EMBER® DEBUG ADAPTER (ISA3) TECHNICAL SPECIFICATION

The Ember Debug Adapter (ISA3) provides the programming, debugging, and data emulation capability for an EM35x-based application. The Silicon Labs' Ember EM35x chip family integrates the ARM® Cortex™-M3, 32-bit microcontroller core. The Debug Adapter (ISA3) converts between the Ember JTAG and Serial Wire (SW) commands, Packet Trace Interface, TCP/IP, and UDP for an easy-to-deploy system over 10/100 Ethernet.

As part of the EM35x Development Kit, the Debug Adapter (ISA3) connects to the EM35X module through two interfaces: the 10-pin Packet Trace Port and the 12-pin data emulation interface (DEI). These two interfaces provide access to most EM35x GPIO as well as the EM35x programming and debug I/O.

The Debug Adapter (ISA3) also contains power management logic to transform Power-over-Ethernet (PoE) into IC-friendly voltage planes. The PoE functionality allows a design team to integrate the EM35x-based debugging environment into an existing network infrastructure and remotely deploy hardware during the development phase without having to remain close to a wall outlet. In addition, a self-powered, USB connection is also available for applications that interface directly to a PC or USB device. You can use the Debug Adapter (ISA3) to perform the following tasks:

- Program or debug EM35x applications using Serial Wire or JTAG.
- Monitor packets sent and received by the radio.
- Send and receive serial port data.
- Send and receive debugging data.
- Power cycle the EM35x.
- Control reset, bootloader and GPIO signals.

Therefore, the Debug Adapter (ISA3) contains the same functionality as the previous Ember product family. With Ember Desktop and the Debug Adapter (ISA3), an EM35x-based network integrates into an existing EM2xx-based network. The Debug Adapter (ISA3) cannot be used to debug or program an EM250 or EM260.

This document describes Debug Adapter (ISA3) features and specifications. For more information on the different services and IP ports supported by the Debug Adapter (ISA3), see document UG110, *EM35x Development Kit User Guide*.

New in This Revision

Added troubleshooting appendix.

Contents

1 Features

The Debug Adapter (ISA3) offers:

- Programming and debugging of the Ember EM35x chip family
- Programming speed up to 3 MHz (tested to 10' cable length)
- Power-over-Ethernet conversion, no power supply needed
- One self-powered USB jack, for applications not using PoE
- Support for 10/100 Ethernet protocols (TCP/IP and UDP) through an RJ-45 connector
  - Auto-Rate negotiation for either 10 or 100 Mbps Ethernet
  - Auto-MDIX detection and switching (allowing use of both normal and crossed RJ-45 cables)
- Access to the EM35X UART (TTL-compatible) through the data emulation interface
- Access to Virtual UART (VUART) serial port emulation through Packet Trace Port
- Packet Trace Port signals individually buffered for RCM operation down to 2.1 V
- Target Power Select Switch (Internal vs. External)
- Target Over-current Detection
- USB-support for administration and configuration
- Debug Adapter (ISA3) factory defaults button
- Cables included with Debug Adapter (ISA3):
  - USB cable
  - Packet Trace Port cable
  - Data emulation interface cable
  - Ethernet patch cable

1.1 Debug Adapter (ISA3) Enclosure

The Debug Adapter (ISA3) PCB enclosure is secured on the bottom by four screws. You can deploy the adapter in any convenient orientation on a bench-top or throughout the application environment. **Do not open the enclosure.**

If you experience issues or problems with the adapter, contact Customer Support at www.silabs.com/zigbee-support.

Table 1 lists the interfaces and mechanical characteristics of the Debug Adapter (ISA3).

Table 1. Mechanical characteristics of the Debug Adapter (ISA3)

Parameter	Description
Dimensions Enclosure End plate	 4.625" x 2.85" x 1.0" (l x w x h) 2.53" x 0.68"
Interfaces Data Emulation Interface Packet Trace Port RJ-45 for PoE and 10/100 Data USB Factory Defaults Firmware Erase Target Power Select	 12-pin, dual-row, 0.1" pitch 10-pin, dual-row, 0.05″ pitch 10-pin, 802.3af standard connector USB-B Type Connector for power and serial administration Push button (Normally Open) Push button (Normally Open) Single-pole double-throw toggle switch
LEDs (left to right: Green, Red, Yellow, Orange)	Power Status Activity Target 🟢 🔴 🟡 🟠

2 Supplying Power to the Debug Adapter (ISA3)

Warning: The Power-over-Ethernet circuitry within the Debug Adapter (ISA3) carrier board operates at a 48 V DC potential. Before connecting Power-over-Ethernet, follow the basic electrical safety instructions provided in the *NetGear User Manual*.

As shown in Figure 1, you can power the Debug Adapter (ISA3) with either:

- USB connector using USB cable from PC or USB power supply
- RJ-45 connector using Power-over-Ethernet

IEEE standard 802.3af-2003 defines Power-over-Ethernet. This standard recommends that power and data be delivered to a device through a standard Ethernet (Cat5) cable, eliminating the need for an electrical cable in addition to a data cable. When a device is not drawing power from the Ethernet cable, the power-sourcing equipment turns off power to that device. You must have a power injector in order to power the board with the Ethernet cable. Silicon Labs recommends the power injector supplied in the Development Kits (from NetGear), which Silicon Labs has tested and determined performs satisfactorily. If you plan to use a different PoE injector, contact Customer Support at www.silabs.com/zigbee-support before connecting.

Note: Power-over-Ethernet is disabled when the Debug Adapter (ISA3) is connected to USB. However, the Ethernet data is still available.

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Table 2 describes the electrical characteristics of the Debug Adapter (ISA3).

Table 2. DC electrical characteristics of the Debug Adapter (ISA3)

Parameter	Min.	Typ.	Max.	Unit
USB Connector Voltage supply Current draw (5 V)	3.3	5 500	5	V mA
Power-over-Ethernet Power rating		1.44		W
Packet Trace Port current source (to RCM or EM35x-based design)		50	250	mA
Packet Trace Port voltage source (to RCM or EM35x-based design)[1]	2.70	3.10	3.30	V
Temperature range	0		55	C

[1] Due to the power distribution circuit of the Debug Adapter (ISA3), the target voltage drops as the load current increases. Therefore, when the target current is 250 mA, the target voltage is 2.70 V. The resistance of the target current measurement circuit is 2.5 Ω from the on-board target regulator to the target itself, so for every 50 mA current sourced, the target voltage will drop 125 mV. If a constant 3.3 V target voltage is desired with high current loads, the target should be powered externally rather than through the Debug Adapter (ISA3).

3 Setting up the Debug Adapter (ISA3)

The Ember Development Kit supports network debug connected to Ethernet through its Debug Adapter (ISA3), which also takes node activity accessible to the Ember Desktop network analyzer utility. Together, Debug Adapters (ISA3s) and Ember Desktop provide an integrated development environment where you can perform a number of tasks, including:

- Debug hardware
- Monitor application or debug data
- Monitor radio data packets

Note: The Ember Development Kit is configured to support DHCP. If your site is configured for static IP addresses, see document 120-4031-000, *EM35X Quick Start Guide*, about configuring nodes for static IP addresses.

To set up an Ember development environment:
1. Connect the supplied PoE switch so it has access to a DHCP server.
2. Connect to the PoE switch:
   - All Debug Adapters (ISA3s)
   - The workstation where Ember Desktop is installed
3. Connect Breakout Boards with Debug Adapters (ISA3s) through Packet Trace Port and DEI Port cables.
4. Connect each RCM to the EM35X Module area of a breakout board.
5. Verify that each breakout board powers up by checking whether its power LEDs are on. If not, check the Target Power Select Switch on its Debug Adapter (ISA3) and verify it is set to Int as shown in Table 3.

4 Interfaces

Figure 1 and Figure 2 show the interfaces on the front and back panels of the Debug Adapter (ISA3). Figure 3 shows the LEDs on the cover.

Figure 1. Debug Adapter (ISA3) Front Panel (Packet Trace Port, DEI, Factory Defaults)

Figure 2. Debug Adapter (ISA3) back panel (USB, Ethernet, Target Power)

Figure 3. Debug Adapter (ISA3) cover

4.1   Back Panel Interfaces

Figure 2 shows two PC-based interfaces (a USB connector and an RJ-45 connector) and one Target Power select switch. The Debug Adapter (ISA3) can be powered either by the USB connector (self-powered through PC or USB power supply brick) or by PoE through the RJ-45 connector. Therefore, the Debug Adapter (ISA3) ships with a USB power supply with appropriate AC plugs for your region, while the EM35x Kit ships with a PoE switch.

Note: PoE and USB can be connected to the Debug Adapter (ISA3) at the same time. Logic in the Debug Adapter (ISA3) gives priority to the USB connection.

4.1.1   RJ-45 Connector

The RJ-45 is a 10-pin surface-mount interface for a standard Cat5 cable. It provides access to the Ethernet 10/100 Ethernet link. The connector also provides for a 48 V interface from the Ember Development Kit's Power-over-Ethernet switch. The connector on the Debug Adapter (ISA3) integrates the link and 100M LEDs for an immediate feedback for proper installation.

4.1.2   USB

The USB connector (USB-B type) is used for administration and configuration of the Debug Adapter (ISA3), as well as a power supply through either a PC or USB power supply brick. A standard 6-foot USB cable (USB-B to USB-A) ships with the Debug Adapter (ISA3); however, you can use any USB cable. For more information on configuration and administration commands, see document UG110, the *EM35x Development Kit User Guide.*

4.1.3   Target Power Select Switch

Because the EM35x IC family can operate with a supply voltage between 2.1 and 3.6 V and the core logic of the Debug Adapter (ISA3) is at 3.3 V, the Debug Adapter (ISA3) must be able to properly buffer the signals between the EM35x and itself. In addition, the Debug Adapter (ISA3) can supply power to the EM35x through the Packet Trace Port. Therefore, the Debug Adapter (ISA3) contains digital control logic for the Packet Trace Port voltage buffers based on the position of the two-position voltage selection toggle switch. Table 3 describes the toggle switch positions.

Table 3. Voltage Selection Toggle Switch Positions

Toggle switch position	Description
Ext – Int	The Packet Trace Port enables current draw from the Debug Adapter (ISA3) power management block. This is at 3.3 V and sources as much as 250 mA. See Table 2 for more details on voltage and current specs.
Ext – Int	The EM35x-based hardware contains its own power supply (such as a battery source), and the Packet Trace Port signals are buffered to that voltage level. **Note:** The Packet Trace Port Voltage Selection Logic requires 5 mA (max) of current from the "external" power supply.

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4.2   Front Panel Interfaces

The front panel (shown in Figure 1) contains two data interfaces and a factory defaults button. The two data interfaces include the data emulation interface (labeled "DEI Port" in Figure 1) and the Packet Trace Port. The voltage selector switch enables appropriate buffering on the Packet Trace Port cable. The four LEDs indicate the operation state of the Debug Adapter (ISA3).

4.2.1   Packet Trace Port

The 10-pin, dual-row, 0.05-inch-pitch Packet Trace Port is the programming and debug interface for the EM35x family of chips. It contains the five multipurpose JTAG/Serial Wire Signals (nJRST, JTDO/SWO, JTMS/SWDIO, JTDI, and JCLK/SWCLK), two Packet Trace signals (PTF and PTD), and voltage and ground connections. A Packet Trace Port cable is shipped with the Debug Adapter (ISA3). With the Packet Trace Port cable (Samtec P/N: FFSD-05-D-12.00-01-N), direct connection to the EM35x-based design (either the Ember Module or customer-designed module) is available. When the Packet Trace Port cable is attached, full access to the features of Ember Desktop is available.

Note: Any design involving an Ember EM35x chip should route the Packet Trace Port signals to test pins or, ideally, to a dual-row, 0.05-inch-pitch SMT footprint similar to the Samtec (MFG P/N: FTSH-105-01-F-DV-K) connector.

Figure 4 illustrates the Packet Trace Port connector and Table 4 describes the pins on the Packet Trace Port.

VBRD	1	2	PC2 (JTDO/SWO)
PC0 (nJRST)	3	4	PC3 (JTDI)
GND	5	6	JCLK/SWCLK
PC4 (JTMS/SWDIO)	7	8	nRESET
PA4 (PTF)	9	10	PA5 (PTD)

Figure 4. Packet Trace Port Connector

Table 4. Packet Trace Port Pins

Pin #	Signal name	Direction (to Debug Adapter (ISA3))	Description
1	VBRD	Power	2.1 to 3.6 V supply for the EM35x Module RCM
2	PC2 (JTDO/SWO)	Output	JTAG JTDO, serial wire out
3	PC0 (nJRST)	Output	JTAG reset
4	PC3 (JTDI)	Input	JTAG data in
5	GND	Power	Ground
6	JCLK/SWCLK	Input	JTAG clock, serial wire clock
7	PC4 (JTMS/SWDIO)	I/O	JTAG JTMS, serial wire data in/out
8	nRESET	Input	Active low EM35X Reset Signal (internal pull up on EM35X)
9	PA4 (PTF)	Output	Packet Trace enable signal
10	PA5 (PTD)	Output	Packet Trace data signal; 500 kbps

4.2.2 Data Emulation Interface

The 12-pin, dual-row, Extended Debug Connector allows additional access to a subset of the EM35x series GPIO. On the EM35X, it allows access from the UART passthrough port 4901 to the EM35x UART connection on the EM35x Breakout Board. The DEI cable (3M P/N: 70-0100-1832-6) is custom to the Debug Adapter (ISA3) and is provided as part of the Debug Adapter (ISA3) assembly. For more information on the EM35x Breakout Board, refer to document TS6, the *EM35x Breakout Board Technical Specification*.

Figure 5 illustrates the DEI Port connector and Table 5 describes the pins on the DEI Port.

VBRD	1	2	PB1 (SC1TXD/SC1MOSO)
PC6 (nTX_ACTIVE)	3	4	PB2 (SC1RXD/SC1MISI)
PB4 (SC1RTS/SC1SSEL)	5	6	PB3 (SC1CTS/SC1MCLK)
PB6 (ADC1/INTB)	7	8	PC5 (TX_ACTIVE)
PC1 (ADC3/TRACEDATA0)	9	10	PA7 (REG_EN/TMR1C4)
PB0 (TRACECLK/INTA)	11	12	GND

Figure 5. DEI Port Connector

Table 5. DEI Port Pins

Pin #	Signal name	Direction (to Debug Adapter (ISA3))	Description
1	VBRD	Power	2.1 to 3.6V supply for the RCM
2	PB1 (SC1TXD/SC1MOSO)	Input	SC1TXD – SC1MOSO –

Pin #	Signal name	Direction (to Debug Adapter (ISA3))	Description
3	PC6 (nTX_ACTIVE)	Open Collector	Button0
4	PB2 (SC1RXD/SC1MISI)	Output	SC1RXD – SC1MISI –
5	PB4 (SC1RTS/SC1SSEL)	Input	SC1RTS – SC1SSEL –
6	PB3 (SC1CTS/SC1MCLK)	Output	SC1CTS – SC1MCLK –
7	PB6 (ADC1/INTB)	Open Collector	Button1
8	PC5 (TX_ACTIVE)	Input	TX_ACTIVE
9	PC1 (ADC3/TRACEDATA0)	Input	TRACEDATA0 – ADC3 –
10	PA7 (REG_EN/TMR1C4)		REGEN – TMR1C4 –
11	PB0 (TRACECLK/INTA)		TRACECLK – INTA –
12	GND	Power	Ground

4.2.3 Debug Adapter (ISA3) Factory Defaults Button

The Debug Adapter (ISA3) factory defaults button is accessible through a small hole to the left of the Packet Trace Port connector, as seen in Figure 1. Depressing the button with a paper clip on power-up for between 2 and 5 seconds before releasing causes the Debug Adapter (ISA3) to jump into its factory defaults state machine, configuring the Debug Adapter (ISA3) with all default settings and a known good configuration. Depressing the button on power-up for more than 5 seconds before releasing causes the Debug Adapter (ISA3) to jump into Bootloader Mode. This mode allows for updating the Debug Adapter (ISA3) firmware while bypassing the existing firmware execution.

4.3 Cover Interfaces

The cover (shown in Figure 3) contains four LEDs, which indicate the operation state of the Debug Adapter (ISA3).

4.4 LED Indicators

Four LEDs on the front panel indicate the operational state of the Debug Adapter (ISA3). Table 6 describes the LED states.

Table 6. Debug Adapter (ISA3) LED Indicator States

LED	State	Description
Power Green	Off	Debug Adapter (ISA3) not powered
	On	Debug Adapter (ISA3) has power (from USB or PoE)
	Off	No Error

LED	State	Description
Status Red	Blinking	Internal Error. Contact Customer Support.
Activity Yellow	On , Solid (No Blinking)	Debug Adapter (ISA3) Bootloader Mode
	On (Blinking, (2 sec interval)	Idle Heartbeat
	On, Flashing Quickly	Either of the following: 1) Acquiring IP address 2) Establishing USB connection 3) Processing J-Link command
Target Orange	Off	Target voltage is 0 V. Note: This LED is also off in Debug Adapter (ISA3) Bootloader Mode.
	On	Target voltage is above 0 V, either from internal or external supply (dictated by Target Power Select Switch).
	Blinking	Internal supply shut off due to over-current detection.

5 Appendix—Troubleshooting

This appendix provides some guidance for troubleshooting typical problems found with using the Debug Adapter (ISA3).

5.1   Cannot connect to Debug Adapter (ISA3)

A common problem is not being able to connect to the Debug Adapter (ISA3) via Ember Desktop. This could be caused by any number of the following issues:
- Debug Adapter (ISA3) is not connected via Ethernet to the proper network.
- Debug Adapter (ISA3) is configured for static IP rather than DHCP or vice versa.
- Ember Desktop is not configured to scan the proper network subnet for devices.

If all of these settings are believed to be correct and you are still having issues connecting to the Debug Adapter (ISA3), follow the following steps to gather more information about the problem:

1. Disconnect all cables from the Debug Adapter (ISA3).
2. Power the Debug Adapter (ISA3) via USB cable from PC.
3. What is the state of the Debug Adapter (ISA3) Debug LEDs?
    a. Normal operation is green power LED on, yellow activity LED blinking or heartbeat, red status LED off, and orange target LED on or off depending on state of Target Power Select Switch (LED on for INT setting, off for EXT setting).
4. If the green power LED is on, the yellow activity LED is on solid (not blinking), and you can toggle the Target Power Select switch without affecting the orange Target LED, you are in bootloader mode. In this case, try step 5, as this should then install firmware.
5. Issue "em3xx_isa" on command line.
    a. Does the command output show a valid USB connection to the Debug Adapter (ISA3) or no valid connection ("Error: Failed to connect to InSight Adapter")?
    b. If there is a valid USB connection and configuration information is displayed, please provide this information to us. In the case of yellow activity LED solid in 4 above, you should also see firmware installed.
    c. If there is no valid USB connection, try "em3xx_isa --usb x", where x is 1, 2, and 3, to be sure that the USB address was not changed from the default address of 0.
        i. If a valid USB connection is found on USB address 1, 2, or 3, you can change this back to the default USB address of 0 by issuing the command "em3xx_isa --admin "usbaddr set 0"" and then power cycling the ISA3.
    d. If there is no valid USB connection on any of the 4 valid USB addresses (0 through 3), please open a ZigBee Portal Support case describing this issue and provide us with the MAC Address on the bottom-side of the unit   The MAC address allows us to look up the warranty information for this unit.
6. If only the Debug Adapter (ISA3) green power LED is on, this suggests that the firmware is not booting up. In this case, try the following:
    a. Disconnect USB cable from the Debug Adapter (ISA3).
    b. Using a paper clip, press and hold the button to the left of the Packet Trace Port connector (this is the factory defaults button), accessible through the hole/cutout in the plastics.
    c. While continuing to hold this button pressed, power the Debug Adapter (ISA3) with the USB cable, holding the button for at least 5 seconds (10 for good measure). This will force the Debug Adapter (ISA3) to boot up in its bootloader.
    d. Release the button.
    e. Issue "em3xx_isa" on command line.
        i. You should now see bootloader detected and firmware will be installed onto the Debug Adapter (ISA3).
        ii. When the firmware upload is complete, LED operation should now be normal (per 3a above).
7. If the LED operation is normal, please attach the Packet Trace Port cable to the Debug Adapter (ISA3) and an EM35x module to the target end of the Packet Trace Port cable. Move the Target Power Select Switch to INT if it is not already in this position.

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8. Issue the command "em3xx_load --reui64" on the command line.
   a. Are you able to read the EUI from the target device, or is there an error? If an error is displayed, please provide this information to us.
9. Issue the command "em3xx_load <path>/nodetest.s37", where <path> is the location of the nodetest image.
   a. Are you able to successfully program the target device? If an error is displayed, please provide this information to us.

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