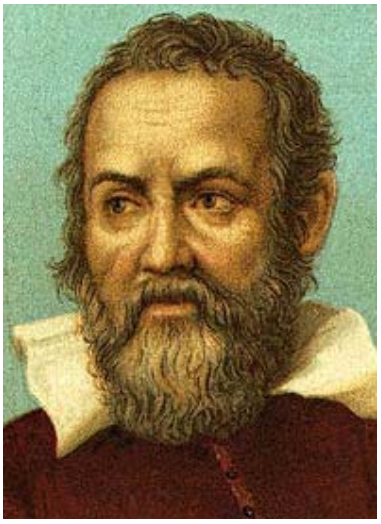
Fox Delta

Amateur Radio Projects & Kits

FD – Galileo2

Technical Info Doc: Galileo2 A simple Direct Conversion Receiver for 20.1MHZ

This Project is dedicated to our beloved scientist Galileo:



Galileo was born in Pisa, ITALY on February 15, 1564.

Galileo made his first telescope in 1609, modeled after telescopes produced in other parts of Europe that could magnify objects three times. He created a telescope later the same year that could magnify objects twenty times.

With this telescope, he was able to look at the moon, discover the four satellites of Jupiter, observe a supernova, verify the phases of Venus, and discover sunspots.

Galileo's real originality lay in the way he approached scientific problems.

First, Galileo reduced those problems to very simple terms on the basis of everyday experience and common-sense logic.

Then he analyzed and resolved the problems according to simple mathematical descriptions.

The success with which Galileo applied this technique to the analysis of physics, especially the physics of motion, opened the way for the development of modern mathematical physics.

In this project we try to follow Galileo's simplified methods in making a complex Radio Astronomy receiver using simple design that most amateurs can work on.

Although this is called a Radio Astronomy receiver (At 20.1MHZ) Radio amateurs may use it as a portable 7, 14 or 21MHZ receiver for listening to local nets!!

Basics of 20.1MHZ Radio Astronomy Direct Conversion Receiver:

NASA's Radio Jove Project:

FD-Galileo2 is basically designed for NASA's Radio Jove project. Here is some basic information for your quick review.

NASA's Radio JOVE project is centered on the low cost radio telescope receiver, which can be used by science classes to collect planetary or solar radio astronomy data. Schools may opt to use other equipment to collect this data, but use of the Radio Jove receiver is highly recommended and provides good educational value to the students.

The radio telescope is intended for high school level classes, but may be appropriate for introductory college courses or advanced middle school students.

The students setup the receiver & understand receiver basics. They also construct the special antenna needed to receive the planetary or solar emissions. The antenna requires construction of a basic structure using wood or pipe, ropes, stakes, etc. which gives them basic understanding of a Dipole antenna & its construction.

Once the receiver & antenna rigged & tested, the students determine a good time to observe Jupiter based on predictions supplied on the Radio JOVE website.

Note that Jupiter radio signals can only be received at night and the conditions are often best in the hours just before dawn. Also, the antenna needs to be set up in a location that is as free from electrical interference as possible.

This may be possible near some open areas such as play grounds or schools, but it is recommended that observing be done in nighttime field trips to locations away from power lines and other sources of interference.

The Radio Telescope is designed for 20.1MHZ, High Performance/Low Noise, Direct Conversion Receiver such as Fox Delta "Galileo2" may be purchased online.

Galileo-2 Radio Astronomy Receiver:

FD-Galileo2 is considered as "all Inclusive" type of Jove Receiver. However, as having more interest in Jove Project, I had a good look at the basic requirements of the project.

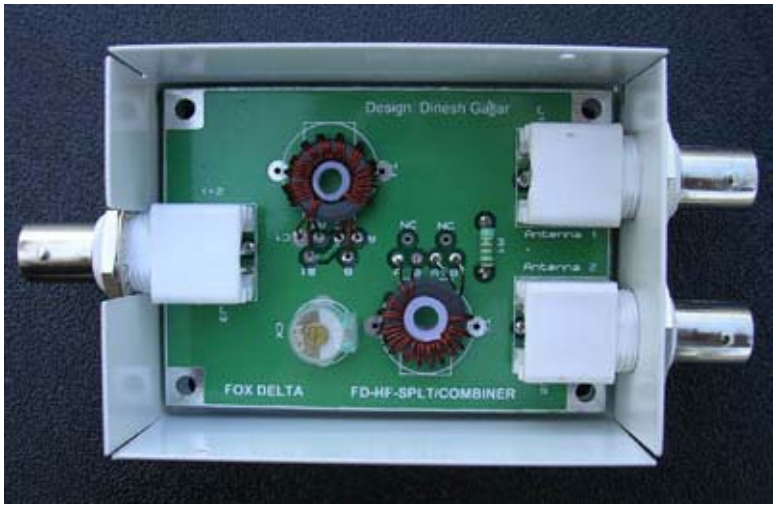
Conclusion: Although "all Inclusion" concept was a good idea, we needed a Jove receiver with bare minimum of a 20.1MHZ receiver requirement that a user may need. Galileo 2 project detailed here has achieved that basic requirement.

Important Points that this project addresses:

1. **Direct Conversion Receiver for 20.1MHZ Uses SA602/612 Double balance mixer**
2. **Stable Oscillator with tuning range of over 100KHZ**
3. **Very low power consumption**
4. **Supplied in a Powder Coated Metal Case**
5. **Built-in 20MHZ Osc. For Calibration**
6. **Audio sockets for Earphones/Speakers and Line Out**
7. **Works on +8V to 12V DC**
8. **Uses Standard BNC connectors for Receiver Antenna**
9. **No SMT Parts are used. Easy to assemble Kits or fully assembled.**

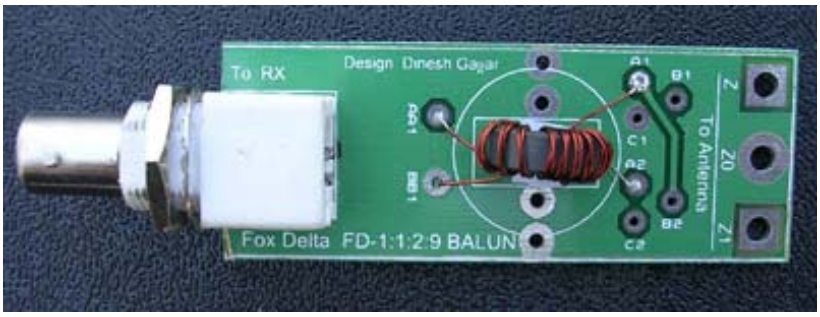
In addition to above, Galileo-2 requires following add-ons to work as a JOVE radio telescope:

1. **An antenna Splitter/Combiner**



Essential when two dipole antennas are used.

2. **Antenna Balun for center feed twin Dipoles:**



3. **Antenna kit consisting 20.1MHZ dipoles and RG59 feeder.**

   Not provided by Foxdelta at moment. Refer to NASA's Jove website for simple construction details of dipoles.

Project Notes:

Fox Delta do not supply materials for supporting (poles etc) the antenna, tools that are necessary to put the antenna together, such as a soldering iron, wire clippers, and other typical tools which you will require for putting up the antenna.

In order to analyze the data and share it with others, you will require to capture the received data. This may be done by either feeding the audio output of the receiver into a tape recorder or using audio out to concert into digital by using an external A/D converter to connect to your PC's COM or USB Port.

On a field trip, it may be more convenient to use the tape recorder than to carry along a computer. Small tape recorders can be purchased for this purpose, but they must not have an automatic gain control (automatic volume adjustment) or the control must be capable of being switched off since such a control makes it difficult to measure the relative strength of the signals.

The Radio Jove project has created software for Window 95/98 that simulates a chart recorder for plotting the data on a 486 or better model personal computer having a sound card. The software is available from the Nasa's Jove project Website.

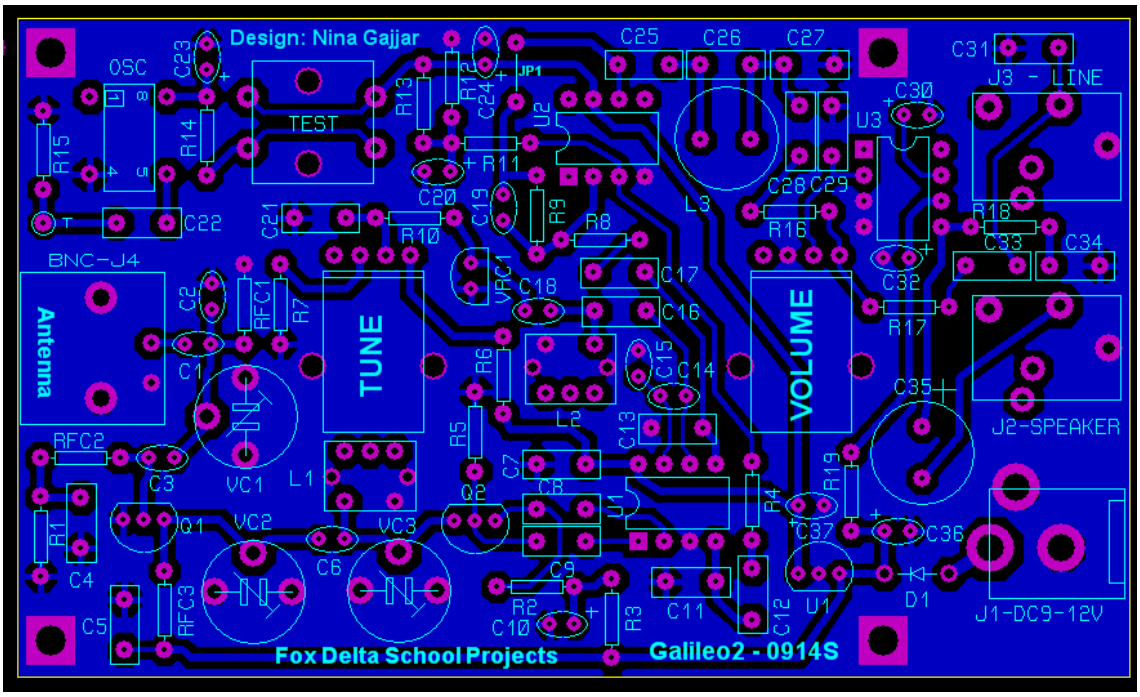
A central web site will accept files of data from observing groups around the country and make them available for schools and scientists to see and hear. The site also contains general information and activities relevant to the understanding of radio astronomy and, in particular, how to order, build, use, and understand the data from radio receiver kits. These web pages are currently under construction.

Technical information of Galileo2 Radio Astronomy Receiver:

Although design of this DC receiver is not different from many other available receivers, following points were kept in mind while developing Galileo2:

1. **Low cost. Uses Single Sided PCB**
2. **Low power consumption**
3. **Portability: Works on 8-12V battery**
4. **Audio out for recorders: Standard 3.5mm**
5. **Constant Audio output for external A/D converters**
6. **All components installs on PCB. No loose wires.**
7. **A Free Powder Coated metal case included with kits.**

Single Sided PCB:



Galileo2 is designed on a single sided PCB. All components mount on board without a single loose wire around.

RF Front End:

Galileo2 uses dual J310/309 FETs as front end. The First FET is used in Grounded Gate config, which can sustain large signals without damage and also matches the Dipole antenna at antenna socket.

Output of this first FET is tuned at 20.1MHZ using resonator and trimmer capacitors.

Signal amplified by first stage is then fed to second FET, which is similar to first one but is used as a common source/Differential amplifier to interface differential inputs of SA602 Double Balanced Mixer.

Double Balanced Mixer:

SA / NE 602 / 612 type Mixer cum Oscillator is used to make this direct conversion receiver as simple as possible.

Part of SA602 act as an Oscillator at 20.1MHZ (+/- 10KHZ)
Oscillator is tuned by using MV2109 type varicap (Variable Capacitance Diode)
We apply variable voltage to this diode by way of turning Front Panel "TUNE" pot to shift frequency of oscillator.

Buffer Amp and AF amp:

MCP601 or NE5534 type op.amp is used as a low noise audio amplifier to further amplify output of SA602 mixer.

A simple LC type audio Low Pass filter is used to remove unwanted signal/noise from the audio that we require as a data.

LM386 is used as an audio amplifier to supply low impedance audio to J2: a 3.5mm audio socket where a tape recorder or headphone may be connected. Gain of Audio out at J2 is controlled by Front Panel "VOLUME" control.

A constant audio is available at J3. Audio at this socket is without any control (of Front Panel "Volume Control")

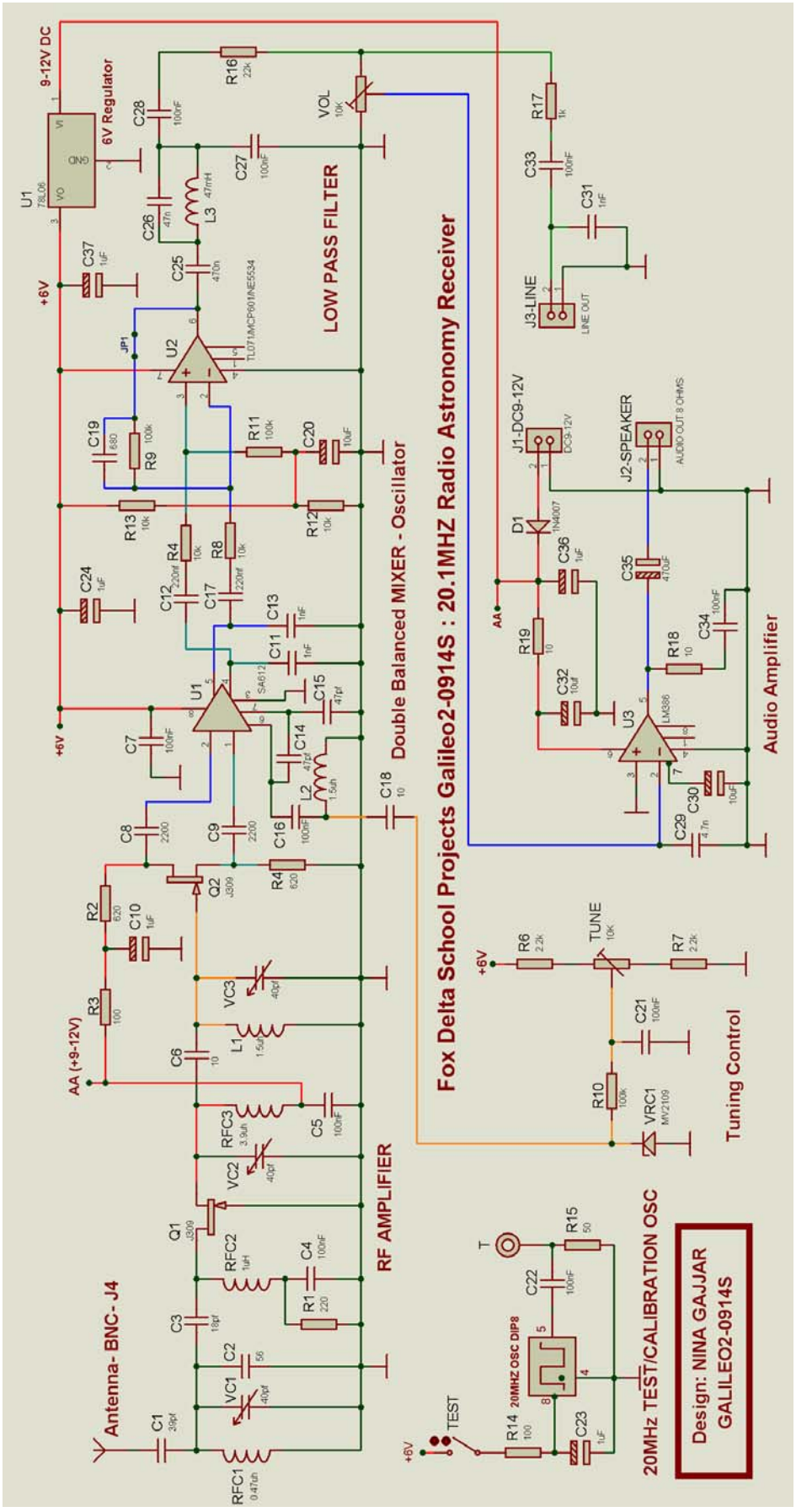
Test Oscillator:

A 20MHZ test oscillator is available. Front Panel pushbutton is provided to check receiver calibration at 20.000MHZ.

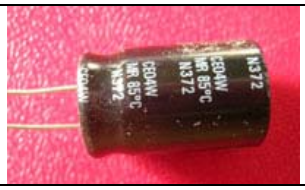
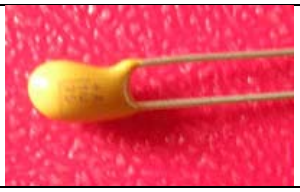
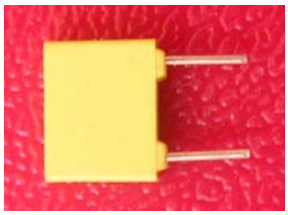
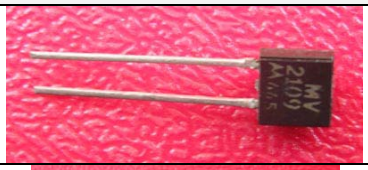
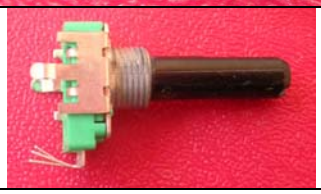
Side View (Antenna) of the completed Galileo Receiver:

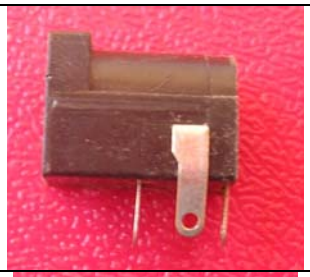
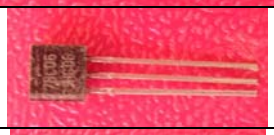
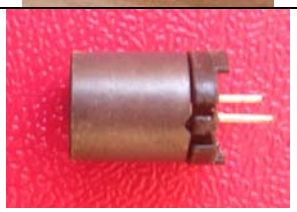
Audio Connector Side:

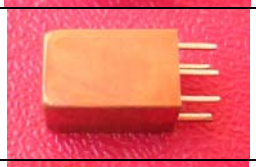
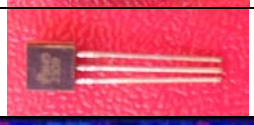
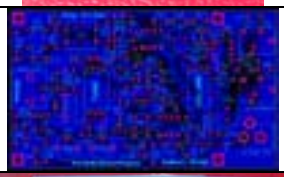
Schematic: Galileo2 Direct Conversion Radio Astronomy Receiver:



Galileo2 Parts List:

No	PART ID		Details
		Resistors	
1	R1		Resistor 220 Ohms 1/4w
2	R2, 4		Resistor 620 Ohms
3	R3, 15, 18		Resistor 100 Ohms
2	R19, 8		Resistor 10 Ohms
1	R16		Resistor 50 Ohms (47)
3	R20, 5, 6		Resistor 2.2K
1	R21		Resistor 1.8K
3	R11, 10, 14		Resistor 100K
5	R7, 9, 13, 12, 17		Resistor 10K
		Capacitors	
2	C6, 15		10pf Ceramic
1	C1		39pf Ceramic
1	C3		18pf Ceramic
2	C12, 13		47pf Ceramic
1	C33		680pf Ceramic
1	C22		470uf Electro / 25V
5	C10, 20, 32, 35, 21,		1uf Tantalum
4	C34, 25, 27, 26		10uF Tantalum
		Capacitors Poly	
7	C36, 16, 28, 5, 4, 8, 11, 29		0.1uF Poly
2	C19, 14		0.22uF Poly
1	C31		0.47uF Poly
1	C24		0.0047uF Poly
2	C19, 14		0.0022uF Poly
2	C18, 17		0.001uF Poly
		Other Parts	
1	Z1		MV2109 Varicap Diode
2	VOL/TUNE		10K Pots Mouser 858-P1100K

1	J1		DC Input Connector
1	D1		Diode 1N4007
1	U1		78L06 Regulator
1	OSC		20MHZ Half Size OSC
3	VC1, 2, 3		40pf Air Variable
2	J2, 3		3.5mm Stereo Sockets MX15
1	L3		47mH Chock
1	RFC1		0.47uH
1	RFC2		1mH
1	RFC3		3.9uH
1	U2		SA612/602 Mixer

1	U3		MCP601/NE5534 DIP8
1	U4		LM386 Audio Amp DIP8
3	IC Sockets		3xDIP8 SA612, LM386, TL071
2	L1, 2		Neosid 1.5uH Inductors
2	Q1, 2		J309 TO92
1	Galileo2-0914S		Single Sided PC Board
1	Metal Case		Project Box. Powder Coated.
1	BNC		PCB BNC Connector
1	TEST		Push Switch 12MM, Long Shaft

If you wish to make your own PCBs, Gerber files are available on Galileo2 web page for download.

Good Luck and Happy Radio Astronomy

Nina Gajjar / 020115

For more details please visit http://www.foxdelta.net/