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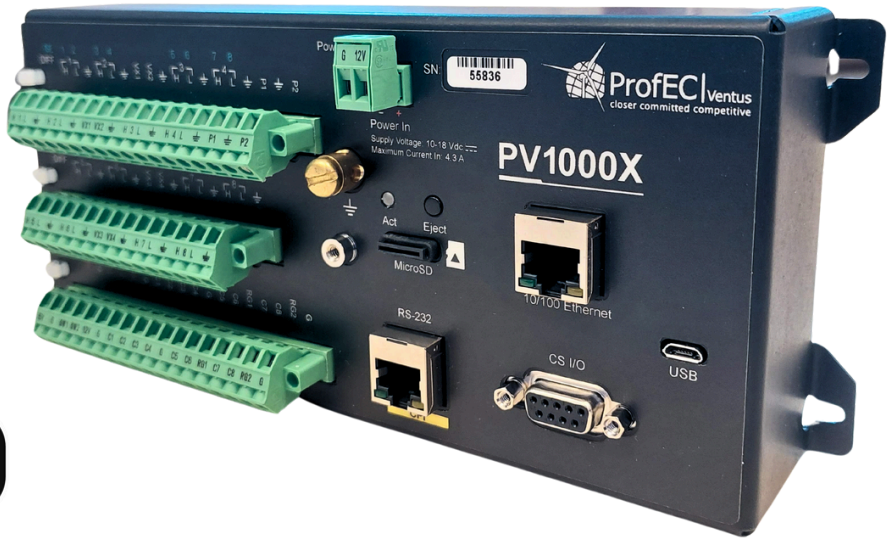
Technical Data Sheet

PV1000X



ProfEC Ventus GmbH Phone:
+49 (0)4421 209089 0

Website: www.profec-ventus.com
Email: info@profec-ventus.com

PV1000X
Technical Data Sheet

Electrical specifications are valid over a -40 to +70 °C, non-condensing environment, unless otherwise specified. Extended electrical specifications (noted as XT in specifications) are valid over a -55 to +85 °C non-condensing environment. Recalibration is recommended every three years. Critical specifications and system configuration should be confirmed with Campbell Scientific before purchase.

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System specifications

Processor: Renesas RX63N (32-bit with hardware FPU, running at 100 MHz)

Memory:

- Total onboard: 128MB of flash+4MB battery-backed SRAM
  - Data storage: 4 MB SRAM + 72 MB flash (extended data storage automatically used for auto-allocated Data Tables not being written to a card)
  - CPU drive: 30 MB flash
  - OS load: 8 MB flash
  - Settings: 1 MB flash
  - Reserved (not accessible): 10 MB flash
  - Data storage expansion: Removable microSD flash memory, up to 16 GB

Program Execution Period: 1 ms to 1 day

Real-Time Clock:

- Battery backed while external power is disconnected
- Resolution: 1ms
- Accuracy:±3min. per year, optional GPS correction to ±10 µs

Wiring Panel Temperature: Measured using a 10K3A1A BetaTHERM thermistor, located between the two rows of analog input terminals.

Physical specifications

Dimensions: 23.8 x 10.1 x 6.2 cm (9.4 x 4.0 x 2.4 in); additional clearance required for cables and wires.
Weight/Mass: 0.86 kg (1.9 lb)
Case Material: Powder-coated aluminum

Power requirements

Protection: Power inputs are protected against surge, over-voltage, over-current, and reverse power. IEC 61000-4 Class 4 level.
Power In Terminal:

- VoltageInput:10to18VDC
- InputCurrentLimitat12VDC:
  - 4.35Aat-40°C o 3Aat20°C
  - 1.56Aat85°C
- 30VDC sustained voltage limit without damage.

USB Power: Functions that will be active with USB 5 VDC include sending programs, adjusting data logger settings, and making some measurements. If USB is the only power source, then the CS I/O port and the 5V, 12V, and SW12 terminals will not be operational.

Internal Lithium Battery: AA, 2.4 Ah, 3.6 VDC (Tadiran TL 5903/S) for battery-backed SRAM and clock. 3-year life with no external power source.

Average Current Drain:
Assumes 12VDC on POWER IN terminals.

- **Idle**: <1 mA
- **Active 1 Hz Scan**: 1 mA
- **Active 20 Hz Scan**: 55 mA
- **Serial**(RS-232/RS-485): Active+25mA
- **Ethernet Power Requirements**:
  - **Ethernet 1 Minute**: Active + 1 mA
  - **Ethernet Idle**: Active + 4 mA
  - **Ethernet Link**: Active + 47 mA

Vehicle Power Connection: When primary power is pulled from the vehicle power system, a second power supply OR charge regulator may be required to overcome the voltage drop at vehicle start-up.

Power output specifications

| System power out limits (when powered with 12 VDC)

Temperature (°C)	Current limit[1] (A)
–40°	4.53
20°	3.00
70°	1.83
85°	1.56
[1] Limited by self-resetting thermal fuse	

| 12 V and SW12 V power output terminals

12V, SW12-1, and SW12-2: Provide unregulated 12 VDC power with voltage equal to the Power Input supply voltage. These are disabled when operating on USB power only.

SW12 current limits	
Temperature (°C)	Current limit [1] (mA)
–40°	1310
0°	1004
20°	900
50°	690
70°	550
80°	470
[1] Thermal fuse hold current.	

| 5 V fixed output

5V: One regulated 5 V output. Supply is shared between the 5V terminal and CS I/O DB9 5 V output.

- Voltage Output: Regulated 5V output(±5%)
- Current Limit:230mA

| C as power output

- CTerminals:
  - Output Resistance (Ro): 150 Ω
  - 5 V Logic Level Drive Capacity: 10 mA @ 3.5 VDC
  - 3.3 V Logic Level Drive Capacity: 10 mA @ 1.8 VDC

| CSI/Opin1

5 V Logic Level Max Current: 200 mA

| Voltage excitation

VX: Four independently configurable voltage terminals (VX1- VX4). When providing voltage excitation, a single 16-bit DAC shared by all VX outputs produces a user-specified voltage during measurement only.VX terminals can also be used to supply a selectable, switched, regulated 3.3 or 5 VDC power source to power digital sensors and toggle control lines.

	Range	Resolution	Accuracy	Maximum source/sink current[1]
Voltage Excitation	±4 V	0.06 mV	±(0.1% of setting + 2 mV)	±40 mA
Switched, Regulated	+3.3 or 5 V	3.3 or 5 V	±5%	50 mA
[1] Exceeding current limits causes voltage output to become unstable. Voltage should stabilize when current is reduced to within stated limits.				

Analog measurement specifications

16 single-ended (SE) or 8 differential (DIFF) terminals individually configurable for voltage, thermocouple, current loop, ratiometric, and period average measurements, using a 24-bit ADC. One channel at a time is measured.

| Voltage measurements

Terminals:

- **Differential Configuration**:DIFF1H/1L–8H/8L
- **Single-Ended Configuration**:SE1–SE16

Input Resistance: 20 GΩ typical
Input Voltage Limits: ±5 V
Sustained Input Voltage without Damage: ±20 VDC DC
Common Mode Rejection:

- >120dB with input reversal
- ≥86dB without input reversal

Normal Mode Rejection: > 70 dB @ 60 Hz
Input Current @ 25 °C: ±1 nA typical
Filter First Notch Frequency(fN1)Range: 0.5Hz to 31.25kHz (user specified)

Analog Range and Resolution:

		Differential with input reversal		Single-ended and differential without input reversal	
Notch frequency (f_{N1}) (Hz)	Range[1] (mV)	RMS (µV)	Bits[2]	RMS (µV)	Bits[2]
15000	±5000	8.2	20	11.8	19
	±1000	1.9	20	2.6	19
	±200	0.75	19	1.0	18
50/60[3]	±5000	0.6	24	0.88	23
	±1000	0.14	23	0.2	23
	±200	0.05	22	0.08	22
5	±5000	0.18	25	0.28	25
	±1000	0.04	25	0.07	24
	±200	0.02	24	0.03	23

[1] Range overhead of ~5% on all ranges guarantees that full-scale values will not cause over range

[2] Typical effective resolution (ER) in bits; computed from ratio of full-scale range to RMS resolution.

[3] 50/60 corresponds to rejection of 50 and 60 Hz ac power mains noise.

Accuracy (does not include sensor or measurement noise):

- 0to40°C:±(0.04%of measurement+offset)
- –40to70°C:±(0.06%of measurement+offset)

Voltage Measurement Accuracy Offsets:

	Typical offset (µV RMS)	
Range (mV)	Differential with input reversal	Single-ended or differential without input reversal
±5000	±0.5	±2
±1000	±0.25	±1
±200	±0.15	±0.5

Measurement Settling Time: 20 µs to 600 ms; 500 µs default

Multiplexed Measurement Time:

Measurement time = INT(multiplexed measurement time • (reps+1) + 2ms

	Differential with input reversal	Single-ended or differential without input reversal
Example fN1[1] (Hz)	Time[2] (ms)	Time[2] (ms)
15000	2.04	1.02
60	35.24	17.62
50	41.9	20.95
5	401.9	200.95

[1] Notch frequency (1/integration time).

[2] Default settling time of 500 µs used.

| Resistance measurement specifications

The data logger makes ratio metric-resistance measurements for four- and six-wire full-bridge circuits and two-, three-, and four-wire half-bridge circuits using voltage excitation. Excitation polarity reversal is available to minimize dc error.

Accuracy:

Assumes input reversal for differential measurements **RevDiff** and excitation reversal **RevEx** for excitation voltage <1000 mV. Does not include bridge resistor errors or sensor and measurement noise.

- 0 to 40°C:±(0.01%of voltage measurement+offset)
- –40 to 70°C:±(0.015%of voltage measurement+ offset)
- –55 to 85°C(XT):±(0.02%of voltage measurement+ offset)

| Period-averaging measurement specifications

Terminals: SE1-SE16

Accuracy: ±(0.01% of measurement + resolution), where resolution is 0.13 µs divided by the number of cycles to be measured

Ranges:

- Minimum signal centered around specified period average threshold.
- Maximum signal centered around data logger ground.
- Maximum frequency=1/(2*[minimum pulse width])

for 50% duty cycle signals

Gain code option	Voltage gain	Minimum peak to peak signal (mV)	Maximum peak to peak signal (V)	Minimum pulse width (µs)	Maximum frequency (kHz)
0	1	500	10	2.5	200
1	2.5	50	2	10	50
2	12.5	10	2	62	8
3	64	2	2	100	5

| Current-loop measurement specifications

The data logger makes current-loop measurements by measuring across a current-sense resistor associated with the RS-485 resistive ground terminal.

Terminals: RG1 and RG2
Maximum Input Voltage: ±16 V
Resistance to Ground: 101 Ω
Current Measurement Shunt Resistance: 10 Ω Maximum
Current Measurement Range: ±80 mA
Absolute Maximum Current: ±160 mA
Resolution: ≤ 20 nA
Accuracy: ±(0.1% of reading + 100 nA) @ -40 to 70 °C

Pulse measurement specifications

Two inputs (P1-P2) individually configurable for switch closure, high-frequency pulse, or low-level AC measurements. See also Digital input/output specifications (p. 4). Each terminal has its own independent 32-bit counter.

> NOTE:
> Conflicts can occur when a control port pair is used for different instructions (TimerInput(), PulseCount(), SDI12Recorder(), WaitDigTrig()). For example, if C1 is used for SDI12Recorder(), C2 cannot be used for TimerInput(), PulseCount(), or WaitDigTrig().

Maximum Input Voltage: ±20 VDC
Maximum Counts Per Channel: 2^{32}
Maximum Counts Per Scan: 2^{32}
Input Resistance: 5 kΩ
Accuracy: ±(0.02% of reading + 1/scan)

| Switch closure input

Terminals: C1-C8
Pull-Up Resistance: 100 kΩ to 5 V
Event: Low (<0.8 V) to High (>2.5 V)
Maximum Input Frequency: 150 Hz
Minimum Switch Closed Time: 5 ms
Minimum Switch Open Time: 6 ms
Maximum Bounce Time: 1 ms open without being counted

| High-frequency input

Terminals: C1-C8
Pull-Up Resistance: 100 kΩ to 5 V
Event: Low (<0.8 V) to High (>2.5 V) Maximum Input
Frequency: 250 kHz

| Low-level AC input

Minimum Pull-Down Resistance: 10 kΩ to ground
DC-offset rejection: Internal AC coupling eliminates DC-offset voltages up to ±0.05 VDC
Input Hysteresis: 12 mV at 1 Hz
Low-Level AC Pulse Input Ranges:

Sine wave (mV RMS)	Range (Hz)
20	1.0 to 20
200	0.5 to 200
2000	0.3 to 10,000
5000	0.3 to 20,000

Digital input/output specifications

Terminals configurable for digital input and output (I/O) including status high/low, pulse width modulation, external interrupt, edge timing, switch closure pulse counting, high-frequency pulse counting, UART[1], RS-232[2], RS-422[3], RS-485[4], SDM[5], SDI-12[6], I2C[7], and SPI[8] function. Terminals are configurable in pairs for 5 V or 3.3 V logic for some functions.

> NOTE:
> Conflicts can occur when a control port pair is used for different instructions (TimerInput(), PulseCount(), SDI12Recorder(), WaitDigTrig()). For example, if C1 is used for SDI12Recorder(), C2 cannot be used for TimerInput(), PulseCount(), or WaitDigTrig().

Terminals: C1-C8
Maximum Input Voltage: ±20 V
Logic Levels and Drive Current:

Terminal pair configuration	5 V source	3.3 V source
Logic low	≤ 1.5 V	≤ 0.8 V
Logic high	≥ 3.5 V	≥ 2.5 V
C1 - C8	10 mA @ 3.5V	10 mA @ 1.85V

1Universal Asynchronous Receiver/Transmitter for asynchronous serial communications.
2Recommended Standard 232. A loose standard defining how two computing devices can communicate with each other. The implementation of RS-232 in Campbell Scientific data loggers to computer communications is quite rigid, but transparent to most users. Features in the data logger that implement RS- 232 communications with smart sensors are flexible.
3Communications protocol similar to RS-485. Most RS-422 sensors will work with RS-485 protocol.
4Recommended Standard 485. A standard defining how two computing devices can communicate with each other.
5Synchronous Device for Measurement. A processor-based peripheral device or sensor that communicates with the data logger via hardwire over a short distance using a protocol proprietary to Campbell Scientific.
6Serial Data Interface at 1200 baud. Communications protocol for transferring data between the data logger and SDI-12 compatible smart sensors. 7Inter-Integrated Circuit is a multi-controller, multi-peripheral, packet switched, single-ended, serial computer bus.
8Serial Peripheral Interface - a clocked synchronous interface, used for short distance communications, generally between embedded devices.

Phone: +49 (0)4421 209089 0
Website: www.profec-ventus.com
Email: info@profec-ventus.com

| Edge timing

Terminals: C1-C8

Maximum Input Frequency: ≤ 1 kHz Resolution: 500 ns

| Edge counting

Terminals: C1-C8

Maximum Input Frequency: ≤ 2.3 kHz

| Quadrature input

Terminals: C1-C8 can be configured as digital pairs to monitor the two sensing channels of an encoder.

Maximum Frequency: 2.5 kHz Resolution: 31.25 µs or 32 kHz

| Pulse-width modulation

Maximum Period: 36.4 seconds

Resolution:

- 0–5ms:83.33ns
- 5–325ms:5.33µs
- >325ms:31.25µs

Communications specifications

Ethernet Port: RJ45 jack, 10/100Base Mbps, full and half duplex, Auto-MDIX, magnetic isolation, and TVS surge protection.

Internet Protocols: Ethernet, PPP, RNDIS, ICMP/Ping, Auto-IP (APIPA), IPv4, IPv6, UDP, TCP, TLS (v1.2), DNS, DHCP, SLAAC, Telnet, HTTP(S), SFTP, FTP(S), POP3/TLS, NTP, SMTP/TLS, SNMPv3, CS I/O IP, MQTT

Additional Protocols: CPI, PakBus, PakBus Encryption, SDM, SDI-12, Modbus RTU / ASCII / TCP, DNP3, custom user definable over serial, NTCIP, NMEA 0183, I2C, SPI

USB Device: Micro-B device for computer connectivity

CS I/O: 9-pin D-sub connector to interface with Campbell Scientific CS I/O peripherals.

SDI-12 (C1, C3, C5, C7): Four independent SDI-12 compliant terminals are individually configured and meet SDI-12 Standard v 1.4.

RS-485 (C5 to C8): One full duplex or two half duplex

RS-422 (C5 to C8): One full duplex or two half duplex

RS-232/CPI: Single RJ45 module port that can operate in one of two modes: CPI or RS-232. CPI interfaces with Campbell Scientific CDM measurement peripherals and sensors. RS-232 connects, with an adapter cable, to computer, sensor, or communications devices serially.

CPI: One CPI bus. Up to 1 Mbps data rate. Synchronization of devices to 5 µS. Total cable length up to 610 m (2000 ft). Up to 20 devices. CPI is a proprietary interface for communications between Campbell Scientific data loggers and Campbell Scientific CDM peripheral devices. It consists of a physical layer definition and a data protocol.

Hardwired: Multi-drop, short haul, RS-232, fiber optic

Satellite: GOES, Argos, Inmarsat Hughes, Irridium

Standards compliance specifications

View compliance and conformity documents at www.campbellsci.com/cr1000x

Shock and Vibration: MIL-STD 810G methods 516.6 and 514.6

Protection:

- Wiringpanel:IP40
- Measurement module when connected to the wiring panel: IP65

EMI and ESD protection:

- Immunity:Meets or exceeds following standards:
  - ESD: per IEC 61000-4-2; ±15 kV air, ±8 kV contact discharge
  - Radiated RF: per IEC 61000-4-3; 10 V/m, 80-1000 MHz
  - EFT: per IEC 61000-4-4; 4 kV power, 4 kV I/O
  - Surge: per IEC 61000-4-5; 4 kV power, 4kV I/O
  - Conducted RF: per IEC 61000-4-6; 10 V power, 10VI/O
- Emissions and immunity performance criteria available on request.

Warranty

Standard: Three years against defects in materials and workmanship.

Extended (optional): An additional four years, bringing the total to seven years.

Analog input terminal functions																		
SE DIFF	1 2 ┌1┐ H L		3 4 ┌2┐ H L		5 6 ┌3┐ H L		7 8 ┌4┐ H L		9 10 ┌5┐ H L		11 12 ┌6┐ H L		13 14 ┌7┐ H L		15 16 ┌8┐ H L		RG1	RG2
Single-Ended Voltage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Differential Voltage	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L		
Ratiometric/Bridge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Thermocouple	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Current Loop																	✓	✓
Period Average	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		

Pulse counting terminal functions			
	P1	P2	C1-C8
Switch-Closure	✓	✓	✓
High Frequency	✓	✓	✓
Low-level AC	✓	✓	

Analog output terminal functions	
	VX1-VX4
Switched Voltage Excitation	✓

Voltage Output						
	C1-C8[1]	VX1-VX4	5V	12V	SW12-1	SW12-2
5 VDC	✓	✓	✓			
3.3 VDC	✓	✓				
12 VDC				✓	✓	✓
[1] C terminals have limited drive capacity. Voltage levels are configured in pairs.						

Communications terminal functions									
	C1	C2	C3	C4	C5	C6	C7	C8	RS-232/CPI
SDI-12	✓		✓		✓		✓		
GPS	PPS	Rx	Tx	Rx	Tx	Rx	Tx	Rx	
TTL 0-5 V	Tx	Rx	Tx	Rx	Tx	Rx	Tx	Rx	
LVTTL 0-3.3 V	Tx	Rx	Tx	Rx	Tx	Rx	Tx	Rx	
RS-232					Tx	Rx	Tx	Rx	✓
RS-485 (Half Duplex)					A-	B+	A-	B+	

Communications terminal functions									
	C1	C2	C3	C4	C5	C6	C7	C8	RS-232/CPI
RS-485 (Full Duplex)					Tx-	Tx+	Rx-	Rx+	
I2C	SCL	SDA	SCL	SDA	SCL	SDA	SCL	SDA	
SPI	SCLK	COPI	CIPO		SCLK	COPI	CIPO		
SDM[1]	Data	Clk	Enabl		Data	Clk	Enabl		
CPI/CDM									✓
[1] SDM can be on either C1-C3 or C5-C7, but not both at the same time. Communications functions also include Ethernet and USB.									

Digital I/O terminal functions	
	C1-C8
General I/O	✓
Pulse-Width Modulation Output	✓
Timer Input	✓
Interrupt	✓
Quadrature	✓