Fuzzy + PID
Process / Temperature Controller

FEATURES

- High accuracy 18-bit input A-D
- High accuracy 15-bit output D-A
- Fast input sample rate (5 times / second)
- Basic & full function
- User menu configurable
- Pump control
- Fuzzy+PID microprocessor-based control
- Automatic programming
- Differential control
- Auto-tune function
- Self-tune function
- Sleep mode function
- "Soft-start" ramp and dwell timer
- Programmable inputs (thermocouple, RTD, mA, VDC)
- Analog input for remote set point and CT
- Event input for changing function & set point
- Programmable digital filter
- Hardware lockout + remote lockout protection
- Loop break alarm
- Heater break alarm
- Sensor break alarm + Bumpless transfer
- RS-485, RS-232 communication
- Analog retransmission
- Signal conditioner DC power supply
- A wide variety of output modules available
- Safety UL / CSA / IEC1010-1
- EMC / CE EN 61326

BTC-4300 BTC-8300 BTC-9300 BTC-2500

BrainChild

The Fuzzy Logic plus PID microprocessor-based controller series, incorporates a bright, easy to read 4-digit LED display, 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.

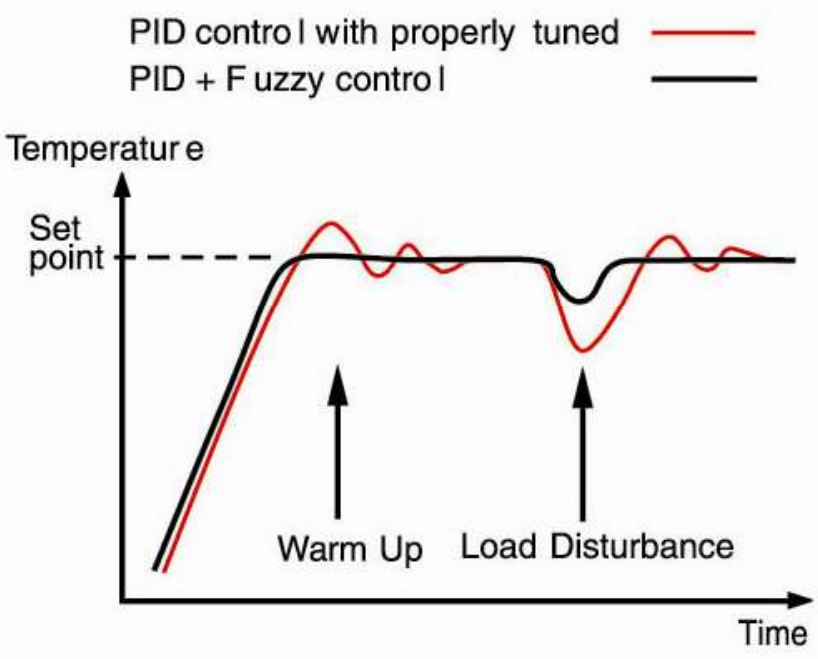
BTC-9300 is a 1/16 DIN size panel mount controller,
BTC-2500 is a 1/32 DIN size panel mount controller,
BTC-8300 is a 1/8 DIN size panel mount controller
and BTC-4300 is a 1/4 DIN size panel mount controller.

These units are powered by 11-26 VDC or 90-264 VAC supply, incorporating a 2 amp. control relay output as standard. Alternative output options include triac, 5V logic output, linear current and linear voltage. The units are fully programmable for PT100 and thermocouple types J, K, T, E, B, R, S, N, L 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.

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 loading the configuration data with no need to use the keypads on front panel.

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



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 allow sthis series to control fast processes.

Overview

Fuzzy Control
The function of Fuzzy control is to adjust PID parameters from time to time in order to making 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 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
The parameters can be locked to prevent from being changed by using either Hardware lockout or Remote lockout or both.

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.

Soft-start Ramp
The ramping function is performed during power up as well as any time the set point is changed. It can be ramping up or ramping down. The process value will reach the set point with a predetermined constant rate.

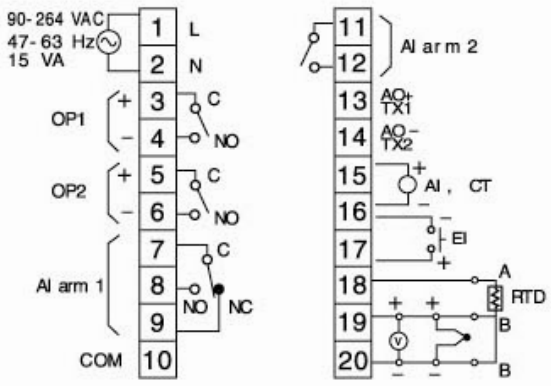
Digital Filter
A first order low pass filter with a programmable time constant is used to improve the stability of process value. This is particularly useful in certain application where the process value is too unstable to read.

SEL Function
The units have the flexibility for user to select those parameters which is most significant to him and put these parameters in the front of display sequence. There are at most 5 parameters can be selected to allow the user to build his own display sequence.

Pump Control
Only the superior noise rejection capability in addition to the fast sampling rate owned by this series of controllers can control the water pressure in a pump system which is driven by a variable speed motor.

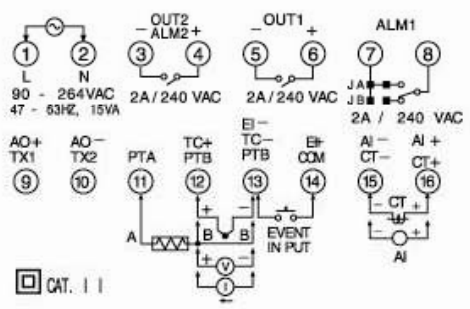
Connection Diagrams

BTC-4300, BTC-8300

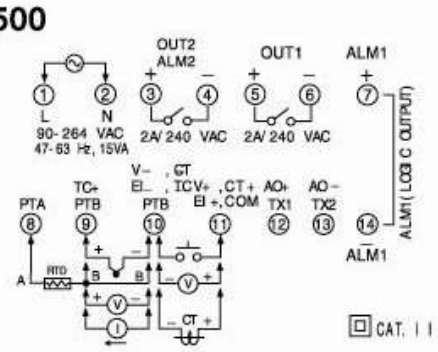


ALL RELAY CONTACTS:
RESI STIVE 2A / 240 VAC

BTC- 9300



BTC- 2500



Specifications

Power

90 - 264 VAC, 47 63 Hz, 15VA, 7W maximum
11 - 26 VAC / VDC, 15VA, 7W maximum

Input 1

Characteristics :

Type	Range	Accuracy @25°C	Input Impedance
J	-120°C -1000°C (-184°F -1832°F)	±2°C	2.2M
K	-200°C -1370°C (-328°F -2498°F)	±2°C	2.2M
T	-250°C -400°C (-418°F -752°F)	±2°C	2.2M
E	-100°C -900°C (-148°F -1652°F)	±2°C	2.2M
B	0°C -1820°C (32°F -3308°F)	±2°C (200°C - 1820°C)	2.2M
R	0°C -1767.8°C (32°F -3214°F)	±2°C	2.2M
S	0°C -1767.8°C (32°F -3214°F)	±2°C	2.2M
N	-250°C -1300°C (-418°F -2372°F)	±2°C	2.2M
L	-200°C -900°C (-328°F -1652°F)	±2°C	2.2M
PT100 (DIN)	-210°C -700°C (-346°F -1292°F)	±0.4°C	1.3K
PT100 (JIS)	-200°C -600°C (-328°F -1112°F)	±0.4°C	1.3K
mV	-8mV -70mV	±0.05%	2.2M
mA	-3mA -27mA	±0.05%	70.5
V	-1.3V -11.5V	±0.05%	302K

Resolution : 18 bits
Sampling Rate : 5 times / second
Maximum Rating : -2 VDC minimum, 12 VDC maximum
(1 minute for mA input)
Temperature Effect : ±1.5 uV/ ˚C for all inputs except mA
input ±3.0 uV/ ˚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 200nA
Common Mode Rejection Ratio (CMRR) : 120dB
Normal Mode Rejection Ratio (NMRR) : 55dB
Sensor Break Detection :
Sensor open for TC, RTD and mV inputs,
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.

Input 2

Resolution : 18 bits
Sampling Rate : 1.66 times / second
Maximum Rating : -2 VDC minimum, 12 VDC maximum
Emperature Effect : ±1.5uV/ ˚C for all inputs except mA
input ±3.0uV/ ˚C for mA input
Common Mode Rejection Ratio (CMRR): 120dB
Normal Mode Rejection Ratio (NMRR) : 55dB
Sensor Break Detection : Below 1 mA for 4-20 mA input,
below 0.25V for 1 - 5V input,
unavailable for other inputs.
Sensor Break Responding Time : 0.5 second
Characteristics :

Type	Range	Accuracy @25°C	Input Impedance
CT94-1	0-50.0 A	±2% of Reading ±0.2 A	302 K
mA	-3mA-27mA	±0.05%	$70.5 + \frac{0.8V}{\text{input current}}$
V	-1.3V-11.5V	±0.05%	302 K

Input 3 (Event Input)

Logic Low : -10V minimum, 0.8V maximum.
Logic High : 2V minimum, 10V maximum
External pull-down Resistance : 400 K maximum
External pull-up Resistance : 1.5 M minimum
Functions :
Select second set point and/or PID , reset alarm 1 and/or alarm 2 , disable output 1 and/or output 2 , remote lockout.

Output 1 / Output 2

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

Type	Zero Tolerance	Span Tolerance	Load Capacity
4-20 mA	3.6-4 mA	20-21 mA	500 max.
0-20 mA	0 mA	20-21 mA	500 max.
0-5 V	0 V	5-5.25 V	10K min.
1-5 V	0.9-1 V	5-5.25 V	10K min.
0-10 V	0 V	10-10.5 V	10K min.

Linear Output
Resolution : 15 bits
Output Regulation : 0.01 % for full load change
Output Settling Time : 0.1 sec. (stable to 99.9 %)
Isolation Breakdown Voltage : 1000 VAC
Temperature Effect : ±0.0025 % 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	±0.1 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 1/ Alarm 2 (Output 2)

Alarm 1 Relay :
Form A or Form B for BTC-9300, Form C for BTC4300, BTC-8300, 5V Logic output for BTC-2500 Max. Rating 2A/240VAC, life cycles 200,000 for resistive load. life cycles 200,000 for resistive load.
Alarm 2 Relay :
Form A,Max. rating 2A/240VAC, life cycles 200,000 for resistive load.
Alarm Functions :
Dwell timer,
Deviation Band High / Low Alarm,
PV2 High / Low Alarm,
PV1-PV2 High /Low Alarm,
Sensor Break Alarm.
Deviation High / Low Alarm,
PV1 High / Low Alarm,
PV1 or PV2 High /Low Alarm,
Loop Break Alarm,
Alarm Mode : Normal, Latching, Hold, Latching / Hold.
Dwell Timer : 0 - 6553.5 minutes

Data Communication

Interface : RS-232 (1 unit), RS-485 (up to 247 units)
Protocol : Modbus Protocol RTU mode
Address : 1 - 247
Baud Rate : 0.3 ~ 38.4 Kbits/sec
Data Bits : 7 or 8 bits
Parity Bit : None, Even or Odd
Stop Bit : 1 or 2 bits
Communication Buffer : 50 bytes

Analog Retransmission

Functions : PV1, PV2, PV1-PV2, PV2-PV1, Set Point, MV1, MV2, PV-SV deviation value
Output Signal : 4-20 mA, 0-20 mA, 0-1V, 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/ LC
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 :

BTC-4300	Upper	0.55" (14mm)
	Lower	0.4" (10 mm)
BTC-8300, BTC-9300	Upper	0.4" (10 mm)
	Lower	0.31" (8 mm)
BTC-2500		0.4"(10mm)

Keypad : 3 keys
Programming Port : For automatic setup, calibration and testing
Communication Port : Connection to PC for supervisory control

Control Mode

Output 1 : Reverse (heating) or direct (cooling)action
Output 2 : PID cooling control, cooling P band 1 ~ 255% of PB
ON-OFF : 0.1 - 55.6 (˚C) hysteresis control (P band = 0)
P or PD : 0 - 100.0 % offset adjustment
PID : Fuzzy logic modified , Proportional band 0 ~ 500.0 ˚C , Integral time 0 - 1000 seconds , Derivative time 0 - 360.0 seconds
Cycle Time : 0.1 - 100.0 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 ~ 500.0 ˚C/minute or 0 ~ 500.0 ˚C/hour ramp rate
Sleep Mode : Enable or Disable
Ramping Control : 0 ~ 500.0 ˚C/minute or 0 ~ 500.0 ˚C/hour ramp rate
Power Limit : 0 - 100 % output 1 and output 2
Pump / Pressure Control : Sophisticated functions provided
Remote Set Point : Programmable range for voltage or current input
Differential Control : Control PV1 - PV2 at set point
Digital Filter
Function : First order
Time Constant : 0, 0.2, 0.5, 1, 2, 5, 10, 20, 30, 60 seconds programmable

Environmental & Physical

Operating Temperature : -10˚C to 50˚C
Storage Temperature : -40˚C to 60˚C
Humidity : 0 to 90 % RH (non-condensing)
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^2 for 2 hours
Shock Resistance : 200 m/s^2 (20 g)
Moldings : Flame retardant polycarbonate
Dimensions :
BTC-4300 ---96mm(W) X 96mm(H) X 66 mm(D), 53 mm depth behind panel
BTC-8300 ---48mm(W) X 96mm(H) X 80mm(D), 65 mm depth behind panel
BTC-9300 ---50.7mm(W) X 50.7mm(H) X 88.5mm(D), 75mm depth behind panel
BTC-2500 ---50mm(W) X 26.5mm(H) X 110.5 mm(D), 98.0 mm depth behind panel
Mounting:
BTC-4300 ---panel mount, cutout 92 X 92 (mm)
BTC-8300 ---panel mount, cutout 45 X 92 (mm)
BTC-9300 ---panel mount, cutout 45 X 45 (mm)
BTC-2500 ---panel mount, cutout 45 X 22.2 (mm)
Weight :
BTC-4300 --- 255 grams
BTC-8300 --- 220 grams
BTC-9300 --- 150 grams
BTC-2500 --- 120 grams

Approval Standards

Safety : UL 61010C-1 , CSA C22.2 No. 24-93 , EN61010-1 (IEC1010-1)
Protective Class :
BTC-8300, BTC-4300:
IP 20 housing and terminals with protective covers.
BTC-2500, BTC-9300:
NEMA 4X(IP65) front panel , IP 20 housing and terminals
EMC : EN61326

Ordering Code

BTC-2500- □ □ □ □ □ □

Power Input
4: 90 - 264 VAC, 50 / 60 HZ
5: 11 - 26 VAC or VDC
9: Special Order

Signal Input
1: Standard Input
Input 1-Universal Input
Thermocouple: J, K, T, E, B, R, S, N, L
RTD: PT100 DIN, PT100 JIS
Current: 4 - 20mA, 0 - 20mA
Voltage: 0 - 1V, 0 - 5V, 1 - 5V, 0-10V
Input 2-CT: 0 - 50 Amp. AC Current Transformer
Analog Input: 0 - 1V, 0 - 5V, 1 - 5V, 0 - 10V
Event Input (EI)
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
5: Isolated 0 - 10V
6: Triac output 1A / 240VAC,SSR
C: Pulsed voltage to drive SSR, 14V / 40mA
9: Special order

Output 2 / Alarm 2
0: None
1: Form A relay 2A / 240VAC
2: Pulsed voltage to drive SSR, 5V / 30mA
3: Isolated 4 - 20mA / 0 - 20mA
4: Isolated 1 - 5V / 0 - 5V
5: Isolated 0 - 10V
6: Triac output, 1A / 240VAC, SSR
7: Isolated 20V / 25 mA DC Output Power Supply
8: Isolated 12V / 40 mA DC Output Power Supply
9: Isolated 5V / 80 mA DC Output Power Supply
C: Pulsed voltage to drive SSR, 14V / 40mA
A: Special order

Alarm 1
1: 5V Logic Output
9: Special order

Communications
0: None
1: RS-485 interface
2: RS-232 interface
3: Retransmit 4 - 20 mA / 0 - 20 mA
4: Retransmit 1 - 5V / 0 - 5V
5: Retransmit 0 - 10V
9: Special order

BTC-9300- □ □ □ □ □ □

Power Input
4: 90 - 264 VAC, 50 / 60 HZ
5: 11 - 26 VAC or VDC
9: Special Order

Signal Input
1: Standard Input
Input 1-Universal Input
Thermocouple: J, K, T, E, B, R, S, N, L
RTD: PT100 DIN, PT100 JIS
Current: 4 - 20 mA, 0 - 20 mA
Voltage: 0 - 1V, 0 - 5V, 1 - 5V, 0 - 10V
Input 2-CT: 0 - 50 Amp. AC Current Transformer
Analog Input: 4-20mA, 0-20mA, 0 - 1V, 0 - 5V, 1 - 5V, 0 - 10V
Input 3-Event Input (EI)
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
5: Isolated 0 - 10V
6: Triac output 1A / 240VAC,SSR
C: Pulsed voltage to drive SSR, 14V / 40mA
9: Special order

Output 2 / Alarm 2
0: None
1: Form A relay 2A / 240VAC
2: Pulsed voltage to drive SSR, 5V / 30mA
3: Isolated 4-20mA / 0-20mA
4: Isolated 1-5V / 0-5V
5: Isolated 0-10V
6: Triac output, 1A / 240VAC, SSR
7: Isolated 20V-25mA DC Output Power Supply
8: Isolated 12V-40mA DC Output Power Supply
9: Isolated 5V-80mA DC Output Power Supply
C: Pulsed voltage to drive SSR, 14V / 40mA
A: Special order

Alarm 1
0: None
1: Form A relay 2A / 240VAC
2: Form B relay 2A / 240VAC
9: Special order

Communications
0: None
1: RS-485 interface
2: RS-232 interface
3: Retransmit 4-20 mA / 0-20mA
4: Retransmit 1-5V / 0-5V
5: Retransmit 0-10V
9: Special order

BTC-8300 -
BTC-4300 - □ □ □ □ □ □ □

Power Input
4: 90-264 VAC, 50 / 60 HZ
5: 11-26 VAC or VDC
9: Special Order

Signal Input
1: Standard Input
Input 1-Universal Input
Thermocouple: J, K, T, E, B, R, S, N, L
RTD: PT100 DIN, PT100 JIS
Current: 4 - 20mA, 0 - 20mA
Voltage: 0 - 1V, 0 - 5V, 1 - 5V, 0 -1 0V
Input 2 - CT: 0 - 50 Amp. AC Current Transformer
Analog Input: 4 - 20mA, 0 - 20mA 0 - 1V, 0 - 5V, 1 - 5V, 0 - 10V
Input 3-Event Input (EI)
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
5: Isolated 0 -10V
6: Triac output 1A / 240VAC,SSR
C: Pulsed Voltage to drive SSR, 14V / 40mA
9: Special order

Output 2
0: None
1: Form A relay 2A / 240VAC
2: Pulsed voltage to drive SSR, 5V / 30mA
3: Isolated 4 - 20mA / 0-20mA
4: Isolated 1 - 5V / 0-5V
5: Isolated 0 - 10V
6: Triac output, 1A / 240VAC, SSR
7: Isolated 20V / 25mA DC Output Power Supply
8: Isolated 12V / 40mA DC Output Power Supply
9: Isolated 5V / 80mA DC Output Power Supply
C: Pulsed Voltage to drive SSR, 14V / 40mA
A: Special order

Alarm 1
0: None
1: Form C relay 2A / 240VAC
9: Special order

Alarm 2
0: None
1: Form A relay 2A / 240VAC
9: Special order

Communications
0: None
1: RS - 485 interface
2: RS - 232 interface
3: Retransmit 4 - 20mA / 0 - 20mA
4: Retransmit 1-5V / 0 - 5V
5: Retransmit 0 - 10V
9: Special order

Accessories

CT94-1 = 0-50 Amp. AC Current Transformer
OM95-3 = Isolated 4-20mA / 0-20mA Analog Output Module
OM95-4 = Isolated 1 - 5V / 0-5V Analog Output Module
OM95-5 = Isolated 0 - 10V Analog Output Module
OM94-6 = Isolated 1A / 240VAC Triac Output Module (SSR)
OM94-7 = 14V / 40mA SSR Drive Module
DC94-1 = Isolated 20V / 25 mA DC Output Power Supply
DC94-2 = Isolated 12V / 40 mA DC Output Power Supply
DC94-3 = Isolated 5V / 80 mA DC Output Power Supply
CM94-1 = Isolated RS - 485 Interface Module
CM94-2 = Isolated RS - 232 Interface Module
CM94-3 = Isolated 4 - 20 mA / 0-20 mA Retransmission Module
CM94-4 = Isolated 1 - 5V / 0 - 5V Retransmission Module
CM94-5 = Isolated 0 - 10V Retransmission Module
CC94-1 = RS-232 Interface Cable (2M)
CC91-3 = Programming Port Cable

Related Products

SNA10A = Smart Network Adaptor for Third Party Software, 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

BrainChild Electronic Co., Ltd.
No. 209, Chung Yang Rd., Nan Kang Dist.,
Taipei, 115 Taiwan
Tel: 886-2-27861299 Fax: 886-2-27861395
E-mail : sales@brainchild.com.tw
website : http://www.brainchild.com.tw

2007.08