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THE WORLD SCANNER REPORT

A Journal of VHF-UHF Scanner Technology & Engineering

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GROSS IGNORANCE & SHEER STUPIDITY

Humble pie. The subscription blank that appeared in the last few issues was thoroughly confusing with good reason since it was designed for new subscribers with no thought given to renewals. The blank on the inside of the back page has been revised to be easier to understand and fill out. Back Issues are under one heading; current subs are under a separate one now. If, for any reason, you feel that you were shortchanged by the confusion, let us know and we'll make it right. Standard policy is to issue a refund for overpayment, but let us know if that's not satisfactory. The new sub blank & prices are current and supersede all others. Apologies for imbecilic idiocy.

LAST CALL TO RENEW FOR 1992

Check the Expiration Date on your mailing label; if it says "Nov 91", this will be the last issue you'll receive until you renew. A fluorescent color will highlight that part of your label as a reminder of impending expiration. 1992 is shaping up to be a great year for unleashing the power of your scanner. You won't want to miss out! Renew right away before you forget! Thanks to those who have renewed early. Cindy, our Administrator, is delighted to have the work spaced out instead of piled up all at once.

THIS IS THE LAST ISSUE OF 1991

This is the 10th and last issue of 1991. The WSR is published 10 times per year to allow for Staff Holidays and uninterrupted periods of R & D for coming issues. January, 1992, begins our second year with V2N1 to be mailed on or around Jan-1, but slight delays caused by the holidays are to be expected. The mails will be slow (and so will we). By February, we'll be back on track to mail each issue during the last week of the month. Thank you for a great 1991. Your support and acclaim were the booster stages that put us into low orbit. Next year, the moon; and then the planets and the stars.....

WANTED TO BUY: A CHEAP COMPUTER

We're looking for a very cheap IBM/clone MSDOS computer, either 8088 or 80286 based. Minimum requirements are 640-k RAM, one or more floppy drives; monochrome; one serial and one parallel port. Desirable options might include a hard drive, modem, CGA/VGA, etc. Our budget for 1992 includes a serious 386 or 486 computer but a rock-bottom priced model of the above description is needed NOW so that we can begin the final phases of research on Computer Interfaces for the PRO-2004/5/6. R&D is always expensive, so costs have to be kept down. If you have or know of a very cheap computer available, please speed your offer immediately. Serious offers with our minimum needs will be considered. For those who don't know, we've been Apple-based for many years while IBM & MSDOS passed us by. It's clearly evident that an Apple interface for scanners won't be well received; hence our need for a simple and inexpensive IBM/clone developmental machine.

THE LATEST ON COMPUTER INTERFACES

The need for easy computer programming of scanners with 400 or more channels is self evident now. One round of manually punching in 400-channels, only to discover that an inadvertent missed frequency at Ch-47 will be enough to make you see the Cosmic Light. If you've done the 3200, 6400 or 25,600 Channel Mods, that Light will be blinding. Would you believe that computer interfacing of the PRO-2004/5/6 is actually "old hat" now? Two or three years ago a fellow advertised in "Monitoring Times" plans for a Commodore 64/128-PRO-2004 interface. I mentioned this to a digital guru, Lin Burke, who then whipped up a functional interface for the Radio Shack Color Computer II. He went on to modify it and the associated BASIC program for my Apple. No problem. Then came a design by Miles Abernathy for the MacIntosh computer. We converted the design and its BASIC control program for my Apple. Lots of work and cost but it was done. Two things these three interfaces had in common was ONE-WAY communication with the scanner and a computer-specific BASIC program to run the interface.

More recently comes a universal interface kit from RW Systems and an MSDOS-specific interface package including software from DataMetrics, Inc. The kit from RW Systems is promising because (1) it appears to be universal for most computers and (2) computer-specific software is not required to run it. It requires only a serial port and a routine telecom program for operation. DataMetrics' package is complete, ready to install in any MSDOS computer with 640-k RAM and a parallel port. While the DataMetrics' package works only in IBM/clones, it is driven by commercial software; the interface is easy to install and appears to be foolproof in operation. Both the kit from RW Systems and the package from DataMetrics' appear to be two-way devices in the sense that the computer can log and store events from the scanner. RW Systems' kit appears to be functional for any of the PRO-2004/5/6 series, while DataMetrics specifies that theirs is for the PRO-2006 only. I think it is a safe bet that it will work just fine in the PRO-2005 and can be easily adapted to the PRO-2004, but DataMetrics does not support any but the PRO-2006 at this time. I will be evaluating RW Systems' kit and the DataMetrics package in the coming weeks. Perhaps we will have an opinion to offer in the next issue. If you want specs & prices in the interim, contact the companies as follows and tell them you were referred by the ***"WORLD SCANNER REPORT"***.

DATAMETRICS, INC	RW SYSTEMS
2575 SOUTH BAYSHORE DR; STE-8A	PO BOX 910043
COCONUT GROVE, FL 33133	SAN DIEGO, CA 92191

Two of the three one-way interfaces discussed above are not commercial ventures so the circuits & BASIC programs can appear here in future issues if interest warrants. There may be other designs for interfaces that we'll publish, too, as there seems to be a wealth of info and interest circulating now. We will confine our main focus to those interfaces, commercial or public-domain, which give the most for the least and which require a minimum of effort on the hobbyist to install and operate. I have a feeling there will be dozens to look at in the coming year, so a certain amount of focus on our part will be necessary. A key focus will be on the TWO-WAY interface; i.e, one that not only programs the scanner's memory banks, but also which can pass data from the scanner to the computer for logging of active freqs, lengths of transmissions, dates, times, etc. To my way of thinking, the most important side of an interface is that which programs the scanner's memory banks, thereby sparing us the drudgery and opportunity for error. This alone will free up time to enjoy the benefits of our scanners. But if enjoyment is what this business is all about, then we have to look at the other side of the coin: data logging & processing. Half the fun of scanning is in the listening to what's going on, but the other half is in the accumulation of knowledge and understanding of radio communications. The side of an interface that passes data from the scanner to the computer for logging, processing and storage is the long term benefit while the actual monitoring is a short term benefit. Therefore, we will look at both sides of a scanner-computer interface in the coming year. Speaking of both sides, there are a limited number of ways to obtain data FROM the scanner, perhaps only two. DataMetrics found one way that might never have occurred to me; HB Technologies is breaking ground on the only other way that seems possible at the moment: decoding the data from the scanner's CPU to the LCD Display! That data stream contains most everything pertinent to scanning with exception of time and date. The trick is to decode it, since some of that data is superfluous and some is for the PLL circuits but the boys over at HB Technologies seem to have deciphered the stuff for the LCD Display and what's more, they're about to show you how you can do it for yourself.

A SERIAL DATA INTERCEPTOR/DECODER FOR THE PRO-2004/5/6 CPU/LCD DISPLAY DRIVER

By: B.Bond/HB Technologies

This article describes in detail an actual circuit that can "view" data transferred from the PRO-200x CPU to the LCD controller/driver IC. The circuit is elementary in nature and lends itself well to both practicality and cost limitations. A drawback of this approach is that the device (referred herein as the GBL) relies heavily on manual interpretation of captured data. IC's comprising the GBL are described as follows:

74HC164 - Serial-In/Parallel-Out (SIPO). Takes a serial byte of data and converts it to parallel format.

74C14 - Hex Schmitt triggers (inverting). Inverts BUSY\ for use as a write pulse (W\) in addition to generating a read pulse (R\) at the DS2009 FIFO (below).

DS2009 - A 512 x 9 bit First-In/First-Out (FIFO). Used to store the data and C/D\ flag from the CPU.

MC14495 - Hex/7-segment decoder. Converts the hexadecimal data from the FIFO to 7-segment for LED display.

<u>Waveforms used by the GBL</u>

RESET - Used to reset both the uPD7225 and DS2009. Generated by IC-503 (Scanner CPU) at power-up.

BUSY\ - Inverted and used to perform FIFO write operations. Generated by uPD7225 and goes high upon receipt of CS\ (chip select) low from the CPU. BUSY\ remains high for duration of byte transfer and returns low when the uPD7225 is ready to receive the next data byte.

W\ - FIFO write pulse. Leading edge of W\ initializes write. Trailing edge writes data.

SI - Serial data input from CPU. Presented to SIPO and clocked by SCK\.

C/D\ - Control/Data (not) flag. When C/D\ is a logic low, the data transferred from the CPU is a display byte, whereas a logic high represents a command byte. Used within the uPD7225 for data routing and by the GBL for data differentiation.

R\ - Read pulse for retrieving data stored within the FIFO. Also latches display data within the Hex/7-segment decoders.

FF\ - FIFO full flag. Logic low indicates that the FIFO is full and no further writes may be performed. Logic high permits additional writes.

EF\ - FIFO empty flag. Logic low indicates that the FIFO read pointer has returned to the write pointer location following a read operation.

The GBL operation begins with the reset pulse from the CPU. Reset causes both the internal FIFO read and write pointers to reset to the bottom of the memory stack. BUSY\ goes high (driven by CS\ low) prior to data-send causing W\ to go low and initialize a FIFO write. 8 bits of data are sequentially clocked into the SIPO by 8 SCK\ clock pulses. The most significant bit of the data byte will be at the QH output of the SIPO following the 8th

CP. Within 9-usec of the 1st CP, C/D\ will be setup. At this time, the data byte and flag (C/D\) will be present at the FIFO inputs DØ-D8. After the 8th CP, uPD7225 pulls BUSY\ low and routes the byte to internal registers. This action causes W\ to go high, writing the byte and associated flag into the FIFO. Having transferred the byte, uPD7225 returns a BUSY\ high, allowing subsequent byte transfers. Readout of the FIFO content is initiated by R/ pulses which present and latch the data to decoders which drive a dual 7-segment display. Note: C/D\ drives the RH decimal point of the most significant character and is not latched. Consequently, the flag is present only for the duration of the read switch depression before the FIFO output is returned to a high impedance state (release of FIFO read switch).

Because of the rapid data rate, the FIFO is quickly overflowed during dynamic scanner functions (i.e. Scan, Search, etc). This limits the GBL user to initiating discrete functions, trapping the bytes, interpreting the data, and lastly, ascertaining what areas of the memory stacks internal to the uPD7225 are affected. In addition to the transfer speed, the fact that several bytes are Display, compounds the problem of automating an analyzer. The reason is that 9 bits are required to properly ID a byte and UARTs are good for only 5,6,7, or 8 bits. Below are example bytes used within the uPD7225:

<u>BYTE DEFINITION</u>

42 mode set command which configures the IC as a quadruplexed driver.
2Ø clears display RAM.
11 enable display.
EX 1 1 1 D4 D3 D2 D1 DØ; load data pointer w/ 5 bits of X=Dn immediate data.
DX 1 1 Ø 1 D3 D2 D1 DØ; write 4 bits of immediate data X=Dn to the display RAM area addressed by the pointer and increment pointer.
AX 1 Ø 1 Ø D3 D2 D1 DØ , or blinking RAM addressed by X=Dn pointer with immediate data. Write results to same address, increment pointer.

<u>Part sources:</u> DS2ØØ9, MC14495, Allied Electronics, (8ØØ) 433-57ØØ; 74C14, 74HC164, Easy Tech; (8ØØ) 582-4Ø44 or Digi-Key (8ØØ) 344-4539

This concludes an overview of mapping & decoding serial data from the TxD port of the PRO-2ØØ4/5/6 CPU. This info is provided for the benefit of those engineers and technical people who want to contribute to the budding science of interfacing the PRO-2ØØ4/5/6 to a computer.

*[**EDITOR'S NOTE:** I do not pretend to fully understand all the content of this article and therefore probably cannot answer questions about it. You can address questions to B.Bond, c/o Editor, "WORLD SCANNER REPORT", and I will forward to him for reply. Meanwhile, check this issue for a schematic diagram of the GBL Data Analyzer and if not present, it will be included next month. It was lost in the US Mail as of this editing. /bc]*

FEATURE PRESENTATION #1
<u>A TONE DECODER/REJECTOR FOR SCANNERS</u>

Just as the goal of the Computer Interface Project is to enhance the fun and enjoyment of scanning, so too is this neat modification for your scanner! Are you aware of the concerted effort and conspiracy to deprive hobbyists of some of that enjoyment? Government agencies and police departments are especially guilty of this conspiracy when the rascals spend millions of our tax dollars to encrypt their communications. It is fortunate that many of the conspirators can't afford the "unbreakable" DES/DVP encryption systems, but this doesn't dissuade them from taking a stab at other methods of depriving hobbyists of their pleasure! Take for example, the nasty, nuisance tones we hear on some transmissions nowadays. Some of these signals are computer data communications, but others are nothing more than pure tones sent out between real transmissions so as to cause scanners to lock up on them. What could be more obnoxious than loud, unabated squeals? In the space of a few seconds, any sane and sober scannist in full possession of his faculties will punch the LOCKOUT button to preserve the family peace and general state of mind. (Mission accomplished!)

The Toronto, Ontario, metro police agencies were among the first around the world to implement "anti-scanner" tones between transmissions to deter routine monitoring of their communications. The cost was negligible; the effect was monumental. Who, but a lunatic, would monitor a 2-3 KHz piercing tone for hours on end? The public-at-large sure won't. It wasn't long before the radio wizards of Toronto designed a circuit to defeat the anti-scanner tones and I am pleased to offer a variant of what they call the "Metro Mod". I evaluated one version of the Metro Mod as submitted by Mervyn DeGeer and found that it had a few problems so I redesigned it and tested it for hours. With no known bugs, my Tone Decoder/Rejector (TDR) is offered for your evaluation and sadistic use.

My TDR uses an LM-567 Tone Decoder chip and a few parts to detect a single tone of your selection. The TDR is sensitive ONLY to the preselected tone and ignores other sounds in the audio spectrum. When that tone comes in, the TDR quickly reacts to force a SQUELCH-Set and thereby fool the scanner into resuming SCAN or SEARCH. If the scanner is in the MANUAL mode monitoring a frequency which has the offending tone, the SQUELCH will not break until the nuisance tone disappears and a voice signal is present. If the scanner is SCANning or SEARCHing, it won't even pause on a channel that has the offending tone, but it will still stop and monitor any voice and other transmissions that don't have the preset tone! The tone to be rejected is set by adjustment of a trim pot, VR-1, until the offending tone disappears!

There are no known liabilities or bugs in the TDR, but there are limitations; it's good for only one essentially pure and steady tone at a time which must be roughly between 5ØØ Hz and 5 KHz. The TDR will not respond well, if at all, to warbles, repetitions, or data tones such as for FSK, FAX & computers. If you identify two or more different anti-scanner tones in use around the spectrum, then you'll have to use one TDR for each tone; else reset the one TDR for whatever single tone disinterests you the most at a given time. If your tone-rejection needs are lower than 500 Hz or higher than 5 KHz, a variation of the design will be necessary. Likewise, two or more TDRs working together may require a slight revision of a part of the design. For now, let's designate my TDR solely to reject a single tone. If your needs are more complex, we can discuss pertinent revisions in subsequent issues.

There is another situation where my TDR won't fully apply. Some agencies transmit a tone along WITH voice transmissions. Notch filters in their receivers remove the tone leaving only voice to the speaker. My TDR will not remove the tone and still allow the voice to be heard in this type of "anti-scanner" measure. The TDR will prevent the scanner from locking up on such signals, however. To that extent, the TDR will preserve your sanity even though you won't hear the voice signals. I would like to hear from you folks who are plagued with the "tone with voice" attempt at encryption, and if enough of you respond, I will design a notch filter to block such tones and still let voice through. By and large, the "tone between transmissions" is the more prevalent "anti-scanner" measure, and is for what my TDR is designed. Ok, let's get to work and build one.

First, you have to select the correct TDR circuit. Refer to last month's issue, V1N9, Table 2, page 6 for the NFM/AM chip that's in your scanner, and look in the far right column of that table for the type of SQUELCH Logic. If yours is Logic 0 when Squelch is Set, and 5,6, or 8v when Squelch is Broke, then select the Type 1 TDR. If your scanner's logic is just the opposite with Logic 5, 6 or 8v when SQUELCH is Set, and 0 when Squelch is Broke, then select the Type 2 TDR. If there is any doubt on which TDR is for your scanner, a simple test will decide for you: set the scanner to a quiet channel (no signals), and connect a volt meter between scanner ground and the SCAN CONTROL pin of your scanner's NFM/AM chip. See Table 1 below for the correct pin # for your specific NFM/AM chip. Now, set the SQUELCH control so that all noise is silenced, and read the voltage at the SCAN CONTROL pin. Then rotate the SQUELCH control so that static noise can be heard and again read the voltage at the SCAN CONTROL pin. If the first reading was 0-v and the second, between 5 & 8v, you'll need the Type 1 TDR. If your measurements were just the opposite, then yours is the Type 2 TDR. The PRO-2004/5/6 and most Realistic scanners will use the Type 1 TDR while most Uniden & Bearcat scanners need Type 2, but be sure first, before jumping in headlong. There's not much difference between the two TDR's but Type 2 requires one transistor and two more resistors than Type 1. The TDR is easily assembled on perf board about an inch square. Layout is not critical, but follow the schematic diagram for the sake of simplicity. It's not complicated.

The TDR was rigidly tested on the PRO-2004/5/6 & PRO-34 scanners but it will work with most any scanner that uses an NFM/AM chip like we've discussed so often in past issues. There are 4 connections to the scanner: ground; +5v; and two to the NFM/AM chip, "Detector Out" pin and the "Scan Control" pin. Refer to last month's issue, V1N9, Table 2, page 6 for the NFM/AM chip that's in your scanner and then to Table 1 below for the Pins to which you'll connect the TDR:

Table 1: TDR Connections

NFM/AM Chip Type	Scan Control	Detector Out	Notes
TK10420	13	9	PRO-2004/5/6; PRO-34/37
TK10421D-2	13	9	Cobra SR-15
TK10421M-2	16	11	BC-100/200/205/855XLT
MC3357P	13	9	Realistic, Regency,
MC3359P	15	10	BC-800XLT; BC-100XL
MC3361N	13	9	Realistic; AOR
NJM3359D-A	15	10	BC-400/560/760/950XLT

Install the Tone Decoder/Rejector board in a handy, out of the way place in the scanner. If you anticipate the need to occasionally adjust for different tones, then consider a regular potentiometer with an external shaft for VR-1. Another good idea and one which often employ is to drill a hole in the front panel of the scanner and super-glue a trim pot behind the hole for a convenient but unobtrusive screwdriver adjustment. Otherwise, VR-1 can be a trimpot on the perf board of the TDR. I suppose you could dispense with S-1 and let the TDR run full time, but if you want to be in total control of things, install the switch where it can be readily reached.

The LM-567 chip is specified for a maximum of 9-volt dc power, but you don't want to go to the limit when there's no need. Most scanners nowadays have regulated +5vdc so use it if you can. Otherwise, the operating voltage will not be critical between 5-8 vdc. Connect the TDR power point (Pin 4) to +5v via the DPDT switch. Make sure the TDR board is well grounded. Solder R-2 directly to the "Detector Out" or "Recovered Audio" pin of the NFM/AM chip instead of putting it on the TDR board. Connect a wire from the free end of R-2 to the free end of C-1 on the TDR board. Solder a wire to the output (U-1, Pin 8, Type 1 or collector of Q-1, Type 2) of the TDR, but don't connect it to the NFM/AM chip's "Scan Control" pin just yet. We'll first test the TDR to make sure it works.

Preset VR-1 to one end of its rotation. Attach a volt meter between scanner ground and the free loose end of the TDR output wire. Turn on the scanner and the TDR. Set the scanner to a frequency that has an obnoxious tone that you wish would go away. The voltage at the TDR (Type 1) output should be equal to the supply voltage or about 5 volts. For Type 2 TDR's, the voltage will be about 0 volts. Now, slowly adjust VR-1 thru it's range; at some point, that voltage should suddenly change; for Type 1's it will drop to nearly zero volts and for Type 2's it will rise to 5-v. Continue adjusting VR-1 and the voltage should change back to where it was before.

The dropout point (Type 1) or peak point (Type 2) is the tone-reject point of the TDR.

If your tests are successful at this point, then solder the TDR output wire to the "scan control" pin of the NFM/AM chip. Again slowly adjust VR-1 thru its range until the offending tone just disappears. Tweak VR-1 back and forth to determine the middle of the dropout zone and leave it set there. Operate the scanner as normal with a welcome feeling of sheer relief!

Now a bit of theory for those who want to know how this sucker works. The LM-567 chip is the key to it all. It is rather complex on the inside, but with 8-pins on the outside, one for ground and one for power, it is very easy to use. In lay terms, the 567 is a "tone decoder", where the resistance between pins 5 & 6 and capacitance from pin 6 to ground determine the tone to be decoded. The equation for the tone is given as:

$$f_o = \frac{1}{(VR1)(C4)}$$

where:
- f_o is the tone, hertz
- VR1 is resistance, ohms and
- C4 is capacitance, farads

Suppose that VR-1 is set to 2,500-ohms and C-4 is 0.2-uF, then: $f_o = 1 / (2,500)(.2 \times 10^{-6}) = 1 / .0005 = 2000$ Hz

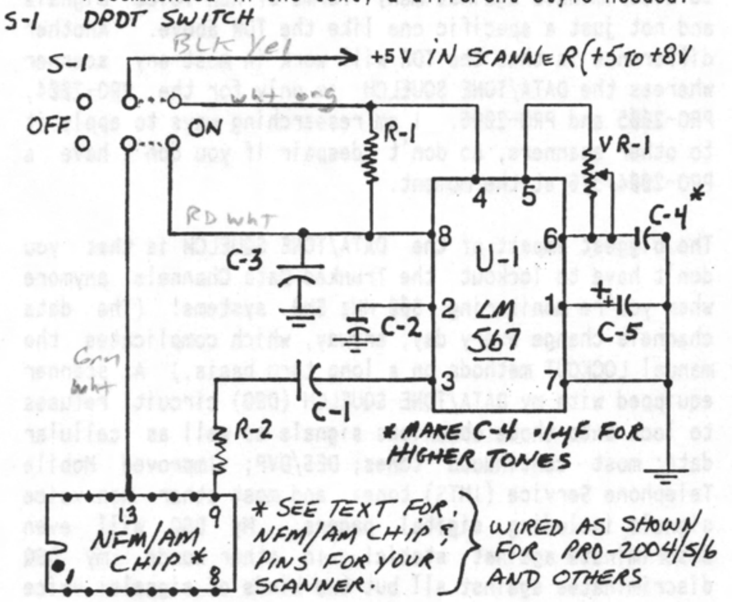
Obviously, changing the value of VR-1 or C-4 will change the tone to be decoded. The 567 is rated for a range of frequencies from about 0.01 Hz to 500 KHz. For our use, we need only a range of maybe 500 Hz to 5 KHz, so VR-1 and C-4 were selected accordingly. The Bandwidth of the tone decoder can be varied somewhat by the value of the capacitor, C-2. The smaller the capacitor, the wider the bandwidth. Too small of a C-2, and the bandwidth will be so narrow that VR-1 will be touchy and hard to set. Too large of a value of C-2, and the TDR will cover too much range and result in "falsing" or reaction to desirable signals. The design here is good as is but the variables are explained in case you find a use for it in some other situation. A neat chip, the 567.

VR-1 and C-4 set a specific tone to be detected. The audio output of the NFM/AM chip is applied to the input of the TDR via R-2 and C-1 to Pin 3. As long as the preset tone is not present, the 567 does nothing and the output at Pin 8 is high at about 5 volts. When the preset tone enters Pin 3, the 567 instantly detects it and changes its output at Pin 8 from high to low or 0v. This 2-state logic is used to discriminate among sounds. For Type 1 scanners, the "high" output of the TDR makes the scanner do nothing but act normal. When the preset tone comes in, the output at Pin 8 goes low to force a synthetic SQUELCH-Set at the NFM/AM chip's SCAN CONTROL pin. This forced SQUELCH-Set blanks the sound and the scanner will resume SCAN or SEARCH. Type 2 scanners have an inverse Squelch Logic, so Q-1 inverts the 567's output logic to match. When the 567's Pin 8 output to Q-1 is high, the collector output of Q-1 is low and vice versa. It is as simple as that; a logic inverter.

TYPE 1 TONE DECODER/REJECTOR CIRCUIT

MOD-56a

Ckt Sym	Description
U-1	LM-567; NE-567; ECG/NTE-832; SK9089; R/S 276-1721
XU-1	IC socket, 8-pin DIP; R/S 276-1995
C-1,3	Capacitors; 0.01-uF; R/S 272-1065
C-2	Capacitor; 0.1-uF; R/S 272-1432
C-4	Capacitor; 0.22-uF; R/S 272-1070
C-5	Capacitor; 2.2-uF; R/S 272-1435
R-1	Resistor; 10-k; R/S 271-1335
R-2	Resistor; 47-k; R/S 271-1342
VR-1	Variable resistor; 10-k; R/S 271-282 (Note: this unit cannot be super glued behind a panel hole as recommended in the text; a different style needed.

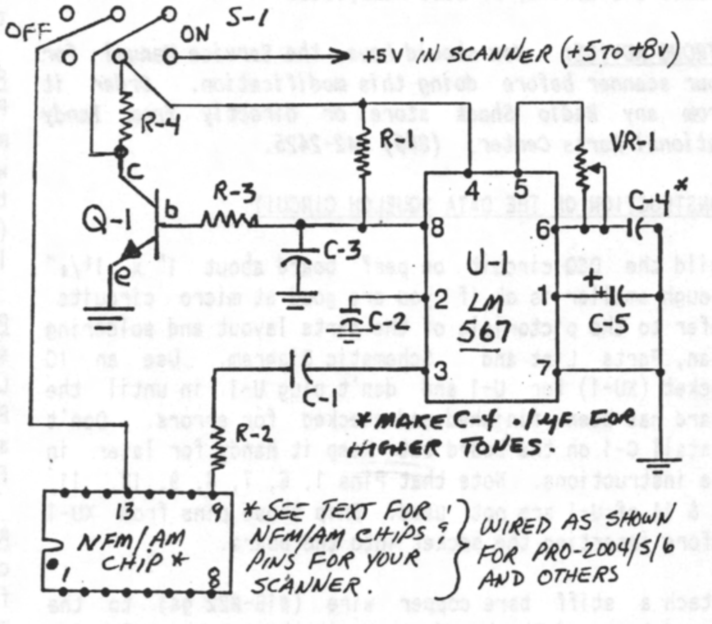


TYPE 2 TONE DECODER/REJECTOR CIRCUIT

Additional parts required:

MOD-56b

Ckt Sym	Description
Q-1	Transistor, NPN; 2N2222A or equiv; R/S 276-2009
R-3	Resistor; 4.7-k; R/S 271-1330
R-4	Resistor; 10-k; R/S 271-1335



FEATURE PRESENTATION #2
DATA/TONE SQUELCH CIRCUIT FOR PRO-2ØØ4/5/6

Here's an exceptionally great mod to let the PRO-2ØØ4/5/6 recognize worthless computer data and other single or multiple tone signals and then resume SCAN or SEARCH within a second or so after locking up on these types of signals. This mod may resemble the Tone Decoder/Rejector described above, but they're totally separate circuits for different applications. The Data/Tone Squelch can serve in a limited capacity as a Tone Decoder/Rejector, (i.e, a "Metro-Mod), but it's really for a broader need to discriminate against many forms of non-voice signals and not just a specific one like the TDR above. Another difference is that the TDR will work in most any scanner whereas the DATA/TONE SQUELCH is only for the PRO-2ØØ4, PRO-2ØØ5 and PRO-2ØØ6. I am researching ways to apply it to other scanners, so don't despair if you don't have a PRO-2ØØ4/5/6 at the moment.

The biggest impact of the DATA/TONE SQUELCH is that you don't have to lockout the Trunked Data Channels anymore when you're monitoring 8ØØ MHz SMR systems! (The data channels change every day, anyway, which complicates the manual LOCKOUT methods on a long term basis.) A scanner equipped with my DATA/TONE SQUELCH (DSQ) circuit refuses to lock onto those obnoxious signals as well as cellular data; most continuous tones; DES/DVP; Improved Mobile Telephone Service (IMTS) tones and most other non-voice signals including digital pagers. My DSQ will even discriminate against static! In other words, my DSQ discriminates against all but two kinds of signals: voice and silent or dead carriers! The latter is ok because the PRO-2ØØ4/5/6 SOUND SQUELCH (SSQ) takes care of silent signals. In fact, my DSQ works with the SSQ but is independent of it except that the SOUND SQUELCH button on the front panel activates/deactivates both functions. Two SPST switches provide independent control of SSQ and DSQ! Construction/installation of the DSQ are simple and within the ability of most hobbyists.

***STRONG ADVICE:* You should have the Service Manual for your scanner before doing this modification. Order it from any Radio Shack store or directly from Tandy National Parts Center; (8ØØ) 442-2425.**

CONSTRUCTION OF THE DATA SQUELCH CIRCUIT

Build the DSQ circuit on perf board about 1" x 1¹/₄" though smaller is ok if you are good at micro circuits. Refer to the pictorials of the parts layout and soldering plan, Parts List and Schematic Diagram. Use an IC socket (XU-1) for U-1 and don't plug U-1 in until the board has been finished and checked for errors. Don't install C-1 on the board but keep it handy for later in the instructions. Note that Pins 1, 6, 7, 8, 9, 1Ø, 11, 13 & 14 of U-1 are not used. Snip those pins from XU-1 before inserting the socket into the board.

Attach a stiff bare copper wire (#18-#22 ga) to the ground trace of the board. Loop it through the holes in the perf board for rigidity and then solder it to the main ground trace of the DSQ. Leave about 1-inch of this bare wire free. It will simplify installation of the DSQ board in the scanner. Solder a RED hookup wire to Pin 3 of XU-1; solder a YELLOW hookup wire to the junction of D-1 and D-2. Solder a WHITE hookup wire to the anode of D-4. Solder an ORANGE wire to the cathode of D-4. Solder a BLUE wire to the cathode of D-3. ***NOTE:* These wires should be about 6"-8" long.**

Construction and layout are not critical and can be varied from my suggestions which are about as simple as possible and involve no loops, jumpers or other weird wiring techniques. Make your board as small as possible, though, so that it won't take up too much room inside the scanner. You may be doing lots of modifications in the future and space might come at a premium. Install the DSQ Board in an out of the way place, though VR-1 should be accessible for initial adjustments. The bare ground wire on the DSQ Board can be soldered to the chassis or to a printed circuit board ground trace, thereby making the mount much easier. This bare wire can be bolted to the chassis if you don't have a heavy duty soldering gun. Once soldered or bolted, this stiff wire should make the DSQ Board relatively immobile and stable. You can wrap the DSQ Board with a layer of clear, plastic tape if there is a chance of anything shorting to it.

PRO-2ØØ4 ONLY: Solder the (+) leg of C-1 directly to IC-5, Pin 14.

PRO-2ØØ5/6 ONLY: Solder the (+) leg of C-1 directly to IC-5, Pin 7.

PRO-2ØØ4/5/6 ALL: Solder the free end of the YELLOW hookup wire to the (-) leg of C-1. Solder the BARE ground wire to the chassis or a circuit ground in the scanner. Solder the free end of the RED hookup wire at Pin 3 of XU-1 to the OUTPUT leg of IC-8, the +5 volt regulator on the main chassis of the scanner. IC-8 is the same in all three scanners, PRO-2ØØ4/5/6.

PRO-2ØØ4 ONLY: Locate CN-5Ø4 on the Logic/CPU Board, PC-3, and follow its wire bundle back to the top of the main receiver board. Locate the sky blue (light blue) wire that connects to the main board at the right end of the row of wires and desolder that wire from the board. (This wire comes from Pin 15 of CN-5Ø4.) Let it hang loose for a moment.

PRO-2ØØ5/6 ONLY: Locate CN-3 on the main receiver Board and follow its wire bundle up to the Logic/CPU board. Locate the sky blue (light blue) wire that connects to Pin 4 of CN-3. Clip that blue wire halfway between CN-3 and the Logic/CPU Board. Let the two cut ends hang loose for a moment.

PRO-2ØØ4/5/6 ALL: Install two SPST switches of your choosing in a place of your choosing on the scanner's front or rear panels. For rear panel installations, Radio Shack's micro-mini toggle switches, #275-624, will be just fine. These switches can also be put into the front panel, and isn't difficult to do on the PRO-2004 where there is plenty of room. It is more difficult on the PRO-2005/6 where the Logic/CPU Board must first be removed. (See V1N2 of the *"WSR"* or Vol-2 of my SCANNER MODIFICATION HANDBOOK for how to do this.) One very neat choice of switch for any of the PRO-2004/5/6 is a 4, 6 or 8-position DIP switch. The extra switch positions can be used for other things in due time!

PRO-2004/5/6 ALL: Solder the ORANGE wire of the DSQ Board to the bottom lug of one switch. This switch will control the stock SOUND SQUELCH (SSQ) function, on or off. Solder the BLUE wire of the DSQ Board to the bottom lug of the other switch. This switch will control the new DATA SQUELCH function, on or off. Solder a bare jumper wire from the free lug of one switch to the free lug of the other switch.

PRO-2004 ONLY: Solder the sky blue wire that was removed from the main board to the bare jumper wire between the lugs of the two switches. Solder the WHITE wire of the DSQ Board to the empty spot on the main scanner board where the sky blue wire was removed. THIS COMPLETES INSTALLATION: Proceed to ADJUSTMENT OF VR-1.

PRO-2005/6 ONLY: Splice the WHITE wire of the DSQ Board to the cut sky blue wire that goes to CN-3 of the main scanner board. Splice one end of a hookup wire to the other cut end of the sky blue wire that goes to the Logic/CPU Board in the front panel. Insulate the splices! Solder the other end of this new hookup wire to the common bare jumper wire between the top lugs of the two switches. THIS COMPLETES YOUR INSTALLATION: Proceed to ADJUSTMENT OF VR-1.

PRO-2004/5/6 ALL: ADJUSTMENT OF VR-1:

Push the front panel SOUND SQUELCH button ON. Turn the SSQ switch OFF and the DSQ switch ON. Attach a voltmeter (-) to ground and (+) to Pin 5 of U-1. Tune the scanner to a strong, noisy data channel or to a loud, single tone carrier. (Cellular or trunked data channels are ideal!) Measure the DC voltage at Pin 5 of U-1, (4.5v typical). Calculate 80% of that voltage; then put the voltmeter at Pin 4 of U-1 and adjust VR-1 for the 80% level of the above measurement. Typically, about 3.6 to 3.8v. The exact adjustment isn't too critical, but if set too low, voice signals will resume SCAN or SEARCH. If set too high, then data & tone signals won't trigger the SCAN/SEARCH RESUME. Another way to find the optimum setting is to put a voltmeter (+) on Pin 2 of U-1 and (-) to ground and tune the scanner to a cellular or trunked data channel. Adjust VR-1, first one way and then the other and then to a point so that the voltage on Pin 2 of U-1 just becomes stable with a nice and steady +5 volts. It takes a steady 5-volts for about one second to trigger the SCAN/SEARCH RESUME function, but don't adjust VR-1 any further than necessary to stabilize the DATA/TONE voltage at Pin 2.

OPERATION & TECHNICAL NOTES: Remember that the SOUND SQUELCH button on the front panel must be ON before either SSQ or DSQ can work. The SOUND SQUELCH button is kind of like a master on/off switch and the two SPST switches control one, the other or both.

Voice signals will cause the scanner to stay locked as normal until the signal goes away. Minor adjustment of VR-1 may be necessary for optimum results, but the final setting will produce a voltage on Pin 4 of U-1 of about 80% of the peak voltage on Pin 5 of U-1. The DC input signal at Pin 5 of U-1 will be nearly zero on silent or quiet signals and about 4 to 4.5v with data & continuous tone signals. Pin 5 will show a very erratic and rapidly changing voltage from nearly zero to 4 volts or so for voice signals. The DC output voltage at Pin 2 of U-1 will be nearly zero on silent or quiet signals; and a steady +5v with data & continuous tone signals. Voice signals will cause a rapid fluctuation of the signal between 0-5 volts at Pin 2 of U-1. When the SOUND SQUELCH button is off, neither SOUND nor DATA SQUELCH are operable and scanner operation will be completely normal.

IN CASE OF DIFFICULTY: The most critical part of this mod is the rectifier circuit consisting of D-1, D-2, R-1, R-2, C-1 and C-2 and proper pin wiring of the LM-339 chip. Make sure the diode polarities are correct (banded end is the cathode). Make sure polarities of capacitors are correct. Tune the scanner to a strong cellular (879 MHz - 881 MHz) or trunked data channel (851 MHz - 866 MHz), and measure the DC voltage at Pin 5 of U-1. There should be between 4 and 4.5 volts. You won't measure "too much" but not enough is possible. If so, check the wiring and components mentioned above. Next most critical is the polarity and wiring of the two isolation diodes, D-3 and D-4. Last but not least is the wiring of U-1. The circuit is so simple and affirmative in its action that you're not likely to encounter trouble if you follow these instructions.

Some PRO-2005 (not PRO-2004 or 2006) may have a chirping or warbling, morse code type of sound on quiet channels after this mod has been done. If yours exhibits this weird sound, change C-1 from 1.0-uF to 0.1-uF, Radio Shack #272-1432. If the "tweet" is still there, then solder a 1,000-uF capacitor (RS 272-1032) directly to Pins 4 and 11 of IC-5 in the scanner. Pin 4 should get the (+) lug of the capacitor while Pin 11 gets the (-). This is a peculiar problem in some PRO-2005's, but it's easy to correct so don't worry about it.

If you can't resolve a problem, send me *a SASE and one loose extra stamp* with a complete description of the problem and its symptoms and I'll respond with written suggestions and advice. Sorry, no phone calls, please.

THEORY OF OPERATION OF THE DATA/TONE SQUELCH

To understand the simple operation of my DATA SQUELCH, it is first necessary to understand the PRO-2004/5/6's SOUND SQUELCH (SSQ) circuit on which we will "piggy back" the new DATA SQUELCH circuit. The circuits are identical among the PRO-2004/5/6 scanners but circuit symbols differ. Bear with me here while I use a simple scheme for this discussion. ***P4*** means ***PRO-2004***; ***P5/6*** means ***PRO-2005*** & ***PRO-2006*** and ***P4/5/6*** means ***ALL***.

SOUND SQUELCH THEORY OF OPERATION: A weak portion of the receiver's audio is sampled at the detector and amplified through IC-5 (P4/5/6). The highly amplified audio is fed from IC5, (P4, Pin 14 or P5/6, Pin 7) to a rectifier network (P4, D-41 & D-42; or P5/6, D-43 & D-44). This rectifier network converts audio signals to a DC level proportional to the level of the audio signal, and is used as a bias to turn on or off a switching transistor, (P4, Q-21; P5/6, Q-19). Most audio signals are strong enough to turn the transistor on while very weak or silent signals keep it off. When the transistor is off, 5-volts is on its collector, but when the transistor is ON, the collector drops to nearly zero volts. 5 volts and 0 volts forms the logic required by the CPU for making decisions. The collector of the transistor is fed directly to the CPU, (P4, IC-503, Pin 24; or P5/6, IC-501, Pin 18). When the SOUND SQUELCH button on the front panel is set to the ON position and when CPU's SSQ pin is at zero volts, the scanner SCANs or SEARCHes as normal, locking on any signals which break the squelch. Similarly, when the SOUND SQUELCH button is off, a ground is placed on the CPU's SSQ pin, which keeps it at zero volts, no matter what.

When the SOUND SQUELCH button is on, and when the scanner encounters a silent or unmodulated carrier, then the transistor discussed above gets turned off and a 5-volt level on its collector is fed to the CPU's SSQ pin. 5-volts on the CPU's SSQ pin makes the scanner resume scanning within a second or so after stopping. As long as there are voices or other audio signals present, the CPU's SSQ pin will be "0-v low" and operation is normal. When that pin goes "+5v high", the CPU is programmed to resume scanning or searching.

DATA SQUELCH THEORY OF OPERATION: Since the CPU's SSQ pin responds only to low and high logic and really doesn't know the difference between voice and data, we can generate this logic with a separate but opposite logic circuit to make it discriminate against tones and data in the same way the SSQ discriminates against silent carriers. All we need is a circuit that sends a "high" to the CPU's SSQ pin in the presence of strong, sustained audio signals such as data or continuous tones. My DSQ does this nicely, thank you, since voice signals are erratic, varying, and not at all like data or continuous tones. C-1 of our circuit samples the same audio as the SSQ but passes it to a new rectifier circuit, D-1 and D-2, which with R-1, R-2 and C-2, creates a DC signal proportional to the level of the audio signal. This DC signal is fed to Pin 5 of U-1, a Voltage Comparator IC. A reference voltage is adjusted by VR-1 and fed to Pin 4 of U-1. As long as the DC signal at Pin 5 is less than the reference signal at Pin 4, the output of U-1 at Pin 2 will be zero volts "low". When the DC signal at Pin 5 exceeds the reference voltage at Pin 4, the output of U-1, Pin 2, will go high to +5v.

The output of U-1, Pin 2 is coupled to the CPU via isolation diode, D-3. A "high" will tell the CPU to make the scanner resume SCANning or SEARCHing while a "low" does nothing unusual. When VR-1 is correctly adjusted, the output of U-1, Pin 2 will never go "high" long enough to trigger the CPU unless data or continuous tones are present. Strong voice signals may make U-1's output go high momentarily, but the interval will not be long enough to trigger the CPU unless the talker does an extended "Ahhhhhhhhhh" into the mike, because about .5 to 1 sec is required before the CPU will trigger. Most voice signals of interest will not send a lengthy "high" to the CPU, but continuous tones and data will! Therefore, my DATA SQUELCH works just like, though inversely to the SOUND SQUELCH.

Isolation diodes, D-3 and D-4, allow the SOUND SQUELCH and the DATA SQUELCH to work simultaneously and not interfere with each other. Depending on the setting of the individual DSQ & SSQ switches, both data/tone and silent signals can cause the scanner to resume SCANning or SEARCHing, but voice signals will not be affected by either the SOUND or DATA SQUELCH!

PARTS LIST FOR DSQ CIRCUIT (MOD-44a)

Ckt Sym	Description
C-1	1-uF/35vdc Tant; #272-1434; See "Difficulty" text
C-2	2.2-uF/35vdc Tantalum; #272-1435
D1-4	1N4148 or 1N914 switching diodes; #276-1122
R-1	390-ohm; #271-018
R-2	12-k; use 10-k + 2.2k in series if need be.
R-3	3.3-k; #271-1328
U-1	LM-339 Comparator; #276-1712
VR-1	10-k ohm trim pot; #271-282
XU-1	IC Socket, 14-pin DIP, for U-1 above; #276-1999
Misc	Perf board; #276-1395
Misc	Hookup wire; #278-776 or #278-775
S1,2	Switch, SPST Toggle Switch, #275-624

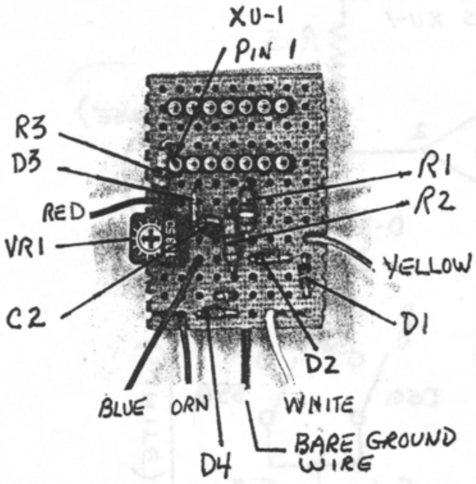
MERRY CHRISTMAS & HAPPY NEW YEAR

Well, that's it; we've run out of space and there's still so much more to write. I am saddened to come to the end of an issue and and the end of a year and still have items on the list not checked off. In a way, it's called "job security" since a dead end won't be reached with the next issue. I laugh at myself now to think about my feelings upon completing Vol-1 of my SCANNER MODIFICATION HANDBOOK. (I wondered if there would ever be anything else to write about.) I worried about it again last January as we launched the "*WSR*", but by mid-year, the checklist only got longer and longer after every issue. One thing grew to inspire another. This spirit is now being carried into 1992. We've only begun! My excitement is rising to a crescendo over the prospects of what yet lies in store for the radio monitoring hobby. I hope some of this has rubbed off and renewed or invigorated your enjoyment and pleasure. A psychic once told me that my mission in Life is to be at the service of others. It's my fondest hope that the "*WSR*" has served your best interests this year, and if it has, my commitment is to make 1992 even better. Merry Christmas and Happy New Year to all! 73/bc & Staff

WIRING & COMPONENT PLACEMENT DIAGRAMS FOR DATA/TONE SQUELCH (MOD-44a)

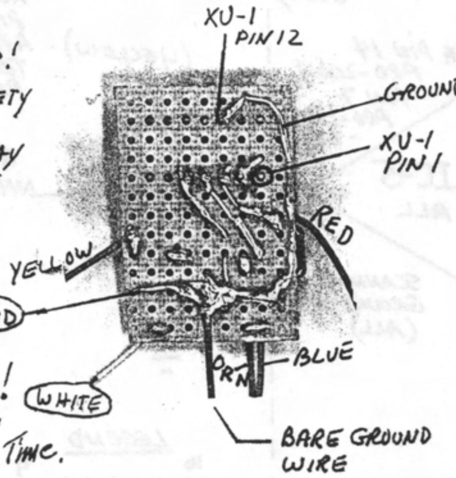
PERF BOARD ASSEMBLY

COMPONENT SIDE



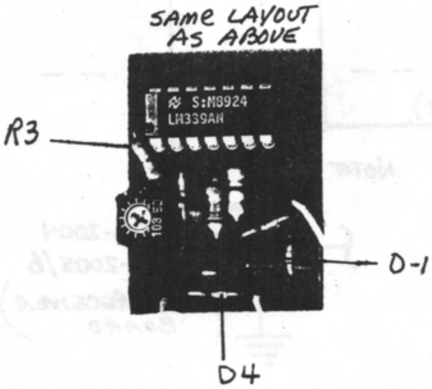
NOTE: THIS CIRCUIT HAS BEEN FIELD PROVEN AND TESTED FOR OVER A YEAR! IT WORKS FOR A WIDE VARIETY OF DATA AND NON-VOICE SIGNALS. SOME PEOPLE SAY IT DOES NOT REJECT THE TONES OF THE GE 16+ TRUNKED SMR SYSTEM. OTHERS SAY IT IS VERY EFFECTIVE ON GE 16+. NO ARGUMENT ON ANY OTHER SYSTEM (MAJORITY) HOWEVER, BUT YOU TELL ME! I USE MINE EXCLUSIVELY WITH SUPERB RESULTS 100% OF THE TIME.

SOLDER SIDE



HOME MADE PRINTED CIRCUIT BOARD

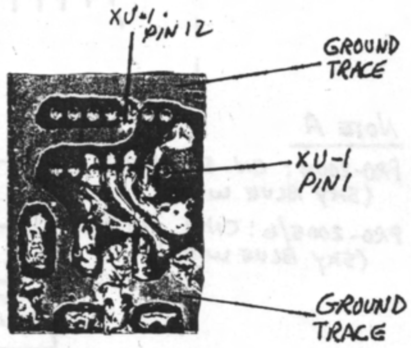
COMPONENT SIDE



NOTE: NO NEED TO MAKE A PRINTED CIRCUIT. THE PERF BOARD VERSION IS QUICKER AND JUST AS GOOD.

NOTE: THIS CIRCUIT HAS NOT HAD ANY REVISIONS IN THE YEAR THAT IT'S BEEN TESTED. IF YOU HAVE ONE ALREADY, IT'S UNCHANGED AS OF 10-30-91.

SOLDER SIDE



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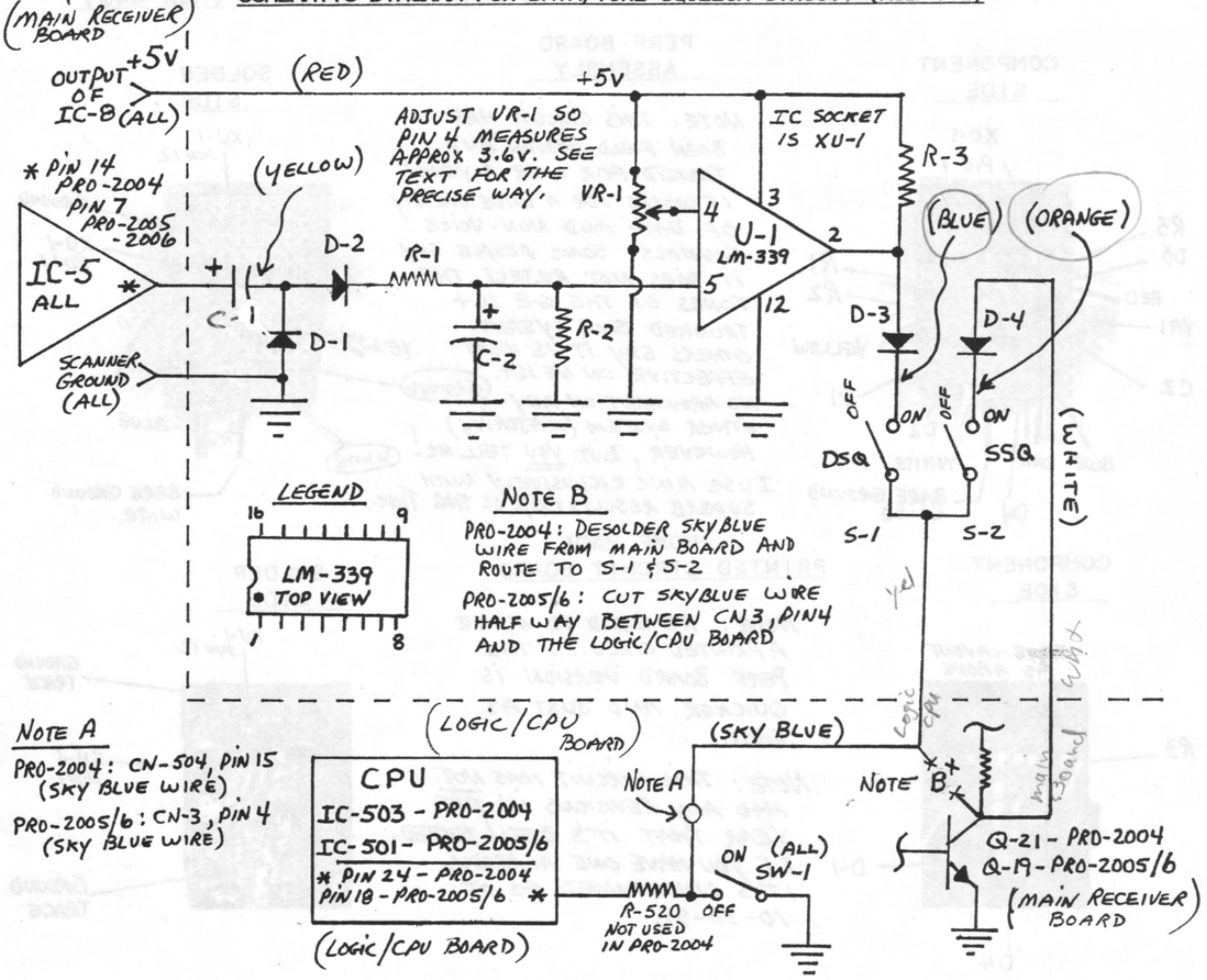
SCHEMATIC DIAGRAM FOR DATA/TONE SQUELCH CIRCUIT (MOD-44a)



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