ATV Controller for Comtech Modules - Construction manual

When constructed this kit will allow the control of Comtech transmit and receiver modules, it may also control modules from other manufacturers which use the TSA5055 or SP5055 PLL I/Cs.

Features

- Rotary tuning
- 125KHz channel spacing
- Seven VFOs each for transmit and receive
- Bar graph "S" meter
- PTT with on-board transmit power switching, PA and antenna change over sequencing
- VFO and band scan modes
- 13 or 23cm operation with the same software*
- Linking of transmit and receive VFOs*
- Auto-net function*
- Receive only function*

** By menu selection*

A 16 character by 2 line LCD is used to display transmit / receive frequencies, "S" meter and menu functions. Versions are available with and without back-light.

Operation

This unit's functionality can be best appreciated from a description of its operation.

Normally both transmit and receive frequencies are displayed, a ">" symbol in the right hand column points to a label on the front panel to indicate which function is current. Receive frequencies and VFO number are display on the top line, transmit on bottom. The 3 press buttons function as follows:

VFO

Each press on the VFO button increments the selected VFO, the ">" symbol indicates which VFO is affected. Note that if "Linked VFOs" is turned on in the menu, both transmit and receive will advance together. There are seven VFOs each for transmit and receive, three have special uses; VFO 0 will be overwritten by the band scan function, VFO 5 holds the lower band scan limit indicated by "SL" and VFO 6 holds the upper band scan limit indicated by "SU".

Mode

Pressing the MODE button toggles between transmit and receive adjustment mode, the ">" symbol indicates which is active.

PTT

Pressing the PTT button initiates the transmit sequencing, the order and timing is as follows:

Immediate	Energise antenna change over relay
50mS	Turn Tx module power on
150ms	load synthesiser with transmit frequency
250mS	Switch on power amplifier

A second press returns to receive, sequencing as follows:

Immediate	PA power is turned off
100mS	Tx module power turned off
200mS	Antenna change over relay de-energised

Scan Functions

Pressing both VFO and Mode buttons together will start the band scan, the start frequency is held in Rx VFO 5 and the stop frequency in Rx VFO 6. Holding both buttons for a couple of seconds will start the VFO scan. Pressing any button or turning the rotary encoder whilst scanning cancels the function.

"S" meter

Pressing and holding the MODE button for more than 1.5 seconds will set the "S" meter, this will be displayed on the second line of the LCD display.

Set-up menu

Pressing and holding the VFO button for more than 1.5 seconds will enter the menu system, changes can be made to each setting with the rotary encoder, store each setting by pressing the VFO button. The menu can be exit at any time without storing a change by pressing the MODE button.

Set-up menu functions

"Set IF Frequency" - On receive it's possible the programmed IF offset doesn't accurately reflect the module's IF frequency, a facility is therefore provided to adjust the internal IF offset so the displayed frequency matches that being received. With a weak signal of known frequency tuned so the display indicates the correct frequency, enter the "Set IF Frequency" mode and use the rotary encoder to adjust the IF offset for the best picture.

"Set Autonet" - If set to "On" receiver will automatically tune to transmitter output when the transmitter is powered up. When set to "Off", receive operation isn't affected.

"Set System" - Change to "Receive only" to permanently display the "S" meter, would normally be used without a transmitter module as all transmit functions are disabled.

"Set Band" - Select either 13cm or 23cm as appropriate, note that when the band is changed all the VFOs are set to default frequencies.

"Linked VFOs" - If set to on, when changing the selected VFO Rx and Tx VFOs change in unison.

System reset

If the eeprom becomes corrupt normal operation may not be possible, to reset, hold down the VFO button and cycle power, all internal settings will be restored to their default values.

Circuit Description

Comtech modules are normally supplied with on board microcontrollers, these instruct the PLL I/Cs within the "cans" to go to specific frequencies selected via. DIP switches. The ATV controller talks to the PLL I/Cs directly making the existing micro redundant, they should be removed from their sockets and kept in case they are required for de-bugging.

The "brains" of the system are provided by a PIC16F628, this controls the display, which is used in the 4-bit mode. Data is output from RB4-7 with control from RB1 (Rs), RB3 (En), and RA1(R/W). The pushbuttons SW2-SW4 are also multiplexed in to RB4-7, an active low key enable signal is taken from RA7. During display use, RA7 goes high reverse biasing diodes D1-3 so isolating the switches. The rotary encoder is input to RB0 and RA5, this function is interrupt driven for smooth operation.

The synthesiser ICs within the Comtech modules are controlled via I_2C [Note 1]. As the receiver "S" meter pin is shared with the I_2C address selection pin, independent device addresses can't be set up, there are therefore separate SDA outputs for transmit and receive. Diodes D4-6 are incorporated to isolate the modules from the I_2C bus when either module is powered down. The Tx SDA line is not isolated, the pin level is periodically checked to determine if the transmitter is powered (for the Auto-net function).

Transmit sequencing is generated from RA3 (PA on), RB2 (antenna relay) and RA6 (telltale LED and transmit module power). Antenna relay and PA switching are provided by open collector outputs, these may be used to drive relays directly (remember to place back EMF protection diodes across the relay coils).

A "confirmation bleep" is provided from RA0 by the filter R16, C3 and R17. This may be connected to the receiver audio output or alternatively to a piezo sounder by omitting C3 and fitting links in place of R16-17.

The "S" meter is input to RA1, R12 is included to limit current as the port pin is also used for display R/W.

The power for microcontroller and display is derived from the receivers 5V regulator, typical power consumption measures 2mA on receive and 10mA in transmit. This extra load shouldn't cause any problems for the receiver regulator, although on the 23cm version the regulator will run hot. Power for the LCD back-light is taken from the 12V supply via resistors R3,4,7,9 and R15 in

series, these have been calculated for an LED current of about 110mA. The display brightness may be adjusted by substituting different resistor values, the maximum current is 140mA with an LED forward voltage of 4.2V.

Note 1 The I^2C bus was invented and patented by Philips, please refer to documentation available on the internet for a proper description. The basic idea is that two-way communications can be made between I/Cs within a system using just two wires and ground.

Components

Component Reference	Quantity	Part Description
C3	1	4n7
C1,2,4,5,7,8	6	100nF Ceramic
C6	1	10uF 16V Electrolytic
R3,4,7,9,15	5	18R
R10,13	2	470R
R12,21,22	3	1K
R11,14,16,20	4	4K7
R1,2,5,6,8	5	10K
R17,19	2	15K
R18	1	2K2 Preset
D1,2,3,4,5,6,7	7	1N4148
D9	1	1N4001
D8	1	Hi Efficiency Red LED
Q1,2,3	3	BC337
Q4	1	BC327
IC1	1	PIC16F628P-04 (Programmed with ATVC V3.x)
SW1	1	Rotary encoder
	1	Bracket, rotary encoder
SW2	1	Momentary push switch, red
SW3,4	2	Momentary push switch, grey
DISP1	1	2*16 LCD
	2	M3*8 Screw
	4	M2.5*8 Screw
	4	M3 Nut
	8	M2.5 Nut
	2	3mm Shake-proof washer
	2	3mm Plain washer
	4	2.5mm Shake-proof washer
	8	2.5mm Plain washer
	1	18 Pin I/C Socket
	1	PCB, ATV Controller main
	1	PCB, ATV Controller sub

Notes on components

For a piezo sounder omit C3 and fit links in place of R16 and R17. For receive only operation SW2, SW3, D2 and D3 can be omitted.

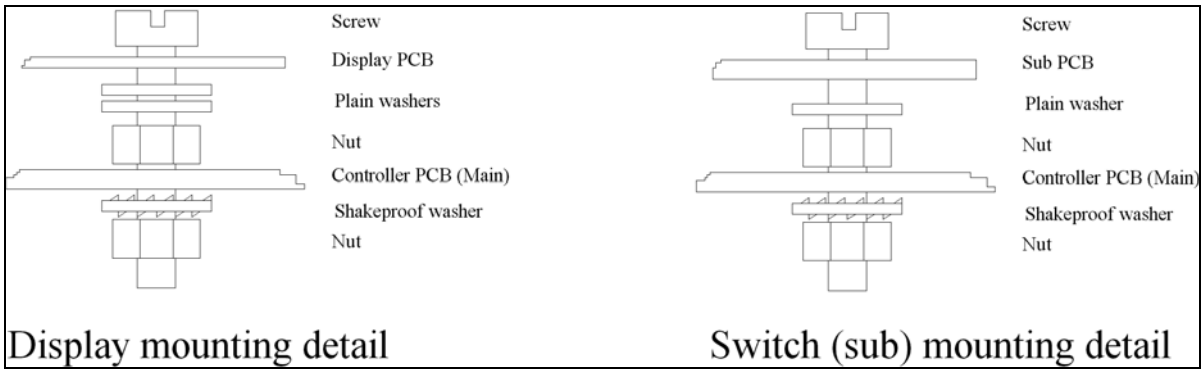
Construction

The PCB has been designed for both backlit and non backlit displays. Backlit displays are thicker in profile, a sub-PCB has been supplied to space the buttons off the board if required. A template is supplied to mark out the front panel for switch positions etc. It is possible to build the PCB for receive only, and for transmit without the relay sequencing functions fitted. For receive only function, MODE and PTT switches need not be fitted.

Firstly prepare the PCB by fitting the four links. Next fit all components starting with the lowest profile, suggested order is:

Resistors, capacitors, diodes (not the LED yet) transistors and rotary encoder. The bracket should be clipped onto the rotary encoder before it is soldered in place, if it's shaft will be too long, this should also be cut before fitting in place

The display should be fitted using four M2.5 screws with a nut and TWO washers between display and PCB, this should give a small clearance between display and control PCB, see sketch. The screws at top of display should be fixed into the slots as far as they go. On no account should any part of the display touch the PCB; if stress is placed on the display it will fail.



There are a few differences in assembly dependent on the type of display used:

Non-backlit display - the three button switches SW2-4 can be fitted directly to the control PCB.

Backlit display - as the display is thicker a small sub PCB is supplied to mount the button switches, this allows the buttons to be spaced about 3mm off the PCB surface to maintain the correct projection through the front panel. Solder the switches in place on the sub PCB, then thread some short (20-30mm) pieces of tinned copper wire through the front and solder to the pads. To hold in place whilst soldering it is best to bend the wire over the top of the sub PCB. Fix the sub panel to the control PCB using two M3 screws, place a nut and washer as spacers between both PCBs.

Connections to the display are made with pieces of tinned copper wire passed through the display and into the control PCB, soldered top side on display and track side on PCB. The transmit "tell-tale" LED (D8) should be fitted so it will correctly protrude through the front panel, note that the anode (+) is the longest lead.

Before applying power check that the 5V input (pin 4) is connected to a 5V supply, excess voltage will destroy the display and microcontroller. Adjust R18 fully clockwise, with power applied re-adjust for correct display contrast.

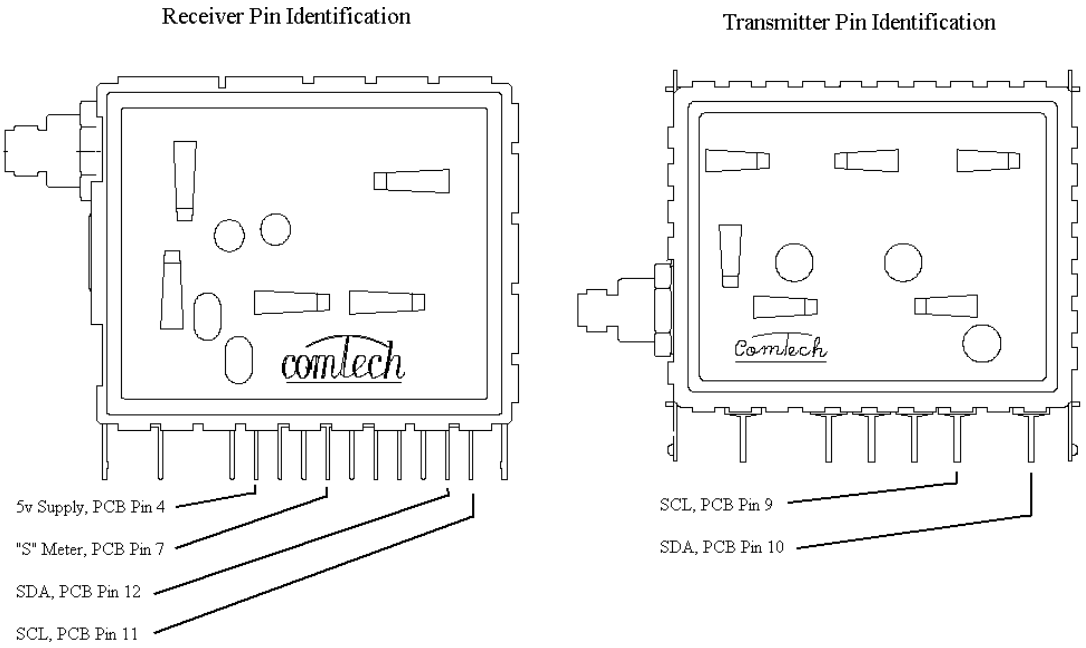
Making the connections

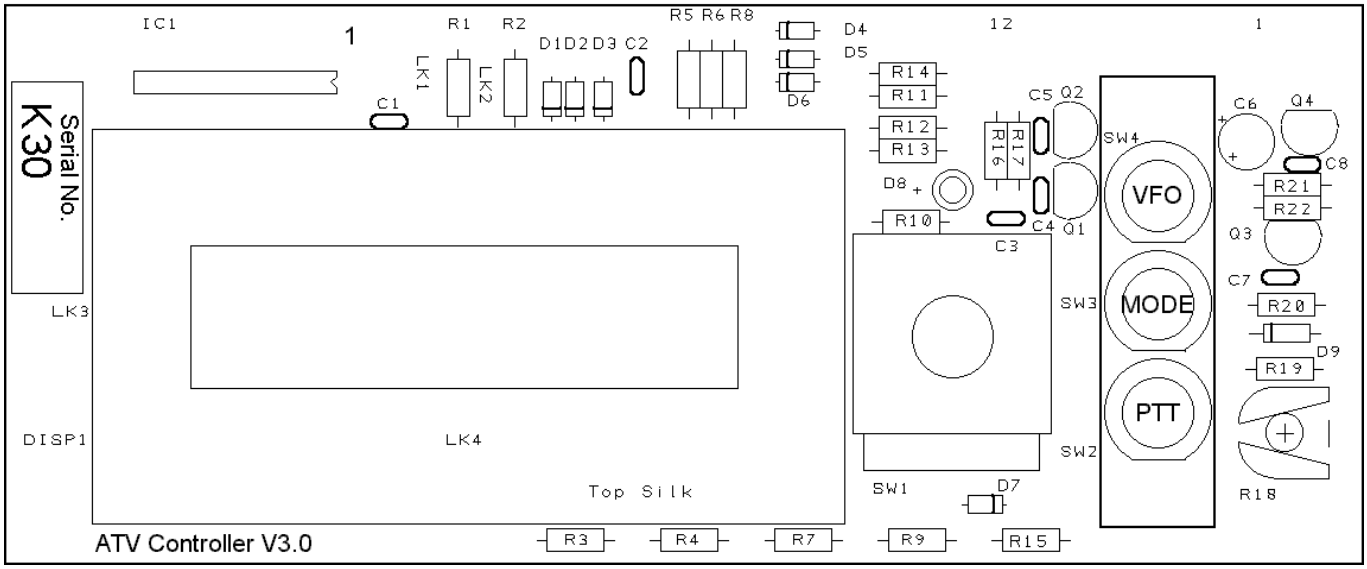
Firstly label, then remove the existing microcontrollers from receiver and transmitter PCBs, keep safe in case they are required later. Follow table 1 for interconnections to transmit and receive PCBs, extracts from the manufacturers data sheet have been reproduced to help with identification.

The controller has I^2C "pull-up" resistors incorporated, if leaded resistors are fitted under the receiver or transmitter PCBs they may be left in place but are not required. Depending on the source, some modules will have one or perhaps two resistors fitted.

Controller connections

Controller Pin Number	Name	Function / Connection
1	Tx Power	Output from transmit power switch, connect to transmitter module power input (centre pin of DC socket on power module). Power is then supplied by the controller NOT by the transmitter power socket, this is required for the Autonet mode to operate correctly.
2	12V Supply	12 V supply for back-light and transmit power. Connect to the system 12V supply, this would normally be the centre pin of receiver DC supply socket.
3	Gnd	System ground. Connect to receiver screening can. If a transmitter module is used a ground connection should be made between transmit and receiver screening cans.
4	5V Supply	Micro and display 5V supply. Take this from the receiver 5V regulator output, this can be found on the 3rd pin from antennae socket end on the receiver module, see diagram.
5	Antenna relay	Open collector output that can be used to switch an antenna relay, this output is sequenced with Tx OK and Tx Power. Transistor turns on in transmit so pulling pin low, in receive this output is open circuit.
6	Tx OK (PA PTT)	Open collector output which can be used to switch a power amplifier on (possibly via a relay), this output is sequenced with Antenna relay and Tx Power. Transistor turns on in transmit so pulling pin low.
7	"S" Meter	"S" meter input to the micro. Connect to "S" meter output of tuner, which is the 6th pin along counting from the antenna end of the tuner, can. Note that a link must be made within the tuner for the "S" meter to function, this can be found under the screening can at the point that pin 6 enters.
8	Key press confirmation Beep	Produces a "beep" output when keys are pressed. May be directly connected to audio output of receiver module or alternatively connected to a piezo sounder. If using a sounder omit C3 and fit links in place of R16 and R17.
9	Tx SCL	Transmit serial clock output. Connect to SCL pin of transmit module, this is the 5th pin from antenna end.
10	Tx SDA	Transmit serial data pin. Connect to the transmitter SDA pin, 6th pin from transmitter module antenna connection.
11	Rx SCL	Receiver serial clock output pin, connect to the SCL pin on receiver module. This is the 12th (last) pin from antenna end.
12	Rx SDA	Receiver serial data pin, connect to the SDA pin on receiver module. This is the 11th pin from antenna end.





Controller Overlay

Fault finding

Hopefully you now have a fully working controller, if not first check the obvious; check for solder blobs and incorrectly inserted components, check for 5V supply on pin14 IC1, is IC1 fitted correctly? If so the table below may assist in fault finding...

Symptom	Check / Possible cause
Apparently dead with no display	Make sure R18 is turned clockwise, can any background be seen on the display? If not check for 5V supply at the display, if present it suggests the display is faulty but check for correct micro operation below.
Display appears OK but micro suspect	Measure pin 8 with a multimeter, when first turned on this should read approx. 0V, after pressing the PTT this pin should rise to 5V. If correct assume micro is OK and check for solder blobs on display control lines, check voltage readings on micro.

"Strange" operation	If the controller doesn't perform as expected first check the voltages on IC1 against the table, if all OK perform a full reset - see operator instructions.
If you are unable to diagnose the fault further send an email to atvc@radio-kits.co.uk , please give as much detail as possible to a good chance of diagnosing the problem for you.	

Voltage table - IC1

Pin No.	Voltage	Pin No.	Voltage
1	5	10	5
2	0 (5)	11	5
3	2 (5)	12	5
4	5	13	5
5	0	14	5
6	5 (Pulses low while turning rotary encoder)	15	0 (5)
7	5	16	0
8	0 (5)	17	0 (2 during key-press -"beep")
9	0	18	0 (No "S" input)

Voltages in brackets taken during transmit

Specifications

Voltage and current ratings

Logic (display and microcontroller)	5V at 2mA rx and 10mA Tx (typical)
Display back-light and Tx switch	12V at 110mA for display + Transmit module current
Transmitter module power switch	Maximum output current 500mA
TxOK and Antenna relay drive	Maximum current 500mA, relay voltage 28V

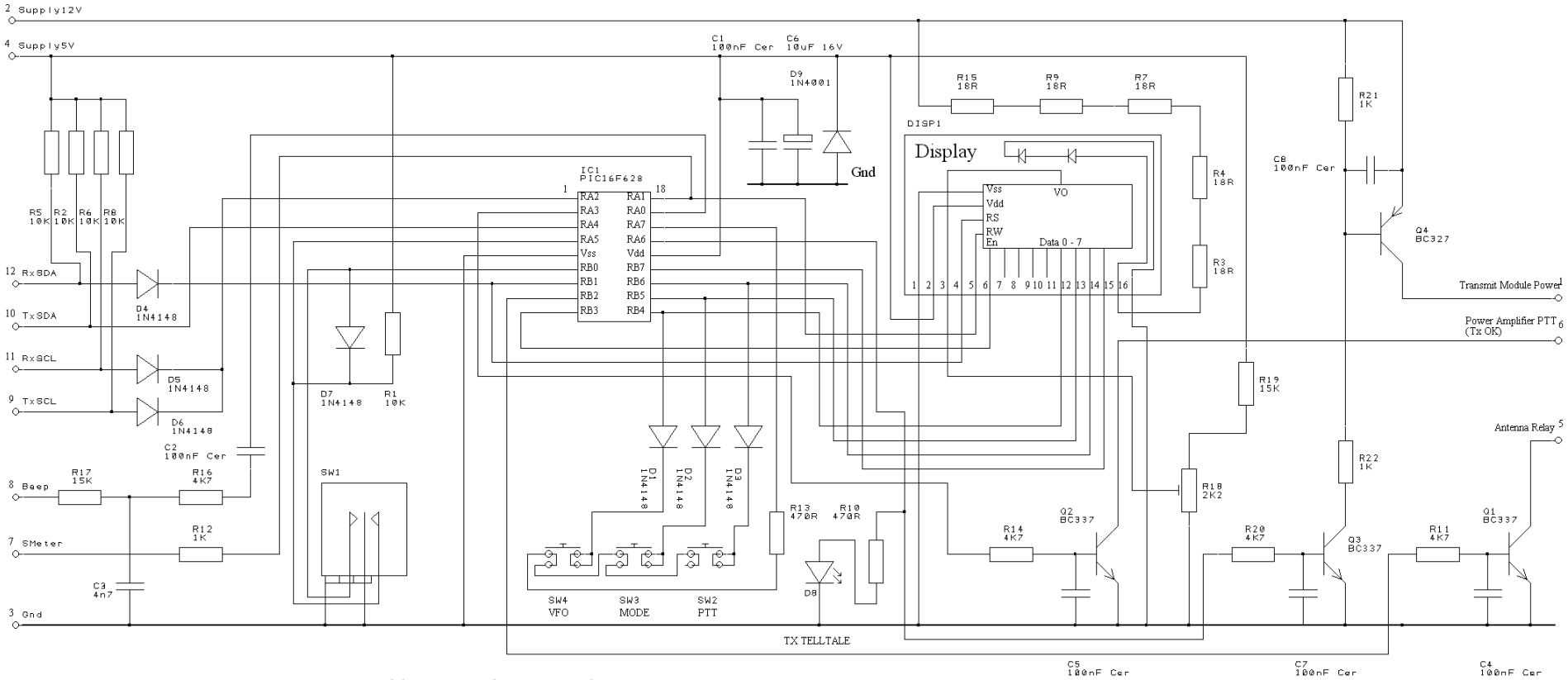
Ensure a back EMF diode is fitted across the relay coil

Tuning specification

23cm Transmit	1240 - 1320MHz
23cm Receive	800 - 1800MHz
13cm Transmit	2310 - 2450MHz
13cm Receive	2200 - 2700MHz
IF offset	479.5MHz (Oscillator high for 23cm and low for 13cm)
IF offset adjustment range	474.5 - 484.5MHz
Channel spacing	125KHz
Steps per revolution	24
Tuning rate	125KHz - 10.125MHz per step depending on speed of rotation

Document history

27-11-03
Modified from published article incorporating changes to PCB and firmware. PCB and firmware currently V3.0.



ATV Controller Schematic V3.0