Johnson Controls
ComBus Quick Tester

MS-CQT485-0
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Introduction – Controls & Features

ComBus Quick Tester

Features

- Pluggable 4-Position N2 Bus Connector can accept 3-Position or 4-Position terminal blocks used on Johnson Controls Controllers
- 2-Line by 8-Character LCD Display with Power On Backlighting
- Display Scroll-up and Scroll-down buttons
- End of Line Slide Switch for Termination Out/In
- Start button Starts or Stops Automatic Testing
Section 1: Introduction

- N2/MSTP Slide Switch Selects Test Mode (for future MSTP upgrade)
- Self protected from accidental connection to 24VAC
- Rugged drop resistant case with bright orange color protective boot uses only 5.5 x 3.4 x 1.4 inches of space.
- Uses two AA alkaline batteries

Introduction

The ComBus Quick Tester is designed to plug into the Johnson Controls N2 or MSTP bus as a Master Controller. It will test using the following sequence:

Instrument Test Sequence

1. Check for bus activity, abnormal data state duration such as 24VAC/50/60Hz on data bus or Ref.
2. Check for other Master Controllers on the bus. Only one Master Controller can be present at a time.
2.1 Master Controllers can be a NCM, Companion, N30 (N2 bus) or NAE (MSTP bus)
3. Check data bus DC voltages, and retain values for review or troubleshooting at test end.
4. Poll all device addresses (1 to 255) using N2/Sys91 or MSTP commands, make internal list of addresses which respond and identify as either an invalid response or the appropriate N2 or Sys91 device. (MSTP test mode may vary)
5. Total the number of device addresses which respond and calculate the sum of all responding addresses for a crosscheck.

If a Fail condition is found during the first 3 tests, testing stops.

Tests 4 and 5 repeat until all addresses have been checked, then the Device Count is displayed. Use the Scroll-up/down buttons to view.

The total of responding Device Addresses can be checked against the number of devices which should be present, and the Sum of responding addresses recorded for future quick checks.

The Device address and Device type can be viewed/checked against your list of devices which are installed and should be found.

Test 4 can be stopped by pressing and holding the START/STOP button until Device Address scanning stops.
Initial Operation

Before use, install a pair of AA batteries (included) as shown in the Battery Installation section.

1. Locate the Master Controller for the communications trunk being tested.

2. Unplug the 4 pin (or 3 pin) Data Bus connection plug from the Master Controller and plug it into the Quick Tester.

3. Set the N2/MSTP slide switch to test N2 or MSTP bus devices. The N2/MSTP switch is only read at Power On. In MSTP mode, initial production units will display “MSTP NO SUPPORT” at Power On.

4. Press & release the Power button to turn On.

5. Set the END OF LINE switch to IN if replacing an End Of Line device (usually only one cable connected to plug), else set to Out (two cables connected to plug).

6. Press the Start button to begin. To stop before completion, press and hold the Start/Stop button until halted.

7. If a failure message is displayed, “24VAC Found”, “Master Found” or “Voltage Fail”, troubleshoot as in Section 3.

8. When “Voltage Pass” is displayed, alternating with “Hit up down key”, automatic testing is done. Check results.

9. Press & release the scroll-down button to sequence through results. Compare the Device Count found to the number of devices installed. If equal, and the “Add. Sum” matches the value specified for the system, testing is complete except for recording system values for future reference.

10. If not equal, see Troubleshoot Missing or Bad Devices.

Continued next page.
Tester & User Operations

Flow Chart 1 - Tester & User Operations

1. START pressed
   - Start
   - 2. Check for AC Voltage on Bus
     - FAIL → 24VAC Found
     - OK
     - 3. Check for Polling Activity on Bus
       - FAIL → Master Found
       - OK
       - 4. Check DC Voltage Levels on Bus
         - FAIL → Voltage Fail
         - OK
         - Display
         - 5. Device Address Scan
           - 001 to 255
           - OK
           - Indicate Testing Address
           - Testing 001/255
           - Voltage Pass
           - Hit up down key
           - See Voltage Pass
             - Display Sequence Table 1
           - OK
           - 6. User Check - Devices Count Found = Actual
             - OK
               - FAIL
               - OK
               - Complete
               - Troubleshoot
                 - Missing Devices
                 - See Section 3.4
                 - OK
                 - Troubleshoot
                   - See Section 3.1
When the Tester stops testing with Voltage Pass, User Checks are needed to complete Testing.

The User must compare the device count found to actual number of devices present, and the Add. Sum to the Engineering Check Sum provided for the installation being tested. See Table 1 for the Display Sequence.

If the Device Count is correct then there are no missing devices.

If the Address Sum is not correct, but the Device Count is correct, then one or more device addresses is not set according to the Engineering Check Sum specified. See Section 3, Troubleshooting Missing or Bad Devices.

Table 1 – Voltage Pass Display Sequence

<table>
<thead>
<tr>
<th>#</th>
<th>Display</th>
<th>Alternating</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Voltage Pass</td>
<td>Hit up down key</td>
<td>D = Data Bus</td>
</tr>
<tr>
<td>2</td>
<td>Add. Sum XXXXX</td>
<td>XXXXX = Sum</td>
<td>Sum of all addresses found</td>
</tr>
<tr>
<td>3</td>
<td>+=x.xxV</td>
<td>x.xx = value</td>
<td>+D Line to REF</td>
</tr>
<tr>
<td></td>
<td>-=x.xxV</td>
<td></td>
<td>-D Line to REF</td>
</tr>
<tr>
<td>4</td>
<td>Bias = +X.XX</td>
<td>x.xx = value</td>
<td>+D to –D</td>
</tr>
<tr>
<td>5</td>
<td>XXX ZZZ</td>
<td>XXX = Address</td>
<td>If device count &gt; 0 then show first 2</td>
</tr>
<tr>
<td></td>
<td>XXX ZZZ</td>
<td>ZZZ = Dev Type Code</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Devices= 0000</td>
<td></td>
<td>Show count of devices found</td>
</tr>
<tr>
<td>2</td>
<td>Add. Sum</td>
<td>Repeat #2</td>
<td></td>
</tr>
</tbody>
</table>

+D is Data bus plus (with N2 bus = N2+) MSTP Future
-D is Data bus minus (with N2 bus = N2-) MSTP Future
Section 3: Troubleshooting

Troubleshooting - Failure Messages

3.1 – 24VAC Found

1. Unplug the connector from the Tester verify that the 24VAC power connection and Data bus connections are not swapped.

2. Use a Multimeter and check for 24VAC between the +D line and –D line connection, then between the +D and REF, and between the –D and the REF.

3. If no AC, possibly some device on the bus has the REF line swapped. Split the trunk and troubleshoot each half separately.

3.2 – Master Found

1. Check for a Master (NCM, N30, NAE, Companion) connected and polling.

2. If necessary, split the trunk and troubleshoot each half separately.

3.3 – Voltage Fail

Voltage Fail means that abnormal DC levels on the bus have been measured.

The ComBus Quick Tester checks for normal values on +D and -D to REF (Common Mode Reference), and the difference between +D and -D (known as Bias) and indicates “Voltage Fail” or “Voltage Pass”.

Table 2 – Voltage Fail Display Sequence

<table>
<thead>
<tr>
<th>#</th>
<th>Display</th>
<th>Alternate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Voltage Fail</td>
<td>Hit up down key</td>
</tr>
<tr>
<td>2</td>
<td>+x.xxV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-x.xxV</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Bias =</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+X.XX</td>
<td></td>
</tr>
</tbody>
</table>
## Section 3: Troubleshooting

Table 3 – Voltage Pass Limits.

<table>
<thead>
<tr>
<th>#</th>
<th>Voltage Pass</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
<th>Parameter D=Data Bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>+ =</td>
<td>2.45V</td>
<td>3.00V</td>
<td>+D to REF</td>
</tr>
<tr>
<td>2</td>
<td>- =</td>
<td>1.90V</td>
<td>2.54</td>
<td>-D to REF</td>
</tr>
<tr>
<td>3</td>
<td>Bias =</td>
<td>+0.38</td>
<td>+0.92</td>
<td>+D to -D</td>
</tr>
</tbody>
</table>

+D is Data bus plus (with N2 bus = N2+) **MSTP future**

-D is Data bus minus (with N2 bus = N2-)

### Voltage Fail Checks

1. Check that End of Line termination is set correctly.

2. Compare Lower Limit values, low values can indicate a data line shorted to another, or to REF, or reversed at an End of Line device.

3. See Voltage Fail Example Profiles

The DC levels between data transmissions on each line will vary depending on how many devices are on the bus, since each device loads it, changes the bias. The bias voltage for all devices on the bus establishes the no-signal state between data transmissions when all devices are tri-stated. DC bias is needed so all devices on the bus are able to recognize the start of data without errors or retries.

*See Example Voltage Fail Profiles – next page.*
Section 3: Troubleshooting

Example Voltage Fail Profiles

Possible Voltage Fail Examples if one unit on the bus is misconnected compared to all the others and the REF on all units also connects to a non-isolated Common/Ground.

Table 4 - Profiles

<table>
<thead>
<tr>
<th>Voltage Fail Examples</th>
<th>Example Profile 1</th>
<th>Example Profile 2</th>
<th>Example Profile 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ =</td>
<td>1.53</td>
<td>0.00</td>
<td>2.58</td>
</tr>
<tr>
<td>– =</td>
<td>0.00</td>
<td>0.70</td>
<td>2.63</td>
</tr>
<tr>
<td>Bias</td>
<td>1.53</td>
<td>0.70</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Possible Faults

| (+) & REF Shorted      | -                 | X                 | -                 |
| (+) & REF Swapped causing short | -                 | X                 | -                 |
| (–) & REF Shorted      | X                 | -                 |
| (–) & REF Swapped causing Short | X                 | -                 | -                 |
| (+) & (–) Shorted      | -                 | -                 | X                 |

Voltage Pass

| (+) & (–) Swapped      | No failure until address search |


3.4 Troubleshooting Missing or Bad Devices

1. When the device code for one address indicates BAD, check the list of addresses found to determine what other address is missing. Two units may be set for the same address.

2. Check for swapped wires for Data + and Data – lines (N2+/N2-) on the device with the missing address, and swapped wires on the next device after the missing device.

3. If many devices are missing, check for swapped or open wiring between the last device prior to the missing address and also the unit set to the missing address.

Check for devices with duplicate addresses.

Depending on the type of both devices, and distance from each other and the master, the device code for duplicate addresses may **not** indicate “BAD”, but only one may be found if they are both N2 or Sys91, or if they are different types, either type may be found.

To isolate which device is responding, go to the unit with the assigned address, disconnect it, and try scanning the downstream bus and upstream bus separately to identify what other device is responding at that address. It will be found on only one segment.

For address problems or Voltage Fail problems, Isolate the device by separating the bus into halves, see which half has the problem, and then perform split half troubleshooting on the problem segment. This is usually faster than going through device connections one at a time.

For Devices that use pluggable terminal blocks, unplug the upstream or downstream connector, and then test separately with the device.

Figure 2 – Split Half Problem Isolation

![Diagram of split half problem isolation](image)
### Section 3: Troubleshooting

#### Table 5 - Device Type Display

<table>
<thead>
<tr>
<th>Dev-Code</th>
<th>Protocol</th>
<th>Device/Controller Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>???</td>
<td>N2</td>
<td>N2 Open Device not listed</td>
</tr>
<tr>
<td>AHU</td>
<td>N2</td>
<td>Air Handling Unit Controller</td>
</tr>
<tr>
<td>BAD</td>
<td>N2</td>
<td>N2 Device with invalid errors</td>
</tr>
<tr>
<td>DC</td>
<td>Sys91</td>
<td>DC-9100 – Plant Controller</td>
</tr>
<tr>
<td>DCM</td>
<td>N2</td>
<td>DCM-Digital Control Module</td>
</tr>
<tr>
<td>DO</td>
<td>Sys91</td>
<td>DO-9100 – Digital Optimizer</td>
</tr>
<tr>
<td>DR</td>
<td>Sys91</td>
<td>DR-9100 Room Controller</td>
</tr>
<tr>
<td>DX</td>
<td>Sys91</td>
<td>DX-9100-Digital Controller</td>
</tr>
<tr>
<td>IAC</td>
<td>N2</td>
<td>Access Controller</td>
</tr>
<tr>
<td>IFC</td>
<td>N2</td>
<td>Fire Controller</td>
</tr>
<tr>
<td>ILC</td>
<td>N2</td>
<td>ILC – Intelligent Lighting Control</td>
</tr>
<tr>
<td>LCP</td>
<td>Sys91</td>
<td>LCP – Lab &amp; Central Plant Controller</td>
</tr>
<tr>
<td>LDT</td>
<td>N2</td>
<td>LDT - User Display</td>
</tr>
<tr>
<td>MIG</td>
<td>N2</td>
<td>MIG - Metasys Integrator</td>
</tr>
<tr>
<td>NDM</td>
<td>N2</td>
<td>N2 Dialer</td>
</tr>
<tr>
<td>PHX</td>
<td>N2</td>
<td>Phoenix Fume Hood</td>
</tr>
<tr>
<td>TC</td>
<td>Sys91</td>
<td>TC-9100 – Temperature Controller</td>
</tr>
<tr>
<td>UNT</td>
<td>N2</td>
<td>Unitary Controller</td>
</tr>
<tr>
<td>VAV</td>
<td>N2</td>
<td>VAV - Variable Air Volume Controller</td>
</tr>
<tr>
<td>VMA</td>
<td>N2</td>
<td>VAM – Variable Air Volume Modular</td>
</tr>
<tr>
<td>VND</td>
<td>N2</td>
<td>VND – Vendor Device (also FX)</td>
</tr>
<tr>
<td>XBN</td>
<td>N2</td>
<td>XM – Baseframe Extension Module</td>
</tr>
<tr>
<td>XRE</td>
<td>N2</td>
<td>XM – Baseframe Extension Module</td>
</tr>
<tr>
<td>XRL</td>
<td>N2</td>
<td>XM – Baseframe Extension Module</td>
</tr>
<tr>
<td>XRM</td>
<td>N2</td>
<td>XM – Baseframe Extension Module</td>
</tr>
<tr>
<td>XT</td>
<td>Sys91</td>
<td>XT-9100 Extension Module</td>
</tr>
<tr>
<td>XTM</td>
<td>Sys91</td>
<td>XTM-101 Extension Module</td>
</tr>
<tr>
<td>WRX</td>
<td>N2</td>
<td>Wireless Receiver</td>
</tr>
</tbody>
</table>
Section 4: Battery Installation

Battery Installation

1. Unplug 4-Position Terminal.
2. Remove Protective boot from the case with left hand on left corner, or use right hand on opposite.

Install 2 AA alkaline cells as shown at right, and then replace protective cover by reversing the steps shown.
Section 5: Specifications

Specifications

Bus Type: Half Duplex RS-485
  +Data, -Data and Common Mode Reference

Bus Connector:

4-Position connector can accept 3-Position or 4-Position pluggable terminal block connectors. Provided with 4-position right angle 5.08mm spacing pluggable Terminal block.

Data Type: Standard (9600, 8, N, 1)

Display Type: 16 Character (2 lines by 8) LCD

Biasing & Termination

+D is N2+ line in N2 bus type – (MSTP bus marking?)
-D is N2- line in N2 bus type – (MSTP bus marking?)
REF is N2 bus Common Mode Reference (bus ground)

Termination: 220 ohms in END OF LINE IN
  Biasing: +D 1200 ohm Pull-up
  Biasing: -D 1200 ohm Pull-down to Ref. Common/Ground

Termination: None in END OF LINE- OUT
  +D Line: 100k ohm Pull-up to +5V
  -D Line: 100K ohm Pull-down to Ref Common/Ground

Voltage Scan Test - Pass

+D line to Ref is between 2.45 and 3.00 VDC
-D line to Ref is between 1.90 and 2.54 VDC
+D to -D difference is +0.38 to +0.92 VDC

N2 Address Scan Test (Device Addresses 1 to 255)
  Send Sys91 message to address
  Check Response for possible N2 device – identify if not.
  Send N2 Identify-Self Command
  Check for no error – N2 device identify type
  If error Identify address with code BAD

MSTP address scan – (Device Addresses 1-255)
  - T.B.D. for MSTP support

Dimensions: 5.5 x 3.4 x 1.4 inches (14 x 8.64 x 3.56 cm)
Section 5: Specifications

Accessories

Included:
ComBus Quick Tester with removable orange protective boot
4-POS Pluggable Terminal Block
Manual: Instruction Manual (paper copy of this booklet)
Batteries: Set of two included, replace with AA alkaline