

NAME

dsepr, dcap, qcap, dsepavg, dcavg, qcavg – capture data from A/D, separate into frames, and average

SYNOPSIS

dcap [-nsi] [-nbi] [-nti i ...] [-nui i ...] [-ti] [-m mode] [-df[smu]] [-wf[smu]] [-lf[smu]] [-ff] [-sf] [[-o] outfile] [-r list] [-c file]

qcap [-nsi] [-npi] [-nbi] [-nti i ...] [-nui i ...] [-ti] [-m mode] [-df[smu]] [-wf[smu]] [-lf[smu]] [-bf[smu]] [-ff] [-sf] [[-o] outfile] [-r list] [-c file]

dsepr [-nsi] [-nbi] [-nti i ...] [-nui i ...] [-ti] [-m mode] [-df[smu]] [-wf[smu]] [-lf[smu]] [-ff] [infile] [-o outfile] [-c file]

dcavg [-nsi] [-nbi] [-nti i ...] [-nui i ...] [-ti] [-m mode] [-df[smu]] [-wf[smu]] [-lf[smu]] [-ff] [-sf] [[-o] outfile] [-r list] [-c file]

qcavg [-nsi] [-npi] [-nbi] [-nti i ...] [-nui i ...] [-ti] [-m mode] [-df[smu]] [-wf[smu]] [-lf[smu]] [-bf[smu]] [-ff] [-sf] [[-o] outfile] [-r list] [-c file]

dsepavg [-nsi] [-nbi] [-nti i ...] [-nui i ...] [-ti] [-m mode] [-df[smu]] [-wf[smu]] [-lf[smu]] [-ff] [infile] [-o outfile] [-c file]

DESCRIPTION

Dcap and *qcap* capture a *run* of data from the A/D converter. A run consists of a set of *triggered channels*, and a set of *untriggered channels*. The triggered channels are stored in a *frame file*, and the untriggered channels are stored in individual *waveform files*. Each channel can be sampled at any rate that is an integer fraction of the specified sampling rate.

Dcavg and *qcavg* capture a *run* of data from the A/D converter, much like *dcap* and *qcap*. The difference is that only one frame is generated in the frame file, consisting of the *average* of all sweeps triggered from each of the *triggered channels*. (If you select a multi-bin average, there will be one frame generated in the frame file for each bin.) The untriggered channels are stored in individual *waveform files*, in the usual way.

You will be prompted to hit RETURN or SPACE to start the capture.

Dcap and *dcavg* perform a disk capture; *qcap* and *qcavg* perform a queued capture. A disk capture allows a higher transfer rate, but requires more processing time. (*Dcavg* will defer the calculation of the average until after the data have been captured, limiting its usefulness.) The queued capture allows you to stop the data capture before the run length has expired, by typing a **Q**, or by limiting the number of sweeps. The queued capture also allows you to pause the capture of triggered channels, by hitting SPACE, or by setting the number of sweeps to capture before an automatic pause. (See *PAUSING CAPTURE* below.)

Dsepr reads an existing file of captured data, in *raw direct-to-disk capture* form, and separates the triggered and untriggered channels. *Dsepavg* does so as well, averaging the sweeps taken from the triggered channels.

These programs will always create a frame file, with the file name suffix **.frm**, which will contain, at the very least, a run header to be used by the analysis software. For unaveraged captures, the run header will be followed by one *frame* for each trigger pulse detected. This frame will contain raw data points from each triggered channel, captured for the duration of the frame sampling window. For averaged captures, the run header will be followed by a single frame for a normal average, or several frames representing the bins in a multi-bin average, provided at least one trigger pulse was detected. Frames in an averaged run contain an averaged trace for each of the triggered channels.

For each untriggered channel, a separate file is created, with the file name suffix **.wnn**, where *nn* is a 2 digit (decimal) waveform number. The first untriggered channel will be waveform 00; the next, waveform 01; and so on.

Dcap and *dcavg* also produce the *raw direct-to-disk capture* data file, with the file name suffix **.raw**, which contains data points from all specified channels, sampled at the given sampling rate. (This is not

to be confused with a *raw run file*, which has been processed to separate the channels, but in which the traces have not been averaged.)

Running display of average

When *qcavg* is called from *cavg(1)*, the averaged traces are displayed periodically on the screen while they are being calculated, so you can see what you are capturing. The display update frequency varies with the amount of data to be displayed. The fewer the number of traces you are averaging, or the shorter the lengths of the traces, the more often the display is updated. The traces can either be overlaid, or stacked vertically with trace 0 at the top. If this is a multi-bin average, the bins are laid out from left to right.

Options

Below is a list of the command line options allowed. In this list, integer quantities are denoted by *i*, and floating-point quantities are denoted by *f*.

- nsi** Specifies the maximum number of sweeps allowed. Processing will cease after this number of sweeps has been triggered, even if the run length has not yet expired. Note that *dcap* and *dcavg* will perform the direct-to-disk capture for the entire run length, before even looking for sweeps. Limiting the number of sweeps for a disk capture will affect the way the run file is processed, but will not limit the size of the *raw direct-to-disk capture* file, nor limit the time taken to capture it.
- npi** Specifies the number of sweeps (or frames) which will be captured, before automatically pausing the capture of data from the triggered channels. This works for queued captures (*qcap* and *qcavg*) only. Triggered capture will pause after this number of sweeps have been triggered. In *qcap*, you are asked to enter a description of the frames just captured. You can then wait, and resume triggered capture, just like when the pause facility is invoked directly, by pressing the space bar during a queued capture. (See *PAUSING CAPTURE* below.) If you set this parameter to **0** (the default), then automatic pausing will not take place.
- nbi** Specifies the number of bins used in a multi-bin, real-time average. The unaveraged captures performed by *dsepr*, *dcap*, and *qcap* will not actually use bins, but if you set this option to **1**, it will enable automatic tagging of frames; otherwise, the tagging information is ignored. For averaged captures, when this number is **0** (the default), the average is a single bin (single frame) containing all sweeps captured, and the tagging information is ignored. When another number is given, the averages are calculated in the specified number of bins, where each bin receives sweeps with a specific tag value. (I.e. sweeps with tag 0 go in the 1st bin, tag 1 in the 2nd, and so on.) The bins are written out to the frame data file as one frame for each bin. The difference between specifying 0 and 1 for this option is that when 0 is specified, the tag values are ignored, and when 1 is specified, only sweeps with tag value 0 are included in the one-bin average. See *TAGGING* below for more details.
- nti i ...**
Specifies the number of triggered channels to extract, followed by up to that number of sample rate divisors for each channel. If this option is selected, the first channel in the input sequence is used as the trigger, followed by the specified number of triggered channels, followed by the untriggered channels (if any). The divisors are used to divide the sampling frequency, allowing each channel to be stored at a different frequency. Missing divisors default to zero (i.e. don't save points from this channel), and any extra divisors are ignored.
- nu i ...**
Specifies the number of untriggered channels to extract, followed by up to that number of sample rate divisors for each channel. The divisors are used to divide the sampling frequency, allowing each channel to be stored at a different frequency. Missing divisors default to zero (i.e. don't save points from this channel), and any extra divisors are ignored.
- ti** Set the trigger pulse threshold to *i* (A/D units); default is **150**. This value determines the change in amplitude required on the trigger pulse channel, in two sampling periods, to trigger a frame. The value must be large enough to avoid triggering on noise, and small enough so no trigger pulses are

missed.

-m mode

Specifies the trigger mode to be used for scanning the trigger signal for trigger pulses, and deciding what action to take if the trigger rate is too fast for the current window. The *mode* can be one of **C**, **R** or **I**, (upper- or lower-case), corresponding to "check" mode, "retrigger" mode, and "ignore" mode. The default is "ignore" mode, where the trigger signal is only scanned between triggered sweeps, not during active windows. Any triggers occurring before the end of the window are ignored. In "check" mode, the trigger signal is scanned continuously; if any triggers occur before the end of the window, a warning is given. In "retrigger" mode, the trigger signal is also scanned continuously; if a trigger occurs before the end of the window, the current sweep is stopped, and a new sweep is triggered. (For reverse compatibility, the mode can also be **F** – "fast" mode – which is equivalent to "ignore" mode.)

-d[f[smu]

Set the post trigger delay to *f*, where *f* is given as a number of samples (at specified sampling rate) or as seconds, milliseconds or microseconds if followed by one of the letters **s**, **m**, or **u**. If a negative delay is specified, it indicates the amount of pre-trigger sampling desired, i.e. the window will start before the trigger by that amount. (Default is **0**.)

-wf[smu]

Set the frame sampling window to *f*, where *f* is specified as above. (Default is **50m**.)

-l[f[smu]

set the overall run length to *f*, where *f* is specified as above. (Default is **10s** for *dcap*, *qcap*, *dcavg* and *qcavg*; entire input file for *dsepr* and *dsepavg*.)

-bf[smu]

Set the total buffer length (i.e. for entire queue) to *f*, where *f* is specified as above. (Default is **2s**; used by *qcap* and *qcavg* only.)

-ff Specifies the sampling frequency (in Hz) used during the capture. (Default is **10000**.)

-sf Specifies the channel scanning frequency (conversion rate, in Hz) for the capture. (Used by *dcap*, *qcap*, *dcavg* and *qcavg* only.)

-stf Specifies the channel number and signal threshold for the channel to be monitored for stimulator triggering. (Used by *qcap* and *qcavg* only.) On systems configured for queued, networked capture and stimulator control, this parameter specifies at least these two numbers, separated by punctuation. When the signal on the specified channel crosses the given threshold, *qcap* will turn on the digital output that controls the stimulator, and turn it off again when the signal drops below that level. Specify the channel number first, followed by the threshold, separated by punctuation (e.g., a comma, slash or "at" sign). The threshold is specified in A/D levels, or can be followed by "uV", "mV" or "V" if specified in microvolts, millivolts or volts. You can optionally include a hysteresis level after the threshold, again separated by a punctuation character, and again optionally followed by a voltage specifier. The hysteresis is specified relative to the threshold level: if you specify a negative hysteresis, the signal must drop by that amount below the threshold before the digital output is turned off; if positive, the triggering is based on a negative crossing of the threshold, and the digital output is turned off again after the signal rises above the threshold plus the hysteresis. Finally, you can optionally include one or two delays after the hysteresis, again separated by a punctuation character, and optionally followed by a time specifier of "us", "ms" or "s". Without the time specifier, the delays are in sampling periods at the sampling rate selected by the **-f** option. The first delay is the time from the detection of the threshold crossing (plus a few milliseconds of jitter elimination) to the beginning of the output trigger pulse. If a second delay is given, it will be a post-trigger delay before scanning resumes for the next threshold crossing.

infile Specifies the file containing the *raw direct-to-disk captured* data. (Default is the standard input; used by *dsepr* and *dsepavg* only.)

-o *outfile*

Specifies the base name to be used for all output files. (Each will have its own suffix added.) Default is *infile* (with **.raw** suffix removed, if present), or **data** if *infile* is not specified. (For *dcap*, *qcap*, *dcavg* and *qcavg*, the **-o** flag is not required, and the default *outfile* is **data**.)

-r *list*

Specifies the random channel list to be used to determine the channel sequence. The *list* is either a string, or a file: if the argument is not the name of an existing file, the program tries to scan the string. The string is a list of channel numbers, in the desired order, separated by commas or spaces (the string should be quoted). The file is a free-format list of pairs of integers, where the first integer is the channel number, and the second is a code indicating the gain. This gain code is ignored, since the gain values are taken from the calibration information file. They are included in the *file* for purposes of historical compatibility with Masscomp's random channel list format. Duplicate channels may appear in the channel list, as the list will be optimized such that repeated channels are only sampled once per sampling period, even if they are to be used more than once, e.g. to capture a channel as both triggered and untriggered signals. The size allowed for the channel list depends on what the A/D hardware will allow, but most modern devices support 256 entries, which is more than enough to support all the traces and waveforms that can be captured. (Default sequence is channels 0 to 15 in that order; used by *dcap*, *qcap*, *dcavg* and *qcavg* only.) For A/D hardware that cannot handle random channel addressing, such as the EF12M, you need only specify a single channel number; the channels will be sampled sequentially, beginning with this channel.

-c *file*

Specifies the calibration file to be used for setting the calibration information in the run header. If this option is omitted, calibration information is taken from **default.cal**, if it exists in your current directory, or else from **/usr/neuro/lib/default.cal**. See the calibration overview in *calibrate*(1) to find out more about managing calibration information.

Environment Variables

Certain environment variables have a special meaning to these programs. These environment variables specify various parameters related to the type of A/D converter used. They should be set in your ".login" or ".profile" file, so you won't have to bother setting them each time.

The variable **DACPAD** indicates the device name for the A/D converter. (The default for this is "/dev/dacp0/adf0".) The variables **DACPCLK0** and **DACPCLK1** indicate the device names for the first and second clocks, such as "/dev/dacp0/efclk0" and "/dev/dacp0/efclk1" for the EF12M (Extended Function Module). (The defaults for these are "/dev/dacp0/clk2" and "/dev/dacp0/clk3".) On Linux-based PowerDAQ systems, the A/D doesn't have separate device nodes for the clocks, so these variables are simply set to the same device name as the **DACPAD** variable.

For systems configured to use a networked capture server, such as any NI USB or PCI based systems, as well as any 64-bit Linux system, the **DACPAD** variable will instead indicate the URL used to contact the server. If the data capture server is configured to support stimulator control via a digital output, a parameter in the URL specifies the output that will be used when triggering based on the parameters specified with the **-st** option.

The variable **MAXADRATE** should be set to the maximum allowable channel scanning rate, such as "333333" for the EF12M. (The default is "1000000".)

ADRANDOM must be set to "no" if your hardware cannot support random channel addressing. In this case, a fixed scanning sequence (incremental channel addressing) is used, starting with the first channel in the specified channel list. Also, the list should be in sequential order, otherwise a warning is issued; in any case, the first channel in the list is used to start the sequence. The gain used for all channels is the gain set for this first channel, in the calibration information file; if the gains in the calibration file are not all equal, a warning is issued. **MAXADCHANS** should be set to the number of channels supported by your A/D hardware, if it is anything other than the default of "16".

TAGGING

It is often useful to tag individual frames, based on conditions at the time the frame was captured. The *analysis*(1) program can use these tag values to accept or reject certain frames when averaging or measuring. *Frmsel*(1) can be used to tag frames after they are captured. It is more convenient, however, to get *dcap*, *qcap* or *dsepr* do this automatically, while generating frames. This can only be done if you have the required hardware support. You must set the *number of bins* option to **1** (**-nb1**) to enable this feature of the software.

In order to perform multi-bin averaging, it is necessary for *dcavg*, *qcavg* or *dsepavg* to automatically tag individual sweeps, based on conditions at the time the sweep was captured. Again, this can only be done if you have the required hardware support. You must set the *number of bins* option to a non-zero value to enable this feature of the software.

The tag values are obtained by sampling an encoded level on the trigger channel. This encoded level can represent up to eight different states of your signal-generating or signal-processing hardware, at the time a trigger pulse is generated. The trigger signal is sampled 0.5 ms, 2 ms, and 4 ms after the onset of a trigger pulse. The first sample measures the height of the pulse, which should be 1 ms wide. After the pulse, and before the trigger signal returns to the baseline level, this signal is expected to drop to a level between 0 and 7 sevenths of the trigger pulse height, for a length of 2 ms. The second sample measures this level, and interprets it as a tag value of 0 to 7. The third sample gives the baseline reference level. A good trigger pulse height is 1.75 Volts – that is the level we use on our systems. In other words, our trigger signals vary between 0 and 7 eights of 2 Volts. The trigger rate should never exceed about 200 Hz when using this automatic tagging scheme, to prevent false tagging. The capture rate should also be fairly high also (not less than about 5000 Hz) to guarantee adequate resolution in the levels sampled.

If your hardware cannot generate the encoded hardware state level, it should still generate a 1 ms trigger pulse; the second sample, which will be at baseline level, will always be interpreted as a tag value of 0. If your trigger pulses are not 1 ms wide, or if the trigger signal is not a clean, square signal, be sure to leave the *number of bins* option at **0**, or the capture may behave unpredictably – frames with a bad tag level are marked as deleted in the run. The program will give you a warning, at the end of the capture, if any frames were deleted because of this.

PAUSING CAPTURE

While *qcap* and *qcavg* are capturing and processing data, they are also checking the keyboard. If you type a **Q** during a queued capture, then the data capture will stop.

If you press the SPACE bar during a queued capture, then the capture of *triggered* channels is temporarily suspended. If you are also capturing *untriggered* channels, they will continue to be captured; it is merely the trigger signal which is ignored when you pause the capture.

In *qcap*, you will be asked to enter a description of the frames captured up to the point where SPACE was hit. You can enter a brief, one line description, then hit RETURN. This description is stored, along with the range of frame numbers, as a line of text in the frame description file. This file, which has the file name suffix **.frd**, is created the first time the capture is paused. If you just hit RETURN, without entering a description, then only the range of frame numbers is stored. The file can be edited later, to add or correct descriptions.

You are then asked to hit RETURN or SPACE to continue the capture of triggered channels, or type **Q** to stop the capture. If you continue, the trigger signal will again be scanned, causing the capture of triggered channels to resume. You can then hit SPACE again, later, to pause again.

START TIME

As of March 2015, captured run files record the start time in the run header, to track the actual time the data capture started for a given run. Before this, we could only estimate this based on the modification time of the oldest waveform files for a run, as anything else was subject to subsequent modification. We use a standard Unix-style *time_t* format data type for this, which records seconds since midnight UTC of January 1st, 1970. When displaying this time, e.g. in *dumprun*, *qm* or *analysis*, it is converted to local time and shown in a readable form.

FILES

| | |
|----------------------------|--|
| default.cal | calibration information |
| /usr/neuro/lib/default.cal | system calibration file |
| *.raw | produced by <i>dcap</i> and <i>dcavg</i> |
| *.frm | the frame file |
| *.w[0-9][0-9] | untriggered waveforms |
| *.frd | the frame description file |

SEE ALSO

cap(1), cavg(1), calibrate(1), lsrn(1), frmselect(1), analysis(1), qm(1)

BUGS

Due to bugs in the kernel (pre-3.0 release), *dcap* and *dcavg* may cause the system to hang.