The GHI CAT System Universal Performance Tables

Description and Use

THEORY

During the A/D process, analog signals are converted to digital format by a sampling process. This process produces narrow time slices of data that constitute "samples" of the analog signal. The samples are taken at equal intervals. A reconstruction of the analog signal is possible by stringing together these time slices. However, it is obvious that some information is lost that was between the time slices. Because of this, there are engineering definitions that provide a measurement of the quality of the reconstruction of the digitized time slices. The following tables provide the engineering "numbers" that describe the quality of any digital record captured by a WinCAT type system, considering variables such as the number of channels, sampling record window length, etc.

The CAT system is classified as a transient recorder. This type of device digitizes at very high sampling rates in order to capture short, non-repetitive transient signals, such as those resulting from shock impacts. A relationship between sample time and accuracy of amplitude measurement for transient recorders is given by the "times 10 rule." This rule states that a transient signal may be captured with less than 5% loss of amplitude resolution, if the sampling frequency is 10 times that of the highest frequency component in the transient signal. These tables provide the engineering values for CAT systems operating in this mode, as well as the more traditional Nyquist limited sampling of repetitive signals. In this latter case, accuracy of amplitude of the repetitive signal can be maintained for analytical purposes when the sampling rate is reduced to approximately twice the highest frequency content of the signal being measured. The tables also provide engineering data for this type of recording.

DESCRIPTION OF TABLES

The following tables provide engineering data when using CAT systems in 1 to 16 channel modes. The tables are for CAT systems with 128KB sample memory. The description of the table columns is given below.

Record Length Setting Duration, Seconds.

> These are the time window settings that appear on the WinCAT Setup Menu. There are 13 setable window time capture durations from 0.132Sec to 1300Sec. This capability is provided by decimation of the digital data samples coming from the A/D converter, and relate to the time it will take to fill 128KB of transient capture memory. Regardless of window length, the A/D runs at the rate of 1microsecond per sample.

Sample Rate, S/Sec.

> This is the equivalent sample rate of the CAT system when running with the particular setup.

Transient Upper Frequency Limit, Hz.

> This is the theoretical upper frequency limit for non-repetitive transient signals at this sampling speed setting. It is based on the 10X rule.

Repetitive Upper Frequency Limit, Hz.

> This is the theoretical upper frequency limit for repetitive signals at this sampling speed setting, based on the Nyquist Theorem.

1024 Byte FFT Time Span, milliseconds.

This is the fundamental FFT harmonic time for one cycle of analysis. It is the time, at the window length setting, that encompasses 1024 bytes of digital data. The reciprocal of this time is the fundamental FFT harmonic frequency.

Lowest FFT\PSD Line Resolution, Hz.

These data are the reciprocal of the FFT span time listed in the adjacent column. These data are the lowest frequency resolutions for the setting of the time window.

Highest FFT/PSD Line Freq. Hz.

Since the FFT returns 512 harmonic lines, the highest frequency that can be analyzed with the FFT is 512 times the Fundamental single cycle frequency.

A/A Filter Roll-Off Freq., Hz. Recommended or actual from Optional AA filter card.

When Operating the WinCAT system to record repetitive waveforms (or transient waveforms) with noise components from the transducer, or environment, it is advisable to use anti-alias filters. This column specifies what frequency for the filter.

Upper Analysis Frequency Limit with A/A filters.

When used, the roll-off frequency of the A/A filter must be set to a frequency to accommodate the beginning of attenuation below the cut-off frequency that all filters exhibit. For this reason, the frequency values given in this column are about 20% lower than the figures in the Repetitive Upper Frequency Limit column.

EXAMPLE OF USE

Case #1. Transient shock, 2 channels, data analysis to 10KHz, transient duration of 0.4 sec.

Using the 2 Channel Operation table, select a recording window time that is just longer than the signal. Select 0.65 sec. Reading across, the Transient Upper Frequency Limit, Hz is 10KHz. This is a valid setting of the system in order to preserve amplitude peaks of the transient signal with no more than 5% error.

Case #2. Repetitive waveform vibration, 4 channels, data analysis to 1KHz.

Using the 4 Channel Operation table, find a frequency that is equal or just greater than the desired analysis bandpass. A value of 1.25KHz is found for a recording window time of 13 sec. In this case, it would probably be advisable to use A/A filters unless there is a guarantee of no signal frequency content above 1.25KHz.

Universal Performance Tables, CAT Systems with 128KB Memory

Recording time vs. Digitized bandwidth for 10X and 2X oversampling, lowest FFT and PSD resolution, highest FFT and PSD analysis frequency. Nyquist Limit, Anti-alias filter cut-off frequency and upper analysis frequency when using anti-alias filters. All data for standard memory length (128KB) products.

For 1 Channel Operation

Record Length Setting Duration. Seconds	Sample Rate S/Sec	Transient Upper Frequency Limit Hz*	Repetitive Upper Frequency Limit Hz**	1024Byte FFT Time Span ms	Lowest FFT/PSD Line Resolution Hz	Highest FFT/PSD Line Frequency Hz	AA Filter Roll-Off Frequency Hz***	Upper Analysis Frequency Limit with AA Filter Hz
.132	1,000K	100K	500K	1.02	972	498K	500K	400K
.26	500K	50K	250K	2.05	498	249K	250K	200K
.64	200K	20K	100K	5.12	192	98.3K	100K	80K
1.3	100K	10K	50K	10.2	96	49K	50K	40K
2.6	50K	5K	25K	20.5	49	24.9K	25K	20K
6.5	20K	2K	10K	51	19.2	9.8K	10K	8K
13	10K	1K	5K	102	9.8	5K	5K	4K
26	5K	500	2.5K	205	5	2.5K	2.5K	2K
65	2K	200	1K	510	2	1K	1K	800
130	1K	100	500	1020	1	512	500	400
260	500	50	250	2050	.5	250	250	200
650	200	20	100	5100	.2	100	100	80
1300	100	10	50	10,200	.1	52	50	40

* Upper frequency limit set by 10 times oversampling. Provides maximum error of 5% at peak in transient data.
** Upper frequency for continuous stationary data based on the Nyquist frequency and using Anti-Alias filters.
*** This is the exact Nyquist frequency and would be the theoretical filter frequency if the filter used had no skirt slope. For typical filters, it is suggested that a filter cutoff frequency of 1.2 times this value be used for the filter roll-off point specification.

For 2 Channel Operation

Record Length Setting Duration. Seconds	Sample Rate S/Sec	Transient Upper Frequency Limit Hz*	Repetitive Upper Frequency Limit Hz**	1024Byte FFT Time Span ms	Lowest FFT/PSD Line Resolution Hz	Highest FFT/PSD Line Frequency Hz	AA Filter Roll-Off Frequency Hz***	Upper Analysis Frequency Limit with AA Filter Hz
.132	500K	50K	250K	2.05	488	250K	250K	200K
.26	250K	25K	125K	4.1	244	125K	125K	100K
.64	100K	10K	50K	10.2	98	50K	50K	40K
1.3	50K	5K	25K	20.5	48.8	25K	25K	20K
2.6	25K	2.5K	12.5K	41	25	12.5K	12.5K	10K
6.5	10K	1k	5K	100	10	5K	5K	4K
13	5K	500	2.5K	205	5	2.5K	2.5K	2K
26	2.5K	250	1.25K	410	2.5	1.25K	1.25K	1K
65	1K	100	500	1000	1	512	500	400
130	500	50	250	2050	.5	250	250	200
260	250	25	125	4100	.25	125	125	100
650	100	10	50	10,240	.1	51	50	40
1300	50	5	25	20,400	.05	25	25	20

For 4 Channel Operation

.132	250K	25K	125K	4.1	244	125K	125K	100K
.26	125K	12.5K	62.5K	8.2	122	62.5K	67K	50K
.64	50K	5K	25K	20.5	48.8	25K	25K	20K
1.3	25K	2.5K	12.5	41	24.4	12.5K	12.5K	10K
2.6	12.5K	1.25K	6.25K	82	12.2	6.25K	6.25K	5K
6.5	5K	500K	2.5K	205	5	2.5K	2.5K	2K
13	2.5K	250	1.25K	410	2.44	1.25K	1.25K	1K
26	1.25K	125	625	820	1.22	625	625	500
65	500	50	250	2050	.5	250	250	200
130	250	25	12.5	4100	.244	125	125	100
260	125	12.5	62.5	8020	.122	62.5	62.5	50
650	50	5	25	20,500	.05	25	25	20
1300	25	2.5	12.5	41,000	.024	12.5	12.5	10

For 8 Channel Operation

Record Length Setting Duration. Seconds	Sample Rate S/Sec	Transient Upper Frequency Limit Hz*	Repetitive Upper Frequency Limit Hz**	1024Byte FFT Time Span ms	Lowest FFT/PSD Line Resolution Hz	Highest FFT/PSD Line Frequency Hz	AA Filter Roll-Off Frequency Hz***	Upper Analysis Frequency Limit with AA Filter Hz
.132	125k	12.5K	62.5K	8.2	122	62.5K	62.5K	50K
.26	62.5K	6.25K	31.25K	16.4	61	31.25K	31.25K	25K
.64	25K	2.5K	12.5K	41	24.4	12.5K	12.5K	10K
1.3	12.5K	1.25K	6.25K	82	12.2	6.25K	6.25K	5K
2.6	6.25K	625	3.125K	164	6.1	3.125K	3.125K	2.5K
6.5	2.5K	250	1.25K	410	2.4	1.25K	1.25K	1K
13	1.25K	125	625	820	1.22	625	625	500
26	625	62.5	312	1640	.6	312	312	250
65	250	25	125	4100	.244	125	125	100
130	125	12.5	62	8200	.122	62.5	62.5	50
260	62.5	6.2	31	16,400	.06	31	31	25
650	25	2.5	12.5	41,000	.024	12.5	12.5	10
1300	12.5	1.25	6.2	82,000	.0122	6.25	6.25	5

For 16 Channel Operation

.132	62.5K	6.25K	31.25K	16.4	61	31.25K	31.25K	25K
.26	31.25K	3.1K	16.5K	33	30.5	15.4K	15.4K	12K
.65	12.5K	1.25K	6.25K	82	12.2	6.25K	6.25K	5K
1.3	6.25K	625	3.125K	164	6.1	3.125K	3.1K	2.5K
2.6	3.125K	310	1.65K	330	3.05	1.54K	1.54K	1.2K
6.4	1.25K	125	625	820	1.22	625	625	500
13	625	62.5	312	1640	.6	312	310	250
26	312	31	160	3300	.3	154	150	120
65	125	12.5	62	8200	.122	62.5	62	50
130	62.5	6.2	31	16400	.06	31	31	25
260	31	3.1	16	33,000	.03	15.4	15	12
650	12.5	1.25	6.2	82,000	.0122	6.25	6.2	5
1300	6.25	.62	3.1	164,000	.006	3.1	3.1	2.5