AM MODULATION MONITOR
MODEL 732

TFT
TIME AND FREQUENCY TECHNOLOGY, INC.
AM MODULATION MONITOR

MODEL 732

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246-6365
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SECTION 1
GENERAL INFORMATION

1.1 General Description.

The Model 732 AM Modulation Monitor is intended for continuous monitoring of an AM transmitter operating in the standard broadcast band (540 to 1600kHz) to enable the station to comply with the requirements of Section 73.60 of the FCC Rules and Regulations. The Monitor, which is factory-adjusted for the customer's assigned transmitter frequency, provides direct peak-reading meter indication of modulation percentage. Other features include:

- A flasher to indicate 100-percent negative modulation peaks.
- An adjustable flasher to indicate positive or negative modulation peaks.

1.2 Specifications.

RF Input

Frequency range ........................................... 540 - 1600 kHz

Sensitivity

Automatic gain control mode, Antenna Input ................ approx. 1.0mV, with 40 dB automatic gain control range 100 mV maximum.

Manual gain control mode, RF input ........................ approx. 5V to 10V input without external pad.

Selectivity

| ±10 kHz    | 0.25 dB |
| ±11 kHz    | -3 dB   |
| ±20 kHz    | -40 dB  |
| ±30 kHz    | -60 dB  |

Input impedance ........................................... 50 ohms nominal

Input connector ........................................... BNC

Image rejection ........................................... 50 dB or greater
1.2 (Continued)

Modulation Meter

Meter range . . . . . . . . . . . . Switchable, 0 to 133% on positive peaks, 0 to 100% on negative peaks.

Accuracy . . . . . . . . . . . . ±2% at 100% modulation,
+4% at any other % modulation for modulation frequency between 30 Hz and 10 kHz.

Meter characteristics . . . . . Peak reading circuit, scale and ballistics conform to FCC requirements.

Remote metering . . . . . . . . . Output provided for Model 704D.

Peak Modulation Indicators

Variable peak indicator . . . . Level set by front-panel 3-digit thumb-wheel switch in 1% steps, 50 to 129% on positive peaks, 50 to 100% on negative peaks.

Fixed peak indicator . . . . . . 99.5% or greater on negative modulation only.

Accuracy . . . . . . . . . . . . ±2%

Response time . . . . . . . . . . 200μsec pulse

Remote Indicators . . . . . . . Output provided for Model 704D.

Modulation Calibrator

Built-in modulation calibrator indicates ±100% modulation

Accuracy . . . . . . . . . . . . ±2%

Rear Panel Outputs

Audio . . . . . . . . . . . . . . . . Two volts RMS into 600 ohms at 100% modulation, ±0.5 dB 30 Hz to 10 kHz, less than 1% harmonic distortion.

Broad Band Audio
(Output is present only when rear panel Jack, J5 is used)

Remote meter and peak flasher . . . For use with Model 704 D remote meter and peak flasher panel.
Rear Panel Outputs (cont.)

- Carrier Alarm (optional) ........ *floating relay contact closure provided
- Absence of Audio Alarm (optional) ...
- Peak counter .....................
- Telemetry output (optional) ....... 1.5 Vpp at 5% modulation, 600 ohms unbalanced.

*Note: all relay contacts are rated for a maximum load of 500 ma at 50V.

Physical and Environmental Specifications

- Power .................. 115/230V, 50-400 Hz, 30 watts max.
- Operating Temperature ....... 0° to +50°C
- Dimensions ................ 19" W x 7" H x 16" D
- Weight ................... 17 pounds
- Cabinet ................... Rack mounting.

1.3 Accessory Equipment

Model 704D Remote Meter and Peak Flasher Panel: Duplicates meter and peak flasher readings of the Model 732.

Model 722 Resonant Loop Antenna: A compact loop antenna for use with Model 732 where field strength is at least 20 mV per meter.

1.4 Warranty

TIME & FREQUENCY TECHNOLOGY, INC., warrants each of the instruments of its manufacture to be produced to meet the specifications delivered to the BUYER; and to be free from defects in material and workmanship and will repair or replace, at its expense, for a period of one year from the date of delivery of equipment, any parts which are defective from faulty material or poor workmanship.
1.4 (Continued)

Instruments found to be defective during the warranty period shall be returned to the factory with transportation charges prepaid by BUYER. It is expressly agreed that replacement and repair shall be the sole remedy of BUYER with respect to any nonconforming equipment and parts thereof and shall be in lieu of any other remedy available by applicable law. All returns to the factory must be authorized by the SELLER, prior to such returns. Upon examination by the factory, if the instrument is found to be defective, the unit will be repaired and returned to the BUYER, with transportation charges prepaid by SELLER.

Transportation charges for instruments found to be defective within the first thirty (30) days of the warranty period will be paid both ways by the SELLER.

Transportation charges for warranty returns, wherein failure is found not to be the fault of the SELLER, shall be paid both ways by the BUYER.

This warranty does not apply to instruments which, in the opinion of the SELLER, have been altered or misused.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. TFT IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

1.5 Claim for Damage in Shipment.

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier, of if insured separately, with the insurance company.

WE SINCERELY PLEDGE OUR IMMEDIATE AND FULLEST COOPERATION TO ALL USERS OF OUR PRECISION ELECTRONIC INSTRUMENTS.

PLEASE ADVISE US IF WE CAN ASSIST YOU IN ANY MANNER

Time & Frequency Technology, Inc.
3000 Olcott St.
Santa Clara, Ca. 95051

408-246-6365

1-4
SECTION 2

INSTALLATION

2.1 Unpacking and Inspection.

Upon receiving the instrument, inspect the packing box and instru-
ment for signs of possible shipping damage. Operate the instrument in accordance
with the procedures of Section 3 of this manual. If the instrument is damaged or
fails to operate properly, file a claim with the transportation company, or with
the insurance company if insured separately.

2.2 Power Requirements.

The Model 732 is factory wired to operate from either a 115-volt
or a 230-volt AC source. A marking on the rear panel of the instrument indicates
which voltage is to be used. The line frequency must be between 50 and 400 hertz.
Maximum power required is 30 watts.

2.3 Installation Remote from Transmitter.

When the instrument is installed in the studio, or any place distant
from the transmitter, a rooftop antenna must be used. Where a strong signal can
be expected (i.e. greater than 40 mV/meter) the Model 722 Resonant Loop Antenna
may be used. In lower signal locations a long wire (approximately 200 feet) can
be used with good results. When the Model 722 Antenna is used a 50 ohm coax should
be used to connect the antenna to the Model 732. When a long wire is used it can
be connected at the ANTENNA INPUT of the Model 732, a 51 ohm resistor should also
be connected from the input to the chassis ground. The procedure for proper adjust-
ment of the input level is as follows:

a. Depress the PWR ON switch and set the Gain Switch to
   Automatic on the Model 732 front panel.

b. Connect a DC Voltmeter with at least 20,000 ohms per
   volt impedance to pin F of the 9-pin rear-panel connector.
   This is the I.F. AGC Voltage. For the AGC to be in its
   operable range this voltage should be less than +5 volts
   and greater than +2 volts. This range between 2.5 and
   2.75 volts is optimum.

c. When the Model 722 Antenna is incorporated, rotate the
   antenna until a minimum AGC Voltage is read on the DC
   voltmeter. When a resonant loop antenna is constructed,
   change the value of "C" until a null is realized. (Fig. 3-2).
   (Note: the AGC voltage decreases as the RF level into the
   Model 732 increases.) If the AGC voltage goes below 2.0
   volts, too much RF signal is being received and an attenuator
   pad must be inserted in the RF cable from the antenna.
2.3 (Cont'd)

d. With the AGC voltage in the proper range, adjust the Automatic Gain pot such that the CARRIER LEVEL meter is at the SET position.

In order to observe the changes in carrier intensity during modulation it is necessary to transfer the antenna cable from the ANTENNA INPUT to the RF INPUT on the rear panel, set the front panel GAIN Switch to MANUAL position and adjust the MANUAL gain pot so that the CARRIER LEVEL METER is at SET position. Because of the difference in sensitivity between the two RF signal input jacks, it may be necessary to use a different input attenuator to bring the RF level within the effective range of the monitor.

2.4 Installation at the Transmitter Site

When the Model 732 is installed at the transmitter site, a 50 ohm coaxial cable should be used to bring the RF signal from the transmitter sampling point to the RF INPUT at the rear panel of the monitor.

CAUTION

Always use the factory furnished attenuator when connecting the monitor input to an unknown RF voltage. Remove attenuator if signal level is found to be inadequate to operate the monitor.

Set the GAIN switch on the front panel to MANUAL position and adjust the MANUAL Gain Control pot so that the CARRIER LEVEL METER is at SET position.
SECTION 3
OPERATION

3.1 General.

The Model 732 AM Modulation Monitor displays modulation percentage and provides a flashing indication when the modulation percentage exceeds 99.5 percent on negative peaks and when it exceeds a preset limit on either positive or negative peaks depending on the selection of the front panel switch.

3.2 Front-Panel and Rear-Panel Controls.

The front-panel controls, connectors, and indicators of the Model 732 are described in Table 3-1 and illustrated in Figure 3-1. Rear-panel controls and connectors are described in Table 3-2 and illustrated in Figure 3-1.

3.3 Turn-On and Warm-up.

Check the marking on the rear panel to make sure the instrument is wired for the line voltage to be used (115 volts or 230 volts). Plug the line cord into the power source. Energize the instrument by depressing the PWR ON switch. If the monitor is at the transmitter site, connect the rear-panel RF INPUT connector to the transmitter RF coupler, as described in Section 2.4, and adjust the input level as described in that section.

If the Monitor is used at the remote control location, refer to Section 2.3 of this manual for proper adjustment.

3.4 Measurement of Amplitude Modulation Using Modulation Meter.

The modulation meter is used by simply pushing either the "+" or "-" switch on the front panel. The meter gives a quasi-peak indication of either "+" or "-" peak modulation depending upon front-panel selection. For maximum accuracy the modulation meter calibration should be checked regularly and adjusted if necessary. Calibration of the meter is performed by depressing the CAL button and adjusting the METER CAL control until the meter reads exactly 100 percent.

3.5 Peak Flasher Operation.

The peak flasher is intended to catch fast transients and peaks that the meter cannot respond to. The peak flasher is operated by depressing either the "+" or "-" switch and setting the thumbwheel switches to the desired percentage of modulation. If the modulation then exceeds that number in the direction selected, the flasher lamp will go on, and stay on for approximately 2 seconds. The peak flasher accuracy should also be checked regularly and adjusted if necessary.
Peak flasher calibration is achieved by depressing the CAL button, setting the thumbwheel switches for 100 percent, and adjusting the FLASHER CAL control until the peak flasher lamp just comes on.

3.6 Use of the Model 704D Remote Meter and Peak Flasher Panel.

This panel duplicates the indications of the front-panel MODULATION meter and the variable and -100% peak flasher lamps. The 50-foot cable from the Model 704D connects to the rear panel of the Model 732.

3.7 Audio Output

An audio output is available at the AUDIO connector on the rear panel. Its level is approximately 4 volts RMS into an open circuit, and it can be fed into a distortion analyzer to measure system distortion. It can also be used to operate high-impedance earphones if desired. (600Ω output impedance)

3.8 Subaudible Telemetry (Optional).

When this option is incorporated, subaudible telemetry modulation on the carrier is delivered to the rear-panel TELEMETRY OUTPUT connector through a low-pass filter and amplifier.

3.9 10kHz Whistle Filter (Optional)

This Hi-"Q" notch filter can be inserted in the audio output to eliminate interference from an adjacent channel. This does not apply to the Modulation meter or peak flasher circuits, only the audio output.

3.10 Absence of Modulation Alarm (Optional)

This circuit closes a set of relay contacts when the recovered modulation drops below 10% for a fixed period of time. This fixed delay time is internally adjustable from two to sixty seconds.

3.11 Carrier Power Alarm (Optional)

This circuit closes a set of relay contacts when the carrier level exceeds pre-set limits. In the Manual gain mode the carrier level limits are set to +5% and -10% of nominal. In the automatic gain mode the carrier alarm can only detect the total loss of carrier signal.

3.12 Peak Modulation Indicator.

The Model 732 contains a relay which is energized when the peak modulation exceeds the Limit set on the front-panel thumbwheel switch. The normally open relay contacts close to short the rear-panel outputs together. The contacts are floating with respect to the chassis and therefore can be hooked up in many different ways to ring an alarm or trigger an event counter.
3.13 Carrier Frequency Output (Option)

With the Carrier Frequency Output Option installed, a signal representing the frequency of the monitored carrier is available at the Carrier Frequency Output jack on the front panel of the 732. This option is designed to provide 150 m.V.r.m.s. into the 50 ohm (nominal) input of an external frequency counter.

Table 3-1. Front-Panel Controls and Indicators

<table>
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<tr>
<th>Fig. 3-1</th>
<th>Ref. No.</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>&quot;Manual/Automatic Gain&quot; Switch and Controls</td>
<td>When the switch is in the &quot;Manual&quot; position the &quot;manual&quot; knob should be adjusted so that the &quot;Carrier Level&quot; meter is at the Set position. Any change in input level will show up a shift on the &quot;Carrier Level&quot; meter, and will require a re-adjustment of the manual gain control for the Modulation indicators to be calibrated. When the switch is in the &quot;Automatic&quot; position the &quot;automatic&quot; knob should be adjusted so that the &quot;Carrier Level&quot; meter is on the &quot;Set&quot; mark. The instrument will now automatically compensate for changes in input level.</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>&quot;Power&quot; Switch</td>
<td>This switch applies 115/230 VAC to the power transformer primary when depressed.</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>&quot;+&quot; and &quot;-&quot; Switches</td>
<td>These switches allow the modulation meter, and the &quot;+/-&quot; peak indicator to be switched between plus and minus modulation peaks.</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>&quot;Cal&quot; Switch, &quot;Meter Cal&quot; pot and &quot;Peak Flasher Cal&quot; pot.</td>
<td>When this switch is depressed the Carrier modulation is replaced by a very amplitude stable internal oscillator to calibrate the &quot;Modulation&quot; meter and the &quot;+/-&quot; peak flasher at 100%.</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>&quot;+/-&quot; peak Modulation indicator, and Thumbwheel Switches.</td>
<td>This indicator flashes when modulation exceeding the amount set on the thumbwheel switches is present. The indicator will signal + or - modulation peaks, depending upon the + and - switch settings as indicated in Section 3 above.</td>
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### Table 3-1. (Continued)

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<th>Fig. 3-1 Ref. No</th>
<th>Name</th>
<th>Function</th>
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<tr>
<td>6</td>
<td>-100% Peak indicator</td>
<td>This indicator flashes when modulation peak exceeds 99%.</td>
</tr>
<tr>
<td>7</td>
<td>Modulation meter</td>
<td>Reads carrier modulation directly in percentage. The Modulation being monitored positive or negative, depends on the setting of the &quot;+&quot; and &quot;−&quot; switch. (See Section 3 above).</td>
</tr>
<tr>
<td>8</td>
<td>&quot;Carrier Level&quot; meter</td>
<td>In conjunction with the gain controls, (See Section 1 above is used to set the proper carrier level for the modulation indicators to be calibrated.</td>
</tr>
<tr>
<td>9</td>
<td>Carrier Frequency</td>
<td>High level carrier output, to be monitored with counter.</td>
</tr>
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### Table 3-2. Rear-Panel Connectors and Controls

<table>
<thead>
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<th>Fig. 3-2 Ref. No</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
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<tr>
<td>1</td>
<td>RF INPUT (Automatic Gain Only)</td>
<td>Provides a means of connecting a 50-ohm cable from a rooftop antenna, or from the transmitter RF coupler through a 40-dB pad at the transmitter site. Maximum input at this connector is 100 mV. The input gain is controlled automatically after the level is set by the Automatic gain control pot.</td>
</tr>
<tr>
<td>2</td>
<td>A-Remote Meter</td>
<td>The same voltage that drives the front-panel modulation meter is used to drive the remote modulation meter Model 704D.</td>
</tr>
<tr>
<td>3</td>
<td>C-&quot;+&quot; Peak</td>
<td>Closes a circuit to ground to operate the &quot;+&quot; Peak Lamp on the remote panel Model 704D.</td>
</tr>
<tr>
<td>4</td>
<td>E-&quot;−&quot; Peak</td>
<td>Closes a circuit to ground to operate the &quot;−100% Peak&quot; Lamp on the remote panel Model 704D.</td>
</tr>
<tr>
<td>Fig. 3-2 Ref. No.</td>
<td>Name</td>
<td>Function</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------------------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>5</td>
<td>F - AGC</td>
<td>AGC Voltage, should be measured with a 20,000-ohm-per-volt meter. Decreases with increasing Carrier level.</td>
</tr>
<tr>
<td>6</td>
<td>Whistle Filter</td>
<td>(Optional) When switched to the IN position a 10 kHz notch filter is inserted in series with the audio output.</td>
</tr>
<tr>
<td>7</td>
<td>Audio</td>
<td>Recovered carrier Modulation, 2V RMS into 600 ohms for 100% modulation.</td>
</tr>
<tr>
<td>8</td>
<td>Telemetry Output</td>
<td>(Optional) Supplies subaudible telemetry information contained on the carrier.</td>
</tr>
<tr>
<td>9</td>
<td>Peak Counter</td>
<td>Provides closure on floating relay contacts when the front panel peak lamp is activated.</td>
</tr>
<tr>
<td>10</td>
<td>Absence of Audio Alarm</td>
<td>(Optional) Provides closure on floating relay contacts when audio modulation drops below 10% for longer than the delay internally set.</td>
</tr>
<tr>
<td>11</td>
<td>Carrier Alarm</td>
<td>(Optional) Provides closure of floating relay contacts when limits of +5% or -10% are exceeded in the manual gain mode, or the carrier drops below the minimum sensitivity in the automatic gain mode.</td>
</tr>
<tr>
<td>12</td>
<td>RF INPUT (Manual Gain Mode Only)</td>
<td>When the instrument is used in the Manual gain mode the transmitter sampling point may be directly connected to this input. Maximum input at this connector is 2.25 V. This input also provides the means of observing the carrier intensity shift due to modulation. Provides the audio signal obtained by demodulating the transmitter carrier. Level is 2 volts RMS into, 600 ohms at 100% Modulation. Response is within ±0.5 dB from 30 Hz to 20 kHz.</td>
</tr>
<tr>
<td>13</td>
<td>Broad Band Audio</td>
<td></td>
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</table>
MODEL 722 ANTENNA OR CUSTOMER BUILT
ANTENNA SUGGESTED
PER DRAWING AT RIGHT

1/2" THREADED UNION
OR "U" CLAMP

50 Ω COAX

MOUNTING SURFACE

4' SQUARE

5.8"

CUSTOMER BUILT

1.2k

4W

5%

2.5t

TO 50 Ω LOAD

TUNE C So THAT ANTENNA
RESONATES AT DESIRED FREQ

1600 KHZ C = 30 PF
540 KHZ C = 600 PF

MODEL 732

REAR PANEL

MODEL 732

SUGGESTED ANTENNA SET-UP

FIG. 3-3

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SECTION 4

THEORY OF OPERATION

4.1 General.

The Model 732 AM Modulation Monitor is a single-conversion superheterodyne receiver. The Model 732 makes high-accuracy measurements of the percentage modulation of an AM broadcast signal.

Figure 6-1 is a block diagram of the Model 732. The RF signal to be monitored is brought in through the RF INPUT connector and applied through an RF filter to one input of the gain controlled mixer. The RF filter is factory selected to pass the frequency of the carrier to be monitored. The gain controlled mixer converts the carrier down to 450 kHz, the amplitude of the 450 kHz product can be controlled by the AGC circuit as described in a later paragraph.

The Local-oscillator (L.O.) input to the mixer comes from Board A4, the power supply and L.O.Board. The L.O. signal is generated by a crystal controlled oscillator. The oscillator frequency is set to 450 kHz above the assigned carrier frequency.

The 450 kHz output of the mixer is passed through two I.F. filters and amplified. These two filters give the Model 732 its excellent rejection to close channels. The Amplified 450 kHz is then processed by the audio detector circuits.

The audio output from the audio detector is fed through an amplifier to the modulation measurement circuits on the A2 Board. When the amplitude of the negative half cycles of the audio signal corresponds to -99-percent modulation of the transmitter carrier, the output of the -100% peak detector triggers a one-shot multivibrator, which turns on the -100% PEAK light-emitting diode (LED) to cause it to flash, indicating that the transmitter carrier has been modulated to 100 percent in a negative direction.

The output of the audio amplifier is also fed through two unity-gain amplifiers, one inverting and one noninverting. The noninverting amplifier output is selected by the METER (+) switch, and the inverting amplifier output by the METER (-) switch. The selected output is fed through the meter calibration potentiometer and an amplifier to the MODULATION meter. The same selected output is also fed through the flasher calibration potentiometer to the programmable peak detector. This peak detector is referenced to a voltage selected by a front panel thumbwheel switch. When the peak detector input voltage exceeds the reference DC voltage, it triggers a one-shot multivibrator which produces a pulse to light the PEAK LED for approximately 2 seconds.

To calibrate the MODULATION meter and PEAK lamp, the METER CAL switch is depressed, causing a stable 1-kHz sine wave source to be substituted.
for the detected audio signal. The amplitude of the 1-kHz sine wave corresponds to 100-percent modulation of the monitored carrier when the carrier level is adjusted to its calibrated value as indicated by the CARRIER LEVEL meter. The METER CAL potentiometer is then adjusted so that the MODULATION meter reads 100 percent, and the FLASH CAL potentiometer is adjusted so that the PEAK lamp flashes with the front-panel PEAK MODULATION thumbwheels set for 100 percent.

4.2 Detailed Circuit Description.

4.2.1 Power Supply and L.O. Board (A4).

(Circuit Diagram: Figure 6-7)

This board contains the rectifiers and regulators for ±15V and +5V power supplies, as well as the Crystal Controlled Local Oscillator, and the calibration oscillator.

The three power supplies each consist of a diode bridge rectifier, followed by a filter capacitor, and an I.C. voltage regulator. The voltage regulators are fully self-protecting, and not adjustable. Z1 is the regulator for the +15V supply, Z2 the -15V supply, and Z4 the +5V supply.

Z3, Y1 and associated components make up the Crystal Controlled Local Oscillator. The crystal (Y1) frequency is selected to be 450 kHz above the customer assigned frequency. Z3 is a differential pair with current source. The current source is used with Y1 as an oscillator, and 1/2 of the differential pair is used as a common base amplifier. The L.O. output at pin 6 of Z3 is fed to the gain controlled mixer on A1.

The Calibration Oscillator consists of Q1, Q2, Q3, Z5, Z6, and associated components. Q1 and Q2 form a stable multivibrator that runs at a 1kHz rate. Q3 acts as a buffer stage, and Z5 with its associated components is an active lowpass filter. The output at pin 6 of Z5 is a 1kHz sinewave. The pot R15 at the output of Z5 is set to give the correct amplitude to simulate a 100% audio signal. Z6 sums a D.C. Voltage with the 1kHz signal to simulate the correct carrier level. The output of Z6 is a 1kHz signal "riding" on a D.C. Voltage. This corresponds exactly to a 100% modulation signal when the carrier level is adjusted to the "SET" mark.

4.2.2 IF Board (A1).

(Circuit Diagram: Figure 6-4)

The signal to be monitored, at pin 4 of P1, is applied through an RF filter to one input of integrated circuit mixer Z1. The filter, which consists of all the components shown on the schematic diagram between pin 4 of P1 and the attenuator, provides 50 dB of image rejection.
4.2.2 (Continued)

The filter components are factory selected to provide a 3-dB bandwidth of 90kHz, centered on the frequency to be monitored. The second input to mixer Z1 is the LO signal from Board A4, brought into Board A1 through pin 2 of P1. The mixer output, at pin 9 of Z1, is fed through jumpered test points TP-1 and TP-2 to the input of the first IF filter. Potentiometers R18 and R22 adjust the filter input and output resistances respectively for proper matching. Buffer Q3 provides isolation between the first and second IF filters, and R43 and R39 adjust input and output resistances of the second filter.

The gain of the IF strip is controlled by varying the gain at the IC mixer Z1. This is accomplished using an optically coupled isolator consisting of a photosensitive resistor and Light Emitting Diode (LED) packaged together. As the current through the LED varies, it changes the resistance of the photosensitive resistor. The resistance increases as the current through the diode decreases. The LED is driven from the AGC circuits.

The audio detector is an active rectifier consisting of Z2, CR2, CR3 and associated components. The resulting waveform at TP-6 contains the positive half cycles of the 450kHz signal, bounded by the modulation envelope. This signal is applied through an active low-pass filter (Z3) with a cutoff of approximately 25kHz to differential amplifier Z4 in the AGC amplifier circuit; to amplifier Z8 in the meter amplifier circuit; and to audio amplifier Z5. The output of the low-pass filter contains the Audio Information and Carrier Level Information.

The Model 732 gain can be controlled manually or by the internal automatic gain control circuitry, by use of the front-panel gain switch and the manual or automatic gain pots. When the switch is in the manual mode the I.F. gain is switched to approximately 100 mV sensitivity, and the input RF is controlled by the manual gain pot. The RF input is attenuated before it reaches the I.F. strip so that in the manual mode the sensitivity of the instrument varies from 0.5 V RMS to 2.25 V RMS depending upon the setting of the manual gain pot. When the Model 732 is used in the automatic gain mode, the RF signal is fed directly to the RF filter on the I.F. Board, where it is mixed with the L.O. to produce the 450kHz I.F. signal. The sensitivity of the Model 732 in the automatic mode varies from 1 mV RMS to 100 mV RMS, automatically holding the Carrier level meter to the point set by the automatic gain pot. Normally this is on the "SET" mark.

When the Model 732 is operated in the automatic gain control mode the wiper of the front-panel 100 ohm CARRIER LEVEL pot supplies a reference voltage to the noninverting input of Z4, with the rectified I.F. signal from Z3 being applied to the inverting input of Z4. If the carrier level increases, the rectified I.F. level increases, causing the output of Z4 to decrease and increasing the resistance of the optically coupled isolator which reduces the I.F. level to its proper value. A decrease in the carrier power has just the opposite effect. The AGC amplifier has a high frequency cutoff at about 5Hz so that it responds only to the average value of the rectified I.F. signal and not to the modulation. Zener diode CR1 in the base circuit of Q6 limits the current through the LED to a safe value. Note the AGC voltage at the output Z4 and at pin D of the rear panel connector (J3) decreases with increasing carrier level.
4.2.2

(Continued)

The meter amplifier consists of differential amplifier Z8 and current drive Z7. Current through the CARRIER LEVEL meter varies with the average value of the rectified IF applied to pin 2 of Z8. The reference voltage at pin 3 of Z8 is factory set by potentiometer R70 so that an IF level of 400 millivolts at the output of buffer amplifier Q5 (TP-5 and TP-9) will cause the CARRIER LEVEL meter to indicate midscale (SET position).

The audio amplifier consists of integrated-circuit amplifier Z5 with a gain of 5 and integrated-circuit amplifier Z6 with a gain of 2.5. Two audio outputs are provided, one at pin 5 of J1 for the rear-panel AUDIO jack and the other at pin 8 at J1 for the rear-panel TELEMETRY OUTPUT jack.

4.2.3

Peak Flasher and Meter Amplifier (A2).

(Circuit Diagram: Figure 6-5)

This board drives the modulation meter, the peak modulation lamps, and the peak counter relay from the audio signal on Board A1. The audio signal is brought into Board A2 at pin 2 of the board connector. When the front-panel METER CAL switch is depressed, this audio input is a sine wave from Board A4 with a negative peak of 0 VDC and a positive peak of approximately +4.5 VDC which corresponds to 100-percent modulation of the monitored carrier. The audio input is applied to the inverting input of high-threshold detector Z1, which acts as a comparator. The other input to the comparator is a DC voltage, very nearly 0 VDC, factory-set by potentiometer R3 to give a positive pulse out of Z1 when the negative peaks of the audio input just reach 0 VDC. When the front-panel METER "+" or "-" switch is depressed, thus releasing the METER CAL switch, any audio input from Board A1 at pin 2 of the Board A2 connector whose negative peaks reach zero or a negative value will produce a positive pulse at the output of Z1. This positive pulse triggers the one-shot multivibrator Z2, R4 and C7 producing a positive pulse approximately 2 seconds in duration at pin 2 of Z2. This 2-second pulse is inverted by Z3 and applied to driver Z4 which turns on the -100% PEAK LED for the duration of the pulse out of the one-shot multivibrator. This same output is also fed to pin E of rear-panel connector J3 to operate a remote negative-peak lamp.

The audio input at pin 2 of the board connector is also applied to inverting unity-gain amplifier Z5 and noninverting unity-gain amplifier Z6. The outputs from these two amplifiers are fed to the front-panel METER "-" and METER "+" switches so that either the negative or positive peaks can be measured. The selected output is applied to front-panel METER CAL potentiometer R2 and front-panel FLASH CAL potentiometer R1 (see Figures 6-1 and 6-2).

The selected (positive or negative peak) audio signal at the wiper of R2 on the front panel enters Board A2 at pin 18 of the board connector, and is applied through emitter follower Q1 and amplifier Z9 to the audio rectifier consisting of CR2 and associated components. The DC voltage at the cathode of CR2, whose
value is proportional to the peak modulation amplitude, is fed through current
driver Z10 to the front-panel MODULATION meter and to rear-panel connector
J3-A to drive a remote meter.

The selected (negative or positive) audio signal at the wiper of
R1 of front panel enters Board A2 at pin 8, and is applied to the noninverting input
of the comparator Z7. The inverting input to Z7 is from constant-current source
Z8. The voltage output of Z8 applied to the inverting input of Z7 is controlled by
the resistance selected by the front-panel thumbwheel switches SW8 and SW9. Thus,
when the audio input at pin 8 of the board connector exceeds the voltage at pin 4
of Z7, a positive pulse is produced at pin 9 of Z7. This pulse is stretched by one-
shot multivibrator Z2 to approximately 2 seconds and this 2-second pulse is applied
through inverter Z3 and driver Z4 to the front-panel PEAK LED CR1 and to Board
A3 to energize a relay and also to drive a remote peak indicator.

4.2.4 Telemetry Output Board (A3)

(Circuit Diagram: Figure 6-6)

4.2.4.1 Telemetry Output Board

This board contains the circuitry for the remote peak counter
and is standard equipment. The board also contains the telemetry circuitry,
the carrier alarm circuitry, 10kHz Whistle Filter and the Loss of Modulation
Alarm when these options are selected.

The peak counter circuit consists of relay K1 and associated
components. The relay is energized when the output of driver Z4 on A2 board
goes low, as described in Section 4.2.5. When relay K1 energizes, it supplies
a contact closure to rear-panel connectors J4 and J5.

4.2.4.2 Telemetry Lowpass (Optional)

The telemetry circuit is simply a low-pass active filter consisting
of Z5, Z6 and associated components. This filter has an upper cut-off of approximately 35 Hz to pass only subaudio telemetry signals.

4.2.4.3 Carrier Power Alarm (Optional)

The carrier alarm consists of Z1, Z2, Q1, K2 and associated
components. Input is from the carrier level meter circuit on Board A1 through
pin 9 of the A5 board connector. Integrated circuits Z1 and Z2 are comparators.
When the Model 732 is located at the transmitter being monitored, potentiometers
R9 and R6 can be adjusted to cause K2 to energize when the carrier level goes
5 percent above or 10 percent below nominal. During this mode of operation, the
gain must be controlled manually as described in Section 4.2.2. For remote
operation and automatic gain control of the Model 732, the alarm circuitry can
only be used to energize K2 when the carrier goes completely off. The contacts of
K2 provide a short between rear-panel connector J4-1, and J4-2 when relay K2
is energized.
4.2.4.4  Loss of Modulation Alarm (Optional)

The modulation alarm consists of Q2, Q3, Z7, Q4, and their associated components on the A3 Board. The input to this circuit comes from the modulation meter circuit on the A2 Board. This circuit looks at the A.C. signal driving the meter detector, on the A2 Board, Q2 amplifies this A.C. signal such that it will keep Q3 turned ON when modulation greater than 10% is present. When the modulation drops below 10%, Q3 is shut off and C22 charges through R38. When the voltage on C22 reaches the threshold set by the pot R40, the output of Z7 goes high and turns ON Q4, closing the K3 relay contacts. By varying the setting of R40, the delay between loss of modulation, and closing the relay contact, can be varied; from a minimum of two seconds to a maximum of 60 seconds.

4.2.4.5  10kHz Whistle Filter (Optional)

The 10kHz filter is an active High "Q" twin-tee notch filter consisting of Z3, Z4, and their associated components on the A3 Board. The capacitors C9-C17 along with R26, R27, and R28 form a twin-tee notch circuit. Op-Amps Z3 and Z4 provide feedback to increase the "Q" of the notch, and the output to the rear panel Whistle Filter Switch. This circuit is only affecting the rear panel audio output, and not the modulation meter or peak flasher circuits.

4.2.4.6  Carrier Frequency Output (Optional) (A5)

The L.O. and I.F. signals are mixed in the Double-Balanced Mixer, I.C., Z1. The difference of the two frequencies, the carrier frequency, is selected by the factory-tuned, high-Q circuit of L3 and C1. The emitter-follower, Q1, drives the low-impedance input of an external frequency counter.
SECTION 5

MAINTENANCE

5.1 General.

Since the Model 732 is a solid-state instrument and its power requirements are low, no maintenance problems due to high temperature should be encountered, provided the instrument is installed well away from vacuum-tube and other heat-generating equipment. Likewise, because the operating voltages are low, excessive dust accumulation associated with high-voltage devices should not occur.

5.2 Access.

To gain access to the top-of-chassis components (all printed-circuit boards) remove six screws from the top cover, three on each side, and then remove the top cover. Removing six similar screws from the bottom cover provides access to the below-chassis components (connectors, power transformer and switches).

5.3 Periodic Maintenance.

The only periodic maintenance that should be required is an annual inspection and cleaning. The printed circuit boards should be removed and blown off with compressed air to remove any dust accumulation. In dusty environments more frequent cleaning may be necessary. The chassis should also be blown out with compressed air.

5.4 Calibration of Modulation Meter.

A. Front Panel Calibration

1. Depress the front-panel METER CAL switch. The modulation meter should read 100%. If it does not, adjust the front-panel METER CAL potentiometer. If there is reason to believe that the modulation calibrator is not accurate, a procedure is outlined in Paragraph B below for adjusting the modulation calibrator. Section 5.6 outlines a procedure for calibrating the carrier level meter. This should be done before attempting to adjust the modulation calibrator.
5.4 (Cont'd)

2. To check balance, hold the METER CAL switch down while pressing the METER (-) switch. The meter should read the same as above within 2%. If the meter balance is bad using the internal calibrator either the calibrator circuit, or one of the audio amplifiers is failing, and the factory should be consulted for return and repair.

B. Adjustment of the modulation calibrator

1. Test equipment required for this adjustment are:

(a) Low distortion AM modulator, or signal generator capable of being AM modulated such as Wavetek model #136 Generator.

(b) Oscilloscope with 10 MHz or greater bandwidth, such as Hewlett Packard Model #180 A.

(c) Audio generator such as Hewlett Packard Model #204.

2. Test equipment set-up.

(a) Connect the output of the Wavetek generator to the input of the Model 732 and also to the input of the scope.

(b) AM modulate the R. F. signal using the H. P. 204 audio generator. Set the audio generator for 1KHz and adjust the amplitude such that 100% modulation of the R. F. signal is seen on the scope. 100% modulation should be determined by looking at the point of negative modulation peaks, and increasing the scope vertical sensitivity. The accuracy of this measurement will determine the accuracy of the monitor, so great care should be taken to make correct adjustments. -100% modulation is defined as the point at which the R. F. signal is just cutoff by the modulating signal. Correct -100% modulation is shown in Figure #1.

(c) Depress "-" modulation button on the model 732 front panel, and observe the reading on modulation meter. The meter should read 100% if everything is calibrated correctly. Depress the "+" modulation button on the 732 front panel and again observe the modulation meter reading. It may or may not read 100% depending upon the modulator distortion. If the "+" reading is greater than 101% or less than 99% the -100% reading should be compensated by averaging the "+" and "-" readings.
5.4 (Cont'd)

If the difference between the "+" and "-" readings is greater than 3% an effort should be made to lower the modulator distortion or find a better generator, as more than 3% difference makes it difficult to accurately calibrate the model 732.

(d) Again with the "-" modulation button depressed and making any corrections necessary for differences between the "+" and "-" modulation readings, adjust (if necessary) the "Meter Cal" pot on the front panel for a 100% reading. Depress the front panel "Cal" button and observe the modulation meter reading, it should be 100%. If the internal calibration signal is in error, adjust R15 on the Power Supply and L.O. Board (A4) for a correct (100%) reading.

NOTE: ANY TIME AN ADJUSTMENT IS MADE TO R15 ON THE A4 BOARD, THE PEAK FLASHER CALIBRATION MUST ALSO BE CHECKED!

5.5 Calibration of the Rear Flasher.

A. The -100% flasher.

1. Depress the "METER CAL" button and observe the -100% peak flasher, it should be "ON", or flashing "ON and OFF". If it does not the procedure in the following paragraph can be used to make the necessary adjustments.

2. With the same equipment and set-up used to check the modulation meter calibration in Section 5.4.B the -100% lamp should come ON with -100% modulation. Reducing the modulation to -99% as read on the modulation meter, the -100% lamp should still be ON. Again reducing the modulation to -98%, the -100% lamp should be OFF. Adjusting R3 on the peak flasher and meter amp board (A2) will correct any errors in -100% peak lamp setting.

B. The switchable peak flasher.

1. Again with the AM generator set up for -100% modulation, depress the "-" modulation button on Model 732 front panel, and set the thumbwheel switches for 100%. The peak lamp should be ON, or flashing ON and OFF. Moving the thumbwheel switch setting to 101%, the peak flasher should go out. If necessary, adjust the front panel "Flasher CAL" pot until these conditions are met.

2. Depress the "meter CAL" pushbutton and observe the peak flasher. It should be ON, or flashing ON and OFF with a thumbusheel switch setting of 100%, and
by OFF with a switch setting of 101%. If necessary, adjust R16, on the A4 board to meet these conditions.

5.6  **CARRIER LEVEL Meter Calibration Check.**

With the top cover of the instrument removed, connect a precision AC voltmeter (HA 3469A digital voltmeter or equivalent) to test point TP5 on IF Board A1. With a signal input to the monitor that is of the correct frequency and of sufficient amplitude to cause the CARRIER LEVEL meter to read to the SET position, the voltage at TP5 should be 400 mV RMS±4 mV. If it is not, calibrate the meter as follows:

a. Rotate the front-panel CARRIER LEVEL potentiometer counterclockwise until the AC voltmeter reads 320 mV. (NOTE: gain control should be in the AGC mode).

b. Adjust potentiometer R70 on the A1 board so that the CARRIER LEVEL meter reads −20%.

c. Rotate the CARRIER LEVEL potentiometer clockwise until the AC voltmeter reads 480 mV.

d. Adjust potentiometer R66 on the A1 board so that the meter reads +20%.

e. Rotate the CARRIER LEVEL potentiometer counterclockwise again until the voltmeter reads 400 mV. The CARRIER LEVEL meter should now read exactly on SET.
SCHEMATIC DIAGRAMS
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NOTES: UNLESS OTHERWISE SPECIFIED:
1. RESISTORS - VALUES IN OHMS ±5%, 1/4 WATT.
2. CAPACITORS - VALUES IN MICROFARADS.
3. INDUCTORS - VALUES IN MICROHENRYS ±10%
4. *FACTORY SELECT VALUE, TYPICAL VALUE SHOWN.
5. VOLTAGES ARE DC CONDITIONS.
NOTES: UNLESS OTHERWISE SPECIFIED:
1. RESISTORS - VALUES IN OHMS ±10%, 1/4 WATT.
2. CAPACITORS - VALUES IN MICROFARADS.
3. INDUCTORS - VALUES IN MICROHENRYS ±10%.
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