DTDisk™

Direct-to-disk Recorder

User Guide

Version 3.0
February, 2007

Engineering Design

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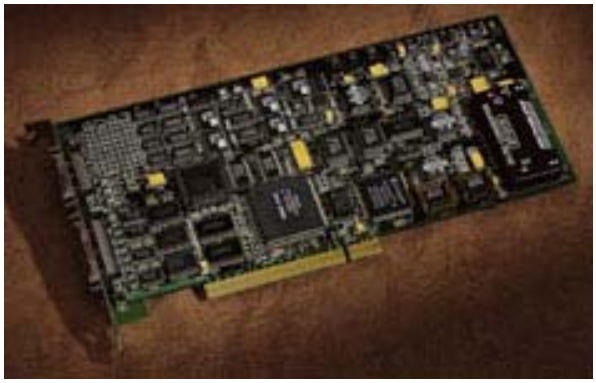


1. Overview

DTDisk[tm] provides direct-to-disk data acquisition and playback using analog I/O cards from Data Translation (DT). Program capabilities include:

- Recording up to 8 input channels at up to 1.25 MHz aggregate sample rate
- Playback of 1 or 2 output channels at up to 500 kHz aggregate sample rate
- Simultaneous recording and playback
- Programmable input gain up to factor of 8
- Recording and playback can be initiated by external TTL trigger
- TTL output signal provided for synchronization with external systems
- Recording and playback duration up to the capacity of the hard disk
- Records and plays sound data in either SIGNAL or Wave file format
- Operates with all current Data Translation I/O cards
- Runs under Windows 98/2000/XP

DTDisk can store acquired data in either SIGNAL or Wave file format. Both file types can be read directly into SIGNAL or RTS for display and analysis. Applications for DTDisk sound files within the SIGNAL family include:

- Review, measure, and edit sound data in the RTS
- Produce continuous spectrograms in SIGNAL
- Automatically analyze recorded files for sound events using the Event Detector
- Read file segments into SIGNAL for precision display and measurement

DTDisk does not require SIGNAL in order to operate - it can be installed on any Windows 95/98/2000/XP computer for stand-alone data acquisition.

DTDisk supports current all analog I/O cards manufactured by Data Translation (DT) (800-525-8528, www.datx.com). These include PCI **desktop** cards providing 12-bit and 16-bit resolution at sample rates up to 1.25 MHz, PCMCIA **notebook** cards providing 12-bit

resolution at sample rates up to 100 kHz, and the **USB** unit providing 16-bit resolution at sample rates up to 500 kHz . DTDisk automatically makes the installed card's capabilities available, including maximum sample rate and programmable input gain. **DTDisk does not support the DT-2821 family of ISA I/O boards used with SIGNAL 3.x.**

DTDisk has been tested extensively with the 12-bit, 1250 kHz desktop analog I/O card, model DT3010, the 16-bit, 250 kHz desktop analog I/O card, model DT3016, and the 500 kHz DT9834 USB I/O unit.

2. Installation

To install DTDisk, perform these steps in the following order:

1. Install the DT-Open Layers system driver.
2. Install the device driver for your DT analog I/O board.
3. Install your I/O board in the device driver.
4. Install the DTDisk software.

Install DT-Open Layers, Device Driver, and I/O Board

Instructions for installing the DT-Open Layers system driver, the board device driver, and the I/O board are provided in Appendix C of the ***SIGNAL Reference Guide***. **Be sure to read "Data Translation: Overview" in that section before installing any Data Translation boards!**

Data Translation uses different system drivers for Windows 95/98 vs. Windows 98/2000/XP. Be sure to follow the instructions in that section for your operating system.

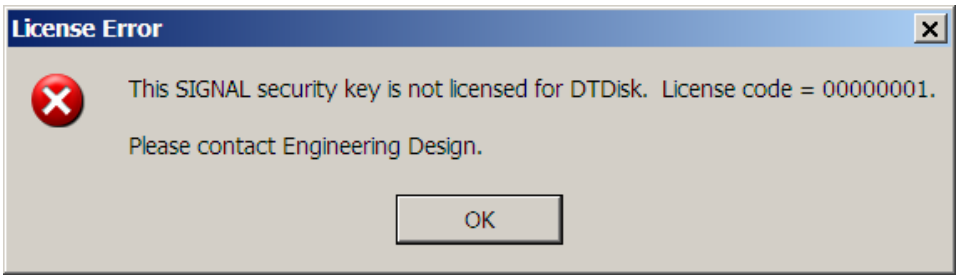
Install DTDisk

After installing the DT-Open Layers system driver, board device driver, and I/O board, follow these steps to install DTDisk.

1. Launch the setup file **dtdisk_xxx_setup.exe** (where **xxx** is the version number) by double-clicking on the filename in Windows Explorer. If you received a zip file, extract dtdisk_xxx_setup.exe from the zip file, then launch it.
2. Follow the installation prompts.
3. Install DTDisk in the same directory as SIGNAL. The default SIGNAL program directory is c:\Program Files\Engineering Design\Signal 4.0.

Enable SIGNAL Security Key

DTDisk requires a SIGNAL security key which has been licensed for DTDisk. If DTDisk reports a non-licensed security key, contact Engineering Design, and the key can be enabled by email.



DTDisk User Guide

The DTDisk User Guide (this document) is installed as a PDF (Portable Document Format) file in the \docs directory under the SIGNAL root directory (normally c:\Program Files\Engineering Design\Signal 4.0). PDF files require the **Acrobat Reader** program from Adobe Corporation for viewing. If not already installed, this program is available for free download at http://www.adobe.com/products/acrobat/readstep.html. Acrobat Reader is also required by Help | User Guide on the DTDisk menu.

Acrobat Reader provides full text search capability, which can be extremely useful as a "super-index", to find all occurrences of a particular word or phrase in the document. To perform a text search, select Edit | Find in the Acrobat menu.

This guide can be accessed from the DTDisk menu at Help | User Guide.

3. Getting Started

Connecting Signals to the I/O board

See Appendix D, "I/O Hardware Connections" in the ***SIGNAL Reference Guide*** for **important notes** on connecting signals to the I/O board.

Starting DTDisk

To execute DTDisk, do any of the following:

- Click on the DTDisk desktop icon
- Select DTDisk from the Start menu or Programs menu

- In Windows Explorer, navigate to the folder containing the DTDisk executable, then click on dtdisk.exe

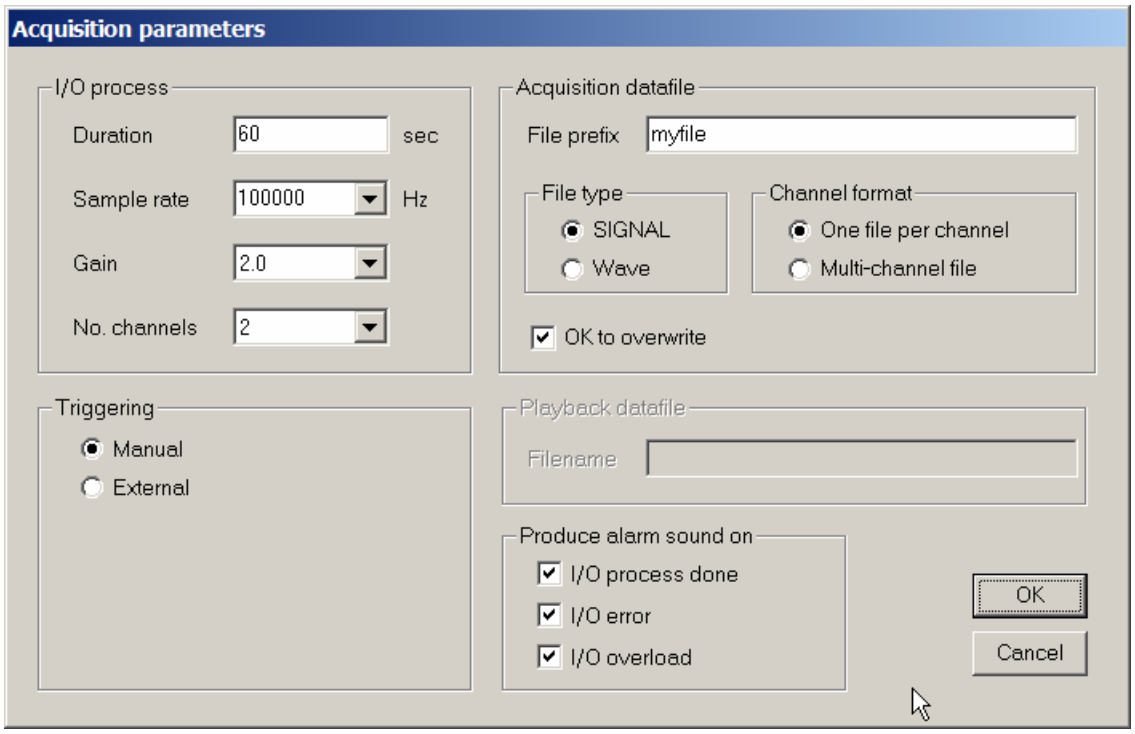
To execute DTDisk from a DOS window, select Start | Programs | Accessories | Command Prompt, change to the folder containing the DTDisk executable (type "cd <foldername>"), then enter the desired DTDisk command line (see "Command line mode" below).

4. Acquisition

Performing Acquisition

To perform an acquisition, select I/O | Acquire on the DTDisk menu. DTDisk displays the Acquisition parameter screen, which allows the user to configure the acquisition. DTDisk then displays the Acquisition summary screen, which summarizes acquisition parameters and allows the user to initiate the acquisition.

Acquisition Parameter Screen



The Acquisition parameter screen allows the user to specify acquisition duration, sample rate, input gain, number of channels, the name or prefix, file type, and channel format of the datafile to receive the acquired data, optional overwrite of pre-existing datafiles, triggering, and optional alarm sounds. These are described here.

Duration is specified in seconds, and is limited only by the available space on the destination disk drive. **Note:** DTDisk does not check for sufficient disk space for your requested duration. Acquisition length in seconds is related to disk space in MB as follows. For example, at 250 kHz sample rate, 30 minutes of sound will require 860 MB of disk space.

Disk space in MB = (Acquisition length in secs) * (sample rate in Hz) * (no. channels) / 525,000

Sample rate may be selected from the drop list of available sample rates in Hz or entered manually. Available sample rates vary with the specific I/O card. They are a subset of the submultiples of some fixed frequency, such as 20 MHz for the DT3010/3016 family. Due to this mathematics, the drop list typically displays all available high frequency rates and a subset of the low frequency choices, which are very dense.

Gain sets the gain applied to the input signal before digitizing. Gain is specified as a multiplier (rather than dB). Available gains are 1, 2, 4, 8 for the DT3010/3016 family.

No. channels can be set to any nymber between 1 and 8. Input sample rate is limited to the maximum sample rate of the I/O card **divided by the number of channels**. Thus a 250 kHz card can sample two channels at 125 kHz per channel.

Filename specifies the destination sound file. If the filename does not include a full path (drive letter and directory), files are stored in the directory containing DTDisk. Embedded spaces are allowed in the filename. DTDisk will append the ".wav" extension to Wave files if not included.

For a one-channel acquisition, Filename simply specifies the name of the destination sound file.

For a multi-channel acquisition, the Filename specification depends on the Channel format setting. With "One file per channel" (the recommended setting), specify the **File prefix** and DTDisk will store the data, one file per channel, in SIGNAL files *prefix*.1, *prefix*.2, etc. or Wave files *prefix*.1.wav, *prefix*.2.wav, etc. File prefixes should not end with a period (.). With "Multi-channel file", specify the **Filename** and DTDisk will store all acquisition channels in this file (see Channel format). Note that multi-channel SIGNAL files require SIGNAL 4.1, and Wave files with more than 2 channels may require special software.

File type may be SIGNAL or Wave. Sound data are written as 16-bit integers, coded as follows. SIGNAL files are strongly recommended.

- SIGNAL files are written in the native 12-bit or 16-bit coding of the installed I/O board, with offset removed from 16-bit data. A conversion factor is stored in the file header that allows SIGNAL to reconstruct the original voltage range.
- Wave files are written in 16-bit coding (0 offset, ±32768 range), independent of the installed I/O card. Offset is removed and 12-bit data are scaled to 16 bits. Files are uncompressed, i.e., in the "PCM" or "type 1" standard Wave file format.
- **Note that Wave file amplitudes may not scale correctly in SIGNAL, since the Wave header contains no conversion factor to indicate the original voltage range of the data.**
- **Note also that Wave files with sample rates other than 44,100 Hz may not be playable on all systems.**

Channel format indicates how to store multi-channel acquisition data. **One channel per file** stores each acquisition channel in a different file (see Filename). **Multi-channel file** stores all channels in one file, interleaved, e.g., point 1 of channel 1, point 1 of channel 2, point 2 of channel 1, point 2 of channel 2, etc. for a 2-channel acquisition.

Overwrite allows DTDisk to overwrite pre-existing data files of the same name without warning the user. If Overwrite is not checked, DTDisk will request permission before overwriting.

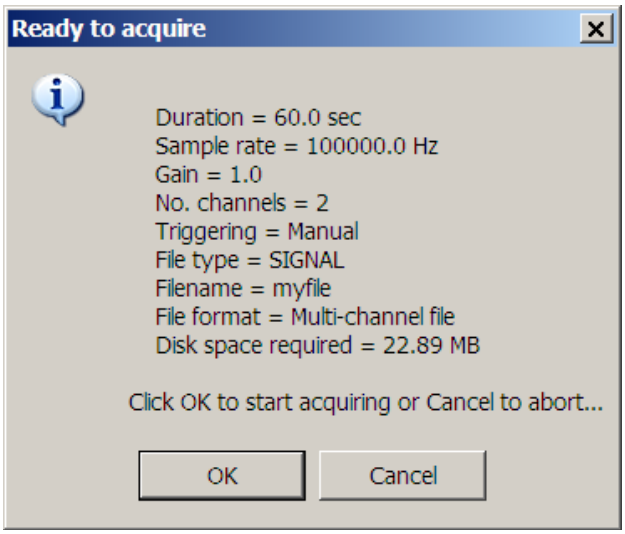
Triggering allows the user to initiate playback manually by clicking OK [**Manual**] or electronically via a trigger signal from an external system [**External**]. See "External Trigger" below for discussion.

I/O process done produces an alarm sound when the acquisition is done by playing the sound file IoDone.wav. See "Other Functions" for details.

I/O error produces an alarm sound when acquisition ends in error, by playing the sound file IoError.wav. See "Other Functions" for details.

I/O overload produces an alarm sound when the input signal overloads the A/D converter by playing the sound file IoOverload.wav. To avoid auditory runaway on a continuously overloaded signal, the overload alarm is played no more than once per second. See "Acquisition / Playback Progress Screen" and "Other Functions" for details.

Acquisition Summary Screen



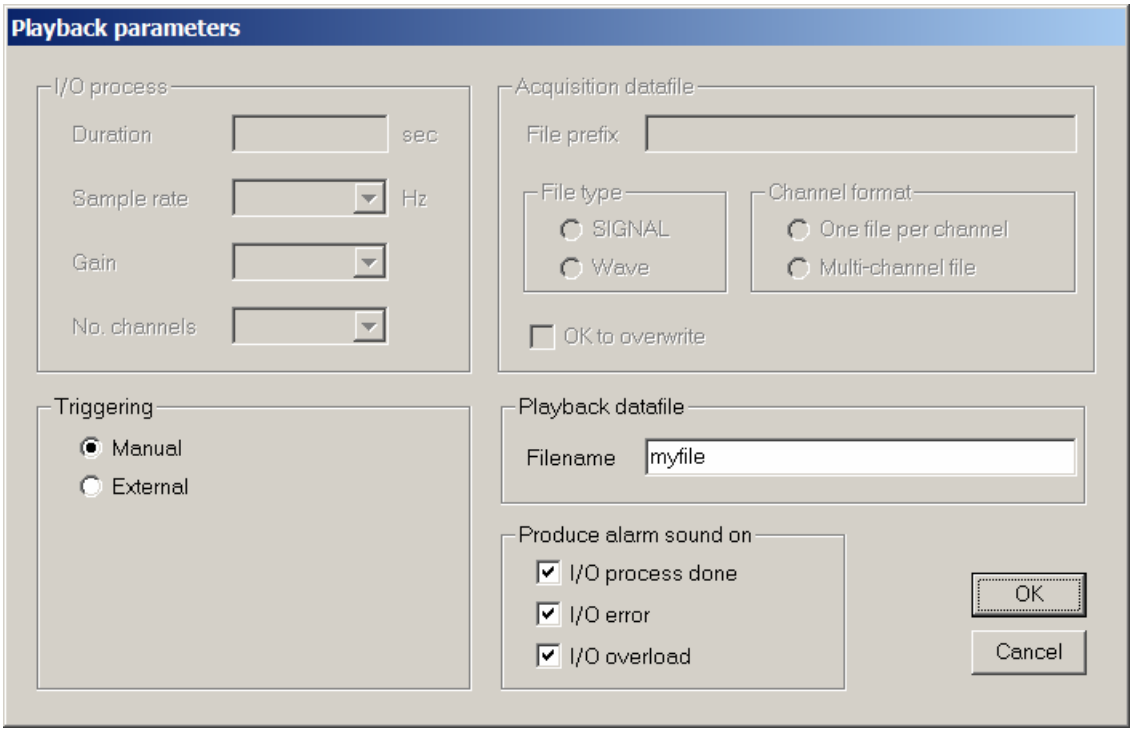
After closing the acquisition parameter screen, DTDisk displays a summary of the acquisition parameters, showing the actual sample rate, gain, number of channels, destination filename(s), required disk space, and other information. **DTDisk does not check for sufficient disk space before acquiring,** so be sure the required space is available on the disk. Acquisition will begin when the user clicks OK (Manual triggering) or after the user clicks OK and applies the external trigger (External triggering).

5. Playback

Performing Playback

To perform a playback, select I/O | Play on the DTDisk menu. DTDisk displays the Playback parameter screen, which allows the user to configure the playback. DTDisk then displays the Playback summary screen, which summarizes playback parameters and allows the user to initiate the playback.

Playback Parameter Screen



The Playback parameters screen allows the user to specify the file to be played, triggering mode and optional alarm sounds. Other parameters such as duration, sample rate and number of channels are predetermined by the sound file. The playback file may be a 1- or 2-channel SIGNAL or Wave file. Wave files must be stored in uncompressed 16-bit coding (0 offset, ±32768 range), which is the "PCM" or "type 1" standard Wave file format.

Filename specifies the name of the file to be played, **including file extension** (e.g., myfile.1 or myfile.wav). If the filename does not include a full path (drive letter and directory), files are played from the directory containing DTDisk. Embedded spaces are allowed in the filename.

DTDisk accepts SIGNAL integer-format files and Wave files, but not SIGNAL floating-point format files. SIGNAL files are strongly recommended.

- SIGNAL files are played at their original voltage range, using a conversion factor stored in the SIGNAL file header.
- Wave files are played using an assumed voltage range of ±3 Volts (the default for Wave hardware), which may or may not be the original voltage range of the data.

To perform a multi-channel playback, submit a multi-channel SIGNAL or Wave sound file. SIGNAL 4.1 or later is required to write multi-channel SIGNAL files.

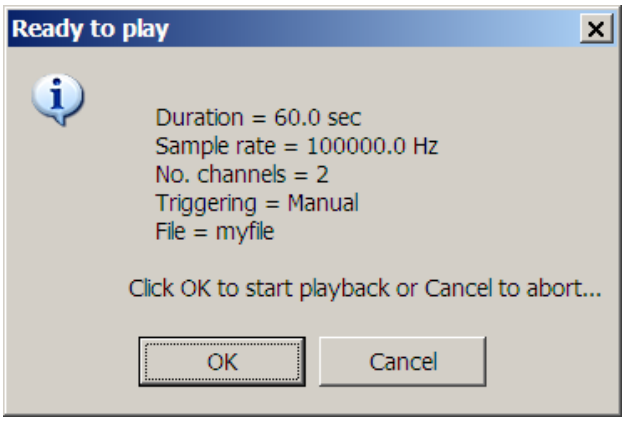
Triggering allows the user to initiate playback manually by clicking OK [**Manual**] or electronically via a trigger signal from an external system [**External**]. See "External Trigger" below for discussion.

I/O process done produces an alarm sound when the acquisition is done by playing the sound file IoDone.wav. See "Other Functions" for details.

I/O error produces an alarm sound when acquisition ends in error, by playing the sound file IoError.wav. See "Other Functions" for details.

I/O overload produces an alarm sound when the input signal overloads the A/D converter by playing the sound file IoOverload.wav. To avoid auditory runaway on a continuously overloaded signal, the overload alarm is played no more than once per second. See "Acquisition / Playback Progress Screen" and "Other Functions" for details.

Playback Summary Screen



After closing the playback parameter screen, DTDisk displays a summary of the playback parameters, showing the duration, sample rate, number of channels, triggering, source file name, and file type. Playback will begin when the user clicks OK (Manual triggering) or after the user clicks OK and applies the external trigger (External triggering).

6. Simultaneous Acquisition/Playback

About Simultaneous Acquisition/Playback

DTDisk can perform simultaneous acquisition and playback when supported by the I/O device. Simultaneous I/O is supported by most high-performance DT cards, including the DT3010 (12-bit) and DT3016 (16-bit).

Applications include synchronized stimulus-response experiments and playbacks adapted dynamically based on vocalization responses acquired during playback.

The acquisition and playback processes must physically start at the same time, but the two processes can be offset either by inserting silence at the beginning of the playback signal (to delay playback), or discarding an intial segment of the acquired signal (to "delay" acquisition). Acquisition and playback processes need not be the same length. The I/O process will proceed until both acquisition and playback have completed.

To precisely synchronize acquisition and playback processes, use an external trigger (see below). The status signals AC_ACTIVE and PL_ACTIVE will be driven by the acquisition and playback processes, respectively (see below). Only the acquisition progress screen is displayed.

Simultaneous acquisition and playback can be controlled from SIGNAL via the SIMIO command.

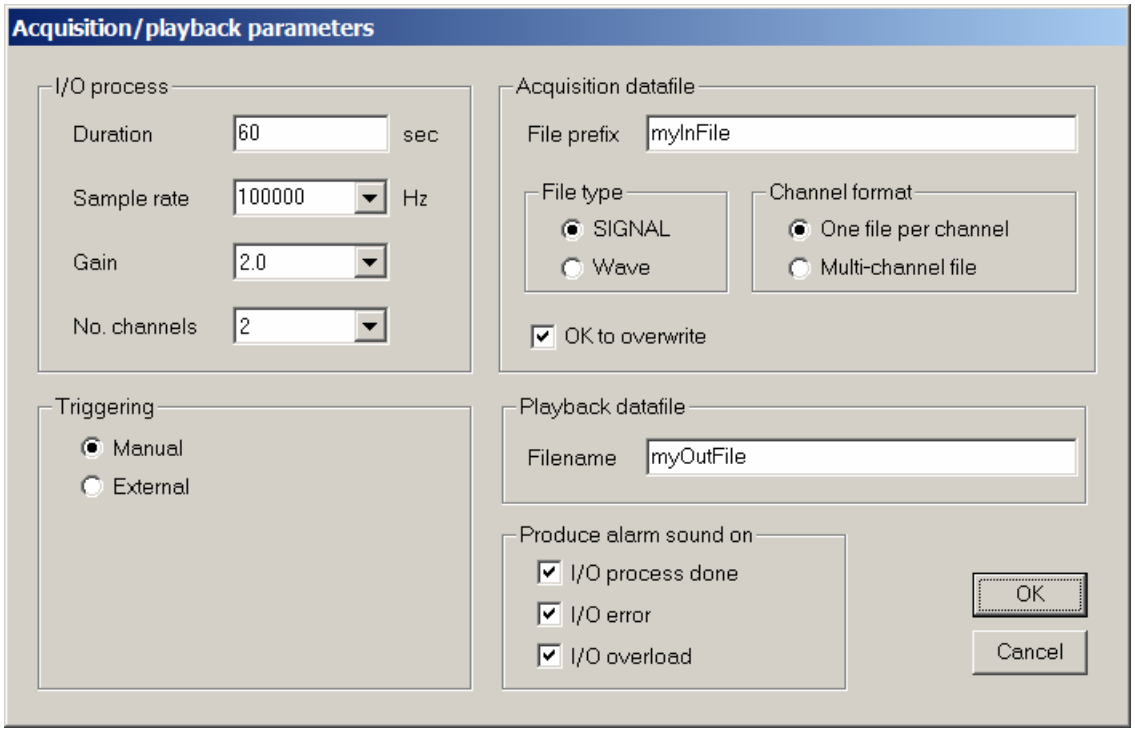
Concurrent I/O processes normally divide the bandwidth of the I/O device, e.g., a 500 kHz I/O device will typically support simultaneous one-channel acquisition and playback at 250 kHz per process. However, the DT3010/3016 family does not seem to have this limitation, and delivers **full rated bandwidth on acquisition and playback simultaneously**.

Data Translation I/O devices do not support simultaneous processes of the same type, e.g., two acquisition processes on the same device.

Performing Simultaneous Acquisition/Playback

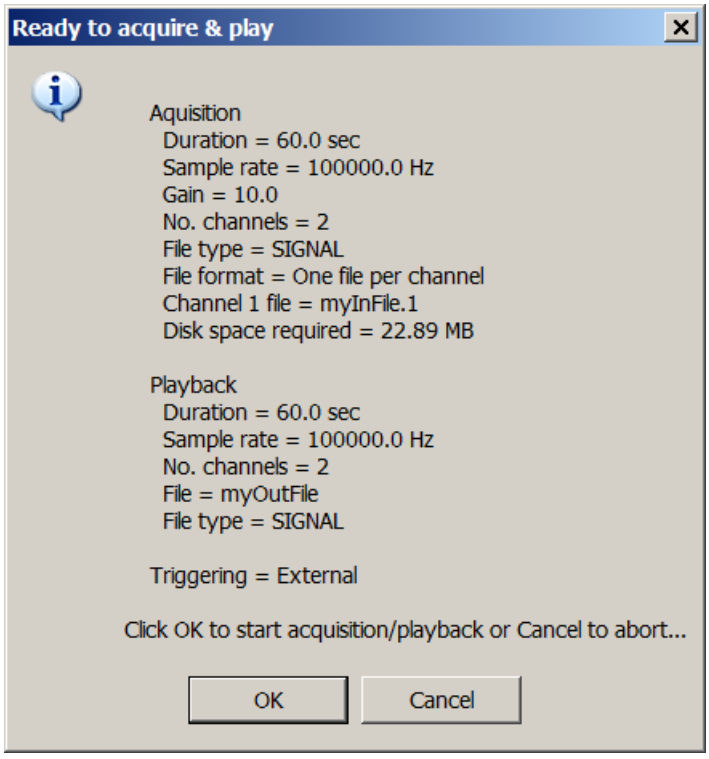
To perform simultaneous acquisition/playback, select I/O | Acquire & Play on the DTDisk menu. DTDisk displays the Acquisition/Playback parameter screen, which allows the user to configure the acquisition and playback. DTDisk then displays the Acquisition/Playback summary screen, which summarizes acquisition/playback parameters and allows the user to initiate the I/O process.

Acquisition/Playback Parameter Screen



The Acquisition/Playback parameter screen allows the user to specify acquisition duration, sample rate, input gain, number of channels, the name or prefix, file type, and channel format of the datafile to receive the acquired data, optional overwrite of pre-existing datafiles, triggering, datafile to be played, and optional alarm sounds. See "Acquisition Parameter Screen" and "Playback Parameter Screen" for a description of these parameters.

Acquisition/Playback Summary Screen



After closing the acquisition/playback parameter screen, DTDisk displays a summary of the acquisition/playback parameters, showing the actual sample rate, gain, number of channels, destination filename(s), required disk space, and other information. **DTDisk does not check for sufficient disk space before acquiring,** so be sure the required space is available on the disk. Acquisition and playback will begin when the user clicks OK (Manual triggering) or after the user clicks OK and applies the external trigger (External triggering).

7. Acquisition and Playback Progress Screens

During acquistion and playback, DTDisk displays a progress screen containing:

- Numerical readout of elapsed acquisition time
- Numerical readout of current signal headroom
- Graphical bar display of elapsed acquisition time
- Graphical bar display of current headroom

Click Stop to halt the acquisition or playback before it completes. If acquisition is halted in this way, **sound data recorded up to that point is saved.**

The meter also provides a summary display of total I/O time and total headroom when acquistion or playback has completed. See the figures.

During simultaneous acquisition/playback, only the acquisition progress screen is displayed.

Elapsed Time Display

The meter shows elapsed acquisition or playback time graphically via a real-time linear bar display and numerical readout. See the figures.

Headroom Display

The meter shows peak signal level graphically via a real-time linear bar display, similar to an LED-based VU meter on a recording console. See the figures.

Like a VU meter, the display is oriented towards **headroom**, the parameter of greatest concern to the recording engineer. Headroom is the dB difference between peak signal level and the overload level of the A/D converter. Overload level is the converter's maximum positive code, e.g., +2047 and +32767 for 12-bit and 16-bit converters, respectively. When headroom decreases to 0, the input signal will be distorted in the A/D.

Headroom is also reported numerically. The operator can monitor display color for an overview of headroom status and can use the numerical readout to adjust system gain precisely, so as to maximize the signal-to-noise of the recorded signal without risking overload distortion.

Display Refresh

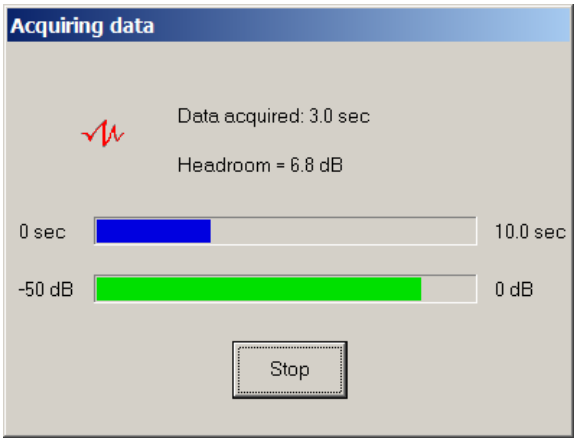
During recording, the program updates the entire display every 100 msec, reporting the worst-case headroom during that interval. Refresh interval represents a tradeoff between a more responsive meter and system loading at very high sample rates. It may be user-configurable in a future version.

Meter Color Display

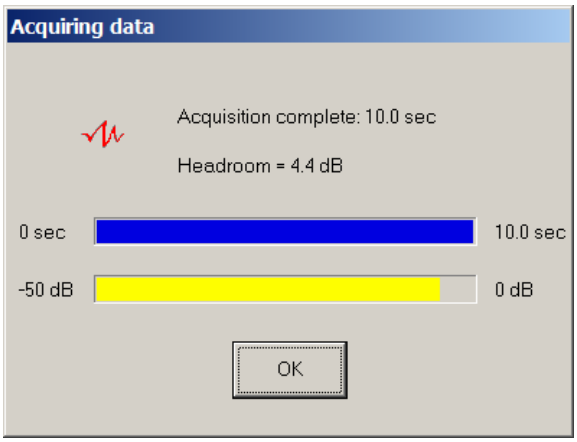
The headroom bar changes color dynamically to indicate headroom status, as illustrated in the figures:

- Green = sufficient headroom: headroom > 6 dB
- Yellow = low headroom: headroom < 6 dB but > 0
- Red = overload: headroom = 0

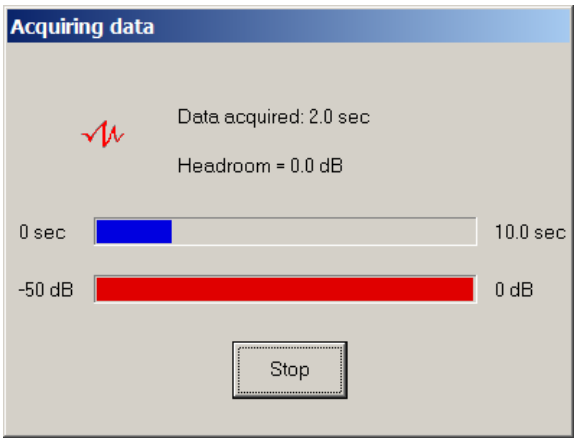
Here is the meter during recording with sufficient headroom represented by a green bar:



Here is the meter after recording with low headroom represented by a yellow bar:



and here is the meter during an overload condition represented by a red bar:



Final Meter Display

After recording, the meter reports **total headroom**, which is the worst-case (minimum) headroom of the signal during the entire recording. In this way, the operator can always tell if the A/D has overloaded at any point during the recording without continuously monitoring

the display. The total headroom value is reflected in both the numerical readout and bar display.

8. Acquisition and Playback Triggering

Triggering DTDisk from an External System

External triggering allows the user to initiate acquisition or playback in DTDisk via an external control signal, in order to synchronize the DTDisk I/O process with an external system. For example, an external system might begin neural data acquisition, collect pre-trigger data for 5 seconds, then issue a trigger to DTDisk to begin playback stimulation. This "hardware" triggering provides very high accuracy, typically on the order of 1 microsecond, which is much more accurate than synchronizing the two systems from the keyboard.

Trigger signal

The DT3010 and DT3016 require separate trigger signals for acquisition and playback, called **AC_TRIG** and **PL_TRIG** respectively. These signals are TTL-compatible trigger signals with a falling edge and a minimum duration of 10 nsec, but **consult the trigger specs of your specific I/O board to confirm this.** Then confirm that the external system can output a compatible trigger signal.

Trigger signal latency

Trigger latency is the time delay between the external trigger and the beginning of the triggered I/O process. It is board-dependent but not CPU-dependent, and is typically < 1 microsecond.

Trigger signal connections

If you have an Engineering Design (ED) I/O panel, connect the external trigger to the AC TRIG IN or PL TRIG IN connector on the panel. If your ED panel does not have this connector, contact ED for modification options. **DT3010/3016 also require an additional digital signal cable between the ED panel and the I/O board to carry the trigger signals.**

If you are using a Data Translation (DT) screw terminal panel, connect the incoming trigger signal to "External A/D TTL Trigger" or "External D/A TTL Trigger" on the panel, as appropriate.

Triggering instructions

To perform external triggering:

1. Connect the external trigger signal as described above.
2. On the acquisition or playback parameter screen in DTDisk, select External triggering.

3. Click OK on the acquisition or playback summary screen. DTDisk will prepare the I/O process and display a blank Acquiring data or Playing data box.
4. Acquisition or playback will begin on receipt of the external trigger signal.

Triggering an External System from DTDisk

Output triggering allows the user to initiate some process in an external system at the beginning or end of acquisition or playback in DTDisk, in order to synchronize the DTDisk I/O process with an external system. For example, the user can start a playback in DTDisk, then use the output trigger signal to trigger an external neurophysiological data acquisition system. To gather "pre-trigger" data, insert a segment of silence at the beginning of the DTDisk playback signal.

Synchronization signals

The DT3010 and DT3016 provide separate synchronization signals for acquisition and playback, called **AC_ACTIVE** and **PL_ACTIVE** respectively. These signals go HIGH at the beginning of the I/O process and LOW at the end of the process. These rising and falling edges can be used to inform the external system of the beginning and the end of the I/O process. **Note: synchronization signals are issued with manual triggering only, not with external triggering.**

Synchronization signal latency

Synchronization signal latency is the time delay between the beginning and end of the I/O process and the rising and falling edges, respectively, of the synchronization signal. It is board-dependent and CPU-dependent, but is typically 1-20 usec.

Signal connections

If you have an Engineering Design (ED) I/O panel with the digital I/O option, AC_ACTIVE and PL_ACTIVE are provided at the AC TRIG OUT and PL TRIG OUT connectors. If your ED panel does not have these connectors, contact ED for modification options.

If you are using a Data Translation (DT) I/O panel, AC_ACTIVE and PL_ACTIVE are provided at lines 0 and 1, respectively, of the first digital port. On the DT9834 panel, AC_ACTIVE, PL_ACTIVE, and their ground are provided at pins 20, 21, and 18, respectively, of the Digital In/Out connector. For the DT3010/3016, AC_ACTIVE and PL_ACTIVE are provided at "Digital I/O Bank A 0" and "Digital I/O Bank A 1", respectively, on the screw terminal panel.

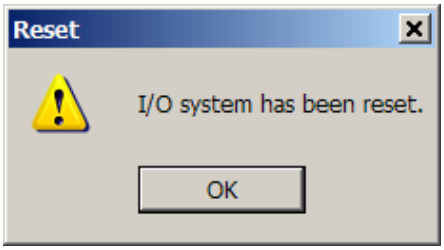
9. Other Functions

Alarm Sounds

DTDisk can produce alarm sounds to alert the user to certain acquisition or playback conditions. These sounds are played through the system sound card, independent of the DTDisk I/O board. Alaram sounds are stored as Wave files in the DTDisk directory (see "Acquisition and Playback" for the filenames). Users can customize any sound by substituting another Wave file of the same name.

I/O Reset

The menu selection I/O | Reset performs a local reset, in case DTDisk malfunctions or stops responding. It clears DTDisk status variables and status files, and resets the I/O board driver. If I/O | Reset doesn't solve the problem, follow the troubleshooting suggestions in "Operating Hints and Troubleshooting".



User Guide

Select Help | User Guide to display the ***DTDisk User Guide*** (this document).

About DTDisk

Help | About DTDisk reports the DTDisk program version, creation date, and the optional high-resolution version of DTDisk (see "Triggering an External System from DTDisk" above).

10. Command Line Mode

DTDisk can be executed directly from the DOS command line, by including all necessary parameters with the DTDisk command. DTDisk will bypass the parameter setup screen and summary screen and begin the I/O process immediately. Only the "Acquiring data" or

"Playing data" screen will be displayed. Command line mode can be used for convenience (to avoid specifying parameters on the setup screen) and for automation and interfacing with SIGNAL, as described below.

Command Line Syntax

Following is the command line syntax for acquisition, playback, and simultaneous acquisition/playback:

dtdisk a *nchan duration srate gain filetype acqfile* [*chanform*] [*trig*] [*nrep*]
dtdisk p *playfile* [*trig*]
dtdisk s *nchan duration srate gain filetype acqfile playfile* [*chanform*] [*trig*]

where:

A, P, S	= acquisition, playback, or simultaneous acquisition/playback
nchan	= number of channels
duration	= recording duration in seconds
srate	= sample rate in Hz
gain	= gain multiplier
filetype	= file format: s = SIGNAL, w = Wave
acqfile	= acquisition filename or file prefix
playfile	= playback filename
chanform	= [optional] file channel format: s = one file per channel, m = multi-channel file
trig	= [optional] trigger mode ("manual" or "ext")
nrep	= [optional] no. program repetitions

Note: other program options can be altered in command line mode. For example, pre-existing data files of the same name are overwritten and alarm sounds are played on I/O error but not on I/O done. If the *chanform* argument is omitted, all channels are written to one multi-channel datafile ("m" option). If the *trig* argument is omitted, manual triggering is assumed. If the file format is "one file per channel", *filename* should contain the file prefix; otherwise *filename* should contain the full filename. See "Acquisition Parameter Screen" above for details.

Examples:

```
dtdisk a 2 60 50000 10 s myAcqFile
```

will acquire two channels for 60 seconds at 50 kHz sample rate per channel with a gain multiplier of 10, to a two-channel SIGNAL-format sound file called myAcqFile.

```
dtdisk p myPlayFile
```

will play the sound file myPlayFile, which may contain 1 or 2 channels.

```
dtdisk a 2 60 50000 10 s myAcqFile s
```

will acquire to two SIGNAL-format sound files called myAcqFile.1 and myAcqFile.2.

```
dtdisk s 2 60 50000 10 s myAcqFile myPlayFile
```

will acquire two channels for 60 seconds at 50 kHz sample rate per channel with a gain multiplier of 10, to a two-channel SIGNAL-format sound file called myAcqFile, while simultaneously playing the sound file myPlayFile.

If the filename or filename prefix includes embedded spaces, enclose the entire name in quotation marks, for example:

```
dtdisk a 2 60 50000 10 s "\my project\myfile"
```

The optional parameter *nrep* repeats the acquisition process *nrep* times. Output files are named *prefix.n.chan*, where *n* is the repetition index. Thus a repeated 2-channel process would produce myfile.1.1 and myfile.1.2 on the first repetition, myfile.2.1 and myfile.2.2 on the second repetition, etc.

Calling DTDisk from SIGNAL

DTDisk can be called from SIGNAL using the EXEC command. Include the full pathname of the DTDisk executable, and enclose this in quotes if it contains embedded spaces, as in the example below. Two applications are: 1) enclosing DTDisk in a SIGNAL program loop to automate and time repetitive playbacks (using DOLOOP and TWAIT), and 2) using TWAIT to run DTDisk at a particular time of day, for scheduled recording. The following example (which should be presented on a single line) will perform the acquisition described above:

```
EXEC "c:\Program Files\Engineering Design\Signal 4.0\dtdisk"
        a 2 60 50000 8 s "\my project\myfile"
```

Calling DTDisk from DOS

A DTDisk command can also be run from a DOS batch file. This avoids entering parameters manually into the parameter setup screen, to perform the same process repeatedly. Create a one-line .bat file containing the command line text, such as "dtdisk a 2 60 50000 8 s myfile" without the quotes. Then either 1) double-click on this file in Windows Explorer, or 2) open a DOS window (in the Start menu, click Programs | MS-DOS Prompt in Windows 95/98 or Programs | Accessories | Command Prompt in Windows 2000/XP) and type the .bat file name.

Status File

DTDisk writes acquisition and playback status files to enable communication with a calling program. These files are called DTDiskAcqStatus.txt and DTDiskPlayStatus.txt, and are located in the DTDisk program directory. These files contain one line in the format

status=*status*

where *status* is the status of the current or just-completed I/O process:

ACTIVE	= in progress
DONE	= successfully completed

ABORTED = aborted by the user
ERROR = terminated by the program due to error

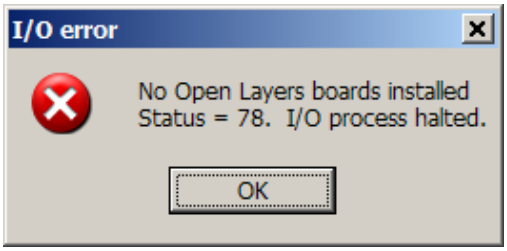
Normally, *status* will be ACTIVE during acquisition or playback and DONE after the I/O process completes. The user can call DTDisk from SIGNAL, then poll the status file (using RA family commands) to determine when the I/O process has completed and whether it was successful.

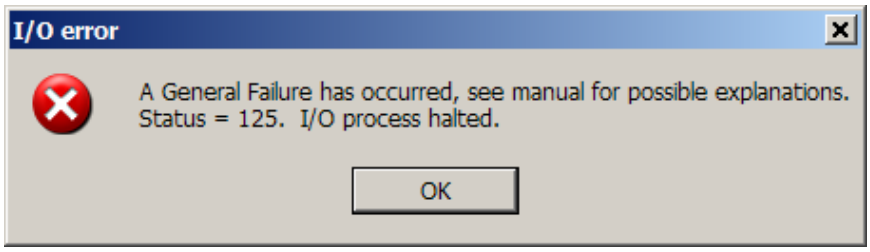
11. Operating Hints and Troubleshooting

Following are operating hints and troubleshooting guidelines for the DTDisk system.

I/O Board Not Present or Disabled

DTDisk will display the following error messages if the I/O board is not present or disabled, respectively. Note that removable I/O devices, such as PCMCIA cards and USB units, **may need to be removed and reinserted after the system is restored from Standby,** even when Device Manager reports the device as installed and "working properly". If the I/O device is removable, power off and on again (if appropriate), then remove and reinsert it. If the error persists, reboot the computer. If the error still persists, uninstall and reinstall the system driver and board driver for the I/O device.



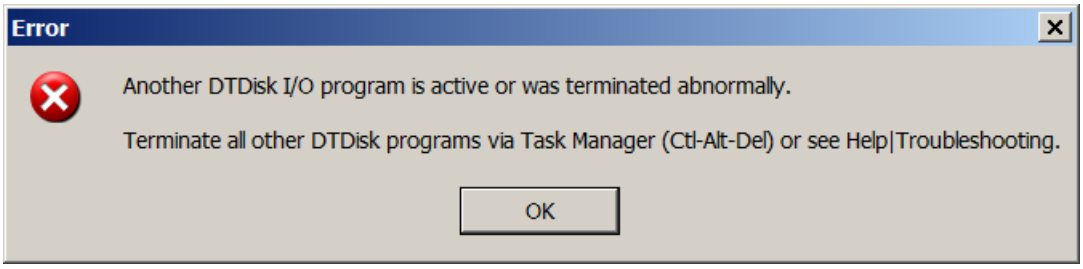


Note: the internal processor in the DT9834 USB sound unit can occasionally hang. To perform a hardware reset, disconnect and reconnect the power to the unit.

DTDisk Program Already Active or Terminated Abnormally

DTDisk may issue the following message on startup. This can occur if another DTDisk program is running, or if a previous DTDisk process terminated abnormally and is running invisibly. To check for an invisible DTDisk, open Task Manager (Ctl-Alt-Del), search for

dtdisk.exe, and terminate the process if present. If this does not correct the problem, follow the steps in "I/O Device Not Recognized or Not Responding".



Minimum and Maximum Duration

Minimum acquisition and playback duration is 0.1 seconds. Maximum acquisition and playback duration is the capacity of the hard disk.

Minimum and Maximum Sample Rate

Minimum sample rate is 100 Hz for acquisition and playback. Maximum sample rate is determined by the analog I/O card. DTDisk has been tested extensively with the 12-bit, 1250 kHz desktop analog I/O card, model DT3010, the 16-bit, 250 kHz desktop analog I/O card, model DT3016, and the 500 kHz DT9834 USB I/O unit.

I/O Errors

Acquisition and playback errors occur when the I/O board cannot convert data, or when DTDisk cannot cannot store or retrieve data from memory or the hard disk, at the requested sample rate. DTDisk will issue the following message. Possible causes include performing demanding processes in parallel with DTDisk, a slow CPU, or a slow hard disk. Remedies are to terminate other processes, defragment the hard disk, increase CPU or disk capabilities, or reduce sample rate.

Following is a sample acquisition error message:

Disk Fragmentation and Maximum Sample Rate

On older hard disks, fragmentation can degrade the maximum sample rate. Disks can be defragmented by clicking My Computer | Files | Properties | Tools | Defragment Now in Windows 95/98 or My Computer | Local Disk | Properties | Tools | Defragment Now in Windows 2000/XP. This process should be performed with care.

Portability to All Data Translation Analog I/O Cards

DTDisk operates with all Data Translation analog I/O cards. DTDisk automatically makes the installed card's capabilities available, including maximum sample rate and programmable input gain.

Running DTDisk with Multiple DT Analog I/O Boards Installed

If you have installed multiple DT boards in your DT-Open Layers environment, **DTDisk will always select the first installed board**, and will not be able to access other installed DT boards. To access a different DT board, uninstall the undesired DT board (but **not** the DT-Open Layers system driver) according to the instructions in its device driver manual. Repeat this process until only the desired DT board is installed.

Examining DTDisk Output in SIGNAL

By default, DTDisk stores acquired sound files in the directory containing the DTDisk executable. If in doubt about the location of DTDisk output files, use the Windows search facility via Find (Windows 95/98) or Search (Windows 2000/XP) on the Start menu.

12. Technical Notes

Technical Specifications for DTDisk with DT3010 and DT3016

Following are technical specifications of the DTDisk program, operating with the DT3010 and DT3016 analog I/O cards.

	DT3010	**DT3016**
Input characteristics		
Maximum channels	8	8
Minimum sample rate	100 Hz	100 Hz
Maximum sample rate	1250 kHz	250 kHz
Programmable gain	1, 2, 4, 8	1, 2, 4, 8

Impedance	100 M-ohm	100 M-ohm
Noise (re max signal)	n/s	n/s
THD	-71 dB	n/s

Output characteristics

Maximum channels	2	2
Minimum sample rate	100 Hz	100 Hz
Maximum sample rate	500 kHz	200 kHz
Impedance	n/s	n/s
Noise (re max signal)	n/s	n/s
THD	n/s	n/s

Input/output characteristics

No. sample rates	> 1000	> 1000
Maximum signal level	± 10 Volts	± 10 Volts
Maximum signal length	Limited by physical disk size	
Digitizing resolution	12-bit = 72 dB	16-bit = 96 dB
Converter type	Linear	Linear
Anti-alias filter	Not included	Not included

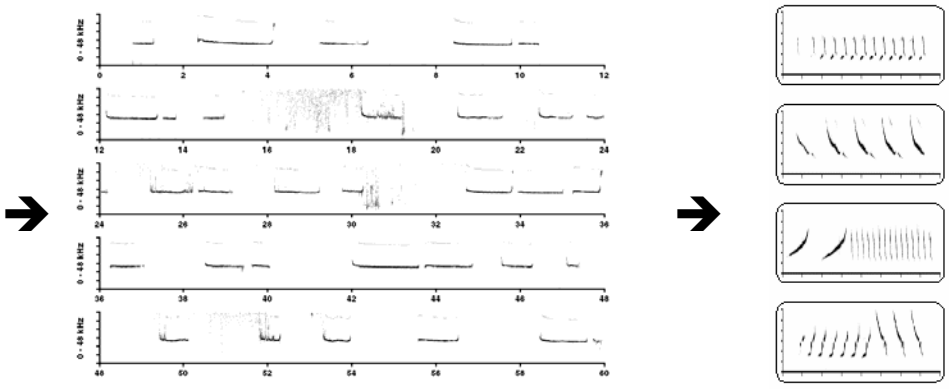
n/a = not applicable, n/s = not specified

13. Using DTDisk and SIGNAL

DTDISK can be used in conjunction with the **SIGNAL**[tm] sound analysis program to record extended acoustic data sequences, then locate and analyze the sound events within them. This section describes the overall approach, basic tools, and important information sources. The two programs work together as follows:

- **DTDisk** provides long-duration high-frequency direct-to-disk recording, producing long continuous sound files in the SIGNAL or Wave sound file format.
- **SIGNAL** can display the entire sound file (see below), which the researcher can use as a roadmap to extract specific sound events. SIGNAL can manually extract, display, measure, and analyze these events and store them as individual sound files. SIGNAL can also be programmed to perform acoustic measurements automatically on the stored events.

Subject **Microphone** **Record sound file in DTDisk**



Continous sound spectrogram in SIGNAL using STRIP **Edit and measure sound events in SIGNAL**

The above figure illustrates this process. Following is an overview of the steps involved.

1. Present the acoustic vocalization stream to the microphone or hydrophone.
2. Connect the microphone or hydrophone to the DTDisk input panel.
3. Use DTDisk to digitize and record the vocalization stream to one or more continuous sound files. Normally, set the DTDisk sample rate to at least 2.5 times the desired recording bandwidth.
4. Start SIGNAL and use the STRIP command to view a continuous spectrogram of the recorded sound file. STRIP produces a multi-screen "strip-chart" frequency-time spectrogram with typically 30-60 seconds of sound per screen. This allows the user to navigate through a long recording, spotting sound events and extracting them for detailed analysis. Settings such as frequency range and spectrogram resolution can be used to customize the display. **Note:** STRIP settings can be collected in a SIGNAL macro for convenience.
5. After using STRIP to review the sound file and locate vocalization events, read individual events into SIGNAL using the R /Q command.

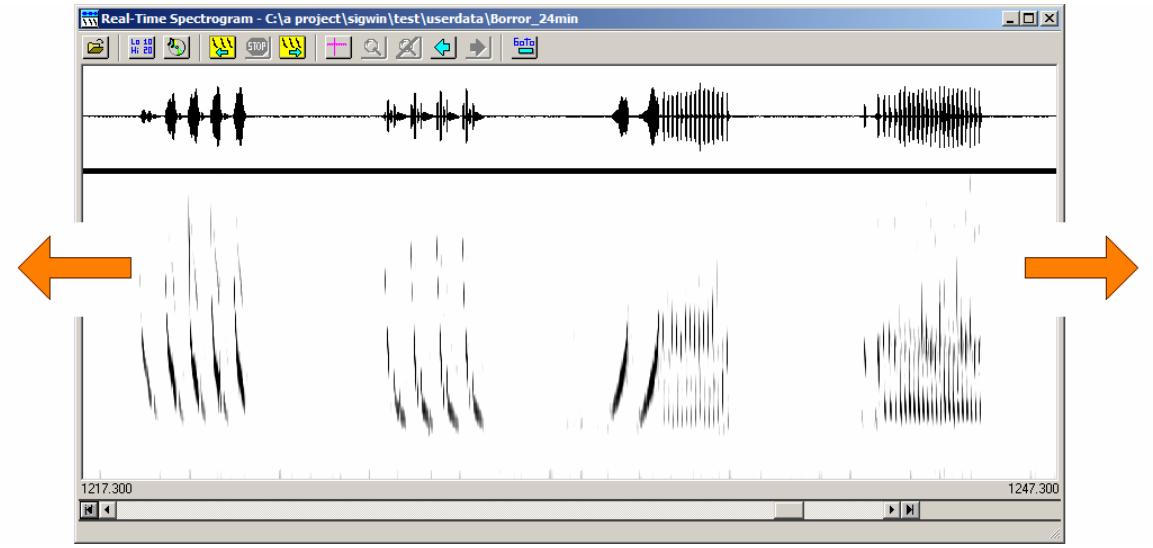
6. Use SIGNAL to measure and analyze the sound events. Events can also be saved on disk as individual sound files if desired.
7. SIGNAL can be programmed to perform many acoustic measurements automatically on an entire group of sound files. See the programming chapters in the ***SIGNAL User Guide***.

14. Using DTDisk with RTS

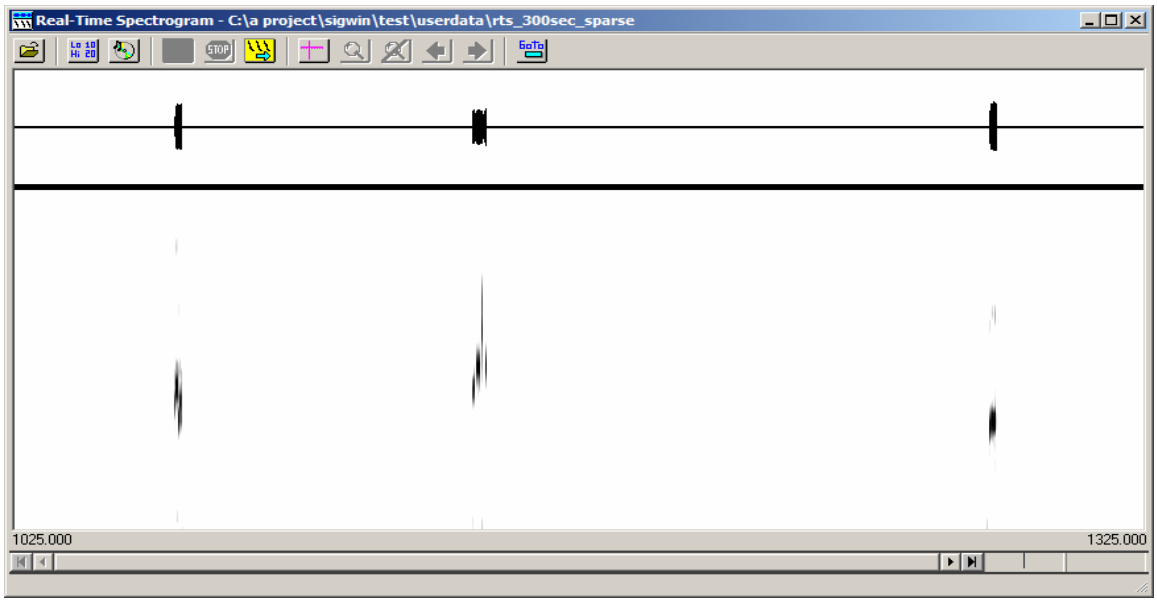
DTDISK can be used together with the **Real-Time Spectrogram™ (RTS)** program to record and visually review, measure, and edit extended acoustic data sequences up to hours in length. The two programs work together as follows:

- **DTDisk** can digitize an entire data tape to a sound file, or perform direct-to-disk recording, bypassing the tape entirely.
- **RTS** can rapidly page or scroll through the sound file on-screen, while measuring, extracting, and storing sound parameters and sound segments directly from the screen. Navigating a sound file on disk is much more efficient than playing, pausing, and replaying from a tape player!

The RTS can scroll or page rapidly forward or backward through a sound file to search for events interest. For example, the following 30-second sample screen was scrolled in 3 seconds – a review rate of **10 times real-time!** The user can also page through the sound file in either direction at **15 times real-time.**



The wide screen and high-resolution spectrogram of the RTS can be used to locate events in sparse data sets. For example, the sparse sound file in the following figure was displayed in **5-minute** segments, in which the 3 events are clearly visible. With 3 seconds to draw or scroll a new screen, this allows sparse data sets to be analyzed at **100 times real-time.** Once located, individual events can be zoomed for close examination.



The RTS runs within SIGNAL, so sound segments can be transferred easily to SIGNAL buffers for immediate analysis, and measured sound parameters can be stored in the SIGNAL logfile. In the following figure, the RTS has saved 6 events in SIGNAL buffers and 11 measurement records have been stored in the SIGNAL logfile. Events can also be stored as SIGNAL, Wave, or AIFF sound files for later analysis.