MS-FIT100-0 Field Inspection Tool User Guide

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Contents

Introduction

The Field Inspection Tool (FIT) is a portable handheld device with a user interface that is used to test and troubleshoot the BACnet® protocol MS/TP RS-485 communications bus that connects supervisory controllers and field controllers to field point interfaces.

The FIT can be used to check out the wiring of the MS/TP RS-485 bus as well as verify proper communications of supervisory controllers and field controllers connected to the bus. The FIT can be used on both the Field Controller Bus (FCB) and Sensor Actuator Bus (SAB).

The FIT can perform the following functions on the FC/SA Bus:

- Measure bus bias voltage levels
- Communicate with controllers and provide:
    - - Number of Devices Online
    - - Device addresses
    - - Model Name
    - - Application Name
    - - Firmware Revision
    - - Status of **End of Line** (EOL) termination switch
    - - Measure RS-485 communication voltage levels from controller
    - - Other controller attributes
- Monitor and report communication errors

For more information on MS/TP basics see, *MS/TP Communication Basics and the FIT*.

Accessories

The following accessories for the FIT can be ordered separately:

Table 1: Products and Accessories

Code Number	Description
MS-FITCASE-0	FIT carrying case; includes one soft-sided carrying case
FX-BTCVTCBL-700	FIT cable replacement; includes one 5 ft. (1.5m) retractable cable

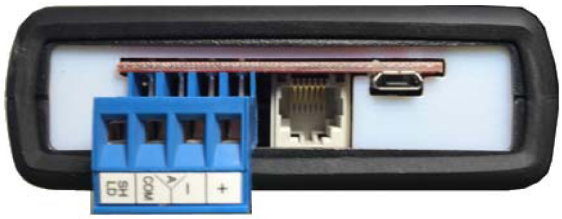
Physical Features

The FIT is a portable handheld device. It is powered by two AA Alkaline batteries through the on/off power switch. The LCD display is a two-line by eight-character display with backlight, and the keypad consists of four keys. A Four-Pin removable terminal block, and the RJ-12 connector cable provide the interface to the MS/TP bus. The FIT also has a Micro-USB port, which is used to update the firmware and extract report data. See Figure 1.

Figure 1: FIT Physical Features

FIT Front View

FIT Top View



Up/Down Arrow Keys —Move the cursor field up or down on the current display, or within a menu. They are also used for incrementing or decrementing a number or digit within a number.

Enter Key—Performs the action of the cursor field on the display.

ESC Key—Returns the display to the previous menu.

Note: All the keys on the FIT have a repeat function in which the key action is repeated when the key is held down for more than one second. For example, if you hold down the **Down Arrow** Key, the cursor field moves down one selection each half second. The repeat rate is the same for all the keys.

General Use and Information

FIT User Guidelines

Observe the following guidelines when using the FIT:

- Do not use the RJ-12 cable to support the weight of the FIT. The FIT comes with a magnetic strap for hanging from ductwork or other metal surfaces.
- Keep the FIT in the protective shell with which it ships.
- The FIT has not been designed for prolonged outdoor use. Leaving it in outdoor environments may result in damage.
- Keep FIT power off when not in use. Test the FIT batteries and replace them when necessary. Prolonged battery use may cause battery leakage to occur.

To view training videos on using the FIT tool, click here to visit the uLearn website.

FIT Connection to Bus

The FIT is provided with a RJ-12 connector cable that is connected to the FC/SA 6 pin RJ-12 jack found on most Johnson Controls® controllers. The FIT also has a Four-Pin removable terminal block that is used to wire the FIT to the FC/SA bus. When the FIT is connected to the FC bus, it can only

see the devices directly connected on the FC bus, but not the SA bus. Conversely, when the FIT is connected to the SA bus, it can only see the devices on the FC bus, but not the SA bus

It is best to connect the FIT tool to the bus and then power it up. Assuming communication is occurring, the FIT first has to determine the baud rate of the communication signal before it can read the communication messages. If the FIT is powered before it is connected to the bus, the mechanical connection causes the bus voltage to be unstable for a time, which can cause the FIT to mistake the proper baud rate. The occurrence of this issue is unlikely, but it can occur. When no communication is occurring (the bus is in a fixed idle state), the FIT initially displays **Offline**.

Modes of Operation

The FIT has three main modes of operation to help troubleshoot MS/TP buses: Monitor mode, Scan Bus mode, and 1-ON-1 mode.

Monitor Mode

The **Monitor** mode allows the FIT to see devices that are connected to and communicating on the bus. If the health bars appear on the display when the FIT is connected to the bus, then communications are occurring. Enter the Monitor mode by pressing the **Enter Key** or by scrolling to the Monitor menu. The Monitor mode only listens to the communications occurring on the bus, does not interact with the communications, and therefore does not affect the operation of the bus. The Monitor mode is recommended to use first if communications are already occurring on the bus. For more information, see the *FIT Menu* and *Monitor Menu*.

Scan Bus Mode

The **Scan Bus** mode interacts with the communications on the bus because it reads the attributes of the controllers communicating on the bus. If no communications are occurring on the bus, the Scan Bus mode starts communications to all controllers on the bus. The Scan Bus mode is helpful when there is not an active supervisory controller connected to the bus since it is the supervisory controller that usually starts the communications due to fixed address. The Scan Bus mode is used to read the EOL termination attribute of the controller. The EOL termination attribute is limited to Johnson Controls manufactured products that have a built-in EOL switch. The location of other EOL devices, such as the MS-BACEOL-0 or jumpers, are not detected. See *Proper EOL Termination*, *FIT Menu* and *Scan Bus Menu* for more information.

1-ON-1 Mode

The **1-ON-1** mode is used to test a single controller that is disconnected from the network with the FIT connected to the FC Bus. In the 1-ON-1 mode, the FIT supplies the proper EOL termination to test the communications of the device. In the 1-ON-1 mode, all of the attributes of the controller can also be read, such as Model name, Firmware revision, EOL termination switch, and other attributes. The 1-ON-1 mode is used to verify the operation of any single controller that does not communicate on the bus. It is used to help determine if a Johnson Controls manufactured controller is defective.

The FIT only validates MS/TP controllers and devices that are hardwired to a FC/SA Bus. Wireless devices are not currently supported other than the 1-ON-1 mode at the controller's SAB port.

For more information, see *FIT Menu* and *1-ON-1 Menu*.

Battery Usage

The FIT is operated from two AA Alkaline battery cells. When operated with the LCD backlight turned off, the FIT can operate for approximately 50 continuous hours. Continuous operation with the LCD backlight on is approximately 20 hours.

There is a battery test under the **Systems** menu to determine when to replace the batteries. To replace the batteries, turn the power switch off. Remove the two AA battery cells and replace with two AA Alkaline cells, while noting the proper polarity of the battery holder.

Getting Prepared to use the FIT

The FIT tool is intended to be used with the Branch Engineered Installation Control Drawings, Riser Diagrams, and Room Schedules. The tool, does not only validate the cable and terminations are correct but ensures the anticipated number of controllers match the quantity found. Validate controller addresses and correct any duplicates.

Before using the FIT, the user needs to make sure the bus installation to be tested (FC or SA) is complete and ready to be validated. This includes the following:

1. Bus cable is installed, and terminated at every controller.

2. MS/TP bus shield is continuous end to end for each bus segment with only one hard ground per bus segment.

   ⓘ **Note:** RJ-12 connections, typically for sensors, do not require use of shielded cable due to distance limitations.

3. EOLs are present at the end of each bus segment.

   ⓘ **Note:** Not applicable for SAB RJ-12 connections.

4. Power is available for every controller on the bus to be validated.

If no power is available to the controller when the MS/TP bus needs to be tested, providing temporary power to the controllers to validate bus wiring is an option. If temporary power to all controllers is not practical, there are two other options:

1. Use two FITs connected at each end of a bus or bus segment if unpowered repeaters are present. Each FIT would be required to have different addresses and EOL set if applicable. See *System Menu* section for more information on setting addresses and EOL attributes.

2. Use one FIT connected at the end of a bus and temporary power applied to the last controller on that bus or bus segment if unpowered repeaters are present. If the FIT is at the end of a bus segment, its EOL attribute should be set to **ON**.

Testing in these two methods does not ensure addresses are correctly set or detect every potential controller MS/TP wiring mistake but does validate continuous bus wiring and end-to-end continuity.

For every installation, it is the installer's responsibility to use the FIT to confirm:

1. A Bus Health reading of four bars or greater for all FC Bus installations.

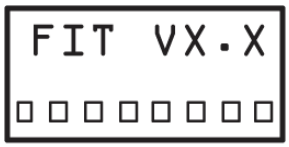
2. All device addresses are reporting for each FC Bus installation and each address is correct.

3. A Bus Health reading of four bars or greater on all SA Bus installations.

   ⓘ **Note:** For most MS/TP installations, a properly installed bus achieves a Bus Health of eight bars. Anything less than eight bars is normally an indication of an installation error but could be caused by extremely long cable distances or a heavily loaded bus.

4. For each SA Bus installation, all device addresses are reporting.

Figure 2: FIT Menu Screens



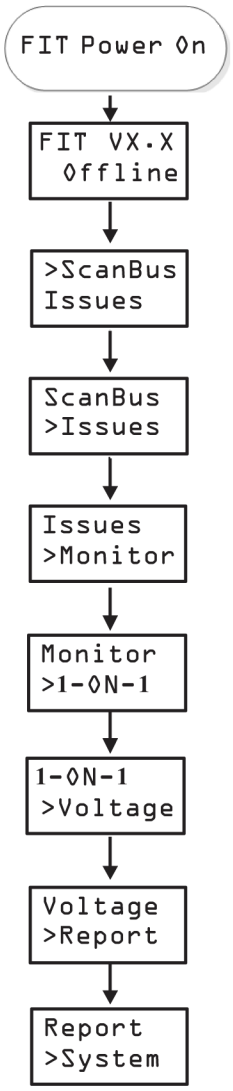
FIT Bus Health with eight bars showing.

FIT Monitor Bus mode with 12 devices reporting.

The FIT is designed to work with MS/TP hard wired controllers only and ignores wireless connected controllers.

FIT Menu

Figure 3: FIT Menu



The **FIT Firmware Revision** VX.X displays on the first line. The second line shows the Offline message if no MS/TP bus traffic is detected. If bus traffic is detected, the Bus Health bars display.

The **Scan Bus** menu, when selected, communicates to all controllers on the bus and report the status of all the controllers communicating. The Scan Bus mode starts communications if no communications are occurring.

The **Issues** menu reports the last five communication errors and other bus issues when connected to an MS/TP network.

The **Monitor** menu reports on the status of all controllers connected to an MS/TP network. It reports the number of devices, address, and other information. The Monitor mode only listens to communication on a bus.

The **1-ON-1** menu is used to report on the status of a single controller connected to the FIT but not connected to the network.

The **Voltage** menu is used to measure the idle voltage of the RS-485 bus and the bit voltage of the communications.

The **Report** menu has six submenu operations: **Save, Name, View, Delete, Upload**, and **Format**.

The **System** menu controls the Backlight feature, EOL termination, FIT Battery Test, FIT Baud rate, FIT Address, and System time functions.

FIT Power On Menu

Figure 4: FIT Power Menu

The FIT Firmware Revision VX.X displays on the first line. The second line displays an Offline message if no FC/SA bus traffic is detected. The second line displays Timing, which indicates the FIT is determining the baud rate of the bus.

The FIT Firmware Revision VX.X displays on the first line. If FC/SA bus traffic is detected, the second line displays the Bus Health which consists of one to eight bars. Eight bars is currently shown.

In this initial power on mode, the FIT is just monitoring FC/SA bus communications and is not actively participating in communications.

The **Bus Health** consists of eight bars indicating the health of the FC/SA communication bus. The higher number of bars the higher the health. When the FIT is first connected to the bus, the Bus Health starts out at eight bars and then the communications are monitored for errors. The number of bars is reduced if communication errors are occurring. Communication errors can occur for various reasons such as noise from electrical sources, long wire lengths, heavily loaded buses, loose terminations, duplicate addresses, or improperly wired buses. Some communication errors are tolerated as long as they do not cause issues such as controllers going online and offline, erratic communications, or poor system control.

A Bus Health reading of eight bars is obviously desired, but it is considered acceptable to have a Bus Health reading of four bars or more. Bus Health is basically calculated by counting communication errors over time. A Bus Health of four bars equates to two communication errors per minute, which is tolerable for FC/SA communications.

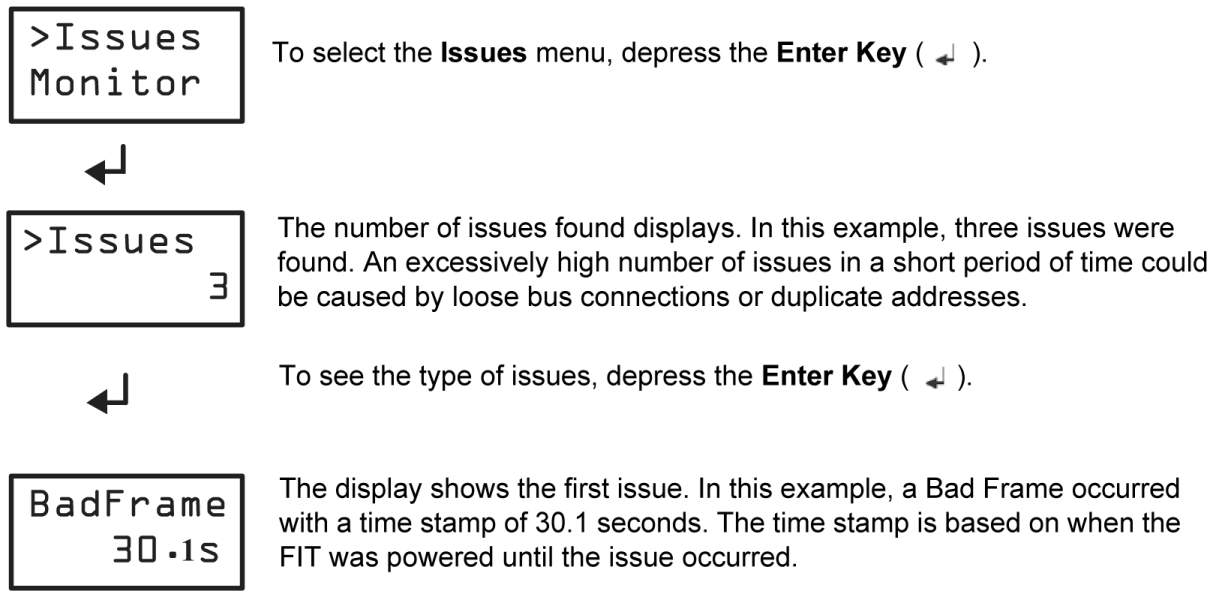
When the FIT powers on, it may display **No MSTP**. This can mean the FIT is seeing bus traffic, but a token is not passing between addresses. This occurs when one or multiple FEC/VMA controllers on the bus have an address switch position eight (normally labeled 128) in the **ON** position. This switch is not to be used on a hard-wired Johnson Controls MS/TP Bus. It is reserved for Wireless bus installations. If you see this condition, validate that all FEC/VMA MS/TP hard-wired controllers have the 128 switch in the **OFF** position.

No MSTP can also be displayed if an MS/TP bus which is active has installation errors significant enough for the FIT to fail determining a baud rate. If this condition is experienced, use the FIT's Voltage > IdleBus to validate proper voltages (see *Voltage Levels* for more information). In addition, the FIT's baud rate could be adjusted from the default autobaud in the System Menu to the specific baud rate of the bus that is being tested (see *System Menu* for more information).

FIT Issues Menu

The **Issues** menu reports on any bus errors or other issues that are occurring on the FC/SA bus the FIT is monitoring. The FIT is constantly monitoring the FC/SA bus for errors. Only the most current five the fire mose current issues are retained in FIT history, but the FIT continues to count and update the number of issues during an MS/TP validation session. If the FIT is turned **OFF**, issue count and history are not maintained. For a list of common issues and corrective actions, see Figure 5. **No MSTP** displays when the FIT is connected to a Bus with a very poor Health Index.

Figure 5: FIT Issues Menu



ⓘ **Note:** To display the rest of the issues, depress the **Down Arrow** to scroll through the issues. On any issue being displayed, depressing the **Enter Key** provides more information specific to that issue. See Table 2 for a list of possible common issues. See the *FIT Display Table* for more information of terminology used and acronyms in the display examples.

Figure 6: Issue History

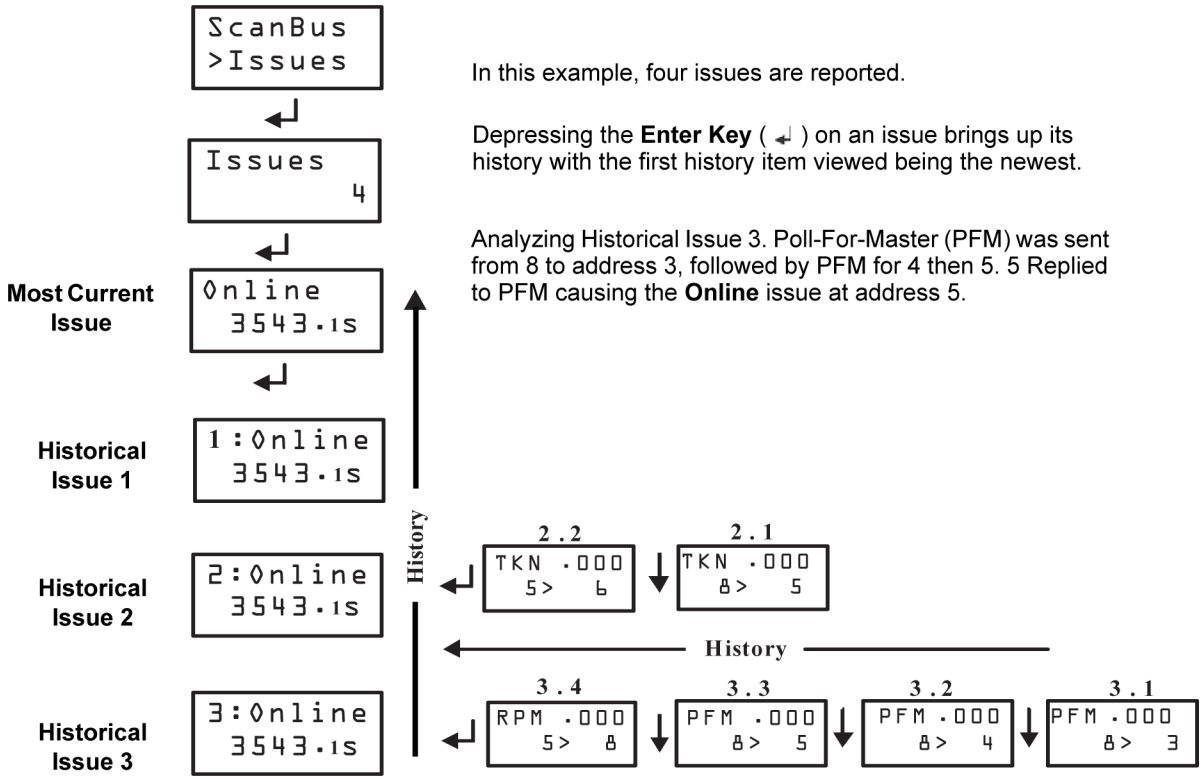


Table 2: List of Common Issues and Corrective Action

Display	Description	Potential Corrective Action
BadFrame *system time*	Bad MS/TP frame. Invalid MS/TP header CRC or data CRC. Bad frames are typically caused by wiring issues, duplicate addresses, wrong baud rates and/or noise.	1. Check Idle Bus Voltage. 2. Confirm the correct FIT baud rate is being used. 3. If repeaters are present, check their baud rate. 4. Check for duplicate addresses. 5. Break the bus segments down into smaller segments to isolate, find and correct the wiring problem.

Table 2: List of Common Issues and Corrective Action

Display	Description	Potential Corrective Action
Online *system time*	Device came online. This is listed as an issue because a device came online after the last bus loop.	Unless the controller was purposely removed from the bus or had its power turned off, determine why it came online late. This could be caused by a problem with termination of 24 VAC power or bus cables. Go to the controller in question and make sure all 24 VAC power and bus cables are securely terminated. ⓘ **Note:** If token passing is not occurring and is initiated with the FIT connected to a bus (ScanBus Menu is selected), Online Issues may result until all addresses participate in the token passing loop.
ChrFrame *system time*	Received character framing error. Character frames can also be caused by wiring issues, duplicate addresses, wrong baud rate or noise.	1. Check Idle Bus Voltage. 2. Confirm the correct FIT baud rate is being used. 3. If repeaters are present, check their baud rate. 4. Check for duplicate addresses. 5. Break the bus segments down into smaller segments to isolate, find, and correct the wiring problem.
2ndTkn *system time*	MS/TP token was re-transmitted. A device handed off the token, but did not see any characters transmitted on the bus, so it re-transmitted the token.	1. Can be caused by wiring problems such as loose wires. If one controller has to send a token more than once it could be a wiring issue with the controller receiving the token. 2. It can also be caused by a duplicate address situation where an address was changed and duplicated on a communicating bus.
Offline *system time*	Device went offline. This device was online, received a PFM (Poll for Master) and did not reply to it.	Same potential corrective actions as **Online**

Table 2: List of Common Issues and Corrective Action

Display	Description	Potential Corrective Action
EOL >2 system time	More than two devices with EOL switch **ON**. When the FIT is reading multiple bus segments (across repeaters) more than 2 EOL's could be expected.	If reading more than 2 EOL switch positions **ON** for a single bus segment, review switch positions of each controller on the bus segment to ensure only the actual controllers at the EOL are being used. See *Proper EOL Termination* for more information.
OutOfSeq	A device on the bus talked Out of Sequence or attempted communication without the token.	1. Check to make sure there are not EOLs set in the middle of a bus segment. Not typically caused by installation errors. Identify issue to Johnson Controls® personnel, so it can be addressed with the manufacturer.

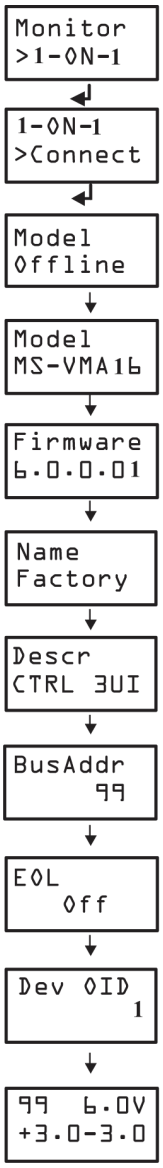
1-ON-1 Menu

The **1-ON-1** menu is for testing a single controller disconnected from the network. The controller of interest should first be disconnected from the network bus. For the 1-ON-1 test, the FIT should be connected to the controllers MS/TP bus of concern being either the FC bus or the SA bus. The FIT can either be plugged into the RJ-12 jack on the controller if available or wired to the FC bus or SA bus terminal block of the controller.

ⓘ **Note:** If the controller being connected to is not disconnected from the network and is in an idle state, the connection can start the token passing on an idle network.

Use the 1-ON-1 test to verify the operation of an individual controller that may be having communication issues when connected to the network or a controller that may not be functioning properly. The FIT 1-ON-1 test communicates to the controller and provide feedback to the user pertaining to the operation of the controller.

Figure 7: 1-ON-1 Test Menu



To select the **1-ON-1** menu, move the cursor to the 1-ON-1 line and depress the **Enter Key** (↵).

The **Connect Command** starts the FIT communicating with the controller. Depress the **Enter Key** (↵) to select.

It should take the FIT less than a minute to connect to and read the controller. The **Offline** status appears until the FIT connects. Once the FIT connects the **Reading** status appears until the information is read from the controller.

The controller model name is displayed by scrolling across the screen. This example would show the **MS-VMA1630-0** when fully scrolled.

The controller **Firmware** revision is displayed by scrolling across the screen. this example would show the **6.0.0.0159** when fully scrolled.

The controller **Application Name** is displayed if the controller has one programmed. In this example, the factory default **Factory VMA-1630** is the application name when fully scrolled. This factory default allows input and outputs to be validated through a display (*Part: MS-DIS1710-0*).

The **Controller Description** displays if the controller has one programmed. In this example, the description reads **CTRL 3UI, 3BI, 2CO** when fully scrolled.

The **Controller Address** switch is read and displayed. In this example, the controller address is set to 99.

The status of the **End of Line** switch appears. This example shows the EOL switch is in the **OFF** position. For controllers that do not have an EOL or do not report its status the display reads, **Unknown**.

The BACnet device ID for the connected controller.is displayed.

The communication bus voltage levels of the controller appears. The address of the controller is displayed in the upper left corner (99). The total voltage (6.0V) and the Field bus + signal and - signal voltage levels are displayed. The total voltage is the combination of the + and – voltage levels.

The 1-ON-1 test provides the following information from a Johnson Controls manufactured controller:

- Model Type
- Firmware Revision
- Application Name
- Controller Description
- FC/SA Bus Address
- Status of EOL termination switch (ON/OFF)
- Voltage level of RS-485 communication from controller

Notes:

- The **Up Arrow** key is used at any time to return to the previous screen.
- The EOL is automatically turned on.
- See *Voltage Levels* for more information on bus voltage levels.

Monitor Menu

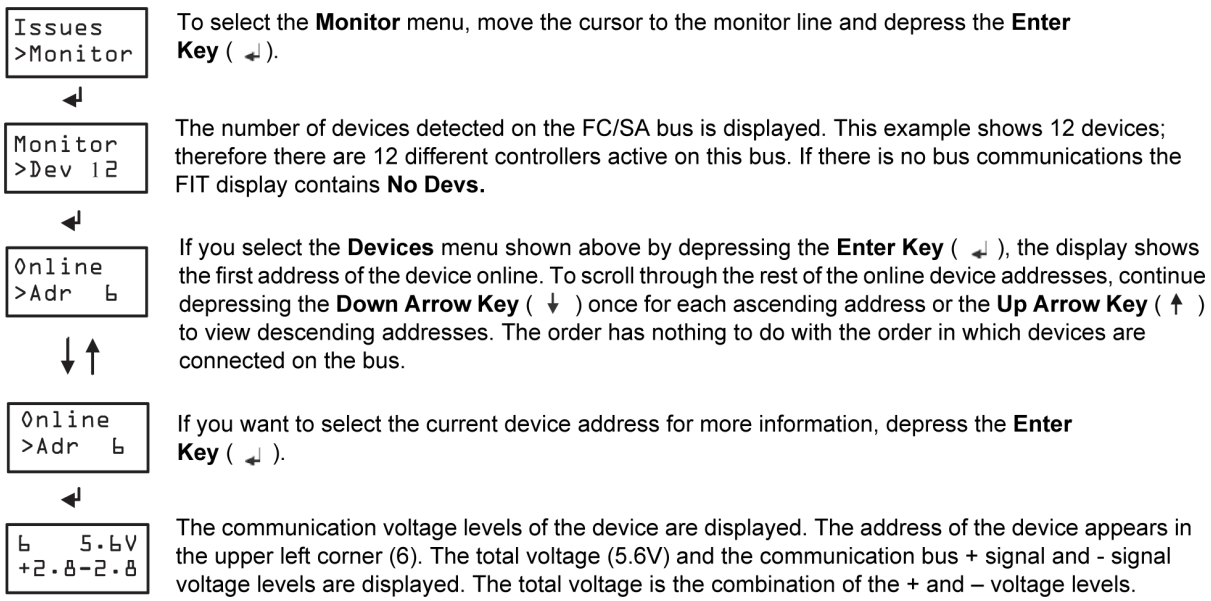
The **Monitor** menu is used to monitor FC/SA bus controllers on a connected network. In the Monitor mode the FIT monitors communications occurring on the bus and report the status of the devices communicating.

When powered and connected to the bus if the FIT automatically displays the health bars, then communication is occurring and the Monitor mode is entered by depressing the **Enter Key**. See Figure 8.

In the Monitor mode, the FIT monitors communications and report:

- The number of devices online
- The address of each device online
- The communication bus voltage levels of the device

Figure 8: Monitor Menu



ⓘ **Note:** See *Voltage Levels* for more information on bus voltage levels.

To scroll through the rest of the communication voltages for each controller address, keep depressing the return key once for each device address. If you hold down the **Return Key,** the display automatically scrolls through the voltage readings.

Scan Bus Menu

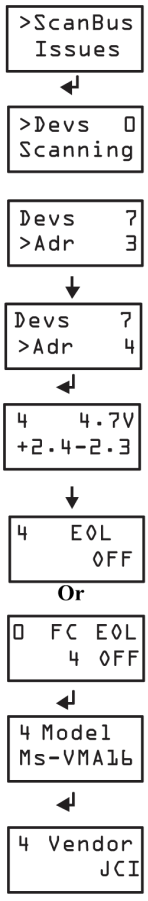
The **Scan Bus** mode is used to initiate, monitor, and interrogate controllers on the FC/SA bus. In this mode, the FIT communicates with the controllers to read their attributes. The Scan Bus mode

is used when there are communications occurring on the bus or if there are no communications occurring. If no communication is occurring, do not initiate the Scan Bus mode until you verify that the idle bus voltage readings are at their desired levels on each bus segment. See *Idle Bus Voltage Levels* and the *Voltage Menu* section for more information. Selecting Scan Bus initiates communications to all devices on the bus. A correctly installed bus scan completes within a couple of minutes.

In the Scan Bus mode, the FIT monitors communications and interrogates controllers to report:

- The number of devices online
- The address of each device online
- The communication bus voltage levels of the device
- Status of EOL termination switch on the device
- Model
- Vendor

Figure 9: Scan Bus Menu



To select the **Scan Bus** menu, move the cursor to the Scan Bus line and depress the **Enter Key** (↵).

When the FIT begins scanning, the word **Scanning** scrolls on the bottom of the display. The FIT display shows 0 devices until it detects devices on the bus. If no communications were occurring on the bus, it takes time (usually less than a minute) before the FIT starts displaying the devices.

When the FIT begins scanning, the word **Scanning** scrolls on the bottom of the display. The FIT display shows 0 devices until it detects devices on the bus. If no communications were occurring on the bus, it takes time (usually less than a minute) before the FIT starts displaying the devices.

The display updates showing the number of devices and the address of the first device.
To scroll through the addresses, use the **Down** or (↓) **Up Arrow Key** (↑).
If you want to select the current device address for more information, depress the **Enter Key** (↵).

The communication voltage levels of the device are displayed. The address of the device appears in the upper left corner (4). The total voltage (4.7V) and the communication bus + signal and - signal voltage levels are displayed. The total voltage is the combination of the + and – voltage levels.You can use the **Enter Key** (↵) to scroll through the voltage levels of all of the devices.To read the next attribute, depress the **Down Arrow Key** (↓).

FC Bus If connected to an FC Bus, the status of the End of Line switch is displayed. This example shows the EOL Switch is in the **OFF** position. For controllers that do not have an EOL or do not report its status, the display will read **Unknown**.
You can use the **Enter Key** (↵) to scroll through the EOL status of all the devices.

SA Bus If connected to an SA Bus (the RJ of a Network Sensor), both the FC Bus Address and the status of the End of Line are displayed. The **0** indicates the fixed SA Bus Address of the controller.

The controller **Model** name scrolls across the screen. This example shows **MS-VMA1630-0** when fully scrolled. Displayed for most Johnson Controls products, otherwise the display shows **--------**.

The controller **Vendor** property for device. Displayed for most Johnson Controls products, otherwise the display shows **unknown**.

Note: Use Expert mode instead of Install mode when you need to read a greater number of attributes from each device. The FIT defaults to Install mode to make user operation easier. The User Mode can be changed from Install to Expert under the System Menu. See *System Menu* for more information. Using the Expert Mode communication is slower when a large

amount of information is being transmitted and received. For Johnson Controls manufactured equipment, Model and Vendor data are displayed.

For a complete list of all attributes, and modes see the Table 9. See *Network Communication Voltage Levels* for more information on bus voltage levels.

Voltage Menu

The voltage menu has three voltage reading modes available:

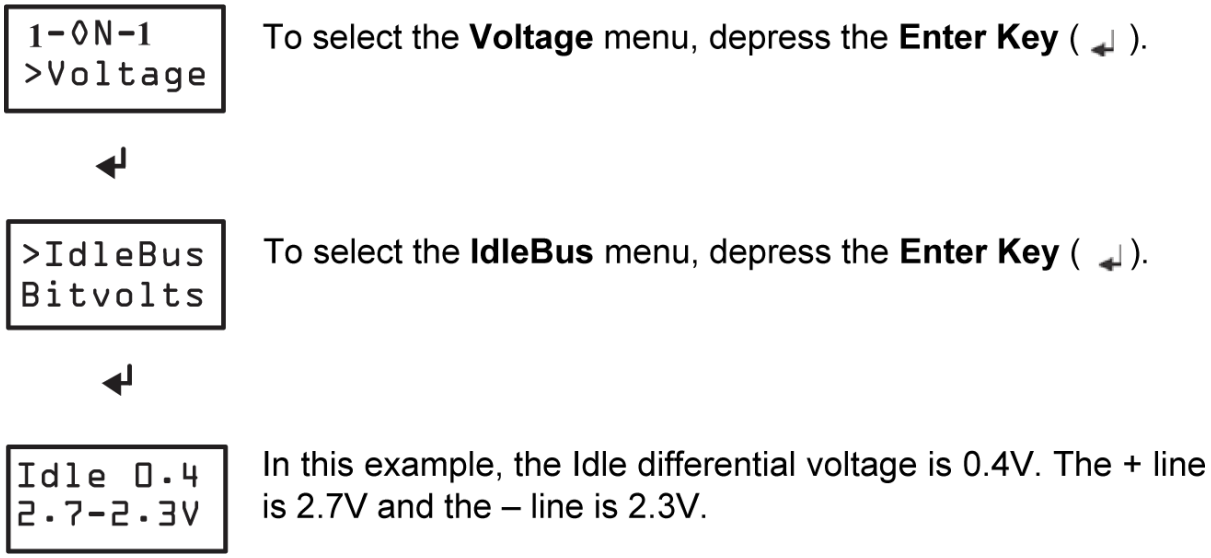
- Idle Bus Voltage
- Bit Voltage
- Meter

Idle Bus Menu

When selected, the **Idle Bus Menu** reads the bus bias voltage when no communications are present. Proper idle bus voltage levels will not be displayed unless EOL termination is present. The idle bus voltage menu shows the + line voltage with respect to the COM line and the – line voltage with respect to the COM line. The FIT can still read this voltage on an active communication bus by taking readings during communication pauses. For acceptable Idle Bus Voltage ranges, see *Voltage Levels* and the *Voltage Table*.

Note: It is possible and normal for there to be minor voltage fluctuations while reading Idle Bus Voltages.

Figure 10: Idle Bus Menu



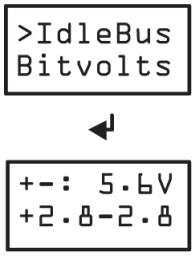
See *Idle Bus Voltage Levels* for more information.

Bit Voltage Menu

The **Bit Voltage** menu displays in real time the voltage when communication is occurring on the bus. The differential voltage and bit voltage (+, – line with respect to COM) from a controller are shown on the display. Approximately every half second, a new voltage sample is taken from the bus and displayed. The voltage sample could be from any controller on the bus that is communicating at the time of the sample. Use the Bit Voltage mode for a quick look at the quality

of the communications occurring on the bus. For acceptable Bit Voltage ranges, see *Voltage Levels* and the *Voltage Table*.

Figure 11: Bit Voltage Menu



To select the **Bit Voltage** menu, depress the **Enter Key** (↵).

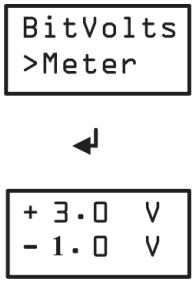
The differential voltage and bit voltage of the + and – line are displayed. Every 0.5 seconds a new voltage reading appears.

Meter Menu

The **Meter** menu turns the display into a voltmeter that is measuring the current voltage seen on the bus. This mode can be used to look at voltage bias levels or to determine if there is any voltage caused by noise sources or improper wiring occurring on the bus.

It is important to understand that once MS/TP communication is active, voltage readings with a Volt-Ohm-Meter (VOM) or via the FIT's Voltage Menu item Meter are largely irrelevant. These readings could be used and provide meaningful data only if the MS/TP is completely idle due to communication not being activated by an NAE or the FIT tool. For an active bus, to achieve this complete idle state, every controller would have to be powered down, bus connection to the NAE removed and the controllers powered back up. If the FIT is connected to a properly wired bus and indicates Offline, meaning the Bus Health bar is not displayed, the bus is in an idle state and will remain that way until the FIT Tool, NAE or some other device starts MS/TP communication. The FIT is designed to work around typical VOM limitations and can provide idle bus reading on active MS/TP communications. See the *Voltage Levels* for more information.

Figure 12: Meter Menu



To select the **Meter** menu, depress the **Enter Key** (↵).

In the **Meter** menu when the FIT is not connected to a FC/SA, the voltages shown are caused by bias resistors on the FIT. When connected to a FC/SA terminated bus these voltages are overridden by the bus voltage.

System Menu

Some of the System Menu selections have user functions to adjust variables to match the condition being tested. Any adjustments changes made will reset to their default values at FIT power on.

The System Menu has the following functions:

BackLit—Turn backlight On/Off. The default setting is Off.

EOL—Turn the EOL termination on the FIT On/Off. The EOL termination is controlled by the FIT depending on the function being used, either the 1-ON-1 Mode Default EOL is on or the Monitor and Scan Bus mode default EOL is **Off**. This command allows the user to override the EOL status.

Mode—Select the Install mode or the Expert mode. In expert mode when using Scan Bus menu more attributes are available to read from the device such as Model, Firmware Version, Application name and more. The default mode is Install mode and is recommended for most users.

Battery—Select Battery to perform a battery test, display the battery status of Good/Replace or display the battery voltage

Baudrate—Select FIT baud rate to Auto Baud, 9600, 19200, 38400, 76800. Auto Baud is default mode.

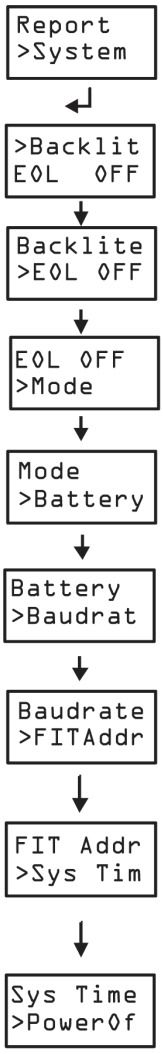
FitAddr—This menu allows the user to change the FIT address on the MS/TP bus. The default address is 1. If the FIT determines there is already a device addressed at 1, it will automatically default to the next available free address.

Sys Time—Displays the amount of time FIT has been powered in seconds.

PowerOf—Displays the amount of time in minutes the FIT will stay in operation before moving into a Sleeping mode. Adjustable from zero to 99 minutes. Default is 15 minutes and zero minutes means never enter sleep mode.

RS-485—Displays communication bit voltages, bit times and calculated baud rate of the connected RS-485 circuit.

Figure 13: System Menu



To select the System menu, depress the **Enter Key** (↵).

To move to next menu, depress the **Down Arrow Key** (↓). To turn **Back Light On/Off**, depress the **Enter Key** (↵)

To move to next menu, depress the **Down Arrow Key** (↓). To turn the **EOL** termination **On/Off** depress the **Enter Key** (↵).

To move to next menu, depress the **Down Arrow Key** (↓). To select the **Mode,** depress the **Enter Key** (↵). Depress the **Enter Key** again to select between **Install** and **Expert** mode. Expert mode allows more attributes to be displayed in both Monitor and ScanBus operation.

To move to the **Battery** menu, depress the **Down Arrow Key** (↓) twice.
To test battery depress the **Enter Key** (↵). The display shows **Battery** status **Good/Bad**. Depress the **Enter Key** again to display battery voltage.

To move to next menu, depress the **Down Arrow Key** (↓). To change baud rate depress the **Enter Key** (↵). The display shows Autobaud. Depress the **Down Arrow Key** to scroll through baud rates. Depress the **Enter Key** to select baud rate.

To move to next menu, depress the **Down Arrow Key** (↓). To change FIT address, depress the **Enter Key** (↵).The default address is **1**. Use the **Up** (↑) and **Down Arrow Keys** to scroll through addresses. Depress the **Enter Key** to select an address.

To move to next menu, depress the **Down Arrow Key** (↓). To view how long the FIT has been powered on, depress the **Enter Key** (↵). The display shows a timer **ssss.s** in seconds. Depressing **ESC** returns to the menu.

To view or adjust how long the FIT will stay active before going to sleep, depress the **Enter Key** (↵). The display shows mm in minutes. Default is 15 minutes and is adjustable from 0 to 99 minutes. 0 minutes means the FIT will not enter sleep mode automatically. Pressing **ESC** will return to the menu.The FIT displays **Sleeping** if the number of minutes since a key has been pressed has passed. The FIT must be powered **Off** before usage can resume.

See *Proper EOL Termination*, *Voltage Levels*, *Report Menu*, and *Communication Voltage Levels* for more information.

Report Menu

The FIT can save up to seven reports. The information saved to a report is captured from the current data in the FIT's memory. Normally only complete and functional FC Bus installations are saved to Reports but if problems persist during installation validation a Report could be used to capture and share information about a bus or bus segment.

Each Report has three types of information stored as follows:

- General Bus Information
- Device Information
- Issue Information

General Bus Information

The General information section of the report is one record and contains the following information:

Table 3: General Bus Information

Heading	Description
Report Name	Name of the report entered by the user.
Health	The Bus Health Index.
Devices	The quantity of devices on the bus.
Idle Volts	Differential Voltage Idle. This is + to – voltage reading without communication.
Idle +	+ to Com Idle Voltage reading without communication.
Idle -	- to Com Idle Voltage reading without communication.
Issues	The number of issues reported.
Token Loop ms	The recorded Loop Time.
Runtime sec	This is the number of seconds from when the FIT was powered on until the data was captured. The FIT does not have a Clock. If report date and time is desired the information must be captured manually.
Report # (Seq Num)	This is a sequential number the FIT assigns to each report.

Device Information

The **Device** information section of the report is one record per address discovered. Some information in this section can only be completed if:

- a ScanBus was performed
- The device is a Johnson Controls manufactured product.

If either of these two items are not true the report fields, except Address, will result with **unknown**. See Table 4 for information on the Device Section.

Table 4: Device Information

Heading	Description
Address	The device address for each device recorded. By default these are sorted ascending by address number.

Table 4: Device Information

Heading	Description
Model	Device object Model Name property for device at address. (Typically only Johnson Controls manufactured devices.)
Type	Device object Vendor property for device at address. (Typically only Johnson Controls manufactured devices.)
Transmit Volts	The differential communication voltage recorded for the device at address.
EOL	The Position of the End-Of-Line Switch reported at address. (Typically only Johnson Controls manufactured devices.)

Issue Information

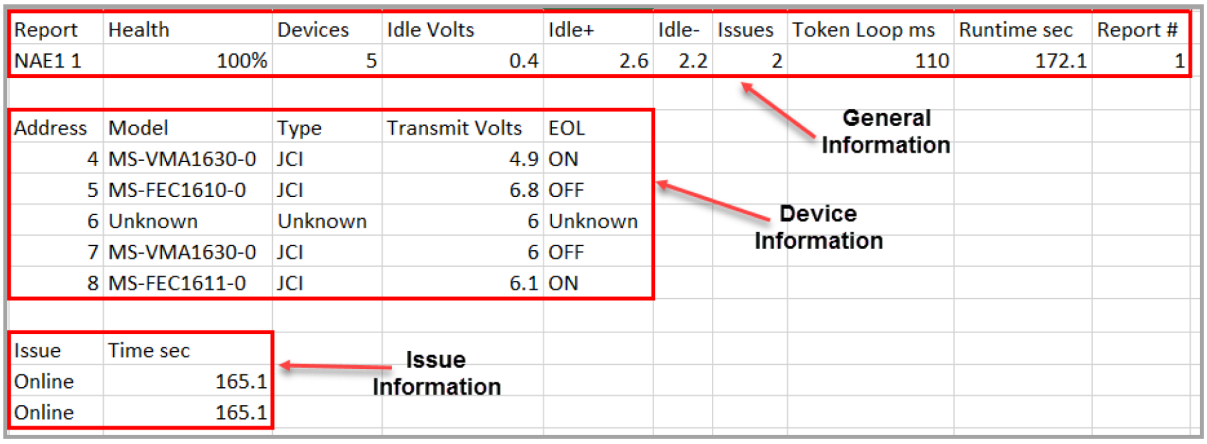
The Issue information section of the report is one record per issue recorded.

Table 5: Issue Information

Heading	Description
Issue	The name of the issue (Online, Badframe) SeeTable 2 for a complete list of possible recorded issues.
Time sec	This is the number of seconds from when the FIT was powered on until the issue was captured.

Example Report in Excel

Figure 14: Example Report



Report Submenu

The Report menu has six submenu items:

Save: Save the current data in the tool to a Report.

Name: Enter the name of the report.in alphanumeric characters. For FC Bus reports, it is recommended to use the Engine name followed by trunk number, if applicable.

ⓘ **Note:** NAE1 1 would mean trunk 1 on NAE 1.

View: View the data currently stored in a report. The display shows the general information. When viewing a report and the display is on **Devices**, depressing the **Enter Key** results in the Device information screen being displayed. When the display is on **Issues**, depressing **Enter** results in the Issue information screen being displayed.

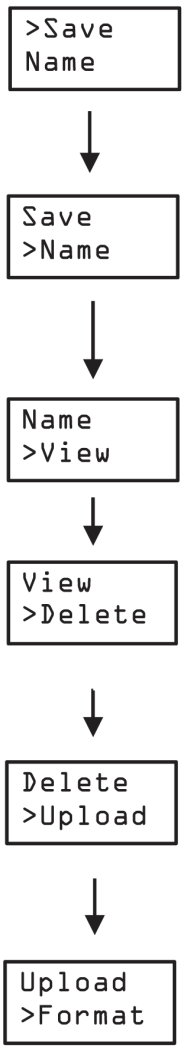
Delete: Allows a report to be deleted.

Upload: Sends a report to a computer connected through the Micro-USB port.

Format: Select the format of the report to be sent. Select either **tab** or **csv** formats.

ⓘ **Note:** The CSV file format best used with Microsoft® Notepad or a similar simple text editor. The TAB format is best used with most other applications.

Figure 15: Report Submenu



To move to next menu, depress the **Down Arrow Key** (↓). To save a report, depress the **Enter Key** (↵). The display shows **Save** with the report number and name. The report number is the first available location and up to seven reports can be saved. Depress the **Down Arrow Key** to enter or edit the **Report Name**. Depress the **Enter Key** to save the Report. When a report is saved, a confirmation screen is shown. Depress the **ESC Key** to back out of any step in the **Save** menu.

To move to next menu, depress the **Down Arrow Key** (↓). To enter a report name, depress the **Enter Key** (↵).Use the **Up** (↑) and **Down Keys** to edit the desired alphanumeric name. Depress the **Enter Key** to move to the next character in the name. Up to eight characters can be used. Continue to depress the **Enter Key** to store the desired name. When a **Name** is complete, the screen defaults back to the **Name Submenu**. Depressing the **ESC Key** while entering a name goes back to the previous character or from Character 1 aborts the Name edit.

To move to next menu, depress the **Down Arrow Key** (↓). To view a report, depress the **Enter Key** (↵). The display shows View with the report number and name. Depress the **Enter Key** again to view a report. Use the **Up** (↑) and **Down Arrow Keys** to move from field to field in the report. While on either **Devices** or **Issues**, depress the **Enter Key** to view device or issue information. Depress the **ESC Key** to stop viewing a report.

To move to next menu, depress the **Down Arrow Key** (↓). To delete a report, depress the **Enter Key** (↵) .The display shows Delete with the report number and name. Use the **Up** (↑) and **Down Arrow Keys** to move from report to report. Depress the **Enter Key** again to delete a report. Depress the **ESC Key** to exit the **Delete** submenu.

To move to next menu, depress the **Down Arrow Key** (↓). To upload a report to a computer, depress the **Enter Key** (↵). The display shows **UpLoad** with the report number and name. Use the **Up** (↑) and **Down Arrow Keys** to move from report to report.Depress the **Enter Key** again to upload a report. **Sending** is displayed on the screen. Depress the **ESC Key** to exit the **Upload** submenu or to abort sending a report.

Note: Make sure a computer is connected by using the Micro-USB port and the desired computer program, such as Microsoft® Excel®, is open and selected on the computer before depressing the **Enter Key** to upload the report.

To move to next menu, depress the **Down Arrow Key** (↓). To set the format of a report to send to a computer, depress the **Enter Key** (↵). The display shows **Format** and either **TAB or CSV**. Use the **Up** (↑) and **Down Keys** to change the desired type. Depress the **Enter Key** again to save the desired type. Depress **ESC** to exit the **Format** submenu.

Appendix A

MS/TP Communication Basics and the FIT

MS/TP is a token-passing (TP) communication protocol used in the building automation and HVAC (Heating, Ventilation, and Air-Conditioning) industry that allows devices to communicate with one

another. The physical layer in which MS/TP communicates is called RS-485. This physical layer consists of the hardware, including address settings, cable, terminations, EOLs, baud rates, or shield grounds that allow the MS/TP communication protocol to travel from controller to controller and other devices.

To understand the data the FIT provides, it is important to have an understanding of how MS/TP communication basically functions. MS/TP only allows for one controller or device to talk at any given point in time. Communication is controlled by passing a token from controller to controller based on address in a serial fashion (address 0 to 1 to 2 to 3 to 4). A controller or device must have its token to communicate on the bus. Once its communication is complete, it passes the token to the next address. This cycle repeats which each individual cycle is called a loop. The amount of time for one loop is called Loop Time. The FIT displays this as looptime. It also provides other useful bus statistics.

When a controller has the token, it transmits data in Frames. These Frames are structured in size and content but ultimately contain the information being communicated, the address of the communicating controller, or the address of the destination controller.

For a loop to be successful, the physical layer has to be installed correctly. For example, if you have two different MS/TP devices with the same address, the network becomes unstable and produces unpredictable results. Both devices incorrectly perceive that they received the token and they transmit outbound messages at the same time. This causes communication collisions. The FIT attempts to let the user know about any communication collisions or other problems with the physical layer. See the *FIT Issues Menu* for more information.

For detailed information on BACnet® MS/TP Bus communication, installation, related documentation, and cable guidelines refer to FAN-410 (File Access Number) Installation Quick Reference Handbook (HVAC), Section 10 *BACnet MS/TP Communications Bus Guidelines (LIT-12011034)*, and FAN-410 Section 45 *Metasys* System Cable and Wire Standards.

Most Johnson Controls manufactured devices are defaulted from the factory with a baud rate of Auto Baud; however, the Network Automation Engine (NAE), as an example, is defaulted to a baud rate of 38,400. This means that if no communication is occurring, then the NAE starts a token at 38,400, whereas, in the absence of an NAE or another device with a fixed baud rate, Johnson Controls devices wait for a valid signal on the trunk before attempting to communicate. A bus in this state is called idle. It is important to understand that if even one bus connected device is set to a valid baud rate (38,400, 76,800), this fixed idle state does not occur even when the NAE is removed.

Having a bus in a fixed idle state has some advantages for troubleshooting various problems. In this state, the bus should have very stable voltage readings so that a digital Volt-Ohm-Meter (VOM) or the FIT's Meter, from the *Voltage Menu*, could be used to make sure all controllers are terminated properly and End-of-Lines (EOL) are set. If the FIT is connected to an MS/TP bus in a fixed idle state, it will display **Offline**. The FIT has the ability to start the token passing and request information from each controller on a bus. This feature is called Scan Bus. More information on this mode of operation is provided in the *Scan Bus Menu* section of this guide.

Once communication is occurring, the voltage on an MS/TP will change as communication occurs. A digital VOM in this state, can no longer provide reliable readings because of this fluctuation. If connected to a bus that already has communication occurring the FIT has the ability to merely listen, collect information, gather statistics, measure idle voltage readings when communication pauses or bit voltage readings when communication is occurring, and report bus health based on bus traffic and errors. If the FIT is connected to an MS/TP bus when communication occurring, it will automatically display the bus health. This listen-only mode of operation by the FIT is called Monitor Bus. More information is provided in the *Monitor Menu* section of this guide.

It is also important to understand MS/TP Bus installations can have Johnson Controls or Third-Party Vendor manufactured devices on them. Information availability, device responses, default baud rates, and voltage readings will vary from product to product and manufacturer to manufacturer. The information in this guide is based on the FIT's use with current Johnson Controls manufactured products.

The *FIT Display Table* contains information for every potential FIT displayed item. The purposed of the table is to provide additional information about each FIT menu, selection or result.

Voltage Levels

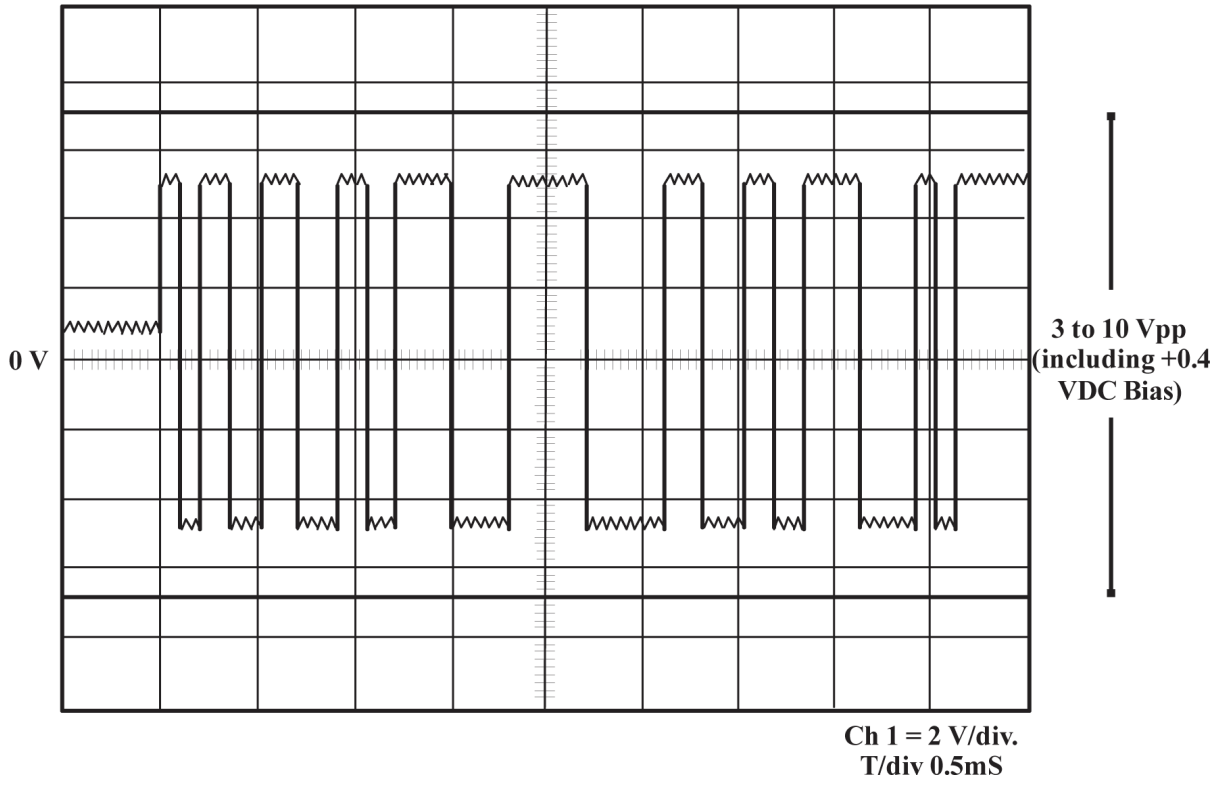
There are two types of voltage levels read by the FIT.

- Communication Voltage Levels—The voltage when communication is active (also called BitVolts).
- Idle Voltage Levels—The voltage when communication is inactive. The FIT can still read this voltage on an active communication bus by taking a reading when communication pauses.

Communication Voltage Levels

The FIT can measure the voltage levels on the RS-485 MS/TP communications on the FC/SA bus. The RS-485 communications produce a differential voltage between the + and – communication wires. The differential voltage is the addition of the + wire voltage with respect to the COM wire and the – wire voltage with respect to the COM wire. The FIT will measure the (+, COM) voltage and the (–, COM) voltage, and the sum of these voltages is the differential voltage. If you view the differential voltage of a RS-485 communication on an oscilloscope, it resembles Figure 16.

Figure 16: Communication Voltage Example



ⓘ **Note:** The waveform is uniform above and below the 0 V line which represents the COM line. The bus EOL termination provides approximately 0.4 VDC of bias voltage to keep the bus in the high state when communications are idle. The EOL also provides proper bus termination.

When reading an FC Bus with multiple controllers, this Communication Voltage is the reading displayed by the FIT during the Monitor or Scan modes. It can also be displayed though the Voltage menu in submenu item BitVolts, but the reading displayed through the Voltage menu is from the controller on the bus that is communicating at the time of the sample was read when no address is provided by the FIT. Ideally, the + to COM and – to com readings should have an absolute value almost equal and no more than approximately 0.2 VDC apart. When the two readings have an absolute value greater than approximately 0.2 VDC difference, it could mean there is a

loose connection on the bus cable at the controller, some other cable problem near the address displayed, or a problem with the controller itself.

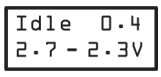
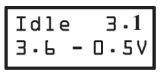
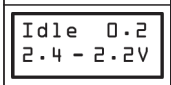
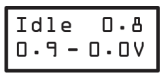
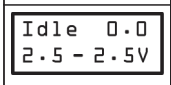
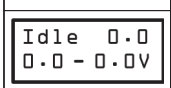
Idle Bus Voltage Levels

With proper EOL termination, the idle bus voltage should read approximately 2.7–2.3 VDC or 0.4V DC differential. The + communication line is biased at 2.7 VDC with respect to the COM line and the—communication line is biased at 2.3 VDC with respect to the COM line. The idle bus voltage can vary with wire length and bus loading but should not be lower than approximately 0.2 VDC differential or higher than approximately 0.9 VDC differential.

ⓘ **Note:** It is also possible to read minor voltage fluctuations while reading the idle bus voltage. These minor changes are normal.

Reading the idle bus voltage is a good way to find common wiring mistakes. If you discover that the MS/TP voltages are outside the recommended ranges, see Table 6 for guidelines and possible solutions.

Table 6: Using Voltages and Issues to Troubleshoot

FIT Display	Installation Problem	Idle Bus Voltage Symptom	FIT Issues Menu	Resolution Process
	None	None	None	FIT is showing a correct reading
	Missing all EOLs, Cut Cables	Reading value greater than 3 VDC.	2*nd* Token	Look at as-built drawings. Check EOLs. Use FIT to look for quantity of devices on bus. Check each controller's EOL switch using the FIT.
	EOL(s) ON but no power at controller	+ to - reading drops too low and other readings are dropping low in their range.	None	Look for quantity of devices on bus. Check each controller EOL switch using the FIT.
	- and COM are swapped.	+ to COM and - to COM drops with the - to COM reading attempting to go to near 0 VDC.	CHRFrame BadFrame OutOfSeq	Controllers near the problem are not reporting. Look for missing addresses.
	+ and - are swapped	The + to - reading is trying to go to 0 VDC and the + to COM and - to COM is trying to equalize including all readings resulting at 0 VDC.	ChrFrame	Zero or few controller addresses are reporting.Split the bus in half and test each segment individually. Continue this process with smaller segments until the issue is found.
	+ and COM are swapped	All the readings are trying to go to 0 VDC.	ChrFrame	Zero or few controller addresses are reporting.Split the bus in half and test each segment individually. Continue this process with smaller segments until the issue is found.

Keep in mind the following:

- The further away from a problem the FIT is positioned, the reduced effect on a reading that problem may have.
- Each bus segments Idle Bus Voltage must be read independently. It cannot be read across repeaters.

Proper EOL Termination

It is recommended that most FCBs should have an EOL termination set on each controller at the end of each bus segment. Proper EOL termination is needed for reliable communications. The FIT tool has an EOL termination circuit that can be turned On or Off by the user. See Table 7 for the EOL switch positioning.

Table 7: EOL Termination Switch Positions

Mode	Switch Position
1-ON-1 Mode	EOL circuit is **On.**
Monitor Mode	EOL circuit is **Off**.
Scan Bus Mode	EOL circuit is **Off**.

The user can override the EOL operation by using the **EOL Command** under the **System** menu. If the supervisory controller is not connected to the bus, use the FIT to start communications in Scan Bus mode.

ⓘ **Note:** If the FIT is connected at the end of the bus where the supervisory controller would be and the supervisory controller was an EOL, then it would be advisable to set the EOL switch to On in the FIT System menu.

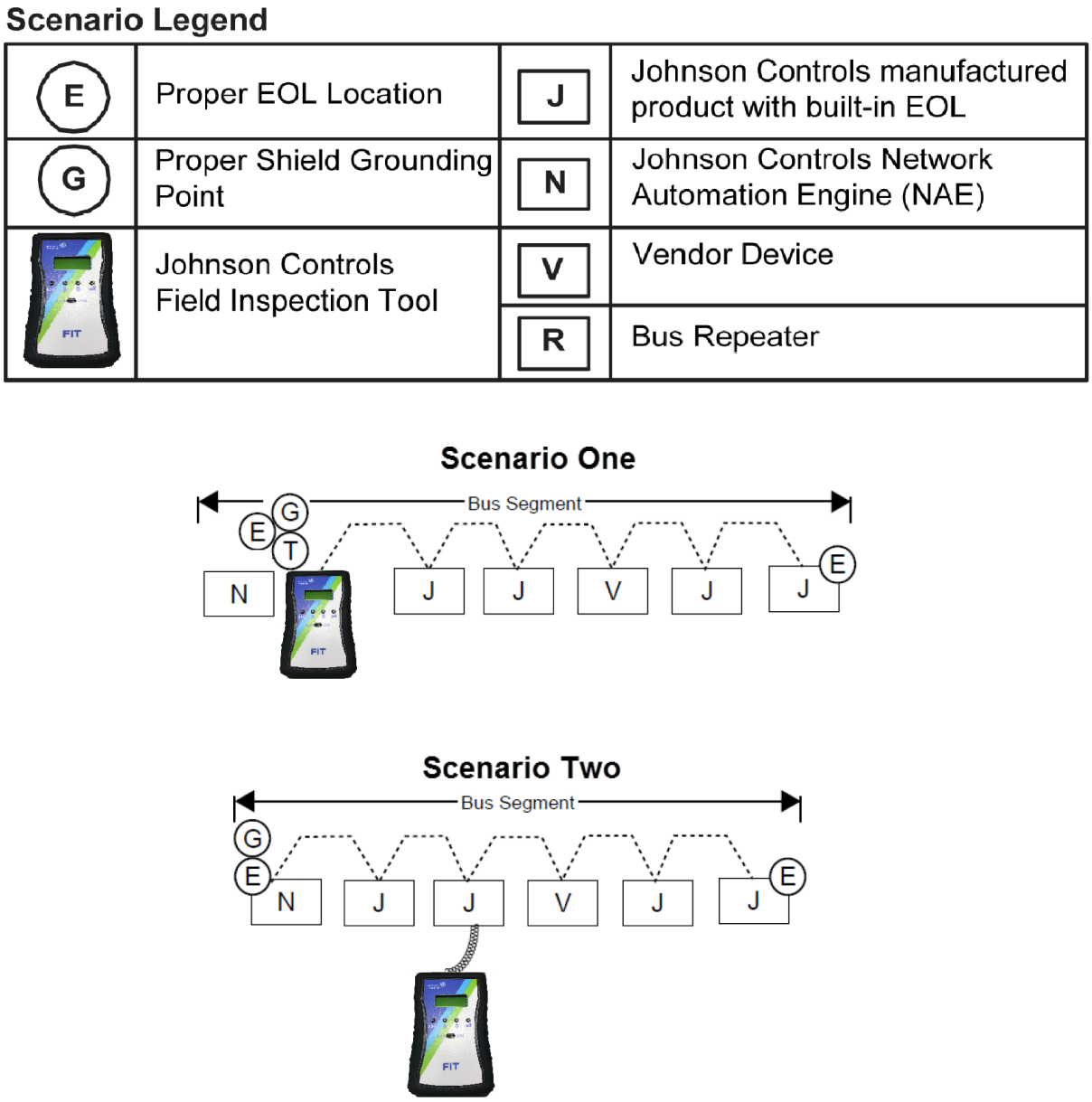
The bus is now properly terminated as if the supervisory controller was in place. The EOL On command allows the FIT to act as an active termination that can be placed anywhere on the bus to help troubleshoot bus communication issues.

Keep in mind the FCB EOL termination attribute is limited to Johnson Controls manufactured products that have a built-in EOL switch. The location of other EOL devices and jumpers is not detected. Not all legacy Johnson Controls; controllers support the EOL termination attribute. Figure 17, Figure 18, and Figure 19 show different scenarios, how the FIT should be configured, and what EOL switches are monitored.

On an SAB, the minimum requirement is that the EOL termination must be enabled on at least one device on the bus, and because a SAB supervisor (a controller like the FEC or VMA) always has EOL termination enabled, this requirement is always met; however, for enhanced bus performance, it is preferable to have EOL termination enabled on the devices at each end of the SA Bus.

FIT Connection, EOL, and Shield Grounding Scenarios

Figure 17: FIT Connection, EOL, and Shield Grounding Scenarios One and Two



In scenario one, shown in Figure 17, the following is occurring:

- The FIT is in place of an NAE.
- The FIT identifies one EOL.
- The FIT EOL should be **ON.**
- Leave the Proper Shield Grounding Point at the NAE.

In scenario two, shown in Figure 17, the following is occurring:

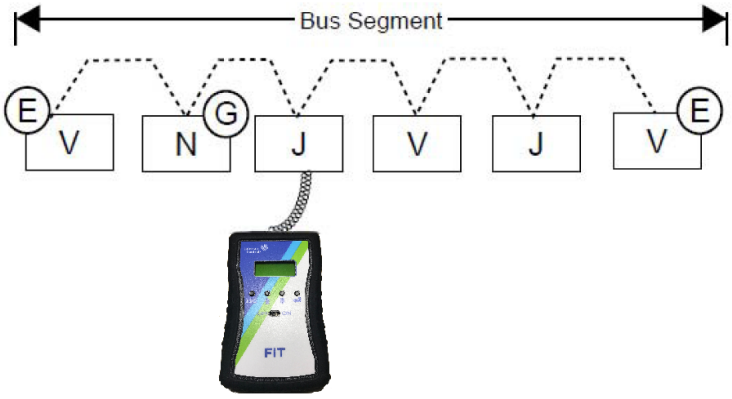
- The FIT is plugged into Johnson Controls Field Control Bus RJ.
- The FIT identifies two EOLs.
- The FIT EOL should be **ON.**
- Leave the Proper Shield Grounding Point at the NAE.

Figure 18: FIT Connection, EOL, and Shield Grounding Scenarios Three and Four

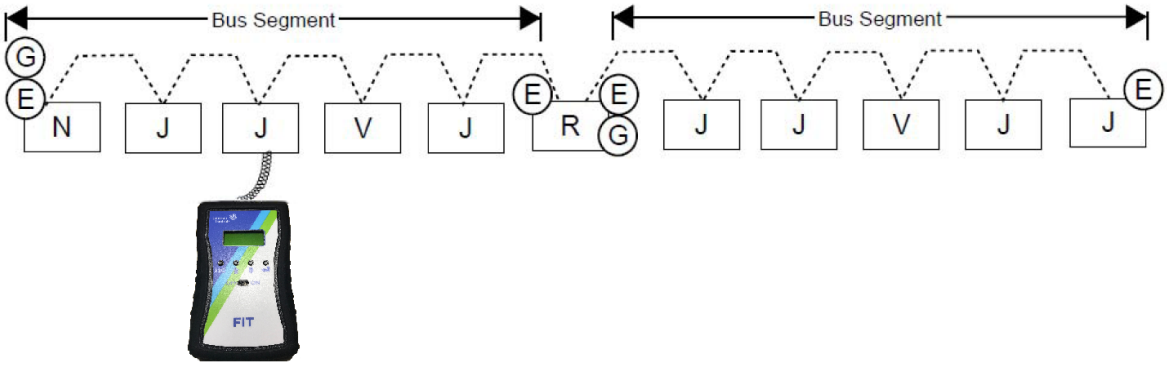
Scenario Legend

E	Proper EOL Location	J	Johnson Controls manufactured product with built-in EOL
G	Proper Shield Grounding Point	N	Johnson Controls Network Automation Engine (NAE)
	Johnson Controls Field Inspection Tool	V	Vendor Device
		R	Bus Repeater

Scenario Three



Scenario Four



In scenario three, shown in Figure 18, the following is occurring:

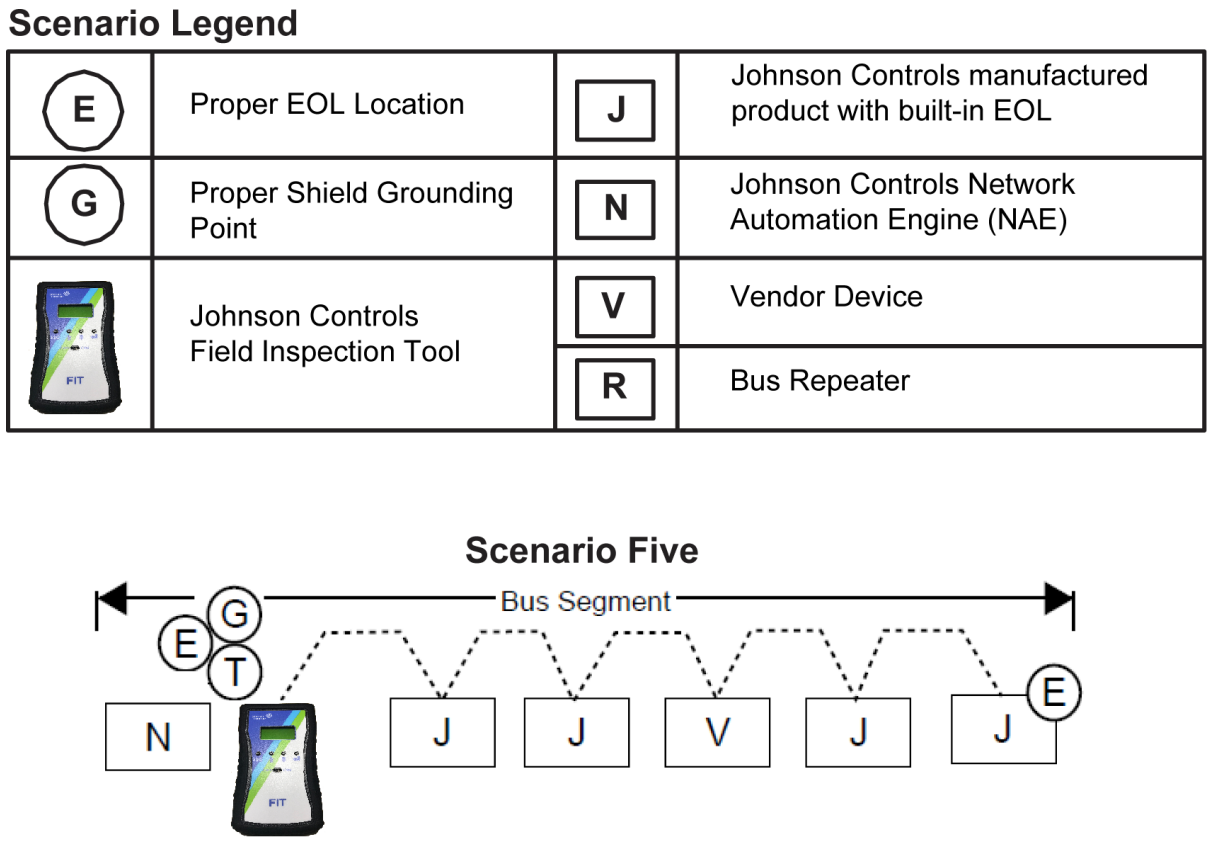
- The FIT is plugged into Johnson Controls Field Control Bus RJ.
- The FIT has not identified any EOLs.
- The FIT EOL should be **OFF.**

- Leave the Proper Shield Grounding Point at the NAE.
- Make sure third-party vendor devices at the end of the bus have EOL.

In scenario four, shown in Figure 18, the following is occurring:

- The FIT is plugged into Johnson Controls Field Control Bus RJ.
- The FIT has identified two EOLs (N, J) and the Repeater EOLs are not readable.
- The FIT EOL should be **OFF.**
- Leave the Proper Shield Grounding Point at the NAE and repeater Side B.

Figure 19: FIT Connection, EOL, and Shield Grounding Scenario Five



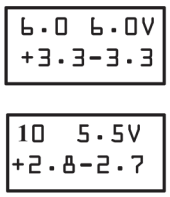
In scenario five, shown in Figure 19, the following is occurring:

- The FIT is plugged into Johnson Controls Field Control Bus RJ.
- The FIT has Identified three EOLs (N, J, x2) and the Repeater EOLs are not readable.
- The FIT EOL should be **OFF.**
- Leave the Proper Shield Grounding Point at the NAE and repeater Side B.

1-ON-1 Communication Voltage Levels

In the 1-ON-1 mode, the FIT is only connected to a single controller that is not connected to a network. The communication voltage readings in this mode should be in the range of 4–10 VDC differential voltage and 2 to 5 VDC for the +, – line voltages. The important thing to note is that the + and – line readings typically are equal or within approximately 0.2VDC of each other. The + line voltage will usually read equal to or slightly higher than the – line voltage. See Figure 20 for an example.

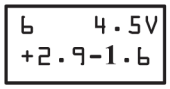
Figure 20: 1-ON-1 Communication Example 1



In the examples shown, the + and – line voltage readings are equal or within 0.1 volts of each other.

If the readings taken are below 4V differential or the + and – readings are not within 0.4VDC of each other, then the controller may be damaged. Damaged controllers typically have a larger voltage difference (greater than 0.4VDC) between + and - readings. See Figure 21 for an example.

Figure 21: 1-ON-1 Communication Example 2



In this example, the + and – line voltage readings are not within 0.4VDC and thus this controller may be damaged. The controller may still communicate but the voltage readings indicate there is an issue with this controller.

Network Communication Voltage Levels

When the FIT is connected to a network of controllers it will measure the communication voltage levels of each individual controller. When looking at communication voltage levels on a network, it is important to note that the voltage levels are affected by many factors, such as wire length, wire gauge, number of controllers, network topology, EOL terminations, and the FIT connection on the bus. The FIT's connection location affects the voltage readings taken. The controllers closer to the FIT typically have higher voltage readings than the controllers farther away from the FIT. It is therefore important to take note of the network location where the FIT is connected since the voltage readings are affected.

Differential voltage levels in the range of (2.5V to 8V) are expected on most properly functioning buses. The + line voltage and – voltage should be approximately equal or within 0.2VDC of each other on a properly wired and terminated bus.

Since the FIT is reading and calculating these voltages, they are only accurate for the bus segment to which the FIT is connected. If using communication voltages to troubleshoot, each bus segment should be read independently. Voltage readings where there are large voltage differences between the + line and – line can indicate a wiring problem such as a shorted, pinched, or open wire connection.

Voltage Table

Table 8: Voltage Table

Voltage	Communication State	Meaning	Acceptable Range[1]
Bias Voltage	Either Idle or Active Communication	The + to COM Reading, - to COM or + to -. Typically used such as + is biased to com, -, etc. It is the voltage applied to the bus by the EOL termination on the controller to establish a properly biased bus.	See notes below for acceptable ranges based on active or idle communication states.
Idle Voltage	Idle	The term **idle voltage** could be referring to + to COM, - to COM or the + to – (differential) Reading. What it really means is no communication is occurring at the time of the reading.	Typically near 2.7 (+ to com) -2.3 VDC (- to com) with a differential (+ to -) of 0.4VDC. Can vary with wire length & bus load but should not be lower than ~0.2VDC differential or higher than ~0.9VDC differential.
Idle Differential Voltage	Idle	This is typically referring to the + to – voltage reading without communication.	~0.2 to ~0.9 VDC
Communication Voltage	Active	The term communication voltage could be referring to + to COM, - to COM or the + to – Reading. Communication is occurring at the time of the reading.	See Bit Voltage and Differential Voltage below.
Bit Voltage	Active	+ or – with respect to COM when communication is occurring.	+2.0 to +4.0 VDC (+ to Com), -2.0 to -4.0 VDC (- to Com). When comparing the absolute value of these two readings, there should be no more than approximately a 0.2 VDC difference.
Differential Voltage, Total Voltage	Active	The + to COM Reading plus the absolute value of the - to COM Reading when communication is occurring.	2.5VDC to 8VDC is acceptable.

1 These voltages should typically not be read with a Volt-Ohm-Meter (VOM). Use the FIT instead. Idle bus voltages are read with a VOM when communication is not occurring. When FIT is connected to a bus and then powered on, it will display **Offline** if the bus is Idle.

Tips for Correcting Bus Installation Problems

The MS/TP Bus is subject to a number of installation factors that can affect performance. Consider the following common physical attributes when trying to resolve communication problems:

- Validate controller/device power is available and undisrupted.
- Check wiring for:
    - - Proper wire gauge, cable type, connections, polarity, and lengths.
    - - Opens and shorts.
    - - Confirmation that one shield ground point exists per bus segment (made at the source of the bus segment —the NAE, Side B of a Repeater).
- Check EOLs to verify that EOL terminations are only at the ends of daisy chains for each bus segment.
- Check addresses for:
    - - duplicate addresses
    - - address ranges are sequential
- Check for and eliminate T-Taps (wire configurations that create a T shape) and star configurations.
- Check for consistent baud rates (often baud rates problems occur with vendor devices and repeaters).
- Check for sources of electrical interference.

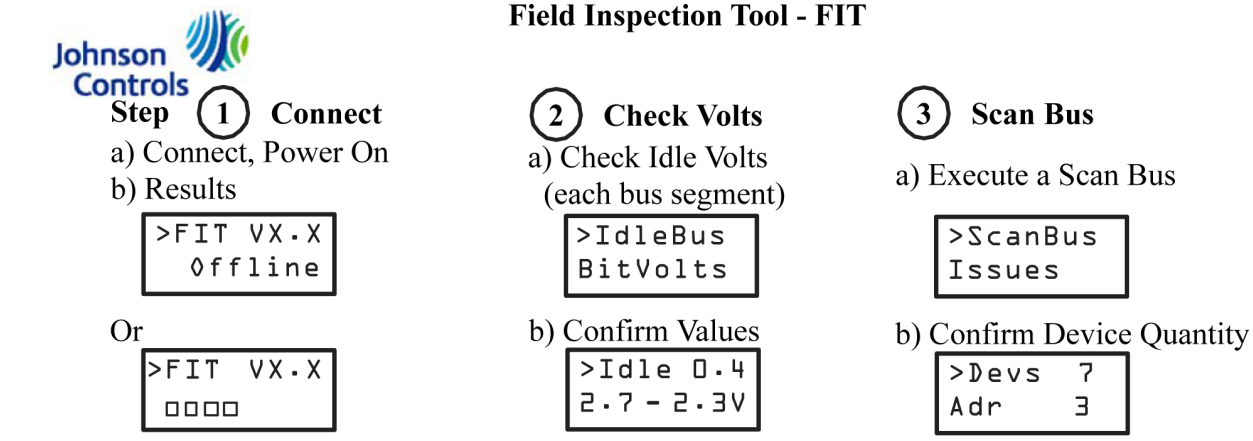
Here are some additional best practices to find and eliminate problems with the physical layer:

- Check and confirm proper idle voltage levels on each bus segment. See *Voltage Menu* and *Voltage Levels* for more information.
- Separate the bus into smaller segments to isolate and find problems.
- Check idle voltage levels on these smaller segments.
- Use the FIT's 1-ON-1 modes on disconnected controllers to validate they have proper attributes and are not defective. See *1-ON-1 Menu* for more information.
- Remove vendor equipment from the bus. Johnson Controls does not manage vendor equipment communication or default states. Isolating a bus to devices with known defaults ensures effective communication.

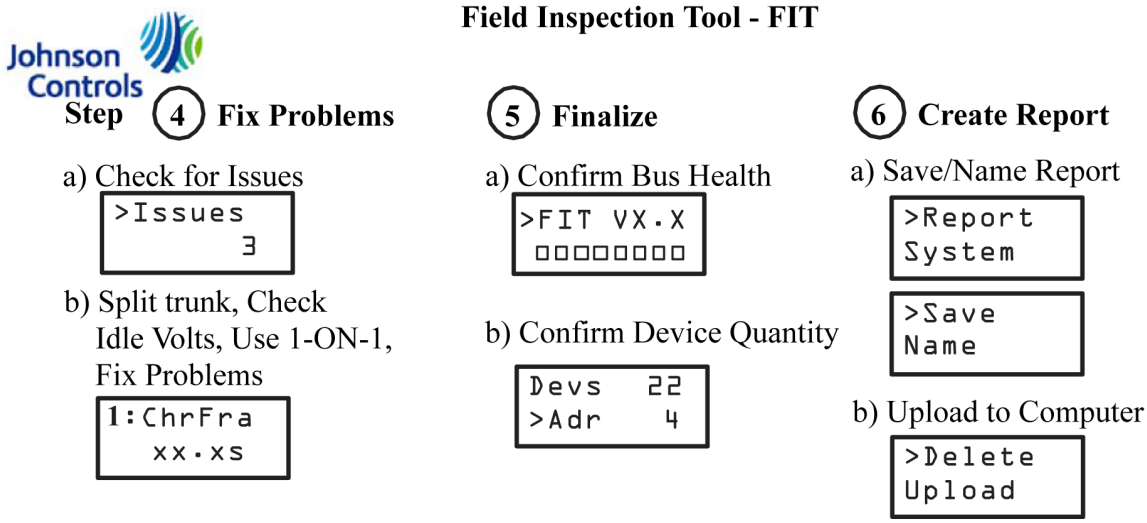
See *Getting Prepared to use the FIT* section for ways to use the tool on unpowered buses to validate continuous bus wiring and end-to-end continuity.

Quick Start Guide

Figure 22: Quick Start Card



To view training videos on using the FIT tool, click here to visit the uLearn website.



For the most up-to-date version of the *Field Inspection Tool Users Guide (LIT-12012443)*, refer to https://docs.johnsoncontrols.com/bas.

FIT Display Table

Table 9: FIT Display Table

Menu	Fit Display	Short Meaning	Expert Mode	Description
Health	Bus Health Bars	Health of a Bus		An overall indication of Bus Health. 8 is desired, but 4 is the minimum.
ScanBus	ScanBus	Force a Bus Scan		Main Menu item. Used to initiate, monitor & interrogate controllers on the FC/SA bus.

Table 9: FIT Display Table

Menu	Fit Display	Short Meaning	Expert Mode	Description
ScanBus	Scan Devs	Quantity of Addresses Found		Displays the quantity of nodes talking on a bus.
ScanBus	Adr	Bit Volts Reading at Address		Address reported by the controller.
Scanbus	BitVolts	Bit Volts Reading at Address		Communication Voltage reported by the Address.
ScanBus	EOL FC EOL	FC Bus: EOL Switch Position at Address SA Bus: FC Address and EOL Switch Position		When connected to a FC Bus this shows the Position of the End-Of-Line Switch reported at address. When connected to a SA Bus this shows the FC Bus Address and the Position of the End-Of-Line Switch reported at address.
ScanBus	Model	Model Name at Address		Device object Model Name property for device at address
ScanBus	Ver	Firmware Version at Address	X	The version of the Firmware loaded in the controller at this address.
ScanBus	Name	Device Name at Address		Device object Object_Name property for device at address
ScanBus	OID	Device Object ID	X	The BACnet device ID for the scanned controller. This is set by the application file in the controller and are not necessarily unique.
ScanBus	Vendor	Device Vendor at Address	X	Device object Vendor property for device at address
ScanBus	Desc	Device Description at Address	X	Device object Description property for device at address
Issues	Issues	Bus Issues Menu Item		Main Menu item. Select to see quantity, history, and history details of Issues.
Issues	Issues	Quantity of Issues recorded		Quantity of potential Issues discovered by the FIT.
Issues	Online	Device Came Online		Most current Issue (no leading number). In this case, a controller came on line after initial FIT token loop was complete.
Issues	n Issue Type	Historical Issue number and Type		Where **n** represents a historical issue, **Issue Type** is either Online, Offline, Badframe, ChrFrame, 2ndTkn or EOL>2
Issues	TKN	Token		Represents the Token (TKN) passing from one address to the next.

Table 9: FIT Display Table

Menu	Fit Display	Short Meaning	Expert Mode	Description
Issues	Badframe	Bad Data Received		Bad Data Received. Bad MS/TP frame. Invalid MS/TP header CRC or data CRC.
Issues	ChrFrame	Character Framing Error		Characters are transmitted in frames. If a frame is too long or short, a framing error occurs.
Issues	2ndTkn	Token Re-transmitted.		A device handed off the token, but no transmission seen. the TKN is re-transmitted.
Issues	Offline	Device went offline.		This device was online, received a PFM, and did not reply to it.
Issues	EOL>2	>2 EOL Switches are On		More than two devices with EOL switch ON. ⓘ **Note:** This is all EOL switches on ALL bus segments for connected bus.
Monitor	Monitor	Monitor Traffic on Bus		Main Menu item Monitor Bus. Selecting Monitor puts the FIT in a listen-only mode.
Monitor	Monitor Bus	Listen to bus communications		Used to listen to bus traffic and report bus statistics.
Monitor	Offline	There is no token passing		The FIT is listening to the Bus, but no token is passing. The bus is in an idle state.
Monitor	Dev	Quantity of Addresses Found		Qty of Addresses discovered by the FIT
Monitor	Adr	Address of current device		Address reported by the controller
Monitor	BitVolts	Bit Volts Reading at Address		Communication Voltage reported by the selected Address.
Monitor	TxTkn	Tokens Sent by Address		Displays the number of Token Frames the device transmits. In MS/TP, each master device passes a logical token to the next device during normal operation. Only the master device currently holding the token is allowed to initiate a message, thus the number of Token Frames sent or received should be large. Normally, the number of Token Frames received should be almost the same as the number of Token Frames transmitted.
Monitor	DevId	Device ID at Address	X	Device ID when an I-Am is seen in a capture (trigger with Who-Is) or -1 if not seen.

Table 9: FIT Display Table

Menu	Fit Display	Short Meaning	Expert Mode	Description
Monitor	RxTkn	Tokens Received by Address	X	Displays the number of Token Frames the device receives. In MS/TP, each master device passes a logical token to the next device during normal operation. Only the master device currently holding the token is allowed to initiate a message; thus, the number of Token Frames sent or received is large. Normally the number of Token Frames received should be almost the same as the number of Token Frames transmitted.
Monitor	PFM	Poll For Master by Address	X	Displays the number of PFM frames sent by the device. In normal operation on a clean network, only the bus supervisor (MAC address 0) and the highest numbered master device on the network is sending PFM frames. These frames are used to discover other devices on the network.
Monitor	RPM	Reply To PFM by Address	X	Counts the number of Reply to PFM frames the device transmits. On a clean network during normal operation, only one Reply to PFM frame needs to be sent when the device first comes online. These frames are used to announce the presence of other devices on the network.
Monitor	Postpd	Reply Postponed by Address	X	Counts the number of data frames received at the device that requires an immediate reply where this device requests additional time to prepare the reply. This may happen normally if the reply involves a large amount of data. It may also indicate that this device is overloaded.
Monitor	TstReq	Test Request	X	Displays the number of Test Request Frames the device transmits. Test Request Frames are a normal part of bus analysis, but should not be sent during normal operation. A Test Response Frame should be received in response to each test Request Frame sent to an online device. Test Request Frames may also be sent to offline devices where no response is received.

Table 9: FIT Display Table

Menu	Fit Display	Short Meaning	Expert Mode	Description
Monitor	TstRsp	Test Response	X	Displays the number of Test Response Frames transmitted by this MS/TP port. Test Response Frames are a normal part of bus analysis, but should not be sent during normal operation. A Test Response Frame should be sent in response to each Test Request Frame received.
Monitor	DER	Data Expecting Reply	X	Displays the number of data frames sent by the device that requires an immediate reply from the destination device. This value includes proprietary frames that have been sent and are expecting a reply.
Monitor	DNER	Data Not Expecting Reply	X	Displays the number of data frames sent by the device that do not require an immediate reply. This value includes proprietary frames that have been sent and received a reply.
Monitor	Treply	Time to Reply	X	Max milliseconds (ms) to reply with token after receiving a token. Must be <25 ms.
Monitor	Tder	Response Time to DER	X	Max ms to respond to a DataExpectingReply. Must be <250 ms.
Monitor	Tpostp	Response Time Postponed	X	Max ms to respond to DataExpectingReply with ReplyPostponed. Must be <250 ms.
Monitor	Tusage	Total Wait RPFM	X	Max ms waits for a ReplyToPollForMaster or Token retry. Must be >20ms and <100ms.
Monitor	Trpfm	Response Time PFM	X	Max ms to respond to PFM with RPFM. Must be <25 ms.
Monitor	Retry	Retries	X	Displays the number of times the device tried to pass a token as the next node did not start using it within the time allowed by BACnet protocol.
Monitor	MaxMst	Max Master	X	Highest destination address during PFM. Default is 127. Normally, when all controllers have power and a ScanBus is executed, the address seen listed is the next address in the loop (Address 10 passed to Address 11, so it will show 11).
Monitor	MaxFrm	Max info Frames	X	Maximum number of frames from this address.
Monitor	Npoll	Tokens between PFM	X	Number of Tokens between Poll-For-Master.
Monitor	Self	Sent to Self	X	Number of Tokens sent to self.
Monitor	Stats	Bus Statistics Menu Item	X	This menu item provides overall bus statistical information.

Table 9: FIT Display Table

Menu	Fit Display	Short Meaning	Expert Mode	Description
Monitor	LoopTime	Loop Time	X	Indicates how much time passes between the periods when the device allows initiation of messages on the network. This time is a strong indicator of network performance and is associated strongly with the amount of traffic or errors on the network. Shorter times indicate a more responsive network. Longer times indicate an increasingly busy and slow network.
Monitor	PcktErrs	Packet Errors	X	Counts errors detected in the data portion of data frames sent to the device. Many data frames are used only for protocol control and do not contain a data portion, and thus cannot have Data CRC Errors. The Header CRC Errors check must be successful before the device attempts a Data CRC check. This attribute supplies an error count for the Bus Health Index attribute. Some possible reasons are bus exposure to noise or poor wiring.
Monitor	CharErrs	Character Errors	X	Counts the number of errors detected in the individual data bytes received by the device. A framing error occurs when the device receives a stop bit in the wrong state. This attribute supplies an error count for the Bus Health Index attribute. Framing errors are usually caused by electrical noise on the bus, message collisions, incorrect baud rate settings, bus wiring or termination errors, or devices that are not operating within the BACnet specified timing. Framing errors generally cause CRC errors since the frame has been corrupted.
Monitor	Baudrate	Communication Baud Rate	X	The speed at which controllers are communicating. MS/TP is normally 38,400 bits per second (bps).
Monitor	Chrs/Sec	Characters per Second	X	The number of characters in the frames currently being transmitted per second.
Monitor	Over Run	Over Run of Data	X	Displays the number of times the MS/TP port hardware loses received data because the device is too slow in reading the data. An overrun error occurs when the hardware receives a byte before it moves the prior byte to a buffer.

Table 9: FIT Display Table

Menu	Fit Display	Short Meaning	Expert Mode	Description
Monitor	Packets	Number of Packets	X	A running total of the number of packets transmitted while the FIT has been connected.
Monitor	Chars	Number of Characters	X	Indicates the number of data bytes received by the FIT. This number includes all messages from all devices.
One-on-One	1-on-1	Connect to 1 Controller		Main Menu item One-On-One. Used to read attributes on 1 controller disconnected from the bus.
One-on-One	Connect	Start 1-on-1 Communication		Used by the FIT to communication with a controller disconnected from a Bus.
One-on-One	Model	Model Name		Device object Model_Name property for device connected to FIT (if disconnected from the bus).
One-on-One	Firmware	Firmware Version		The version of the Firmware loaded in the controller connected to FIT (if disconnected from the bus).
One-on-One	Name	Configuration File Name		The Name of the configuration file loaded in the controller connected to FIT (if disconnected from the bus).
One-on-One	Descr	Device Description at Address		Device object Description property for device connected to FIT (if disconnected from the bus).
One-on-One	BusAddr	Address of current device		Address reported for device connected to FIT (if disconnected from the bus).
One-on-One	EOL	EOL Switch Position at Address		Position of the End-Of-Line Switch reported by connected controller (if disconnected from the bus).
One-on-One	Dev OID	Device Object Id		The BACnet device ID for the connected controller.
One-on-One	BitVolts	Bit Volts Reading		Communication Voltage reported by device connected to FIT (if disconnected from the bus).
Voltage	Voltage	Measure Bus Voltages		Main Menu Item Voltage. Read Voltages Idle Voltage, BitVolts and Meter Voltage Levels.
Voltage	IdleBus	Submenu item		This is a submenu item. Press **Enter** to see the Idle Bus Voltage.
Voltage	IdleBus	Idle Bus Voltage Reading		Idle state (no communication) Voltage. Measured when no communication is occurring.
Voltage	BitVolts	Submenu item		This is a submenu item. Press **Enter** to see the Bit Voltage.

Table 9: FIT Display Table

Menu	Fit Display	Short Meaning	Expert Mode	Description
Voltage	BitVolts	Bit Volts Reading		Communication Voltage reported by random sample.
Voltage	Meter	Submenu item		This is a submenu item. Press **Enter** to see the Meter Voltage.
Voltage	System	Change FIT's Settings		Main Menu Item Systems. Used to change FIT's default power on settings.
System	BackLit	Turn Display on or off		The FIT display can be used with back lighting on or off. Using back lighting decreases battery life. Setting is Persistent once set.
System	Report	Menu Sub Selection		Sub Menu Item Systems. Used to change, create and manage Reports.
System	Save	Report Menu - Saves the current memory data to a Report		Read key bus health, statistics, and summary information. Device specific information and logged issues and save them to a csv file on the device.
System	Name	Report Menu - User enters name for the current report		User enters an eight character alpha-numeric name for the current data being saved to a CSV.
System	View	Report Menu - Scroll and View saved data		User can view any saved reports. Open the report and see all the summary, device and issues recorded in the CSV.
System	Delete	Report Menu - Scroll and Delete saved data		Can delete any saved reports on the device.
System	Upload	Report Menu – Select Report & send to Computer via USB		Select a saved report and send it a computer via Micro-USB. Computer must be connected (USB) and in the destination program.
System	Format	Report Menu – Select method of Upload (csv or tab)		Select the method of Upload CSV (Microsoft® Notepad) or TAB (Microsoft®Excel®). If the user’s desire is save to a simple file, CSV is recommended to save into a spreadsheet directly use TAB.
System	EOL	EOL Switch Position of the FIT		Change the status of the FIT’s End-Of-Line.
System	Mode	Submenu item		Submenu item. Press **Enter** to allow changing of the User mode.
System	UserMode	FIT Installer Mode		Switch between normal Installation and Expert mode. Expert mode provides more data

Table 9: FIT Display Table

Menu	Fit Display	Short Meaning	Expert Mode	Description
System	Battery	Submenu item		Submenu item. Press **Enter** to see the current state of the FIT's AA batteries.
System	Battery	Battery Measurements		Press **Enter** to switch the display between State (Good) and Voltage.
System	Baudrat	Submenu item		Submenu item. Press **Enter** to see current FIT baud rate selection.
System	Baudrate	Communication Baud Rate		The current selected baud rate (autobaud is default). Pressing up or down changes the rate the FIT will communicate.
System	FITAddr	Submenu item		Submenu item. Pressing **Enter** will all viewing and changing the FIT's Address.
System	FIT Addr	Address of the FIT		What address the FIT is using on a bus. Up and down arrows change the FIT address used.
System	sys Tim	Submenu item		Submenu System Time. Pressing Enter allows user to see how long the FIT has been powered on.
System	Sys Time	System Time		The amount of time in seconds the FIT has been powered on.
System	PowerOf	Auto Power Off		Adjust the number of minutes for the FIT to go into Sleep mode. Adjustable 0-99 minutes. Default is 15 minutes. 0 minutes keeps the FIT on indefinitely.
System	RS-485	Submenu item	X	Submenu Item to all the user to see the current RS-485 properties.
System	BitVolts	Submenu item	X	Submenu Item. Pressing **Enter** displays the communicating Bit Volts for the bus.
System	BitVolts	Bit Volts Reading	X	Communication Voltage reported by random sample.
System	BitTimes	Bit Times	X	Submenu Item. Pressing Enter displays the Bit Times for the bus.
System	Samples	Submenu item	X	Menu item to all the user to see the samples used to calculate the baud rate.
System	Samples	nn	X	The number of samples. Pressing Enter allows the samples to be viewed. They are used to determine the baud rate (displayed with CalBaud).
System	CalBaud	Calculated Baud Rate	X	Calculated Baud rate based on communication samples.

Appendix B: FIT Firmware Update Instructions

To upgrade the FIT firmware, first you need to download the Renesas® Flash Programmer V3.01.00 software. The Renesas software download file is the **Renesas_Flash_Programmer_Package_V30100_free.exe.** This file is for a Windows-based operating system only.

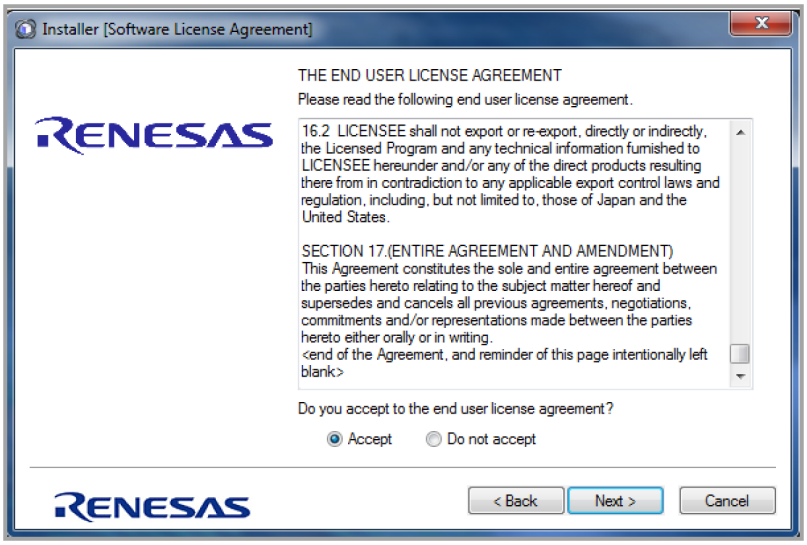
1. Download the **Renesas_Flash_Programmer_Package_V30100_free.exe** file to your hard drive and double-click on the file.

2. On the main installer window, click **Next.**

Figure 23: Renesas Download Main Screen

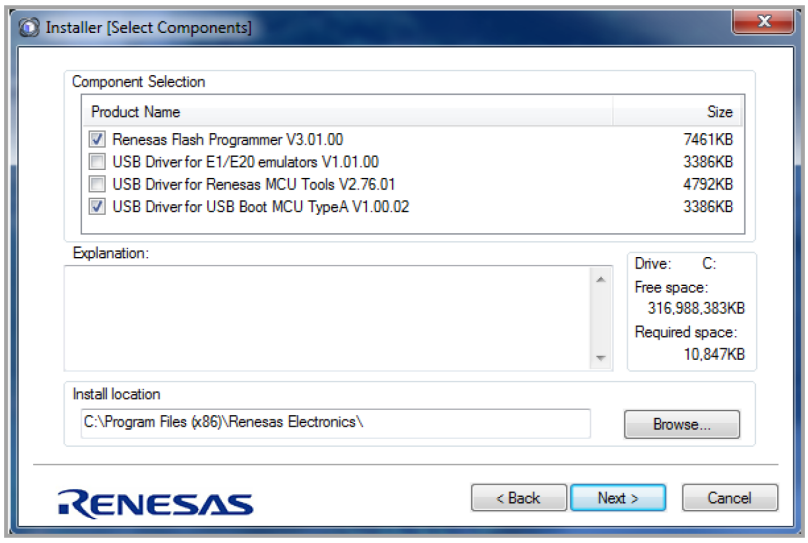
3. On the End User License Agreement window, accept the agreement and click **Next**.

Figure 24: End User License Agreement Window



4. Deselect the **USB Driver for E1/E20 emulators V1.0100** and the **USB driver for Renesas MCU Tools V2.76.01** boxes.

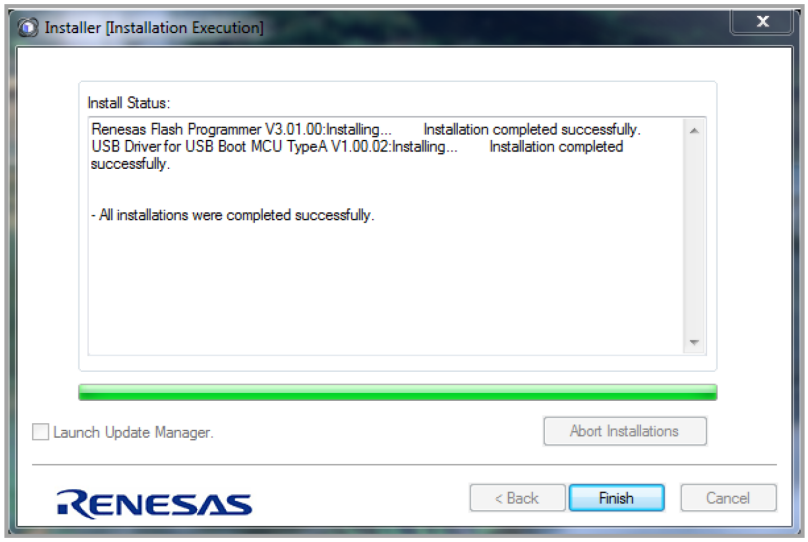
Figure 25: Select Components



Note: Change the location for the program at this time, if desired.

5. Click **Next**.The Renesas Flash Programmer installation starts. When the installation is complete, click **Finish**.

Figure 26: Installation Complete



The Renesas Flash Programmer software is now installed. The FIT firmware is now ready to be programmed. You will need a USB 2.0 Cable A Male to Micro B Male in order to connect the FIT to a USB port on your computer.

1. Turn off the FIT and remove the rubber protective boot.

2. Turn the FIT over and remove the battery cover.

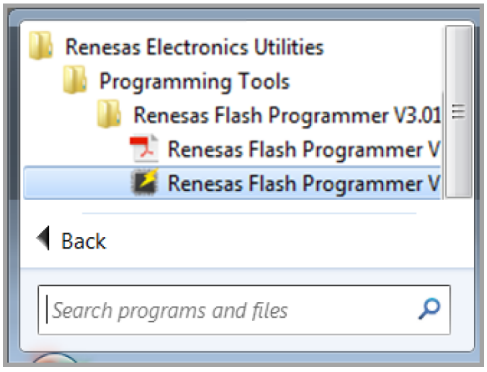
3. Remove the four screws holding the cover to the base as shown in Figure 27.

Figure 27: Back of FIT

4. Remove the top cover from the base to expose the circuit board.

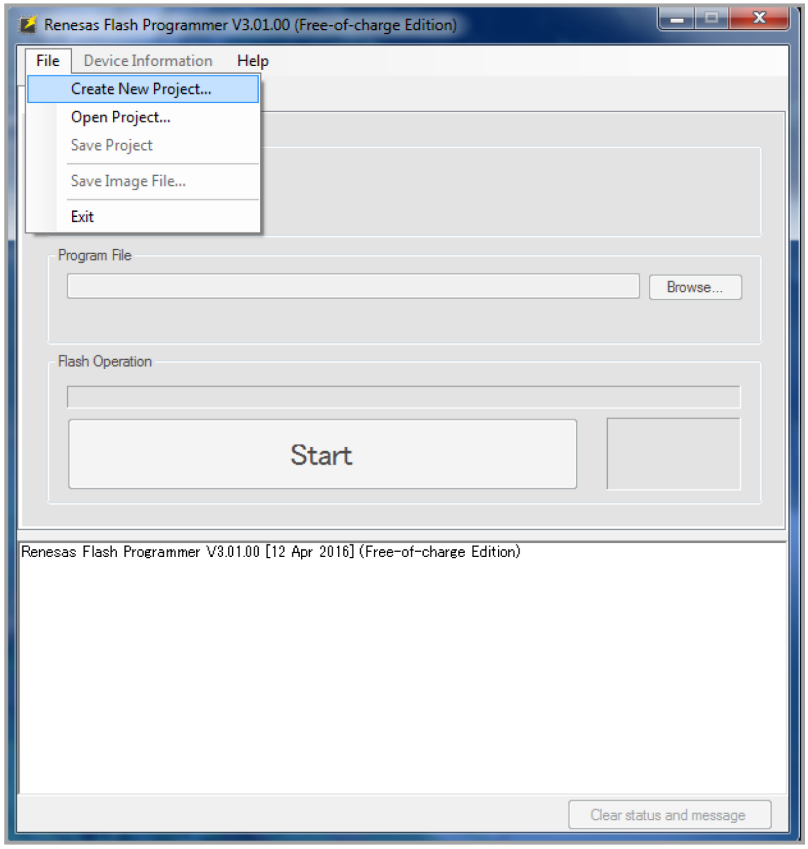
5. Open the Renesas Flash Programmer software: (**Start >All Programs >Renesas Electronics Utilities >Programming Tools >Renesas Flash Programmer V3.01.00 >Renesas Flash Programmer** shown in Figure 28).The programming tool will open.

Figure 28: Renesas Flash Programmer



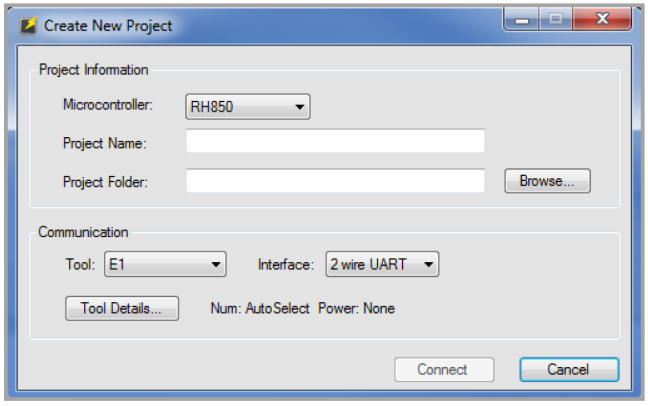
6. From the **File** menu, select **Create New Project.**

Figure 29: Renesas Flash Programmer—Create New Project



7. The Create New Project Window will appear.

Figure 30: Create New Project Window



8. Select the **Microcontroller** drop-down window and change the microcontroller type from **RH850** to **RX100.**

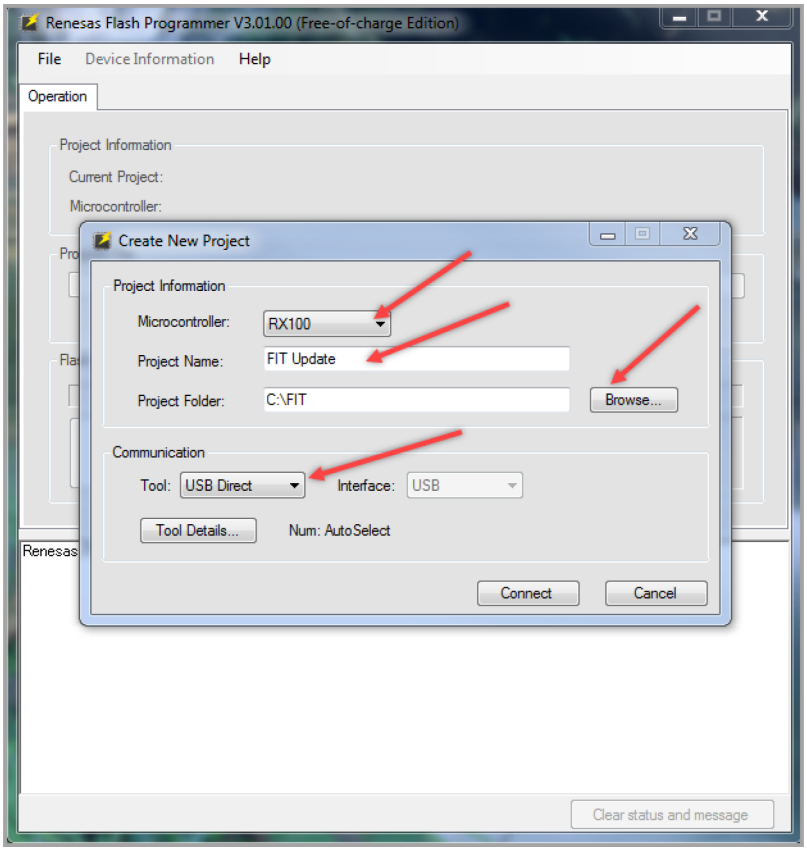
9. In the Project Name window, type in the name of the project. In this example, the project is named **FIT Update.**

10. In the **Project Folder** window type in the location of the project folder you prefer. In this

example the project folder location will be *C:\FIT*.

11. Select the **Tool** drop-down menu and change the tool type to **USB Direct.**

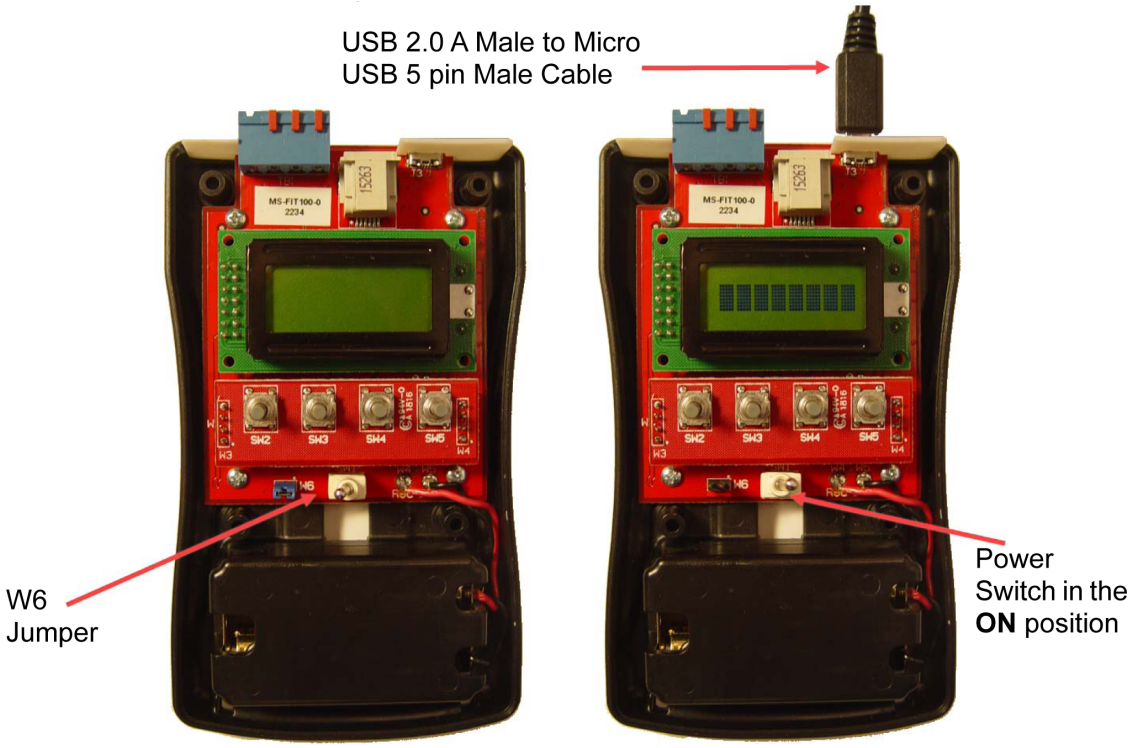
Figure 31: Create New Project Window—Settings



12. Connect the USB 2.0 A Male to Micro USB 5 pin Male Cable to the FIT. See Figure 32.

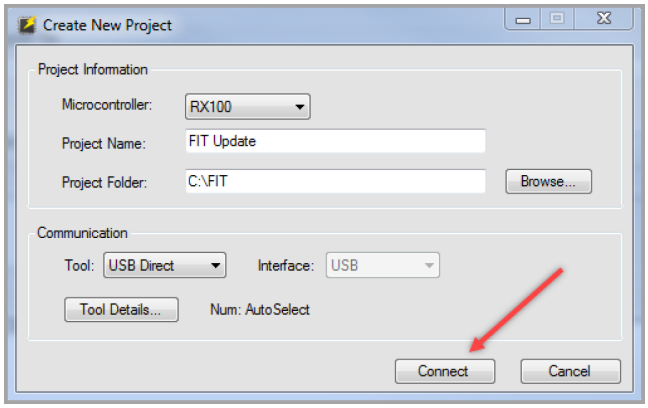
13. Remove the programming jumper **W6** located on the FIT to the left of the power switch and turn the FIT power switch to the **On** position.

Figure 32: W6 Jumper and Power Switch



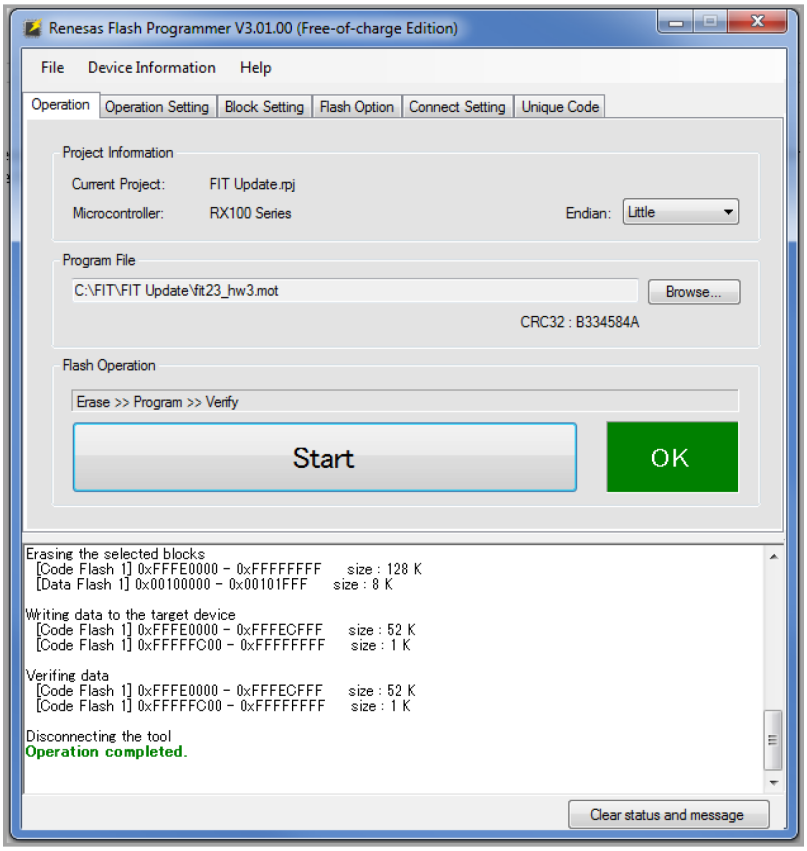
14. Select the **Connect** button on the **Create New Project** window.

Figure 33: Create New Project Window—Connect



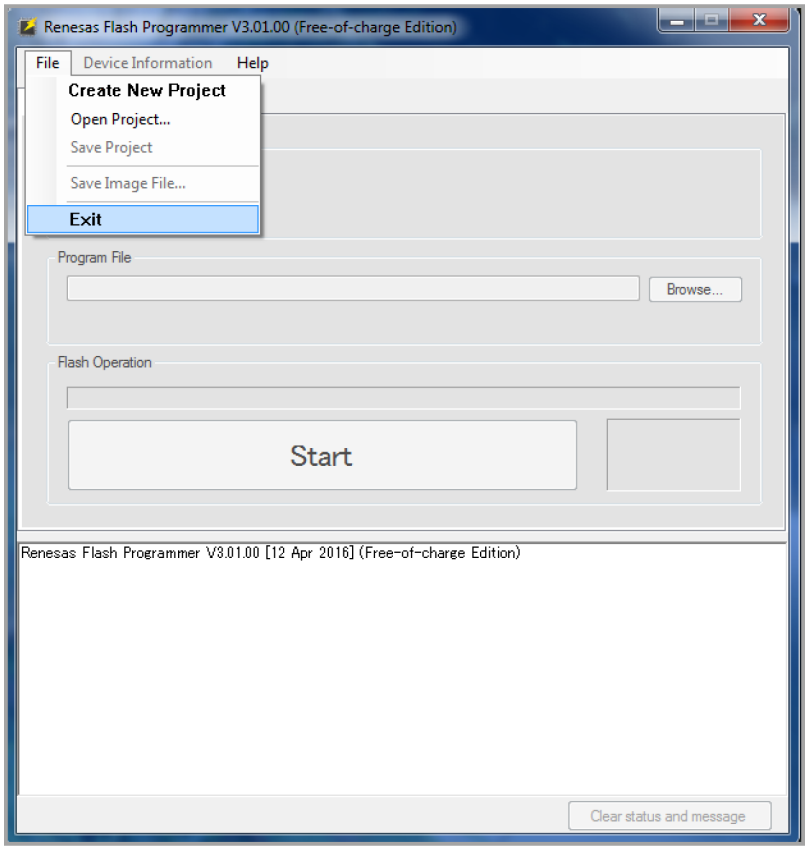
The FIT should now connect with the Flash Programmer software. The USB driver for the FIT is loaded from your computer. When the USB Driver has loaded, the Flash Programmer status window should look like Figure 34.

Figure 34: USB Driver Loader Complete



15. The Renesas Programming software is now installed. Power off the FIT. Close out the Renesas Flash Programmer software by selecting **File** > **Exit**.

Figure 35: Renesas Flash Program—Exit



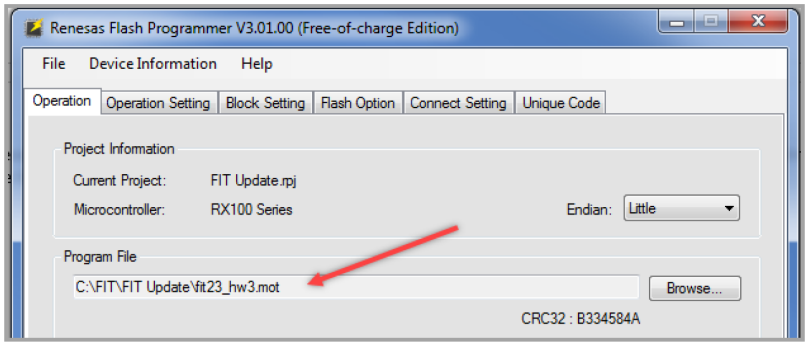
Programming the FIT

The Program File window needs to be updated with the path for the FIT firmware to be downloaded.

1. Locate and run the **Renesas Flash Programmer** software. Repeat this step as many times as necessary to download the firmware to the FIT. See *Appendix B: FIT Firmware Update Instructions*.

2. In **Program File**, use the **Browse** button to locate the FIT firmware file on your computer.

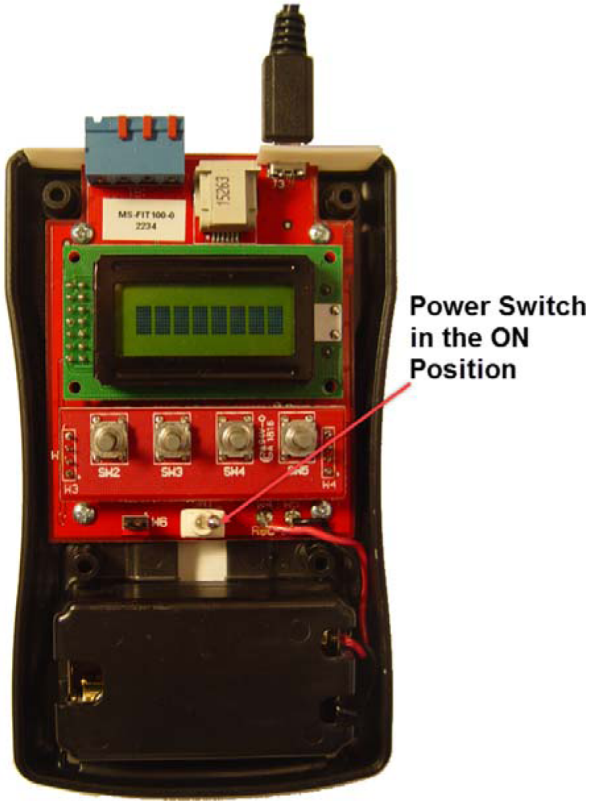
Figure 36: Renesas Flash Programmer Main Screen



3. Make sure the **W6 Jumper** is removed.

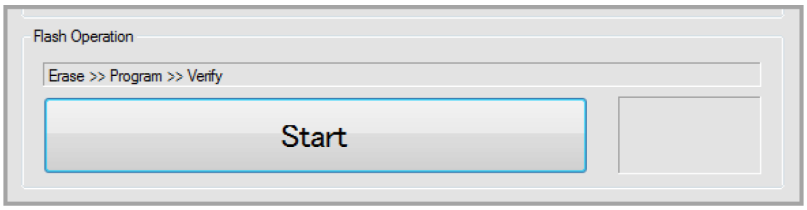
4. Turn the **Power Switch** on the front of the FIT to the **ON** position.

Figure 37: Power Switch—ON



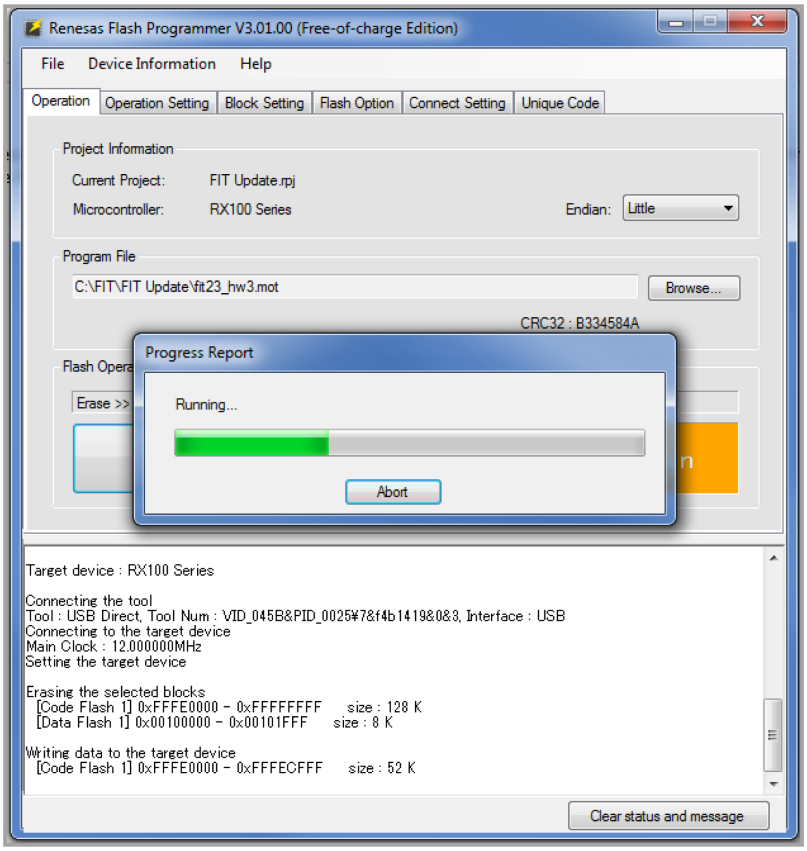
5. On the **Operation** tab select **Start.**

Figure 38: Flash Operation Confirmation



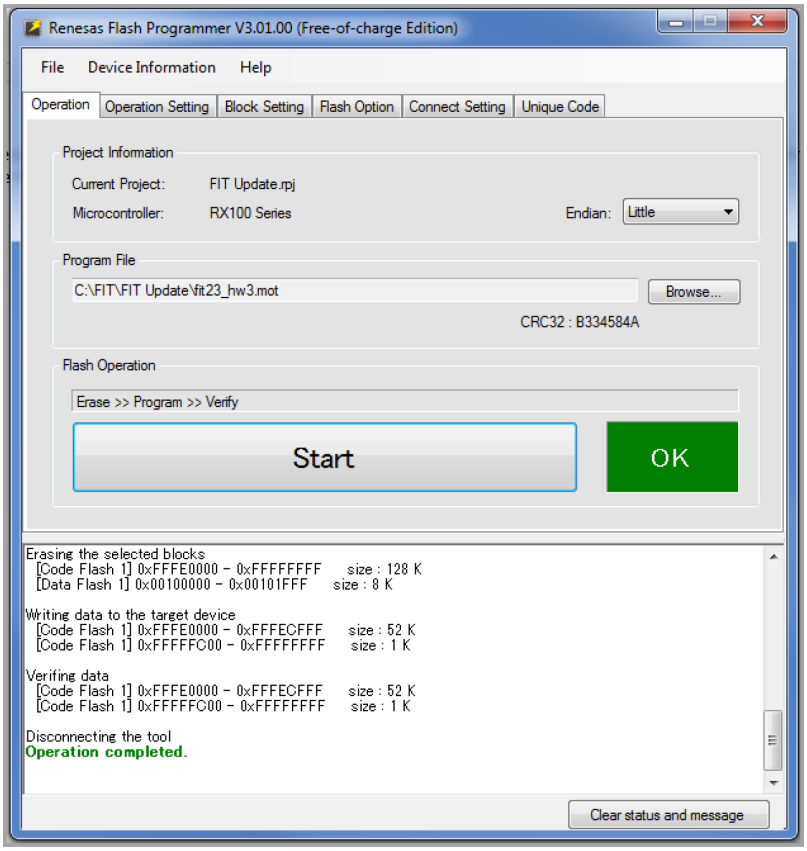
6. The flash programming should start as shown in Figure 39.

Figure 39: Flash Operation—Running



7. When the Renesas Flash Programming is complete, the window will look like Figure 40.

Figure 40: Flash Operation—Complete



8. Turn the FIT **Power Switch** to the **Off** position.

9. Replace the **W6 Jumper**.

10. Turn the FIT **Power Switch** to the **ON** position.
    The FIT will power and display the proper firmware version on the display screen.

Figure 41: FIT Firmware Updated

11. Turn the **Power Switch** to the **OFF** position.
12. Remove the USB 2.0 A Male to Micro USB 5 pin Male Cable from the FIT.
13. Replace the back cover and return the FIT to the rubber protective boot.