Example

```
Function Test()
    SetDataFolder root:
    Make/O/FREE aaa
    Make/O bbb
    Make/O/WAVE/N=3 wr
    Wr[0]=aaa
    // Wr[1] is null by initialization.
    wr[2]=bbb
    Print WaveRefWaveToList(wr,0)
End

// Executing Test() gives:
  ;;root:bbb;
```

The first empty string corresponds to the free wave 'aaa' and the second empty string corresponds to the null entry in the wave reference wave.

See Also

ListToWaveRefWave, **ListToTextWave**, **Wave References** on page IV-71

WaveStats

WaveStats [***flags***] ***waveName***

The WaveStats operation computes several statistics on the named wave.

Flags

/ALPH=*val* Sets the significance level for the confidence interval of the mean (default *val*=0.05).

/C=*method* Calculates statistics for complex waves only. Does not affect real waves.

You can use *method* in various combinations to process the real, imaginary, magnitude, and phase of the wave. The result is stored in the wave M_WaveStats (see **Details** for format).

method is defined as follows:

method=0: Default; ignores the imaginary part of *waveName*. Use /W to also store statistics in M_WaveStats.

method=1: Calculates statistics for real part of *waveName* and stores it in M_WaveStats.

method=2: Calculates statistics for imaginary part of *waveName* and stores the result in M_WaveStats.

method=4: Calculates statistics for magnitude of *waveName*, i.e., `sqrt(real^2 +imag^2)`, and stores the result in M_WaveStats.

method=8: Calculate statistics for phase of *waveName* using `atan2(imag,real)`.

/CCL When computing per-column statistics using /PCST, /CCL tells Igor to copy the column dimension labels of the input to the corresponding columns of M_WaveStats. /CCL was added in Igor Pro 9.00.

If you use a single *method* the results are stored both in M_WaveStats and in the standard variables (e.g., V_avg, etc.). If you specify *method* as a combination of more than one binary field then the variables reflect the results for the lowest chosen field and all results are stored in the wave M_WaveStats.

For example, if you use /C=12, the variables will be set for the statistics of the magnitude and M_WaveStats will contain columns corresponding to the magnitude and to the phase.

In this mode V_numInfs will always be zero.

Note: If you invoke this operation and M_WaveStats already exists in the current data folder, it will be either overwritten or initialized to NaN.

/M=*moment* Calculates statistical moments.

moment is defined as follows:

moment=1: Calculates only lower moments: V_avg, V_npnts, V_numInfs, and V_numNaNs. Use it if you do not need the higher moments.

moment=2: Default; calculates both lower moments and higher order quantities: V_sdev, V_rms, V_adev, V_skew, and v_kurt.

/Q Prevents results from being printed in history.

/P Causes WaveStats to set the location output variables in terms of unscaled index values instead of the default scaled index values. The location output variables are:

```
V_minRowLoc, V_maxRowLoc, V_minColLoc, V_maxColLoc
V_minLayerLoc, V_maxLayerLoc, V_minChunkLoc, V_maxChunkLoc
```

For 1D waves, `V_minRowLoc` and `V_maxRowLoc` are always unscaled.

/P requires Igor Pro 8.03 or later.

/PCST Computes the statistics on a per-column basis for a real valued wave of two or more dimensions. The results are saved in the wave M_WaveStats which has the same number of columns, layers and chunks as the input wave and where the rows, designated by dimension labels, contain the standard WaveStats statistics. All the V_ variables are set to NaN. Note that this flag is not compatible with the flags /C, /R, /RMD.

The /PCST flag was added in Igor Pro 7.00.

/R=(*startX*,*endX*) Specifies an X range of the wave to evaluate.

/R=[*startP*,*endP*] Specifies a point range of the wave to evaluate.

If you specify the range as /R=[*startP*] then the end of the range is taken as the end of the wave. If /R is omitted, the entire wave is evaluated.

/RMD=[*firstRow*,*lastRow*][*firstColumn*,*lastColumn*][*firstLayer*,*lastlayer*][*firstChunk*,*lastChunk*]

Designates a contiguous range of data in the source wave to which the operation is to be applied. This flag was added in Igor Pro 7.00.

You can include all higher dimensions by leaving off the corresponding brackets. For example:

```
/RMD=[firstRow,lastRow]
```

includes all available columns, layers and chunks.

You can use empty brackets to include all of a given dimension. For example:

```
/RMD=[][firstColumn,lastColumn]
```

means "all rows from column A to column B".

You can use a * to specify the end of any dimension. For example:

```
/RMD=[firstRow,*]
```

means "from firstRow through the last row".

/W Stores results in the wave M_WaveStats in addition to the various V_ variables when /C=0.

/Z No error reporting.

/ZSCR Computes z scores

$$z_i = \frac{Y_i - \bar{Y}}{\sigma},$$

which are saved in W_ZScores.

Details

WaveStats uses a two-pass algorithm to produce more accurate results than obtained by computing the binomial expansions of the third and fourth order moments.

WaveStats returns the statistics in the automatically created variables:

V_npnts	Number of points in range excluding points whose value is NaN or INF.
V_numNans	Number of NaNs.
V_numINFs	Number of INFs.
V_avg	Average of data values.
V_sum	Sum of data values.
V_sdev	Standard deviation of data values, $\sigma = \sqrt{\frac{\sum \left(Y_i - V\_avg\right)^2}{V\_npnts - 1}}$ "Variance" is V_sdev^2.
V_sem	Standard error of the mean $sem = \frac{\sigma}{\sqrt{V\_npnts}}$
V_rms	RMS of Y values $= \sqrt{\frac{1}{V\_npnts}\sum Y_i^2}$
V_adev	Average deviation $= \frac{1}{V\_npnts}\sum_{i=0}^{V\_npnts-1}\left\|Y_i - \bar{Y}\right\|$
V_skew	Skewness $= \frac{1}{V\_npnts}\sum_{i=0}^{V\_npnts-1}\left(\frac{Y_i - \bar{Y}}{\sigma}\right)^3$
V_kurt	Kurtosis $= \left(\frac{1}{V\_npnts}\sum_{i=0}^{V\_npnts-1}\left(\frac{Y_i - \bar{Y}}{\sigma}\right)^4\right) - 3$
V_minloc	X location of minimum data value.
V_min	Minimum data value.
V_maxloc	X location of maximum data value.
V_max	Maximum data value.
V_minRowLoc	Row containing minimum data value. See /P above for further information.
V_maxRowLoc	Row containing maximum data value. See /P above for further information.
V_minColLoc	Column containing minimum data value (2D or higher waves). See /P above for further information.
V_maxColLoc	Column containing maximum data value (2D or higher waves). See /P above for further information.

V_minLayerLoc	Layer containing minimum data value (3D or higher waves). See /P above for further information.
V_maxLayerLoc	Layer containing maximum data value (3D or higher waves). See /P above for further information.
V_minChunkLoc	Chunk containing minimum data value (4D waves only). See /P above for further information.
V_maxChunkLoc	Chunk containing maximum data value (4D waves only). See /P above for further information.
V_startRow	The unscaled index of the first row included in caculating statistics.
V_endRow	The unscaled index of the last row included in caculating statistics.
V_startCol	The unscaled index of the first column included in calculating statistics. Set only when /RMD is used.
V_endCol	The unscaled index of the last column included in calculating statistics. Set only when /RMD is used.
V_startLayer	The unscaled index of the first layer included in calculating statistics. Set only when /RMD is used.
V_endLayer	The unscaled index of the last layer included in calculating statistics. Set only when /RMD is used.
V_startChunk	The unscaled index of the first chunk included in calculating statistics. Set only when /RMD is used.
V_endChunk	The unscaled index of the last chunk included in calculating statistics. Set only when /RMD is used.

WaveStats prints the statistics in the history area unless /Q is specified. The various multidimensional min and max location variables will only print to the history area for waves having the appropriate dimensionality.

The format of the M_WaveStats wave is:

Row	Statistic	Row	Statistic	Row	Statistic	Row	Statistic
0	numPoints	9	minLoc	18	maxColLoc	27	startCol
1	numNaNs	10	min	19	maxLayerLoc	28	endCol
2	numInfs	11	maxLoc	20	maxChunkLoc	29	startLayer
3	avg	12	max	21	startRow	30	endLayer
4	sdev	13	minRowLoc	22	endRow	31	startChunk
5	rms	14	minColLoc	23	sum	32	endChunk
6	adev	15	minLayerLoc	24	meanL1		
7	skew	16	minChunkLoc	25	meanL2		
8	kurt	17	maxRowLoc	26	sem		

meanL1 and meanL2 are the confidence intervals for the mean

$$MeanL1 = V\_avg - t_{\alpha,v}\frac{V\_sdev}{\sqrt{V\_npnts}}, \quad \text{and} \quad MeanL2 = V\_avg + t_{\alpha,v}\frac{V\_sdev}{\sqrt{V\_npnts}}$$

where $t_{a,v}$ is the critical value of the Student T distribution for *alpha* significance and degree of freedom *v*=*V_npnts*-1.