

MAINTENANCE MANUAL FRONT CAP ASSEMBLY 19D903555G1

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DESCRIPTION

Front Cap Assembly 19D903555G1 is used in the MDR mobile radio. This assembly consists of a plastic front cap that houses Handset Interface Board 19D903510G1 and a shield/bracket. The Handset Interface Board performs handset transmit and receive audio compression, handset power line filtering, external speaker 3-Watt audio amplification and audio muting.

CIRCUIT ANALYSIS

Handset Interface Board 19D903510G1 circuitry includes transmit and receive audio compressor circuits, a 3Watt external speaker audio amplifier, muting controls, external option interfaces, handset power filter, and power supplies.

AUDIO COMPRESSORS

The audio compressor circuits for the board consist of analog compandor U802, operational amplifier U803 and associated circuitry. The receiver's audio compressor is formed by U802.1 and U803.1. The transmit audio compressor for the mic audio is formed by U802.2 and U803.2. These circuits provide automatic level control and noise reduction for the audio signals which pass through them.



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Op amp stage U803 buffers (attenuates and compresses) the audio signal passing through the circuit. The device is configured as an inverting amplifier. The compandor's gain cell sets the AC coupled variable resistance in the feedback loop of the op amp. This allows the compandor to control the gain the op amp.

Compandor U802 contains a temperature-compensated linearized gain cell with a full-wave rectifier and a buffer amplifier. A wide dynamic range is obtained from the device due to the inherent low distortion, low noise, and linearization of large signals. The internal buffer amplifier provides independent control of the attack and recovery time. The onset of compression occurs at inputs of 320 millivolts rms.

TX Compressor

The transmit audio signals to be compressed are AC coupled to both the inverting input of op amp U803.2 and to the rectifier input of compandor U802.2. Larger signals are attenuated more than the smaller signals. Diode package D851 provides fast limiting for the circuit. The signal fed to the compandor's input via C860 and R861 is used by the compandor to control the overall gain of the op amp.

The compandor's variable resistance (gain cell) is connected in parallel with the feedback path of the op amp. This resistance is controlled by the average level of the rectified input. For low-level input signals, the diode rectifier in the compandor does not turn on, thus maintaining maximum gain cell resistance and maximum U803.2 stage gain. Large input signals cause the compandor to reduce the gain cell's resistance, thus maintaining a constant level on the output of the circuit. The compandor's attack and decay times are set by the external capacitor and resistor networks. The audio is processed so that short audio peaks cause flat release times (increasing the average loudness). Long audio phrases with a high average level cause slower release times to reduce the annoying rush of gain and noise between words. The absolute maximum output for the circuit is 250 millivolts rms.

RX Compressor

Receive audio compressor is performed by compandor U802.1, op amp U803.1 and associated components. This compressor circuit is identical to the TX compressor circuit. Tables 1 and 2 list level and frequency response data for both circuits.

Table 1 - Typical Compressor Audio Levels (At 1000 Hz)

TX AUDIO J725-6	MIC HI P701-4	
RX AUDIO P701-5	COMP RX AUDIO J752-8	
(mV rms)	(mV rms)	
50	26	
100	52	
200	102	
400	168	
1000	210	
2000	225	

Table 2 - Compressor Frequency Responses (At 100 mV rms Input)

TX AUDIO J725-6	MIC HI P701-4	
RX AUDIO P701-5	COMP RX AUDIO J752-8	
(mV rms)	(mV rms)	
300	-0.2 dBm	
500	-0.1 dBm	
1000	0 dBm (Ref)	
2500	-0.1 dBm	
3000	-0.2 dBm	

EXTERNAL SPEAKER AUDIO AMPLIFIER

Audio from the RX compressor is amplified by audio power amplifier U801. This amplifier stage provides up to 3-Watts of drive for an external speaker connected to option connector J905 on the System Board. Resistor R802, capacitors C801 and C802, and field-effect transistor Q802 couple the compressed audio to the amplifier. Q802 provides mute operation. The external speaker audio is applied to J901 pin 1 (SPKR HI).

The 3-Watt audio amplifier has a gain of 22 (27 dB). This gain is set by R805, R806 and C803. Components R803, R804, C804, C806 and C810 prevent high-frequency oscillations. Table 3 shows the amplifier's response characteristics. Rated power occurs at an input of approximately 320 mV rms.

Table 3 - External Speaker Amplifier Response Characteristics (at 1000 Hz)

RX AUDIO P701-5 (mV rms)	COMP RX AUDIO J752-8 (mV rms ±20%)*)
50	475
100	945
200	1800
400	3250
1000	4050
2000	4175

* Into A 4-Ohm Speaker Load

MUTING CIRCUITS

Receive audio applied to the handset and external speaker amplifier is muted several different ways. The microprocessor circuits on the Logic Board mute both the handset and the external speaker audio via HANDSET SPKR MUTE (P701 pin 7). The active low AUDIO MUTE line (J901 pin 12) from the option connector (J905 pin 10) on the System Board provides muting capability for options. Muting of the external speaker when the radio is transmitting is provided by the EXT SPKR MUTE / EXT PTT line (P701 pin 2) and the EXT PTT line (J901 pin 15). In addition, power-up mute is performed by MUTE 1 and MUTE2 from transistors Q806 and Q807 respectively.

Simultaneous Handset And External Speaker <u>Muting</u>

When muted from the microprocessor, HANDSET SPKR MUTE (P701 pin 7) is high, Q805 is turned on and its collector is pulled low. This turns FET Q804 off, thus preventing the receiver's audio on RX AUDIO (P701 pin 5) from passing to the RX compressor. The audio input to the RX compressor is then muted. This action mutes both the handset and the 3-Watt external speaker.

Power-up muting for the handset's earpiece and on hook speaker is provided by the MUTE 1 line from Q806. When the radio is turned on, the rising + 8V line causes C887 to charge and turn on Q806 via R875. This causes Q806's collector to pull the COMP RX AUDIO output (J725 pin 8) to ground. This mute lasts approximately 20 milliseconds.

A bidirectional line from the microprocessor on the Logic Board periodically samples the EXT SPKR MUTE / EXT PTT line (P701 pin 2) to determine if EXT PTT (J901 pin 15) is being pulled low to key the radio. If it is, the microprocessor reconfigures the line as an output and then it pulls EXT SPKR MUTE / EXT PTT low for a few milliseconds before it samples it again. With EXT SPKR MUTE / EXT PTT low, Q803 is off, Q808 and Q801 are on, and Q802 is off. With Q802 off, no audio from the RX compressor is allowed to pass to audio

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When muted from an externally connected option, the active low AUDIO MUTE line (J901 pin 12) is pulled low by the option. This low turns FET O804 off via D852 and R878. With Q804 off, the audio is muted as described in the previous paragraph. AUTO MUTE is used by options that generate tone or data (FSK for example) signalling. This action also mutes both the handset and the 3-Watt external speaker. VOL/SQ HI on the option connector is not muted.

External Speaker Muting

When the external speaker amplifier is operating (not muted), P701 pin 2 is high. In this condition, O803 is on, Q808 and Q801 are off, and Q802 is on. With Q802 on, audio from the RX compressor is allowed to pass to, and be amplified by U801. With Q801 off approximately 0.8 Vdc appears on U801 pin 2 and U801 operates normally.

amplifier U801. In addition, since O801 is on, approximately 1.25 Vdc is applied to the inverting input of U801. This action causes U801 's output to rail to ground, thus disabling the amplifier. Mute circuit chatter caused by the microprocessor sampling of the EXT SPKR MUTE / EXT PTT line is prevented by the RC time constant consisting of R757, R871 and C869.

Power-Up Muting

Power-up muting for the external speaker amplifier is provided by the MUTE2 line from Q807. This circuit operates similar to the MUTE1 circuit. Q807's collector pulls the non-inverting input of U801 low. This mute also lasts approximately 20 milliseconds.

EXTERNAL MICROPHONE AUDIO

When an external microphone is being keyed, the external mic audio is applied through the System Board to EXT MIC HI (J901 pin 7). This mic audio is summed with the handset's mic audio at the input of the TX compandor. This summing of mic audio allows customer specific devices to generate tones, data (ex. FSK), or audio to modulate the transmitter.

HANDSET POWER FILTER

The handset power filter circuit consists of transistor Q850 and associated circuitry. Capacitor C880 provides bulk filtering on the switch power line (SW A+). The filter consisting of R780, R781, C881, and C882 is a two-pole network that filters out ripple noise present on the switched power line. This well filtered DC level is applied to the base of Q850. Since Q850 is configured as an emitter-follower, the DC power applied to the handset at J725 pin 5 is a well filtered level regardless of supply fluctuations on SW A + or changing current requirements of the handset. With a switched supply (SW A +) voltage of 13.8 Vdc, the power to the handset is approximately 12 Vdc.

The handset power supply is switch on and off by the active low HANDSET POWER ENABLE line from the Logic Board. When this line is low, Q851 and Q852 are turned on to supply SW A + power to the filter circuit.

HANDSET SERIAL DATA

The handset is linked to and from the microprocessor on the Logic Board through two (2) serial data lines. They are: KEYPAD SERIAL (J725 pin 1 to P701 pin 1) and DISPLAY SERIAL (P701 pin 6 to J725 pin 3). The handset communicates with the microprocessor through the 300 baud serial data link at TTL logic levels. Commands are inverted 8-bit ASCII bursts. When the handset display is updated, the microprocessor passes data over the DISPLAY SERIAL line. When key presses are detected by the handset, the microprocessor receives data over the KEYPAD SERIAL line. When no data is transmitted, both lines remain at a high logic level.

RADIO ON/OFF CONTROL

The radio is turned on and off via the POWER SW (J725 pin 4 and J901 pin 9) control line from the hand-set. This control is derived from an independent button on the hand-set; it is not controlled by the microprocessor in the handset. When the button is pressed, the power switch momentarily shorts POWER SW to ground. This falling edge toggles a D-type flip-flop on the System Board. The output of the flip-flop drives a power transistor on the System Board which routes continuous battery power (A +) to the switched power line (SW A+).

POWER DISTRIBUTION

Switched power (SW A +) from the System Board feeds the Handset Interface Board through J901 pins 5 and 6. SW A + supplies 13.8 Vdc (nominal) to the 3-Watt audio amplifier, 8-Volt regulator, and the hand-set power filter.

Regulator U804 supplies 8 Vdc to the + 8V supply line used throughout the board and to bias regulator U805. Bias regulator U805 supplies 5 Vdc on the bias line. This 5 Vdc supply is used as a pull-up voltage source on various digital signals. It is also used on various points on the audio lines.

FRONT VIEW







SIDE VIEW



⁽¹⁾ NOTES: TORQUE SCREWS: ITEM 4, 6 TO 10 INCH-POUNDS ITEM 5 TO 15 INCH-POUNDS

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FRONT CAP ASSEMBLY 19D903555G1

(19D903555, Sh. 1, Rev. 0)





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VOLTAGE REGULATOR U804 19A704073P2

VOLTAGE REGULATORS

19A7040732P2

BOTTOM VIEW

PIN	1 -	OUTPUT
PIN	2 -	GROUND
PIN	3 -	INPUT

VOLTAGE REGULATOR U805 19A704971P1

VOLTAGE REGULATORS

19A704971P1 & P2





PIN INDENTIFICATION

PIN 1 - OUTPUT PIN 2 - GROUND PIN 3 - INPUT

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OUTLINE DIAGRAM

COMPONENT SIDE



(19D903510, Sh. 1, Rev. 4) (19D903508, Layer 1, Rev. 4)

SOLDER SIDE



(19D903510, Sh. 1, Rev. 4) (19D903508, Layer 2, Rev. 4)



CAUTION **OBSERVE PRECAUTIONS** FOR HANDLING ELECTROSTATIC SENSITIVE DEVICES

(SOT) DIODES (TOP VIEW)



LEAD IDENTIFICATION FOR D850, D851 AND D852

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(SOT) TRANSISTORS (TOP VIEW)



LEAD IDENTIFICATION FOR Q801, Q803, Q805, Q806 Q807, Q808, Q851, & Q852

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IN-LINE TOP VIEW

FLAT



19D903510G1

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FRONT CAP ASSEMBLY 19D903555G1

ISSUE 1

SYMBOL	PART NO.	DESCRIPTION
A9		HANDSET INTERFACE BOARD
		19D903510G1
		CAPACITORS
C750 thru C755	19A 702061 P61	Ceramic: 100 pF <u>+</u> 5%, 50 VDCW, temp coef 0 <u>+</u> 30 PPM.
C756 and C757	19A702061P77	Ceramic: 470 pF \pm 5%, 50 VDCW, temp coef 0 ± 30 PPM.
C758 and C759	19A.702061P61	Ceramic: 100 pF \pm 5%, 50 VDCW, temp coef $\theta \pm 30$ PPM.
C761 thru C763	19A702061P77	Ceramic: 470 pF \pm 5%, 50 VDCW, temp coef 0 \pm 30 PPM.
C764 and C765	19A702061P61	Ceramic: 100 pF \pm 5%, 50 VDCW, temp coef 0 \pm 30 PPM.
C801	19A705205P19	Tantalum: 2.2 uF <u>+</u> 20%, 10 VDCW.
C802	19A702052P14	Ceramic: 0.01 uF + 10%, 50 VDCW.
C803	19A705205P6	Tantalum: 10 uF, 16 VDCW; sim to Sprague 293D.
C804	19A702052P26	Ceramic: 0.1 uF ± 10%, 50 VDCW.
C806	19A702052P26	Ceramic: 0.1 uF + 10%, 50 VDCW.
C808	19A701225P11	Electrolytic: 470 uF -10% to +75%, 16 VDCW.
C809	19A705205P13	Tantalum: 4.7 uF, 10 VDCW; sim to Sprague 293D.
C810	19A 702052 P26	Ceramic: 0.1 uF + 10%, 50 VDCW.
C850	19A705205P2	Tantalum: 1 uF, 16 VDCW; sim to Sprague 293D.
C851 thru C854	19A 705205P19	Tantalum: 2.2 uF <u>+</u> 20%, 10 VDCW.
C855	19A 705205P12	Tantalum: .33 uF, 16 VDCW; aim to Sprague 293D.
C856	19A 705205P6	Tantalum: 10 uF, 16 VDCW; sim to Sprague 293D.
C857	19A704879P1	Electrolytic: 100 uF, 6.3 VDCW.
C858	19A 702061 P77	Ceramic: 470 pF \pm 5%, 50 VDCW, temp coef 0 \pm 30 PPM.
C859 thru C862	19A705205P19	Tantalum: 2.2 uF <u>+</u> 20%, 10 VDCW.
C863	19A705205P12	Tantalum: .33 uF, 16 VDCW; sim to Sprague 293D.
C864	19A705205P6	Tantalum: 10 uF, 16 VDCW; sim to Sprague 293D.
C865	19A704879P1	Electrolytic: 106 uF, 6.3 VDCW.
C866	19A 702061 P77	Ceramic: 470 pF \pm 5%, 50 VDCW, temp coef 0 ± 30 PPM.
C867 and C868	19A 705205P19	Tantalum: 2.2 uF <u>+</u> 20%, 10 VDCW.
C869	19A705205P2	Tantalum: 1 uF, 16 VDCW; sim to Sprague 293D.
C880	19A703314P11	Electrolytic: 47 uF +20%, 35 VDCW.
C381 and C882	19A704879P2	Electrolytic: 47 uF \pm 20%, 16 VDCW.
C883	19A702052P26	Ceramic: 0.1 uF + 10%, 50 VDCW.
C886	19A704879P2	Electrolytic: 47 uF +20%, 16 VDCW.
C887	19A 705205P19	Tantalum: 2.2 uF <u>+</u> 20%, 10 VDCW.

SYMBOL	PART NO.	DESCRIPTION
		····· DIODES ·····
D850 thru D852	19A 700053P2	Silicon: 2 Diodes in Series; sim to BAV99.
		JACKS
J 725	19B801698P1	Connector, modular: 8-Position, 8 Contacts.
J901	19A703248P17	Post: Gold Plated, 14 mm length.
		·····PLUGS ·····
P701	19B209727P31	Connector.
		TRANSISTORS
Q801	19A.700059P2	Silicon, PNP: sim to MMBT3906, low profile.
Q802	19A134137P7	Silicon, FET N-type.
Q603	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q804	19A134137P7	Silicon, FET N-type.
Q805 thru Q808	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q850	19A702503P2	Silicon, NPN: sim to 2N4401.
Q851	19A700076P2	Silicon, NPN: sim to MMBT3904, low profile.
Q852	19A700059P2	Silicon, PNP: sim to MMBT3906, low profile.
		·····RESISTORS ·····
R750	19B800607P104	Metal film: 100K ohms <u>+</u> 5%, 1/8 w.
R752		
R753	19B800607P105	Metal film: 1M ohms <u>+</u> 5%, 1/8 w.
R754	19B800607P563	Metal film: 56K ohma <u>+</u> 5%, 1/8 w.
R755 and R756	19B800607P104	Metal film: 100K ohms <u>+</u> 5%, 1/8 w.
R757	19B800607P563	Metal film: 56K ohms <u>+</u> 5%, 1/8 w.
R780	19B800607P470	Metal film: 47 chms <u>+</u> 5%, 1/8 w.
and R781		
R782	19B800607P472	Metal film: 4.7K ohms <u>+</u> 5%, 1/8 w.
R783	19B800607P473	Metal film: 47K ohms <u>+</u> 5%, 1/8 w.
R784	19B800607P103	Metal film: 10K ohms <u>+</u> 5%, 1/8 w.
R785		
R786	19B800607P222	Metal film: 2.2K ohma <u>+</u> 5%, 1/8 w.
R802	19A702931P265	Metal film: 4640 ohms +1%, 1/8 w.
R803 and R804	19B800607P2R2	Metal film: 2.2 ohms <u>+</u> 5%, 1/8 w.
R805	19B800607P221	Metal film: 220 ohma <u>+</u> 5%, 1/8 w.
R806	19B800607P100	Metal film: 10 ohms <u>+</u> 5%, 1/8 w.
R809	19B800607P102	Metal film: 1K ohms + 5%, 1/8 w.
R810	19B800607P103	Metal film: 10K ohma + 5%, 1/8 w.
R811	19B800607P472	Metal film: 4.7K chms <u>+</u> 5%, 1/8 w.
R812	19B800607P222	Metal film: 2.2K ohms + 5%, 1/8 w.
R850	19A 702931 P368	Metal film: 49.9K ohma +1%, 1/8 w.
R851	19A 702931 P418	Metal film: 150K ohma <u>+</u> 1%, 1/8 w.
R85 2	19A702931P337	Metal film: 23.7K ohms +1%, 1/8 w.
R853	19B800607P102	Metal film: 1K ohms <u>+</u> 5%, 1/8 w.

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SYMBOL	PART NO.	DESCRIPTION
R854 and R855	19B800607P274	Metal film: 270K ohms <u>+</u> 5%, 1/8 w.
R856	19B800607P472	Metal film: 4.7K ohms + 5%, 1/8 w.
R857	19B800607P272	Metal film: 2.7K ohms <u>+</u> 5%, 1/8 w.
R858	19A702931P176	Metal film: 604 ohms <u>+</u> 1%, 1/8 w.
R859	19A702931P368	Metal film: 49.9K ohms <u>+</u> 1%, 1/8 w.
R860	19A702931P418	Metal film: 150K ohma <u>+</u> 1%, 1/8 w.
R861	19A 702931P337	Metal film: 23.7K ohms +1%, 1/8 w.
R862	19B800607P102	Metal film: 1K chma <u>+</u> 5%, 1/8 w.
R863 and R864	19B800607P274	Metal film: 270K ohms <u>+</u> 5%, 1/8 w.
R.865	19B800607P472	Metal film: 4.7K ohms <u>+</u> 5%, 1/8 w.
R866	19B800607P272	Metal film: 2.7K ohms <u>+</u> 5%, 1/8 w.
R867 and R868	19B800607P100	Metal film: 10 ohms <u>+</u> 5%, 1/8 w.
R870	19B800607P104	Metal film: 100K ohms <u>+</u> 5%, 1/8 w.
R871	19B800607P223	Metal film: 22K ohms <u>+</u> 5%, 1/8 w.
R874 thru R876	19B800607P104	Metal film: 100K ohms <u>+</u> 5%, 1/8 w.
R877	19B800607P1	Jumper.
R878	19B800607P102	Metal film: 1K ohms <u>+</u> 5%, 1/8 w.
R879	19B800607P472	Metai film: 4.7K ohma <u>+</u> 5%, 1/8 w.
R880 and R881	19A 702931 P1 76	Metal film: 604 ohms <u>+</u> 1%, 1/8 w.
R882 and R883	19B800607P103	Metal film: 10K ohms <u>+</u> 5%, 1/8 w.
		·····INTEGRATED CIRCUITS ·····
U801	19A 701830P1	Linear: Audio Power Amplifier; sim to TDA2003.
U802	19A703165P1	Linear: Dual Compandor; sim to NE572.
U803	19A 700086P4	Linear: Dual Op Amp; sim to 4558.
U804	19A 704073P2	Linear: + 8 Volt Regulator; sim to MC78L08CP.
U805	19A 704971P1	Linear: + 5 Volt Regulator; sim to MC78L05ACP.
		MISCELLANEOUS
2	19D901889G1	Can, Shield.
3	19D902023P2	Front Cap, Plastic.
4	19A 705381 P13008	Screw, thread forming.
5	19A 702381 P508	Screw, thread forming: No. 3.5-0.6 x 8.
6	19A 705381P13004	Screw, thread forming: Torx Drive Plastite.
7	19A 705244P2	Clip, spring tension.
8	344A3768P1	Cover.
9	19A705406P408	Bolt, machine: M4-0.7.
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COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

PRODUCTION CHANGES

Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Part+ List for the descriptions of parts affected by these revisions.

REV. A - <u>HANDSET INTERFACE BOARD 19D903510G1</u> Incorporated into original shipment.

HANDSET INTERFACE BOARD 19D903510G1

(19D903510, Sh. 1, Rev. 4)