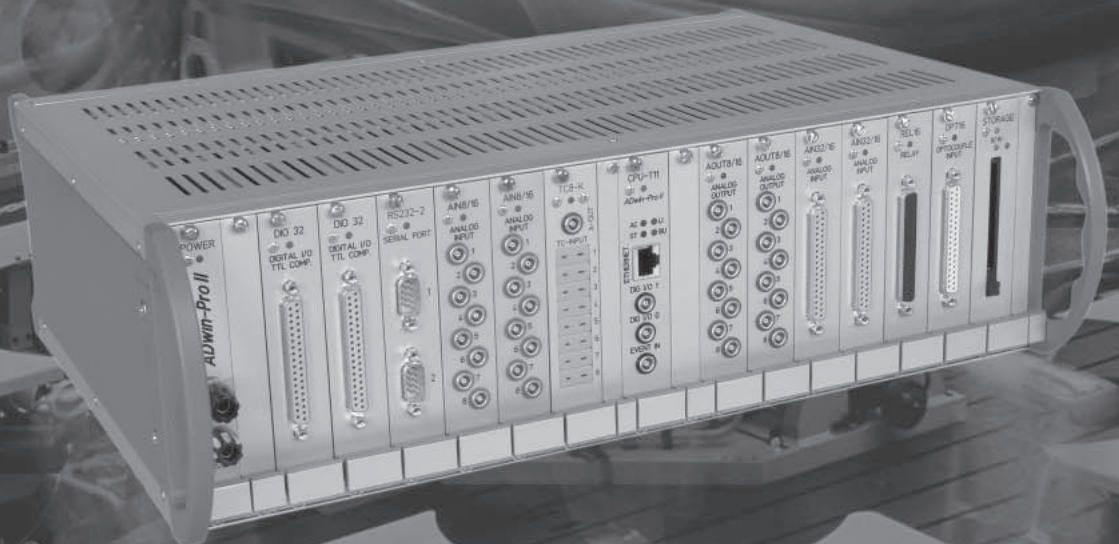# Robust Scalable Real-Time System

ADwin-Pro

KEITHLEY

A GREATER MEASURE OF CONFIDENCE

Robust Scalable Enclosures
ADwin-Pro

Enclosures for *ADwin-Pro*

ADwin-Pro has a variety of different chassis for control and measurement applications in a laboratory, in an industrial environment or for mobile usage.

The modularity of the system allows you to select the right Real-Time CPU and the required type and number of I/O modules. The expandability of *ADwin-Pro* leaves room for future applications needs.

The chassis combines a high-performance back-plane for deterministic Real-Time access between the local *ADwin-CPUs* and all I/O-modules, as well as a rugged mechanical packaging. *ADwin* offers chassis for every application, with 5, 7 or 16 slots, and with AC or DC power supplies. The *ADwin-Pro* has feet and handles, and also mounting points for an included rack-mount kit.

These different chassis offer you a solution for all your flexible requirements :

ADwin-Pro-II

ADwin-Prolight-II

ADwin-Pro-II Enclosures – For *Pro-CPU-T11-ENET* and *ADwin-Pro-II* and *ADwin-Pro* only	
ADwin-Pro-II	19" enclosure (19 inch wide, 5 ¼ inch high), AC power supply, 115/230V, 1 slot for *Pro-CPU-T11*, 15 slots *ADwin-Pro-II* modules, or 13 slots *ADwin-Pro* modules alternatively, desktop unit, front-side module access
ADwin-Pro-II-BM	19" enclosure (19 inch wide, 5 ¼ inch high), AC power supply, 115/230V, 1 slot for *Pro-CPU-T11*, 14 slots *ADwin-Pro-II* modules, or 12 slots *ADwin-Pro* modules alternatively, desktop unit, backside module access
ADwin-Prolight-II	½ 19" enclosure (9 inch wide, 5 ¼ inch high), AC power supply, 115/230V, 1 slot for *Pro-CPU-T11*, 6 slots *ADwin-Pro-II* or *ADwin-Pro* modules, desktop unit, front-side module access
ADwin-Pro-DC-II	19" enclosure (19 inch wide, 5 ¼ inch high), DC power supply, 10..35VDC, 1 slot for *Pro-CPU-T11*, 15 slots *ADwin-Pro-II* modules, or 13 slots *ADwin-Pro* modules alternatively, desktop unit, front-side module access
ADwin-Prolight-II-DC	½ 19" enclosure (9 inch wide, 5 ¼ inch high), DC power supply, 10..35VDC, 1 slot for *Pro-CPU-T11*, 6 slots *ADwin-Pro-II* or *ADwin-Pro* modules, desktop unit, front-side module access

ADwin-Pro-Standard Enclosures – For *Pro-CPU-T9, -T10* and *ADwin-Pro* only	
ADwin-Pro	19" enclosure (19 inch wide, 5 ¼ inch high), AC power supply, 115/230V, 1 slot for *Pro-CPU-T10* or *-T9*, 15 slots for *ADwin-Pro* modules. Desktop unit, front-side module access
ADwin-Pro-BM	19" enclosure (19 inch wide, 5 ¼ inch high), AC power supply, 115/230V, 1 slot for *Pro-CPU-T10* or *-T9*, 14 slots for *ADwin-Pro* modules. Desktop unit, backside module access
ADwin-Pro-DC	19" enclosure (19 inch wide, 5 ¼ inch high), DC power supply, 10..35VDC, 1 slot for *Pro-CPU-T10* or *-T9*, 15 slots for *ADwin-Pro* modules. Desktop unit, front-side module access
ADwin-Prolight	½ 19" enclosure (9 inch wide, 5 ¼ inch high), AC power supply, 115/230V, 1 slot for *Pro-CPU-T10* or *-T9*, 6 slots for *ADwin-Pro* modules. Desktop unit, front-side module access
ADwin-Pro-mini-2	Small enclosure (5.4 inch wide, 5 ¼ inch high), DC power supply, 10..18VDC, 1 slot for *Pro-CPU-T10* or *-T9*, 4 slots for *ADwin-Pro* modules. Desktop unit, front-side module access
ADwin-Pro-mini-3	Small enclosure (5.4 inch wide, 5 ¼ inch high), DC power supply, 20..35VDC, 1 slot for *Pro-CPU-T10* or *-T9*, 4 slots for *ADwin-Pro* modules. Desktop unit, front-side module access

Real-Time CPUs
ADwin-Pro

Fast deterministic CPUs

The heart of every **ADwin-Pro** system is a fast dedicated Real-Time CPU, responsible for all deterministic functions in the system. The applications are running guaranteed independently from the PC and it's operating system. The CPU software timings are completely predictable, what enables a precise control of all processes. Run multiple processes (tasks) in parallel with high speeds of some kHz, some hundred kHz, up to some MHz – in Real-Time.

Unique is a very short Real-Time response time of 300ns for task changes.

Only this allows an accurate timing of all **ADwin** software processes.

The **ADwin-Pro** CPU can evaluate every sampled analog or digital value from an **ADwin-Pro** I/O module in the same sampling step. A Real-Time evaluation of measurement data is user programmable by software and performs functions like:

• Closed-Loop-Controls; PID, adaptive controls …
• Open-Loop-Controls, formula or table based
• Intelligent data acquisition with online analysis
• Complex triggering
• Signal/Waveform adaptive generation

The Real-Time development tool **ADbasic** and the **ADtools** offer a very efficient and easy way to create fast, precise and deterministic time critical processes.

ADwin-Pro-II

| Pro-CPU-T11-ENET |
|---|
| Processor ADSP-TS101S, 32bit, 300MHz, 768kB CPU RAM, 256MB ext. DRAM, Ethernet interface (10/100Mbit/s) for PC communication, 1× trigger input, for **ADwin-Pro-II** only. |
| **Pro-CPU-T10-ENET** |
| Processor ADSP21160, 32bit, 80MHz, 512kB CPU RAM, 128MB ext. DRAM, Ethernet interface (10/100Mbit/s) for PC communication, 1× trigger input, for **ADwin-Pro** only. |
| **Pro-CPU-T9-ENET** |
| Processor ADSP21062, 32bit, 40MHz, 256kB CPU RAM, 16MB ext. DRAM, Ethernet interface (10/100Mbit/s) for PC communication, 1× trigger input, for **ADwin-Pro** only. |
| **Pro-Boot** |
| Boot-loader option for Ethernet Pro-CPUs; loads the **ADwin-Pro** CPU without a PC and starts the software processes automatically. |

Ethernet Interface

You can use standard Ethernet communication to a test-stand PC using a point-to-point connection or distributed network connection. One PC can 'talk' to one **ADwin** System, or one PC can 'talk' to multiple **ADwin** Systems, or multiple PCs can 'talk' to a single **ADwin** System, whatever the application requires. This concept allows that multiple test-stands can be controlled by a single PC, a great advantage for durability test-stands.

One of the key benefits in the **ADwin** <> PC communication is that it is possible to run fast deterministic Real-Time processes AND in the same time having the communication. Both have no influence on each other, the communication does not disturb the precision of the Real-Time processes, but also while running fast processes it is still possible to run the communication.

Analog Input Modules
ADwin-Pro
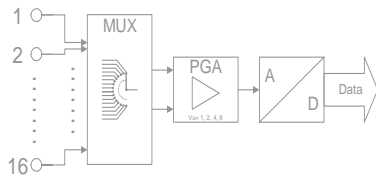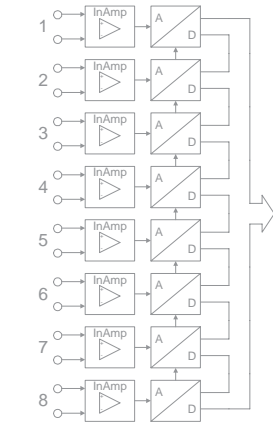
## Analog Input Modules – Overview

The *ADwin-Pro* system provides many different solutions for analog measurements. There are input modules with multiplexed analog to digital converters (ADC's), modules with parallel synchronous ADC's, modules with onboard RAM for very high-speed parallel measurements and modules with FPGA's for customized state machine code, onboard pre-calculation, analog signal based counters and other advanced functions.

Technical Features

- 8, 16 or 32 analog inputs per module, up to 15 modules per system
- 14, 16 or 18 bit resolution
- **Multiplexed** inputs, from 8 to 480 channels/system
- Parallel synchronous inputs, with one **ADC per channel** for measurements without channel to channel phase shift, from 4 to 120 channels per system
- Sampling rate from kHz up to 50MHz
- Programmable gain of 1×, 2× 4× or 8×
- On-board RAM buffer for the fastest sampling speed
- Customized onboard FPGA provides flexible pre-processing of data at MHz speeds
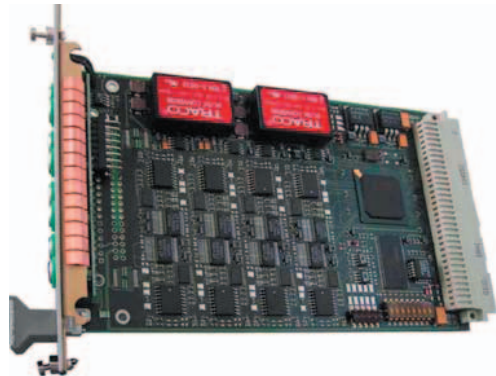
Real-Time Measurement Data Acquisition

The Real-Time capability is the most important feature of all *ADwin* modules. Measurement data can be processed during every sampling step. It's possible to read new analog values, perform a user defined calculation, and write to an output in the same sampling step if necessary. These Real-Time operations can run with process cycle times from milliseconds down to microseconds; from kHz up to MHz rates.

This feature enables many solutions in the field of Real-Time automation, including open or closed loop control, data acquisition with on-line analysis, or complex triggering functions.

Parallel or Multiplexed Analog Measurements?

The most significant error occurring during a multiplexed measurement is the phase error. It occurs due to the channel-to-channel delay when sequentially sampling the analog inputs via a multiplexer.

Parallel sampling does not cause a phase error, because there is a dedicated ADC per channel. The errors due to multiplexed sampling and its importance in the application normally depends on the dynamics of the signals which have to be acquired and have to be evaluated based on the individual application. >>Feel free to contact your local *ADwin* support staff for assistance in configuring a system.

Applications

- Data acquisition with complex triggering conditions
- Data acquisition with on-line analysis
- Open or closed loop control, PID, state space control, etc.
- Low to mid speed multiplexed measurements
- Mid to high speed parallel measurements
- Real-Time on-line evaluation up to 2MHz
- 50MHz parallel high speed measurements into a local module RAM buffer

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- Automation applications
- Automated test equipment / ATE
- Automated analog tests
- Contact test for µ-interruptions
- OEM state machines (with VHDL customization) for advanced triggering functions

… and many other applications.

Analog Input Modules
ADwin-Pro

Multiplexed Analog Input Modules

Analog measurement modules with multiplexed inputs offer a high number of channels, 8, 16 or 32 analog inputs, in a single module at a reasonable price. In a single **ADwin-Pro** chassis, up to 480 channels are possible; for more channels, several **ADwin-Pro** systems can be used in parallel.

The analog inputs are connected via a multiplexer and a programmable amplifier to an ADC. The acquisition of the input signals is executed in time-delayed intervals. The delay is determined by the conversion time of the ADC as well as by the settling time of the multiplexer, with the largest value of either being the determining factor.

The 8 channel modules have differential inputs, those with 16/32 channels can be software selected as 16 differential inputs or 32 single-ended inputs, and a mixed mode is possible as well.

The inputs have shielded LEMO sockets or a 37 pin DSUB socket.

Technical Features
- Real-Time signal evaluation
  - On-line analysis of data
  - Intelligent, complex triggering
  - Open loop & closed loop control
- 8, 16 or 32 analog inputs
- 14bit or 16bit resolution
- 16bit resolution @ 5 µs conversion time
- 14bit resolution @ 0.5 µs conversion time
- Voltage range ±10V
- Programmable gain amplifier – gain 1×, 2×, 4×, 8×
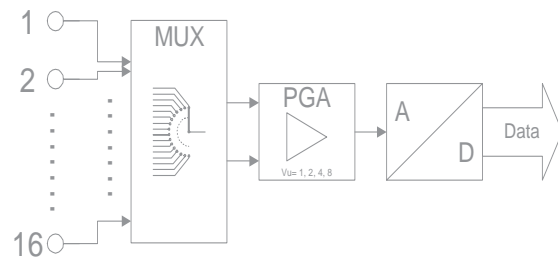
Module	Pro-AIn-8/14	Pro-AIn-32/14	Pro-AIn32/14-C	Pro-AIn-8/16	Pro-AIn-32/16
Input Channels	8 diff.	16 diff. or 32 se	16 diff.	8 diff.	16 diff. or 32 se
No. of ADC	1	1	1	1	1
Multiplexer	yes	yes	yes	yes	yes
Resolution	14	14	14	16	16
ADC conversion time	0.5µs	0.5µs	0.5µs	5µs	5µs
MUX settling time	3µs	3µs	3µs	6µs	6µs
Input range	±10V	±10V	±20mA[1]	±10V	±10V
Input over-voltage	±35V	±35V	±35V	±35V	±35V
Input resistance	330kΩ	330kΩ	Shunt 500Ω, 0.05%, TK10	330kΩ	330kΩ
Isolation	–	–	–	–	–
Gain	1, 2, 4, 8	1, 2, 4, 8	1, 2, 4, 8	1, 2, 4, 8	1, 2, 4, 8
Input type	diff	diff & single-e.	diff	diff	diff & single-e.
Typical nonlinearity integral	±2	±2	±2	±2	±2
differential	±1	±1	±1	±1	±1
Lemo connector	Pro-AIn-8/14	–	–	Pro-AIn-8/16	–
D-type connector	Pro-AIn-8/14-D	Pro-AIn-32/14	Pro-AIn-32/14	Pro-AIn-8/16-D	Pro-AIn-32/16

[1] the voltage potential at the current inputs must be in the range of ±10V vs. GND

Analog Input Modules
ADwin-Pro

### Parallel Analog Input Modules

The parallel analog measurement modules acquire all channels synchronously, without any phase shift between the measurement channels. This measurement technique is achieved by using one ADC per channel.

Different 4 and 8 channel modules are available, with a resolution/speed of 14 bits at 2 MHz.

Parallel sampling is a great advantage if measurement signals are correlated to each other and if, based on these signals, controls loops or on-line signal analyses are executed, for instance the determination of phase shift.

If the application requires more channels, additional modules can be used simultaneously, up to 120 channels in a single system. All channels on several modules can convert synchronously through a single instruction. A key feature is that the values of all channels can be processed on-line in the same sampling step. This functionality is only offered by *ADwin*'s Real-Time capabilities.

The modules have differential inputs with shielded LEMO sockets or D-SUB sockets.
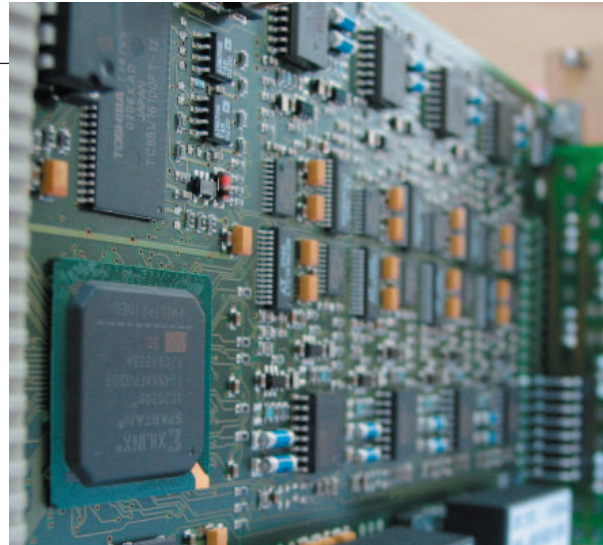
Technical Features

- Parallel, synchronous inputs with no phase shift
- 4 or 8 analog inputs with one ADC per channel
- 14bit resolution with 0.5µs conversion time,
- Up to 120 synchronous channels per *ADwin-Pro* chassis
- Input voltage range of ±10V
- Programmable gain amplifier with 1×, 2×, 4×, 8×
- Real-Time signal evaluation
- 2MB memory buffer for fastest sampling operations

Module	Pro-AIn-F-4/14	Pro-AIn-F-8/14
Input Channels	4	8
No. of ADC	4	8
Resolution	14	14
ADC conversion time	0.5µs	0.5µs
Memory Buffer (RAM)	2 MByte	2 MByte
Voltage range	±10V	±10V
Input over-voltage	±35V	±35V
Input resistance	100kΩ	100kΩ
Isolation, ch-to-ch	–	–
Gain	1, 2, 4, 8	1, 2, 4, 8
Input type	differential	differential
Typ. integral nonlinearity	±2 LSB	±2 LSB
Typ. diff. nonlinearity	±2 LSB	±2 LSB
Standard connector	4 × Lemo[2]	8 × Lemo[2]
Optional D-type connector	Pro-AIn-F-4/14-D	Pro-AIn-F-8/14-D

[1] optional   [2] Lemo connector [3] with channel count <= 4 conversion time is up to 0.02µs [4] preliminary specifications
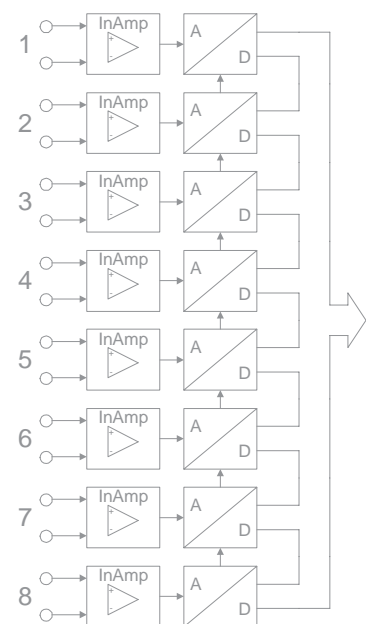
Analog Output Modules
ADwin-Pro


Parallel Analog Output Modules

Generating waveforms with signal generators is largely used for many test and automation applications to re-produce any kind of specific signals. Applications can be found in many kinds of mechanical test stands, tests for electronic components, semiconductor and board level tests, beam deflection applications, atomic traps, sensor simulation, ECU tests, and many more.

Because of the *ADwin* systems Real-Time capabilities, it is easily possible to create any kind of periodical or non-periodical signal, online calculated by the *ADwin* systems CPU. Single-channel or multi-channel signal generators for analog and/or digital signals can be created. Online processing of data is possible in every output step, even with cycle times down to one µs. This feature opens many solutions in the field signal and waveform generation such as:

- Multi-channel signal generator for analog and/or digital signals
- Periodical or non-periodical signals
- Adaptive signal generation, based on RT feedback measurements
- Sinus, triangular, trapezoid, rectangular, random, noise
- Arbitrary signal generation, combinable arbitrary shapes
- Superimposition of different signal shapes
- Block modes
- Online adjustable: frequency, phase, amplitude, offset, timing
- Outputs for open- or closed loop controllers
- Electron and laser beam control, deflection, dynamic focus
- Atomic traps, magneto optical traps, …
- N-channel (x, y, z, ..) figure generation, online adjustable figure type, position, size, rotation

The analog output modules *Pro-AOut-4/16* and *Pro-AOut-8/16* have 4 or 8 channels, with a resolutions of 16 bit. The output range is ±10V, so the FSR-Full Scale Range is 20V. The settling time is 10µs to FSR and 3µs FSR/20. The modules have shielded LEMO sockets, or 37-pin DSUB sockets.

The analog output modules can update all channels synchronously, without any phase shift between the channels. Parallel updating is a great advantage, especially if these signals are correlated to each other in the application – e.g. closed-loop controls. This update technique is achieved by using one DAC per channel, with one register per DAC. It is possible to first write new values into the register, and then start the conversion for all channels with a single command. A key feature is that the values of all channels can be processed on-line in the same sampling step. This functionality enables true Real-Time operation.
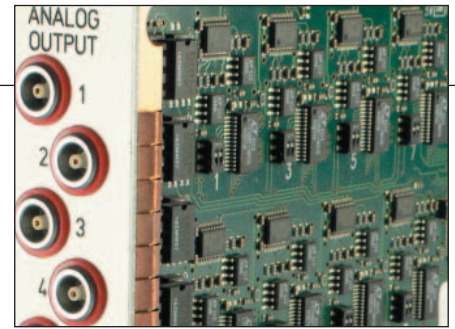
If an application needs more channels than 8, simply more modules can be used simultaneously with up to 120 channels per *ADwin-Pro* system. Here too, all channels on several modules can convert synchronously through one single instruction.

Technical Features

- 4 or 8 analog outputs per module
- 4..120 analog outputs per *ADwin-Pro* system
- 16bit resolution
- Parallel synchronous or individual outputs, also synchronized with analog inputs or digital inputs/ outputs
- Shielded LEMO or 37pin D-type sockets
- Customized VHDL onboard code provides Real-Time data processing in MHz range

Module	*Pro-Aout-4/16*	*Pro-Aout-8/16*
Output Channels	4	8
No. of DAC	4	8
Resolution	16	16
DAC settling time to FSR to FSR/20	10µs 3µs	10µs 3µs
Output range	±10V	±10V
Output current max.	±5mA short-circuit-proof	±5mA short-circuit-proof
Typ. integral nonlinearity	±2	±2
Typ. diff. nonlinearity	±1	±1
Lemo connector	*Pro-Aout-4/16*	*Pro-Aout-8/16*
D-type connector	*Pro-Aout-4/16-D*	*Pro-Aout-8/16-D*
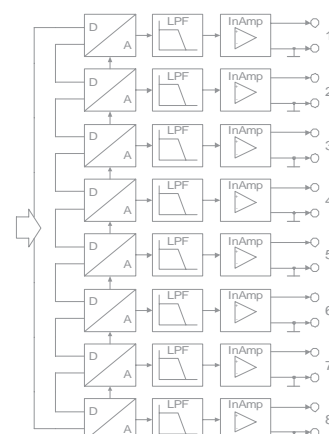
# Digital Input/Output Modules
ADwin-Pro
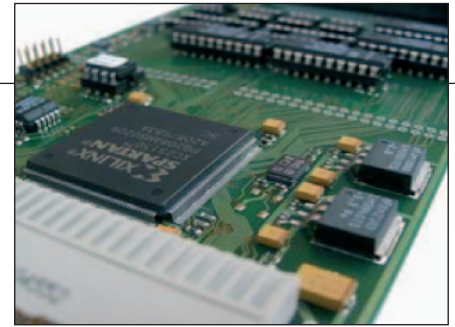
Parallel Digital I/O Modules

ADwin's high-speed digital input/output modules offer flexible solutions for a wide range of digital applications. As always, the digital modules are optimized for fast Real-Time applications, e.g. used in digital controllers. Fast waveform/pattern generator and analyzer applications are easily possible as well. The Real-Time performance reaches up to some MHz, while fast generator applications can be done with 20MHz and more.

The *ADwin-Pro* system offers different digital I/O modules:

- TTL I/Os – The digital input/output module *Pro-DIO-32* provides 32 programmable digital input and output channels at 5V TTL /CMOS level, plus an Event input. The channels can be software selected in blocks of 8 as inputs or outputs. After power-up all channels are configured as inputs.

- Optically isolated inputs – The *Pro-OPT-16* provides 16 channels of optically isolated digital inputs with jumper selectable thresholds for 5V, 12V, 24V operating levels. Each channel is optically isolated from system circuitry and other input channels. The settling time of the isolation circuit is 200ns, allowing sampling of high-speed digital inputs. The factory setting for the input range is 24V. The event input is optically isolated from the system circuitry.

- Transistor switching outputs – The *Pro-TRA-16* provides 16 channels of isolated transistor outputs. The channels are isolated from the system circuitry. The voltage must be provided by an external power supply, the voltage range is 5..35VDC. The event input is optically isolated from the system circuitry

- Relay outputs – The *Pro-REL-16* provides 16 channels of isolated relay outputs. Each channel is isolated from system circuitry and other output channels. The module is factory configured with normally open relays. As an option, normally closed relays are available. The maximum switching voltage is 30V. The event input is optically isolated from system circuitry.

- Comparator inputs – The module *Pro-Comp-16* offers 16 comparator inputs. The input voltage range is –2V..8V with a software selectable threshold for the Low/High switching levels, individually per channel. The inputs are based on 20MHz 8bit ADCs and a digital comparator function in the FPGA. Customized versions are available, e.g. with specialized counters, pre-calculations or online statistics. The comparator function works as follows:

High threshold

Low threshold
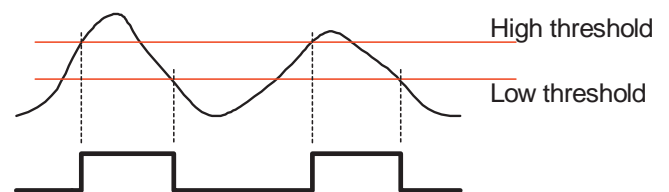
Module	Pro-DIO-32	Pro-Rel-16	Pro-Tra-16	Pro-Opt-16	Pro-Comp-16
Output Channels	4 × 8, in blocks of 8 selectable	16	16	–	–
Input Channels		–	–	16	16 single ended
Isolation	no	yes	yes	yes	no
No. of ADC	–	–	–	–	16
Resolution	–	–	–	–	8bit
Range	5V TTL/CMOS	30V	5..35V	5V, 12V, 24V	–2V..8,2V
Input resistance	10kΩ pull down				10kΩ pull down
Input current	10 (1) µA		–	7mA typ/15mA max.	1mA
Output current	8 (35) mA/ch.	500mA max./ch.	200mA max./ch.	–	–
Switching time	–	on 6ms/off 5ms	10µs	200ns	–
Event input	Yes, TTL	Yes, isolated	Yes, isolated	Yes, isolated	–
Connector	37pin D-Type	37pin D-Type	37pin D-Type	37pin D-Type	37pin D-Type

Counter & PWM Modules
ADwin-Pro
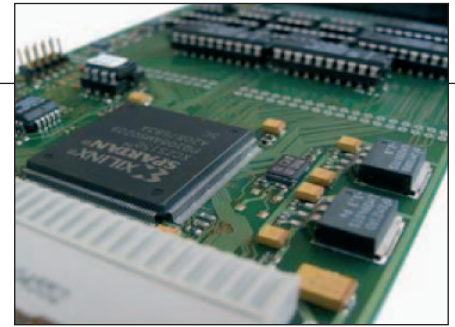
Counter Modules

ADwin's high-speed digital counter and PWM modules offer flexible solutions for a wide range of counting applications. Connect quadrature encoders to the modules, measure properties of pulses, acquire SSI signals, evaluate or generate PWM signals, and many more.

There are different counter modules available :

- Most flexible *ADwin* counters – The module *Pro-CO4* provide 4 × 32bit independent multifunctional counter. The counter modes are software selectable, for each counter individually.
  Each counter can be configured as
  - Pulse/event counting, f_{max}=20MHz
  - Precise period measurement, f_{ref}=40MHz
  - Encoder measurement, type A,B,0; f_{max}=5MHz
  - Encoder measurement, clock/direction, f_{max}=20MHz
  - SSI encoders, clock$_{SSImax}$=1MHz (*Pro-CO4-D* only)
  - PWM measurement, f_{ref}=40MHz

All counters values can be loaded into latch-registers with a single *ADbasic* command, what means that all counter values can be latched simultaneously. Also it is possible to latch specified counters individually. The module is available in three different voltage ranges: Differential TTL (RS-485/422 range), 5V TTL and isolated with 5V, 12V, 24V input voltage.

- Highest channel count – The module *Pro-CNT-16/32* provides 16 × 32bit pulse/event counters with a f_{max}=20MHz. With a rising edge of a TTL pulse the specified 32bit counter increments its value. The counters are cleared by software commands. The module offers inputs as 5V TTL or isolated with 5V, 12V, 24V voltage range. All counters values can be loaded into latch-registers with a single *ADbasic* command, what means that all counter values can be latched simultaneously. Also it is possible to latch specified counters individually.

- PWM – The module *Pro-PWM* provides 4 PWM outputs.

Tp - time periode

No. of pulse per periode
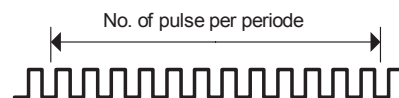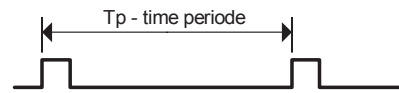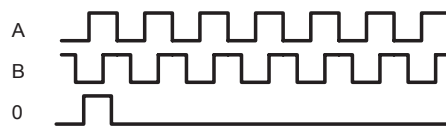
time period devided by No. of pulses, by using 2 counter

Module	*Pro-CO4-D*	*Pro-CO4-T*	*Pro-CO4-I*	*Pro-CNT-16/32*	*Pro-CNT-16/32-I*	*Pro-PWM-4*	*Pro-PWM-4-I*
No. of counter	4	16	16	16	16	–	–
Type of counter	multifunctional	multifunctional	multifunctional	event/pulse	event/pulse	PWM output	PWM output
Frequencies[1]							
Event/pulse,	20MHz	20MHz	5MHz	20MHz	5MHz	–	–
Period, internal ref.	40MHz	40MHz	40MHz	–	–	–	–
PWM, internal ref.	40 MHz	40MHz	40MHz	–	–	5MHz	5MHz
Encoder A, B, 0	5MHz	5MHz	5MHz	–	–	–	–
Encoder clk/dir	20MHz	20MHz	5MHz	–	–	–	–
SSI	1 MHz max.	–	–	–	–	–	–
Resolution	32bit	32bit	32bit	32bit	32bit	16bit High/Low	16bit High/Low
Isolation	–	–	yes	–	yes	–	yes
Range	diff. TTL, RS485	5V TTL	5V, 12V, 24V	5V TTL	5V, 12V, 24V	5V TTL	5..35V
Input resistance	120Ω[2]	10kΩ pull down	0.5/1.5/3kΩ	10kΩ pull down	0.5/1.5/3kΩ	–	–
Output current	–	–	–	–	–	5mA max./ch.	100mA max./ch.
Event Input	yes	yes	yes	yes	yes	yes	yes
Connector	37pin D-Type	37pin D-Type	37pin D-Type	37pin D-Type	37pin D-Type	37pin D-Type	37pin D-Type

1) min. pulse length -tp- for high or low is equal to tp = $1/(2 × f_{max})$, fmax = $1/(2× tp)$ 2) between pos./neg. of differential input

ADwin-Pro

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Industrial and Scientific R&D Laboratories + Production Line Test Stands + Production Line Automation Systems