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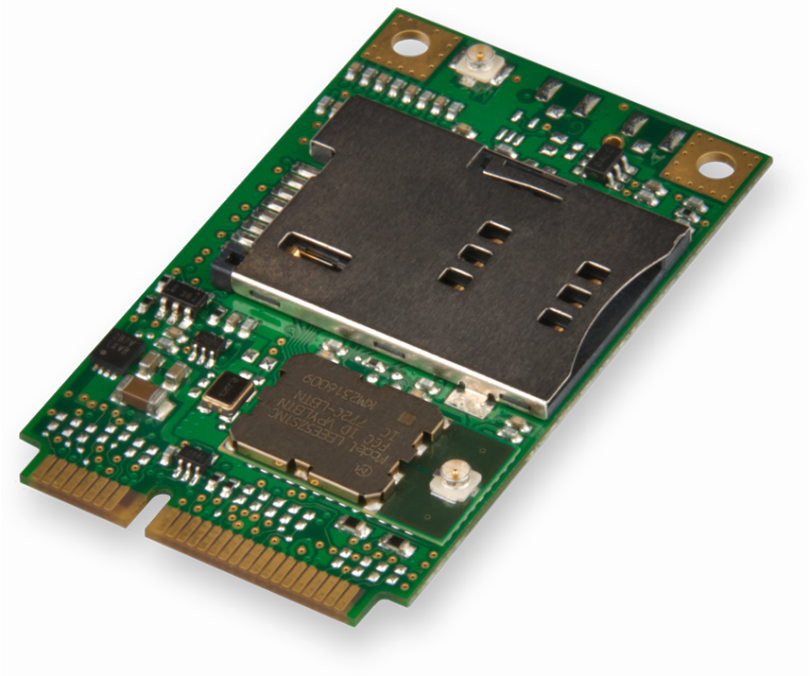

MultiConnect® PCIe

MTPCIE-H5/MTPCIE-BW Developer Guide

MultiConnect PCIe Developer Guide

Models: MTPCIE-H5-xx, MTPCIE-H5-V-BW, MTPCIE-BW

Part Number: S000572, Version 1.4 European Edition

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Chapter 1 – Product Overview

About MultiConnect PCIe

The MultiConnect™ PCIe embedded cellular modem is a complete, ready-to-integrate communications device that offers standard-based seven-band HSPA+ 21 CDMA performance. This quick-to-market communications device allows developers to add wireless communication and GPS tracking to products with a minimum of development time and expense. The MultiConnect PCIe embedded cellular modem is based on industry-standard open interfaces and utilizes a PCI Express Mini Card form factor.

Documentation

Download the following documentation at www.multitech.com/setup/product.go.

Document	Description
MultiConnect PCIe Developer Guide	This document. Provides an overview, safety and regulatory information, developer board schematics and pinouts, and device.
USB Driver Installation Guide	Provides instructions for installing USB drivers on Linux and Windows systems (part number S000553)(part number S000569).
HSPA+ AT Commands Reference Guide	Configure the MTPCIE-H5 with HSPA+ AT Commands (part number S000574).
EV-DO and CDMA AT Commands Reference Guide	Configure the MTPCIE-C2 with CDMA AT Commands (part number S000546).

Documentation

The following documentation is available by email to oemsales@multitech.com ,

- **MultiConnect PCIe Developer Guide** - Provides an overview, safety and regulatory information, design considerations, schematics, and device information.
- **AT Command Guide** - Use S000528, HSPA+ H5 AT Command Reference Guide.

Product Build Options

Product	Description
MTPCIE-H5-V-BW-EU	HSPA+ Embedded Cellular Modem with digital voice, GPS, Wi-Fi and Bluetooth
MTPCIE-H5-EU	HSPA+ Embedded Cellular Modem
MTPCIE-BW	Wi-Fi and Bluetooth
Developer Kit	
MTPCIE-DK	Developer Kit

Note:

- These units ship without network activation.
- To connect them to the cellular network, you need a cellular account. For more information, refer to Account Activation.

- GP devices have a dedicated GPS receiver.
- The complete product code may end in .Rx. For example, MTPCIE-H5.Rx, where R is revision and x is the revision number.
- All builds can be ordered individually or in 50-packs.

Developer Kit Contents

Your Developer Kit (MTPCIE-DK1) includes the following:

Developer Board	1 - MTPCIE-DK1 Developer Board
Power Supply	1 - 100-240V 9V-1.7A power supply with removable blades, 1 - US blade/plug, 1 - EURO blade/plug, 1 - UK blade/plug
Cables	1 - RS-232 DE9F-DE9M serial cable, 1 - RJ-45 Ethernet cable, 2 -USB cable 2 - SMA-to-UFL antenna cables (1 - for cellular, 1 - for GPS) 1 - RSMA-to-UFL antenna cable for Bluetooth/Wi-Fi.
Antennas	1 - 3.3V magnetic GPS antenna , 1 - HEPTA band SMA antenna, 1 - 2.4GHz, dipole Wi-Fi antenna
Customer Notices	Legal and Support information
Additional	One promotional screwdriver

Chapter 2 – Pinout

Multi-Tech Mini PCIe Pinout

Note:

Some modems do not include all the pins.

SDIO can operate up to 25Mhz. Treat the SDIO traces to Host like a bus and keep the bus length as short as possible. Multi-Tech recommends adding series termination resistors on all the SDIO traces.

Pin #	Name	I/O	Function	MTPCIE-H5	MTPCIE-H5-V-BW	MTPCIE-BW
1	SDIO_D0	I/O	Wi-Fi SDIO_D0		X	X
2	3.3Vaux	I	3.3Vaux	X	X	X
3	SDIO_D1	I/O	Wi-Fi SDIO_D1		X	X
4	GND		Ground	X	X	X
5	SDIO_D2	I/O	Wi-Fi SDIO_D2		X	X
6	BT_TXD	I	Bluetooth Transmit data		X	X
7	SDIO_D3	I/O	Wi-Fi SDIO_D3		X	X
8	BT_RTS	I	Bluetooth RTS		X	X
9	GND		Ground	X	X	X
10	BT_CTS	O	Bluetooth CTS		X	X
11	SDIO_CMD	I/O	Wi-Fi SDIO_CMD		X	X
12	BT_RXD	O	Bluetooth Receive data		X	X
13	SDIO_CLK	I	Wi-Fi SDIO_CLK		X	X
14	BT_EN	I	Bluetooth enable (low disable)		X	X
15	GND		Ground	X	X	X
16	GPIO_2	I/O	3G Cellular General purpose I/O		X	
17	WLAN_EN	I	Wi-Fi enable (low disable)		X	X
18	GND		Ground	X	X	X
19	WLAN_IRQ	O	Wi-Fi interrupt (low active)		X	X
20	3G_ONOFF	I	3G Cellular On/Off (low active)	X	X	
21	GND		Ground	X	X	X

Pin #	Name	I/O	Function	MTPCIE-H5	MTPCIE-H5-V-BW	MTPCIE-BW
22	3G_RST	I	3G Cellular Reset line (low active)	X	X	
23	1.8V	O	1.8V output		X	X
24	3.3Vaux	I	3.3Vaux	X	X	X
25	GPIO_1	I/O	Bluetooth General purpose I/O		X	X
26	GND		Ground	X	X	X
27	GND		Ground	X	X	X
28	3G_DVI_WA0	I/O	3G Cellular digital voice control line		X	
29	GND		Ground	X	X	X
30	3G_DVI_CLK	I/O	3G Cellular digital voice clock		X	
31	3G_DVI_RX	I	3G Cellular digital voice receive		X	
32	RI	O	3G Cellular UART RI		X	
33	3G_DVI_TX	O	3G Cellular digital voice transmit		X	
34	GND		Ground	X	X	X
35	GND		Ground	X	X	X
36	USB_D-	I/O	3G USB Negative Data	X	X	
37	GND		Ground	X	X	X
38	USB_D+	I/O	3G USB Positive Data	X	X	
39	3.3Vaux	I	3.3Vaux	X	X	X
40	GND		Ground	X	X	X
41	3.3Vaux	I	3.3Vaux	X	X	X
42	LED_WWAN#	O	3G Cellular STAT LED Output	X	X	
43	GND		Ground	X	X	X
44	DCD	O	3G Cellular UART DCD		X	
45	CTS	O	3G Cellular UART CTS		X	
46	GPIO_3	I/O	3G Celllular General purpose I/O		X	
47	RTS	I	3G Cellular UART RTS		X	
48	DTR	I	3G Cellular UART DTR		X	

Pin #	Name	I/O	Function	MTPCIE-H5	MTPCIE-H5-V-BW	MTPCIE-BW
49	RXD	O	3G Cellular UART Receive data		X	
50	GND		Ground	X	X	X
51	TXD	I	3G Cellular UART transmit data		X	
52	3.3Vaux	I	3.3Vaux	X	X	X

Standard Mini-PCI Express Pinout

For reference only.

Pin #	Function	I/O	Description
1	WAKE#	O	WAKE
2	3.3Vaux	I	3.3Vaux
3	COEX1	I	Co-existence pin, not defined
4	GND		GND
5	COEX2	I	Co-existence pin, not defined
6	1.5V	I	1.5V
7	CLKREQ#	O	CLKREQ#
8	UIM_PWR	I	UIM_PWR
9	GND		GND
10	UIM_DATA	I/O	UIM_DATA
11	REFCLK+	I	PCI Express reference clock
12	UIM_CLK	I	UIM_CLK
13	REFCLK-	I	PCI Express reference clock
14	UIM_RESET	I	UIM_RESET
15	GND		GND
16	UIM_VPP	0	UIM_VPP
17	Reserved		Reserved
18	GND		GND
19	Reserved		Reserved
20	W_DISABLE#	I	W_DISABLE#
21	GND		GND
22	PERST#	I	PERST#
23	PERn0	O	PCI Express receiver differential pair signal
24	3.3Vaux	I	3.3Vaux
25	PERp0	O	PCI Express receiver differential pair signal
26	GND		GND
27	GND		GND
28	1.5V	I	1.5V
29	GND		GND
30	SMB_CLK	I	SMB_CLK
31	PETn0	I	PCI Express transmitter differential pair signal

Pin #	Function	I/O	Description
32	SMB_DATA	I/O	SMB_DATA
33	PETp0	I	PCI Express transmitter differential pair signal
34	GND		GND
35	GND		GND
36	USB_D-	I/O	USB Negative Data
37	GND		GND
38	USB_D+	I/O	USB Positive Data
39	3.3Vaux	I	3.3Vaux
40	GND		GND
41	3.3Vaux	I	3.3Vaux
42	LED_WWAN#	O	LED Output
43	GND		GND
44	LED_WLAN#	O	LED Output
45	Reserved		Reserved
46	LED_WPAN#	O	LED Output
47	Reserved		Reserved
48	1.5V	I	1.5V
49	Reserved		Reserved
50	GND		GND
51	Reserved		Reserved
52	3.3Vaux	I	3.3Vaux

Pinout for Cellular USB Only

Pin #	Name	I/O	Description
2	3.3 Vaux	I	3.3 Vaux
4	GND		Ground
9	GND		Ground
15	GND		Ground
18	GND		Ground
20	3G_ONOFF	I	3G cellular on/off
21	GND		Ground
22	3G_RST	I	3G cellular reset line
24	3.3 Vaux	I	3.3 Vaux
26	GND		Ground
27	GND		Ground
29	GND		Ground
35	GND		Ground
36	USB_D-	I/O	3G USB Negative Data
37	GND		Ground
38	USB_D+	I/O	3G USB Positive Data
39	3.3 Vaux	I	3.3 Vaux
40	GND		Ground
41	3.3 Vaux	I	3.3 Vaux
42	LED_WWAN	O	3G Cellular STAT LED Output
43	GND		Ground
50	GND		Ground
52	3.3 Vaux	I	3.3 Vaux

Chapter 3 – Design Considerations

Design Consideration

When using the Multi-Tech MiniPCIe form factor:

- Consult your modem's device guide for device dimensions. With the modem, the Multi-Tech Mini PCIe form factor exceeds the standard Mini PCIe maximum component height for top and bottom.
- If you need to install components under the module, use taller connectors to avoid conflict. Multi-Tech recommends not installing components under the module.
- Check the Pinout table for pins that differ from the MiniPCIe spec.

Noise Suppression Design

Adhere to engineering noise-suppression practices when designing a printed circuit board (PCB). Noise suppression is essential to the proper operation and performance of the modem and surrounding equipment.

Any OEM board design must consider both on-board and off-board generated noise that can affect digital signal processing. Both on-board and off-board generated noise that is coupled on-board can affect interface signal levels and quality. Noise in frequency ranges that affect modem performance is of particular concern.

On-board generated electromagnetic interference (EMI) noise that can be radiated or conducted off-board is equally important. This type of noise can affect the operation of surrounding equipment. Most local government agencies have certification requirements that must be met for use in specific environments.

Proper PC board layout (component placement, signal routing, trace thickness and geometry, and so on) component selection (composition, value, and tolerance), interface connections, and shielding are required for the board design to achieve desired modem performance and to attain EMI certification.

Other aspects of proper noise-suppression engineering practices are beyond the scope of this guide. Consult noise suppression techniques described in technical publications and journals, electronics and electrical engineering text books, and component supplier application notes.

PC Board Layout Guideline

In a 4-layer design, provide adequate ground plane covering the entire board. In 4-layer designs, power and ground are typically on the inner layers. Ensure that all power and ground traces are 0.05 inches wide.

The recommended hole size for the device pins is 0.036 in. +/-0.003 in. in diameter. Use spacers to hold the device vertically in place during the wave solder process.

All creepages and clearances for the device meet requirements of safety standards listed in the technical specifications. The requirements are based on a working voltage of 125V or 250V. When implementing the recommended DAA* circuit interface in a third party design, strictly follow all creepage and clearance requirements to meet safety standards. The third party safety design must be evaluated by the appropriate national agency according to the required specification.

User Accessible Areas

Based on where the third party design is marketed, sold, or used, it may be necessary to provide an insulating cover over all TNV exposed areas. Consult with the recognized safety agency to determine the requirements.

Note: Even if the recommended design considerations are followed, there are no guarantees that a particular system complies with all the necessary regulatory requirements. Make sure a qualified and recognized agency evaluates specific designs. .

*DAA stands for Data Access Arrangement. DAA is the device's telephone line interface.

Electromagnetic Interference

The following guidelines are offered specifically to help minimize EMI generation. Some of these guidelines are the same as, or similar to, the general guidelines. To minimize the contribution of device-based design to EMI, you must understand the major sources of EMI and how to reduce them to acceptable levels.

- Keep traces carrying high frequency signals as short as possible.
- Provide a good ground plane or grid. In some cases, a multilayer board may be required with full layers for ground and power distribution.
- Decouple power from ground with decoupling capacitors as close to the device's power pins as possible.
- Eliminate ground loops, which are unexpected current return paths to the power source and ground.
- Decouple the power cord at the power cord interface with decoupling capacitors. Methods to decouple power lines are similar to decoupling telephone lines.
- Locate high frequency circuits in a separate area to minimize capacitive coupling to other circuits.
- Locate cables and connectors to avoid coupling from high frequency circuits.
- Lay out the highest frequency signal traces next to the ground grid.
- If using a multilayer board design, make no cuts in the ground or power planes and be sure the ground plane covers all traces.
- Minimize the number of through-hole connections on traces carrying high frequency signals.
- Avoid right angle turns on high frequency traces. Forty-five degree corners are good; however, radius turns are better.
- On 2-layer boards with no ground grid, provide a shadow ground trace on the opposite side of the board to traces carrying high frequency signals. This will be effective as a high frequency ground return if it is three times the width of the signal traces.
- Distribute high frequency signals continuously on a single trace rather than several traces radiating from one point.

Electrostatic Discharge Control

Handle all electronic devices with precautions to avoid damage due to the static charge accumulation.

See the ANSI/ESD Association Standard (ANSI/ESD S20.20-1999) – a document “for the Development of an Electrostatic Discharge Control for Protection of Electrical and Electronic Parts, Assemblies and Equipment.” This document covers ESD Control Program Administrative Requirements, ESD Training, ESD Control Program Plan Technical Requirements (grounding/bonding systems, personnel grooming, protected areas, packaging, marking, equipment, and handling), and Sensitivity Testing.

MultiTech strives to follow these recommendations. Input protection circuitry is incorporated in MultiTech devices to minimize the effect of static buildup. Take precautions to avoid exposure to electrostatic discharge during handling.

MultiTech uses and recommends that others use anti-static boxes that create a faraday cage (packaging designed to exclude electromagnetic fields). MultiTech recommends that you use our packaging when returning a product and when you ship your products to your customers.

USB Design

MultiTech recommends that you review Intel's High Speed USB Platform Design Guidelines for information about USB signal routing, impedance, and layer stacking. Also:

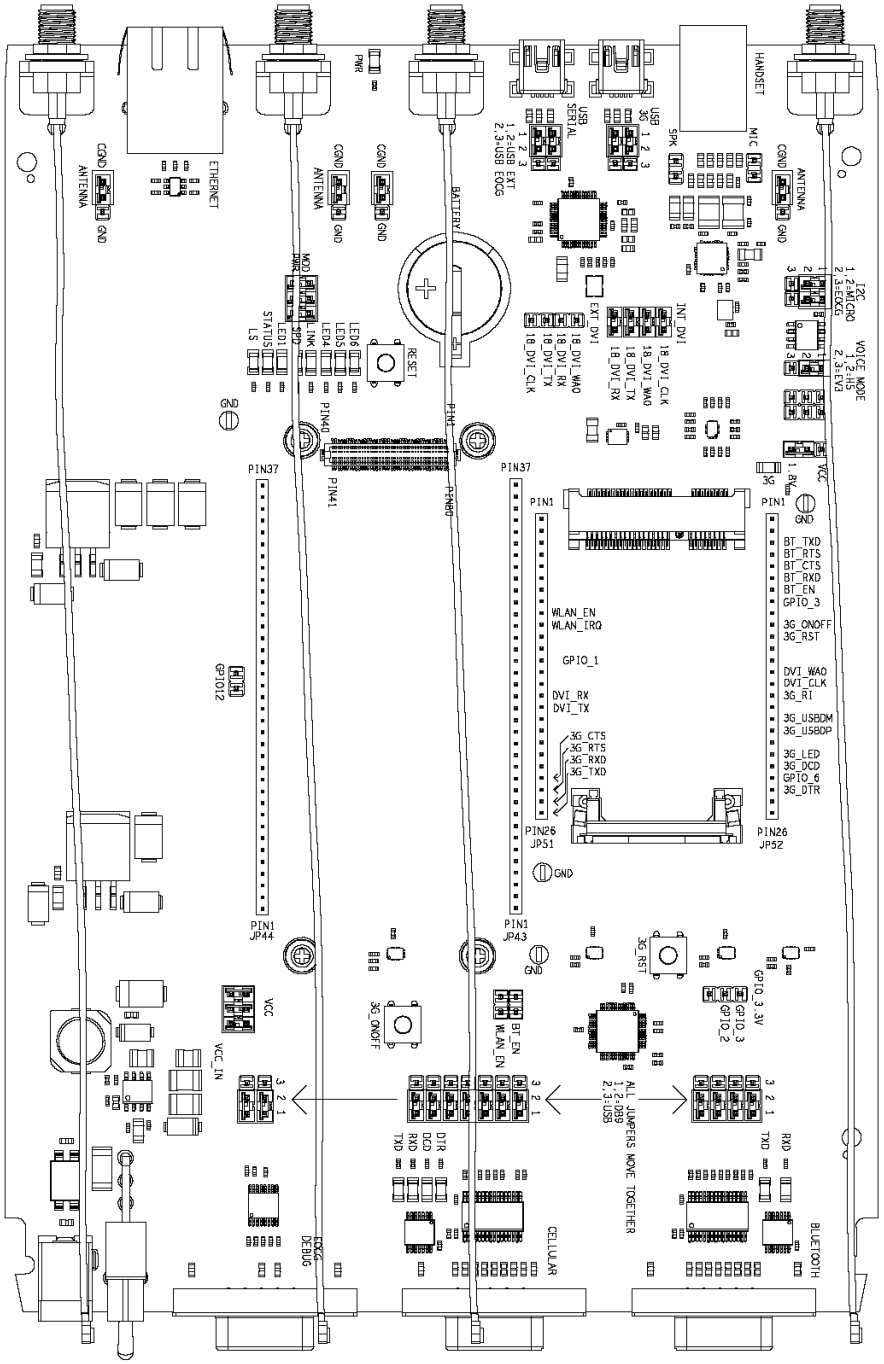
- Shield USB cables with twisted pairs (especially those containing D+/D-).
- Use a single 5V power supply for USB devices. See Power Draw for current (ampere) requirements.
- Route D+/D- together in parallel with the trace spacing needed to achieve 90 ohms differential impedance for the USB pair and to maintain a 20 mil space from the USB pair and all other signals.
- If power is provided externally, use a common ground between the carrier board and the device.

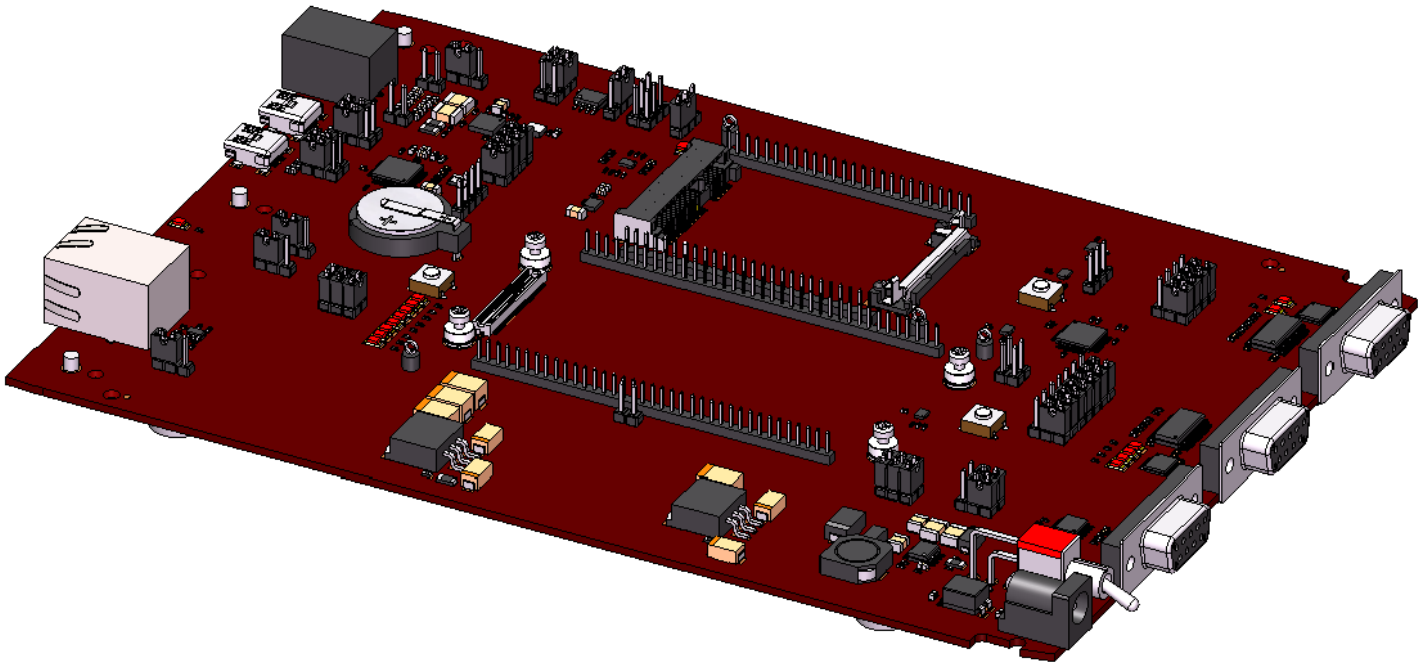
Chapter 4 – Developer Board and Schematics

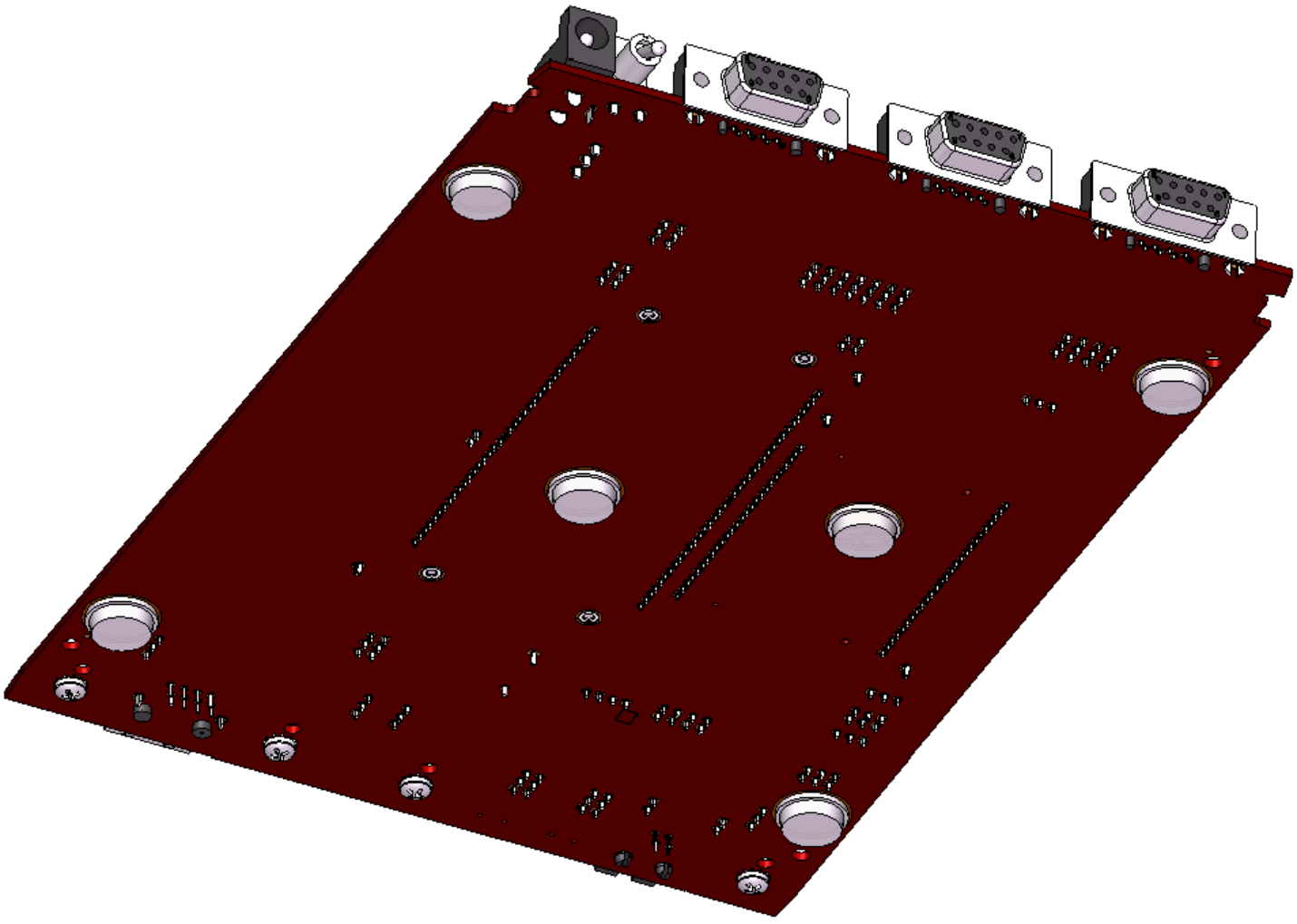
Note: Third-party components shown in the following drawings are included as examples only.

Developer Board

This developer board drawing shows the major board components.

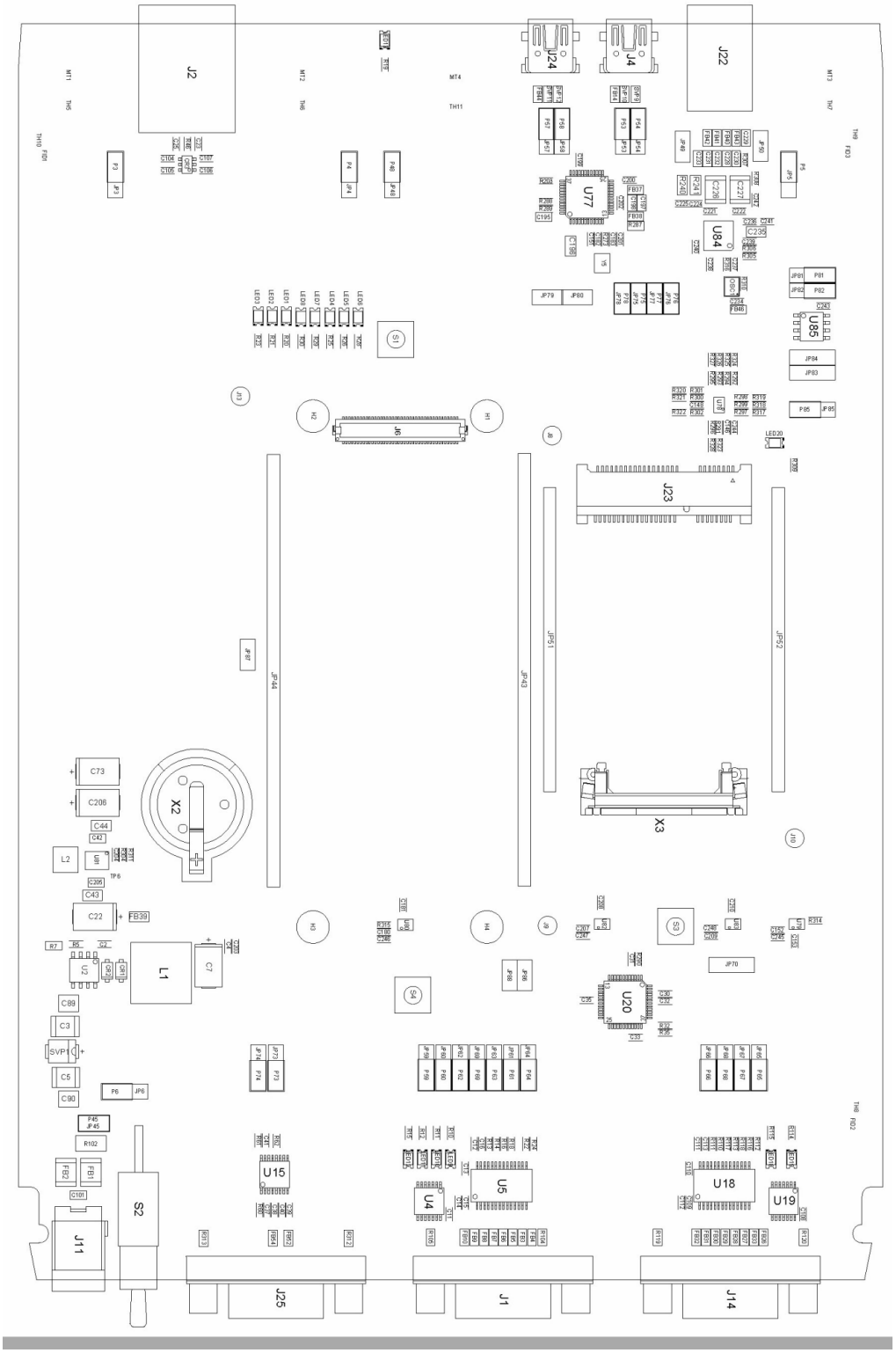




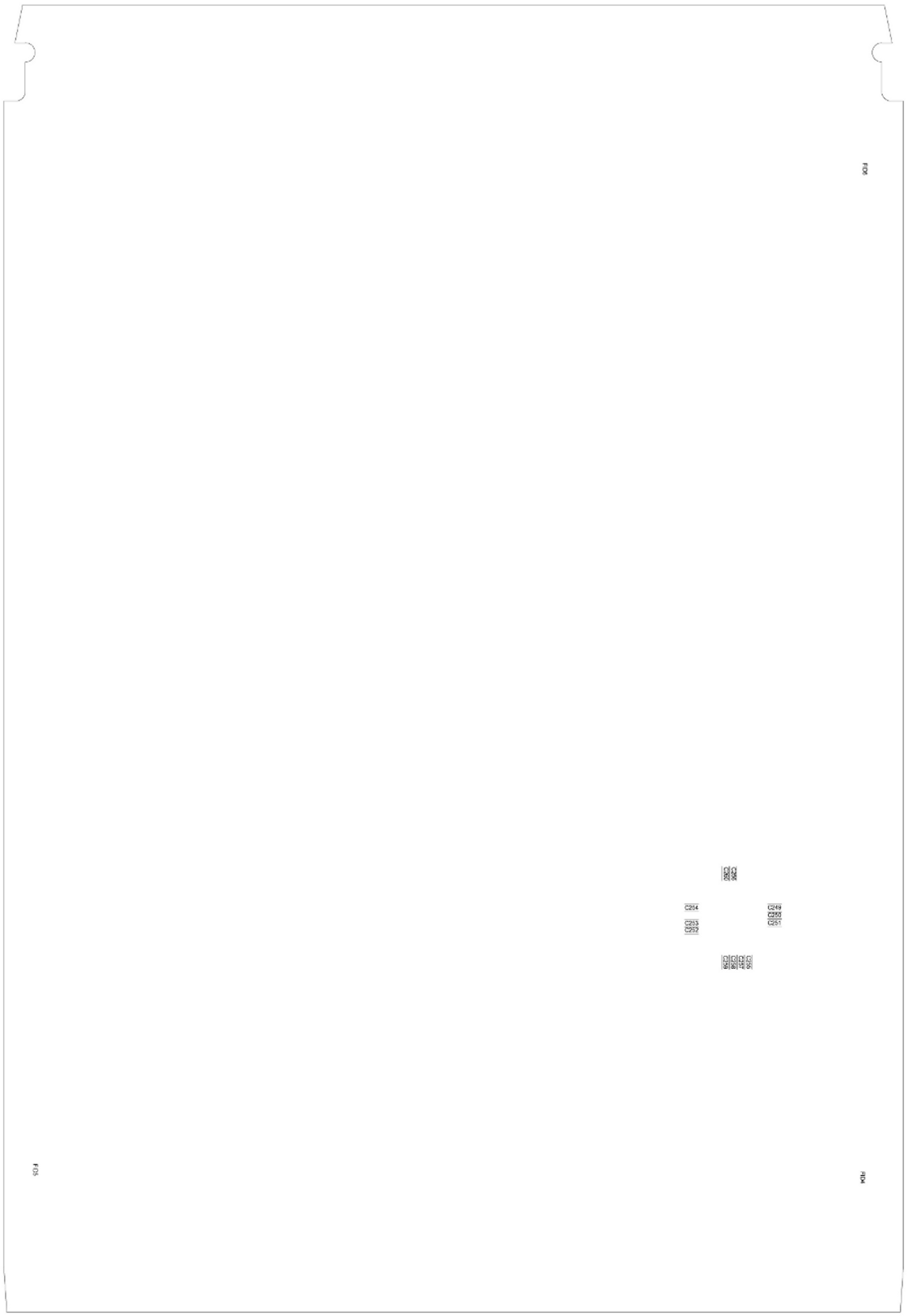


Assembly Diagram

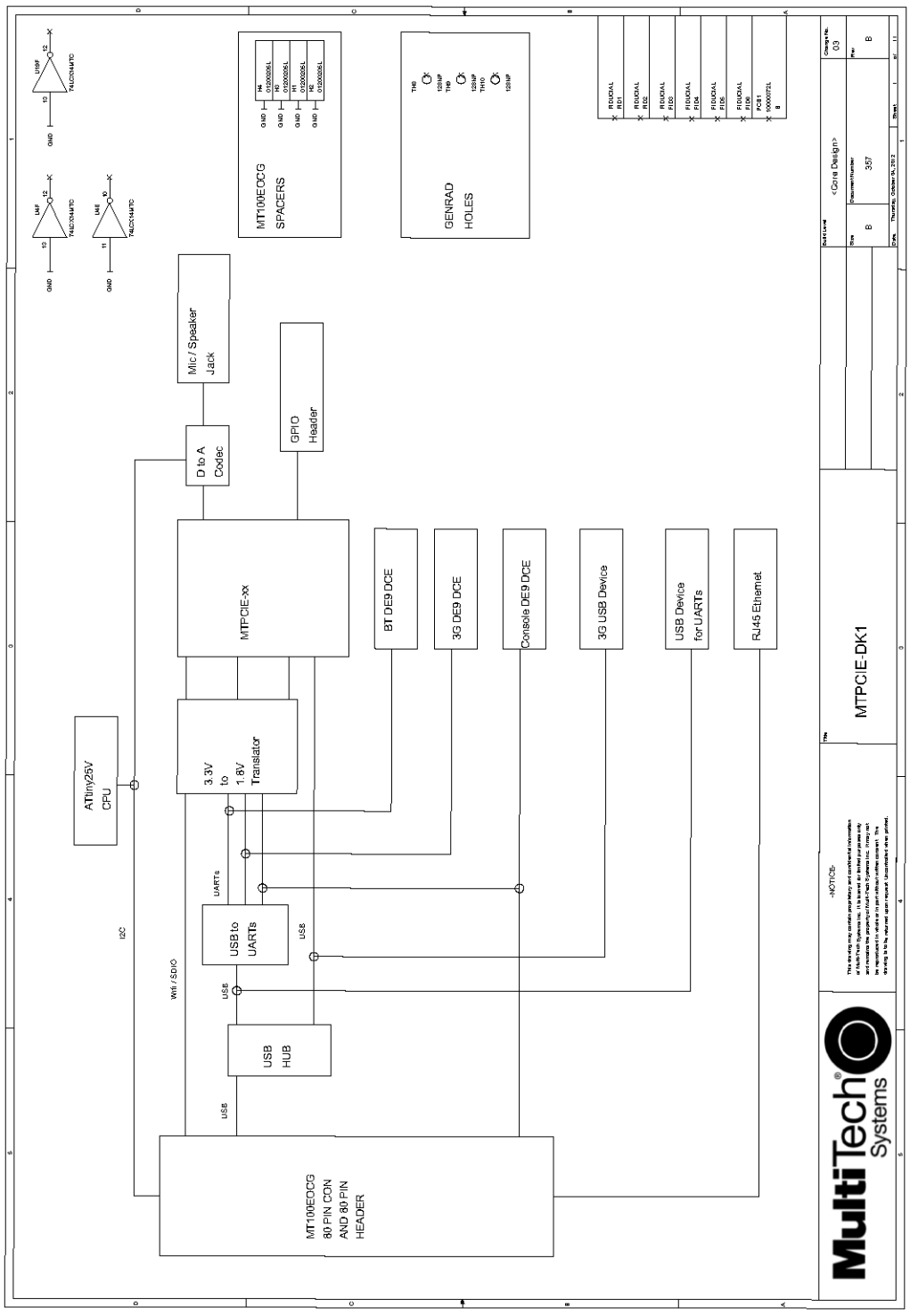
Top



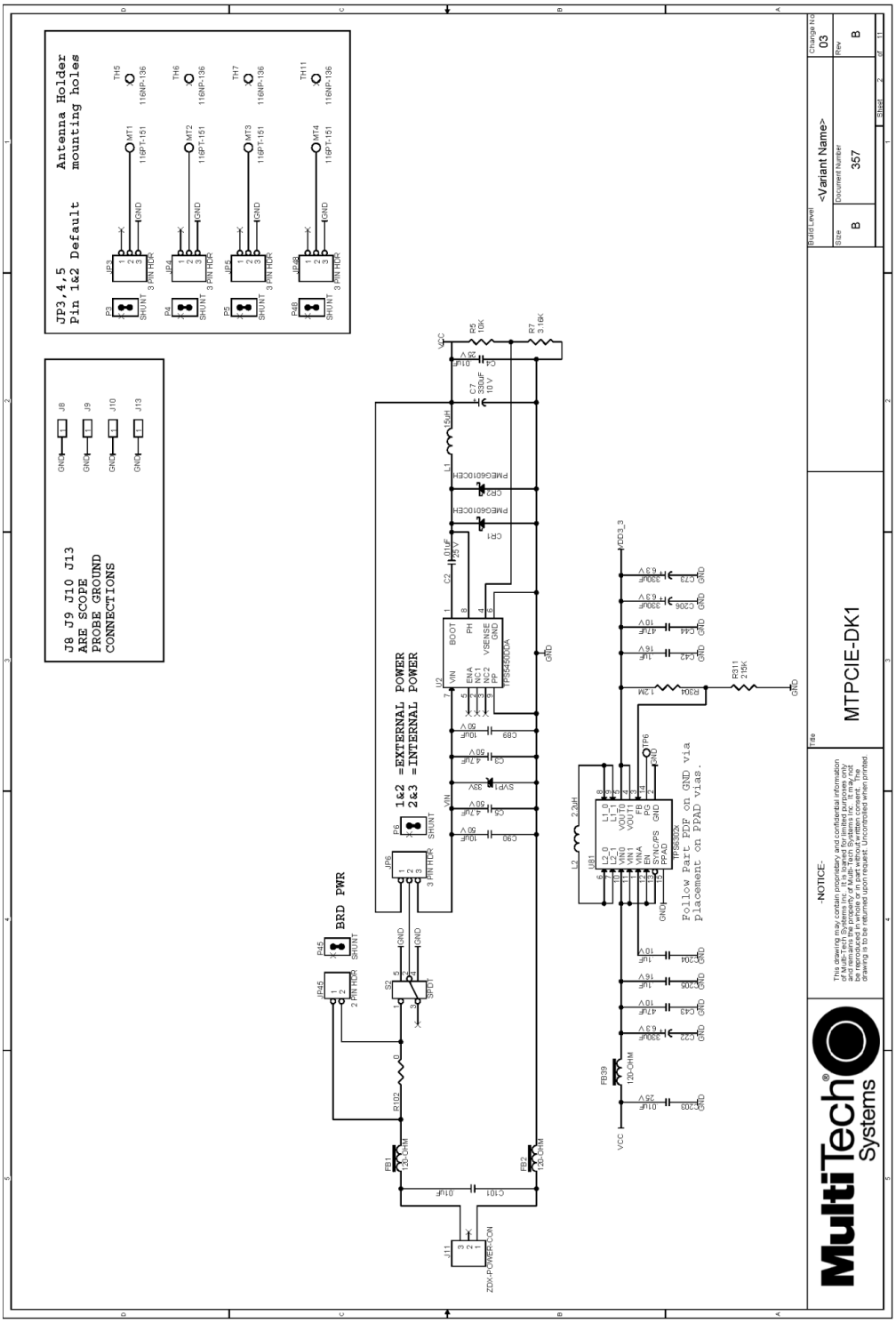
Bottom

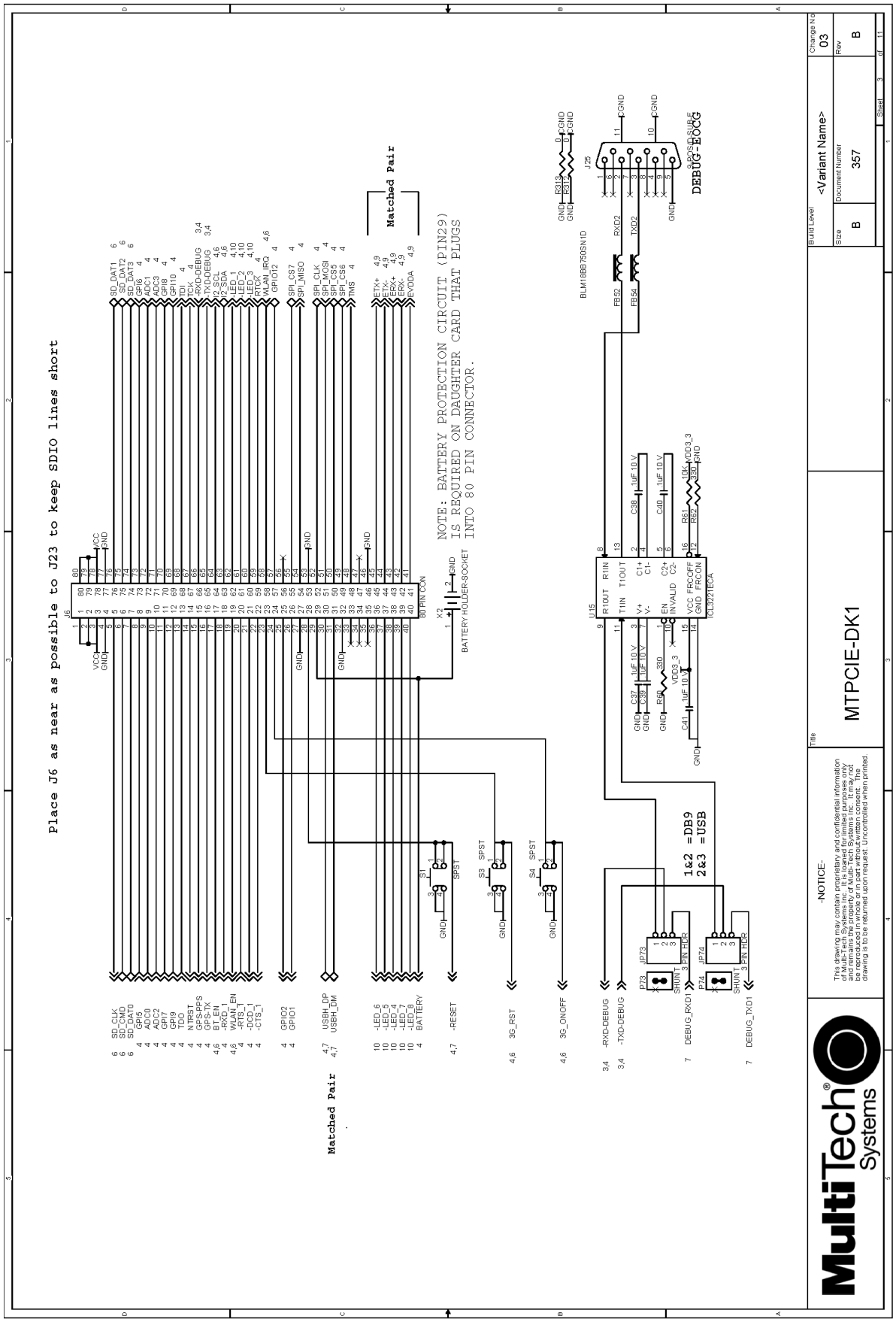


Developer Board Block Diagram



Developer Board Schematics




Place J6 as near as possible to J23 to keep SDIO lines short
NOTE: BATTERY PROTECTION CIRCUIT (PIN29)
IS REQUIRED ON DAUGHTER CARD THAT PLUGS
INTO 80 PIN CONNECTOR.
Matched Pair
Matched Pair
1&2 =DB9
2&3 =USB
DEBUG-EOCG
MTPCIE-DK1
MultiTech Systems
-NOTICE-
Title
Build Level
<Variant Name>
Change No
03
Size
B
Document Number
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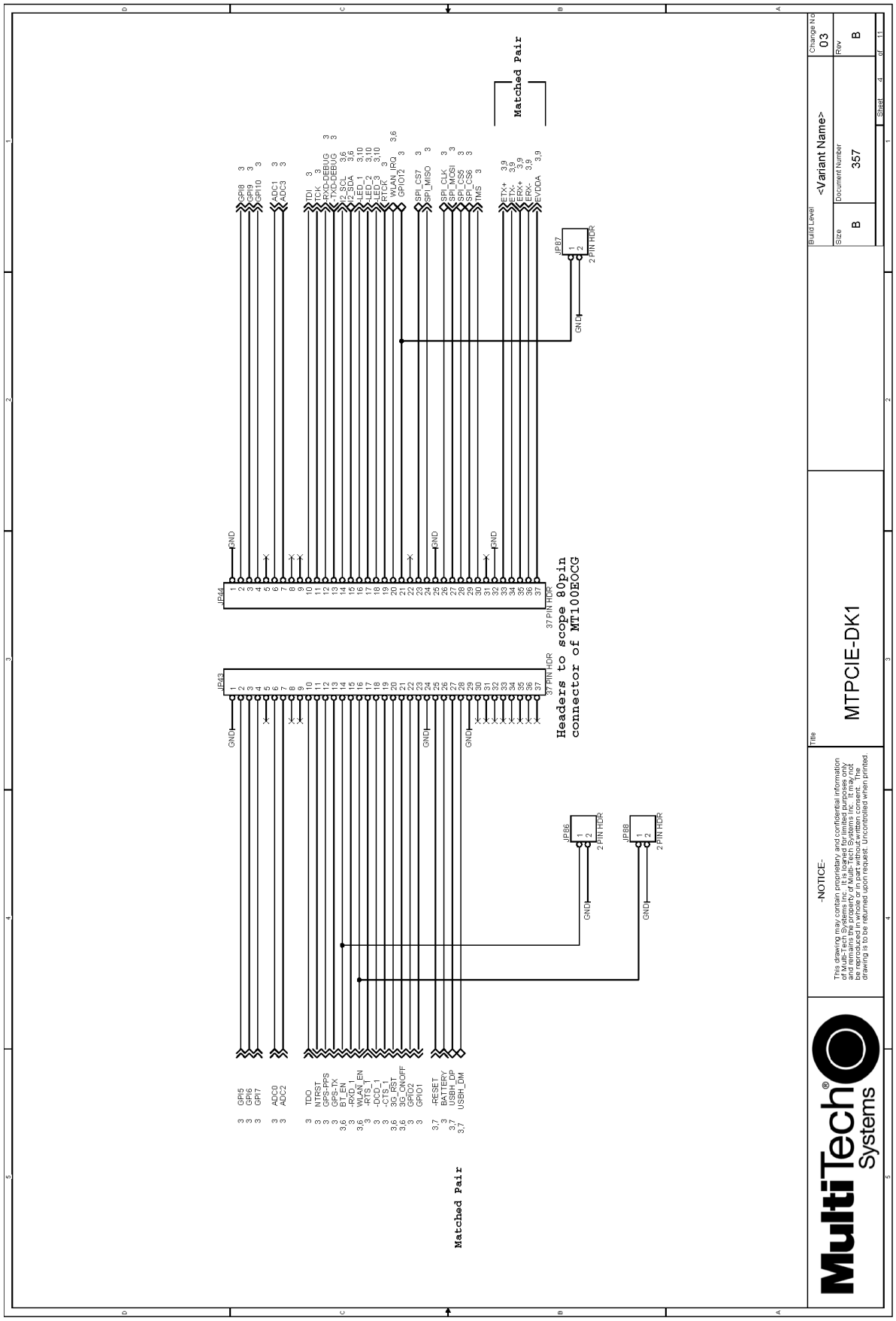
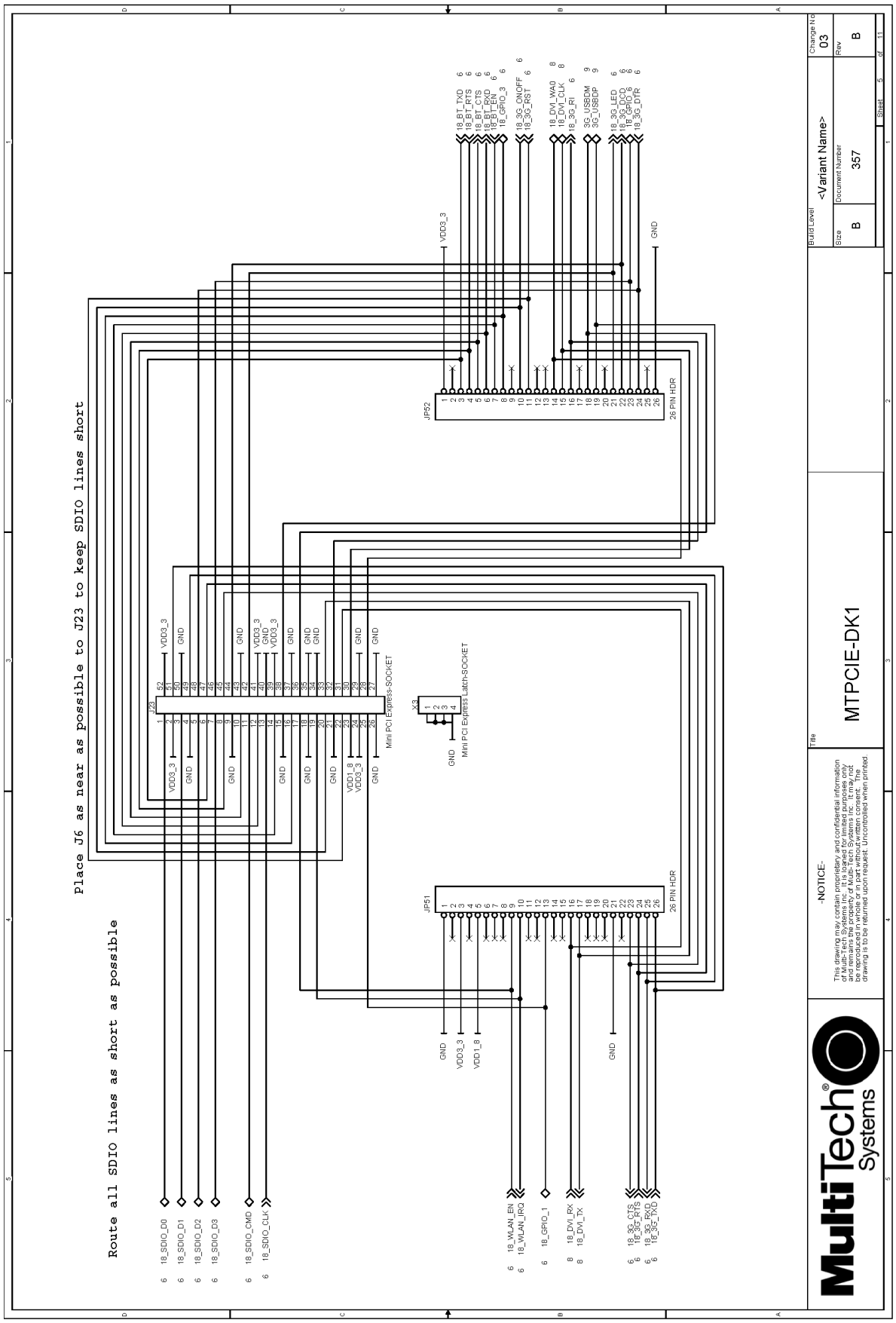
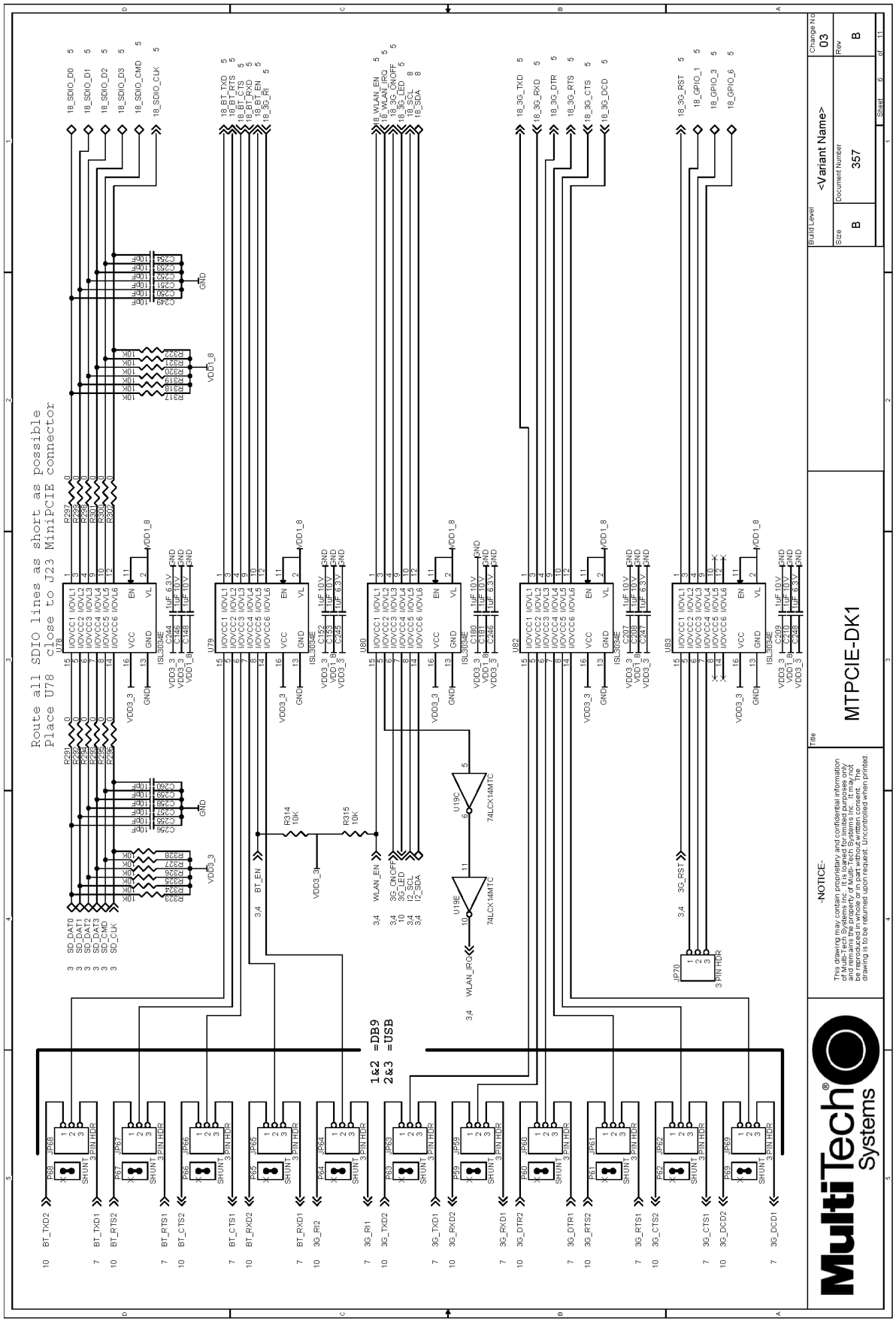
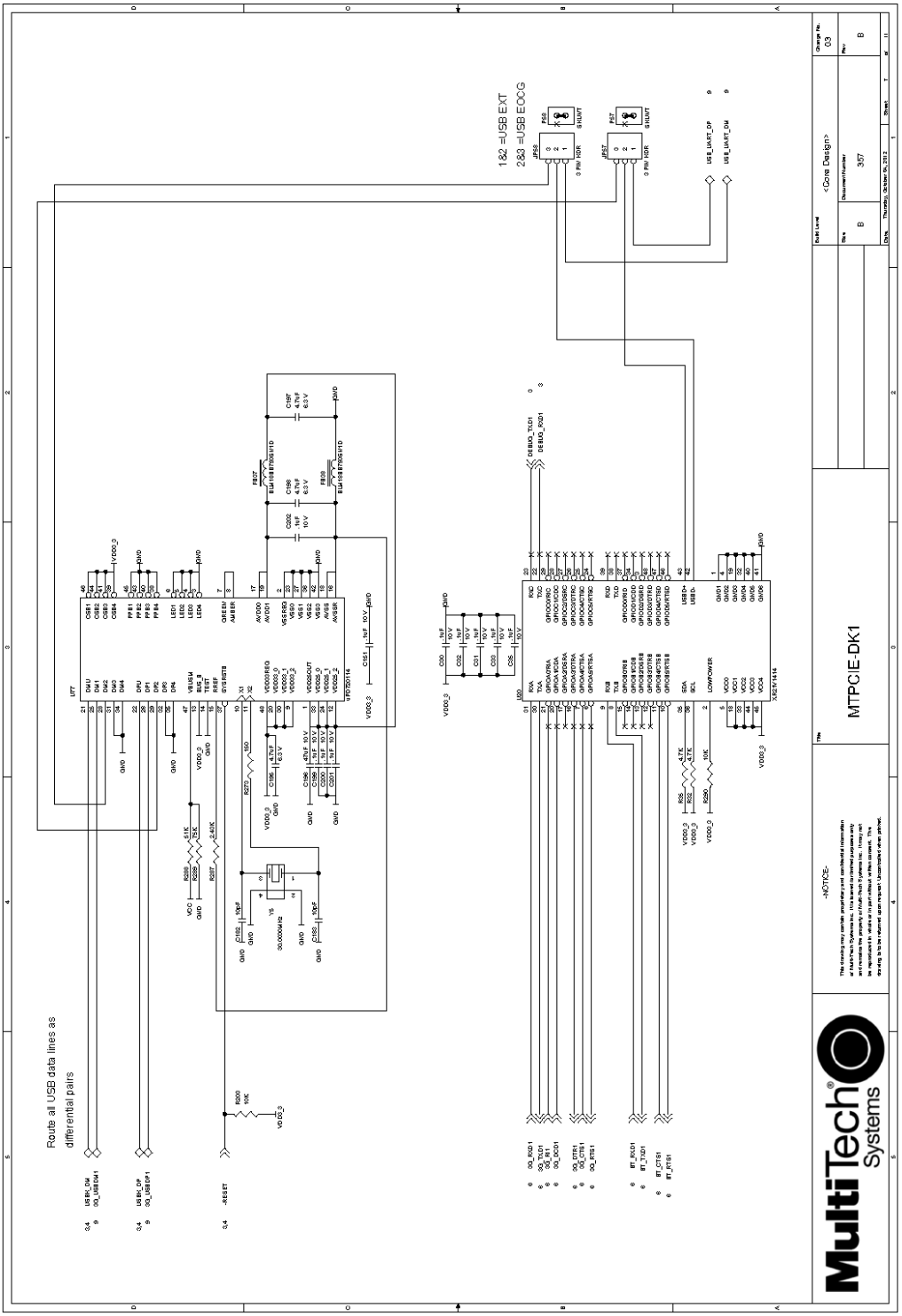
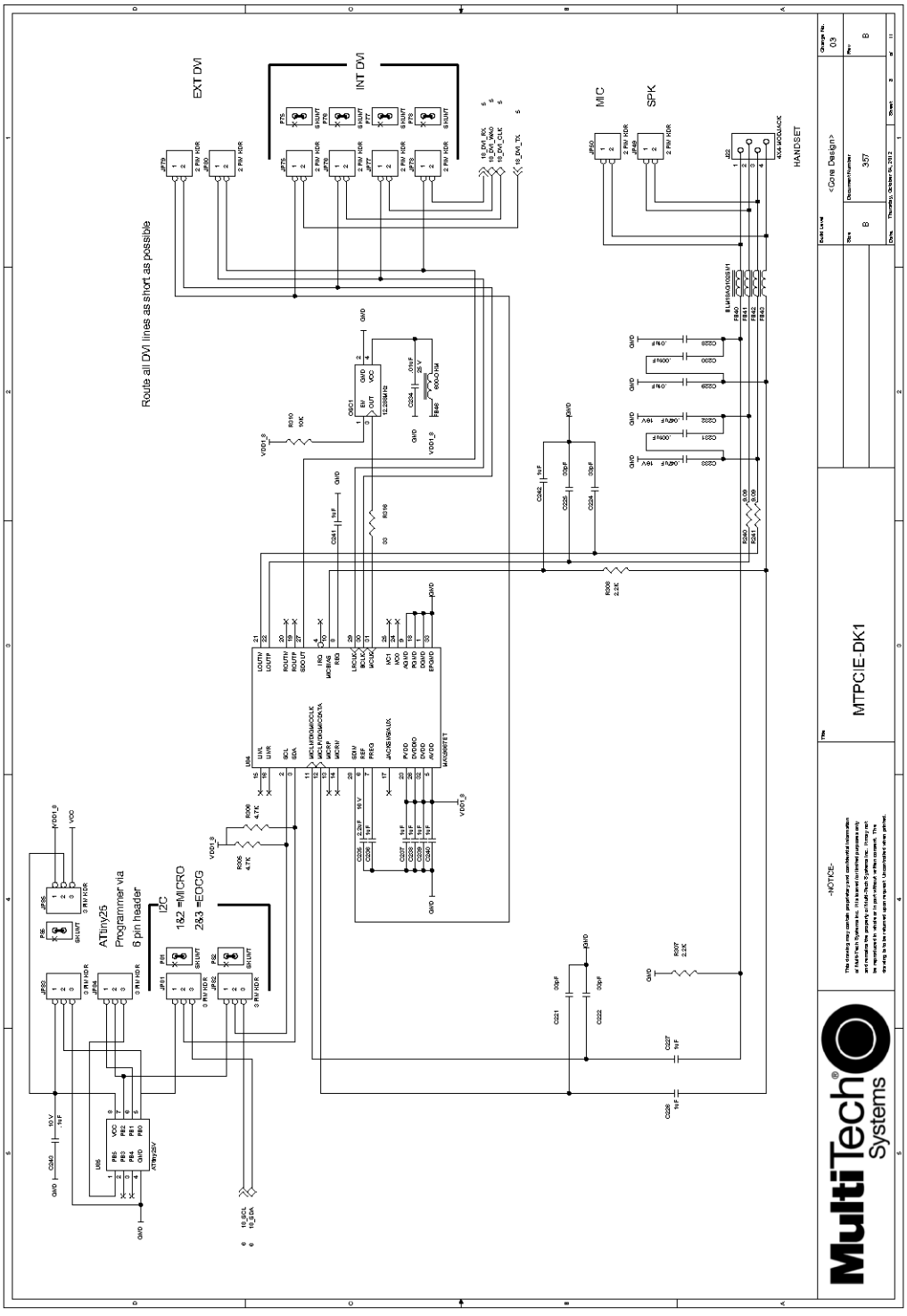
B
Sheet 3 of 11

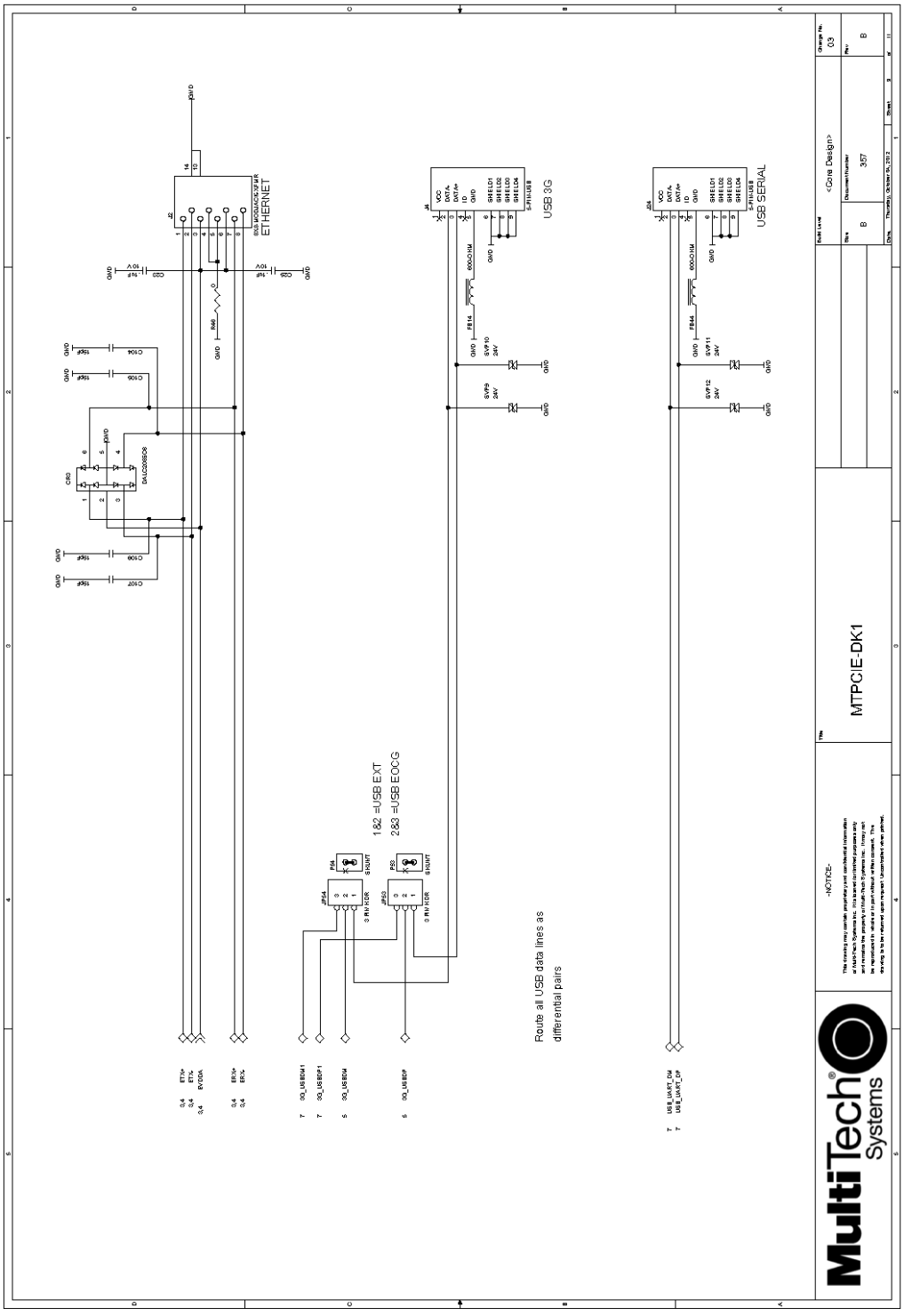

MTPCIE-DK1
<Variant Name>
Headers to scope 80pin connector of MT100EOCG
Matched Pair
Matched Pair
JP44
JP43
JP86
JP88
JP87
37 PIN HDR
2 PIN HDR
GND
-NOTICE-
MultiTech Systems

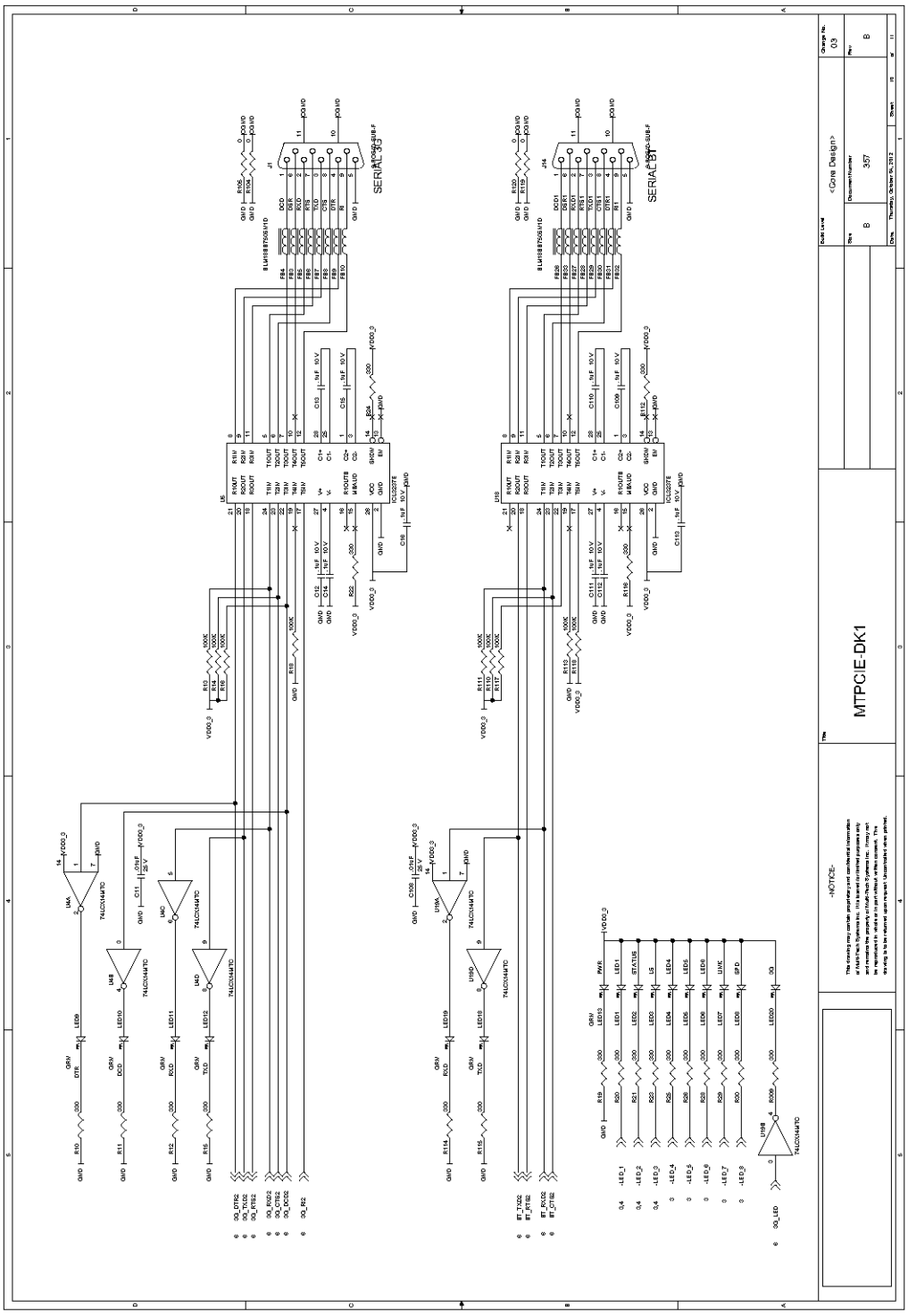

Place J6 as near as possible to J23 to keep SDIO lines short
Route all SDIO lines as short as possible
Mini PCI Express-SOCKET
Mini PCI Express Latch-SOCKET
26 PIN HDR
MTPCIE-DK1
-NOTICE-
Multi-Tech Systems


Route all SDIO lines as short as possible
Place U78 close to J23 MiniPCIE connector
1&2 =DB9
2&3 =USB
MTPCIE-DK1
<Variant Name>
Document Number
357
Size
B
Rev
B
Change No
03
Sheet 6 of 11
MultiTech Systems
-NOTICE-
This drawing may contain proprietary and confidential information of Multi-Tech Systems Inc. It is loaned for limited purposes only and may not be used, reproduced or disclosed without written consent. The drawing is to be returned upon request. Uncontrolled when printed.


1&2 =USB EXT
2&3 =USB EOCG
Route all USB data lines as
differential pairs
MTPCIE-DK1
MultiTech Systems


EXT DVI
INT DVI
MIC
SPK
HANDSET
Route all DVI lines as short as possible
ATtiny25
Programmer via
6 pin header
I2C
182 =MICRO
283 =EOCG
MTPCIE-DK1
MultiTech Systems


ETHERNET
USB 3G
USB SERIAL
1&2 =USB EXT
2&3 =USB EOCG
Route all USB data lines as
differential pairs
MTPCIE-DK1
<Core Design>
MultiTech Systems


MTPCIE-DK1
<Core Design>
SERIAL0
SERIAL1
74LCX244MTC
-NOTICE-

Board Components

Jumper	Description
JP3, JP4, JP5, JP48	Selects CGND or GND for antenna holder grounding. Default is CGND.
JP6	JP6 allows you to select either the internal 5V regulator (INT PWR) or to choose EXT 5V (EXT PWR). For the EXT PWR, you can use your own external 5V power source and plug it into J11.
JP43, JP44	Not used by PCIe devices.
JP45	Board Power. Default is installed.
JP49	Probes for connecting speaker.
JP50	Probes for connecting microphone.
JP51, JP52	Debugging probes for PCIE connector J23.
JP53, JP54	Selects USB host connected to PCIe device. Pins 1 & 2 jumpered select external USB host connected to J4.
JP57, JP58	Selects USB host connected to quad serial UART U20. Pins 1 & 2 jumpered select external USB host connected to J24.
JP59, JP60, JP61,JP63,JP64, JP69	Selects serial connection for PCIe device. Pins 1 & 2 jumpered select DB9 connector J1 connected to PCIe device. Pins 2 & 3 jumpered select quad UART U20 connected to PCIe device. All jumpers must be moved to the same position.
JP65, JP66, JP67, JP68	Selects serial connection for PCIe Bluetooth device. Pins 1 & 2 jumpered select DB9 connector J14 connected to PCIe Bluetooth device. Pins 2 & 3 jumpered select quad UART U20 connected to PCIe Bluetooth device. All jumpers must be moved to the same position.
JP70	Probes for PCIe GPIO2 & GPIO3. The pin next to the text "GPIO_3.3V" is GPIO3. The center pin is GPIO2.
JP73, JP74	Not used by PCIe devices.
JP75, JP76, JP77, JP78	When these jumpers are installed, DVI interface of audio codec U84 is connected to DVI interface of PCIe device. By removing these jumpers when connecting an external DVI device.
JP79, JP80	Use these jumper pins to connect an external DVI device.
JP81, J82	Selects source for programming audio codec U84. Pins 1 & 2 jumpered select MICRO U84 as source. Default is MICRO.
JP83, JP84	These pins can be used for programming MICRO U84.
JP85	Selects power source for MICRO U85. Default is 1.8v
JP86	May be used to manually reset PCIe Bluetooth device by briefly installing and then removing a jumper. Default is no jumper installed.
JP87	Not applicable for this device.
JP88	May be used to manually reset PCIe Wi-Fi device by briefly installing and then removing a jumper. Default is no jumper installed.
JP89	This jumper, when installed, connects power to PCIe device.

Jumper	Description
JP90	Not used by PCIe device.This jumper, when installed, connects power to OCG-E device. (When using Developer Kit with OCG-E devices).
J6	Not used by PCIe device.
J23	Socket for installing PCIe device.
J8, J9, J10, J13	Oscilloscope probe ground connections
S1	Not used by PCIe device.
S3	Reset button for PCIe device.
S4	Button for on/off of PCIe.

Installing the Device and Antennas

To install a device on the board:

1. With the radio side down, slide the device into the J23 connector.
2. Press down until the device snaps into the X3 connector clips.
3. Optional. Snap cables onto the device's antenna connectors and attach the antennas to the cables. Refer to the device's mechanical drawing for connector details.

Installing a SIM Card

To install a SIM card:

- Install the SIM card into the SIM card holder on the radio.

Making Other Board Connections

Other connections you may need:

- If your application needs a power supply, connect the power supply lead to the power connector on the developer board.
- If you need to connect the debug cable for your application, connect the D89 male connector of the RS-232 cable to the D89 debug jumper next to the power switch.

Attaching Power Supply Blades

Power Supply and Blades

If your device shipped with a power cord, attach the blades for your region.

Power Supply no blades

Power Supply with EU blade

Power Supply with NAM blade

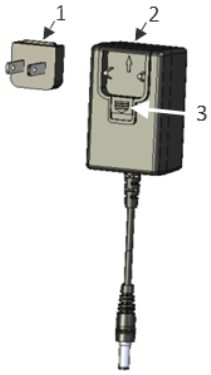
Power Supply with UK blade

Power Supply with AU-NZ blade

Attaching the Blades

To attach a power supply blade:

1. Remove the power supply cover (not shown). To do this, slide the lock down and hold it while you lift off the cover.
2. Insert the latch on the blade into the notch on the power supply.
3. Slide the lock down and hold it while you press the blade in place. Then, release it.



1 - Latch

2 - Notch

3 - Sliding lock

Chapter 5 – Safety Notices and Warnings

The following safety statements may be relevant and required in the host product literature.

Radio Frequency (RF) Safety

Due to the possibility of radio frequency (RF) interference, it is important that you follow any special regulations regarding the use of radio equipment. Follow the safety advice given below.

- Operating your device close to other electronic equipment may cause interference if the equipment is inadequately protected. Observe any warning signs and manufacturers' recommendations.
- Different industries and businesses restrict the use of cellular devices. Respect restrictions on the use of radio equipment in fuel depots, chemical plants, or where blasting operations are in process. Follow restrictions for any environment where you operate the device.
- Do not place the antenna outdoors.
- Switch OFF your wireless device when in an aircraft. Using portable electronic devices in an aircraft may endanger aircraft operation, disrupt the cellular network, and is illegal. Failing to observe this restriction may lead to suspension or denial of cellular services to the offender, legal action, or both.
- Switch OFF your wireless device when around gasoline or diesel-fuel pumps and before filling your vehicle with fuel.
- Switch OFF your wireless device in hospitals and any other place where medical equipment may be in use.

Notice regarding Compliance with FCC, EU, and Industry Canada Requirements for RF Exposure

The antenna intended for use with this unit meets the requirements for mobile operating configurations and for fixed mounted operations, as defined in 2.1091 of the FCC rules for satisfying RF exposure compliance. This device also meets the European RF exposure requirements of EN 62311. If an alternate antenna is used, consult user documentation for required antenna specifications.

Compliance of the device with the FCC, EU and IC rules regarding RF Exposure was established and is given with the maximum antenna gain as specified above for a minimum distance of 20 cm between the devices radiating structures (the antenna) and the body of users. Qualification for distances closer than 20 cm (portable operation) would require re-certification.

Wireless devices could generate radiation. Other nearby electronic devices, like microwave ovens, may also generate additional radiation to the user causing a higher level of RF exposure.

Power Supply Caution

CAUTION: Do not replace the power supply with one designed for another product; doing so can damage the modem and void your warranty. Adapter shall be installed near the equipment and shall be easily accessible.
CAUTION: Pour garantir une protection continue contre les risques d'incendie, remplacez les fusibles uniquement par des fusibles du même type et du même calibre. L'adaptateur doit être installé à proximité de l'appareil et doit être facilement accessible.

Vehicle Safety

When using your device in a vehicle:

- Do not use this device while driving.
- Respect national regulations on the use of cellular devices in vehicles.
- If incorrectly installed in a vehicle, operating the wireless device could interfere with the vehicle's electronics. To avoid such problems, use qualified personnel to install the device. The installer should verify the vehicle electronics are protected from interference.
- Using an alert device to operate a vehicle's lights or horn is not permitted on public roads.
- UL evaluated this device for use in ordinary locations only. UL did NOT evaluate this device for installation in a vehicle or other outdoor locations. UL Certification does not apply or extend to use in vehicles or outdoor applications.

User Responsibility

Respect all local regulations for operating your wireless device. Use the security features to block unauthorized use and theft.

Device Maintenance

When maintaining your device:

- Do not attempt to disassemble the device. There are no user serviceable parts inside.
- Do not misuse the device. Follow instructions on proper operation and only use as intended. Misuse could make the device inoperable, damage the device and/or other equipment, or harm users.
- Do not apply excessive pressure or place unnecessary weight on the device. This could result in damage to the device or harm to users .
- Do not use this device in explosive or hazardous environments unless the model is specifically approved for such use. The device may cause sparks. Sparks in explosive areas could cause explosion or fire and may result in property damage, severe injury, and/or death.
- Do not expose your device to any extreme environment where the temperature or humidity is high. Such exposure could result in damage to the device or fire.
- Do not expose the device to water, rain, or spilled beverages. It is not waterproof. Exposure to liquids could result in damage to the device.
- Do not place the device alongside computer discs, credit or travel cards, or other magnetic media. The information contained on discs or cards may be affected by the device.
- Using accessories, such as antennas, that MultiTech has not authorized or that are not compliant with MultiTech's accessory specifications may invalidate the warranty.

If the device is not working properly, contact MultiTech Technical Support.

Chapter 6 – Labeling Requirements

Approvals and Certification

Your Multi-Tech device is an industry and/or carrier approved modem.

PTCRB Requirements (GPRS and HSPA/HSDPA only).
The antenna system cannot be altered. If altered, additional PTCRB testing may be required.

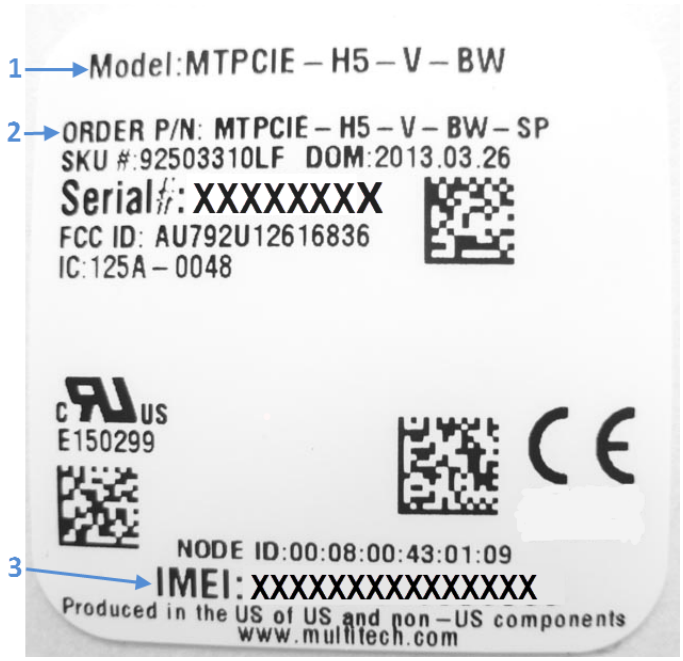
For HSPA+, HSPA, HSDPA and GPRS Devices
The modem's 15-character IMEI (International Mobile Equipment Identity) number is printed on the modem's label.

Example HSPA+ H5 Labels

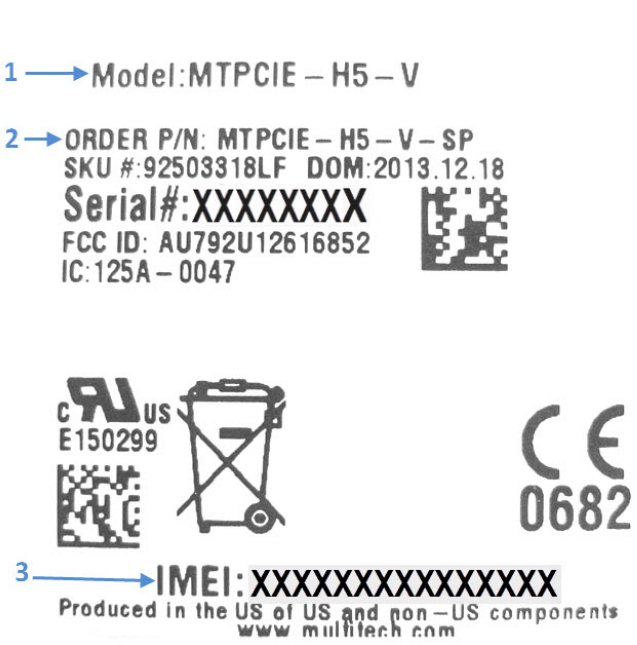
Note: Actual labels will vary depending on the regulatory approval markings and content.

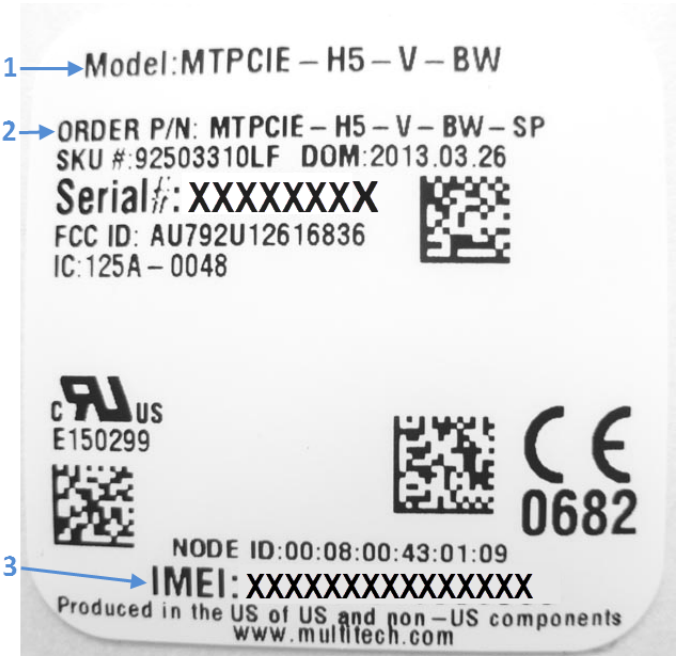
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The label shown is larger than actual size.

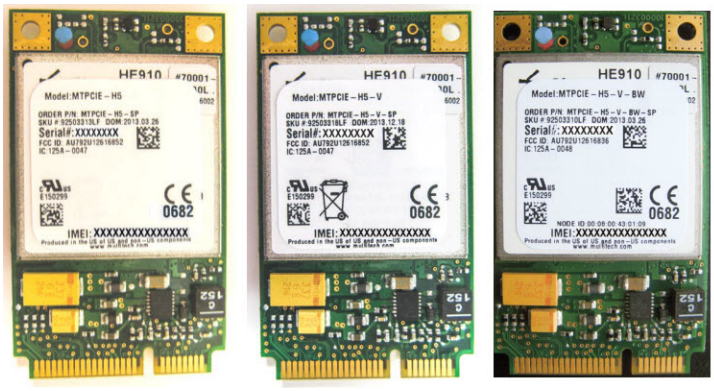


1 - Multi-Tech Model Identification.
2 - Multi-Tech Ordering Part Number.
3 - IMEI (International Mobile Equipment Identity).





Labels are positioned on the device as follows:



Chapter 7 – Regulatory Statements

EMC, Safety, and Radio Equipment Directive (RED) Compliance

CE

The CE mark is affixed to this product to confirm compliance with the following European Community Directives:

> Council Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment;
> and
> Council Directive 2014/53/EU on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.

MultiTech declares that this device is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU. The declaration of conformity may be requested at https://support.multitech.com.

Restriction of the Use of Hazardous Substances (RoHS)

RoHS 2011/65/EU COMPLIANT

Multi-Tech Systems, Inc.

Certificate of Compliance

2011/65/EU

Multi-Tech Systems, Inc. confirms that its embedded products comply with the chemical concentration limitations set forth in the directive 2011/65/EU of the European Parliament (Restriction of the use of certain Hazardous Substances in electrical and electronic equipment - RoHS).

These MultiTech products do not contain the following banned chemicals[1]:

- Lead, [Pb] < 1000 PPM
- Mercury, [Hg] < 1000 PPM
- Hexavalent Chromium, [Cr+6] < 1000 PPM
- Cadmium, [Cd] < 100 PPM
- Polybrominated Biphenyl, [PBB] < 1000 PPM
- Polybrominated Diphenyl Ether, [PBDE] < 1000 PPM

Environmental considerations:

- Moisture Sensitivity Level (MSL) =1
- Maximum Soldering temperature = 260C (in SMT reflow oven)

[1]Lead usage in some components is exempted by the following RoHS annex, therefore higher lead concentration would be found in some modules (>1000 PPM);

- Resistors containing lead in a glass or ceramic matrix compound.

International Modem Restrictions

Some dialing and answering defaults and restrictions may vary for international modems. Changing settings may cause a modem to become non-compliant with national regulatory requirements in specific countries. Also note that some software packages may have features or lack restrictions that may cause the modem to become non-compliant.

Other Countries

The above country-specific information does not cover all countries with specific regulations; they are included to show you how each country may differ. If you have trouble determining your own country's requirements, check with MultiTech's Technical Support for assistance.

Chapter 8 – Environmental Notices

Waste Electrical and Electronic Equipment Statement

Note: This statement may be used in documentation for your final product applications.

WEEE Directive

The WEEE Directive places an obligation on EU-based manufacturers, distributors, retailers, and importers to take-back electronics products at the end of their useful life. A sister directive, ROHS (Restriction of Hazardous Substances) complements the WEEE Directive by banning the presence of specific hazardous substances in the products at the design phase. The WEEE Directive covers all MultiTech products imported into the EU as of August 13, 2005. EU-based manufacturers, distributors, retailers and importers are obliged to finance the costs of recovery from municipal collection points, reuse, and recycling of specified percentages per the WEEE requirements.

Instructions for Disposal of WEEE by Users in the European Union

The symbol shown below is on the product or on its packaging, which indicates that this product must not be disposed of with other waste. Instead, it is the user's responsibility to dispose of their waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, please contact your local city office, your household waste disposal service or where you purchased the product.

July, 2005

Information on HS/TS Substances According to Chinese Standards

In accordance with China's Administrative Measures on the Control of Pollution Caused by Electronic Information Products (EIP) # 39, also known as China RoHS, the following information is provided regarding the names and concentration levels of Toxic Substances (TS) or Hazardous Substances (HS) which may be contained in Multi-Tech Systems Inc. products relative to the EIP standards set by China's Ministry of Information Industry (MII).

Hazardous/Toxic Substance/Elements

Name of the Component	Lead (PB)	Mercury (Hg)	Cadmium (CD)	Hexavalent Chromium (CR6+)	Polybrominated Biphenyl (PBB)	Polybrominated Diphenyl Ether (PBDE)
Printed Circuit Boards	O	O	O	O	O	O
Resistors	X	O	O	O	O	O
Capacitors	X	O	O	O	O	O
Ferrite Beads	O	O	O	O	O	O
Relays/Opticals	O	O	O	O	O	O
ICs	O	O	O	O	O	O
Diodes/ Transistors	O	O	O	O	O	O
Oscillators and Crystals	X	O	O	O	O	O
Regulator	O	O	O	O	O	O
Voltage Sensor	O	O	O	O	O	O
Transformer	O	O	O	O	O	O
Speaker	O	O	O	O	O	O
Connectors	O	O	O	O	O	O
LEDs	O	O	O	O	O	O
Screws, Nuts, and other Hardware	X	O	O	O	O	O
AC-DC Power Supplies	O	O	O	O	O	O
Software /Documentation CDs	O	O	O	O	O	O
Booklets and Paperwork	O	O	O	O	O	O
Chassis	O	O	O	O	O	O

X Represents that the concentration of such hazardous/toxic substance in all the units of homogeneous material of such component is higher than the SJ/Txxx-2006 Requirements for Concentration Limits.
O Represents that no such substances are used or that the concentration is within the aforementioned limits.

Information on HS/TS Substances According to Chinese Standards (in Chinese)

依照中国标准的有毒有害物质信息

根据中华人民共和国信息产业部 (MII) 制定的电子信息产品 (EIP) 标准－中华人民共和国《电子信息产品污染控制管理办法》（第 39 号），也称作中国 RoHS, 下表列出了 Multi-Tech Systems, Inc. 产品中可能含有的有毒物质 (TS) 或有害物质 (HS) 的名称及含量水平方面的信息。

有害/有毒物质/元素

成分名称	铅 (PB)	汞 (Hg)	镉 (CD)	六价铬 (CR6+)	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷电路板	O	O	O	O	O	O
电阻器	X	O	O	O	O	O
电容器	X	O	O	O	O	O
铁氧体磁环	O	O	O	O	O	O
继电器/光学部件	O	O	O	O	O	O
ICs	O	O	O	O	O	O
二极管/晶体管	O	O	O	O	O	O
振荡器和晶振	X	O	O	O	O	O
调节器	O	O	O	O	O	O
电压传感器	O	O	O	O	O	O
变压器	O	O	O	O	O	O
扬声器	O	O	O	O	O	O
连接器	O	O	O	O	O	O
LEDs	O	O	O	O	O	O
螺丝、螺母以及其它五金件	X	O	O	O	O	O
交流-直流电源	O	O	O	O	O	O
软件/文档 CD	O	O	O	O	O	O
手册和纸页	O	O	O	O	O	O
底盘	O	O	O	O	O	O

X 表示所有使用类似材料的设备中有害/有毒物质的含量水平高于 SJ/Txxx-2006 限量要求。
O 表示不含该物质或者该物质的含量水平在上述限量要求之内。

Chapter 9 – Antennas, Cables, GPS

Antenna System Cellular Devices

The cellular/wireless performance depends on the implementation and antenna design. The integration of the antenna system into the product is a critical part of the design process; therefore, it is essential to consider it early so the performance is not compromised. If changes are made to the device's certified antenna system, then recertification will be required by specific network carriers.

Requirements for Cellular Antennas with regard to FCC/IC Compliance

There cannot be any alteration to the authorized antenna system. The antenna system must maintain the same specifications. The antenna must be the same type, with similar in-band and out-of-band radiation patterns.

This device has been designed to operate with the antennas listed below and having a maximum gain for 850 MHz of <= 6.4 dBi , for 1700 MHz of <= 6.5 dBi, and for 1900 MHz of <= 3 dBi. Antennas not included in this list or that have a gain greater than specified are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

HEPTA Antenna Information

Authorized Antenna/Antenna Specifications for Cellular Bands

The cellular radio portion of the device is approved with the following antenna or for alternate antennas meeting the given specifications.

Manufacturer:	Laird Technologies.
Description:	HEPTA-SM
Model Number:	MAF94300
Multi-Tech Part Number:	45009735L

MultiTech Ordering Information:

Model	Quantity
ANHB-1HRA	1
ANHB-10HRA	10
ANHB-50HRA	50

3G Antenna Requirements/Specifications

Category	Description
Frequency Range	824 – 960 MHz / 1710 – 1990 MHz / 1920 – 2170 MHz
Impedance	50 Ohms
VSWR	VSWR should not exceed 2.0:1 at any point across the bands of operation

Category	Description	
Typical Radiated Gain	850 MHz	3.17 dBi
	950 MHz	3.51 dBi
	1800 MHz	3.55 dBi
	1900 MHz	3.0 dBi
	2100 MHz	3.93 dBi
Radiation	Omni-directional	
Polarization	Linear Vertical	

GPS Antenna Specifications

Manufacturer:	Trimble
Description:	GPS Antenna with low noise amplifier
Model Number:	66800-52
Multi-Tech Part Number:	45009665L

MultiTech Ordering Information

Model	Quantity
ANGPS-1MM	1
ANGPS-10MM	10
ANGPS-50MM	50

Antenna Specifications

Category	Description
Frequency Range	1575.24 MHz
Impedance	50 Ohms
VSWR	2.0:1 max
Gain	10-30 dBi
LNA Current Consumption	40 mA max
Noise Figure	< 2dB
Polarization	RHCP
Input voltage	3.0V M M 0.2V

Bluetooth Antenna Specifications

Category	Description
Frequency Range	2402 to 2480 MHz
Impedance	50 Ohms

Category	Description
VSWR	2.0:1 max
Typical Radiated Gain	2 dBi
Radiation	Omni-directional

Bluetooth and Wi-Fi Antennas

Manufacturer:	Taoglas Antenna Solutions
Manufacturer's Model Number:	GW.11.A153
Multi-Tech Systems:	45009740L

Multi-Tech Ordering Information

Model Number	Quantity
ANWF-1HRA	1
ANWF-10HRA	10
ANWF-50HRA	50

Antenna Specifications

Category	Description
Frequency Range	2.4000 to 2.4835 GHz
Impedance	50 Ohms
VSWR	VSWR should not exceed 2.0:1 at any point across the bands of operation
Peak Radiated Gain	2.3 dBi on azimuth plane
Radiation	Omni-directional
Polarization	Linear Vertical
Connector	RP-SMA(M)

Chapter 10 – Device Overview

Description

The MultiConnect PCIe embedded cellular modem is a complete, ready-to-integrate communications device that offers standards-based seven-band HSPA+ 21 performance. This quick-to-market communications device allows developers to add wireless communication and GPS tracking to products with a minimum of development time and expense. The MultiConnect PCIe embedded cellular modem is based on industry-standard open interfaces and uses a PCI Express Mini Card form factor.

Product Build Options

Product	Description
MTPCIE-H5-V-BW-EU	HSPA+ Embedded Cellular Modem with digital voice, GPS, Wi-Fi and Bluetooth
MTPCIE-H5-EU	HSPA+ Embedded Cellular Modem
MTPCIE-BW	Wi-Fi and Bluetooth
Developer Kit	
MTPCIE-DK	Developer Kit

Note:

- These units ship without network activation.
- To connect them to the cellular network, you need a cellular account. For more information, refer to Account Activation.
- GP devices have a dedicated GPS receiver.
- The complete product code may end in .Rx. For example, MTPCIE-H5.Rx, where R is revision and x is the revision number.
- All builds can be ordered individually or in 50-packs.

Account Activation for Cellular Devices

Some MultiTech devices are pre-configured to operate on a specific cellular network. To use the device, you must set up a cellular data account with your service provider. Each service provider has its own process for adding devices to their network. To find activation steps for your device:

1. Go to **http://www.multitech.com/support**.
2. Select your device.
3. Scroll to **Activation** and click **Download**.

Bluetooth/Wi-Fi

All Wi-Fi and Bluetooth drivers and stacks are based on Linux open source.

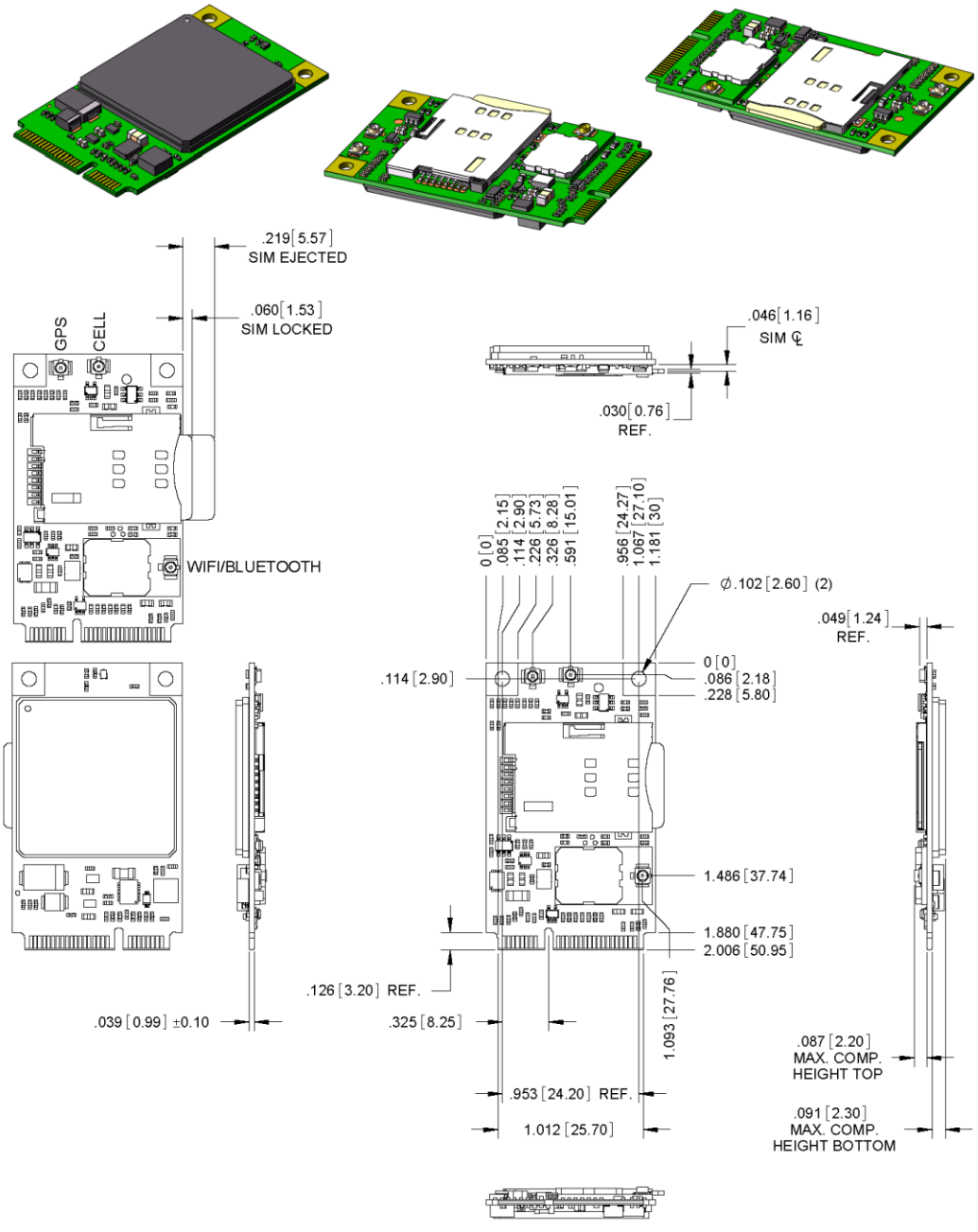
- For Wi-Fi, use the Linux calibrator tool. The WiFi drivers are compat-wireless drivers for TI WL12XX build under Linux kernel 2.6.39.4. For more information see http://linuxwireless.org/en/users/Drivers/wl12xx/calibrator.

- For BlueTooth, use the Linux hcitool.

Both tools are currently available inside our embedded Linux systems. These tools do not run on PCs. To invoke the tools, secure shell into the device using putty or another tool from your Windows computer. Once you secure shell and login, you can invoke the tools and test. You will need Ethernet connectivity to the development board for the secure shell and login.

Chapter 11 – Mechanical Drawing

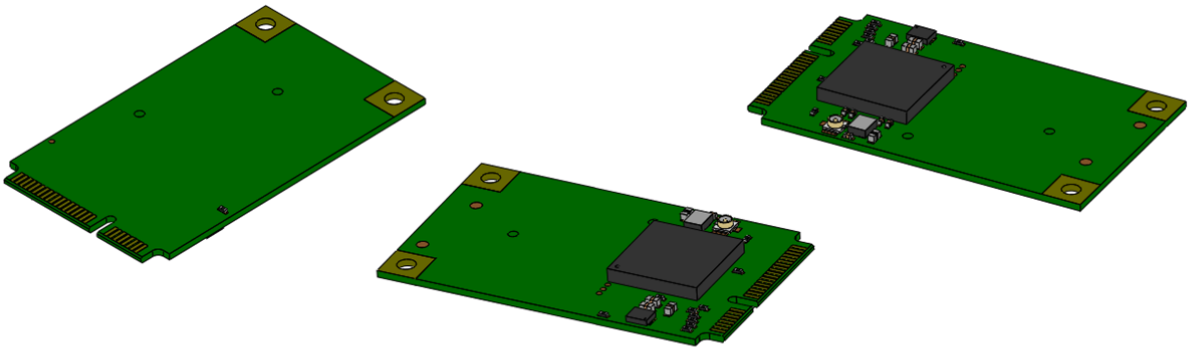
MTPCIE-H5-xx

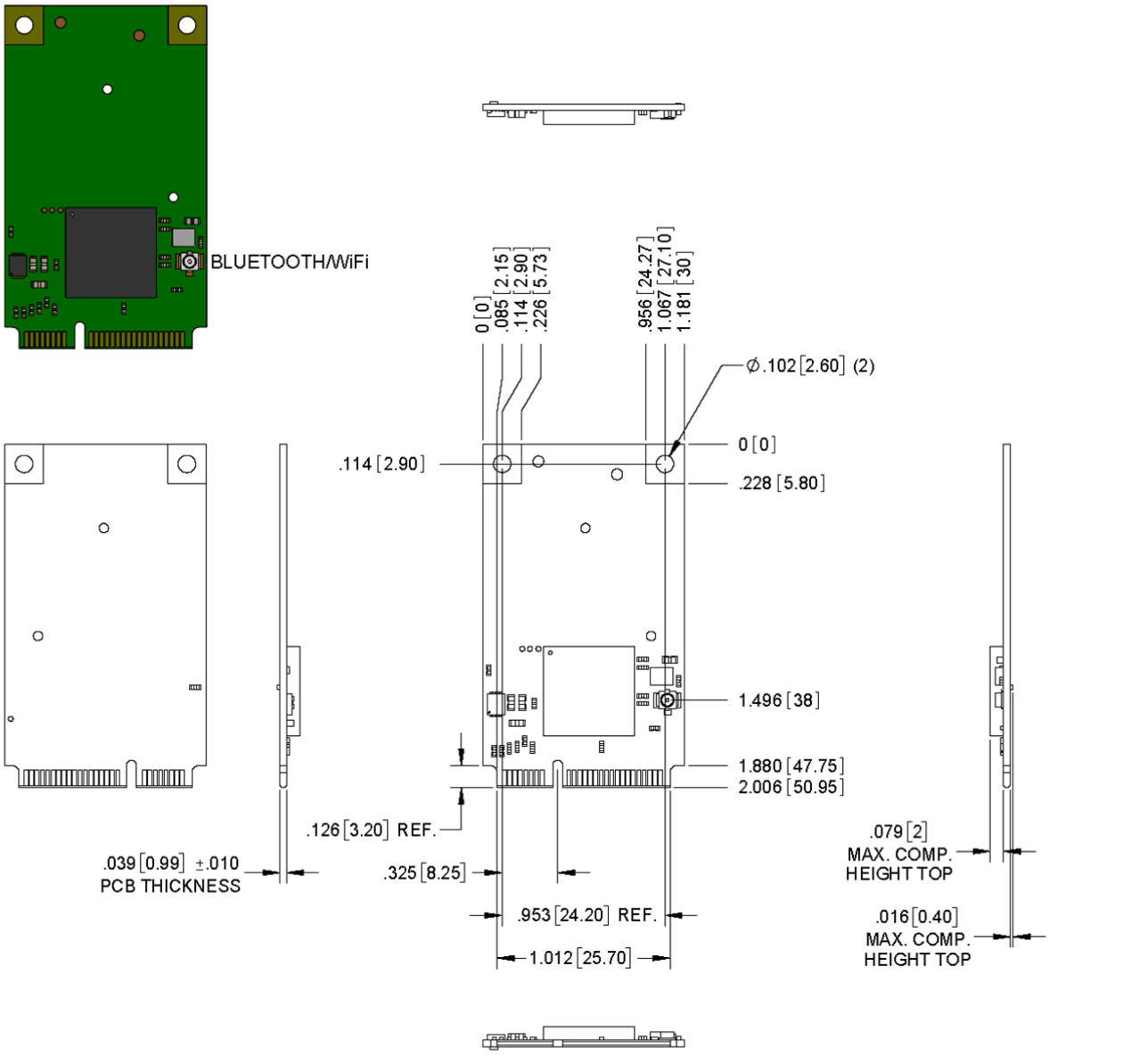


MTPCIE-H5-xx

DIMENSION IN INCHES [mm]

MTPCIE-BW





DIMENSION IN INCHES [mm]

MTPCIE-BW1

Chapter 12 – Specifications

MTPCIE-H5 Device Specifications

Category	Description
General	
Standards	Seven-band HSPA+ 21
	Quad-band GSM/GPRS/EDGE
	SMS is based on CS/Packet-Switched (PS) domain of GSM and WCDMA
	USB Interface is CDC-ACM compliant
Frequency Bands	Refer to the following Frequency Bands table for details.
Speed	
Data Speed	HSDPA data service of up to 21.0 Mbps downlink/5.76 Mbps uplink
Interface	
USB Interface	USB 2.0 high speed compatible
UART Interface	0-1.8V
Physical Description	
Weight	0.4 oz. (10 g)
Dimensions	Refer to Mechanical Drawing for Dimensions. **Note:** With the form factor, dimensions exceed the standard MiniPCIe maximum component height for top and bottom.
Connectors	
Antenna Connector	1 surface mount UFL connector for cellular
	1 surface mount UFL connector for GPS
	Bluetooth and Wi-Fi: share 1 UFL connector
SIM	1.8V and 3V SIM holder for mini-SIM card 
Environment	
Operating Temperature	-35° C to +85° C
Storage Temperature	-35° C to +85° C
Humidity	20%-90% RH, non-condensing
Power Requirements	
Operating Voltage	3.1 V to 3.5 V, normal is 3.3 V
Input Power	3.3VDC
SMS, Wi-Fi, Bluetooth	

Category	Description
SMS	Point-to-Point messaging
	Mobile-Terminated SMS
	Mobile-Originated SMS
Wi-Fi	IEEE 802.11 b,g, n, compliant
	SDIO host interface (0-1.8V)
Bluetooth	Serial Port Protocol (SPP)
	UART Interface 1.8V
GPS	High-sensitivity of indoor reception, better than -165
	Cold start autonomous -147 dBm
	Hot start autonomous -161 dBm
	Tracking mode -166 dBm
	Accuracy 3 m
	TTF from cold start 42 s
	TTF from warm start 30 s
	TTF from hot start 1.8 s
	Multi-channel GPS
	L1 1575.42 MHz
	GPS NMEA 0183 output format
	Datum WGS-84
Certifications and Compliance	
EMC Compliance	FCC Part 15 Class B
	EN55022 Class B
	EN55024

Category	Description
Radio Compliance	FCC Part 22
	FCC Part 24
	FCC Part 15C (BT & Wi-FI intentional radiators)
	RSS 132
	RSS 133
	Part 27 resp. RSS-139
	EN 301 511 EN301908-1 & -2
	EN 301 489-1
	EN 301 489-3
	EN 301 489-52
	CD RED Radio/SAR
Safety Compliance	UL 60950-1
	cUL 60950-16t
	EN 60950-1
Network Compliance	GCF Certified Module

Frequency Bands (H5)

Mode	Freq. TX (MHz)	Freq. RX (MHz)	Channels	TX - RX offset
GSM850	824.2- 848.8	869.2 - 893.8	128 - 251	45 MHz
EGSM900	890.0 - 914.8	935.0 - 959.8	0 - 124	45 MHz
	880.2 - 889.8	925.2 - 934.8	975 - 1023	45 MHz
DCS1800	1710.2 - 1784.8	1805.2 - 1879.8	512 - 885	95MHz
PCS1900	1850.2 - 1909.8	1930.2 - 1989.8	512 - 810	80MHz
WCDMA850 (band V)	826.4 - 846.6	871.4 - 891.6	Tx: 4132 - 4233 Rx: 4357 - 4458	45MHz
WCDMA900 (band VIII)	882.4 - 912.6	927.4 - 957.6	Tx: 2712 - 2863 Rx: 2937 - 3088	45MHz
WCDMA1700 (band IV)	1710.4 - 1755.6	2112.4 - 2167.6	Tx: 1312 - 1513 Rx: 9662 - 9938	400MHz
WCDMA1900 (band II)	1852.4 - 1907.6	1932.4 - 1987.6	Tx: 9262 - 9538 Rx: 9662 - 9938	80MHz

Mode	Freq. TX (MHz)	Freq. RX (MHz)	Channels	TX - RX offset
WCDMA2100 (band I)	1922.4 - 1977.6	2112.4 - 2167.6	Tx: 9612 - 9888 Rx: 10562 - 10838	190MHz

HE910 Telit Transmission Output Power

Band	Power Class
GSM 850/900 MHz	4 (2W)
DCS 1800, PCS 1900 MHz	1 (1W)
EDGE, 850/900 MHz	E2 (0.557W)
EDGE, 1800/1900 MHz	Class E2 (0.4W)
WCDMA 850/900, AWS 1700, 1900/2100 MHz	Class 3 (0.25W)

MTPCIE DC Electrical Characteristics

Units: Volts

Parameter	Minimum	Maximum
3.3 Volt Powered	3.0	3.6
Input Low Level	0	0.35
Input High Level	1.5	1.9
Output Low Level	0	0.2
Output High Level	1.6	1.9
USB_D +and USB_D-	1.4	5

Absolute Maximum Rating

Voltage at any signal pin: 0.0V to +1.9V

PCIE Connector Leads

PIN #	Name	I/O	Function	Type	Notes	MTPCIE-H5-V-BW	MTPCIE-H5	MTPCIE-H5-V
1	SDIO_D0	I/O	Wi-Fi SDIO_D0	1.8V	SDIO can operate up to 25Mhz. The SDIO traces to Host must be treated like a bus and the bus length shall be as short as possible. Recommend adding series termination resistors on all the SDIO traces.		no function	no function
2	3.3Vaux	I	3.3Vaux					
3	SDIO_D1	I/O	Wi-Fi SDIO_D1	1.8V			no function	no function
4	GND		Ground					
5	SDIO_D2	I/O	Wi-Fi SDIO_D2	1.8V			no function	no function
6	BT_TXD	I	Bluetooth Transmit data	1.8V			no function	no function
7	SDIO_D3	I/O	Wi-Fi SDIO_D3	1.8V			no function	no function
8	BT_RTS	I	Bluetooth RTS	1.8V			no function	no function
9	GND		Ground					

PIN #	Name	I/O	Function	Type	Notes	MTPCIE-H5-V-BW	MTPCIE-H5	MTPCIE-H5-V
10	BT_CTS	O	Bluetooth CTS	1.8V			no function	no function
11	SDIO_CMD	I/O	Wi-Fi SDIO_CMD	1.8V			no function	no function
12	BT_RXD	O	Bluetooth Receive data	1.8V			no function	no function
13	SDIO_CLK	I	Wi-Fi SDIO_CLK	1.8V	Upto 25mhz		no function	no function
14	BT_EN	I	Bluetooth enable (low disable)	1.8V	low disable		no function	no function
15	GND		Ground					
16	GPIO_2	I/O	3G Cellular General purpose I/O	1.8V	AT#GPIO=2,x,x		no function	
17	WLAN_EN	I	Wi-Fi enable (low disable)	1.8V	Low disable		no function	no function
18	GND		Ground					
19	WLAN_IRQ	O	Wi-Fi interrupt (low active)	1.8V	Low active		no function	no function
20	3G_ONOFF	I	3G Cellular On/Off (low active)	1.8V	Minimum pulse is 200 µs up to 900 msec. This short pulse can cause an unconditional radio shutdown. There is no controlled disconnect from the network. The radio restarts. The radio takes 10 seconds to recover and finish starting.			

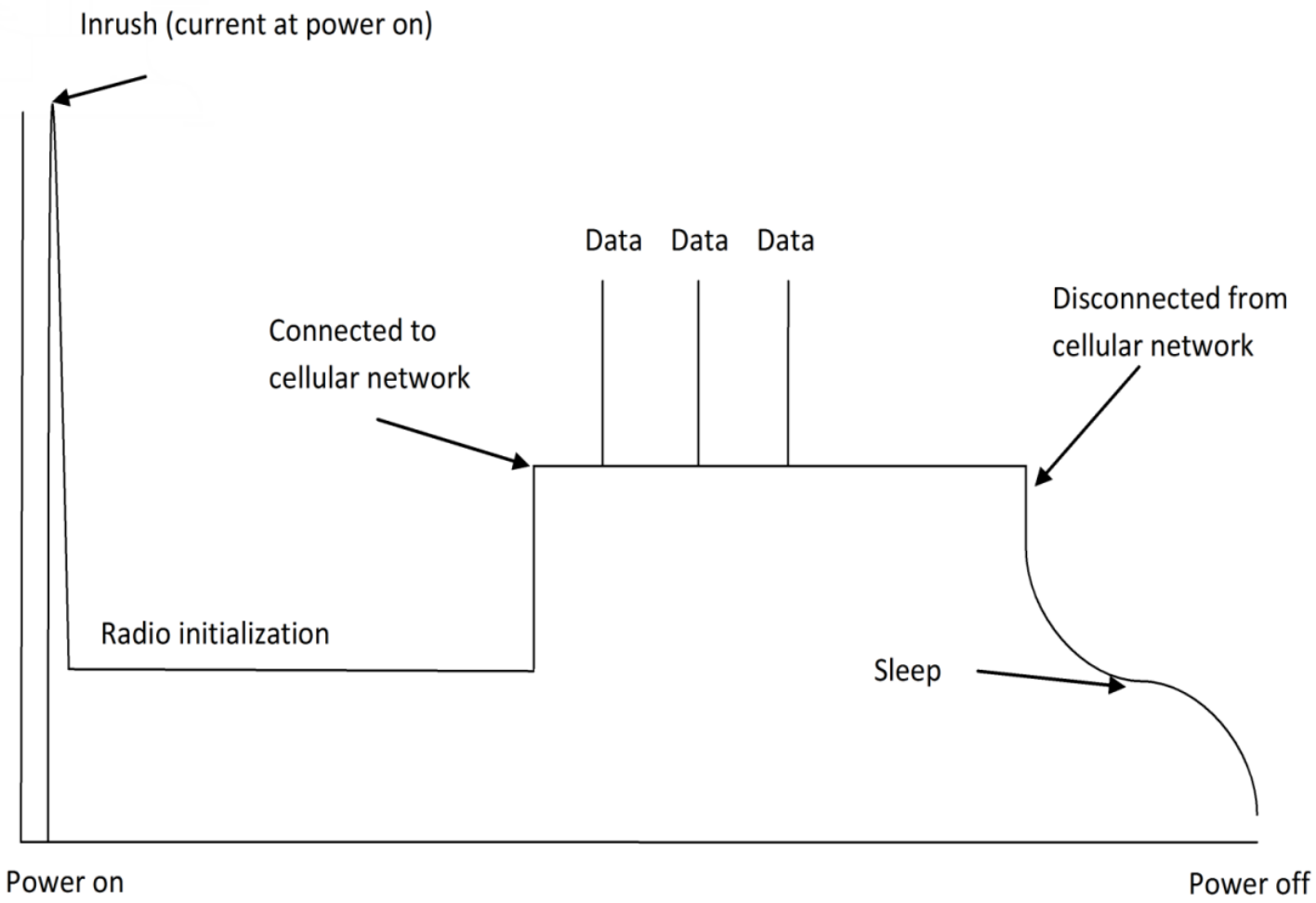
PIN #	Name	I/O	Function	Type	Notes	MTPCIE-H5-V-BW	MTPCIE-H5	MTPCIE-H5-V
					Active Low: Properly turn off and detach from the carrier network. Low for at least 1 second turns off the 3G radio. Shut off can take up to 30 seconds. High turns on the 3G radio and it needs at least 13 seconds before AT commands are issued. No connect if not used.			
21	GND		Ground					
22	3G_RST	I	3G Cellular Reset line (low active)	1.8V	Active Low: Emergency reset without proper shutdown and without detach from the network. Low for at least 50 ms resets the 3G radio. It takes at least 2.5 seconds to reset and turn the 3G radio off. High turns on the 3G radio and needs at least 7.5 seconds before AT commands are issued. No connect if not used.			
23	1.8V	O	1.8V output	100mA output current at 1.8V			no function	no function
24	3.3Vaux	I	3.3Vaux					
25	GPIO_1	I/O	Bluetooth General purpose I/O	1.8V	No connect		no function	no function
26	GND		Ground					
27	GND		Ground					
28	3G_DVI_WA0	I/O	3G Cellular digital voice control line	1.8V			no function	
29	GND		Ground					

PIN #	Name	I/O	Function	Type	Notes	MTPCIE-H5-V-BW	MTPCIE-H5	MTPCIE-H5-V
30	3G_DVI_CLK	I/O	3G Cellular digital voice clock	1.8V			no function	
31	3G_DVI_RX	I	3G Cellular digital voice receive	1.8V			no function	
32	RI	O	3G Cellular UART RI	1.8V			no function	
33	3G_DVI_TX	O	3G Cellular digital voice transmit	1.8V			no function	
34	GND		Ground					
35	GND		Ground					
36	USB_D-	I/O	3G USB Negative Data	3.3V				
37	GND		Ground					
38	USB_D+	I/O	3G USB Positive Data	3.3V				
39	3.3Vaux	I	3.3Vaux					
40	GND		Ground					
41	3.3Vaux	I	3.3Vaux					

PIN #	Name	I/O	Function	Type	Notes	MTPCIE-H5-V-BW	MTPCIE-H5	MTPCIE-H5-V
42	LED_WWAN#	O	3G Cellular STAT LED Output	1.8V	Command to enable LED function, AT#GPIO=1,0,2. This pin needs an external transistor to drive an external LED. Therefore, status indicated is reversed with respect to the pin status: Permanently off = Device off Fast blinking (Period 1s, Ton 0.5s) = Net search / Not registered / turning off Slow blinking (Period 3s, Ton 0.3s) = Registered full service Permanently on = a voice call is active			
43	GND		Ground					
44	DCD	O	3G Cellular UART DCD	1.8V			no function	
45	CTS	O	3G Cellular UART CTS	1.8V			no function	
46	GPIO_3	I/O	3G Celllular General purpose I/O	1.8V	AT#GPIO=3,x,x		no function	
47	RTS	I	3G Cellular UART RTS	1.8V	Avoid having any HIGH logic level signal applied to any 3G input digital pins when the 3G module is powered off or during an ON/OFF transition.		no function	
48	DTR	I	3G Cellular UART DTR	1.8V	Avoid having any HIGH logic level signal applied to any 3G input digital pins when the 3G module is powered off or during an ON/OFF transition.		no function	

PIN #	Name	I/O	Function	Type	Notes	MTPCIE-H5-V-BW	MTPCIE-H5	MTPCIE-H5-V
49	RXD	O	3G Cellular UART Receive data	1.8V			no function	
50	GND		Ground					
51	TXD	I	3G Cellular UART transmit data	1.8V	Avoid having any HIGH logic level signal applied to any 3G input digital pins when the 3G module is powered off or during an ON/OFF transition.		no function	
52	3.3Vaux	I	3.3Vaux					

Typical Power Flow



- Peak inrush current is a fast rising pulse at power start up on board supplies or modem cap charging. It is influenced by the design and limits of the power supply providing power to the device.

- Radio initialization is a lower value steady current phase that occurs while the radio gets initialized and ready to talk to the cell network.
- Once connected to the network, there is a steady idle current state.
- When data is transmitted to the network, power peaks from this idle state. Peak data values are influenced by the distance from the towers and decided by the carrier network.
- Power starts dropping when the device is disconnected.
- After it is disconnected, power draw lowers if the device is told to enter sleep mode. Sleep mode keeps the receiver active and the device periodically wakes up long enough to tell the network it is still available.

Power Measurements

Multi-Tech Systems, Inc. recommends that you incorporate a 10% buffer into your power source when determining product load.

MTPCIE-H5 Power Draw

Radio Protocol	Cellular Call Box Connection No Data (Amps)	Average Measured Current (Amps) at Maximum Power	TX Pulse (Avg) Amplitude Current (Amps) for GSM850 or Peak Current for HSDPA	Total Inrush Charge Measured in Millicoulomb
3.3 Volts				
GSM850	0.056	0.629	2.5	5.27
HSDPA	0.057	0.727	0.804	5.27

Note: **Inrush Current:**The input current during power up, or a reset.

MTPCIE-H5-V-BW Power Draw

Radio Protocol	Cellular Call Box Connection No Data (Amps)	Average Measured Current (Amps) at Maximum Power	TX Pulse (Avg) Amplitude Current (Amps) for GSM850 or Peak Current for HSDPA	Total Inrush Charge Measured in Millicoulomb
3.3 Volts				
GSM850	0.062	1.058	2.9	2.51
HSDPA	0.062	0.970	1.052	2.51

Note: **Inrush Current:**The input current during power up, or a reset.

MTPCIE-BW Power Draw

Voltage	Inrush Current (Amps)	Idle Mode after MT100EOCG Boots Up (Amps)	Max Power with Bluetooth and Wi-Fi in Broadcast Mode (Amps)
3.3 Volts	0.056	0.0064	0.326

Note: **Inrush Current:**The input current during power up, or a reset.

Powering Down Your Device

CAUTION: Failing to properly power down the device before removing power may corrupt your device's file system.

To properly power down your device, use the following sequence :

1. Issue the AT#SHDN command.
2. Wait 30 seconds.
3. Power off or disconnect power.

Chapter 13 – Device Configuration

Device Configuration Notes

```
# Country code (ISO/IEC 3166-1). Used to set regulatory domain.
# Set as needed to indicate country in which device is operating.
# This can limit available channels and transmit power.
country_code=US

# Enable IEEE 802.11d. This advertises the country_code and the set of
allowed # channels and transmit
power levels based on the regulatory limits. The # country_code setting must
be configured with the correct country
for # IEE 802.11d.functions.
# (default: 0 = disabled)
ieee80211d=1
```

Chapter 14 – Application Notes

RF Performances

RF performances are compliant with the ETSI recommendation 05.05 and 11.10. The module's radio transceiver meets the requirements of 3GPP Release 5 & 6. All values indicated are conducted.

Receiver Features for Cellular Devices

Category	Description
GSM 850 Sensitivity	< -109 dBm
E-GSM 900 Sensitivity	< -106 dBm
DCS 1800 Sensitivity	< -105 dBm
PCS 1900 Sensitivity	< -105 dBm
UMTS Band I 2100 Sensitivity	< -109 dBm
UMTS Band II 1900 Sensitivity	< -108 dBm
UMTS Band V 850 Sensitivity	< -110 dBm
UMTS Band VI 800 Sensitivity	< -110 dBm

RF connection and antenna

The RF connector on the modem is a UFL standard type.

Note: For unlicensed transmitters in this device (Bluetooth, WiFi) only antennas as specified in this manual may be permanently connected / installed by the OEM, so that it can not be replaced by end-users without availability of special tools.

Frequency Bands

Mode	Freq. TX (MHz)	Freq. RX (MHz)	Channels	TX-RX offset
GSM850	824.2- 848.8	869.2 - 893.8	128 - 251	45 MHz
EGSM900	890.0 - 914.8	935.0 - 959.8	0 - 124	45 MHz
	880.2 - 889.8	925.2 - 934.8	975 - 1023	45 MHz
DCS1800	1710.2 - 1784.8	1805.2 - 1879.8	512 - 885	95 MHz
PCS1900	1850.2 - 1909.8	1930.2 - 1989.8	512 - 810	80 MHz
WCDMA850 (band V)	826.4 - 846.6	871.4 - 891.6	Tx: 4132 - 4233 Rx: 4357 - 4458	45 MHz
WCDMA900 (band VIII)	882.4 - 912.6	927.4 - 957.6	Tx: 2712 - 2863 Rx: 2937 - 3088	45 MHz
WCDMA1700 (band IV)	1712.4 - 1752.6	2112.4 - 2152.6	Tx: 1312 - 1513 Rx: 9662 - 9938	400MHz
WCDMA1900 (band II)	1852.4 - 1907.6	1932.4 - 1987.6	Tx: 9262 - 9538 Rx: 9662 - 9938	80MHz
WCDMA2100 (band I)	1922.4 - 1977.6	2112.4 - 2167.6	Tx: 9612 - 9888 Rx: 10562 - 10838	190MHz

Chapter 15 – Installing Drivers for Non-UIP HSPA+ Devices

Device Driver Installation

Installing on Linux

The Linux OS includes a generic USB driver for modems supporting CDC/ACM.

To install the device on Linux Kernel 2.6.x and newer with CDC/ACM support, connect USB cable from the device to a USB port on your computer. For most recent Linux distributions, there are no drivers to install.

Beginning with Linux Kernel 3.18, an LTE driver named option was included in Linux. If using an older version of Linux, build an updated option driver.

If the operating system recognizes the modem, seven devices are created (assuming no other ACM values have been assigned):

- /dev/ttyACM0
- /dev/ttyACM1
- /dev/ttyACM2
- /dev/ttyACM3
- /dev/ttyACM4
- /dev/ttyACM5
- /dev/ttyACM6

Only the following devices can be used for AT commands:

- /dev/ttyACM0 (data port for PPP connections and AT commands)
- /dev/ttyACM3 (generic port for AT commands)

If the operating system recognizes the modem, devices named /dev/ttyUSBx are created, for example:

- /dev/ttyUSB0 Diagnostic port
- /dev/ttyUSB1 NMEA port
- /dev/ttyUSB2 Auxiliary port
- /dev/ttyUSB3 Modem port

Note: AT commands are allowed on modem and auxiliary ports.

If the operating system recognizes the modem, devices named /dev/ttyUSBx are created, for example:

- /dev/ttyUSB0
- /dev/ttyUSB1
- /dev/ttyUSB2
- /dev/ttyUSB3
- /dev/ttyUSB4

Only the following devices can be used for AT commands:

- /dev/ttyUSB2 (data port for PPP connections and AT commands)
- /dev/ttyUSB3 (generic port for AT commands)

Need to know which Linux kernel we are testing on and what devices are created.

Troubleshooting Linux

If Linux does not create devices, check for the kernel module:

```
# lsmod | grep cdc_acm
```

If entries aren't found, load the kernel module with root privileges:

```
# modprobe cdc-acm
```

If this returns an error response, such as
`# FATAL: Module cdc-acm`
not found, the kernel module is not on your system. You will need to build the driver.

Building a Linux Driver

If your system is missing the Linux driver:

1. Retrieve the appropriate kernel source code version for your system. This should be in your OS distribution package. Unpack it.
2. In its root directory type:

 # make menuconfig

3. Configure the kernel according to your system configuration,
4. Browse to menu **Device Driver > USB Support** and select **USB Modem (CDC ACM) support**.
5. To start the build once configured, type

 # make

The kernel module cdc-acm.ko is in the directory drivers/usb/class. If the kernel was built previously, compile the module by typing:

```
# make M=drivers/usb/class
```

To load the module use
`modprobe`
or
`insmod`
.

Windows Release Notes

We tested h5-g3-usb-windriver_8.00.04-1.zip ev3-c2-usb_windriver_8.00.04-1.zip driver on the following Windows operating systems.

- **Windows 8 x86 and x64, Windows 7 x86 and x64, Vista x86 and x64, XP x86 and x64, Windows Server 2012, Windows Server 2008 x86 and x64, and Windows Server 2003 x86**

  Drivers install correctly, but may require .NET Framework version 3.5 or older.

  After installing the driver for this device, the device may not be available when Windows comes out of a sleep/hibernate state. To correct this issue, unplug the device from the USB port and then plug it back in to the same port.

- **Windows Server 2003 x64**

  Not supported.

Downloading the Windows USB Driver

If you haven't downloaded the driver:

1. Go to multitech.com and search to find your device's model page. Your device's model number is on the product label.
2. Under **Downloads**, click on the Windows USB Driver. A popup window appears.
3. Click to **Download** the driver zip file to your computer.
4. Extract the files to your computer.

Windows Notes

Installing on USB Host Powered Devices

When you connect a USB host powered device to a computer through a USB cable, the Windows **Add New Hardware Wizard** may display **Cannot Install this Hardware**. If this occurs, click **Finish**. Windows detects additional devices and prompts you to install them.

Installing on Non-USB Powered Devices

Turn on the device and wait 15 seconds before connecting the USB cable. If you connect the USB cable before supplying power to the device, the Windows **Add New Hardware Wizard** may appear and show **Cannot Install this Hardware**. If this occurs, click Finish. Windows detects additional devices and prompts you to install the additional devices. If Windows does not detect new device, unplug the USB cable, turn the device off and on, wait 15 seconds, insert the USB cable, and install devices when prompted.

Installing on Windows 8, 7 or Vista

This process installs multiple drivers and ports.

Note: If you previously installed USB drivers for this device, uninstall them before installing or re-installing this driver. Uninstall all existing drivers for this device. Refer to Uninstall Windows Drivers for details.

Before you connect the device (disconnect the device if you connected it):

CAUTION: If you connected the device before installing the drivers, Windows may install drivers automatically. Your device may not operate correctly with these drivers. Uninstall the drivers before proceeding. See Remove Microsoft Installed Drivers for details.

1. Go to the location where you extracted the driver and open the **H5-G3-USB\Driver** folder.
2. Right-click on **TelitUSBInstaller_In_U8.00.04.exe** and select **Run as Administrator**.
3. Click **Yes** or **Allow** to allow the installer to make changes to your computer.
4. Click **Next** and follow the instructions in the installation wizard.
5. Click the **Install** option when prompted, for example, Install this driver software anyway.
6. Click **Finish.**
7. Connect USB cable from the device to a USB port on your computer. Windows indicates when the device is ready to use.
8. Signal strength LEDs require a device reboot after installing software. Disconnect the device from the computer's USB port for a few seconds and reconnect the device to the same USB port.

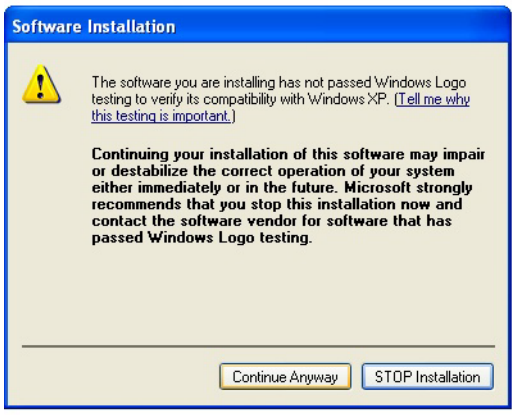
Installing on Windows XP

This process installs four drivers.

Note: If you previously installed USB drivers for this device, uninstall them before installing or re-installing this driver. Uninstall all existing drivers for this device. Refer to Uninstall Windows Drivers for details.

Before you connect the device (disconnect the device if you connected it):

1. Go to the location where you extracted the driver and open the **H5-G3-USB\Driver** folder.
2. Right-click on **TelitUSBInstaller_In_U8.00.04.exe** and select **Run**.
3. Click **Next** and follow the instructions in the installation wizard.
4. Click **Continue Anyway** each time this screen appears.



5. Click **Finish.**
6. Connect USB cable from the device to a USB port on your computer. After it detects the hardware, Windows opens the New Hardware Wizard.
7. Select **No, not this time** and click **Next.**
8. Select **Install the software automatically (Recommended)** and click **Next.**
9. Select **Finish.**
10. Repeat Steps 7-9 for each additional New Hardware Wizard. Windows indicates when the device is ready to use.
11. Signal strength LEDs require a device reboot after installing software. Disconnect the device from the computer's USB port for a few seconds and reconnect the device to the same USB port.

Uninstalling Windows Drivers

Note: Disconnect the device before uninstalling drivers.

Windows 8 or 8.1

To uninstall drivers from Windows 8 or 8.1:

1. Open Windows **Programs and Features**.
2. Scroll to **TelitModulesDrivers_x##**, where ## is 64 or 86, and click Uninstall. Confirm that you want to uninstall the driver.

   Uninstalling the TelitModulesDrivers, uninstalls all related Telit modems, ports, and drivers, so you don't need to uninstall these individually.

Windows 7

To uninstall drivers from Windows 7:

1. Open **Programs and Features** from the Windows Control Panel.
2. Scroll to **TelitModulesDrivers_x##**, where ## is 64 or 86, and click Uninstall. Confirm that you want to uninstall the driver.

   Uninstalling the TelitModulesDrivers, uninstalls all related Telit modems, ports, and drivers, so you don't need to uninstall these individually.

Windows XP

To uninstall drivers from Windows XP:

1. Open the **Control Panel** and go to **Add or Remove Programs**.
2. Uninstall **Windows Driver Package – Telit Wireless Solutions (telitusbser) Modem**.
3. Uninstall all other **Telit modems, Ports and USB**.

Remove Microsoft Installed Drivers

If using Windows 7 and connect the device before installing drivers, Windows Update automatically installs drivers. Your device may not operate correctly with these drivers. To remove these drivers:

1. With the device plugged in, open the **Device Manager.**

2. Right-click on the Telit Mobile Modem and select **Uninstall.**
3. Select **Delete the driver software for this device** and click **OK**.
4. Repeat the removal steps to uninstall each Telit port and the Telit Universal Serial Bus Control.

Developer Note

By default each time an H5 or G3 device with a different IMEI value is connected using this USB driver, the operating system will not require searching for the drivers again and uses the same ports created in a previous installation. To prevent this, use the utility included with the driver download to manage port creation as follows.

To enable USB IMEI identification, where the operating system creates a new set of ports with different COM enumeration for each H5 device with a different IMEI value:

1. Uninstall the driver if already installed.
2. Double-click the enable USB IMEI file for your model in the folder where you extracted the driver files.
    - For H5: **H5_enable_USB_IMEI_indentification.reg**
    - For G3: **G3_enable_USB_IMEI_indentification.reg**
3. Install the driver as normal.

To disable USB IMEI identification (driver default setting):

1. Uninstall the driver if already installed.
2. Double-click the disable USB IMEI file for your model in the folder where you extracted the driver files.
    - For H5: **H5_disable_USB_IMEI_indentification.reg**
    - For G3: **G3_disable_USB_IMEI_indentification.reg**
3. Install the driver as normal.

Chapter 16 – Using Linux with H5 Devices

Shell Commands

Testing Serial Ports

To test the serial ports created by the driver, type in a shell:

```
# cat /dev/ttyACM0 &
# echo –en "ATE0\r" > /dev/ttyACM03
# echo –en "AT\r" > /dev/ttyACM0
```

Note: Sending ATE0 is required, to avoid issues in the terminal output. It prevents the sending/receiving spurious characters to/from the modem when used with the Linux commands “echo” and “cat”

You can perform the same test using the other interface (ttyACM1 ttyACM3).

Create a PPP Connection

Most recent Linux distributions have GUI tools for creating PPP connections; the following instructions are for creating a PPP connection through command line interface.

PPP support must be compiled into the kernel; pppd and chat programs are also required.

H5 Example

Step 1. Use a text editor to create a peer file containing the lines in the example below. (/dev/ttyACM0 may need to be something like /dev/ttyS0 for a serial build). Save the file as /etc/ppp/peers/H5-peer.

Example peer file:

```
/dev/ttyACM0
connect "/usr/sbin/chat -v -f /etc/chatscripts/H5-chat"
noipdefault
usepeerdns
defaultroute
noauth
```

Step 2. Use a text editor to create a chat script containing the lines in the example below. In this example [APN] should be replaced with the APN assigned by your cellular provider. Save the file as /etc/chatscripts/H5-chat.

Example chat script:

```
ABORT "ERROR"
ABORT "NO CARRIER"
ABORT "BUSY"
"" at+cgdcont=1,"IP","[APN]"
OK atd*99***1#
CONNECT ""
```

Step 3. Use the following command line to start pppd:

```
pppd debug call H5-peer
```

This command line enables logging of debug information and tells pppd to use the peer file referenced by the call option. After 20-30 seconds, type ifconfig and check whether a ppp interface is listed. If it is not, then check syslog for pppd and chat events. Normally pppd/chat logging is written to /var/log/syslog (could vary depending on syslog configuration).

EV3 Example

Step 1. Use a text editor to create a peer file containing the lines in the example below. (/dev/ttyUSB2 may need to be something like /dev/ttyS0 for a serial build). Save the file as /etc/ppp/peers/EV3-peer.

Example peer file:

```
/dev/ttyUSB2
connect "/usr/sbin/chat -v -f /etc/chatscripts/EV3-chat"
noipdefault
usepeerdns
defaultroute
noauth
```

Step 2. Use a text editor to create a chat script containing the lines in the example below. In this example [APN] should be replaced with the APN assigned by your cellular provider. Save the file as /etc/chatscripts/EV3-chat.

Example chat script:

```
ABORT "ERROR"
ABORT "NO CARRIER"
ABORT "BUSY"
"" at
OK atd#777
CONNECT ""
```

Step 3. Use the following command line to start pppd:

```
pppd debug call EV3-peer
```

This command line enables logging of debug information and tells pppd to use the peer file referenced by the call option.

After 20-30 seconds, type ifconfig and check whether a ppp interface is listed. If it is not, then check syslog for pppd and chat events. Normally pppd/chat logging is written to /var/log/syslog (could vary depending on syslog configuration).

MAT1 (MVW1) Example

> **Note:** Except for the "MVW1" text, the peer file (for Step 1), the chat script (for in Step 2), and the command line to start pppd (for Step 3) are the same. Follow the same instructions for the MVW1 for creating a PPP connection through command line interface.

Step 1. Use a text editor to create a peer file containing the lines in the example below. (/dev/ttyACM0 may need to be something like /dev/ttyS0 for a serial build). Save the file as /etc/ppp/peers/MAT1-peer.

Example peer file:

```
/dev/ttyACM0
connect "/usr/sbin/chat -v -f /etc/chatscripts/MAT1-chat"
noipdefault
```

```
usepeerdns
defaultroute
noauth
```

Step 2. Use a text editor to create a chat script containing the lines in the example below. In this example [APN] should be replaced with the APN assigned by your cellular provider. Save the file as /etc/chatscripts/MAT1-chat.

Example chat script:

```
ABORT "ERROR"
ABORT "NO CARRIER"
ABORT "BUSY"
"" at+cgdcont=1,"IP","[APN]"
OK atd*99***1#
CONNECT ""
```

Step 3. Use the following command line to start pppd:

```
pppd debug call MAT1-peer
```

This command line enables logging of debug information and tells pppd to use the peer file referenced by the call option. After 20-30 seconds, type ifconfig and check whether a ppp interface is listed. If it is not, then check syslog for pppd and chat events. Normally pppd/chat logging is written to /var/log/syslog (could vary depending on syslog configuration).

C Programming

The following topics show all the functions that can be used from C source code to perform read/write operations on the serial devices.

open()

The *open()* function shall establish the connection between a file and a file descriptor. The file descriptor is used by other I/O functions to refer to that file.

Header File

fcntl.h

Prototype:

int open(const char *pathname, int flags)

Parameters:

pathname – file name with its own path.

flags – is an *int* specifying file opening mode: is one of O_RDONLY, O_WRONLY or O_RDWR which request opening the file read-only, write-only or read/write, respectively.

Returns:

The new file descriptor *fildes* if successful, -1 otherwise.

Example

```
Open the /dev/ttyACM0.
```

```
int fd; // file descriptor for the /dev/ttyACM0 entry
if((fd = open("/dev/ttyACM0", O_RDONLY) < 0)
{
/* Error Management Routine */
} else {
/* ttyACM0 Device Opened */
}
```

read()

The *read()* function reads *nbyte* bytes from the file associated with the open file descriptor, *fildes*, and copies them in the buffer that is pointed to by *buf*.

Header File

unistd.h

Prototype:

ssize_t read(int fildes, void *buf, size_t nbyte)

Parameters:

fildes - file descriptor

buf - destination buffer pointer

nbyte - number of bytes that read() attempts to read

Returns:

The number of bytes actually read if the operation is completed successfully, otherwise it is -1.

Example

```
Read sizeof(read_buff) bytes from the file associated with fd and stores them
into read_buff.
char read_buff[BUFF_LEN];
if(read(fd, read_buff, sizeof(read_buff)) < 0)
{
/* Error Management Routine */
} else {
/* Value Read */
}
```

write()

The *write()* function writes *nbyte* bytes from the buffer that are pointed by *buf* to the file associated with the open file descriptor. *fildes*.

Header File

unistd.h

Prototype:

ssize_t write(int fildes, const void *buf, size_t nbyte)

Parameters:

fildes – file descriptor

buf – destination buffer pointer

nbyte – number of bytes that write() attempts to write

Returns:

The number of bytes actually written if the operation is completed successfully, otherwise it is -1.

Example

```
Write strlen(value_to_be_written) bytes from the buffer pointed by
value_to_be_written to the file
associated with the open file descriptor, fd.
char value_to_be_written[] = "dummy_write";
if (write(fd, value_to_be_written, strlen(value_to_be_written)) < 0)
{
/* Error Management Routine */
} else {
/* Value Written */
}
```

close()

The *close()* function shall deallocate the file descriptor indicated by *fildes*. To deallocate means to make the file descriptor available for return by subsequent calls to *open()* or other functions that allocate file descriptors.

Header File

unistd.h

Prototype:

int close(int fildes);

Parameters:

fildes - file descriptor

Returns:

0 if successful, otherwise it is -1.

Example

```
Close the ttyACMx file.
if(close(fd) < 0)
{
/* Error Management Routine */
} else {
/* File Closed */
}
```

Test Program()

The following simple C program is useful to test the modem issuing an AT command. The program opens the /dev/ttyACM0 interface and calls the write() and the read() function to send an AT command and receive the subsequent output.

```
#include <stdio.h> /* Standard input/output definitions */
#include <string.h> /* String function definitions */
#include <unistd.h> /* UNIX standard function definitions */
#include <fcntl.h> /* File control definitions */
#include <errno.h> /* Error number definitions */
#include <termios.h> /* POSIX terminal control definitions */
#define USB "/dev/ttyACM0"
#define BUFSIZE 1000
#define BAUDRATE B115200
int open_port(char *port)
{
struct termios options;
int fd;
fd = open(port, O_RDWR | O_NOCTTY | O_NDELAY);
if (fd == -1)
{
printf("open_port: Unable to open the port - ");
}
else
{
printf ( "Port %s with file descriptor=%i",port, fd);
fcntl(fd, F_SETFL, FNDELAY);
tcgetattr( fd, &options );
cfsetispeed( &options, BAUDRATE );
cfsetospeed( &options, BAUDRATE );
options.c_cflag |= ( CLOCAL | CREAD);
options.c_cflag &= ~(CSIZE | PARENB | CSTOPB | CSIZE);
options.c_cflag |= CS8;
options.c_cflag &= ~CRTSCTS;
options.c_lflag &= ~(ICANON | ECHO | ECHOE | ISIG);
options.c_iflag &= ~(IXON | IXOFF | IXANY | ICRNL | INLCR |
IGNCR);
options.c_oflag &= ~OPOST;
if ( tcsetattr( fd, TCSANOW, &options ) == -1 )
printf ("Error with tcsetattr = %s\n", strerror ( errno )
);
else
printf ( "%s\n", "succeed" );
}
return (fd);
}
int main()
{
int serialFD = open_port(USB);
char buf[BUFSIZE];
```

```
memset(buf,0,BUFSIZE);
write(serialFD, "AT\r" , strlen("AT\r"));
sleep(1);
read( serialFD, buf, BUFSIZE );
printf("The string is: %s\n", buf);
close(serialFD);
return 0;
}
```

The sleep instruction is required because the modem response after issuing the AT command is not immediate, so you need to wait a bit before reading. There are more efficient ways to do this, for example, you can put the read call in a while loop and exit when the read buffer contains a certain string.

Chapter 17 – Bluetooth Developer Information

If using the MTPCIE Developer Kit with an MT100EOCG and an MTPCIE Bluetooth/Wi-Fi radio, Bluetooth developer content and sample code are available online at multitech.net.

The following models support Bluetooth/Wi-Fi functionality:

Model	Description
MTPCIE-BW	Bluetooth/Wi-Fi only
MTPCIE-H5-V-BW	HSPA+ with Bluetooth/Wi-Fi

Bluetooth/Wi-Fi

All Wi-Fi and Bluetooth drivers and stacks are based on Linux open source.

- For Wi-Fi, use the Linux calibrator tool. The WiFi drivers are compat-wireless drivers for TI WL12XX build under Linux kernel 2.6.39.4. For more information see http://linuxwireless.org/en/users/Drivers/wl12xx/calibrator.
- For BlueTooth, use the Linux hcitool.

Both tools are currently available inside our embedded Linux systems. These tools do not run on PCs. To invoke the tools, secure shell into the device using putty or another tool from your Windows computer. Once you secure shell and login, you can invoke the tools and test. You will need Ethernet connectivity to the development board for the secure shell and login.

Configuring the MTPCIE-DK1 Developer Board

To use the MTPCIE-DK1 developer board with an MT100EOCG and an MTPCIE Bluetooth/Wi-Fi device:

1. Position jumpers next to USB 3G connector J4 in the 2,3 position.
2. Install the radio and MT100EOCG on the MTPCIE-DK1 developer board and power up the board.
3. Connect the serial cable between the computer's serial port and the MT100EOCG debug DB9 connector.
4. Run terminal software on the computer with the serial port configured as: 115.2K Bits per second 8 Data bits None Parity 1 Stop bits None Flow control
5. Power up the MTPCIE-DK1. Linux boots up and the command prompt appears.
6. Enter **root** as the default user name and password.

Calibrating Wi-Fi and Programming the MAC Address

To calibrate the Wi-Fi and program the MAC address:

1. Attach Wi-Fi/Bluetooth antenna to the MTPCIE.
2. Run the following command on the device:

```
calibrate-wifi.sh <WIFI-MAC-ADDRESS>
```

Creating a PPP Connection

For more information, go to www.multitech.net/developer/products/multiconnect-ocg/applications/ppp-peers.

1. Verify your wireless account is activated with a data plan. If using a GSM radio like MTPCIE-H5-BW, install the SIM card.
2. If using a GSM radio, edit **/etc/ppp/peers/gsm_chat** file and change the APN to match up with the SIM card
3. Connect the cellular antenna to the MTPCIE device.
4. In the MT100EOCG, enter:

   For MTPCIE-H5 devices: **pppd call gsm**
5. After 10 seconds, enter **ip a** in the MT100EOCG to verify the PPP link is up and an IP address obtained.

Setting Wi-Fi Access Point with an MT100EOCG and an MTPCIE Bluetooth/Wi-Fi

To setup a Wi-Fi access point with an MT100EOCG and an MTPCIE Bluetooth Wi-Fi device:

1. Build **corecdp-wifi-ap-image** and flash it into the MT100EOCG.
2. Edit **/etc/udhcpd.conf** to configure the dhcp server.
3. Edit **/etc/hostapd.conf** to configure access point settings. Configure **ssid=<name>** with the access point name. Save hostapd.conf.
4. To start the access point, type ocg-wifi-ap.sh start <desired IP address of AP> on the MT100EOCG. For example:

   `ocg-wifi-ap.sh start 192.168.2.1`
5. If you run a script like the example, the MT100EOCG acts as a cell router that allows Wi-Fi and Ethernet endpoints to access the Internet through EOCG's cellular PPP link. Uncomment the ppd call line for your device model.
6. Create a wireless network connection on a remote computer and configure it to use DHCP to obtain IP and DNS addresses.
7. Enable the wireless connection on the computer. Verify that your computer can communicate to the Internet using MT100EOCG as the access point.

Example Wi-Fi Access Point Script

```
#!/usr/bin/env bash

echo "Updating DNS, ppp scripts"
echo "nameserver 8.8.8.8" > /etc/resolv.conf

killall pppd && sleep 2

echo "Starting pppd"

#uncomment line below if gsm radio (H5, etc)
#pppd call gsm

#uncomment line below if cdma radio (EV3,etc)
#pppd call cdma

sleep 4
```

```
echo "Setting up iptables"

# Flush all the tables first
iptables -t filter -F
iptables -t nat -F
iptables -t mangle -F

iptables -t filter -P INPUT DROP
iptables -t filter -A INPUT -i lo -j ACCEPT
iptables -t filter -A INPUT -m state --state RELATED,ESTABLISHED -j ACCEPT

# accept all traffic from LAN
iptables -t filter -A INPUT -i eth0 -j ACCEPT
iptables -t filter -A INPUT -i wlan0 -j ACCEPT

iptables -t filter -P FORWARD DROP
iptables -t filter -A FORWARD -m state --state RELATED,ESTABLISHED -j ACCEPT
iptables -t filter -A FORWARD -i eth0 -o ppp0 -j ACCEPT
iptables -t filter -A FORWARD -i wlan0 -o ppp0 -j ACCEPT

iptables -t filter -P OUTPUT ACCEPT

iptables -t nat -A POSTROUTING -o ppp0 -j MASQUERADE

# turn on packet forwarding last
echo 1 > /proc/sys/net/ipv4/ip_forward
```

Using an MT100EOCG with an MTPCIE Bluetooth/Wi-Fi Device as Wi-Fi Client

To use the MT100EOCG with MTPCIE Bluetooth/Wi-Fi Device on the MTPCIE-DK1 as a Wi-Fi client:

1. On MT100EOCG, copy the file **wpa_supplicant.conf.example** to **/var/config folder**.

```
cp /etc/wpa_supplicant.conf.example
/var/config/wpa_supplicant.conf
```

2. Edit **/var/config/wpa_mtechpc.conf** and change AP_Name and AP_Password to values required by your Wi-Fi network.

```
ctrl_interface=/var/run/wpa_supplicant
network={
        ssid=" AP_Name "
        scan_ssid=1
        #       key_mgmt=NONE
        key_mgmt=WPA-PSK
        psk=" AP_Password "
        priority=1
```

```
}
```

3. Edit **/etc/network/interfaces** and uncomment the lines pertaining to wlan0 as shown below.

```
iface wlan0 inet dhcp
wpa-conf /var/config/wpa_supplicant.conf
wpa-driver nl80211
```

4. Reboot the MT100EOCG or type **ifup wlan0** at the console. MT100EOCG communicates through your Wi-Fi network.

Setting up Bluetooth with an MT100 EOCG and an MTPCIE Bluetooth/Wi-Fi Device

To setup MT100EOCG to control Bluetooth on a MTPCIE Bluetooth/Wi-Fi device, you need a remote Bluetooth device that supports serial communication. Then:

1. On the MTPCIE-DK1 developer board, position jumpers next to USB 3G port J4 to the 1,2 position.
2. Position jumpers next to USB Serial port J24 connector to the 2,3 position.
3. Position jumpers next to Bluetooth DB9 connector J14 to the 2,3 position.
4. Use a terminal program to connect the remote Bluetooth adapter to the computer's serial port.
5. On the MT100EOCG, type **rfcomm –S connect 0 xx:xx:xx:xx:xx:xx &**, where xx is the MAC address of the remote Bluetooth device. It returns a connected response similar to:

```
# rfcomm –S connect 0 00:A0:96:10:30:14 &
[1] 498
# Connected /dev/rfcomm0 to 00:A0:96:10:30:14 on channel 1
Press CTRL-C for hangup
```

6. Run a serial communication program, such as minicom, on the MT100EOCG which is configured to use /dev/rfcomm0 as the serial device. You can now communicate with the remote Bluetooth serial device.

Setting up an External USB to MTPCIE Bluetooth Serial Interface

To set up an external USB to the serial Bluetooth interface on the MTPCIE-DK1 developer board when a MTPCIE radio is installed:

Note: The external USB connection terminates to a quad UART on the MTPCIE-DK1 board with one UART channel connected to the Bluetooth device.

1. On the MTPCIE-DK1 developer board, position jumpers next to Bluetooth DB9 connector J14 to the 2,3 position.
2. Position jumpers next to USB Serial connector J24 to the 1,2 position.
3. Position jumpers next to USB 3G connector J4 to the 1,2 position.
4. Power up the MTPCIE-DK1 developer board with the MTPCIE Bluetooth/Wi-Fi capable radio installed.
5. Connect computer USB port to the USB Serial J24 USB connector on DK1 board.
6. Use commands such as dmesg, lsusb -v, etc to find the ports Linux assigned to the quad uart on DK1. Record the port designation assigned to the second port. For example:

```
          [  126.376017] usb 7-
1: new full speed USB device using uhci_hcd and address 3
          [  126.532263] usb 7-1: configuration #1 chosen from 1 choice
          [  126.582980] cdc_acm 7-
1:1.0: This device cannot do calls on its own. It is not a modem.
          [  126.583024] cdc_acm 7-1:1.0: ttyACM0: USB ACM device
          [  126.590282] cdc_acm 7-
1:1.2: This device cannot do calls on its own. It is not a modem.
          [  126.590322] cdc_acm 7-1:1.2: ttyACM1: USB ACM device
          [  126.592170] cdc_acm 7-
1:1.4: This device cannot do calls on its own. It is not a modem.
          [  126.592215] cdc_acm 7-1:1.4: ttyACM2: USB ACM device
          [  126.595064] cdc_acm 7-
1:1.6: This device cannot do calls on its own. It is not a modem.
          [  126.595115] cdc_acm 7-1:1.6: ttyACM3: USB ACM device
```

7. Copy the file TIInit_7.6.15.bts to the /lib/firmware folder of the computer.
8. Install jumper JP86(labeled “BT_EN”), then remove it again to toggle the Bluetooth Enable signal for the MTPCIE.
9. Enter the following string, substituting the computer's tty port that corresponds to uart port B on MTPCIE-DK1:

```
hciattach -s 115200 /dev/ttyACM1 texas 3000000
```

10. On the Linux computer, enter:

```
hciconfig -a name
```

Example Response

```
ptg@ptg-desktop:~$ hciconfig -a name
hci0:    Type: UART
    BD Address: 1C:E2:CC:04:5C:C2 ACL MTU: 1021:4 SCO MTU:
180:4
    UP RUNNING PSCAN
    RX bytes:1013 acl:0 sco:0 events:30 errors:0
    TX bytes:883 acl:0 sco:0 commands:30 errors:0
    Features: 0xff 0xfe 0x2d 0xfe 0xdb 0xff 0x7b 0x87
    Packet type: DM1 DM3 DM5 DH1 DH3 DH5 HV1 HV2 HV3
    Link policy: RSWITCH HOLD SNIFF PARK
    Link mode: SLAVE ACCEPT
    Name: ''
    Class: 0x4a0104
    Service Classes: Networking, Capturing, Telephony
    Device Class: Computer, Desktop workstation
    HCI Ver:  (0x6) HCI Rev: 0x0 LMP Ver:  (0x6) LMP Subver:
0x1f29
    Manufacturer: Texas Instruments Inc. (13)
```

11. Verify the remote serial Bluetooth device is configured to wait for a connection.

12. Verify the remote Bluetooth device's MAC address is in the list of detected Bluetooth devices. Enter:

```
hcitool scan
```

Example Response

```
ptg@ptg-desktop:~$ hcitool scan
Scanning ...
    CC:55:AD:2B:53:FA    BB 9330
    00:18:E7:36:CF:91    DTMVW7JREI01
    00:A0:96:0F:B8:2A    SocketWireless
```

13. Enter the following, where xx represents MAC address of the remote Bluetooth device you set up previously:

```
rfcomm -S connect 0 xx:xx:xx:xx:xx:xx
```

To run rfcomm in the background add "&" to the end of the string as follows:

```
rfcomm -D connect 0 00:A0:96:0F:B8:2A &
```

14. Open another Linux terminal session and run a terminal program such as minicom at 3000000 bps attached to /dev/rfcomm0 port. Use minicom to communicate with your remote device.

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