

  
**BENISON**

**V7**

**FM TRANSCEIVERS**

**Service Manual**

# SPECIFICATIONS

## GENERAL

Frequency Range	245.0000 245.9875
Working Temperature	-10°C +55°C
Power Supply Requirement	DC 7.2V
Current Consumption	≤1.6A(transmit 4W)
Sensitivity Adjust	2 20mV
Antenna impedance	50 Ω

## TRANSMITTER

Frequency Stability	5ppm
Output Power	5W(High),1W(Low)
Maximum Frequency Deviation	≤ 2.5KHz
Intermodulation Response Rejection	70dB
Audio Distortion	≤10%
Adjacent Channel Power	≤-65dB
Occupied Bandwidth	≤16KHz

## RECEIVER

RF Sensitivity	≤0.2μV
Audio Frequency Response	300-3000Hz
Audio Output	≥0.5w
Audio Distortion	≤10

**All stated specifications are subject to change without notice or obligation.**

# CIRCUIT DESCRIPTION

## 1. Frequency configuration

The receiver utilizes double conversion. The first IF is 38.85MHz and the second IF is 450kHz. The first local oscillator signal is supplied from the PLL circuit. The PLL circuit in the transmitter generates the necessary frequencies. Fig. 1 shows the frequencies.

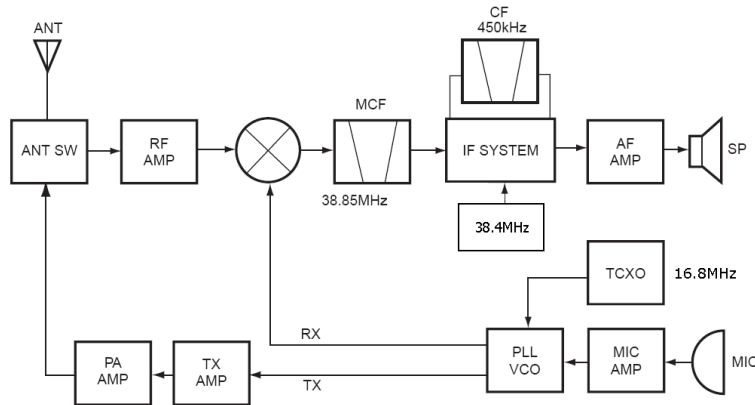


Fig. 1 Frequency configuration

## 2. Receiver

The frequency configuration of the receiver is shown in Fig. 2.

### 1) Front - end RF amplifier

An incoming signal from the antenna is applied to an RF amplifier (T201) after passing through a transmit/receive switch circuit (D101 D102 D103) and a 3-pole LC filter (L203 L204). After the signal is amplified (T201) the signal is filtered and pass filter (a 3-pole LC filter) (L217 L218 L221) to eliminate unwanted signals before it is passed to the mixer. The voltages of these diodes are controlled to track the MPU(U811) center frequency of the band pass filter. (See Fig. 2)

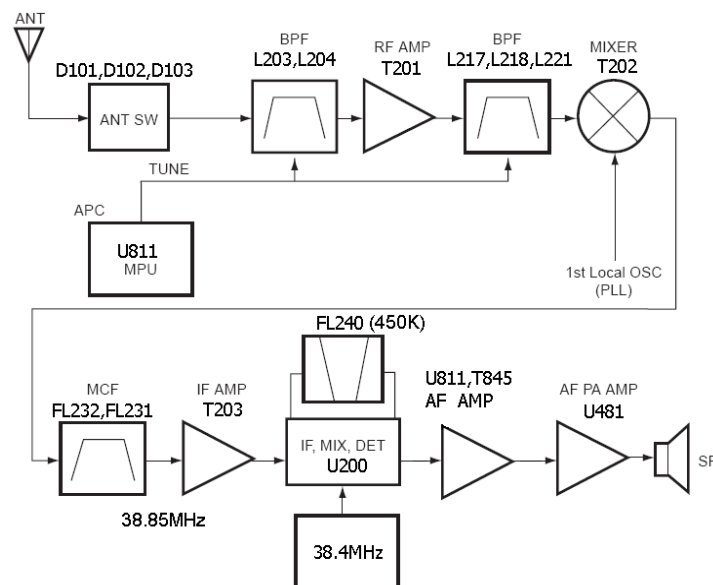


Fig. 2 Receiver section configuration

## 2) First Mixer

The signal from the RF amplifier is heterodyned with the first local oscillator signal from the PLL frequency synthesizer circuit at the first mixer (T202) to create a 38.85MHz first intermediate frequency (1st IF) signal. The first IF signal is then fed through crystal filters (FL231 FL232) to further remove spurious signals.

## 3) IF amplifier

The first IF signal is amplified by T203 and then enters U200 (FM processing IC). The signal is heterodyned again with a second local oscillator signal within U200 to create a 450kHz second IF signal. The second IF signal is then fed through a 450kHz ceramic filter (FL240) to further eliminate unwanted signals before it is amplified and FM detected in FL240.

## 4) AF amplifier

The recovered AF signal obtained from U200 goes to the microprocessor (U811). The processed AF signal passes through an AF volume control and is amplified to a sufficient level to drive a loudspeaker through an AF power amplifier (U481).

## 5) Squelch

Part of the AF signal from the IC enters the FM IC again and the noise component is amplified and rectified by a filter and an amplifier to produce a DC voltage corresponding to the noise level. The DC signal from the FM IC goes to the analog port of the microprocessor (U811). U811 determines whether to output sounds from the speaker checking whether the input voltage is higher or lower than the preset value. To output sounds from the speaker U811 sends a high signal to the AF Power lines and turns U481 on through T471 T472.

## 6) Receive signaling

### QT/DQT

The output signal from FM IC (U200) enters the microprocessor (U811). U811 determines whether the QT or DQT matches the preset value and controls the AF Power and the speaker output sounds according to the squelch results.

## 3. PLL frequency synthesizer

The PLL circuit generates the first local oscillator signal for reception and the RF signal for transmission.

### 1) PLL

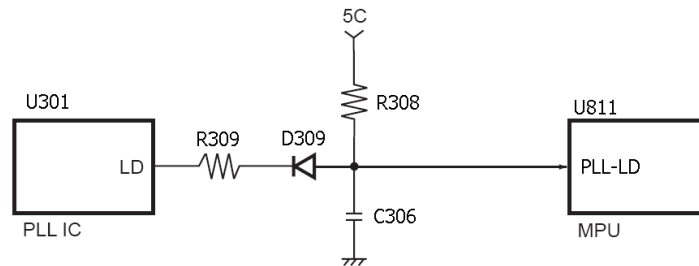
The frequency step of the PLL circuit is 5 and 6.25kHz and so on. A 16.8MHz reference oscillator signal is divided at U301 by a fixed counter to produce the 5 or 6.25kHz reference frequency. The voltage controlled oscillator (VCO) output signal is further amplified by T373 then divided in U301 by a programmable counter. The divided signal is compared in phase with the 5 or 6.25kHz reference signal in the phase comparator in U301. The output signal from the phase comparator is filtered through a low-pass filter and passed to the VCO to control the oscillator frequency.

### 2) VCO

The operating frequency is generated by T331 in transmit mode and T357 in receive mode. The oscillator frequency is controlled by applying the VCO control voltage obtained from the phase comparator to the varactor diodes (D331 and D332 in transmit mode and D350 and D351 in receive mode). The TC/RC pin is set low in receive mode causing T192 off and turn T291 on. The TC/RC pin is set high in transmit mode causing T291 off and T192 T191 on.

### 3) UNLOCK DETECTOR

If a pulse signal appears at the LD pin of U301 an unlock condition occurs and the DC voltage obtained from D309 and C306 causes the voltage applied to the PLL-LD pin of the microprocessor to go low. When the microprocessor detects this condition the transmitter is disabled in order the push-talk switch input signal. ( See Fig .3)



**Fig. 3 Unlock detector circuit**

## 4. Transmitter

### 1)Microphone Amplifier

The signal from the microphone passes through U411. When encoding DTMF it is turned OFF for mute the microphone input signal T414. The signal passes through the Audio processor (U411) for the maximum deviation adjustment and goes to the VCO modulation input.

### 2)Drive and Final Amplifier

The signal from the T/R switch (D100) is amplified by the pre-driver (T101, T102) and driver amplifier (T105) to 50mW. The output of the driver amplifier is amplified by the RF power amplifier (T107) to 4.0W (1W when the power is low). The RF power amplifier consists of two MOS FET stages. The output of the RF power amplifier consists of two MOS FET stages. The output of the RF power amplifier is then passed through the harmonic filter (LPF) and antenna switch (D101, D102) and applied to the antenna terminal.

## 5. Power supply

There are four 5V power supplies for the microprocessor: 5M, 5C, 5R, and 5T. 5M for microprocessor is always output while the power is on. 5M for microprocessor is always output but turns off when the power is turned off to prevent malfunction of the microprocessor.

5C is a common 5V and is output when SAVE is not set to OFF.

5R is 5V for reception and output during reception.

5T is 5V for transmission and output during transmission.

## 6.Control Circuit

The control circuit consists of a microprocessor (U811) and its peripheral circuits. It controls the TX-RX unit. U811 mainly performs the following:

- (1) Switching between transmission and reception by the PTT signal input.
- (2) Reading system group frequency and program data from the memory circuit.
- (3) Sending frequency program data to the PLL.
- (4) Controlling speech on/off by the DC voltage from the speech circuit.
- (5) Controlling the audio mute circuit by the decode data input.
- (6) Transmitting tone and encode data.

### 1)Memory Circuit

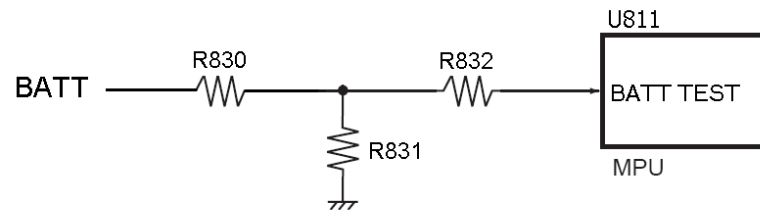
Memory circuit consists of the CPU (U811) and an EEPROM(U821).An EEPROM has a capacity of 32k bits that contains the transceiver control program for the CPU and data such as Transceiver channels and operation features

### 2)Low Battery Warning

The battery voltage is checked using the microprocessor.

(1) The red LED lights when the battery voltage falls below 6.2V.

(2) A Warning tone generates when the red LED lights. ( See Figure 4)



**Fig. 4 Low battery warning**

# ADJUSTMENT

## Required Test Equipment

The following items are required to adjust radio parameters

### 1. Regulated power supply

Supply voltage 5-14V DC

Current 3A or more

### 2. Digital multimeter

Voltage range FS Appro. 20V

Current 10A or more

Input resistance High impedance

### 3. Oscilloscope

Measure frequency Audio frequency

### 4. Audio dummy load

Impedance 8 ohm

Dissipation 1W or more

Jack 3.5mm

### 5. SSG

Output frequency 200MHz or more

Output level -20dBu/0.1uV -120dBu/1V

Modulation FM

### 6. Spectrum Analyzer

Measuring range Up to 2GHz or more

### 7. Power meter

Measure frequency Up to 200MHz

Impedance 50 unbalanced

Measuring range 0.1W -10W

### 8. Audio voltmeter

Measure frequency Up to 100kHz

Sensitivity 1mV to 10V

### 9. Audio generator

Output frequency 67Hz to 10kHz

Output impedance 600 unbalanced

### **10. Distortion meter/SINAD meter**

Measurement frequency 1kHz

Input level Up to 40dB

Distortion 1% - 100%

### **11. Frequency counter**

Measurement frequency Up to 200MHz

Measurement stability Approx. +/-0.1ppm

### **12. Linear detector**

Measurement frequency Up to 200MHz

Characteristics Flat

CN 60dB or more

### **Note**

Standard modulation 1kHz +/-2.5kHz/DEV

Reference sensitivity 12dB SINAD

Specified audio output level 200mW at 8

## EIA 0402 Chip capacitors

Comment	Footprint	Quantit	Desi nators					
100P	0402	10	C255	C170	C424	C482	C811	C812
			C402	C331	C241	C492		
104P	0402	35	C256	C181	C412	C417	C423	C444
			C474	C476	C546	C548	C549	C494
			C193	C817	C818	C306	C257	C115
			C131	C231	C236	C243	C253	C261
			C262	C302	C307	C491	C493	C821
			C840	C843	C844	C824	C108	
103P	0402	30	C164	C180	C291	C292	C392	C451
			C472	C473	C475	C547	C827	C820
			C191	C361	C128	C223	C226	C232
			C235	C248	C251	C252	C344	C822
N.U	0402	1	C841	C845	C903	C908	C910	C336
			C165					
470P	0402	31	C167	C168	C294	C391	C435	C446
			C293	C192	C194	C114	C362	C363
			C107	C112	C125	C129	C132	C143
			C210	C211	C214	C227	C247	C106
			C102	C215	C109	C207	C213	C222
			C303					
102P	0402	20	C173	C177	C401	C419	C421	C337
			C371	C831	C305	C376	C378	C113
			C119	C123	C343	C345	C350	C324
			C849	C902				
472P	0402	3	C413	C481	C282			
273P	0402	1	C418					
223P	0402	5	C420	C422	C515	C521	C523	
473P	0402	4	C441	C445	C483	C281		
332P	0402	3	C442	C448	C846			
680P	0402	2	C443	C848				
820P	0402	1	C447					
221P	0402	3	C484	C485	C284			
NC	0402	15	C836	C837	C838	C839	C832	C833
			C834	C835	C204	C206	C218	C234
			C316	C280	C155			
7P	0402	2	C229	C372				
N.C	0402	2	C127	C116				
10P	0402	14	C355	C340	C111	C202	C216	C219
			C224	C246	C317	C200	C153	C150
			C147	C304				
5P	0402	1	C338					
2P	0402	2	C339	C205				

### EIA 0402 Chip capacitors

Comment	Footprint	Quantit		Desi nators					
0.5P	0402	2		C341	C356				
39P	0402	1		C351					
15P	0402	3		C373	C225	C142			
22P	0402	6		C377	C332	C825	C826	C104	C100
6.8nH	0402	1		C118					
1P	0402	3		C220	C217	C334			
8P	0402	2		C221	C354				
18P	0402	2		C233	C242				
220P	0402	2		C244	C245				
27P	0402	1		C254					
101P	0402	4		C308	C309	C310	C311		
392P	0402	1		C842					
105P	0402	1		C847					
470p	0402	1		C909					
4P	0402	1		C353					

### EIA 0603 Chip capacitors

Comment	Footprint	Quantit		Desi nators					
NC	0603	4		C130	C126	C134	C137		
5P	0603	3		C154	C151	C149			
1P	0603	1		C148					
470P	0603	1		C145					
102P	0603	1		C138					
15P	0603	1		C136					
10P	0603	1		C135					
33P	0603	1		C133					

### EIA 0805 Chip capacitors

Comment	Footprint	Quantit		Desi nators					
4.7uF	0805	7		E405	E423	E514	E337	E301	E281
				E302					
105P	0805	2		C471	C901				
6.8uF	0805	1		E173					
2.2uF	0805	1		E417					
223P	0805	1		E452					
10uF	0805	7		E471	E482	E362	E232	E248	E908
				E910					
0.1uF	0805	2		E319	E321				
1uF	0805	2		E320	E126				

### Polarized capacitors

Comment	Footprint	Quantit		Desi nators					
22uF	EIA3528	1		E324					
100uF	EIA6032	1		E483					

## EIA 0402 Chip Resistors

Comment	Footprint	Quantit	Desi nators						
1K5	0402	3		R255	R422	R104			
10R	0402	4		R249	R450	R484	R111		
2K2	0402	5		R405	R472	R322	R300	R847	
10K	0402	21		R826	R825	R301	R171	R179	R444
				R449	R471	R476	R481	R518	R520
				R545	R827	R415	R304	R372	R841
				R848	R101	R292			
150K(F)	0402	5		R165	R166	R168	R169	R170	
150k(F)	0402	1		R167					
N.U	0402	2		R172	R177				
220K	0402	2		R175	R212				
47K	0402	13		R176	R180	R181	R452	R515	R811
				R812	R191	R832	R114	R125	R126
				R517					
1M	0402	2		R178	R494				
18K	0402	2		R182	R418				
4K7	0402	13		R391	R435	R519	R549	R815	R817
				R818	R308	R491	R361	R281	R282
				R283					
1K	0402	14		R392	R417	R485	R514	R814	R850
				R851	R291	R192	R309	R256	R346
				R375	R224				
100R	0402	8		R402	R403	R404	R406	R370	R374
				R215	R223				
100K	0402	10		R413	R253	R210	R824	R845	R336
				R335	R216	R218	R207		
0R	0402	13		R414	R483	R836	R837	R838	R839
				R133	R317	R493	R820	R821	R200
				R321					
820R	0402	1		R416					
750K	0402	1		R420					
22K	0402	5		R421	R453	R516	R305	R324	
30K	0402	1		R423					
51K	0402	1		R424					
1K8	0402	1		R433					
33K	0402	6		R441	R442	R446	R448	R306	R846
				R522					
1M8	0402	2		R443	R447				
3K3	0402	5		R451	R373	R377	R247	R100	
150R	0402	2		R482	R307				
68K	0402	1		R842					
NC	0402	10		R521	R816	R214	R225	R523	R331
				R217	R219	R208	R302		

**EIA 0402 Chip Resistors**

Comment	Footprint	Quantit		Desi nators					
330K	0402	2		R546	R492				
680R	0402	4		R548	R107	R102	R105		
560R	0402	3		R813	R319	R318			
NU	0402	1		R834					
150K	0402	4		R830	R831	R284	R843		
47k	0402	1		R924					
10k	0402	1		R925					
6k8	0402	1		R320					
120k	0402	1		R371					
220R	0402	2		R376	R211				
470R	0402	2		R226	R235				
47R	0402	3		R113	R128	R227			
120K	0402	1		R115					
270R	0402	4		R139	R143	R355	R340		
2K7	0402	1		R236					
680K	0402	1		R237					
180K	0402	2		R243	R245				
3.9K	0402	1		R244					
22R	0402	4		R345	R103	R106	R343		
15K	0402	2		R822	R337				
82K	0402	1		R823					

**EIA 0603Chip Resistors**

Comment	Footprint	Quantit		Desi nators					
0R	0603	1		R123					
4K7	0603	2		R351	R332				

**EIA 1206Chip Resistors**

Comment	Footprint	Quantit		Desi nators					
0.33R	1206	3		R160	R161	R162			
0R	1206	1		R901					

**Chip Resistor packs**

Comment	Footprint	Quantit		Desi nators					
1K	RP-1206-4	2		PR811	PR301				
47K	RP-1206-4	1		PR813					

**Chip Variable Resistors**

Comment	Footprint	Quantit		Desi nators					
100K	RV1208	1		RV453					
50K	RV1208	1		RV307					

## inductance

Comment	Footprint	Quantit		Desi nators					
101T	L0603	6		L412	L481	L363	L325	L840	L103
100nH	L0603	7		L371	L324	L107	L102	L345	L344
				L336					
6.8uH	L0603	2		L331	L350				
2.2uH	L0603	2		L340	L355				
47nH	L0603	2		L372	L224				
82nH	L0603	1		L373					
100P	L0603	1		L119					
560nH	L0603	1		L225					
330nH	L0603	1		L226					
301T	L0603	1		L821					
0R	L0603	2		L900	L323				
5P	L0805	2		L332	L351				
101T	L0805	3		L105	L126	L901			
220nH	L0906	1		L139					
1uH	L1009	1		L114					
1uH	L1310	1		L118					
5T	LC-0352424	3		L111	L112	L113			
6T	LC-0352428	5		L204	L214	L110	L218	L221	
0R	LC-0352428	1		L201					
8T	LC-0352436	1		L128					
100nH	L-S5R0301020	1		C333					
150nH	L-S5R0301020	1		C352					

<b>Light Emitting Diode</b>									
Comment	Footprint	Quantit		Desi nators					
RED	0603	1		D813					
GREEN	0603	1		D814					
<b>High Frequency Switching Diode</b>									
Comment	Footprint	Quantit		Desi nators					
HSC277	ESC	4		D102	D103	D100	D200		
HVU131	USC	1		D101					
<b>Variable Capacitance Diode</b>									
Comment	Footprint	Quantit		Desi nators					
MA2S11	ESC	1		D361					
<b>Switching Diode</b>									
Comment	Footprint	Quantit		Desi nators					
PMSD4148	ESC	1		D309					
DAN222	ESM	1		D416					
1SS372	USM	2		D417	D493				
<b>Zener Diode</b>									
Comment	Footprint	Quantit		Desi nators					
1SR154-400	SMA	1		D901					
<b>Diode</b>									
Comment	Footprint	Quantit		Desi nators					
C376	ESC	4		D351	D350	D332	D331		
H376	ESC	1		D334					
<b>RF Power FET Transistors</b>									
Comment	Footprint	Quantit		Desi nators					
2SK3476	2-5N1A	1		T107					
2SK3078	SOT89	1		T105					
2SC3357	SOT89	1		T102					
<b>General Purpose Transistors</b>									
Comment	Footprint	Quantit		Desi nators					
2SC4617	ESM-2SC4617(S)	3		T451	T441	T845			
2SC4617(S)	ESM-2SC4617(S)	1		T361					
2SB624	TSM	4		T391	T471	T191	T822		
MRF497	USM	1		T414					
<b>RF/IF Transistors</b>									
Comment	Footprint	Quantit		Desi nators					
2SC4649	ESM	1		T203					
2SC3356	ISM-2SC3356(R2)	2		T372	T373				
2SC4226	USM	1		T101					

<b>Switching FET Transistors</b>									
Comment	Footprint	Quantit		Desi nators					
2SJ243	ESM	1		T343					
2SK508NV(K52)	TSM-2SK508NV	2		T355	T340				
<b>Swiching Transistors</b>									
Comment	Footprint	Quantit		Desi nators					
DTA114EE	ESM	3		T291	T815	T204			
DTC114EE	ESM	6		T161	T171	T472	T192	T813	T814
UMC4	USV	1		T344					
<b>Dual Gate RF FET Transistors</b>									
Comment	Footprint	Quantit		Desi nators					
3SK299	TSQ	2		T202	T201				
<b>Integrated Circuits</b>									
Comment	Footprint	Quantit		Desi nators					
U-TMP87P805BU	QFP44-1414-P1.0	1		U811					
LM4558	SOP8-245	1		U411					
AUDIO	SOP8-245	1		U511					
24C32	SOP8-245	1		U821					
5A	SOT89-5A-JN0102	1		U909					
TA7368	SSOP10-225-P1.0	1		U481					
TA31136F	SSOP16-225	1		U200					
LMX2336ATM	SSOP20-225	1		U301					
NJM2904V	SSOP8-225	1		U161					

<b>Ceramic Filter</b>									
Comment	Footprint	Quantit		Desi nators					
450K	FL-LTC450	1		FL240					
<b>Crystal Filters</b>									
Comment	Footprint	Quantit		Desi nators					
38.85MHz	FL-UM-5-3S	2		FL231	FL232				
38.4MHZ	FX-UM-5-2S	1		CR240					
<b>Ceramic Oscillator</b>									
Comment	Footprint	Quantit		Desi nators					
C24	FX-BS-06260	1		CR255					
<b>TCXO</b>									
Comment	Footprint	Quantit		Desi nators					
16.8MHZ	FX-DS0305	1		CR340					
<b>Crystal Oscillator</b>									
Comment	Footprint	Quantit		Desi nators					
32.768KHz	FX-DS-6025	1		CR825					

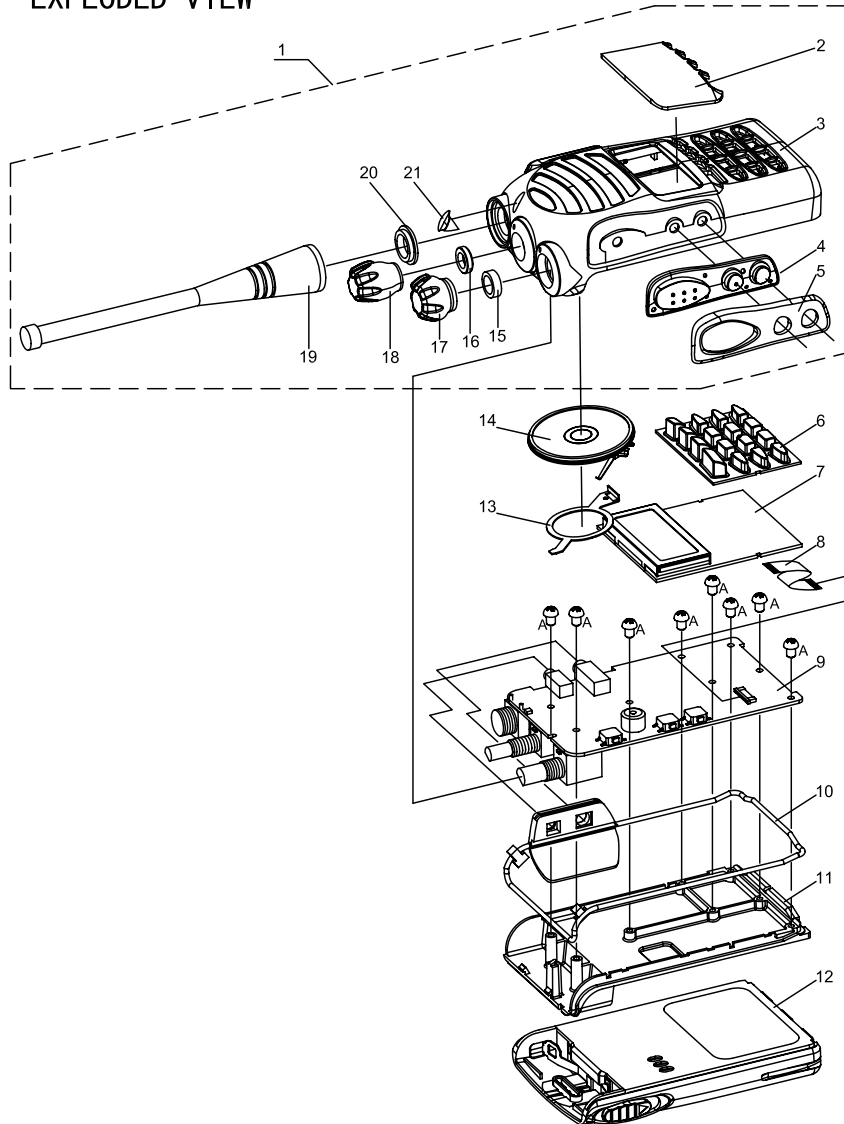
**Orthers**

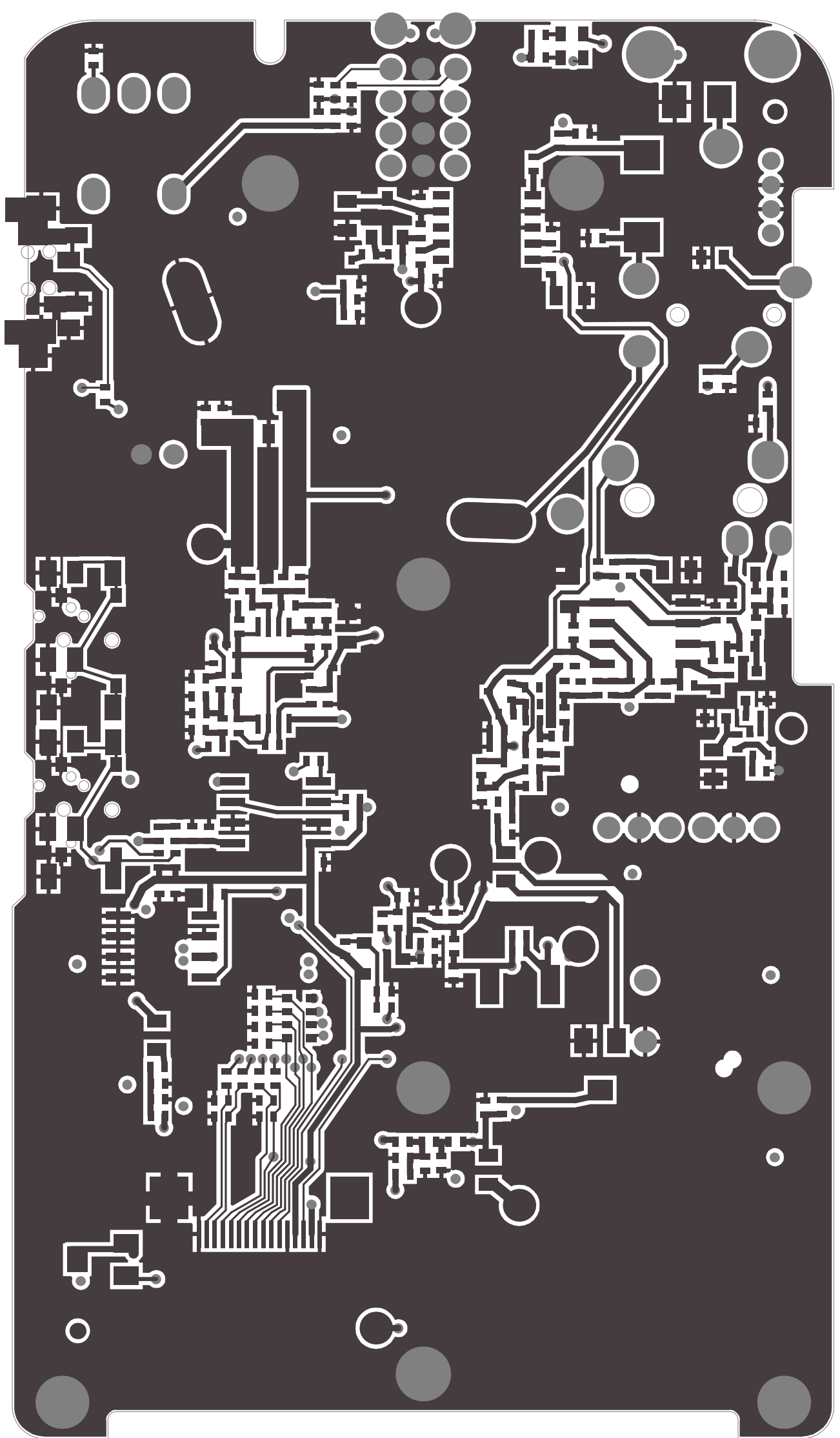
Comment	Footprint	Quantit		Desi nators					
ANT	ANT	1		ANT111					
BATTERY	BATT TUCHER	1		BAT111					
2.5mm	JK-ST-106	1		JK481					
3.5mm	JK-ST-301-6-F	1		JK402					
JP4	JP-I3T050-150S	1		JP401					
JP16	JP-S16S100-050S	1		JP811					
MIC	MIC60	1		MIC401					
MONI	S-1	1		SW401					
CALL	S-1	1		SW400					
SP	SP-JN0101	1		SP401					
RD82-TD2	S-RD82-T02	1		SW812					
RD840G	S-RD840G	1		SW811					
RD91	S-RD910S	1		VR411					
PTT	S-TD-15EA	1		SW402					

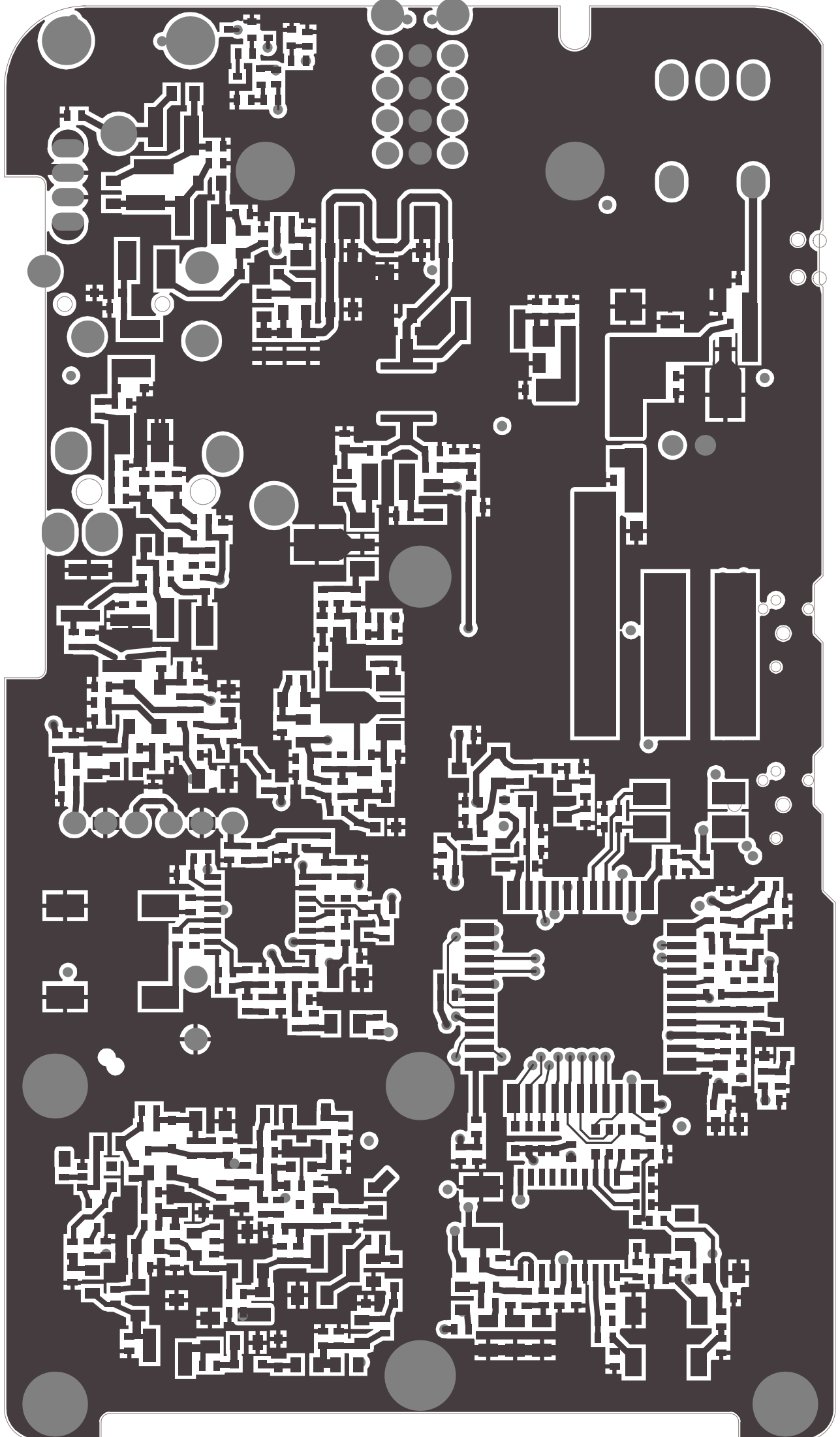
**JN0402**

Comment	Footprint	Quantit		Desi nators						
1N4148	D-ESC	2		D701	D722					
4K7	R0402	2		R717	R718					
100P	C0402	6		C700	C711	C702	C703	C701	C713	
104P	C0402	2		C718	C717					
510R	R0402	4		R712	R713	R714	R710			
560R	R0402	2		R715	R716					
C-1	C0402	1		C720						
DIO-2	D0603	4		D712	D715	D713	D710			
DTC114EE	T-ESM-DTC114EE	3		T711	T712	T713				
GD-4460	JN_JN04	1		LCD720						
JP16	JP-S16S100-050S	1		JP710						
R-1	R0402	7		R724	R723	R729	R725	R726	R727	R728
R-2	RP-1206-4	1		RP700						
S6A0069	U-CHIP80-S6A0069-JN04	1		U720						
ZJDB-756B-Y	D-LED-B420160-3PNA	1		D720						

# EXPLODED VIEW



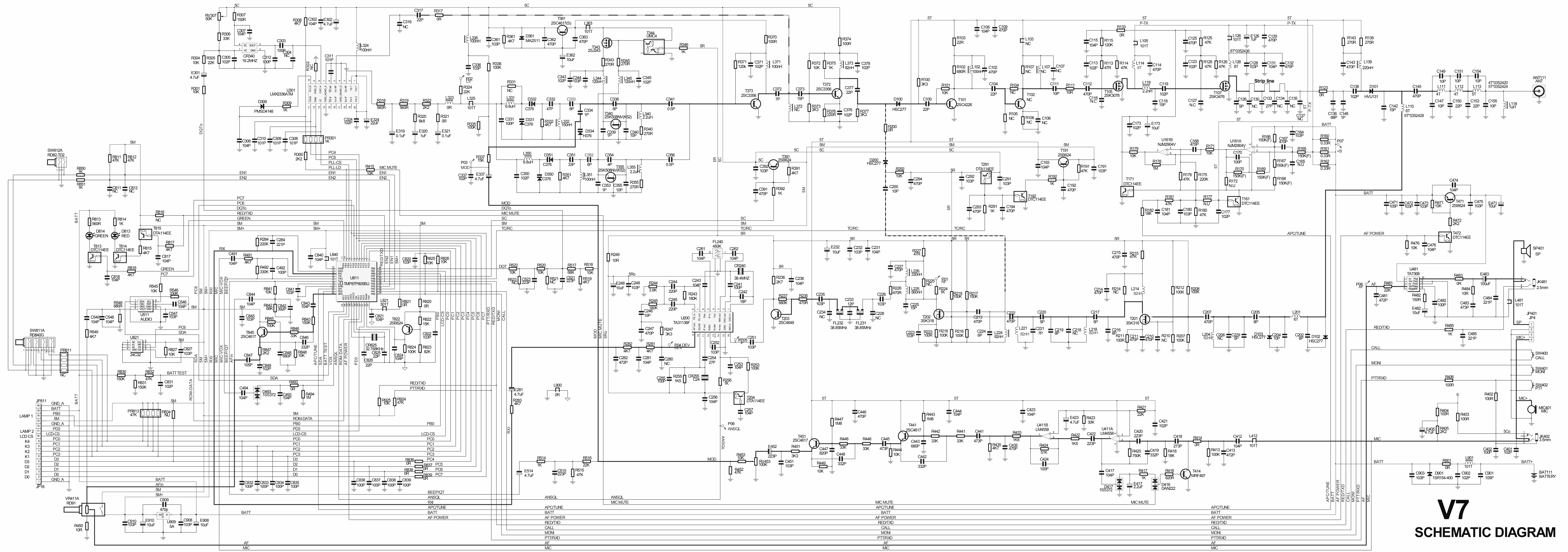












**V7**  
SCHEMATIC DIAGRAM

