EL-32

Digital replacement display kit incl. CTCSS function for the YAESU FT-221R

Construction, operating and functional description

from SW-Version 2.0e

January 18, 2024

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Important!
Advices or tips for the correct function of the EL-32.

Caution!
The instructions must be observed carefully.

1 Introduction

The old YASEU FT-221R VHF (2m-band) transceiver (ca. 70s) is still popular because of its very good reception. Unfortunately, it only has an analog frequency display. A digital display of the frequency is only possible with the FY-221. Today this frequency display is no longer available, or only at exorbitant prices, e.g. on eBay.

Today, modern microcontroller-controlled transceivers can be purchased. However, many radio amateurs still want to keep - perhaps their first device - alive and use it. But an analog frequency display is no fun when repeater stations are becoming increasingly narrow-band and require higher frequency accuracy when transmitting.

Replacing the mechanical display unit with a 7-digit digital frequency display is easy with this kit.

A display module has been developed that can be installed directly in the FT-221R and has useful additional functions, such as CTCSS for repeater operation.

The design is simple, as almost only wired components are used.

2 Assembly of the display 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
♦ several screwdrivers (Phillips)
♦ tweezers
♦ fine side cutter
♦ multi meter (ohmmeter, voltmeter)

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 on page 5 continued 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.

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2.1 Parts lists

EL-32 board

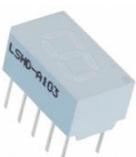| piece	components No.	Description
1	R1 (not installed)	22Ω 1/8 W (red-red-black) [Component 1]
1	R5 (not installed)	51Ω 1/8 W (green-brown-black) [Component 1]
2	R3, R14	100Ω 1/8 W (brown-black-brown) [Component 1]
2	R9, R13	10kΩ 1/8 W (brown-black-orange) [Component 1]
3	R6, R8, R11	22kΩ 1/8 W (red-red-orange) [Component 1]
1	R16	33kΩ 1/8 W (orange-orange-orange) [Component 1]
2	R4, R12	47kΩ 1/8 W (yellow-purple-orange) [Component 1]
3	R2, R7, R15	100kΩ 1/8 W (brown-black-yellow) [Component 1]
1	R10	10kΩ Trim potentiometer (blue) 3296P [Component 2]
4	C6, C7, C8, C11	1nF Ceramic marked with 102 [Component 3]
11	C2, C3, C4, C5, C10, C12, C13, C14, C16, C17, C19	0.1uF Ceramic marked with 104 [Component 3]
3	C9, C15, C18	1uF/50V electrolyte [Component 14]
2	C1, C20	47uF/16V electrolyte [Component 14]
1	X1 (already installed)	20MHz TCXO SMDR0053-T-040-3 [Component 4]
7	U1, U2, U3, U4, U5, U6, U7	LSHD-A103, 7 Segment LED [Component 11]
1	U8	MAX7221CNG or AS1106PL [Component 8]
1	U9	PIC18F2550 I/SP programmed [Component 7]
1	U10 (already installed)	MC12093DG 1.1 GHz prescaler [Component 6]
1	U11	PIC12F1571 I/SP programmed [Component 9]
1	U12 (already installed)	MAX9203ESA 7ns, Voltage Comparator [Component 6]
1	U13	TSOP4838 IR-Rx [Component 12]
1	U14	L78L05ACZ Positive Voltage Regulator [Component 16]
1	D1	1N4148 Diode [Component 10]
1	D2	1N4148 Diode [Component 10]
1	B1	AT-1220-TT-5-R Buzzer [Component 13]
1	P1 (already installed)	USB-B mini jack (SMD) [Component 5]
1	P2	JST B7B-XH-A Socket connector [Component 23]
1		JST XHP-7 Plug housing [Component 24]
7		JST Socket contact SXH-001T-P0.6 [Component 25]
1	J1 (not installed)	Header 6 Pin [Component 18]
1	RF-In	Coaxial RG-316 Length 23 cm [Component 17]
1	Tone Out	Audio cable length 23 cm [Component 26]
5	Stranded wires	various lengths (see text) [Component 22]
3	Spacer bolt M3x12mm	[Component 19]
3	Screws M3x6mm	[Component 20]
1	Foil for display red	[Component 21]
1	Polarization film for display	[Component 27]
1	PCB EL-32	Board version 2.1b [Component 15]

Table 2

Component 1	Component 2	Component 3	Component 4	Component 5
Component 6	Component 7	Component 8	Component 9	Component 10
Component 11	Component 12	Component 13	Component 14	Component 15
Component 16	**Component 17**	Component 18	Component 19	Component 20
Component 21	Component 22	Component 23	Component 24	Component 25
Component 26	Component 27			

Table 3

2.2 Step by Step assembly and testing of printed circuit boards

2.2.1 Assembling the PCB

For the placement drawings of the top and bottom of the PCB refer to Chapter 5.3 (Figure 32 and Figure 33). The SMD components are already assembled.

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

☐ R1 to R16, resistors R1 and R5 are not installed.
The trim potentiometer R10 is fitted on the back of the PCB.

☐ C1 to 20, capacitors → Pay attention to the polarity of electrolytic capacitors!

☐ U1 to U6, 7-segment LED display 10 pin→ note installation direction!

The LEDs must be very accurately aligned in a straight line! Solder only 2 pins (diagonal) first, so that the alignment can still be corrected.

☐ U8, IC MAX7221 or AS1106 LED Display-Driver 24 pin → note installation direction!

☐ U9, IC PIC18F2550 microcontroller → note the installation direction!

☐ U11, IC PIC12F1571 microcontroller → note the installation direction!

☐ U13, IC TSOP4838 IR Receiver → leads have to be turned by 90°.

☐ U14, IC 78L05 5V Voltage regulator, horizontally mounted → note installation direction!

☐ B1, AT-1220 Buzzer

☐ P2, the socket connector is fitted on the back of the PCB.

⚠ The connection (coaxial cable RF-In) is inserted into the circuit board at the rear and soldered at the front.

☐ An RG-216 coaxial cable is used to feed the VHF signal. Prepare the 23 cm long coaxial cable as shown in Figure 1:

Remove 15mm of insulation.
Shorten the shielding and the inner conductor insulation to 5mm each.

A thin wire (wire cut-off from a resistor) is wrapped twice around the shield and soldered.

Figure 1

Solder the prepared coaxial cable into the circuit board from the rear. See Figure 2

Figure 2

☐ Strip approx. 15 mm off the second end of the coaxial cable. Unbraid the shielding and twist it together. Strip approx. 4 mm of insulation from the inner conductor. Tin both ends.

2.3 Plug assembly

All connector housings and contacts are supplied to allow easy connection of power supply and signals. Use only high quality, colored stranded wire. The colors of the wires should be chosen to match the function, e.g. red + 13.8V power supply, blue or black for ground (GND) and other colors for the signals PTT-In and RPT-In etc.

The connectors consist of two components; the connector housing and the contacts. To connect a wire, strip the wire for about 2 mm, twist and tin it. Insert the tinned end of the wire into the contact so that the wire is inside the inner and the insulation is inside the outer pair of tabs.
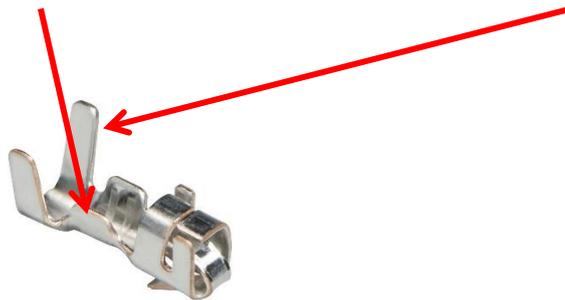
Figure 3

Using a crimping tool or small needle nose pliers, carefully press the outer tabs around the wire insulation to hold the wire in place. Repeat this with the inner tabs to hold the conductor in place. Solder the conductor to the inner lugs, taking great care to ensure that no solder flows into the contact.

Now insert the contact into the connector housing, with the small locking tab on the front of the housing. Push the contact inwards until the locking tab snaps into place. If you need to remove a contact, press carefully on the locking tab with a small screwdriver or the end of a pair of pointed pliers. The contact is released and can be pulled out of the housing.
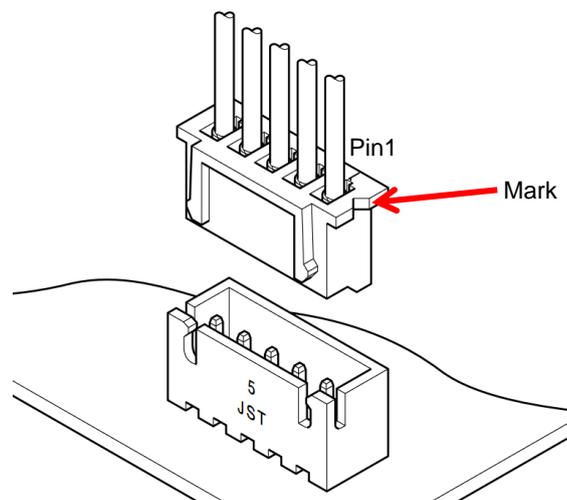
Figure 4

☐ The shielded audio cable is used for the CTCSS signal.
Prepare the 15 cm long cable. Crimp (or solder) the inner conductor and shield to one crimp contact each.

☐ Strip approx. 15 mm of insulation from the second end of the shielded audio cable. Unbraid the shielding and twist it together. Strip approx. 4 mm of insulation from the inner conductor. Tin both ends.

☐ For the GND connection, strip approx. 2 mm of insulation from a 10 cm long black stranded wire on both sides and crimp (or solder) the wire to a crimp contact on one side.

☐ For the +8V supply, strip a 12cm long red stranded wire approx. 2mm on both sides and crimp (or solder) the wire on one side to a crimp contact → This is connected to +8V of the transceiver after the display board has been installed.

☐ For the voltage measurement of the +13.8V rail, strip approx. 2mm of insulation from a 10cm long orange stranded wire on both sides and crimp (or solder) the wire on one side to a crimp contact → This is connected to the 13.5V power supply of the transceiver after the display board has been installed.

☐ For the PTT-In signal, strip approx. 2 mm of insulation from both sides of an 11 cm long yellow stranded wire and crimp (or solder) the wire on one side to a crimp contact → This is connected to TX8V of the transceiver after the display board has been installed.

☐ For the RPT-In signal, strip approx. 2 mm of insulation from both ends of an 18 cm long violet stranded wire (RPT-In) and crimp (or solder) the wire on one end to a crimp contact →. This is connected to RPT8V of the transceiver after the display board has been installed.

☐ Push the prepared cables with the contacts into the 7-pin connector housing in the order shown in Figure 5.
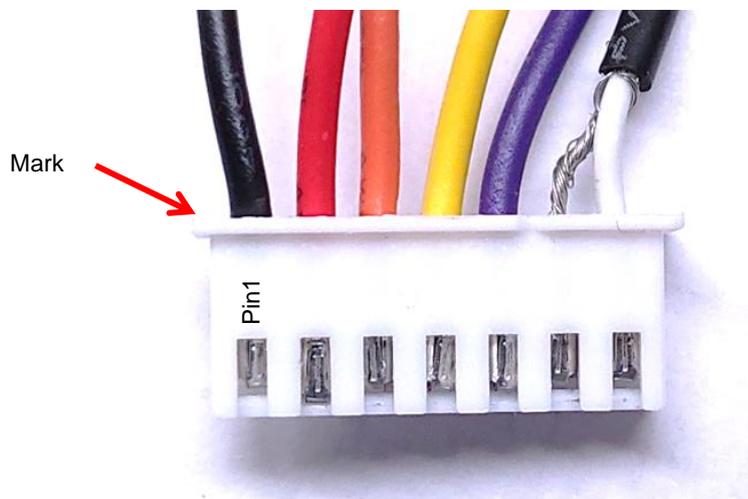

Figure 5

☐ Check all solder joints on the EL-32 display module very carefully! Check all components for correct installation direction and value.

⚠️ A magnifying glass can help here, because even the smallest, unwanted solder bridges can have disastrous effects.

2.3.1 Initial test of the PCB

Once all the elements have been assembled, a first electrical test can be carried out.

Ensure that the workplace is clean so that the circuit board does not lie on cut pieces of wire, which can create short circuits.

☐ Connect the DC power supply unit to the black (- on P2 pin1 GND) and red wire (+ on P2 pin2 +8V and P2 pin3 +13.8V) of the display board and set the voltage to approx. +8V.

⚠ If you have a power supply unit with current limitation, set this to a maximum current of approx. 50mA.

☐ Switch on the supply voltage.
The following text will appear on the 7-segment display:

`uEr.20C`   `YRESU`   `Ft-221E` followed by the Morse code character "R" (di dah dit)

☐ The digital display is then in frequency measurement mode. As no VHF signal is yet present at J2, the display will show `-------`.

If the first test is successful, you can proceed with the conversion of the FT-221R.

2.4 Converting the FT-221

2.4.1 Removing the analog display from the FT-221

⚠ The mechanical conversion must be carried out strictly according to the following sequence, otherwise problems may occur.
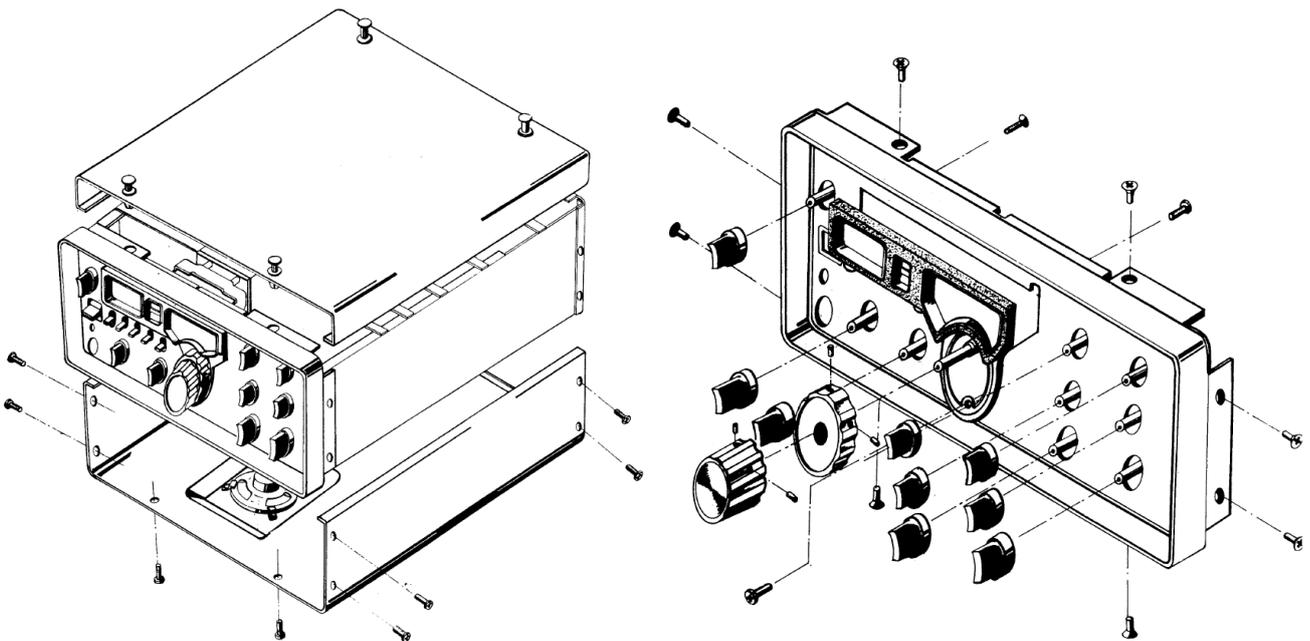

Figure 6

- [ ] Remove the cover of the device, which is fastened with four plastic rivets.

- [ ] Disconnect the speaker connection cable.

- [ ] Turn the device upside down and remove the 12 screws and the bottom cover.

- [ ] Remove all 11 rotary knobs on the front panel.

- [ ] Remove the 8 countersunk screws that secure the front frame to the cabinet and remove the front frame.

- [ ] Use a blunt object to release the two indicators CLAR and RPT through the front panel by carefully pushing them out of the front cover and then remove the front panel.
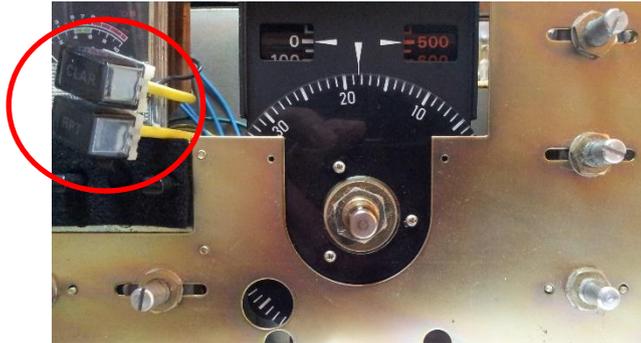

Figure 7

- [ ] Remove the 4 screws (two at the top and two at the bottom) with which the VFO is attached to the front cabinet. (see Figure 8).
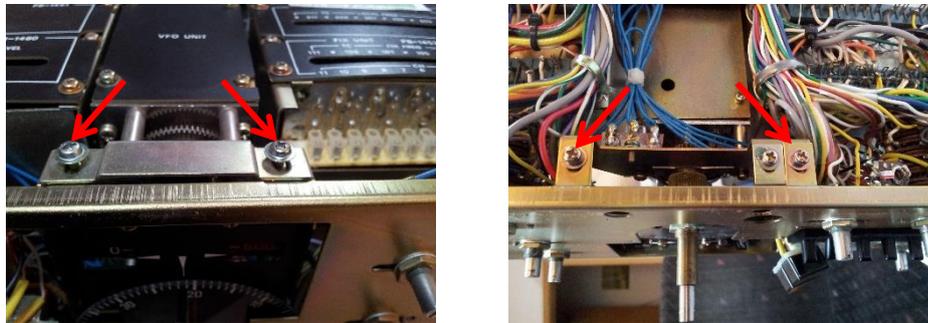

Figure 8

- [ ] Remove the 4 screws (two on the left and two on the right) on the front cabinet and fold it forward by 90°. Make sure that no wires break off. (see Figure 9)
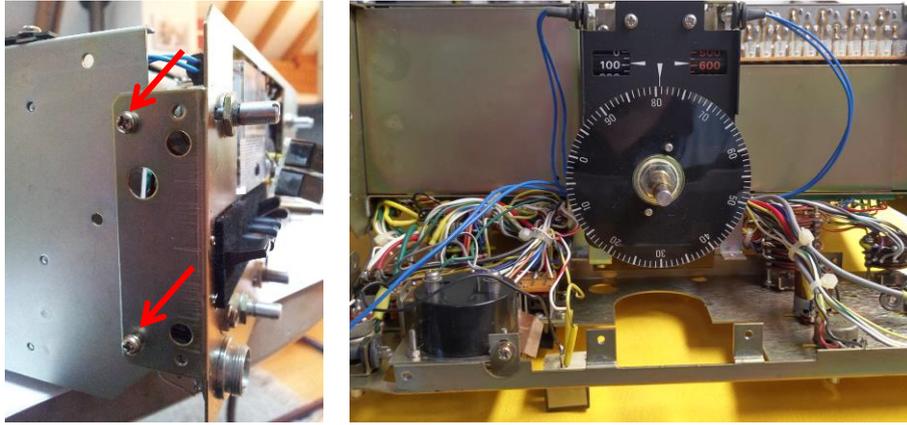
Figure 9

☐ Remove the scale disk and the two screws of the scale cover as well as the two scale illumination lamps. (see Figure 10)
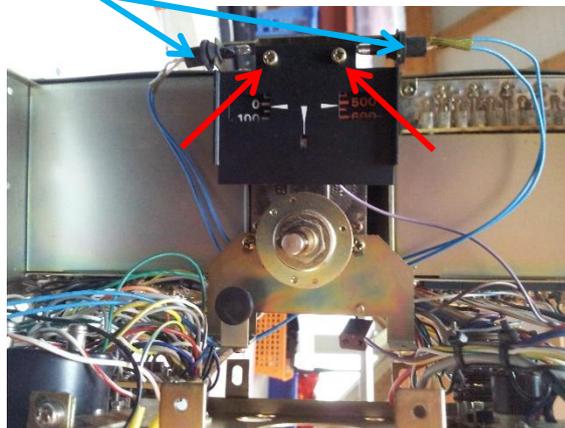

Figure 10

☐ Remove the PB-1471 circuit board (LED board) and then the two screws that secure the coarse scale. Also remove the retaining bracket for the scale lamps and the scale wheel. (see Figure 11)

Figure 11

☐ Desolder the two scale lamps (four blue wires) on the connection block (see Figure 12) and the PB1471 PCB (one violet wire) on the CHANNEL rotary switch.
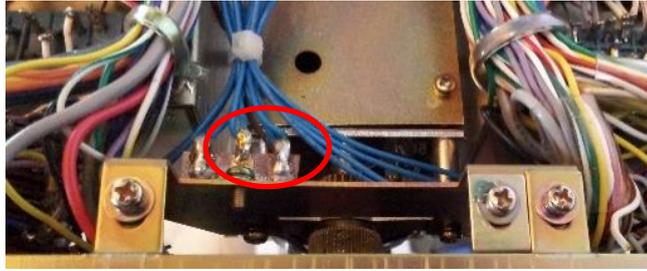
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Figure 12

2.4.2 Installation of the new digital display board in the FT-221

☐ Screw three M3x12 spacer bolts into the corresponding threaded holes on the front of the VFO gearbox as shown in Figure 13.
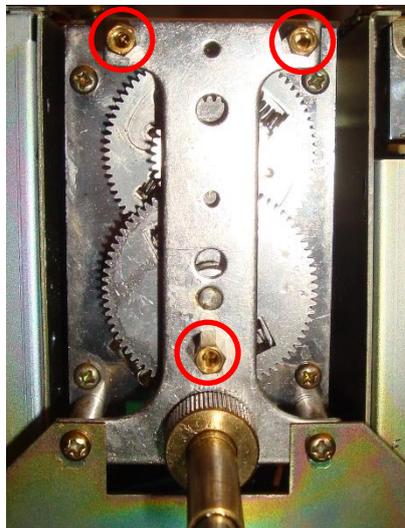

Figure 13

☐ Take the assembled and tested EL-32 display module and fasten it to the spacer bolts using three M3x6 screws (with washer).

⚠️ **Caution!** All connecting wires, the audio cable and the coaxial cable must be led out downwards. The two lamps CLAR and RPT must protrude between the S-meter and the new display module at the front (as shown in Figure 18).

☐ Fold the front cabinet back up and secure it with 4 screws (two on the left and two on the right). Make sure that no wires break off or become trapped.

☐ Turn the device over, so that the bottom is facing upwards.

☐ Reattach the VFO to the front cabinet with 2 screws.

☐ Solder the two prepared cables (black = Gnd and orange = +13.5V) of the display module to the soldering points as shown in Figure 14.
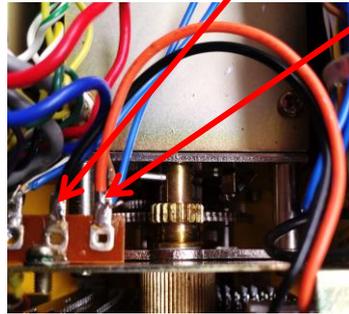
Figure 14

☐ Solder the prepared cables of the display module to the connector strips as shown in Figure 15.

- violet = RPT-In on J21-Pin 11 (TONE-BURST UNIT)
- yellow = PTT-In on J22-Pin 16 (MIC-AMP UNIT)

Figure 15

☐ Solder the prepared cables of the display module according to Figure 15 to the connector strip J22 (MIC AMP UNIT).

- Shielded audio cable: Tone to pin 20, shield (GND) to pin 19.
  Make sure that the shielding does not cause a short circuit on the circuit board → Use insulating or shrink tubing.

- 8V supply of the display module: red = +8V at pin21.

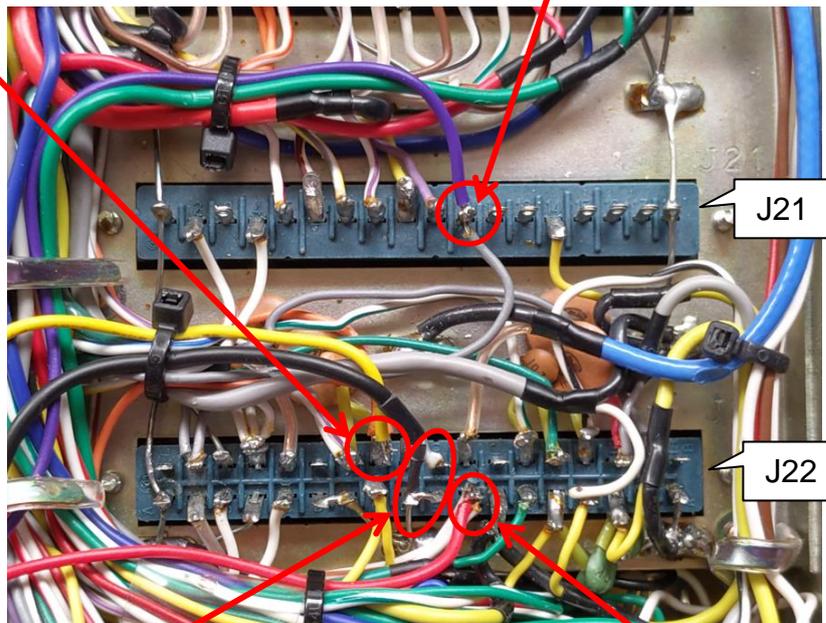☐ Route the coaxial cable to the buffer board (PB-1671A) as shown in Figure 16 and solder the shield and inner conductor parallel to the coaxial cable leading to the socket on the back of the FT-221R. Make sure that the shielding does not cause a short circuit on the circuit board → use insulating or shrink tubing.

Figure 16

Before you finish reassembling the device, it must be commissioned and calibrated.

2.5 Start-up and adjustments

You will need the following tools to calibrate the EL-32 display board:

♦ Digital voltmeter with a range of DC 0 to 20V (resolution 10mV)
♦ Frequency counter with a measuring range up to 150MHz and a resolution of 10Hz.
♦ A PHILIPS, Sony, NEC or universal IR remote control, which you set to TV mode with RC5, Sony or NEC protocol.

With the calibration routines implemented in the display board, the module can be calibrated quickly and easily for all operating modes.

If you have set and saved incorrect values during calibration, e.g. for the voltage display, incorrect values will be displayed. However, you can repeat the calibration procedure as often as you like and recalibrate the device.

2.5.1 Adjusting the voltage measurement circuit

Attention: The following measurements and calibration work are carried out at the open device. Please note that certain parts, mainly on the bottom of the device, carry 230V AC voltage. Always disconnect the power plug when handling the device (e.g. turning the device, soldering, etc.). Never hold the appliance with your hands from the side of the open cabinet, as this could result in an electric shock!

☐ Connect the multimeter (min. 3 ½ digits → resolution 10mV) to the 5-pin socket (Gnd = Pin2, +13.5V=Pin5), see Figure 17.
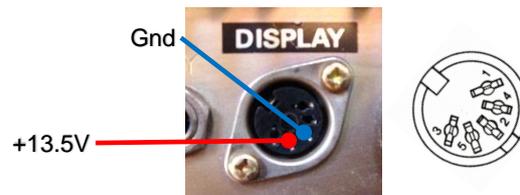

Figure 17

☐ Supply the FT-221R with 230V AC or 13.8V DC via the power cable.

☐ Switch the device on with the POWER switch.

☐ Use the multimeter to measure the supply voltage as shown in Figure 17.

☐ Log the measured voltage _____V

☐ If the display shows **145.650.7** select, the **SEtUP** „Setup"-Mode, by pressing the **VOL+** or **VOL-** button on the remote control.

☐ Press the numeric key **4** on the remote control. **CAL-U** „Calibrate V" will be displayed.

☐ Use the **VOL+** or **VOL-** buttons to calibrate the display to the voltage noted above, e.g. **13.53** volts.

☐ Press again the numeric key **4** on the remote control. You are now back to the **SEtUP** mode, and the calibration value is stored in the memory of the microcontroller.

☐ Select the display **U= 13.5** volts by using the **VOL+** or **VOL-** key.

☐ The adjustment is completed. Switch off the appliance and unplug the mains plug.

2.5.2 Adjustment of the frequency measuring circuit

A precise frequency counter is required for the adjustment. It must be possible to measure accurately in the frequency range of 130-140 MHz (<10 Hz accuracy).

Before the frequency adjustment can be done, the device must be prepared for it.

☐ Mount three rotary knobs on the device (without front panel) as shown in Figure 18 and set the BAND and CHANNEL switches to the 145.0 MHz or VFO position and all lever switches must be in the horizontal position.

Figure 18

All switches in
horizontal position

BAND=145.0   **CHANNEL=VFO**

☐ Connect the frequency counter to the 5-pin socket (Gnd = Pin2, RF-Out=Pin1) on the back of the FT-221 so that you can measure the exact frequency.
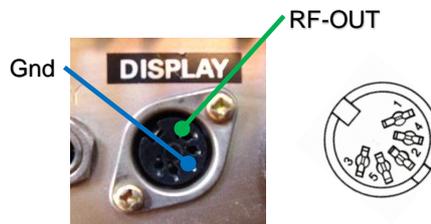
RF-OUT

Gnd

Figure 19

☐ Now plug the appliance into the mains and switch it on using the POWER switch.

☐ Allow the appliance to warm up for at least 15 minutes.

☐ Now use the tune knob on the VFO to set the frequency on the frequency counter exactly to 134.300.00MHz (Rx frequency - IF). → IF = 10.7MHz

☐ Calibrate the frequency display as precisely as possible to 145.000.0 MHz using the following adjustment function from the "Setup" mode.

☐ The current frequency display may show a frequency slightly different from 145.000.0 MHz due to the target frequency deviation of the temperature stabilized oscillator (TCXO) on the EL-32. For example, `145.000.2` MHz

☐ Now use the remote control to select `SEtUP` "Setup" mode using the **VOL+** or **VOL-** buttons.

☐ Press the numeric key **7** on the remote control. `CAL 0.23` is displayed.

☐ Press the **VOL+** or **VOL-** buttons (10Hz steps) or the **|<<** or **>>|** buttons (100Hz steps) several times until the display shows exactly `CAL 0.00`.

☐ Press the numeric key **7** (or **OK** button) on the remote control again. `SEtUP` is displayed again.

☐ Press the **VOL+** or **VOL-** buttons until `145.000.0` is displayed
(last digit 100Hz).

☐ This completes the frequency adjustment.
Switch the device off and disconnect the mains plug.

2.5.3 Test of the CTCSS encoder

A frequency counter is required for the test. It must be possible to measure accurately in the frequency range of 50-300Hz (<1Hz accuracy).

☐ Now plug the appliance into the mains and switch it on using the POWER switch.

☐ Now use the remote control to select **SEtUP** "Setup" mode using the **VOL+** or **VOL-** buttons.

☐ Press the numeric key **8** to switch to **CtCSS** mode.

☐ Press the **OK** button to switch to CTCSS frequency selection mode.

☐ Use the **VOL+** or **VOL-** buttons to select the corresponding CTCSS frequency.

☐ Standard frequencies according to TIA/EIA-603-D from **67.0Hz** to **250.3Hz** can be set.

☐ Use the frequency counter on the audio cable (J22 pin 20) to measure the CTCSS frequency. The measured frequency must correspond to the value shown on the display (±1%).

☐ Press the numeric key **8** (or **OK** button) on the remote control again **SEtUP** is displayed again.

☐ This completes the CTCSS test.
Switch off the device and disconnect the mains plug.

2.5.4 Adjustment of the CTCSS encoder

An FM deviation meter in the frequency range 144-148 MHz is required for this setting.

Repeater operation with the CTCSS encoder requires adjustment of the AF level.

☐ Now plug the appliance into the mains and switch it on using the POWER switch.

☐ Connect the transmitter output to a 50Ω dummy load that has a measurement output.

☐ Connect the FM deviation meter to the measurement output of the dummy load (measurement range 200 to 500Hz).

☐ Select the following settings on the transceiver:
Frequency = 145MHz
Mode = FM
MIC-GAIN = completely counterclockwise

☐ Now use the remote control to select **SEtUP** "Setup" mode using the **VOL+** or **VOL-** buttons.

☐ Press the numeric key **8** to switch to **CtCSS** mode.

☐ Press the **OK** button to switch to CTCSS frequency selection mode.

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☐ Use the **VOL+** or **VOL-** buttons to select the CTCSS frequency `100.0Hz`

☐ Turn the VOX GAIN control counter-clockwise to the MOX position.

☐ Adjust the AF level of the CTCSS signal on the EL-32 board using the trim potentiometer (R10) until the FM deviation meter indicates approx. 400Hz.

☐ Turn the VOX GAIN control clockwise to the PTT position.

☐ This completes the CTCSS encoder setting.
Switch off the device and disconnect the mains plug.

2.5.5 Assembly

⚠️ <u>Important:</u> For your safety, always remove the mains cable from the FT-221R.

☐ Remove the scale window for the frequency display from the front panel.

☐ Take the red filter film [Component 21], cut it to size, remove the cover film and stick it to the inside of the scale window. Make sure that there are no air bubbles.

☐ Once you have stuck on the red filter film and pressed it on with a cloth, remove the second protective film.

☐ Take the polarizing film [Component 27], cut it to size, carefully remove the cover foil with the red stripe and do not touch the adhesive layer with your fingers.

☐ Stick the polarizing film onto the red filter film. Make sure that there are no air bubbles.

☐ Once you have applied the polarizing film and pressed it on with a cloth, remove the second protective film.
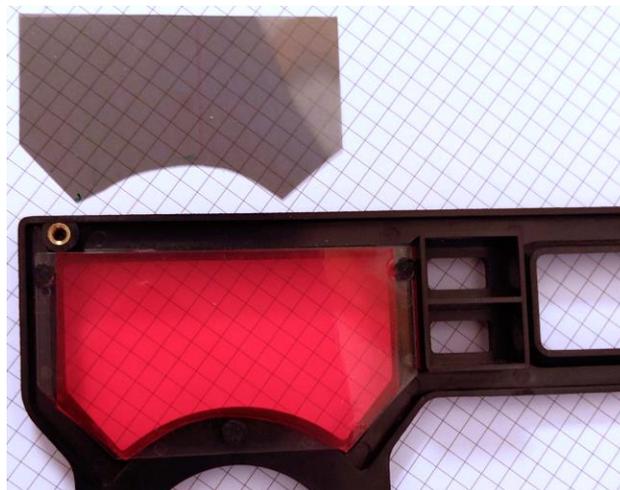

Figure 20

☐ Refit the scale window for the frequency display in the front panel.

☐ Remove the three temporarily attached rotary knobs from the appliance.

☐ Place the front panel in the front frame and reattach it to the cabinet using 8 countersunk screws.

☐ Fit all 11 rotary knobs to the front panel. Ensure that the switch positions are correct.

☐ Turn the device, so that the bottom is up.

- ☐ Take the bottom cover and connect the speaker to the speaker cable.
- ☐ Mount the bottom cover with 12 screws.
- ☐ Turn the device over, so that the top is facing upwards again.
- ☐ Place the cover on the appliance and secure it with the four plastic rivets.

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3 Operation and functions

The EL 32 LED display is primarily intended as a replacement for the analog frequency display of the Yaesu FT-221R. With modern microcontroller technology, it is possible to implement additional functions and make the replacement even more worthwhile.

The various operating modes are explained below.

3.1 Display

The display is a seven-digit, 7 segments LED on one line.

7 segment LEDs were originally developed for the display of numeric characters and often used in watches or first digital calculators. For alphanumeric characters the 7-segment display is only partly suitable. With some performance loss it is possible to display simple information.

In the EL-31, the characters are as defined in Figure 21:

AbCcdEF9HhI iJHLLĩnOoP9rStUu'HY2
ABCcDEFGHhIiJKL1MNOoPQRSTUVWXYZ

0 123456789   ┠-_=ⁿⁱ ?C]⌐
0123456789   +-.:^`?()/

Figure 21

3.2 Communication with the display module

The display module has no input elements such as keys that allow selecting the different functions of the EL 31. To be able to communicate with the built-in display module on the EL-31, an infrared sensor is installed. With a commercially available IR remote control transmitter, as are common for TV sets, commands can be sent to the display module.

The remote control must control the RC5 protocol from PHILIPS. If you use a universal IR remote control unit, select a device code for a Philips TV-set.

On the IR remote control, the following keys can be used:

VOL+	→	**Up**	Change menu / selection
VOL-	→	**Down**	Change menu / selection
0 to 9	→	**0 ..9**	Selection of item
OK	→	**Enter**	Selection of submenu point / retour

The 6-digit 7-segment display is used as feedback for the inputs. Unfortunately, the comfort is not great; therefore, only short status messages to the user are possible.

For visually handicapped users, there is an acoustic feedback for the frequency- and the voltage display by Morse code via the built-in buzzer.

All settings are stored in the microcontroller of the display.

3.3 Menu structure

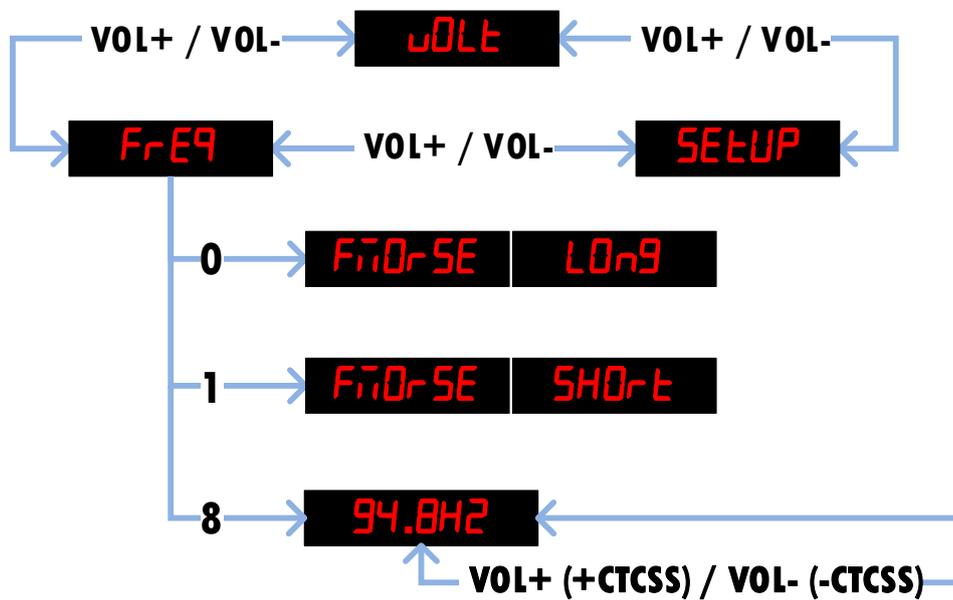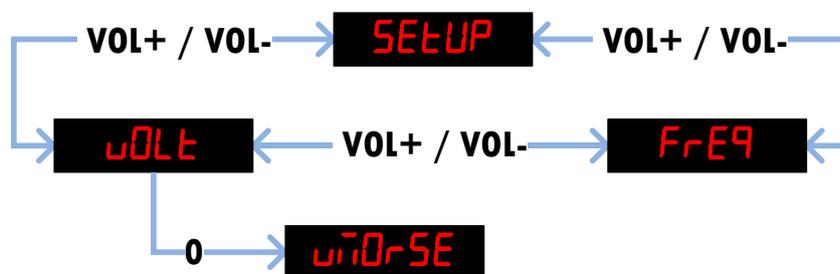Operation is done via menus, which are shown in the figures below.
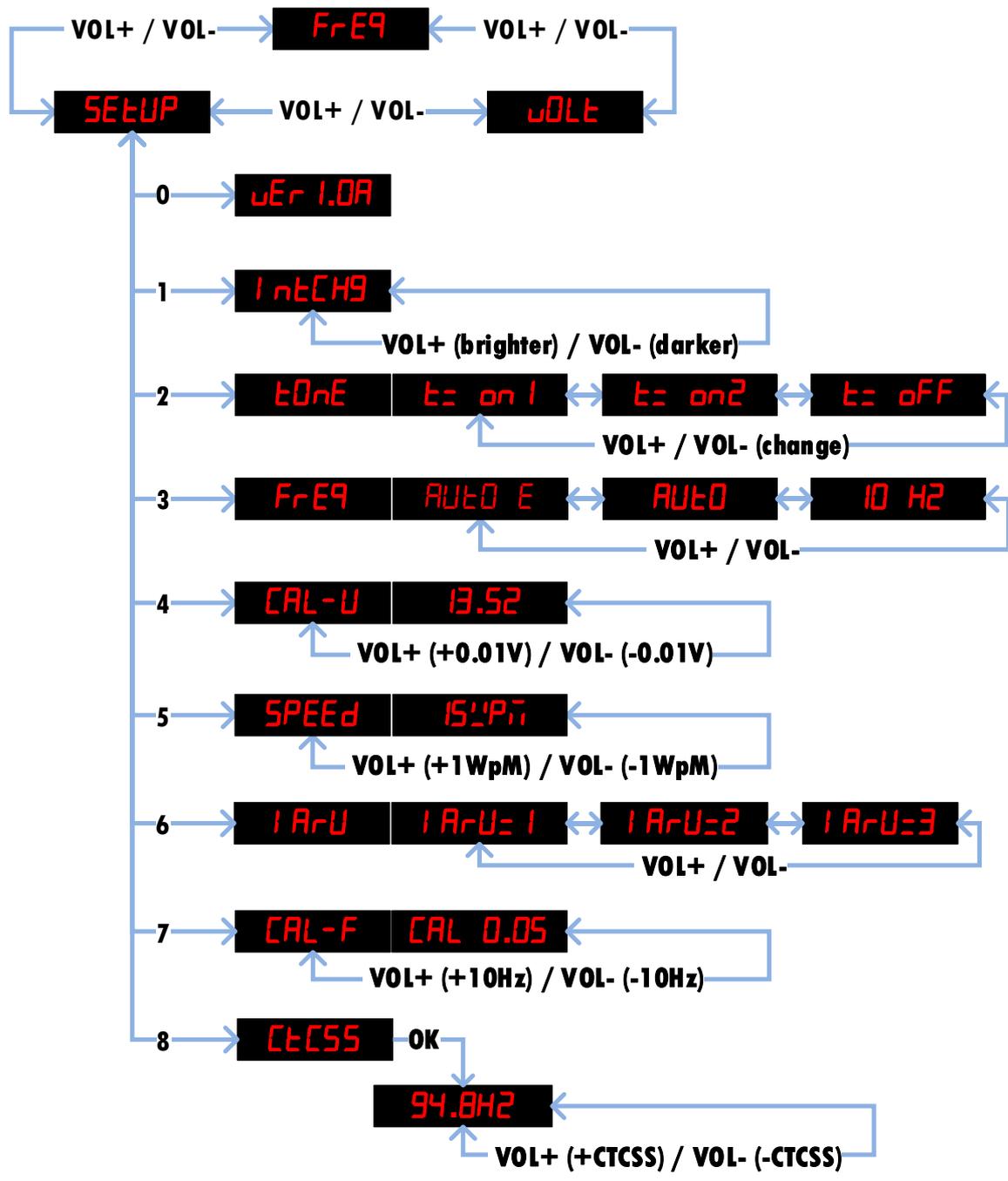

Figure 22

Figure 23

Figure 24

3.4 Operating modes

3.4.1 Frequency Display

When the FT-221R is switched on, the frequency display mode is automatically selected. This is the default setting and therefore also the basic function of the digital display for the FT-221R.

The frequency is measured with a 10 Hz resolution, even if the frequency is displayed in a 100Hz resolution only.

A big advantage of the new digital frequency display is that the frequency range is not limited anymore within a range of 500 kHz. Since the tuning range of the VFO reaches

about 50 to 100 kHz over the lower and upper frequency range, a transfer of the one-MHz digit must be executed.

For example, a frequency of 145.010 MHz (VFO above the 500 kHz range) is not displayed as 144.510 MHz in the 144.5 MHz band switch setting, but correctly as 145.010 MHz.

The new digital display offers the following display modes:

10Hz-Mode:

This mode always shows the frequency in 10 Hz resolution.

You can set this mode via the menu **`SEtUP`** using the remote control.

- ☐ Press the numeric key **3** on the remote control. For example, **`AUtO`** might be displayed.
- ☐ Change to the **`10 H2`** mode by using the **VOL+** or **VOL-** key.
- ☐ Press the numeric key **3** again. You are now back in the **`SEtUP`** mode.
- ☐ By using the **VOL+** or **VOL-** key change to the **`FrE9`** mode.

As the 7-digit display is no longer sufficient for frequencies of 145.650.25 MHz, for example, the display is always shown in the format **`-5.650.25`**. **`-`** in the tens of MHz digit (**`-5.`**) indicates that the display is fixed in 10Hz format.

Auto-Mode:

This operating mode always shows the frequency in the highest possible resolution.

This mode is set via the menu **`SEtUP`** using the remote control.

- ☐ Press the numeric key **3** on the remote control.
  For example, **`10 H2`** is displayed.
- ☐ Use the **VOL+** or **VOL-** buttons to switch to **`AUtO`** mode.
- ☐ Press the numeric key **3** again. **`SEtUP`** is displayed again.
- ☐ Use the **VOL+** or **VOL-** buttons to switch to **`FrE9`** mode.

Auto E-Mode:

This operating mode displays a 10Hz resolution during the tuning process.

This mode is set via the menu **`SEtUP`** using the remote control.

- ☐ Press the numeric key **3** on the remote control.
  For example, **`AUtO`** is displayed.
- ☐ Use the **VOL+** or **VOL-** buttons to switch to **`AUtO E`** mode.
- ☐ Press the numeric key **3** again. **`SEtUP`** is displayed again.
- ☐ Use the **VOL+** or **VOL-** buttons to switch to **`FrE9`** mode.

As the display has 7 digits, the frequencies e.g. `144.563.8` can only be displayed with a resolution of 100Hz. During the tuning process, the display shows the frequency with a resolution of 10Hz, e.g. `-4.563.83` for 144.563.83MHz. If the tuning knob is no longer turned, the display changes back again after approx. 5 seconds.

3.4.2 Voltage Display

The voltage display is an additional function.

This feature allows you to measure an external voltage in the range of 0 to 20V. Usually the operating voltage of the device (nominal 13.8V) is measured within 100mV and displayed.

☐ Change to the `uOLt` mode by using the **VOL+** or **VOL-** key.

To obtain an accurate reading, the voltage measurement must be calibrated first (see chapter 2.5.1).

3.4.3 Morse readout of frequency

When the frequency appears on the display, it is possible to emit this information as Morse code via the built-in buzzer.

☐ Change to the `FrE9` mode by using the **VOL+** or **VOL-** key.

☐ Press the numeric key **0** (**zero**). → this results in the "long" output of the frequency; i.e. the frequency is emitted in _MHz.kHz_ (without the 100Hz- and 10Hz- digits)

☐ Press the numeric key **1** → this results in the "short" output of the frequency; i.e. the frequency is emitted in _kHz_ only (without the MHz-, 100Hz- digits).

3.4.4 Morse readout of voltage

When the voltage appears on the display, it is possible to emit this information as Morse code through the built-in buzzer.

☐ Change to the `uOLt` mode by using the **VOL+** or **VOL-** key.

☐ Press the numeric key **0** (**zero**) → this results in the output of the voltage; i.e. the voltage is emitted in _V.100mV_.

3.4.5 Sound settings

The automatic signal tones can be switched on or off using the `tonE` setting in setup mode. If the voltage is shown on the display, it is possible to output this information as a Morse code signal via the built-in buzzer.

These modes are set via the menu `SEtUP` using the remote control.

☐ Press the numeric key **2** to switch to `tonE` mode.

☐ Change to `t: oFF` mode using the **VOL+** or **VOL-** buttons.
All automatic sound outputs are switched off, i.e. the "R" is no longer output when the FT 221R is switched on.

☐ Change to `t: on1` mode using the **VOL+** or **VOL-** buttons.
When the FT 221R is switched on, the "R" is emitted and a warning tone is emitted when the band limits are exceeded (depending on the setting `1 ArU`)

☐ Change to `t: on2` mode using the **VOL+** or **VOL-** buttons.
All automatic sound signals are switched on. All changes with the IR remote control are signaled, e.g. "F" for frequency or "S" for set-up etc.

3.4.6 CTCSS (Continuous Tone Coded Squelch System)

With the `CtCSS` setting in setup mode, 38 standard frequencies can be selected. When the frequency is shown on the display, it is possible to output the CTCSS information as Morse code via the built-in buzzer.

The CTCSS tones are set using the remote control via the menu `SEtUP`.

☐ Press the numeric key **8** to switch to `CtCSS` mode.

☐ Press the **OK** key to change to CTCSS frequency selection mode.

☐ Select the corresponding CTCSS frequency using the **VOL+** or **VOL-** buttons.

☐ Standard frequencies from `67.0H2` to `250.3H2` can be set, see Table 4.

1	67.0 Hz	14	107.2 Hz	27	167.9 Hz
2	71.9 Hz	15	110.9 Hz	28	173.8 Hz
3	74.4 Hz	16	114.8 Hz	29	179.9 Hz
4	77.0 Hz	17	118.8 Hz	30	186.2 Hz
5	79.7 Hz	18	123.0 Hz	31	192.8 Hz
6	82.5 Hz	19	127.3 Hz	32	203.5 Hz
7	85.4 Hz	20	131.8 Hz	33	210.7 Hz
8	88.5 Hz	21	136.5 Hz	34	218.1 Hz
9	91.5 Hz	22	141.3 Hz	35	225.7 Hz
10	94.8 Hz	23	146.2 Hz	36	233.6 Hz
11	97.4 Hz	24	151.4 Hz	37	241.8 Hz
12	100.0 Hz	25	156.7 Hz	38	250.3 Hz
13	103.5 Hz	26	162.2 Hz		

Table 4

☐ Press the numeric key **8** again (or the **OK** key) to save the selection. Then `SEtUP` is displayed again.

When `oFF` is displayed, the CTCSS encoder is switched off and no CTCSS tone is generated and transmitted in TX mode.

If the CTCSS encoder is switched on, the right decimal point in the frequency display `145.650.7` flashes as an indicator during transmission (TX).

3.4.7 CTCSS memory for repeater operation

To work more comfortably via repeaters with CTCSS tone, the corresponding CTCSS tone can be selected and stored for a repeater frequency.

There are 10 memories available, which are used as follows:

CTCSS memories are only available when the RPT switch is activated.

Example:
You want to work via a repeater on the <u>frequency = 145.650MHz</u>, which requires a <u>CTCSS tone = 94.8Hz</u>.

☐ Activate repeater mode with the RPT switch on the front panel of the FT-221R.

☐ With the VFO, set the receive frequency of the repeater, → `145.650.0` MHz.

☐ By pressing the numeric key **8** you switch to the CTCSS display.

⚠️ Press the OK key to exit this mode without saving or changing the CTCSS frequency.

☐ Select the CTCSS frequency from `94.8H2` using the **VOL+** or **VOL-** buttons.

☐ Press the numeric keys no **0 - 9** (e.g. key **0**) to save the VFO and CTCSS frequency in memories **0 - 9**.
Successful storage is confirmed e.g. with `ñEñ 0` (MEMory 0). The display then shows the frequency `145.650.0`.
The memory numbers **0 - 9** have no direct connection with the repeater frequencies.

Memory no.	Repeater frequency	CTCSS frequency
0	*145.650MHz*	*94.8Hz*

You can repeat for a further 9 repeaters (frequencies) with corresponding CTCSS frequencies. It is best to record the values in the following table.

Memory no.	Repeater frequency	CTCSS frequency
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		

Table 5

⚠️ In repeater mode, if you set the repeater frequency with the VFO (±3kHz) and it matches a frequency in the memory, the corresponding CTCSS frequency is automatically selected.

If the CTCSS encoder is switched on for repeater mode, the right decimal point in the frequency display `145.650.7` flashes as an indicator during transmission (TX).

If you want to delete a memory entry, save any VFO frequency with CTCSS `oFF` in the corresponding memory.

4 Software Update

To keep the digital display EL 32 up to date a new software version can be programmed into the EL 32 with the program "USB Updater". For this purpose; a "Loader" software for the PC and a USB cable from the PC to EL 32 are needed.

The required software and all necessary drivers can be downloaded from the website http://shop.elcon.ch

Unzip the zip file into the directory "EL-32 USB-Loader Setup" and open the file "EL-32 USB-Loader Setup \ cd.htm with the Internet Explorer,
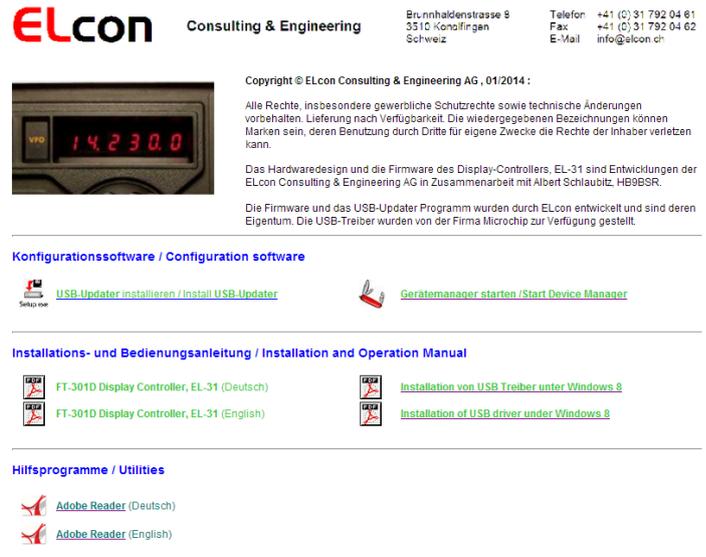
Figure 25

4.1.1 Installing the USB-updater software on the PC

The USB-updater program must first be installed on your PC.

☐ Close all applications running on the PC.

☐ From the CD or USB stick open the file "... \ USB-Loader Setup \ cd.htm" with an Internet browser → the window appears as shown in Figure 25.

☐ Start the "USB-updater" installation program by clicking on the link

USB-Updater installieren / install **USB-Updater** (see Figure 25).

and follow the installation instructions.

4.1.2 Installing the USB driver software

⚠️ So that the "USB-updater" program can communicate via USB connection with the microcontroller, the PC requires a special USB driver. These drivers are located in the ". \ USB-Loader Setup \ USB Updater \ Driver" directory.

Proceed with the installation as follows:

☐ Download the latest firmware update "EL 32xxx.elc" or "EL 32xxx.hex" from the website http://shop.elcon.ch and save the file on your PC to a folder of your choice.

☐ Turn on the FT-221R.

☐ Connect the PC with a USB cable (A / mini B) to the USB connector P4 of the EL 32. The display of the FT-221R shows `5U-UP9` `5U-UP8` etc. to `5U-UP0` . You have the option to cancel the "USB update" within 10 seconds, by removing the USB cable from the EL-32.

☐ When **UPdAtE** is displayed, the microcontroller of the digital display in the FT-221R is ready to exchange data with the PC.

☐ Once your PC recognizes the new device, a window "Wizard Installation" of new hardware appears.

For some operating systems, the installation of unsigned drivers will be blocked to protect the user. Especially on Windows 8 /8.1 the drivers need to be installed in a special manner. With the command in Command Prompt "Shutdown.exe / r / o" Windows 8 will launch directly to the boot menu option. Further details are on the website (see Figure 25).

☐ Follow the wizard prompts → step ① to ⑦.
Look carefully at the activated buttons (see ➡) . Depending on the operating system, the window text may differ slightly. (As an example here the installation on Windows 8.1).
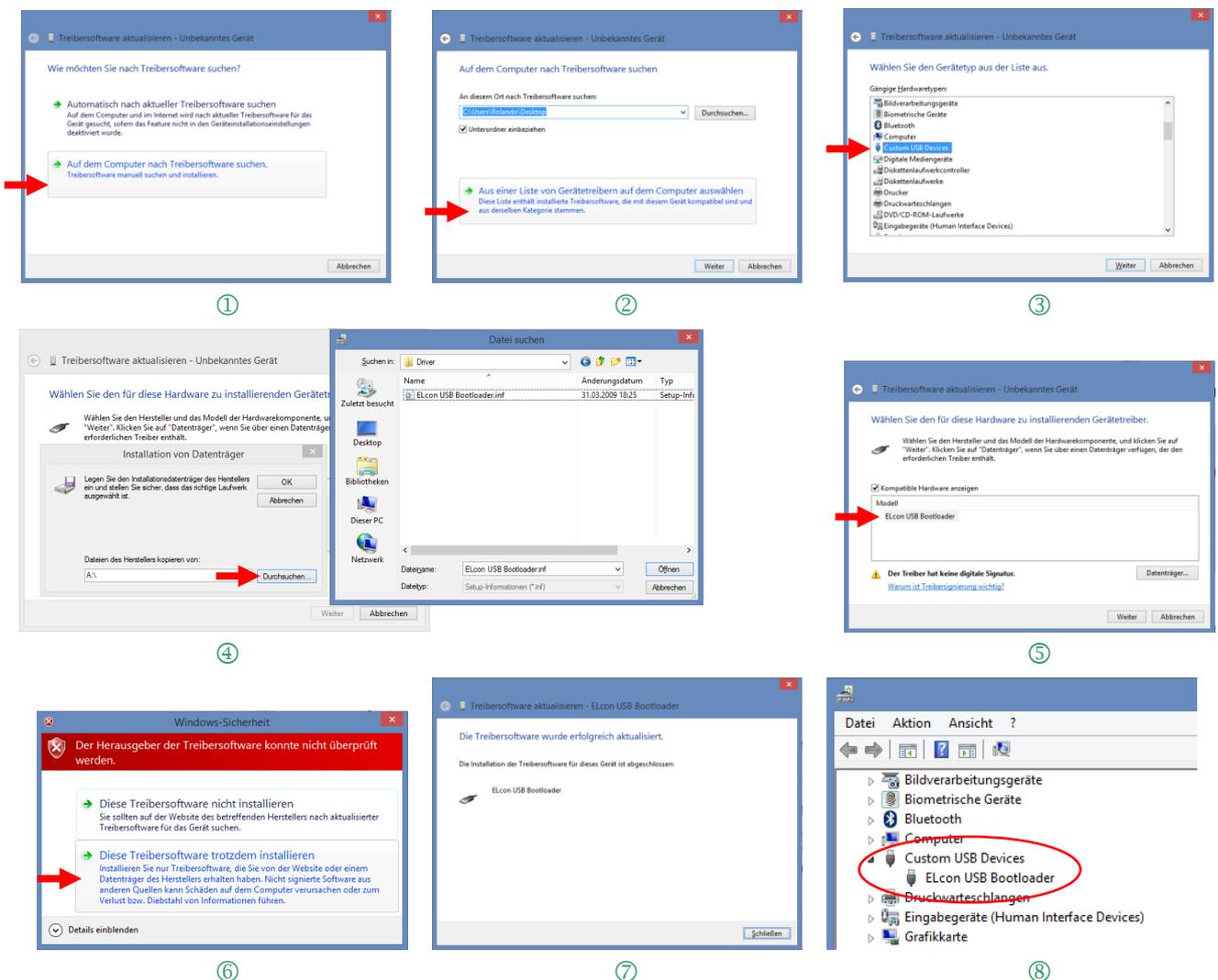
Figure 26

☐ With the Device Manager, the result can be checked under "Custom USB Devices" (see ⑧) → there is a new entry "Elcon USB Bootloader" as long as the connection with the EL-32 exists.

The Device Manager can be started directly from the Web page (see Figure 25).

4.1.3 Transferring the software updates in the EL-32

For the software update proceed as follows:

- [ ] Download the latest firmware update "EL 32xxx.elc" or "EL 32xxx.hex" from the website http://shop.elcon.ch and save the file on your PC to a folder of your choice.

- [ ] Turn off the FT-221R (EL-32).

- [ ] Connect the PC with a USB cable (A / mini B) to the USB connector P4 of the EL 32.

- [ ] Start the program "USB Updater.exe". The program opens the following "USB Updater" program window.
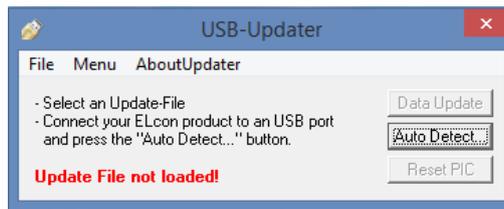
Figure 27

- [ ] Click to [Auto Detect...] button to connect the USB-updater program automatically with the EL-32. The following "Auto Detect" window should show a successful detection of the EL-32 USB boot loader in order to perform the software update.
  Confirm with the key [OK] .

Figure 28

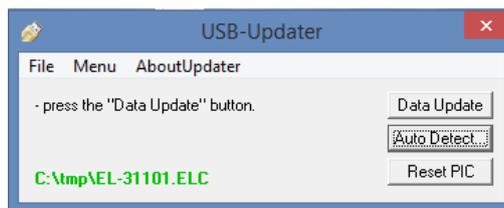- [ ] Load the update file EL 32xxx.ELC or EL 32xxx.HEX with <File / Open…> or <Ctrl+O>.

Figure 29

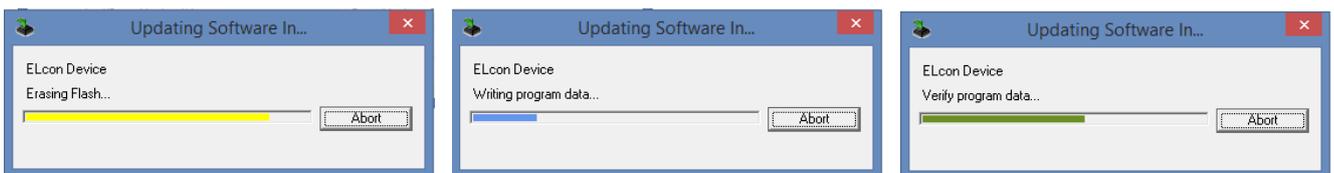- [ ] Start the data transfer with the key [Data Update] .

Figure 30

- [ ] Do not interrupt the loading process until the program update is completed and you see the following message:
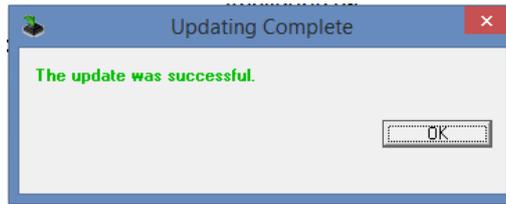
Figure 31

If the data transmitting is not successful, check the correct USB connection to the EL 32 by using the Device Manager and verify if the "Elcon USB Bootloader" is listed in "Custom USB Devices" section.

Then repeat the data update.

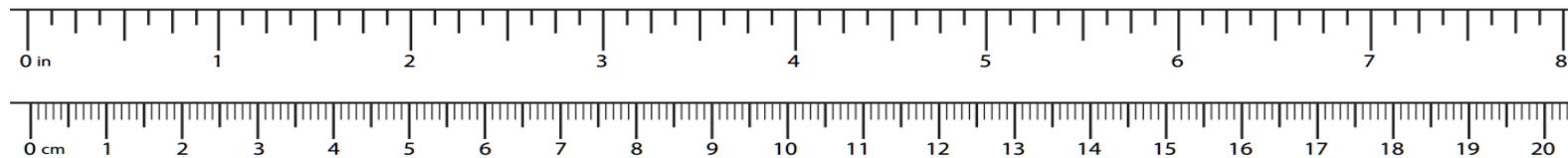# 5 Appendix

5.1 Specifications

Measuring ranges:

Frequency: 50 -150MHz, with addition of the IF = 10.7MHz at > 130MHz

Power supply: 8V from FT-221R, approx. 30-70mA
                                        (depending on operating mode)

Dimensions: 90(L) × 68(W) × 15(H) mm (installation in FT-221R)

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

5.2 Rulers

5.3 Repair / Warranty

We have no influence on the correct and proper assembly and can only guarantee the completeness and flawless condition of the components. We guarantee that the components will function in accordance with their characteristic values when not installed and that the technical data of the module will be adhered to when professionally processed in accordance with the installation instructions and commissioned or connected and operated as prescribed. We do not warrant or assume any liability for damages or consequential damages in connection with this product. We reserve the right to repair, rectify, deliver spare parts or refund the purchase price. Further claims are excluded.

The following criteria will not be repaired or are not covered by warranty:

- if acidic solder, solder grease or acidic flux etc. was used for soldering.
- if the kit has been improperly soldered, glued and assembled.
- during modifications and repair attempts on the module.
- in case of unauthorized modification of the module or the circuit.
- in case of improper removal of components not provided for in the design, improper free wiring, etc.
- Use of other components not originally part of the kit.
- in the event of incorrect assembly and wiring, as well as the resulting consequential damage.
- damage caused by non-observance of the operating instructions or the schematic and assembly diagram.
- if the module is connected to an incorrect voltage or type of current or if the polarity is incorrect.
- in the event of faulty operation or damage due to negligent handling or misuse.
- defects caused by bridged fuses or the use of incorrect fuses.

In all cases the transport costs of the kit shall be borne by you.

5.4 Disclaimer of liability

Any actions based on the information contained in this document are taken at the user's own responsibility. Any liability is excluded, both for direct and indirect damages and consequential damages that may arise in connection with the use of the information contained in this document.
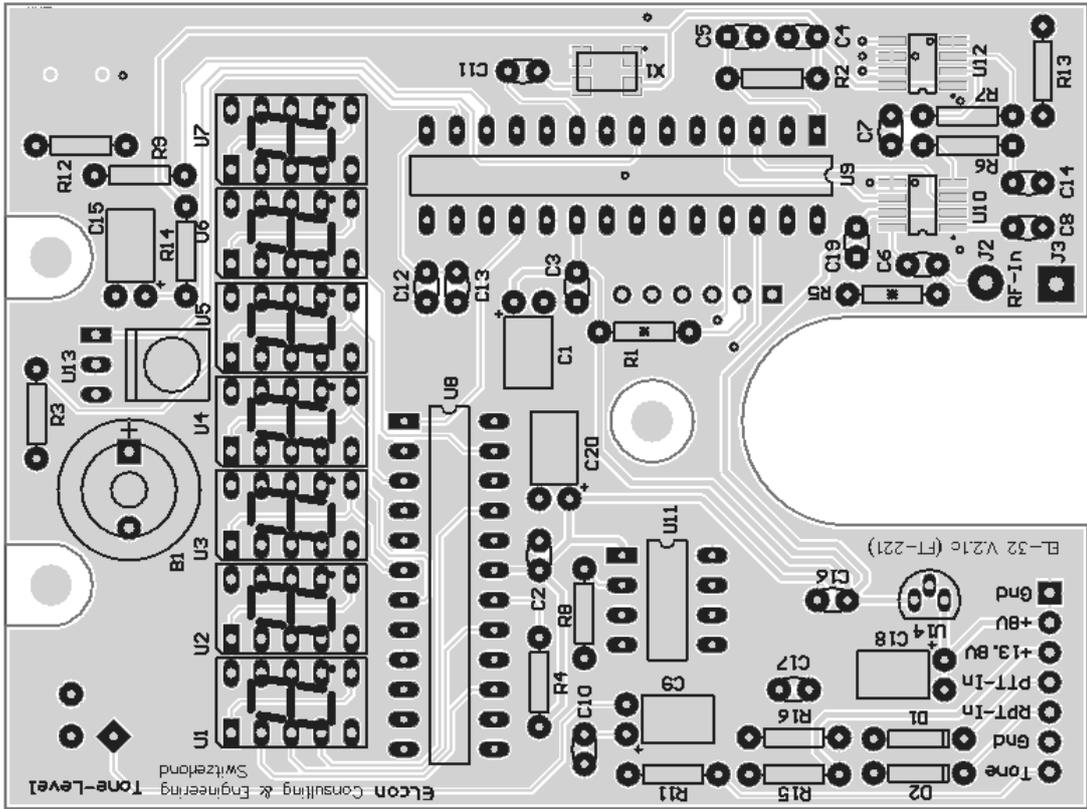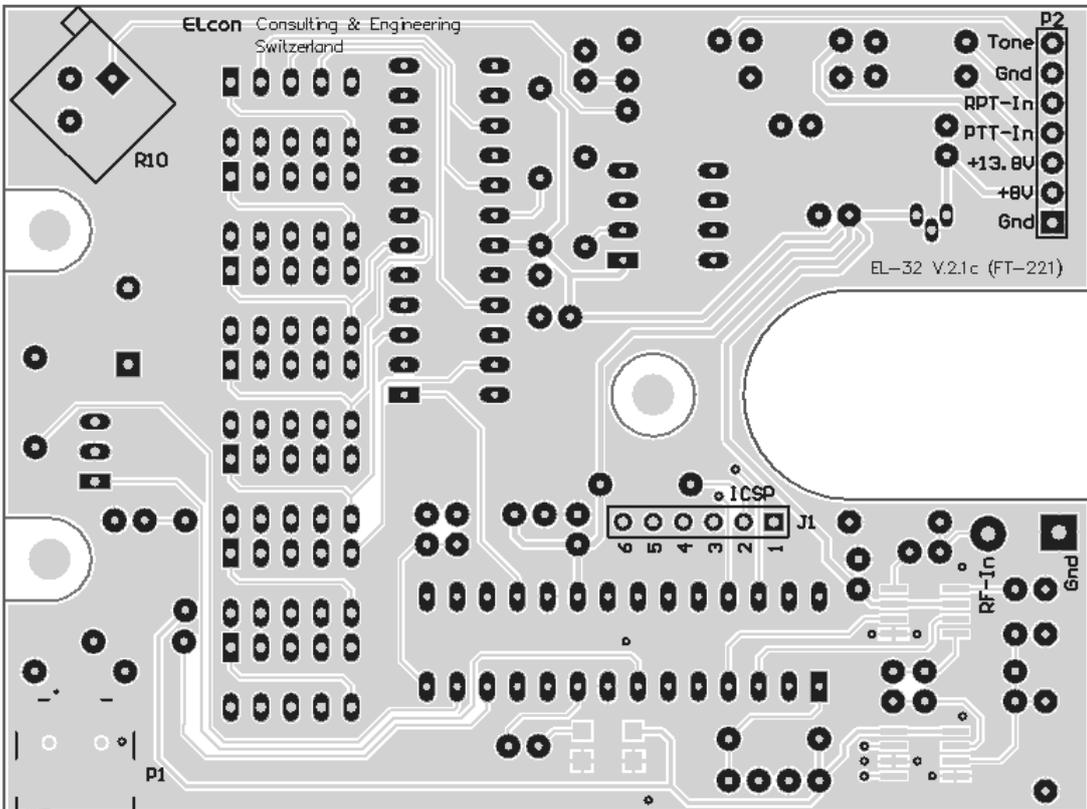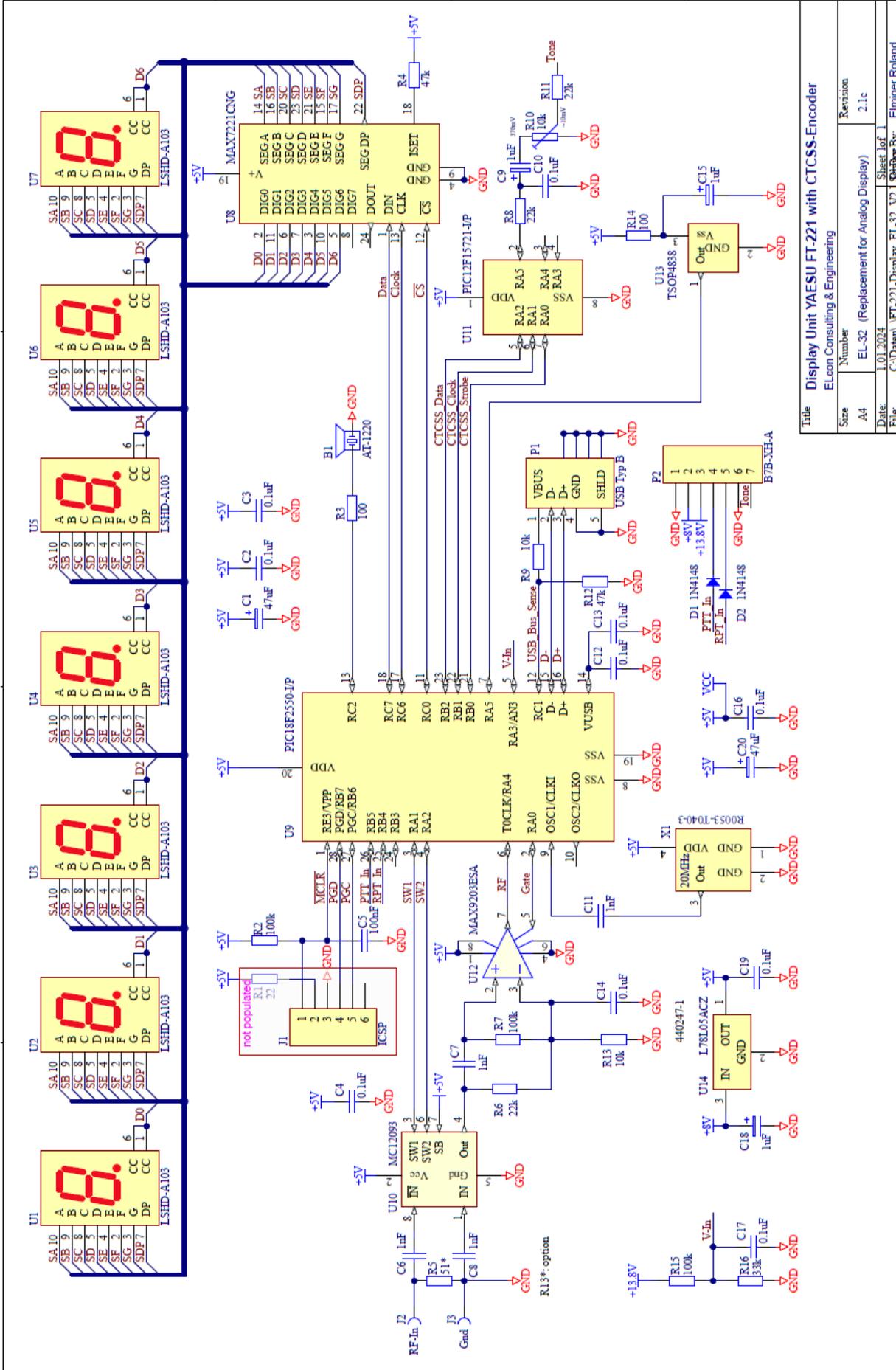
5.5 PCB assembly

Figure 32

Figure 33

5.6 Schematic

Figure 34

5.7 Notes

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