

# Temperature / Process Controllers & Programmers

## PID with Time / Temperature Profiling Controllers



### Features

- Total 9 profiles, a profile with 16, 32 or 64 segments at most
- Each segment to be configured as a ramp or dwell (soak)
- After event process goes to run, hold, abort, manual, failure transfer, off mode, next segment or select the second PID values
- High accuracy of 18-bit A to D input, and 15-bit D to A output
- The fast sample rate of 200 msec
- Fuzzy control to reach set point at the least overshooting & less time
- Up to three relays are configurable for event output
- Analog retransmission of process value & set point value
- Optional RS-485 or 232 communications
- Programmable port for easy configuration or calibration
- Lockout protection for security requirement
- Bumpless transfer of safely control while sensor breaks
- Digital filter to improve the stability of process value
- SEL function for easy operation





## Overview

The Fuzzy Logic plus PID microprocessor-based profiling controller series, incorporate two bright, easy to read 4-digit LED displays, indicating process value and set point value. The Fuzzy Logic technology enables a process to reach a predetermined set point in the shortest time, with the minimum of overshoot during power-up or external load disturbance.

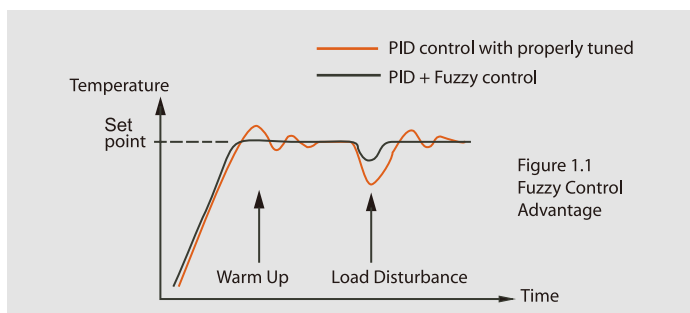
P91 is a 1/16 DIN size panel mount profiling controller. It can also be used for rail mount by adding a rail mount kit. P41 is a 1/4 DIN size panel mount profiling controller. These units are powered by 11-26 or 90-250 VDC/VAC supply, incorporating a 2 amp. control relay output as standard. The second output can be used as cooling control, an event output or an alarm. Both outputs can select triac, logic output, linear current or linear voltage to drive external device. The units are fully programmable for PT100 and thermocouple types J, K, T, E, B, R, S, N, L, C, P with no need to modify the unit. The input signal is digitized by using a 18-bit A to D converter. Its fast sampling rate allows the unit to control fast processes.

There are more functions than the heating and cooling control could be configured for the controller outputs, these include: up to three alarm outputs, up to three event outputs and up to two analog retransmission outputs.

Digital communications RS-485 or RS-232 are available as an additional option. These options allow the units to be integrated with supervisory control system and software.

A programming port is available for automatic configuration, calibration and testing without the need to access the keys on front panel.

By using proprietary Fuzzy modified PID technology, the control loop will minimize the overshoot and undershoot in a shortest time. The following diagram is a comparison of results with and without Fuzzy technology.



The series can be configured as a single set point controller (static mode) or a ramp and dwell profiling controller (profile mode). The profile mode feature allows the user to program up to 9 profiles of up to 64 free-format (ramp, dwell, jump or end) segments each. The total segments available for the product is 288 segments.

The profiling controllers contain the following features:

### Flexible Configuration of Program

There are up to 64 segments can be defined for a profile. Each segment can be configured as a ramp or a dwell (soak) segment or defining a repeat number of cycles at arbitrary location within the profile and finally terminated by an end segment. The user can edit a currently running profile.

### Maximum Capacity of Program

There are at most 9 profiles can be defined and 288 segments totally available for all profiles. The profiles are divided into three kinds of length. The short length profile contains 16 segments, the medium length profile contains 32 segments while the long length profile contains 64 segments at most.

### Event Input

The event input feature allows the user to select one of eight functions:

enter profile run mode, enter profile hold mode, abort profile mode, enter manual mode, perform failure transfer, enter off mode, advance to the next segment and select second set of PID values.

### Programmable Event Outputs

Up to three relays are configurable for event outputs and the state of each output can be defined for each segment and end of profile.

### Analog Retransmission

The output 4 and output 5 (P41 only) of the products can be equipped with analog output module. The output can be configured for transmitting the process value as well as set point value.

### High Accuracy

The series are manufactured with custom designed ASIC (Application Specific Integrated Circuit) technology which contains a 18-bit A to D converter for high resolution measurement (true 0.1°F resolution for thermocouple and PT100) and a 15-bit D to A converter for linear current or voltage control output. The ASIC technology provides improved operating performance, low cost, enhanced reliability and higher density.

### Fast Sampling Rate

The sampling rate of the input A to D converter reaches 5 times/second. The fast sampling rate allows this series to control fast processes.

### Fuzzy Control

The function of Fuzzy control is to adjust PID parameters from time to time in order to make manipulation output value more flexible and adaptive to various processes. The results is to enable a process to reach a predetermined set point in the shortest time, with the minimum of overshoot and undershoot during power-up or external load disturbance.

### Digital Communication

The units are equipped with RS-485 or RS-232 interface card to provide digital communication. By using the twisted pair wires there are at most 247 units can be connected together via RS-485 interface to a host computer.

### Programming Port

A programming port is used to connect the unit to a hand-held programmer or a PC for quick configuration, also can be connected to an ATE system for automatic testing & calibration.

### Auto-tune

The auto-tune function allows the user to simplify initial setup for a new system. A clever algorithm is provided to obtain an optimal set of control parameters for the process, and it can be applied either as the process is warming up (cold start) or as the process has been in steady state (warm start).

### Lockout Protection

According to actual security requirement, a password is provided to prevent the unit from being changed abnormally.

### Bumpless Transfer

Bumpless transfer allows the controller to continue to control by using its previous value as the sensor breaks. Hence, the process can be well controlled temporarily as if the sensor is normal.

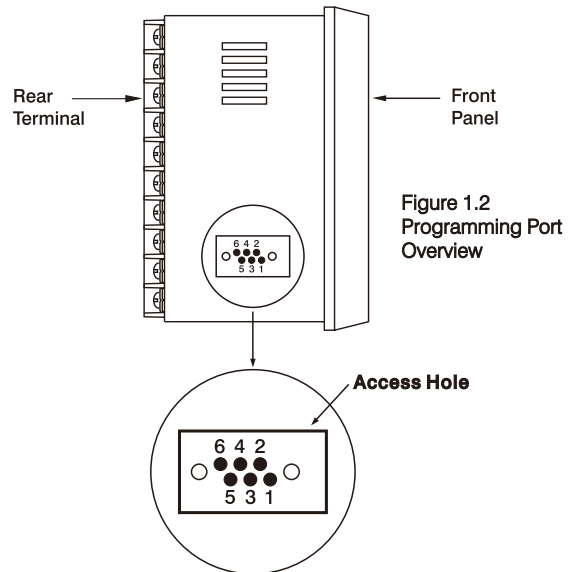
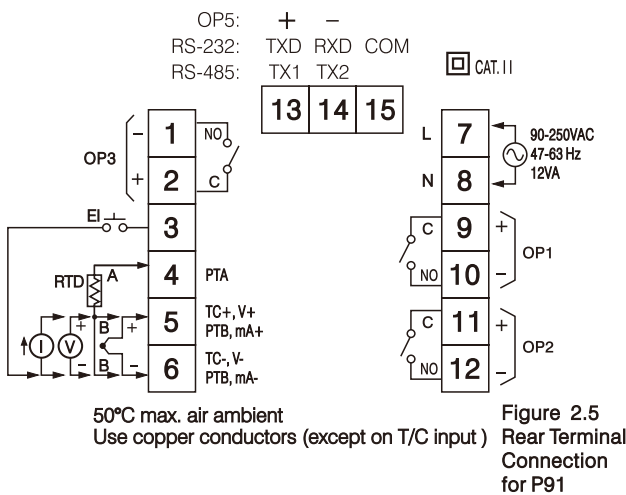
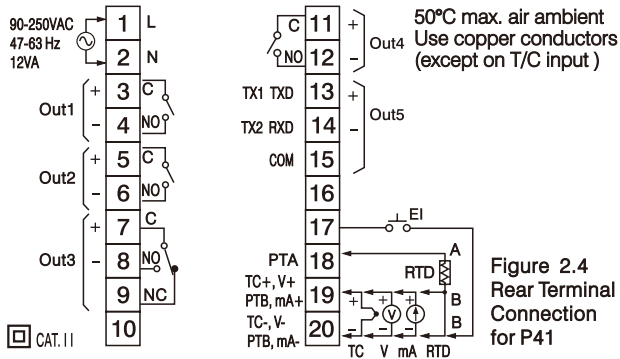
### Digital Filter

A first order low pass filter with a programmable time constant is used to improve the stability of process value. This is particularly useful in certain application where the process value is too unstable to be read.

### SEL Function

The units have the flexibility for user to select those parameters which are most significant to him and put these parameters in the home page. There are at most 8 parameters can be selected to allow the user to build his own display sequence.

## Connection Diagrams



A special connector can be used to touch the programming port which is connected to a PC for automatic configuration, also can be connected to an ATE system for automatic calibration and testing.

The programming port is used for off-line automatic setup and testing procedures only. Don't attempt to make any connection to these pins when the unit is used for a normal control purpose.

## Specifications

### Power

90 ~ 250 VAC, 47 ~ 63 Hz, 12VA, 5W maximum  
11 ~ 26 VAC / VDC, 12VA, 5W maximum

### Input

**Resolution** : 18 bits

**Sampling Rate** : 5 times / second

**Maximum Rating** : -2 VDC minimum, 12 VDC maximum  
( 1 minute for mA input )

**Temperature Effect** : A1.5uV/ °C for all inputs except mA input  
A3.0uV/ °C for mA input

**Sensor Lead Resistance Effect** :  
T/C: 0.2uV/ohm  
3-wire RTD: 2.6 °C/ohm of resistance difference  
of two leads  
2-wire RTD: 2.6 °C/ohm of resistance sum of two leads

**Burn-out Current** : 200 nA

**Common Mode Rejection Ratio ( CMRR )** : 120dB

**Normal Mode Rejection Ratio ( NMRR )** : 55dB

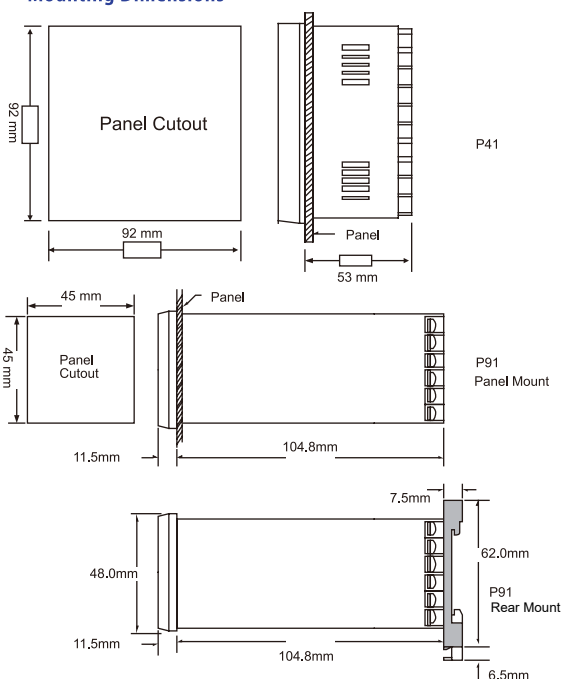
### Sensor Break Detection :

Sensor open for TC, RTD and mV inputs,  
Sensor short for RTD input  
below 1 mA for 4-20 mA input,  
below 0.25V for 1 - 5 V input,  
unavailable for other inputs.

### Sensor Break Responding Time :

Within 4 seconds for TC, RTD and mV inputs,  
0.1 second for 4-20 mA and 1 - 5 V inputs.

### Mounting Dimensions



## Characteristics:

Type	Range	Accuracy @ 25 °C	Input Impedance
J	-120°C~1000°C (-184°F~1832°F)	±2°C	2.2 MΩ
K	-200°C~1370°C (-328°F~2498°F)	±2°C	2.2 MΩ
T	-250°C~ 400°C (-418°F~752°F)	±2°C	2.2 MΩ
E	-100°C~ 900°C (-148°F~1652°F)	±2°C	2.2 MΩ
B	0°C~ 1800°C (32°F~3272°F)	±2°C ( 200°C~1800°C)	2.2 MΩ
R	0°C~ 1767.8°C (32°F~3214°F)	±2°C	2.2 MΩ
S	0°C~ 1767.8°C (32°F~3214°F)	±2°C	2.2 MΩ
N	-250°C~ 1300°C (-418°F~2372°F)	±2°C	2.2 MΩ
L	-200°C~ 900°C (-328°F~ 1652°F)	±2°C	2.2 MΩ
C	0°C~ 2315°C (32°F~ 4199°F)	±2°C	2.2 MΩ
P	0°C~ 1395°C (32°F~ 2543°F)	±2°C	2.2 MΩ
PT100 ( DIN )	-210°C~ 700°C (-346°F~ 1292°F)	±0.4°C	1.3 MΩ
PT100 ( JIS )	-200°C~ 600°C (-328°F~ 1112°F)	±0.4°C	1.3 MΩ
mV	-8mV~70mV	±0.05 %	2.2 MΩ
mA	-3mA~27mA	±0.05 %	70.5 MΩ
V	-1.3V~11.5V	±0.05 %	650 KΩ

## Output 1 / Output 2

**Relay Rating :** 2A/240 VAC, life cycles 200,000 for resistive load  
**Pulsed Voltage :** Source Voltage 5V, current limiting resistance 66Ω  
**Linear Output Characteristics:**

Type	Zero Tolerance	Span Tolerance	Span Tolerance
4~20 mA	3.6~4 mA	20~21 mA	500Ω max.
0~20 mA	0 mA	20~21 mA	500Ω max.
0~5 V	0 V	5~5.25 V	10 KΩ min.
1~5 V	0.9~1 V	5~5.25 V	10 KΩ min.
0~10 V	0 V	10~10.5 V	10 KΩ min.

## Linear Output

**Resolution :** 15 bits  
**Output Regulation :** 0.02 % for full load change  
**Output Settling Time :** 0.1 sec. ( stable to 99.9 % )  
**Isolation Breakdown Voltage :** 1000 VAC  
**Temperature Effect :** ±0.01 % of SPAN /°C

## Triac ( SSR ) Output

**Rating :** 1A / 240 VAC  
**Inrush Current :** 20A for 1 cycle  
**Min. Load Current :** 50 mA rms  
**Max. Off-state Leakage :** 3 mA rms  
**Max. On-state Voltage :** 1.5 V rms  
**Insulation Resistance :** 1000 Mohms min. at 500 VDC  
**Dielectric Strength :** 2500 VAC for 1 minute

## DC Voltage Supply Characteristics ( Installed at Output 2 )

Type	Tolerance	Max. Output Current	Ripple Voltage	Isolation Barrier
20 V	±1 V	25 mA	0.2 Vp-p	500 VAC
12 V	±0.6 V	40 mA	0.1 Vp-p	500 VAC
5 V	±0.25 V	80 mA	0.05 Vp-p	500 VAC

## Alarm

**Alarm Relay :** Form C Rating  
2A/240VAC, life cycles 200,000 for resistive load.  
**Alarm Functions :** Dwell timer, Deviation High / Low Alarm,  
Deviation Band High / Low Alarm,  
PV High / Low Alarm,  
**Alarm Mode :** Normal, Latching, Hold, Latching / Hold.  
**Dwell Timer :** 0.1-4553.6 minutes

## Data Communication

**Interface :** RS-232 (1 unit), RS-485 (up to 247 units)  
**Protocol :** Modbus Protocol RTU mode  
**Address :** 1-247  
**Baud Rate :** 2.4~38.4 Kbits/sec  
**Parity Bit :** None, Even or Odd  
**Stop Bit :** 1 or 2 bits  
**Communication Buffer :** 64 bytes

## Analog Retransmission

**Output Signal :** 4-20 mA, 0-20 mA, 0-5V, 1-5V, 0-10V  
**Resolution :** 15 bits  
**Accuracy :** ±0.05 % of span ±0.0025 %/°C  
**Load Resistance :** 0 - 500 ohms (for current output)  
10 K ohms minimum (for voltage output)  
**Output Regulation :** 0.01 % for full load change  
**Output Settling Time :** 0.1 sec. (stable to 99.9 %)  
**Isolation Breakdown Voltage :** 1000 VAC min.  
**Integral Linearity Error :** ±0.005 % of span  
**Temperature Effect :** ±0.0025 % of span/°C  
**Saturation Low :** 0 mA (or 0V )  
**Saturation High :** 22.2 mA (or 5.55V, 11.1V min.)  
**Linear Output Range :** 0-22.2mA(0-20mA or 4-20mA)  
0-5.55V (0-5V, 1-5V)  
0 - 11.1 V (0-10V)

## User Interface

**Dual 4-digit LED Displays**  
**Keypad :** 4 keys  
**Programming Port :** For automatic setup, calibration and testing  
**Communication Port :** RS-232 and RS-485

## Control Mode

**Output 1 :** Reverse (heating) or direct (cooling) action  
**Output 2 :** PID cooling control, cooling P band 50~300%  
of PB, dead band -36.0 ~ 36.0 % of PB  
**ON-OFF :** 0.1 - 90.0 (°F) hysteresis control (P band = 0)  
**P or PD :** 0-100.0 % offset adjustment  
**PID :** Fuzzy logic modified  
Proportional band 0.1~900.0 °F. Integral time 0-1000 seconds  
Derivative time 0-360.0 seconds  
**Cycle Time :** 0.1-90.0 seconds  
**Manual Control :** Heat (MV1) and Cool (MV2)  
**Auto-tuning :** Cold start and warm start  
**Failure Mode :** Auto-transfer to manual mode while  
sensor break or A-D converter damage  
**Ramping Control :** 0-900.0 °F/minute or 0-900.0 °F/hour ramp rate

## Digital Filter

**Function :** First order  
**Time Constant :** 0, 0.2, 0.5, 1, 2, 5, 10, 20, 30, 60 seconds programmable

## Profiler

**Number of profiles :** 9  
**Number of Segment per profile**  
**Profile 1, 2, 3, 4 :** 16  
**Profile 5, 6, 7:** 32  
**Profile 8, 9:** 64  
**Event Outputs :** 3

## Environmental & Physical

**Operating Temperature :** -10°C to 50°C  
**Storage Temperature :** -40°C to 60°C  
**Humidity :** 0 to 90 % RH ( non-condensing )  
**Altitude :** 2000m maximum  
**Pollution :** Degree 2  
**Insulation Resistance :** 20 Mohms min. ( at 500 VDC )  
**Dielectric Strength :** 2000 VAC, 50/60 Hz for 1 minute  
**Vibration Resistance :** 10 - 55 Hz, 10 m/s<sup>2</sup> for 2 hours  
**Shock Resistance :** 200 m/s<sup>2</sup> ( 20 g )  
**Moldings :** Flame retardant polycarbonate  
**Dimensions :** P41 - 96mm(W) X 96mm(H) X 65mm(D),  
53 mm depth behind panel  
P91 - 48mm(W) X 48mm(H) X 116mm(D),  
105 mm depth behind panel  
**Weight :** P41 - 250 grams  
P91 - 150 grams  
**Approval Standards**  
**Safety :** UL61010C-1  
CSA C22.2 No.24-93  
EN61010-1 (IEC1010-1)

## Protective Class :

IP65 for panel with additional option  
IP50 for panel without additional option  
IP20 for terminals and housing with protective cover.  
All indoor use.

**EMC:** EN61326



## Ordering Code

P41-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
P91-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Power Input** —

4: 90 - 250 VAC, 47-63 Hz  
5: 11 - 26 VAC or VDC, SELV, Limited Energy

**Signal Input** —

1: Standard Input  
Thermocouple:  
J, K, T, E, B, R, S, N, L, C, P  
RTD: PT100 DIN, PT100 JIS  
Voltage: 0-60mV  
5: 0-10V, 0-1V, 0-5V, 1-5V  
6: 0-20/4-20 mA  
9: Special Order

**Output 1** —

0: None  
1: Relay rated 2A/240VAC  
2: Pulsed voltage to drive SSR, 5V/30mA  
3: Isolated 4 - 20mA / 0 - 20mA  
4: Isolated 1 - 5V / 0 - 5V/0 - 10V  
6: Triac output 1A / 240VAC, SSR  
C: Pulsed voltage to drive SSR, 14V/40mA  
9: Special order

**Output 2** —

0: None  
1: Relay rated 2A/240VAC  
2: Pulsed voltage to drive SSR, 5V/30mA  
3: Isolated 4 - 20mA / 0 - 20mA  
4: Isolated 1 - 5V / 0 - 5V/0 - 10V  
6: Triac output 1A / 240VAC, SSR  
7: Isolated 20V/25mA transducer power supply  
8: Isolated 12V/40mA transducer power supply  
A: Isolated 5V/80mA transducer power supply  
C: Pulsed voltage to drive SSR, 14V/40mA  
9: Special order

**Options**

0: Panel mount IP50 standard  
1: Panel mount IP65 water resistant rubber installed  
2: DIN rail mount with IP50 (for P91 only)  
3: DIN rail mount with IP65 (for P91 only)

**Output 5**

0: None  
3: Retransmit 4 - 20mA / 0 - 20mA  
4: Retransmit 1 - 5V / 0 - 5V/0 - 10V  
7: Isolated 20V/25mA transducer power supply  
8: Isolated 12V/40mA transducer power supply  
A: Isolated 5V/80mA transducer power supply  
D: Isolated RS-485 interface  
E: Isolated RS-232 interface

**Output 4**

0: None  
1: Relay rated 2A/240VAC  
2: Pulsed voltage to drive SSR, 5V/30mA  
3: Retransmit 4 - 20mA / 0 - 20mA  
4: Retransmit 1 - 5V / 0 - 5V/0 - 10V  
6: Triac output 1A / 240VAC, SSR  
7: Isolated 20V/25mA transducer power supply  
8: Isolated 12V/40mA transducer power supply  
A: Isolated 5V/80mA transducer power supply  
C: Pulsed voltage to drive SSR, 14V/40mA  
9: Special order

**Output 3**

0: None  
1: Relay rated 2A/240VAC  
2: Pulsed voltage to drive SSR, 5V/30mA  
6: Triac output 1A / 240VAC, SSR  
7: Isolated 20V/25mA transducer power supply  
8: Isolated 12V/40mA transducer power supply  
A: Isolated 5V/80mA transducer power supply  
C: Pulsed voltage to drive SSR, 14V/40mA  
9: Special order



### **Accessories**

OM94-6 = Isolated 1A / 240VAC Triac Output Module ( SSR )  
OM94-7 = 14V / 40mA SSR Drive Module  
OM98-3 = Isolated 4 - 20 mA / 0 - 20 mA Analog Output Module  
OM98-5 = Isolated 0 -10V Analog Output Module  
CM94-1 = Isolated RS-485 Interface Module for P41 Output 5  
CM94-2 = Isolated RS-232 Interface Module for P41 Output 5  
CM94-3 = Isolated 4-20mA/0-20mA Retrans Module for P41 Output 5  
CM94-5 = Isolated 0-10V Retrans Module for P41 Output 5  
CM97-1 = Isolated RS-485 Interface Module for P91 Output 5  
CM97-2 = Isolated RS-232 Interface Module for P91 Output 5  
CM97-3 = Isolated 4-20mA/0-20mA Retrans Module for P91 Output 5  
CM97-5 = Isolated 0-10V Retrans Module for P91 Output 5  
DC94-1 = Isolated 20V/25mA DC Output Power Supply  
DC94-2 = Isolated 12V/40mA DC Output Power Supply  
DC94-3 = Isolated 5V/80mA DC Output Power Supply  
DC97-1 = Isolated 20V/25mA DC Output Power Supply for P91 Output 5  
DC97-2 = Isolated 12V/40mA DC Output Power Supply for P91 Output 5  
DC97-3 = Isolated 5V/80mA DC Output Power Supply for P91 Output 5  
CC94-1 = RS-232 Interface Cable ( 2M )  
CC91-1 = Programming Port Cable  
RK91-1 = Rail Mount kit for BTC-9100 / P91  
DC21-1 = Isolated 20V/25mA DC Output Power Supply for P41 Output 5  
DC21-2 = Isolated 12V/40mA DC Output Power Supply for P41 Output 5  
DC21-3 = Isolated 5V/80mA DC Output Power Supply for P41 Output 5

### **Related Products**

SNA10A = Smart network adaptor for Brainchild software  
    *DAQ Studio* or third party software,  
    which converts 255 channels of  
    RS-485 or RS-422 to RS-232 network.  
SNA12A = Smart network adaptor for programming port to RS-232  
    interface  
BC-Set = Configuration software  
*DAQ Studio* software = PC software for data logging  
PC-E = RS-232/485 to Ethernet converter  
PC-W = RS-232/422/485 x 2 + Ethernet x 1 converted to Ethernet wireless