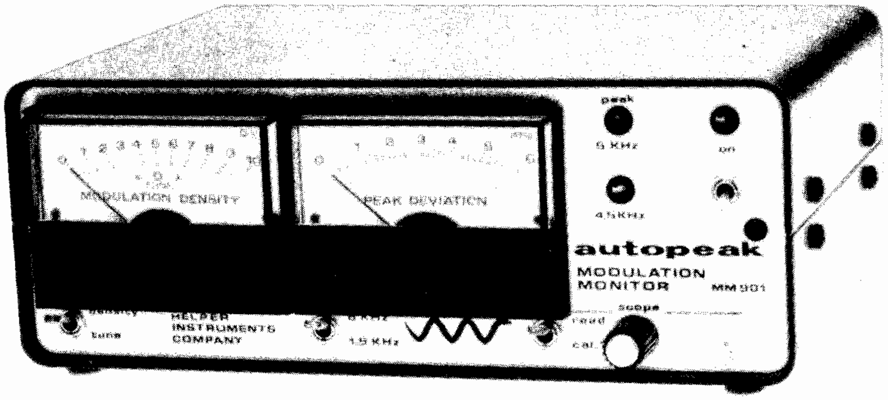
INSTRUCTION MANUAL

Model MM901

Autopeak ™

MODULATION MONITOR



HELPER INSTRUMENTS COMPANY

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SPECIFICATIONS

GENERAL: The **AUTOPEAK™ MODULATION MONITOR** is used in conjunction with an FM receiver to read peak modulation and density of the received signal. It may be used with any receiver (typically a scanner) whose 2nd I.F. frequency is 400, 450 or 455 KHz. Other frequencies may be accommodated on special order.

INPUT: 100 microvolts minimum from receiver 2nd I.F. A receiver connection kit is supplied that consists of an isolation capacitor (2pf.), connector and interconnecting cable.

READOUTS: PEAK MODULATION DEVIATION METER with switch selected 6 KHz and 1.5 KHz scales. A low pass filter on the 1.5 KHz range reduces the effect of background noise when measuring squelch tones. Exclusive AUTOPEAKT™circuit displays greater of the negative or positive peaks.

PEAK INDICATING LED's at 4.5 KHz and 5 KHz.

MODULATION DENSITY METER with switch selected frequency error scale.

SCOPE OUT: A front panel jack and calibration control permits use of an external oscilloscope for observation of modulated wave forms.

TONE: A 1000 Hz sine wave with front panel level control is provided as an audio source for modulation setting.

DEMOD OUTPUT JACK: For connecting TONER II™ for off the air tone measurements.

POWER REQUIREMENTS: 117/240 Volts, 50/60 Hz, as chosen by transformer taps. Also operable from 13.5 V.D.C. negative ground automotive supply

DIMENSIONS: 3" H x 1/2" W x 6 7/8" D (metric) 76mm W x 175 mm D

ORDERING Unless otherwise specified, the MODULATION MONITOR is wired to accept 450 KHz from the associated receiver. It is easily reset to 400 KHz or 455 KHz user without affecting calibration. Unit will be factory preset to your receiver's I.F. when requested.

GENERAL DESCRIPTION

THE MM901 MODULATION MONITOR requires a receiver, usually one of the popular scanners, to receive the signal to be measured. A connection kit is provided that permits the MM901 to be plugged into the receiver. Actual connection is made through a 2 pf. capacitor connected to the low I.F. point in the receiver. Detailed connection instructions will be found in the section entitled, "MAKING THE CONNECTION TO THE ASSOCIATED RECEIVER".

A PEAK DEVIATION METER reads peak modulation deviation directly in KHz . **"AUTOPEAK™"** circuitry displays the greater of the positive or negative peak. GO - NO GO red and yellow LED flashers indicate modulation peaks too brief for meter readings. A yellow LED lights when peak deviation reaches 4.5 KHz. A red LED lights when peak deviation reaches 5 KHz. These LEDs are driven by the same **"AUTOPEAK™"** circuitry as the meter. The driving circuits stretch the flashes so that a short peak will light the LED for a relatively long time. The switch below the peak deviation meter changes it from 6 KHz full scale to 1.5 KHz full scale. When this switch is in the 1.5 KHz position, the peak flashers are disconnected and a low pass filter is connected into the measurement circuits. This filter is used to reduce background noise when measuring modulation of low frequency tone systems such as CTCSS and digital squelch. Because of the filter, the 1.5 KHz scale will give very erroneous readings if an attempt is made to measure speech deviation.

A MODULATION DENSITY meter is provided that reads directly in density units. This meter provides an accurate non-subjective indication of effective modulation. It meters the relationship between average and peak modulation. A complete description of this will be found in the section entitled "MODULATION DENSITY". Switching this meter to TUNE provides a metered relative indication of the center frequency of the received signal. When this meter is switched to the TUNE position, it serves as a relative transmitter frequency indicator. A scope output jack is provided on the front panel of the **MODULATION MONITOR**. A measured 1 KHz tone is provided through this jack for rapid scope calibration. In addition, this 1 KHz low distortion sine wave is available from a rear panel jack for use as an audio signal source for modulating transmitters, or for other test tone needs. Its level is controlled by the "scope cal" control on the front panel. The control has no effect on the scope display except during calibration. A demod output jack is provided on the rear panel for direct connection to the TONER II tone frequency counter.

OPERATING GUIDE

AUTOPEAK™ MODULATION MONITOR OPERATING GUIDE

DENSITY METER

Switch Position: DENSITY
Read: Density Units

To obtain a valid Density reading, the peak deviation should be between 4.5 and 5 KHz. 6 to 8 Density Units indicates normally acceptable Density.

Switch Position: TUNE

Read: Center Frequency Error

Meter indication is approximately 1 division per KHz. Direction of needle deflection depends on receiver and does not indicate whether transmission is above or below correct frequency. Set prior to use. See Page 5

DEVIATION METER

Switch Position: 6 KHz
Read: Peak Deviation

AUTOPEAK™ circuit displays higher of positive or negative peaks.

Switch Position: 1.5 KHz
Read: Peak Deviation of tones below 250 Hz only.

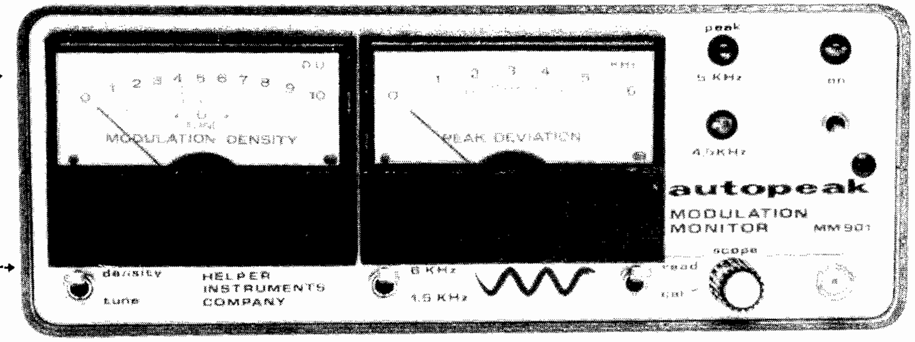
A 300 Hz low pass filter on this range reduces background noise when measuring low frequency tone signals.

LED DISPLAYS

Red 5 KHz LED lights whenever peak modulation exceeds 5 KHz.

Amber 4.5 KHz LED lights whenever peak modulation exceeds 4.5 KHz.

Green LED for power ON indication.



REAR PANEL

IF INPUT JACK
DEMOD OUTPUT to TONER II for off the air tone measurements.
1 KHz TONE OUTPUT. Level set by front panel "scope cal" control.

Tune Meter set control.

Peak Flash set control

EXTERNAL SCOPE CONNECTION

Connect Scope to BNC Output Jacks

Switch Position: CAL

Adjust pot for 5 KHz reading on Peak Deviation meter Adjust scope so that displayed sine wave covers 10 divisions.

Switch Position: READ
Scope reads directly in KHz.

MAKING THE CONNECTION TO THE ASSCOCIATED RECEIVER

To operate the MM901, a connection must be made to the associated receiver. The connection samples a portion of the 450 KHz (or 400 KHz, or 455 KHz) low IF signal for delivery to the MM901. The sample is taken through a 2 pf capacitor that is installed in the receiver. The high reactance of the sampling capacitor prevents upsetting the alignment or operation of the receiver's IF system. An installation kit is provided with the MM901, which includes the following:

1. RG58/U cable assembly to connect the MM901 to the receiver.
2. Phono jack to be installed on the receiver (scanner).
3. Coupling capacitor, 2 pf (2 supplied, one with extension cable assembly for use when the connection point is some distance from the panel jack.)

Most modern FM monitoring receivers use a single integrated circuit for the functions of 10.7 MHz (typical) High IF amplifier, second mixer, 10.245 MHz (typical) 2nd crystal oscillator, 455 KHz (typical) amplifier and limiter, and phase detector (discriminator) functions. The integrated circuit also often contains sections which control squelch and scanning circuits. The integrated circuits used are similar to the MC3357, although they may be marked by the scanner manufacturer's in-house number and may have different pin outs.

Remove the cover from your scanner. The Figure 1 block diagram of portions of the MC3357 and nearby circuitry will aid you in finding the proper location for the sampling connection:

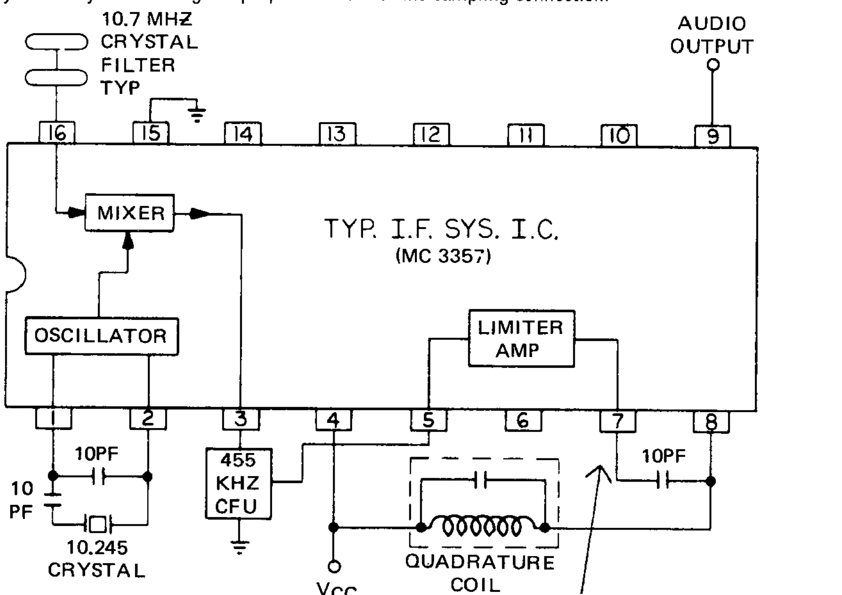


Figure 1 connect 2 pf cap here

It is easy to locate the IF system integrated circuit in a receiver, because the crystal filter, the ceramic filter, the 2nd oscillator crystal, and the quadrature coil are clustered around it. (The ceramic filter is usually a small plastic cube, about ¼" on each side. The quadrature coil is usually a small square can with an adjustment slug similar to the IF transformers in transistor radios.)

Bearcat™ scanners and some Regency™ scanners use an IC similar to this. (Bearcat part marked B531-01, Regency part marded 501-271). In both cases, connect the 2 pf cap to pin #7. Newer Regency scanners use an 18 pin integrated circuit which is stamped with the part #600-596. The proper connection point to this IC is pin #8.

Even if the IF integrated circuit has a different pinout than the one shown, the proper pin can be found easily. Once you have located the IF system integrated circuit, find the pin that connects the small size (typically 10 pf)capacitor that then connects to one side of the quadrature coil. (See Figure 1.) That pin (in this case pin #7) is the correct location for the connection of the 2 pf sampling capacitor.

In older receivers using discrete parts instead of integrated circuits for the IF system, connection should be made to the output of the last IF amplifier/limiter stage.

After you have found the proper pin on the IF integrated circuit, find a good place on the rear panel to locate the phono style jack. A location should be picked so that the leads on the 2 pf sampling condensor will reach from the IC pin to the jack if possible. Punch or drill (be careful of chips!) a ¼" diameter hole for the jack, and install it. Then solder one lead of the 2 pf sampling capacitor to the jack and the other lead to the proper pin of the IF integrated circuit.(See Figure 2.)

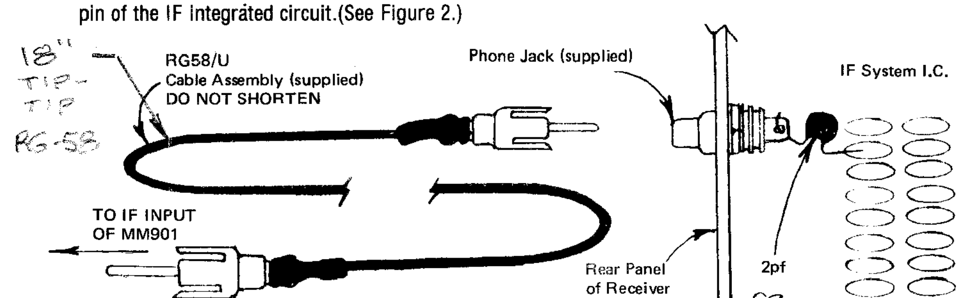


Figure 2

For those cases where longer leads are required, the installation kit includes an 8" section of coaxial cable with a 2 pf capacitor on one end. Tie the free end of the 2 pf capacitor to the sampling point. Connect the white (clear)lead at the other end to the phono jack, and the black lead to the phono jack ground lead. (See Figure 3.)

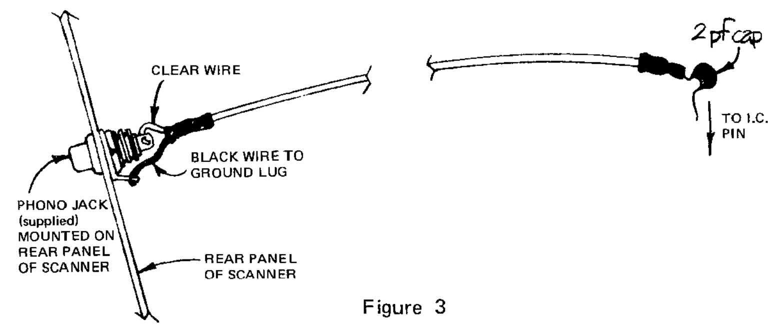


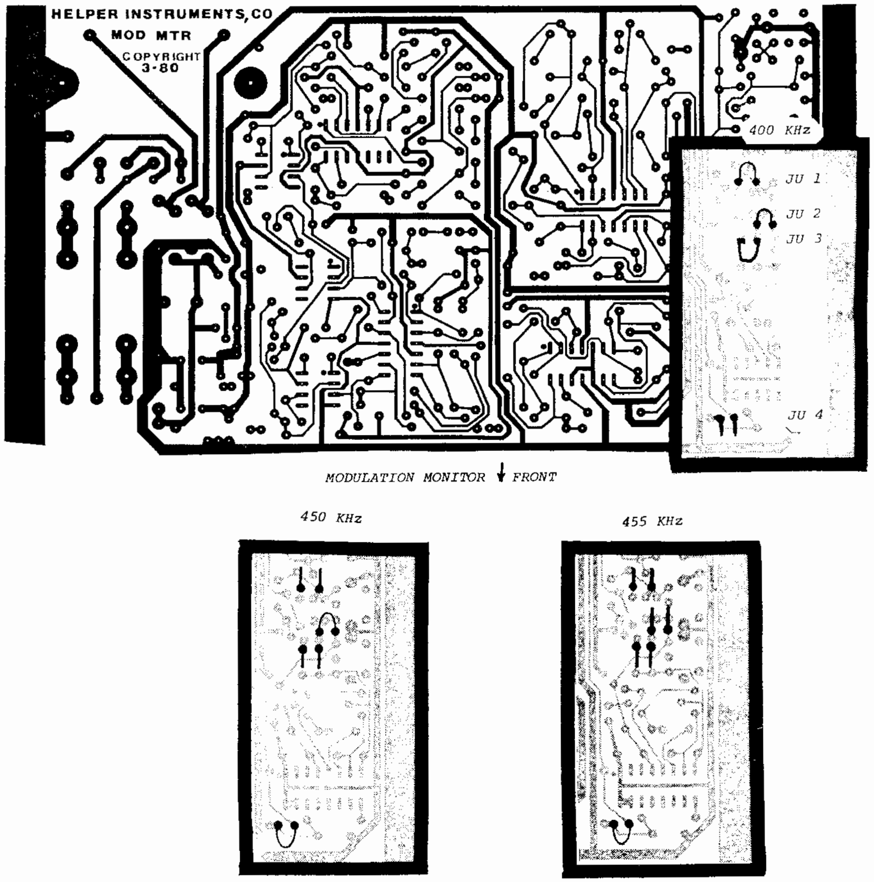
Figure 3

If you do not know the IF frequency of the monitoring receiver, you can determine it by tuning in a known, on frequency signal and connect a frequency counter to the sampling point (where you have just connected the 2 pf capacitor). The frequency counter should indicate the low IF frequency within a couple of Kilohertz. This completes the modification to the monitoring receiver. Replace the cover.

Connect the MM901 IF cable to the phono chassis connector you have installed on the scanner. Dial your scanner to a known frequency signal. Switch the left hand switch on the MM901 to the "tune" position. The "tune" meter should read within about two divisions of center. It can be corrected to center reading by adjustment of the "set tune meter" control accessible through a hole in the rear panel of the MM901.

The MM901 is shipped from the factory, prepared and aligned for operation on one of three popular IF frequencies, 400 KHz, 450 KHz, or 455 KHz. The factory preparation is indicated on the rear panel. Changing from one of these IF frequencies to another is accomplished simply by clipping (or resoldering) jumper connections on the bottom of the MM901's circuit board. Once the jumper connections are changed to the appropriate frequency, no additional alignment or calibration is required.

Remove the bottom cover from your MM901 and determine if the jumpers have been properly clipped (or soldered) for operation on the proper IF frequency (400 KHz, 450 KHz, or 455 KHz as determined above). See Figure 4, for proper jumper connections. Make the appropriate changes (if any) and replace the cover.



FREQUENCY / JUMPER	JU 1	JU 2	JU 3	JU 4
400 KHz	closed	closed	closed	open
450 KHz	open	closed	open	closed
455 KHz	open	open	open	closed

JUMPER LOCATIONS, AUTOPEAK MODULATION MONITOR

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FIGURE 4

OPERATING INSTRUCTIONS OF THE MM901

The basic operation of the MM901 is explained in the preceding pictorial guide (Figure 1). The following information will help you get the most usage from your MM901.

NOTE:
WHEN NO SIGNAL IS BEING RECEIVED, THE PEAK DEVIATION METER AND THE DENSITY METER WILL "PEG" TO THE RIGHT. THIS CONDITION IS NORMAL AND WILL NOT DAMAGE THE METERS.

PEAK DEVIATION METER:

The **PEAK DEVIATION** meter reads the peak modulation deviation directly in KHz. The electronics driving this meter have two important features: (1) An "AUTOPEAK™" circuit, which selects the greater of the positive and negative peaks and displays it. (2) A meter "hold" circuit that speeds the upward movement of the meter needle, while slowing its return.

Use the 1.5 KHz position only for measuring deviation due to tone frequencies below 250 Hz. It will give very inaccurate results on speech modulation as a 300 Hz low pass filter is activated in this switch position.

PEAK DEVIATION FLASHERS:

The 4.5 KHz and 5 KHz flashing LEDs permit a rapid GO -NO GO check of transmitter deviation control. If the 5 KHz LED does not flash and the 4.5 KHz LED does flash, the deviation setting is correct. These indicators will catch peaks that are too fast for a meter to display properly. Depend on them for knowing when transmitter deviation control is set properly. Use the meter primarily for measurement of steady signals, such as tones and data. It will be noted that the peak flashing LEDs will register on voice peaks which are too short in duration for the **PEAK DEVIATION** meter to follow. This is a normal condition. When the meter is measuring steady tone modulation of a transmitter (on the 6 KHz scale), the Peak Flashers should coordinate with the meter reading within .1 KHz.

The peak deviation LEDs are disconnected from the circuit when the **PEAK DEVIATION** meter is switched to the 1.5 KHz range.

The AUTOPEAK™ circuit in the MM901 measures both the positive and negative going peaks and presents the greater value on the **PEAK DEVIATION** meter. This value is also indicated on the 4.5 KHz and 5 KHz flashers. The Modulation of FM transmitters is not necessarily symetrical. That is, positive modulation peaks may be greater, or less, than negative going peaks. Most modulation meters are activated by the average of the positive and negative going peaks, or merely indicate one or the other. Monitors with scope presentations show both peaks, but it is necessary to check both to see which is the greater. With the MM901, you are always looking at the higher peak. For proper system operation, neither of the modulation peaks should exceed 5 KHz.

MODULATION DENSITY METER:

The left hand meter reads **MODULATION DENSITY** when the switch is in the "Density" position.

To make a Density measurement, be sure that the Peak Deviation of the transmitter is between 4.5 KHz and 5 KHz, as indicated by frequent flashing of the 4.5 KHz LED flasher, and no flashing of the 5.0 KHz flasher. Then, observe the signal for a few seconds, noting the maximum reading that is repeatedly achieved on the Density meter.

Density readings in the vicinity of 6 to 8 Density Units indicate a proper degree of speech clipping within the transmitter. We suggest that you read the section on **MODULATION DENSITY**, starting on Page 7 of this manual. Proper attention to Density readings can be of substantial help in getting optimum communication performance from radio systems.

TUNE METER:
Before using the "tune" meter, it should be adjusted to read correctly with the associated receiver. Tune the receiver to a known, accurate, signal. An accurate signal generator, or a transmitter known to be on the exact channel frequency, will suffice. Switch the "TUNE DENSITY" switch to the "Tune" position, and adjust the "set tune meter" control (a screwdriver adjustment accessible through the rear panel) to obtain a center scale reading on the "tune" meter.

The tune meter gives a relative indication of the center frequency of a received signal. Although its indication is dependent upon the accuracy of the frequency determining elements in the receiver, it can be used to make a precise comparison between two received signals. A distant transmitter's frequency can, therefore, be measured by comparing it with the output of an accurately calibrated signal generator.

OSCILLOSCOPE CALIBRATION SYSTEM:
For those occasions where a 'scope readout is desired, you can connect your oscilloscope to the front panel "scope" jack.

Provisions are included to permit rapid calibration of the 'scope display. The pictorial shows the steps involved in the calibration procedure. A 1,000 Hz internal tone oscillator is used as the calibration signal.

1,000 Hz TEST TONE:
The 1,000 Hz calibration tone is a low distortion sine wave and can be used as an audio signal source for modulating transmitters, or for other test tone needs.

Connection to the 1,000 Hz test tone is available at a BNC jack on the rear panel of the MM901. Level of the tone is controlled by the "scope cal" control on the front panel of the MM901. This control has no effect on the 'scope display once the 'scope has been calibrated.

GETTING THE MOST FROM YOUR MM9901

Best measurements are from strong, noise-free, signals. When measuring a weak signal, the thermal noise heard on the signal will add directly to the peak modulation reading, causing the reading to be greater than the correct value.

The measurement of transmitters at a distance is considerably enhanced by using a high elevation antenna for your scanner. If intermodulation interference causes problems when the high antenna is connected, try inserting a 6 or 10 db attenuator pad in the coaxial line to the scanner. The improvement can be substantial.

Some receivers have a tendency to "block" on extremely strong signals. If your receiver exhibits this problem, remove its antenna when checking modulation of nearby transmitters.

Since the MM901 has its own discriminator circuit, its calibration is essentially independent on the receiver to which it is attached. However, a receiver which is badly detuned from the center frequency of the received signal, or a receiver with a badly detuned crystal filter, can cause the deviation readings to be higher than the correct value. In synthesized scanner receivers, it is a simple matter to set the primary reference crystal to the correct frequency. Problems due to a detuned crystal filter in the receiver can be remedied by aligning the filter for best SINAD while receiving an on-frequency signal modulated with about 6 KHz peak deviation of 1,000 Kz tone.

Certain synthesized scanners have a large amount of noise created in the synthesizer circuit. This causes a jumpy noise reading of some 300 Hz or more on the peak deviation meter, even when strong, unmodulated, signals are being received. The error caused by this noise is negligible when deviations near 5 KHz are being measured, but is significant when measuring tone squelch modulation deviations in the 500 to 1000 Hz range. If your receiver synthesizer does create noise in the region of, say, 300 Hz, subtract this amount from the value of tone squelch deviation read on the meter. (i.e., if the residual noise reading is 300 Hz, and

the deviation meters show 800 Hz of deviation, the actual tone squelch modulation deviation can be figured as 500 Hz.)

An adjustment provided on the rear panel permits you to change the level at which the flashers operate. (See Calibration Section for procedure.) The 4.5 KHz flasher will operate at 90% of the level of the 5 KHz flasher.

MODULATION DENSITY

The Helper MM901 provides a measurement of Modulation Density in addition to Peak Deviation measurement.

All modern FM communication transmitters employ a modulation limiter (clipper) circuit to assure that the modulation never exceeds the correct amount. In most administrations, a legal maximum of 5 KHz is imposed. In addition to the legal requirement of keeping peak modulation within this limit, the modulation acceptance limitations of receivers make it necessary that the 5 KHz peak deviation not be exceeded.

A good clipper circuit, with the proper amount and type of clipping, permits higher average levels of speech signal to be applied to the modulation stage, while preventing the peaks from exceeding the 5 KHz limit. If the speech is not subjected to enough clipping, the average amount of modulation will be low, and the speech will sound weak in comparison to circuit noise. If the limiting is excessive, the speech will sound distorted and intelligibility will suffer.

A peak deviation measurement indicates only the value of the peaks. It tells nothing about the "average"* amount of modulation, and therefore, nothing about the degree of clipping that has occurred in the clipper circuits. Clipping can be so low that the peak value is reached only occasionally, or it can be so severe that speech is badly distorted. The peak deviation in either case may be the same.

*The term "average" has been put in quotations throughout this explanation to avoid confusion with various mathematical and electrical definitions of the word "average".

The degree of clipping in a transmitter is determined by the level of the speech signal as it reaches the modulation limiter (clipper) stage. A high level input creates more clipping, a low level decreases the amount of clipping.

If the peak deviation control of a transmitter has been set so that modulation peaks fall just below the 5 KHz limit, a measurement of the "average" amount of modulation will be an indication of the degree of clipping imposed on the speech signal. An extremely high "average" value would indicate excessive clipping; a low "average" value would indicate inadequate clipping.

The Density measurement circuits of the MM901 actually make a measurement of the "average" modulation, intergrate it, and present it on a meter scaled from 0 to 10 Density Units (D.U.).

Before attempting to make any judgments about the Modulation Density of a transmitter, be sure that its deviation control has been set so the peak deviation is running between 4.5 KHz and 5.0 KHz. The proper setting is reached when the 4.5 KHz LED is flashing frequently, and the 5.0 KHz LED is not flashing. Observe the density meter for a few seconds of continuous speech and notice the highest reading that is repeated consistently. This reading is the modulation density.

The Modulation Density scale is divided into ten Density Units. A variation of less than one density unit is not significant. It is important that the density observation be made while the transmitter operator is using typical microphone technique and is talking with typical loudness.

The proper Modulation Density depends somewhat upon the amount of distortion acceptable to the user of the system, whether naturalness of the speech or optimum intelligibility is the more important. Our observations are that a density below 4 D.U. definitely indicates inadequate clipping. A density reading in the region of 6 to 8 Density Units will result on a transmitter that is giving crisp, clear sounding speech capable of giving good communication into the poorer signal areas. A density reading of 10 or more indicates excessive clipping and obvious distortion.

THEORY OF OPERATION

Connection of the MM901 to the receiver is made at its 2nd IF through a 2 pf capacitor. The high reactance of this 2 pf cap causes negligible circuit loading. This capacitor samples a portion of the IF signal and feeds it into a tuned circuit (stages Q1 and Q2) in the modulation monitor. It is further amplified and limited by a multi-stage limiting amplifier inside IC 1. IC 1 also serves as a demodulator (also called "discrimanator" or "phase detector" of FM detector), providing the demodulated signal as a combination of D.C. and audio frequency voltages at pin 9 of IC 1.

The demodulated audio frequency signal from U1 is fed through a 5 KHz "notch" filter consisting of U2B. This filter is required because many "scanner" receivers use a frequency synthesizer system which adds a small amount of 5 KHz FM to the signal. The signal is then passed through two low pass filters, composed of U2C and U2D, to remove noise and synthesizer "hash" above 5 KHz from the demodulated audio signal. The output of U2D, which consists of the demodulated and filtered signal, is then fed to an "Absolute Value Circuit" consisting of U3B and U3C. This circuit acts as a precision full wave rectifier, leaving the positive portions of the audio signal unchanged, while inverting the negative portions and making them go positive. Thus, both the negative and the positive peaks of demodulated audio signal appear as positive peaks at the output of U3C. This signal then goes to a "peak hold" circuit consisting of U4. The "peak hold" circuit uses the highest peaks of the signal to charge condenser C30 to the highest peak value. The voltage across C3 is then amplified by U5 and used to drive the "Peak Deviation" meter. Since the voltage across C3 discharges slowly (compared to its charging time), the meter will read the maximum of the modulation peaks, whether they be modulation in the negative or positive direction. This is the basis of the "AUTOPEAKT™ It makes it unnecessary to switch from reading positive to negative peaks. . .the meter automatically reads the highest peak.

When S2 is switched to the "1.5 KHz" position, an additional low pass filter consisting of U3A is switched into the signal path. This filter has a cut-off frequency of about 300 Hz. The 1.5 KHz scale is primarily intended for use in measuring the modulation deviation of CTCSS (tone squelch) systems. CTCSS tones are below about 250 Hz in frequency. The added filter removes much of the background noise from the signal, making the measurement of CTCSS deviation easier.

PEAK FLASHING INDICATORS

Two LEDs are provided to flash when specific levels of modulation are exceeded. The signal from the "Absolute Value Circuit" (U3B and U3C) is fed to comparator circuits U8A and U8B. When any of the peaks from the absolute value circuit exceed 4.5 KHz, the output of U8A goes positive, charging capacitor C35, causing Q3 to conduct, which lights LED1. Since the discharge circuit for C35 is much higher in resistance than its charge circuit, LED1 stays on for many milleseconds after the peak has passed. Similarly, LED2 lights when peaks of greater than 5.0 KHz occur at the input of U8B. The LED indicators provide a very fast "GO - NO GO" gauge for setting the Peak Deviation control of transmitters.

OSCILLOSCOPE CALIBRATION PROVISIONS

An oscilloscope connection is provided in the MM901 to permit visual observation of the modulation waveshapes. The signal to the scope is obtained from the output of U3D. The MM901 contains the following provision for calibrating the scope trace in terms of modulation deviation:

Then S1 is switched to the "Cal" position, the output of a 1 KHz oscillator (consisting of U7 and U8D) is

switched into the signal path in place of the received signal. When S1 is in the "Cal" position, the 1,000 Hz tone will be observed on a scope connected to the oscilloscope jack. The level of the 1,000 tone is adjusted by the "Cal" panel control to cause the Peak Deviation meter to read 5 KHz. Adjust the vertical gain control of the oscilloscope until the 1,000 Hz trace reads ten divisions peak-to-peak. It is then switched to "read" and the oscilloscope will display the demodulated signal at a calibration of one KHz per division.

MODULATION DENSITY MEASUREMENT

The signal from the "Absolute Value Circuit" (U3B and U3C) is fed to an integrating circuit consisting of R43 and C29. The output of the R43, C29 circuit is essentially a time average of the output of the Absolute Value Circuit. The time constant of the R43, C29 circuit is long enough so that the averaging period is several cycles of the lowest speech frequency. This averaged signal is fed to a peak holding circuit (U4). The peak holding circuit rapidly charges C32 to the highest value of its input signal. The holding circuit retains the highest voltage seen over a time equivalent to the length of several speech syllables. The output is fed on to the meter driving amplifier U6, which drives the Modulation Density Meter, M2.

TUNING METER INDICATION

The voltage output at pin 9 of U1 varies according to the center frequency of the IF signal being sampled from the associated receiver. This voltage is sent to the combination of R11, C14, which removes audio frequency variations from the voltage, leaving only the slow variations caused by slow variations of the input IF frequency. This filtered voltage is then sent to the positive input of operation amplifier U2A. When S3 is in the "TUNE" position, U2A drives M2, which then functions as a Tuning Indication Meter. The negative input of U2A is connected to the arm of R13. R13 permits the output of U2A to be adjusted so that M2 will be in the center scale when an "on frequency" signal is received.

The Tuning Meter indication can be used to compare frequencies of stations on the same channel, and can also be used to compare the frequencies of received stations with a signal generator. If the signal generator (such as a service monitor) is accurately calibrated, it can be used with the MM901 to measure the frequency of distant stations "off the air".

CALIBRATION INSTRUCTIONS

The MM901 is shipped from the factory fully calibrated. The unit is quite stable, a field calibration should not normally be required.

SIGNAL SOURCE

In order to carry out a calibration procedure, a signal generator that provides as accurate standard of modulation deviation is needed. The calibration may be carried out by feeding an accurate frequency modulated signal at the input IF frequency into the input cable jack of the MM901. The MM901 is supplied to operate on an IF input of 400 KHz, 450 KHz, or 455 KHz. Alternatively, the MM901 may be connected to its associated receiver, and an accurate frequency modulated signal at the receiver input (channel) frequency used for calibration. These instructions assume that the latter method is used.

These instructions also assume that the MM901 has been prepared for the proper IF frequency, as explained on Page 3 of these instructions.

1. Connect the MM901 to its associated tuner-receiver, and adjust the center frequency of the signal generator accurately to the appropriate receiver channel. Adjust the signal generator R.F. output attenuator to enough signal to get a fully saturating, quiet signal in the receiver. Modulate the signal generator with a 1,000 Hz tone, and set the modulation deviation of the signal generator to 5 KHz.

2. a. Switch the "6 KHz - 1.5 KHz" front panel switch to the 6 KHz position.

b. Switch the "read-cal" front panel switch to the "read" position.

c. Using an insulated alignment screwdriver, adjust the core of L5 for a maximum reading on the PEAK DEVIATION meter of the MM901.

d. Adjust R16 to obtain a 5 KHz reading on the Peak Deviation meter.

3. ADJUSTMENT OF "AUTOPEAK™" CIRCUIT. (This adjustment is not ordinarily required unless the factory seal on R51 has been disturbed or components in the U3B, U3C area have been changed.)

Connect an oscilloscope to pin 8 of U3. The following waveshape should be observed:

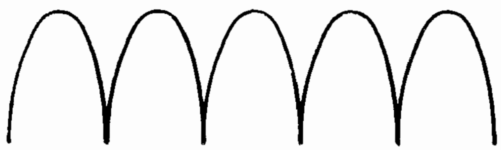


FIGURE 5

If the peaks are not the same height, adjust R51 to obtain a uniform height. (If R51 is improperly adjusted, the alternate peaks will be of different height. With some adjustments of the scope sweep, the peaks will seem to have double traces at the top . . . readjustment of the sweep will show alternate peaks of differing height.)

4. ADJUSTMENT OF 5 KHz "NOTCH" CIRCUIT. (This adjustment is not ordinarily required unless the factory seals on R19 and R21 have been disturbed, or components associated with U2B have been replaced.)

a. Change the modulation on the signal generator to use a 5 KHz tone, and giving 5 KHz deviation. Frequency of the 5KHz tone should be accurate to within 50 Hz. (Alternately, a 1 volt RMS 5 KHz audio tone may be inserted at the junction of R10 and C13.)

b. If R21 and R19 have not been properly adjusted, the PEAK DEVIATION meter will show more than 500 Hz of deviation (as read on the 6 KHz scale). In this event, adjust R19 and R21 alternately for the smallest reading on the PEAK DEVIATION meter.

5. CALIBRATION OF THE 6 KHz PEAK DEVIATION SCALE.

a. Modulate the signal generator with a 1,000 Hz tone, and with a peak deviation of 5 KHz. Assure yourself that the signal generator is still operating at the correct channel center frequency, and that it is delivering a fully quieting signal to the receiver.

b. Adjust R16 to obtain a meter reading of 5 KHz on the PEAK DEVIATION meter.

6. 1.5 KHz DEVIATION CALIBRATION

Place the "6 KHz - 1.5 KHz" switch in the 1.5 KHz position. Adjust the signal generator for an accurate modulation deviation of 1.5 KHz. Modulating frequency for this step should be between 60 and 250 Hz. Set R45 for an indication of 1.5 KHz on M1, the Peak Modulation Meter. Remove the modulation from the signal generator. The reading on M1 should drop to less than .2 KHz, depending upon the noise generated in the associated receiver and the signal generator.

7. MODULATION DENSITY CALIBRATION

Assuming that the 6 KHz Peak Deviation scale has been calibrated accurately, the following calibration of the modulation deviation function can be made using the internal 1,000 Hz oscillator of the MM901 as a signal source: Switch S3 to the "Density" position. Switch S1 to the "CAL" position. Switch S2 to the "6 KHz" position. Then, adjust the "CAL" pot (front panel, adjacent to S1) to obtain a reading of 4 KHz on M1. Then adjust R53 to obtain a reading of 10 density units on M2.

8. LED PEAK FLASH CALIBRATION

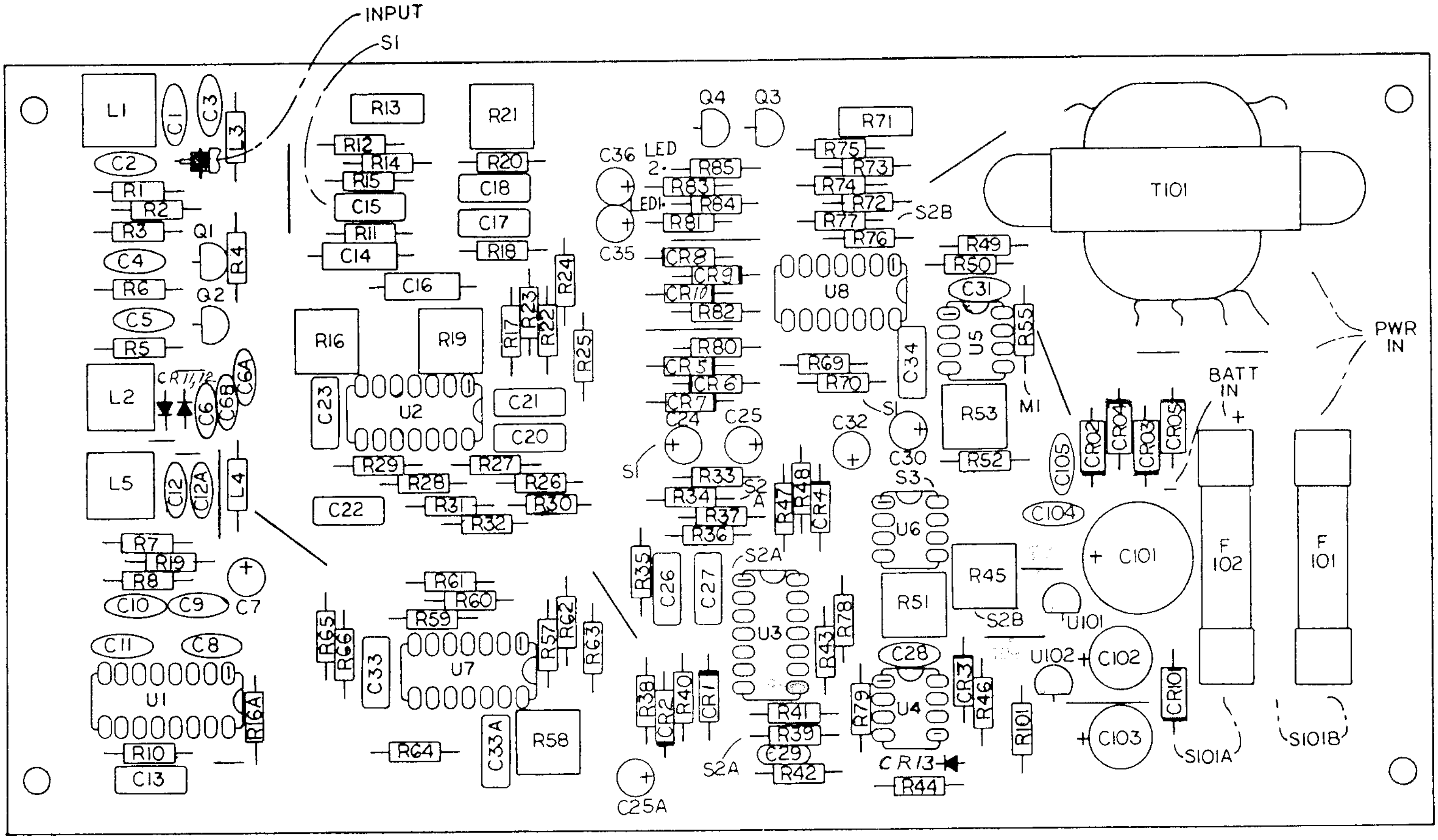
Assuming that the 6 KHz Peak Deviation scale has been adjusted properly, the following calibration can be made using the internal 1,000 Hz oscillator of the MM901 as a signal source:

Switch S1 to the "CAL" position. Switch S2 to the "6 KHz" position. Adjust the "CAL" pot (R67 - front panel, next to S1) to obtain a meter reading of 5 KHz on M1. Then adjust R71 until the 4.5 KHz LED turns on, and continue rotating R71 until the 5.0 KHz LED just turns on. Be sure of your setting of R71 by moving R67 above and below the 5 KHz reading on M1. The 4.5 KHz LED should light as 4.5 KHz reading is approached, and the 5.0 KHz LED should light as a 5.0 KHz reading is approached.

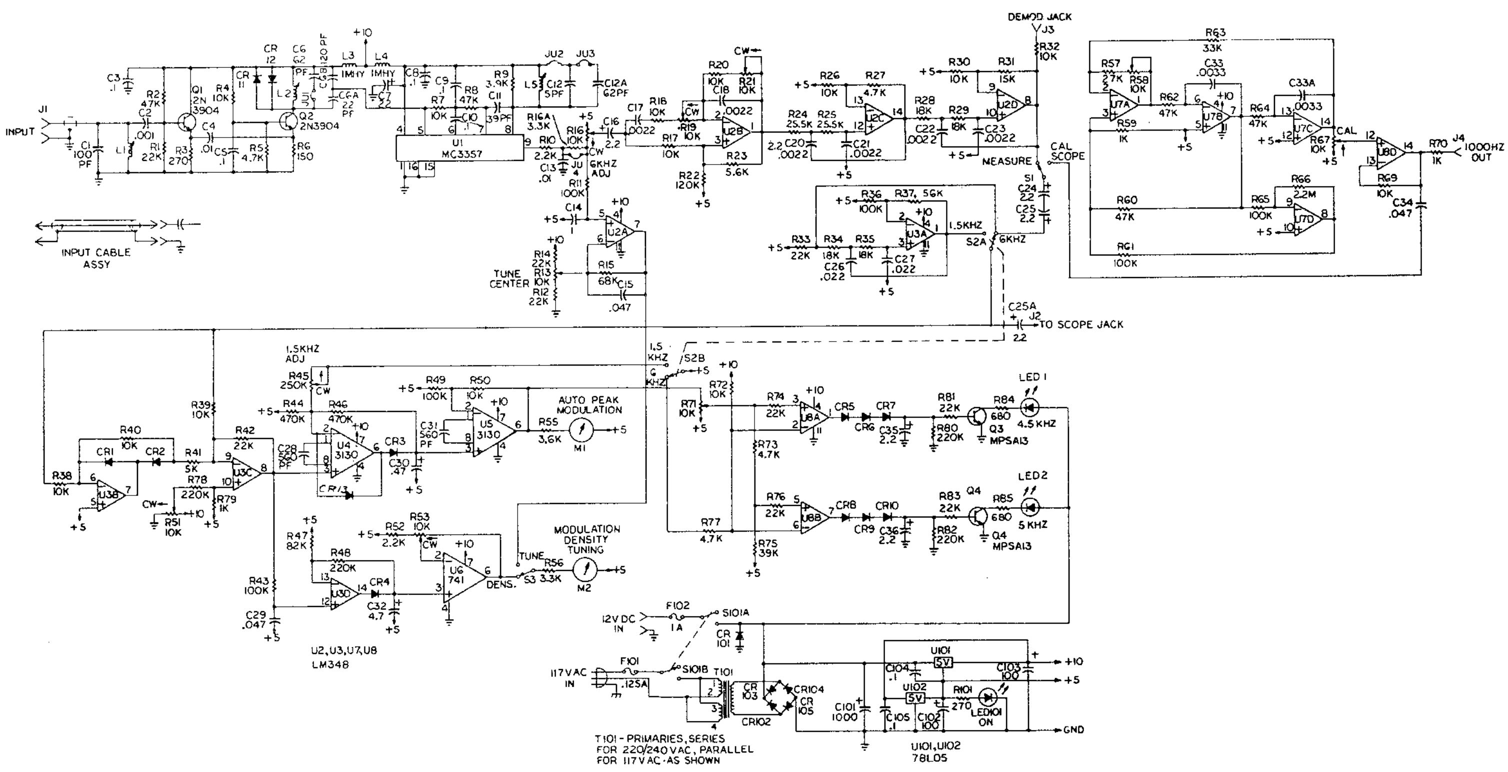
You may wish to set the LED flashes level slightly below 5KHz. to assure compliance with rules limiting peak deviation to 5 KHz. The flash level of the 5 KHz LED could be set, for example, at 4.8 KHz, using the above procedure. In such case, the 4.5 KHz LED will flash at 90% of the level set on the 5.0 KHz LED.

9. ADJUSTMENT OF THE TUNE METER ZERO CENTER

Place the "DENSITY-TUNE" switch in the "TUNE" position. Be sure that the signal generator is still tuned accurately to the channel center frequency. Then, adjust R13 (accessible through rear panel) to obtain a zero center indication on the DENSITY-TUNE meter.



COMPONENTS PLACEMENT



MM901 SCHEMATIC