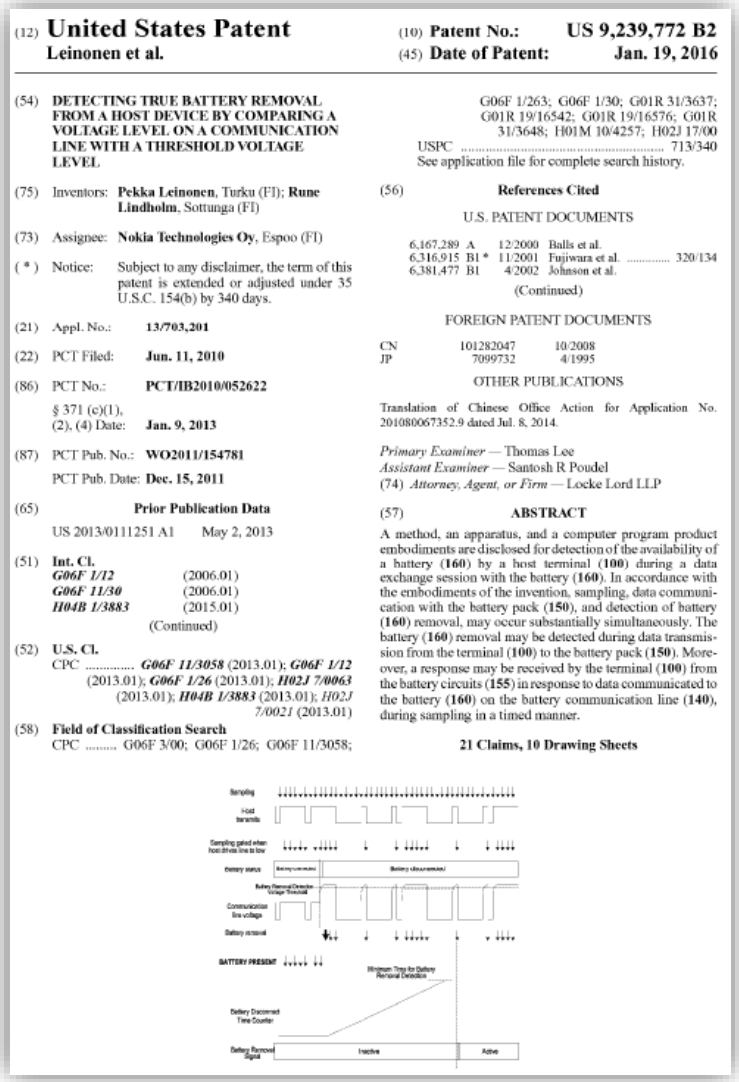
US 9,239,772 (Family ID: 73238)

Detecting true battery removal from a host device by comparing a voltage level on a communication line with a threshold voltage level

Exemplary of:

MIPI Alliance Specification for Battery Interface V 1.0



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Leinonen et al.

(10) **Patent No.: US 9,239,772 B2**
(45) **Date of Patent: Jan. 19, 2016**

(54) **DETECTING TRUE BATTERY REMOVAL FROM A HOST DEVICE BY COMPARING A VOLTAGE LEVEL ON A COMMUNICATION LINE WITH A THRESHOLD VOLTAGE LEVEL**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 340 days.

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(51) **Int. Cl.**
G06F 1/12 (2006.01)
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H04B 1/3883 (2015.01)
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CPC ***G06F 11/3058*** (2013.01); ***G06F 1/12*** (2013.01); ***G06F 1/26*** (2013.01); ***H02J 7/0063*** (2013.01); ***H04B 1/3883*** (2013.01); *H02J 7/0021* (2013.01)

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CPC G06F 3/00; G06F 1/26; G06F 11/3058; G06F 1/263; G06F 1/30; G01R 31/3637; G01R 19/16542; G01R 19/16576; G01R 31/3648; H01M 10/4257; H02J 17/00
USPC 713/340
See application file for complete search history.

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(57) **ABSTRACT**

A method, an apparatus, and a computer program product embodiments are disclosed for detection of the availability of a battery (**160**) by a host terminal (**100**) during a data exchange session with the battery (**160**). In accordance with the embodiments of the invention, sampling, data communication with the battery pack (**150**), and detection of battery (**160**) removal, may occur substantially simultaneously. The battery (**160**) removal may be detected during data transmission from the terminal (**100**) to the battery pack (**150**). Moreover, a response may be received by the terminal (**100**) from the battery circuits (**155**) in response to data communicated to the battery (**160**) on the battery communication line (**140**), during sampling in a timed manner.

21 Claims, 10 Drawing Sheets

1. A method, comprising:

comparing a digital voltage level of a host device waveform with a threshold voltage level and providing a comparison signal resulting from the comparison, the digital voltage level of the host device waveform being on a battery digital communication line coupled to a battery connector, wherein the digital voltage level of the host device waveform comprises at least one predetermined low digital communication voltage level and at least one predetermined high digital communication voltage level used for digital communication with circuits of a battery capable of digital communication coupled to the battery connector via the battery digital communication line to determine if the voltage of the battery connector exceeds the threshold voltage level, wherein the threshold voltage level is different from the at least one predetermined low digital communication voltage level and the at least one predetermined high digital communication voltage level;

sampling the comparison signal in a timed manner in order to ensure that digital communication with the circuits of the battery is not disturbing battery removal detection, by gating the sampling when the host device waveform is at the at least one predetermined low digital communication voltage level;

timing a duration with a timer, that the comparison signal corresponds to the digital voltage level of the host device waveform exceeding the threshold voltage and triggering a battery status signal when the duration exceeds a predetermined delay; and

determining a battery connection status based on the battery status signal.

https://www.google.com/patents/US9239772

US 9,239,772 Claim 1

Exemplary of:
MIPI Alliance Specification for Battery Interface V 1.0

1. A method, comprising:
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9.11 Battery Presence and Removal Detection Implementation Considerations

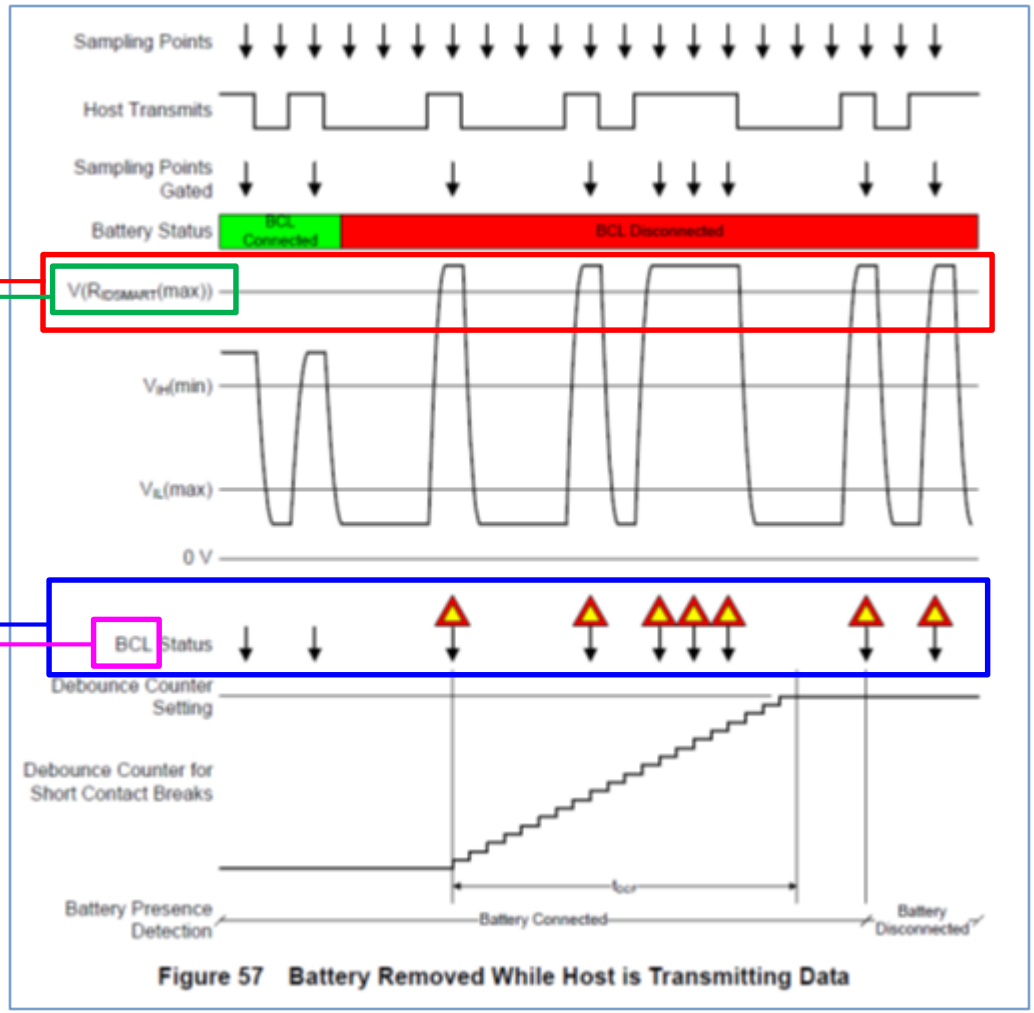

Figure 57 Battery Removed While Host is Transmitting Data

MIPI Alliance Specification for Battery Interface V 1.0

US 9,239,772 Claim 1

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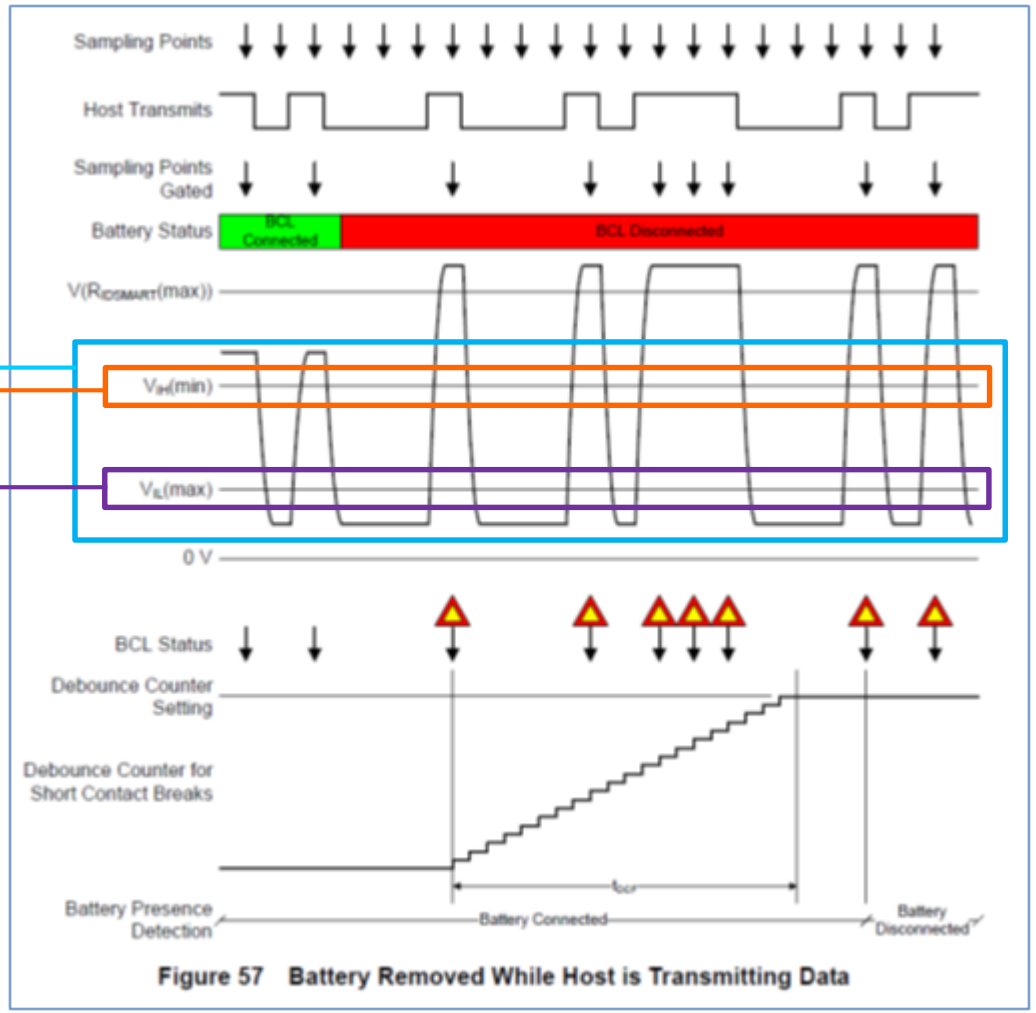

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2.3 Acronyms

45 BCL Battery Communication Line

4 Architecture Overview

The battery interface (BIF) is a single-wire communication interface with respect to electrical ground.

4.1 Features

The BIF has the following features and capabilities:

- Single-wire, open-drain communication interface.
- Supports a single low-cost battery or a single smart battery on a battery communication line (BCL).
- Fast, battery presence and removal detection.
- Low-cost battery identification.
- Single master, multi-slave (up to 256 slaves).
- Scalable data rate up to 250 kbps (average), determined on a per-transaction basis.

5.4 Battery Type Detection

141 A Battery Pack can be a low cost battery that allows obtaining battery information only via analog measurement of RID or a smart battery with the capability for digital communication. Separate RID values are defined for low cost battery (RIDLC) and smart battery (RIDSMART) types.

6 Protocol

The BIF protocol enables communication between multiple devices on the BCL. It is designed to meet the specific needs of mobile-device batteries, such as communication over a single wire and low power consumption.

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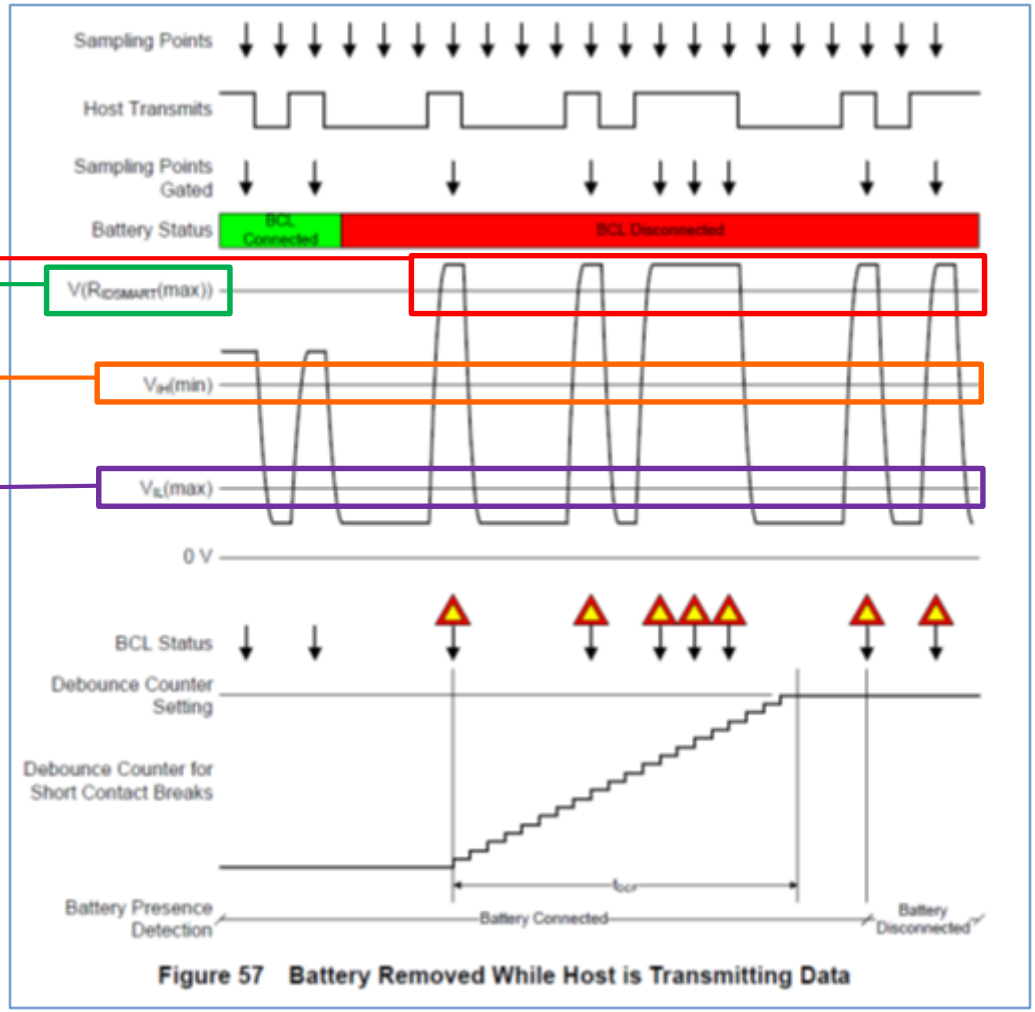

Figure 57 Battery Removed While Host is Transmitting Data

MIPI Alliance Specification for Battery Interface V 1.0

US 9,239,772 Claim 1

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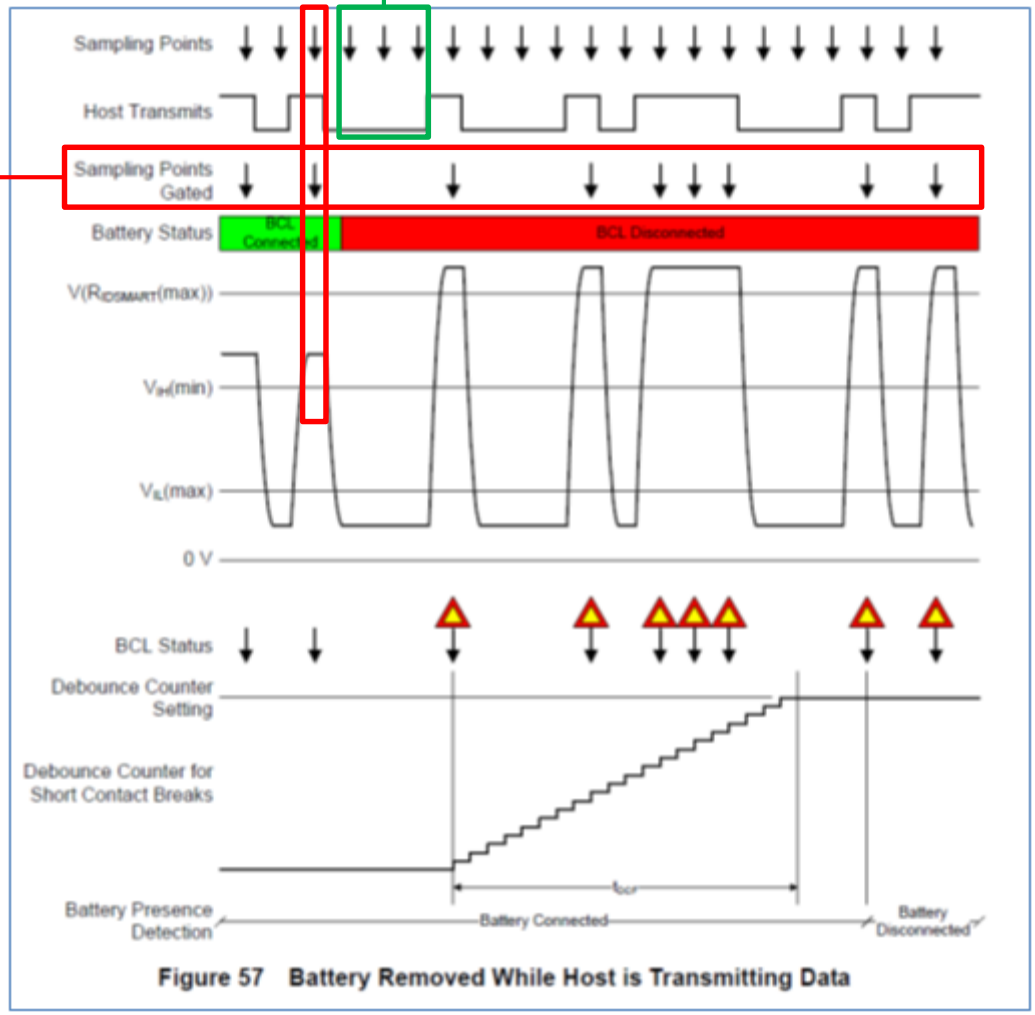

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timing a duration with a timer, that the comparison signal corresponds to the digital voltage level of the host device waveform exceeding the threshold voltage and **triggering a battery status signal when the duration exceeds a predetermined delay**; and

determining a battery connection status based on the battery status signal.

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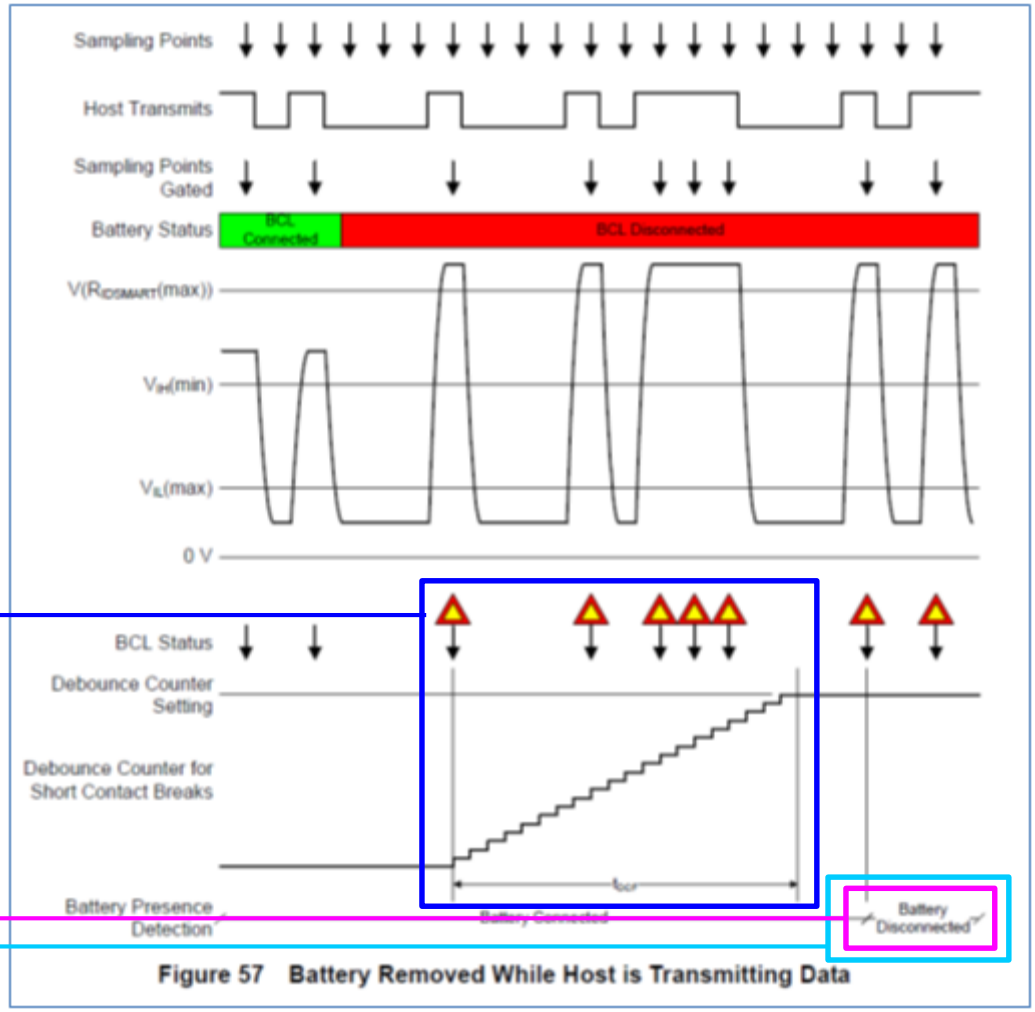

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