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1. Functional Description

1.1 Connecting the Board to a Computer

The evaluation board can be connected to a computer via the USB connector (see Figure 4). This board has a USB-C type connector. The on-board USB-to-I2C bridge (FTDI chip) handles the data communication, and the +5V in the USB bus powers the on-board regulators. Using a bench power supply with the VDD jacks is optional. The board can fully function with just the USB cable to a computer.

Renesas' *RICBox Software* can control the RC32504A on the board. RICBox is compatible with both the on-board USB-to-I2C bridge and the Aardvark adapter. RICBox uses a software wizard for entering the overall configuration and has several tools to fine tune the configuration (e.g., block diagram GUI).

The Bus Source connector J30 can be used to select the source of the communication bus. The bus will be I2C for most communication but can also be SPI for specific tests. Pins 1 and 2 in J30 are SDA and SCL from the FTDI chip. Pins 3 and 4 pass the SDA and SCL to the I2C level shifter. To use the on-board FTDI chip, install jumpers on pins 1-3 and 2-4. The board will be shipped with these jumpers installed. Theoretically, any I2C adapter can be connected to pins 3 and 4 for SDA and SCL. Pin 6 can be used as the ground connection for the I2C connection. Pins 3, 4, 5, and 6 are arranged such that an Aardvark connector can be plugged onto pins 3, 4, 5, and 6 only (see Figure 5).

The Bus Type connector J33 is added to allow bypassing the I2C Level Shifter in case the connection type is SPI. For default I2C operation, jumpers are installed on pins 1-3 and 2-4.

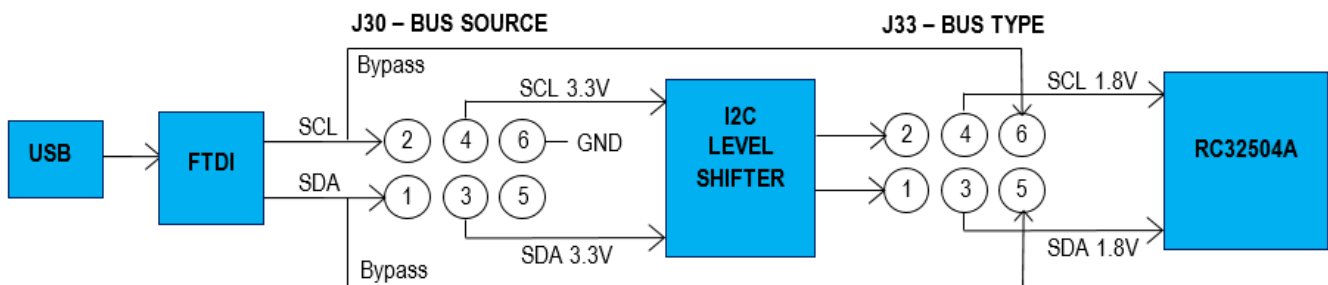


Figure 4. Communication Path Block Diagram

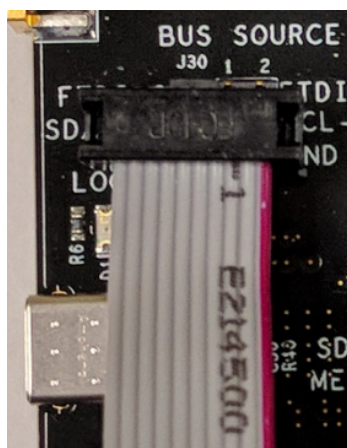


Figure 5. Connect Aardvark Adapter to J30

In Figure 14 the Aardvark adapter communicates with the RC32504A and the FTDI bridge chip is disconnected. USB can still be used to power the board.

1.2 Board Power Supply

The power source for each VDD pin can be selected with jumpers. The voltage for each pin, except one, is 1.8V. The exception is VDDD, which can be powered with 1.8V or 3.3V.

The power source can be either an on-board voltage regulator or the VDD_J jack. Most power source selectors have only two choices, 1.8V from the on-board 1.8V regulator or connect to the VDD_J J21 jack. The jack can connect to a bench supply; this connection can be useful, for example, to measure supply current into pins.

In Figure 2 the source for the pin VDDXO is chosen to be the on-board 1.8V regulator. The two pins on the bottom are both connected to the VDDXO pin through a power filter. The top left pin is connected to the on-board 1.8V regulator and the top right pin is connected to the VDD_J jack.



Figure 2. Power Source Selector Example

In Figure 3 the source for the pin VDDD is chosen to be the on-board 3.3V regulator. J25 allows three choices for VDDD: 1.8V, 3.3V, or the VDD_J jack. The three pins on the right are all connected to the VDDD pin through a power filter. The top left pin is connected to the on-board 3.3V regulator, the mid left pin is connected to the on-board 1.8V regulator, and the bottom left pin is connected to the VDD_J Jack.



Figure 3. Power Source Selector for VDDD

1.3 Differential Output Termination Selectors

Each of the four differential output pairs can be programmed to LVDS, HCSL, or CMOS logic type. CMOS is a single-ended logic type and the output pair will essentially be two CMOS outputs of the same frequency. HCSL is the most versatile output because it can be customized. The HCSL driver is a current driver that simply turns a current on and off. Standard HCSL turns 15mA on and off to make 750mVpp swing in 50Ω termination.

The RC32504A HCSL driver can be programmed to drive 4mA to 19mA levels. When AC coupled, the HCSL driver can be compatible with LVDS, CML, and LVPECL signal swing requirements. Because of the output architecture, it needs a DC coupled termination to ground to drive the current into. The circuit at each output splits the termination into a DC part and an AC coupled RF part. The RF part is connected to the SMA edge connectors of each output and the DC part is controlled by the termination selectors.

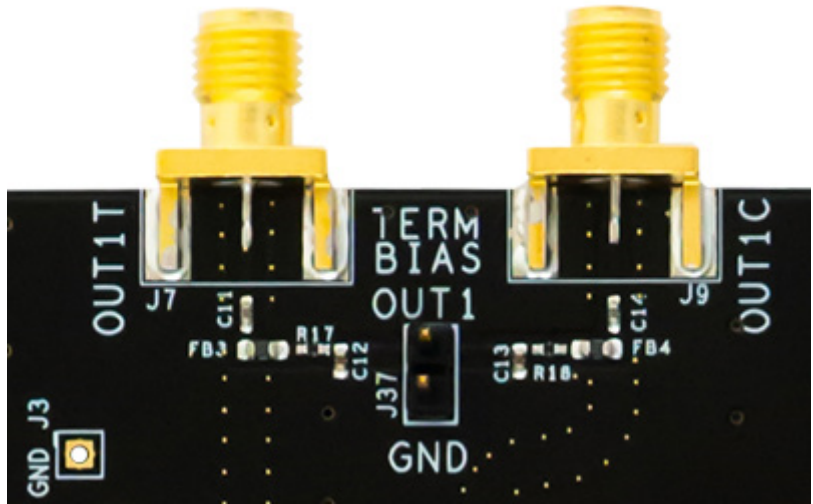


Figure 4. Termination Bias Jumpers

Figure 4 shows J36 for applying DC load to OUT0. When HCSL is selected and the on-chip termination is disabled, a jumper must be placed to provide the required DC load to ground. No jumper is needed for LVDS or LVCMOS, and when the on-chip termination is enabled with HCSL.

Separating DC load from AC coupled RF load helps increase the signal swing on the SMA connectors for better noise measurements. This method can also be used in the end application when the receiver input has on-chip termination, is AC coupled, and a large signal swing is required.

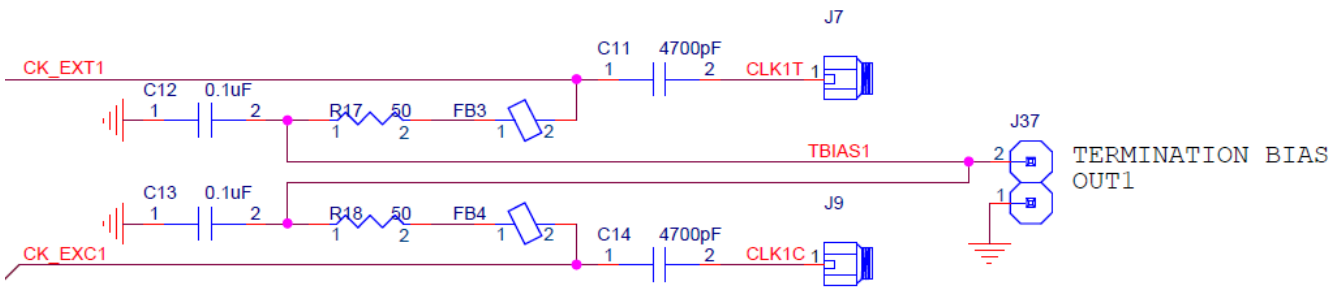


Figure 5. Termination Bias Schematic

1.4 Miscellaneous Selectors



Figure 6. OE Pin Control

J32 pins 2, 4, and 6 connect together to the OE pin of the RC32504A. Apply a jumper on pins 1 and 2 to pull the OE pin high or on 5 and 6 to pull the OE pin low. The RC32504A can be programmed to pull high or low on the chip so in most cases no jumpers are needed on J32.

A pull-up or pull-down jumper can also be used to latch a specific programmed configuration at power up.

When experimenting with SPI, a jumper can be applied to pins 3 and 4 to pass the CS (Chip Select) signal from the FTDI chip to the RC32504A.



Figure 7. Lock Pin and SDA Pin Latch Control

J34 can be used to latch a specific level on the LOCK pin at power up. J35 can be used to latch a specific level on the SDA pin at power up.

Both are used to select a specific pre-programmed configuration. It is not needed to program OTP of the RC32504A on the evaluation board. Every possible configuration can be set up with RICBox in volatile registers. It is not recommended to attempt to program the OTP memory because of the risk that a mistake or error can destroy the chip.

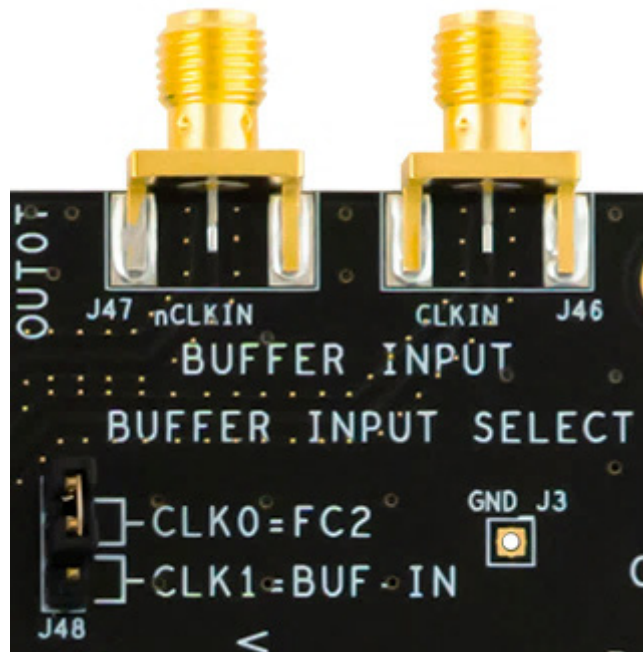


Figure 8. Buffer Input Select

J48 can be used to select the input source for the 8P34S1208I fan-out buffer. The CLK0 input pair on the buffer is connected to OUT0 of the FemtoClock 2, and the CLK1 input pair is connected to SMAs J46 and J47. By default, the jumper is on CLK0 for passing OUT0 of FC2 through the buffer. Changing the jumper to CLK1 and

another output can be passed through the buffer by connecting a pair of coax cables from that output to the buffer input SMA pair.

The CLK0 input is DC coupled to OUT0 on FC2 to demonstrate a connection with minimum components. OUT0 on FC2 must be configured as LVDS for this to work properly. The 8P34S1208I is an LVDS fan-out buffer.

The CLK1 input is AC coupled, using the buffer VREF for DC bias, to make that input compatible with any differential swing applied to the buffer input SMA pair.

1.5 On-Board Crystal

The evaluation board is assembled with a crystal. The default frequency for the crystal is 60MHz but Renesas can ship the board with a different crystal frequency to better match the specific application where the RC32504A will be used. The default 60MHz crystal is best suited for jitter attenuator applications. Synthesizer applications with output frequencies like 156.25MHz or 312.5MHz work better with a 62.5MHz crystal, or even better, with a 78.125MHz crystal. The crystal footprint U1 has a universal shape to allow assembly of 3.2 x 2.5 mm and 2.5 x 2.0 mm size crystals.

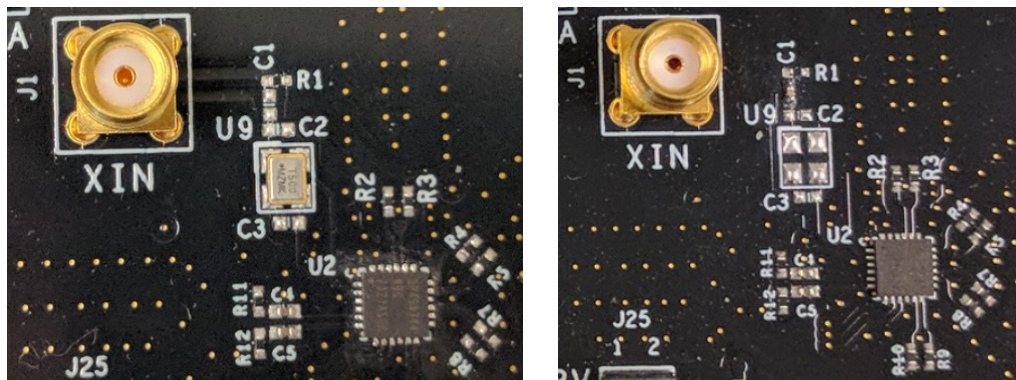


Figure 9. Crystal and XIN Input

1.6 Bypassing the Fan-Out Buffer at OUT0

Remove R60 and place at R59. Also remove R61 and place R58. The red rectangles are the new positions. These two resistors are 0Ω and the change will route the OUT0 clock to the J4 and J6 SMA connectors as opposed to the fan-out buffer input in the R60 and R61 positions.

When the fan-out buffer is not used, it is a good idea to remove jumper J49 (VDDFO) to remove power from the fan-out buffer.

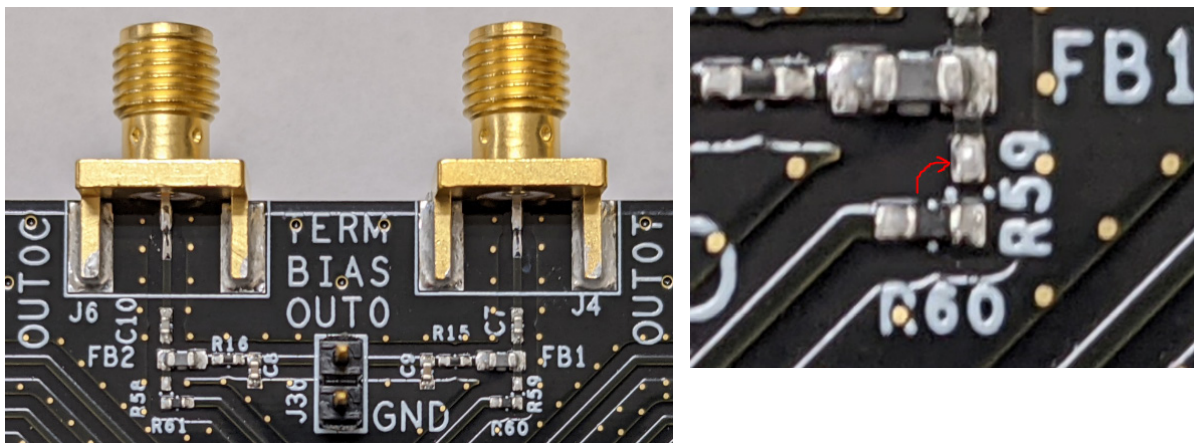
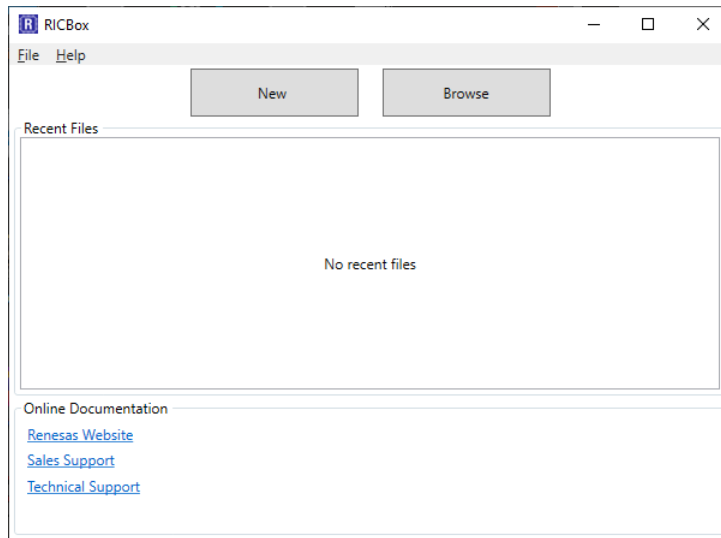


Figure 10. OE Pin Control

1.7 Setup and Configuration

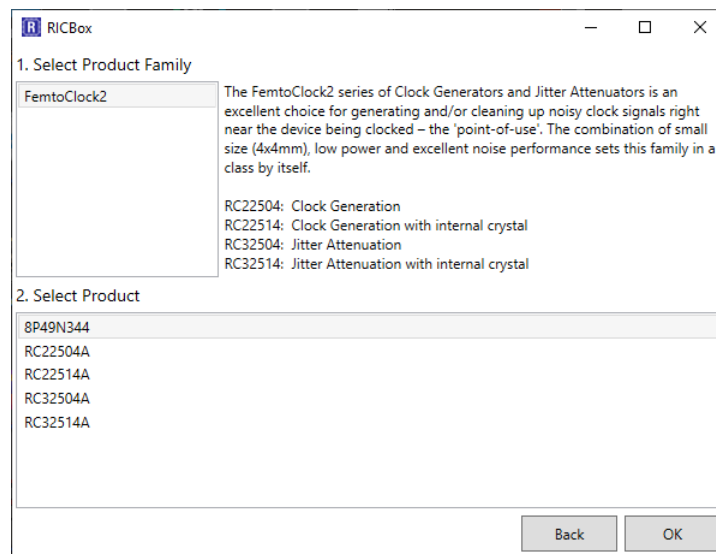
Complete the following steps to set up the RC32504A / RC22504A EVB using I2C and start the configuration of the board.

1. Connect J31 to a USB port of the user's computer using the USB cable supplied with the board.
2. Launch Renesas' *RICBox Software* according to the instructions in the *FemtoClock 2 RICBox User Guide*. The software and guide are downloadable from the [RC32504A](#) product page.
3. Following the "Getting Started" steps in the *RICBox Software*, an I2C connection is established between the GUI software and the RC32504A.
4. Open an existing settings file (click Browse) or start a new configuration (click New).



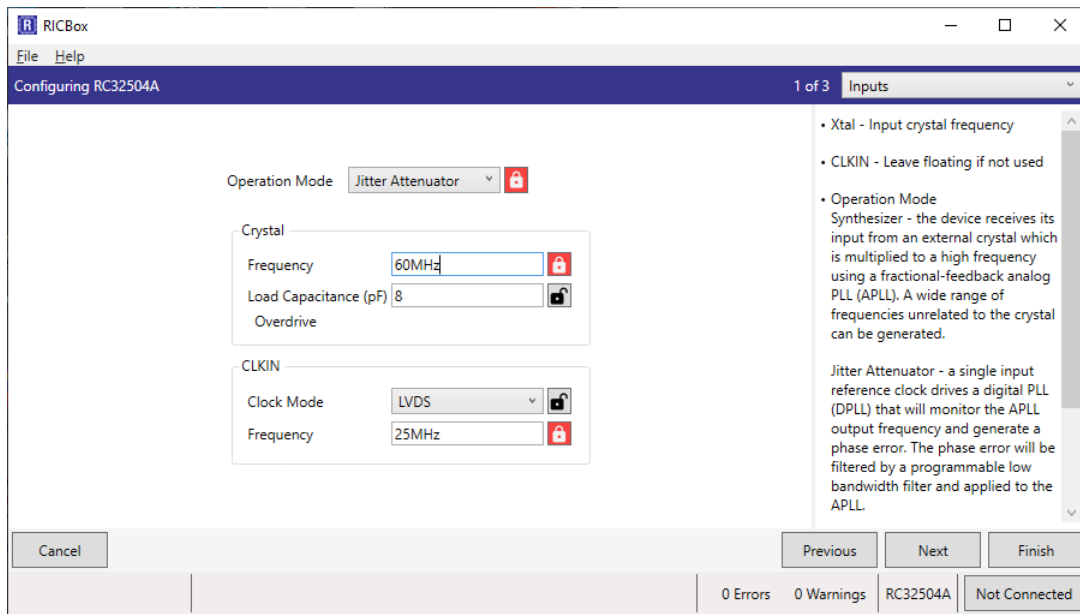
Configurations that were saved recently will show in the "Recent Files" box. Double-click on a file to load the configuration.

5. When starting a new configuration, the software first needs to know what product family to load the "Virtual Environment" for:



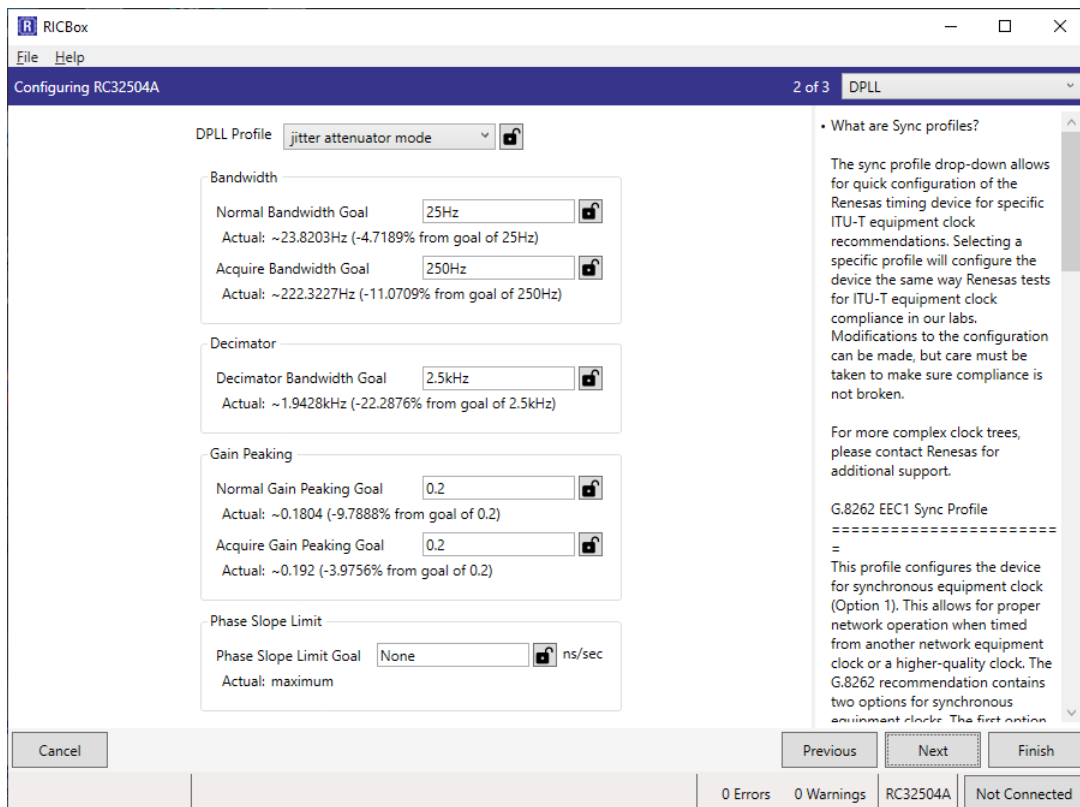
This screen shows only FemtoClock 2 but it is possible to install multiple Virtual Environments for various product families. At item 1, select FemtoClock 2 then select the specific product at item 2 and click "OK".

6. Select the “Operation Mode”: Synthesizer or Jitter Attenuator.

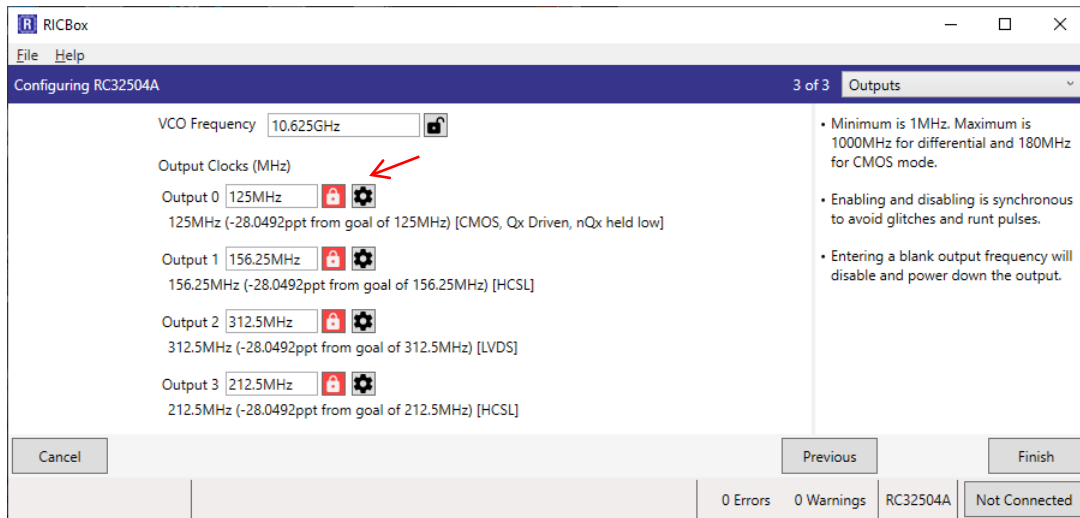


On the right are explanations and instructions. Click “Next” to go to the next screen.

7. Screen 2 has a list of Jitter Attenuator settings.

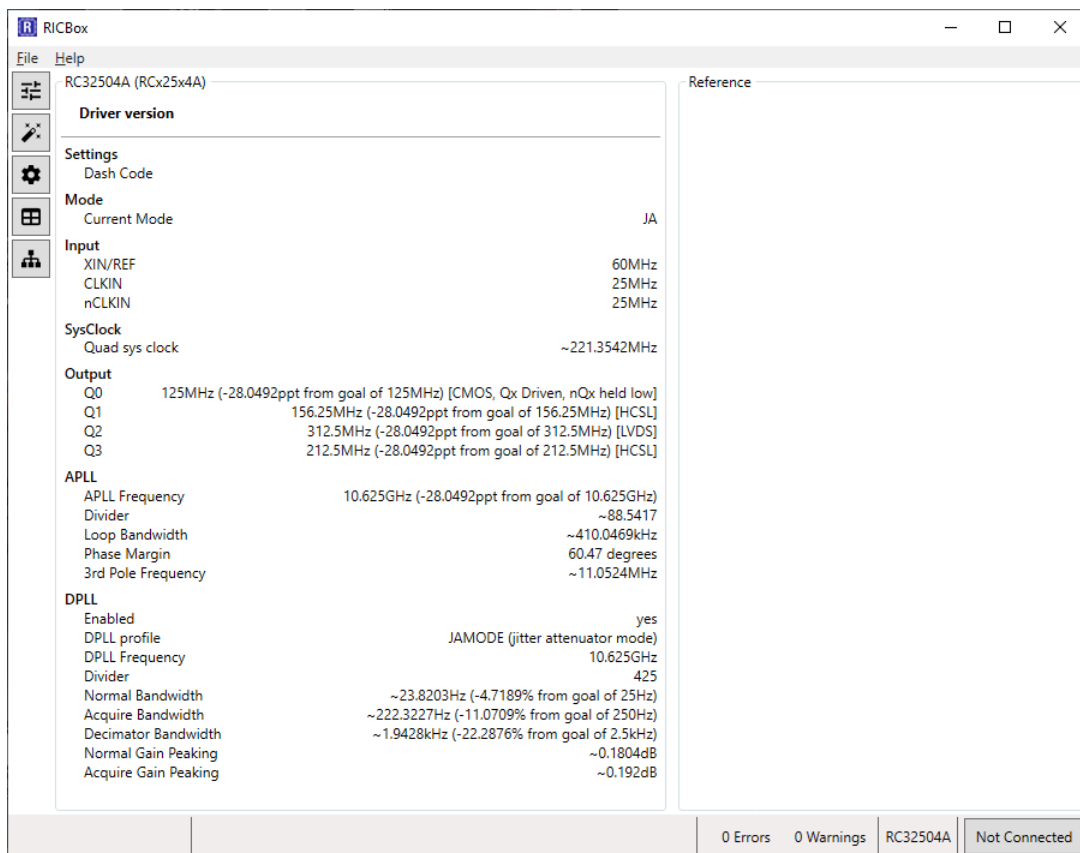


8. Screen 3 sets up the outputs.



- Fill in the desired output frequencies. Leave blank unused outputs.
- Click on “Advanced Settings” at the red arrow to select Logic Type and Signal Amplitude.
- Click “Finish” to end the Wizard and enter the main configuration utility.

9. The main configuration utility.

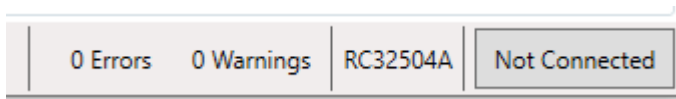


The buttons on the top left are Control Panel (the above screen), Wizard, Configuration, Registers, and Block Diagram.

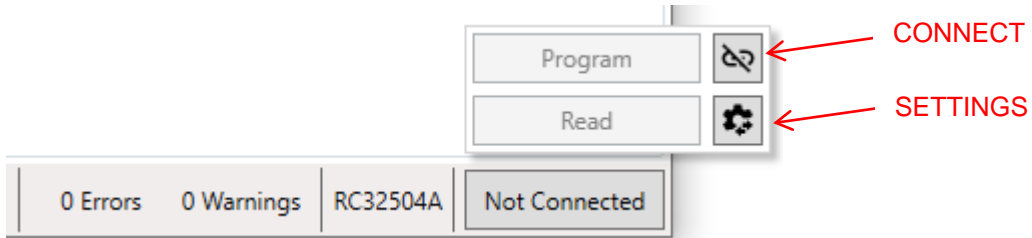
For more information, see the *FemtoClock 2 RICBox User Guide* located on the [RC32504A](#) product page.

10. Transfer the Configuration from RICBox into the FemtoClock 2 device:

The bottom right of the screen has buttons to control the I2C connection with the device.

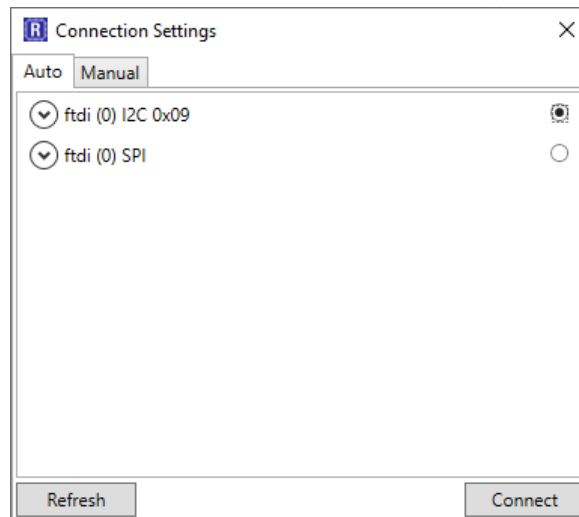


a. Click the "Not Connected" button to connect.



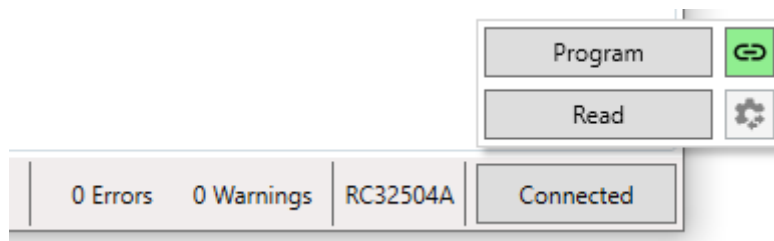
b. Click the small button to the right of "Program" to connect.

The small button next to "Read" opens I2C settings and starts a search for connected devices.



The "Connection Settings" screen allows you to select a specific device and Connect.

After attempting to Connect:



The small Connect button turns green to indicate that the connection was successful. Now click "Program" to transfer all settings to the device.

2. Board Design

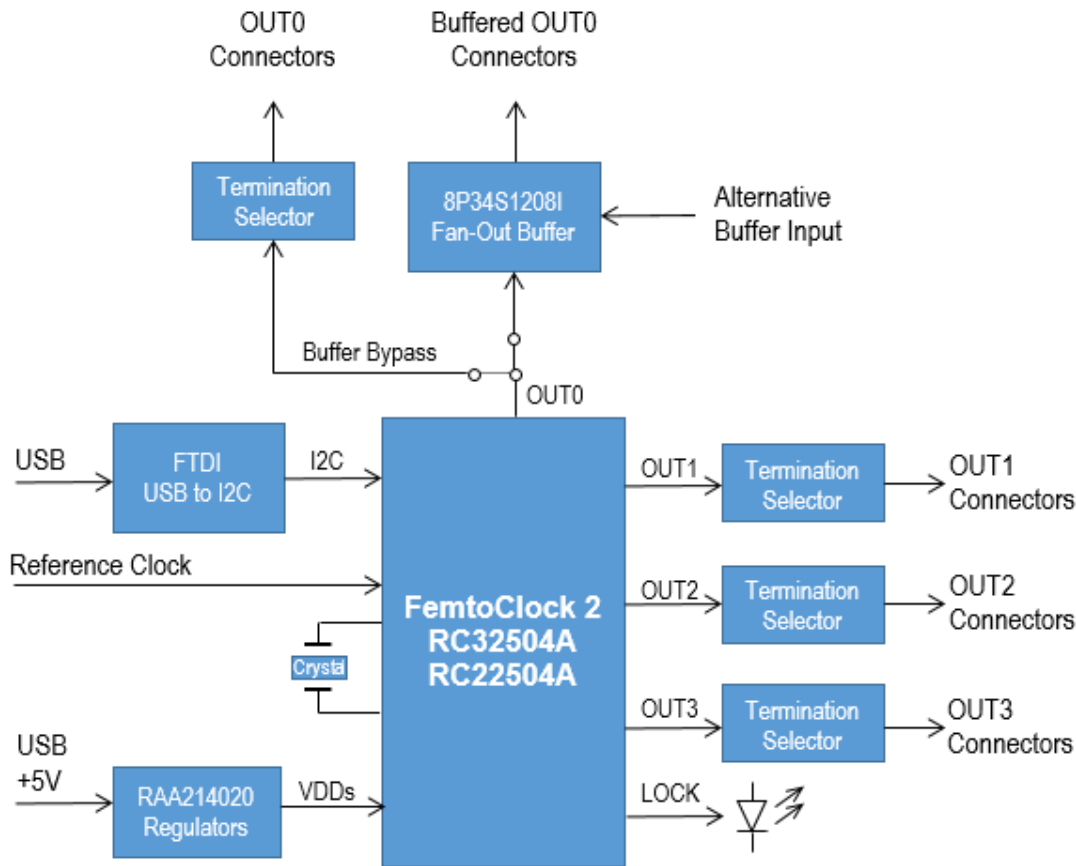


Figure 11. RC32504A / RC22504 EVB – Block Diagram

Each differential output clock is available on a pair of SMA connectors. Each pair of SMA connectors is AC coupled on the board. The termination selector can provide a DC path to ground for the HCSL output type when the on-chip termination is disabled.

Power is provided through the USB connection and regulated with RAA214020 low noise LDOs. Each power pin can also be switched to a banana plug jack for supply current measurements or other tests.

The board has an FTDI USB-to-I2C bridge for programming FemtoClock 2 from a computer. Renesas RICBox software is available for easy development of configurations and uploading these configurations to the FemtoClock 2 device.

To demonstrate the use of FemtoClock 2 with fan-out buffers, an 8P34S1208I is added at OUT0 of FemtoClock 2. When the buffer is not desired, the board can be easily modified by moving two 0Ω resistors to pass OUT0 to its own pair of SMA connectors, just like the other outputs. The buffer has one of its two inputs connected to OUT0 and the other connected to an SMA pair so the buffer can always be used to pass a clock from any output through a pair of coax cables.

The LOCK pin drives an LED and the LED lights up when the pin is high. Default function assigned to the LOCK pin is “APLL Lock” so the LED shows if the APLL is locked or not. Several other status items can be assigned to the LOCK pin.

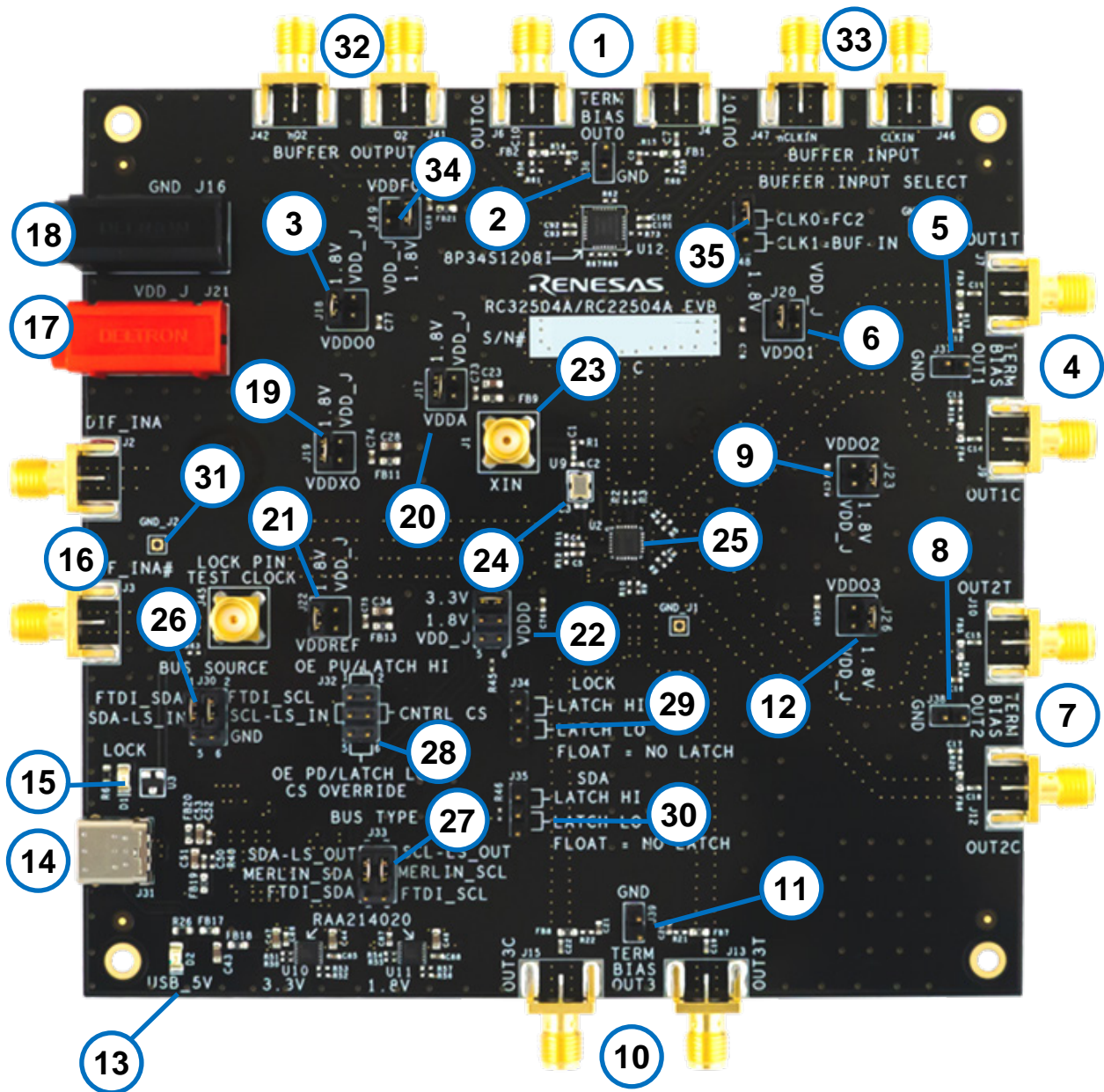


Figure 12. RC32504A / RC22504A Board – Top View

Table 1. RC32504A / RC22504A – EVB Pins and Functions

Note: See Figure 12 for reference numbers in the following table.

Ref.	Name	On-Board Connector Label	Function
1	Output 0	J4, J6	Differential Clock Output 0 (not active with typical assembly)
2	Termination 0	J36	Termination Selector for Output 0 (not active with typical assembly)
3	VDDO0	J18	Power Source Selector for pin VDDO0
4	Output 1	J7, J9	Differential Clock Output 1
5	Termination 1	J37	Termination Selector for Output 1
6	VDDO1	J20	Power Source Selector for pin VDDO1

Ref.	Name	On-Board Connector Label	Function
7	Output 2	J10, J12	Differential Clock Output 2
8	Termination 2	J38	Termination Selector for Output 2
9	VDDO2	J23	Power Source Selector for pin VDDO2
10	Output 3	J13, J15	Differential Clock Output 3
11	Termination 3	J39	Termination Selector for Output 3
12	VDDO3	J26	Power Source Selector for pin VDDO3
13	LED_5V	D2	LED lights when 5V USB Supply is present
14	USB Interface	J31	USB-C Type Jack for connection with the user's computer and interaction with Renesas RICBox Software.
15	LOCK LED	D1	LED lights up LOCK pin goes high. Default the LOCK pin signals APLL locking.
16	DIF_IN	J2, J3	Differential Reference Clock Input
17	Power VDD Jack	J21	External Power Supply, Positive Terminal
18	Power GND Jack	J16	External Power Supply, Negative Terminal or Ground
19	VDDXO	J19	Power Source Selector for pin VDDXO (Crystal Oscillator Power)
20	VDDA	J17	Power Source Selector for pin VDDA (Analog Power)
21	VDDREF	J22	Power Source Selector for pin VDDREF (Ref Clock Input Power)
22	VDDD	J25	Power Source Selector for pin VDDD (Digital Power)
23	XIN	J1	Overdrive XIN pin with External Clock
24	Crystal	U9	Quartz Crystal
25	RC32504A	U2	Evaluation Device. The RC32504A can also demonstrate RC22504A functionality.
26	Bus Source	J30	Select Communication Bus Source
27	Bus Type	J33	Select Communication Bus Type
28	OE / SPI CS	J32	OE pin Pull-Up / -Down or Latch High / Low or Pass SPI Chip Select
29	LOCK Latch	J34	Lock pin Latch High / Low
30	SDA Latch	J35	SDA pin Latch High / Low
31	GND	GND_J1/2/3/4	Miscellaneous Ground Points
32	OUT0 Buffer Output	J41, J42	Differential Fan-Out Buffer Output
33	2 nd Buffer Input	J46, J47	Alternative Fan-Out Buffer Input
34	VDDFO	J49	Power Source Selector for 8P34S1208I Fan-Out Buffer
35	Buffer Input Select	J48	Select between CLK0 = FemtoClock 2 OUT0 and CLK1 = Buffer Input SMA pair.

2.1 Schematic Diagrams

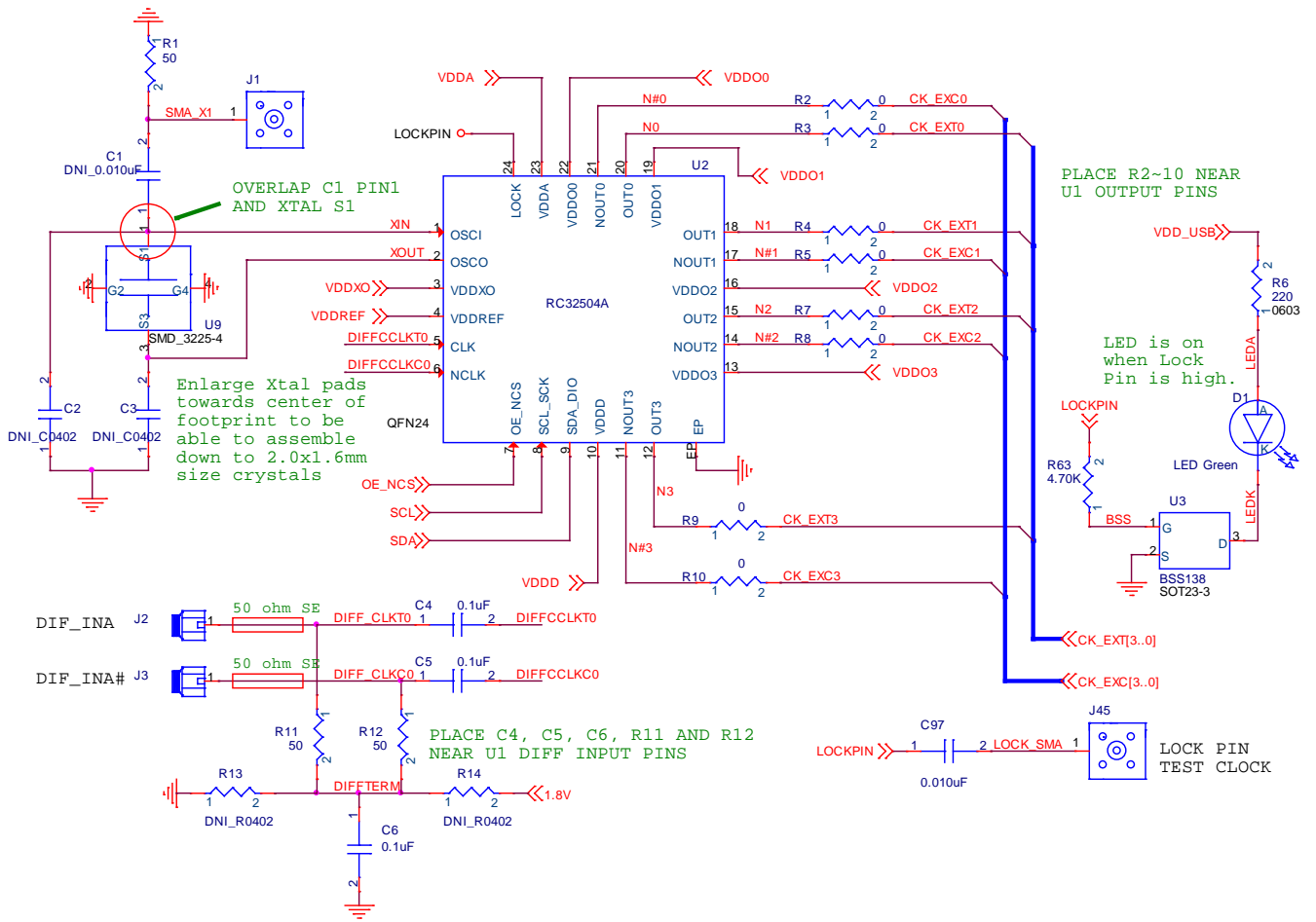


Figure 13. RC32504A Evaluation Board Schematics – Page 1

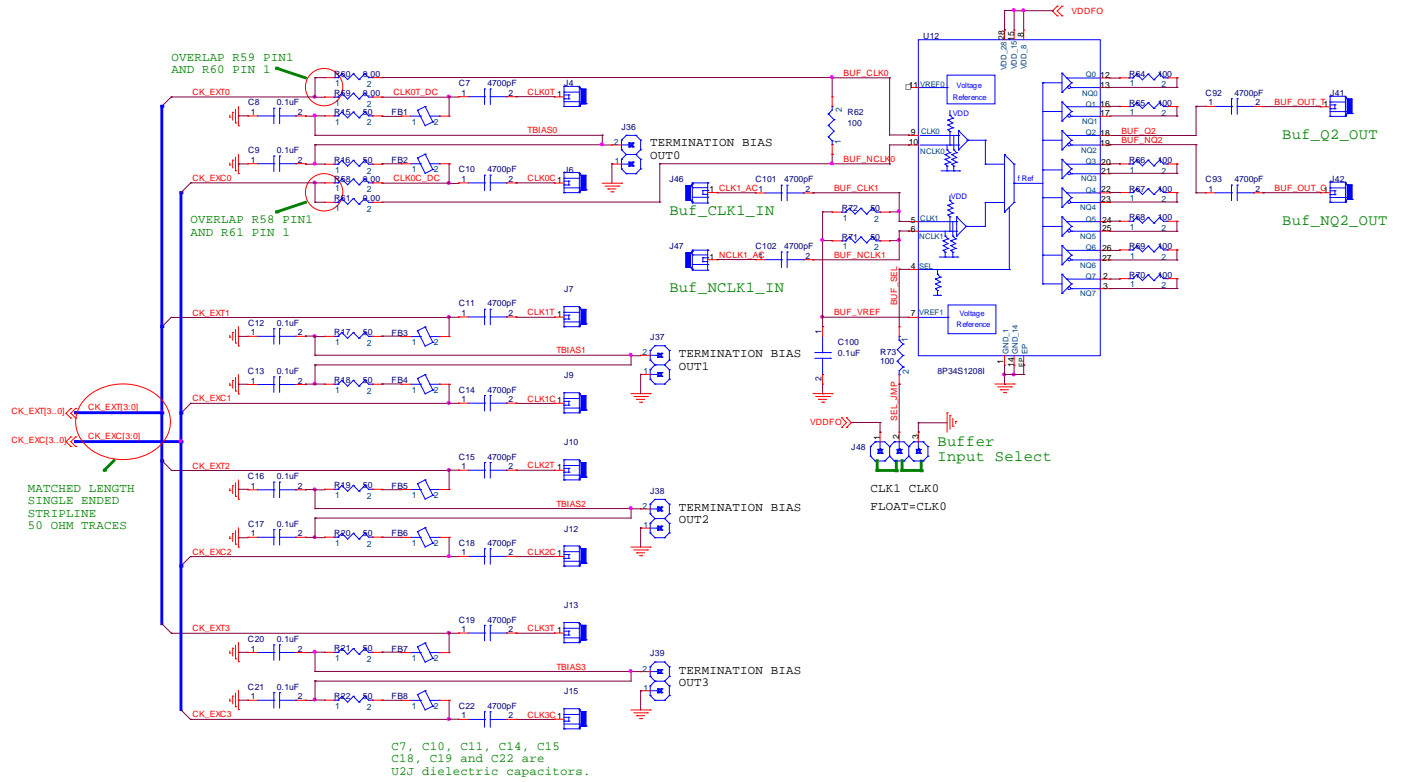


Figure 14. RC32504A Evaluation Board Schematics – Page 2

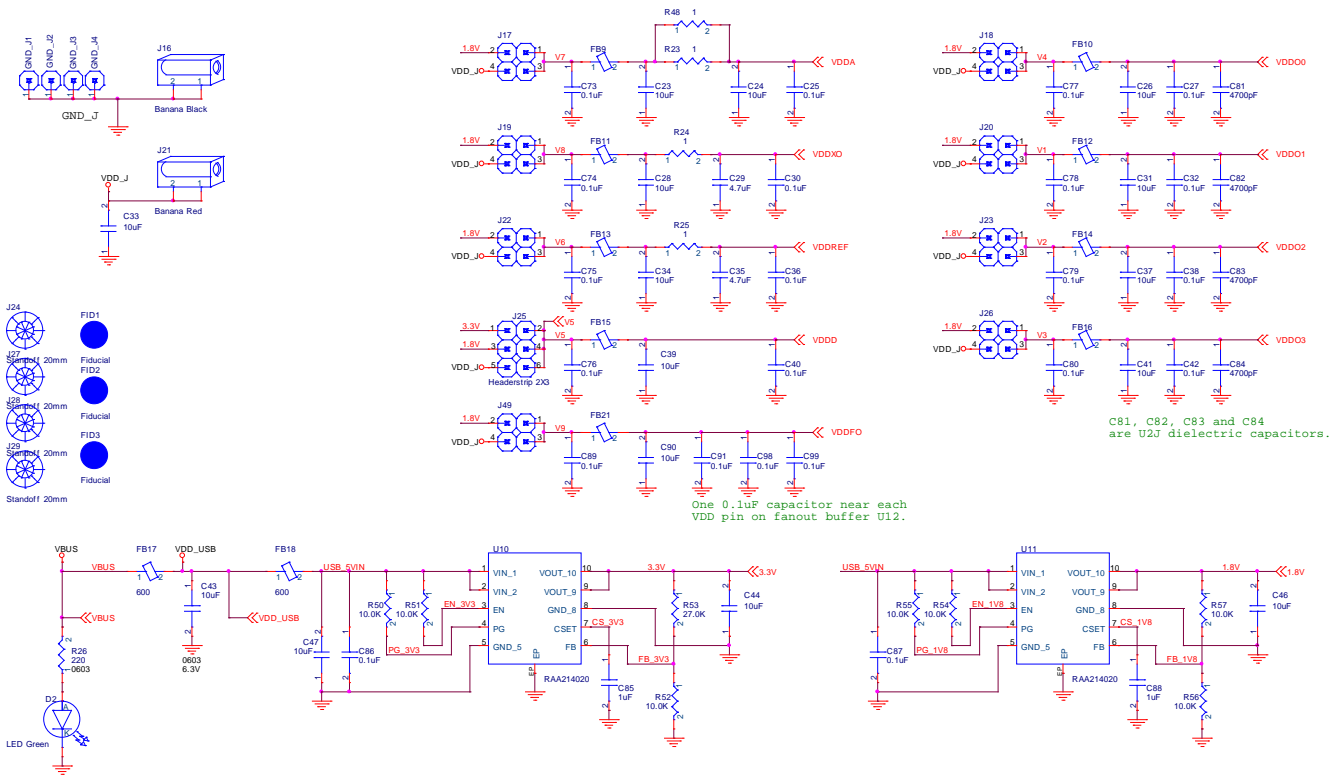


Figure 15. RC32504A Evaluation Board Schematics – Page 3

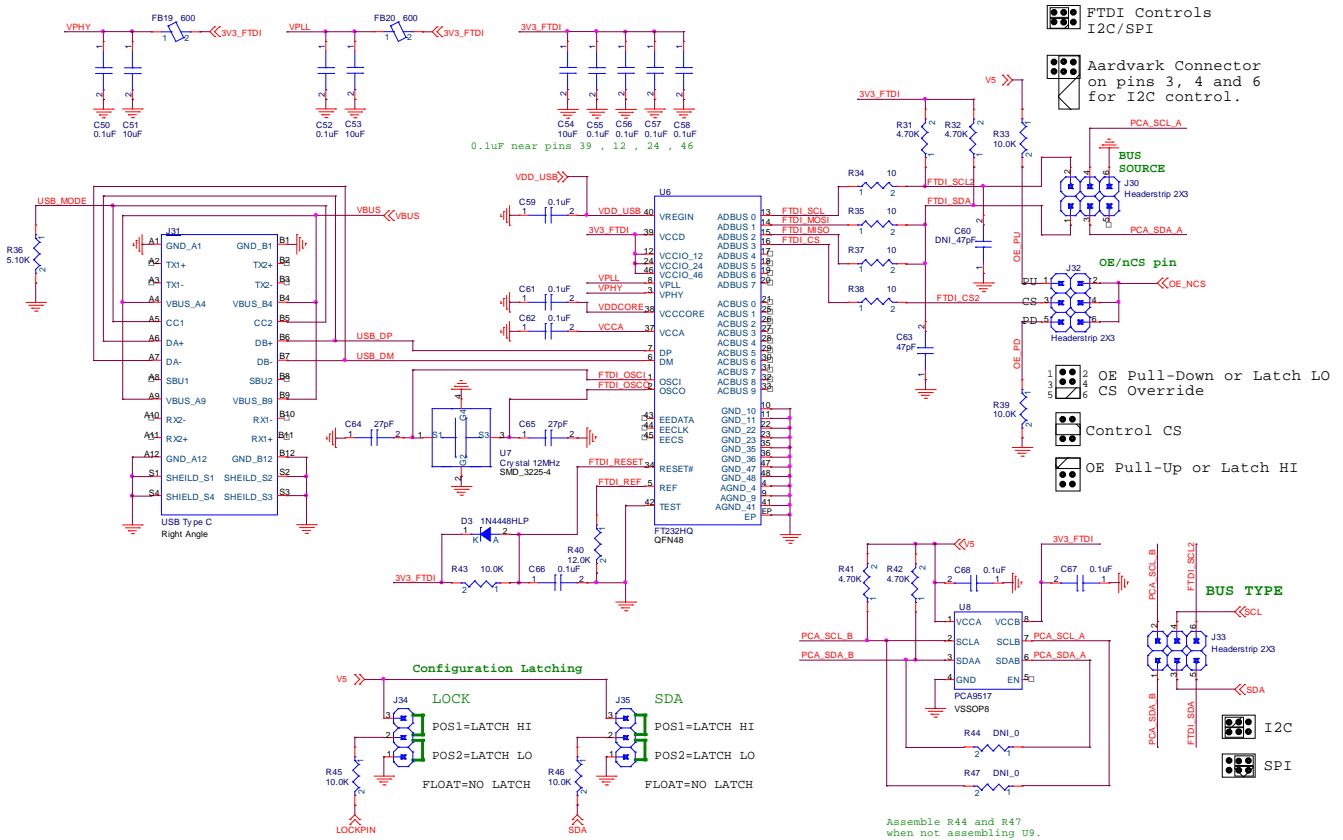


Figure 16. RC32504A Evaluation Board Schematics – Page 4

2.2 Bill of Materials

Item	Qty	Reference	Value	Part Number	Manufacturer
1	1	C1	DNI_0.010uF	GRM155R71E103J	
2	2	C2,C3	DNI_C0402	DNI_C0402	
3	46	C4,C5,C6,C8,C9,C12,C13,C16,C17,C20,C21,C25,C27,C30,C32,C36,C38,C40,C42,C50,C52,C55,C56,C57,C58,C59,C61,C62,C66,C67,C68,C73,C74,C75,C76,C77,C78,C79,C80,C86,C87,C89,C91,C98,C99,C100	0.1uF	GRM155R71C104KA88D	Murata Electronics
4	16	C7,C10,C11,C14,C15,C18,C19,C22,C81,C82,C83,C84,C92,C93,C101,C102	4700pF	GRM1557U1A472JA01D	Murata Electronics
5	18	C23,C24,C26,C28,C31,C33,C34,C37,C39,C41,C43,C44,C46,C47,C51,C53,C54,C90	10uF	GRM188D70J106MA73D	Murata Electronics
6	2	C29,C35	4.7uF	ZRB15XR61A475ME01	
7	1	C60	DNI_47pF	GRM1555C1E470J	Murata Electronics
8	1	C63	47pF	GRM1555C1E470J	Murata Electronics
9	2	C64,C65	27pF	GRM1555C1E270J	Murata Electronics

Item	Qty	Reference	Value	Part Number	Manufacturer
10	2	C85,C88	1uF	GCM155C71A105KE38D	Murata Electronics
11	1	C97	0.010uF	GRM155R71E103J	Murata Electronics
12	2	D1,D2	LED Green	APT3216CGCK	
13	1	D3	1N4448HLP	1N4448HLP	
14	21	FB1,FB2,FB3,FB4,FB5,FB6,FB7,FB8,FB9,FB10,FB11,FB12,FB13,FB14,FB15,FB16,FB17,FB18,FB19,FB20,FB21	600	BLM18AG601SN1D	Murata
15	3	FID1,FID2,FID3	Fiducial	Fiducial DNI	
16	4	GND_J1,GND_J2,GND_J3,GND_J4	DNI Headerstrip 1X1	DNI 1x1	
17	2	J1,J45	SMA_JACK_STR_50	733910070	Molex
18	14	J2,J3,J4,J6,J7,J9,J10,J12,J13,J15,J41,J42,J46,J47	Cinch_142_0701_851	142_0701_851	Johnson
19	1	J16	Banana Black	571-0100	
20	8	J17,J18,J19,J20,J22,J23,J26,J49	Header 2X2	499-10-202-10-009000	
21	1	J21	Banana Red	571-0500	
22	4	J24,J27,J28,J29	Standoff 20mm	R30-1612000	
23	4	J25,J30,J32,J33	Headerstrip 2X3	10897062	Molex
24	1	J31	USB Type C	12401598E4#2A	Amphenol
25	3	J34,J35,J48	Headerstrip 1X3	22-28-4035	Molex
26	4	J36,J37,J38,J39	Headerstrip 1X2	22-28-4023	Molex
27	11	R1,R15,R16,R17,R18,R19,R20,R21,R22,R71,R72	50	ERA-2AEB49R9X	Panasonic
28	8	R2,R3,R4,R5,R7,R8,R9,R10	0	ERJ-2GE0R00	Panasonic
29	2	R6,R26	220	CRCW0603220RFK	Vishay
30	2	R11,R12	DNI_50	ERA-2AEB49R9X	Panasonic
31	2	R13,R14	DNI_R0402	DNI_R0402	
32	4	R23,R24,R25,R48	1	RC0402FR-071RL	Yageo
33	5	R31,R32,R41,R42,R63	4.70K	CRCW04024K70FK	Vishay
34	12	R33,R39,R43,R45,R46,R50,R51,R52,R54,R55,R56,R57	10.0K	RCG040210K0FK	Yageo
35	4	R34,R35,R37,R38	10	RC0402FR-0710RL	Yageo
36	1	R36	5.10K	CRCW04025K10FK	Vishay
37	1	R40	12.0K	CRCW040212K0FK	Vishay

Item	Qty	Reference	Value	Part Number	Manufacturer
38	2	R44,R47	DNI_0	ERJ-2GE0R00	Panasonic
39	1	R53	27.0K	CRCW040227K0FK	Vishay
40	2	R58,R59	DNI_0.00	ERJ-2GE0R00	Panasonic
41	2	R60,R61	0	ERJ-2GE0R00	Panasonic
42	9	R62,R64,R65,R66,R67,R68,R69,R70, R73	100	CRCW0402100RFK	Vishay
43	1	U2	RC32504A	RC32504A	Renesas
44	1	U3	BSS138	BSS138	On Semi
45	1	U6	FT232HQ	FT232HQ-REEL	FTDI
46	1	U7	Crystal 12MHz	ABM8G-12.000MHZ- 18-D2Y-T	Abracon
47	1	U8	PCA9517	PCA9517	Texas Instruments
48	1	U9	Crystal 50MHz	EXS00A-CG03550	NDK America
49	2	U10,U11	RAA214020	RAA214020	Renesas
50	1	U12	8P34S1208I	8P34S1208I	Renesas

3. Ordering Information

Part Number	Description
RC32504A-EVK	RC32504A / RC22504A Evaluation Board; A-male to USB-C cable.

4. Revision History

Revision	Date	Description
1.0	Apr 21, 2021	Initial release.

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