EU096-3 Flexible 6-Channels Power Sequencer

Quick Start Guide

Contents

1. Introduction 2
1.1 Scope of the document 2
1.2 Main features 2
1.3 Block Diagram 2
2. PoC key Components Arrangement 3
3. Specifications 4
4. Instructions of use 5
4.1 Power supply connection 7
4.2 Connecting to the PC/Laptop 8
5. GUI – Graphical User Interface 9
6. Schematic 12
References 17
Revision History 18

1. Introduction

1.1 Scope of the document

The Quick Start-Guide document describes the functional principle and the required steps for the configuration of an EU096-3 Flexible 6-Channels Power Sequencer for PLCs PoC.

1.2 Main features

The board provides:

- 2 x Renesas MCUs, one for the main functionality of the board, and other for Micro-USB to UART Serial communication with the GUI.
- An input LDO powered by a 12V external source,
- A dual (red + green) LED for indication,
- 6 x output regulators with hardware configurable soft-start time, compensation circuit and output voltage,
- One LED for each regulator, to indicate the status of the supply current.

1.3 Block Diagram

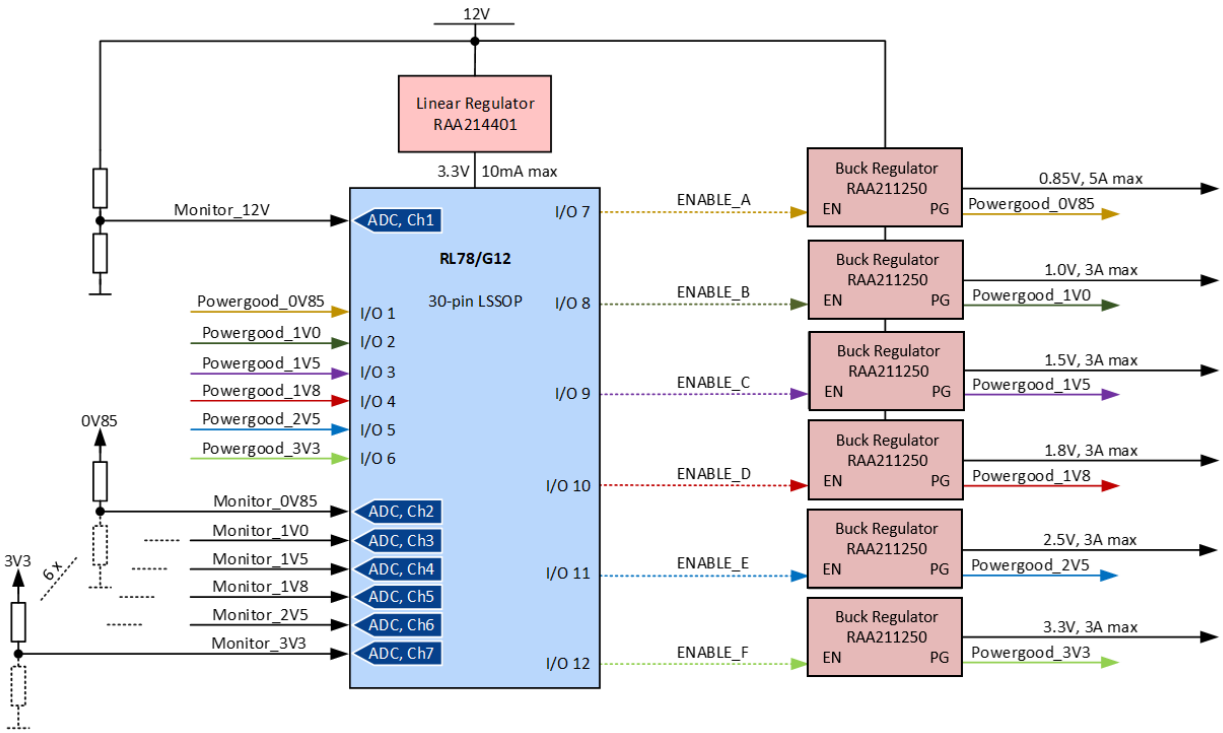


Fig.1 Flexible 6-Channels Power Sequencer block diagram

2. PoC key Components Arrangement

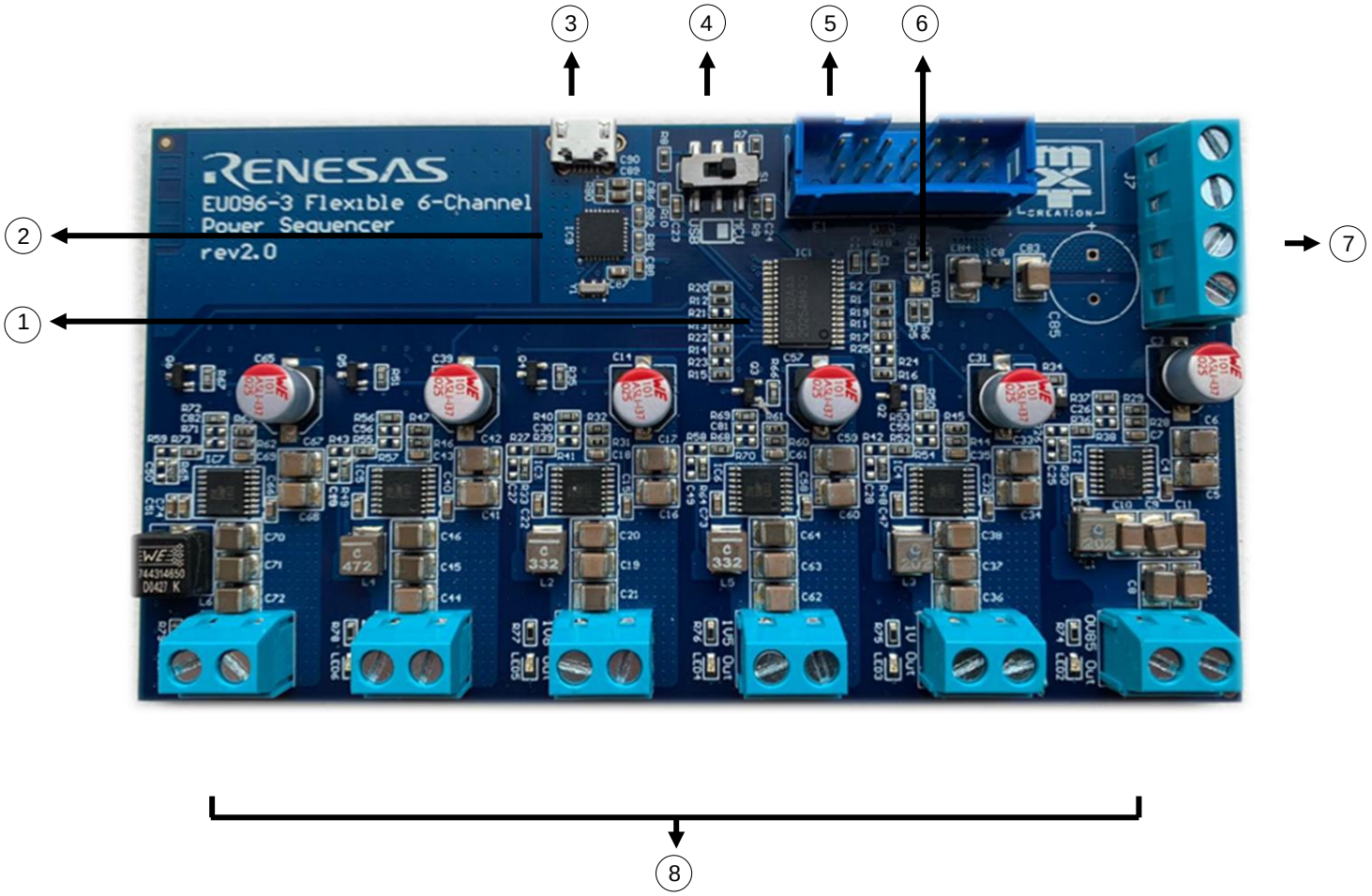


Fig.2 Flexible 6-Channels Power Sequencer component arrangement

1) RL78/G12 MCU
2) RL78/G1C MCU
3) Micro USB connector
4) Switch slider
5) Debugger connector
6) User red and green LEDs
7) Power Supply connector
8) Output connectors & LEDs indicating the status of the power supply.

3. Specifications

- **Operating voltage range:** 5 -15V (12V Recommended)
- **Power Supply:** External power supply
- **Output voltage:** 0.85V – 3.3V (default configuration)
- **Current limits:** 0.85V **–** 3.3V max 5A
- **Precision:** ±1% of output voltage
- **Power consumption:** Dependent on load

4. Instructions of use

The current design of the board provides two main functionalities: a power-up sequence, and a power-down sequence, which occur based on the presence of the input voltage, as follows:

Power ON Sequence:

1. The board is supplied with 12V.
2. The ADC reads 12V on the supply line.
3. After a delay, the enabling signal for the 0.85V regulator is asserted.
4. When the Power Good signal from the 0.85V regulator is asserted and received by the MCU as an interrupt, the delay for the 1V regulator starts.
5. After the delay, the enable signal for the 1.0V regulator is asserted.
6. Steps 4 and 5 are repeated for the 1.5V, 1.8V, 2.5V and 3.3V regulators.
7. After all 6 regulators are turned on, the 12V line is constantly monitored.

Power OFF Sequence:

1. The 12V supply is disconnected from the board.
2. The ADC reads too low of a value for the 12V line.
3. The enable signal for the 3.3V regulator is de-asserted.
4. When the Power Good signal from the 3.3V regulator is de-asserted and received by the MCU as an interrupt, the delay for the 2.5V regulator starts.
5. After a delay, the enable signal for the 2.5V regulator is de-asserted.
6. Steps 4 and 5 are repeated for the 1.8V, 1.5V, 1.0V and 0.85V regulators.

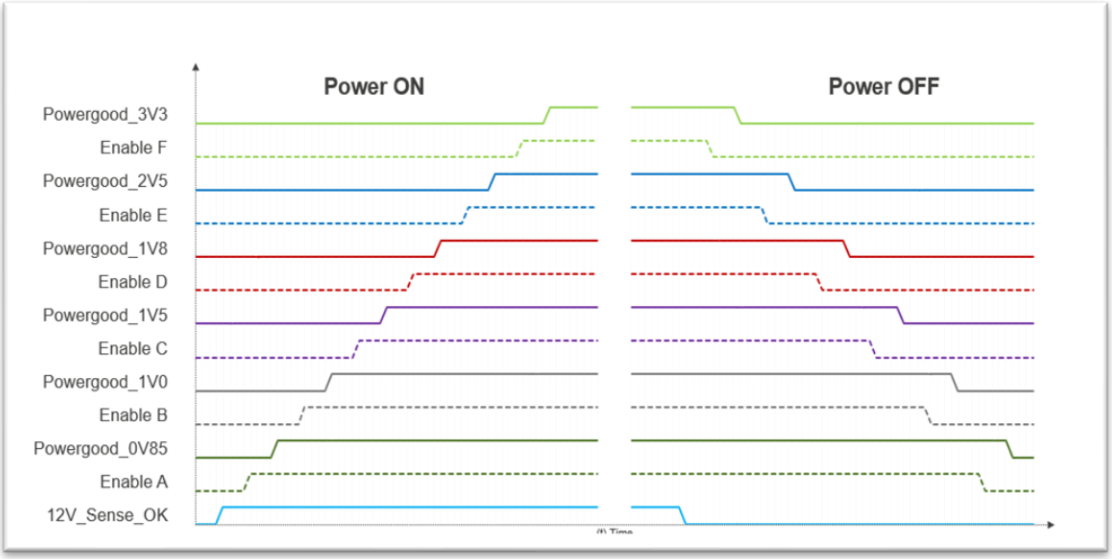


Fig.3 Flexible 6-Channels Power Sequencer power ON/OFF sequences

The delays between each regulator (*enable* and *disable)* are individually programmable via the GUI. The delays for the Power OFF Sequence are limited by the maximum time that the input capacitors can buffer and are heavily dependent on the load of each regulator. If longer delays are required for the Power OFF Sequence, an additional electrolytic capacitor (C85) can be installed on the board.

Fig.4 Electrolytic capacitor position

For normal functioning mode, make sure the slider switch is set on the "**MCU**" position:

Fig.5 USB/MCU Slider

4.1 Power supply connection

The power to the board is supplied via the "**12V Input"** screw terminal, respecting the polarity marked on the silk-screen.

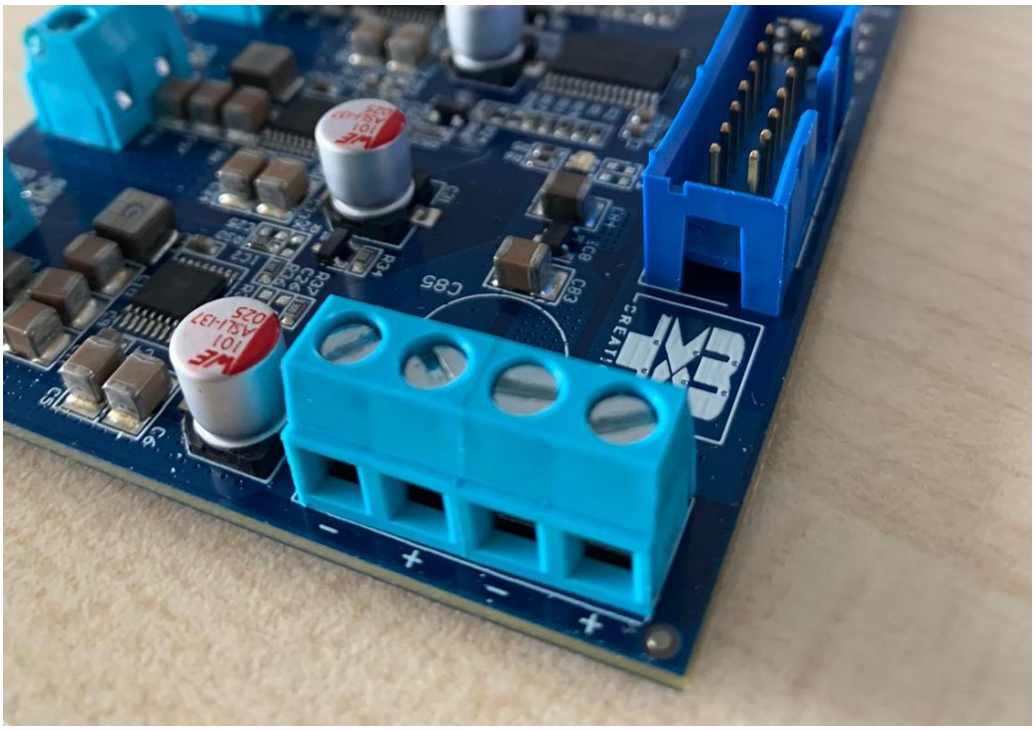


Fig.6 Flexible 6-Channels Power Sequencer screw terminal

The screw terminal has two pairs of inputs, so that two or more boards can be daisy-chained to share the same power supply.

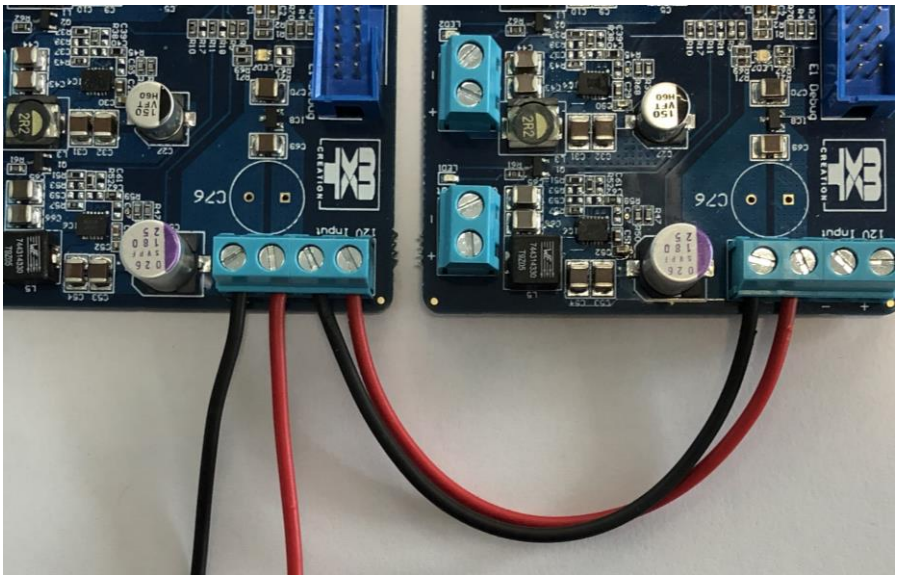


Fig.7 Flexible 6-Channels Power Sequencer daisy chain

4.2 Connecting to the PC/Laptop

The connection of the board to the PC is done through the Micro-USB connector.

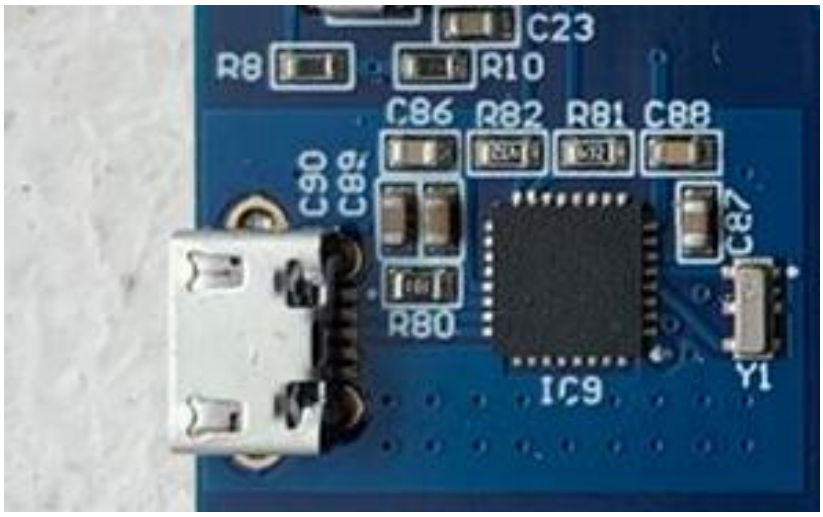


Fig.8 Flexible 6-Channels Power Sequencer micro-USB connector

5. GUI – Graphical User Interface

The GUI was created to ease the parameter modification and monitoring of each converter voltage level through UART.

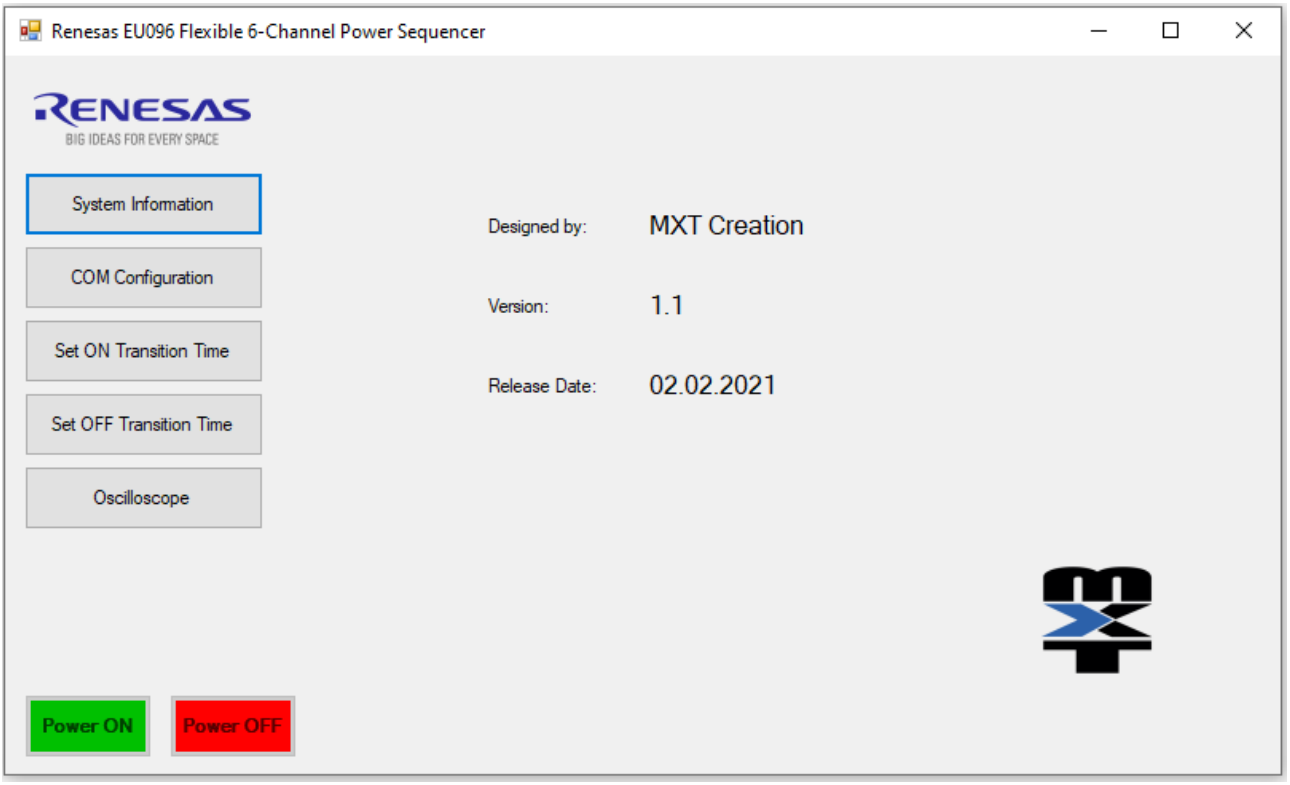


Fig.9 Flexible 6-Channels Power Sequencer graphical user interface

The connection to the board is realized in the "**COM Configuration"** tab. Only the serial COM port must be selected, and the other values should be left default. For a successful connection, make sure that the board is externally powered, and the slider switch is set in the "**MCU**" position.

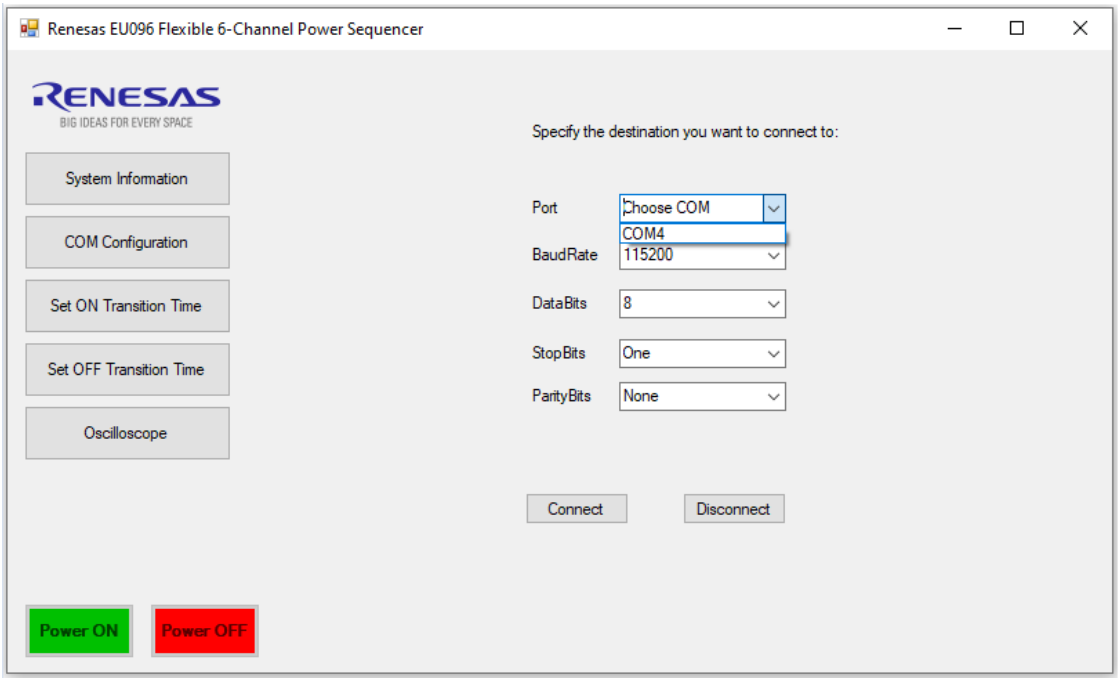


Fig.8 GUI – COM Configuration menu

The "**Set ON Transition Time**" and "**Set OFF Transition Time**" tabs allow the user to individually modify the delays between each *enable* and *disable* regulator. The introduced values in these fields must be of integer type in the interval 1-65535. When connecting to the board, these fields are automatically populated with the current settings of the board. If the user changes these values and clicks on "**SET Transitions**", the new values will be saved in the data flash of the microcontroller and the board must be power cycled for these new values to apply.

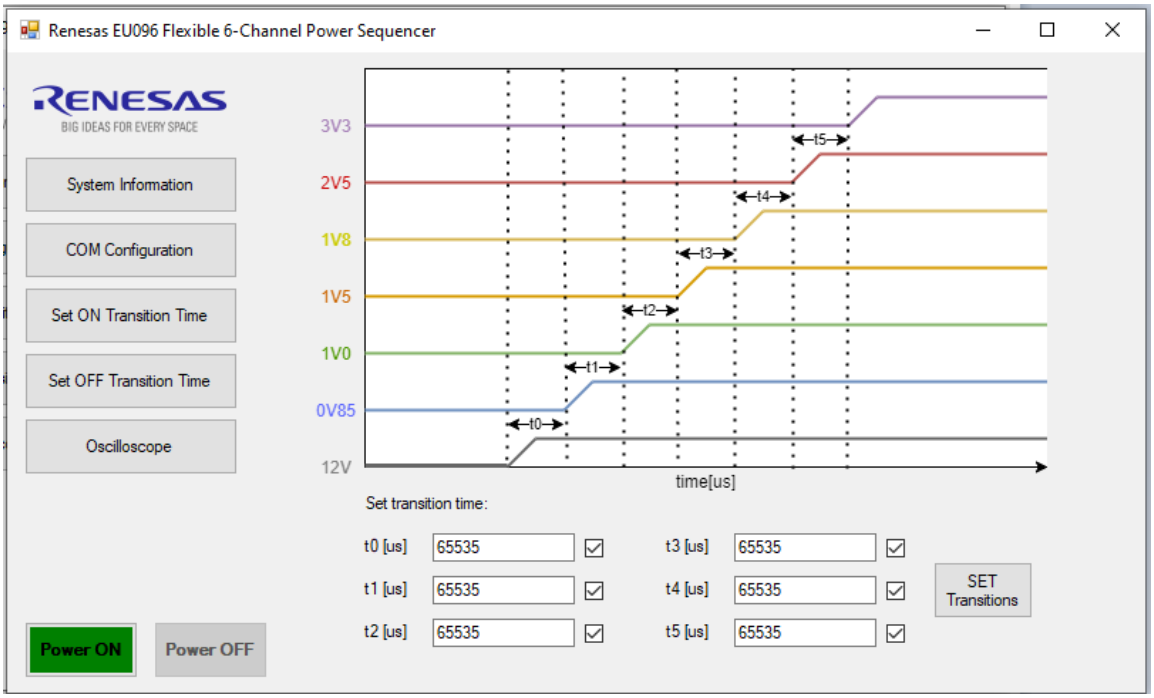


Fig.9 GUI – Set ON Transition Time menu

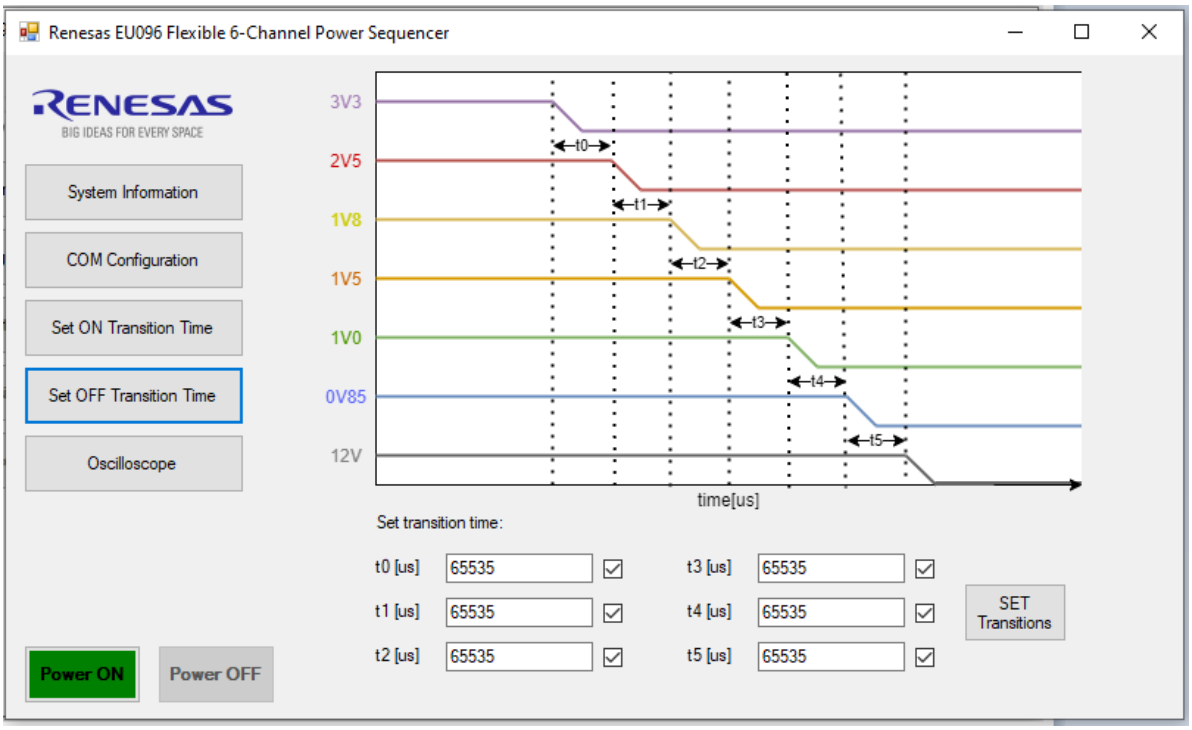


Fig.10 GUI – Set OFF Transition Time menu

The "**Console Log**" allows the user to activate the transmission of all the ADC values for each voltage regulator and enables the **Oscilloscope** function, which plots each individual voltage value on a graph.

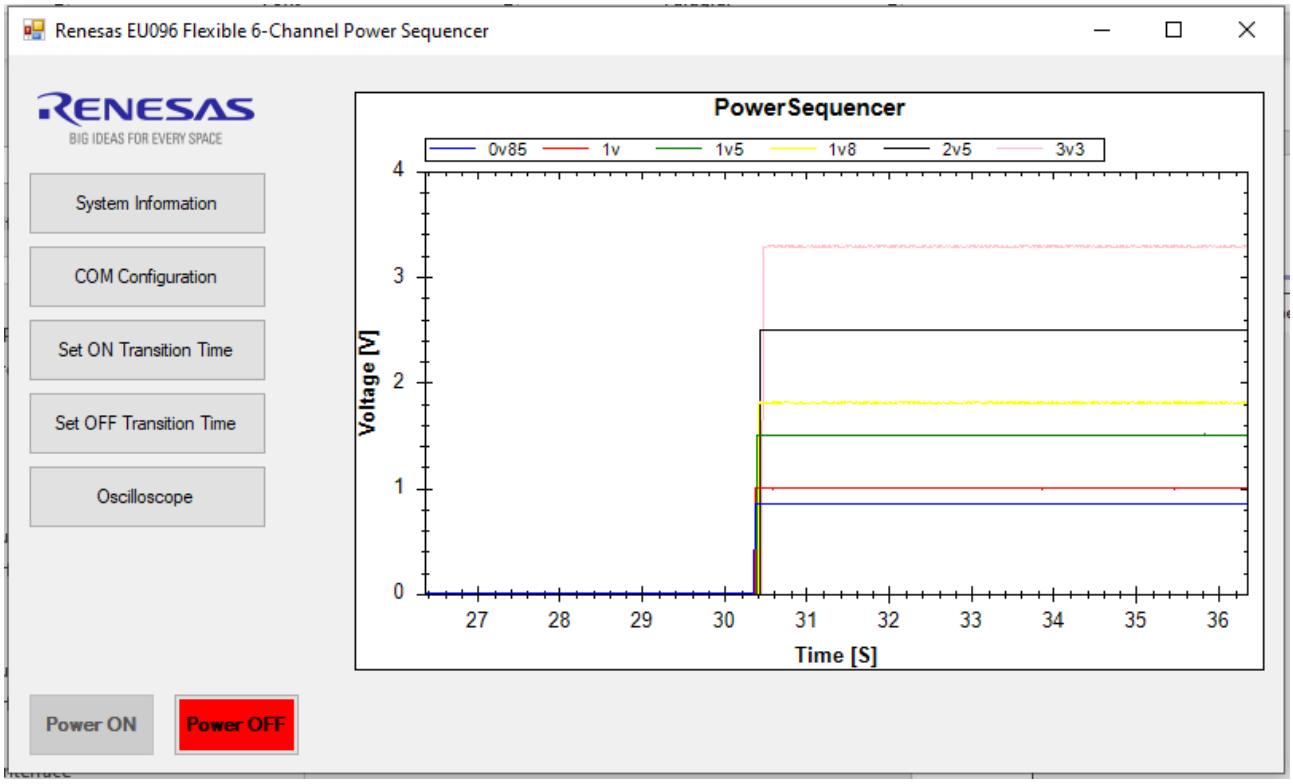


Fig.11 GUI – Oscilloscope menu

6. Schematic

The main components of the Power sequencer application are:

- Board Power Supply, the default power source is 12V, supplied from an external connector: 12V Input.

- Six independent DC-DC Converters supplied by 12V input:

• 0.85V 5A RAA211250 is a DC/DC synchronous buck regulator with integrated high-side and low-side FETs, that support 4.2V to 24V input range, with adjustable output voltage, adjustable soft-start time, 400kHz switching frequency and output Power-Good (PG) indicator. It can delivery up to continuous 5A output current. On the safe operation side, the IC provides a valley current limit, input voltage and output under voltage protection and thermal shutdown.

• 1V 5A RAA211250.

• 1.5V 5A RAA211250.

• 1.8V 5A RAA211250.

• 2.5V 5A RAA211250.

• 3.3V 5A RAA211250.

- RL78/G12 microcontroller, main controller.

- RL78/G1C microcontroller with integrated USB Controller for USB2Serial converter.

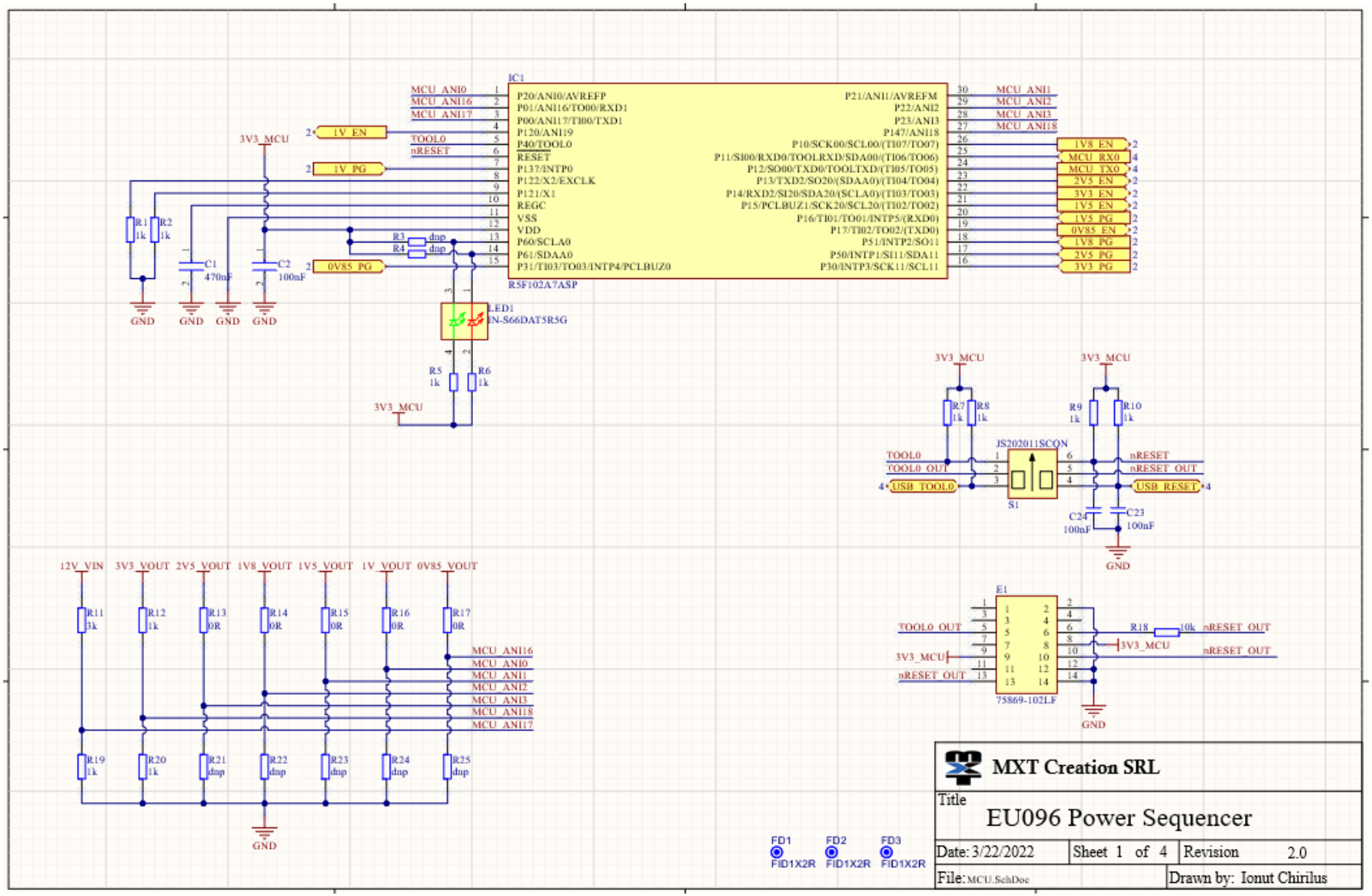
- Individual PG and output voltage monitoring. PG transitions high about 1ms after the switching regulator's output voltage reaches the regulation threshold, which is typically 85% of the regulated output voltage.

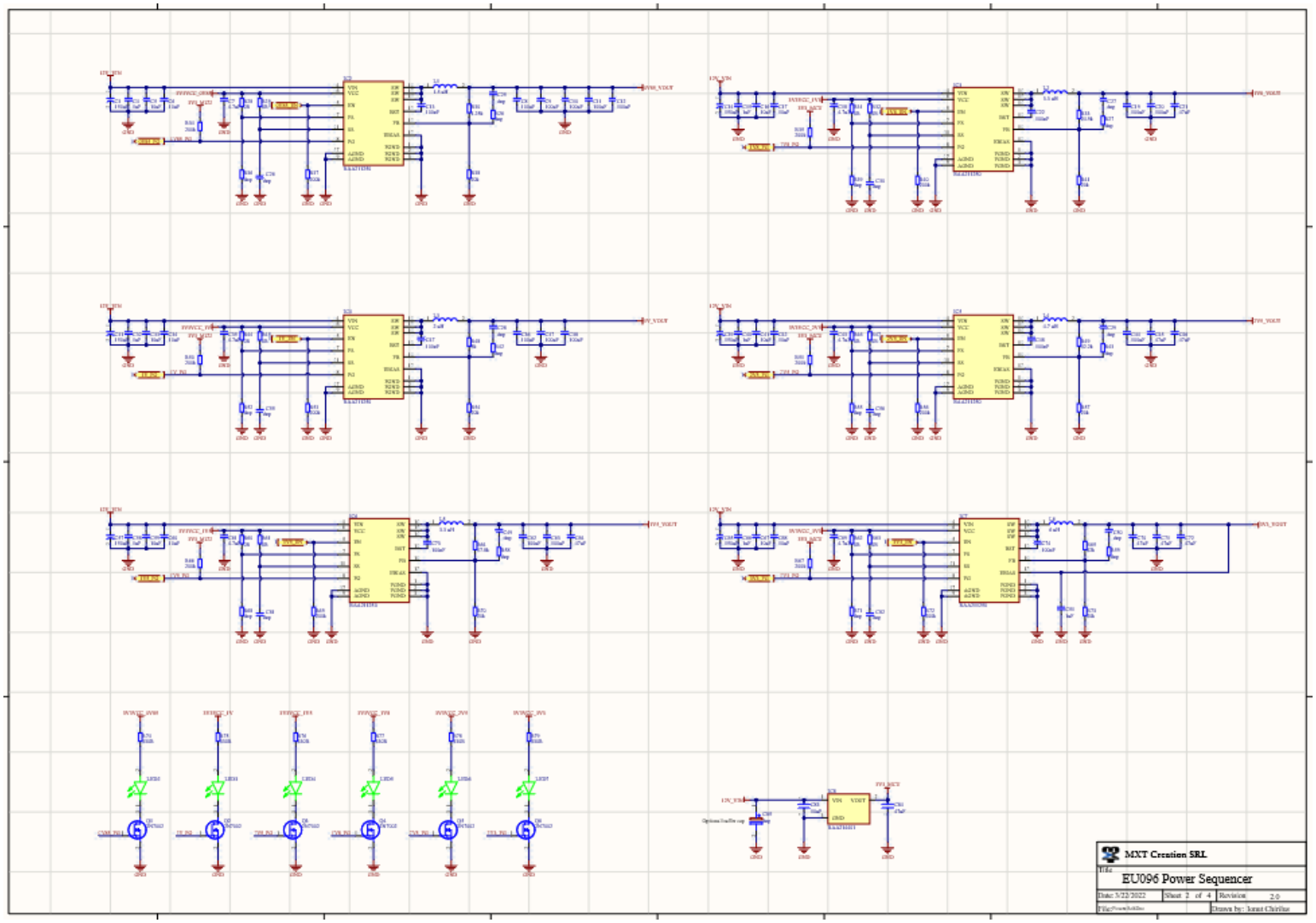
- Debug feature via E1 connector.

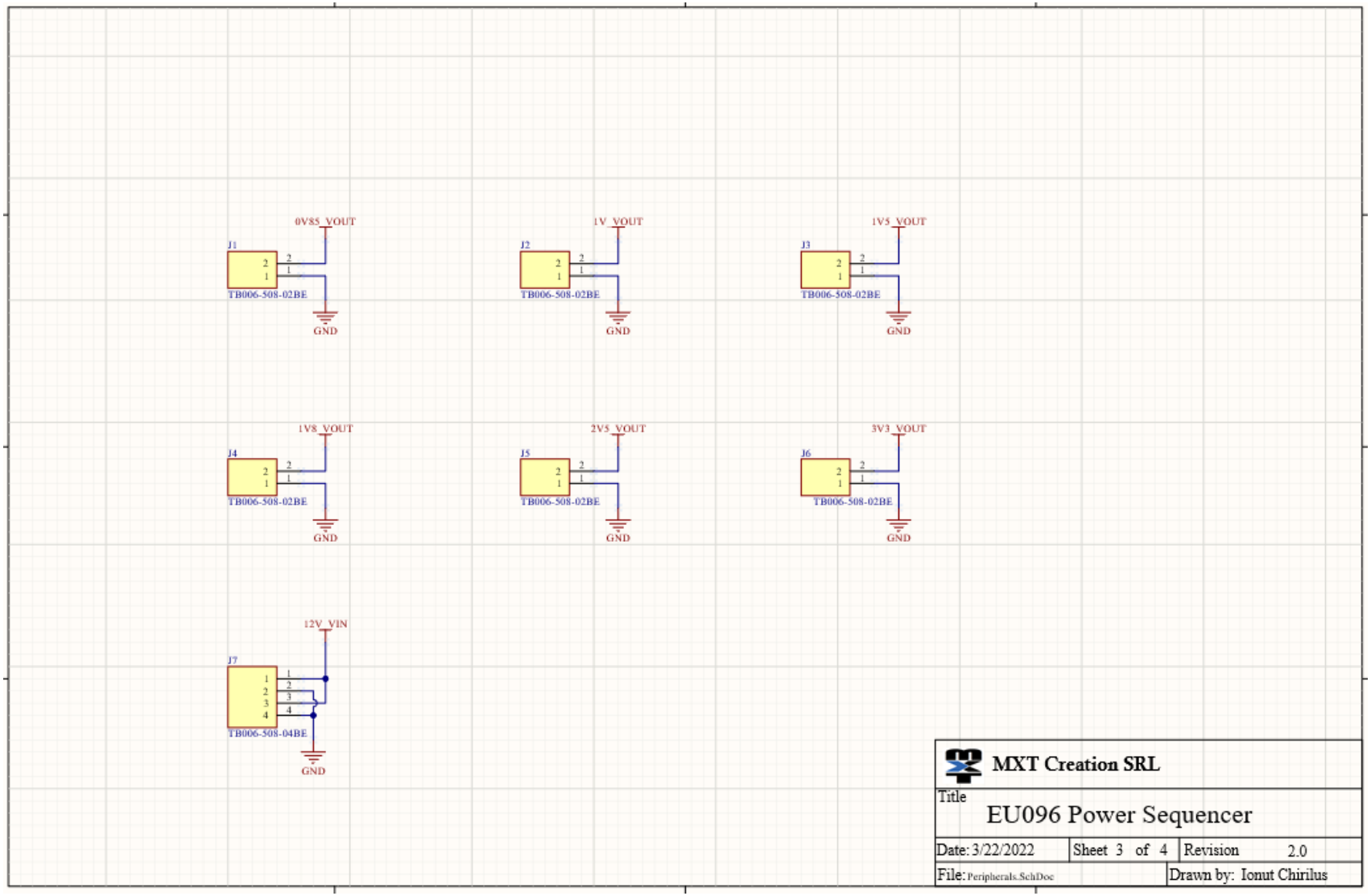
- RAA214401, 150mA Wide Input Range Ultralow Quiescent Current (3uA) Linear Regulator with 3V3 fixed output.

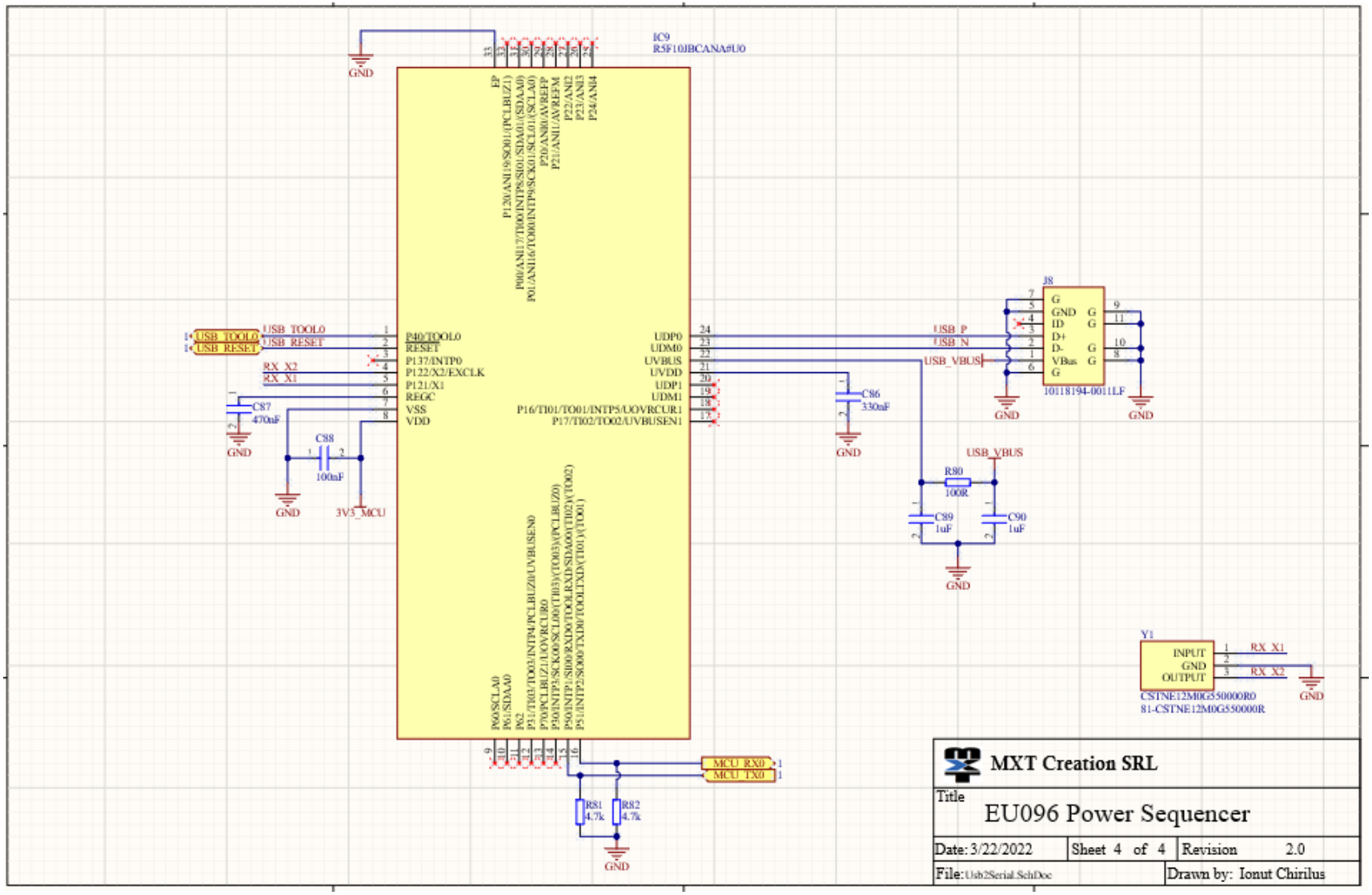
- Possibility of individual adjusting Soft-Start and Compensation of each regulator by populating the required passive components

- Possibility of modifying the output voltage of each regulator by replacing the feedback resistors


IC1
R5F102A7ASP
P20/ANI0/AVREFP
P01/ANI116/TO00/RXD1
P00/ANI17/TI00/TXD1
P120/ANI19
P40/TOOL0
RESET
P137/INTP0
P122/X2/EXCLK
P121/X1
REGC
VSS
VDD
P60/SCLA0
P61/SDAA0
P31/TI03/TO03/INTP4/PCLBUZ0
P21/ANI1/AVREFM
P22/ANI2
P23/ANI3
P147/ANI18
P10/SCK00/SCL00/(TI07/TO07)
P11/SI00/RXD0/TOOLRXD/SDA00/(TI06/TO06)
P12/SO00/TXD0/TOOLTXD/(TI05/TO05)
P13/TXD2/SO20/(SDAA0)/(TI04/TO04)
P14/RXD2/SI20/SDA20/(SCLA0)/(TI03/TO03)
P15/PCLBUZ1/SCK20/SCL20/(TI02/TO02)
P16/TI01/TO01/INTP5/(RXD0)
P17/TI02/TO02/(TXD0)
P51/INTP2/SO11
P50/INTP1/SI11/SDA11
P30/INTP3/SCK11/SCL11
MCU_ANI0
MCU_ANI116
MCU_ANI17
MCU_ANI1
MCU_ANI2
MCU_ANI3
MCU_ANI18
1V_EN
1V_PG
0V85_PG
TOOL0
nRESET
1V8_EN
MCU_RX0
MCU_TX0
2V5_EN
3V3_EN
1V5_EN
1V5_PG
0V85_EN
1V8_PG
2V5_PG
3V3_PG
3V3_MCU
GND
R1 1k
R2 1k
C1 470nF
C2 100nF
R3 dnp
R4 dnp
LED1
LN-S66DAT5R5G
R5 1k
R6 1k
R7 1k
R8 1k
R9 1k
R10 1k
JS202011SCQN
S1
TOOL0_OUT
USB_TOOL0
nRESET_OUT
USB_RESET
C24 100nF
C23 100nF
E1
75869-102LF
R18 10k
12V_VIN
3V3_VOUT
2V5_VOUT
1V8_VOUT
1V5_VOUT
1V_VOUT
0V85_VOUT
R11 3k
R12 1k
R13 0R
R14 0R
R15 0R
R16 0R
R17 0R
R19 1k
R20 1k
R21 dnp
R22 dnp
R23 dnp
R24 dnp
R25 dnp
FD1 FID1X2R
FD2 FID1X2R
FD3 FID1X2R
MXT Creation SRL
Title
EU096 Power Sequencer
Date: 3/22/2022
Sheet 1 of 4
Revision 2.0
File: MCU.SchDoc
Drawn by: Ionut Chirilus


MXT Creation SRL
EU096 Power Sequencer


0V85_VOUT
J1
TB006-508-02BE
GND
1V_VOUT
J2
TB006-508-02BE
GND
1V5_VOUT
J3
TB006-508-02BE
GND
1V8_VOUT
J4
TB006-508-02BE
GND
2V5_VOUT
J5
TB006-508-02BE
GND
3V3_VOUT
J6
TB006-508-02BE
GND
12V_VIN
J7
TB006-508-04BE
GND
MXT Creation SRL
Title
EU096 Power Sequencer
Date: 3/22/2022
Sheet 3 of 4
Revision 2.0
File: Peripherals.SchDoc
Drawn by: Ionut Chirilus


IC9
R5F10JBCANA#U0
USB_TOOL0
USB_RESET
RX_X2
RX_X1
C87
470nF
C88
100nF
3V3_MCU
P40/TOOL0
RESET
P137/INTP0
P122/X2/EXCLK
P121/X1
REGC
VSS
VDD
UDP0
UDM0
UVBUS
UVDD
UDP1
UDM1
P16/TI01/TO01/INTP5/UOVRCUR1
P17/TI02/TO02/UVBUSEN1
C86
330nF
USB_P
USB_N
USB_VBUS
J8
10118194-0011LF
R80
100R
C89
1uF
C90
1uF
Y1
INPUT
GND
OUTPUT
CSTNE12M0G550000R0
81-CSTNE12M0G550000R
MCU_RX0
MCU_TX0
R81
4.7k
R82
4.7k
GND
MXT Creation SRL
Title
EU096 Power Sequencer
Date: 3/22/2022
Sheet 4 of 4
Revision 2.0
File: Usb2Serial.SchDoc
Drawn by: Ionut Chirilus

References

[1] Renesas Electronics, “EU096 – Software User’s Guide”.

[2] Renesas Electronics, “EU096 – Hardware User’s Guide”.

[3] Renesas Electronics, “RL78/G12 - User’s Manual: Hardware” Jun. 2020 - R01DS0193EJ0230

[4] Renesas Electronics, “E1/E20/E2 Emulator, E2 Emulator Lite - Additional Document for User’s Manual - (Notes on Connection for RL78)”, Jul. 2020 - R20UT1994EJ0702: Link.

Revision History

Rev.	Date	Description	
		Page	Summary
1.0	22.03.2022		Initial version.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
5. Renesas Electronics products are classified according to the following two quality grades: “Standard” and “High Quality”. The intended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user’s manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, user’s manuals, application notes, “General Notes for Handling and Using Semiconductor Devices” in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.
(Note2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit: www.renesas.com/contact/.

© 2020 Renesas Electronics Corporation. All rights reserved.