NC24T

RS-485 Modbus RTU Networking Universal Controllers with Digital Display

Features

- Supports standalone operation on RS-485 communication failure
- Large easy-to-read liquid crystal display (LCD), with LED backlight (white)
- A stylish bi-directional rotating dial and two compact touch keys to provide ease of operation
- Choice of single on-off or 0-10 VDC output, on-off plus 0-10 VDC outputs or dual 0-10 VDC outputs
- Configurable operating parameters and selectable functions via setup menu
- Choice of engineering units and display scale
- Universal input for various applications
- PI or P control algorithm
- Digital input for day/night changeover
- Digital input for economy mode activation
- Retains last entered settings on power resumption

Selectable Functions

- Choice of 12 application specfic control modules
- Configurable primary input to suit passive TE10 NTC temperature sensor or active 0-10 VDC
- Choice of ºC, ºF, % or no specified unit
- Choice of display range and setpoint range
- Secondary 0-10 VDC input for remote setpoint override or higher signal selection
- Adjustable proportional band and integral time
- Adjustable valve stroke time
- Adjustable 3-wire floating output limit
- Adjustable ECO mode setpoint value
- Adjustable setpoint differential (SD) value
- Adjustable control bandwidth (CB)
- Offset adjustment of measured value reading
- Choice of constant display of primary analog input value or setpoint value

General

The NC24T Modbus RTU networking universal controllers use the communication technologies of Modbus RTU protocol to monitor and supervise proportional controllers and employ a simple master/slave protocol.

The NC24T microprocessor-based universal controllers with digital display are designed for comfort control in heating, ventilating, air-conditioning and refrigeration installations. They can be mounted on a control panel or wall in plant rooms.

The NC24T is a universal controller which performs both primary and auxiliary control functions. Applications include measurement and control of temperature, relative humidity, absolute humidity, enthalpy, pressure differential, volumetric airflow and indoor air quality. The input scale can be set from –99 to 999 units. The start and end points of output can be any position from 0 to 100%.

The microprocessor combines a proportional plus integral (PI) algorithm with advanced adaptive control logic. The proportional component of the algorithm adjusts the control output in response to changes in the measured environment. The integral component of the algorithm adjusts the control output to eliminate offset (difference between the setpoint and the actual sensing element). This provides precise and stable control under various system capacity and varying load conditions without the need for tuning or calibrating the control algorithm in the field. The digital display of input value, setpoint value and operating mode provides the user with an attractive and functional controller that is easy to use.
A bi-directional rotating dial allows change of settings such as temperature setpoint values.

If NC24T controllers are required to be interfaced to a BACnet system, BMG-NC24T BACnet MS/TP gateways are also available. The BMG-NC24T gateways are native BACnet MS/TP devices and communicate using the BACnet MS/TP protocol. In this protocol, all NC24T controllers are slaves and under the control of the BMG-NC24T which is called the master.

If more than 32 BMG-NC24T gateways are needed in the system, an additional BACnet MS/TP network supervising device is required for the second BACnet MS/TP network.

Net 2 port of the BMG master and all slaves are daisy-chained through a RS -485 Modbus RTU network. The maximum number of NC24T slaves in a Modbus RTU network is 32.

The BMG-NC24T has 2 addresses. Net 2 address is always 0 which is the address of the Modbus RTU network. Net 1 address is the MAC address of the BACnet MS/TP network which is also set up for a maximum of 32 devices in a trunk with cable length not exceeding 1,000 m.

Ordering

To order, specify complete model number. If BMG-NC24T gateways are also required, order separately.

Specifications

Product model number	NC24T
Power requirements	24 V ±15%, 50/60 Hz
Power consumption	1 VA @ 24 VAC
Display range	-99 to 999 in 1 increments: accuracy ±1
Setpoint range	-99 to 999 in 1 increments: accuracy ±1
Constant display on LCD	Choice of constant display of primary analog input or setpoint value
Offset adjustment of indication	-50 to 99, factory setting 0
Display engineering unit	ºC, ºF, % or no specified unit
Proportional band	Adjustable 1 to 20 for ºC, ºF or % engineering unit setting, factory setting 5; Adjustable 1 to 99 for no specified engineering unit setting
Integral time	Adjustable 0 to 30 minutes in 1 minute increments, factory setting 15 minutes. Setting = 0 means integral time being turned off.
Valve stroke time	Adjustable from 10 to 240 seconds in step of 10 seconds; factory setting 120 seconds
Universal input X1	Passive TE10 NTC temperature sensor (-50 to 110ºC) or 0-10 VDC active input
Analog input X2	0-10 VDC active input
3-wire floating outputs Y1 and Y2	20 VA @24 VAC
Digital output Q1	20 VA @ 24 VAC
Input sampling time	2 s
Setpoint differential for on-off control mode (SD)	1-20 for ºC, ºF or % engineering unit setting, factory setting 1); 1-99 for no specified unit
Control bandwidth between setpoints	-99 to 99
High-end and low-end setpoint values	See parameters setup menu
Day/night action control changeover	Via external contact
RS-485 communication speed	Baud rate fixed at 19,200 bps
Device MAC addressing	01-32 via parameter setup menu, factory set address “01”
Modbus RTU network guideline	Maximum 32 devices and maximum 1,000 m cable length
Enclosure	Material: Self-extinguishing, molded ABS Finish: Off white housing and dark grey faceplate
Protective class	IP30
Ambient/Storage temperature limits	0 to 50ºC / -30 to 50ºC, 10% to 90% RH non-condensing
Electrical ratings	On-off output: 24 V, 0.3 A resistive, 0.3 A inductive, 50/60 Hz
Connectors	Non-removable screw-type terminal blocks
Power and voltage signal wires	Wire size 1 mm^2 or 18 AWG solid copper recommended
RS-485 communication wires	22 0r 24 AWG twisted shielded pair double-insulated cable
Temperature sensor wires	22 AWG twisted shielded pair double-insulated cable
Accessories and options	See Figure 1: Accessories and Options
Agency approval	CE Mark compliant to EMC Directive pending
Dimensions	See Figure 3: Dimensions in mm
Shipping weight	0.12 kg (0.3 lb)

The performance specifications above are nominal and subject to tolerances and application variables of generally acceptable industry standards. The manufacturer shall not be liable for damages resulting from misapplication or misuse of its products.

Figure 1: Accessories

Description	Part No.
Probe-type Temperature Sensor	TE10-1
Duct-mount Temperature Sensor	TE10-2
Wall-mount Temperature Sensor	TE10-3

Figure 2: Display Control Unit and LCD Layout

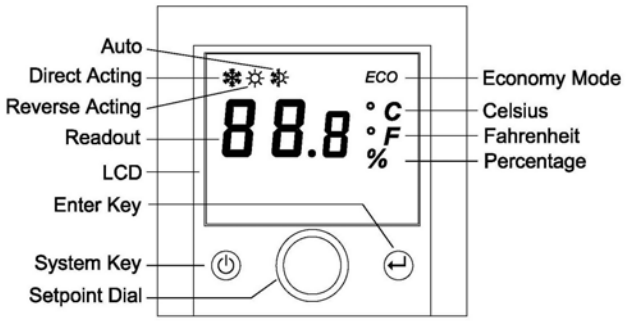


Figure 3: Dimensions in mm

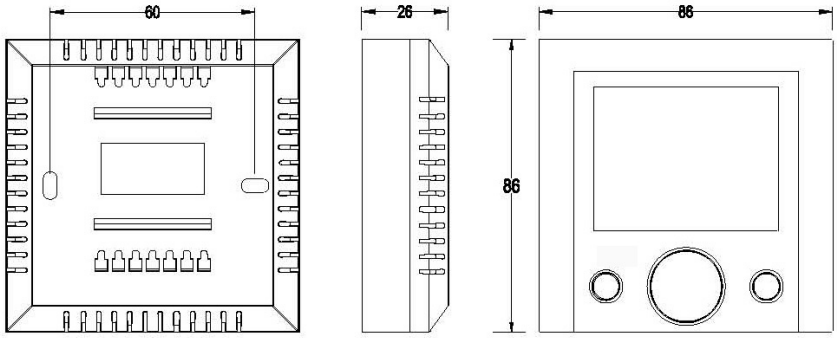
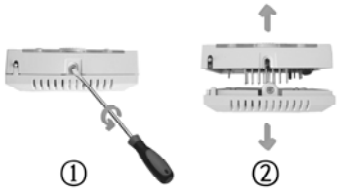
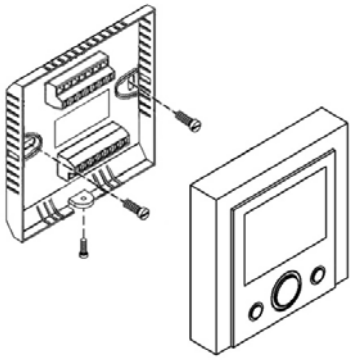


Figure 4: Cover Removal Procedure



1. Loosen the fixed screw.
2. Slightly twist the screw driver to crack open the cover from the base.
3. Hold the base firmly with one hand and remove the cover with another hand by pulling away from the base forcibly.

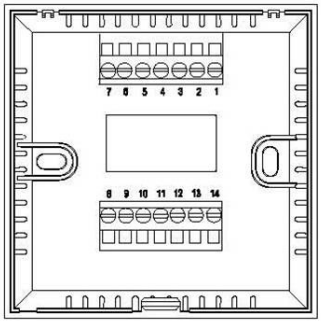
Figure 5: Mounting Details

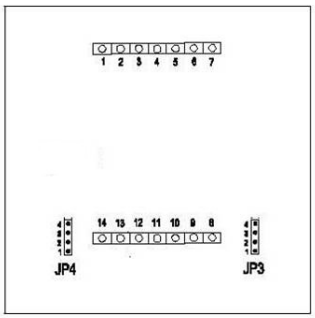


Mounting

The universal controller can be surface mounted or secured to a standard European 75 x 75 x 35 mm electrical box or on a control panel. See Figure 4: Mounting Details. Two mounting screws are included.

Figure 6: Wiring Terminals and Jumper Settings



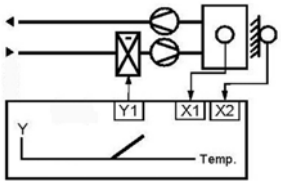


Jumper Settings	
Jumper	Jumper Position
JP3	Type of X1 input: insertion of 3 & 4 for 0-10 VDC active input (factory setting); 1 & 2 for TE10 Series NTC sensor input
JP4	Always at positions 3 and 4 for X2 with 0-10 VDC active input

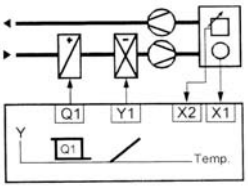
Inputs and Outputs

Input/Output Point	Terminal No.	Description
Universal input X1	11	The universal input X1 is used as the primary input with a passive TE10 Series temperature sensor or a 0-10 VDC active signal. Refer to jumper Settings table and setup menu for setting details.
Analog input X2	12	The analog input X2 is used as the secondary input with a 0-10 VDC active signal that allows remote setpoint override, higher input signal priority or . higher output priority. Refer to setup menu for configuring details.
Digital input DI1	8	The digital input DI1 is used to activate the ECO (economy or energy saving) mode.
Digital input DI2	9	The digital input DI2 is used to activate day/night changeover.
Digital output Q1	3	24 VAC 2-position output for either reverse acting (RA) or direct acting (DA)
Digital output Q2	6	24 VAC 2-position output for either reverse acting (RA) or direct acting (DA)
3-wire floating output Y1	3 and 4	3-wire floating output for either reverse acting (RA) or direct acting (DA)
3-wire floating output Y2	6 and 7	3-wire floating output for reverse acting (RA)

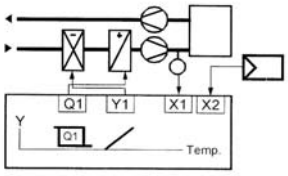
Typical Applications of X1, X2, DI1 and DI2



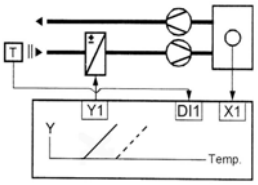
Higher Input Priority
X2 is acting as the input signal to calculate the output value of Y1 when its value is greater than the value of X1 and its value will be displayed on the LCD.



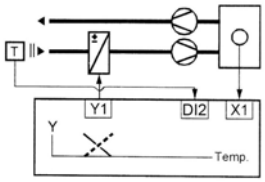
Remote Setpoint Override
A 0-10VDC signal input to X2 is acting as remote setpoint for Y1/Q1 outputs and its value will be displayed on the LCD.



Higher Output Priority
X2 is acting as the output value of Y1 when its value is greater than the calculated output value of the cooling sequence. X2 must be the output from another controller.



ECO mode
The local setpoint will be overridden by ECO mode setpoint when DI1 contact is closed.



Day/night Changeover
The action of Y1 output is reversed when DI2 contact is closed.

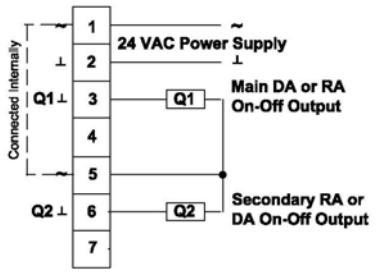
Notes: For details on how to configure X1, X2 and ECO mode functions, refer to the setup menu shown on Page 7. Illustration of application specific control is provided on Page 6.

Wiring Notes

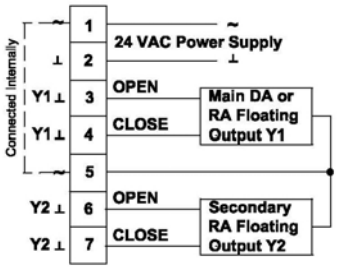
- The controller is designed for 24 VAC power supply.
- Move jumper JP2 to open position if 2-10 VDC proportional output is required.
- Conventional cables can be used for the controller but shielded cables are recommended if and when installed in an intense EMI environment.
- 22 or 24 AWG twisted shielded pair double-insulated cable must be used as RS-485 communication wiring and its length must not exceed 1,000 m without a repeater
- 22 or 24 AWG twisted shielded pair double-insulated cable is recommended as temperature sensor wiring and its length must not exceed 25 m.
- Do not bundle and run power wiring and sensor wiring in the same conduit.
- Run the external sensor wires away from any electric motors or power wiring. Failure to do so may result in poor controller performance due to electrical noise.
- When several isolated double-wound step-down transformers are used in a control loop, observe the polarities of the AC power supply of all devices including the universal controller.

Figure 7: Wiring Diagram

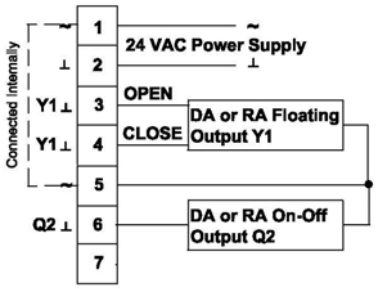
For Application No. 1, 2, 3, 4 and 5



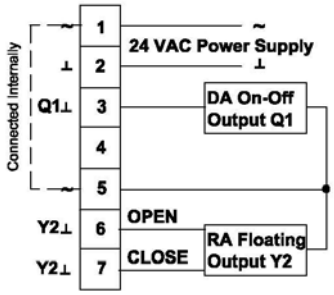
For Application No. 6, 7 and 8



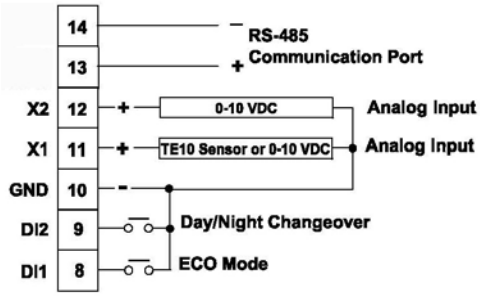
For Application No. 9, 11 and 12



For Application No. 10



For All Applications



Operation Notes

Operation

- LCD shows ambient temperature constantly except when set point adjustment is being made.
- Press the system key **Φ** to enter into the desired operating mode.
- Increase or decrease temperature set point by rotating the adjustment dial clockwise or counter-clockwise. When the dial is rotated, the LCD shows the existing setpoint setting.

ECO Mode

- When the ECO contact closes, it will override the operating mode and operate the controller in energy saving mode despite the controller being in operating or standby mode.
- In ECO mode, the factory-set cut-in points will be activated and all operating keys are locked out until the ECO contact opens.

Day/Night Mode

- When the DI2 contact closes, it will reverse the Y1 output action of the controller and maintain the desired ambient temperature at night.

Parameter Setup Mode

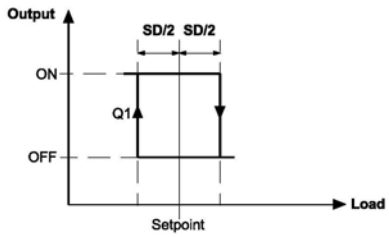
- The controller allows authorized service agent to change a number of operating parameters in the field. Refer to the parameter setup menu for details.

Error Reporting

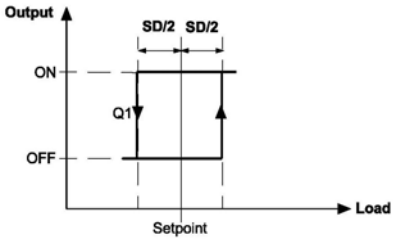
- All controller outputs will be shut down when error is reported.

Graphic Representation of Application Specific Control

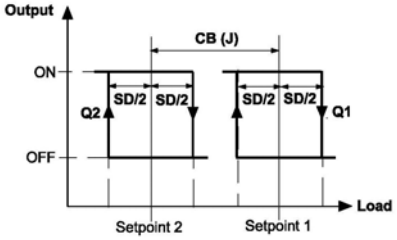
Application No. 1:
Single RA On-Off Output



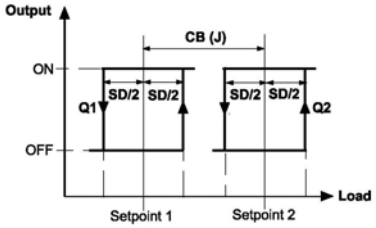
Application No. 2:
Single DA On-Off Output



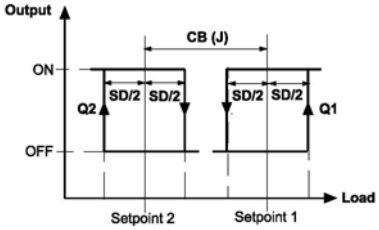
Application No. 3:
Dual RA On-Off Outputs



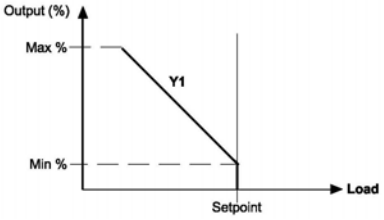
Application No. 4:
Dual DA On-Off Outputs



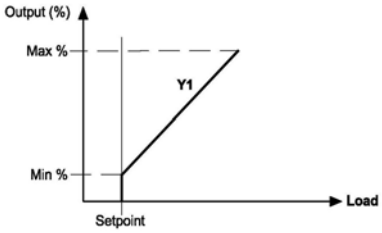
Application No. 5:
DA On-Off + RA On-Off Outputs



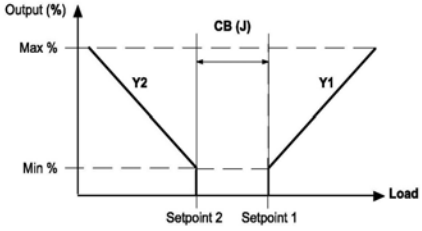
Application No. 6:
Single RA 3-Wire Floating Output



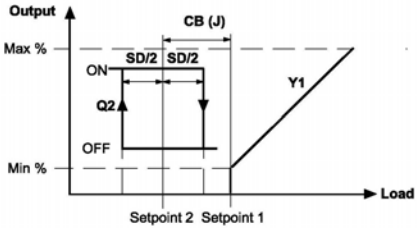
Application No. 7:
Single DA 3-Wire Floating Output



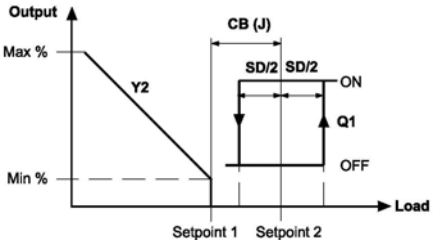
Application No. 8:
RA + DA 3-Wire Floating Outputs



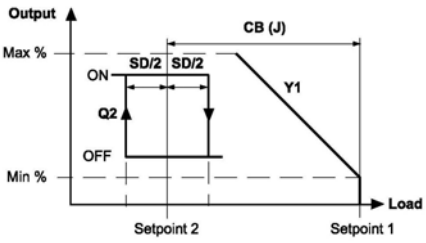
Application No. 9:
DA 3-Wire Floating + RA On-Off Outputs



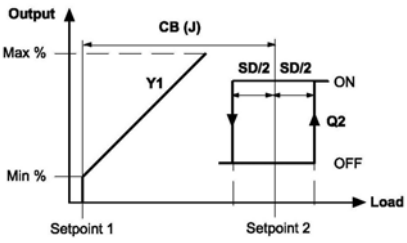
Application No. 10:
RA 3-Wire Floating
+ DA On-Off Outputs



Application No. 11:
RA 3-Wire Floating
+ RA On-Off Outputs



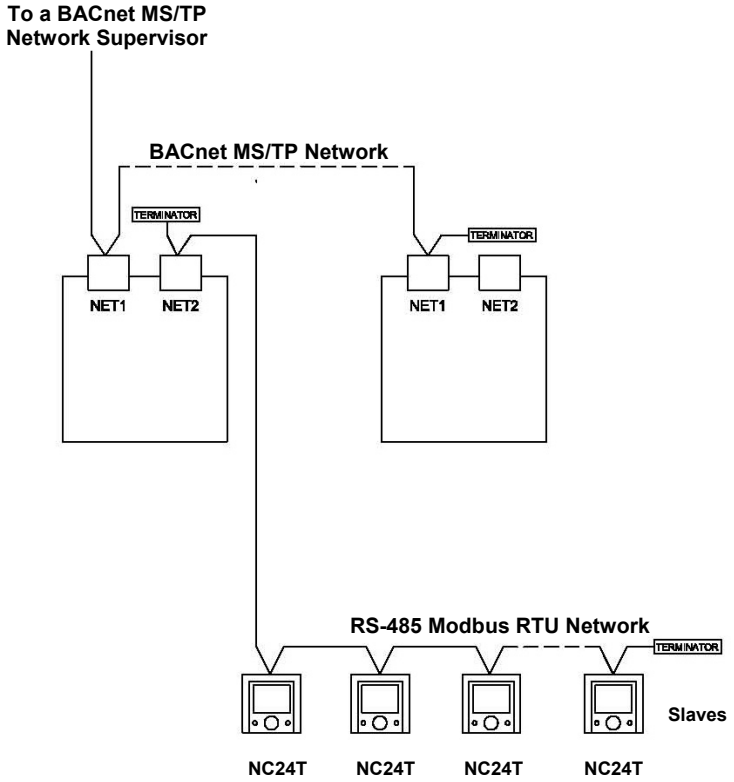
Application No. 12:
DA 3-Wire Floating
+ DA On-Off Outputs



Parameter Setup Menu

Symbol	Function	Description
0	MCU firmware revision level	Firmware revision 0x.x appears after entering the setup menu
1	Choice of application specific control	101 = application 01 - single RA on-off output 102 = application 02 - single DA on-off output 103 = application 03 - Dual RA on-off outputs 104 = application 04 - Dual DA on-off outputs 105 = application 05 - DA on-off and RA on-off outputs 106 = application 06 - Single RA 3-wire floating output 107 = application 07 - Single DA 3-wire floating output (factory setting) 108 = application 08 - RA 3-wire floating and DA 3-wire floating outputs 109 = application 09 - DA 3-wire floating and RA on-off outputs 110 = application 10 - RA 3-wire floating and DA on-off outputs 111 = application 11 - RA 3-wire floating and RA on-off outputs 112 = application 12 - DA 3-wire floating and DA on-off outputs
2	Configuration of universal input X1	201 = active 0-10 VDC (factory setting) when JP3 is shorted between 3 & 4 202 = passive TE10 Series NTC sensor when JP3 is shorted between 1 & 2
3	Choice of engineering unit	3-C = ºC 3-F = ºF 3-P = % (factory setting) 3-0 = no specified unit
4	Low-end value of universal input readout (X1)	From: -50 (when 202 and 3-C are set), default setting = -50 or -99 (when 201 and 3-C, 201 and 3-F, or 201 and 3-0 are set), default setting = 0 or -58 (when 202 and 3-F are set), default setting = 58 or 0 (when 201 and 3-P are set) (factory setting) To: current high-end value of X1 minus 4 units
5	High-end value of universal input readout (X1)	From: current low-end value of X1 plus 4 To: 110 (when 202 and 3-C are set), default setting = 110 or 999 (when 201 and 3-C, 201 and 3-F, or 201 and 3-0 are set), default setting = 50 or 230 (when 202 and 3-F are set), default setting = 230 or 100 (when 201 and 3-P are set) (factory setting)
6	Configuration of analog input X2	600 = no action (factory setting) 601 = remote setpoint override (local setpoint value overriden by X2 value) 602 = higher input priority (X1 is overriden by X2 only when X2 value is higher) 603 = higher output priority (0-10 VDC calculated output value of Y1 is overridden by X2 value when X2 value is higher)
7	Proportional band	When 3-C, 3-F or 3-P is selected, 701 = 1 …….705 = 5 (factory setting)……..720 = 20; When 3-0 is selected, 701 = 1 … ...799 = 99
8	Integral time	800 = 0 min …….815 = 15 min. (factory setting)…….830 = 30 min.; setting = 0 means integral time being turned off.
9	Choice of valve stroke time for 3-wire floating models	901 = 10 seconds...912 = 120 seconds (factory setting)...924 = 240 seconds
A	Low-end value of X1 setpoint range	From low-end value of universal input readout of X1 to high-end value of setpoint range minus 4 units,
b	High-end value of X1 setpoint range	From low-end value of setpoint range plus 4 units to high-end value of universal input readout of X1
c	Minimum limit of Y1 and Y2 outputs (Min %)	From c00 (factory setting) to value of maximum limit minus 1 (Example: c01 = 10%)
d	Maximum limit of Y1 and Y2 outputs (Max %)	From value of minimum limit plus 1 to d10 (factory setting) (Example: d10 = 100%)
E	ECO mode setpoint value of RA output(s)	From low-end value of setpoint range to ECO mode DA setpoint value minus 4
F	ECO mode setpoint value 0f DA output(s)	From ECO mode RA setpoint value plus 4 to high-end value of setpoint range
G	Setpoint differential (SD)	G01 = 1 (factory setting)……..G20 = 20 when 3-C, 3-F or 3-P is selected; or G01 = 1 … ...G99 = 99 when 3-0 is selected
h	Display offset for readout value of X1 input	-50 to 99, factory setting = 0
J	Control bandwidth between setpoint 1 and setpoint 2 (available and functional only for Applications No. 5, 6, 7, 8 and 9)	-99 to 99, factory setting = 2
r	Controller MAC address setting	To set the slave device address from r01 to r32 (factory setting = 01)
u	Choice of constant display of X1 input or set-point value	u-1 = constant display of X1 input value (factory setting) u-2 = constant display of setpoint value
rS	Restoration of default factory settings	rS1 = Retain current settings (factory setting) rS2 = Restore default factory settings

Figure 8: Network Configuration



BACnet MS/TP Network Notes:

1. Ensure the recommended balanced cable is used.
2. Ensure the cable is installed as a daisy chain from one device to the next (1,000 m maximum) and the shield is grounded at one single point of the network only.
3. Ensure a MS/TP terminator is installed on each end of each MS/TP network.
4. The maximum nodes per MS/TP network is 32 without a repeater.

Modbus RTU Network Notes:

1. Ensure the recommended balanced cable is used.
2. Ensure the cable is installed as a daisy chain from one device to the next (1,000 m maximum) and the shield is grounded at one single point of the network only.
3. Ensure a terminator is installed on each end of each Modbus RTU network.
4. The maximum nodes per Modbus RTU network is 32

Network & Cabling Requirements

To ensure network stability and reliable communications, particularly at high speeds on a BACnet MS/TP network for a number of devices, it is imperative that the following network and cabling requirements are adhered to:

Item	Description
Cabling	It is recommended to use networking cabling that matches the following specifications: • Balanced 100 to 120 ohms nominal impedance, 22 or 24 AWG Twisted Shielded Pair (TSP) Cable • Nominal capacitance of 52 pF/m or lower • Nominal velocity of propagation of 66% or higher • Terminating the shield to ground at one end only for each isolated segment will prevent ground loops in the shield and drain RF energy to ground. Grounding at the BACnet router or controller is preferred.
Topology	Ensure the MS/TP network cable is installed as a daisy chain from one device to the next.
Maximum Nodes	The maximum number of devices is 32 per MS/TP network segment and 64 per network trunk with one repeater.
Terminator	A terminator of 120-ohm impedance must be installed at each end of each MS/TP network segment, or two per MS/TP network. Ensure that this requirement is not overlooked in laying out the network architecture and ordering product.
Cable Shielding	Use a shielded, twisted pair cable for communications. Never directly ground wire in more than one point on the shield. Doing so can induce large currents and result in communication problem.
Repeater	A repeater is not necessary unless more than 32 nodes will be installed on a network or the MS/TP network is extended beyond 1,000 m.
Step-down Transformer	A separate isolated double-wound transformer is recommended for supplying 24 VAC power to each BMG. If and when the same transformer is shared with other devices, observe the polarities of the power supply of all devices including the BMG.

Mega Controls Limited
Room 2505, Trend Centre;
29 Cheung Lee Street, Chai Wan, Hong Kong
Phone: +852 2896 7277 Fax: +852 3741 7084 E-mail: sales@megacontrols.com Website: www.megacontrols.com