Vertex Standard

# VHF FM Transceiver

# VX-410/-420 series

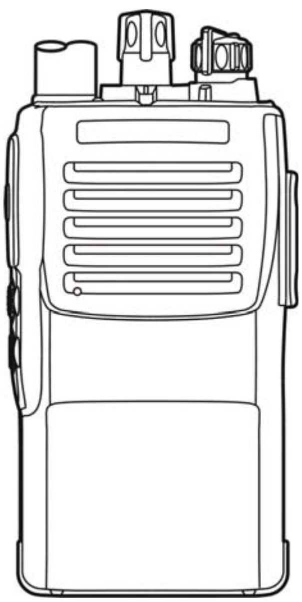
# Service Manual


Vertex Standard LMR, Inc.





EC050N95J (USA)

**VX-410 series**


**VX-420 series**

## *Introduction*

This manual provides technical information necessary for servicing the VX-410/-420 series VHF FM Transceiver.

Servicing this equipment requires expertise in handling surface-mount chip components. Attempts by non-qualified persons to service this equipment may result in permanent damage not covered by the warranty, and may be illegal in some countries.

Two PCB layout diagrams are provided for each double-sided circuit board in the transceiver. Each side of is referred to by the type of the majority of components installed on that side ("leaded" or "chip-only"). In most cases one side has only chip components, and the other has either a mixture of both chip and leaded components (trimmers, coils, electrolytic capacitors, ICs, etc.), or leaded components only.

While we believe the technical information in this manual to be correct, VERTEX STANDARD assumes no liability for damage that may occur as a result of typographical or other errors that may be present. Your cooperation in pointing out any inconsistencies in the technical information would be appreciated.

**Important Note**

After Lot.36 of this transceiver was assembled using Pb (lead) free solder, based on the RoHS specification.

Only lead-free solder (Alloy Composition: Sn-3.0Ag-0.5Cu) should be used for repairs performed on this apparatus. The solder stated above utilizes the alloy composition required for compliance with the lead-free specification, and any solder with the above alloy composition may be used.

## Contents

## GENERAL Specifications

| | |
|---|---|
| **Frequency Range:** | 146 - 174 MHz |
| **Number of Channels:** | 32 (16+16) channels |
| **Number of Groups:** | 2 groups |
| **Channel Spacing:** | 12.5 / 20 / 25 kHz |
| **PLL Steps** | 2.5 / 6.25 kHz |
| **Operating Voltage:** | 7.5 VDC ± 20% |
| **Battery Life** (w/save): | 12.5 h (16 h) w/ FNB-V67LI (Rx 5 : Tx 5 : STBY 90 Duty) |
| | 7 h (8.8 h) w/ FNB-V57 (Rx 5 : Tx 5 : STBY 90 Duty) |
| **Temperature Range:** | –22 °F to +140 °F (–30 °C to +60 °C) |
| **Frequency Stability:** | ±2.5 ppm |
| **Dimensions** (WxHxD): | 2.3″ x 4.3″ x 1.2″ (58 x 18.5 x 30 mm) w/FNB-V67LI |
| **Weight** (approx.): | 10.6 oz (300 g) w/Antenna, Battery (FNB-V67LI), and Belt Clip |

## RECEIVER Specifications (Measurements made per TIA/EIA-603)

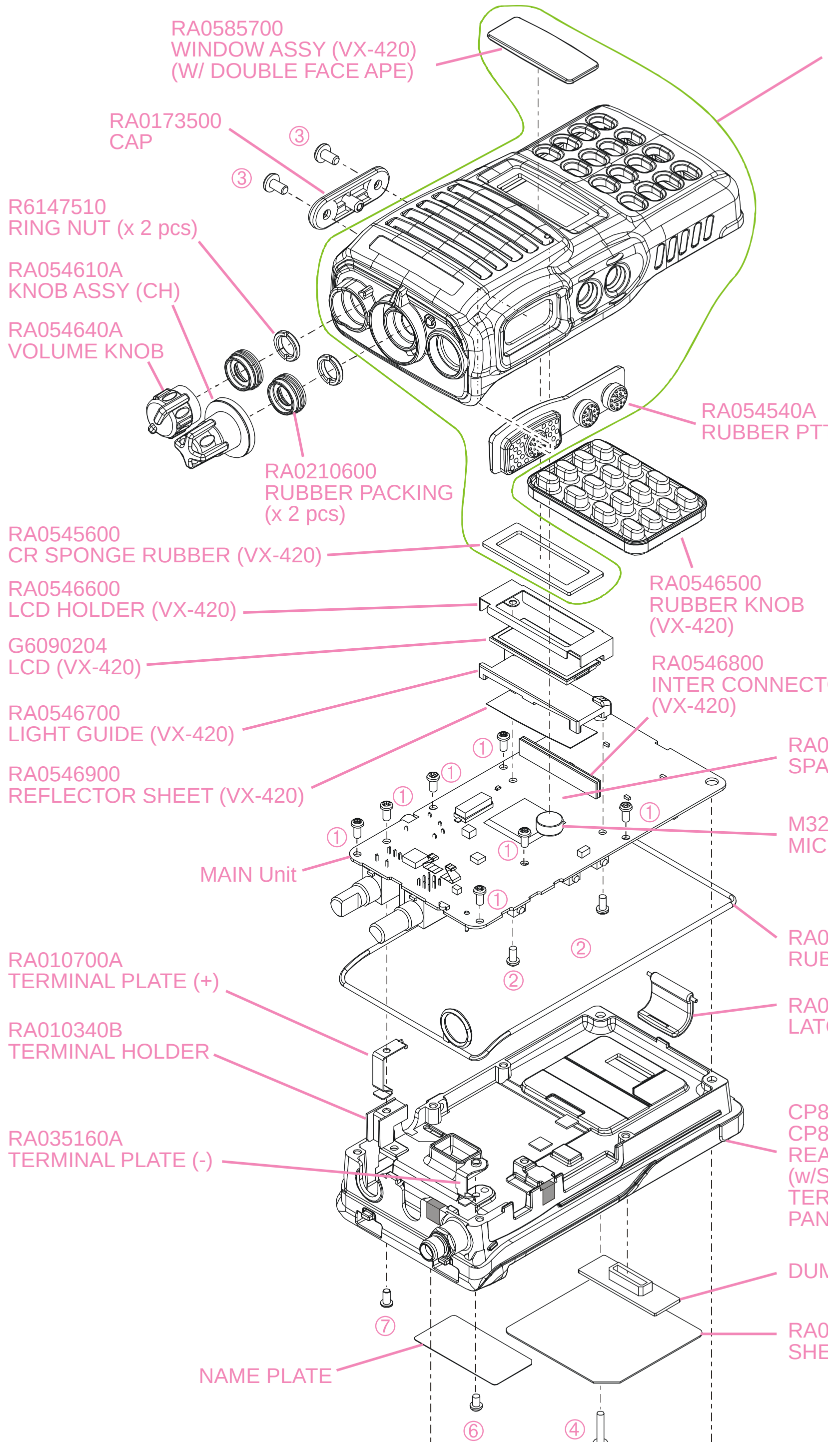
| | |
|---|---|
| **Sensitivity** (12 dB SINAD): | 0.25 μV |
| **Adjacent Channel Selectivity** (W/N): | 70 / 65 dB |
| **Intermodulation** (W/N): | 70 dB |
| **Spurious and Image Rejection:** | 70 dB |
| **Hum and Noise** (W/N): | 45 / 40 dB |
| **Audio output:** | 500 mW @4 Ohms, 5% THD |

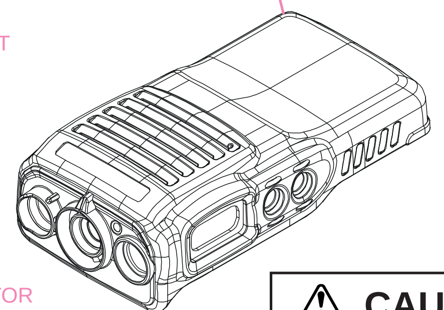
## TRANSMITTER Specifications (Measurements made per TIA/EIA-603)

| | |
|---|---|
| **Power output:** | 5 / 1 W |
| **Modulation** (W/N): | 16K0F3E, 11K0F3E |
| **Spurious Emissions:** | 70 dB |
| **FM Hum and Noise Analog** (W/N): | 45 / 40 dB |
| **Audio Distortion:** | Less than 3% @ 1 kHz |

Measurements per EIA standards unless noted above. Specifications subject to change without notice or obligation.

# *Exploded View & Miscellaneous Parts*

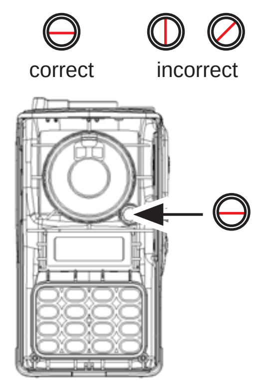


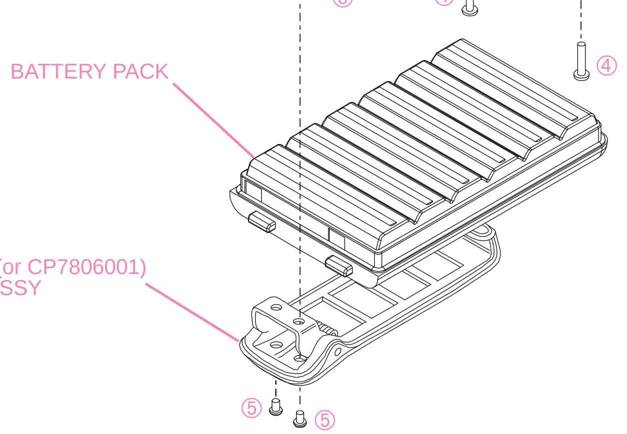




## ⚠ CAUTION

(Lot. 1 ~ Lot. 66 Only)

When installing a mic, please align the inter-connector horizontally, as shown.

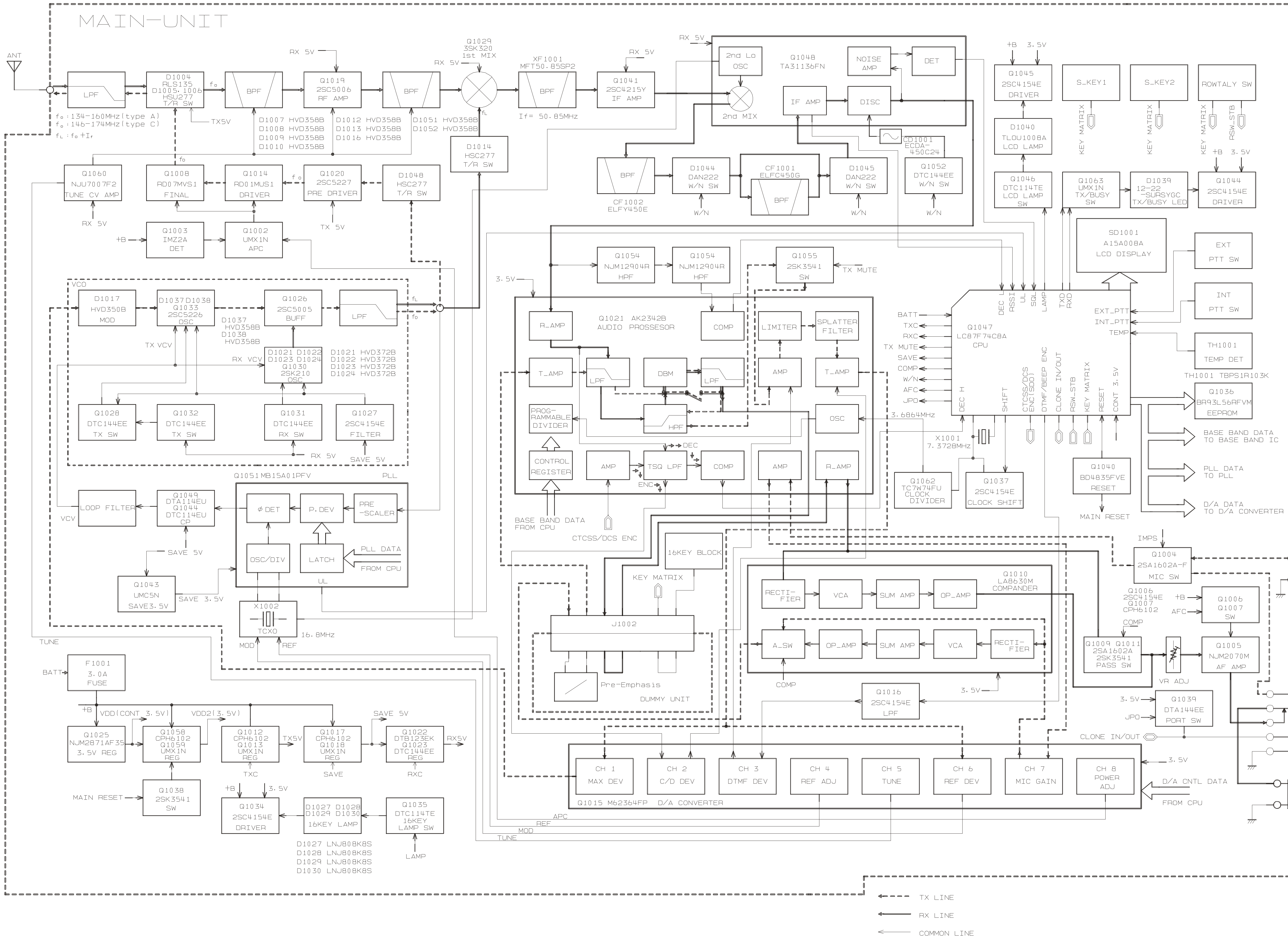



| REF. | VXSTD P/N | Description | Qty. |
|---|---|---|---|
| ① | U44104002 | TAPTITE SCREW M2X4NI | 7 |
| ② | U44104002 (VX-420) | TAPTITE SCREW M2X4NI | 2 |
| ③ | U20206007<br>U20105007 | BINDING HEAD SCREW M2.6X6B (Lot.1~)<br>BINDING HEAD SCREW M2.6X5B (Lot.16~) | 2 |
| ④ | U24110002 | TAPTITE SCREW M2X10NI | 2 |
| ⑤ | U02206007 | SEMS SCREW SM2.6X6B | 2 |
| ⑥ | U00103002 | PAN HEAD SCREW M2X3NI | 1 |
| ⑦ | U9900158 | TAPTITE SCREW 2X4NI | 1 |

Non-designated parts are available only as part of a designated assembly.

| REF. | DESCRIPTION | VALUE | V/W | TOL. | MFR'S DESIG | VXSTD P/N | VERS. | LOT. | SIDE | LAY ADR |
|---|---|---|---|---|---|---|---|---|---|---|
| | Main Unit PCB with Components | | | | | CB3575003 | VX-420 | | | |
| | | | | | | CB3575004 | VX-410 | | | |
| | | | | | | CB3575017 | VX-420 (IS Type) | | | |
| | | | | | | CB3575018 | VX-410 (IS Type) | | | |
| | Dummy Unit PCB with Components | | | | | CB2731001 | | | | |
| | FRONT CASE ASSY | | | | | CP8477001 | VX-420 | | | |
| | | | | | | CP8477002 | VX-410 | | | |
| | REAR CASE ASSY | | | | | CP8427002 | | | | |
| | | | | | | CP8427003 | IS Type | | | |
| | VOLUME KNOB | | | | | RA054640A | | | | |
| | KNOB ASSY | | | | (CH) | RA054610A | | | | |
| | RING NUT | | | | | R6147510 | | | | |
| | RUBBER PACKING | | | | | RA0210600 | | | | |
| | RUBBER PTT | | | | | RA054540A | | | | |
| | RUBBER KNOB | | | | | RA0546500 | VX-420 | | | |
| | LCD HOLDER | | | | | RA0546600 | VX-420 | | | |
| | INTER CONNECTOR | | | | | RA0546800 | VX-420 | | | |
| | PAN HEAD SCREW | 1 pc | | | M2X3NI | U00103002 | | | | |
| | SEMS SCREW | 2 pcs | | | SM2.6X5B | U02205007 | | | | |
| | BINDING HEAD SCREW | 2 pcs | | | M2.6X6B | U20206007 | | | | |
| | TAPTITE SCREW | 2pcs | | | M2X10NI | U24110002 | | | | |
| | TAPTITE SCREW | 7 pcs | | | M2X4NI | U44104002 | | | | |
| | TAPTITE SCREW | 2 pcs | | | M2X4NI | U44104002 | VX-420 | | | |
| | TAPTITE SCREW | 1 pc | | | 2X4NI | U9900158 | | | | |
| | SPEAKER | | | | 36N-D2114B 1.0W/4-OHM | M4090157 | | | | |
| CD1001 | CERAMIC DISC | | | | JTBM450CX24-A | H7901530A | | 1- | B | c2 |
| CF1001 | CERAMIC FILTER | | | | LTUCG450G-A | H3900566A | | 1- | B | c3 |
| CF1002 | CERAMIC FILTER | | | | LTWC450E-A | H3900565A | | 1- | B | c3 |
| DS1001 | LCD | | | | GTO4966SY01 | G6090204 | VX-420 | 1- | A | C2 |
| F 1001 | CHIP FUSE | 3.15A | | | FHC16 322ADTP | Q0000118 | | 1- | A | E3 |
| F 1001 | CHIP FUSE | 3A | | | 0434 003. 3.0A | Q0000107 | IS Type | 1- | A | E3 |
| MC1001 | MICROPHONE ELEMENT | | | | 0B-22S44-C1033MG H/F | M3290056 | | 1- | A | D1 |
| Q 1008 | FET | | | | RD07MVS1A-T12 | G3070352 | | 1- | B | b1 |
| S 1002 | ROTARY SWITCH | | | | TP70TF5161 | N0190183 | | 1- | B | a2 |
| S 1003 | TACT SWITCH | | | | SKRTLAE010 | N5090130 | | 1- | B | a1 |
| S 1004 | TACT SWITCH | | | | SKRTLAE010 | N5090130 | | 1- | B | b1 |
| S 1005 | TACT SWITCH | | | | SKRTLAE010 | N5090130 | | 1- | B | c1 |
| TH1001 | THERMISTOR | | | | ERTJ1VR103J | G9090118 | | 1- | A | D2 |
| TH1002 | THERMISTOR | | | | ERTJ0EV473J | G9090120 | | 1- | A | C2 |
| VR1001 | POT. | | | | R087A0NSFX13.5C6.5A20300I | J60800316 | | 1- | B | a3 |
| X 1001 | XTAL U3B | 7.3728MHz | | | 7.3728MHZ | H0103280 | | 1- | A | C3 |
| X 1002 | TCXO | 16.8MHz | | | TTS05VS-M1 16.8MHZ | H9500830 | | 1- | B | d2 |
| XF1001 | XTAL FILTER | | | | MFT50.85P2 50.85MHZ | H1102364 | | 1- | B | b2 |


MAIN-UNIT
ANT
LPF
D1004 RLS135 D1005,1006 HSU277 T/R SW
TX5V
fo:134-160MHz(type A)
fo:146-174MHz(type C)
fL:fo+If
BPF
RX 5V
Q1019 2SC5006 RF AMP
D1007 HVD358B
D1008 HVD358B
D1009 HVD358B
D1010 HVD358B
D1012 HVD358B
D1013 HVD358B
D1016 HVD358B
D1051 HVD358B
D1052 HVD358B
Q1029 3SK320 1st MIX
XF1001 MFT50.85SP2
If= 50.85MHz
Q1041 2SC4215Y IF AMP
D1014 HSC277 T/R SW
Q1060 NJU7007F2 TUNE CV AMP
Q1008 RD07MVS1 FINAL
Q1014 RD01MUS1 DRIVER
Q1020 2SC5227 PRE DRIVER
D1048 HSC277 T/R SW
TX 5V
Q1003 IMZ2A DET
Q1002 UMX1N APC
+B
RX 5V
2nd Lo OSC
Q1048 TA31136FN
NOISE AMP
DET
2nd MIX
IF AMP
DISC
CD1001 ECDA-450C24
BPF
CF1002 ELFY450E
D1044 DAN222 W/N SW
CF1001 ELFC450G
D1045 DAN222 W/N SW
Q1052 DTC144EE W/N SW
W/N
VCO
D1017 HVD350B MOD
D1037 D1038 Q1033 2SC5226 OSC
D1037 HVD358B
D1038 HVD358B
Q1026 2SC5005 BUFF
LPF
TX VCV
RX VCV
D1021 D1022 D1023 D1024 Q1030 2SK210 OSC
D1021 HVD372B
D1022 HVD372B
D1023 HVD372B
D1024 HVD372B
Q1028 DTC144EE TX SW
Q1032 DTC144EE TX SW
Q1031 DTC144EE RX SW
Q1027 2SC4154E FILTER
RX 5V
SAVE 5V
Q1051 MB15A01PFV
PLL
LOOP FILTER
VCV
Q1049 DTA114EU Q1044 DTC114EU CP
φ DET
P.DEV
PRE-SCALER
OSC/DIV
LATCH
PLL DATA FROM CPU
UL
SAVE 5V
Q1043 UMC5N SAVE3.5V
SAVE 3.5V
X1002 TCXO
16.8MHz
MOD
REF
TUNE
3.5V
Q1054 NJM12904R HPF
Q1055 2SK3541 SW
TX MUTE
Q1021 AK2342B AUDIO PROSSESOR
R_AMP
COMP
LIMITER
SPLATTER FILTER
T_AMP
LPF
DBM
AMP
PROG-RAMMABLE DIVIDER
HPF
OSC
3.6864MHz
CONTROL REGISTER
TSQ LPF
DEC
ENC
BASE BAND DATA FROM CPU
CTCSS/DCS ENC
16KEY BLOCK
KEY MATRIX
J1002
Pre-Emphasis
DUMMY UNIT
S_KEY1
S_KEY2
ROWTALY SW
+B 3.5V
Q1045 2SC4154E DRIVER
D1040 TLOU1008A LCD LAMP
Q1046 DTC114TE LCD LAMP SW
Q1063 UMX1N TX/BUSY SW
D1039 12-22-SURSYGC TX/BUSY LED
Q1044 2SC4154E DRIVER
KEY MATRIX
RSW_STB
SD1001 A15A008A LCD DISPLAY
EXT PTT SW
INT PTT SW
TH1001 TEMP DET
TH1001 TBPS1R103K
Q1047 LC87F74C8A CPU
BATT
TXC
RXC
TX MUTE
SAVE
COMP
W/N
AFC
JPO
DEC L
RSSI
UL
SQL
LAMP
TXD
RXD
EXT_PTT
INT_PTT
TEMP
DEC H
SHIFT
CTCSS/DCS ENC(SDO)
DTMF/BEEP ENC
CLONE IN/OUT
RSW_STB
KEY MATRIX
RESET
CONT 3.5V
Q1036 BR93L56RFVM EEPROM
BASE BAND DATA TO BASE BAND IC
PLL DATA TO PLL
D/A DATA TO D/A CONVERTER
X1001 7.3728MHz
Q1062 TC7W74FU CLOCK DIVIDER
Q1037 2SC4154E CLOCK SHIFT
Q1040 BD4835FVE RESET
MAIN RESET
IMPS
Q1004 2SA1602A-F MIC SW
MC1001
MIC
Q1010 LA8630M COMPANDER
RECTI-FIER
VCA
SUM AMP
OP_AMP
A_SW
Q1006 2SC4154E Q1007 CPH6102
COMP
Q1006 Q1007 SW
AFC
Q1009 Q1011 2SA1602A 2SK3541 PASS SW
VR ADJ
Q1005 NJM2070M AF AMP
Q1016 2SC4154E LPF
Q1039 DTA144EE PORT SW
JPO
J1001
CLONE IN/OUT
CH 1 MAX DEV
CH 2 C/D DEV
CH 3 DTMF DEV
CH 4 REF ADJ
CH 5 TUNE
CH 6 REF DEV
CH 7 MIC GAIN
CH 8 POWER ADJ
Q1015 M62364FP D/A CONVERTER
D/A CNTL DATA FROM CPU
SP1001
APC
REF
MOD
TUNE
F1001 3.0A FUSE
BATT
VDD(CONT 3.5V)
VDD2(3.5V)
Q1025 NJM2871AF35 3.5V REG
Q1058 CPH6102 Q1059 UMX1N REG
Q1012 CPH6102 Q1013 UMX1N REG
TX5V
TXC
Q1017 CPH6102 Q1018 UMX1N REG
SAVE
Q1022 DTB123EK Q1023 DTC144EE REG
RX5V
RXC
Q1038 2SK3541 SW
MAIN RESET
Q1034 2SC4154E DRIVER
D1027 D1028 D1029 D1030 16KEY LAMP
Q1035 DTC114TE 16KEY LAMP SW
LAMP
D1027 LNJ808K8S
D1028 LNJ808K8S
D1029 LNJ808K8S
D1030 LNJ808K8S
TX LINE
RX LINE
COMMON LINE

### *Receive Signal Path*

Incoming RF from the antenna jack is delivered to the RF Unit and passes through a low-pass filter consisting of coils L1002, and L1003, capacitors C1001, C1002, C1021, C1024, C1025, C1026, and C1027, and antenna switching diode D1004 (**RLS135**).

Signals within the frequency range of the transceiver enter a varactor-tuned band-pass filter consisting of coils L1012 and L1015, capacitors C1058, C1059, C1085, C1118, and C1119, and diodes D1007, D1008, D1009, and D1010 (all **HVD350B**), then are amplified by Q1019 (**2SC5006**) and enter a varactor-tuned band-pass filter consisting of coils L1020, and L1025, capacitors C1053, C1054, C1056, C1180, and C1181, and diodes D1012, D1013, and D1016 (all **HVD350B**), before application to the first mixer, Q1029 (**3SK320**).

Buffered output from the VCO is amplified by Q1026 (**2SC5005**) to provide a pure first local signal between 196.85 and 224.85 MHz for injection to the first mixer Q1029. The 50.85 MHz first mixer product then passes through monolithic crystal filter XF1001 (**MFT50.85PT**, 5.5 kHz BW) to strip away unwanted mixer products, and is then amplified by Q1041 (**2SC4215Y**).

The amplified first IF signal is applied to FM IF subsystem IC Q1048 (**TA31136FN**), which contains the second mixer, second local oscillator, limiter amplifier, noise amplifier, and RSSI amplifier.

The second local signal is produced from the PLL reference/second local oscillator of X1002 (TCXO TTS05VS-M1 16.80 MHz). The 16.80 MHz reference signal is tripled by Q1048, capacitor C1251, and coil L1042, and the resulting the 50.4 MHz second local signal is then delivered to the mixer section of Q1048 which produces the 450 kHz second IF when mixed with the first IF signal.

The second IF then passes through the ceramic filter CF1001 (**ELFC450G** on "Narrow" channels) or CF1002 (**ELFY450E** on "Wide" and "Narrow" channels) to strip away all but the desired signal, and is then applied to the limiter amplifier in Q1048, which removes amplitude variations in the 450 kHz IF, before detection of the speech by the ceramic discriminator CD1001 (**ECDA450C24**).

### *Squelch Control*

The squelch circuitry consists of a noise amplifier, band-pass filter, and noise detector within Q1048 (**TA31136FN**).

When no carrier is received, noise at the output of the detector stage in Q1048 is amplified and band-pass filtered by the noise amplifier section of Q1048 and the network between pins 7 and 8, and then is rectified by detection circuit in Q1048.

The resulting DC squelch control voltage is passed to pin 19 of the microprocessor Q1047 (**LC87F74C8A**). If no carrier is received, this signal causes pin 19 of Q1047 to go high and pin 30 to go high. Pin 35 signals Q1006 (**2SC4154E**) to disable the supply voltage to the audio amplifier Q1005, while pin 30 holds the green (Busy) half of the LED off, when pin 35 is high and pin 30 is high.

Thus, the microprocessor blocks output from the audio amplifier, and silences the receiver, while no signal is being received (and during transmission, as well).

When a carrier appears at the discriminator, noise is removed from the output, causing pin 19 of Q1047 to go low and the microprocessor to activate the "Busy" LED via Q1047.

The microprocessor then checks for CTCSS or CDCSS code squelch information, if enabled. If not transmitting and CTCSS or CDCSS is not activated, or if the received tone or code matches that programmed, audio is allowed to pass through the audio amplifier Q1005 (**NJM2070M**) to the loudspeaker by the enabling of the supply voltage to it via Q1048.

### *Transmit Signal Path*

Speech input from the microphone MC1001 passes through the audio amplifier Q1021 (**AK2342B**) to Q1015 (**M62364FP**) which adjusts the microphone gain. The adjusted audio is applied to the compander Q1010 (**LA8630M**) which compresses the speech signal according to a control command from the microprocessor Q1047 (**LC87F74C8A**).

The compressed speech signal passes through the dummy unit and pre-emphasis circuit to Q1021, which contains the low-pass filter, Voice Scrambler selector, and high-pass filter.

The output from Q1021 is applied to the AF mute gate Q1055 (**2SK3541**), then returns to Q1021, which contains the limiter amplifier, splatter filter and audio amplifier.

The filtered audio signal is applied to Q1015 (**M62364FP**) which is adjusts the audio level, then is applied to varactor diode D1017 (**HVD350B**), which frequency modulates the VCO Q1033 (**2SK508**). A portion of the audio signal from Q1015 is applied to TCXO X1002 (**TTS05VS**).

The processed audio may then be mixed with a CTCSS tone generated by Q1047 (**LC87F74C8A**) for frequency modulation of the PLL carrier (up to ±5 kHz from the unmodulated carrier) at the transmitting frequency.

If a CDCSS code is enabled for transmission, the code is generated by microprocessor Q1047 and delivered to X1002 (**TCXO TTS05VS**) for CDCSS modulating.

The modulated signal from the VCO Q1033 (**2SC5226**) is buffered by Q1026 (**2SC5005**). The low-level transmit signal then passes through the T/R switching diode D1048 (**HSC277TRF**) to the driver amplifier Q1014 (**2SK2596BXTL**), and then the amplified transmit signal is applied to the final amplifier Q1008 (**RD07MVS1**), which delivers up to 5 watts of output power.

The transmit signal then passes through the antenna switch D1004 (**RLS135**) and is low-pass filtered, to suppress harmonic spurious radiation before delivery to the antenna.

## *Automatic Transmit Power Control*

Current from the final amplifier is sampled by R1015, R1038 and R1040, and is rectified by Q1003 (**IMZ2A**). The resulting DC is fed back through Q1002 (**UMX1**) to the drive amplifier Q1014 and final amplifier Q1008, for control of the power output.

The microprocessor selects “High” or “Low” power levels.

## *Transmit Inhibit*

When the transmit PLL is unlocked, pin 7 of PLL IC Q1005 (**MB15A01PFV**) goes to a logic “Low.” The resulting DC unlock control voltage is passed to pin 10 of the microprocessor Q1047. While the transmit PLL is unlocked, pin 31 of Q1047 remains high, which then turns off Q1012 (**CPH6102**) and the Automatic Power Controller Q1002 (**UMX1**) to disable the supply voltage to the drive amplifier Q1014, Q1020 and final amplifier Q1008, thereby disabling the transmitter.

## *Spurious Suppression*

Generation of spurious products by the transmitter is minimized by the fundamental carrier frequency being equal to final transmitting frequency, modulated directly in the transmit VCO. Additional harmonic suppression is provided by a low-pass filter consisting of coils L1002, and L1003 plus capacitors C1001, C1002, C1021, C1023, C1024, C1025, C1026, and C1027, resulting in more than 60 dB of harmonic suppression prior to delivery of the RF signal to the antenna.

## *PLL Frequency Synthesizer*

The PLL circuitry on the Main Unit consists of VCO Q1030 (**2SK210GR**), Q1033 (**2SC5226**), VCO buffer Q1026 (**2SC5005**), and PLL subsystem IC Q1051 (**MB15A01PFV1**), which contains a reference divider, serial-to-parallel data latch, programmable divider, phase comparator and charge pump, and TCXO unit X1002 (**TTS05VS**) which yields frequency stability of ±2.5ppm @ –22°F to +140°F (–30°C to +60°C).

While receiving, VCO Q1030 oscillates between 196.85 and 224.85 MHz according to the transceiver version and the programmed receiving frequency. The VCO output is buffered by Q1026, then applied to the prescaler section of Q1051. There the VCO signal is divided by 64 or 65, according to a control signal from the data latch section of Q1051, before being sent to the programmable divider section of Q1051.

The data latch section of Q1051 also receives serial dividing data from the microprocessor Q1047, which causes the pre-divided VCO signal to be further divided in the programmable divider section, depending upon the desired receive frequency, so as to produce a 2.5 kHz or 3.125 kHz derivative of the current VCO frequency.

Meanwhile, the reference divider section of Q1051 divides the 16.80 MHz crystal reference from the reference oscillator Q1051, by 6720 (or 5376) to produce the 2.5 kHz (or 3.125 kHz) loop references (respectively).

The 2.5 kHz (or 3.125 kHz) signal from the programmable divider (derived from the VCO) and that derived from the reference oscillator are applied to the phase detector section of Q1051, which produces a pulsed output with pulse duration depending on the phase difference between the input signals.

This pulse train is filtered to DC and returned to varactors D1021, D1022, D1023, and D1024 (all **HVD372B**). Changes in the level of the DC voltage are applied to the varactors, affecting the reference in the tank circuit of the VCO according to the phase difference between the signals derived from the VCO and the crystal reference oscillator.

The VCO is thus phase-locked to the crystal reference oscillator. The output of the VCO Q1030 (**2SK210GR**), after buffering by Q1026, is applied to the first mixer as described previously.

For transmission, the VCO Q1033 (**2SC5226**) oscillates between 146.00 and 174.00 MHz according to the model version and programmed transmit frequency. The remainder of the PLL circuitry is shared with the receiver. However, the dividing data from the microprocessor is such that the VCO frequency is at the actual transmit frequency (rather than offset for IFs, as in the receiving case). Also, the VCO is modulated by the speech audio applied to D1017 (**HVC350B**), as described previously.

Receive and transmit buses select which VCO is made active, using Q1028, Q1031, Q1032 (all **DTC144EE**).

## *Miscellaneous Circuits*

**Push-To-Talk Transmit Activation**

The PTT switch on the microphone is connected to pin 22 of microprocessor Q1047, so that when the PTT switch is closed, pin 27 of Q1047 goes high. This signal disables the receiver by disabling the 5 V supply bus at Q1022 (**DTB123EK**) to the front-end, FM IF subsystem IC Q1048 and the receiver VCO circuitry.

At the same time, Q1013 (**UMX1N**) and Q1012 (**CPH6102**) activate the transmit 5V supply line to enable the transmitter.

## Introduction

The **VX-410/-420** series has been aligned at the factory for the specified performance across the entire frequency range specified. Realignment should therefore not be necessary except in the event of a component failure. All component replacement and service should be performed only by an authorized Vertex Standard representative, or the warranty policy may be voided.

The following procedures cover the sometimes critical and tedious adjustments that are not normally required once the transceiver has left the factory. However, if damage occurs and some parts are replaced, realignment may be required. If a sudden problem occurs during normal operation, it is likely due to component failure; realignment should not be done until after the faulty component has been replaced.

We recommend that servicing be performed only by authorized Vertex Standard service technicians who are experienced with the circuitry and fully equipped for repair and alignment. Therefore, if a fault is suspected, contact the dealer from whom the transceiver was purchased for instructions regarding repair. Authorized Vertex Standard service technicians realign all circuits and make complete performance checks to ensure compliance with factory specifications after replacing any faulty components. Those who do undertake any of the following alignments are cautioned to proceed at their own risk. Problems caused by unauthorized attempts at realignment are not covered by the warranty policy. Also, Vertex Standard must reserve the right to change circuits and alignment procedures in the interest of improved performance, without notifying owners. Under no circumstances should any alignment be attempted unless the normal function and operation of the transceiver are clearly understood, the cause of the malfunction has been clearly pinpointed and any faulty components replaced, and the need for realignment determined to be absolutely necessary. The following test equipment (and thorough familiarity with its correct use) is necessary for complete realignment. Correction of problems caused by misalignment resulting from use of improper test equipment is not covered under the warranty policy. While most steps do not require all of the equipment listed, the interactions of some adjustments may require that more complex adjustments be performed afterwards. Do not attempt to perform only a single step unless it is clearly isolated electrically from all other steps. Have all test equipment ready before beginning, and follow all of the steps in a section in the order presented.

## Required Test Equipment

- ❐ Avionics Radio Tester with calibrated output level at 500 MHz
- ❐ In-line Wattmeter with 5% accuracy at 500 MHz
- ❐ 50-ohm, 10-W RF Dummy Load
- ❐ Regulated DC Power Supply (standard 7.5V DC, 2A)
- ❐ Frequency Counter: ±0.2 ppm accuracy at 500 MHz
- ❐ AF Signal Generator
- ❐ AC Voltmeter
- ❐ DC Voltmeter
- ❐ VHF Sampling Coupler
- ❐ IBM® PC/Compatible Computer with Microsoft® Windows® 95 or later operating system
- ❐ Vertex Standard CE64 Alignment program
- ❐ Vertex Standard FIF-12 USB Programming Interface and CT-104A, CT-106, or CT-171 PC Programming Cable
- ❐ Vertex Standard FRB-6 Tuning Interface Box and CT-160 Connection Cable

## Alignment Preparation & Precautions

A 50-ohm RF Dummy load and in-line wattmeter must be connected to the main antenna jack in all procedures that call for transmission, except where specified otherwise. Correct alignment is not possible with an antenna.

After completing one step, read the following step to determine whether the same test equipment will be required. If not, remove the test equipment (except dummy load and wattmeter, if connected) before proceeding.

Correct alignment requires that the ambient temperature be the same as that of the transceiver and test equipment, and that this temperature be held constant between 20° and 30°C. When the transceiver is brought into the shop from hot or cold air, it should be allowed time to come to room temperature before alignment.

Whenever possible, alignments should be made with oscillator shields and circuit boards firmly affixed in place. Also, the test equipment must be thoroughly warmed up before beginning.

**Note:** Signal levels in dB referred to in this procedure are based on 0 dBμ = 0.5 μV (closed circuit).

### Important Note

When connecting the **CT-160** plug into the **MIC/SP** jack of the **VX-410/-420** series, you must remove the plastic cap and its mounting screws prior to programming. Please remember to re-attach the cap and screws when the programming is complete.

## Test Setup

Set up the test equipment as shown below for transceiver alignment, and apply 7.5V DC power to the transceiver.

The transceiver must be programmed for use in the intended system before alignment is attempted. The RF parameters are loaded from the file during the alignment process.

In order to facilitate alignment over the complete operating rang of the equipment, it is recommended that the channel data in the transceiver be preset as per the chart below.

## The alignment tool outline

*Installation of the Alignment tool*

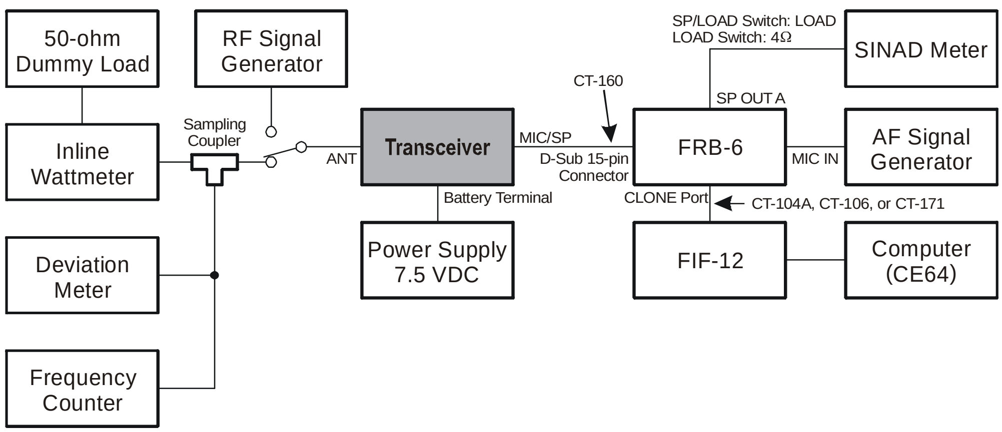
The "alignment mode" is a software-based protocol, accessed by an "Alignment Mode" command from the computer while switching the transceiver on. It is operated by the alignment tool automatically. During use of the alignment mode, normal operation is suspended. The alignment tool program provides all needed operation capability.

*Alignment Sequence*

Although the data displayed on the computer's screen during alignment is temporary data, it is important you follow the basic alignment sequence precisely, so that the displayed data and the data loaded into the transceiver are identical.

*Basic Alignment Sequence*

1. Enter the alignment mode
2. Upload data from transceiver
3. Align data
4. Download data to transceiver




| CHANNEL | TYPE | FREQUENCY | CTCSS TONE | DCS CODE |
|---|---|---|---|---|
| Low Band Edge (Channel 1) | A | 134.000 MHz | --- | --- |
| | C | 146.000 MHz | | |
| Band Center (Channel 2) | A | 147.000 MHz | 254.1 Hz | --- |
| | C | 160.000 MHz | | |
| High Band Edge (Channel 3) | A | 160.000 MHz | --- | 325 |
| | C | 174.000 MHz | | |

## PLL VCV (Varactor Control Voltage)

- ❒ Connect the DC voltmeter between **TP1045** on the Main Unit and ground.
- ❒ Set the transceiver to CH 3 (high band edge), and adjust **L1036** on the Main Unit for 3.7 V ± 0.1 V on the DC voltmeter.
- ❒ Set the transceiver to CH 1 (low band edge), and confirm the low-end VCV is more than 1.2 V while receiving.
- ❒ Set the transceiver to CH 3 (high band edge), and adjust **L1038** on the Main Unit for 3.6 V ± 0.1 V while transmitting.
- ❒ Set the transceiver to CH 1 (low band edge), and confirm the low-end VCV is more than 1.1 V while transmitting.

## Reference Frequency

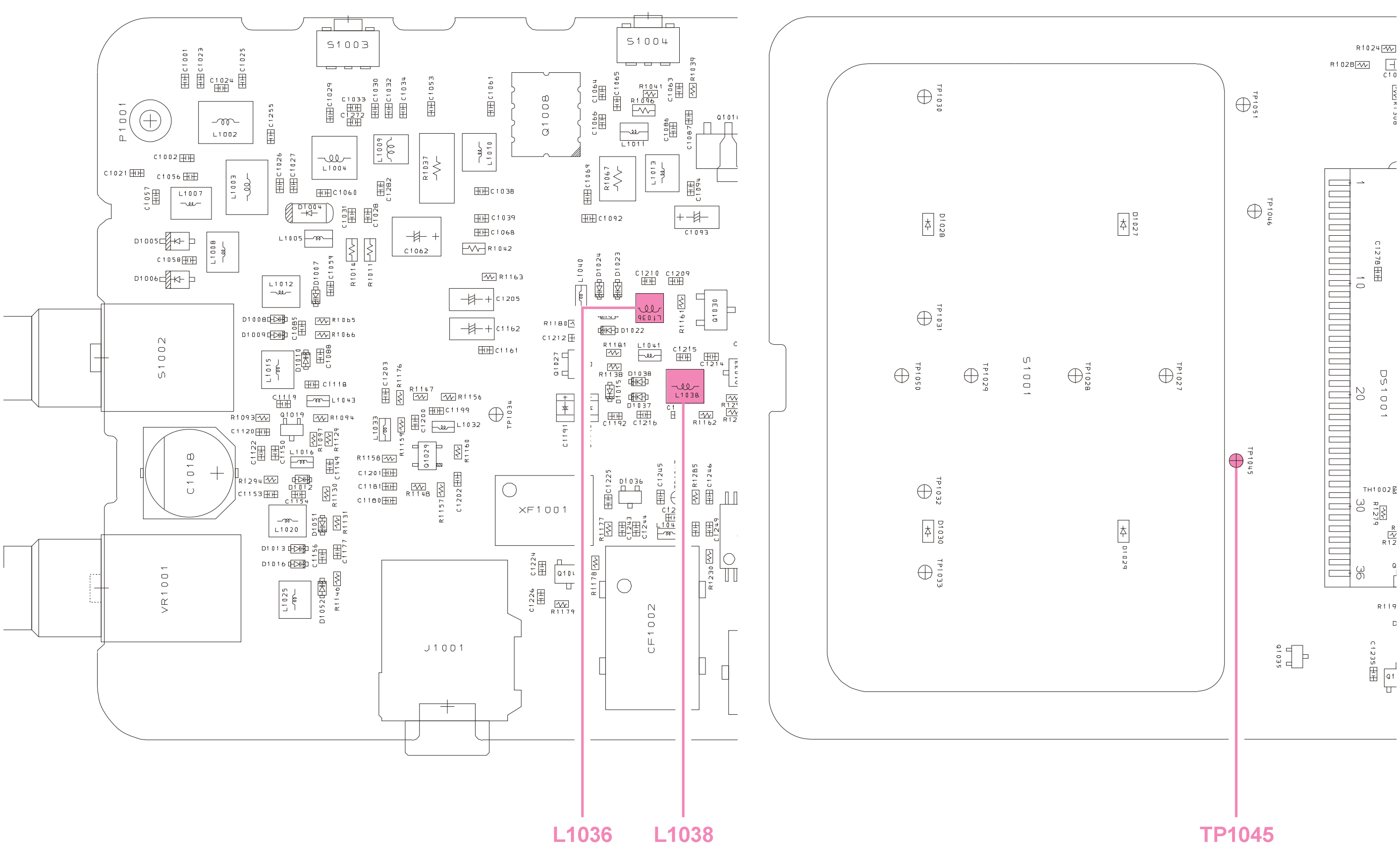
- ❒ Set the transceiver to CH 2 (band center) via the "CH" box on the "Alignment" window previously.
- ❒ To adjustment, click the left mouse button on the "**RF Frequency**" box, then press the [**ENTER**] key to open the pop-up window.
- ❒ Use the [🡐] or [🡒] arrow keys so that the frequency counter displays the band center frequency (±100 Hz) for the version being aligned.
- ❒ Press the "OK" box to lock in the new data.

## Transmitter Output Power

- ❒ Set the transceiver to CH 2 (band center).
- ❒ To adjustment, click the left mouse button on the "**RF Power {High}**" or "**RF Power {Low}**" box, then press the [**ENTER**] key to open the pop-up window.
- ❒ Use the [🡐] or [🡒] arrow keys so that the power meter reading is 5.0 W (± 0.1 W) (for "RF Power High") or 1.0 W (± 0.1 W) (for "RF Power Low"). Confirm that the current consumption is 2.3 A or lower (for "RF Power High") or 1.0 A or lower (for "RF Power Low").
- ❒ Press the "OK" box to lock in the new data.

## MAX Deviation

- ❒ Set the transceiver to CH 2 (band center).
- ❒ Inject a 1 kHz tone at –17 dBm to the **MIC** jack.
- ❒ To adjustment, click the left mouse button on the "**MAX Deviation**" box, then press the [**ENTER**] key to open the pop-up window.
- ❒ Use the [🡐] or [🡒] arrow keys so that the deviation meter reading is ±4.3 kHz (±0.1 kHz) (for 25 kHz steps) or ±2.1 kHz (±0.1 kHz) (for 12.5 kHz steps) deviation.
- ❒ Press the "OK" box to lock in the new data.



### CTCSS Deviation

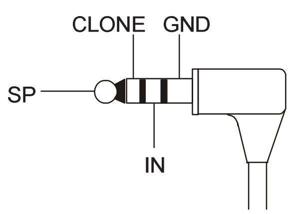
❒ Set the transceiver to CH 2 (band center).
❒ To adjustment, click the left mouse button on the "**CTCSS Modulation**" box, then press the [**ENTER**] key to open the pop-up window.
❒ Use the [←] or [→] arrow keys so that the deviation meter reading is ±0.8 kHz (±0.1 kHz) (for 25 kHz steps) or ±0.5 kHz (±0.1 kHz) (for 12.5 kHz steps) deviation.
❒ Press the "OK" box to lock in the new data.

### MAX Ref Deviation

❒ Set the transceiver to CH 2 (band center).
❒ To adjustment, click the left mouse button on the "**MAX Ref Deviation**" box, then press the [**ENTER**] key to open the pop-up window.
❒ Use the [←] or [→] arrow keys so that the deviation meter reading is ±0.5 kHz (±0.1 kHz) (for 25 kHz steps) or ±0.4 kHz (±0.1 kHz) (for 12.5 kHz steps) deviation.
❒ Set the transceiver to CH 2 (band center), then key the transmitter, and confirm that the deviation is ±0.6 kHz ~ ±0.9 kHz (for 25 kHz steps) or ±0.35 kHz ~ ±0.6 kHz (for 12.5 kHz steps).
❒ Press the "OK" box to lock in the new data.

### STD Deviation

❒ Set the transceiver to CH 2 (band center).
❒ Inject a 1 kHz tone at –37 dBm to the **MIC** jack.




❒ To adjustment, click the left mouse button on the "**MIC Sensitivity**" box, then press the [**ENTER**] key to open the pop-up window.
❒ Use the [←] or [→] arrow keys so that the deviation meter reading is ±3.0 kHz (±0.1 kHz) (for 25 kHz steps) or ±1.5 kHz (±0.1 kHz) (for 12.5 kHz steps) deviation.
❒ Press the "OK" box to lock in the new data.

### DTMF Deviation

❒ Set the transceiver to CH 2 (band center).
❒ To adjustment, click the left mouse button on the "**DTMF Deviation**" box, then press the [**ENTER**] key to open the pop-up window.
❒ Use the [←] or [→] arrow keys so that the deviation meter reading is ±3.0 kHz (±0.1 kHz) (for 25 kHz steps) or ±1.5 kHz (±0.1 kHz) (for 12.5 kHz steps) deviation.
❒ Press the "OK" box to lock in the new data.

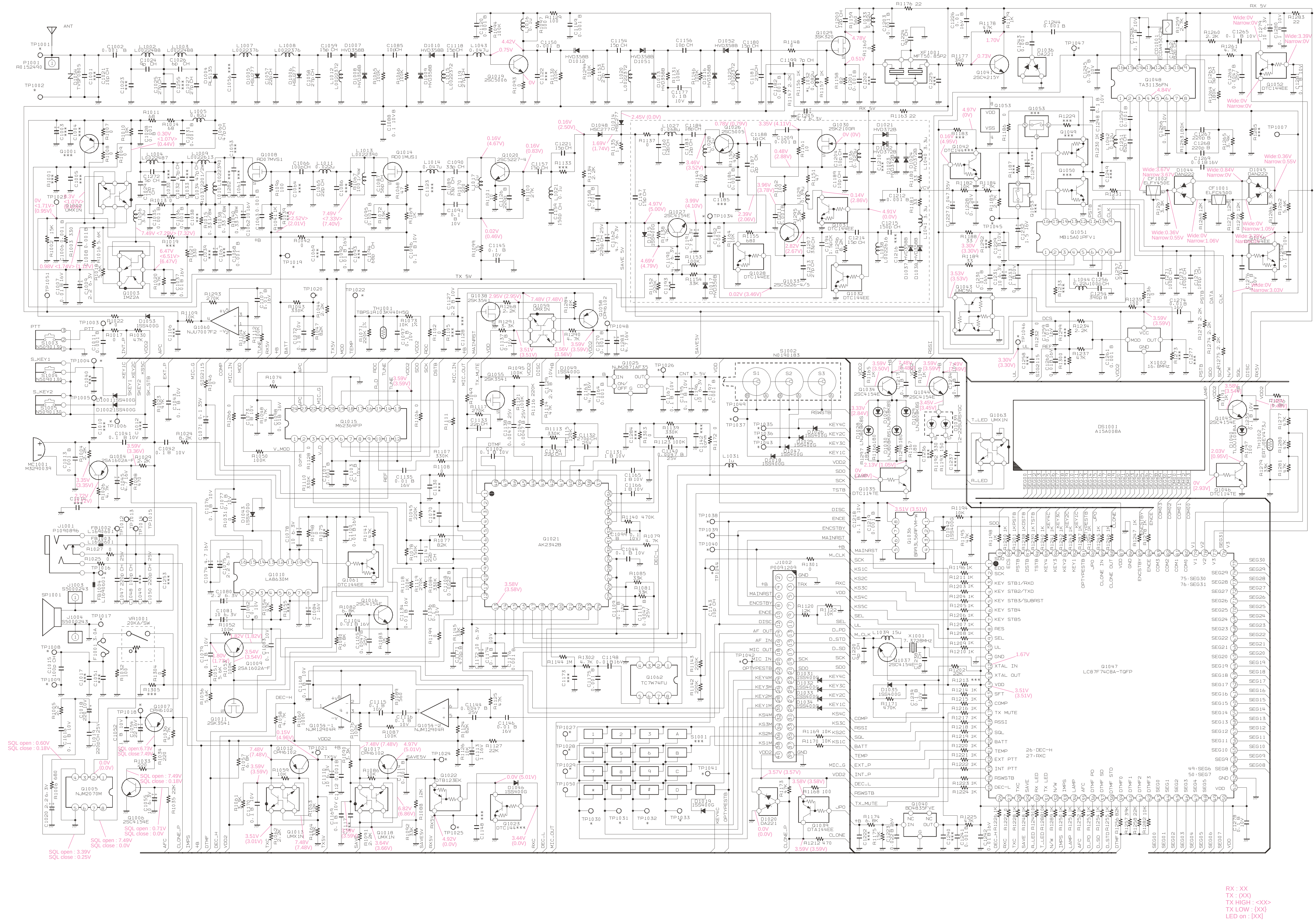
### DCS Deviation

❒ Set the transceiver to CH 2 (band center).
❒ To adjustment, click the left mouse button on the "**DCS Modulation**" box, then press the [**ENTER**] key to open the pop-up window.
❒ Use the [←] or [→] arrow keys so that the deviation meter reading is ±0.7 kHz (±0.1 kHz) (for 25 kHz steps) or ±0.45 kHz (±0.1 kHz) (for 12.5 kHz steps) deviation.
❒ Press the "OK" box to lock in the new data.

### Sensitivity

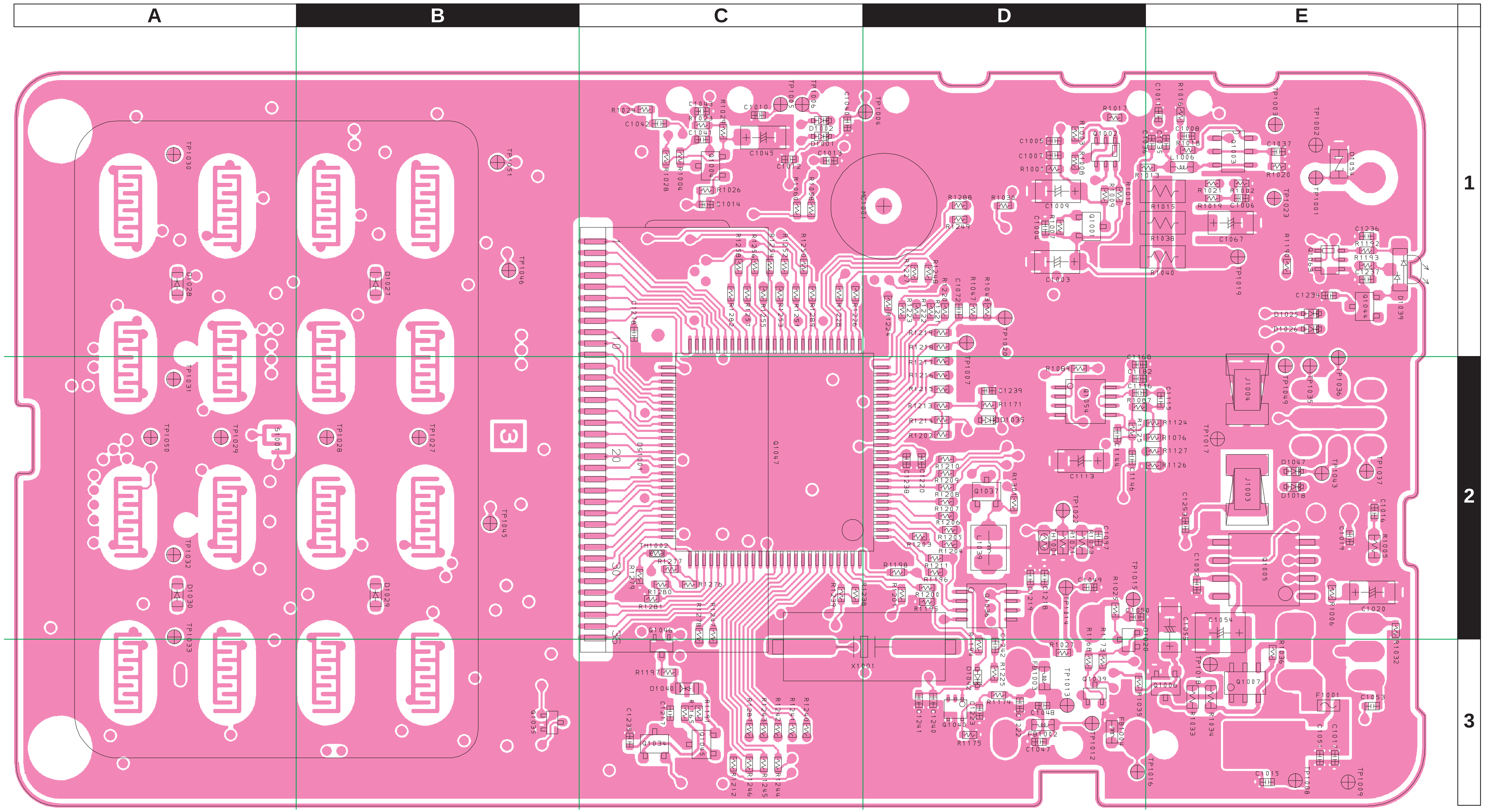
❒ Set the transceiver to CH 3 (high band edge).
❒ Tune the RF signal generator to the same frequency as the transceiver's, then set the generator output level to 40 dBμ with ±3.0 kHz deviation @ 1 kHz tone modulation.
❒ To adjustment, click the left mouse button on the "**RX Sensitivity**" box, then press the [**ENTER**] key to open the pop-up window.
❒ Use the [←] or [→] arrow keys to tune for best sensitivity; ultimately, the radio should be aligned so that the RF signal generator output level is –6 dBμ EMF (0.25 μV) or less for 12 dB SINAD.
❒ Press the "OK" box to lock in the new data.

This completes the internal alignment routine. To save all settings and exit, press the "OK" box.

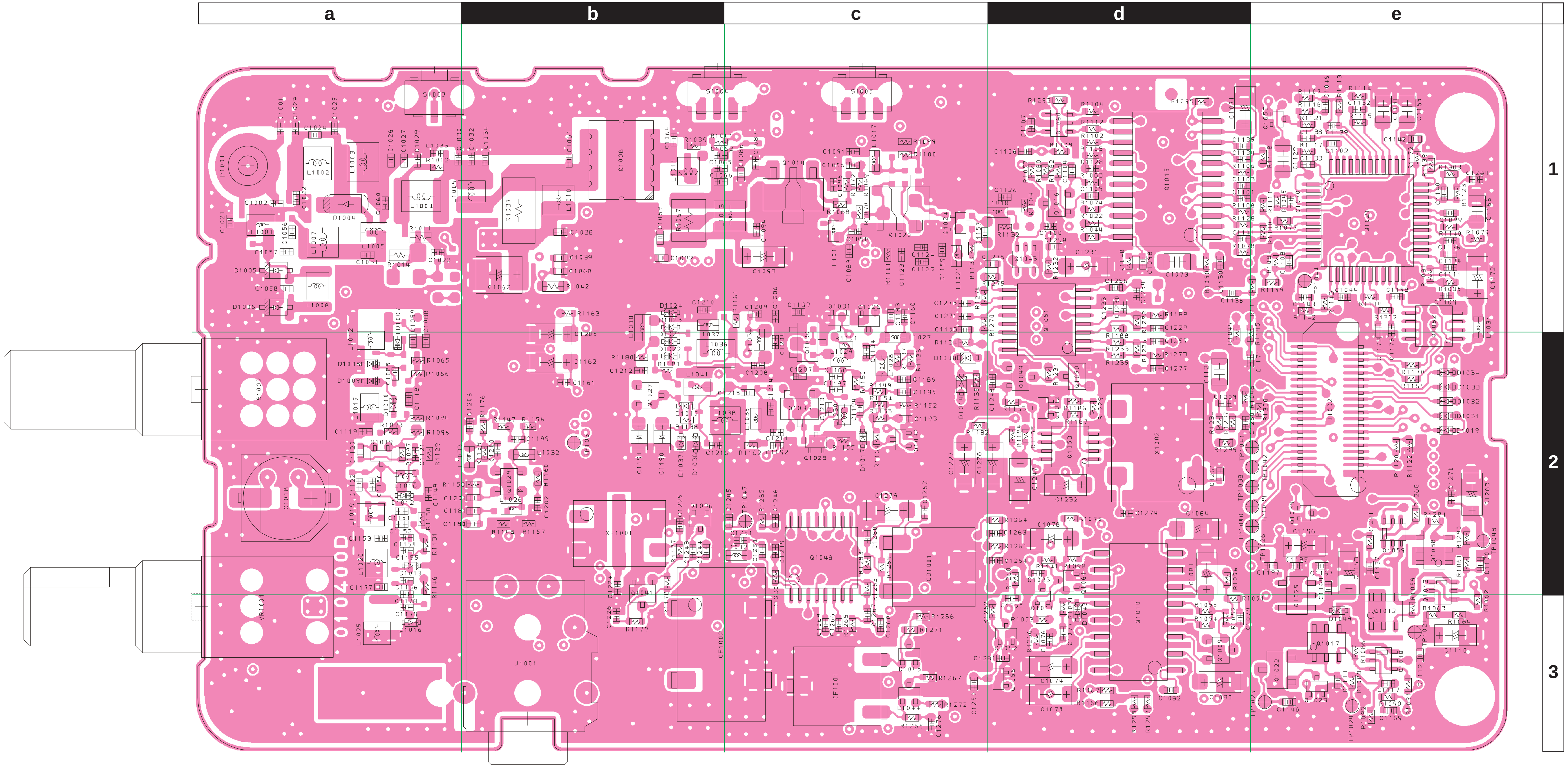


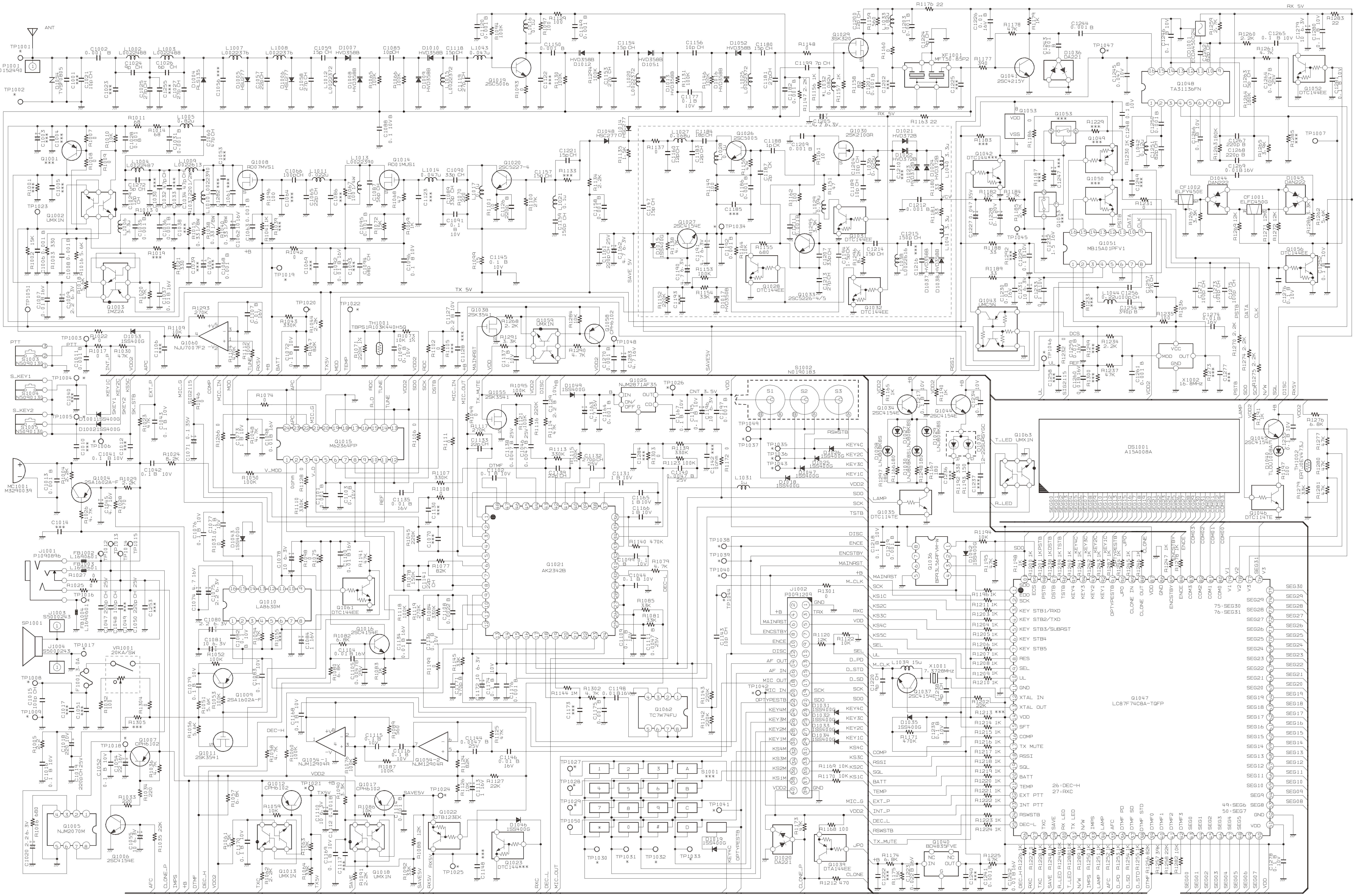
RX : XX
TX : (XX)
TX HIGH : <XX>
TX LOW : {XX}
LED on : [XX]

*Parts Layout (Side A)*

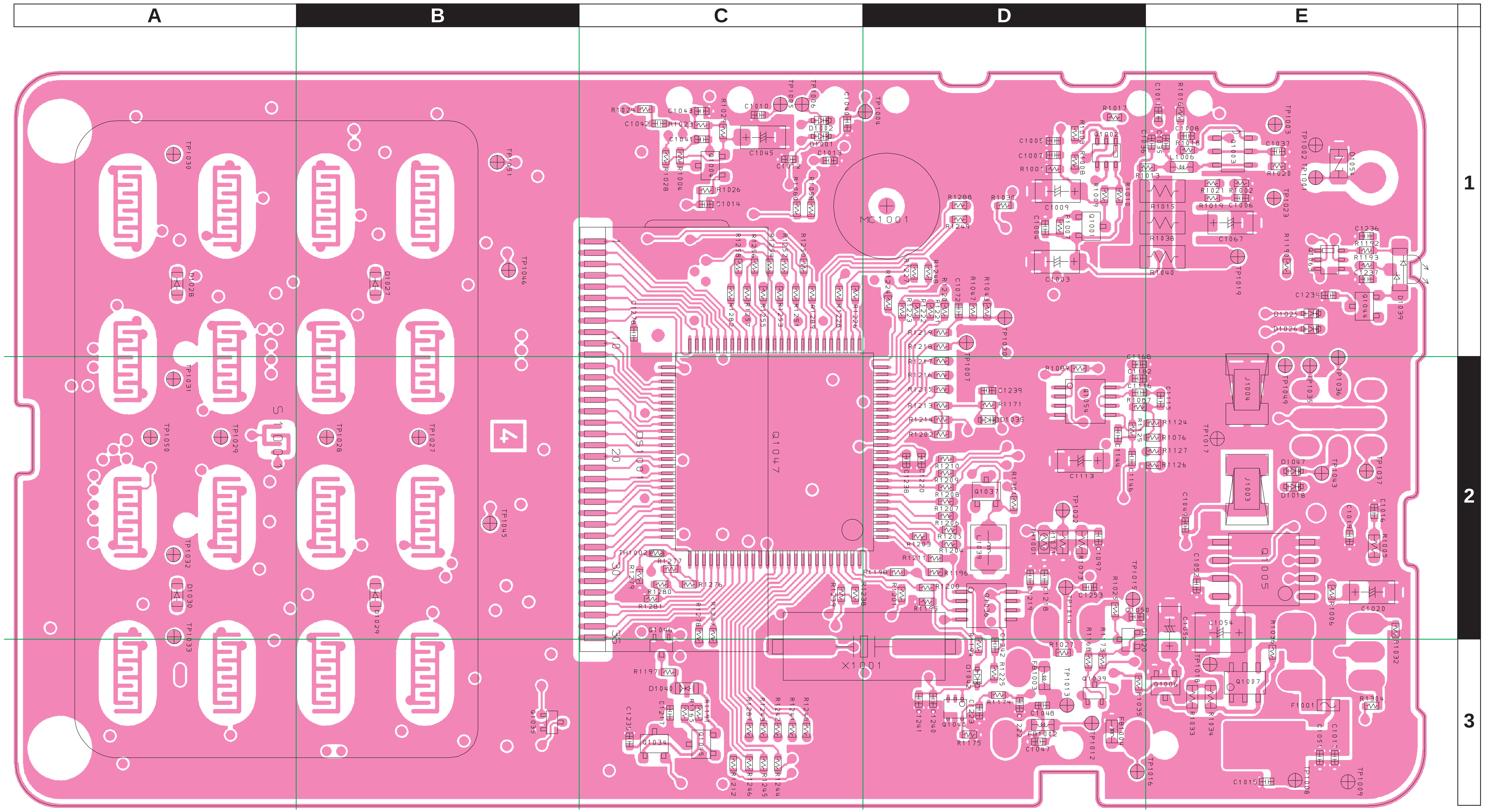


## *Parts Layout (Side B)*

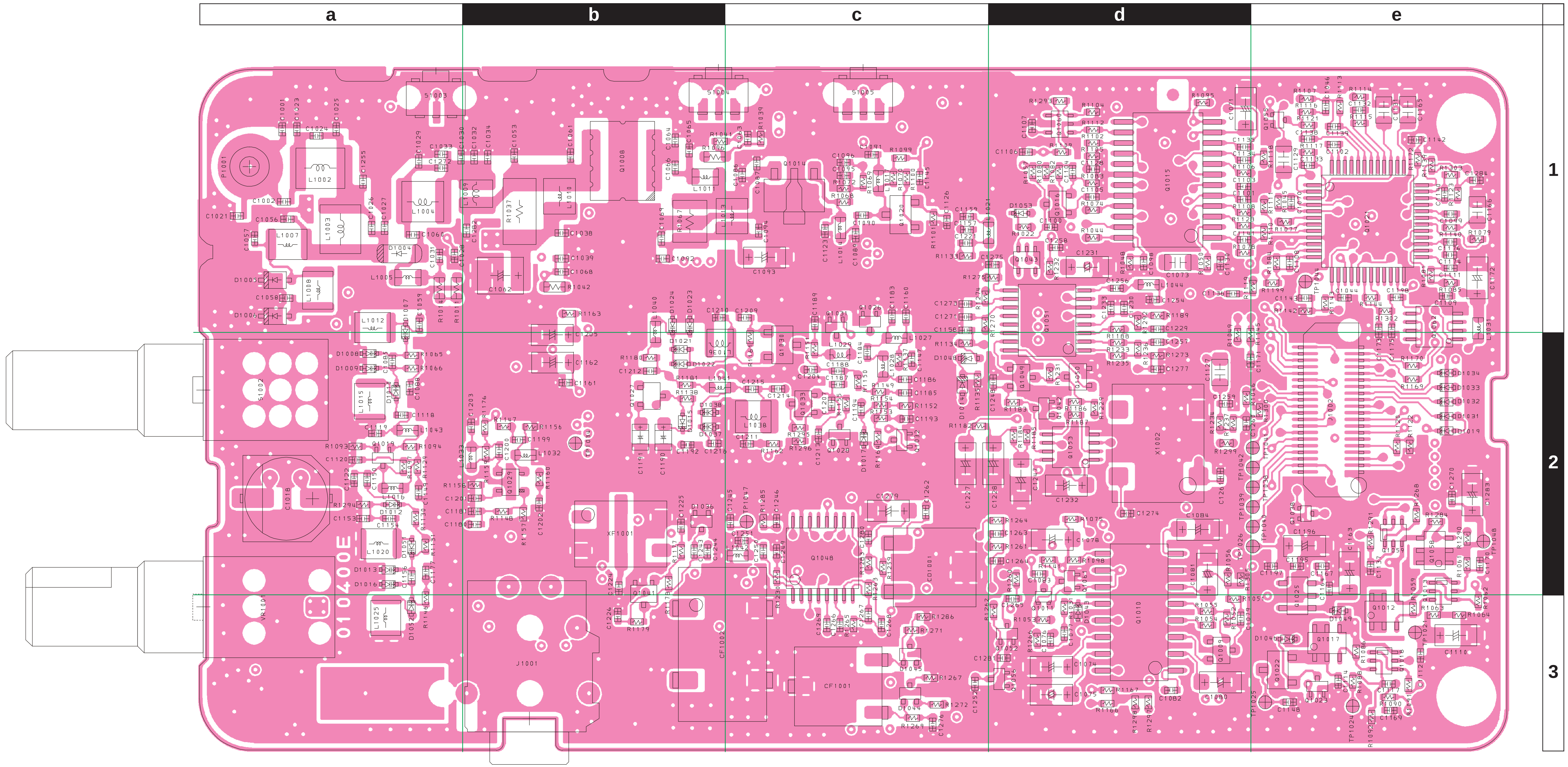


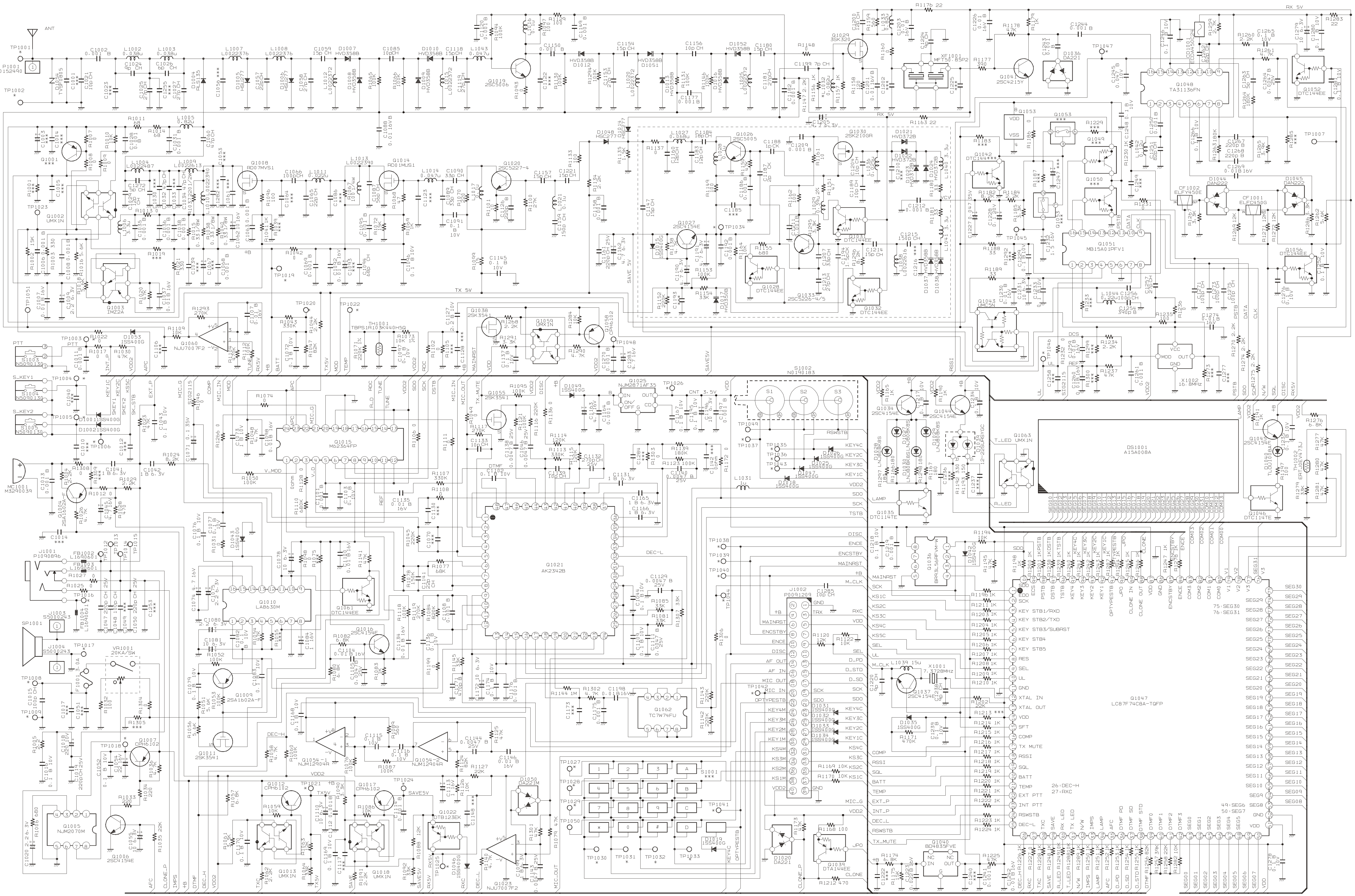

ANT
RX 5V
TX 5V
Q1021 AK2342B
Q1047 LC87F74C8A-TQFP
DS1001 A15A008A
Q1048 TA31136FN
Q1051 MB15A01PFV1
Q1015 M62364FP
Q1010 LA8630M

## Parts Layout (Side A)

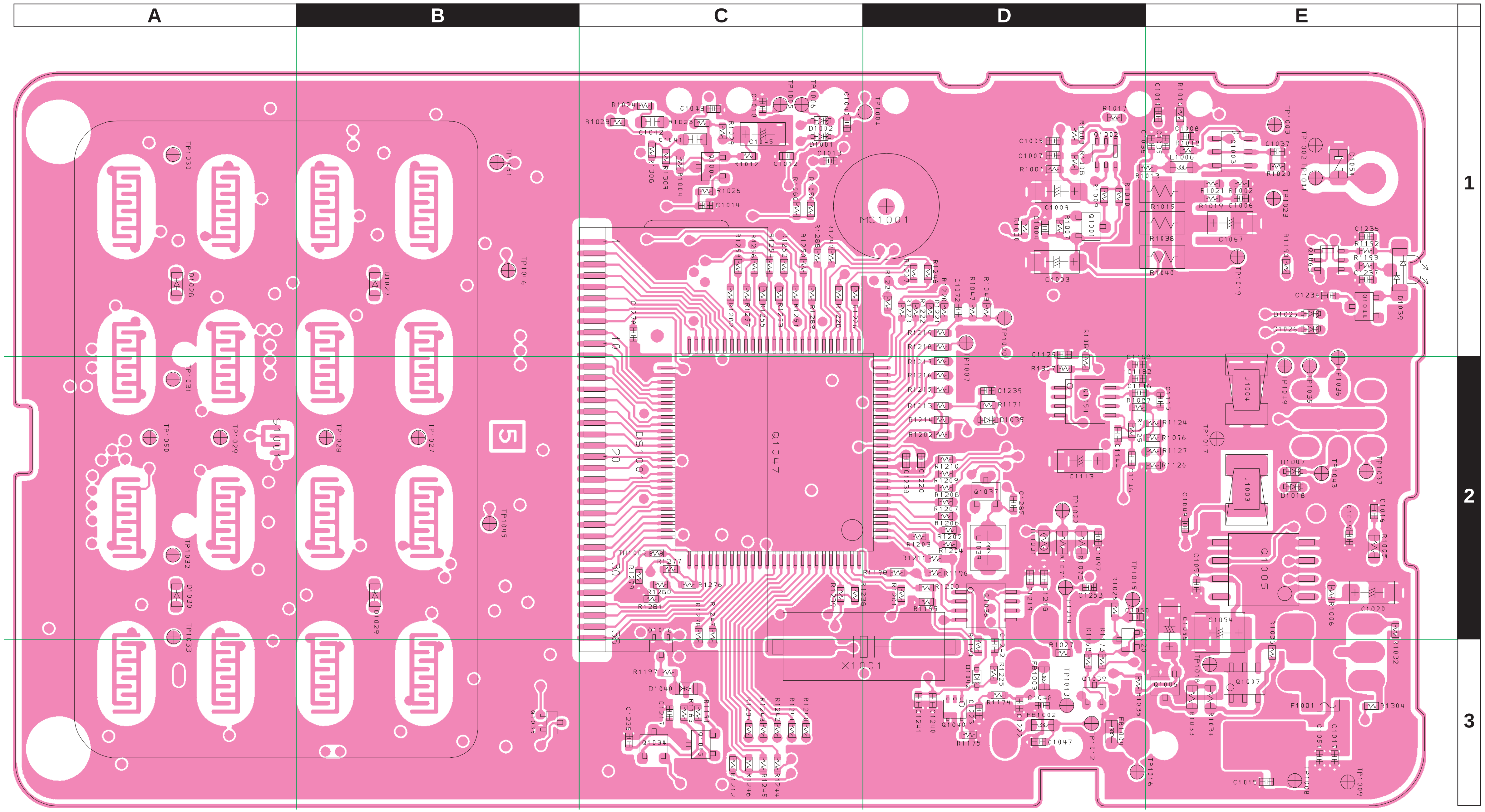


## *Parts Layout (Side B)*

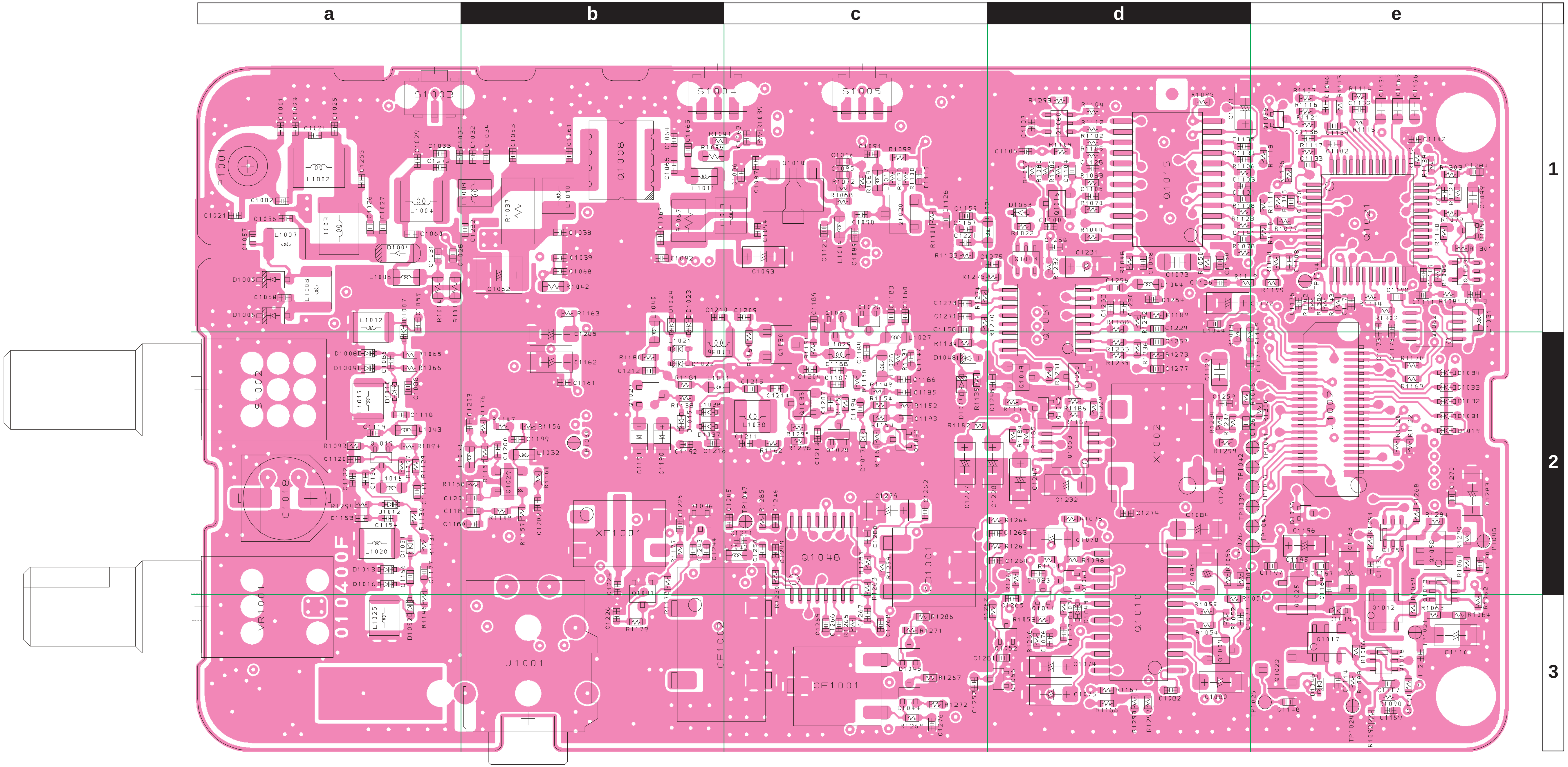




## Parts Layout (Side A)

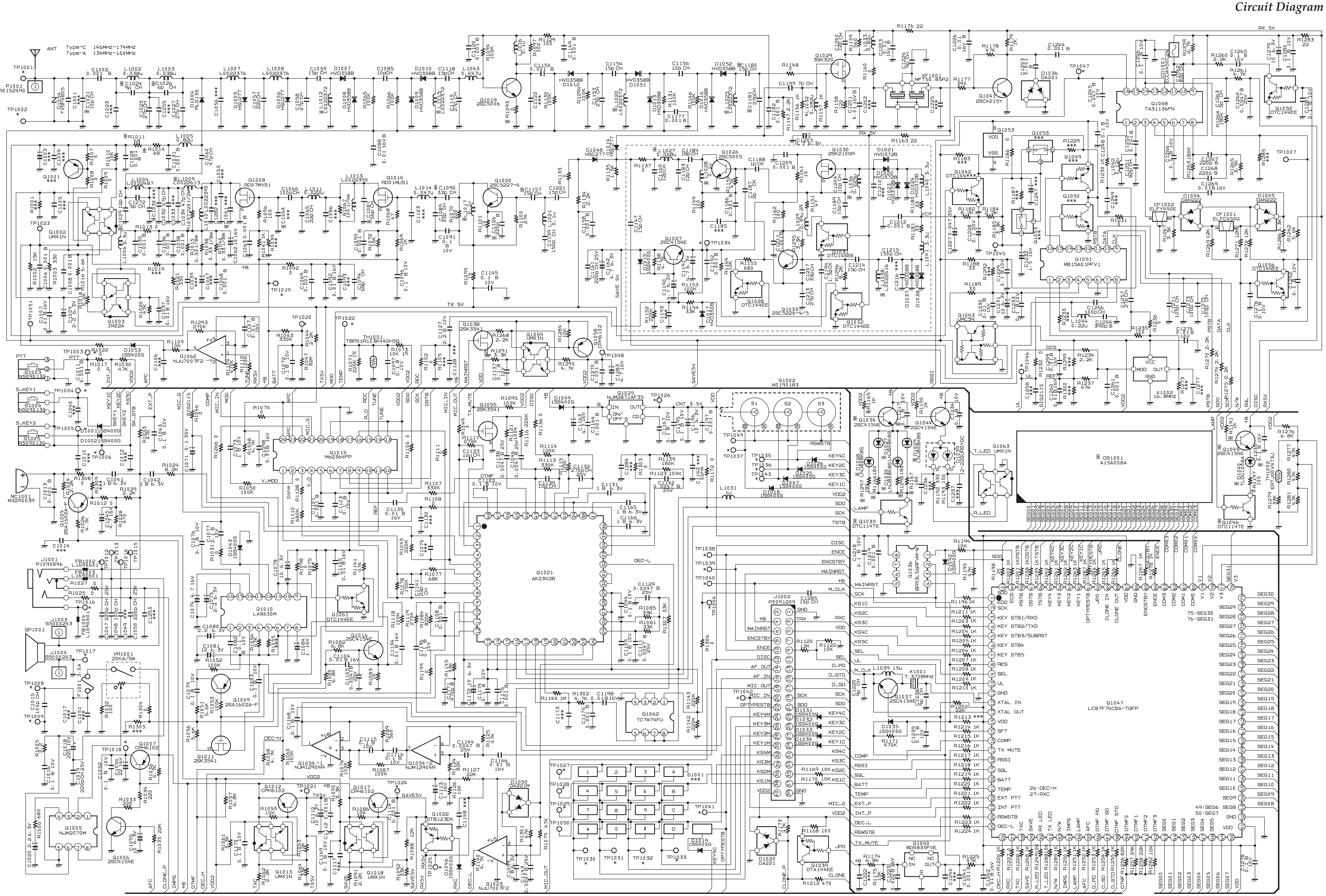


## *Parts Layout (Side B)*



# *MAIN Unit (Lot. 29~35)*

## *Circuit Diagram*



| | Type-C |
|---|---|
| C1021 | 10p |
| C1024 | 9p |
| C1026 | *** |
| C1029 | 12p |
| C1030 | *** |
| C1061 | *** |
| C1064 | *** |
| C1087 | *** |
| C1090 | *** |
| C1126 | *** |
| C1157 | *** |
| C1180 | *** |

| | Type-C |
|---|---|
| C1181 | *** |
| C1256 | 100p |
| L1009 | L0022613 |
| L1012 | L0022372 |
| L1015 | L0022372 |
| L1017 | *** |
| L1020 | L0022372 |
| L1025 | L0022372 |
| L1027 | 68n |
| L1028 | 100n |
| L1036 | L0022585 |
| L1038 | L0022416 |

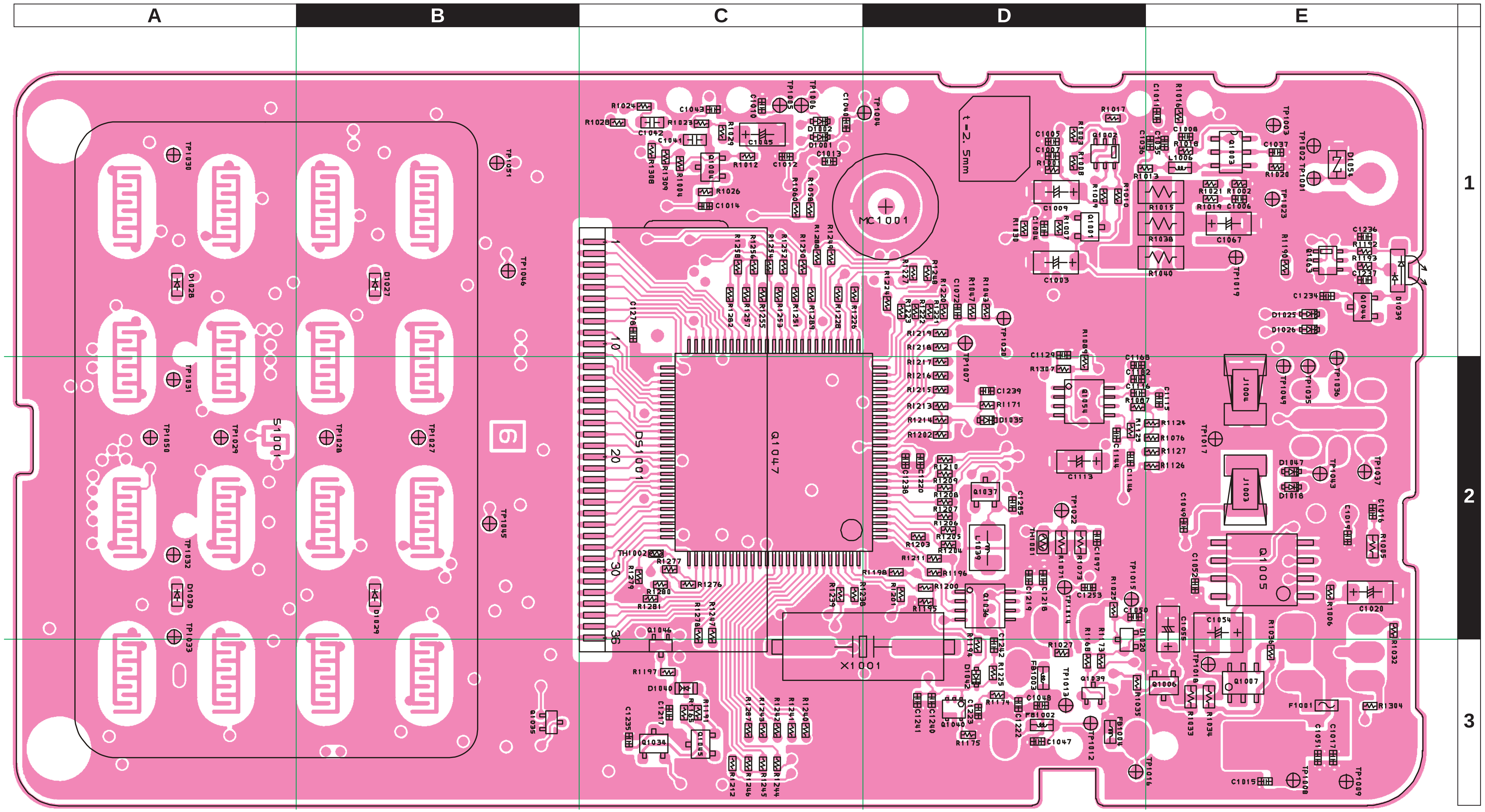
| | Type-C |
|---|---|
| R1011 | 68 |
| R1014 | 68 |
| R1093 | *** |

| | Type-C CE=OFF |
|---|---|
| C1026 | 6p |
| C1061 | *** |
| C1087 | 56p |
| C1090 | 33p |
| C1126 | 220p |
| C1157 | 15p |
| C1180 | 15p |
| C1181 | 27p |
| L1017 | 100n |
| R1093 | 0 |

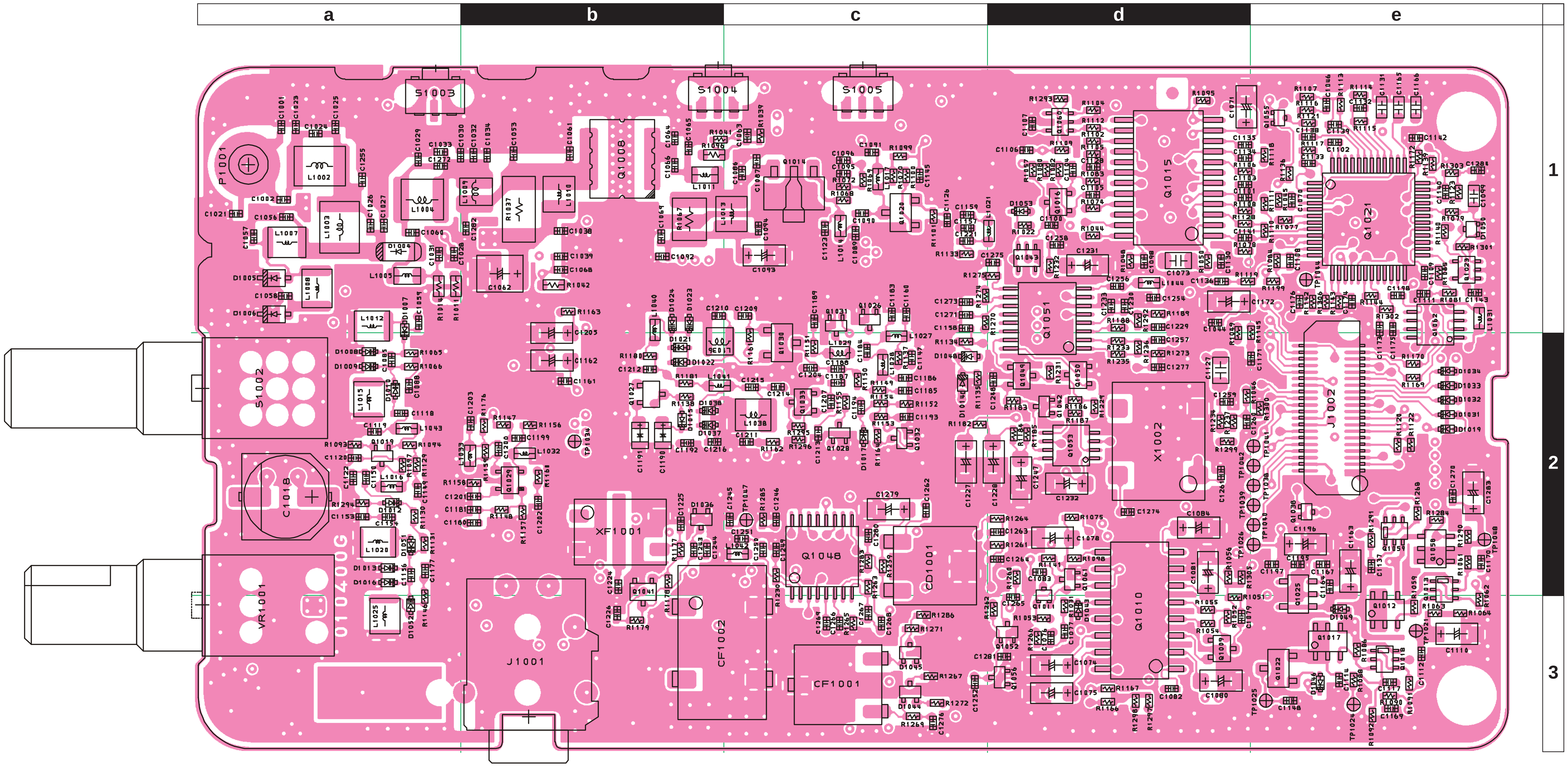
| | VX-414 | VX-424 |
|---|---|---|
| C1217 | *** | 0.1u |
| C1235 | *** | 0.1u |
| D1027 | *** | LNJ808K8S |
| D1028 | *** | LNJ808K8S |
| D1029 | *** | LNJ808K8S |
| D1030 | *** | LNJ808K8S |
| D1040 | *** | TLOU100BA |
| DS1001 | *** | A15A008A |
| Q1034 | *** | 2SC4154E |
| Q1035 | *** | DTC114TE |
| Q1045 | *** | 2SC4154E |
| Q1046 | *** | DTC114TE |

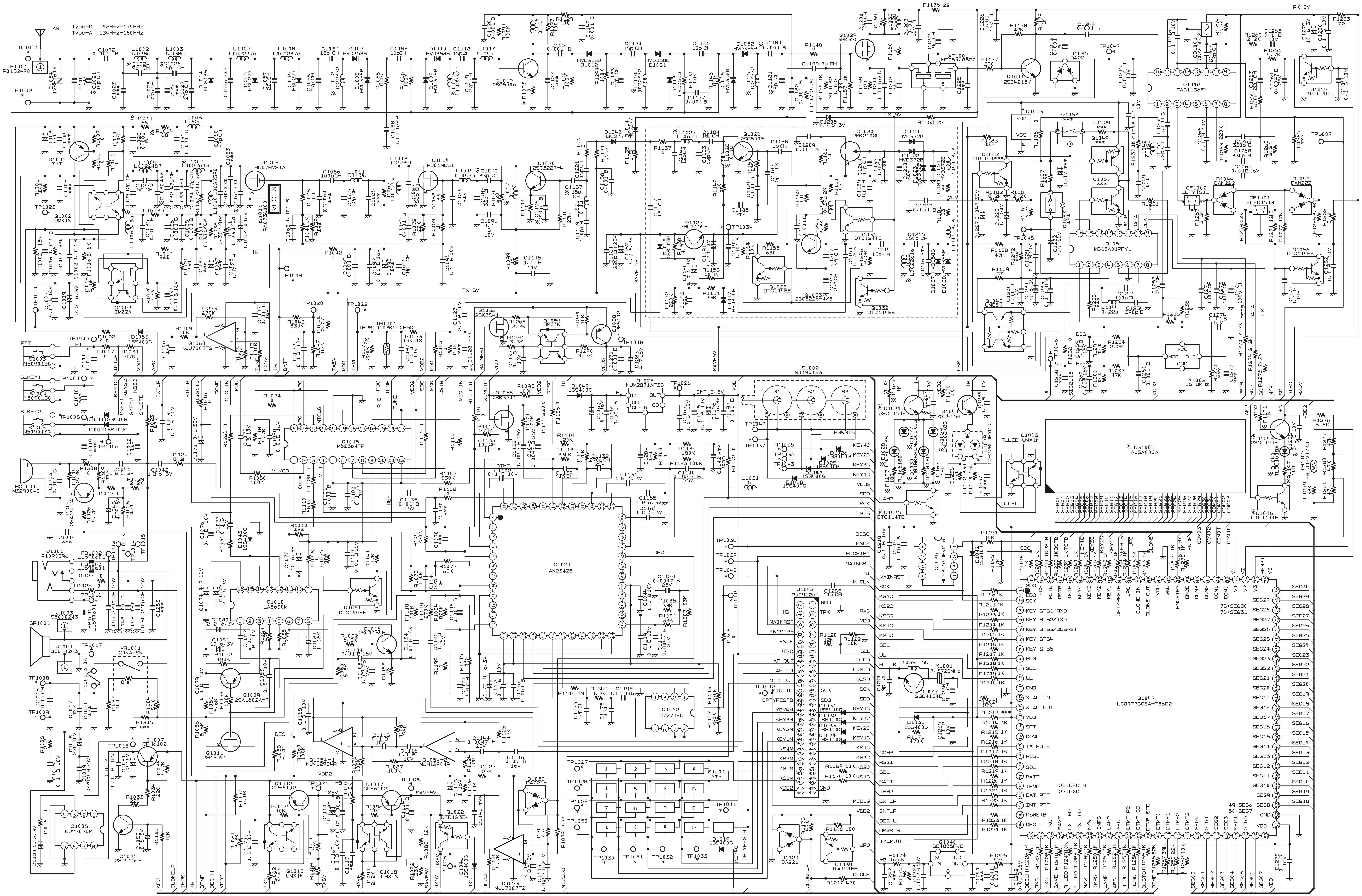
| | VX-414 | VX-424 |
|---|---|---|
| R1165 | *** | 1.0K |
| R1166 | *** | 180 |
| R1167 | *** | 180 |
| R1191 | *** | 1.0K |
| R1197 | *** | 100 |
| R1297 | *** | 180 |
| R1298 | *** | 180 |

## Parts Layout (Side A)



*Parts Layout (Side B)*





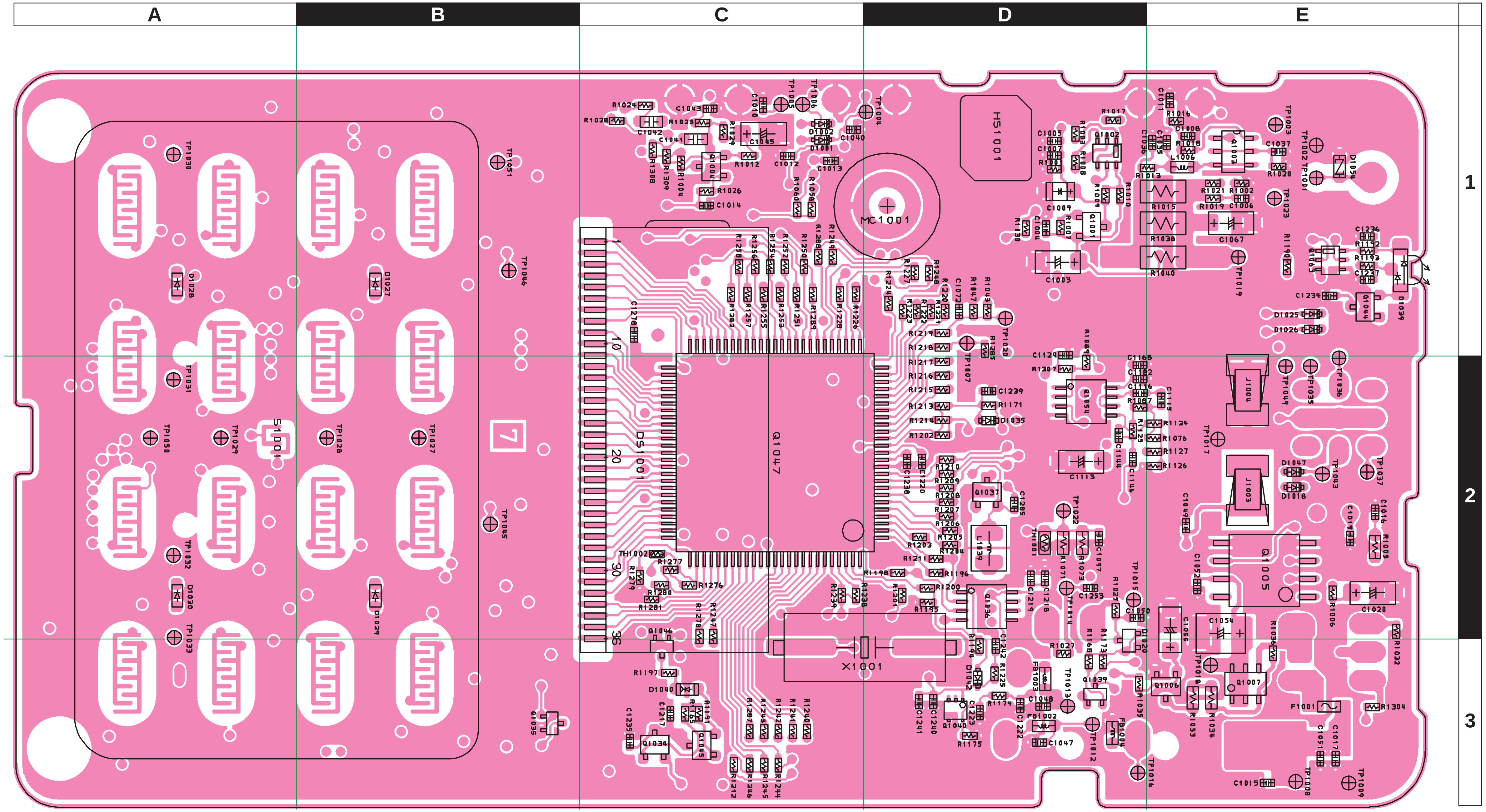
| | Type-C |
|---|---|
| | CE=ON |
| C1026 | 8p |
| C1061 | 5p |
| C1087 | 33p |
| C1090 | 27p |
| C1126 | 100p |
| C1157 | 7p |
| C1180 | 12p |
| C1181 | 18p |
| L1017 | 39n |
| R1093 | 15 |

| | Type-A |
|---|---|
| | CE=ON |
| C1180 | 12p |
| C1181 | 18p |
| R1093 | 15 |

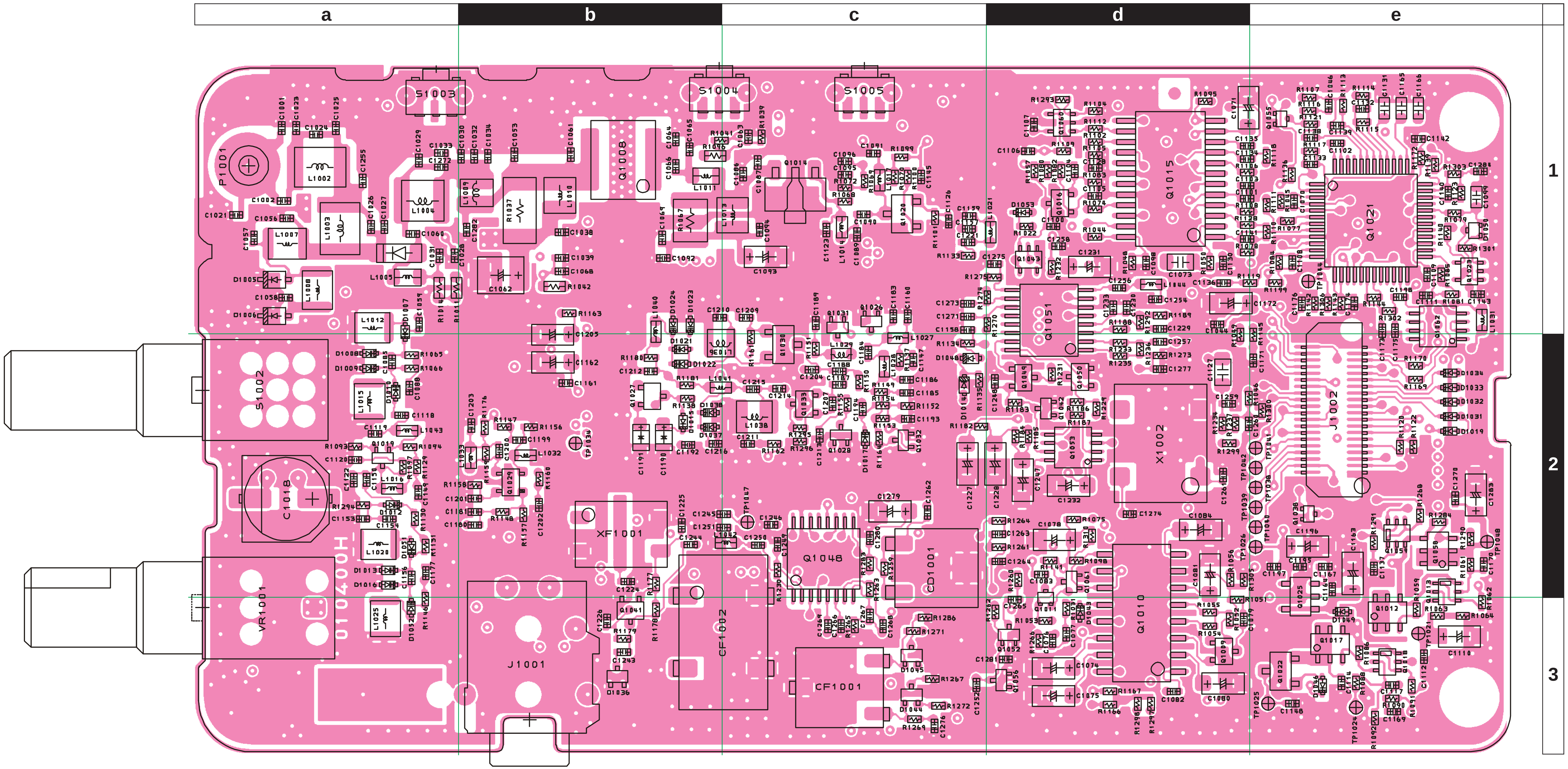
| | VX-414 | VX-424 |
|---|---|---|
| C1217 | *** | 0.1u |
| C1235 | *** | 0.1u |
| D1027 | *** | LNJ808K8S |
| D1028 | *** | LNJ808K8S |
| D1029 | *** | LNJ808K8S |
| D1030 | *** | LNJ808K8S |
| D1040 | *** | TLOU100BA |
| DS1001 | *** | A15A008A |
| Q1034 | *** | 2SC4154E |
| Q1035 | *** | DTC114TE |
| Q1045 | *** | 2SC4154E |
| Q1046 | *** | DTC114TE |

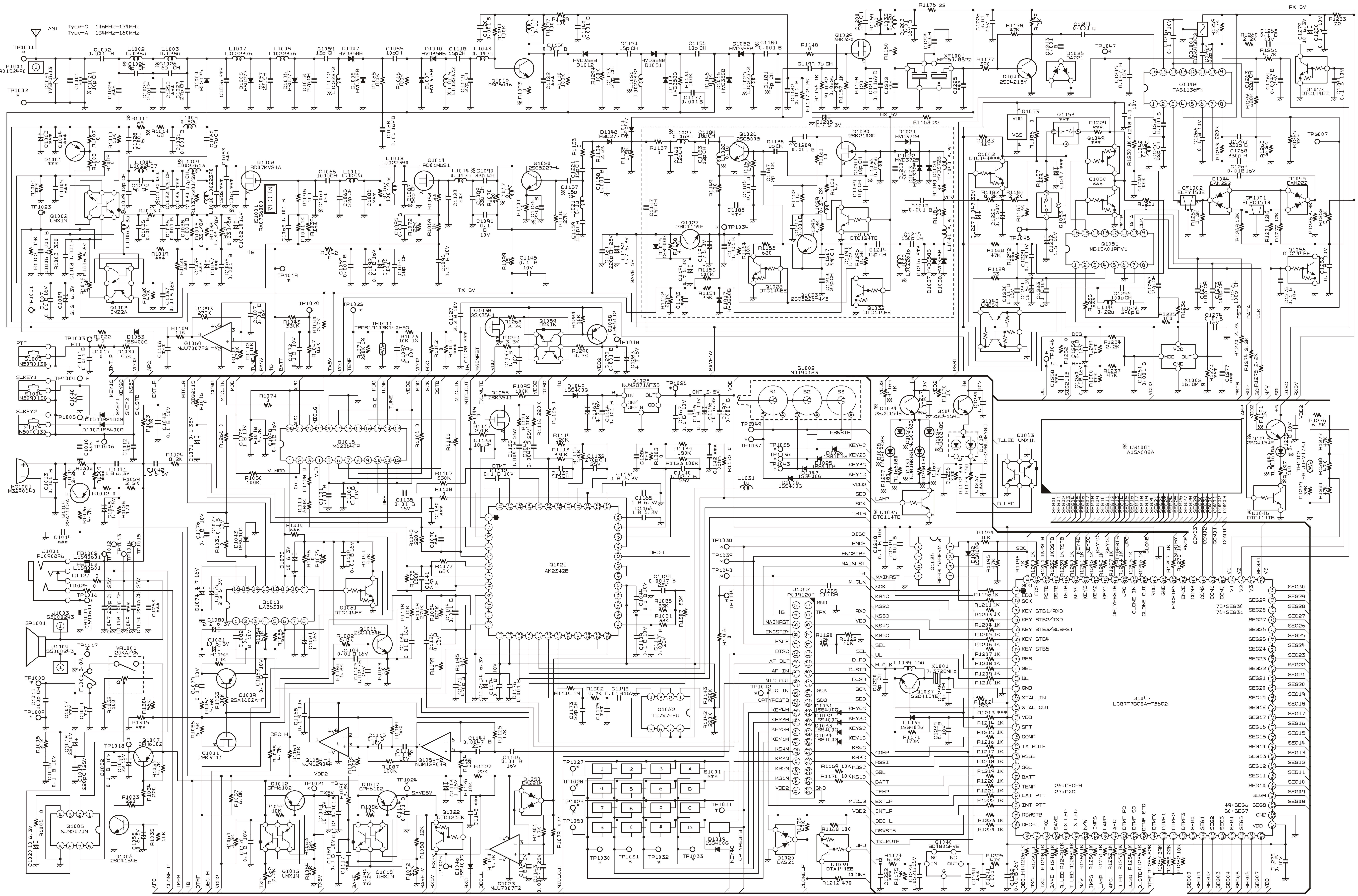
| | VX-414 | VX-424 |
|---|---|---|
| R1165 | *** | 1.0K |
| R1166 | *** | 180 |
| R1167 | *** | 180 |
| R1191 | *** | 1.0K |
| R1197 | *** | 100 |
| R1297 | *** | 180 |
| R1298 | *** | 180 |

*Parts Layout (Side A)*



*Parts Layout (Side B)*





| | Type-C |
|---|---|
| C1021 | 10p |
| C1024 | 9p |
| C1026 | *** |
| C1029 | 12p |
| C1030 | *** |
| C1061 | *** |
| C1064 | *** |
| C1087 | *** |
| C1090 | *** |
| C1126 | *** |
| C1157 | *** |
| C1180 | *** |

| | Type-C |
|---|---|
| C1181 | *** |
| C1256 | 100p |
| L1009 | L0022613 |
| L1012 | L0022372 |
| L1015 | L0022372 |
| L1017 | *** |
| L1020 | L0022372 |
| L1025 | L0022372 |
| L1027 | 68n |
| L1028 | 100n |
| L1036 | L0022585 |
| L1038 | L0022416 |

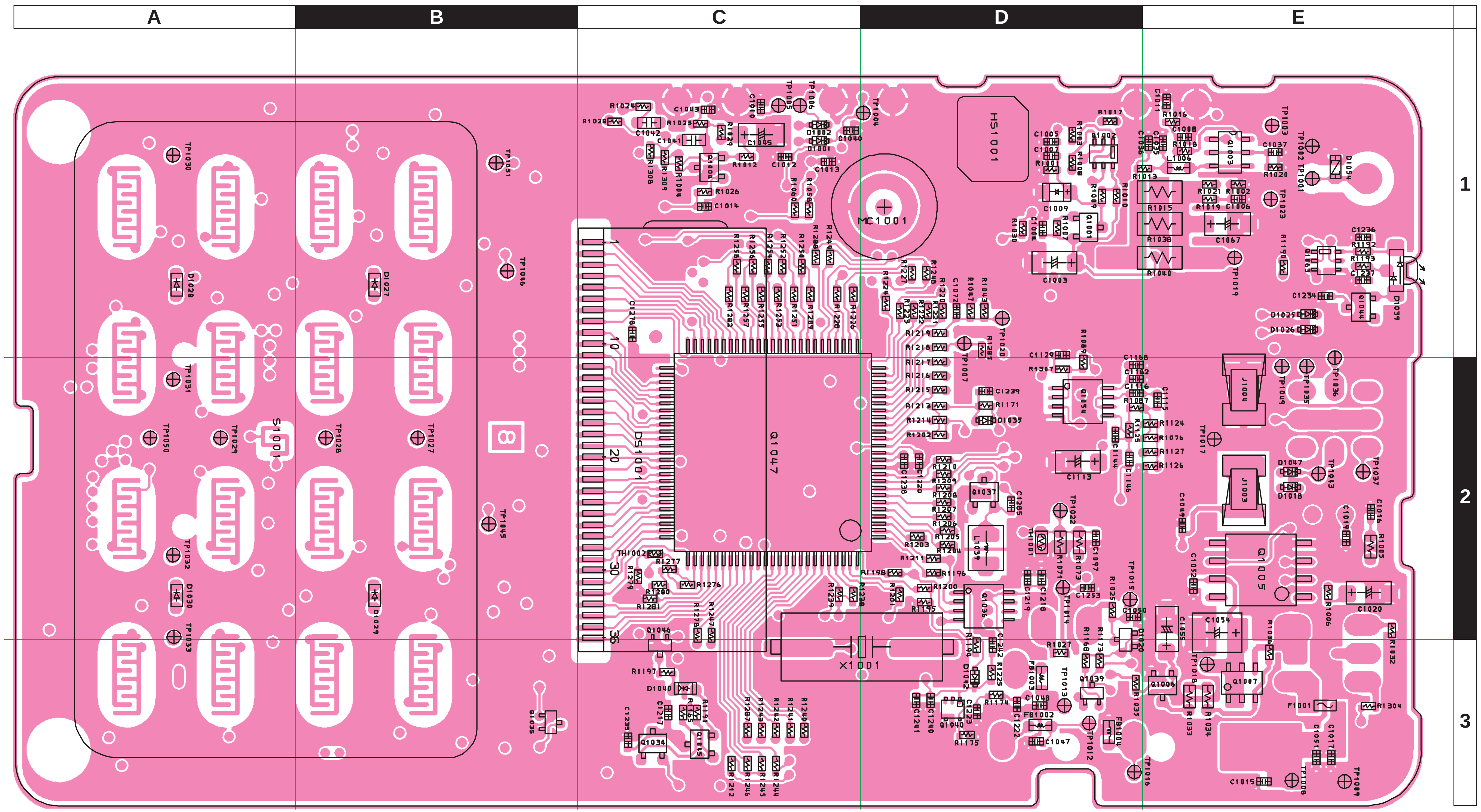
| | Type-C |
|---|---|
| R1011 | 68 |
| R1014 | 68 |
| R1093 | *** |

| | Type-C CE=OFF |
|---|---|
| C1026 | 6p |
| C1061 | *** |
| C1087 | 56p |
| C1090 | 33p |
| C1126 | 220p |
| C1157 | 15p |
| C1180 | 1000p |
| C1181 | 9p |
| L1017 | 100n |
| R1093 | 0 |

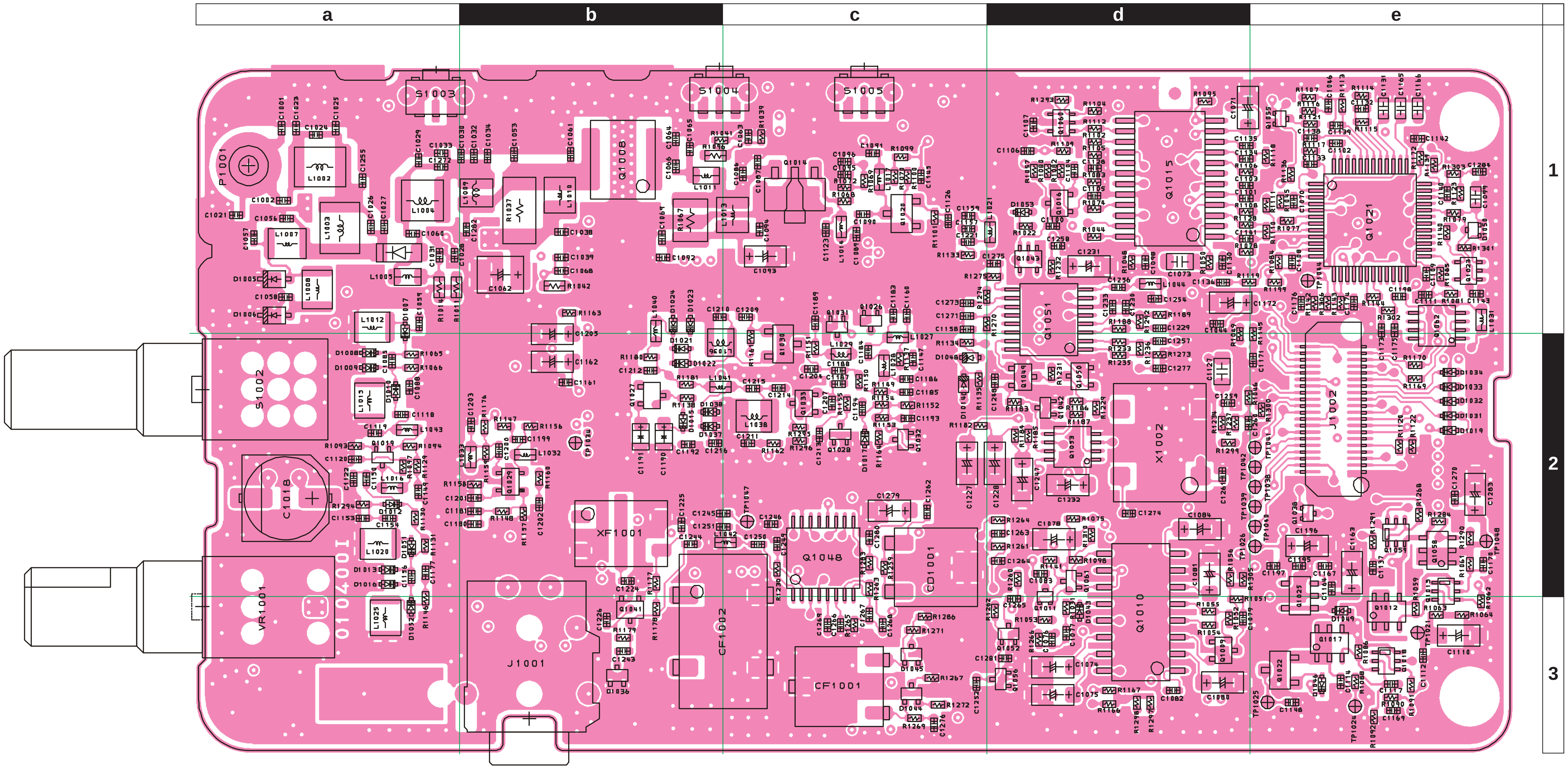
| | VX-414 | VX-424 |
|---|---|---|
| C1217 | *** | 0.1u |
| C1235 | *** | 0.1u |
| D1027 | *** | LNJ808K8S |
| D1028 | *** | LNJ808K8S |
| D1029 | *** | LNJ808K8S |
| D1030 | *** | LNJ808K8S |
| D1040 | *** | TLOU100BA |
| DS1001 | *** | A15A008A |
| Q1034 | *** | 2SC4154E |
| Q1035 | *** | DTC114TE |
| Q1045 | *** | 2SC4154E |
| Q1046 | *** | DTC114TE |

| | VX-414 | VX-424 |
|---|---|---|
| R1165 | *** | 1.0K |
| R1166 | *** | 180 |
| R1167 | *** | 180 |
| R1191 | *** | 1.0K |
| R1197 | *** | 100 |
| R1297 | *** | 180 |
| R1298 | *** | 180 |

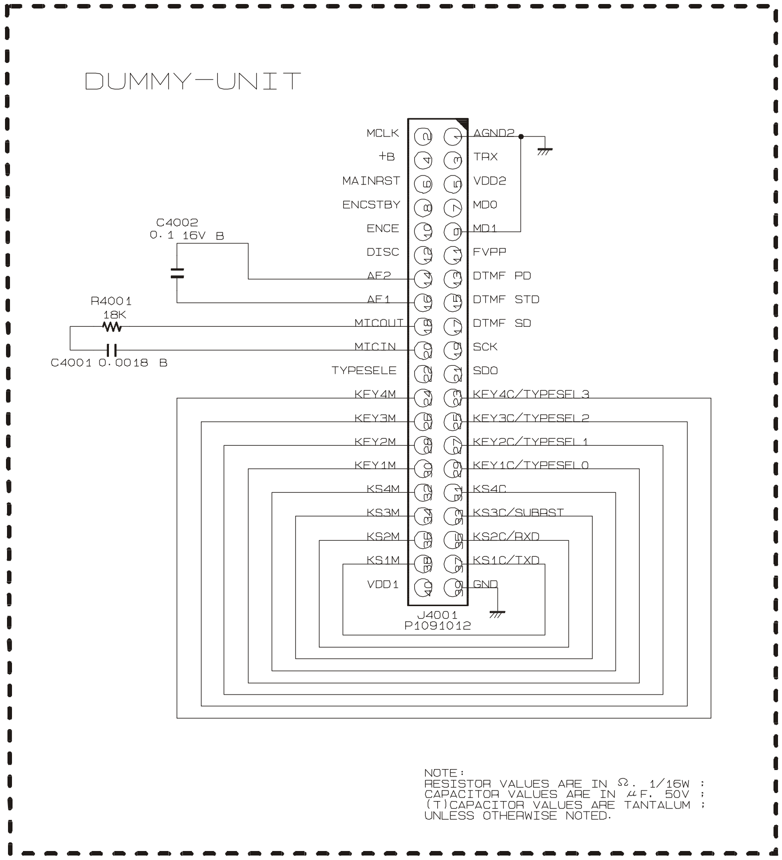
## *Parts Layout (Side A)*



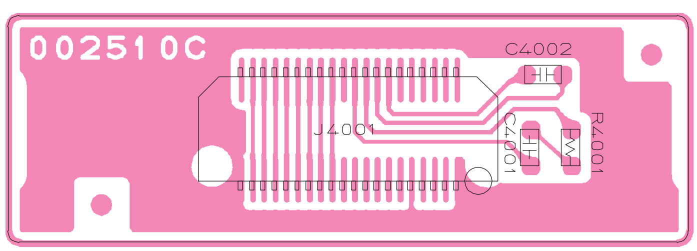
*Parts Layout (Side B)*



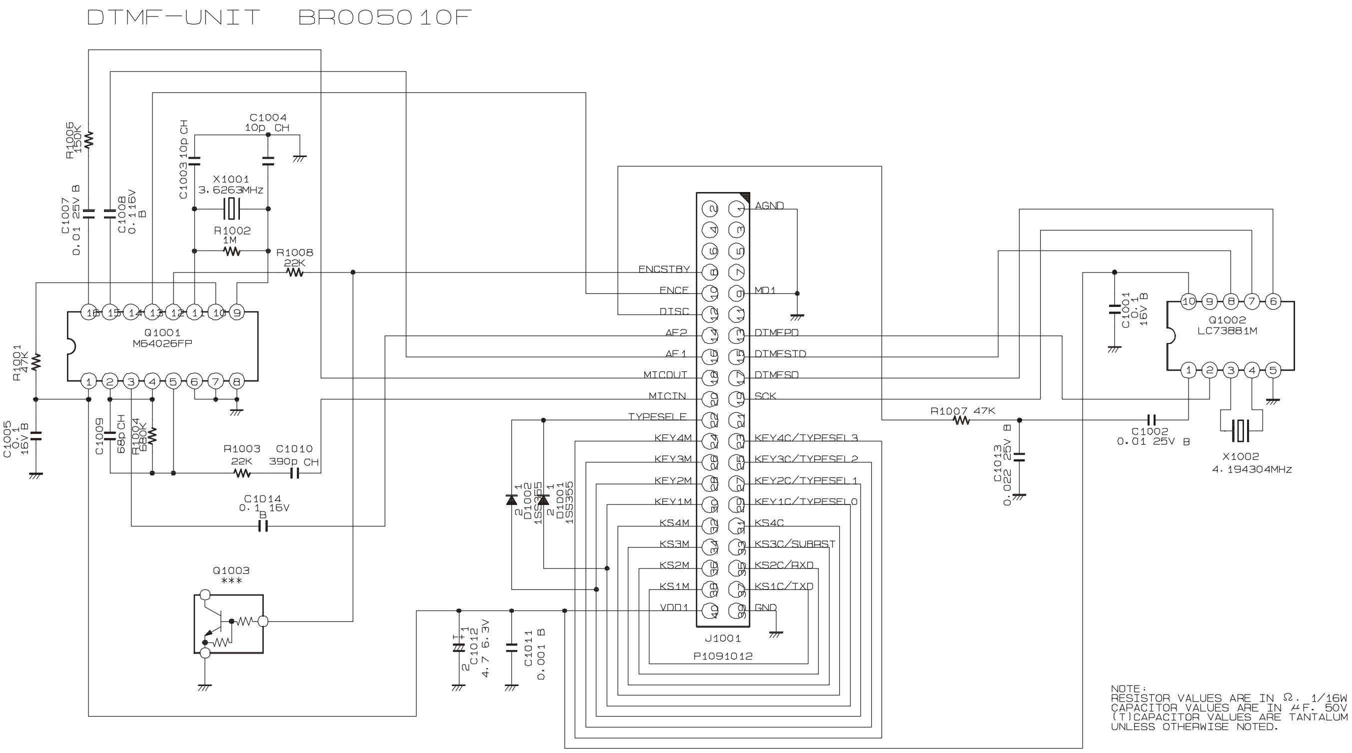
## Circuit Diagram



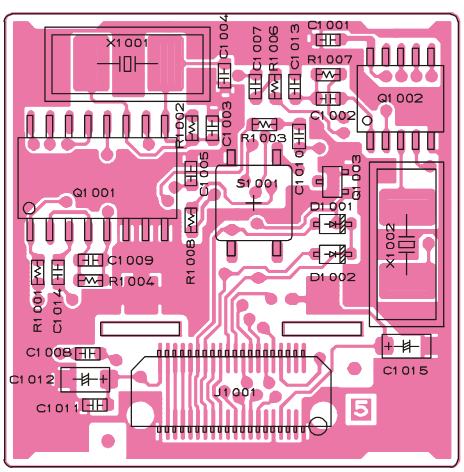

## Parts Layout



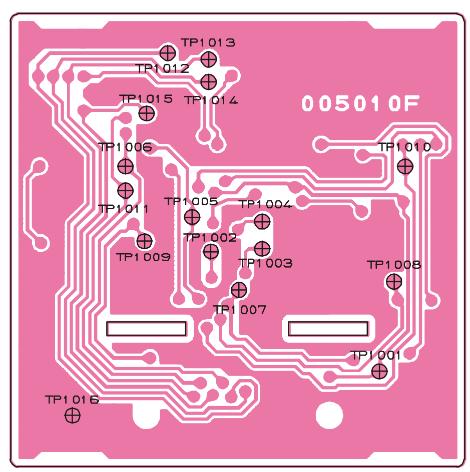
## Circuit Diagram




## Parts Layout

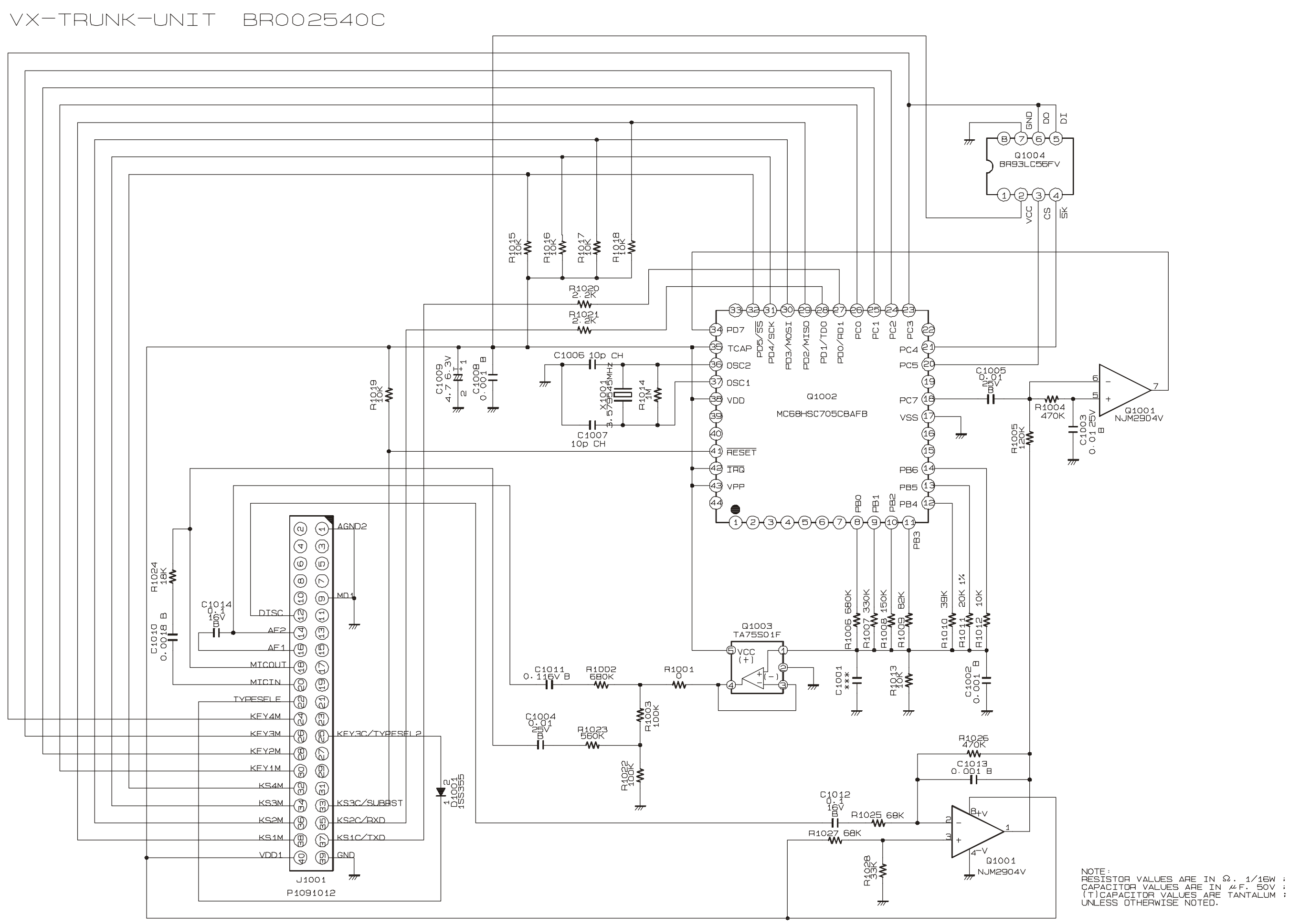


Side A

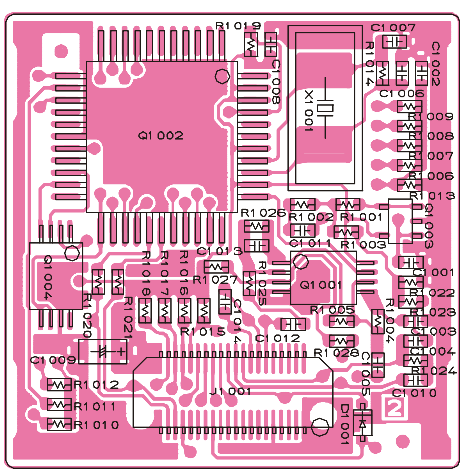


Side B

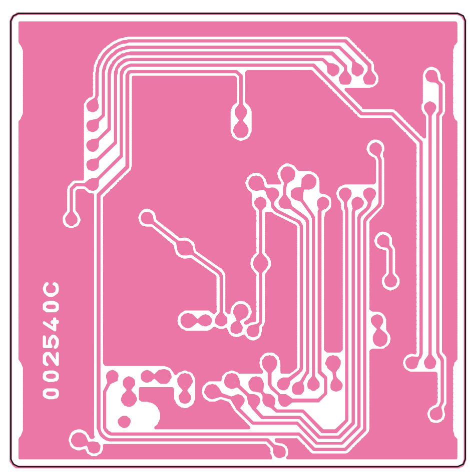
## Circuit Diagram




## Parts Layout

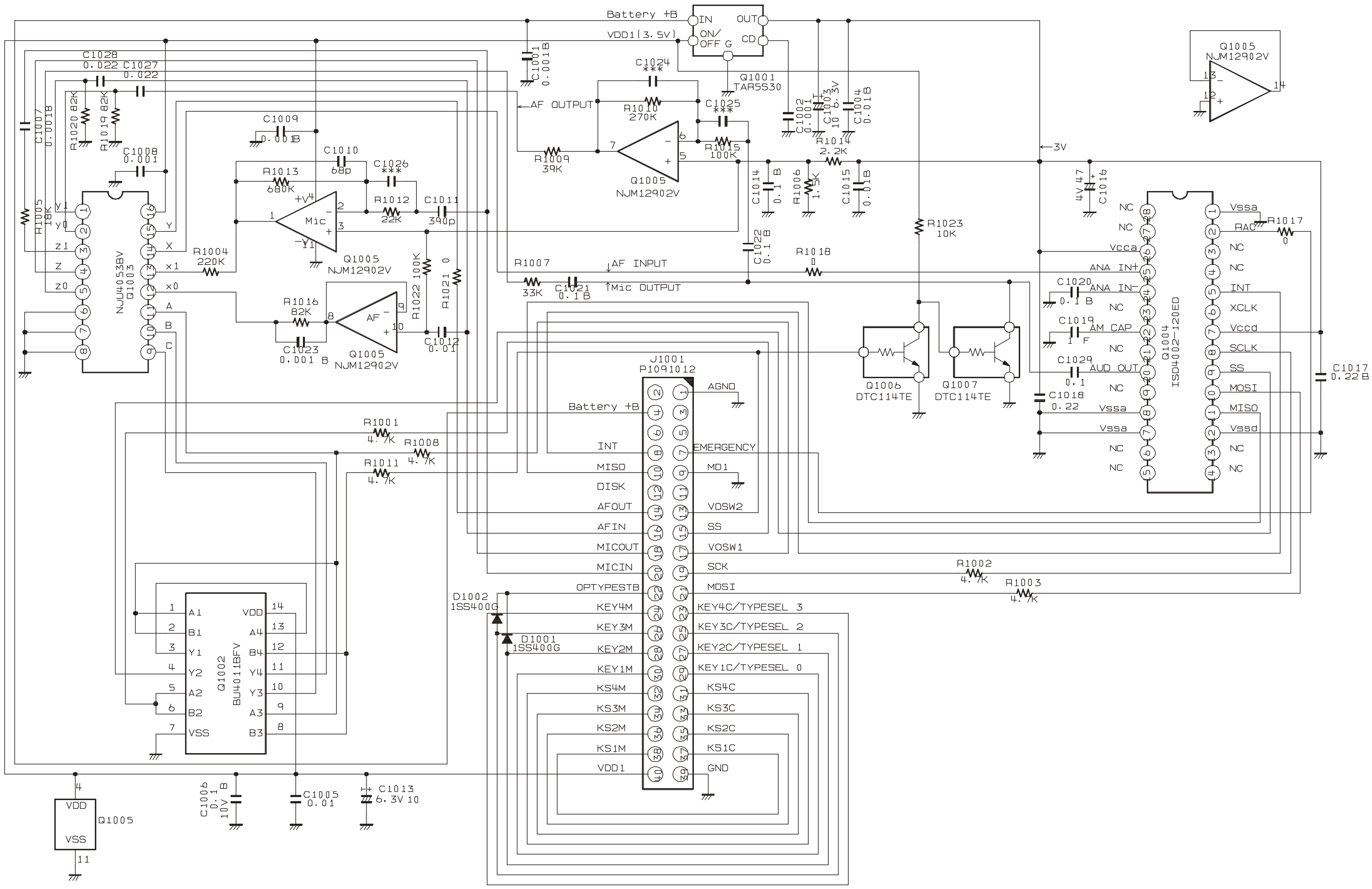


Side A

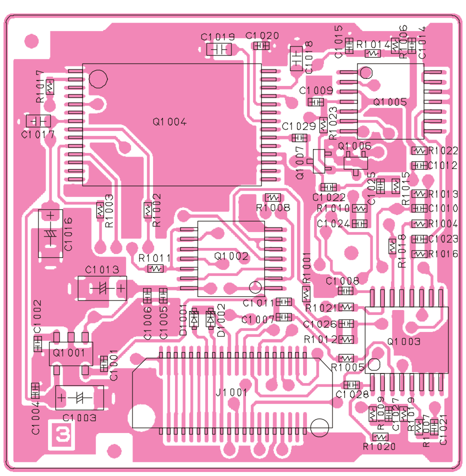


Side B

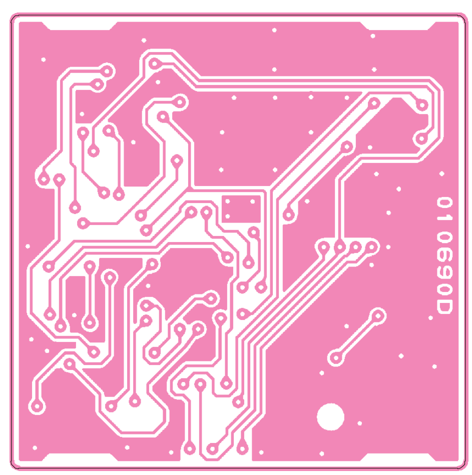
## *Circuit Diagram*




## *Parts Layout*



Side A



Side B

Vertex Standard