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WARNING! - DO NOT CROSS-CONNECT 2400 BUS WITH ETHERNET PORTS ...EVER!
DOING SO WILL PERMANENTLY DAMAGE ETHERNET PORTS!

CAUTION - DANGER OF ELECTRIC SHOCK OR DEATH!
SERVICE BY QUALIFIED PERSONNEL ONLY! DE-ENERGIZE BEFORE OPENING. TO REDUCE THE
RISK OF ELECTRIC SHOCK DISCONNECT POWER SOURCE FEEDING THIS EQUIPMENT BEFORE
SERVICING!

CAUTION - SENSITIVE TO ELECTRO STATIC DISCHARGE!
Use static grounding devices! - Properly bleed-off any possible electrostatic charge before coming in contact
with the electronic components!

IMPORTANT! - BASIC UNDERSTANDING OF TCP/IP and MS/TP NETWORKING IS REQUIRED TO
PROPERLY CONFIGURE AND UTILIZE THIS DEVICE!
When choosing a location to mount the BACnet MSTP gateway keep in mind that this device will require access to multiple systems:

1. A 120V or 277V AC power source to energize the equipment.
2. A connection to the Lighting Control & Design GR2400 lighting control network.
3. A connection to the MSTP BACnet control network.

It is the responsibility of the installing contractor to assure that all power and network connections are available at the final mounting location.
INSTALLATION

ELECTRICAL & NETWORK CONNECTIONS

**WARNING:** When planning connections and running wires to the enclosure be aware that there are line voltage and low voltage compartment within the enclosure. Under no circumstances should line voltage conductors be run through the low voltage communication compartment or low voltage lines run through the high-voltage power compartment.

1. Connect the input power line to the power supply terminal blocks using either the 120V or 277V terminal (use appropriate lug) neutral and ground. The BACnet MSTP gateway uses two isolated power transformers. Both transformer inputs must be connected to the input power line and neutral for the device to operate properly.

2. Run the data cables from the Lighting Control & Design GR2400 lighting control network to the GR 2400 bus ports located on the Link-To BACnet control card. If this will be the last device on the lighting control network you will have one cable and be required to install an end of line terminator jumper on the control card. If this is not the last device on the network you will have two cables running through the Link-To BACnet control card. (Refer to the GR 2400 installation manual and documentation for additional instructions on the commissioning the network)

3. Run the data cables from the MSTP BACnet control network to the location of the green terminal block located on the side of the MSTP / IP converter module. Do not connect the data lines to the module until instructed to do so during the configuration procedure.

**IMPORTANT:** Although EIA-485 (RS485) is thought of as a 2-wire network, you MUST include a third conductor connected to GND or common at each device so that all devices are operating at close to the same ground potential. Proper grounding of equipment should ensure proper operation without the third conductor; however, proper grounding often cannot be relied upon. If large common mode voltages are present, you may even need to insert optically isolated repeaters between EIA-485 devices.
Factory Default Configuration

Factory default IP addresses:
Link-To BACnet Card: 10.0.0.102
MSTP / IP converter Gateway: 10.0.0.101
MS/TP Baud rate: 38400
MS/TP Bias: OFF
MS/TP Terminator: OFF

Prerequisites

1. A computer running a Windows XP or above operating system.
2. A computer network port configured to operate in the 10.0.0.X (where X is not 101 or 102) IP range.
3. An installed copy of LC&D’s BACnet Configuration software Version 1.0.0.64 or higher.
4. A completely installed and energized BACnet MSTP converter unit.

Warning: Never cross connect the LC&D lighting control network and the Ethernet network connections. Doing so will damage the Ethernet network equipment including the computer network port, Link-To BACnet IP port, and the MSTP / IP converter module BACnet IP port. This will also void the warranty on the equipment.

Note: before proceeding with the configuration process:

Verify that the LC&D lighting control system has been completely installed, commissioned, and all equipment is online. (Refer to the GR 2400 installation manual and documentation for additional instructions on the commissioning the network)

Verify that the Link-To BACnet card is visible on the LC&D lighting control network at address 126 on the DTC Bus Scan Display.

If the lighting control system is not completely installed or the lighting control network is unstable, all objects may not be found while creating the BACnet object list and the commands from the BACnet control system may not work as expected after the configuration is completed.

Note: Verify that both the Link-To BACnet card (red indicator next to power connector) and the MSTP / IP converter module (blue indicator inside enclosure) are energized before proceeding with the configuration procedure.

Note: If the computer network port being used does not auto detect the transmit and receive lines, you will need a crossover cable or a network hub to establish connection between the computer and the device you are configuring.
1. Temporarily disconnect the network cable running between the Link-To BACnet card and the MSTP / IP converter module.
2. Connect a network cable from the computer loaded with the BACnet configuration software to the Link-To BACnet IP network port that had the jumper cable connected to it.

Warning: Never cross connect the LC&D lighting control network and the Ethernet network connections. Doing so will damage the Ethernet network equipment including the computer network port, Link to BACnet IP port, and the MSTP / IP converter module BACnet IP port. This will also void the warranty on the equipment.

3. Open the application “BACnet Configurator” v1.0.0.64 or higher, use Target IP 10.0.0.102, click Connect button, the following screen should appear. If not already present the corresponding vendor IDs should show up after clicking the **Who-Is** button under the **Simple Test** tab.

4. Click on [Create Object List] tab, then click on [Force Object List Rebuild] button, click "Yes" to the pop up warning. Answering ‘Yes’ will cause the card to scan the GR2400 bus to find all of the objects that are present. The scan procedure will only take about 5 - 10 seconds.

5. At this point an object name can be type into the "Description" field. After uploading, this will be the text that will be issued when the "Object Name" property is invoked. If No text has been type in the "Description" field, the card will automatically create a generic name similar to the "Root" column in the table.
6. Click the [Upload Object List] button and answer Yes to the popup warning

This will force store the scanned items into the non-volatile memory of the Link-To BACnet card. An “Upload Successful” notification will pop up when the uploading is finished. If any problems occur, a notification will let the operator know that the upload was NOT successful.

During this process, the Link-To BACnet card will reboot. If the upload fails, close the BACnet Configurator application. Reboot the Link-To BACnet card by unplugging the red power connector from the card then replacing it. Then go back to step 3 and repeat the procedure.

7. Upon completion of storing the object list in the Link-To BACnet card memory create an output file of the object list for future reference by performing the following steps:
   a. Click on **Simple Test** tab.
   b. Check the **Scan to Output File** check box in the **ReadProperty** section.
   c. Accept the output filename or enter a new name in the file name field.
   d. Press the **Scan Current Table** button. After several seconds a comma delimited text file will be created that contains all of the data in the object list.
   e. By default this file will be saved to the C:\Program Files\BacnetTest directory. This information will be needed to send commands to the lighting control system when programming the BACnet control system.
8. Once the previous steps have been successfully completed the configuration of the Link-To BACnet card is complete. Close the BACnet Configurator application, disconnect the computer network cable from the network port on the card, reboot the Link-To BACnet card, and proceed to the MSTP Converter Configuration procedure.
Note: If the computer network port being used does not auto detect the transmit and receive lines, you will need a crossover cable or a network hub to establish connection between the computer and the device you are configuring.

1. Connect the computer network cable that you removed from the Link-To BACnet card’s network port in the last step of the previous procedure to the MSTP / IP converter module’s Ethernet network port.

2. Open a web browser on the computer and type the IP address 10.0.0.101 in the browser’s address bar and hit enter to connect to the converter’s built in web server interface. You will see the following screen.
3. Select the System Setup tab, you will be asked to enter an access code, the default code is (user= system ; pw= admin). If the page returns with error like "not found", click on the refresh button in your browser to have the page re-sent.

4. Select the Local Host tab, the following page should show up. This device has been factory configured to operate with the companion Link-To BACnet card via the Ethernet network connections, do not change any settings on this page, but verify that they match the settings shown below. Move to the next step.

5. Select the **BACnet IP Port** tab, the following page should show up. This device has been factory configured to operate with the companion Link-To BACnet card via the Ethernet network connections, do not change any of the **BACnet IP Settings** values on this page, but verify that they match the settings shown below.

6. Go to the **MSTP Port Configuration** section at the bottom of the page and if necessary change the **MSTP MAC address, Max Masters, and MS/TP Baud Rate** values as necessary to match the configuration of your MSTP BACnet network. When you have finished changing the settings press the **Update** button when the page refreshes press the **Save** button.
Note: The hardware will effectively prevent you from duplicating the MAC address on the IP side, but you do need to select a MAC address for the MS/TP side of the router. Enter that MAC address at the bottom of this page. The MAC addresses must not be duplicated on the network. Enter your MS/TP baud rate and Max Master setting as well.

7. Select the BACnet Router tab, the following page should show up.

Note: Network numbers MUST NOT be duplicated anywhere else on the network. Duplicated network numbers on two or more routers will result in erratic operation of the network that can be difficult to diagnose. Duplicated network numbers means two physically disconnected networks have been assigned the same network number.

Note: The IP and MS/TP network numbers MUST be different.

Note: Two routers connected to the same physical network segment or link MUST use exactly the same network numbers to refer to that segment of the network. Using two different network numbers to refer to the same physical network will result in erratic behavior that is difficult to diagnose. Using the same network number in two routers does not constitute a duplicated network number, provided those identically numbered ports are physically electrically connected to each other if MS/TP.

Note: Do not change the BACnet IP Network Number value. It has been factory configured to operate with the companion Link-To BACnet card via the Ethernet network connections.

9. If necessary set the MS/TP Network Number value as required to be compatible with your MSTP network configuration. When you have finished changing the settings press the Save button to write the changes to the device memory.

10. Select the System Setup tab, the following screen should appear.
11. Click "Save" to store the present configuration to a Flash file.

**IMPORTANT:** Configuration changes will be lost the next time you cycle power if you did not click the "Save" button to place those changes in non-volatile memory (Flash file).

12. Unplug the green connector from the MSTP converter and connect the MS/TP BACnet network to the input terminals on the connector (shown below) noting the polarity of the data wires.
IMPORTANT: Although EIA-485 (RS485) is thought of as a 2-wire network, you MUST include a third conductor connected to GND or common at each device so that all devices are operating at close to the same ground potential. Proper grounding of equipment should ensure proper operation without the third conductor; however, proper grounding often cannot be relied upon. If large common mode voltages are present, you may even need to insert optically isolated repeaters between EIA-485 devices.

13. Reconnect the terminal connector to the converter.

14. Close the web browser on the computer, disconnect the computer network cable from the Ethernet port on the MSTP / IP converter module, and reconnect the network cable running between the Link-To BACnet card and the MSTP / IP converter module that was removed in step one of the Link-To BACnet Card Configuration procedure.

15. Power cycle the entire converter unit and wait 60 seconds before proceeding to the next step.

16. Test the communication through the converter by sending control commands from the BACnet controller to the relays in the relay panels using the data from the object list generated in step 6 of the Link-To BACnet Card Configuration procedure.
Fixed Numbering Map

Whatever the Base Number for Objects might be set at, the internal Object Numbers will fall in these ranges:

<table>
<thead>
<tr>
<th>Start</th>
<th>Stop</th>
<th>Type</th>
<th>Serves</th>
<th>Modulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1016</td>
<td>Binary Output</td>
<td>Relays</td>
<td>8</td>
</tr>
<tr>
<td>1017</td>
<td>1524</td>
<td>Analog Output</td>
<td>Dimmers</td>
<td>4</td>
</tr>
<tr>
<td>1525</td>
<td>2032</td>
<td>Analog Input</td>
<td>Dimmers</td>
<td>4</td>
</tr>
<tr>
<td>2033</td>
<td>2159</td>
<td>Analog Input</td>
<td>PCC1</td>
<td>1</td>
</tr>
<tr>
<td>2160</td>
<td>2540</td>
<td>Analog Input</td>
<td>PCC3</td>
<td>3</td>
</tr>
<tr>
<td>2541</td>
<td>4318</td>
<td>Binary Output</td>
<td>Switches</td>
<td>14</td>
</tr>
<tr>
<td>4319</td>
<td>4350</td>
<td>Binary Output</td>
<td>Groups</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Object numbers leaving the card will have the Base Number added to them; numbers entering the card have the Base Number subtracted from them. Modulus is described in the next section.

Derivation of Address/Offset by Object Number

The Modulus number is the number of objects of this type that can reside at a given address.

**The address of each object can be derived from:**
Address = ((integer)((Object number – Start number)/Modulus)+1.

**The offset is derived by:**
Offset = ((Object number – Start number) mod Modulus)+1 (the ‘mod’ operator merely gives the remainder of a division)

Let’s say that the original Base Number of the card was 256 (100h), and that Object number is 2657 (A61h). Subtracting the Base number gives a true object number of 2401. From the previous table, this means the object is a PCC3. It is sitting at address 80 \([(2401-2160/3) = 80.333…\]. It is the second Photocell of the group (Remainder = 1, add 1 to equal 2)

Consequently, you can see that from the object number we can get the object type, its address, and its offset.
BACNET PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT

Date: 08/12/2011
Vendor Name: Lighting Control and Design, Inc.
Product Name: Link-2 BACnet
Product Model Number: L 2 BAC

Applications Software Version: 6.0  Firmware Revision: 117  BACnet Protocol Revision: 1.0

Product Description:

A gateway between a BACnet system and the LC&D GR2400 lighting control system. This device is Conformance Class II, with support for Class III “I-Am” (initialize), along with the standard Class II “ReadProperty” (execute) and “WriteProperty” (execute) functions. Device is shipped factory preset as device #10, can be set to any value (along with a base object number for the BO/O/AI object list) by using downloadable utility software. Device is capable of containing up to 1770 objects, which can be any combination of BO, AO and AI as required by the customer system.

BACnet Standardized Device Profile (Annex L):

- BACnet Operator Workstation (B-OWS)
- BACnet Building Controller (B-BC)
- BACnet Advanced Application Controller (B-AAC)
- BACnet Application Specific Controller (B-ASC)
- BACnet Smart Sensor (B-SS)
- X BACnet Smart Actuator (B-SA)

BACnet Interoperability Building Blocks Supported (BIBBS):

- DS-RP-B  Read Property (execute)
- DS-WP-B  Write Property (execute)
- DM-DDB-B  Who-is (execute) I-am (initiate)

Standard Object Types Supported:
(A) Device Object:

1> Device is not dynamically creatable or deletable
2> No optional properties supported
3> No properties are writable
4> No proprietary properties
5> No property range restrictions
6> Device contains up to 1770 internal objects (listed below)
(B) Binary Output Objects:

1> BO’s dynamically created internally, not with CreateObject / DeleteObject services.
2> Optional properties supported : Active_Text, Inactive_Text
3> Present Value writable per Priority Array specifications
4> No proprietary properties
5> No property range restrictions

(C) Analog Input Objects:

1> AI’s dynamically created internally, not with CreateObject / DeleteObject services.
2> Optional properties supported : Active_Text, Inactive_Text
3> No proprietary properties
4> No property range restrictions

(D) Analog Output Objects:

1> AO’s dynamically created internally, not with CreateObject / DeleteObject services.
2> Optional properties supported : Active_Text, Inactive_Text
3> Present Value writable per Priority Array specifications
4> No proprietary properties
5> Range of output value is 0-1023. These values are scaled internally to 0-100

Segmentation Capability:

- [ ] Segmented requests supported Window Size
- [x] Segmented responses supported Window Size
- [x] Segmentation not supported

Data Link Layer Options:

- [x] BACnet IP, (Annex J)
- [ ] BACnet IP, (Annex J), Foreign Device
- [ ] ISO 8802-3, Ethernet (Clause 7)
- [ ] ANSI/ATA 878.1, 2.5 Mb. ARCNET (Clause 8)
- [ ] ANSI/ATA 878.1, RS-485 ARCNET (Clause 8), baud rate(s) _____________
- [ ] MS/TP master (Clause 9), baud rate(s):
- [ ] MS/TP slave (Clause 9), baud rate(s):
- [ ] Point-To-Point, EIA 232 (Clause 10), baud rate(s):
- [ ] Point-To-Point, modem, (Clause 10), baud rate(s):
- [ ] LonTalk, (Clause 11), medium: _____________
- [ ] Other:
Networking Options:

- Router, Clause 6 - List all routing configurations, e.g., ARCNET-Ethernet, Ethernet-MS/TP, etc.
- Annex H, BACnet Tunneling Router over IP
- BACnet/IP Broadcast Management Device (BBMD)

  Does the BBMD support registrations by Foreign Devices?  Yes  No

Character Sets Supported:

X ANSI X3.4
- IBM  Microsoft  DBCS
- ISO 8859-1
- ISO 10646 (UCS-2)
- ISO 10646 (UCS-4)
- JIS C 6226

If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports:

Allows both reading of status and writing of binary/analog levels to LC&D lighting control panels. It MUST be noted that when writing to BO’s that represent SWITCHES, writing a value of ‘0’ represents a button push, while writing a ‘1’ represents a button release.
MSTP/IP CONVERTER MODULE

BACnet Protocol Implementation Conformance Statement

Date: 29-September-2010
Vendor Name: Control Solutions, Inc.
Product Name: Babel Buster BB2-7030
Product Model Number: BB2-7030
Applications Software Version: 3.04  Firmware Revision: 3.04  BACnet Protocol Revision: 5

Product Description:
BACnet gateway and router providing (a) MS/TP to IP (Annex J) routing, (b) BACnet to Modbus TCP gateway, (c) BACnet to SNMP gateway.

BACnet Standardized Device Profile (Annex L):
- BACnet Operator Workstation (B-OWS)
- BACnet Building Controller (B-BC)
- BACnet Advanced Application Controller (B-AAC)
- BACnet Application Specific Controller (B-ASC)
- BACnet Smart Sensor (B-SS)
- BACnet Smart Actuator (B-SA)

List all BACnet Interoperability Building Blocks Supported (Annex K):

Segmentation Capability:
- Segmented requests supported Window Size
- Segmented responses supported Window Size

Standard Object Types Supported:
An object type is supported if it may be present in the device. For each standard Object Type supported provide the following data:
1) Whether objects of this type are dynamically creatable using the CreateObject service
2) Whether objects of this type are dynamically deletable using the DeleteObject service
3) List of the optional properties supported
4) List of all properties that are writable where not otherwise required by this standard
5) List of proprietary properties and for each its property identifier, datatype, and meaning
6) List of any property range restrictions

Object types: AI, AO, AV, BI, BO, BV, MSI, MSO, MSV, DEV (all static)
All standard properties supported. See additional documentation for optional & proprietary properties.
SPECIFICATIONS

Power consumption:

BB2 with 12VA transformer @120V _______________________________________________ 48mA
BB2 with 12VA transformer @277V _______________________________________________ 25mA
Link-To BACnet with 12VA transformer @120V w/no BUS load _____________________ 42mA
Link-To BACnet with 12VA transformer @277V w/no BUS load _____________________ 24mA

Operating temperature ______________________________________________________ 0°C...+70°C
Humidity ______________________________________________________ up to 90% non-condensing

Installation:

Enclosure dimensions _______________________________________________________ 12"x12"x4"
Enclosure color __________________________________________________________ standard powder coat electrical gray
Enclosure access _________________________________________________________ screw cover
Enclosure access screw type _____________________________________________ Phillips
Enclosure type and mount __________________________________________________ NE1 surface mount
Enclosure Low voltage wiring ______________________________________________ factory installed
Enclosure Line voltage wiring ______________________________________________ field installed
MS/TP BAUD rate (soft select) ___________________________________________ default 38400
MS/TP hardware communication (half duplex) ______________________________ EIA-485 transceiver
MS/TP bias (jumper select) ______________________________________________ default OFF
MS/TP terminator (jumper select) __________________________________________ default OFF
MS/TP connection ______________________________________________________ de-pluggable screw terminal
MS/TP connection access screw type ______________________________________ flat
MS/TP wiring __________________________________________________________ field installed twisted pair

BB2 JUMPER SETTINGS:

Termination and Bias jumpers for RS485 (MS/TP) on Control Solutions, Inc. Radiodetection 7 Model B4D-70110

Note: Termination should only be applied at ends of RS485 link. Line bias, if used, should only be applied one place on the link.
Additional information on the Babel Buster 2 BACnet IP / MSTP gateway can be found at the link locations below:


Technical support

You may contact Lighting Control & Design technical support for assistance with this product via telephone or e-mail:

Technical support phone number: 800-345-4448 (please listen to and follow the prompts)
Technical support e-mail: support@lightingcontrols.com