ELcon Consulting & Engineering

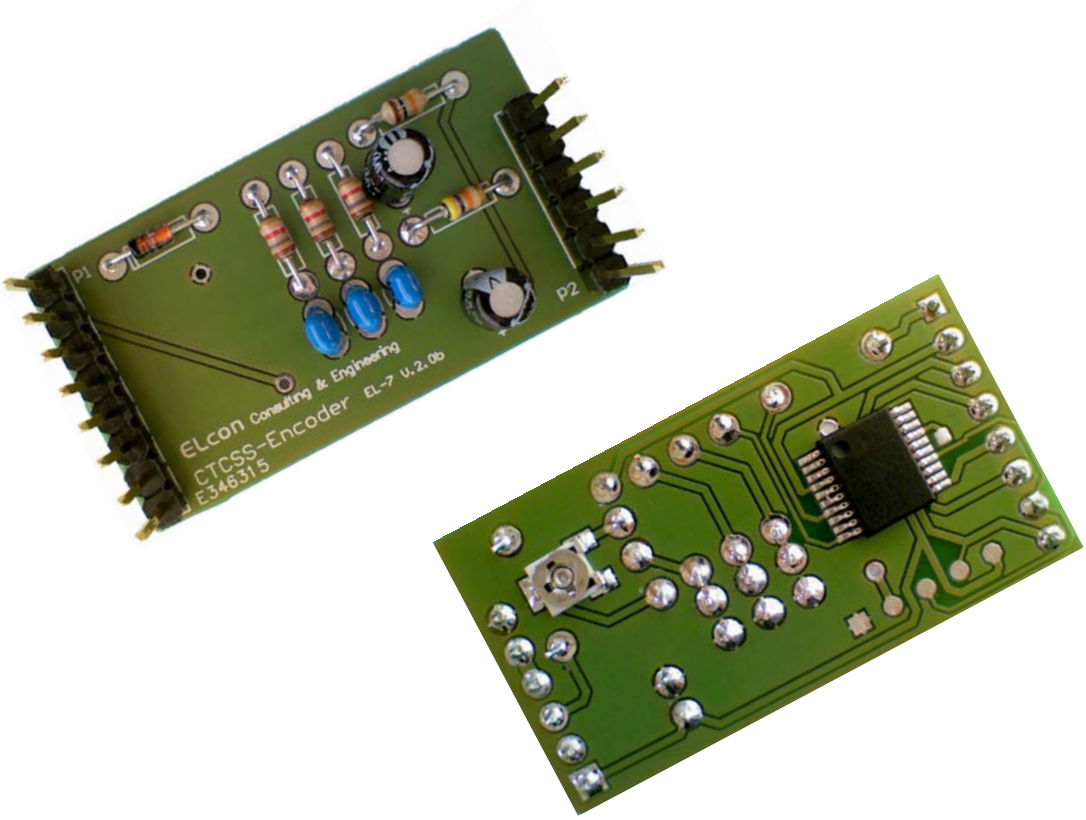
Brunnhaldenstrasse 8
3510 Konolfingen
Switzerland

Telefon +41 (0) 31 792 04 61
Fax +41 (0) 31 792 04 62
E-Mail info@elcon.ch
Shop http://shop.elcon.ch

EL-7

CTCSS-Encoder

(Yaesu FTS-8 Encoder replacement)
FT-270, FT-736, FT-650, FT-767, FT-2700RH, FT-4700RH and more



Construction and functional description

Version 2.0b

March 14, 2023

Table of Contents

Important! Advices or tips for the correct function of the EL-7.

Caution! The instructions must be strictly observed

1 Introduction

Many radio amateurs still prefer the use of older 2 m or 70 cm radio equipment, which is not able to generate the sub tones often required for traffic via repeater stations.

We show you a variant of how you can make your treasured device fit for the new operating technology so that the sub-tone squelch of repeater stations will open.

For some time now, not only in Switzerland, more and more repeater stations have been converted to the PL Squelch method (CTCSS, Continuous Tone Coded Squelch System). The reason for this are strong disturbances, generated by devices as computer cash registers or webcam systems etc. They keep the carrier-keyed repeaters constantly on transmission. By transmitting a sound simultaneously to the speech, the CTCSS-method prevents the opening of the repeaters without sub-tone modulation.

Many older devices and those specially manufactured for the European market only have the option of outputting a 1750 Hz call tone. The CTCSS function, which is very common in North America, is often missing.

The original FTS-8 Tone Squelch Module, with which the CTCSS functions can be retrofitted, is no longer available from the manufacturer.

In most cases it is sufficient to retrofit only the CTCSS encoder function, because this makes it possible to work with CTCSS via a modern repeater radio station. The EL-7 is a CTCSS encoder which can be installed in the device instead of the FTS-8 module. The tone frequencies can be set and stored via the original tone squelch function of the radio.

The EL-7 module is compatible with the FT-270, FT-736, FT-650, FT-767, FT-2700RH, FT-4700RH and other YAESU radios.

2 Assembly of the module

For the assembly you need the following tools and additional material:

- 50 to 80W pencil-style soldering iron
- solder Ø 0.5mm flux-core
- small needle nose pliers
- fine side cutter

It is advisable to study carefully and print out this documentation as a reference when you assemble the device. It allows you to control each implemented step.

Make sure the workspace is safe and free of static electricity, so that the installed elements are not damaged. It might be helpful to wear an antistatic bracelet. The illustrations (Table 3) on page 6 should help to identify the shapes and colors of the individual components.

The components, pcb and all mechanical elements corresponding to the component list (Table 2) are packed in a bag. Open the bag carefully, so that no components are lost or damaged.

Soldering is one of the most important aspects of setting up this device. A bad solder joint - even with a carefully assembled kit - can make it impossible to operate the unit and lead to frustration.

It's easy to create a good solder joint, if the following rules are observed:

1. Use a temperature-controlled pencil-style soldering iron with about 50 to 80 watts. A 1 to 2 mm wide chisel or pyramid tip works best.
2. Set the temperature for lead-free solder to a maximum of 320°C (608°F) and for leaded tin to a maximum of 360°C (680°F).
3. The tip must always be clean and well tinned. Wipe the tip often on stainless steel wool (to be found in the cleaning-products department at a supermarket), never on a wet sponge. Otherwise the soldering iron tip cools off unnecessarily, and there is not enough heat at the solder joint.
4. Do not use solder pastes, but good quality solder wire with a flux-core.
5. Keep the soldering iron tip only once, but long enough (approximately 2 to 3 seconds),

to the soldering joint, so that the solder can flow well. During this time enter very little solder between solder joint and tip.

6. Never touch the soldering pads on the board; otherwise a good soldering will not be possible. Should this happen anyway, clean the pcb with a lint-free cloth and benzine.
7. For multi-pole components such as IC sockets, plugs, etc. solder only 2 pins on diagonally opposite corners. This has the advantage that the elements can still be adjusted and afterwards soldered definitively. Subsequently, all other connections can be soldered.

Always make sure that you do not burn the already soldered components with the soldering iron.

The resistors in the parts list show the respective color coding (see also Table 1). If you are not familiar in dealing with the color coding, it is better to measure the resistance value with an ohmmeter prior to soldering.

Color coding of resistors with 4 rings				
Color	Resistance in Ω			Tolerance
	1st ring (1st digit)	2nd ring (2nd digit)	3rd ring (multiplier)	4th ring
none	-	-	-	±20%
silver	-	-	10^{-2} = 0.01	±10%
gold	-	-	10^{-1} = 0.1	±5%
black	-	0	10^{0} = 1	-
brown	1	1	10^{1} = 10	±1%
red	2	2	10^{2} = 100	±2%
orange	3	3	10^{3} = 1'000	-
yellow	4	4	10^{4} = 10'000	-
green	5	5	10^{5} = 100'000	±0.5%
blue	6	6	10^{6} = 1'000'000	±0.25%
violet	7	7	10^{7} = 10'000'000	±0.1%
gray	8	8	10^{8} = 100'000'000	-
white	9	9	10^{9} = 1'000'000'000	-

Table 1

Note: all polarized components (diodes, transistors, capacitors, ICs, relays, etc.) must have the correct mounting orientation.

2.1 Parts lists

EL-7 board

piece	components No.	Description
3	R2, 3, 4	1.8kΩ 1/8 W (brown-grey-red) [Component 1]
1	R1	10kΩ 1/8 W (brown-black-orange) [Component 1]
1	R6	47kΩ 1/8 W (yellow-violet-orange) [Component 1]
3	C3, 4, 5	0.1uF ceramic designated 104 [Components 2]
2	C1, 2	1uF electrolyte [Components 3], note polarity.
1	D1	1N4148 universal diode [Components 4], note polarity
1	P1	1x8 pin header [Components 5]
1	P2	1x6 pin header [Components 5]
1	R5	10kΩ trim potentiometer [Components 6] already assembled and adjusted
1	U1	PIC16F1826 I/SS [Components 7] already assembled and programmed

Table 2

 Components 1	 Components 2	 Components 3	 Components 4	 Components 5
 Components 6	 Components 7			

Table 3

2.2 Assembling the PCB

For the placement drawings of the top and bottom of the pcb refer to Chapter 3.3 (Figure 2 / bottom, Figure 3/ top). The SMD components are already assembled.

Populate the following components, using the parts list (Table 2).

- ☐ R1 to R6, resistors
- ☐ D1 Diode → mind the polarity!
- ☐ C1, C2, electrolytic capacitors → mind the polarity! white stripe = negative, see Chapter 3.3 (Figure 2 / bottom).
- ☐ C3 to 5, capacitors
- ☐ P1, and P2 pin connectors 1x8

⚠ The pin strips must lie flat and stay perpendicular to the pcb.

- ☐ Check all solder joints very accurately!

⚠ A magnifying glass may be helpful, because even the smallest, unwanted solder bridges can prove disastrous impact to the function.

2.3 Installation and adjustment of the module

For the installation of the EL-7 CTCSS encoder module, please refer to the chapter "FTS-8 CTCSS Tone Squelch Unit Installation" in the corresponding operating manual of the radio. The output level of the CTCSS module is preset with the trim potentiometer R4, so no adjustment should be necessary.

However, if there are any problems, the output level must be set with the trimming potentiometer R4 so that the maximum deviation is ±250 Hz. If you do not have a deviation meter available, the setting must be found by experimentally. The CTCSS level should only be set so high that the repeater responds reliably!

2.4 Operation

The operation of the CTCSS module EL-7 (encoder only) as a replacement for the FTS-8 is described in the radio operating instructions (under "Tone Squelch Operation").

All 37 CTCSS tones can be set via the radio's sub-tone function and stored together with the transmission frequency. An activated decoder function is ineffective and does not affect reception.

EL-7 Tone Frequencies (Hz)

01	067.0 Hz	09	091.5 Hz	17	123.0 Hz	25	162.2 Hz	33	218.1 Hz
02	071.9 Hz	10	094.8 Hz	18	127.3 Hz	26	167.9 Hz	34	225.7 Hz
03	074.4 Hz	11	100.0 Hz	19	131.8 Hz	27	173.8 Hz	35	233.6 Hz
04	077.0 Hz	12	103.5 Hz	20	136.5 Hz	28	179.9 Hz	36	241.8 Hz
05	079.7 Hz	13	107.2 Hz	21	141.3 Hz	29	186.2 Hz	37	250.3 Hz
06	082.5 Hz	14	110.9 Hz	22	146.2 Hz	30	192.8 Hz		
07	085.4 Hz	15	114.8 Hz	23	151.4 Hz	31	203.5 Hz		
08	088.5 Hz	16	118.8 Hz	24	156.7 Hz	32	210.7 Hz		

Table 4

3 Appendix

3.1 Specifications

Frequency:	67Hz – 250.3Hz (tolerance $\leq$1%)
Output level:	~ 100mV
Output impedance:	~ 50kΩ
Supply voltage:	= 5V / 3mA (directly from the transceiver)
Dimensions:	40(L) × 20(W) × 10(H) mm

All specifications can be changed by ELcon without further notice or obligation.

3.2 Schematics

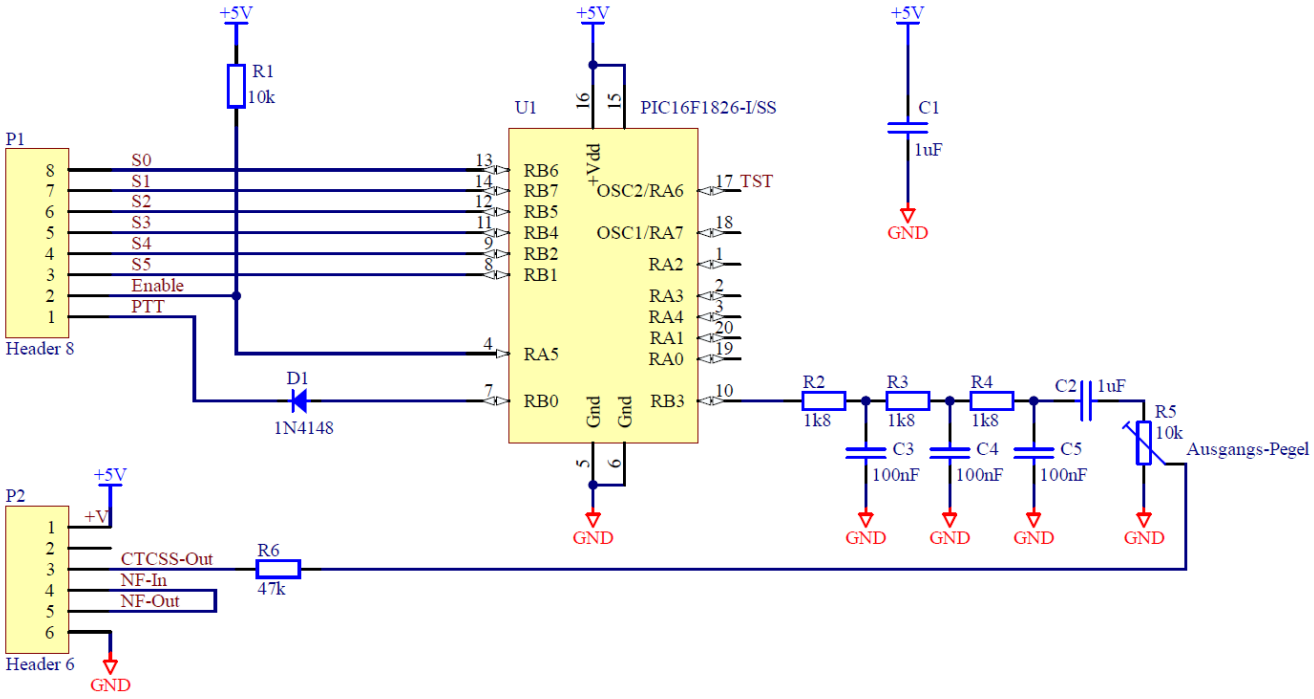


Figure 1

3.3 PCB assembly

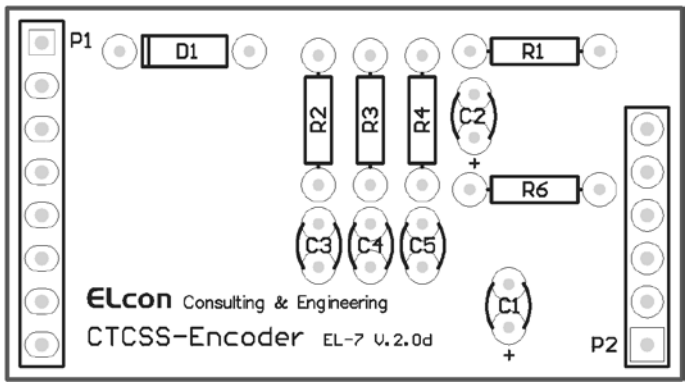


Figure 2 / bottom

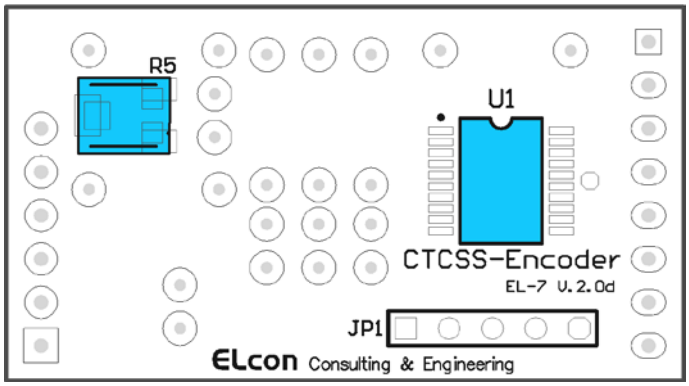


Figure 3/ top