User's Manual

16

Fuse Box Reference Board

RL78/F14 48pin

User's Manual: Fuse Box Reference Board

Y-IPD-EFUSE-PDB-01-V1
Y-IPD-EFUSE-PDB-01-V2

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1. 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 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. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment 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 moment 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 moment 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 moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   – The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has 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. Moreover, 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.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   – The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the 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.

Content

1. Introduction

This User Manual describes how to use the Fuse Box in combination with RL78/F14 software. There are 4 interfaces how to use the Fuse Box:

- Debugger interface
- USB/UART interface
- CAN interface
- LIN interface (option)

The first version of Fuse Box in combination with RL78/F14 software was based on Debugger interface. This version will support also the communication with CAN interface. Later on a software to support the communication with LIN interface is planned. The USB/UART interface can be also used with a different software.

A GUI for control and settings of the Fuse Box is available. For this a PC needs to be connected to the Fuse Box via CAN Interface using a CAN-USB Adapter.

The Fuse Box provides three current classes by IPD's (Intelligent Power Devices):

- 30A
- 10A
- 3A

The user can select a current in order to configure the desired fuse function depending on cable diameter (high cable diameter → high currents for fuse function).

The fuse parameters are cable parameter (cable resistance, heat capacitance of cable and thermal resistance of cable) or I^2t value in combination with I_∞ current. In addition, the ambient temperature and the maximum temperature is needed.

The IPD's provide self-protection features such as over-current, over-temperature, open load and short circuit to ground.

2. Overview and introduction of Fuse Box

2.1 Features of Fuse Box

The Fuse Box has following features:

- ***Implemented channels***
  - 2 x 30A
  - 4 x 10A
  - 4 x 3A

- ***Communication***
  - CAN
  - LIN (option)

- ***Modi***
  - Off Mode
  - On Mode (Normal Mode)
  - Parking Emulation Mode
  - Calibration Mode

- ***Fuse algorithm***
  - I^2t based on cable parameter method
  - I^2t based on two point method (I^2t value and $I\infty$ value)

- ***Other features***
  - 1 x Temp sense (between 30A devices)
  - 10 x Current measurement

2.2 Board (Frontside and Backside)

Figure 1 below shows the fuse box board from top view and bottom view.

On top view are soldered the following components:

- 2 x 30A IPD's (RAJ2800024H12HPF)
- 4 x 10A IPD's (uPD166033T1U)
- Linear regulator (ISL78301)
- Battery connector
- Load connector
- Connector for adapter board
- DIP Switches

On bottom view are soldered the following components:

- 2 x 3A IPD's (uPD166027T1J)
- RL78/F14 16-bit MCU
- LIN Transceiver (TJA1020T)
- CAN Transceiver (TJA1041T)

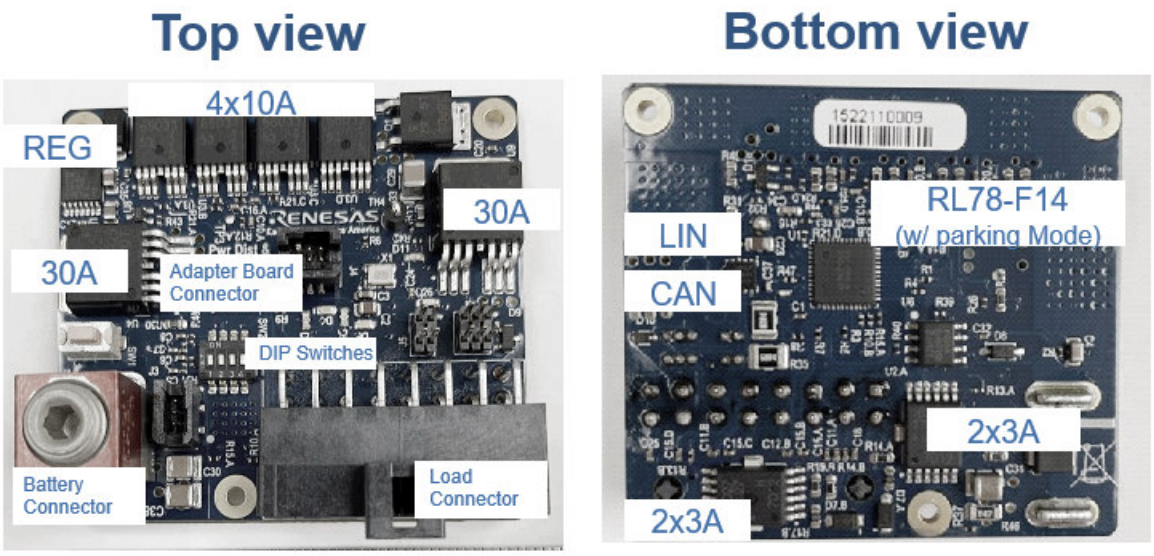

Figure 1: Board of Fuse Box (Frontside and Backside)

2.3 Description of DIP switches and LEDs

The figure below shows the DIP switches of the Fuse Box. Only DIP 4 is used in GUI mode, DIP1, DIP2 and DIP3 have no function. Figure 1 shows all DIP switches.

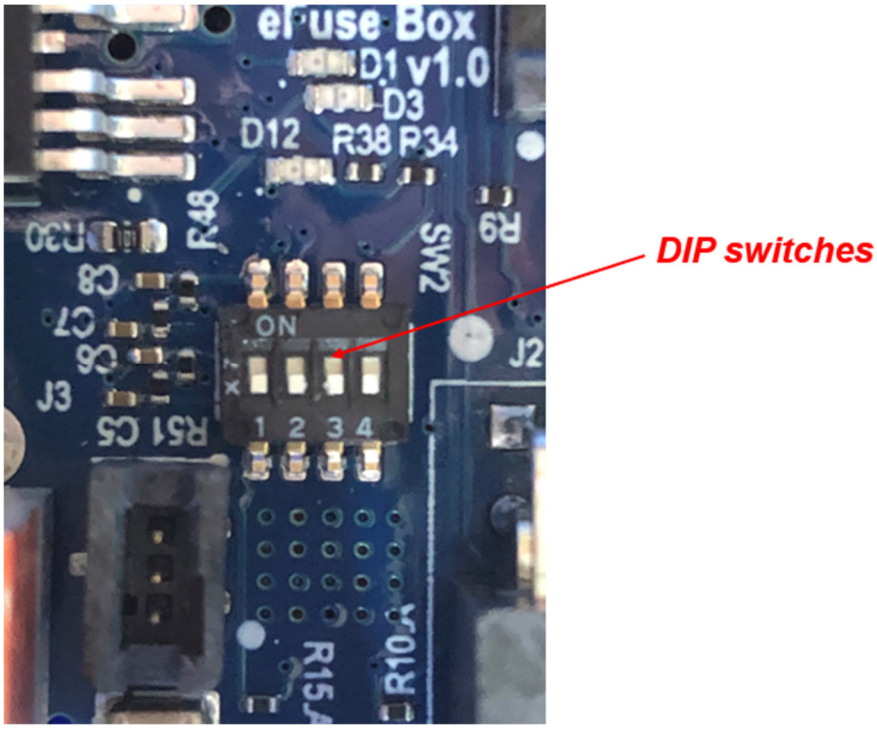

Figure 2: Picture of DIP switches

The table below describes the functions of DIP switches.

DIP	***Function***
DIP1	*No function*
DIP2	*No function*
DIP3	*No function*
DIP4	*on=GUI mode / off=debugger mode (not used)*

Table 1: Description of DIP switches

The figure below shows the LEDs of the Fuse Box. There are 7 LEDs available to show which mode/function is active.

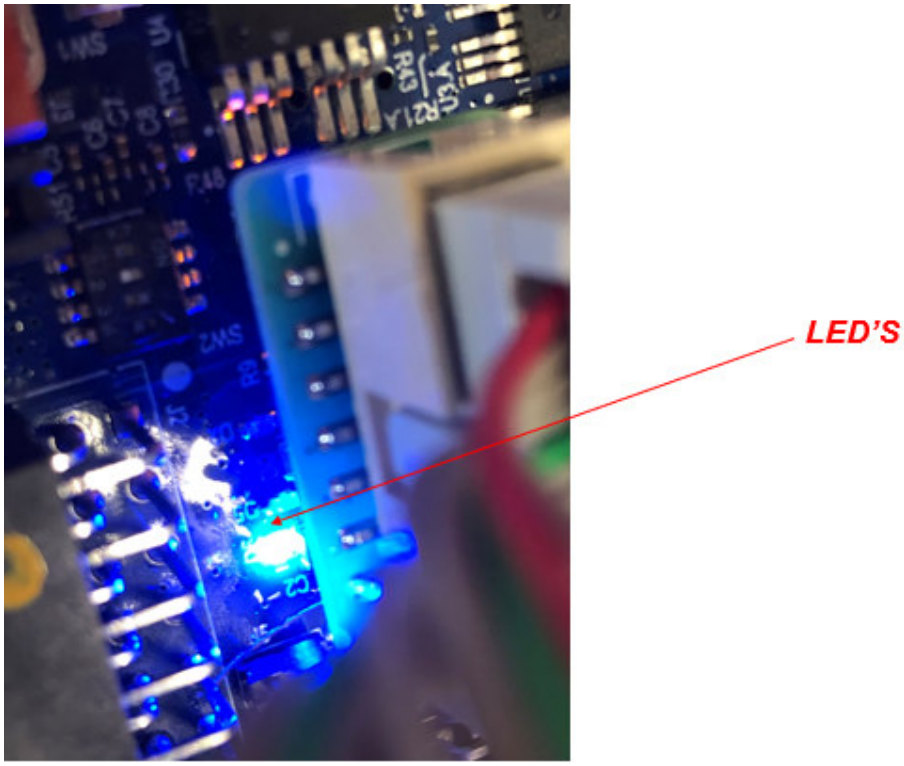

Figure 3: Picture of LEDs

The table below describes the functions of LEDs.

LED	***Function***	***color***
LED D4	*Not used*	*Blue*
LED D6	*IPDs on/off if any channel is on*	*Blue*
LED D2	*Parking Mode*	*Yellow*
LED D3	*Normal Mode*	*Yellow*
LED D5	*Failure / Error*	*red*
LED D11	*CAN enabled*	*green*
LED D1	*2.5V reference enabled*	*green*

Table 2: Description of LEDs

2.4 Description of components

2.4.1 RAJ2800024H12HPF

Please refer to data sheet “RAJ2800024H12HPF (30A IPD)”

RAJ2800024

2.4.2 uPD166033T1U

Please refer to data sheet “uPD166033T1U (10A IPD)”

uPD166033

2.4.3 uPD166027T1J

Please refer to data sheet “uPD166027T1J (3A IPD)”

uPD166027

3. Quick Start

3.1 How to connect Fuse Box to a PC

The figure below shows how to connect the Fuse Box to a PC.

- Connect Peak Adapter via CAN Connector to the Fuse Box
- Connect Peak Adapter to a PC

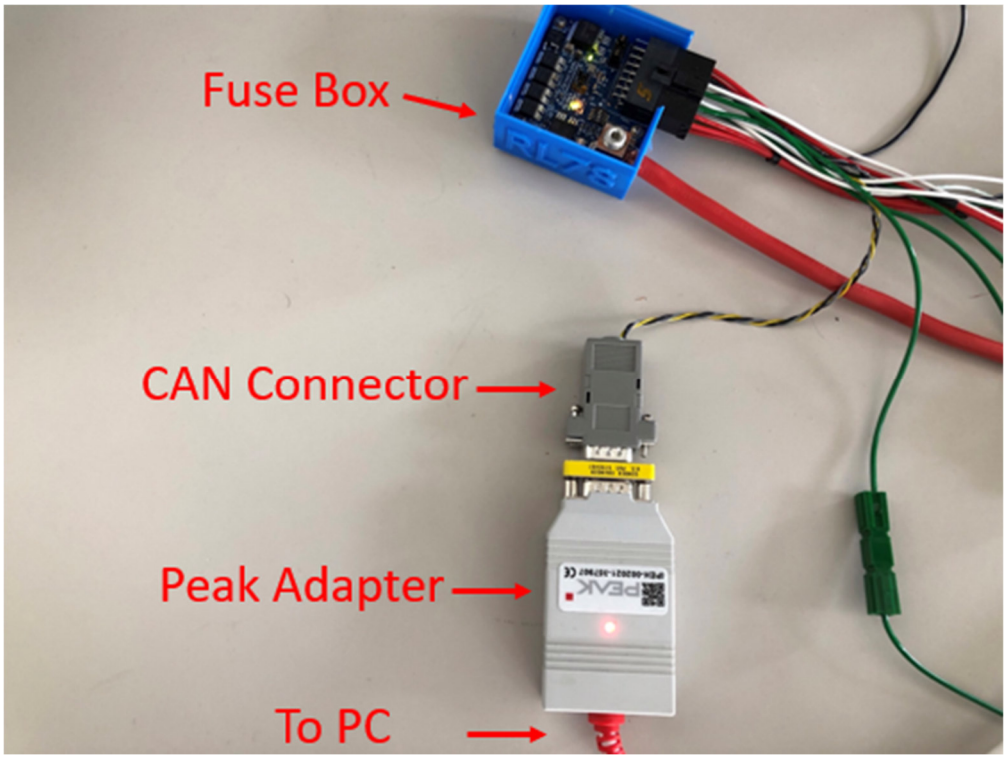

Figure 4: Pictures to show how to connect Fuse Box to PC

3.2 How to connect Battery Voltage, Ground and Loads

The figure below shows how to connect the Fuse Box board with Loads and Ground.

- Connect Battery to Battery Connector
  - Please use 12V as a typical supply voltage
  - The voltage supply range is from 4,5V to 28V

- Connect Loads and Ground to the Fuse Box
  - The color of ground connection is as follows:
    - Ground: black

  - The color of load cables is as follows:
    - 30A channel: red
    - 10A channel: white
    - 3A channel: green

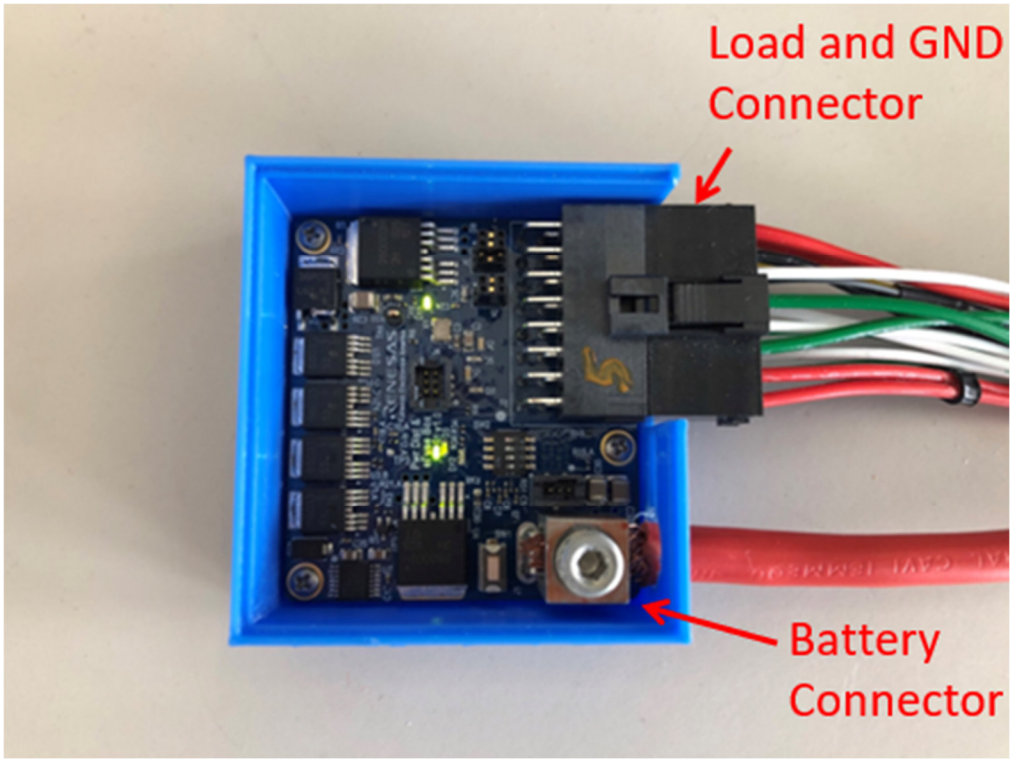

Figure 5: Pictures to show how to connect Fuse Box to Battery, GND and Loads

3.3 How to set DIP switches for “Quick Start”

DIP1 = no function

DIP2 = no function

DIP3 = no function

DIP4 = on (with GUI)

3.4 How to connect GUI to Fuse Box (via CAN)

The figure below shows how to connect GUI to the Fuse Box after starting the GUI: select “Connect to PEAK CAN”.

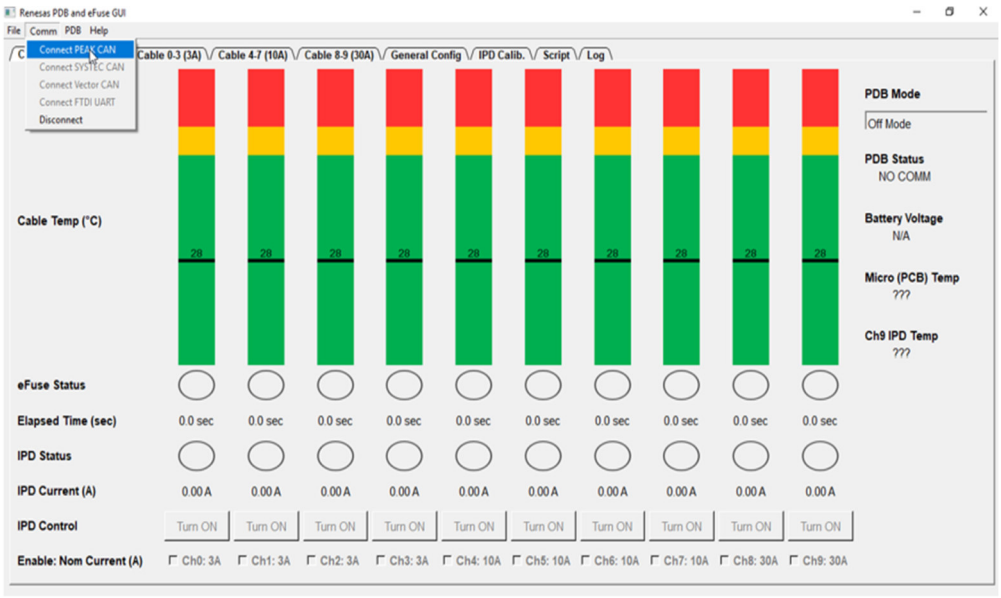

Figure 6: How to connect GUI to Fuse Box

After GUI is connected to Fuse Box there is a green “ok” for PCB status.

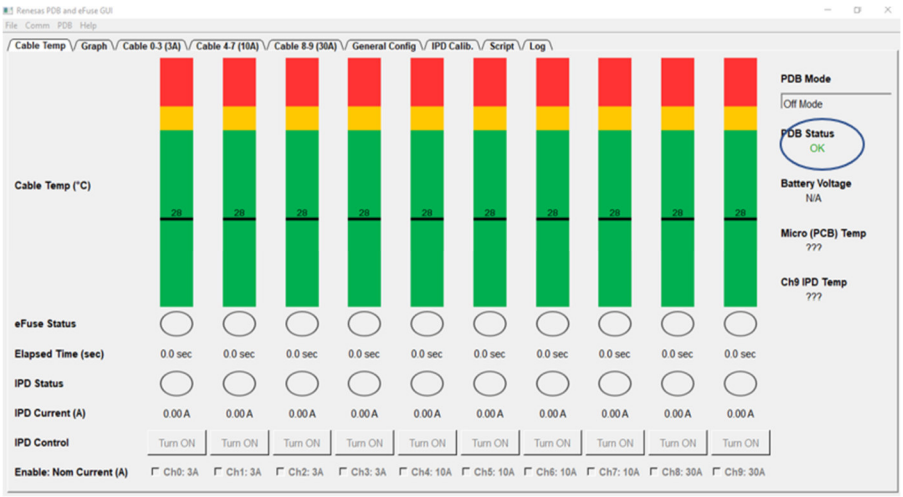

Figure 7: PDB status after connection to GUI

3.5 Selection of PDB Modes

The picture below shows how to select PDB Modes.

- Off Mode
- On Mode (Normal Mode)
- Parking Emulation Mode
- Calibration Mode

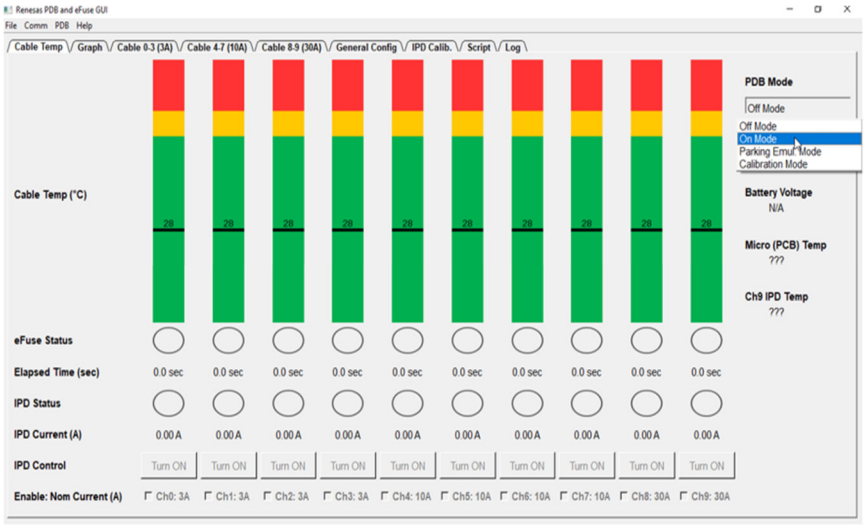

Figure 8: Selection of PDB mode

3.6 How to set fuse parameter

In the picture below shows how to configure fuse parameter. The user can select between

- Cable Parameter Method
- Two Point Method

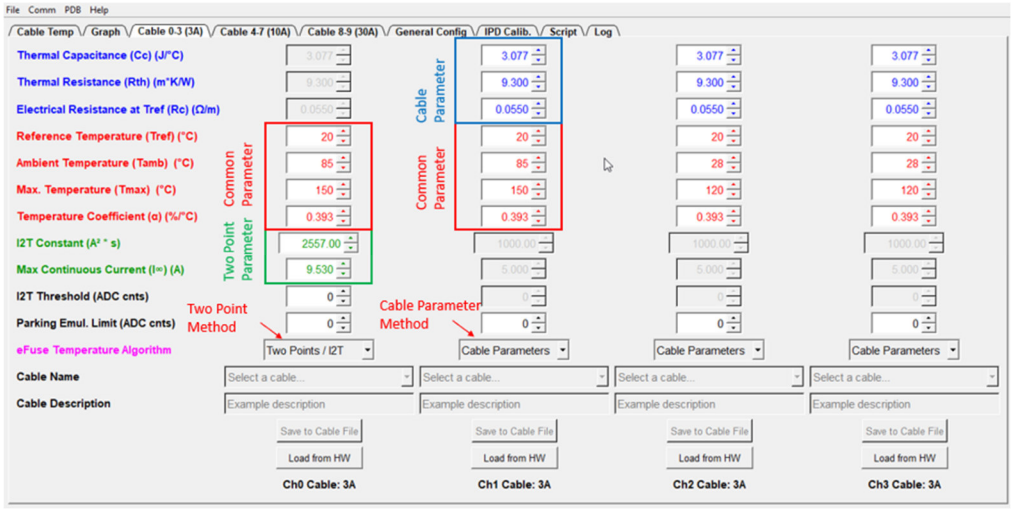

Figure 9: Most important parameter

To store configured parameter, proceed the following steps:

- Turn on related channel
- Deselect related channel
- To check whether parameter have been stored push “Load from HW”

3.7 How to save plots

The picture below shows how to save the related plot. Please push “Save to file” button. The plot can be saved in “csv” format. It is possible to open the file either in EXCEL or with an Editor.

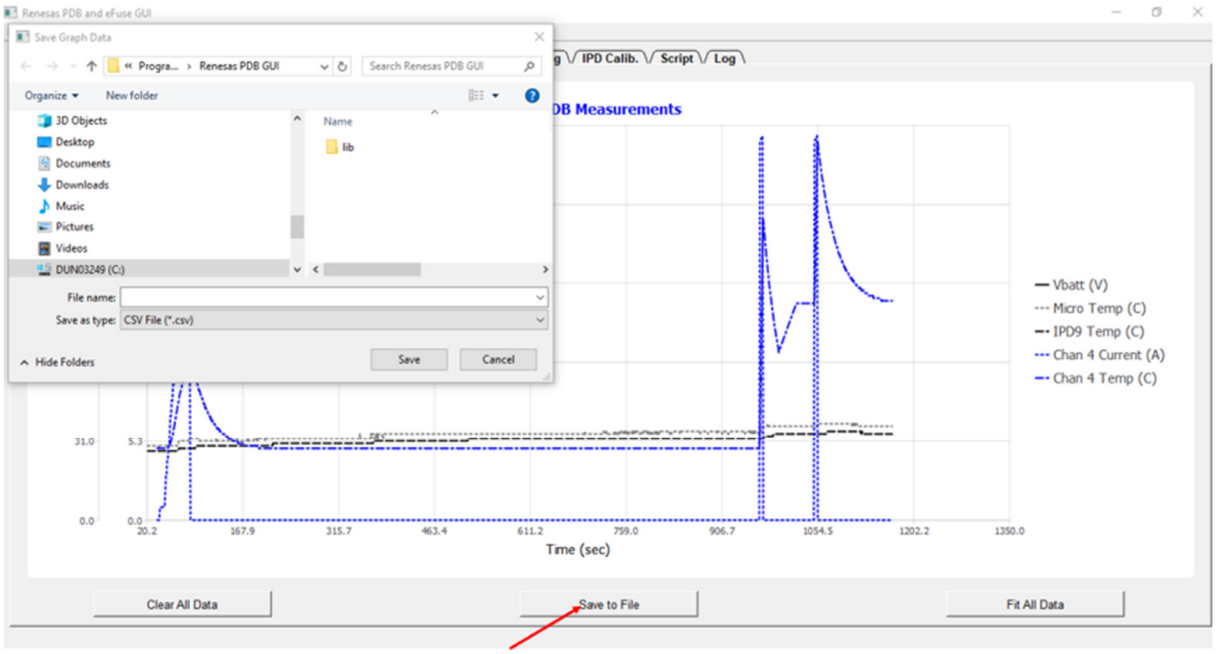

Figure 10: How to save plots

4. How to calibrate IPD’s

All IPD’s have been already calibrated and values are stored inside “Data Flash” of the “microcontroller”. If a new calibration is required, the picture below describes how to calibrate the IPD’s.

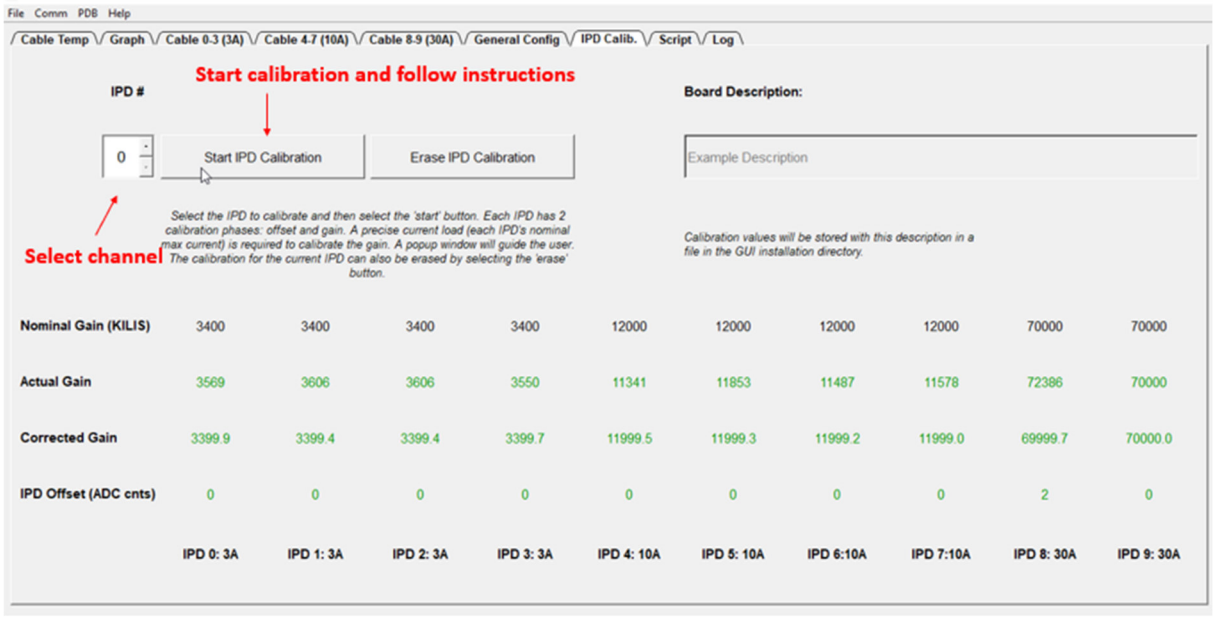

Figure 11: Calibration procedure

5. How to select Parking Mode

The figure 12 below shows how to select Parking Mode.

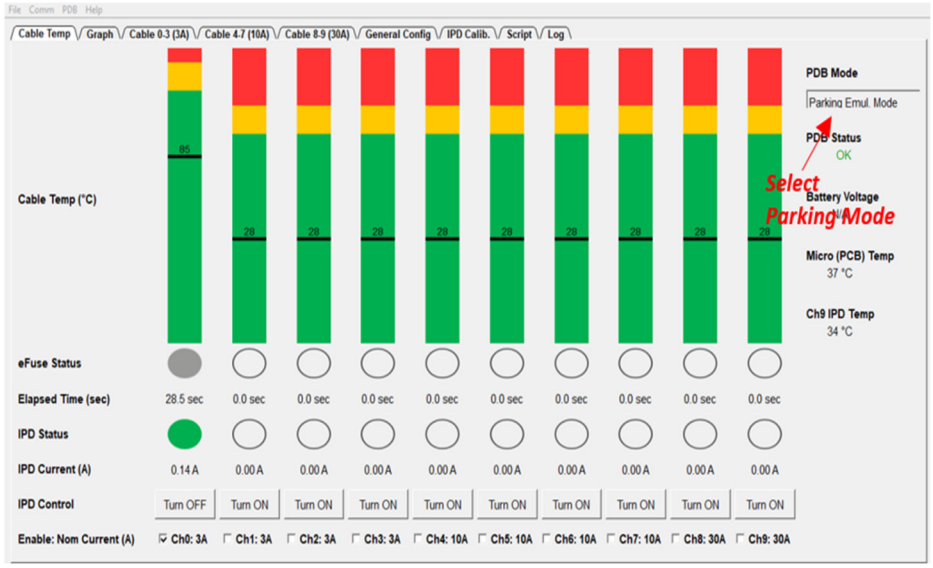

Figure 12: Selection of IPD's

Figure 13 below shows how to configure "Parking Emulation Limit" (ADC value). The value can be calculated in Ampere for each channel:

CH0 – CH3: 1LSB = 16mA

CH4 – CH7: 1LSB = 60mA

CH8 – CH9: 1LSB = 330mA

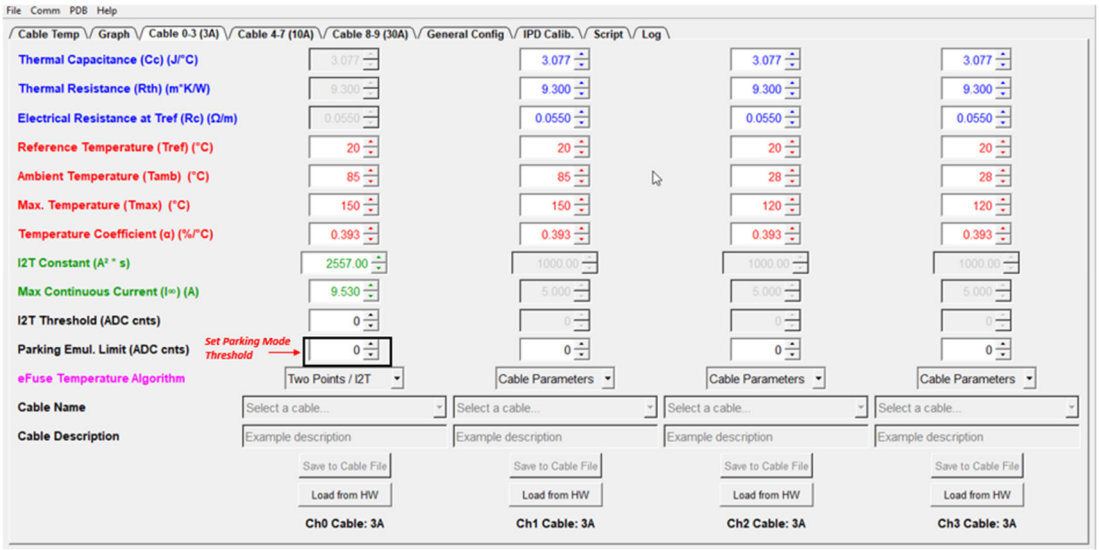

Figure 13: Select Parking Mode Threshold

The transition from "Parking Mode" to "Normal Mode" can be seen in Figure 13. If the current is below "Parking Emulation Limit" there is no e-fuse calculation (status is gray). If

the current is equal or above “Parking Emulation Limit” the e-fuse calculation starts (status is green)

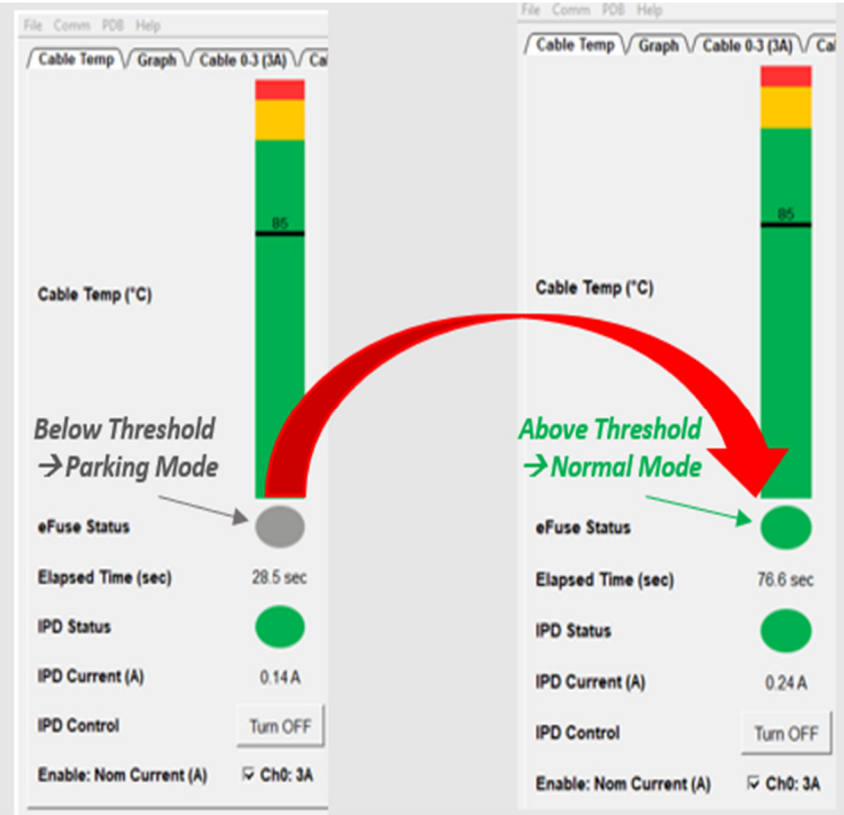

Figure 14: Parking Mode → Normal Mode

6. How to read diagnosis

6.1 Diagnosis in “on-state” and “off-state”

The following diagnosis items can be checked in “on-state” or “off-state”

- OC (over current, on state)
- OT (over temperature, on state)
- SCG (short circuit to ground, on state)
- OL (open load, off state)

The IPD’s switch off very fast in case of detection of diagnosis in “on-state”.

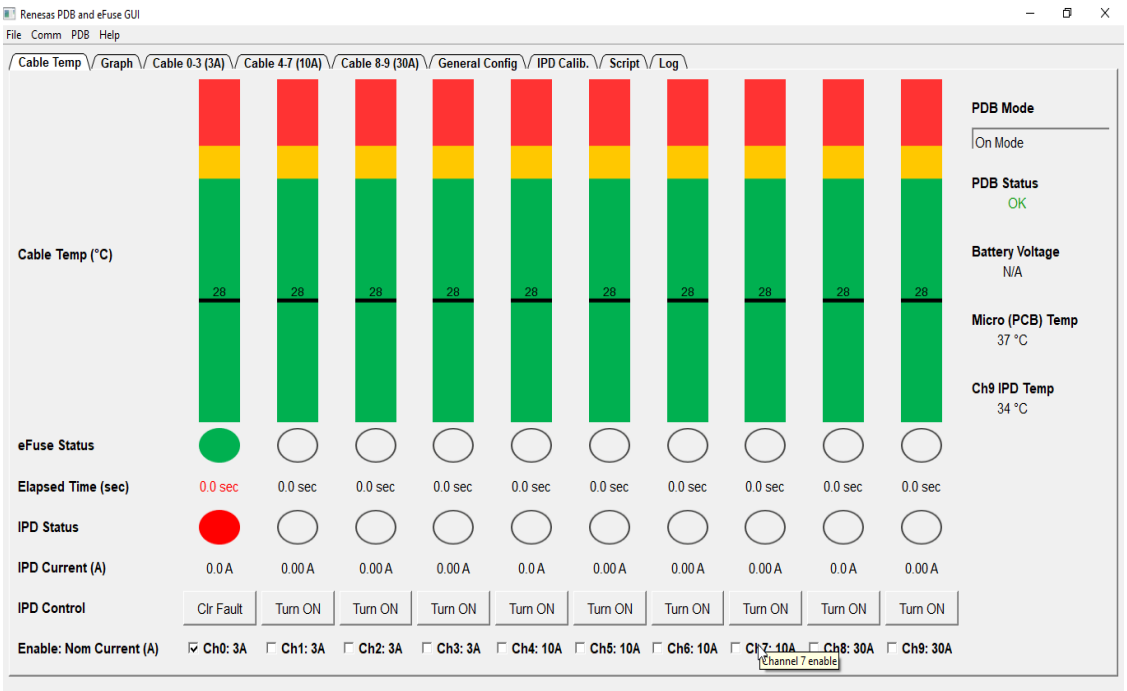

Figure 15: Figure to show ADC value in case of failure in “On-state”

The user can restart the system after failure detection with “Clr Fault”. Please refer to the figure above.

7. Appendix

7.1 Example of cable

An example of FLRY cable can be seen in the figure below.

FLRY mit dünnwandiger PVC-Isolierung

Typ A / Typ B

Temperaturbereich (3.000 h)

–40 °C bis +105 °C

Aufbau / Werkstoffe

Leiter	Weichgeglühtes Elektrolytkupfer Cu-ETP1 nach DIN EN 13602, blank oder verzinnt Leiteraufbau gemäß ISO 6722-1
Isolierung	Weich-PVC mit Eigenschaften gemäß ISO 6722-1, Klasse B

Normen / Spezifikationen

BMW GS 95007-1-1 · VW 60306-1 · DBL 6312

Ford ES-AU5T-1A348 · LV 112-1 · MAN 3135

	Leiteraufbau				Isolierung	Kabel		
						Außen-Ø		
Nenn-quer-schnitt	Anzahl Einzel-drähte*	Einzel-draht-Ø max.	Leiter-Ø max.	Elektr. Widerstand bei 20 °C blank/verzinnt max.	Wand-dicke min.	max.	zu-lässige Abwei-chung	Gewicht ca.
mm²		mm	mm	mΩ/m	mm	mm	mm	kg/km
FLRY – Typ A								
0,22	7	0,21	0,7	84,8 / 86,5	0,20	1,2	–0,1	3
0,35**	7	0,26	0,8	54,4 / 55,5***	0,20	1,3	–0,1	5
0,5	19	0,19	1,0	37,1 / 38,2	0,22	1,6	–0,2	7
0,75	19	0,23	1,2	24,7 / 25,4	0,24	1,9	–0,2	9
1	19	0,26	1,35	18,5 / 19,1	0,24	2,1	–0,2	11
1,25	19	0,3	1,7	14,9 / 15,9	0,24	2,3	-0,2	15
1,5	19	0,32	1,7	12,7 / 13,0	0,24	2,4	–0,2	16
2	19	0,38	2,0	9,42 / 9,69	0,28	2,8	–0,3	22
2,5	19	0,41	2,2	7,6 / 7,82	0,28	3	–0,3	26
FLRY – Typ B								
0,35	12	0,21	0,9	54,4 / 55,5***	0,20	1,4	–0,2	5
0,5	16	0,21	1,0	37,1 / 38,2	0,22	1,6	–0,2	7
0,75	24	0,21	1,2	24,7 / 25,4	0,24	1,9	–0,2	9
1	32	0,21	1,35	18,5 / 19,1	0,24	2,1	–0,2	11
1,25	16	0,33	1,7	14,9 / 15,9	0,24	2,3	-0,2	14
1,5	30	0,26	1,7	12,7 / 13,0	0,24	2,4	–0,2	16

Figure 16: Example of a cable specification

7.2 Schematic and layout

The pictures below show the schematics of the “fuse box”.

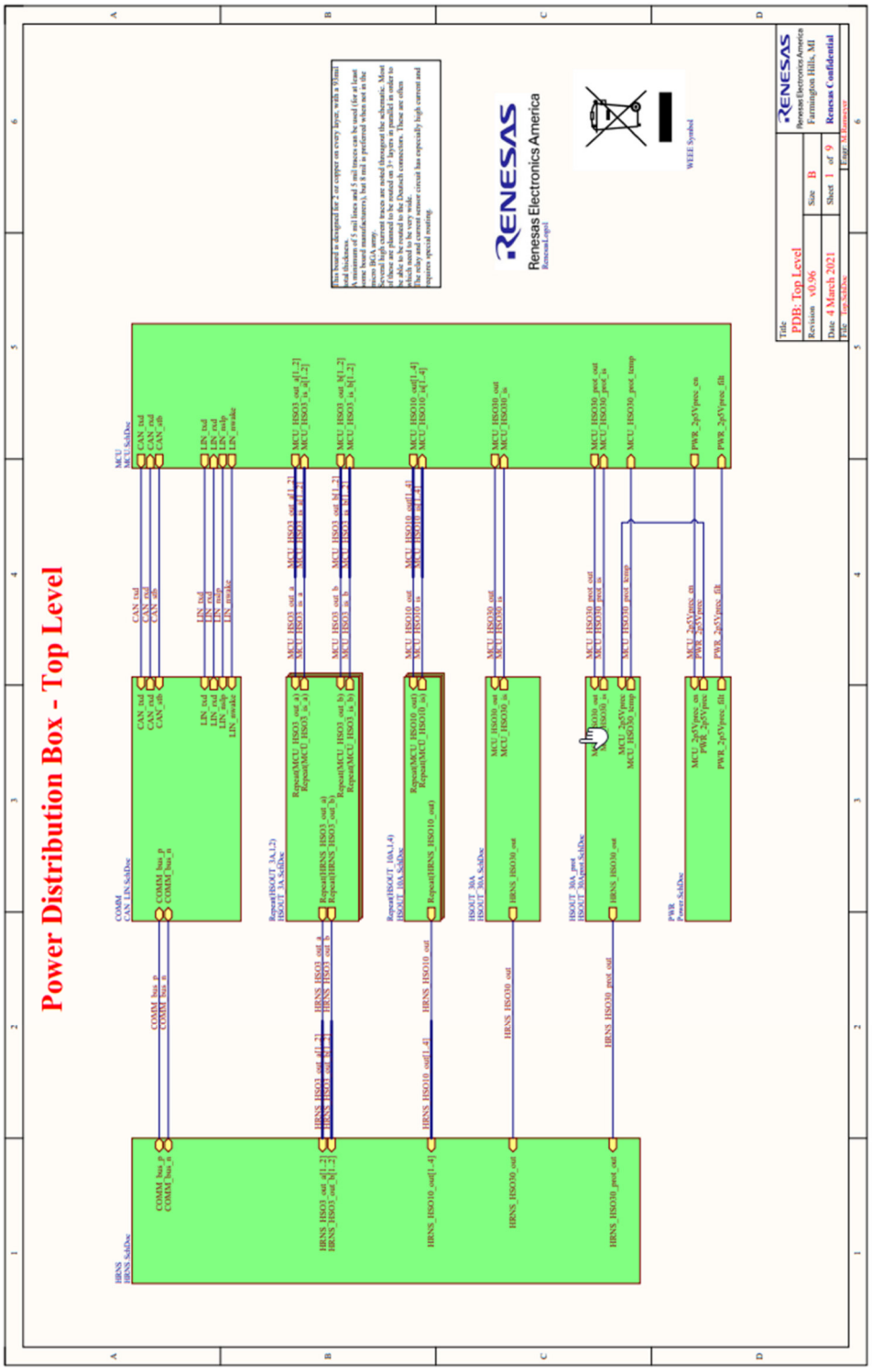

Figure 17: Schematic of “Top Level”

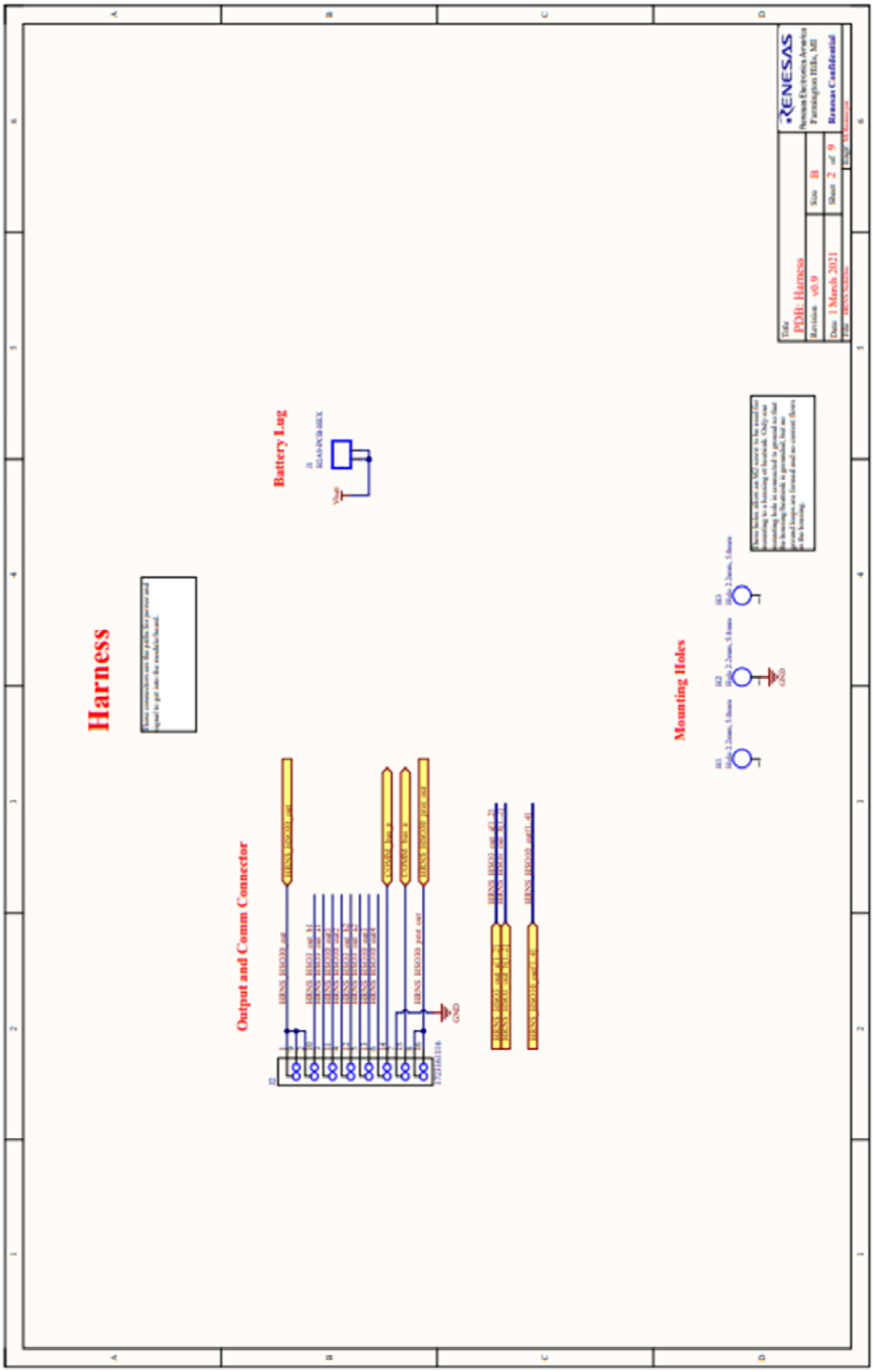

Figure 18: Schematic of “Wire Harness”

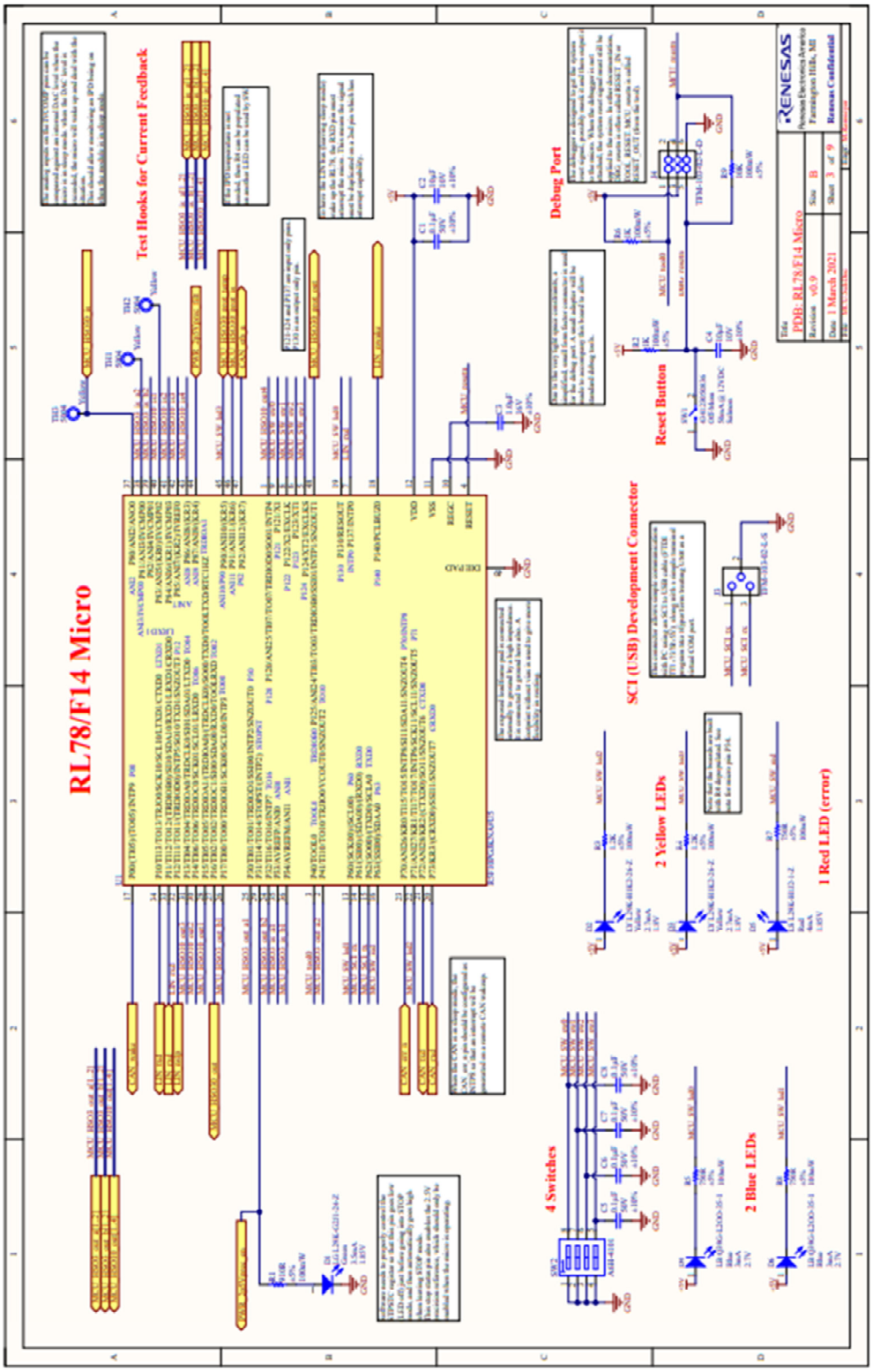

Figure 19: Schematic of "RL78/F14"

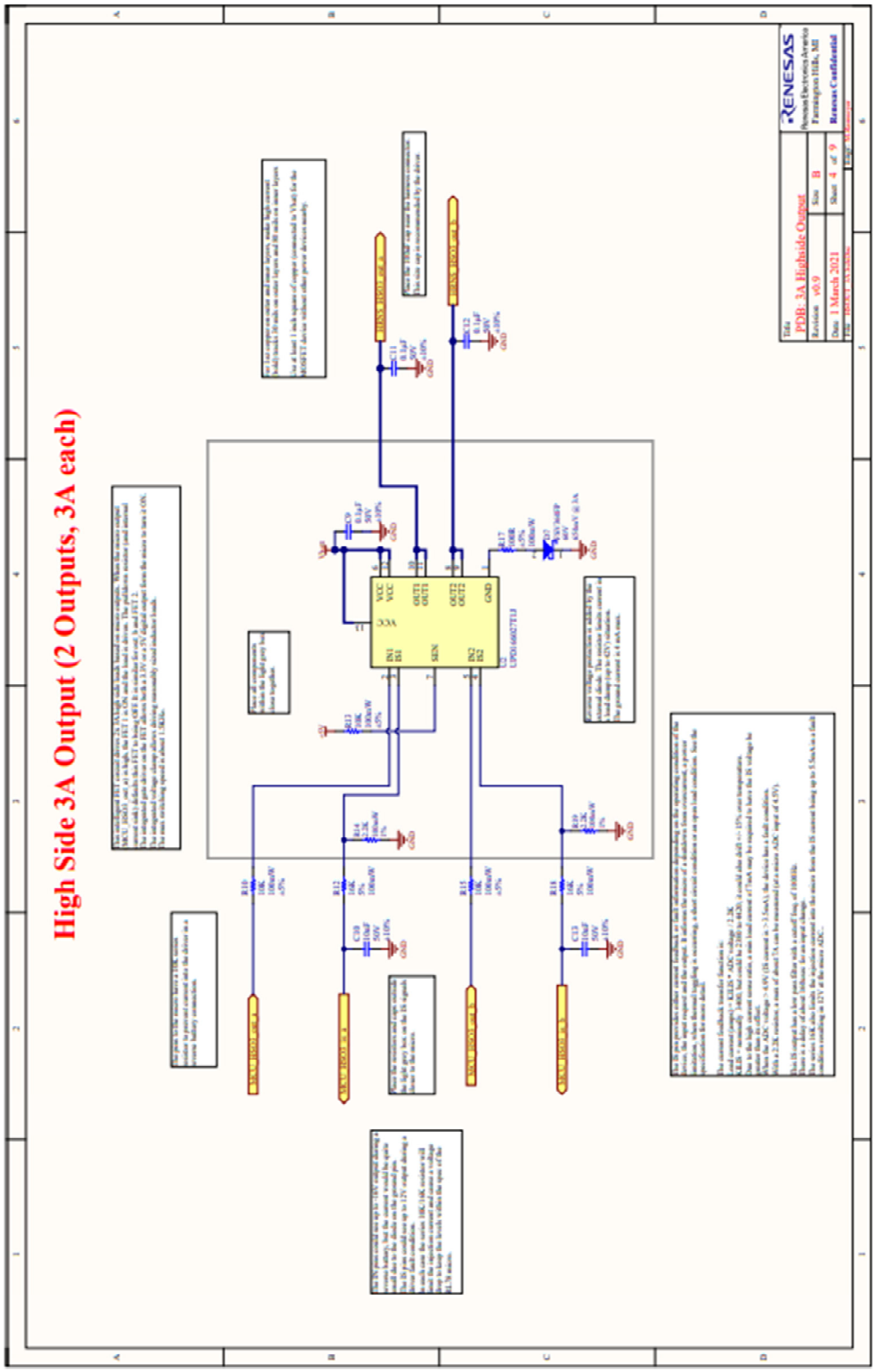

Figure 20: Schematic of “3A IPD”

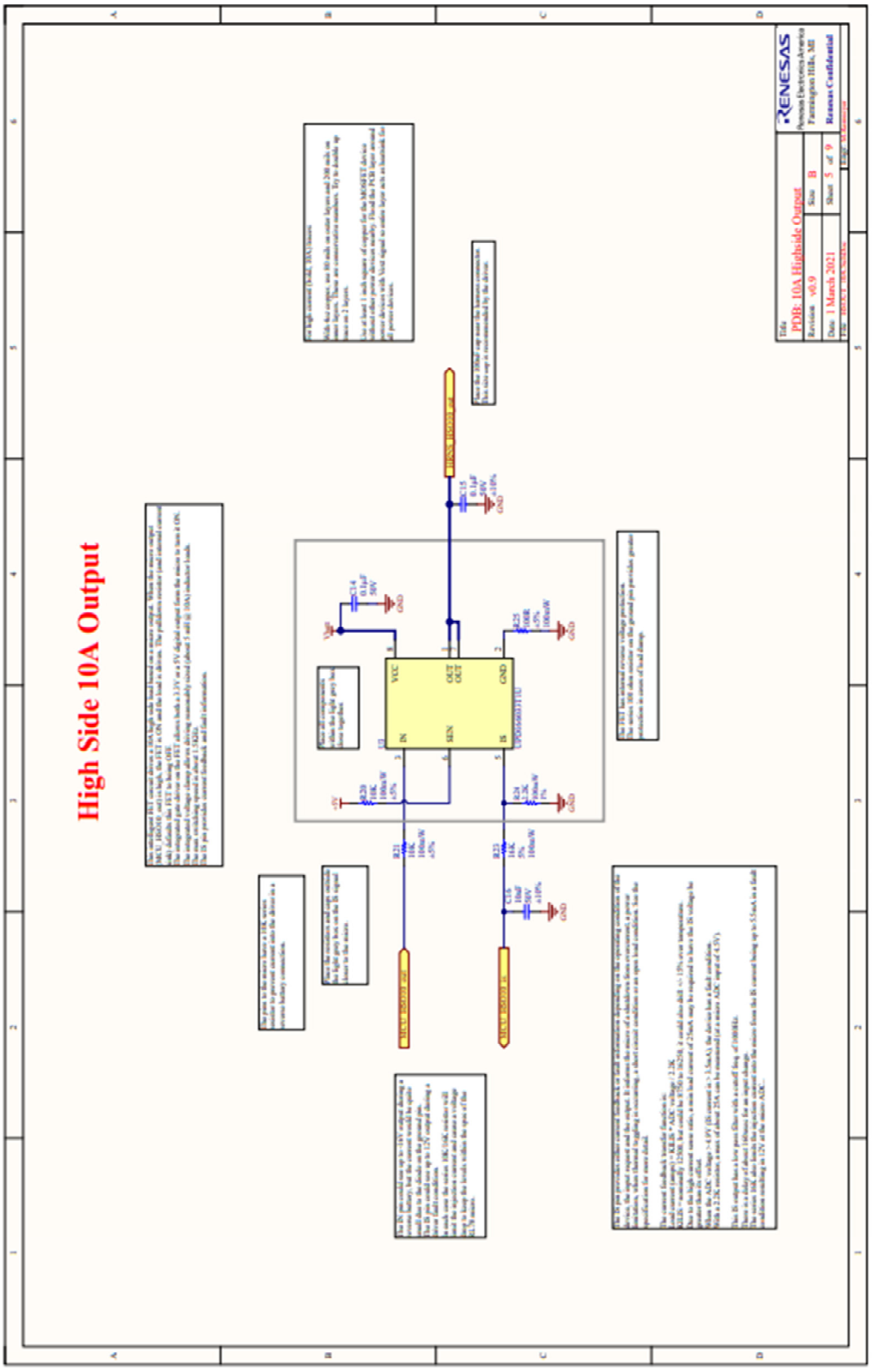

Figure 21: Schematic of “10A IPD”

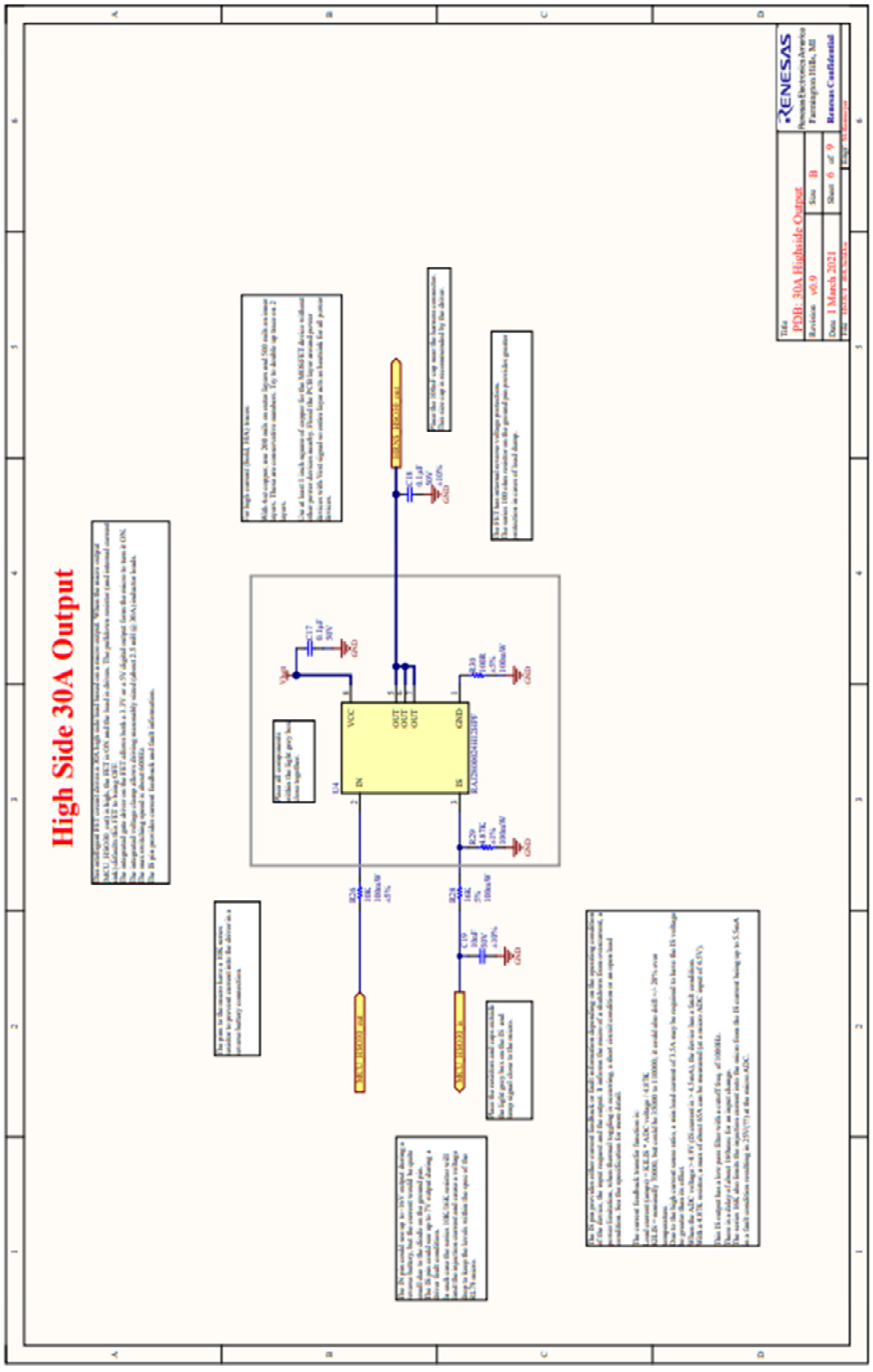

Figure 22: Schematic of “30A IPD”

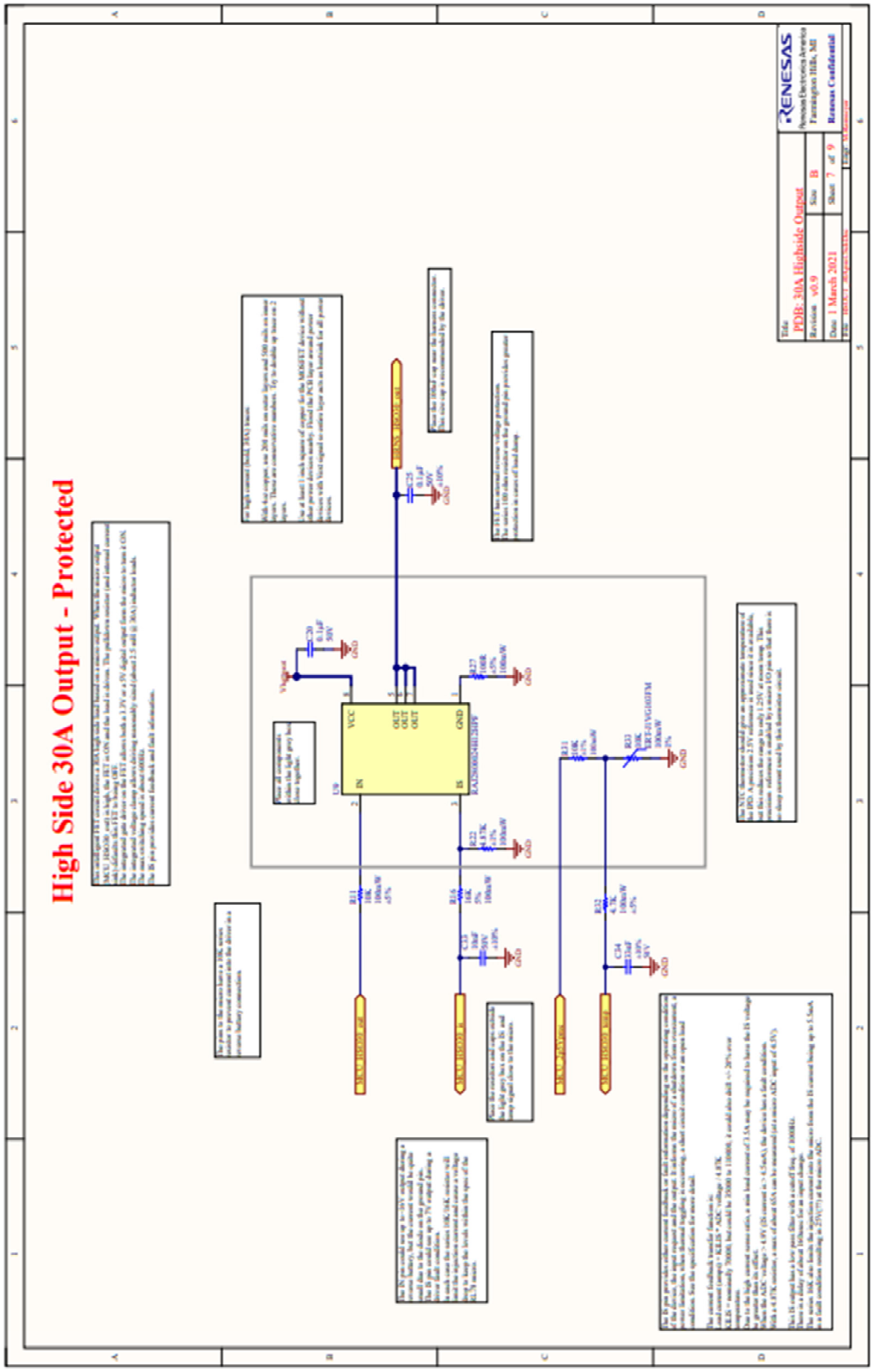

Figure 23: Schematic of “30A protected IPD”

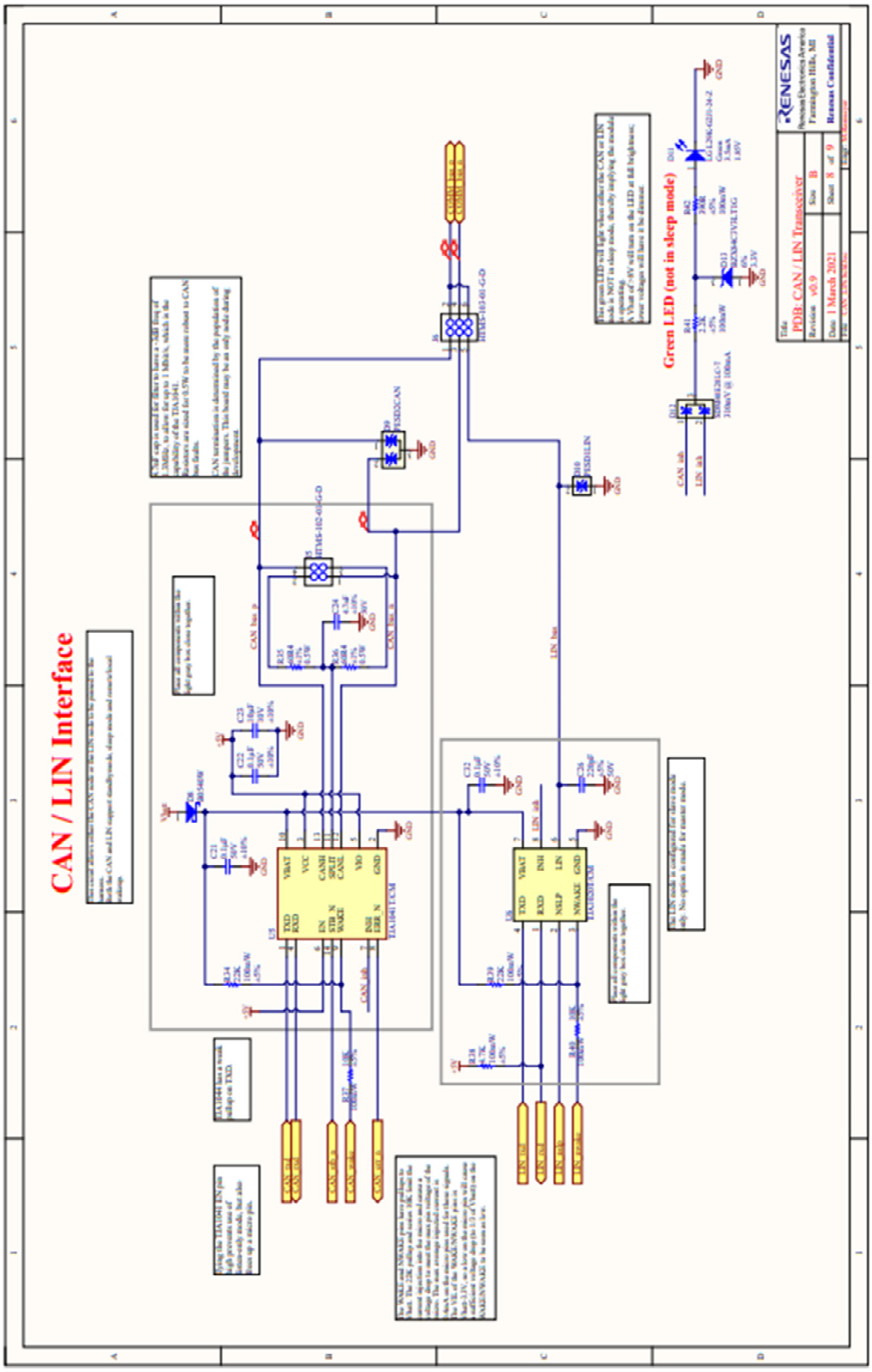

Figure 24: Schematic of “CAN and LIN Interface”

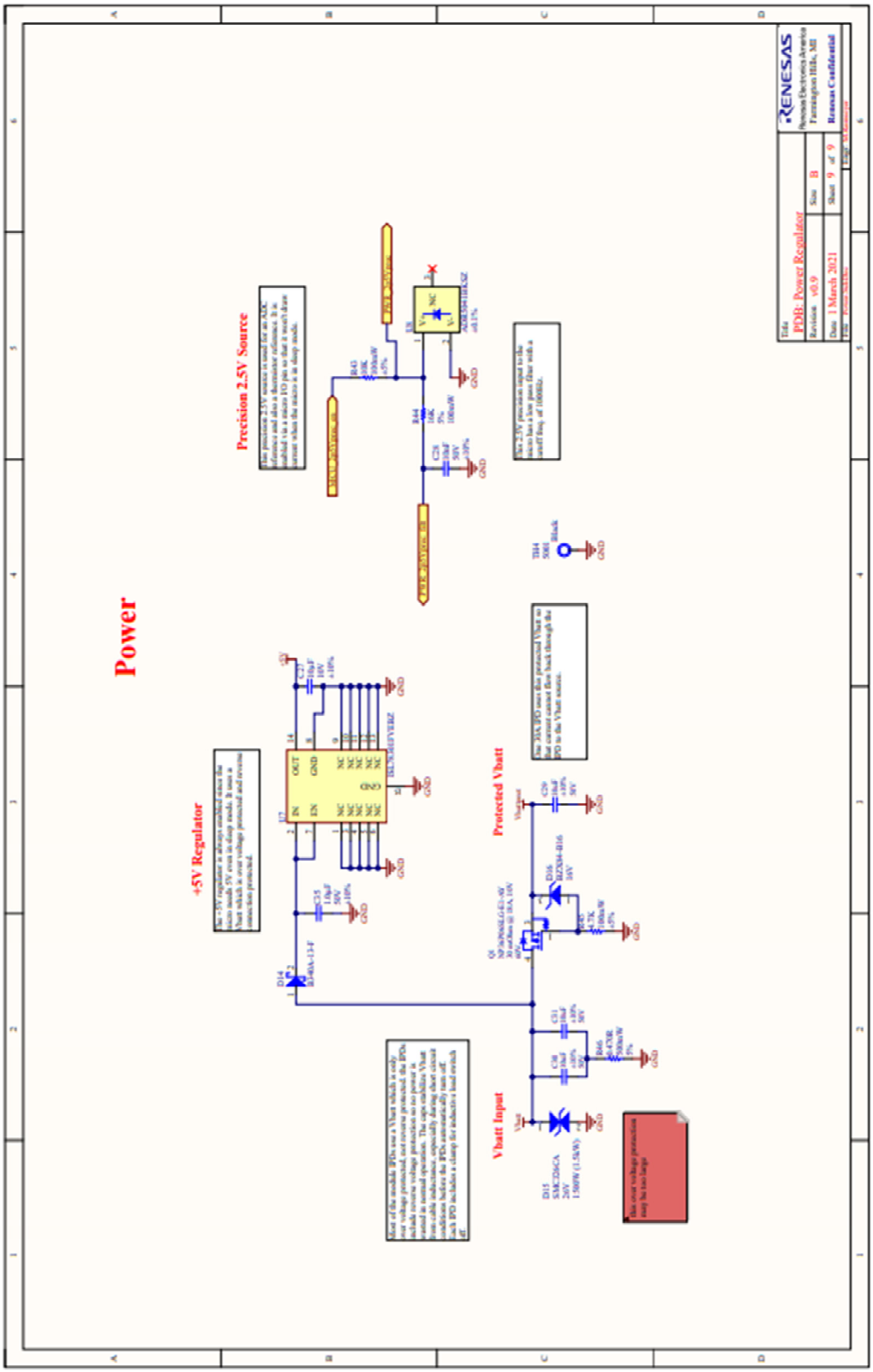

Figure 25: Schematic of "Power Supply"

The picture below shows the layout of the “fuse box”.

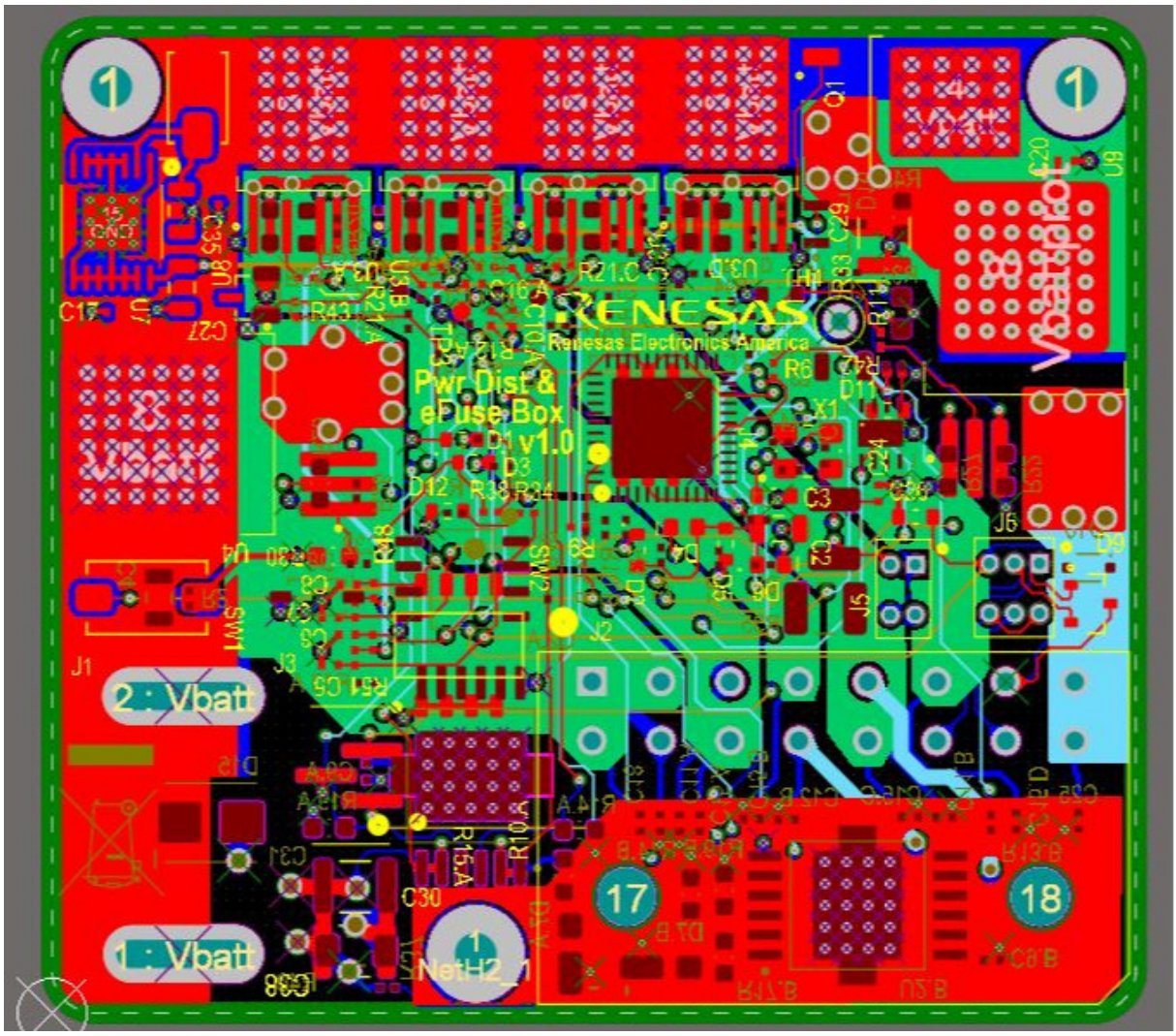

Figure 26: Layout of the “Fuse Box (all layer)”

Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
V1.00	2021-06-30	–	Initial release
V1.01	2021-08-30	19	Add temperature coefficient α in description
V2.00	2022-06-24	all	Change document from Debugger mode to GUI mode

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