MOTOROLA INC.
Communications
Group

OPTION C585AM-SP

MSF 5000™ DTMF DECODER/ENCODER MODULE

(With Speech Synthesis Capability)

1. ATTACHMENTS

--	QRN8800A DTMF Decoder/Encoder Board Diagrams	2-SP5740118
--	Parts List For QRN8800A	2PL-SP5740118
--	QRN8802A DTMF Decoder/Encoder Code Plug Kit Parts List	3PL-SP5470118
--	QRN8801A DTMF Decoder/Encoder Module Bezel Kit Parts List	4PL-SP5740118
--	QRN8842A DTMF Decoder/Encoder Program EPROM Kit Parts List	6PL-SP5740118
--	Base Station and Repeater (RT) Instruction Manual	68P81062E75

2. DESCRIPTION

The special C585AM-SP option, when added to any 4-wire, tone remote control *MSF 5000* Repeater (RT) Station, provides the station with control functions activated via decoded DTMF inputs received over-the-air, or via the wireline "backbone," or locally via Touch-Code™ inputs applied through the module front panel PROGRAM jack (J2702). The DTMF module is mounted in an *MSF 5000* Expansion Tray, which is installed in the station on top of the station control tray. Refer to the *MSF 5000* Expansion Tray Instruction Section 68P81114E93 for equipment description.

The DTMF activation digits and corresponding control functions provided by the DTMF module are:

- 0 -- Mobile-to-Mobile Repeater Operation, Wireline Not Accessed;
- * -- Mobile-to-Mobile Repeater Operation, Wireline Accessed;
- # -- Station De-Key (repeater knockdown);
- 9 -- Disable Private-Line™ (PL) Operation, with Monitor Of All Receiver Activity On Wireline "backbone;" and,
- 5 -- Enable Edit Mode (used to verify or change station Access Code or ID number).

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3. MODEL COMPLEMENT

The model complement of the special option C585AM-SP consists of the following items. All items are described in this instruction section.

ITEM	CHANGE
QRN8800A DTMF Decoder/Encoder Board	Added
QRN8801A DTMF Decoder/Encoder Module Bezel Kit	Replaces TRN5954A Blank Bezel Kit
QRN8802A DTMF Code Plug Kit	Added
QRN8842A DTMF Decoder/Encoder Program EPROM Kit	Added

4. INSTALLATION

4.1 General

The *MSF 5000* repeater (RT) station with Option C585AM-SP incorporated is installed in the same manner as any 4-wire, tone remote control, repeater (RT) station described in the attached Station Instruction Manual 68P81062E75. Two wireline "backbone" pairs are connected to the station via the junction box wireline "backbone" interface terminals, as follows. Line 1 is used for audio input to the station transmitter. Line 2 is used for the audio output from the station receiver.

LINE 1–	LINE 1+	LINE 2–	LINE 2+
TB1601-1	TB1601-3	TB1601-4	TB1601-6

For five seconds after energizing the station, all four LED's on the front panel of the DTMF decoder/encoder module will light for a LED-check. Normal station operation will begin when these LED's extinguish.

4.2 Installation Adjustments

Step 1. Initiate a wireline-to-mobile key-up (line push-to-talk) by entering the station Access Code followed by "*".

Step 2. Apply a 1 kHz sinewave to the LINE 1 inputs that is half of (6 dB below) the full deviation (peak speech) level that will appear across the terminals from the wireline "backbone" (level should be between -5 and +10 dBm).

Step 3. Adjust the AGC control on front panel of tone remote control module to give ±3 kHz peak deviation out of the station transmitter. (The AGC is now disabled and audio deviation will rise and fall linearly with the wireline input level from the "backbone").

No other adjustments are normally necessary upon installation (all others are factory pre-set)

4.3 Line Level Output Adjustment

The wireline "backbone" output of the station is factory adjusted for 0 dBm into 600 ohms. If desired, this level may be re-adjusted in the field by using the following procedure.

Step 1. Terminate the station to the wireline "backbone" or desired load impedance, and connect (but do not activate) an rf signal generator to the station receiver input.

CAUTION

When adjusting a repeater station, do NOT connect rf signal generator to the Junction Box antenna connector on the side of the station. This is to prevent unintentional damage to the rf signal generator caused by the inadvertent key-up of the station transmitter. Instead, open the station and disconnect the duplexer receiver input cable from the receiver preselector filter input J11, and then directly connect the rf signal generator to the receiver, via J11.

Step 2. Initiate a wireline-to-mobile key-up (line push-to-talk) by entering the station Access Code followed by "*".

NOTE

Step 2 must be performed before Step 3, since the station will not respond to DTMF commands while a modulated rf signal is applied to the station receiver with S802 activated to the PL DISable position. This occurs because received audio mixes with the DTMF command tone and prevents detection.

IMPORTANT

Both Step 3 and Step 4 MUST be accomplished within 45-seconds (before time-out), AFTER entering the "*" command.

Step 3. Move the PL DIS/XMIT switch (S802), located on the station control module front panel, to the PL DISable position (up). This allows receiver audio to be gated down the wireline "backbone" without requiring PL squelch code.

Step 4. Apply an rf signal into the receiver, modulated to 5 kHz peak deviation, with a 1 kHz tone. (PL squelch code modulation is not required).

Step 5. Adjust the LINE LEVel control (R1113), located on the tone remote control module front panel, to obtain the desired line level as measured on LINE 2 using a high impedance voltmeter (which has both inputs isolated from earth ground).

Step 6. Disconnect the rf signal generator and re-connect the duplexer receiver input cable to J11 on the receiver preselector.

4.3 Line Level Output Adjustment

The wireline "backbone" output of the station is factory adjusted for 0 dBm into 600 ohms. If desired, this level may be re-adjusted in the field by using the following procedure.

NOTE

This procedure is slightly different than the procedure described for Line Level Adjustment in Station Instruction Manual 68P81062E75.

Step 1. Terminate the station to the wireline "backbone" or desired load impedance, and connect (but do not activate) a rf signal generator to the station receiver input.

CAUTION

When adjusting a repeater station, do NOT connect rf signal generator to the Junction Box antenna connector on the side of the station. This is to prevent unintentional damage to the rf signal generator caused by the inadvertent key-up of the station transmitter. Instead, open the station and disconnect the duplexer receiver input cable from the receiver preselector filter input J11, and then directly connect the rf signal generator to the receiver, via J11.

Step 2. Initiate a wireline-to-mobile key-up (line push-to-talk) by entering the station Access Code followed by "*".

NOTE

Step 2 must be performed before Step 3, since the station will not respond to DTMF commands while a modulated rf signal is applied to the station receiver with S802 activated to the PL DISable position. This occurs because received audio mixes with the DTMF command tone and prevents detection.

IMPORTANT

Both Step 3 and Step 4 MUST be accomplished within 45-seconds (before time-out), AFTER entering the "*" command.

Step 3. Move the PL DIS/XMIT switch (S802), located on the station control module front panel, to the PL DISable position (up). This allows receiver audio to be gated down the wireline "backbone" without requiring PL squelch code.

Step 4. Apply a rf signal into the receiver, modulated to 5 kHz peak deviation, with a 1 kHz tone. (PL squelch code modulation is not required).

Step 5. Adjust the LINE LEVel control (R1113), located on the tone remote control module front panel, to obtain the desired line level as measured on LINE 2 using a high impedance voltmeter (which has both inputs isolated from earth ground).

Step 6. Disconnect the rf signal generator, re-connect the duplexer receiver input cable to J11 on the receiver preselector, and return S802 to its center (OFF) position.

5. ITEM DESCRIPTION

5.1 QRN8800A DTMF Decoder/Encoder Board

5.1.1 Operation

The station is controlled by DTMF *Touch-Code* digit input(s) received over-the-air, from the wireline "backbone", or locally through the module front panel PROGRAM jack (J2702). All commands are in the following format, with an interdigit timeout when entering any digits of 6-seconds:

[ACCESS CODE DIGITS] followed by a [FUNCTION DIGIT]
with the form of (for example):
[8 7 6 5 4 3 2 1] [9]

-- Access Code: A two to eight digit sequence of DTMF (*Touch-Code*) digits.

The Access Code may consist of a sequence of digits 0-9, *, #, and (on those keypads so equipped) any letter A through D. Access codes, other than factory defaults, are to be programmed by the installer.

NOTE

The station Access Code cannot contain the two sequences [# #] or [* #]. These two sequences are reserved as programming commands and are explained in the programming paragraph.

Up to eight different station Access Codes are allowed for each station. Any of these eight Access Codes (when not blank) can access the station.

The Factory Default Access Codes (for each station) Are:

[1 6] -- Station Access Code Number One; and,

BLANK -- Station Access Code Numbers Two Through Eight.

-- Function Digit: A single *Touch-Code* digit which causes the station to perform a desired function such as key up transmitter or access wireline "backbone."

The Factory Default Function Digits (for each station) Are:

[0] -- Mobile-To-Mobile Repeater Operation, Wireline Not Accessed;

[*] -- Mobile-To-Mobile Repeater Operation, Wireline Accessed;

[#] -- Station De-Key (repeater knockdown);

[9] -- Disable PL And Monitor All Receiver Activity On Wireline "Backbone" (this function is manually reset by choosing the [#] Function Digit, or via a no carrier 45-second timeout after the [0] or [*] functions are selected); and,

[5] -- Enable Edit Mode (used to verify or change station Access Code or ID number).

For example, a mobile operator wishing to access a station, and communicate with it via the wireline "backbone," would enter: [1 6] [*], if that station Access Code was: [1 6]. If the operator entered only part of the Access Code, and then paused for more than 6-seconds, he would have to re-enter the entire Access Code. If in doubt, the operator may always immediately re-enter the Access Code, even if some of its digits have already been entered, without it being necessary to wait 6-seconds before re-entering.

Each time a [0] or [*] function is executed, the station outputs a 3-second alert tone (941 Hz sinewave) acknowledging that the station has keyed up.

After being keyed up by a [0] or [*] function, the station will time-out and de-key within 45-seconds after no carrier (plus PL tone in PL-squelch systems) is received, even if the de-key function [#] is never manually selected.

NOTE

There is no time-out limitation for a mobile transmission, since the station receiver remains unsquelched for the duration of the mobile transmission. The 45-second timer does not start until the station receiver squelches. However, the 45-second limitation does apply to all transmissions originating via the wireline "backbone".

5.1.2 Programming

5.1.2.1 Instructions

Programming of the station Access Code and ID number requires a source of DTMF *Touch-Code* digits. To enable programming, jumper plug P(JU2703) on the DTMF decoder/encoder module must be in the PROGRAM ENABLE position. The station can be programmed locally via the front panel PROGRAM jack J2702, or remotely via the wireline "backbone," or over-the-air. If remote programming is not to be allowed, P(JU2703) should be moved to the PROGRAM DISABLE position, once the installation programming is complete.

The DTMF Source May Consist Of Any Of The Following:

1. A transmitter which can be received by the station receiver (i.e. employing a hand-held portable transciever with a built-in DTMF keyboard); or,

2. A Motorola Model HMN1011A DTMF Microphone, which has a RJ-11X plug; or,

3. A standard *Touch-Code* telephone, which has a RJ-11X plug.

While in the Edit Mode, the station will prompt and acknowledge the operator via synthesized speech generated by the DTMF encoder/decoder module. The synthesized speech is routed to the station speaker (audible if a Diagnostic Metering Panel or Radio Metering Panel is connected to the station via the EXPANSION connector), and to J2702 (audible if a telephone is connected to the PROGRAM connector). The synthesized speech is also sent down the wireline "backbone" and transmitted by the station, unless the ACCESS DISABLE switch (S801), on the front panel of the station control module is in the access disable position (up).

NOTE

If S801 is not in the access disable position (as in the case of remote programming), all synthesized speech is transmitted and sent down the wireline "backbone". If S801 is in the access disable position, the synthesized speech is available through the local speaker, and/or as earpiece audio via DTMF decoder/encoder module PROGRAM jack J2702.

As noted previously, there are two DTMF *Touch-Code* digit sequences reserved as programming commands. They are:

[* #]

Which means: Enter The Preceding Numbers

and

[# #]

Which means: Leave The Numbers Now In Memory Alone and Exit This Mode With No Further Changes.

There are two levels of programming. The first level enables programming and is named the EDIT MODE. The second level, named the ENTRY MODE, speaks to the operator and informs him of how a function is currently programmed and then allows changes to be made (if desired). To leave either level and return to the previous level, without making any further changes, the operator enters the [# #] command.

The programming sequence proceeds from normal station operation to the first level, then to a second level stage, then back to the first level before

going on to any other second level stage, etc. Programming never proceeds directly from one second level stage to another second level stage. Refer to Figure 1.

The Edit Mode is the first level of programming from which one of the eight station Access Code Entry Modes or the station ID number Entry Mode may be selected. The station will time-out and leave the Edit Mode within 45-seconds if no DTMF tones are received within that time. Just before time-out of the Edit Mode, the station outputs two beeps to warn of the impending time-out. If the station is in one of the Entry Modes and after 45-seconds of no detected DTMF tones, the station will first time-out to the Edit Mode and, after an additional 45-seconds, it will then time-out to normal station operation.

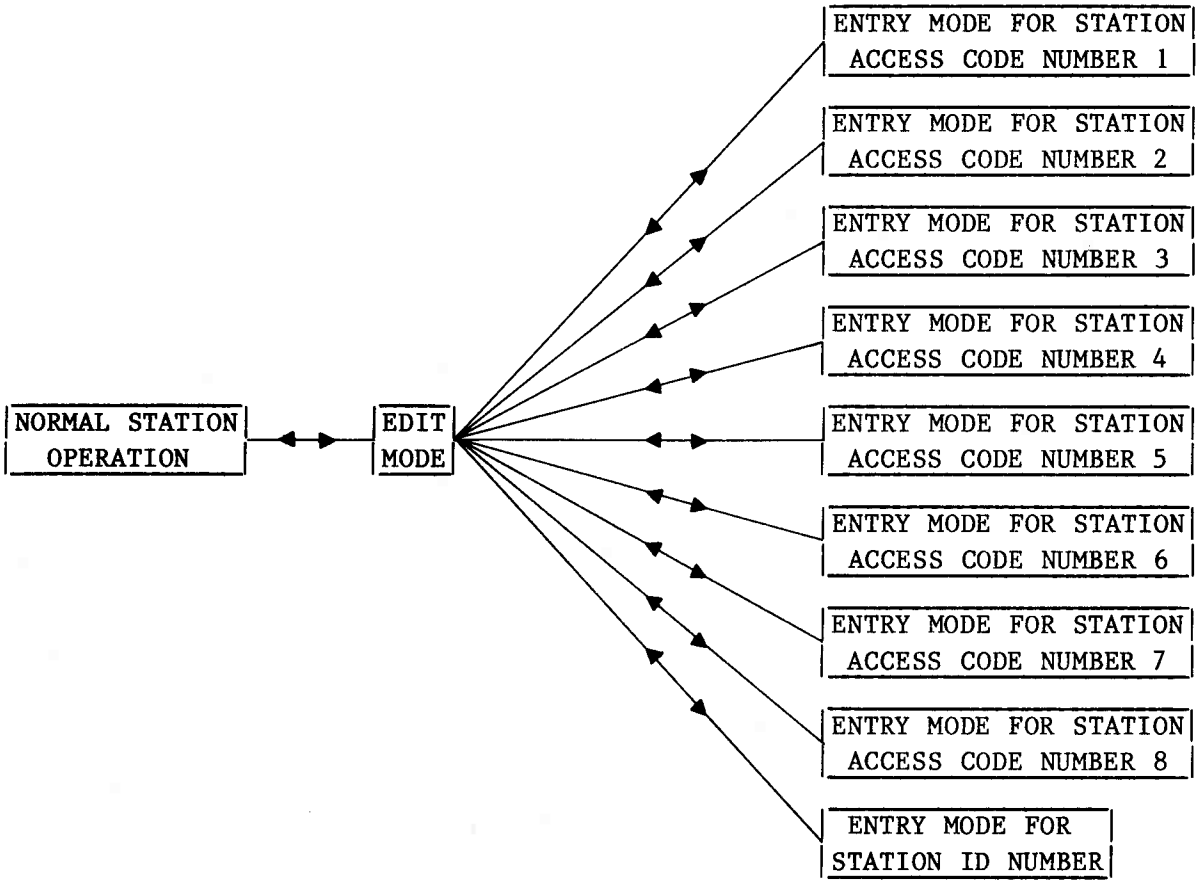


Figure 1. Programming Levels

The Station Access Code, as explained previously, is the sequence of digits that must precede a Function Digit before that function will be performed. Each station should be programmed with its own unique Access Code, 2 to 8 digits in length.

IMPORTANT

It is recommended that all stations in one system have Access Codes of the same length in order to avoid inadvertently having a short Access Code contained within a longer one. If this should occur, both stations would respond to the function command.

Up to eight different Access Codes are allowed on a single station. Any one of the valid Access Codes will cause the station to execute the Function Digit. An Access Code can be removed by entering [* #] with no value, making it blank.

The Station ID Number is only used to identify the station in a manner corresponding to the station number on a customer provided RF Indicator Decoder Panel at the central dispatch office, which provides a visual indication of the transmitter ON/OFF status of each station. As far as the station is concerned, the station ID number determines which combination of guard tone and function tone to send down the wireline "backbone" each time the station keys up or de-keys. These tone bursts are generated by the station tone remote control module and are determined by code plug firmware. Code plug firmware is established per customer requirements via Motorola Option C402__-SP. Refer to the instruction manual accompanying the tone remote control module code plug option C402__-SP for a tabular representation of guard tone/function tone combinations corresponding to each station ID number. The factory default station ID number for each new station is: [1].

IMPORTANT

When in the Edit Mode or Entry Mode, do not begin to enter digits until after the synthesized speech and BEEP responses are completed.

5.1.2.2 Command Structure

When programming, it is important that the operator keep the following constraints in mind.

1. Do not make entries until hearing the end of the prompt: a single audible BEEP.

2. The station Access Code cannot be longer than 8 digits.

3. If no new station Access Code digits are entered before entering [* #], then the present Access Code will be eliminated. If all of the eight Access Codes are blank, then the station can never be accessed for normal operation or normal programming.

4. As a failsafe, the Edit Mode can be entered directly without entering the password or the station Access Code by grounding TP6 for about 1-second on the DTMF decoder/encoder board. This method of entry can be used if the station Access Code is unknown or has been inadvertently changed.

5. The digits [# #] are entered once to exit an Entry Mode stage. If [# #] is then entered a second time, the Edit Mode will be exited and normal Station Operation will resume.

6. To enter Edit Mode: enter [Access Code] [5]. Wait for prompt to finish, then enter the station password [# * *].

7. To select an Entry Mode stage: refer to Table 1 for the proper DTMF digit entries, and wait for prompt to finish.

Table 1. Entry Mode Stage Selection Commands

ENTRY MODE STAGE	ENTER
Station Access Code Number 1	[9 1]
Station Access Code Number 2	[9 2]
Station Access Code Number 3	[9 3]
Station Access Code Number 4	[9 4]
Station Access Code Number 5	[9 5]
Station Access Code Number 6	[9 6]
Station Access Code Number 7	[9 7]
Station Access Code Number 8	[9 8]
Station ID Number	[3 1]

8. To place a new value in an Entry Mode stage, enter: [new value] [* #], after the synthesized speech prompt.

9. To remove a value from one of the Entry Mode stages and leave the stage blank, enter: [* #]

10. To leave the present Mode without any further changes, enter: [# #]

IMPORTANT

When in doubt about what to do, keep entering [# #] until back in normal Station Operation Mode.

5.1.3 Programming Step By Step

5.1.3.1 Programming A Station Access Code

Step 1. Verifying a station Access Code.

	OPERATOR ENTERED DIGITS	SYNTHESIZED SPEECH RESPONSE
a.	[station Access Code] [5]	*"Enter the station password; BEEP."*
b.	[# * *]	*"You are in the edit mode. You may select a feature; BEEP."*
c.	[9 N] (refer to Table 1 for N)	*"Access code 'N' is:* (whatever the current value of Access Code 'N' is). *You may select a new access code; BEEP."*

Step 2. Entering a new station Access Code.

OPERATOR ENTERED DIGITS	SYNTHESIZED SPEECH RESPONSE
[desired new code] [* #]	*"Access code 'N' is: (*the new code*). You may select a new access code; BEEP."*

Step 3. Leaving the station Access Code Entry Mode stage and returning to the Edit Mode.

OPERATOR ENTERED DIGITS	SYNTHESIZED SPEECH RESPONSE
[# #]	*"You are in the edit mode." You may select a feature; BEEP."*

5.1.3.2 Programming A Station ID Number

The station ID number is required for the station to send the proper guard tone/function tone sequence down the wireline "backbone" to the console monitor to indicate whether this station number is on-the-air or not. The station ID number possibilities are firmware limited to 1 through 18, inclusive. The factory default station ID number for each station is "1."

The following Steps assume that the operator is already in the Edit Mode. If not, enter the Edit Mode as described in Step 1a and 1b of paragraph 5.1.3.1 before proceeding.

Step 1. Verifying a Station ID number.

OPERATOR ENTERED DIGITS	SYNTHESIZED SPEECH RESPONSE
[3 1]	*"The station number is (*whatever the present number is*). You may select a new station number; BEEP."*

Step 2. Changing the Station ID number.

OPERATOR ENTERED DIGITS	SYNTHESIZED SPEECH RESPONSE
[new station ID number] [* #]	*"The station number is (*the new station ID number*). You may select a new station number; BEEP."*

Step 3. Leaving the Station ID Entry Mode to returning to Edit Mode.

OPERATOR ENTERED DIGITS	SYNTHESIZED SPEECH RESPONSE
[# #]	*"You are in the Edit Mode". You may select a feature; BEEP."*

5.3.1.3 . Leaving Edit Mode and Returning To Normal Operation

OPERATOR ENTERED DIGITS	SYNTHESIZED SPEECH RESPONSE
[# #]	*"You are leaving the edit mode."*

NOTE

When in the Entry Mode for a given feature, the first [# #] leaves the Entry Mode stage and returns to the Edit Mode. At this point a second [# #] would leave the Edit Mode and return to normal Station Operation. However, another feature could be selected after the first [# #] and the operator would then enter another Entry Mode stage (refer to Figure 1).

5.1.4 Programming Example

Current Values (Factory Defaults With Every New Station):

-- Station Access Code number 1 = 1 6
-- Station Access Code numbers 2 through 8 = BLANK
-- Station ID number = 1

Values To Be Programmed In:

-- Station Access Code number 1 = 8 4
-- Station Access Code numbers 2 through 8 = BLANK
-- Station ID number = 18

NOTE

P(JU2703) must be moved to the PROGRAM ENABLE position. If remote programming is not to be allowed, P(JU2703) should be placed in the PROGRAM DISABLE position after programming is complete.

OPERATOR ENTERED DIGITS	SYNTHESIZED SPEECH RESPONSE
[1 6][5]	*"Enter the station password; BEEP."*
[# * *]	*"You are in the edit mode. You may select a feature; BEEP."*
[9 1]	*"Access code one is 1 6. You may select a new access code; BEEP".*
[8 4][* #]	*"Access code one is 8 4. You may select a new access code; BEEP."*
[# #]	*"You are in the edit mode. You may select a feature; BEEP."*

OPERATOR ENTERED DIGITS	SYNTHESIZED SPEECH RESPONSE, cont'd.
[3 1]	*"The station number is one. You may select a new station number; BEEP."*
[1 8] [* #]	*"The station number is eighteen. You may select a new station number; BEEP."*
[# #]	*"You are in the Edit Mode. You may select a feature; BEEP."*
[# #]	*"You are leaving the Edit Mode."*

5.1.5 Maintenance and Troubleshooting

5.1.5.1 Maintenance Deviation Adjustment

If deviation adjustment on the Station Control board is necessary, after the IDC on the station control module and XMIT LEVEL on the tone remote control module are adjusted, perform the Installation Adjustments as given in paragraph 4.2. Then, use the following procedure to adjust the audio level leaving the DTMF decoder/encoder board.

NOTE

No devices should be plugged into the CONTROL jack on the front panel of the station control module during deviation adjustment of the DTMF decoder/encoder board.

Step 1. Put the ACCESS DISABLE switch (S801), on the front panel of the station control module, to the access disable position (up). If S801 is in the access disable position, the test tone (of Step 2) will be transmitted over-the-air and gated down the wireline "backbone". Otherwise, it will only be heard in the local speaker and/or as earpiece audio, via DTMF decoder/encoder module PROGRAM jack J2702.

Step 2. Connect TP3 to the LOGIC GND test point. A DTMF tone will be encoded by the board (# tone) as long as TP3 is held to ground.

NOTE

S801 should be set per Step 1 before grounding TP3.

Step 3. Adjust output level control R2755 on the DTMF decoder/encoder board to cause 3 kHz peak deviation of the transmitted rf carrier.

5.1.5.2 DTMF Decoder/Encoder Module Check-Out Procedure

Step 1. See if deviation can be set as in paragraph 5.1.5.1.

Step 2. Verify that the synthesized voice properly vocalizes the station Access Code, and that the Access Code(s) can be changed only if P(JU2703) is in the PROGRAM ENABLE position.

Step 3. Using a DTMF source, enter [Access Code] [0] to verify that the transmitter keys up (local PTT occurs and the yellow PA KEY LED on the station control module lights), sends the guard tone/function tone sequence (corresponding to the station ID number) that indicates RF ON down the wireline "backbone," and transmits the alert tone over-the-air and to the local speaker, but not down the wireline "backbone". After the alert tone, local PTT ceases and repeater PTT and line PTT occur. After the transmitter keys up, but before 45-seconds have elapsed, apply an rf signal to the receiver modulated with a 1 kHz tone (with the proper PL squelch tone in tone-coded squelch systems). Check to see that the audio is re-transmitted on the proper frequency.

Step 4. Remove the 1 kHz modulating tone from the rf signal going into the receiver. De-select the station by entering the DTMF command digits [Access Code] [#]. The transmitter should de-key, and the guard tone/function tone sequence (corresponding to the station ID number) that indicates RF OFF should be sent down the wireline "backbone".

Step 5. Enter DTMF digits [Access Code] [*]. Verify that the transmitter keys up and that the alert tone is transmitted over-the-air and down the wireline "backbone". Re-apply 1 kHz modulating tone to the rf carrier going into receiver and verify that audio is sent down the wireline "backbone" at the specified level.

5.1.5.3 Circuit Description and Troubleshooting

5.1.5.3.1 Microprocessor and digital circuits

As in other MSF 5000 modules, microprocessor U2701 services a "watchdog" timer every 53 mSecs. If watchdog pulses fail to appear as on the attached schematic diagram 2-SP5740118 waveform detail at TP11, then the watchdog timer assumes that the processor is not functioning properly and issues a reset to TP12 and pins 6, 8, and 10 of U2701. The watchdog timer will hold U2701 in reset for approximately 145 mSecs, then will wait 130 milliseconds for U2701 to respond with a pulse before resetting again. Note that if U2701 is not putting out any watchdog pulses the watchdog timer will reset it every 130 mSec, and these periodic reset pulses couple to TP11 through diode CR2701. The reset pulses which appear on TP11 should not be confused with the proper watchdog pulse waveform as shown on the schematic.

The positive edge of the watchdog pulse from U2701 pin (TP11) clocks U2713 pin 8 to a logic low, rapidly discharging timing capacitor C2703 through R2716 and CR2705. When the low threshold of approximately 1.2 V is reached, U2714 pin 14 goes low, resetting U2713 to a logic high and allowing C2703 to slowly charge through R2718. Normally, another watchdog pulse comes in before C2703 charges to its high threshold of 3 V (which takes approximately 130 mSec), but if not U2714 pin 13 goes low and resets U2701. During normal operation the voltage on C2703 never reaches 3 V due to the watchdog pulses from U2701, and ramps between approximately 1.2 and 2.1 V.

NOTE

The watchdog timer circuit can be temporarily inhibited from resetting the microprocessor in the absence of properly spaced watchdog pulse inputs by grounding TP1. However, this is not recommended due to the fact that since microprocessor U2701 is not working properly (as evidenced by lack of proper watchdog pulse output on pin 10 or TP11), it is possible that the code plug memory U2704 could be partially overwritten and corrupted.

Until the microprocessor successfully comes out of reset, the DELAYED RESET line inhibits address decoding of certain devices and inhibits the gates of U2717 from writing to the MUXbus. While in reset, and for 6-seconds thereafter, all four front panel LED's on the DTMF board are lit for an LED check.

If the microprocessor does come out of reset, it performs diagnostic tests on many of its interfaces. If it fails these internal tests, it will flash the TEST LED on the front panel of the DTMF module a certain number of times in sequence, followed by a pause, then a single short pulse, then the series of flashes again. The number of short flashes in a row indicates the problem, as shown in Table 2.

Table 2. TEST LED Indications

NUMBER OF FLASHES	PROBLEM
1	U2701 or U2703 defective or a problem on interconnecting lines.
2	U2704 defective or problem on address decoding of chip (going to pins 18, 20).
3	MUXbus (time-multiplexed inter-module signalling bus) problem. Refer to station instruction manual for station control module or tone remote control module instruction sections.
4	IPCB line (inter-module serial data link) problem. Refer to station instruction manual for station control module or tone remote control module instruction sections.

U2720 is a one-shot timer which only allows the microprocessor to write information to the non-volatile memory of U2703 for 10 uSec at a time to prevent corruption of memory due to failure of another device (such as U2701). The microprocessor triggers it only when programming a new value into U2704 the Code Plug EEPROM memory (during programming, for example) by toggling U2701-13 momentarily low.

For further troubleshooting of these sections, refer to the instruction manual sections for the station control or tone remote control modules.

5.1.5.3.2 DTMF detection circuits

The input of U2707 contains an op-amp stage which sums together inputs from RX1 AUDIO (from main receiver), TX AUDIO (from wireline "backbone" interface, i.e. tone remote control board), and the front panel PROGRAM jack J2702. RX1 AUDIO passes through FET Q2702 which functions as an audio control gate to prevent discriminator noise from reaching U2707 when there is no receiver activity. When the gate of Q2702 is held at ground by the processor (U2701), the gate is OFF and receiver discriminator audio will be visible on the drain of Q2702, but not the source. When receiver activity is present, Q2702 is turned on by allowing the gate to be pulled up to the bias level of the drain (approximately 4.7 V dc offset) through R2750, and RX1 AUDIO is visible at both the drain and source of Q2702.

The output of the first stage of the DTMF decoder U2707 is visible on TP7. At this point the summation of all audio entering through input resistors R2749, R2741, R2763, and (if used) R2748 and R2764. The audio should not be clipped and should be approximately 0.5 to 2.4 V peak depending on the source.

U2707 uses a 3.5795 MHz crystal connected to a built-in oscillator. The 3.58 MHz output should be visible on U2707-8 and U2709-7 (5 V p-p).

TP8 can be used as an indicator of whether circuits up through the DTMF detector U2707 are working. Normally TP8 is LO (0 V), but when a DTMF tone pair is detected, it is HI (+5 V). U2707 then puts out the DTMF tone pair number in binary on pins 11 through 15 (Q1 through Q4) as shown in Table 3.

Table 3. Binary Coded DTMF Digits

F lo	F hi	KEY	Q4	Q3	Q2	Q1
697 Hz	1209 Hz	1	0	0	0	1
697 Hz	1336 Hz	2	0	0	1	0
697 Hz	1477 Hz	3	0	0	1	1
770 Hz	1209 Hz	4	0	1	0	0
770 Hz	1336 Hz	5	0	1	0	1
770 Hz	1477 Hz	6	0	1	1	0
852 Hz	1209 Hz	7	0	1	1	1
852 Hz	1336 Hz	8	1	0	0	0
852 Hz	1477 Hz	9	1	0	0	1
941 Hz	1336 Hz	0	1	0	1	0
941 Hz	1209 Hz	*	1	0	1	1
941 Hz	1477 Hz	#	1	1	0	0
697 Hz	1633 Hz	A	1	1	0	1
770 Hz	1633 Hz	B	1	1	1	0
852 Hz	1633 Hz	C	1	1	1	1
941 Hz	1633 Hz	D	0	0	0	0

Microprocessor U2701 periodically reads input latch U2706 to determine whether TP8 is high, and if so it reads in the binary number corresponding to the DTMF digit.

5.1.5.3.3 DTMF encode circuits

U2709 is a DTMF tone generator which produces a step-approximation to a summation of two sinusoidal tones. A tone pair is produced at output U2709 pin 16 when one of the ROW pins (11-14) and one of the COLUMN pins (3, 4, 5, or, 9) are held low by output latch U2708. When no DTMF tone is being generated all ROW and COLUMN pins are held high. A test tone (#) can be generated by grounding TP3 (refer to the Deviation Adjustment paragraph). U2709 uses a 3.58 MHz clock input generated by U2707. A 5 V p-p 3.58 MHz signal should be visible on U2709-7 at all times.

5.1.5.3.4 Synthesized voice generation circuits

U2705 generates synthesized speech based on inputs from microprocessor U2701. The chip is addressed via pins 6, 7, 8, 19, 20, 21, and 22. When addressed, data present on the digital data bus (D0-D7 on pins 9-17) is latched into the chip. The audio output on pin 1 is approximately 400 mV peak, with a DC bias level of approximately 3.2 V DC. The speech can be activated by entering the programming mode (refer to the programming paragraph).

5.1.5.3.5 Audio output circuits

Audio from the DTMF tone generator U2709 and synthesized speech generator U2705 is summed and amplified by operational amplifier U2718 (one half of the chip). The output is routed through R2760 to the LOCAL AUDIO input on the station control module. There is an attenuation factor of 5 (gain of 1/5 or -14 dB) between TP9 and the LOCAL AUDIO line on the expansion connector due to the drop across R2760.

U2718-1 (the other half of the chip) drives the local speaker through summing/attenuating resistor R2773 and also will drive the speaker of a standard telephone connected to PROGRAM jack J2702.

The DC bias level of the outputs of U2718 (pins 7 and 1) is approximately 4.8 V, provided by voltage divider R2761 and R2762.

5.1.5.4 Required Station Control Code Plug Parameters

If the Model TRN5194A Station Control Code Plug (on the station control module) must be replaced or reprogrammed, the following parameters must be programmed as part of its firmware.

-- The time-out-timers for local push-to-talk, repeater push-to-talk, and wireline push-to-talk must all be disabled (i.e.: set to zero).

-- The repeater drop-out delay must be set to zero.

-- The push-to-talk priority must be set with local push-to-talk having priority over repeater push-to-talk over wireline push-to-talk (i.e.: L-R-W).

5.2 QRN8801A DTMF Decoder/Encoder Module Bezel Kit

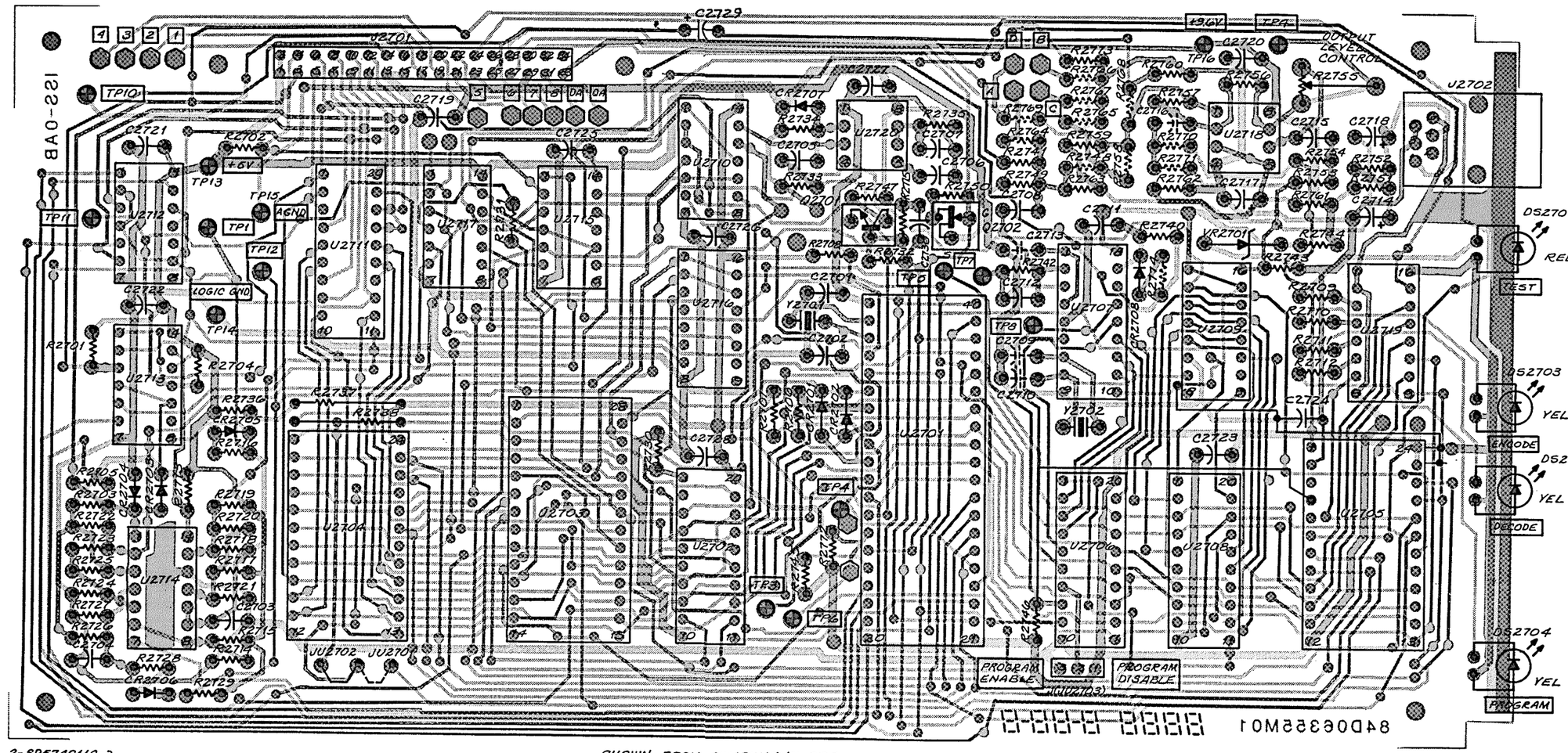
The bezel in this kit fastens the DTMF decoder/encoder module into the expansion tray and provides a screened legend on its surface. Refer to the attached parts list 4PL-SP5740118 for kit contents.

5.3 QRN8802A DTMF Code Plug Kit

The programmed EEPROM in this kit provides the unique DTMF station operating system as required by the customer and described in the DTMF parameter card. This unique system functions in conjunction with the customer required station operating system described in the station parameter booklet and programmed into the station control and tone remote control module code plugs. Refer to the attached parts list 3PL-SP5740118 for kit contents.

5.4 QRN8842A DTMF Decoder/Encoder Program EPROM Kit

The programmed EPROM in this kit provides the generic DTMF station operating system. This generic system functions in conjunction with the generic station operating system described in the station instruction manual and programmed into the station control and tone remote control module program EPROMs. Refer to the attached parts list 6PL-SP5740118 for kit contents.



2-SP5740118-2
(SHEET 1 OF 3)

SHOWN FROM COMPONENT SIDE

OPTION JACK (PIN VIEW)

CONNECTOR DETAILS

5V	1	2	5V
IPCB	3	4	EXPANSION RESET
BA0	5	6	BA1
BA2	7	8	BA3
$\overline{BD0}$	9	10	$\overline{BD1}$
$\overline{BD2}$	11	12	$\overline{BD3}$
	13	14	$\overline{DS}$
LOGIC GND	15	16	
	17	18	LOGIC SPARE
LOGIC SPARE	19	20	
	21	22	AUDIO SPARE
AUDIO SPARE	23	24	SELECT AUDIO
LOCAL AUDIO	25	26	TX DATA AUDIO
RX2 AUDIO	27	28	TX AUDIO
AUDIO GND	29	30	RX1 AUDIO
QUAD AUDIO	31	32	AUDIO REFERENCE
+9.6V	33	34	A+

J2701

PROGRAM JACK (FRONT VIEW)

6	LOGIC GND
5	AUDIO GND
4	PROGRAMMING AUDIO
3	AUDIO GND
2	NOT USED
1	IPCB

J2702

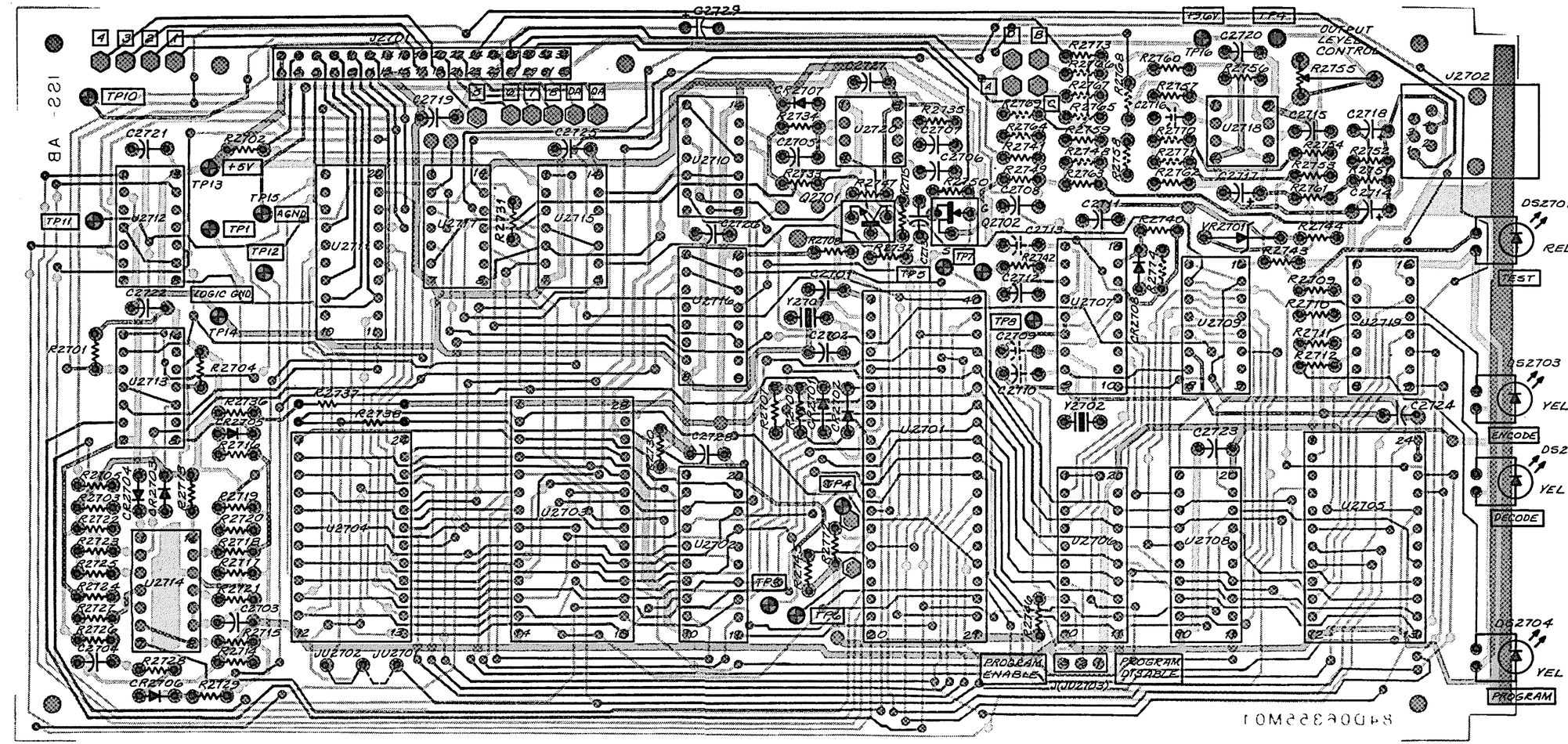
TRANSISTOR BASE DETAILS

Q2701: C B E

Q2702: G S D

(PIN VIEW)

QRN8800A DTMF Decoder/Encoder Board
Circuit Board Detail (EARLIER VERSION)
Motorola No. 2–SP5740118–2
(Sheet 1 of 3)
8/30/84



2-SP5740118-2
(SHEET 2 OF 3)

SHOWN FROM COMPONENT SIDE

OPTION JACK (PIN VIEW) — CONNECTOR DETAILS

J2701

5V	1	2	5V
IPCB	3	4	EXPANSION RESET
BA0	5	6	BA1
BA2	7	8	BA3
BD0	9	10	BD1
BD2	11	12	BD3
	13	14	DS
LOGIC GND	15	16	
	17	18	LOGIC SPARE
LOGIC SPARE	19	20	
	21	22	AUDIO SPARE
AUDIO SPARE	23	24	SELECT AUDIO
LOCAL AUDIO	25	26	TX DATA AUDIO
RX2 AUDIO	27	28	TX AUDIO
AUDIO GND	29	30	RX1 AUDIO
QUAD AUDIO	31	32	AUDIO REFERENCE
+9.6V	33	34	A+

PROGRAM JACK (FRONT VIEW)

J2702

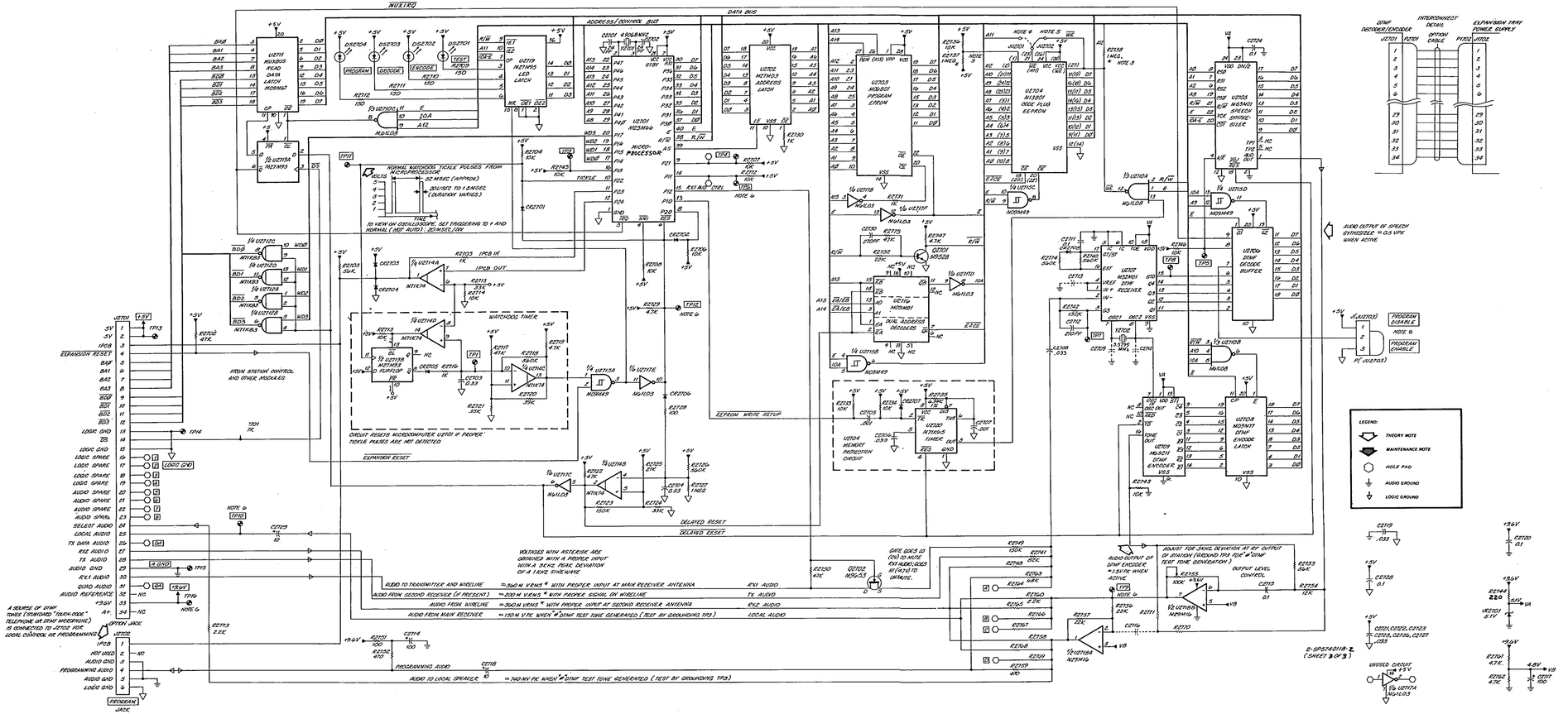
6	LOGIC GND
5	AUDIO GND
4	PROGRAMMING AUDIO
3	AUDIO GND
2	NOT USED
1	IPCB

TRANSISTOR BASE DETAILS

Q2701: C B E — Q2702: G S D

(PIN VIEW)

QRN8800A DTMF Decoder/Encoder Board
Circuit Board Detail (Later Version)
Motorola No. 2–SP5740118–2
(Sheet 2 of 3)
9/4/84



NOTES:

1. Unless otherwise specified, all resistor values are in ohms, and all capacitor values are in microfarads.
2. Unless otherwise specified, all voltage measurements are DC and should be made using a DVM with at least 10 megohms/volt input impedance.
3. Components marked with a single asterisk (*) are not used with a 28-pin code plug.
4. JU2701 is normally OUT, and JU2702 is normally IN.
5. U2704 pin numbers in parentheses are used when a 28-pin code plug is employed.
6. Refer to Table 1 for test point definitions.
7. Refer to the chart of Table 2 for integrated circuit data.
8. When P(JU2703) is installed in the PROGRAM DISABLE position, the Edit Mode (programming mode) of MCU U2701 cannot be entered. When installed in the PROGRAM ENABLE position, programming can be accomplished via the front panel PROGRAM jack J2702, or via the wireline, or via received audio.

Table 1. Test Point Definitions

TEST POINT	SCHEMATIC LOCATION	USE
TP1	U2714C-10	Connect To Logic GND To Disable Watchdog Timer Circuit
TP2	NONE	NOT USED
TP3	U2701-16	Ground to Cause Generation Of # DTMF Test Tone
TP4	U2701-9	Spare
TP5	U2706-8	Factory Test
TP6	U2701-4	If P(JU2703) Is In The PROGRAM ENABLE Position, The Programming Mode Of MCU U2701 Can Be Entered By Momentarily Grounding The Pin (No Access Code Required)
TP7	U2707-3	DTMF Decoder Stage 1 Audio Output Is Summation Of All Audio Inputs
TP8	U2707-15	HI (+5V) When A Valid DTMF Tone Is Being Detected
TP9	U2718B-7	Output Audio (DTMF Tones Or Speech) To Transmitter, Wireline, and Speaker/Handset
TP10	J2701-25	Local Audio (Audio Out To Transmitter And Wireline)
TP11	U2701-10	Watchdog Timer Circuit Tickle Pulses
TP12	U2701-6	If LO (0 V) Microcomputer U2701 Is Reset, Normally HI (+5V)
TP13	J2701-1,2	+5V
TP14	J2701-13,15	Logic GND
TP15	J2701-29	Audio GND
TP16	J2701-33	+9.6V

Table 2. Integrated Circuit Data Chart

INTEGRATED CIRCUIT	+5V PIN	LOGIC GND	+9.6V PIN	AUDIO GND	AUDIO VA
U2701	7,21	1			
U2702	20	10		2	
U2703	1,28	14			
U2704	24	12			
U2705		12			23,24
U2706	20	10			
U2707			9	10,18	
U2708	20	10			
U2709			6	1,15	
U2710	14	7			
U2711	20	10			
U2712	14	7			
U2713	14	7			
U2714	3	12			
U2715	14	7			
U2716	16	8			
U2717	14	7			
U2718			8	4	
U2719	16	8			
U2720	8	1			

QRN8800A DTMF Decoder/Encoder Board
Schematic Diagram
Motorola No. 2–SP5740118–**2**
(Sheet **3** of 3)
8/**3**0/84

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed; uF; +80-20%; 50V; unless otherwise stated:
C2701, 2702	2111022G39	24±5%
C2703, 2704	0811051B16	0.33±10%; 63 V
C2705	0811017A01	.001±5%
C2706	2111021H06	.033
C2707	0811017A01	.001±5%
C2708	0811017A13	.033±5%
C2709, 2710	----	NOT USED
C2711	0811051A13	0.1
C2712	2111021A06	270±10%
C2713	----	NOT USED
C2714	2311019A46	100±20%; 25 V
C2715	0811051A13	0.1±5%; 63 V
C2716	----	NOT USED
C2717	2311019A46	100±20%; 25 V
C2718	2311019A22	10±20%
C2719	2111021H06	.033
C2720	0811051A13	0.1±5%; 63 V
C2721, 2722, 2723	2111021H06	.033
C2724	0811051A13	0.1
C2725, 2726, 2727	2111021H06	.033
C2728	0811051A13	0.1±5%; 63 V
C2729	2311019A22	10±20%
C2730	2111021A06	270±10%
		DIODE: (SEE NOTE)
CR2701, 2702	4884616A09	hot carrier
CR2703 thru 2708	4811034D01	silicon
		LIGHT EMITTING DIODE: (SEE NOTE)
DS2701	4888245C28	RED
DS2702 thru 2704	4888245C30	YEL
		CONNECTOR, receptacle:
J2701	2883136N05	male, 34-contacts
J2702	0983112N01	female, 6-contacts; type RJ-11X
J(JU2703)	2884729L02	male, 3-contacts
		JUMPER, resistor:
JU2702	0611009F23	zero ohms
		CONNECTOR, plug:
P(JU2703)	0984728L01	female, 2-contacts
		TRANSISTOR: (SEE NOTE)
Q2701	4800869528	NPN; type M9528
Q2702	4800869653	FET; type M9653

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		RESISTOR, ohms; ±5%; 1/4W; unless otherwise stated:
R2701, 2702	0611009E89	47k
R2703	0611009E91	56k
R2704	0611009E73	10k
R2705	0611009E49	1k
R2706, 2707, 2708	0611009E73	10k
R2709 thru 2712	0611009E29	150
R2713, 2714	0611009E73	10k
R2715	0611009E85	33k
R2716	0611009E49	1k
R2717	0611009E89	47k
R2718	0611009F16	560k
R2719	0611009E65	4.7k
R2720	0611009E87	39k
R2721	0611009E85	33k
R2722	0611009E65	4.7k
R2723	0611009F02	150k
R2724	0611009E85	33k
R2725	0611009E83	27k
R2726	0611009F16	560k
R2727	0611009F22	1 meg
R2728	0611009E25	100
R2729	0611009E65	4.7k
R2730, 2731	0611009E49	1k
R2732	0611009E81	22k
R2733, 2734	0611009E73	10k
R2735	0610621C72	6.34k±1%
R2736	0611009E73	10k
R2737, 2738	0611009B22	1 meg
R2739	----	NOT USED
R2740	0611009F16	560k
R2741	0611009E95	82k
R2742	0611009F02	150k
R2743	0611009E73	10k
R2744	0611009E33	220
R2745, 2746	0611009E73	10k
R2747	0611009E65	4.7k
R2748	----	NOT USED
R2749	0611009F02	150k
R2750	0611009E89	47k
R2751	0611009E25	100
R2752	0611009E41	470
R2753	0611009E91	56k
R2754	0611009E75	12k
R2755	1884944C07	variable, 100K±20%; 0.1 W (Output Level)
R2756, 2757	0611009E81	22k
R2758	----	NOT USED
R2759	0611009E41	470
R2760	0611009E57	2.2k
R2761, 2762	0611009E65	4.7k
R2763	0611009E93	68k
R2764 thru 2771	----	NOT USED
R2772	0611009E73	10k

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R2773	0611009E57	2.2k
R2774	0611009F16	560k
R2775	0611009E65	4.7k
		INTEGRATED CIRCUIT: (SEE NOTE)
U2701	5183625M66	microprocessor, MC6803; type M25M66
U2702	5183627M03	octal D-type latches; type M27M03
U2703	----	NOT USED
U2704	----	NOT USED
U2705	5106353M01	speech synthesizer; type M53M01
U2706	5183627M96	octal line driver/buffers; type M27M96
U2707	5106352M01	DTMF receiver; type M52M01
U2708	5182609M77	octal D-type flip-flops; type M09M77
U2709	5180065C11	DTMF encoder; type M65C11
U2710	5184561L08	triple 3-input NAND gates; type M61L08
U2711	5182609M67	octal D-type flip-flops; type M09M67
U2712	5184371K83	quad 2-input NAND gates; type M71K83
U2713	5183627M93	dual D-type flip-flops; type M27M93
U2714	5184371K74	quad comparators; type M71K74
U2715	5182609M49	quad 2-input NAND triggers; type M09M49
U2716	5182609M81	dual address decoders; type M09M81
U2717	5184561L03	hex inverters; type M61L03
U2718	5183629M16	dual operational amplifiers; type M29M16
U2719	5183627M95	4-bit D-type register; type M27M95
U2720	5184371K65	timer; type M71K65
		VOLTAGE REGULATOR: (SEE NOTE)
VR2701	4882256C15	zener; 5.1 V
		CRYSTAL: (SEE NOTE)
Y2701	4882611M15	quartz; 4.068 MHz
Y2702	4882611M18	quartz; 3.5795 MHz
		NON-REFERENCED PARTS:
	0984881F02	SOCKET, 28-contacts (U2703)
	0984881F03	SOCKET, 40-contacts (U2701)
	0984881F01	SOCKET, 24-contacts; 2-used (U2704, 2705)
	1484602K01	INSULATOR, crystal; 2-used
	2910271A15	TERMINAL, pin; 15-used (Test Points)
	8406355M01	BOARD, printed circuit

NOTE: For optimum performance, crystals, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
U2704	5106370M02	INTEGRATED CIRCUIT: (SEE NOTE) 2k x 8 EEPROM, programmed; type M70M02
	5484594N03	NON-REFERENCED PART: CARD, parameter
		NOTE: For optimum performance, crystals, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		MECHANICAL PART:
	13-06369M01	BEZEL, screened

PARTS LIST

REF SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		INTEGRATED CIRCUIT: (SEE NOTE)
U2703	51-06370M01	8k x 8 EPROM, programmed; type M70M01
		NON-REFERRENCED PART:
	54-84691N01	LABEL, identification
		NOTE: For optimum performance, crystals, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.