TMS320C5515 Fingerprint Development Kit (FDK) Hardware Guide

User's Guide

Literature Number: SPRUFX3D
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Read This First

The C5515 Fingerprint Development Kit (FDK) hardware guide provides all the hardware features that will assist manufacturers and developers who are interested in integrating fingerprint biometrics features into their product.

The following link allows contains the core board schematics and extension board schematics for the C5515 FDK: sprufx3.zip

Related Documentation From Texas Instruments

The following documents describe the TMS320C5515 documentation. Copies of these documents are available on the Internet at http://www.ti.com. *Tip:* Enter the literature number in the search box provided at www.ti.com.

SPRS645 — TMS320C5515 Fixed-Point Digital Signal Processor Data Manual. This document describes the C5515 fixed-point digital signal processor.

SWPU073 — TMS320C55x 3.0 CPU Reference Guide. This manual describes the architecture, registers, and operation of the fixed-point TMS320C55x digital signal processor (DSP) CPU.

SPRU652 — TMS320C55x DSP CPU Programmer's Reference Supplement. This document describes functional exceptions to the CPU behavior.

SPRUFO1 — TMS320C5515/14/05/04/VC05/VC04 Digital Signal Processor (DSP) Inter-Integrated Circuit (I2C) Peripheral User's Guide. This document describes the inter-integrated circuit (I2C) peripheral in the TMS320C5515/14/05/04/VC05/VC04 Digital Signal Processor (DSP) devices. The I2C peripheral provides an interface between the device and other devices compliant with Phillips Semiconductors Inter-IC bus (I2C-bus) specification version 2.1 and connected by way of an I2C-bus. This document assumes the reader is familiar with the I2C-bus specification.

SPRUFO2 — TMS320C5515/14/05/04/VC05/VC04 Digital Signal Processor (DSP) Timer/Watchdog Timer User's Guide. This document provides an overview of the three 32-bit timers in the TMS320C5515/14/05/04/VC05/VC04 Digital Signal Processor (DSP) devices. The 32-bit timers of the device are software programmable timers that can be configured as general-purpose (GP) timers. Timer 2 can be configured as a GP, a Watchdog (WD), or both simultaneously.

SPRUFO3 — TMS320C5515/14/05/04/VC05/VC04 Digital Signal Processor (DSP) Serial Peripheral Interface (SPI) User's Guide. This document describes the serial peripheral interface (SPI) in the TMS320C5515/14/05/04/VC05/VC04 Digital Signal Processor (DSP) devices. The SPI is a high-speed synchronous serial input/output port that allows a serial bit stream of programmed length (1 to 32 bits) to be shifted into and out of the device at a programmed bit-transfer rate. The SPI supports multi-chip operation of up to four SPI slave devices. The SPI can operate as a master device only.

SPRUFO4 — TMS320C5515/14/05/04/VC05/VC04 Digital Signal Processor (DSP) General-Purpose Input/Output (GPIO) User's Guide. This document describes the general-purpose input/output (GPIO) on the TMS320C5515/14/05/04/VC05/VC04 digital signal processor (DSP) devices. The GPIO peripheral provides dedicated general-purpose pins that can be configured as either inputs or outputs. When configured as an input, you can detect the state of an internal register. When configured as an output you can write to an internal register to control the state driven on the output pin.

SPRUFO5 — TMS320C5515/14/05/04/VC05/VC04 Digital Signal Processor (DSP) Universal Asynchronous Receiver/Transmitter (UART) User's Guide. This document describes the universal asynchronous receiver/transmitter (UART) peripheral in the TMS320C5515/14/05/04/VC05/VC04 Digital Signal Processor (DSP) devices. The UART performs serial-to-parallel conversions on data received from a peripheral device and parallel-to-serial conversion on data received from the CPU.

SPRUFP1 — TMS320C5515/05/VC05 Digital Signal Processor (DSP) Successive Approximation (SAR) Analog to Digital Converter (ADC) User's Guide. This document provides an overview of the Successive Approximation (SAR) Analog to Digital Converter (ADC) on the TMS320C5515/14/05/04/VC05/VC04 Digital Signal Processor (DSP) devices. The SAR is a 10-bit ADC using a switched capacitor architecture which converts an analog input signal to a digital value.

SPRUFP3 — TMS320C5515/05/VC05 Digital Signal Processor (DSP) Liquid Crystal Display Controller (LCDC) User's Guide. This document describes the liquid crystal display controller (LCDC) in the TMS320C5515/14/05/04/VC05/VC04 Digital Signal Processor (DSP) devices. The LCD controller includes a LCD Interface Display Driver (LIDD) controller.

SPRUFX2 — TMS320C5515/14/05/04 DSP Real-Time Clock (RTC) User's Guide. This document describes features and operation of the real-time clock (RTC) on the TMS320C5515/14/05/04 Digital Signal Processor (DSP).

SPRUFX3 — PLC System-on-Module Serial Application Program Interface User's Guide. This document describes the Application Program Interface (API) to the PLC System-on-Module (SoM).

SPRUFX4 — TMS320C5515/14/05/04 DSP Inter-IC Sound (I2S) Bus User's Guide This document describes the features and operation of the Inter-IC Sound (I2S) Bus on the TMS320C5515/14/05/04 Digital Signal Processor (DSP). This peripheral allows serial transfer of full duplex streaming data, usually streaming audio, between DSP and an external I2S peripheral such as an audio codec.

SPRUFX5 — TMS320C5515 DSP System User's Guide. his document describes various aspects of the C5504/5505 digital signal processor (DSP) including: system memory, device clocking options and operation of the DSP clock generator, power management features, interrupts, and system control.

SPRUGU6 — TMS320C5515/14/05/04 DSP External Memory Interface (EMIF) User's Guide. This document describes the operation of the External Memory Interface (EMIF) in the Digital Signal Processor (DSP).

1 Overview

The C5515 Fingerprint Development Kit (FDK) is a complete signal chain solution that enables manufacturers and developers, who are interested in integrating fingerprint biometrics features into their product, to go to market faster. The kit contains two widely-used fingerprint sensor types (1 swipe sensor and 1 optical sensor), one core board with Texas Instruments' latest C5515 low power digital signal processor, and one extension board for power supply and user interaction.

The kit also includes complete hardware design collateral, simplified application source code, and technical documentation including a user's guide, and application notes, to help users understand how to develop a fingerprint application. A production quality demo and binary files for swipe and optical sensors are also included in the kit to enable users to experience the final product performance. Some target applications include fingerprint-enabled physical access control products (electronic door locks and safe boxes), USB smart keys and storage device, PC user identification, and time and attendance monitoring systems.

Figure 1 and Figure 2 show the top and bottom views of the FDK core board, and Figure 3 and Figure 4 show the top and bottom views of the FDK extension board. The part number for the FDK is TMDXBDKFP5515.

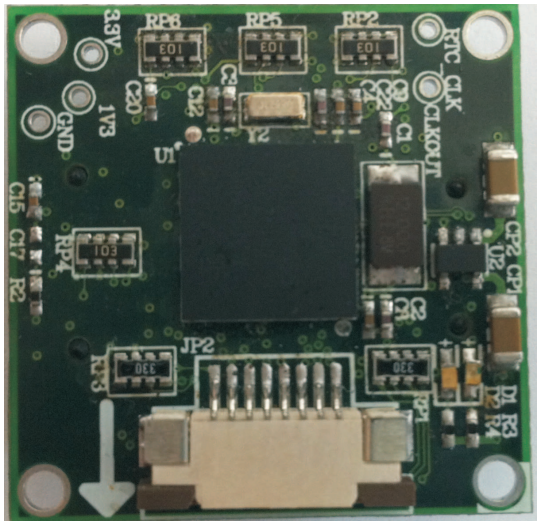

Figure 1. FDK Core Board Top View

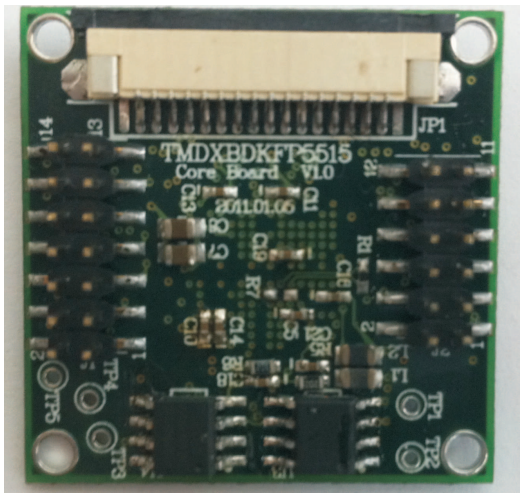

Figure 2. FDK Core Board Bottom View

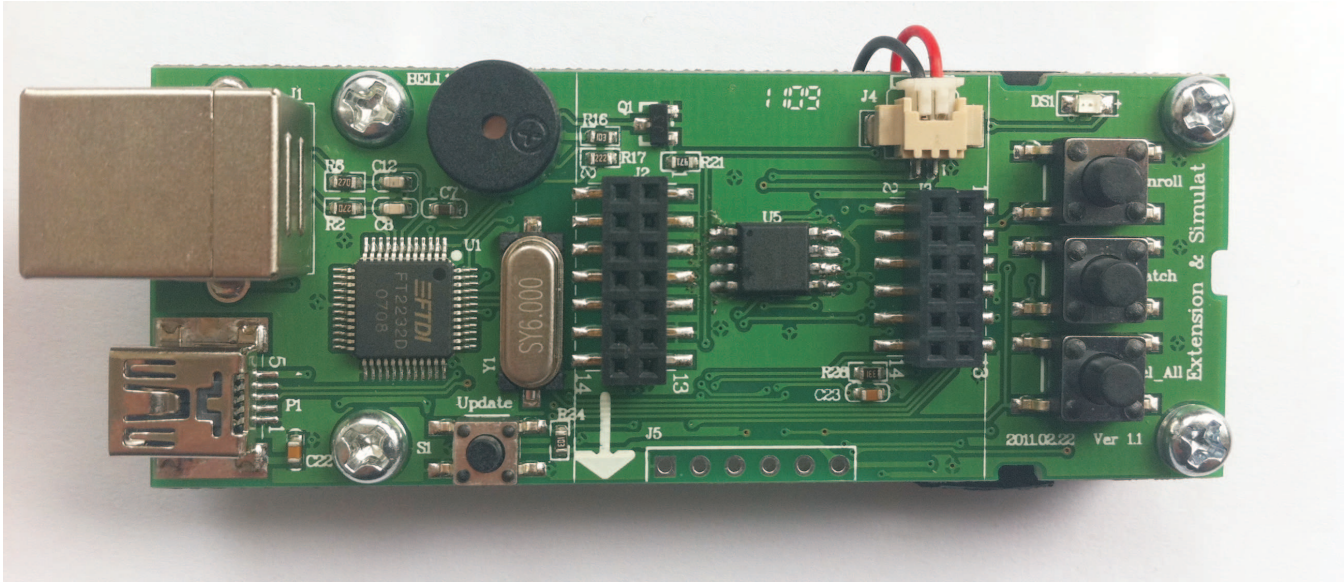

Figure 3. FDK Extension Board Top View

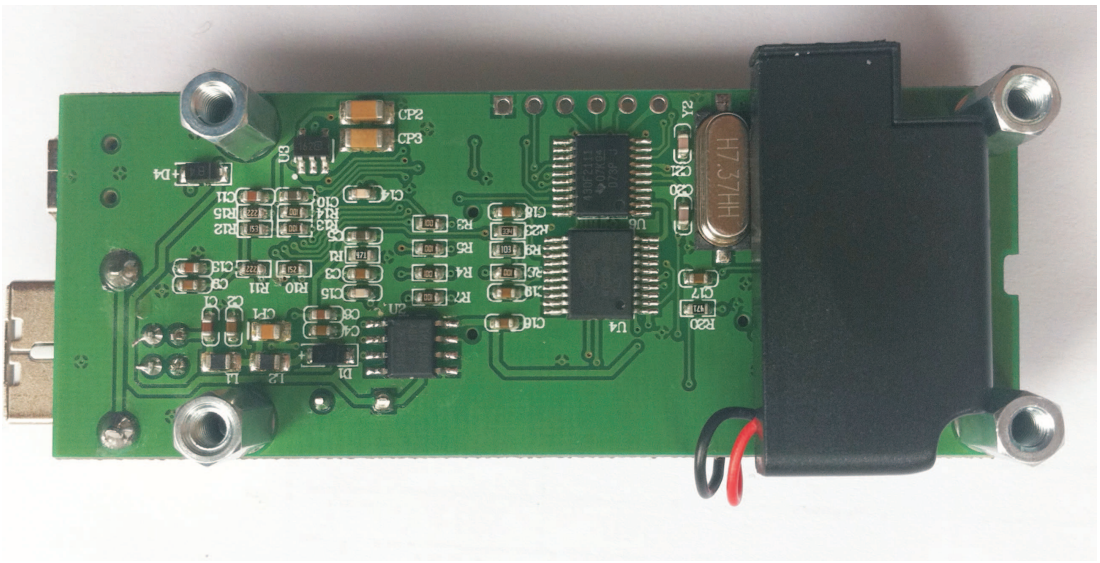

Figure 4. FDK Extension Board Bottom View

1.1 FDK Content

The FDK includes:

- 1 core board (30 mm x 30 mm) based on C5515 low-power DSP
- 1 extension board (78 mm x 30 mm) for power supply, communication and user interaction
- 1 swipe sensor (AuthenTec ATW310)
- 1 optical sensor (Tooan OP-100N)
- 1 Type-B USB cable for updating program and user interaction
- 1 mini DVD containing:
  - Code Composer Studio™ IDE
  - Simplified fingerprint application source code and API documentation
  - Production quality demo code .out file
  - C5515 datasheet and chip support library (CSL)
  - Technical documentation, including user guide, application notes, quick start guide, schematics, BOM, and gerbers

1.2 FDK System Specifications

Table 1 shows the system specifications for the fingerprint development kit.

Table 1. FDK System Specifications

Matching Method	1:1 and 1:N
1:1 matching speed	< 20ms
Template size per fingerprint	256 bytes
Template storage capacity	50-400 prints
Fingerprint sensor resolution	300-500 dpi
False rejection rate	<1%
False acceptance rate	<0.001%
Power requirement	DC 5V / 100mA (not including sensor)↔
Communication interfaces	UART 1200-115200bps; USB2.0 full and high speed
Operating temperature	-10°C ~ 70°C
Board size	Core board: 30mmx30mm Extension board: 78mmx30mm

1.3 FDK Block Diagrams

Figure 5 and Figure 6 respectively, show the block diagrams of the FDK core and extension board.

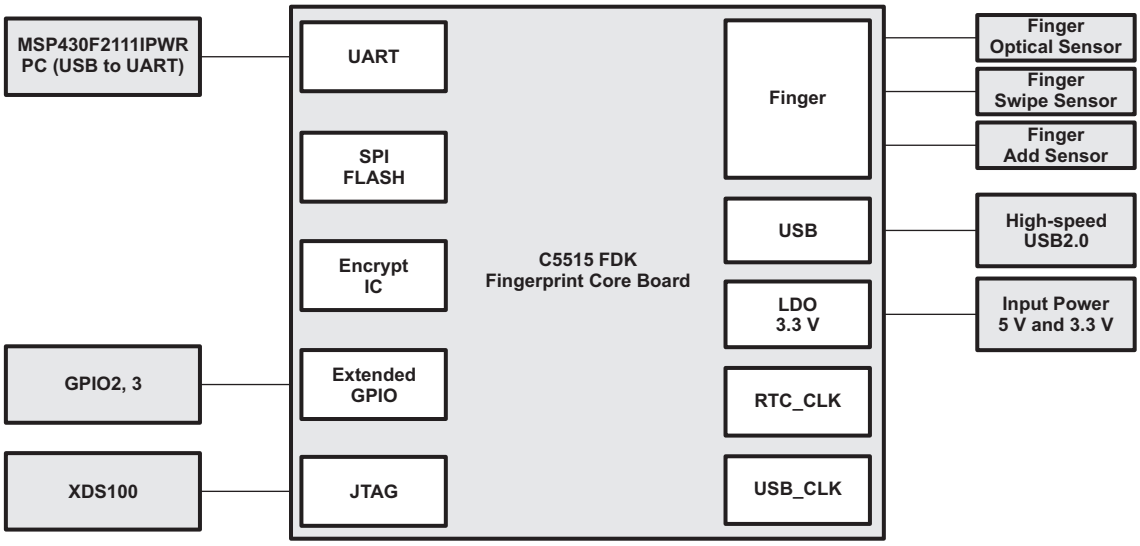

Figure 5. FDK Core Board Block Diagram

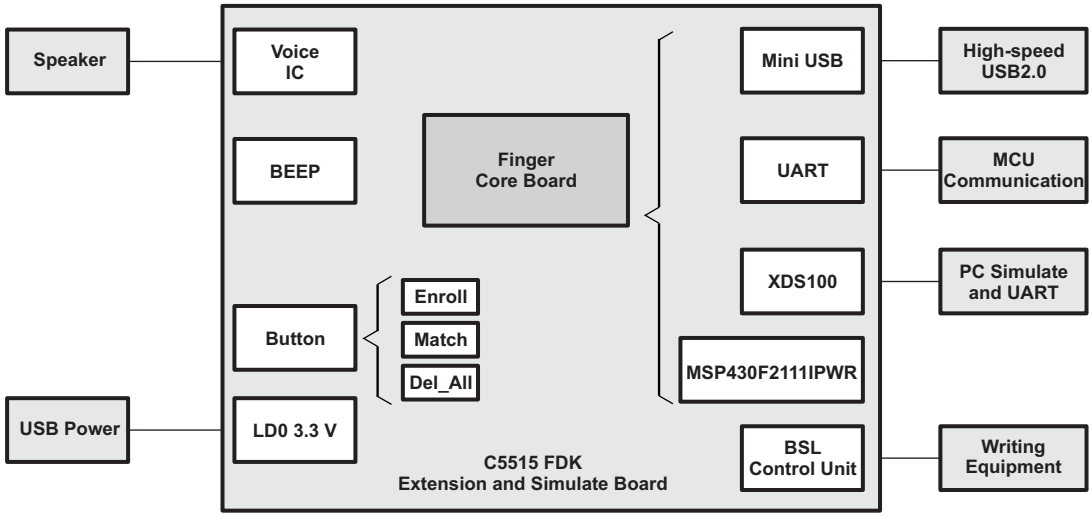

Figure 6. FDK Extension Board Block Diagram

2 Physical Description of the C5515 FDK Core Board

2.1 C5515 Core Board Layout

The C5515 FDK core board is a 30mm x 30mm six-layer printed circuit board that is externally powered by 5V voltage. Figure 7 and Figure 8 provide top and bottom views of the core board.

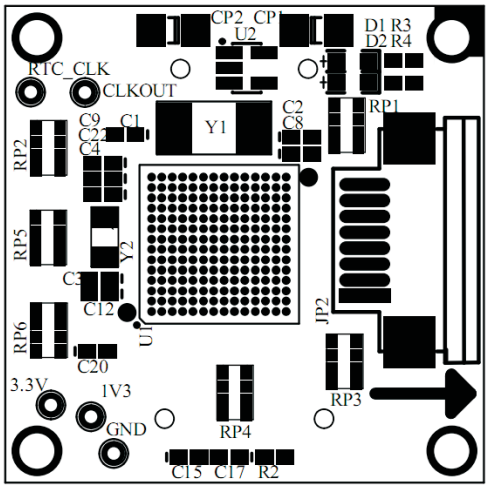

Figure 7. C5515 FDK Core Board Layout Top View

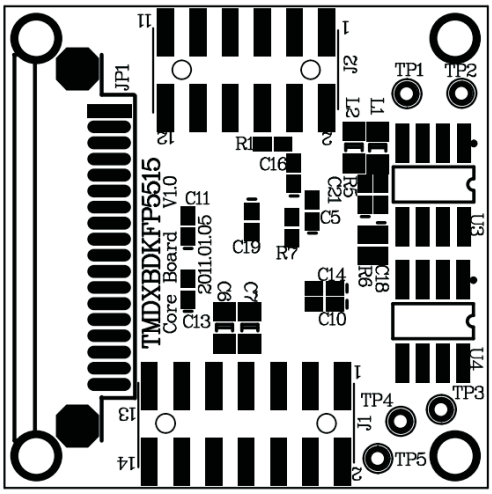

Figure 8. C5515 FDK Core Board Layout Bottom View

2.2 Connector Index

There are five connectors on the FDK core board as listed in Table 7.

Table 2. C5515 FDK CORE Board Connectors

Connector	#Pins	Function	Schematic Page	Board Side
JP1	18	Optical Sensor		Bottom
JP2	8	Swipe Sensor		Top
J1	8	Core board and extension board connection interface		Bottom
J2	8	Core board and extension board connection interface		Bottom

2.2.1 JP1 – Optical Sensor Connector

The JP1 optical fingerprint sensor interface is shown in Table 3 and illustrated in Figure 9.

Table 3. JPI - Optical Sensor Connector

Pin#	Signal Name
1	NC
2	PPIO
3	PPI1
4	PPI2
5	PPI3
6	PPI4
7	PPI5
8	PPI6
9	PPI7
10	I2C_SDA
11	I2C_SCL
12	VSYNC
13	HREF
14	PPI_CLK
15	CTRL_LED
16	GND
17	+3.3V
18	Touch

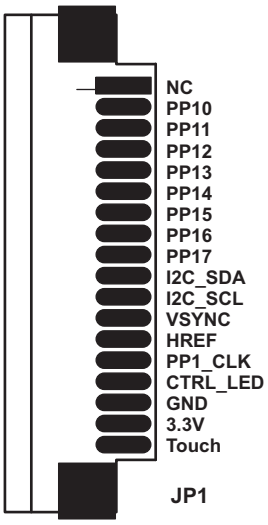

Figure 9. JPI Top View

2.2.2 JP2 - Swipe Sensor Connector

The JP2 connector uses an SPI communication scheme. It can be used to interface with various fingerprint sensors communicating through the SPI method. It is shown in Table 4 and illustrated in Figure 10.

Table 4. JP2 - Interface Connector

Pin#	Signal Name
1	SPI_RX
2	3.3V
3	SPI_RESET
4	SPI_CLK

Table 4. JP2 - Interface Connector (continued)

Pin#	Signal Name
5	GND
6	SPI_DX
7	SPI_CS
8	GND

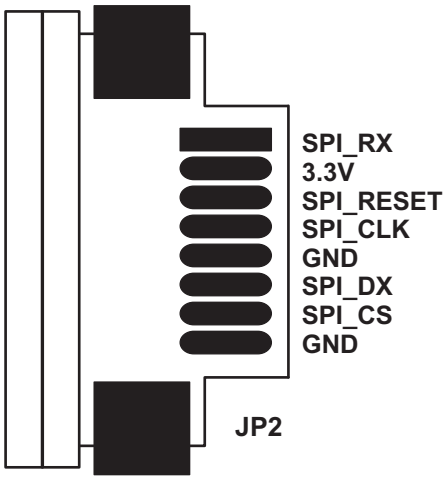

Figure 10. JP2 Bottom View

2.2.3 J1,J2 - Core Board and Extension Board Connector

J1 and J2 are male DIP connectors on the core board. They plug into and communicate to the extension board. They are explained in Table 5 and Figure 11.

Table 5. J1, J2 - Interface Connector

Pin#	Signal Name J1	Signal Name J2
1	GPIO1	VCC_USB
2	RESET	Enabled
3	GPIO2	D-
4	3.3 V	CTRL_BEEP
5	GPIO3	D+
6	TMS	SPI_CS2
7	TRSTN	GND
8	TDI	SPI_DX
9	JT1	UART_RX
10	TDO	SPI_RX
11	GND	UART_TX
12	TCK	SPI_CLK
13	EMU1	
14	EMU0	

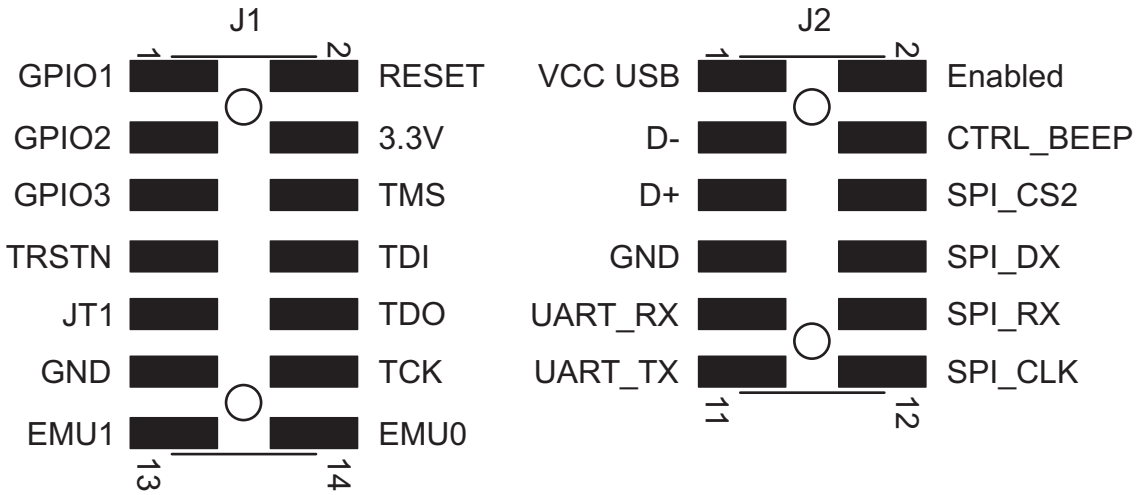

Figure 11. J1, J2 Bottom View

2.3 Test Points

Table 6 lists the five test points on the FDK core board and the signal present on each test point. This is illustrated in Figure 12.

Table 6. Test Points on Core Board

Test Point#	Signal
TP1	CLKOUT
TP2	RTC_CLKOUT
TP3	3.3V
TP4	1V3
TP5	GND

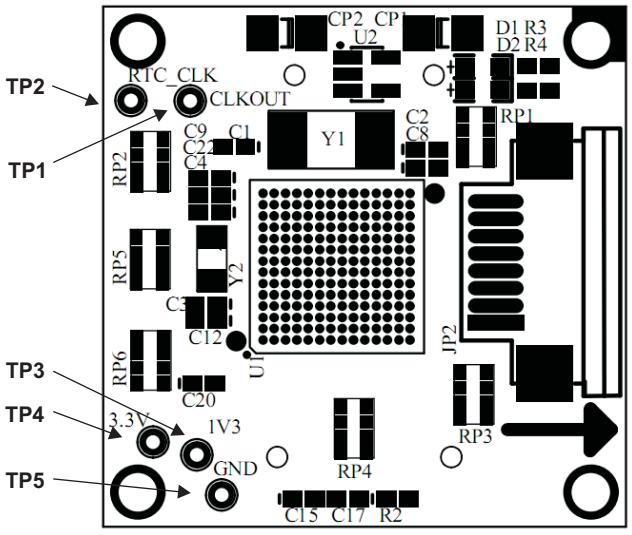

Figure 12. Test Point Locations Top View

3 Physical Description of the C5515 FDK Extension Board

3.1 Board Layout

The C5515 FDK extension board is a 78mm x 30mm two-layer printed circuit board that is externally powered by 5V voltage. Figure 13 and Figure 14 show the top and bottom layout of the extension board.

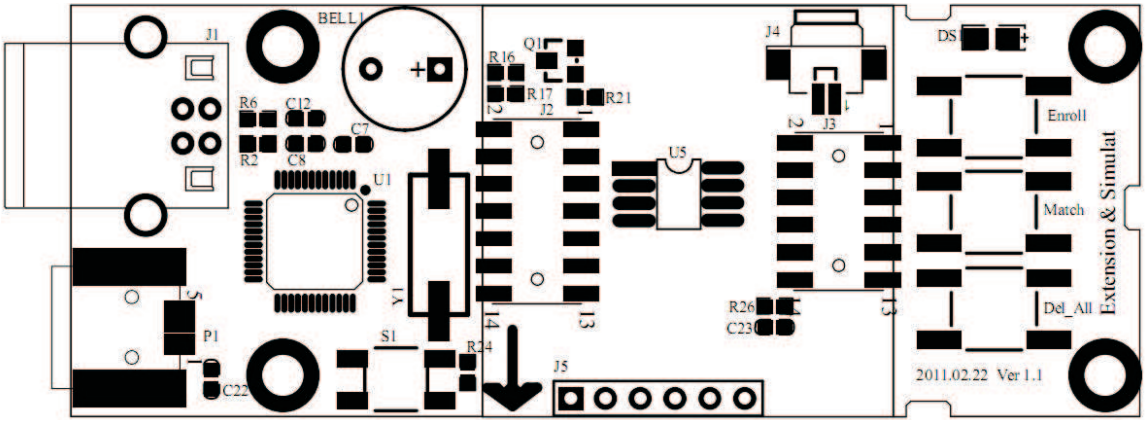

Figure 13. C5515 FDK Extension Board Layout Top View

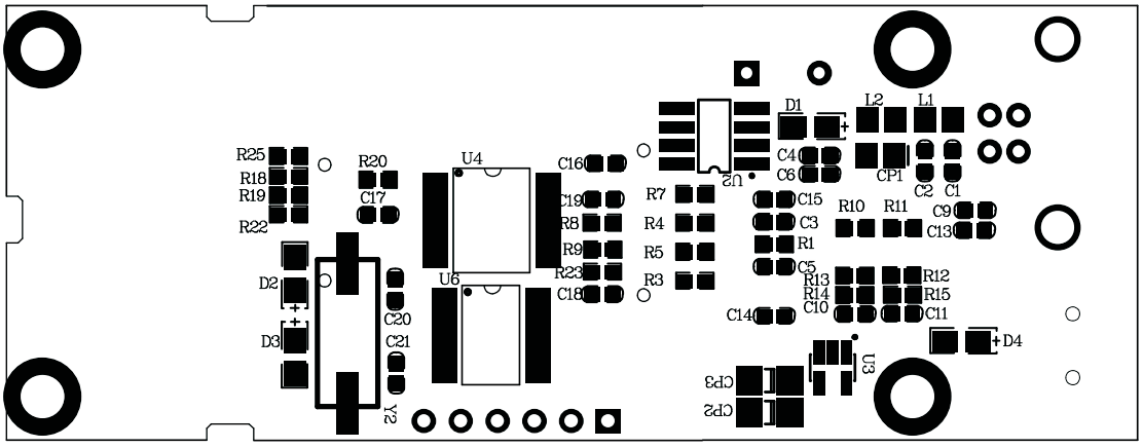

Figure 14. C5515 FDK Extension Board Layout Bottom View

3.2 Connector Index

There are seven connectors on the FDK extension interface board, as described in Table 7.

Table 7. C5515 FDK Extension Board Connectors

Connector	#Pins	Function	Board Side
P1	5	MINI_USB Port	Top
J1	4	USB_B TYPE	Top
J2	14	Core board and extension board connection interface	Top
J3	12	Core board and extension board connection interface	Top
J5	6	BSL Connector	Top

3.2.1 J4 - Speakers

The speaker on the C5515 FDK extension board provides audio indication during fingerprint authentication operations in demonstration mode.

Table 8. J4 - Speakers

Pin#	Signal Name
1	Speaker +
2	Speaker -

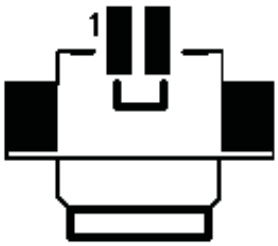

Figure 15. J4 Top View

3.2.2 USB_B Port

The USB_B port, J1 (see Figure 16), on the C5515 FDK extension board brings out the RX and TX signals of the C5515 DSP for UART communication and simulation using. This extension board uses the FT2232D driver and the pin information of J1 is listed in Table 9.

Table 9. J1 – USB_B Port

Pin#	Signal Name
1	+5 V
2	D-
3	D+
4	GND

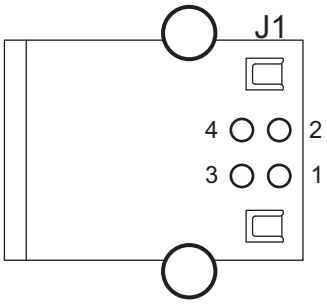

Figure 16. J3 Top View

3.2.3 P1_Mini_USB Port

The P1 connector is a USB Type B connector. It enables users to exercise the functionality of the high-speed USB2.0 integrated in TMS320C5515 DSP and can be used for power supply and PC communication. Table 10 and Figure 17 illustrate this connector.

Table 10. P1 Mini_USB Port

Pin#	Signal Name
1	GND
2	NC
3	D+
4	D-
5	Vin

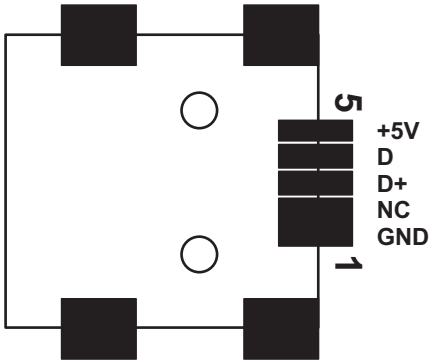

Figure 17. P1 Top View

3.2.4 J2, J3 - Core Board and Extension Board Connection Interface

J2 and J3 are the female connectors for core board and extension board connection and communication. Table 11 shows the daughtercard interface and Figure 18 illustrates the view of J2 and J3.

Table 11. J2,J3 - Daughtercard interface

Pin#	Signal Name J1	Signal Name J2
1	GPIO1	VCC_USB
2	RESET	Enabled
3	GPIO2	D-
4	3.3 V	CTRL_BEEP
5	GPIO3	D+
6	TMS	SPI_CS2
7	TRSTN	GND
8	TDI	SPI_DX
9	JTI	UART_RX
10	TDO	SPI_RX
11	GND	UART_TX
12	TCK	SPI_CLK
13	EMU1	
14	EMU0	

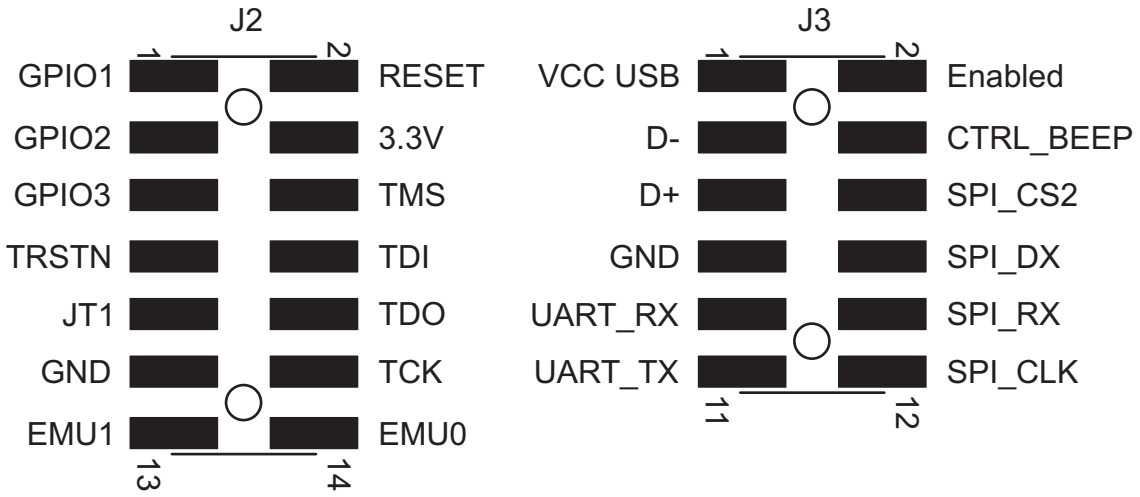

Figure 18. J2,J3 Top View

3.2.5 J5 - BSL Interface

The 6-pin connector on the extension board is the BSL programming interface; it is used by the Texas Instruments MSP430F2111A ultra low-power micro-controller.

Table 12. J5 – BSL Interface

Pin#	Signal Name
1	TEST(TCK)
2	/RES
3	P1.1(TXD)
4	P2.2(RXD)
5	GND
6	VCC

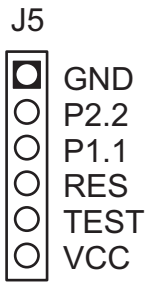

Figure 19. J5 Top View

Appendix A Mechanical Information for the FDK Core Board

This appendix contains the mechanical information for the FDK core board.

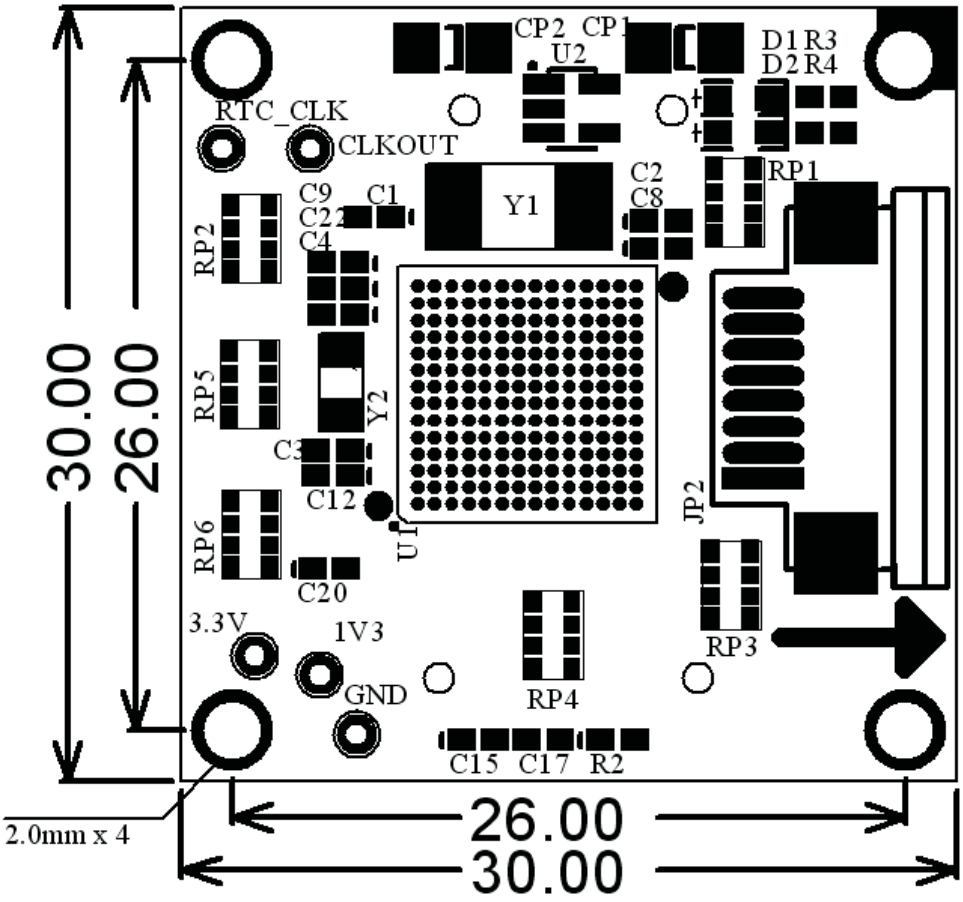

Figure 20. Mechanical for FDK Core Board

Appendix B Mechanical Information for the FDK Extension Board

This appendix contains the mechanical information for the FDK extension board.

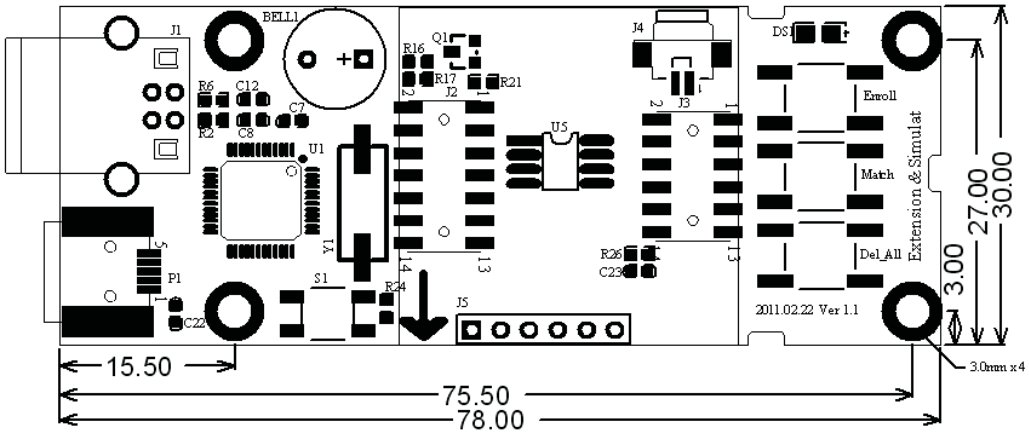

Figure 21. Mechanical for FDK Extension Board

Appendix C Core Board BOM

The following table provides information for the core board BOM.

Table 13. TMDXBDKFP5515 Core Board BOM

NO.	Footprint	Comment	Designator	Description	Quantity	Mfr Name
1	TMX320VC5515 A9AAG40QW	BGA196-14X14-.65MM	U1	Low Power DSP	1	Texas Instruments (TI)
2	TLV70033DDC	SOT-25	U2		1	TI
3	TPS79913DDC	SOT-25	U3		1	TI
4	TA102502	SO-8	U4	Config IC	1	TOOAN
5	W25X40AVNING	SO-8	U5	SPI FLASH	1	WINOND
6	AT24C512	SO-8	U6	IICEEPROM	1	ATMEL
7	FPC1.0mm -16	CMOSCON16	JP1	DOWN SMD	1	
8	FPC1.0mm-8	CMOSCON8	JP2	UP SMD	1	
9	CON8	PIN8_2.0MM	J1, J2	Needle	2	
10	12MHZ	5*3.2	Y1	2 pads SMD	1	
11	32.768KHZ	3.2*1.5	Y2	2 pads SMD	1	
12	30OHM	805	L1, L2	Ferrite bead	2	
13	10uF/16V	1206	CP1-CP3		3	
14	1N4148	805	D1		1	
15	LED(G)	603	D2		1	
16	LED(R)	603	D3		1	
17	0.1uF	603	C8-C15,		10	
			C19,C21			
18	0.1uF	402	C5-C7,C17,		6	
			C18,C20			
19	15pF	603	C16		1	
20	33pF	603	C1-C4		4	
21	0 OHM	603	R3		1	
22	100K	603	R1		1	
23	100 OHM	603	R4		1	
24	10K	603	R2		1	
25	470 OHM	603	R5,R6		2	
26	100 OHM	603	RP1,RP3	3.1*1.55*0.55	2	
27	10K	603	RP2,RP4-RP7	3.1*1.55*0.55	5	
28	JTAG	1.27mm*7	JTAG	Two rows	1	
29	TP-NO-TOP	NP	TP1-TP5		6	

Table 14. TMDXBDKFP5515 Extension Board BML

NO.	Footprint	Comment	Designator	Description	Quantity	Mfr Name
1	TLV70033DDC	SOT-25	U1		1	TI
2	TRS3232ECDR	SO-16	U2		1	TI
3	AP89021	SO-16	U3		1	PLUS
4	MSP430F1111A	SO-20	U4		1	TI
5	9013	SOT-23	Q1,Q2		2	
6	1N4001	805	D1		1	
7	1N5819	805	D2-D4		3	
8	LED(R)	805	DS1	RED	1	

Table 14. TMDXBDKFP5515 Extension Board BML (continued)

NO.	Footprint	Comment	Designator	Description	Quantity	Mfr Name
9						
10	FUSE 350mA	805	F1		1	
11						
12	BUZA	09A05	BEEL		1	
13	BUTTON	6*6*9.5mm	Match Enroll, Del_ALL	SMD	3	
14	10uF/16V	1206	CP1,CP2		2	
15	0.1uF	603	C1,C2,C4-C6		5	
16	0.01uF	603	C3		1	
17						
18	240K	603	R8		1	
19	100 OHM	603	R5,R6		2	
20	10K	603	R9-R12		4	
21	15K	603	R7		1	
22						
23	330 OHM	603	R3,R4		2	
24	470 OHM	603	R1,R2		2	
25	DC-005(NO-POP)	Power DC	J1	DIP	1	
26	RS232	DB9	J3	DIP 90 degrees	1	
27	USB	MINI_USB	J4	SMD	1	
28	CON2	1.0mm-PIN2	J2	SMD	1	
29	JTAG NO-POP	2.54mm*6	J7		1	
30	CON8	2.0mm*8	J5,J6	DIP socket	2	

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