December 1995 QST Volume 79, Number 12

DAS—DTMF Accessory Squelch

Easy on your ears and nerves—this DTMF decoder silently monitors a radio channel alerting you only when a designated identifier is recognized.

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The DTMF Accessory Squelch (DAS) is a DTMF (dual-tone, multifrequency) decoder that acts like a switch connected in series between the speaker output of your VHF or UHF transceiver and an external speaker. DAS monitors a radio channel for you with the speaker switch open so the speaker remains silent until someone sends one of the DTMF (also known as Touch-Tone[1]) sequences you have selected.

Introduction

Refer to Figure 1. When DAS detects your personal (**PER**) identification (ID) digit sequence on the radio channel, it lights an LED (DS2), sounds a horn and closes the series speaker switch so that you can hear the audio of the calling station. If you don't want to monitor the call, the speaker switch opens automatically after 30 seconds. If you want to monitor or answer the call, set the monitor switch to the **MON** position to continue listening to the channel. When the monitor switch is in the **MON** position, the speaker is connected to the radio so you can hear what's on the radio channel, as though DAS was not in the circuit. Press the **CLR** button at any time to cause the LEDs, horn and speaker relay to immediately return to their idle (off) state.

Your personal ID sequence can consist of 1 to 7 digits. You can load your personal ID sequence into DAS right off the air using a hand-held or other transmitter to generate the appropriate DTMF signals.

In addition to DAS watching for your own personal ID sequence, you can also configure it to simultaneously look for an alternate group (**GRP**) ID sequence. If you are the member of a RACES or ARES group, this might be handy for alerting all users with just one common ID sequence.

Another feature of DAS is that it's always watching for urgent calls using the ARRL LiTZ system (Long Tone Zero—transmit DTMF zero for three seconds or more).[2] [3] Whenever DAS detects a continuous DTMF zero for two or more seconds, it lights its urgency (**URG**) LED (DS1), sounds a horn and closes the speaker switch. Three other features of DAS bear mention. One allows for automatically monitoring the channel whenever the hand microphone is out of its hanger. Another provides a "ScanStop" output that can be used with scanning radios to hold the radio on the current channel when DTMF signals are detected. The third provides a "transpond" output suitable to interface to an off-board tone generator and PTT driver. The microphone monitoring feature is described later in more detail.

Circuit Description

An external dc power source (10 to 15 V at 100 mA) is applied to terminals TB1-1 and TB1-2. Current from this power source passes through D1, which provides reverse-polarity protection. C1 through C3 provide bulk capacitance as well as high-frequency filtering. U5 provides a regulated 5-V output for powering the ICs. C4 and C5 filter the regulator output. C6 through C9 are IC bypass filters and should be located such that the capacitors are *physically* near their respective ICs. Test points are provided at TP +V, TP +5 V, TP AV and TP GND.

U1's read-only memory (ROM) stores the program that provides DAS functionality. U2 is an electrically erasable programmable read-only memory (EEPROM). This device retains user configuration information even when power is removed from the decoder. On power-up, U1 reads U2's information and uses it to customize the decoder as the user previously configured it. If the U2 checksum fails—as may occur whenever a new part is installed at U2—the default values from U1's ROM are used and the **STA** LED blinks to show the checksum failure. Once a configuration operation has taken place, U1 stores data in U2 with a correct checksum. From then on, U2's data (instead of the default data within U1) is used to configure the decoder.

R1, R2, C10 and D2 comprise a power-on reset circuit. If you want a manual reset switch (to supplement the power-on reset), connect it to H1. (The H identifies two-pin SIP headers used as jumper blocks.)

U1's clock signal is derived from Y1, a 3.58-MHz color-burst crystal, and the respective crystal loading capacitors, C11 and C12. The oscillator's output is also coupled to the clock input of the DTMF receiver, U3. More on this later.

External audio is applied to TB1-3 (input) and TB1-1 (ground). The signal can be terminated with a 560-Ω load by installing a shunt at H2. Note: For proper operation, install a shunt at H2 whenever the audio driving DAS is taken from a radio receiver's external speaker jack.

The audio input is also coupled to the audio output through the speaker-control relay, K1. Note that the audio passes through K1's normally closed contacts. This way, the audio normally passes from input to output if DAS is off. K1 must be energized to open those relay contacts and interrupt the audio path. The firmware within U1 causes K1 to be energized when DAS is in the idle state. For applications that require the lowest possible current drain, wire the audio to pass through K1's normally open contacts and configure DAS option **SPK RLY ENERG FOR GUARD** (speaker relay energized for guard) OFF. This causes U1 to deenergize K1 when in the idle state for lowest current drain.

C13 provides dc blocking of the audio signal while R7, R8, R9 and an op amp internal to U3 (the DTMF receiver) provide a variable signal gain/loss of up to 20 dB. In general, when a DTMF signal is applied to TB1-3, adjust R8 to provide a signal of 850 mV P-P at TP AV. If you're using a non-RMS voltmeter (most meters with price tags of less $100 are likely to be non-RMS-reading meters), adjust R8 for a reading of 300 mV ac.

U1's 3.58-MHz clock is connected to one side of H3. The other side of H3 goes to the clock input of U3. A jumper must be installed at H3 for U3 to operate correctly. C15, D3, R10, D4 and R11 provide for DTMF detect and release timing. U3 outputs a modified, active high, BCD output value. It's modified in that the DTMF symbol 0 is represented by bit pattern 1010 (Ah—hexadecimal) while DTMF symbol D is represented by bit pattern 0000 (0h). U3 pin 15 goes high when a valid DTMF symbol is being received. U4 provides eight buffers with noninverting, open-collector outputs. Two buffers drive the relays, four buffers drive LEDs and the two remaining buffers drive the OT0 and OT1 outputs.

Q1 and associated components provide a voltage-protected inverting buffer for the **MICUP** input. When **MICUP** is floating, Q1 is biased on, causing U1 pin 23 to go low, indicating that the microphone is out of its hanger (more on this later). When **MICUP** is pulled to ground, Q1 is cut off and U1 pin 23 goes high, indicating that the microphone is resting in its hanger. U1 uses this signal to connect the audio input to the audio output (via K1) when the microphone is out of its hanger. If you don't use **MICUP** monitoring system, you *must* ground the **MICUP** input. If **MICUP** isn't grounded, the DAS audio input always cuts through to the DAS audio output.

Locating Parts

The DAS ICs can be difficult to locate. For those that don't want to round up all the parts needed for this project, a complete kit of the PC-board-mounted parts and a PC board are available from Tucson Amateur Packet Radio (TAPR). Contact TAPR directly for information about their DAS kit and DAS parts.[4]

Construction

Building the DAS is fairly simple. You can use perf board or a PC board. There are a couple of caveats, however. Y1 and crystal-loading capacitors (C11 and C12) of Figure 1 should be mounted within one inch of U1 pin 12. Additionally, the ground legs of these crystal-loading capacitors should be returned directly to U1 pin 12.

U1 must be *programmed* with the object code that causes it to function as DAS (see Note 4). If you get one of these ICs that hasn't been programmed (or has been programmed to implement a different function), your DAS system isn't going to function as expected if that part is installed as U1.

All off-board connections are made via terminal blocks TB1 and TB2. I like to use screw terminals for these off-board connections. A fine two-terminal block that's cascadable to provide any even number of terminals is available from Digi-Key.[5]

Initial Testing

Apply power to DAS. You may see the **STA** lamp blinking (mostly *off* with very short *on* periods, repeated at regular intervals). If so, press and immediately release the **CLR** button and see that the **STA** lamp is now off. STA blinking means that the data in the EEPROM (U2) fails a checksum test. Don't worry about this right now—once DAS has been configured, this problem goes away.[6]

Next, press and hold the **CLR** button for three seconds. You should now see that the **STA** lamp is winking (mostly *on* with very short *off* periods, repeated at regular intervals). This indicates that DAS is in the configuration (CONFIG) mode. Press and immediately release **CLR** and see that the **STA** lamp is now off. This confirms that U1 is functioning correctly.

Adjust the **DTMF LEVEL** control, R8, to its center position. Connect an 8-Ω speaker to the audio output of DAS and connect the external speaker output of your transceiver to the DAS audio input, J1. Set monitor switch S3 to the **MON** position. Adjust your radio's squelch control for a white-noise output, then adjust your radio's volume control for the desired listening level. Note and record the position of the radio's volume control. Next, adjust the radio's squelch control to silence the white-noise output.

Using another radio (perhaps an H-T connected to a dummy antenna) on the same channel as the radio connected to DAS, transmit each of the 16 DTMF tones, one at a time. Ensure that the **STA** lamp lights with the transmission of each DTMF tone. If it doesn't, you may need to readjust R8.

Now, decrease the radio's volume control some amount (about 1/8 of a turn below the normal listening level). Again, transmit each DTMF tone. Ensure that the **STA** lamp lights with each DTMF tone transmission. If it doesn't, you may need to readjust R8.

Next, increase the radio's volume control some amount (about 1/8 of a turn above the normal listening level). Set the monitor switch to **GUARD**. Again, transmit each of the DTMF tones. Ensure that the **STA** lamp lights with each DTMF tone. If it doesn't, you may need to readjust R8.

Return your radio's volume control to the normal listening level position you recorded. If all these tests were successfully completed, it shows that your audio levels are adequate to decode DTMF symbols. No further adjustment of R8 is needed.

Operation

Chances are, most hams will want to use DAS only for its basic operations: monitoring for LiTZ signals, your personal ID sequence and/or your group ID sequence.

When DAS detects your personal ID sequence, group ID sequence or LiTZ, it activates the horn for two seconds, activates the speaker relay for 30 seconds and enables the appropriate LED. Specifically, the **PER** LED is set to a *fast* flash rate on detection of your personal ID sequence, the **GRP** LED is set to a *slow* flash rate on detection of your group ID sequence, and the **URG** LED is set to a *flutter* flash rate on detection of a LiTZ signal.

If you choose to wire the mike hanger to DAS (see Figure 2), it can automatically activate the speaker relay whenever the mike is out of its hanger. This ensures that the operator always monitors the radio channel when picking up the microphone to make a transmission.

Sequence Delimiting

One item of particular interest is the method that DAS uses to determine where a received ID sequence starts and where it ends. DAS makes use of the same conventions now provided by some telephone networks.[7] The DTMF # (pound) symbol is used like the **ENTER** key on your computer keyboard. Additionally, just like the long-distance networks, a “no more input” timer (two seconds) is used as a backup for those who forget to send a # or just choose not to send the # at the end of a digit sequence. You can also configure DAS to use the * (star) as either a wild-card character (such as the question mark [?] character is used in computer systems) or an “erase current entry” command (as with some telephone networks).

Whenever DAS receives a # character, it checks the data in its received-digit register to see if it matches either the personal or group ID sequences. If so, it takes the action described earlier. After making the check, it clears the received-digit register to get ready for the next DTMF digit sequence. The no-more-input timer can also initiate the digit sequence checking if the DTMF # symbol isn’t the last symbol received. It provides pretty much the same functionality as the # symbol.

Using # to mark the end of an ID sequence is a very helpful characteristic. For example, assume that your personal ID sequence is 293, and a very popular autopatch telephone number is 824-2938. Your DAS unit *won’t* respond to the 293 that’s transmitted as part of the 824-2938 telephone number. Another great thing about using # to mark the end of a sequence is that it allows you to quickly send repeated ID sequences to the same station, or to send different ID sequences to several stations, as one continuous blast of DTMF tones. If you want to alert a user that makes use of personal ID sequence 123, you can load #123#123#123# into an auto dial register and send that string. The first # ensures that the decoder’s received-digit register is clear and ready for immediate reception. After that, there are three transmissions of the ID sequence. If the first transmission of the sequence isn’t detected correctly, the redundant second and third transmissions should be.

Advanced Features

DAS includes 16 on/off options that you can change to customize DAS for a particular application. All options default to values for SELCAL operation that I believe are most useful for the greatest number of users, but you can change all of DAS’s options. I won’t take up space here to layout the specifics of all the options, however, a list of available options and their configuration sequences are in the Appendix. A complete discussion of all system configuration information is provided in the *DAS Configuration Reference Guide* described in the Appendix.

Personalized Configuration

Most likely, you’ll want to use something other than the default ID digit sequences of 123 for personal and 456 for group. You’ll need to configure DAS to change these sequences to your desired values.

First, you must determine the values you want to use for your personal and group ID sequences. The personal ID sequence can be as short as one digit or as long as seven digits. The group ID sequence can be as short as one digit or as long as three digits. Using no digits when configuring a particular ID sequence effectively disables that ID sequence. You cannot use * or # as part of your personal or group ID sequences.

ID Sequence Selection

Here are some other suggestions regarding choices of ID sequences. First, I recommend that you use ID sequences that consist only of the digits 1 through 8. Second, ID sequences should be at least three digits long. Third, don’t use the same digit twice in a row (ie, don’t use something like 2334, but 2343 would be fine). That’s because a common radio DTMF decoding error is for one signal to be considered as two, perhaps because of a fade during the transmission. I excluded digits 0 and 9 for good reason. I recommend that you not make use of the digit 0 just because it’s used for the LiTZ signal. I also recommend that you not make use of the digit 9 because one advanced configuration option of DAS allows the sending station to immediately mute your speaker—without waiting for the standard 30-second time-out period—by sending a DTMF 9. These aren’t hard and fast rules, they’re suggestions. If you have good reasons for doing something other than what I recommend, then by all means do what you think is best for your application.

Configuring DAS for SELCAL

Here’s a step-by-step procedure on how to configure DAS for SELCAL default options, as well as your personal and group ID sequences.

1. Choose your personal ID sequence. Write the sequence in the spaces below:

* 1 ___ ___ ___ ___ ___ ___ ___ #

2. Choose your group ID sequence. Write the sequence in the spaces below:

* 2 ___ ___ ___ #

3. Enter the CONFIGURE mode by pressing and holding the **CLR** button for three seconds. You should now see the **STA** lamp winking (mostly *on* with very short *off* periods, repeated at regular inter-vals). This indicates that DAS is in the CONFIGURE mode.

Note: When DAS is in the CONFIGURE mode, it *always* considers the ***** to be the "delete all previous input" command and the **#** to mark the end of a configuration command. There isn't a "no-more-input" timer when DAS is in the CONFIGURE mode. When in the CONFIGURE mode, DAS does nothing until you enter the **#** symbol to mark the end of your CONFIGURE command. Within three seconds of entering a **#** to mark the end of a CONFIGURE command, you should see a *command accepted* or *command rejected* flash code from the LEDs. The *command accepted* flash code consists of the **GRP** LED flashing 10 times. The *command rejected* flash code consists of the **URG** and **PER** LEDs alternating on and off (like railway grade-crossing warning lights) 10 times. To lessen the likelihood of bogus inputs, start each CONFIGURE command with a * to erase any existing DTMF entries.

4. Send the DTMF sequence *** 3 0 #** to DAS using your DTMF signal source. Within three seconds of sending **#**, you should see the *command accepted* flash code on the **GRP** LED. This configures DAS to the SELCAL default options, as well as 123 for the personal ID sequence and 456 for the group ID sequence.

5. Send the DTMF symbols listed in Step 1 to DAS, beginning with ***** and ending with **#**. Observe a *command accepted* flash code on the **GRP** LED. This configures the decoder to your selected personal ID sequence.

6. Send the DTMF symbols listed in Step 2 to DAS, beginning with ***** and ending with **#**. Observe a *command accepted* flash code on the **GRP** LED. This configures the decoder to your selected group ID sequence.

7. Press and immediately release **CLR** to return to SELCAL mode. All LEDs should now be off.

Test the personal, group and LiTZ functions to ensure that they work properly. If not, repeat the foregoing steps.

If you want to return the decoder to the original SELCAL hard-coded configuration, perform all steps *except* 5 and 6. That sets the personal ID sequence to 123 and group ID sequence to 456. It also sets all configuration options to their default values (see Appendix for values).

Indicators

DAS provides audible and visual indicators. The audible indicators consist of the horn and speaker. In general, whenever a configured personal or group ID sequence or LiTZ signal is detected, the horn and K2 (the external-alarm control) are energized for two seconds. Additionally, the speaker relay (K1) is energized for 30 seconds, which causes the audio input (radio receiver) to be connected to the audio output (speaker) of the decoder. The speaker is also active whenever the monitor switch is in the **MON** position, whenever the **MICUP** input is not grounded, or when power is removed from the decoder.

The visual indicators consist of four LEDs. The LEDs are labeled **URG** (for URGent — ie, LiTZ), **PER** (for PERsonal ID sequence), **GRP** (for GRouP ID sequence), and **STA** (for STAtus—to display various status conditions). Following is a description of the various flash codes available for each LED and what they mean.

STA On

STA on steady indicates that a valid DTMF signal is detected at that instant. The **STA** lamp is on any time that a valid DTMF symbol is being received by the unit, regardless of mode.

STA Blinking

A blinking display (mostly *off* with very short *on* periods, repeated at regular intervals) on the **STA** LED indicates that data in U2 is invalid and that hard-coded default values were taken from U1 instead. Most likely, this will occur when your unit is first powered up after construction and before you've configured it for the first time. If a blinking LED display occurs at other times, it indicates that U2 may be bad, or that signals to or from U2 are corrupted (shorted or open circuit).

STA Winking

A winking display (mostly *on* with very short *off* periods, repeated at regular intervals) indicates that DAS is in the CONFIGURE mode. This means that the unit considers received DTMF digit sequences as commands to configure DAS, rather than as SELCAL sequences. Because STA is active whenever a valid DTMF signal is received, it is common to miss some of the *off*-time indications of the winking flash pattern when in the configuration mode if the unit is receiving a DTMF signal at that instant.

URG Flutter

A flutter display (50 ms *on*, 50 ms *off*, repeated) indicates that a LiTZ signal has been received.

PER Fast Flashing

A fast flashing display (200 ms *on*, 200 ms *off*, repeated) indicates that your personal ID sequence has been detected.

GRP Slow Flashing

A slow flashing display (600 ms *on*, 600 ms *off*, repeated) indicates that a group ID sequence has been detected.

GRP Interrupted Flutter

An interrupted flutter display indicates that a long-digit signal (any digit, 1 through 8 inclusive, detected continuously for two or more seconds) has been detected. Note: The long-digit detection feature defaults to *off* (ie, disabled), so you would not normally see this flash rate on this LED.

Controls

DAS has three switch controls: **PWR, MON** and **CLR.**

PWR — Power ON/OFF (SPST Toggle)

When in the **OFF** position, speaker relay (K1) is deenergized and the audio output is electrically connected to the audio input via K1's normally closed contacts. When in the **PWR** position, power is applied to the decoder and the power-on reset circuit gives U1 a hardware reset signal. The DAS microcomputer can be reset at any time by turning the power off, waiting three seconds, then restoring power to the unit.

MON — Monitor/Guard Audio (SPST Toggle)

The monitor switch is in parallel with the speaker control relay (K1) contacts. When the monitor switch contacts are open (**GUARD** position) the decoder operates normally. When the monitor switch contacts are closed (**MON** position), the speaker is always connected to the audio input of the decoder.

CLR — Clear Decoder Status (SPST Momentary)

Closing the **CLR** switch contacts causes the decoder to return the speaker, horn and external alarm to their normally idle states. It also returns the LEDs to their normally idle states (off). Pressing and holding the **CLR** button for three seconds or more causes DAS to enter the CONFIGURE mode.

Closing Comments

This article covers just about everything most users will want to know about DAS. However, for those people that have unusual applications or just want to know more about the system, there are several additional documents that describe DAS. The *DAS Configuration Reference Guide* provides complete details about all the options and their interactions. A series of DAS Application Notes outlines some less-common ways to use DAS, including remote-control applications. All documents can be found on the ARRL BBS and Internet Info Server,[8] as well as the TAPR file server. The object code (Intel hex format) for DAS's U1 is also available from the ARRL BBS and TAPR file server. (Source code has not been released.) If you don't have the capability to download these items directly, you can get a printout of the *DAS Configuration Reference Guide* and object code listing for a nominal fee from the ARRL Technical Department.[9]

It's my hope that DAS serves as a useful accessory to hams that have a need for an easy-to-use selective-calling decoder. If you have comments or suggestions about how to improve DAS, please contact me. The best way to reach me is via Internet e-mail or US mail.

Appendix

Additional Configuration Commands

Tables 1 and 2 contain a brief summary of CONFIGURE options, commands to activate or disable these options and default values. When issuing CONFIGURE commands, DAS must be in the CONFIGURE mode (**STA** winking) and each command must end with a # symbol. It's also good procedure to begin each command with the configuration erase character, DTMF *. This information is only a partial summary of DAS CONFIGURE options and commands. A complete listing of all options and their functions is provided in the *DAS Configuration Reference Guide.*

Paul Newland, AD7I, was first licensed in 1971 at the age of 15. He upgraded to Extra Class in 1979 when presented with the carrot of trading in the three-syllable W at the beginning of his call for the monosyllable A.

Paul has focused most of his ham radio efforts on designing, testing and building small computer-controlled accessories for his ham radio station, including a homebrew AMTOR controller. He is one of the designers of the popular TAPR TNC-2 packet-radio controller.

To earn money to support his hobby, Paul works for a telecommunications company where he's currently designing equipment for PCS frequencies. Paul received a BSEL degree from California Polytechnic State University and an MSE-ECE degree from the University of Michigan. Paul is licensed as a Professional Engineer by the State of New Jersey.

Microphone Monitoring

Microphone monitoring means that you can monitor the channel via the microphone. Let's discuss why this is important and how it works.

One of my biggest complaints about the DTMF squelch systems integral to commercially manufactured ham mobile transceivers is that they don't provide an easy way (or an automatic way) for you to monitor the channel before you make a voice call. [A] Many times I've heard someone with their integrated DTMF squelch enabled unwittingly clobber an ongoing QSO because the offending operator didn't know the channel was in use before he pushed the PTT switch (I've been guilty of this myself). The offender didn't know the channel was in use because he forgot to monitor the channel without benefit of DTMF or CTCSS[E] squelch—and didn't monitor the channel without benefit of DTMF or CTCSS squelch because his radio didn't make it easy for him to do so.

The commercial land mobile radio folks faced the same problem years ago when CTCSS squelch started to become commonplace in car radios (not just repeaters). Business users on a shared channel, with different groups using different CTCSS tones, were clobbering each other because the users didn't monitor the channel with the CTCSS squelch disabled before transmitting. The solution was simple: Wire the hand-microphone hanger so that when the microphone is out of the hanger, the radio disables the CTCSS squelch function and just uses the standard noise squelch. It still transmits CTCSS (if enabled), but the receiver reverts to noise squelch whenever the microphone is out of the hanger. Let's take a closer look at how this "monitoring by microphone position" works in practice.

Normally, users won't make a spontaneous transmission when the channel is in use (as indicated by the speaker reproducing a conversation). When CTCSS squelch is enabled, the speaker is silent until a transmitter with the same CTCSS tone makes a transmission. When the speaker is silent and the user wants to make a call, he picks the microphone out of the hanger, disabling the CTCSS squelch and switching to noise or carrier squelch. If someone is using the channel—with a different CTCSS tone or no CTCSS tone—the user now knows that the channel is in use because he can hear the sound from the speaker. The user can leave the microphone in his lap to monitor, or switch off the CTCSS (or DTMF) squelch and wait for the channel to go idle before making a transmission. This is how the commercial folks ensure that all operators monitor the channel—with CTCSS squelch disabled—before making a transmission, even if the operator has the CTCSS squelch set to *on* at the control head.

A neat DAS feature allows you to wire your microphone so it works the same way as the commercial folks operate with CTCSS. DAS includes an input labeled **MICUP** that, when open, assumes that the microphone is out of the hanger. This has the same effect as having the monitor switch in the **MON** position. When **MICUP** is grounded, DAS operates normally, with a silent speaker, until a configured DTMF sequence is received (or the monitor switch is placed in the **MON** position).

One way to make use of **MICUP** is to glue a small magnet to the back of your microphone, install a magnetic-reed switch next to the microphone hanger and wire the reed switch to **MICUP** and ground. When the microphone is in the hanger, the reed switch closes (**MICUP** grounded) for normal SELCAL operation. When the microphone is out of the hanger, the reed switch opens (**MICUP** floating), routing any radio audio to the speaker. See Figure 2A for an example of this magnetic reed-switch implementation.

Another way I've made use of **MICUP** is to insulate the microphone hanger from all other electrical circuits (including ground) and then connect the hanger to **MICUP**. Next, I connect the metal tab on the back of the microphone to ground through a 1-kΩ resistor within the microphone housing. I use a resistor (rather than hard-wiring to ground) to ensure that there are no low-impedance paths to ground from the exposed metal parts of the microphone. Providing a resistive path to ground from the microphone tab requires opening the microphone and somehow tacking the resistor in the right place. Use caution when doing this. It's easy to mess up the electronic innards of some microphones. Also, I've found that the hanger tabs on some microphones may *look* like conductive metal, but they're *not*. In such cases I've placed a thin metal washer on the face of the tab to provide a conductive surface that faces the microphone hanger. See Figure 2B for an example of this insulated-hanger implementation. Remember: If you don't make use of **MICUP**, be sure to ground the **MICUP** input. If you don't, DAS always passes audio to the speaker.

[A] Most late-model hand-helds provide a simple monitor button that over-rides all squelch functions. However, I'm not aware of any ham mobile units that provide a feature like this.

[B] CTCSS: Continuous Tone-Coded Squelch System. This is the same thing that Motorola calls Private Line, which almost everybody else just calls PL. CTCSS was designed to be used for selective access to reduce co-channel chatter and interference. It consists of a tone frequency between 67 and 255 Hz, with a deviation of about 10% of the maximum allowed, transmitted along with your voice.

Notes

(1) Touch-Tone is a formerly trademarked term, now generally considered to be a generic term, that refers to the tone-signaling system used for dialing by most every telephone network in the world where tone dialing is used. It's also the signaling system incorporated in most VHF and UHF FM ham transceivers and actuated by a built-in keypad.

(2) Brian Battles, WS1O, "FM/RPT—It's LiTZ," *QST*, Oct 1992, page 82.

(3) Paul Newland, AD7I, "ZERO: An Alerting Device For Repeater Users," *QST*, Nov 1992, pages 108-110.

(4) TAPR: Tucson Amateur Packet Radio, 8987-309 E Tanque Verde Rd, No. 337, Tucson, AZ 85749-9399, tel: 817-383-0000. TAPR FTP file server: ftp.tapr.org (look in /tapr/das. TAPR on the Worldwide Web: **http://www.tapr.org**.)

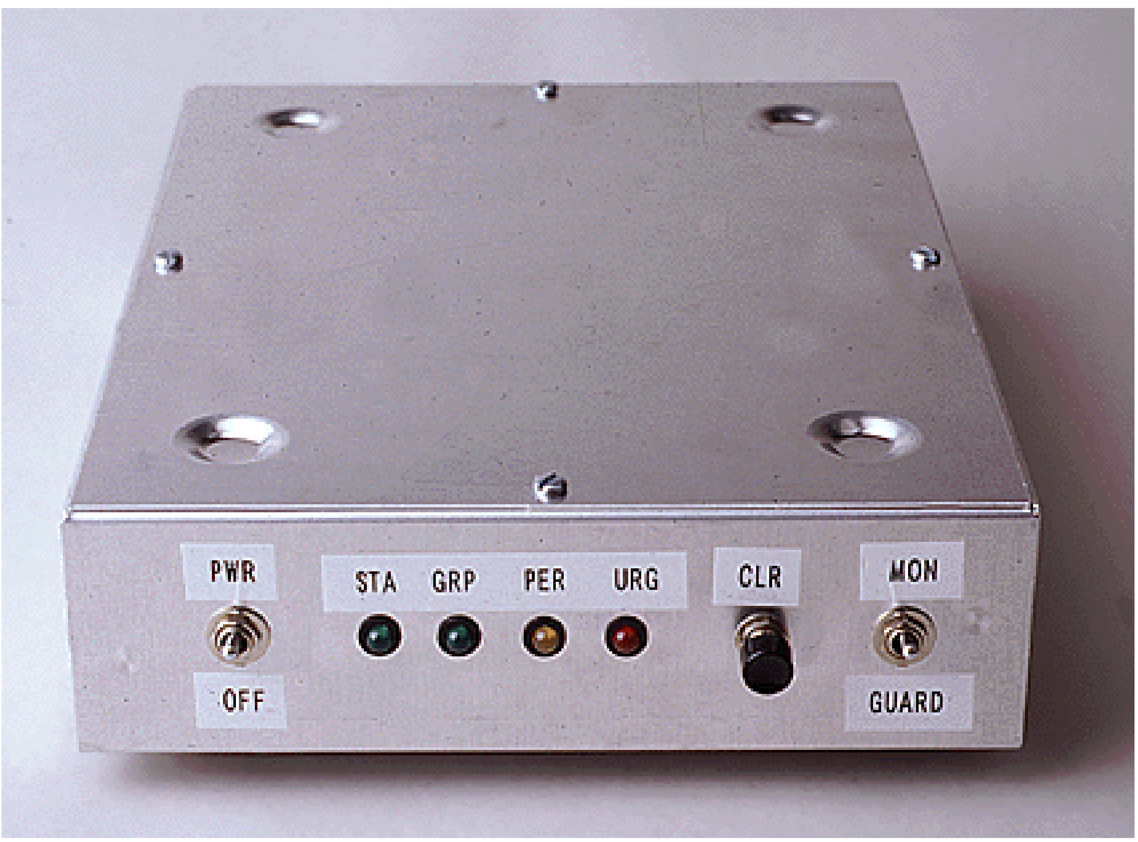
(5) Digi-Key, PO Box 677, Thief River Falls, MN 56701-0677, tel 800-344-4539, 218-681-6674; fax 218-681-3880. Consider the On-Shore Technology two-terminal screw blocks, Digi-Key part number ED1609. Get the blocks with 0.2-inch (5.08-mm)-spaced terminals; they fit nicely into perf board with 10 holes per inch.

(6) In the unlikely event that you don't get past this point, you may need to take one additional step. If you get stuck here it's possible, but very unlikely, that the checksum in U2 is correct but the data causes the LEDs to be inoperative. In this case you can force U1 to ignore the data in U2 and load system defaults. Do this as follows: (1) remove power from DAS; (2) press and hold the **CLR** button; (3) apply power to DAS; (4) wait five seconds; (5) release **CLR**. Within five seconds of releasing **CLR**, you should see that the **STA** lamp is blinking, indicating that data in U2 was ignored and that DAS is now working from default SELCAL data. Now press and hold **CLR** for three seconds to enter the CONFIGURE mode.

(7) For example, AT&T's Long Distance Network makes use of the DTMF # (pound) signal, as well as using a timer to sense end of digit transmission. You can test these features by calling 1-800-CALL-ATT. End-of-digit transmission is signaled by either #, a several-second time-out (values vary) or by digit scanning (DAS can't do digit scanning to determine number of digits to expect). DTMF * is a command to erase all prior input of the digit sequence under construction. DTMF * is also used to note the beginning of a command when used as the first symbol of an input.

(8) ARRL BBS, 860-594-0306, 8-N-1, look in the FILES area, search on DAS. If you have Internet access, send e-mail to info@arrl.org and put SEND DAS.OBJ on one line and SEND DASNOTES.TXT on the next line. End the e-mail with QUIT on a line by itself. The files are also available via FTP from oak.oakland.edu in the directory pub/hamradio/arrl/infoserver.

(9) To cover postage and photocopying costs, please send $5 with your request for the NEWLAND DAS template package to the Technical Department Secretary, ARRL, 225 Main St, Newington, CT 06111-1494.



The DAS front panel.

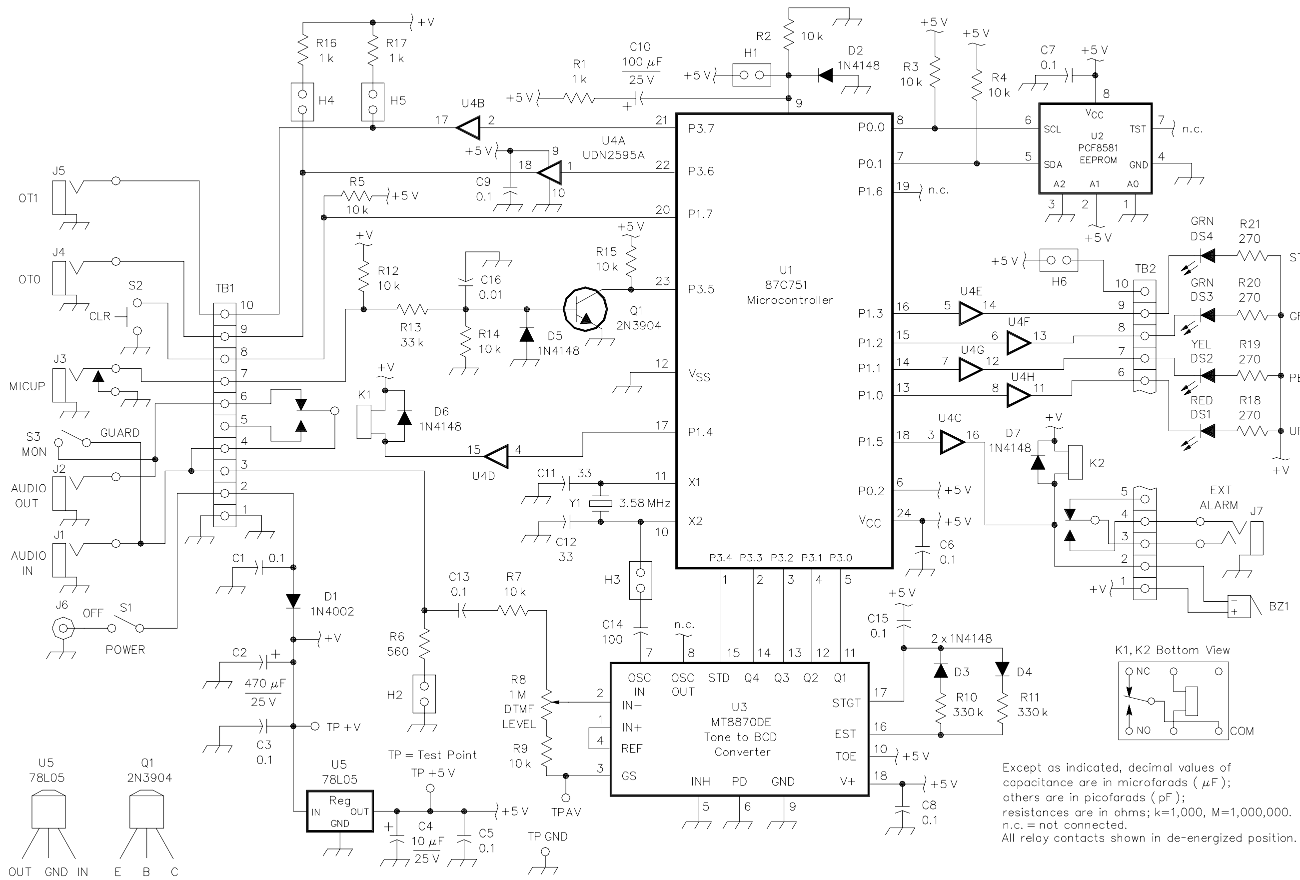


Figure 1—Schematic of the Digital Automatic Squelch. RS part numbers in parentheses are Radio Shack; DK part numbers in parentheses are Digi-Key (Digi-Key Corp, PO Box 677, Thief River Falls, MN 56701-0677 tel 800-344-4539, 218-681-6674; fax: 218-681-3880); equivalent parts can be substituted. Unless otherwise specified, resistors are 1/4-W carbon-composition or film units. All capacitors and resistors can be ±20% tolerance.

BZ1—Piezo buzzer or horn (RS 273-054; DK P9914-ND), Panasonic EFB-RL20C102; see text

C2—470-µF, 25-V electrolytic or tantalum capacitor (RS 272-1030; DK P6242-ND), Panasonic ECE-A1EU471

C4—10-µF, 25-V electrolytic or tantalum (RS 272-1025 DK P6264-ND), Panasonic ECE-A1HU100

C10—100-µF, 25-V electrolytic or tantalum (RS 272-1028; DK P6239-ND), Panasonic ECE-A1EU101

D1—1N4002 (RS 276-1102 [1N4003] sufficient; DK 1N4002CT-ND)

D2-D7—1N4148 (RS 276-1122; DK1N4148CT-ND)

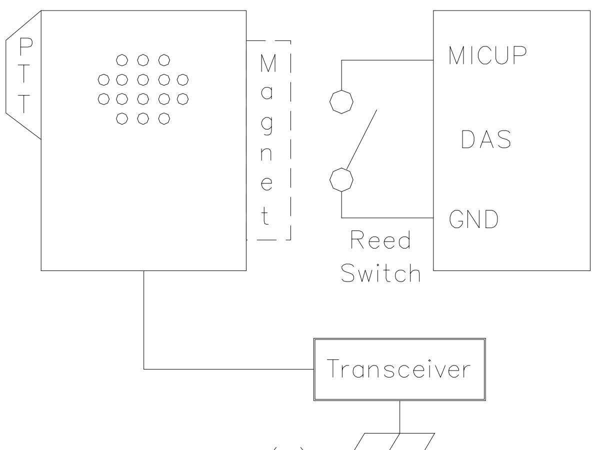
DS1-DS4—LED, one red (RS 276-044; DK P300-ND); one yellow (RS 276-021; DK P306-ND) and two green (RS 276-022; DK P303-ND)

H1-H6—Two-pin SIP header (DK 929834-02-36-ND)

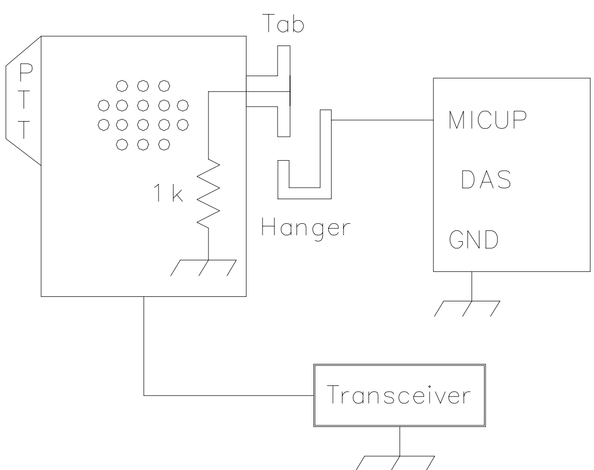
J1, J2, J4, J5—Two-conductor open-circuit jack (RS 274-251 [1/8-inch dia])

J3—Two-conductor, closed-circuit jack (RS 274-248 [1/8-inch dia])

J6—Coaxial power jack (RS 274-1563 [2.1 mm ID])
J7—Three-conductor (stereo) jack (RS 274-259 [1/8-inch dia])
K1, K2—5-V coil, SPDT (RS 275-240; DK Z773-ND)
Q1—2N3904 (RS MPS3904; DK 2N3904-ND)
R8—1 MΩ trimmer potentiometer, PC mount (DK 3362P-105-ND), Bourns 3362P series
S1, S3—SPST toggle (RS 275-624)
S2—SPST normally open pushbutton (RS 275-1556, 275-1547, 275-1571)
TB1, TB2—10-position terminal blocks (DK ED1609-ND); see Note 5
U1—87C751 microcontroller. This device must be *programmed* prior to use (see Note 4)
U2—PCF8581 EEPROM; see Note 4
U3—8870 tone-to-BCD converter; see Note 4
U4—UDN2595A 8-channel saturated sink driver; see Note 4
U5—78L05 voltage regulator (DK AN78L05-ND)
Y1—3.58 MHz color-burst crystal (DK CTX049-ND)
Misc: speaker; enclosure; IC sockets; hardware



(A)



(B)

Figure 2—Microphone-switch diagram. See the sidebar "Microphone Monitoring" for some ideas on how you can use this feature.

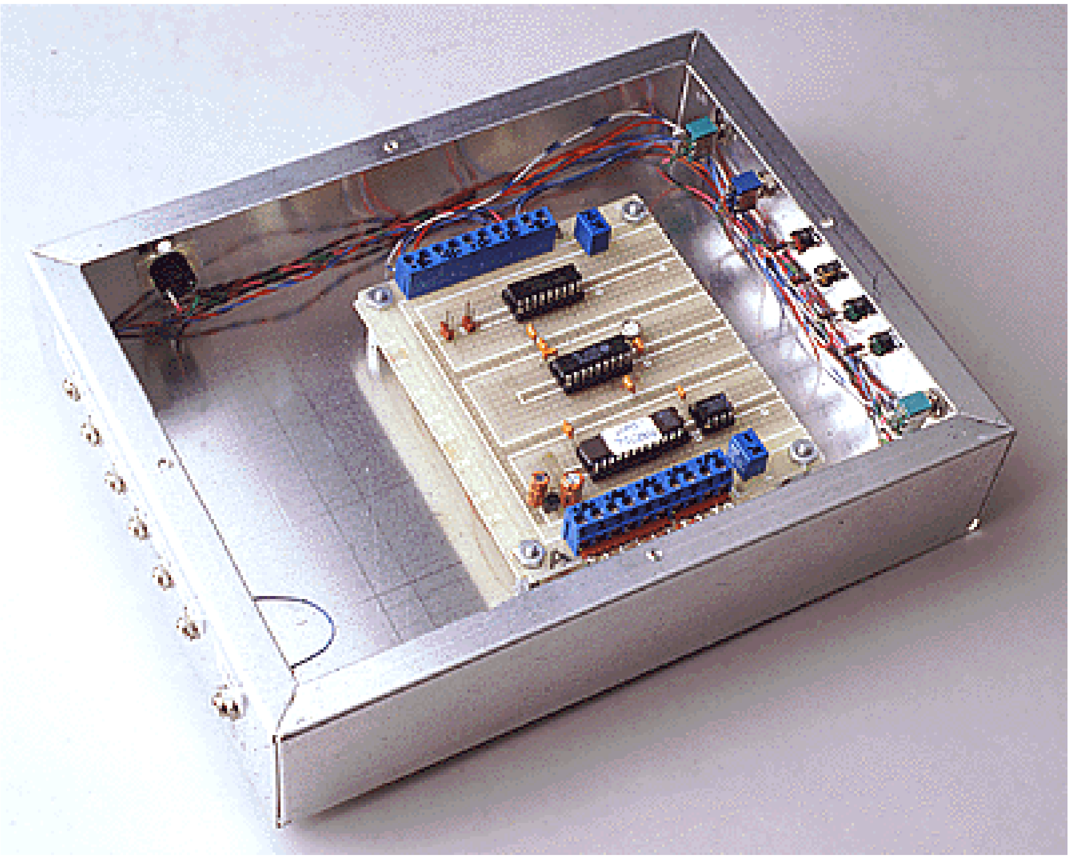


Figure 3—An inside view of the prototype. On the upper-left side panel is BZ1, the piezo buzzer. At the bottom left of the rear panel is J6, the power-supply input jack. All jacks, switches and LEDs are arranged in neat rows along the rear and front panels (see the title photo).

Table 1

Individual Options Configure Commands

Option Name	*SELCAL Default Value*	*Option Sequence Off*	*Option Sequence On*
SELCAL Control	On	4000	4001
Scanstop OT0, Trans OT1	On	4010	4011
Long Tone Zero (LiTZ)	On	4020	4021
Long Digit Detection	Off	4030	4031
Star is Wildcard Char	Off	4040	4041
Star is Clear Register	Off	4050	4051
Speaker 180 Sec	Off	4060	4061
Horn 5 Sec	Off	4070	4071
LEDs Via Per+Cmd OK	Off	4100	4101
Remote Configure OK	Off	4110	4111
Spec Seq Required	Off	4120	4121

Term Speaker Tmr On '9'	Off	4130	4131
Speaker Tmr doesn't Run	Off	4140	4141
Spk Rly Energ for Guard	On	4150	4151
MICUP is CLR	Off	4160	4161
Search For PER ID	Off	4170	4171

Table 2

Global Options Configure Commands

Cmd	*Description*
0	Leave CONFIGURE mode (like pressing CLR)
1nnn	Configure PER ID sequence as nnn
2nnn	Configure GRP ID sequence as nnn
30	Establish all SELCAL default values (incl PER/GRP IDs)
31	Get Values from EEPROM (and test checksum)
32	Establish SELCAL std options (w/o changing PER/GRP IDs)
33	Establish CONTROLLER std options (w/o changing PER/GRP IDs)
34	Establish REMOTE RESET std options (w/o changing PER/GRP IDs)
4abd	Write bit at option address a, position b with data d
5aaddd	Write byte at sequence address aa, with data ddd (octal)
7	System Status Display