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I2C BASED SECURITY INK SUPPLY SMART-CHIP RECOGNITION

HP INC

I2C Based Security Ink Supply Smart-Chip recognition

Abstract:

In Thermal Ink printers, Ink supplies include a security chip to properly identify the supplies and control the remaining ink quantity. This security smart chip is owned by each brand and optimized to ensure the robustness in front hacker attacks and counterfeiting.

Smart-chip communication with the host printer uses I2C serial bus protocol which is a wide spread industry standard. HP latest device revision includes new functionality beyond the I2C protocol which helps the printer in trying to recognize if the smart-chip is original. The printer sends a command to the smart-chip, which in response pulls down the I2C data line during a certain time; an HP original chip is expected to respond precisely, meeting the time interval.

Enabling the ability of doing time measurements on the I2C data line typically requires extra Hardware resources and the redesign of the existing electronics. Such modification takes time to design and complete the validation of the new hardware and can lead to cost increments.

The implementation presented enables the capacity to send the I2C commands, check if the smart-chip pulls down the data line and the certain time measurement only with the I2C serial bus dedicated pins. Not adding more resources and without changing the PCA design.

Background:

As mentioned earlier, the communications from the printer to the smart-chip are implemented over I2C protocol. In a typical printer architecture, the smart-chips from the supplies are connected to the host (main CPU in the printer) through a μController. In this architecture, the host leads all the high-level workflow of the conversation with the supplies while the μController acts as a bridge translating the communications into I2C.

I2C protocol uses two transmission lines: Data (also named SDA) and Clock (also named SCL). Each line is connected to a port (a pin of the electronic circuit) of each of the devices connected. The configuration of the I2C ports is specific to perform the signalling required by the I2C communication and, therefore, time measurements of an electrical voltage pulse over a transmission line cannot be easily achieved by this electrical configuration.

Description:

Checking this time usually requires an extra μController port dedicated and configured as an input. There are many options to implement this feature but depending on the availability of resources in the current design, this extra port can translate into trade-offs or even additional ICs on board. This solution optimizes the use of current PCA resources avoiding the use of any additional electronics port or device. As a result, there is no impact in materials cost to enable this feature

The solution uses the port reconfiguration capacity of the μController, which can be "on-the-flight" (during the normal operation) and takes advantage of the fact that the "acknowledge pulse" happens in a moment in time where there are no communications transmitted on the line. In summary, the same I2C SDA port is dynamically reconfigured to be used either as data transmission or for pulse width measurement. Using this strategy, the controlling host processor is provided access to I2C bus and a virtual measurement input pin using the same physical port.

The basic behaviour is very simple. The ports of the I2C channel (SDA and SCL) are all the configured as I2C bus ports by default. When the host operates the virtual measurement input pin to do the time measurement, the μController switches the operating mode of the SDA. Once the time measurement is completed the port is configured back to I2C bus allowing the communications to continue.

From the point of view of the controlling host, the operation remains very similar to that of the prior solution. However, the innovation lies in not requiring a separate physical input pin for the task.

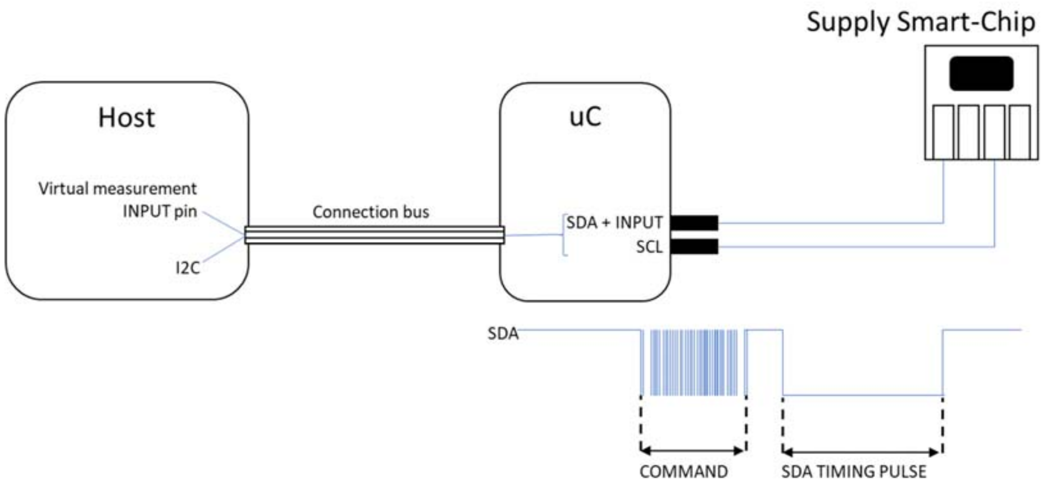

Figure 1 - Solution based on "virtual" measurement input pin

Conclusions:

The design described in this paper is the simplest implementation possible and, additionally, the following advantages are achieved:

- Allows to implement the new smart-chip functionality without add additional μController resources, just with current I2C ports (data and clock) avoiding any cost impact.
- Being the solution that uses less resources, this is the simplest solution in terms of Hw and Sw leading to advantages in design, validation and maintenance.
- The solution implemented requires only Sw modifications and therefore is backwards compatible with previous Hw implementations. In other words: this new functionality could be upgraded to the installed base just upgrading the Software on the printer.

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