100W Power Delivery Sink with RUTDevKit

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***Abstract* — USB Type-C connector together with USB Power Delivery Specification enables us to consume and deliver power at much higher rates than its predecessors USB Type-A, USB Type-B. To take advantage of this technology the device must be compliant with USB PD specification. STMicroelectronics STM32L562 MCUs are fully compatible with USB PD specification therefore power delivery sink role example is described in this application note.**

Index Terms* — *Microcontroller (MCU), Universal Serial Bus Power Delivery (USB PD), Analog-Digital Converter – (ADC), Power Data Object – (PDO), Request Data Object – (RDO), Application Programming Interface – (API).

I. Introduction

The Power Delivery Sink solution is based on STMicroelectronics MCU STM32L562 and USB PD firmware stack which is integrated into STM32Cube already. The firmware example is also available for the RUTDevKit development platform, which is written with IAR Embedded Workbench IDE.

II. Hardware

The RUTDevKit development platform is equipped with a USB Type-C connector and stand-alone protector TCPP01-M12 which protects from ESD and overvoltage events. The TCPP01-M12 drives two MOSFETs connecting the load and the source. If a fault is detected, the source and load are isolated from both sides. This solution has the advantage that the source will never be back-powered from the load side. The disadvantage is that the circuit has higher series resistance therefore higher power losses (Fig. 2).

The STM32L562 MCU can communicate with any device connected to the USB-C via dedicated pins CC1 and CC2. The voltage on the USB-C power line is monitored using the microcontroller's ADC which is fed through a voltage divider and low-pass filter.

The USB Type-C power and data lines are additionally protected with TVS and ESD devices: ESDA25P35-1U1M and USBULC6-2M6 accordingly.

In case of fatal failures, the high inrush current chip fuse is used: CC12H5A-TR.

III. Firmware

The main goal of the RUTDevKit firmware example is to select the PDO provided by the source which has the highest voltage and applies it to the sink output.

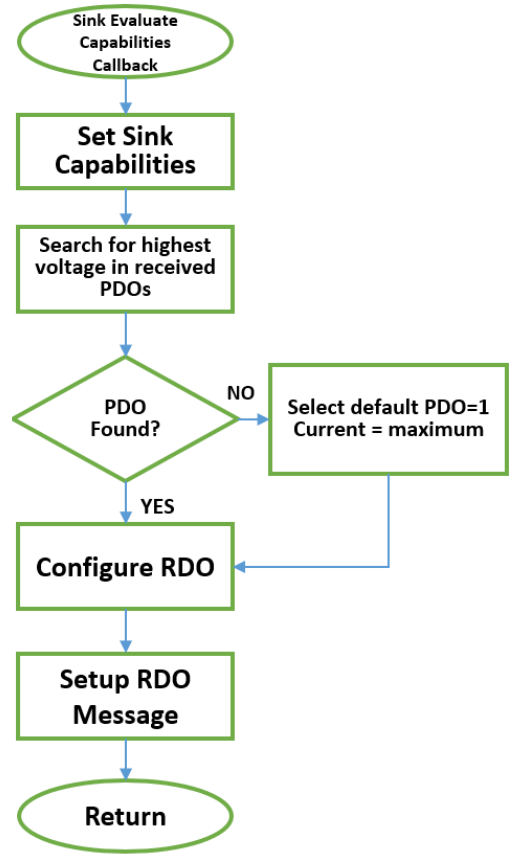

Fig. 1 Sink Evaluate Capabilities Callback algorithm.

The USB PD stack and API for STM32L5 are provided and well documented by STMicroelectronics.

The main part of the firmware where source device capabilities are analyzed and finally power profile is requested is located in "usbpd_dpm_user.c" file. The USB PD stack's callback function "USBPD_DPM_SNK_EvaluateCapabilities" (Fig. 1) is used to set up the board's power capabilities in the sink role, evaluate if it meets the requirements, and applies for the desired PDO from the power source attached.

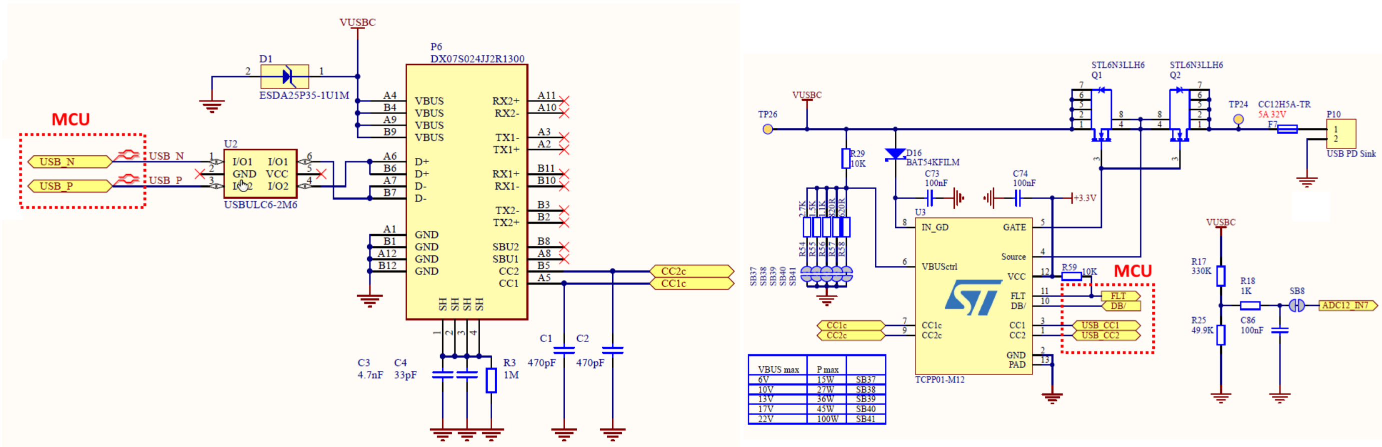

Fig. 2 USB PD Connector & Protection Schematics.

IV. SOFTWARE

The firmware example was initially generated using STM32CubeMX software (Version 5.6.1). The IAR Embedded Workbench IDE was chosen for the example's development. To monitor debug messages and other information generated by the firmware example, the STM32CubeMonitor-UCPD software has to be used ('TRACES' monitoring function only). The RUTDevKit is not recognized by the STM32CubeMonitor-UCPD software at the moment.

V. TEST RESULTS

To load the sink output fully, the 4R 100W resistor was attached. The environment temperature 25C° (Fig. 7).

The RUTDevKit's temperature was monitored using a thermal imaging device. The voltage drop on the resistor was 20.1V and the current flow through the resistor was 4.91A. The hottest parts on the board appeared to be MOSFETs. If no cooling was applied, the temperature rose to more than 133 C° in two minutes and still kept rising (Fig. 3).

Fig. 3 No cooling, 20.1V 4.91A.

The small fan without a heatsink was used to cool the whole board. The temperature settled at 113C° after 5 minutes of operation (Fig. 4, Fig. 5).

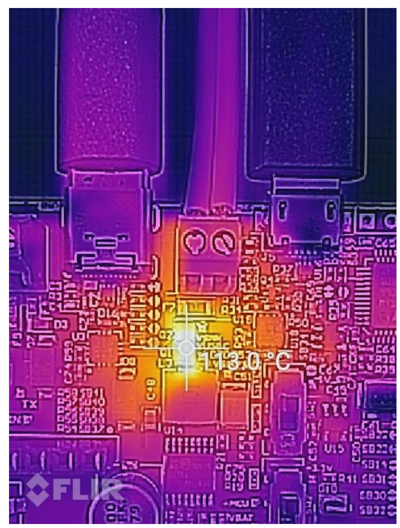

Fig. 4 Active cooling, 20.1V 4.91A.

Fig. 5 Active cooling while the USB PD circuit is fully loaded.

If the power profile with 19V output was selected the temperature settled at 105C° after 5 minutes of operation (Fig. 6).

Fig. 6 No cooling, 18.37V 4.43A.

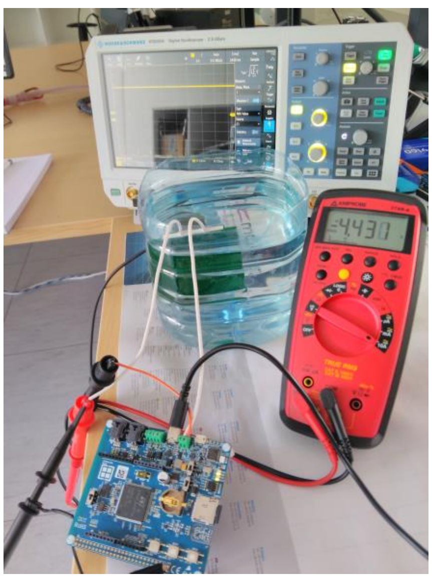

Fig. 7 RUTDevKit USBPD Test Setup.

Finally, the 15V output was enabled. The temperature was 73.8C° after 5 minutes of operation (Fig. 8).

Fig. 8 No cooling, 14.87V 3.7A.

Power supply: “i-tec CHARGER-C112W”.
Thermal Imaging Device used: “CAT S60 (FLIR sensor)”.
Resistor: “ARCOL LPR100 4R J”

VI. Summary

The RUTDevKit Rev2 is capable of delivering the 5A of current continuously if active cooling without heatsink is used. If no cooling is used the 4.4A could be delivered to the load, but in case of high-reliability requirements, only 3.7A is recommended using RUTDevKit’s hardware configuration.

References

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