# Personal Daq/3000 Series

## USB 1-MHz, 16-Bit Multifunction Modules



## Features

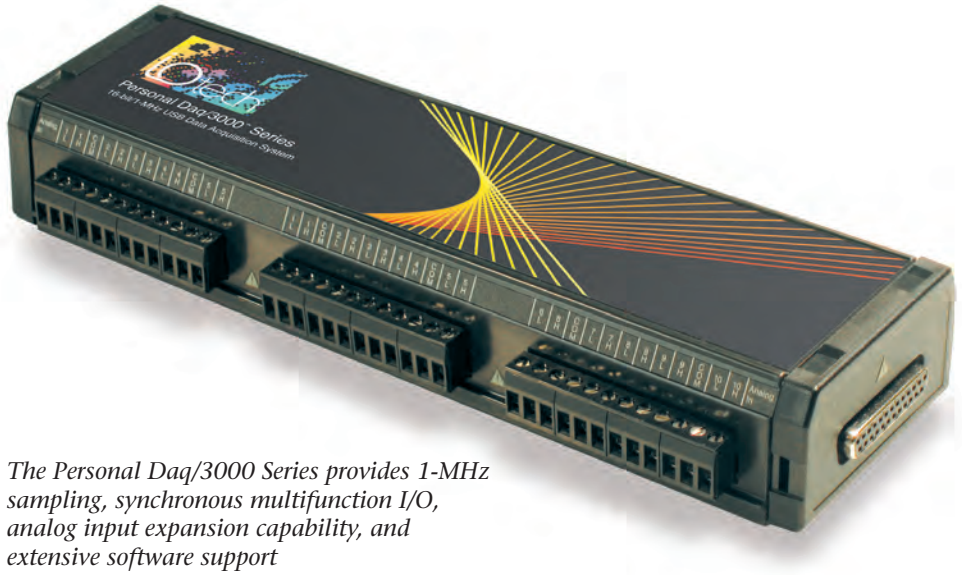
- 1-MHz, 16-bit multifunction USB modules
- Synchronous analog input, analog output, digital I/O, and counter/timer I/O
- 8 differential or 16 single-ended analog inputs (software selectable per channel)
- Thermocouple inputs on any of the 8 differential inputs
- User-expandable up to 64SE/32DE analog inputs including thermocouple measurements
- Up to four 16-bit, 1-MHz analog outputs
- 24 high-speed digital I/O lines
- Four 32-bit counter input channels with quadrature encoder capability
- Low-latency control output capability (as low as 2 µs latency)

## Software

- Includes DaqView *Out-of-the-Box* software for instant set-up, real-time viewing, data logging, and optional frequency domain analysis
- Support for Visual Studio® and Visual Studio® .NET, including examples for Visual C++®, Visual C#®, Visual Basic®, and Visual Basic® .NET
- Comprehensive drivers for DASYLab®, LabVIEW®, and MATLAB®
- DaqCal software application for easy user calibration
- Supported Operating Systems: Windows 7/Vista/XP SP2, 32-bit or 64-bit

The new USB 2.0 Personal Daq/3000 Series offers high-speed, multifunction data acquisition in a low-cost, portable package. The module offers synchronous and concurrent voltage input, temperature input, waveform output, counter input, quadrature encoder input, timer output, and digital I/O. For OEM or embedded applications, the same functionality is offered in a board-level product — see DaqBoard/3000USB. Everything needed to begin acquiring, viewing, and storing data is included with the Personal Daq/3000, including comprehensive software support.

The Personal Daq/3000 Series feature a 16-bit/1-MHz A/D converter, 16 analog input channels — user expandable to 64, up to four 16-bit/1-MHz analog outputs, 24 high-speed digital I/O, 2 timer outputs, and four 32-bit counters. All analog I/O, digital I/O, and counter/timer I/O can operate synchronously and simultaneously, guaranteeing deterministic I/O among all signal types.




*The Personal Daq/3000 Series provides 1-MHz sampling, synchronous multifunction I/O, analog input expansion capability, and extensive software support*

| Personal Daq/3000 Series Selection Chart | | | | | |
|---|---|---|---|---|---|
| **Product or System** | **Analog Inputs** | **Input Ranges** | **Digital I/O** | **Analog Outputs** | **Counters/Timers** |
| Personal Daq/3005 | 16SE/8DE | 7 | 24 | 0 | 4/2 |
| Personal Daq/3000 | 16SE/8DE | 7 | 24 | 2 | 4/2 |
| Personal Daq/3001 | 16SE/8DE | 7 | 24 | 4 | 4/2 |
| Personal Daq/3005 + PDQ30 | 64SE/32DE | 7 | 24 | 0 | 4/2 |
| Personal Daq/3000 + PDQ30 | 64SE/32DE | 7 | 24 | 2 | 4/2 |
| Personal Daq/3001 + PDQ30 | 64SE/32DE | 7 | 24 | 4 | 4/2 |

*Personal Daq/3000 attached to a PDQ30 expansion module*

Unique to the Personal Daq/3000 Series is a low-latency, highly deterministic control output mode that operates independent of the PC. In this mode digital, analog, and timer outputs can respond to analog, digital, and counter inputs as fast as 2 µs; at least 1,000 times faster than other products that rely on the PC for decision making.

### Other Hardware Features Include:

- Encoder measurements up to 20 MHz, including Z-channel zeroing
- Frequency and pulse-width measurements with 20.83 ns resolution
- Timing mode that can measure the time between two counter inputs to 20.83 ns resolution
- Self-calibration

*Personal Daq/3000 attached to a PDQ30 expansion module via a CA-96A cable*

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# Personal Daq/3000 Series

## General Information

### Software

Included with the Personal Daq/3000 Series is new DaqView software, a comprehensive *Out-of-the-Box* application that enables set-up, data logging, and real-time data viewing without any programming skills. DaqView also features direct-to-Excel® enhancements, and FFT analysis, statistics.

Also included with the Personal Daq/3000 Series is a complete set of drivers and detailed example programs for the most popular programming languages and software packages. Driver support includes Visual Basic®, C/C++, DASYLab®, LabVIEW®, and MATLAB®. DaqCOM provides Windows®-based ActiveX/COM-based programming tools for Microsoft® Visual Studio® and Visual Studio® .NET.

### Analog Input

The Personal Daq/3000 Series has a 16-bit, 1-MHz A/D coupled with 16 single-ended, 8 differential analog inputs, or 8 differential thermocouple inputs. Seven software programmable ranges provide inputs from ±10V to ±100 mV full scale. Each channel can be software-configured for a different range, as well as for single-ended or differential bipolar input, or thermocouple input.

Every analog input on the Personal Daq or on the PDQ30 expansion option can accept a thermocouple (TC) input. Built-in cold-junction sensors are provided for each of the removable screw-terminal connectors, and any TC type can be attached to any channel. When measuring TCs the Personal Daq operates in an over-sample mode, where multiple readings are taken on each TC channel, digitally filtered, cold-junction compensated, and converted to temperature. As a result, channels with TC's attached are measured at a rate from 50 Hz to 10 kHz, depending on how much over sampling is selected. In-line cycle rejection mode, over sampling occurs during one cycle of either 50 Hz or 60 Hz, providing a high level of 50 Hz or 60 Hz rejection.

### Analog Channel Expansion

Adding additional analog input channels for the Personal Daq/3000 Series is easy using the optional PDQ30 expansion module. The PDQ30 connects to the Personal Daq/3000 Series by either plugging directly into the expansion connector, or via a cable if distance is required between the two units. The PDQ30 provides an additional 48SE/24DE analog inputs, or 24 differential thermocouple inputs, software configured on a per channel basis. The total channel capacity with a PDQ30 attached is 64 single ended, or 32 differential inputs. The measurement speed of PDQ30 channels is the same 1 Msample/s as with Personal Daq/3000 channels. When configured to measure thermocouple channels the system sample rate is typically 50 Hz to 10 kHz per channel. This reduction in sample rate insures that temperature measurements are accurate, low noise, and stable.

### Synchronous I/O

The Personal Daq/3000 Series can make analog measurements and read digital and counter inputs, while synchronously generating up to four analog outputs as well as digital pattern outputs. Digital and counter inputs do not affect the overall A/D rate because they use no time slot in the scanning sequencer. For example, an analog input channel can be scanned at the full 1-MHz A/D rate along with digital and counter input channels. The 1-MHz A/D rate is unaffected by the additional digital and counter channels. Other data acquisition devices provide no capability to scan digital/counter channels concurrent with analog channels, in which case digital and counter channels must be read asynchronously, which leads to a non-deterministic collection of data.

### Input Scanning

The Personal Daq/3000 has several scanning modes to address a wide variety of applications. A 512-location scan buffer can be loaded by the user with any combination of analog input channels. All analog input channels in the scan buffer are measured sequentially at 1 µs per channel. The user can also specify that the sequence repeat immediately, or repeat after a programmable delay from 0 to 19 hours, with 20.83 ns resolution. For example, in the fastest mode, with a 0 delay, a single analog channel can be scanned continuously at 1 Msamples/s; two analog channels can be scanned at 500 Ksamples/s each; 16 analog input channels can be scanned at 62.5 Ksamples/s.

Personal Daq/3000 digital inputs and counter inputs can be read in several modes. First, via software the digital inputs or counter inputs can be read asynchronously at anytime before, during, or after an analog input scan sequence. This mode is not deterministic as to exactly when the digital or counter input is read relative to an analog input channel.

In either of the two synchronous modes, the digital inputs and/or counter inputs are read with deterministic time correlation to the analog inputs. In the once-per-scan mode, all of the enabled digital inputs and counter inputs are read during the first analog measurement of an analog input scan sequence. The advantage of this mode as compared to most other devices is the digital and counter inputs do not consume an analog input time slot, and therefore do not reduce the available bandwidth for analog input measurements. For example, presume all 24 bits of digital input are enabled, and all four 32-bit counters are enabled, and eight channels of analog inputs are in the scan sequence at the full 1 µs/channel rate. At the beginning of each analog input scan sequence, which would be 8 µs in total duration, all digital inputs and counter inputs will be measured and transferred to the PC during the first µs of the analog scan sequence.

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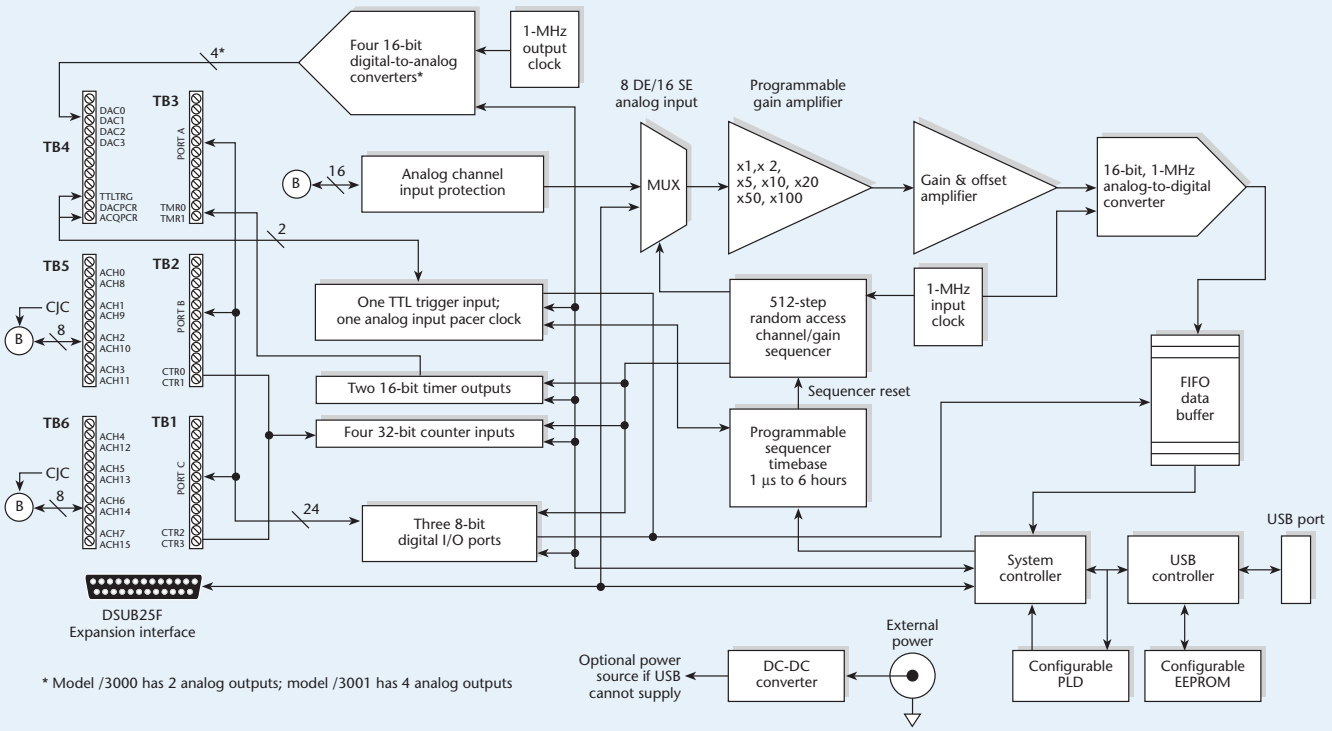
# Personal Daq/3000 Series

## General Information

**Personal Daq/3000 Series Block Diagram**




Another synchronous mode is where digital inputs are scanned every time an analog input channel is scanned. For example, if eight analog inputs are scanned at 1 µs per channel continuously, and 24 bits of digital inputs are enabled, then the 24 bits of digital inputs will be scanned at 24 bits per 1 µs. If counters are enabled in this mode, they will be scanned at once per scan, in the same manner as in the prior example.

## Output Timing

The digital and analog outputs on the Personal Daq/3000 can be updated asynchronously or synchronously in several modes. In the asynchronous mode, digital and analog outputs can be updated at anytime before, during, or subsequent to an analog input sequence. The maximum update rate in this mode is non-deterministic and entirely dependent on the PC processor speed, the operating system, and programming environment.

In the synchronous output modes, the outputs can be updated continuously from the PC, or as the direct result of an input from either an analog channel, digital channel, or counter channel. When updated from the PC, the user can specify the rate by which the output is updated in 20.83 ns intervals, and outputs are updated synchronously at a maximum rate of 1 µs. For example, all four 16-bit analog outputs can be generating different waveforms from PC memory, while up to 16 bits of digital pattern could be generated from PC memory concurrently. The maximum rate of output is dependent on a number of factors, including the speed of the USB implementation on the PC. Typically, a total output bandwidth of 6 Msamples/s can be achieved.

## Low-Latency Setpoint Control Mode

The other synchronous method of output is where either a digital, analog, or timer output is associated with any input — analog, digital or counter. The state or level of the output is determined by the level or state of an associated input. For example, a digital output can be programmed to be a logic 1 when an analog input exceeds a certain value, or when a freqency input exceeds a certain rate. In addition, hysteresis can be programmed for each limit to insure the output is stable near the transition point. Up to 8 digital outputs, 4 analog outputs, and 2 timer outputs can be programmed to respond to any analog, digital, or counter input. When analog or digital outputs are used in this mode, the user can specify two output values, determined by whether the input is above or below the limit.

The slowest rate by which an output can respond to an input is 2 µs plus the time period of a scan sequence. For example, if 4 channels of analog input are scanned continuously at 4 µs per scan, then the maximum latency between an analog input satisfying a limit, and the output responding, is 4 + 2 or 6 µs max. The worst-case response time can also be improved in several ways. For example, if a digital

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output is correlated to a digital input, then the worst-case latency can be reduced to 2 µs total if all digital inputs are scanned at the 1 µs rate without a delay period at the end of each scan.

In addition, an output status channel can be specified in the input scan sequence buffer so that users can correlate output state changes to their respective input channels within their data buffers and files. Adding the status channel takes no additional scan time and has no effect on the overall acquisition rate. The status channel can also be read asynchronously at any time during an acquisition for monitoring of the control outputs.

The advantage of this mode as compared to other boards is the response time can be in the range of 2 to 20 µs, vs. 1000 or more microseconds when using boards from other suppliers.

## Triggering

The Personal Daq/3000 Series supports a full complement of trigger modes to accommodate any measurement application.

**Hardware Analog Triggering.** The Personal Daq/3000 Series uses true analog triggering, whereby the trigger level programmed by the user sets an analog DAC, which is then compared in hardware to the analog input level on the selected channel. The result is analog trigger latency which is guaranteed to be less than 1.3 µs, significantly shorter than most data acquisition boards. Any analog channel can be selected as the trigger channel, including PDQ30 expansion channels. The user can program both the trigger level, as well as the edge (rising or falling), and hysteresis.

**Digital Triggering.** A separate digital trigger input line is provided, allowing TTL-level triggering with latencies guaranteed to be less than 1 µs. Both the logic levels (1 or 0), as well as the edge (rising or falling), can be programmed for the discrete digital trigger input.

**Pattern Triggering.** The user can specify a 16-bit digital pattern to trigger an acquisition, including the ability to mask or ignore specific bits.

**Software-Based Channel Level Triggering.** This mode differs from the modes described previously because the readings, analog, digital, or counter, are interrogated by the PC in order to detect the trigger event. Triggering can also be programmed to occur when one of the counters reaches, exceeds, or is within a programmed window. Any of the built-in counter/totalizer channels can be programmed as a trigger source. Triggers can be detected on scanned digital input channel patterns as well.

Normally software-based triggering results in long latencies from the time that a trigger condition is detected, until the actual capturing of data commences. However, the Personal Daq/3000 Series circumvents this undesirable situation by use of pre-trigger data. Specifically, when software-based triggering is employed, and the PC detects that a trigger condition has occurred, (which may be thousands of readings later than the actual occurrence of the signal), the Personal Daq driver automatically looks back to the location in memory where the actual trigger-causing measurement occurred. The acquired data that is presented to the user actually begins at the point where the trigger-causing measurement occurs. The maximum latency in this mode is equal to one scan period.

**Multi-Channel Triggering.** The Personal Daq can also be configured to trigger on any combination of analog, digital, and counter inputs (not on temperature measurements, however). In this mode, the maximum latency is one scan period. Triggering can occur based on a logical "and" or logical "or" of the multiple trigger conditions. For example, a trigger condition can be programmed to occur when several analog input channels reach their respective trigger level, *and* several digital inputs are in the proper logic state, *and* several counters exceed or are below a pre-programmed frequency.

**Stop Trigger.** Any of the software trigger modes described previously including scan count can also be used to stop an acquisition. Thus an acquisition can be programmed to begin on one event, such as a voltage level, and then can stop on another event, such as a digital pattern.

**Pre- and Post-Triggering Modes.** Six modes of pre- and post-triggering are supported, providing a wide variety of options to accommodate any measurement requirement. When using pre-trigger, the user must use software-based triggering to initiate an acquisition.

***No pre-trigger, post-trigger stop event.*** This mode acquires data upon receipt of the trigger, and stops acquiring upon receipt of the stop-trigger event.

***Fixed pre-trigger with post-trigger stop event.*** In this mode the user specifies the number of pre-trigger readings to be acquired, after which acquisition continues until a stop-trigger event occurs.

***No pre-trigger, infinite post-trigger.*** No pre-trigger data is acquired in this mode. Instead, data is acquired beginning with the trigger event, and is terminated when the operator issues a command to halt the acquisition.

***Fixed pre-trigger with infinite post-trigger.*** The user specifies the amount of pre-trigger data to acquire, after which the system continues to acquire data until the program issues a command to halt acquisition.

***Variable pre-trigger with post trigger stop event*.*** Unlike the previous pre-trigger modes, this mode does not have to satisfy the pre-trigger number of readings before recognizing the trigger event. Thus the number of pre-trigger readings acquired is variable and dependent on the time of the trigger event relative to the start. In this mode, data continues to be acquired until the stop trigger event is detected.

***Variable pre-trigger with infinite post-trigger*.*** This mode is similar to the mode described above, except that the acquisition is terminated upon receipt of a command from the program to halt the acquisition.

* Driver support only

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## General Information

### Calibration

Every range on the Personal Daq/3000 is calibrated from the factory using a digital NIST traceable calibration method. This method works by storing a correction factor for each range on the unit at the time of calibration. The user can adjust the calibration of the board while in their system, without destroying the factory calibration supplied with the board. This is accomplished by having three distinct calibration tables in the Personal Daq/3000 Series on-board EPROM, one which contains the factory cal, and two which are available for user calibration. The user can select any of the three cal tables provided: factory, user, or self-cal tables by API call, or within software provided by IOtech.

Included with each Personal Daq is DaqCal softare, an easy-to-operate, user-calibration package, allowing users to calibrate their Personal Daq. Two calibration modes are supported in DaqCal. Self-cal, a user cal mode for analog inputs, can be performed automatically in minutes with included software and without the use of external hardware or instruments. Self-cal derives it's traceability through an on-board reference which has a stability of 0.005% per year. The second mode, user-cal, is for users that require traceability to international standards such as NIST. A 6-1/2 digit digital multimeter is required and user-calibration software is included with step-by-step instructions for full calibration. This process is automated when using a digital multimeter specified by IOtech*. A 2-year calibration period is recommended for the Personal Daq/3000 Series.

### Analog Output

**(Personal Daq/3000 and /3001 Only)**

Two or four 16-bit, 1-MHz analog output channels are built into the Personal Daq/3000 Series with an output range from -10V to +10V. The maximum rate at which analog outputs can be updated is dependent on several factors, including the speed of your USB port. Typically, with the A/D operating at full 1 Mreading/s rates, all 4 analog outputs can be updated continuously from PC memory at 1 MHz**. In addition, a program can asynchronously output a value to any of the D/As for non-waveform applications, presuming that the D/A is not already being used in the waveform output mode. Lastly, each of the analog outputs can be used in a control mode, where their output level is dependent on whether an associated analog, digital, or counter input is above or below a user-specified limit condition.

When used to generate waveforms, the D/As can be clocked in several different modes. Each D/A can be separately selected to be clocked from one of the sources described as follows.

**Asynchronous Internal Clock.** The on-board programmable clock can generate updates ranging from 1 MHz to once every 19 hours, independent of any acquisition rate.

**Synchronous Internal Clock.** The rate of analog output update can be synchronized to the acquisition rate derived from 1 MHz to once every 19 hours.

**Asynchronous External Clock.** A user-supplied external input clock can be used to pace the D/A, entirely independent of analog inputs.

**Synchronous External Clock.** A user-supplied external input clock can pace both the D/A and the analog input.

### Digital I/O

Twenty four TTL-level digital I/O lines are included in the Personal Daq/3000 Series. Digital I/O can be programmed in 8-bit groups as either inputs or outputs, and can be scanned in several modes (see Input Scanning). Ports programmed as inputs can be part of the scan group and scanned along with analog input channels, or can be asynchronously accessed via the PC at any time, including when a scanned acquisition is occurring. Two synchronous modes are supported when scanned along with analog inputs. One mode is where the digital inputs are scanned at the start of each scan sequence, which means the rate at which they are scanned is dependent on the number of analog input channels, and the delay period. For example, if eight analog inputs are enabled with 0 delay period, then the digital inputs in this mode would be scanned at once per 8 µs, which is 125 kHz.

In the other synchronous mode, the enabled digital inputs are scanned synchronously with every analog input channel. So in the example above, the digital inputs would be scanned at once per µs, or 1 MHz.

If no analog inputs are being scanned, the digital inputs can be scanned at up to 12 Msamples/s.

The low-latency digital output mode allows a digital output to be updated based on the level of an analog, digital, or counter input. In this mode, the user associates a digital output bit with a specific input, and specifies the level of the input where the digital output changes state. The response time in this mode is dependent on the number of input channels being scanned, and can typically be in the range of 2 to 6 µs.

### Pattern Generation

Two of the 8-bit ports can be used to generate a 16-bit digital pattern at up to 1 MHz. The digital pattern can be read from PC RAM, or a file on the hard disk. Digital pattern generation is clocked in the same four modes as described with analog output.

### Counter Inputs

Four 32-bit counters are built into the Personal Daq/3000 Series. Each of the four counters will accept frequency inputs up to 20 MHz, and each counter channel can be configured in a variety of modes including counter, period, pulse width, time between edges, or multi-axis quadrature encoder. The counters can concurrently monitor time periods, frequencies, pulses, and other event-driven incremental occurrences from encoders, pulse generators, limit switches, proximity switches, and magnetic pick-ups. As with all other inputs to the Personal Daq/3000 Series, the counter inputs can be read asynchronously under program control, or synchronously as part of an analog and digital scan group based either on an internal programmable timer, or an external clock source. The use of Z-channel encoders or usage of mapped

* Contact factory for user calibration availability

** If waveform output throughput is critical to your application, contact factory for the most recent update on multi-channel DAC output rates

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channels requires that these channels need to be read synchronously.

The Personal Daq/3000 supports quadrature encoders with up to 2 billion pulses per revolution, 20 MHz input frequencies, and x1, x2, x4 count modes. With only A phase and B phase signals, 2 channels are supported. With A phase, B phase, and Z index signals, 1 channel is supported. Each input can be debounced from 500 ns to 25.5 ms (total of 16 selections) to eliminate extraneous noise or switch induced transients. Encoder input signals must be within -5V to +10V and the switching threshold is TTL (1.3V).

## Timer Outputs

Two 16-bit timer outputs are built into the Personal Daq/3000, each capable of generating different square waves with a programmable frequency range from 16 Hz to 1 MHz.

| Voltage Range* | Accuracy ±(% of reading + % Range) 23°C ±10°C, 1 year | Temperature Coefficient ±(ppm of reading + ppm Range)/°C -30°C to 13°C and 33°C to 70°C | Noise** (cts RMS) |
|---|---|---|---|
| -10V to 10V | 0.031% + 0.008% | 14 + 8 | 2.0 |
| -5V to 5V | 0.031% + 0.009% | 14 + 9 | 3.0 |
| -2V to 2V | 0.031% + 0.010% | 14 + 10 | 2.0 |
| -1V to 1V | 0.031% + 0.02% | 14 + 12 | 3.5 |
| -500 mV to 500 mV | 0.031% + 0.04% | 14 + 18 | 5.5 |
| -200 mV to 200 mV | 0.036% + 0.05% | 14 + 12 | 8.0 |
| -100 mV to 100 mV | 0.042% + 0.10% | 14 + 18 | 14.0 |

* Specifications assume differential input single channel scan, 1-MHz scan rate, unfiltered, CMV=0.0V, 30 minute warm-up, exclusive of noise, range -FS to +FS

** Noise reflects 10,000 samples at 1-MHz, typical, differential short

## Specifications

### General

| Power Consumption[1] | |
|---|---|
| Model | Power Consumption (Typical)[2] |
| /3000 | 2500 mW |
| /3001 | 3000 mW |
| /3005 | 2000 mW |
| /3000 + PDQ30 | 2900 mW |
| /3001 + PDQ30 | 3400 mW |
| /3005 + PDQ30 | 2400 mW |

1. The power consumption listed is for a single Personal Daq/3000 Series device, or for a single device connected to a PDQ30 expansion module.
2. An optional power adapter (TR-2) will be required if the USB port cannot supply adequate power. USB2 ports are, by USB2 standards, required to supply 2500 mW (nominal at 5V, 500 mA).

**Environment**
- **Operating Temperature:** -30 to +70 ˚C
- **Storage Temperature:** -40 to +80 ˚C
- **Relative Humidity:** 0 to 95% non-condensing

**Communications:** USB 2.0 high-speed mode (480 Mbps) if available, otherwise USB 1.1 full-speed mode (12 Mbps)
**Acquisition Data Buffer:** 1 MSample
**Vibration:** MIL STD 810E Category 1 and 10
**Signal I/O Connector:** 6 banks of removable screw-terminal blocks
**External Power**
- **Connector:** Switchcraft#RAPC-712
- **Power Range:** 6 to 16 VDC (used when USB port supplies insufficient power, or when an independent power supply is desired)
- **Over-Voltage:** 20V for 10 seconds, max

**Expansion Connector:** 25-pin DSUB, female
**Dimensions:** 269 mm W x 92 mm D x 45 mm H (10.6" x 3.6" x 1.6")
**Weight:** 431g (0.95 lbs)

### Analog Inputs

**Channels:** 16 single-ended or 8 differential, programmable on a per-channel basis as single-ended or differential
**Expansion:** An additional 48 analog inputs per module via optional PDQ30 module, expansion channel features are identical to those of the main channels
**Expansion Connector:** 25-pin DSUB, female
**Over-Voltage Protection:** ±30V without damage
**Voltage Measurement Speed:** 1 µs per channel
**Ranges:** Software or sequencer selectable on a per-channel basis, ±10V, ±5V, ±2V, ±1V, ±0.5V, ±0.2V, ±0.1V
**Input Impedance:** 10M Ohm single-ended; 20M Ohm differential
**Total Harmonic Distortion:** -80 dB, typ for ±10V range, 1 kHz fundamental
**Signal to Noise and Distortion:** 72 dB, typ for ±10V range, 1 kHz fundamental
**Bias Current:** 40 pA typical (0 to 35 ˚C)
**Crosstalk:** -75 dB typ DC to 10 kHz
**Common Mode Rejection:** -70 dB typ DC to 1 kHz

| Maximum Usable Input Voltage + Common Mode Voltage | |
|---|---|
| Ranges | Maximum (CMV + Vin) |
| 5, 10V | 10.5V |
| 0.1, 0.2, 0.5, 1, 2V | 6.0V |

**TC Types and Accuracy†**

| TC Type | Temperature Range (˚C) | Accuracy (±˚C) | Noise, Typical (±˚C) |
|---|---|---|---|
| J | -200 to +760 | 1.7 | 0.2 |
| K | -200 to +1200 | 1.8 | 0.2 |
| T | -200 to +400 | 1.8 | 0.2 |
| E | -270 to +650 | 1.7 | 0.2 |
| R | -50 to +1768 | 4.8 | 1.5 |
| S | -50 to +1768 | 4.7 | 1.5 |
| N | -270 to +1300 | 2.7 | 0.3 |
| B | +300 to +1400 | 3.0 | 1.0 |

† Assumes 16384 oversampling applied, CMV = 0.0V, 60 minute warm-up, still environment, and 25 ˚C ambient temperature; excludes thermocouple error; $TC_{DN}$ = 0 ˚C for all types except B (1000 ˚C), TR-2 for External Power

### A/D Specifications

**Type:** Successive approximation
**Resolution:** 16 bit
**Maximum Sample Rate:** 1 MHz
**Nonlinearity (Integral):** ±2 LSB max
**Nonlinearity (Differential):** ±1 LSB max

### Input Sequencer

Analog, digital, and counter inputs can be scanned synchronously, based on either an internal programmable timer or an external clock source. Analog and digital outputs can be synchronized to either of these clocks.

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## Specifications

**Scan Clock Sources:** 2
**Note:** The maximum scan clock rate is the inverse of the minimum scan period. The minimum scan period is equal to 1 µs times the number of analog channels. If a scan contains only digital channels then the minimum scan period is 250 ns.
1. **Internal, programmable**
   Analog Channels from 1 µs to 19 hours in 20.83 ns steps
   Digital Channels and Counters from 250 ns to 19 hours in 20.83 ns steps
2. **External, TTL level input**
   Analog Channels down to 1 µs min
   Digital Channels and counters down to 250 ns min

**Programmable Parameters per Scan:** Channel (random order), gain
**Depth:** 512 locations
**On-Board Channel-to-Channel Scan Rate**
**Analog:** 1 MHz max
**Digital:** 4 MHz if no analog channels are enabled, 1 MHz with analog channels enabled

### External Acquisition Scan Clock Input

**Maximum Rate:** 990 kHz
**Clock Signal Range:** Logical zero 0V to 0.8V; logical one 2.4V to 5.0V
**Minimum Pulse Width:** 50 ns high, 50 ns low

### Triggering

**Trigger Sources:** 7, individually selectable for starting and stopping an acquisition. Stop acquisition can occur on a different channel than start acquisition; stop acquisition can be triggered via modes 2, 4, 5, or 6 described below.

1. **Single-Channel Analog Hardware Trigger**
   Any analog input channel can be software programmed as the analog trigger channel, including any of the analog expansion channels.
   **Input Signal Range:** -10 to +10V max
   **Trigger Level:** Programmable (12-bit resolution)
   **Hysteresis:** Programmable (12-bit resolution)
   **Latency:** 350 ns typ, 1.3 µs max
   **Accuracy:** ±0.5% of reading, ±2 mV offset
   **Noise:** 2 mV RMS
2. **Single-Channel Analog Software Trigger**
   Any analog input channel, including any of the analog expansion channels, can be selected as the software trigger channel. If the trigger channel involves a calculation, such as temperature, then the driver automatically compensates for the delay required to obtain the reading, resulting in a maximum latency of one scan period.
   **Input Signal Range:** Anywhere within range of the selected trigger channel
   **Trigger Level:** Programmable (16-bit resolution), including "window triggering"
   **Latency:** One scan period max
3. **Single-Channel Digital Trigger**
   A separate digital input is provided for digital triggering.
   **Input Signal Range:** -15V to +15V
   **Trigger Level:** TTL
   **Minimum Pulse Width:** 50 ns high, 50 ns low
   **Latency:** 100 ns typ, 1.1 µs max
4. **Digital Pattern Triggering**
   8- or 16-bit pattern triggering on any of the digital input ports. Programmable for trigger on equal, above, below, or within/outside of a window. Individual bits can be masked for "don't care" condition.
   **Latency:** One scan period max
5. **Counter/Totalizer Triggering**
   Counter/totalizer inputs can trigger an acquisition. User can select to trigger on a frequency or on total counts that are equal, above, below, or within/outside of a window.
   **Latency:** One scan period, max
6. **Software Triggering**
   Trigger can be initiated under program control.
7. **Multi-Channel Triggering**
   Up to 16 channels can be used to generate a trigger condition for any combination of analog, digital, or counter inputs. Multiple channels can either be combined in a logical "or" or "and" condition, with hysteresis programmable per channel. Maximum latency in this mode is one scan period.

### Analog Outputs (/3000 and /3001 models only)

Analog output channels are updated synchronously relative to scanned inputs, and clocked from either an internal clock, or an external clock source. Analog outputs can also be updated asynchronously, independent of any other scanning in the system. Streaming from disk or memory is supported, allowing continuous waveform outputs (limited only by available PC system resources).

**Channels**
**Personal Daq/3000:** 2 DAC channels
**Personal Daq/3001:** 4 DAC chanels
**Resolution:** 16 bits
**Data Buffer:** PC-based memory
**Output Voltage Range:** ±10V
**Output Current:** ±1 mA; sourcing more current (1 to 10 mA) may require a TR-2 power adapter option
**Offset Error:** ±0.0045V max
**Digital Feedthrough:** <10 mV when updated
**DAC Analog Glitch:** <12 mV typical at major carry
**Gain Error:** ±0.01%
**Update Rate:** 1 MHz max, 19 hours min (no minimum with external clock), resolution 20.83 ns
**Settling Time:** 2 µs to rated accuracy
**Clock Sources:** 4, programmable
1. Internal D/A clock, independent of scanning input clock
2. Internal scanning input clock
3. External D/A input clock, independent of external scanning input clock
4. External scanning input clock

### Digital I/O

**Channels:** 24
**Ports:** 3 x 8-bit, each port is programmable as input or output
**Input Scanning Modes:** 2 programmable
1. Asynchronous, under program control at any time relative to input scanning
2. Synchronous with input scanning

**Input Characteristics:** 220 Ohm series resistor, 20 pF to common
**Logic Keeper Circuit:** Holds the logic value to 0 or 1 when there is no external driver.
**Input Protection:** ±15 kV ESD clamp diodes
**Input Levels**
**Low:** 0 to 0.8V
**High:** +2.0V to +5.0V
**Output Levels**
**Low:** <0.8V
**High:** >2.0V
**Output Characteristics:** Output 1.0 mA per pin; sourcing more current (1 to 10 mA) may require a TR-2 power adapter option
**Sampling:** 4 MHz, max
**Update Rate:** 4 MHz, max, 19 hours min (no minimum with external clock); resolution: 20.83 ns

### Pattern Generation Output

Two of the 8-bit ports can be configured for 16-bit pattern generation. The pattern can also be updated synchronously with an acquisition at up to 4 MHz.

### Counter

Each of the four high speed, 32-bit counter channels can be configured for counter, period, pulse width, time between edges, or multi-axis quadrature encoder modes. Counter inputs can be scanned synchronously along with analog and digital scanned inputs, based on an internal programmable timer, or an external clock source.

**Channels:** 4 x 32-bit
**Input Frequency:** 20 MHz max
**Input Signal Range:** -5V to +10V
**Input Characteristics:** 10k Ohm pull-up, 200 Ohm series resistor, ±15 kV ESD protection
**Trigger Level:** TTL
**Minimum Pulse Width:** 25 ns high, 25 ns low
**Debounce Times:** 16 selections from 500 ns to 25.5 ms; positive or negative edge sensitive; glitch detect mode or debounce mode
**Time Base Accuracy:** 50 ppm (0 to 50 ˚C)
**Five Programmable Modes:** Counter, Period, Pulsewidth, Timing, Encoder
**Counter Mode Options:** Totalize, Clear on Read, Rollover, Stop at all Fs, 16- or 32-bit, any other channel can gate or decrement the counter
**Period Mode Options:** Measure x1, 10, 100, or 1000 periods, 16- or 32-bit, 4 different time bases to choose from: 20.83 ns, 208.3 ns, 2.083 µs, 20.83 µs, any other channel can gate the period measurement
**Pulsewidth Mode Options:** 16- or 32-bit values, 4 time bases to choose from: 20.83 ns, 208.3 ns, 2.083 µs, 20.83 µs, any other channel can gate the pulsewidth measurement
**Timing Mode Options:** 16- or 32-bit values, 4 time bases to choose from: 20.83 ns, 208.3 ns, 2.083 µs, 20.83 µs
**Encoder Mode Options:** x1, 2, 4 options, 16- or 32-bit values, Z-channel clearing of counter, any other channel can gate the counter
**Multi-axis Quadrature Encoder Inputs:**
- 1 channel with A (phase), B (phase), and Z (index)
- 2 channel with A (phase) and B (phase)
- x1, x2, and x4 count modes
- Single-ended TTL

### Frequency/Pulse Generators

**Channels:** 2 x 16-bit
**Output Waveform:** Square wave
**Output Rate:** 1-MHz base rate divided by 1 to 65,535 (programmable)
**High-Level Output Voltage:** 2.0V min @ -1.0 mA; 2.9V min @ -400 µA
**Low-Level Output Voltage:** 0.4V max @ 400 µA

### PDQ30

See the PDQ30 data sheet for complete specifications.

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# Personal Daq/3000 Series

## Ordering Information

## Ordering Information

| Description | Part No. |
|---|---|
| 16-bit, 1-MHz USB data acquisition module with 16 analog inputs, 24 digital I/O, four counters, and two timers; includes DaqView software; support for Visual Studio and Visual Studio .NET, including examples for Visual C++, Visual C#, Visual Basic, and Visual Basic .NET; drivers for DASYLab®, LabVIEW®, and MATLAB®; and DaqCal software application | Personal Daq/3005 |
| Same as Personal Daq/3005 but with two 16-bit, 1-MHz analog outputs | Personal Daq/3000 |
| Same as Personal Daq/3005 but with four 16-bit, 1-MHz analog outputs | Personal Daq/3001 |
| DIN-rail mounting adapter for Personal Daq | PDQ10 |
| Powered 4-port USB hub with one USB cable | PDQ11 |
| USB-powered extension cable, 16 ft. | PDQ12 |
| Analog input expansion module, adds 48SE/24DE channels to Personal Daq/3000 Series | PDQ30 |

### Accessories & Cables

| | |
|---|---|
| Personal Daq/3000 Series to PDQ30 cable, 2 ft. | CA-96A |
| USB cable, 1 meter | CA-179-1 |
| USB cable, 3 meters | CA-179-3 |
| USB cable, 5 meters | CA-179-5 |
| Terminal block | CN-153-12 |
| External power supply, 90 to 264 VAC; requires additional cable | TR-2U |
| USA version | CA-1 |
| European version | CA-216 |

### Software

| | |
|---|---|
| Icon-based data acquisition, graphics, control, and analysis software | DASYLab |

**Note:** For OEM and embedded applications, see DaqBoard/3000 USB.

*PDQ30, analog input expansion module*

*PDQ10, DIN-rail mounting adapter*

*DaqBoard/3000USB, 16-bit/1-MHz USB data acquisition board*

*PDQ12, USB-powered extender cable*

*CA-96A, Personal Daq/3000 to PDQ30 cable*