

## CSTN01 - CTCSS Tone Encoder Circuit Sticker

### 1. General Description

A photo of the CSTN01 Circuit Sticker Tone Encoder appears in Figure 1.



Figure 1 - CSRX01 Circuit Sticker Tone Encoder

The CSTN01 Circuit Sticker tone encoder generates 50 different subaudible tones. It is based on the Microchip PIC16F54 microcontroller. Two option jumpers are used to select which of the 50 tones to generate. The output level is set by adjusting a trim-pot. The tone encoder requires 7 VDC to 20 VDC and about 5 mA.

### 2. Features

- ◇ CTCSS Tone Encoder
- ◇ Generates 50 different standard tones
- ◇ Based on PIC16F54 microcontroller
- ◇ Crystal oscillator stability
- ◇ Circuit Sticker construction on perforated board
- ◇ Circuit Stickers reduce the chance of error compared to building on plain board
- ◇ Circuit Stickers cost less than printed circuit boards
- ◇ Circuit Stickers look better compare to plain board
- ◇ Circuit Stickers make it easier to do repairs compared to plain board

### 3. Applications

- ◇ Add tone encoder to old rigs
- ◇ Generate tone at repeater
- ◇ Test tone decoders
- ◇ Something fun to build

## 4. Schematic

The schematic of the CSRX01 Circuit Sticker receiver appears in Figure 2. U1 is PIC16F54 microcontroller. It operates at a crystal controlled clock rate of 20 MHz. U2 is a voltage regulator that takes the 7 VDC to 20 VDC input down to the 5 VDC required by U1. R2 through R8 form a 6-bit digital to analog converter. The output of the converter is filtered by C4. R7 is the tone level control. JP1 is 2 jumpers that are installed to selected the desired tone frequency.

## 5. Parts List

The parts list for the CSTN01 Circuit Sticker tone encoder appears in Table 1.

## 6. Layout

The CSTN01 Circuit Sticker is shown in Figure 3. The sticker can be used on any perforated board with an appropriate pattern on the solder side. The basic perforated board pattern is shown in Figure 4. There are 3 holes per pad and traces for Vdd and ground. The Circuit Sticker is stuck to the component side of the board opposite the pattern on the solder side. The rectangle in Figure 4 shows the typical alignment of the sticker with the pattern. The board is trimmed to fit the outline.

The board is glass-epoxy with tinned pads and traces. There's a solder mask. However it's still necessary to be careful when constructing the circuit. It is possible to lift a pad by applying too much heat. Use a low wattage soldering pencil. Inspect your work frequently for solder bridges and cold solder joints.

## 7. Assembly Instructions

- ◇ Read all instructions before beginning assembly.
- ◇ Observe all safety precautions during assembly.
- ◇ Inventory parts before beginning assembly.
- ◇ Carefully remove the release paper from the tone encoder Circuit Sticker and apply it to the perforated board properly aligned and orientated if not already done. See Figure 4.
- ◇ Using a sharp point make holes in the Circuit Sticker for the jumper and component leads but don't yet make holes for the jumpers between the X and Y and the A, B, C, D, E, F, G, and H holes.
- ◇ Install the 18-pin IC socket for U1. Make sure the notch on one end of the socket matches the notch on the outline. Tack solder 1 pin of the socket then make sure it's seated flat against the board. You might have to heat the pin while pushing the socket down with your finger. Once the socket is properly seated then solder all of the pins. Don't install the IC at this time.
- ◇ Install and solder the capacitors in place. Save the trimmed capacitor leads to use for the bare wire jumpers.
- ◇ Install and solder the R1 and R9 resistors in place. Save the leads for the bare wire jumpers.
- ◇ The bare wire jumpers are indicated on the Circuit Sticker by straight lines. The saved capacitor and R1 and R9 leads should be sufficient for making the bare wire jumpers but 22AWG solid wire may also be used to form the jumpers. Solder them in place so that the jumpers are flat against the component side of the board. See Figure 1 as an example.
- ◇ Resistors R2 through R5 are installed in the following manner. First install R2 with it's body positioned above the R2 outline and solder the lead that goes through the outline. The other lead extends horizontally from the top of R2 until it's above the hole adjacent the R5 outline and then goes straight down vertically to the board where it is soldered. R3, R4, and R5 are then installed above the corresponding outlines with the top lead tack soldered to the horizontal section of the top lead of R2 and the bottom lead soldered to the board. See the sketch in Figure 5
- ◇ Install R8 and R6 in a fashion similar to R2 through R5.
- ◇ Install R7, the trimmer resistor, and solder in place.
- ◇ Install and solder the insulated wire jumpers in place. The insulated wire jumpers are indicated on the stickers by curved lines. Use 22AWG solid wire to form the jumpers and solder them in

place so that the jumpers are flat against the component side of the board. See Figure 1 as an example. Make sure the insulated wire jumpers near the X and Y option jumper holes stay clear of those holes.

- ◇ Install Y1, the crystal, and solder in place. It doesn't seat flat against the board but sits up a little.
- ◇ Install U2, the voltage regulator, and solder in place. It also sits up a little.
- ◇ Before installing the X and Y jumpers determine your required tone frequency and the jumper positions from Table 2. For example for a tone frequency of 151.4 Hz jumper X goes to E and jumper Y goes to D. Double check your determination to make sure you're correct. Make holes in the Circuit Sticker for the jumper wires leaving the unused holes unpunched for future reference. Install and solder in place the X any Y jumper wires using 2.5" long 22 AWG stranded wire. The wires must be sufficiently long to allow the installation of U1 and for possible future changes to the tone frequency.
- ◇ Chassis wiring is summarized in Table 3. Use 22AWG stranded wire.
- ◇ Install U1 making sure the notch in one end of the chip aligns with the notch in one end of the IC socket and none of the pins are bent.
- ◇ Inspect the board for solder bridges, cold solder joints and incorrectly installed components. Correct any problems before proceeding.
- ◇ Before installing the tone encoder in your rig make sure your rig functions properly then install the board in your rig.
- ◇ Again inspect your work for shorts, cold solder joints, incorrectly installed components, and incorrectly made connections.
- ◇ This completes assembly.

## 8. Test and Tune Up

- ◇ Make sure all power is off.
- ◇ Turn pot R7 full counter-clockwise for minimum tone level.
- ◇ Use a modern rig with the tone decode function as a test receiver. Tune that rig to an unused simplex frequency and set it's tone decode function to decode your required tone frequency.
- ◇ Power on the old rig with the tone encoder installed and make sure it's not drawing excessive power , stuck in transmit, or exhibits any other problems.
- ◇ Tune the rig with the tone encoder to the test simplex frequency.
- ◇ Transmit with the rig and adjust the tone level with R7 so that it reliably operates the tone decode function in the test receiver and doesn't transmit an excessive tone level.
- ◇ Tune the rig to the frequency of the system you desire to access. Ask for on-air reports that you're accessing the system reliably and aren't transmitting an excessive tone level.
- ◇ This completes test and tune up.

## 9. Operation

Operation is straight forward, use the rig with the installed tone encoder to access the desired system.

**Table 1 - CSRX01 Circuit Sticker Receiver Parts List**

Item	Quantity	Reference	Description	Marking/Color
1	2	C1,C2	15pF	15J
2	3	C3,C4,C6	0.1uF	104
3	1	C5	0.33uF	u33K
4	3	R1,R8,R9	10k ohms	brn-blk-brn-gld
5	1	R2	330k	org-org-yel-gld
6	1	R3	160k	brn-blu-yel-gld
7	1	R4	82k	gry-red-org-gld
8	1	R5	39k	org-wht-org-gld
9	1	R6	20k	red-blk-org-gld
10	1	R7	100k trim pot	104
11	1	Y1	20 MHz crystal	20.00
12	1	U1	PIC16F54 microcontroller	PIC16F54
13	1	U2	LM78L05 voltage regulator	78L05
14	6"		22AWG solid	
15	6"		22AWG stranded white wire	
16	6"		22AWG stranded black wire	
17	6"		22AWG stranded red wire	
18	1		perforated board	
19	1	U1	18 pin DIP socket	
20	1		Circuit Sticker	CSTN01

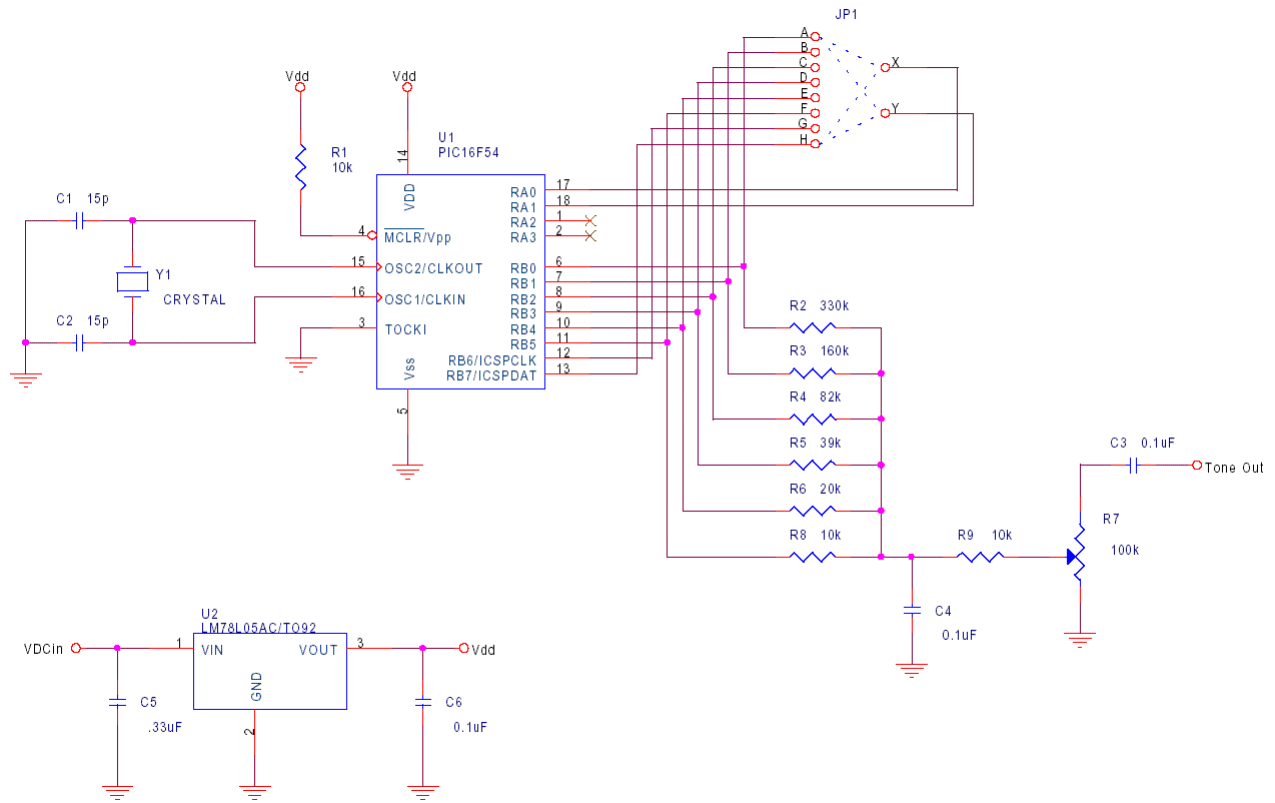


Figure 2 - CSTN01 Circuit Sticker Tone Encoder Schematic

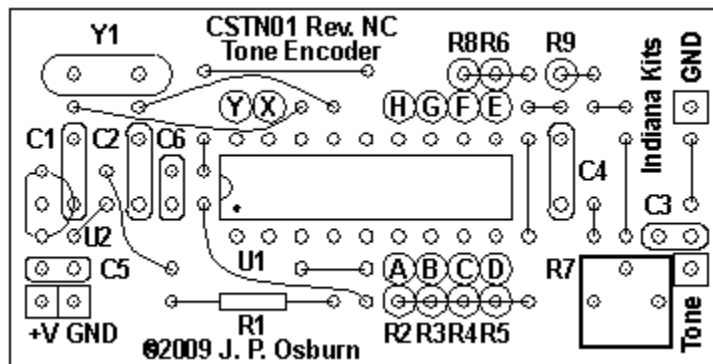
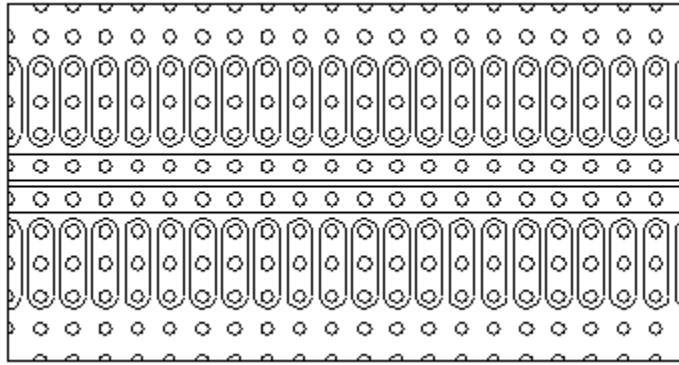
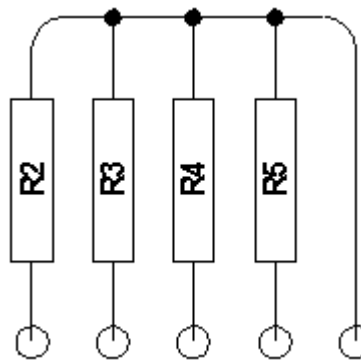


Figure 3 - CSTN01 Circuit Sticker



**Figure 4 - Basic Perforated Board Pattern**



**Figure 5 - R2, R3, R4, R5 Installation**

**Table 2 - X and Y Jumper Positions**

		Y						
X	A	B	C	D	E	F	G	H
A	not used	85.4	107.2	136.5	165.5	186.2	210.7	254.1
B	67	not used	110.9	141.3	167.9	189.9	218.1	not used
C	69.3	88.5	not used	146.2	171.3	192.8	225.7	not used
D	71.9	91.5	114.8	not used	173.8	196.6	229.1	not used
E	74.4	94.8	118.8	151.4	not used	199.5	233.6	not used
F	77	97.4	123	156.7	177.3	not used	241.8	not used
G	79.7	100	127.3	159.8	179.9	203.5	not used	not used
H	82.5	103.5	131.8	162.2	183.5	206.5	250.3	not used

**Table 3 - Chassis Wiring**

From	To	On Sticker	Wire Color
Rig Power +	+V	+V	Red
Rig Power -	Ground	Gnd	Black
Tone	Rig Mic Input	Tone	White
Tone Ground	Rig Mic Ground	Gnd	Black