

# ***bq500212A Wireless Power Transmitter I2C Interface***

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## **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**

| <b>bq500212A</b> |
|------------------|
| 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.

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

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#### 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<br>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.

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**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.

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#### 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<br>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  $3860 / 2^7 = 30.16^{\circ}\text{C}$ .

## 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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