An external display for the Kenwood TM-V7

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It was titled the "Blue Wonder" the time Kenwood presented the TM-V7. Unluckily the wonder turned into a disaster quickly: Many of the rigs' displays started to fail soon, noticed angrily by their users: vertical line dropouts or totally screwed up displays left the device unusable. But there might be at least a workaround – read on to learn how!

The Kenwood TM-V7 was more than state-of-the-art at presentation: Introducing a huge dot-matrix display it featured totally new possibilities in HAM communications like the spectrum-analyzer to monitor almost the whole band at once or some kind of "online user guide" for people who didn't want to read manuals on and on just to operate their transceiver.

Simply the joy didn't last too long for many of the owners: Using a glued connection between LCD and PCB instead of a soldered one wasn't a first class solution since the glue ceased rather soon, leading to connection failures and displaying errors. Kenwood offered a cost-free repair service for failing units but stopped it after a few years, leaving users alone whose transceivers failed after that period. Purchasing spare displays seemed and still seems quite impossible, neither eBay nor second hand stores offer parts anymore.

In fact the transceiver would still operate quite well, making it the perfect deal for use at your weekend-site, as scanner or for chats on your local club frequency, but handling it blindly is too much a job for gamblers: Selecting the right frequency with a defective display isn't very funny and you'd have to use a frequency counter while poking around with the VFO knob and PTT key until you'd manage to set your desired QRG.

The TM-V7 incorporates a data port to connect a terminal node controller (TNC[1]). By shorting pins 4 and 5 on that port and by using TTL-to-RS232-converters (e. g. a MAX232) a PC can be used to control the unit (→ figure 1) via the COM port.

This offers the possibility of using tools like Kenwood's "MCP-V7"[2] or "RCV7"[3] by Mike McLendon (KE4U) to program memory channels or – at least with the latter - even fully operate the transceiver via the PC. But: do you really want to fire up your PC just to have a chat with your friends in the evening?

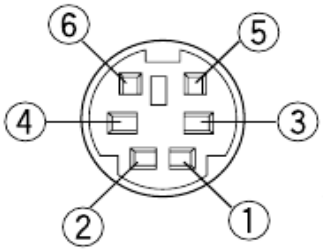

Figure 1: The TM-V7 data port offers the possibility to connect a PC via RS232 (COM port)

1 – NC	4 – connect to 5
2 – GND	5 – connect to 4
3 – TM-V7 RX	6 – TM-V7 TX

Micro-Power

That's clearly a job for a micro controller! Data sent over RS232 via the TM-V7's data port is received and interpreted by an Atmel ATmega8 which sends the decoded values to a HD44780-compatible 20x4-LCD. All important information regarding both bands are displayed simultaneously: selected operating frequency, VFO-, call- or memory mode (and memory

1 Operator's Manual, page 80 - http://www.kenwood-service.com/e_imdl/com/TM-V7/TM-V7-English.pdf
2 http://inform3.kenwoodusa.com/Resources/AMA_SoftwareRCPMCP/Mv7110.exe
3 http://mclendon.info/files/RCV7_2.exe

channel), repeater shift, CTCSS function and tone value, S-meter level etc. And yes: To remain it the "Blue Wonder" it certainly has to be a LCD with blue backlight![4] :-)

Thereby the circuit remains really simple: the ATmega8 runs off the internal 8 Mhz oscillator and the LCD is directly connected in the 4 bit nibble-mode. Connections between transceiver and micro controller don't need any sort of level shifter since both devices operate on TTL levels. Summed up the amount of parts and money figures out to be rather low for this project (→ figure 2).

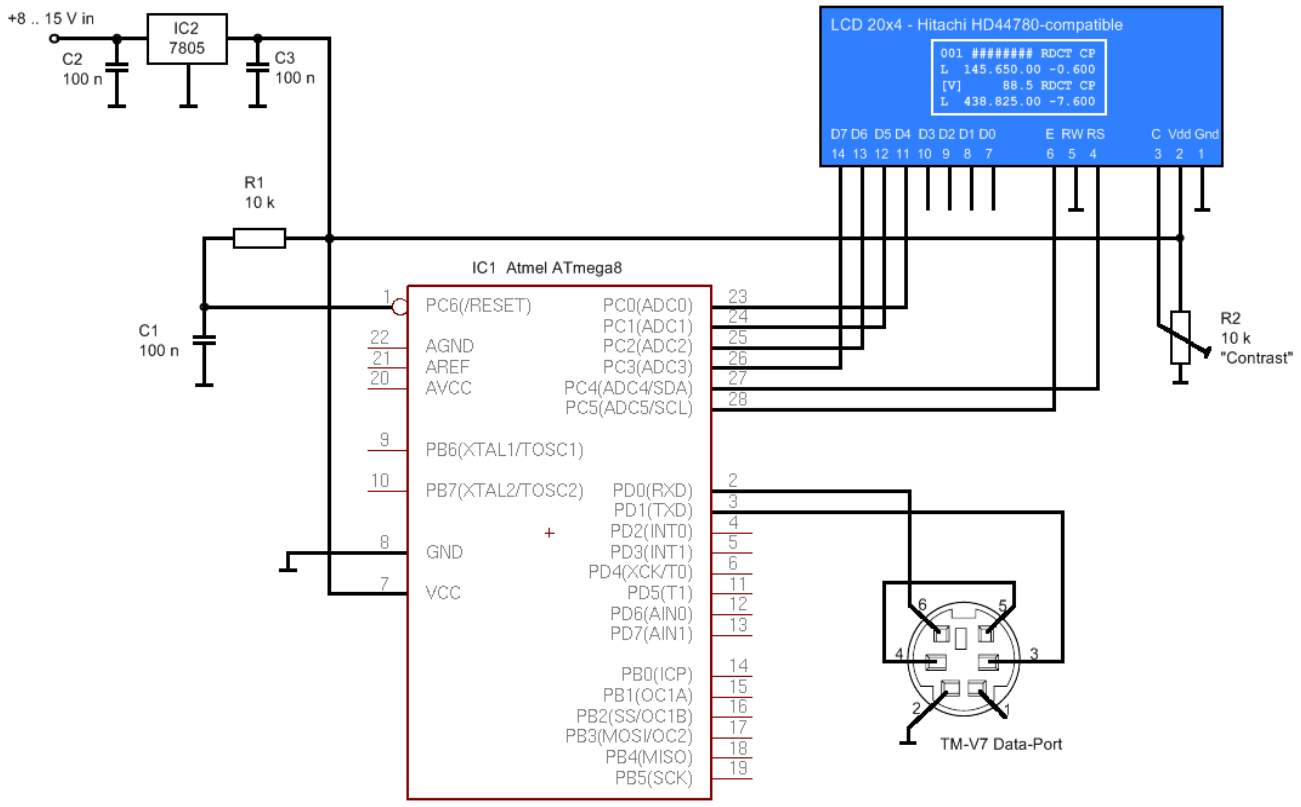

Figure 2: The schema

Coming up to the power supply of the circuit shows one little disadvantage of Kenwood's data port design: There's simply no pin to take power from! You might feed the circuit by an external supply, e. g. the one that also supplies the TM-V7, or you'd want to use the offered +8 V on pin 7 at the microphone jack, which is is able to source 100 mA to 200 mA. The exact amount depends on whom you believe (→ figure 3). At least it's sufficient for our purpose. In both cases you'll want to use a 78(L)05 voltage regulator to prevent the micro controller from being roasted - even when using an external supply there probably won't be +5 V in reach.

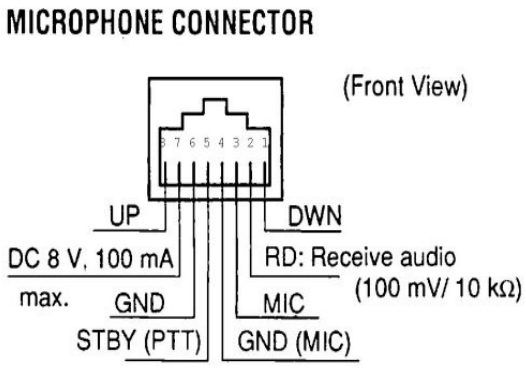

Figure 3: Pinout of the TM-V7 mic jack

4 20x4 LCDs are often offered at eBay quite cheaply.

"Talk to me!"

Kenwood uses a text-based protocol for communication with the TM-V7 – like with its other radios too. Unfortunately the TM-V7's implemented commands aren't documented in public; at least the author spent hours and hours on searching such documentation on the internet. Only for other Kenwood transceivers like the TH-D7[5] and the TM-D700[6] such information is available. By undergoing extensive trial-and-error, after comparing the commands with other models and by analyzing the TM-V7's outputs via RS232 when operating it finally turned out how to control the rig via the data port.

Communication with the TM-V7 means sending and receiving commands and data; separated by exactly one blank (ASCII 0x20) if any parameters are needed. Every communication step is terminated by a simple CR (ASCII 0x0D) *without* a LF (ASCII 0x0A). That's not only true when sending commands to the rig but also when interpreting answers from it. The transceiver can be set to a mode in which it gets very verbose about what it's doing by sending the sequence "*AI 1<CR>*" (Auto-Information = on), making it very chatty about its status. All changes on the VFOs, memory channels, repeater shifts, S-meter levels, power levels, etc. are then reported on the RS232 so the micro controller knows almost everything about the rig's actual state.

Software

The software was designed using BasCom[7]. Received data on the RS232 generate interrupts which is handled in the ISR (interrupt-service-routine), where two FIFO buffers store received bytes. One FIFO stores commands (10 lines @ 5 chars max.) and the other one stores the corresponding parameters (10 lines @ 50 chars max.).

At power-up a power-on-message is displayed for about 2 seconds, after which the connected TM-V7 is initialized. In fact the "Auto-Information" mode is shut down first and the transceiver is set to receive mode. Possilby running scans on boths bands are terminated and the whole transceiver status is checked. Finally the "Auto-Information" mode is activated again to receive and interpret changes made on the unit.

The main program is an infinite loop where a sub routine to process the FIFOs is called continuously. Herein all usable data and state information is stored in variables to ensure the transceiver status is consistently known within the controller at every time. Furtheron all important data for both bands is displayed on the LCD within this main loop. About 8 to 15 loops per seconds are run, depending on the CPU-load produced by RS232-IRQs etc. This should be sufficient for a flicker-free readout.

The software doesn't claim to be fully-featured, somehow complete, perfect or of brilliant design, it's just the best known compromise of several different tries taken during development. More elegant solutions were quite slow, leading to corrupt outputs for example when memory scanning because of too much data to process.

Finally the source code is freely availabe and fairly documented, non-commecial usage for amateur purposes is welcome. Commercial usage without written permission from the author is strictly prohibited.

5 http://www.qsl.net/ta1dx/kenwood/thd7kom.htm
6 http://www.on7lds.net/auto/tmd700a.htm
7 BasCom-Homepage: http://www.mcselec.com/

"On the screen, Scotty!"

Even on a 20x4-LCD there's not much room left to display all relevant data. From the author's view it seemed most logical to use the upper half to display data from band 0 and the lower half for data of band 1; both halfs being organized quite identically.

Special modes of the TM-V7 are announced by using 5 of the 8 user-definable characters of the Hitachi HD44780; the remaining three help to form a bar graph display for S-meter and power level indicator when transmitting.

Description of the displayed data:

```
MMM ###FFF.F RDCT BP
H  QQQ.QQQ.QQ -S.SSS
MMM ######## RDCT BP
H  QQQ.QQQ.QQ =S.SSS
```

M	Tuning mode: "[V]" = VFO "[C]" = Call channel or the selected three-digit memory channel number
#	S-meter resp. power level indicator (8 level bar graph)
F	selected CTCSS frequency in 0.1 Hz steps (only if CTCSS is activated and no S-meter or power level is displayed)
R	inverted "R" = reverse shift enabled
D	inverted "D" = DTSS enabled ("dual tone squelch system")
C	inverted "C" = CTCSS activated in receive mode
T	inverted "T" = CTCSS activated in transmit mode
B	inverted "C" = indicates the active band ("control band")
P	inverted "P" = indicates the band on which transmissions are made ("transmit band")
H	selected TX power level ("H"/"M"/"L")
Q	frequency in 10 Hz steps (the TM-V7 reports frequency in 1 Hz steps, but there is not enough room on the LCD to display that)
S	selected repeater shift in 1 kHz steps "+" ... positive shift "-" ... negative shift "=" ... negative special UHF fixed -7,6 MHz shift (see below) "#" ... positive special UHF fixed -7,6 MHz shift (in reverse-mode)

Just an example from "real life":

```
[V]      88.5     T CP
H  145.650.00 -0.600
007
M  438.825.00 =7.600
```

Transmissions and transceiver control happen on band 0. There is no signal received on both bands (no s-meter) and no transmission is underway on both bands.

On band 0 VFO tuning mode is selected, dialing to frequency 145.650.00 MHz. A negative repeater shift of 600 kHz is enabled. When transmitting the CTCSS system is used at a sub audio tone of 88.5 kHz. Maximum transmission power will be used ("H" level).

On band 1 memory channel 7 is selected, the herein stored frequency is 438.825.00 MHz with special UHF-shift[8]. Medium transmission power is chosen.

Known Issues

The are a few known issues in this project which couldn't be eliminated so far:

- The TM-V7 switches off the "Auto-Info" (AI) function when transmitting on the UHF band. During transmissions on the VHF band no such side effects have been seen. The source for this trouble remains unknown but might not be caused by this circuit, it can be observed also when a PC is connected instead. By sending the "AI 1" command the "Auto-Info" function can be re-activated.
  Different cable lengths have been evaluated and the data lines have been led through ferrite rf filters, not leading to any improvement. It is most likely that the source of the problem is found inside of the transceiver, either being a general problem in the transceiver's hard- and/or software or a dedicated problem with the author's rig.[9]

- With the TM-V7 memory channels can be given a channel-name instead of plain numbers. These names are also reported via the RS-232 connection. Since there is no space left on the 20x4 LCD at least in the author's design, memory channel names received from the TM-V7 are simply not processed, altough the controller had still enough RAM, ROM and CPU power to realize this function.

- Only functions that are in reach via RS-232 communication with the rig are implemented, of course. Unfortunately all settings that are taken via the menu are out of reach for the LCD's microcontroller, namely VFO steps, repeater shift, scan modes (busy/free/timed) etc. These settings still have to be changed in trial-and-error mode without optical feedback since Kenwood doesn't provide commands to change these settings via RS-232 (or they are at least unknown until today).

- Simultanous memory-scan operation on both bands prevent the TM-V7 to interrupt scanning on busy channels if "Auto-Info" function is enabled. Either the microcontroller inside the TM-V7 gets into performance troubles or Kenwood's firmware is just buggy [10].

Finally

Using such a simple circuit a TM-V7 with blown display might be brought back to life again and could be used for simple tasks like memory scans or a local chat. The original display can't be fully substituted, of course, but for one or another rig it might be the last chance to escape the recycle bin.

Translation from German manuscript.

Feldkirch, April 2011.
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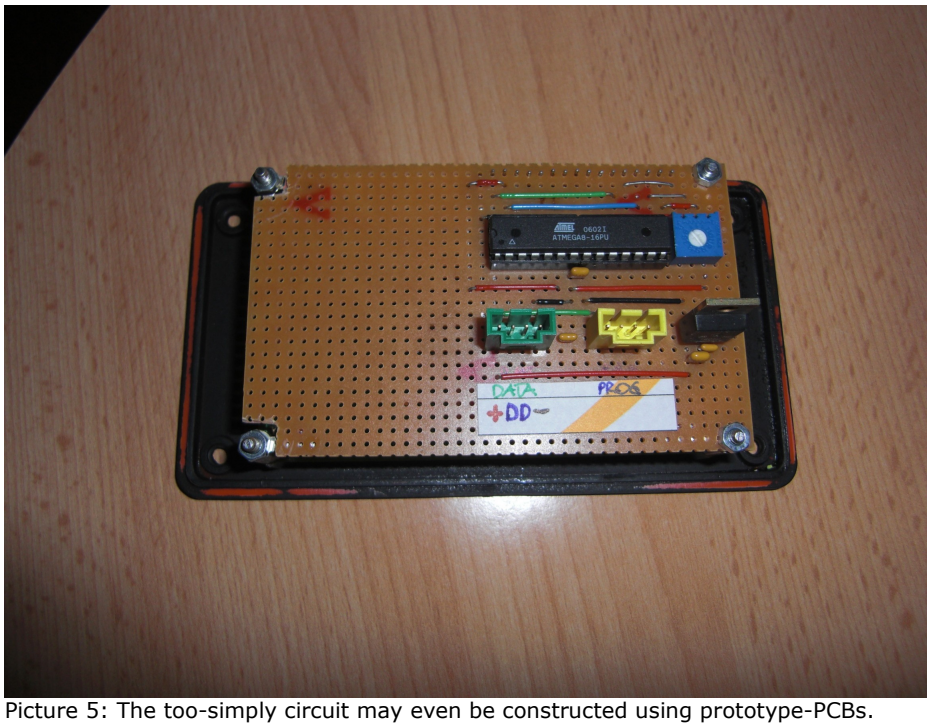
8 Only TM-V7E; fixed shift @ 7,6 MHz. For details see user manual page D-23.
9 Any feedback on this topic is very much appreciated.
10 Mentioned just for full coverage.

Picture 4: The external display for the TM-V7 ready for action!



Picture 5: The too-simply circuit may even be constructed using prototype-PCBs.

Image sources
Picture 1: Kenwood TM-V7 user manual
Pictures 2, 4, 5: own work
Picture 3: http://www.oz1bxm.dk/BS/TM455-MIC-connector4.jpg