# Trimming interface board USB to $I^2C$ with embedded load for automatic trimming of power supply based on SEA01

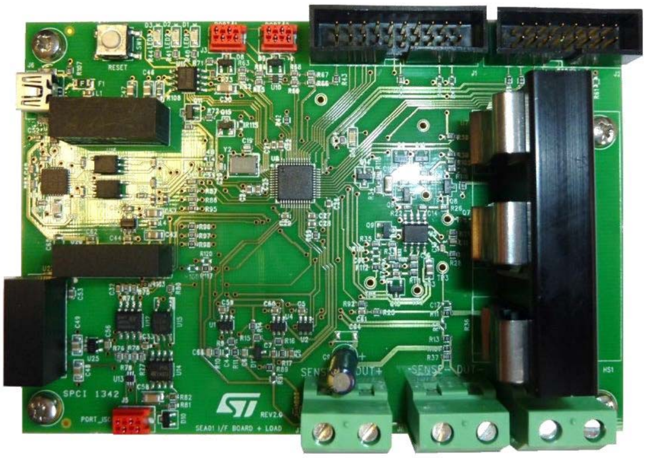
## Introduction

This user manual describes the operation of the STEVAL-PCC019V1 USB to $I^2C$ trimming interface board, with embedded load for automatic power supply trimming based on SEA01.

Hardware and software installation is explained in the first part of the document, followed by details regarding use of the interface.

The STEVAL-PCC019V1 is a tool used to interface a Windows®-based PC with digitally trimmable products like the SEA01. It is therefore essentially a bidirectional bridge between USB and $I^2C$ buses. The board also embeds an active CC/CV load to trim SEA01-based power supplies without any external instruments (such as supply, voltmeter, active load).

**Figure 1. STEVAL-PCC019V1 evaluation board**



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# 1 Main characteristics of the board

- Bidirectional communication between PC (USB) and SEA01 ($I^2C$).
- Self-powered from the USB line.
- On-board 19 V generation for SEA programming
- Electrical isolation between USB and the other circuitry on the board
- Three $I^2C$ buses running at 100 kHz, including one which is electrically isolated from the active load (if the SEA01 is on the primary side)
- Integrated electronic active load with sink capabilities of up to 25 V/10 A
- Self-calibrated references
- Voltage and current measurement with precision of 0.1% (voltage) and 1% (current)
- Integrated temperature sensor to monitor load temperature

# 2 Getting started

## 2.1 System requirements

To use the STEVAL-PCC019V1 board, a PC with Windows® operating system must be used. The GUI (graphical user interface) works with Microsoft Windows XP, Windows 7 or later and .NET Framework 2.

*Note: The .NET Framework 2 is installed by default on all Windows XP (or later) operating systems, so it is not included in the installation package.*

## 2.2 Package contents

The STEVAL-PCC019V1 includes the following items:

- Hardware:
  - Trimming interface and load demo board, also referred to as the *Trimming Board* later in this document
  - USB A to USB mini-B cable
  - 4-wire flat cable for target connection to SEA01 board
- Software:
  - USB drivers
  - PC GUI installation package
- Documentation:
  - User manual
  - Data brief

# 3 Software installation

To use the STEVAL-PCC019V1, first install the USB driver and the PC GUI.

## 3.1 Virtual com port drivers installation (SiLabs CP2102)

First install the USB drivers.

Install either:
- CP210xCVCPInstaller_x86.exe (for 32-bit OS)
- CP210xCVCPInstaller_x64.exe (for 64-bit OS)
- Alternatively, the latest driver versions can be downloaded from the SiLabs web site http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx

When the trimming board is subsequently plugged into the PC, the driver is automatically installed on the system.

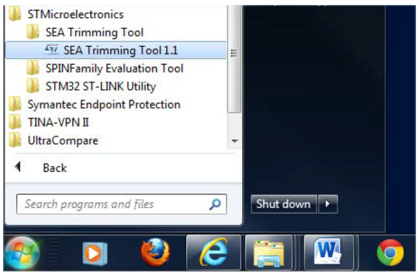
## 3.2 GUI installation (using the installer)

Launch “setup.exe” and follow the installation wizard instructions.

The GUI is installed by default under C:\Program Files (x86)\SMicroelectronics\SEA Trimming Tool 1.1\

*Figure 2* shows the GUI icon created in the *Start* menu, under STMicroelectronics\SEA Trimming Tool.

**Figure 2. SEA trimming tool icon in the start program**




*Note: Any previously installed versions of the software must first be uninstalled with the uninstall feature in Windows Control Panel.*

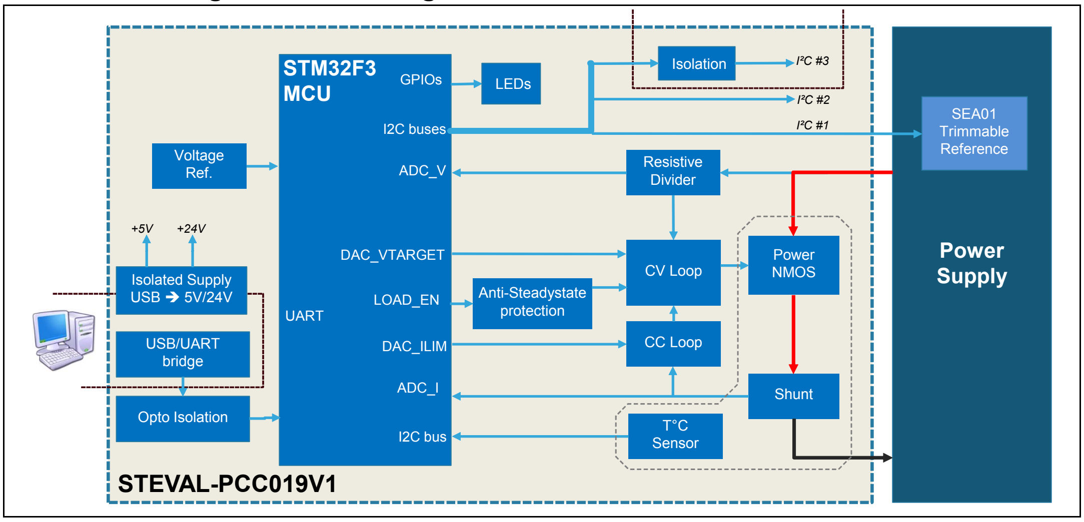
## 3.3 GUI installation (without installer)

If the user does not want to use the installer, the GUI executable and DLL files are also available.
- Copy the two files to a local folder
- Create a shortcut pointing to the executable on the local folder “SEATool.exe”

# 4 Hardware description and setup

## 4.1 Block diagram

Figure 3. Block diagram of the STEVAL-PCC019V1 board




## 4.2 Power supply section

The STEVAL-PCC019V1 is self-supplied through the USB connector 5 V supply. This voltage directly supplies U18 and related circuitry.

Three isolated DC-DC modules (U20, U22 and U23) are used to provide the correct supplies to the remaining part of the board, maintaining the isolation between the PC and target sides.

- U20: 5 V to 5 V and 15 V: MCU (5 V then 3V3) and the CCCV circuitry
- U22: 5 V to +24 V: voltage for burning operation for port #1 and #2
- U23: 5 V to +24 V: voltage for burning operation for port #3

### OTP burning operation

The trimming board is also able to provide the target device with a sufficient $V_{CC}$ voltage for burning. If the $V_{CC}$ on the target device is less than17 V, the programming $V_{CC}$ can be simply connected to the target $V_{CC}$ with a couple of OR-ing diodes.

*Note: On STEVAL-PCC019V1 series diodes D8 and D9 are already implemented.*

The 19 V supply current delivered is limited to 100 mA by the on-board LDOs U11 and U14.

## 4.3 USB to I²C bridge

Communication between the STEVAL-PCC019V1 and the PC is managed by the latter as a standard serial peripheral: the IC U18 converts the USB connection into a virtual COM port (refer to the *Section 9: Board schematic*).

The RX and TX signals are then isolated using opto-couplers U16 and U19 and connected to the STM32 microcontroller U8, ensuring that the USB port and the remaining parts of the board are isolated from the mains.

The microcontroller is the heart of the system and is in charge of performing conversion between UART and $I^2C$ protocols.

The STM32 manages the UART to $I^2C$ conversion, for bidirectional communication between the PC and the target device.

The $I^2C$ speed is set to 100 KHz (maximum speed allowed by the SEA01).

A yellow LED placed near the mini-B USB connector turns on when the CP2102 has been recognized (enumerated) by the operating system.

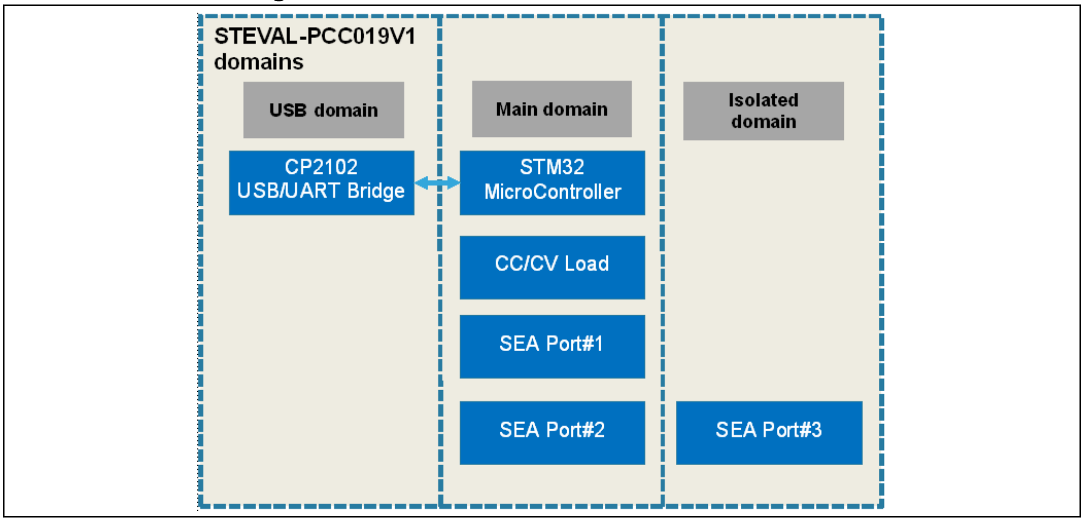
## 4.4 Isolation

The galvanic isolation between the USB side and $I^2C$ side is very important because it allows the target to have any potential without electrical problems.

For example, if the SEA01 is placed on the primary side of an SMPS, its ground is directly connected to the rectified mains. If the interface board has no isolation, the ground of the USB connector (connected to the earth inside the PC) will cause a short circuit on a rectifier bridge diode, damaging the SMPS and the connected hardware.

In order to fulfill all possible SEA01 application needs, the board embeds three $I^2C$ ports, one of which is also isolated from the main domain by U12.

**Figure 4. The 3 electrical domains of the board**

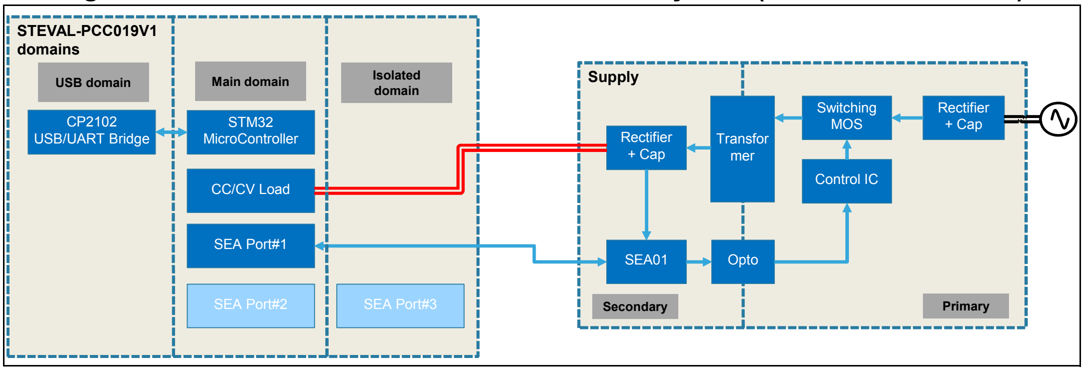



This allows trimming of the SEA01 in various configurations (primary, secondary side), or even multiple SEA01 chips.

### SEA01 on the secondary side

In this case, either Port#1 or Port#2 can be used.

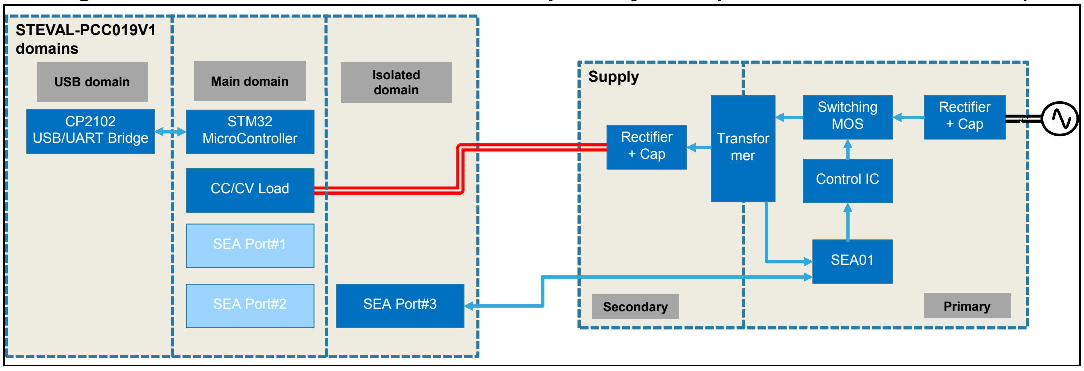
Figure 5. Connection for SEA01 on the secondary side (isolated from mains)




### SEA01 on the primary side

In this case, Port#3 must be used; otherwise, the primary and secondary of the power supply are connected together, which would cause a lack of galvanic isolation and safety requirements, and perhaps even damage the boards.

Figure 6. Connection for SEA01 on the primary side (not isolated from mains)




## 4.5 Grounds for SEA01 ports#1 and #2

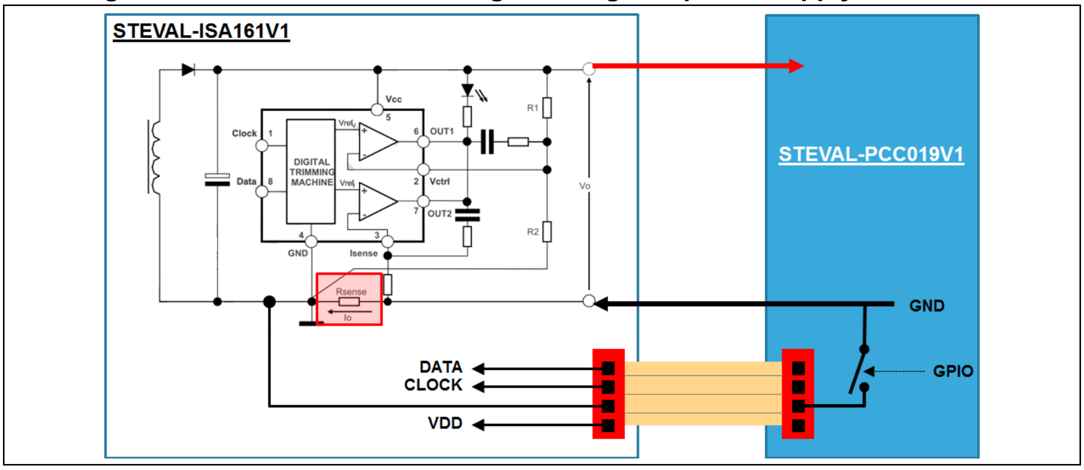
As mentioned above, the SEA01 ports #1 & #2 share the same domain as the load. This means the SEA01 grounds and active load are connected together.

Conversely, on the STEVAL-ISA161V1:

- the main ground is connected to the STEVAL-PCC019V1 board
- the SEA01 ground is connected before Rsense

Hence if we connect the grounds, the Rsense shunt is short-circuited, which interferes with the current measurement.

**Figure 7. Recommended SEA01 grounding and power supply connection**




In order to avoid this situation, the ground of the 4-wire connector is *not connected by default* (we assume the ground connection is made through the supply ground).

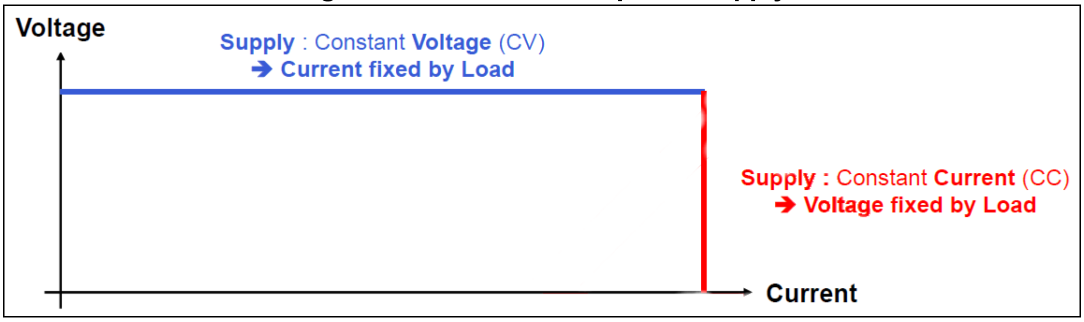
However, if the user wants to have a ground connection on the SEA01, this is still possible without changing the hardware thanks a small signal NMOS (Q15) controlled by a GPIO. The GPIO is controlled in the GUI advanced configuration.

## 4.6 Active load: CV loop (constant voltage)

While trimming the output voltage is straightforward (just measure the supply output voltage), trimming of the current limitation is more complex. You can increase the current until the voltage drops, but this process is quite long and uncertain.

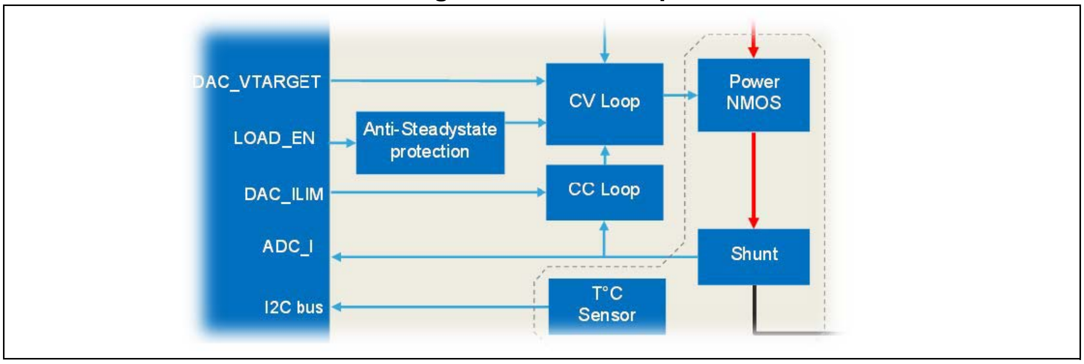
The easiest way is to use an active load asserted on the output voltage: when the supply enters current limitation mode, its output voltage decreases (see *Figure 8*).

**Figure 8. CC/CV mode of power supply**




In *Figure 9*, the CV loop (U5A) increases the current (by increasing Q7 gate voltage) until the supply voltage reaches the desired target voltage (typically 80-90% of nominal output voltage).

**Figure 9. CC/CV loop**




The desired target voltage is set by a 12-bit DAC from the STM32; the target voltage range is between 0 and 26 V, with 6.4 mV/LSB.

*Note: - The absolute precision of the target voltage is not designed to be precise (it is governed by the DAC 0.5% gain error, resistive dividers of the loop, etc.)*

*- The CV loop is mainly used to measure the limiting current, and the CV voltage has very limited influence in this case.*

*- The ADC voltage measurement, on the other hand, has a precision of 0.1%.*

## 4.7 Active load: CC loop (constant current)

Another loop is the constant current (CC) loop, designed to:

- protect the board in case of overcurrent
- sink a given current from the supply (so the supply operates in CV mode)

This loop is built around U5B, which compares the current (measured on R36 shunt) and the target current set the by the BB. If the current is higher, U5B/Q9 artificially decreases the feedback voltage of the CV loop, thus U5A lowers the gate voltage of Q7 until the current reaches the target limit of the MCU.

The load limiting current is set by a 12-bit DAC from the STM32; the limiting current range is between 0 and 33A (DAC full range), but the board is sized up to 10A. Resolution is 8 mA/LSB.

The MCU is informed when the load is operating in constant current mode: the output voltage of U5B (comparator) is connected to Q13 wired in open collector and connected to a MCU GPIO. Thus the GPIO is low when the loop is in CC mode.

*Note: - As with the voltage, the absolute precision of the load limiting current is not designed to be precise (it is governed by the DAC 0.5% gain error; precision of the loop, etc.)*

*- The CC loop is mainly used to limit current; during the current sweep operation, the current considered is the measured current, not the limiting current target (obviously they're very close).*

*- The current ADC, on the other hand, is designed to be 1% precise.*

## 4.8 Thermal considerations

The power delivered by the power supply is dissipated by the MOS and shunt, mounted together on a heat sink.

The STEVAL-ISA161V1 delivers 3.5 A/19 V, so the power dissipated in the load is approximately 3.5 A*19 V = 66.5 W.

The heat sink on the board has a limited thermal resistance $R_{th}$ = 10 °K/W in order to minimize cost/size of the board. This implies a temperature of 25° + 66.5 * 10 = 690° in steady state conditions. Obviously far above the maximum junction temperature.

Actually, the heat sink can sustain 80 W during 25 s steady state operation, thus reaching a temperature of 90 °C.

In order to limit the temperature, all the measurements are burst (load is engaged, measurement is performed, load is shutdown), with the maximum on-time being in the order of 1 s.

The temperature of the load is also monitored by the firmware and the GUI to ensure it does not exceed a given threshold (typ. +60 °C, settable by software).

## 4.9 Anti-steady state protection

As mentioned above, all measurements are burst. The MCU enables/disables the load in order to keep the heat sink temperature inside a “reasonable” range.

A hardware safety mechanism based around Q10 is implemented on the board to prevent the load being engaged for more than 1 s (e.g., if the CPU is stalled).

## 4.10 ADC reference and calibration

The STM32F3 series embeds 16-bit sigma-delta ADCs (SDADC).

The reference voltage of the SDADC is provided by a shunt voltage generator, D1, which delivers 1.225 V ± 0.1%. However, the internal analog front-end (amplifiers) before the SDADC needs to be calibrated.

Each channel (V and I) is therefore connected to a mux (U1 and U2) in order to measure a reference voltage.

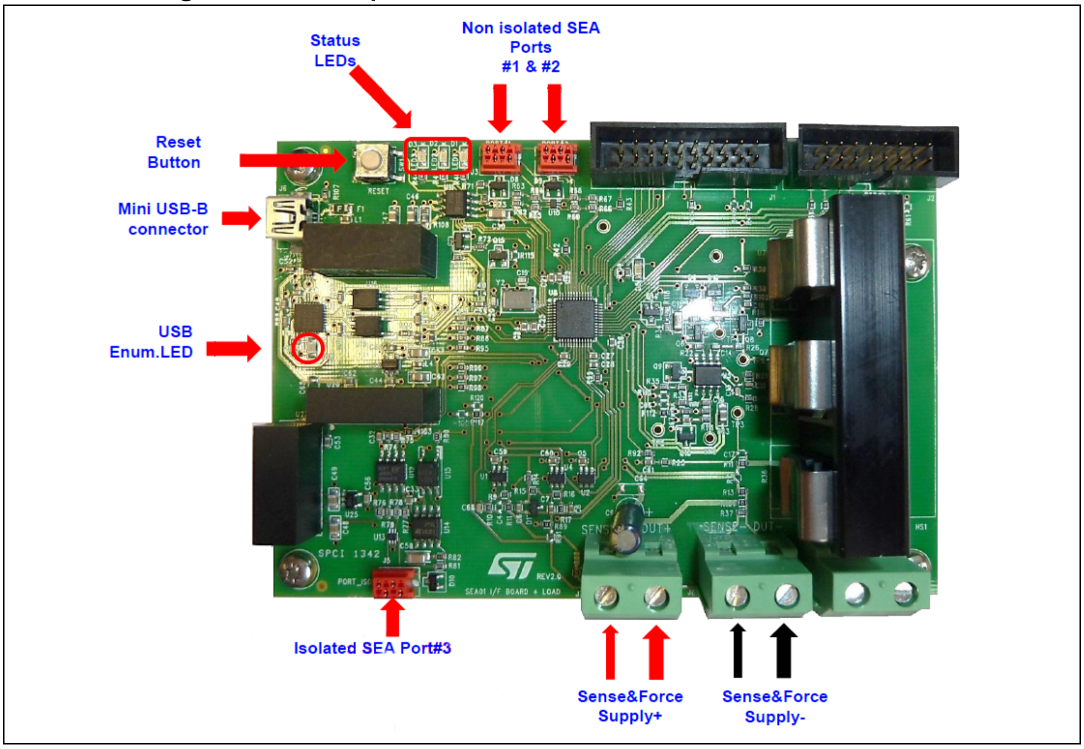
The reference voltage to be measured is provided by U4 in order to select 10% or 90% of the SDADC reference voltage.

This calibration process is only run once, when the GUI connects with the board.

# 5 Running the evaluation board

## 5.1 Hardware interfaces

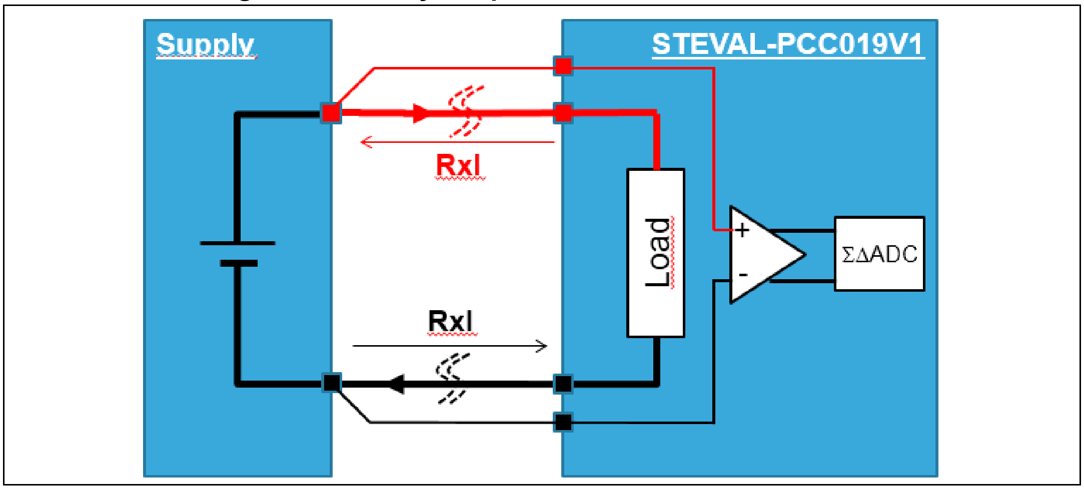
Figure 10. Description of the various connectors of the board




## 5.2 Use of sense cables

Given the amount of current, we highly recommend using sense connection.

Figure 11. Theory of operation for sense connection



Consider 5 A going through a cable of 1.5 mm² section over a length of 50 cm: if the resistance of the cable is 6 mΩ, the IR drop across the cable is

2*R*I = 60 mV!

60 mV represents 0.3% of the error, which is more than one trimming step of the SEA01!

To alleviate this issue, the board has dedicated sense inputs for measuring voltage at the supply connection so the IR drop of the cable does not disturb the voltage measurements.

If the user does not want to use sense connection, the sense and force signal must be shorted as in *Figure 12*; otherwise the board will not operate correctly.

**Figure 12. Measure without sense**

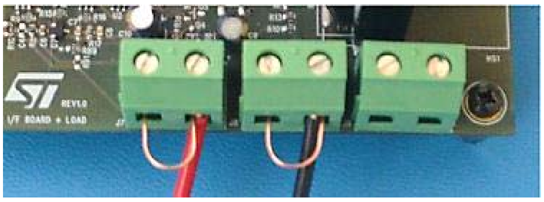
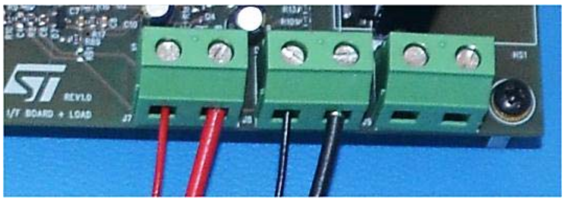


**Figure 13. Measure with sense**



## 5.3 Status LEDs

The status of the board is given by three LEDs.

**Figure 14. Status LEDs**

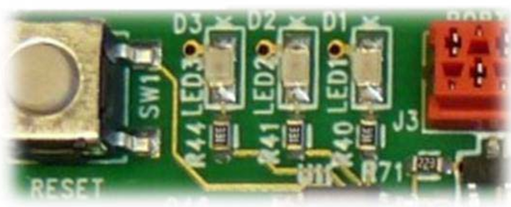



**Table 1. LED status definition**

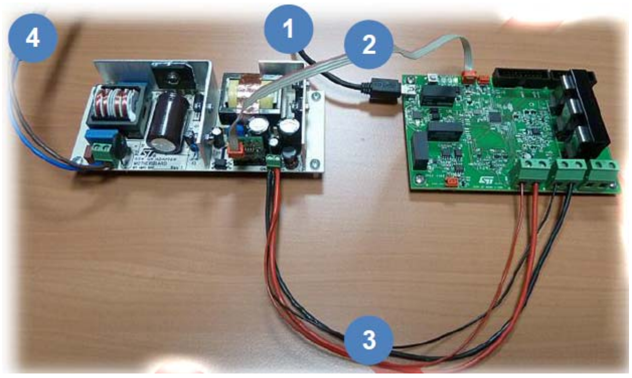
| LED & color | Status |
|---|---|
| D1 / Green | MCU firmware OK |
| D2 / Green | Connection with SEA01 established |
| D3 / Red | Unused |

## 5.4 Connecting supply and trimming board together

See *Figure 15* for a typical setup of the STEVAL-PCC019V1 board connected to the STEVAL-ISA161V1:

1. connect the trimming board to a PC with the USB cable
2. connect the target device (SEA01 board) with the 4-wire flat cable to the trimming board
3. connect the power supply terminal to the load (see *Section 4.2*)
4. connect the mains to the power supply board

**Figure 15. Basic setup with STEVAL-ISA161V1 board (left) and trimming board (right)**




Be sure that the target device is correctly supplied.

- the green LED D1 turns on when the MCU has booted and the board is supplied by the USB power
- the yellow LED D4 turns on when the USB-UART bridge is correctly recognized by the PC.

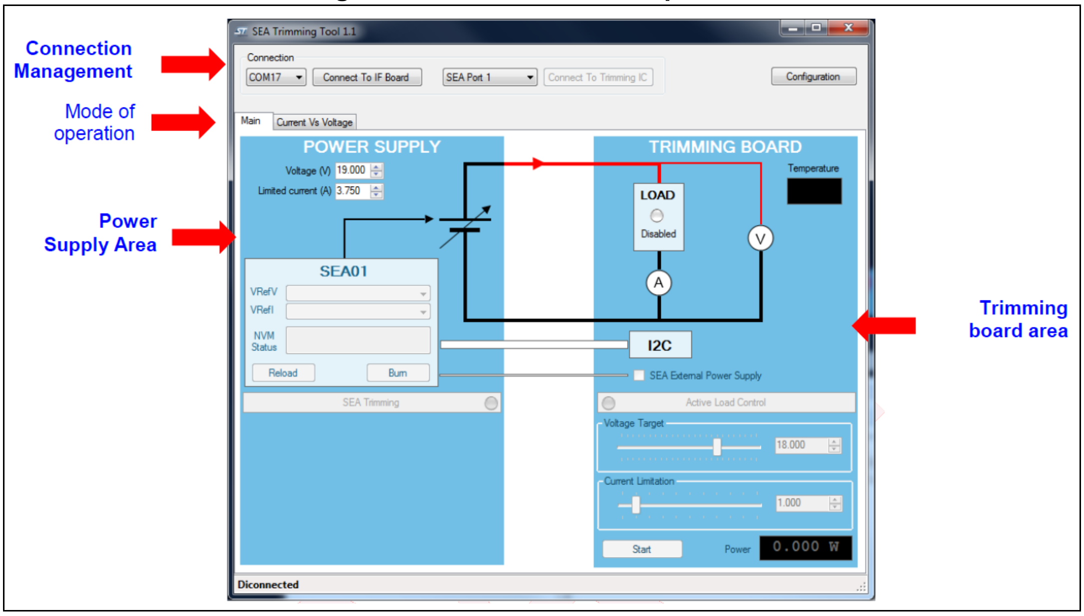
*Note: If this is the first time a CP210x SiLabs USB-UART bridge driver is installed on the system, it will first install the drivers*

Run the SEA01 GUI software on the PC.

# 6 Running the GUI

The first screen that appears is shown in *Figure 16*.

**Figure 16. SEA01 GUI startup screen**




The GUI is divided in 3 areas:

- Connection management: used to manage connection with the trimming board and the SEA01 chip
- Power supply area: all controls related to the SEA01-based supply (nominal specification, trimming controls)
- Trimming board area: control of the active load

## 6.1 Connection management

The GUI automatically detects the COM port to be used (the GUI selects the CP2102 based VCP).

First, we establish connection with the trimming board:

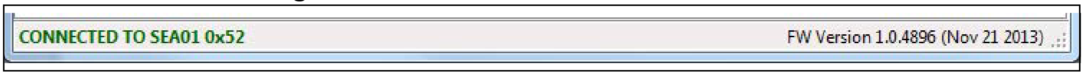
- click “connect to IF board”
- the firmware performs ADC voltage and current calibration (takes 2 s approx.)

If connection is successfully established, the rest of the GUI becomes undimmed and the status bar reads “connected to IF board”

The next step is to communicate with the trimming IC

- select the SEA01 port where the trimming IC is connected
- click “connect to trimming IC”
- the system looks for a known trimming IC and displays its reference and the associated $I^2C$ address in the status bar, see *Figure 17*
- The firmware revision of the trimming board is also displayed in the right corner

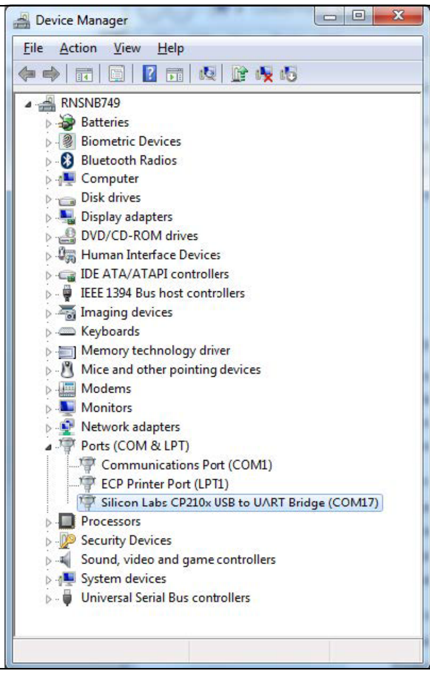
Figure 17. Successful connection to SEA01




*If the GUI does not find a SiLabs based VCP, an error message pops-up. Check Device Manager to ensure the SiLabs VCP is correctly recognized:*

Click *+Pause, and select Device Manager (see Figure 18)*

Figure 18. SiLabs VCP in the device manager

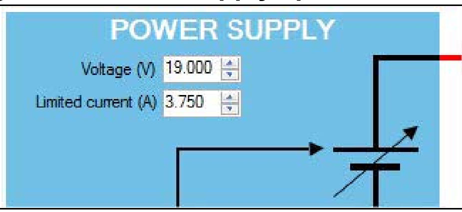



## 6.2 Power supply (basic) specifications

The GUI must have a nominal power supply specification. These values are used as the target for the trimming operation, see *Figure 19*.

The default values match the STEVAL-ISA161V1 board, i.e. 19 V/3.75 A.

Figure 19. Power supply specification box




**Warning: Be sure to select the voltage and current that match the power supply used.**
**- Effectively, the SEA01 range is +/-3% for voltage and ±50%**

**- If the target voltage/current exceed this window (e.g. 12 V or 5 A), it will obviously be impossible to trim the power supply.**

## 6.3 Modes of operation

There are three possible modes of operation:

- SEA trimming — the GUI trims the SEA01 chip in order to meet the target power supply voltage and current specification
- Manual control — this allows tuning of both the SEA01 target chip and the active load
- V/I graph — the GUI displays the voltage/current graph so the user can view the supply characteristics

Following sections will describe each mode in details.

## 6.4 SEA trimming

### How to activate SEA trimming

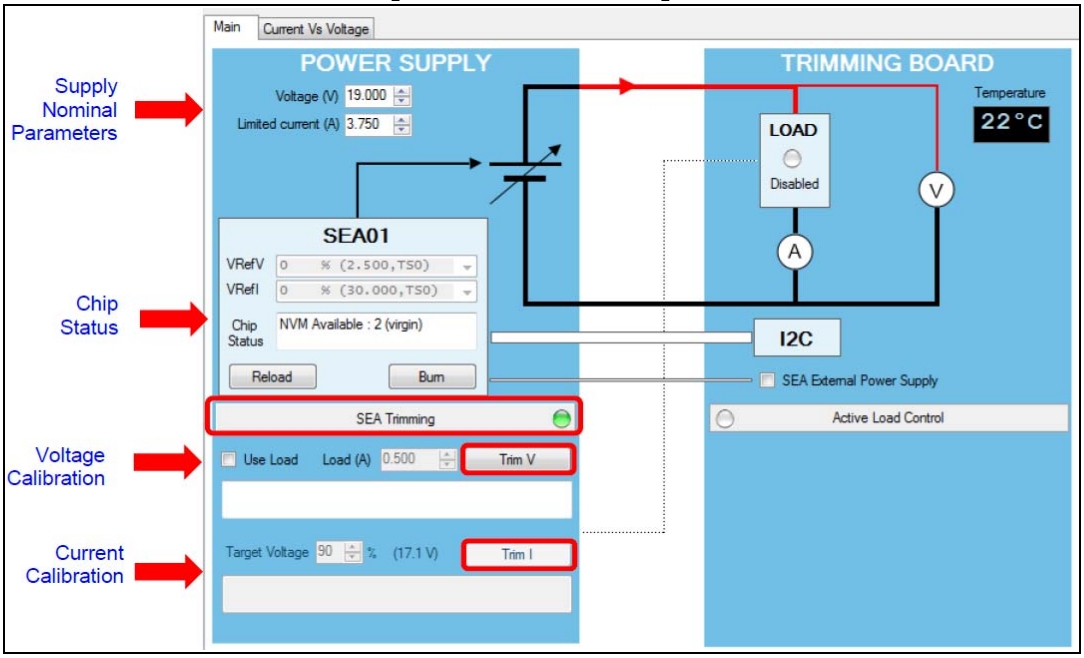
Go to the main tab and click the SEA trimming button. *Figure 20* shows the trimming tab environment.

### Chip status

This box indicates:

- the actual V/I trimming parameter used
- the number of OTP fuse operations available (SEA01 can only be trimmed twice)

**Figure 20. SEA trimming tab**




### 6.4.1 Voltage trimming

The only parameter is the load current under which voltage calibration is performed.

To perform voltage trimming without a load, un-check the “use load” check box. Otherwise, check the box and specify the load current (% of nominal voltage) used for voltage trimming. Then, click the “TrimV” button.

Once the trimming is achieved, the status box displays the voltage trimming step and the associated effective voltage.

### 6.4.2 Limiting current trimming

As discussed in *Section 4.6*, the load operates in CV mode for supply current trimming.

Specify the ratio of the nominal voltage used during current trimming; the ratio must be between 50% and 95%. Then, click the “TrimI” button.

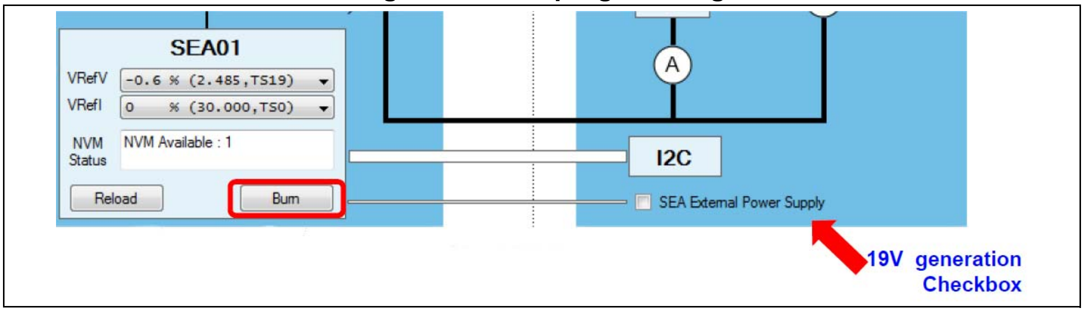
Once the trimming is achieved, the status box displays the current trimming step and the associated effective limitation current.

### 6.4.3 OTP Programming operation

Once voltage and current have been trimmed, the user can program the trim value in the SEA01 chip, see *Figure 21*.

*Note: The SEA01 OTP fuse operation requires $V_{cc}$ to be greater than 17 V; if the SEA01 $V_{cc}$ (hence nominal voltage of the supply) is lower than this value, the on-board supply generating 19 V can be enabled by activating the “SEA external power supply” check box.*

Figure 21. OTP programming



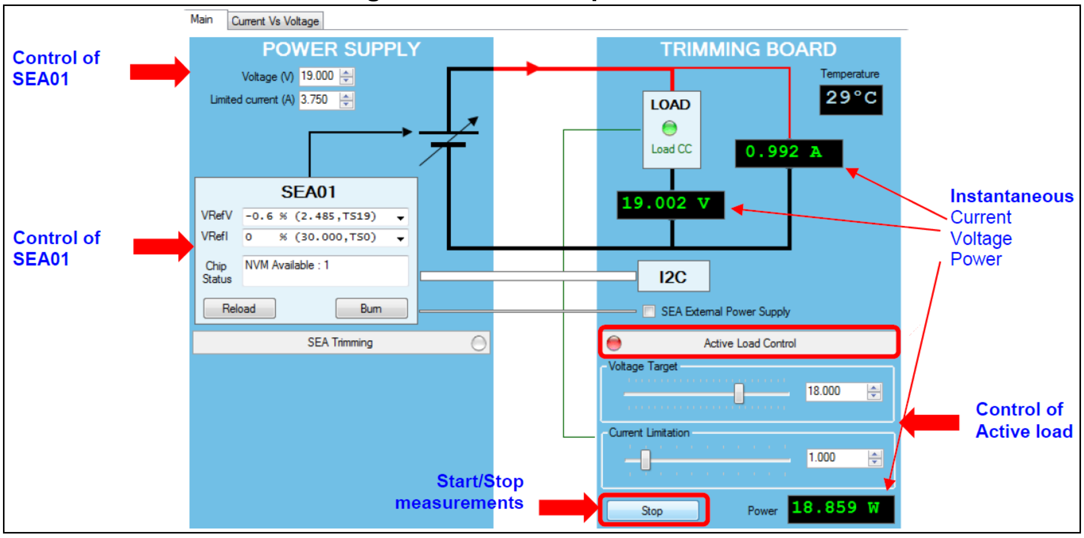

## 6.5 Manual operation

### How to set manual operation

Go to the main tab, and click the active load control button

Manual operation (See *Figure 22*) is perhaps the most interesting mode because you can play with the SEA01 and the active load as if you were using real laboratory instruments.

Figure 22. Manual operation tab




### SEA controls

The user can dynamically change the V/I trimming values of the SEA01 or reload the original V/I trimming values stored in the OTP.

### Active load control

The user can dynamically change the active load control:

- Voltage Target – this is the target the CV loop will try to reach
- Current Limitation – this is the limiting current of the load

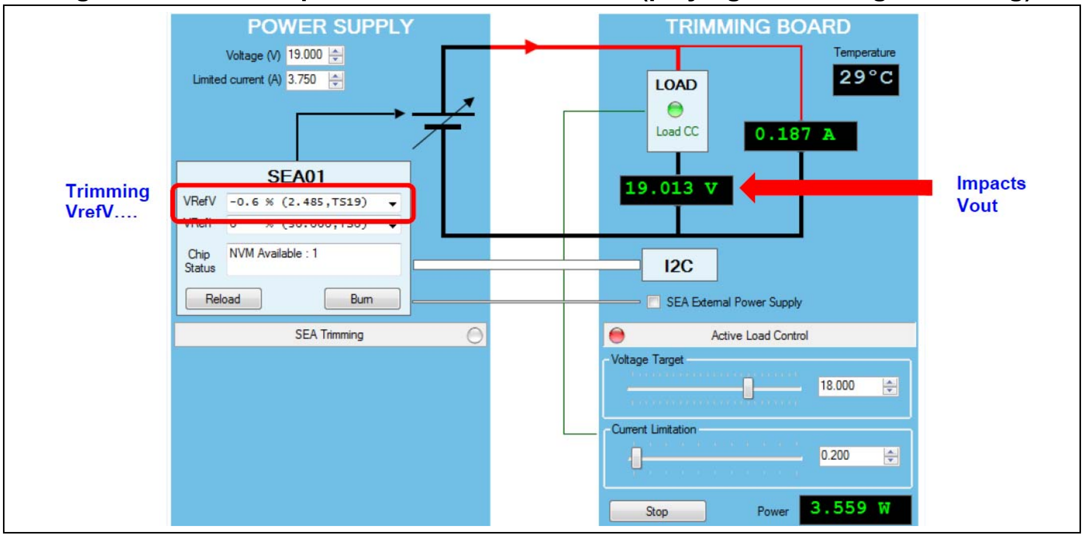
### 6.5.1 Example #1: the effects of voltage trimming

See *Figure 23*:

- Set a “reasonable” current limit, let’s say 200 mA; this will allow the dissipation of very low power into the load (19*0.2=3.8 W), hence long operating time
- The Voltage Target value does not have any influence: the CC loop of the load effectively limits the current, so the CV loop has no influence
- Play with the VrefV trimming knob of the SEA01box and observe the variations in the output voltage

*Note: The load is operating in CC mode, as expected (187 mA measured for 200 mA target).*

**Figure 23. Manual operation: load in CC mode (playing with voltage trimming)**



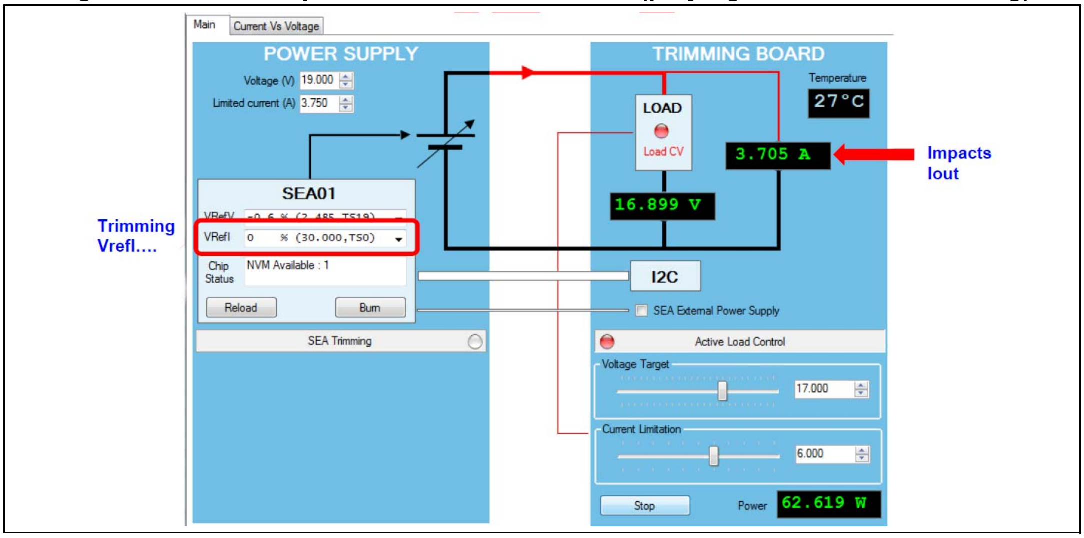

### 6.5.2 Example #2: the effects of current trimming

See *Figure 24*:

- Set a “reasonable” voltage for VTarget, typically 1 or 2 V below the nominal voltage (e.g. 19-2 = 17 V).
- Set limit above the expected current limitation of the supply (e.g., 6 A), it does not impact the measurement as the current is limited by the supply itself this time.
- Play with the IrefV Trimming knob of the SEA01box and observe the variations in the current limitation.

*Note: The load is operating in CV mode: 16.899 V measured for a target of 17 V.*

**Figure 24. Manual operation: load in CV mode (playing with current trimming)**

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**Warning:** **Do not maintain these load conditions for too long, as the power dissipated by the load in this case is 17*3.7 A = 63 W! The GUI will automatically disable the load when the heat sink temperature reaches 60 °C, but it is better to avoid stressing the load.**

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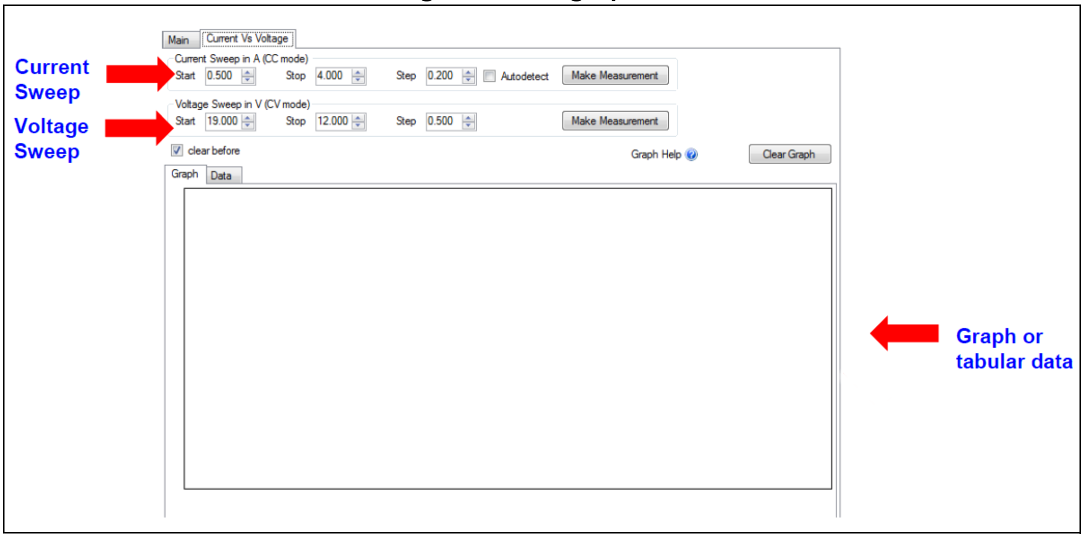
## 6.6 Voltage/current graph

This feature plots a voltage vs. current graph by performing a current or voltage sweep, providing a very convenient graphical view of the supply behavior (see *Figure 25*).

**Figure 25. V/I graph tab**



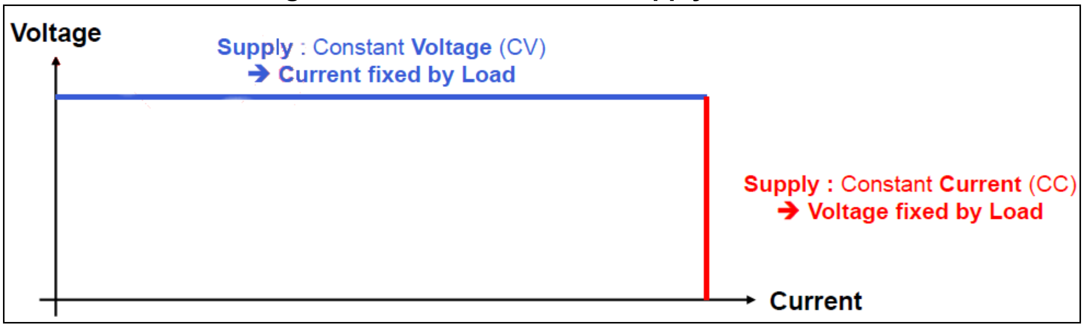
### Current or voltage sweep

As already explained, we can either perform a current or voltage sweep. See *Figure 26*.

**Table 2. CC/CV operating mode on supply/load side**

| Supply | Load | Curve | Remark |
|---|---|---|---|
| Constant voltage (CV) | Constant current (CC) | Blue | "Normal" working area of the supply |
| Constant current (CC) | Constant voltage (CV) | Red | Limiting current area of the power supply |

**Figure 26. CC/CV curves for supply and load**




*Note: To ensure maximum speed, all the measurements are first collected by the firmware and then sent to the PC. This is why it may take some time between when the measurement begins and the graph is shown.*

### 6.6.1 Chart controls

The graphical chart has some very useful tools.

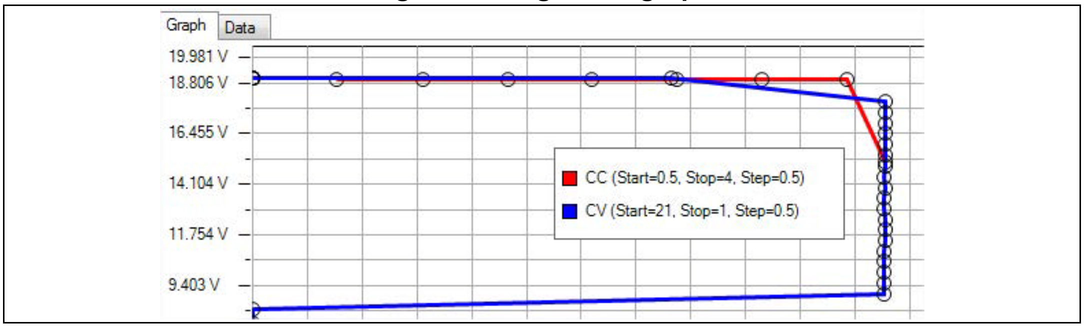
- The main operations are:

**Table 3. Chart Control using keypad and mouse**

| Action | Effect |
|---|---|
| Single click | Full view (0V-0A / Max V-MaxI) |
| Ctrl + click and select area | Zoom on selected Area |
| Mouse wheel | Zoom in/zoom out (center of the chart) |
| Mouse wheel click | Full screen |
| Move mouse on a data point | Display V/I measurements (green box) |
| Move mouse on the grid | Display V/I value (yellow box) |

- If the "clear before" box is checked, each time a new measurement is performed, the previous data is automatically cleared; otherwise, the previous data remains displayed on the graph
- Multiple curves on the same chart:
  - when multiple data is displayed on the same graph, a new color is associated with each new set of measurements
  - you can show or hide sets of measurements by clicking the associated color in the legend box, see *Figure 27*
  - for each curve, the type of sweep (CC/CV) and the conditions are displayed in the legend box

**Figure 27. Legend of graph**




- Measurements in tabular form are also available in the *Data* tab (see *Figure 28*):
  - voltage and current are given in mV/mA
  - temperature is also displayed
  - CCLim indicates whether the load is operating in CCmode (limit) or CVmode (nothing)

**Figure 28. Tabular data**

Graph | Data

| V | I | TEMPERATURE | CCLIM |
|---|---|---|---|
| 19058 | 3288 | 26 | Limit |
| 19080 | 3342 | 26 | Limit |
| 19078 | 3387 | 26 | Limit |
| 19079 | 3441 | 26 | Limit |
| 19078 | 3487 | 26 | Limit |
| 19076 | 3540 | 26 | Limit |
| 19076 | 3588 | 26 | Limit |
| 19076 | 3641 | 26 | Limit |
| 19076 | 3687 | 26 | Limit |
| 18289 | 3728 | 26 | Limit |
| 15413 | 3708 | 26 | Limit |
| 15211 | 3711 | 26 | |
| 15212 | 3709 | 26 | |
| 15212 | 3709 | 26 | |
| 15210 | 3709 | 26 | |

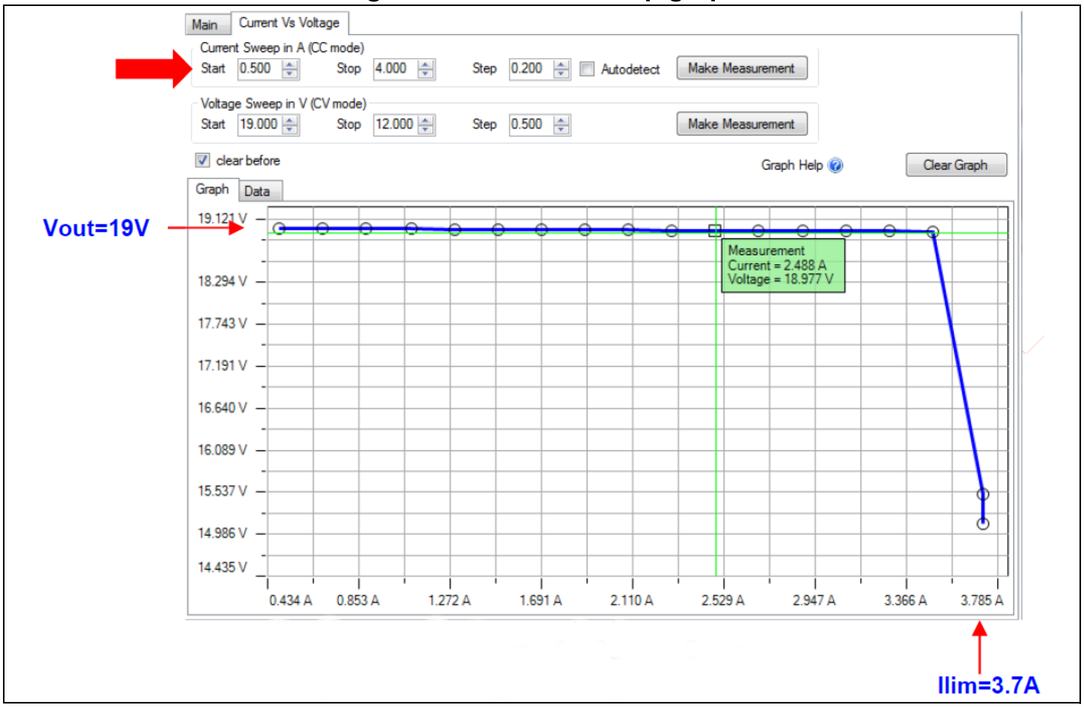
## 6.6.2 Current sweep

The user only needs to enter the start and stop and step values of the sweep, and then click the "make measurement" button.

*Figure 29* shows an example of current sweep observed on the STEVAL-ISA161V1 supply. We can clearly see the limiting current around 3.7 A

*Note: During the CC sweep, the target voltage used is set to 80% of the nominal voltage, hence 19 V*80%=15.2 V.*

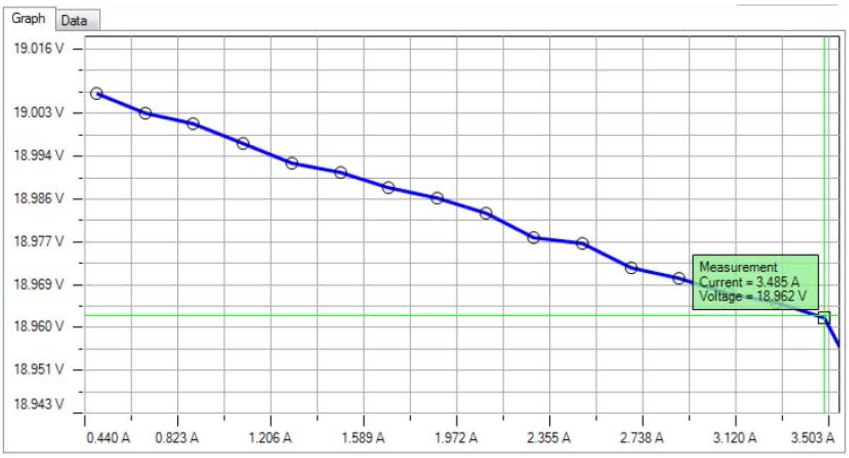
**Figure 29. Current sweep graph**



In *Figure 30*, we zoom the CV area of the supply, where we can clearly observe the supply load regulation characteristics of the STEVAL-ISA161V1 supply:

- between 0.5 A and 3.5 A, the output voltage drops from 19.007 V to 18.962 V
- hence 45 mV/3 A=15 mV/A.

**Figure 30. Supply load regulation**




It may also be of interest to zoom the current limitation area a little to observe the detailed power supply behavior.

In *Figure 31*, we sweep the current between 3.4 A and 4.0 A with a smaller step (50 mA), and we can clearly see the current limitation is around 3.70 A

This is also clear in the tabular data (see *Figure 32*): above 3.71 A, the current no longer increases because it is limited by the power supply itself.

**Figure 31. Zooming on current limitation**

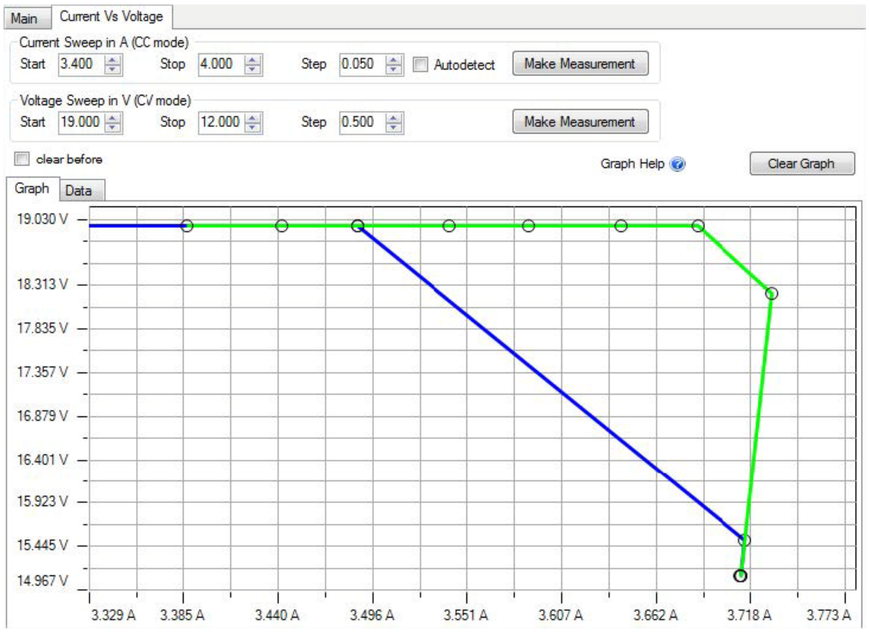
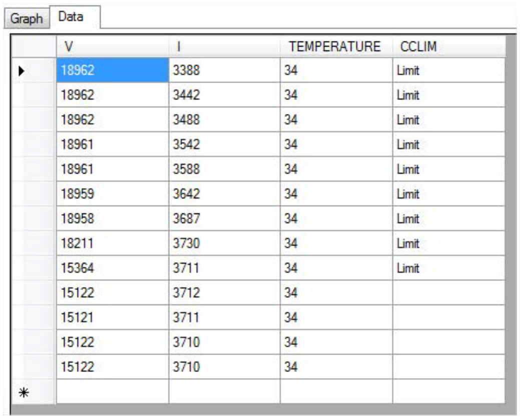


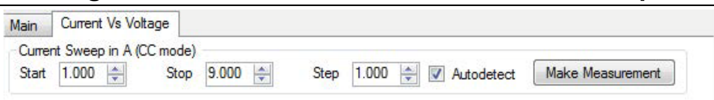

**Figure 32. Tabular data of supply in limitation mode**



| V | I | TEMPERATURE | CCLIM |
|---|---|---|---|
| 18962 | 3388 | 34 | Limit |
| 18962 | 3442 | 34 | Limit |
| 18962 | 3488 | 34 | Limit |
| 18961 | 3542 | 34 | Limit |
| 18961 | 3588 | 34 | Limit |
| 18959 | 3642 | 34 | Limit |
| 18958 | 3687 | 34 | Limit |
| 18211 | 3730 | 34 | Limit |
| 15364 | 3711 | 34 | Limit |
| 15122 | 3712 | 34 | |
| 15121 | 3711 | 34 | |
| 15122 | 3710 | 34 | |
| 15122 | 3710 | 34 | |

*Note: The GUI can also detect the limiting region automatically and zoom the inflection area by checking the AutoDetect box, see Figure 33.*

**Figure 33. AutoDetect feature of current sweep**




## 6.6.3 Voltage sweep

As already mentioned, it is also possible to perform a voltage sweep of the load. In this case, the current limitation is set to the maximum value (10 A), hence we can observe the various current protection capabilities of the supply vs. voltage.

The user only needs to enter the start and stop and step values of the voltage sweep, and click the “make measurement” button

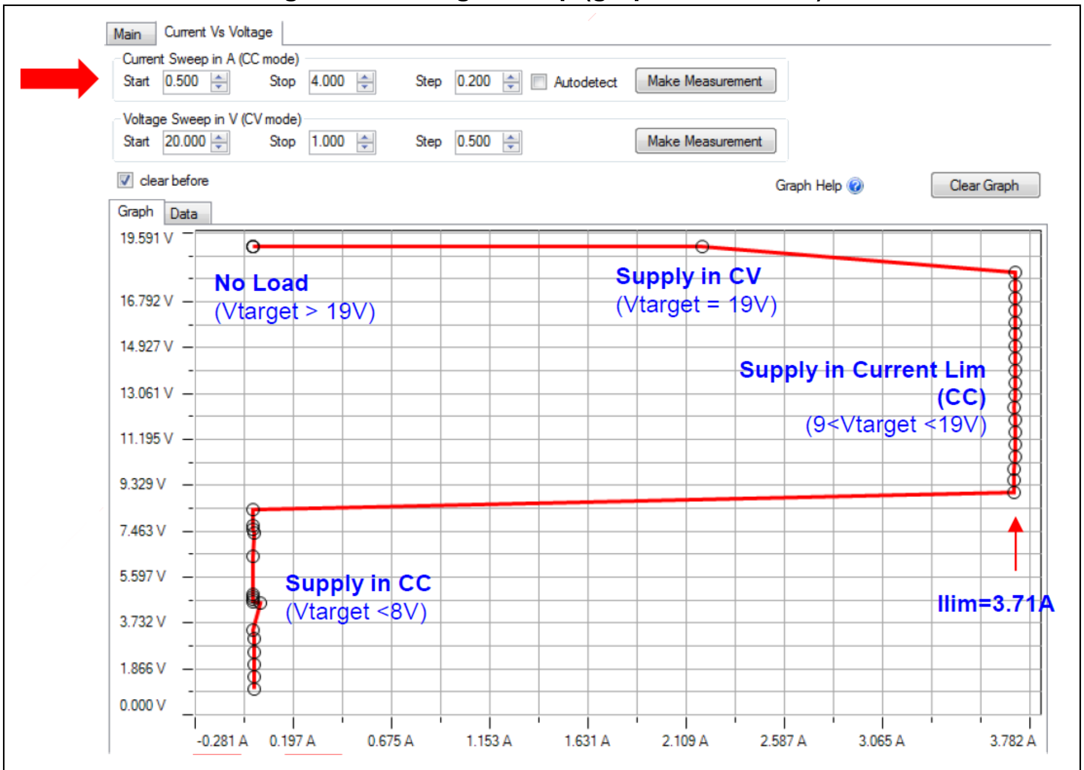
*Note:* *$V_{start}$ must always be greater than $V_{stop}$*

See example *Figure 34*, where a sweep from 20 V down to 1 V is performed and the results are shown:

- for $V_{target}$ above 19 V, there is no current, which is expected as the load can only sink current from the supply, so $V_{out}$ is always 19 V
- for $V_{target}$ around 19 V, the supply is regulating, hence operating in CV Mode
- below 19 V (nominal), the behavior of the STEVAL-ISA161V1 supply is a constant current at 3.710A ± 2 mA (measurement uncertainty)
- below 8V, the supply enters short circuit protection mode ($V_{cc}$ below turn-off threshold)

*Note:* *During CV sweep, the limitation current used is set to 10 A.*

**Figure 34. Voltage sweep (graph and tabular)**



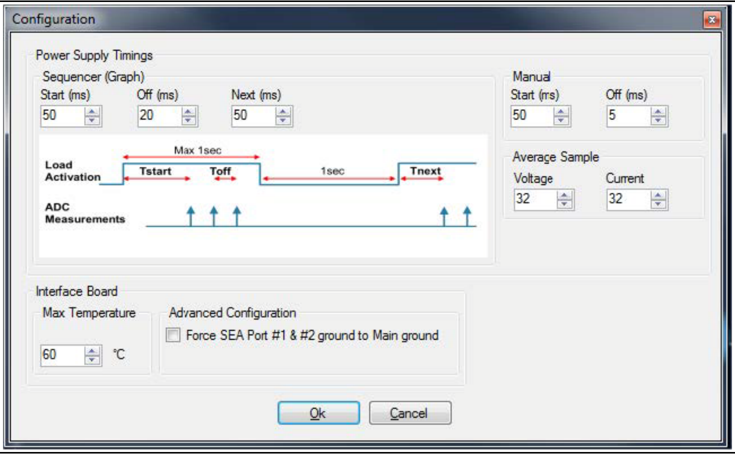

| V | I | TEMPERATURE | CCLIM |
|---|---|---|---|
| 19012 | -2 | 28 | |
| 19012 | -2 | 28 | |
| 19012 | -2 | 27 | |
| 19012 | 2187 | 27 | |
| 17964 | 3713 | 28 | |
| 17449 | 3713 | 27 | |
| 16953 | 3713 | 27 | |
| 16457 | 3710 | 28 | |
| 15962 | 3711 | 28 | |
| 15466 | 3712 | 28 | |
| 14968 | 3712 | 28 | |
| 14470 | 3713 | 28 | |
| 13975 | 3713 | 28 | |
| 13478 | 3711 | 28 | |
| 12969 | 3709 | 28 | |
| 12487 | 3707 | 28 | |
| 11992 | 3708 | 28 | |
| 11498 | 3708 | 28 | |

| V | I | TEMPERATURE | CCLIM |
|---|---|---|---|
| 11002 | 3708 | 28 | |
| 10511 | 3708 | 28 | |
| 10016 | 3704 | 28 | |
| 9523 | 3705 | 28 | |
| 9026 | 3705 | 28 | |
| 8327 | -1 | 28 | |
| 7674 | -1 | 28 | |
| 7542 | -1 | 28 | |
| 7408 | 8 | 28 | |
| 6451 | 0 | 28 | |
| 4890 | -2 | 28 | |
| 4795 | -2 | 29 | |
| 4705 | -2 | 29 | |
| 4615 | -2 | 29 | |
| 4525 | 34 | 29 | |
| 3469 | 1 | 29 | |
| 3097 | 5 | 29 | |
| 2550 | 4 | 29 | |

# 7 Configuration

Click the “configuration” button in the upper panel to open the *Configuration* window (*Figure 35*) and change certain configuration parameters.

**Figure 35. Configuration window**




## 7.1 Timings

Default timings are optimized to guarantee safe operating conditions while minimizing execution speed.

*Unless there is something specific to check, it is NOT recommended to change timings.*

Timings are defined for both graphic operations (timing controlled by MCU firmware) or manual mode (timings controlled by the PC).

**Table 4. Timings**

| Parameter | Description |
|---|---|
| Start (ms) | Delay between load activation and first ADC measurements – this is basically in order to take into account both the supply & load loops settling time. |
| Off (ms) | This is the delay between two consecutive ADC measurements – the delay is smaller than Tstart given the fact the loops have already settled. |
| Next (ms) | Same as start, but for subsequent load activation. |
| Average Sample | Number of ADC averaging for both voltage and current measurements. |

## 7.2 Force SEA ground

By default, it is assumed the SEA01 ground is grounded by the power supply (not the 4-wire flat cable) so the box is un-checked. See *Section 4.5: Grounds for SEA01 ports#1 and #2* for further details.

## 7.3 Temperature

This parameter specifies the maximum heat sink temperature. Above this threshold, the system disables the load and prevents any new operation until the temperature decreases.

*Note: We strongly recommend leaving this setting unchanged.*

# 8 Troubleshooting

## 8.1 No LED activity is observed on the trimming board

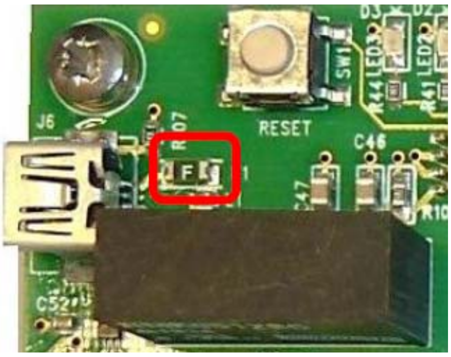
Usually, when the board is plugged onto the system:

- LED D1 lights up, indicating the MCU has booted and the power supply is present
- LED D4 then lights up, indicating the USB port has been enumerated correctly

If none of the above occurs, it may be due to power supply issue:

- Locate Fuse F1 (near the USB connector, see *Figure 36*) and check the voltage between J6 ground (shield) and the right side of the fuse - if it is not 5 V +/- 10%, an overcurrent has blown the fuse
- Before replacing the fuse (0.5 A), try to determine the root cause

**Figure 36. Fuse location**



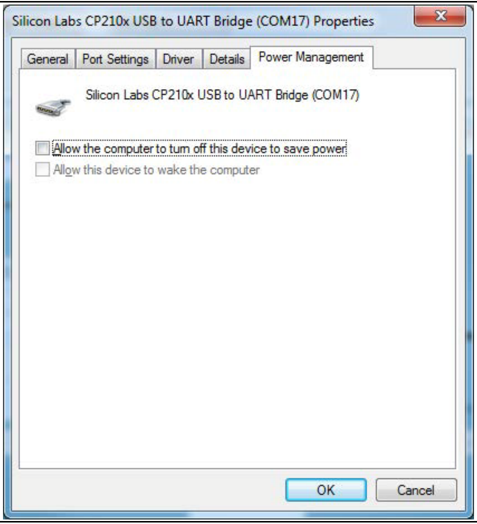

## 8.2 USB yellow LED turns off after 3 or 4 seconds

The yellow LED D4 is wired to the USB-suspend/ signal from CP2102, this means it only lights when the USB port is not in USB suspend mode.

By default, under Win7/Win8, the system forces external devices into suspend mode to save power, which is what happens when the COM port is not being used. It does not mean the power supply is shut down, just that the CP2102 has entered low power mode.

To avoid this, open Device Manager, select the SiLabs COM port, open the Power Management tab (see *Figure 37*) and un-check “allow the computer to turn off this device to save power”.

**Figure 37. Disabling USB suspend mode of CP2102**




## 8.3 Voltage measurement fluctuating when using isolated SEA Port#3

Despite it not being necessary with the STEVAL-ISA161V1, the user may want to use the SEA isolated port#3 (see *Chapter 4.4: Isolation*). It this condition, the user might observe unstable voltage measurements (roughly 100-mV fluctuations).

The reason is that, as Port#3 is isolated, the EMI AC currents aren't under control and this can damage high impedance/low voltage nodes, and especially the voltage measurements!

In order to avoid this, add a decoupling capacitor between GND_PRIM (the isolated ground from Port#3) and GND_STM (the ground of the microcontroller), as shown in *Figure 38*.

*Figure 39* shows an applied decoupling capacitor (4.7 nF 400 V X1Y1 is used).

**Figure 38. Closing AC currents between isolated domain and main domain**

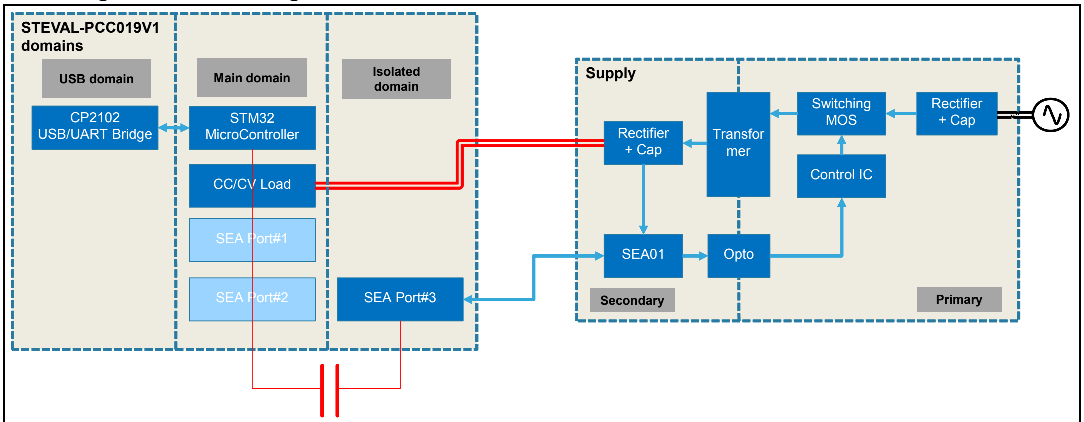
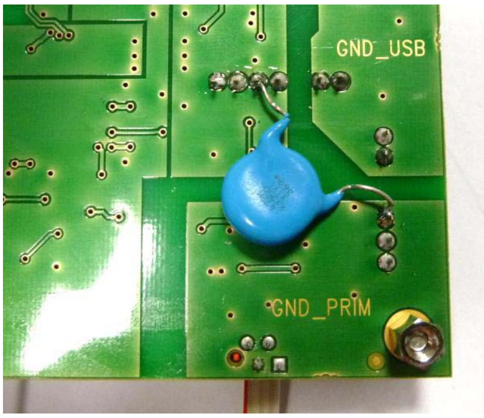


Figure 39. Detail of the Y cap implementation




## 8.4 Transient peak current when load is operating in CC mode on the STEVAL-ISA161V1

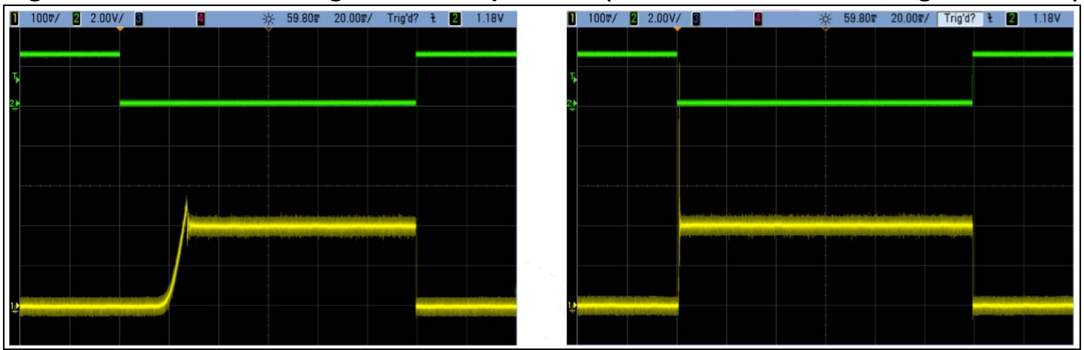
When the load is operating in CC mode (e.g., CV_target = 18 V and CC_lim = 2 A), the eLOAD will exhibit a small transient peak current of about 200 - 300 µs for a low CV target.

In some cases, the peak current can trip the OCP protection from the supply for a short duration.

This is due to the CC loop limiting the current by changing the feedback of the CV loop. This is absolutely not related to the SEA01 behavior.

Note: *Remember also that the current is burst as the on-board heatsink is very small and unable to sustain steady-state operation. To mitigate this, the load is constantly engaged/disengaged (like in PWMs).*

Figure 40. Transient during CC mode operation (CC= 2 A; left:CV=18 V; right CV=12 V)



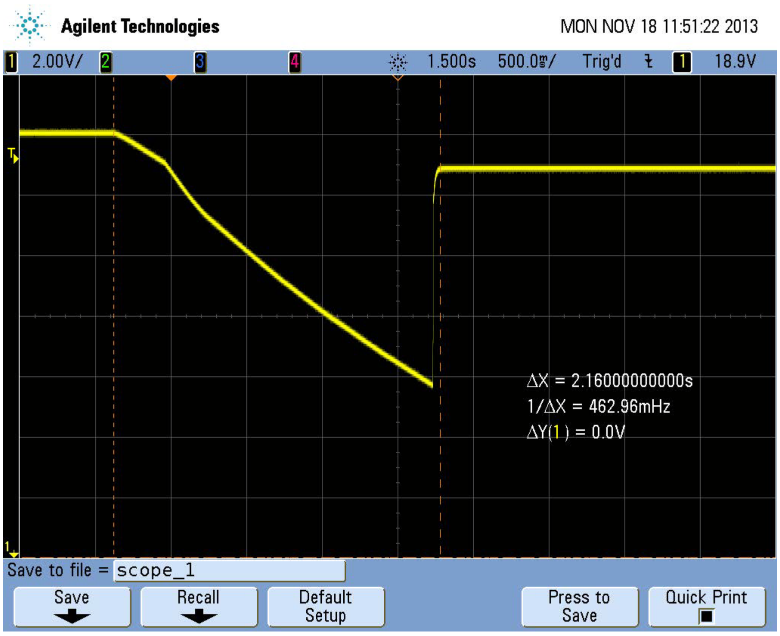
## 8.5 Supply enters protection mode during voltage trimming on the STEVAL-ISA161V1

If the user performs a large negative step for the voltage reference during manual trimming, the supply will go into protection mode for a small duration (typically 2.1 s at light load).

This is expected behavior, see *Figure 41*, where we switch from Vref=+3% to Vref=-3%: as the output voltage is higher than the target, the L6566B switching controller detects an OVP (overvoltage condition) and enters protection mode.

On the STEVAL-ISA161V1, the OVP is wired in auto-restart mode so the supply recover after approximately 2 seconds.

**Figure 41. Snapshot of supply going into OVP mode**




## 8.6 Supply sometimes produces clicking sounds on the STEVAL-ISA161V1

The STEVAL-ISA161V1 produces some audible clicks when it enters OCP (overcurrent protection) mode; the switching is abruptly stopped.

The supply is prone to entering OCP mode when the output voltage is too low; this is possible, for instance, in manual mode, when the load is operating in CV move with a voltage target that is too low:

- between 8 and 12 V – the supply produces audible clicks, but will resume operation
- below 8 V – the switching controller supply enters OCP as soon as the load is applied

In order to use the STEVAL-ISA161V1 under normal operating conditions, choose a CV voltage greater than 12 V.

## 8.7 Power supply continuously produces clicking sounds on the STEVAL-ISA161V1

If the STEVAL-ISA161V1 is continuously producing audible clicks, this normally signifies overcurrent protection mode.

If this occurs even when the load board is disconnected from the PC, it means the power NMOS has been damaged and presents a very low impedance (dead short) to the supply, usually when the temperature has breached the maximum rating.

Even though this should not happen, it can occur when the user deliberately removes the thermal protection of the system.

In this case, replace Q7 (STP160N75F3).

If user needs to operate at higher power for longer periods of time, bigger heat sinks (from Fischer Electronic) with compatible footprints are available through the distribution channel (Radiospare, Ref 203-583).

# 9 Board schematic

Figure 42. Power supply section

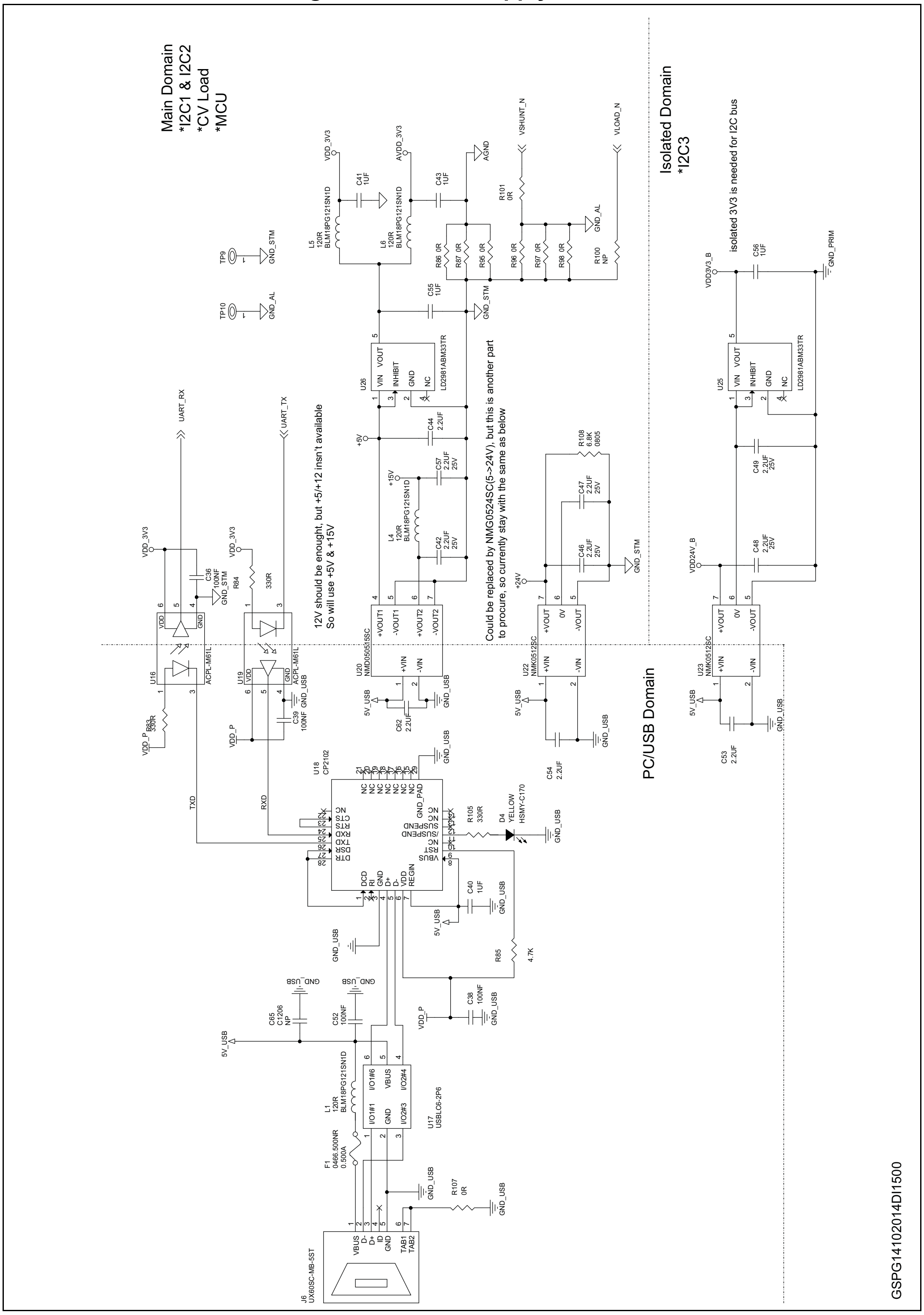
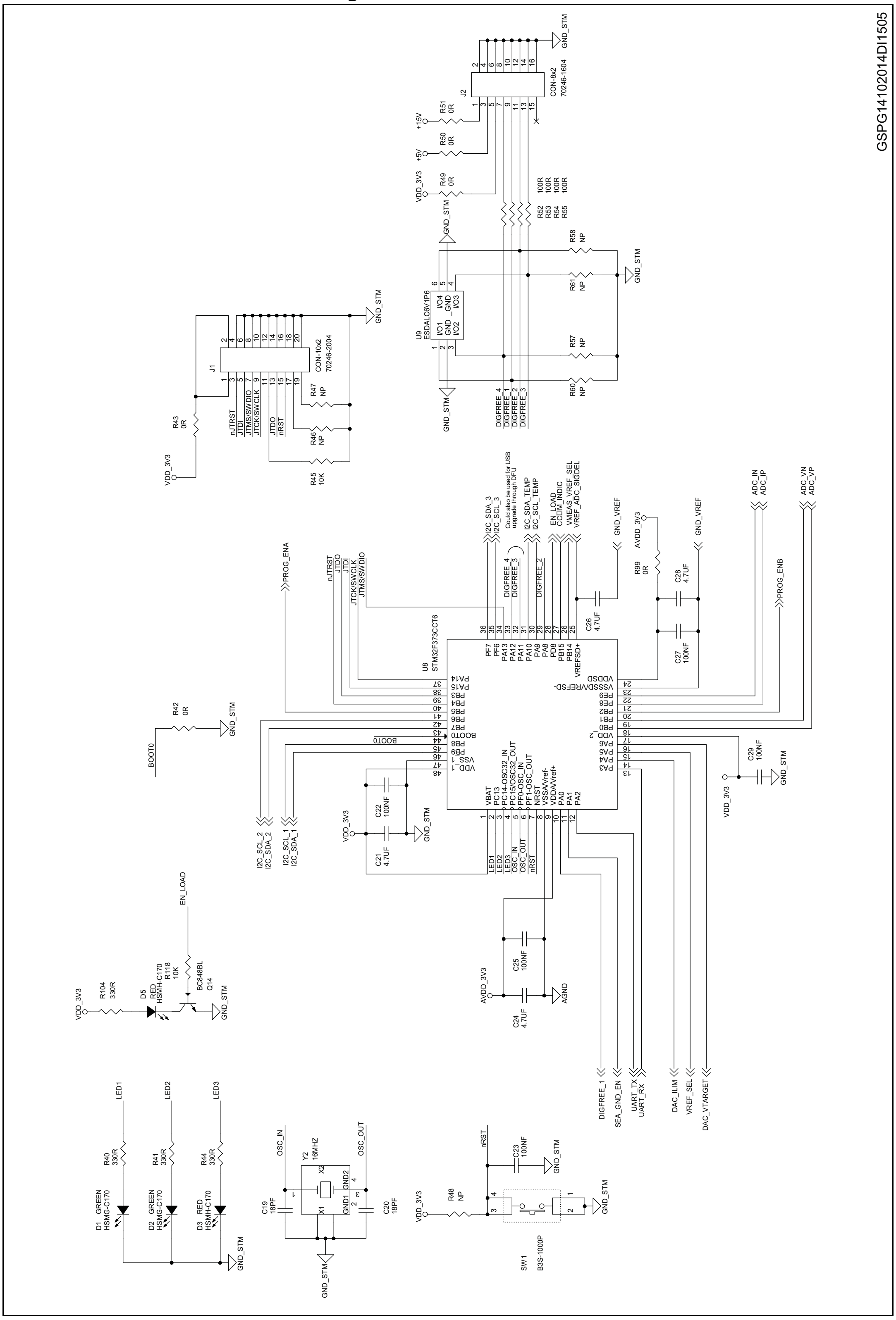
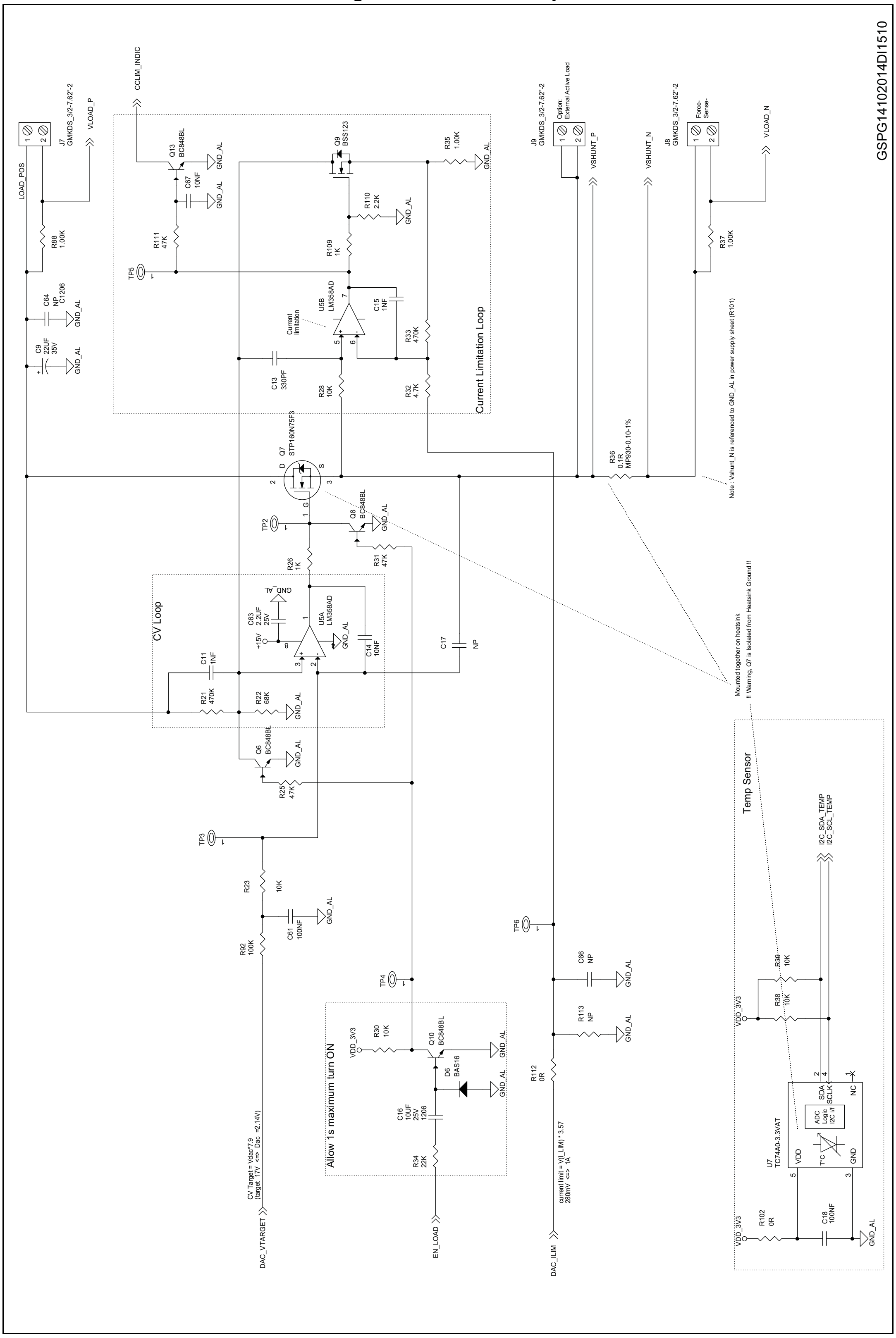


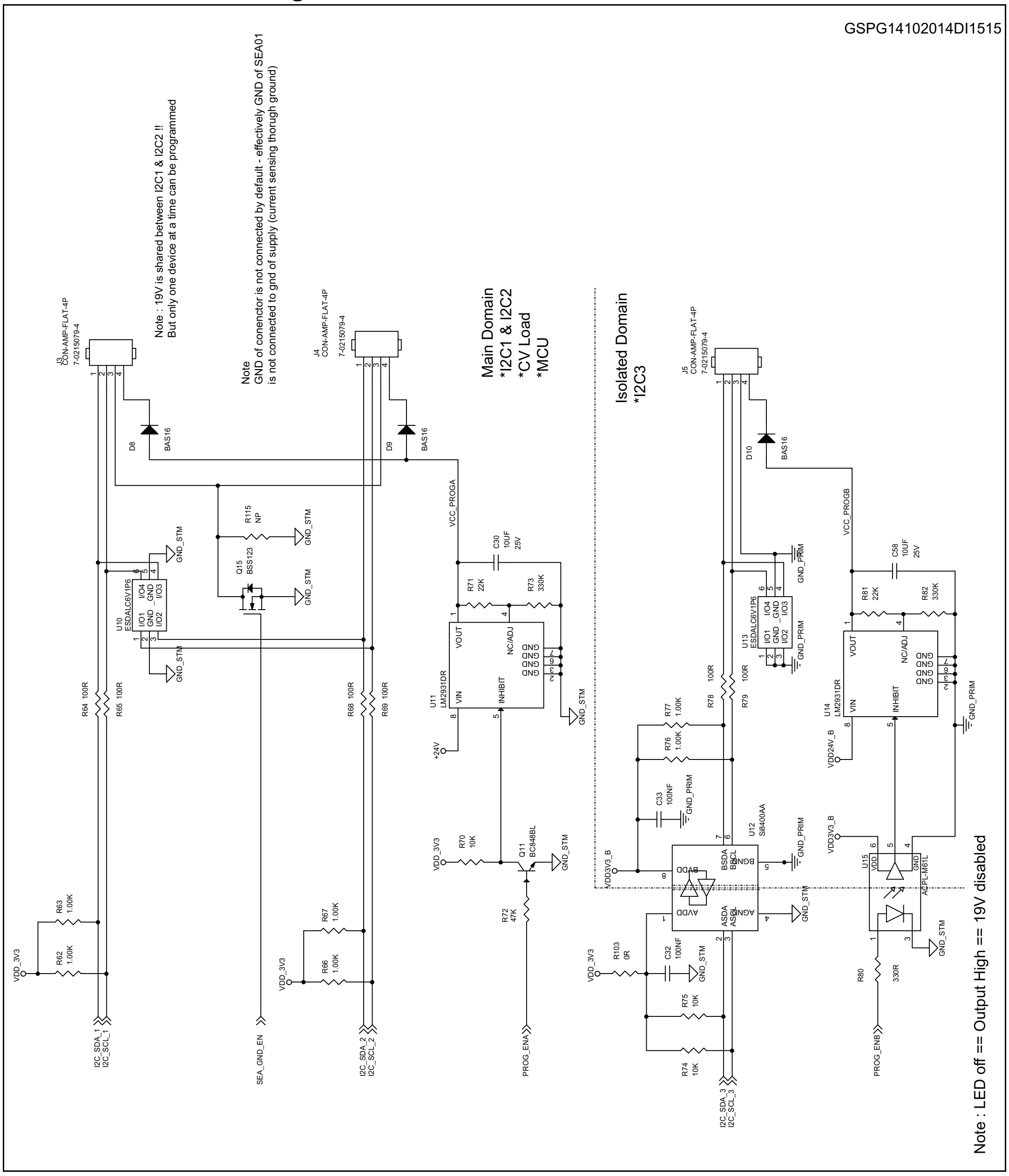
**Figure 43. MCU section**



## Figure 44. CC-CV loop



## Figure 45. SEA01 interface and isolation



### Figure 46. ADC reference and calibration

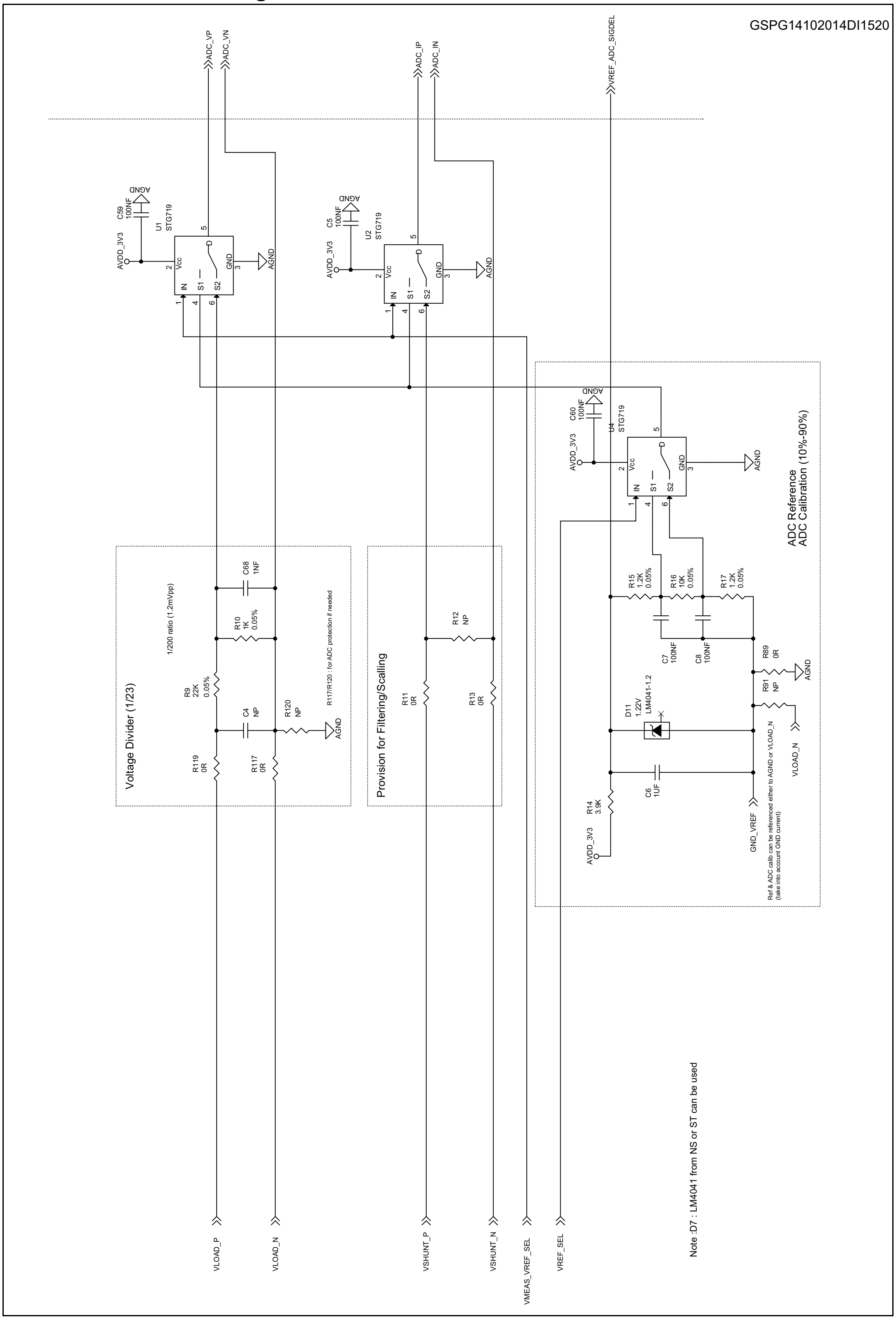
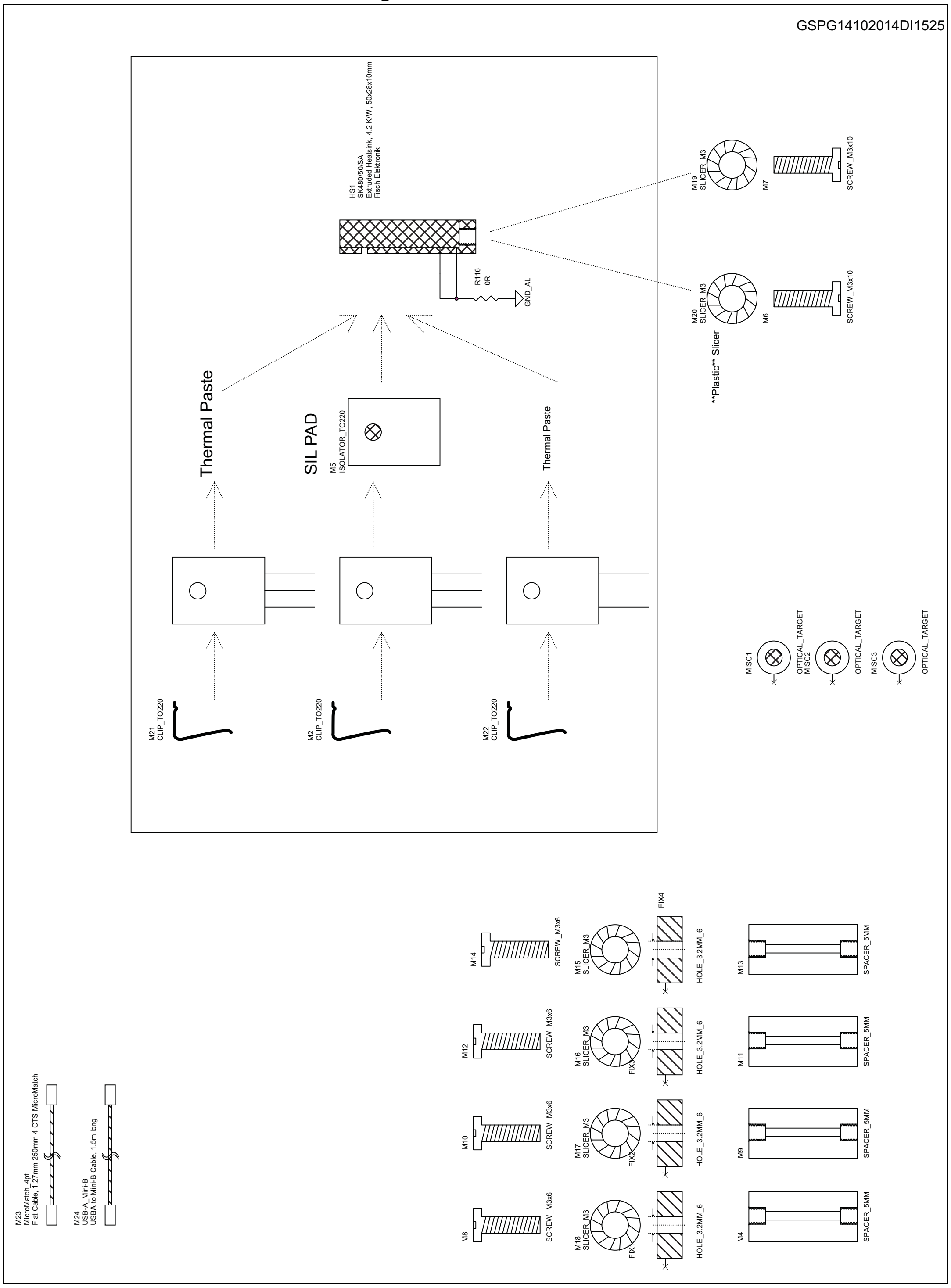


**Figure 47. Mechanics**



# 10 Board layout

**Figure 48. Top side (component side)**

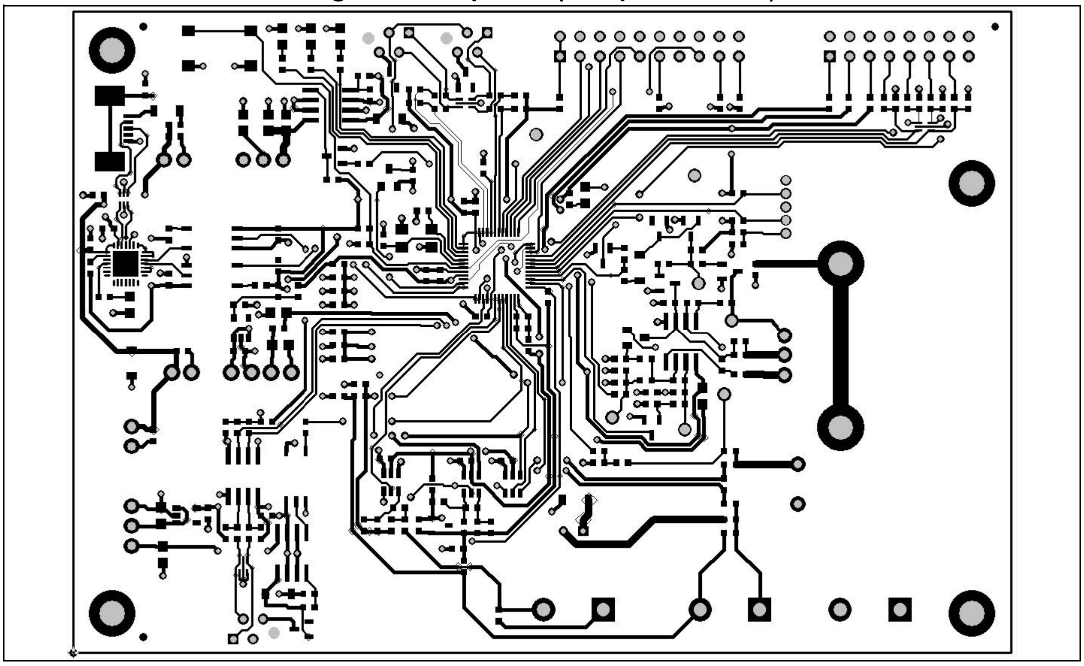


**Figure 49. Bottom side**

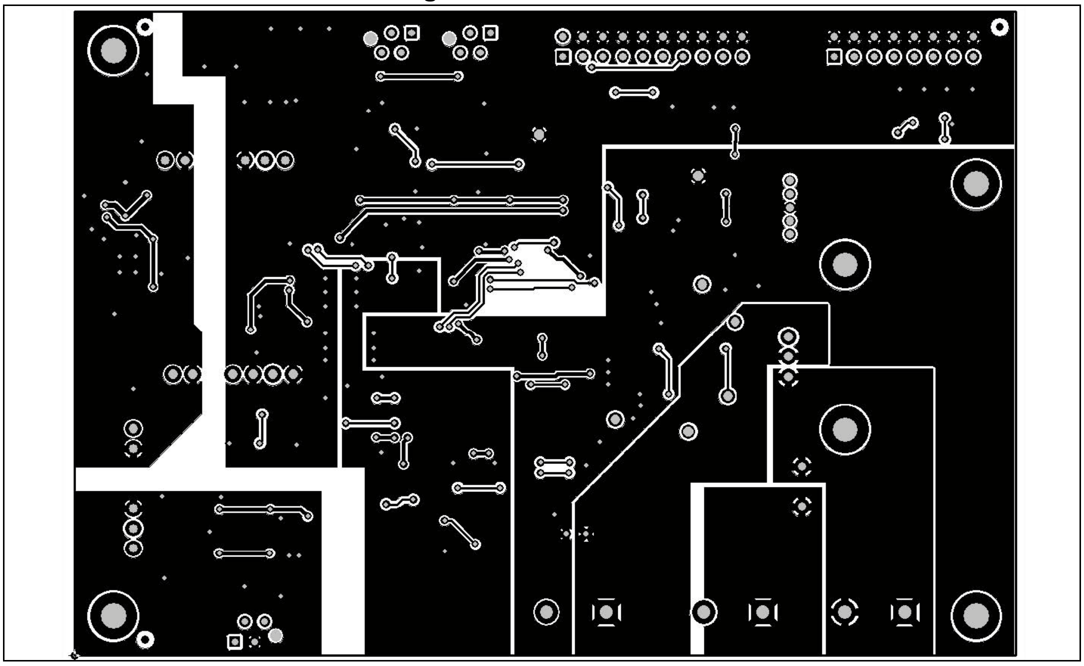
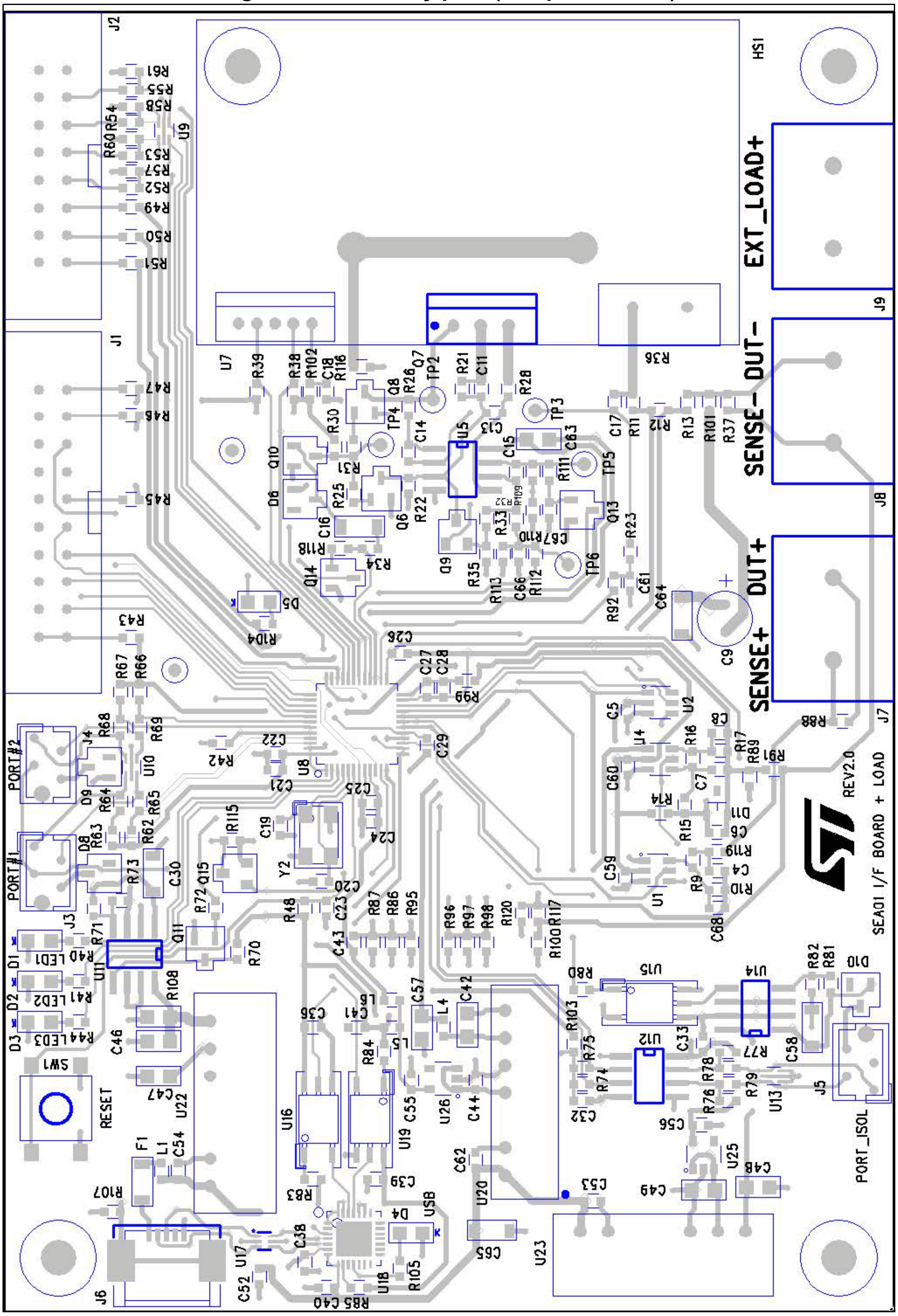


**Figure 50. Assembly plan (component side)**



# 11 Bill of material

**Table 5. Bill of material**

| Ref | Value | Description | Manufacturer |
|---|---|---|---|
| C4 | NP | CAP NP 0603 | |
| C5 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C6 | 1UF | CAP CER 1UF 16V X5R 0603 | TAIYO YUDEN |
| C7 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C8 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C9 | 22UF | CAP ELEC 22UF | Panasonic |
| C11 | 1NF | CAP CER 1nF 50V X7R 0603 | Murata |
| C13 | 330PF | CAP CER 330pF 50V X7R 0603 | |
| C14 | 10NF | CAP CER 10nF 25V X7R 0603 | AVX |
| C15 | 1NF | CAP CER 1nF 50V X7R 0603 | Murata |
| C16 | 10UF | CAP CER 10µF 25V X5R 1206 | Murata |
| C17 | NP | CAP NP 0603 | |
| C18 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C19 | 18PF | CAP CER 18pF 50V X7R 0603 | |
| C20 | 18PF | CAP CER 18pF 50V X7R 0603 | |
| C21 | 4.7UF | CAP CER 4.7UF 6V3 X5R 0603 | |
| C22 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C23 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C24 | 4.7UF | CAP CER 4.7UF 6V3 X5R 0603 | |
| C25 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C26 | 4.7UF | CAP CER 4.7UF 6V3 X5R 0603 | |
| C27 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C28 | 4.7UF | CAP CER 4.7UF 6V3 X5R 0603 | |
| C29 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C30 | 10UF | CAP CER 10µF 25V X5R 1206 | Murata |
| C32 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C33 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C36 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C38 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C39 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C40 | 1UF | CAP CER 1UF 16V X5R 0603 | TAIYO YUDEN |
| C41 | 1UF | CAP CER 1UF 16V X5R 0603 | TAIYO YUDEN |

**Table 5. Bill of material (continued)**

| Ref | Value | Description | Manufacturer |
|---|---|---|---|
| C42 | 2.2UF | CAP CER 2.2µF 25V | AVX |
| C43 | 1UF | CAP CER 1UF 16V X5R 0603 | TAIYO YUDEN |
| C44 | 2.2UF | CAP CER 2.2uF 6.3V X5R | TDK |
| C46 | 2.2UF | CAP CER 2.2µF 25V | AVX |
| C47 | 2.2UF | CAP CER 2.2µF 25V | AVX |
| C48 | 2.2UF | CAP CER 2.2µF 25V | AVX |
| C49 | 2.2UF | CAP CER 2.2µF 25V | AVX |
| C52 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C53 | 2.2UF | CAP CER 2.2uF 6.3V X5R | TDK |
| C54 | 2.2UF | CAP CER 2.2uF 6.3V X5R | TDK |
| C55 | 1UF | CAP CER 1UF 16V X5R 0603 | TAIYO YUDEN |
| C56 | 1UF | CAP CER 1UF 16V X5R 0603 | TAIYO YUDEN |
| C57 | 2.2UF | CAP CER 2.2µF 25V | AVX |
| C58 | 10UF | CAP CER 10µF 25V X5R 1206 | Murata |
| C59 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C60 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C61 | 100NF | CAP CER 100nF 50V X7R 0603 | Murata |
| C62 | 2.2UF | CAP CER 2.2uF 6.3V X5R | TDK |
| C63 | 2.2UF | CAP CER 2.2µF 25V | AVX |
| C64 | NP | CAP NP 1206 | |
| C65 | NP | CAP NP 1206 | |
| C66 | NP | CAP NP 0603 | |
| C67 | 10NF | CAP CER 10nF 25V X7R 0603 | AVX |
| C68 | 1NF | CAP CER 1nF 50V X7R 0603 | Murata |
| D1 | GREEN | LED Green - 0805 | Avago |
| D2 | GREEN | LED Green - 0805 | Avago |
| D3 | RED | LED Red - 0805 | Avago |
| D4 | YELLOW | LED Yellow - 0805 | Avago |
| D5 | RED | LED Red - 0805 | Avago |
| D6 | BAS16 | DIODE, SWITCHING, BAS16, 85V, 0.5A, 4nS, SOT23-3 | NXP |
| D8 | BAS16 | DIODE, SWITCHING, BAS16, 85V, 0.5A, 4nS, SOT23-3 | NXP |
| D9 | BAS16 | DIODE, SWITCHING, BAS16, 85V, 0.5A, 4nS, SOT23-3 | NXP |
| D10 | BAS16 | DIODE, SWITCHING, BAS16, 85V, 0.5A, 4nS, SOT23-3 | NXP |
| D11 | 1.22V | Precision MicroPower Shunt Voltage 1.22V 0.1% | NS |
| F1 | 0.500A | FUSE 0.500A 63V SLO 1206 SMD | Littelfuse |

Table 5. Bill of material (continued)

| Ref | Value | Description | Manufacturer |
|---|---|---|---|
| FIX1 | HOLE_3.2MM_6 | Through hole, drilled 3.2mm, Pad 6mm | |
| FIX2 | HOLE_3.2MM_6 | Through hole, drilled 3.2mm, Pad 6mm | |
| FIX3 | HOLE_3.2MM_6 | Through hole, drilled 3.2mm, Pad 6mm | |
| FIX4 | HOLE_3.2MM_6 | Through hole, drilled 3.2 mm, pad 6 mm | |
| HS1 | SK480/50/SA | Extruded heatsink, 4.2 K/W, 50x28x10mm | Fischer Elektronik |
| J1 | CON-10x2 | Conn 20p dual row, platted, 2.54mm vertical | Molex |
| J2 | CON-8x2 | Conn 16p dual row, platted, 2.54mm vertical | Molex |
| J3 | CON-AMP-FLAT-4P | Micromatch on-board connector, 4 ways | AMP/TE Connectivity |
| J4 | CON-AMP-FLAT-4P | Micromatch on-board connector, 4 ways | AMP/TE Connectivity |
| J5 | CON-AMP-FLAT-4P | Micromatch on-board connector, 4 ways | AMP/TE Connectivity |
| J6 | UX60SC-MB-5ST | Conn mini USB2.0 SMT | HIROSE |
| J7 | GMKDS_3/2-7.62"-2 | Connector, 2 way with screen, 7.62mm pitch | Phoenix Contact |
| J8 | GMKDS_3/2-7.62"-2 | Connector, 2 way with screen, 7.62mm pitch | Phoenix Contact |
| J9 | GMKDS_3/2-7.62"-2 | Connector, 2 way with screen, 7.62mm pitch | Phoenix Contact |
| L1 | 120R | Ferrite bead120 Ω 2 A 0603 | Murata |
| L4 | 120R | Ferrite bead120 Ω 2 A 0603 | Murata |
| L5 | 120R | Ferrite bead 120 Ω 2 A 0603 | Murata |
| L6 | 120R | Ferrite bead 120 Ω 2 A 0603 | Murata |
| M2 | CLIP_TO220 | Clip for TO220-TO247 heatsink | Fischer Elektronik |
| M4 | SPACER_5MM | Spacer M3, 5mm, female-female | Richco |
| M5 | ISOLATOR_TO220 | Heatsink electrical isolator, TO220, 0.18mm | Bergquist |
| M6 | SCREW_M3x10 | Screw, M3, 10mm, Cruciforme | RS |
| M7 | SCREW_M3x10 | Screw, M3, 10mm, Cruciforme | RS |
| M8 | SCREW_M3x6 | Screw, M3, 6mm, Cruciforme | RS |
| M9 | SPACER_5MM | SPACER M3, 5mm, Female-Female | Richco |
| M10 | SCREW_M3x6 | Screw, M3, 6mm, Cruciforme | RS |
| M11 | SPACER_5MM | SPACER M3, 5mm, Female-Female | Richco |
| M12 | SCREW_M3x6 | Screw, M3, 6mm, Cruciforme | RS |
| M13 | SPACER_5MM | SPACER M3, 5mm, Female-Female | Richco |
| M14 | SCREW_M3x6 | Screw, M3, 6mm, Cruciforme | RS |
| M15 | SLICER_M3 | Slicer, M3, with break | RS |
| M16 | SLICER_M3 | Slicer, M3, with Break | RS |
| M17 | SLICER_M3 | Slicer, M3, with Break | RS |

**Table 5. Bill of material (continued)**

| Ref | Value | Description | Manufacturer |
|---|---|---|---|
| M18 | SLICER_M3 | Slicer, M3, with Break | RS |
| M19 | SLICER_M3 | Slicer, M3, with Break | RS |
| M20 | SLICER_M3 | Slicer, M3, with Break | RS |
| M21 | CLIP_TO220 | Clip for TO220-TO247 heatsink | Fischer Elektronik |
| M22 | CLIP_TO220 | Clip for TO220-TO247 heatsink | Fischer Elektronik |
| M23 | MicroMatch_4pt | Flat cable, 1.27 mm 250 mm 4 CTS Micromatch | TE Connectivity |
| M24 | USB-A_Mini-B | USBA to Mini-B Cable, 1.5m long | |
| MISC 1 | OPTICAL_TARGET | Optical_target | |
| MISC 2 | OPTICAL_TARGET | Optical_target | |
| MISC 3 | OPTICAL_TARGET | Optical_target | |
| Q6 | BC848BL | XSTR,GEN PURP,NPN,30V,100mA,300mW,SOT-23 | ON Semiconductor |
| Q7 | STP160N75F3 | NMOS, 75V/120A, TO220 | STMicroelectronics |
| Q8 | BC848BL | XSTR,GEN PURP,NPN,30V,100mA,300mW,SOT-23 | ON Semiconductor |
| Q9 | BSS123 | NMOS, 100V/0.17A, SOT23 | DiodesZetex |
| Q10 | BC848BL | XSTR,GEN PURP,NPN,30V,100mA,300mW,SOT-23 | ON Semiconductor |
| Q11 | BC848BL | XSTR,GEN PURP,NPN,30V,100mA,300mW,SOT-23 | ON Semiconductor |
| Q13 | BC848BL | XSTR,GEN PURP,NPN,30V,100mA,300mW,SOT-23 | ON Semiconductor |
| Q14 | BC848BL | XSTR,GEN PURP,NPN,30V,100mA,300mW,SOT-23 | ON Semiconductor |
| Q15 | BSS123 | NMOS, 100V/0.17A, SOT23 | DiodesZetex |
| R9 | 22K | RES 22K Ω 1/10W 0.05% 0603 SMD | Panasonic corp |
| R10 | 1K | RES 1K Ω 1/10W 0.05% 0603 SMD | Panasonic corp |
| R11 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R12 | NP | RES NP 0603 | |
| R13 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R14 | 3.9K | 3.9K Ω 5% 0603 SMD | |
| R15 | 1.2K | RES 1.2K Ω 1/10W 0.05% 0603 SMD | Panasonic corp |
| R16 | 10K | RES 10K Ω 1/10W 0.05% 0603 SMD | Panasonic corp |
| R17 | 1.2K | RES 1.2K Ω 1/10W 0.05% 0603 SMD | Panasonic corp |
| R21 | 470K | RES 470K Ω 5% 0603 | |
| R22 | 68K | RES 68K Ω 1/10W 5% 0603 SMD | Panasonic corp |
| R23 | 10K | RES 10K Ω 5% 1/10W 0603 SMD | |
| R25 | 47K | 47K Ω 5% 1/10W | |
| R26 | 1K | 1K Ω 5% 1/10W | Panasonic corp |

Table 5. Bill of material (continued)

| Ref | Value | Description | Manufacturer |
|---|---|---|---|
| R28 | 10K | 10K Ω 5% 1/10W | Panasonic corp |
| R30 | 10K | 10K Ω 5% 1/10W | Panasonic corp |
| R31 | 47K | 47K Ω 5% 1/10W | |
| R32 | 4.7K | RES 4.7K Ω 5% 1/10W 0603 SMD | |
| R33 | 470K | RES 470K Ω 5% 0603 | |
| R34 | 22K | 22K Ω 5% 1/10W | Panasonic corp |
| R35 | 1.00K | Resistor, 1.00K Ω 1/10W 1% 0603 SMD | Panasonic corp |
| R36 | 0.1R | RES 0.1 Ω 1% 30W | CADDOCK |
| R37 | 1.00K | Resistor, Ω1.00K Ω 1/10W 1% 0603 SMD | Panasonic corp |
| R38 | 10K | 10K Ω 5% 1/10W | Panasonic corp |
| R39 | 10K | 10K Ω 5% 1/10W | Panasonic corp |
| R40 | 330R | 330R Ω 5% 1/10W | |
| R41 | 330R | 330R Ω 5% 1/10W | |
| R42 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R43 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R44 | 330R | 330R Ω 5% 1/10W | |
| R45 | 10K | 10K Ω 5% 1/10W | Panasonic corp |
| R46 | NP | RES NP 0603 | |
| R47 | NP | RES NP 0603 | |
| R48 | NP | RES NP 0603 | |
| R49 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R50 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R51 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R52 | 100R | 100 Ω 5% 1/10W | Panasonic corp |
| R53 | 100R | 100 Ω 5% 1/10W | Panasonic corp |
| R54 | 100R | 100 Ω 5% 1/10W | Panasonic corp |
| R55 | 100R | 100 Ω 5% 1/10W | Panasonic corp |
| R57 | NP | RES NP 0603 | |
| R58 | NP | RES NP 0603 | |
| R60 | NP | RES NP 0603 | |
| R61 | NP | RES NP 0603 | |
| R62 | 1.00K | Resistor, 1.00K Ω 1/10W 1% 0603 SMD | Panasonic corp |
| R63 | 1.00K | Resistor, 1.00K Ω 1/10W 1% 0603 SMD | Panasonic corp |
| R64 | 100R | 100 Ω 5% 1/10W | Panasonic corp |
| R65 | 100R | 100 Ω 5% 1/10W | Panasonic corp |

Table 5. Bill of material (continued)

| Ref | Value | Description | Manufacturer |
|---|---|---|---|
| R66 | 1.00K | Resistor, 1.00K Ω 1/10W 1% 0603 SMD | Panasonic corp |
| R67 | 1.00K | Resistor, 1.00K Ω 1/10W 1% 0603 SMD | Panasonic corp |
| R68 | 100R | 100 Ω 5% 1/10W | Panasonic corp |
| R69 | 100R | 100 Ω 5% 1/10W | Panasonic corp |
| R70 | 10K | 10K Ω 5% 1/10W | Panasonic corp |
| R71 | 22K | 22K Ω 1% 1/10W | Panasonic corp |
| R72 | 47K | 47K Ω 5% 1/10W | |
| R73 | 330K | 330K Ω 5% 0603 SMD | |
| R74 | 10K | 10K Ω 5% 1/10W | Panasonic corp |
| R75 | 10K | 10K Ω 5% 1/10W | Panasonic corp |
| R76 | 1.00K | Resistor, 1.00K Ω 1/10W 1% 0603 SMD | Panasonic corp |
| R77 | 1.00K | Resistor, 1.00K Ω 1/10W 1% 0603 SMD | Panasonic corp |
| R78 | 100R | 100 Ω 5% 1/10W | Panasonic corp |
| R79 | 100R | 100 Ω 5% 1/10W | Panasonic corp |
| R80 | 330R | 330R Ω 5% 1/10W | |
| R81 | 22K | 22K Ω 1% 1/10W | Panasonic corp |
| R82 | 330K | 330K Ω 5% 0603 SMD | |
| R83 | 330R | 330R Ω 5% 1/10W | |
| R84 | 330R | 330R Ω 5% 1/10W | |
| R85 | 4.7K | RES 4.7K Ω 5% 1/10W 0603 SMD | |
| R86 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R87 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R88 | 1.00K | RESISTOR, 1.00K Ω 1/10W 1% 0603 SMD | Panasonic corp |
| R89 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R91 | NP | RES NP 0603 | |
| R92 | 100K | 100K Ω 5% 1/10W | Panasonic corp |
| R95 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R96 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R97 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R98 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R99 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R100 | NP | RES NP 0603 | |
| R101 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R102 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R103 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |

Table 5. Bill of material (continued)

| Ref | Value | Description | Manufacturer |
|---|---|---|---|
| R104 | 330R | 330R Ω 5% 1/10W | |
| R105 | 330R | 330R Ω 5% 1/10W | |
| R107 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R108 | 6.8K | RESISTOR, 6.8K 1/8W 5% 0 805 SMD | |
| R109 | 1K | RES 1K Ω 5% 1/10W 0603 SMD | |
| R110 | 2.2K | RES 2.2KΩ 1/10W 5% 0603 SMD | |
| R111 | 47K | 47K Ω 5% 1/10W | |
| R112 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R113 | NP | RES NP 0603 | |
| R115 | NP | RES NP 0603 | |
| R116 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R117 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R118 | 10K | 10K Ω 5% 1/10W | Panasonic corp |
| R119 | 0R | 0.0 Ω 5% 1/10W 0603 | YAGEO |
| R120 | NP | RES NP 0603 | |
| SW1 | B3S-1000P | SMT Tactile Switch | OMRON |
| TP2 | TP | Point Test TPTH-ANELLO-1MM | |
| TP3 | TP | Point Test TPTH-ANELLO-1MM | |
| TP4 | TP | Point Test TPTH-ANELLO-1MM | |
| TP5 | TP | Point Test TPTH-ANELLO-1MM | |
| TP6 | TP | Point Test TPTH-ANELLO-1MM | |
| TP9 | TP | Point Test TPTH-ANELLO-1MM | |
| TP10 | TP | Point Test TPTH-ANELLO-1MM | |
| U1 | STG719 | IC,ANLG SW,SPDT,6 PIN,SOT-23 | STMicroelectronics |
| U2 | STG719 | IC,ANLG SW,SPDT,6 PIN,SOT-23 | STMicroelectronics |
| U4 | STG719 | IC,ANLG SW,SPDT,6 PIN,SOT-23 | STMicroelectronics |
| U7 | TC74A0-3.3VAT | Temp Senor, $I^2C$, -40/+125°C, 3V3 | MICROCHIP |
| U8 | STM32F373CCT6 | IC, MCU, RISC, 72 MHz, 256KB/32KB, TQFP-48 | STMicroelectronics |
| U9 | ESDALC6V1P6 | Quad TVS 3V | |
| U10 | ESDALC6V1P6 | Quad TVS 3V | |
| U11 | LM2931DR | IC,VOLT REG,ADJ,100MA,8 PIN,SOIC | STMicroelectronics |
| U12 | Si8400AA | $I^2C$ Silicon IC Isolator, 1kV, 1.7MHz, SO8 | Silicon Laboratories |
| U13 | ESDALC6V1P6 | Quad TVS 3V | |
| U14 | LM2931DR | IC,VOLT REG,ADJ,100MA,8 PIN,SOIC | STMicroelectronics |
| U15 | ACPL-M61L | 1ch Optocoupler, CMOS output, Low Power SO-5 | Avago |

Table 5. Bill of material (continued)

| Ref | Value | Description | Manufacturer |
|---|---|---|---|
| U16 | ACPL-M61L | 1ch Optocoupler, CMOS output, Low Power SO-5 | Avago |
| U17 | USBLC6-2P6 | USBLC6-2P6 - RESEAU DE DIODE TVS USB2 | STMicroelectronics |
| U18 | CP2102 | UART over USB bridge, QFN28 | Silicon Labs |
| U19 | ACPL-M61L | 1ch Optocoupler, CMOS output, Low Power SO-5 | Avago |
| U20 | NMD050515SC | Isolated Dual Output DCDC (5V->+5 & +15V) | Murata |
| U22 | NMK0512SC | Isolated Dual Output DCDC (5V->+12 & -12V) | Murata |
| U23 | NMK0512SC | Isolated Dual Output DCDC (5V->+12 & -12V) | Murata |
| U25 | LD2981ABM33TR | IC,VOLT REG,3.3V,100MA,5 PIN,SOT-23 | STMicroelectronics |
| U26 | LD2981ABM33TR | IC,VOLT REG,3.3V,100MA,5 PIN,SOT-23 | STMicroelectronics |
| U5 | LM358AD | Dual op amp, 1.1MHz, rail-to-rail, SO8 | STMicroelectronics |
| Y2 | 16MHZ | XTAL,16MHZ,30PPM,10PF,5x3.2 | FOX Electronics |

# 12 References

1. SEA01 - Constant voltage and current controller with online digital trimming”
http://www.st.com/web/catalog/sense_power/FM142/CL1454/SC276/PF255674
2. “L6566B - Multi-mode controller for SMPS”
http://www.st.com/web/catalog/sense_power/FM142/CL1454/SC352/PF185802

# 13 Revision history

**Table 6. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 29-Oct-2014 | 1 | Initial release. |

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