Esempio di acquisizione dati da un sensore: misure con un fotometro

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Corso di Metodi di Trattamento del Segnale,

Evoluzione dei dispositivi di acquisizione dati:

- ADC con elettronica di interfaccia dedicata
- bus di acquisizione sincroni (CAMAC, GPIB, etc. ...)
- bus di acquisizione asincroni (Fastbus)
- bus interni a PC (PCI)
- bus esterni a PC (USB-2)
- utilizzo dell’interfaccia wireless 802.11

S Series Multifunction DAQ – up to 16-Bit, up to 3 MS/s per Channel, up to 8 Analog Inputs

NI 6123, NI 6122, NI 6133, NI 6132

- 4 or 8 simultaneous-sampling differential analog inputs
- 14- or 16-bit resolution
- 3 MS/s[1] or 500 kS/s per channel maximum sampling rate
- 4 analog input ranges
- Deep onboard memory – 16 or 32 MS
- 8 digital I/O lines (5 V/TTL/CMOS); two 24-bit counter/timers
- Digital and analog triggering
- Measurement services that simplify configuration and measurements

Operating Systems

- Windows 2000/NT/XP

Recommended NI Software

- LabVIEW 7.x or higher
- LabWindows/CVI 7.x or higher
- Measurement Studio 7.x or higher
- Digital Waveform Editor
- SignalExpress 1.x or higher

Other Compatible Software

- VI Logger 2.x or higher
- Visual Studio .NET
- Visual Basic, C/C++, and C#

Measurement Services Software (included)

- NI-DAQmx driver
- Measurement & Automation Explorer configuration utility
- VI Logger Lite data-logging software

Calibration Certificate Available

Family	Bus	Analog Inputs	Input Resolution (bits)	Sampling Rate	Input Ranges	Digital I/O	Counter/Timers	Trigger
NI 6123	PCI, PXI	8	16	500 kS/s per channel	4	8 @ 10 MHz	2, 24-bit	Analog, digital
NI 6122	PCI, PXI	4	16	500 kS/s per channel	4	8 @ 10 MHz	2, 24-bit	Analog, digital
NI 6133	PCI, PXI	8	14	3 MS/s per channel[1]	4	8 @ 10 MHz	2, 24-bit	Analog, digital
NI 6132	PCI, PXI	4	14	3 MS/s per channel[1]	4	8 @ 10 MHz	2, 24-bit	Analog, digital

[1] 2.5 MS/s with NI-DAQmx; 3 MS/s with additional download. Special conditions apply.

Table 1. Channel, Speed, and Resolution Specifications

Specifications

These specifications are typical at 25 °C unless otherwise noted.

Analog

Input Characteristics

Number of channels	
NI 6123	8
NI 6122	4
NI 6133	8
NI 6132	4
ADC Resolution	
NI 6122, 6123	16 bits, 1 in 65,536
NI 6132, 6133	14 bits, 1 in 16,384
Sampling rate	
Maximum (NI 6133, 6132)	3.0 MS/s per channel[1]
Maximum (NI 6123, NI 6122)	500 kS/s per channel
Minimum	No minimum
Input signal ranges (selectable by channel)	±10, ±5, ±2.5, ±1.25 V
Input coupling	DC
Input FIFO size	
NI 6123	16 or 32 MS
NI 6122	16 MS
NI 6133	16 or 32 MS
NI 6132	16 MS

[1] 2.5 MS/s with NI-DAQmx; 3 MS/s with additional download. Special conditions apply.

Digital I/O

Number of channels	8 input/output
Compatibility	TTL/CMOS
Power-on state	Input (high-impedance)
Input buffer	2,044 B
Output buffer	2,044 B
Transfer rate (1 word = 8 bits)	10 Mwords/s

Timing I/O

Number of channels	2 up/down counter/timers, 1 frequency scaler
Resolution	
Counter/timers	24 bits
Frequency scaler	4 bits
Compatibility	TTL/CMOS
Base clocks available	
Counter/timers	20 MHz, 100 kHz
Frequency scaler	10 MHz, 100 kHz
Max source frequency	20 MHz

Triggers

Analog Trigger

Source	All analog input channels
Level	± Full-scale
Slope	Positive or negative (software selectable)
Resolution	8 bits, 1 in 256
Hysteresis	Programmable

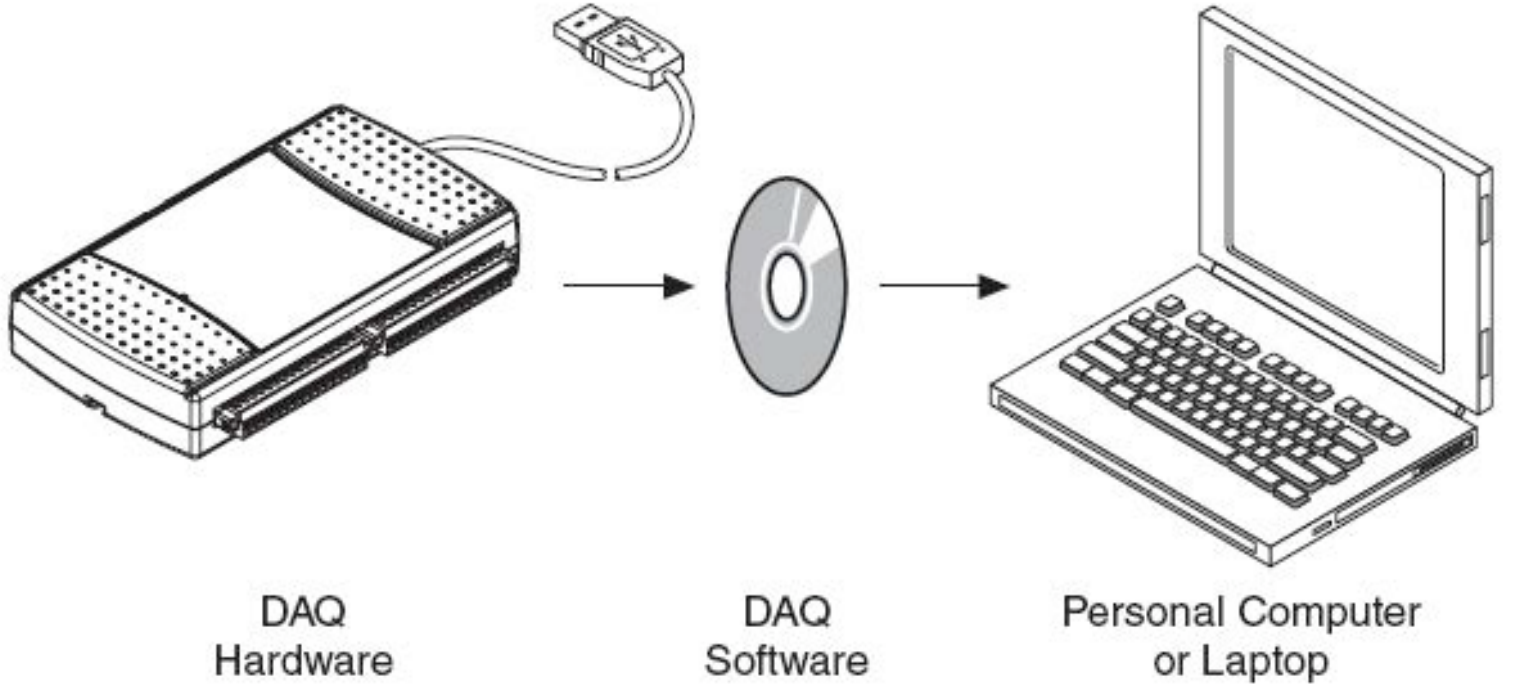
Digital Trigger

Compatibility	TTL
Response	Rising or falling edge


X Series
Multifunction DAQ Device
NATIONAL INSTRUMENTS
PXI
X Series
Multifunction DAQ Device
NATIONAL INSTRUMENTS

Module	Analog Inputs	Max AI Sampling Rate	Aggregate AI Throughput (All ch)	Analog Outputs	Digital I/O	DIO Max Clock Rate
NI USB-6341	16	500 kS/s	500 kS/s	2	24	1 MHz
NI USB-6343	32	500 kS/s	500 kS/s	4	48	1 MHz
NI USB-6351	16	1.25 MS/s	1 MS/s	2	24	10 MHz
NI USB-6353	32	1.25 MS/s	1 MS/s	4	48	10 MHz
NI USB-6361	16	2 MS/s	1 MS/s	2	24	10 MHz
NI USB-6363	32	2 MS/s	1 MS/s	4	48	10 MHz
NI USB-6356	8 Simultaneous	1.25 MS/s/ch	10 MS/s	2	24	10 MHz
NI USB-6366	8 Simultaneous	2 MS/s/ch	16 MS/s	2	24	10 MHz
NI PCIe-6320	16	250 kS/s	250 kS/s	0	24	1 MHz
NI PCIe-6321	16	250 kS/s	250 kS/s	2	24	1 MHz
NI PCIe-6323	32	250 kS/s	250 kS/s	4	48	1 MHz
NI PCIe-6341	16	500 kS/s	500 kS/s	2	24	1 MHz
NI PCIe-6343	32	500 kS/s	500 kS/s	4	48	1 MHz
NI PCIe-6351	16	1.25 MS/s	1 MS/s	2	24	10 MHz
NI PCIe-6353	32	1.25 MS/s	1 MS/s	4	48	10 MHz
NI PCIe-6361	16	2 MS/s	1 MS/s	2	24	10 MHz
NI PCIe-6363	32	2 MS/s	1 MS/s	4	48	10 MHz
NI PXIe-6341	16	500 kS/s	500 kS/s	2	24	1 MHz
NI PXIe-6361	16	2 MS/s	1 MS/s	2	24	10 MHz
NI PXIe-6363	32	2 MS/s	1 MS/s	4	48	10 MHz
NI PXIe-6356	8 Simultaneous	1.25 MS/s/ch	10 MS/s	2	24	10 MHz
NI PXIe-6358	16 Simultaneous	1.25 MS/s/ch	20 MS/s	4	48	10 MHz
NI PXIe-6366	8 Simultaneous	2 MS/s/ch	16 MS/s	2	24	10 MHz
NI PXIe-6368	16 Simultaneous	2 MS/s/ch	32 MS/s	4	48	10 MHz

NI9201



fotodiodo + preamp (fotometro) → USB-6211 → DAQmx → LabView

La scheda di acquisizione e generazione di segnali USB-6211

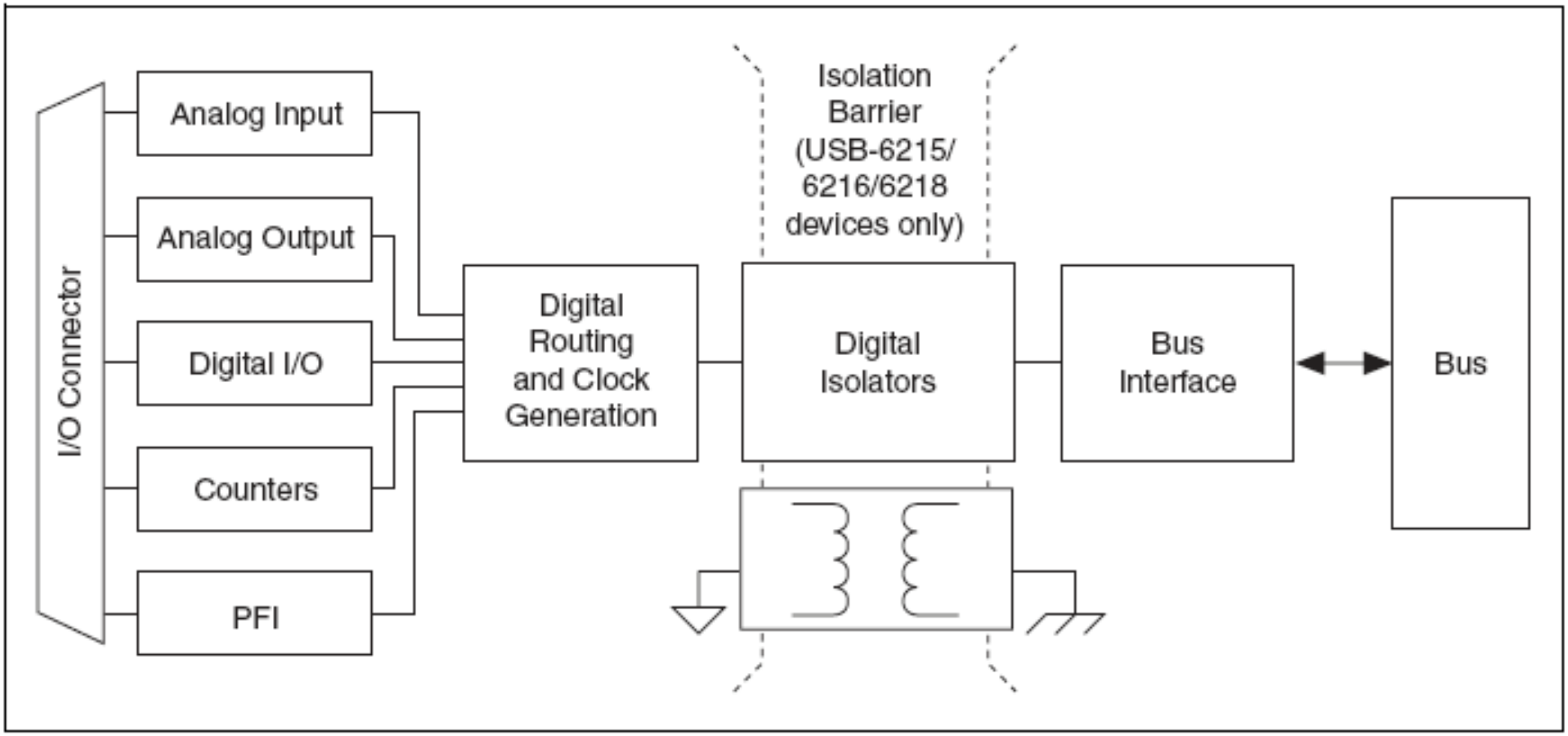
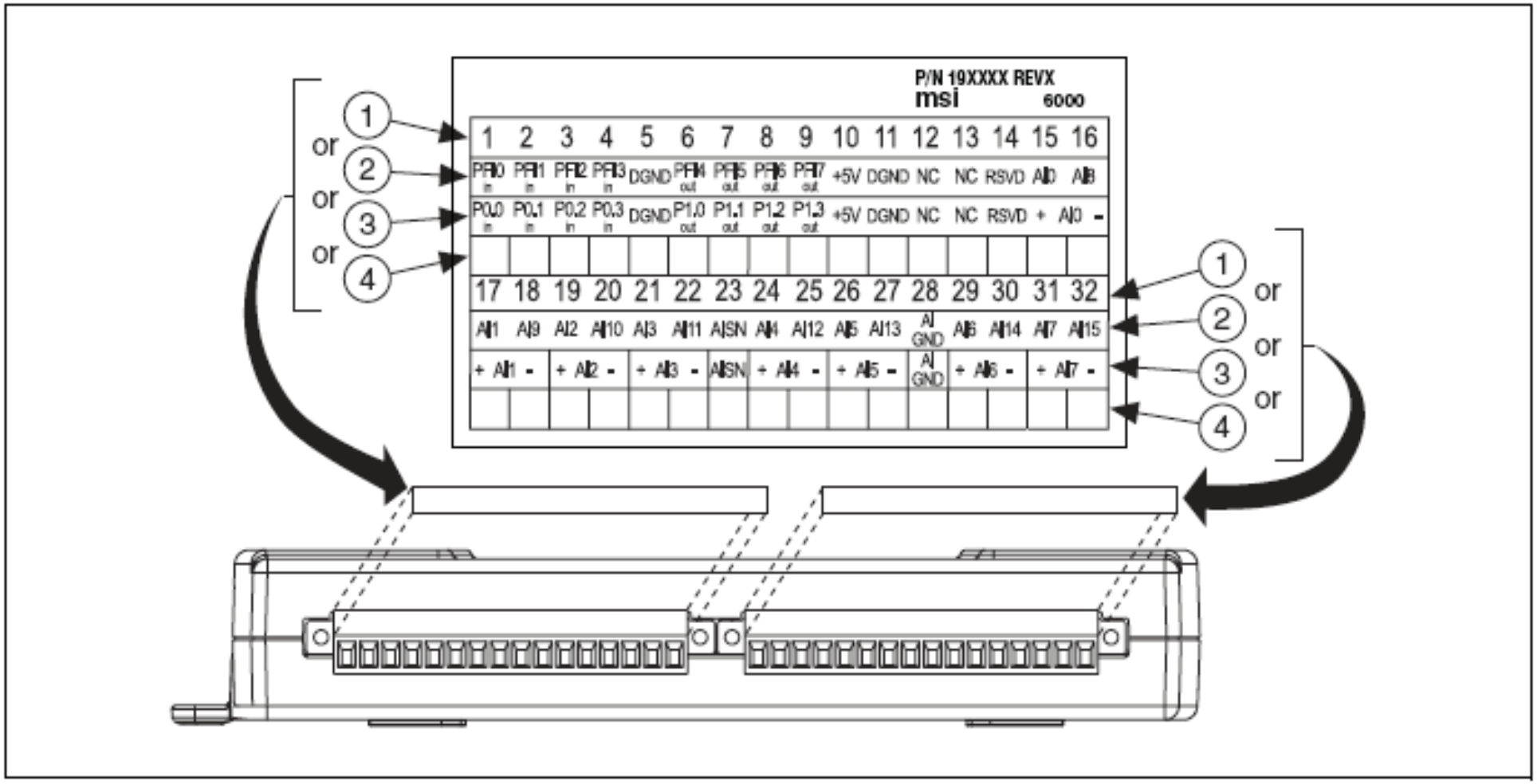


Figure 2-2. USB-621*x* Block Diagram



1	Terminal Number Label	3	Differential Signal Name Label
2	Single-Ended Signal Name Label	4	User-Defined Custom Label

Analog Input

Number of channels

- USB-6210/6211/6212/6215/6216 ..... 8 differential or 16 single ended
- USB-6218 ..... 16 differential or 32 single ended

ADC resolution ..... 16 bits

DNL ..... No missing codes guaranteed

INL ..... Refer to the *AI Absolute Accuracy Tables*

Sampling rate

- Maximum
  - USB-6210/6211/6215/6218 ... 250 kS/s single channel, 250 kS/s multichannel (aggregate)
  - USB-6212/6216 ..... 400 kS/s single channel, 400 kS/s multichannel (aggregate)
- Minimum ..... 0 S/s
- Timing accuracy ..... 50 ppm of sample rate
- Timing resolution ..... 50 ns

Input coupling ..... DC

Input range ..... ±10 V, ±5 V, ±1 V, ±0.2 V

Maximum working voltage for analog inputs (signal + common mode) ..... ±10.4 V of AI GND

CMRR (DC to 60 Hz) ..... 100 dB

Input impedance

- Device on
  - AI+ to AI GND ..... >10 GΩ in parallel with 100 pF
  - AI– to AI GND ..... >10 GΩ in parallel with 100 pF
- Device off
  - AI+ to AI GND ..... 1200 Ω
  - AI– to AI GND ..... 1200 Ω

Input bias current ..... ±100 pA

Crosstalk (at 100 kHz)

- Adjacent channels ..... –75 dB
- Non-adjacent channels ..... –90 dB

Small signal bandwidth (–3 dB)

- USB-6210/6211/6215/6218 ..... 450 kHz
- USB-6212/6216 ..... 1.5 MHz

Input FIFO size ..... 4,095 samples

Scan list memory ..... 4,095 entries

Data transfers ..... USB Signal Stream, programmed I/O

Overvoltage protection (AI <0..31>, AI SENSE)

- Device on ..... ±30 V for up to two AI pins
- Device off ..... ±20 V for up to two AI pins

Input current during overvoltage condition ..... ±20 mA max/AI pin

Analog Output

Number of channels

- USB-6210 0
- USB-6211/6212/6215/6216/6218 2

DAC resolution ..... 16 bits

DNL ..... ±1 LSB

Monotonicity ..... 16 bit guaranteed

Maximum update rate

- 1 channel ..... 250 kS/s
- 2 channels ..... 250 kS/s per channel

Timing accuracy ..... 50 ppm of sample rate

Timing resolution ..... 50 ns

Output range ..... ±10 V

Output coupling ..... DC

Output impedance ..... 0.2 Ω

Output current drive ..... ±2 mA

Overdrive protection ..... ±30 V

Overdrive current ..... 2.4 mA

Power-on state ..... ±20 mV

Power-on glitch ..... ±1 V for 200 ms

Output FIFO size ..... 8,191 samples shared among channels used

Data transfers ..... USB Signal Stream, programmed I/O

AO waveform modes:

- Non-periodic waveform
- Periodic waveform regeneration mode from onboard FIFO
- Periodic waveform regeneration from host buffer including dynamic update

Settling time, full scale step

15 ppm (1 LSB) ..... 32 µs

Slew rate ..... 5 V/µs

Glitch energy

- Magnitude ..... 100 mV
- Duration ..... 2.6 µs

Digital I/O/PFI

Static Characteristics

Number of channels

- Digital input
  - USB-6210/6211/6215 ..... 4 (PFI <0..3>/P0.<0..3>)
  - USB-6218 ..... 8 (PFI <0..3>/P0.<0..3>, PFI <8..11>/P0.<4..7>)
- Digital output
  - USB-6210/6211/6215 ..... 4 (PFI <4..7>/P1.<0..3>)
  - USB-6218 ..... 8 (PFI <4..7>/P1.<0..3>, PFI <12..15>/P1.<4..7>)
- Digital input or output
  - USB-6212/6216 Screw Terminal ..... 32 total, 16 (P0.<0..15>), 16 (PFI <0..7>/P1.<0..7>, PFI <8..15>/P2.<0..7>)
  - USB-6212/6216 Mass Termination ..... 24 total, 8 (P0.<0..7>), 16 (PFI <0..7>/P1.<0..7>, PFI <8..15>/P2.<0..7>)

Ground reference ..... D GND

Pull-down resistor

- USB-6210/6211/6215/6218..... 47 kΩ ±1%
- USB-6212/6216..... 50 kΩ typical, 20 kΩ minimum

Input voltage protection[1]..... ±20 V on up to 8 pins

General-Purpose Counter/Timers

Number of counter/timers..... 2

Resolution ..... 32 bits

Counter measurements..... Edge counting, pulse, semi-period, period, two-edge separation

Position measurements ..... X1, X2, X4 quadrature encoding with Channel Z reloading; two-pulse encoding

Output applications..... Pulse, pulse train with dynamic updates, frequency division, equivalent time sampling

Internal base clocks..... 80 MHz, 20 MHz, 0.1 MHz

External base clock frequency ..... 0 MHz to 20 MHz

Base clock accuracy..... 50 ppm

Inputs ..... Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down

Routing options for inputs

- USB-6210/6211/6215/6218 ..... PFI <0..3>, PFI <8..11>, many internal signals
- USB-6212/6216..... PFI <0..15>, many internal signals

FIFO..... 1,023 samples

Data transfers ..... USB Signal Stream, programmed I/O

External Digital Triggers

Source

- USB-6210/6211/6215/6218 ..... PFI <0..3>, PFI <8..11>
- USB-6212/6216 ..... PFI <0..15>

Polarity ..... Software-selectable for most signals

Analog input function ..... Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Convert Clock, Sample Clock Timebase

Analog output function ..... Start Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase

Counter/timer functions ..... Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down,

Bus Interface

USB ..... USB 2.0 Hi-Speed or Full-Speed[1]

USB Signal Stream (USB) ..... 4, can be used for analog input, analog output, counter/timer 0, counter/timer 1

Power Limits

+5 V terminal as output[2,3]

- Voltage ..... 4.6 to 5.2 V
- Current (internally limited) ..... 50 mA max, shared with digital outputs

+5 V terminal as input[2,3]

- Voltage ..... 4.75 to 5.35 V
- Current ..... 350 mA max, self-resetting fuse

Power Requirements

Input voltage on USB-621*x*

- USB port ..... 4.5 to 5.25 V in configured state

Maximum inrush current ..... 500 mA

No load typical current ..... 320 mA at 4.5 V

Maximum load

- Typical current ..... 400 mA at 4.5 V
- Suspend current ..... 260 µA, typical

Physical Characteristics

Enclosure dimensions (includes connectors)

- USB-621*x* Screw Terminal ..... 16.9 × 9.4 × 3.1 cm (6.65 × 3.70 × 1.20 in
- USB-621*x* Mass Termination ..... 19.3 × 9.4 × 3.1 cm (7.61 × 3.68 × 1.20 in

Weight

- USB-6210/6211/6212/6215/6216/6218 Screw Terminal ..... 206 g (7.2 oz)
- USB-6212 Mass Termination ..... 227 g (8.0 oz)
- USB-6216 Mass Termination ..... 231 g (8.1 oz)
- USB-6210 OEM ..... 73 g (2.5 oz)
- USB-6212/6216/6218 OEM ..... 76 g (2.6 oz)

I/O connectors

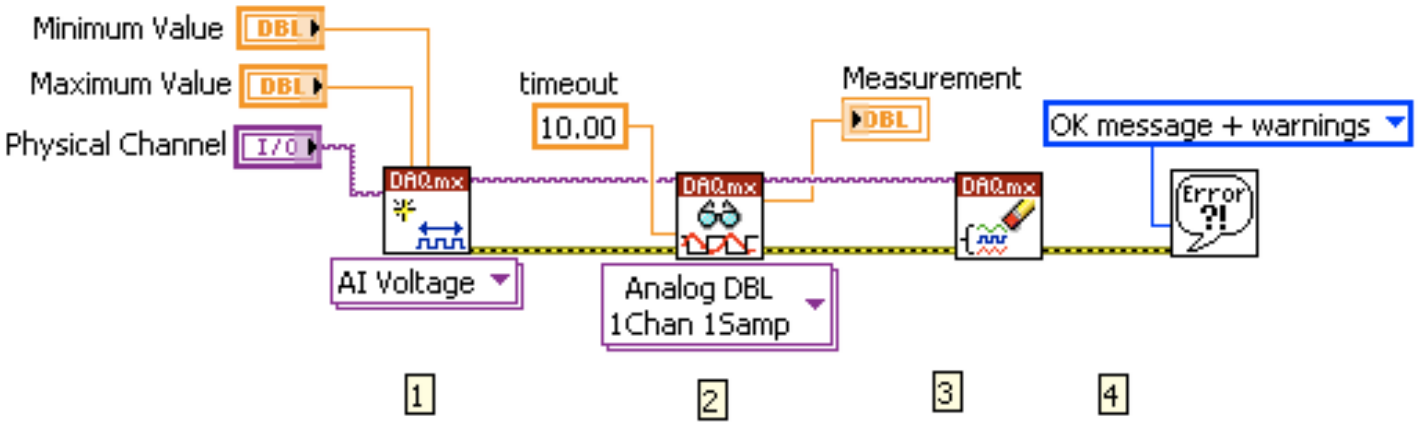
- USB-6210/6211/6215 ..... Two 16-position combicon
- USB-6212/6216/6218 Screw Terminal ..... Four 16-position combicon
- USB-6212/6216 Mass Termination ..... One 68-pin SCSI

USB connector ..... Series B receptacle

Screw terminal wiring ..... 16 to 28 AWG

Torque for screw terminals ..... 0.22–0.25 N · m (2.0–2.2 lb · in.)

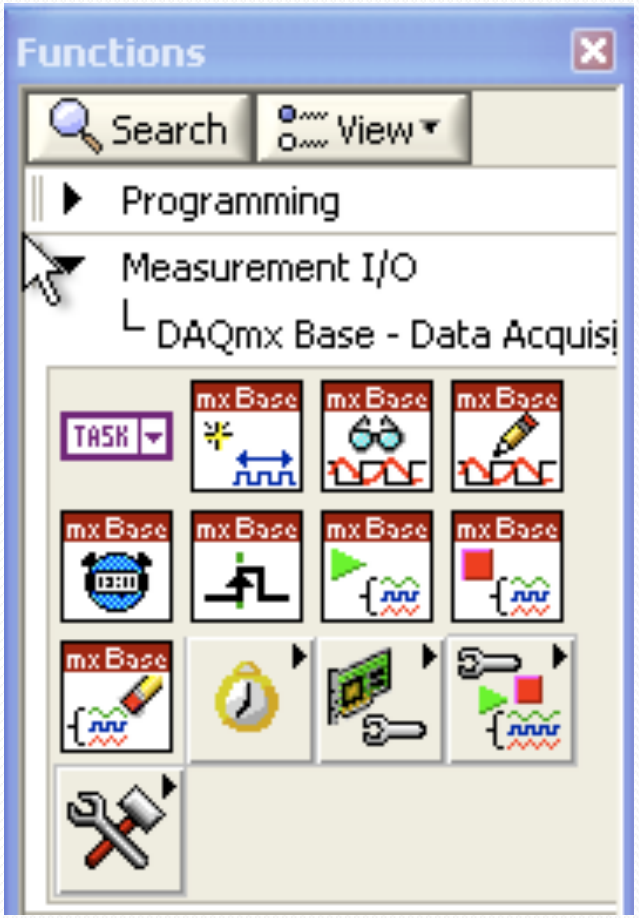
Acq One Sample.vi



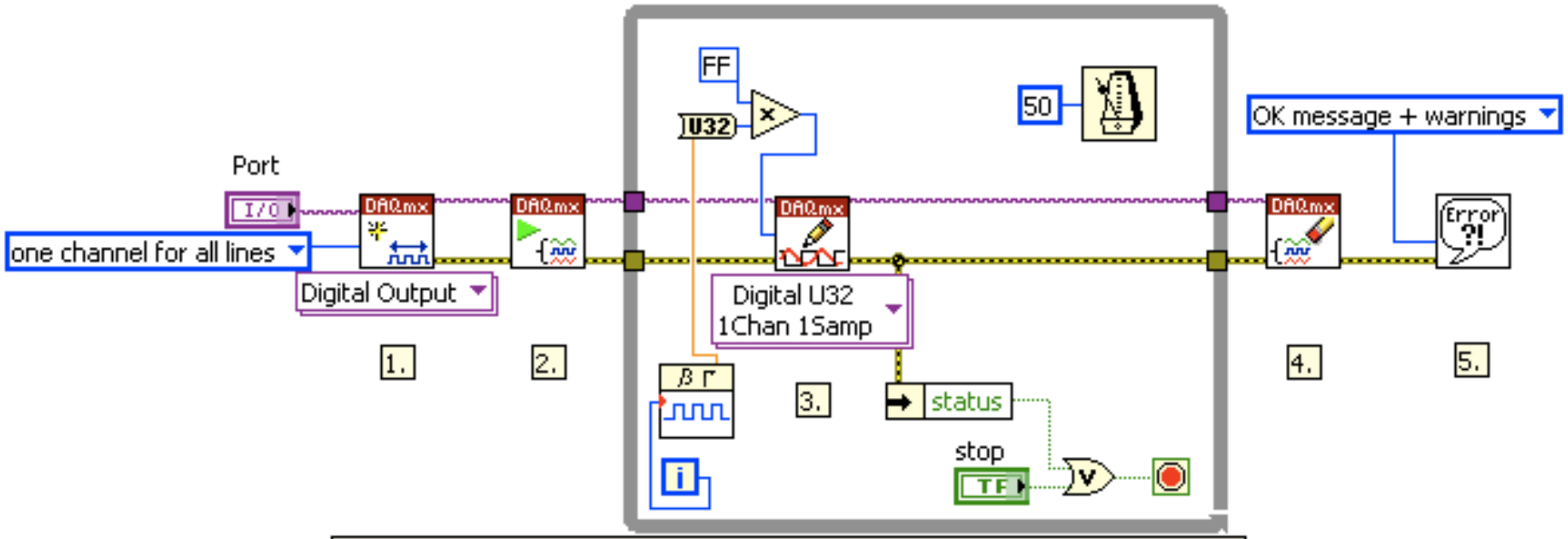
Steps:
1. Create an Analog Input Voltage Channel.
2. Use the Read VI to Measure 1 Sample from 1 Channel on the Data Acquisition Card. Set a timeout so an error is returned if the sample is not returned in the specified time limit
3. Call the Clear Task VI to clear the Task.
4. Use the popup dialog box to display an error if any.

Interazione tra strumento e computer gestita da DAQmx

LabView può interagire direttamente con DAQmx



Write Dig Port.vi (modificato)



Steps:
1. Create a Digital Output channel. Use one channel for all lines. In this case, the port itself acts as an individual channel.
2. Call the Start VI to start the task.
3. Write digital port data in a loop until the user hits the stop button or an error occurs. This write VI writes a single sample of digital data on demand, so no timeout is necessary.
4. Call the Clear Task VI to clear the Task.
5. Use the popup dialog box to display an error or warning if any.

DAQmx Create Virtual Channel

Creates a virtual channel or set of virtual channels and adds them to a task. The instances of this polymorphic VI correspond to the I/O type of the channel, such as analog input, digital output, or counter output; the measurement or generation to perform, such as temperature measurement, voltage generation, or event counting; and in some cases, the sensor to use, such as a thermocouple or RTD for temperature measurements.

If you use this VI within a loop without specifying a **task in**, NI-DAQmx creates a new task in each iteration of the loop. Use the DAQmx Clear Task VI within the loop after you are finished with the task to avoid allocating unnecessary memory. Refer to Task Creation and Destruction for more information about when NI-DAQmx creates tasks and when LabVIEW automatically destroys tasks.

The DAQmx Channel properties include additional channel configuration options.

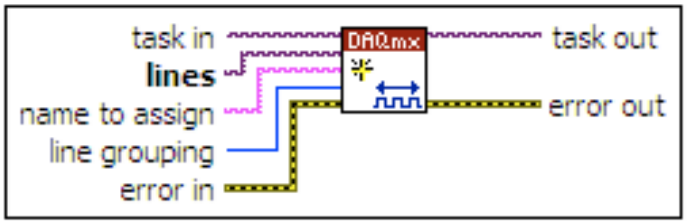
Use the pull-down menu to select an instance of this VI.

Select an instance

Place on the block diagram. Find on the **Functions** palette.

Digital Output

Creates channel(s) to generate digital signals. You can group digital lines into one digital channel or separate them into multiple digital channels. If you specify one or more entire ports in **lines** input by using port physical channel names, you cannot separate the ports into multiple channels. To separate ports into multiple channels, use this VI multiple times with a different port each time.



DAQmx Start Task

Transitions the task to the running state to begin the measurement or generation. Using this VI is required for some applications and is optional for others.

If you do not use this VI, a measurement task starts automatically when the DAQmx Read VI runs. The **autostart** input of the DAQmx Write VI determines if a generation task starts automatically when the DAQmx Write VI runs.

If you do not use the DAQmx Start Task VI and the DAQmx Stop Task VI when you use the DAQmx Read VI or the DAQmx Write VI multiple times, such as in a loop, the task starts and stops repeatedly. Starting and stopping a task repeatedly reduces the performance of the application.

☐ Place on the block diagram. ☐ Find on the **Functions** palette.

DAQmx Write

Writes samples to the task or virtual channels you specify. The instances of this polymorphic VI specify the format of the samples to write, whether to write one or multiple samples, and whether to write to one or multiple channels.

If the task uses on-demand timing, this VI returns only after the device generates all samples. On-demand is the default timing type if you do not use the DAQmx Timing VI. If the task uses any timing type other than on-demand, this VI returns immediately and does not wait for the device to generate all samples. Your application must determine if the task is done to ensure that the device generated all samples.

The DAQmx Write properties include additional configuration options for write operations.

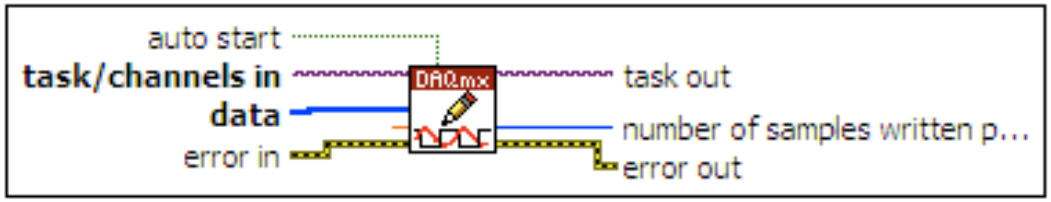
Use the pull-down menu to select an instance of this VI.

Select an instance

Place on the block diagram. Find on the **Functions** palette.

Digital 1D U32 NChan 1Samp

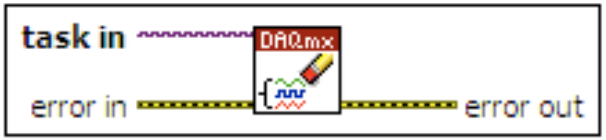
Writes a single 32-bit unsigned integer sample to a task that contains one or more digital output channels. Use an instance that writes 32-bit unsigned integers for devices with up to 32 lines per port.



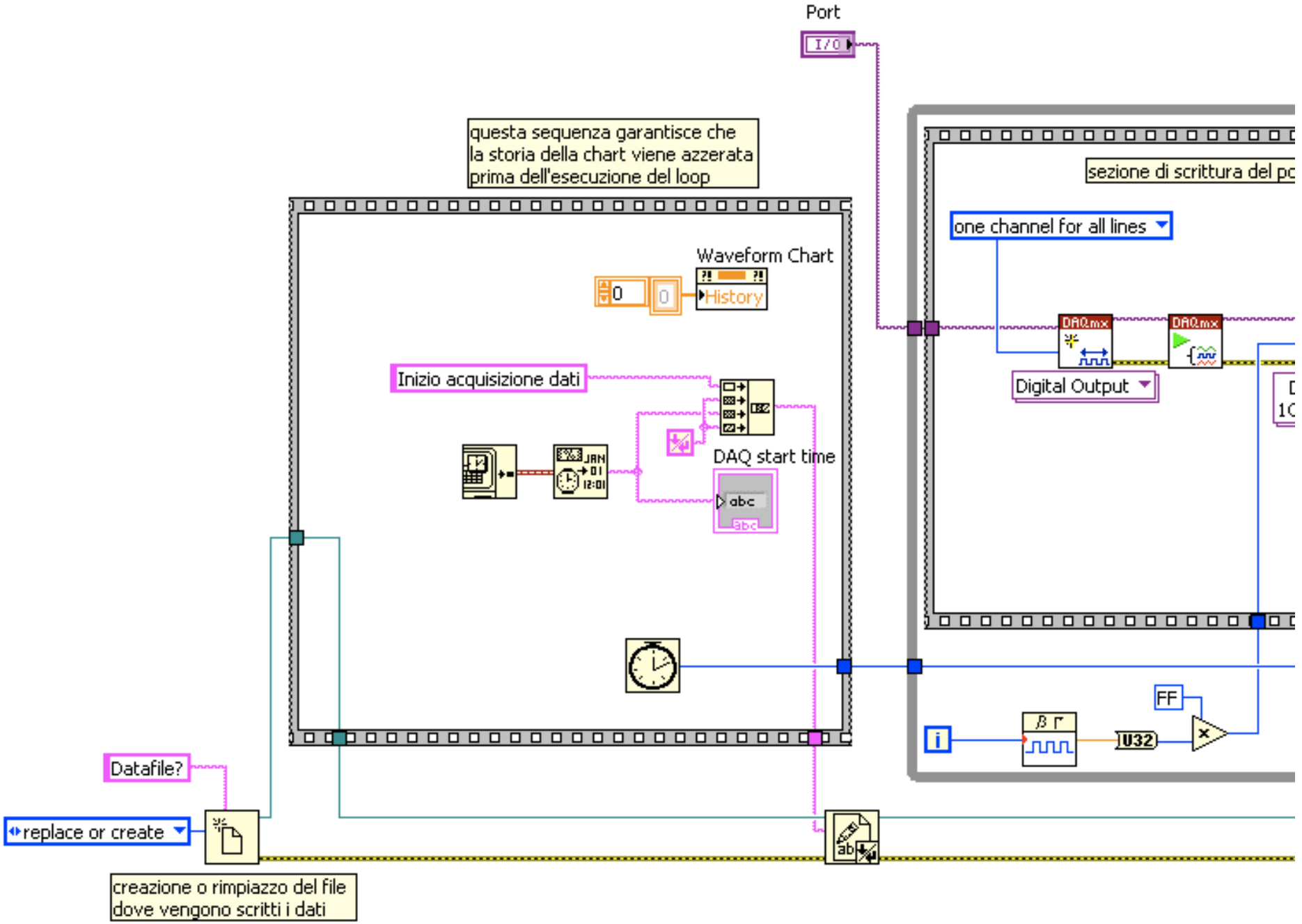
DAQmx Clear Task

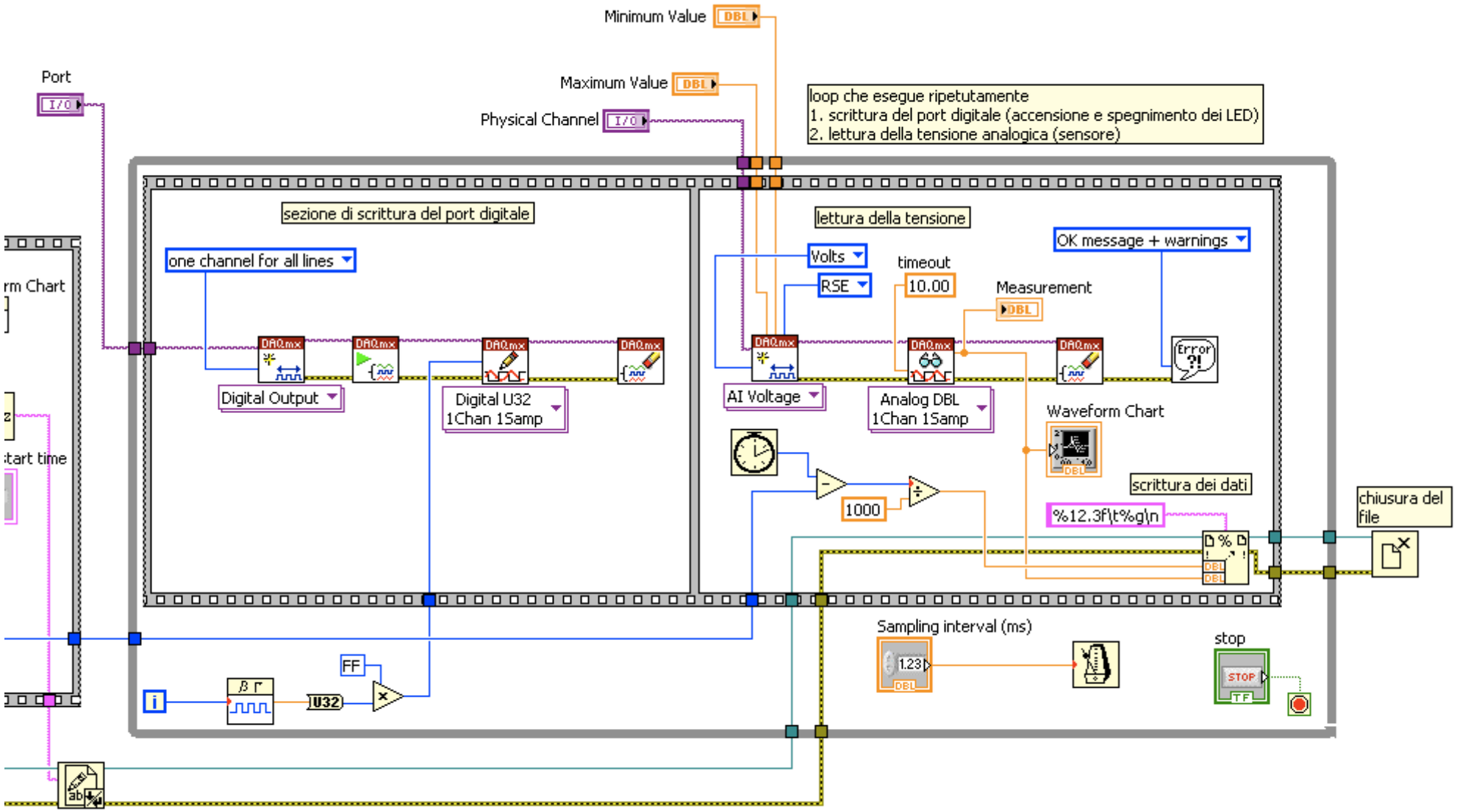
Clears the task. Before clearing, this VI stops the task, if necessary, and releases any resources the task reserved. You cannot use a task after you clear it unless you recreate the task.

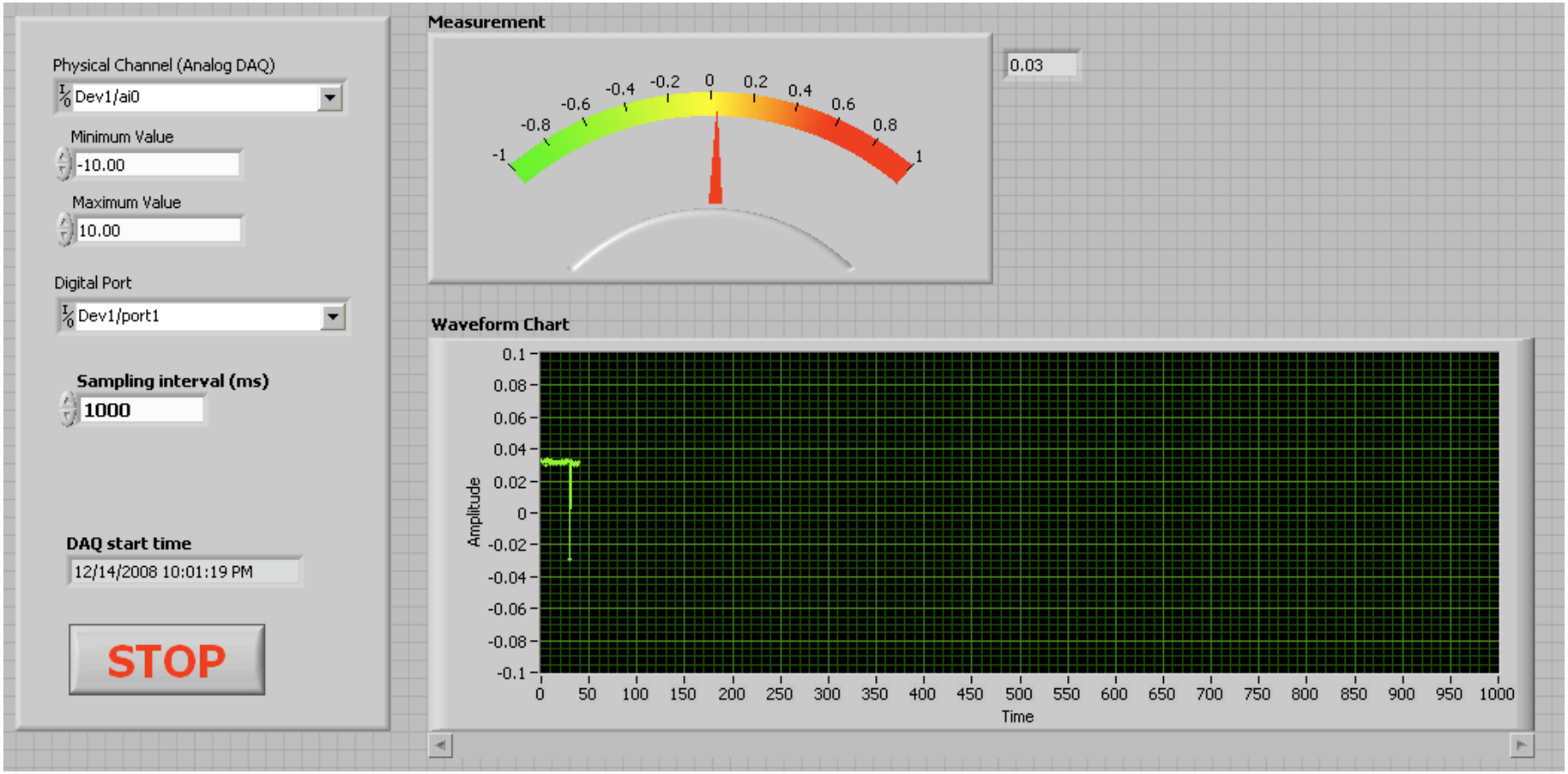
If you use the DAQmx Create Task VI or the DAQmx Create Virtual Channel VI within a loop, use this VI within the loop after you are finished with the task to avoid allocating unnecessary memory. Refer to Task Creation and Destruction for more information about when to use this VI.



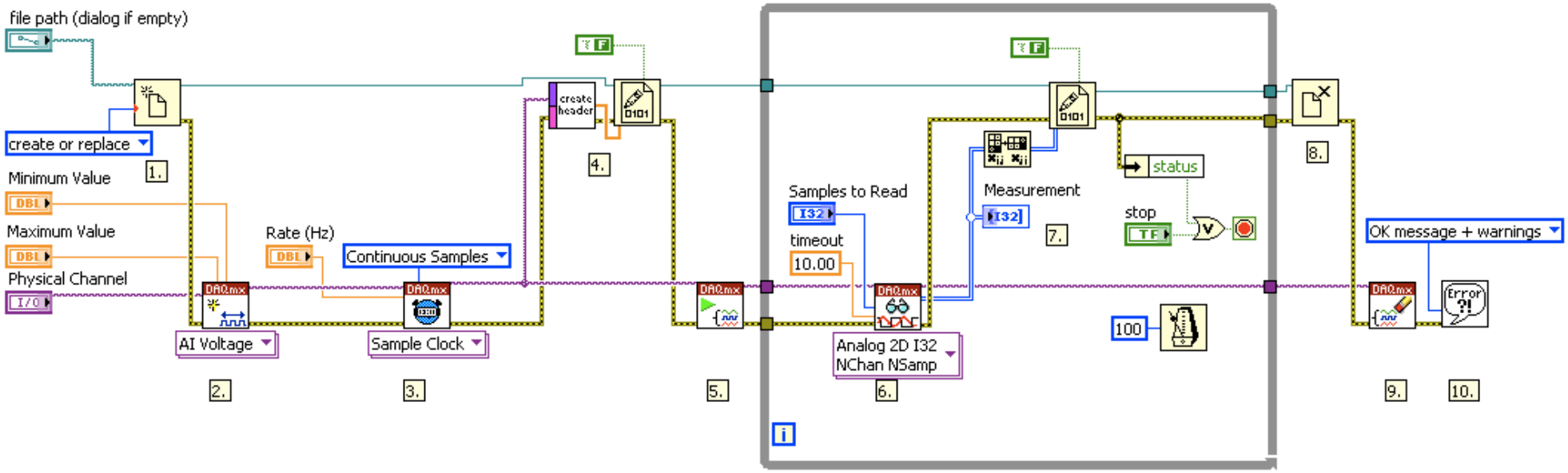
Place on the block diagram. Find on the **Functions** palette.


Port
I/O
questa sequenza garantisce che
la storia della chart viene azzerata
prima dell'esecuzione del loop
Waveform Chart
History
Inizio acquisizione dati
DAQ start time
sezione di scrittura del pc
one channel for all lines
DAQmx
DAQmx
Digital Output
FF
U32
Datafile?
replace or create
creazione o rimpiazzo del file
dove vengono scritti i dati


Minimum Value
Maximum Value
Physical Channel
Port
loop che esegue ripetutamente
1. scrittura del port digitale (accensione e spegnimento dei LED)
2. lettura della tensione analogica (sensore)
sezione di scrittura del port digitale
one channel for all lines
Digital Output
Digital U32
1Chan 1Samp
lettura della tensione
Volts
RSE
timeout
10.00
Measurement
OK message + warnings
AI Voltage
Analog DBL
1Chan 1Samp
Waveform Chart
1000
scrittura dei dati
%12.3f\t%g\n
chiusura del file
Sampling interval (ms)
stop
FF
U32
rm Chart
tart time


Physical Channel (Analog DAQ)
Dev1/ai0
Minimum Value
-10.00
Maximum Value
10.00
Digital Port
Dev1/port1
Sampling interval (ms)
1000
DAQ start time
12/14/2008 10:01:19 PM
STOP
Measurement
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
0.03
Waveform Chart
Amplitude
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
Time

Cont Acq&Graph Voltage-To File(Binary).vi (modificato)



Steps:
1. Create or Replace a file to store the data.
2. Create an analog input voltage channel.
3. Set the rate for the sample clock. Additionally, define the sample mode to be continuous.
4. Create a header and write it to the binary file.
5. Call the Start VI to start acquiring samples.
6. Read the unscaled data in a loop until the user hits the stop button or an error occurs.

Note: This example uses unscaled I32 reads. Some devices support unscaled reads in smaller widths, such as I16. To get the maximum performance out of your device, use the unscaled read with the smallest supported width.

7. Transpose the unscaled array of data and append it to the file.
8. Close the File.
9. Call the Stop VI to stop acquiring samples.
10. Use the popup dialog box to display an error if any.

Problemi da risolvere in laboratorio:

1. Collegare l’ hardware a disposizione
2. Utilizzare NI Example Finder per individuare gli esempi
3. Ricostruire il programma di acquisizione descritto sopra
4. Accendere il web server per vedere i dati in remoto

"I CAN REMEMBER WHEN ALL WE NEEDED WAS SOMEONE WHO COULD CARVE AND SOMEONE WHO COULD SEW."