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.

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 TFT, 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 TFT.

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 TFT.

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.

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, or 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.

TFT
TIME AND FREQUENCY TECHNOLOGY, INC.
3000 Olcott St.
Santa Clara, CA 95051
408-246-6365
2.4 Antenna Installation

Delete Resistor

Figure 6-2 AM Receiver (Schematic only)
ADD X 100 KHz, X 1MHz and X10 KHz to SI as shown

Figure 6-3 FM Receiver (Schematic only)
ADD: Line from the junction of Z1-6 and R43 to center tap of L3

Figure 6-4 Tone Generator (Schematic & Material List)
Change: C2 1000pf Part No. 1005-1000 to a 1200pf Part No. 1007-0012

Figure 6-5 Tone Decoder (Schematic & Material List)
REMOVE: F1 a 2A Slo Blo Fuse, Part No. 1900-0002,
Replaced with a jumper

Figure 6-6 Dual Purpose Decoder (Schematic & Material List)
REMOVE: F1 a 2a Slo Blo Fuse, Part No. 1900-0002, replaced with a jumper

CHANGE: P.C. Board No. 6609-0970 to 6608-0970
CHANGE: Switch S1, reverse nomenclature of LISTEN/OPERATE
CHANGE: On Material List Z3 to a 74132 Part No. 1100-4132
CHANGE: On Schematic C27 from a 7000μf capacitor to a 8000μf capacitor
2.4 Antenna Installation

Delete Resistor

Figure 6-2 AM Receiver (Schematic and Material List)
ADD X 100 KHz, X 1MHz and X10 KHz to S1 as Shown

![Schematic Diagram]

Change: Q1 40841 Part No. 1271-4084 to a 40673 Part No. 1271-4067
Change: R14 330Ω Part No. 1065-0230 to a 240Ω Part No. 1065-0240, factory select.

Figure 6-3 FM Receiver (Schematic only)
ADD: Line from the junction of Z1-6 and R43 to center tap of L3

Figure 6-4 Tone Generator (Schematic & Material List)
Change: C2 1000pf Part No. 1005-1000 to a 1200pf Part No. 1007-0012

Figure 6-5 Tone Decoder (Schematic & Material List)
REMOVE: F1 a 2A Slo Blo Fuse, Part No. 1900-0002, replaced with a jumper

Figure 6-6 Dual Purpose Decoder (Schematic & Material List)
REMOVE: F1 a 2A Slo Blo Fuse, Part No. 1900-0002, replaced with a jumper
CHANGE: P.C. Board No. 6609-0970 to 6608-0970
CHANGE: Switch S1, reverse nomenclature of LISTEN/OPERATE
CHANGE: On Material List Z3 to a 74132 Part No. 1100-4132
CHANGE: On Schematic C27 from a 7000μf capacitor to a 8000μf capacitor

Figure 2-1 CHANGE: As Shown Below

TFT MODEL 760

![Circuit Diagram]

K1: POTTER & BRUMFIELD R10-E1-V2-V85. TOTAL RELAY CURRENT MUST NOT EXCEED 250mA.
APPLICATION BULLETIN: 75-02

TO: Model 760 EBS System Users

FROM: F. Stolten, Customer Service Manager

DATE: December 15, 1975

SUBJECT: Automatic Reset of Two-Tone Generator

TFT has recently received inquiries from the field requesting information on how to modify the Model 760-04 Two-Tone Generator to make the RESET automatically function after the 23.5 second two-tone transmission period. This change is desired because some broadcasters want to make EBS announcements on their normal program line and thus do not want to manually reset the Two-Tone Generator after each tone transmission before making Emergency announcements—or maybe forget to reset??

There are several ways to implement the automatic reset. One way is to modify the generator directly. This is done by removing C20, 1μf, and placing a 0.22μf capacitor between Z3 pin 11 and Z1 pin 13.

An alternate approach to automatically reset the generator would be:

1. Do not route the normal program audio through K1 on the Two-Tone Generator.

2. Connect a pair of lines from the AUDIO OUTPUT terminals of the Two-Tone Generator to a mixer on the audio console.

This would inject the two-tones on the program line without interrupting it. However, the Generator must be reset either manually or automatically before the next tone transmission.
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*These Diagrams are only included when applicable.
Section 1
General Information

1.1 General Description.

The TFT EBS System is designed to meet the FCC Two-Tone EBS intersstation signaling requirements. It normally consists of three modules—the model 760-04 Two-Tone Generator, the Model 760-01 AM Receiver or the Model 760-02 FM Receiver, and the Model 760-03 Tone Decoder—mounted in a cabinet for installation in a 19-inch relay rack.

1.2 Specifications.

EBS Cabinet Assembly
Module Capacity

Input Power*  
Operating Temperature*  
Operating Humidity*  
Size

Weight

1.2.1 Model 760-01, Frequency-Synthesized AM Receiver
Frequency Range
Local Oscillator Stability
Tuning Method

Antenna Input
Sensitivity
Image Rejection
AGC
IF Bandwidth, 6dB
Harmonic Distortion
Noise
Audio Outputs, 600ohms
Carrier-Off Output

1.2.2 Model 760-02, Crystal Controlled FM Receiver
Frequency Range
Channel Frequency

Antenna Input
Sensitivity
IF Bandwidth, 6dB
Image Rejection
AGC
Audio Frequency Response
Harmonic Distortion
S/N Ratio

An emergency two-tone signal received from the AM or FM station being monitored will be heard on the EBS System speaker after such a tone has been received for at least 8 seconds. The EBS System provides the means for interrupting normal programming and broadcasting the two-tone emergency signal for 23.4 seconds, and for inserting emergency announcements. Normal operation can be restored by operation of two reset switches.

will accept up to three EBS modules (Models 760-01, -02, -03, -04, and -05). Blank panels are provided when fewer than three modules are in use.

117 VAC ± 15%, 50/60 Hz, 20 watts maximum.
0 ° to 50 °C.
95% Relative.
3.5” (8.9 cm) high x 19” (48.3 cm) wide x 12” (30.5 cm) deep.
Approx. 10 pounds (4.5 kg)

540-1620 kHz
±500 Hz per year
Channel frequency digitally set in 10 kHz steps by thumbwheel switches.
75 ohms nominal, unbalanced.
30 µV for 20 dB S/N at 30% modulation.
50 dB
70 dB
±5 kHz
Less than 3% at 90% modulation.
45 dB or greater below 100% modulation with 10 MV RF
Balanced: +8 dBm. Unbalanced: 1 V rms
Active pullup to 10 V, 10 ma

88-108 MHz
Specify frequency, either one or two channel versions available.
75 ohms nominal, unbalanced.
2 µV for 30 dB of quieting.
±150 kHz
40 dB
80 dB
±1 dB, 50 Hz - 15 kHz
1%
60 dB or greater below 100% modulation at 50 µV RF input

* Specifications apply to all system modules.
### 1.2.3 Model 760-03, Two-Tone Decoder

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Level Required</td>
<td>100 mV into 600 ohms</td>
</tr>
<tr>
<td>Tone Frequencies**</td>
<td>853 Hz and 960 Hz</td>
</tr>
<tr>
<td>Bandwidth**</td>
<td>±5 Hz</td>
</tr>
<tr>
<td>Listen Operate Switch</td>
<td>In Operate mode the loudspeaker is muted until an EBS alert is decoded. In Listen mode, the loudspeaker is demuted. 1 Watt, internal loudspeaker. Resets decoder and mutes loudspeaker. The RESET switch wiring is brought out to the rear panel. 12 seconds ±4 seconds, SPDT relay contacts brought out to rear panel.</td>
</tr>
<tr>
<td>Audio Output</td>
<td>853 Hz and 960 Hz</td>
</tr>
<tr>
<td>Reset Switch</td>
<td>±0.25 Hz, crystal controlled</td>
</tr>
<tr>
<td>Remote Operation</td>
<td>+8 dBm nominal (per tone)</td>
</tr>
<tr>
<td>Time Delay for De-muting**</td>
<td>600 ohms, balanced</td>
</tr>
<tr>
<td>External Alarm Contacts</td>
<td>Less than 2%</td>
</tr>
<tr>
<td></td>
<td>23.4 seconds, ±0.15 seconds</td>
</tr>
<tr>
<td></td>
<td>Front panel pot, −2 dBm to +8 dBm</td>
</tr>
<tr>
<td></td>
<td>Rear panel DPDT relay contacts. Balanced input and output. Switchover and latch to EBS programming is automatic.</td>
</tr>
<tr>
<td>Emergency Program</td>
<td>Unbalanced input. Internally inserted into program line. Connects Generator to Decoder for testing without interrupting program audio. Enables one tone at a time for setting level and checking distortion. 2 toggle switches. Must be activated in opposite directions to turn on Generator. Releases latch to restore normal program audio. The COMMAND and RESET switch wiring is brought to the rear panel.</td>
</tr>
</tbody>
</table>

### 1.2.5 Model 760-05, Dual-Purpose Decoder

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrier Break/1000 Hz Specifications:</td>
<td>100 mV into 600 ohms</td>
</tr>
<tr>
<td>Input Level Required</td>
<td>1000 Hz</td>
</tr>
<tr>
<td>Tone Frequency</td>
<td>±50 Hz</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>23 to 27 sec.</td>
</tr>
<tr>
<td>Time to demute after start of Carrier</td>
<td>Resets decoder and mutes loudspeaker. In Operate mode the loudspeaker is muted until an EBS alert is decoded. In Listen mode the loudspeaker is demuted. 1 Watt, internal loudspeaker. The RESET switch is brought out to the rear panel. SPDPT relay contacts brought out to rear panel.</td>
</tr>
<tr>
<td>Break sequence</td>
<td></td>
</tr>
<tr>
<td>RESET switch</td>
<td></td>
</tr>
<tr>
<td>Listen/Operate Switch</td>
<td></td>
</tr>
<tr>
<td>Audio Output</td>
<td></td>
</tr>
<tr>
<td>Remote Operation</td>
<td></td>
</tr>
<tr>
<td>External Alarm Contacts</td>
<td></td>
</tr>
</tbody>
</table>

Specifications are typical except those identified by ** which are guaranteed.
Section 2
Installation

2.1 Unpacking and Inspection.
Upon receiving the instrument, inspect the packing box and instrument 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 760 EBS System operates from a 117-volt AC source. The line frequency must be between 50 and 60 hertz. Maximum power required is 20 watts.

2.3 Installation and Hookup.
When the EBS System Cabinet assembly is mounted in a 19-inch relay rack with all modules in place, make the following connections to the module terminal strips at the rear of the cabinet. After all connections have been made, plug the power cord into a 117-volt, 60-hertz source. There is no power switch in the system; it is energized whenever its power cord is plugged in.

2.3.1 Receiver AM or FM.
\( a \) If an AM or FM Receiver is installed, connect a 75 ohm coax cable from the antenna to the rear-panel ANTENNA connector.
\( b \) Connect the rear-panel UNBAL AUDIO terminal to the DECODER AUDIO INPUT terminal.
\( c \) If desired, the rear-panel BALANCED AUDIO terminals can be connected to a monitor or other device. Output at these terminals is +6 dBm at 600 ohms for 100% modulation.
\( d \) If a remote indication of carrier failure is to be provided, connect the rear-panel CARRIER FAIL terminal to the remote indicator. Output from this terminal is 10 volts @ 10 ma for normal carrier level, and 0 volts with 5 ma current sinking for carrier failure. For operating an external carrier fail alarm relay, see Figure 2-1 for suggested circuit. Total external relay current must not exceed 250 ma.

2.3.2 Two-Tone Generator.
\( a \) If the monaural program audio is to be looped through the Two-Tone Generator, connect the program input line to the rear-panel AUDIO IN terminals and connect the program output line to the rear-panel AUDIO OUT terminals.
\( b \) If the program line is not to be looped through the Two-Tone Generator, or if combined AM/FM/TV program audio is to be controlled, external circuitry like that diagrammed in Figure 2-2 is recommended. Relays K1, K2, and K3 shown in Figure 2-2 should have 12-volts coils, and the total coil current must not exceed 250 milliamperes. Relay power and EBS audio input come from connector J2 on the rear panel of the Two-Tone Generator.
\( c \) Connect a wire from the rear-panel TEST OUT terminal to the DECODER TEST INPUT terminal. This provides a means to test the Two-Tone Generator and Tone Decoder together without interrupting the program.
\( d \) Connect the emergency announcement audio line (unbalanced) to the rear-panel AN INPUT terminal.
\( e \) If remote control of the command and reset functions is desired, connect the rear-panel COMMAND and RESET terminals to remote switches. Grounding these lines activates the functions.

NOTE: Pursuant to Section 73.940 (j) of the FCC Rules & Regulations, the remotely located command switch must be guarded such as to prevent accidental operation.

2.3.3 Tone decoder.
\( a \) Connect the rear-panel AUDIO INPUT terminal to the RECEIVER UNBAL AUDIO as previously stated in Subsection 2.3.1b or to another EBS monitor receiver if used. The sensitivity of the Tone Decoder is factory adjusted so that a 100 per cent modulated signal (+8 dBm at the DECODER AUDIO INPUT terminal) will produce 10 volts peak-to-peak at the rear-panel LEVEL terminal when used with

Figure 2-1

K1: POTTER & BRUMFIELD R10-E1-Y2-V185. TOTAL RELAY CURRENT MUST NOT EXCEED 250 mA.
a TFT Model 760-01 or Model 760-02 Receiver. If a different receiver is used, the audio input should not be less than 250 mV rms for a 100% modulated signal (100mV rms for 40% modulation), and internal potentiometer R6 can be adjusted for 10 volts peak-to-peak at the LEVEL terminal.

b. Connect the rear-panel TEST INPUT terminal to the GENERATOR TEST OUT terminal as described in Subsection 2.3.2c.

c. If remote control of the Tone Decoder reset function is desired, connect the rear panel RESET terminal to the remote switch. Grounding the RESET terminal effects a reset.

d. If a received two-tone signal is to actuate a station alarm, connect the alarm device to the rear-panel DECODER RELAY terminals. The normally open and normally closed contacts of the internal alarm relay together with the relay common, are internally connected to these terminals.

2.3.4 Dual Purpose Decoder.
The Model 760-05 EBS Dual-Purpose Decoder operates on both the EBS signal to be used after April 16, 1976, and the EBS signal used before that date.

After the new EBS goes into effect, it is important to disable the circuit which was used to detect the old EBS signal by removing Resistor R46 from the module. The board on which this Resistor is mounted is marked "CUT" in two places to facilitate the removal.

a. Connect the rear-panel AUDIO INPUT terminal to the RECEIVER UNBAL AUDIO or to another EBS monitor receiver if used. The sensitivity of the Tone Decoder is factory adjusted so that a 100-percent modulated signal (+8 dBm at the Decoder AUDIO INPUT terminal) will produce 10 volts peak-to-peak at the rear-panel DECODER LEVEL terminal when used with a TFT Model 760-01 or Model 760-02 Receiver. If a different receiver is used, the audio input should not exceed 5V rms, and internal potentiometer R5 can be adjusted for 10 volts peak-to-peak at the LEVEL terminal (signal should be adjusted just into limiting).

b. Connect the rear-panel TEST INPUT terminal to the GENERATOR TEST OUT terminal.

c. If remote control of the Tone Decoder reset function is desired, connect the rear-panel RESET terminal to the remote switch. Grounding the RESET terminal effects a reset.

d. If a received two-tone signal is to actuate a station alarm, connect the alarm device to the rear-panel DECODER RELAY terminals. The normally open and normally closed contacts of the internal alarm relay, together with the relay common, are internally connected to these terminals.

e. Connect the rear-panel CARRIER FAIL terminal to the CARRIER FAIL terminal of the Receiver.
2.4 Antenna Installation

If a local FM antenna is not available, any conventional FM or TV antenna is satisfactory. If a local AM antenna is not available, an end-fed long wire antenna (approximately 250 ft.) can be used with good results. One end of the long wire should be connected at the rear-panel ANTENNA connector.

For moderately strong signal areas, the above illustration is an alternative to the long-wire antenna.
Section 3
Operation

3.1 General.
After the installation procedures of Section 2 have been carried out, the EBS System is ready for operation. The system is energized whenever the power cord is plugged into an appropriate power receptacle. Figure 3-1, the EBS System front panel, illustrates the controls and indicators referred to in the following paragraphs.

When an emergency two-tone signal is received from the station to which the receiver is tuned, and when the tone is present for at least 8 seconds, the speaker will be demuted, allowing the two-tone signal to be heard. The operator can then transmit the two-tone emergency signal by moving the handles of the two COMMAND toggle switches in opposite directions. This will interrupt normal programming, transmit the tones for 23.4 seconds, and allow emergency announcements to be transmitted. At any time after the COMMAND switches, the operator can resume normal programming by moving the RESET/TEST switch to RESET. He can also mute the speaker by operating the Tone Decoder RESET switch.

Detailed operating instructions for each module are presented in Subsections 3.2 through 3.6.

3.2 AM Receiver.
a. Dial in the desired frequency on the thumbwheel switches. These switches indicate the frequency in tens of kilohertz.
b. Tune the preselector for the best signal as determined by maximum speaker volume with the Tone Decoder LISTEN/OPERATE switch in the LISTEN position, and by the CARR lamp being lighted.

3.3 FM Receiver.
a. Press the channel selector switch for the desired channel, if ordered with two channels. The single channel receiver is fixed tuned to the specified channel.
b. The CARR lamp must be lighted, indicating sufficiently strong signal for satisfactory operation.

3.4 Two Tone Generator.
3.4.1 Basic Operation.
a. Check that the POWER lamp is lighted, indicating that the Two-Tone Generator is receiving DC power from the Tone Decoder.
b. To transmit an emergency signal, operate the two COMMAND switches in opposite directions as indicated by the arrows on the front panel. The COMMAND lamp should light, indicating that the dual-tone audio signal is being delivered to the transmitter for a period of 23.4 seconds. At the end of the tone period, emergency announcements can be made on the audio circuit connected to the rear-panel AN. INPUT terminal.
c. To restore normal programming, move the RESET/TEST switch to the RESET position.
d. To test the operation of the Two-Tone Generator with the Tone Decoder without interrupting normal programming, move the RESET/TEST switch to the TEST position. The Dual-tone signal should be present at the speaker for 23.4 seconds, with the Decoder in the listen mode.
e. To test the tones separately, move the 853 Hz/OPERATE/960 Hz switch to the desired tone position. The tone should be heard on the speaker as long as the switch is held in the selected position.
f. The GAIN control allows adjustment of the Two-Tone Generators' two-tone audio output to interface with the stations audio system.

3.4.2 Remote Control.
Both the COMMAND and RESET functions can be remotely controlled if the connections described in Subsection 2.3.3e have been made. Operating the remote COMMAND switch performs the same functions described in Subsection 3.4.1a, and operating the remote RESET switch is the same as operating the front-panel RESET switch as described in Subsection 3.4.1b.

NOTE: Pursuant to Section 73.940 (j) of the FCC Rules & Regulations, the remotely located command switch must be guarded such as to prevent accidental operation.

3.4.3 External Audio Switching.
If audio switching is to be accomplished externally by means of circuitry like that of Figure 2-2, move the AM/FM/TV/OPERATE switch to either AM TEST, FM TEST, or TV TEST to test these circuits individually.

3.5 Tone Decoder.
The POWER lamp should be on, indicating that DC power is available from the Tone Decoder power supply.

When the LISTEN/OPERATE switch is set to OPERATE, the speaker circuit will be muted until a dual 853 Hz/960 Hz tone is received for 8 seconds, at which time the speaker circuit will be enabled and the alarm relay will energize. This condition will exist until the RESET switch is operated, at which time the speaker circuit will again be muted and the alarm will de-energize.

When the LISTEN/OPERATE switch is set to LISTEN the speaker is demuted and incoming audio is continuously monitored.
3.6 Dual Purpose Decoder

The POWER lamp should be on, indicating that DC power is available from the Tone Decoder power supply.

When the LISTEN/OPERATE switch is set to OPERATE, the speaker circuit will be muted until an EBS signal is received. This will enable the speaker circuit and the alarm relay will energize. This condition will exist until the RESET switch is operated, at which time the speaker circuit will again be muted and the alarm relay will be deenergized.
Section 4
Theory of Operation

4.1 System.
(Block Diagram: Figure 6-1)

The received signal is demodulated in the AM or FM Receiver, and the resulting audio is applied to the Tone Decoder. If an EBS emergency signal is present (853 Hz and 960 Hz tones present simultaneously for at least 8 seconds), the Tone Decoder demutes its speaker so that the audio can be heard, and energizes a relay to actuate an external alarm. The station’s program audio is normally fed through closed relay contacts in the Two-Tone Generator. However, when the COMMAND switches are closed, the program is interrupted, the EBS two-tone signal is placed on the program line to the transmitter for 23.4 seconds, and a local announcement line is activated so that emergency announcements can be made.

The Tone Decoder external alarm circuit and speaker muting can be reset by a front-panel switch or by grounding a remote reset line. The Two Tone Generator can be reset for normal programming by a front panel switch or by grounding a remote reset line. Provisions are made for testing the Two Tone Generator with the Tone Decoder without interrupting the programming, and for separately checking the generation of the two emergency tones, as described in the following paragraphs. Both the AM and FM Receiver furnish an output for a remote carrier-fail alarm.

4.2 AM Receiver Model 760-01.
(Schematic Diagram: Figure 6-2)

This module is a superheterodyne receiver covering the AM broadcast band from 540-1620 kHz in 10 kHz steps. RF amplifier Q1 is tuned by a front-panel control to peak the received signal. Its output is mixed by Q2 with a local-oscillator input from a frequency synthesizer (described in the next paragraph.) The 450-kHz IF signal is amplified by Q4 and Q5, and detected by CR3. The resulting audio signal is amplified by Z16 and fed to the UNBALANCED audio output terminal. It is also fed through transformer T1 to the BALANCED audio output terminals. The output from detector CR3 is also amplified by Q3 and applied as an AGC voltage to RF amplifier Q1 and mixer Q2.

The LO input to the mixer comes from dual retriggerable monostable multivibrator Z11 functioning as a voltage controlled oscillator. The phase-locked loop consists of oscillator Z11, a divide-by-N divider (Z5 through Z10), and a phase detector (Z12). A precision 10 kHz reference signal for the phase detector is obtained from 5 MHz crystal oscillator Q10 by dividing by 500 in Z15, Z14, and Z13. The logic ones and zeros from the front-panel thumbwheel switches (S1) are decoded by the logic circuitry of gates Z1 through Z4 to cause the divide-by-N divider to divide the output frequency of oscillator Z11 by the appropriate number to produce a 10-kHz input to pin 1 of phase detector Z12 when the oscillator output is exactly 450 kHz above the frequency indicated by the thumbwheel switches. Any phase difference between the output of the divide-by-N-circuit and this 10-kHz reference is detected in Z12, which produces a voltage to reset the oscillator by means of Q11.

The IF signal at the output of mixer Q2 is detected in Q7/Q8, and used to turn on the CARR LED CR7 to indicate the reception of a carrier. The output of detector Q7/Q8 is also amplified by Q6 and fed to rear-panel connector J3-5 to operate a carrier-fail alarm; this output is +10 volts at 10 ma when a carrier is present, and 0 volts (2000 ohm return to ground) for carrier failure.

4.3 FM Receiver Model 760-02.
(Schematic Diagram: Figure 6-3)

The FM Receiver is capable of receiving any two preselected frequencies within the FM broadcast band of 88 to 108 MHz. The RF amplifier and mixer are each one-half of a MOSFET dual-gate transistor pair. In the RF amplifier the RF input is applied to one gate and AGC to the other. In the Mixer, the RF input is applied to one gate, and the LO signal to the other. The LO is a crystal oscillator (Q2) whose output is tuned to twice the crystal frequency. One crystal is standard, the second optional crystal is selectable by a front-panel switch. This switch also connects an additional tuning capacitor in the crystal oscillator and RF amplifier circuits when the switch is in the position that selects the lower of the two channel frequencies. The LO output frequency is 10.7 MHz above the desired RF signal.

The 10.7 MHz mixer output is fed through two ceramic filters (FL1 and FL2) to provide high selectivity, and into integrated circuit Z2, which functions as an IF amplifier, squelch circuit, detector, AGC, and AFC. The IF amplifier is factory-tuned to 10.7 MHz by L9 and C32.

The AGC voltage at pin 15 of Z2 controls the gain of the RF amplifier. The squelch voltage at pin 12 of Z2 is amplified by Z5 and used to light CARR LED CR1 when received carrier develops sufficient squelch voltage. The squelch is also further amplified by Q3 to drive an external carrier alarm circuit through rear-panel terminal 5; this output is +10 volts at 10 ma when a carrier is present and 0 volts (2000 ohm return to ground) for carrier failure.

4.4 Tone Decoder Model 760-03.
(Schematic Diagram: Figure 6-5)

This module detects the presence of the 853 Hz and 960 Hz tones in the receiver audio output. If both tones are present simultaneously for at least 8 seconds,
the Tone Decoder demutes its speaker circuit so that the receiver audio can be heard; it also energizes a relay whose contacts can be connected to an external alarm circuit. Provision is made for testing system operation by using the test signals from the Two Tone Generator.

The audio input from the AM or FM receiver is applied to the piezoelectric filters, FL1 and FL2, through a section of buffer amplifier Z1. The filter outputs are amplified in different sections of Z1 and drive detector diodes CR1 and CR2. Z1 input stage, pins 11, 12, and 10, is configured to limit significant overdrives in input level. When either 853 Hz or 960 Hz are present, voltages build up across capacitors C9 or C11 driving the collector of Q1 or Q2 low. If one of the two tones is present only one of collectors Q1 or Q2 will be low and transistor Q3 will be on, holding the voltage at TP3 close to ground. LEDs CR3 and CR4 turn off as collectors Q1 and Q2 go low, respectively. These LEDs are inside the module and may be used for maintenance test purposes.

If both tones are present, collectors Q1 and Q2 are low and Q3 is off, allowing C13 to charge through R26. At the end of 8 seconds, the voltage across C13, amplified by Q4/Q5, is high enough to fire SCR Q7, thus energizing relay K1, and turning on speaker amplifier Z2 to demute the speaker audio, which is normally muted as described below. To reset the relay and speaker, RESET switch S2 is operated to either position, or RESET terminal J2-4 is grounded. This turns off Q6 and therefore Q7.

The unbalanced audio input from the Receiver is also applied to the speaker amplifier Z2 through volume control R5 with switch S1 in the OPERATE position, pin 2 of Z2 is pulled up to a positive voltage causing speaker amplifier Z2 to mute. Placing S1 in the LISTEN position removes this positive voltage at pin 2 of Z2 and thus demutes the speaker amplifier.

The audio output of buffer Z1 is also fed to LEVEL terminal J2-2. GAIN control R4 is factory set so that at 100-percent modulation, the voltage at the LEVEL terminal is 10 volts peak-to-peak, when used with the 760-01 or 760-02 Receivers.

The power supply for the entire EBS System is contained in the Tone Decoder module, with the exception of the 12-volt transformer which is mounted on the cabinet. Power connections to the receiver and the Two Tone Generator are made through J1 and J3.

4.5 Two Tone Generator Model 760-04.
(Schematic Diagram: Figure 6-4)

This module generates the two tone, 23.4 second tone pulse required by the system. It also contains the circuitry for switching the transmitter modulation from normal programming to emergency tones and announcements. Provision is made for testing the 853 Hz and 960 Hz tones separately, and for testing the operation of the Generator with the Tone Decoder without interrupting normal programming.

The 853 Hz tone is generated by dividing the 3.2552 MHz output of crystal oscillator Q2 by 3840 in the divider chain consisting of Z16, Z15, Z14, and Z13. When pin 9 of Z2 is held at logic 1 by the control circuitry, the 853 Hz tone is gated through an active 1-KHz low-pass filter (Z18), level control R23, and GAIN control R24 to audio power amplifier Z17.

The crystal oscillator output is also divided by 2 in Z16 and then by 1706 in the divider chain consisting of Z9, Z10, Z11, and Z8 to produce the 960 Hz tone. When pin 9 of Z8 is held at logic 1 by the control circuitry, the 960 Hz tone is delivered through low-pass filter Z19, level control R20, and GAIN control R24 to amplifier Z17. Transformer T1 provides a 600 ohm balanced output which is delivered to AUDIO OUT terminals J3-7 and J3-8 when relay K1 is energized.

Pin 10 of flip-flop Z3 is normally at logic 1. This resets decade counters Z5, Z7, Z5, and Z4 to 0, and holds them at this count. When COMMAND toggle switches S3 and S4 are activated simultaneously in opposite directions, or when switch S1 is placed in the TEST position, a logic 0 is applied to pin 7 or Z3. This drives pin 10 of Z3 to logic 0, enabling the four decade counters, which proceed to divide the 853 Hz tone from pin 8 of Z13 by 100,000. The frequency is further divided by 2 in Z3 to produce the required 23.4 second time pulse at pin 15 of Z3. Flip-flop Z3 is so connected that the pin 10 output returns to logic 1 at the end of the 23.4 second pulse and remains there until the next operation of the COMMAND or TEST switch. The 23.4 second negative-going pulse at pin 10 of Z3 turns on gate Z2-3 by means of Z2-6 to enable the 853 Hz tone, and also the 960 Hz tone through gate Z2-3 and flip-flop Z-8.

When the Command switches are activated (or REMOTE COMMAND terminal J3-1 is grounded), latch Z1-11/Z1-8 is set to turn on Q1 and thus light COMMAND LED CR2 and energizes relay K1. When K1 is de-energized, its contacts feed the normal program audio to AUDIO OUT terminals J3-7 and J3-8. When the relay is energized, the tones (or the announcement input form J3-10) supply the audio output. Once energized, the relay will remain in that condition until a logic 0 is applied to the reset input of the latch from switch S1 or from remote RESET terminal J3-2. Note that placing S1 in the TEST position does not energize relay K1.

Placing S2 in the 853 Hz position gates the 853 Hz tone through to TEST OUTPUT J3-4, so that this tone can be tested independently. Similarly, the 960 Hz tone can be delivered to the TEST OUTPUT terminal by placing S2 in the 960 Hz position.

Power for the Two Tone Generator is normally supplied from the Tone Decoder through connector J1. When the Generator is used without the Decoder, the power supply shown in Figure 6-4 is used, with AC power input supplied from the cabinet-mounted 12 volt transformer through connector J4.

4.6 Dual Purpose Decoder Model 760-5
(Schematic diagram Figure 6-6)

These instructions apply to the EBS operating
before April 16, 1976. For the EBS operating after that date, refer to Section 4.4.

This Module detects the presence of a Carrier Break/1kHz emergency signal from the transmitter being monitored. When such a signal is detected, the Tone Decoder demutes its speaker circuit so that the receiver audio can be heard; it also energizes a relay whose contacts can be connected to an external alarm circuit.

The Dual-Purpose Decoder detects the emergency signal consisting of the following sequence:

Transmitter carrier off 5 seconds.
Transmitter carrier on 5 seconds.
Transmitter carrier off 5 seconds.
Transmitter carrier on with 1-KHz tone modulation.

The audio input from the AM or FM Receiver is applied to tone decoder Z2 through buffer amplifier Z1-5. The decoder output at pin 8 of Z2 is logic 0 when a 1 kHz tone is present, and logic 1 when it is not. R41 and C19 provide a time delay of approximately 10 seconds, so that the 1 kHz signal must be present for at least that length of time before an alarm is indicated. After amplification by Q9, Q10, Q11, the received tone will produce a logic 1 at pin 2 of Z3.

When a carrier is being received, the Receiver will deliver +10 volts to the Decoder CARRIER FAIL terminal 9. When the carrier goes off, the voltage at terminal 9 drops to approximately 0 volts, which causes integrator Z4-5 to develop a positive-going ramp voltage, producing an abrupt drop from +5 volts to 0 volts in the output of comparator Z4-4 when the threshold voltage is reached. When the carrier comes back on, Z4-5 develops a negative-going ramp voltage, causing the output of Z4-4 to return again to 5 volts. Thus, the emergency signal will produce two positive-going pulses at the clock input (pin 6) of Z5. The Q outputs of the two Z5 flip-flops are normally at logic 0, but the two pulses of the emergency signal cause the Q output of the second flip-flop (pin 15) to go to logic 1. The two logic 1's at the input of Z3-3 thus deliver a logic 1 to the gate of SCR Q6 when an EBS signal is received.

Gate Z3-8, integrator Z4-10, and comparator Z4-9 constitute an error detector which resets the Z5 flip-flops to 0 when carrier interruptions are received that do not meet the specifications of an EBS emergency signal. Operation of the front-panel or remote RESET switch will also reset the flip-flops to 0.

When SCR Q6 is fired by the EBS signal, it energizes relay K1 and turns off CR8 to demute the speaker audio, which is normally muted as described below. To reset the relay and speaker, RESET switch S2 is operated to either position, or RESET terminal J2-4 is grounded. This turns off Q7 and therefore Q6.

The unbalanced audio input from the Receiver is also applied to the speaker amplifier (Z4) through volume control R8 and muting circuit CR8. With switch S1 in the OPERATE position, CR8 is normally on and furnishes an offset bias to pin 2 of Z6, thus muting it. The speaker audio can be demuted by placing S1 in the LISTEN position.

The audio output of buffer Z1 is also fed to LEVEL terminal J2-2. Gain control R5 is factory set so that at 100-percent modulation, the voltage at the LEVEL terminal is 10 volts peak-to-peak.

The power supply for the entire EBS System is contained in the Tone Decoder module, with the exception of the 12-volt transformer which is mounted on the cabinet. Power connections to the Receiver and the Two-Tone Generator are made through J1 and J3.
Section 5

Maintenance

5.1 General.
Since the Model 760 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 associates with high-voltage devices should not occur.

5.2 Periodic Maintenance.
The only periodic maintenance required is cleaning. Once a year, or more often in dusty locations, take off the top cover and blow off the dust with compressed air.

5.3 Performance Checks.
The following procedures will enable the technician to determine whether the instrument is operating properly. If the tests indicate substandard operation, it is recommended that the instrument be returned to the factory for adjustment or repair. Internal adjustments are not recommended to be made in the field.

5.3.1 AM Receiver, Model 760-01
a. Sensitivity
1. Connect a Signal Generator (HP8640B or equivalent) to the ANTENNA input on the rear panel with its frequency at 540kHz and AM modulation set to 50%, 1kHz. Set output level at 10μV.
2. Connect a general purpose oscilloscope to the UNBAL and GND terminals on the rear panel.
3. Dial in 540kHz on thumb wheel switches of 760-01 and tune the preselector for maximum signal on the oscilloscope.
4. Slowly increase the level of the Signal Generator until the CARR LED comes on — this should occur at approximately 30μV. At the time the CARR LED comes on the voltage at the CARR FAIL terminal on the rear panel should change from 0 volts to 10V DC.

b. AGC Range
1. Increase the Signal Generator level to 20mV and the 1kHz sinewave on the oscilloscope should remain undistorted.
2. If receiver is a dual-channel version, repeat procedure for alternate channel.

5.3.3 Tone Decoder, Model 760-03
a. Connect a jumper wire between rear panel terminals TEST INPUT on the Decoder and TEST OUT on the Generator. If a receiver is available connect its UNBAL output to the AUDIO INPUT terminal and tune the receiver to a local channel. With the LISTEN / OPERATE switch on the Decoder in the LISTEN position audio should be heard on the speaker. Switch to the OPERATE position and the audio should no longer be audible.

b. Activate the COMMAND switch on the Generator and check that LED's CR3 and CR4 go out, indicating that the two tones are being received. 8 to 12 seconds after the initiation of the COMMAND switch, the speaker should demute and the two tones should be audible for another 12 to 16 seconds. When demuting the speaker the Decoder RELAY contacts should switch. The speaker will remain in the demuted mode and the relay will stay switched until reset by the Decoder RESET switch.

5.3.4 Two-Tone Generator, Model 760-04
a. Connect a voltmeter and a counter at the TEST OUT terminal at the rear panel of the Two-Tone Generator.

b. Activate the 853Hz tone by placing the 853Hz/OPERATE /960Hz switch in the 853Hz position. The voltage (unloaded) should be approximately 4V r.m.s. (This voltage may be adjusted with the front panel GAIN control).
The frequency should be 853Hz ± 0.5 Hz. Repeat the procedure for the 960 Hz tone.
c. Activate the TEST switch and two tones should be present for 23.4 seconds.
d. Activate the COMMAND switch and the two tones should be present for 23.4 seconds and the AUDIO #1 relay should switch and stay switched until RESET is activated on the front panel.

5.3.5 Dual Purpose Decoder, Model 760-05
a. Connect a jumper wire between rear panel terminals TEST INPUT on the Decoder and TEST OUT on the Generator. Connect a jumper wire between the AUDIO UNBAL and AUDIO INPUT terminals of the Receiver and Decoder, respectfully. Tune the Receiver to a local channel so the GARR LED on its Receiver front panel is on.
b. With LISTEN/OPERATE switch in the OPERATE position perform the following Carrier-Break simulation. Disconnect the ANTENNA for 5 seconds, reconnect for 5 seconds, disconnect for 5 seconds and simultaneously reconnect the ANTENNA and activate the 960Hz switch on the Generator. After 8 to 12 seconds, the audio should demute.
c. Refer to 5.3.3 for check out of the Two-Tone operational mode of the Decoder.
### Two Tone Generator

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**Capacitors:**
- 100V 1000pF
- 150V 1000pF
- 220V 1000pF
- 330V 1000pF
- 470V 1000pF
- 630V 1000pF
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**Diagram: TONE GENERATOR**

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STEAM POWERED RADIO.COM
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### TONE DECODER

ASSY NO. 660B-0930 REV.