

# EL-31

## Replacement display kit for the YAESU FT-301D



## Construction, operational and functional description

SW-Version 2.1d

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Important! Advices or tips for the correct function of the EL-31



Caution! The instructions must be observed carefully.

# 1 Introduction

The old YASEU FT-301D shortwave transceiver (first built in the 70s), is still popular, due to the very good receiver. It was probably one of the first devices that came with a digital frequency display. Unfortunately, the display module with LEDs causes big problems. At that time the 7-segment LED displays were not as efficient as today, and they have a huge power consumption. The resulting heat had the effect that individual segments in the LED displays failed.

The replacement of the 7-segment displays was still possible some years ago. Today these components are practically impossible to buy and if so, at exorbitant prices. The replacements fail as well after some use due to overheating.

Today, modern microcontroller-controlled transceivers can be purchased. However, many radio amateurs are enthusiastic about their old device. However, it's no fun to use it with a damaged display.

Therefore, a replacement display module has been developed that is 1:1 compatible with the old one and includes additional useful functions.

The assembling of the kit is simple, since wired components are used almost exclusively.

## 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 (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 $\Omega$			Tolerance
	1st ring (1st digit)	2nd ring (2nd digit)	3rd ring (multiplier)	4th ring
none	-	-	-	$\pm 20\%$
silver	-	-	$10^{-2} = 0.01$	$\pm 10\%$
gold	-	-	$10^{-1} = 0.1$	$\pm 5\%$
black	-	0	$10^0 = 1$	-
brown	1	1	$10^1 = 10$	$\pm 1\%$
red	2	2	$10^2 = 100$	$\pm 2\%$
orange	3	3	$10^3 = 1'000$	-
yellow	4	4	$10^4 = 10'000$	-
green	5	5	$10^5 = 100'000$	$\pm 0.5\%$
blue	6	6	$10^6 = 1'000'000$	$\pm 0.25\%$
violet	7	7	$10^7 = 10'000'000$	$\pm 0.1\%$
gray	8	8	$10^8 = 100'000'000$	-
white	9	9	$10^9 = 1'000'000'000$	-

Table 1



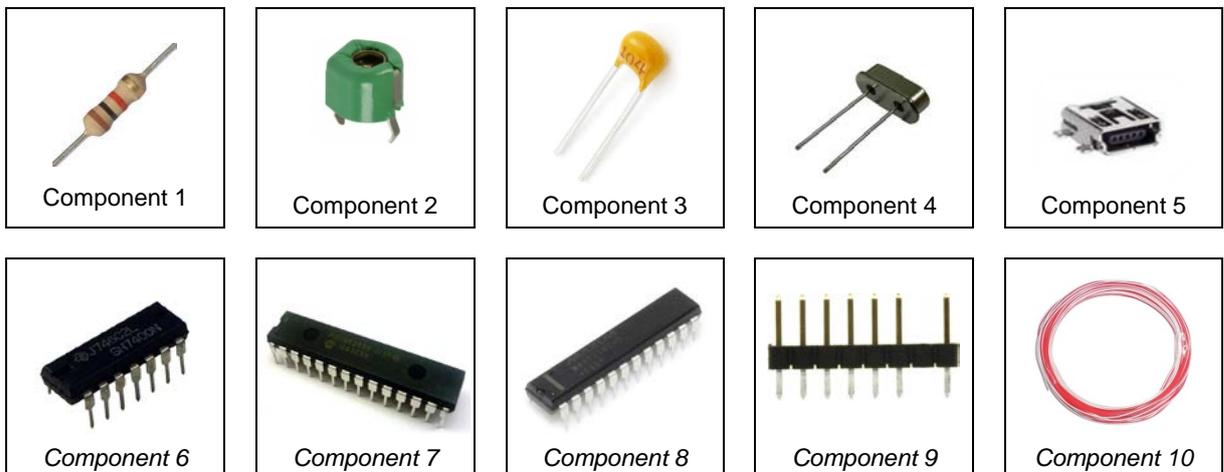
Note: all polarized components (diodes, transistors, capacitors, ICs, relays, etc.) must have the correct mounting orientation.

## 2.1 Parts lists

### EL-31 board

piece	components No.	Description
1	R2 (not installed)	22Ω 1/8 W (red-red-black) [Component 1]
2	R8, R13	100Ω 1/8 W (brown- black - brown) [Component 1]
3	R6, R9, R10	10kΩ 1/8 W (brown -black-orange) [Component 1]
1	R12	33kΩ 1/8 W (orange-orange-orange) [Component 1]
2	R5, R7	47kΩ 1/8 W (yellow-violet-orange) [Component 1]
2	R1, R11	100kΩ 1/8 W (brown-black-yellow) [Component 1]
1	C7	6.5-30pF Trimmer (green) [Component 2]
1	C6	22pF ceramic, designated 150 [Component 16]
7	C1, C2, C3, C4, C5, C8, C11	0.1uF ceramic designated 104 [Component 3]
1	C10	1uF/50V electrolyte [Component 14]
2	C9, C12	47uF/16V electrolyte [Component 14]
1	X1	8MHz Crystal HC-49U [Component 4]
6	U1, U2, U3, U4, U5, U6	LSHD-A103, 7 Segment LED [Component 11]
1	U7	MAX7221CNG or AS1106PL [Component 8]
1	U8	PIC18F2550 I/SP programmed [Component 7]
1	U9	SN7400N Quad NAND [Component 6]
1	U10	TSOP4838 IR-Rx [Component 12]
1	B1	AT-1220-TT-5-R Buzzer [Component 13]
2	P1, P3	1x7 pin header [Component 9]
1	P4 (already installed)	USB-B mini jack (SMD) [Component 5]
1	J6 (not installed)	RJ-11 Jack
1	J1	Jumper on the board (leave open)
1	J2	Wire length 5cm red [Component 10]
1	J3	Wire length 30cm white [Component 10]
1	PCB EL-31	PCB Version 1.0a [Component 15]

Table 2



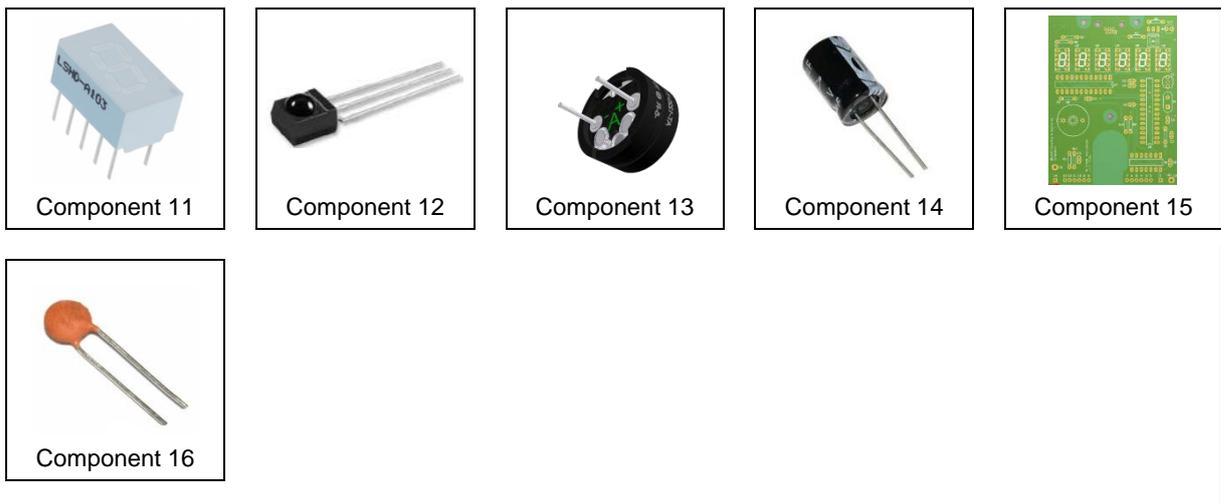


Table 3

## 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 20 and Figure 21). The SMD components are already assembled.

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

- R1 to R13, resistors
- X1, Crystal 8MHz → The crystal is soldered with a small distance to the circuit board:
  -  Cut a paper or a plastic strip 4mm x 30mm (thickness approx. 0.2mm) and place it on the component side between the two quartz ports. After soldering, remove the strip.
- C1 to 12, capacitors → mind the polarity in electrolytic capacitors!
- U1 to U6, 7-segment LED display 10 pin → note installation direction!
- U7, IC MAX7221 or AS1106 LED Display-Driver 24 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 PIC18F2550 microcontroller → note the installation direction!
- U9, IC SN7400N Quad 2-Port NAND → note the installation direction!
- U10, IC TSOP4838 IR Receiver → leads have to be turned by 90°.
- B1, AT-1220-TT-5-R Buzzer
- P1 and P3, pin connectors 2x7
  -  The pin connectors are fitted on the backside and soldered on the front side. The pin strips must lie flat and stay perpendicular to the pcb.
- J2, Solder the 30 cm long white wire → This wire will be connected to the 13.8V supply voltage of the transceiver after installation of the display board into the FT-301D.

- J3, Solder the 5 cm long red wire → this wire will be connected to the resistor R15 (3.3kΩ) after installation of the pcb into the FT301D (see 2.4.1 Removal of the old display board from the FT-301D).

- 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.

## 2.2.2 Initial testing of the board

If all elements are fitted, a first electrical test can be followed.



Note: Keep your workspace clean so that the pcb is not laying on cut pieces of wires which can lead to short circuits.

- Plug in a 5V-power supply to the connector P3 (pin 1 is the +pole, pin 2 the -pole).



If you have a power supply with current limit set it to a maximum current of about 40mA.

- Turn on the power supply.  
The following text will appear on the 7-segment display :

**uEr. 10A** **YAESU** **FT-301** followed by the Morse code "R" ( di-dah-dit)

- Subsequently the display is in the frequency measurement mode. If on P3 Pin 5 no RF-signal is present, the display will show **0.000.00**.

If the first test is successful, you can do the adjustment procedures for voltage and frequency.

## 2.3 Start-up and adjustments

For the calibration procedure, you need the following measurement instruments:

- ◆ Digital voltmeter for the range DC 0 to 20V (resolution 10mV)
- ◆ An additional (auxiliary) power supply, adjustable between DC 5 to 20V, minimal current 2mA
- ◆ PHILIPS or universal IR-remote control, set to the RC5 TV mode.
- ◆ A frequency counter with a range up to 15MHz and a resolution of 1Hz.
- ◆ A RF-signal generator in the frequency range 10 to 20MHz, in which the output signal can be set to about 0dBm (1mW, 223mV).

With the built-in calibration routines, the display board can be easily calibrated for all operating modes.



For example, if you set and save incorrect values in the voltage calibration procedure, the meter will indicate wrong values. But you can repeat the calibration procedures as many times as you want, until you get the correct result.

### 2.3.1 Adjustment of the voltage measurement circuit

- Plug in a 5V-power supply to the connector P3 (pin 1 is +pole, pin 2 is -pole).
-  If you own a power supply with current limit, set it to a maximum current of about 40mA.
- Connect the auxiliary power supply to the GND (-) and the white wire (+), connected to J2 on the display board.
- Set the voltage of the auxiliary power supply exactly on 13V. Measure the voltage with the voltmeter.
- Turn on the 5V power supply to power the display board.
- If the display shows **0.000.00** select, the **SETUP** „Setup“-Mode, by pressing the **VOL+** or **VOL-** button on the remote control.
- Press the numeric key no 4 on the remote control. **CAL-U** „Calibrate V“ will be displayed.
- Using the **VOL+** or **VOL-** key to calibrate the display to exactly **13.00** Volt.
- Press again the numeric key no 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= 13.0** volts by using the **VOL+** or **VOL-** key.
- Increase the voltage on the auxiliary power supply to e.g. 15.7V (see Voltmeter) and the display should now show **U= 15.7** volts.
- The adjustment is completed. Turn off the auxiliary and the 5V power supply.

### 2.3.2 Adjustment of the frequency measurement circuit



For the following adjustments you should use an RF signal generator with a precise frequency from 10 to 15MHz at a level of about 0dBm (220mV). The frequency of the calibration is not as essential as is the precision with which the alignment can be implemented. This requires an accurate frequency counter (<1Hz accurate).

- If your RF signal generator has a TTL-level output, the auxiliary interface circuit is not needed.  
You can connect the signal generator directly to the EL-31 P3 / Pin 3.
- For the injection of a sinusoidal test frequency an auxiliary circuit is required. This auxiliary circuit is available in the transceiver FT-301D, but it is needed to carry out the frequency alignment on the not built-in display board.

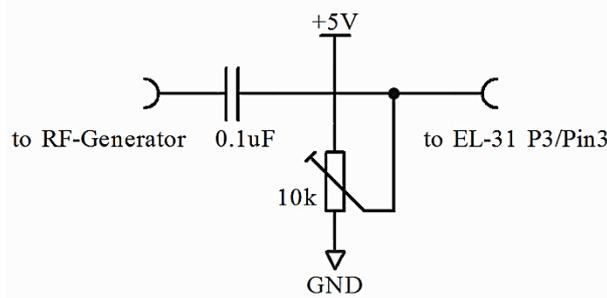


Figure 1

- Plug in a 5V-power supply to the connector P3 (pin 1 is +pole, pin 2 is -pole).
-  If you own a power supply with current limit, set it to a maximum current of about 40mA.
- Connect the frequency counter to the RF signal generator so that you can always measure the exact frequency.
- Connect the input of the auxiliary circuit to the signal generator. Connect the output of the auxiliary circuit with P3 / Pin 3 of the display board.
- Turn on the 5V power supply to power the display board.
- If the display shows **0.000.00** select the **SEtUP** „Setup“-Mode by pressing the **VOL+** or **VOL-** button on the remote control.
- Press the numeric key no **3** on the remote control. **AUtO** „Automatic Frequency Display Mode“ is displayed.
- Using the **VOL+** or **VOL-** buttons the **10 Hz** „10Hz-Frequency Display Mode“, the frequency is always displayed in the 10Hz-resolution without the MHz digits.
- Press the numeric key no **3** on the remote control again. You are now back in the **SEtUP** mode.
- Press the **VOL+** or **VOL-** key until **-.000.00** is displayed.
- Turn on the signal generator and set a frequency, for example 13.000.000 MHz at a level of about 0dBm.
- Change the trim potentiometer at the auxiliary circuit to a stable frequency reading on the display unit, for example **-.999.75** (last digit = 10Hz).
- Set the frequency with a non-conductive screwdriver on the trimming capacitor C7 exactly to the frequency that you are reading on the frequency counter.  
e.g. **-.000.00** if accurate 13.000.000 MHz is measured.
- Use the remote control by pressing the **VOL+** or **VOL-** key to select the **SEtUP** „Setup“ mode.
- Press the numeric key no **3** on the remote control. You see **10 Hz**.
- Change with the **VOL+** or **VOL-** key to the **AUtO** mode.
- Press the numeric key no **3** on the remote control again. You see **SEtUP**.
- Press the **VOL+** or **VOL-** key until the display shows **13.000.0** (last digit = 100Hz).

- The adjustment is completed. The auxiliary circuit can be disconnected from the display board and the power can be switched off.

## 2.4 Conversion of the FT-301D

### 2.4.1 Removal of the old display board from the FT-301D



To prevent problems the mechanical assembly has to be done strictly according to the following order:

- Remove the cover of the device, which is secured by four plastic tabs.
- Disconnect the cable from the speaker terminal.
- Place the unit upside down and remove the 12 screws and the bottom cover.
- Carefully pull off the two header connectors from the display board.

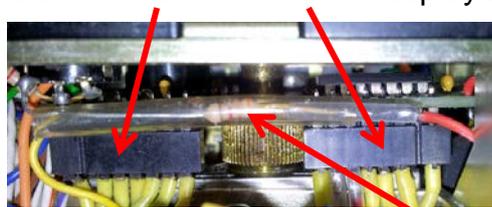


Figure 2

- With a side cutter cut the wire of the 3.3kΩ resistor to the terminal connector on the side it is soldered to the display board. The resistor will be reconnected after installation of the new display board into the FT-301D.
- Turn the device over again, so that the top is facing up.
- Remove the large frequency setting knob on the front panel by loosening the two grub screws.
- Remove the mounting screw behind the frequency setting knob (see Figure 3).



Figure 3

- Loosen the two screws securing the display device holder on top (do not remove entirely).

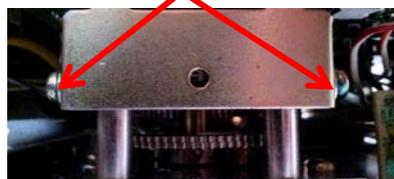


Figure 4

- Pull the display board upwards very carefully. You may need to tilt the board slightly.

## 2.4.2 Installation of the new display board in the FT-301D

- Remove the bracket from the old display board and mount them to the back of the new board. Use the same screws.
- Slide the new display board very carefully behind the front panel of your device until the mounting bracket rests on the two screws.



Note: The two wires (red and white) must be routed down.

- Install the mounting screw behind the frequency setting knob (see Figure 3).
- Tighten the two fixing screws on the display device holder again.
- Mount the large frequency setting knob on the front panel again.
- Turn the device over, so the bottom is facing up.
- Take 2cm (3/4") of shrink tubing and put it over the red wire, which is soldered to the new display board.
- Solder the 3.3k $\Omega$  resistor to the red wire, and slip the shrink tube over the soldered point to prevent a short circuit.
- Carefully plug the two pin headers connections back to the new display board (see Figure 2).

### **Option operating voltage display**

- Route the white wire, which is soldered to the new display board, to the rear wall and solder it on the connection of the cable entry (see Figure 5).



Figure 5

### Option operation of a transverter on the 10m band

- Route the white wire, which is soldered to the new display board, to the rear panel and solder it to the connector (pin1) of the EXT VFO socket. (see Figure 6).

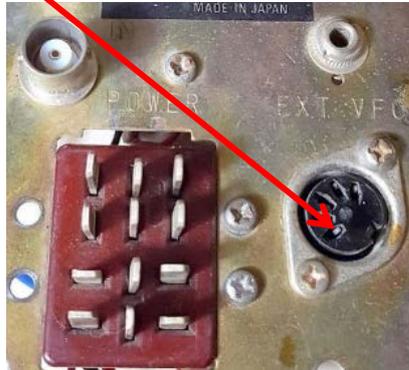


Figure 6

The operating voltage of the transverter via pin1 (EXT VFO socket) signals its operating state to the display module (<5V = transverter OFF, >5V = transverter ON).



Before mounting the base and cover, a functional test is carried out.

- Connect the device to a power supply with a voltage of about 13.8V / 2A.
- Set the BAND switch to **20** and CHANNEL switch to **VFO**.
- Turn on the FT-301D. The following text will appear on the display: **VER.2.1A** **YAESU**  
**FT-301** followed by the Morse code "R" ( di-dah-dit).
- Now the frequency will be displayed, for example **14.138.7**

Should the display show only **-----** the display module is missing an input signal. The trimming potentiometer for the DC offset in the MIXER COUNTER UNIT PB-1541D must be re-adjusted.

Proceed as follows:

- Open the small metal cover (it is only pressed) of the COUNTER MIXER UNIT PB-1541D. This unit can be found on the bottom side behind the display unit.
- Using a small screwdriver, rotate the trim potentiometer until the display shows a stable frequency in the 20m band.



Figure 7

Close (only press on) the MIXER COUNTER UNIT PB-1541D with the metal cover.

---

- Install the bottom cover with the 12 screws.
- Turn the device over, so that the top is facing up.
- Take off the cover and insert the speaker wire again.
- Put the cover onto the device and secure it with the four plastic plugs.

### 3 Operation and functions

The LED display EL-31 is primarily intended as a 1:1 replacement for the failure-prone original display module. With the modern microcontroller technology, it is relatively easy to implement additional features and make the replacement even more worthwhile.

The various operating modes will be explained below.

#### 3.1 Display

The display is a six-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 8:

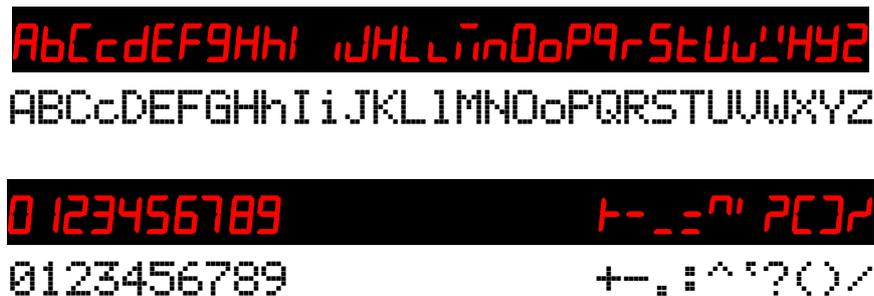


Figure 8

#### 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:

<b>VOL+</b>	→	<b>Up</b>	Change menu / selection
<b>VOL-</b>	→	<b>Down</b>	Change menu / selection
<b>0 to 9</b>	→	<b>0 ..9</b>	Selection of item
<b>OK</b>	→	<b>Enter</b>	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 9

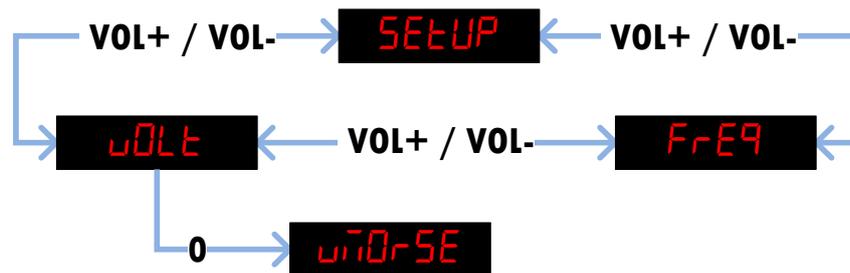


Figure 10

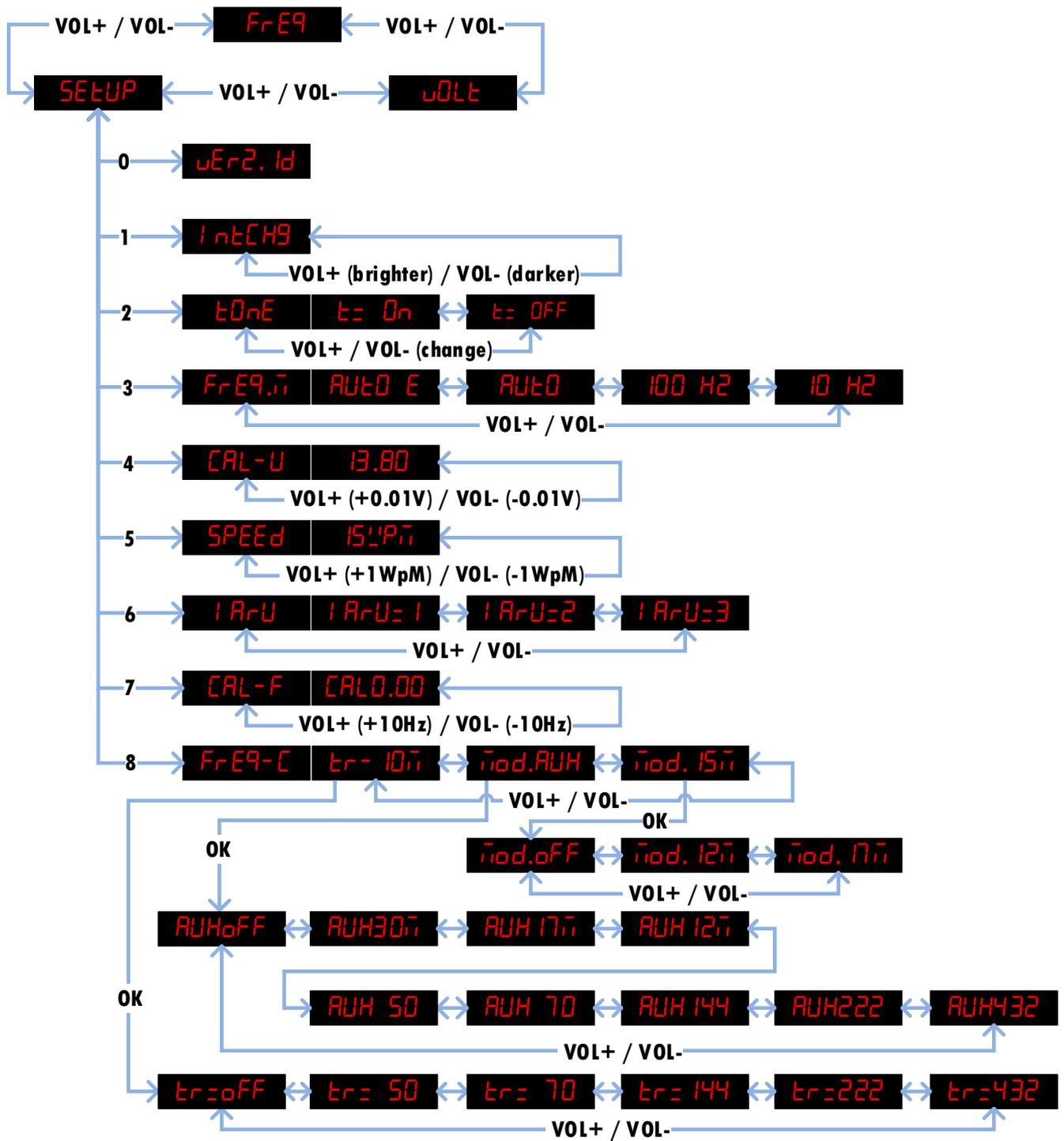


Figure 11

## 3.4 Modes

### 3.4.1 Frequency Display

After switching on the FT-301D, the frequency display mode is automatically selected. This is the standard setting and also the basic function of the digital display for the FT-301D. All frequency display options of the original display board are implemented in EL 31.

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 29.010 MHz (VFO slightly above the 500 kHz range) in the band switch position 10C (28.5 MHz) no longer appears as 28.510 MHz, but correctly as 29.010 MHz.

The new digital display offers the following display modes:

#### 100Hz-Mode:

This mode displays the frequency in 100Hz resolution and corresponds to the original display. We set this mode with the remote control via the menu **SETUP**.

- Press the numeric key no **3** on the remote control. For example **AUTO** might be displayed.
- Change to the **100 HZ** mode by using the **VOL+** or **VOL-** key.
- Press the numeric key no **3** again. You are now back in the **SETUP** mode.
- Change to the **FREQ** mode by using the **VOL+** or **VOL-** key.

#### 10Hz-Mode:

This mode always shows the frequency in 10 Hz resolution.

We set this mode with the remote control via the menu **SETUP**.

- Press the numeric key no **3** on the remote control. For example **100 HZ** might be displayed.
- Change to the **10 HZ** mode by using the **VOL+** or **VOL-** key.
- Press the numeric key no **3** again. You are now back in the **SETUP** mode.
- By using the **VOL+** or **VOL-** key change to the **FREQ** mode.

Since at frequencies of > 9.999.99 MHz the 6-digit display is no longer sufficient, the frequency is always displayed in the format **-.537.32**. The **-.** in the one-MHz digit indicates that the display is permanently set at 10Hz format. (see also Auto E-Mode)

### **Auto-Mode:**

This mode of operation always displays the frequency in the highest possible resolution. Below 10 MHz, the resolution is 10Hz and changes over 10MHz in the 100Hz mode.

We set this mode with the remote control via the menu **SEtUP**.

- Press the numeric key no **3** on the remote control. For example **10 HZ** might be displayed.
- Change to the **AUtO** mode by using the **VOL+** or **VOL-** key.
- Press the numeric key no **3** again. You are now back in the **SEtUP** mode.
- Change to the **FREq** mode by using the **VOL+** or **VOL-** key.

### **Auto E-Mode:**

This mode displays a 10Hz resolution during the tuning process, even for frequencies above 10MHz.

We set this mode with the remote control via the menu **SEtUP**.

- Press the numeric key no **3** on the remote control. For example **AUtO** might be displayed.
- Change to the **AUtO E** mode by using the **VOL+** or **VOL-** key.
- Press the numeric key no **3** again. You are now back in the **SEtUP** mode.
- Change to the **FREq** mode by using the **VOL+** or **VOL-** key.

The 6 digit display allows the frequencies e.g. **14.563.8** to be displayed with a resolution of 100Hz. During the tuning process, the display shows the frequency with a resolution of 10Hz, e.g. **- .563.83** for 14.563.83MHz. **-.** in the one MHz digit indicates that the display is in 10Hz format. If the tuning knob is no longer moved, the display changes back again after approx. 5 seconds.

## **3.4.2 Band modifications (band switch positions 160m, 15m or AUX)**

### **AUX-modification:**

The FT-301D has an AUX band (auxiliary) provided by Yaesu for the 11m band (27MHz). Since the FT-301D lacks the WARC bands 30m, 17m and 12m, one of these bands can be placed on the AUX band. Modifying the device is not difficult, and the change has no effect on the operation of the other bands in the transceiver.

Also a transverter (transceiver / converter) can be connected behind the FT-301D. Usually the 10m band is used as intermediate frequency (IF).

The transverter extends the frequency range in the 6m band from 50-52MHz, 4m band from 70-72MHz, 2m band from 144-146MHz, 1.25m band from 222-224MHz or in the 70cm band from 432-434MHz. To ensure that the frequency display shows the correct frequency even in transverter mode, the display modes for the corresponding transverter can be configured via the setup menu.

To ensure that the frequency display corresponds to the new frequency band again after a band modification, the diode matrix in the "Counter Mixer Unit PB-1541" could also be changed. However, this requires a lot of effort. The EL-31 display module allows various settings which correct the frequency display for the new band.

This mode is set via the menu **SEtUP** with the remote control:

- Press the Number Button **8** on the Remote Control and then press the **VOL+** or **VOL-** buttons until **Mod.AUH** (Mod. AUX) is displayed.
- Press the **OK** key to switch to the **AUHoff** AUX setup mode.
- Use the **VOL+** or **VOL-** buttons to select the band you want to put on the AUX band (27MHz):
  - AUHoff** (AUX band, => no modification), **AUH30.7** (30m band), **AUH 17.7** (17m band), **AUH 12.7** (12m band), **AUH 50** (transverter 50MHz), **AUH 70** (transverter 70MHz), **AUH 144** (transverter 144MHz), **AUH222** (transverter 222MHz), or **AUH432** (transverter 432MHz).
- Press the Number key **8** or **OK** key again. **SEtUP** is displayed again.
- Use the **VOL+** or **VOL-** buttons to switch to **FREQ** mode.

### **160m band modification:**

As already described in the chapter AUX modification, it is also possible to modify the 160m band to the 30m WARC band. Yaesu also produced a special version "SOMMERKAMP FT-301D CBM", which already contains the CB-band (11m-band) on the AUX switch position, and the frequency range of the 160-band is 1.7MHz to 2.2MHz, so that you can work on the "MF-Marine-Band" (USB 2182kHz, 2187.5kHz).

For this purpose, the software of the display module can be parameterized in such a way that a correct frequency display is achieved with the CBM version or after the 30m band modification.

This mode is set via the menu **SEtUP** with the remote control:

- Press the Number Button **8** on the Remote Control and then press the **VOL+** or **VOL-** buttons until **Mod.160** (Mod. 160m band) is displayed.
- Press the **OK** key to switch to the setup mode.
- Use the **VOL+** or **VOL-** buttons to select the band you want to put on the 160m band (1.5MHz):
  - Mod.Std** (160m band, => no modification 1.5-2.0MHz), **Mod.Cb7** (CBM 160m band 1.7-2.2MHz), or **Mod.30.7** (30m band)
- Press the Number key **8** or **OK** key again. **SEtUP** is displayed again.
- Use the **VOL+** or **VOL-** buttons to switch to **FREQ** mode.

### **15m band modification:**

As already described in the chapter AUX modification, it is also possible to sacrifice the 15m band for one of the WARC bands (17m or 16m or 12m).

Also here the software of the display module can be parameterized, so that after the 15m-band modification a correct frequency display shows.

This mode is set via the menu **SEtUP** with the remote control:

- Press the Number Button **8** on the Remote Control and then press the **VOL+** or **VOL-** buttons until **Mod.15** (Change 15m band) is displayed.
- Press the **OK** key to switch to the setup mode.
- Use the **VOL+** or **VOL-** buttons to select the band you want to put on the 15m band (21MHz):  
**Mod.oFF** (15m band, => no modification), **Mod.17** (17m band), **Mod.16** (16m band), or **Mod.12** (12m band)
- Press the Number key **8** or **OK** key again. **SEtUP** is displayed again.
- Use the **VOL+** or **VOL-** buttons to switch to **FrEQ** mode.

### 3.4.3 Transverter operation (band switch positions 10A to 10D)

A transverter (transceiver / converter) can be connected behind the FT-301D. Usually the 10m band is used as the IF.

The transverter extends the frequency range in the 6m band from 50-52MHz, 4m band from 70-72MHz, 2m band from 144-146MHz, 1.25m band from 222-224MHz and in the 70cm band from 432-434MHz. To ensure that the frequency display shows the correct frequency even in transverter mode, the display modes for the corresponding transverter can be configured via the setup menu.

This mode is set via the menu **SEtUP** with the remote control:

- Press the Number Button **8** on the Remote Control and then press the **VOL+** or **VOL-** buttons until **Tr=10** (Transverter in the 10m band) is displayed.
- Press the **OK** key to switch to the **Tr=oFF** transverter setup mode.
- Use the **VOL+** or **VOL-** buttons to select the corresponding frequency range of your transverter.  
**Tr=oFF** (10m band, => no transverter), **Tr=50** (transverter 50MHz), **Tr=70** (transverter 70MHz), **Tr=144** (transverter 144MHz), **Tr=222** (transverter 222MHz), or **Tr=432** (transverter 432MHz)
- Press the Number key **8** or **OK** key again. **SEtUP** is displayed again.
- Use the **VOL+** or **VOL-** buttons to switch to **FrEQ** mode.

### 3.4.4 Transverter and status signaling

A transverter can be easily connected between the output of the 10W driver stage and the input of the 100W power amplifier (see Figure 12).

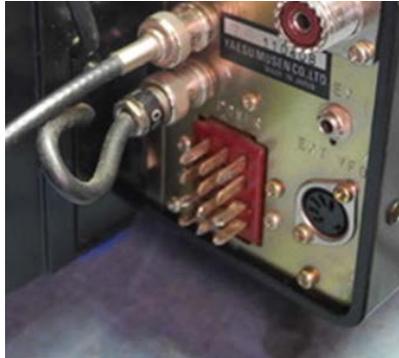


Figure 12

When operating a transverter in the 10m range (band switch 10A-10D), no modification of the FT-301D is necessary, because the 10m band is used as IF. To display the frequency correctly, the different transverter frequencies (50MHz to 432MHz) can be selected in the setup menu.

The status (ON / OFF) of the transverter is signaled to the frequency display module and so the correct frequency is always displayed.

The FT-301D can be used as usual on the 10m band with the transverter switched off (see chapter 2.4.2 Option operation of a transverter on the 10m-band).

Due to the fact that the display has 6 digits, the frequencies e.g. **144.563** can only be displayed with a resolution of 1kHz. During the tuning process the display shows the frequency with a resolution of 100Hz e.g. **-4.563.8** for 144.563.8MHz. If the tuning knob is no longer turned, the display changes back again after approx. 5 seconds.

### 3.4.5 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 **uDLt** mode by using the **VOL+** or **VOL-** key.

To obtain an accurate reading, the voltage measurement must be calibrated first (see chapter 2.3.1).

Voltage measurement is not possible when operating a transverter on the 10m band. In this case, the voltage display input (J2, white wire) is reserved for signaling transverter status (<5V→transverter OFF, >5V→transverter ON).

### 3.4.6 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 **FrEQ** mode by using the **VOL+** or **VOL-** key.
- Press the numeric key no **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 no **1** → this results in the “short” output of the frequency; i.e. the frequency is emitted in kHz only (without the MHz-, 100Hz- und 10Hz- digits).

### 3.4.7 Morse readout of voltage

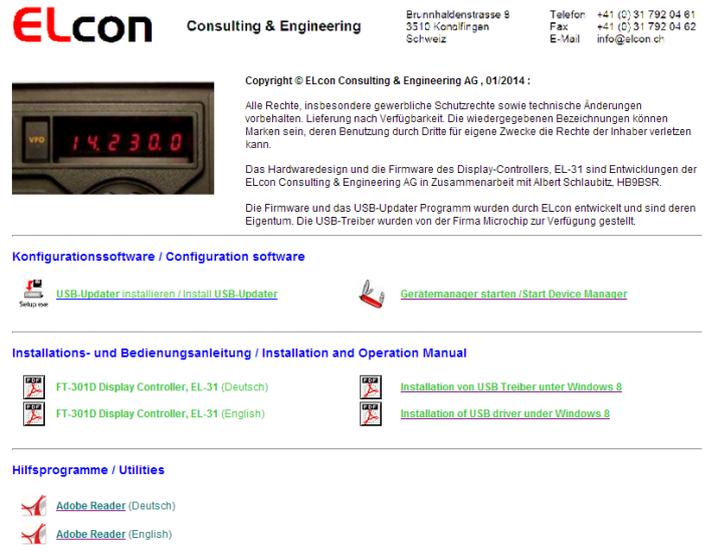
When the voltage appears on the display, it is possible to emit this information as Morse code through the built-in buzzer.

- Change to the **VOLT** mode by using the **VOL+** or **VOL-** key.
- Press the numeric key no **0 (zero)** → this results in the output of the voltage; i.e. the voltage is emitted in V.100mV.

## 4 Software Update

To keep the digital display EL 31 up to date a new software version can be programmed into the EL 31 with the program "USB Updater". For this purpose; a "Loader" software for the PC and a USB cable from the PC to EL 31 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-31 USB-Loader Setup" and open the file "EL-31 USB-Loader Setup \ cd.htm with the Internet Explorer,



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Das Hardware-Design und die Firmware des Display-Controllers, EL-31 sind Entwicklungen der ELcon Consulting & Engineering AG in Zusammenarbeit mit Albert Schlaubitz, HBBSR.  
Die Firmware und das USB-Updater Programm wurden durch ELcon entwickelt und sind deren Eigentum. Die USB-Treiber wurden von der Firma Microchip zur Verfügung gestellt.

Konfigurationssoftware / Configuration software  
[USB Updater installieren / Install USB Updater](#) [Gerätemanager starten / Start Device Manager](#)

Installations- und Bedienungsanleitung / Installation and Operation Manual  
[FT-301D Display Controller, EL-31 \(Deutsch\)](#) [Installation von USB Treiber unter Windows 8](#)  
[FT-301D Display Controller, EL-31 \(English\)](#) [Installation of USB driver under Windows 8](#)

Hilfsprogramme / Utilities  
[Adobe Reader \(Deutsch\)](#)  
[Adobe Reader \(English\)](#)

Figure 13

### 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 13.
- Start the "USB-updater" installation program by clicking on the link

 [USB-Updater installieren / install USB-Updater](#) (see Figure 13).

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 31xxx.elc" or "EL 31xxx.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-301D.
- Connect the PC with a USB cable (A / mini B) to the USB connector P4 of the EL 31. The display of the FT-301D shows **S!-UP9** **S!-UP8** etc. to **S!-UP0** . You have the option to cancel the "USB update" within 10 seconds, by removing the USB cable from the EL-31.

- When **UPDATE** is displayed, the microcontroller of the digital display in the FT-301D 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 needs 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 13).

- 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).

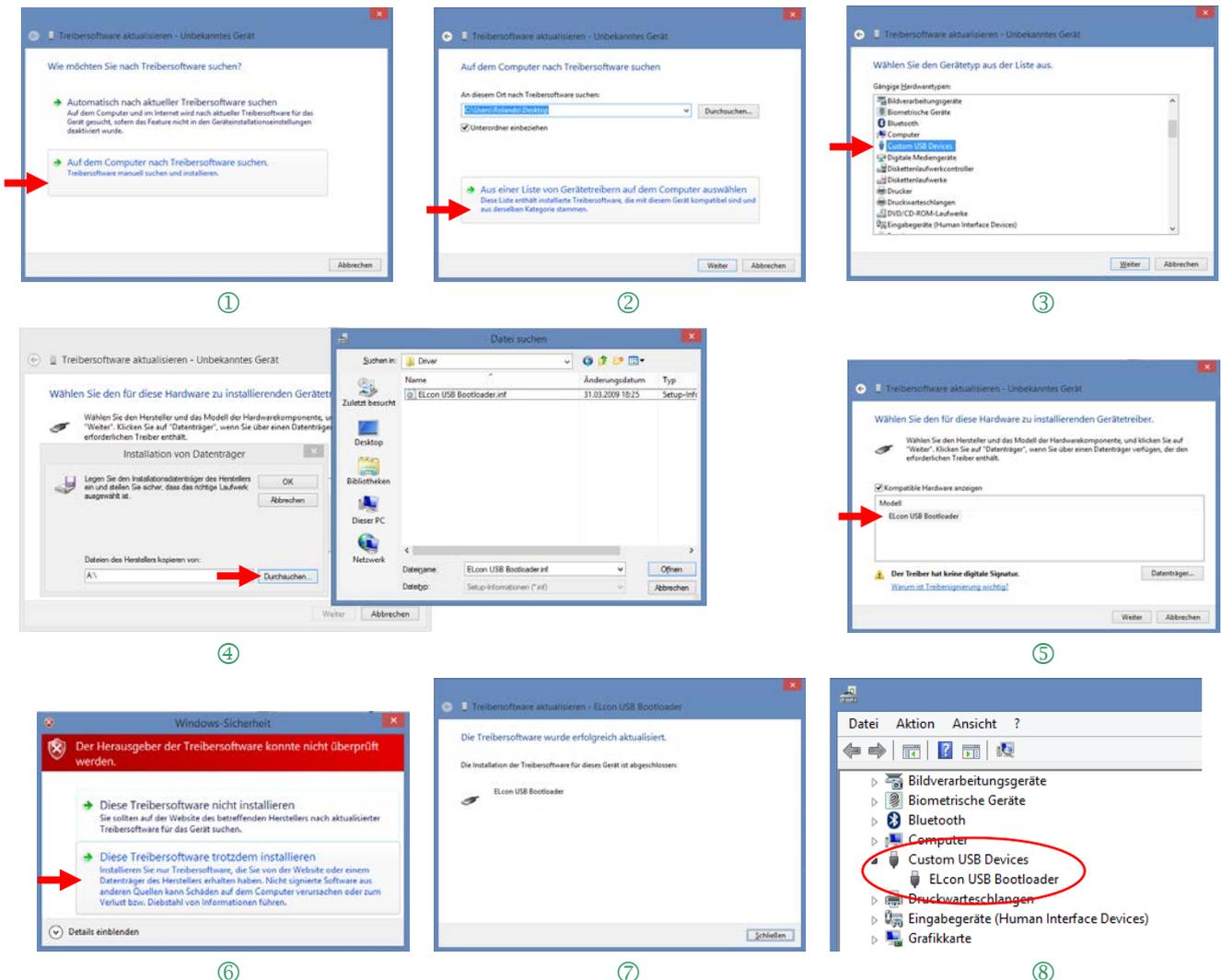


Figure 14

- 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-31 exists.

The Device Manager can be started directly from the Web page (see Figure 13).

### 4.1.3 Transferring the software updates in the EL-31

For the software update proceed as follows:

- Download the latest firmware update "EL 31xxx.elc" or "EL 31xxx.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-301D (EL-31).
- Connect the PC with a USB cable (A / mini B) to the USB connector P4 of the EL 31.
- Start the program "USB Updater.exe". The program opens the following "USB Updater" program window.



Figure 15

- Click to  button to connect the USB-updater program automatically with the EL-31. The following "Auto Detect" window should show a successful detection of the EL-31 USB boot loader in order to perform the software update. Confirm with the key  .



Figure 16

- Load the update file EL 31xxx.ELC or EL 31xxx.HEX with <File / Open...> or <Ctrl+O>.

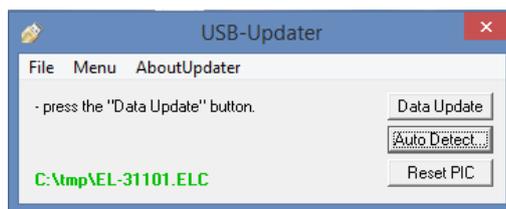


Figure 17

- Start the data transfer with the key  .

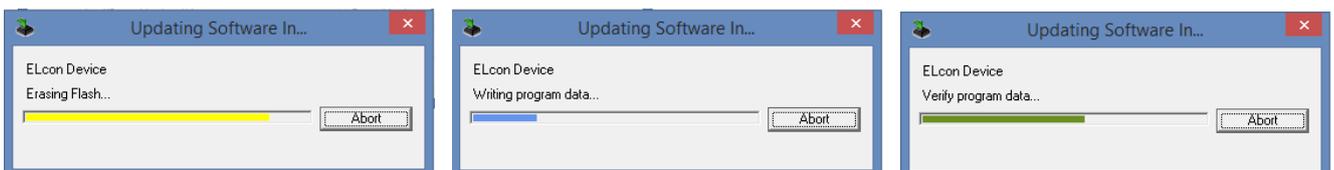


Figure 18

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

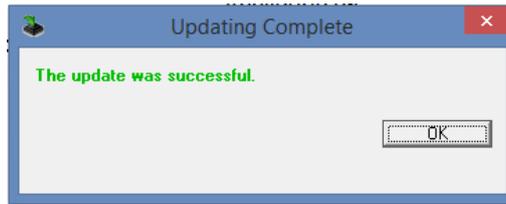


Figure 19

If the data transmitting is not successful, check the correct USB connection to the EL 31 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:

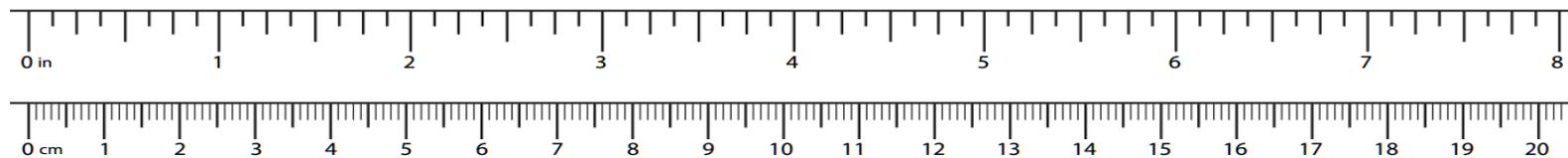
Frequency: 0 -30MHz, with Transverter 50-432MHz

Power supply: 5V from FT-301D, about 30-70mA (depending on mode)

Dimensions: 160(L) × 90(B) × 35(H) mm

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 PCB assembly

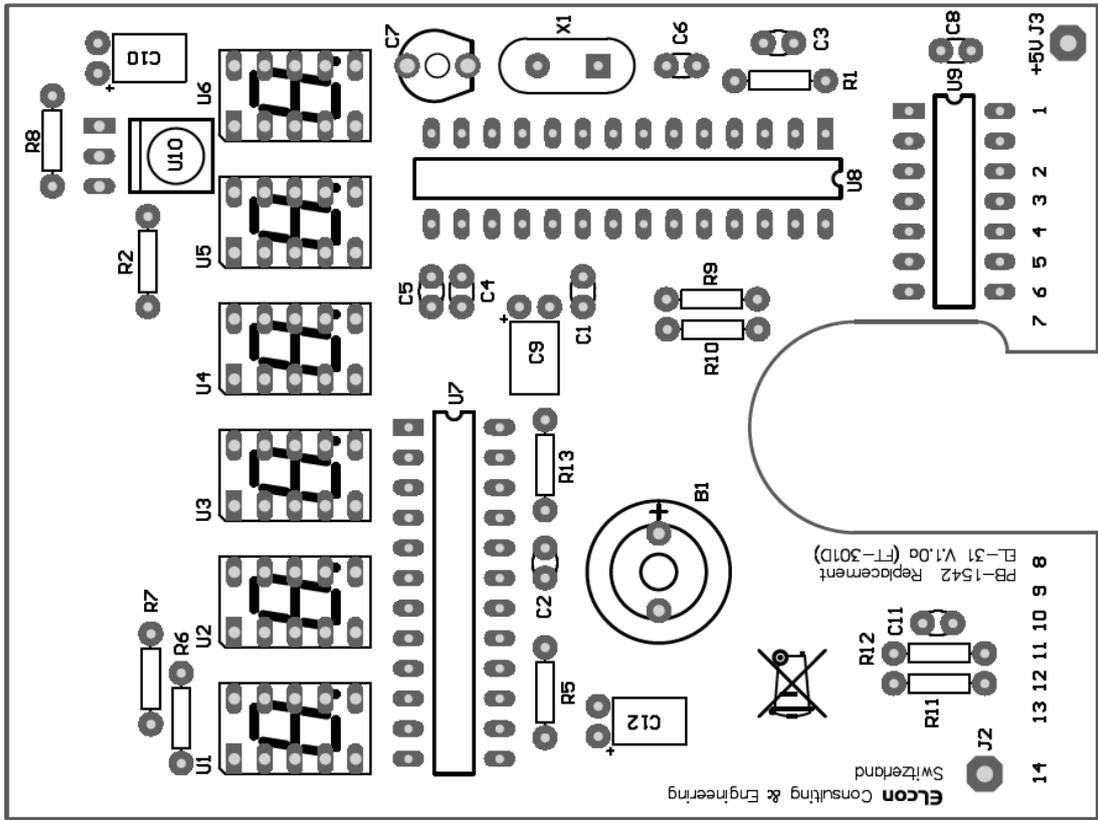


Figure 20

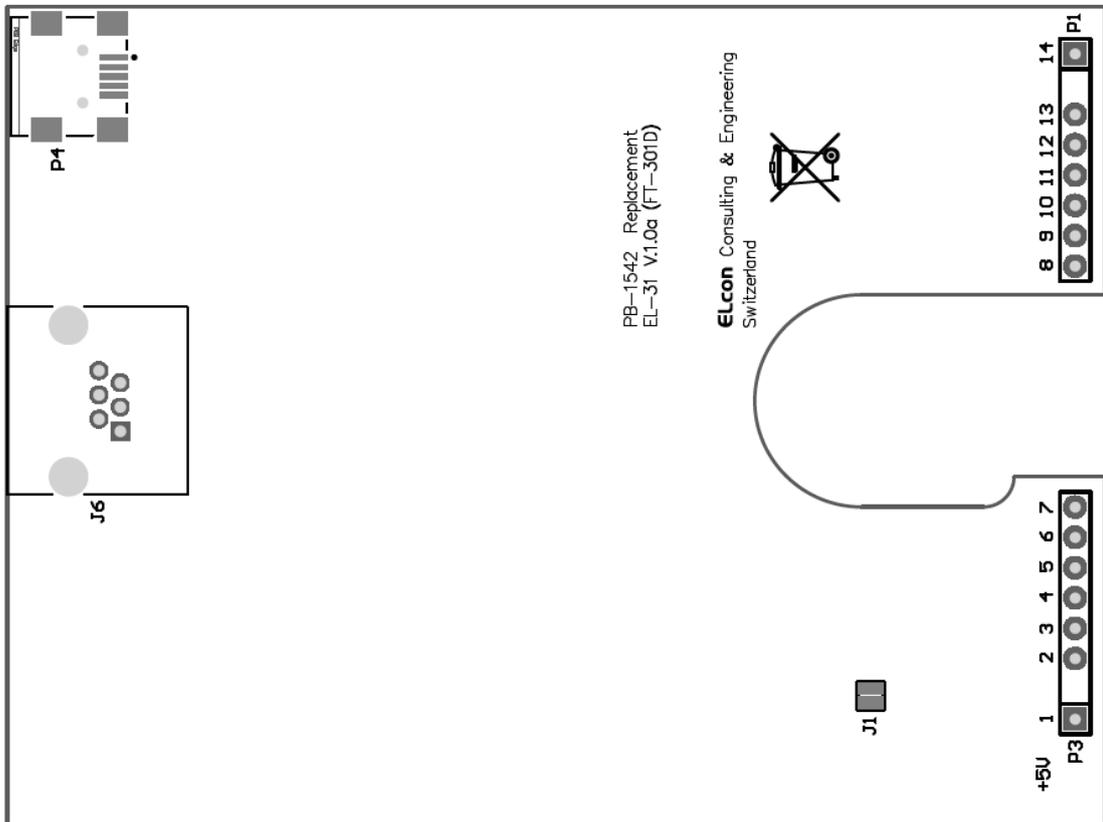
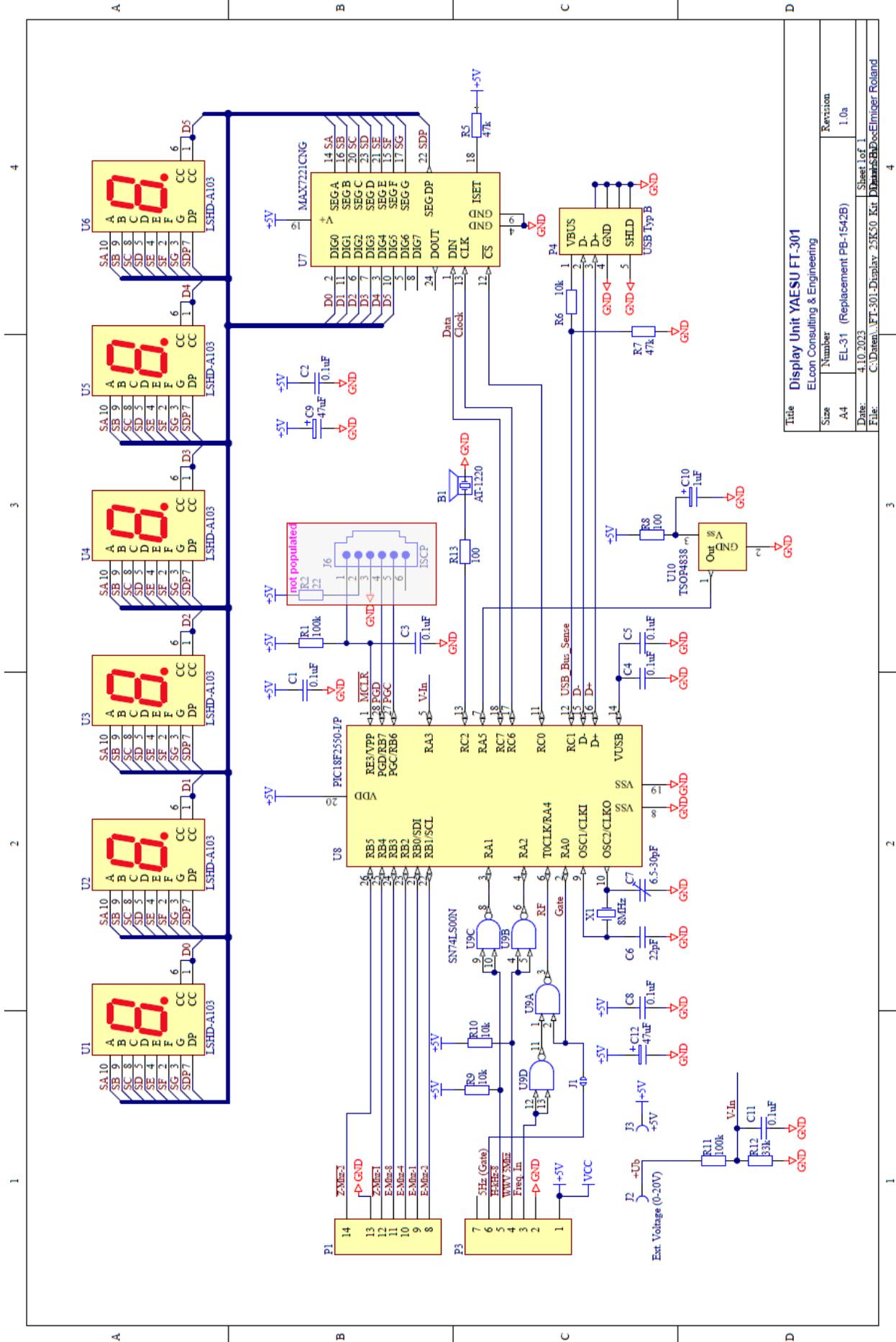


Figure 21

# 5.5 Schematics



Title		Display Unit YAESU FT-301	
ELeon Consulting & Engineering			
Size	A4	Revision	1.0a
Number	EL-31 (Replacement PB-1542B)	Sheet	1 of 1
Date:	4.10.2023	Doc:	D:\Drawings\FT-301-Display_25K50_Kit
File:	C:\Drawings\FT-301-Display_25K50_Kit	Doc:	D:\Drawings\FT-301-Display_25K50_Kit