Replacement display for the FT-290R

The Yaesu FT-290R 144MHz portable transceiver was released over 30 years ago, yet still remains popular, particularly for microwave portable operation.

However, the transceiver (and its 50MHz and 432MHz counterparts the FT-690 and FT-790) can suffer from three age-related faults: the electrolytic capacitors dry out, the printed circuit board becomes conductive in humid atmospheres and the display is gradually obscured by a darkening phenomenon. These faults have been discussed on The Electric Handbag FT-290R Group on Yahoo [1], which is a very useful resource. My particular problem was that the display on my FT-290R was so badly obscured that I could not tell what frequency it was on.

I found some information about a replacement display that had been designed by ZS1KE [2] but could not find a small enough LCD to replace the existing unit. However, ZS1KE's article described the data format used to pass data to the display, so initially I decided to try to build an interface to an external LED display using a PIC. Later, I found an LED display small enough to fit inside the FT-290R and this is described here. As I no longer use the internal battery pack and have removed the battery holder, I was able to fit the PIC and driver electronics inside the battery compartment.

Software

The PIC code is written in assembler and simply listens for the data to be output by the FT-290R microcontroller before displaying each digit in turn on the display, then listening for the data again. After the CE line goes high the data is output from the microcontroller in twelve 4-bit nibbles (on R40 – R43), which are read on the falling edge of the STD pulses. These nibbles are intended to be put together into six 8-bit words. The first word describes the '100s of Hz', the second the kHz and so on up to the fifth, which describes the MHz. The 10s and 100s of MHz are not output by the microcontroller as they are not intended to be displayed. The sixth word indicates clarifier, memory and/or function selection.

The PIC software uses a look-up table based on the four lower bits of the 8-bit words to look up the 7-segment display segments that need illuminating. As 7 digits were available on my chosen display I decided to show the 10s and 100s of MHz as well, except when clarifier, memory or function were selected. In these cases, a separate look-up table was used to display custom symbols instead of the 100s of MHz.

Hardware

My PIC of choice is the Microchip PIC16F883, which has up to 24 input/output pins, can be configured to use a 4MHz internal oscillator and is available in a 28 pin DIP package. I mounted the PIC in a socket on strip board with solder pins to connect the display and the data input. I also fitted a header to allow in-circuit programming of the PIC. Apart from the current limiting resistors, the only other components were 7 NPN transistors used to turn on each digit in turn, as the combined current would otherwise exceed the direct sink capability of the PIC. The type of NPN transistor is not critical, but they need to switch up to 100mA with a gain of 50; I used 2N2369s from my junk box, but would recommend the 2N3704 or 2N3904 for new purchases. Although there were a number of options for powering the display from the FT-290R power supply I decided that, rather than introduce noise and possible overload, I would use a 7805 regulator supplied directly from the switched 12 volt supply provided for the panel light in the transceiver.

The circuit diagram is in **Figure 1** with the pin numbering and connections marked.

I found that Kevin Avery of G3AAF Electronics [3] stocked a 7-digit common-cathode LED display that, with some modification, would replace the existing LCD display. It is marked with part number 24R01 and is available by mail order.

Construction and testing

No special precautions are required for constructing the main board with the voltage regulator, PIC and driver transistors. I used stripboard. Ribbon cables are used to connect this board to the FT-290R Key Board Unit and the new display,

I initially built the driver board and display outside the FT-290R, testing as much as possible before putting the PIC in its socket and making connections to the transceiver. I then connected the PIC board to the FT-290R Key Board Unit connector using a

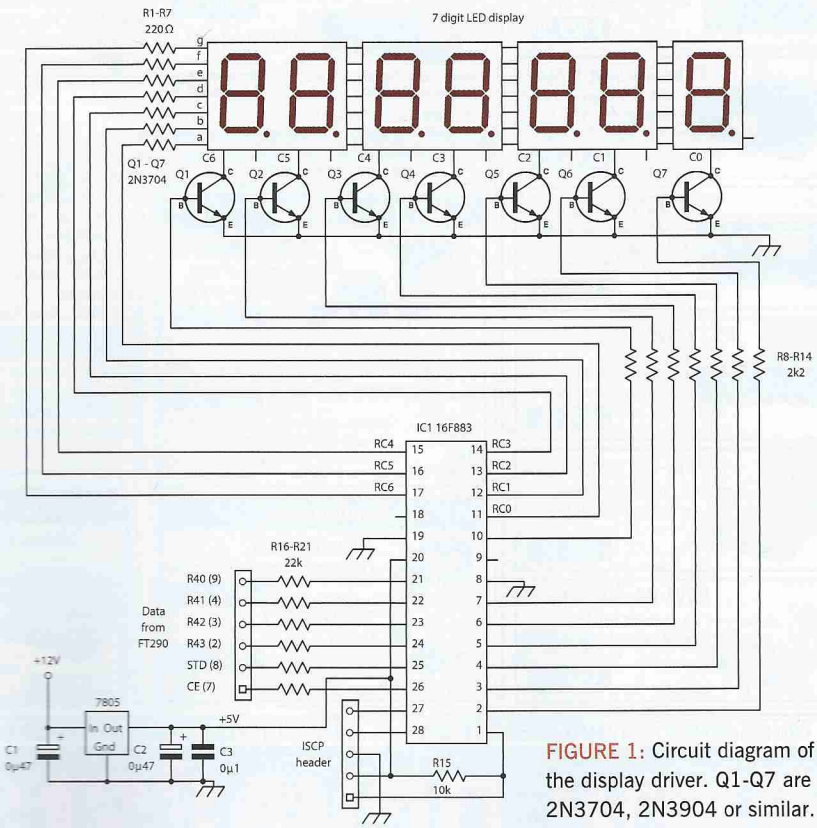

FIGURE 1: Circuit diagram of the display driver. Q1-Q7 are 2N3704, 2N3904 or similar.

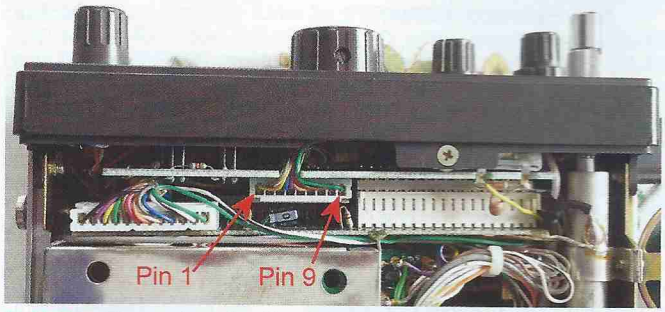

PHOTO 1: Pin number identification on the FT-290R Display Unit.

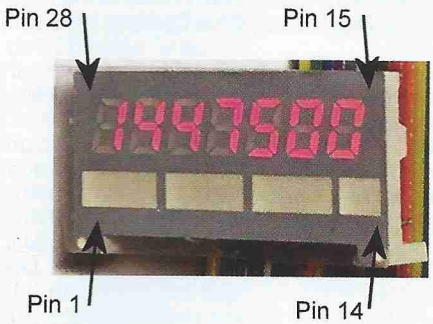

PHOTO 2: LED pin number identification.

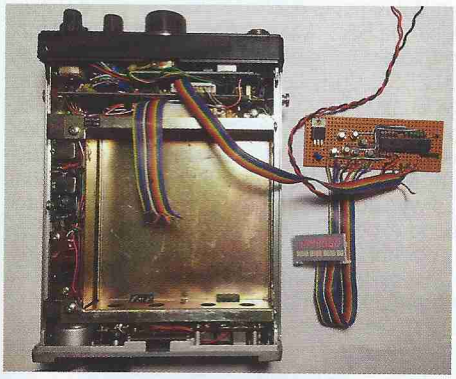

PHOTO 3: Testing the prototype board before final integration. The loose ribbon cable connects to the display buried within the front panel; a test display is temporarily connected here.

ribbon cable and a nine-pin header with the pins slightly bent to fit into the back of the existing connector; see **Photo 1** and **Table 1**. Note that the pins are not in a logical order (details at [2]) and there is no ground connection on the connector. The LED display will not illuminate until the CE and STD pulses from the FT-290R are present. The LED display pinout is shown in **Photo 2** and **Table 2**.

Fitting the display

All elements of the construction to this point have been relatively simple. However, fitting the display into the FT-290R is difficult and involves some risk of damage as the stack of boards behind the front panel on the FT-290R is tightly packed and interconnected. Some wires need to be unsoldered for disassembly and correctly reattached later. I suggest you take notes (and/or photos) as you progress, for reference on reassembly.

The first step is to dismantle the stack of boards behind the front panel and remove (and unplug) the old LCD PCB and its bezel. Cut some of the bottom of the inside frame of the plastic bezel away so that the new LED display will fit flush to the display window. You may wish to replace the display window with a red filter at this point. Using a piece of stripboard, make a replacement for the old LCD PCB that is the same size and arrange it so it will mount the new display centrally in the window. To make it all fit, cut off the bottom row of pins on the display (not used in our application) and the plastic feet on the back of the display. Solder a ribbon cable to the display pins on the stripboard.

If required, this is also a golden opportunity to replace the small bulb that illuminates the panel meter.

Solder a second ribbon cable to the relevant pins on the back of the display connector on the FT-290R Key Board Unit and take extra wires to ground and +12V. You can then reassemble the PCB stack, routing the ribbon cables to the battery compartment. **Photo 3** shows my prototype under test at this stage. Once the FT-290R has been reassembled, you can trim the ribbon cables to the correct length and solder them to the PIC board. After testing, attach the PIC board to the inside of the battery compartment, and use suitable insulation to prevent any future short circuits.

PHOTO 4: The completed modification looks smart.

Design issues

The LED display is power-hungry; the FT-290R takes about 100mA on receive and this is increased by 40mA or so by the LED display. The additional consumption can be reduced at the expense of display brightness; or the display can be made brighter at the cost of increased consumption by reducing the LED drive resistors R1-R7.

Resistors have been included in the input data lines from the FT-290R to enable the display to be powered off without placing too much load on the microcontroller. Thus, if monitoring a single channel on battery power, the current consumption can be minimised by switching off the display.

The data updates from the FT-290R microcontroller are not exactly regular; the PIC code (display timing) has been optimised to reduce flicker on the display, but there is a very small amount of residual flicker. This could be eliminated by a more complex design.

The PIC code works best as designed in assembler as it is easy to design the timing for minimum display flicker. The source and assembled code (for programming into the PIC using a PICkit 3 programmer) is at [4].

Conclusion

This modification can breathe some new life into FT-290R series transceivers, and just goes to prove that they aren't impenetrable black boxes.

Websearch

[1] https://groups.yahoo.com/neo/groups/electrichandbag/info
[2] www.retro.co.za/zs1ke/FT-290R/index.html
[3] kevin@avery03.fsnet.co.uk
[4] http://rsgb.org/main/publications-archives/radcom/supplementary-information/radcom-downloads/

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TABLE 1: Pinout of the Display Unit connector (see also Photo 1).

Pin	Signal
1	Vdd (not used)
2	R43
3	R42
4	R41
5	Vss (not used)
6	FC (not used)
7	CE
8	STD
9	R40

TABLE 2: LED pin connections.

Pin	Signal
1-14	Not used
15	segment d
16	segment e
17	K6
18	segment f
19	K5
20	segment b
21	K4
22	K3
23	K2
24	segment a
25	K1
26	segment g
27	K0
28	segment c