Einsatz von Analog/Digital (A/D) und Digital/Anlaog (D/A) - Wandlern

Soundkarte
CD-Spieler - Laufwerk (ROM)
ISDN
Graphikkarte + Monitor
"joystick"
analoger TFT-Monitor
DVM
Modem
DSO
Funktionsgeneratoren
digitale S&H

Digitales Speicheroszilloskop (DSO)

früher: spezielle Speicherröhren

heute: A/D-Wandler, Speicher, Rechner, Video-Bildschirm

vertikale Auflösung:

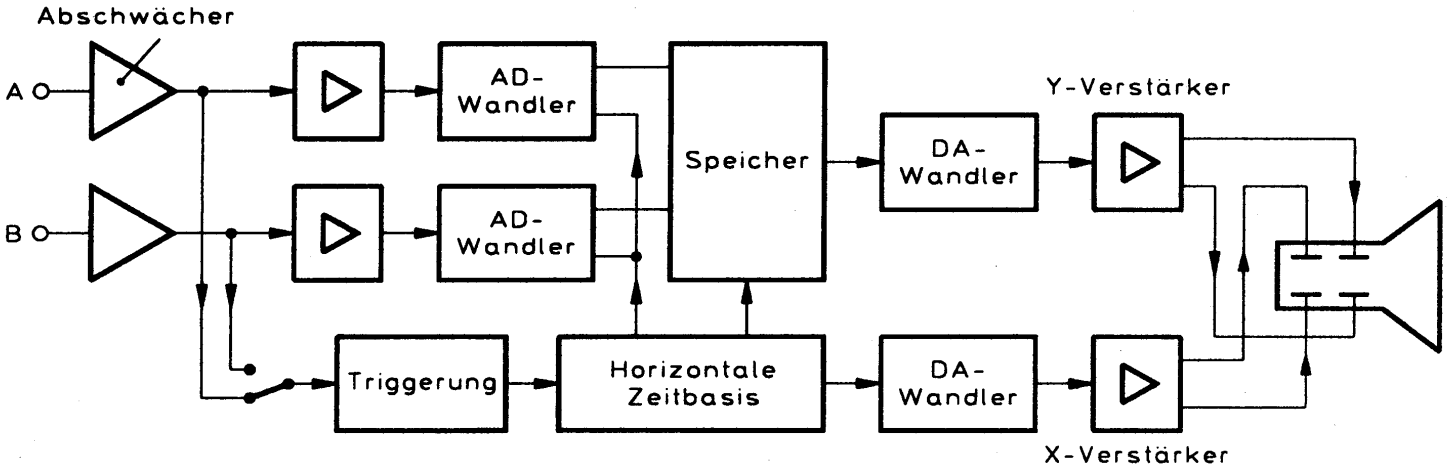
8 bit	↔	1 : 256
10 bit	↔	1 : 1024
12 bit	↔	1 : 4096

Verbesserung durch Mittelung !!

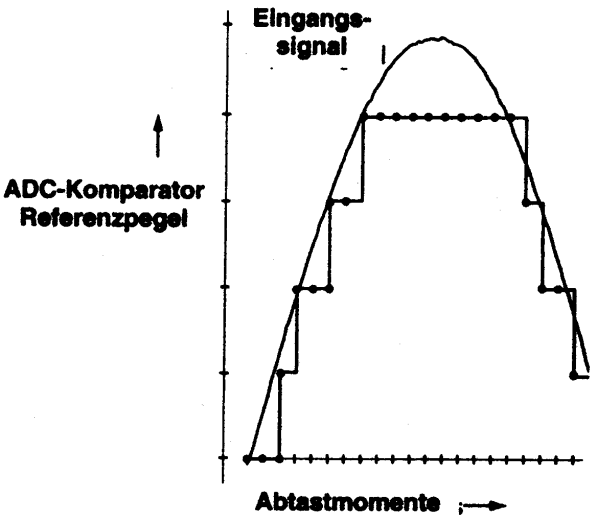
"Permanente" Speicherung in
- Ausdruck, Floppy, PC
- per serielle Schnittstelle, GPIB, Ethernet

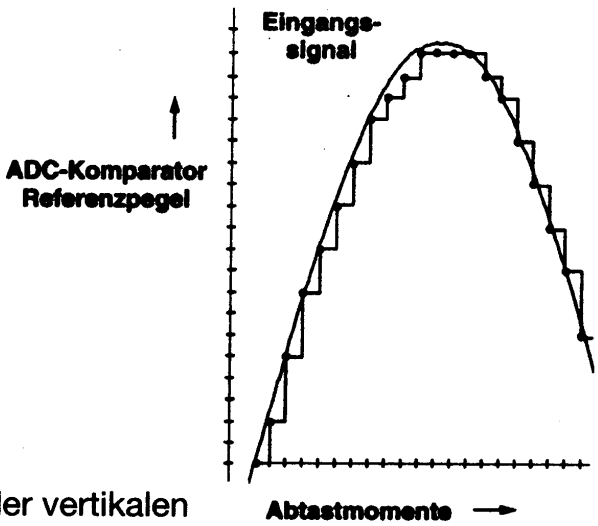
Analyse in DSO oder Rechner

Digitales Speicheroszilloskop

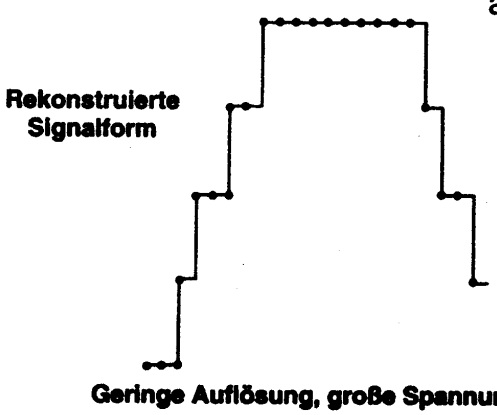


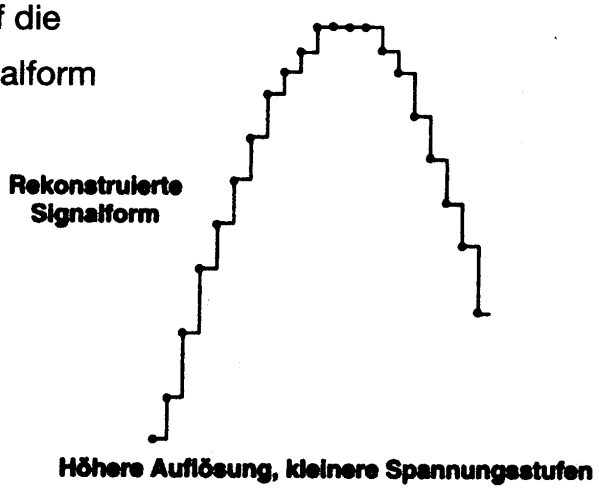
Blockschaltung eines digitalen Speicheroszilloskops





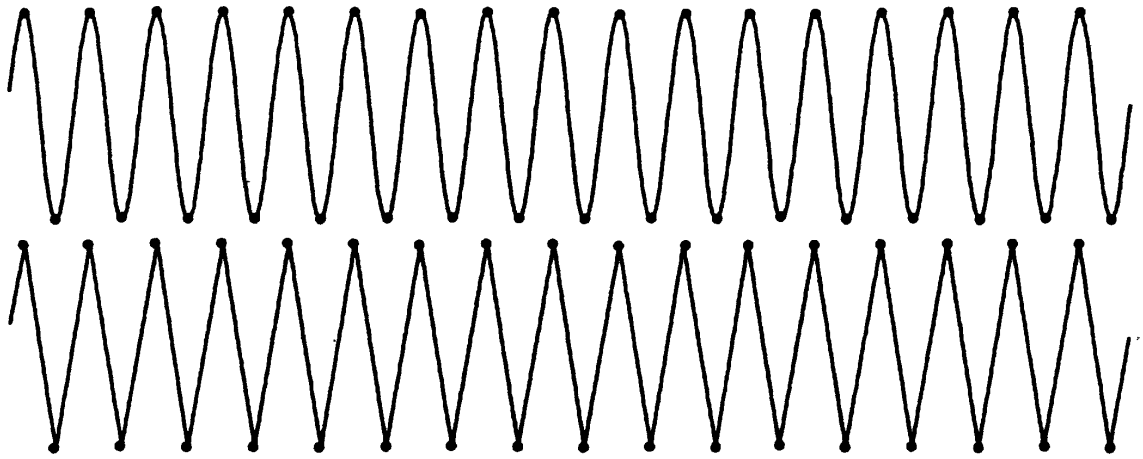
Einfluß der vertikalen Auflösung auf die angezeigte Signalform





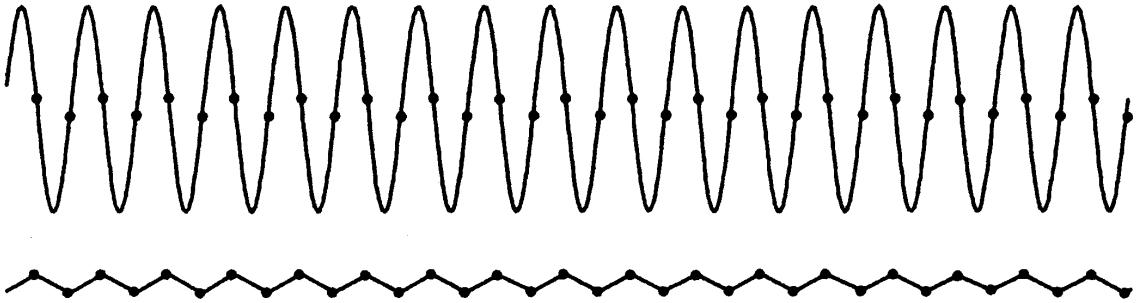
Eingangssignal, abgetastet bei den Extremwerten ...

... und die rekonstruierte Signalform.



Eingangssignal, abgetastet nahe den Nulldurchgängen ...

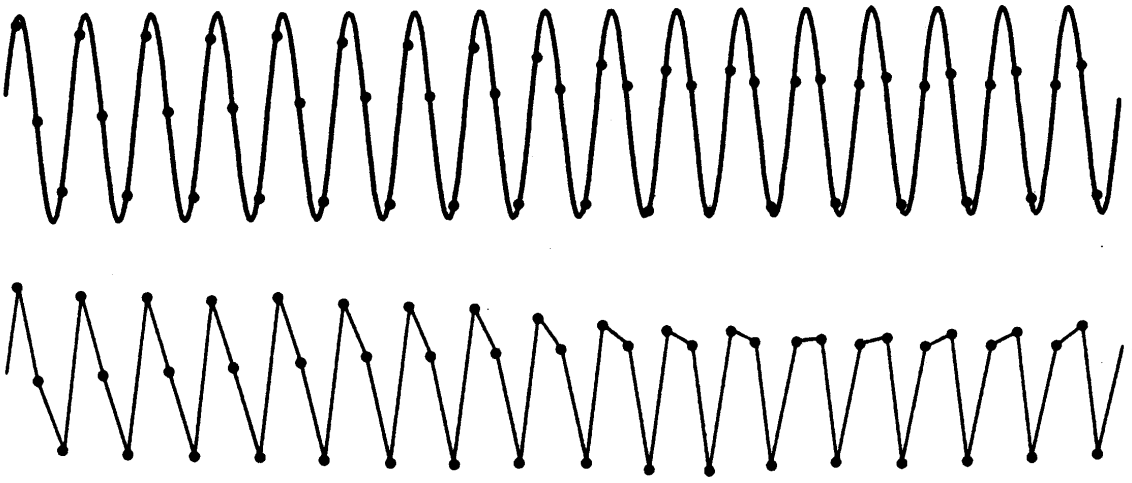
... und die rekonstruierte Signalform.



Sinussignal, abgetastet mit der doppelten Signalfrequenz nahe den Extremwerten und nahe den Nulldurchgängen

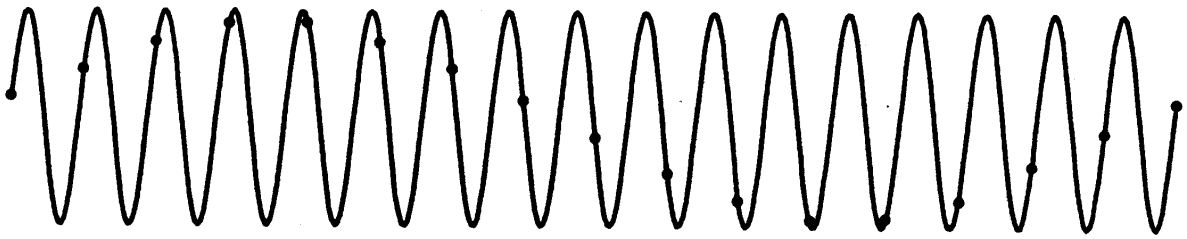
Eingangssignal, abgetastet mit drei Samples/Periode ...

... und die rekonstruierte Signalform.

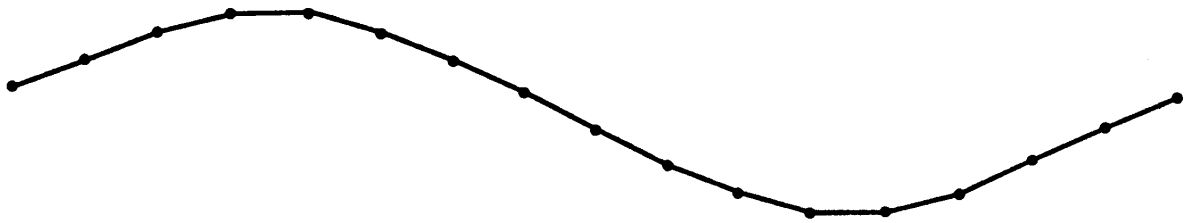


Sinussignal, abgetastet mit drei Samples pro Periode

Eingangssignal und Abtastmomente; Abtastfrequenz zu niedrig ...



.. und das rekonstruierte Abbild mit Aliasing.



Durch eine Fehlabtastung mit einer unpassenden Abtastrate entsteht ein Sinussignal nach dem Aliasing-Effekt, also einer Scheinfrequenz

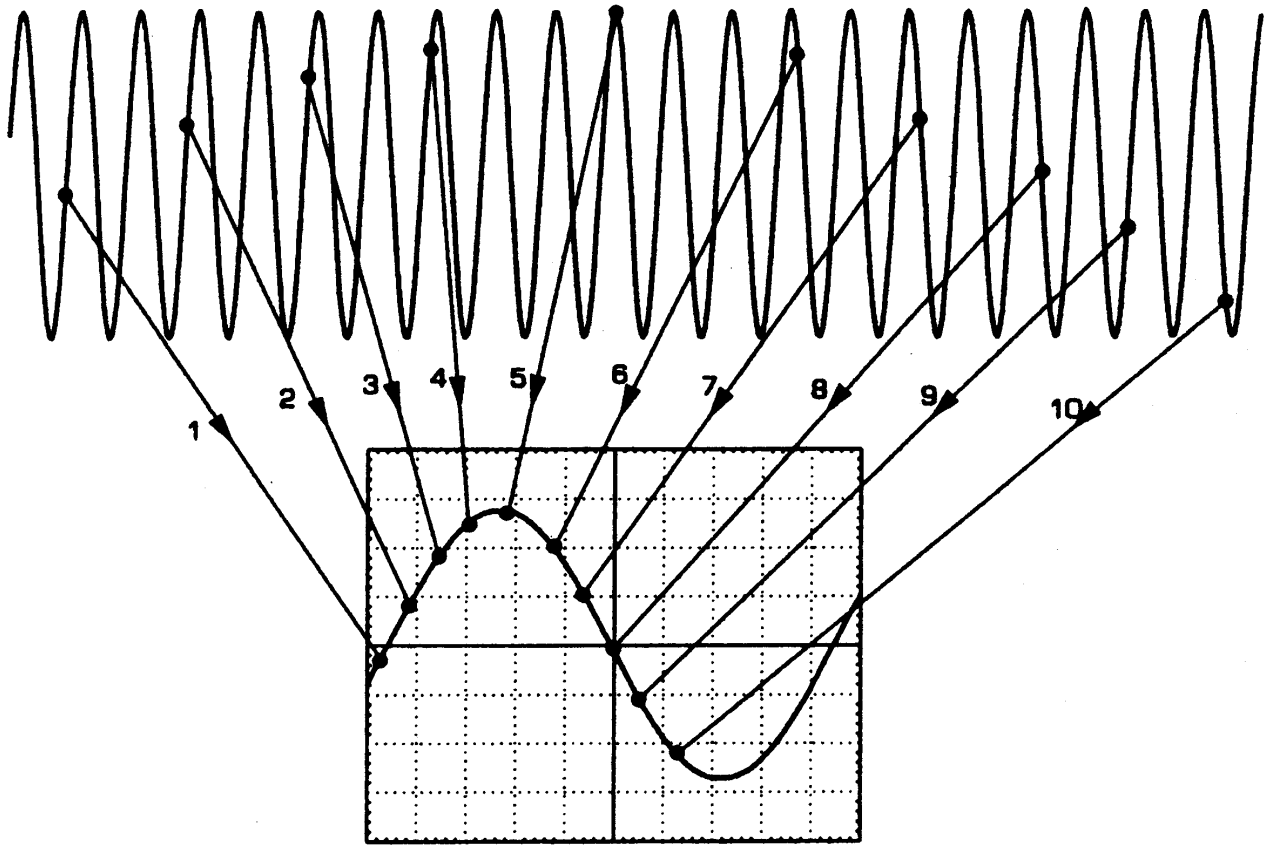
Shannonsches Abtasttheorem:

- Mindestens 2 Punkte per Periode
- besser 10 Punkte per Periode

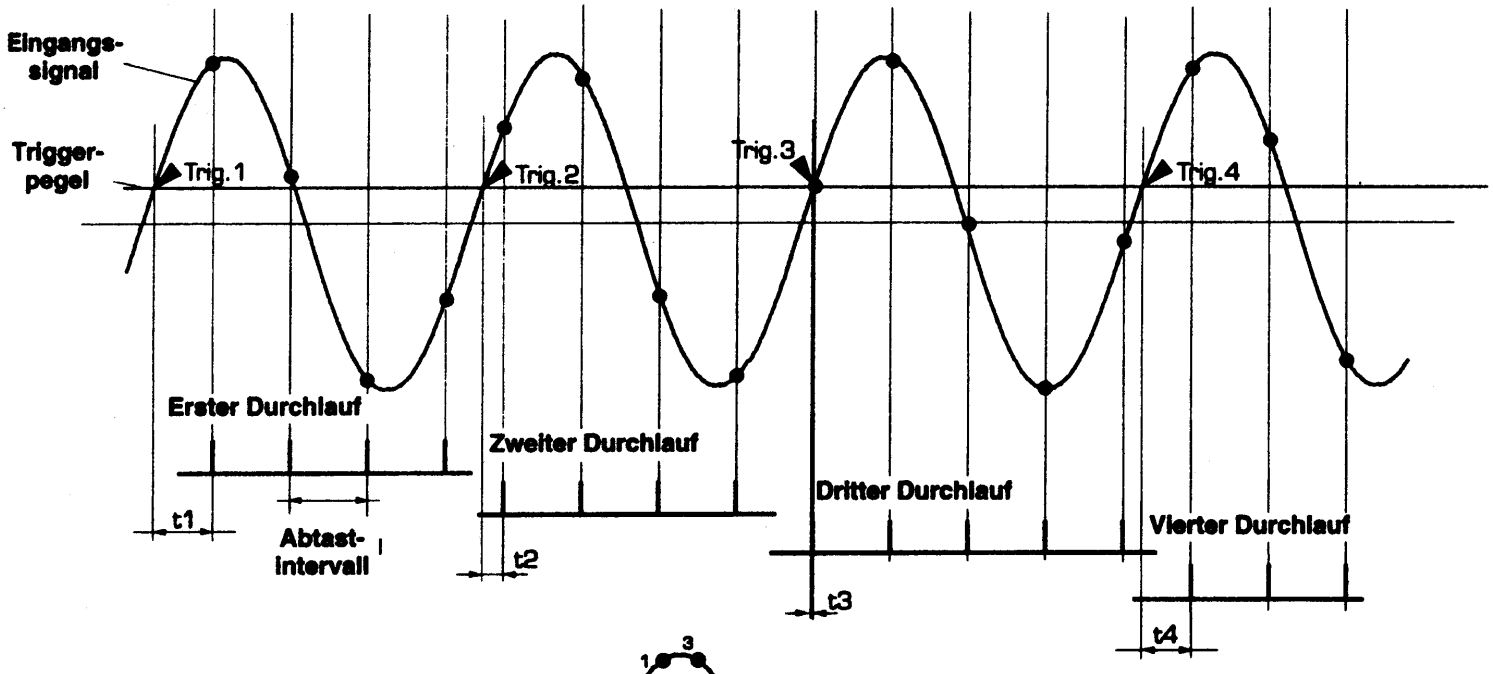
Abtastrate:
- single shot: 50 MSa/s – 10 GSa/s
- repetitive (Äquivalenzabtastung)

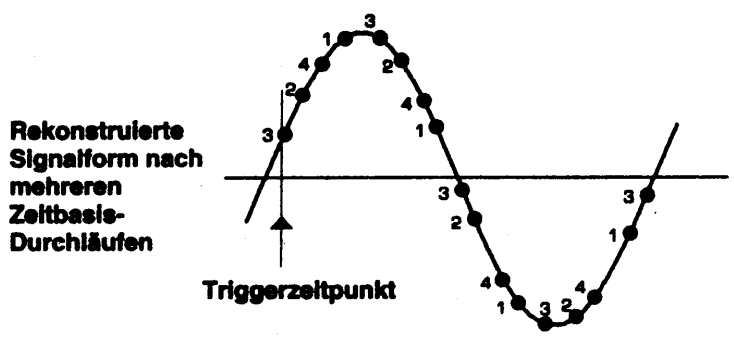
Speichertiefe: ≈ 1 K bis 1 M Punkte

Preise: DM 1.500,- bis 50.000,-



Bildaufbau für eine sequentielle Abtastung

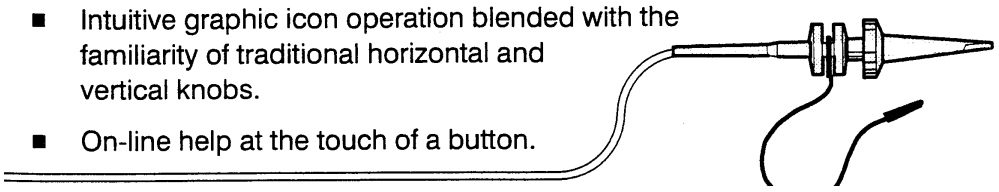




Bildaufbau bei einem Random-Sampling

Tektronix TDS 600A Digitizing Oscilloscopes are superb tools for acquiring, displaying, and measuring waveforms. Their performance addresses the needs of both benchtop lab and portable applications with the following features:

- 500 MHz maximum analog bandwidth.
- 2 Gigasamples/second maximum digitizing rate.
- Four channels for acquisition — the TDS 640A & 644A let you use and display all four channels simultaneously; the TDS 620A lets you use and display any two channels simultaneously. All channels can acquire at the maximum digitizing rate.
- Waveform Math — Invert a single waveform and add, subtract, multiply, and divide two waveforms. On instruments with Advanced DSP Math (standard on the TDS 644A), integrate or differentiate a single waveform or perform an FFT (fast fourier transform) on a waveform to display its magnitude or phase versus its frequency.
- Eight-bit digitizers.
- Up to 2,000-sample record length per channel.
- Full GPIB software programmability. Hardcopy output using RS-232 or Centronics ports (Optional on TDS 620A & 640A) and the GPIB.
- Complete measurement and documentation capability.
- Intuitive graphic icon operation blended with the familiarity of traditional horizontal and vertical knobs.
- On-line help at the touch of a button.



Oszilloskope HP 54645A/D

Anzahl der Kanäle	2 Analoge - beim HP 54645A mit 1 und 2 und beim HP 54645D mit A1 und A2 bezeichnet
Tastköpfe	10074A
Bereich	1 mV/Div - 5 V/Div
Feineinstellung kalibriert	+/- 3%
Pósitions- (Offset-) bereich	mind. +/- 8 Skalenteile +/- 2 V in Bereichen < 200 mV/Div +/- 40 V in Bereichen > 200 mV/Div
Dynamikbereich	Weniger als +/- 8 Div oder +/- 32 V
DC-Vertikal-Verstärkungsgenauigkei	
1-, 2-, 5-Sequenzen	+/- 1,5% des Bereichsendwertes
Feineinstellung	+/- 3% des Bereichsendwertes
DC-Vertikal-Offset-Genauigkeit	+/- 1% des Bereichsendwertes +/- 0,5% des Positionswertes
Einzel-Cursor-Genauigkeit	DC-Vertikal-Verstärkungsgenauigkeit + DC-Vertikal-Offset-Genauigkeit +/- 1/2 LSB (LSB=0,4% des Bereichsendwertes)
Dual-Cursor-Genauigkeit	DC-Vertikal-Verstärkungsgenauigkeit +/- 1 LSB

Bandbreite (3dB)	100 MHz @ >= 10 mV/Div 75 MHz @ < 10 mV/Div
Bandbreitenbegrenzung	(~ 20 MHz)
Anstiegszeit (berechnet)	~3,5 ns @ > 10 mV/Div ~3,9 - 4,6 ns @ < 10 mV/Div
Kopplung	AC, DC, GND
Eckfrequenz bei AC-Kopplung	~1,5 Hz
Eingangsimpedanz	1 MΩ, +/- 1%, ~13 pF
Maximale Eingangsspannung	400 V (DC + AC-Spitze)
Tastkopf-ID (HP & Tek-kompatibel)	1X, 10X, 20X, 100X
ESD-Toleranz	+/- 2 kV
Kanaltrennung (mit Kanälen bei gleicher V/Div-Einstellung)	DC bis 20 MHz > 40 dB 20 MHz bis 100 MHz > 30 dB
Störeinstreuung Spitze-zu-Spitze	<=3Ω Pegel oder 1 mV, je nachdem, welches der größere Wert ist
Gleichtaktunterdrückung	20 dB @ 50 MHz
XY-Bandbreite	
Bandbreite	100 MHz
Phasenfehler @ 1 MHz	1,8 Grad

[1]Leistungsdaten, getestet durch Schwellentest. Siehe Kapitel "Tests, Abgleich und Fehlerbehebung".

Oszilloskop-Digitalisierungssystem des HP 54645A/D

Vertikal-Auflösung	8 Bit bei allen Einstellungen
Horizontal-Auflösung	500 (angezeigte Punkte)
Abtastrate	maximal 200 MSa/s pro Kanal
Genauigkeit der Abtastrate	0,01%
Spitzenerkennung	5 ns digital
Mittelwerte	4, 8, 16, 32, 64, 128, 256, Glätten - wählbar
Speichertiefe	maximal 1 M
Datendurchsatz	Bis zu 3.000.000 Meßproben pro Sekunde mit ausreichender Triggergeschwindigkeit und ohne Mittelwertbildung, Feineinstellung der Zeitbasis, Signalberechnung oder Vektoren.

Logik-Digitalisierungssystem des HP 54645D

Vertikal-Auflösung	1 Bit
Maximale Horizontal-Auflösung	500 (angezeigte Punkte)
Abtastperiode	maximal 2,5 ns
Störspitzenerkennung	5 ns
8 Kanäle	2,5 ns
16 Kanäle	5 ns
Speichertiefe pro Kanal	maximal 2 M
Genauigkeit der Abtastperiode	0,01%
leichzeitige Erfassung	An allen Kanälen verfügbar.
<=8 Kanäle am gleichen Tastkopf	400 MSa/s
> 8 Kanäle	200 MSa/s
2 beliebige Kanäle an 2 Sammel-Tastköpfen	200 MSa/s
Erfassung	
Alle Kanäle aus	Kanäle 0-7 @ 400 MSa
0-7 ein, 8-15 aus	Kanäle 0-7 @ 400 MSa
8-15 ein, 0-7 aus	Kanäle 8-15 @ 400 MSa
Alle ein	Kanäle 0-15 @ 200 MSa
Datendurchsatz	Bis zu 1.500.000 Meßproben pro Sekunde mit ausreichender Triggergeschwindigkeit und ohne Feineinstellung der Zeitbasis.

All select | All clear

Select Products	Max. Sampling Rate	Bandwidth	Analog Input Channels	Logic Input	Max. Record Length (St'd)
DL9240L	10 GS/s	1.5 GHz	4 ch	-	6.25 MW
DL9240	10 GS/s	1.5 GHz	4 ch	-	2.5 MW
DL9140L	5 GS/s	1 GHz	4 ch	-	6.25 MW
DL9140	5 GS/s	1 GHz	4 ch	-	2.5 MW
DL9040L	5 GS/s	500 MHz	4 ch	-	6.25 MW
DL9040	5 GS/s	500 MHz	4 ch	-	2.5 MW
DL9710L	5 GS/s	1 GHz	4 ch	32-bit (8 bits x 4)	6.25 MW
DL9705L	5 GS/s	500 MHz	4 ch	32-bit (8 bits x 4)	6.25 MW
DL9510L	5 GS/s	1 GHz	4 ch	16-bit (8 bits x 2)	6.25 MW
DL9505L	5 GS/s	500 MHz	4 ch	16-bit (8 bits x 2)	6.25 MW

http://www.yokogawa.com/de/

DL7480	2 GS/s	500 MHz	8 ch	16-bit (8 bits x 2)	16 MW
DL7480	2 GS/s	500 MHz	8 ch	16-bit (8 bits x 2)	4 MW
DL7440	2 GS/s	500 MHz	4 ch	16-bit (8 bits x 2)	16 MW
DL7440	2 GS/s	500 MHz	4 ch	16-bit (8 bits x 2)	4 MW
DL1740EL	1 GS/s	500 MHz	4 ch	-	8 MW
DL1740E	1 GS/s	500 MHz	4 ch	-	2 MW
DL1735E	1 GS/s	350 MHz	4 ch	-	2 MW
DL1720E	1 GS/s	500 MHz	2 ch	-	1 MW
DL1640L	200 MS/s	200 MHz	4 ch	-	32 MW
DL1640	200 MS/s	200 MHz	4 ch	-	8 MW
DL1620	200 MS/s	200 MHz	2 ch	-	8 MW
DL750	10MS/s (701250)	3 MHz (701250)	16 ch (isolation, 701250)	16-bit (8 bits x 2)	50 MW
DL750P	10MS/s (701250)	3 MHz (701250)	16 ch (isolation, 701250)	16-bit (8 bits x 2)	50 MW

DSO and DSA	DSO90254A	DSO90404A	DSO90604A	DSO90804A	DSO91204A	DSO91304A
Bandwidth	*2.5 GHz*	*4 GH*	*6 GHz*	*8 GHz*	*12 GHz*	*13 GHz*
Sample rate	*20 GSa/s*			*40 GSa/s*		
Channels	*4 channels*					
Display	*12.1" XGA touch screen*					
Display update rate	*400,000 waveforms per second (in segmented memory mode)*					
Memory	*10 Mpts standard, optional up to 1 Gpts (20 Mpts std. on DSA)*					
Vertical resolution	*8 bits, ≥ 12 bits with averaging*					
Vertical sensitivity	*1 mV/div to 1 V/div*					
Bandwidth limit	*500 MHz (using E2697A 1 MΩ adaptor)*					
Max input voltage	*± 5 V*					
Input impedance	*50 Ω, ±3%*					
Timebase range	*5 ps/div to 20 s/div real-time*					
Timebase accuracy	*± (0.4 + 0.5 * YrsSinceCal) ppm pk*					
Triggering	*3-level sequence hardware (2 levels) and InfiniiScan software trigger: edge, edge transition,edge then edge, glitch, line, pulse width, runt, timeout, pattern/pulse range, state, setup/hold, window, HDTV, non-monotonic, measurement, and zone qualify*					
Typical noise floor	*147 µVrms*	*186 µVrms*	*234 µVrms*	*283 µVrms*	*365 µVrms*	*389 µVrms*
Max data transfer rate	*22 MSa/s*					
Dimensions	*43.2 cm wide x 28.3 cm high x 50.6cm deep*					
Weight	*20 kg*					
Power	*800 watts, max.*					

Model comparison chart Agilent Family | 4

	U1600	2700	1000	2000X	3000X	4000X
Channels	2	2	2, 4	2, 2+8, 4, 4+8	2, 2+16, 4, 4+16	2, 2+16, 4, 4+16
Bandwidth	20 MHz to 200 MHz	100 MHz to 200 MHz	50 MHz to 200 MHz	70 MHz to 200 MHz	100 MHz to 1 GHz	200 MHz to 1.5 GHz
Sample rate	Up to 2 GSa/s	1 GSa/s	Up to 2 GSa/s	2 GSa/s	Up to 5 GSa/s	Up to 5 GSa/s
Memory depth	Up to 2 Mpts	32 Mpts, std.	Up to 10 kpts	100 kpts	2 Mpts, std. Up to 4 Mpts, opt.	4 Mpts, std.
Connectivity and storage	USB 2.0 host/ device port: std. (U1610A/20A) USB 2.0 device port: std. (U1602B/04B) *USB 2.0 host port - Option 001	USB device: std.	USB 2.0 host (one front, one back) and device	USB host (one front, one back), USB device, LAN: opt., VGA: opt., GPIB: opt.	USB host (one front, one back), USB device, LAN: opt., VGA: opt., GPIB: opt.	USB 2.0 (device and host x3), LAN, VGA out, opt GPIB-LAN adapter
Waveform math and analysis	Waveform math and FFT. Complimentary PC link software, USB cable can be used to quickly transfer data to a PC for further post-processing and analysis.	Waveform math and FFT. Data can easily be transferred to an external PC for further post-processing and analysis.	Waveform math and FFT. Data can easily be transferred to an external PC for further post-processing and analysis.	Waveform math, InfiniiView offline analysis and FFT. Data can easily be transferred to an external PC for further post-processing and analysis.	Waveform math, InfiniiView offline analysis and FFT. Data can easily be transferred to an external PC for further post-processing and analysis.	Waveform math, InfiniiView offline analysis and FFT. Data can easily be transferred to an external PC for further post-processing and analysis.

Model comparison chart Agilent Family | 4

	6000/7000	9000	90000A	90000X/Q	86100D
Channels	2, 2+16, 4, 4+16	4 , 4+16	4	4	Up to 16
Bandwidth	100 MHz to 1 GHz	600 MHz to 4 GHz	2.5 GHz to 13 GHz	13 GHz to 63 GHz	Module dependent to 65 GHz optical, 90 GHz electrical
Sample rate	4 GSa/s	Up to 20 GSa/s	20 or 40 GSa/s on all 4 channels	Up to 80 GSa/s on 4 channels and 160 GSa/s on 2 channels	40 kSa/s
Memory depth	8 Mpts, std.	20 Mpts/channel, std.	10 Mpts, std. Up to 1 Gpts, opt.	Up to 2 Gpts	Limited by hard drive
Connectivity and storage	USB (device and host), LAN, XGA-out: std.	USB 2.0, LAN, I/O ports, RS-232, parallel, dual-monitor video, auxiliary output	USB 2.0 host and device, Gigabit Ethernet: std., GPIB: opt.	USB 2.0 host and device, Gigabit Ethernet: std., GPIB: opt.	USB 2.0, LAN, RS-232, VGA-out, parallel, PS/2, GPIB:out
Waveform math and analysis	Waveform math, InfiniiView offline analysis and FFT. Data can easily be transferred to an external PC for further post-processing and analysis.	Up to four independent/cascaded math functions, FFT, eye, jitter, standards compliance, InfiniiView offline analysis, MATLAB (opt), Windows 7 based-system.	Up to four independent/cascaded math functions, FFT, eye, jitter, standards compliance, InfiniiView offline analysis, MATLAB (opt), Windows 7 based-system.	Up to four independent/cascaded math functions, FFT, eye, jitter, standards compliance, InfiniiView offline analysis, MATLAB (opt), Windows 7 based-system.	TDR, S-Parameters, eye diagram analyzer, advanced jitter and amplitude analysis, de-embed, embed, FFT, phase noise analysis application, MATLAB: opt.

Technical Specifications

Panasonic

Portable CD Player

SL-S505C

Operating Instructions

Audio	
No. of channels:	2 channels (left and right, stereo)
Frequency response:	20–20,000 Hz (+0.5 dB, −1.5 dB)
Output voltage:	1 V (50 kΩ)
Dynamic range:	more than 94 dB
S/N ratio:	more than 96 dB
Digital filter:	8 times oversampling
Phones output:	max. 15 mW/16Ω (adjustable)

Explanation of 44.1 kHz CD sampling rate

The CD sampling rate has to be larger than about 40 kHz to fulfill the Nyquist criterion that requires sampling at twice the maximum analog frequency, which is about 20 kHz for audio. The sampling frequency is chosen somewhat higher than the Nyquist rate since practical filters needed to prevent aliasing have a finite slope. Digital audio tapes (DATs) use a sampling rate of 48 kHz. It has been claimed that their sampling rate differs from that of CDs to make digital copying from one to the other more difficult. 48 kHz is, in principle, a better rate since it is a multiple of the other standard sampling rates, namely 8 and 16 kHz for telephone-quality audio. Sampling rate conversion is simplified if rates are integer multiples of each other.

From John Watkinson, The Art of Digital Audio, 2nd edition, pg. 104:

In the early days of digital audio research, the necessary bandwidth of about 1 Mbps per audio channel was difficult to store. Disk drives had the bandwidth but not the capacity for long recording time, so attention turned to video recorders. These were adapted to store audio samples by creating a pseudo-video waveform which would convey binary as black and white levels. The sampling rate of such a system is constrained to relate simply to the field rate and field structure of the television standard used, so that an integer number of samples can be stored on each usable TV line in the field. Such a recording can be made on a monochrome recorder, and these recording are made in two standards, 525 lines at 60 Hz and 625 lines at 50 Hz. Thus it is possible to find a frequency which is a common multiple of the two and is also suitable for use as a sampling rate.

The allowable sampling rates in a pseudo-video system can be deduced by multiplying the field rate by the number of active lines in a field (blanking lines cannot be used) and again by the number of samples in a line. By careful choice of parameters it is possible to use either 525/60 or 625/50 video with a sampling rate of 44.1KHz.

In 60 Hz video, there are 35 blanked lines, leaving 490 lines per frame or 245 lines per field, so the sampling rate is given by :

60 X 245 X 3 = 44.1 KHz

In 50 Hz video, there are 37 lines of blanking, leaving 588 active lines per frame, or 294 per field, so the same sampling rate is given by

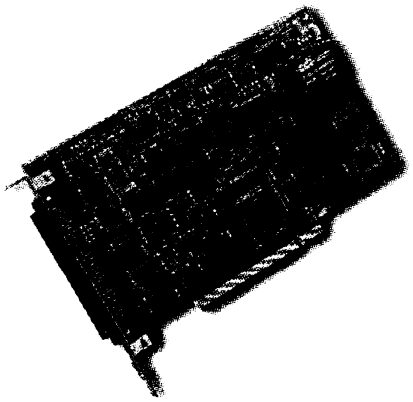
50 X 294 X3 = 44.1 Khz.

The sampling rate of 44.1 KHz came to be that of the Compact Disc. Even though CD has no video circuitry, the equipment used to make CD masters is video based and determines the sampling rate.

(Reference kindly provided by Kavitha Parthasarathy.)

Also, David Singer noted that 44,100 can be factored as 2^2 * 3^2 * 5^2 * 7^2, i.e., the product of the squares of the first four prime numbers.

http://www.cs.columbia.edu/~hgs/audio/44.1.html (Yvo Fischer)



PCI-DAS1200

- 12 Bit A/D-Wandler mit 16 s.e. oder 8 diff. Kanälen
- 2 Kanal 12 Bit D/A-Wandler
- 24 Digital-I/O Kanäle

Spezifikationen

A/D-Teil

Kanäle: 16 se od. 8 diff
Auflösung: 12 Bit
Max. Abtastrate: 330 kHz
Fifo-Puffer: 512 Werte
Eingangsbereiche: 0-10V, 0-5V, 0-2.5V, 0-1.25V, ±10V, ±5V, ±2.5V, ±1.25V

D/A-Teil

Kanäle: 2
Auflösung: 12 Bit
Einschwingzeit: 10 µs (auf 0,01%)
Ausgangsstrom: min. ±5 mA
Ausgangsbereiche: 0-10V, 0-5V, ±10V, ±5V

Digital-I/O-Teil

Anzahl Ein-/Ausg.: 24 (2 x 8 Bit Ports, 2 x 4 Bit Ports)

Softwareunterstützung (opt.)

UNIV-LIB
HP VEE
DASY-LAB
LAB-VIEW
LABTECH-NOTEBOOK
TESTPOINT
DIA/DAGO®/DIAdem®

Bestell-Infos

PCI-DAS1200 **1476,- DM***
12 Bit Multi-I/O-Karte für PCI-Bus

Im Lieferumfang:
- PCI-Karte je nach Version
- Installations-Software
- Handbuch

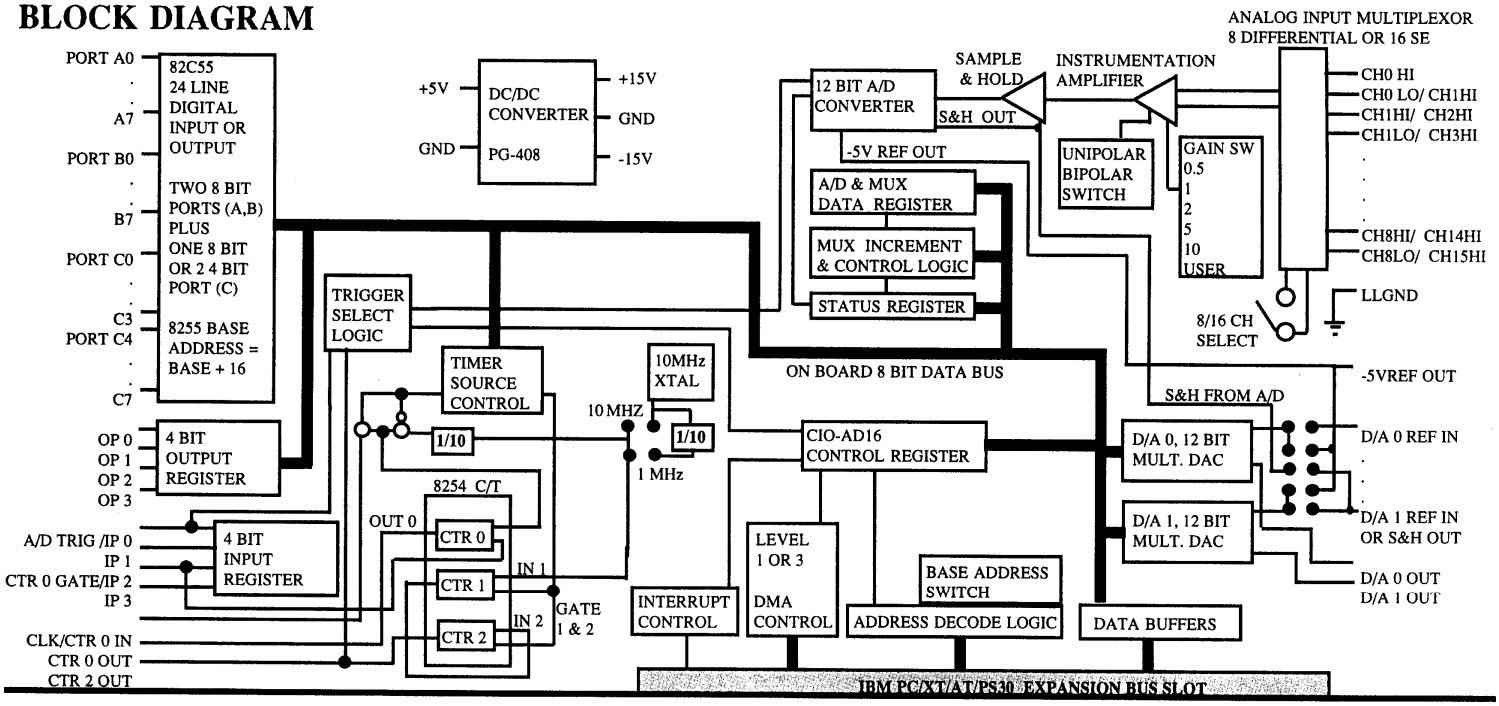
Zubehör:
C100FF-2 **225,- DM***
Anschlußkabel ca. 60 cm
CIO-TERM100 **338,- DM***
Anschlußblock

CIO-DAS16 & CIO-DAS16/F

High Speed 16 Channel 12 Bit Analog Input, 2 Channel 12 Bit Analog Output with 32 Digital I/O & 3, 16 Bit Counters

This is the tried and true standard of the DAS16 family. For new applications, we recommend the CIO-DAS1600 for better performance and value

BLOCK DIAGRAM



NI PCI-5122 Hochauflösender Digitizer - 100 MS/s, 14 bit

- Abtastraten bis zu 100 MS/s (Echtzeit) bzw. 2.0 GS/s (ETS)
- 2 simultan abgetastete Eingangskanäle mit 14-bit-Auflösung
- Signalbandbreite von 100 MHz, integrierte Rausch- und Antialiasing-Filter
- Nutzbarer Dynamikbereich von >75 dBc (SFDR)
- Großer Onboard-Speicher mit bis zu 256 MB pro Kanal (8 MB pro Kanal Standard)
- Flanken-, Fenster-, Hysterese-, Video- und Digitaltriggerung mit 40-ps-Zeitstempel

1

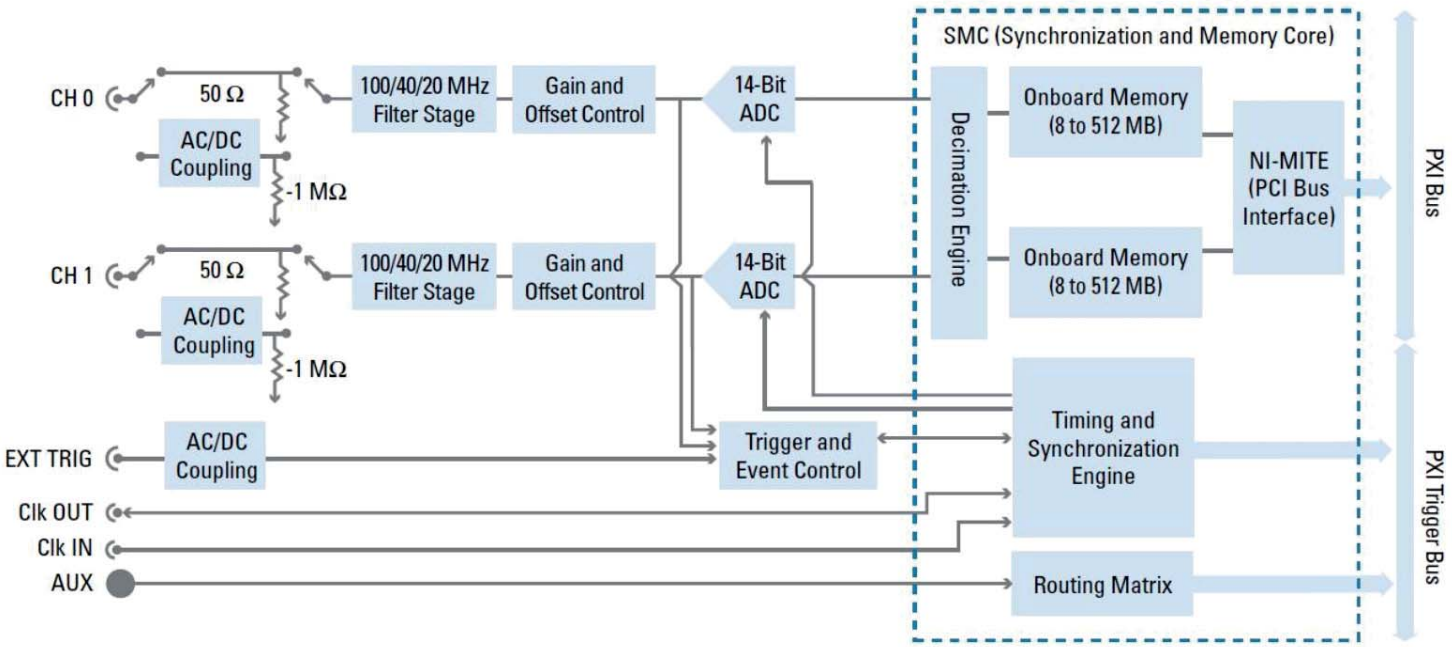
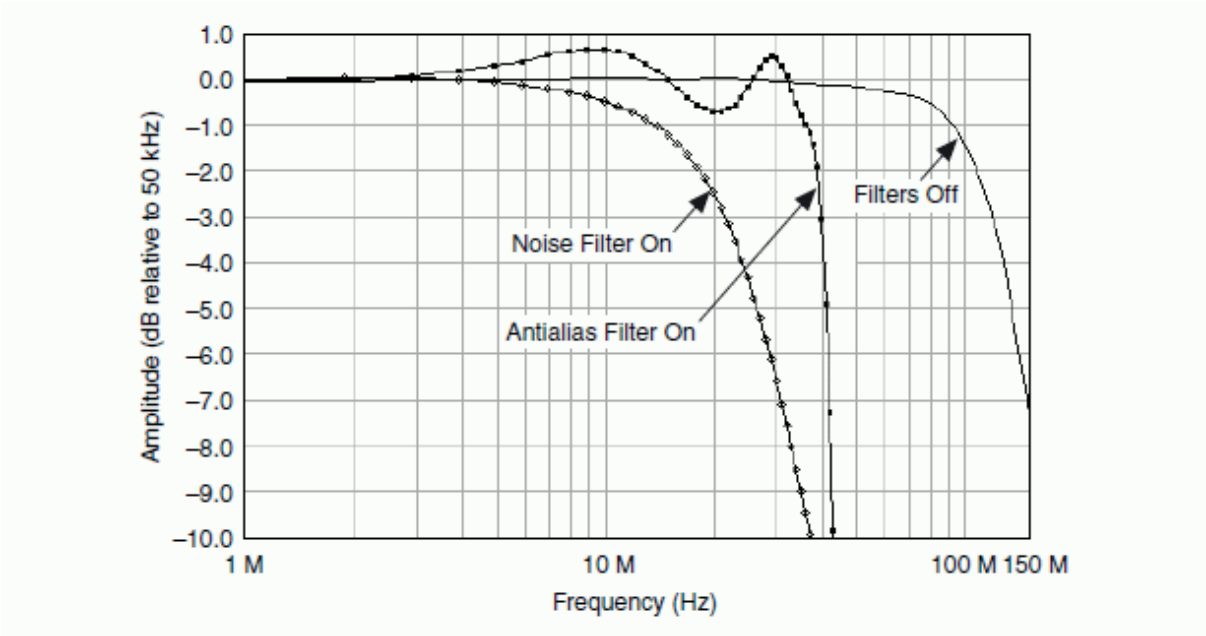


Figure 2. Hardware Block Diagram


1.0
0.0
–1.0
–2.0
–3.0
–4.0
–5.0
–6.0
–7.0
–8.0
–9.0
–10.0
Amplitude (dB relative to 50 kHz)
Filters Off
Noise Filter On
Antialias Filter On
1 M
10 M
100 M 150 M
Frequency (Hz)