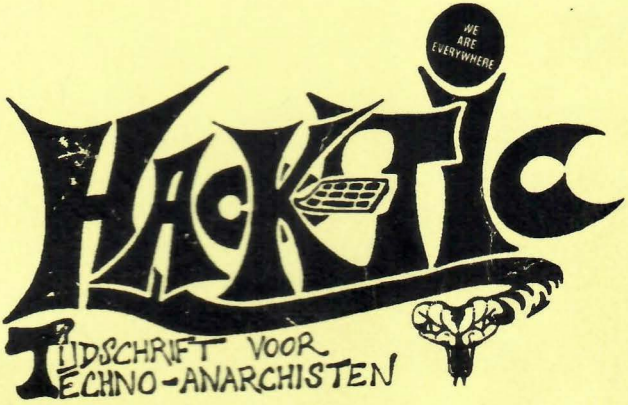
Do it yourself

Demon-Dialer



Operation & Software reference manual

(v 1.40)

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1 The basic functions

1.1 Getting started

Once the device is powered up by pressing the shift-key, a short upward tone sweep will emit from the system speaker. When changing batteries hold down the shift key when the power comes on to make sure the device starts up properly. If you power-up for the first time since changing batteries, all the settings will default to their standard values. This will also mean that in order to gain access to the system you will first have to type your system password. This password is supplied with the Demon-Dialer and should not (repeat NOT) be lost. The password that we supplied with your device is not archived at Hack-Tic Technologies or anywhere else, it's only in your device and on the piece of paper that came with it.

1.2 Getting in

As said, when the device starts up for the first time, you have to type a password. While you are typing this, the device will act like a normal Touch-Tone dialer. A word of warning here: Touch-Tones all sound similar, but a trained ear can identify all the digits. If you wish to keep your password a secret, it is advisable to cover the speaker with your hand while you type the password. If the wrong password is keyed in, the device will remain operative as a Touch-Tone dialer. To get access to it's more sophisticated functions, leave the device untouched for 30 seconds. The device will then auto-power off (6 seconds after a four beep alert-sound), at which point you can restart the device with the shift-key and start over.

Once the correct code is entered a victorious tune sounds, signalling you that it is now ready to emulate any in-band signalling system.

Of course the security of this device depends fully on how secure the data is within the heart of it, the MC68HC705C8/DD. The program in this chip (which also contains your password) is protected with a security-bit that tells the processor not to allow the outside world to read the contents of its PROM. We do not know of any methods to read the contents of a security-bit protected PROM short of probing on the surface of the chip itself, which is a hyper-expensive operation, even if you did get the bare silicon out of the package in one piece. In other words, it is VERY HARD for someone who does not know the code to prove that your device is anything but an ordinary DTMF-dialer.

If you decide not to deal with all this ultra-paranoid password nonsense, you can switch off the password protection using a special command sequence discussed later on.

1.3 Getting used to it

Of all the in-band signalling systems, Touch-Tone (also known as DTMF to the more technically minded) is the most well-known. The Demon-Dialer includes many more systems, whose only similarity is that they use tones to get a message across. Modems all over the world use in-band signalling to send data. One might even find in-band systems used to signal information between phone-switches, or from mobile phones to their base-stations. Rumour has it that there exists countries that have payphones using in-band signalling to indicate coin deposits. An unlikely story, but you never know.

The Demon-Dialer starts up in Touch-Tone mode, but can be switched to a lot of other modes. Modes are numbered 0 through 19. Modes 0 through 9 are accessed by pressing shift and the * key together followed by the number of the mode. From now on we will refer to keys that are pressed with the shift down by printing a ^ in front of the key. Modes 10 through 19 are accessed by pressing ^* followed by ^0 through ^9. Here is a list of modes currently implemented:

- 0 Touch-Tone
- 1 ATF1
- 2 R2-forward
- 3 CCITT No. 3
- 4 CCITT No. 4
- 5 CCITT No. 5 / R1
- 6 RedBox
- 7 line signalling menu
- 8 tone slot
- 12 R2-backward
- 18 user programmable

Mode 18 is a RAM-mode, which means it can be user-defined. See chapter 5 for more information on mode 18.

2 Macro mode

2.1 Using macros

Now that you are familiar with the basic operation of the unit it is time for macros. A macro is nothing but a stored sequence of keypresses that can be played back. It means that you do not have to retype something that you may need to send multiple times. It also means that you can send sequences of tones at speeds otherwise impossible.

To work with macros you must first put the device in "macro mode". This is done by typing ^#. Two tones, the last one lower than the first tell you that you are now in macro mode. There are 10 different macros and they can be played by pressing 0 through 9 while in macro mode.

To record anything in the macros first press ^<M> (where<M> is the macro you wish to record). If the macro you are recording into is not empty the four-beep alert sequence will sound. Press # to confirm programming, or any other key to abort it. If it was empty you will get only two beeps and you can start programming right away. Now just press the keys that you want to put in the macro. The keys will produce one beep when you press them; they will not produce the sounds they would when pressed outside the macro mode. Don't worry, they'll sound just fine when the macro is played. If you wish to change modes inside the macro just do what you would normally do: press ^* followed by the mode you want.

Of the special functions (see section 4), only ^* * 4 and ^* * 5 (guard tone on and guard tone off) can be put in a macro.

To end macro recording press ^# followed by #. To go back to normal operation just press #. Two tones, the last one higher than the first will sound to indicate that you have left the macro mode. You can stop a macro while it is playing by

pressing #.

2.2 Macro nesting

It is even possible to nest macros. This means that inside one macro you can tell the device to play the contents of another macro. The nested macros are called by name which means that if macro B is nested inside macro A and the contents of macro B are changed, the change will also affect the nested B that is played as part of macro A. To nest a macro press ^# followed by the macro you wish to nest while recording.

2.3 Macro aliasing

It is possible to set up a macro-alias. This enables you to "rename" one of the macros to another macro. If we for instance alias macro 3 to macro 4, it means that whenever macro 3 is referenced, macro 4 is played instead. Macro 3 is still there, it can just not be accessed until this function is disabled.

To use macro aliasing go to macro mode and press *<M1><M2> where <M1> is the macro that aliased to <M2>. If you now press <M1> you hear <M2>. To turn this off press *<M1><M1>. In effect, you are then aliasing the macro back to itself. Only one alias can be in effect at any time. It is also possible to alias a macro to silence by pressing *<M>#.

2.4 Macro pausing and retry

You can include special sequences in the macros to tell the Demon-Dialer to wait for shift to be pressed, and you can place retry points.

Using ^* # 0 in a macro places a retry marker.

^* # 1 means that at this point, when the macro is played, the Demon-Dialer waits for the shift to be pressed before

continuing.

^* # 2 means that at this point the Demon-Dialer macro just continues. unless shift is pressed. If it is, it waits until shift is released and pressed again before continuing.

^* # 3 is the same as ^* # 2 except that in order to continue shift has to be repressed within 125 ms, otherwise the macro is 'rewound' to the last retry marker (nifty huh?).

^* # 4 is like putting ^* # 0 and ^* # 1 in the macro.

If you programmed a macro with some of the above sequences and you want to play the macro normally, use ^* # <M>. This will ignore all pause and retry sequences.

3 The FIN-table

Inside your Demon-Dialer is a frequency table. This table contains twelve RAM-based frequencies that you can change and 82 ROM-based (fixed) frequencies. The frequencies are referenced to by number. These numbers are called Frequency Index Numbers (FIN). Apart from the tone made during frequency stepping and sweeping, these are the tones the device will produce. Some of the RAM-based frequencies have been used in modes 3 and 7 and have a default value that is loaded in them every time you change the batteries or reset the device. The FIN-table is listed in full in Appendix A.

4 Special functions

A number of special functions is built into the device. They are all accessed by pressing ^* * followed by the number of the function.

4.0 Device init

This function will initialize the device, deleting all macro definitions, RAM mode 18, all time-templates and RAM frequencies. It will also turn the password protection back on (if it was off). In other words: EVERYTHING YOU EVER PUT INTO THE DEVICE IS GONE. When you press ^* * 0 an alert will sound. If you press # the Demon-Dialer will initialize, if you press anything else it will not.

4.1 RAM FIN programming

The Demon-Dialer has 12 FIN-locations in its memory where the user can define frequencies. Type ^* * 1 <FIN> # <frequency> #

The frequency number ranges from 0 to 11, the frequency has to be entered in Hertz. The system will acknowledge programming by playing a short sample of the frequency just programmed.

These user-defined FINs as well as the ROM-based FINs can be used when programming your own keys into mode 18, they can also be used as guard tones. The C3 mode uses two RAM frequencies (0 and 1) as its mark and space frequency respectively so that you can use it to emulate any Single Frequency system.

4.2 Time template programming

The user of the Demon-Dialer can define up to 8 periods in

milliseconds and then use these periods in the User Defined Mode as durations for tones. Most of the time-templates are also used in the ROM-modes of the device. The fact that a certain time-template has been used in a ROM-mode does not mean you cannot use it in one of your own modes. Time templates are programmed in a manner similar to the user-defined frequencies above. Typing ^* * 2 <time-template number> <time in milliseconds> # will program a time-template. Note that the time-template number itself is not followed by a pound because it is always one digit long (0-7). Here is a list of time-templates, what the system uses them for, and what their default values are:

0 - DTMF and C3 mark (50 ms default)
1 - DTMF and C3 space (50 ms default)
2 - C5/R2 mark (50 ms default)
3 - C5/R2 space (50 ms default)
4 - C5 kp time (100 ms default)
5 - free
6 - C3 interdigit time (500 ms default)
7 - free

4.3 Guard tone programming

Guard tones are tones that are played simultaneously with the real signalling. They are used to jam any filters on the line so that they act as if the signal you are sending is speech. The Demon-Dialer has three guard tones that it can store in memory. To program any of these three guard tones press ^* * 3 <Guard tone number> <FIN> # The Guard tone number is 0, 1 or 2. See section 3 and Appendix A for more info.

If you first turn on the Demon-Dialer, the guard tones default to certain values. Guard tone 0 defaults to 2280 Hz, guard tone 1 to 3100 Hz and guard tone 2 defaults to 3250 Hz.

4.4 Start guard tone

Pressing ^* * 4 <guard tone number> will turn on that guard tone. It will then continuously sound until it is turned off or another guard tone is started.

4.5 Stop guard tone

If a guard tone is on, ^* * 5 will stop it. This command and the previous one can be used inside macros. If you are programming a macro, don't forget that a guard tone will still sound when the macro is finished. Use this command in the macro if that is not what you want.

4.6 Frequency stepping

Pressing ^* * 6 <start frequency> # <step size> # will sound the start frequency. If you then press * the tone will step up with the step size specified, pressing 0 will step down. If you press # the tone will end. Frequencies have to be typed in Hertz.

4.7 Continuous sweep

This will sound a tone sweep through the full voice-range (0 - 4 kHz) and back in +/- 15 seconds and then start over. Pressing # ends the sweep.

4.8 Password protection on

If you turn on the password protection, the device will turn itself off. To continue using it, press shift to turn it on and type your password.

4.9 Password protection off

If password protection is turned off, the device will not sound the down-going sweep when it times out, it will not sound the up-going sweep if it is turned on. If the password protection is turned off, the device will come back alive at the same point in

the software where it powered down. If you were in the middle of programming a macro and let the device time out and power down, you can finish the macro when you power up again.

4.10 Number scan

This function can be used to scan through numbers in a sequential way. First assign a macro to contain the first try in your scan. This macro is called the 'number macro'. Optionally you can program a second macro to contain the whole sequence you want to play each time around. This second macro is called the 'play macro' and contains the number macro nested somewhere in it. See macro nesting (Section 2) for details on how to define and nest macros.

Type ^* * * <play macro> <number macro> <step size> # to start the number scan. The device will then play the play macro and wait for the user to press either * or 0 to increment or decrement the <number macro> with the step size and then play the <play macro>. Pressing # will end the scan.

To use this you can either use the same macro as both the play and the number macro if you only wish to play the number itself. You can also use a different macro for playing and nest the number macro somewhere in it. The number macro has to have digits at the end, so that the Demon-Dialer knows what to increment or decrement. The contents of the number macro are changed by scanning.

It is also possible to use scanning in macro mode by pressing * * for scanning down and * # for scanning up. In order to use this function set up a scan using ^* * * and switch to macro mode.

4.11 Power off

If you press ^* ^* the system will power down after producing the short down-going sweep. The system also has an automatic

power-down so that you can never leave it on and drain the batteries.

4.12 Hookswitch Control

See chapter 7 "Demon-Dialer and the outside world"

5 Key programming

Mode 18 is a User Programmable Mode. This means that you can program a pause, a single tone or a double tone and even a whole sequence of tones to sound when a key is pressed. Keys 0/9 and ^0/^9 as well as * and # (a total of 22 keys) can be programmed. To program a key first switch to mode 18 by pressing ^*^8. Then type ^*#<key> where <key> is the key to be programmed. An alert tone will sound if the key is already programmed. Press # to confirm reprogramming, or any other key to cancel. You can now enter the data on the first silence or tone that you wish to attach to that key. Use the following format:

<# of tones> <timing type> <time> #[<tone 1 dB level># <tone 1 FIN># [<tone 2 dB level># <tone 2 FIN>#]]

<# of tones> 0, 1 or 2 for silence, a single or a double tone. If you just type a # at this point, you tell the dialer that you are done programming this key. If you type # as the first tone, it means that you 'empty' the key.

<timing type> Four different timing types can be entered (0 through 3).

0 play fixed time, in this case <time> is entered in milliseconds

1 play while pressed when not used in macro mode, fixed time in macros. Again, <time> is entered in milliseconds.

2 play template time, in this case <time> is a time-template number (0-7).

3 play while pressed when not used in macro, template time in macros, <time> is a time-template number (0-7).

The <dB level> is entered as a value between 0 and 15, giving dB levels ranging from 0 to -15 dB of full volume. Presently 4 dB levels are implemented, 0, -6, -10 and -15 dB. If you enter a different number, the machine will still store it, but rounds down the value to the nearest implemented value. Future versions of the Demon-Dialer may contain more possible dB levels.

The <FIN> is a number from the table as described in Appendix A.

If, after typing the <timing type>, an error-tone sounds, then the memory of the device is full. The sequence you are then programming is ended and key programming is finished. If you need more RAM you could consider emptying non-used keys in mode 18.

5.1 About timing and frequencies in the Demon-Dialer

The Demon-Dialer uses a crystal for its timing and frequency generation. The tolerance of the used crystal is guaranteed to be better than 0.01 %. This tolerance affects both timing and frequency accuracy.

For the Demon-Dialer, a millisecond programmed into the device is not really 1/1000 of a second. In fact it is 1/1024 of a second. So if you want 50 ms, you should not type 50, but 51. The tone will then last 49.8 ms, which is within 0.4 % of the range. For most if not all of your applications none of this will make any difference.

Frequencies used in stepping are to the Hertz exact (within the tolerance of the crystal).

5.2 dB levels and distortion, a little bit of theory

As said, the Demon-Dialer supports a number of different volumes. Inside your device are sinewave tables, 1 per volume. Making a double tone you have to make sure that the level of the combined tones does not exceed 100% of the amplitude range of the D/A converter that makes the tones. Using 0 dB means 100% of the amplitude range. -6 dB means 50%, -10 dB means 32%, -15 dB means 18%. More than 100% causes distortion, try it for yourself!

If the device is generating a guard-tone, the standard settings for a played tone are ignored. A single tone is played at -6 dB, as is the guard tone. A double tone is played at -10 dB each, and the guard tone is then also played at -10 dB.

6 A few examples ....

If the contents of this manual have utterly confused you, here are a few examples that may help in understanding all the functions. These examples were constructed to make use of as many of the functions in the Demon-Dialer as possible, they do not necessarily mean anything to the phone system or any other system for that matter.

6.1 A guard tone while playing macros

In this example we will program a guarded clear forward in a macro. This means the clear-forward is played together with the guard-tone.

Type ^* * 3 0 2 #. This means that we have programmed guard-tone 0 to FIN 2. This is a RAM FIN which defaults to 0 Hz. We have to set it to something else to use it as a guard tone.

So now we press ^* * 1 2 # 3125 #. The system will then play a quick sample of 3125 Hz as a confirmation. FIN 2, and therefore guard tone 0 is now programmed to 3125 Hz.

Now go to the macro mode (^#). Type ^0 to start programming macro 0. If something was in macro 0, the device will sound four beeps to warn you. Pressing # will erase macro 0 and overwrite it with what you are about to type. If on pressing ^0 only two beeps sounded you start typing right away (do not press #, for it will end up in the macro).

Press ^* * 4 0 to start the guard tone. This tone will not sound now, but only once the macro is played. Now press ^* 5 to go to the C5 mode, and then * to sound a clear forward. Then type ^* * 5 to end the guard tone. Finish off by typing ^# followed by # to end macro recording.

Now press 0 to hear your guarded clear-forward.

6.2 Using templates to make an SF (Single Frequency) system

Suppose we want to use a 2280 Hz pulse system that uses 35 ms mark and space timing and 300 ms interdigit delay.

Type ^* * 2 0 35 # to set time-template 0 (mode 3 mark timing) to 35 ms. Also type ^* * 2 1 35 # to set the space timing to 35 ms as well. Then do ^* * 2 6 300 # to set the interdigit time to 300 ms.

Now press ^* * 1 0 2280 # to program FIN 0 to 2280 Hz. FIN 0 is the mark frequency for this mode. Typing ^* * 1 1 0 # sets FIN 1, the space frequency for this mode, to 0 Hz (silence).

Switch to mode 3 by pressing ^* 3 and use!

6.3 Programming the RAM-mode

We will program key 0 in mode 18 to be the following sequence:

- A dual tone consisting of 1400 and 1700 Hz for 250 milliseconds

- a silence lasting 200 milliseconds

- and finally a single tone of 900 Hz lasting 400 milliseconds.

First go to mode 18 by typing ^* ^8. Then press: ^* # 0 to start programming key 0. If an alert (4 beeps) sounds press # to confirm reprogramming. Then press:

2 0 250 # 6 # 68 # 6 # 17 # 0 0 200 # 1 0 400 # 0 # 13 # #.

The spaces are in there for 'easy reading'. The first part means: program 2 tones of timing type 0 (fixed time) that last 250 milliseconds, the first one at -6 dB, frequency number 68 (1400 Hz) and the second one also -6dB, frequency number 17 (1700 Hz). The other two sequences are similar and fairly easy to understand. If you are done press 0 to hear the key that you have programmed.

6.4 Macro nesting and scanning

In this example we will scan numbers in C5 with the format KP1 XXX ST. To do this we make two macros. One is called the 'play macro', it holds the KP1, a reference to the part that has to be scanned (the number macro) and then an ST.

After typing ^# to get to macro mode press ^0 to record macro 0. If you hear four beeps confirm reprogramming by pressing #.

Press ^* 5 ^3 ^# 1 ^5 ^# #

Step by step, this means: switch to mode 5, play a KP1 (^3), nest macro 1 (^# 1), play an ST (^5) and stop recording (^# #).

Then program macro 1 to contain '000' as follows: ^1 [#] 000 ^# # and leave macro mode (#)

Now type ^* * * 0 1 1 # to scan using macro 0 as play macro, 1 as number macro and a step size of 1. The system will respond by playing the first sequence (KP1 000 ST). If you now press 0 you will get KP1 001 ST. If you then press * it will scan back to KP1 000 ST. If you press star again it will play KP1 999 ST, which (to this device) is before 000.

7 Demon-Dialer and outside world

You may have noticed the pin called AUX on the PCB of your Demon-Dialer and the serial connector. The AUX pin is used to control an external hookswitch relay, with the serial port you can connect your Demon-Dialer to a computer.

7.1 Hookswitch control

You can use the hookswitch control bit (AUX) to control an external relay to 'pick up the phone' and you can also pulse-dial through it. To toggle the hookswitch-control bit press ^* ^#.

As you have seen in the part about the FIN-table, programming a frequency of 1 Hz means that the device puts the external hookswitch control bit in a high position (+5 V), a frequency of 2 Hz means putting it in a low position (0 V). All other frequencies will just sound and not affect the hookswitch bit. If FINs 0 and 1 are at their default values (1 and 2 Hz) then you can use the external relay to pulse dial in mode 3. Time-templates 0 and 1 are used for mark and space timing respectively (default 50 ms). Time-template 6 is used for the interdigit time (default 500 ms). Please note that the device has only a 4 position keyboard-buffer so you can easily out-type it when pulse dialling.

7.2 Serial interface

The serial interface signals are sent asynchronously at a speed of 16384 bps. The format is 1 start bit, 8 data-bits, no parity, 1 stop-bit. The port is at TTL-level. Most computers will talk to it as it is. If your computer requires the real RS-232 levels, appendix A of the construction manual contains a circuit to convert voltages.

To use the serial interface single byte commands are sent to the Demon-Dialer. Keys 0-9 are sent as ASCII values 0 through 9 (not the characters, but the values). * is sent as 10, # as 11. To send shifted keys add 16 to the key code. These keys are then interpreted as if the user presses the key on the keyboard and holds it down. To release a key send code 255. All functions are accessible from the serial port, except for turning the device on, this has to be done with the shift key on the device itself.

Apart from these functions, three extra functions have been incorporated. There is an upload function that lets you read the contents of all the relevant RAM in the device to the computer. Directly after issuing the upload command, ASCII character 'U', the Demon-Dialer sends a stream of bytes. The format of this data-packet is described in appendix B.

The download is used to put information in the Demon-Dialer's memory. The data-format is exactly the same as what the Demon-Dialer uses for the upload function. After sending the download command, ASCII value 'D', you send the packet of data as described in Appendix B. The Demon-Dialer does not do any error-checking on the incoming data. You can program impossible key or macro combinations which might cause the device to hang. To un-hang the device, remove the batteries and power up with the shift key pressed.

If you send an ASCII 'P' to the device, it will respond with a sequence containing:

- one byte Demon-Dialer Software version * 100
- one byte telling how many digits the password consists of
- several bytes containing the key codes for the password

Upload, Download and Password functions will only work once the password was entered correctly. Once the Demon-Dialer is powered up you can also enter the password using the serial interface.

Appendix A

RAM-based FINs

0 - C3 (Mode 3) Mark Frequency. Defaults to 2 Hz, meaning off-hook
1 - C3 (Mode 3) Space Frequency. Defaults to 1 Hz, meaning on-hook
2 - Special Menu (Mode 7) frequency number 1. Defaults to 0 Hz
3 - Special Menu (Mode 7) frequency number 2. Defaults to 0 Hz
4
5
6
7
8
9
10
11

} Free, no default value

ROM-Based FINs

12 - 700 Hz
13 - 900 Hz
14 - 1100 Hz
15 - 1300 Hz
16 - 1500 Hz
17 - 1700 Hz

} MF

18 - 694.8 Hz
19 - 770.1 Hz
20 - 852.4 Hz
21 - 940.0 Hz
22 - 1206.0 Hz
23 - 1331.7 Hz
24 - 1486.5 Hz
25 - 1639.0 Hz

} DTMF

26 - 1380 Hz
27 - 1500 Hz
28 - 1620 Hz
29 - 1740 Hz
30 - 1860 Hz
31 - 1980 Hz

} R2 forward

32 - 1140 Hz
33 - 1020 Hz
34 - 900 Hz
35 - 780 Hz
36 - 660 Hz
37 - 540 Hz

} R2 backward

38 - 1500 Hz	
39 - 1700 Hz	Red
40 - 2200 Hz	
41 - 1950 Hz	
42 - 2070 Hz	ATF1
43 - 600 Hz	
44 - 750 Hz	
45 - 1200 Hz	
46 - 1600 Hz	
47 - 1625 Hz	
48 - 1700 Hz	
49 - 1900 Hz	
50 - 2040 Hz	
51 - 2100 Hz	Pliek
52 - 2280 Hz	
53 - 2400 Hz	
54 - 2500 Hz	
55 - 2600 Hz	
56 - 3000 Hz	
57 - 3350 Hz	
58 - 3825 Hz	
59 - 147 Hz	
60 - 350 Hz	
61 - 400 Hz	
62 - 440 Hz	
63 - 450 Hz	Call Progress
64 - 480 Hz	
65 - 500 Hz	
66 - 620 Hz	
67 - 950 Hz	
68 - 1400 Hz	SIT
69 - 1800 Hz	
70 - 1400 Hz	
71 - 1850 Hz	
72 - 2450 Hz	Call progress HI
73 - 2600 Hz	
74 - 0 Hz	
75 - 2000 Hz	Special
76 - 2700 Hz	
77 - 150 Hz	Call Progress
78 - 550 Hz	Modem tone
79 - 853 Hz	EBS
80 - 960 Hz	EBS
81 - 1060 Hz	
82 - 1270 Hz	
83 - 2025 Hz	Modem tone
84 - 2225 Hz	

85 - 2713 Hz		Loopback
86 - 2750 Hz	}	
87 - 2800 Hz		
88 - 2850 Hz		Guard
89 - 2900 Hz		
90 - 2950 Hz	}	
91 - 1160 Hz		
92 - 1530 Hz		
93 - 1670 Hz		Tone slot
94 - 1830 Hz	}	

FINs in ascending frequency order

74 - 0 Hz	14 - 1100 Hz	30 - 1860 Hz
59 - 147 Hz	32 - 1140 Hz	49 - 1900 Hz
77 - 150 Hz	91 - 1160 Hz	41 - 1950 Hz
60 - 350 Hz	45 - 1200 Hz	31 - 1980 Hz
61 - 400 Hz	22 - 1206 Hz	75 - 2000 Hz
62 - 440 Hz	82 - 1270 Hz	83 - 2025 Hz
63 - 450 Hz	15 - 1300 Hz	50 - 2040 Hz
64 - 480 Hz	23 - 1331.7 Hz	42 - 2070 Hz
65 - 500 Hz	26 - 1380 Hz	51 - 2100 Hz
37 - 540 Hz	68 - 1400 Hz	40 - 2200 Hz
78 - 550 Hz	70 - 1400 Hz	84 - 2225 Hz
43 - 600 Hz	24 - 1486.5 Hz	52 - 2280 Hz
66 - 620 Hz	16 - 1500 Hz	53 - 2400 Hz
36 - 660 Hz	27 - 1500 Hz	72 - 2450 Hz
18 - 694.8 Hz	38 - 1500 Hz	54 - 2500 Hz
12 - 700 Hz	92 - 1530 Hz	55 - 2600 Hz
44 - 750 Hz	46 - 1600 Hz	73 - 2600 Hz
19 - 770.1 Hz	28 - 1620 Hz	76 - 2700 Hz
35 - 780 Hz	47 - 1625 Hz	85 - 2713 Hz
20 - 852.4 Hz	25 - 1639 Hz	86 - 2750 Hz
79 - 853 Hz	93 - 1670 Hz	87 - 2800 Hz
13 - 900 Hz	17 - 1700 Hz	88 - 2850 Hz
34 - 900 Hz	39 - 1700 Hz	89 - 2900 Hz
21 - 940 Hz	48 - 1700 Hz	90 - 2950 Hz
67 - 950 Hz	29 - 1740 Hz	56 - 3000 Hz
80 - 960 Hz	69 - 1800 Hz	57 - 3350 Hz
33 - 1020 Hz	94 - 1830 Hz	58 - 3825 Hz
81 - 1060 Hz	71 - 1850 Hz	

Appendix B

Serial upload and download format

byte(s)	meaning
0	current mode
1	# of macro keys
2	# of bytes in programmable key area
3-5	guard tones FINs 0,1 and 2
6-21	time-templates
22-121	key area (always 100 bytes sent)
122-193	macro area
194-207	RAM frequencies

current mode :
7 6 5 4 3 2 1 0
p i o m m m m m

p	- set when password is entered correctly
i	- key is played in macro mode when set
o	- password protection off when set
mmmmm	- current mode (0-19, 20-31 unused)

The guard tones are stored as FINs. Bit 7 of guard 0 set means a guard tone is played (not necessarily guard tone 0).

The time-templates are 2-byte values MSB first. The value is stored in ms. (1/1024 seconds actually)

The programmable keys are stored one after each other first 0-9 then * and # and finally ^0-^9. The keyarea format for each tone is :

7 6 5 4 3 2 1 0
l n n t t h h h

l - when set indicates last tone of key, else indicates more tones are following

nn - # of tones (0,1,2)

tt - 0 means play fixed time hhh=high 3 bits
- 1 means play while pressed if not in macro, else fixed time
- 2 means play template time hhh=index
- 3 means play while pressed if not in macro, else template time hhh=index

If fixed time then next byte is lower 8 bits of time in 1/1024 secs If more than one tone then next bytes :

7 6 5 4 3 2 1 0
a a a a b b b b

aaaa - dB level tone a

bbbb - dB level tone b

Then for each tone a one byte FIN

This sequence is repeated until all tones of one key are done.

The RAM-frequencies are 2-byte values MSB first. The values are stored as 8*freq in Hz. So 1000 Hz is stored as 8000.

The macro area is a 72 byte area. It can hold up to 96 macro entries, which are stored as 6-bit values. The first 6 bit-value is stored in the 6 LSB of byte 0, the second 6-bit value is stored in the 2 MSB of byte 0 and the 4 LSB of byte 1, etc.

The macro entries have the following format :

0skkkk : key code skkkk where
s = shift and kkkk 4-bit key
kkkk = 0-11 for non-shifted and 0-9 for shifted keys)

001100 : start guard tone 0
001101 : start guard tone 1
001110 : start guard tone 2
001111 : stop guard tone

1mmmmm : if 0 <<= mmmmmm <<= 19 sets mode mmmmm
if 20 <<= mmmmm <<= 29 nests macro mmmmm-20
111111 : end of macro

Appendix C

Mode 0, DTMF (default)

The tones in the right hand column are commonly referred to as A, B, C and D. In military networks they are Flash Override, Flash, Immediate and Priority. The keys are played while pressed, in macros the mark is time-template 0, the space is time-template 1. These timings are also used in C3 / Pulse Dial. The tones are slightly off from the specified frequency to match those produced by the popular 5089 DTMF chip.

	1206.0	1331.7	1486.5	1639.0
694.8	1	2	3	^1 (A)
770.1	4	5	6	^2 (B)
852.4	7	8	9	^3 (C)
940.0	*	0	#	^4 (D)

Mode 1, ATF1 (B-netz)

This standard uses a 100 baud FSK modulated signal, using 1950 Hz as '1' and 2070 Hz as '0'. The start is preceded by a 600 millisecond preamble of 2070 Hz. The keys are defined as follows:

* (start)	01110 01000100010
# (stop)	01110 10000100001
^0 (cancel)	01110 10101010101
0	01110 11000 0 0001
1	01110 10100 0 00101
2	01110 10010 0 01001
3	01110 10001 0 10001
4	01110 01100 0 00110
5	01110 01010 0 01010
6	01110 01001 0 10010
7	01110 00110 0 01100
8	01110 00101 0 10100
9	01110 00011 0 11000

Mode 2, R2-forward

Key is played while pressed, in macro mode, each key is played for the duration of time-template 2, and then a pause of time-template 3 follows. Both time-templates are also used as the mark and space timing of C5. They both default to 50 ms.

1	1380	1500
2	1380	1620
3	1500	1620
4	1380	1740
5	1500	1740
6	1620	1740
7	1380	1860
8	1500	1860
9	1620	1860
0	1740	1860
^1	1380	1980
^2	1500	1980
^3	1620	1980
^4	1740	1980
^5	1860	1980

Mode 3, C3/pulse dial

This mode is very flexible: signal is pulsed, mark and space timing of pulses are stored in time-templates 0 and 1. They both default to 50 ms. This timing is also used for the DTMF mark and space.

The mark tone is stored in RAM-frequency 0 and the space is RAM-frequency 1. The space defaults to 2 Hz, which has a special meaning, it means the external relay is off-hook. The mark defaults to 1 Hz, which means on-hook. The interdigit delay is set in time-template 6, it defaults to 500 ms.

Mode 4, C4

All digit signals have 35 ms pauses between the tones, interdigit delay is 100 ms.

x = 2040, 35 ms
y = 2400, 35 ms
X = 2040, 100 ms
Y = 2400, 100 ms
XX = 2040, 350 ms
YY = 2400, 350 ms
P = 2040 + 2400, 150 ms

Clear Forward PXX *
Transit Seizure PX ^7
Forward Transfer PYY ^9
Terminal Seize PY #

1	yyyx	9	xyyx
2	yyxy	0	xyxy
3	yyxx	11 ^1	xyxx
4	yxyy	12 ^2	xxyy
5	yxyx	13 ^3	xxyx
6	yxxy	14 ^4	xxxy
7	yxxx	15 ^5	xxxx
8	xyyy	16 ^6	yyyy

Mode 5, C5

Digits are played while pressed, in macros they last for the duration of time-template 2, followed by a pause of time-template 3. In C5 ^1 is called 'Code 11', ^2 is called 'Code 12', ^3 is 'KP1', ^4 is 'KP2' and ^5 is 'ST'. ^6 lasts 500 ms, ^7 is 120 ms, ^8 is 120 ms, ^9 is 240 ms and ^0 is a silence of 50 ms. * is called clear forward and lasts 175 ms. # is called seize and lasts 300 ms.

1	700	900	^1	700	1700
2	700	1100	^2	900	1700
3	900	1100	^3	1100	1700
4	700	1300	^4	1300	1700
5	900	1300	^5	1500	1700
6	1100	1300	^6	2600	
7	700	1500	^7	2400	2600
8	900	1500	^8	2400	
9	1100	1500	^9	2400	
0	1300	1500	^0	0	
*	2400	2600	#	2400	

Mode 6, redbox

These tones are used for payphone coin signalling in North America. There are three types of tones for different systems and three types of cadences for the coins.

Tones:

ACTS	1700	2200
IPTS	1500	2200
non ACTS	2200	

Cadences:

0.05 = 60 ms on
0.10 = 60 ms on, 60 ms off, 60 ms on
0.25 = 5 x (35 ms on, 35 ms off)

Key Layout:

	$0.05	$0.10	$0.25
ACTS	1	2	3
IPTS	4	5	6
non ACTS	7	8	9

Mode 7, line signalling menu

This mode contains several line signalling tones from various systems, the * and # keys are user programmable. All frequencies are played while pressed, In Macro mode they will sound for 50 ms (not shifted) and 10 ms (shifted). In macro mode * is always 50 ms and # is always 10 ms.

1 = 2400 + 2600 Hz
2 = 2400 Hz
3 = 2600 Hz
4 = 2040 + 2400 Hz
5 = 2280 Hz
6 = 3000 Hz
7 = 1700 Hz
8 = 1900 Hz
9 = 2500 Hz
0 = silent
* = RAM freq. #2 + #3 (50 ms)
# = RAM freq. #2 + #3 (10 ms)

Mode 8, tone-slot

Each tone is 70 ms. No pause between tones when in macro.

1 = 1060 Hz
2 = 1160 Hz
3 = 1270 Hz
4 = 1400 Hz
5 = 1530 Hz
6 = 1670 Hz
7 = 1830 Hz
8 = 2000 Hz
9 = 2200 Hz
0 = 2400 Hz
* = 2600 Hz (separator)

Mode 12 (^2), R2-backward

Key is played while pressed, in macro mode, each key is played for the duration of time-template 2, and then a pause of time-template 3 follows. Both time-templates are also used as the mark and space timing of C5. They both default to 50 ms.

1	1140	1020
2	1140	900
3	1020	900
4	1140	780
5	1020	780
6	900	780
7	1140	660
8	1020	660
9	900	660
0	780	660
^1	1140	540
^2	1020	540
^3	900	540
^4	780	540
^5	660	540

Mode 18 (^8), user programmable mode

This mode is user programmable. The data is stored in 100 bytes in the format listed in Appendix B. See section 5 of this manual for more details on how to program the keys.

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Notes: