



SDR Cube Transceiver **Online Assembly Guide**

Detailed construction notes for building and testing each of the SDR Cube kit modules

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Building the DSP Board

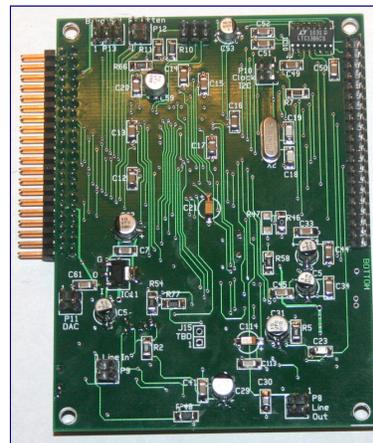
... (Section version 1.0a)

What Is It?

The DSP Board is the heart, soul and brains of the SDR Cube. It contains the dsPIC microcontroller that performs all I/O, user interface and signal processing, and it interfaces to the I/O board on one side, getting its 5V power and raw signals from it; and with the Controls board on the other side, providing for all the user controls and LCD display. The DSP board sits along the left-hand side of the chassis and plugs directly into the Controls board; and plugs into the I/O board on the other side via a 40-wire flat ribbon cable. Furthermore, a number of tentacle-like cables snake over to the RF front end (i.e., the internal Softrock RXTX 6.3, or the external RF deck through the rear panel connector) in order to handle the clocking, PTT, RF gain, and audio signal needs for transmit and receive operation with the chosen RF deck.



DSP Board (top side)



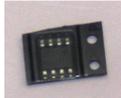
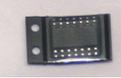
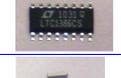
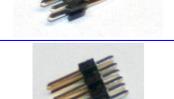
DSP Board (bottom side)

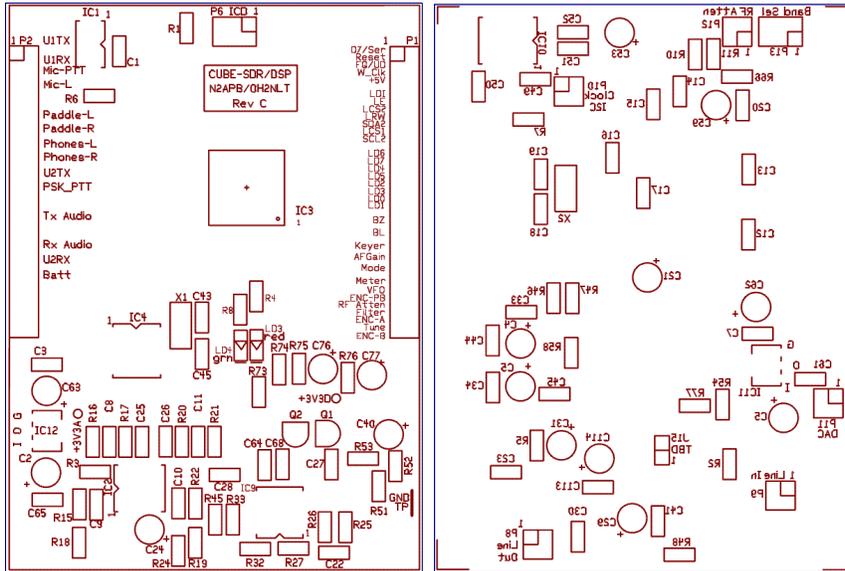
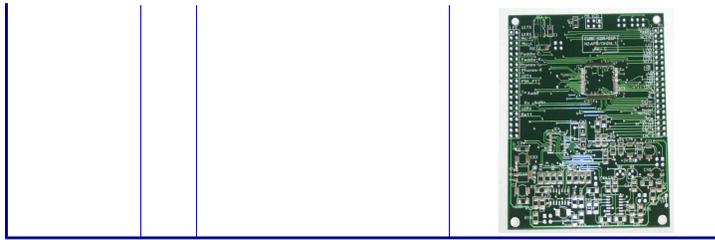
DSP BOARD (1 of 2)		DSP BOARD (2 of 2)	
C42, C43 15 pF		R46 0.0 ohm	
C18, C19, C23 22 pF		R1, R24, R66 10.0 ohm	
C1, C3, C7, C12, C13, C14, C15, C16, C17, C20, C22, C33, C34, C41, C44, C45, C49, C50, C51, C52, C61, C65, C113 0.1 uF		R10, R18, R19, R48, R77 100 ohm	
C8, C9, C10, C11, C30 3300 pF		R4, R6, R7, R8 1.00K ohm	
C25, C26, C27, C28, C64, C68 0.47 uF		R5, R11, R16, R17, R20, R21, R51, R52, R54, R58, R73, R74 10K ohm	
C21, C114 10 uF		R15, R22 22.0K ohm	
LD3 LED red face up		R3 47.0K ohm	
LD4 LED green face up		R2, R53 100K ohm	
		R25, R26, R27, R32, R33, R45 220K ohm	
		R75, R76 1M ohm	
		R47 (open)	



IC Bag in static-safe pink plastic bag
 (Note: The large dsPIC chip IC3 is actually in its own compartment of the plastic bag, protected from the outside by two layers of plastic.)

Designator	QTY	Description
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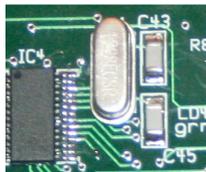
IC Bag			
IC1	1	128x8 bit EEPROM, 24LC256, 8SOIC 24LC256T-I/SNCT-ND	
IC2	1	OP AMP QUAD, 14-SOIC LMV324MXCT-ND	
IC3	1	DSPIC MCU/DSP 256K 100TQFP DSPIC33FJ256GP710-I/PF-ND	
IC4	1	STEREO AUDIO CODEC 28-TSSOP (TLV320AIC23BPW) 296-15635-5-ND	
IC9	1	MUX SWITCH ICS QUAD BILATERAL ANALOG (14-SOIC) 595-SN74HC4066DRE4	
IC10	1	IC, RS232 driver LTC1386CS#PBF-ND	
IC11, IC12	2	LDO REG FXD 3.3V SOT223 LT1117CST-3.3#PBF-ND	
Q1, Q2	2	Transistor, FET, 2N7000, TO92 2N7000_D26DZCT-ND	
X1	1	X228-ND, 12.288 MHZ	
X2	1	X1084-ND, 7.3728 MHZ	
Loose			
P1	1	Pinheader, 2x40, 0.1", right angle	
P2	1	Pinheader, 2x40, 0.1"	
P8, P9, P10, P11, P12	5	Pinheader, 2x2, 0.1"	
P6, P13	2	Pinheader, 2x3, 0.1"	
C2, C4, C5, C6, C24, C53, C76, C77	8	CAP 1.0UF 50V HB ELECT SMD	
C29, C31, C40, C59, C62, C63	6	CAP 10UF 35V ELECT FC SMD	
	1	SolderWick	
	1	Solder, .015"	
PCB-DSP	1	PCB, DSP	



STEP 2: Install the surface mount capacitors and resistors from the SMT Card.

First, attach the capacitors to their respective pads ...using the order of the parts as listed on the SMT card and the Parts Layout diagrams above (and on the board's silkscreen) as guides ...

[] C42, C43 **NOTE:** The silkscreen for "C42" is mislabeled as "C45" next to crystal X1 on the top of the pc board. You should put the two 15pF capacitors here at the locations R43 and "C45", as shown in the photo below. [The real C45, a 0.1uF cap, is on the bottom side by the C5 electrolytic can.]



[] C18, C19, C23

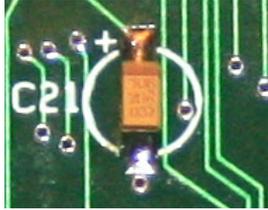
[] C1, C3, C7, C12, C13, C14, C15, C16, C17, C20, C22, C33, C34, C41, C44, C45, C49, C50, C51, C52, C61, C65, C113

[] C8, C9, C10, C11, C30 ... **NOTE:** These 3300pF SMT caps are the smaller "0805" package, not the larger "1206" package used for all other SMT components in the kit. They may still easily be attached: just place them in between the pads for that component and put enough solder on the each pad to flow onto the ends of the chip cap. See the photo below as a guide ...



C25, C26, C27, C28, C64, C68

C21, C114 ... **NOTE:** These are "tantalum" capacitors, which have the + polarity marked with a band. So be sure to put the banded end toward the + pad on the board. Further ... the designator for these two components shows as a round capacitor, but just place this rectangular capacitor across the pads as shown in the photo below.



Next, attach the resistors to the board, in the order they are listed on the SMT parts card ...

R46

R1, R24, R66

R10, R18, R19, R48, R77

R4, R6, R7, R8

R5, R11, R16, R17, R20, R21, R51, R52, R54, R58, R73, R74

R15, R22

R3

R2, R53

R25, R26, R27, R32, R33, R45

R75, R76

R47 ... this is an "open" = nothing to install!

STEP 3: Install the 100-pin SMT IC "IC3" (dsPIC controller)

Using the flood solder techniques described on our Construction home page, install the TQFP-100 package U3. Be careful to orient the corner with the "dot" on the package closest to the "pin 1" label on the pc board. This IC is pre-programmed with SDR Cube software v1.0.

If you spend three hours assembling this whole DSP board kit, spending one hour on carefully attaching the dsPIC would be entirely appropriate and understandable. You **need** to get this one right, or nothing else will work. If you are comfortable using the "solder paste and oven" method of attaching SMT chips, this would be a good one to use it on and you will have excellent results. Otherwise, you'll need a very fine tipped soldering iron, a magnified lamp and/or magnified viewer headset, some Solder Wick™ (supplied in the kit), and some of the very thin .015" solder (also supplied in this kit). There is a dot on the IC package that denotes pin 1 and that corner of the chip should mate with the dot on the pcb legend for IC3. Next, holding the package with your fingertips or tweezers, carefully ensure that the package leads are all oriented properly over their respective pads and tack solder the lead in one corner to its pad. Then go to the opposite corner and, again ensuring that the IC leads are still properly aligned over their pads, tack down that second lead to its pad. Double, triple, and quadruple check that all pins are properly aligned over their leads. Is the package dot in the bottom right corner where the dot is by pin 1 on the silkscreen? Okay, now go ahead and solder the rest of the pins to the pads. The pins of the IC will need to be kept all in the same plane for best results in attaching each leg to its respective pad. (i.e., don't go bending each leg down to the pad when soldering, but instead let the solder flow up to the lead.) You might need to add a little solder along the way – don't worry about slobbering too much and shorting pins, as you'll be able to go back and draw it off using the solder wick. When you're all done, you should inspect every lead, at every angle, using the highest power magnification possible to ensure that each is soldered to the pad and not floating above without connection, as well as ensuring that there are no shorts between pads. You could clean off the flux now with isopropyl alcohol and a cotton swap, if desired. Not too hard, actually. It takes George or Juha about 10 minutes to attach these TQFP-100 ICs ... although we've done many of them over the combined number of our homebrewing years.

IC3 ... this is the 100-pin SMT package attached and ready to go!



STEP 4: Install the 28-pin SMT IC "IC4" (codec)

Again using the solder techniques described above and on our home page, install the TSSOP-28 package U4. Be careful to orient the corner with the "dot" on the package closest to the "pin 1" label on the pc board.

IC4 ... this is the 28-pin TSSOP package

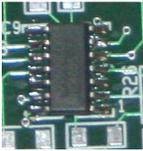
STEP 5: Install the remaining ICs

The rest of the ICs do not have closely-spaced leads, so the leads on these packages may be individually soldered in the conventional fashion. Again, take care to orient pin 1 on the package with pin 1 on the silkscreen layout.

IC1 ... this is the 8-pin SOIC package marked as 24LC256

IC2 ... this is the 14-pin SOIC package marked as LMV324MXCT

IC9 ... this is the 8-pin SOIC package marked as SN74HC4066DRE4



IC10 ... this is the 8-pin SOIC package marked as LTC1386

IC11, IC12 ... these are the 3.3V regulators (LT1117CST-3.3) in an SOT-223 package

STEP 6: Install the red and green LEDs

NOTE: These surface mount LEDs have a marking on their bottom sides indicating polarity: a solid square with a line protruding from one side points to the cathode side of the device, which of course is oriented toward the lower pad with the extra line, as shown in the photo below.

LD3 ... this is the **red** LED, shown mounted on the right in the photo below

LD4 ... this is the **green** LED, shown mounted on the left in the photo below

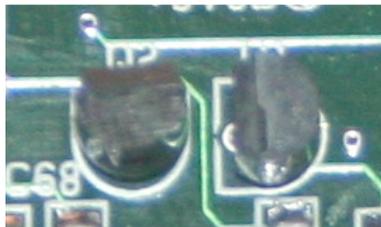


STEP 7: Install the 2N7000 FETs (Q1 and Q2)

The devices are quite static sensitive so practice good ESD handling. Be sure to orient these TO92-packaged devices according to the half-moon symbol on the board, with the flat of the FET on the same side as the flat of the symbol. Push the device down as far as possible and then solder.

Q1

Q2

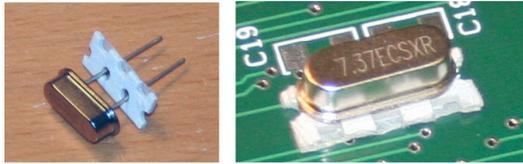


STEP 8: Install the crystals (X1 and X2)

These two crystals look very similar, so you will need to look carefully at the case markings using your magnifying lens. **NOTE:** When you mount each crystal into position, make sure it is raised a small amount from the pc board to ensure that there is no possibility of the case shorting out a trace beneath it. A practice followed by many homebrewers is to use some scrap paper material leftover from the SMT resistors and capacitors as insulating "spacers" between the crystal and the pc board.

X1 ... **NOTE:** this crystal is marked as "1228"

X2 ... **NOTE:** this crystal is marked "7.37"



STEP 9: Install the 1.0 uF Electrolytic capacitors

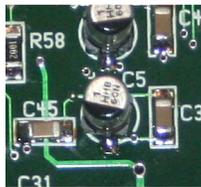
The electrolytic caps look like little silver "tin cans" with leads on the bottom that will attach to the pads at their location. It is important to note that these electrolytic capacitors are polarized and must be installed with the proper orientation or things could get messy when powered up. The negative side is indicated with a black half-moon mark, and the positive side is the unmarked side, as shown below for a 47 uF capacitor (the marking is the same for the 1 uF and 10 uF caps used here on the DSP board) ...

Positive



Negative

C2, C4, C5, C6, C24, C53, C76, C77 ... **NOTE:** If you found two C5 locations on the bottom of the pc board and none for C6, you are not alone! The "C5" on the left side of the board (near IC11) is the real C5 location. **The "C5" on the right side of the board (next to C4) is really C6.**



The "real" C6 location is at this C5 spot

STEP 10: Install the 10 uF Electrolytic capacitors

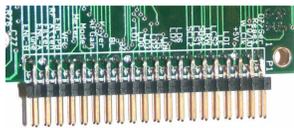
As above with the 1 uF capacitors, take note of proper polarity and orientation of these 10 uF electrolytic capacitors ...

C29, C31, C40, C59, C62, C63

STEP 11: Install the 40-position pinheader P1 on the right side of the board

Ensuring that you have the correct [right-angle pinheader](#), insert it on the top-right side of the board. Holding it firmly in place such that the pins are parallel to the plane of the board, solder one pin at each end on the bottom of the board. Double check to ensure that the connector is sitting flush on the board, and then solder the remaining pins.

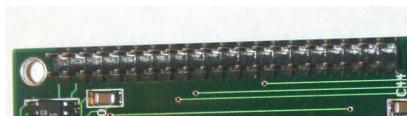
P1 ... **NOTE:** [Right-angle pinheader](#), mounted on the [top](#) side of the board.



STEP 12: Install the 40-position pinheader P2 on the left side of the board

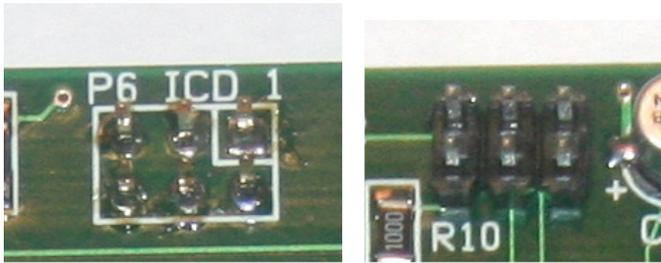
Ensuring that you have the correct [straight pinheader](#), insert it on the bottom side of the board at "P2". Holding it firmly in place such that the pins are quite perpendicular to the plane of the board, solder one pin at each end on the top of the board. Double check to ensure that the connector is sitting flush on the board, and then solder the remaining pins.

P2 ... **NOTE:** [Straight pinheader](#), mounted on the [bottom](#) side of the board.



STEP 13: Install one 2x3-position pinheader P6 on the top-center side of the board

P6 ... **NOTE the special mounting required!** We need to watch how far the P6 pins extend above the top of the board. **So we will mount the long end of P6 into the bottom of the board to extend up through the top side.** See photos below as a guide for this important step ...



Long pins of P6 extend up through the top of the board (photo on left), yet the black plastic carrier with the shorter pins is on the bottom of the board (photo on right). The ICD connector will plug into P6 on the top side of the board ... **do not snip off these pins!**

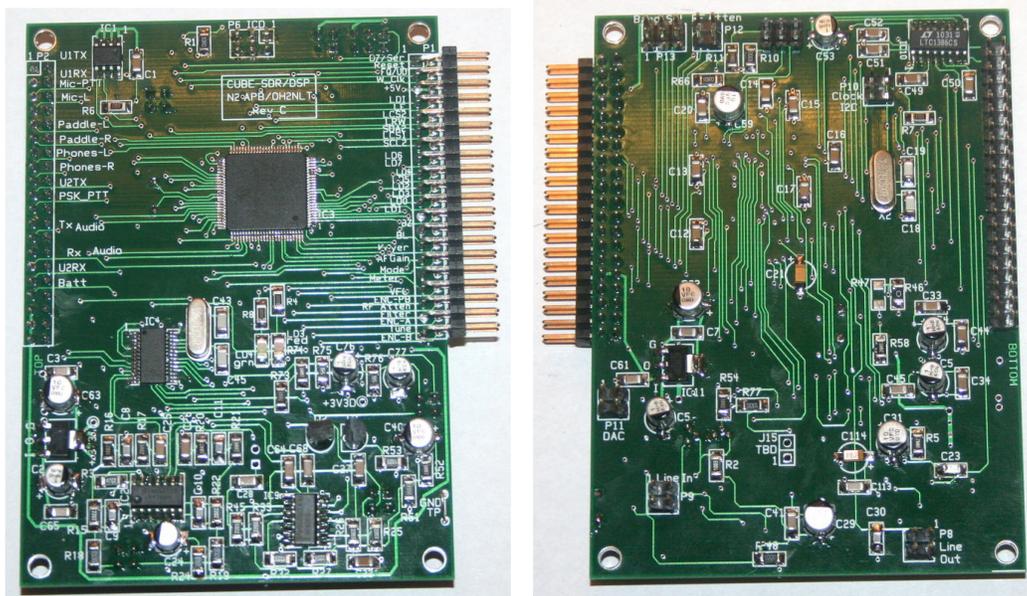
STEP 14: Install the remaining pinheaders on the bottom side of the board

P8, P9, P10, P11, P12 ... these are 2x2-position pinheaders

P13 ... this is the remaining 2x3-position pinheader

STEP 15: Attach 1/4" nylon standoffs to the top and bottom corners of the DSP board

To handle the natural outward bending of the DSP board when ultimately mounted in the enclosure, attach the remaining two #4 threaded nylon standoffs to bottom side of the DSP board at the upper-rear and lower-rear corners (i.e., along the "P2 side" of the board), using the remaining #4-40 screws.



Completed DSP Board (top and bottom sides)

(NOTE: Nylon standoffs from Step 15 are not yet shown in these photos)

Congratulations, the DSP Board is complete! Set it aside and move on to the Digital Sub-assembly Test section!

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