

HT 1000™, JT 1000®, MT 2000™, MTS 2000™, and MTX Series

Handie-Talkie® Portable Radios

Service Manual



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HT 1000™, JT 1000® , MT 2000™ , MTS 2000™ , and MTX Series Handie-Talkie® Portable Radios

Service Manual

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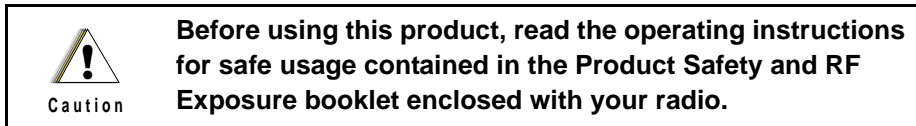
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Foreword

The information contained in this manual relates to all HT 1000™, JT1000®, MT 2000™, MTS 2000™, and MTX Series Handie-Talkie® portable radios, unless otherwise specified. This manual provides sufficient information to enable qualified service shop technicians to troubleshoot and repair the portable radio to the component level.

For details on the operation of the radio or level 1 or 2 maintenance procedures, refer to the applicable manuals, which are available separately. A list of related publications is provided in the section, "Related Publications Available Separately" on page vii.

Product Safety and RF Exposure Compliance



ATTENTION!

This radio is restricted to occupational use only to satisfy FCC RF energy exposure requirements. Before using this product, read the RF energy awareness information and operating instructions in the Product Safety and RF Exposure booklet enclosed with your radio (Motorola Publication part number 6881095C98) to ensure compliance with RF energy exposure limits.

For a list of Motorola-approved antennas, batteries, and other accessories, visit the following web site which lists approved accessories: <http://www.motorola.com/cgiss/index.shtml>

Manual Revisions

Changes which occur after this manual is printed are described in FMRs (Florida Manual Revisions). These FMRs provide complete replacement pages for all added, changed, and deleted items, including pertinent parts list data, schematics, and component layout diagrams. To obtain FMRs, contact the Radio Parts Services Division (refer to "Replacement Parts Ordering" on page 115).

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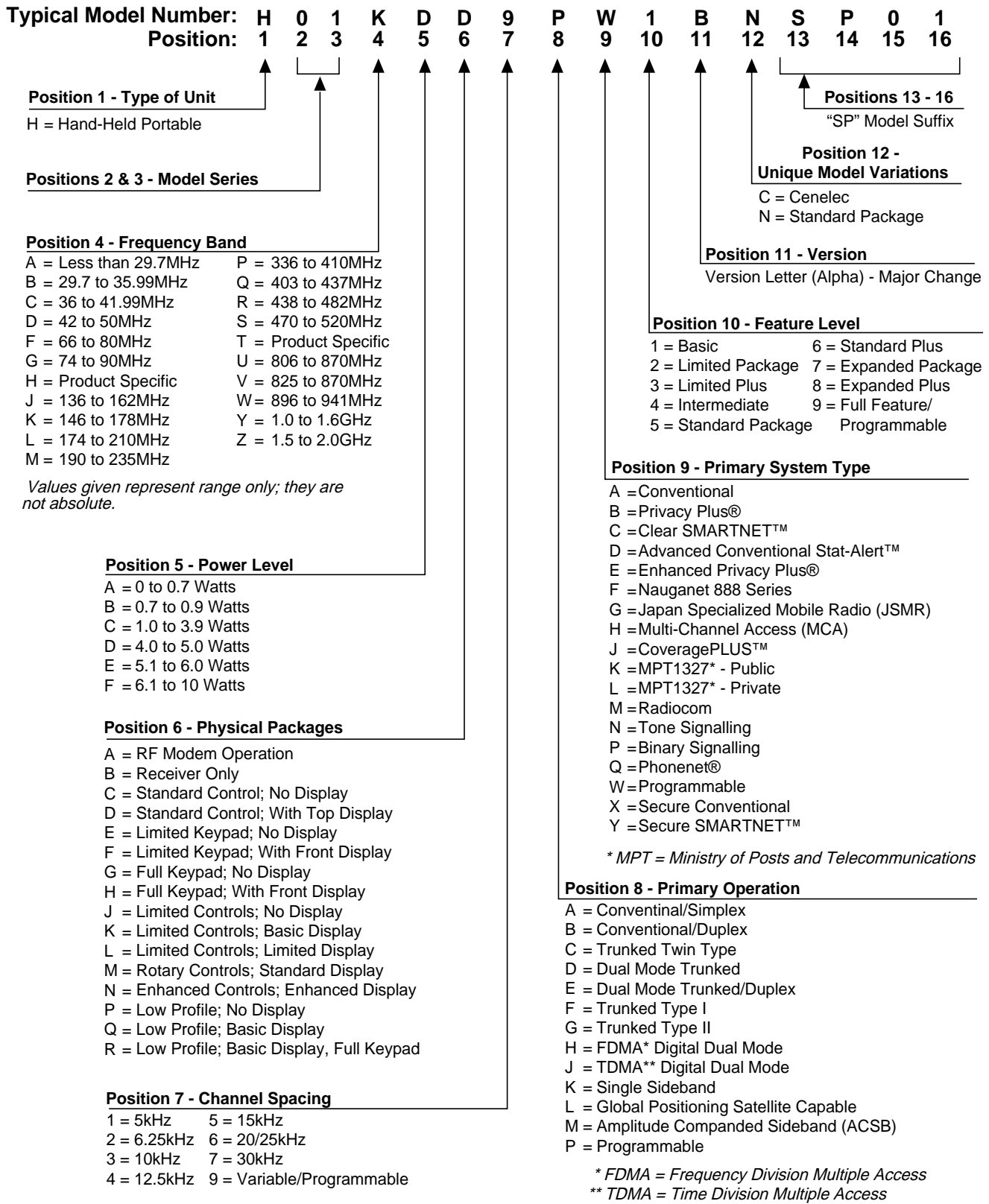
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Related Publications Available Separately

Service Manual (earliest version radios; first issue- 4/92)	68P81200C20
Service Manual (early version radios; first issue- 4/93)	68P81200C25
Service Manual (later version radios; first issue- 7/94)	68P81200C40
Service Manual (this publication; present version radios; first issue- 3/98)	68P81200C75
includes:	
• all servicing information	
• assembly / disassembly	
• maintenance	
Theory Manual	68P81200C15
includes:	
• theory of operation	
• troubleshooting information and troubleshooting charts	
Operating Instructions	
• HT 1000 A Model Portable Radios	68P81071C70
• HT 1000 B Model and later Portable Radios	68P81079C50
• JT 1000 Portable Radios	68P81078C45
• JT 1000 Portable Radios Front Panel Programming Instructions	68P81081C30
• MT 2000 Portable Radios	68P81076C65
• MTS 2000 I Portable Radios	68P81072C15
• MTS 2000 II and III Portable Radios	68P81072C45
• MTX Series Model B3 Privacy Plus Portable Radios	68P81072C10
• MTX Series Model B4 Privacy Plus Portable Radios	68P81073C60
• MTX Series Model B5 and B7 Privacy Plus Portable Radios	68P81072C40
• MTX•LS Trunked Portable Radios	68P81083C35
Mobile Vehicular Adapter (MTVA) Operating Instructions	68P81075C85
Mobile Vehicular Adapter (MTVA) Installation Instructions	68P81075C90
Mobile Vehicular Adapter (MTVA) Service Manual	68P81075C95
Option•Mate, HT 1000 Analog Voice Security; Installation/ Programming/Troubleshooting Manual	68P81084C35
Option•Mate, HT 1000 Analog Voice Security Operating Instructions	68P81084C36
Option•Mate, HT 1000 Analog Voice Security Service Help Card	68P81084C37

Refer to Chapter 10 for ordering information.

Model Numbering System



Model Charts

Model Programming, Flashing, and Cloning

Model Charts General Description

Four model charts cover the three families of radios discussed in this publication:

- Conventional Systems Radios, HT 1000
- Conventional Systems Radios, JT 1000 and MT 2000
- Private Systems Radios
- Shared Systems Radios

Each model chart lists the model number and its description, and the three main radio components: the transceiver board, the controller board, and the front cover. A single model may be built using alternate controller boards and alternate transceiver boards. The model charts will list all alternate controllers and all alternate transceivers for any one particular model. Other model components are referenced in electrical parts lists and exploded view parts lists located toward the rear of the manual.

To determine which controller and transceiver is in a radio, that radio must be opened and physically examined. Identification kit number labels are attached to the controller board and to the transceiver board.

Programming, Flashing, and Cloning

All HT 1000, JT 1000, MT 2000, MTS 2000, and MTX Series Radios covered in this manual are clonable. The JT 1000 Model Radios are also front-panel programmable, and the MTS 2000 Series Radios are “flashable.” The following cloning information applies only to HT 1000 Model Radios.

HT 1000 Model Radios:

- VHF DN models **cannot** be cloned to AN, BN, or CN models.
- Any DN model can be cloned from like CN or DN models.
- Prior to cloning any AN or BN model into a like CN or DN model, a code plug fix must be performed on the AN or BN model. Failure to do so could seriously degrade the scan and battery-saver capabilities of the CN or DN model radio. For code plug-fix information, order Service Repair Notice, SRN-1218.

Note: Cloning any AN model into a like CN or DN model will remove the TEST MODE capability.

MODEL CHART

Conventional Systems Radios

(HT 1000 Models)

MODEL NUMBER							DESCRIPTION											
H01	KDC	9AA	1DN				VHF, 2F, 5- to 1-Watt											
				H01	RDC	9AA3DN	VHF, 16F, 5- to 1-Watt											
						H01	RDC	9AA1DN	UHF B1, 2F, 4- to 1-Watt									
								H01	SDC	9AA3DN	UHF B1, 16F, 4- to 1-Watt							
										H01	SDC	9AA1DN	UHF B2, 2F, 4- to 1-Watt					
												H01	SDC	9AA3DN	UHF B2, 16F, 4- to 1-Watt			
														H01	UCC	6AA3DN	800MHz, 16F, 3-Watt	
																ITEM NO.		DESCRIPTION
A																	NUD7085E / NUD7085F / NUD7091A / NUD7091B / NUD7095B / PMUD7095B	Transceiver Board
A																	NUD7070E / NUD7070F / NUD7092A / NUD7092B / NUD7095B / PMUD7095B	Transceiver Board
			A														NUE7240D / NUE7240E / NUE7265A / NUE7265B / NUE7272B / PMUE7272B	Transceiver Board
			A														NUE7231C / NUE7231D / NUE7266A / NUE7266B / NUE7272B / PMUE7272B	Transceiver Board
			A														NUE7241D / NUE7241E / NUE7267A / NUE7267B / NUE7273B / PMUE7273B	Transceiver Board
				A													NUE7232C / NUE7232D / NUE7268A / NUE7268B / NUE7273B / PMUE7273B	Transceiver Board
					A												NUF6394B / NUF6497A / NUF6497B / NUF6500D / PMUF6500D	Transceiver Board
B	B																NCN6129C / NCN6129D / NCN6129E / NCN6129F / NCN6129G / NCN6138A / NCN6138B / NCN6140A / NCN6140B	Controller Board *
			B	B	B	B											NCN6129C / NCN6141A / NCN6141B / NCN6141C	Controller Board *
								B									NCN6129C / NCN6145A / NCN6145B / NCN6145C	Controller Board *
B	B	B	B	B	B	B	B										NCN6140C / PMCN6140C	Controller Board *
X	X	X	X	X	X	X	X										NTN7151B / NTN7151C	Front Cover
X		X			X												NTN7156A / NTN7156B	Front Cover

Note: This model chart lists the model numbers and their respective major components of all conventional systems radios covered in this publication.

A = Alternate transceiver board supplied, see “Model Charts General Description” (this section).

B = Alternate controller board supplied, see “Model Charts General Description” (this section).

X = One item is supplied per radio.

* = The radio model number is required when placing an order for the controller board. The model number can be found on the FCC Label on the back of the radio. Refer to Replacement Parts Ordering, Section 10 of this manual for instructions on how to place an order.

MODEL CHART

Conventional Systems Radios

(JT 1000 and MT 2000 Models)

MODEL NUMBER										DESCRIPTION			
H01KDH9PA3AN										JT 1000, VHF, 16CH, Front Display			
H01RDH9PA3AN										JT 1000, UHF B1, 16CH, Front Display			
H01SDH9PA3AN										JT 1000, UHF B2, 16CH, Front Display			
H01KDD9AA4AN										MT 2000, VHF, 16F, 5- to 1-Watt, Top Display			
H01KDH9AA7AN										MT 2000, VHF, 16CH, 5- to 1-Watt, Front Display			
H01RDD9AA4AN										MT 2000, UHF B1, 16F, 4- to 1-Watt, Top Display			
H01RDH9AA7AN										MT 2000, UHF B1, 16CH, 4- to 1-Watt, Front Display			
H01SDD9AA4AN										MT 2000, UHF B2, 16F, 4- to 1-Watt, Top Display			
H01SDH9AA7AN										MT 2000, UHF B2, 16CH, 4- to 1-Watt, Front Display			
H01UCD6AA4AN										MT 2000, 800MHz, 16F, 4- to 1-Watt, Top Display			
H01UCH6AA7AN										MT 2000, 800MHz, 16CH, 4- to 1-Watt, Front Display			
										ITEM NO.		DESCRIPTION	
A	A		A	A							NUD7070E / NUD7070F / NUD7095A / NUD7095B / NUD7092B / PMUD7095B	Transceiver Board	
	A	A		A	A						NUE7231C / NUE7231D / NUE7272A / NUE7272B / NUE7272C / NUE7272D / PMUE7272B	Transceiver Board	
		A				A	A				NUE7232C / NUE7232D / NUE7273A / NUE7273B / NUE7273C / PMUE7273B	Transceiver Board	
							A	A	A	A	NUF6394B / NUF6498A / NUF6498B / NUF6498C / NUF6500A / NUF6500B / NUF6500C / NUF6500D / PMUF6500D	Transceiver Board	
B	B	B									NTN7089C / NTN7089D / NCN6146A	Controller Board *	
			B	B	B	B	B	B	B	B	NTN7091D / NTN7091E / NCN6147A / NCN6147B / PMCN6147B	Controller Board *	
			X		X		X		X		NTN7152A / NTN7152B	Front Cover	
X	X	X		X		X		X		X	NTN7154A / NTN7154B	Front Cover	

Note: This model chart lists the model numbers and their respective major components of all conventional systems radios covered in this publication.

A = Alternate transceiver board supplied, see "Model Charts General Description" (this section).

B = Alternate controller board supplied, see "Model Charts General Description" (this section).

X = One item is supplied per radio.

* = The radio model number is required when placing an order for the controller board. The model number can be found on the FCC Label on the back of the radio. Refer to Replacement Parts Ordering, Section 10 of this manual for instructions on how to place an order.

MODEL CHART

Private Systems Radios

(MTS 2000 Models)

MODEL NUMBER													DESCRIPTION			
H01KDD9PW1BN													VHF, 16-Mode, Top Display, 5- to 1-Watt			
H01KDF9PW1BN													VHF, 160-Mode, Front Display, Limited Keypad, 5- to 1-Watt			
H01KDH9PW1BN													VHF, 160-Mode, Front Display, Full Keypad, 5- to 1-Watt			
H01RDD9PW1BN													UHF B1, 16-Mode, Top Display, 4- to 1-Watt			
H01RDF9PW1BN													UHF B1, 160-Mode, Front Display, Limited Keypad, 4- to 1-Watt			
H01RDH9PW1BN													UHF B1, 160-Mode, Front Display, Full Keypad, 4- to 1-Watt			
H01SDD9PW1BN													UHF B2, 16-Mode, Top Display, 4- to 1-Watt			
H01SDF9PW1BN													UHF B2, 160-Mode, Front Display, Limited Keypad, 4- to 1-Watt			
H01SDH9PW1BN													UHF B2, 160-Mode, Front Display, Full Keypad, 4- to 1-Watt			
H01UCD6PW1BN													800MHz, 16-Mode, Top Display, 3-Watt			
H01UCF6PW1BN													800MHz, 160-Mode, Front Display, Limited Keypad, 3-Watt			
H01UCH6PW1BN													800MHz, 160-Mode, Front Display, Full Keypad, 3-Watt			
H01WCD4PW1CN													900MHz, 16-Mode, Top Display, 2.4W (Typ), 2.9W (Max)			
H01WCF4PW1CN													900MHz, 160-Mode, Front Display, Limited Keypad			
H01WCH4PW1CN													900MHz, 160-Mode, Front Display, Full Keypad			
													ITEM NO.		DESCRIPTION	
A	A	A											NUD7070E / NUD7070F / NUD7095A / NUD7095B / NUD7092B / PMUD7095B	Transceiver Board		
A	A	A											NUE7231C / NUE7272A / NUE7272B / NUE7272C / NUE7272D / PMUE7272B	Transceiver Board		
			A	A	A								NUE7232C / NUE7273A / NUE7273B / NUE7273C / PMUE7273B	Transceiver Board		
						A	A	A					NUF6410B / NUF6500A / NUF6500B / NUF6410C / NUF6410D NUF6500C / NUF6500D / NUF6533A / PMUF6500D	Transceiver Board		
											A	A	A	NUF6395C / NUF6499A / NUF6499B / NUF6499C / NUF6499D / PMUF6499D	Transceiver Board	
B	B	B	B	B	B	B	B	B	B	B	B	B		NTN7620E / NCN6150A / NCN6150B / PMCN6150B NCN6176A	Controller Board *	
			B	B	B	B	B	B			B	B	B	NCN6106C / NCN6153A / NCN6153B / PMCN6153B	Controller Board *	
X			X			X			X		X			NTN7152A / NTN7152B	Front Cover	
	X			X			X			X		X		NTN7153A / NTN7153B	Front Cover	
		X			X			X			X		X	NTN7154A / NTN7154B	Front Cover	

Note: This model chart lists the model numbers and their respective major components of all private systems radios covered in this publication.

A = Alternate transceiver board supplied, see "Model Charts General Description" (this section).

B = Alternate controller board supplied, see "Model Charts General Description" (this section).

X = One item is supplied per radio.

* = The radio model number and flash code are required when placing an order for the controller board. The model number can be found on the FCC Label on the back of the radio. The Flashcode can be obtained several ways:

- Check the FCC Label on the back of the radio.
- Hook the radio (or sister radio) up to the Smart RIB.

MODEL CHART

Shared Systems Radios

(MTX 838, MTX 8000, MTX•LS, and MTX 9000 Models)

MODEL NUMBER	DESCRIPTION	
	MTX 838	
H01KDC9DB3AN	VHF, 16-Mode, 5- to 1-Watt	
H01KDD9DB4AN	VHF, 99-Mode, Top Display, 5- to 1-Watt	
H01KDF9DB5AN	VHF, 160-Mode, Front Display, Limited Keypad, 5- to 1-Watt	
H01KDH9DB7AN	VHF, 160-Mode, Front Display, Full Keypad, 5- to 1-Watt	
H01RDC9DB3AN	UHF B1, 16-Mode, 4- to 1-Watt	
H01RDD9DB4AN	UHF B1, 99-Mode, Top Display, 4- to 1-Watt	
H01RDF9DB5AN	UHF B1, 160-Mode, Front Display, Limited Keypad, 4- to 1-Watt	
H01RDH9DB7AN	UHF B1, 160-Mode, Front Display, Full Keypad, 4- to 1-Watt	
H01SDC9DB3AN	UHF B2, 16-Mode, 4- to 1-Watt	
H01SDD9DB4AN	UHF B2, 99-Mode, Top Display, 4- to 1-Watt	
H01SDH9DB7AN	UHF B2, 160-Mode, Front Display, Full Keypad, 4- to 1-Watt	
H01UCC6DF3AN	800MHz, 16-Mode, Type II	
	MTX 8000	
H01UCC6DB3AN	800MHz, 16-Mode, Type I	
H01UCF6DB5AN	800MHz, 160-Mode, Front Display, Limited Keypad, 3-Watt	
H01UCH6DB7AN	800MHz, 160-Mode, Front Display, Full Keypad, 3-Watt	
	MTX•LS	
H01UCC6DU3AN	800MHz, 16F	
	MTX 9000	
H01WCC4DB3AN	900MHz, 16-Mode, 2.4W (Typ), 2.9W (Max)	
H01WCF4DB5AN	900MHz, 160-Mode, Front Display, Limited Keypad	
H01WCH4DB7AN	900MHz, 160-Mode, Front Display, Full Keypad	
	ITEM NO.	
	DESCRIPTION	
A A A A A A	NUD7085E / NUD7085F / NUD7096A / NUD7096B / NUD7095A / NUD7095B / PMUD7095B	Transceiver Board
A A A A A A	NUE7240D / NUE7240E / NUE7274A / NUE7274B / NUE7272A / NUE7272B / PMUE7272B	Transceiver Board
A A A	NUE7241C / NUE7241D / NUE7241E / NUE7275A / NUE7275B	Transceiver Board
A A A A	NUF6423B / NUF6501A / NUF6501B / NUF6501C / NUF6500D / PMUF6500D	Transceiver Board
A A A	NUF6424B / NUF6502A / NUF6502B / NUF6502C / PMUF6499D	Transceiver Board
X	NUF6460A / NUF6460B	Uniboard *
B B B B B B B B B B	NTN7512D / NTN7512E / NCN6147A / NCN6147B / PMCN6147B	Controller Board *
B B B	NTN7513D / NTN7513E / NCN6153A / NCN6153B / PMCN6153B	Controller Board *
B B B B B B B B B B	NTN7857D / NTN7857E / NCN6147A / NCN6147B / PMCN6147B	Controller Board *
B B B B	NTN7858D / NTN7858E / NCN6153A / PMCN6153A / NCN6153B / PMCN6153B	Controller Board *
X	NTN7151B / NTN7151C	Front Cover
X	NTN7152A / NTN7152B	Front Cover
X	NTN7153A / NTN7153B	Front Cover
X	NTN7154A / NTN7154B	Front Cover

Note: This model chart lists the model numbers and their respective major components of all shared systems radios covered in this publication.

A = Alternate transceiver board supplied, see "Model Charts General Description" (this section).

B = Alternate controller board supplied, see "Model Charts General Description" (this section).

X = One item is supplied per radio.

* = The radio model number is required when placing an order for the uniboard. The model number can be found on the FCC Label on the back of the radio. Refer to Replacement Parts Ordering, Section 10 of this manual for instructions on how to place an order.

List of Antennas

ANTENNA KIT NOS.	DESCRIPTION
NAD6566*	Helical (136 - 151MHz)
NAD6567*	Helical (151 - 162MHz)
NAD6568*	Helical (162 - 174MHz)
NAD6563*	Helical Wideband (136 - 174MHz)
NAE6546*	Helical (403 - 435MHz)
NAE6547*	Helical (435 - 470MHz)
NAE6548*	Helical (470 - 512MHz)
NAE6549*	Whip (403 - 512MHz)
NAF5037*	Whip (800MHz)
NAF5038*	Whip (900MHz)
NAF5039*	Dipole (800MHz)
NAF5040*	Dipole (900MHz)
NAF5042*	Quarter Wave, Stubby (800MHz, 900MHz)

List of Batteries

BATTERY KIT NOS.	DESCRIPTION
NTN7143	High-Capacity Nickel-Cadmium (groups A, B, C, D)
NTN7144	Ultra-High-Capacity Nickel-Cadmium (groups A, B, C, D)
NTN7146*	High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups D, F, G)
NTN7147*	Ultra-High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups D, F, G)
NTN7341*	Ultra-High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups C, D, E, F, G)
NTN7372*	High-Capacity Nickel-Cadmium FMRC Intrinsically Safe (groups C, D, E, F, G)



Substitution of components may impair the intrinsic safety of the radio.

WARNING

* These accessories are approved as being intrinsically safe by Factory Mutual Research Corporation (FMRC). Refer to the radio label for intrinsic safety ratings and required batteries. Only the accessories and antennas noted (by *) may be used on approved radios.

Maintenance Specifications for VHF Radios

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT3768	Frequency Range:	*136-178MHz	RF Power:	
Power Supply:	Nickel-Cadmium Battery	Bandwidth:	42MHz	136-174MHz	1-5 Watts
Battery Voltage:		Quieting Sensitivity (20dBQ):	0.5µV Max.	174-178MHz	1-4 Watts
Nominal:	7.5 Volts	Usable Sensitivity (12dB SINAD):	0.35µV Max.	Frequency Range:	*136-178MHz
Range:	6 to 9 Volts	Intermodulation:	-70dB	Freq. Stability	
Battery Drain, Typical:		Selectivity (30kHz Adjacent Channel):	-70dB	-30 to +60°C; 25°C ref.:	± .0005%(30kHz syst)
Standby:	56mA	(12.5kHz Adjacent Channel):	-70dB		: ± .0003%(12.5kHz syst)
Receive:	180mA	Spurious Rejection:	-70dB	Emission (Conducted and Radiated):	-66dBw
Transmit:	2100mA	Freq. Stability (-30 to +60°C; 25°C reference):	± 0.0005%	FM Hum and Noise (Companion Receiver):	-45dB Typical
Temperature Range:		Rated Audio:	500mW	Distortion:	3% Typical
Operating:	-30°C to +60°C	Distortion (At Rated Audio):	3% Typical	Modulation Limiting:	±5kHz (30kHz syst)
Storage:	-40°C to +85°C	Channel Spacing:	30kHz		: ± 2.5kHz(12.5kHz syst)
Duty Cycle (5-5-90):	1 Watt/5 Watts			Recommended Battery:	
High Cap. Battery:	11.2 Hrs./8 Hrs.			High Capacity:	NTN7143
Ultra-High Cap. Battery:	12.9 Hrs./9 Hrs.			Ultra-High Capacity:	NTN7144
Dimensions (H x W x D)					
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra-High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

* Frequencies in the 174-178MHz range are not permitted in the USA.

Maintenance Specifications for UHF Radios

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT4781 (403-470MHz) AZ489FT4780 (450-520MHz)	Frequency Range:	403-470MHz *450-520MHz	RF Power:	
Power Supply:	Nickel-Cadmium Battery	Bandwidth:	70MHz	403-470MHz	1-4 Watts
Battery Voltage:		Quieting Sensitivity (20dBQ):	0.5µV Max.	450-512MHz	1-4 Watts
Nominal:	7.5 Volts	Usable Sensitivity (12dB SINAD):	0.35µV Max.	512-520MHz	1-3 Watts
Range:	6 to 9 Volts	Intermodulation:	-70dB	Frequency Range:	403-470MHz *450-520MHz
Battery Drain, Typical:		Selectivity (25kHz Adjacent Channel):	-70dB	Freq. Stability	
Standby:	60mA	(12.5kHz Adjacent Channel):	-60dB	(-30 to +60°C; 25°C ref.):	± .0005% (25kHz syst)
Receive:	180mA	Spurious Rejection:			: ± .0003%(12.5kHz syst)
Transmit:	1800mA	450-512MHz	-70dB	Emission (Conducted and Radiated):	-66dBw
Temperature Range:		512-520MHz	-65dB	FM Hum and Noise (Companion Receiver):	-45dB Typical
Operating:	-30°C to +60°C	Freq. Stability (-30 to +60°C; 25°C reference):	± 0.0005%	Hear Clear:	-48dB Typical
Storage:	-40°C to +85°C	Rated Audio:	500mW	Distortion:	3% Typical
Duty Cycle (5-5-90):	1 Watt/4 Watts	Distortion (At Rated Audio):	3% Typical	Modulation Limiting:	±5kHz (25kHz syst)
High Cap. Battery:	11 Hrs./8.4 Hrs.	Channel Spacing:	25kHz		: ±2.5kHz (12.5kHz syst)
Ultra-High Cap. Battery:	12.7 Hrs./9.7 Hrs.			Recommended Battery:	
Dimensions (H x W x D)				High Capacity:	NTN7143
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)			Ultra-High Capacity:	NTN7144
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra-High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

* Frequencies in the 512-520MHz range are not permitted in the USA.

Maintenance Specifications for 800MHz Radios

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT5747	Frequency Range:	851–870MHz	RF Power:	3 Watts
Power Supply:	Nickel-Cadmium Battery	Bandwidth:	19MHz	Frequency Range:	806–824MHz 851–869MHz
Battery Voltage:		Quieting Sensitivity (20dBQ):	0.5µV Max.	Freq. Stability	
Nominal:	7.5 Volts	Usable Sensitivity		(–30 to +60°C; 25°C ref.):	± .00025%
Range:	6 to 9 Volts	(12dB SINAD):	0.35µV Max.	(821-824MHz Capable):	± .00015%
Battery Drain, Typical:		Intermodulation:	–70dB	Emission (Conducted and Radiated):	–46dBw
Standby:	65mA	Selectivity		FM Hum and Noise	
Receive:	190mA	(25kHz Adjacent Channel):	–70dB	(Companion Receiver):	–40dB Typical
Transmit:	1900mA	Spurious Rejection:	–70dB	Distortion:	3% Typical
Temperature Range:		Freq. Stability		Modulation Limiting:	±5kHz
Operating:	–30°C to +60°C	(–30+60°C; 25°C reference):	± .00025%	(821-824MHz):	±4kHz
Storage:	–40°C to +85°C	(821-824MHz Capable):	±.00015%	Recommended Battery:	
Duty Cycle (5-5-90):		Rated Audio:	500mW	High Capacity:	NTN7143
High Cap. Battery:	8 Hours	Distortion (At Rated Audio):	3% Typical	Ultra-High Capacity:	NTN7144
Ultra-High Cap. Battery:	9 Hours	Channel Spacing:	25kHz		
Dimensions (H x W x D)					
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra-High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

Maintenance Specifications for 900MHz Radios

(All Specifications Are Per Electronic Industries Association (EIA) 316B Unless Otherwise Noted.)

GENERAL		RECEIVER		TRANSMITTER	
FCC Designation:	AZ489FT5748	Frequency Range:	935–941MHz	RF Power:	2.4 Watts (Typ.) 2.9 Watts (Max.)
Power Supply:	Nickel-Cadmium Battery	Bandwidth:	6MHz	Frequency Range:	896–902MHz 935–941MHz
Battery Voltage:		Quieting Sensitivity (20dBQ):	0.5µV Max.	Freq. Stability	
Nominal:	7.5 Volts	Usable Sensitivity		(–30 to +60°C; 25°C ref.):	± .00015%
Range:	6 to 9 Volts	(12dB SINAD):	0.35µV Max.	Emission (Conducted and Radiated):	–46dBw
Battery Drain, Typical:		Intermodulation:	–60dB	FM Hum and Noise	
Standby:	65mA	Selectivity		(Companion Receiver /	
Receive:	185mA	(12.5kHz Adjacent Channel):	–60dB	HEAR CLEAR):	–45dB Typical
Transmit:	1910mA	Spurious Rejection:	–60dB	Distortion:	3% Typical
Temperature Range:		Freq. Stability		Modulation Limiting:	±2.5kHz
Operating:	–30°C to +60°C	(–30+60°C; 25°C reference):	± .00015%	Recommended Battery:	
Storage:	–40°C to +85°C	Rated Audio:	500mW	High Capacity:	NTN7143
Duty Cycle (5-5-90):		Distortion (At Rated Audio):	3% Typical	Ultra-High Capacity:	NTN7144
High Cap. Battery:	8 Hours	Channel Spacing:	12.5kHz		
Ultra-High Cap. Battery:	9 Hours				
Dimensions (H x W x D)					
Less Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With High Cap. Battery:	6.30" x 2.34" x 1.49" (16.0cm x 5.9cm x 3.8cm)				
With Ultra-High Cap. Battery:	6.30" x 2.34" x 1.54" (16.0cm x 5.9cm x 3.9cm)				
Weight: (w/Helical Antenna)					
Less Battery:	12.1oz. (343gm)				
With High Cap. Battery:	20.2oz. (573gm)				
With Ultra-High Cap. Battery:	21.3oz. (604gm)				

Specifications Subject to Change Without Notice.

Glossary

A/D	Analog to Digital converter; converts an instantaneous dc voltage level to a corresponding digital value.
ALC	Automatic Level Control; a circuit in the transmit RF path that controls RF power amplifier output, provides leveling over frequency and voltage, and protects against high VSWR.
CMOS	Complementary metal-oxide semiconductor.
Channel	Defines conventional transmit and receive frequencies and muting conditions.
Closed Architecture	A controller configuration that utilizes a microcontroller with no external memory (non-FLASHport operation).
CBI	(Customer Board Initialization) When the controller board is received, it will need a serial from the defect unit. The serial is manually entered via the RSS prior to proceeding any further with the replacement process.
D/A	Digital to Analog converter; converts a digital value to a corresponding dc voltage value.
DTMF	Dual Tone Multi-Frequency.
DPL	Digital Private-Line™.
Firmware	Software or a software/hardware combination of computer programs and data, with a fixed logic configuration stored in a read-only memory; information can not be altered or reprogrammed.
FGU	Frequency Generation Unit.
Flashcode	A Motorola term (model option definition code) that determines what FLASHport options are in a radio.
FLASHport™	A Motorola term that describes the ability of a radio to change memory. Every FLASHport radio contains a FLASHport EEPROM memory chip that can be software written and rewritten to, again and again.
IC	Integrated Circuit.
ISW	Inbound Signalling Word; data transmitted on the control channel from the subscriber unit to the central controller.
LTR	Logic Trunked Radio; a registered trademark of E.F. Johnson Company.
MCU	MicroControl Unit.
MDC	Motorola Digital Code.
OMPAC	Over-Molded Pad-Array Carrier; a Motorola custom IC package, distinguished by the presence of solder balls on the bottom pads.
Open Architecture	A controller configuration that utilizes a microprocessor with extended ROM, RAM, and EEPROM, (FLASHport capable).
OSW	Outbound Signalling Word; data transmitted on the control channel from the central controller to the subscriber unit.
PC Board	Printed Circuit board.
PL	Private-Line® tone squelch; a continuous sub-audible tone that is transmitted along with the carrier.

PLL	Phase-Locked Loop; a circuit in which an oscillator is kept in phase with a reference, usually after passing through a frequency divider.
PTT	Push-To-Talk; the switch located on the left side of the radio which, when pressed, causes the radio to transmit.
Registers	Short-term data-storage circuits within the microcontrol unit or programmable logic IC.
RESET	Reset line; an input to the microcontroller that restarts execution.
RF PA	Radio Frequency Power Amplifier.
RSS	Radio Service Software.
RSSI	Received signal strength indicator; a dc voltage proportional to the received rf signal strength.
RX DATA	Recovered digital data line.
SLIC	Support-Logic IC; a custom gate array used to provide I/O and memory expansion for the microcontroller.
SmartRib	Use in conjunction with the RSS to read the Flashcode and Model Number, and to flash upgrade radios.
Softpot	Software potentiometer; a computer-adjustable electronic attenuator.
Software	Computer programs, procedures, rules, documentation, and data pertaining to the operation of a system.
Squelch	Muting of audio circuits when received signal levels fall below a pre-determined value.
SRAM	Static-RAM chip used for volatile, program/data memory.
Standby Mode	An operating mode whereby the radio is muted but still continues to monitor data.
TOT	Time-Out Timer; a timer that limits the length of a transmission.
TPL	Tone Private-Line; Continuous Tone Coded Squelch System (CTCSS), industry standard.
TSOP	Thin Small-Outline Package.
μC	Microcontrol unit (see MCU).
VCO	Voltage-Controlled Oscillator; an oscillator whereby the frequency of oscillation can be varied by changing a control voltage.
VSWR	Voltage Standing Wave Ratio.

Introduction

This manual includes safety information, model charts, specifications, fundamental disassembly/reassembly procedures; schematic diagrams, printed circuit board details, flex circuit diagrams, and several parts lists to completely cover the HT 1000, JT 1000, MT 2000, MTS 2000, and MTX series radios. Hereafter, the text will refer collectively to these radios as “this family of radios.” For maintenance/troubleshooting, theory, accessories, and operation of the radio, refer to the applicable manuals available separately. To help you with your selection, a list is provided in this manual, titled “Related Publications Available Separately.”

Special notices are incorporated into the text, alerting you to safety hazards and suggesting procedures. These notices are divided and labeled according to the information they contain so that you can become immediately aware of the type of information being presented. The three classifications are: WARNINGS, CAUTIONS, and NOTES.



WARNING

This is an operational procedure, practice, or condition, etc., which may result in injury or death if not carefully observed.



Caution

This is an operational procedure, practice, or condition, etc., which may result in damage to the equipment if not carefully observed.

NOTE: This is an operational procedure, practice, or condition, etc., which is essential to emphasize.

Notes

Test Equipment, Service Aids, and Tools

2

Recommended Test Equipment

The list of equipment contained in Table 1 includes all of the standard test equipment required for servicing two-way portable radios, as well as several unique items designed specifically for servicing this family of radios. Battery-operated test equipment is recommended when available. The “Characteristics” column is included so that equivalent equipment may be substituted; however, when no information is provided in this column, the specific Motorola model listed is either a unique item or no substitution is recommended.

Table 1 Recommended Test Equipment

MOTOROLA MODEL NUMBER	DESCRIPTION	CHARACTERISTICS	APPLICATION
R2600 Series R2670 (for trunking)	System Analyzer	This monitor will substitute for items with an asterisk (*)	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
*R1097A	Digital Multimeter	4,000 counts True RMS Metering 0.3% basic accuracy	Digital voltmeter recommended for ac/dc voltage and current measurements
*R1150E	Code Synthesizer		Injection of audio and digital signalling codes
*R1527A	Portable Test Receiver	Counter; CTCSS, DCS, and DTMF decoder	Portable Radio Monitor
R1368A	Dual-Trace Oscilloscope	20MHz bandwidth (some system analyzers, R2000 series, are 15MHz bandwidth) 5mV to 5V/division	Waveform measurements
*S1350C *ST1213B (VHF) *ST1223B (UHF)	Watt Meter Plug-in Element RF Dummy Load	50-ohm, ±5% accuracy 10 Watts, maximum 0-1000MHz, 300W	Transmitter power output measurements
R1065	Load Resistor	10-watt Broadband	For use with Wattmeter
S1339A	RF Millivolt Meter	100µV to 3V rf 10kHz to 1.2GHz	RF level measurements
*R1013B or *R1370A	SINAD Meter SINAD Meter V/RMS	RMS Audio Voltmeter	Receiver sensitivity measurements
S1347D or S1348D (programmable)	DC Power Supply	0-20Vdc, 0-5 Amps current limited	Bench supply for 7.5Vdc

Service Aids and Recommended Tools

Refer to the “Service Aids” in Table 2 and “Recommended Service Tools” list in Table 3 for a listing and description of the service aids and tools designed specifically for servicing this family of radios, as well as the more common tools required to disassemble and properly maintain the radio. These kits and/or parts are available from the United States and Canada Radio Products Services Division listed in the “Replacement Parts Ordering” section at the back of this manual.

Field Programming

This family of radios can be aligned and programmed in the field. This requires specific equipment and special instructions. Refer to the applicable “Radio Service Software User's Manual” for complete field programming information.

The following table lists service aids recommended for working on this family of radios. These items are available from Radio Products Services Division.

Table 2 Service Aids

MOTOROLA PART NO.	DESCRIPTION	APPLICATION
Servicers Video Tape	Video Tape	Includes Radio Introduction.
RKN-4035D	RIB/Radio/test set cable	Connects radio to RTX-4005B Test Box and RIB.
RLN-1014A	Battery Eliminator	Interconnects radio to power supply.
RLN-1018A	Test Fixture	Provides for troubleshooting of the radio when the housing is removed.
RTX-4005B or both RTX-4005A / RPX-4665A	Portable Test Set Field Modification Kit	Allows switching for radio testing.
RLN-4460A	Portable/Mobile Test Set	Provides more convenient testing of mobiles and portables.
RLN-4008B	Radio Interface Box (RIB)	Enables communications between the radio and the computer's serial communications adapter.
RLN-1015C 0180302E27 3080390B48	Smart RIB Power Supply Computer Interface Cable	Used to read Flashcode. Used to supply power to the Smart RIB. Connects computer serial adapter to Smart RIB.
0180357A57 0180358A56	Wall-mounted Power Supply Wall-mounted Power Supply	Used to supply power to the RIB (120 VAC). Used to supply power to the RIB (220 VAC).
3080369B71 3080369B72	Computer Interface Cable	Use B72 for the IBM PC AT (7-pin). All other IBM models use B71. Connects the computer's serial communications adapter to the RIB (25-pin).
RKN-4036D	Cloning Cable	Allows a radio to be duplicated from a master radio by transferring programmed data from one radio to another (HT 1000/MT 2000 Models Only).
RVN-4097L	Radio Service Software	Software on 3-1/2 in. and 5-1/4 in. floppy disks.
RVN-4098G	Radio Service Software (HT/JT 1000/VISAR Models Only)	Software on 3-1/2 in. and 5-1/4 in. floppy disks.
RVN-4138B	Radio Service Software MTX•LS Model	Software on 3-1/2 in. and 5-1/4 in. floppy disks.
5880348B33	SMA to BNC Adaptor	Adapts radio's antenna port to BNC cabling of test equipment.
RLN-4201B	Battery Tester	Tests battery charge.
RLN-4048A	Battery Tester Adapter	Adapts HT 1000, JT 1000, MT 2000, MTS 2000, and MTX Series radio batteries to the RLN-4201 Battery Tester.
RTL-4208A	RF Probe	50-ohm, high-frequency probe.
RT-5144/48/0 RT-5144/48/2	Test Probe (black) Test Probe (red)	Needle-fine test probes for high-density circuitry.

Service Tools

The following table lists the tools recommended for working on this family of radios; these tools are also available from Motorola. The R-1319A solder/desolder workstation requires the use of some reflow nozzles which are included with the workstation.

Table 3 Recommended Service Tools

MOTOROLA PART NO.	DESCRIPTION	APPLICATION
R1319A	Chip Master Surface Mount Device (SMD) Rework Station	Temperature-controlled, self-contained soldering/desoldering repair station for installation and removal of surface-mounted devices. Removes RF PA's.
0180356B79	Solder/Desolder Station	For soldering and desoldering thru-hole components.
0180372E51	Illuminated Magnifying System	
0180386A82	Anti-static Grounding Kit	Used during all radio assembly and disassembly procedures.
6680384A98	Brush	
1010041A86	Solder (RMA type), 63/37, 0.020" diameter, 1 lb. spool	
0180303E45	SMD Tool Kit	Kit includes chemicals and hand tools required to do many SMD rework procedures.
6680334E07	Chassis/Front Cover Separation Tool	Used to pry the chassis away from the front cover during disassembly.
6680334E08	Flex Connector Opening Tool	Used to raise the sliding portion of the flex connectors.

Transceiver Performance Testing

General

The HT 1000, JT 1000, MT 2000, MTS 2000, and MTX series radios have been prepared to meet published specifications through their manufacturing process, with the use of laboratory-quality test equipment of highest accuracy. The recommended field service equipment approaches the accuracy of the manufacturing equipment with a few exceptions. Accuracy of the equipment must be maintained in compliance with the manufacturer's recommended calibration schedule.

Setup

Supply voltage can be connected from the battery eliminator. The equipment required for alignment procedures is connected as shown in the Radio Alignment Test Setup diagram.

Initial equipment control settings should be as indicated in the following table, and should hold for all alignment procedures except as noted in Table 4.

Table 4 Equipment Initial Control Settings

SERVICE MONITOR	TEST SET	POWER SUPPLY
Monitor Mode: Pwr Mon RF Attn: -70 AM, CW, FM: FM O'scope Source: Mod O'scope Horiz: 10mSec/Div O'scope Vert: 2.5kHz/Div O'scope Trig: Auto Monitor Image: Hi Monitor BW: Nar Monitor Squelch: mid CW Monitor Vol: 1/4 CW	Spkr set: A Spkr/load: Speaker PTT: OFF (center)	Voltage: 7.5Vdc DC on/standby: Standby Volt Range: 10 Current: 2.5

- * When testing TX deviation, where the modulation is greater than 1kHz, set the Service Monitor low pass filter (LPF) to 15kHz.
- ** The Test Set MT/PL switch controls internal/external audio switching.

Test Mode

RF Test Mode,
HT 1000/JT 1000 Radios

NOTE: This note applies to software version R02.09 and earlier. If the radio is placed in TEST MODE

with Option•Mate interface plug enabled through the HT 1000 RSS, TX and RX audio will be muted. Do not test Analog Voice Security (AVS) installed radios in the TEST MODE.

When the HT 1000/JT 1000 radio is operating in its normal environment, the radio's microcontroller controls the RF channel selection, transmitter key-up, and receiver muting. However, when the unit is on the bench for testing, alignment, or repair, it is removed from its normal environment. It cannot receive commands from its system and, therefore, the internal microcontroller will not key the transmitter nor unmute the receiver. This prevents the use of normal tune-up procedures. To solve this problem a special routine, called TEST MODE or "air test," has been incorporated in the radio.

To enter test mode:

1. Turn the radio on.
2. Within ten seconds after the self test is complete, press the monitor button (side button 3, SB3) five times in succession. After the fifth press:
 - a. (HT 1000 radios), a tone is emitted to indicate that the rf test mode has been entered.
 - b. (JT 1000 radios), the display will show the firmware version of the microprocessor for two seconds, emit a tone, then display TEST MODE).
3. Each additional press of SB3 will advance to the next test channel. (refer to Table 6), and a corresponding set of tones will indicate the channel.
4. Pressing SB2 will scroll through and access test environments as shown in Table 5.

NOTE: Transmit into a load when keying a radio under test.

To exit test mode, turn the radio off then back on.

Table 5 Test Environments, HT 1000/JT 1000 Radios

NO. OF BEEPS	DESCRIPTION	FUNCTION
1	Carrier Squelch	RX: if carrier detected TX: mic audio
3	Tone Private-Line	RX: unsquelch if carrier and tone (192.8Hz) detected TX: mic audio + tone (192.8Hz)
4	Digital Private-Line	RX: unsquelch if carrier and digital code (131) detected TX: mic audio + digital code (131) detected

Table 6 Test Frequencies, HT 1000 / JT 1000

NO. OF BEEPS	TEST CHANNEL	VHF	UHF BAND 1	UHF BAND 2	800
1	TX #1	136.025	403.100	450.025	806.0125
	RX #1	136.075	403.150	450.075	851.0625
2	TX #2	142.125	424.850	465.225	815.0125
	RX #2	142.175	424.900	465.275	860.0625
3	TX #3	154.225	438.050	475.225	824.9875
	RX #3	154.275	438.100	475.275	869.9375
4	TX #4	160.125	444.050	484.975	851.0125
	RX #4	160.175	444.100	485.025	851.0625
5	TX #5	168.075	456.350	500.275	860.0125
	RX #5	168.125	456.400	500.325	860.0625
6	TX #6	173.975	463.700	511.975	869.9875
	RX #6	173.925	463.650	511.925	869.9375

Control Head Test Mode, HT 1000/JT 1000 Radios

To check the buttons and the switches, perform the following tests:

1. Turn radio on.
2. After the self test is complete, press the monitor button (side button 3, SB3) five times in succession, within 10 seconds. After the fifth press, a tone is emitted to indicate that the RF test mode has been entered.
3. Exit the RF test mode and enter the control head test mode by pressing and holding SB3 for more than three seconds. Upon entering the control head test mode, a tone is emitted and the green LED begins flashing. The green LED continues to flash until the control head test mode is exited.

NOTE: Return to the RF test mode by pressing and holding SB3 for more than three seconds. Then re-enter the control head test mode by pressing and holding SB3 for more than three seconds.

4. Test each switch (toggle, rotary, or button-actuated) by changing the position of the switch. A tone is emitted to indicate a "good test" each time a switch position is changed.

NOTE: Pressing and releasing a button-actuated switch are both considered switch-position changes.

NOTE: No tone when a switch position is changed indicates a test failure. Test the on/off volume potentiometer/switch by rotating the potentiometer clockwise and counter

clockwise. The loudness of tone beeps will increase and decrease accordingly.

NOTE: During test mode, the volume level is not regulated to the same limits as during normal radio operation.

To exit test mode, turn the radio off then back on.

RF Test Mode, MT 2000, MTS 2000, and MTX Series Radios

When the MT 2000, MTS 2000, or MTX series radio is operating in its normal environment, the radio's microcomputer controls the RF channel selection, transmitter key-up, and receiver muting. However, when the unit is on the bench for testing, alignment, or repair, it is removed from its normal environment. It cannot receive commands from its system and, therefore, the internal microcomputer will not key the transmitter nor unmute the receiver. This prevents the use of normal tune-up procedures. To solve this problem a special routine, called TEST MODE or "air test," has been incorporated in the radio.

To enter test mode:

1. Turn the radio on.
2. After the self test is complete, press the monitor button (side button 3, SB3) five times in succession, within 10 seconds.
3. After "RF TEST" appears (on 14-character displays) or "RF TST" appears (on 6-character displays), press the orange button on top of the radio once. "1 CSQ" appears, indicating: test frequency 1, carrier squelch mode.
4. Each additional press of SB3 will advance to the next test channel. (Refer to Table 8.)
5. Pressing SB2 will scroll through and access test environments as shown in Table 7.

NOTE: Transmit into a load when keying a radio under test.

NOTE: Radios without display indicate test-environment function by emitting a corresponding number of beeps. See Table 7.

Control Head Test Mode, MT 2000, MTS 2000, and MTX Series Radios

To check the display, the buttons, and the switches, perform the following tests:

1. Turn radio on.
2. After the self test is complete, press the monitor button (side button 3, SB3) five times in succession, within 10 seconds.
3. After "RF TEST" appears on the display, press side button 1 (SB1), "CH TEST" (14-character radio) or "CH TST" (6-character radio) appears on the display.
4. Next, press and hold the orange button on top of the radio; all segments on the display will light, and the LED on the control top will illuminate a yellowish color.

5. Release the orange button; "3/0" appears, which indicates that switch 3 is in the open condition.
6. Press the orange button again; "3/1" appears, which indicates that switch 3 is in the closed condition.
7. Rotate the mode selector knob; "4/0" thru "4/15" appears, which indicates that knob 4 is in mode position 1 thru 15.
8. Rotate the concentric switch; "65/0" and "65/1" appears.
9. Rotate the volume control; "2/0" thru "2/255" appears.
10. Press SB1, view "96/1"; release, view "96/0"
11. Press SB2, view "97/1"; release, view "97/0"
12. Press SB3, view "98/1"; release, view "98/0"
13. Press PTT, view "1/1"; release, view "1/0"
14. Toggle Switch in 'A' position "64/0", 'B' position "64/1", 'C' position "64/2"
15. Keypad:
 - Press 0, view "48/1"; release, view "48/0"
 - Press 1, view "49/1"; release, view "49/0"
 - Press 2, view "50/1"; release, view "50/0"
 - Press 3, view "51/1"; release, view "51/0"
 - Press 4, view "52/1"; release, view "52/0"
 - Press 5, view "53/1"; release, view "53/0"
 - Press 6, view "54/1"; release, view "54/0"
 - Press 7, view "55/1"; release, view "55/0"
 - Press 8, view "56/1"; release, view "56/0"
 - Press 9, view "57/1"; release, view "57/0"
 - Press *, view "58/1"; release, view "58/0"
 - Press #, view "59/1"; release, view "59/0"
 - Press <, view "128/1"; release, view "128/0"
 - Press HOME, view "129/1"; release, view "129/0"
 - Press >, view "130/1"; release, view "130/0"

To exit test mode, turn the radio off then back on.

Table 7 Test Environments, MT 2000, MTS 2000, and MTX Series Radios

NO. OF BEEPS	DISPLAY	DESCRIPTION	FUNCTION
1*	CSQ	Carrier Squelch	RX: unsquelch if carrier detected TX: mic audio
2	HC	Hear Clear**	RX: unsquelch if carrier detected TX: compressed mic audio
3	TPL	Tone Private-Line	RX: unsquelch if carrier and tone (192.8Hz) detected TX: mic audio + tone (192.8Hz)
4	DPL	Digital Private-Line	RX: unsquelch if carrier and digital code (131) detected TX: mic audio + digital code (131) detected
5	TLS	Trunking Low Speed	RX: unsquelch if carrier detected TX: mic audio + connect tone (105.8Hz) @ correct deviation
6	THS	Trunking	RX: unsquelch if valid outbound signalling word (OSW) detected High Speed TX: 1500Hz tone
7	DTM multiple freq.	dual-tone	RX: unsquelch if carrier detected TX: selected DTMF tone pair
8	M12	MDC1200	RX: unsquelch if carrier detected without DOS (1800Hz); squelch if carrier detected with DOS (1800Hz) TX: 1500Hz tone
9	SEC	Secure***	RX: auto-coded clear TX: with key present - encrypted audio with key absent - constant unsquelch

* radios without display indicate function by emitting a number of beeps

** on 900 MHz radios only

*** on radios equipped with secure option

**** not available on all radios

Table 8 Test Frequencies, MT 2000, MTS 2000, and MTX Series Radios

TEST CHANNEL	VHF	UHF BAND 1	UHF BAND 2	800	900	R-BAND
TX #1	136.025	403.100	450.025	806.0125	896.0125	885.0125
RX #1	136.075	403.150	450.075	851.0625	935.0625	830.0125
TX #2	142.125	424.850	465.225	815.0125	899.0125	885.0125
RX #2	142.175	424.900	465.275	860.0625	938.0625	859.9875
TX #3	154.225	438.050	475.225	824.9875	901.9875	885.0125
RX #3	154.275	438.100	475.275	869.9375	940.9375	859.9875
TX #4	160.125	444.050	484.975	851.0125	935.0125	895.0125
RX #4	160.175	444.100	485.025	851.0625	935.0625	859.9875
TX #5	168.075	456.350	500.275	860.0125	938.0125	905.0125
RX #5	168.125	456.400	500.225	860.0625	938.0625	859.9875
TX #6	173.975	463.700	511.975	869.9875	940.9875	914.9875
RX #6	173.925	463.750	511.925	869.9375	940.9375	859.9875

Table 9 Receiver Performance Checks

TEST NAME	COMMUNICATIONS ANALYZER	RADIO	TEST SET	COMMENTS
Reference Frequency	Mode: PWR MON 4th channel test frequency \diamond Monitor: Frequency error Input at RF In/Out	TEST MODE, 4 CSQ output at antenna	PTT to continuous during the performance check)	Frequency error to be $\pm 150\text{Hz}$
Rated Audio	Mode: GEN Output level: 1.0mV RF 4th channel test frequency \diamond Mod: 1kHz tone at 3kHz deviation (1.5kHz deviation for 12.5kHz system) Monitor: DVM: AC Volts	TEST MODE, 4 CSQ	PTT to OFF (center), meter selector to Audio PA	Set volume control to 3.74Vrms
Distortion	As above, except to distortion	As above	As above	Distortion < 3.0%
Sensitivity (SINAD)	As above, except SINAD, lower the RF level for 12dB SINAD.	As above	PTT to OFF (center)	RF input to be < 0.35 μV
Noise Squelch Threshold (only radios with conventional system need to be tested)	RF level set to 1mV RF	As above	PTT to OFF (center), meter selection to Audio PA, spkr/load to speaker	Set volume control to 3.74Vrms
	As above, except change frequency to a conventional system. Raise RF level from zero until radio unsquelches.	out of TEST MODE; select a conventional system	As above	Unsquelch to occur at < 0.25 μV . Preferred SINAD= 8-10dB

\diamond See Table 6 or Table 8 as applicable.

Table 10 Transmitter Performance Checks

TEST NAME	COMMUNICATIONS ANALYZER	RADIO	TEST SET	COMMENTS
Reference Frequency	Mode: PWR MON 4th channel test frequency \diamond Monitor: Frequency error Input at rf In/Out.	TEST MODE, 4 CSQ	PTT to continuous (during the performance check).	Frequency error to be < 150Hz.
Power RF	As above.	As above, 4 CSQ	As above.	Refer to Maintenance Specifica tions page in front of manual.
Voice Modulation Δ	Mode: PWR MON 4th channel test frequency \diamond atten to -70, input to RF In/Out, Monitor: DVM, AC Volts Set 1kHz Mod Out level for 0.025Vrms at test set, 80mVrms at AC/DC test set jack	As above, 4 CSQ	As above, mete selector to mic.	Deviation: VHF, UHF, and 800MHz: ≥ 3.6 kHz but ≤ 5.0 kHz.
Low-Speed Data Modulation 800/900 UHF	As above.	TEST MODE 4TLS output at antenna	PTT to continuous (during the performance check).	Deviation: UHF, 800MHz: ≥ 500 Hz but ≤ 1000 Hz.
Voice Modulation (internal) Δ	Mode: PWR MON 4th channel test frequency \diamond atten to -70, input to RF In/Out.	TEST MODE, 4 CSQ, output at antenna.	Remove modulation input.	Press PTT switch on radio. Say "four" loudly into the radio mic. Measure deviation: VHF, UHF, and 800MHz: ≥ 3.8 kHz but ≤ 5.0 kHz. 900MHz: ≤ 2.5 kHz.
High-Speed Data Modulation***	As above.	TEST MODE, 4 THS, output at antenna.	PTT to continuous (during the performance check).	Deviation: UHF and 800MHz: ≥ 2.4 kHz but ≤ 3.6 kHz. 900MHz: ≥ 1.52 kHz but ≤ 1.95 kHz.
DTMF Modulation	As above, 4th channel test frequency \diamond	TEST MODE, 4 DTMF, output at antenna.	As above.	Deviation: VHF, UHF, and 800MHz: ≥ 3.05 kHz but ≤ 3.45 kHz. 900MHz: ≥ 1.5 kHz but ≤ 1.9 kHz.
PL/DPL Modulation (radios with conventional, clear mode, coded squelch operation only)	Change frequency to a conventional transmit frequency, BW to narrow.	Conventional coded squelch personality (clear mode operation). 4 TPL 4 DPL	As above.	Deviation: VHF, UHF, and 800MHz: ≥ 500 Hz but ≤ 1000 Hz. 900MHz: ≥ 250 Hz but ≤ 500 Hz.
Talk-around Modulation (radios with conventional, clear mode, talk-around operation only)	Change frequency to conventional talk-around frequency. Mode: PWR MON deviation, attenuation to -70, input to RF In/Out Monitor: DVM, AC volts Mod: 1kHz Out level for 25mVrms at test set.	Conventional talk-around personality (clear mode operation). 1 CSQ	As above.	Deviation: UHF and 800MHz: ≥ 3.8 kHz but ≤ 5.0 kHz. 900MHz: ≥ 1.95 kHz but ≤ 2.45 kHz.
Talk-around Modulation (radios with conventional, secure mode, talk-around operation only (**))	Change frequency to conventional talk-around frequency. Mode: PWR MON deviation, attenuation to -70, input to RF In/Out Monitor: DVM, AC volts Mod: 1kHz Out level for 25mVrms at test set.	Conventional talk-around personality (secure mode operation). Load key into radio 1 Sec.	As above.	Deviation: UHF and 800MHz: ≥ 3.6 kHz but ≤ 4.4 kHz.

* 800 MHz radios only

** The secure mode, talk-around modulation test is only required for trac mode radios which do not have clearmode talk-around capability.

*** Trunked Only

Δ When testing voice modulation in the continuous mode, AGC must be disabled.

\diamond See Table 6 or Table 8 as applicable.

Error-Code Displays

4

Power-up Display Codes

At power-up, the radio performs cursory tests to determine if its basic electronics and software are in working order. Problems detected during these tests are presented as error codes on the radio display. The presence of an error code should prompt the user that a problem exists and that a service technician should be contacted.

Self-test errors are classified as either fatal or non-fatal. Fatal errors will inhibit user operation, while non-fatal errors will not. Use Table 11 to aid in understanding particular power-up error code displays.

Table 11 Power-up Display Codes

FAILURE DISPLAY		TYPE OF FAILURE	DESCRIPTION	POSSIBLE SOURCE
14-Character Display	6-Character Display			
ERROR 01/02	E01/02	NON-FATAL	External EEPROM checksum error	Bad external codeplug data
ERROR 01/12	E01/12	NON-FATAL	Internal EEPROM checksum error	Bad internal codeplug data
ERROR 09/10	E09/10	<i>NOTE: Refer to the Secure Module Appendix "ERROR 09/10" section at the rear of this manual for more information.</i>		
FAIL 01/81	F01/81	FATAL	External ROM/Flash checksum error	Bad ROM data, Defective ROM
FAIL 01/82	F01/82	FATAL	External EEPROM checksum error	Bad external codeplug data, Defective external EEPROM
FAIL 01/84	F01/84	FATAL	External EEPROM checksum blank	Unprogrammed external codeplug data
FAIL 01/88	F01/88	FATAL	External RAM error	Defective RAM
FAIL 01/90	F01/90	FATAL	Hardware failure	Defective IC
FAIL 01/92	F01/92	FATAL	Internal EEPROM checksum error	Bad internal codeplug data, Defective microcontroller
FAIL 01/93	F01/93	FATAL	Flashport security error	Improper RSS
FAIL 01/94	F01/94	FATAL	Internal EEPROM checksum blank	Unprogrammed internal codeplug data
FAIL 01/98	F01/98	FATAL	Internal RAM error	Defective microcontroller

NOTE: Due to the nature of fatal ROM and RAM errors, it may not be possible to present an error code on the display. In these cases the radio will attempt to display the appropriate error code, generate an illegal mode tone for one second and then reset its microcontroller.

Operational Display Codes

During operation, the radio performs dynamic tests to determine if it is working properly. Problems detected during these tests are presented as error codes on the radio display. The presence of an error code should prompt a user that a problem exists and that a service technician should be contacted. Use Table 12 to aid in understanding particular operational error code displays.

Table 12 Operational Display Codes

FAILURE CODE		DESCRIPTION	POSSIBLE SOURCE
14-Character Display	6-Character Display		
FAIL 001	F001	Synthesizer out of lock	Bad frequency data in codeplug; defective synthesizer
FAIL 002	F002	Selected Mode (Zone/Channel) codeplug checksum error	Bad codeplug data
FAIL 100	F100	Incompatible trunking software and hardware	Trunking hardware decoder disabled in codeplug; old SLIC IC version
FAIL 101	F101	Incompatible MDC1200 software and hardware	MDC 1200 hardware decoder disabled in codeplug; old SLIC IC version

Radio Alignment Procedure

General

An IBM PC (personal computer) and Radio Service Software (RSS) are required to align the radio. Refer to the applicable RSS manual for installation and setup procedures for the software. To perform the alignment procedures, the radio must be connected to the PC, RIB (radio interface box), and Universal Test Set as shown in Figure 1.

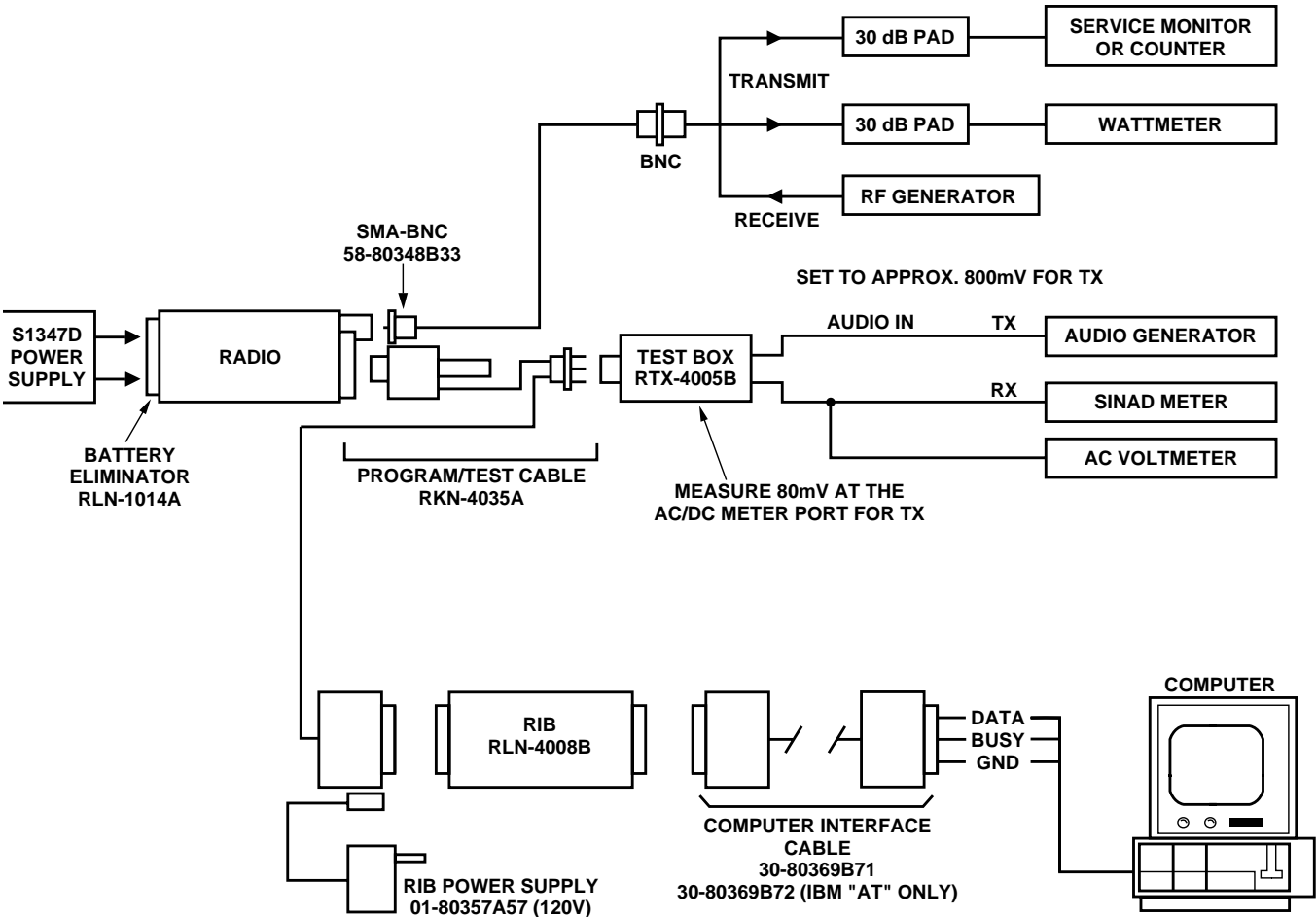
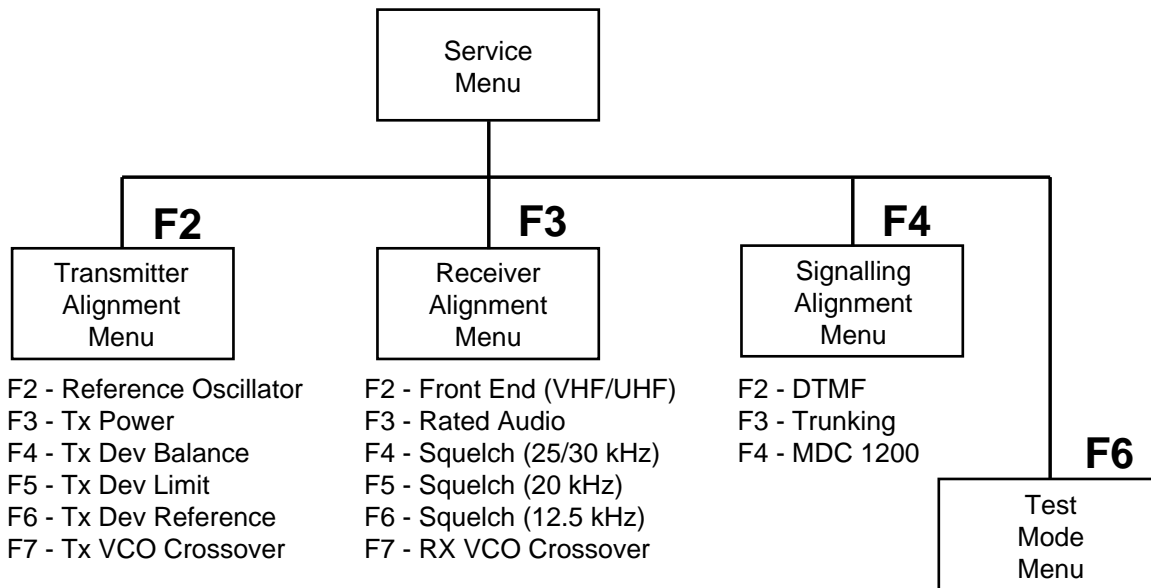


Figure 1 Radio Alignment Test Setup



Note: F2 = Function Key 2

Figure 2 RSS Service Menu Layout

All service and tuning procedures are performed from the SERVICE menu, which is selected by pressing F2 from the MAIN MENU. Figure 2 illustrates how the RSS SERVICE screens are organized.

All SERVICE screens read and program the radio codeplug directly; you do NOT have to use the RSS GET/SAVE functions to use the SERVICE menus. You will be prompted at each screen to save changed values before exiting the screen. RSS references in this manual are to HT 1000 / JT 1000 RSS. Some slight differences may be noted if you are using the MTS/MTX RSS.



Caution

Do NOT switch radios in the middle of any SERVICE procedure. Always use the EXIT key to return to the MAIN menu screen before disconnecting the radio. Improper exits from the SERVICE screens may leave the radio in an improperly configured state and result in seriously degraded radio or system performance.

The radio contains internal test modes that can be accessed from the RSS. The test modes permit the service technician to easily select various frequency, modulation, and transmit power combinations to verify proper operation of the radio. The test modes can be used to check both transmit and receive operation. From the Service Menu press F6 to navigate to the TEST MODE screen.

The SERVICE screens introduce the concept of the “softpot”, an analog SOFTWARE controlled POTentiometer used for adjusting all transceiver alignment controls.

Each SERVICE screen provides the capability to increase or decrease the 'softpot' value with the keyboard UP/DOWN arrow keys respectively. A graphical scale is displayed indicating the minimum, maximum, and proposed value of the softpot, as shown in Figure 3.

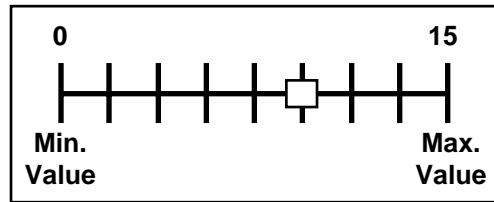


Figure 3 Softpot Concept

Adjusting the softpot value sends information to the radio to increase (or decrease) a DC voltage in the corresponding circuit. For example, pressing the UP arrow key at the Reference Oscillator screen instructs the radio microprocessor to increase the voltage across a varactor in the reference oscillator to increase the frequency.

In ALL cases, the softpot value is just a relative number corresponding to a D/A (Digital-to-Analog) generated voltage in the radio. All standard measurement procedures and test equipment are similar to previous radios.

Perform the following procedures in the sequence indicated.

Reference Oscillator Alignment

Adjustment of the reference oscillator is critical for proper radio operation. Improper adjustment will not only result in poor operation, but also a misaligned radio that will interfere with other users operating on adjacent channels. For this reason, the reference oscillator should be checked every time the radio is serviced or once a year, whichever comes first. The frequency counter used for this procedure must have a stability of 0.1 ppm (or better).

1. From the SERVICE menu, press F2 to select TRANSMITTER alignment.
2. Press F2 again to select the REFERENCE OSCILLATOR softpot.
3. Press F6 to key the radio. The screen will indicate that the radio is transmitting.
4. Measure the transmit frequency on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the reference oscillator per the targets shown in Table 13.

Table 13 Reference Oscillator Alignment

BAND	TARGET
VHF	0 to 300 Hz
UHF	0 to 300 Hz
800/900 MHz	0 to 300 Hz

Front-End Pre-Selector (VHF/UHF only)

NOTE: This procedure is only required for tuning the front-end filter varactors in the VHF and UHF models. The 800 and 900 MHz models utilize a stripline pre-selector.

1. Set the Test Box (RTX4005B) meter selection switch to the "VOL" position, and connect a dc voltmeter capable of 1mV resolution on a 2V scale to the Test Box AC/DC meter port to monitor the Received Signal Strength Indicator (RSSI).
2. From the SERVICE menu, press F3 to select RECEIVER alignment.
3. Press F2 to select the FRONT END FILTER softpot. The screen will indicate the receive frequencies at which the filter is to be tuned.
4. Set the RF test generator to the first receive frequency +150 Hz. Set the RF level at the radio standard antenna port to 4.0 μ Volts with no modulation.
5. Adjust the UP/DOWN arrow keys to obtain a peak voltage on the dc voltmeter.
6. Press F8 to program the softpot value.
7. Repeat steps 4-6 for the remaining test frequencies.
8. Press F10 and F2 to return to the RECEIVER menu.

Rated Audio

1. Set test box (RTX-4005B) meter selection switch to the "AUDIO PA" position and connect an ac voltmeter to the test box ac/dc meter port.
2. Press F3 to select the RATED AUDIO softpot. The screen will indicate the receive test frequency to be used.
3. Set the RF test generator to the receive test frequency, and set the RF level at the radio standard antenna port to 1 mV modulated with standard test modulation (see Table 14).

Table 14 Standard Test Modulation (1 kHz Tone)

Band	Deviation
VHF/UHF/800 MHz	3.0 kHz
900 MHz	1.5 kHz

4. Adjust the UP/DOWN arrow keys to obtain rated audio (as close as possible to 3.74 Vrms) into a speaker (28 ohms) or equivalent resistive load.
5. Press F8 to program the softpot value.
6. For HearClear-equipped radios, go to step 7; otherwise press F10 to return to the RECEIVER menu.
7. Now set the RF test generator to the receive test frequency, and set the RF level at the radio standard antenna port to 1 mV modulated with a 1kHz tone, 1.2kHz deviation.

8. Select the Hear Clear RATED AUDIO softpot, and adjust the UP/DOWN arrow keys to obtain rated audio (3.74 Vrms) into a speaker (28 ohms) or equivalent resistive load.
9. Press F8 to program the softpot value.
10. Press F10 to return to the RECEIVER menu.

Squelch

NOTE: Verify that audio output is set to rated audio (3.74 Vrms)

1. Select the 25kHz squelch tuning menu. (note: 25 kHz must be tuned before tuning either 12.5kHz or 20kHz squelch).
2. With no signal applied, decrease the softpot value until squelch opens. Set the RF test generator to the frequency plus the following offset; (VHF: +200HZ), (UHF: +200HZ), (800MHZ: +500HZ). Adjust the generator for 8 to 10 dB Sinad.
3. Increase the softpot until the squelch closes.
4. Monitor for squelch chatter. If chatter is present, increase the softpot until no chatter is detected. Press F8 to program the softpot value. Press ENTER to select the next softpot adjustment.
5. Repeat step 2 through 4 for all test frequencies shown on the screen.
6. If you are using 25kHz channel spacing, skip to step 8. Otherwise, go into the 12.5kHz or 20kHz squelch tuning menus.
7. Repeat steps 2 through 5.
8. Press F10, then F10 again to return to the service menu.

Transmitter Power

VHF and UHF radios require two power-level adjustments, a high-power or rated-power adjustment, and a low-power adjustment. The low power adjustment is required since the radio may be used in a reduced power mode, or with a vehicular adapter.

NOTE: All power measurements are to be made at the antenna port.

1. From the SERVICE menu, press F2 to select TRANSMITTER alignment.
2. Press F3 to select the TRANSMIT POWER softpot. The screen will indicate the transmit test frequencies to be used.
3. Begin with the highest test frequency shown.
4. Press F6 to key the radio, and use the UP/DOWN arrow keys to adjust the transmit power per the value shown in Table 15.
5. Press F6 to dekey the radio, and then press F8 to program the value.
6. Repeat steps 4 and 5 for the remaining test frequencies.
7. Press F10, then F2 to return to the TRANSMIT menu.

Table 15 Transmit Power Setting

VHF			UHF		
Power Level	Test Frequencies		Power Level	Test Frequencies	
	136 - 174MHz	177.975MHz		450 - 512MHz	512 - 520MHz
5 W	5.2 - 5.4	4.2 - 4.4	4 W	4.2 - 4.4	3.2 - 3.4
1 W	1.2 - 1.4	1.2 - 1.4	1 W	1.2 - 1.4	1.2 - 1.4
800 MHz			900 MHz		
Power Level	All Test Frequencies		Power Level	All Test Frequencies	
3 W	3.2 - 3.4		2.4 W (Typ.) 2.9 W (Max.)	2.4 - 2.6	

Transmit Deviation Balance (Compensation)

Compensation alignment balances the modulation sensitivity of the VCO and reference modulation (synthesizer low frequency port) lines. The compensation algorithm is critical to the operation of signalling schemes that have very low frequency components (e.g. DPL) and could result in distorted waveforms if improperly adjusted.

NOTE: Disable all audio band filters on the service monitor.

NOTE: (Secure-Equipped Radios Only)

If a secure module is currently installed in the radio being aligned, refer to the appendix at the rear of this manual. Read section III, "Secure Alignment Procedure", before performing the transmit deviation balance (compensation) procedure.

1. Press F4 to select the TRANSMIT DEVIATION BALANCE softpot. The screen will indicate the transmit test frequencies to be used.
2. Begin with the lowest test frequency shown on the screen.
3. Set the Test Box (RTX4005B) meter selector switch to the "MX DISC" position, and inject an 80Hz tone at 100mVrms into the AC/DC MTR port. Keep the ac voltmeter in parallel to ensure the proper input signal level.
4. Press F6 to key the radio, and measure deviation. Record this measurement.
5. Change the input tone to 3 kHz, 100mVrms and use the UP/DOWN arrow keys to adjust the deviation to within $\pm 2\%$ of the value recorded in step 4.
6. Change the input tone back to 80 Hz and measure the deviation.
7. Repeat steps 5 and 6 until the 3kHz tone deviation is within $\pm 2\%$ of the 80Hz tone deviation.
8. Press F6 to dekey the radio, and press F8 to program the softpot value. Press ENTER to move to next softpot value.

9. Repeat steps 3 through 8 for the remaining test frequencies.
10. Press F10 to return to the TRANSMIT menu.

NOTE: The step size change for step 5 is approximately 2.5% per softpot value. This adjustment should only be made to the 3kHz deviation. Do not adjust the 80Hz deviation.

Transmit Deviation Limit

1. Press F5 to select the TRANSMIT DEVIATION LIMIT softpot. The screen will indicate the transmit test frequencies to be used.
2. Begin with the lowest test frequency shown on the screen.
3. With the meter selector switch (RTX4005B) set to MIC, inject a 1kHz tone on the AUDIO IN terminal on the test set, 80mVrms as measured on the AC/DC MTR port.
4. Press F6 to key the radio, and use the UP/DOWN arrow keys to adjust the deviation per the values shown in Table 16.

Table 16 Transmit Deviation Limit

BAND	Deviation (KHz)
VHF/UHF/800 MHz	4.30 - 4.60
900 MHz	2.20 - 2.30

5. Press F6 to dekey the radio, and press F8 to program the softpot value. Press ENTER to move to the next softpot value.
6. Repeat steps 3-5 for the remaining frequencies shown on the screen.
7. Press F10 to return to the TRANSMIT menu.

Transmit Deviation Limit Reference

NOTE: This procedure is required for VHF, UHF, and 800 MHz models with 20kHz channel spacing and VHF and UHF models with 12.5kHz channel spacing. This procedure is not required for 900MHz models.

1. Press F6 to select the TRANSMIT DEVIATION LIMIT REFERENCE softpot.
2. With the meter selector switch (RTX4005B) set to MIC, inject a 1kHz tone on the AUDIO IN terminal on the test set, 80mVrms as measured on the AC/DC MTR port.
3. Press F6 to key the radio, and use the UP/DOWN arrow keys to adjust the deviation per Table 17.

Table 17 Transmit Deviation Limit Reference

Channel Spacing	Deviation (kHz)
20 KHz	3.40 - 3.60
12.5 KHz	2.20 - 2.30

4. Press F6 to dekey the radio, and press F8 to program the softpot value.
5. Press F10 to return to the TRANSMIT menu.

VCO Crossover Frequency

NOTE: This procedure is only required after the field repair of a VHF or UHF VCO.

In order for a phase-locked-loop to tune very wide bandwidths, both negative and positive control voltages (Vcntl) are required. This procedure sets the crossover frequency at which the negative Vcntl (or -Vee) switches from zero to negative.

Transceiver Board Identification

VHF Radios

VHF transceiver board NUD7070 and NUD7085 ("C" and later) kits include new VCO varactors, and are factory aligned with a new transmit VCO crossover frequency of 164.850MHz.

Since the transmit crossover frequency has changed, whenever transmit VCO crossover alignment (an RSS function) is performed, circuit board identification will be important. The "C" kits can be identified by the circuit board number 5511Y02 or 5511Y32 visible on side 2 of the board, located along the circuit board edge just next to crystal filter FL1. All future VHF transceiver boards will be in the "5511Y" series.

Anytime a controller board or transceiver board is replaced in a radio, it will be necessary to perform the RSS transmit VCO crossover alignment, and check the transmit VCO crossover frequency. The RSS screen for this alignment will show a "current value" box with a frequency already assigned, placed inside the box. When performing transmit VCO crossover alignment, first check the transceiver circuit board number. In a VHF radio:

- If the board number is any "5511Y" series number, other than 5511Y01 or 5511Y31, the transmit VCO crossover frequency in the "current value" box should be 164.850MHz. If it is not, change it to 164.850MHz.
- If the board number is 5511Y01, 5511Y31 or any other number not in the 5511Y series, the transmit VCO crossover frequency in the "current value" box should be 161.50500MHz. If it is not, change it to 161.50500MHz.

VCO varactors (CR201, 202, and 203) in “C” and later kits are not interchangeable with VCO varactors in earlier kits; Motorola parts and part numbers are different. When replacing a VCO varactor, identify the transceiver board and order replacement parts from the applicable parts list.

UHF, 403-470MHz Radios

UHF transceiver board (403 - 470MHz band split) NUE7231 and NUE7240 (“C” and later) kits include new VCO varactors, and are factory aligned with a new transmit VCO crossover frequency of 449.500MHz.

Since the transmit crossover frequency has changed, whenever transmit VCO crossover alignment (an RSS function) is performed, UHF band split and circuit board identification will be important.

- UHF band split can positively be determined by checking the markings on the power amplifier shield. If the power amplifier shield marking is 25U04 or 85Y10, then the transceiver is a 403 - 470MHz band split. If the power amplifier shield marking is 25U05 or 85Y11, then the transceiver is a 450 - 520MHz band split.
- The “C” kits can be identified by the circuit board number 4221J07 or 4221J37 visible on side 2 of the board, located along the circuit board edge just next to crystal filter FL1. All future UHF transceiver boards will be in the “4221J” series.

Anytime a controller board or transceiver board is replaced in a radio, it will be necessary to perform the RSS transmit VCO crossover alignment, and check the transmit VCO crossover frequency. The RSS screen for this alignment will show a “current value” box with a frequency already assigned, placed inside the box. When performing transmit VCO crossover alignment, determine the UHF transceiver band split, and then check the transceiver circuit board number. In a UHF radio (403 - 470MHz range):

- If the board number is any “4221J” series number, other than 4221J01 thru 4221J06 or 4221J36, the transmit VCO crossover frequency in the “current value” box should be 449.500MHz. If it is not, change it to 449.500MHz.
- If the board number is 4221J01 thru 4221J06, 4221J36, or any other number not in the 4221J series, the transmit VCO crossover frequency in the “current value” box should be 438.025MHz. If it is not, change it to 438.025MHz.

VCO varactors (CR201, 203, 207, 208, and 209) in “C” and later kits are not interchangeable with VCO varactors in earlier kits; Motorola parts and part numbers are different. When replacing a VCO varactor, identify the UHF transceiver band split and the transceiver circuit board number, and then order replacement parts from the applicable parts list.

UHF, 450-520MHz Radios

UHF transceiver board (450 - 520MHz band split) NUE7232 and NUE7241 (“C” and later) kits include new VCO varactors, and are factory aligned with a new transmit VCO crossover frequency of 495.375MHz.

Since the transmit crossover frequency has changed, whenever transmit VCO crossover alignment (an RSS function) is performed, UHF band split and circuit board identification will be important.

- UHF band split can positively be determined by the markings on the power amplifier shield. If the power amplifier shield marking is 25U04 or 85Y10, then the transceiver is a 403 - 470MHz band split. If the power amplifier shield marking is 25U05 or 85Y11, then the transceiver is a 450 - 520MHz band split.
- The "C" kits can be identified by the circuit board number 4221J07 or 4221J37 visible on side 2 of the board, located along the circuit board edge just next to crystal filter FL1. All future UHF transceiver boards will be in the "4221J" series.

Anytime a controller board or transceiver board is replaced in a radio, it will be necessary to perform the RSS transmit VCO crossover alignment, and check the transmit VCO crossover frequency. The RSS screen for this alignment will show a "current value" box with a frequency already assigned, placed inside the box. When performing transmit VCO crossover alignment, determine the UHF transceiver band split, and then check the transceiver circuit board number. In a UHF radio (450 - 520MHz range):

- If the board number is any "4221J" series number, other than 4221J01 thru 4221J06 or 4221J36, the transmit VCO crossover frequency in the "current value" box should be 495.375MHz. If it is not, change it to 495.375MHz.
- If the board number is 5521Y03, the transmit VCO crossover frequency in the "current value" box should be 486.025MHz. If it is not, change it to 486.025MHz.

VCO varactors (CR201, 203, 207, 208, and 209) in "C" and later kits are not interchangeable with VCO varactors in earlier kits; Motorola parts and part numbers are different. When replacing a VCO varactor, identify the UHF transceiver band split and the transceiver circuit board number, and then order replacement parts from the applicable parts list.

TX VCO Crossover Procedure

1. From the SERVICE menu, press F2 to select TRANSMITTER alignment.
2. Press F7 to select the TRANSMIT VCO CROSSOVER softpot. The screen will indicate the transmit test frequency to be used.
3. Connect a dc voltmeter capable of 1mV resolution to test point 5 (TP5), which is accessible through a hole in the bottom side VCO circuitry shield.
4. Beginning with the default softpot frequency of line 2, press F6 to key the transmitter, and adjust the UP/DOWN arrow keys until the voltage reading at TP5 is 3.0 ± 0.1 volts. The frequency will increment in steps of 50kHz.
5. Press F6 again to dekey the transmitter, and press F8 to program the softpot value.
6. Press F10 twice to return to the SERVICE menu.

RX VCO Crossover Procedure

1. From the SERVICE menu, press F3 to select RECEIVER alignment.
2. Press F5 to select the RECEIVE VCO CROSSOVER softpot. The screen will indicate the receive test frequency to be used.
3. Connect a dc voltmeter capable of 1mVolt resolution to test point 5 (TP5), which is accessible through a hole in the bottom side VCO circuitry shield.
4. Beginning with the default softpot frequency of line 2, adjust the UP/DOWN arrow keys until the voltage reading at TP5 is 3.0 ± 0.1 volts.
5. Press F8 to program the softpot value.
6. Press F10 twice to return to the SERVICE menu.

Signalling Deviation

Transmit deviation balance compensation and transmit deviation limit adjustments should be completed before signalling deviation is adjusted.

DTMF Tuning

1. From the SERVICE menu, press F4 to select SIGNALLING alignment.
2. Press F2 to select the DTMF softpot.
3. Press F6 to key the radio on the test frequency. The screen will indicate that the radio is transmitting.
4. Measure the DTMF deviation on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the DTMF deviation per Table 18.
6. Press F6 again to dekey the radio.
7. Press F8 to program the softpot value; press F10 to return to the SIGNALLING menu.

High Speed Signalling

1. From the SERVICE menu, press F4 to select SIGNALLING alignment.
2. Press F3 to select the TRUNKING HIGH SPEED softpot.
3. Press F6 to key the radio on the test frequency. The screen will indicate that the radio is transmitting.
4. Measure the TRUNKING HIGH SPEED deviation on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the TRUNKING HIGH SPEED deviation per Table 18.

Table 18 Signalling Deviation

Channel Spacing (kHz)	DTMF	High Speed	MDC	Single Tone
25 / 30	3.05-3.45	2.5-3.5	3.40-3.75	3.0-4.0
20 (VHF/UHF)	2.44-2.76	2.0-2.8	2.6-3.0	2.4-3.2
20 (821-824, 866-869)	2.44-2.76	2.0-2.8	2.6-3.0	2.4-3.2
12.5	1.55-1.85	1.40-1.75	1.640-1.875	1.5-2.0

6. Press F6 again to dekey the radio.
7. Press F8 to program the softpot value; press F10 to return to the SIGNALLING menu.

MDC 1200

1. From the SERVICE menu, press F4 to select SIGNALLING alignment.
2. Press F4 to select the MDC softpot.
3. Press F6 to key the radio on the test frequency. The screen will indicate that the radio is transmitting.
4. Measure the MDC deviation on your service monitor.
5. Use the UP/DOWN arrow keys to adjust the MDC deviation per Table 18.
6. Press F6 again to dekey the radio.
7. Press F8 to program the softpot value; press F10 twice to return to the SERVICE menu.

Alignment Procedure Conclusion

The radio alignment procedure is now complete; the radio may be disconnected and returned to service.

Disassembly and Reassembly

6



Caution

THIS RADIO CONTAINS STATIC-SENSITIVE DEVICES. DO NOT OPEN THE RADIO UNLESS PROPERLY GROUNDED. TAKE THE FOLLOWING PRECAUTIONS WHEN WORKING ON THIS UNIT.

1. Store and transport all complementary metal-oxide semiconductor (CMOS) devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS devices into conventional plastic “snow” trays used for storage and transportation of other semiconductor devices.
2. Ground the working surface of the service bench to protect the CMOS device. We recommend using the Motorola Static Protection Assembly (part number 0180386A82), which includes a wrist strap, two ground cords, a table mat, and a floor mat.
3. Wear a conductive wrist strap in series with a 100k resistor to ground. Replacement wrist straps that connect to the bench top covering are Motorola part number RSX-4015.
4. Do not wear nylon clothing while handling CMOS devices.
5. Neither insert nor remove CMOS devices with power applied. Check all power supplies that are to be used for testing CMOS devices to be certain that there are no voltage transients present.
6. When straightening CMOS pins, provide ground straps for apparatus used.
7. When soldering, use a grounded soldering iron.
8. If at all possible, handle CMOS devices by the package and not by the leads. Prior to touching the unit, touch an electrical ground to remove any static charge that you may have accumulated. The package and substrate may be electrically common. If so, the reaction of a discharge to the case would cause the same damage as touching the leads.

General

Since this product disassembles and reassembles without the use of any screws, it is important for the technician to pay particular attention to the snaps and tabs, and how parts align with each other.

NOTE: In the disassembly/reassembly procedure, the numbers in parentheses refer to call-out numbers in the referenced figures.

Disassembly to Board Level

1. Turn off the radio.
2. Remove the battery (see Figure 4).
 - a. Hold the radio such that the battery is tilted down.
 - b. Press down on the two battery-release levers.
 - c. With the release levers pulled down, the top of the battery will fall away from the radio.
 - d. Remove the battery completely from the radio.

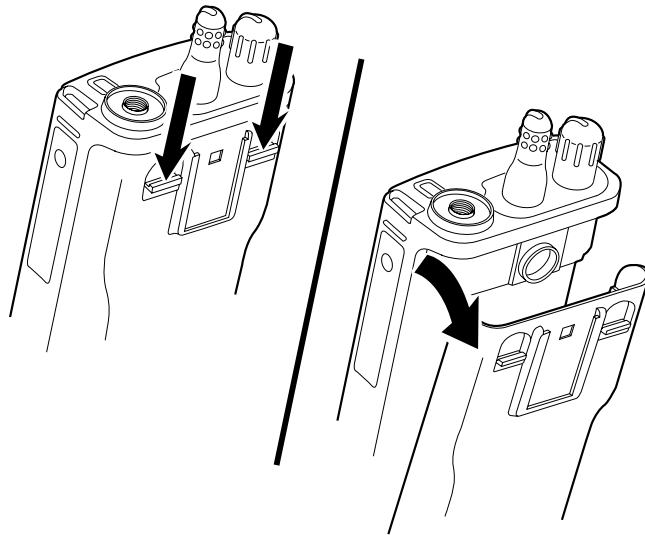


Figure 4 Removing the Battery

3. Loosen the antenna by turning it in a counterclockwise direction, and remove it from the radio.
4. Remove the volume on/off knob and the channel selector switch knob by pulling them off their respective switch shafts.

NOTE: Both knobs slide on and off but fit very snug on their respective switch shafts. A small flat blade screwdriver may be necessary to help pry the knobs loose. Take care not to mar the surrounding radio surface.

5. Separate the front cover assembly from the internal electronics (chassis) (see Figure 5).
 - a. Insert the chassis/front cover separation tool (Motorola part no. 6680334E07) or like instrument in the slotted area at the bottom center of the radio. Take care not to mar the O-ring sealing area on the housing.

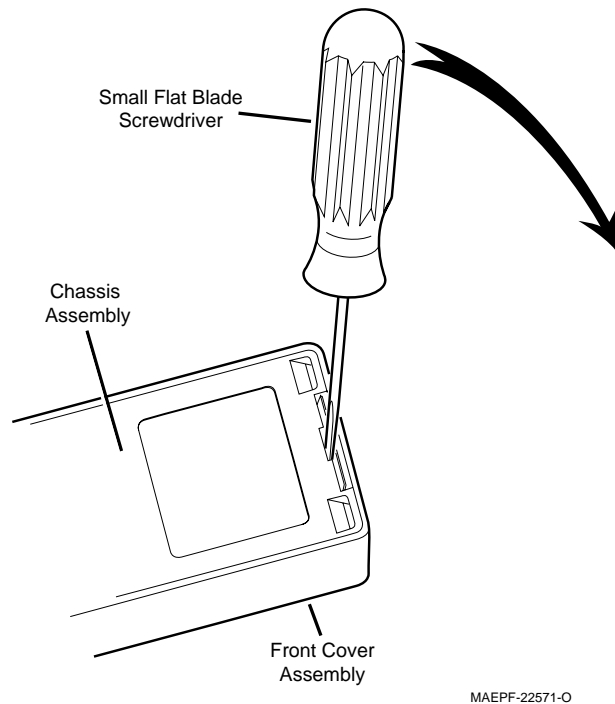


Figure 5 Separating the Cover From the Chassis

- b. Pry the bottom of the chassis free from the cover by pushing the separation tool down and rotating the handle of the separation tool over and behind the base of the radio. This prying action forces the thin inner plastic wall toward the base of the radio, which releases the two chassis base tabs.

NOTE: A flexible ribbon cable (front cover/display flex), which connects to the front cover assembly and the chassis, keeps you from completely separating the two units.

- c. Lay the chassis down, and rotate the front cover back and partially away from the chassis (see Figure 6).

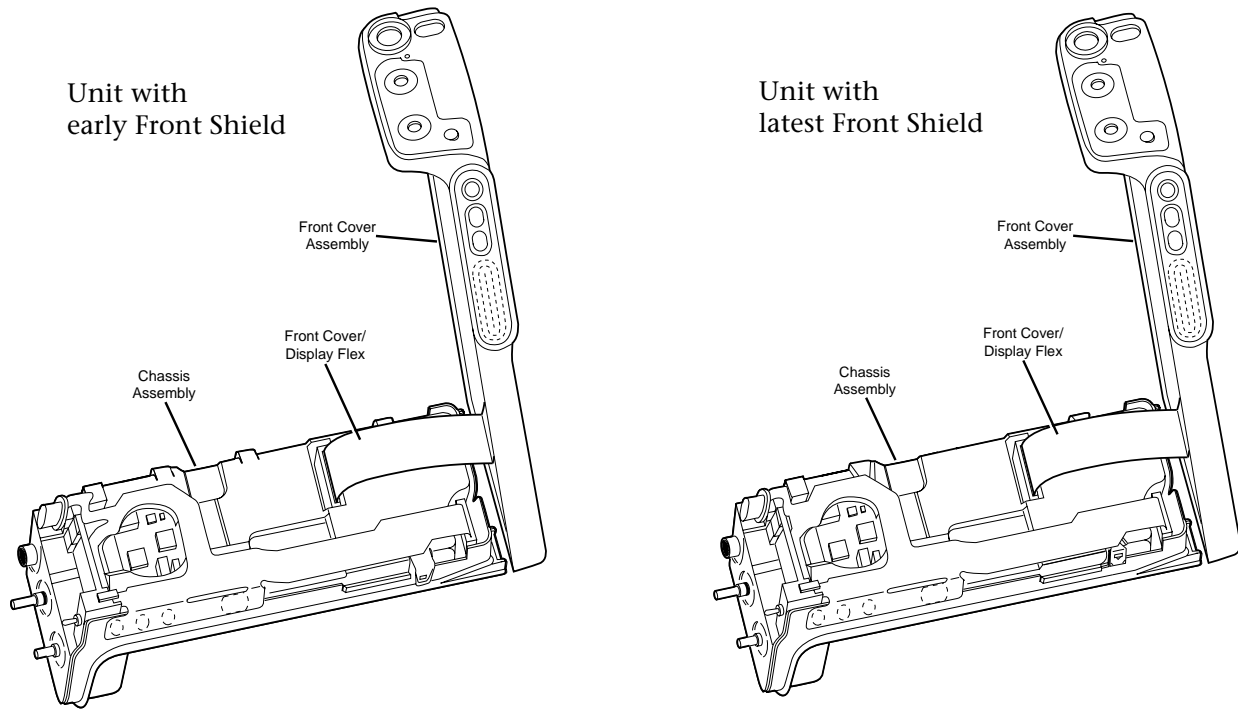


Figure 6 Rotating the Front Cover

6. Disconnect the front cover display flex from the connector on the chassis.

NOTE: A special locking connector secures the flex to the chassis (see Figure 7).

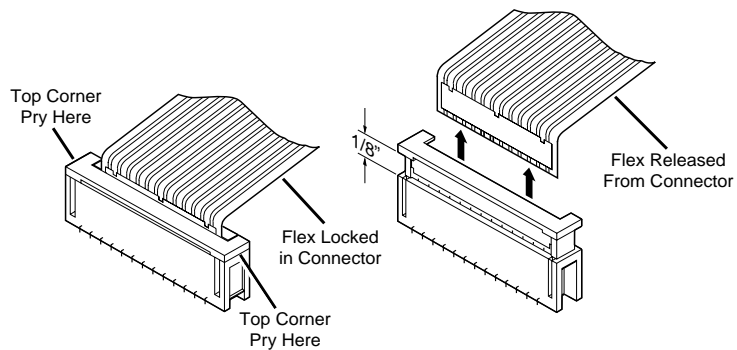


Figure 7 Disconnecting the Flex

- a. Use the flex connector opening tool, large curved end (Motorola part no. 6680334E08), or like instrument to help raise the sliding portion of the connector approximately 1/8 of an inch from its seated position. A slight prying action will achieve the best results for unlocking the connector.
 - b. Remove the flex from the chassis connector.
7. Remove the contoured O-ring/antenna bushing seal from the chassis.
 8. Disconnect the controls flex from the connector on the controller board by following the procedure in step 6a and 6b.

NOTE: A large portion of the controls flex is attached to the large metal shield (front shield) with adhesive. Do not remove the controls flex from the front shield.

9. As a unit, separate the control top, the front shield, and the controls flex from the chassis and circuit boards (see Figure 8).

NOTE: Three locking clips (four tabs on early front shield) secure the front shield to the chassis and hold the RF board and the controller board in the chassis.

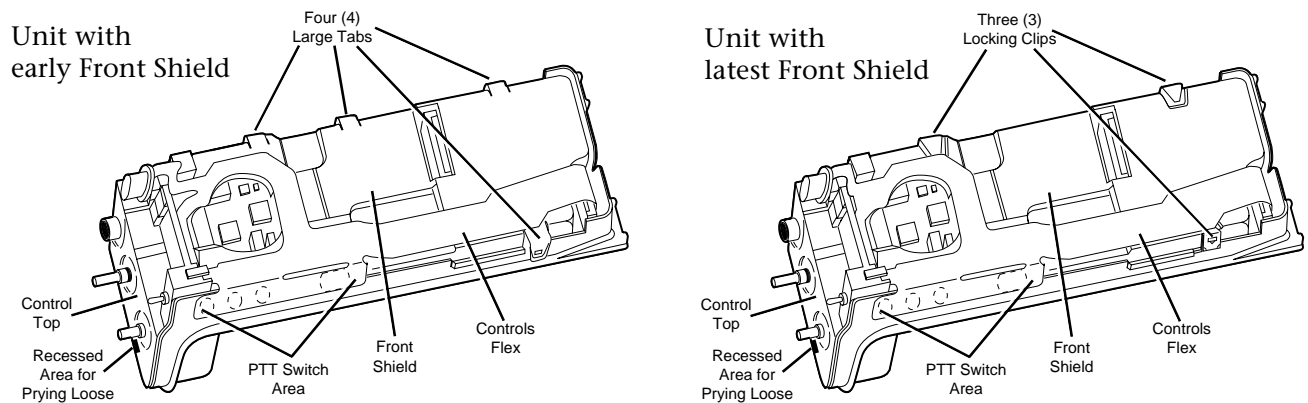


Figure 8 Separating Control Top From the Chassis

- a. Loosen the front shield by prying each of the three clips (four tabs on early front shield) away from the chassis. Be careful not to pry the clips/tabs any more than is necessary to free them from their respective retaining slots. To completely loosen the shield from the chassis, a slight lifting and clockwise twisting action may be required.
 - b. Insert a small, flat-blade screwdriver in the recessed area of the control top and pry the control top slightly away from the chassis.
 - c. Completely remove the control top/front shield/controls flex unit from the chassis.
10. Carefully remove the RF board and the controller board from the chassis.

NOTE: The RF board and the controller board are connected together with a stiff connector strip (P301/P704). See Figure 9.

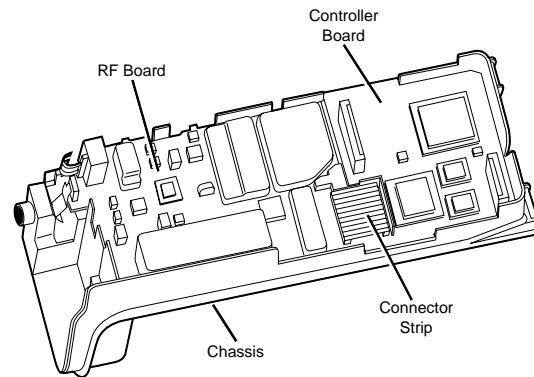


Figure 9 Removing the RF and Controller Boards

Disassembly of Control Top

1. Remove the rubber controls seal from the control top.
2. Turn the control top such that the grey switch housing cover is facing up.
 - a. Five retaining clips hold the switch housing cover to the switch housing. Clips 1, 2, and 3 are important during disassembly (see Figure 10).

NOTE: To perform step 2b, two tools will be required; your thumbnail or small, flat-blade screwdriver, and a pen, pencil, or another small, flat-blade screwdriver.

- b. Using your thumbnail or small, flat-blade screwdriver, lift the tab that covers the base of the LED approximately 1/16 of an inch from its seated position. While applying constant lifting pressure there, (in order) release clips 1, 2, and 3 with the other tool.

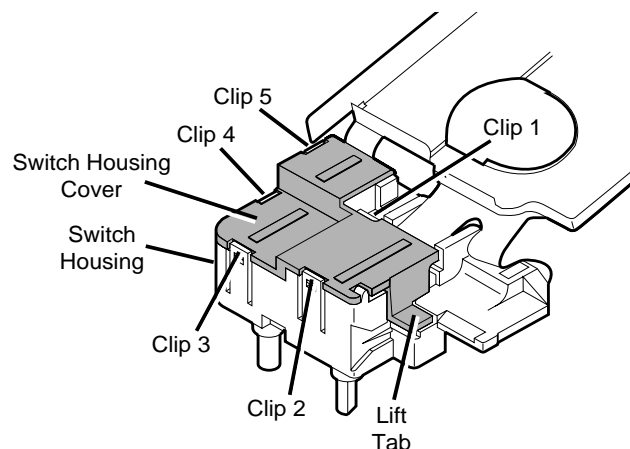


Figure 10 Switch Housing Retaining Clips

- c. The cover will pop loose from the switch housing.
3. Push the three switches and the LED out of the switch housing.

4. The remainder of the controls flex is attached to the switch housing with adhesive. Do not remove the flex from the switch housing unless it is absolutely necessary.

Disassembly of Front Cover Assembly

1. On top display model radios only, release the display board by using a “press and pull” action on the top two corners of the display board. Press down on the two top corners of the display board and pull the top of the board away from the two corner retaining tabs. The display board will free itself from the retaining tabs and two retaining slots in the front cover housing.
2. Remove the wedge connector (part of the front cover flex, located behind the universal connector), by sliding it out of the plastic rails that hold it in place. A slight prying action, alternating back and forth on the bottom corners of the connector, achieves the best results. Be careful not to damage the spring contacts on the wedge.
3. Remove the speaker retainer bracket, speaker, microphone, and front cover flex from the front cover housing (see Figure 11).

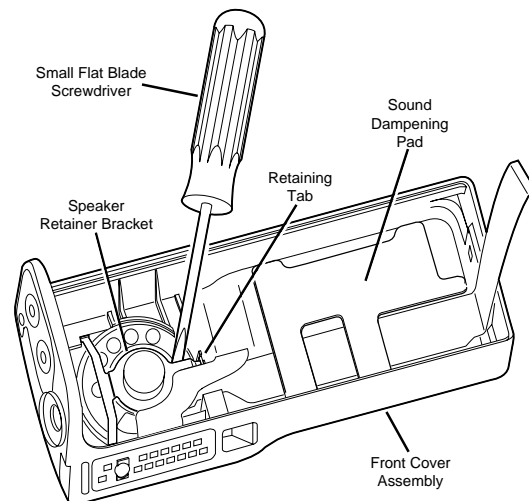


Figure 11 Removing the Speaker and Flex From the Front Cover

NOTE: The speaker and front cover flex are held in position with a three-leg retainer bracket. The legs of the bracket are secured by slots in the front cover. When removing the retainer bracket, use caution not to damage the speaker.

- a. Disengage the retainer bracket leg that points toward the bottom of the front cover from its retaining tab.
 - (1) Insert a small, flat-blade screwdriver under the base of the bracket leg near the ring.
 - (2) Lift the bracket leg until it pops loose from under its retaining tab.
- b. Lift the freed leg of the retainer bracket and use it to pull the remaining two legs of the bracket out and away from their respective slots in the front cover housing.
- c. Pull the rubber microphone boot, containing the microphone, from its seated position. Unless you are

replacing the microphone, leave the microphone in the boot.

4. Remove, if necessary, and replace the sound dampening pad.
5. As necessary, replace the speaker and/or microphone while out of the front cover housing.

NOTE: If the microphone is replaced, ensure that the microphone is reinstalled back into the rubber boot with the microphone port facing the round hole at the bottom of the boot.

6. On front display model radios only, notice that the keypad/display board is secured to the front cover housing using six tabs, three small tabs on one side and three larger tabs on the universal connector side. Remove the keypad/display board by inserting a small flat-blade screwdriver in the circuit board slot provided (slot nearest the top retaining tab on the universal connector side of the radio, see Figure 12). A slight prying action will release the keypad/display board. If applicable, remove the rubber keypad.

NOTE: Be careful not to mar the front cover housing O-ring sealing area. Doing so will compromise the sealing integrity of the radio.

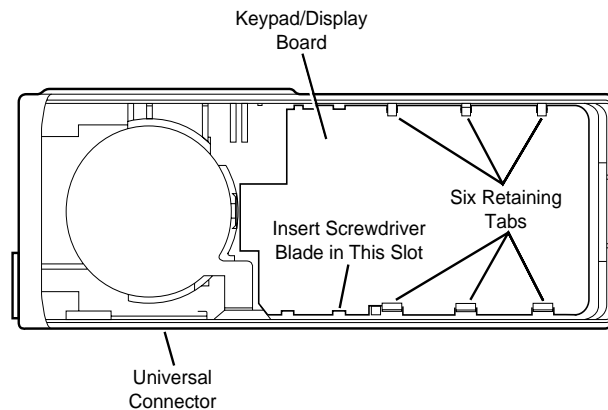


Figure 12 Removing the Keypad/Display Board

Reassembly

Reassembly is the reverse of disassembly. Some suggestions and illustrations are provided to help you more easily reassemble the radio.

Keypad/Display Board (front display model radios only)

1. If applicable, replace the rubber keypad.
2. Place the keypad/display board into the front cover housing at an angle such that the three small slots on the edge of the board slide under the three mating retaining tabs. Ensure that the board slides under the tabs.
3. Near the three larger slots on the other side of the board, use finger pressure to push and press that side of the board down until it snaps into place under the three large retaining tabs.

Front Cover Assembly

1. Place the speaker and microphone into their respective positions in the front cover. Make sure that the speaker is seated properly in the recessed area provided.

2. Press the rubber microphone boot into its respective recessed area in the front cover housing. The little rubber flap in the back of the rubber boot should fold up to cover the microphone insertion opening.
3. Reinstall the speaker retainer bracket (see Figure 13).

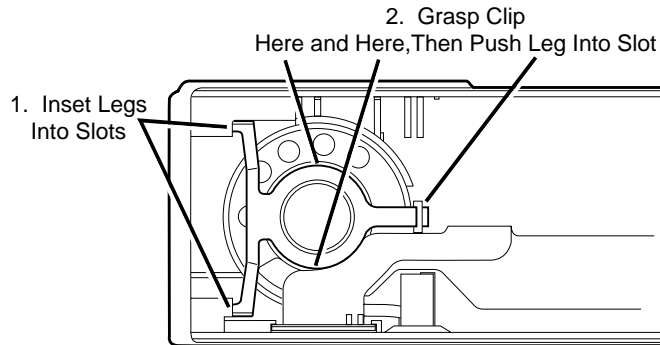


Figure 13 Reinstalling the Speaker Retainer Bracket

- a. Position the spring bracket over the speaker, and toward the top of the front cover housing; insert the appropriate two legs of the bracket into their respective slots.
 - b. Grasp the center portion of the spring bracket (ring area) with thumb and forefinger.
 - c. While holding the ring area of the spring bracket at approximately the same height as the speaker's base, push the remaining leg down and into its respective slot.
4. Orient the wedge connector so that its gold contacts face the gold contacts of the housing. Align the wedge connector with the respective slots in the housing, and slide the connector down into place. Ensure that the wedge connector is fully seated into position.

5. On top display model radios only, seat the display board by inserting the two display board tabs into their mating slots in the front cover housing. Push the top of the display board toward the top of the radio until the front cover housing retaining tabs engage the display board and secure it into position.

Chassis

Inside of the chassis where the RF board fits is a protruding block that functions as the PA heatsink. To help provide maximum heat transfer, ensure that the PA heatsink block (top surface) includes a thermal pad (Motorola part number 7505922Z01) adhered to it.

Place the RF board and controller board into the chassis. Ensure that the plastic cover that more rigidly holds the two boards together is snapped into place.

Control Top

1. Reinstall the switches and LED into the switch housing.
2. Reinstall the switch housing cover onto the switch housing by sliding tabs 4 and 5 of the cover into their respective clips on the housing. Then press down on the cover to engage tabs 1, 2, and 3.

Control Top/ Front Shield/ Controls Flex as a Unit to Chassis

1. Slide the control top into the appropriate position in the chassis, and place the front shield into position over the chassis and circuit boards.
2. Check to see that the three clip recesses (four large tabs on early front shield) of the front shield are aligned with the respective slots on the sides of the chassis, then snap the front shield in place. Ensure that the shield is fully seated, especially in the PTT switch area.
3. **a. Units using early front shield with tabs (no separate clips), skip step three (3); proceed to step four (4).**
b. Units using latest front shield with separate clips – Insert clip 1 (Motorola part number 4285350C01) onto front shield by orienting clip stamped “1” with front shield recess stamped “1”. Insert the narrow hook end of the clip into the slot of the front shield. While keeping the clip hook in to the front shield slot, press the bent portion of the clip toward the front shield until it snaps into place. The two remaining clips (Motorola part number 4285350C02) are stamped “2”. Insert these clips into the recessed areas on the front shield stamped “2”, and snap them into place as was done with clip stamped “1”.
4. Slide the connector end of the controls flex into the special locking connector mounted on the control board. Ensure that the flex is fully seated into the board connector and secure the connection.

NOTE: View the flex connection at a slight angle from the bottom of the radio (see Figure 14). If the flex is fully seated, the orange circuit plating will be parallel with the connector top surface and three reliefs in the plating will make the flex plating appear to be separated. If the orange plating of the flex is not parallel with the connector's top surface, or the three reliefs

are raised enough to see plating under them, then the flex is not fully seated.

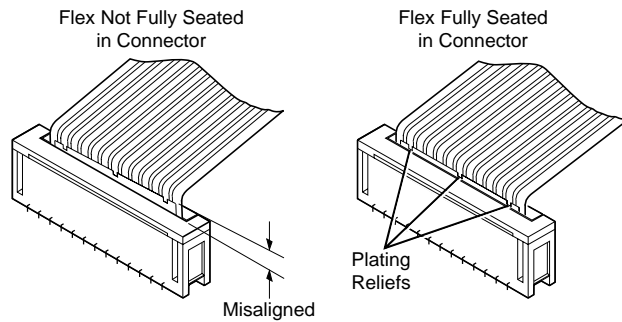


Figure 14 Seating the Flex

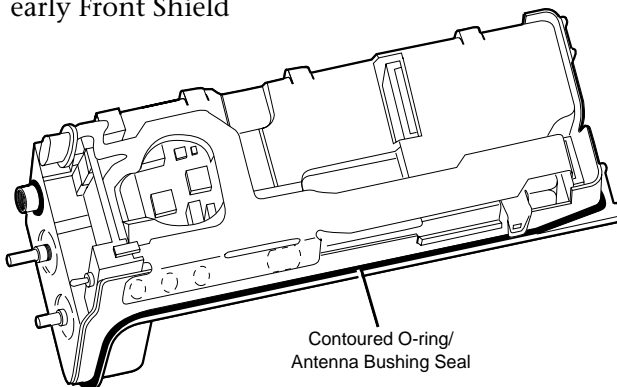
5. Reinstall the rubber controls top seal on the control top.

NOTE: Two tabs are provided in the emergency button area to help hold the seal in place.

Front Cover Assembly to Chassis

1. Install the contoured O-ring/antenna bushing seal around the antenna and in the groove provided (see Figure 15).

Unit with
early Front Shield



Unit with
latest Front Shield

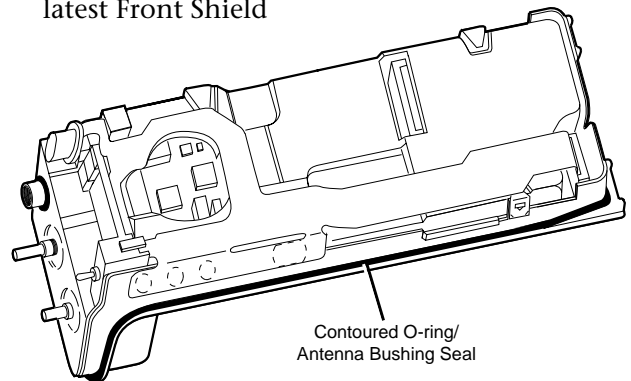


Figure 15 Installing the O-Ring/Antenna Bushing Seal

2. Orient the front cover assembly with the chassis, and insert the front cover/display flex connector into the locking connector of the controller board (refer back to Figure 6). Secure the connection. View the flex connection at a slight angle from the top of the radio and ensure that the flex connector is fully seated into the locking connector as illustrated in Figure 7.
3. Check to make sure that the O-ring is in place, and slide the chassis (control top first) into the front cover assembly. Check to ensure that the orange emergency button seal slides into position freely.

NOTE: When performing the next part of this step, pay particular attention to the O-ring near the bottom of the radio to ensure that it does not raise up and get pinched between the front

cover clip and the chassis. With the top of the chassis fully seated, lower the bottom of the chassis and press it into the front cover assembly until it snaps into place.

4. Check the emergency button again. If it is cocked to one side, repositioning it will be necessary.

Knobs, Antenna, and Battery

1. Reinstall the switch knobs and antenna; the shorter knob with the volume on/off switch, the taller knob with the channel selector switch.
2. Reinstall the battery.

Maintenance



Introduction

This section of the manual describes preventive maintenance, safe handling of CMOS devices, and repair procedures and techniques. Each of these topics provides information vital to the successful operation and maintenance of your radio.

Preventive Maintenance

In order to avoid operating outside the limits set by the FCC, it is recommended that the reference oscillator of the HT 1000, JT 1000, MT 2000, MTS 2000, and MTX radio be aligned every time the radio is disassembled, or once a year, whichever comes first. Periodic visual inspection and cleaning are also recommended.


Inspection

Check that the external surfaces of the radio are clean, and that all external controls and switches are functional. A detailed inspection of the interior electronic circuitry is not needed or desired.

Cleaning

The following procedures describe the recommended cleaning agents and the methods to be used when cleaning the external and internal surfaces of the radio. External surfaces include the front cover, chassis (rear cover), and battery case. These surfaces should be cleaned whenever a periodic visual inspection reveals the presence of smudges, grease, and/or grime. Internal surfaces should be cleaned only when the radio is disassembled for servicing or repair.

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent, such as JOY®, in water. The only factory recommended liquid for cleaning the printed circuit boards and their components is isopropyl alcohol (70% by volume).



Caution The effects of certain chemicals and their vapors can have harmful results on certain plastics. Aerosol sprays, tuner cleaners, and other chemicals should be avoided.

Cleaning External Plastic Surfaces

The detergent-water solution should be applied sparingly with a stiff, non-metallic, short-bristled brush to work all loose dirt away from the radio. A soft, absorbent, lintless cloth or tissue should be used to remove the solution and dry the radio. Make sure that no water remains entrapped near the connectors, cracks, or crevices.

Cleaning Circuit Boards and Components

Isopropyl alcohol may be applied with a stiff, non-metallic, short-bristled brush to dislodge embedded or caked materials located in hard-to-reach areas. The brush stroke should direct the dislodged material out and away from the inside of the radio.

Alcohol is a high-wetting liquid and can carry contamination into unwanted places if an excessive quantity is used. Make sure that controls or tunable components are not soaked with the liquid. Do not use high-pressure air to hasten the drying process, since this could cause the liquid to puddle and collect in unwanted places.

Upon completion of the cleaning process, use a soft, absorbent, lintless cloth to dry the area. Do not brush or apply any isopropyl alcohol to the frame, front cover, or back cover.

NOTE: Always use a fresh supply of alcohol and a clean container to prevent contamination by dissolved material (from previous usage).

Safe Handling of CMOS Devices

Complementary metal-oxide semiconductor (CMOS) devices are used in this family of radios. While the benefits of CMOS are many, their characteristics make them susceptible to damage by electrostatic or high voltage charges. Damage can be latent, resulting in failures occurring weeks or months later. Therefore, you must take special precautions to prevent device damage during disassembly, troubleshooting, and repair. Handling precautions are mandatory for CMOS circuits, and are especially important in low humidity conditions. DO NOT attempt to disassemble the radio without first referring to the CMOS CAUTION paragraph in the Disassembly and Reassembly section of the manual.

Repair Procedures and Techniques

Refer to the Disassembly and Reassembly section of the manual for pertinent information prior to replacing and substituting parts.

General

Parts Replacement and Substitution

Special care should be taken to be as certain as possible that a suspected component is actually the one at fault. This special care will eliminate unnecessary unsoldering and removal of parts, which could damage or weaken other components or the printed circuit board itself.

When damaged parts are replaced, identical parts should be used. If the identical replacement component is not locally available, check the parts list for the proper Motorola part number and order the component from the nearest Motorola Communications Parts office listed in the "Replacement Parts Ordering" section of this manual.

Rigid Circuit Boards

This family of radios uses bonded, multi-layer, printed circuit boards. Since the inner layers are not accessible, some special considerations are required when soldering and unsoldering components. The printed-through holes may interconnect multiple layers of the printed circuit. Therefore, care should be exercised to avoid pulling the plated circuit out of the hole.

When soldering near the module socket pins, use care to avoid accidentally getting solder in the socket. Also, be careful not to form solder bridges between the module socket pins. Closely examine your

work for shorts due to solder bridges. When removing modules with metal enclosures, be sure to desolder the enclosure ground tabs as well as the module pins.

Flexible Circuits

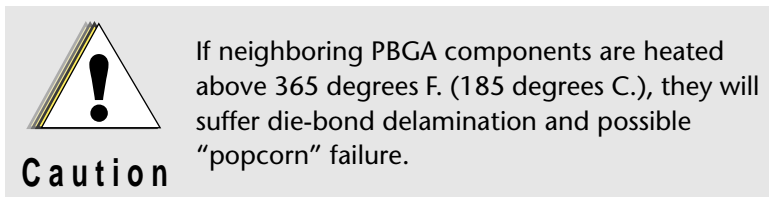
The flexible circuits are made from a different material than the rigid boards, and different techniques must be used when soldering. Excessive prolonged heat on the flexible circuit can damage the material. Avoid excessive heat and excessive bending. For parts replacement, use the ST-1087 Temperature-Controlled Solder Station with a 600 or 700 degree tip, and use small diameter solder such as ST-633. The smaller size solder will melt faster and require less heat being applied to the circuit.

To replace a component on a flexible circuit, grasp the edge of the flexible circuit with seizers (hemostats) near the part to be removed, and pull gently. Apply the tip of the soldering iron to the component connections while pulling with the seizers. Do not attempt to puddle out components. Prolonged application of heat may damage the flexible circuit.

Specific

During all repair procedures, heating neighboring components can be minimized by:

- using upper heat only.
- using the correct size heat-focus head, approximately the same size as the carrier being replaced.
- keeping the heat focus head approximately 1/8" above the printed circuit board when removing or replacing the device.



Strip Connector (P301/P704)

On the latest version HT 1000, JT 1000, MT 2000, MTS 2000, and MTX series radios, a strip connector, two female connectors and a strain relief electrically connect the RF board with the controller board. On earlier versions of these radios, the RF board and controller board were connected using a jumper flex that soldered directly to the circuit board solder pads.

An interconnect kit, REX4350A, is available to retrofit earlier version jumper-flex radios with the later version strip connector parts. The REX4350A kit includes the following items:

- CONNECTOR, Female (J301) 0905461X01
- CONNECTOR, Female (J704) 0905461X01
- CONNECTOR, Male (P301/P704) 0905461X01
- STRAIN RELIEF 4205507X01
- INSTRUCTIONS 6880309F14

Jumper Flex (on radios shipped prior to 7/94)

Jumper flexes are not available. They are replaced with connectors as described in paragraph "a" of this section. If the jumper flex needs to be replaced, order Interconnect Kit REX4350A. The retrofit kit includes all of the parts required and detailed instructions on the removal of the old jumper flex, and the installation of the new connector arrangement.

RF Switch (S101):

Refer to the applicable exploded view and to your radio's RF board (antenna contact area) to locate the RF switch components.

NOTE: The RF switch spring and the RF switch piston must be ordered separately.

To Remove the RF Switch:

1. On VHF and UHF radios, unsolder the two tabs of the RF switch bracket that secure the RF switch to the RF board. On 800MHz and 900MHz radios, use a #2 slotted screwdriver to straighten the two tabs of the RF switch bracket that wrap around the RF board. Use your forefinger to hold the RF switch bracket to the RF board while straightening the tabs to avoid lifting the solder tabs on the opposite end of the RF switch bracket.
2. Refer to Figure 16 and use a small heat-focus head to distribute heat over the area occupied by the three solder tabs until the solder softens.

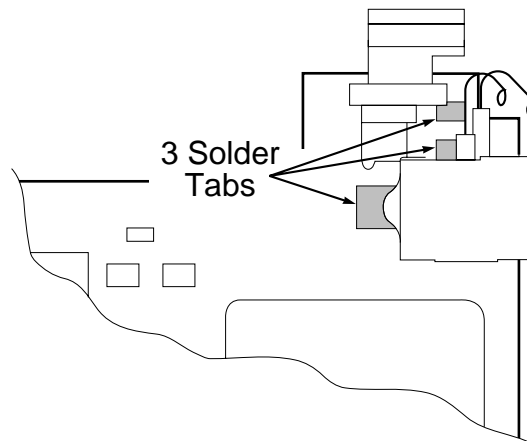


Figure 16 Solder Tabs

3. Carefully lift the RF switch assembly away from the rf board. Notice that the RF switch circuit board remains attached (soldered) to the RF board.
4. Using the same heat-focus head as in steps (2) and (3), unsolder the RF switch circuit board, and remove it from the RF board using forceps.
5. In the RF switch circuit board area, reflow all the solder pad areas on the main RF board such that similarly shaped pads have uniform solder heights. Add or remove solder as required. Clean the RF board thoroughly. Then swab on a minimum amount of flux to each of the solder pads.

To Replace the RF Switch:

1. Place the RF switch assembly on the RF main board and gently heat. Visually inspect to make sure no flux migrated onto the gold plated areas of the RF switch board. The guide pins should provide self alignment between the two circuit boards. Visually inspect the

- plastic switch housing to ensure that it has not warped due to overheating.
2. While holding the RF switch bracket firmly against the RF board:
 - VHF and UHF radios - solder the two leads of the housing to the solder pads on the RF board.
 - 800MHZ and 900MHz radios - bend the two tabs around the side of the RF board as close to the board edge as possible to hold the bracket down tightly.
 3. Insert the new RF switch spring and RF switch piston into the RF switch assembly. The contacts of the piston should be facing the gold-plated pads of the RF switch board. Once the spring and piston are inserted into the RF switch, they will be retained by the switch.

Chip Components

Use either the RLN-4062 Hot-Air Repair Station or the Motorola 0180381B45 Repair Station for chip component replacement. When using the 0180381B45 Repair Station, select the TJ-65 mini-thermojet hand piece. On either unit, adjust the temperature control to 700 degrees F. (370 degrees C), and adjust the airflow to a minimum setting. Airflow can vary due to component density.

1. To remove a chip component, select a hot- air hand piece and position the nozzle of the hand piece approximately 1/8" (0.3cm) above the component to be removed. Begin applying the hot air. Once the solder reflows, remove the component using a pair of tweezers. Using solder wick and a soldering iron or a power desoldering station, remove the excess solder from the pads.
2. To replace a chip component using a soldering iron, select the appropriate micro-tipped soldering iron and apply fresh solder to one of the solder pads. Using a pair of tweezers, position the new chip component in place while heating the fresh solder. Once solder wicks onto the new component, remove the heat from the solder. Heat the remaining pad with the soldering iron and apply solder until it wicks to the component. If necessary, touch up the first side. All solder joints should be smooth and shiny.
3. To replace a chip component using hot air, select the hot-air hand piece and reflow the solder on the solder pads to smooth it. Apply a drop of solder paste flux to each pad. Using a pair of tweezers, position the new component in place. Position the hot-air hand piece approximately 1/8" (0.3cm) above the component and begin applying heat. Once the solder wicks to the component, remove the heat and inspect the repair. All joints should be smooth and shiny.

Plastic-Ball Grid-Array (PBGA), Over-Molded Pad-Array Carrier (OMPAC), and Glob Top Components

The term Plastic-Ball Grid-Array (PBGA) will be used to describe most of this products type of modules. PBGA modules may be the construction of an Over-Molded Pad-Array Carrier (OMPAC) component or "Glob Top" component. A U204 synthesizer component in one radio may be an OMPAC and the same U204 synthesizer in another radio may be a Glob Top. The two components look a little different, but are electrically the same and are interchangeable.



Caution

If neighboring PBGA components are heated above 365 degrees F. (185 degrees C.), they will suffer die-bond delamination and possible "popcorn" failure. To prevent this delamination problem, circuit boards to be repaired must be baked in an oven for eight hours at 260 degrees F. (125 degrees C.) prior to solder repairs.



Caution

All pad-array carriers in these radios, except for the IF IC (U3), are PBGA components. Prior to use, all PBGA components must be kept in the sealed bag (with moisture-indicator card) as supplied by the Motorola Parts Department. Once the sealed bag is opened and/or the PBGA component subjected to ambient humidity (for an unknown amount of time or for more than 96 hours) then that PBGA component must be baked in an oven for at least eight hours at 260 degrees F. (125 degrees C.)

During all repair procedures, heating neighboring components can be minimized by:

- using upper heat only.
- using the correct size heat-focus head, approximately the same size as the carrier being replaced.
- keeping the heat focus head approximately 1/8"-1/4" (0.3cm-0.6cm) above the printed circuit board when removing or replacing the device.

To Remove a PBGA Component,

select the R-1319 Rework Station and the appropriate heat-focus head (approximately the same size as the PBGA. Attach the heat-focus head to the chimney heater. Adjust the temperature control to approximately 415 degrees F (215 degrees C); 445 degrees F (230 degrees C) maximum. Apply the solder paste flux around the edge of the PBGA. Place the circuit board in the circuit board holder, and position the PBGA component under the heat-focus head. Lower the vacuum tip and attach it to the PBGA component by turning on the vacuum pump. Lower the heat-focus head until it is approximately 1/8"-1/4" (0.3cm-0.6cm) above the carrier. Turn on the heater and wait until the PBGA component lifts off the circuit board. Once the part is off, grab it with a pair of tweezers and turn off the vacuum pump. Remove the circuit board from the R-1319's circuit board holder.



Caution

The application of heat to the PBGA device, beginning at ambient air temperature and ending with the PBGA component lifting from the circuit board, should take longer than 60 seconds. If the PBGA component lifts from the circuit board earlier than 60 seconds:

- check the temperature control setting on the rework station, and if OK
- lift the heat-focus head an additional 1/8" from nominal setting, and
- check the circuit board plating for possible damage.

To Replace an PBGA component,

the solder pads on the board must first be cleaned of all solder to ensure alignment of the new chip carrier. Prepare the site by using solder wick and a soldering iron to remove all solder from the solder pads on the circuit board. If a power desoldering tool is available, it can be used instead of the solder wick. Clean the solder pads with alcohol and a small brush. Dry and inspect. Ensure that all solder is removed.

Once the preparation is complete, place the circuit board back in the circuit board holder. Add solder paste flux in the trench of the flux block and spread it using a one-inch putty knife. Flux the PBGA component by placing it in the trench of the flux block. Once the flux is applied, place the PBGA component on the circuit board, making certain that it is oriented correctly on the board. Position the heat-focus head over the PBGA component and lower it to approximately 1/8"-1/4" (0.3cm-0.6cm) over the carrier. Using the same heat setting used to remove the PBGA component, turn on the heater and wait for the carrier to reflow (heating and reflow should take longer than 60 seconds). Watch the PBGA component reflow and note that when a proper reflow has taken place, the PBGA component will drop (usually one side, then the other). The end result is that both sides have reflowed, and the PBGA component is sitting parallel to the circuit board.

Once the carrier reflows, raise the heat-focus head and wait approximately one minute for the part to cool. Remove the circuit board and inspect the repair. No cleaning should be necessary.

Thin Small Outline Package (TSOP) Components

Removing and Replacing a TSOP Component:

will be done with the R-1319, using the same procedure used to remove and replace an PBGA component.

Place the circuit board in the circuit board holder. Select the proper heat focus head and attach it to the heater chimney. Position the TSOP component under the heat-focus head. Lower the vacuum tip and attach it to the component by turning on the vacuum pump. Lower the focus head until it is approximately 1/8"-1/4" (0.3cm-0.6cm) above the component. Turn on the heater and wait until the TSOP lifts off the circuit board.

Once the part is off, turn off the heat, grab the part with a pair of tweezers, and turn off the vacuum pump. Prepare the circuit board for the new component by applying solder paste flux to the solder pads. Position the circuit board under the heat-focus head, lower the head to approximately 1/8"-1/4" (0.3cm-0.6cm) above the board, and turn on the heat. When the solder left behind on the pads reflows, turn off the heat and raise the heat-focus head. Remove the circuit board from the holder and inspect the pads to ensure that the solder has flattened out and that there are no solder shorts. Clean the area with alcohol and a small brush.

Once the preparation is complete, place the circuit board back in the circuit board holder. Add solder paste flux to the solder pads and place the new component on the circuit board. Position the heat-focus head over the component and lower it to approximately 1/8"-1/4" (0.3cm-0.6cm) above the carrier. Turn on the heater and wait for the component to reflow.

Once the component reflows, raise the heat-focus head and wait approximately one minute for the part to cool. Remove the circuit board and inspect the repair. No cleaning should be necessary.

Shields

Removing and Replacing the Shields:

will be done with the R-1319, using the same procedure used to remove and replace TSOP and PBGA components.

Place the circuit board in the circuit board holder. Select the proper heat focus head and attach it to the heater chimney. Add solder paste flux around the base of the shield. Position the shield under the heat-focus head. Lower the vacuum tip and attach it to the shield by turning on the vacuum pump. Lower the focus head until it is approximately 1/8"-1/4" (0.3cm-0.6cm) above the shield. Turn on the heater and wait until the shield lifts off the circuit board. Once the shield is off, turn off the heat, grab the part with a pair of tweezers, and turn off the vacuum pump. Remove the circuit board from the circuit board holder.

To replace the shield, add solder to the shield if necessary, using a micro-tipped soldering iron. Next, rub the soldering iron tip along the edge of the shield to smooth out any excess solder. Use solder wick and a soldering iron to remove excess solder from the solder pads on the circuit board. Place the circuit board back in the circuit board holder. Place the shield on the circuit board using a pair of tweezers. Position the heat-focus head over the shield and lower it to approximately 1/8"-1/4" (0.3cm-0.6cm) above the shield. Turn on the heater and wait for the solder to reflow.

Once complete, turn off the heat, raise the heat-focus head, and wait approximately one minute for the part to cool. Remove the circuit board and inspect the repair. No cleaning should be necessary.

RF PA (U105)

The procedure for removing and replacing the RF PA is very similar to the procedure for removing and replacing an PBGA or a TSOP component. But because the device is large, extra heating time is required to flow the pads. And as a result, neighboring components (especially those on the opposite side of the circuit board) will heat,

reflow, and may inadvertently move. Be careful when performing the following procedure.

Refer to Figure 17 for RF PA nomenclature.

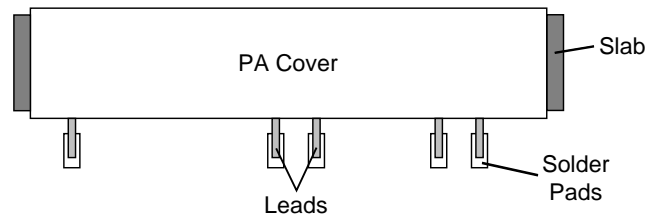


Figure 17 RF PA Nomenclature

To Remove the RF PA,

add flux to the leads of the device, and use a soldering iron and pair of tweezers to heat and lift each lead free and clear of its respective solder pad on the circuit board. Use the R-1319 Rework Station and the heat-focus head designed especially for removal of the RF PA. Attach the heat-focus head to the chimney heater. Adjust the temperature control to approximately 415 degrees F (215 degrees C) 445 degrees F (230 degrees C) maximum. Apply solder paste to the exposed solder pads under the PA. Place the circuit board in the circuit board holder, and position the RF PA under the heat-focus head. Lower the heat-focus head until it is approximately 1/8"-1/4" (0.3cm-0.6cm) above the PA cover. Turn on the heater and begin the reflow cycle. Heating time should not be less than two minutes.

Once the part has reflowed, before trying to remove the PA, carefully lower the circuit board holder as follows:

- Loosen the thumbscrew on the shaft of the circuit board holder,
- push the spring-loaded holder down and away from the heat-focus head, and
- retighten the thumbscrew with the holder in the bottomed position.

Grab the PA with a large pair of tweezers and remove it from the circuit board. Let the circuit board cool for approximately two minutes. Then remove the circuit board from the circuit board holder.

To Replace the RF PA;

if necessary, add solder to the PA ground plane on the printed circuit board. Then clean each PA lead solder pad on the circuit board to ensure alignment of the new RF PA. Prepare the sight by using solder wick and a soldering iron to remove all solder from the solder pads. Clean the solder pads with alcohol and a small brush. Dry and inspect. Ensure that all solder is removed.

Once the preparation is complete, place the circuit board back in the circuit board holder. Add solder paste flux to the ground plane and to the leads' solder pads. Once the flux is applied, place the new RF PA on the circuit board, making certain that the PA heatsink sits flush on the board. Position the heat-focus head over the RF PA and lower it to approximately 1/8"-1/4" (0.3cm-0.6cm) above the PA cover. Turn on

the heater and begin the reflow cycle. Heating time should not be less than two minutes.

Once the RF PA reflows, raise the heat-focus head and wait approximately two minute for the part to cool. Remove the circuit board and inspect the solder joint between the slab and the ground plane. No cleaning should be necessary. Use the soldering iron and add solder to each of the RF PA leads and associated pads. Inspect the lead/pad bond for opens and solder shorts.

Exploded Views

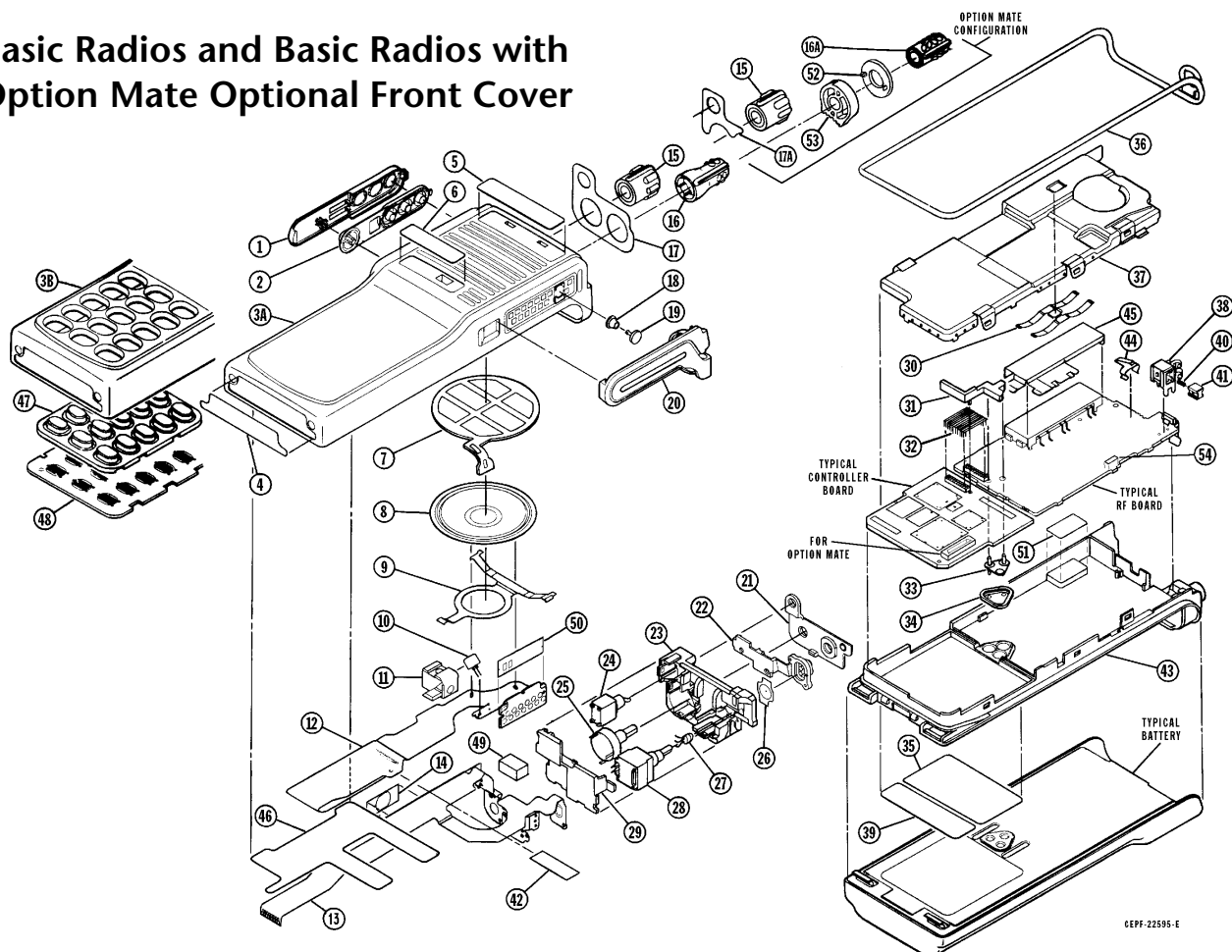
8

There are several models in this family of radios: HT 1000, JT 1000, MT 2000, MTS 2000, and MTX Series radios. The exploded view diagrams in this section illustrate this family of radios by capturing them into one of four categories:

- basic radios
- top-display radios
- keypad radios
- uni-board radios

Determine which category describes your unit, and use the appropriate exploded view to help identify components with description and Motorola part number.

Basic Radios and Basic Radios with Option Mate Optional Front Cover

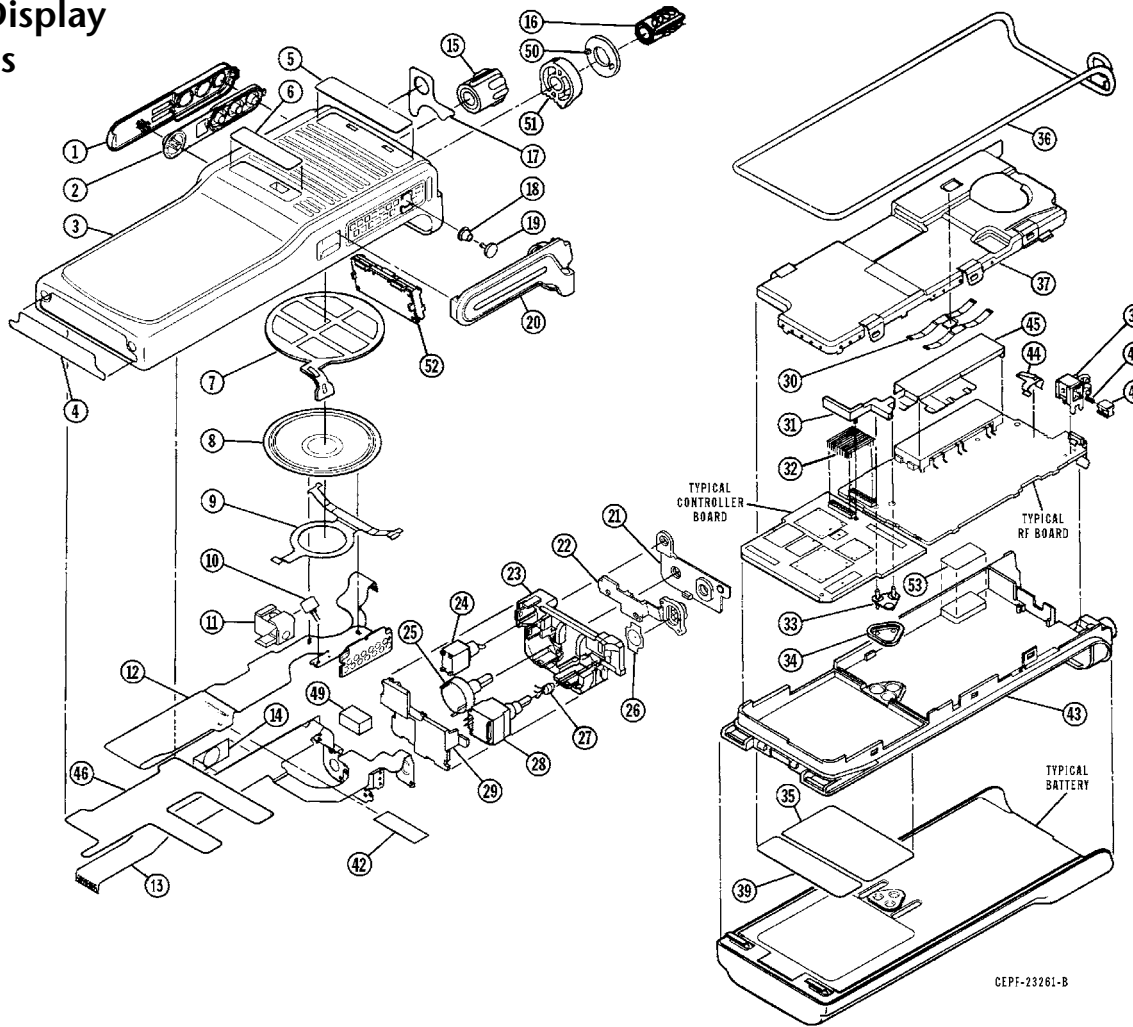


ITEM NO.	MOTOROLA PART NO.	DESCRIPTION
1	4505896U01	LEVER, PTT
2	3205902U01	SEAL, PTT, and ACTUATOR for S404, S405, S406, and S408
3A	1505627V05 or 1505627V03	COVER, Front COVER, Front; Option•Mate
3B	1505637V06 or 1505637V07	COVER, Front; DTMF COVER, Front; DTMF Option•Mate
4	-----	LABEL, Agency Approval; not field replaceable
5	3305183R55	LABEL, Motorola
6	3305183R56	LABEL, HT1000
7	3505535X02	FELT, Speaker
8	See Note 1	SPEAKER (LS401)
9	0705470V01	BRACKET, Speaker Retainer
10	See Note 1	MICROPHONE (MK401)
11	1405330W01	BOOT, Microphone
12	8405310W04	FLEX, Front Cover/Display
13	8405333W03	FLEX, Controls
14	3905517V01	POPPLE, PTT (p/o S406)
15	3605253V01	KNOB, On/Off/Volume
16	3605254V02 or 3605254V01	KNOB, Frequency; 2-Freq. Radios KNOB, Frequency; 16-Frequency Radios
16A	3605636V01	KNOB, Frequency; Option•Mate
17	1305872U02 or 1305872U01	ESCUTCHEON, Control Top; 2-Freq. Radios ESCUTCHEON, Control Top; 16-Freq. Radios
17A	1305698V01	ESCUTCHEON, Control Top; Option•Mate
18	3205160W01	SEAL, Actuator; for S101
19	2205159W01	PIN, Actuator; for S101
20	3205514W01	SEAL, Accessory Connector
21	3205177Z01	SEAL, Control Top
22	3205178Z01	SEAL, Emergency Button
23	2705877U01	HOUSING, Switch
24	See Note 1	SWITCH, Toggle (S402)
25	See Note 1	POTENTIOMETER/SWITCH, On/Off/Volume Control (R401/S403)
26	3905329W01	POPPLE, Emergency Button

27	See Note 1	LED (CR400A/CR400B)
28	See Note 1	SWITCH, Frequency (S401)
29	1505632V01	COVER, Switch Housing
30	-----	SPRING, PA; not field replaceable, order front shield (item 37)
31	4205507X01	STRAIN RELIEF
32	See Note 1	CONNECTOR, Strip (P301/P704)
33	See Note 2	PLUG, Connector (P404)
34	3205820V02	SEAL, Connector Plug
35	-----	LABEL, Rear; Information; not field replaceable
36	3205176Z01	O-RING, Contoured/SEAL, Antenna
37	2605891U03 or 2685351C01	SHIELD, Front (earlier radios) SHIELD, Front (latest radios; requires CLIPs, Locking: 4285351C01 [Numbered 1, 1 req'd] and 4285351C02 [Numbered 2, 2 req'd])
38	See Note 1	SWITCH, RF (S101)
39	-----	LABEL, Barcode; not field replaceable
40	4105266V01	SPRING, RF Switch
41	4405524V01	PISTON, RF Switch
42	1405307X01	INSULATOR
43	1505892U06	CHASSIS (Rear Cover)
44	3905838V01	CONTACT, Antenna Shield Ground (800MHz and 900MHz radios only)
45	2605898U01	SHIELD, PA (800MHz and 900MHz radios only)
46	7505334W01	PAD, Sound Dampening
47	7505437W01	KEYPAD, DTMF
48	5102463J08	CIRCUIT BOARD, DTMF
49	7505393N33	PAD, Shock
50	3205827V01	WEDGE, Universal
51	7505922Z01	PAD, Thermal
52	1305633V01	RING, Concentric; Escutcheon
53	3605635V01	Knob, Concentric Ring
54	1405307X07	TAPE, Insulator (trim to size, 0.3" x 0.2")

Notes: 1. Refer to electrical parts list (miscellaneous)
2. Refer to electrical parts list (transceiver board)

Top-Display Radios

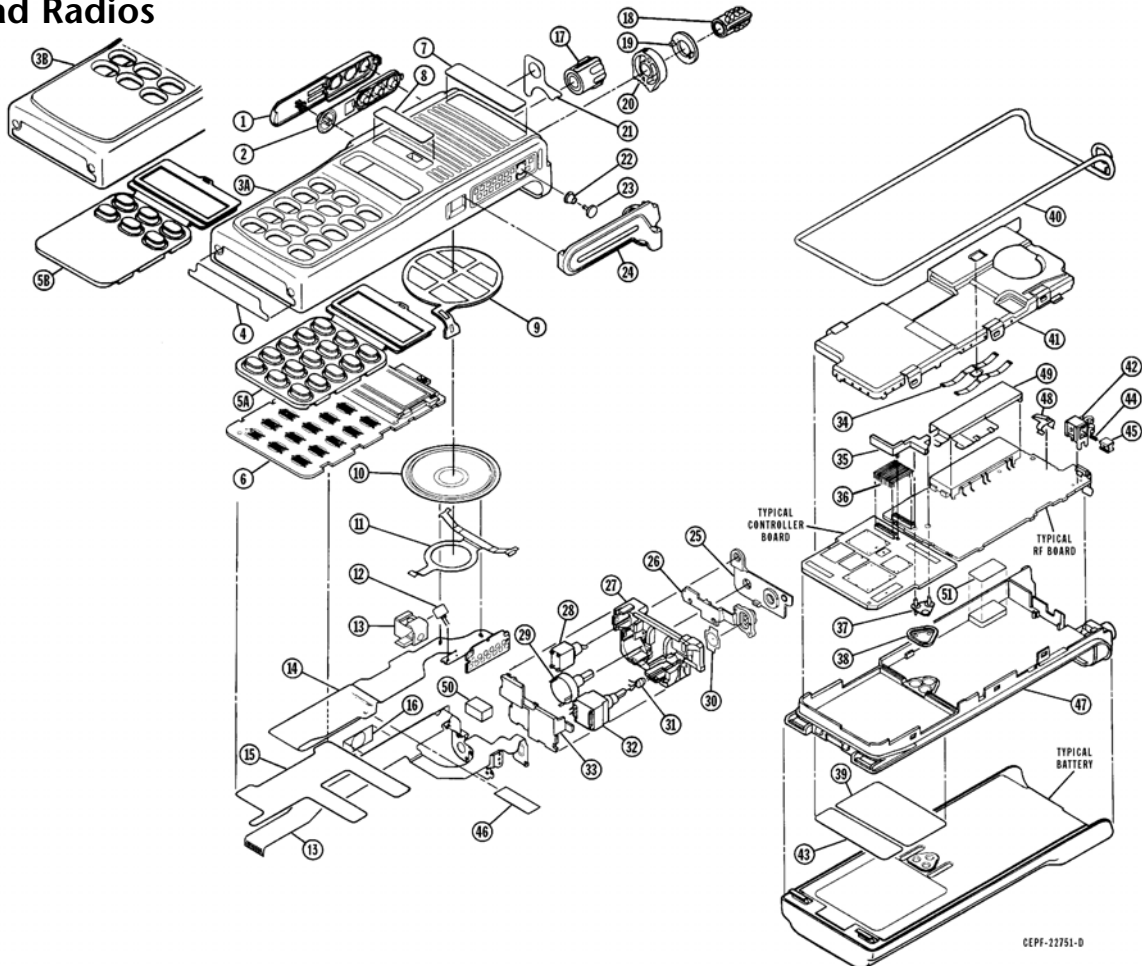


ITEM NO.	MOTOROLA PART NO.	DESCRIPTION
1	4505896U01	LEVER, PTT
2	3205902U01	SEAL, PTT, and ACTUATOR for S404, S405, S406, and S408
3	1505627V04	COVER, Front
4	-----	LABEL, Agency Approval; not field replaceable
5	3305183R55	LABEL, Motorola
6	3305183R70 or 3305183R71 or 3305183R94	LABEL, MT 2000 LABEL, MTS 2000 LABEL, MTX
7	3505535X02	FELT, Speaker
8	See Note 1	SPEAKER (LS401)
9	0705470V01	BRACKET, Speaker Retainer
10	See Note 1	MICROPHONE (MK401)
11	1405330W02	BOOT, Microphone
12	8405641V02	FLEX, Front Cover/Display
13	8405333W03	FLEX, Controls
14	3905517V01	POPPLE, PTT (p/o S406)
15	3605253V01	KNOB, On/Off/Volume
16	3605636V01	KNOB, Frequency
17	1305698V01	ESCUTCHEON, Control Top
18	3205160W01	SEAL, Actuator; for S101
19	2205159W01	PIN, Actuator; for S101
20	3205514W01	SEAL, Accessory Connector
21	3205177Z01	SEAL, Control Top
22	3205178Z01	SEAL, Emergency Button
23	2705877U01	HOUSING, Switch
24	See Note 1	SWITCH, Toggle (S402)
25	See Note 1	POTENTIOMETER/SWITCH, On/Off/Volume Control (R401/S403)
26	3905329W01	POPPLE, Emergency Button
27	See Note 1	LED (CR400A/CR400B)
28	See Note 1	SWITCH, Frequency (S401)

29	1505632V01	COVER, Switch Housing
30	-----	SPRING, PA; not field replaceable, order front shield (item 37)
31	4205507X01	STRAIN RELIEF
32	See Note 1	CONNECTOR, Strip (P301/P704)
33	See Note 2	PLUG, Connector (P404)
34	3205820V02	SEAL, Connector Plug
35	-----	LABEL, Rear; Information; not field replaceable
36	3205176Z01	O-RING, Contoured/SEAL, Antenna
37	2605891U03 or 2685351C01	SHIELD, Front (earlier radios) SHIELD, Front (latest radios; requires CLIPS, Locking: 4285351C01 [Numbered 1, 1 req'd] and 4285351C02 [Numbered 2, 2 req'd])
38	See Note 1	SWITCH, RF (S101)
39	-----	LABEL, Barcode; not field replaceable
40	4105266V01	SPRING, RF Switch; part of item 39
41	4405524V01	PISTON, RF Switch; part of item 39
42	1405307X01	INSULATOR
43	1505892U06	CHASSIS (Rear Cover)
44	3905838V01	CONTACT, Antenna Shield Ground (800MHz and 900MHz radios only)
45	2605898U01	SHIELD, PA (800MHz and 900MHz radios only)
46	7505334W01	PAD, Sound Dampening
47	Not Used	
48	Not Used	
49	7505393N33	PAD, Shock
50	1305633V01	RING, Concentric; Escutcheon
51	3605635V01	KNOB, Concentric Ring
52	5105238U82	LCD, Top Display
53	7505922Z01	PAD, Thermal

Notes: 1. Refer to electrical parts list (miscellaneous)
2. Refer to electrical parts list (transceiver board)

Keypad Radios

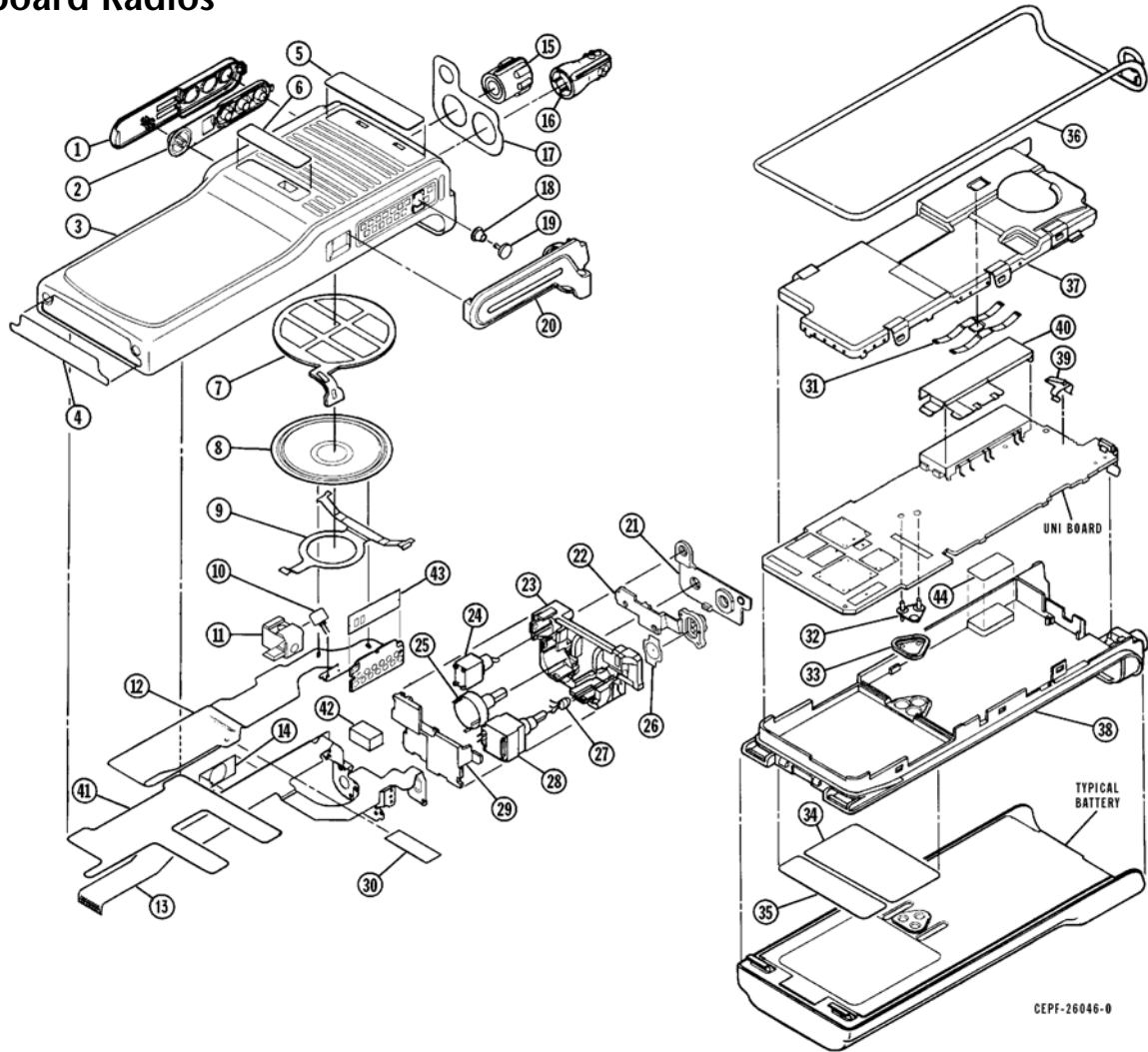


ITEM NO.	MOTOROLA PART NO.	DESCRIPTION
1	4505896U01	LEVER, PTT
2	3205902U01	SEAL, PTT, and ACTUATOR for S404, S405, S406, and S408
3A	1505637V04	COVER, Front; Full Keypad
3B	1505637V05	COVER, Front; Limited Keypad
4	-----	LABEL, Agency Approval; not field replaceable
5A	7505870U01	KEYPAD, 15-key
5B	7505870U02	KEYPAD, 6-key
6	5105238U83	MODULE, Display
7	3305183R55	LABEL, Motorola
8	3305183R70	LABEL, MT2000
	or 3305183R71	LABEL, MTS2000
	or 3305183R94	LABEL, MTX
	or 3305409X06	LABEL, JT 1000
9	3505535X02	FELT, Speaker
10	See Note 1	SPEAKER (LS401)
11	0705470V01	BRACKET, Speaker Retainer
12	See Note 1	MICROPHONE (MK401)
13	1405330W02	BOOT, Microphone
14	8405310W04	FLEX, Front Cover/Display
15	8405333W03	FLEX, Controls
16	3905517V01	POPPLER, PTT (p/o S406)
17	3605253V01	KNOB, On/Off/Volume
18	3605636V01	KNOB, Frequency
19	1305633V01	RING, Concentric; Escutcheon
20	3605635V01	KNOB, Concentric Ring
21	1305698V01	ESCUTCHEON, Control Top
22	3205160W01	SEAL, Actuator; for S101
23	2205159W01	PIN, Actuator; for S101
24	3205514W01	SEAL, Accessory Connector
25	3205177Z01	SEAL, Control Top
26	3205178Z01	SEAL, Emergency Button

27	2705877U01	HOUSING, Switch
28	See Note 1	SWITCH, Toggle (S402)
29	See Note 1	POTENTIOMETER/SWITCH, On/Off/Volume Control (R401/S403)
30	3905329W01	POPPLER, Emergency Button
31	See Note 1	LED (CR400A/CR400B)
32	See Note 1	SWITCH, Frequency (S401)
33	1505632V01	COVER, Switch Housing
34	-----	SPRING, PA; not field replaceable, order front shield (item 41)
35	4205507X01	STRAIN RELIEF
36	See Note 1	CONNECTOR, Strip (P301/P704)
37	See Note 2	PLUG, Connector (P404)
38	3205820V02	SEAL, Connector Plug
39	-----	LABEL, Rear; Information; not field replaceable
40	3205176Z01	O-RING, Contoured/SEAL, Antenna
41	2605891U03 or 2685351C01	SHIELD, Front (earlier radios) SHIELD, Front (latest radios; requires CLIPs, Locking: 4285351C01 [Numbered 1, 1 req'd] and 4285351C02 [Numbered 2, 2 req'd])
42	See Note 1	SWITCH, RF (S101)
43	-----	LABEL, Barcode; not field replaceable
44	4105266V01	SPRING, RF Switch
45	4405524V01	PISTON, RF Switch
46	1405307X01	INSULATOR
47	1505892U06	CHASSIS (Rear Cover)
48	3905838V01	CONTACT, Antenna Shield Ground (800MHz and 900MHz radios only)
49	2605898U01	SHIELD, PA (800MHz and 900MHz radios only)
50	7505393N33	PAD, Shock
51	7505922Z01	PAD, Thermal

Notes: 1. Refer to electrical parts list (miscellaneous)
2. Refer to electrical parts list (transceiver board)

Uni-board Radios



ITEM NO.	MOTOROLA PART NO.	DESCRIPTION
1	4505896U01	LEVER, PTT
2	3205902U01	SEAL, PTT, and ACTUATOR for S404, S405, S406, and S408
3	1505627V05	COVER, Front
4	-----	LABEL, Agency Approval; not field replaceable
5	3305183R55	LABEL, Motorola
6	3305252X18	LABEL, MTX•LS
7	3505335X02	FELT, Speaker
8	See Note 1	SPEAKER (LS401)
9	0705470V01	BRACKET, Speaker Retainer
10	See Note 1	MICROPHONE (MK401)
11	1405330W01	BOOT, Microphone
12	8405310W04	FLEX, Front Cover/Display
13	8405333W03	FLEX, Controls
14	3905517V01	POPPLER, PTT (p/o S406)
15	3605253V01	KNOB, On/Off/Volume
16	3605254V01	KNOB, Frequency; 16-Frequency
17	1305872U01	ESCUTCHEON, Control Top; 16-Freq.
18	3205160W01	SEAL, Actuator; for S101
19	2205159W01	PIN, Actuator; for S101
20	3205514W01	SEAL, Accessory Connector
21	3205177Z01	SEAL, Control Top
22	3205178Z01	SEAL, Emergency Button
23	2705877U01	HOUSING, Switch
24	See Note 1	SWITCH, Toggle (S402)

25	See Note 1	POTENTIOMETER/SWITCH, On/Off/Volume Control (R401/S403)
26	3905329W01	POPPLER, Emergency Button
27	See Note 1	LED (CR400A/CR400B)
28	See Note 1	SWITCH, Frequency (S401)
29	1505632V01	COVER, Switch Housing
30	1405307X01	INSULATOR
31	-----	SPRING, PA; not field replaceable, order front shield (item 37)
32	See Note 2	PLUG, Connector (P404)
33	3205820V02	SEAL, Connector Plug
34	-----	LABEL, Rear; Information; not field replaceable
35	-----	LABEL, Barcode; not field replaceable
36	3205176Z01	O-RING, Contoured/SEAL, Antenna
37	2605891U03 or 2685351C01	SHIELD, Front (earlier radios) SHIELD, Front (latest radios; requires CLIPs, Locking: 4285351C01 [Numbered 1, 1 req'd] and 4285351C02 [Numbered 2, 2 req'd])
38	1505892U06	CHASSIS (Rear Cover)
39	3905838V01	CONTACT, Antenna Shield Ground
40	2605898U01	SHIELD, PA
41	7505334W01	PAD, Sound Dampening
42	7505393N33	PAD, Shock
43	3205827V01	WEDGE, Universal
44	7505922Z01	PAD, Thermal

Notes: 1. Refer to electrical parts list (miscellaneous)
2. Refer to electrical parts list (transceiver board)

Notes

Component Location Diagrams, Parts Lists, and Schematic Diagrams

9

Introduction

General

Transceiver components and controller components reside on separate circuit boards. Refer to the model charts located in the front of this manual (prior to Section 1) to determine the controller board and transceiver board unique to your model radio. Then locate the appropriate transceiver board and controller board component location diagram, schematic diagram, and parts list located in this section of the manual.

Component location diagrams of the controls flex, two front cover/display flexes, and the strip connector are also located in this section. A miscellaneous parts list accompanies the flex circuits.

Almost all circuit boards in this family of radios are either six or eight layers. Layer 1 is the outer most layer viewed from side 1, and layer 6 or 8 (as applicable) is the outer most layer viewed from side 2. A typical 8-layer circuit board detail, viewing copper steps in proper layer sequence, is illustrated in Figure 18.

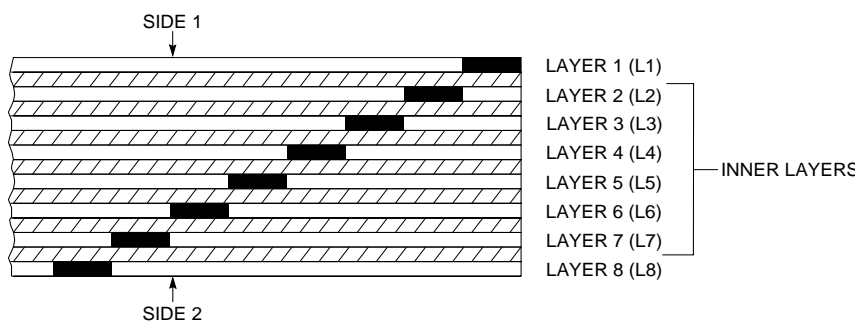


Figure 18. Circuit Board Layers

Transceiver

Frequently, transceivers that use a common transceiver board will be combined into one component location diagram, one schematic diagram, and one parts list. The differences between transceivers will be noted throughout the applicable parts list.

Controller

Frequently, controllers that use a common controller board will be combined into one component location diagram, one schematic diagram, and one parts list. The differences between controllers will be noted throughout the applicable parts list.

Schematic and Circuit Board Notes

Most all of the schematic diagrams in this manual include specific notes. Typically the notes are colored red to make them stand-out

from the overall schematic. The following two notes are general and apply to all schematic and circuit board applications.

1. Unless otherwise stated, resistor values are in ohms ($k = 1000$), capacitor values are in picofarads (pF) or microfarads (μF), and inductor values are in microhenrys (μH) or nanohenrys (nH).
2. DC voltages are measured from point indicated to chassis ground using a high impedance (10 megohm) Motorola DC voltmeter or equivalent. Transmitter measurements should be made with a 1.2 μF choke in series with the voltage probe to prevent circuit loading.

Reference Designator Assignment

Reference designators are assigned in the following manner:

- Units Series = Receiver
- 100 SERIES = Transmitter
- 200 SERIES = Frequency Generation
- 300 SERIES = Miscellaneous
- 400 SERIES = Housing/Escutcheon
- 500 SERIES = Display
- 600 SERIES = Hear Clear Option
- 700 SERIES = Controller

Interconnect Tie Point Legend

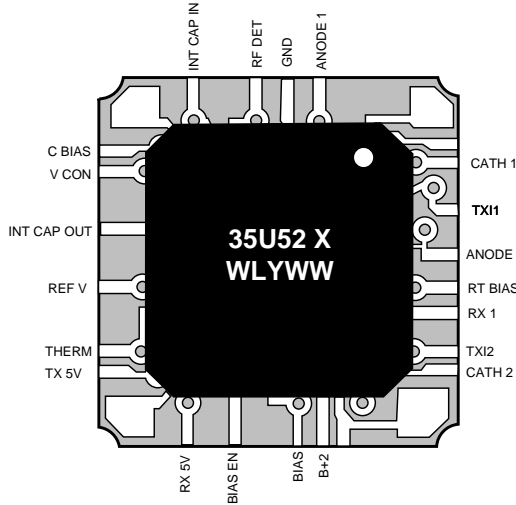
5V REG	=	Regulated Five Volts
B+	=	Battery Voltage (7.5V)
R5	=	Receiver Five Volts
T5	=	Transmitter Five Volts
CLK	=	Clock
D	=	Data
DAC	=	Digital To Analog Converter
DAC RST	=	DAC Reset
LCK	=	Lock
NC	=	No Connection
SYN	=	Synthesizer
VR	=	Voltage Regulator

Integrated Circuit Details with Pin-Out Names

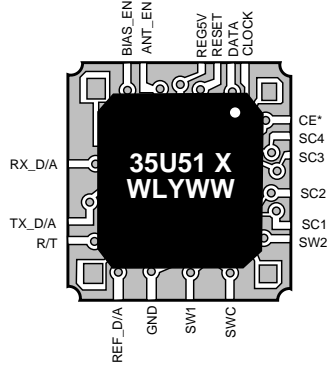
Because of today's technology, integrated circuits and special modules are able to perform a vast amount of functions in a single component. The components are getting smaller and the number of IO pins is getting greater, to the point that there is not enough room to put enough IC information on the schematics and circuit boards. To help troubleshoot and signal trace this family of radios, several of the IC's are detailed with pin-out names and illustrated on the next few pages.

Remember that PBGA components in a radio can be a combination of OMPAC and/or Glob Top. Although the illustrations on the next few pages reflect OMPAC devices, like Good-by components are electrically the same.

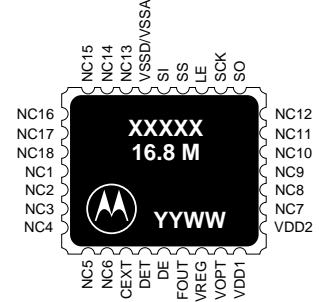
U101, ALC



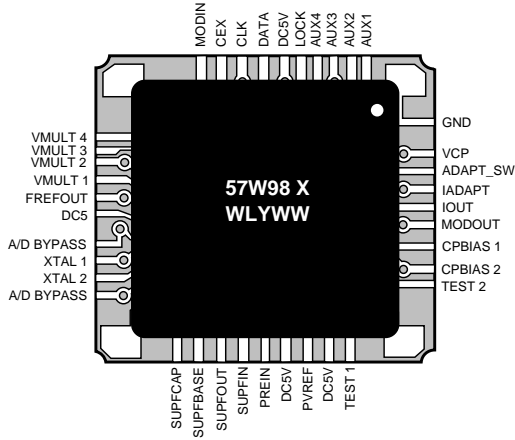
U102, D/A



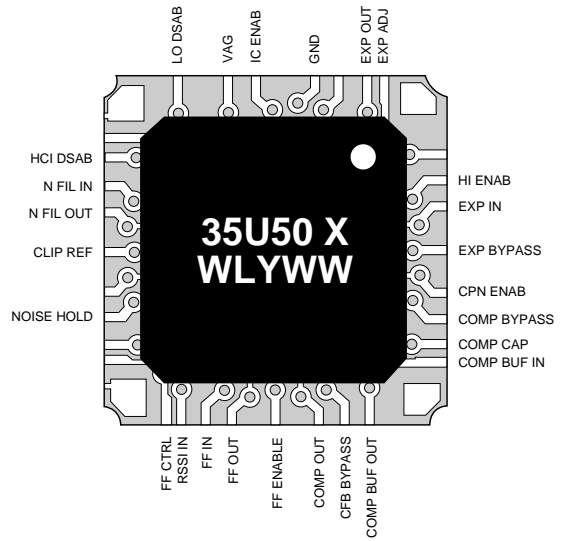
U203, REF. OSC.



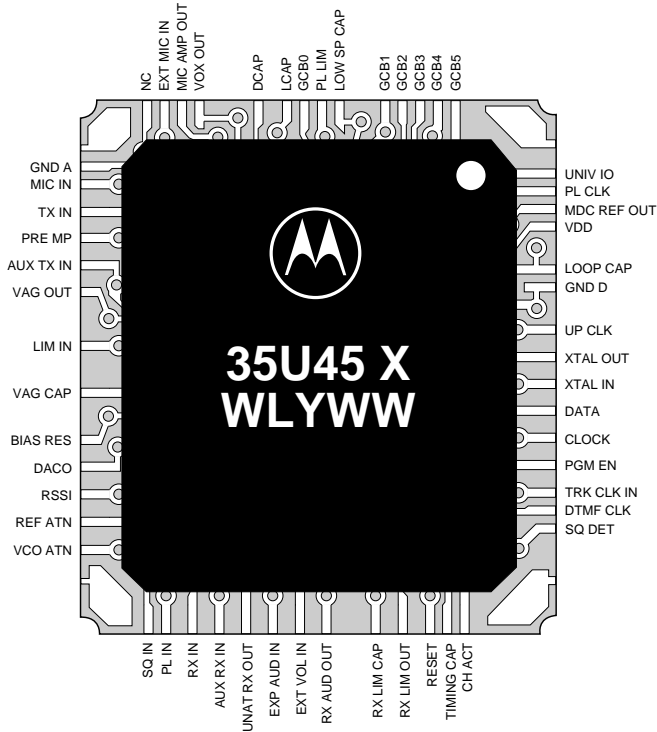
U204, SYNTHESIZER



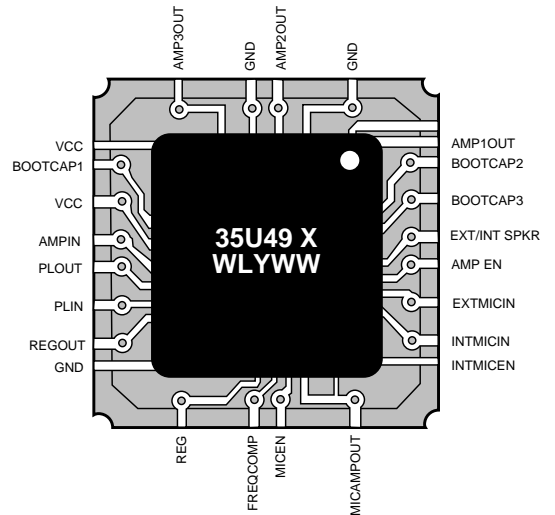
U601, HEAR CLEAR



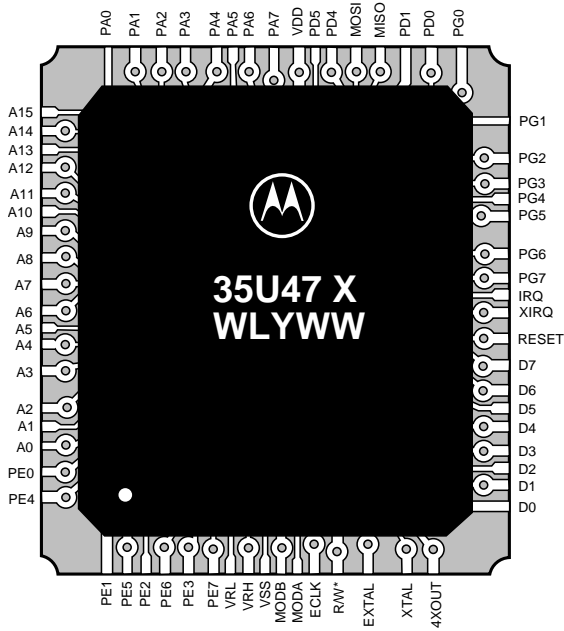
U701, ASFC



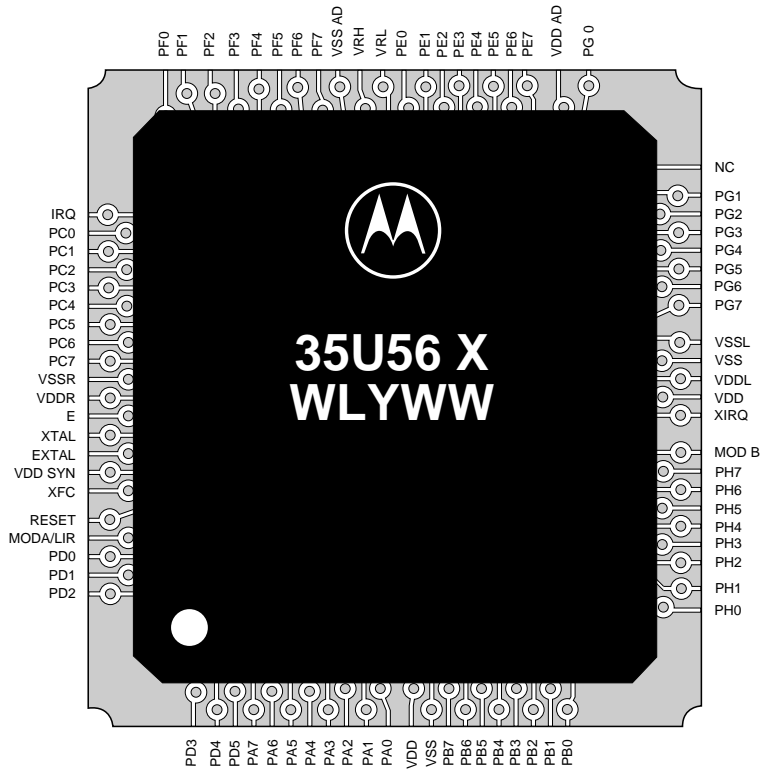
U702, AUDIO PA, Open Controller
U706, AUDIO PA, Closed Controller



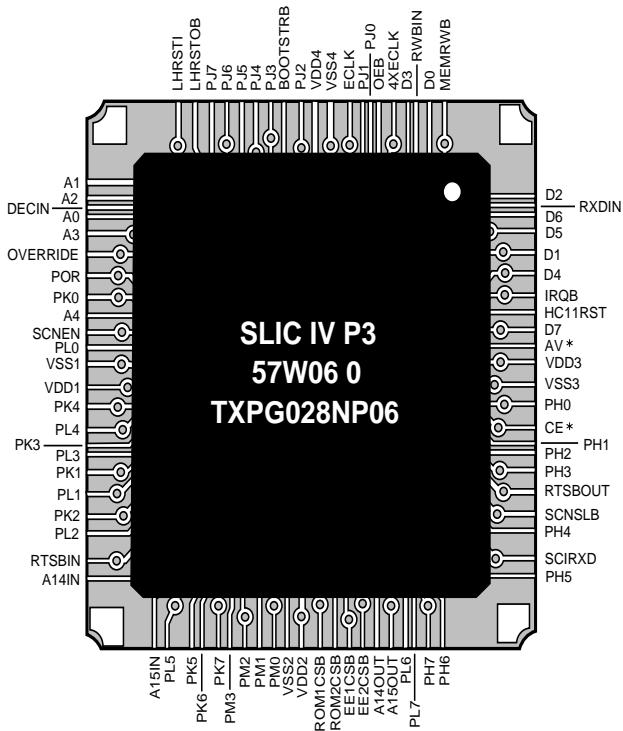
**U705, MICROCOMPUTER
Open Controller**



**U705, MICROCOMPUTER
Closed Controller**



**U710, SLIC IV
Open Controller**



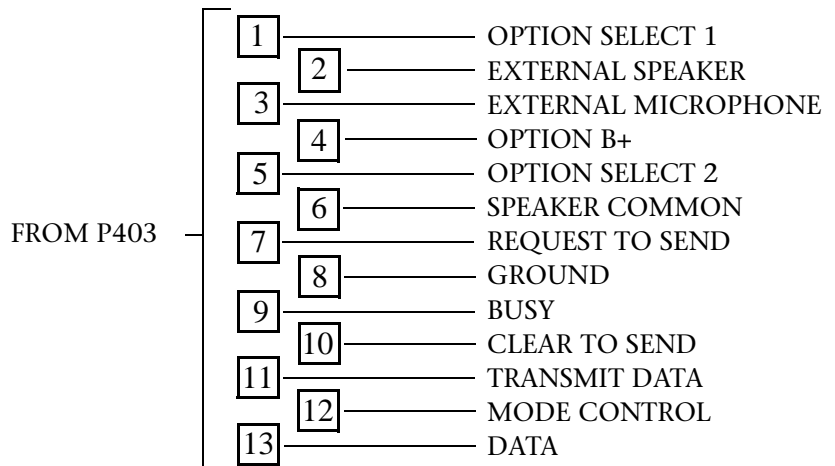
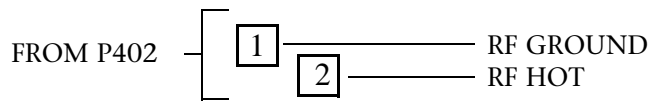
U713, EEPROM



U714, SCRAM



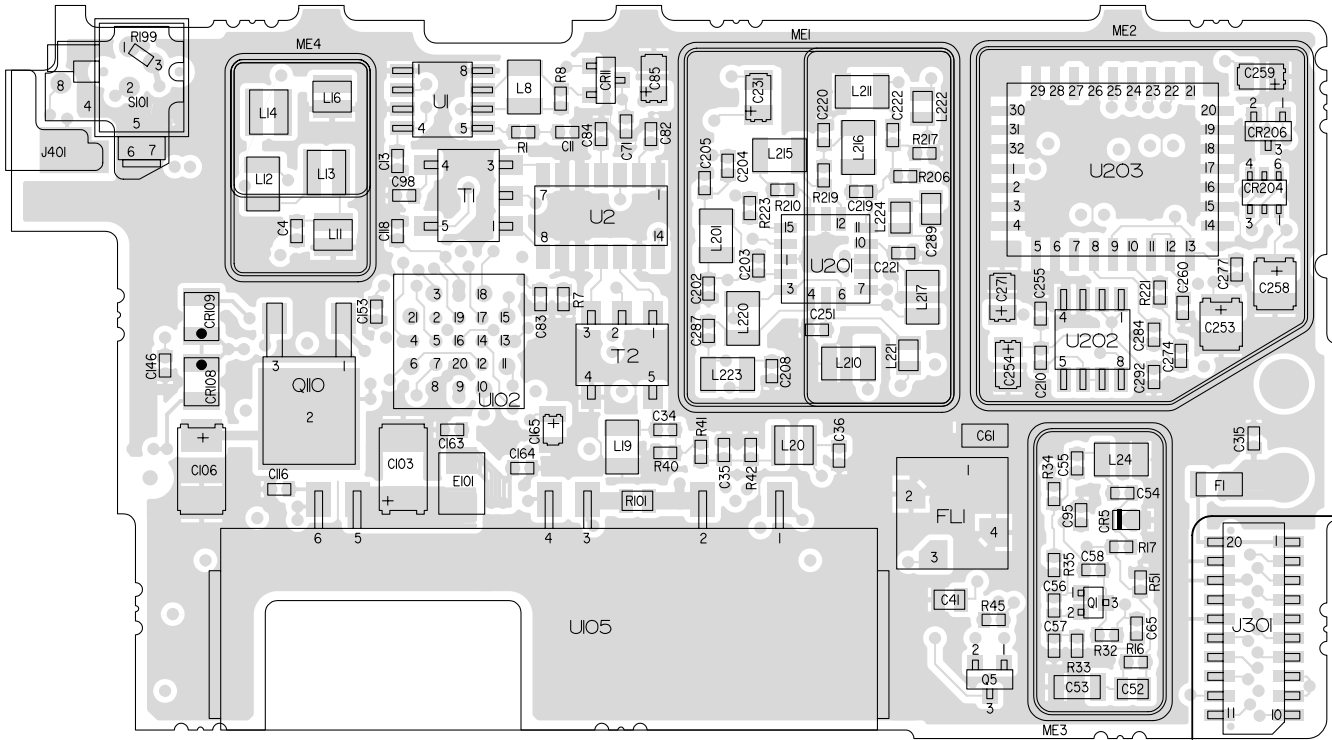
Universal Connector Pin Numbers and Signal Assignments



Universal Connector Option Select (OPT SEL) Definition

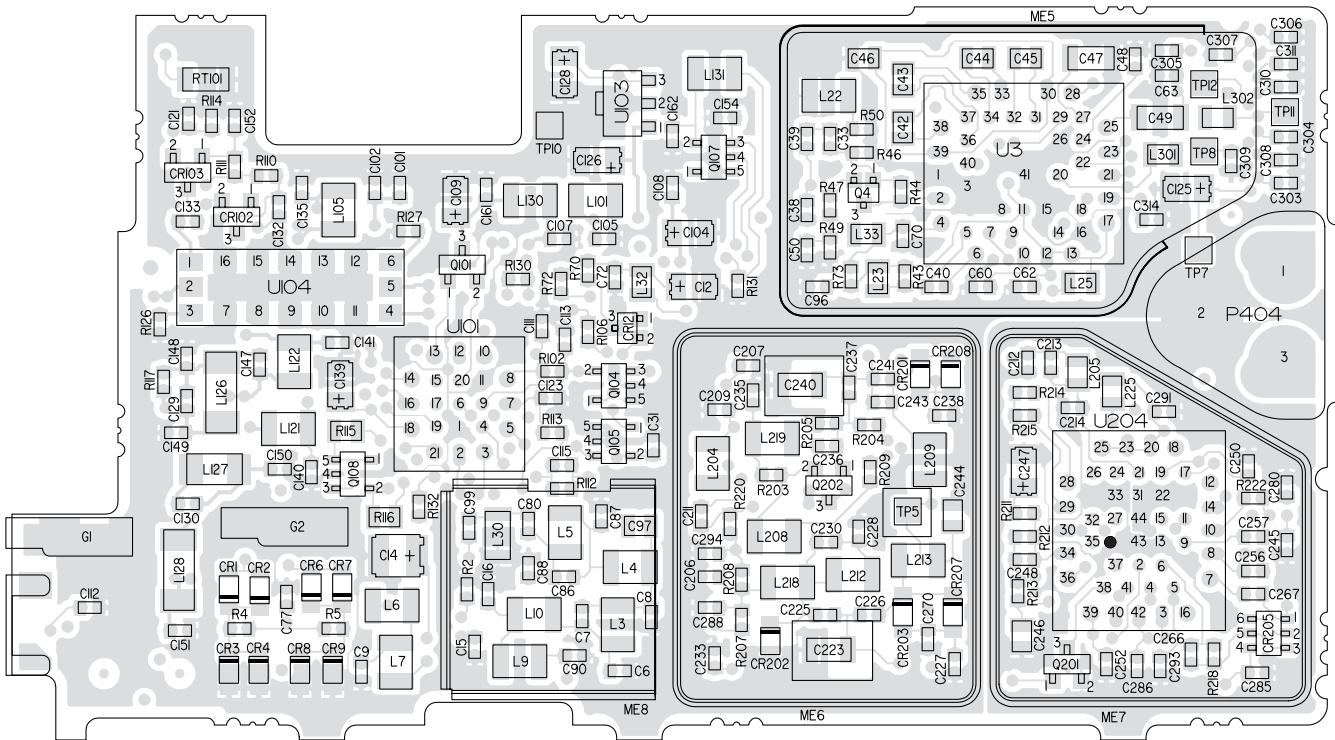
MODE #	MODE	OPT SEL 1	OPT SEL 2	COMMENT
00	External PTT	0	0	
01	External Audio	0	1	External Speaker
10	Mandown	1	0	
11	Normal Operation	1	1	
A	MTVA			Fixed Audio Output Level
B	"SMART" SB9600 Accessory			Identifies SB9600 Accessory
C	External RF Modem/FAX			Enables AUX TX and Discriminator Audio Output

VIEWED FROM SIDE 1



MAEPF-26300-O

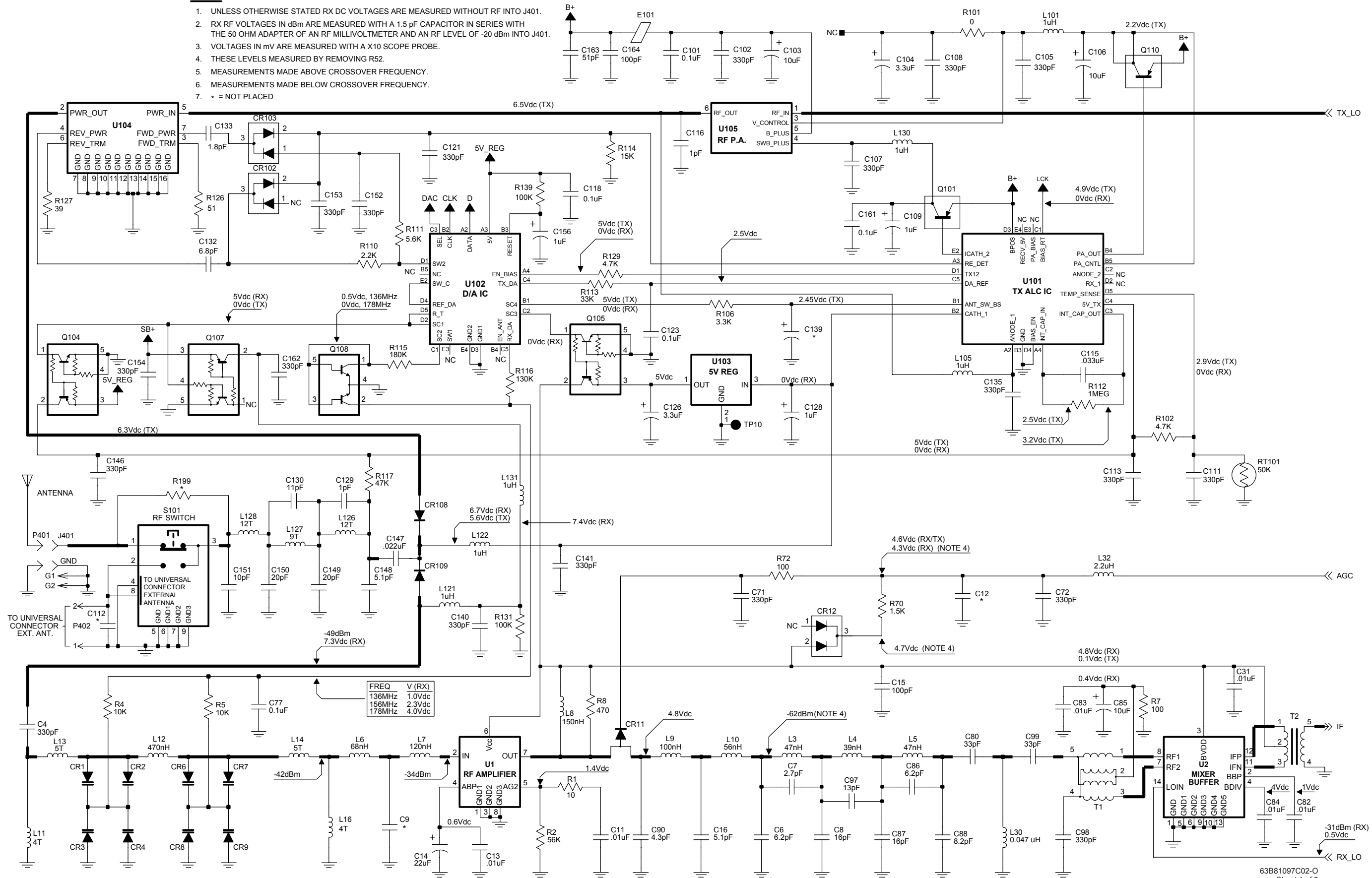
VIEWED FROM SIDE 2

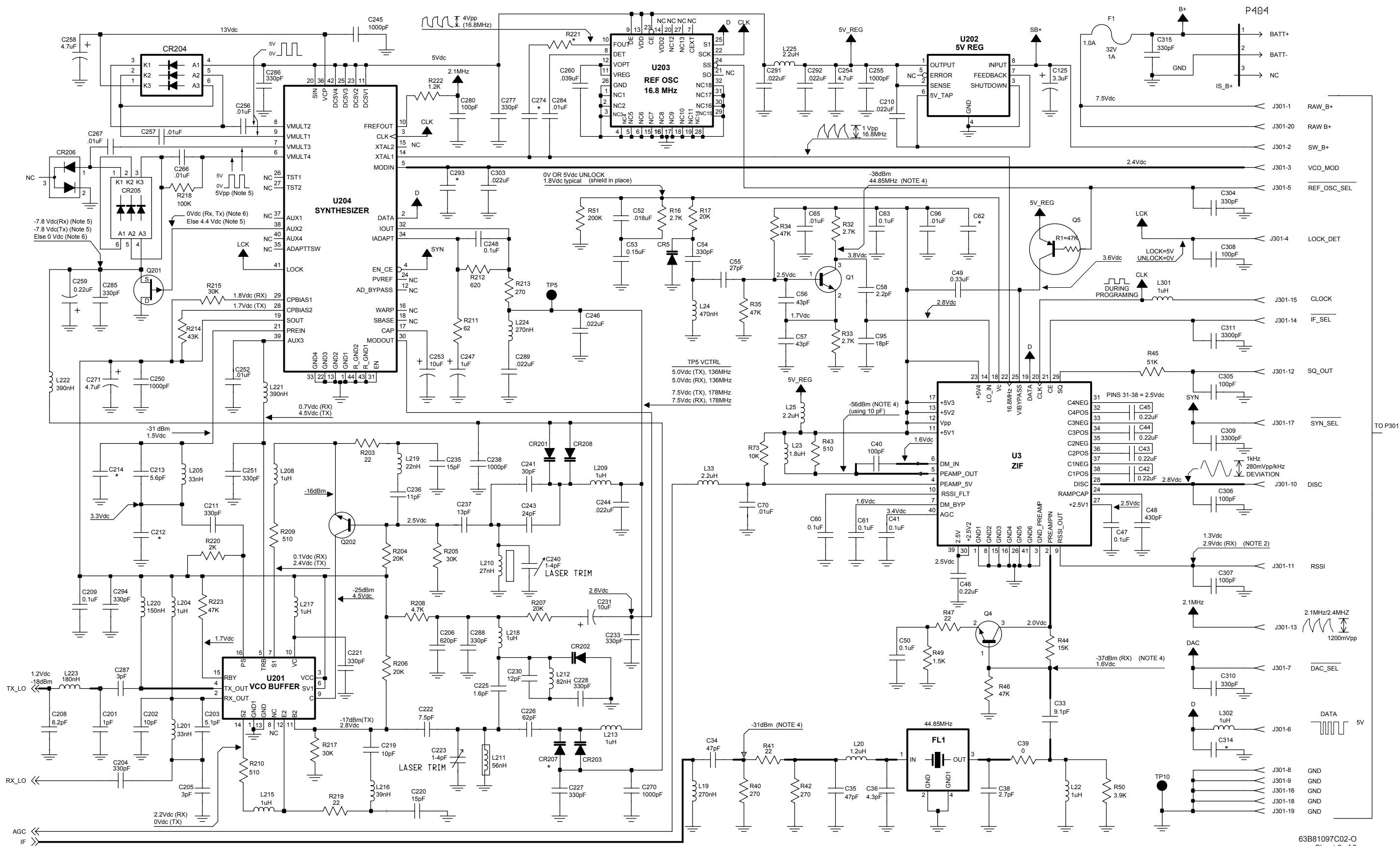


MAEPF-26301-O

NOTES:

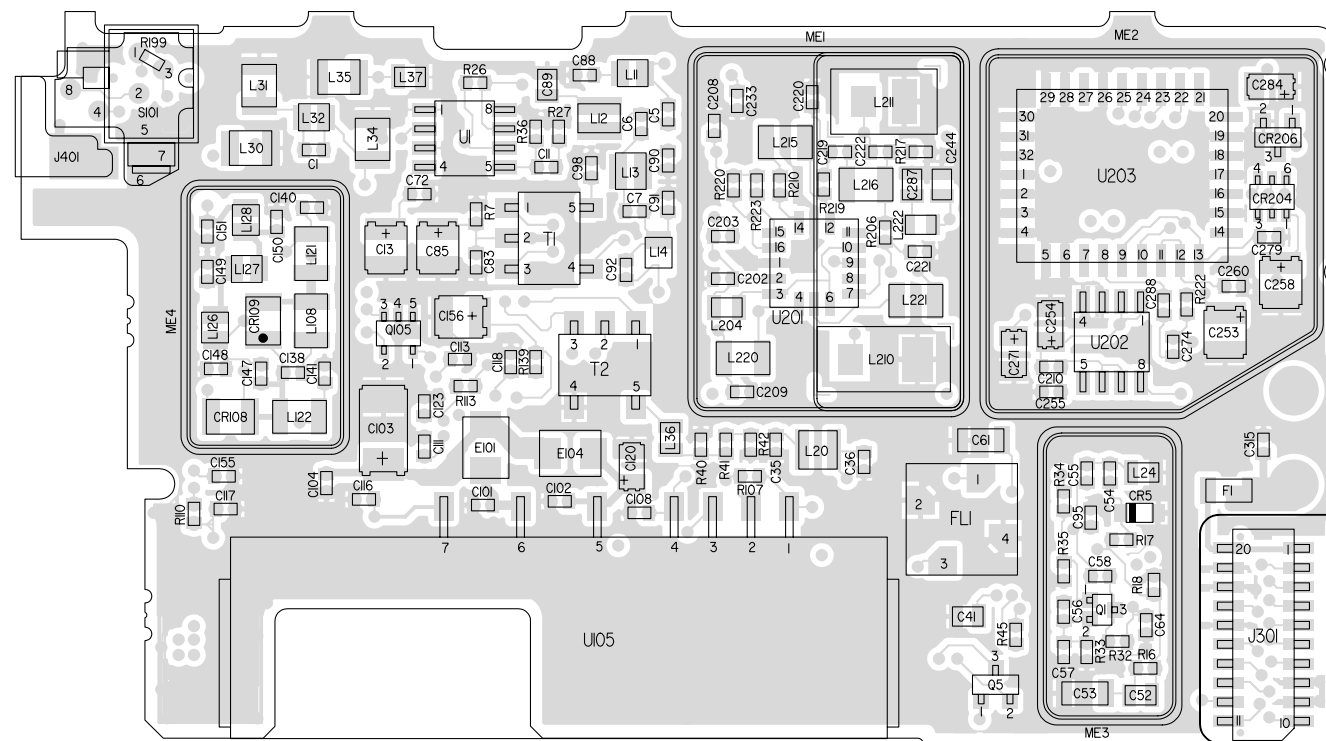
1. UNLESS OTHERWISE STATED RX DC VOLTAGES ARE MEASURED WITHOUT RF INTO J401.
2. RX RF VOLTAGES IN dBm ARE MEASURED WITH A 1.5 pF CAPACITOR IN SERIES WITH THE 50 OHM ADAPTER OF AN RF MILLIVOLTMETER AND AN RF LEVEL OF -20 dBm INTO J401.
3. VOLTAGES IN mV ARE MEASURED WITH A X10 SCOPE PROBE.
4. THESE LEVELS MEASURED BY REMOVING R52.
5. MEASUREMENTS MADE ABOVE CROSSOVER FREQUENCY.
6. MEASUREMENTS MADE BELOW CROSSOVER FREQUENCY.
7. * = NOT PLACED





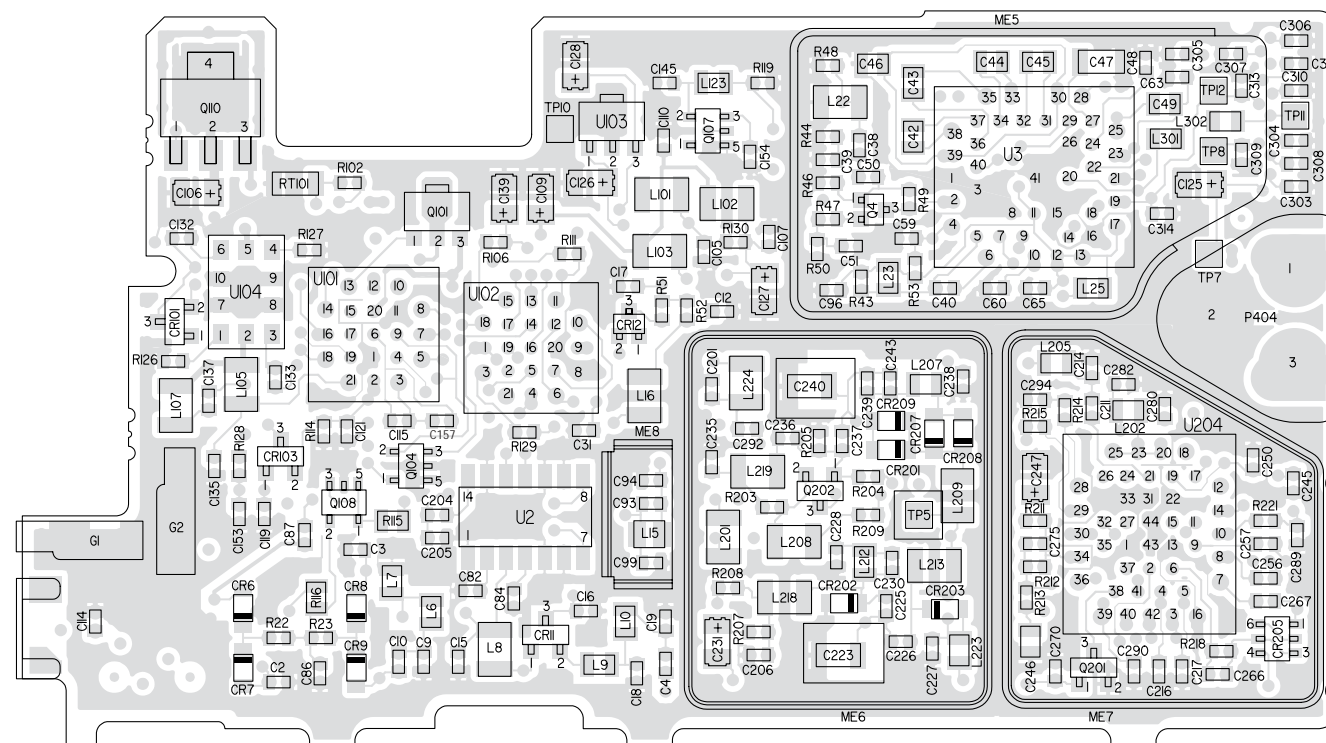
NUD7091B, NUD7092B, NUD/PMUD7095B, AND NUD7096B VHF (136-178 MHz) TRANSCEIVER BOARDS' SCHEMATIC DIAGRAM (Sheet 2 of 2)

VIEWED FROM SIDE 1



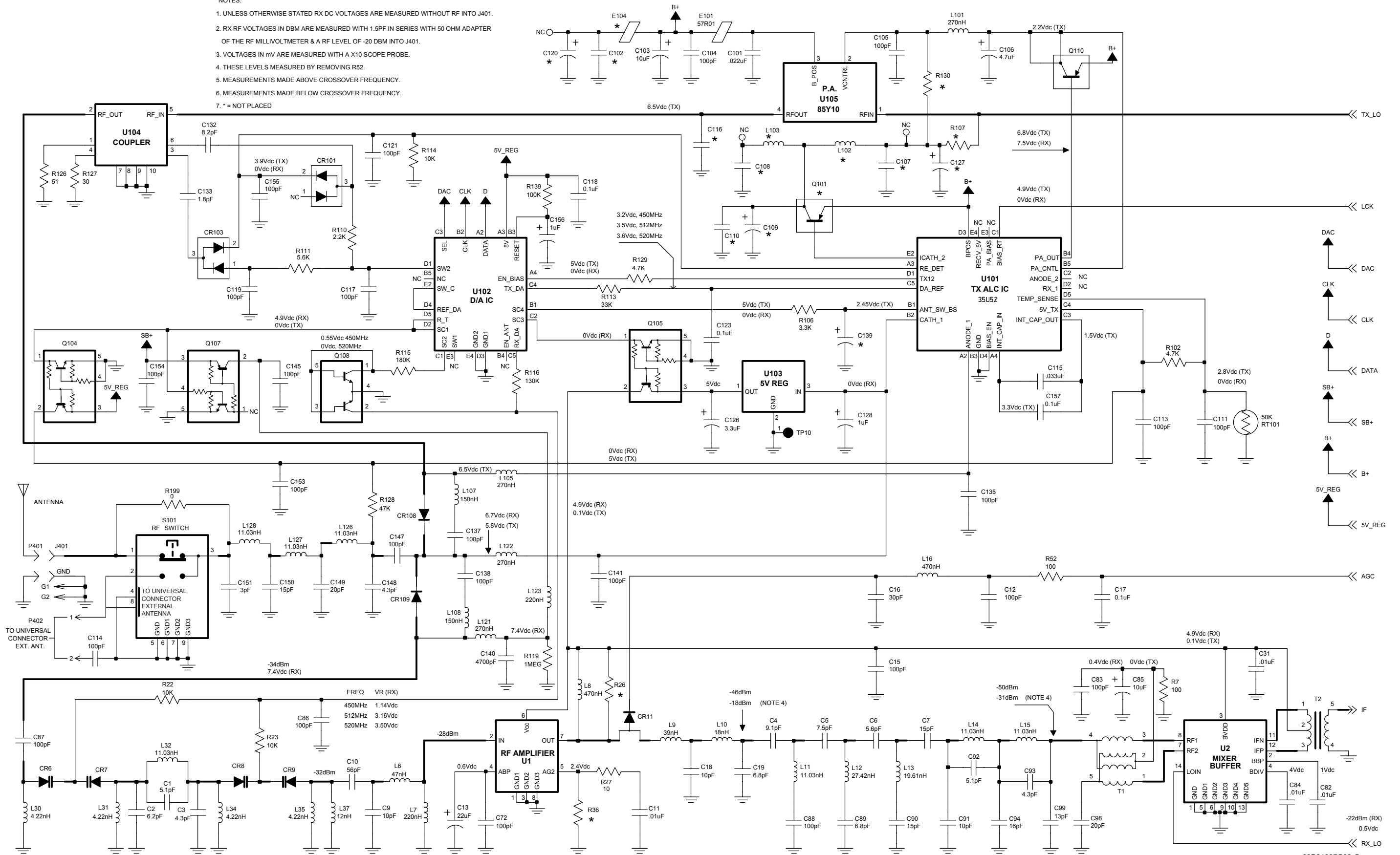
MAEPF-26302-O

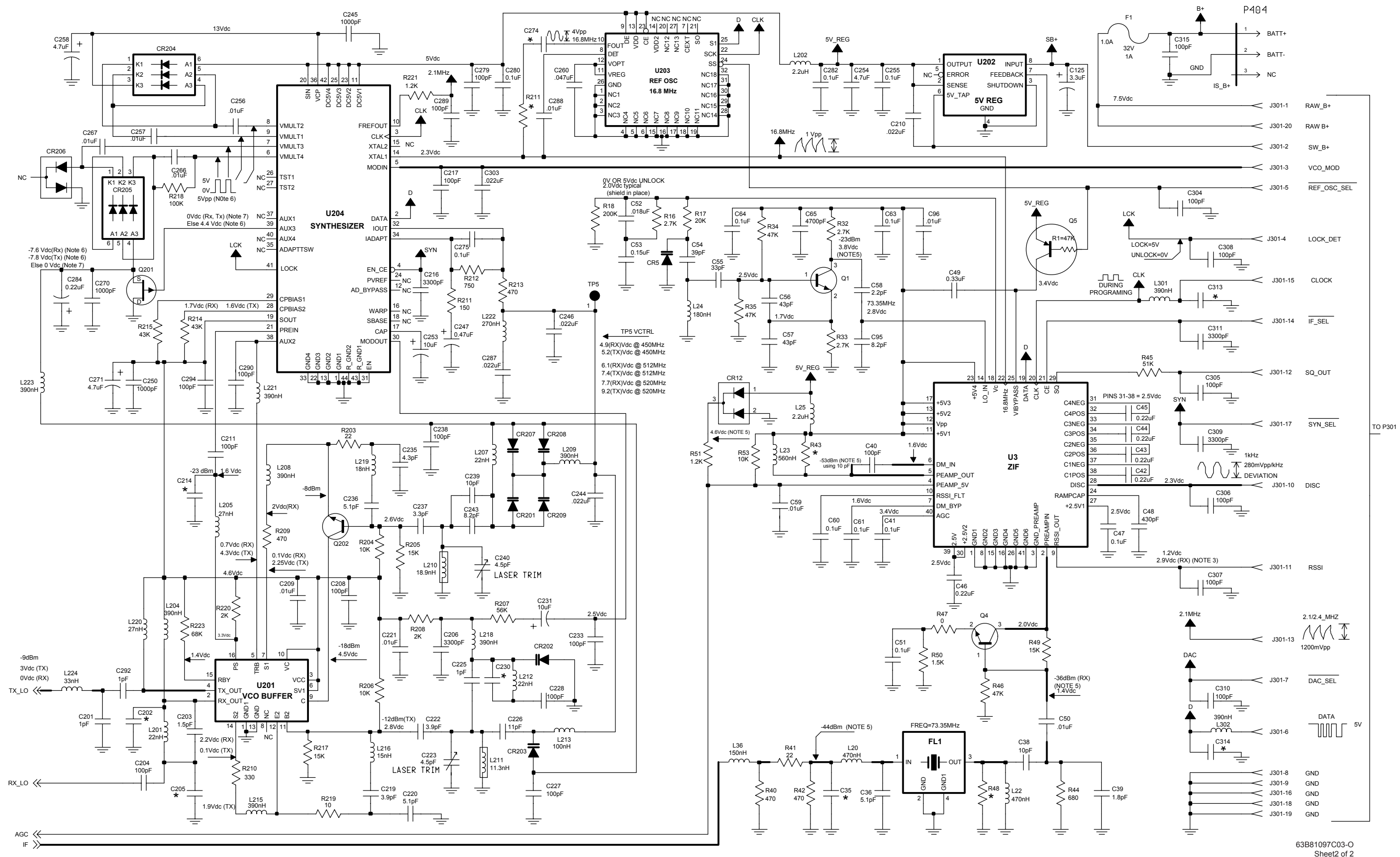
VIEWED FROM SIDE 2



MAEPF-26303-O

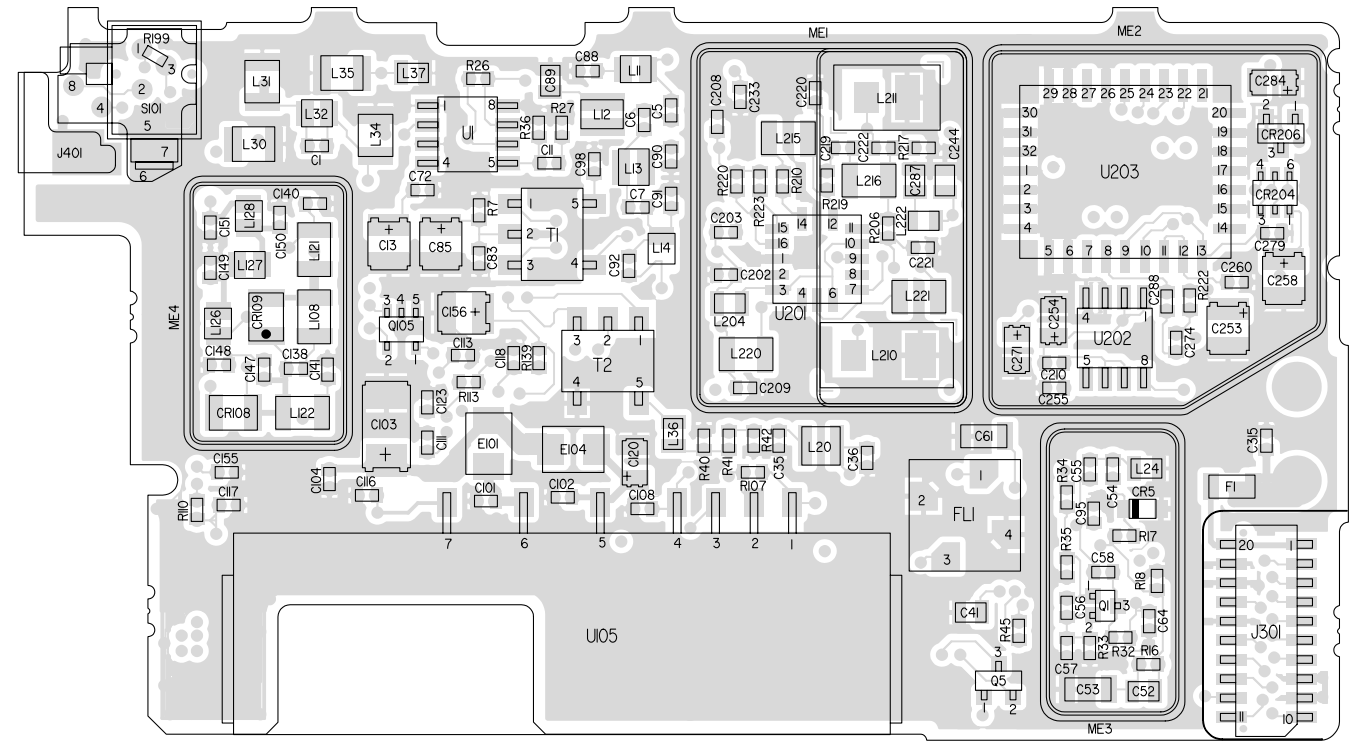
- NOTES:
1. UNLESS OTHERWISE STATED RX DC VOLTAGES ARE MEASURED WITHOUT RF INTO J401.
 2. RX RF VOLTAGES IN DBM ARE MEASURED WITH 1.5PF IN SERIES WITH 50 OHM ADAPTER OF THE RF MILLIVOLTMETER & A RF LEVEL OF -20 DBM INTO J401.
 3. VOLTAGES IN mV ARE MEASURED WITH A X10 SCOPE PROBE.
 4. THESE LEVELS MEASURED BY REMOVING R52.
 5. MEASUREMENTS MADE ABOVE CROSSOVER FREQUENCY.
 6. MEASUREMENTS MADE BELOW CROSSOVER FREQUENCY.
 7. * = NOT PLACED



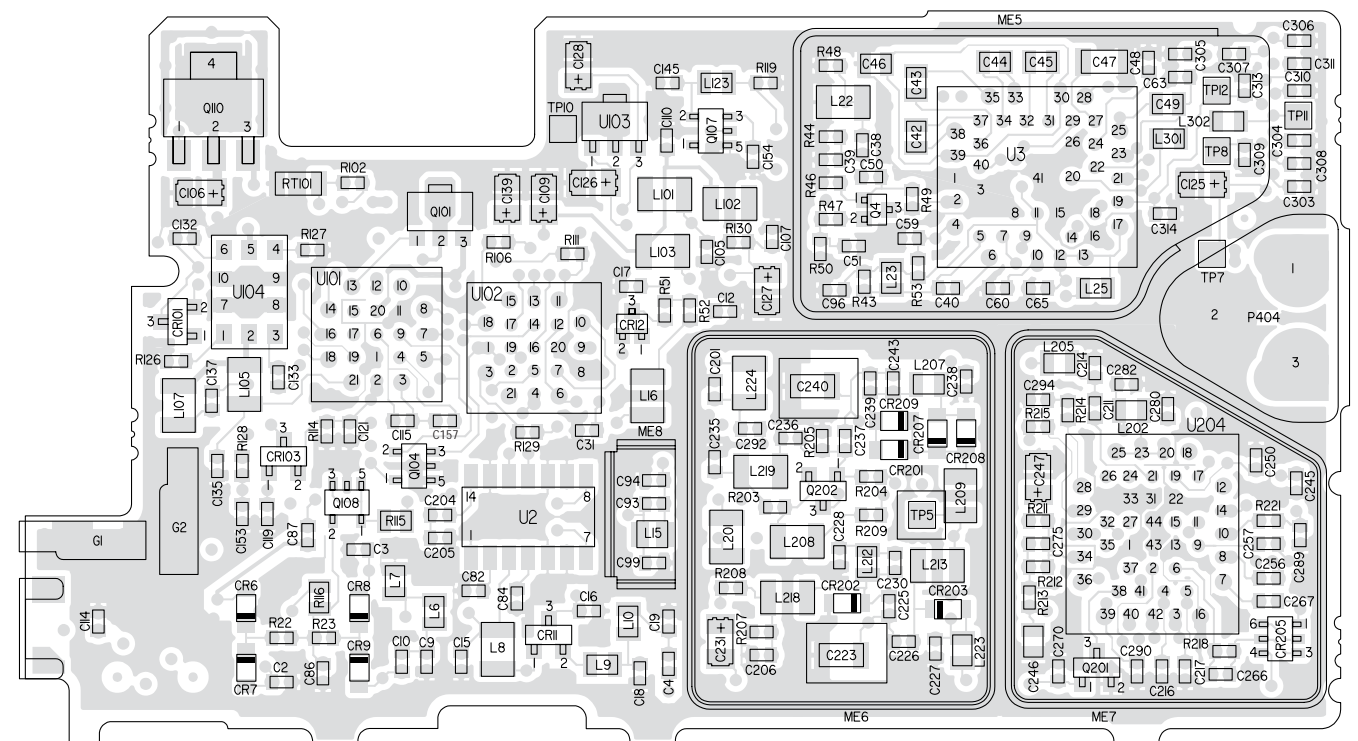


NUE7265B, NUE7266B, NUE/PMUE7272B, AND NUE7274B UHF (403-470MHz) TRANSCIVER BOARDS' SCHEMATIC DIAGRAM (Sheet 2 of 2)

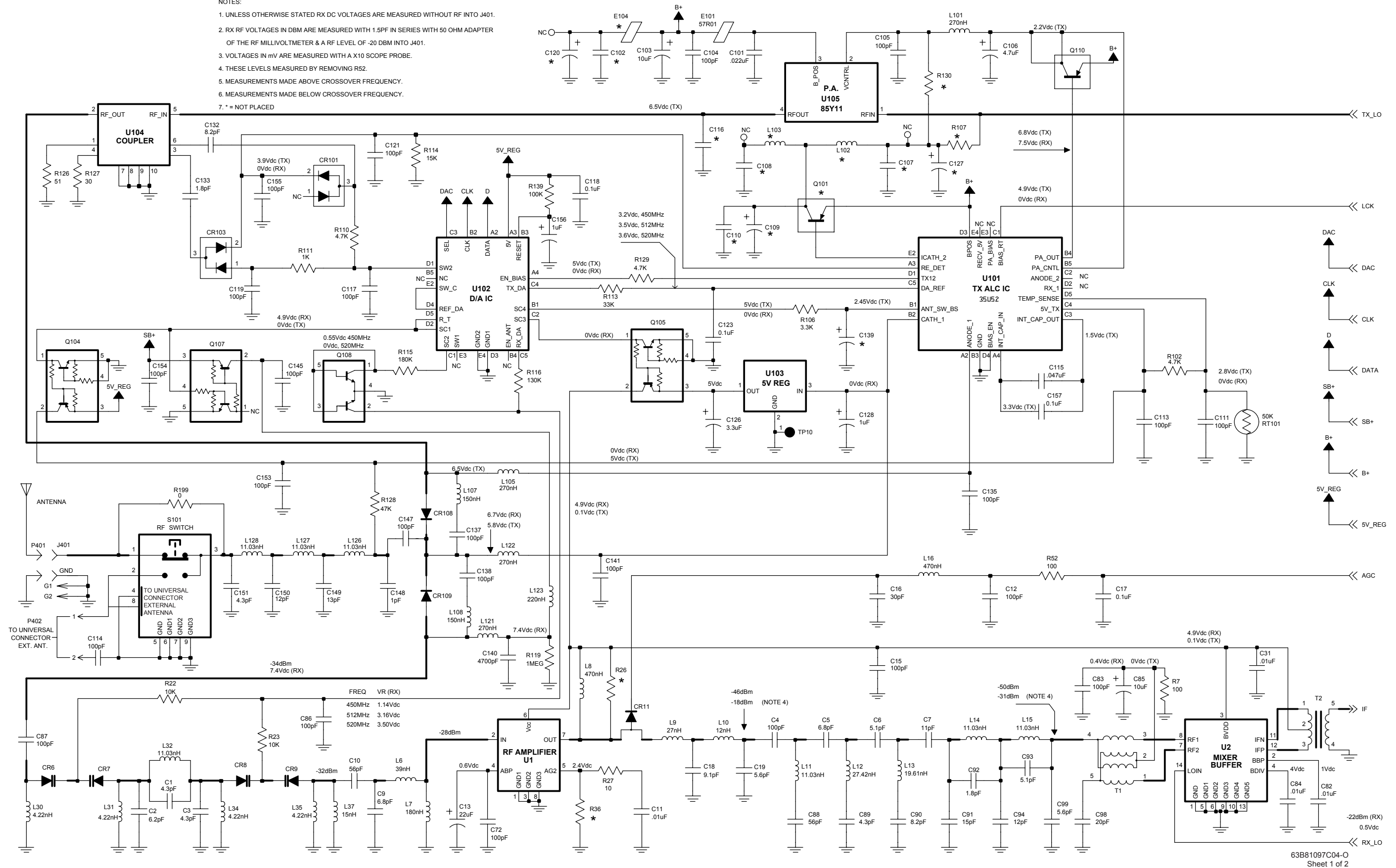
VIEWED FROM SIDE 1

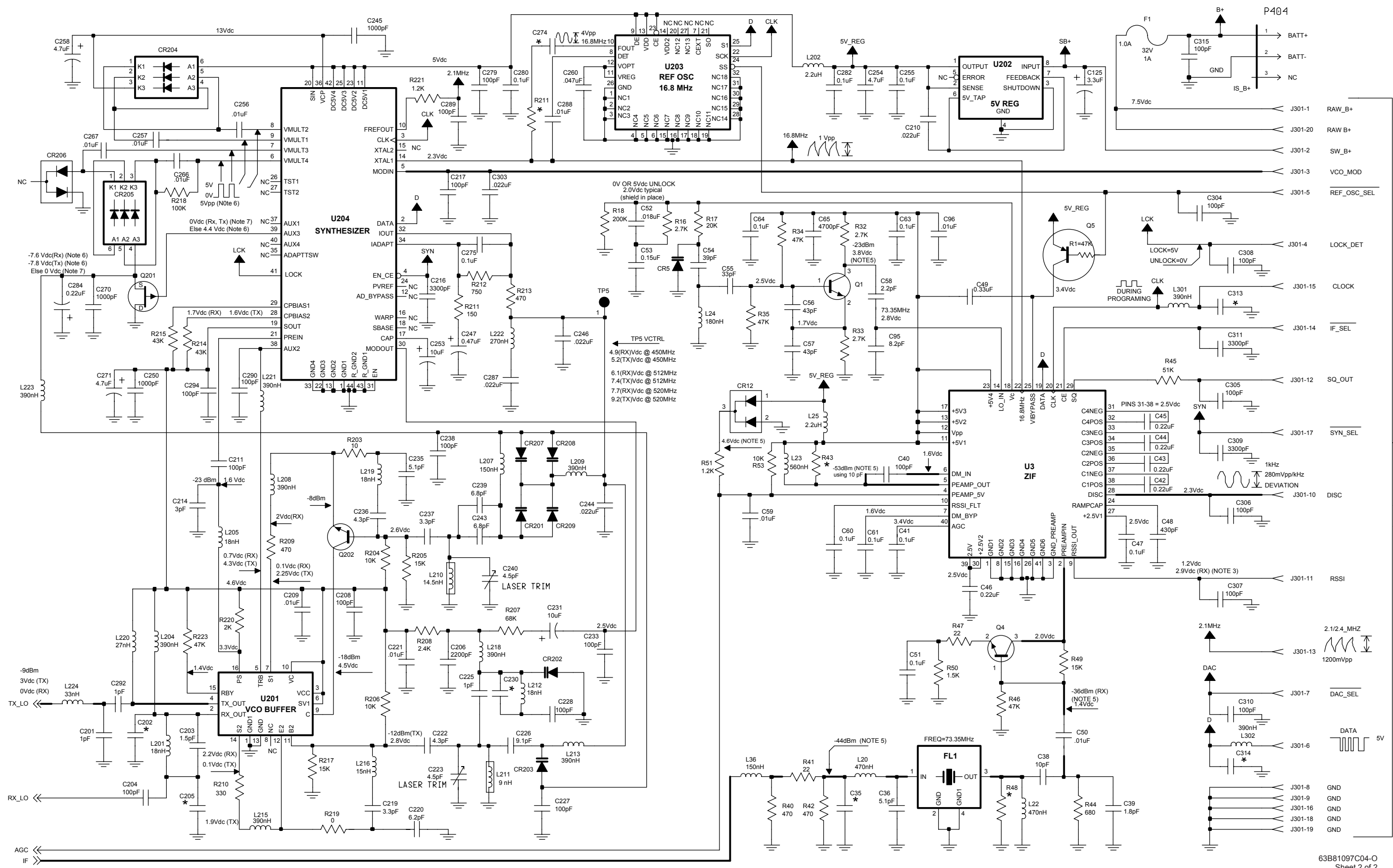


VIEWED FROM SIDE 2



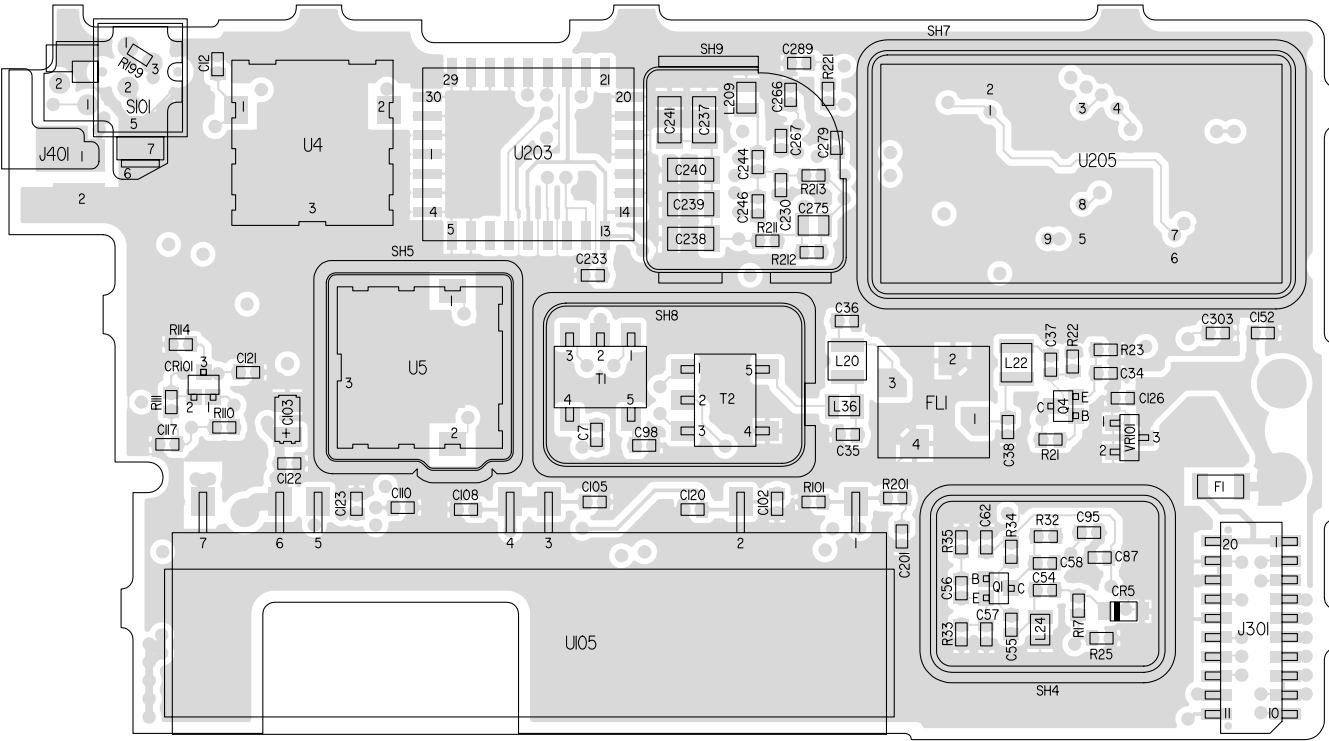
- NOTES:
1. UNLESS OTHERWISE STATED RX DC VOLTAGES ARE MEASURED WITHOUT RF INTO J401.
 2. RX RF VOLTAGES IN DBM ARE MEASURED WITH 1.5PF IN SERIES WITH 50 OHM ADAPTER OF THE RF MILLIVOLTMETER & A RF LEVEL OF -20 DBM INTO J401.
 3. VOLTAGES IN mV ARE MEASURED WITH A X10 SCOPE PROBE.
 4. THESE LEVELS MEASURED BY REMOVING R52.
 5. MEASUREMENTS MADE ABOVE Crossover FREQUENCY.
 6. MEASUREMENTS MADE BELOW Crossover FREQUENCY.
 7. * = NOT PLACED





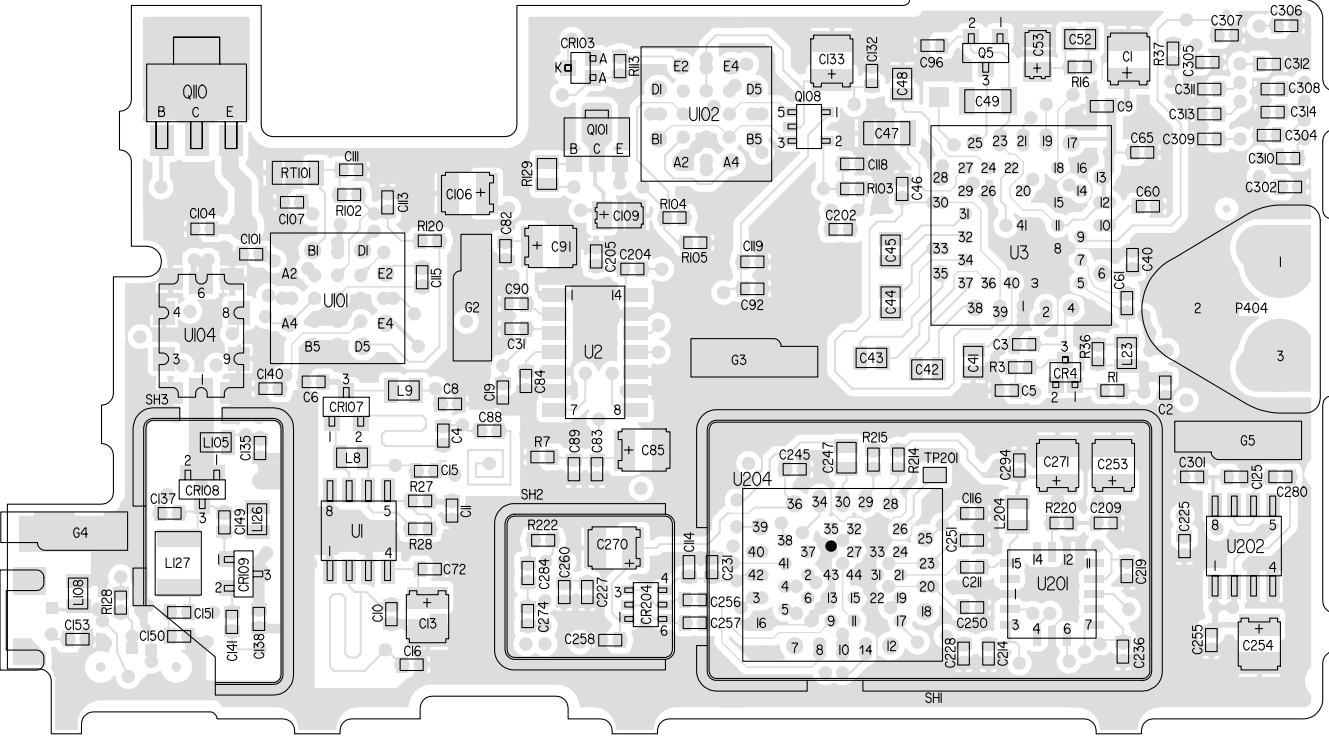
NUE7267B, NUE7268B, NUE/PMUE7273B, AND NUE7275B UHF (450-520MHz) TRANSCEIVER BOARDS' SCHEMATIC DIAGRAM (Sheet 2 of 2)

VIEWED FROM SIDE 1



MAEPF-26304-O

VIEWED FROM SIDE 2



MAEPF-26305-O

Electrical Parts List, Transceivers (800MHz)
NUF6410B/C, NUF6498B/C, NUF6500B/C AND NUF6501C

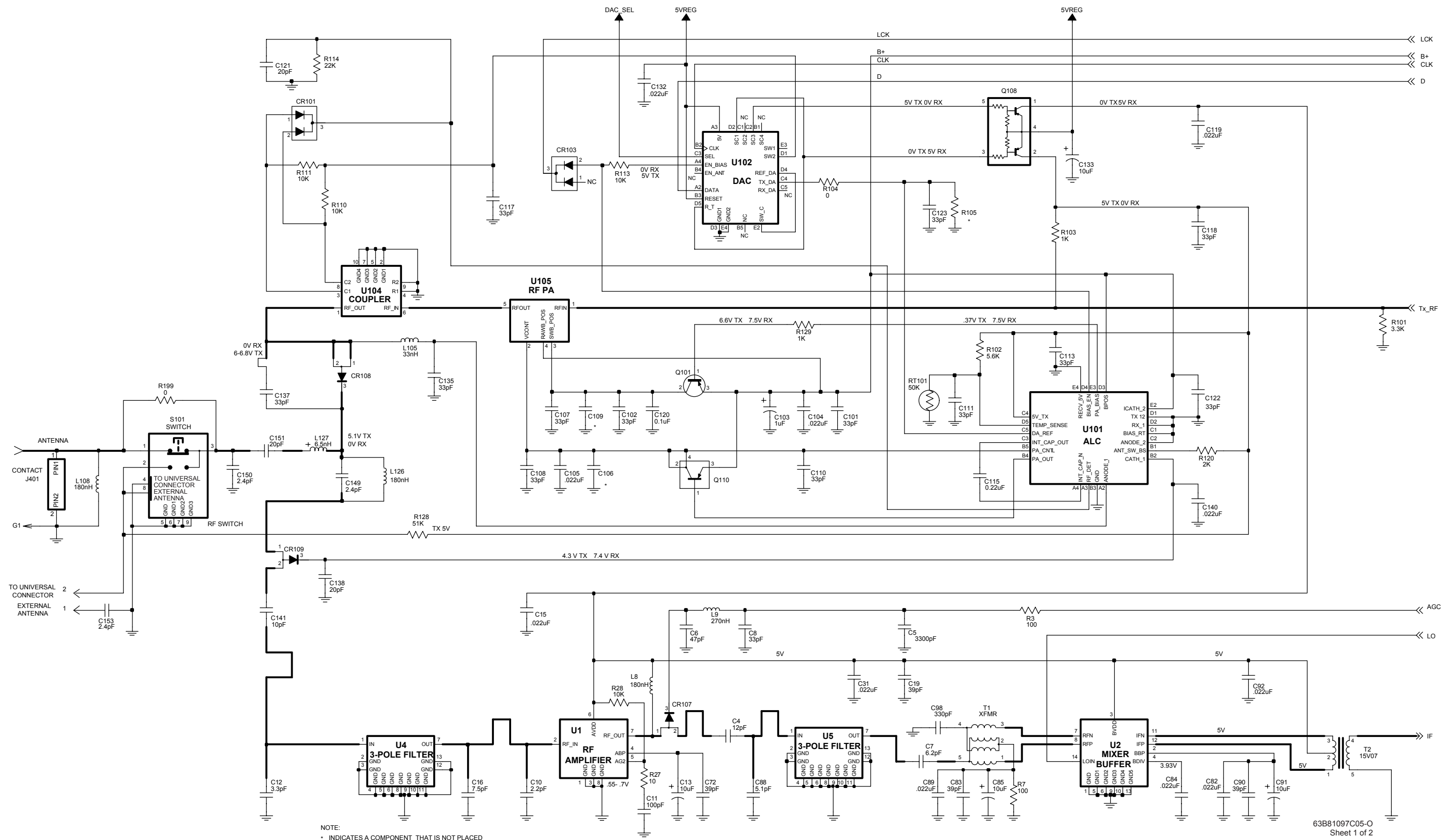
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
3Pack.xls (Sheet 2)		CAPACITOR, Fixed: pF ± 5%; 50V unless stated
C1	2311049J23	10uF
C2	2113932K15	0.1uF
C3	2113931F37	3300
C4	2113930F29	12
C5	2113931F37	3300
C6	2113930F43	47
C7	2113930F22	6.2
C8	2113930F39	33
C9	2113932K15	0.1uF
C10	2113930F11	2.2
C11	2113930F51	100
C12	2113930F15	3.3
C13	2311049J23	10uF
C15	2113932E07	0.022uF
C16	2113930F24	7.5
C19	2113930F41	39
C31	2113932E07	0.022uF
C34	2113932K15	0.1uF
C35	2113930F43	47
C36	2113930F13	2.7
C37	2113932E07	0.022uF
C38	2113930F17	3.9
C40	2113930F51	100
C41	2113743A19	0.1uF
C42 thru 45	2113743A23	0.22uF
C46	2113932K15	0.1uF
C47	2109720D14	0.1uF
C48	2113740A70	430
C49	2311049A04	0.33uF
C52	2113741A51	18nF
C53	2311049A02	0.15uF
C54, 55	2113930F41	39
C56, 57	2113930F42	43
C58	2113930F11	2.2
C60	2113932K15	0.1uF
C61	2113930F51	100
C62	2113932K15	0.1uF
C65	2113932K15	0.1uF
C72	2113930F41	39
C82	2113932E07	0.022uF
C83	2113930F41	39
C84	2113932E07	0.022uF
C85	2311049J23	10uF
C87	2113932K15	0.1uF
C88	2113930F20	5.1
C89	2113932E07	0.022uF
C90	2113930F41	39
C91	2311049J23	10uF
C92	2113932E07	0.022uF
C95	2113930F25	8.2
C96	2113932K15	0.1uF
C98	2113931F13	330
C101, 102	2113930F39	33
C103	2311049A07	1uF
C104, 105	2113932E07	0.022uF
C106	-----	Not Placed
C107, 108	2113930F39	33
C109	-----	Not Placed
C110, 111	2113930F39	33
C113	2113930F39	33
C114	2113932K15	0.1uF
C115	2113743K16	0.22uF
C116	2113932K15	0.1uF
C117, 118	2113930F39	33
C119	2113932E07	0.022uF
C120	2113932K15	0.1uF
C121	2113930F34	20
C122, 123	2113930F39	33
C125	2113932K15	0.1uF
C126	2113932E07	0.022uF
C132	2113932E07	0.022uF
C133	2311049J23	10uF
C135	2113930F39	33
C137	2113930F39	33
C138	2113930F34	20
C140	2113932E07	0.022uF
C141	2113930F27	10
C149, C150	2113930F12	2.4
C151	2113930F34	20
C152	2113930F39	33
C153	2113930F12	2.4
C201	2113930F19	4.7

C202	2113930F34	20
C204	2113930F39	33
C205	2113930F14	3
C209	2113932E07	0.022uF
C211	2113930F14	3
C214	2113932E07	0.022uF
C219	2113932E07	0.022uF
C225	2113930F39	33
C227, 228	2113930F39	33
C230, 231	2113930F39	33
C233	2113932E07	0.022uF
C236	2113932E07	0.022uF
C237 thru 241	2109720D14	0.1uF
C244	2113741F18	510
C245, 246	2113932E07	0.022uF
C247	2105248W02	1200
C250	2113932K15	0.1uF
C251	2113930F39	33
C253, 254	2311049J23	10uF
C255	2113932E07	0.022uF
C256 thru 258	2113932K15	0.1uF
C260	2113932K07	0.047uF
C266, 267	2113931F37	3300
C270	2311049J12	4.7uF
C271	2311049J23	10uF
C274	-----	Not Placed
C275	2113743A13	0.047uF
C279	2113932K15	0.1uF
C280	2113932E07	0.022uF
C284	2113932E07	0.022uF
C289	2113930F42	43
C294	2113930F39	33
C301	2113932E07	0.022uF
C302	2113930F39	33
C303	2113931F37	3300
C304 thru 308	2113930F39	33
C309	2113931F37	3300
C310	2113930F39	33
C311	2113931F37	3300
C312 thru 314	2113930F39	33
CR4	4805218N57	Dual
CR5	4862824C01	Varactor
CR101	4805218N57	Dual
CR103	4805218N57	Dual
CR107 thru 109	4805129M96	PIN
CR204	4802233J09	Triple
F1	6505757V01	FUSE SURFACE MT
FL1	4802655J03	FILTER: 73.35MHz, See Note 2
G2 thru 5	3905643V01	CONNECTOR: Contact, Ground
J301	0905461X03	JACK: Connector, 20 contacts; to P301 Strip Connector
J401	3905264W01	Contact, Antenna
L8	2462587V37	COIL, RF: 180 nH
L9	2462587Q40	270 nH
L20	2405452C58	820 nH
L22	2405452C64	1500 nH
L23	-----	Not Placed
L24	2462587V37	180 nH
L36	2462587V37	180 nH
L105	2462587V28	33 nH
L108	2462587V37	180 nH
L126	2462587V37	180 nH
L127	2405430Y01	6.5 nH
L204	2462587V24	15 nH
L209	2462587Q59	10uH
P404	3905861X02	PLUG: Connector, Battery
Q1	4805218N63	TRANSISTOR: See Note 1 NPN
Q2	-----	Not Placed
Q4	4805218N63	NPN
Q5	4880048M04	PNP
Q101	4805128M27	PNP
Q108	4805921T06	Dual PNP
Q110	4805218N45	PNP

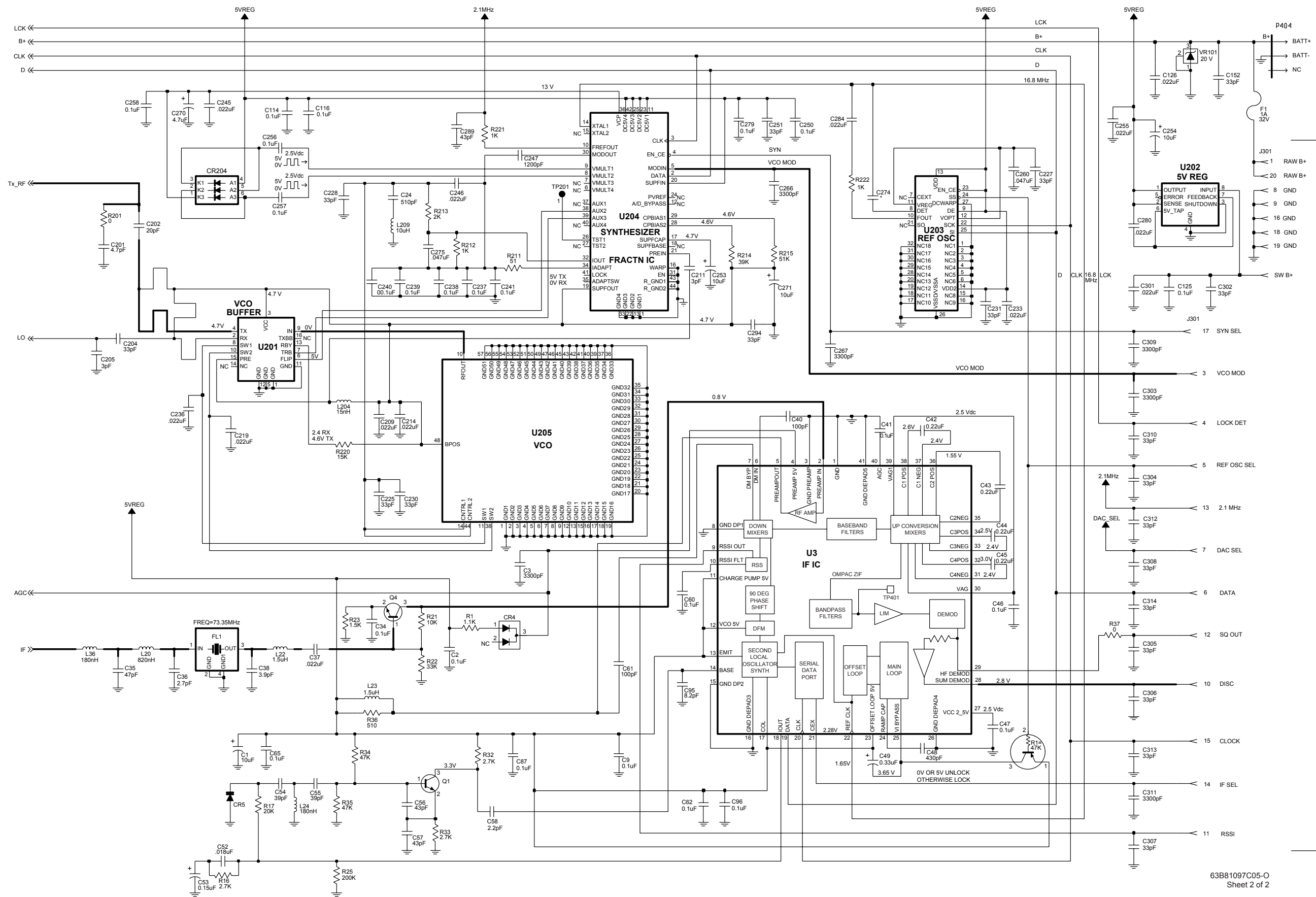
R1	0662057A50	RESISTOR, Fixed: Ω ± 0.0625W unless stated 1.1k
R3	0662057A25	100
R4	-----	Not Placed
R5	-----	Not Placed
R6	0662057B22	1.0 meg
R7	0662057A25	100
R16	0662057A59	2.7k
R17	0662057A80	20k
R21	0662057A73	10k
R22	0662057A85	33k
R23	0662057A53	1.5k
R25	0662057B05	200k
R27	0662057A01	10
R28	0662057A73	10k
R32, 33	0662057A59	2.7k
R34, 35	0662057A89	47k
R36	0662057A42	510
R37	0662057B47	0
R101	0662057A61	3.3k
R102	0662057A67	5.6k
R103	0662057A49	1.0k
R104	0662057B47	0
R105	-----	Not Placed
R110, 111	0662057A73	10k
R113	0662057A73	10k
R114	0662057A81	22k
R120	0662057A56	2.0k
R128	0662057A90	51k
R129	0662057C75	1.0k
R199	-----	Not Placed
R201	0662057B47	0
R211	0662057A18	51
R212	0662057A49	1.0k
R213	0662057A56	2.0k
R214	0662057A87	39k
R215	0662057A90	51k
R220	0662057A77	15k
R221, 222	0662057A49	1.0k
RT101	0605621T02	THERMISTOR: 50k
S101	4005831W01	SWITCH: RF
T1	2505515V04	TRANSFORMER: Balun; 5:1
T2	2505515V07	Balun; 25:1
U1	5105457W51	MODULE: See Note 1 RF Amp
U2	5105457W52	Mixer
U3	5186296A02	ZIF
U4, 5	5105279V15	3-Pole Filter
U101	5105835U52	TX ALC
U102	5105835U51	DAC
U104	5105279V26	coupler
U105	5105385Y83	RF PA
U201	5105662U76	VCO/Buffer
U202	5105469E65	5V Regulator
U203	5105385Y61	Ref. Osc., 16.8MHz
U204	5105457W81	Synthesizer
U205	5105385Y53	VCO
VR101	4813830A33	DIODE, ZENER: See Note 1 20 V
SH1	2605258V02	MECHANICAL PARTS SHIELD, Synthesizer
SH2	2605259V01	SHIELD, Diode
SH3	2605260V01	SHIELD, RF Switch
SH4	2605261V01	SHIELD, ZIF
SH5	2605263V02	SHIELD, 3-Pole Filter
SH7	2605890U02	SHIELD, VCO
SH8	2605418V01	SHIELD, Transformer
SH9	2605540W01	SHIELD, Loop Filter

Notes:

1. For optimum performance, order replacement diodes, transistors, and circuit modules by Motorola part number only.
2. When ordering crystals, specify carrier frequency, crystal frequency, crystal type number, and Motorola part number.
3. "Not Placed" means that components are for future use, and are not placed on the circuit board at this time.



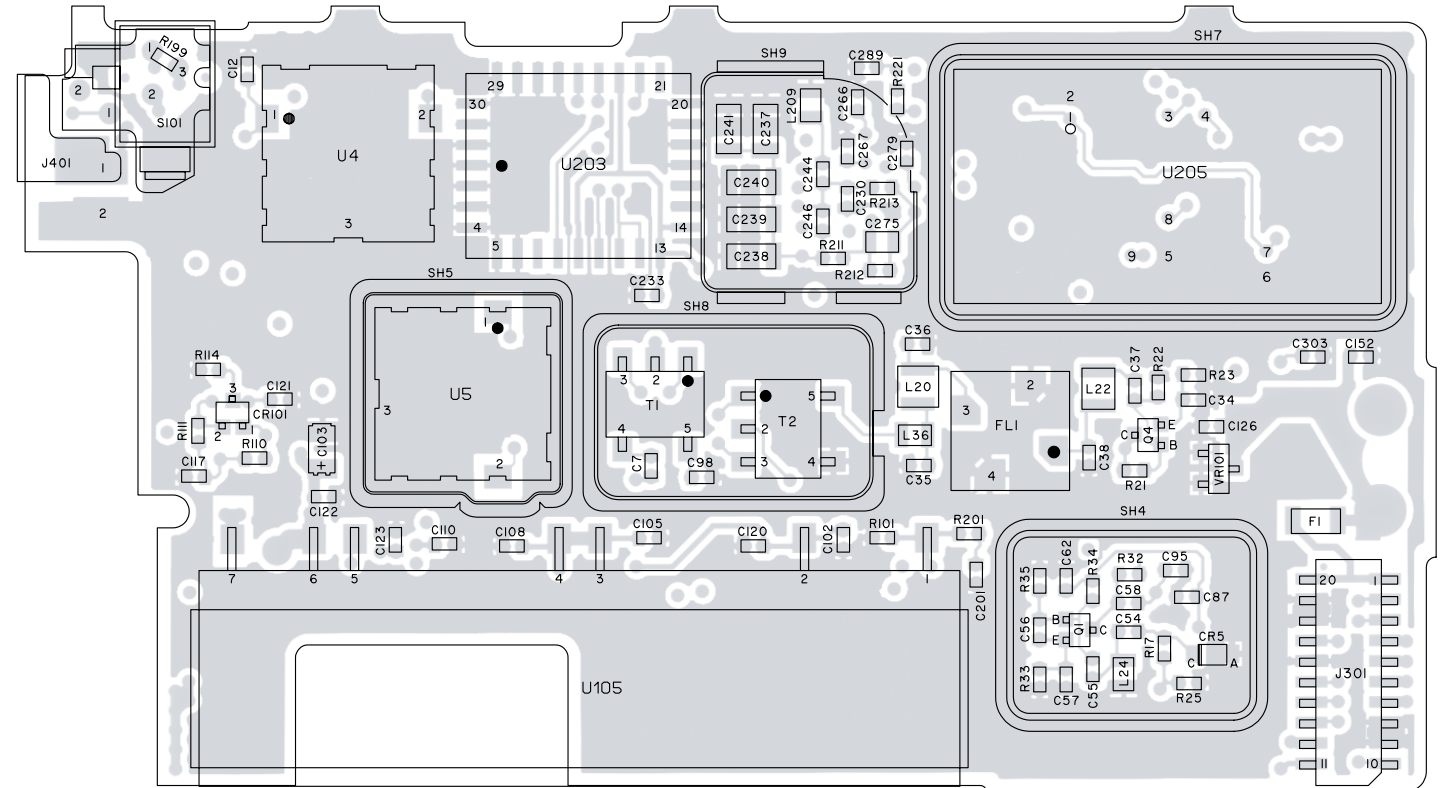
NOTE:
 * INDICATES A COMPONENT THAT IS NOT PLACED



63B81097C05-O
Sheet 2 of 2

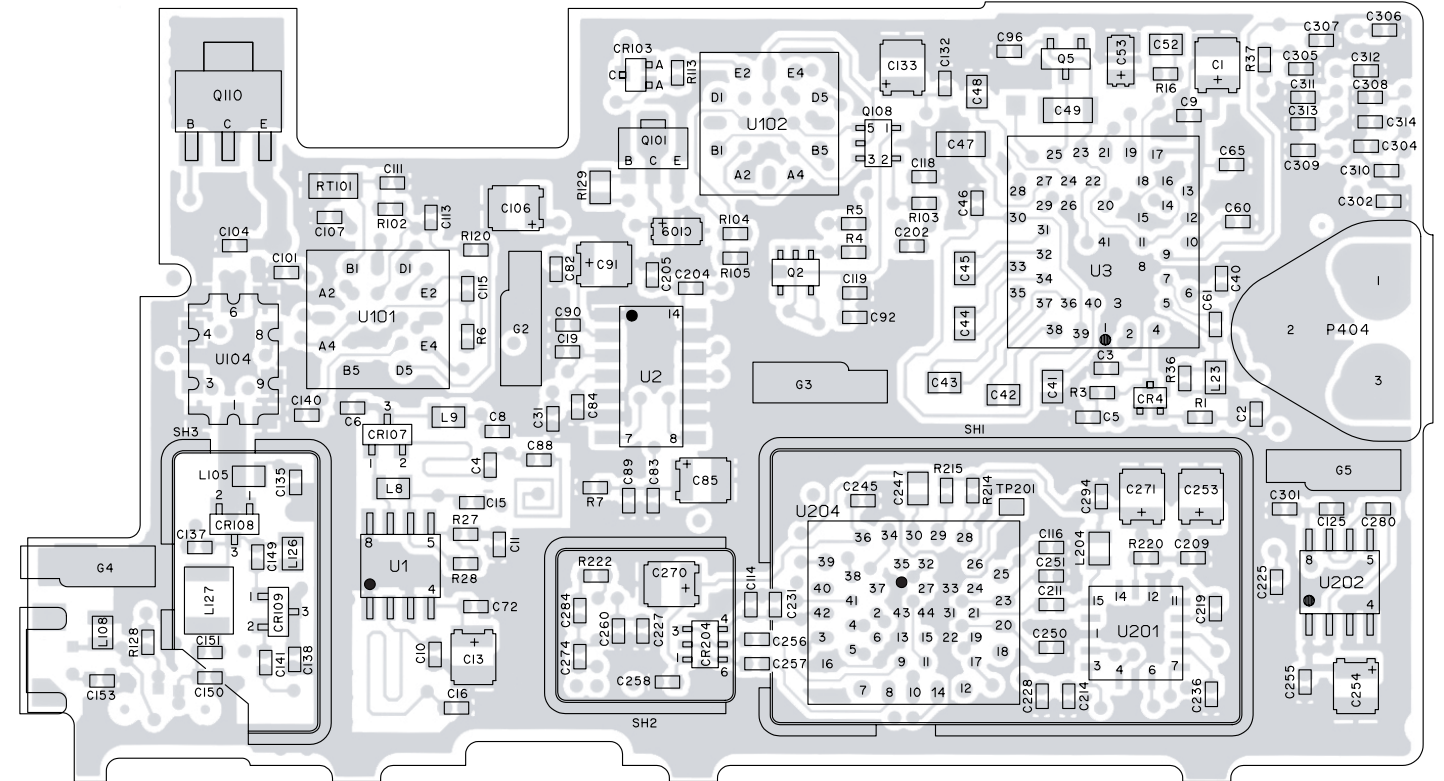
NUF6410B/C, NUF6498B/C, NUF6500B/C AND NUF6501C (800MHz)
TRANSCIVER BOARDS' SCHEMATIC DIAGRAM (Sheet 2 of 2)

VIEWED FROM SIDE 1

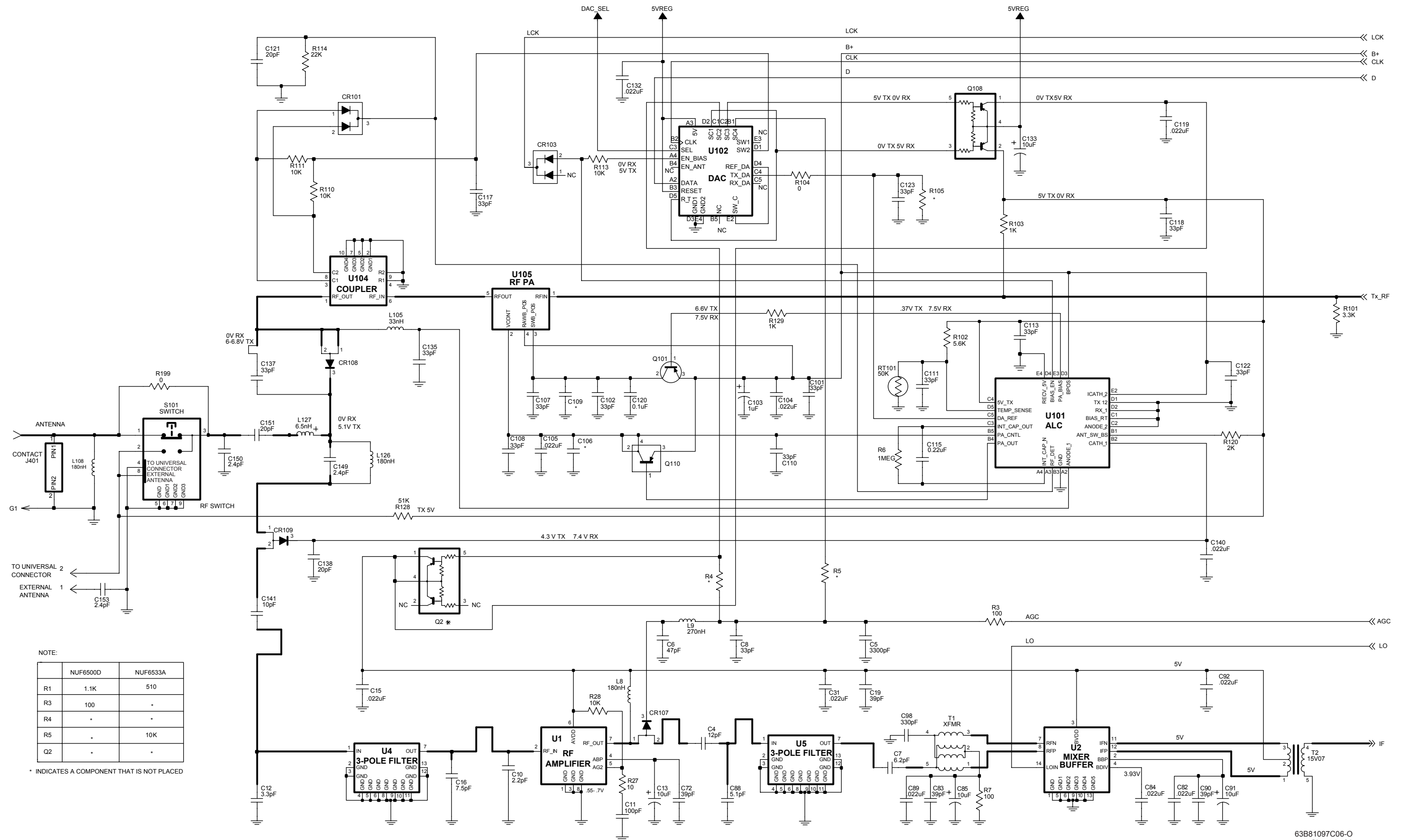


MAEPF-27151-O

VIEWED FROM SIDE 2



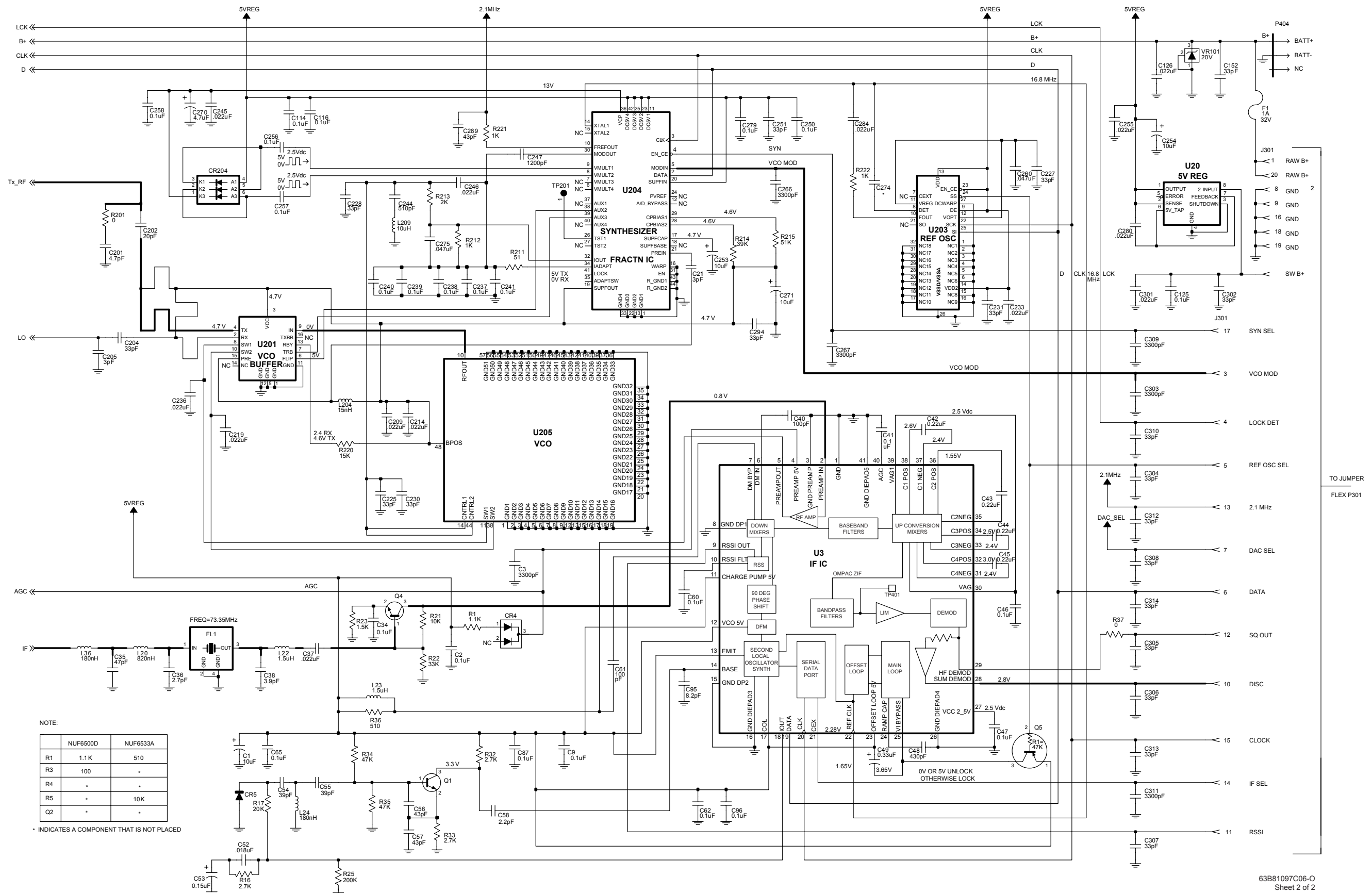
MAEPF-27152-O



NOTE:

	NUF6500D	NUF6533A
R1	1.1K	510
R3	100	.
R4	.	.
R5	.	10K
Q2	.	.

* INDICATES A COMPONENT THAT IS NOT PLACED

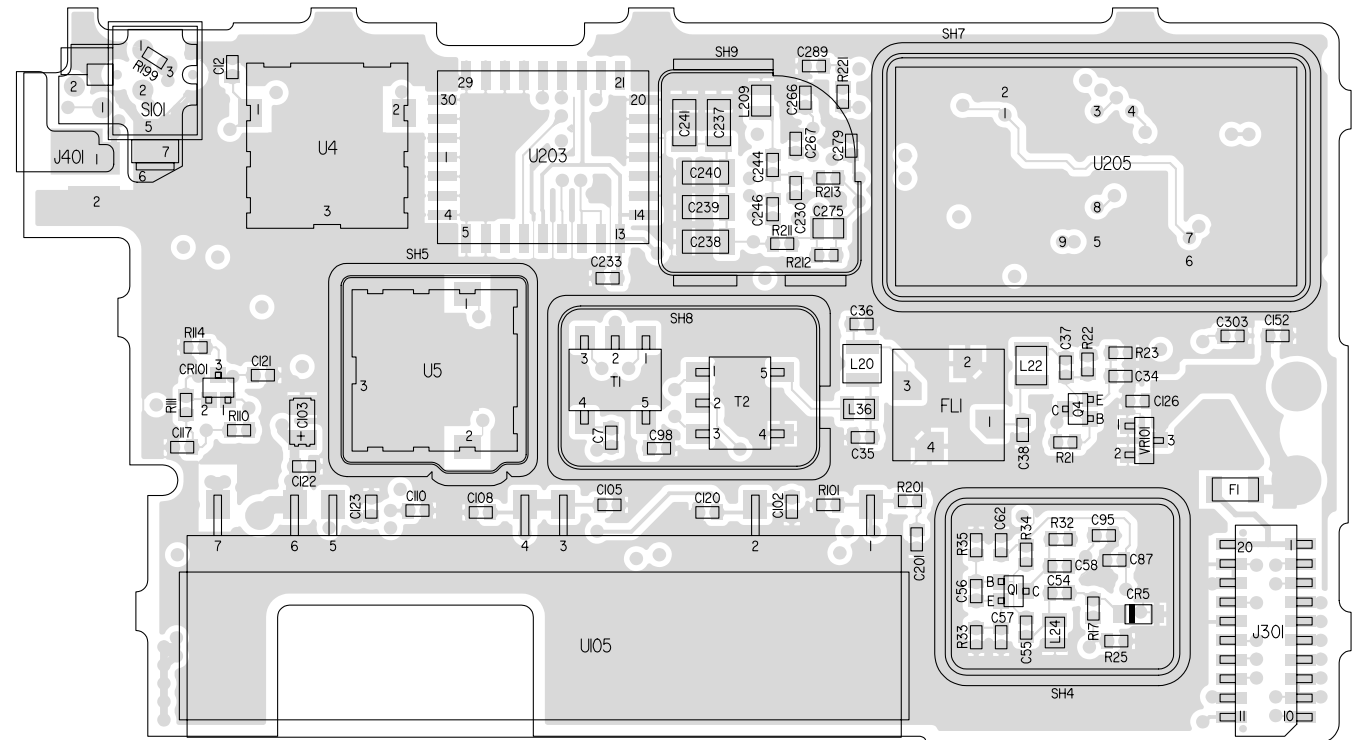


NOTE:

	NUF6500D	NUF6533A
R1	1.1K	510
R3	100	-
R4	-	-
R5	-	10K
Q2	-	-

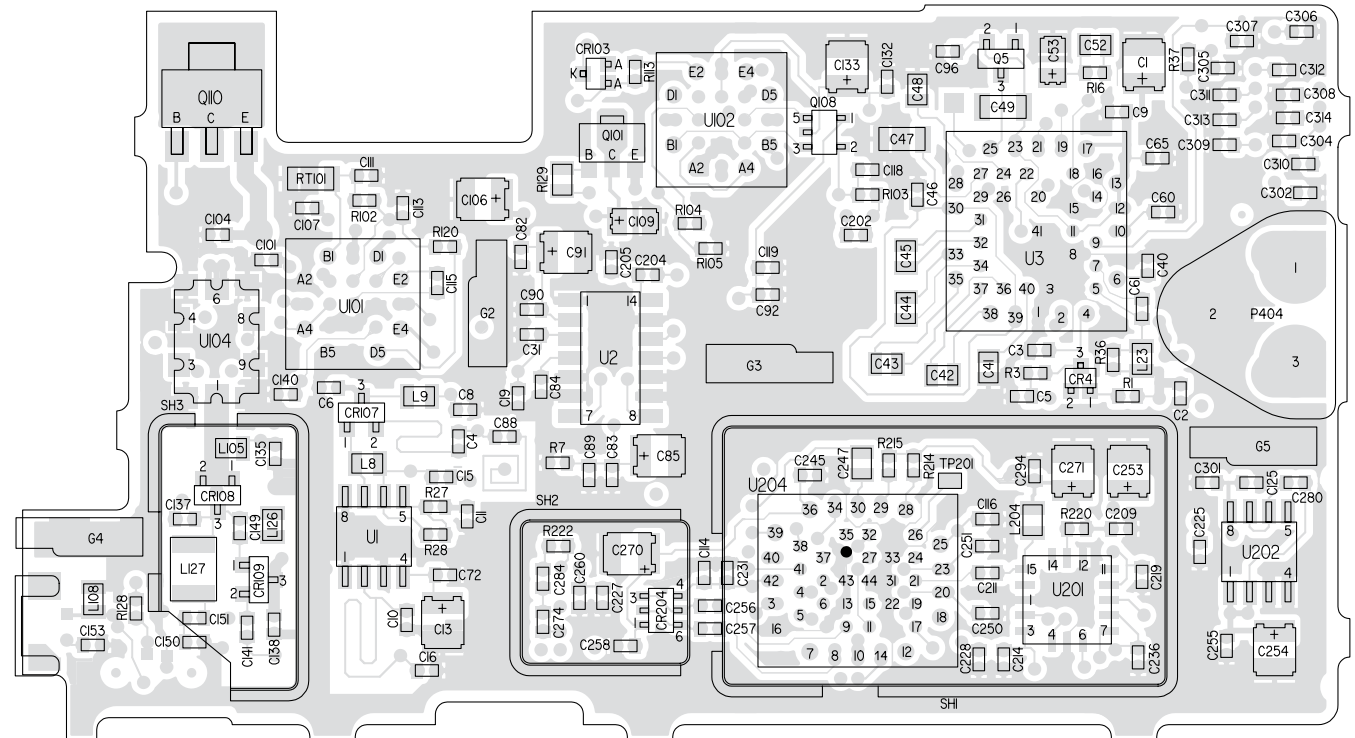
* INDICATES A COMPONENT THAT IS NOT PLACED

VIEWED FROM SIDE 1

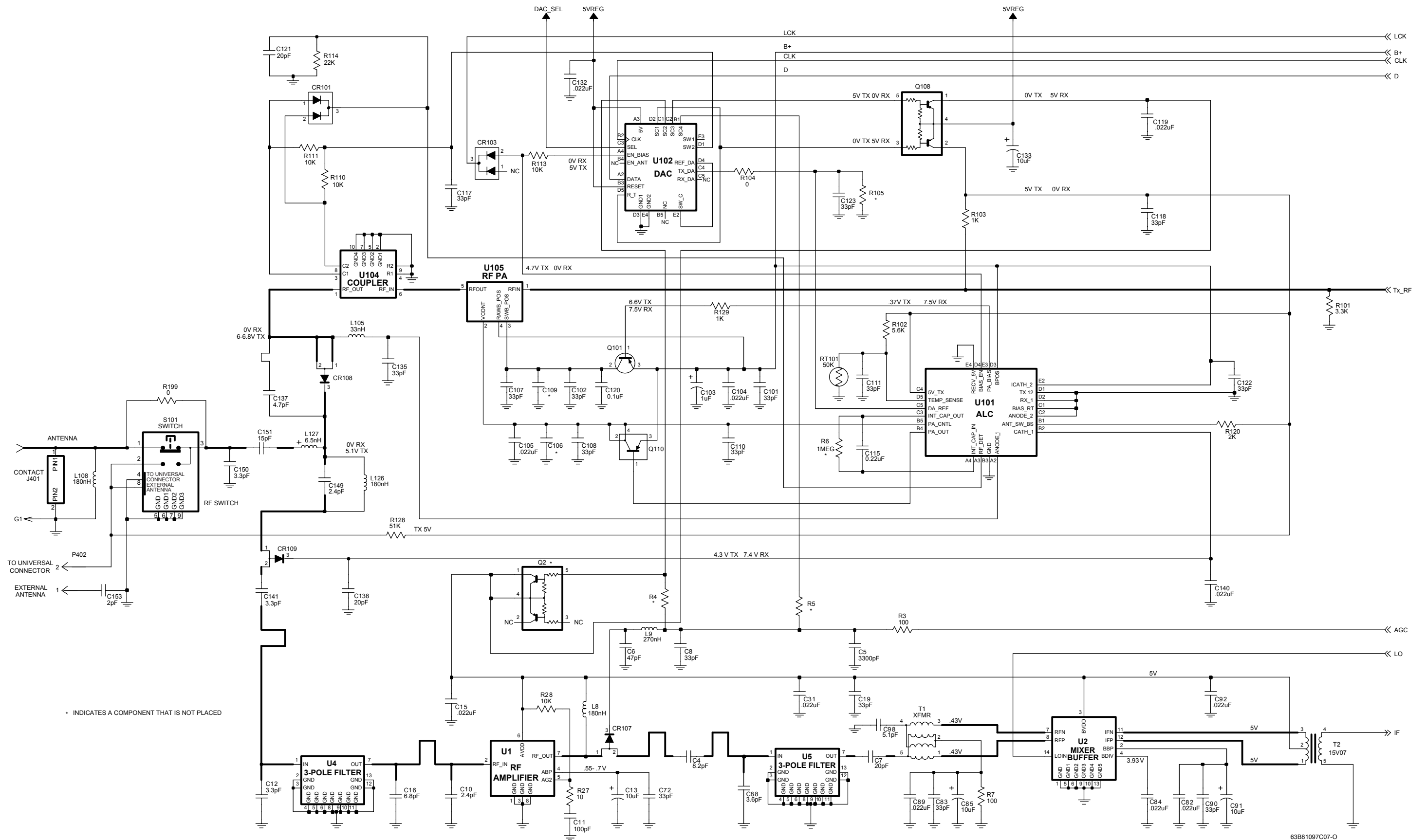


MAEPF-26304-O

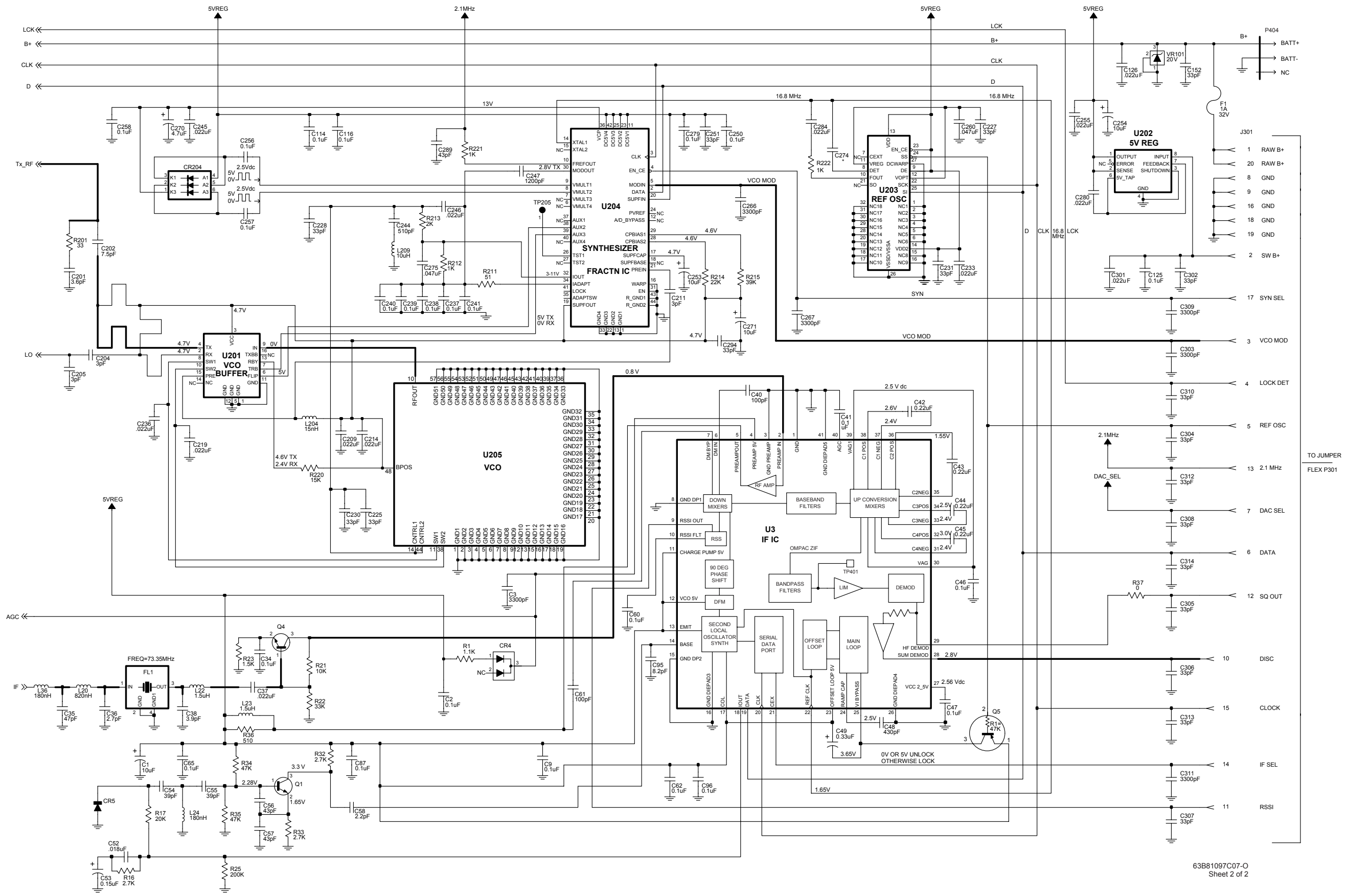
VIEWED FROM SIDE 2



MAEPF-26305-O



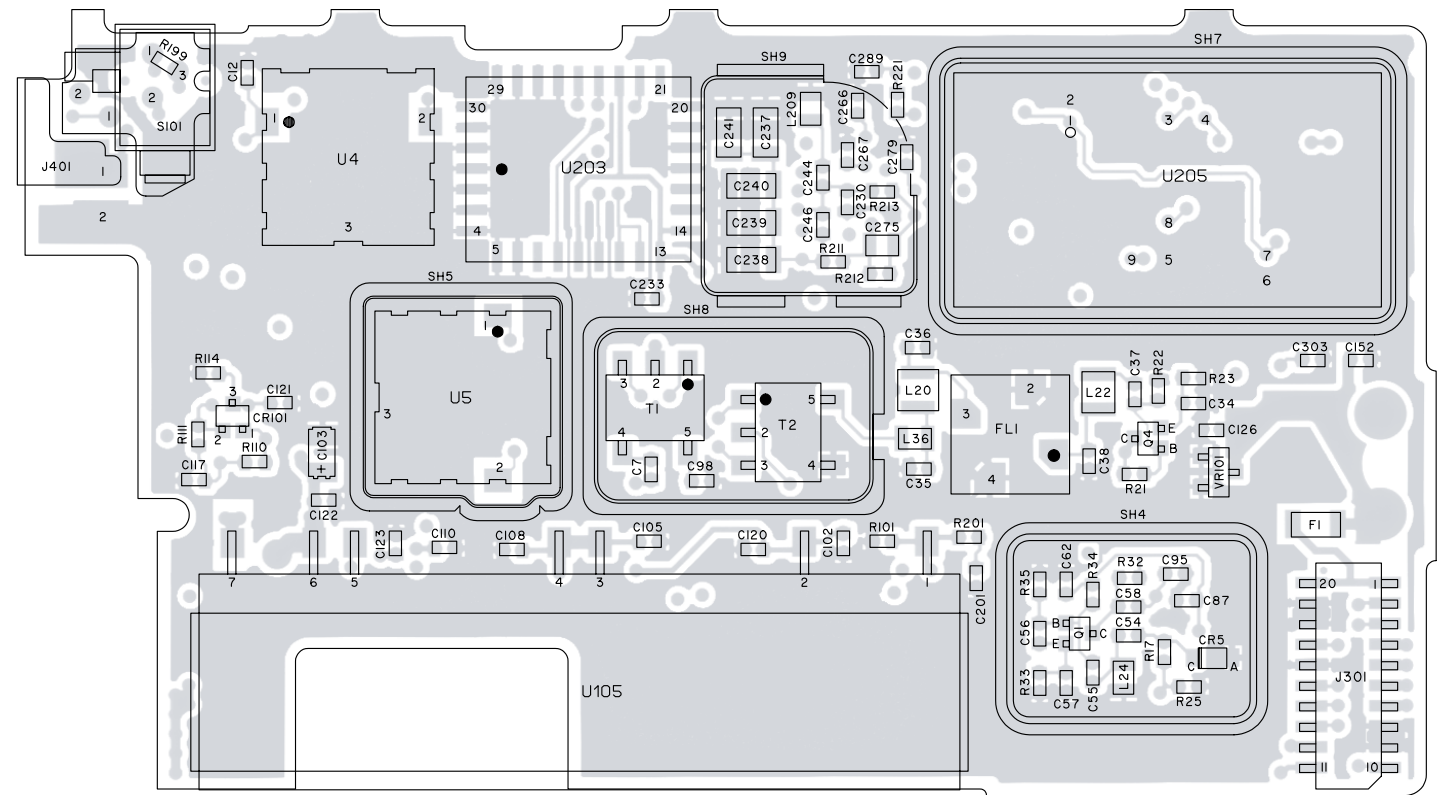
• INDICATES A COMPONENT THAT IS NOT PLACED



63B81097C07-0
Sheet 2 of 2

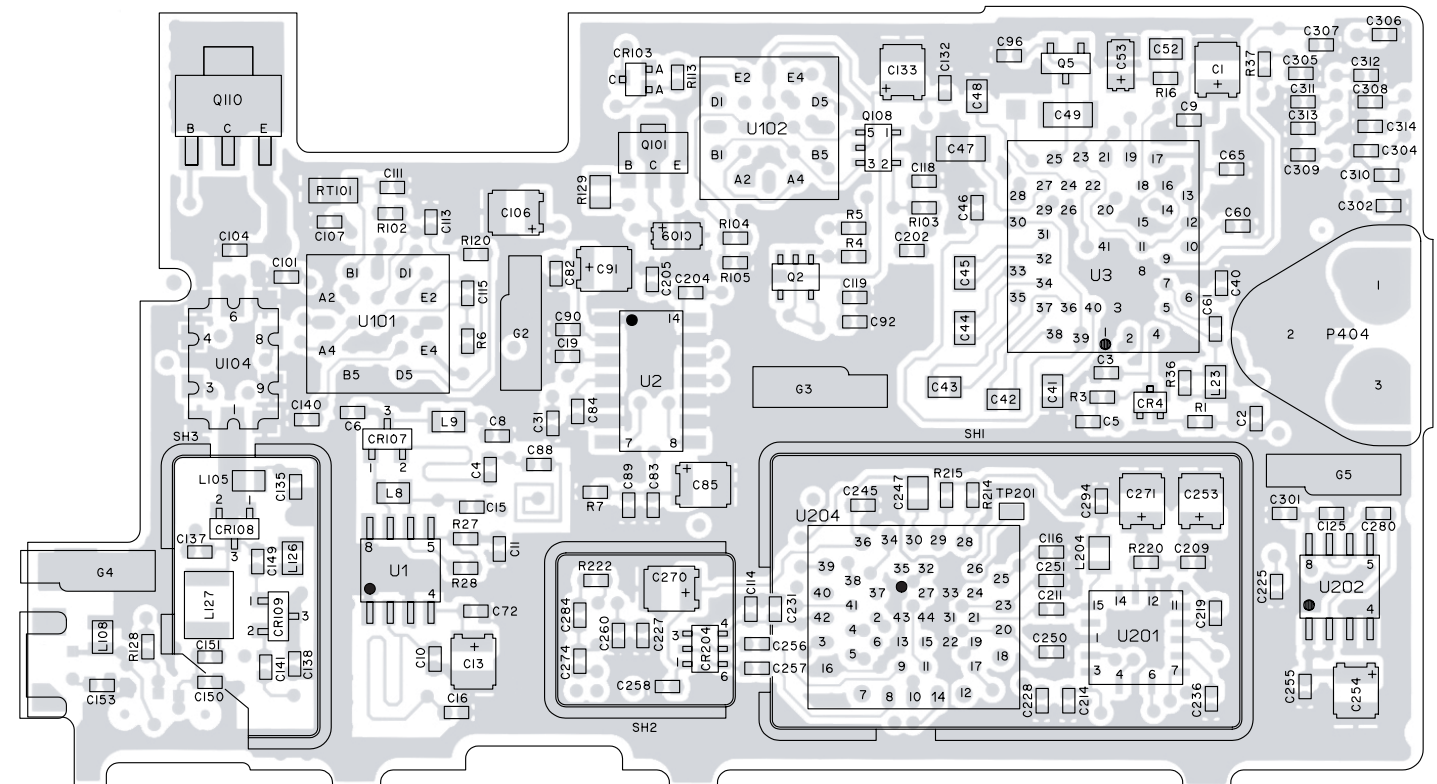
NUF6499B/C AND NUF6502B/C (900MHz)
TRANSCIEVER BOARDS' SCHEMATIC DIAGRAM (Sheet 2 of 2)

VIEWED FROM SIDE 1

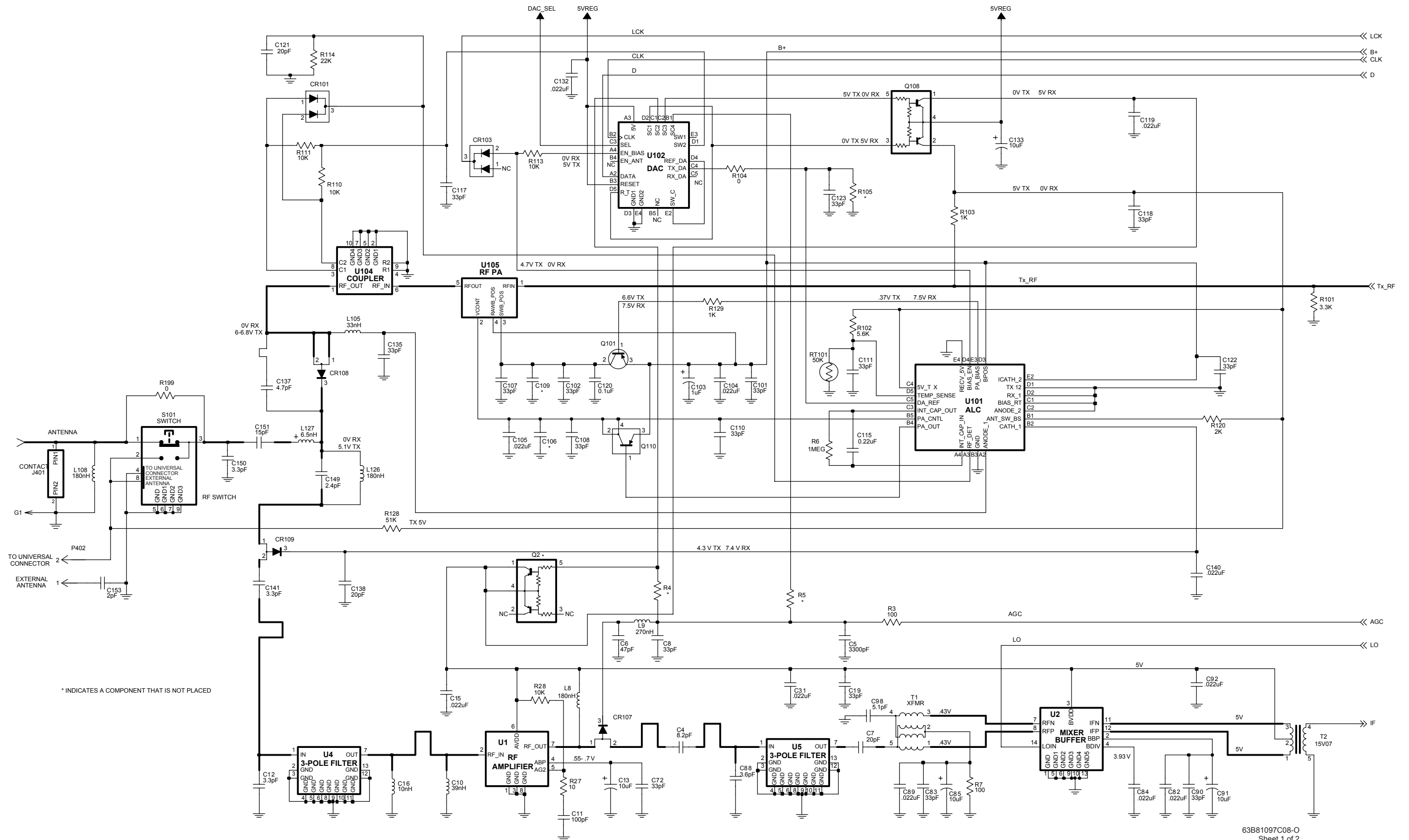


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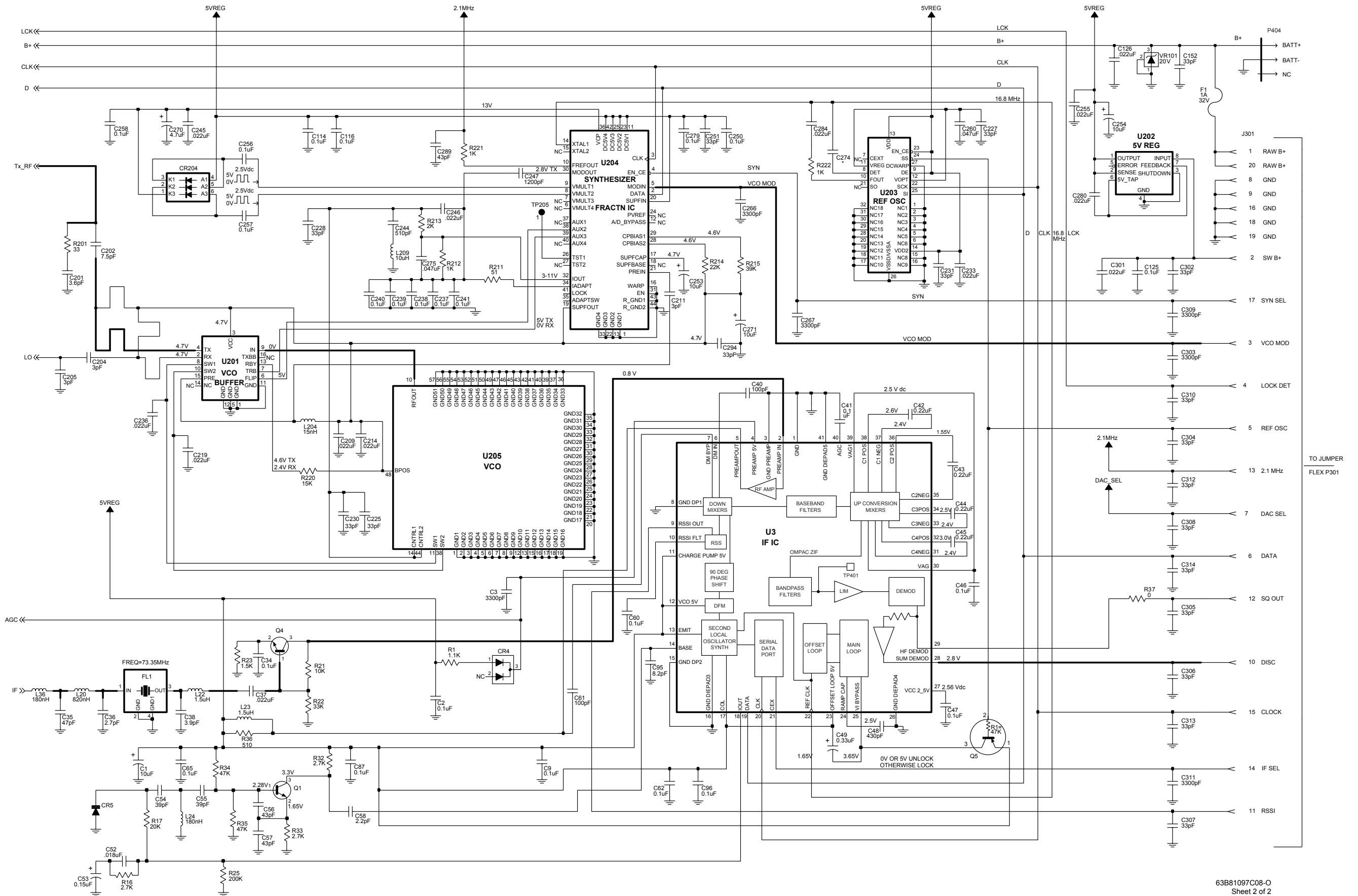
VIEWED FROM SIDE 2



MAEPF-27152-O

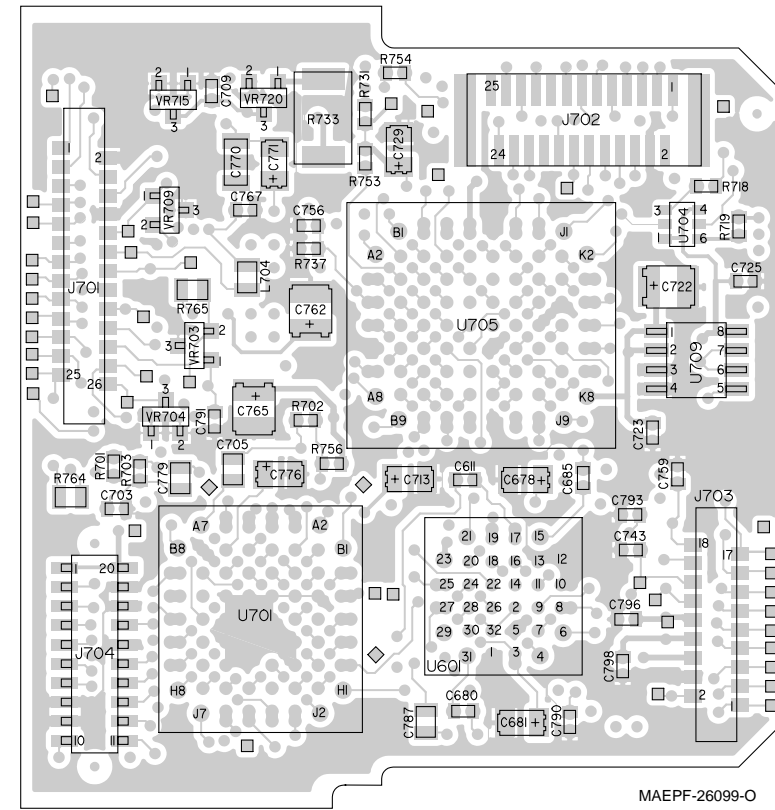


* INDICATES A COMPONENT THAT IS NOT PLACED

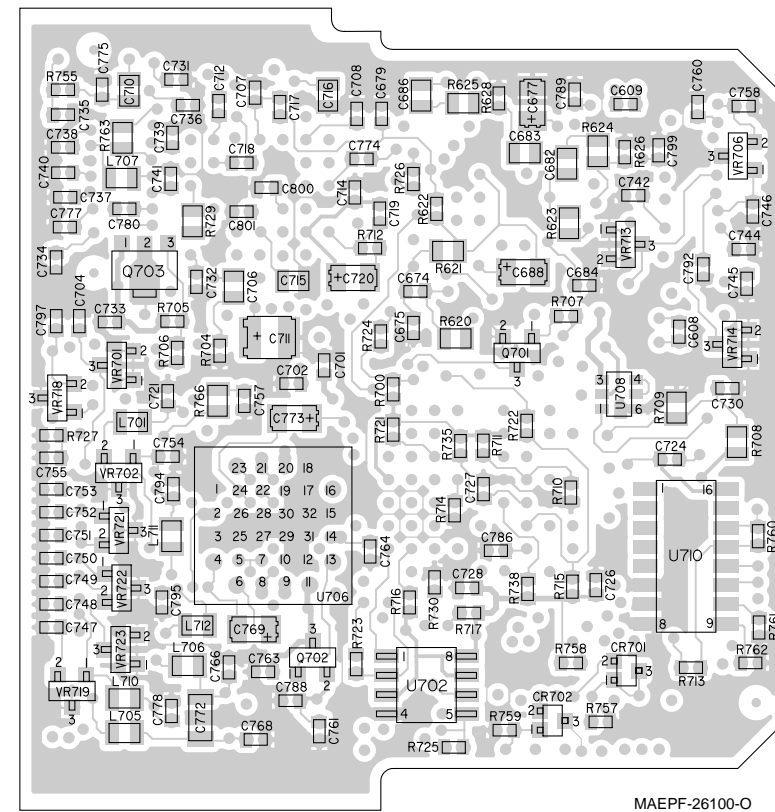


63B81097C08-O
Sheet 2 of 2

VIEWED FROM SIDE 1



VIEWED FROM SIDE 2



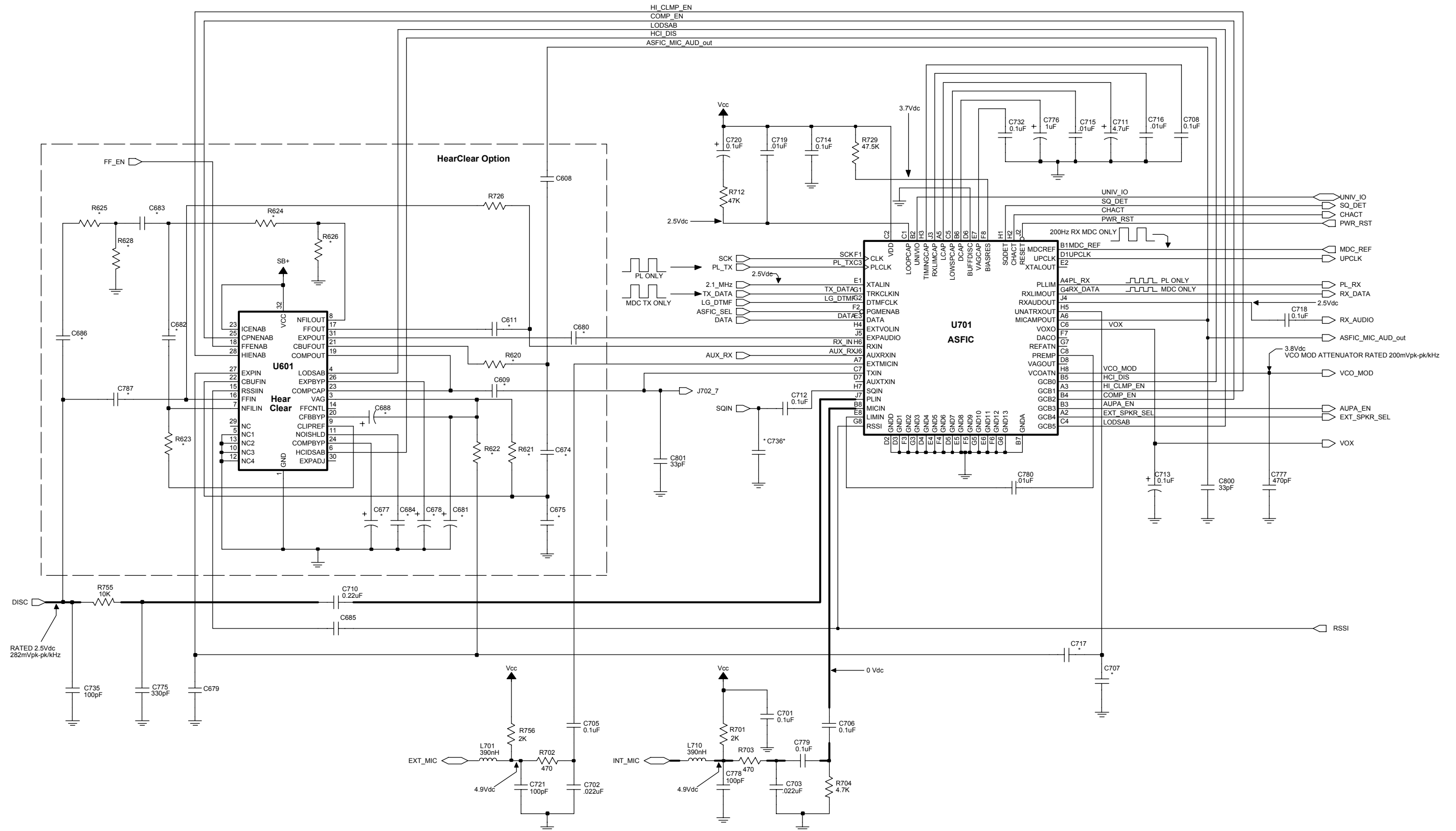
Electrical Parts List, Controller:
NCN6129C And NCN6138A (all HT 1000 Models)
NCN6140A/B (VHF HT 1000 Models)
NCN6141A (UHF HT 1000 Models)
NCN/PMCN6140C (all HT 1000 Models)
NCN6145A/C (800MHz HT 1000 Models)
NTN7089C And NCN6146A (JT 1000 Models)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, FIXED: pF ±5%; 50V unless stated
C608, 609, 611	-----	Not Placed
C674, 675	-----	Not Placed
C677 thru 686	-----	Not Placed
C688	-----	Not Placed
C701	2113932K15	.1µF 16V
C702, 703	2113932E07	.022µF 16V
C704	2113930F51	100pF
C705, 06	2113743A19	.1µF
C707	-----	Not Placed
C708	2113932K15	.1µF 16V
C709	2113930F51	100pF
C710	2113743A23	.22µF
C711	2311049J11	4.7µF 16V
C712	2113932K15	.1µF 16V
C713	2311049A01	.1µF 35V
C714	2113932K15	.1µF 16V
C715, 716	2113741A45	.01µF
C717	-----	Not Placed
C718	2113932K15	.1µF 16V
C719	2113931F49	.01µF
C720	2311049A01	.1µF 35V
C721	2113930F51	100pF
C722	2311049J23	10µF 6V
C723	2113932K15	.1µF 16V
C724	2113931F49	.01µF
C725	2113932K15	.1µF 16V
C726	-----	Not Placed
C727	2113932K15	.1µF 16V
C728	2113931F49	.01µF
C729	2311049A42	3.3µF 6V
C730	2113932K15	.1µF 16V
C731	2113930F51	100pF
C732	2113932K15	.1µF 16V
C733, 734, 735	2113930F51	100pF
C736	-----	Not Placed
C737 thru 746	2113930F51	100pF
C747 thru 754	-----	Not Placed
C755 thru 760	2113930F51	100pF
C761	2113931F49	.01µF
C762	2311049A57	10µF 16V
C763	2113931F49	.01µF
C764	2113931F41	4, 700pF
C765	2311049J11	4.7µF 16V
C766, 767, 768	2113930F51	100pF
C769	2311049A07	1µF 16V
C770	2113743B23	.33µF
C771	2311049A07	1µF 16V
C772	2113743B23	.33µF
C773	2311049A07	1µF 16V
C774	2113931F17	470pF
C775	2113931F13	330pF
C776	2311049A07	1µF 16V
C777	2113931F17	470pF
C778	2113930F51	100pF
C779	2113743A19	.1µF
C780	2113931F49	.01µF
C786	2113930F51	100pF
C787	-----	Not Placed
C788	2113931F25	1, 000pF
C789 thru 793	2113930F51	100pF
C794	2113931F13	330pF
C795	-----	Not Placed
C796 thru 799	2113930F51	100pF
C800, 801	2113930F39	33pF
		DIODE:
CR701, 702	4805218N57	Dual, See Note 1
		JACK:
J701	0905257V04	Connector, 26-pin; to P701
J702	0913915A11	Connector, 25-pin (HT 1000); J702 Not Placed on JT 1000
J703	0905257V03	Connector, 18-pin; to P703
J704	0905461X03	Connector, 20-contact; to P704

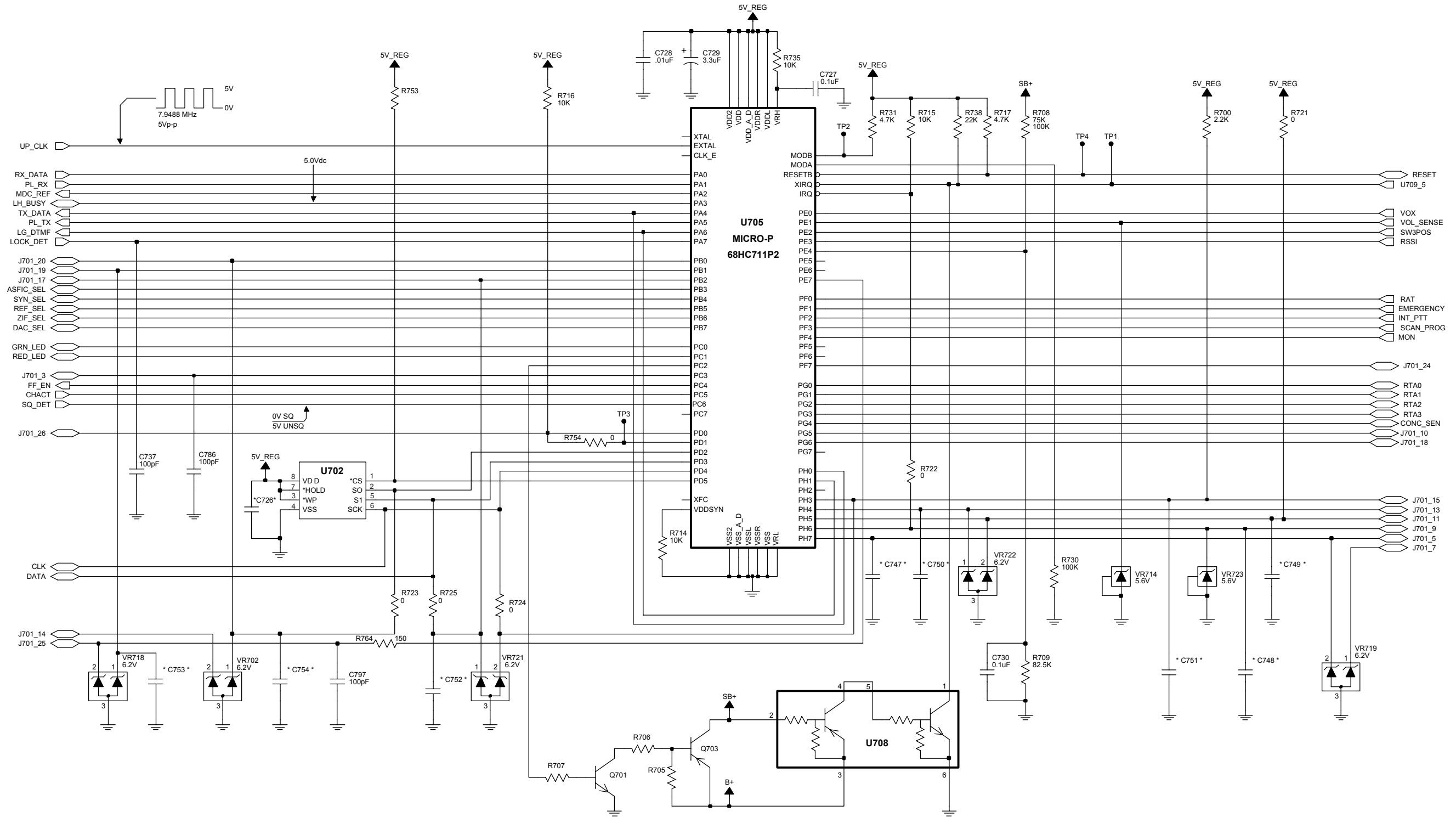
L701	2462587Q42	COIL, RF:
L704 thru 707	2462587Q42	.39µH
L710 thru 712	2462587Q42	.39µH
		TRANSISTOR: See Note 1
Q701	-----	Not Placed
Q702	4802245J04	PNP
Q703	-----	Not Placed
		RESISTOR, Fixed: Ω ± 5% .0625W Unless stated
R620 thru 626	-----	Not Placed
R628	-----	Not Placed
R700	0662057A57	2200Ω
R701	0662057A56	2000Ω
R702, 703	0662057A41	470Ω
R704	0662057A65	4700Ω
R705, 706, 707	-----	Not Placed
R708	0662057G07	75KΩ ± 1%; .1W (HT1000)
	0662057G13	100KΩ ± 1%; .1W (JT1000)
R709	0662057G08	82.5KΩ ± 1%; .1W
R710, 711, 712	0662057A89	47KΩ
R713	0662057A25	100Ω
R714, 715, 716	0662057A73	10KΩ
R717	0662057A65	4700Ω
R718, 719	0662057A29	150Ω
R721 thru 725	-----	Not Placed (HT1000)
	0662057B47	0 (JT1000)
R726	-----	Not Placed
R727	0662057A97	100KΩ
R729	0662057R92	47.5KΩ ± 1%; .1W
R730	0662057A97	100KΩ
R731	0662057A65	4700Ω
R733	0683962T45	68 5-1
R735, 737	0662057A73	10KΩ
R738	0662057A81	22KΩ
R753	-----	Not Placed
R754	0662057B47	0Ω ± .050Ω
R755	0662057A73	10KΩ
R756	0662057A56	2000Ω
R757	0662057A97	100KΩ
R758	0662057A97	100KΩ (HT1000)
		Not Placed (JT1000)
R759	0662057A97	100KΩ
R760	0662057B47	0 Ω ± .050Ω
R761, 762	0662057A97	100KΩ (HT1000)
		Not Placed (JT1000)
R763	0660076A41	470Ω
R764, 765, 766	0662057C55	150Ω
		MODULE: See Note 1
U601	-----	Not Placed
U701	5185765B33	Audio Signaling Filter
U702	-----	Not Placed
U704	4805921T07	NPN
U705	5105835U96	Microcomputer (NCN6146A)
	5105835U22	Microcomputer (NTN7089C)
	5105835U71	Microcomputer (NCN6129C, NCN6138A)
	5105835U85	Microcomputer (NCN6140A, NCN6141A, NCN6145A)
	5186296A10	Microcomputer (NCN6140B, NCN6141B, NCN6145B)
	5185765B31	Microcomputer (NCN6140C)
U706	5105835U49	Audio PA
U708	-----	Not Placed
U709	5105469E65	5V regulator
U710	5113806A20	Multiplexer (HT1000)
	-----	Not Placed (JT1000)
		DIODE, Zener:
VR701	4813830A15	5.6V
VR702, 703	4805117Y01	Dual, 6.2V
VR704	4813830A15	5.6V
VR706	4805117Y01	Dual, 6.2V
VR709	4805117Y01	Dual, 6.2V
VR713, 714	4813830A15	5.6V
VR715	4813830A28	15V
VR718, 719	4805117Y01	Dual, 6.2V
VR720	4813830A28	15V
VR721, 722	4805117Y01	Dual, 6.2V
VR723	4813830A15	5.6V

Notes:

1. For optimum performance, order replacement diodes, transistors, and circuit modules by Motorola part number only.
2. When ordering crystals, specify carrier frequency, crystal frequency, crystal type number, and Motorola part number.
3. "Not Placed" means that components are for future use, and are not placed on the circuit board at this time.

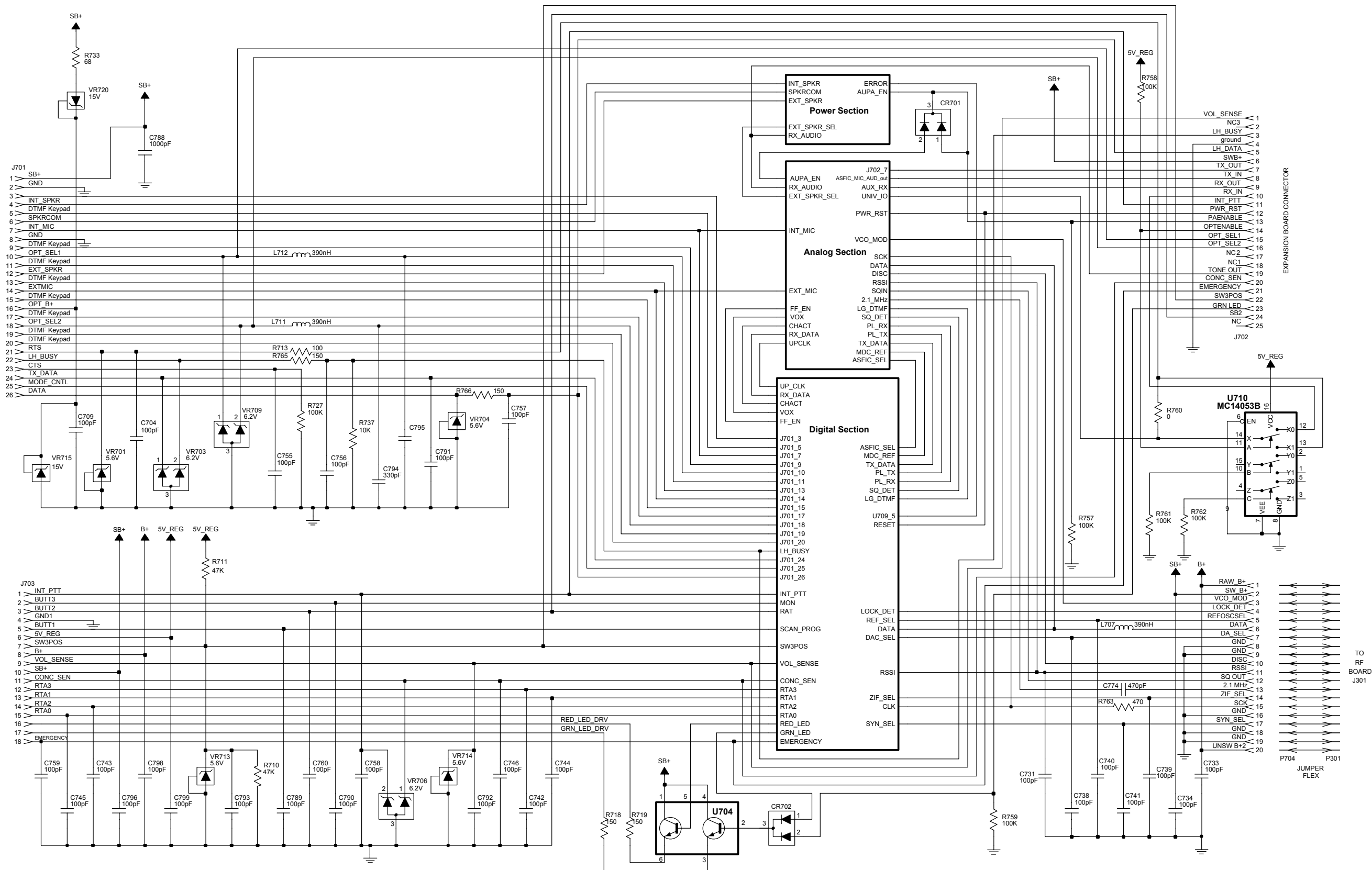


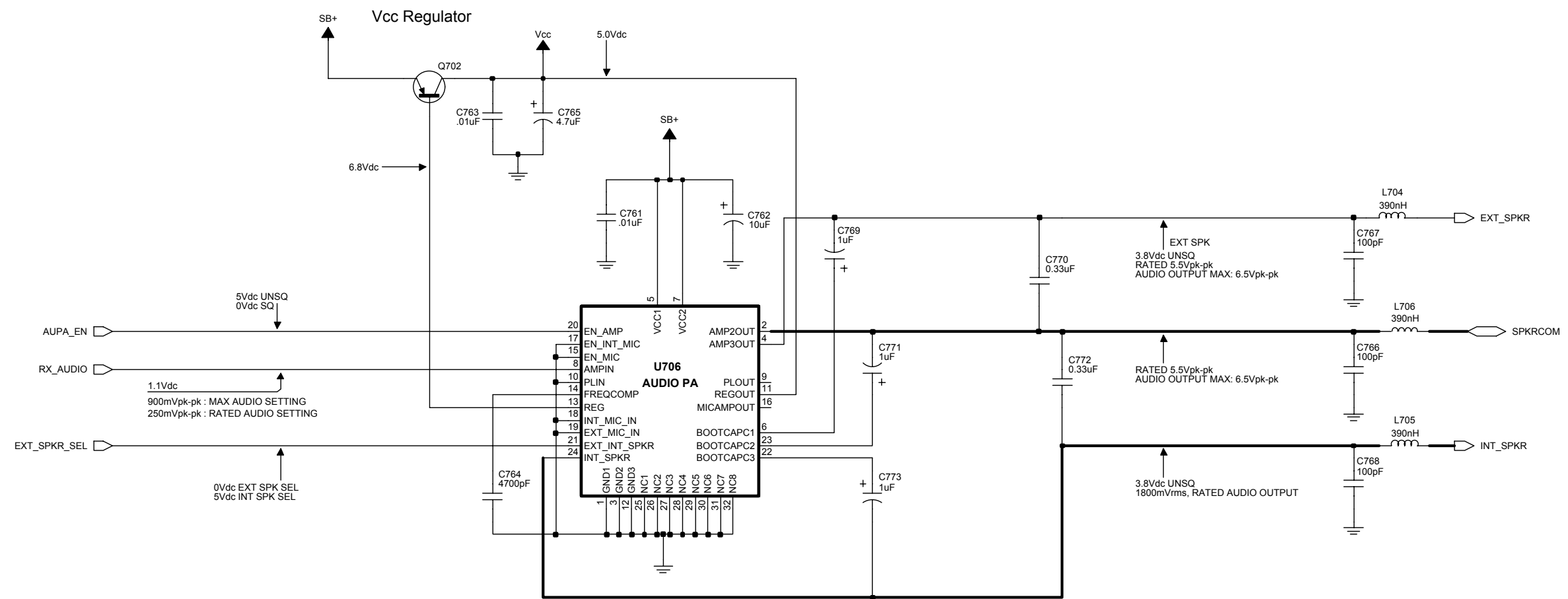
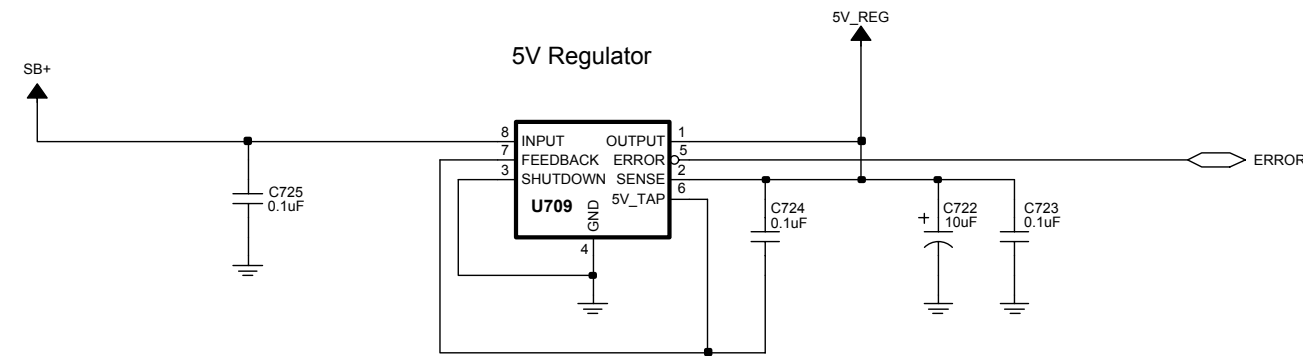
63B81097C09-O



63B81097C10-O

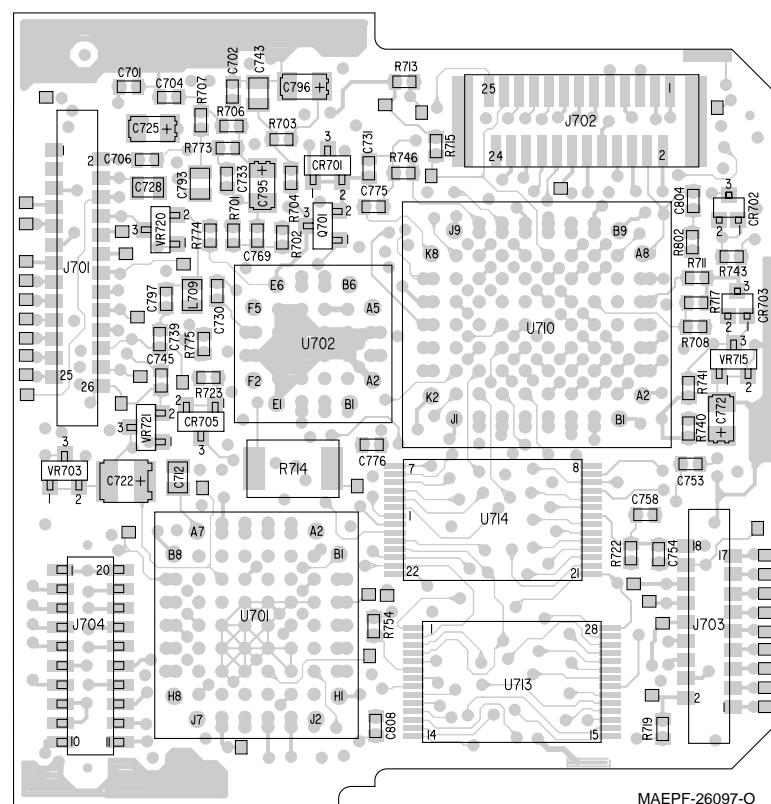
NCN6129C, NCN6138A, NCN6140A/B, NCN/PMCN6140C, NCN6141A, NCN6145A/C, NCN6146A, NTN7089C
CONTROLLER BOARD DIGITAL SECTION SCHEMATIC DIAGRAM



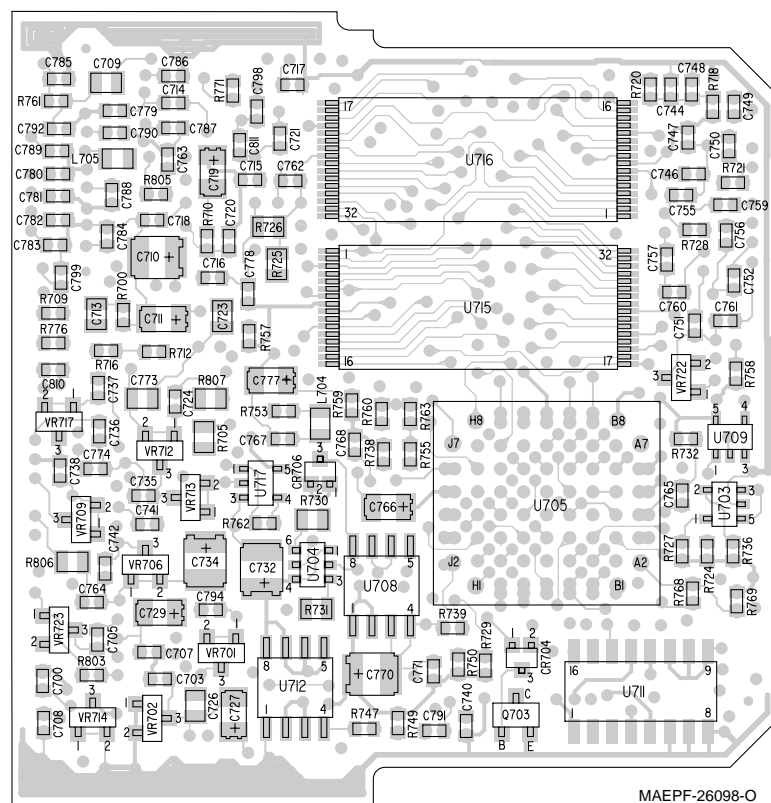


63B81097C12-O

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Electrical Parts List, Controllers
 NCN6147A/B, NCN6150A/B, NTN7091D, NTN7620E,
 PMCN6147B, PMCN6150B

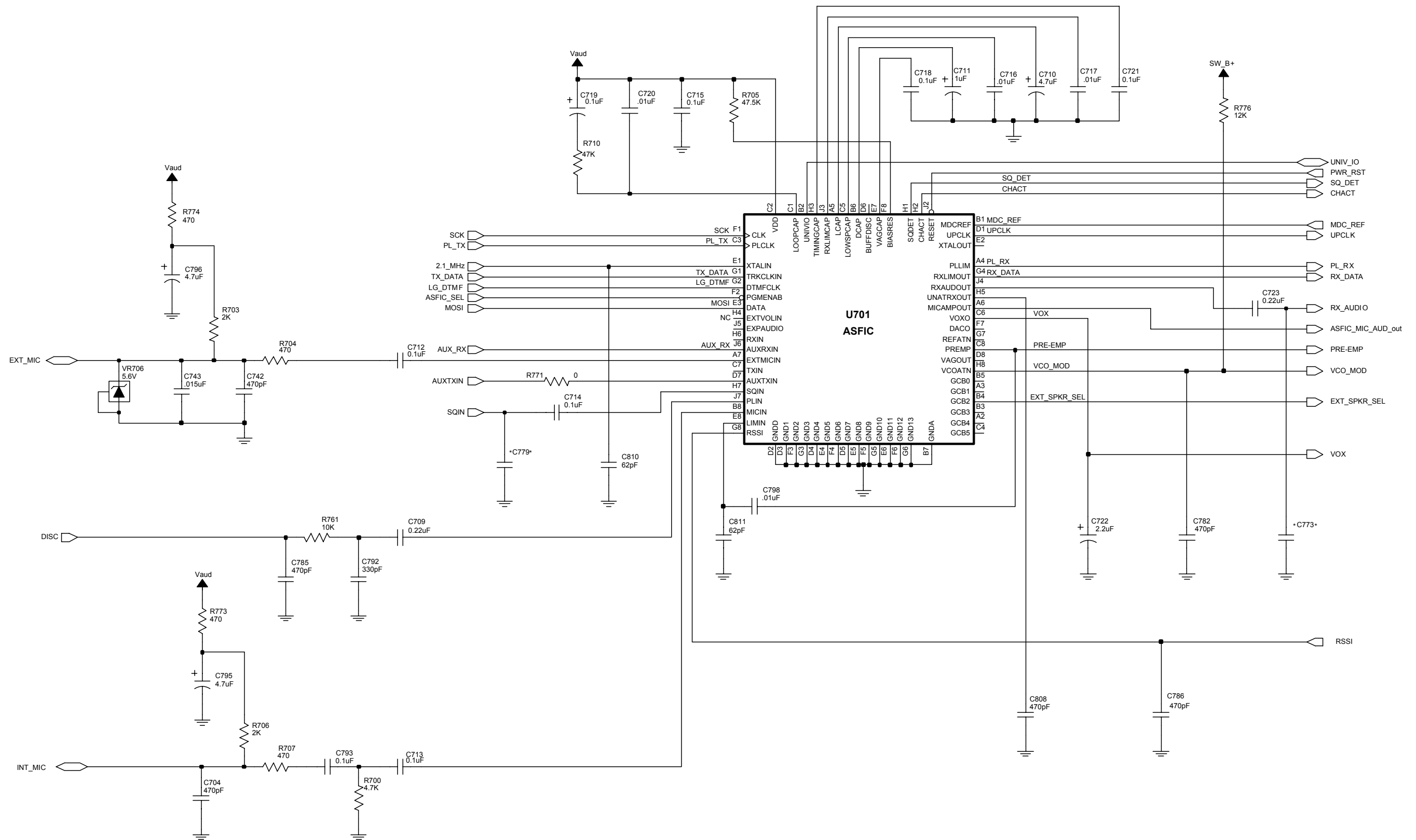
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, Fixed: pF ± 5%; 50V unless stated
C700 thru C708	2113931F17	470pF
C709	2113743A23	0.22µF
C710	2311049J11	4.7µF
C711	2311049A07	1µF
C712, C713	2113743A19	0.1µF
C714, C715	2113932K15	0.1µF
C716, C717	2113931F49	10nF
C718	2113932K15	0.1µF
C719	2311049A01	0.1µF
C720	2113931F49	10nF
C721	2113932K15	0.1µF
C722	2311049A09	2.2µF
C723	2113743A23	0.22µF
C724	2113930F44	51
C725	2311049A07	1µF
C726	2113743F12	0.33µF
C727	2311049A07	1µF
C728	2113743F12	0.33µF
C729	2311049A07	1µF
C730	2113931F41	4700
C731	2113932K15	0.1µF
C732	2311049A57	10µF
C733	2113932K15	0.1µF
C734	2311049J23	10µF
C735 thru C738	2113931F17	470pF
C739	2113930F39	33
C740 thru C742	2113931F17	470pF
C743	2113741A49	15nF
C744	2113931F49	10nF
C745	2113930F39	33
C746 thru C757	2113931F17	470pF
C758	2113932K15	0.1µF
C759 thru C761	2113931F17	470pF
C762	2113932K15	0.1µF
C763	2113930F36	24
C764	2113930F44	51
C765	2113932K15	0.1µF
C766	2311049A42	3.3µF
C767	2113932K15	0.1µF
C768	2113931F13	330
C769	2113931F17	470pF
C770	2311049J23	10µF
C771	2113932K15	0.1µF
C772	2311049A42	3.3µF
C773	-----	Not Placed
C774, C775	2113931F17	470pF
C776	2113932K15	0.1µF
C777	2311049A07	1µF
C778	2113932K15	0.1µF
C779	-----	Not Placed
C780 thru C786	2113931F17	470pF
C787	2113930F39	33
C788 thru C790	2113931F17	470pF
C791	2113931F20	620
C792	2113931F13	330
C793	2113743A19	0.1µF
C794	2113932K15	0.1µF
C795, C796	2311049A56	4.7µF
C797	2113930F51	100
C798	2113931F49	10nF
C799	2113930F39	33
C804	2113931F41	4700
C808	2113931F17	470pF
C810	2113930F46	62
C811	2113931F17	470pF
CR701	4813825A05	DIODE: Schottky
CR702 thru CR704	4805218N57	Dual
CR705	4813833C02	Dual
CR706	4805218N57	Dual
J701	0905257V04	JACK: Connector, 26-pin; to P701 on Front Cover Display Flex
J702	0913915A11	Connector, 25-pin (NCN/PMCN6150A/B and NTN7620E)
	-----	Not Placed (NCN/PMCN6147B and NTN7091D)

J703	0905257V03	Connector, 18-pin; to P703 on Controls Flex
J704	0905461X03	Connector, 20 contacts; to P704 Strip Connector
L704	2462587Q40	COIL, RF: 270nH
L705	2462587Q40	270nH (NCN/PMCN6150A/B and NTN7620E)
	0660076A41	470Ω resistor (NCN/PMCN6147B and NTN7091D)
L709	2462587Q40	IND CHIP 270nH 10%
Q701	4805128M40	TRANSISTOR: TSTR BCW61BB LH 48G26
Q703	4880048M01	TSTR NPN DIG 47K/47K
		RESISTOR, FIXED: Ω ± 5%; 0.0625W unless stated
R700	0662057A65	4.7k
R701	0662057A56	2.0k
R702	0662057A81	22k
R703	0662057A56	2.0k
R704	0662057A41	470
R705	0662057R92	47.5k
R706	0662057A56	2.0k
R707	0662057A41	470
R708	0662057A56	2.0k
R709	0662057A41	470
R710	0662057A89	47k
R711	0662057A97	100k
R712	0662057A56	2.0k
R713	0662057A81	22k
R714	0683962T45	68
R715	0662057A97	100k
R716, R717	0662057A81	22k
R718	0662057A97	100k
R719	0662057B02	150k
R720 thru R724	0662057A89	47k
R725	0662057G07	75k 1%
R726	0662057G08	82.5k 1%
R727	0662057A81	22k
R728, R729	0662057A89	47k
R730, R731	0662057C55	150
R732	0662057A73	10k
R736, R738	0662057A81	22k
R739	0662057A73	10k
R740, R741	0662057A81	22k
R743	0662057A73	10k
R746	0662057A97	100k
R747	0662057B02	150k
R749	0662057A73	10k
R750	0662057A97	100k
R753	-----	Not Placed
R754	0662057B47	0
R755	-----	Not Placed
R757	0662057A81	22k
R758	0662057A97	100k
R759	0662057A81	22k
R760	0662057B47	0
R761	0662057A73	10k
R762	0662057B47	0
R763	-----	Not Placed
R768	-----	Not Placed (NCN/PMCN6150B and NTN7620E)
	0662057A81	22k (NCN/PMCN6147B and NTN7091D)
R769	0662057A81	22k (NCN/PMCN6150A/B and NTN7620E)
	-----	Not Placed (NCN/PMCN6147B and NTN7091D)
R771	0662057B47	0
R773, 774	0662057A41	470
R775	0662057A29	150
R776	-----	Not Placed
R802, R803	0662057A56	2.0k
R805	0662057A41	470
R806, R807	0660076A29	150
		MODULE:
U701	5185765B33	ASFIC
U702	5105835U49	Audio PA
U703	4805921T09	Dual Transistor
U704	4805921T07	Transistor, NPN
U705	5185765B32	Microcomputer 68HC11F1
U708	5105469E65	SV Regulator
U709	5105750U28	Mux

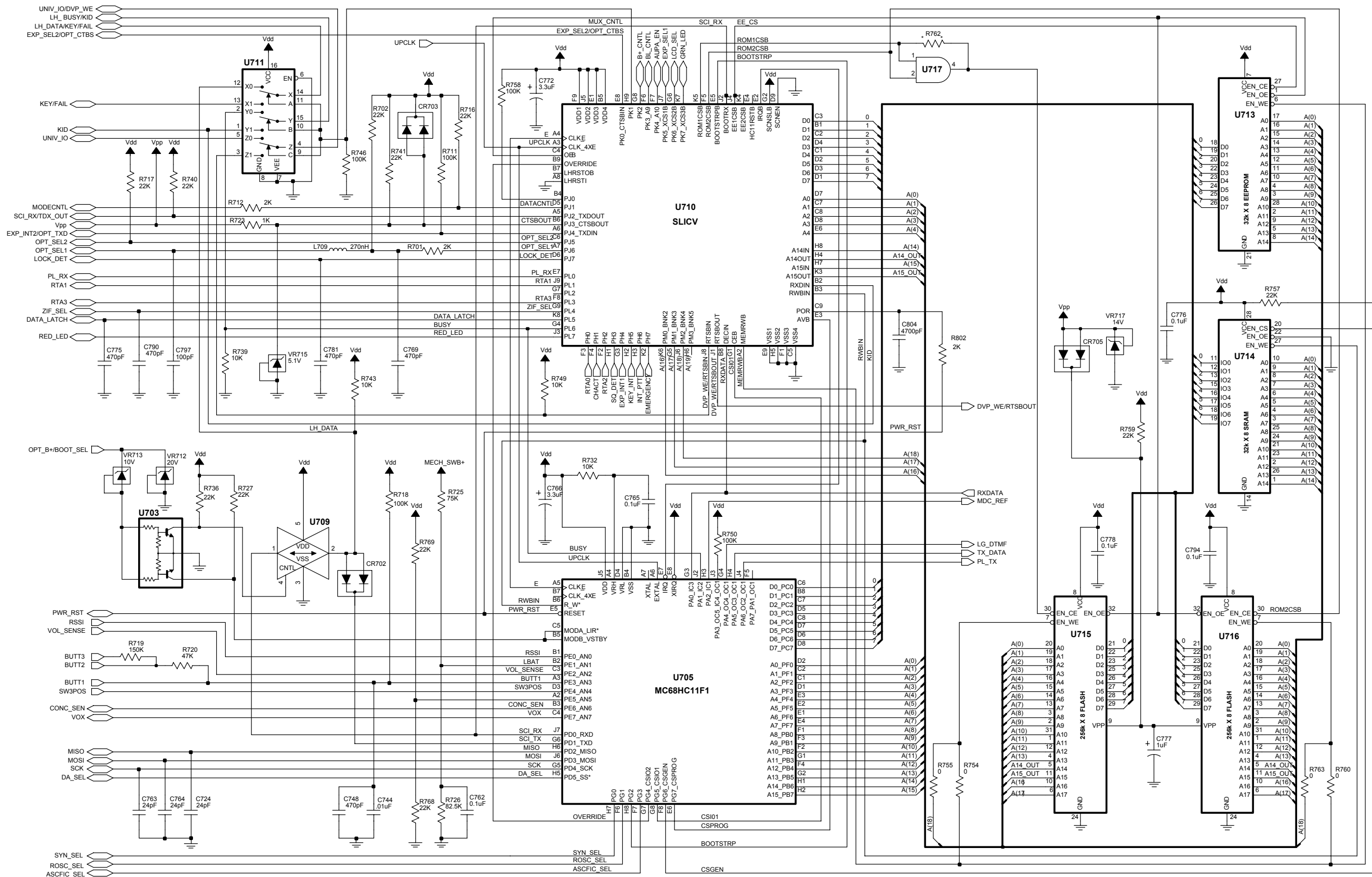
U710	5185765B30	SLIC V
U711	5113806A20	Multiplexer
U712	4805718V01	Transistor, NPN
U713	5105109Z72	EEPROM
U714	5185748L01	SRAM
U715	5105625U84	256k X 8 FLASH
U716	5105625U84	256k X 8 FLASH (NCN/PMCN6150A/B and NTN7620E)
	-----	Not Placed (NCN/PMCN6147B and NTN7091D)
U717	-----	Not Placed
		DIODE, Zener:
VR701, VR702	4813830A23	10V
VR703	4813830A18	6.8V
VR706, VR709	4813830A15	5.6V
VR712	4813830A33	20V
VR713	4813830A23	10V
VR714	4813830A18	6.8V
VR715	4813830A14	5.1V
VR717	4813830A27	14V
VR720 thru VR723	4805117Y01	6.2V

Notes:

- For optimum performance, order replacement diodes, transistors, and circuit modules by Motorola part number only.
- When ordering crystals, specify carrier frequency, crystal frequency, crystal type number, and Motorola part number.
- "Not Placed" means that components are for future use, and are not placed on the circuit board at this time.

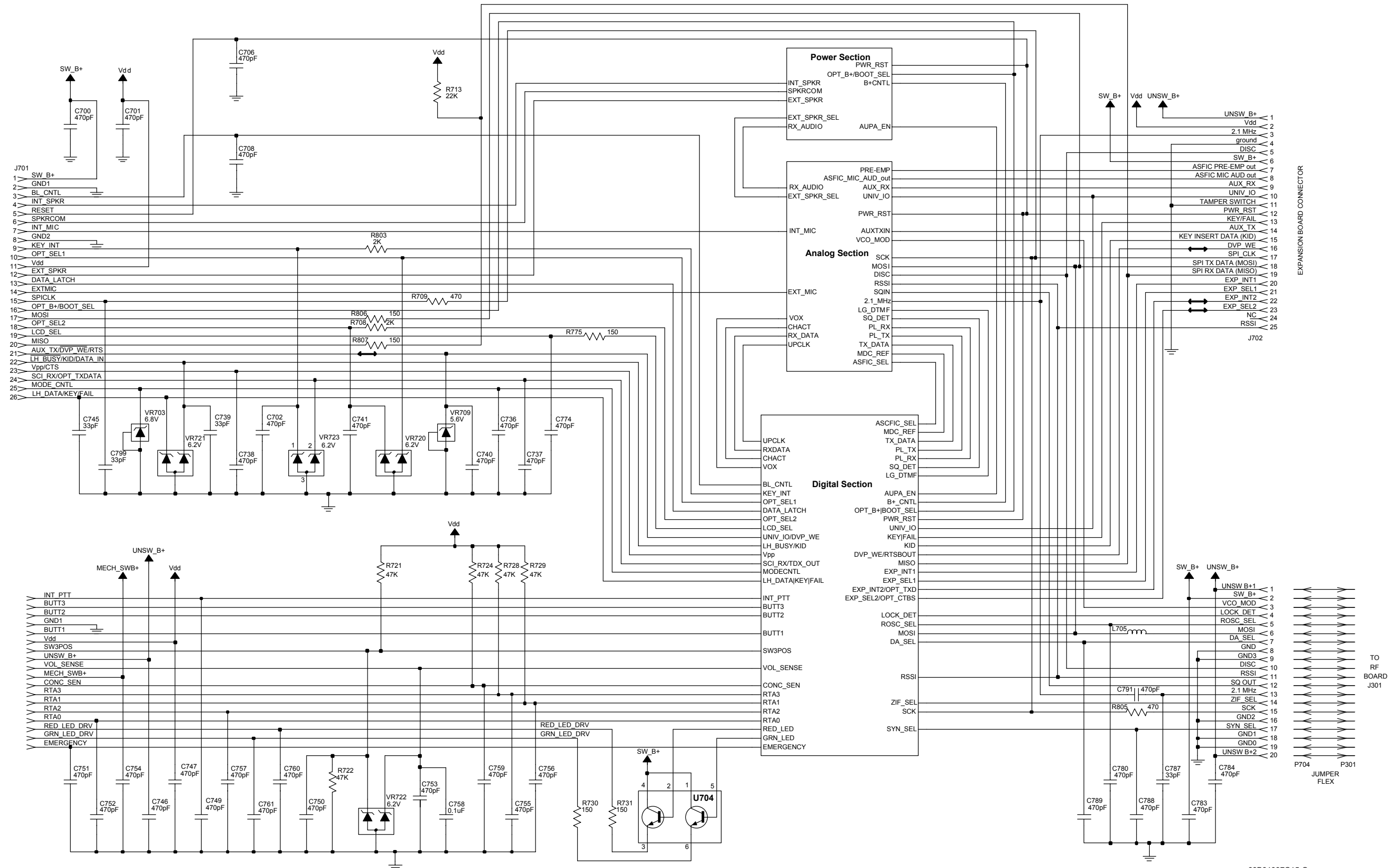


63B81097C13-O

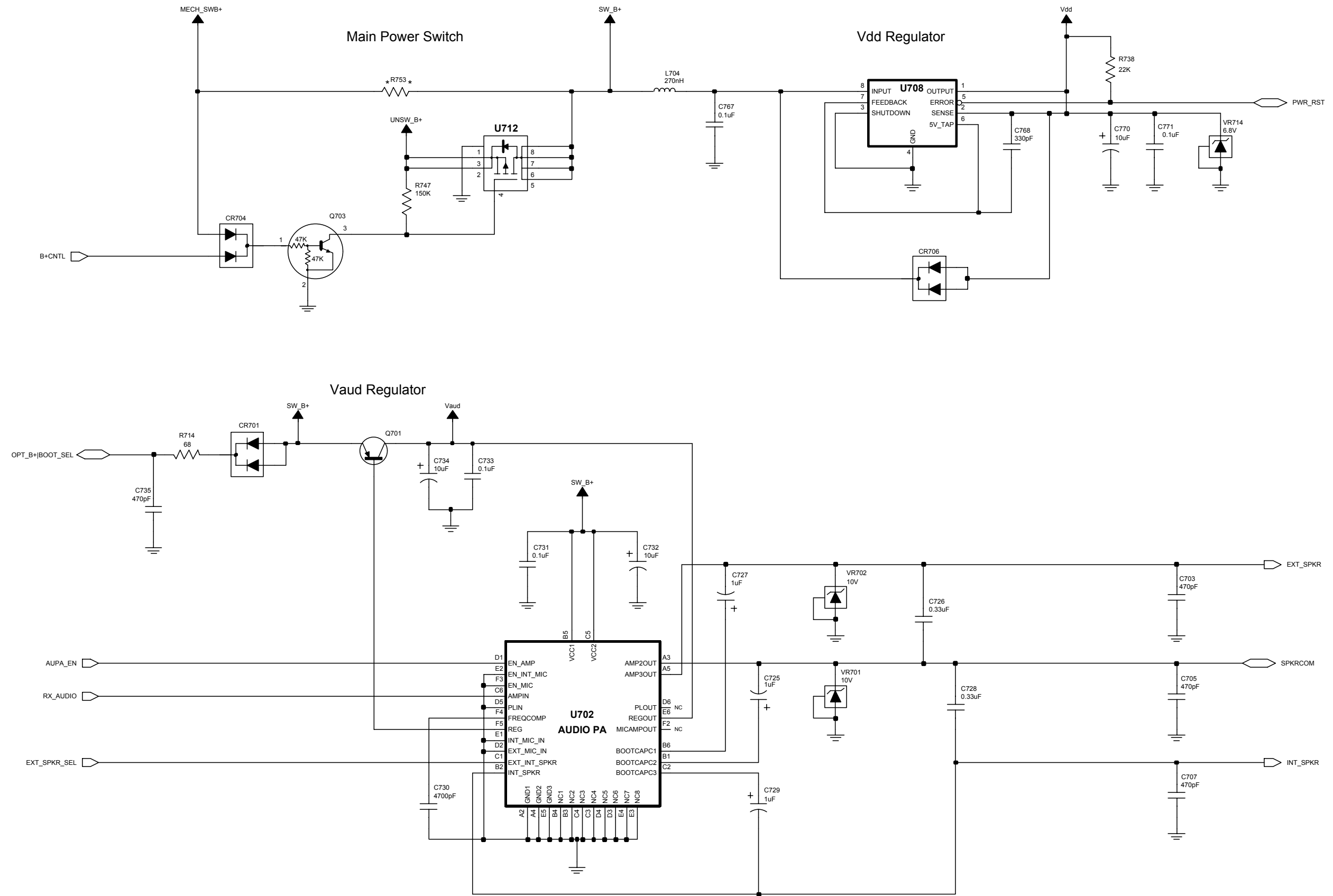


63B81097C14-0

NCN6147A/B, NCN6150A/B, NTN7091D, NTN7620E, PMCN6147B AND PMCN6150B
CONTROLLER BOARD DIGITAL SECTION SCHEMATIC DIAGRAM

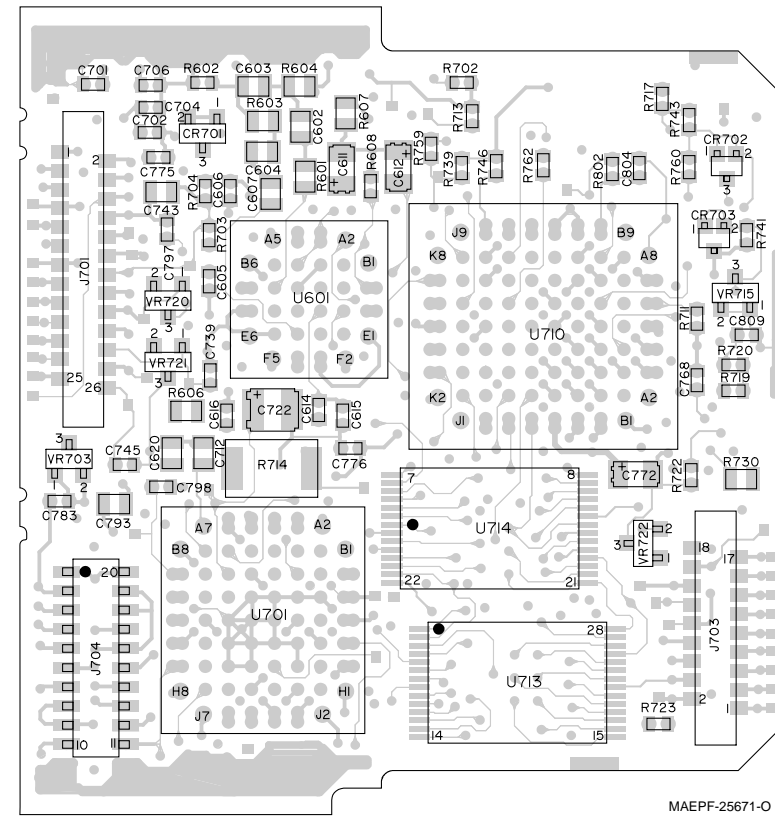


63B81097C15-0

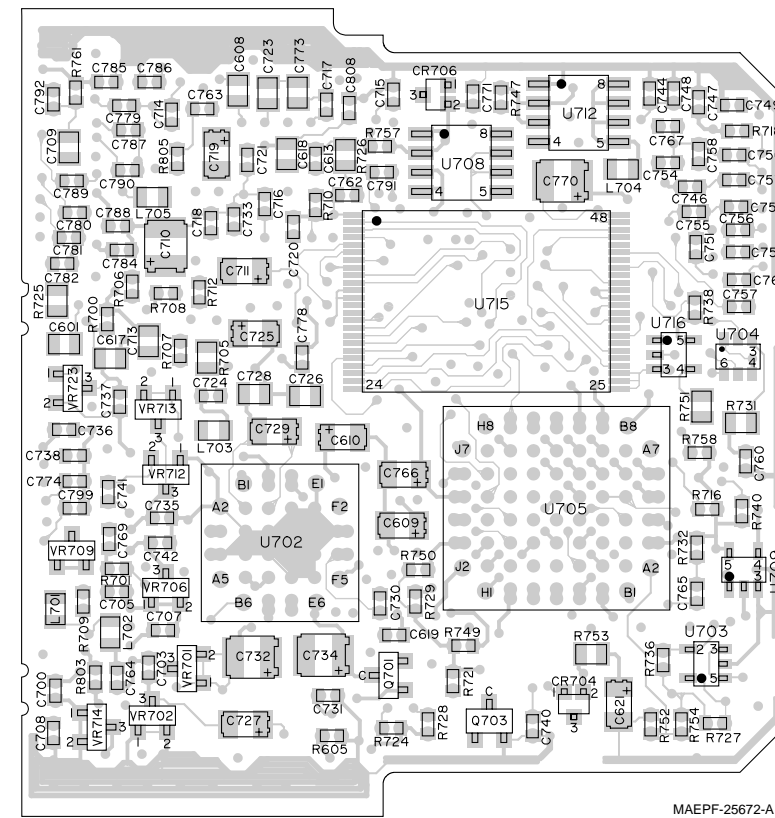


63B81097C16-0

VIEWED FROM SIDE 1



VIEWED FROM SIDE 2



Electrical Parts List, Controllers

NTN7512D/E Front Display VHF, UHF and 800MHz Radios

NTN7513E Front Display 900MHz Hear Clear Radios

NTN7857D/E Top/No Display VHF, UHF and 800MHz Radios

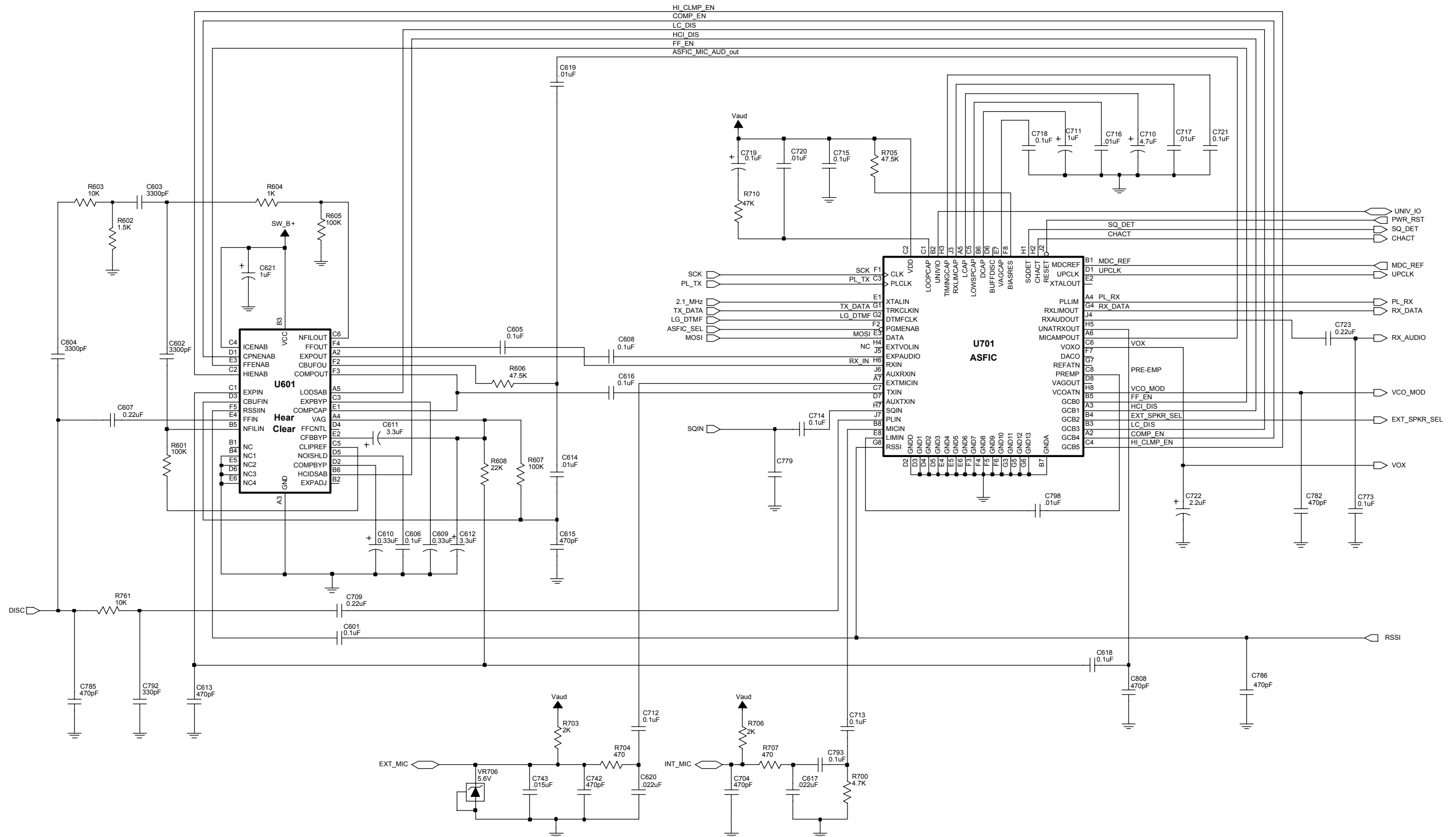
NTN7858D/E Top/No Display 900MHz Hear Clear Radios

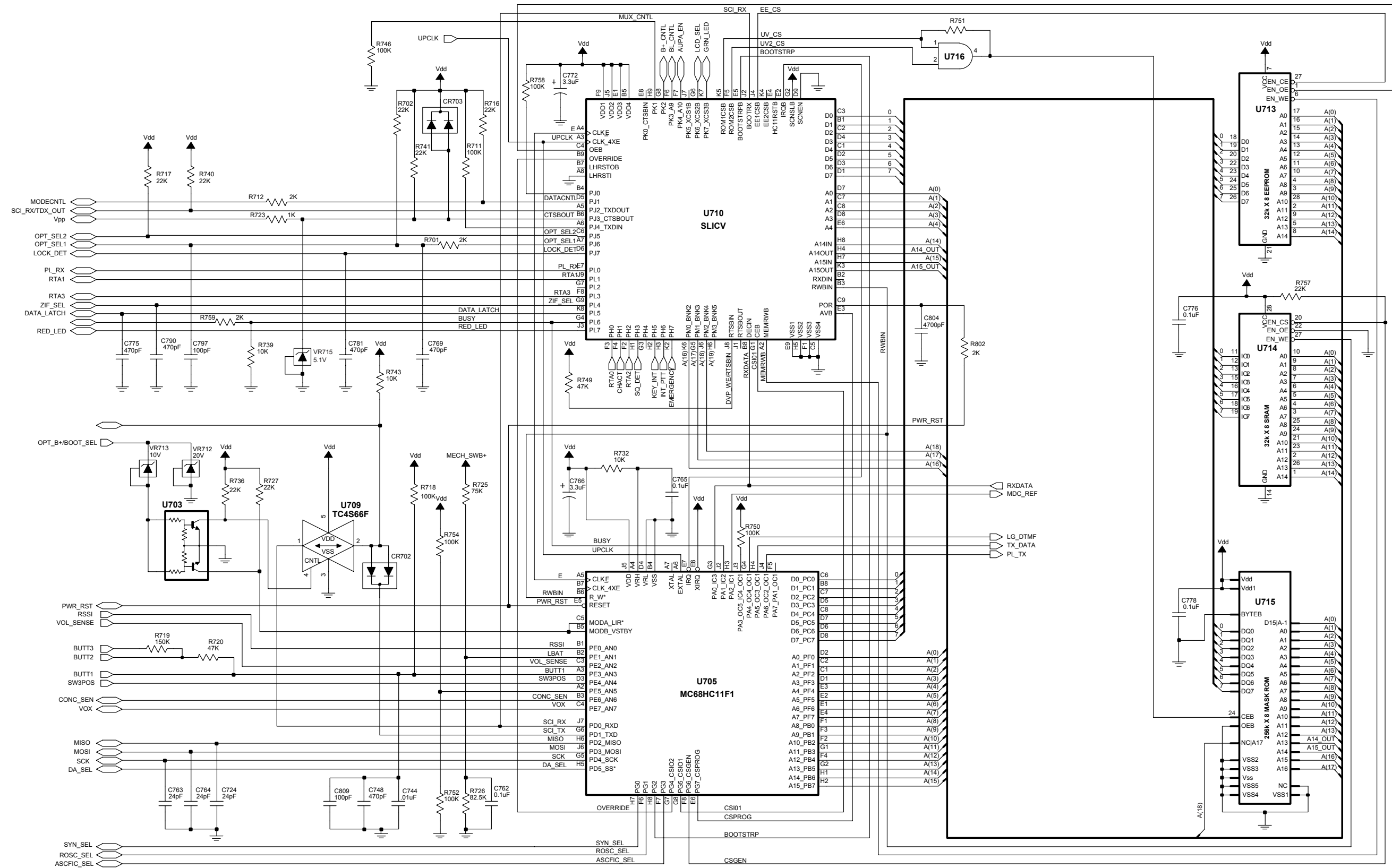
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, Fixed: pF ± 50V unless stated
C601 thru 621	-----	Not Placed
C700 thru 708	2113741F17	470
C709	2113743A23	0.220µF
C710	2311049J11	4.7µF; 16V
C711	2311049A07	1µF; 16V
C712, 713	2113743A19	0.1µF
C714, 715	2113743K15	0.1µF
C716, 717	2113741F49	10nF
C718	2113743K15	0.1µF
C719	2311049A01	0.1µF
C720	2113741F49	10nF
C721	2113743K15	0.1µF
C722	2311049A09	2.2µF
C723	2113743A23	0.22µF
C724	2113740F36	24
C725	2311049A07	1µF
C726	2113743F12	0.33µF
C727	2311049A07	1µF; 16V
C728	2113743F12	0.33µF
C729	2311049A07	1µF; 16
C730	2113741F41	4700
C731	2113743K15	0.1µF
C732	2311049A57	10µF; 16V
C733	2113743K15	0.1µF
C734	2311049J23	10µF
C735 thru 738	2113741F17	470
C739	2113740F39	33
C740 thru 742	2113741F17	470
C743	2113741A49	15nF
C744	2113741F49	10nF
C745	2113740F39	33
C746 thru 757	2113741F17	470
C758	2113743K15	0.1µF
C759 thru 761	2113741F17	470
C762	2113743K15	0.1µF
C763, 764	2113740F36	24
C765	2113743K15	0.1µF
C766	2311049A42	3.3µF
C767	2113743K15	0.1µF
C768	2113741F49	10nF
C769 thru 771	2113741F17	470
C770	2311049J23	10µF
C771	2113743K15	0.1µF
C772	2311049A42	3.3µF
C773	2113743A19	0.1µF
C774, 775	2113741F17	470
C776, 778	2113743K15	0.1µF
C779	-----	Not Placed
C780 thru 786	2113741F17	470
C787	2113740F39	33
C788 thru 791	2113741F17	470
C792	2113741F13	330
C793	2113743A19	0.1µF
C797	2113740F51	100
C798	2113741F49	10nF
C799	2113740F39	33
C804	2113741F41	4700
C808	2113741F17	470
C809	2113740F51	100
CR701	4813825A05	DIODE: See Note 1 Schottky
CR702 thru 704	4805218N57	Dual
CR706	4805218N57	Dual
J701	0905257V04	JACK: Connector; 26-pin; to P7031 on Front Cover Display Flex
J703	0905257V03	Connector; 18-pin; to P703 on Controls Flex
J704	0905461X03	Connector; 18-pin; to P704 Strip Connector
L701	2462587Q20	COIL, RF: 2.2uH
L702 thru 705	2462587Q40	270nH

Q701	4805128M40	TRANSISTOR: See Note 1 PNP
Q703	4880048M01	NPN
R601 thru 608	-----	RESISTOR, Fixed: Ω ± 0.0625W unless stated Not Placed
R700	0662057A65	4.7K
R701	0662057A56	2K
R702	0662057A81	22K
R703	0662057A56	2K
R704	0662057A41	470
R705	0662057R92	47.5K
R706	0662057A56	2K
R707	0662057A41	470
R708	0662057A56	2K
R709	0662057A41	470
R710	0662057A89	47K
R711	0662057A97	100K
R712	0662057A56	2K
R713	0662057A81	22K
R714	0683962T45	68
R716, 17	0662057A81	22K
R718	0662057A97	100K
R719	0662057B02	150K
R720 thru 722	0662057A89	47K
R723	0662057A49	1000
R724	0662057A89	47K
R725	0662057G07	75K
R726	0662057G08	82.5K
R727	0662057A81	22K
R728, 729	0662057A89	47K
R730, 731	0662057C55	150
R732	0662057A73	10K
R736, 738	0662057A81	22K
R739	0662057A73	10K
R740, 741	0662057A81	22K
R743	0662057A73	10K
R746	0662057A97	100K
R747	0662057B02	150K
R749	0662057A89	47K
R750	0662057A97	100K
R751	0662057C01	0 + .050
R752	0662057A97	100K
R753	-----	Not Placed
R754	0662057A97	100K
R757	0662057A81	22K
R758	0662057A97	100K
R759	0662057A56	2K
R760	0662057A29	150
R761	0662057A73	10K
R762, 802, 803	0662057A56	2K
R805	0662057A41	470
U601	-----	MODULES: See Note 1 Not Placed on NTN7512D/E and NTN7857D/E NTN7513D/E and NTN7858D/E (900MHz Boards)
U701	5105835U45	Audio Signaling Filter
U702	5105835U49	Audio PA
U703	4805921T09	Dual Transistor
U704	4805921T07	Transistor, NPN
U705	5105835U47	Microcomputer
U708	5105469E65	5V Regulator
U709	5105750U28	Mux
U710	5105835U80	SLIC IV
U712	4805718V01	Transistor Package
U713	5105109Z72	EEPROM
U714	5185963A21	SRAM
U715	5195229A01	256 x 8 Masked ROM (for all keypad radios)
		256 x 8 Masked ROM (for no display and top display radios)
U716	-----	Not Placed
VR701, 702	4813830A23	DIODE, Zener: See Note 1 10V
VR703	4813830A18	6.8V
VR706, 709	4813830A15	5.6V
VR712	4813830A33	20V
VR713	4813830A23	10V
VR714	4813830A18	6.8V
VR715	4813830A14	5.1V
VR720 thru 723	4805117Y01	Dual, 6.2V

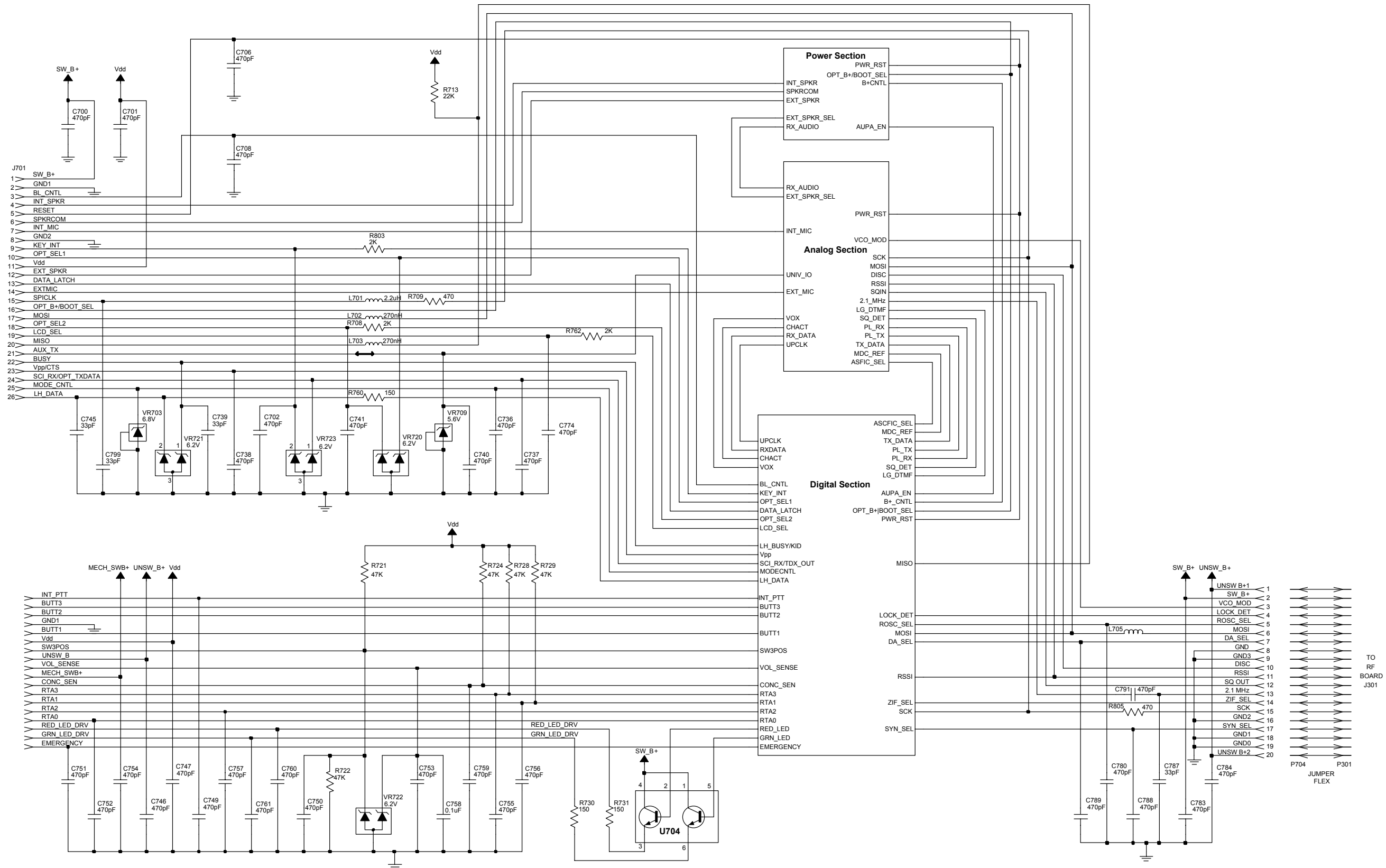
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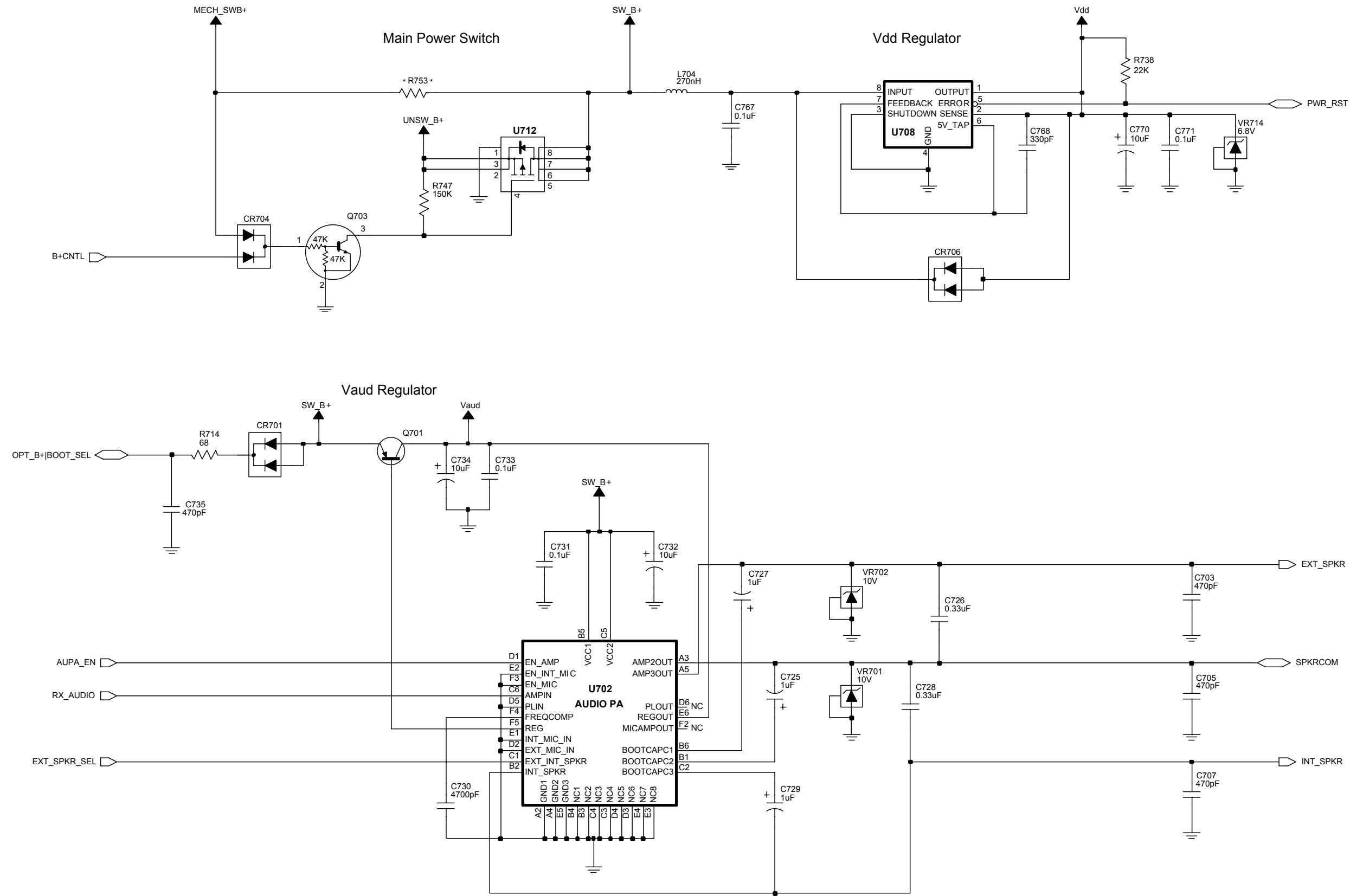
1. For optimum performance, order replacement diodes, transistors, and circuit modules by Motorola part number only.
2. "Not Placed" means that components are for future use, and are not placed on the circuit board at this time.





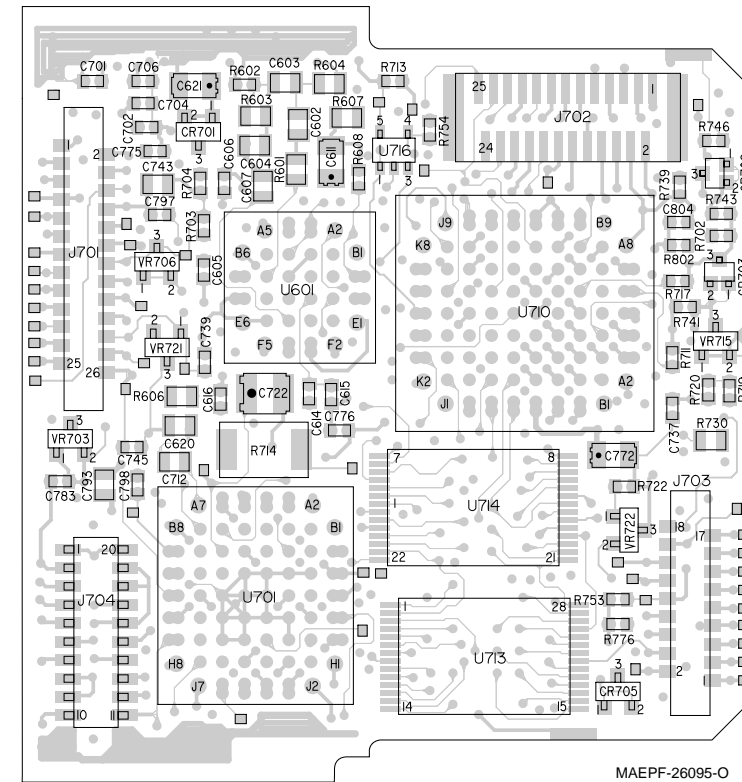
63B81097C18-0



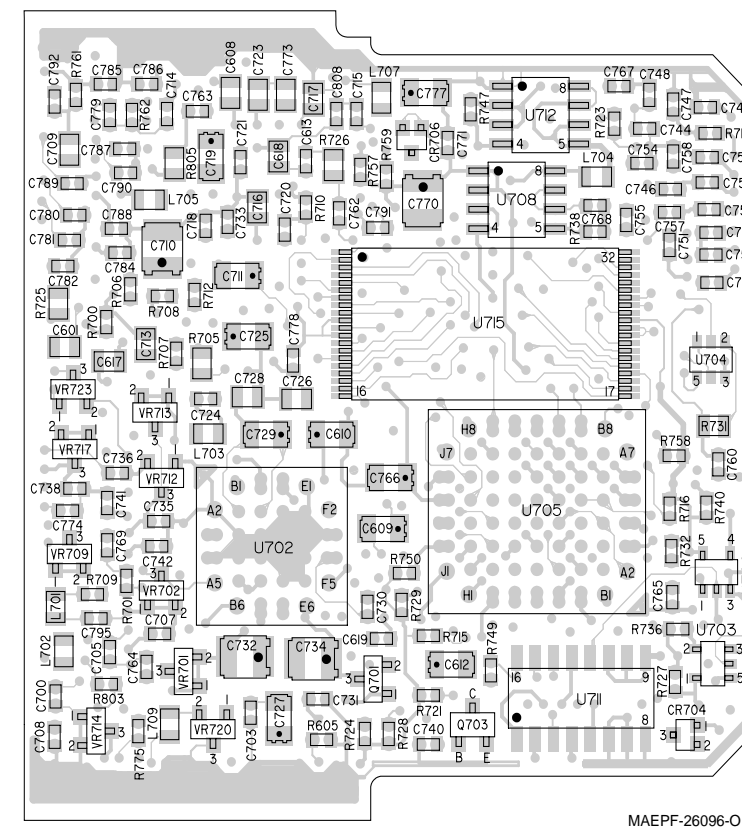


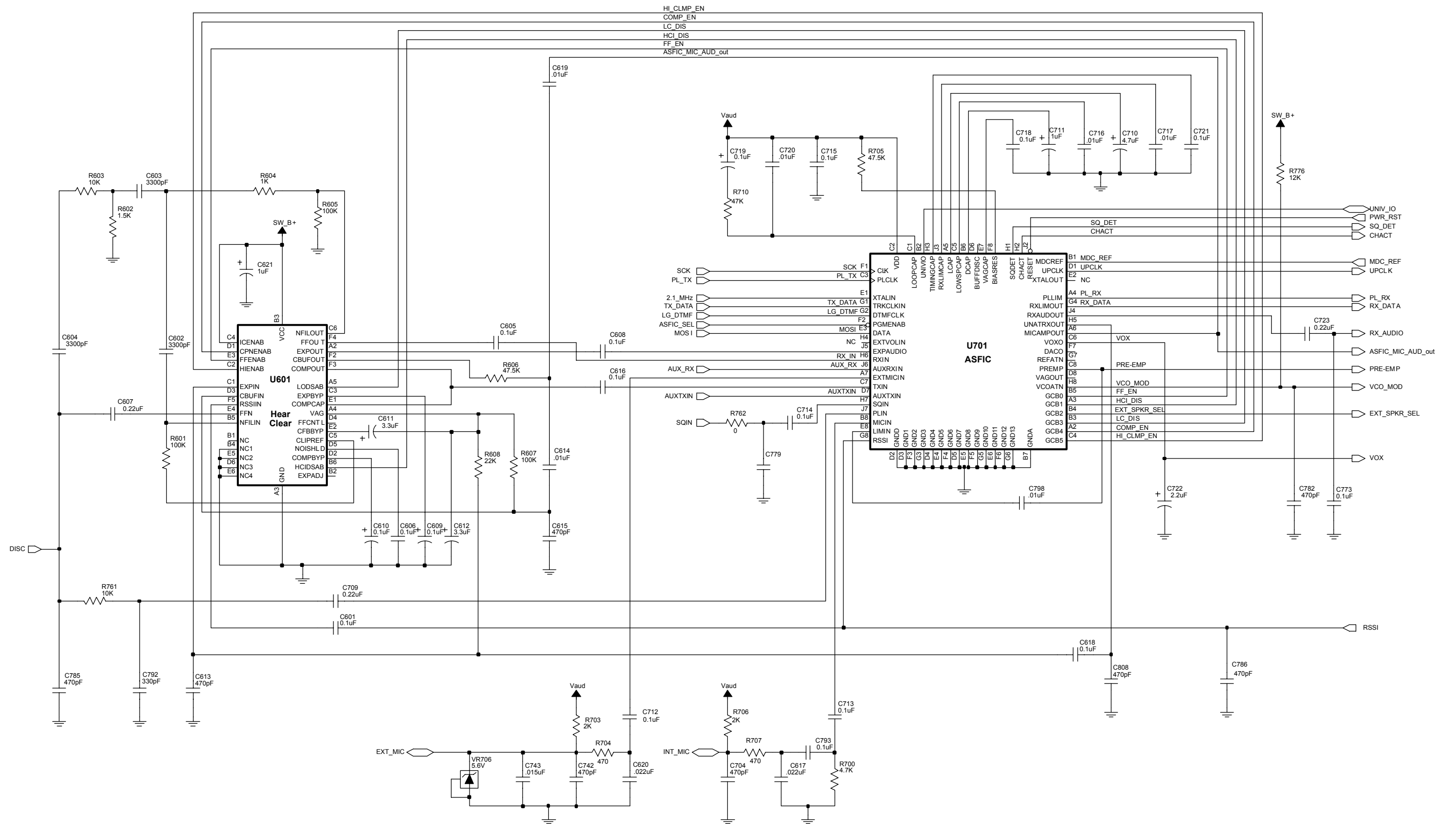
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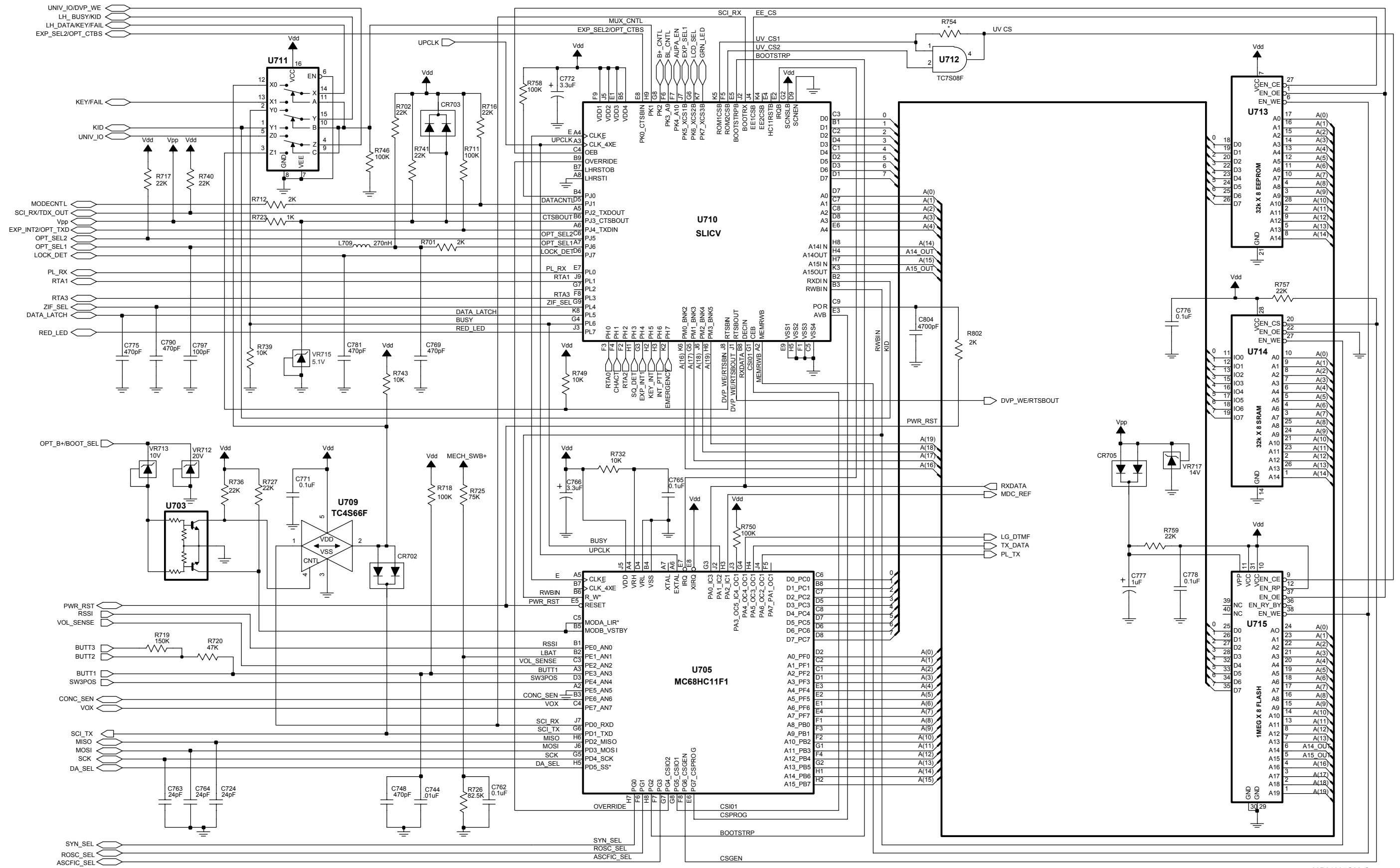
VIEWED FROM SIDE 1



VIEWED FROM SIDE 2

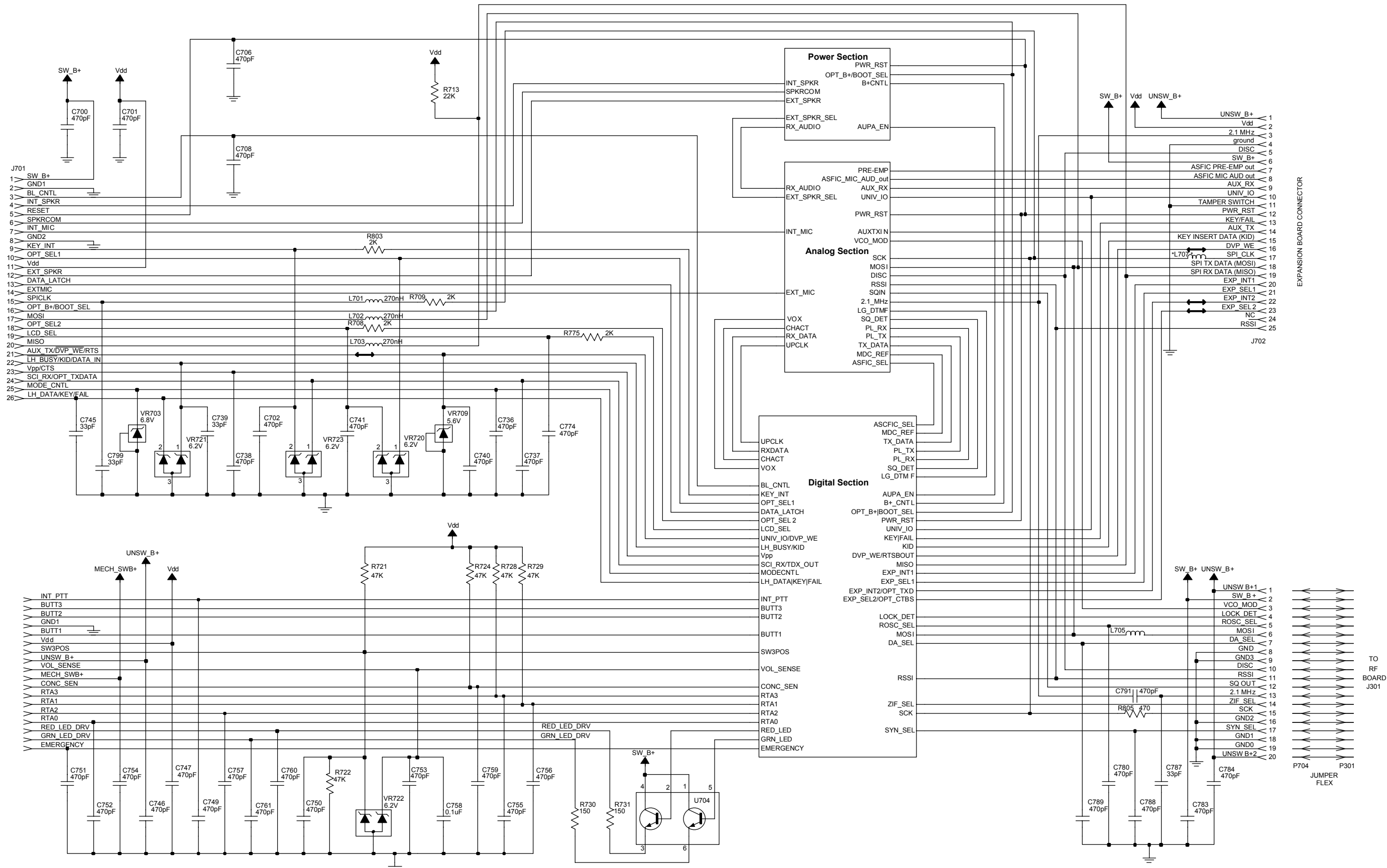


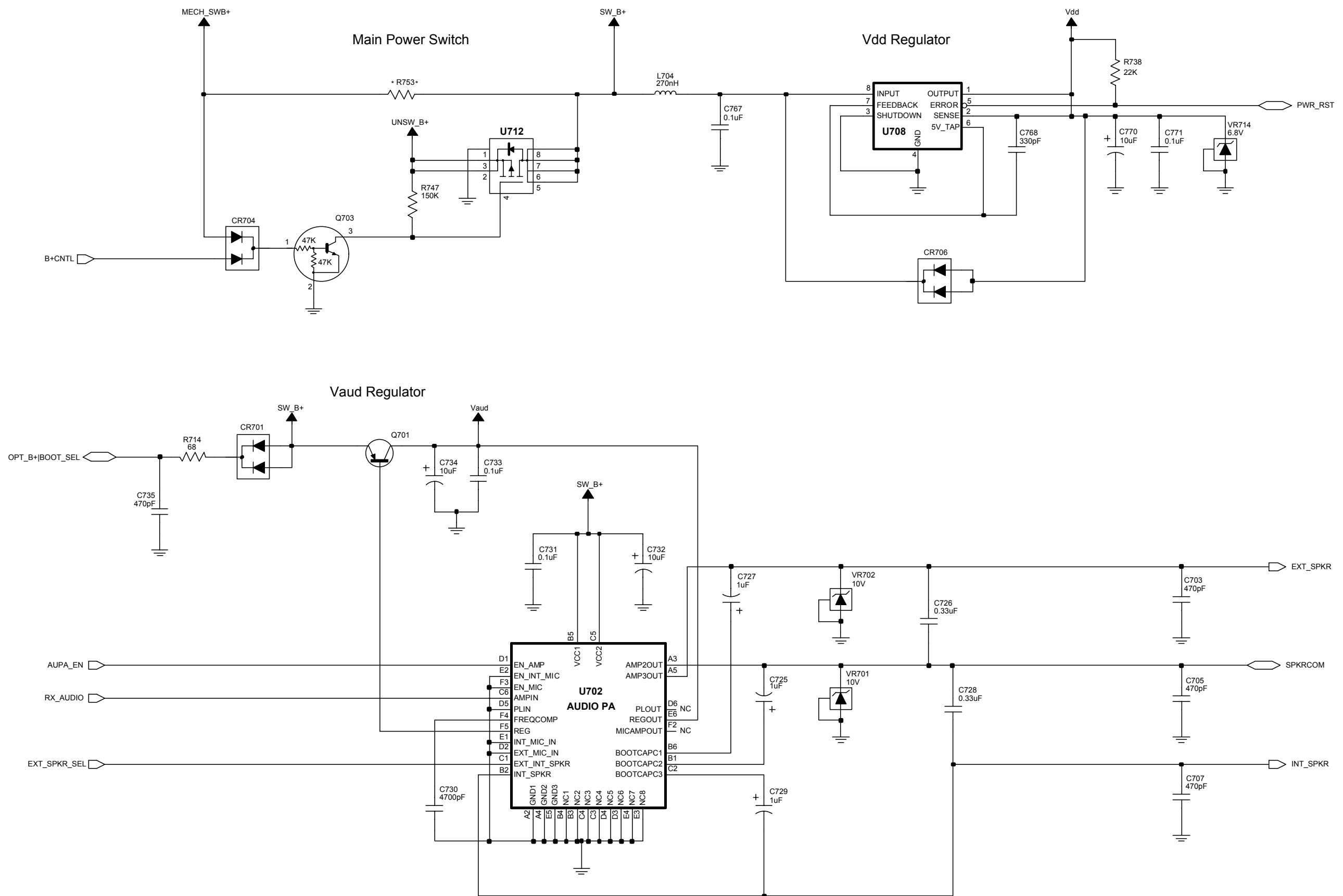




63B81097C22-O

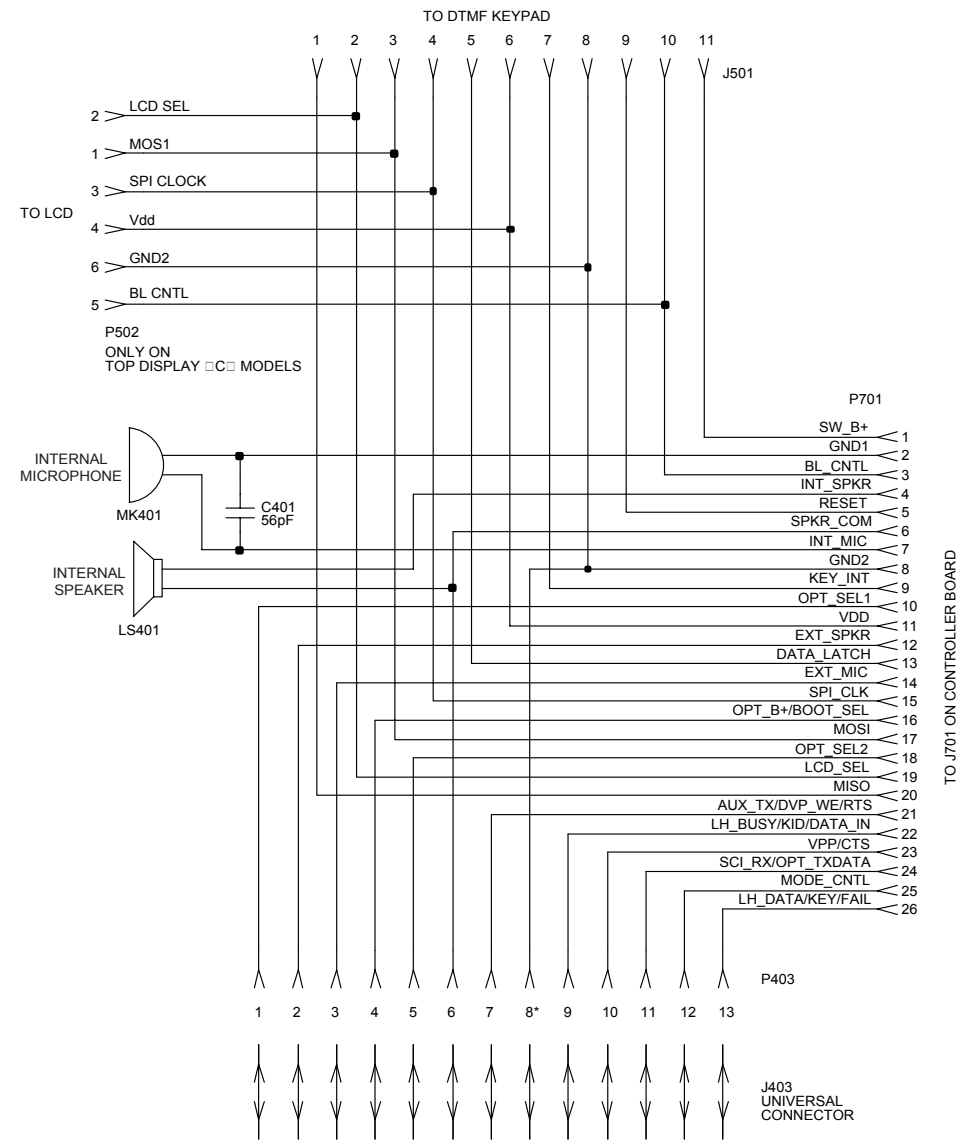
NCN6106C, NCN/PMCN6153A/B AND NCN/PMCN6176A
CONTROLLER BOARD DIGITAL SECTION SCHEMATIC DIAGRAM





63B81097C24-O

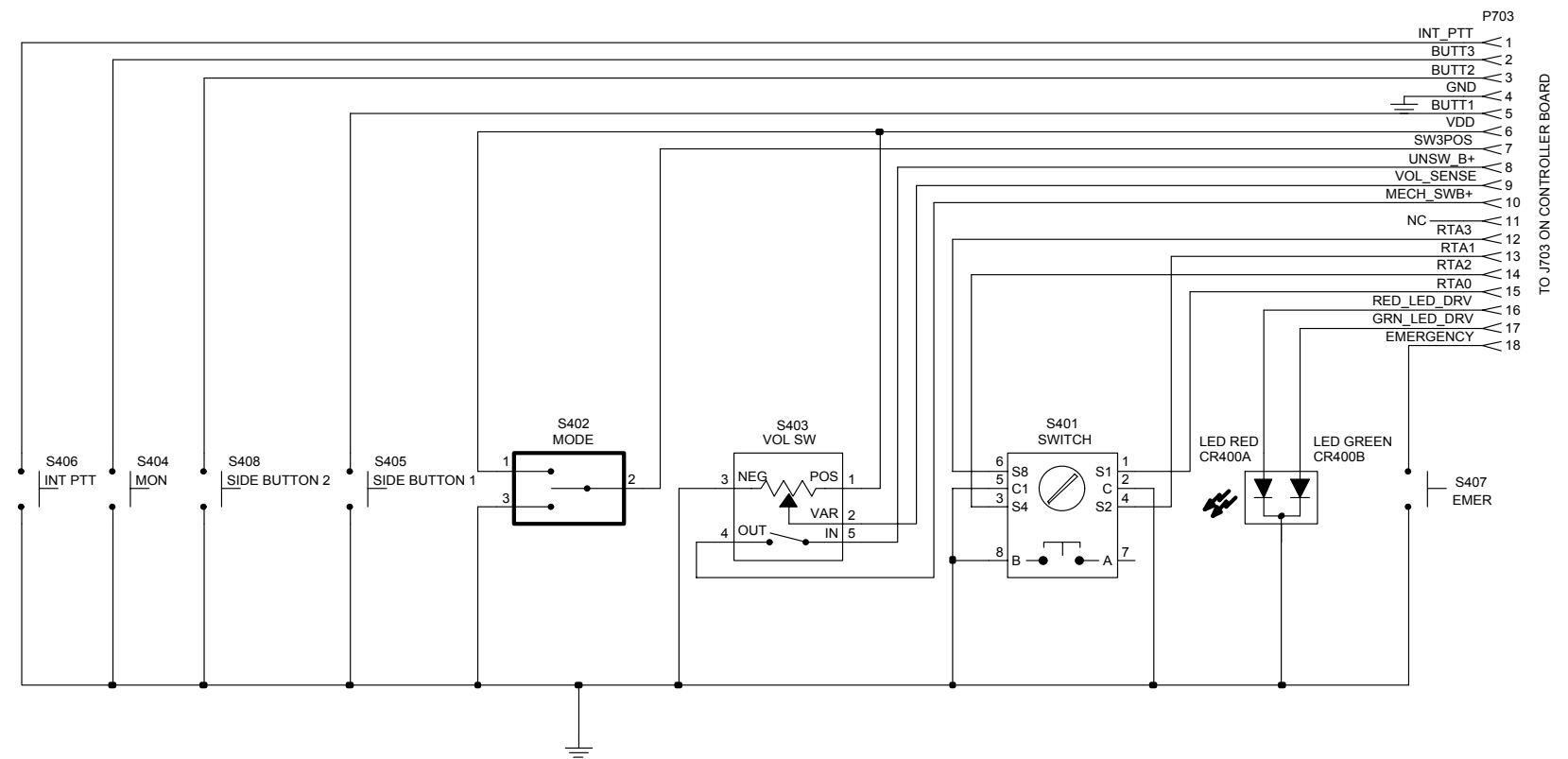
FRONT COVER DISPLAY FLEX



MODE	OPT_SEL1	OPT_SEL2
NORMAL	1	1
EXT SPK	0	1
MAN DOWN	1	0
EXT PTT	0	0

* P403 Pin 8 Connected to P701 pin 2 instead of P701 pin 8 On Front Display Models

CONTROLS FLEX



63B81097C27-O

Replacement Parts Ordering

10

Introduction

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

Crystal and channel element orders should specify the crystal or channel element type number, crystal and carrier frequency, and the model number in which the part is used.

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- International customers: please go to <https://www.motorola.com/businessonline> and click on "Sign Up Now."

Mail Orders

Send written orders to the following addresses:

**Replacement Parts/
Test Equipment/Manuals/
Crystal Service Items:**

Motorola Inc.
Radio Products Services Division*
Attention: Order Processing
2200 Galvin Drive
Elgin, IL 60123
U.S.A.

Federal Government Orders:

Motorola Inc.
U.S. Federal Government
Markets Division
Attention: Order Processing
7230 Parkway Drive
Landover, MD 21076
U.S.A.

International Orders:

Motorola Inc.
Radio Products Services Division*
Attention: Order Processing
2200 Galvin Drive
Elgin, IL 60123
U.S.A.

Telephone Orders

Call telephone orders to the following numbers:

Radio Products Services Division*
(United States and Canada)
7:00 AM to 7:00 PM (Central Standard Time)
Monday through Friday (Chicago, U.S.A.)
1-800-422-4210
1-847-538-8023 (International Orders)

U.S. Federal Government Markets Division (USFGMD)
1-800-826-1913 Federal Government Parts - Credit Cards Only
8:30 AM to 5:00 PM (Eastern Standard Time)

FAX Orders

FAX orders to the following numbers:

Radio Products Services Division*
(United States and Canada)
1-800-622-6210
1-847-576-3023 (International)

USFGMD
(Federal Government Orders)
1-800-526-8641 (For Parts and Equipment Purchase Orders)

Parts Identification

Radio Products Services Division*
(United States and Canada)
1-800-422-4210, menu 3

Product Customer Service

Customer Response Center
(Non-technical Issues)
1-800-247-2346
FAX:1-800-247-2347

*The Radio Products Services Division (RPSD) was formerly known as the Customer Care and Services Division (CCSD) and/or the Accessories and Aftermarket Division (AAD).

Secure Modules: NTN7279A, NTN7280A, NTN7281A, NTN7282A, and NTN7283A for MTS 2000 Radios

NOTE: The Secure Module is NOT serviceable. The information contained in this appendix is only meant to help determine whether a problem is due to the Secure Module or the radio itself.

Introduction

The Secure Module is designed to digitally encrypt and decrypt voice data in Motorola's MTS 2000 Series Handie-Talkie™ Portable Radios. The Secure Module uses a custom encryption integrated circuit (IC) and an encryption key variable to perform its encode/decode function. The encryption key variable is loaded into the Secure Module via the radio's universal (side) connector from a hand held key variable loader. The encryption IC corresponds to the particular encryption algorithm purchased. The encryption algorithms and their corresponding kit numbers are:

- Data Encryption Standard (DES)NTN7279A
- DES-XLNTN7280A
- Digital Voice Protection (DVP)NTN7281A
- DVP-XLNTN7282A
- DVI-XLNTN7283A

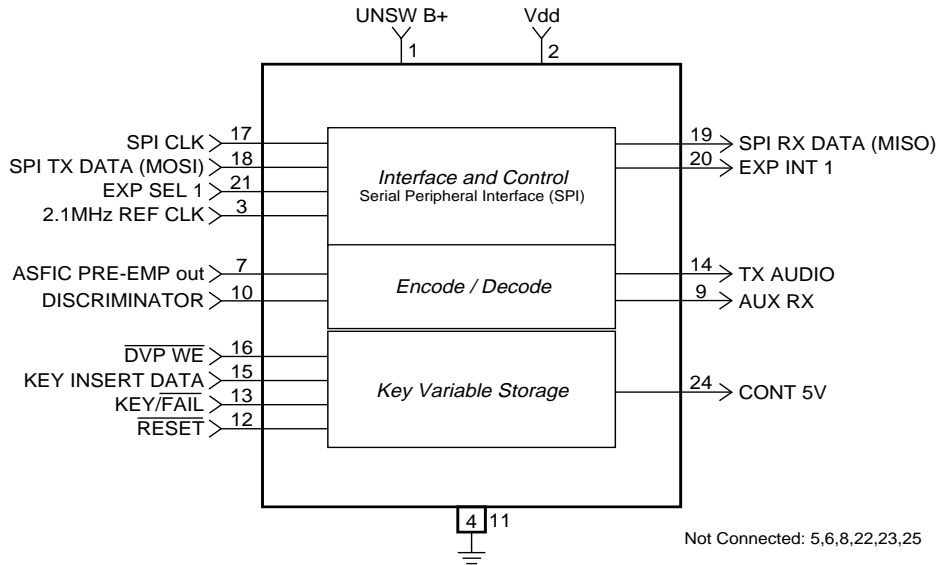
Circuit Description

The Secure Module, shown in Appendix Figure 1, operates from two power supplies. The first 5 volt supply (Vdd) is received from the controller board through connector plug P1 pin 2. This Vdd supply is turned on and off with the radio on/off switch. The second supply (UNSW B+) is received from the controller board through connector Plug P1 pin 1. UNSW B+ provides power to the Secure Module as long as the radio battery is in place.

Key variables are loaded into the Secure Module through connector P1 pins 13, 15, and 16. One key variable can be stored in the module at a time. The key variable is stored in volatile electronic memory, so it can only remain in memory as long as the radio is connected to a charged battery. If the battery is removed or if the battery fails, then a capacitor will allow the module to retain the key variable for at least 30 seconds while the battery is being replaced.

The radio's host processor communicates with the Secure Module on the Serial Peripheral Interface (SPI) bus. The host processor is the master on this bus, while the Secure Module is a slave on the bus. The

SPI bus consists of five signal lines. Refer to Appendix Table 1 for the signal information. A communications failure between the host processor and the Secure Module will be indicated as an “ERROR 09/ 10” message on the radio display.



Appendix Figure 1. Secure Module

Appendix A Table 1. MTS 2000 Single Key Secure Module I/O Definition

SIGNAL NAME	CONNECTOR PLUG P1 PIN NUMBER	FUNCTION
UNSW B+	1	Unswitched battery voltage
Vdd	2	Switched 5 volt supply
2.1MHz REF CLK	3	2.1/2.4 MHz clock signal
GROUND	4	Ground
ASFIC PRE-EMP out	7	Transmit Clear Audio
AUX RX	9	Receive Clear Audio
DISCRIMINATOR	10	Receive Encrypted Audio
GROUND	11	Ground
RESET	12	Radio Reset - Does NOT reset module
KEY/FAIL	13	Keyloading Signal
TX AUDIO	14	Transmit Encrypted Audio
KEY INSERT DATA	15	Keyloading Signal
DVP WE	16	Keyloading Signal
SPI CLK	17	SPI Data Clock
SPI TX DATA (MOSI)	18	SPI Data from Host
SPI RX DATA (MISO)	19	SPI Data to Host
EXP INT1	20	SPI Secure Interrupt Request
EXP SEL1	21	SPI Secure Slave Select
CONT 5V	24	Continuous 5 Volt Regulator Output (Not Used)
	5,6,8,22,23,25	Not Used

Troubleshooting Secure Operations

Refer to Section 6 of this radio service manual for disassembly and reassembly information, refer to Section 9 "Removal And Installation" for secure module and pad orientation, and refer to the radio theory/troubleshooting manual for a general overview of troubleshooting information and procedures. A key variable loader and oscilloscope are needed to troubleshoot the Secure Module.

NOTE: The Secure Module itself is NOT serviceable. If the Secure Module is found to be defective then it must be replaced.

ERROR 09/10

The MTS 2000 Series Handie-Talkie™ Portable Radio automatically performs a self test on every power-up. Should the radio fail the self tests, the display will show "ERROR XX/XX" (where XX/XX is alphanumeric) accompanied by a short beep. If the display shows "ERROR 09/10" or "E09/10", then the radio failed the secure power-up self tests and the host microcontroller is unable to communicate with the Secure Module via the SPI bus. Turn off the radio, check the battery connection, and turn the radio back on. If the radio still does not pass the self tests, then a problem exists with the secure operations of the radio.

Since the module is removable, a good first step in troubleshooting secure operation is simply to replace the suspect Secure Module with a known working module. If this does not fix the problem, then the original module is probably not the cause of the problem. If the new module does fix the problem, then the original module must be replaced.

A complete procedure for troubleshooting this error is listed below:

1. Turn the radio off, check the battery connection, and turn the radio back on.
2. If the error condition still exists, check that a Secure Module is installed and make sure that it is properly connected to the controller board. To do this, refer to the disassembly and reassembly sections of this manual.
3. Turn the radio back on.
4. If the error condition still exists and a working secure module with the same kit number is available, replace the suspect module with the working module.
5. If the problem persists, disassemble the radio and check the encryption connector SPI pins (listed in Appendix Table 1) for data transitions when the radio is turned on and off. If activity is not seen on all five lines, check both sides of the connector for broken connections.
6. Troubleshoot the Controller Board.

Keyloading Problems

Use the following procedure to troubleshoot keyloading problems:

1. Verify that the correct Key Variable Loader (KVL) is being used for the particular encryption algorithm present in the radio. Refer to Appendix Table 2:

Appendix A Table 2. Key Variable Loader

Secure Module Kit	KVL Kit	Description
NTN7279A	T3011_X	DES
NTN7280A	T3011_X	DES-XL
NTN7281A	T3010_X	DVP
NTN7282A	T3014_X	DVP-XL
NTN7283A	T3012_X	DVI-XL

2. 2.Connect the KVL to the radio via the TDN9390A keyloader cable. When the cable is connected to the radio, the radio should enter the keyloading mode of operation, and the radio should display “KEYLOADING” or “KEYLDG” and make a beep tone.
3. 3.If the radio displays “ERROR 09/10” or “E09/10” then go to the ERROR 09/10 troubleshooting section.
4. 4.If the radio does not go into keyloading mode, detach and reattach the keyloader cable.
5. 5.If there is still a problem, refer to the universal connector illustration found in the schematic and circuit board section of this manual, and short pins 8, 10, and 12 on the universal connector together. If this causes the radio to go into keyloading mode, then replace the keyloader cable.
6. 6.If the radio still does not go into keyloading mode, check the continuity of the Front Cover/Display Flex and make sure that the Flex is properly connected to the Universal Connector and to the Controller Board.
7. 7.If the radio does go into keyloading mode, but after starting the keyloading process the KVL display indicates “X FAIL”, then check to see if there are transitions on pins 13, 15, and 16 of connector P1 on the Secure Module during a keyload.
8. 8.If there are no transitions on any one of these lines during a keyload, check the integrity and continuity of the Expansion Board Connector. If it is OK, try replacing the Controller Board.
9. 9.If there are transitions on these lines, try replacing the Secure Module.
- 10.10.If the KVL display indicates “X PASS” but you cannot hear a keyload verification tone, then check the volume of the radio. If the volume is OK, troubleshoot the receive routing paths in the radio.

Service Aid

A cable, Motorola kit number TDN9390A, connects the MTS 2000 radio universal connector to the keyloader.

Retrofit Instructions

General

This section gives instructions on retrofitting a secure module into a secure-capable MTS 2000 radio. The following paragraphs give directions on how to physically install the secure module, how to

enable the secure options by updating the codeplug, and how to tune the radio for optimum secure performance.

Physical Retrofit of Secure Module

The radio must be partially disassembled to install the secure module.



Anti-static precautions must be observed at all times.

Caution

Follow the disassembly procedures in Section 6, located toward the front of this manual. Proceed through “**Disassembly to Board Level**”) step 8, where the front cover has been removed and the controls flex has been disconnected from the controller board.

Continue through step 9a, to loosen the front shield. Do not completely remove the front shield. Simply raise the lower portion of the shield while the opposite end is still connected to the top of the radio. With the front shield raised, observe the controller board which takes up the bottom third of the radio. On the lower right corner of the controller board is an empty female connector, which will be used to mate the controller board to the secure module. Place the secure module (component side toward controller board) over the controller board with the secure module’s male connector placed above and aligned to the female connector on the controller board. Interlock the connectors by pressing down on the back of the secure module. The secure module has now been installed. Reassemble the radio according to the reassembly instructions in Section 6, located toward the front of this manual. Begin with “**Reassembly** (Control Top/Front Shield/ Controls Flex as a unit to Chassis), step 2.

Update Codeplug Through RSS

General

Once the secure module is installed, the radio's codeplug must be reprogrammed so that the new hardware can be used. There will also be some secure options that the user may or may not want to activate. Appendix Table 3, at the end of this appendix, gives a quick reference to several properties and a brief description for each parameter. Refer to the RSS manual for general instructions in the use of RSS.

Set Secure-Equipped Field

The radio must be reprogrammed to utilize the secure module. At the RSS main menu, press F4 for the CHANGE/CREATE/VIEW menu. Press F3 for the Radio Wide Buttons, Switches, Display, Scan, Phone screen. Press F2 for Radio Wide Options screen. Here, press tab to reach the Secure Equipped field. Press up/down arrow keys to select YES.

Set XL IC Present Field

If the secure module has an XL IC (the Range Extension or -XL option), the radio must be reprogrammed to show that this IC is present. While still in the Radio Wide Options screen, press F6 to see Secure Options. Press Tab until the XL IC Present field is highlighted. Press up/down arrow keys to select YES. If the secure module does not have an XL IC, set the XL IC Present field to NO.

Enable Secure On Desired Channels

To actually use the secure option, Secure must be enabled on the channels for which it is desired. A channel can be strapped to secure-only, or clear-only, or secure/clear-selectable.

For conventional channels, proceed as follows: Press F4 at the Main Menu to see the CHANGE/CREATE/VIEW menu. Press F6 to see Conventional Systems, Personalities, MDC, Options. Press F3 to see Conventional Personalities, Options. Press F6 to see the SECURE OPTIONS screen. Press Tab to select the Secure/Clear Strapping field.

For trunking channels, proceed as follows: Press F4 at the Main Menu to see the CHANGE/CREATE/VIEW menu. Press F4 to see Trunking Systems, Personalities, Call Lists, Options screen. Press F4 to see Trunking Personalities: Talk Groups, Emergency Options, etc. Press Tab to select the Strapping field. An Announcement Group must be specified for the Strapping parameter to appear. This selects the Announcement Group Strapping. Press F7 to select Talk Groups. Press Tab to select the strapping of each Talk Group.

Other Secure Options

There are other secure options that can be changed on a per-channel basis, such as: Proper Code Detection, Transmit XL, or CFB. For conventional channels, these options are found on the same screen as Secure/Clear Strapping (F4/F6/F3/F6). These options are XL Transmit, Scan Holdoff Strapping, RX Modulation, and Proper Code Detect. For trunking channels, the only selectable option is Proper Code Detect. This can be found by going to the MORE OPTIONS screen (F9) from the screen that was used to select secure/clear Strapping for trunking channels.

Secure Retrofit Tuning

After installing a secure-retrofit board into a radio, the secure TX deviation and the secure RX discriminator level must be tuned. Follow the procedure outlined in Section 9 **“Secure Alignment Procedure”** in this publication for the tuning of these two secure-related alignments.

The TX deviation balance (compensation) does not need to be performed as part of the secure retrofit procedure. Use the transmit deviation balance (compensation) procedure as outlined in this appendix, only when a complete radio alignment is being performed with a secure board installed.

Secure Alignment Procedure

General

For optimum radio performance, the secure transmit deviation and the receive discriminator level must be set. Refer to Section 5, **“Radio Alignment Procedure”**, for a description of the radio alignment test setup, an RSS service menu overview, and for general radio tuning procedures. All normal radio tuning should be performed in the proper sequence before proceeding with secure tuning.

Note that the transmit deviation balance (compensation) tuning must be performed differently if a secure board is installed in the radio. Follow the procedure changes outlined below when tuning transmit deviation balance, and complete the normal tuning. Then proceed

with the additional tuning for secure TX deviation and secure RX discriminator level tuning.

Transmit Deviation Balance (Compensation)

When tuning with a secure board installed, the coupling capacitor inside the RKN4035A Test Cable will cause rolloff of the low port modulation. To fix this, the cable should be dc coupled (“VOL” position) and an external coupling capacitor (1.3µF or larger) must be placed in series with the signal source input to the AC/DC MTR.

Follow the “**Transmit Deviation Balance (Compensation)**” procedure outlined in Section 5, except change step 3 as follows:

3. Set the RTX4005B Test Box meter selector switch to the “VOL” position, and connect the signal source to the AC/DC MTR port thru a 1.3µF capacitor. Inject an 80 Hz tone at 100mVrms thru this capacitor. Keep the ac voltmeter in parallel to the AC/DC MTR input to ensure the proper input signal level.

Secure TX Deviation

Transmit deviation balance (compensation) and transmit deviation limit adjustments should be completed before secure deviation is adjusted. Remember to use the new transmit deviation balance procedure outlined in the previous paragraphs before performing the following steps.

1. From the SERVICE menu, press F2 to select TRANSMITTER alignment.
2. Press F8 to select the SECURE TX DEV softpot.
3. Press F6 to key the radio on the test frequency. The screen will indicate that the radio is transmitting.
4. Measure the secure deviation on your service monitor.
5. Use the up/down arrow keys to adjust the secure deviation per Appendix Table 3.

Appendix A Table 3. Secure Deviation

Channel Spacing (kHz)	Secure Deviation (kHz)
25 / 30	2.91 - 3.06
20 (VHF / UHF)	1.69 - 1.84
20 (821 - 824, 866 - 969)	1.69 - 1.84
12.5	N / A

6. Press F6 to dekey the radio. Press F8 to program the softpot value.
7. Press F10 to return to the TRANSMITTER menu.
8. Set the RTX4005B Test Box meter selector switch to the “MX DISC” position, and connect an ac volt-meter (capable of 1mV resolution on a 2V scale) to the test box AC/DC meter port.
9. From the SERVICE menu, press F3 to select RECEIVER alignment.
10. Press F8 to select the SECURE DISCRIMINATOR LEVEL softpot. The screen will indicate the receive test frequency to be used.
11. Set the RF test generator to the receive test frequency. Set the RF

Secure RX Discriminator Level

level at the radio standard antenna port to 1mV (-47dBm) modulated with 3.0 kHz FM deviation of a 1 kHz tone.

12. Use the UP/DOWN arrow keys to obtain a discriminator level between 206 - 218mVrms (target value of 212 mVrms) observed on the ac volt-meter.

13. Press F8 to program the softpot value.

14. Press F10 to return to the RECEIVER menu.

Removal And Installation

Refer to Appendix Figure 2, Secure Module Location Detail, when adding, removing, or replacing the secure module and/or secure module pad. Notice the orientation of the secure module and the secure module pad to the controller board.

Removal

Perform the disassembly procedure outlined in Section 6, up to and including removing the radio's front shield. Remove the secure module by pulling it out and away from the controller board.

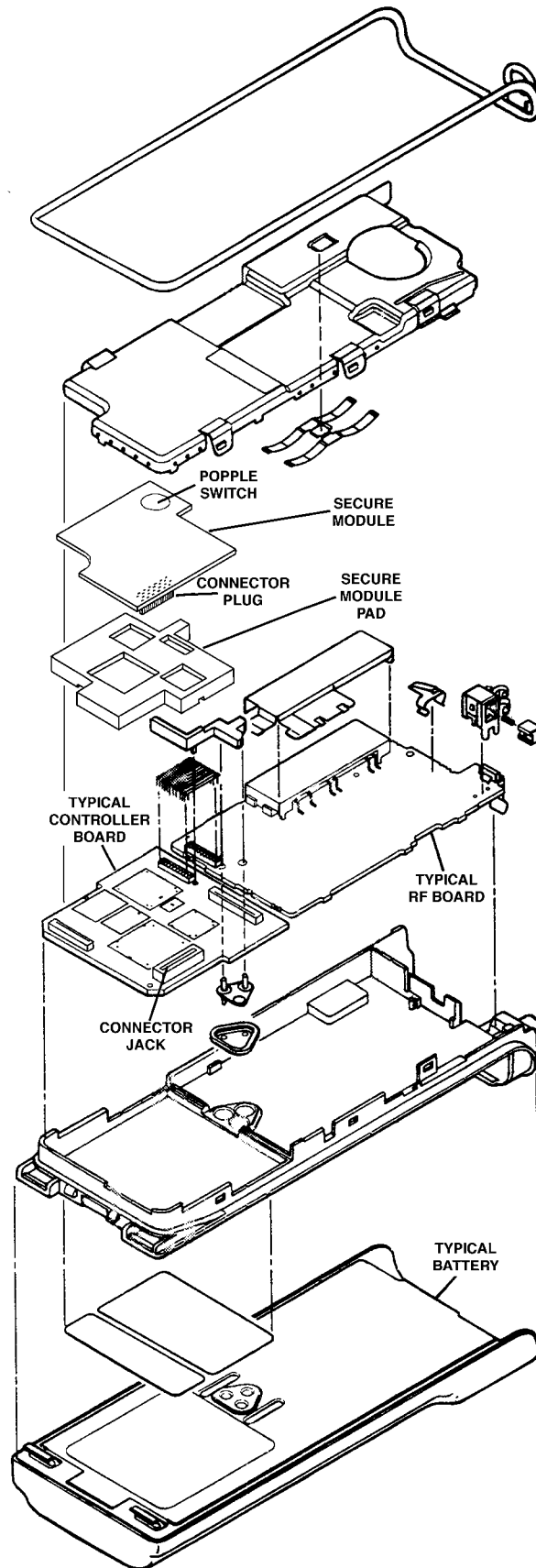
NOTE: The secure module and the controller board connect via a plug and jack located at the opposite corner from the round popple switch.

Remove the secure module pad as necessary.

Replacement/Installation

Perform the disassembly procedure described in the preceding paragraphs. Refer to Appendix Figure 2 for secure module pad and secure module board orientation. If the secure module pad was removed, place the removed pad or a new pad (Motorola part number 7505670Z01) on the controller board and ensure that it seats flush with the controller board on all sides. Place the secure module on the secure module pad. Press the secure module plug into the controller board jack with enough force so that the jack and plug snap together.

Reassemble the radio per the procedure outlined in Section 6 of this manual.



Appendix Figure 2. Secure Module Location Detail

Appendix A Table 4. RSS Secure Parameters

Parameter	Default	Possible Settings	Radio Wide/Per Channel	Used in Conv/Trunk	Description
Secure Equipped	No	Yes/No	Radio Wide	Both	Notifies radio that Secure Module is present
XL IC Present	No	Yes/No	Radio Wide	Both	Notifies radio that Secure Module contains XL IC
Secure/Clear Strapping	Select	Select/ Clear/ Secure	Per Channel	Conv	Sets channel to Clear-Only or Secure-Only or user Selectable
Strapping	Clear	Select/ Clear/ Secure	Per Channel	Trunk	Sets channel to Clear-Only or Secure-Only or user Selectable
XL Transmit	Enable	Enable/ Disable	Per Channel	Conv	Enables TX XL operation or disables for CFB
Scan Select	Non-XL&XL	Non-XL/ Non-XL&XL	Per Channel	Conv	Selects between Non-XL and XL Scan Unsilence Duration
Scan Holdoff Strapping	Both	Both/ Clear Only/ Secure Only	Per Channel	Conv	Scan for Clear or Secure or Both on a particular channel
RX Modulation	2-Level Rx	Auto Rx/ 2-Level Rx	Per Channel	Conv	Tells radio to look for 2&4-level signals or 2-level signals only
Proper Code Detect (Conv)	Enabled	Enabled/ Disabled	Per Channel	Conv	Enables RX proper code detection
Proper Code Detect (Trunk)	Disabled	Enabled/ Disabled	Per Channel	Trunk	Enables RX proper code detection
TX Clear Alert Tones	Enabled	Enabled/ Disabled	Radio Wide	Both	Enables alert tone when PTT is pressed while in the Clear mode
Periodic Keyfail Alert Tone	Enabled	Enabled/ Disabled	Radio Wide	Both	Enables a Keyfail Alert Tone to sound periodically in a key-fail condition
Non-XL Scan Unsilence Duration	275mS	0-6375ms	Radio Wide	Both	The time after an activity detect that radio will wait on channel without an unsilence in Non-XL mode
Non-XL Scan Unsilence Duration	875mS	0-6375ms	Radio Wide	Both	The time after an activity detect that radio will wait on channel without an unsilence in XL mode

Appendix B

Model History Tables

The following five tables include all of the HT 1000, JT 1000, MT 2000, MTS 2000, and MTX Series models from the beginning of this product line to date. Each table includes model number, model number description, and the kit numbers of the transceiver board (Xcvr Bd) and the controller board (Ctrl Bd) that shipped with that particular model. The chart also lists replacement transceiver board, controller board, and codeplug.

Refer to the "Read Me" file on the replacement code plug disc to ensure current code plug use. Be sure to use the HJV_0002.EXE code plug tool for correct programming.

Appendix B Table 1. HT 1000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacement		
				Xcvr Bd	Ctrl Bd	Codeplug
H01KDC9AA1AN	VHF 2-F Closed 5-1W	NUD7070A	NTN7090A	NUD7085E	NCN6129B	D64W
H01KDC9AA1BN	VHF 2-F Closed 5-1W	NUD7085A	NTN7092A	NUD7085E	NCN6129B	D64W
H01KDC9AA1BN	VHF 2-F Closed 5-1W	NUD7085B	NTN7092B	NUD7085E	NCN6129B	D64W
H01KDC9AA1CN	VHF 2-F Closed 5-1W	NUD7085C	NCN6129A	NUD7085E	NCN6129B	D64W
H01KDC9AA1CN	VHF 2-F Closed 5-1W	NUD7085C	NCN6129B	NUD7085E	NCN6129B	D64W
H01KDC9AA1DN	VHF 2-F Closed 5-1W	NUD7085D	NCN6129C	NUD7085E	NCN6140C	D64W
H01KDC9AA1DN	VHF 2-F Closed 5-1W	NUD7085E	NCN6138A	NUD7085E	NCN6140C	D64W
H01KDC9AA1DN	VHF 2-F Closed 5-1W	NUD7091A	NCN6140A	NUD7091B	NCN6140C	F91P-3
H01KDC9AA1DN	VHF 2-F Closed 5-1W	NUD7091B	NCN6140B	NUD7091B	NCN6140C	F91P-3
H01KDC9AA1DN	VHF 2-F Closed 5-1W	NUD7091B	NCN6140C	NUD7091B	NCN6140C	F91P-3
H01KDC9AA1DN	VHF 2-F Closed 5-1W	NUD7095B	NCN6140C	NUD7095B	NCN6140C	F91P-3
H01KDC9AA1DN	VHF 2-F Closed 5-1W	PMUD7095B	PMCN6140C	NUD7095B	NCN6140C	
H01KDC9AA3AN	VHF 16-F Closed 5-1W	NUD7070A	NTN7090A	NUD7070D	NCN6129B	D64W
H01KDC9AA3BN	VHF 16-F Closed 5-1W	NUD7070B	NTN7092B	NUD7070D	NCN6129B	D64W
H01KDC9AA3CN	VHF 16-F Closed 5-1W	NUD7070C	NCN6129A	NUD7070D	NCN6129B	D64W
H01KDC9AA3CN	VHF 16-F Closed 5-1W	NUD7070C	NCN6129B	NUD7070D	NCN6129B	D64W
H01KDC9AA3DN	VHF 16-F Closed 5-1W	NUD7070D	NCN6129C	NUD7070D	NCN6140C	D64W
H01KDC9AA3DN	VHF 16-F Closed 5-1W	NUD7070E	NCN6138A	NUD7070D	NCN6140C	D64W
H01KDC9AA3DN	VHF 16-F Closed 5-1W	NUD7092A	NCN6140A	NUD7092B	NCN6140C	F91P-3
H01KDC9AA3DN	VHF 16-F Closed 5-1W	NUD7092B	NCN6140B	NUD7092B	NCN6140C	F91P-3
H01KDC9AA3DN	VHF 16-F Closed 5-1W	NUD7092B	NCN6140C	NUD7092B	NCN6140C	F91P-3
H01KDC9AA3DN	VHF 16-F Closed 5-1W	NUD7095B	NCN6140C	NUD7095B	NCN6140C	F91P-3
H01KDC9AA3DN	VHF 16-F Closed 5-1W	PMUD7095B	PMCN6140C	NUD7095B	NCN6140C	
H01RDC9AA1AN	UHF B1 2-F Closed 4-1W	NUE7213A	NTN7090A	NUE7240D	NCN6129B	D64W

Appendix B Table 1. HT 1000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacement		
				Xcvr Bd	Ctrl Bd	Codeplug
H01RDC9AA1BN	UHF B1 2-F Closed 4-1W	NUE7240B	NTN7092B	NUE7240D	NCN6129B	D64W
H01RDC9AA1CN	UHF B1 2-F Closed 4-1W	NUE7240C	NCN6129A	NUE7240D	NCN6129B	D64W
H01RDC9AA1CN	UHF B1 2-F Closed 4-1W	NUE7240C	NCN6129B	NUE7240D	NCN6129B	D64W
H01RDC9AA1DN	UHF B1 2-F Closed 4-1W	NUE7240D	NCN6129C	NUE7240D	NCN6140C	D64W
H01RDC9AA1DN	UHF B1 2-F Closed 4-1W	NUE7265A	NCN6141A	NUE7265B	NCN6140C	F91P-3
H01RDC9AA1DN	UHF B1 2-F Closed 4-1W	NUE7265B	NCN6141B	NUE7265B	NCN6140C	F91P-3
H01RDC9AA1DN	UHF B1 2-F Closed 4-1W	NUE7265B	NCN6140C	NUE7265B	NCN6140C	F91P-3
H01RDC9AA1DN	UHF B1 2-F Closed 4-1W	NUE7272B	NCN6140C	NUE7272B	NCN6140C	F91P-3
H01RDC9AA1DN	UHF B1 2-F Closed 4-1W	PMUE7272B	PMCN6140C	NUE7272B	NCN6140C	
H01RDC9AA3AN	UHF B1 16-F Closed 4-1W	NUE7213A	NTN7090A	NUE7231C	NCN6129B	D64W
H01RDC9AA3BN	UHF B1 16-F Closed 4-1W	NUE7213B	NTN7092B	NUE7231C	NCN6129B	D64W
H01RDC9AA3CN	UHF B1 16-F Closed 4-1W	NUE7213C	NCN6129A	NUE7231C	NCN6129B	D64W
H01RDC9AA3CN	UHF B1 16-F Closed 4-1W	NUE7213C	NCN6129B	NUE7231C	NCN6129B	D64W
H01RDC9AA3DN	UHF B1 16-F Closed 4-1W	NUE7231C	NCN6129C	NUE7231C	NCN6140C	D64W
H01RDC9AA3DN	UHF B1 16-F Closed 4-1W	NUE7266A	NCN6141A	NUE7266B	NCN6140C	F91P-3
H01RDC9AA3DN	UHF B1 16-F Closed 4-1W	NUE7266B	NCN6141B	NUE7266B	NCN6140C	F91P-3
H01RDC9AA3DN	UHF B1 16-F Closed 4-1W	NUE7266B	NCN6140C	NUE7266B	NCN6140C	F91P-3
H01RDC9AA3DN	UHF B1 16-F Closed 4-1W	NUE7272B	NCN6140C	NUE7272B	NCN6140C	F91P-3
H01RDC9AA3DN	UHF B1 16-F Closed 4-1W	PMUE7272B	PMCN6140C	NUE7272B	NCN6140C	
H01SDC9AA1AN	UHF B2 2-F Closed 4-1W	NUE7214A	NTN7090A	NUE7241D	NCN6129B	D64W
H01SDC9AA1BN	UHF B2 2-F Closed 4-1W	NUE7241B	NTN7092B	NUE7241D	NCN6129B	D64W
H01SDC9AA1CN	UHF B2 2-F Closed 4-1W	NUE7241C	NCN6129A	NUE7241D	NCN6129B	D64W
H01SDC9AA1CN	UHF B2 2-F Closed 4-1W	NUE7241C	NCN6129B	NUE7241D	NCN6129B	D64W
H01SDC9AA1DN	UHF B2 2-F Closed 4-1W	NUE7241D	NCN6129C	NUE7241D	NCN6140C	D64W
H01SDC9AA1DN	UHF B2 2-F Closed 4-1W	NUE7267A	NCN6141A	NUE7267B	NCN6140C	F91P-3
H01SDC9AA1DN	UHF B2 2-F Closed 4-1W	NUE7267B	NCN6141B	NUE7267B	NCN6140C	F91P-3
H01SDC9AA1DN	UHF B2 2-F Closed 4-1W	NUE7267B	NCN6140C	NUE7267B	NCN6140C	F91P-3
H01SDC9AA1DN	UHF B2 2-F Closed 4-1W	NUE7273B	NCN6140C	NUE7273B	NCN6140C	F91P-3
H01SDC9AA1DN	UHF B2 2-F Closed 4-1W	PMUE7273B	PMCN6140C	NUE7273B	NCN6140C	
H01SDC9AA3AN	UHF B2 16-F Closed 4-1W	NUE7214A	NTN7090A	NUE7232C	NCN6129B	D64W
H01SDC9AA3BN	UHF B2 16-F Closed 4-1W	NUE7214B	NTN7092B	NUE7232C	NCN6129B	D64W
H01SDC9AA3CN	UHF B2 16-F Closed 4-1W	NUE7214C	NCN6129A	NUE7232C	NCN6129B	D64W
H01SDC9AA3CN	UHF B2 16-F Closed 4-1W	NUE7214C	NCN6129B	NUE7232C	NCN6129B	D64W
H01SDC9AA3DN	UHF B2 16-F Closed 4-1W	NUE7232C	NCN6129C	NUE7232C	NCN6140C	D64W
H01SDC9AA3DN	UHF B2 16-F Closed 4-1W	NUE7268A	NCN6141A	NUE7268B	NCN6140C	F91P-3
H01SDC9AA3DN	UHF B2 16-F Closed 4-1W	NUE7268B	NCN6141B	NUE7268B	NCN6140C	F91P-3

Appendix B Table 1. HT 1000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacement		
				Xcvr Bd	Ctrl Bd	Codeplug
H01SDC9AA3DN	UHF B2 16-F Closed 4-1W	NUE7268B	NCN6140C	NUE7268B	NCN6140C	F91P-3
H01SDC9AA3DN	UHF B2 16-F Closed 4-1W	NUE7273B	NCN6140C	NUE7273B	NCN6140C	F91P-3
H01SDC9AA3DN	UHF B2 16-F Closed 4-1W	PMUE7273B	PMCN6140C	NUE7273B	NCN6140C	
H01UCC6AA3AN	800MHz 16-F Closed 3W	NUF6394A	NTN7090A	NUF6394B	NCN6129B	D64W
H01UCC6AA3BN	800MHz 16-F Closed 3W	NUF6394B	NTN7092B	NUF6394B	NCN6129B	D64W
H01UCC6AA3CN	800MHz 16-F Closed 3W	NUF6394B	NCN6129A	NUF6394B	NCN6129B	D64W
H01UCC6AA3CN	800MHz 16-F Closed 3W	NUF6394B	NCN6129B	NUF6394B	NCN6129B	D64W
H01UCC6AA3DN	800MHz 16-F Closed 3W	NUF6394B	NCN6129C	NUF6394B	NCN6140C	D64W
H01UCC6AA3DN	800MHz 16-F Closed 3W	NUF6497A	NCN6145A	NUF6497B	NCN6140C	F91P-3
H01UCC6AA3DN	800MHz 16-F Closed 3W	NUF6497B	NCN6145B	NUF6497B	NCN6140C	F91P-3
H01UCC6AA3DN	800MHz 16-F Closed 3W	NUF6497B	NCN6140C	NUF6497B	NCN6140C	F91P-3
H01UCC6AA3DN	800MHz 16-F Closed 3W	NUF6500D	NCN6140C	NUF6500D	NCN6140C	F91P-3
H01UCC6AA3DN	800MHz 16-F Closed 3W	PMUF6500D	PMCN6140C	NUF6500D	NCN6140C	

Appendix B Table 2. JT 1000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcyr Bd	Ctrl Bd	Codeplug
H01KDH9PA3AN	VHF 16-Ch Front Display	NUD7070A	NTN7089A	NUD7070E	NCN6146A	D64W
H01KDH9PA3AN	VHF 16-Ch Front Display	NUD7070B	NTN7089B	NUD7070E	NCN6146A	D64W
H01KDH9PA3AN	VHF 16-Ch Front Display	NUD7070C	NTN7089C	NUD7070E	NCN6146A	D64W
H01KDH9PA3AN	VHF 16-Ch Front Display	NUD7070E	NTN7089C	NUD7070E	NCN6146A	D64W
H01KDH9PA3AN	VHF 16-Ch Front Display	NUD7095A	NCN6146A	NUD7095B	NCN6146A	F91P-3
H01KDH9PA3AN	VHF 16-Ch Front Display	NUD7095B	NCN6146A	NUD7095B	NCN6146A	F91P-3
H01KDH9PA3AN	VHF 16-Ch Front Display	PMUD7095B	NCN6146A	NUD7095B	NCN6146A	
H01RDH9PA3AN	UHF B1 16 Ch Front Display	NUE7213B	NTN7089B	NUE7213C	NCN6146A	D64W
H01RDH9PA3AN	UHF B1 16-Ch Front Display	NUE7213C	NTN7089C	NUE7213C	NCN6146A	D64W
H01RDH9PA3AN	UHF B1 16-Ch Front Display	NUE7272A	NCN6146A	NUE7272B	NCN6146A	F91P-3
H01RDH9PA3AN	UHF B1 16-Ch Front Display	NUE7272B	NCN6146A	NUE7272B	NCN6146A	F91P-3
H01RDH9PA3AN	UHF B1 16-Ch Front Display	PMUE7272B	NCN6146A	NUE7272B	NCN6146A	
H01SDH9PA3AN	UHF B2 16-Ch Front Display	NUE7214B	NTN7089B	NUE7232C	NCN6146A	D64W
H01SDH9PA3AN	UHF B2 16-Ch Front Display	NUE7214C	NTN7089C	NUE7232C	NCN6146A	D64W
H01SDH9PA3AN	UHF B2 16-Ch Front Display	NUE7232C	NTN7089C	NUE7232C	NCN6146A	D64W
H01SDH9PA3AN	UHF B2 16-Ch Front Display	NUE7273A	NCN6146A	NUE7273B	NCN6146A	F91P-3
H01SDH9PA3AN	UHF B2 16-Ch Front Display	NUE7273B	NCN6146A	NUE7273B	NCN6146A	F91P-3

Appendix B Table 2. JT 1000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01SDH9PA3AN	UHF B2 16-Ch Front Display	PMUE7273B	NCN6146A	NUE7273B	NCN6146A	

Appendix B Table 3. MT 2000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01KDD9AA4AN	VHF 48-F Top Display 5-1W	NUD7070A	NLD8896A	NUD7070E	NCN6147A	D64W
H01KDD9AA4AN	VHF 48-F Top Display 5-1W	NUD7070B	NTN7091C	NUD7070E	NCN6147A	D64W
H01KDD9AA4AN	VHF 48-F Top Display 5-1W	NUD7070C	NTN7091C	NUD7070E	NCN6147A	D64W
H01KDD9AA4AN	VHF 48-F Top Display 5-1W	NUD7070D	NTN7091D	NUD7070E	NCN6147A	D64W
H01KDD9AA4AN	VHF 48-F Top Display 5-1W	NUD7070E	NTN7091D	NUD7070E	NCN6147A	D64W
H01KDD9AA4AN	VHF 48-F Top Display 5-1W	NUD7095A	NCN6147A	NUD7095B	NCN6147A	F91P-3
H01KDD9AA4AN	VHF 48-F Top Display 5-1W	NUD7095B	NCN6147A	NUD7095B	NCN6147A	F91P-3
H01KDD9AA4AN	VHF 48-F Top Display 5-1W	NUD7095B	NCN6147B	NUD7095B	NCN6147B	F91P-3
H01KDD9AA4AN	VHF 48-F Top Display 5-1W	PMUD7095B	PMCN6147B	NUD7095B	NCN6147B	
H01KDH9AA7AN	VHF 16-Ch Front Display 5-1W	NUD7070A	NTN7091A	NUD7070E	NCN6147A	D64W
H01KDH9AA7AN	VHF 16-Ch Front Display 5-1W	NUD7070B	NTN7091C	NUD7070E	NCN6147A	D64W
H01KDH9AA7AN	VHF 16-Ch Front Display 5-1W	NUD7070C	NTN7091C	NUD7070E	NCN6147A	D64W
H01KDH9AA7AN	VHF 16-Ch Front Display 5-1W	NUD7070D	NTN7091D	NUD7070E	NCN6147A	D64W
H01KDH9AA7AN	VHF 16-Ch Front Display 5-1W	NUD7070E	NTN7091D	NUD7070E	NCN6147A	D64W
H01KDH9AA7AN	VHF 16-Ch Front Display 5-1W	NUD7095A	NCN6147A	NUD7095B	NCN6147A	F91P-3
H01KDH9AA7AN	VHF 16-Ch Front Display 5-1W	NUD7095B	NCN6147A	NUD7095B	NCN6147A	F91P-3
H01KDH9AA7AN	VHF 16-Ch Front Display 5-1W	NUD7095B	NCN6147B	NUD7095B	NCN6147B	F91P-3
H01KDH9AA7AN	VHF 16-Ch Front Display 5-1W	PMUD7095B	PMCN6147B	NUD7095B	NCN6147B	
H01RDD9AA4AN	UHF B1 48-F Open Top Display 4-1W	NCN6111AU HF Only	NTN7091A	NUE7231C	NCN6147A	D64W
H01RDD9AA4AN	UHF B1 48-F Open Top Display 4-1W	NUE7213B	NTN7091B	NUE7231C	NCN6147A	D64W
H01RDD9AA4AN	UHF B1 48-F Open Top Display 4-1W	NUE7231C	NTN7091B	NUE7231C	NCN6147A	D64W

Appendix B Table 3. MT 2000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01RDD9AA4AN	UHF B1 48-F Open Top Display 4-1W	NUE7231C	NTN7091D	NUE7231C	NCN6147A	D64W
H01RDD9AA4AN	UHF B1 48-F Open Top Display 4-1W	NUE7272A	NCN6147A	NUE7272B	NCN6147A	F91P-3
H01RDD9AA4AN	UHF B1 48-F Open Top Display 4-1W	NUE7272B	NCN6147A	NUE7272B	NCN6147A	F91P-3
H01RDD9AA4AN	UHF B1 48-F Open Top Display 4-1W	NUE7272B	NCN6147B	NUE7272B	NCN6147B	F91P-3
H01RDD9AA4AN	UHF B1 48-F Open Top Display 4-1W	PMUE7272B	PMCN6147B	NUE7272B	NCN6147B	
H01RDH9AA7AN	UHF B1 16-Ch Front Display 4-1W	NUE7213A	NTN7091A	NUE7231C	NCN6147A	D64W
H01RDH9AA7AN	UHF B1 16-Ch Front Display 4-1W	NUE7213B	NTN7091B	NUE7231C	NCN6147A	D64W
H01RDH9AA7AN	UHF B1 16-Ch Front Display 4-1W	NUE7231C	NTN7091B	NUE7231C	NCN6147A	D64W
H01RDH9AA7AN	UHF B1 16-Ch Front Display 4-1W	NUE7231C	NTN7091D	NUE7231C	NCN6147A	D64W
H01RDH9AA7AN	UHF B1 16-Ch Front Display 4-1W	NUE7272A	NCN6147A	NUE7272B	NCN6147A	F91P-3
H01RDH9AA7AN	UHF B1 16-Ch Front Display 4-1W	NUE7272B	NCN6147A	NUE7272B	NCN6147A	F91P-3
H01RDH9AA7AN	UHF B1 16-Ch Front Display 4-1W	NUE7272B	NCN6147B	NUE7272B	NCN6147B	F91P-3
H01RDH9AA7AN	UHF B1 16-Ch Front Display 4-1W	PMUE7272B	PMCN6147B	NUE7272B	NCN6147B	
H01SDD9AA4AN	UHF B2 48-F Top Display 4-1W	NUE7214A	NCN6111AU HF Only	NUE7232C	NCN6147A	D64W
H01SDD9AA4AN	UHF B2 48-F Top Display 4-1W	NUE7214B	NTN7091B	NUE7232C	NCN6147A	D64W
H01SDD9AA4AN	UHF B2 48-F Top Display 4-1W	NUE7232C	NTN7091B	NUE7232C	NCN6147A	D64W
H01SDD9AA4AN	UHF B2 48-F Top Display 4-1W	NUE7232C	NTN7091D	NUE7232C	NCN6147A	D64W
H01SDD9AA4AN	UHF B2 48-F Top Display 4-1W	NUE7273A	NCN6147A	NUE7273B	NCN6147A	F91P-3
H01SDD9AA4AN	UHF B2 48-F Top Display 4-1W	NUE7273B	NCN6147A	NUE7273B	NCN6147A	F91P-3
H01SDD9AA4AN	UHF B2 48-F Top Display 4-1W	NUE7273B	NCN6147B	NUE7273B	NCN6147B	F91P-3
H01SDD9AA4AN	UHF B2 48-F Top Display 4-1W	PMUE7273B	PMCN6147B	NUE7273B	NCN6147B	

Appendix B Table 3. MT 2000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01SDH9AA7AN	UHF B2 16-Ch Front Display 4-1W	NUE7214A	NTN7091A	NUE7232C	NCN6147A	D64W
H01SDH9AA7AN	UHF B2 16-Ch Front Display 4-1W	NUE7214B	NTN7091B	NUE7232C	NCN6147A	D64W
H01SDH9AA7AN	UHF B2 16-Ch Front Display 4-1W	NUE7232C	NTN7091B	NUE7232C	NCN6147A	D64W
H01SDH9AA7AN	UHF B2 16-Ch Front Display 4-1W	NUE7232C	NTN7091D	NUE7232C	NCN6147A	D64W
H01SDH9AA7AN	UHF B2 16-Ch Front Display 4-1W	NUE7273A	NCN6147A	NUE7273B	NCN6147A	F91P-3
H01SDH9AA7AN	UHF B2 16-Ch Front Display 4-1W	NUE7273B	NCN6147A	NUE7273B	NCN6147A	F91P-3
H01SDH9AA7AN	UHF B2 16-Ch Front Display 4-1W	NUE7273B	NCN6147B	NUE7273B	NCN6147B	F91P-3
H01SDH9AA7AN	UHF B2 16-Ch Front Display 4-1W	PMUE7273B	PMCN6147B	NUE7273B	NCN6147B	
H01UCD6AA4AN	800MHz 48-F Top Display 4-1W	NUF6394A	NTN7091A	NUF6394B	NCN6147A	D64W
H01UCD6AA4AN	800MHz 48-F Top Display 4-1W	NUF6394B	NTN7091B	NUF6394B	NCN6147A	D64W
H01UCD6AA4AN	800MHz 48-F Top Display 4-1W	NUF6394B	NTN7091D	NUF6394B	NCN6147A	D64W
H01UCD6AA4AN	800MHz 48-F Top Display 4-1W	NUF6498A	NCN6147A	NUF6498B	NCN6147A	F91P-3
H01UCD6AA4AN	800MHz 48-F Top Display 4-1W	NUF6498B	NCN6147A	NUF6498B	NCN6147A	F91P-3
H01UCD6AA4AN	800MHz 48-F Top Display 4-1W	NUF6500D	NCN6147B	NUF6500D	NCN6147B	F91P-3
H01UCD6AA4AN	800MHz 48-F Top Display 4-1W	PMUF6500D	PMCN6147B	NUF6500D	NCN6147B	
H01UCH6AA7AN	800MHz 160-Ch 4-1W	NUF6394A	NTN7091A	NUF6394B	NCN6147A	D64W
H01UCH6AA7AN	800MHz 160-Ch 4-1W	NUF6394B	NTN7091B	NUF6394B	NCN6147A	D64W
H01UCH6AA7AN	800MHz 160-Ch 4-1W	NUF6394B	NTN7091D	NUF6394B	NCN6147A	D64W
H01UCH6AA7AN	800MHz 160-Ch 4-1W	NUF6498A	NCN6147A	NUF6498B	NCN6147A	F91P-3
H01UCH6AA7AN	800MHz 160-Ch 4-1W	NUF6498B	NCN6147A	NUF6498B	NCN6147A	F91P-3
H01UCH6AA7AN	800MHz 160-Ch 4-1W	NUF6500D	NCN6147B	NUF6500D	NCN6147B	F91P-3
H01UCH6AA7AN	800MHz 160-Ch 4-1W	PMUF6500D	PMCN6147B	NUF6500D	NCN6147B	

Appendix B Table 4. MTS 2000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01KDD9PW1AN	VHF 3-SYS/Zone Top Display	NUD7070A	NTN7091A			
H01KDD9PW1BN	VHF 16-Mode Top Display 5-1W	NUD7070A	NLD8897A	NUD7070E	NCN6150A	D64W
H01KDD9PW1BN	VHF 16-Mode Top Display 5-1W	NUD7070B	NTN7620D	NUD7070E	NCN6150A	D64W
H01KDD9PW1BN	VHF 16-Mode Top Display 5-1W	NUD7070C	NTN7620D	NUD7070E	NCN6150A	D64W
H01KDD9PW1BN	VHF 16-Mode Top Display 5-1W	NUD7070D	NTN7620E	NUD7070E	NCN6150A	D64W
H01KDD9PW1BN	VHF 16-Mode Top Display 5-1W	NUD7070E	NTN7620E	NUD7070E	NCN6150A	D64W
H01KDD9PW1BN	VHF 16-Mode Top Display 5-1W	NUD7095A	NCN6150A	NUD7095B	NCN6150A	F91P-3
H01KDD9PW1BN	VHF 16-Mode Top Display 5-1W	NUD7095B	NCN6150A	NUD7095B	NCN6150A	F91P-3
H01KDD9PW1BN	VHF 16-Mode Top Display 5-1W	NUD7095B	NCN6150B	NUD7095B	NCN6150B	F91P-3
H01KDD9PW1BN	VHF 16-Mode Top Display 5-1W	PMUD7095B	PMCN6150B	NUD7095B	NCN6150B	
H01KDF9PW1AN	VHF 16-Mode Front Display Limited Keypad 5-1W	NUD7070A	NTN7091A	NUD7070E	NCN6150A	D64W
H01KDF9PW1BN	VHF 16-Mode Front Display Limited Keypad 5-1W	NUD7070B	NLD8897A	NUD7070E	NCN6150A	D64W
H01KDF9PW1BN	VHF 16-Mode Front Display Limited Keypad 5-1W	NUD7070C	NTN7620D	NUD7070E	NCN6150A	D64W
H01KDF9PW1BN	VHF 16-Mode Front Display Limited Keypad 5-1W	NUD7070D	NTN7620E	NUD7070E	NCN6150A	D64W
H01KDF9PW1BN	VHF 16-Mode Front Display Limited Keypad 5-1W	NUD7070E	NTN7620E	NUD7070E	NCN6150A	D64W
H01KDF9PW1BN	VHF 16-Mode Front Display Limited Keypad 5-1W	NUD7095A	NCN6150A	NUD7095B	NCN6150A	F91P-3
H01KDF9PW1BN	VHF 16-Mode Front Display Limited Keypad 5-1W	NUD7095B	NCN6150A	NUD7095B	NCN6150A	F91P-3
H01KDF9PW1BN	VHF 16-Mode Front Display Limited Keypad 5-1W	NUD7095B	NCN6150B	NUD7095B	NCN6150B	F91P-3
H01KDF9PW1BN	VHF 16-Mode Front Display Limited Keypad 5-1W	PMUD7095B	PMCN6150B	NUD7095B	NCN6150B	
H01KDH9PW1AN	VHF 16-Mode Front Display Full Keypad 5-1W	NUD7070A	NTN7091A	NUD7070E	NCN6150A	D64W
H01KDH9PW1BN	VHF 16-Mode Front Display Full Keypad 5-1W	NUD7070B	NLD8897A	NUD7070E	NCN6150A	D64W

Appendix B Table 4. MTS 2000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01KDH9PW1BN	VHF 16-Mode Front Display Full Keypad 5-1W	NUD7070C	NTN7620D	NUD7070E	NCN6150A	D64W
H01KDH9PW1BN	VHF 16-Mode Front Display Full Keypad 5-1W	NUD7070D	NTN7620E	NUD7070E	NCN6150A	D64W
H01KDH9PW1BN	VHF 16-Mode Front Display Full Keypad 5-1W	NUD7070E	NTN7620E	NUD7070E	NCN6150A	D64W
H01KDH9PW1BN	VHF 16-Mode Front Display Full Keypad 5-1W	NUD7095A	NCN6150A	NUD7095B	NCN6150A	F91P-3
H01KDH9PW1BN	VHF 16-Mode Front Display Full Keypad 5-1W	NUD7095B	NCN6150A	NUD7095B	NCN6150A	F91P-3
H01KDH9PW1BN	VHF 16-Mode Front Display Full Keypad 5-1W	NUD7095B	NCN6150B	NUD7095B	NCN6150B	F91P-3
H01KDH9PW1BN	VHF 16-Mode Front Display Full Keypad 5-1W	PMUD7095B	PMCN6150 B	NUD7095B	NCN6150B	
H01RDD9PW1AN	UHF B1 16-Mode 4-1W	NUE7213A	NTN7091A	NUE7231C	NCN6150A	D64W
H01RDD9PW1BN	UHF B1 16-Mode 4-1W	NUE7231B	NTN7620C	NUE7231C	NCN6150A	D64W
H01RDD9PW1BN	UHF B1 16-Mode Top Display 4-1W	NUE7231C	NTN7620C	NUE7231C	NCN6150A	D64W
H01RDD9PW1BN	UHF B1 16-Mode Top Display 4-1W	NUE7231C	NTN7620E	NUE7231C	NCN6150A	D64W
H01RDD9PW1BN	UHF B1 16-Mode Top Display 4-1W	NUE7272A	NCN6150A	NUE7272B	NCN6150A	F91P-3
H01RDD9PW1BN	UHF B1 16-Mode Top Display 4-1W	NUE7272B	NCN6150A	NUE7272B	NCN6150A	F91P-3
H01RDD9PW1BN	UHF B1 16-Mode Top Display 4-1W	NUE7272B	NCN6150B	NUE7272B	NCN6150B	F91P-3
H01RDD9PW1BN	UHF B1 16-Mode Top Display 4-1W	PMUE7272B	PMCN6150 B	NUE7272B	NCN6150B	
H01RDF9PW1AN	UHF B1 16-Mode 4-1W	NUE7213A	NTN7091A	NUE7231C	NCN6150A	D64W
H01RDF9PW1BN	UHF B1 16-Mode 4-1W	NUE7231B	NTN7620C	NUE7231C	NCN6150A	D64W
H01RDF9PW1BN	UHF B1 16-Mode Front Display Limited Keypad 4-1W	NUE7231C	NTN7620C	NUE7231C	NCN6150A	D64W
H01RDF9PW1BN	UHF B1 16-Mode Front Display Limited Keypad 4-1W	NUE7231C	NTN7620E	NUE7231C	NCN6150A	D64W
H01RDF9PW1BN	UHF B1 16-Mode Front Display Limited Keypad 4-1W	NUE7272A	NCN6150A	NUE7272B	NCN6150A	F91P-3
H01RDF9PW1BN	UHF B1 16-Mode Front Display Limited Keypad 4-1W	NUE7272B	NCN6150A	NUE7272B	NCN6150A	F91P-3

Appendix B Table 4. MTS 2000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01RDF9PW1BN	UHF B1 16-Mode Front Display Limited Keypad 4-1W	NUE7272B	NCN6150B	NUE7272B	NCN6150B	F91P-3
H01RDF9PW1BN	UHF B1 16-Mode Front Display Limited Keypad 4-1W	PMUE7272B	PMCN6150B	NUE7272B	NCN6150B	
H01RDH9PW1AN	UHF B1 16-Mode 4-1W	NUE7213A	NTN7091A	NUE7231C	NCN6150A	D64W
H01RDH9PW1BN	UHF B1 16-Mode 4-1W	NUE7231B	NTN7620C	NUE7231C	NCN6150A	D64W
H01RDH9PW1BN	UHF B1 16-Mode Front Display Full Keypad 4-1W	NUE7231C	NTN7620C	NUE7231C	NCN6150A	D64W
H01RDH9PW1BN	UHF B1 16-Mode Front Display Full Keypad 4-1W	NUE7231C	NTN7620E	NUE7231C	NCN6150A	D64W
H01RDH9PW1BN	UHF B1 16-Mode Front Display Full Keypad 4-1W	NUE7272A	NCN6150A	NUE7272B	NCN6150A	F91P-3
H01RDH9PW1BN	UHF B1 16-Mode Front Display Full Keypad 4-1W	NUE7272B	NCN6150A	NUE7272B	NCN6150A	F91P-3
H01RDH9PW1BN	UHF B1 16-Mode Front Display Full Keypad 4-1W	NUE7272B	NCN6150B	NUE7272B	NCN6150B	F91P-3
H01RDH9PW1BN	UHF B1 16-Mode Front Display Full Keypad 4-1W	PMUE7272B	PMCN6150B	NUE7272B	NCN6150B	
H01SDD9PW1AN	UHF B2 16-Mode 4-1W	NUE7214A	NTN7091A	NUE7232C	NCN6150A	D64W
H01SDD9PW1BN	UHF B2 16-Mode 4-1W	NUE7232B	NTN7620C	NUE7232C	NCN6150A	D64W
H01SDD9PW1BN	UHF B2 16-Mode Top Display 4-1W	NUE7232C	NTN7620C	NUE7232C	NCN6150A	D64W
H01SDD9PW1BN	UHF B2 16-Mode Top Display 4-1W	NUE7232C	NTN7620E	NUE7232C	NCN6150A	D64W
H01SDD9PW1BN	UHF B2 16-Mode Top Display 4-1W	NUE7273A	NCN6150A	NUE7273B	NCN6150A	F91P-3
H01SDD9PW1BN	UHF B2 16-Mode Top Display 4-1W	NUE7273B	NCN6150A	NUE7273B	NCN6150A	F91P-3
H01SDD9PW1BN	UHF B2 16-Mode Top Display 4-1W	NUE7273B	NCN6150B	NUE7273B	NCN6150B	F91P-3
H01SDD9PW1BN	UHF B2 16-Mode Top Display 4-1W	PMUE7273B	PMCN6150B	NUE7273B	NCN6150B	
H01SDF9PW1AN	UHF B2 16-Mode 4-1W	NUE7214A	NTN7091A	NUE7232C	NCN6150A	D64W
H01SDF9PW1BN	UHF B2 16-Mode 4-1W	NUE7232B	NTN7620C	NUE7232C	NCN6150A	D64W
H01SDF9PW1BN	UHF B2 16-Mode Front Display Limited Keypad 4-1W	NUE7232C	NTN7620C	NUE7232C	NCN6150A	D64W
H01SDF9PW1BN	UHF B2 16-Mode Front Display Limited Keypad 4-1W	NUE7232C	NTN7620E	NUE7232C	NCN6150A	D64W

Appendix B Table 4. MTS 2000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01SDF9PW1BN	UHF B2 16-Mode Front Display Limited Keypad 4-1W	NUE7273A	NCN6150A	NUE7273B	NCN6150A	F91P-3
H01SDF9PW1BN	UHF B2 16-Mode Front Display Limited Keypad 4-1W	NUE7273B	NCN6150A	NUE7273B	NCN6150A	F91P-3
H01SDF9PW1BN	UHF B2 16-Mode Front Display Limited Keypad 4-1W	NUE7273B	NCN6150B	NUE7273B	NCN6150B	F91P-3
H01SDF9PW1BN	UHF B2 16-Mode Front Display Limited Keypad 4-1W	PMUE7273B	PMCN6150B	NUE7273B	NCN6150B	
H01SDH9PW1AN	UHF B2 16-Mode 4-1W	NUE7214A	NTN7091A	NUE7232C	NCN6150A	D64W
H01SDH9PW1BN	UHF B2 16-Mode 4-1W	NUE7232B	NTN7620C	NUE7232C	NCN6150A	D64W
H01SDH9PW1BN	UHF B2 16-Mode Front Display Full Keypad4-1W	NUE7232C	NTN7620C	NUE7232C	NCN6150A	D64W
H01SDH9PW1BN	UHF B2 16-Mode Front Display Full Keypad4-1W	NUE7232C	NTN7620E	NUE7232C	NCN6150A	D64W
H01SDH9PW1BN	UHF B2 16-Mode Front Display Full Keypad4-1W	NUE7273A	NCN6150A	NUE7273B	NCN6150A	F91P-3
H01SDH9PW1BN	UHF B2 16-Mode Front Display Full Keypad4-1W	NUE7273B	NCN6150A	NUE7273B	NCN6150A	F91P-3
H01SDH9PW1BN	UHF B2 16-Mode Front Display Full Keypad4-1W	NUE7273B	NCN6150B	NUE7273B	NCN6150B	F91P-3
H01SDH9PW1BN	UHF B2 16-Mode Front Display Full Keypad4-1W	PMUE7273B	PMCN6150B	NUE7273B	NCN6150B	
H01UCD6PW1AN	800MHz 16-Mode 3W	NUF6410A	NTN7091A	NUF6410B	NCN6150A	D64W
H01UCD6PW1BN	800MHz 16-Mode 3W	NUF6410B	NTN7620C	NUF6410B	NCN6150A	D64W
H01UCD6PW1BN	800MHz 16-Mode Top Display 3W	NUF6410B	NTN7620D	NUF6410B	NCN6150A	D64W
H01UCD6PW1BN	800MHz 16-Mode Top Display 3W	NUF6410B	NTN7620E	NUF6410B	NCN6150A	D64W
H01UCD6PW1BN	800MHz 16-Mode Top Display 3W	NUF6500A	NCN6150A	NUF6500B	NCN6150A	F91P-3
H01UCD6PW1BN	800MHz 16-Mode Top Display 3W	NUF6500B	NCN6150A	NUF6500B	NCN6150A	F91P-3
H01UCD6PW1BN	800MHz 16-Mode Top Display 3W	NUF6500D	NCN6150B	NUF6500D	NCN6150B	F91P-3
H01UCD6PW1BN	800MHz 16-Mode Top Display 3W	PMUF6500D	PMCN6150B	NUF6500D	NCN6150B	
H01UCF6PW1AN	800MHz 16-Mode 3W	NUF6410A	NTN7091A	NUF6410B	NCN6150A	D64W
H01UCF6PW1BN	800MHz 16-Mode 3W	NUF6410B	NTN7620C	NUF6410B	NCN6150A	D64W

Appendix B Table 4. MTS 2000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01UCF6PW1BN	800MHz 16-Mode Front Display Limited Keypad 3W	NUF6410B	NTN7620D	NUF6410B	NCN6150A	D64W
H01UCF6PW1BN	800MHz 16-Mode Front Display Limited Keypad 3W	NUF6410B	NTN7620E	NUF6410B	NCN6150A	D64W
H01UCF6PW1BN	800MHz 16-Mode Front Display Limited Keypad 3W	NUF6500A	NCN6150A	NUF6500B	NCN6150A	F91P-3
H01UCF6PW1BN	800MHz 16-Mode Front Display Limited Keypad 3W	NUF6500B	NCN6150A	NUF6500B	NCN6150A	F91P-3
H01UCF6PW1BN	800MHz 16-Mode Front Display Limited Keypad 3W	NUF6500D	NCN6150B	NUF6500D	NCN6150B	F91P-3
H01UCF6PW1BN	800MHz 16-Mode Front Display Limited Keypad 3W	PMUF6500D	PMCN6150B	NUF6500D	NCN6150B	
H01UCH6PW1AN	800MHz 16-Mode 3W	NUF6410A	NTN7091A	NUF6410B	NCN6150A	D64W
H01UCH6PW1BN	800MHz 16-Mode 3W	NUF6410B	NTN7620C	NUF6410B	NCN6150A	D64W
H01UCH6PW1BN	800MHz 16-Mode Front Display Full Keypad 3W	NUF6410B	NTN7620D	NUF6410B	NCN6150A	D64W
H01UCH6PW1BN	800MHz 16-Mode Front Display Full Keypad 3W	NUF6410B	NTN7620E	NUF6410B	NCN6150A	D64W
H01UCH6PW1BN	800MHz 16-Mode Front Display Full Keypad 3W	NUF6500A	NCN6150A	NUF6500B	NCN6150A	F91P-3
H01UCH6PW1BN	800MHz 16-Mode Front Display Full Keypad 3W	NUF6500B	NCN6150A	NUF6500B	NCN6150A	F91P-3
H01UCH6PW1BN	800MHz 16-Mode Front Display Full Keypad 3W	NUF6500D	NCN6150B	NUF6500D	NCN6150B	F91P-3
H01UCH6PW1BN	800MHz 16-Mode Front Display Full Keypad 3W	PMUF6500D	PMCN6150B	NUF6500D	NCN6150B	
H01WCD4PW1AN	900MHz 16-Mode 2.4W (Typ.), 2.9W (Max.)	NUF6395A	NTN7093A	NUF6395C	NCN 6153A	D64W
H01WCD4PW1BN	900MHz 16-Mode 2.4W (Typ.), 2.9W (Max.)	NUF6395C	NTN7093B	NUF6395C	NCN 6153A	D64W
H01WCD4PW1CN	900MHz 16-Mode Top Display 2.4W (Typ.), 2.9W (Max.)	NUF6395C	NCN6106C	NUF6395C	NCN 6153A	D64W
H01WCD4PW1CN	900MHz 16-Mode Top Display 2.4W (Typ.), 2.9W (Max.)	NUF6499A	NCN 6153A	NUF6499B	NCN 6153A	F91P-3
H01WCD4PW1CN	900MHz 16-Mode Top Display 2.4W (Typ.), 2.9W (Max.)	NUF6499B	NCN 6153A	NUF6499B	NCN 6153A	F91P-3
H01WCD4PW1CN	900MHz 16-Mode Top Display 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN 6153A	NUF6499D	NCN 6153A	F91P-3

Appendix B Table 4. MTS 2000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01WCD4PW1CN	900MHz 16-Mode Top Display 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN 6153B	NUF6499D	NCN 6153B	F91P-3
H01WCD4PW1CN	900MHz 16-Mode Top Display 2.4W (Typ.), 2.9W (Max.)	PMUF6499D	PMCN 6153B	NUF6499D	NCN 6153B	
H01WCF4PW1AN	900MHz 16-Mode 2.4W (Typ.), 2.9W (Max.)	NUF6395A	NTN7093A	NUF6395C	NCN 6153A	D64W
H01WCF4PW1BN	900MHz 16-Mode 2.4W (Typ.), 2.9W (Max.)	NUF6395C	NTN7093B	NUF6395C	NCN 6153A	D64W
H01WCF4PW1CN	900MHz 16-Mode Front Display Limited Keypad 2.4W (Typ.), 2.9W (Max.)	NUF6395C	NCN6106C	NUF6395C	NCN 6153A	D64W
H01WCF4PW1CN	900MHz 16-Mode Front Display Limited Keypad 2.4W (Typ.), 2.9W (Max.)	NUF6499A	NCN 6153A	NUF6499B	NCN 6153A	F91P-3
H01WCF4PW1CN	900MHz 16-Mode Front Display Limited Keypad 2.4W (Typ.), 2.9W (Max.)	NUF6499B	NCN 6153A	NUF6499B	NCN 6153A	F91P-3
H01WCF4PW1CN	900MHz 16-Mode Front Display Limited Keypad 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN 6153A	NUF6499D	NCN 6153A	F91P-3
H01WCF4PW1CN	900MHz 16-Mode Front Display Limited Keypad 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN 6153B	NUF6499D	NCN 6153B	F91P-3
H01WCF4PW1CN	900MHz 16-Mode Front Display Limited Keypad 2.4W (Typ.), 2.9W (Max.)	PMUF6499D	PMCN 6153B	NUF6499D	NCN 6153B	
H01WCH4PW1AN	900MHz 16-Mode 2.4W (Typ.), 2.9W (Max.)	NUF6395A	NTN7093A	NUF6395C	NCN 6153A	D64W
H01WCH4PW1BN	900MHz 16-Mode 2.4W (Typ.), 2.9W (Max.)	NUF6395C	NTN7093B	NUF6395C	NCN 6153A	D64W
H01WCH4PW1CN	900MHz 16-Mode Front Display Full Keypad 2.4W (Typ.), 2.9W (Max.)	NUF6395C	NCN6106C	NUF6395C	NCN 6153A	D64W
H01WCH4PW1CN	900MHz 16-Mode Front Display Full Keypad 2.4W (Typ.), 2.9W (Max.)	NUF6499A	NCN 6153A	NUF6499B	NCN 6153A	F91P-3
H01WCH4PW1CN	900MHz 16-Mode Front Display Full Keypad 2.4W (Typ.), 2.9W (Max.)	NUF6499B	NCN 6153A	NUF6499B	NCN 6153A	F91P-3
H01WCH4PW1CN	900MHz 16-Mode Front Display Full Keypad 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN 6153A	NUF6499D	NCN 6153A	F91P-3

Appendix B Table 4. MTS 2000 Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01WCH4PW1CN	900MHz 16-Mode Front Display Full Keypad 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN 6153B	NUF6499D	NCN 6153B	F91P-3
H01WCH4PW1CN	900MHz 16-Mode Front Display Full Keypad 2.4W (Typ.), 2.9W (Max.)	PMUF6499D	PMCN 6153B	NUF6499D	NCN 6153B	

Appendix B Table 5. MTX Series Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01KDC9DB3AN	MTX838 VHF 16-Mode 5-1W	NUD7085A	NTN7857A	NUD7085E	NCN6147A	D64W
H01KDC9DB3AN	MTX838 VHF 16-Mode 5-1W	NUD7085B	NTN7857C	NUD7085E	NCN6147A	D64W
H01KDC9DB3AN	MTX838 VHF 16-Mode Closed 5-1W	NUD7085C	NTN7857D	NUD7085E	NCN6147A	D64W
H01KDC9DB3AN	MTX838 VHF 16-Mode Closed 5-1W	NUD7085E	NTN7857D	NUD7085E	NCN6147A	D64W
H01KDC9DB3AN	MTX838 VHF 16-Mode Closed 5-1W	NUD7096A	NCN6147A	NUD7096B	NCN6147A	F91P-3
H01KDC9DB3AN	MTX838 VHF 16-Mode Closed 5-1W	NUD7096B	NCN6147A	NUD7096B	NCN6147A	F91P-3
H01KDC9DB3AN	MTX838 VHF 16-Mode Closed 5-1W	NUD7095B	NCN6147B	NUD7095B	NCN6147B	F91P-3
H01KDC9DB3AN	MTX838 VHF 16-Mode Closed 5-1W	PMUD7095B	PMCN6147B	NUD7095B	NCN6147B	
H01KDD9DB4AN	MTX838 VHF 99-Mode Trunked 5-1W	NUD7085A	NTN7857A	NUD7085E	NCN6147A	D64W
H01KDD9DB4AN	MTX838 VHF 99-Mode Trunked 5-1W	NUD7085B	NTN7857C	NUD7085E	NCN6147A	D64W
H01KDD9DB4AN	MTX838 VHF 99-Mode Trunked 5-1W	NUD7085B	NTN7857C	NUD7085E	NCN6147A	D64W
H01KDD9DB4AN	MTX838 VHF 99-Mode Top Display Trunked 5-1W	NUD7085C	NTN7857D	NUD7085E	NCN6147A	D64W
H01KDD9DB4AN	MTX838 VHF 99-Mode Top Display Trunked 5-1W	NUD7085E	NTN7857D	NUD7085E	NCN6147A	D64W
H01KDD9DB4AN	MTX838 VHF 99-Mode Top Display Trunked 5-1W	NUD7096A	NCN6147A	NUD7096B	NCN6147A	F91P-3
H01KDD9DB4AN	MTX838 VHF 99-Mode Top Display Trunked 5-1W	NUD7096B	NCN6147A	NUD7096B	NCN6147A	F91P-3
H01KDD9DB4AN	MTX838 VHF 99-Mode Top Display Trunked 5-1W	NUD7095B	NCN6147B	NUD7095B	NCN6147B	F91P-3
H01KDD9DB4AN	MTX838 VHF 99-Mode Top Display Trunked 5-1W	PMUD7095B	PMCN6147B	NUD7095B	NCN6147B	

Appendix B Table 5. MTX Series Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01KDF9DB5AN	MTX838 VHF 160-Mode Trunked 5-1W	NUD7085A	NTN7512A	NUD7085E	NCN6147A	D64W
H01KDF9DB5AN	MTX838 VHF 160-Mode Trunked 5-1W	NUD7085B	NTN7512C	NUD7085E	NCN6147A	D64W
H01KDF9DB5AN	MTX838 VHF 160-Mode Front Display Limited Keypad Trunked 5-1W	NUD7085C	NTN7512D	NUD7085E	NCN6147A	D64W
H01KDF9DB5AN	MTX838 VHF 160-Mode Front Display Limited Keypad Trunked 5-1W	NUD7085E	NTN7512D	NUD7085E	NCN6147A	D64W
H01KDF9DB5AN	MTX838 VHF 160-Mode Front Display Limited Keypad Trunked 5-1W	NUD7096A	NCN6147A	NUD7096B	NCN6147A	F91P-3
H01KDF9DB5AN	MTX838 VHF 160-Mode Front Display Limited Keypad Trunked 5-1W	NUD7096B	NCN6147A	NUD7096B	NCN6147A	F91P-3
H01KDF9DB5AN	MTX838 VHF 160-Mode Front Display Limited Keypad Trunked 5-1W	NUD7096B	NCN6147B	NUD7096B	NCN6147B	F91P-3
H01KDH9DB7AN	MTX838 VHF 160-Mode Trunked 5-1W	NUD7085B	NTN7512C	NUD7085E	NCN6147A	D64W
H01KDH9DB7AN	MTX838 VHF 160-Mode Trunked 5-1W	NUD7085B	NTN7512C	NUD7085E	NCN6147A	D64W
H01KDH9DB7AN	MTX838 VHF 160-Mode Front Display Full Keypad Trunked 5-1W	NUD7085C	NTN7512D	NUD7085E	NCN6147A	D64W
H01KDH9DB7AN	MTX838 VHF 160-Mode Front Display Full Keypad Trunked 5-1W	NUD7085E	NTN7512D	NUD7085E	NCN6147A	D64W
H01KDH9DB7AN	MTX838 VHF 160-Mode Front Display Full Keypad Trunked 5-1W	NUD7096A	NCN6147A	NUD7096B	NCN6147A	F91P-3
H01KDH9DB7AN	MTX838 VHF 160-Mode Front Display Full Keypad Trunked 5-1W	NUD7096B	NCN6147A	NUD7096B	NCN6147A	F91P-3
H01KDH9DB7AN	MTX838 VHF 160-Mode Front Display Full Keypad Trunked 5-1W	NUD7095B	NCN6147B	NUD7095B	NCN6147B	F91P-3
H01KDH9DB7AN	MTX838 VHF 160-Mode Front Display Full Keypad Trunked 5-1W	PMUD7095B	PMCN6147B	NUD7095B	NCN6147B	
H01RDC9DB3AN	MTX838 UHF B1 16-Mode Trunked 4-1W	NUE7240A	NTN7857A	NUE7240D	NCN6147A	D64W
H01RDC9DB3AN	MTX838 UHF B1 16-Mode Trunked 4-1W	NUE7240B	NTN7857C	NUE7240D	NCN6147A	D64W

Appendix B Table 5. MTX Series Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01RDC9DB3AN	MTX838 UHF B1 16-Mode Closed Trunked 4-1W	NUE7240C	NTN7857D	NUE7240D	NCN6147A	D64W
H01RDC9DB3AN	MTX838 UHF B1 16-Mode Closed Trunked 4-1W	NUE7240D	NTN7857D	NUE7240D	NCN6147A	D64W
H01RDC9DB3AN	MTX838 UHF B1 16-Mode Closed Trunked 4-1W	NUE7274A	NCN6147A	NUE7274B	NCN6147A	F91P-3
H01RDC9DB3AN	MTX838 UHF B1 16-Mode Closed Trunked 4-1W	NUE7274B	NCN6147A	NUE7274B	NCN6147A	F91P-3
H01RDC9DB3AN	MTX838 UHF B1 16-Mode Closed Trunked 4-1W	NUE7272B	NCN6147B	NUE7272B	NCN6147B	F91P-3
H01RDC9DB3AN	MTX838 UHF B1 16-Mode Closed Trunked 4-1W	PMUE7272 B	PMCN6147 B	NUE7272B	NCN6147B	
H01RDD9DB4AN	MTX838 UHF B1 99-Mode Trunked 4-1W	NUE7240A	NTN7857A	NUE7240D	NCN6147A	D64W
H01RDD9DB4AN	MTX838 UHF B1 99-Mode Trunked 4-1W	NUE7240B	NTN7857C	NUE7240D	NCN6147A	D64W
H01RDD9DB4AN	MTX838 UHF B1 99-Mode Top Display Trunked 4-1W	NUE7240C	NTN7857D	NUE7240D	NCN6147A	D64W
H01RDD9DB4AN	MTX838 UHF B1 99-Mode Top Display Trunked 4-1W	NUE7240D	NTN7857D	NUE7240D	NCN6147A	D64W
H01RDD9DB4AN	MTX838 UHF B1 99-Mode Top Display Trunked 4-1W	NUE7274A	NCN6147A	NUE7274B	NCN6147A	F91P-3
H01RDD9DB4AN	MTX838 UHF B1 99-Mode Top Display Trunked 4-1W	NUE7274D	NCN6147A	NUE7274B	NCN6147A	F91P-3
H01RDD9DB4AN	MTX838 UHF B1 99-Mode Top Display Trunked 4-1W	NUE7272B	NCN6147B	NUE7272B	NCN6147B	F91P-3
H01RDD9DB4AN	MTX838 UHF B1 99-Mode Top Display Trunked 4-1W	PMUE7272 B	PMCN6147 B	NUE7272B	NCN6147B	
H01RDF9DB5AN	MTX838 UHF B1 160-Mode Trunked 4-1W	NUE7240A	NTN7512A	NUE7240D	NCN6147A	D64W
H01RDF9DB5AN	MTX838 UHF B1 160-Mode Trunked 4-1W	NUE7240B	NTN7512C	NUE7240D	NCN6147A	D64W
H01RDF9DB5AN	MTX838 UHF B1 160-Mode Front Display Limited Keypad Trunked 4-1W	NUE7240C	NTN7512D	NUE7240D	NCN6147A	D64W
H01RDF9DB5AN	MTX838 UHF B1 160-Mode Front Display Limited Keypad Trunked 4-1W	NUE7240D	NTN7857D	NUE7240D	NCN6147A	D64W
H01RDF9DB5AN	MTX838 UHF B1 160-Mode Front Display Limited Keypad Trunked 4-1W	NUE7274A	NCN6147A	NUE7274B	NCN6147A	F91P-3
H01RDF9DB5AN	MTX838 UHF B1 160-Mode Front Display Limited Keypad Trunked 4-1W	NUE7274B	NCN6147A	NUE7274B	NCN6147A	F91P-3

Appendix B Table 5. MTX Series Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01RDF9DB5AN	MTX838 UHF B1 160-Mode Front Display Limited Keypad Trunked 4-1W	NUE7274B	NCN6147B	NUE7274B	NCN6147B	F91P-3
H01RDF9DB5AN	MTX838 UHF B1 160-Mode Front Display Limited Keypad Trunked 4-1W	PMUE7274 B	PMCN6147 B	NUE7274B	NCN6147B	
H01RDH9DB7AN	MTX838 UHF B1 160-Mode Trunked 4-1W	NUE7240A	NTN7512A	NUE7240D	NCN6147A	D64W
H01RDH9DB7AN	MTX838 UHF B1 160-Mode Trunked 4-1W	NUE7240B	NTN7512C	NUE7240D	NCN6147A	D64W
H01RDH9DB7AN	MTX838 UHF B1 160-Mode Front Display Full Keypad Trunked 4-1W	NUE7240C	NTN7512D	NUE7240D	NCN6147A	D64W
H01RDH9DB7AN	MTX838 UHF B1 160-Mode Front Display Full Keypad Trunked 4-1W	NUE7240D	NTN7512D	NUE7240D	NCN6147A	D64W
H01RDH9DB7AN	MTX838 UHF B1 160-Mode Front Display Full Keypad Trunked 4-1W	NUE7274A	NCN6147A	NUE7274B	NCN6147A	F91P-3
H01RDH9DB7AN	MTX838 UHF B1 160-Mode Front Display Full Keypad Trunked 4-1W	NUE7274B	NCN6147A	NUE7274B	NCN6147A	F91P-3
H01RDH9DB7AN	MTX838 UHF B1 160-Mode Front Display Full Keypad Trunked 4-1W	NUE7272B	NCN6147B	NUE7272B	NCN6147B	F91P-3
H01SDC9DB3AN	MTX838 UHF B2 16-Mode Trunked 4-1W	NUE7241A	NTN7857A	NUE7241D	NCN6147A	D64W
H01SDC9DB3AN	MTX838 UHF B2 16-Mode Trunked 4-1W	NUE7241B	NTN7857C	NUE7241D	NCN6147A	D64W
H01SDC9DB3AN	MTX838 UHF B2 16-Mode Closed Trunked 4-1W	NUE7241C	NTN7857D	NUE7241D	NCN6147A	D64W
H01SDC9DB3AN	MTX838 UHF B2 16-Mode Closed Trunked 4-1W	NUE7241D	NTN7857D	NUE7241D	NCN6147A	D64W
H01SDC9DB3AN	MTX838 UHF B2 16-Mode Closed Trunked 4-1W	NUE7275A	NCN6147A	NUE7275B	NCN6147A	F91P-3
H01SDC9DB3AN	MTX838 UHF B2 16-Mode Closed Trunked 4-1W	NUE7275B	NCN6147A	NUE7275B	NCN6147A	F91P-3
H01SDC9DB3AN	MTX838 UHF B2 16-Mode Closed Trunked 4-1W	NUE7275B	NCN6147B	NUE7275B	NCN6147B	F91P-3
H01SDD9DB4AN	MTX838 UHF B2 99-Mode Trunked 4-1W	NUE7241A	NTN7857A	NUE7241D	NCN6147A	D64W
H01SDD9DB4AN	MTX838 UHF B2 99-Mode Trunked 4-1W	NUE7241B	NTN7857C	NUE7241D	NCN6147A	D64W

Appendix B Table 5. MTX Series Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01SDD9DB4AN	MTX838 UHF B2 99-Mode Top Display Trunked 4-1W	NUE7241C	NTN7857D	NUE7241D	NCN6147A	D64W
H01SDD9DB4AN	MTX838 UHF B2 99-Mode Top Display Trunked 4-1W	NUE7241D	NTN7857D	NUE7241D	NCN6147A	D64W
H01SDD9DB4AN	MTX838 UHF B2 99-Mode Top Display Trunked 4-1W	NUE7275A	NCN6147A	NUE7275B	NCN6147A	F91P-3
H01SDD9DB4AN	MTX838 UHF B2 99-Mode Top Display Trunked 4-1W	NUE7275B	NCN6147A	NUE7275B	NCN6147A	F91P-3
H01SDD9DB4AN	MTX838 UHF B2 99-Mode Top Display Trunked 4-1W	NUE7275B	NCN6147B	NUE7275B	NCN6147B	F91P-3
H01SDH9DB7AN	MTX838 UHF B2 160-Mode Trunked 4-1W	NUE7241A	NTN7512A	NUE7241D	NCN6147A	D64W
H01SDH9DB7AN	MTX838 UHF B2 160-Mode Trunked 4-1W	NUE7241B	NTN7512C	NUE7241D	NCN6147A	D64W
H01SDH9DB7AN	MTX838 UHF B2 160-Mode Front Display Full Keypad Trunked 4-1W	NUE7241C	NTN7512D	NUE7241D	NCN6147A	D64W
H01SDH9DB7AN	MTX838 UHF B2 160-Mode Front Display Full Keypad Trunked 4-1W	NUE7241D	NTN7512D	NUE7241D	NCN6147A	D64W
H01SDH9DB7AN	MTX838 UHF B2 160-Mode Front Display Full Keypad Trunked 4-1W	NUE7275A	NCN6147A	NUE7275B	NCN6147A	F91P-3
H01SDH9DB7AN	MTX838 UHF B2 160-Mode Front Display Full Keypad Trunked 4-1W	NUE7275B	NCN6147A	NUE7275B	NCN6147A	F91P-3
H01SDH9DB7AN	MTX838 UHF B2 160-Mode Front Display Full Keypad Trunked 4-1W	NUE7275B	NCN6147B	NUE7275B	NCN6147B	F91P-3
H01UCC6DB3AN	MTX8000 800MHz 16-Mode Trunked Type I 3W	NUF6423A	NTN7857A	NUF6423B	NCN6147A	D64W
H01UCC6DB3AN	MTX8000 800MHz 16-Mode Trunked Type I 3W	NUF6423B	NTN7857C	NUF6423B	NCN6147A	D64W
H01UCC6DB3AN	MTX8000 800MHz 16-Mode Closed Trunked Type I 3W	NUF6423B	NTN7857D	NUF6423B	NCN6147A	D64W
H01UCC6DB3AN	MTX8000 800MHz 16-Mode Closed Trunked Type I 3W	NUF6501A	NCN6147A	NUF6501B	NCN6147A	F91P-3
H01UCC6DB3AN	MTX8000 800MHz 16-Mode Closed Trunked Type I 3W	NUF6501B	NCN6147A	NUF6501B	NCN6147A	F91P-3
H01UCC6DB3AN	MTX8000 800MHz 16-Mode Closed Trunked Type I 3W	NUF6500D	NCN6147B	NUF6500D	NCN6147B	F91P-3
H01UCC6DB3AN	MTX8000 800MHz 16-Mode Closed Trunked Type I 3W	PMUF6500D	PMCN6147B	NUF6500D	NCN6147B	

Appendix B Table 5. MTX Series Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01UCC6DF3AN	MTX838 800MHz 16-Mode Trunked Type II 3W	NUF6423A	NTN7857A	NUF6423B	NCN6147A	D64W
H01UCC6DF3AN	MTX838 800MHz 16-Mode Trunked Type II 3W	NUF6423B	NTN7857C	NUF6423B	NCN6147A	D64W
H01UCC6DF3AN	MTX838 800MHz 16-Mode Closed Trunked Type II 3W	NUF6423B	NTN7857D	NUF6423B	NCN6147A	D64W
H01UCC6DF3AN	MTX838 800MHz 16-Mode Closed Trunked Type II 3W	NUF6501A	NCN6147A	NUF6501B	NCN6147A	F91P-3
H01UCC6DF3AN	MTX838 800MHz 16-Mode Closed Trunked Type II 3W	NUF6501B	NCN6147A	NUF6501B	NCN6147A	F91P-3
H01UCC6DF3AN	MTX838 800MHz 16-Mode Closed Trunked Type II 3W	NUF6501B	NCN6147B	NUF6501B	NCN6147B	F91P-3
H01UCF6DB5AN	MTX8000 800MHz 160-Mode Front Display Limited Keypad Trunked 3W	NUF6423A	NTN7512A	NUF6423B	NCN6147A	D64W
H01UCF6DB5AN	MTX8000 800MHz 160-Mode Front Display Limited Keypad Trunked 3W	NUF6423B	NTN7512C	NUF6423B	NCN6147A	D64W
H01UCF6DB5AN	MTX8000 800MHz 160-Mode Front Display Limited Keypad Trunked 3W	NUF6423B	NTN7512D	NUF6423B	NCN6147A	D64W
H01UCF6DB5AN	MTX8000 800MHz 160-Mode Front Display Limited Keypad Trunked 3W	NUF6501A	NCN6147A	NUF6501B	NCN6147A	F91P-3
H01UCF6DB5AN	MTX8000 800MHz 160-Mode Front Display Limited Keypad Trunked 3W	NUF6501B	NCN6147A	NUF6501B	NCN6147A	F91P-3
H01UCF6DB5AN	MTX8000 800MHz 160-Mode Front Display Limited Keypad Trunked 3W	NUF6500D	NCN6147B	NUF6500D	NCN6147B	F91P-3
H01UCF6DB5AN	MTX8000 800MHz 160-Mode Front Display Limited Keypad Trunked 3W	PMUF6500 D	PMCN6147 B	NUF6500D	NCN6147B	
H01UCH6DB7AN	MTX8000 800MHz 160-Mode Front Display Full Keypad Trunked 3W	NUF6423A	NTN7512A	NUF6423B	NCN6147A	D64W
H01UCH6DB7AN	MTX8000 800MHz 160-Mode Front Display Full Keypad Trunked 3W	NUF6423B	NTN7512C	NUF6423B	NCN6147A	D64W
H01UCH6DB7AN	MTX8000 800MHz 160-Mode Front Display Full Keypad Trunked 3W	NUF6423B	NTN7512D	NUF6423B	NCN6147A	D64W
H01UCH6DB7AN	MTX8000 800MHz 160-Mode Front Display Full Keypad Trunked 3W	NUF6501A	NCN6147A	NUF6501B	NCN6147A	F91P-3

Appendix B Table 5. MTX Series Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01UCH6DB7AN	MTX8000 800MHz 160-Mode Front Display Full Keypad Trunked 3W	NUF6501B	NCN6147A	NUF6501B	NCN6147A	F91P-3
H01UCH6DB7AN	MTX8000 800MHz 160-Mode Front Display Full Keypad Trunked 3W	NUF6500D	NCN6147B	NUF6500D	NCN6147B	F91P-3
H01UCH6DB7AN	MTX8000 800MHz 160-Mode Front Display Full Keypad Trunked 3W	PMUF6500 D	PMCN6147 B	NUF6500D	NCN6147B	
H01WCC4DB3AN	MTX9000 900MHz 16-Mode Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6424A	NTN7858A	NUF6424B	NCN6153A	D64W
H01WCC4DB3AN	MTX9000 900MHz 16-Mode Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6424B	NTN7858C	NUF6424B	NCN6153A	D64W
H01WCC4DB3AN	MTX9000 900MHz 16-Mode Closed Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6424B	NTN7858C	NUF6424B	NCN6153A	D64W
H01WCC4DB3AN	MTX9000 900MHz 16-Mode Closed Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6502A	NCN6153A	NUF6502B	NCN6153A	F91P-3
H01WCC4DB3AN	MTX9000 900MHz 16-Mode Closed Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6502B	NCN6153A	NUF6502B	NCN6153A	F91P-3
H01WCC4DB3AN	MTX9000 900MHz 16-Mode Closed Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN6153A	NUF6499D	NCN6153A	F91P-3
H01WCC4DB3AN	MTX9000 900MHz 16-Mode Closed Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN6153B	NUF6499D	NCN6153B	F91P-3
H01WCC4DB3AN	MTX9000 900MHz 16-Mode Closed Trunked 2.4W (Typ.), 2.9W (Max.)	PMUF6499 D	PMCN6153 B	NUF6499D	NCN6153B	
H01WCF4DB5AN	MTX9000 900MHz 160-Mode Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6424A	NTN7513A	NUF6424B	NCN6153A	D64W
H01WCF4DB5AN	MTX9000 900MHz 160-Mode Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6424B	NTN7513C	NUF6424B	NCN6153A	D64W
H01WCF4DB5AN	MTX9000 900MHz 160-Mode Front Display Limited Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6424B	NTN7513D	NUF6424B	NCN6153A	D64W
H01WCF4DB5AN	MTX9000 900MHz 160-Mode Front Display Limited Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6502A	NCN6153A	NUF6502B	NCN6153A	F91P-3

Appendix B Table 5. MTX Series Models

Model Number	Description	Xcvr Bd	Ctrl Bd	Replacements		
				Xcvr Bd	Ctrl Bd	Codeplug
H01WCF4DB5AN	MTX9000 900MHz 160-Mode Front Display Limited Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6502B	NCN6153A	NUF6502B	NCN6153A	F91P-3
H01WCF4DB5AN	MTX9000 900MHz 160-Mode Front Display Limited Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN6153A	NUF6499D	NCN6153A	F91P-3
H01WCF4DB5AN	MTX9000 900MHz 160-Mode Front Display Limited Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN6153B	NUF6499D	NCN6153B	F91P-3
H01WCF4DB5AN	MTX9000 900MHz 160-Mode Front Display Limited Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	PMUF6499D	PMCN6153B	NUF6499D	NCN6153B	
H01WCH4DB7AN	MTX9000 900MHz 160-Mode Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6424A	NTN7513A	NUF6424B	NCN6153A	D64W
H01WCH4DB7AN	MTX9000 900MHz 160-Mode Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6424B	NTN7513C	NUF6424B	NCN6153A	D64W
H01WCH4DB7AN	MTX9000 900MHz 160-Mode Front Display Full Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6424B	NTN7513D	NUF6424B	NCN6153A	D64W
H01WCH4DB7AN	MTX9000 900MHz 160-Mode Front Display Full Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6502A	NCN6153A	NUF6502B	NCN6153A	F91P-3
H01WCH4DB7AN	MTX9000 900MHz 160-Mode Front Display Full Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6502B	NCN6153A	NUF6502B	NCN6153A	F91P-3
H01WCH4DB7AN	MTX9000 900MHz 160-Mode Front Display Full Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN6153A	NUF6499D	NCN6153A	F91P-3
H01WCH4DB7AN	MTX9000 900MHz 160-Mode Front Display Full Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	NUF6499D	NCN6153B	NUF6499D	NCN6153B	F91P-3
H01WCH4DB7AN	MTX9000 900MHz 160-Mode Front Display Full Keypad Trunked 2.4W (Typ.), 2.9W (Max.)	PMUF6499D	PMCN6153B	NUF6499D	NCN6153B	



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