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A TECHNICAL SUPPLEMENT TO CONTROL NETWORK
ESSENTIALS

BACnet/IP to MS/TP Router or BACnet MS/TP Repeater — What is Best?

Granted we are talking apples and oranges when we mention BACnet routers that operate at the network layer and BACnet repeaters that operate at the physical layer — but can one replace the other? BACnet MS/TP uses 2-wire EIA-485 transceivers, so it only seems logical that a simple EIA-485 repeater can be used to extend distances on MS/TP networks. However, there is another way of solving the distance issue and that is to use Contemporary Controls' BACnet/IP to MS/TP routers instead — thereby taking advantage of the building's existing Ethernet infrastructure. The BASrouter has one 10/100 Mbps Ethernet port that attaches to the BACnet/IP network and one isolated EIA-485 port that attaches to the BACnet MS/TP network. EIA-485 repeaters have two EIA-485 ports — each connected to a MS/TP segment. So what is the best way to extend distance? Let's study the issues.

Distance — A typical reason to use repeaters is to extend the length of MS/TP segments beyond the 1200 m (4,000 ft.) specified in the BACnet standard. Achieving this maximum distance depends upon low-capacitance cable and transceivers rated for the desired data rate. BACnet addendum 135-2008ab allows for data rates as high as 115.2 kbps. Distance requirements beyond the maximum

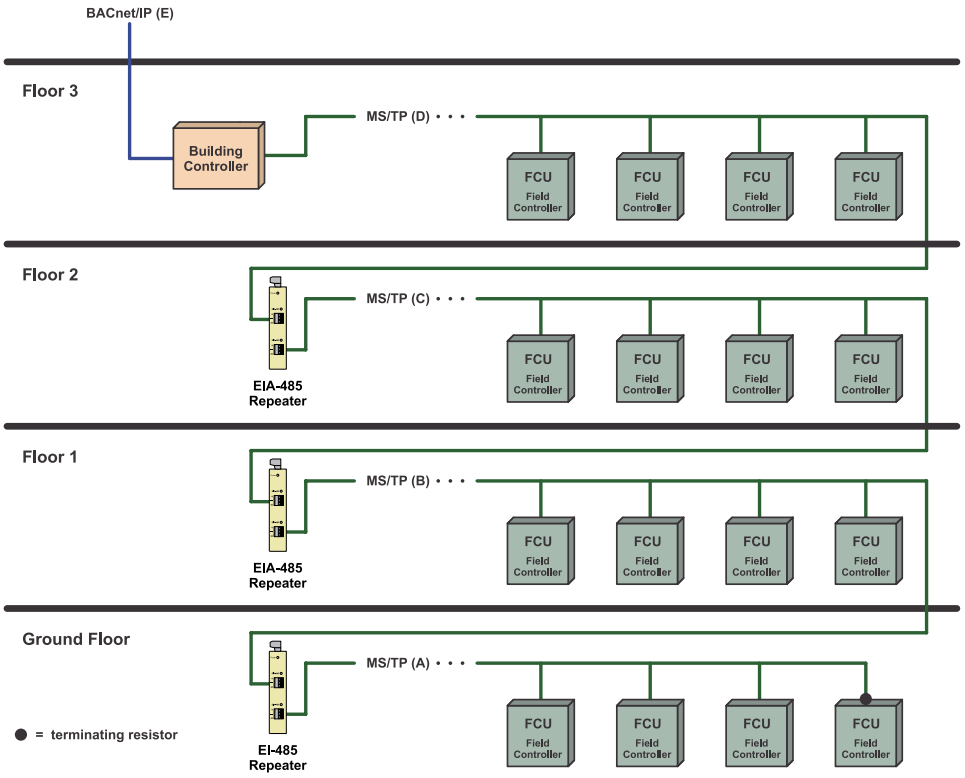

Figure 1 — To extend MS/TP segments beyond 4,000 feet requires repeaters which can be cascaded. However, each segment can only support up to 32 full-load EIA-485 transceivers. With BACnet, only 127 master devices are allowed per MS/TP network regardless of the number of repeaters. The baud rate on all segments must be the same.

probably involve the need to span multiple buildings and BACnet addendum 135-2008y mentions the need to have 3-way isolated repeaters between buildings with 1500 V isolation. This means there is galvanic isolation between the two network connections and the power supply. Some repeaters provide only power supply isolation or none at all. The Ethernet campus wiring probably supports fibre optic cabling between buildings, so it might be easier to install a BASrouter in each building and use the existing fibre optic cabling — versus installing a 3-way isolated EIA-485 repeater in one or both buildings. The BASrouter has 3-way isolation between its Ethernet port, power supply and its MS/TP port.

Isolation — Your typical BACnet MS/TP unitary controller utilizes 2-wire non-isolated EIA-485 transceivers. Therefore, the transceivers are referenced to the power supply common and all other transceivers on the same MS/TP bus must have the same ground reference. Transceiver damage can occur when ground imbalances exceed the common-mode voltage limit of the transceivers which can be a low as 7 volts. Maintaining a common ground is not difficult within a control panel or within a building, but between buildings it is necessary to use isolated repeaters. The BASrouter has an opto-isolated MS/TP transceiver that can support either a 2-wire non-isolated or 3-wire isolated MS/TP bus. A short MS/TP bus with a BASrouter at one end makes for a more reliable system.

Topology — A 2- or 3-wire EIA-485 bus is by definition a bus topology with multiple devices sharing a common medium. This means that the cable needs to serpentine through all devices attached to the cable. No drops are allowed. The topology does not change by adding a repeater. This may not be the most desirable cabling option — especially when devices are clustered in several locations within the building. If an Ethernet drop is close by, the BASrouter is inexpensive enough that it could service a cluster of MS/TP devices without the need of pulling a long EIA-485 cable around the building. Ethernet's star topology can be very handy in situations like this.

Auto-bauding — It is common for unitary controllers on a MS/TP segment to auto-baud their data rate to the rate detected on the MS/TP segment. Since unitary controllers are typically servers, they may never transmit until they detect a client request on the bus. At that time they will set their baud rate to what rate is detected. Two-wire EIA-485 communication is half-duplex — meaning transmissions can occur in either direction but not at the same time.

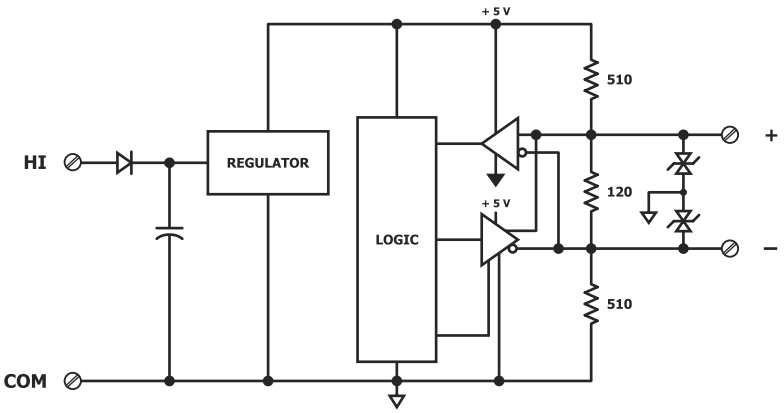

Figure 2 — A two-wire EIA-485 network has an implied transceiver ground reference which is the device's power supply ground. All connected devices must share the same ground reference. EIA-485 repeaters can have isolated or non-isolated EIA-485 transceivers.

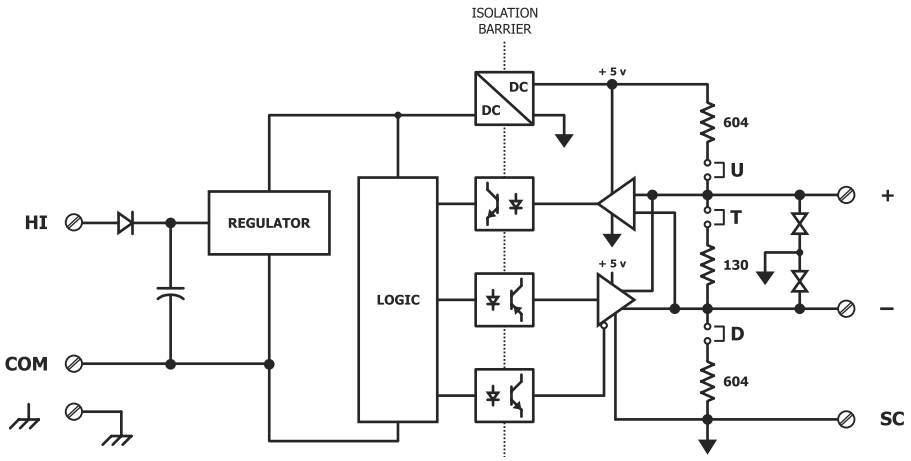

Figure 3 — A three-wire EIA-485 network is isolated from the device's power supply so the required transceiver ground reference is carried by the third conductor in the cable. The BASrouter has isolated EIA-485 transceivers and can work with either 2- or 3-wire networks.

Therefore, the EIA-485 repeater needs to quickly turnaround the line when it sees an absence of data. The required turnaround time depends upon the baud rate and usually there is a DIP switch to set the baud rate. However, using a fixed-speed repeater makes the auto-bauding capability of the unitary controllers moot. Therefore, it is best to select an auto-bauding EIA-485 repeater and to test it with the BACnet MS/TP system to make sure the turnaround time of the repeater does not impact MS/TP communication. Some repeaters support either 2-wire EIA-485 or 4-wire EIA-422. BACnet only uses EIA-485. The BASrouter's baud rate can be set via a web page. Because the BASrouter functions as a proxy for a client located on the BACnet/IP side, it initiates transmissions that the auto-bauding controllers use to set their data rate. In an auto-bauding system, one device must set the baud rate and the BASrouter is the logical choice.

Number of MS/TP nodes — The EIA-485 standard specifies a maximum of 32 full-load transceivers along with two 120-ohm terminators at each end of the line. Sometimes repeaters are used when this loading is exceeded. Modern EIA-485 transceivers can represent ½-load, ¼-load or even ⅛-load — so loading rules can be confusing. Although ⅛-load transceivers would allow for 256 devices on one MS/TP segment, the BACnet protocol only allows for 127 masters. Granted you can add slave devices that share the same bus, but how many slave devices are commonly found in the field? Very few. Who would want to troubleshoot an MS/TP segment with 127 devices? It is best to break up the 127 devices into two or more segments for ease of troubleshooting. That would require a BASrouter at the end of each segment. In fact, we suggest each floor have one BASrouter connected to a MS/TP segment. This allows the riser wiring to be Ethernet with the horizontal wiring being EIA-485. As for EIA-485 termination and bias, the BASrouter is shipped with both installed. For mid-span installations they can be removed.

Although it is possible to use EIA-485 repeaters to extend MS/TP segments, it might be more cost effective to use the existing Ethernet wiring and BASrouters to interconnect all the MS/TP devices within a system. It makes even more sense when BACnet clients are already attached to a BACnet/IP network which is typically the case with modern systems.

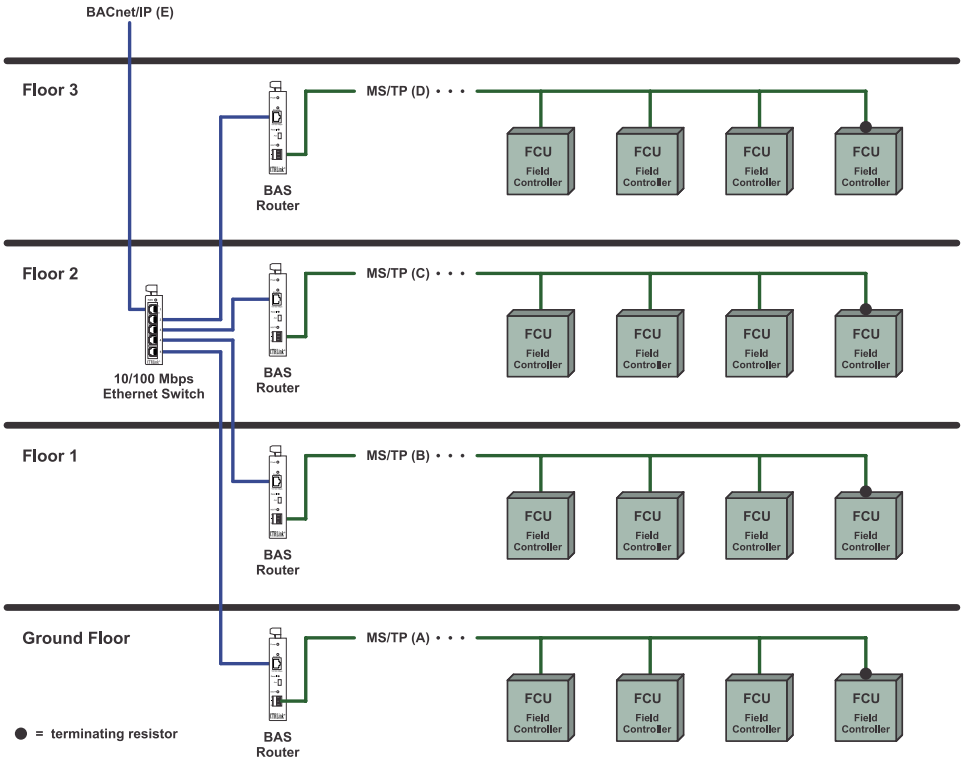

Figure 4 — When using distributed BACnet routers, one MS/TP segment attaches to each router forming a unique network. EIA-485 loading rules still apply but troubleshooting individual MS/TP networks is much easier than one very long network. Dedicating a MS/TP network per floor with Ethernet cabling in the risers could make installation less expensive especially if Ethernet cabling already exists. The baud rate on each MS/TP network can be different.