GAGE APPLIED TECHNOLOGIES

CS14105 Hardware Manual

Reorder #: MKT-HWM-PCI01-CS14105
0408

First Edition (August 2004)

Please complete the following section and keep it handy when calling Gage for **technical support**:

Owned by: _____
Serial Number(s): _____
_____
Purchase Date: _____
Purchased From: _____

You must also have the following information when you call:

- Software Driver & Application Version
- Software Development Kit, if applicable
- Brand name and type of computer
- Processor and bus speed
- Total memory size
- Information on all other hardware in the computer

How to reach Gage Applied Technologies for Product Support
Toll-free phone: (800) 567-GAGE Toll-free fax: (800) 780-8411

To reach Gage from outside North America
Tel: (514) 633-7447 Fax: (514) 633-0770

Email: prodinfo@gage-applied.com **Website**: www.gage-applied.com

Table of Contents

What you should receive with your CompuScope 14105 Comm Analyzer

If you order an independent CompuScope 14105 Comm Analyzer card, you should receive the following articles:

- CompuScope 14105 Comm Analyzer card

- You will also receive a number of standard items included with each order:

  Hardware Manual and Installation Guide

Note that you will receive only one copy of the Hardware Manual per order placed with Gage. Additional copies can be requested at order time.

The Hardware Manual is also available in PDF format on the Gage Software Disk or you can download card-specific manuals from Gage's Web site.

  Gage Software Disk (with GageScope Software)

The Gage Software Disk, included at the back of the Hardware Manual and Installation Guide, contains all of the software drivers you need to operate your Gage hardware. The CD also contains all of the installers for the application packages provided by Gage, including Lite, Standard and Professional editions of GageScope.

Note that some packages will only be available if you have purchased the software and have a key provided by Gage.

  CompuScope Certificate of NIST Traceable Calibration

Each CompuScope card is shipped with a Certificate of NIST Traceable Calibration. NIST is the National Institute to Standards and Technologies - the US organization that is responsible for the definitions and measurement of metrology standards.

Prior to shipment, Gage runs each CompuScope card through a battery of over 1000 automated performance verification tests using a NIST traceable calibration source. The tested CompuScope is then considered a NIST traceable calibration instrument for a period of one year – the calibration interval that is generally accepted by the Test and Measurement industry.

  Warranty card

- You may also receive a number of optional items, if purchased:

GageScope® software and Standard or Professional edition Software Key envelope

Software Development Kits (SDKs) & applicable manual(s)

Carefully inspect these articles before proceeding further. If you find any damage caused by transportation, please report it to the organization from which you purchased the CompuScope card.

Introduction to the CompuScope 14105 Comm Analyzer

The CompuScope 14105 Comm Analyzer is a 14 bit, 105 MS/s dual channel waveform digitizer card for the PCI Bus. It was designed specifically for Communications and Signal Intelligence applications.

The CompuScope 14105 Comm Analyzer has several key features:

- High Resolution

  The CompuScope 14105 Comm Analyzer has a nominal resolution of 14 bits.

- Input Coupling

  The CompuScope 14105 Comm Analyzer is equipped with transformer-coupled inputs which provide a unique 50 Ohm impedance AC input range of 0.5 V RMS.

- Frequency Response

  The CompuScope 14105 Comm Analyzer was designed to make precise In-Phase & Quadrature (I&Q) measurements for which phase distortions, introduced by the sampling as well as by the timing between the two channels, must be kept to a minimum.

  Much effort has gone into synchronizing the two channels and making the frequency response fall within a ± 1 dB band of the 'ideal' response for the bandwidth.

- 2 synchronous channels at maximum sampling speed of 105 MS/s.
- Up to a total of 1 billion samples of on-board acquisition memory in a single full-length PCI slot format.
- Data transfer rates from CompuScope memory to PC memory as high as 200 MB/s through Bus Mastering on 66 MHz, 32 bit PCI bus.
- 180 kHz to 230 MHz bandwidth for communication applications.
- Ease of integration with External Clock In and Out, External Trigger In and Out.
- Ease of system development with Software Development Kits (SDKs) for C/C++, MATLAB and LabVIEW.
- Pre-Trigger Multiple Record functionality, which help optimize the use of the on-board memory by stacking data from successive acquisitions.
- Time-stamping acquired records using an on-board 44 bit counter that is clocked by a 66 MHz crystal oscillator. This is particularly useful in Multiple Record mode. Optionally, the time-stamp counter can use the sample clock as its reference.
- On-board Phase Lock Loop (PLL) circuitry allows an external 10 MHz clock reference to synchronize the on-board oscillator to provide the sampling clock signal.

CompuScope 14105 Comm Analyzer specifications

PLEASE CHECK THE GAGE WEBSITE FOR THE MOST UP-TO-DATE SPECIFICATIONS.

SYSTEM REQUIREMENT

PCI-based computer with at least one free full-length PCI slot, 128 MB RAM, 100 MB hard disk. Minimum Pentium II 500 MHz and SVGA video.

SIZE

Plugs into one full-length PCI slot, 13" x 4.1", for all memory configurations.

POWER

+ 5 Volts		
	Worst Case	**Typical**
All memory depths	18.5 W	18.5 W
+3.3 Volts		
	Worst Case	**Typical**
All memory depths	5.9 W	5.9 W
+ 12 Volts		
	Worst Case	**Typical**
All memory depths	0 W	0 W
- 12 Volts		
	Worst Case	**Typical**
All memory depths	0 W	0 W

COOLING SYSTEM

Power Down: Software-controlled

A/D SAMPLING

Inputs per card: 2

Resolution: 14 bits

Sampling Rates, channels A and B simultaneously, or A or B only:
105 MS/s, 100 MS/s, 50 MS/s, 25 MS/s, 20 MS/s, 10 MS/s, 5 MS/s,
2 MS/s, 1 MS/s, 500 kS/s, 200 kS/s, 100 kS/s, 50 kS/s

Connector: SMA

Impedance: 50 Ω
Insertion Loss: 0.8 dB @ 10 MHz
1.0 dB @ 200 MHz

Coupling: Transformer-coupled

Bandwidth (see note 1): 180 kHz to 230 MHz

Flatness (see note 1): Within ± 1 dB of ideal response to > 100 MHz

Typical Accuracy: No missing codes – guaranteed
Offset Error: + 1.2 mV
Gain Error: 0% of Full Scale
DNL: ± 0.5 LSB
INL: ± 1.5 LSB

Input Voltage Range: 0.5 V RMS

Absolute Maximum Amplitude:
± 5 V (continuous)

DYNAMIC PARAMETERS

ENOB:	11.48
SNR:	70.9 dB (input frequency of 9.85 MHz)
SFDR:	86.9 dB (input frequency of 9.85 MHz)
SINAD:	70.7 dB (input frequency of 9.85 MHz)

ACQUISITION MEMORY

Data Storage: In on-board memory

Memory depth per channel:
8 Msamples, 64 Msamples, 512 Msamples; (14 bit samples in 16 bit words)

One Channel Mode (Channel A or B only):
Up to full on-board memory

TRIGGERING

Trigger engines:	2 per system
Source:	Ch. A, Ch. B, EXT or Software; software-selectable
Input combination:	1, 2, 1 or 2
Type:	Analog triggering
Level Accuracy:	± 5% of full scale
Slope:	Positive or Negative, software selectable
Sensitivity:	± 10% of full scale This implies that the signal amplitude must be at least 20% of full scale to cause a trigger to occur. Smaller signals are rejected as noise.
Post Trigger Data:	128 *(256)* points minimum. Can be defined with a 64 *(128)* point resolution in dual *(single)* channel mode
Max. Record Length:	Up to maximum memory

INTERNAL CLOCK

Source:	Clock oscillator
Accuracy:	± 25 ppm (0 to 70° C)

EXTERNAL TRIGGER

Impedance:	50 Ω
Amplitude:	Absolute Maximum ± 15 V
Voltage Ranges:	± 1 V and ± 5 V (software-selectable)
Bandwidth:	200 MHz
Coupling:	AC or DC
Connector:	SMA

TRIGGER OUT

Impedance:	50 Ω
Amplitude:	0-2.5 V (TTL)
Connector:	SMA

EXTERNAL CLOCK

Maximum Frequency:	105 MHz
Minimum Frequency:	30 MHz
Signal Level:	Minimum 1 V RMS Maximum 2 V RMS
Impedance:	50 Ω
Sampling Edge:	Rising
Duty Cycle:	50% ± 5%
Connector:	SMA

EXTERNAL REFERENCE

The External Reference timebase is used to synchronize the Internal Sampling Clock

Frequency:	10 MHz; Software-selectable
Signal Level:	Minimum 1 V RMS Maximum 2 V RMS
Impedance:	50 Ω
Sampling Edge:	Rising
Duty Cycle:	50% ± 5%
Connector:	SMA

CLOCK OUT

Maximum Frequency:	105 MHz
Minimum Frequency:	30 MHz (from External Clock) 50 MHz (from Internal Clock)
Signal Level:	0-2.5 V (TTL)
Impedance:	50 Ω
Duty Cycle:	50% ± 5%
Connector:	SMA

MULTIPLE RECORD

Pre-trigger Data:	Up to virtually full record length
Record Length:	128 points minimum; can be defined with a 64 points resolution
Maximum Number of Triggers:	8,388,608

TIMESTAMPING

Resolution:	7.2 ns
Counter turnover:	24 hours continuous

PCI BUS INTERFACE

Plug-&-Play:	Fully supported
Bus Mastering:	Fully supported
Scatter-Gather:	Supported in Driver
Bus Width:	32 bits
Bus Speed:	66 MHz or 33 MHz
Bus Throughput:	200 MB/s to PC Memory (66 MHz PCI; dependent on motherboard and number of PCI-PCI bridges)
Compatibility:	PCI-compliant v.2.2 systems Also v.2.1 systems that supply 3.3 V to PCI slot

OPERATING SYSTEMS SUPPORTED

- Windows 2000*/XP CompuScope Driver version 3.80.xx

  * SP1 or higher

APPLICATION SOFTWARE

GageScope®: Windows-based software for programming-free operation

LITE Edition:	Included with purchase, provides basic functionality
Standard Edition:	Provides limited functionality of advanced analysis tools, except for Extended Math
Professional Edition:	Provides full functionality of all advanced analysis tools

SOFTWARE DEVELOPMENT KITS (SDK)

- CompuScope SDK for C/C++
  Includes Sample Programs in Visual C++
- CompuScope SDK for MATLAB
- CompuScope SDK for LabVIEW

WARRANTY

One year parts and labor.

ALL SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

Notes: 1) Detailed characterization curves pending and will be available upon request.

CompuScope 14105 Comm Analyzer ordering information

Hardware and upgrades

Product	Order No.
CompuScope 14105 – 16M	143-001-002
CompuScope 14105 –128M	143-001-004
CompuScope 14105 – 1G	143-001-006
CS14105: Memory Upgrade Charge	143-181-200

GageScope Software

Product	Order No.
GageScope Lite Edition	Included
GageScope Standard Edition – purchased with CompuScope hardware	300-100-351
GageScope Standard Edition – purchased independently	300-100-352
GageScope Professional Edition – purchased with CompuScope hardware	300-100-354
GageScope Professional Edition – purchased independently	300-100-355

Software Development Kits (SDKs)

Product	Order No.
Gage SDK Pack (No Hardcopy of Manuals included)	200-113-000
Gage SDK Pack (Hardcopy of Manuals included)	200-113-002
CompuScope SDK for C/C++	200-200-101
CompuScope SDK for MATLAB	200-200-102
CompuScope SDK for LabVIEW	200-200-103

CompuScope 14105 Comm Analyzer simplified block diagram

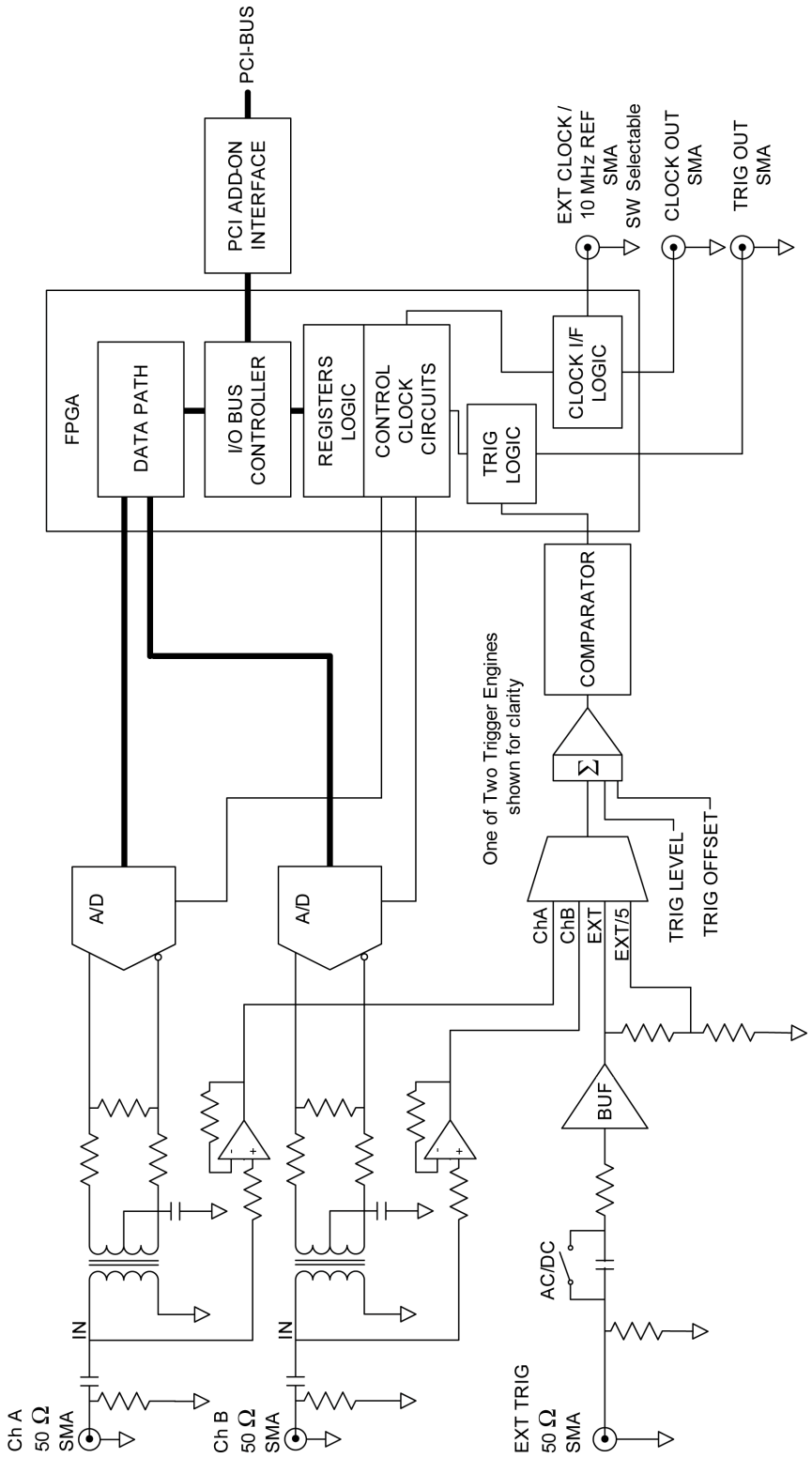

Figure 1: CS14105 Comm Analyzer simplified block diagram

CompuScope 14105 Comm Analyzer connectors and headers

CompuScope cards connect to the outside world through connectors, both analog (SMAs or BNCs) and digital (PCI bus). This section describes these connectors for the CS14105 Comm Analyzer card.

The connectors and headers on the CS14105 Comm Analyzer card are shown below:

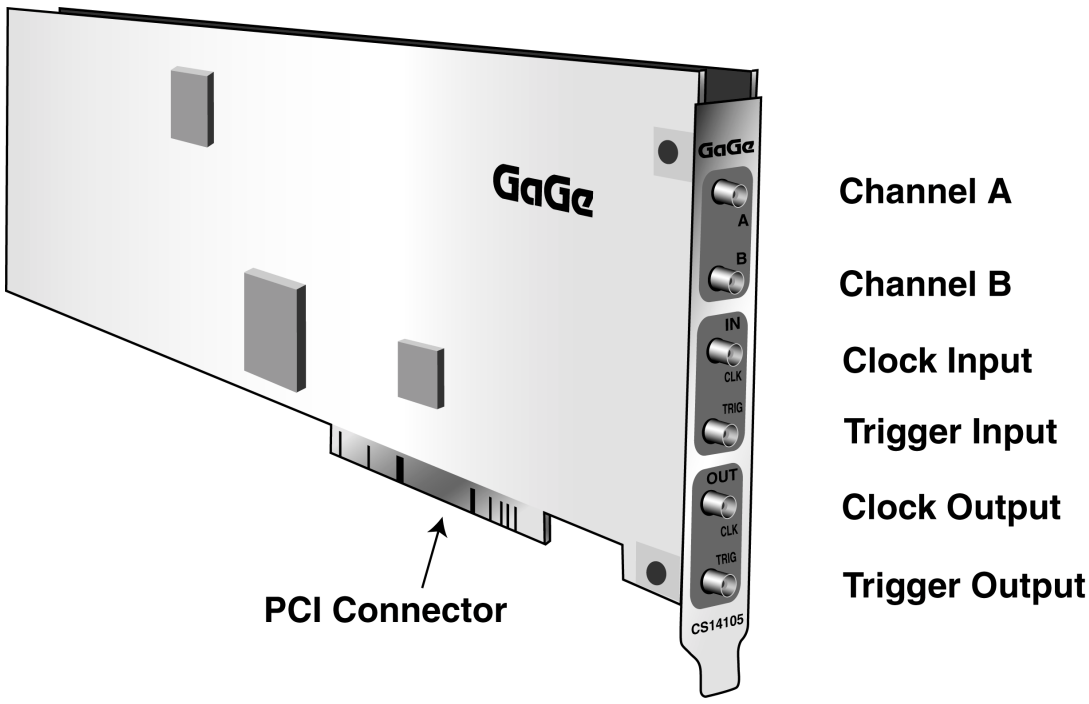

Figure 2: Connectors on CS14105 Comm Analyzer

- **Channel A SMA** connector is used to input an analog signal that is sampled as Channel A.
- **Channel B SMA** connector is used to input an analog signal that is sampled as Channel B.
- **Clock Input SMA** connector is used to input a signal to be used as the sampling clock. This signal is referred to as the External Clock signal.
- **Trigger Input SMA** connector is used to input a signal that is used as an External Trigger. External Trigger is defined exactly as in an oscilloscope. This signal can be used to trigger the system but cannot be viewed or digitized.
- **Clock Output SMA** connector is used to supply the clock signal, either from the internal oscillator or from the External Clock Input, to another module of the test system or experimental setup. The characteristics of the Output are detailed in the Specifications section.
- **Trigger Output SMA** connector is used to supply a trigger signal generated by the card to another module of the test system or experimental setup.

Special characteristics and features of the CompuScope 14105 Comm Analyzer

The CompuScope 14105 (CS14105) Comm Analyzer is a specialized digitizer dedicated to Communications and Signal Intelligence applications. The following section is a review of some of the special characteristics and features offered by the card.

Frequency response

For Communications and Signal Intelligence applications, it is critical that the CS14105 provides frequency measurements as precise and reliable as possible over the analog bandwidth of the card.

The CS14105 has a very flat frequency response, minimizing the attenuation or amplification of frequency components, so that the signals from the SMA connectors to the ADCs are as identical as possible. The paths of clocking signals to the ADCs are also as similar to one another as possible. As such, the frequency responses of both channels falls within a narrow band around the ideal frequency response for the bandwidth.

The figure below illustrates the actual frequency response of the CS14105.

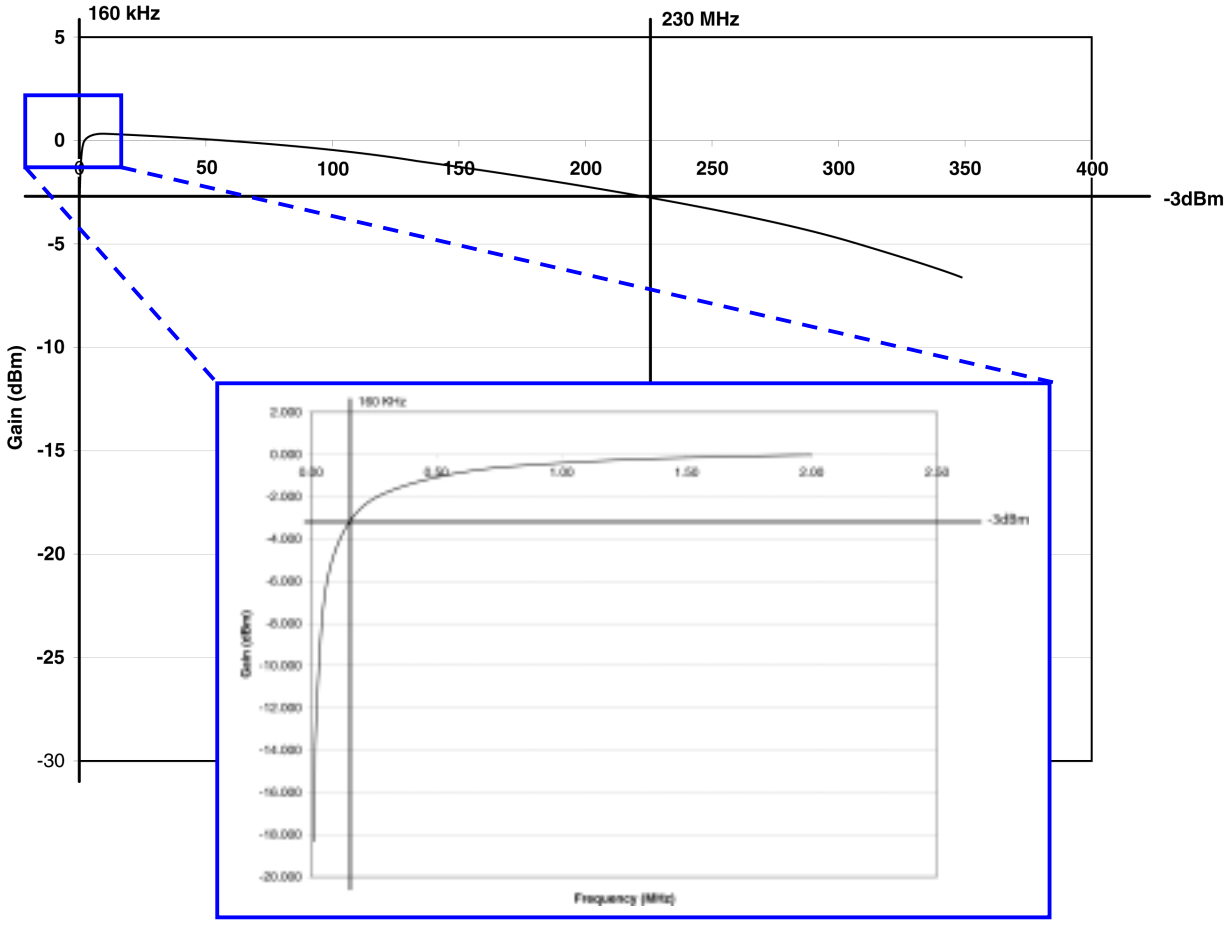

Figure 3: Illustration of the frequency response

Accuracy and linearity

Since it is designed to provide the input signals almost directly to the on-board ADCs, the CompuScope 14105 Comm Analyzer does not have the usual calibration circuitry as that of other Gage digitizers. Instead, the CS14105 has accuracy and linearity very similar to its ADCs. More detailed specifications of the accuracy and linearity than those found in the Specifications section.

Trigger Output signal

The Trigger Output signal provides a mechanism to synchronize other system elements to the trigger event that caused the CS14105 to start acquiring data.

Please note that the trigger signal provided by the CompuScope 14105 is only designed to drive one other device with 50 Ω impedance.

Clock Output signal

The Clock Output signal provides a clock synchronous to the sample clock being used to acquire data on the CS14105. The function is independent of the clock source, that is it functions the same way when the internal oscillator, the external clock or the external reference clock is active.

Please note that the clock signal provided by the CompuScope 14105 is only designed to drive one other device with 50 Ω impedance.

Clock Input signal

The CompuScope 14105 can be clocked in any of three modes of operation, which are accessible via software commands.

The normal mode of operation consists in using the internally generated clock. This the mode of operation by default; in this mode, the card ignores any signal present at the Clock Input connector. When developing an application for the CS14105 (in C/C++, LabVIEW, or MATLAB) you must supply the sampling rate to be used.

The second mode of operation consists in using the externally provided clock. In this mode, the card is instructed to expect a signal at the Clock Input connector, and to use it as the sampling clock. It is not critical to provide the sampling rate for this mode, but it is a good practice.

Finally, you can select to use a reference clock, which is an industry standard 10 MHz clock, used to synchronize the card to the rest of the test system or experimental setup. In this mode the card is instructed to expect a signal at the Clock Input connector and to use the signal to control a proprietary phase frequency detector that synchronizes the on-board oscillators to the external reference signal.

The input characteristics detailed in the Specifications section are valid for both the External Clock and for the Reference Clock situations.

Windowed triggering

Using the CompuScope 14105 Comm Analyzer card's ability to have two independent trigger sources which are ORed together, the user can set up the triggering such that a trigger will occur if the input signal is outside a specified "window," i.e. it is higher than the upper limit or lower than the lower limit.

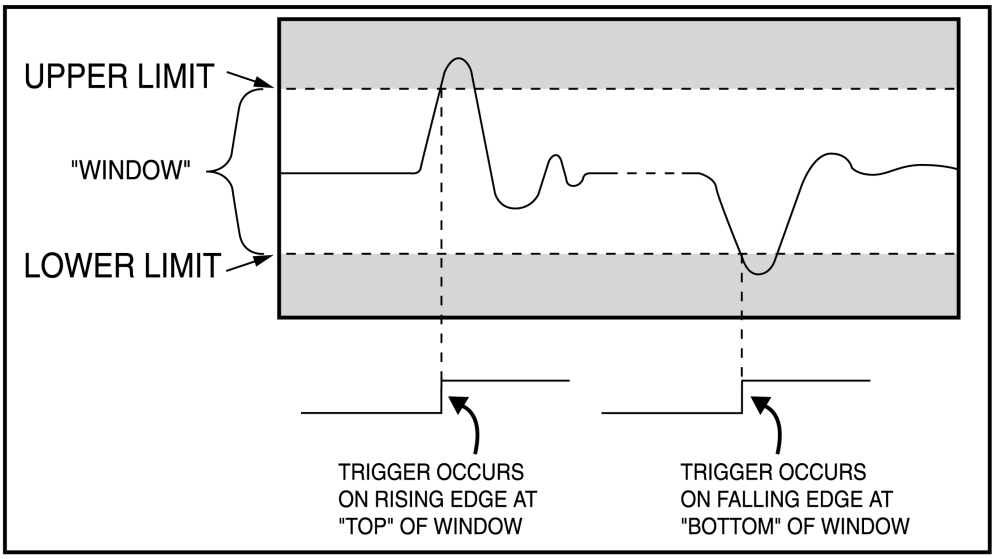

Figure 4: Windowed triggering

CompuScope 14105 Comm Analyzer throughput & maximum PRF

A number of applications require the CompuScope 14105 Comm Analyzer to acquire data based on a rapidly occurring trigger signal. These high Pulse Repeat Frequency (PRF) applications include radio, radar and ultrasound signal capture.

Gage has performed extensive repetitive capture benchmarks in single record mode. In this mode, the signal is captured into on-board CompuScope memory and the captured data are transferred through the PCI bus using PCI bus mastering to PC RAM.

Please note that much higher PRFs will be achieved using CompuScope Multiple Record mode.

The following test results were obtained using a computer configured as follows:

- Dual Pentium II, 400 MHz processor,
- LX400 Intel motherboard
- 512 MB RAM
- 20 GB disk drive
- Windows 2000
- NT File System
- 66 MHz, 32 bit PCI bus
- All slots support bus mastering

The application software used for throughput measurements was CSTest.

The CS14105 was operated using CSTest in both single and dual channel mode for many different capture depths and the results are plotted as points in the graph below. The PCI transfer rates were calculated from the linear portion of the curves at high depths.

Data transfer rate:	***200 MB/s***

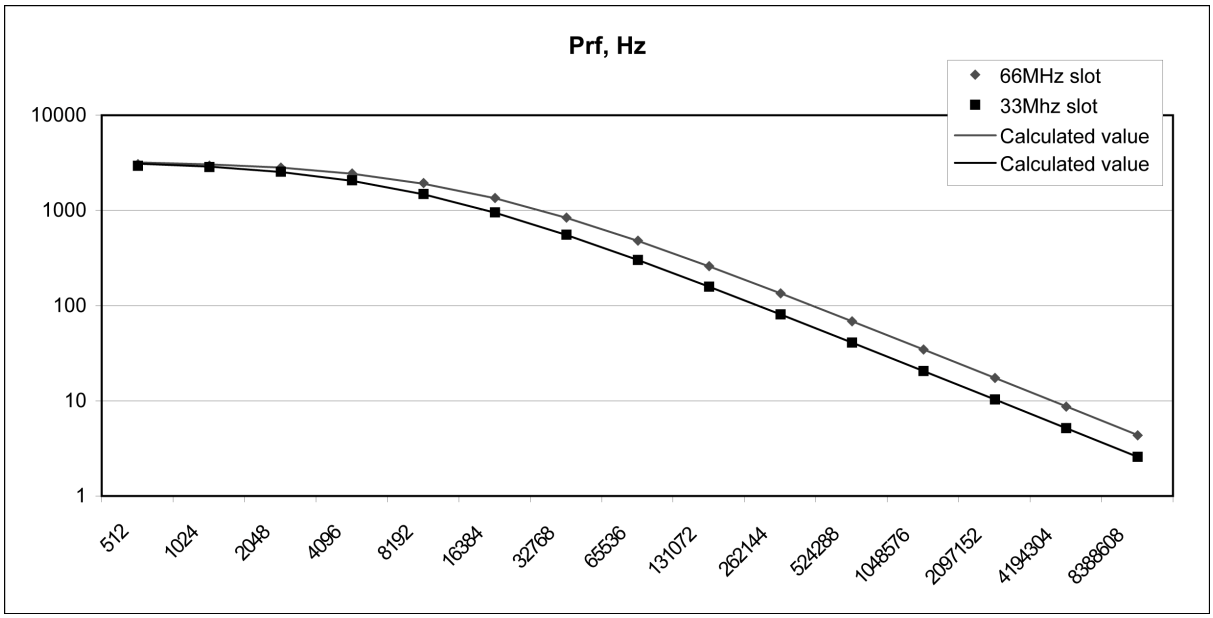

Figure 5: Maximum PRF vs. acquisition lengths