Hercules™ TMS570LS0432 / RM42L432 LaunchPad

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Trademarks

Hercules is a trademark of Texas Instruments.

1 Kit Overview

The LAUNCHXL-TMS57004 and LAUNCHXL-RM42 LaunchPad kits from Texas Instruments provide a low cost vehicle to evaluate and develop with members of the Hercules family that are based on either the TMS570LS0432 or RM42L432 microcontrollers. Both kits are identical except for the Hercules microcontroller that is hosted by the kit. Figure 1 shows a photo of one of these kits with the major components labeled.

Project collateral and source files discussed in this application report can be downloaded from the following URL: http://www.ti.com/lit/zip/spnu612.

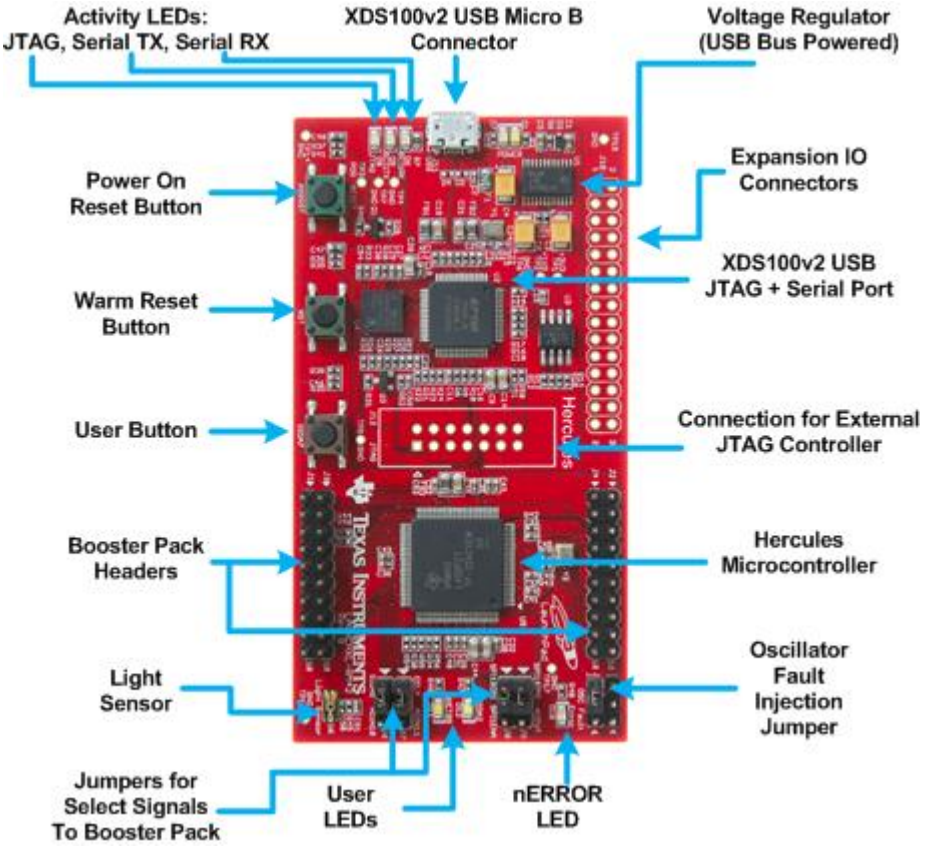


Figure 1. Hercules RM42L432 / TMS570LS0432 LaunchPad

1.1 Kit Contents

Each kit contains:

1. One LaunchPad Board with:
   (a) On Board XDS100v2 Debug Interface
   (b) Hercules Microcontroller with 384KB Flash and 32KB RAM in 100 Pin PZ Package
      (i) LAUNCHXL-RM42 includes the 100MHz RM42L432
      (ii) LAUNCHXL-TMS57004 includes the 80MHz TMS570LS0432
   (c) One BoosterPack site and One Expansion Connector
2. USB micro-B plug to USB-A plug cable
3. Hercules LaunchPad Quick Start Guide - RM42 or Hercules LaunchPad Quick Start Guide - TMS570LS04x/TMS570LS03x
4. Standard Terms and Conditions for Evaluation Modules

1.2 Specifications

Key operating specifications for the LaunchPad are listed in Table 1 .

Table 1. LAUNCHXL-RM42 and LAUNCHXL-TMS57004 Specifications

Parameter	Value
Board Supply Voltage	4.75 V_{DC} to 5.25 V_{DC} from USB Micro-B cable or Booster Pack Header
Power Available to Expansion Boards (Total)	Sum of +5V, +3.3 V Supply Current: 10mA max for USB Bus Powered Operation
Dimensions	94 mm x 50 mm x 15 mm (L x W x H)
Operating Temperature Range	Room Temperature Operation Only

2 Hardware Description

2.1 Block Diagram

Figure 2 shows a block diagram of the LaunchPad printed circuit board. The major components of the board are described in the sections that follow.

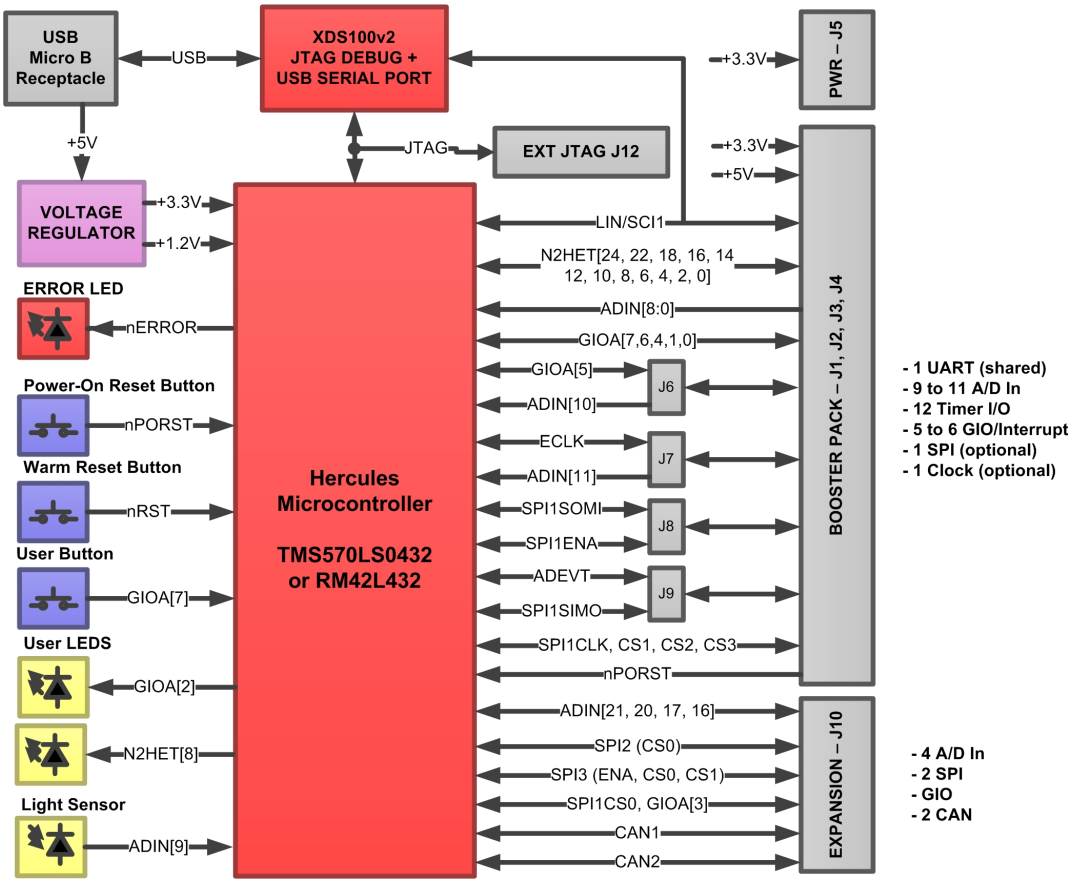


Figure 2. Hercules RM42L432 / TMS570LS0432 LaunchPad Block Diagram

2.1.1 Hercules Microcontroller

2.1.1.1 TMS570LS0432 MCU (LAUNCHXL-TMS570LS04)

The TMS570LS0432 device is a high-performance automotive-grade microcontroller for safety systems. The safety architecture includes dual CPUs in lockstep, CPU and Memory BIST logic, ECC on both the flash and the data SRAM, parity on peripheral memories, and loopback capability on peripheral I/Os.

The TMS570LS0432 device integrates the ARM Cortex-R4 CPU. The CPU offers an efficient 1.66 DMIPS/MHz, and has configurations that can run up to 80 MHz, providing up to 132 DMIPS. The device supports the big-endian (BE32) format.

The TMS570LS0432 device has 384KB of integrated flash and 32KB of data RAM. Both the flash and RAM have single-bit error correction and double-bit error detection. The flash memory on this device is a nonvolatile, electrically erasable, and programmable memory implemented with a 64-bit-wide data bus interface. The flash operates on a 3.3-V supply input (the same level as I/O supply) for all read, program, and erase operations. When in pipeline mode, the flash operates with a system clock frequency of 80 MHz. The SRAM supports single-cycle read and write accesses in byte, halfword, word, and double-word modes throughout the supported frequency range.

For additional information, refer to the device product folder: http://www.ti.com/product/TMS570LS0432.

2.1.1.2 RM42L432 MCU (LAUNCHXL-RM42)

The RM42L432 device is a high-performance microcontroller for safety systems. The safety architecture includes dual CPUs in lockstep, CPU and Memory BIST logic, ECC on both the flash and the data SRAM, parity on peripheral memories, and loopback capability on peripheral I/Os.

The RM42L432 device integrates the ARM Cortex-R4 CPU. The CPU offers an efficient 1.66 DMIPS/MHz, and has configurations that can run up to 100 MHz, providing up to 166 DMIPS. The device operates in little-endian (LE) mode.

The RM42L432 device has 384KB of integrated flash and 32KB of data RAM. Both the flash and RAM have single-bit error correction and double-bit error detection. The flash memory on this device is a nonvolatile, electrically erasable, and programmable memory implemented with a 64-bit-wide data bus interface. The flash operates on a 3.3-V supply input (the same level as I/O supply) for all read, program, and erase operations. When in pipeline mode, the flash operates with a system clock frequency of up to 100 MHz. The SRAM supports single-cycle read and write accesses in byte, halfword, word, and double-word modes throughout the supported frequency range.

For additional information, refer to the device product folder: http://www.ti.com/product/rm42l432.

2.1.2 XDS100v2 JTAG Debugger and USB Serial Port

An XDS100v2 Debug Probe is integrated onto the LaunchPad to make getting started with the LaunchPad as seamless as possible. This emulator is supported by Code Composer Studio and other third party IDEs.

The XDS100v2 is a USB composite device consisting of two functions:

- TI XDS100 debug probe
- A USB Serial Port

Each function may be used independently, for example it is possible to use the XDS100 debug probe with Code Composer Studio and at the same time connect to the USB Serial Port with any terminal program. The USB serial port provides a convenient method to interact with the Hercules microcontroller through the microcontroller LIN/SCI peripheral.

2.1.3 Voltage Regulator

The LaunchPad includes an on-board Low Dropout Voltage Regulator (TPS70445) that supplies the 3.3V and 1.2V power rails required by the MCU and XDS100V2 from the USB Bus. In normal operation, the LaunchPad operates as a USB bus powered device.

The On-Board LDO is rated for up to 1A on the 3.3V rail, but USB bus powered devices are limited to drawing less than 500mA from the USB Bus. If BoosterPacks are added to the LaunchPad and more current is required by the booster packs than is specified in Table 1, then the LaunchPad should be converted so that it operates as a self-powered USB device. In this case, it is recommended to:

- Remove fuse F1 so that the LaunchPad (when operating as a self powered device) does not back power the USB bus VBUS rail.
- Supply the LaunchPad with a fused +5 V rail from header J3 or J10.
- Use the +3.3 V IO rail provided by the LaunchPad on-board voltage regulator and available on J1 and J10 to power any interface logic between the MCU and booster packs.
- Avoid supplying a regulated +3.3 V rail from the BoosterPack as this would conflict with the LaunchPad on-board LDO regulator.

2.1.4 LEDs

There are eight LEDs on the LaunchPad. Two of the LEDs are available for use by application code running on the MCU (D11, D12). Table 2 contains a summary of the LaunchPad LEDs and their purpose.

Table 2. LEDs

LED	Color	Driver	Description
D1	White	+5 V	+5 V Power Indicator
D5	Blue	XDS100v2	Indicates USB Serial Port Transmit Activity
D6	Blue	XDS100v2	Indicates USB Serial Port Receive Activity
D7	Blue	+3.3 V	+3.3 V Power Indicator
D8	Blue	XDS100v2	Indicates JTAG Activity
D10	Red	MCU nERROR Pin	Indicates Error Detected by MCU ESM Module
D11	White	MCU GIOA[2]/SPI3nCS[1] Pin	General Purpose Indicator LED. Drive pin to logic high to light LED.
D12	White	MCU N2HET[8] Pin	General Purpose Indicator LED. Drive pin to logic high to light LED.

2.1.5 Push Buttons

There are three pushbutton switches on the LaunchPad, described in Table 3. There are many subtle differences between a warm reset (S2) and power on reset (S3) but the main difference involves certain error and reset status flags that are only cleared during a power on reset.

Table 3. Push Button Switches

Switch	MCU Pin	Description
S1	GIOA[7]	General Purpose User Input. GIOA[7] reads '0' when the button is pressed, '1' when the button is released.
S2	nRST	Pressing the button asserts a warm reset (nRST).
S3	nPORRST	Pressing the button asserts a power on reset (nPORRST).

2.1.6 Light Sensor

To demonstrate the capabilities of the TMS570LS0432 / RM42 A/D Converter, the LaunchPad includes an Ambient Light Sensor (Vishay TEMT6000). The light sensor is tied to ADIN[9].

2.1.7 Oscillator Failure Jumper

The MCU is capable of detecting a failure on its external oscillator and of automatically switching to an on chip oscillator so that the MCU may continue to operate in the event of such a failure. To demonstrate this capability, a shunt installed on jumper JP1 will short the oscillator to ground causing it to 'fail'. This jumper should be removed for normal operation.

2.1.8 Booster Pack Headers

The LaunchPad supports Booster Packs through headers J1, J2, J3, and J4. The pinout of each header is described in Table 4 - Table 7.

The official TI list of BoosterPacks can be found at www.ti.com/boosterpacks.

Note that four of the connections to the MCU for J1 and J2 map to two different MCU pins depending on the settings of J6, J7, J8, J9. These are three pin jumpers. The first MCU function listed is selected by placing a shunt across pins 1-2 of the three pin jumper; and the second function listed is selected by placing a shunt across pins 2-3 of the jumper.

The ADC inputs on the BoosterPack are limited to the range of 0 V_{DC} - 3.3 V_{DC}. Note that the ADC on the TMS570LS0432 and RM42L432 MCU only supports inputs in this voltage range; where other members of the TMS570 and RM4 series of MCUs support up to +5V on the ADC input.

All of the digital I/O on the BoosterPack (and Expansion) headers are 3.3 V LVCMOS. A transceiver is usually required before connecting to a serial bus (ex. CAN or RS-232). There are no transceivers on the LaunchPad itself.

Table 4. Booster Pack J1 Connections

Header	Header Pin	MCU	MCU Pin	Description
J1	1			+3V3
J1	2	U5	57	ADIN[8]
J1	3	U5	94	LINRX through R44
J1	4	U5	95	LINTX through R46
J1	5	U5	10 or 50	GIOA5/EXTCLKIN or ADIN[10] (selected by J6)
J1	6	U5	84 or 53	ECLK or ADIN[11] (selected by J7)
J1	7	U5	67	MIBSPI1CLK
J1	8	U5	93	MIBSPI1nCS[1]/EQEPS/N2HET[17]
J1	9	U5	27	MIBSPI1nCS[2]/N2HET[20]/N2HET[19]
J1	10	U5	39	MIBSPI1nCS[3]/N2HET[26]

Table 5. Booster Pack J2 Connections

Header	Header Pin	MCU	MCU Pin	Description
J2	1			GND
J2	2	U5	64	N2HET[24]
J2	3	U5	1	GIOA[0]/SPI3nCS[3]
]J2	4	U5	2	GIOA[1]/SPI3nCS[2]
J2	5	U5	31	nPORRST
J2	6	U5	65 or 58	MIBSPI1SIMO or ADEVT (selected by J9)
J2	7	U5	66 or 68	MIBSPI1SOMI or MIBSPI1nENA/N2HET[23]/N2HET[30] (selected by J8)
J2	8	U5	12	GIOA[6]/SPI2nCS[1]/N2HET[31]
J2	9	U5	18	GIOA[7]/N2HET[29]
J2	10	U5	9	GIOA[4]/SPI2nCS[2]

Table 6. Booster Pack J3 Connections

Header	Header Pin	MCU	MCU Pin	Description
J3	1			+5 V
J3	2			GND
J3	3	U5	42	ADIN[0]
J3	4	U5	49	ADIN[1]
J3	5	U5	51	ADIN[2]
J3	6	U5	52	ADIN[3]
J3	7	U5	54	ADIN[4]
J3	8	U5	55	ADIN[5]
J3	9	U5	56	ADIN[6]
J3	10	U5	43	ADIN[7]

Table 7. Booster Pack J4 Connections

Header	Header Pin	MCU	MCU Pin	Description
J4	1	U5	19	N2HET[0]
J4	2	U5	22	N2HET[2]
J4	3	U5	25	N2HET[4]
J4	4	U5	26	N2HET[6]
J4	5	U5	83	N2HET[10]
J4	6	U5	89	N2HET[12]
J4	7	U5	90	N2HET[14]
J4	8	U5	97	N2HET[16]
J4	9	U5	98	N2HET[18]
J4	10	U5	11	N2HET[22]

2.1.9 Expansion Header

The MCU IO pins that are not routed to the Booster Pack headers are available on expansion header J10. This is not installed by default. It is a 2 row, 15 pin per row, 0.100" pitch header footprint. The MCU signals available at this header are listed in Table 8.

The ADC inputs on the Expansion Header are limited to the range of 0 V_{DC} - 3.3 V_{DC}. Note that the ADC on the TMS570LS0432 and RM42L432 MCU only supports inputs in this range.

All of the digital I/O on the BoosterPack (and Expansion) headers are 3.3V LVCMOS. A transceiver is usually required before connecting to a serial bus (ex. CAN or RS-232). There are no transceivers on the LaunchPad itself.

Table 8. Expansion Header J10 Connections

Header	Header Pin	MCU	MCU Pin	Description
J10	1			+5V
J10	2			+3V3
J10	3			GND
J10	4			GND
J10	5	U5	40	ADIN[16]
J10	6	U5	41	ADIN[17]
J10	7	U5	44	ADIN[20]
J10	8	U5	45	ADIN[21]
J10	9			GND
J10	10			GND
J10	11	U5	36	SPI3CLK/EQEPA
J10	12	U5	34	SPI3SOMI
J10	13	U5	38	SPI3nCS[0]/EQEPI
J10	14	U5	35	SPI3SIMO
J10	15	U5	37	SPI3nENA/EQEPB
J10	16	U5	73	MIBSPI1nCS[0]
J10	17	U5	93	MIBSPI1nCS[1]/EQEPS/N2HET[17]
J10	18	U5	8	GIOA[3]/SPI2nCS[3]
J10	19			GND
J10	20			GND
J10	21	U5	23	SPI2nCS[0]
J10	22	U5	69	SPI2SOMI
J10	23	U5	70	SPI2SIMO
J10	24	U5	71	SPI2CLK
J10	25	U5	62	CAN1TX
J10	26	U5	63	CAN1RX
J10	27	U5	91	CAN2TX
J10	28	U5	92	CAN2RX
J10	29			GND
J10	30			GND

2.1.10 External JTAG Header

Header J12 allows the use of an external (presumably faster or more convenient) JTAG controller with the LaunchPad, in place of the on-board XDS100v2.

This header is not populated. The footprint supports a 14-pin TI JTAG header. You can install a header such as the SAMTEC TSM-17-DV in this footprint. Make sure that pin 6 of the header you install is removed as this is used as a key.

The LaunchPad on-board XDS100v2 will detect the external emulator by sensing that pin J12-8 is pulled to ground and this will cause it to au tomatically 3-state its drive of the MCU JTAG lines and allow the external JTAG emulator to take control of the MCU.

Table 9. External JTAG Debug Header

Header	Header Pin	MCU	MCU Pin	Description
J12	1	U5	75	TMS
J12	2	U5	76	nTRST
J12	3	U5	77	TDI
J12	4			GND
J12	5			+3V3
J12	6			key - no remove pin from header before installing
J12	7	U5	78	TDO
J12	8			JTAG_SEL
J12	9	U5	80	RTCK
J12	10			GND
J12	11	U5	79	TCK
J12	12			GND
J12	13			pulled to +3.3 V via 10K R51
J12	14			pulled to +3.3 V via 10K R51

3 Software Development

3.1 Hercules Safety MCU Demos

The LaunchPad is preprogrammed with code that supports the Hercules Safety MCU Demos. The demo GUI client as well as the MCU driver code can be downloaded from http://www.ti.com/tool/hercules_safety_mcu_demos.

The demo launch page is show in Figure 3. This screen appears when the demo is launched, and a LaunchPad containing the demo code is detected on the host PC. If no LaunchPad is connected to the host, or if a LaunchPad is connected but it does contain the MCU safety demo code (for example, if the LaunchPad has been erased/reprogrammed) then a different set of screens will appear prompting the user to either plug in or reprogram the LaunchPad.

The main safety feature demo screen is shown in Figure 4. This demo allows the user to exercise the safety features of the device by either running built in self tests or inserting error conditions and showing that the diagnostic logic on the device catches the error.

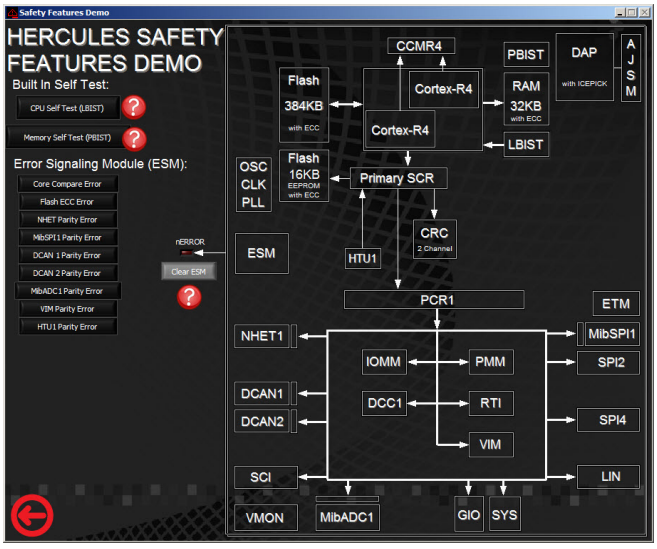


Figure 3. Demo GUI Main Screen

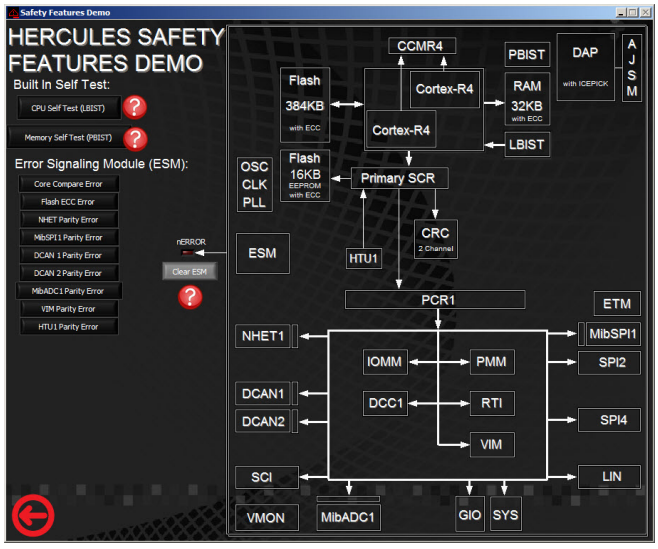


Figure 4. Safety Features Demo

3.2 Hardware Abstraction Layer Code Generator for Hercules MCUs (HALOGEN)

HALOGEN provides a graphical user interface that allows the user to configure peripherals, interrupts, clocks, and other microcontroller parameters. Once the device is configured, the user can generate peripheral initialization and driver code, which can be imported into CCS, IAR Workbench, or Keil uVision.

HALCoGen is available from http://www.ti.com/tool/halcogen. The files that are generated by HalCoGen are distributed under an open-source (BSD style) license.

3.3 Code Composer Studio

Code Composer Studio includes an optimizing C/C++ compiler, source code editor, project build environment, debugger, profiler, and many other features. It is available for download from http://www.ti.com/tool/ccstudio-safety.

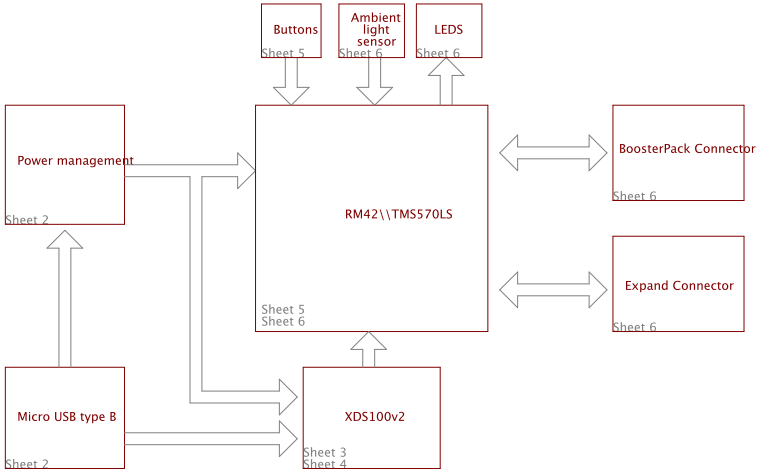
3.4 Other Tools and Software

Other available tools and software for Hercules MCUs can be found on the "Tools & Software" tab in the MCU Product folder, or http://www.ti.com/lsds/ti/microcontrollers_16-bit_32-bit/c2000_performance/safety/tools_software.page.

Schematics

A.1 Schematics

REVISION HISTORY----------REV C: - No changes to schematic other than revision history and letter - PCB BOM updated for Revison B Silicon, and LED part # Change - PCB top copper pour cutout added where pour feature size was less than min. allowed.



Note:"DNP" mean the component is not populated by default.

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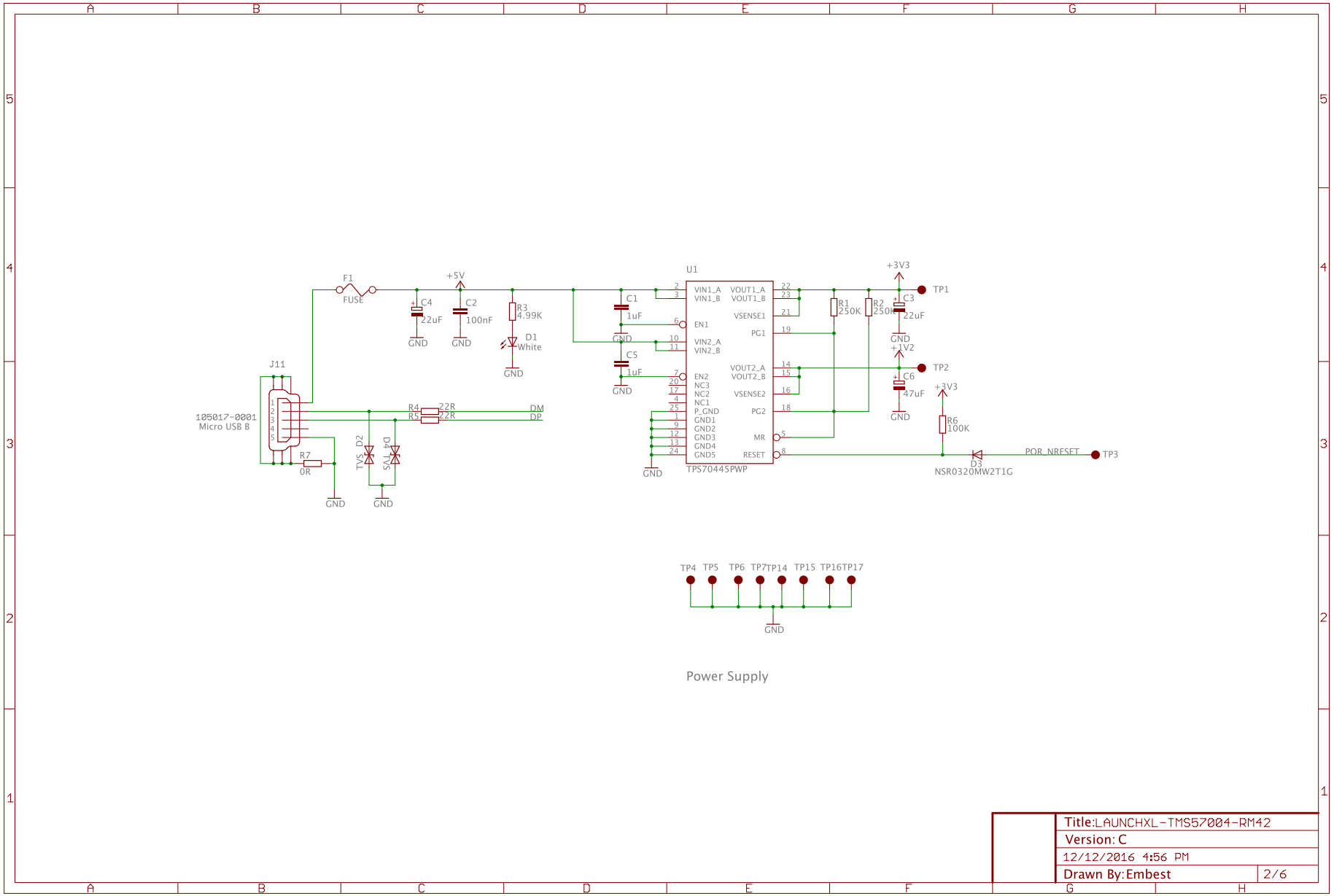
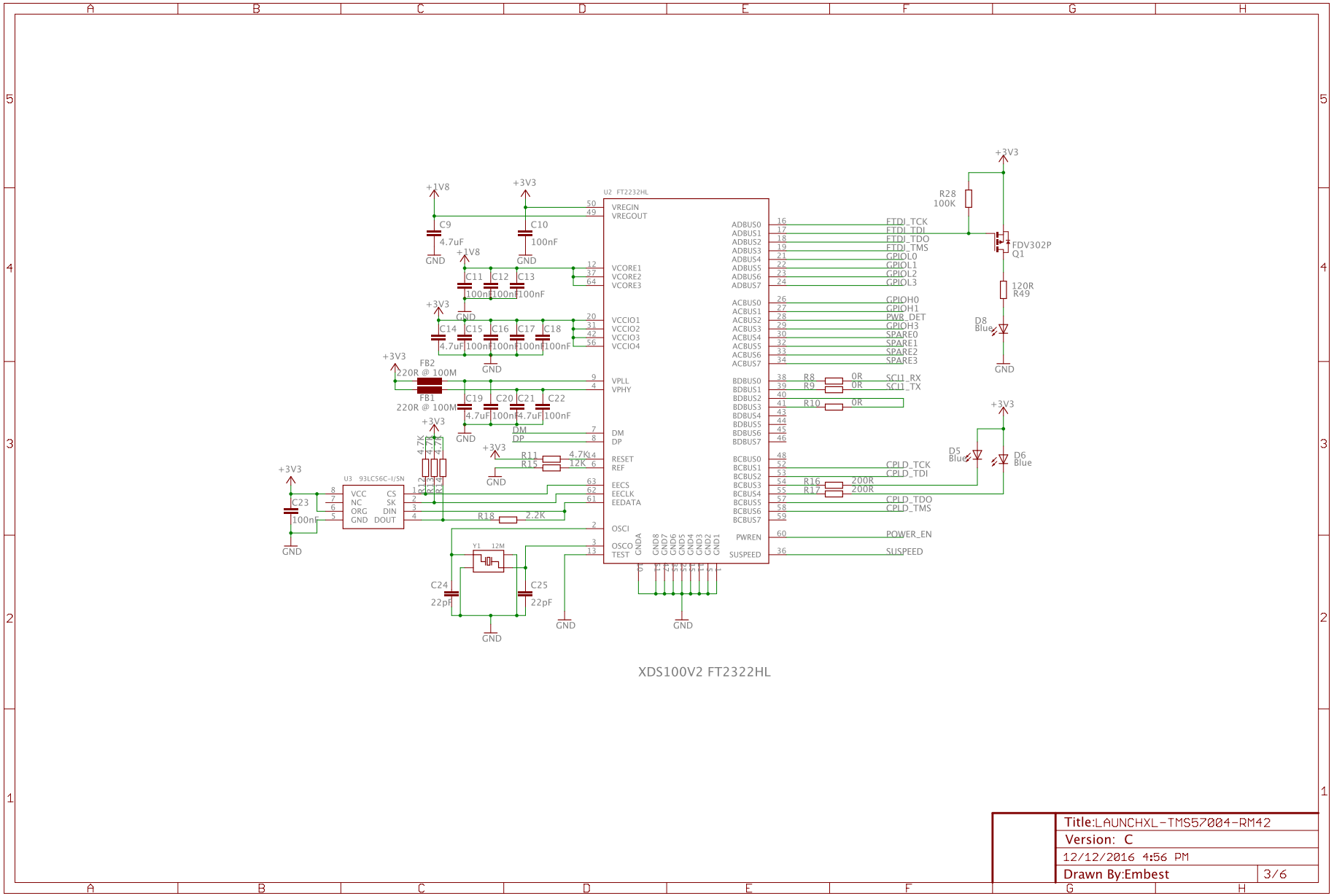
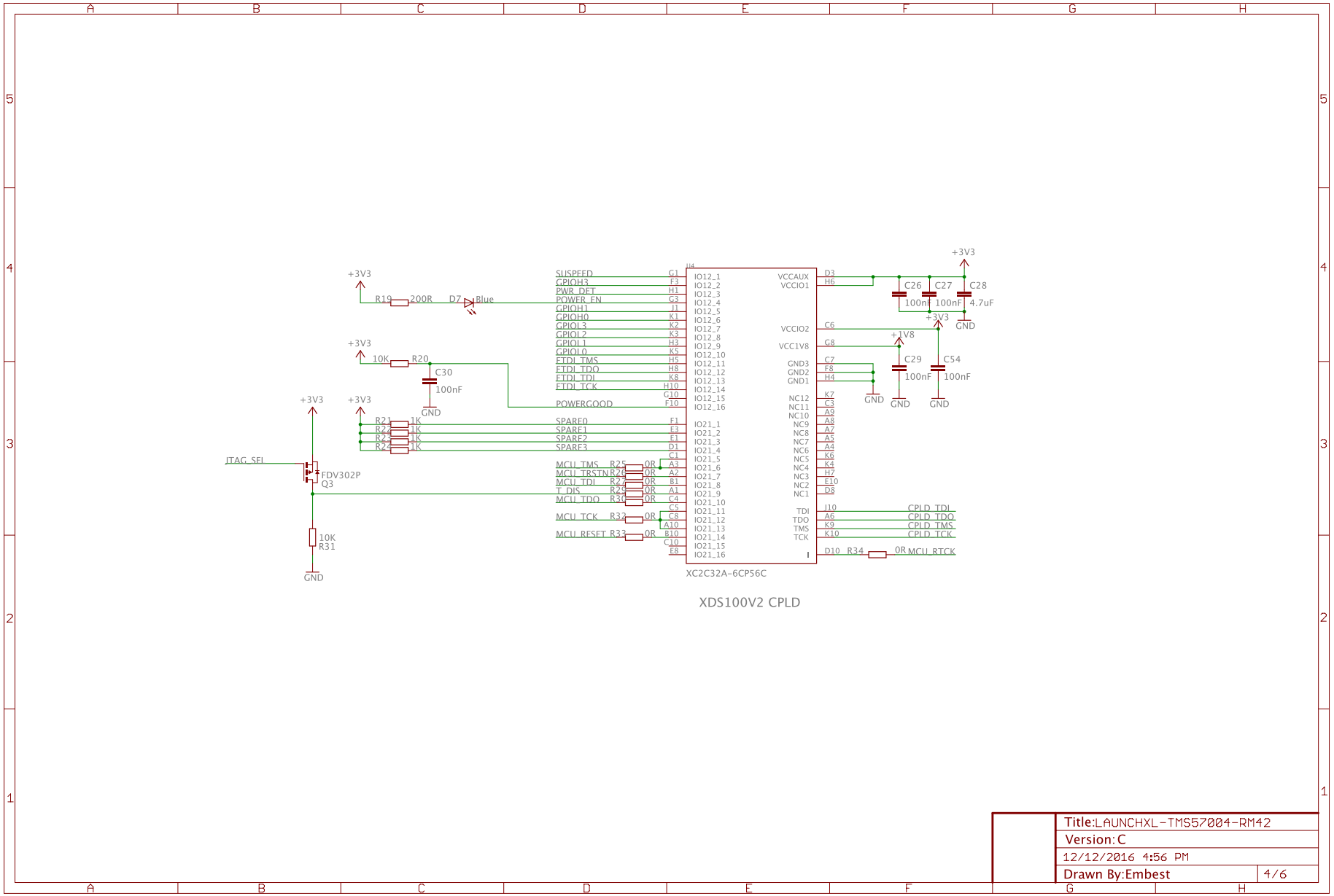
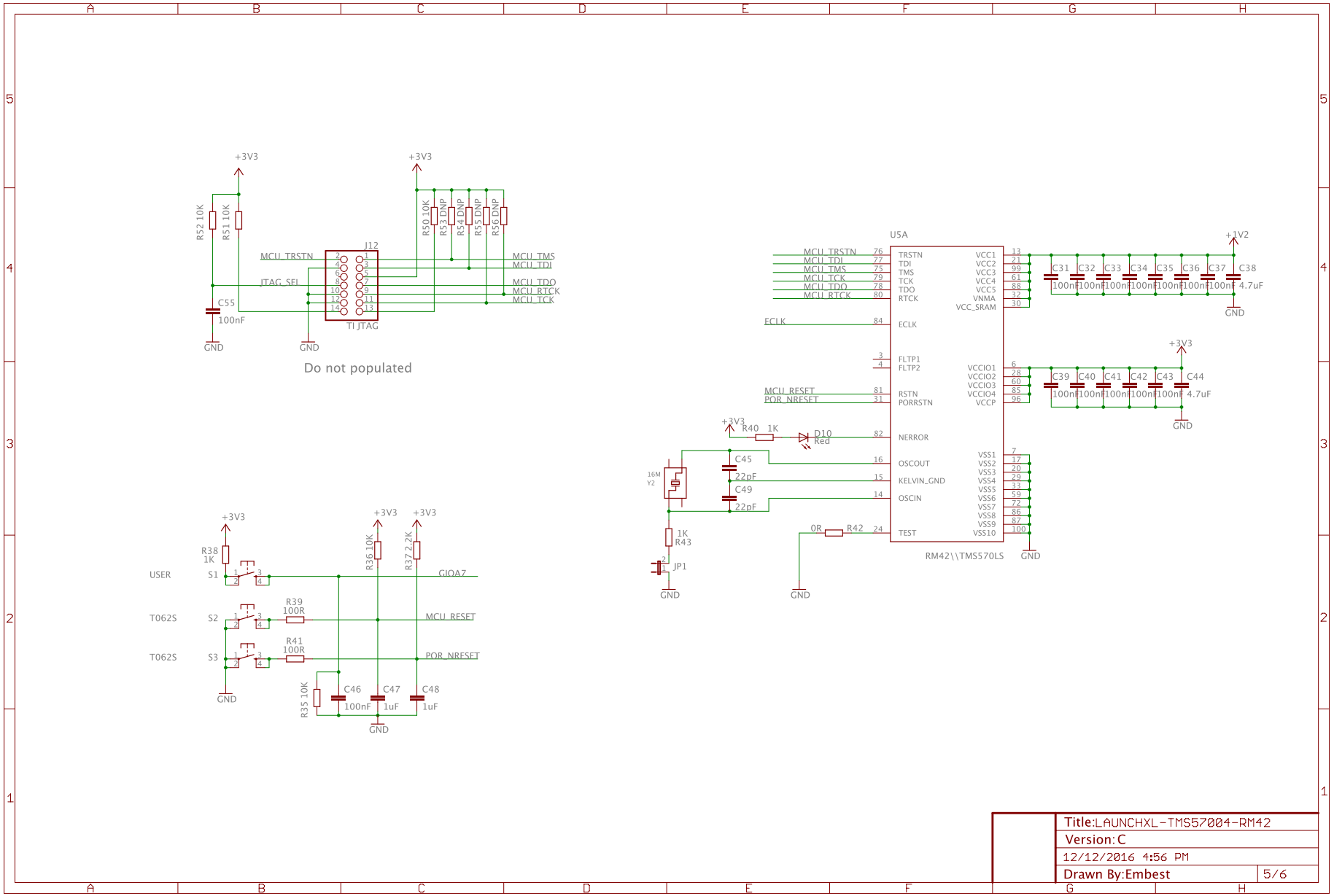
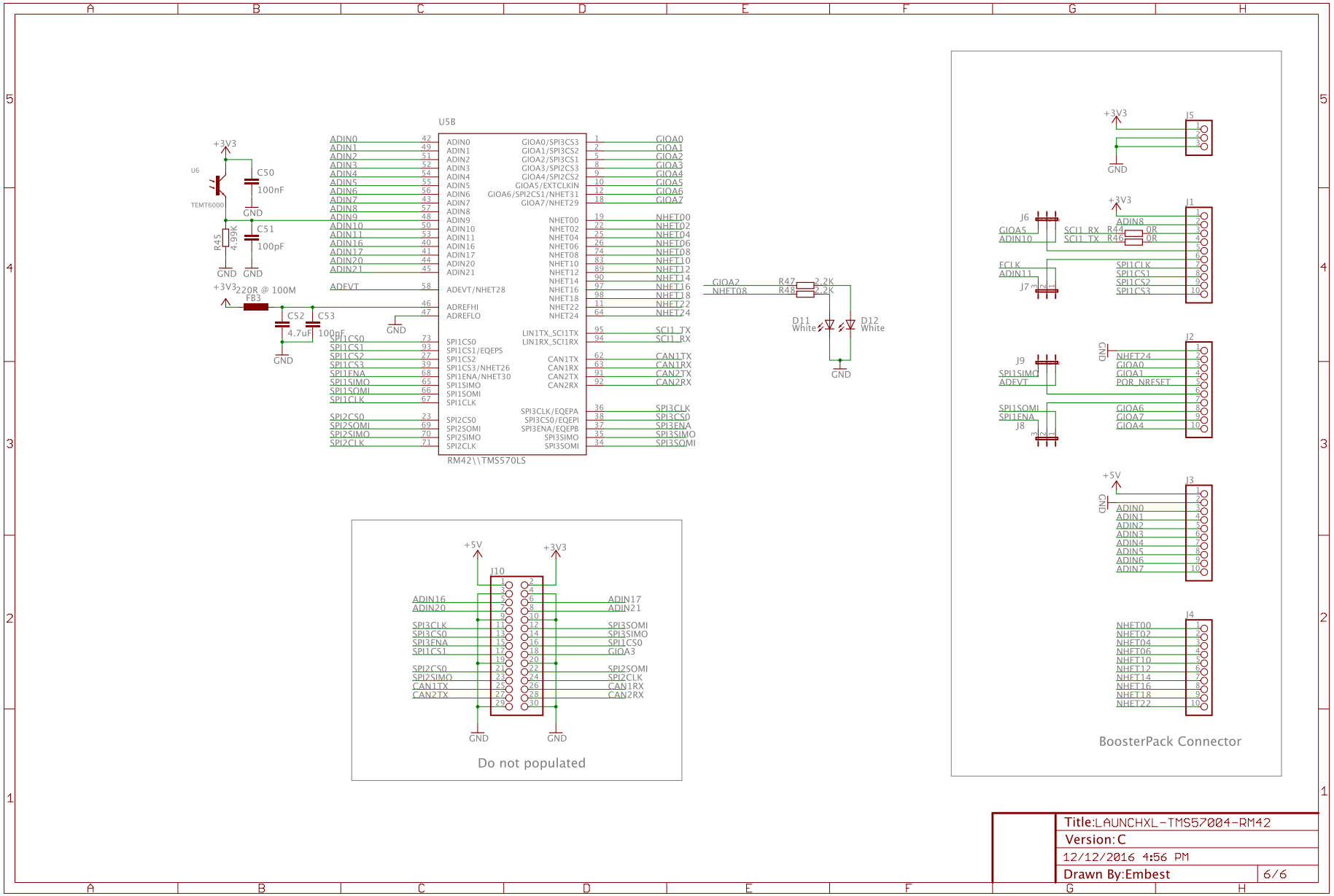
Version:	C
	12/12/2016 4:56 PM
Drawn By:	Embest 1/6











Design File Sources

B.1 Design File Sources

Design file sources are available for download from: http://www.ti.com/lit/zip/spnu612.

Regulatory Information

C.1 EMC Compliance

This is a class A product as defined by standard EN 61326-1:2013. For important information regarding the use of this product in a domestic environment, see the attached “STANDARD TERMS FOR EVALUATION MODULES”.

C.2 Electrostatic Discharge Caution

This EVM can be damaged by ESD. Texas Instruments recommends this EVM be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications. For more information on proper handling, see Electrostatic Discharge (ESD) .

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (January 2017) to A Revision	Page
• Added Appendix C.	20

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