Application Report
SLUA767–March 2016

bq500511 Wireless Power Transmitter I²C Interface

ABSTRACT

The bq500511 family of devices support an I²C interface which can be used to perform tuning, and monitor various system parameters. This may be useful in an end product for an advanced status display. During development it may provide feedback useful for system calibration and design guidance to improve system performance.

1 Physical Bus Interface

The communication protocol is based on the SMBus definition. All bq500511 controllers function as SMBus slave devices. For electrical details of the communication please refer to the SMBus specification which can be found on the web at: http://smbus.org/specs/smbus110.pdf. The slave address assigned to all bq500511 wireless power devices has been hardcoded to 20 (decimal). The maximum bus speed is limited to 100 kHz.

2 Texas Instruments Supported Tools

The easiest method to access the basic features of the I²C interface is using TI's EV2400 USB-Based PC Interface Board: https://store.ti.com/EV2400-USB-Based-PC-Interface-Board-for-Battery-Fuel-Gas-Gauge-Evaluation-Module-P2575.aspx in combination with the "Battery Management Studio (bqStudio)": http://www.ti.com/tool/BQSTUDIO.

Ground, Clock and Data are the only three signals needed to interface between the bq500511 device and the USB Serial Interface Adapter (or any other I²C host). In bq500511 controller, Clock is pin#29 and data is pin#28.

3 Supported Commands by Device Part Number

Table 1 provides a summary of which commands are supported by bq500511 device. Details on each of the commands listed here are provided in Section 4.

Table 1. Commands

bq500511	Command
DEVICE_ID	FD
PLD_MONITOR	D5
PLD_THRESHOLD	D6
RX_PROP	D3
RX_PROP_COUNT	D4
RX_STATS	D0
TX_STATS	D1

4 Command Definitions

Commands may be Read Only, Write Only, or Read/Write and are further categorized into BYTE, WORD, or BLOCK types. BYTE commands specify an 8-bit operand (both read/write). WORD commands are 16-bits. BLOCK commands have variable length which is specified as part of the block message.

4.1 DEVICE_ID (Read only BLOCK – Command 0xFD)

The transmitter firmware build information is returned in a string containing the device number, the firmware version (major.minor.sub.build), and a date-code (YYMMDD).

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Ex:    BQ500511|2.1.4.3548|110714
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4.2 PLD_MONITOR (Read only BLOCK – Command 0xD5)

The parasitic loss monitor command returns data related to the FOD operation. The block returned in response to PLD_MONITOR comprises the following bytes in order:

Table 2. PLD_Monitor Command 0xD5

byte(s)	Parameter	Unit/Scaling
0	number of bytes to follow	constant = 31
1	reported received power	128ths of max power
2	raw reported max power	*500 = mW
3-6	threshold set from resistor	mw (q19,13)
7-10	calculated parasitic loss	mw (q19,13)
11-12	DC input voltage	V (q6,10)
13-14	DC input current	mA (q13,3)
15-18	Calculated input power	mw (q19,13)
19-20	spare	
21-22	FOD peak	V (arbitrary)
23-27	spare	
28-29	output frequency	kHz (q10, 6)
30-31	spare	

4.3 PLD_THRESHOLD (Read/Write WORD – Command 0xD6)

The parasitic loss threshold can be used to overwrite the resistor determined value. Note that this value is reset when the device is power cycled. Adjusting the threshold is useful during development and characterization to determine an appropriate value for the MOD_THRESH resistor or to evaluate friendly losses in the system. The threshold value specified defines the mW threshold; it is expressed as an integer. A threshold value of -1 will disable FOD.

4.4 RX_PROP (Read only BLOCK – Command 0xD3)

The WPC specification allows the receiver to send “proprietary packets”. There are several header numbers designated as proprietary which containing a various number of bytes of data. These packets may be used for some wireless power transfer related function, or they could be used to convey information from the device being charged to the host controlling the wireless charger. i.e. the wireless charging system can provide a conduit to pass information. When a proprietary packet is received, it is stored in the transmitter memory, and a counter containing the total number of proprietary packets received is incremented.

The RX_PROP command will return 22 bytes. Byte 0 specifying the length of block to follow (21), followed by 21 bytes containing the data from the most recently received proprietary packet. Twenty-one bytes is large enough to contain all of the data from any of the proprietary packets.

After RX_PROP is read, the header byte in memory is reset to 0. This allows the host to detect when a new proprietary packet is received.

4.5 RX_PROP_COUNT (Read only WORD – Command 0xD4)

The RX_PROP_COUNT command returns the total number of proprietary packets that have been received.

NOTE: Note: Power cycling or entering low-power mode will clear this counter.

4.6 RX_STATS (Read only BLOCK – Command 0xD0)

The RX_STATS command returns data which was communicated from a wireless power receiver placed on the transmitter. Presently there are nine message types defined by the WPC specification that the RX can send. The most recent value for each of these messages is returned in a block when the RX_STATS command is issued. Following is the list of WPC defined packets:

Table 3. RX_STATS Command 0xD0

Header	Message	Bytes	Comment
0x01	Signal Strength	1	Sent only once when RX placed on pad.
0x02	End Power Transfer	1	Will contain the most recent EPT code.
0x03	Control Error	1	Latest value only – updated frequently.
0x04	V1.0 Rectified Power V1.1 Received Power	1	Used for FOD
0x05	Charge Status	1	Optional packet from RX.
0x06	PID Holdoff	1	Optional – will contain default if not received.
0x51	Configuration	5	Needs post processing to decode.
0x71	Identification	7	Needs post processing to decode.
0x81	Extended Identification	8	Presently undefined.

The block returned in response to RX_STATS comprises the following bytes in order:

Table 4. RX_STATS BYTES

Byte	Message	
0	31	(number of bytes to follow)
1	signal_strength	
2	end_power_transfer	
3	control_error	
4	8-bit rectified_power / received power (V1.0 receivers will send a rectified power message)	
5	charge_status	
6	holdoff	
7	configuration [0]	** For multi-byte messages, the order matches the order
...	...	** sent by the recevier. i.e. configuration[0] is the first
11	configuration[4]	
12	identification[0]	
...	...	
18	identification [6]	** byte received in a configuration message.
19	extended_identification [0]	
...	...	
26	extended_identification [7]	
27-31	spare	

4.7 TX_STATS (Read only BLOCK – Command 0xD1)

The transmitter status command returns data related to the operating status of the transmitter. The data includes recent results from the ADC converter, statistics regarding the communication channel, the present power operating point (frequency and duty cycle), status indicators, and parasitic loss parameters.

The block returned in response to TX_STATS comprises the following bytes in order:

Table 5. TX_STATS Command 0xD1

Byte	Parameter	Description	Units	Scaling
0	31	number of bytes to follow		
1	voltage_in msb	Input voltage	volts	(q6,10)
2	voltage_in lsb			
3	iout msb	I_SENSE current	mA	(q13,3)
4	iout lsb			
5	invalid byte			
6	invalid byte			
7	temp_int msb	internal temperature	degC	(q9,7)
8	temp_int lsb			
9	invalid byte			
10	invalid byte			
11	good_msg_cnt_msb	good message counter		
12	good_msg_cnt lsb			
13	invalid byte			
14	invalid byte			
15	bad_msg_cnt_msb	bad message counter		
16	bad_msg_cnt lsb			
17	frequency msb	operating frequency	kHz	(q10,6)
18	frequency lsb			
19	duty_cycle msb	operating duty_cycle	percent	(q1,15)
20	duty_cycle lsb			
21	led_mode	resistor selected led mode		
22	led_out	present LED indication 4–bits per LED 0 = off, 1 = slow, 2 = fast, 3 = on		
23	fod_threshold msb	resistor set threshold	mW	(q19,13)
24	fod_threshold ..			
25	fod_threshold ..			
26	fod_threshold lsb			
27	pld msb	parasitic loss detected	mW	(q19,13)
28	pld ..			
29	pld ..			
30	pld lsb			
31	cs100_latched	indicator of CS100 detection		

NOTE: Note: The “Q-notation” used in the scaling convention is a fixed point representation of a floating point number comprising the number of integer bits and the number of fractional bits. Ex. (q9,7) denotes 9 integer bits and 7 fractional, and the conversion can be made by dividing by 2 raised to the fractional count. If the internal temperature variable returned is 0x0F14 = 3860 (decimal) the internal temperature of the device is 3860 / 2^7 = 30.16ºC.

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

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3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

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