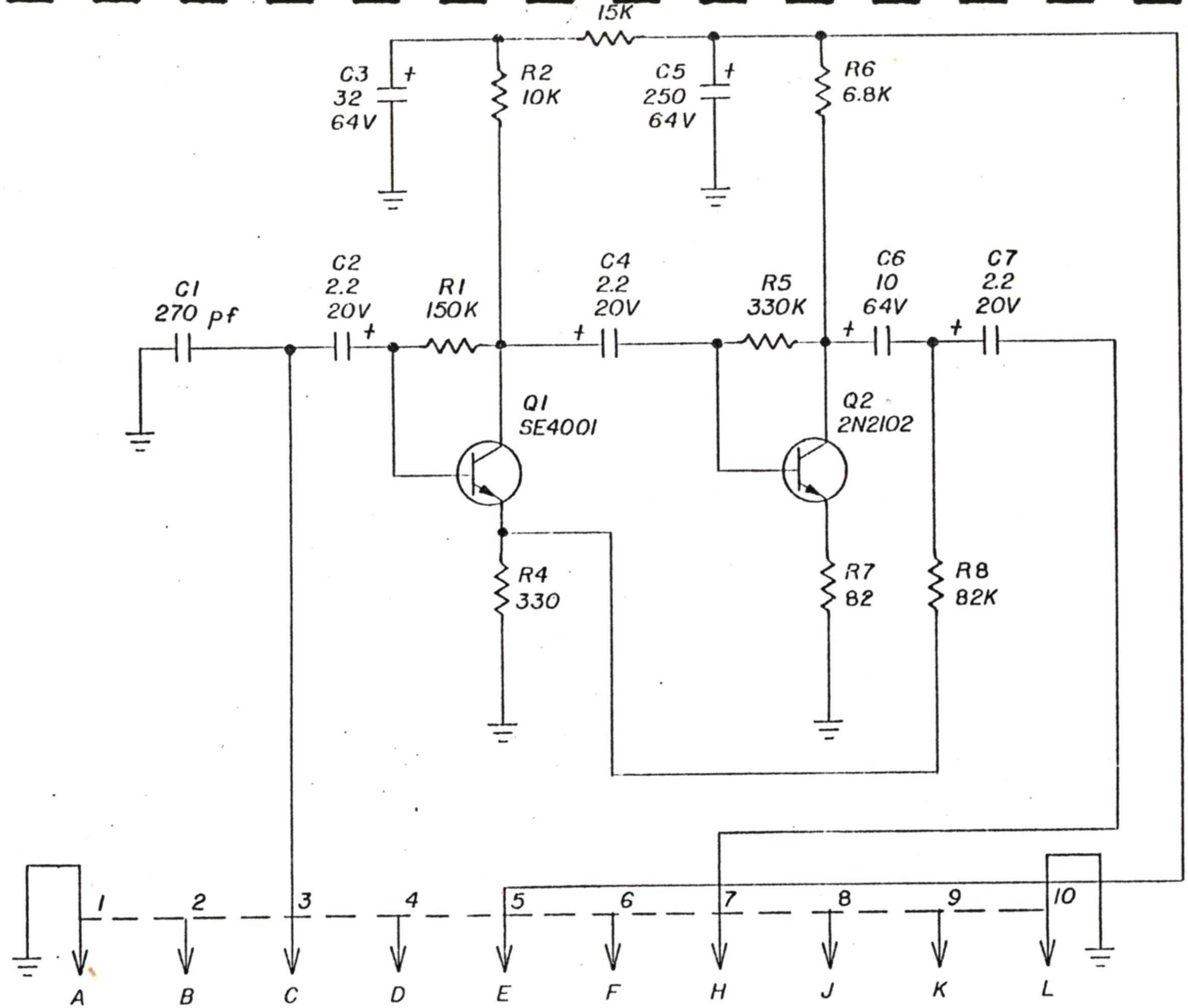


MASTER SCHEMATIC
TBM-2200A
NOTES:
UNLESS OTHERWISE SPECIFIED
ALL RESISTORS 1/2 WATT 5%
ALL CAPACITORS IN MFD
DENOTES FRONT PANEL FUNCTION



DUAL AUDIO AMP
TBM-2200A (A10)
P/N 552069

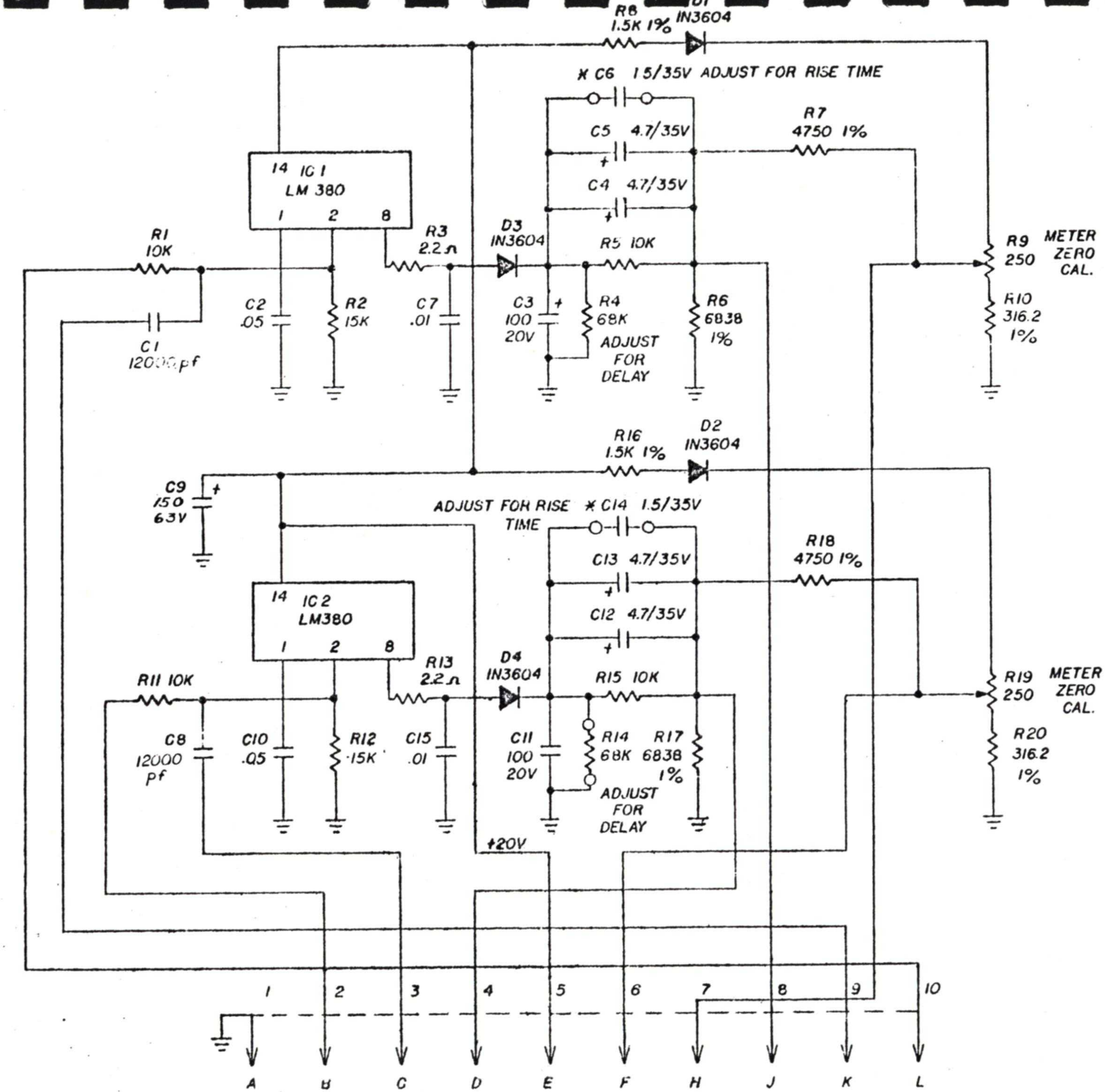
NOTES: 1. UNLESS OTHERWISE SPECIFIED:
RESISTORS 1/2W ±5%
CAPACITORS IN MFD.



DB AMP
TBM-2200A (A9)

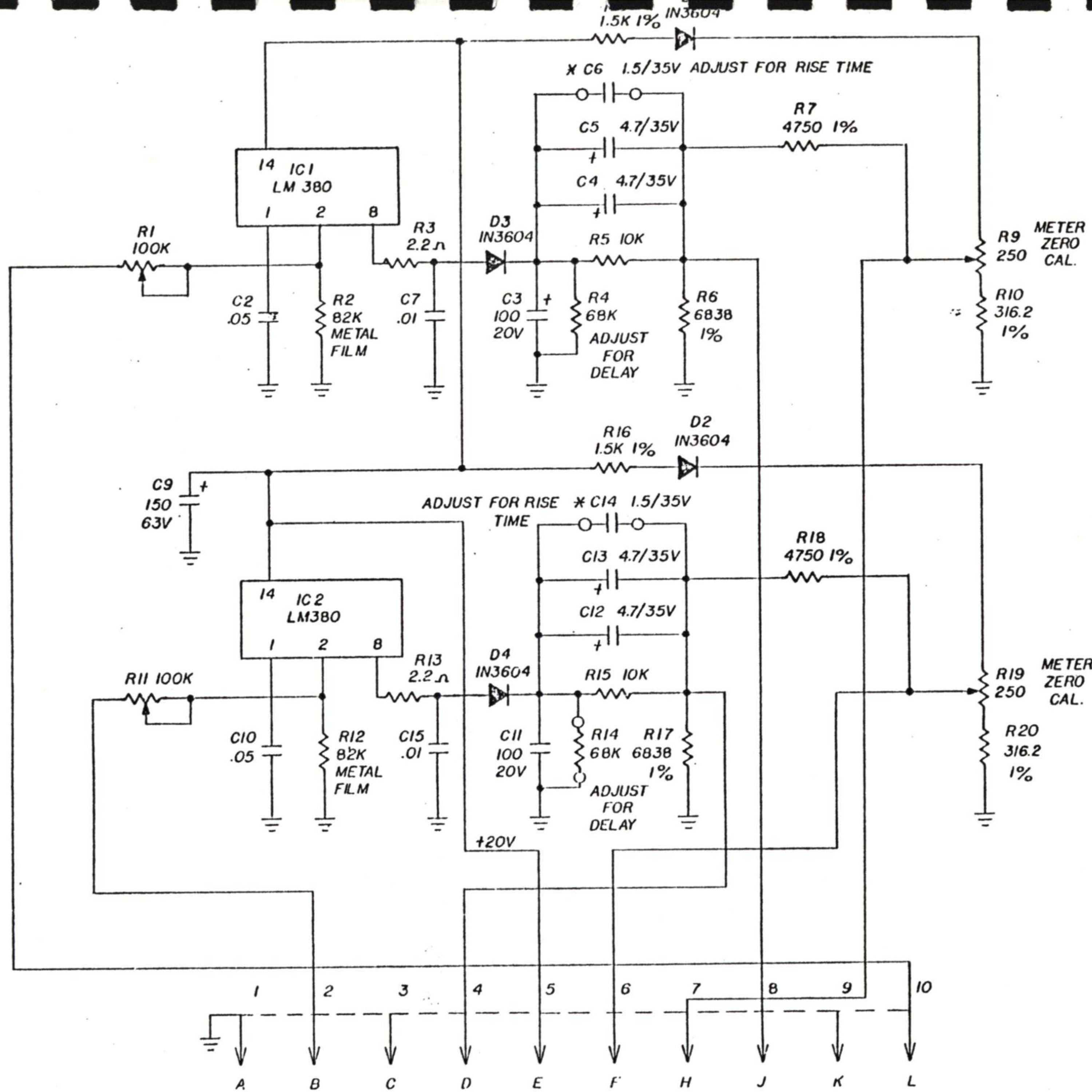
P/N 552068

NOTES
1. UNLESS OTHERWISE SPECIFIED:
RESISTORS 1/2W ±5%
CAPACITORS IN MFD



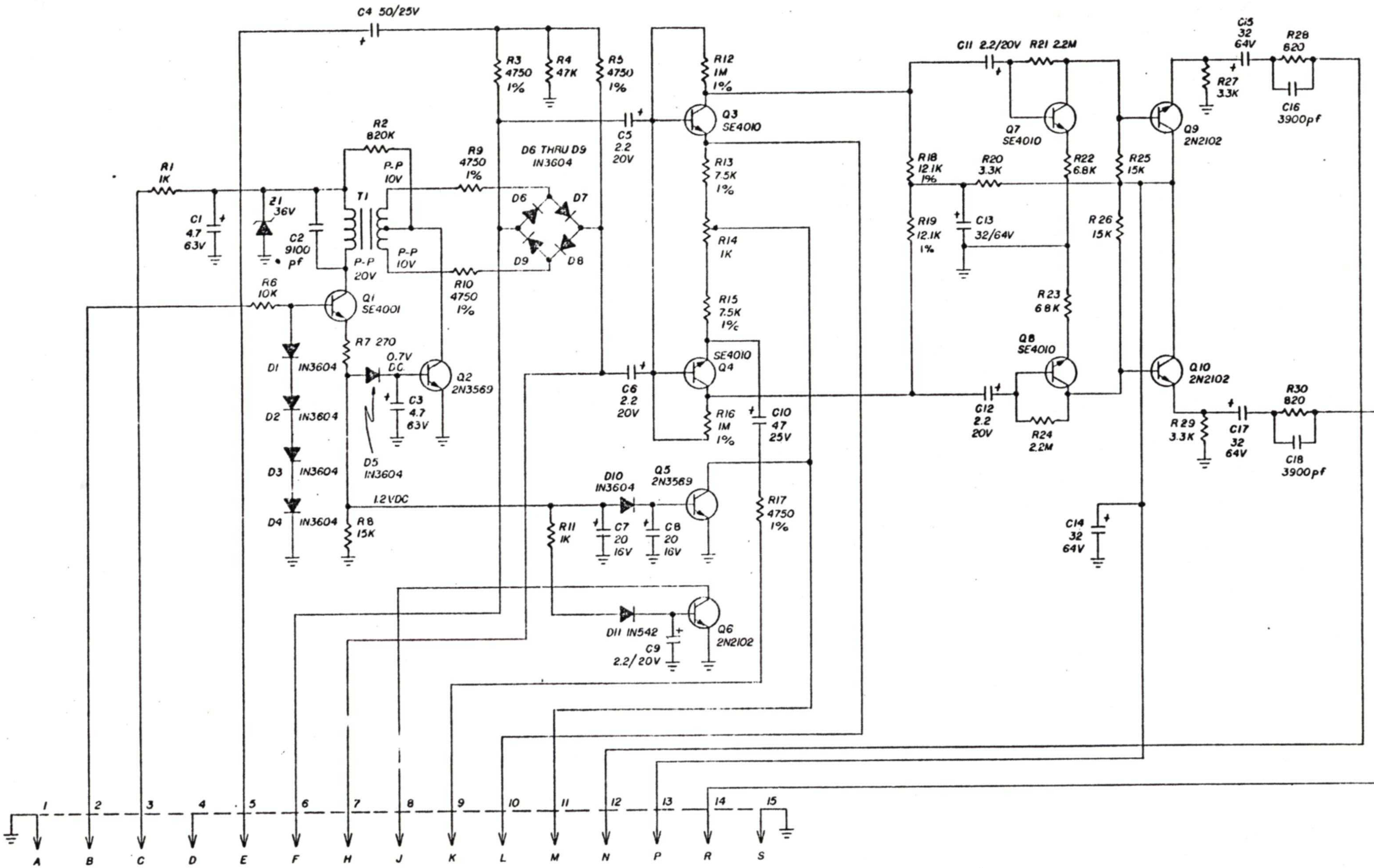
NOTES: UNLESS OTHERWISE SPECIFIED:
RESISTORS 1/2W ±5%
CAPACITOR IN MFD.

DUAL METER AMP.
TBM-2200A (A8)
P/N 551048



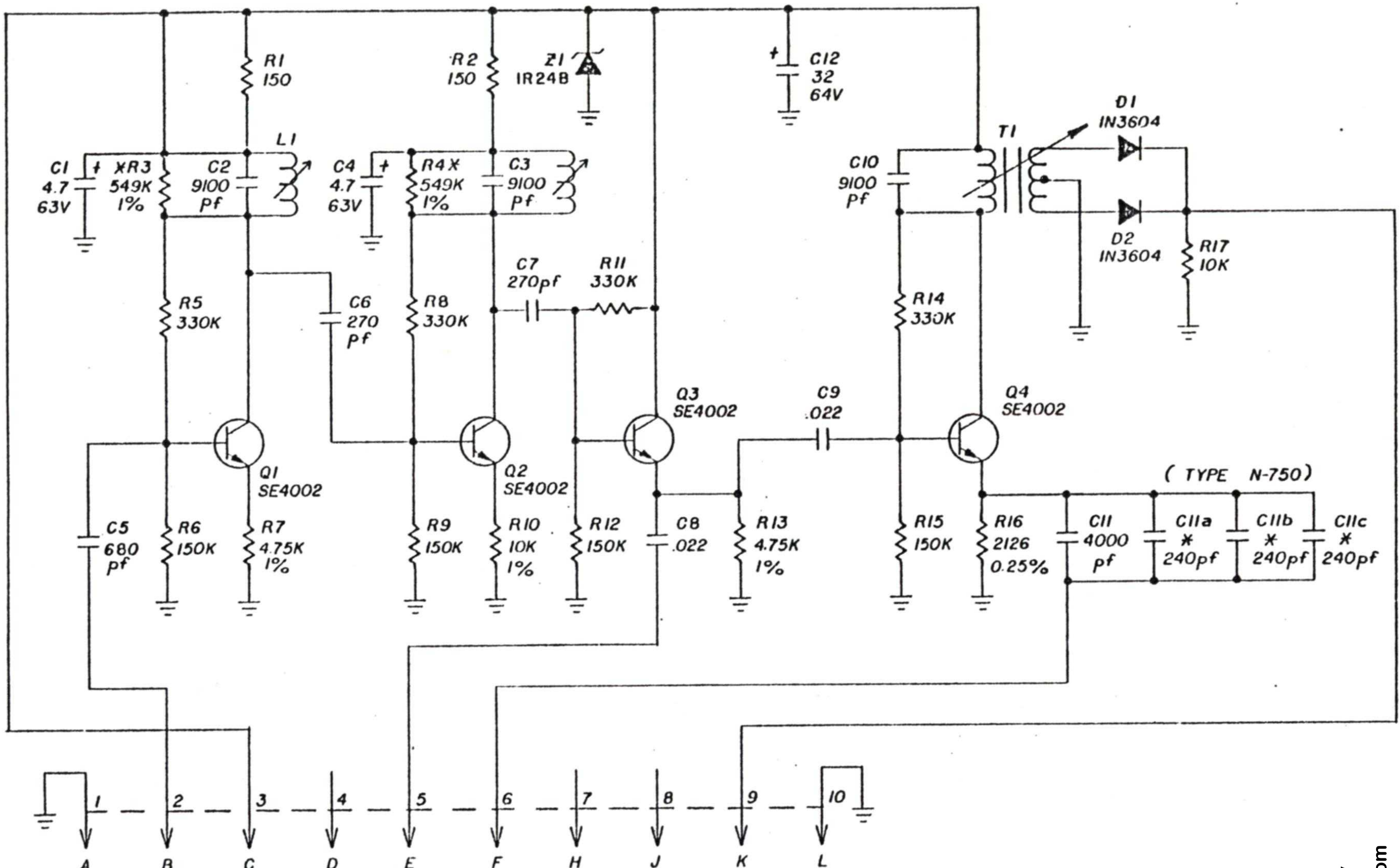
DUAL [illegible]TER AMP. (REMOTE)
TBM-[illegible]0A (A7)
P/N 559022

NOTES: 1. UNLESS OTHERWISE SPECIFIED:
RESISTORS 1/2W ±5%
CAPACITOR IN MFD.



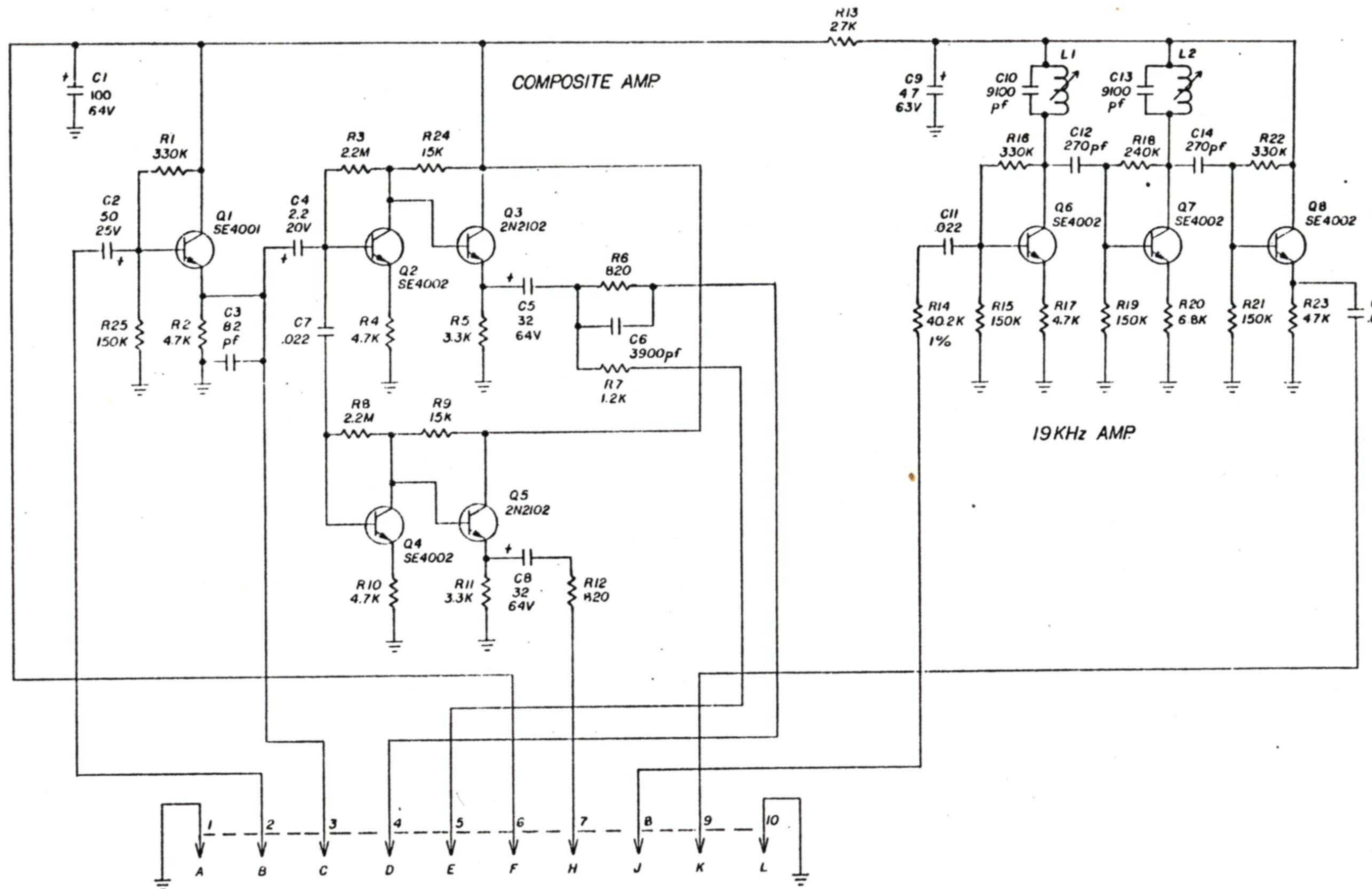
STEREO DEMODULATOR
TBM-2200A (A6)
P/N 554020

NOTES 1. UNLESS OTHERWISE SPECIFIED:
RESISTORS ±5% 1/2W
CAPACITORS IN MFD



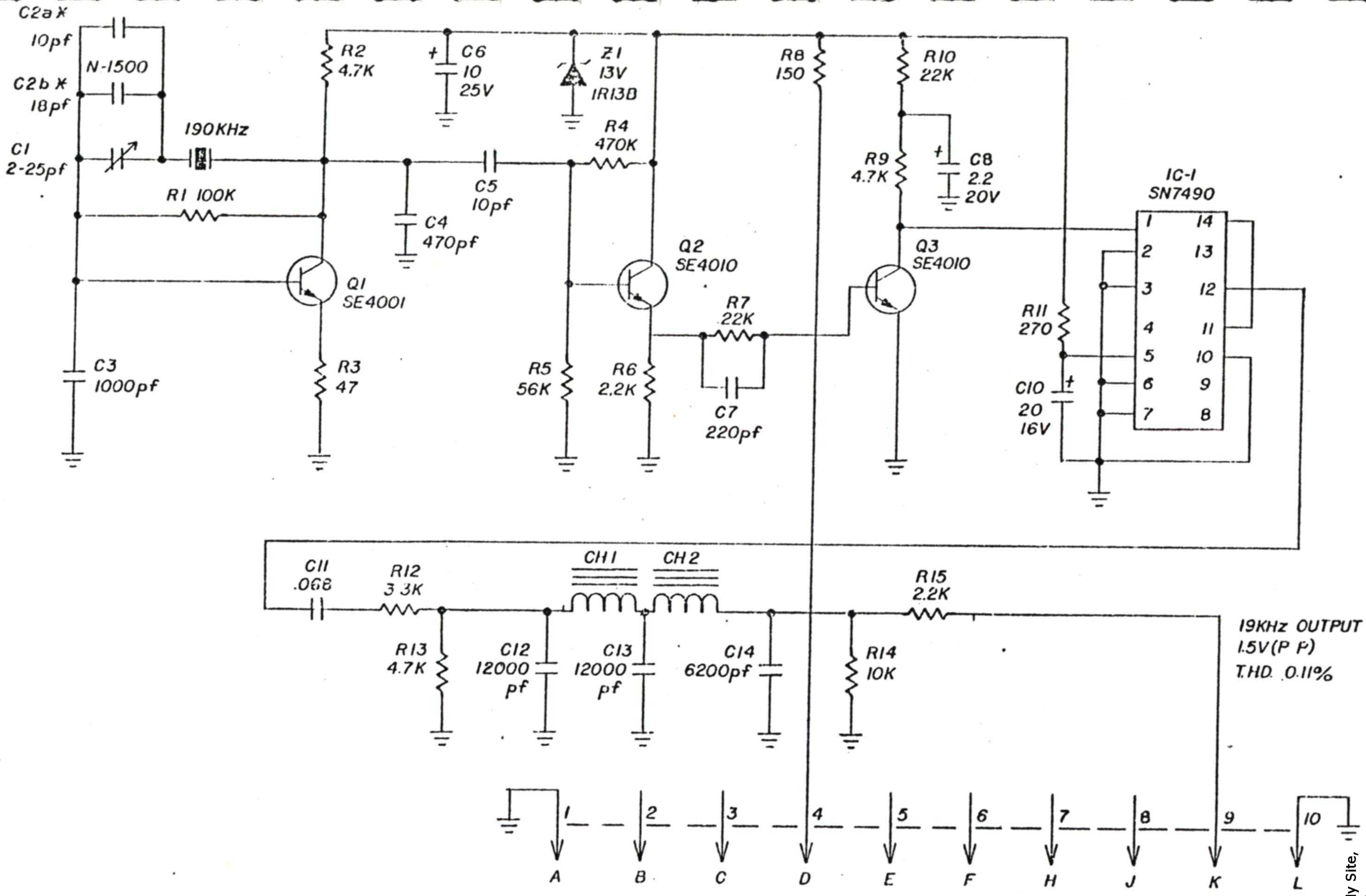
19-38KHz AMP
TBM 2200A (A5)
P/N 552067

NOTES:
2. * SELECTED IN PRODUCTION
1. UNLESS OTHERWISE SPECIFIED:
RESISTORS 1/2W ± 5%
CAPACITORS IN MFD.



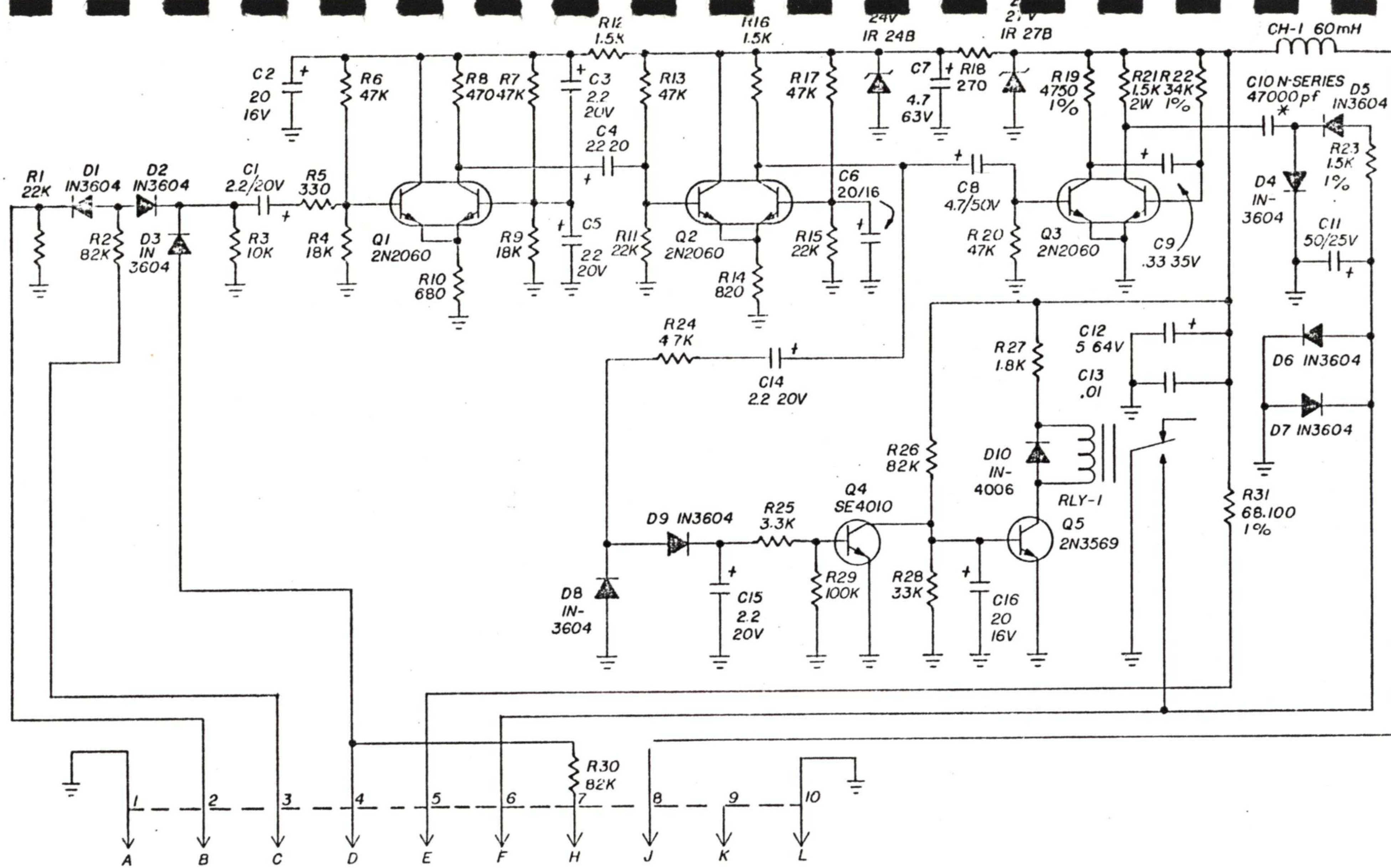
COMPOSITE AMP & 19KHz AMP
TBM-2200A (A4)
P/N 552066

NOTES: 1. UNLESS OTHERWISE SPECIFIED:
RESISTORS 1/2W ± 5%.
CAPACITORS IN MFD.



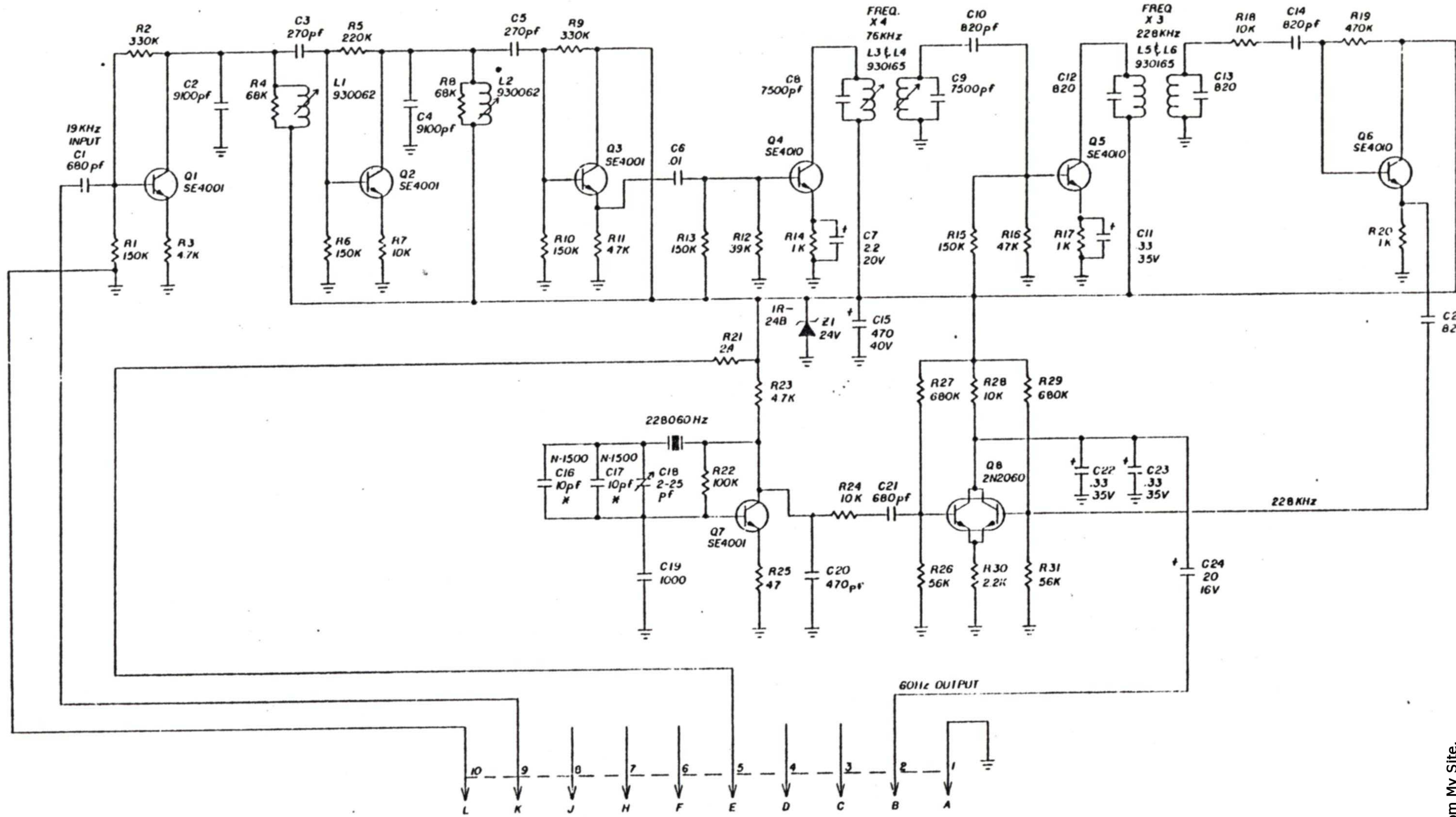
INJECTION CALIBRATE OSC.
TBM-2200A (A3)
P/N 554019

NOTES:
1. UNLESS OTHERWISE SPECIFIED:
RESISTORS 1/2W ±5%.
CAPACITORS IN MFD.
2. * SELECTED IN PRODUCTION.



60Hz AMPLIFIER, LIMITER, AND
FREQ. METER CIRCUIT (A-2A)
TBM-2200A, TBM-3000B
P/N-552063

NOTES:
1. UNLESS OTHERWISE SPECIFIED
RESISTORS 1/2W ±5%.
CAPACITORS IN MFD.
2. SELECTED IN PRODUTION *.



SELECTIVE 19KHz AMP REF. OSC., AND
MIXER CIRCUIT (A-1A)
TBM-2200A, TBM-3000B
P.N 550154

NOTES:
1. UNLESS OTHERWISE SPECIFIED RESISTORS 1/2W ± 5%. CAPACITORS IN MFD
2. SELECTED IN PRODUCTION ✱ MAY BE ONE OR TWO CAP

209 441 7600
591 0745

McMartin

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