Application Report
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bq500212A Wireless Power Transmitter I2C Interface

Bill Johns, Eric Oettinger

ABSTRACT

The bq500212A supports an I2C interface which can be used to program the device, perform tuning, and monitor various system parameters. This may be useful in an end product for device control or an advanced status display. During development it may provide feedback useful for system calibration and design guidance to improve system performance. It also provides a mechanism for field updates.

1 Physical Bus Interface

The communication protocol is based on the SMBus definition. The bq500212A controller functions 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 bq500212A wireless power devices has been hardcoded to 20 (decimal). The hardware can support 100 kHz, 400 kHz, or 1 MHz operation.

2 Texas Instruments Supported Tools

The easiest method to access the basic features of the I2C interface is using TI's USB Serial Interface Adapter http://www.ti.com/tool/USB-TO-GPIO in combination with the "bqTesla TX Tuning Tool" which can be obtained by contacting Texas Instruments support.

Ground, Clock and Data are the only three signals needed to interface between the bq500212A device and the USB Serial Interface Adapter (or any other I2C host). Clock is pin#10 and Data is pin#11.

3 Supported Commands

The following table provides a summary of which commands. Details on each of the commands listed here is provided in Section 4.

Table 1. Commands

bq500212A
DEVICE_ID
N/A
PLD_MONITOR
PLD_THRESHOLD
RX_PROP
RX_PROP_COUNT
RX_STATS
SHUTDOWN
SLEEP_DISABLE
TX_STATS

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).

Ex: BQ500212A|2.4.2.6072|110714

4.2 PLD_MONITOR (Read only BLOCK – Command 0xD5)

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

Table 2. PLD_MONITOR bytes

Byte(s)	Parameter	Units / Scaling
0	number of bytes to follow	constant = 31
1	reported received power	128ths of max power
2	raw reported max power	Raw power X 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)
19-22	COMM+ amplitude	V (arbitrary)
23	PLD state machine	0 = clear 1 = triggered 2 = set
24-27	PLD timer	msec (q16,16)
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/PMOD.

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 25 bytes. Byte 0 specifying the length of block to follow (24), followed by 24 bytes containing the data from the most recently received proprietary packet. Twenty-four 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: 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. WPC Defined Packets

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 PMOD / 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. Response to RX_STATS

Byte	Message	
0	28	(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	
7-11	configuration	For multi-byte messages, the order matches the order sent by the receiver. i.e. configuration[0] is first
12-18	identification	
19-26	extended_identification	
27	Spare	
28	Spare	

4.7 SLEEP_DISABLE (Read/Write BYTE – Command 0xD2)

The Bq500212A attempts to reduce system power consumption by turning itself off when not in use (when no receiver is present, after a fault, or when the receiver sends an “End Power Transfer” message). While off, communication is not possible, and issued commands have no effect. Additionally statistical counters such as those for good and bad messages will be reset on wake–up.

When set to 1, SLEEP_DISABLE, prevents the Bq500212A from entering sleep mode. This disables the low-power standby mode which is normally implemented by periodically turning off the 3.3-V input power to the processor. When power is removed, the processor is unable to communicate, which can make debug and system diagnosis more difficult. The SLEEP_DISABLE function prevents the low-power mode from operating which leaves communication with the devices possible during system idle periods when normally it would be prevented.

NOTE: Communication must be currently active in order to issue this command. This can be due to the presence of a functioning receiver, or forced by shorting the LED_MODE selection resistor to ground.

4.8 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 bytes

Byte(s)	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	temp_ext msb	external temperature, raw ADC result		
6	temp_ext lsb			
7	temp_int msb	internal temperature	°C	(q9,7)
8	temp_int lsb			
9	good_msg_cnt msb	good message counter		
10	good_msg_cnt ..	count of successfully received messages		
11	good_msg_cnt ..			
12	good_msg_cnt lsb			
13	bad_msg_cnt msb	bad message counter		
14	bad_msg_cnt ..	count of detected errors: checksum, invalid values,		
15	bad_msg_cnt ..	count of detected errors: checksum, invalid values,		
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	mod_threshold msb	resistor set threshold	mW	(q19,13)
24	mod_threshold ..			
25	mod_threshold ..			
26	mod_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: 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 $3860 / 2^7 = 30.16$ºC.

4.9 TX_STATS2

The block size is limited to 32 bytes; to accommodate a few more fields with useful information, a second TX_STATS command was required. Presently mostly filled with 0's, there is room for expansion.

The block returned in response to TX_STATS2 comprises the following bytes in order:

Table 6. TX_STATS2 bytes

Byte(s)	Parameter	Description	Units	Scaling
0	31	number of bytes to follow		
1	fod_correction msb	Value read from FOD_CAL input	mW/A	1024/1000
2	fod_correction lsb			
3	dpl_state	value >0 indicates DPL triggered, state machine status		
...	...			
31	0			

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