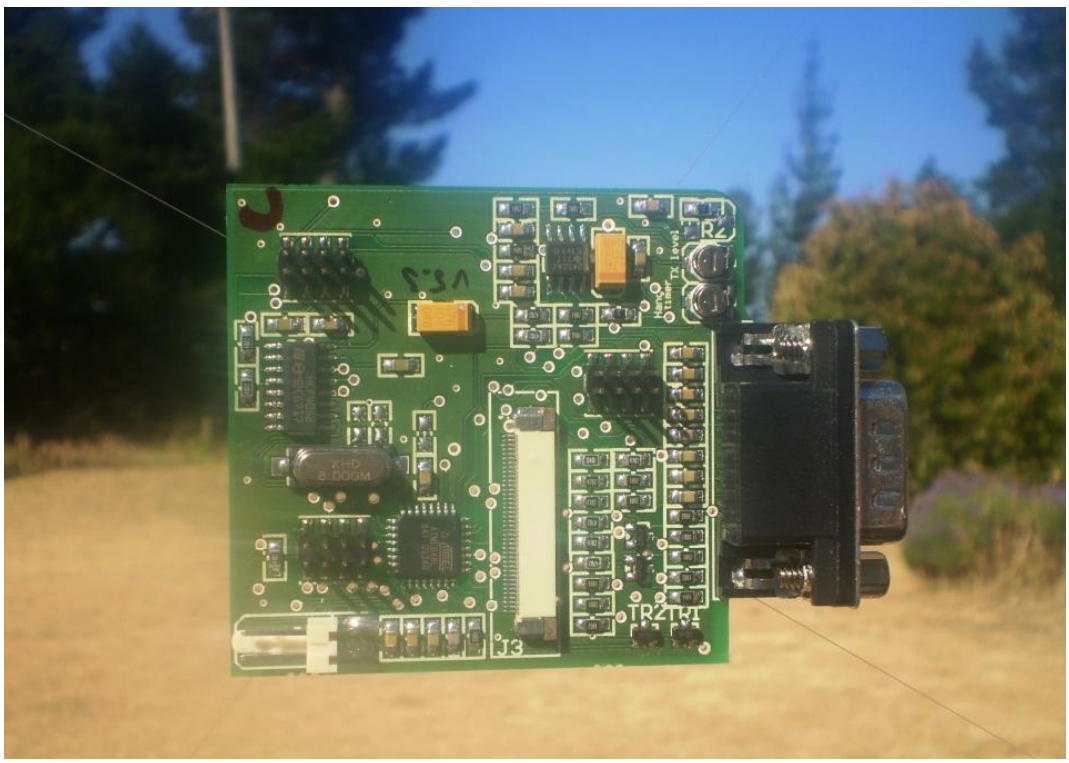
Version 01-01

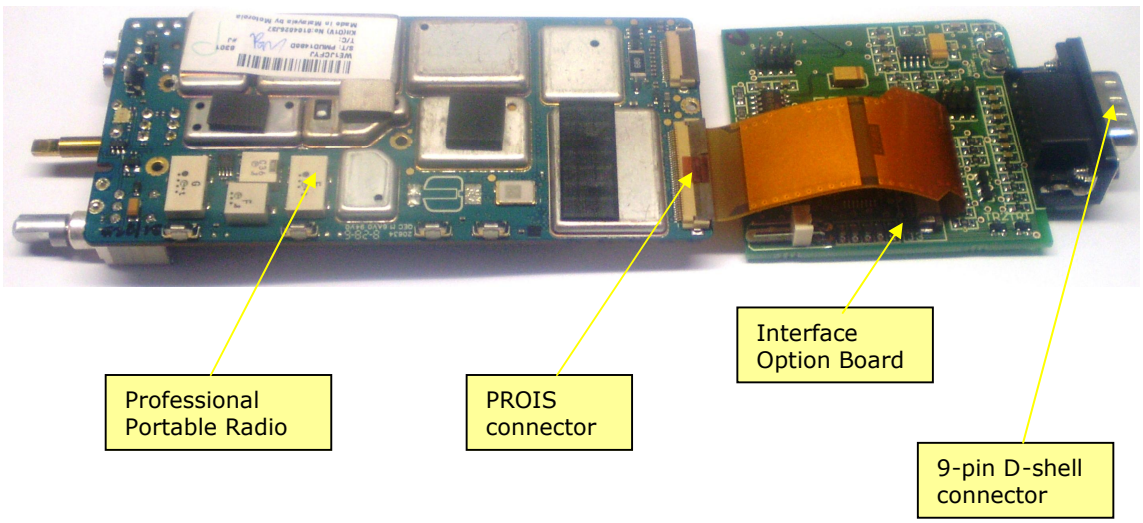
Motorola Professional Portable Radio Interface Option Board (IOB) Manual©



Contents

1 Summary:

The Professional Portable Radio Interface Option Board (IOB) is a Rotronix Ltd proprietary Printed Circuit Board (PCB) with embedded in the memory of a microprocessor the proprietary software needed to utilize the Motorola™ Professional Radio Option Interface (PROIS) software interface. The option board has a 9-pin D-shell connector to control the radio, e.g. transmit/receive, channel-change and feedback about channel status e.g. the radio is receiving a valid signal. The option board is connected to the radio via the internal 40-pin ZIF connector and a custom made flat-cable.
(Motorola part number: 8404078G03.)



2 Introduction:

This manual provides information about the Interface Option Board (IOB) for the Motorola Professional Portable Radio (MPPR) series. The IOB provides for M2M connectivity of the MPPR, making a universal low current transmit/receive module compliant with most regulatory acceptance requirements.
It applies to IOB version 1.01 and radio software version R03.10.03 and later versions.

2.1 ASSOCIATED MOTOROLA PROPRIETY DOCUMENTATION:

Motorola service manual: (Part No: 6804110J64-H)
Motorola PROIS 2.03 Manual
Motorola PROIS 2.03 Electrical Manual: (Part No: 1202899J28)

2.2 SUPPORTED PORTABLE RADIOS:

PRO5150, PRO5350, GP140, GP318, GP328, GP328 LS, HT750, HT750.LS, MTX850LS, HT1250, HT1250.LS+, MTX8250LS, PRO7150, PRO7350, GP338, GP338 LS, PRO9150, HT1550XLS

2.3 PUBLICATION RECORD:

Issue	Publication Date	Author	Description
1.01	December 2008	Hans de Roode	First issue

1.4 ALERT NOTICES:

Within this manual, four types of alerts are given to the reader: warning, caution, important and note. The following paragraphs illustrate each type of alert and its associated symbol.

Warning!!

This alert is used when there is a potential risk of death or serious injury.

Caution

This alert is used when there is the risk of minor or moderate injury to people.

Important

This alert is used to warn about the risk of equipment damage or malfunction.

Note

This alert is used to highlight information that is required to ensure that procedures are performed correctly.

1.5 CONTACT DETAILS:

Rotronix Ltd
135 Darnley Road
RD3 Amberley, New Zealand
Commercial e-mail: sales@rotronix.co.nz
Technical e-mail: hans@rotronix.co.nz

1.6 COPYRIGHT:

1.7 ABBREVIATIONS

Abbreviation	Description
3DK	Third-Party Developer's Kit
ASCII	American Standard Code for Information Interchange
AVL	Automatic Vehicle Location
CCRI	Computer Controlled Radio Interface
CRC	Cyclic Redundancy Check
CTCSS	Continuous Tone Coded Squelch System
CTS	Clear to Send
DCE	Data Circuit-Terminating Equipment
DCS	Data Carrier System
DTE	Data Terminal Equipment
DTMF	Dual Tone Multi-Frequency
FEC	Forward Error Correction
FFSK	Fast Frequency Shift Keying
GPIO	General Purpose Input/Output
IPN	Internal Part Number
LED	Light-Emitting Diode
MSD	Most Significant Digit
MPPR	Motorola Professional Portable Radio
NMEA	National Marine Electronics Association standard. Combined electrical and data specification for communication between marine electronics and GPS
IOB	Interface Option Board
PC	Personal Computer
PTT	Press To Talk
PCB	Printed Circuit Board
PROIS	Motorola proprietary Professional Radio Option Interface Specification
RMC	Recommended Minimum sentence C. NMEA GPS message type for the minimum recommended
RTS	Request to Send
Rx	Receive mode
RXD	Receive Data
SDM	Short Data Message
SMC	Switched Mode Converter (12 to 7.5V)
TX	Transmit mode
TXD	Transmit Data
UART	Universal Asynchronous Receiver-Transmitter
XON	Data Transmitter On
XOFF	Data Transmitter Off
ZIF	Zero Insertion Force Connector

3 Technical outline:

3.0 INTERFACE OPTION BOARD (IOB).

The IOB consist of the following components:

- Printed Circuit Board (PCB)
- Connectors
- Micro-processor
- Audio circuitry
- Input/Output buffers
- controls

3.1 PRINTED CIRCUIT BOARD (PCB)

The PCB has Trough-Hole Plating and electrical tracks on the bottom and top of the PCB, and has the following dimensions:
54 mm wide X 56 mm long.

3.2 CONNECTORS:

The connectors provide interfacing to various external circuits:

JP1 to JP3:

Are dedicated for extension boards, e.g. CTCSS multi-tone board.

J3:

Connects to the Professional Portable Radio 40 pin accessory connector via a 40 wire flat-cable, providing connectivity for the audio paths, SPI bus and 3.3 Volt power-supply to the IOB.

J5:

Provides buffered input and outputs for audio, channel-change, signaling and power supply to the radio (7.5 Volt) or Switch Mode Converter (SMC).

J6:

Power supply to radio.

3.3 MICROPROCESSOR:

The Microprocessor is of the RICS type and controls the audio-path's and communicates with the Professional Portable Radio via the SPI bus. Detailed information on the SPI bus protocol is available from the Motorola PROIS v2.03 Manual.
The internal Analogue to Digital (A/D) converters are used to monitor the power supply, channel-change voltage level and a dc voltage used for setting the hang-timer (transmit-tail).
The Microprocessors logic input and outputs control the Receive signal indication, "valid received audio", "flat-audio select" and monitors the PTT and "flat audio Select" inputs.

3.4 AUDIO CIRCUITRY:

One pin of connector J5 is used for audio in (transmit) and out (receive) giving a one-wire interface for transmit/receive audio with an impedance of 1k ohm. The un-muted receive audio is muted (U3) and buffered (IC2) and send to pin 3 of connector J5.
Transmit audio is presented on pin 3 of connector J5 level is set with adjustable potentiometer VR3.
When selecting flat-audio mode, the audio in and out of the IOB is flat in frequency response from 10Hz to 5 kHz.

3.4.1 FLAT AUDIO:

Flat audio is selected by placing R30 (0 ohm) on the PCB.
In flat-audio mode, pre/de-emphasis and the TX and RX band-pass-filters are switched off. RX audio is un-muted.

TX audio is not limited; Take care with the audio input level and frequency, in order not to exceed the maximum allowed bandwidth.

3.5 INPUT/OUTPUT BUFFERS:

The PTT and Channel select inputs are clamped to +3.9 Volt and minus 0.6 Volt. The "channel-busy" output is a open collector with a 10k ohm "pull-up" resister to 7.5 Volt the transistor can sink 60mA.

3.6 CONTROLS:

The IOB has three adjustable potentiometers:

1 VR1, sets the TX-tail, (0 to 2 sec).
2 VR2, Audio output-level (replaced with 0 ohm resistor).
3 VR3, Audio input-level (TX audio).

4 Technical description:

Please refer to circuit diagrams 5.1,5.2 and 5.3 .

4.0 AUDIO:

The audio circuitry consist of two IC's, a double opamp, IC2 (A and B) and an audio switch IC, U3.
The DC level for the audio circuit is set by resisters R18, R19 and R20, R24 to half of 3.3 Volt (1.65 Volt). To avoid audio clipping, IC2 is powered from the7.5 Volt.
IC U3 is a dual bidirectional audio switch, each with one common and four input/outputs.
The two control wires A and B select the audio-path:

A	B	Audio path selected:
0	0	TX audio
0	1	RX audio
1	0	Flat TX audio
1	1	Flat RX

Audio path selection is controlled by the microprocessor, PORTD6 and PORTD7.
The four audio-wires connect to the corresponding connections on connector J3.Transmit audio from J5.3 is RF-decoupled with C25 and fed into the positive input of opamp IC2.B via adjustable potentiometer VR3. The gain of IC2.B is set with R12 and R13, the gain H is: H = 1 + R13/R12.
Receive audio from the audio-switch IC U3 is fed into the positive input of opamp IC2.A via adjustable potentiometer VR2.
The gain of IC2.A is set with R10 and R11, the gain H is:
H = 1 + R10/R11. The output of IC2.A is supplying the receive-audio to J5.3 via R17. R17 determines the input/output impedance of the audio-line.

4.1 DC POWER SUPPLIES:

The operating voltage of the Portable Radio is 7.5 Volt.

The power-supply to the radio enters the IOB on J5.8+9, and leaves the IOB on J6.1, a fly-lead connects to the battery connectors of the radio. The power-supply can be either 7.5V. Alternatively, if an optional switch mode DC-DC converter is fitted, then the supply voltage can be in the range of 10 to 30 Volt DC (part number: PSU322859.) The supply-voltage is measured by the microprocessor via divider R9 and R15.
The radio has a build-in DC-DC converter that converts the 7.5 Volt to 3.3 Volt. The IOB has no internal power-supply and relies on the radio to supply the necessary voltages. The IOB derives the 3.3 Volt from connector J3.4 via R16 and 7.5 Volts from connector J3.3.
The 3.3 Volt is used to power the microprocessor U1, audio-switch U3 and is used as a reference voltage on J5.4. The 7.5 Volt from J3.4 leaves the IOB on J5.2, to power optional low current (500mA) peripheral equipment.

4.2 INPUT/OUTPUT:

Board header connector JP1:

Pin	Source:	Pin	To:
1	Flat RX	2	Detector audio send (J3.6)
3	TX audio	4	TX audio return (J3.9)
5	RX audio	6	Unmuted RX audio send (J3.13)
7	Flat TX	8	Postlimiter flat TX audio return (J3.10)

Place the appropriate jumpers if no option board is fitted.
e.g. for flat TX and RX audio, place jumpers from 1 to 2 and 7 to 8.

Board header connector JP2:

Pin	Description:	Pin	Description:
1	7V5	2	ADC.7
3	RS232 TXD 3v3	4	PORTD.4
5	RS232 RXD 3v3	6	PORTD.5
7	PORTD.3	8	Gnd

Board header connector JP3:

Pin	Description:	Pin	Description:
1	3.3 Volt	2	Microprocessor reset
3	SCL (PORTC.4)	4	MISO (PORTB.4)
5	SDA (PORTC.5)	6	MOSI (PORTB.3)
7	Gnd	8	SCK (PORTC.5)

PCB connector J1:

Pad:	Description:
1	MOSI
2	3V3
3	Reset
4	GND
5	SCK
6	MOSI

This connector is intended for initializing and programming of the microprocessor via the SPI bus. Make sure no other electronics are connected to the SPI bus when progra mming the microprocessor.

4.2 CONNECTORS:

J3: Please refer to the "PROIS electrical" manual or the radio service manual.

J5: Main PCB Connector.

Pin:	Description:
1	GND
2	7.5V (max. 500mA)
3	RX/TX audio
4	3.3V (reference)
5	Channel select input
6	PTT
7	RX busy out
8	Power supply
9	Power supply
shell	GND

J5 is of the type D-shell, 9 pin, plug.

J6: Power-supply PCB plug to the radio.

Pin:	Description:
1	Power supply
2	GND

This is a fly-lead to the radio (7.5 Volt) or to the optional Switched Mode Power converter.

4.3 MICROPROCESSOR

The timing for the microprocessor is derived from an external crystal (Y1) oscillating on 8 MHz.
The supply voltage is 3.3 Volt this is derived via R16 from the internal 3.3 Volt radio supply.

4.3.1 ANALOGUE TO DIGITAL CONVERTERS:

The A/D converter converts a DC signals to a digital representation (10 bits accuracy). The microprocessor has seven A/D converter inputs but only one A/D converter.

Inputs used:

Input:	Description:
ADC0 (PINC.0)	Battery voltage
ADC2 (PINC.2)	TX hang-timer
ADC6 (19)	Channel switching
ADC7 (22)	Spare (JP2.2)

4.4 BATTERY-VOLTAGE MEASUREMENT:

The battery-voltage is measured at JP5.8+9 and divided by R9 and R15 division factor is: (10+1)/1 = 11.

4.4.1 LOW-VOLTAGE DETECTION:

The low-voltage detection is factory-set in the software according to the following table:

Battery-voltage	Action taken by software
Lower then 11.3 Volt	Low-voltage alarm
Lower then 10 Volt	Inhibit transmitter
Higher then 10.3 Volt	Allow transmit
Higher then 12 Volt	Silence low-voltage alarm

The Low-voltage alarm adds a 150 mS DTMF tone to the tail of the transmitter; the low-voltage alarm overwrites the TX-tail if this is set shorter then 150 mS.
The DTMF tone used is D (1633 Hz + 941 Hz.)

4.5 TX-HANG TIMER:

The TX-hang timer is the time between when the command is given to stop transmitting and when the transmitter stops transmitting. During this time no audio is fed to the Portable Radio, however, sub - audio tones (CTCSS) are allowed trough.
The TX-hang timer is set with potentiometer VR1. The range is 0 to 3.3 Volt this is converted to a 10 bit digital number and used to set the timer inside the microcontroller. The timer is derived from the crystal oscillator.
This facility is useful when the Portable Radio is used in a repeater configuration.

4.6 CHANNEL SWITCHING:

A voltage on J3.5 will select a channel. The voltage can be in the range of 0 to 3.3 Volts (J3.4). The A/D converter in the Microprocessor has a resolution of 10 bits, this equates to a precision of 3.22 mV. The maximum number of channels depends on the radio- model, the number of channels programmed in the radio and the software in the IOB. The current version supports ten channels. The software in the IOB provides for selecting two channels with a SPST toggle switch. Channel 1 is selected when J3.5 is left unconnected. J3.5 has a 10 k ohm pull-up resistor (R29.) Channel 2 is selected when J3.5 is set to 0 Volt (Ground), or 3 Volt. Channel selection is according to the following table:

Channel:	Voltage:
1	3.3
2	3
3	2.7
4	2.4
5	2.1
6	1.8
7	1.5
8	1.2
9	0.9
10	0.6
2	0

4.7 LOGIC INPUTS AND OUTPUTS:

Microprocessor port:	Function:	Direction:
PORTB.0	Radio hardware reset	output
PORTB.1	Data ready request (PROIS)	output
PORTB.2	O/B enable (PROIS)	input
PORTB.3	MOSI (PROIS)	input
PORTB.4	MISO (PROIS)	output
PORTB.5	SCK (PROIS)	input
PORTB.6	Cristal 1	input
PORTB.7	Cristal 2	output

Microprocessor port:	Function:	Direction:
PORTC.0	ADC0, Battery voltage	input
PORTC.1	Optional LED control	input
PORTC.2	ADC2, TX Tail	input
PORTC.3	PTT	input
PORTC.4	I2C-SDA	In/output
PORTC.5	I2C-SCL	In/output
PORTC.6	Microprocessor reset	input

PTT is active when low (0 Volt) and has a pull-up resistor of 1 k Ohm (R28.)

Microprocessor port:	Function:	Direction:
PORTD.0	RS232 RX (3.3V)	input
PORTD.1	RS232 TX (3.3V)	output
PORTD.2	Flat audio select	input
PORTD.3	Spare, N/U	input
PORTD.4	Spare, N/U	input
PORTD.5	Spare, N/U	input
PORTD.6	Audio select A	output
PORTD.7	Audio select A	output

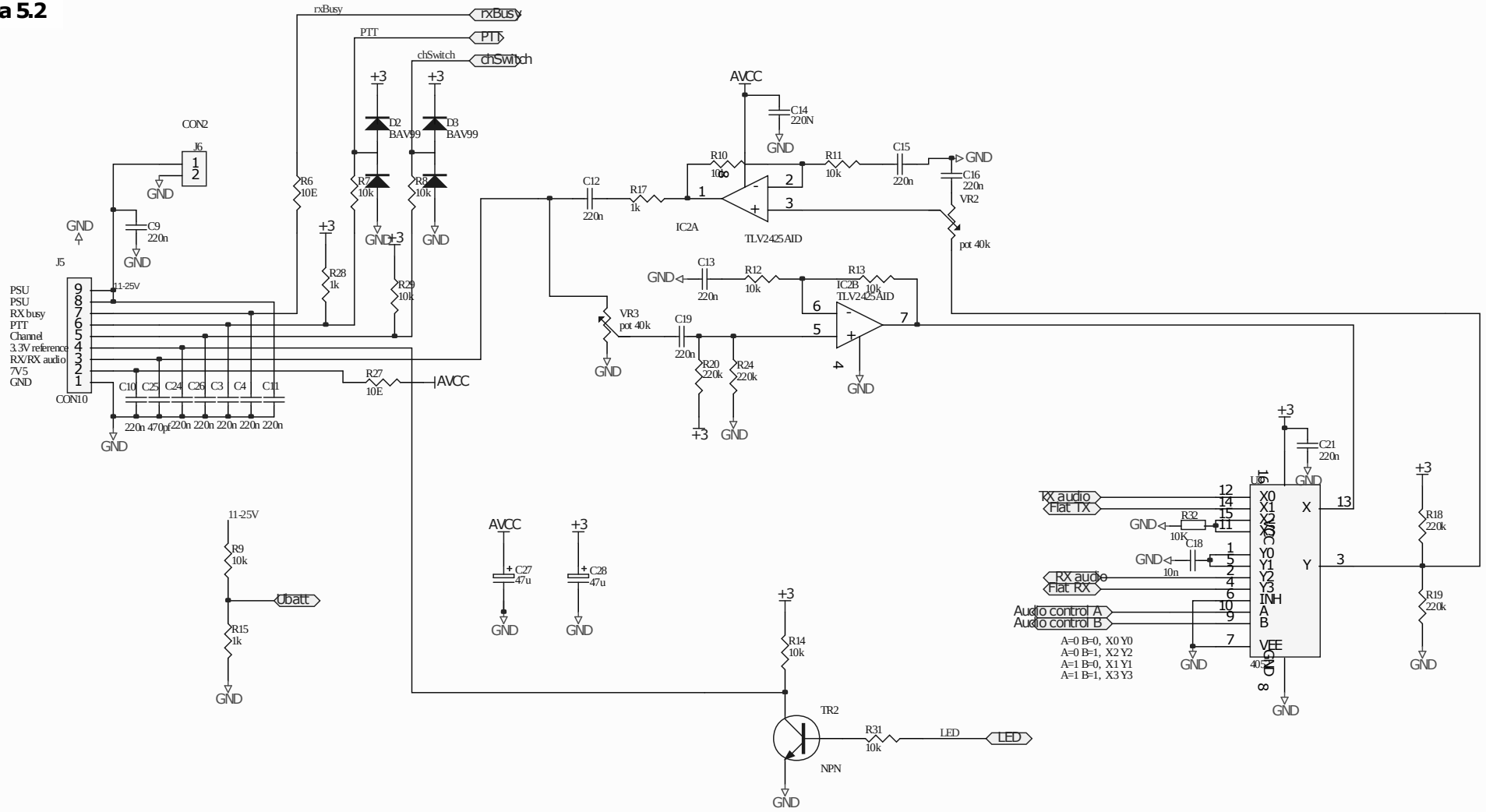
Flat audio is selected when low, (0 Volt).
All the Microprocessor inputs have the internal pull-up resistor enabled (47 k Ohm.)

5 Bill of materials, Schematics, PCB layout:

Designator	Description	Footprint	Comment
C1	Capacitor	0805	10pf
C2	Capacitor	0805	10pf
C3	Capacitor	0805	220n
C4	Capacitor	0805	220n
C5	Capacitor	0805	220n
C6	Capacitor	0805	220n
C8	Capacitor	0805	220n
C9	Capacitor	0805	220n
C10	Capacitor	0805	220n
C11	Capacitor	0805	220n
C12	Capacitor	0805	220n
C13	Capacitor	0805	220n
C14	Capacitor	0805	220N
C15	Capacitor	0805	220n
C16	Capacitor	0805	220n
C18	Capacitor	0805	10n
C19	Capacitor	0805	220n
C21	Capacitor	0805	220n
C23	Capacitor	0805	470pF
C24	Capacitor	0805	220n
C25	Capacitor	0805	470pf
C26	Capacitor	0805	220n
C27	Electrolytic Capacitor	7227	47u
C28	Electrolytic Capacitor	7227	47u
D2	Double diode	SOT-23	BAV99
D3	Double diode	SOT-23	BAV99
IC2	Double op-amp	SO-8	TLV2425AID
J1	Connector	TEST6	CON6
J3	Connector	NELTRON 40/5	PROIS GP328
J5	Connector	DB9RA/M	CON10
J6	Connector	molex02	CON2
JP1	HEADER socket	8PIN	socket 4X2
JP2	HEADER socket	8PIN	socket 4X2
JP3	HEADER socket	8PIN	socket 4X2
R1	Resistor	0805	0
R2	Resistor	0805	0
R3	Resistor	0805	0
R4	Resistor	0805	0
R6	Resistor	0805	10E
R7	Resistor	0805	10k
R8	Resistor	0805	10k
R9	Resistor	0805	10k
R10	Resistor	0805	10k
R11	Resistor	0805	10k
R12	Resistor	0805	10k

Designator	Description	Footprint	Comment
R13	Resistor	0805	10k
R14	Resistor	0805	10k
R15	Resistor	0805	1k
R16	Resistor	0805	10E
R17	Resistor	0805	1k
R18	Resistor	0805	220k
R19	Resistor	0805	220k
R20	Resistor	0805	220k
R21	Resistor	0805	47k
R22	Resistor	0805	47k
R23	Resistor	0805	47k
R24	Resistor	0805	220k
R25	Resistor	0805	10k
R26	Resistor	0805	10k
R27	Resistor	0805	10E
R28	Resistor	0805	1k
R29	Resistor	0805	10k
R30	Resistor	0805	10E n/u
R31	Resistor	0805	10k
R32	Resistor	0805	10k
TR1	NPN Transistor	SOT-23	npn
TR2	NPN Transistor	SOT-23	NPN
U1	Microcontroller	TQFP32	ATMEGA8_TQFP32
U3	Audio switch	SO-16	4052
VR1	Adjustable potentiometer	VR6	40k
VR2	Adjustable potentiometer	VR6	pot 40k
VR3	Adjustable potentiometer	VR6	pot 40k
Y1	Crystal Motorola custom made flat-cable	xtal3	CRYSTAL 8404078G03

Schema 5.2



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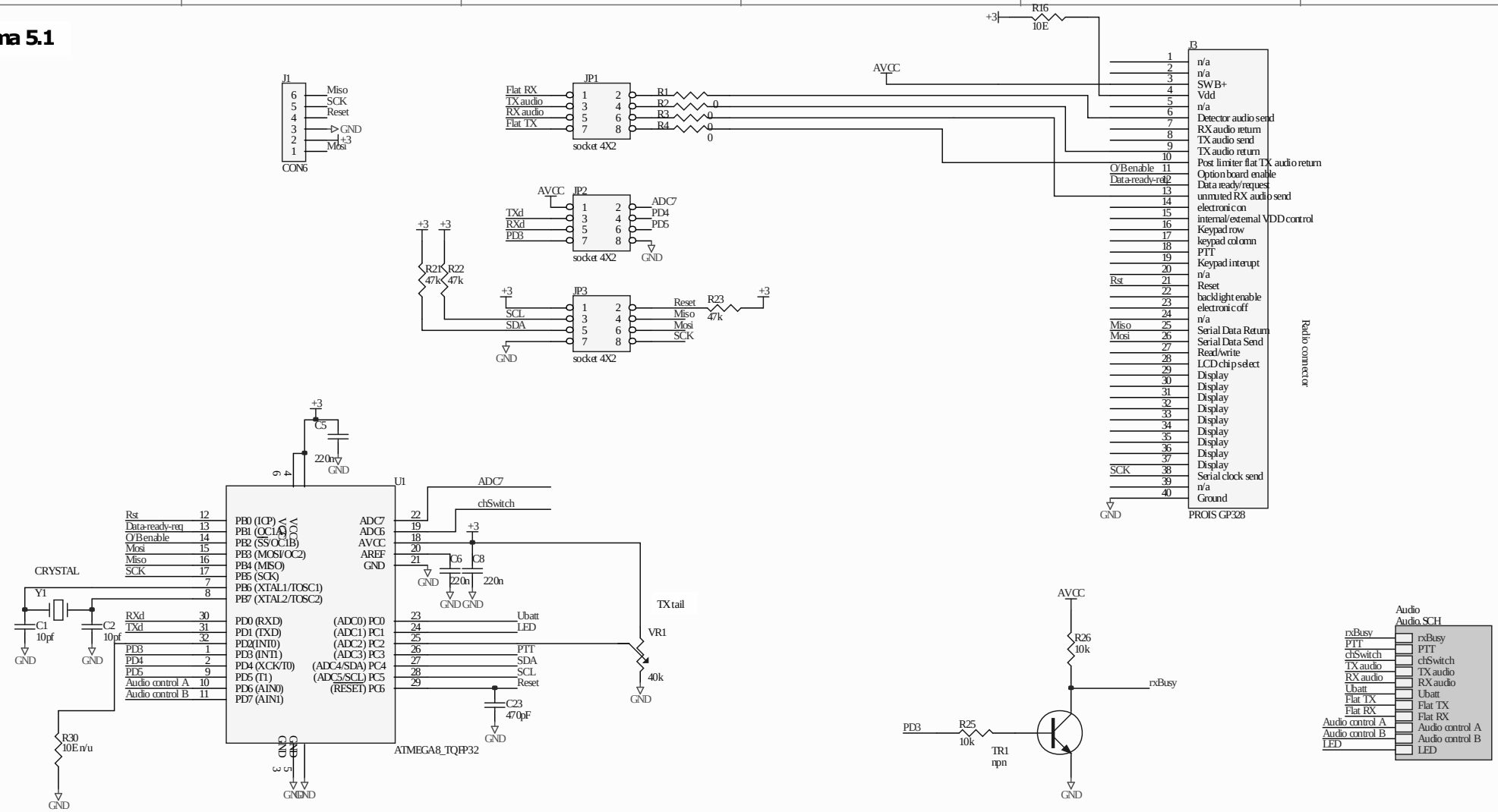
Schema 5.1



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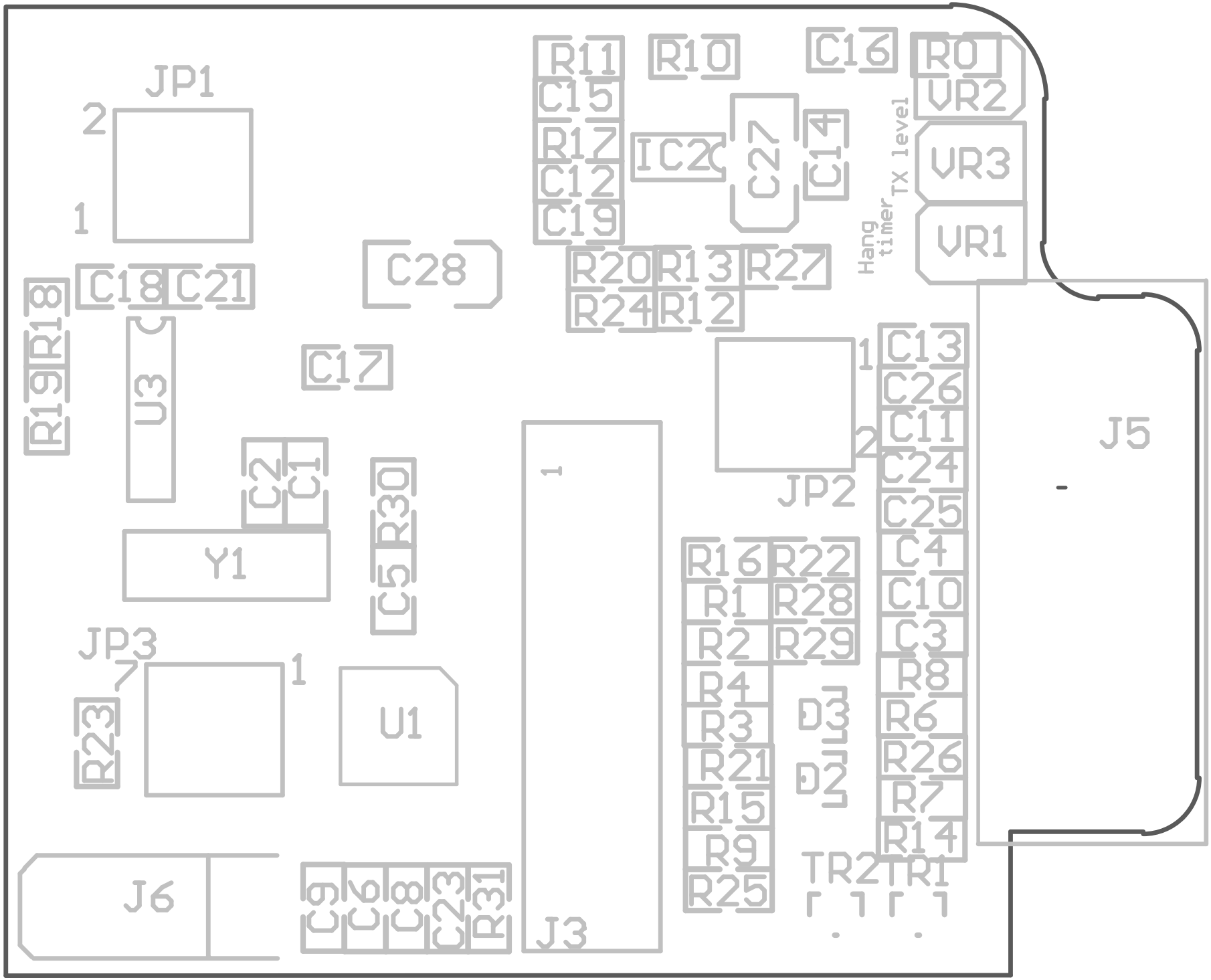
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C24
C25
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