

EU096-3 Flexible 6-Channels Power Sequencer

Quick Start Guide

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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

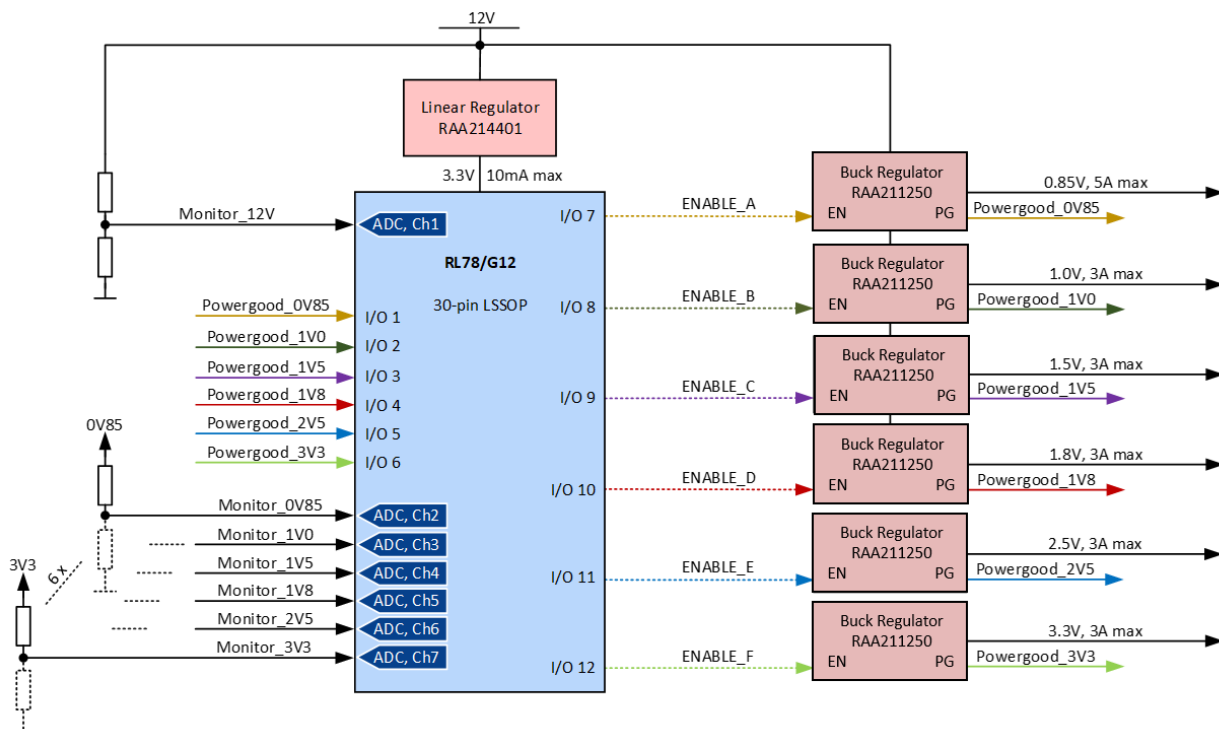


Fig.1 Flexible 6-Channels Power Sequencer block diagram

2. PoC key Components Arrangement

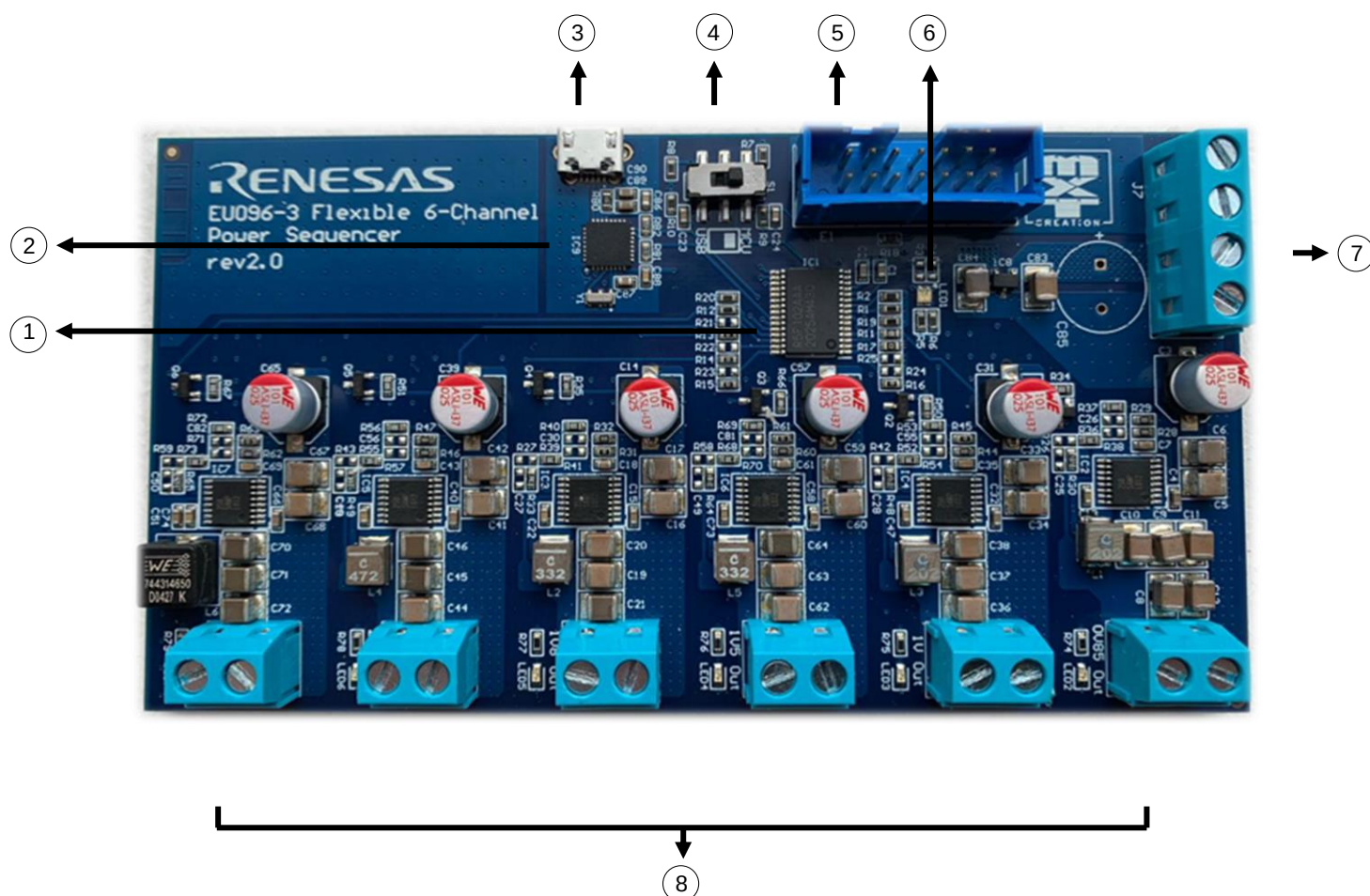


Fig.2 Flexible 6-Channels Power Sequencer component arrangement

- 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:** $\pm 1\%$ 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.

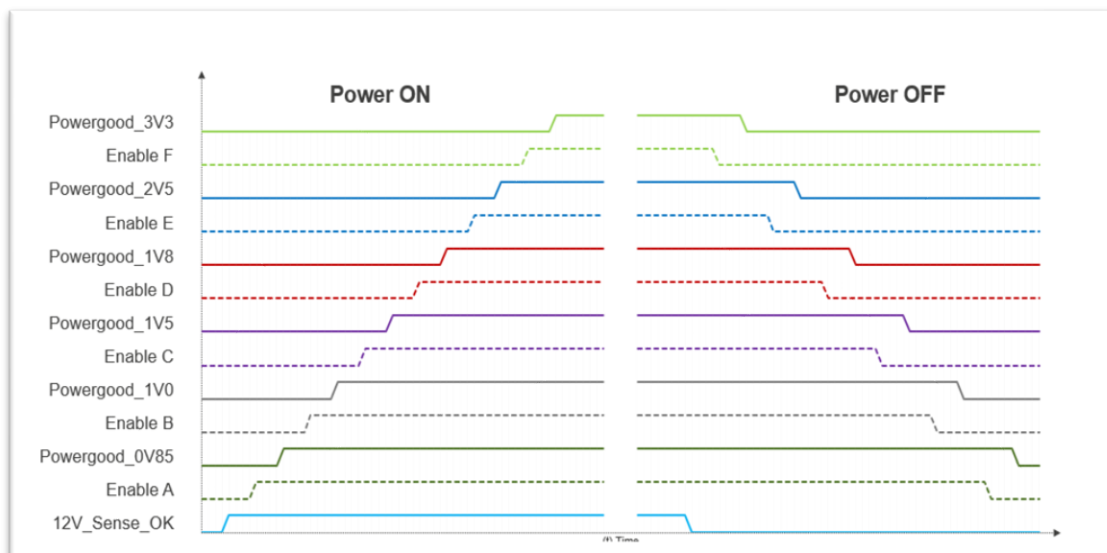


Fig.3 Flexible 6-Channels Power Sequencer power ON/OFF sequences

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.

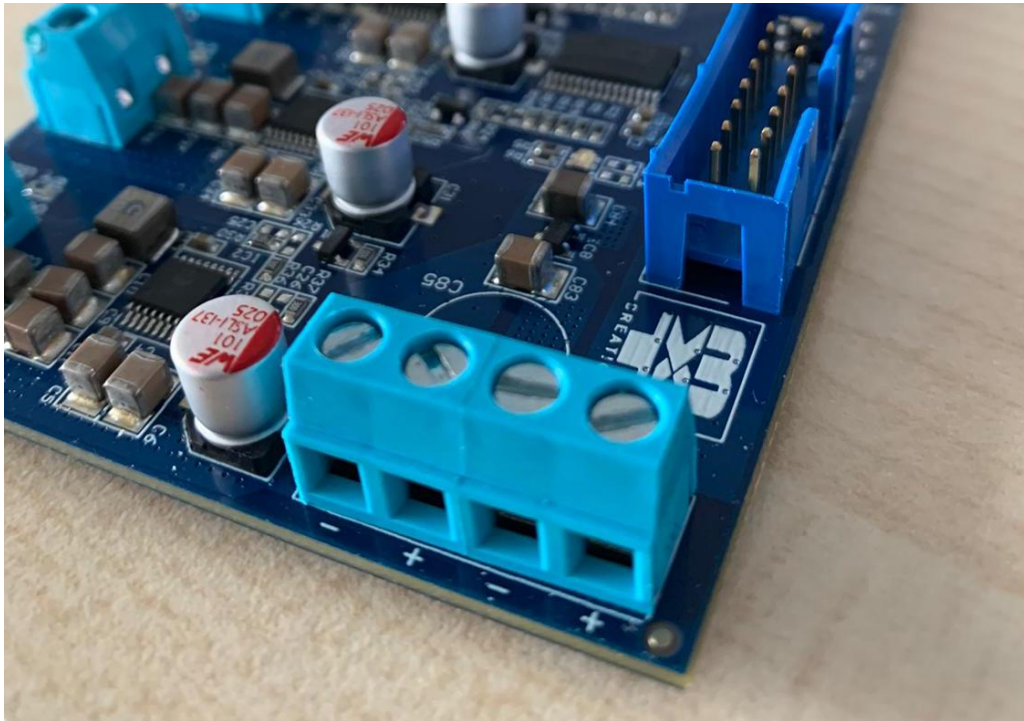


Fig.6 Flexible 6-Channels Power Sequencer screw terminal

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

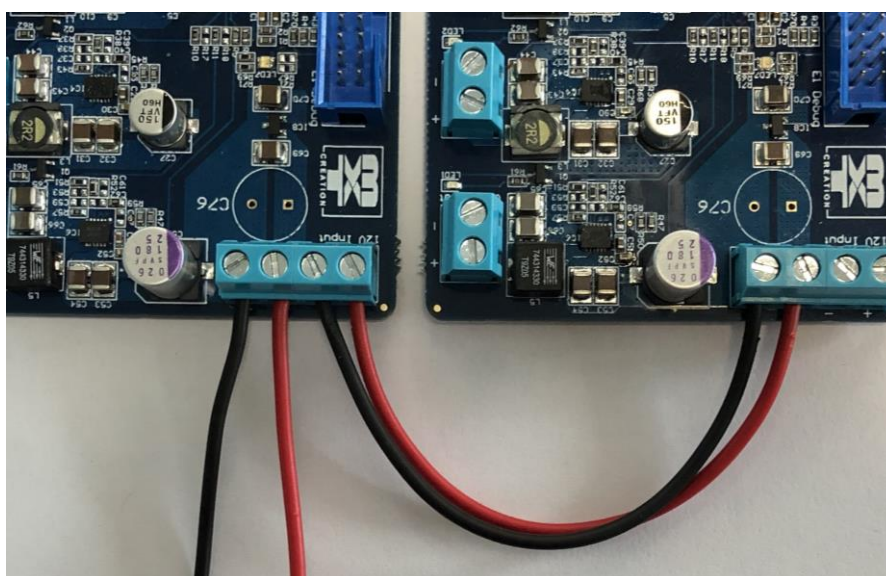


Fig.7 Flexible 6-Channels Power Sequencer daisy chain

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.

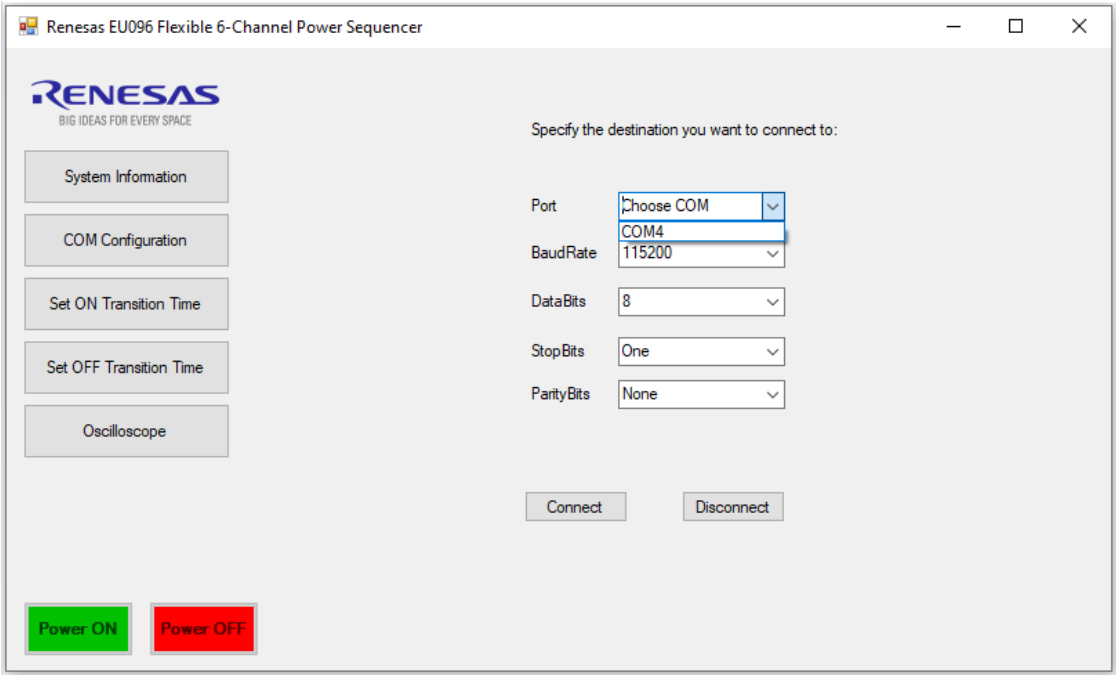


Fig.8 GUI – COM Configuration menu

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.

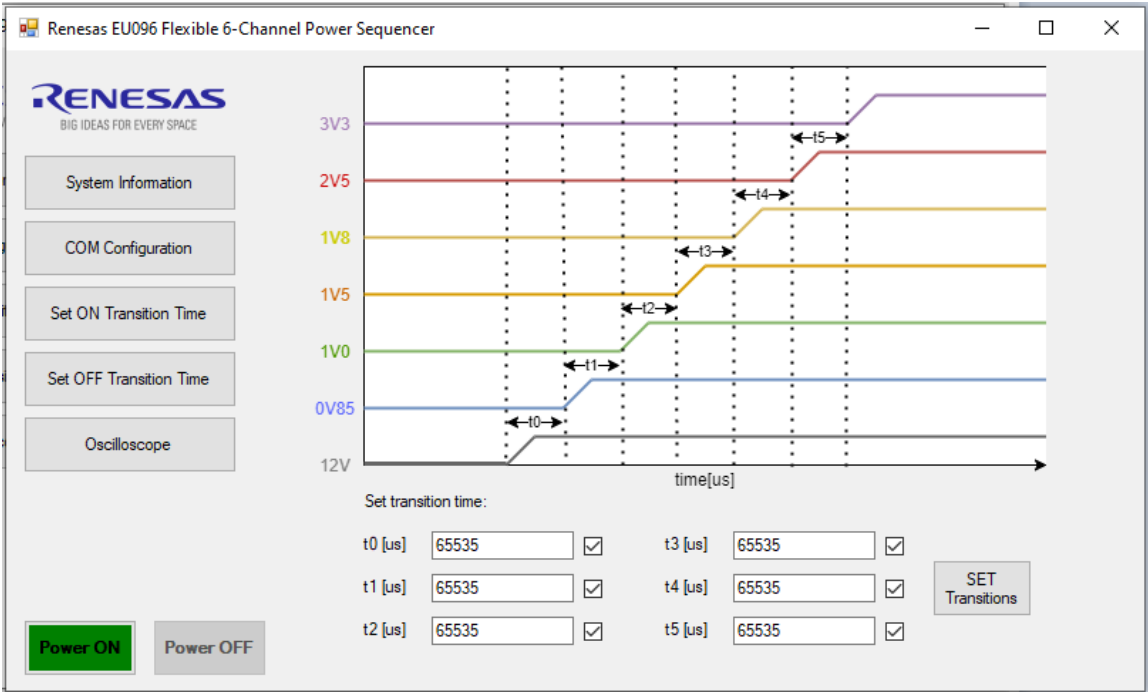


Fig.9 GUI – Set ON Transition Time menu

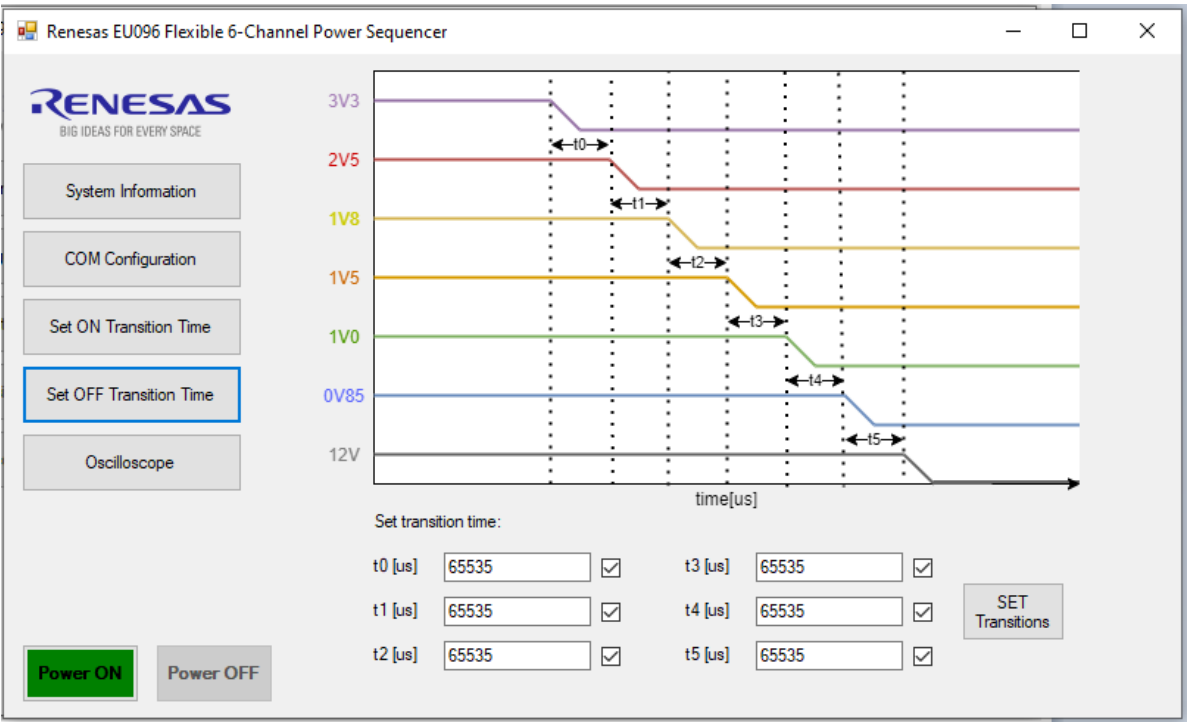


Fig.10 GUI – Set OFF Transition Time menu

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.

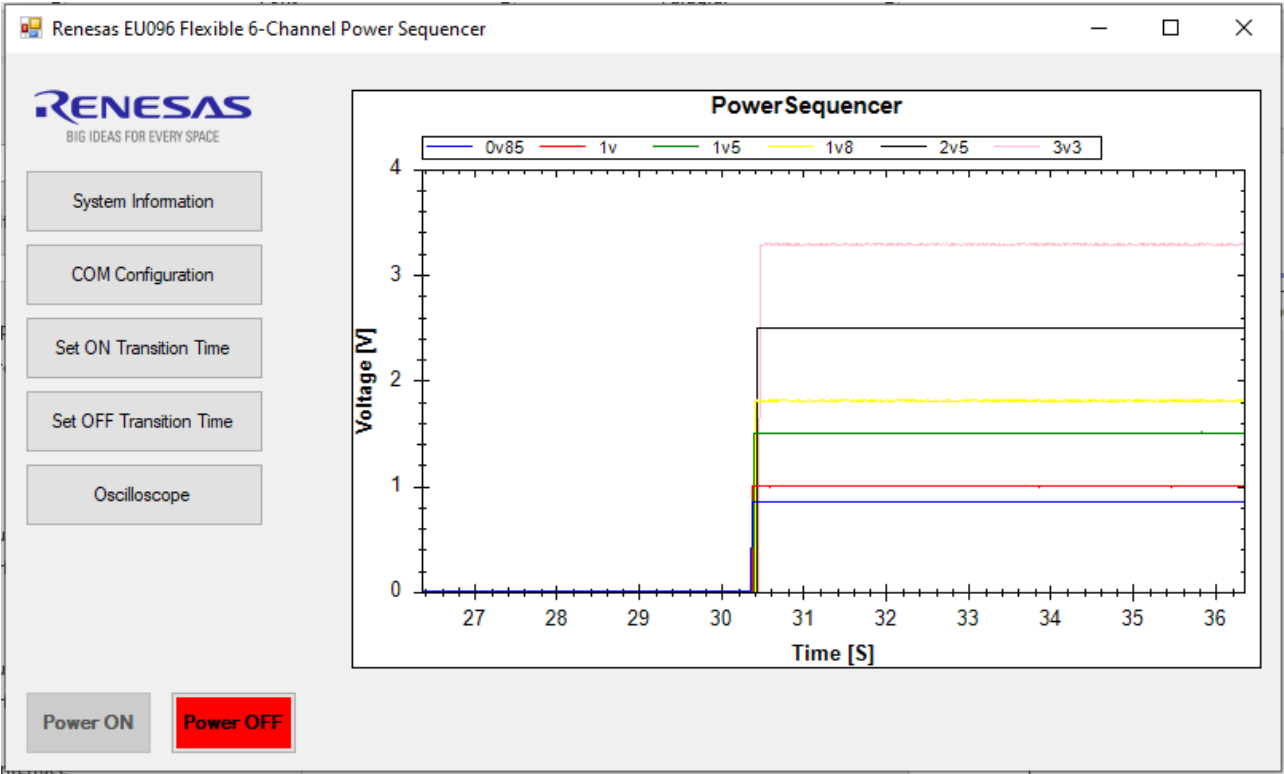
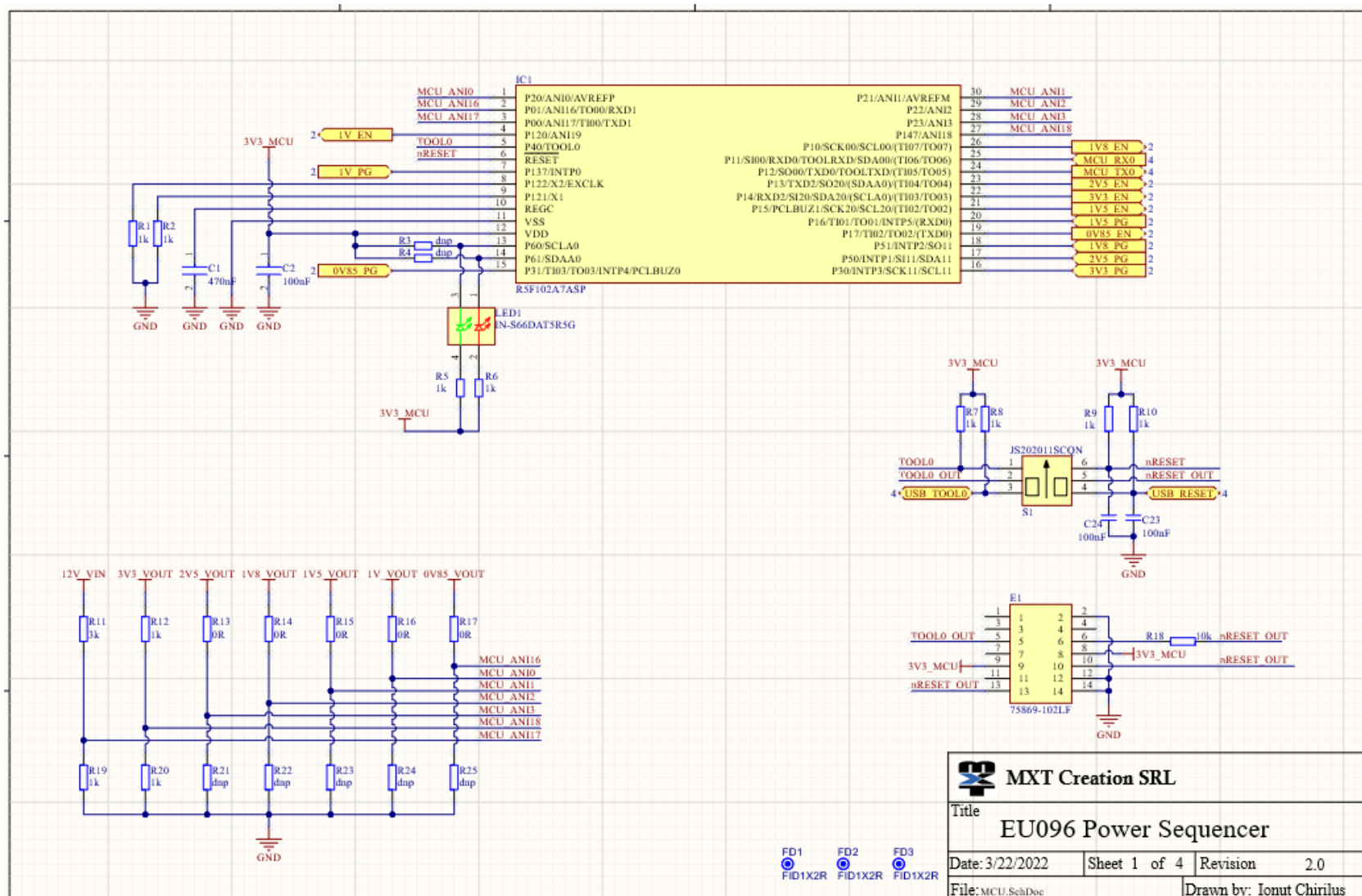


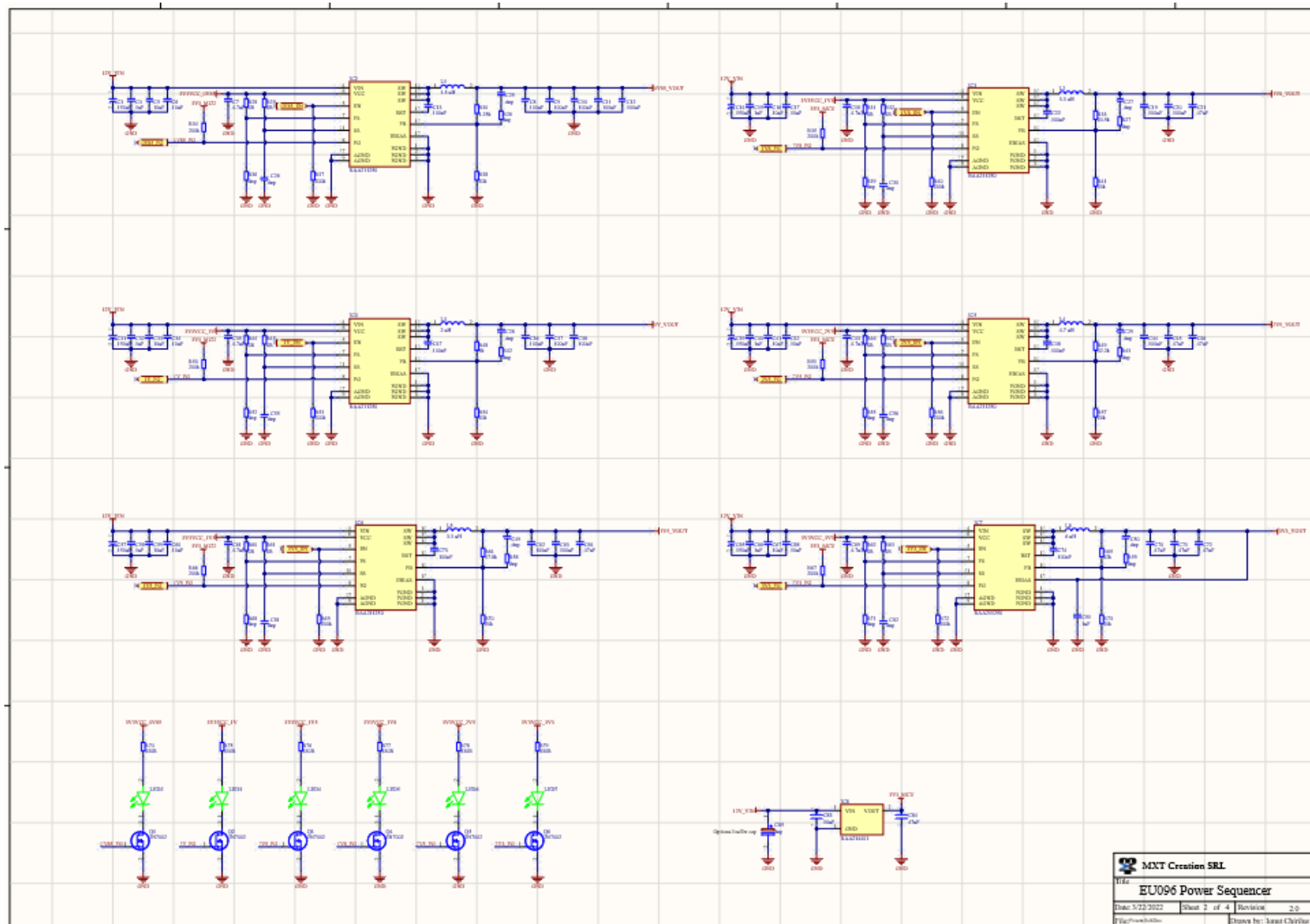
Fig.11 GUI – Oscilloscope menu

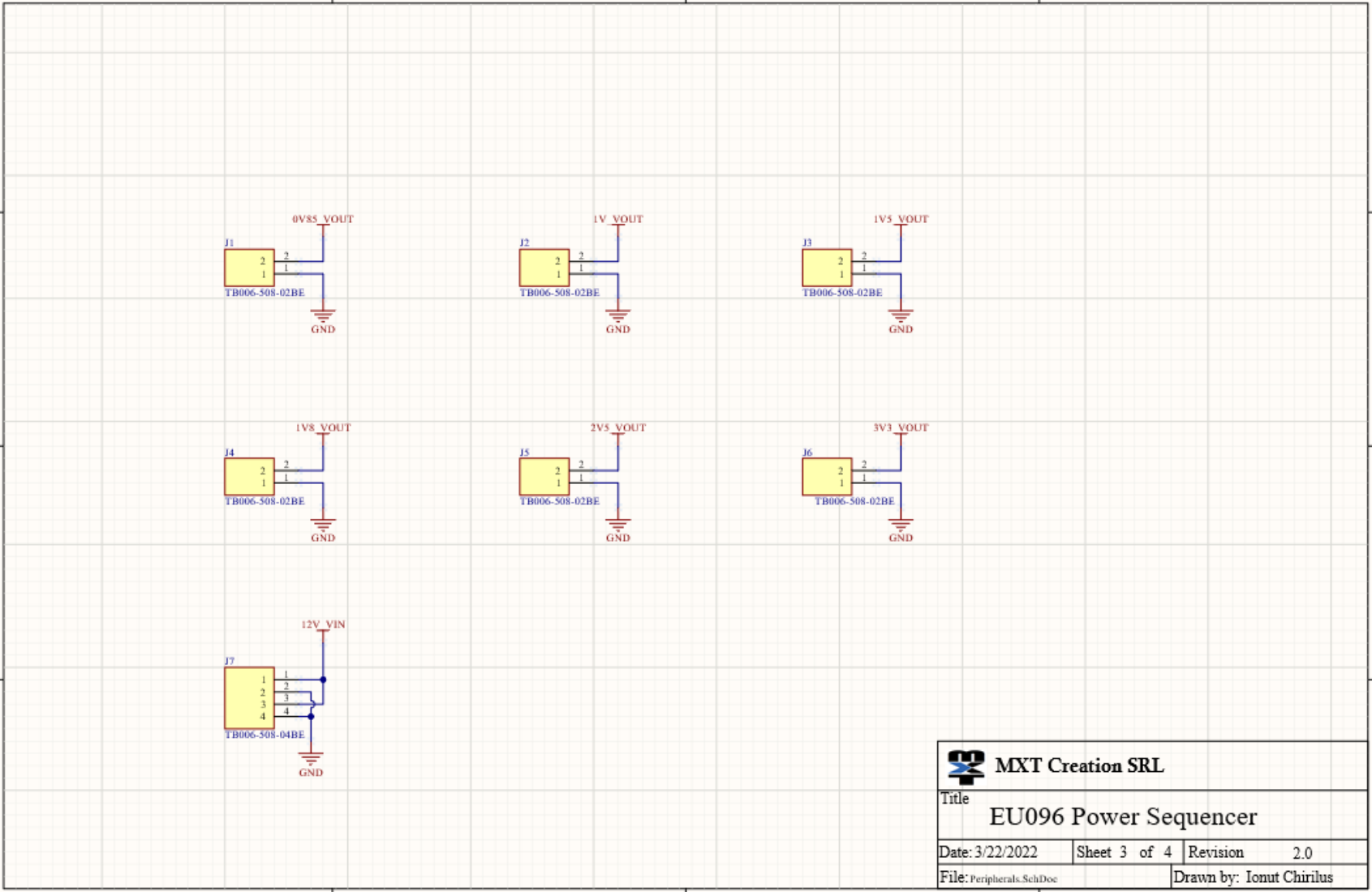
6. Schematic

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









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.

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