HB3 Host Board Technical Manual

Contents

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Introduction

This document acts as a technical manual for the HB3 evaluation platform for use with Blue Chip Technology RMx products, and also as a reference for customers designing their own host boards.

The RMx SoM product range is an ARM-based set of compact processing modules designed for embedded control and media applications, and the host interfaces are designed to maximise re-use. A host board designed for one SoM should be able to implement the same functionality with an upgraded SoM with little or no adaptation, and a SoM offering a subset of functionality should also operate in the same board.

The HB3 host board is intended primarily to support RM2 & RM3 products, and has been designed against the Blue Chip Technology RMx System On Module Specification Version 1.5. It is deliberately 'oversized' for the technology in order to provide on-board examples of supported functionality and options (minimising the need for cabling and additional evaluation boards), and using full-sized 'PC-style' connectors (rather than miniature mobile versions) to ensure that interconnect and usage are as standard and simple as possible.

Document History

Issue	Date	Details
1.0		Initial draft (internal only)
1.1	2013-08-13	Updated with details for HB3 1981-1299 rev. 2

References

This document should be read in conjunction with:

Title	Source
System on Module Specification v1.5	Blue Chip Technology Ltd
1981-1299C2_HB3_BASEBOARD (HB3 schematic)	Blue Chip Technology Ltd
Mini-ITX Addendum Version 2.0 To the microATX Motherboard Interface Specification Version 1.2	www.intel.com/cd/channel/reseller/asmo-na/eng/479761.htm

Features

- Evaluation platform based on Mini-ITX form-factor (170mm x 170mm)
- Accepts standard RMx SoM modules
- Low-profile connectors including:
    - HDMI connector for connection of external digital displays
    - DVI connector for optional second display (alternative to LCD interface below)
    - 2-off USB host Type-A sockets
    - USB Device socket Type mini-B
    - RJ45 [8P8C to TIA-568] Ethernet connector for Gigabit Ethernet
    - RJ45 [8P8C to TIA-568] Ethernet connector for Fast Ethernet
- Additional on-card headers are available for:
    - 24-bit LCD interface
    - 4-wire resistive touchscreen [Other touchscreens can be evaluated using USB or I^2C]
    - Additional USB Host sockets
    - Serial TX/RX (RS-232 levels)
    - Serial TX/RX (3V3 logic levels)
    - GPIO
    - 12-bit multi-channel 225kbps ADC/DAC attached to SPI interface
    - CAN bus
- Multimedia features including:
    - Analogue video input (component, S-Video or composite)
    - Analogue video output (S-Video or composite)
    - PC99 audio option (mic in, line in/out)
    - RMx audio option (mic in, line in/out)
    - Audio amplifier for direct drive of loudspeakers
- PCI Express Mini Card socket
- On-board ZigBee transceiver
- 7-pin SATA socket for connection to HDDs (also HDD power socket)
- SD card socket
- uSD card socket
- Barrel jack or screw-terminal inputs for connection of an external, 12V DC power supply
- Battery power option (including charger)
- Debug/development features to assist with board development

Safety

Batteries

The HB3 is designed to support connection of batteries for maintenance of the Real Time Clock settings, and may also (in some circumstances) be operated with Li-Ion batteries providing the primary DC feed. The user should familiarise himself with any battery technology he intends to use, and ensure he takes appropriate precautions. **Be aware in particular that Li-Ion batteries may present an explosion hazard if short-circuited or connected incorrectly.**

Electric Shock

All of the electronics within the HB3 are within the ELV limits of EN 60950-1 and so do not represent a shock hazard.

External Cables

Most of the potential hazards associated with the equipment are due to external cabled connections. In general:

- The equipment should only be powered from a suitable, low-voltage, DC supply
- The equipment should not be directly connected to any to 'exposed' cabling (i.e. cabling which is run outside a building where it may be subjected to the effects of lightning strikes, or which is connected to hazardous electronic equipment). Neither should any connection be made from the equipment to cables that are routed alongside any such 'exposed' cabling.

Regulatory (CE)

The product is intended primarily as an evaluation and development platform for use in typical laboratory/workshop environments. This use demands greater levels of access and flexibility than for typical product implementations, and users should be aware that levels of emissions and susceptibility may therefore be higher than those which would reasonably be expected of commercial products of similar technology.

This product has been designed to meet the essential protection requirements of the European EMC Directive (2004/108/EC), the Low Voltage Directive (2006/95/EC), and the R&TTE Directive (1999/5/EC) when installed and used in conjunction with the guidelines provided within this document and in the environment for which it is intended.

Please note in particular that:-

- The product should not be used in locations where radio-frequency interference with other equipment might present a safety risk
- Electro-static discharge controls and precautions should be adopted to minimise the risk of damage or disturbance to exposed electronics

See the section on 'Guidance for Operation and Use' overleaf for further information.

Guidance for Operation and Use

EMC Performance – Exposed Working

The HB3 follows traditional design practices, and is designed to meet EN 55022/55024 Class ‘A’ criteria when properly installed and operated within a suitable enclosure. It is supplied, however, as an evaluation/development platform intended to be used in a flexible and ‘exposed’ configuration in laboratory/workshop type environments, and so emissions and susceptibility performance in this mode may be outside of these limits.

ESD/conducted susceptibility

As with any areas where electronic equipment is maintained, repaired, or otherwise operated in an ‘exposed’ manner, electro-static precautions are required to minimise the risk of damage. Suitable precautions may include:-

- Working in an ESD-controlled environment (where static build-up is minimised)
- Use of anti-static leads & wrist-bands

Additional protection against ESD, and also against conducted noise interference, can also be achieved by:-

- Restricting cabled interfaces to the HB3 to those supplied as standard with the equipment
- Mounting the HB3 itself on a suitable conductive plate (or ideally within a suitable conductive enclosure) with all of the screened on-board and cabled connectors mounted such that the connector screens have a low-impedance path to this plate (e.g. using brackets/EMC gaskets/etc.)
- Providing a low-impedance path to ground from this plate/enclosure to ground

Radiative Emissions/Susceptibility

The best way to reduce emissions (and increase resilience to external RF interference) is to apply very similar practices to those given above for managing ESD & conducted interference.

For general working, it should be noted that every wire/cable attached to electronics also acts as an antenna (both for emission and reception); keeping these as short as practical, selecting screened wires/cables (and terminating the screens with a suitable ground reference), and routing the cables away from other sensitive/noisy cables, and/or close to a ground-plane, all help to minimise unwanted interference.

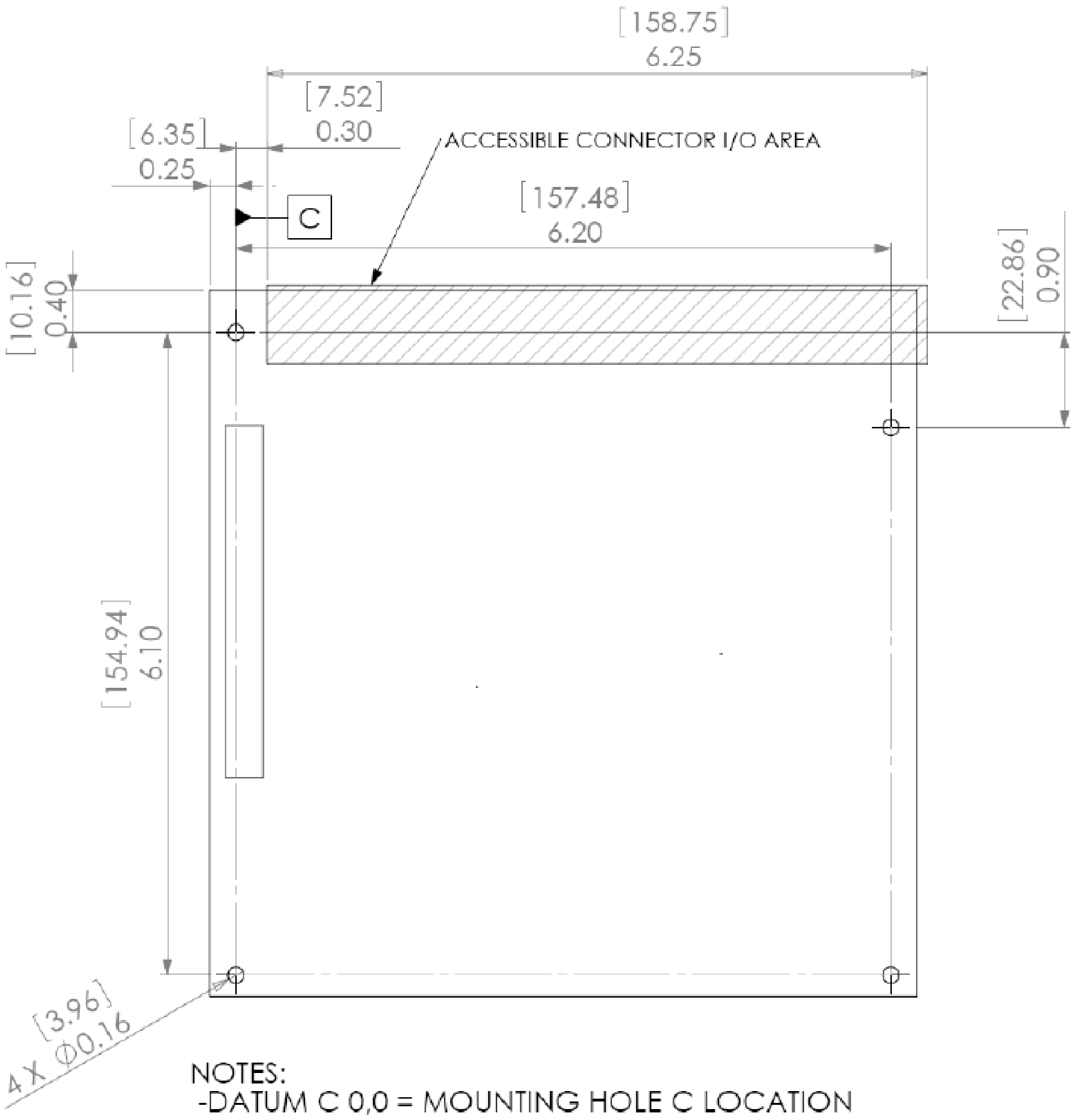
Hardware Platform User Guide

Mounting Holes

Four mounting holes are provided (see 'Board Outline' below); these holes are 4mm diameter (nominal) and are connected to the GND plane using the through-hole plating as well as several vias in the surrounding land. The surrounding land is 8mm diameter (nominal), and at least 10mm diameter clearance is provided from nearby components.

Board Outline

The board is 170mmx170mm and is based on the standard Mini-ITX form factor:



Jumper Settings

Location	Type	Function
J14	2-pin, 0.1”	Audio amplifier input select. Present = RMx audio Absent = Host board audio
J17	2-pin, 0.1”	Battery thermistor select. Present = override battery thermistor (pin 2 of P23 must be disconnected) Absent = use battery thermistor (pin 2 of P23 must be connected to a 10K thermistor inside the battery pack)
J18	2-pin, 0.1”	UART A serial data TX. Present = UART A TX connected to Zigbee module RX Absent = no connection (access point for UART A TX and Zigbee module RX)
J19	2-pin, 0.1”	Access point for Zigbee module RTS
J20	2-pin, 0.1”	Access point for Zigbee module CTS
J21	2-pin, 0.1”	UART A serial data RX. Present = UART A RX connected to Zigbee module TX Absent = no connection (access point for UART A RX and Zigbee module TX)
J6	3-pin, 0.1”	Voltage select for Aux Power Feed P10 1-2 = 12V 2-3 = 5V Absent = disable power feed
J9	3-pin, 0.1”	Voltage select for Aux Power Feed P12 1-2 = 12V 2-3 = 5V Absent = disable power feed

Switches

Control switches are mounted on the top side of the PCB as follows:

Location	Type	Function
SW1	Momentary	BOOT_MODE Hold down during reset or power-up to force the RMx to boot from an alternative source (USB for RM3).
SW2	Momentary	Reset
SW3	8x DIP-switch	GPIO inputs (used as GPIO inputs if links are fitted to P21 positions 2-9) On = 0 Off = 1
SW4	Slide switch	Power On/Off (drives PSON, which is used by the PIC to control the main power supplies)

Test Points

Test points are provided for easy access to the following signals:

Location	Colour	Signal	Type
TP1	Red	VCC_5V	Power
TP2	Red	VCC_3V3SBY	Power
TP7	Red	VCC_1V5	Power
TP8	Red	VCC_1V8	Power
TP9	Red	VCC_3V3	Power
TP10	Red	VCC_12V	Power
TP16	Red	VIO	Power
TP18	Red	VCC_7-12V	Power (intermediate bus)
TP3, TP4, TP5, TP6, TP11, TP12, TP17, TP19	Black	GND	Power
TP13	White	GPIO10	GPIO, referenced to 3V3 (not available using RM2)
TP14	White	CAN_3	CAN transceiver control, referenced to 3V3 May be used as GPIO (not available using RM2)
TP15	White	UARTA_ENTX	UART A control, referenced to 3V3 May be used as GPIO (cannot be used as input on RM2 - output only)
TP20	White	IC37-REF1	ADC/DAC reference voltage (input or output depending on device configuration)

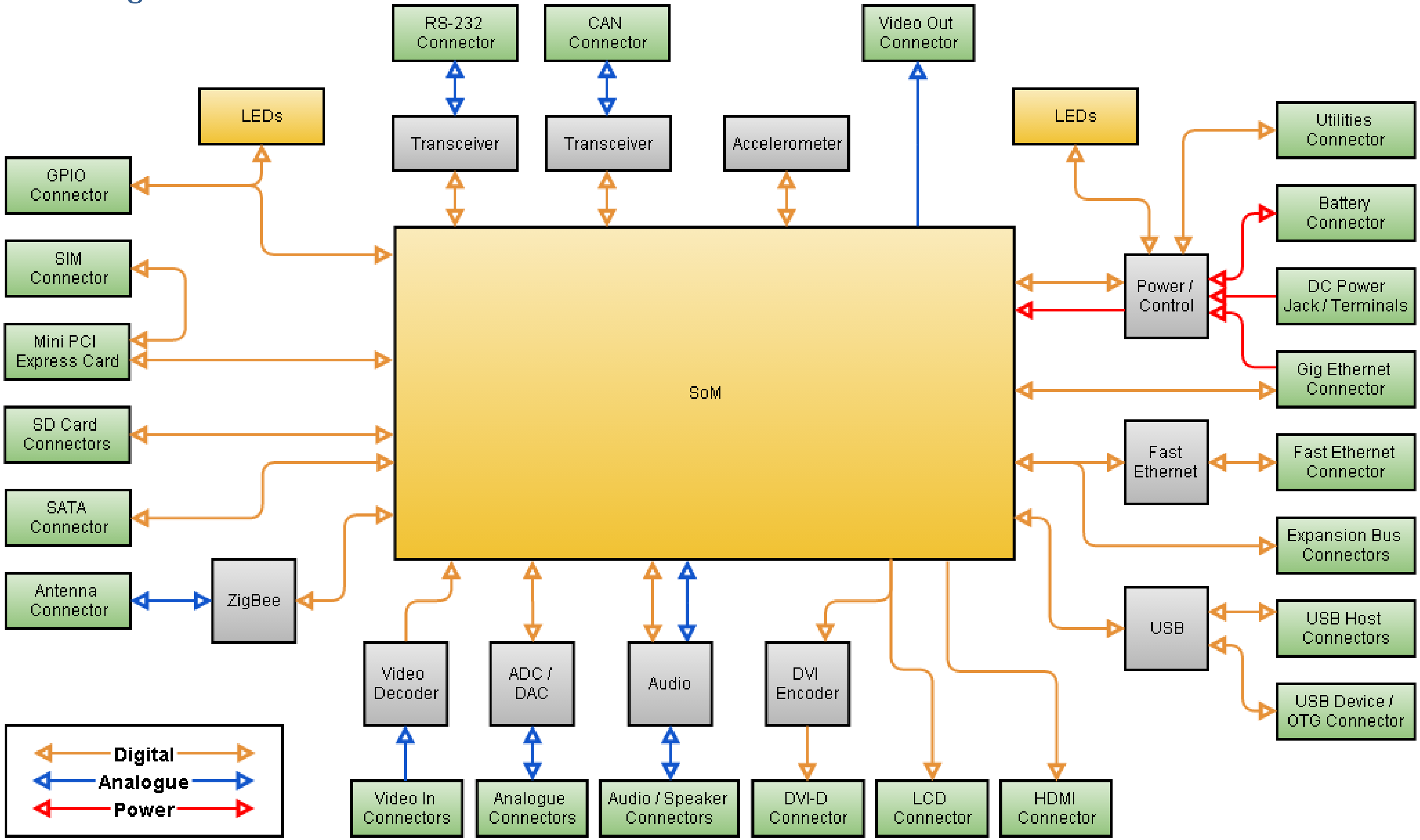
Indicators

LED indicators are mounted on the top side of the PCB as follows:

Location	Type	Function	Behaviour
LED1	GREEN	Mini PCIe card, LED_WWAN#	Depends on card
LED2	ORANGE	Mini PCIe card, LED_WLAN#	Depends on card
LED3	YELLOW	Mini PCIe card, LED_WPAN#	Depends on card
LED4	GREEN	Power on	Lit when 5V & 3V3 power supplies are on
LED5	GREEN	HDD Power 12V good	Goes off for over-current situation > 2.5A
LED6	GREEN	Aux Power P10 good	Goes off for over-current situation > 0.5A
LED7	ORANGE	Jack Power good	Lit when DC power is present (at least 11V) on jack P15 or terminals P17
LED8	ORANGE	PoE Power good	Lit when DC power is present (at least 11V) from PoE
LED9	RED	3V3 Power fail	Lit if VCC_3V3 is approx 10% below spec.
LED10	RED	5V Power fail	Lit if VCC_5V is approx 10% below spec.
LED11	RED	1V5 Power fail	Lit if VCC_1V5 is approx. 10% below spec.
LED12	GREEN	Aux Power P12 good	Goes off for over-current situation > 0.5A
LED13	RED	1V8 Power fail	Lit if VCC_1V8 is approx. 10% below spec.
LED14	GREEN	HDD power 5V good	Goes off for over-current situation > 1.1A
LED15 - LED22	YELLOW	GPIO state	Lit for logic 1, unlit for logic 0
LED23	YELLOW	Battery charge status 1*	Lit when battery is being charged
LED24	GREEN	Battery switch status	Lit when running from DC power, unlit when running from battery
LED25	YELLOW	Battery charge status 2*	Lit when charging is complete
LED26	YELLOW	Boot Mode	Lit for normal boot, unlit for alternative boot

* When both battery charge status LEDs are off, this indicates a fault condition (one of: charge suspend, timer fault, overvoltage, sleep mode, or battery absent)

Block Diagram



Design Description

[Page numbers refer to HB3 Schematics]

Board-to-Board Headers for SoM Connection [Page 2]

The HB3 board supports standard Blue Chip Technology RMx SoM cards, designed to the RMx System On Module Specification.

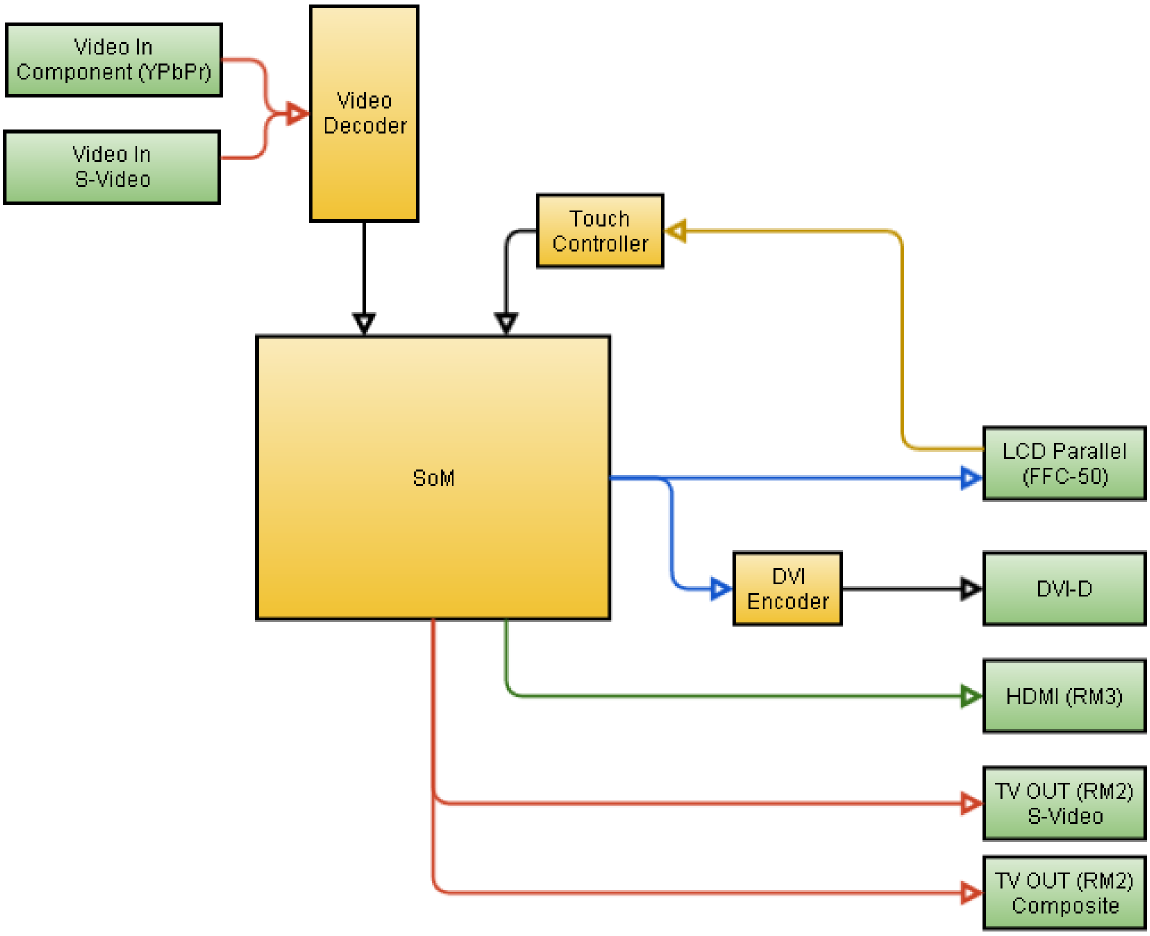
The HB3 incorporates 5mm pillars for mechanical fixing of the SoM, and these can be secured with M2.5 x 4mm screws.

Note that the SoM is not intended for hot-swap operation, so insertion/removal of the module should always be performed with the power removed.

Currently, there are a number of signals on the SoM connectors that are reserved for use by future RMx modules. A connector P8 has been laid out (but not fitted) to allow access to these signals in the future.

Display & Video Interfaces [Pages 3 & 4]

The display and video system is summarized in the diagram below:



Parallel LCD and Touchscreen

The parallel LCD interface comes from the SoM, referenced to VIO. This is level-shifted to 3.3V and is available on the FFC connector P34 underneath the board.

P34 also includes a raw power feed (taken from the DC input, PoE or the battery) which may be used to power an LCD panel. The FFC connector is rated at 0.4A per contact; if more current is required, power for the panel can be taken from P5 instead. These power feeds are not protected against overload or short-circuit, so care must be taken when using them.

The power is a nominal 12V when running from the DC input or PoE, but falls to 6-7V when running from battery.

An I2C bus is also made available on P34, which may be used (for example) to drive other types of touchscreen.

A number of adapter boards are available from Blue Chip Technology to condition the power and data connections to suit specific LCD panels.

Touchscreen

The parallel LCD interface P34 includes connections for a 4-wire resistive touchscreen.

The SPI touchscreen controller uses SOM_IRQB# to allow interaction with the SoM. The controller also sends an interrupt to the PIC microcontroller, to support “Wake-on-touch” applications when the SoM is in sleep mode or powered down.

DVI-D

An encoder/transmitter converts the parallel LCD data into a DVI-D format for connection to an external DVI or HDMI monitor. This supports single-link DVI-D up to 165MHz pixel rates, and provides a DDC channel for communicating with the monitor.

The DVI-D interface can be used at the same time as the parallel LCD interface, and will always show the same picture.

HDMI

HB3 supports an HDMI interface where that feature is provided by the SoM (currently available on RM3). This is completely separate from the parallel LCD and DVI-D interfaces, and can be used at the same time as parallel LCD or DVI-D interfaces for multi-monitor applications.

The following HDMI features are supported:

- Hot-plug detect (HPD)
- Consumer Electronics Control (CEC)
- Display Data Channel (DDC)

Video Output

HB3 supports a video output where that feature is provided by the SoM (currently available on RM2). An S-Video connector (P3) is provided on the board, and an external adapter can be used to convert this to a composite video connection.

Video Input

HB3 supports a video input, which can operate in one of three modes:

- Component YCbCr (using on-board phono sockets P28, P29 and P30)
- S-Video (using adapter cable from P31)
- Composite (up to 3 inputs, using on-board phono sockets P28, P29 and P30)

The S-Video input can be connected at the same time as either the component YCbCr or up to three composite inputs. Only one video source can be digitized at once, but the source can be selected under software control.

The digitizer output format may be either of these:

- 10-Bit ITU-R BT.656 4:2:2 YCbCr with embedded syncs
- 10-Bit 4:2:2 YCbCr with separate syncs

The digitizer output is connected to the camera interface on the SoM.

Mini PCI-Express Card [Page 5]

HB3 supports a mini PCI-Express card, where that feature is provided by the SoM.

It has a latch to hold a full card, and there is a mounting hole to accept a spacer/pillar to support a half card.

The PCI-Express interface is designed to work with PCI Express 2.0 (5Gbits/s).

Power management features are not supported, and the power is applied as soon as the main 3V3 and 1V8 power supplies are turned on.

Hot-swap operation is not supported, so cards should only be inserted or removed with the power removed.

The UIM interface is supported, and connects to the SIM socket underneath the board (P35).

The pins 45, 47, 49, 51 are reserved in the Mini PCI-Express specification, but have been used by Telit as a PCM digital audio connection for 2G/3G modems. This digital audio implementation is supported by HB3.

SATA [Page 5]

HB3 supports a single SATA rev 2.0 (3.0 Gbits/s) interface, where that feature is provided by the SoM.

Power is also provided for a single hard disk drive, on P13. This comprises 5V and 12V. The 12V supply for a rotating hard drive requires considerable current (up to 2.0A) at start-up while the spindle gets up to speed. The feed from P13 can supply this temporary demand, but in situations where a continuous high current (i.e. greater than 1A) is required at 12V, it is recommended to use an external power supply for the hard disk.

Both voltages have over-current protection (5V at 1.1A, 12V at 2.5A) and indicator LEDs that are normally lit, and will go off in an over-current situation.

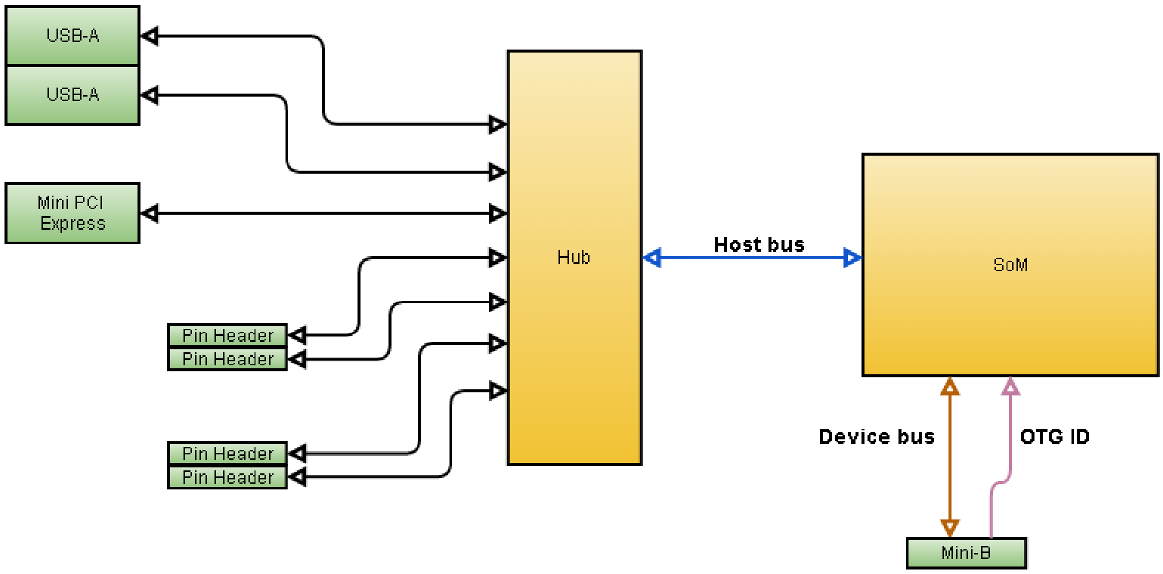
Aux Power Feeds [Page 5]

There are two auxiliary power feeds available for external devices such as fans. The current is limited to 0.5A and normally-on indicator LEDS will go off in an over-current situation.

The voltage for each feed can be set at 12V or 5V using a jumper link.

USB [Page 6]

The USB system is summarized in the picture below:



USB Host

HB3 provides a 7-port USB 2.0 hub to enable multiple USB devices to be attached to the SoM.

1 port is routed to the Mini PCI-Express card, and is a simple data connection without power.

2 ports are routed to the on-board USB-A sockets on P8

4 ports are routed to headers P6 and P9, and can be accessed using a standard 2mm PC-style USB adapter cable.

All 6 external ports have ESD protection and provide the full 500mA USB power at 5V.

USB Device / OTG

HB3 provides a USB device port on P1 that can also be configured as a USB OTG port, where that feature is supported by the SoM.

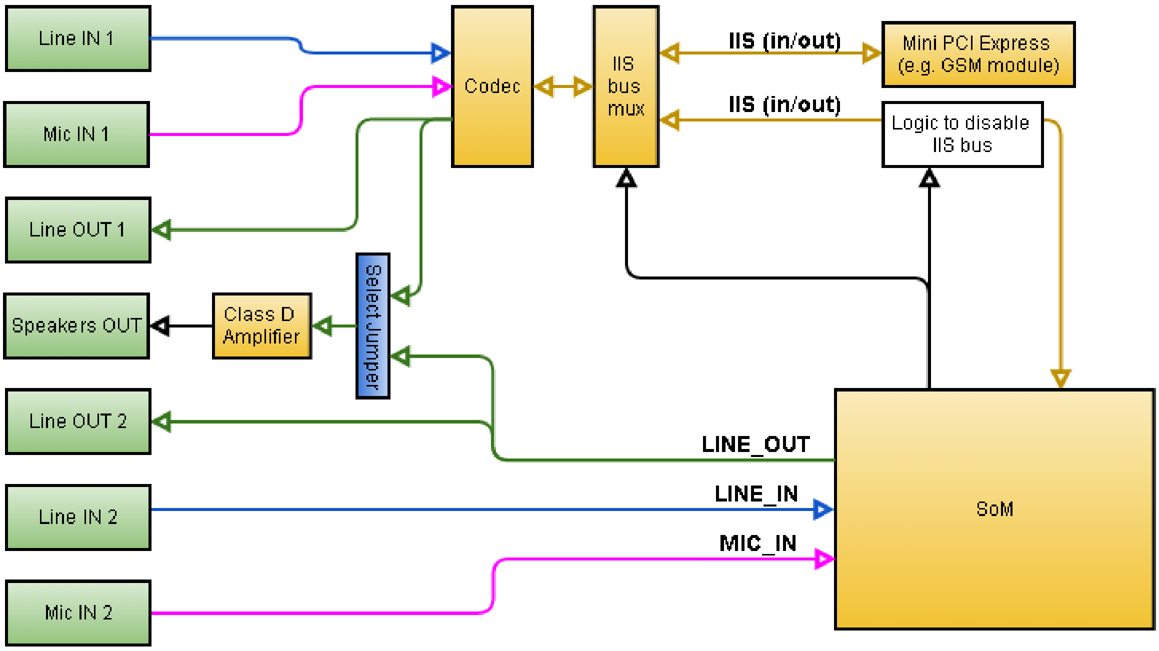
P1 is fitted with a USB Mini-B connector, although an alternative Mini-AB connector is available with the same footprint (Molex 565790519), so the user can replace this connector if they choose.

As a USB device port, no power is supplied to the port.

For USB OTG operation, the ID pin is routed back to the SoM and a power option is available, controlled by software using GPIO10. If this power option is not wanted, it can be permanently disabled by removing the zero-ohm link R324.

Audio [Page 7]

The audio system is summarized in the diagram below:



SoM codec

A set of analogue connections are provided from the codec on the SoM. These are brought to connector P16 and are compatible with the audio connections on other Blue Chip Technology products such as RE2 and RE3.

Host-board codec

A separate codec is implemented on the HB3, with a digital IIS/PCM connection to the SoM.

On RM3, this codec and the SoM codec are mutually exclusive and cannot operate simultaneously. The host-board codec will be permanently held in reset if the SoM codec is selected (a dedicated GPIO line on the RM3 CPU makes the selection under software control). This is necessary because there is only one IIS/PCM bus available on the i.MX6.

The analogue connections from this codec are PC99 standard, and are brought to a PC99 connector P4 at the edge of the HB3 board.

Telit PCI-Express Audio

The Mini PCI-Express pins 45, 47, 49, 51 are reserved in the Mini PCI-Express specification, but have been used by Telit as a PCM digital audio connection for 2G/3G modems. This digital audio implementation is supported by HB3.

IIS/PCM bus multiplexing

Multiplexors allow three different configurations for the IIS/PCM bus, selected using GPIO9 and WIRELESS_PWR_EN as shown below:

WIRELESS_POWER_EN	GPIO9	IIS/PCM Routing
0	0	Bus disconnected (host-board codec disabled)
0	1	Host-board codec ←→SoM
1	0	Host-board codec ←→ Telit Mini PCI-Express audio
1	1	SoM ←→ Telit Mini PCI-Express audio

Class-D amplifier

A stereo amplifier is provided on HB3, which can be attached to the Line Out connections of either the host-board codec or the SoM, depending on the state of link J14.

The amplifier can be shut down by adding a 0R link R154

For its default setting, with 0dBFS input signal applied, the amplifier output is around 3.3V pk-pk (differential), equivalent to 2.3VRMS. This gives around 0.7WRMS into 8 Ohm speakers. Gain can be changed by selectively populating 0R links R140 & R142 as shown below:

R140	R142	Gain V/V	Gain dB
Fitted	Fitted	2	6dB
Fitted*	Not fitted*	4*	12dB*
Not fitted	Fitted	8	18dB
Not fitted	Not fitted	16	24dB

*Default setting

Fast Ethernet [Page 8]

HB3 offers a 10/100 Ethernet interface, partly as an example of interfacing to the EXPN bus.

The Chip Enable signal can be chosen by selectively populating 0R links as shown below:

R55	R56	R54	CE in use	Comment
Not fitted	Not fitted	Not fitted	none	Interface disabled
Fitted	Not fitted	Not fitted	EXPN_CE#0	
Not fitted	Fitted	Not fitted	EXPN_CE#1	
Not fitted	Not fitted	Fitted	EXPN_CE#4	Default setting

The Interrupt Request line can be chosen by selectively populating 0R links as shown below:

R36	R41	R42	IRQ in use	Comment
Not fitted	Not fitted	Not fitted	none	Interrupt disabled
Fitted	Not fitted	Not fitted	SOM_IRQA#	
Not fitted	Fitted	Not fitted	SOM_IRQB#	
Not fitted	Not fitted	Fitted	SOM_IRQC#	Default setting

GPIO [Page 9]

HB3 provides 8 GPIO lines, brought to connector P21.

These GPIO lines can operate at either 3.3V or 5V, depending on the voltage supplied on pin 1 of P21. For 3.3V operation, a 2mm jumper link can be attached from pin 1 to pin2 of P21.

The status of all GPIO lines is shown on the yellow indicators LED15 - LED22.

For operation with off-board circuitry, a ribbon cable can be attached to P21.

For operation on-board, 2mm jumper links can be fitted across P21, and the DIP switch SW3 can then be used to drive inputs. The level shifters IC58 - IC61 include pull-up resistors of approximately 10K, so a simple switch to GND or an open-drain / open-collector logic output can be used to drive these inputs.

The direction of the GPIOs is fixed for RM2, but is software programmable for RM3.

In addition to the main 8 GPIO lines, some SoM variants also support:

- GPIO9 - already used for USB OTG power control (see USB Device / OTG)
- GPIO10 - available on test point TP13 (see Test Points)

RS-232 [Page 9]

HB3 provides a simple serial TX/RX link at RS-232 voltage levels on P32.

Data rates up to 460kbps are supported.

The pin-out is suitable for a standard PC adapter cable.

This is the primary debug serial port and is used by boot-loaders and the Linux console.

SD Cards [Page 9]

SD1

This is a full-sized SD card socket with support for:

- Card detect
- Write-protect
- Variable supply voltage (up to 300mA available from VSD1)

SD2

This is a basic microSD card socket. Note that RM2 does not support this device.

Expansion Bus [Page 9]

The EXPN bus is brought to P7 and P33 in parallel. P33 is compatible with the EXPN bus connector on HB2.

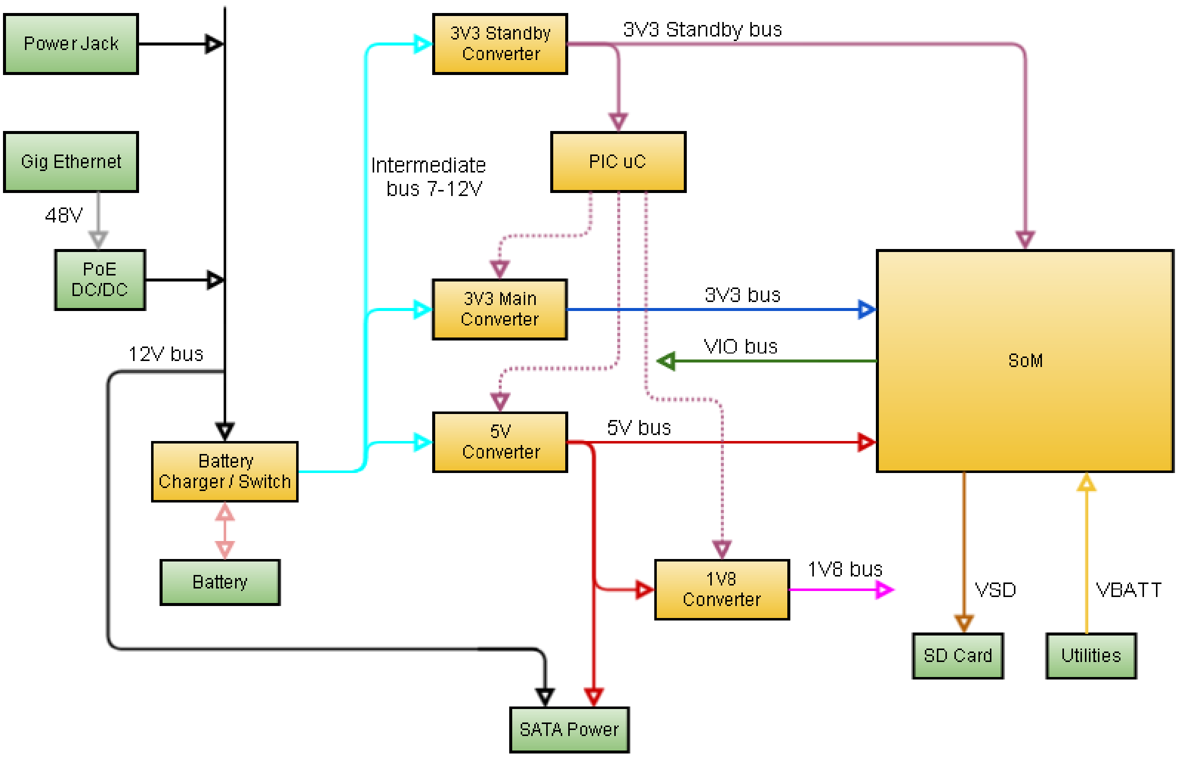
The CE signals and IRQ lines may already be used by peripherals on the board, as shown below:

Peripheral	CE?	IRQ?
Fast Ethernet [Page 8]	Yes	Yes
Accelerometer [Page 12]	No	Optional (x2)
Touchscreen	No	Yes

Signal timings are dependent on the SoM, and are mostly software programmable. See the CPU datasheets for more details.

Power Supplies [Page 10]

HB3 has been designed to demonstrate a wide range of power options, although it is unlikely that all these options would be used in a real-world product. The power system is summarized below:



Power Summary

The various power inputs provide a 12V bus that can be used for battery charging and for powering the system. 12V consumption is limited to approximately 4A.

The intermediate bus is 12V when fed from the power inputs, and is 6-7V when fed from the battery.

The 3V3 Standby Converter is always active, and powers the PIC microcontroller, as well as offering RTC backup for the SoM. The PIC micro can enable the main converters for 5V, 3V3 and 1V8.

The VIO bus is provided by the SoC. It is derived from the main3V3 bus, but has a delayed start-up with respect to the main 3V3 supply.

One additional supply (not shown on the diagram above) provides 1V5 for the Mini PCI-Express card, and is derived from the main 1V8 supply.

All power rails have a red test point (and GND has several black test points) for easy access.

Power & Reset Management

A PIC microcontroller is used to control the main power converters. This PIC also generates reset pulses for the general system (using SYS_RESWARM#), and several peripherals (USB hub, DVI encoder, Mini PCI-Express card).

A debug/programming header P19 can be used with a PICKit2 unit.

The SoM software can request reset pulses for the peripherals by sending an I2C message to the PIC.

The PIC de-bounces the reset input (PIC_SYS_RESWARM#) and the power enable input (PSON) which can come from on-board switches or off-board sources (available on the utilities connector, P18).

Watchdog functionality is supported as a configurable feature in the PIC software, and can be turned on/off from the RMx module (under I2C control). Watchdog expiry (failure to write – I2C – to specific register within timeout) results in a 'SYS_RESWARM#' reset cycle.

Power Inputs

Input power connectors offer simple, diode-based polarity protection, input filtering, and over-voltage/transient protection (limiting transients to nominally 15V).

Input power can be provided via one of the following:-

- P15 - 5.5/2.5mm barrel-jack (5A rated)
- P17 - 2-pin screw terminal
- J7 - Gigabit Ethernet port with an 802.3af PoE

Orange indicators show the status of the power inputs (see Indicators). The indicators can be interpreted as shown below:

LED7 "JACK"	LED8 "PoE"	Description
		No DC power input - host board is OFF or running from battery
		PoE supply has power (up to 15W available - not suitable for battery charging)
		DC jack/terminals have power
		PoE and DC jack/terminals both have power. Current will mainly be drawn from whichever source has the higher voltage.

Power Consumption

Total power consumed varies depending on the RMx module fitted, and the level of functionality / interfaces supported. For example, the RM3 SoM may consume between 2W and 6.5W depending on the level of CPU and graphics (GPU/VPU) activity. Each USB interface may draw up to 2.5W, and additional power may be consumed by fans, SATA HDDs and Mini PCI-Express cards.

For general use, a minimum 15W power supply is recommended. PoE can supply up to 15W.

The main 5V, 3V3, 1V8 and 1V5 converters are sized to handle all possible configurations - in most real-world applications a host board could use smaller (and maybe fewer) converters.

Current measurement

There are various points on HB3 where current measurements can be made, as shown below:

Location	Power Rail	Type	Comment
J12	VCC_5V	Wire link*	Total, including current drawn by 1V8 converter
J13	VCC_5V	Wire link*	Only current drawn by 1V8 converter
R280	VCC_5V	10 milliohm resistor	Only current drawn by the SoM
R267	VCC_3V3SBY	10 milliohm resistor	Only current drawn by the SoM
J16	VCC_3V3	Wire link*	Total
R271	VCC_3V3	10 milliohm resistor	Current drawn by the SoM, including power drawn from VIO by host board
R279	VIO	10 milliohm resistor	Total drawn by host board
R149	VCC_7-12V	10 milliohm resistor	Total drawn from 12V input, including battery charging.
R172	BATT+VE	10 milliohm resistor	Battery charging current (voltage varies during charging cycle).

*Note that wire links have to be cut in order to measure current, and must be repaired afterwards to resume normal operation.

Voltage Monitoring

The main supplies (5V, 3V3, 1V8, 1V5) are monitored and a red “power fail” LED will show for any supply which is less than approx. 90% of its nominal value.

The monitoring circuit is only active when at least one of the main supplies (5V or 3V3) is enabled. This reduces current consumption from the 3V3 Standby supply when the system is inactive. The green indicator LED4 is lit when the voltage monitoring circuit is active.

The red “power fail” indicators should never come on in normal operation (except very briefly as the main supplies are switched on/off).

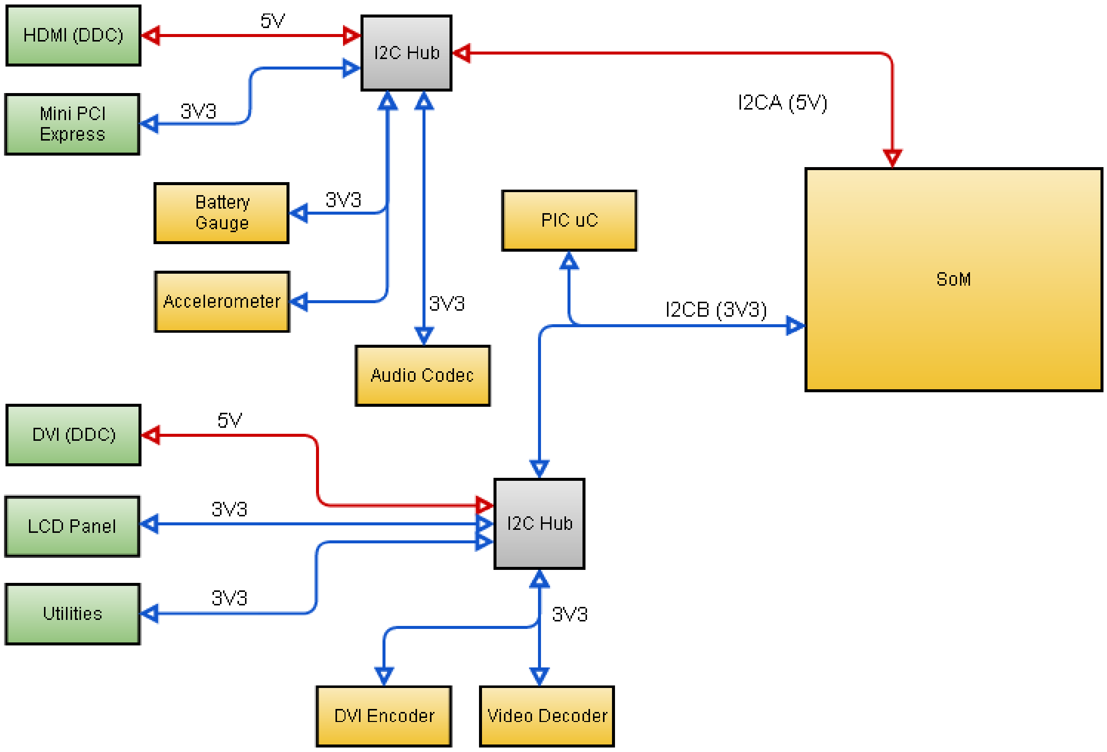
The voltage indicators are also provided as inputs to the PIC microcontroller, so software monitoring of power supplies is possible.

RTC backup battery

The real-time clock (RTC) on the SoM requires constant power in order to retain its settings. This is obtained from the 3V3 Standby supply, which is fed to the SoM. To provide reliable 24/7 RTC operation, a small Lithium coin cell e.g. CR2032 can be attached to the VBATT supply (available on the utilities connector, P18). This will ensure RTC operation even if all other supplies are removed.

I2C [Page 11]

The I2C system is summarized below:



I2C hubs

The I2C system is based around a pair of I2C hubs, which provide a degree of electrical separation between bus segments. This allows segments on the same bus to operate at different voltages, and reduces the total bus capacitance seen by the bus master (the SoM or the PIC).

By default, all segments are enabled, but each segment can be individually disabled by selectively populating 0R links as shown below:

0R link Location	Segment	Description
R220	Bus A, segment 1	HDMI DDC
R218	Bus A, segment 2	Mini PCI-Express card
R222	Bus A, segment 3	Host-board codec
R230	Bus A, segment 4	Accelerometer and Battery Gauge
R206	Bus B, segment 1	DVI DDC
R203	Bus B, segment 2	LCD Parallel connector (P34)
R209	Bus B, segment 3	Utilities connector (P18)
R215	Bus B, segment 4	DVI encoder and Video decoder

I2C Addressing

The I2C peripherals generally support 7-bit addressing only.

Device	Bus	Address	Comments
Power Manager (RM3 only)	A	0x08 - 0x0F	Using MMPF0100 device (address [2:0] depends on OTP fuses - default is 0x08)
Host-board Audio Codec	A	0x18	Using TLV320AIC3105 device
Accelerometer	A	0x1C or 0x1D*	Using MMA7455L device (address LSB depends on input pin state)
Battery Gauge	A	0x36	Using MAX17041 or MAX17049 device
HDMI (DDC)	A	0x50	Address mandated by VESA DDC2B protocol. Bus chosen to avoid conflict with DVI DDC.
SoM Audio Codec (RM3 only)	B	0x18	Using TLV320AIC3105 device
DVI Encoder	B	0x38	Using TFP410 device
DVI (DDC)	B	0x50	Mandated by VESA DDC2B protocol. Bus chosen to avoid conflict with HDMI DDC.
PIC micro	B	0x56	Depends on firmware
Video Decoder	B	0x5C* or 0x5D	Using TVP5146 device (address LSB depends on input pin state)

*Default setting on HB3

ZigBee [Page 12]

HB3 includes support for ZigBee through an embedded module. This is connected to the SoM using the UART A RX/TX connections.

To use ZigBee, add 0.1” jumper links to J18 and J21. If the ZigBee feature is not required, the SoM UART A TX/RX connections can be used for another purpose by connecting to J18 and J21.

The serial connections to the ZigBee module (all referenced to 3V3) are accessible as shown below:

Signal	Connector	Description
TX	J21	UART data output from ZigBee module
RX	J18	UART data input to ZigBee module
CTS	J20	UART handshake input to ZigBee module
RTS	J19	UART handshake output from ZigBee module

P27 is a programming header that allows the user to update the firmware in the module.

The module requires a suitable (50 ohms, 2.4 GHz) external antenna, which should be connected to the U.FL socket on the module.

For more details about the ZigBee module see
http://www.telegesis.com/support/document_centre.htm

Accelerometer [Page 12]

HB3 supports a three-axis accelerometer. This can be operated in polled-mode by simply reading values from the I2C interface, or can be configured with alarm thresholds to generate interrupts for a fast response in applications like freefall detection.

The Interrupt Request lines can be chosen by selectively populating 0R links as shown below:

INT1:

R79	R72	R73	IRQ in use	Comment
Not fitted	Not fitted	Not fitted	none	Interrupt disabled (Default setting)
Fitted	Not fitted	Not fitted	SOM_IRQA#	
Not fitted	Fitted	Not fitted	SOM_IRQB#	
Not fitted	Not fitted	Fitted	SOM_IRQC#	

INT2:

R57	R58	R59	IRQ in use	Comment
Not fitted	Not fitted	Not fitted	none	Interrupt disabled (Default setting)
Fitted	Not fitted	Not fitted	SOM_IRQA#	
Not fitted	Fitted	Not fitted	SOM_IRQB#	
Not fitted	Not fitted	Fitted	SOM_IRQC#	

Boot Mode [Page 12]

HB3 can force the SoM to boot from an alternative source using the BOOT_MODE# signal.

For example, RM3 normally boots from on-board Flash, but when BOOT_MODE# is held low RM3 will boot from USB Device instead. This can be useful as a recovery mechanism when developing boot-loader software.

The yellow indicator LED26 is lit for normal boot source, and is off for alternative boot source.

To select the alternative boot source, hold down the BOOT MODE switch SW1 during power-up or reset.

Analogue I/O [Page 12]

HB3 supports 12-bit analogue I/O using a MAX1340B multi-channel ADC/DAC.

This has 8 ADC inputs on P26 and 4 DAC outputs on P20. and communicates with the SoM over SPI.

Inputs and outputs include a single-pole RC filter with -3dB point at 106kHz to reduce aliasing. The maximum sampling rate is 225kHz; additional filtering may be required for some applications, depending on sample rate and required accuracy.

The device has an internal 4.096V reference, which is output on test point TP20. Alternatively the device can be configured to accept an external reference input on the same pin.

The DAC outputs default to 0x000 value on power-up. This can be changed to 0xFFF by removing R152 and adding a 0R link in location R151.

CAN bus [Page 12]

HB3 supports a CAN interface with speeds up to 1Mbit/s.

The connections are brought to P24, and will suit a standard PC-type header-to-DB9 adapter cable.

Note that there is no bus termination on the HB3, so the CAN bus needs to be terminated elsewhere.

Main Ethernet / Power over Ethernet [Page 13]

HB3 supports PoE, compliant with the IEEE 802.3af standard , on J7.

This is also the main Ethernet port from the SoM. Note that the circuit design here is a compromise between the requirements of RM2 (which uses current-mode PHY drivers for 10/100 operation) and RM3 (which uses voltage-mode PHY drivers for 10/100/1000 operation).

If your host board will only be used for RM2, or only RM3, the circuit can be optimized as follows:

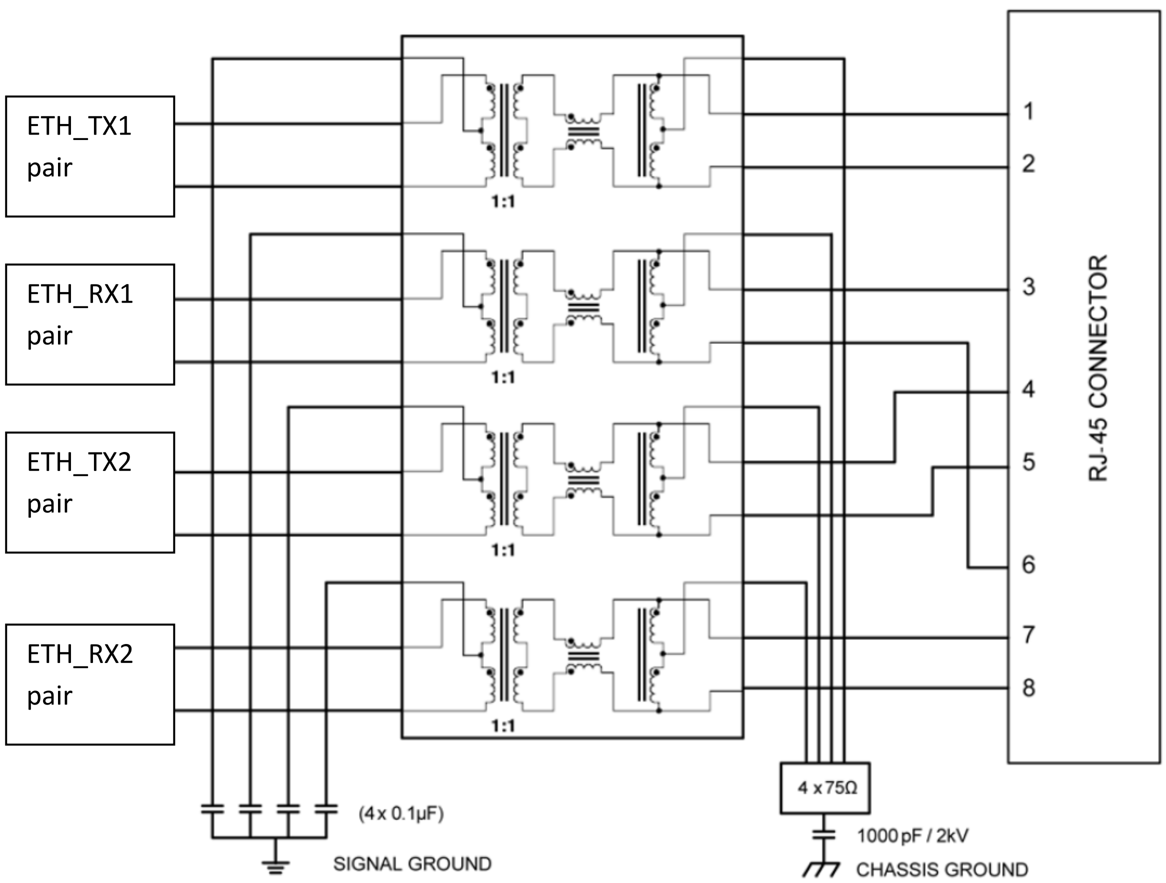
RM2 optimized Ethernet

- Use simpler 10/100 line transformers with one TX and one RX pair only
- PHY-side centre-taps from line transformer(s) should both be connected to ETH_CTT

This allows the use of “MagJack” RJ45 connectors with integrated magnetics where the PHY-side centre-taps are already connected together internally.

RM3 optimized Ethernet

- ETH_CTT is left unconnected
- All four PHY-side centre-taps from line transformer(s) should be kept separate from one another and each should be connected via 0.1uF capacitor to GND (see example below).



Battery Charger / Switch [Page 14]

The HB3 board has provision for a Li-Ion battery to be charged and used as a power source.

Nominal battery voltage is 7.2 - 7.4V, corresponding to a 2-cell battery.

Only use 2-cell Li-Ion batteries.

It is not safe to use any other battery type, or configuration.

The integrated battery switch will smoothly shift between input power and battery power as the input power is applied or removed.

The battery charger is self-contained, and operates without any software intervention.

Charge Indicators

There are three indicators that show the status of the battery:

Label	Colour	Description
OK	Green	Lit when external power is available (e.g. from DC jack or PoE)
1	Yellow	Lit when battery charging is in progress
2	Yellow	Lit when battery has been fully charged

If there is no battery attached, or a fault condition exists, indicators "1" and "2" are both off.

Thermal Monitoring and Protection

The battery charger circuit can monitor a battery-pack thermistor to ensure the battery-pack does not get too hot during charging. Charging current will be reduced (or stopped altogether) as necessary. The circuit is configured for a 103AT NTC thermistor.

Some battery packs do not include a thermistor. In this case, a jumper must be fitted to J17 to override the thermal protection. If the battery-pack includes a thermistor, this must be wired to the middle pin on P23 battery connector, and jumper J17 must be removed. Otherwise, the thermal protection will not operate properly.

Current limits

The battery switch monitors several current paths and sets current limits as described below:

Current Path	Limit	Comment
Incoming current from DC power source	Approx. 4.1 A	This is controlled by the voltage on ACSET, and can be modified by changing R162 and R166. See BQ24610 datasheet for details.
Battery charging current	Approx. 3.0A	This is controlled by the voltage on ISET1, and can be modified by changing R169 and R170. See BQ24610 datasheet for details.
Battery Pre-charge current	Approx. 0.3A	This is controlled by the voltage on ISET2, and can be modified by changing R165 and R167. See BQ24610 datasheet for details.

Note that the difference between incoming current and charging current is the amount of current available for the rest of the board to operate (4.1A - 3.0A = 1.1A, equivalent to approx. 13W at 12V).

When using PoE as the input power source, there is not sufficient power available to charge the battery as well as running the rest of the board. **This scenario must be avoided by disconnecting the battery when running from PoE.**

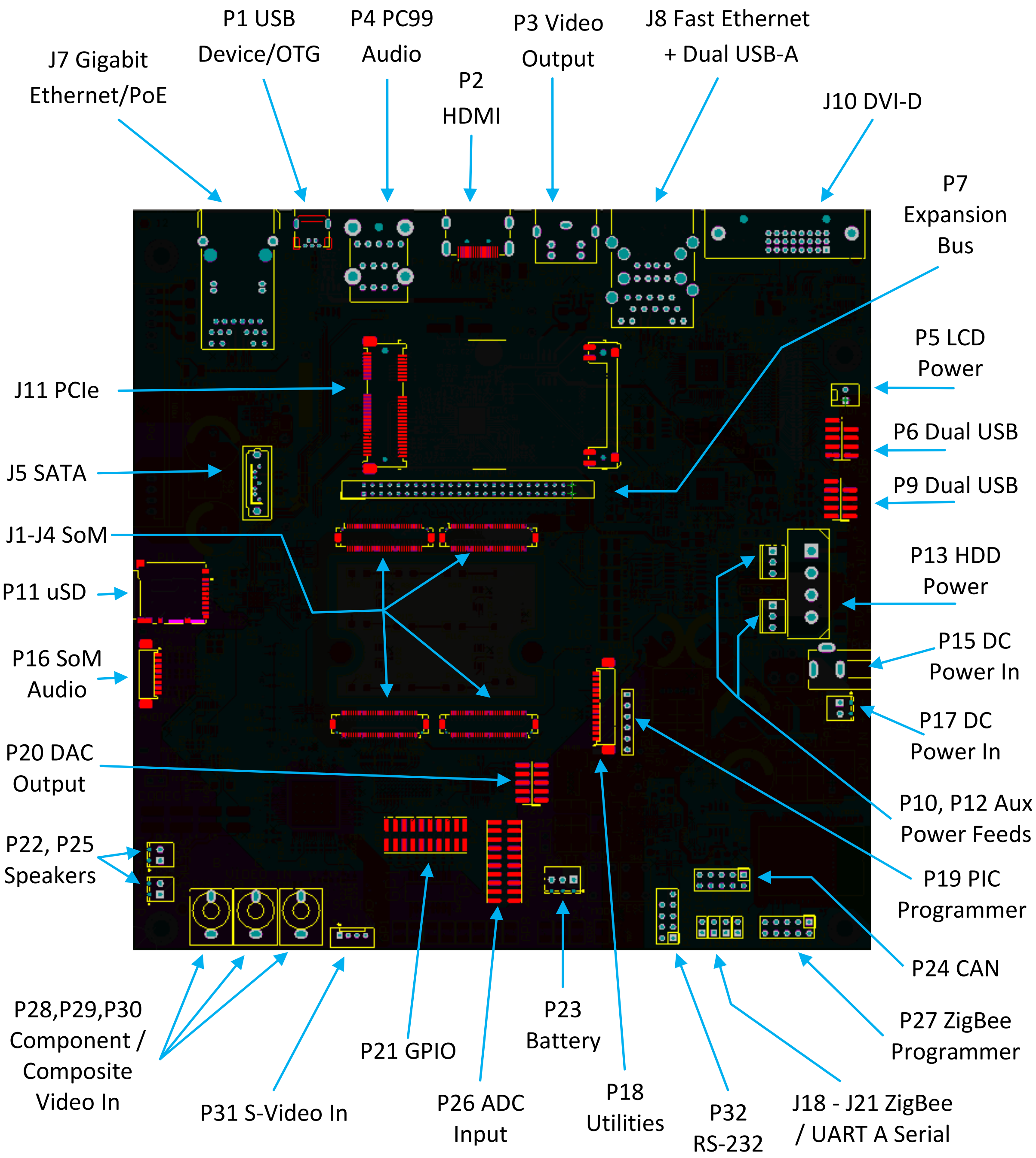
Charging Voltage

The charging voltage is set to 8.23V by the resistor network R303, R301, R171. See BQ24610 datasheet for details.

Battery Gauge [Page 14]

HB3 supports a battery gauge that can be queried by the SoM over I2C. This uses a voltage modelling approach rather than a coulomb-counting approach, and therefore can react quickly to batteries being removed or substituted.

Appendix - Connectors (Top View)



Appendix - Connectors (Bottom View)