WaveAnl - Waveform Analysis Record

1. Introduction

The waveform analysis record is used to generate statistical parameters of an input array.

Outputs generated by the record are

- Maximum value
- Minimum value
- Peak to Peak
- Mean value
- Mean absolute deviation
- Variance
- Standard deviation
- Full Width Half Maximum (FWHM)
- Eight user defined outputs

To help with plotting the output the record produces an output array for the X axis. Each element of the input array has a corresonding element in the X axis array. The user specifies a resolution and offset for the X axis array.

The user can specify a “region of interest” within the array so that the analysis calculations are performed only on this region. The region is specified in the units of the X axis.

A user-supplied baseline value is subtracted from the input data prior to calculating the FWHM value.

Most of the outputs are self descriptive. Although referred to as FWHM, the record can calculate the width of a peak at any fraction of its maximum value, by the setting of a user-defined threshold value. For example, setting the threshold to 0.1 would result in a value for "Full Width One-tenth Maximum" being calculated. A time resolution field is also available for scaling the FWHM value.

In addition, user specified subroutines can be called at initialistion and during processing. Eight inputs and eight outputs are provided for use by these subroutines. The subroutine called during record processing is actually called twice each time the record is processed, once before and once after the analysis calculations are performed. This allows the user to pre and post process data.

2. Scanning Parameters

The waveform analysis record has the standard fields for specifying under what circumstances the record will be processed. These fields are listed in Scan Fields, of the

record reference manual. In addition, the chapter on Scanning Specification explains how these fields are used. Since the waveform analysis record supports no direct interfaces to hardware, its SCAN field cannot specify I/O Intr.

3. Inputs and Algorithm Parameters

These fields determine what channel to read and what to do with the data.

The waveform analysis record has twelve input links. INP is the main input link and is used to input arrays of type DOUBLE. The input specification should be a database or channel access link. The values retrieved from the input link are placed in the input aray which is referenced by VAL. See the chapter on Address Specification in the record reference manual for information on specifying links.

The number of elements in the records array is specifed by setting NELM. Space for the array is allocated at initialization time, the space allocated being NELM doubles. It is not possible to change the value of NELM at run time. Therefore if INP is connected to an input that supplies more than the number of elements specified by NELM only the number of elements specified by NELM will be used. If INP is connected to an input that supplies less than the number of elements specified by NELM then only the number of elements supplied by the input record will be used in calculations.

The XRES field provides a scaling factor for the X axis sample resolution. It can be set as a constant or be obtained via the XRSL link. The default value of XRES is 1.

The XOFF field provides an offset value for the X axis array. It can be set as a constant or be obtained via the XOFL link. The default value of XOFF is 0.

The value of the i^{th} element of the X axis array equals $i \times XRES + XOFF$. Values of the X axis array are automatically recalculated if XRES or XOFF change.

The XRES field also provides a scaling factor for the FWHM value. The result of the FWHM calculation is divided by the XRES value to give the FWHM value in the required units. For example: If the time interval between samples is 100mS, to give FWHM in units of 1mS XRES would be set to 0.01.

The BLOF field holds a baseline offset value which is sunbtacted from the input data prior to calculating the FWHM. The BLOF value can be a constant or obtained via the BLOL input link.

A “region of interest” within the input data can be specified by the user. The analysis will only performed on input data withis the region of interest. The beginning and end of the region of interest are specified in the BGRI and ENRI fields respectively. The region of interest is specified in units of the X axis. If no values are specified for BGRI and ENRI the region of interest will be the whole input array. If BGRI or ENRI are outside the array bounds then the record will limit the region of interest to the input array by modifying either BGRI or ENRI. If BGRI is greater than ENRI then the values will be swapped.

The THLD field sets the threshold at which the width measurement is taken. The default is 0.5 which gives FWHM measurement. A value of 0.25 would give the width at one quarter maximum.

Inputs INPA through INPH, each of which has a corresponding value field (A through H) are inputs that can be used by the user subroutine to retrieve and store values.

The user input links can be either channel access or database links, or constants. When constants, the corresponding value field for the link is initialized with the constant value and the field's value can be changed at run-time via dbPuts. Otherwise, the values for A through H are fetched from the input links when the record is processed. See Address Specification in the record reference manual, for information on specifying links.

Field	Summary	Type	DCT	Initial	Access	Modify	Rec. Proc. Monitor	PP
INP	Input link for waveform	INLINK	Yes	0	No	Yes	N/A	No
NELM	Number of elements	ULONG	Yes	2	Yes	No	No	No
XRES	X axis resolution	DOUBLE	Yes	1	Yes	Yes	No	No
XRSL	X axis resolution location	INLINK	Yes	0	No	Yes	N/A	No
XOFF	X axis offset	DOUBLE	Yes	0	Yes	Yes	No	No
XOFL	X axis offset location	INLINK	Yes	0	No	Yes	N/A	No
BLOF	Baseline offset value	DOUBLE	Yes	0	Yes	Yes	No	No
BLOL	Baseline offset location	INLINK	Yes	0	No	Yes	N/A	No
BGRI	Beginning of region of interest	DOUBLE	Yes	0	Yes	Yes	No	No
ENRI	End of region of interest	DOUBLE	Yes	0	Yes	Yes	No	No
THLD	FWHM threshold	DOUBLE	Yes	0.5	Yes	Yes	No	No
INPA	User input link A	INLINK	Yes	0	No	Yes	N/A	No
INPB	User input link B	INLINK	Yes	0	No	Yes	N/A	No
INPC	User input link C	INLINK	Yes	0	No	Yes	N/A	No
INPD	User input link D	INLINK	Yes	0	No	Yes	N/A	No
INPE	User input link E	INLINK	Yes	0	No	Yes	N/A	No
INPF	User input link F	INLINK	Yes	0	No	Yes	N/A	No
INPG	User input link G	INLINK	Yes	0	No	Yes	N/A	No
INPH	User input link H	INLINK	Yes	0	No	Yes	N/A	No
A	Value for A	DOUBLE	No	0	Yes	Yes	No	No
B	Value for B	DOUBLE	No	0	Yes	Yes	No	No
C	Value for C	DOUBLE	No	0	Yes	Yes	No	No
D	Value for D	DOUBLE	No	0	Yes	Yes	No	No
E	Value for E	DOUBLE	No	0	Yes	Yes	No	No
F	Value for F	DOUBLE	No	0	Yes	Yes	No	No
G	Value for G	DOUBLE	No	0	Yes	Yes	No	No
H	Value for H	DOUBLE	No	0	Yes	Yes	No	No

4. Algorithms and Outputs

The record produces the following outputs:

- maximum value
- minimum value
- mean value
- mean absolute deviation
- variance
- standard deviation
- Full Width Half Maximum
- Eight user defined outputs

Maximum, minimum and mean values are self explanatory.

The mean absolute deviation is given by:

$$MADev(x_1 \ldots x_N) = \frac{1}{N} \sum_{j=1}^{N} |x_j - \bar{x}|$$

Variance is given by:

$$Var(x_1 \ldots x_N) = \frac{1}{(N-1)} \sum_{j=1}^{N} (x_j - \bar{x})^2$$

Standard deviation is the square root of the variance, i.e.

$$StdDev(x_1 \ldots x_N) = \sqrt{Var(x_1 \ldots x_N)}$$

The FWHM calculation assumes that the waveform has one peak.

Field	Summary	Type	DCT	Initial	Access	Modify	Rec. Proc. Monitor	PP
MAX	Maximum value	DOUBLE	No	0	Yes	No	Yes	No
MIN	Minimum value	DOUBLE	No	0	Yes	No	Yes	No
MADV	Mean absolute deviation	DOUBLE	No	0	Yes	No	Yes	No
MEAN	Mean	DOUBLE	No	0	Yes	No	Yes	No
VAR	Varience	DOUBLE	No	0	Yes	No	Yes	No
SDEV	Standard deviation	DOUBLE	No	0	Yes	No	Yes	No
FWHM	Full Width Half Maximum	DOUBLE	No	0	Yes	No	Yes	No
PKPK	Peak to Peak	DOUBLE	No	0	Yes	No	Yes	No
XPTR	Reference to x-axis array	DOUBLE	No	0	Yes	No	No	No
VAL	Reference to input array	DOUBLE	No	0	Yes	Yes	No	No
VALA	User output value A	DOUBLE	No	0	Yes	Yes	Yes	Yes
VALB	User output value B	DOUBLE	No	0	Yes	Yes	Yes	Yes
VALC	User output value C	DOUBLE	No	0	Yes	Yes	Yes	Yes
VALD	User output value D	DOUBLE	No	0	Yes	Yes	Yes	Yes
VALE	User output value E	DOUBLE	No	0	Yes	Yes	Yes	Yes

Field	Summary	Type	DCT	Initial	Access	Modify	Rec. Proc. Monitor	PP
VALF	User output value F	DOUBLE	No	0	Yes	Yes	Yes	Yes
VALG	User output value G	DOUBLE	No	0	Yes	Yes	Yes	Yes
VALH	User output value H	DOUBLE	No	0	Yes	Yes	Yes	Yes

5. User Subroutines

The SNAM and INAM fields are used to connect to the user-supplied C subroutines. They are optional, if not set, no subroutines will be executed.

The name of a C subroutine to be executed at initialization time should be entered in the INAM field.

The name of the subroutine to be executed during record processingshould be entered in the SNAM field. The subroutine name can be changed at run time. The record will execute the new routine if it is available. If the routine can't be found an error will be generated.

The subroutine is executed twice during record processing. It is first executed prior to any analysis being performed on the input data,with the PASS field set to 0. Once the record has performed its analysis of the input data the user subroutine is called again, this time with the PASS field set to 1.

The SADR field is used by the record to hold the address of the subroutine.

If either subroutine returns a value less than zero a SOFT_ALARM is raised with severity given by the BSVR field.

The user subroutines return a long (0 for success, <0 for failure) and take a single argument which is a pointer to the record:

```
long userFunc(waveAnlRecord *pwanl);
```

Field	Summary	Type	DCT	Initial	Access	Modify	Rec. Proc. Monitor	PP
INAM	Initialization subroutine name	STRING[40]	Yes	Null	Yes	Yes	No	No
SNAM	Subroutine name	STRING[40]	Yes	Null	Yes	Yes	No	No
PASS	Pass count	SHORT	No	0	Yes	No	No	No
SADR	Address of subroutine	LONG	No	0	Yes	No	Yes	No
BSVR	Severity for a subroutine returning a value less than zero	GLBLCHOICE	Yes	0	Yes	Yes	No	Yes

6. Operator Display Parameters

These parameters are used to present meaningful data to the operator. They display the value and other parameters of the record either textually or graphically.

The record has fields that are related to either the X axis or the Y axis.

The X axis fields are: XRES, XOFF and XPTR.

The Y axis fields are: VAL, MAX, MIN, MEAN, VAR, SDEV, MADV, FWHM, PKPK, VALA...VALH, and A...H.

The HORX and LORX fields specify the display range for the X axis fields.

The HORY and LORY fields specify the display range for the Y axis fields.

The EGUX field should be given a string that describes units used for the X axis.

The EGUY field should be given a string that describes units used for the Y axis.

PREC controls the floating-point precision whenever get_precision is called, and the field being referenced is the VAL field.

See the chapter Fields Common to All Record Types in the record reference manual, for more on the record name (NAME) and description (DESC) fields.

Field	Summary	Type	DCT	Initial	Access	Modify	Rec. Proc. Monitor	PP
HORX	High operating range for X axis fields	FLOAT	Yes	0	Yes	Yes	No	No
LORX	Low operating range for X axis fields	FLOAT	Yes	0	Yes	Yes	No	No
HORY	High operating range for Y axis fields	FLOAT	Yes	0	Yes	Yes	No	No
LORY	Low operating range for Y axis fields	FLOAT	Yes	0	Yes	Yes	No	No
EGUX	Engineering units for X axis fields	String[16]	Yes	Null	Yes	Yes	No	Yes
EGUY	Engineering units for Y axis fields	String[16]	Yes	Null	Yes	Yes	No	Yes

7. Alarm Parameters

The waveform analysis record has the alarm parameters common to all record types. The Alarm Fields section in the record reference manual lists fields related to alarms that are common to all record types.

8. Run-time Parameters

These parameters are used by the run-time code for processing the data. They are not configurable by the user.

9. Record Support Routines

10. Record Processing