

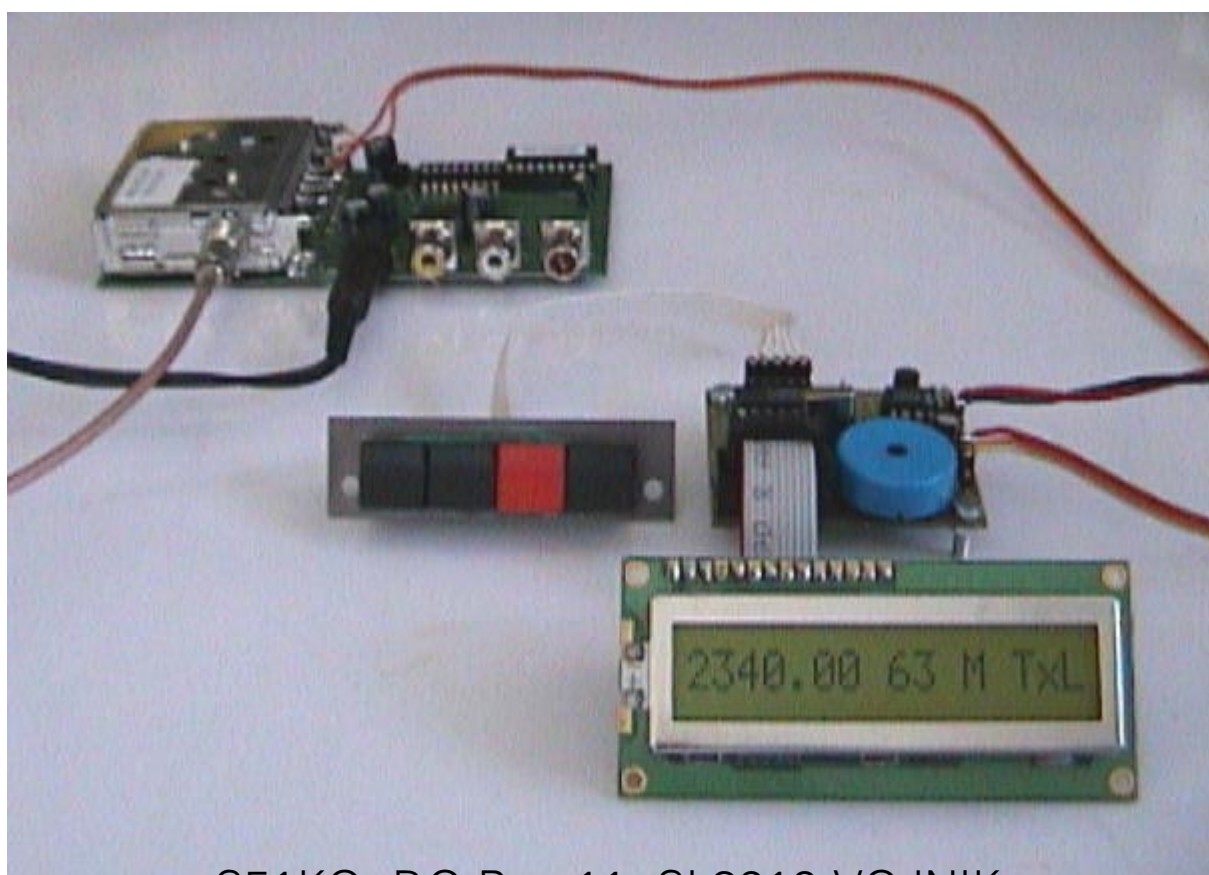


# UNI13P & ATV13P

Controller for 2.4GHz module v2.00

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## Introduction

A few years ago a number of companies started to trade in 2.4GHz LPD wireless modules for Low power audio & video home (room to room) transmissions. These modules are similar to TV or SATV tuners. They are available world-wide and come in different frequency versions for: 900MHz, 1.3GHz and 2.4GHz. The original module maker is COMTECH TECHNOLOGY Co., Ltd from Taiwan, web page at: <http://www.bstuner.com.tw/fm.htm>. The Modules are small, measuring only: 6 x 5 x 1.5 cm. The Transmitter module incorporates a complete PLL transmitter with video modulator and stereo sound modulator with subcarriers on 6.0MHz and 6.5 MHz. The receiver module incorporates the complete PLL HF part of the receiver with main BaseBand FM demodulator, but without sound subcarriers, which must be extracted externally using a simple filter & demodulator.

For practical use of these transmitters and receivers a power supply and microprocessor based controller is required (as they are primary intended for domestic use without the need for a special radio licence), also for the receiver a demodulator is needed for the audio subcarriers. They are generally

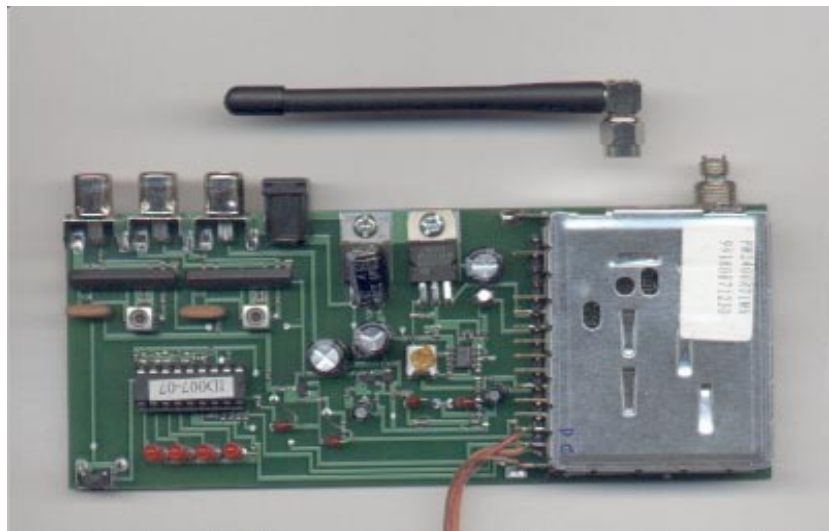


Figure 1 - 2.4 GHz stereo 4 channel transmitter

available on the world market in similar forms to figures 1 and 2, but such versions are not really suitable for Radio Amateurs. The main reason for this is that the original microprocessors are pre-programmed with 4 fixed ISM (LPD) channels which are not within the 13cm HAM radio band. These units are available from a number of companies (using the same modules) in some attractive plastic housings designed for domestic use. However buying the units in these PVC housings puts the price up to at best twice and in some cases triple.

Bare modules as seen on figures 1 and 2 (with additional

controller boards) are available, with the best prices in USA from MATCO Inc. (<http://www.matco.com>), EzATV (<http://4atv.com/index.htm>), and in Europe - Germany at WIMO GmbH (<http://www.wimo.com>), in France: PICOTRONIC F1GE (<http://hometown.aol.com/atv13cm/myhomepage/index.htm>) and INFRACOM (<http://www.infracom-fr.com/indexg.html>). Direct links for all of these pages are available on our web page, in the Hardware sub area. The UNI13P project is also to be found on the same page.

Some time ago one of my friends (S56EJL) came to me with these 2.4 GHz modules (as show in figures 1 and 2) with a request to build an external controller for HAM radio ATV usage. The modules were ordered from USA, but as there was only one pair available to me at that time and development of a new controller can take a week or two I was at that point hesitant to start a new project with very limited equipment. Some months later other companies were found on the WWW with the same products. Stefan, DC5MPC sent me information about Wimo in DL who also trade the same modules here in Europe. The idea for HAM controller became more and more interesting to me, and therefore this

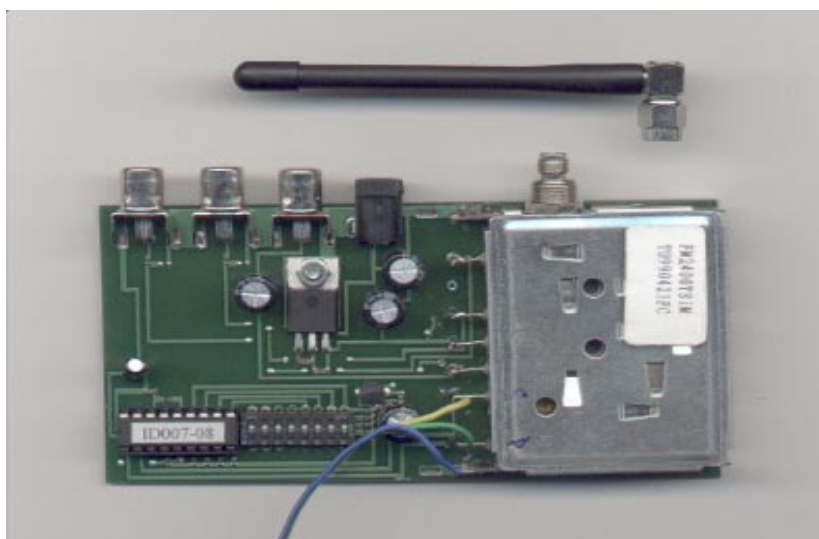
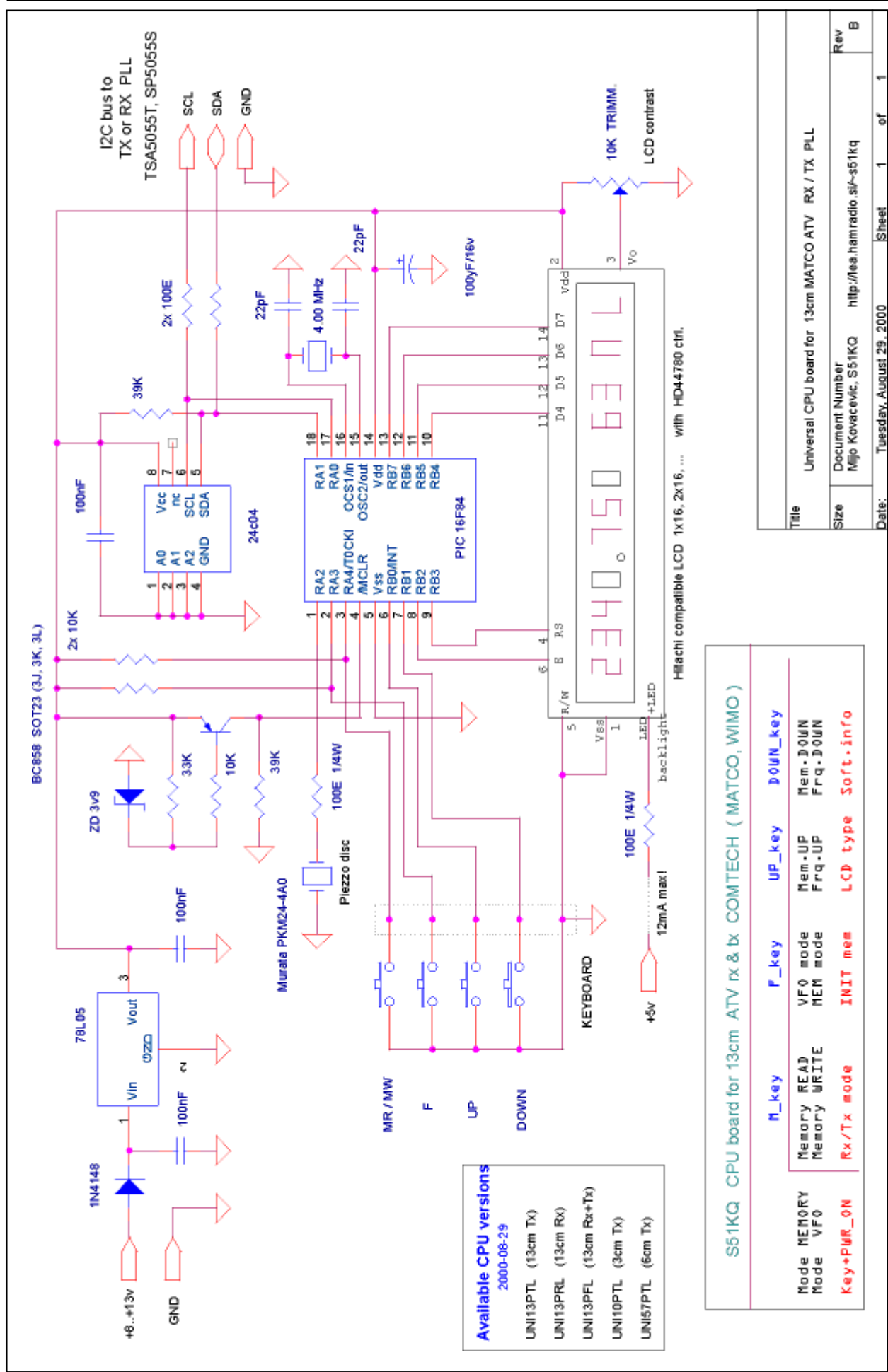


Figure 2 - 2.4 GHz stereo 4 channel receiver



**Available CPU versions**  
 2000-08-29  
 UNI13PTL (13cm Tx)  
 UNI13PRL (13cm Rx)  
 UNI13PFL (13cm Rx+Tx)  
 UNI10PTL (3cm Tx)  
 UNI57PTL (6cm Tx)

**S51KQ CPU board for 13cm ATV rx & tx COMTECH ( MATCO, WIMO )**

Mode MEMORY	VF0 mode	VF_key	UP_key	DOWN_key
Mode VFO	MEM mode	VF0 READ	Mem-UP	Mem-DOWN
Key+PWR_ON	INIT mem	VF0 WRITE	Freq-UP	Freq-DOWN
			LCD type	Soft-info

Title	Universal CPU board for 13cm MATCO ATV RX / TX PLL		
Size	Document Number	Miljo Kovacevic, S51KQ	http://mes.hamradio.si/~s51kq
Rev	B		

Date: Tuesday, August 29, 2000 Sheet 1 of 1

project was started.

### UNI13P controller

The UNI13P controller board was developed in just over two weeks including software support for a 13cm ATV receiver, as well the software support for a 13cm ATV transmitter, and latter for 3cm and 6cm transmitter. Over the next week the stand-alone Windows software package was developed. The Windows software and interface pack is intended for stand-alone control of both modules without the need for a UNI13P hardware based module controller. There are further details of all variants at the end of this article. And, at the time the article been written, the software support for 23cm modules is under development.

During the development stages I adopted a KISS approach to the UNI13P controller (figure 3) keeping in mind ease of build and use. The project was named as UNI13P as it is similar to other projects using my UNIPLL board. The heart of this new project is the now well known microcontroller manufactured by Microchip Technology Inc. The PIC 16F84-04, in DIL form, with FLASH program memory area. Yes the PCB could be smaller if we adopted the use of the SMD version but this would complicate future software upgrades using a parallel professional Programmer.

A Project of this nature is useless without adequate software, therefore all major functions are 'hidden' in the software inside the microcontroller. The user status monitor is a single line (or dual line) 16 or 20 character LCD. The LCD is connected in 4 bit mode (4 MSB of the LCD) along with two control lines making a six wire (plus power) connection to the LCD. There is not enough free I/O lines on the PIC (or the need to) run the LCD in 8 bit mode. The PIC16F84 runs on a 4.00 MHz

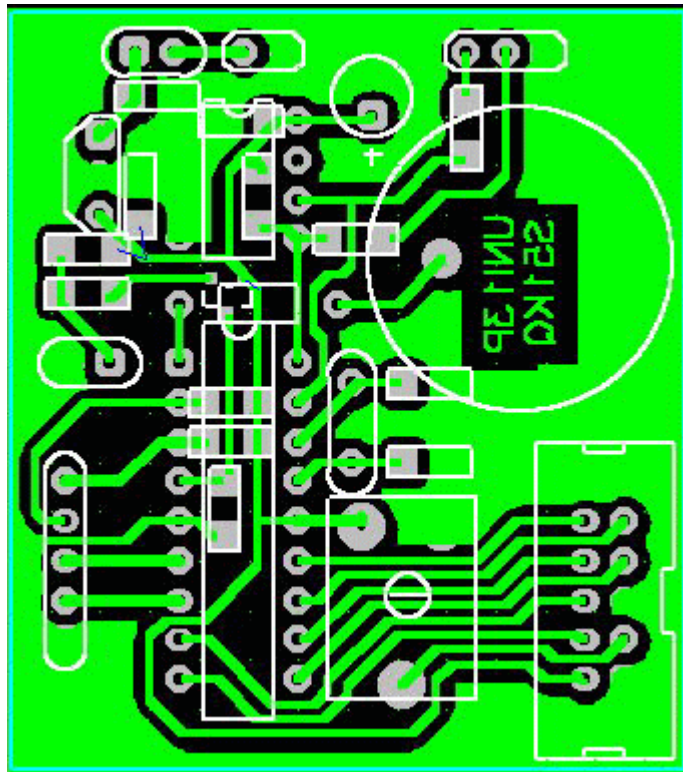


Figure 4 - Single sided UNI13P board

clock, with the help of an external crystal and two 22pF SMD capacitors, connected to ground.

The keyboard is connected directly onto microcontrollers I/O lines. There are only two external pull-up resistors needed on the pushbuttons connected to RA3 and RA4 inputs. The PIC16F84 microcontroller has its own internal pull-ups on port B only (RB0...RB7). These pull-ups are switched ON in software, eliminating the need for external pull-up resistors. By reviewing various PIC projects on world wide web though it can be seen that many designers are not aware of this facility, or simply don't know how to use internal pull-up's. I have found the internal pull-ups on this microcontroller be very stable and safe to use.

In order to be sure of a 'clean' power-up the UNI13P uses an external reset circuit. The reset circuit is made from: PNP transistor (this is a BC858 in SOT23 casing), three resistors, plus one Zener diode. There is also one

Piezo beeper - The Piezo transducer (not stand alone oscillator) used in project is connected on to microcontroller via 100E resistor. Beeps are made purely with software.

The 2.4 GHz modules are controlled via an I2C bus. The I2C protocol is generated in software on the PIC16F84 using RA0 and RA1 I/O lines. There is one pull-up resistor needed on the I2C bus. In this case the SDA line of the I2C bus (bidirectional serial Data line) needs an external pull-up (note: port A does not have internal pull-ups). An external EEPROM is used for memory storage. Why? The wireless modules run on an I2C bus and as the software for I2C support is already built in it is an easy task (in software) for external memory (also I2C) to be used. Moreover, if some of the memory locations die in during its life time, an external eeprom can easily be exchanged with new one. For this reason the DIL version of EEPROM was selected.

Power consumption of the UNI13P is very low, therefore



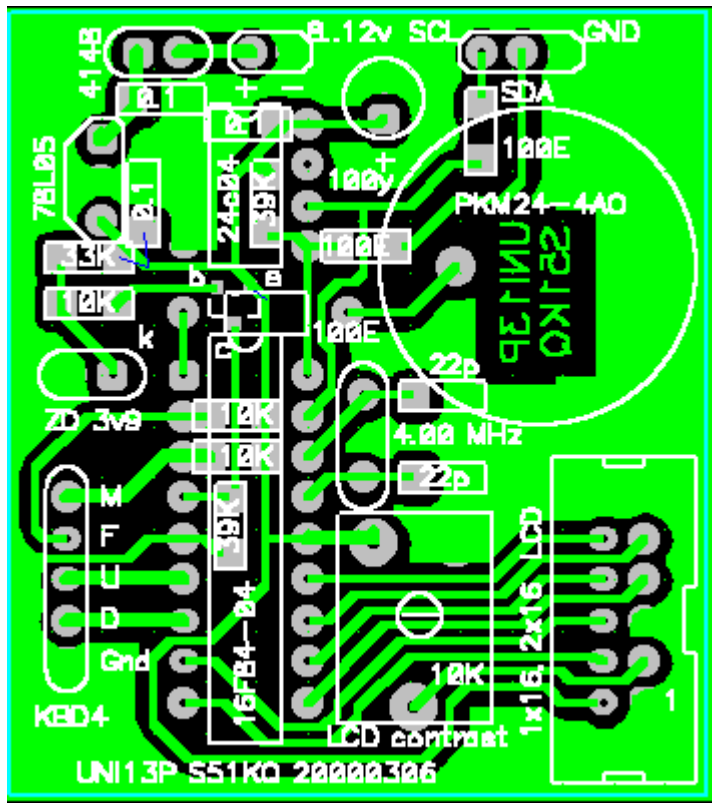


Figure 5 - Componet placement with values

a 78L05 voltage regulator can be used to generate the +5v supply. An Idiot diode on the supply line will protect the circuit against reverse polarity of the supply. Also it will reduce the input voltage to the voltage regulator. If the LED illuminated type of LCD is used, the constructor must take care to consider the illumination current. Due to a 78L05 being used, illumination current should not exceed 12-15mA (figure 3, below).

**Construction**

The printed circuit board is single sided, measuring approximately 4.5 x 5cm.. The PCB is shown on figure 4. As we needed to minimise the circuit board, SMD components are used. All SMD elements are 1206 (or 0805) size. There is one 100E standard resistor used for the piezo transducer and a second (if required) for LED illumination on LCD ( this is soldered directly onto the display).

Constructing begins with a visual check of the printed cir-

cuit board. If all lines are ok, SK10 soldering spray is used to deposit the flux on board. Assembly begins with lowest components (SMD's). Superspeed cored solder

wire 0.7mm or less, should be used (made by Frys Metals Ltd.U.K.). All SMD parts should be turned to the same direction, so the values can easily be read (figure 6).

Next the reset transistor, a BC858 is used (any type with codes:3J,3K,3L), or equivalent PNP transistor can be used. After all the SMD's are soldered on, normal components can be soldered onto the top of the PCB. The Microcontroller and EEPROM need professional turned pin type sockets. A Single line female SIL socket is used as the keyboard, I2C bus and power supply connector. The connector for LCD is a standard IDC male connector, and IDC female is fitted onto the flat IDC cable going onto the LCD. Pin numbers on the IDC connectors are pointing in the same direction as numbers on LCD connector.

The 4 MHz crystal can be replaced with a 4 MHz (2 wire) ceramic resonator in order to reduce costs. The software inside the microcontroller don't need an exact and very stable clock, therefore the ceramic resonator will do

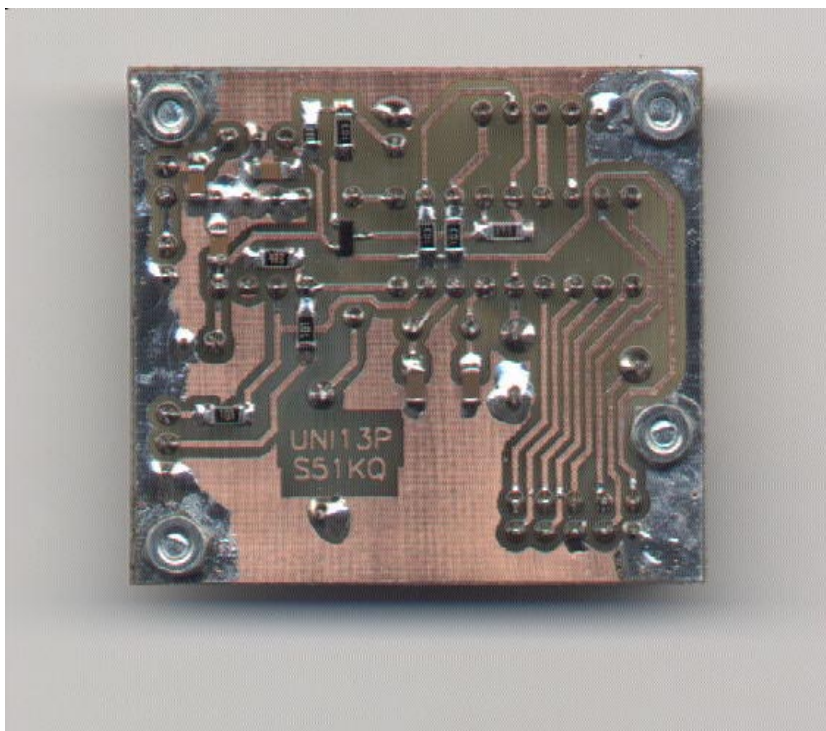


Figure 6 - Bottom view on to UNI13P controller



Figure 7 - Ready to use UNI13P controller prototype

the job.

### First run of UNI13P

The finished (soldered) PCB should be cleaned with brush and proper liquid (Similar to 'Fluxclene') and if required dried with hair drier. Next SK10 spray (or other conformal coating) is used to protect the soldered joints on the PCB. It is now time for a final

error check of the PCB, and if all is well, the PCB can be connected complete with the LCD and keyboard, plus a +12v power supply (via an Ammeter). The maximum current that is allowed (LCD with LED backlight on) is below 20mA. Without The LED backlight the current should be approximately 6mA. If the current exceeds these readings, then something is wrong. Attention: The 78L05 has its input on the right-hand side, and output on left (Opposite to a 7805)

! The correct position is printed on the printed circuit board (see figure 5), The signature on the 78L05 should be facing the Piezo transducer.

After the unit is powered the welcome message will be displayed, followed by the frequency, mode (VFO/memory), memory number, and the PLL Lock state on the right (figure 7). On the first run the frequencies will be false, as the EEPROM was not initialised. This can be done with the following power\_on function: Turn the UNI13P module OFF, push and hold down the "F" button, then turn the power to the module ON, wait until a message "EEPROM Init.." or "INIT..." to be displayed on the LCD, now release the "F" button and wait for the process to end.

Using this software is very similar to my previous ATV projects (UNIPLL, ATVRX2). The UNI13P is provided with 64 user selectable memories, with one VFO with a frequency step of 250 kHz. There are some other 'hidden' Power\_ON functions built in, these are: "UP+Pwr\_ON" to change the used display type (single line/ double line). "DOWN+Pwr\_ON", The software identification with software version and date will be displayed. "MR/MW+Pwr\_ON" to toggle between RX and TX mode in UNI13PFL RTX software, only! At beginning there was no free space



Figure 8 - LCD snapshots (various software)

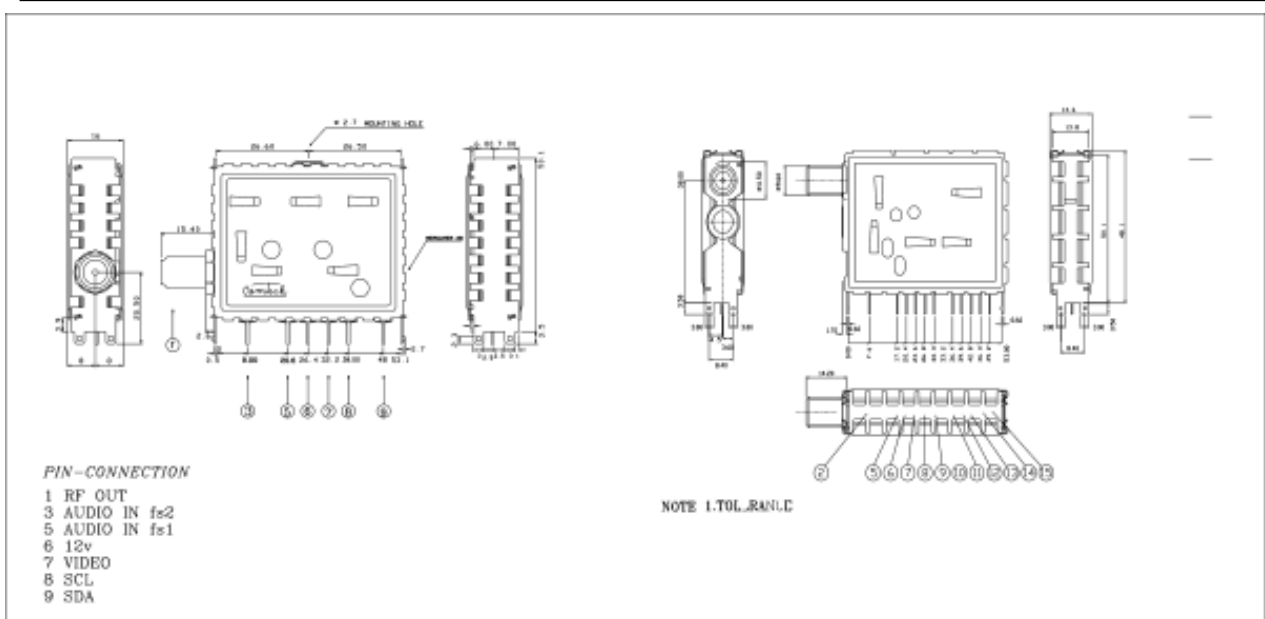


Figure 9 - Comtech 2.4GHz modules I/O

for sound routines in the RX program area of the microprocessor (UNI13PRL). RX software is extended with IF mathematical routines, and there was not a single free byte left for anything., until I optimized and build in some new routines.

Supply voltage for UNI13P board can be now delivered from TX or RX module. The I2C bus should be now connected to UNI13P. First the SDA and SCL wires from original 4 channel controller must be disconnected (left open). The UNI13P I2C bus is connected with 3 wire flat cable directly on to RX or TX 2.4GHz module. If all well, after next power\_on the 2.4GHz module will start, locked on to frequency selected on UNI13P controller. This can be also checked using a frequency counter, spectrum analyser and HF generator. Note that after every power\_on, memory "00" and memory mode is selected. Both of the COMTECH modules used in UNI13P development process were found to be operational over a wide frequency area between 2000 and 2700 MHz.

The completed device (HF module plus UNI13P controller) can be mounted in any type of box. The best type is a metal one, (es-

pecially if project is intended for use on mountain repeater site) !!. Also the LCD not need to be connected onto UNI13P all of the time. The controller will operate properly regardless of the LCD connection.

### Using AWW314 modules

There are some other 13cm modules (made by AIR-WAVE ?) on the German market under name "2.4GHz Video Sender" Model No.: AWW314

(Conrad electronics). Both modules are built in some attractive plastic housings designed for domestic use, figure 10. However buying these low cost units in PVC housings may be a risk. Therefore we tested that particular type. Both modules are very different from modules build by Comtech, but they can be controlled using UNI13P v2.0 without any changes on UNI13P controller. Under operation they are a bit cooler than those from Comtech. They use SP-5055S PLL circuit in Tx module and



Figure 10 - AWW314 2.4GHz module



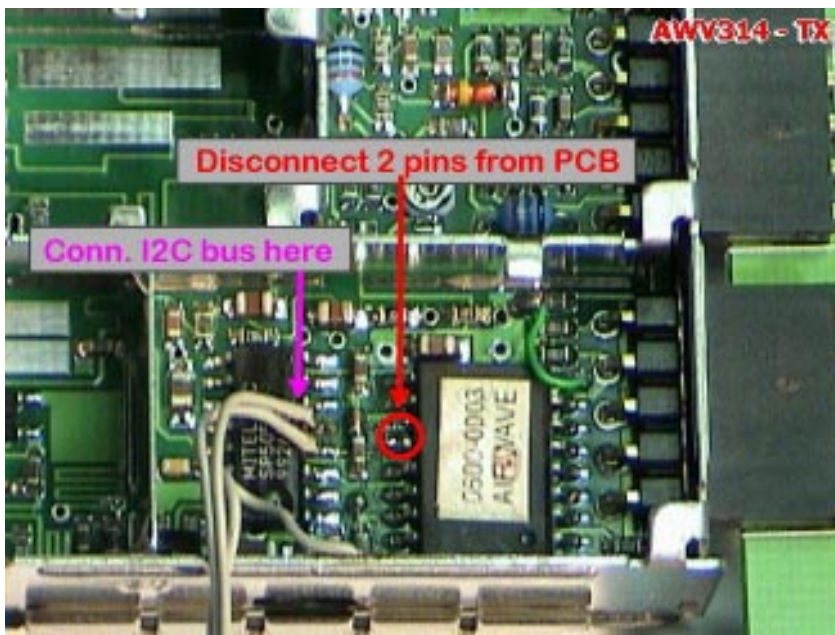


Figure 11 - Connecting UNI13P to AWW314 Tx module

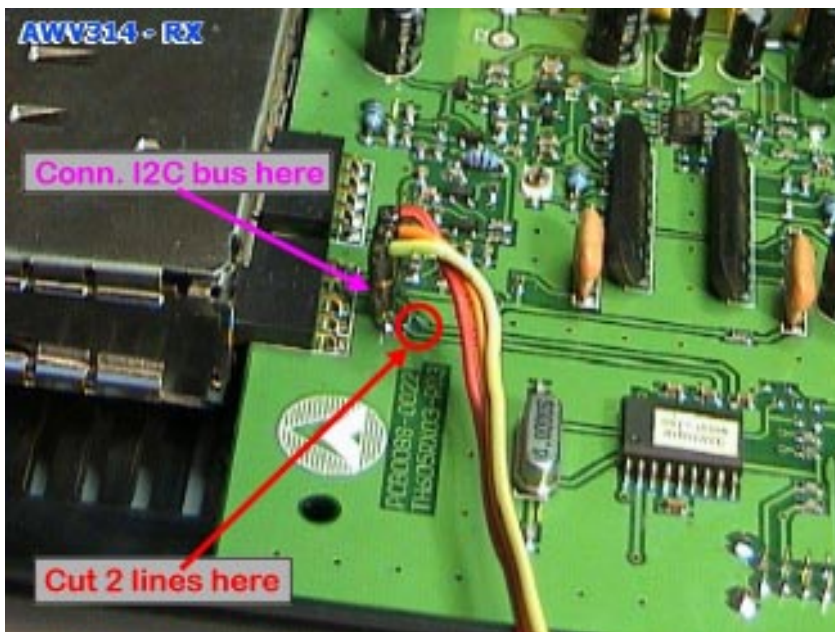


Figure 12 - Connecting UNI13P to AWW314 Rx module

TSA-5055T in Rx module. Tested Tx module can be tuned only from 2329 MHz up to 2650 MHz, and the PLL locks very very slowly! Tested Rx module can be tuned only from 2220 MHz up to 2528 MHz.

How to connect "Video Sender" to the UNI13P? Tx module must be completely disassembled (figure 11). Carefully

cut the AWW314 Tx CPU pin 12 & 13 out of the PCB. Now connect the tiny 3 wire flat cable, on to SP-5055S. First wire is GND and should be connected to chassis of Tx module, second wire is SDA and must be connected to pin 4 of SP-5055S, third wire is SCL and must be connected to pin 5 of SP-5055S. Assemble all parts together and Tx is ready for run. On Rx PCB cut - brake a part two lines

that goes out from Rx CPU pin 10 (SCL) & pin 11 (SDA), as shown on figure 12. Connect GND to the chassis, connect SDA & SCL to the Rx module (on PCB), and the receiver is ready for ATV use.

The general impression is: if you have an AWW314 at home, then use it. But if you seeking for a new 13cm modules, then select the TX from Comtech (MATCO, WIMO), and the RX out of AWW314 pair (Conrad). Comtech TX is the best choice, have more output power, frequency range is wider: 2.0 GHz up to 2.7 GHz, without any problems, and the PLL locks faster. AWW314 RX seems to be a bit less sensitive, but the picture output quality was quite better (due to more complex deempfazis and video stage - external circuit on big PCB).

### ATV13P package

Once the UNI13P was completed, an interesting idea for a stand-alone PC software package came to me. For use with Window95 and Windows98 operating systems the ATV13P software was born (figure 13). An in depth discussion won't take place here only most important points will be presented.

This software is a bit different from my previous PC software packs. There is no drop down menus, and no extra help files. Instead there are mouse hints (short help) known from my other software packages. ATV13P is a single package for both the TX and RX modules. There are only 10 memories, plus one VFO with few predefined frequency steps: 125KHz, 250KHz, 500KHz, 1MHz, and 10MHz. All changes in software are memorised without any special commands on software exit (Except for Memory write). A few additional functions are built in, like: I2C bus scan (search for active I2C slave devices), detect PLL Lock state. The software communicates with HF modules via a



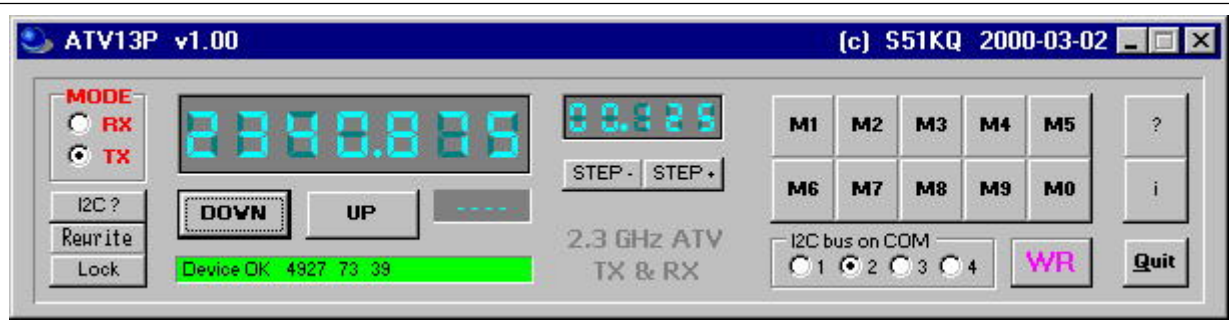


Figure 13 - ATV13P Win95/98 software 1st release

very simple RS232 / TTL interface, shown on figure 14.

The ATV13P software pack is unfortunately not freeware. It will be traded by various companies worldwide. Therefore one third of the complete package is a complex mathematical security system against unauthorised copying and distribution. A Demo version of the ATV13P package can be downloaded free from our web server. The Demo version is fully functional, except for I2C communications and registration were not build in. The full operational version can be obtained from the author. An new ATV13P version will be released soon, supporting 1.2GHz, 10GHz (with help of ex-

ternal multiplier by 4), and 5.7 GHz (with help of external multiplier by 2) in TX mode.

### Conclusion

Both of the projects UNI13P and ATV13P were designed and built in two weeks, and few days after publishing on the WWW became real top hit project. Both are fully usable with the Comtech or similar 2.4GHz wireless modules, those can be ordered from companies around the world. The transmitter module output is only approx.30-100mW, but this is enough to drive further power amplifier stages...

The current receiving module does not run as hot as some of the older 2.4GHz RX modules (sold by Conrad in DL). Also the receiving sensitivity is a bit better, therefore they can be successfully used for 13cm ATV. The UNI13P hardware part is also full compatible for controlling of other S51KQ, plus S52ME ATV projects with frequency multiplication for 2.3GHz, 5.7GHz and 10GHz, based on Siemens 6102-5X PLL, Philips TSA-5055T and Mitel SP-5055S circuits. No hardware changes are needed, only UNI13P cpu will need to be changed with an adequate cpu for such project.

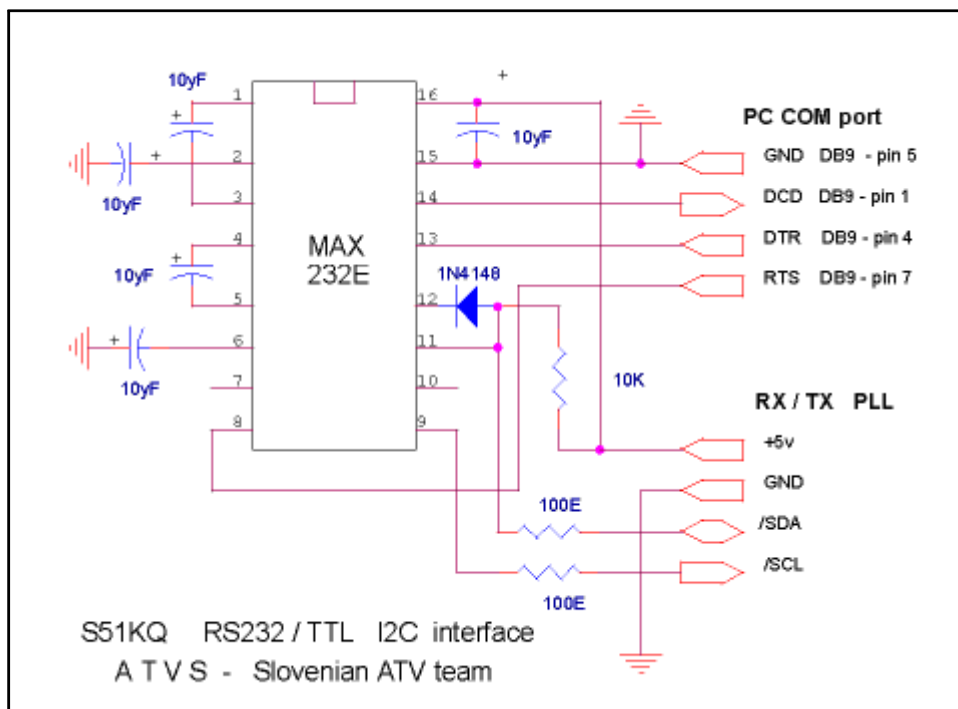


Figure 14 - Simple RS232/TTL ( I2C ) converter