

SENCORE MX129 FM MULTIPLEX  
GENERATOR and ANALYZER



INSTRUCTION MANUAL  
FOR THE  
SENCORE MX129 FM MULTIPLEX  
GENERATOR and ANALYZER

The MX129 is a stable, transistorized Multiplex Signal Generator, that provides all signals required for analyzing, trouble shooting and aligning the stereo portion of FM multiplex receivers. In addition to the signals generated, an "Ext. Meter" jack is provided for visually monitoring the output of stereo speakers or other points after detection. The MX129 generates all signals normally received from an FM station that is transmitting in stereo or monaural.

The MX129 provides the following signals and special features:

Composite Multiplex Signal

This signal is the same as that normally transmitted from an FM station during transmission of a stereo program. It consists of right and left channel information properly combined, a crystal controlled 19KC pilot and, when desired, a 67 KC SCA signal. The composite signal is available from a front panel jack and also modulates an FM oscillator for front end injection. The composite level is adjustable and can be monitored on the panel meter in percent of modulation for front end injection (40 percent level is normal setting) or can be read in peak to peak volts for signal injection into the receiver after the detector.

Left and Right Signal Selection and Control

Full control of left and right channel signal selection and signal level is offered by separate signal and level controls for each channel. Each channel can be fed with a choice of two internally generated signals, 60 cycles or 1000 cycles, or can be fed with an external signal. The signal level of each channel in peak to peak volts can be monitored on the panel meter.

19 KC Pilot Out

The 19KC Pilot carrier, which is added to the composite signal, is adjustable in level from zero to 10 percent of modulation. Ten percent modulation level is normal for a standard stereo signal. Lower levels are provided for more accurate alignment adjustments of the adapters in stereo receivers.

SCA Signal

A 67KC SCA (Subsidiary Communication Authority) signal is available at the SCA jack and also modulates the FM carrier. This signal is required for 67 KC trap adjustment in new stereo receivers.

EXT. METER

Two meter scales for external measurements, 3 volts peak to peak and 30 volts peak to peak, are provided so that analyzing, trouble shooting or measuring channel separation in stereo receivers can be done without additional equipment. The scales are also calibrated in decibel for direct DB measurement of separation.

## Other Features

Portability is one of the key features of the MX129. An all steel carrying case and detachable cover protect the meter and controls when the unit is moved. RF cable, power cord and test leads can be neatly tucked away in the storage compartment.

## SPECIFICATIONS

### RF Output

1. Factory tuned to 100 MC (adjustable from 90 - 105 MC)
2. Output, 3000 microvolts
3. Impedance at cable, 300 ohms.

### Composite Multiplex Signal

1. Output voltage, 0-7V peak to peak
2. Output impedance, 2000 ohms
3. Frequency Response, 20 cycles - 20 KC
4. Modulation level of RF oscillator, 0 - 50 %

### 19 KC Pilot

1. Output voltage at composite jack, 0 - 1 volt peak to peak
2. Frequency, crystal controlled 19KC  $\pm .01\%$
3. Modulation level of RF oscillator, 0 - 10%

### SCA Signal

1. Frequency, 67KC  $\pm 100$  cycles
2. Output voltage at SCA jack, 8.0 V peak to peak fixed
3. Modulation level of RF oscillator, 10% fixed

### Left and Right External Inputs

1. Input impedance, 5000 ohms
2. Maximum peak to peak volts input, 10 volts

### External Meter Input

1. Two ranges, 3 volt and 30 volt peak to peak
2. Input impedance on 3V range, 250K shunted by 24 micromicrofarads
3. Input impedance on 30V range, 2.25 meg shunted by 4 micromicrofarads.

### Transistor Complement:

- TR1 - 2N1304, NPN, 76KC Crystal Oscillator
- TR2 - 2N404, PNP, 76KC Buffer
- TR3, TR4 - 2N404, PNP, 38KC Bistable Multivibrator
- TR5 - 2N404, PNP, 19KC Oscillator
- TR6 - 2N1304, NPN, Right Signal Buffer
- TR7 - 2N404, PNP, Right Signal Gate
- TR8 - 2N404, PNP, Left Signal Gate
- TR9 - 2N1304, NPN, Left Signal Buffer
- TR10 - 2N404, PNP, 19KC, Emitter Follower
- TR11 - 2N404, PNP, Operational Amplifier Input
- TR12 - 2N404, PNP, Operational Amplifier Emitter Follower Output
- TR13 - 2N2614, PNP, Internal Generator (1000 cycles or 67KC)
- TR14 - 2N404, PNP, 1000 cycle Emitter Follower
- TR15 - 2N1304, NPN, Balanced Emitter Follower
- TR16 - 2N1180, PNP, Capacitive Modulator
- TR17 - 2N1178, PNP, RF Oscillator
- TR18 - 2N2923, NPN, Meter Input Amplifier
- TR19 - 2N2923, NPN, Meter Output Amplifier

Diode Complement:

5 - 1N295 Germanium

Crystal Complement:1 - 76KC  $\pm$  .01% for 38KC suppressed carrier and 19KC pilotPower Consumption:

4.0W

Size:10" wide X 9 $\frac{1}{4}$ " deep X 4" highNet Weight:7 $\frac{1}{4}$  pounds.CONTROLS ON THE MX129

The MX129 is a very easy generator to use. All of the controls are clearly marked and in most cases the function of the control is self evident. However, it would be well to familiarize yourself with the panel controls before attempting to operate the unit.

AC Power Switch

The AC power switch in the lower left corner of the panel turns the MX129 ON or OFF. Since the generator is completely transistorized, all signal outputs are instantaneous, requiring no warm up time.

Left and Right Signal Switches

The LEFT and RIGHT SIGNAL switches control the signals being fed to the left and right channels. Two internal tones can be selected, 60 cycles and 1000 cycles, or external signals, fed through panel jacks, can be selected. The 1000 cycle tone is generally used for all channel separation measurements made on a receiver.

Both channels can be fed the same tone simultaneously, and if the levels were the same would result in a monaural signal from the generator.

For demonstration purposes, one channel can be fed with a 60 cycle tone and the other with a 1000 cycle tone. If the receiver is operating properly, of course, each tone should be heard in its respective speaker.

Left and Right Level Controls

The LEFT and RIGHT LEVEL controls are used to adjust the level of the signal being fed into each channel. The signal level of each channel can be monitored on the panel meter. The 0 - 10V internal peak to peak scale is used.

Normally left and right signals are adjusted to be approximately 5 volts peak to peak.

Composite Level Control

The COMPOSITE LEVEL control adjusts the level of the composite signal that appears on the COMPOSITE OUTPUT jack and, also, the level of the signal that feeds the modulator. The signal level can be monitored on the panel meter; the 0 - 10V internal peak to peak volt scale is

used when determining the peak to peak level at the COMPOSITE OUTPUT jack and the composite modulation level scale is used when injecting the RF signal through the front end. The composite modulation level is normally set at 40 percent without the pilot or SCA present.

The composite signal consists of (1) right and left signals properly combined on a time sharing basis, (2) 19KC pilot carrier when the PILOT LEVEL control is advanced from zero, and (3) 67KC SCA when the SCA generator is turned on.

### 19KC Pilot Level

The 19KC PILOT LEVEL control injects a 19KC pilot carrier into the composite signal. It is calibrated from zero to 10 percent of modulation. For a normal stereo signal the level should be set at 10 percent in keeping with FCC standards. Lower levels are used when adjusting the 19KC tank circuits in multiplex adapters (in the receiver) for very precise alignment.

### Internal Signal - SCA Switch

The INT SIG - SCA switch turns on the 1000 cycle tone generator in the 1000 cycle position or turns on the 67KC SCA generator when in the 67KC position. When the switch is in the 1000 cycle position the 1000 cycle tone is fed to the LEFT and RIGHT SIGNAL switches. When the switch is in the 67KC position the SCA signal that is generated is inserted into the composite signal at a level which will produce 10 percent modulation of the RF. It is also fed to the SCA OUTPUT jack for direct insertion after the receiver detector for alignment of the 67KC traps.

### Meter Switch

The METER switch connects the meter for monitoring left signal level, right signal level, or composite signal level. It also provides two external meter ranges of 3V and 30V peak to peak. The external ranges are used for general trouble shooting and alignment of stereo receivers. The external ranges are also calibrated in DB for direct DB readings when making stereo separation measurements.

### RF Adjustment

The RF ADJ. is an internal control that is accessible through the front panel with a hex tuning tool. It is factory set at 100 megacycles and normally will not need to be changed. However, if you experience interference from local stations, the RF may be adjusted to a clear spot on the band.

The RF oscillator is frequency modulated with the composite signal. When the composite signal (left and right signals only) is set for 40 percent modulation, the RF oscillator swings 30KC above and below 100MC. (40 percent of 75KC is 30KC) Adding the 19KC pilot to the composite signal at a 10 percent modulation level will cause the RF oscillator to swing an additional 7.5KC above and below or 37.5KC above and below 100MC.

These frequency shifts are detected at the receiver detector and the output of the detector is then identical to the composite signal that modulates the RF oscillator in the MX129.

There are additional internal adjustments on the MX129, which are discussed in a later section titled "Making MX129 Adjustments".

## OPERATION

After becoming familiar with the various controls and output signals on the MX129, the generator should be plugged into a 117V AC line and the unit turned ON.

Connect the RF cable to the receiver antenna terminals and tune the receiver to 100MC. There should be a swamping of the noise when you are properly tuned with an unmodulated signal and, of course, you should hear the tone when modulating the RF carrier with left and/or right signals. Many receivers have a tuning indicator to show when the set is precisely tuned.

After the receiver is tuned, the RF carrier from the MX129 can be modulated with the various signals that are available and tests on the receiver can be made.

Tests can also be made on the receiver by by-passing the RF section of the receiver and feeding signals direct from the output jacks on the MX129 to input points after the detector in the receiver.

### Monaural Signal

In some tests it is desirable to use a monaural signal. This is provided from the MX129 by feeding both left and right channels with the same tone, usually 1000 cycles, and also adjusting the left and right level controls to the same voltage.

### Composite Signal

The composite signal is generated automatically in the MX129 as long as different frequencies and/or voltage levels are fed to both channels. In other words, the composite signal can consist of left signal only, right signal only or a combination of left and right signals of different frequencies and/or levels. The true composite signal would also have the 19KC pilot added.

### Controls on the Stereo Receiver

Since certain controls on the stereo receiver affect the apparent operation of the MX129, we will discuss briefly where these controls should be set.

The bass, treble and loudness controls should be set at midrange (flat response). The left and right channel level controls should be at the same setting and the balance control should be set at zero.

If there is an unbalance in the receiver, when the controls are set as above, it will be impossible to make accurate separation measurements on the receiver until the defective channel is corrected.

## SETTING UP AND TROUBLE SHOOTING STEREO RECEIVERS.

Setting up and trouble shooting stereo receivers is easy with the MX129. In addition to a good stable generator, however, a standard procedure should be followed to avoid wasted time.

Basically a stereo receiver is the same as a monophonic receiver with the addition of an adapter circuit used to separate left and right information and, of course, the addition of a second audio amplifier channel.

In trouble-shooting a stereo receiver, the following three steps will generally pinpoint the defective circuit.

1. Feed the RF output from the MX129, modulated with a 1000 cycle monaural signal into the antenna terminals of the receiver and balance the outputs to the speakers using the MX129 external meter. If the speakers can be balanced and the left and right receiver channel controls are at approximately the same relative settings, the trouble will most likely be in the adapter circuitry, probably misalignment. See Step 3 below. If the speaker outputs cannot be balanced at similar settings of the receiver channel controls, then the trouble will most likely be in one of the audio amplifiers. If no signal can be obtained from either speaker, proceed with Step 2.

2. Feed the monaural signal from the COMP OUT jack on the MX129 (approximately one volt peak to peak level for most receivers) into the receiver at the detector output and balance the speakers as in Step 1 above. If you still cannot obtain a signal from either speaker the trouble would be something that is associated with both audio channels, B plus, for example. If you can balance the speakers by feeding in at the detector, then the trouble must be in the tuner, IF circuit or in the detector.

3. If the speakers can be balanced as in Step 1, then a channel separation measurement should be made. This can be done as follows: After the receiver has been balanced with a monaural signal, switch the right channel off in the MX129 and turn the 19KC pilot signal up to 10 percent modulation. The 1000 cycle tone should now be coming through the left speaker only. If the multiplex adapter circuit is out of alignment, there will be some tone coming from the right speaker also.

The amount of separation can be measured in DB directly by measuring the signal level at each speaker in DB, and subtracting the lower reading from the higher reading. (Note: on the 30 volt peak to peak external meter range, 20DB must be added to the DB shown on the meter.) A 20DB separation, which is considered normal, would be when the high level speaker indicates on the 30 volt scale in the same place that the low level speaker indicates on the 3 volt scale.

If the amount of separation is inadequate, then the adapter circuit should be realigned.

### Multiplex Adapter Circuit

A typical multiplex adapter circuit is shown in Fig. 1. Note that at the output of the detector, the 19KC pilot is picked off the composite signal in the tuned circuit of L3, C46 and R93. The 19KC signal is amplified in V7A and then doubled in frequency to 38KC in V7B. The output of the doubler consists of two 38KC signals 180 degrees apart which are used to gate the left and right channel detectors, consisting of diodes CR2 and CR3. The composite signal from the detector also feeds into the diode detectors through C51, L5, C53, L6, R44 and C54. Two outputs (left signal and right signal) are obtained from the detector and these, of course, feed the left and right audio amplifiers.

The normal procedure for aligning this type of adapter with the MC129 is as follows: (For the most accurate results, of course, the manufacturer's alignment procedure should be followed.)

First feed in a signal from the MX129 that consists of 19KC pilot signal only; turn both LEFT and RIGHT LEVEL controls on the MX129 to zero. Second, connect the external meter at the plate of the doubler and adjust the 19KC tanks, V and W for a peak indication. Use the lowest level of 19KC that will still give a usable indication on the meter. Next move the meter to the secondary (terminal 1 or 2) of the 38KC tank and adjust the 38KC tank for maximum reading. The primary (X) should be adjusted first and then the secondary (Y) should be adjusted.

The final "touch up" of the 38KC adjustments should be made while checking separation at the speakers (feed the 1000 cycle tone into the left channel of the MX129). Touch up the adjustments so that the signal level at the right speaker is minimum and the signal level at the left speaker is maximum.

In the initial check for separation, if the adapter does not appear to be too far out of alignment, usually the "touch up" adjustments described above can be made with good results.

There are other older type adapter circuits that have been on the market that do not use the diode detectors and these operate differently than the circuit described above. However, the basic principle is still the same; the 19KC signal is removed from the composite signal, is amplified, and then is either doubled or is used to sync a 38KC oscillator.

The signals are added and subtracted to produce the left and right signals.

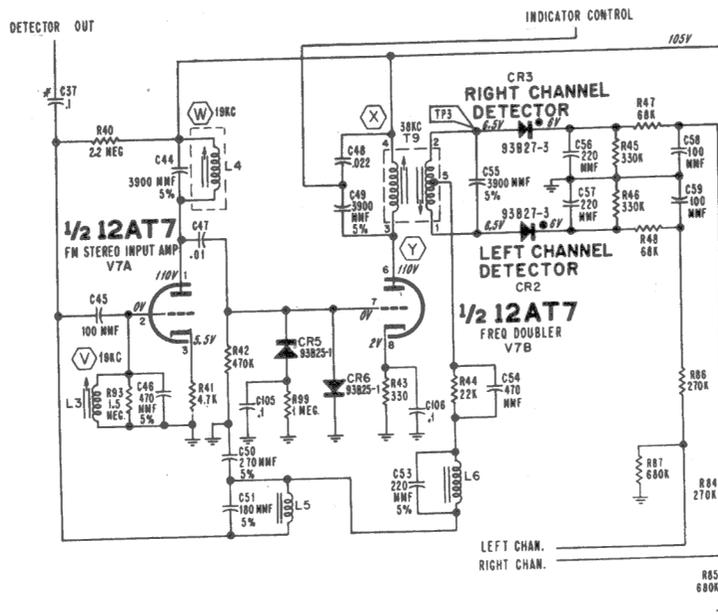


Fig. 1 Typical Multiplex Adapter Circuit

## THE MX129 PRODUCES A STANDARD STEREO SIGNAL

The Federal Communications Commission (FCC) Standards on F.M. Stereo Broadcasting are as follows: See Figure 2.

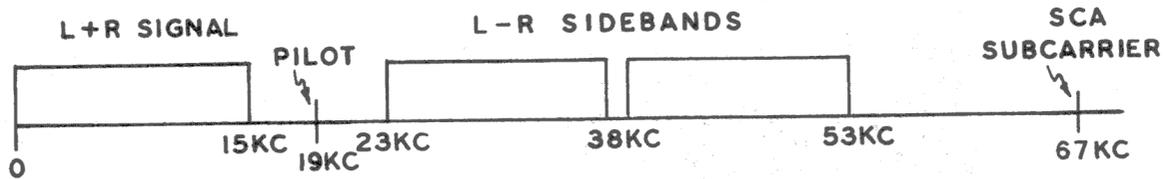


Fig. 2 Frequency Distribution of Composite Stereo FM Signal

- A. The Main Channel contains the sum of both left and right signals (L & R), in the band of frequencies from 50CPS to 15KC. (This is also the signal which is received by the monophonic tuner.)
- B. The Stereo Subchannel contains the difference information of both channels (L - R) modulating a 38KC carrier, which occupies the band of frequencies from 23kc to 53 kc. This (L-R) information is in the form of a double side band suppressed carrier amplitude modulated signal with a carrier frequency of 38KC.
- C. The Pilot carrier is a 19KC signal which is transmitted with the left and right information and is used as a synchronizing signal in the receiver. (This signal is always present during an FM stereo broadcast.)
- D. The Subsidiary Communications Authority (SCA) signal occupies the band of frequencies from 60KC to 74KC and is frequency modulated on a 67KC carrier. It occupies 10% of the modulation.

Graphically, the composite signal looks like that shown in Fig. 3.

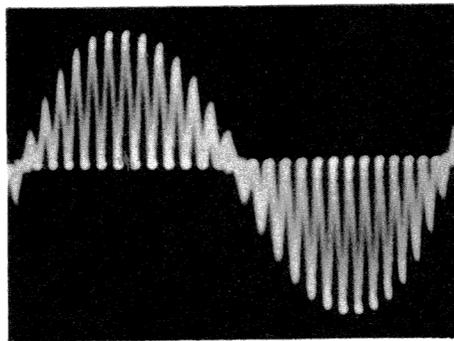


Fig. 3. Single channel composite out (no pilot).

This is shown without the pilot and only one channel being fed with a 1000 note. Note how the signal is present for only half of the time. If a second signal at 60 cycles is fed to the other channel, the composite signal would look like that shown in Fig. 4. Notice the time sharing effect; the envelopes of both signals can be clearly seen.

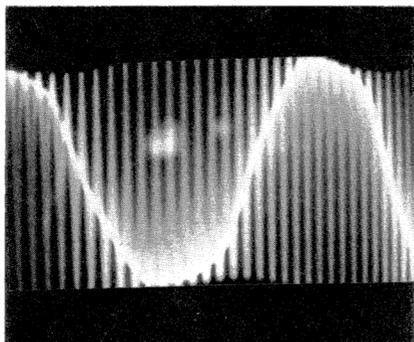


Fig. 4. 1000 and 60 mixed composite out (no pilot).

Adding the 19KC pilot to the signal shown in Fig. 3, results in the pattern shown in Fig. 5.

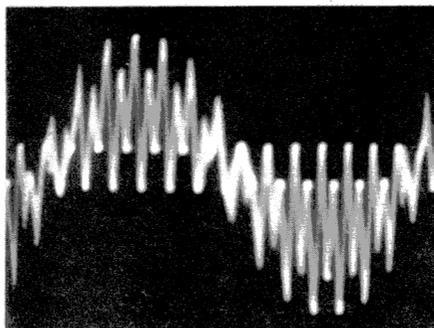


Fig. 5. Single channel with pilot.

When both channels are fed with the same frequency and each channel set to the same signal level the output would be a pure sine wave. Thus, you can see that if both channels are fed with the same signal a monaural output is produced, whereas if only one channel is fed or if each channel is fed with a different frequency, a stereo signal is developed.

## MAKING MX129 ADJUSTMENTS

### Disassembly Instructions

The MX129 panel is disassembled from the case by removing the four phillips head screws, two at the top and two at the bottom of the panel.

The printed circuit board is attached to the panel and is just slightly smaller than the panel. When removing the panel from the case, lift straight up to prevent the board from being damaged.

Four sheet metal screws hold the printed board to the panel brackets, and when these are removed, the board can be folded back exposing all components for service or adjustment. CAUTION: When servicing the MX129, be sure to work on an insulated surface as a metal bench could cause shorts in the board damaging components.

### SCA 67KC Adjustment

The 67KC generator is adjusted by L9, see Fig. 6, while beating the generator against a 67KC signal from an audio oscillator. An oscilloscope can be used and the generator adjusted for a 1:1 Lisajous pattern on the oscilloscope or the two signals can be fed into an audio amplifier and the generator adjusted for a zero beat.

### Panel Meter Calibration

The panel meter should be calibrated on the three volt peak to peak scale using a peak to peak reading VTVM or some other meter as a standard. The accuracy of the MX129 meter, of course, will only be as good as the standard used.

An external signal can be used to calibrate the meter or if none is available, the 1000 cycle signal from the MX129 can be used. To use the internal signal, adjust the left and right switches and level controls for a monaural signal at the COMPOSITE OUTPUT jack; turn the 19KC pilot to zero. Connect a jumper between the COMPOSITE OUTPUT jack and the EXTERNAL METER jack and also connect the standard meter to this point. Turn up the COMPOSITE LEVEL control on the MX129 until the standard meter indicates three volts peak to peak. Adjust the meter calibration control (on the bracket closest to the meter) until the MX129 meter reads full scale (3 volts peak to peak).

### 19KC Phase and Frequency Adjustments

The 19KC phase and frequency adjustments, L4 and L5, (See Fig. 6), will interact. Therefore, when one adjustment is made, the other should be checked.

The pilot phase is probably the most critical adjustment on any multiplex generator. If the 19KC phase, in relationship to the 38KC subcarrier phase, is off, you can align the adapter circuit in the receiver and obtain good separation on the generator signal. However, it will not be good on a station signal.

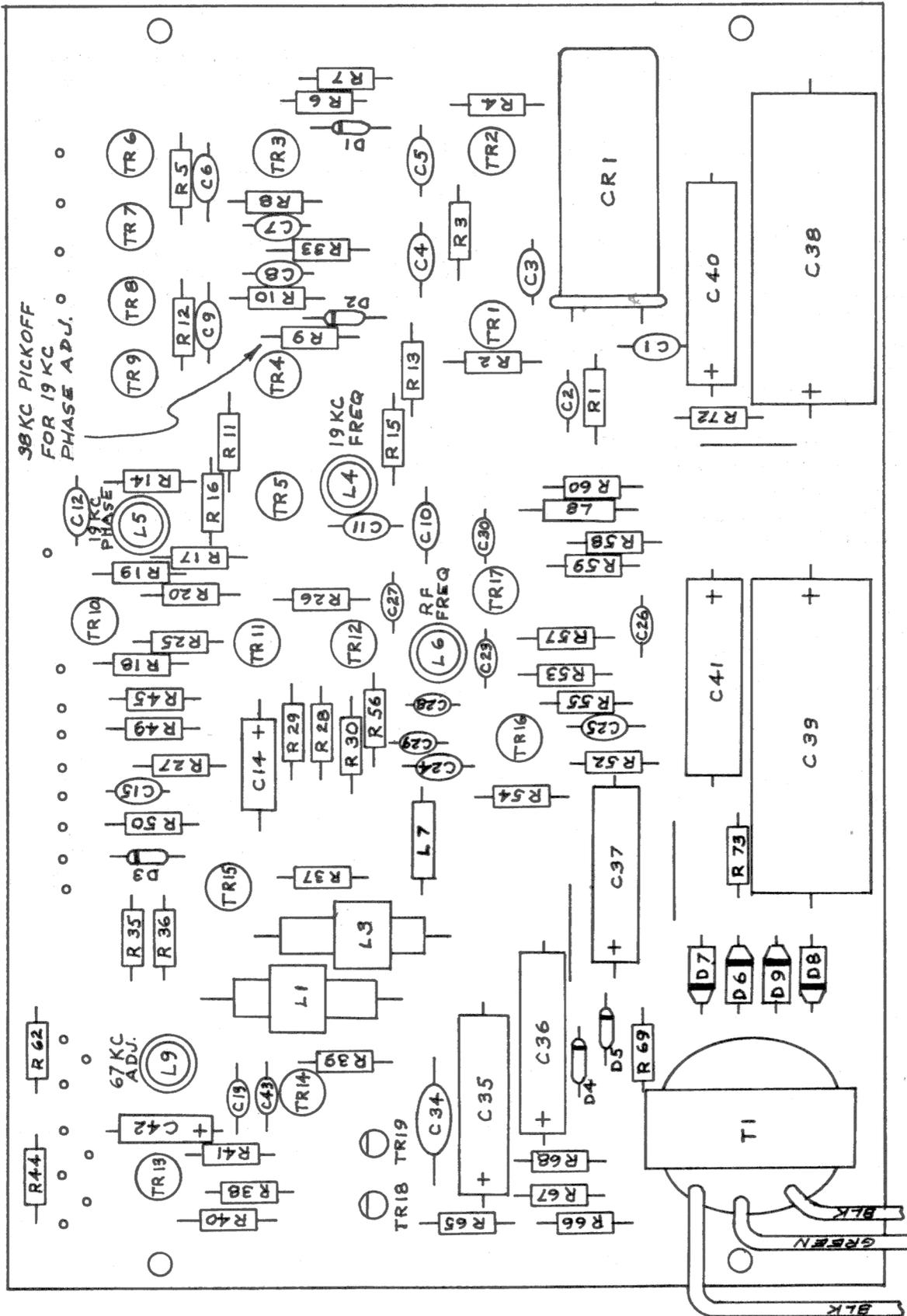


Fig. 6 Board Layout

A rough check on the 19KC phase can be made while observing the composite output signal on an oscilloscope. Feed the 1000 cycle tone into the left channel only, (nothing on the right channel) and turn the pilot level to maximum. The amplitude of the 19KC riding the envelope of the pattern should be the same as the amplitude of the 19KC riding the base line, See Fig. 5. If not, the 19KC phase needs to be adjusted.

The 19KC phase is adjusted while observing a Lisajous figure on an oscilloscope. The horizontal plates of the scope are driven with the 19KC signal taken from the ungrounded end of the pilot level control; the vertical plates are driven with the 38KC signal taken from the collector of TR4. If the 19KC pilot is properly phased, the trace will coincide with the retrace on the scope and the pattern will look as in Fig. 7A. If the 19KC phase is off, the pattern will look as in Fig. 7B. Adjust coil L5 until the pattern of Fig. 7A is obtained. If during the phase adjustment the 19KC oscillator loses sync, adjust coil L4 (just below the phase adjust coil) until the oscillator again synchronizes with the 38KC. Readjustment of L5 will be necessary if L4 was adjusted.

NOTE: It is important that the oscilloscope used for these adjustments does not have any phase shift at 38KC between the horizontal and vertical amplifiers. If it does, the adjustments above will be made in error. The oscilloscope can be checked by feeding the same 38KC signal to both amplifiers, and checking for a diagonal line on the CRT. If the trace and retrace do not coincide perfectly, there is a phase shift in one of the amplifiers (usually the horizontal) and a correcting network should be placed in series with the signal to the horizontal amplifier.

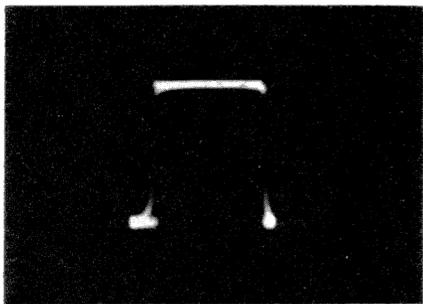


Fig. 7A. Pilot phase properly adjusted.

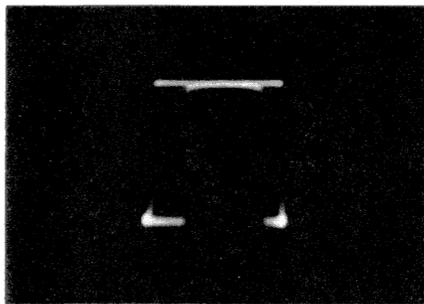


Fig. 7B. Pilot phase misadjusted.

#### Phase Linearity Adjustment

The phase linearity adjustment has nothing to do with the 19KC pilot, but rather is used to prevent phase shift throughout the audio range of the composite signal. The phase linearity control is located on the right mounting bracket closest to the front panel jacks.

It is adjusted while observing the composite output signal on an oscilloscope when the left (or right) channel only is fed with an external 20KC signal. The pilot level should be set at zero. Adjust the horizontal frequency on the scope for two complete patterns and adjust the phase linearity control for a perfectly straight base line through the center of the pattern.

Balance Control

The balance control affects the relative levels of the left and right signals at the composite output. The balance control is located on the right mounting bracket closest to the top of the panel.

It is adjusted while generating a monaural signal (the left and right signal levels must be set to the same peak to peak voltage), and observing the waveform at the COMPOSITE OUTPUT jack. If the balance control is improperly set there will be some 38KC residue riding on the envelope of the signal. The balance control should be set for the minimum amount of 38KC on the envelope.

Modulation Level Control

The modulation level control is difficult to set accurately, because it controls the deviation (frequency spread) of the RF oscillator. This control is located in the center of the right mounting bracket.

The easiest way to adjust this control is to first plot the response of the ratio detector in an FM receiver (DC volts out versus frequency), and then adjust the modulation level control for plus and minus 30KC deviation at the detector. For example, suppose that the output of the detector in the receiver was plus 1.25 volts for plus 75KC deviation and was minus 1.25 volts for minus 75KC deviation. Since plus and minus 75KC represents 100 percent modulation for FM, a 100 percent modulated signal would produce a 2.5 volt peak to peak signal at the detector. We wish to modulate the MX129 carrier at 40 percent with the composite signal (excluding 19KC pilot and SCA signals). Therefore, when the COMPOSITE LEVEL control is set for 40 percent modulation as indicated on the panel meter, then the modulation level control should be set so that a one volt peak to peak signal would be present at the detector output. (Forty percent of 2.5 volts is one volt).

CIRCUIT DESCRIPTION

The MX129 Stereo Generator is completely of solid state design (19 transistors and 9 diodes).

The "Heart" of the MX129 is the 76KC crystal controlled oscillator (TR1). The 76KC signal is coupled to the base of TR2 by capacitor C3. TR2 functions as a buffer and pulse shaper. The collector of TR2 is coupled by C4 and C5 to the base steering diodes D1 and D2 of the 38KC bistable multivibrator (TR3 and TR4).

Since TR3 and TR4 are switching at a 76KC rate, frequency division takes place and the result is the 38KC subcarrier source. Two 38KC square waves 180 degrees apart are coupled from the collectors of TR3 and TR4 through resistors R5, R12 and capacitors C6 and C9 into the triggered gates TR7 and TR8. The gates sample left and right channel information at a 38KC rate. Transistors TR6 and TR9 function as buffers and isolate the signal source from the gates (switch). The outputs of TR7 and TR8 are tied together by the balance control, R32. The output of the "switch" is coupled to the balanced emitter follower (TR15) through diode D3 and R35. The balanced emitter follower prevents compression of the negative portion of the signal coming from the "switch". The output of TR15 is coupled to the 114KC filter

through R35 and R36. The filter network comprised of L1 and L3 functions as a low pass filter and was designed to attenuate the 3rd harmonic of the switch frequency (3 X 38KC) or 114KC and pass all frequencies below 75 KC. The filter is directly coupled to the phase linearity control which corrects the phase relationship between the input and output of the filter for all frequencies in the audio range. The composite level control R48 is also directly coupled to the output of the filter. The signal feeds through an isolating resistor, R49, to the base of TR11.

Transistor TR11 and TR12 form an operational amplifier, which prevents the reflection of any loading at J3 (the composite output jack) back to the filter network and which also prevents the pilot phase from shifting due to loading.

Transistor TR5 is a 19KC triggered Colpitts oscillator, which is synchronized by the crystal controlled, 38KC square wave pulse from TR4 through resistor R11. The frequency of the oscillator is controlled by L4, C10 and C11. The collector of TR5 is coupled by R17 to a phase shifting network (L5 and C12) which determines the phase relationship between the 38KC subcarrier and the 19KC oscillator. The 19KC signal across L5 is coupled to the base of TR10 by resistor R19. TR10 functions as a low gain amplifier and also isolates the 19KC oscillator from the operational amplifier. The output of TR10 appears across the pilot level control (R21) and is coupled through R25 to the base of TR11. R25 determines the 19KC pilot level that feeds the modulator and is set for 10 percent modulation with the pilot level control full clockwise.

Transistor T13 is used as a 1000 cycle tone generator or as a 67KC SCA generator. In the 1000 cycle position of S2, T13 is a conventional phase shift oscillator which directly couples to an emitter follower (TR14). The output of T14 is coupled by C16 and C17 through the RIGHT and LEFT SIGNAL switches (S3 and S4) to the RIGHT and LEFT LEVEL controls (R31 and R34). The outputs of the level controls are directly coupled to the bases of the buffers TR6 and TR9.

Transistor TR13 in the SCA position of S2 is a Colpitts Oscillator operating at 67KC. The output is coupled to J4 (SCA OUTPUT jack) through C42. C42 also functions as an emitter by-pass capacitor in the 1000 cycle position of S2. The output of the SCA generator is coupled by resistor R77 to the base of TR11 (operational amplifier). R77 determines the SCA level that feeds the modulator and is set for 10 percent modulation.

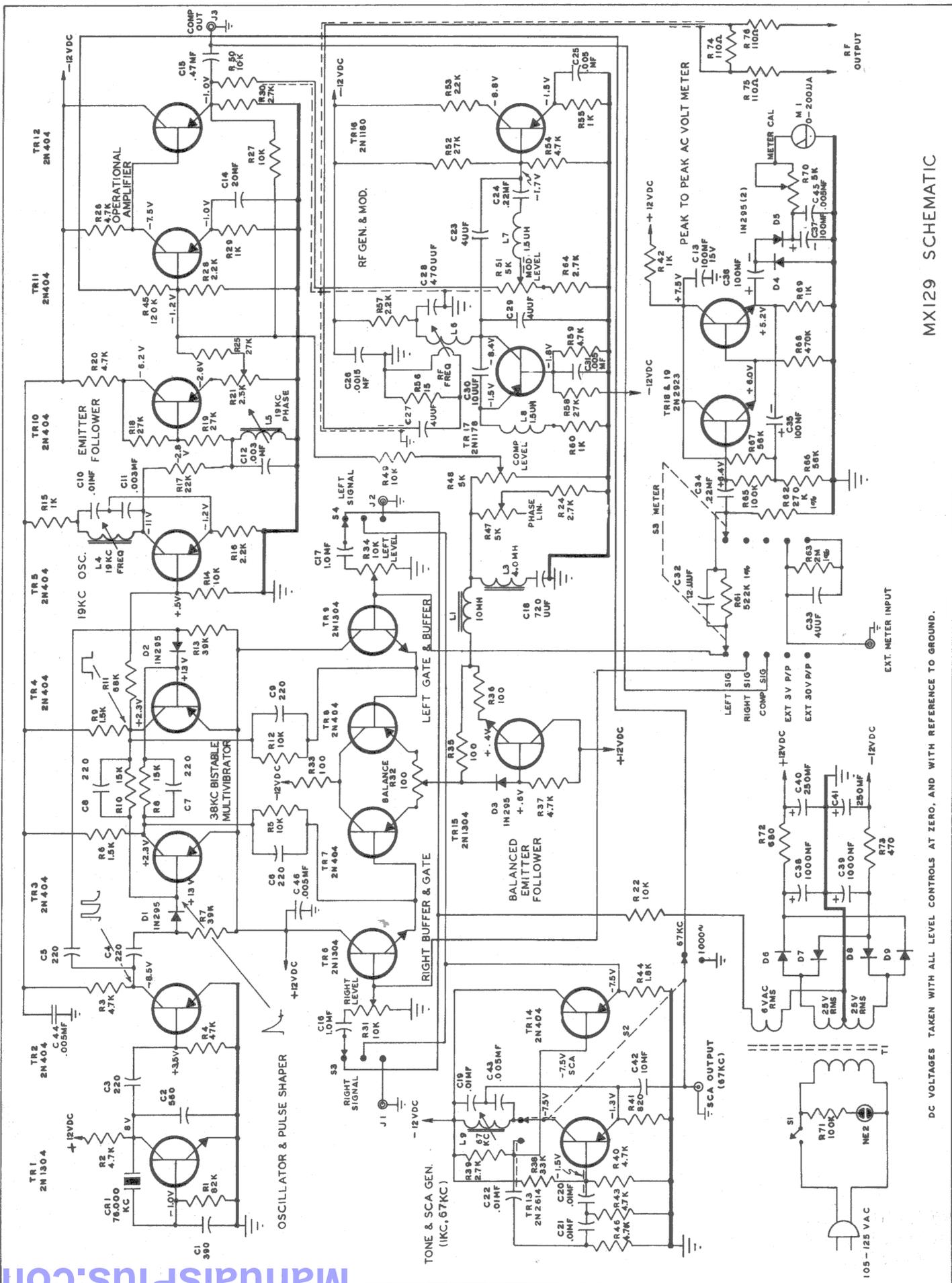
Transistors TR16 and TR17 comprise the FM generator portion of the MX129 and may be briefly described as follows: Transistor TR16 is a reactance type modulator. The collector to emitter capacity is a function of the amplitude of the signal appearing at the base. As the AC signal appearing at the base swings positive, the transistor conducts more heavily reducing the effective collector to emitter capacity, conversely as the signal swings more negative the transistor is being thrown out of conduction and its maximum capacity appears across the collector emitter junction. This change in capacity is utilized to vary the frequency of an RF oscillator and, therefore, generate an FM signal. The capacitive change of the reactance modulator (TR16) is coupled to the RF oscillator (TR17) tuned circuit (L6 and C29) through capacitor C23. The frequency swing of the RF oscillator varies directly with the modulating signal feeding the modulator. The carrier frequency of the RF oscillator is controlled by the adjustment of L6 and may be varied from 90 to 105 megacycles.

The composite output at J3 is coupled to R51 (Modulation level control) through R50. The modulation level control is an internal factory adjustment. The output of R51 is coupled to the base of the reactance modulator through an RF choke L7 and a coupling capacitor C24.

The peak to peak reading voltmeter of the MX129 utilizes a high input impedance current amplifier (TR18 and TR19). The high input impedance is achieved by the feedback capacitor C35, connected between the emitter of TR19 and the junction of R65 and R66. This couples the output voltage back to the input. Since the output voltage is nearly the same as the input voltage the difference voltage across R65 is very small and the effective value of R60 is increased greatly. R68 adds sufficient current to TR18 to maintain high beta frequency response. The output of TR19 is coupled into a voltage doubler with a high time constant to achieve a true peak to peak reading meter. The output of the doubler is coupled to a 200 micro-amp meter through a series control (R70) used to calibrate the meter.

Input to the meter is selected by the METER switch, S3. Appropriate voltage divider resistors (R61 and R63) are selected to provide a 10 volt peak to peak scale for internal signal measurements on the first three switch positions, and 3 volts and 30 volts peak to peak scales for external measurements in the last two positions. The 10 volt and 30 volt scales are frequency compensated by capacitors C32 and C33 across R61 and R63.

The power supply is a conventional full wave bridge rectifier consisting of Transformer T1, Silicon Rectifiers D5, D7, D8, D9 and filter capacitors C38, C39, C40, C41. Positive 11 volts and negative 11 volts are derived. The power supply features extremely good filtering and regulation.



MX129 SCHEMATIC

Figure 8. Schematic of MX129.

MX129 TROUBLE CHART

<u>Symptom</u>	<u>Probable Cause</u>	<u>Corrective Measure</u>
Dead Set	S1, T1, D6, D7, D8, D9, C38, C39, C40, C41	Check switch, diodes and filters with ohmmeter and replace if necessary. Check voltage output of transformer
Composite Audio Output Distorted or Missing	TR1, TR2, TR3, TR4, TR7, TR8, TR11, TR12, TR15 or associated parts in these circuits; R32, R47, R48	Check waveforms against those on schematic to locate the defective circuit, and make the necessary corrections. Check the adjustments of the three controls.
Left Signal Inoperative	S4, C17, R34, TR8, TR9	Check the switch control and capacitor with an ohmmeter and replace if necessary. Check the transistors.
Right Signal Inoperative	S3, C16, R31, TR6, TR7	Check the switch control and capacitor with an ohmmeter and replace if necessary. Check the transistors.
No 19KC Pilot in the Composite Signal	TR5, TR10, L4, L5, C10, C11, C12, R21	Check the transistors, check the coils, capacitors and control with an ohmmeter and replace if necessary. Check the setting of R21.
Receiver Separation Good with Generator Signal but not with Station Signal	L4, L5, C12, TR10	Check the transistor. Check coils and capacitor with ohmmeter and replace if necessary. Check adjust of L4 and L5 for correct phase relation between the 19KC and 38KC signals.
Meter Readings Inaccurate	S3, R61, C32, R63, C33, C34, C35, C36, C37, D4, D5, M1, R70	Check switch, resistors, capacitors and diodes with ohmmeter and replace if necessary. Check adjustment of R70, Check meter against a standard.
No RF Signal	Output cable assembly, C27, L6, C29, C31, C23, TR17	Check output cable, capacitors and coil with ohmmeter and replace if necessary. Check the transistor.
RF Modulation Distorted or Missing	R51, L7, C23, C24, C25, TR16	Check the transistor. Check the adjustment of R51, check the coil and capacitors with an ohmmeter and replace if necessary.

MX129 Parts List

Resistors

Ref. No.	Description	Stock No.	Price
R1	82K, $\frac{1}{2}w$ , 10%, RES.	14G81	.25
R2, R3, R20, R26, R37, R40, R43, R46, R54, R59	4.7K, $\frac{1}{2}w$ , 10% RES.	14G46	.25
R4	47K, $\frac{1}{2}w$ , 10% RES.	14G3	.25
R5, R12, R14, R22, R27, R49, R50	10K, $\frac{1}{2}w$ , 10%, RES.	14G34	.25
R6, R9	1.5K, $\frac{1}{2}w$ , 10%, RES.	14G166	.25
R7, R13	39K, $\frac{1}{2}w$ , 10%, RES.	14G16	.25
R8, R10	15K, $\frac{1}{2}w$ , 10%, RES.	14G80	.25
R11	68K, $\frac{1}{2}w$ , 10%, RES.	14G219	.25
R15, R29, R42, R55, R60, R69	1K, $\frac{1}{2}w$ , 10%, RES.	14G1	.25
R16, R28, R53, R57	2.2K, $\frac{1}{2}w$ , 10%, RES.	14G78	.25
R17	22K, $\frac{1}{2}w$ , 10%, RES.	14G88	.25
R18, R19, R25, R52, R58	27K, $\frac{1}{2}w$ , 10%, RES.	14G15	.25
R24, R30, R39, R64	2.7K, $\frac{1}{2}w$ , 10%, RES.	14G185	.25
R33, R35, R36	100 ohm, $\frac{1}{2}w$ , 10%, RES.	14G74	.25
R38	33K, $\frac{1}{2}w$ , 10%, RES.	14G36	.25
R41	820 ohm, $\frac{1}{2}w$ , 10%, RES.	14G224	.25
R44	1.8K, $\frac{1}{2}w$ , 10%, RES.	14G2	.25
R56	15 ohm, $\frac{1}{2}w$ , 10%, RES.	14G194	.25
R62	270K, $\frac{1}{2}w$ , 1%, RES.	14G214	.50
R65, R71	100K, $\frac{1}{2}w$ , 10%, RES.	14G39	.25
R66, R67	56K, $\frac{1}{2}w$ , 10%, RES.	14G38	.25
R68	470K, $\frac{1}{2}w$ , 10%, RES.	14G47	.25
R72	680 ohm, $\frac{1}{2}w$ , 10%, RES.	14G55	.25
R73	470 ohm, $\frac{1}{2}w$ , 10%, RES.	14G207	.25
R45	120K, $\frac{1}{2}w$ , 10%, RES.	14G130	.25
R61	522K, $\frac{1}{2}w$ , 1%	14G215	.50
R63	2.0 Meg, $\frac{1}{2}w$ , 1%	14G216	.50

Controls

R21	2.5K, 10% LINEAR	15G42	.80
R31, R34	10K, 30%, LINEAR	15G40	.80
R32	100 ohm, 30%, LINEAR	15G26	.75
R47, R51, R70	5K, 30%, LINEAR	15G39	.75
R48	5K, 30%, LINEAR	15G41	.80

Switches

S1	S.P.D.T., Slide switch	25G4	.50
S2	D.P.D.T. " "	25G3	.50
S3, S4	1 P.3.P. Rotary " "	25G73	1.00
S5	2 P.5 P. " "	25G72	1.00

Transistors & Diodes

TR1, TR6, TR9, TR15	Transistor 2N-1304 N.P.N.	19G5	1.25
TR2, 3, 4, 5, 7, 8, 10, 11, 12, 14	Transistor 2N-404 P.N.P.	19G4	.75
TR13	Transistor 2N-2614 P.N.P.	19G9	1.00
TR16	Transistor 2N-1180 P.N.P.	19G7	1.40
TR17	Transistor 2N-1178 P.N.P.	19G6	1.50
TR18, TR19	Transistor 2N-2923 N.P.N.	19G8	1.50
D1, D2, D3, D4, D5	Silicon Diode 1N-295	19G2	.75
D6, D7, D8, D9	Rectifier	16S3	1.00

MX129 Parts List (con't)

<u>Capacitors</u> Ref. No.	Description	Stock No.	Price
C1	390-MMF, 10% 500 v, DISK	24G49	.25
C2	560MMF, 10%, 100V, DISK	24G116	.25
C3, C4, C5, C6, C7, C8, C9	220 MMF, 20%, 600v, DISK	24G25	.25
C10, C19, C20, C21, C22	.01 MF. + <sup>80</sup> / <sub>20</sub> , 500v, DISK	24G33	.30
C11, C12	.003MF. 10%, 500v, DISK	24G117	.25
C13, C35, C36, C37	100 MF. + <sup>80</sup> / <sub>10</sub> , 15v, Lytic	24G118	.80
C14	20MF, +80, 15v, Lytic -10	24G121	.80
C15	.47MF, +80, 10v, DISK -20	24G16	.50
C16, C17	1.0 MF. 20%, 400v, TUB.	24G87	1.25
C18	720MMF., 10%, 500v, DISK	24G123	.25
C23, C27, C29, C33	4MMF, 10%, 500v, DISK	24G72	.25
C24, C34	.22MF. +80, 10v, DISK -20	24G29	.45
C25, C31, C43, C44, C45, C46	.005MF. GMV, 600v, DISK	24G9	.25
C26	.0015MF. + -20%, 600v, DISK	24G74	.25
C28	470MMf, 10%, 500v, DISK	24G119	.25
C30	10MMf, + -10%, 500v, DISK	24G86	.25
C32	12MMF, 10%, 500v, DISK	24G34	.25
C38, C39	1000MF., +80, 25v, Lytic -20	24G115	2.00
C40, C41	250MF, +80, 15V, Lytic -20	24G111	1.00
C42	10MF, +80, 15V, Lytic -20	24G120	.80
<u>Transformers &amp; Coils</u>			
T1	117v AC, PRI, 50v, C.T. SEC. 6v AC/IMA SEC. #2	28S25	3.00
L1	Coil, Filter, 10MH	46G9	.75
L3	Coil, Filter, 4.0MH	46G16	.75
L4	Coil, Osc. 19KC	46G12	1.00
L5	Coil, Phase, Adj.	46G10	1.00
L6	Coil, Oscillator (R.F.)	46G13	.75
L7, 8	Coil; Choke (R.F.)	46G14	.50
L9	Coil, Oscillator, 67KC	46G11	1.00
<u>Misc.</u>			
CR1	76.000KC, .01% Crystal	47G4	17.50
M1	Meter Pan. (2-200 Microamp)	B23S15	15.00