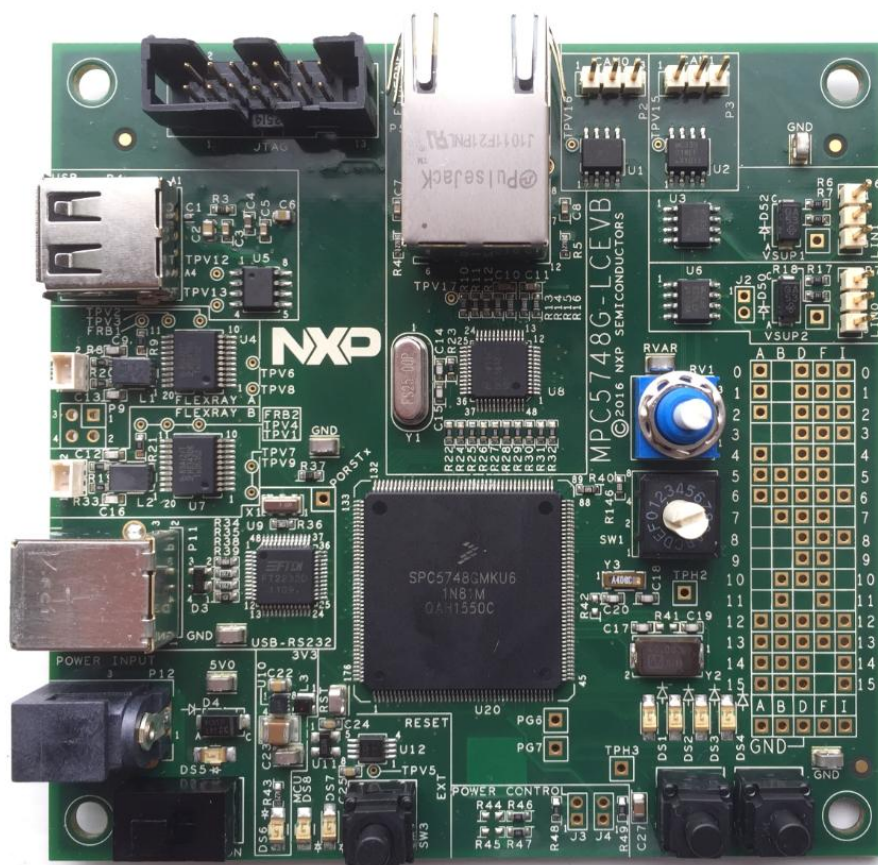




MPC5748G Low Cost EVB User Guide

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1. Introduction

This user guide details the setup and configuration of the NXP MPC5748G Low Cost Evaluation Board (hereafter referred to as the LCEVB). The LCEVB is intended to provide a mechanism for easy evaluation of the MPC5748G family of microcontrollers, and to facilitate basic hardware and software development.

Note that the LCEVB has a limited feature set compared to the main MPC574xG customer EVB and is intended for evaluation purposes. Customers moving to serious development activities are recommended to purchase the fully functional customer EVB which also has device specific daughter cards.

The LCEVB is intended for bench / laboratory use and has been designed using normal temperature specified components (+70° C).

This product contains components that may be damaged by electrostatic discharge. Observe precautions for handling electrostatic sensitive devices when using the LCEVB.

The user guide is intended to be read alongside the respective MCU documentation available at www.nxp.com and includes:

- Reference Manuals
- Product Data Sheets
- Application notes
- Device Errata

2. LCEVB Features

The LCEVB provides the following key features:

- Single 5 V DC external power supply input with on-board 3.3 V regulator. Power is supplied via a 2.1 mm barrel style power jack.
- Simple jumperless configuration (enhanced configuration is possible via 0 Ohm Resistors and optional jumpers if required).
- Master power switch and regulator status LED.
- USB Serial interface.
- 2 x High Speed CAN transceiver routed to 3-way headers.
- 2 x LIN interfaces routed to 3-way headers.
- Main clock supplied from on board crystal.
- User reset switch with reset status LED's.
- Ethernet PHY and RJ45 socket (configured for MII mode).
- USB Type A Host interface.
- 2 x FlexRay interfaces with standard 2-pin connectors.
- 14-pin JTAG connector.

- 4 user LED's wired to MCU ports.
- 2 user pushbutton switches wired to MCU ports.
- Hexadecimal encoded switch wired to 4 MCU ports.
- Simple potentiometer connected to analogue input channel.

2.1. Differences to the Customer EVB

Note that the GPIO pins used for peripherals on the LCEVB are the same as those used on the customer EVB. This ensures maximum code compatibility between the 2 boards, making it easy to migrate from one board to the other

Table 1. Customer EVB vs LCEVB features

Feature	Customer EVB	LCEVB
MCU Support	Custom MCU Daughtercards for multiple devices (socketed)	Soldered 176QFP MPC5748G
Power Supply	External 12 V	External 5 V (Caution)
On Board Regulators (and LED's)	5 V, 3.3 V, 1.25 V (combination of Linear and /or Switching regulators)	3.3 V Switching Regulator
Master Power Switch	Yes	Yes
Reset Control	Reset button with MCU and External Reset LED's	Reset button with MCU and External Reset LED's
USB FTDI Serial Interface	Yes	Yes
CAN Physical Interfaces	2 (routed to 0.1" headers)	2 (routed to 0.1" headers)
LIN Physical Interfaces	2 (routed to Molex headers)	2 (routed to 0.1" headers)
FlexRay Physical Interfaces	2 (routed to 0.1" headers)	2 (routed to 0.1" headers)
Ethernet Physical Interface	1 (MII and RMII Support)	1 (MII only mode)
USB Physical Interface	2 (USB Host and OTG)	1 (USB Host)
MLB Daughtercard Connector	Yes	No
SAI Audio / TWRPI Connectors	Yes	No
SDHC Connector	Full Size SDHC Socket	No
Fast External Osc (FXOSC)	Daughtercard Crystal * and SMA input connector	40 MHz Crystal
Slow External Osc (SXOSC)	Daughtercard Crystal *	32.768 KHz Crystal
CLKOUT signals available	Yes (GPIO Matrix)	Yes (Standalone pads)
User LEDS	4	4
User Pushbutton Switches	4	2
Hex Encoded Switch	Yes	Yes
Test Potentiometer for ADC	Yes	Yes
GPIO Matrix	All Available Pins not otherwise used for peripherals	Selection of Pins available from 5 GPIO Ports
Debug	14 Pin JTAG and 50 pin Nexus	14 Pin JTAG
Configuration	Highly configurable via jumper shunts	Fixed (limited configuration via 0 ohm resistors)

* Daughtercard crystals are typically 40 MHz for FXOSC and 32.768 KHz for SXOSC but may vary between daughtercards.

The figure below shows the customer EVB (left) next to the LCEVB(right).

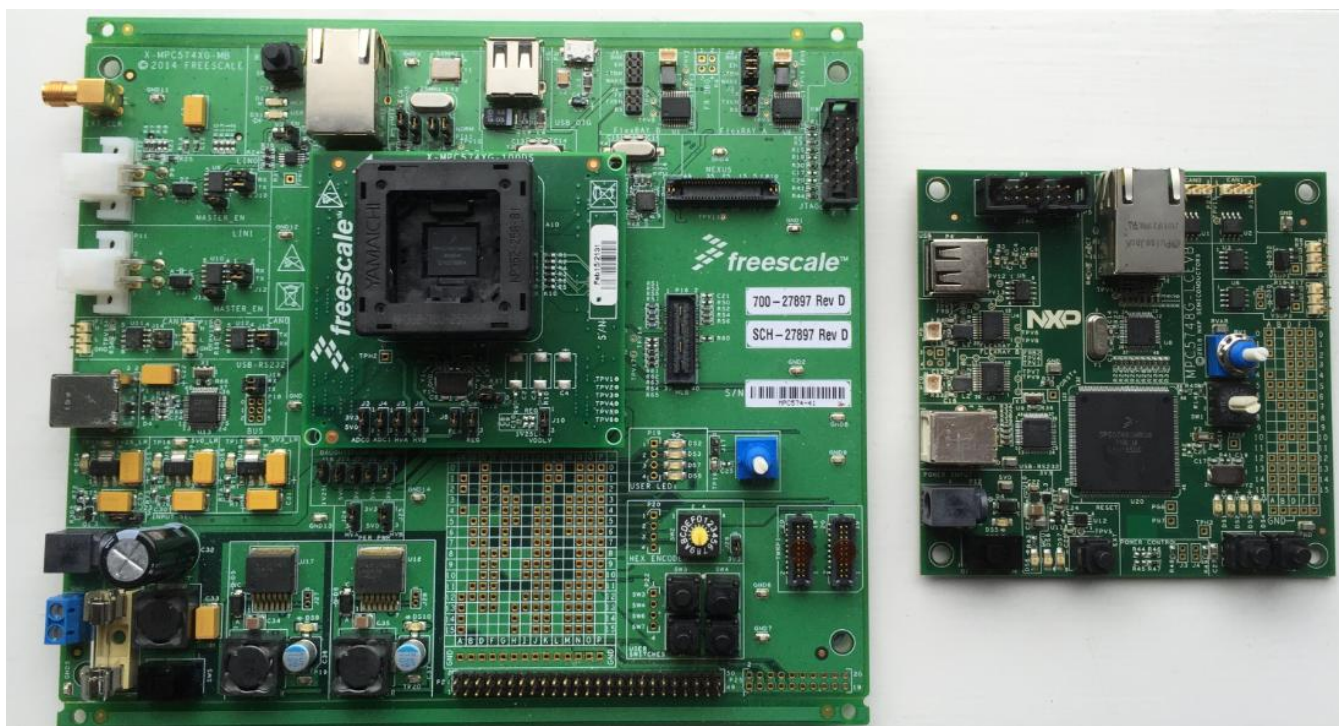


Figure 1. Customer and LCEVB side by side

3. Configuration Overview

Out of the box, there is no configuration required for the LCEVB to function. Unlike the customer EVB, the LCEVB is primarily designed for a single mode of operation with no requirement for user configuration. If you wish to have a more flexible configuration the recommendation is that the fully configurable customer EVB is purchased.

There are however some jumper footprints and zero ohm resistors populated in positions that would normally have jumper headers fitted (for example on the MCU power supply lines and tracking to the peripheral interfaces). If required these can be de-soldered to modify functionality. Any such modification is done at the full risk of the user and no support or warranty repairs will be provided for a board that has been modified. Modifications should only be attempted by appropriately trained personnel using the correct equipment and Personal Protective Apparel

The diagram below gives an overview of the functional blocks of the LCEVB

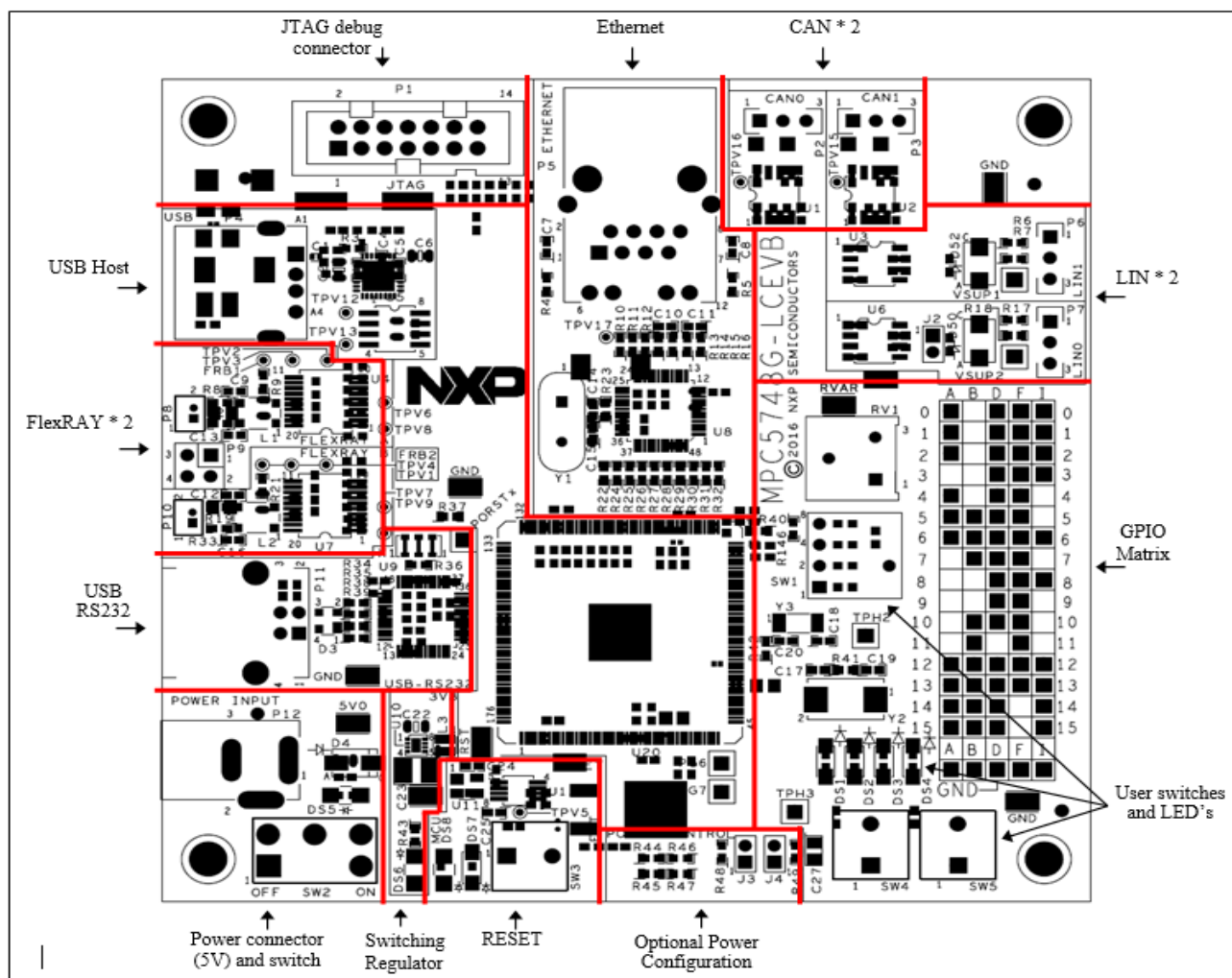


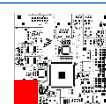
Figure 2. EVB Functional Blocks

4. Initial Setup

This section details the power, reset, clocks, and debug configuration which is the minimum configuration needed in order to power ON the LCEVB.

4.1. Power Supply Configuration

The Power supply section is located in the bottom left corner of the LCEVB



The LCEVB requires an external power supply voltage of 5 V DC, minimum 1 A. There is a single 3.3 V switching regulator on the LCEVB providing MCU and peripheral power.

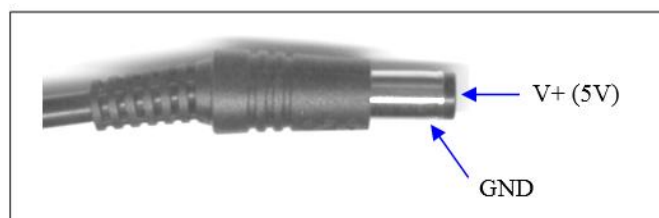
CAUTION

Connecting a power supply with a voltage greater than 5 V will result in irrecoverable board damage. Check the power supply voltage before connecting the plug to the LCEVB.

4.1.1. Power Input Connector

Power is supplied to the LCEVB via a 2.1 mm connector from the wall-plug mains adapter as shown below. Note – if a replacement or alternative adapter is used, care must be taken to ensure the 2.1 mm plug uses the correct polarisation as shown below:

Figure 3. 2.1 mm Power Connector



4.1.2. Power Switch

Slide switch SW2 can be used to isolate the power supply input from the EVB voltage regulators if required.

- Moving the slide switch to the right (away from the power connector) will turn the EVB ON.
- Moving the slide switch to the left (towards the power connector) will turn the EVB OFF.

4.1.3. Power Status LED

When power is applied to the LCEVB, two green LED's adjacent to the regulator and power connector show the presence of the supply voltages as follows:

- LED DS5 – Indicates that the 5.0 V supply voltage is present
- LED DS6 – Indicates that the 3.3 V switching regulator is functioning

If no LED's are illuminated when power is supplied to the LCEVB and the power switch is in the “ON” position, the power adapter may be faulty or there may be a fault with the LCEVB. If only one LED is illuminated there may be a short in that power supply rail – check there is nothing shorting on the EVB. If you continue to have problems, contact NXP for support.

CAUTION

In the event of a short on the regulator output (in which case one of the LED's would be off or dimly illuminated), the regulator and/or the shorted component will likely be hot.

4.1.4. MCU and Peripheral Voltage Configuration

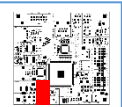
The following MCU supply rails are connected to the 3.3 V switching regulator:

- VDD_HV_ADC0
- VDD_HV_ADC1
- VDD_HV_ADC1_REF
- VDD_HV_A
- VDD_HV_B
- VDD_HV_FLA
- External Ballast Transistor Supply

Similarly all of the peripheral interfaces (or the I/O power in the peripheral interface) are supplied from 3.3 V as is the reset circuitry and the voltage sense wire on the JTAG connector.

4.2. Reset Control (SW3)

The reset circuitry is located in the bottom left quarter of the LCEVB next to the power switch



The MCU has a single bi-directional open drain Reset pin. Rather than connect multiple devices to the reset pin directly, a reset-in and reset-out buffering scheme has been implemented on the LCEVB as shown in [Figure 4](#). The reset “in” from the reset switch (SW3) and the debug connectors are logically OR'd together using an AND gate and then connected to the buffer to provide an open-drain output.

The “reset-out” circuitry provides a buffered reset signal that can be used to drive any circuitry requiring a reset control from the MCU.

This scheme is not required if it is guaranteed that anything driving the reset pin has an open drain drive and that there is no significant output load on the MCU reset pin.

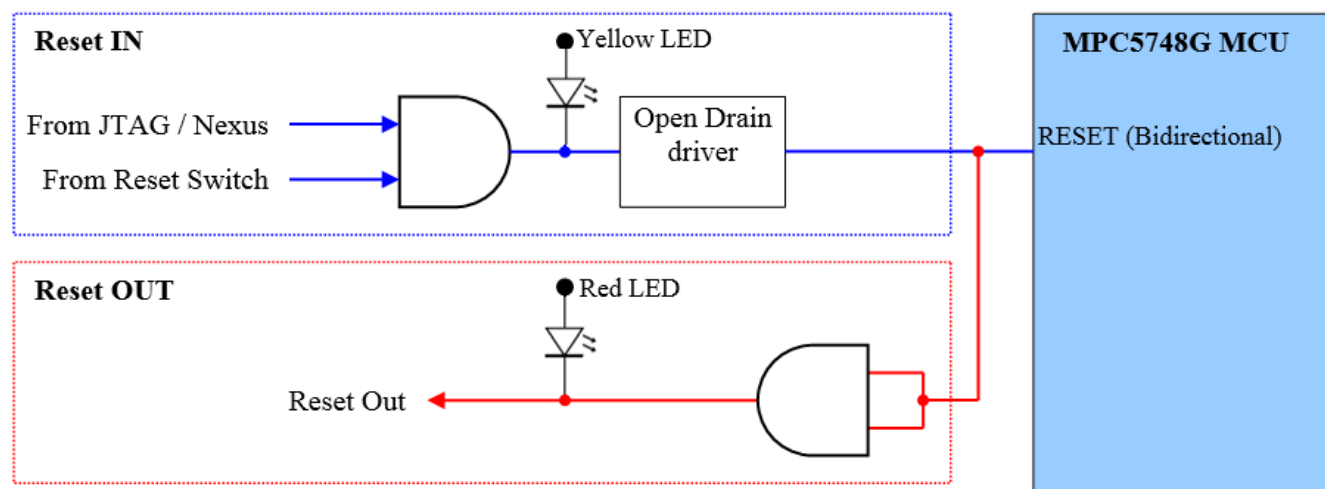


Figure 4. EVB Reset Control

4.2.1. Reset LEDs

As can be seen above, there are two reset LED's that can be used to identify the source / cause of a reset: RED LED DS8 (titled "**MCU**") will illuminate if:

- The MCU issues a reset (in this condition **ONLY** this LED will be illuminated and LED DS1 will be off)
- There is a target reset (ie from the reset switch or from the debugger in which case LED DS1 will be ON)

YELLOW LED DS7 (titled "**EXT**") will illuminate when an external hardware device issues a reset to the MCU:

- The reset switch is pressed
- There is a reset being driven from one of the debug connectors

Table 2. Reset LED Decoding

LED DS7 (Yellow)	LED DS8 (Red)	Description
OFF	OFF	No Reset being issued from MCU or external logic
OFF	ON	MCU has issued a reset
ON	OFF	External reset issued from switch or debug BUT not being issued to MCU (check R137 has not been removed)
ON	ON	External reset issued from reset switch or debug and has been issued to MCU.

4.3. MCU Clock Configuration

There is an external 40MHz crystal connected to the MCU Fast External Oscillator (FXOSC) pins EXTAL and XTAL.

There is also a 32.768 crystal connected to the MCU Slow External Oscillator (SXOSC) pins OSC32K_EXTAL and OSC32K_XTAL. This can be used for accurate time keeping.

There are 2 pads PG6 and PG7 (located just below the MCU) on the LCEVB to facilitate measurement of the CLKOUT1 and CLKOUT0 signals.

Note – there is no external clock input on the LCEVB

4.4. Debug Connector (P1)

The JTAG debug connectors is located in the top left corner of the LCEVB



The LCEVB has a single 14-pin keyed JTAG connector for connection to an external debugger.

Before attaching or removing the debug cable from the LCEVB remove power from the EVB to prevent damage to the LCEVB or debug hardware.

4.4.1. Debug Connector Pinout

The following tables list the pinout for the JTAG connector used on the LCEVB

Table 3. 14-Pin JTAG Debug Connector Pinout

Pin No	Function	Connection	Pin No	Function	Connection
1	TDI	PC0	2	GND	GND
3	TDO	PC1	4	GND	GND
5	TCLK	PH9	6	GND	GND
7	EVTI	PL8	8	N/C	---
9	RESET	JTAG-RSTx	10	TMS	PH10
11	VREF	PER_HVA	12	GND	GND
13	RDY	---	14	JCOMP	10K Pulldown

TDI, TDO and TMS have 10K pullup resistors on the LCEVB. TCLK has a 10K pulldown (R147) to facilitate STANDBY exit without any additional code (at the sacrifice of slightly higher STANDBY current), however this can be changed to a pullup if required by removing R147 and fitting the resistor on R56.

Table 4. JTAG Pins Pull State (from MPC5748G Reference Manual)

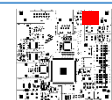
TERMINAL TYPE ¹	POWERUP pad state ²	RESET pad state	DEFAULT pad state ³
RESET	strong pull-down	strong pull-down	weak pull-up
PORST ⁴	Weak pull down	Weak pull up	weak pull-up
GPIO	high impedance	high impedance	high impedance
ANALOG	high impedance	high impedance	high impedance
EOUT0, EOUT1	high impedance	high impedance	high impedance
TCK	high impedance	weak pull-up	weak pull-up
TMS	high impedance	weak pull-up	weak pull-up
TDI	high impedance	weak pull-up	weak pull-up
TDO	high impedance	high impedance	high impedance

5. Communications & Memory Interfaces:

This section details the communication interface and storage peripherals that are implemented on the LCEVB.

5.1. CAN Interfaces (P2, P3)

The CAN circuitry is located on the top right edge of the LCEVB



The LCEVB incorporates two identical CAN interface circuits connected to MCU CAN0 and CAN1 using MC33901 transceivers. Both transceivers are configured for high speed operation by pulling pin 8 to GND via a 4.7 KOhm resistor. There are test points to allow the Select pin to be driven high if desired. The MC33901 is pin compatible with other CAN transceivers supporting full CAN FD data rates.

For flexibility, the CAN transceiver I/O is connected to a 0.1" header (P2 for CAN0 / P3 for CAN1) rather than using non-standard DB9 connectors. The pinout of these headers is shown below.

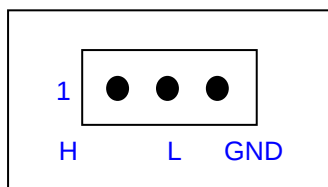


Figure 5. CAN Physical Interface Connectors

5.2. LIN Interfaces (P6, P7)

The LIN Physical interface circuits are located on the right edge of the LCEVB



The LCEVB incorporates two LIN transceiver circuits connected to MCU LIN0 and LIN1, using an NXP MC33662 transceiver. The MPC5748G LIN0 supports both master and slave modes whereas LIN1 only supports master mode.

On the LCEVB, the LIN0 transceiver is configured as slave mode by default. Master mode operation is possible by either populating a zero ohm resistor (R143) or by fitting a jumper header (J2) – see the schematics for details. The LIN0 transceiver is hard wired for master mode.

To save on board space and cost, both LIN transceivers are connected to 0.1” pitch 3x1 headers as shown below rather than the usual LIN Molex header.

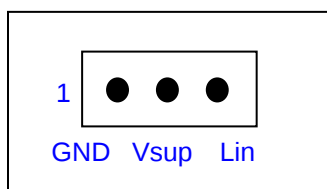
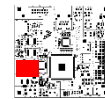


Figure 6. LIN Physical Interface Connector

Note that in order for the LIN transceiver to function, external 12v must be supplied via pin 2 of the connector

5.3. USB RS232 Serial Interface (P11)

The USB RS232 interface is on the left hand edge of the board (USB Type B)



The LCEVB incorporates a USB RS232 serial interface providing RS232 connectivity via a direct USB connection between the PC and the EVB. The circuit contains an FTDI FT2232D USB to Serial interface which should automatically install the drivers for two additional COM ports on your PC. Note that only one of these ports is used so you will need to try both (usually the higher numbered COM port is the active one). For more information on the USB drivers and general fault finding, consult the FTDI website at <http://www.ftdichip.com/>

The MCU LIN2 signals are routed to the FTDI transceiver (UART TX and RX). No handshaking signals are implemented and no board configuration is required.

5.4. USB HOST Interface (P4)

The USB Host interface is on the top left corner of the LCEVB on the left



The LCEVB includes a Type A (Host) USB interface, routed to a USB type A female connector. The USB circuit contains a USB83340 transceiver with a MIC2026-1YM USB power switch. There is no hardware user configuration required to use the USB circuit.

5.5. Ethernet Interface (P5)

The Ethernet interface is mid-way along the top edge of the LCEVB



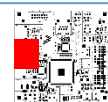
The EVB incorporates a single DP83848c Ethernet transceiver with the circuitry configured for MII mode. The transceiver is connected to a pulse J1011F21PNL RJ45 connector which includes a built-in isolation transformer. There is no hardware configuration needed.

If you require RMII mode or access to both Ethernet ports on the MPC5748G, please purchase the MPC5748G customer EVB and appropriate daughter cards.

Note that the MCU Ethernet signals are all in the VDD_HV_B domain. The Ethernet PHY will only function with 3.3 V I/O so if you have made any modifications to the EVB power domain configuration (via the zero ohm resistors), you need to ensure the VDD_HV_B domain is at 3.3 V before attempting to use the Ethernet module. If VDD_HV_B is set to 5 V, the signals routed to the Ethernet PHY (see the EVB schematics) must be left as tristate to prevent damage to the transceiver.

5.6. FlexRay (P8, P9, P10)

The FlexRay interfaces are midway down the left hand edge of the LCEVB



The LCEVB incorporates two FlexRay TJA1080TS/N interfaces connected to MCU FlexRay channels A and B and routed to two Molex 1.25 mm pitch PicoBlade shrouded headers (standard on many NXP EVB's). There is no hardware configuration required to use FlexRay.

Note that the LCEVB is supplied with a 40 MHz crystal by default. If FlexRay is configured to use the external clock source, then the crystal should be left at 40 MHz.

6. User Interface (I/O)

This section details the user I/O available on the LCEVB and includes the GPIO matrix, switches, LED's and the ADC variable resistor.

6.1. GPIO Matrix

The GPIO matrix is on the right hand edge of the LCEVB



A sub-set of available GPIO pins (available pins being those not already routed to LCEVB peripherals) are available at the GPIO matrix as detailed below. The matrix provides an easy to follow, intuitive, space saving grid of 0.1" header through-hole pads. Users can solder wires, fit headers or simply insert a scope probe into the respective pad.

To use the matrix, simply read the port letter from the top or bottom row of text then the pad number from the columns on the left or right of the matrix. For example, the 1st pad available on Port B is PB5 as outlined below.

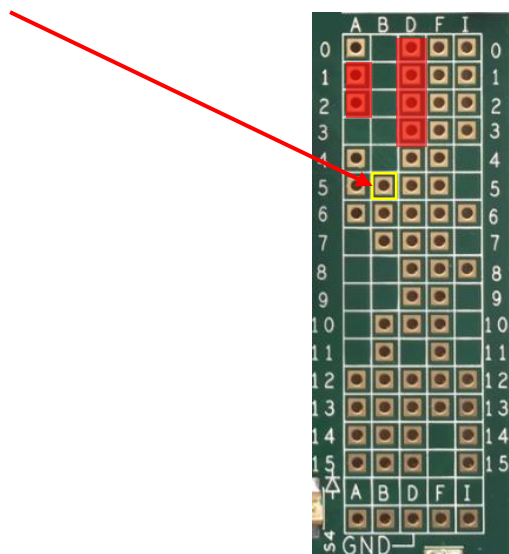


Figure 7. GPIO Matrix

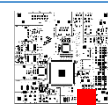
If a pad is populated in the matrix, it means this is available for exclusive use as GPIO. The exception to this are the port pins detailed below which are also shared with switches or user LED's (shaded red in the matrix diagram above).

PD0, PD1, PD2, PD3 – HEX Encoder Switch
PA1, PA2 – User pushbutton Switches

If you require access to all of the available GPIO pads, the customer EVB and daughtercard provides this additional functionality.

6.2. User Switches (SW4, SW5)

The user pushbutton switches are in the bottom right corner of the LCEVB



There are two active high (pulled low, driven to 3.3 V) pushbutton switches on the LCEVB connected directly to MCU GPIO ports. No configuration is required to use the switches.

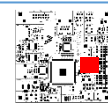
SW4 is connected to port PA1 (which is also the NMI pin) and SW5 is connected to port PA2

NOTE

The MCU ports used on the user pushbutton switches are also routed to the GPIO matrix.

6.3. Hex Encoded Switch (SW1)

The hex encoder switch is located to the left of the GPIO Matrix



There is a single hex encoded 16 position rotary switch on the LCEVB. This outputs a binary encoded hex value (active high) on four MCU ports (Port D[0..3]).

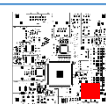
Table 5. Hex Encoder Switch (SW2)

Position	HEX_SW4 (PD3)	HEX_SW3 (PD2)	HEX_SW2 (PD1)	HEX_SW1 (PD0)
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
A	1	0	1	0
B	1	0	1	1
C	1	1	0	0
D	1	1	0	1
E	1	1	1	0
F	1	1	1	1

Note that POSN 0 will ensure that no voltage is applied to the pads. This allows the pads to be used as normal GPIO (with 10K pulldown) and accessed at the respective pads on the GPIO matrix area.

6.4. User LED's (DS1, DS2, DS3, DS4)

The user LED's are above the user switches in the lower right corner



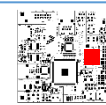
There are four **active low** user LED's, DS1 to DS4, connected directly to 4 MCU ports (PG[2..5]) as shown below. No configuration is required to use the LED's.

Table 6. Use LED's (DS1, DS2, DS3 and DS4)

User LED	MCU Pin
DS1	PG2
DS2	PG3
DS3	PG4
DS4	PG5

6.5. ADC Input Potentiometer (RVAR, RV1)

The ADC Pot is above the hex switch to the left of the GPIO matrix



There is a small variable resistor RV1 on the LCEVB which routes a voltage between 0v and 3.3 V to MCU pin PB4. This is useful for quick ADC testing. Test point RVAR can be used to probe the voltage with a voltmeter.

Note that this circuit provides a very rough way to evaluate the ADC. There is a small current limiting series resistor network to limit the injection current to around 4.4 mA.

7. MCU Port Pin LCEVB Functions

The table below shows what each MCU pin is used for on the LCEVB.

Table 7. LCEVB 176QFP Port Pin Functions

No	Port A	Port B	Port C	Port D	Port E	Port F	Port G	Port H
0	GPIO	CAN0	JTAG	GPIO ³	---	GPIO	Ethernet	Ethernet
1	GPIO ²	CAN0	JTAG	GPIO ³	---	GPIO	Ethernet	Ethernet
2	GPIO ²	LIN0	USB1	GPIO ³	FlexRay A	GPIO	GPIO ⁴	Ethernet
3	Ethernet	LIN0	USB1	GPIO ³	FlexRay A	GPIO	GPIO ⁴	---
4	GPIO	ADC Pot	FlexRay B	GPIO	FlexRay B	GPIO	GPIO ⁴	---
5	GPIO	GPIO	FlexRay A	GPIO	FlexRay B	GPIO	GPIO ⁴	---
6	GPIO	GPIO	LIN1	GPIO	---	GPIO	GPIO	---
7	Ethernet	GPIO	LIN1	GPIO	---	GPIO	GPIO	---
8	Ethernet	EXTAL32	RS232	GPIO	---	GPIO	---	---
9	Ethernet	XTAL32	RS232	GPIO	---	GPIO	---	JTAG
10	Ethernet	SAI Audio	CAN1	GPIO	---	GPIO	USB1	JTAG
11	Ethernet	GPIO	CAN1	---	---	GPIO	USB1	USB1
12	GPIO	GPIO	FlexRay	GPIO	Ethernet	GPIO	Ethernet	USB1
13	GPIO	GPIO	FlexRay	GPIO	Ethernet	GPIO	Ethernet	---
14	GPIO	GPIO	FlexRay	GPIO	USB1	Ethernet	USB1	---
15	GPIO	GPIO	FlexRay	GPIO	USB1	Ethernet	USB1	---

No	Port I	Port J
0	GPIO	---
1	GPIO	---
2	GPIO	---
3	GPIO	---
4	USB1	---
5	USB1	
6	GPIO	
7	USB1	
8	GPIO	
9		
10		
11	Ethernet	
12	GPIO	
13	GPIO	
14	GPIO	
15	GPIO	

Key:	
---	Pin not bonded out on 176QFP package
---	Pin not accessible on LCEVB

² Shared with user switches

³ Shared with Hex Encoder Switch

⁴ Shared with user LED's

8. Appendix

The MPC5748G LCEVB schematics, Rev B are shown below.

MPC5748G Low Cost Evaluation Board (MPC5748G-LCEVB)

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MCU GPIO 2	Sheet 8
Comms1 - CAN and LIN	Sheet 9
Comms 2 - FTDI RS232 Interface	Sheet 10
Comms 3 - USB Host Interface (device footprints only)	Sheet 11
Comms 4 - Ethernet (MII Mode)	Sheet 12
Comms 5 - FlexRay	Sheet 13
User - Switches, LED's and Potentiometer	Sheet 14
User - GPIO Pin Matrix	Sheet 15

Caution:

These schematics are provided for reference purposes only. As such,NXP does not make any warranty, implied or otherwise, as to the suitability of circuit design or component selection (type or value) used in these schematics for hardware design using the NXP Calypso family of Microprocessors. Customers using any part of these schematics as a basis for hardware design, do so at their own risk and NXP does not assume any liability for such a hardware design.

- Notes:**
- All components and board processes are to be ROHS compliant
 - All small capacitors are 0402 unless otherwise stated
 - All resistors are 0603 5% 0.1w unless otherwise stated. All zero ohm links are 0603
 - All connectors and headers are denoted Px and are 2.54mm pitch unless otherwise stated
 - All jumpers are denoted Jx. Jumpers are 2mm pitch
 - Jumper default positions are shown in the schematics. For 3 way jumpers, default is always posn 1-2.
 - 2 Pin jumpers generally have the "source" on pin 1.
 - All switches are denoted SWx
 - All test points (SMT wire loop style) are denoted TPx
 - Test point Vias (just through hole pads) are denoted TPVx

Signals (ports) have not been routed via busses as this makes it harder to determine where each signal goes.

User notes are given throughtout the schematics.
Specific PCB LAYOUT notes are detailed in ITALICS

Revision Information

Rev	Date	Designer	Comments
x1	14 Apr 2015	Alasdair Robertson	Start of capture, Working version (256BGA)
x2	08 May 2015	Alasdair Robertson	Changed to 176 QFP Package and changed peripherhal Matrix
x3	18 May 2015	Alasdair Robertson	Changes required for initial placement
x4	19 May 2015	Alasdair Robertson	Tidy Up, Replaced some "hard to source" components
x5	26 May 2015	Alasdair Robertson	Renumber and Back Annotated from Layout
x6	27 May 2015	Alasdair Robertson	Correction to GND on 3v3 Regulator circuit
x7	29 May 2015	Alasdair Robertson	Correction to CAN Test points
x8	31 May 2015	Alasdair Robertson	Few refdes changes after layout tweaks
x9	01 Jun 2015	Alasdair Robertson	Correction to user LED Refdes after re-number
x10	01 Jun 2015	Alasdair Robertson	DNP Jumpers. 0 Ohm resistors added accross LIN jumpers
A	11 Jun 2015	Andrew MacDonald	Prototype Manufacture Release
AX1	29 Sep 2015	Alasdair Robertson	Prodn Build changes (LIN0 default to Slave, LIN1 Master only) PN Changed to MPC5748G-LCEVB
AX2	26 Oct 2015	Alasdair Robertson	Change to JTAG Pulls to meet latest RM Spec
AX3	29 Oct 2015	Alasdair Robertson	Changed RV1 current limit resistor. SW4 / SW5 refdes swap
AX4	09 Dec 2015	Alasdair Robertson	Pull DOWN on TCLK to mitigate against STANDBY exit issue.
AX5	20 Jan 2016	Alasdair Robertson	Updated NXP Logos
B	12 Feb 2016	Alasdair Robertson	Updated NXP Logos

3 Different test points used in design:

TPVx - Through Hole Pad small

TPHx - Through Hile Pad Large (for standard 0.1" header). Also used on IO Matrix (IOMx)

TPX - Surface Mount Wire Loop

TPV?

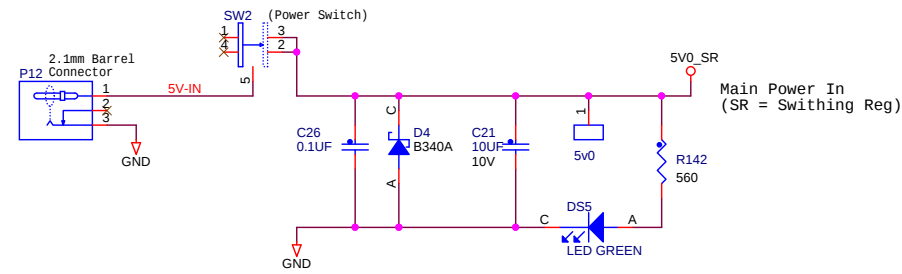
TPH5

TP?

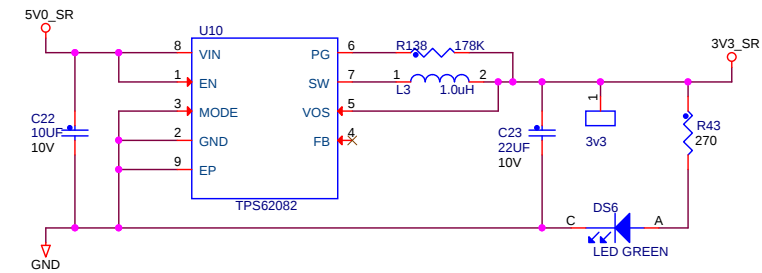
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Designer: A. Robertson	Drawing Title: MPC5748G-LCEVB		
Drawn by: A. Robertson	Page Title: Index and Title Page		
Approved: A. Robertson	Size B	Document Number SCH-27897 PDF: SPF-27897	Rev B
Date: Friday, February 12, 2016		Sheet 1	of 15

Power Input and Linear Voltage Regulators

Power Supply Input

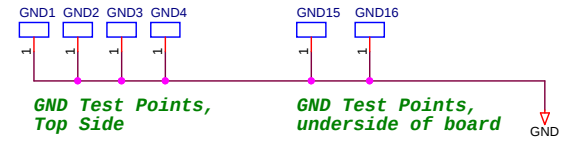


3.3v Switching Regulator



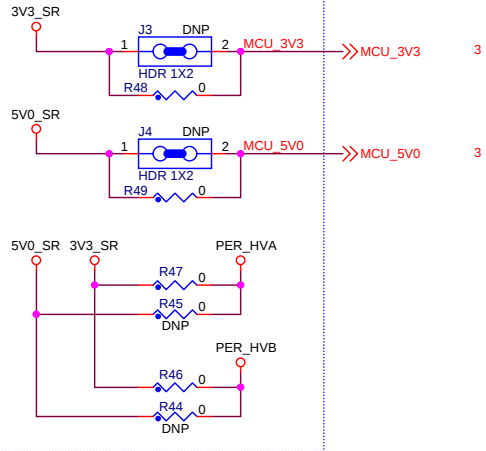
Inoput Voltage 5V, Output 3.3V at 700mA. Ripple 1.4mV, Approx 90% efficient

Test and reference points



Power Control

Jumpers can be fitted to facilitate power measurements



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Calypso MCU Power Connections

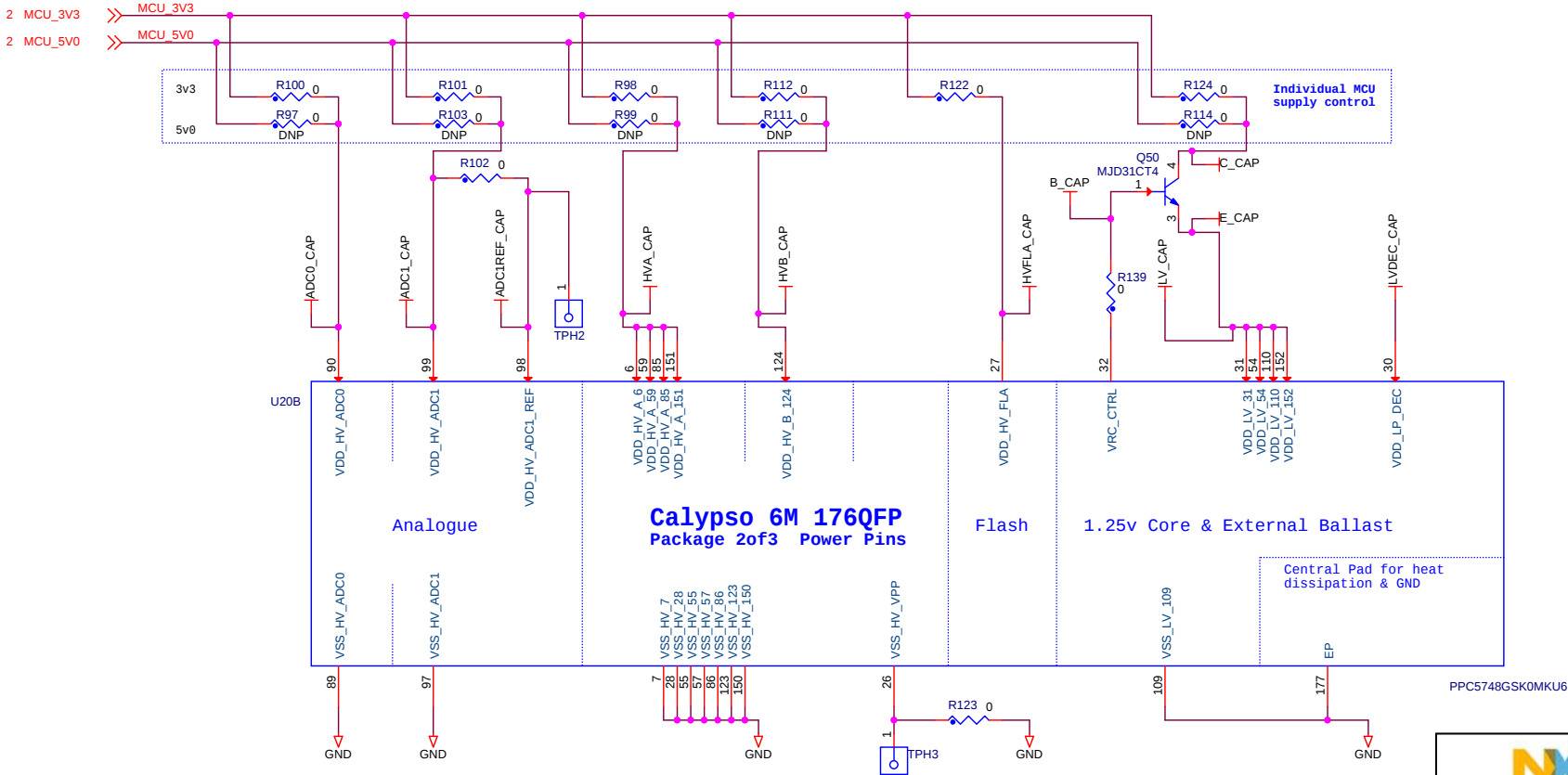
Power Supply Constraints:

- If VDD_HV_A is driven from 3.3V, VDD_HV_FL A must also be supplied from 3.3V
- If VDD_HV_A is driven from 5V, the VDD_HV_FL A pin must be disconnected from 3.3V
- Don't attempt to over drive an analogue pad to 5V when the digital VDD_HV_x supply is set to 3.3V. This will trigger the ESD protection on that pad. For example if VDD_HV_A is set to 3.3V and the analogue supplies are set to 5V, you cannot drive 5V into a pad in the VDD_HV_A domain

Default Configuration:

- ALL MCU supply voltages are set to 3.3V (ADC0, ADC1, VDD_HV_A, VDD_HV_B, VDD_HV_C, VBallast)
- VDD_HV_FL A = External 3.3V supplied (jumper fitted)

The analogue pins can only be driven to the same voltage as the VDD_HV_x domain they are situated in (ie max 3.3V) so makes sense for the analogue supply and reference to be 3.3V



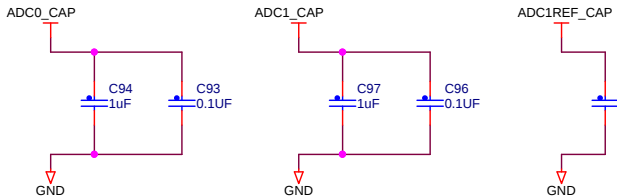
Notes on signal Grounds:

- The scheme shown has the analogue and digital grounds connected to the same plane
- This results in better ADC performance than using an analogue grond plane with single entry point (or ferrite) to digital ground plane.

		Automotive Microcontroller Applications East Kilbride, Scotland NXP General Business Use	
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Page Title: Calypso MCU Power			
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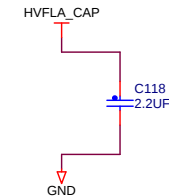
Calypso MCU Decoupling and bulk storage

ADC



Place small Caps as close as possible to MCU pins

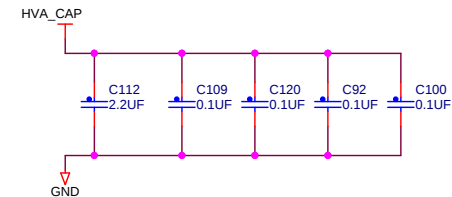
Flash



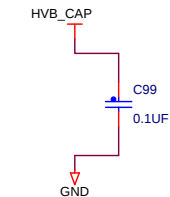
Capacitor Types:

- 4700pF - Ceramic X7R, 50V 10% 0402
- 0.1uF - Ceramic X7R, 16V 10% 0402 (Kemet C0402C104K4RAC)
- 0.68uF - Ceramic X7R, 16V 10% 0805 (Murata GCM219R71C684KA37)
- 1uF - Ceramic X7R, 10V 10% 0603 Low ESR (Taiyo Yuden LMK107B7105KA-T)
- 2.2uF - Ceramic X7R, 10V 10% 0603 Low ESR (Taiyo Yuden LMK107B7225KA-TR)

VDD_HVA

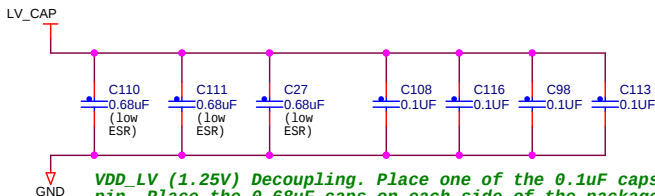


VDD_HVB



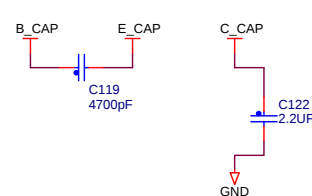
One 0.1uF cap per VDD_HV_x pin. Place as close as possible to pin

VDD_LV



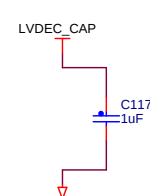
VDD_LV (1.25V) Decoupling. Place one of the 0.1uF caps close to each VDD_LV pin. Place the 0.68uF caps on each side of the package such that there is no cap on the side with the ballast transistor (For regulator stability the total capacitance should be around 2.2uF).

Ballast Transistor



Place close to transistor

LP Internal Reg Cap



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Calypso MCU Decoupling

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Reset and External Clock In

Reset is in the VDD_HVA domain.

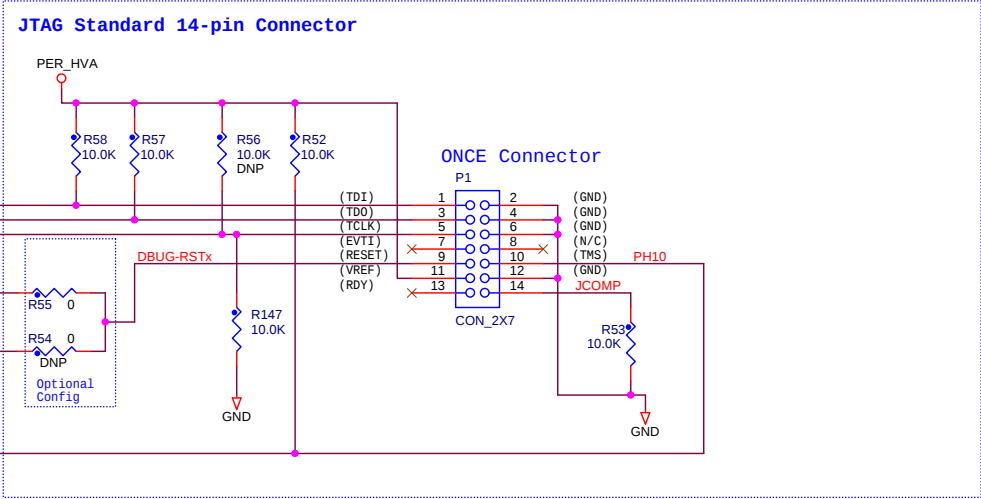
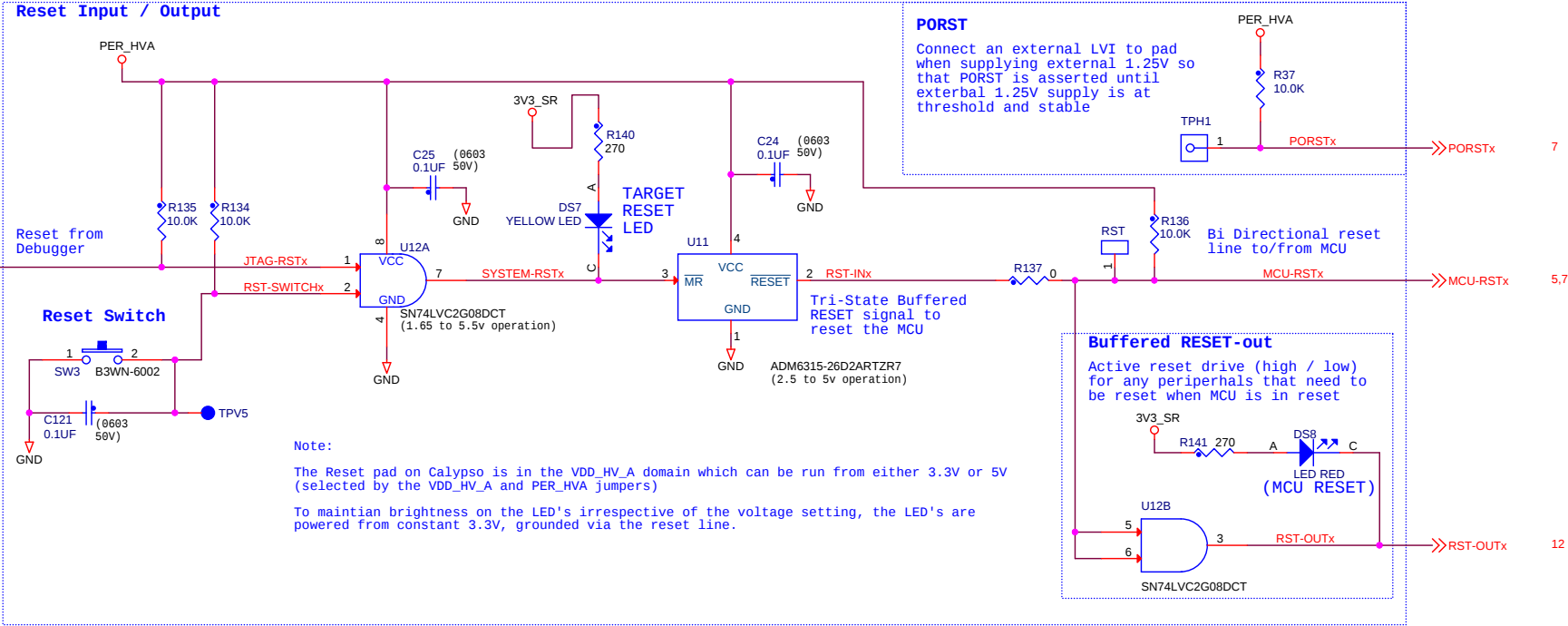


Table 13-3. Functional terminal state during power-up and reset

TERMINAL TYPE ¹	POWERUP pad state ²	RESET pad state	DEFAULT pad state ³	Comments
RESET	strong pull-down	strong pull-down	weak pull-up	functional reset pad
PORST ⁴	Weak pull down	Weak pull up	weak pull-up	power on reset pad
GPIO	high impedance	high impedance	high impedance	by default, but configurable for STANDBY exit
ANALOG	high impedance	high impedance	high impedance	-
EOUT0, EOUT1	high impedance	high impedance	high impedance	-
TCK	high impedance	weak pull-up	weak pull-up	-
TMS	high impedance	weak pull-up	weak pull-up	-
TDI	high impedance	weak pull-up	weak pull-up	-
TDO	high impedance	high impedance	high impedance	-
TCK_ALT	high impedance	weak pull-up	weak pull-up	-
TMS_ALT	high impedance	weak pull-up	weak pull-up	-
TDI_ALT	high impedance	weak pull-up	weak pull-up	-
TDO_ALT	high impedance	high impedance	high impedance	-

Note TCLK needs to be pulled down to allow exit from STANDBY in some corner cases



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MPC5748G-LCEVB

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Reset Circuitry & External Clock In

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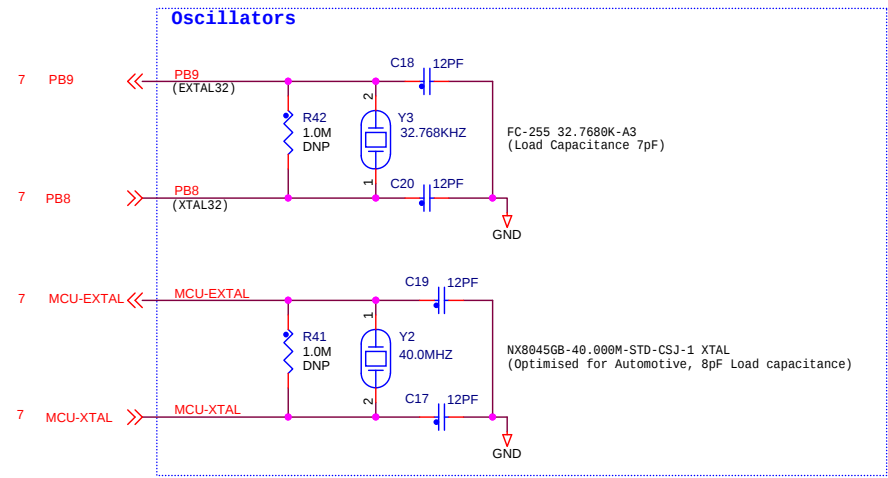
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Clocks



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Calypso GPIO 1 of 2

Key to text colours:
Purple - Comms Physical Interfaces
Orange - Other Peripherals and I/O
Blue - Debug (JTAG & Nexus)
Black - Clock, Reset and Control
RED - I/O Matrix and other functions (eg LED)
Green - I/O Matrix (dedicated)

PA 12..15 has SPI

PD has ADC0 and ADC1

U20A

Calypso 176QFP Package 1of3 GPIO Pins1

PE0	18				
PE1	20				
PE2	156	PE2	(FR_A_TX_EN)	PE2	13
PE3	157	PE3	(FR_A_RX)	PE3	13
PE4	160	PE4	(FR_B_TX)	PE4	13
PE5	161	PE5	(FR_B_RX)	PE5	13
PE6	167				
PE7	168				
PE8	21				
PE9	22				
PE10	25				
PE11	133	PE12	(MII CRS)	PE12	12
PE12	127	PE13	(MII RXD3)	PE13	12
PE13	136	PE14	(USB1_D2)	PE14	11
PE14	137	PE15	(USB1_D3)	PE15	11
PE15					
PF0	63	PF0	(GPIO)	PF0	15
PF1	64	PF1	(GPIO)	PF1	15
PF2	65	PF2	(GPIO)	PF2	15
PF3	66	PF3	(GPIO)	PF3	15
PF4	67	PF4	(GPIO)	PF4	15
PF5	68	PF5	(GPIO)	PF5	15
PF6	69	PF6	(GPIO)	PF6	15
PF7	70	PF7	(GPIO)	PF7	15
PF8	42	PF8	(GPIO)	PF8	15
PF9	41	PF9	(GPIO)	PF9	15
PF10	46	PF10	(GPIO)	PF10	15
PF11	47	PF11	(GPIO)	PF11	15
PF12	43	PF12	(GPIO)	PF12	15
PF13	49	PF13	(GPIO)	PF13	15
PF14	126	PF14	(RMII_MDIO)	PF14	12
PF15	125	PF15	(RMII_RXDV)	PF15	12
PG0	122	PG0	(RMII_MDC)	PG0	12
PG1	121	PG1	(RMII_TXCLK)	PG1	12
PG2	16	PG2	(LED1 & GPIO)	PG2	14
PG3	15	PG3	(LED2 & GPIO)	PG3	14
PG4	14	PG4	(LED3 & GPIO)	PG4	14
PG5	13	PG5	(LED4 & GPIO)	PG5	14
PG6	38	PG6	(CLKOUT1 GPIO)		
PG7	37	PG7	(CLKOUT0 GPIO)		
PG8	34				
PG9	33				
PG10	138	PG10	(USB1_D4)	PG10	11
PG11	139	PG11	(USB1_D5)	PG11	11
PG12	116	PG12	(MII_TXD2)	PG12	12
PG13	115	PG13	(MII_TXD3)	PG13	12
PG14	134	PG14	(USB1_D0)	PG14	11
PG15	135	PG15	(USB1_D1)	PG15	11
PH0	117	PH0	(RMII_TXD1)	PH0	12
PH1	118	PH1	(RMII_TXD0)	PH1	12
PH2	119	PH2	(RMII_TXEN)	PH2	12
PH3	120				
PH4	162				
PH5	163				
PH6	164				
PH7	165				
PH8	166				
PH9	155	PH9	(TCK)	PH9	5
PH10	148	PH10	(TMS)	PH10	5
PH11	140	PH11	(USB1_D6)	PH11	11
PH12	141	PH12	(USB1_D7)	PH12	11
PH13	9				
PH14	10				
PH15	8				

PPC5748GSKOMKU6

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Calypso GPIO 2 of 2

Key to text colours:
Purple - Comms Physical Interfaces
Orange - Other Peripherals and I/O
Blue - Debug (JTAG & Nexus)
Black - Clock, Reset and Control
RED - I/O Matrix and other functions (eg LED)
Green - I/O Matrix (dedicated)

15	PI0	<<	(GPIO)	PI0	172
15	PI1	<<	(GPIO)	PI1	171
15	PI2	<<	(GPIO)	PI2	170
15	PI3	<<	(GPIO)	PI3	169
11	PI4	<<	(USB1_STP)	PI4	143
11	PI5	<<	(USB1_NXT)	PI5	142
15	PI6	<<	(GPIO)	PI6	11
11	PI7	<<	(USB1_RST)	PI7	12
15	PI8	<<		PI8	108
12	PI11	<<	(ENET_RST)	PI11	111
15	PI12	<<	(GPIO)	PI12	112
15	PI13	<<	(GPIO)	PI13	113
15	PI14	<<	(GPIO)	PI14	76
15	PI15	<<	(GPIO)	PI15	75

<<	74	PJ0
<<	73	PJ1
<<	72	PJ2
<<	71	PJ3
<<	5	PJ4

Calypso 176QFP
Package 3of3 GPIO Pins2

PPC5748GSK0MKU6

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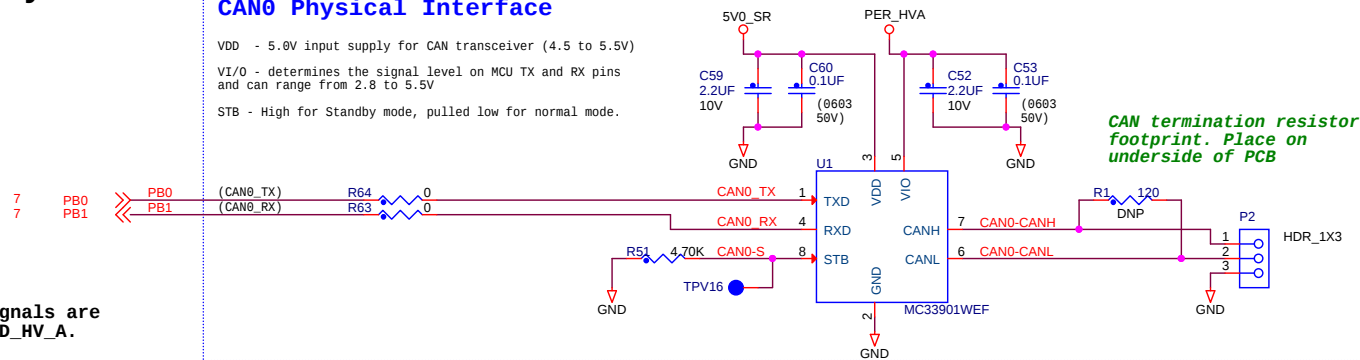
CAN & LIN Physical

CAN0 Physical Interface

VDD - 5.0V input supply for CAN transceiver (4.5 to 5.5V)

VI/O - determines the signal level on MCU TX and RX pins and can range from 2.8 to 5.5V

STB - High for Standby mode, pulled low for normal mode.



All CAN and LIN signals are in power domain VDD_HV_A.

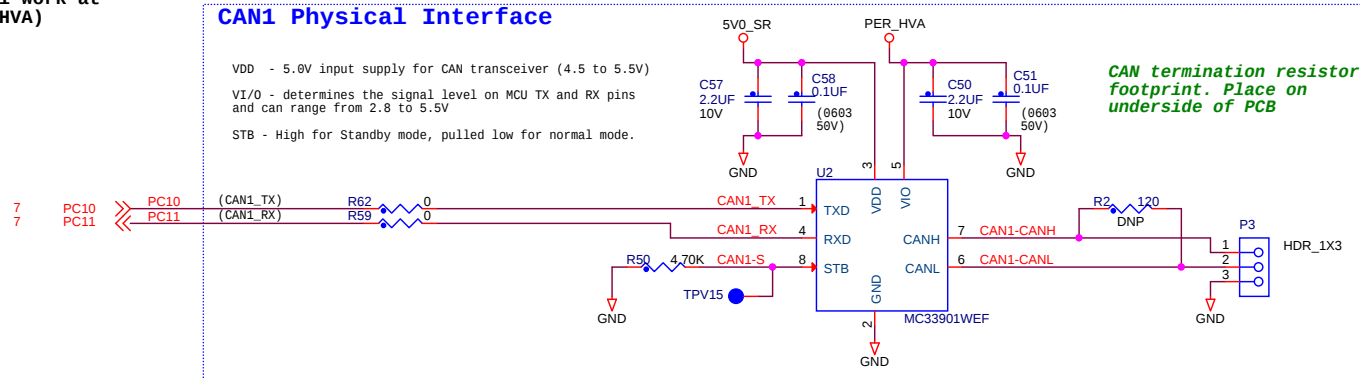
All interfaces will work at 3.3V or 5.0V (PER_HVA)

CAN1 Physical Interface

VDD - 5.0V input supply for CAN transceiver (4.5 to 5.5V)

VI/O - determines the signal level on MCU TX and RX pins and can range from 2.8 to 5.5V

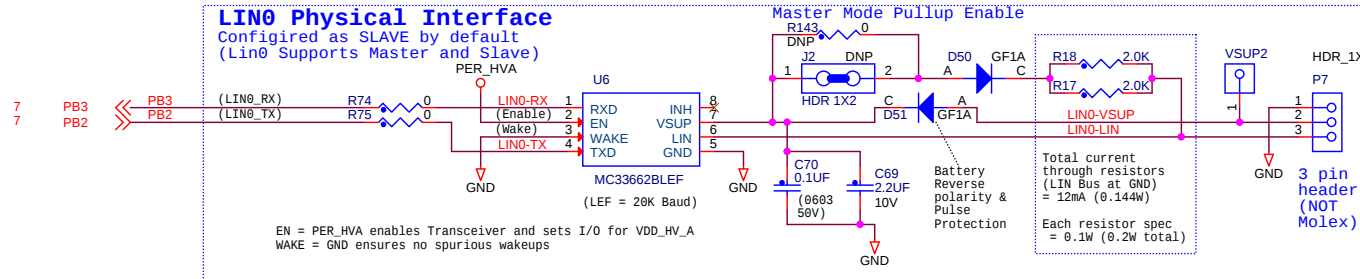
STB - High for Standby mode, pulled low for normal mode.



LIN0 Physical Interface

Configured as SLAVE by default
(Lin0 Supports Master and Slave)

PER_HVA



MC33662LEF LIN transceiver is newer version of 33661 offering:

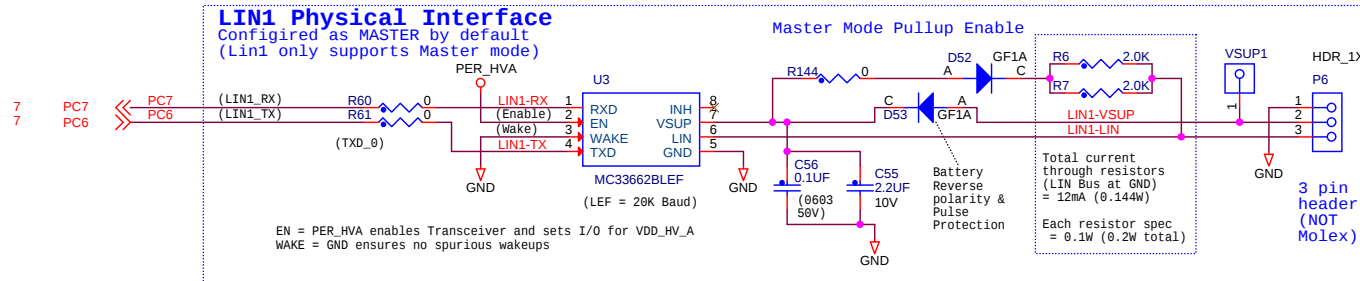
- Full LIN compliance (33661 no longer compliant)
- Improved ESD protection on LIN pin up to 15KV
- Improved ESD on Wake and VSUP Pins
- Other EMC and performance improvements

See freescale.com for more details

LIN1 Physical Interface

Configured as MASTER by default
(Lin1 only supports Master mode)

PER_HVA



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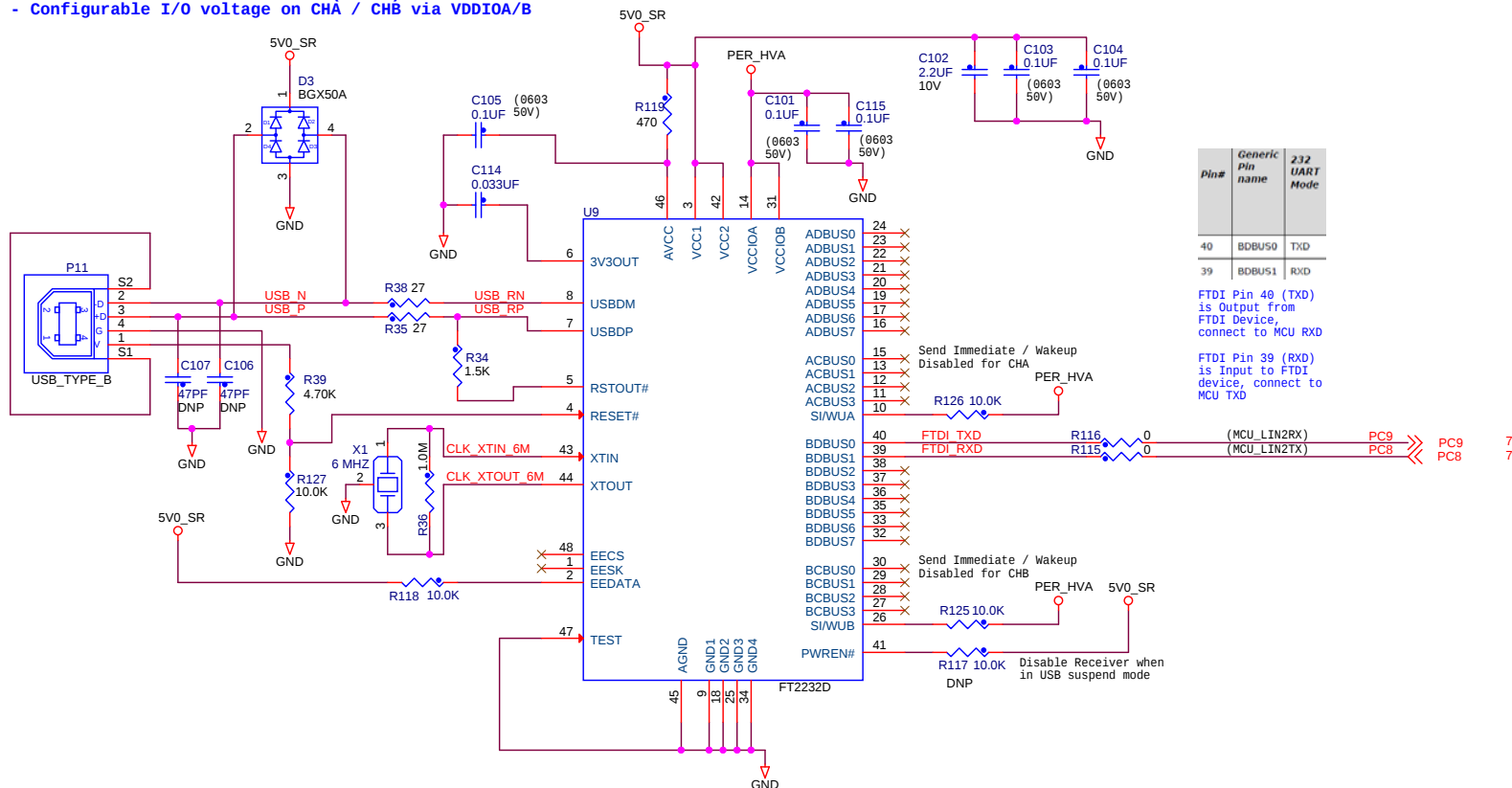
USB RS232 (serial) Interface

All Signals are in power domain VDD_HV_A.

FTDI interface will work at 3.3V or 5.0V (PER_HVA)

FTDI USB <-> Serial Interface

- Self Powered mode. No power is taken from USB
- Device defaults to Dual serial (RS232) mode ie RS232 on both A and B
- Configurable I/O voltage on CHA / CHB via VDDIOA/B



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USB RS232 Interface

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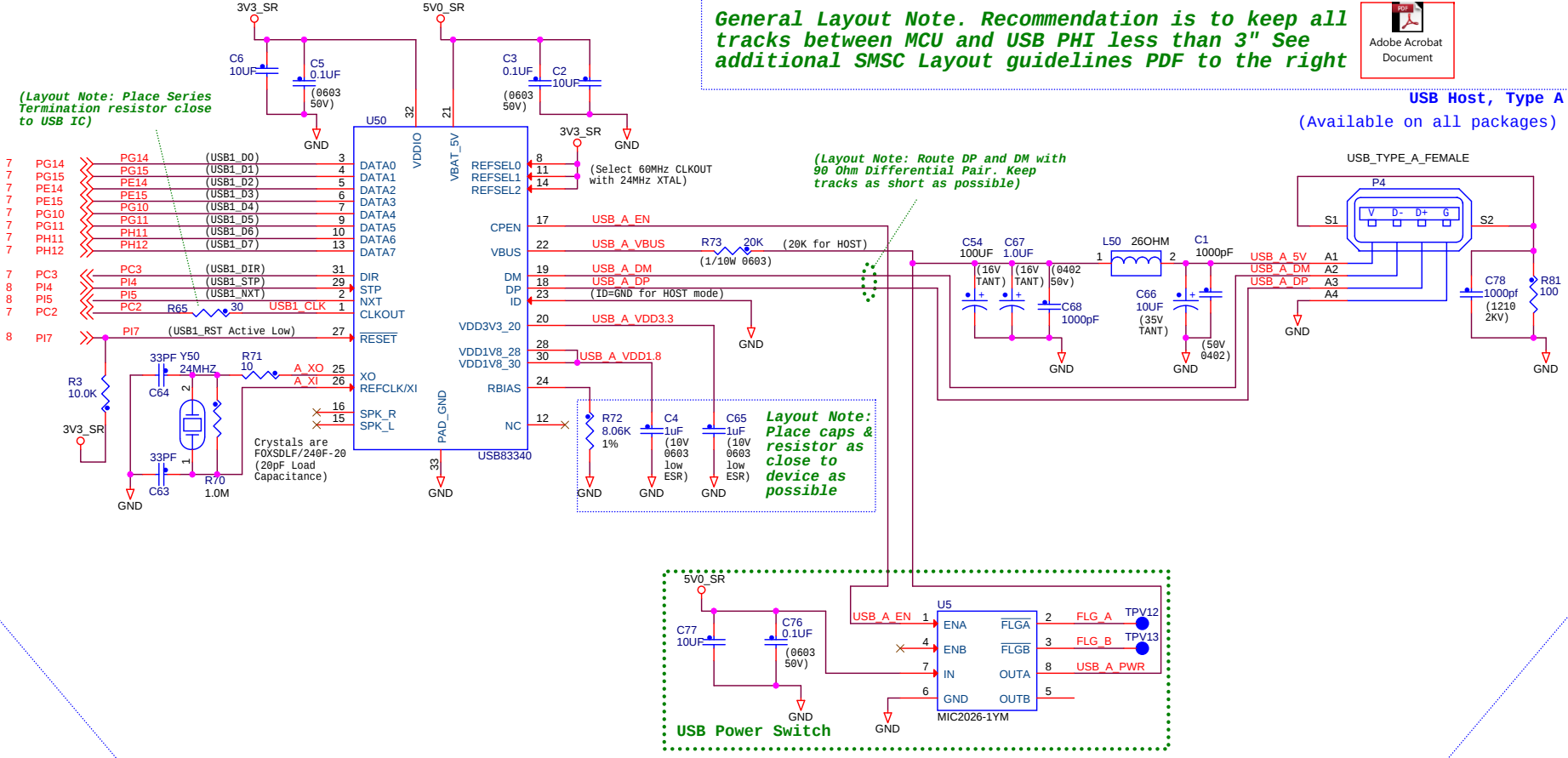
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USB (Type A Host and Type AB OTG)

USB Signals are in power domain VDD_HV_A

The USB interface only supports 3.3V operation. All I/O signals must be 3.3V. If VDD_HVA is set to 5V, USB MCU pads must be left as tri-state with no pullups.

(Layout Note: Place Series Termination resistor close to USB IC)



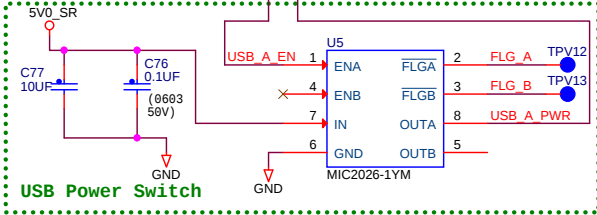
General Layout Note. Recommendation is to keep all tracks between MCU and USB PHI less than 3" See additional SMSC Layout guidelines PDF to the right



USB Host, Type A (Available on all packages)

(Layout Note: Route DP and DM with 90 Ohm Differential Pair. Keep tracks as short as possible)

Layout Note: Place caps & resistor as close to device as possible

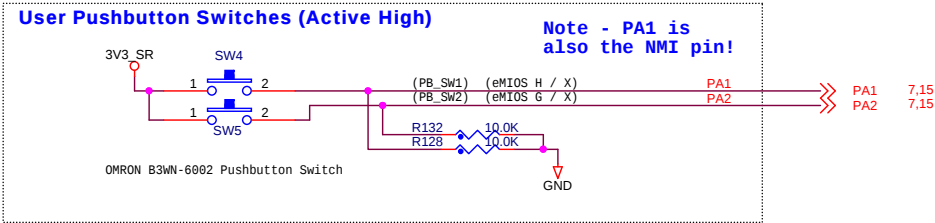
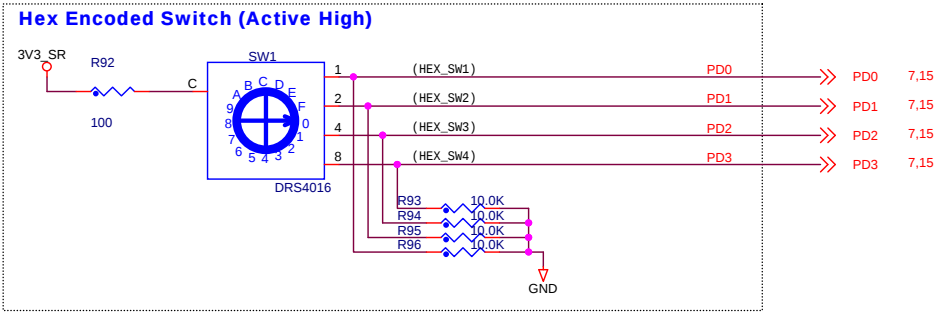
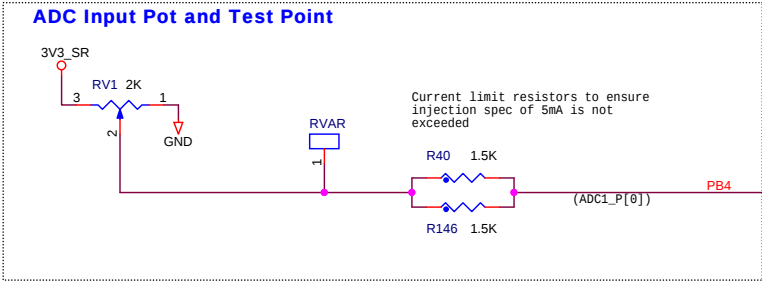
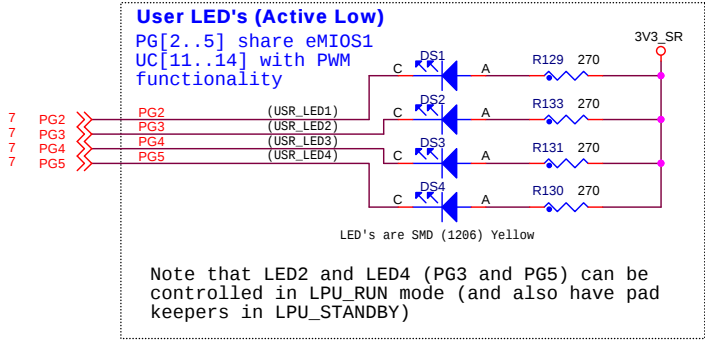


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USB Type A / Type AB			
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User Peripheralls (Led's, Switches and ADC Pot)

Switches are hard wired to 3.3V rather than 5V so it's not possible to drive 5V into a 3.3V pad (which would cause damage)
Similarly, the LED's are active low with 3.3v supply so can be safely coupled to pads on either 3.3V or 5V domains
The ADC input is limited to 3.3V, again to prevent driving 5V into a 3.3V pad which would cause damage

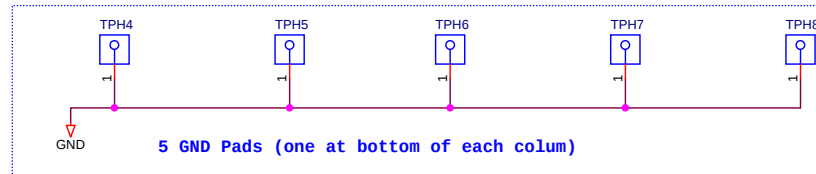
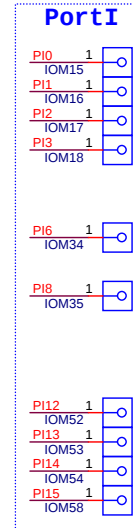
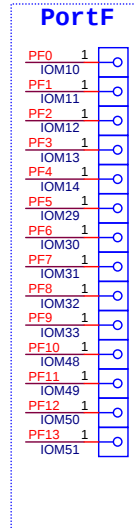
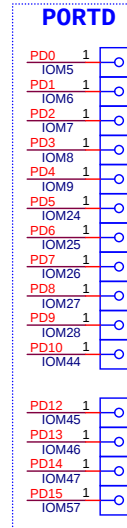
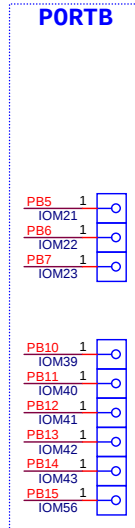
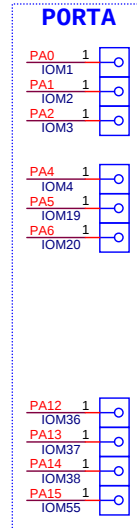


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GPIO Pin Matrix

All pads are DNP (Do Not Populate) 0.1" pitch headers placed on a 0.1" grid

PA[1,2] shared with user switches	7	PA0	PA0
	7,14	PA1	PA1
	7,14	PA2	PA2
	7	PA4	PA4
	7	PA5	PA5
	7	PA6	PA6
	7	PA12	PA12
	7	PA13	PA13
	7	PA14	PA14
	7	PA15	PA15
	7	PB5	PB5
	7	PB6	PB6
	7	PB7	PB7
	7	PB10	PB10
	7	PB11	PB11
PD[0..3] shared with Hex Switch	7	PB12	PB12
	7	PB13	PB13
	7	PB14	PB14
	7	PB15	PB15
	7,14	PD0	PD0
	7,14	PD1	PD1
	7,14	PD2	PD2
	7,14	PD3	PD3
	7	PD4	PD4
	7	PD5	PD5
	7	PD6	PD6
	7	PD7	PD7
	7	PD8	PD8
	7	PD9	PD9
	7	PD10	PD10
PF0	7	PF0	PF0
	7	PF1	PF1
	7	PF2	PF2
	7	PF3	PF3
	7	PF4	PF4
	7	PF5	PF5
	7	PF6	PF6
	7	PF7	PF7
	7	PF8	PF8
	7	PF9	PF9
	7	PF10	PF10
	7	PF11	PF11
	7	PF12	PF12
	7	PF13	PF13
	8	PI0	PI0
PI1	8	PI1	PI1
	8	PI2	PI2
	8	PI3	PI3
	8	PI6	PI6
	8	PI8	PI8
	8	PI12	PI12
	8	PI13	PI13
PI14	8	PI14	PI14
	8	PI15	PI15



Layout Notes:

- Pads must be placed in a 5 (W) x 16(H) matrix pattern, 2.54 mm pitch
- one column for each port
- 16 tall (1 row for each port number from 0 to 15).
- GND pad at bottom of each column
- After production, pads should be through hole (not solder filled)

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