

RHADC-FMCEV1Z

The radiation hardened precision SAR ADC evaluation system enables the evaluation of the Renesas portfolio of low-power, high-performance Successive Approximate Register (SAR) Analog-to-Digital Converters (ADC). The evaluation system uses the iRADAnalyzer software, which displays all pertinent data such as SFDR, SINAD, ENOB, THD, harmonics, current, and power measurements. The software plots ADC output data in frequency spectra and time domain. Data can be saved from the software in from either domain.

To ensure proper operation of the system, Renesas recommends that the most current software version is installed. If iRADAnalyzer is already installed on the machine, a new installation can proceed without removing the prior version.

Key Features

- Complete measurement solution for radiation hardened precision SAR ADCs
- Works with iRADAnalyzer to support datasheet-style, live-updated display with calculation of critical ADC parameters (SNR, SFDR, SINAD, ENOB, Harmonics, Power)
- Supports most Vita 57.1 FPGA Mezzanine Connector (FMC) specifications

Specifications

- Data rates between 1ksps and 1000ksps
- USB 2.0 interface for rapid data transfer
- 32k - 1M word capture depth
- Components supporting commercial temperature range of -40°C to +85°C
- Power supplied by single 5V DC wall supply

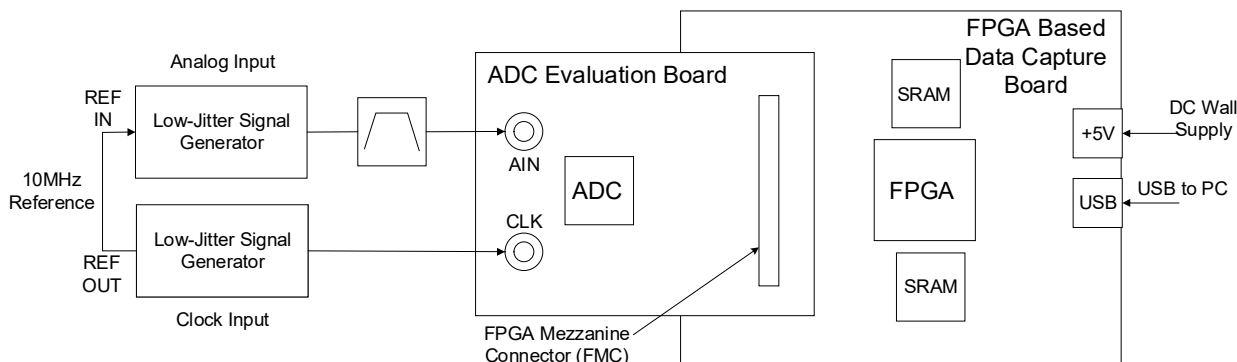


Figure 1. Evaluation Platform Block Diagram

Contents

1. Functional Description	3
1.1 Evaluation System Contents	3
1.2 Installation Requirements	3
1.3 Setup and Operation of the ADC Evaluation Platform	3
1.4 Installing the iRADAnalyzer Software	4
1.5 Running the Software	9
2. PCB Layout Guidelines	10
2.1 RHADC-FMCEV1Z Evaluation Board	10
2.2 RHADC-FMCEV1Z Schematic	11
2.3 Bill of Materials	18
A. Appendix	21
A.1 Input Signal Requirements	21
A.2 USB Driver Information	21
A.3 HPC FMC Pin Configuration	22
A.4 Analog Signal Generators	24
3. Ordering Information	24
4. Revision History	24

1. Functional Description

The the RHADC-FMCEV1Z motherboard along with a radiation hardened precision SAR ADC evaluation board (daughterboard) is intended to operate with iRADAnalyzer software application. The motherboard collects digitized data from the daughterboard ADC and relays that data to a PC running iRADAnalyzer so the data can be analyzed for performance.

1.1 Evaluation System Contents

The evaluation system is provided with a USB cable to connect to a PC and a 5V power supply. A PC running the Microsoft Windows™ 7 or greater operating system with Java installed is required. iRADAnalyzer software can be downloaded from the Renesas web site. When operating the RHADC-FMCEV1Z motherboard with a daughter board (such as the ISL73141SEH daughter board), analog input signal and clock sources should be provided along with any optional filters and power supply connections.

1.2 Installation Requirements

To operate the RHADC-FMCEV1Z motherboard, the iRADAnalyzer software must be installed. Before installing the iRADAnalyzer, confirm the following:

- PC operating system is Windows 7 or greater
- The account that the software is installed from has administrator privileges.
- Java is required for operation of the iRADAnalyzer software which controls the RHADC-FMCEV1Z.
 - If the Java runtime environment is not installed on the PC, Java is installed during the installation of the iRADAnalyzer software.
 - Windows has associated files with the *.jar extension with the java runtime environment. This is done by default during the java runtime environment install. File extension associations can be modified by opening an explorer window, clicking on the **Tools** drop-down menu, selecting **Folder Options**, and interacting with the pop-up window.:

1.3 Setup and Operation of the ADC Evaluation Platform

To set up the ADC evaluation platform, the following items are required:

- RHADC-FMCEV1Z motherboard
- USB cable (USB-A to USB-B, 1.25 to 2M long) (supplied with RHADC-FMCEV1Z)
- 5V power supply, 18W minimum (supplied with RHADC-FMCEV1Z)
- Daughter card containing ADC to be tested (ordered separately)
- Suitable signal and clock sources (see [Input Signal Requirements](#)) (supplied by user)
- PC with free USB2.0 port, logged in with administrator rights (supplied by user)

1.4 Installing the iRADAnalyzer Software

1. Double click the installer executable (that is, iRADAnalyzer_VX.XX.X.exe). This launches the installer, resulting in the following window for language selection. Click **Next >**.

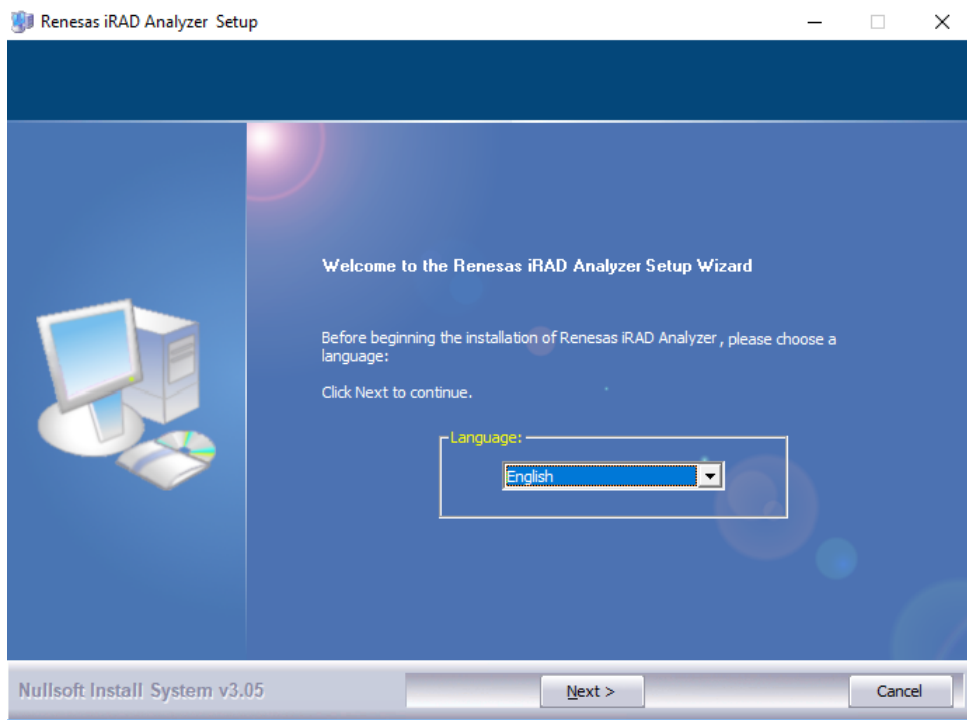


Figure 2. Language Selection Window

2. The install introduction page opens up showing the current version of the software, click **Next >** to continue.

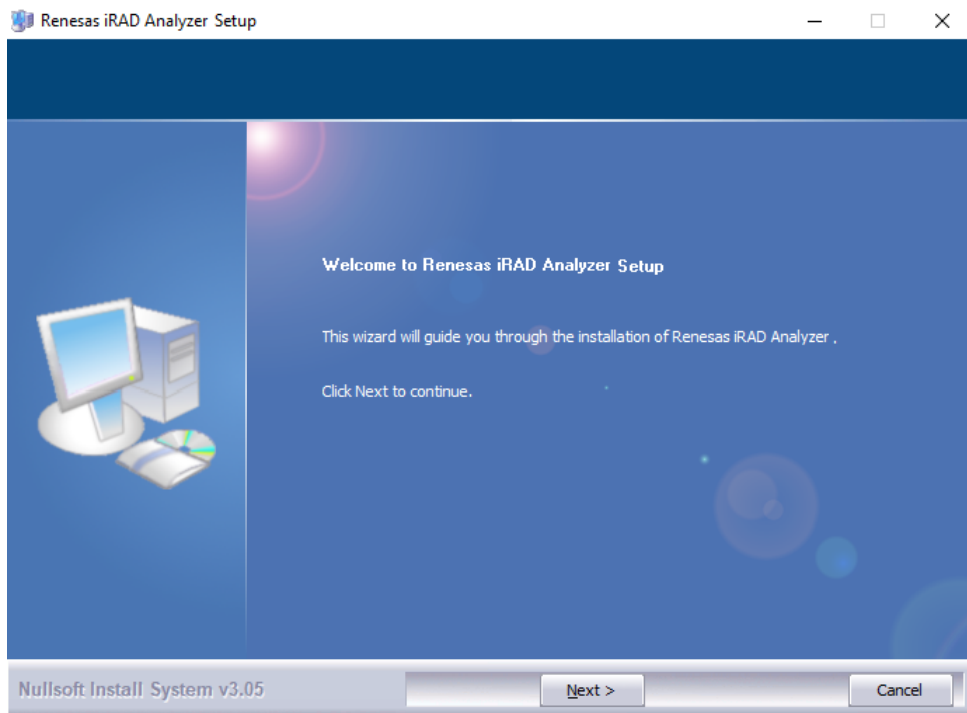


Figure 3. Install Introduction Window

- 3. In the License Agreement window, confirm the Software Evaluation License Agreement, by clicking the **I Agree** radio button, then click **Next >**.

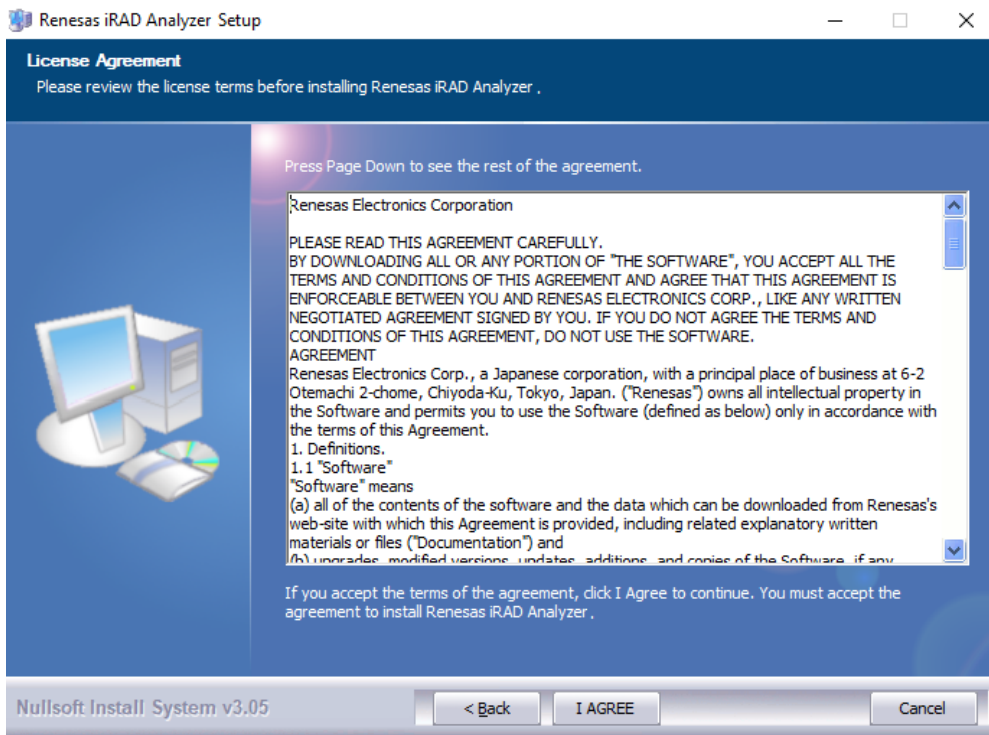


Figure 4. License Agreement Window

- 4. The Choose Install Location window opens. Click **Next >**.

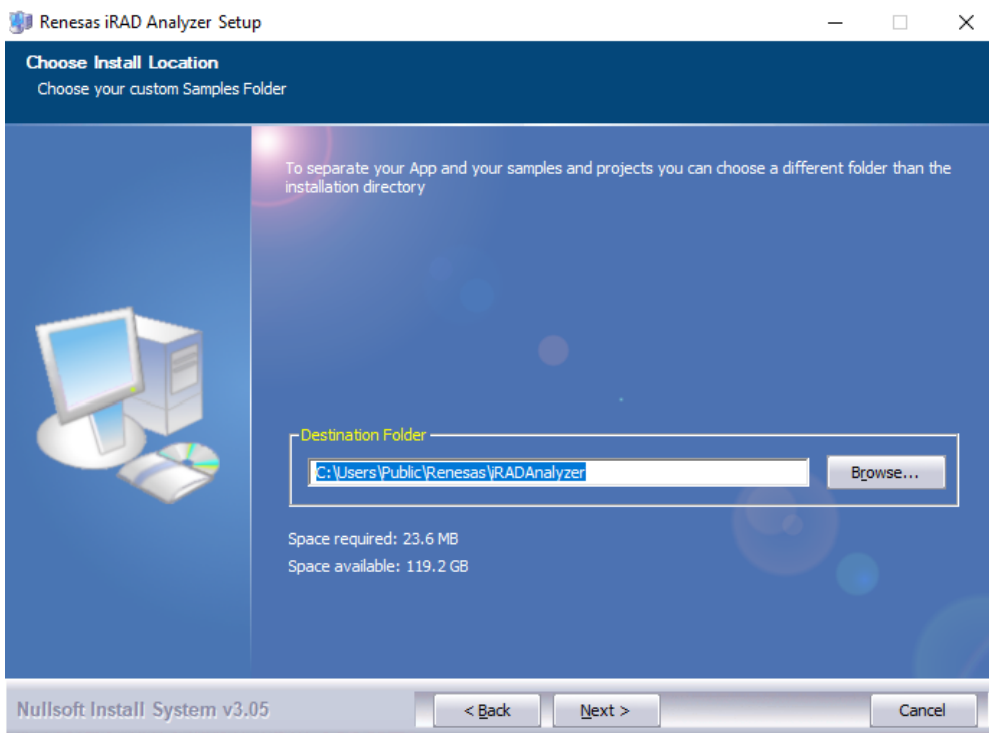


Figure 5. Choose Install Location Window

- 5. The Choose Start Menu Folder window opens. If installing with administrative privileges, the **For all users** or **Only for the current user** options can be selected to indicate which users the shortcuts are created for. Click **Next >**.

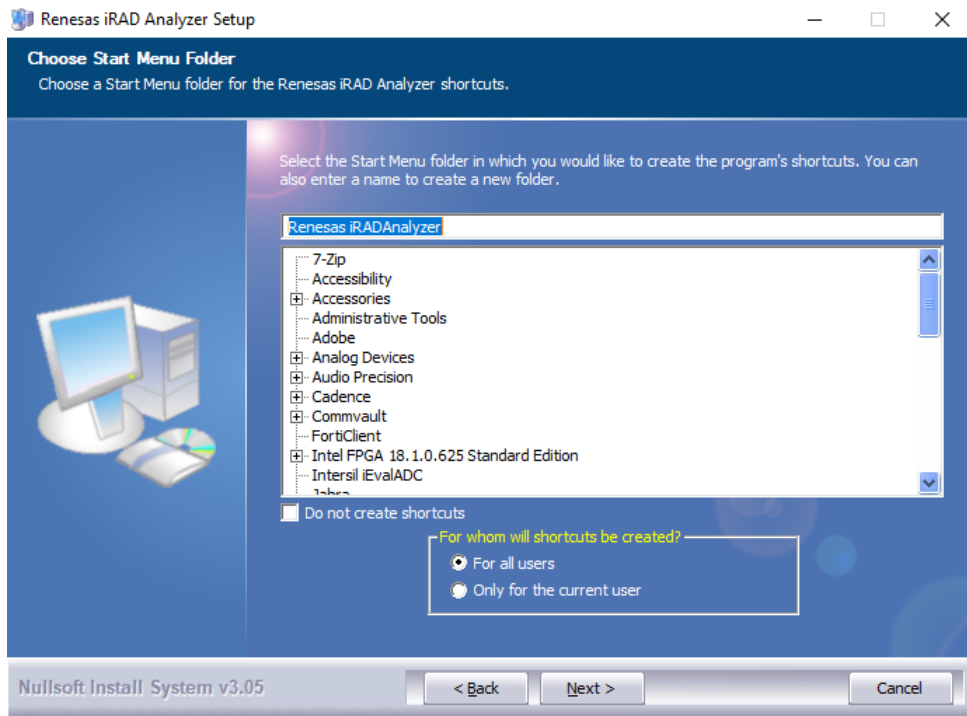


Figure 6. Choose Start Menu Folder Window

- 6. The Additional Tasks window opens. Select the desired options for creating a desktop icon and for installing the driver for the RHADC-FMCEV1Z. **Note:** If the USB driver has previously been installed, the **Install Driver** check box can be left unchecked. Click **Next >**.

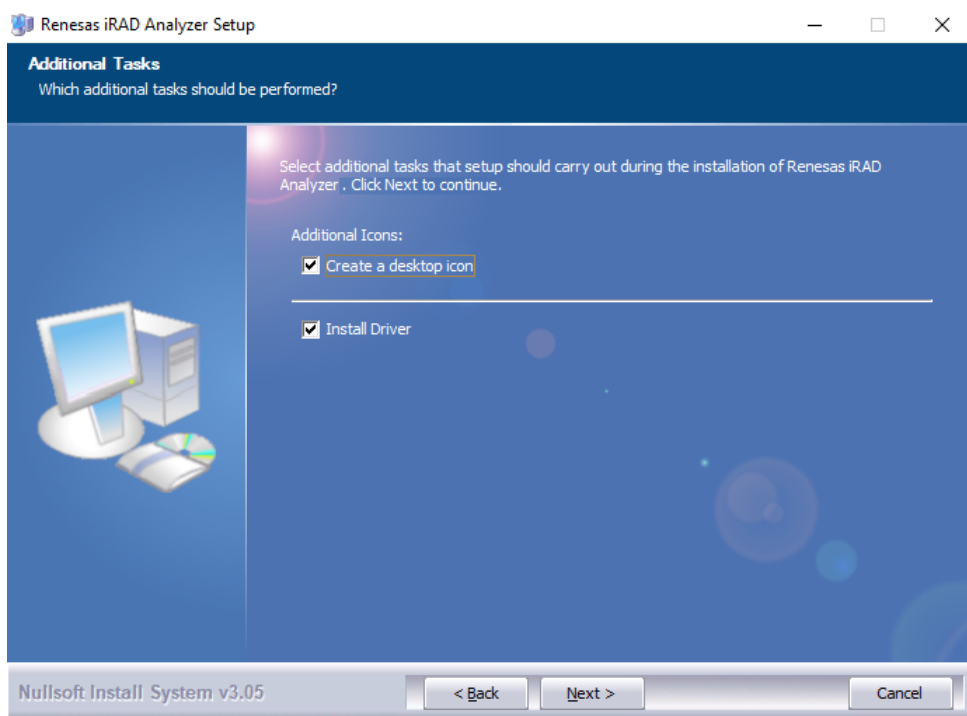


Figure 7. Additional Tasks Window

7. The Complete Installation window opens. Click **Install**.

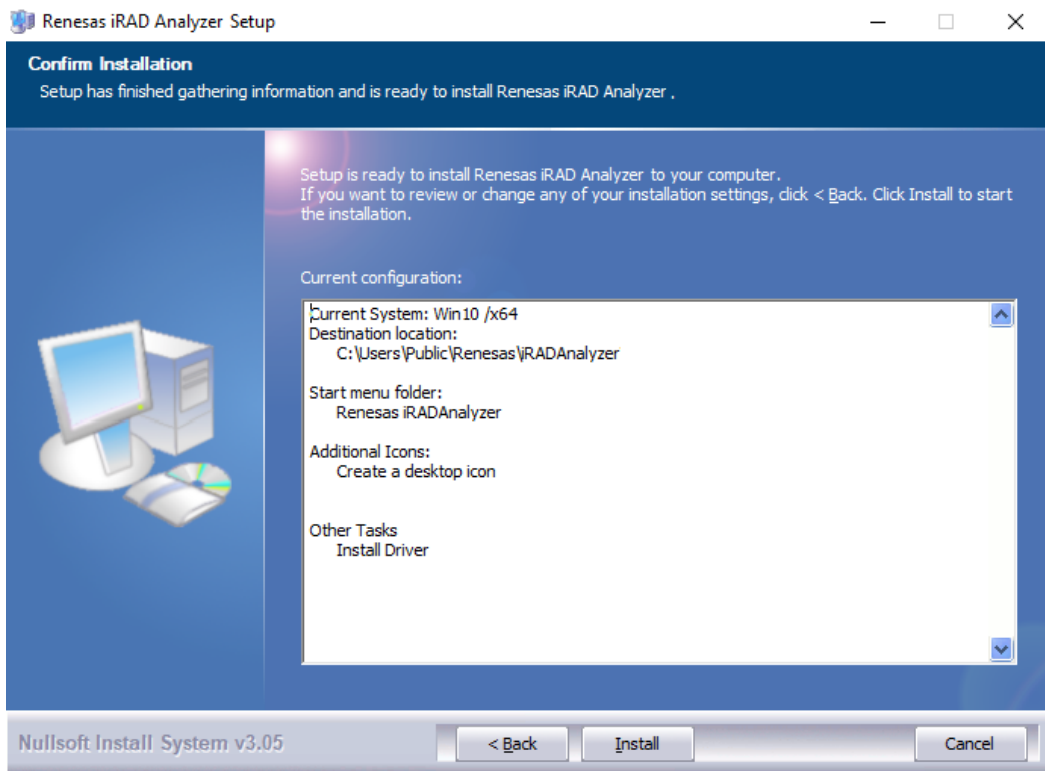


Figure 8. Complete Installation Window

8. If the driver has not previously been installed, follow the prompts to install the driver. Select the check box to always trust drivers from Renesas Electronics America Inc. and click **Install**.

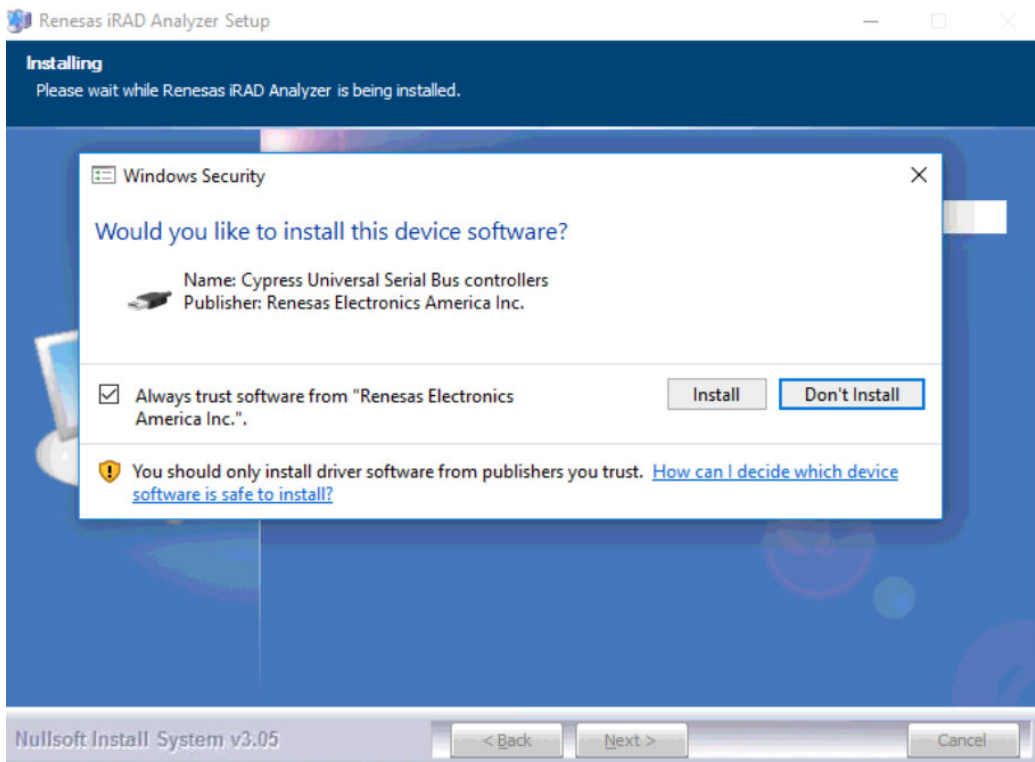


Figure 9. Install the USB Driver

9. The Completing Renesas iRADAnalyzer VX.XX.X Setup window opens. Click **Finish**.

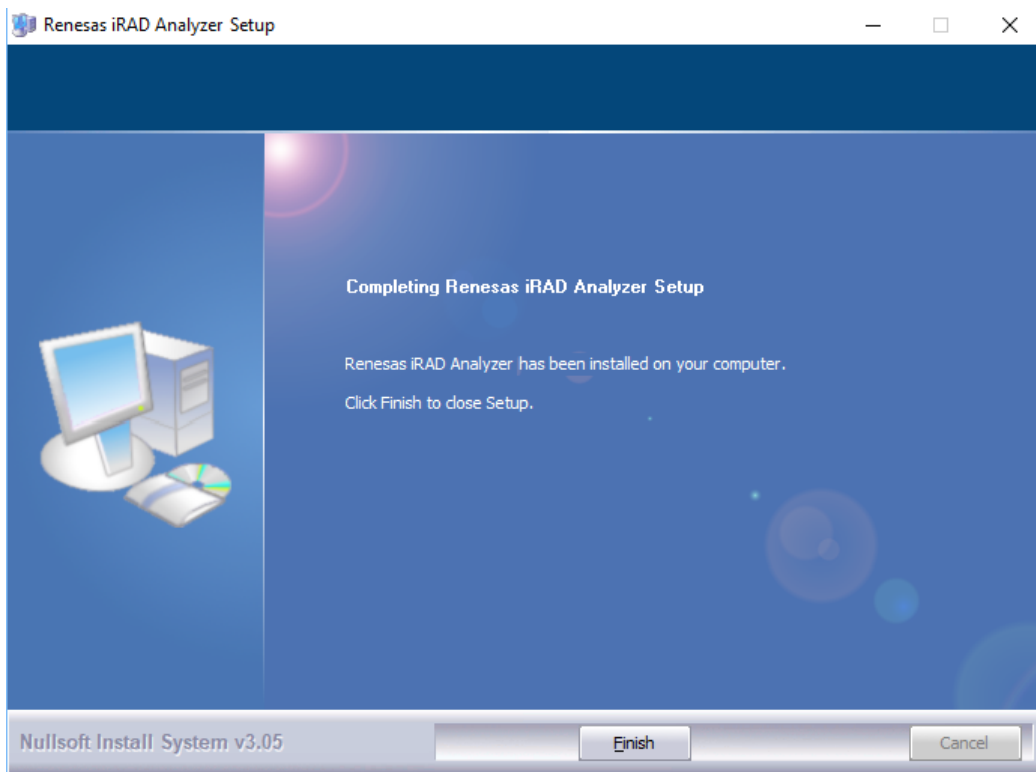


Figure 10. Complete the iRADAnalyzer Installation

1.5 Running the Software

To begin testing, supply +5V to the motherboard, any necessary power supply voltages to the daughter board and then connect the analog input and clock signals to the daughter board (Figure 1). The motherboard (RHADC-FMCEV1Z) can provide the appropriate supply voltages if required by the daughter card and captures digital data from the daughter card. The daughter cards contain the ADC and attach directly to the motherboard to form the ADC evaluation platform (Figure 1).

When the software has been installed, the software can be launched by double-clicking on the shortcut located on the desktop, by default called iRADAnalyzer. The first time the program is launched, there might be a delay as the Java runtime environment unpacks the required libraries. Subsequent runs are much shorter. A window similar to Figure 11 is displayed when iRADAnalyzer has launched.

There is no need to attach the evaluation kit hardware to launch the software. However, some features of the software might not be available or might not operate without hardware attached. The information area at the bottom of the window indicates if the software has detected connected hardware.

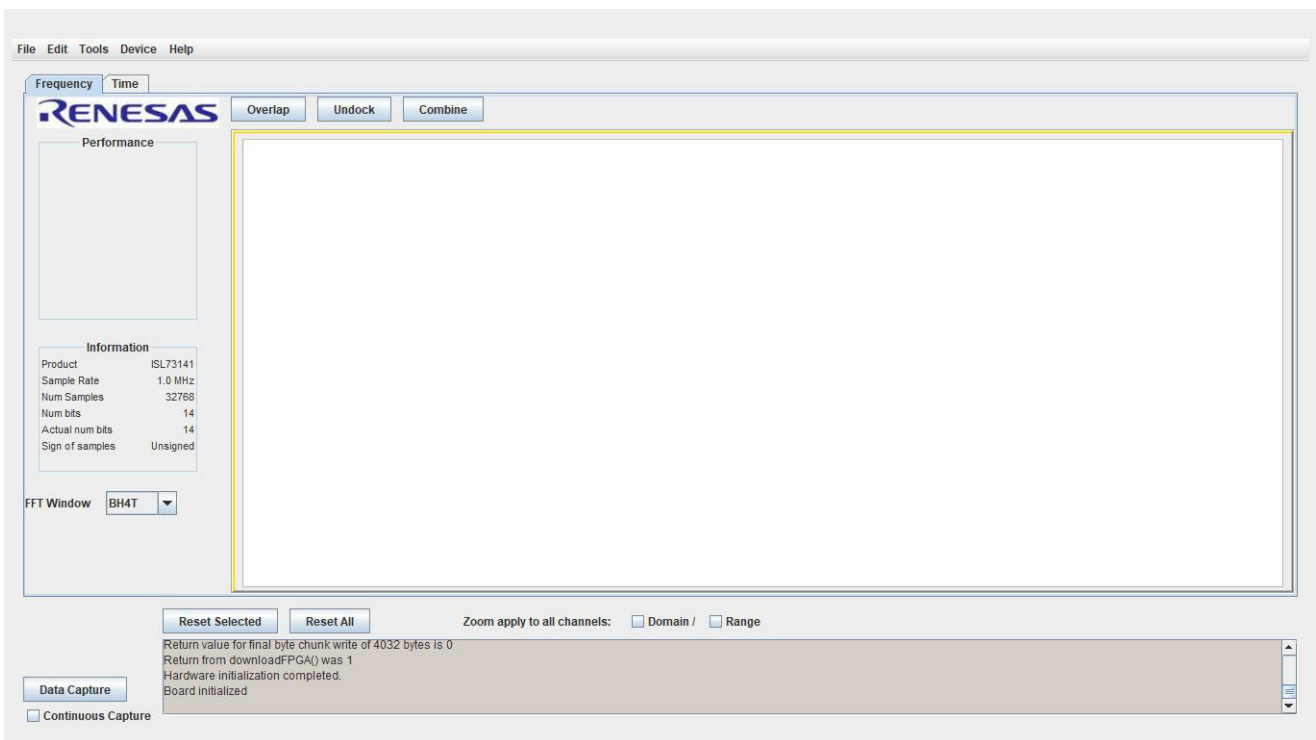


Figure 11. Board Initialization

2. PCB Layout Guidelines

2.1 RHADC-FMCEV1Z Evaluation Board

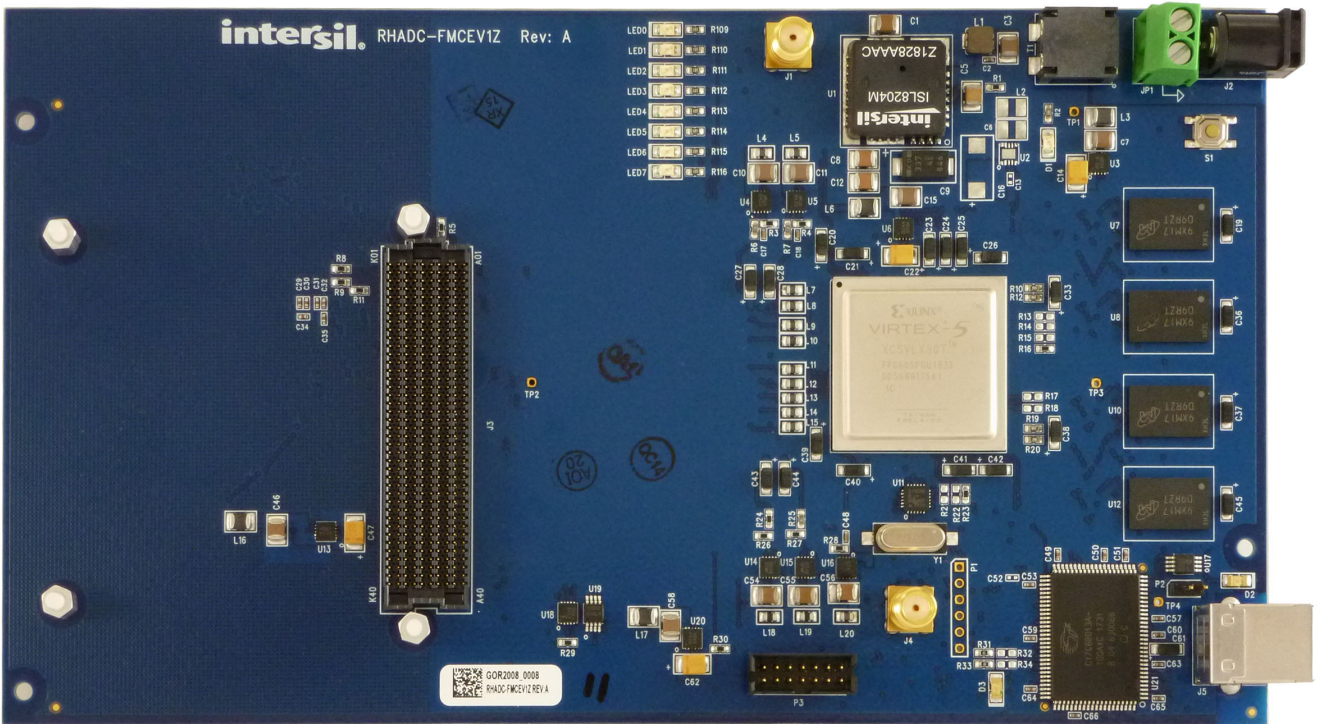


Figure 12. RHADC-FMCEV1Z Top

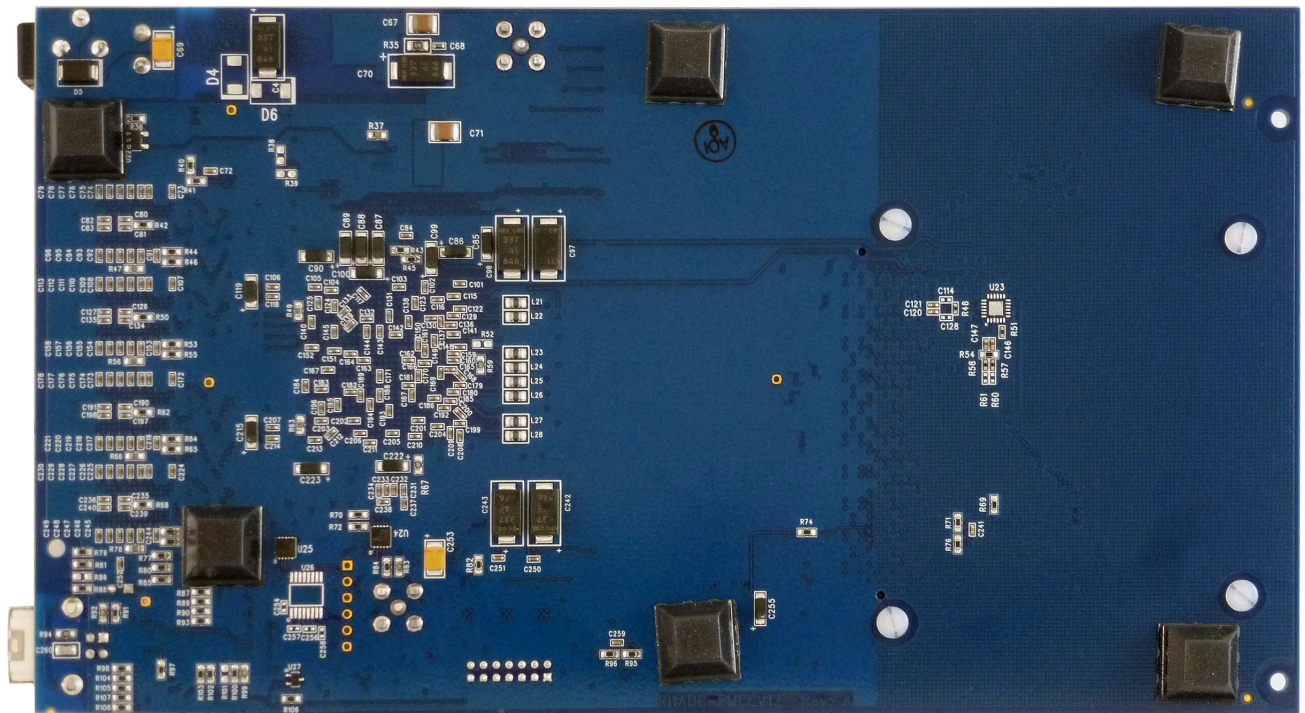


Figure 13. RHADC-FMCEV1Z Bottom

2.2 RHADC-FMCEV1Z Schematic

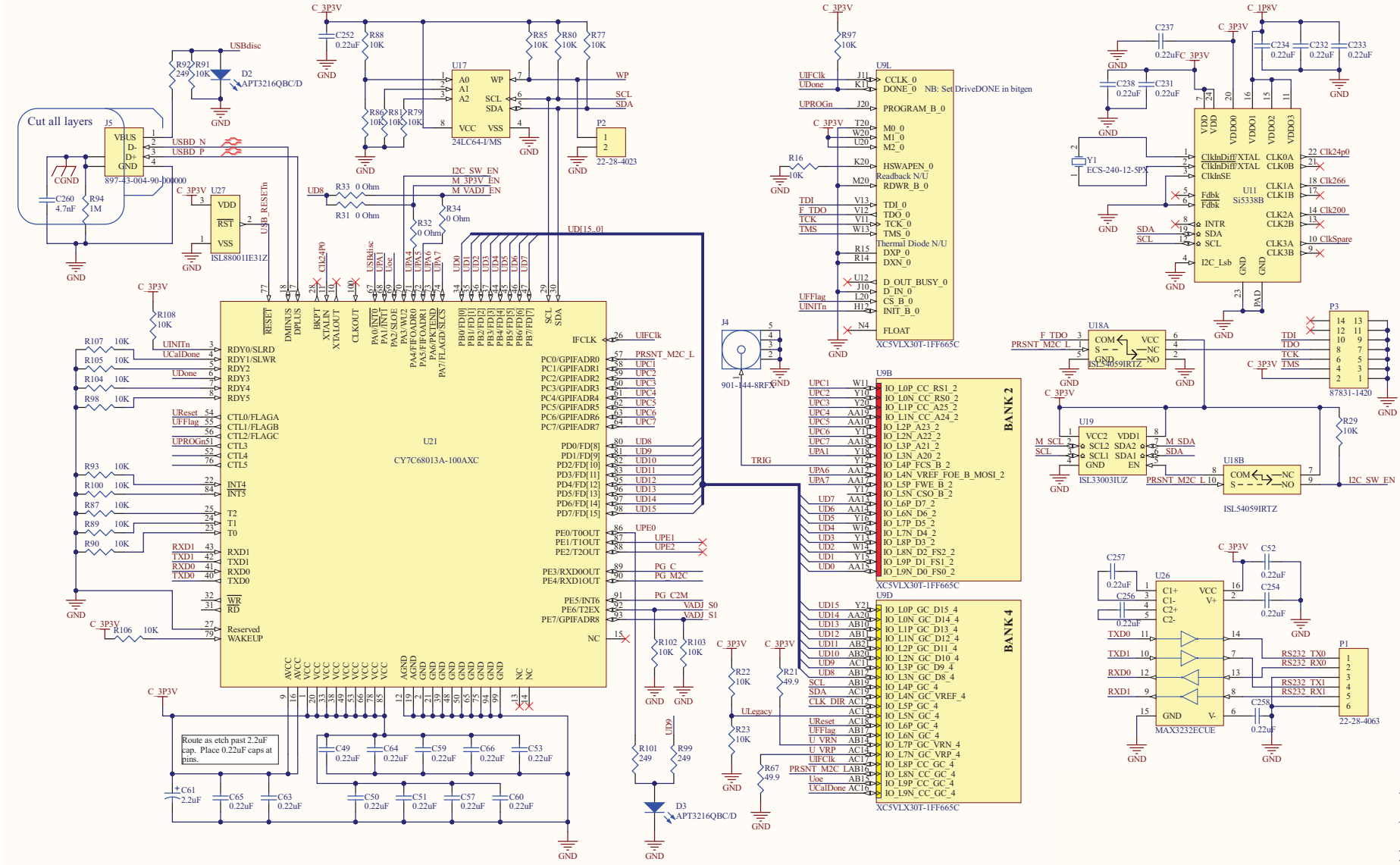


Figure 14. USB Interface

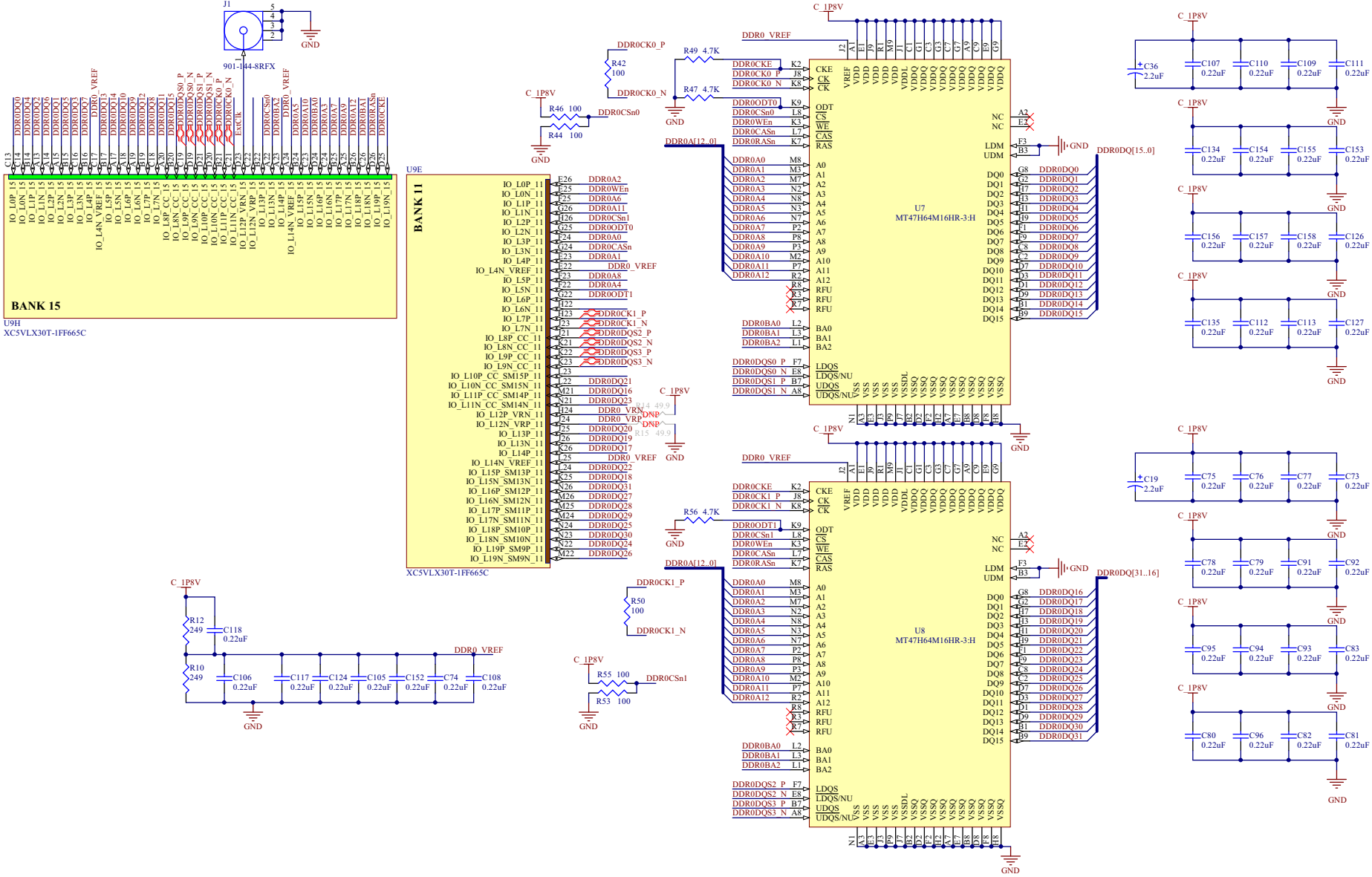


Figure 15. DDR2 DRAM Controller

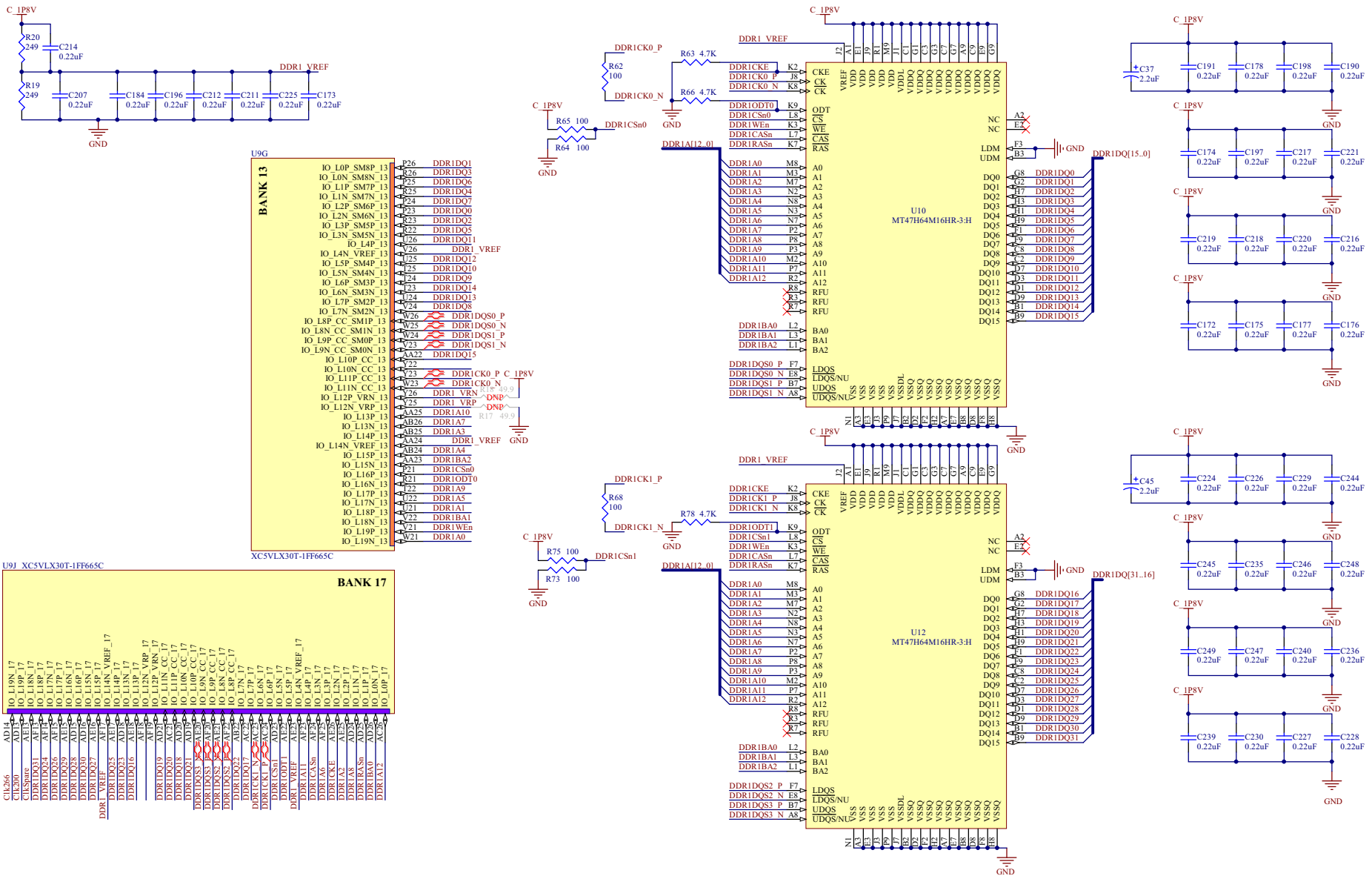


Figure 16. DDR2 DRAM Controller 1

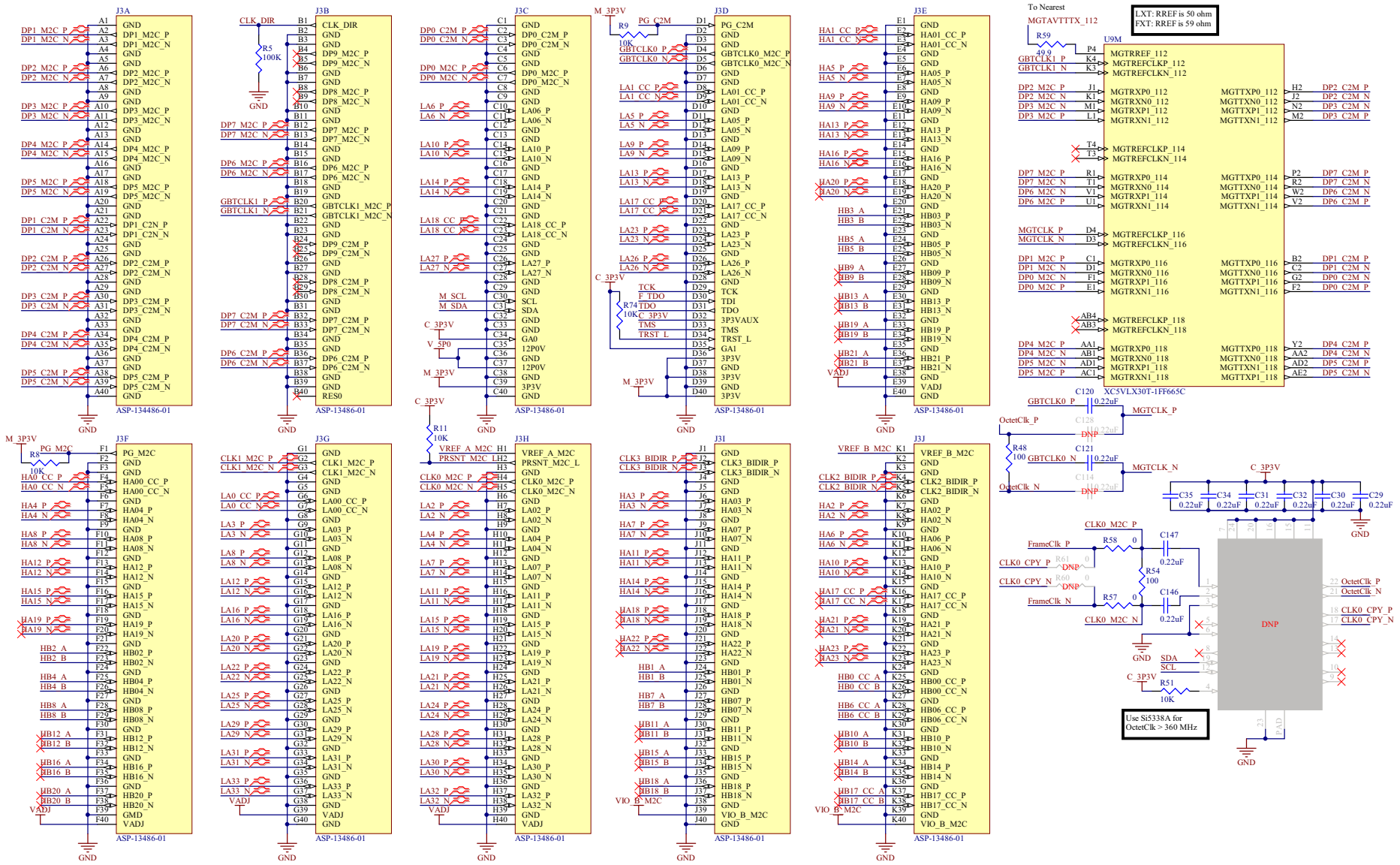


Figure 17. VITA 57 Connector and FPGA MGT

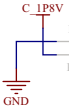
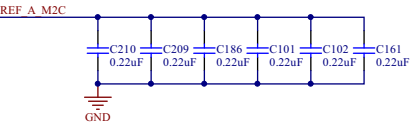
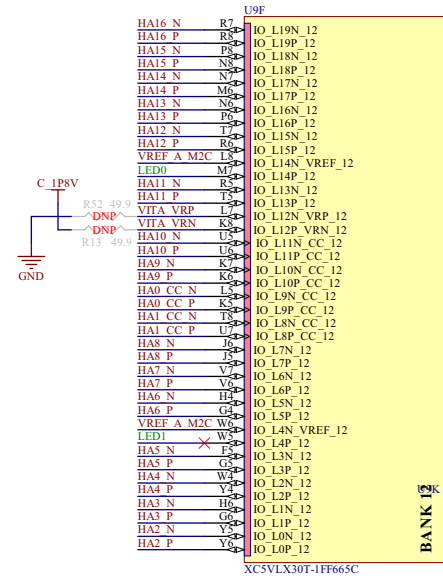
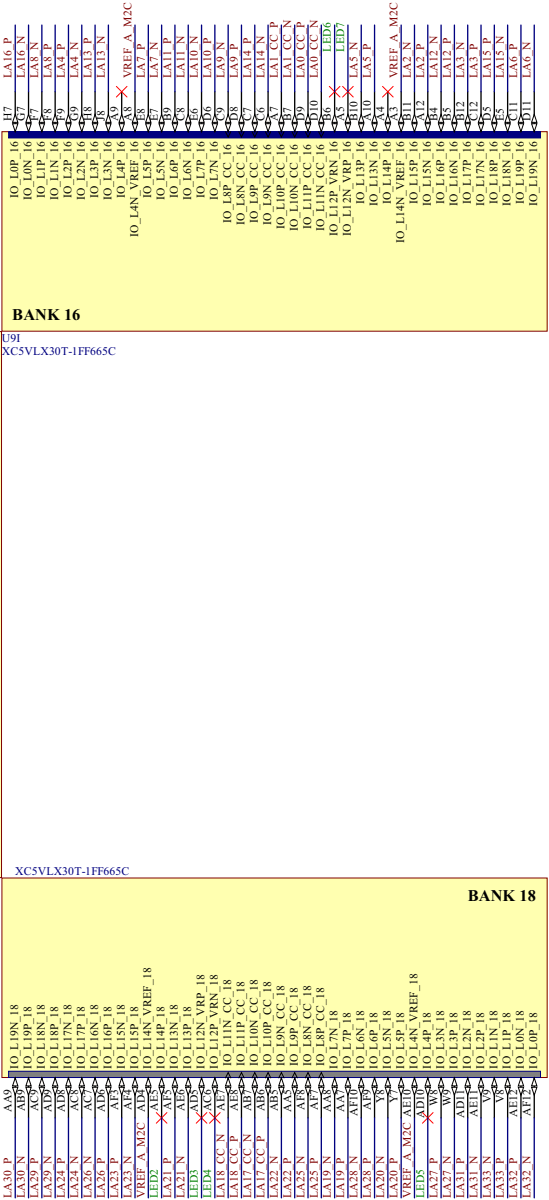
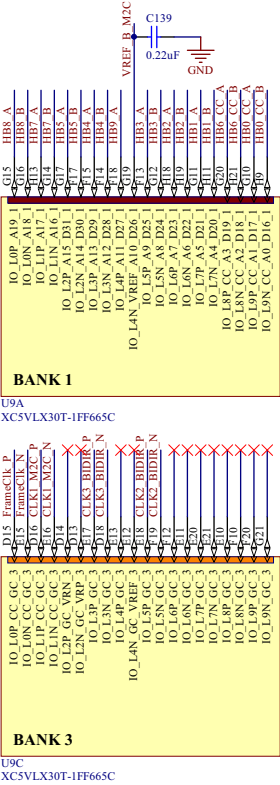
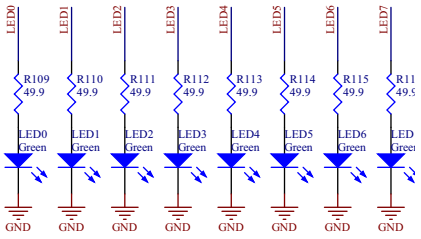


Figure 18. FPGA VITA 57 Interface

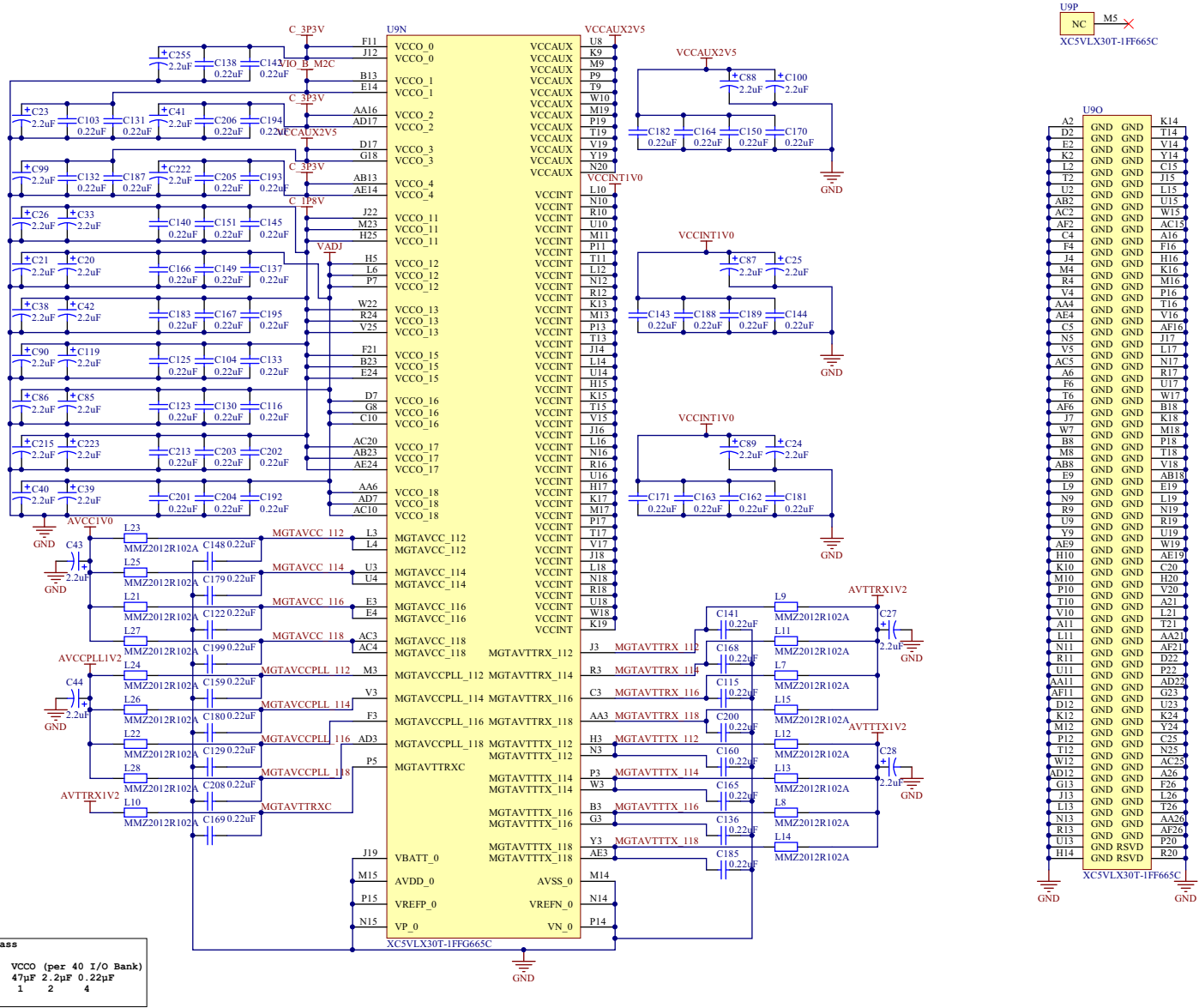


Figure 19. FPGA Power

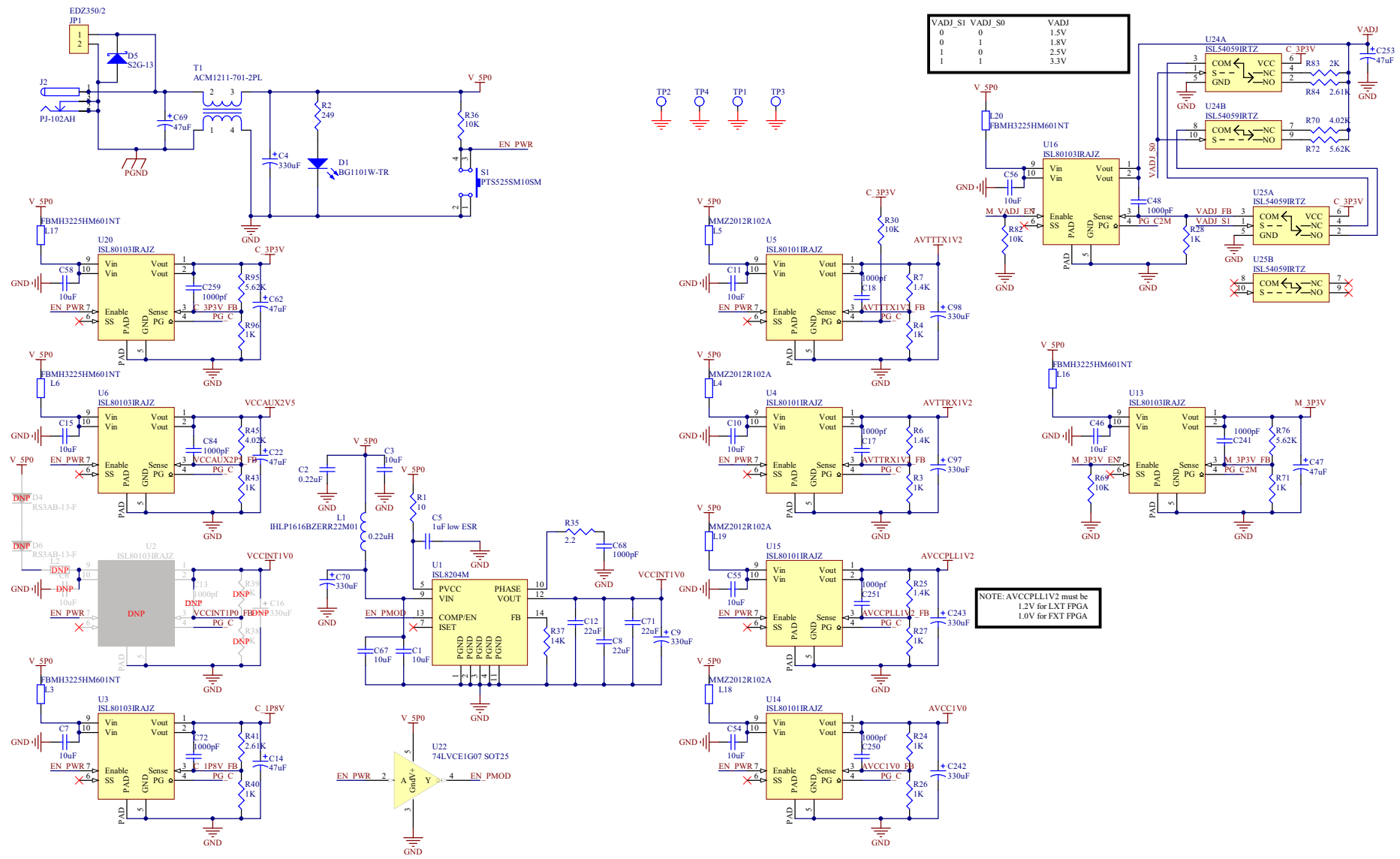


Figure 20. Power Regulation

2.3 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1		PWB-PCB, ADCMB-HSFMC-EV1Z, REVC, ROHS	Imagineering Inc	ADCMB-HSFMC-EV1ZREVCPCB
10	C17, C18, C48, C68, C72, C84, C241, C250, C251, C259	CAP, SMD, 0402, 1000pF, 50V, 10%, X7R, ROHS	Venkel	C0402X7R500-102KNE
176	C2, C29, C30, C31, C32, C34, C35, C49, C50, C51, C53, C57, C59, C60, C63, C64, C65, C66, C73-C83, C91-C96, C101-C113, C115-C118, C120-C127, C129-C214, C216-C221, C224-C240, C244-C249, C252	CAP, SMD, 0402, 0.22 μ F, 16V, 10%, X5R, ROHS	Venkel	C0402X5R160-224KNE
1	C260	CAP, SMD, 0805, 4700pF, 50V, 5%, C0G, ROHS	Murata	GRM2165C1H472JA01D
1	C5	CAP, SMD, 1210, 1 μ F, 50V, 10%, X7R, ROHS	Venkel	C1210X7R500-105KNE
12	C1, C3, C7, C10, C11, C15, C46, C54, C55, C56, C58, C67	CAP, SMD, 1210, 10 μ F, 16V, 10%, X5R, ROHS		
3	C8, C12, C71	CAP, SMD, 1210, 22 μ F, 10V, 10%, X5R, ROHS	Murata	GRM32ER71A226KE20L (X7R)
34	C19, C20, C21, C23, C24, C25, C26, C27, C28, C33, C36-C45, C61, C85, C86, C87, C88, C89, C90, C99, C100, C119, C215, C222, C223, C255	CAP-TANT, SMD, A, 2.2 μ F, 6.3V, 20%, <9 Ω , ROHS	Kemet	T499A225K006ATE6K5
6	C14, C22, C47, C62, C69, C253	CAP-TANT, LOW ESR, SMD, B, 47 μ F, 10V, 20%, 70m Ω , ROHS	AVX	TCJB476M010R0070
7	C4, C9, C70, C97, C98, C242, C243	CAP-TANT, LOW ESR, SMD, D, 330 μ F, 4V, 20%, 7m Ω , ROHS	Kemet	T520D337M004ATE007
1	L1	COIL-PWR INDUCTOR, SMD, 4.4x4, 0.22 μ H, 20%, 13A, ROHS	Vishay	IHLP1616BZERR22M01
1	P2	CONN-HEADER, 1x2, RETENTIVE, 2.54mm, 0.230x0.120, ROHS"	Berg/FCI	69190-202HLF
1	P3	CONN-HEADER, TH, 2X7, SHROUDED, 2mm, VERTICAL, ROHS	Molex	87831-1420
1	J5	CONN-USB TYPE B, RECEPTACLE, PCB MOUNT, ROHS	Mill-Max	897-43-004-90-000
2	J1, J4	CONN-RF, SMA JACK, 50 Ω , PCB MNT, STRAIGHT, ROHS	Amphenol	901-144-8RFX
1	J3	CONN-SOCKET ARRAY, TH, 400P, 0.05 PITCH, CUSTOM, ROHS	Samtec	ASP-134486-01
1	JP1	CONN-TERMINAL BLOCK, TH, 2POS, 5.08mm, 12-22AWG, ROHS	On Shore Technology	EDZ350/2

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1	J2	CONN-PWR JACK, THRU-HOLE, 2.1x5.5mm, BLACK, R/A, ROHS	CUI, Inc.	PJ-102AH
1	D5	DIODE-RECTIFIER, SMD, 2P, SMB, 400V, 1.5A, GPP, ROHS	Diodes Inc.	S2G-13-F
2	D2, D3	LED, SMD, 1206, BLUE, 3.3V, 20mA, 100mcd, 470nm, ROHS	Kingbright	APT3216QBC/D-T
9	D1, LED0-LED7	LED, SMD, 1206, GREEN CLEAR, 2.1V, 20mA, 2mcd, ROHS	Stanley Electric	BG1101W-TR
1	T1	COIL-COMMON CHOKE, SMD, 12x11, 700Ω, 8A, 2LINE, ROHS	TDK	ACM1211-701-2PL-TL
4	L3, L6, L16, L17	FERRITE INDUCTOR, SMD, 1210, 600Ω, 30%, 100MHz, ROHS	Taiyo Yuden	FBMH3225HM601NT
22	L4, L5, L7-L15, L18-L28	FERRITE BEAD, SMD, 0805, 1k, 0.5A, 100MHz, ROHS	TDK	MMZ2012R102A
1	U17	IC-SERIAL EEPROM, 8P, MSOP, 64k, 400kHz, ROHS	Microchip Technology	24LC64F-I/MS
1	U22	IC-BUFFER/DRIVER W/OPEN DRAIN, SMD, 5P, SOT25, ROHS	Diodes Inc.	74LVCE1G07W5-7
1	U21	IC-USB MICROCONTROLLER, HI SPEED, 100P, TQFP, 16Kx8, ROHS	Cypress Semiconductor	CY7C68013A-100AXC
1	U19	IC-I2C 2-WIRE BUS BUFFER, 8P, MSOP, 3x3, ROHS	Renesas Electronics America	ISL33003IUZ
3	U18, U24, U25	IC-DUAL SPDT ANALOG SWITCH, 1.8-6.5V, 10P, TDFN, ROHS	Renesas Electronics America	ISL54059IRTZ
4	U4, U5, U14, U15	IC-ADJ.V, 1A LDO REGULATOR, 10P, DFN, 3x3, ROHS	Renesas Electronics America	ISL80101IRAJZ
5	U3, U6, U13, U16, U20	IC-ADJ.V, 3A LDO REGULATOR, 10P, DFN, 3x3, ROHS	Renesas Electronics America	ISL80103IRAJZ
1	U1	IC-4A DC/DC PWR SUPPLY MODULE, 15P, QFN, 15x15, ROHS	Renesas Electronics America	ISL8204MIRZ
1	U27	IC-3.07V VOLTAGE SUPERVISOR, SMD, 3P, SC-70, ROHS	Renesas Electronics America	ISL88001IE31Z
4	U7, U8, U10, U12	IC-MEMORY, DDR2 SDRAM, 84P, FBGA, ROHS	Micron Semiconductor	MT47H64M16NF-25EIT-M
1	U11 (See Assembly-Note)	IC-QUAD CLOCK GENERATOR, 24P, QFN, ADCMB-HSFMC PROGRAM, ROHS	Silicon Laboratories	SI5338B-A-GM
1	U9	IC-FPGA, VIRTEX-5, 665P, FCBGA, ROHS	Xilinx	XC5VLX30T-1FFG665C
1	Y1	OSC-CRYSTAL, SMD, 11.4x4.8, 24MHz, 12pF, 30ppm, ROHS	ECS Incorporated	ECS-240-12-5PX-TR

RHADC-FMCEV1Z Evaluation Board Manual

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
2	R57, R58	RES, SMD, 0402, 0Ω, 1/16W, 5%, TF, ROHS	Venkel	CR0402-16W-00T
1	R48	RES, SMD, 0402, 100Ω, 1/16W, 1%, TF, ROHS	Venkel	CR0402-16W-1000FT
1	R51	RES, SMD, 0402, 10k, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-2RKF1002X
1	R1	RES, SMD, 0603, 10Ω, 1/10W, 1%, TF, ROHS	KOA	RK73H1JT10R0F
2	R31, R33	RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS	Venkel	CR0603-10W-000T
13	R42, R44, R46, R50, R53, R54, R55, R62, R64, R65, R68, R73, R75	RES, SMD, 0603, 100Ω, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-1000FT
10	R3, R4, R24, R26, R27, R28, R40, R43, R71, R96	RES, SMD, 0603, 1k, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF1001V
32	R8, R9, R11, R16, R23, R29, R30, R36, R69, R74, R77, R79, R80, R81, R82, R85, R87, R88, R89, R90, R91, R93, R97, R98, R100, R102, R103, R104, R105, R106, R107, R108	RES, SMD, 0603, 10k, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-1002FT
1	R5	RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-1003FT
1	R94	RES, SMD, 0603, 1M, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF1004V
3	R6, R7, R25	RES, SMD, 0603, 1.4k, 1/10W, 1%, TF, ROHS	Yageo	RC0603FR-071K4L
1	R37	RES, SMD, 0603, 14k, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-1402FT
1	R83	RES, SMD, 0603, 2k, 1/10W, 1%, TF, ROHS	KOA	RK73H1JT2001F
7	R2, R10, R12, R19, R20, R92, R99	RES, SMD, 0603, 249Ω, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-2490FT
2	R41, R84	RES, SMD, 0603, 2.61k, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-2611FT
2	R45, R70	RES, SMD, 0603, 4.02kΩ, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF4021V
6	R47, R49, R56, R63, R66, R78	RES, SMD, 0603, 4.7k, 1/10W, 1%, TF, ROHS	Yageo	9C06031A4701FKHFT
10	R59, R67, R109, R110, R111, R112, R113, R114, R115, R116	RES, SMD, 0603, 49.9Ω, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-49R9FT
		RES, SMD, 0603, 49.9Ω, 1/10W, 1%, TF, ROHS	Venkel	CR0603-10W-49R9FT
3	R72, R76, R95	RES, SMD, 0603, 5.62k, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF5621V
1	R35	RES, SMD, 0805, 2.2Ω, 1/8W, 1%, TF, ROHS	Panasonic	ERJ-6RQF2R2V

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1	S1	SWITCH-PUSH, SMD, 4P, 5.25mm, 160GF, SPST, OFF-MOM, ROHS	C&K Components	PTS525SM10SMTRLFS
1	BAG & SHIP W/BOARD	AC/DC PWR SUPPLY, DESKTOP ADAPTER, 5V, 20W, 3FT, ROHS	CUI, Inc	SDI24-5-UD-P5
1	BAG & SHIP W/BOARD	AC POWER CORD, NORTH AMERICA, 18AWG, 6FT, ROHS	CUI, Inc	AC-C7-NA
4		SCREW, M2.5, 16mm, METRIC, PANHEAD, NYLON, ROHS	Keystone	29336
4		STANDOFF-M4.5, 8mm, METRIC, F/F HEX, ALUM, ROHS	McMaster-Carr	95947A003
6	Bottom four corners	BUMPONS, 0.5inWx0.23inH, TAPERED SQUARE PAD, ROHS	3M	SJ-5518 (BLACK)
1	a) SI5338B-A-GM requires programming	ASSEMBLY NOTE		
0	b) By product line. SI5338B-A01482-GM	ASSEMBLY NOTE		
0	c) Is pre-programmed part available	ASSEMBLY NOTE		
0	d) From Silicon Laboratories	ASSEMBLY NOTE		
0	TP1, TP2, TP3, TP4	DO NOT POPULATE OR PURCHASE		

A. Appendix

A.1 Input Signal Requirements

A.1.1 Source Requirements

Source jitter and noise degrades performance. For best test results, a combined jitter (for both clock and signal sources) that does not exceed 200fs is recommended.

A.1.2 Sample Clock and Input Signal Source Setup

Sample clock settings are dependent on the connected ADC daughterboard, but can range from:

- 100kHz to 100MHz square wave, +5dBm to +10dBm (1.1V_{PP} to 2V_{PP}), sine wave also acceptable
- Signal settings for ADC daughterboard:
- DC to 1.1MHz, +5dBm to +10dBm (depending on analog input attenuation)

A.2 USB Driver Information

The USB driver for the RHADC-FMCEV1Z board should show up under Universal Serial Bus controllers in the Device Manager of the Windows operating system. It should be listed in the window similar to [Figure 21](#).

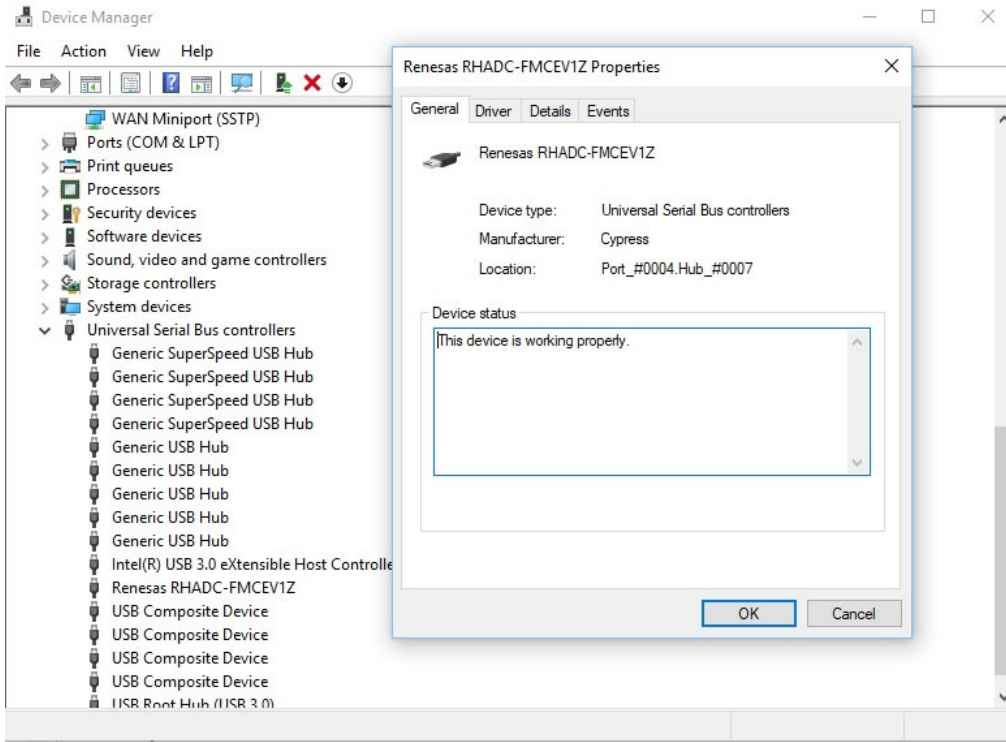


Figure 21. USB Driver Information in Device Manager

A.3 HPC FMC Pin Configuration

HPC Pin	Function	Source ^{[1][2][3][4]}
F4	DCO	Daughter
E2	D0	Daughter
K7	D1	Daughter
J6	D2	Daughter
F7	D3	Daughter
E7	D4	Daughter
K10	D5	Daughter
J9	D6	Daughter
F10	D7	Daughter
E9	D8	Daughter
K13	D9	Daughter
J12	D10	Daughter
F13	D11	Daughter
E12	D12	Daughter
J15	D13	Daughter
F16	D14	Daughter
E15	D15	Daughter

HPC Pin	Function	Source ^{[1][2][3][4]}
C39	3.3V Supply	Host
D1	PG_C2M (Host Power Good)	Host
D36	3.3V Supply	Host
D38	3.3V Supply	Host
D40	3.3V Supply	Host
J24	CSB	Host
J25	SDO	Daughter
J39	VIO_B_M2C	Daughter
K25	SCLK	Host
K26	SDI	Host/Daughter
K40	VIO_B_M2C	Daughter
F26	DEV_OE	Host
F1	VIO_B_M2C Power Good	Daughter
E24	ADC GP 0A	Host
E25	ADC GP 1A	Host
E21	ADC GP 2A	Host
E22	ADC GP 3A	Host
J28	ADC GB 0B	Host
E27	ADC GB 1B	Host
F25	ADC GB 2B	Host
F28	ADC GM 0A	Host
F29	ADC GM 1A	Host
F22	ADC GM 2A	Host
J27	ADC GD 0A	Host
K28	ADC GL 0A	Host
H8	ADC GF 0A	Host
H7	ADC GF 1A	Host
G10	ADC GF 2A	Host
G9	ADC GF 3A	Host
C11	ADC GF 4A	Host
G21	ADC GP 0B	Host
G22	ADC GP 1B	Host
G24	ADC GP 2B	Host
G25	ADC GP 3B	Host
G18	ADC GC 0A	Daughter
G12	ADC GC 1A	Daughter
H10	ADC GC 2A	Daughter
D17	ADC GG 0A	Daughter

HPC Pin	Function	Source ^{[1][2][3][4]}
H13	ADC GG 1A	Daughter
H16	ADC GG 2A	Daughter

1. In this document, the terms host and motherboard are interchangeably used.
2. In this document, the terms daughter card and mezzanine card are interchangeably used.
3. Nets sourced by the host are used by the daughter card and must be supplied.
4. Nets sourced by the daughter are provided to the host card. In some cases (such as VIO_B_M2C, CLK_DIR, Power-Good) these can be ignored by the host or may not be provided by the daughter board.

A.4 Analog Signal Generators

Renesas uses the following analog signal generators as clock and signal sources when characterizing low-power, high-performance radiation hardened precision SAR ADCs:

- Rohde & Schwarz: SMA100A or SMA100B (with low phase noise and clock synthesis options)
- Audio Precision SYS-2722 Audio Analyzer/Generator

These generators provide very low jitter to optimize the SNR performance of the ADC under test. Other generators with similar phase noise performance can also be used. Contact Renesas Technical Support for recommendations.

3. Ordering Information

Part Number	Description
RHADC-FMCEV1Z	FPGA based data capture board for radiation hardened precision SAR ADCs

4. Revision History

Rev.	Date	Description
1.04	Jul 19, 2024	Applied latest template. Updated BOM.
1.03	Oct 26, 2022	Updated Specifications section. Updated Evaluation System Contents section. Updated Installation Requirements section. Updated Figures 11 and 14. Updated Sample Clock and Input Signal Source Setup section. Updated Appendix B, C, and D.
1.02	Jun 15, 2021	Updated the Installation Requirements section.
1.01	Oct 20, 2020	Changed radiation tolerant to radiation hardened Removed Related Literature section Changed ISL73141SEHM to ISL73141SEH in Evaluation System Contents section
1.00	Aug 21, 2020	Initial release

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