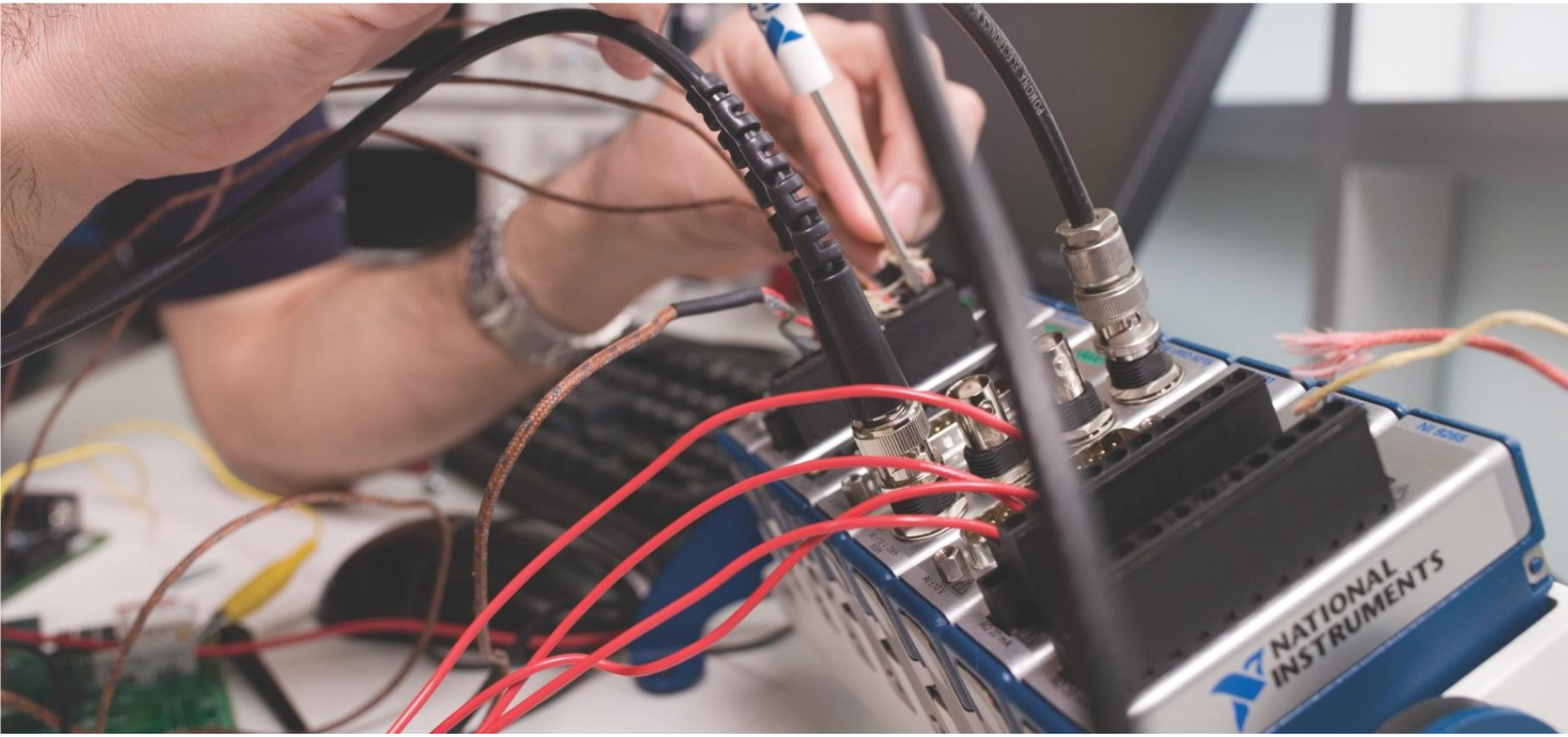


Sensor Measurement Fundamentals Series

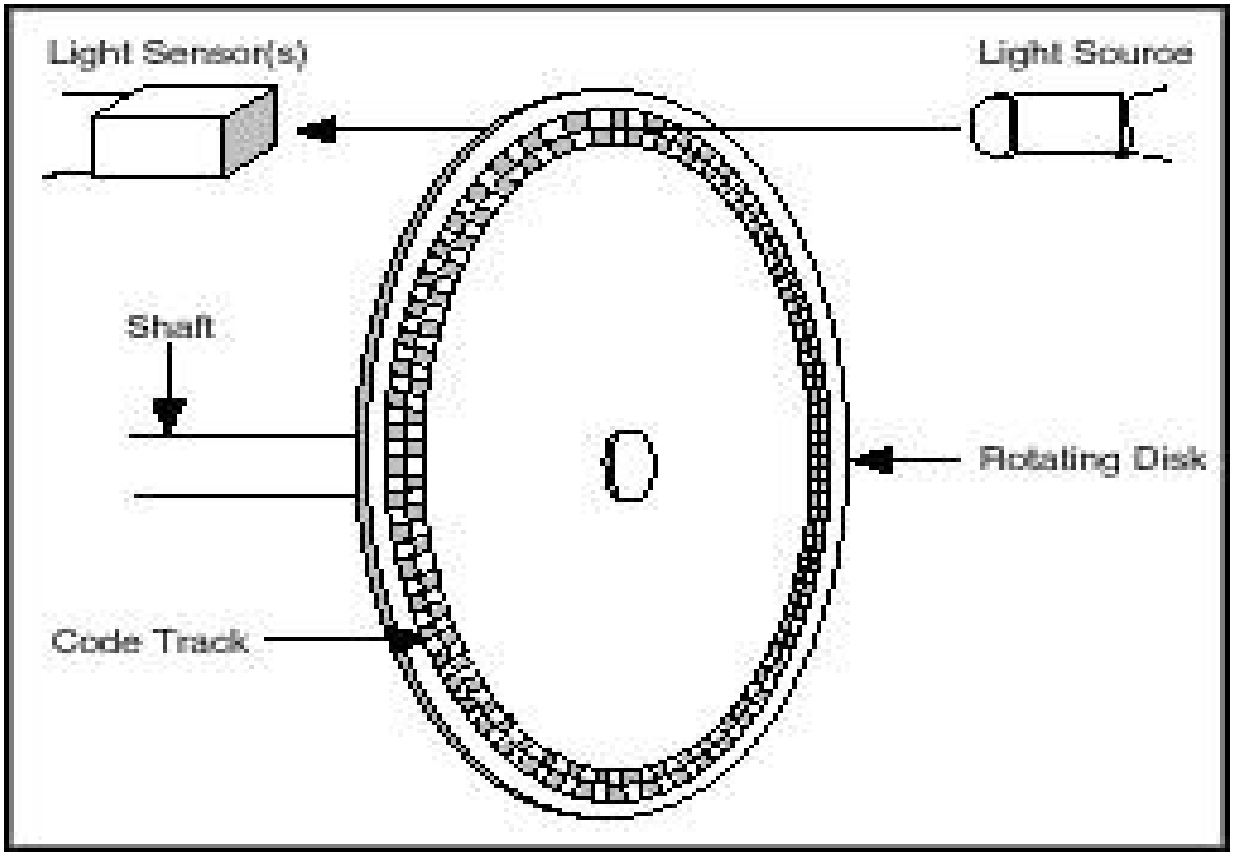
NATIONAL INSTRUMENTS

How to Make Frequency and Encoder Measurements

Jackie Byrne
Product Marketing Engineer
National Instruments

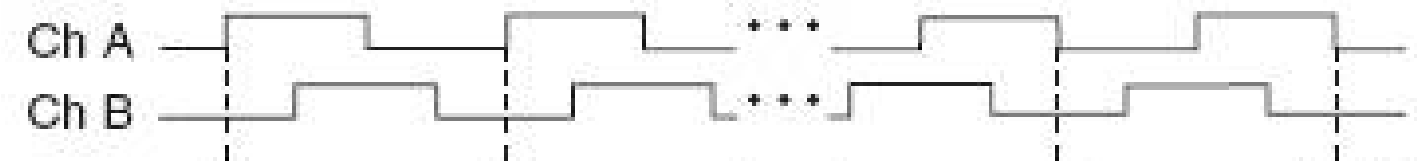
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What Is an Encoder?

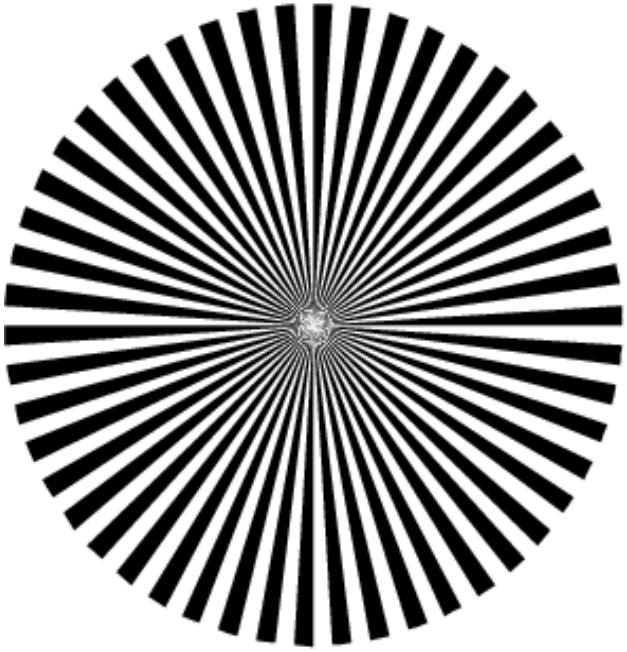


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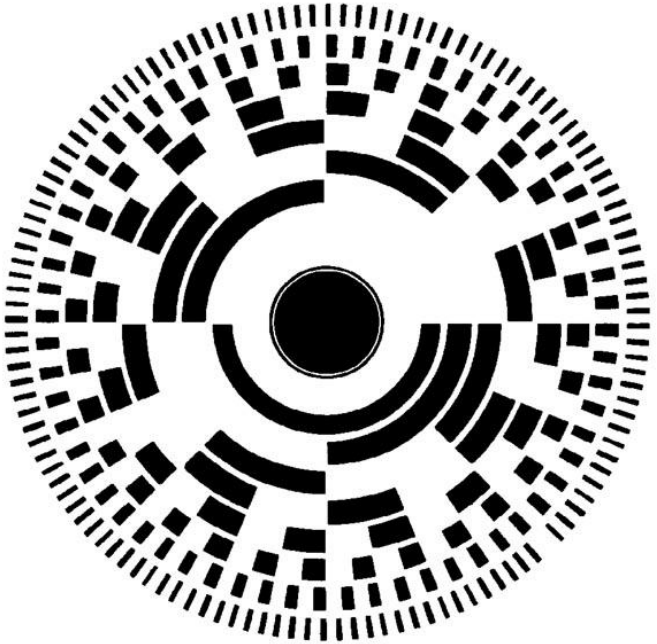
Types of Encoders



Incremental Encoder



Absolute Encoder



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How to Make Encoder Measurements

- Basic requirement is an electronic component called a *counter*
- Two basic functions
  1. Count based on the comparison of input signals (gate, source)
  2. Generate pulses based on inputs and register values

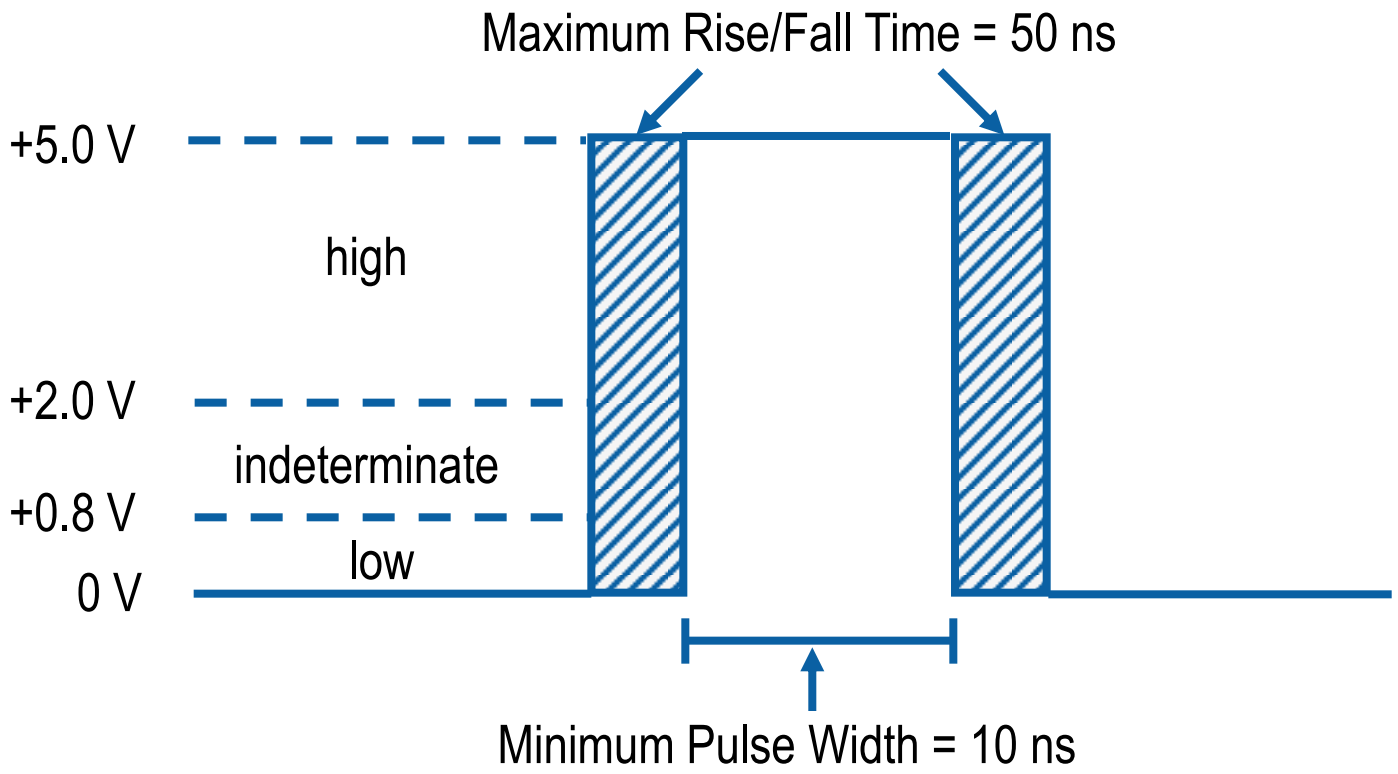


Simplified Version of a Counter

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Counter Signals

- Counters accept and generate TTL signals



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How to Make Encoder Measurements

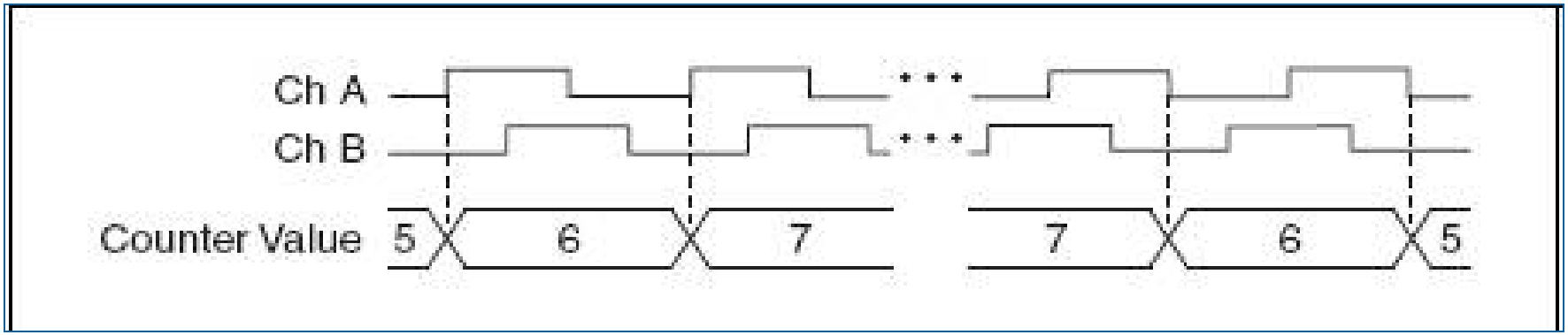


Pin	5-pin Single-ended
1	Ground
2	Index
3	A channel
4	+5VDC power
5	B channel

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How to Make Encoder Measurements

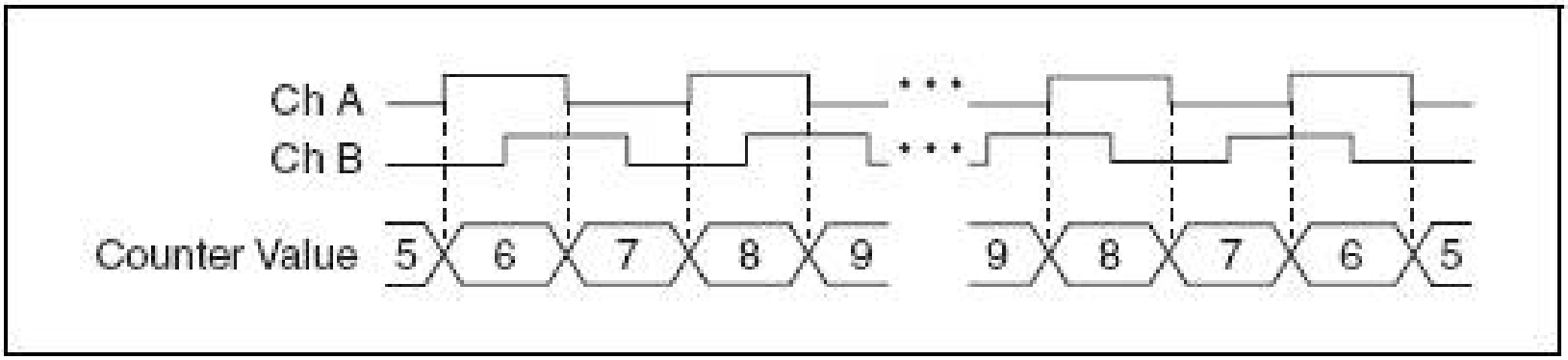
X1 Encoding



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How to Make Encoder Measurements

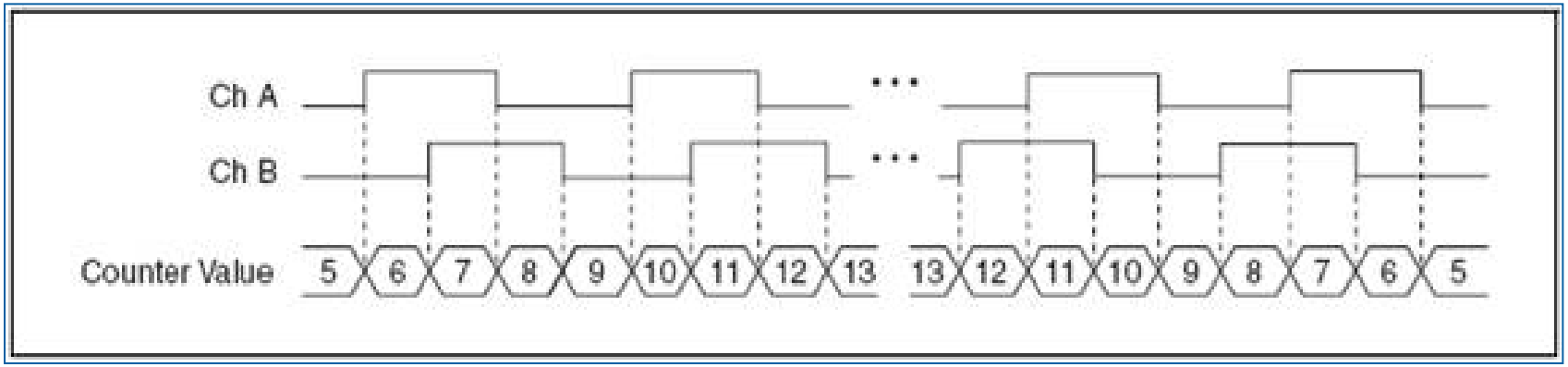
X2 Encoding



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How to Make Encoder Measurements

X4 Encoding



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Encoder Measurement Formulas

For Rotational Position

Amount of rotation is Edge Count/xN * 360

where N = number of pulses generated by the encoder per shaft revolution

x = encoding type

For Linear Position

Amount of displacement is (Edge Count/xN) * (1/PPI)

where PPI = pulses per inch (a parameter specific to each encoder)

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Connecting an Encoder to an Instrument

Required Equipment

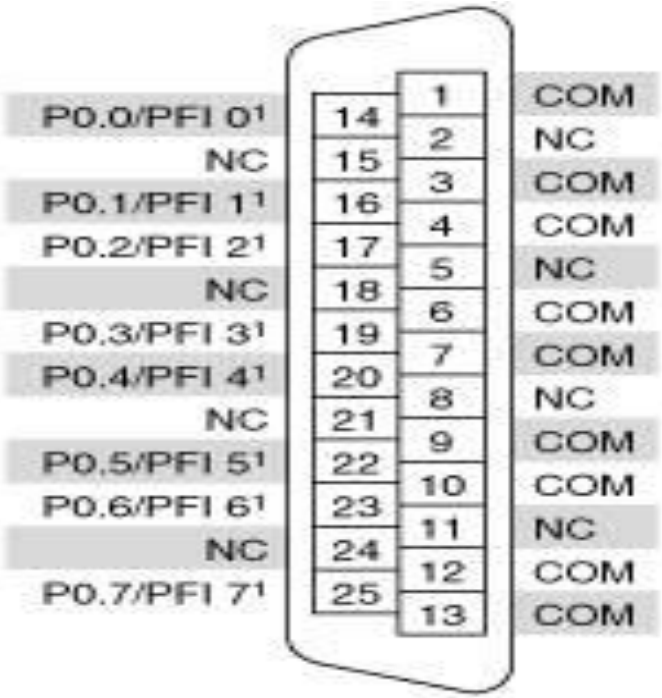
- NI CompactDAQ chassis
- NI 9401 8-channel, 5 V/TTL high-speed bidirectional digital I/O
- 24 pulse/rev rotational quadrature encoder





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Connecting Encoders to an Instrument



NI 9401

Default NI-DAQmx Counter Terminals

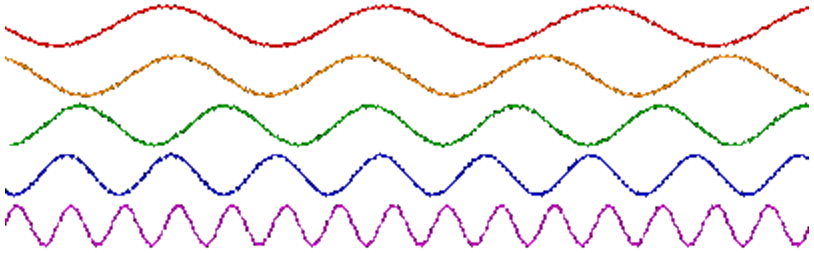
Counter/Timer Signal	Default Pin Number	Signal Name
CTR 0 SRC	14	PFI 0
CTR 0 GATE	16	PFI 1
CTR 0 AUX	17	PFI 2
CTR 0 OUT	19	PFI 3
CTR 0 A	14	PFI 0
CTR 0 Z	16	PFI 1
CTR 0 B	17	PFI 2
CTR 1 SRC	20	PFI 4
CTR 1 GATE	22	PFI 5
CTR 1 AUX	23	PFI 6
CTR 1 OUT	25	PFI 7
CTR 1 A	20	PFI 4
CTR 1 Z	22	PFI 5
CTR 1 B	23	PFI 6
FREQ OUT	17	PFI 2

Default Counter Terminals

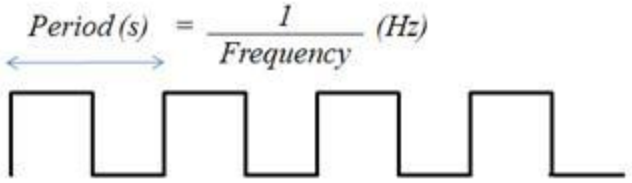
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What Is Frequency?

- Rate of recurrence of a cyclic or periodic event



Waveforms With Frequency Increasing From Top to Bottom



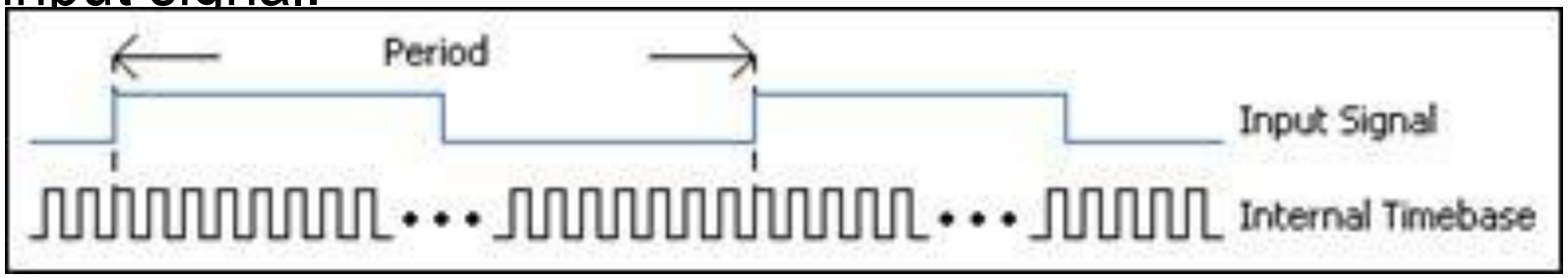
Frequency of a Digital Waveform

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How to Make a Digital Frequency Measurement

- Low-frequency measurement—one counter only

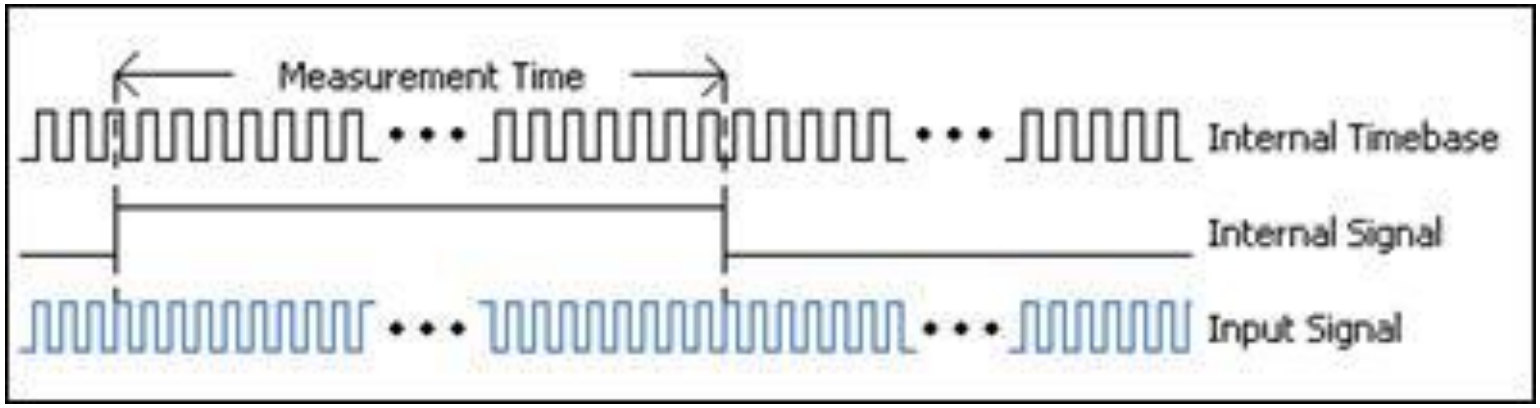
- The rising edge of the input signal triggers the number of timebase ticks to be counted. Because the timebase is of a known frequency, you can calculate the frequency of the input signal.



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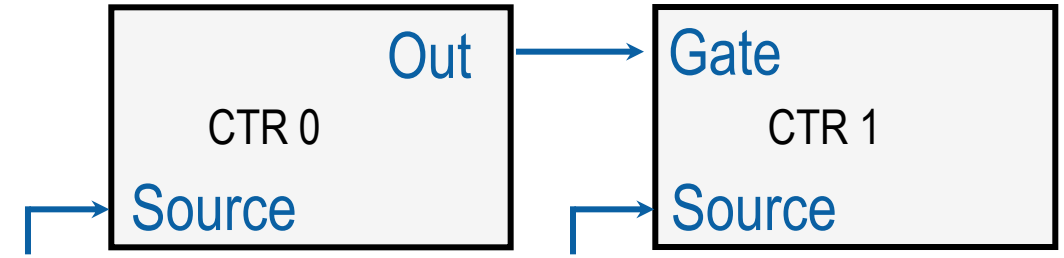
How to Make a Frequency Measurement

- High-frequency measurement—two counters



CTR 0: Pulse Train Generation

CTR 1: Period Measurement



Internal timebase

Signal being measured

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NI Solutions for Encoder Measurements

Portable

NI 9401: WiFi, ENET, USB



- Rugged, compact
- USB, wireless, Ethernet
- Synchronized

High Channel Count

NI 6602: 8 channels, 32 bits



- 80 MHz maximum source frequency
- 3 DMA channels
- Highest sample rate

Reconfigurable

NI 7813R Virtex-II



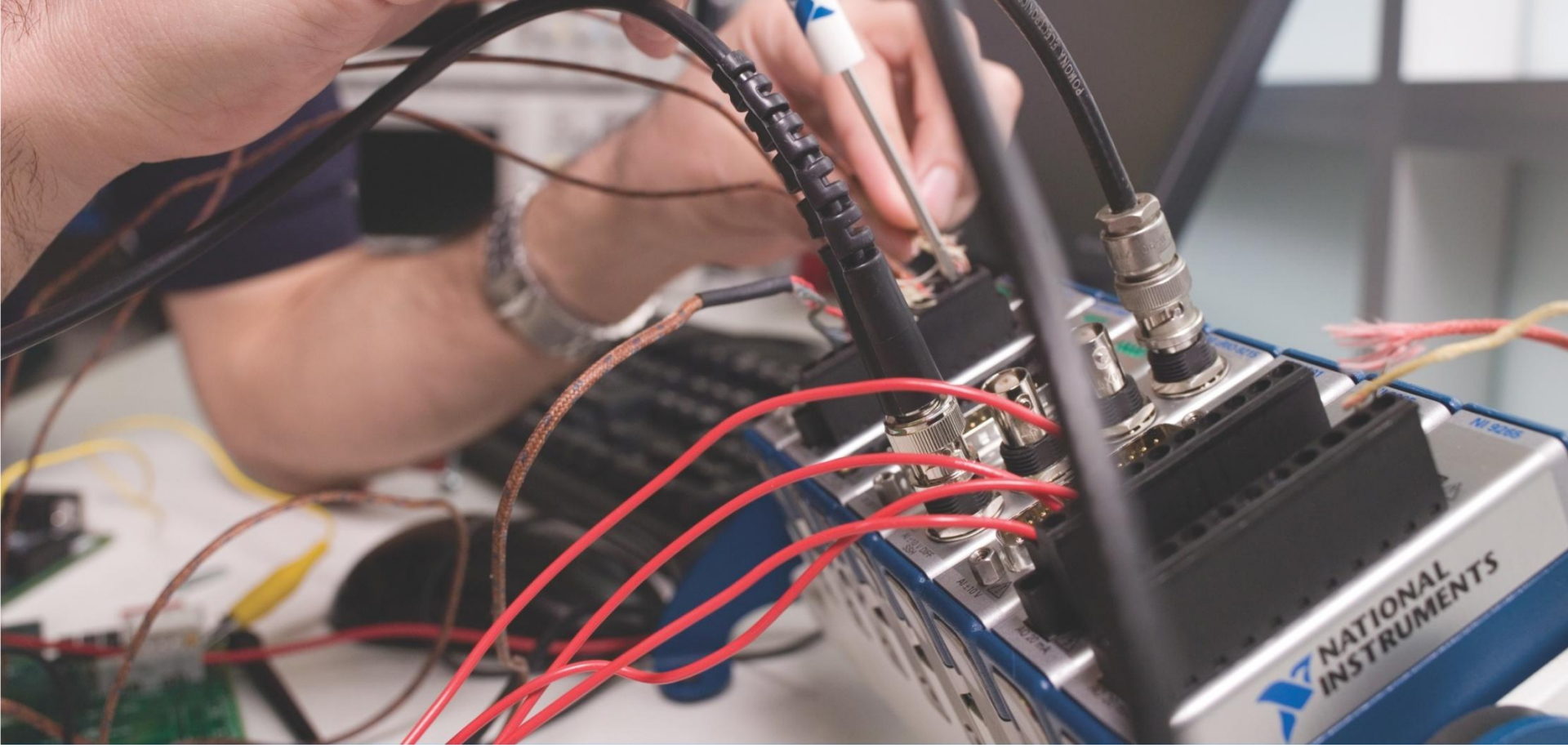
- FPGA-driven I/O
- 160 lines
- User-defined timing/triggering

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NI-STC3: The Best in Counter Technology

Counter	NI X Series (NI-STC3)	NI M Series (NI-STC2)
Counter/Timers	4, 32-Bit	2, 32-Bit
Counter Timebase	100 MHz	80 MHz
Quadrature Encoder Inputs	Yes	Yes
Digital Debouncing Filters	Available on All Digital Lines	Usable With Counter Tasks Only
Maximum Rate Benchmark for Buffered Counter Input Tasks	10 MHz on All Four Counters (PCI Express)	380 kHz (PCI) 1194 kHz—NI USB-621x Single Counter
Buffered Counter Outputs	Yes	No

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ni.com/data-acquisition

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