

ZERO BEAT

10-23

HAMPDEN COUNTY RADIO ASSOCIATION, INC

W1-QSL BUREAU

SPRINGFIELD, MASS

ARRL AFFILIATED, 35th YEAR

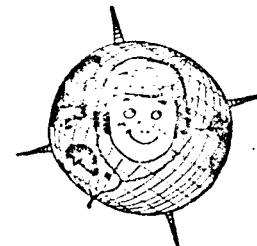
Next Meeting:

*****HAMS IN SPACE!!!*****

FRIDAY OCTOBER 7TH

Feeding Hills Congregational Church

Intersection of routes 57 and 187
Doors open at 7:30, Meeting starts at 8 pm



AN ARRL VIDEOTAPE WILL BE SHOWN GIVING THE DETAILS OF THE SPACE SHUTTLE MISSION CARRYING OWEN GARRIOT, THE FIRST HAM TO OPERATE FROM SPACE! THEN W1KK WILL SHOW US HOW TO MAKE THAT QSO OF A LIFETIME!!!

DON'T MISS THIS MEETING!

PRESIDENT'S CORNER

Steve Nelson, W1EYF

Just as the Fall signals the beginning of a new school year, it is the beginning of a new year for the Hampden County Radio Association. Although we've had one meeting, your Board has met more than once and put together the 1983/84 meeting Schedule. Some interesting meetings and speakers are planned along with contests, Auction, and Flea Market. Much of the work has been done, but there is plenty to do. We need members to help out at the Auction, Flea Market, participate in the contests, and with the coffee bar. (Under Ken Grady's watchful hand!) We would like some help teaching Novice classes and possibly General. We need help to set up and take down the chairs every meeting.

To steal part of an old saying, "The HCRA needs YOU!" When I ask for volunteers, please step forward. 98% of the task before us would be done if everyone did one small bit!

SEPTEMBER MEETING REPORT

The new season started out with a bang! W1LH1H, our Section Emergency Coordinator was the guest speaker. Dick presented an award to Larry, KA1GVS for ourstanding service during the tornado weather watch. FB, Larry! Then Dick told all regarding the tower struggle on Mt. Greylock, and the search for the crashed plane. An interesting and informative evening, with a good crowd despite the heat. During the coffee and donuts, W1KK gave us a demonstration of the new OSCAR, AO-10 in the parking lot. With the help of Ken, Art had set up a complete station. Everyone gathered around to hear a very clear signal from the satellite! Art wrote an article describing the home-brew antenna he uses for OSCAR, which is elsewhere in this issue.

HAMPDEN COUNTY RADIO ASSOCIATION

1983-84 Officers and Directors

<u>Officers</u>	<u>Telephone</u>
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Jeff Duquette, K1BE	569-6739
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Articles, comments,
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**HCRA "Worked 25
Members" Award**

C. Norman Peacor
K1IJU
Country Club Dr
Monson, Ma 01057
QSL's not required!
Send call, time, date,
frequencies, and one
of your QSL cards for
our permanent collection.

FOR SALE: YAESU FT 901DM, HF transceiver, 1.8-29.9 mhz in 9 band positions, plus WWV in 10th position. USB, LSB, CW, FSK, AM, and FM; DC input to PA is 180 watts, for cw/ssb. All others 80 watts. Digital/analog frequency readout, PLL; Built-in Curtis keyer, memory frequency control, 12v/120 volt built-in power supply, dual-filter variable IF bandwidth tuning, and on CW, built-in RC active filter. Many other extras like 20db RF attenuator, speech processor, etc, etc. Includes extra set of 6146's. Price \$600.00 contact K1BE, below.....

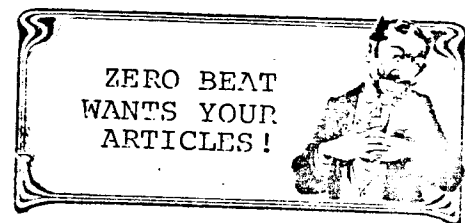
YAESU FT-620B, 6 meter transceiver, LSB, USB, AM, CW with pre-amp, 52.525 xtal, vfo, mike. \$210.00 I'd prefer to sell it to a club member and one more station to work in the January SS on six! see K1BE below...

KENWOOD TR-7200A, 2 meter FM transceiver, 144-148 mhz, 22 channels, all popular frequencies, 10 watts high, 1 watt low, plus some extras, with mike and manual \$175.00 Contact Jeff Duquette, K1BE, at Zero Beat address or 413-569-6739 evenings, 730-3253 days.

FOR SALE YAESU FT-101EX TRANSCEIVER, IN EXCELLENT COND \$275.00
HEATHKIT SWR AND POWER METER, \$20.00, VERTICAL ANTENNA, \$20.00;
CALL ANYTIME, DOUG KALAVI 593-9091

From the estate of W1VON, Griff: HT-37 transmitter, \$100.; SX-115 receiver, \$200. or best offer. D-104 mike with amp, \$20.; Hallicrafters SKYRIDER 5-10 receiver, best offer. National HRO receiver and power supply, best offer. contact W1ALL, GEORGE HUGHES at 569-5360
(Note that I'll be bringing quite a lot of stuff to the November auction-It might take all evening just to sell off W1VON's stuff!)

**SEND ZERO BEAT your
For Sale, Items Wanted
Ads*******



COMPARISON SHOPPING

ZERO BEAT is now typed on a word processor and using that technology I sent out letters to thirteen advertisers in the August '83 QST. The letter asked their prices on the following two radios:

YAESU FT 726R with 144, 50, 430-440 mhz, and the satellite option. This lists for about \$1360.00.

KENWOOD TS 430S with ssb filter and scanning mike. This radio lists for \$998.00. I asked for the price buying it with Master Charge (MC) or with a money order(MO). I also requested the price if I bought them both at the same time.

Seven replies were received:

	<u>FT 726R</u>		<u>TS430S</u>		<u>BOTH AT ONCE</u>	
	MC	MO	MC	MO	MC	MO
STORE 1	1210	Same	880	Same	2075	
STORE 2	1226	"	845	"	2071	
STORE 3	1212	1188	883	865	2039	2019
STORE 4	1242	1218	902	884	----	
STORE 5	1224	Same	903	Same	----	
STORE 6	1287	"	---	---	----	
STORE 7	709*	699*	878	868	1587	1567

* Don't believe this price.

The discount range went from: (100%=1360, : so \$1210 =discount of 11.02%)

STORE 1	11.02%		11.8%		12%
STORE 2	9.85%		15.33%		7.93%
STORE 3	10.88%	12.64%	11.52%	13.32%	13.52%
STORE 4	8.67%	10.49%	9.61%	11.42%	
STORE 5	10%		9.51%		
STORE 6	5.36%				
STORE 7	----		12.02%	13.02%	

So if you want to save a few dollars, send away for several quotes. The company with the best quote on the FT 726R was "Ham Radio Outlet" in California. The best quote on the TS 430S was the "Radio Warehouse" in Texas.

"Quick As A Wink" Printing & Sales Co.
573 Union Street West Springfield, Ma. 01089



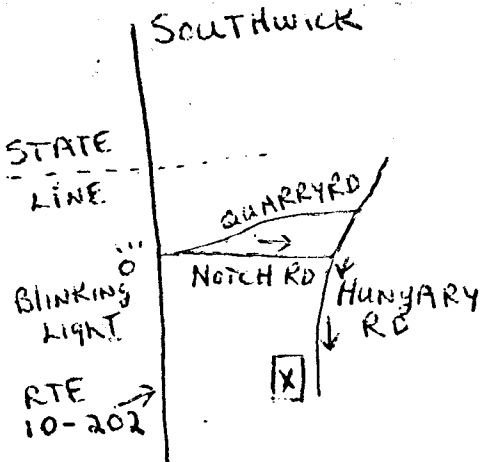
*What do you do with your ZERO BEAT after you've read it?
Why not staple your next QSL card inside and mail it to the contact?
It's a good way to ensure a return QSL too!*

TIDBITS

The HCRA Ten Meter Net is waiting for you to check in! Thursday nights at 9 pm on 28.650 mhz. Did you know it ran all summer with **KALERS** as net control? FB, Bill...**AC1T** is building a ten meter FM transceiver on a surplus CB board. How about a Zero Beat article, John?...On the third Thursday of every month the computer club for owners of VIC-20's and Commodore 64's meets at the WMECO in West Springfield...There's also a computer net Tuesday nites on the .67 machine. NCS is **KALGDV** ...**KALGPX** is now **N1CQT**...Get your goodies ready for the HCRA auction next month...**WB1ETS** is now engaged to be married next June! She's studying for her novice!...Bob McCormick, **K1KPH**, broke his kneecap in an auto accident this summer. Sorry to hear that, Bob...Bob Sullivan, **K1FVT** is now a Silent Key. A personality on the Mt. Tom machine, Bob was a QSL Bureau sorter and is sadly missed by all...**N8BQU**, our illustrious club secretary for the past two years, is moving 1,000 miles away! Dick Manner just passed his bar exam (lawyer-type, not the local pub!) and we are sorry to see him leave. Many thanks for all your work, Dick, stay in touch...**W1RWU/W1ECR** have a very large moon-boonce array now on 432 mhz. Cushcraft's stock went up six points when Frank Potts announced his intentions! ...Don't leave your coffee cup and butts all over the church at the end of the meeting. The "janitor" is one of your friends and you're making it hard on them...The Hampshire Computer Club meets at Smith College the second Tuesday of every month. The next meeting is on October 11th with a guest speaker on home repair of the computer. Contact **W1PGT** at 567-8584 for more info...

TAKE-IT-AWAY SALE!

The lifetime collection accumulated by Silent Key W1VON will be sold at a TAKE-IT-AWAY sale on Saturday and Sunday, October 8th and 9th from 9 am-5 pm. Too numerous to list, too varied to describe, you'll have to see it to believe it! Location is Hungary Road in Granby, Connecticut, just over the state line from Southwick on routes 10-202.



AMATEUR RADIO/COMPUTER GEAR
AUCTION
FRIDAY NOVEMBER 4th
8 pm
GRANGER SCHOOL
INTERSECTION OF ROUTES 57 and 187

HOME-BREW 3-D TWINS FOR OSCAR 10

By Art Zavarella, W1KK

This is the design of the antenna that was casually demonstrated to receive AO-10 at the September meeting. It will be tried again at the October meeting in an attempt to get a two way QSO with conditions cooperating.

This antenna does a good job on the two meter downlink signals from the recently launched phase III AO-10. Two identical 3-element, full wave Delta quads mounted on the same boom at right angles to each other provide circular polarization with appropriate phasing. For convenience in assembly and phasing the vertical antenna is mounted one-quarter wave (20 inches) forward of the corresponding horizontal elements. The driven elements are gamma matched to individual mini-RG-8's of equal length, thereby permitting a choice of Right Hand Circular Polarization (RHCP), Left Hand (LHCP), or conventional horizontal or vertical, to be presented in the next article. For the present, only the predominant RHCP will be given.

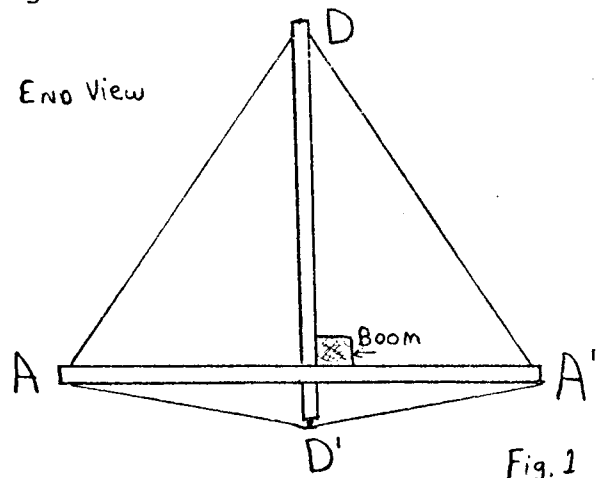
The boom is a piece of weathered wood, in our case a tomato stack about 1"x1"x4 feet. Three pairs of identical elements are made up in advance individually, and later fastened to the boom in the sequence recommended. Figure 1 gives a general view of the six elements. AA is 3/4"x3/4" wood, of lengths 30", 28", and 26" for reflector, driven element, and director, respectively. DD' is 3/4"x3/4" wood, 22 inches for all six elements. A and A' are fastened two inches from D' at right angles. The wires are strung around the four ends of these wooden stretchers and fastened there with twisted #18 solid plastic coated wire. The lengths are:

Driven Element	80 inches
Reflector	84 inches
Director	76 inches

I attached the gamma matches at D', with braid soldered to the side at D' and inner "hot" coax to a small variable capacitor nearby. Another capacitor lead went to a clip tapped at 6 inches from D' towards A or A'.

Starting on the end view of the boom, when you assemble the antenna, mount the boom by itself on its support 24 inches from the boom rear. (reference end) Then mount the elements according to table 1:

1. Vertical Reflector spacing of 20 inches
2. Horizontal director 28 inches
3. Horizontal Driven Element at 12 inches
4. Vertical Driven Element at 32 inches



- 5. Horizontal Reflector at 1 inch
- 6. Vertical Director at 47 inches.

For Right Hand Circular Polarization, have the gamma of the horizontal go to the left of D' and in the vertical Driven Element, gamma to the lower side of D'. This is viewing the antenna from the rear, with connections to the horizontal being above, and to the vertical to the right of their respective Driven Elements. At the shack, the two 50 ohm feedline ends will be paralleled with a T connector, and reconverted to 50 ohms after passing through a 36 ohm matching transformer made from two 13 inch lengths of RG-59 connected in parallel. More on this, and how to switch to LHC, or to the horizontal alone, or the vertical alone, will be covered in the next article. See you next month!

HCRA 1983-84 SCHEDULE OF EVENTS		
<u>DATE:</u>	<u>RESPONSIBILITY:</u>	<u>TOPIC:</u>
October 7th	KALJDY	HAMS IN SPACE!
November 4th	WALEYF	ANNUAL AUCTION
December 2ND	-----	CHRISTMAS PARTY
January 6TH	AC1T	VHF STATIONS IN NEW ENGLAND; HOMEBREW NIGHT
January 15/16 (est. dates) VHF SWEEPSTAKES CONTEST		
February 4th	KALKPH	USING THE HOME COMPUTER ON HAM RADIO.
March 4th	AC1T	POWER SUPPLIES; CB-TO-10 METER FM CONVERSION.
April 2nd	K1BE	RADIO REVIEW NIGHT; HOMEBREW NIGHT
April ARRL INTERNATIONAL DX CONTEST		
May 7th (Saturday)	WA1ZKT	FLEA MARKET
June 3rd	N1AFY/N1AEH	ANNUAL BANQUET
June 25th/26th	ARRL FIELD DAY!!!!	
(SUBJECT TO CHANGE)		

NEWS FLASH:

DEERFIELD FLEA
MARKET, DEERFIELD,
N.H. on SATURDAY
OCTOBER 8th.....

KNOW YOUR OSCILLOSCOPE

Reviewing basic techniques
may reveal forgotten capabilities

by Janet Green

To become familiar with a piece of test equipment you need to be concerned with three issues:

- know where and how to connect the test instrument,
- know how to adjust the controls,
- know how to interpret the data.

This article addresses these three basic concerns as they apply to oscilloscopes. Because an oscilloscope is one of the most versatile troubleshooting instruments available, you can use it to measure voltage levels from dc to micro-wave, phase differences, signal presence or absence, logic highs and lows, frequency response, distortion, complex waveform analysis (e.g., wave shape, overshoot), and a variety of other signal characteristics. By understanding the three basic issues associated with using these instruments, you can increase your ability to use all your oscilloscope's capabilities.

BACK TO THE BASICS

An oscilloscope presents a voltage versus time display of a waveform on a cathode ray tube (i.e., CRT). Inside the CRT, an electron beam draws the waveform on a phosphor-coated screen. This screen presents three types of information: voltage information on the vertical or Y-axis, time information on the horizontal or X-axis, and intensity information on the Z-axis. All oscilloscopes have controls to adjust the voltage, time, and intensity information to present a meaningful picture on the CRT.

The vertical input.—The input signal is connected to the vertical input amplifier, which either attenuates or amplifies the signal for convenient viewing.

The incoming signal next encounters the delay line. The delay line allows the sweep generator circuitry enough time to start a sweep before the signal reaches the CRT's vertical deflection plates. This coordination of vertical and horizontal timing by the delay line

enables viewing of the leading edge of the signal. The vertical amplifier provides additional amplification through the CRT vertical deflection plates.

The time axis.—Although precise horizontal deflection rates are not required in many applications, some sophisticated applications require precise control of the sweep timing with respect to the signal under test. This precise control increases the time interval measurement accuracy and ensures horizontal stability of the trace. Lack of stability appears as jitter.

Intensity.—Intensity information is provided in the form of bias control to the grid controlling the density of the electron beam. If the negative bias is sufficient, the CRT is cut off eliminating the trace.

VERTICAL INPUT CONTROLS

The vertical input controls generally consist of an input coupling switch, calibrated attenuator, and position control. A dual-trace oscilloscope also has switches for selecting single channel, dual channel, or some combination of channels.

Input coupling switch.—The input coupling switch on the oscilloscope usually has four positions—ac, ground, dc and 50 Ω . The ac and dc positions are designated high impedance, which is typically 1 M Ω shunted by about 20 pF. This high input impedance, together with a standard 10:1 divider probe, increases the input impedance to 10 M Ω . This allows you to measure waveforms with minimum circuit loading. Some oscilloscopes also allow you to select 500 Ω input impedance, which is ideal for monitoring pulse and signal generators or other low impedance sources.

AC position.—The ac position couples the input signal through a dc blocking capacitor, allowing only the ac component to be viewed. AC coupling can be very useful when you want to measure a small ac signal superimposed on a

large dc voltage. For example, to measure the small ac ripple voltage from a power supply, ac couple the signal to block the large dc component. Do not use the ac position to measure low frequency digital signals because the internal dc blocking capacitor distorts the waveform.

Ground position.—The ground (GND) position is useful when you want to set a ground or zero volts reference level on the CRT screen without disturbing the input signal connection. The input signal is internally disconnected, and the vertical amplifier's input is grounded. This means that you can leave the input signal connected to your oscilloscope. You will not short it out when you switch to the ground position.

Note: high frequency signals can create special problems for switches in oscilloscopes as well as other instruments. Therefore, when measuring high frequency signals, it is safer to disconnect the input signal before presetting the controls.

DC position.—The dc position allows you to view both dc and ac components of the input signal. For example, if you set the 0 volts reference level at the center of the screen with the ground position, and then switch to dc, the waveform shows the ac component if it is present. The signal is offset either up or down depending on whether the dc component is positive or negative. DC coupling is also used when measuring digital signals or square waves.

50 Ω position.—The 50 Ω position is a dc input (i.e., no blocking capacitor) with the Xc of the input amplifier very large compared to 50 Ω . The 50 Ω input is used to measure high speed pulses and square waves from 50 Ω sources with minimum distortion and VSWR reflections. Most oscilloscopes with a built-in 50 Ω input have internal compensation that make it a better match than an external load.

The input attenuator control—Most modern oscilloscopes combine variable attenuation with adjustable vertical amplifier gain to control input signal levels. High level signals require more attenuation and less gain so that the trace is not deflected off-screen. Low level signals need less attenuation and more gain. The volts/division control allows you to change the vertical sensitivity in calibrated fixed steps.

The vernier portion of the input attenuator provides continuous sensitivity control between the calibrated volts/division ranges. Whenever you move the vernier out of its detent position, an UNCAL light goes on, indicating that the positions on the volts/division dial are not calibrated.

Some oscilloscopes also have a vertical magnification control. The vertical magnifier is useful for measuring low-level signals such as power supply ripple.

HORIZONTAL INPUT CONTROLS

The sweep generator, sometimes called the time base generator, produces the sawtooth waveform that controls the rate at which the beam is drawn horizontally across the face of the CRT. The generator's most important function is to ensure linear beam movement, meaning the beam moves at the same rate from start to finish. Without this precise rate, accurate timing measurements are not possible. Accuracy also depends on the delay line. It delays the vertical input signal so that the trace being displayed is the signal that started the sweep.

The sweep generator also unblanks the CRT. An unblanking pulse is a positive square wave that turns the trace on in relation to the rising portion of the sawtooth. Essentially, the trace is turned on during its left-to-right movement across the screen and then is turned off during retrace (i.e., when the beam resets from right-to-left). If the beam was not turned off in this manner, the retrace lines would show up with every sweep.

Sweep speed control—The sweep generator's sawtooth waveform is controlled by a front panel control called time/division or seconds/division. This is a calibrated control that allows you to select a sweep speed that stably displays the waveform. This control is usually divided into steps in a 1-2-5 sequence from seconds to nanoseconds, depending on how fast the beam is drawn across the CRT. The faster the beam is

drawn, the faster the time reference (i.e., the smaller the scale). For example, if the time/division control is set for 0.5 seconds/division, the time reference over the full 10 divisions on the CRT's graticule is five seconds. If the control is set to five milliseconds/division, the full-scale time reference is 50 milliseconds.

A sweep vernier control, which is part of the time/division control, provides continuous adjustment of the sweep speed between the fixed time/division steps. Whenever you move the vernier out of its detent CAL position, the UNCAL light comes on, indicating that the steps marked on the time/division dial are not calibrated.

The horizontal magnifier is another control that interacts with the sweep speed control. This control expands the sweep time by the factor for which the magnifier is set. For example, if your oscilloscope has a 10 division time axis (i.e., 10 squares on the horizontal axis) and the magnifier has a factor of time 10, you have an effective 100-division wide signal and a 10-division window. This also means that the signal has 10 times more horizontal resolution than before.

Measuring rise time—High-speed, precisely timed sweeps provide data of fundamental importance in waveform analysis. For example, a basic characteristic of a square wave or pulse is its rise time. Rise and fall times are usually measured between the 10 percent and 90 percent amplitude points on the leading or trailing edge of the pulse. These two points are generally accepted as industry standards for waveform measurement.

To measure a rise time, first adjust the vertical controls so that the pulse covers six divisions. Then, use the time/division and horizontal position control to expand the sweep speed. Position the leading edge of the pulse to intersect the bottom 10 percent amplitude point with a vertical graticule line. Read the rise time by measuring the time between the 10 percent and 90 percent points.

How accurate is this measurement? Remember that when measuring rise time, your oscilloscope's vertical amplifier does have limitations. Often, a new technician tries to measure the rise time of a 10 kHz pulse train with a 500 kHz oscilloscope, without realizing that the actual rise time of the pulse is faster than the response of the vertical amplifier. Refer to your operating manual for

rise time specifications. If you do not have a manual, use the following rule of thumb:

$$\text{bandwidth} \times \text{rise time} = .35$$

Using this rule, if you are using a 500 kHz oscilloscope, do not try to measure rise times faster than .7 microseconds. In fact, the vertical system of your oscilloscope should be two to five times faster than the rise time of the applied signal, resulting in a rise time measurement error less than 2 percent.

Measuring pulse width—Measuring the pulse width of a digital signal involves using the time/division control with other sweep circuit controls. You must make the pulse as high and as wide as possible to take advantage of your oscilloscope's full-scale accuracy.

To measure a pulse width, first adjust the vertical controls so that the pulse covers six divisions vertically—this much is needed for you to identify the 50 percent level easily. Next, use the time/division control to expand the sweep speed so that one pulse is in the center of the screen. Do not move the vernier control out of its CAL position. Pulse width is measured at the 50 percent amplitude points. Use the vertical and horizontal position controls to center the pulse around the center horizontal graticule line with the pulse's leading edge over a vertical graticule line. Count the number of divisions between the 50 percent points and multiply it by the main sweep setting on the time/division dial.

Frequency measurements—Frequency is the reciprocal of the time period for one cycle. For example, the time period of the signal is determined by counting the number of horizontal divisions covered by one cycle and multiplying it by the setting of the time/division control. Then, take the reciprocal to determine the frequency of the waveform.

X-Y operation—The X-Y mode of operation is a two-dimensional representation of two ac voltages. While the Y-input signal deflects the beam up and down, the X-input signal replaces the oscilloscope's sweep generator and deflects the beam horizontally. You can add a third dimension by modulating the beam's intensity through the Z-axis.

The X-Y mode is commonly used to generate Lissajous patterns used when checking phase. For example, a transistor checker provides a Lissajous pattern that indicates the voltage-to-current characteristic of a diode junction. A more sophisticated use involves circuit frequency response in which you turn your oscilloscope into a simple network analyzer.

TRIGGER CONTROLS

The trigger circuit's purpose is to produce a stable display. It synchronizes the sweep signal so that each trace is written directly on top of the previous one, causing you to see only one trace on-screen.

The trigger controls allow you to select the source, positive or negative mode, and level of the synchronizing trigger signal.

Auto/horn—This source is probably the greatest source of "pilot error" in oscilloscope operation. Normal mode requires a trigger signal to generate a sweep, and auto does not.

The auto mode selects an internal oscillator or multivibrator that is used to trigger the sweep generator, producing a reference baseline, if there is no other trigger source. As soon as you select one of the three trigger sources (internal, external, or line), that trigger source starts the sweep generator. If the trigger source frequency is below approximately 40 Hz, you must switch to the normal mode to obtain stable triggering. Stated another way, the auto mode is used to get a reference baseline when you are adjusting focus, intensity, position, and dc reference. It also keeps the baseline on the CRT if you remove the signal.

The normal mode requires a trigger signal from one of the three sources (internal, external, or line) to generate a reference or sweep. The "pilot error" mentioned earlier usually occurs when you have set up the oscilloscope for internal triggering and the mode switch is in the normal position. If you do not have a signal connected to the vertical input of the oscilloscope, you will not have a trigger signal and hence no trace. This loss of trace with loss of input can be a valuable troubleshooting aid. For example, if you are probing a circuit looking for the presence of a signal, first you adjust the trigger level control for an optimum level and probe a point in the circuit that has no signal present. Since nothing triggers the display, the screen is blank.

Trigger level and slope—Trigger level and slope controls allow you to select any point on the positive or negative edge of the displayed waveform to trigger the sweep circuit. Usually, when the oscilloscope is in the internal trigger mode, the level control can select any point on the displayed vertical waveform. With external trigger signals, the control has a \pm voltage limit—refer to your operating manual for the number.

Internal trigger—When the switch is set for internal triggering, a portion of the input signal is tapped off, and sent to the trigger circuit. The CRT displays the portion of the input signal related to the first occurrence of a positive or negative slope of the input signal, depending on how you have set the slope and level controls. This allows you to view a time event related to the input signal. If you are using a dual-channel oscilloscope, you must use the input channel that triggers the sweep circuit for your input.

If you are using the internal trigger mode for troubleshooting, you may have to readjust the trigger level control to maintain a trace as you probe different points in the circuit under test. This occurs because you had adjusted the trigger circuit to trigger the sweep at a particular positive or negative voltage level. Therefore, as you move the probe from point-to-point monitoring different signal level, the voltage level to the trigger circuit is also constantly changing. To eliminate this inconvenience, use the external trigger mode and connect the external trigger to a low repetition rate timing signal from the circuit under test. In a digital circuit, use a sub-multiple of the clock pulse rate.

External trigger—When the switch is set for external triggering, you must provide a signal to a connector on the oscilloscope marked EXT TRIGGER. If the signal voltage exceeds the input voltage limit (refer to your manual), then use the EXT \div 10 trigger input. A good rule-of-thumb is to use a 10:1 probe on EXT and no probe on EXT \div 10. This helps prevent saturation of the trigger comparator. The external trigger signal is usually derived from a low repetition rate timing signal related to the input signal. The CRT displays the input signal on each occurrence of the trigger signal. This allows you to view an event that is related in time to the trigger source. The trigger level and slope controls work the same for an external triggered signal as an internal triggered signal.

One method of viewing the time relationship between the input signal and external trigger signal is with a dual-channel oscilloscope. Use one input to look at the signal and one input to look at the trigger. You must use the input channel that triggers sweep circuit as the trigger input. Then, set the source width for INT.

If you are going to use an external trigger signal, you should first look at that signal on the input of your oscilloscope.

You must determine whether it has a dc component or noise greater than the trigger level you are trying to set up, or possibly exceeding the limit of the input. For example, the trigger level range of your oscilloscope may be ± 1.5 volts (± 15 through EXT \div 10). If you try to use an external trigger signal with a dc component greater than 1.5 volts, you cannot trigger the sweep unless you block that dc. Some oscilloscopes have built-in ac coupling (selectable), others do not. At any rate, you must use dc coupling for trigger signals below about 20 Hz.

Your external trigger signal may also have power line pick-up or possibly RF noise. In either case, you must filter out the unwanted portion to obtain a stable display. Some oscilloscopes have built-in filters while others do not. The point is, if you use external triggering, be sure the signal is clean.

Line trigger—In the line mode, the display is triggered by a sample of the power line, which is usually 50 to 60 Hz. Line triggering is often used when you want to determine when there is a relationship between the displayed signal and the line frequency, often called power line hum.

Trigger holdoff—Some oscilloscopes may have this variable control that is used with the trigger level control. Trigger holdoff increases the time between sweeps and helps stabilize the display when you are internally triggering off a complex digital signal or RF signal. □

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Many thanks and also thank you, W1CQF for writing away for the permission!

THE FINAL SOLILOQUY

SEVEN NEFARIOUS YEARS WERE SPENT
'TWEEN YEAS AND NAYS WITH KILL INTENT
AS AMATEURS WERE OUTPOKED WITH SPEED OF LIGHT
DISMANTLING CODE TESTS AND STRAIGHT KEY NIGHT.

WE AWOKE FROM A DEEP DREAM PEACE,
STARTLED - THE SKIDS HAD BEEN SECRETLY GREASED.
EVERYTHING WAS READY, EVEN TO CHAMPAGNE,
THE FUNNY COOKIE CUTTERS HAD WON THE GAME.

SWIFT AS IT TAKES A HAM TO TELL
STRONG VITAL ARGUMENTS WERE SHOT TO H----.
SCORES OF AMATEURS WOULD TOSS IN THE BEDS
WHILE VISIONS OF DISASTER CYCLED THEIR HEADS.

AS THE TORTURED OL'MAN MEETS THE CODELESS CHAP
COMES ONE SHARP TWINGE LIKE THUNDERS CLAP
STRIGHTENING US SWIFTLY FROM OUR CONTENTED SLOUCH
WE NEARLY LANDED ON A HEADSHRINK'S COUCH.

THE SUN IN BRIEF, STRONG SOLAR FLAKES
ROSE CHEERLESS OVER THE HAM SHACK CHAIRS.
AS THE MONEY BOYS TENDERED THE BEST BID
WITH PALTRY POUNDS AND PITTANCE QUID.

NO PITY OR COMFORT TO YOU GREY HEADS
BUT SPARE WHAT MODE? A DOZEN SAID.
CW LOST, IT BOGGLES THE MIND
FOR AMATEURS AND HAMS, IT'S AN OMNIOUS SIGN.

P. C. CHARLIE TRAVELS FAST LANE, READYING THE DASH
WHILE WE WERE IN BREAKDOWN, BLOWN CHIPS - ROM CRASH.
A BATTERY OF LAWYERS, BEST MONEY COULD BUY
SHREWD MANEUVERS, LEFT US GASPING - BUT WHY?

I'LL MISS CODE ALLEY - YOU CAN BE SURE
IT'S ORATORICAL LOGIC PLUS A TOUCH OF MANURE.
I KNOW SOON I SHALL NEVER HEAR
ANOTHER CHARACTER IN CODE, SO DEAR.

SPURRED BY COMRADES LIKE HIRAM AND WILLIAMS
WORDS WILL POUR FORTH BY MANY BILLIONS.
POLITELY WE'LL LISTEN TO THIS WORLDLY SAGE
ONLY BY VIRTUE OF OUR DECLINING AGE.

BEFORE YOU TAKE THE GUN DOWN FROM THE RACK
TO BLOW EVERYTHING UP IN YOUR RADIO SHACK,
REMEMBER MARCONI AND KEEP THE BLOOD FLOWING
WHEN THE GOING GETS TOUGH, THE TOUGH GET GOING.

SO THROUGH ALL ANXIETY, WEEPING AND TEARS
FIRM FRIENDSHIPS MADE OVER CODE FILLED YEARS
WILL LINGER FOREVER WITH YOU WHO CAN CODE
WITH NO APOLOGETIC IFS, FOR C W MODE.

IT IS HERE! IT IS HERE! THE DAY OF COMPUTER
IS CODE FALLS ONCE - JUST ZAP, RE-BOOT HER.
DECODE CW WITH EAR AND BRAIN?
NG - ROBOT CAN DO IT WITHOUT ANY STRAIN.

SO LISTEN MY FRIENDS, BUT YOU SHALL NEVER HEAR
THE DIT DAW SOUNDS OF YESTERYEAR.
AS CODE IS SLAIN WITH SUCH BURRIED BLAST
MY FOLDCOVER ROHN BENDS AT HALF MAST.

DE WINPL

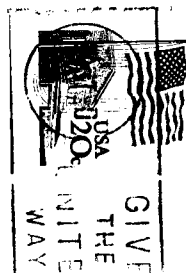
ZERO BEAT

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