

# TO THE MULTIMETER AND BEYOND, PART 2...

## “LOW COST TEST EQUIPMENT THAT YOU CAN BUY ON eBay”

**This presentation was created by Mr. Steve Dick, K1RF  
and was originally presented on May 10, 2017 at the  
Greater Norwalk Amateur Radio Club in Norwalk, Connecticut.**

**The presentation is being re-created here with the  
expressed permission of Mr. Dick and with all due  
credit to him and to the GNARC. A few slides have  
been added to cover other options local to Albuquerque, NM.**

Presented by Larry Goga, AE5CZ and Brent Gordon  
at the 2018 Duke City Hamfest at the Isleta Resort & Casino  
September 21 -23, 2018

Slide added by AE5CZ.

# LOW-COST TEST EQUIPMENT THAT YOU CAN BUY ON eBay

May 10, 2017

Steve Dick, K1RF

# Why do hams need test equipment?

- Good for fixing problems around the shack and at field events.
- An absolute necessity for the amateur radio home-brewer or kit-builder. The more complex the project, the more sophisticated the test equipment required.
- Helps hams learn troubleshooting skills by “hands-on” problem solving.

# Some Typical Amateur Radio test equipment

- ⦿ Digital multimeter/probes
- ⦿ Antenna Analyzer
- ⦿ Power meter
- ⦿ Test Leads
- ⦿ Digital Oscilloscope
- ⦿ Lab power supplies
- ⦿ Inductance/capacitance (L/C) meter
- ⦿ Dummy load
- ⦿ SWR bridge
- ⦿ RF Signal Generator
- ⦿ Frequency counter
- ⦿ For serious homebrewers: Spectrum analyzer with tracking generator
- ⦿ Build and repair equipment (soldering/desoldering, magnifiers, fixtures, solder, flux, SMT solder paste, etc)

**For some things, commercial equipment is the best solution but for other things, inexpensive eBay test equipment can be a better choice.**

# Why buy test equipment on eBay?

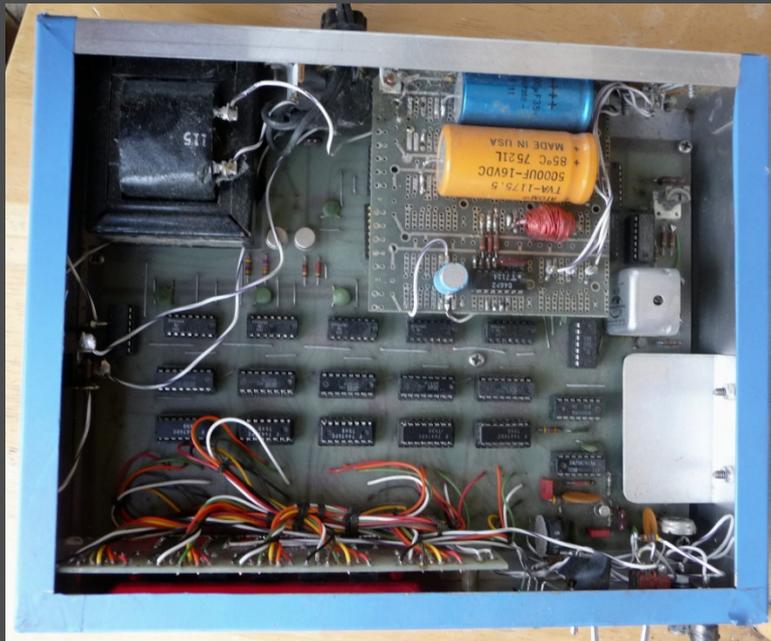
- ⦿ Ready-made. Does not require assembly of kits.
- ⦿ Lots of equipment is available with incredibly high performance at low cost. Good bang for the buck.
- ⦿ Eliminates the need for “lucky finds” at hamfests.
- ⦿ Equipment is available that you just can't find at hamfests.
- ⦿ Often at a fraction of the cost of commercial test equipment with acceptable performance.

# EBAY Cautions

- ⦿ It's a wasteland out there – be careful which vendors you use.
- ⦿ Shoot for vendors with >99.5% favorable rating or top rated plus vendors.
- ⦿ Recommend buying from those with a lot of purchases of the item. You are better off paying slightly higher price from a reliable vendor.
- ⦿ Some have free shipping, some don't. Sometimes the non-free shipping has the best price.
- ⦿ Be patient – items shipped from China typically take several weeks to come. There are some U.S. distributors but they tend to have higher prices for faster delivery.
- ⦿ There are a lot of counterfeit parts or reject parts sold on eBay, or used in circuit cards. That's another reason to stick with reliable vendors.

# “A Modern VHF Frequency Counter”

73 Magazine, May, July & Sept, 1972 by Peter Stark K2OAW



Basic Parts Cost:

Basic counter, PCB, ICs, Readouts \$65

VHF Prescaler: \$25

TCXO \$25

Total Cost: \$115

Less power supply

Total cost in today's dollars: \$446

Performance:

5 digit readout

Basic counter: Up to 20 MHz. 1Hz resolution

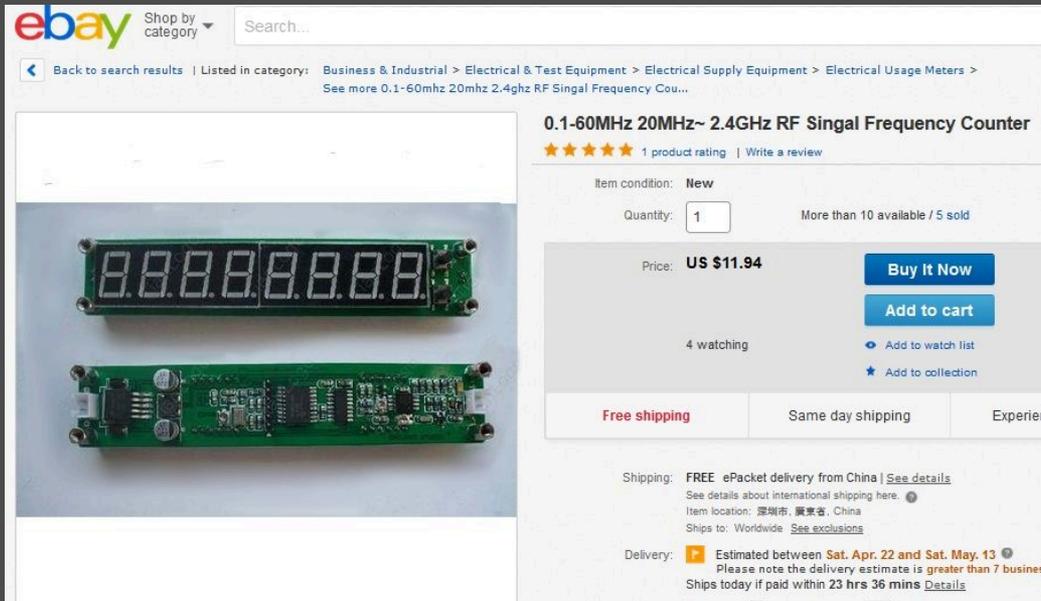
With prescaler: up to 200 MHz, 10Hz resolution

P.C. board 7" X 10"

Labor intensive to build

1972 Frequency Counter 5 digit, 200Mhz, \$446 in today's dollars.  
A commercial Keysight 53220A, 1-350MHz costs ~\$2500 today.

# 45 years later: eBay Frequency Counter Module



Choice of red,  
green, or blue LED  
displays.



Operating manual at:

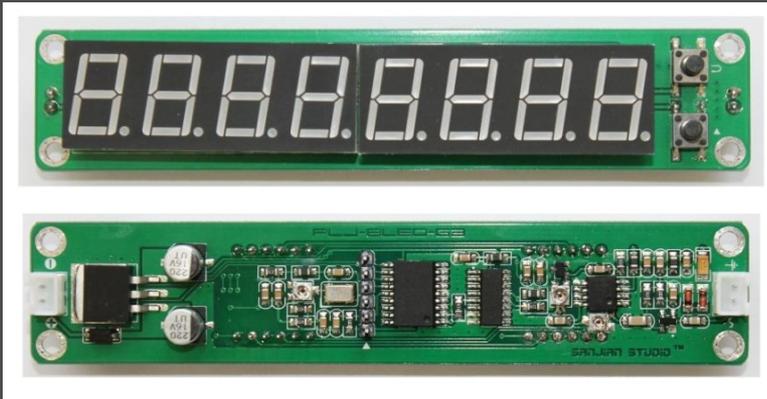
[http://www.zl2pd.com/files/  
PLJ-8LED\\_Manual\\_Translation\\_EN.pdf](http://www.zl2pd.com/files/PLJ-8LED_Manual_Translation_EN.pdf)

3D printed case files available at:

<http://www.zl2pd.com/8digitCounterBox.html>

**EbAY Frequency Counter 8 digit, 0.1MHz-2.4GHz, \$11.94! 37X  
cheaper than 1972 counter, ready built, much higher performance**

# Frequency Counter Module Overview



- Microchip PIC16F648A based
- 13 MHz TCXO (2.5 ppm)
- Can be used with I.F. offset
- Resolution:
  - 100Hz (0.01 sec gate time)
  - 10Hz (0.1 sec gate time)
  - 1Hz (1.0 sec gate time)
- D.C. input power 9-15V  
w/reverse polarity protection

- Notes:
- Power input is reverse polarity protected
- Full specs available in operating manual translated to English by zl2pd.
- The provided R.F cable color coding is reverse of normal conventions (red=ground, black= input)
- Input sensitivity <math><60\text{mV}</math> P-P, 0.1-60MHz. Sensitivity drops off rapidly above 450 MHz with prescaler

# Another Recommended Frequency Counter Module

See more 1 MHz 1.1 GHz RF Frequency Counter Tester Digi...

## 1 MHz ~ 1.1 GHz RF Frequency Counter Tester Digital LED METER FOR Ham Radio

★★★★★ 7 product ratings

Item condition: **New**

Quantity:  More than 10 available / **250 sold**

Price: **US \$11.91** [Buy It Now](#)

[Add to cart](#)

Qualifies for:  **1 yr protection** from Assurant - \$0.99

176 watching [Add to watch list](#)  
[Add to collection](#)

**250 sold** Same day shipping Free shipping

Shipping: **FREE** ePacket delivery from Hong Kong | [See details](#)  
See details about international shipping here.   
Item location: Hong Kong, Hong Kong  
Ships to: Worldwide [See exclusions](#)

**Seller information**  
[kiss\\_buy](#) (36965) ★  
99.4% Positive feedback

[Follow this seller](#)

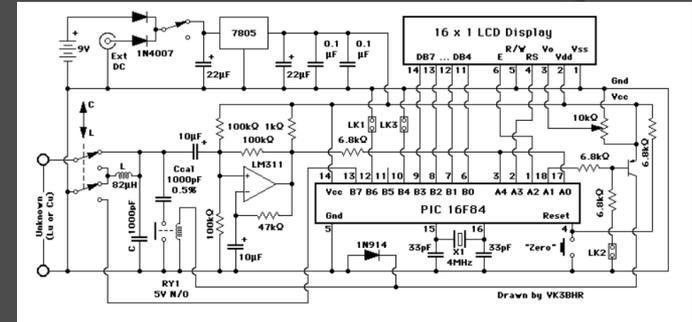
Visit store: [kiss\\_buymiss](#)  
[See other items](#)



- Similar specs to previous counter but physically smaller
- LCD display instead of LED display
- Good for incorporation into homebrew rigs for frequency readout

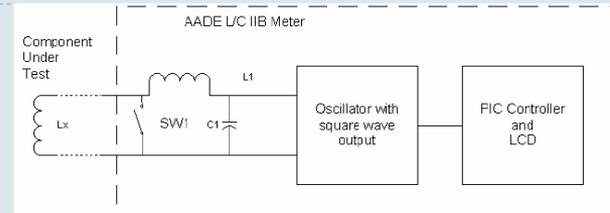
# L-C meters

- AADE was the standard (\$99.95 kit, \$129.95 assembled, \$6.00 S&H.) No longer available. Owner passed away.



## Simplified Theory of Operation

- At start-up, SW1 (a relay under control of the PIC) is closed. C1 is a known value, and the oscillator's frequency is measured by the PIC. Since C1 and frequency are known, the firmware calculates L1. This is frequency f1.
- When an inductive component, Lx, is tested, it is, in effect, in series with L1. This reduces the frequency. The frequency measured with the unknown Lx in series with L1 is frequency f2.
- The measurement frequency depends upon the value of Lx and is always below 750 KHz.

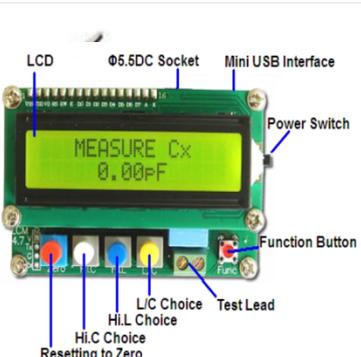


- From the known values of L1, C1, f1 and f2, the value of Lx can be computed.
- A similar technique is used to measure unknown capacitance Cx. It is placed in parallel with C1, and the resonant circuit is comprised of L1, C1 and Cx.
- From knowledge of f1, f2 (with Cx connected), L1 and C1, Cx's value can be computed.
- The measurement frequency depends upon the value of Cx but is always below 750 KHz.

Courtesy Clifton Labs

# Recommended eBay LC Meters

(basically AADE clones)



**Digital LC100-A LCD High Precision Inductance Capacitance L/C Meter Tester**

**\$15.53**  
Buy It Now

363 sold

From China

Top Rated Plus

Labels: LCD, Ø5.5DC Socket, Mini USB Interface, Power Switch, Function Button, Test Lead, H.I.C Choice, H.I.L Choice, H.I.C Choice Resetting to Zero

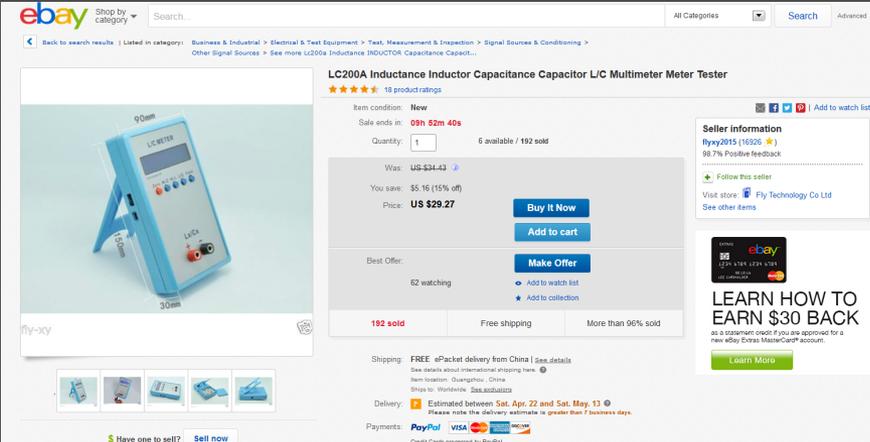


Least expensive  
With clip leads,  
USB cable for power,  
No case  
The LC100-A is more full  
featured than the LC100-S.  
Get the LC-100-A  
\$15.53

Manual

Similar to LC-100A  
but comes with case  
and banana jacks  
\$29.97

Manual



**LC200A Inductance Inductor Capacitance Capacitor L/C Multimeter Meter Tester**

★ ★ ★ ★ ★ 18 product ratings

Item condition: **New**

Sale ends in: **09h 52m 40s**

Quantity:  6 available / 192 sold

Was: **US \$34.43**

You save: **\$5.16 (15% off)**

Price: **US \$29.27**

**Buy It Now**

**Add to cart**

Best Offer

62 watching

**192 sold** Free shipping More than 96% sold

Shipping: **FREE** ePacket delivery from China | See details

Item location: **Quanzhou, China**

Ships to: **Worldwide** See restrictions

Delivery: **Estimated between Sat, Apr. 22 and Sat, May. 13**

Payments: **PayPal** **VISA** **MasterCard** **Discover**

Credit Cards processed by PayPal

Seller information: **flyxy2015 (1626)** 98.7% Positive feedback

Follow this seller

Visit store: **fly Technology Co Ltd**

See other items

**LEARN HOW TO EARN \$30 BACK**

As a partner, eBay will give you a credit for a new eBay Extra MasterCard® account.

**Learn More**

These meters represents a bargain, providing good accuracy of both inductance and capacitance for most hobby and semi-professional use.

# Recommended eBay LC meters

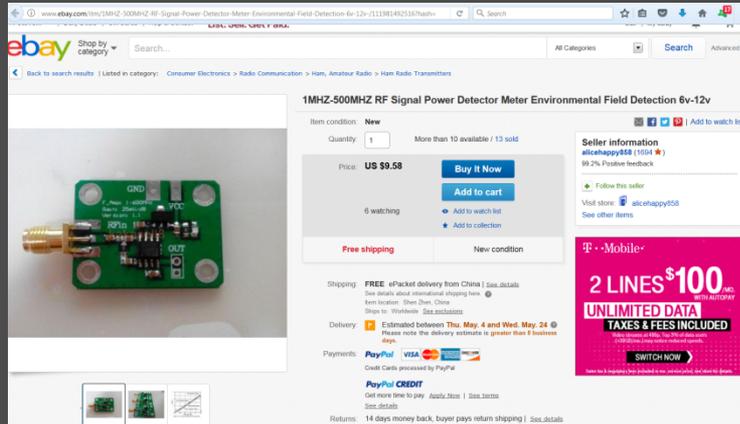
## Specifications

- Model: LC100-A:  
Supply power: +5v ,mini USB interface
- modle:LC200A:
- Supply power: +5v ,miniUSB interface ,4pcs AA battery
- Specifications:  
Measurement accuracy: 1%  
Capacitance measuring range: 0.01 pF - 10uF (The minimum resolution: 0.01 pF )  
Inductance measuring range: 0.001 uH - 100mH  
Big inductance measuring range: 0.001 mH - 100H (The minimum resolution: 0.001uH )  
Big capacitance range: 1-100uF  
Test frequency range: L/C about 500KHZ/Big inductance 500HZ  
Effective display digits: 4 digits

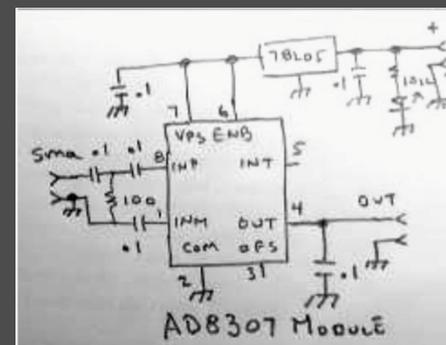
# eBay LC Meters - Notes

- ⦿ Zero (calibrate) just before measurement. Calibrate often for multiple measurements such as for L or C matching
- ⦿ Increasing Inaccuracy for low inductance values ( $< \sim 500\text{nH}$ ) and low capacitance values ( $\sim 10\text{pF}$ ) due to low measurement frequency  $\sim 750\text{KHz}$
- ⦿ Be careful in accepting inductance values of coils with frequency-dependent (and amplitude dependent) permeability, such as most ferrites.
- ⦿ Measures effective inductance, not actual inductance, where distributed capacitance is significant.
- ⦿ For best accuracy when measuring low inductance devices, do not use flexible test leads
- ⦿ You can measure test frequency by pushing the rightmost button (depending on version of software used)

# RF Power Detector Module



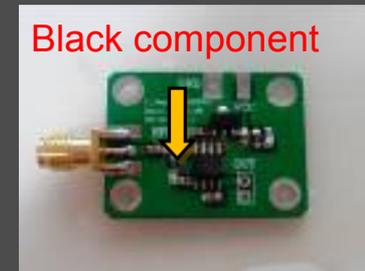
- Operating frequency 1-500 MHz
- Measured power: -74dBm to +18 dBm
- Output voltage range: 0-2.5V
- Detector slope: 25mV/dBm
- Input Impedance 50 ohms
- Supply voltage 6-15V



A bargain at \$9.58 for an AD8307-based power meter! The AD8307 alone costs \$13.14 new. This board includes the difficult to solder AD8307 plus regulator.

# EBAY RF Power Detector Notes

- The input terminating resistor may be 100 ohms instead of 50 ohms. Measure it with an ohmmeter. If it is 100 ohms, parallel a 100 ohm 0805 SMD resistor and verify the parallel combination is 50 ohms. Or just replace with 50 ohms.
- This board does not have output buffering. A circuit with output buffering is shown in June 2001 QST article by W7ZOI, "[Simple RF Power Measurement](#)". The PHSNA yahoo group sells a PC board for an updated version of the W7ZOI circuit.
- With calibration from a known source and attenuators, very accurate power measurements can be performed. See the W7ZOI article and PHSNA files. Microsoft Excel can be used to generate a very accurate curve fit (order 6 polynomial) to a unique device output voltage vs power in.



# Low cost digital multi-meter

category

Back to search results | Listed in category: Business & Industrial > Electrical & Test Equipment > Test, Measurement & Inspection > Test Meters & Detectors > Electric Circuit & Multimeters > Multimeters > See more Cen-Tech Digital 7 Function Multimeter 98025



### CEN-TECH 7 FUNCTION DIGITAL MULTIMETER -TESTER with 9 VOLT BATTERY INCLUDED

★★★★☆ 58 product ratings

Item condition: **New**

Price: **US \$5.99**

[Buy It Now](#)

[Add to cart](#)

Qualifies for:  1 yr protection from Assurant - \$0.99

[Add to watch list](#)

[Add to collection](#)

**Free shipping** Experienced seller New condition

Shipping: **FAST 'N FREE**  
On or before **Mon. Apr. 24** to 06851  
Item location: Lansing, Michigan, United States  
Ships to: United States [See exclusions](#)

Payments: **PayPal** **VISA** **MasterCard** **Discover**  
Credit Cards processed by PayPal

**PayPal CREDIT**  
Get more time to pay. [Apply Now](#) | [See Terms](#)  
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[Get low monthly payments](#) | [Get instant funding](#)

Returns: 14 days money back, buyer pays return shipping | [See details](#)

Guarantee: **ebay** MONEY BACK GUARANTEE | [See details](#)

**Seller information**  
**cantstopshopping** (22000 ★) **me**  
100% Positive feedback

[Follow this seller](#)

Visit store: [cantstopshopping](#)

[See other items](#)

Good basic “throw away” digital multi-meter for <\$5.99. Also sold by Harbor Freight – sometimes given away for free when you buy something else!

# Low cost digital multi-meter specs

- ⦿ Specifications:
  - AC volts 200-750V
  - DC volts 200mV-1000V
  - AC/DC current 200mA-10A
  - Resistance: 200-200K ohms
  - Diode voltage drop test
  - Loaded battery test for 1.5V and 9V batteries.
  - Transistor hfe test
- ⦿ Notes:
  - Has on-off switch which helps life of rotary switch when power off
  - Lowest AC volts is 200V scale
  - Current measurement limited to 200 mA
  - Runs on 9V battery which is expensive.
  - Loses accuracy when 9V battery drops too low but display still works
  - Some complaints of cheaply made leads. The plug ends are too short to fully engage the meter's sockets
- ⦿ Manual available on Harbor Freight website [here](#)

**This suits the average ham's basic troubleshooting needs. But sometimes you need a more professional DMM. Get the meter that fits your needs and that you can afford.**

# 25 MHz Dual Channel DDS Arbitrary Waveform Function Generator

The screenshot shows an eBay product page for a "25MHz Dual-channel DDS Arbitrary Waveform Function Signal Generator Counter Kit". The product is listed by the seller "tomtop\_w" for \$54.99. The listing features a photograph of the white device, which has a digital display showing "F00015.00000 Hz" and "WAVE+SQUARE". The device is connected to a Tektronix DPO 2024B Digital Phosphor Oscilloscope, which displays a square wave on its screen. The eBay interface includes a search bar, navigation links, and a "Buy It Now" button. The product has 26 ratings and 405 units sold.

www.ebay.com/itm/25MHz-Dual-channel-DDS-Arbitrary-Waveform-Function-Signal-Generator-Counter-Kit-/351825634

Hi Steven | Daily Deals | Gift Cards | Help & Contact

Search... All Categories Search Advanced

Back to search results | Listed in category: Business & Industrial > Electrical & Test Equipment > Test, Measurement & Inspection > Signal Sources & Conditioning > Other Signal Sources > See more 25mhz Dual-channel DDS Arbitrary Waveform Func...

**BUY 1, GET 1 AT 5% OFF (add 2 to cart)** See all eligible items

### 25MHz Dual-channel DDS Arbitrary Waveform Function Signal Generator Counter Kit

> Lowest Price > 200MSa/s > High Precision > Thanks

25 viewed per day ★★★★★ 26 product ratings

Item condition: **New** ✉️ 📧 📱 📺 📌 | Add to watch list

Quantity:  More than 10 available / 405 sold

Price: **US \$54.99** Buy It Now

Add to cart

348 watching 👁️ Add to watch list  
★ Add to collection

**405 sold** Free shipping Experienced seller

Shipping: **FREE** ePacket delivery from China | See details  
See details about international shipping here.

**Seller information**  
tomtop\_w (409556) ★ me  
98.3% Positive feedback

+ Follow this seller

Visit store: 📍 TOMTOP Store  
See other items

A real bargain at \$54.99 for a DDS-based dual output accurate, stable signal generator with high output, adjustable amplitudes, up to 25 MHz

# 25 MHz Dual Channel DDS Arbitrary Waveform Function Generator Specs

**Features:**

- Can output arbitrary waveforms and conventional function waveforms (sine/triangle/square/sawtooth wave and TTL signal).
- All functions are digitally controlled, precise and stable.
- Dual-channel output, can work in same phase difference, is adjustable.
- With linear sweep (Max. up to 999k) and logarithmic frequency sweep functions.
- Signal of both channels has built-in sophisticated <math>20dB</math> attenuator in order to reach the minimum amplitude resolution 1mV.
- With 120%  $\pm$  120% DC bias function.
- \* TTL, output phase difference is adjustable.
- Has a frequency measurement, period measurement, positive and negative pulse width measurement, duty cycle measurements and counting function.
- With USB interface, after the connection with PC, the PC can be used to control the instrument.

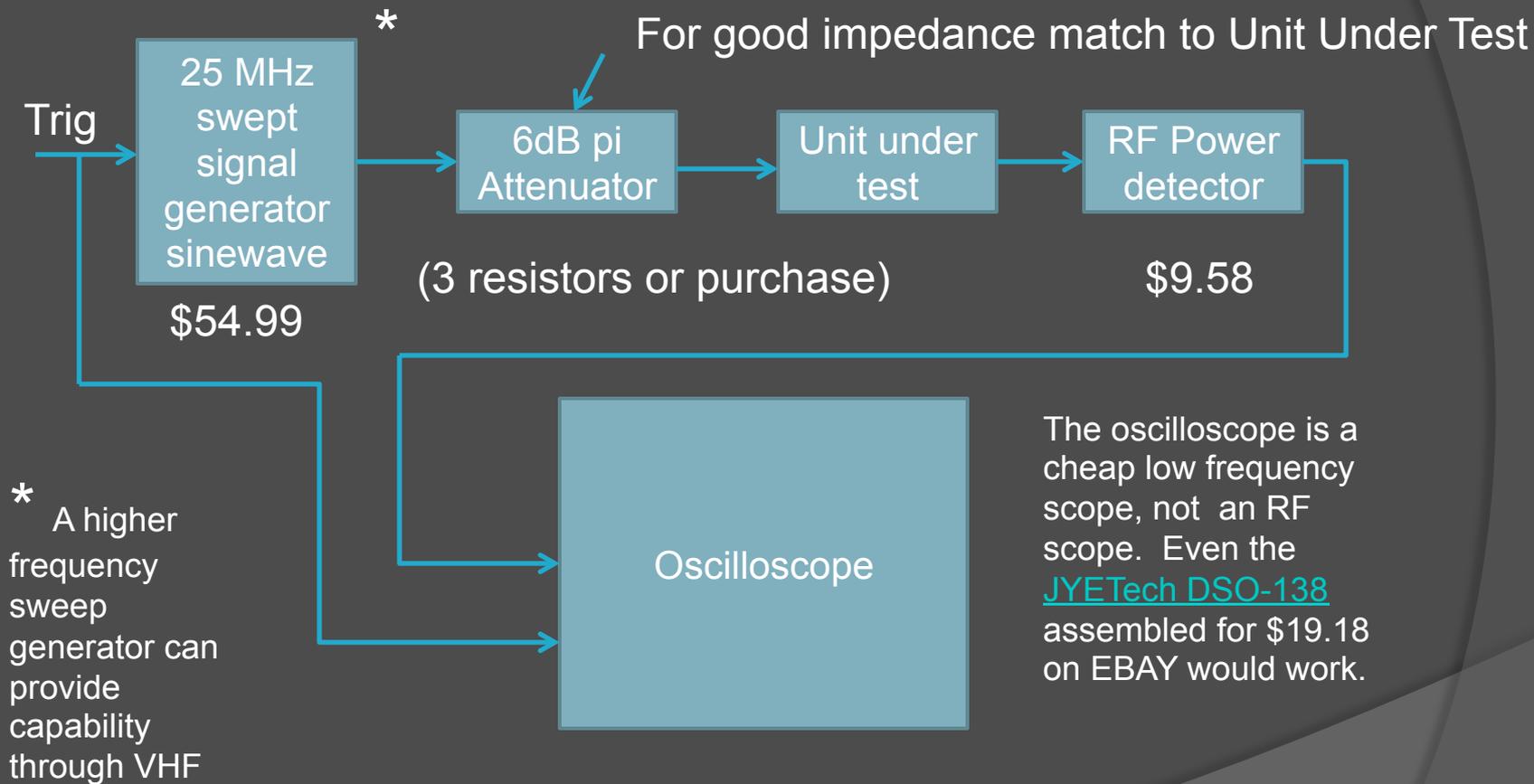
**Specifications:**

Project	Parameters	Value		
Key Features	Frequency Range	Sine Wave Square Wave Triangle Wave Sawtooth Wave Arbitrary Waveform TTL Digital Signal Wave	Normal Modes: 0.01Hz~25MHz 0.01Hz~6MHz 0.01Hz~6MHz 0.01Hz~6MHz 0.01Hz~6MHz 0.01Hz~6MHz	
	Output Modulation	Frequency Sweep		
	Waveform Types		Sine/Triangle/Square/Lifting sawtooth Wave, CMOS Digital Signal Wave and Arbitrary Waveform	
	Waveform Length		2048Sine	
	Sampling Rate		200M Sine	
	Waveform Amplitude Resolution		12 Bits	
	The Min. Frequency Resolution		10mHz	
	Frequency Error		$\pm 5 \times 10^{-6}$	
	Frequency Stability		$\pm 1 \times 10^{-6}$	
	Amplitude Range (Peak to Peak)		5mVp-p~20Vp-p	
Output Impedance		50 $\Omega$ ( $\pm 10\%$ )		
Amplitude Resolution		1mV/p ( $< 20dB$ Attenuation)		
Offset Range		$\pm 120\%$ ~ $\pm 120\%$ (The ratio of bias voltage and signal amplitude)		
Bias Resolution		1%		
Phase Range		0~359°		
Phase Resolution		1°		
Sine Wave	Harmonic Rms System		40dB( $< 1MHz$ ); 35dB( $1MHz \sim 20MHz$ )	
	Distortion		$\pm 0.5\%$ ( $20Hz \sim 20kHz$ )	
Square Wave	Lifting Along Time		$\pm 20ns$	
	Overshoot		$\pm 10\%$	
TTL	Duty Cycle Adjustment Range		9%~99.9%	
	Lifting Along Time		$\pm 20ns$	
Arbitrary Waveform	Low Level		$\pm 0.3V$	
	High Level		1V~7.5V	
Scan	Quantity		16	
	Memory Depth/Group		1KB/16	
External Measurements	Scan Mode		Linear Sweep, Log Sweep	
	Scan Time		16~9999	
	Scan Range		It is determined by the sweep parameter settings	
	Frequency Measuring Range			GATE-TIME=10S 0.1Hz ~ 60MHz
				GATE-TIME=1S 1Hz ~ 60MHz
				GATE-TIME=0.1S 10Hz ~ 60MHz
				GATE-TIME=0.01S 100Hz ~ 60MHz
	Input Voltage Range		0.5Vp-p~20Vp-p	
	Counting Range		0~4294967295	
	Counting		Manually	
Positive and Negative Pulse Width Measurement		10ns Resolution, the Max. Measurable 10s		
Periodic Measurement		20ns Resolution, the Max. Measurable 20s		
Duty Cycle Measurement		0.1% Resolution, Measuring Range from 0.1%~99.9%		
Source Selection		1. Ext. IN Input(AC Signal) ; 2. TTL-IN Input(Digital Signal)		
Memory	Quantity		10	
	Location		M0~M9	
Interface	Interface Mode		using USB to Serial interface	
	Communication Rate		57600bps	
Power Supply	Protocol		Using the Command Line, the Agreement Public	
	DC		MMS200A DC 5V Power Supply	
General	Size		19.5 * 17.5 * 7cm / 7.67 * 6.9 * 2.75in	
	Weight		542g / 19.12oz	
	Package Size		24 * 21 * 9.5cm / 9.45 * 8.3 * 3.74in (L * W * H)	
	Package Weight		986g / 34.76oz	

Package List: E0782-26

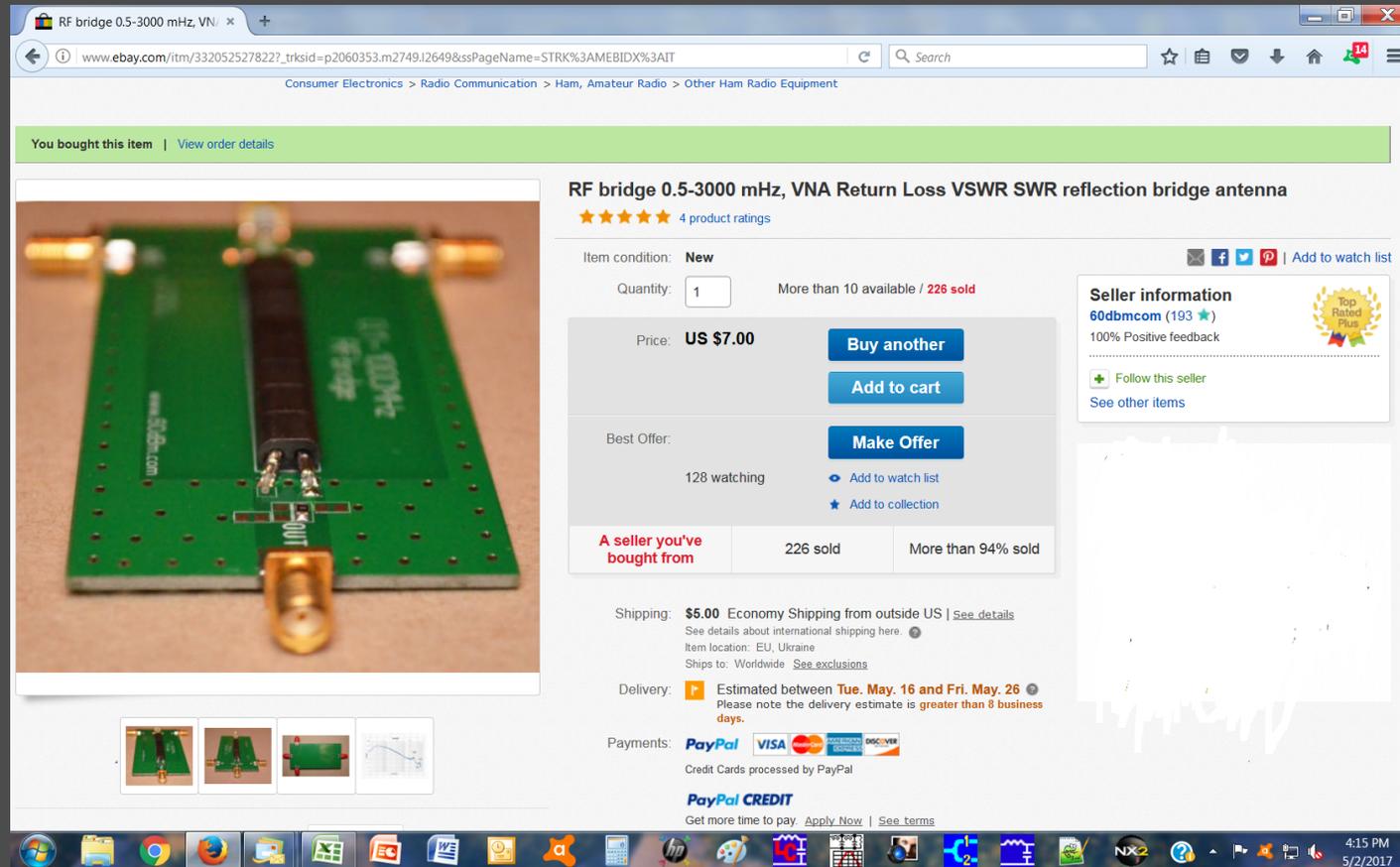
- Up to 25 MHz sinewaves, sweepable linear or log
- Arbitrary waveform generator up to 6 MHz!!
- High level adjustable outputs
- Built-in frequency counter
- Pulse trains 1-99% duty cycle
- Programmable TTL outputs

# An inexpensive spectrum analyzer for testing homebrew filters, etc



This setup can be enhanced with a [return loss bridge](#) for return loss and SWR measurements for \$7.00 + \$5.00 shipping

# Inexpensive return loss bridge



The screenshot shows an eBay listing for an "RF bridge 0.5-3000 mHz, VNA Return Loss VSWR SWR reflection bridge antenna". The item is priced at \$7.00 and has 4 product ratings. The seller is "60dbmcom" with 100% positive feedback. The listing includes a main image of the green PCB antenna and several smaller thumbnail images. The shipping cost is \$5.00, and the estimated delivery is between Tuesday, May 16 and Friday, May 26. The listing also shows the seller's information, including a "Top Rated Plus" badge and a "Follow this seller" button.

RF bridge 0.5-3000 mHz, VNA Return Loss VSWR SWR reflection bridge antenna  
★★★★★ 4 product ratings

Item condition: **New**

Quantity:  More than 10 available / 226 sold

Price: **US \$7.00** [Buy another](#) [Add to cart](#)

Best Offer: [Make Offer](#)

128 watching [Add to watch list](#) [Add to collection](#)

**A seller you've bought from** 226 sold More than 94% sold

Shipping: **\$5.00** Economy Shipping from outside US | [See details](#)  
See details about international shipping here. [See details](#)  
Item location: EU, Ukraine  
Ships to: Worldwide [See exclusions](#)

Delivery: Estimated between **Tue, May 16 and Fri, May 26** [See details](#)  
Please note the delivery estimate is greater than 8 business days.

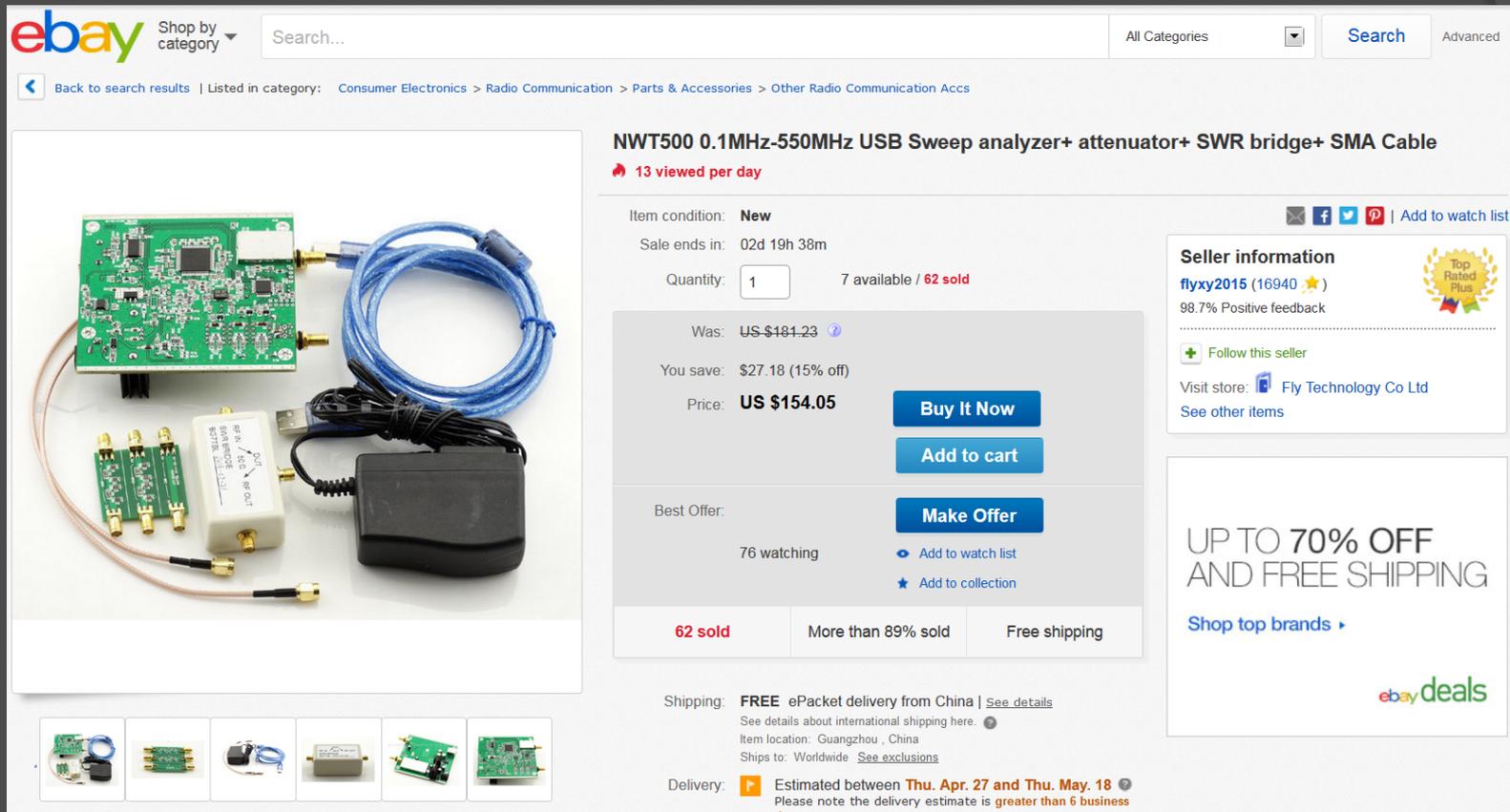
Payments: **PayPal**   
Credit Cards processed by PayPal

**PayPal CREDIT**  
Get more time to pay [Apply Now](#) | [See terms](#)

4:15 PM 5/2/2017

Useable 0.5-3000 MHz, ~45dB directivity up to 50 MHz, 28dB directivity at 1000 MHz, \$7.00 + \$5.00 shipping

# Network analyzer for serious experimenter/homebrewer



The screenshot shows an eBay product listing for a network analyzer kit. The main image displays the kit's components: a green printed circuit board (PCB) with various electronic components, a blue SMA cable, a white SMA bridge, a black power supply, and several other smaller components. The listing title is "NWT500 0.1MHz-550MHz USB Sweep analyzer+ attenuator+ SWR bridge+ SMA Cable". The price is listed as US \$154.05, with a "Buy It Now" button. The seller is "flyxy2015" with a "Top Rated Plus" badge. The listing includes shipping and delivery information, such as "FREE ePacket delivery from China" and an estimated delivery date of "Thu. Apr. 27 and Thu. May. 18".

ebay Shop by category Search... All Categories Search Advanced

Back to search results | Listed in category: Consumer Electronics > Radio Communication > Parts & Accessories > Other Radio Communication Accs

### NWT500 0.1MHz-550MHz USB Sweep analyzer+ attenuator+ SWR bridge+ SMA Cable

13 viewed per day

Item condition: **New**

Sale ends in: 02d 19h 38m

Quantity:  7 available / 62 sold

Was: US \$181.23

You save: \$27.18 (15% off)

Price: **US \$154.05**

[Buy It Now](#)

[Add to cart](#)

Best Offer: [Make Offer](#)

76 watching

[Add to watch list](#)

[Add to collection](#)

**62 sold** More than 89% sold Free shipping

Shipping: **FREE** ePacket delivery from China | [See details](#)  
See details about international shipping here.  
Item location: Guangzhou , China  
Ships to: Worldwide [See exclusions](#)

Delivery: Estimated between **Thu. Apr. 27 and Thu. May. 18**  
Please note the delivery estimate is **greater than 6 business days**

**Seller information**

**flyxy2015** (16940)

98.7% Positive feedback

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Visit store: **Fly Technology Co Ltd**

[See other items](#)

**UP TO 70% OFF AND FREE SHIPPING**

[Shop top brands](#)

**ebay deals**

**\$154.05 0.1 to 550 MHz 1Hz freq steps, USB sweep analyzer 50dB dynamic range, + attenuator + Ret Loss bridge + SMA cable + power supply**

# Network analyzer for serious experimenter/homebrewer – cont'd



Note – should be mounted in a chassis, not supplied

# BG7TBL, a Chinese HAM



10 MHz. OCO 8-output \$120



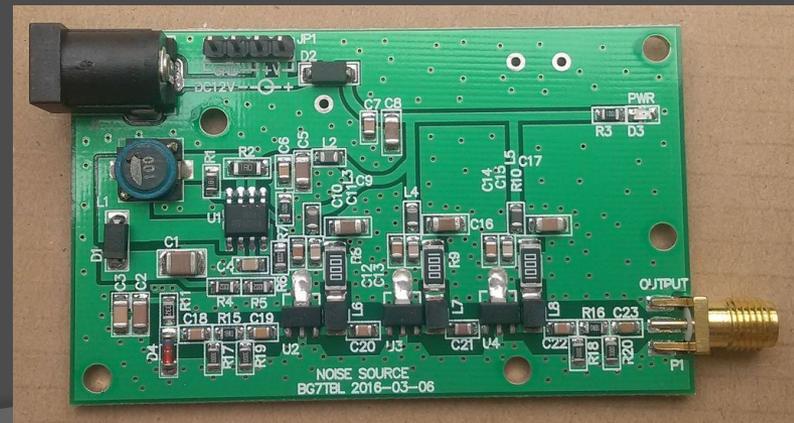
Frequency Multipliers \$10-\$20



Frequency Standard \$52



Adjustable OCO Reference Osc. \$150



RF Noise Source \$12

Slide added by AE5CZ.

# Low cost GPS module

## An Arduino Controlled GPS Corrected VFO

*A VFO that provides 1 to 112.5 MHz signals on two independent outputs. Use it as a stand alone unit or with a GPS receiver to improve frequency accuracy. UTC and six digit grid square locations are also displayed in the GPS Mode*

This project began with the purchase of an Si5351A clock generator breakout board for less than \$8 from Adafruit Industries. Designed as a substitute for crystal oscillator clocks, it features three output ports for frequencies between 8 kHz and 160 MHz. Although the board is specified for a wider bandwidth, this project is limited to 1 through 112.5 MHz.

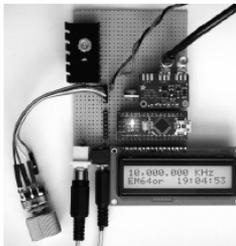


Figure 1 — I constructed the VFO on a piece of perfboard. The heatsink shown at the top left corner of the board is for the 7805 voltage regulator. The regulator is not required for the basic non-GPS configuration of the Si5351 VFO project, if used without the display backlight. The VFO output signals connect to the CLK1 and CLK2 connectors at the edge of the Si5351 board. The Arduino Nano is between the Si5351 board and the display board. At the bottom left of the perfboard are the GPS connections. Also note the rotary encoder to the left side of the perfboard. The pushbutton switches were not included on this version of the VFO.

Figure 1 shows my project, built on a piece of perfboard. The Si5351 board is the top board on the right side of the perfboard. Just below that is the Arduino Nano board I used to control the oscillator. This version uses a rotary encoder to set the operating frequency. You can see the encoder off the left side of the board. Figure 2 shows a completed unit, packaged in a plastic project box. The Resolution, Band Select, and Reset pushbuttons are on the right, just below the rotary encoder.

The Si5351A board does have limitations. Although it is a highly capable and stable board, the output is a square wave with odd harmonic frequencies present in the output. The square wave output does make

a good source for some mixers. Phase noise is also higher than other popular programmable signal sources. A quick search of the Internet will yield a wealth of data concerning the performance of the Si5351A IC. Builders are urged to consider phase noise and crosstalk limitations before using this IC in their project.

A simplified version of the VFO can be built without the GPS module. Figure 3 shows the circuit for this configuration. Figure 4 shows the schematic diagram for the complete circuit, with GPS module, rotary encoder and pushbuttons.

Unlike a GPS disciplined oscillator (GDO) using a phased lock loop (PLL), this project uses a GPS 1 pulse per second (pps)



Figure 2 — Here is a completed VFO project, housed in a plastic project box. The Resolution, Band Select, and Reset pushbutton controls are located just below the rotary encoder.

QEX July/August 2015 3

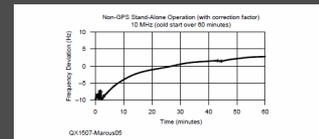
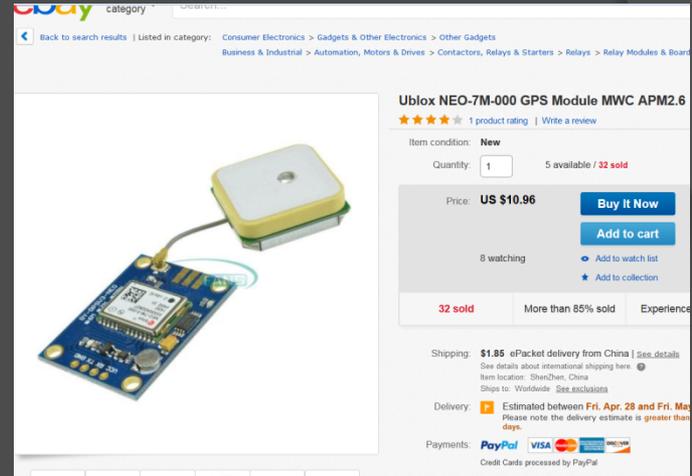


Figure 5 — This is a graph of the frequency versus time over the initial 60 minutes, for the output from the non-GPS version of the VFO project. A constant room temperature was maintained during the data collection. The drift rate is approximately 1.6 Hz / °F (2.8 Hz / °C).

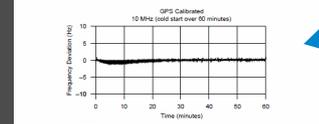


Figure 6 — Here is the graph of the frequency versus time over the initial 60 minutes for the GPS-corrected VFO. A constant room temperature was maintained during this data collection. Frequency corrections to bring the frequency back to normal are shown during the early minutes of warm-up.

Or get a simple kit from QRP labs for \$23.00 for a more sensitive GPS with larger patch antenna

1pps signal from GPS to an Arduino stabilizes frequency to fraction of a Hz.

An \$11.00 EBAY GPS module can be used as the basis of a low cost GPS corrected Arduino-based 1-112.5MHz VFO

# EBAY soldering iron

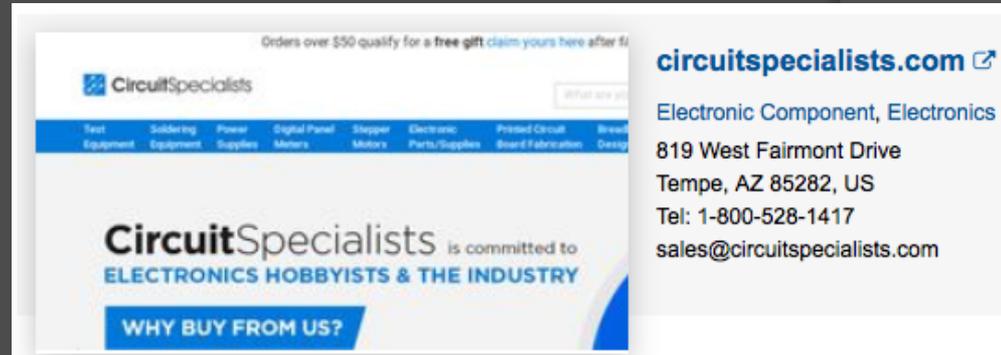
The screenshot shows the Banggood website interface. At the top, the logo 'Banggood.com' is displayed with the tagline 'Shopping with fun Best Bang For Your Buck'. Navigation links include 'Ship to United States, USD', 'New Arrivals', 'Flash Deals', 'Preorder', 'Brands', and 'Community'. A search bar is present with the text 'Enter Keywords'. The main content area features a product listing for the 'Mustool® MT223 60W Adjustable Temperature Electric Soldering Iron Welding Rework Repair Tool with 5pcs Solder Tips I/3C/4C/K/2.4D 110V/220V Option'. The product image shows a black and silver soldering iron. The price is listed as 'US\$ ~ 13.55'. Shipping options are shown as 'CN Warehouse' and 'US Warehouse'. The shipping method is 'Free shipping To United States via Dgm us mail' with a 3-7 business day delivery time. The plug type is '110V US Plug' and '220V EU Plug'. The quantity is set to 1. There are buttons for 'Buy it now' and 'Add to cart'. A 'Wholesale Inquiry' link is also visible. The product has a 4.9 star rating from 1775 reviews. Social sharing options for Facebook, Twitter, Pinterest, and Reddit are available. A 'Report lower price' and 'Price alert' feature is also present.

- Well, not exactly EBAY but Banggood, which ships from U.S. warehouse.
- Also available on EBAY at a higher price from China.
- 60 watts, adjustable temperature, with five screw-in tips.
- Use it to replace faulty components found with other test equipment

**At \$13.55 + free shipping, a decent 60 watt adjustable temperature iron with tips**

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# Bentley's Auction or <https://auctionsouthwest.com>



The screenshot shows the Bentley's Auction website homepage. At the top, there is a search bar and the Bentley's Auction logo in a stylized, glowing gold font. Below the logo, a navigation menu includes Home, Services, Auctions, News/Press, About Us, eMail List, My Account, and Contact Us. The main content area features a large banner for a "Sandia, LANL, UNM, NMT, SFCC, APS & CNMCC & Others 2 Day Surplus Auction" with logos for various institutions. To the right, there is an "Auction Calendar" section listing several upcoming auctions.

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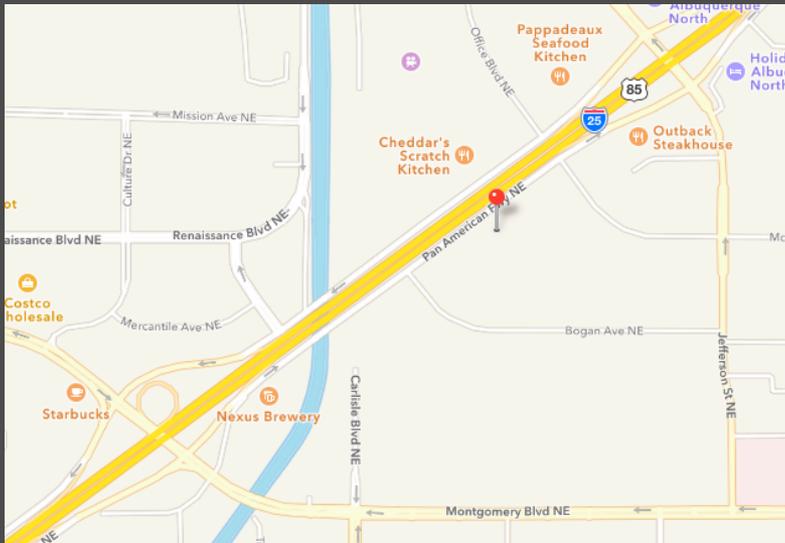
**CNMCC**  
Central New Mexico Community College

**Sandia, LANL, UNM, NMT, SFCC, APS & CNMCC & Others 2 Day Surplus Auction**  
Auction Dates: Thursday, November 8, 2018, at 9:30 AM MST Ring # 1 (Online Absentee, Onsite Bidding, [...])

**Auction Calendar**

- **Aberdeen Construction, LLC Online Auction**
  - August 24, 2018
  - Albuquerque, NM
- **Government, Corporate & Others 2 Day Surplus Auction**
  - September 6, 2018
  - Albuquerque, NM
- **Santa Fe County Sheriff's Fleet Vehicle Auction**
  - September 15, 2018
  - Santa Fe, NM
- **New Mexico Department of Public Safety (DPS) & Others Annual Surplus Auction**
  - September 22, 2018
  - Santa Fe, NM

# Bentley's Auction or <https://auctionsouthwest.com>



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**Watch out for the "ups" and "extras"!**



**Tektronix 2710 S/A  
10 KHz. – 1.8 GHz.  
\$325 / \$442**



**HP 54602B DSO  
4 Channel, 150 MHz.  
\$150 / \$196**



**HP 3325A Sweep  
Function Generator  
\$350 / \$457**



**HP 53181A Freq. Ctr.  
3 GHz., 10 digits res.  
\$240 / \$291**

**Slide added by AE5CZ.**

# Summary:

- EBAY is a great source for cost-effective test equipment for the amateur radio operator
- Much useful test equipment available on EBAY cannot normally be found at hamfests
- Much test equipment on EBAY can do the job of more costly professional test equipment but budget priced for amateur radio operator use