Schematic & Parts List: PIC16F688 Satellite Tracker & Rotor Controller

Introduction to Satellite Antenna Tracking:

The ST1 kit/project was designed as an affordable alternative for radio amateurs and schools, to generate interest in satellite communications, and bring space technology into the classroom.

It provides hardware & firmware to interface satellite tracking software with Yaesu rotators, for automatic antenna azimuth and elevation control.

This kit/project greatly simplifies ham radio contact with astronauts on board the International Space Station (ISS), through a program called Amateur Radio in the International Space Station (ARISS). (Detailed ARISS contact and other relevant information about ARISS can be found at: http://www.arrl.org/ARISS/)

Satellite communication is generally viewed as an expensive endeavor by most hams. Those who buy expensive equipment to show-off their capability further dilute the charm of satellite operation. With some home brewing efforts, excellent results can be achieved at very low cost.

Station Setup for Space Communication:

There are specific station equipment requirements stipulated to achieve an ARISS contact. A typical ARISS ground station would include:

1. A 2-meter FM transceiver with 25-100 watts of output power.
2. A circularly polarized crossed-Yagi antenna capable of being pointed in both azimuth (N-S-E-W) and elevation (degrees above the horizon).
3. Suitable Satellite Tracking Software (Freeware or Purchased)
4. A PC and, an interface suitable for the software.

Pointing of Satellite Antenna:

Automatic pointing of satellite antennas helps to improve, and maintain signal quality while working with satellites, and frees the operator to focus on the satellite contact.

There are three main components in an automatic antenna pointing system:

1. Azimuth (AZ) and elevation (EL) rotors.
2. Satellite tracking software loaded on a computer that calculates where the antennas should be pointed, and….
3. An interface that connects the rotors to the computer.

Rotors are motor driven mechanical devices that slowly move the antenna(s) 360 degrees around the horizon, and 0-90 degrees in elevation above the horizon; generally defined as Azimuth (AZ) and Elevation (EL). Two of the commercially available rotor systems are the Yeasu G5500 and G5400 rotors

The ST1 Satellite Antenna Tracking Interface detailed here is targeted to interface Yaesu rotators to your favorite software running on your PC, thru either a Serial "COM" or USB port.

ST1 PIC16F688 Satellite Antenna Tracking Interface:

The ST1 interface is based on a PIC16F688, programmed to interpret satellite position data in EASYCOM format, generated by the satellite tracking software. The ST1 can be set up with jumper connections to work with both the G5500 and G5400 rotors, as well as serial or USB computer connections. The interface has been tested and verified to work with NOVA and SatPC32 software.

Picture of the completed ST1 interface:
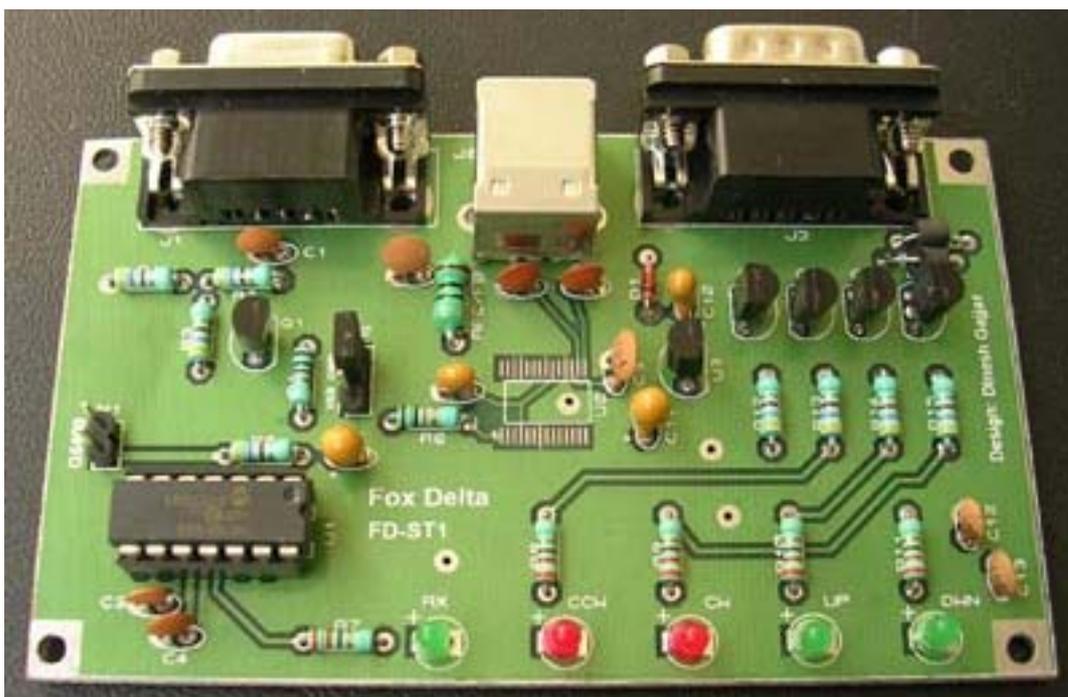
PIC Firmware:

Mark Spencer/WA8SME developed firmware for PIC16F688.

PC to Rotator Interface Hardware:

The ST1 interface is designed on double sided PTH board measuring 6cm (2.4") x 10cm (3.9"). It may be connected to your PC thru a COM (J1) or USB (J2) port. The PCB has both options, and can be wired for either Serial or USB operation. If you are buying assembled units, you may order what is required for your PC.

For the COM port interface, a simple one transistor level converter is used, which accepts RS232 levels & converts into TTL levels, required by the PIC.

For USB, an FTDI-232 chip is used, and will require FTDI chip drivers to be installed on your PC for this interface to work properly. Drivers may be downloaded from the FTDI website. Basically, FTDI-232 creates a virtual COM port on your PC, communicating thru your USB port.

Interface Power:

Power is provided from the Yaesu Rotor(s). A 5V 100ma regulator (78L05) is used to covert the rotor supply of 12-15V to 5V DC, required by the interface.

Rotor Control:

4 NPN transistors are used to drive the rotor motors. The software running on your PC, translated by the firmware on Interface board PIC, and executed thru transistors will initiate commands for rotor movement. LED indication of all four transistors' operation is available on front panel. In addition, Received data (From COM or USB) will illuminate a separate LED provided on front panel.

Details of D9M (J3) connections at the back of ST1:

1. **EL ADC**
2. **CW**
3. **UP**
4. **CCW**
5. **DWN**
6. **AZ ADC**

7. **+12V from Rotor**
8. **GND**
9. **GND**

Header Selection:

Two headers are provided for configuration of this interface.

H1: A shorting pin on this header will enable support for G5400

H2: Selects between RS232 and USB

Connections to Rotor may be made by:

1. **Making a suitable cable (10core shielded) with D9F at one end (to this interface) & DIN8 Male at the other end (to Yaesu Rotor).**

2. **Use supplied adepter (Picture below) to plug into the D9M connector of interface and solder 8 wires to your DIN8 Male connector. (Goes to rotor "External Connection" socket.)**
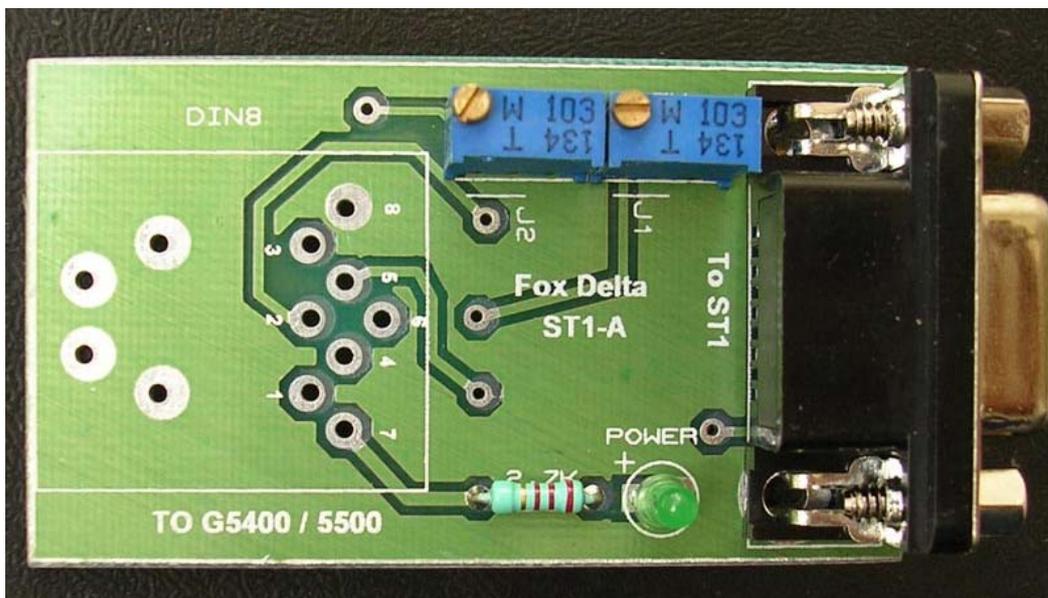
Above adepter may be very useful for connecting various types of rotators available in market.

Two Presets are not required for Yaesu Rotators but may be useful for other types of rotors.

For Yaesu rotors, jumpers at J1 & J2 may be installed.

Rotor to Interface alignment:

The program (firmware) in PIC16F688 depends on the rotor feedback voltages being set to specific values. The output voltages from the G5500 for az and el are assumed to be factory set.

1. With the az set at 360 degrees (the right hand mark), the voltage on pin 6 (of the rotor controller external control jack on the rear panel) should read 3.61 volts.
2. With the el set at 180 degrees the voltage at pin 1 should read 4.5 volts.

If the voltage is outside of these readings, adjust the appropriate potentiometer to obtain the correct voltage.

If you are using adapter board (ST1.A) supplied with the kit at J3, voltage corrections may be achieved by adjusting the two presets.

The output voltages for the G5400 az will probably have to be reset. Run the az full clockwise to south and set the voltage from pin 6 of the rotor controller to 4.5 volts. The voltage for el, full clockwise at right should also be at 4.5 volts.

ST1: Satellite Antenna Tracking Interface Schematic:
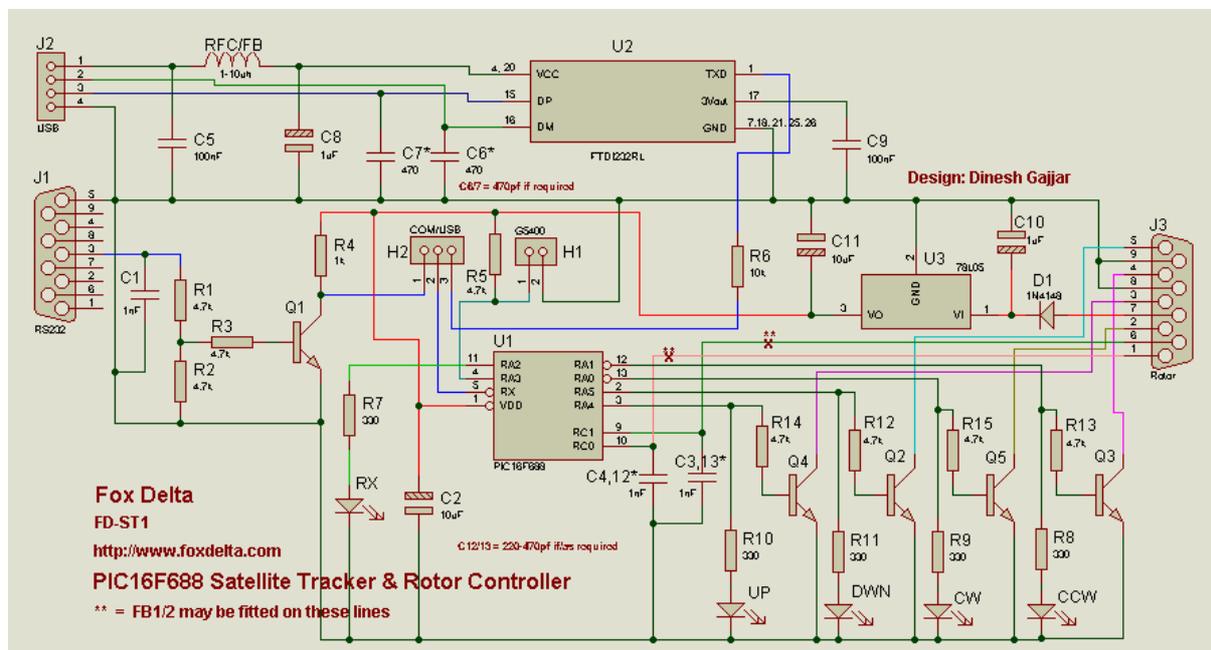
Parts List:

R1, 2, 3, 5, 12,13,14,15	4.7k	1	PIC16F688 with Firmware: FD-SAT1.hex
R4	1k	5	BC547B Transistors (Q1 to Q5)
R7-11	330	1	1N4007 Diode (D1)
R6	10k	1	14pin IC Socket
C1, 3, 4	1000pf ceramic	1*	USB B Type PCB Connector
C6, 7, 12, 13	470pf	5	3mm LEDs
C5*, 8*, 9*,	0.1uf ceramic	1	78L05 (U3)
Q1-5	BC547B	1*	FTDI- FT232RL 28 SOIC (U2)
C10	1uf Tan	1	D9-F-RA
C11, 2	10uf Electro	1	D9-M-RA
RFC/FB*	Ferrite Bead (or 10uh RFC)	2**	FB1/FB2 Ferrite Beads if required.
2	Shorting Pins	2	Headers: 2pin x 1, 3pin x 1
1	Adepter board with D9F		

*= Parts for USB version. **=Not supplied with kit. (A Jumper is required at FB1 & 2)

73s/Dinesh Gajjar / 22nd May 07

For more details, please visit Project Page: http://www.foxdelta.com