



PYTHIA TECHNOLOGIES
data transformation solutions

MSO-BR

BACnet MSTP to BACnet IP Router



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Change History

Date	Version	Change
March, 2013	1	New Document

1. Introduction

The MS0-BR is a multi-network router, sharing messages among BACnet/IP, BACnet Ethernet and MSTP networks. The router is configurable via its internal webpage.

The MS0-BR comes in a metal case, is DIN-rail mounted and is powered from a 24 V AC/DC source. It has one isolated MS/TP port and one 10/100 Mbps Ethernet Auto-MDIX port.

The MSTP port offers a 3-pin terminal block with a removable plug for the EIA-485 connection. Through this port, up to 254 devices can be addressed-as many as 31 full-load devices on the attached segment. All MSTP baud rates (as stated in the BACnet standard) are supported.

The Ethernet port offers a shielded RJ-45 connector. Through auto-negotiation and Auto-MDIX, it automatically matches its duplex setting, data rate and communication pair usage to whatever is needed by the attached equipment. Thus, only a straight-through CAT5 cable is needed for hook-up.

The MS0-BR features a user-accessible switch to reset the IP address, subnet mask, gateway address and User ID/Password to the factory defaults.

Three LEDs are present: A power LED glows green when proper power is provided. The Ethernet LED glows green for 100 Mbps operation and yellow for 10 Mbps and flashes to indicate activity. A green LED flashes when MSTP traffic is received.

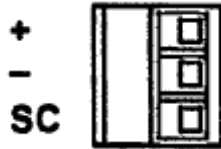
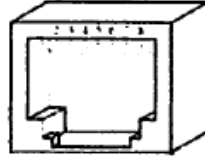


Each unit complies with Class A radiated and conducted emissions as defined by EN55022 and CFR 47, Part 15, and is intended for use in non-residential areas.

A BACnet Broadcast Management Device (BBMD) within the router can be enabled to allow BACnet communication across routed IP networks (ones with multiple IP subnets). If all IP devices use the same subnet, this functionality can be left disabled. The router also supports Foreign Device Registration.

2. Specifications

Electrical:		
Input Voltage	24 VAC	24VDC
Input Power	2W	4VA
Input Frequency	NA	47 – 63Hz
Environmental:		
Operating Temperature	0C – 60C	
Storage Temperature	-40C – +85C	
Relative Humidity	10-95%, non-condensing	
Mounting:		
	T35 DIN-rail	
Functional:		
Physical Layer:	Ethernet	MSTP
	10/100 Base-T(x)	EIA-485
Cable Length	100m	1200m (for 18AWG)
MSTP Baud	9600,19200,38400,76800	
MSTP Node Limit	254 devices total, 31 full-load devices per segment	
MSTP LED	flashing green = receive valid activity	
Ethernet LED	green = 100 Mbps yellow = 10 Mbps flashing = activity	
Compliance:		
	CE Mark; RoHS; CFR47, Part 15 Class A	

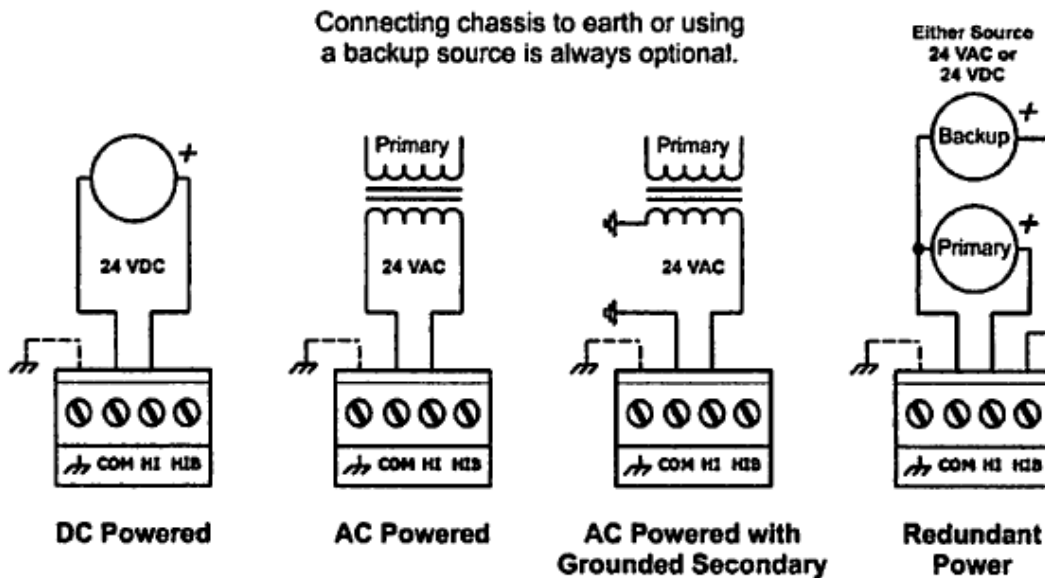
3. Connectors

<p>3-pin (MSTP) Pin Assignments (Also explained on product label)</p>	
<p>RJ-45 (MDI Ethernet) Pin Assignments</p> <p>1 TD+ 3 RD+ 2 TD- 6 RD- (All other pins are unused.)</p>	
<p>USB Mini B Connector (Aux) This connector is only used for firmware upgrades.</p>	
<p>EIA-485 Bias and Termination Jumpers</p> <p>U Install jumper to apply pull-up bias. T Install jumper to terminate bus. D Install jumper to apply pull-down bias. (All jumpers are installed by default.)</p>	

4. Power

The MS0-BR requires 24 VAC or 24 VDC while drawing no more than 4 VA of power. The recommended conductor size is 16-18 AWG. COM is directly connected to zero volts and the chassis is DC isolated from zero volts. Input connections are reverse-polarity protected.

WARNING: Powering devices can present hazards. Read the following text carefully.



Power Options

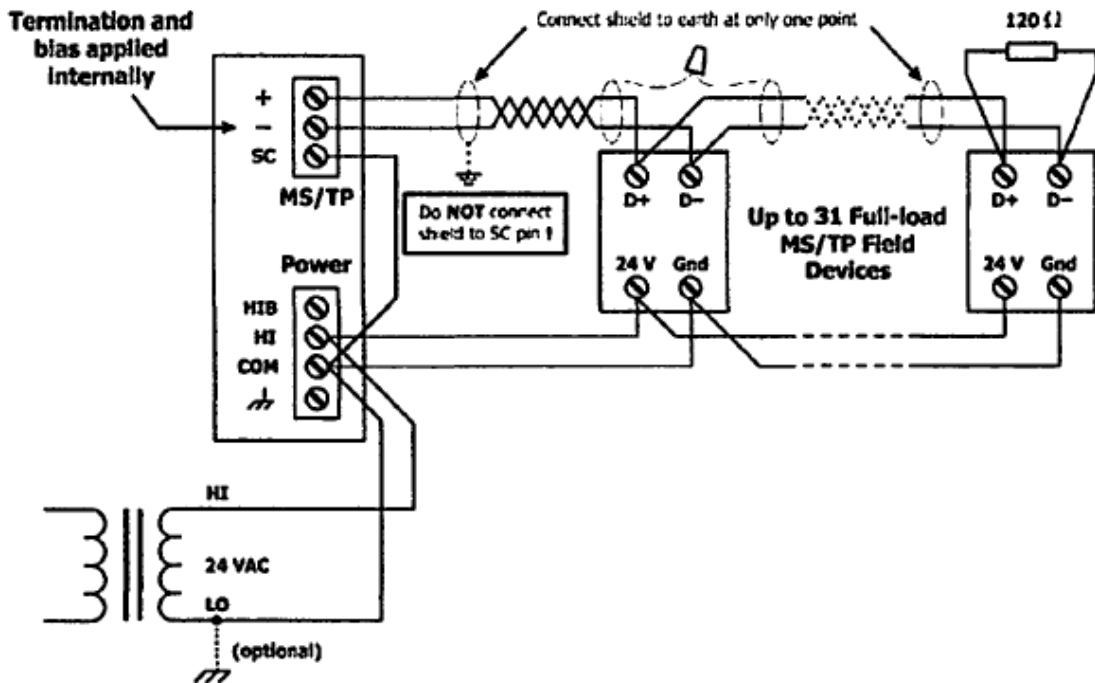
4.1 POWER SUPPLY PRECAUTIONS

Internally, the router utilizes a half-wave rectifier and therefore can share the same AC power source with other half-wave rectified devices. Sharing a common DC power source is also possible. Sharing AC power with full-wave rectified devices is NOT recommended. Full-wave rectified devices usually require a dedicated AC power source that has a secondary elevated above ground. Both secondary connections are considered HOT.

AC power sources that power several half-wave devices have a common secondary connection called either COMMON, LO, or GROUND. This connection might be tied to frame ground or earth. The other side of the secondary is considered the HOT or HI side of the connection.

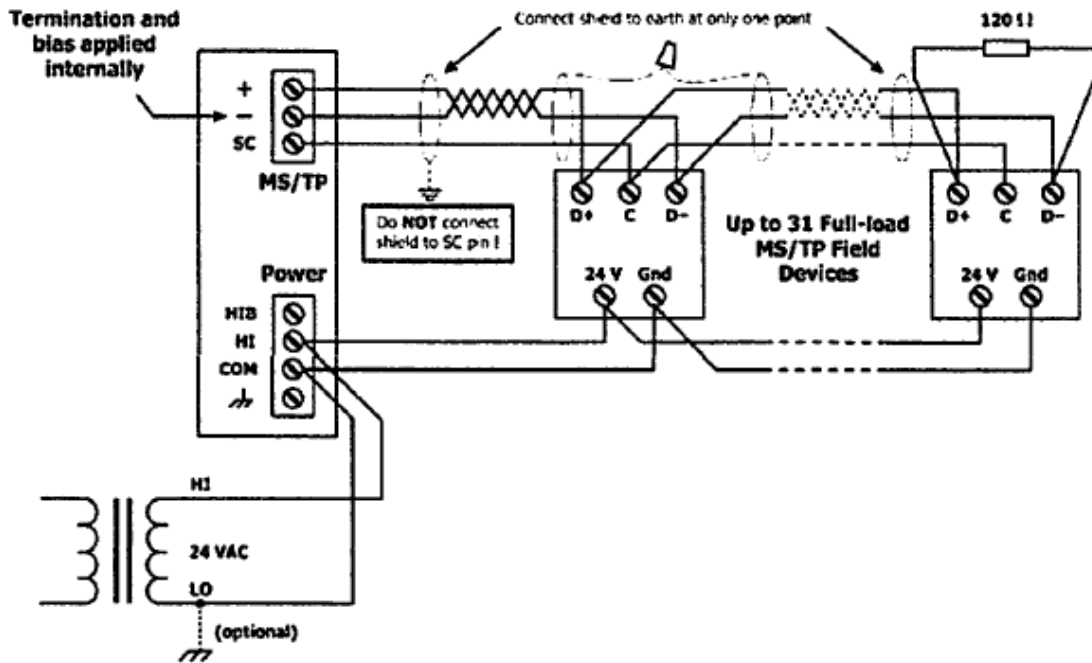
Connect the HOT side of the secondary to either the m or the HIB input on the router and the LO side to COM on the router. All other half-wave devices sharing the same AC power source need to follow the same convention. When using a DC power source, connect the positive terminal of the source to either the m or the HIB input and the negative terminal to COM on the router. Reversing polarity to the router will not damage the router. If shielded cable is used, it is recommended to tie all shield segments together and connect one of the shield ends to chassis while taping back the other.

For MSTP devices that share a power source with the MS0-BR, see illustration for proper 2-wire bus connections and the following illustration for proper 3-wire bus connections.



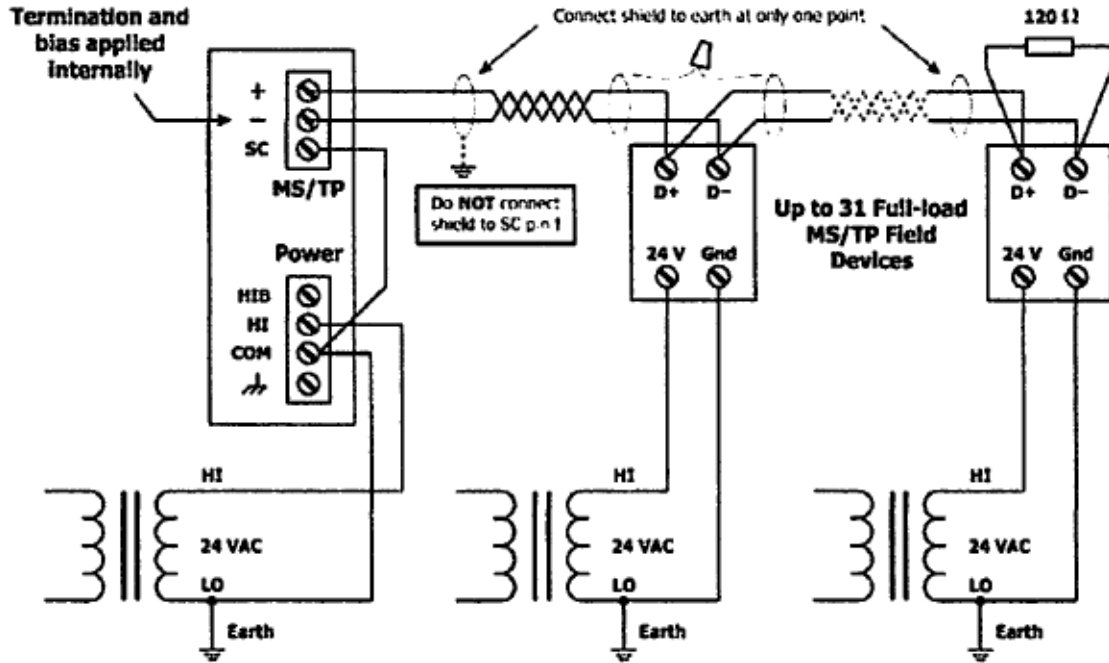
2-Wire MSTP Bus with Shared Power Source

WARNING: Devices powered from a common AC source could be damaged if a mix of half-wave and full-wave rectified devices exist. If you are not sure of the type of rectifier used by another device, do not share the AC source with it.

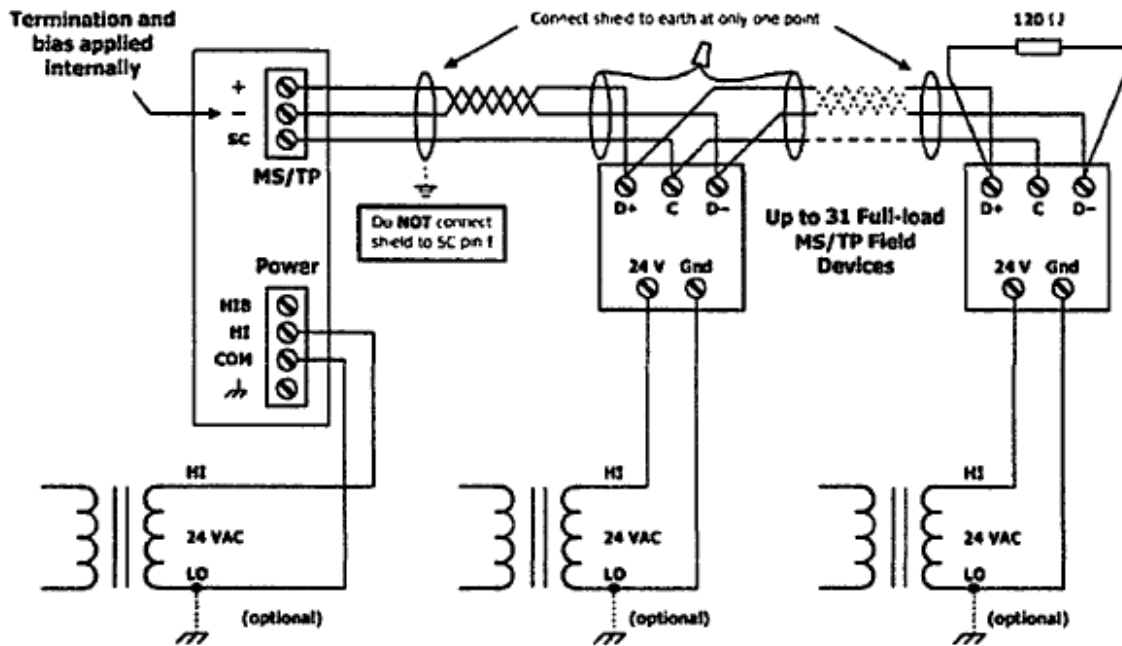


3-Wire MSTP Bus with Shared Power Source

For MSTP devices that use a power source separate from the MS0-BR, illustrations below for proper 2-wire bus and 3-wire bus connections.



2-Wire MSTP Bus with Separate Power Source



3-Wire MSTP Bus with Separate Power Source

4.2 Limited Power Sources

The router should be powered by a limited power source complying with the requirements of the National Electric Code (NEC) article 725 or other international codes meeting the same intent of limiting the amount of power of the source. Under NEC article 725, a Class 2 circuit is that portion of the wiring system between the load side of a Class 2 power source and the connected equipment. For AC or DC voltages up to 30 volts, the power rating of a Class 2 power source is limited to 100 VA. The transformer or power supply complying with the Class 2 rating must carry a corresponding listing from a regulatory agency such as Underwriters Laboratories (UL).

5. LED's

Power glows green if power supplied to the unit is proper

Ethernet glows solid for a valid link (green for 100 Mbps or yellow for 10 Mbps) and flashes to show activity

MS/TP flashes green when receiving valid MSITP traffic

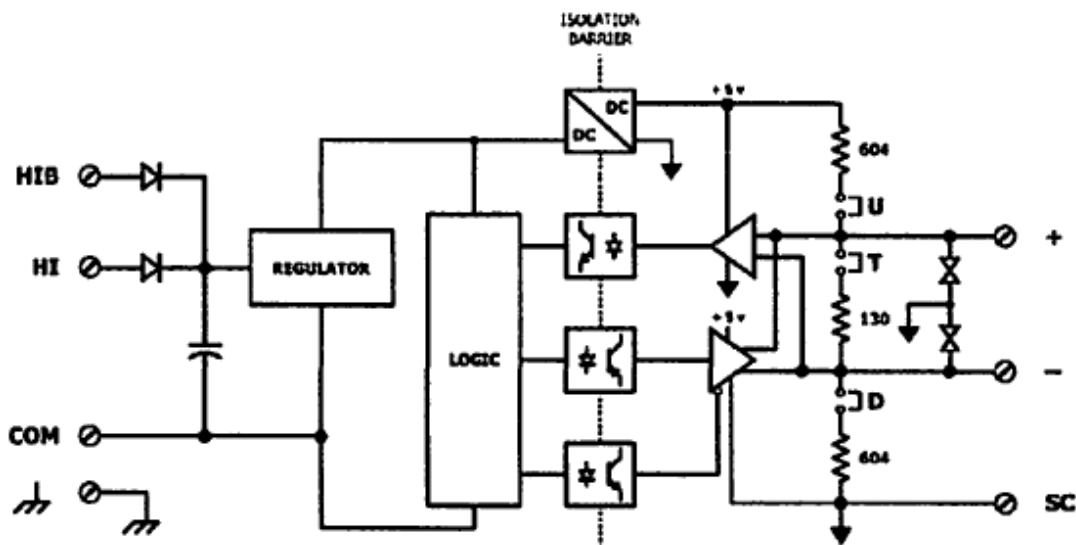
6. Operation

6.1 MSTP Port

The MSTP port uses an isolated EIA-485 transceiver connected to a 3-pin removable connector. The transceiver + and - lines tie to + and - pins of the connector. The SC pin ties to the transceiver ground. You MUST connect the SC pin to the MSTP segment signal common- or MSTP communication will fail!

In the illustration below a simplified schematic of the isolated EIA-485 transceiver is shown. Notice that the transceiver common (SC) is electrically isolated from the router power supply common (COM) through the use of opto-isolators and an isolated DC-DC converter. An isolated EIA-485 transceiver offers less chance of damage to the transceiver from high common-mode voltages, but there is still a risk. Surge suppression is applied between the two differential inputs and between each input and ground. Since the transceiver is electrically isolated, the transceiver circuit common must be brought out for connection to the other devices on the MS/TP network. This is accomplished by pin SC. The differential pair is labeled + and - and corresponds to the same designations in the BACnet MSTP standard. This requires a three-wire connection to the MSTP network. Connecting other isolated MSTP devices is no problem since each device requires a 3-wire connection. Just make corresponding connections. For non-isolated MSTP devices, usually only a 2-wire connection is provided. The third wire is the power supply common. In this situation, the SC connection MUST be made to the power supply common of the non-isolated device. Refer to the device vendor instructions for connecting such a device.

In a router application where one connection is made to Ethernet and the other to MSTP, the location of the router is probably at the end of the MSITP bus segment and therefore both bias and termination must be applied to the segment end. The router is shipped with bias and termination applied, but this can be changed by removing three jumpers. This should be done if the router is to be connected anywhere between the end MSTP devices.



Isolated EIA-485 Transceiver Circuitry

The router can address 254 MSTP devices and supports 31 full-load devices on the local bus at rates of 9600, 19200, 38400, or 76800 bps.

6.1.1 EIA-485 Bias and Termination Jumpers

After removing the MS0-BR cover, three jumpers are accessible on a 6-pin jumper block located near the MSTP connector. These impart 604 ohms of pull-up and pull-down bias at jumpers U and D, and 130 ohms of termination impedance for the T jumper. With all three jumpers installed, the effective termination resistance is 120 ohms - consistent with the BACnet standard. If the MS0-BR is not installed at the end of a segment, remove all the jumpers and install 120 ohm resistor at the far end of the bus.

6.1.2 Ethernet Port

This port offers a shielded RJ-45 connector. Through auto-negotiation and Auto-MDIX, it automatically matches its duplex setting, data rate and communication pair usage to whatever is needed by the attached equipment. Thus, any CAT5 cable (cross-over or straight- through) may be used to connect to the Ethernet.

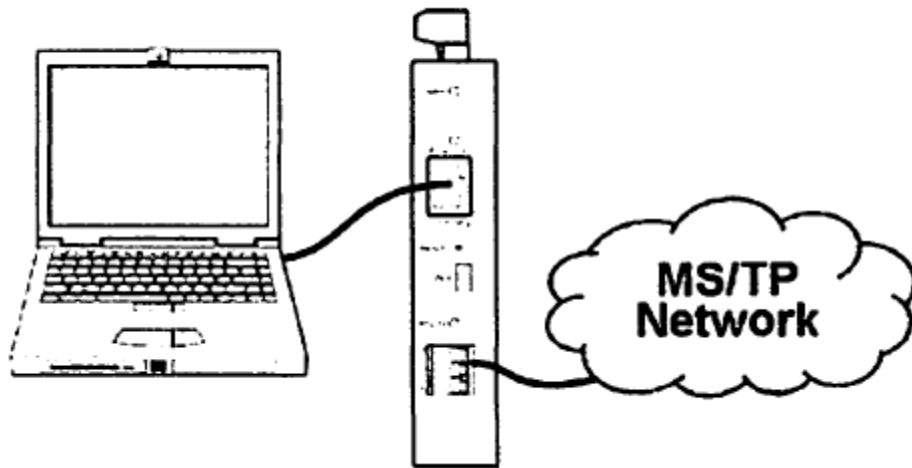
6.1.3 Reset Switch

To reset the router to its default values (except for configuration settings), use a paperclip or similar tool to press the Reset IP button for at least 3 seconds while the router is powered. Then release the reset button and remove power from the router for 3 seconds. Restore power and the unit will now use default IP values and User ID/Password.

7. Web Page Configuration

Each router contains an interactive web server, accessible from any Internet-compatible PC on the local network and compatible with recent versions of Internet Explorer (5.0 or later, suggested) or Netscape Navigator (7.1 or later, required). It is factory-programmed with a default IP address of 192.168.92.68 and a Class C subnet mask of 255.255.255.0 (/24).

The Illustration below shows the setup for accessing the MSTP network using MSO-BR, a computer for configuration, and a connection to the MSTP network.

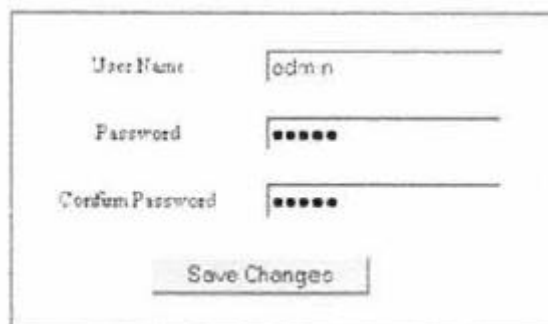


7.1 Setup for Initial IP Address Configuration

To configure the router, attach it to a computer with an Ethernet connection and a standard web browser. For initial configuration, the PC chosen for the procedure should temporarily have a static IP address assigned.

Set your connected PC to an IP address of 192.168.92.69, but the final quad of the address could be any value from 3 to 254 -except for 68 which is used by the router. After the IP address of the PC has been set to the same subnet as the router, a browser can access the router via its default IP address.

After entering the routers IP address into your browser's address field, you will see the Logon Screen below. **The default value of both the User Name and Password is admin.**



The screenshot shows a web form with three input fields and a button. The first field is labeled "User Name" and contains the text "admin". The second field is labeled "Password" and contains six asterisks. The third field is labeled "Confirm Password" and also contains six asterisks. Below the fields is a button labeled "Save Changes".

7.2 Router Logon Screen

After successfully logging on, the Router Configuration Page initially appears with the default values as shown in below.



MS0-BR Configuration



Device Name	MS0-BR	
Device Instance	1	
Device Location	location	
Ethernet Network	0	
BACnet/IP UDP Port 1	BAC0	
BACnet/IP Network 1	6171	
IP Address	192.168.92.68	Advanced
IP Subnet	24	
IP Gateway	192.168.92.254	
MS/TP MAC	1	Status
MS/TP Network	6172	
Max Masters	127	
Max Info Frames	100	
MS/TP Baudrate	38400	Security
MS/TP Tolerance	<input type="radio"/> Strict <input checked="" type="radio"/> Lenient	
<input type="button" value="Save Changes"/>		
MAC Address 00-50-DB-00-A3-F7		
Firmware Revision 2.7.0		

7.3 Router Configuration with Default Values

Each configuration parameter is explained on the following pages. When Save Changes is selected, the parameters are stored to non-volatile memory, the unit will automatically reboot (in a few seconds) and the changes will take effect.

7.3.1 Device Parameters

7.3.1.1 Device Name (Default Value= BASRT-Bxxxxxx)

The BASrouter's Device Object Name can be configured in this field. It is required to be unique throughout the BACnet network. It can be up to 20 characters and defaults to a unique name of the form BASRT-BXXXXIT-where the Xs are replaced with the final six characters of the router's Ethernet MAC address.

7.3.2 Device Instance (Default Value= 0)

The router's device instance is a 22-bit value {0-4,194,302}. Do not use 4,194,303 which is reserved by BACnet. Each BACnet device within the same BACnet internetwork must have a unique device instance. One must be assigned to the MS0-BR.

7.3.3 BACnet Ethernet (0 disables BACnet Ethernet)

7.3.4 Ethernet Network (Default Value= 0)

Most BACnet communication that is carried by Ethernet uses the BACnet/IP protocol. However, there are still instances in which the older BACnet Ethernet protocol (ISO 8802-3) is found. The MS0-BR allows these two protocols to communicate.

BACnet Ethernet uses Ethernet MAC addresses for station addressing - unlike BACnet/IP which addresses messages by means of Internet Protocol (IP) addresses. Each Ethernet MAC address (often called the physical address) is unique to the Ethernet network adapter. It is permanently embedded into the adapter during manufacture and cannot be changed. It is composed of six two-digit hexadecimal numbers (00-FF).

An example of an Ethernet MAC address is: 00-08-A1-10-BD-EB

Each Ethernet network adapter has the ability to store an IP address that is changeable. This IP address is typically represented as four decimal values (each is 0-255) separated by dots. Often called the dotted quad format, an example is: 192.168.92.1

NOTE: *Although they may share the same Ethernet physical network, BACnet Ethernet devices as well as BACnet/IP devices must have their own unique network number and these two networks cannot communicate unless their messages pass through a router. These network numbers must be in the range of 1-65534 (0 and 65535 are reserved). If the BACnet Ethernet network value is left at its default value of 0, the BACnet Ethernet function within the MS0-BR will be disabled. Also, to prevent erratic traffic due to message loops, an IP subnet must have only one router enabled for BACnet Ethernet!*

7.4 BACnet/IP Parameters

7.4.1 BACnet/IP UDP Port (Default Value= 0xBACO)

This 16-bit hex value (BACO-BACF) is set to BACO by default. Usually, this default value should not be changed. In typical networks, each BACnet/IP device will have the same UDP port

7.4.2 BACnet/IP Network (Default Value= 1)

Like all networks in the BACnet internetwork, the BACnet/IP network must have a unique number (1-65534). Do not use addresses 0 or 65535 since these addresses are reserved.

7.4.3 IP Address (Default Value= 192.168.92.68)

The IP address of the router can be 0.0.0.1-255.255.255.254. A private address is usually assigned to the MS0-MP

7.4.4 IP Subnet (Default Value= 24)

This value (0-30 in the "slash" notation) is the number of bits with a "1" in the mask. The default value of 24 corresponds to 255.255.255.0 in the dotted decimal format. All devices on the same subnet which communicate via BACnet/IP should use the same subnet mask.

7.4.5 IP Gateway (Default Value= 192.168.92.1)

The default gateway for the IP stack is a dotted decimal number in the range of 0.0.0.0-255.255.255.254. This will be the IP address of your local IP router -if one exists.

7.5 MSTP Parameters

7.5.1 MSTP MAC (Default Value= 00)

This is the unique 8-bit (0-127) MAC address of the router's MS/TP port, in decimal. Lower MAC address numbers are preferred with the default recommended. It is further recommended that all other BACnet devices attached to the same MS/TP network be assigned consecutive MAC addresses beginning with 1 without allowing any gaps in addressing. Slave devices may have MAC addresses of 128-254, but MAC address 255 is reserved.

7.5.2 MSTP Network (Default Value= 2001)

This 16-bit decimal network number (1-65534) must be unique for all BACnet networks within the BACnet internetwork. No other networks, regardless of type, can have the same network number. Do not use addresses 0 or 65535 since these are reserved.

7.5.3 Max Masters (Default Value= 127)

Only master nodes participate in the MSTP token-passing process. The highest master MAC address (in decimal) in the MS/TP network is 127 and you should use 127 if you are unsure of other MS/TP device addresses. Each MS/TP device should use this same value. For a value in this field to be proper, it must equal or exceed the highest MAC address for any master on the network.

Optimum performance occurs when this value:

1. Equals the highest MAC address of any master, and
2. All masters use sequential MAC addresses starting with 1

Since many BACnet devices do not allow this parameter to be changed, leave the MSO-BR at the default value.

7.5.4 Max Info Frames (Default Value= 100)

This is the maximum number of messages that can be routed onto the MSITP network by the router per token pass. Its range is 1-100, and typical values are 20-40. Smaller values provide less access to the MSITP network from the BACnet/IP network because they give native MS/J'P messages higher priority than those passed by the router from BACnet/IP. The default value usually provides good performance.

7.5.5 MSTP Baud Rate (Default Value= 38400)

The baud rate of the MSTP network can be 9600, 19200, 38400 or 76800 bps. All MSTP devices on the same MSTP network must use the same baud rate. On power up, as the router polls for other masters, auto-bauding devices adjust to its baud rate.

7.5.6 MSTP Tolerance (Default Selection = Strict)

This setting determines the degree to which interoperability with devices is successful. The Lenient option is less efficient for traffic flow but optimizes interoperability. A slight improvement in performance will be realized by selecting the Strict setting.

8. Advanced Features

The right side of the Router Configuration Page has the following three buttons that access advanced features:

- Advanced
- Status
- Security

8.1 Advanced Configuration Page

The BACnet discovery process uses broadcast messages, but broadcasts are blocked by an IP router. To deal with subnets, a BACnet/IP Broadcast Management Device (BBMD) must be used.

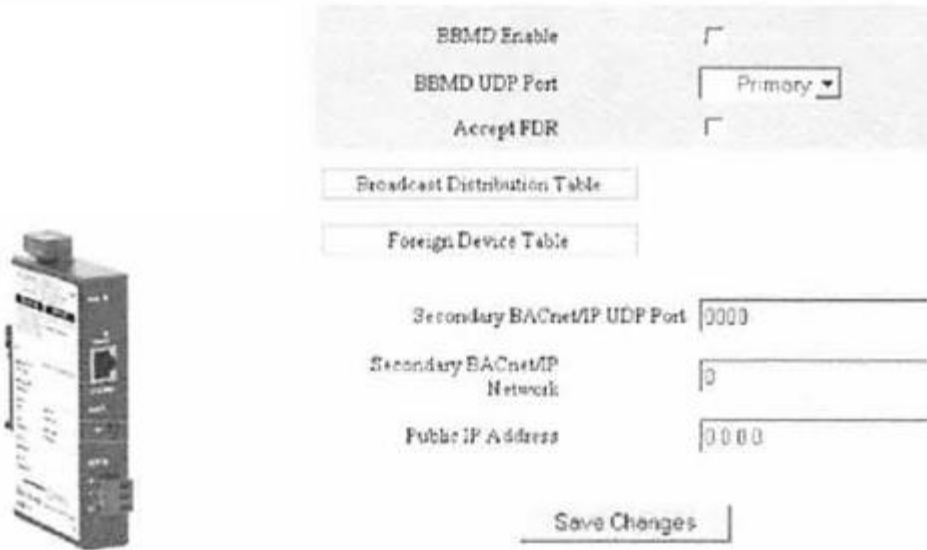
You may deploy the MS0-BR in a situation in which BACnet communication is confined to just one IP subnet. In such a case, advanced configuration is unneeded. But if you are dealing with more than one IP subnet, you will need the BBMD functionality offered in the advanced configuration screen.

To implement BBMD in your router, select the BBMD Enable checkbox in the upper section of the screen. (NOTE: If this box is not checked, you will get a blank screen when you attempt to view Figure 17 or Figure 18.) Unless your router must deal with multiple IP networks, in the BBMD UDP Port drop-down menu accept the "Primary" default setting.

Warning: *If you enable BBMD when it is not needed, the router will attempt to find devices that are not present and thus traffic flow will be impaired and communication will suffer.*

If the router is used to route between two BACnet/IP networks, the Secondary BACnet/IP UDP Port and Secondary BACnet/IP Network numbers must be entered.

When the router is used in a NAT environment and its local IP address is non-routable (for example, 192.168.x.y) and it is communicating with BACnet devices on the other side of the NAT firewall, the Public IP Address is used in the Forwarded- NPDU IP Address field. The NAT router must be configured such that communications to the NAT router on the Secondary BACnet/IP network port are port forwarded to the BAS Router. The Public IP address of the BAS Router will be the public IP address of the NAT router.



The Advanced Configuration Screen

If you click the Broadcast Distribution Table (BDT) button, the screen below appears (if the BBMD Enable box is checked). Enter the IP addresses of all BBMD devices to which the BAS Router will communicate. Do not include the BAS Router's own IP address. Normally you will set the Broadcast Distribution Mask (BDM) to 255.255.255.255. If the BAS Router will communicate through an IP router which can forward broadcasts, then set the BDM to the subnet mask assigned to the destination subnet.

Broadcast Distribution Table	
<input type="button" value="Save Changes"/>	
BBMD IP Address	Broadcast Distribution Mask
0.0.0.0	255.255.255.255
0.0.0.0	255.255.255.255
0.0.0.0	255.255.255.255
0.0.0.0	255.255.255.255
0.0.0.0	255.255.255.255

The Broadcast Distribution Table

If you click the button labeled *Foreign Device Registration (FDR)*, the screen shown in Figure 18 appears (unless you have not checked the BBMD Enable box). This screen will report all devices that have registered with the MS0-BR as Foreign Devices and how long they will remain registered unless a re-registration occurs.

Foreign Device Registrations			
IP Address	Port	TTL	Remaining Time

Foreign Device Registration

8.2 Status Screen

The Status Screen depicted reports the traffic of the various protocols handled by the MS0-BR including the number of messages transmitted and received for each network.

Packet counts only increment for protocols in use. "BIP 1" is the primary BACnet/IP port and "BIP 2" is the secondary port.

After the packet counts, the illustration displays the instantaneous state of some router MSITP values. These are documented in the MSTP portion of the BACnet standard - with the following parameters being noteworthy:

"RFSM" is the current Receive Frame State Machine state.

"MNSM" is the current Master Node State Machine state.

BIP 1 Incoming Packets=73824
BIP 1 Outgoing Packets=29566
BIP 2 Incoming Packets=0
BIP 2 Outgoing Packets=0
BACnet/Ethernet Incoming Packets=0
BACnet/Ethernet Outgoing Packets=0
MSTP Incoming Packets=29554
MSTP Outgoing Packets=36906
SilenceTimer=0
EventCount=54
Flag = Not Set
RFSM state=00 Idle
MNSM state=01 Idle
Next Station=1
Poll Station=0
Available Memory=29504
TX PFM count=67
RX PFM count=1
TX Token Count=381721
RX Token Count=318993
Invalid long Frames=0
Clear Silence Time=0

"Next Station" is the MSTP MAC address of the device to which the router will next pass the token. This value may change if devices leave or enter the network - and when the router searches for devices on the network, as per the BACnet MSITP standard.

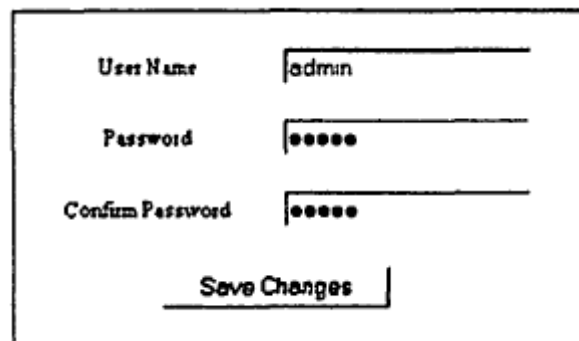
The Status Screen refreshes automatically - so you can watch the router MSTP state change and gain insight into the condition of the MSTP network (as seen by the router). For example, if "MNSM" always reports SoleMaster or PollForMaster, after repeated refreshes, then the router cannot communicate with any MSTP devices.

"Available Memory" is the amount of RAM remaining after buffers are allocated. If one network is temporarily offline and another network is attempting to communicate with this network, the available memory may drop very low until the offline network returns to an online condition.

- "TX PFM Count" is the number of Polls For Master transmitted.
- "RX PFM Count" is the number of Poll For Master received.
- "TX Token Count" is the number of tokens transmitted.
- "RX Token Count" is the number of tokens received.
- "Invalid Long Frames" is the number of frames received that have a length exceeding 1024.
- "Clear Silence Timer" is the number of times the Silence resets because its value is too large.

8.3 Security Screen

The Security Screen of the illustration below displays the default User Name which is "admin". The default Password is also "admin". Each of these values can be up to 10 characters in length. You are encouraged to change these login values to prevent unauthorized access to the MS0-BR.



The image shows a screenshot of a web-based configuration interface for a security screen. It contains three input fields and a button. The first field is labeled "User Name" and contains the text "admin". The second field is labeled "Password" and contains six dots. The third field is labeled "Confirm Password" and also contains six dots. Below these fields is a button labeled "Save Changes".

Security Screen



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