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APPLICATION NOTE: IMPLEMENTING THE SMBus INTERFACE FOR USE WITH BREN-TRONICS BATTERIES

Several battery types supplied by Bren-Tronics are equipped with a "smart battery" communications interface that is fully compliant with version 1.1 of the System Management Bus (SMBus) specification. This specification, developed by a coalition of battery, component, and system producers, is the industry standard for battery-management data communications – a two-signal (clock and data) synchronous, bidirectional, open-drain bus that is similar to … but not identical to … the ubiquitous I^2C bus.

The SMBus V1.1 specification can be found here: http://smbus.org/specs/smbus110.pdf

While this specification is relatively straightforward, the experience of both Bren-Tronics and its customers has shown that certain requirements of the specification demand attention to details that are not always obvious, particularly when implementing a SMBus interface for the first time. The information below is provided so that developers can avoid the "bumps and potholes" that others have run into during SMBus-interface development – it supplements, but does NOT substitute for, a thorough understanding of the SMBus V1.1 specification.

SIGNAL RETURN PATH(S)

It is imperative that, when interfacing to dual-section batteries (like the BB-2590/U), EACH SMBus interface is referenced to the negative-return of the particular battery section it connects to. Typically, battery SMBus interfaces are NOT galvanically isolated from their associated cells and battery-management circuitry (due to the need to minimize both cost and "on the shelf" power consumption); therefore the two SMBus interfaces in a dual-section battery DO NOT share the same ground.

In particular, when the two sections of a dual-section battery are series-connected (a very common configuration), one SMBus interface will be "floating" above the other by several volts – so the host interface for that battery section must also be capable of floating to that level. This usually requires some form of galvanic isolation between the SMBus interface for the "floating" section, and the host's signal common.

LENGTH LIMITATIONS

The SMBus interface specification was tailored for low-power/medium-speed communications over relatively short distances (i.e. the few inches of wiring between battery and motherboard in a laptop). The combination of rise-time requirements, output-current limitations, and stray capacitances in wiring and components severely limit the distance an SMBus signal can travel – in practical terms, to approximately 0.5 meters or less.

PULL-UP REQUIREMENTS

One of the features of SMBus is its ability to interface systems with different supply voltages, through its implementation of an open-drain interface with absolute (as opposed to ratiometric, relative to the supply voltage, like I^2C) high/low voltage thresholds. Vih of the SMBus interface is 2.1V; the upper bound of logic-high voltage is 5.5V – facilitating operation with 3.V/3.3V/5V logic. The pull-up devices for the open drain interface (one for each line – clock and data) are simply connected to the supply voltage in the host system.

The "letter of the law" in SMBus is that the "steady-state" output-low current (I_{ol}) must be limited to 350 microamperes or less. This translates into pull-up resistors of 15K ohms in a 5V system, for the simplest of SMBus interfaces. However, the stray capacitances present in wiring and/or ESD/EMI-suppression devices of bus-connected devices can sometimes extend rise times beyond the 1.0 microsecond specification limit if resistive pull-ups that comply with the I_{ol} limit are used.

There are a number of options that can be used to address these limitations.

Active pull-up devices, that provide higher dynamic current during the low-to-high transition while maintaining the steady-state limit elsewhere, can be implemented as shown in Figure 2.3 of the specification.

A simpler approach is to use lower-value resistive pull-ups, if currents higher than the I_{ol} limit can be tolerated by ALL bus-connected devices (present and future) without violating the 0.8Vdc V_{il} specification limit. This is often the case, as this is a technique frequently used in commercial system designs. In this regard, Bren-Tronics batteries go beyond the specification, with the ability to sink SMBus current at levels up to 700 microamperes or more.

CLOCK STRETCHING

One of the commonly-overlooked features of the SMBus is the ability of the battery, any other peripheral device, or the host to "stretch" the (host-generated) clock, by actively holding the CLK line of the SMBus low during communications. This is described in section 5.3 of the specification as "clock low extending".

Clock stretching allows slower-speed (i.e. lower-power-consumption) devices to slow down communications with the host, to a speed compatible with the capabilities of the peripheral (slave) device. It also allows the peripheral (or host) to pause communications (without completely interrupting them) so that it can gather/process data as part of the communications process, and/or service another task in real time.

Support for clock stretching, by peripherals and by the host, is essential for full compliance with the SMBus specification. Bren-Tronics SMBus-equipped batteries fully support clock stretching.

Adherence to the SMBus specification, along with the guidelines above, assures that the target system will communicate with the selected Bren-Tronics SMBus-compliant battery – the first time, and every time – in turn assuring that the host will have the real-time and predictive data it needs to optimize system power management and battery performance.