December 2019

SMART POWER MANAGEMENT ON MULTI-UNIT USB POWER DELIVERY CHARGERS

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Smart Power Management on Multi-unit USB Power Delivery Chargers

Abstract

Multi-unit USB power delivery chargers allow multiple notebooks/devices to charge simultaneously from a single charging station through USB power delivery over USB Type-C ports. Such chargers are powered from a fixed capacity power supply and are responsible for charging multiple units of varying power requirements. The technique described below enables the multi-unit charger to regulate charging capabilities of different ports and implement a scheme that allows maximum number of notebooks to charge in a given time with a fixed power supply.

Problem Statement

A multi-unit USB power delivery charger is powered from a fixed capacity power adapter. The conventional approach is to distribute available power equally to all ports. This approach does not consider the charging requirements of connected devices and results in inefficient distribution of power. This could prevent some of the devices from charging even when the total available power is more than the sum of required power from all connected devices.

Proposed Solution

This disclosure proposes to include a micro controller (uC) in each multi-unit charger along with a traditional USB PD controller. The uC in the charger communicates with USB PD controller(s) over an I2C interface. The USB PD controllers are responsible for regulating the output power through one or more type-C ports based on policies dictated by uC in the charger. The USB PD controllers on charger communicate with PD controllers on connected notebooks/devices through standard type-C PD interface to negotiate a contract and deliver power.

The PD controllers on notebook/devices communicate the charge requirements to PD controller on charger via standard USB power delivery messages. The uC in charger can read these requirements from its PD controller over an I2C connection and identify the charge requirements of each connected unit. In addition, the Embedded Controller (EC) in each connected notebook/device can communicate real time battery charging requirements and status to uC in the PD charger through any one of the following methods.

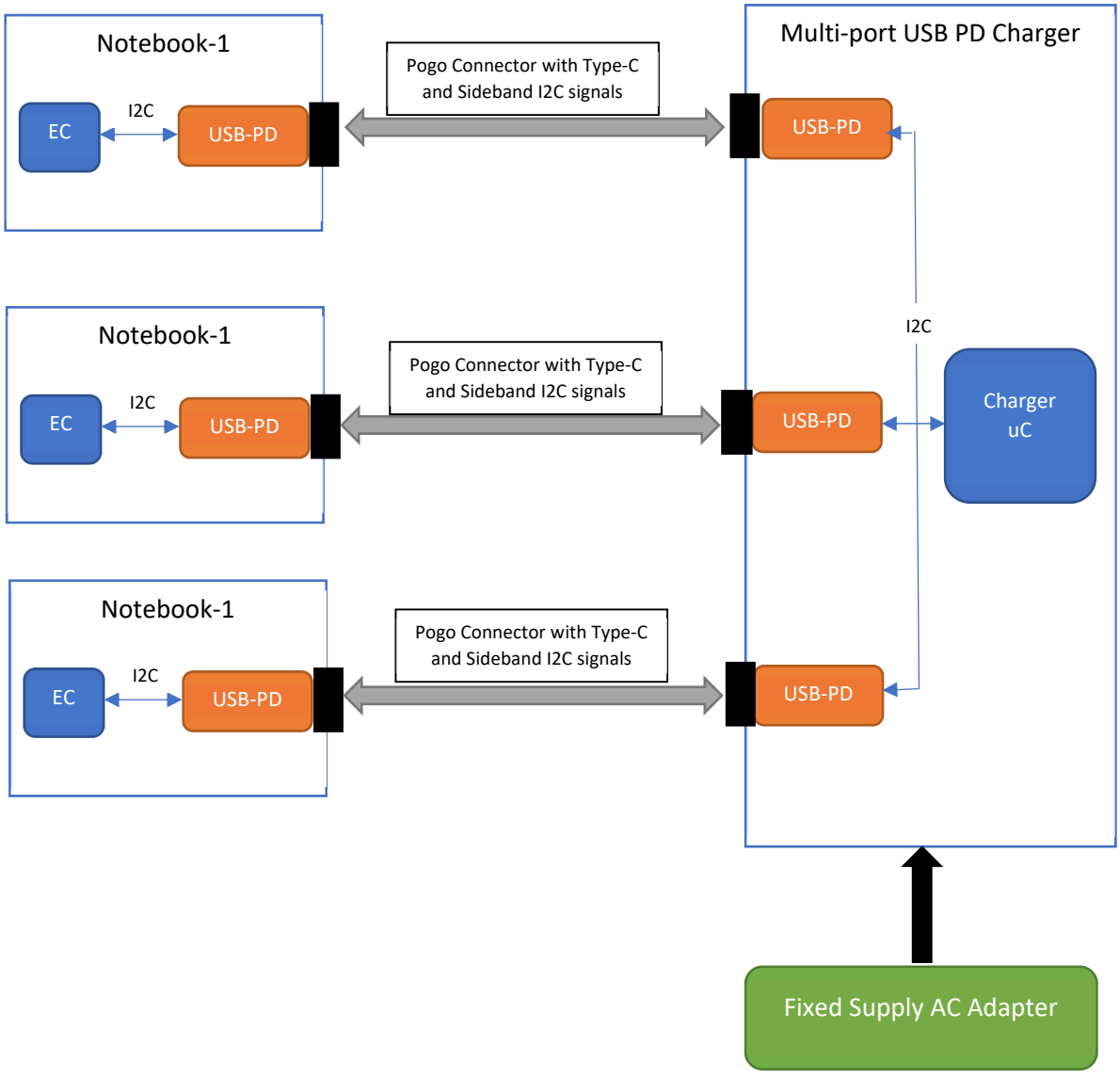
1. Sideband communication packets between EC in notebook and uC in charger - This is achieved through a customized connector used in multi-unit chargers which incorporate sideband signals for I2C connection along with standard USB Type-C signals.
2. Custom Alternate Mode VDMs between PD controllers on each end.
3. Standard PD3.0 Alert and Status messages (if both notebook/device and charger support Power Delivery Version 3.0 or higher)

The EC in notebook can communicate following states for each battery in the system

1. Battery absent
2. Battery present and charging
3. Battery present and not-charging
4. Battery requests charging

The uC in charger receives battery charging status messages indirectly through PD controllers or directly from EC in notebooks over I2C. Based on the battery charging status, the uC can reprogram the capabilities of individual USB power delivery ports to redistribute the available power for maximum utilization. Further intelligence can be added to uC in charger to ensure that maximum number of notebooks reach a sufficiently high level of charge (more than 50%) in minimum possible time. This can be achieved by reading the present capacity of each battery and adjusting the profile of each port on charger so that maximum number of batteries are charged above 50% in minimum amount of time.

The following figure describes an example system with this approach.



Example Scenario

A charger with 3 ports and an input power supply of 150W can safely advertise 45W(15V@3A) on each of its ports. 2 notebooks each requiring a minimum of 45W to charge are plugged into ports 1 and 2 of charger. A 3rd notebook which requires a minimum of 65W to charge is plugged into port 3. With equal distribution of power to each port, the 3rd notebook would not be able to charge from the multi-unit charger.

With the implementation of proposed disclosure, EC in notebook 1 or 2 can communicate battery charging status to uC in the charger. When batteries in notebook 1 or 2 no longer need charge, the uC in charger can reduce the offered power on ports 1 or 2 and increase the offering on port 3 to meet the 65W(15V@4.33A) requirement. This allows notebook in port3 to charge. Over a period, all 3 notebooks would reach their full charge capacity.

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