Fox Delta

Amateur Radio Projects & Kits

Tech. Information Document: PIC16F877A Dual Channel HF/VHF SWR Meter

This project is developed for Amateur Radio Community by:

Antonio Alfinito / I2TZK
Dinesh Gajjar / VU2FD
Frank Dzuirda / K7SFN

HF/VHF 100W to 1KW LCD DUAL Channel SWR / POWER Meter:

Introduction:

Measuring SWR at HF from 0 to 30MHZ is always interesting for most radio amateurs. Till date, thousands of radio amateurs run their station without an SWR Meter, without knowing what is happening between their TX and antenna. Resulting a lot of spurious transmission, splatters and power loss.

SWR Meters of Analog variety are many, but not economical. LCD meters are more expensive, crossing a range of over $140.

LCD SWR Meter presented here meet many SWR measuring tasks, using a PIC16F877A micro controller. Purpose to make this project is to encourage radio amateurs to build their own SWR Meter at low cost & understand usefulness of PIC Micro-controllers.

 Further this is an attempt to remove a mental hype that everything with "Micro Controller" & "LCD" is to be "Expensive" or "Factory built

First attempt to make an LCD HF SWR meter went well with over 100 Kits sold. We decided to go further into this and redesign the whole thing from root.

The firmware by Tony / I2TZK will give us ability to:

1. Interface with PC.
2. Backlight Control
3. Dual channel observation of two SWRs on LCD
4. Ability to read RF voltages
5. Bar Graph
6. Auto Scaling of RF Power from 100 to 2KW. (With dual Range bridge)
7. Measures HF or VHF RF Power (Depending on type of bridge connected)

Following task achieved thru this new design:

1. Simple single micro controller with built-in A/D converter.
2. Choice of three HF Bridges and One VHF Bridge.
3. Back light control
4. SWR, FWD, POWER and Actual Power to antenna calculations.
5. Bar graph for SWR & Forward Power
6. Compact Design
7. Economical CPU design with just one Micro.
8. PC WIN Software by I2TZK, specially developed for this project

Project Bases:

Project is developed on two double-sided PTH boards. The concept being that the CPU unit be placed on your ham shack and the bridge placed suitably at the RF level points (Mostly back of the shack)

The CPU board has LCD, Voltage Regulator and Back Light Controllers. Tit requires 12V DC for operation and receives pure DC level voltages from sensor (Bridge) board for calculation & display.

The second board, "RF Sensor or Bridge": RF Power from transceiver comes in and goes out to antenna. Three different bridges were designed and tested for this CPU. They are:

1. HF Simple Bridge
2. HF Dual Scale Bridge
3. HF Balanced Bridge

One Strip-line bridge is designed for VHF (144MHZ)

Dual channel SWR Meter Top View:
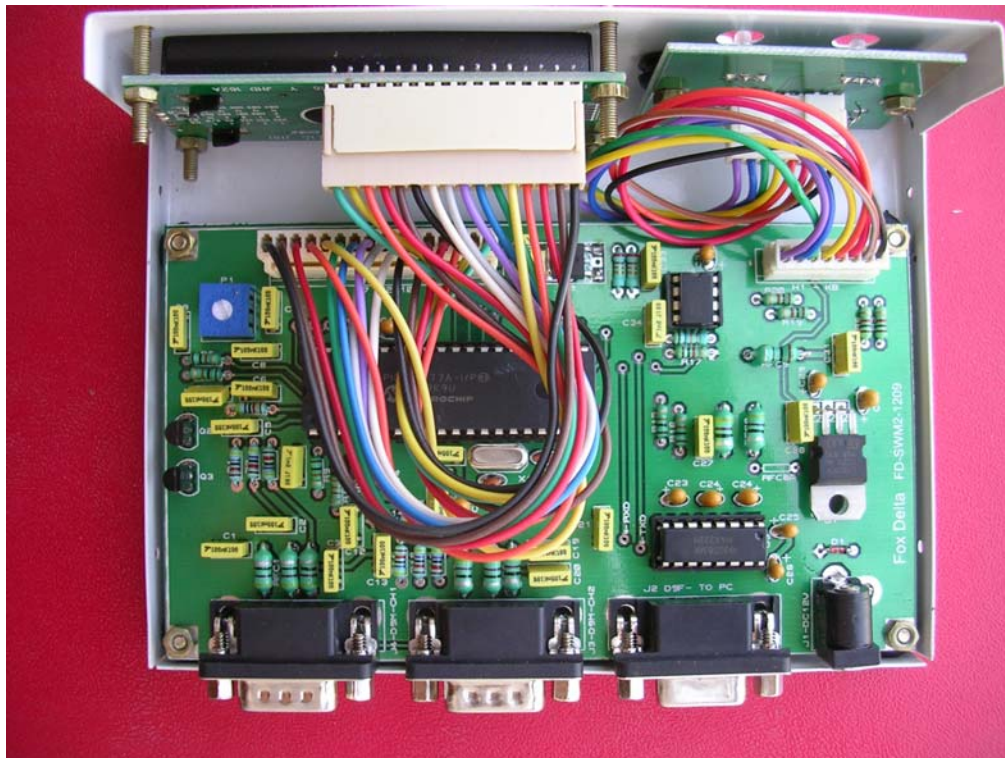
As visible in picture above, CPU unit is supplied with a simple powder coated metal case. LCD and Keyboard are mounted on front panel by 3mm bolts. A pair or ribbon cables supplied with kit connects LCD and Keyboard to main CPU board.

CPU has an SMT part IRF120. Although its SMT, its not really that small and it would be pleasant experience for kit builders to solder this part.

Two D9Male connectors are used to connect sensor Ch1 and Ch2. D9 Female is used for PC Connection. For true RS232, MAX232 chip is used.

Keyboard PCB house two menu buttons and two dual color LEDs. Purpose of LEDs are defined in firmware document by Tony / I2TZK.

Choice of Bridges:

Dual Channel SWR Meter CPU Unit requires that we connect a suitable bridge for RF measurement.

Following four types of bridges are available at moment:

1. HF Simple Bridge – Measures 0-30MHZ but do not have auto scaling
2. HF Dual Scale Bridge – Same as above but with scaling relays.
3. HF Balanced Bridge – measures 0-30MHZ.
4. 144MHZ / VHF Bridge: Simple strip line bridge for 144MHZ / 100W

Kits will be available as:

1. CPU unit
2. Choice of a bridge.

Note:
You require at least one CPU Unit and one Bridge to start with.
Preferably, you would buy two bridges if your station has two radios.

If you run 2KW HF Transmitter, you will require a dual scale bridge.
Similarly, Dual Scale HF bridge is good for those running 100W unit and want to run 5W QRP.

Balanced HF Bridge is simple to build, as almost no alignment is required.

CPU UNIT:

Micro Controller Board: PIC16F877A
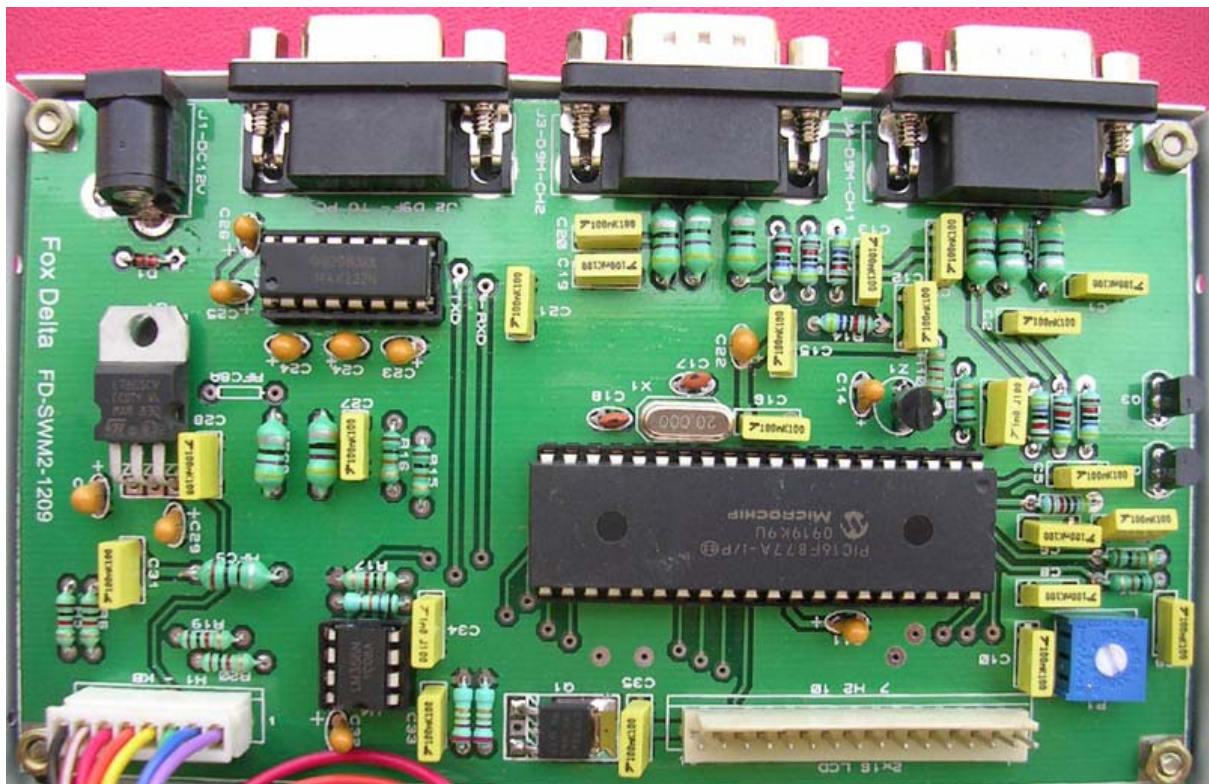
A PIC16F877A is used for measurement of SWR & FWD voltages using available A/D inputs.

LM385-2.5 is used to supply a reference voltage to CPU.

A Contrast preset is provided and must be adjusted till you see characters on LCD. A Dual Op.Amp.(U2) is used for controlling MOSFET(Q1:IRF120) for LCD Back light. MAX232 is used for true RS232 communication with PC.
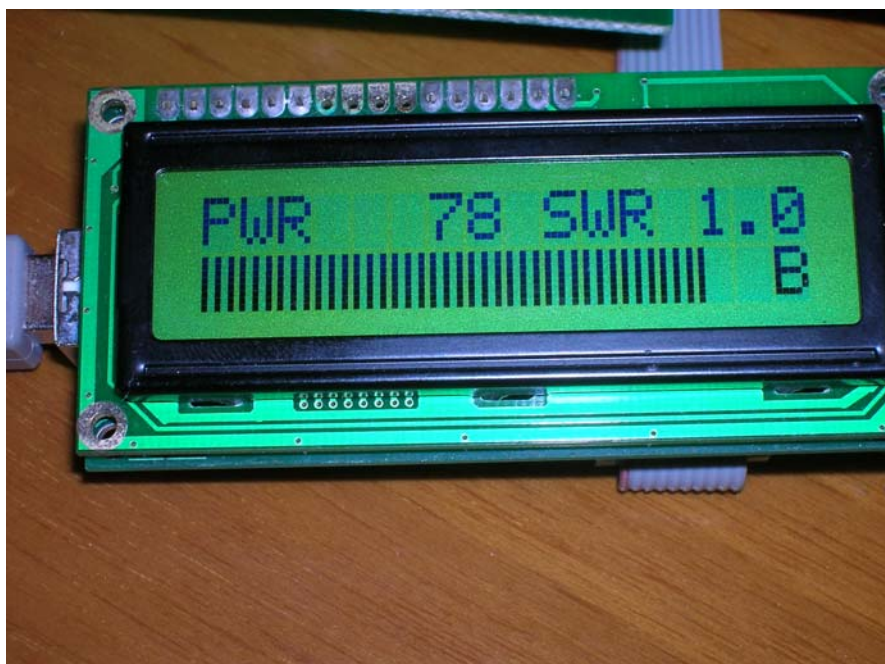
LCD Display and SWR Measurement Menus:

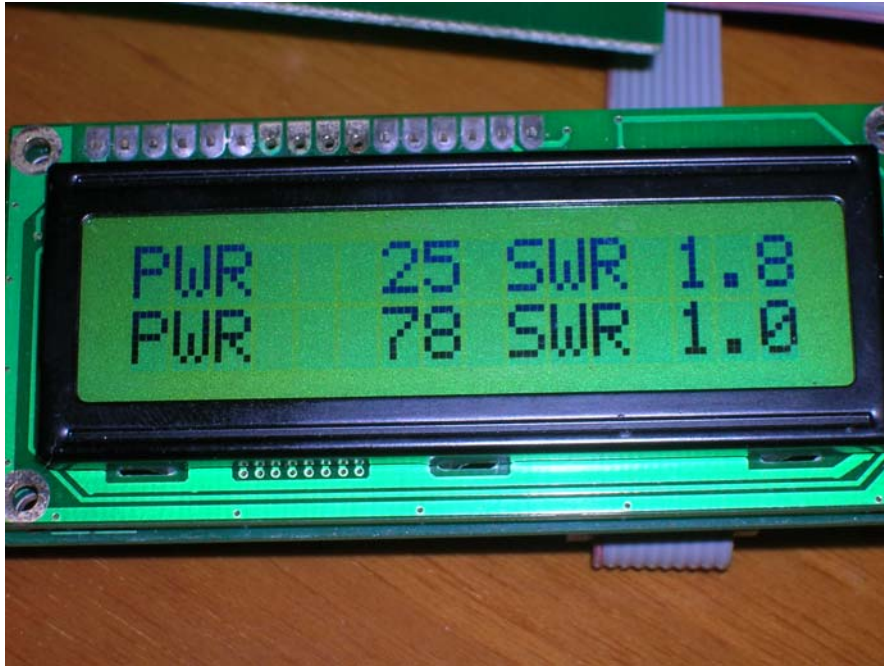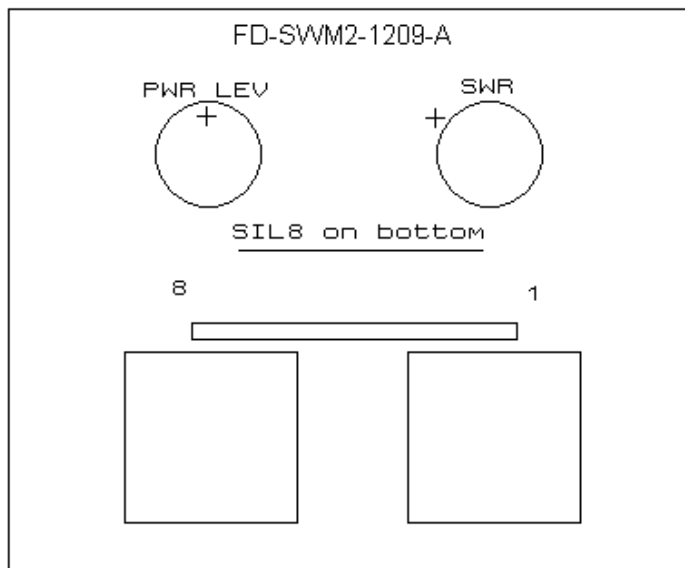**A 2x16 LCD with Backlight is used for this project.**

Channel A:

Channel B:

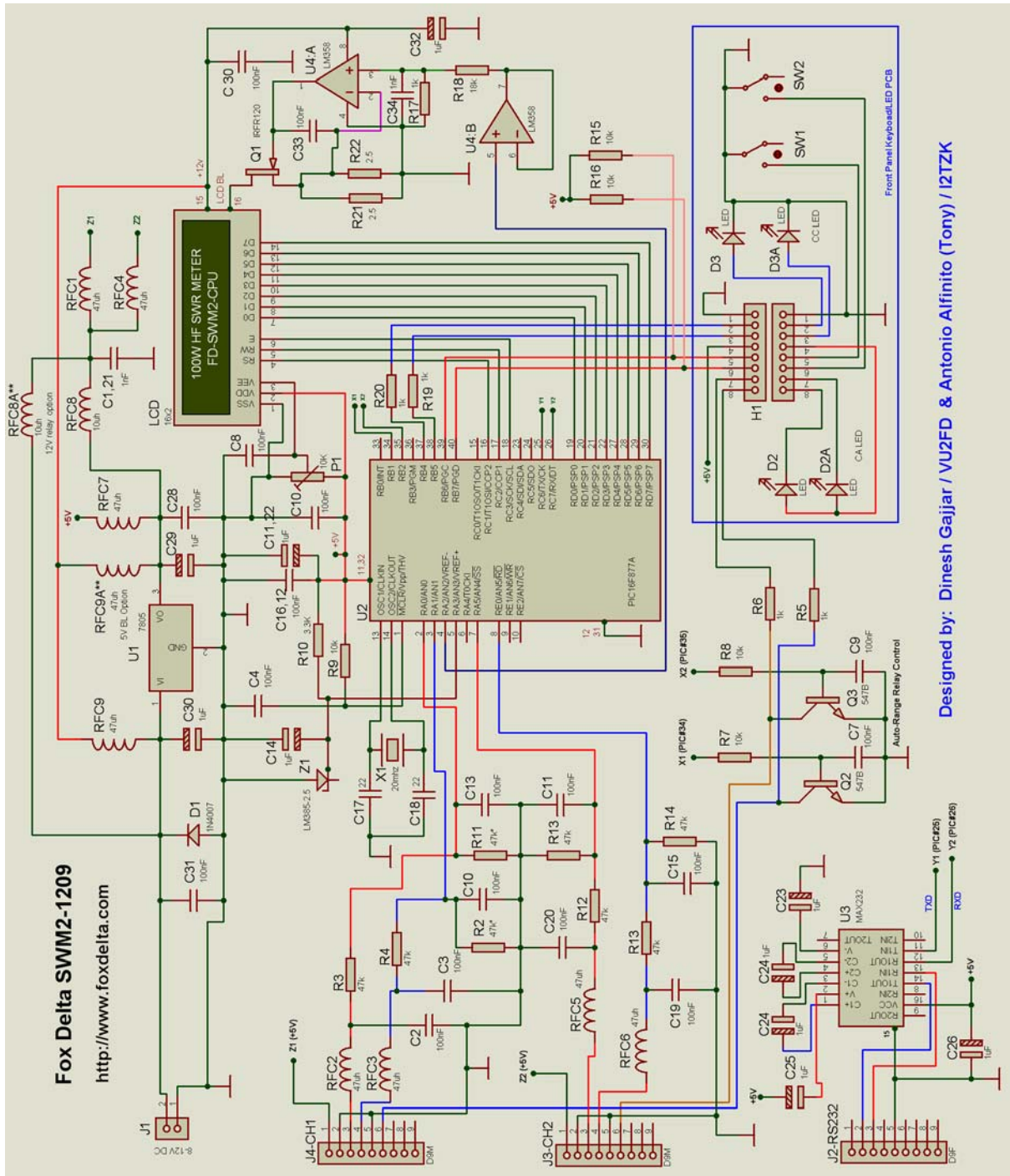
Channel A+B:

Function Menu Board:

This is a small double-sided PTH PCB housing 2 push buttons and two warning LEDs, each a dual color.
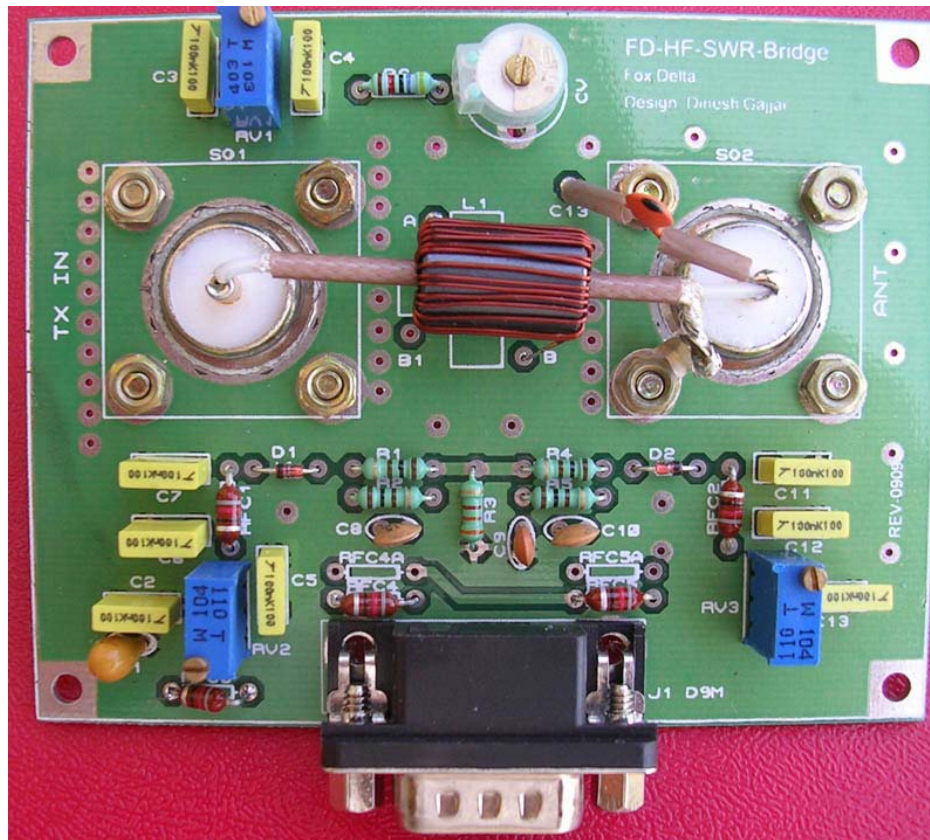
PCB mounts on main board by way of a 6pin SIL header and a Plastic Spacer at the other end of the board.

Schematic of the Dual Channel HF SWR Meter CPU Board:

Fox Delta SWM2-1209
http://www.foxdelta.com

Designed by: Dinesh Gajjar / VU2FD & Antonio Alfinito (Tony) / I2TZK

Details of Available & Tested Bridges for Dual Channel CPU:

100W to 1KW: Simple HF Bridge:

Variable Capacitor (CV) is used to align the Bridge. Usually this is done by connecting a dummy load and a known RF power metre.

Toroidal core is FT-50-43. (A tubular core may also be used as visible in above picture) Diodes are BAT85.

Toroid is wound with #26 wire with about 35 turns.

SO239 connectors are installed on the other side of the Bridgeboard. You may use type "N" connectors if you like.

Although SO239 types of connectors are used, there is no reason why N type connectors may not be used. They will fit nicely on four mounting holes available for SO239 sockets.

Presets are provided on FORWARD and REFLECTED outputs of bridge. They are 10 Turn type and usually supplied at mid-range position by preset manufacturers. They need to be adjusted to get proper readings on LCD.
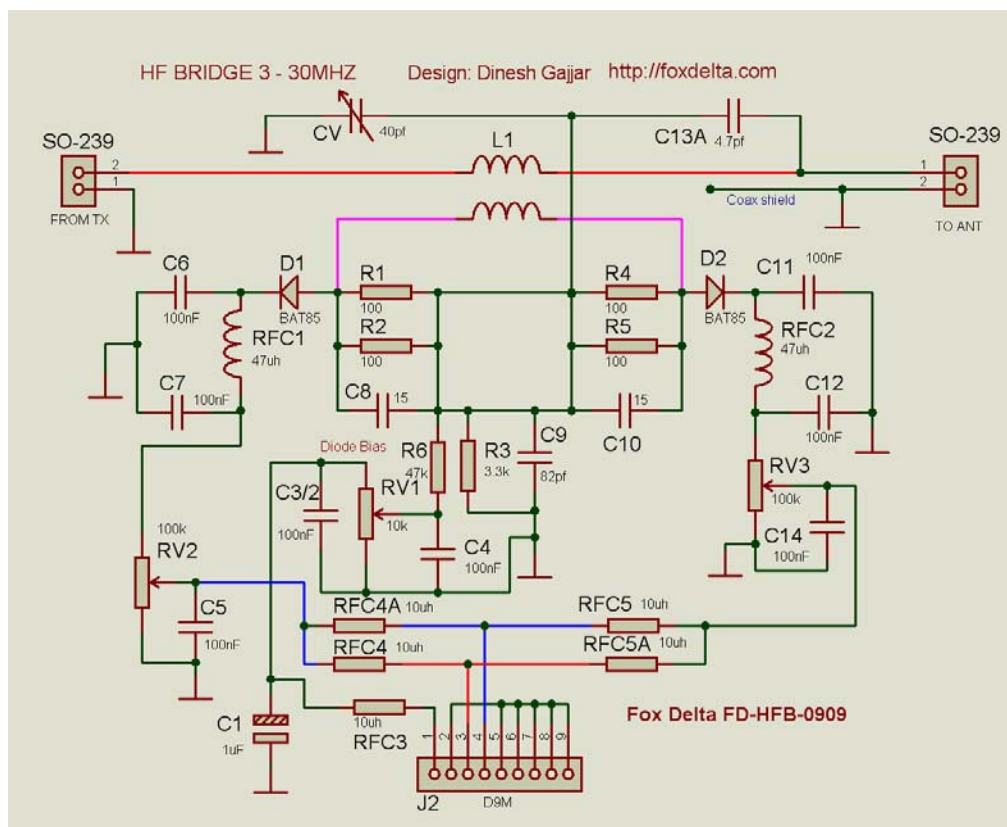
In a complete SWR Meter Measurement configuration, Two boards, CPU & SWR Bridge, will be housed in metal boxes connected by a D9 cable (Shielded) used for interconnection.

This project is delayed a lot only because of delay in getting customized metal cases for this project.
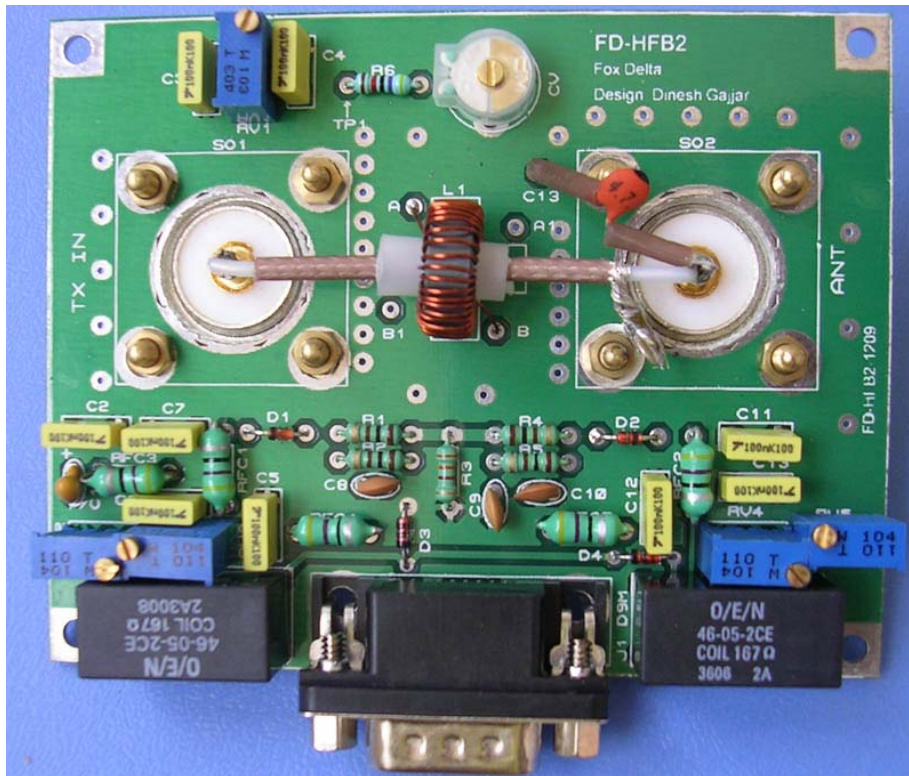
Closer look at C13, CV and SO239 :
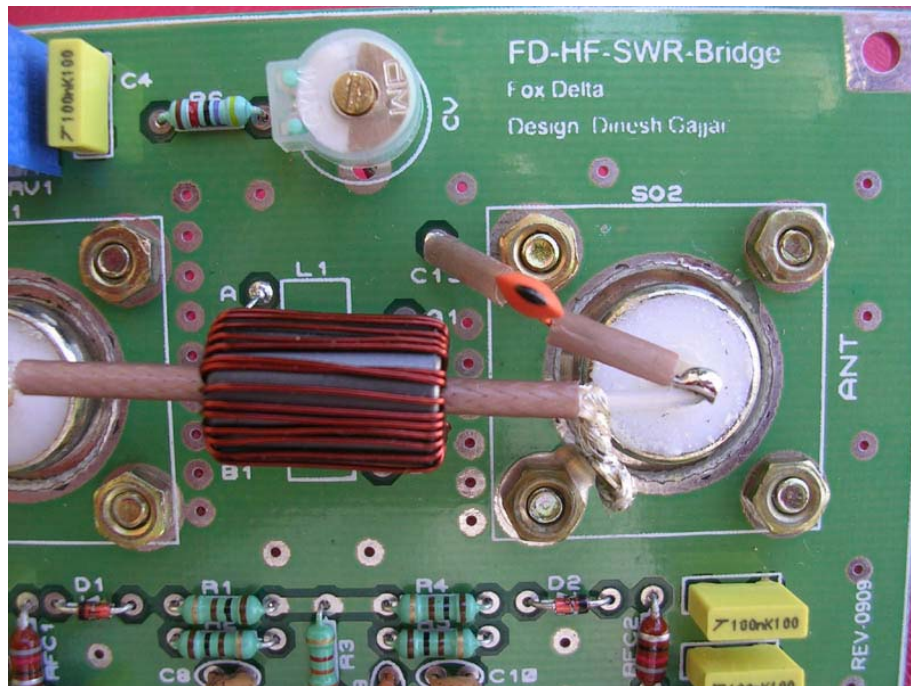
Simple HF Bridge Schematic:

Dual Scale HF Bridge:

Dual Scale HF Bridge is similar to Simple HF Bridge except that it has two scaling relays under CPU control.

Basic procedure would be to adjust bridge with first set of presets for "Lower" range and then, adjust "HIGH" range using second set of presets.
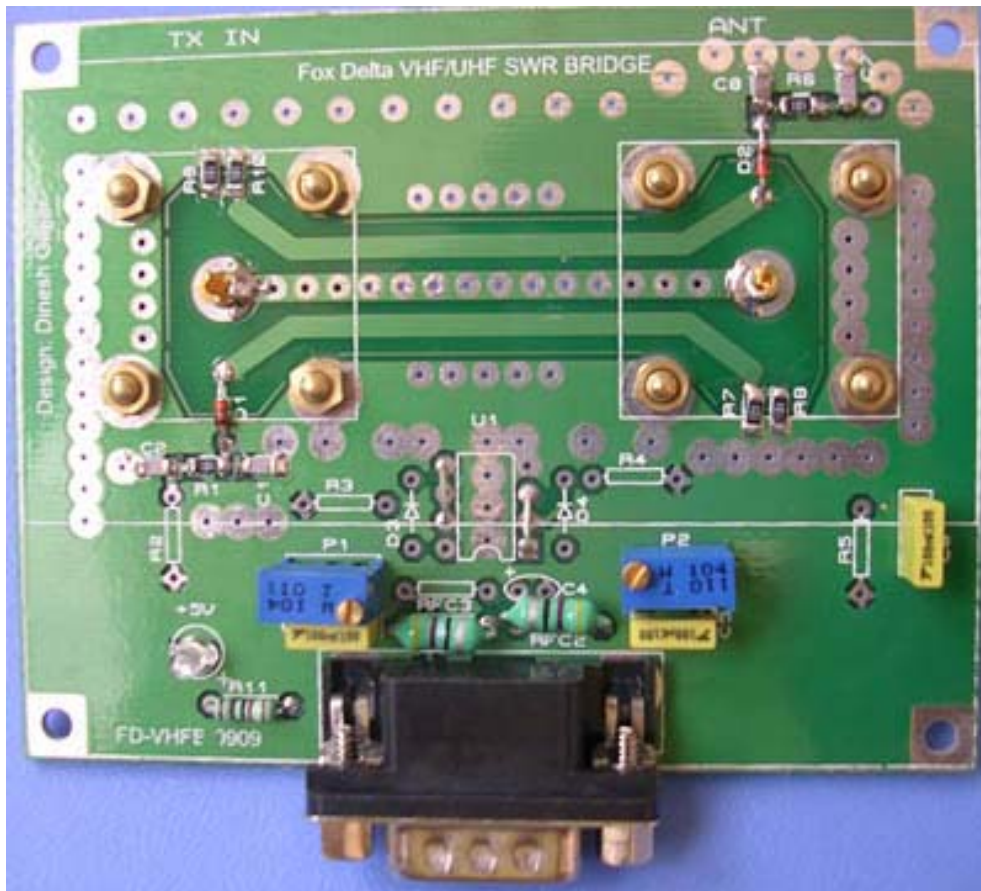
Relays used in this project are OEN 5V DC and has 2CO contacts.

Dual Scale Bridge Schematic:

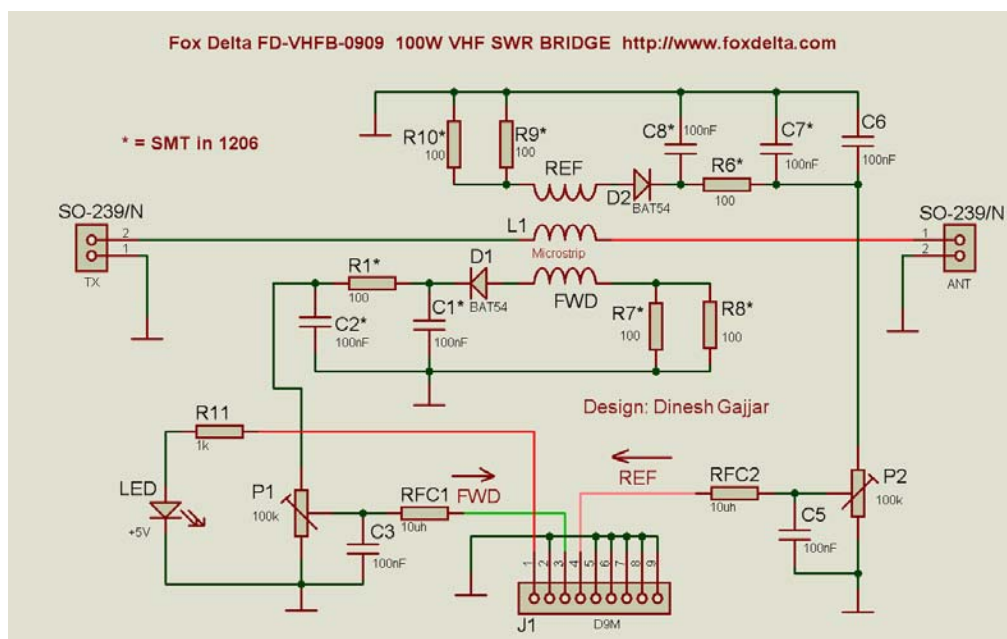Fox Delta FD-HFB2-1209 Dual Scale HF BRIDGE 3 - 30MHZ
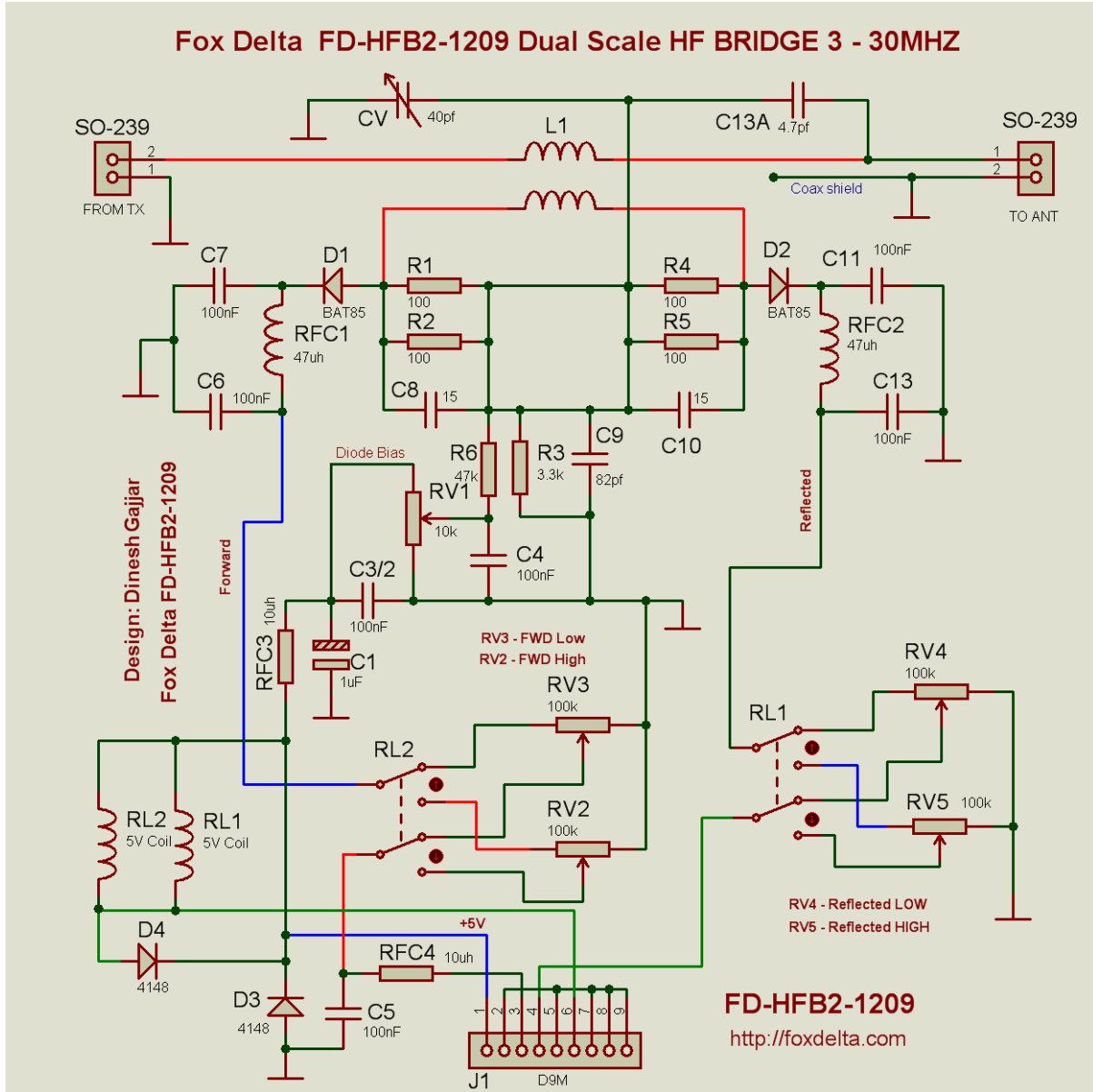
VHF Bridge: 144MHZ
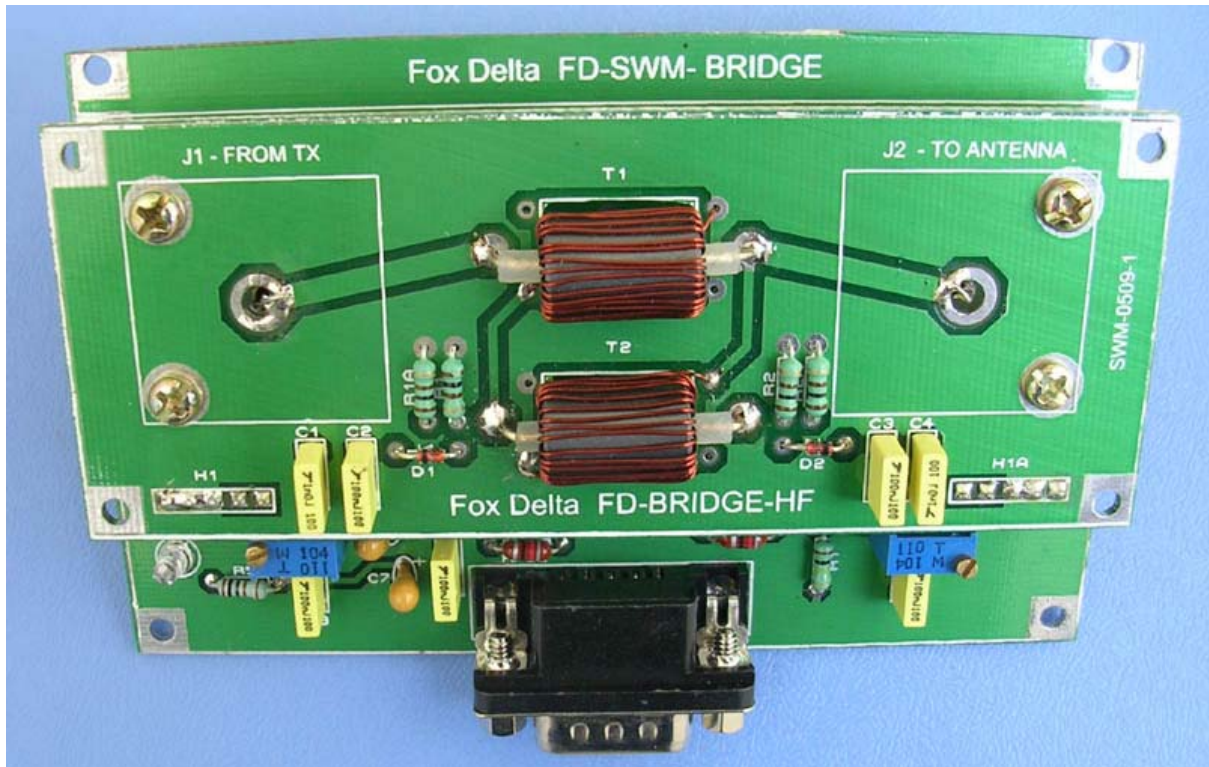
This is a strip-line bridge for 2Mtr ham bands.
SMT parts are presoldered on all Kit boards.
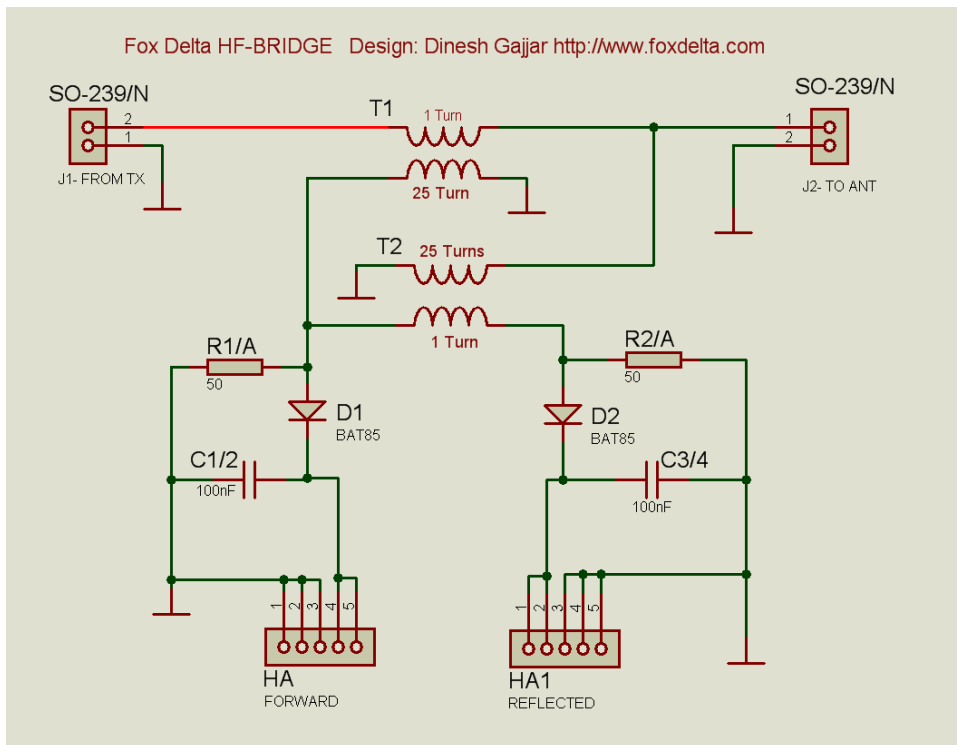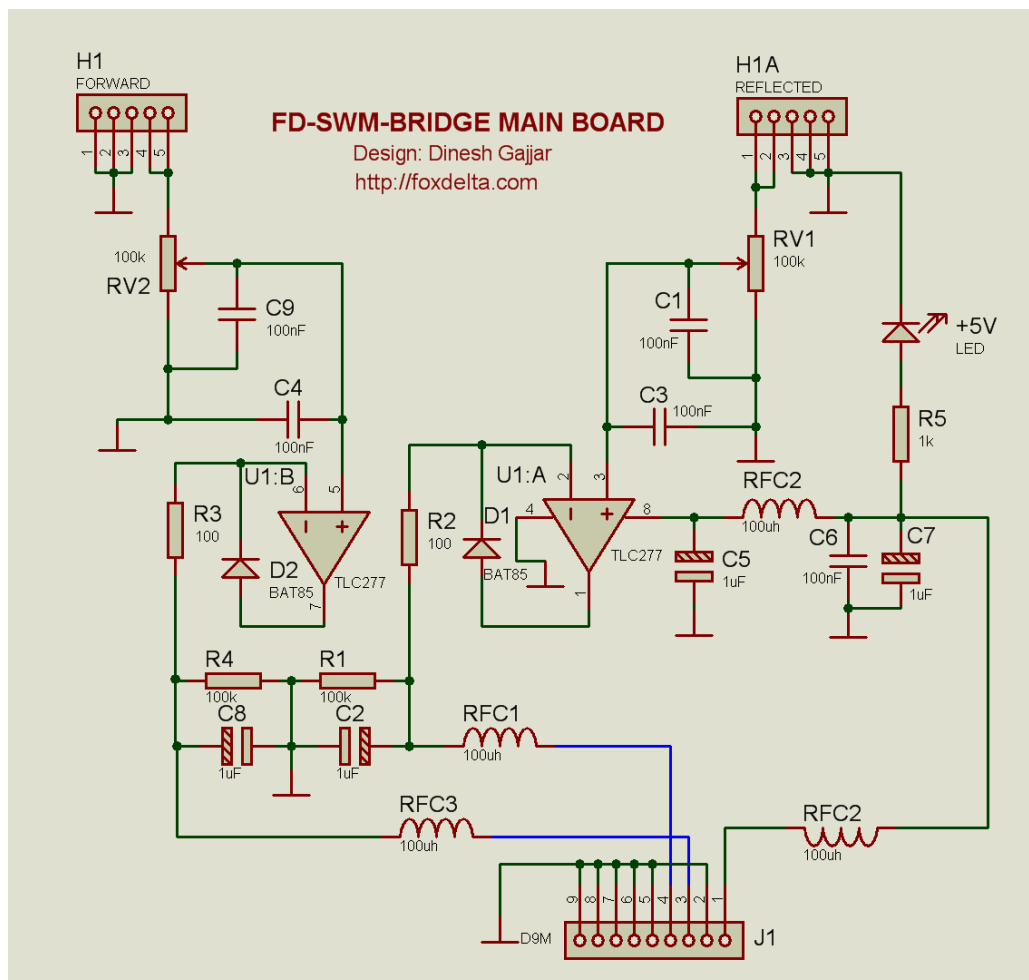A choice of SO239 or N connectors will be available.

VHF Bridge Schematic:

HF Balanced Bridge:

HF Balanced Bridge Schematic: TOP Board

HF Balanced Bridge: Main Board

Interconnections:

Bridge & CPU are inter connected by using a shielded D9 cable. This cable is supplied with Bridge kits.

Kit Assembly:

Kits are specially designed for radio amateurs with necessary expertise in understanding SWR, RF power measurement etc. You will also require proper shielding of CPU & Bridge boards. A dummy load and a Variable RF power source (Trx) will complete the alignment requirements.

Do not buy this kit if you do not know what is an RF Bridge or if you do not understand what "SWR" means!!

For those who do not have time to build kits, Assembled SWR Meters housed in a metal case (Powder Coated) will be available soon.

Although kits are made and sold, the basic concept of this project is to make available complete details on hardware and firmware/software. We expect that radio amateurs build this project on their own, using components from their ham shack!!

Following files are available for homebrewers:

1. This info doc
2. CPU Schematic and parts list
3. Schematic and parts list for all four types of bridges
4. A Free PC Program by Tony / I2TZK
5. A free Firmware by Tony /I2TZK for PIC16F877A

For more details on each of the bridges, Please refer to documents provided for each of the bridge.

Also do not forget to refer calibration procedure by Frank / K7SFN

Hope this project will receive quite good response from radio amateurs interested in having a good quality LCD SWR meter for their station.

73s
Dinesh Gajjar / VU2FD
Antonio Alfinito / I2TZK
Frank Dzuirda / K7SFN

16th July 2010

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