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EM250 Breakout Board Technical Specification

The Ember EM250 breakout board contains the hardware stimulus for the development and deployment of a low-data-rate, low-power ZigBee application on the EM250 radio communication module (RCM). The four-layer (FR4) RCM features a temperature sensor, two buttons, a piezo buzzer, two LEDs, and a 2" x 2" through-hole prototyping area. In addition, it contains an RS-232 transceiver with DB-9 connector, InSight data emulation interface, regulated power planes, and direct attachment to the EM250 RCM. These features allow for proper development of an EM250 application.

The breakout-board voltage supply can be obtained from one of three sources: EM250 RCM (via the InSight Port), 12V DC, and battery pack. This feature offers a degree of flexibility when testing different network topologies.

This document provides the technical specification for the EM250 breakout board. It describes the board level interfaces as well as the key performance parameters. In addition it provides the necessary information for a developer to validate their application design using the EM250 breakout board.

New in this Revision

Schematic quality is improved.

Contents

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Breakout Board Features

The EM250 breakout board offers:

- Configurable hardware support for application development
  - Temperature sensor (connects to EM250 ADC module)
  - Two buttons (connect to GPIO)
  - Piezo buzzer (connect to GPIO)
  - Two LEDs (connect to GPIO)
- RS-232 transceiver with DB-9 connector for serial communication (no HW handshake support)
- Control Interface for the EM250 RCM
  - RCM RESET button
  - Voltage Supply connection (VBRD)
- 2" x 2", 0.1" pitch prototyping area
- 20-pin, 0.1" pitch, dual-row logic-analyzer shrouded connector
- 28-pin, 0.05" pitch, dual-row EM250 RCM connector
- 26-pin, low-profile InSight data emulation interface with configuration header
- Automatic DC power source selection (either 12 V DC Wall Wart or AAA battery pack)

Table 1 lists the DC electrical characteristics of the EM250 breakout board.

Table 1. DC electrical characteristics

Parameter	Min.	Typ.	Max.	Unit
VDD supply				
from battery	2.1		3.6	V
from DC jack		12	16	V
Current draw (peripherals)				
Piezo buzzer			10	mA
Buttons (enabled)			6	mA
Temperature sensor (enabled)			5	mA
Current draw (miscellaneous)				
RS-232 transceiver			4	mA
TPS2105 (power distribution switch)			35	µA
LDO distribution			10	mA
Operating temperature	- 40		+ 85	C

Components

Figure 1 illustrates the components on layer 1 (top side).

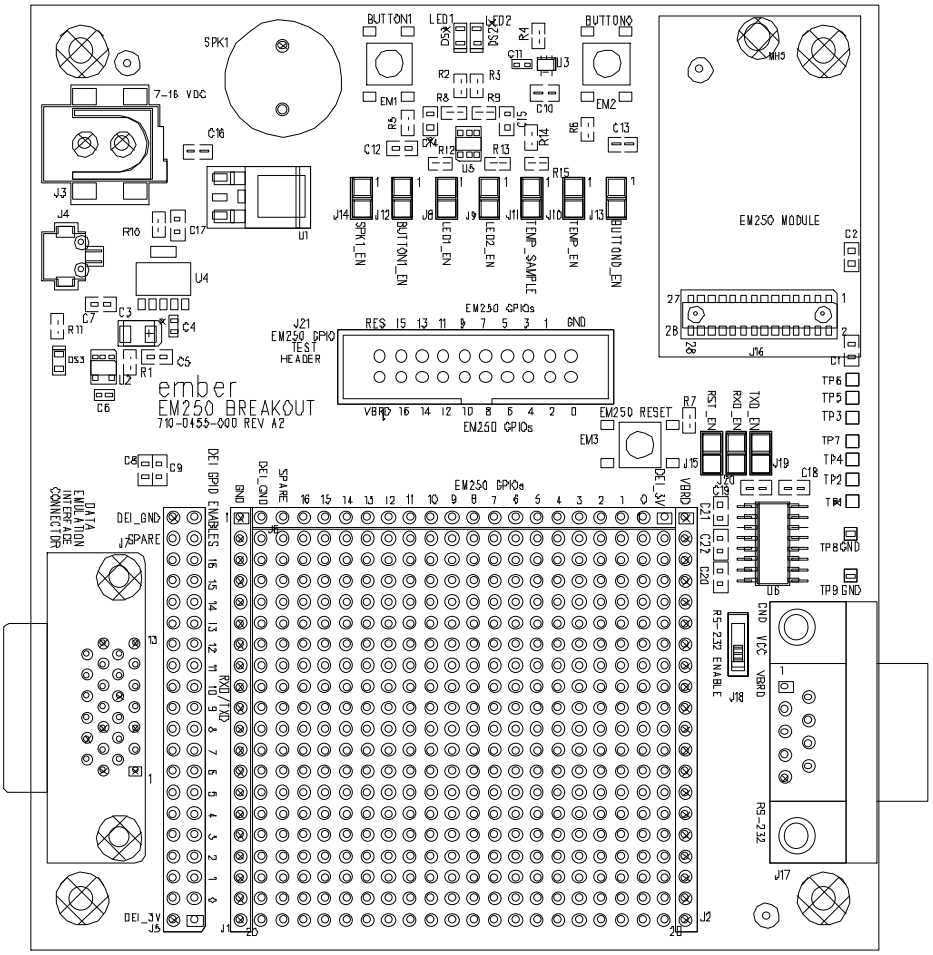


Figure 1. Assembly print for layer 1

Power supply and distribution

The EM250 breakout board can be powered from one of three sources:

- DC jack (J3) with 12 V DC power supply
- Battery pack connector (J4)
- The InSight Adapter (via InSight Port, J1 on the EM250 RCM)

The EM250 breakout board contains power source selection logic which grants priority to the DC jack power supply over the battery pack. However, it cannot automatically sense when the attached RCM is sourcing power via InSight Adapter. Therefore, be careful to make sure power is being sourced from either the InSight Adapter (from the RCM) *or* from the breakout board (from J3 or J4).

Caution: Only one power source should be active at any given time.

DC jack (J3)

The DC jack on the EM250 breakout board allows for a robust connection (5,000 cycles) to the regulated 12 V DC power adapter shipped with the EM250 breakout board. The 2.1 x 5.5mm jack from CUI, Inc (MFG P/N: PJ-105A-SMT) is rated to 16 V DC at 2.5A. The center pin of the jack is +V with shroud connected to the GND plane. If a different power adapter is to be used (not recommended), the minimum power required at the DC jack port is 7V @ 100mA.

Battery connector (J4)

The 2-pin, keyed battery connector (Hirose, P/N: DF13-2P-1.25H(50)) allows for connection to a DC power supply or battery pack. The EM250 breakout board is shipped with a 2-AAA battery pack with appropriate mating connector for easy attachment.

Although Ember recommends that only one power supply be connected to the EM250 breakout board, the board does contain voltage-sensing logic to properly switch between the battery connector and the DC jack. However the voltage sensing logic does not operate at battery voltages below 2.7V. In addition, it grants priority to the DC jack over the battery pack.

InSight Adapter (through EM250 RCM)

The EM250 breakout board can also be powered from the InSight Adapter when an EM250 RCM is attached. To enable this power supply, the InSight Adapter selection toggle switch must be put in the INT position (as described in the *InSight Adapter Technical Specification* (120-2002-000)), and the InSight port cable must be attached to the EM250 RCM. The InSight Adapter is able to source 50 mA of current at 3.0 V. Therefore, use care when enabling application peripherals on the breakout board.

Note: When powering the EM250 breakout board with the InSight Adapter, disconnect the battery pack (J4) and 12 V DC power supply (J3).

Application peripherals

As previously mentioned, the EM250 breakout board offers six peripherals to assist in application development. These include:

- Temperature sensor
- Two “normally open” buttons
- 4kHz piezo buzzer
- Two LEDs

Each peripheral connects to an EM250 GPIO through a two-pin peripheral header. Because each peripheral header on the EM250 breakout board ships with a jumper in place, the peripherals default to “HW Enabled.” If application development does not require the peripheral, simply remove the jumper. Note that each peripheral consumes power, so factor this into the current consumption equations for battery consumption (if using a battery to power the breakout board).

Temperature sensor (U3)

The temperature sensor is an off-the-shelf component from National Semiconductor (MFG P/N: LM20BIM7). The temperature sensor requires an enable signal to be asserted (active high) prior to generating an analog voltage proportional to the ambient

temperature of the EM250 breakout board. Therefore, two EM250 GPIO signals, GPIO7 and GPIO6, are routed to pin 2 of peripheral headers J10 and J11, respectively.

- GPIO7 enables the temperature sensor when asserted (active high), when a jumper is installed at J10.
- GPIO6 contains the analog temperature information from the sensor, when it is enabled and a jumper is installed at J11.

Due to the EM250 ADC voltage reference at 1.2V, the temperature sensor output is scaled to between 0 and 1.2V through a resistive voltage divider. If a developer wants to connect a temperature sensor from a different manufacturer, the output needs to be scaled in a similar manner.

The EM250 breakout board is shipped with a jumper installed at J10 and J11. If the jumpers are removed, a different compatible device can be attached to pin 2 of both J10 and J11.

For more information on the temperature sensor, refer to its datasheet (www.national.com/pf/LM/LM20.html).

Buttons (EM1, EM2)

Two programmable, normally-open buttons are provided for software debugging and application development. When either button is pressed, the connected net is driven low. A single-pole RC filter minimizes the effects of switching noise.

These buttons map to the backchannel button commands as follows:

- EM2: controlled by the `button 0` command
- EM1: controlled by the `button 1` command

For information about the `button` command, see the *EM250 User Guide* (120-4024-000).

Two EM250 GPIO signals, GPIO15 and GPIO8, are routed from the EM250 RCM to pin 2 of peripheral headers J12 and J13, respectively. In the default configuration of the EM250 breakout board, jumpers are positioned across J12 and J13 to enable buttons EM1 and EM2, respectively.

If the jumpers are removed, different compatible devices can be attached to pin 2 of breakout headers J12 and J13 instead of the buttons.

Buzzer (SPK1)

A programmable buzzer is provided for software debugging and application development. An EM250 GPIO signal, GPIO16, is routed to pin 2 of peripheral header J14. In the default configuration of the carrier board, a jumper is positioned across J14 to enable use of the buzzer. The buzzer installed on the EM250 breakout board is from CUI (MFG P/N: CEP-1160). For more information on the buzzer, refer to its datasheet (http://products.cui.com/getPDF.aspx?filename=CEP-1160.pdf).

LEDs (DS1 and DS2)

The EM250 breakout board contains two LEDs for software debugging and application development. Each LED is buffered (non-inverting) to allow for connection to any

EM250 GPIO. Two EM250 GPIOs, GPIO11 and GPIO12, are routed to pin 2 of headers J8 and J9, respectively. To turn on DS1 and DS2 from the EM250 RCM, install jumpers at J8 and J9, respectively; an active low signal is driven from the EM250 RCM.

Serial communication for EM250 SC1 UART

To enhance the software development experience, access to the EM250 SC1 UART is available directly from the EM250 breakout board or by telnetting into port 4901 of the InSight Adapter. On the EM250 breakout board, it is available as both RS-232 and TTL-compliant signal levels. From the InSight Adapter, it is only available as TTL-compliant signal levels.

To minimize current consumption and allow for different configuration options, the EM250 breakout board individually routes the EM250 SC1 UART signals TXD (EM250 GPIO9) and RXD (EM250 GPIO10) to peripheral headers J19 and J20, respectively. In addition, they are routed to the InSight data emulation interface jumper connector (J5).

To eliminate contention on the RXD signal, you must select only one data path for the EM250 SC1 UART. Therefore, it can be accessed from the EM250 breakout board *or* from the InSight Adapter, but not from both.

The following sections describe three configuration options for access to the serial communication of the EM250: two through the EM250 breakout board and one through the Insight Adapter.

RS-232 serial communication on breakout board

The EM250 breakout board contains an RS-232 transceiver (U6). To enable communication with EM250 SC1 UART as an RS-232 device, install three jumpers at peripheral headers J18, J19, and J20:

- J18: A center-tapped 3-pin header connects VBRD (pin 1) to the RS-232 transceiver.
- J19: A 2-pin header connects TXD with the TX port of the RS-232 transceiver.
- J20: A 2-pin header connects RXD with the RX port of the RS-232 transceiver

Figure 2 illustrates this connection scheme.

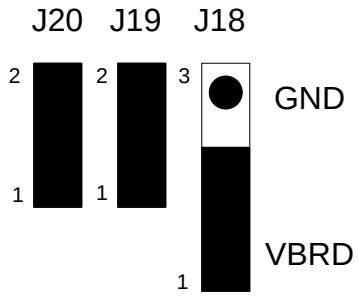


Figure 2. RS-232 serial communication

TTL-compatible serial communication on breakout board

The EM250 breakout board enables TTL-compatible communication with the EM250 SC1 UART. Pin 2 of peripheral headers J19 and J20 expose the TXD and RXD signals from SC1 UART. To reduce the risk of contention, connect the jumper at J18 so that the center pin connects to ground (pin 3). Figure 3 illustrates this connection scheme.

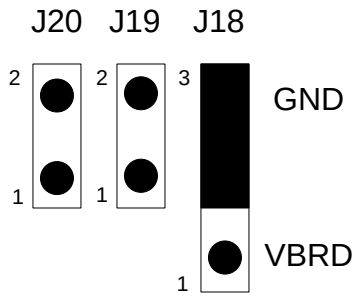


Figure 3. TTL-compatible serial communication

TTL-compatible serial communication from InSight Adapter

To access the EM250 SC1 UART from port 4901 of the InSight Adapter:

1. Disconnect the InSight data emulation interface cable from the InSight Adapter.
2. Connect jumpers at J18, J19, and J20, as shown in Figure 3.
3. Use the jumpers previously on J20 and J19 for GPIO10 and GPIO9 on J5, as shown in Figure 3.
4. Move the InSight Adapter voltage toggle switch to the INT position.
5. Remove the secondary power source from the EM250 breakout board.

Note: Power must be supplied by the InSight Adapter.

6. Connect the InSight data emulation interface cable to the Insight Adapter.

Warning: Because the InSight data emulation interface is not buffered, the InSight Adapter must provide power for the EM250 breakout board and the EM250 RCM when using this interface.

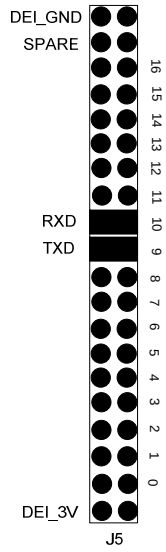


Figure 4. Jumper settings required for EM250 SC1 UART access by InSight Adapter

InSight data emulation interface (J7)

The 26-pin, dual-row, InSight data emulation interface contains all 17 of the EM250 GPIOs, as well as voltage (VBRD) and ground (GND) connections. When connected to the InSight Adapter, the connector provides additional debug features to the software developer.

One feature involves the port 4901 UART connection via InSight Adapter. To enable the UART connection to the EM250 UART signals, two jumpers must be installed on the J5. These are labeled GPIO10 and GPIO9.

Another feature involves manipulation of BUTTON0 and BUTTON1 GPIO signals. To enable GPIO manipulation of BUTTON0 and BUTTON1, jumpers must be installed on J5 at GPIO8 and GPIO15, respectively.

EM250 RCM interface connector (J16)

The 28-pin, dual-row, 0.05" pitch socket allows direct connection of the EM250 RCM to the EM250 breakout board. This socket allows access to all 17 EM250 GPIOs, SIF signals, power, and ground. The connector on the EM250 breakout board is from Samtec (MFG P/N: FLE-114-01-G-DV-A).

The EM250 GPIOs are exposed on the EM250 breakout board for application development. Figure 5 shows the pinout of the RCM interface connector and Table 2 describes the pinout and signal names. For more information on the alternate functions of the GPIO connector, refer to the *EM250 Datasheet* (120-0082-000).

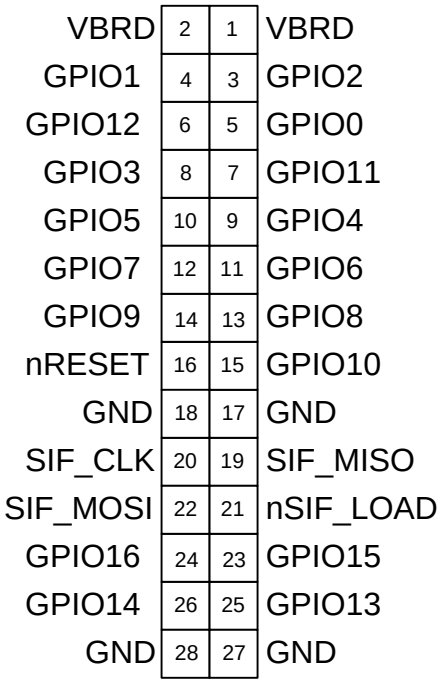


Figure 5. RCM interface connector (J16)

Table 2. Pinout and signal names of the interface connector

Pin #	Signal name	Direction *	Description
1	VBRD	Power	2.1 to 3.6 V DC net (RCM)
2	VBRD	Power	2.1 to 3.6 V DC net (RCM)
3	GPIO2	I/O	Digital I/O
4	GPIO1	I/O	Digital I/O
5	GPIO0	I/O	Digital I/O
6	GPIO12	I/O	Digital I/O
7	GPIO11	I/O	Digital I/O
8	GPIO3	I/O	Digital I/O
9	GPIO4	I/O	Digital I/O
10	GPIO5	I/O	Digital I/O
11	GPIO6	I/O	Digital I/O
12	GPIO7	I/O	Digital I/O
13	GPIO8	I/O	Digital I/O
14	GPIO9	I/O	Digital I/O
15	GPIO10	I/O	Digital I/O

Pin #	Signal name	Direction *	Description
16	nRESET	Input	Active low chip reset (internal pull-up on EM250)
17	GND	Power	Ground connection
18	GND	Power	Ground connection
19	SIF_MISO	Input	Serial interface, master in/slave out
20	SIF_CLK	Output	Serial interface, clock (internal pull-down on EM250)
21	nSIF_LOAD	Input	Serial interface, load strobe (open collector with internal pull-down on EM250)
22	SIF_MOSI	I/O	Serial interface, master out/slave in
23	GPIO15	I/O	Digital I/O
24	GPIO16	I/O	Digital I/O
25	GPIO13	I/O	Digital I/O
26	GPIO14	I/O	Digital I/O
27	GND	Power	Ground connection
28	GND	Power	Ground connection

* with respect to the RCM

Prototyping area

The 2" x 2" (0.1" pitch) prototyping area on the EM250 breakout board offers software developers an extra degree of flexibility. As shown in Figure 6, it allows access to VBRD, GND, and each of the 17 EM250 GPIOs. Therefore, you can solder any sensor or input device to the prototyping area and connect it to the EM250 GPIO for development and debugging.

As shown in Figure 6, the leftmost column is connected to GND and the rightmost column to VBRD. The top row is connected to the EM250 GPIOs. Included in the top row are additional GND and VBRD connections, as well as a SPARE signal for future use. The remainder of the array is available for application development.

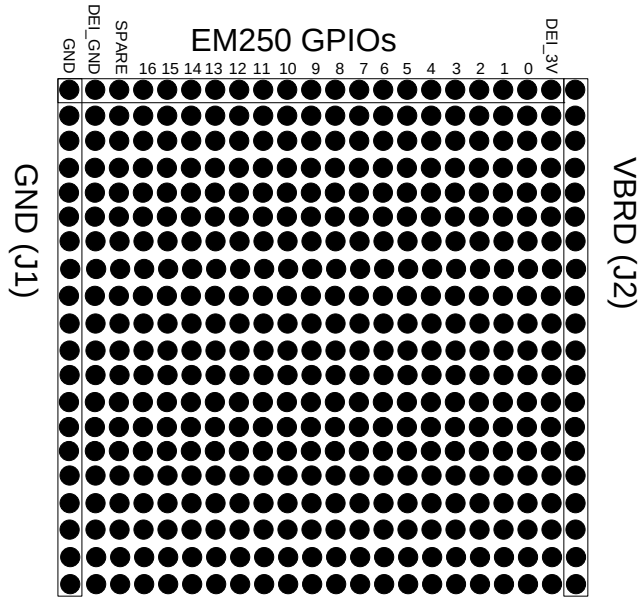


Figure 6. EM250 breakout board prototyping area

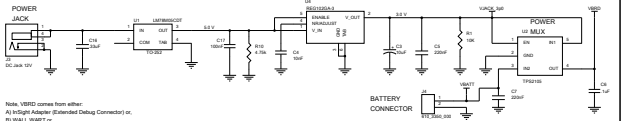
Schematic of Breakout Board

The breakout board schematics are included at the end of this document.

After Reading This Document

If you have questions or require assistance with the procedures described in this document, contact an Ember support representative at http://www.ember.com/support_index.html.

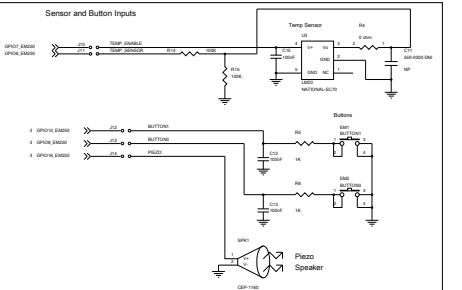
Power Distribution



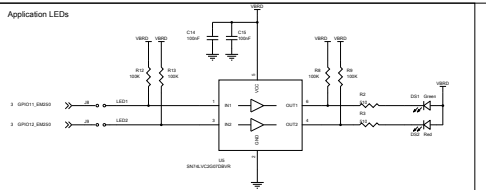
Note, VBRD comes from either:
A) InSight Adapter (Extended Debug Connector) or,
B) WALL WART or
C) Battery Pack

Notes for POWER MUX (U2):
1) VJACK is 3V when connected to an InSight Adapter or when using the 12V Wall Wart.
2) VBATT can be 2.1 to 3.6V, but usually it will be 3.0V
3) VBRD = VJACK when using a 12V Wall Wart or InSight Adapter
4) VBRD = VBATT when Battery connected AND VJACK is not connected.

Sensor and Button Inputs



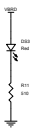
Application LEDs

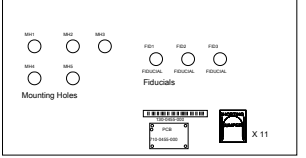


Reset (Active Low)

Note, RESET sources:
1) SIF_RESET from SIF Pod to EM250 Module (Debug Connector.
2) EM1 Button on Breakout Board

Power Indicator LED





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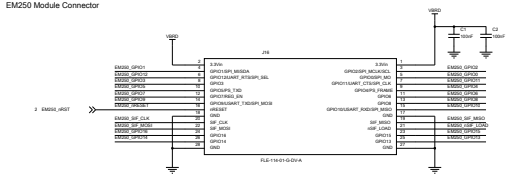
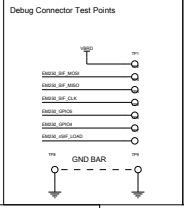
Date: Wednesday, March 08, 2006		Sheet 1 of 1	

EM250 Module Connector

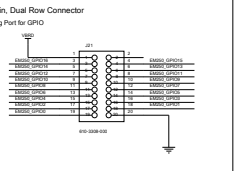


Debug Connector Test Points



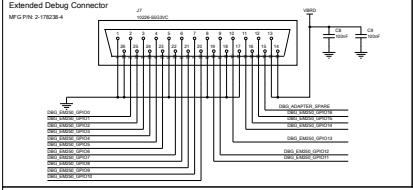
20-pin, Dual Row Connector

Debug Port for GPIO



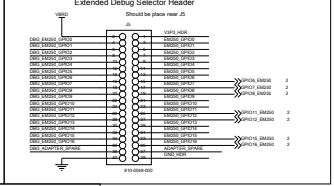
Extended Debug Connector

MFG P/N: 2-178238-4



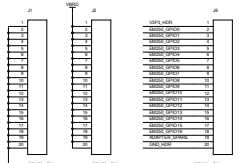
Extended Debug Selector Header

Should be place near J5

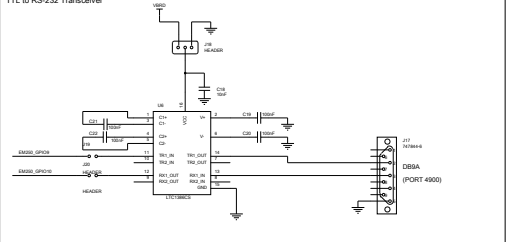


Scratch Pad Area

Defined by J1 ,J2 and J6



TTL to RS-232 Transceiver



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Title
EM250 Breakout Board
Board Interfaces

Date	Document	Rev
	SCH0033	A2

Date: Thursday, March 23, 2006 Sheet 3 of 3