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# AS3610/11

## Switching Charger for Li-Ion/LiPo/LiFePO4 powered devices

### 1 General Description

The AS3610/11 is a highly integrated standalone or optional I<sup>2</sup>C controlled step down charger. All supervision and regulation functions are realized internal and independent from the processor.

The 100/500mA USB current limit can be set via a dedicated control pin. Other limits like 900mA can be programmed in the OTP ROM.

In addition, the Charger can generate a 5.05V output supply at VBUS for USB OTG.

AS3610 features an I2C interface which can be used by a micro-controller to fully control all functionality of the chip. Charging current and EOC current can be set with external resistors and adjusted via register settings if needed.

AS3611 is a stand-alone version of this charger IC. Charging and EOC current is set by resistor only. Functions like OTG boost mode or max current limit for wall adapter mode can be enabled using dedicated pins.

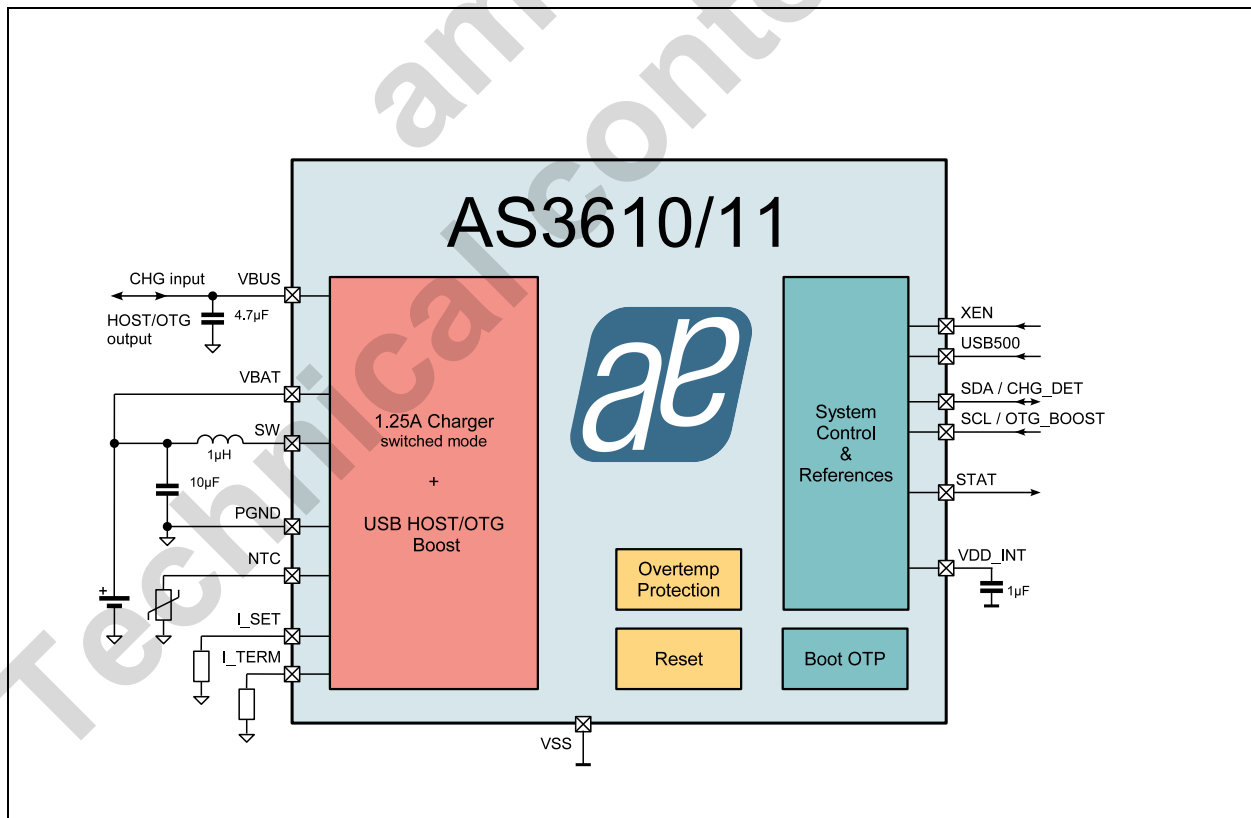
### 2 Key Features

- DCDC USB Charger
- 1.25A, 3MHz DCDC Charger
- OTG Boost with low IQ (700µA) up to 500mA
- 22V over voltage protection
- Seamless 100% Mode
- Reverse Polarity protection on VBUS
- NTC support
- Low side LED driver
- No external shunt resistor required
- “No Battery” operation without voltage drop
- Package: MLPD14 3x3mm

### 3 Application

The device is ideal as 1 Cell Lilon, LiPo or LiFePO4 charger for mobile phones and portable devices.

Figure 1. AS3610/11 Block Diagram

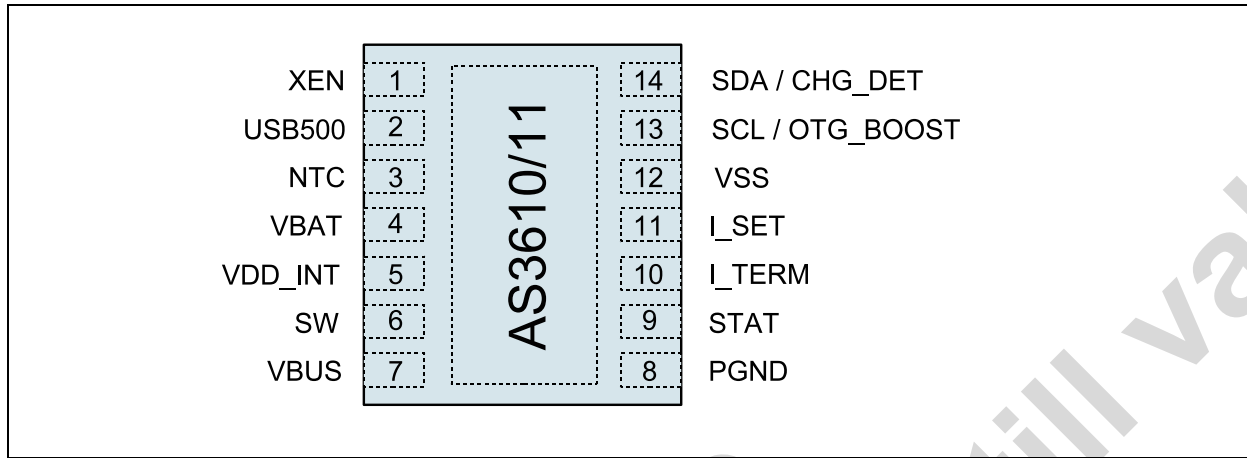


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## 4 Pin Assignments

Figure 2. AS3610/11 Pin Assignments (Top View)



### 4.1 Pin Descriptions

Table 1. Pin Descriptions

| Pin Number | Pin Name AS3610 | Pin Name AS3611 | Pin Type                                                             | Supply  | Description                                                             |
|------------|-----------------|-----------------|----------------------------------------------------------------------|---------|-------------------------------------------------------------------------|
| 1          | XEN             | XEN             | Analog pin                                                           | VBAT    | XEnable pin for step down charger                                       |
| 2          | USB500          | USB500          |                                                                      | VBAT    | Set current limit in charger mode. 100mA / 500mA USB current limit.     |
| 3          | NTC             | NTC             |                                                                      | VDD_INT | NTC input                                                               |
| 4          | VBAT            | VBAT            |                                                                      |         | Analog Sense input                                                      |
| 5          | VDD_INT         | VDD_INT         |                                                                      |         | Connect 1 $\mu$ F (0402) for internal LDO supply 2.5V                   |
| 6          | SW              | SW              | Power pin                                                            |         | SW node of step down charger. Connect to 1 $\mu$ H inductor (chip coil) |
| 7          | VBUS            | VBUS            |                                                                      |         | Charger input (USB voltage or charger voltage)                          |
| 8          | PGND            | PGND            |                                                                      |         | Power GND connection of step down charger                               |
| 9          | STAT            | STAT            | Digital Open Drain Output pin                                        |         | Pulled to GND for error / status indication via LED                     |
| 10         | I_TERM          | I_TERM          | Analog pin                                                           | VBAT    | Sets trickle / EOC current                                              |
| 11         | I_SET           | I_SET           |                                                                      | VBAT    | Sets charging current (Constant current)                                |
| 12         | VSS             | VSS             |                                                                      |         | Analog VSS                                                              |
| 13         | SCL             |                 | Digital Open Drain Output pin; Requires an external pull-up resistor | VBAT    | I <sup>2</sup> C clock line                                             |
|            |                 | OTG_BOOST       | I                                                                    | VBAT    | switches mode to OTG boost                                              |
| 14         | SDA             |                 | Digital Open Drain Output pin; Requires an external pull-up resistor | VBAT    | I <sup>2</sup> C data line                                              |
|            |                 | CHG_DET         | I                                                                    | VBAT    | selects the highest input current limit for wall adapter charging       |

## 5 Absolute Maximum Ratings

Stresses beyond those listed in [Table 2](#) may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in [Operating Conditions on page 5](#) is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 2. Absolute Maximum Ratings

| Symbol                                    | Parameter                 | Min                  | Max  | Unit | Comments                                                                                                    |
|-------------------------------------------|---------------------------|----------------------|------|------|-------------------------------------------------------------------------------------------------------------|
| Electrical Parameters                     |                           |                      |      |      |                                                                                                             |
| V_HV20                                    | High voltage pins         | -2                   | 22   | V    | Applicable to high voltage pins: VBUS, SW, STAT                                                             |
| V_MV                                      | 5V pins                   | -0.3                 | 7.0  | V    | Applicable to 5V-pins: VBAT, XEN, SDA, SCL, USB500, I_SET, I_TERM                                           |
| V_LV                                      | 3.3V pins                 | -0.3                 | 5.0  | V    | Applicable to 3.3V-Pins: VDD_INT, NTC                                                                       |
| IIN                                       | Input pin current         | -100                 | +100 | mA   | Norm: JEDEC JESD78                                                                                          |
| Electrostatic Discharge                   |                           |                      |      |      |                                                                                                             |
| VESD                                      | Electrostatic discharge   | +/-1500 <sup>1</sup> |      | V    | Norm: JEDEC JESD22-A114F                                                                                    |
| Temperature Ranges and Storage Conditions |                           |                      |      |      |                                                                                                             |
| SCSB                                      | Operating Temperature     | -40                  | +85  | °C   |                                                                                                             |
| T <sub>J</sub>                            | Junction Temperature      |                      | +110 | °C   |                                                                                                             |
|                                           | Storage Temperature Range | -55                  | +150 | °C   |                                                                                                             |
|                                           | Humidity non-condensing   | 5                    | 85   | %    |                                                                                                             |
| Temperature (soldering)                   |                           |                      |      |      |                                                                                                             |
| T <sub>BODY</sub>                         | Package Body Temperature  |                      | 260  | °C   | Norm IPC/JEDEC J-STD-020 <sup>2</sup><br>The lead finish for Pb-free leaded packages is matte tin (100% Sn) |
|                                           | Moisture Sensitive Level  | 3                    |      |      | Represents a max. floor life time of 168h                                                                   |

1. pin STAT is +/-750V only

2. The reflow peak soldering temperature (body temperature) is specified according IPC/JEDEC J-STD-020 "Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices"

## 6 Electrical Characteristics

VBAT=+2.7V...+5.5V,  $T_A$  = -40°C...+85°C. Typical values are at VBAT=+3.6V,  $T_A$  = +25°C, unless otherwise specified.

The parameters with min and max values are guaranteed with production tests or SQC (Statistical Quality Control) methods.

Table 3. Operating Conditions

| Symbol                         | Parameter                                                           | Notes                                                                                                                              | Min                     | Typ                      | Max                     | Unit |
|--------------------------------|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------|-------------------------|------|
| <b>Operating Range</b>         |                                                                     |                                                                                                                                    |                         |                          |                         |      |
| V <sub>HV20</sub>              | High voltage pins                                                   | Applicable to high voltage pins: VBUS, SW.                                                                                         | -2                      | 5.0                      | 20                      | V    |
| V <sub>MV</sub>                | 5V pins                                                             | Applicable to 5V pins: VBAT, XEN, SDA, SCL, USB500, I_SET, I_TERM                                                                  | -0.3                    |                          | 5.5                     | V    |
| V <sub>LV</sub>                | 3.3V pins                                                           | Applicable to 3.3V-Pins: VDD_INT, NTC                                                                                              | -0.3                    |                          | 3.6                     | V    |
| T <sub>AMB</sub>               | Ambient Temperature                                                 |                                                                                                                                    | -40                     | 25                       | 85                      | deg  |
| <b>Operating Currents</b>      |                                                                     |                                                                                                                                    |                         |                          |                         |      |
| I <sub>VBUS_ACT</sub>          | VBUS current, if step down charger is active                        | I <sub>USB</sub> limit > 100mA                                                                                                     |                         | 10                       |                         | mA   |
|                                |                                                                     | I <sub>USB</sub> limit < 100mA                                                                                                     |                         | 5                        |                         | mA   |
| I <sub>BOOST</sub>             | VBAT current, if boost active without load                          | VBAT=4.2V                                                                                                                          |                         | 700                      |                         | μA   |
| I <sub>VBUS_OFF</sub>          | VBUS current in OFF mode                                            | VBUS=5V, T <sub>J</sub> < 85°C                                                                                                     |                         | 16                       |                         | μA   |
| I <sub>VBAT</sub>              | VBAT quiescent current in OFF mode                                  | VBAT=4.2V, T <sub>J</sub> < 85°C<br>Including leakage current to VBUS                                                              |                         | 16                       |                         | μA   |
| <b>Charging Mode Parameter</b> |                                                                     |                                                                                                                                    |                         |                          |                         |      |
| V <sub>BUS_UVLO</sub>          | VBUS undervoltage lockout                                           | Step Down charger disabled below this threshold. -150mV hysteresis                                                                 | 3.7                     | 3.8                      | 3.9                     | V    |
| V <sub>BUS_OV</sub>            | VBUS overvoltage off mode                                           | Step Down charger disabled above this threshold. -140mV hysteresis                                                                 | 6.3                     | 6.5                      | 6.7                     | V    |
| V <sub>BUS_min</sub>           | VBUS minimum voltage to regulate current to VBAT                    | Programmable (2-bit)                                                                                                               | V <sub>nom</sub> - 0.12 | 3.9<br>4.2<br>4.5<br>4.7 | V <sub>nom</sub> + 0.12 | V    |
| I <sub>CHARGE</sub>            | Charge current accuracy of mean output current                      | Current selected by resistor on I <sub>SET</sub> pin:<br>I <sub>CHARGE</sub> = 21450/R <sub>SET</sub> and register const_curr<1:0> | -8%                     | 550...<br>1250           | +8%                     | mA   |
| I <sub>TERM</sub>              | Termination and trickle (precharge) current                         | Current selected by resistor on I <sub>TERM</sub> pin:<br>I <sub>TERM</sub> = 1200/R <sub>TERM</sub>                               | -40mA or<br>-30%        | 50...<br>200             | +40mA or<br>+30%        | mA   |
| I <sub>USB</sub>               | USB input current limit resistor                                    | 100mA USB current limit                                                                                                            | 88                      | 93                       | 105                     | mA   |
|                                |                                                                     | 500mA USB current limit                                                                                                            | 450                     | 475                      | 500                     | mA   |
|                                |                                                                     | 900mA USB current limit                                                                                                            | 800                     | 850                      | 900                     | mA   |
| V <sub>SOFT</sub>              | Apply I <sub>SOFT</sub> current below this VBAT voltage             | Hysteresis -100mV                                                                                                                  | 1.9                     | 2.0                      | 2.1                     | V    |
| I <sub>SOFT</sub>              | Soft current, if VBAT is below V <sub>SOFT</sub>                    |                                                                                                                                    | 25                      | 38                       | 55                      | mA   |
| V <sub>TRICKLE</sub>           | Apply trickle current (=I <sub>TERM</sub> ) below this VBAT voltage |                                                                                                                                    | -0.1                    | 2.9                      | +0.1                    | V    |
| V <sub>CHARGE</sub>            | End of charge voltage                                               | 20mV steps Programmable                                                                                                            |                         | 3.5...4.44               |                         |      |
|                                | End of charge accuracy                                              | 4.2V EOC voltage, -40..85°C                                                                                                        | -1                      |                          | +1                      | %    |
| V <sub>CHDET</sub>             | Charge detect voltage difference                                    | VBUS-VBAT                                                                                                                          | +1                      | +40                      | +100                    | mV   |

Table 3. Operating Conditions

| Symbol                                | Parameter                                                           | Notes                                                                   | Min  | Typ         | Max              | Unit |
|---------------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------------------|------|-------------|------------------|------|
| V <sub>RESUME</sub>                   | Resume voltage                                                      | $V_{THRESHOLD} = V_{CHARGE} - V_{RESUME}$                               |      | 120         |                  | mV   |
| R <sub>PMOS</sub>                     | Resistance of PMOS switch                                           |                                                                         |      | 300         |                  | mΩ   |
| R <sub>NMOS</sub>                     | Resistance of NMOS switch                                           |                                                                         |      | 300         |                  | mΩ   |
| f <sub>OSC</sub>                      | Switching frequency                                                 |                                                                         | 2.7  | 3.0         | 3.3              | MHz  |
| D <sub>MAX</sub>                      | Maximum duty cycle                                                  | Smooth transition. No skipmode.                                         |      |             | 100              | %    |
| T <sub>MIN</sub>                      | Minimum ON time of PMOS                                             | Minimum ON time of PMOS. Below this value, transition to pulseskip mode |      | 60          |                  | nsec |
| I <sub>COIL</sub>                     | Coil current limit                                                  |                                                                         |      | 1.7         |                  | A    |
| <b>Boost Mode Parameter</b>           |                                                                     |                                                                         |      |             |                  |      |
| V <sub>BOOST</sub>                    | VBUS regulated voltage in boost mode                                |                                                                         | 4.9  | 5.05        | 5.2              | V    |
| I <sub>BOOST</sub>                    | Boost current                                                       | $2.7 < V_{BAT} < 4.5$ (boost_lowcurr=1)                                 | 200  |             |                  | mA   |
| I <sub>HBOOST</sub>                   | Boost current (high current mode)                                   | $3.2 < V_{BAT} < 4.5$ (boost_lowcurr=0)                                 | 500  |             |                  | mA   |
| I <sub>COIL</sub>                     | Coil current limit                                                  |                                                                         |      | 0.75<br>1.5 |                  | A    |
| I <sub>SU</sub>                       | Stepup no load current on VBAT                                      | V <sub>BAT</sub> =4.2V                                                  |      | 700         |                  | μA   |
| <b>Thermal Limitation</b>             |                                                                     |                                                                         |      |             |                  |      |
| T <sub>REG</sub>                      | Thermal current regulation for charger mode                         |                                                                         |      | 110         |                  | °C   |
| T <sub>SHDOWN</sub>                   | Thermal shutdown limit                                              |                                                                         |      | 140         |                  | °C   |
| <b>NTC Charging Temperature Range</b> |                                                                     |                                                                         |      |             |                  |      |
| V <sub>BATTEMP_ON</sub>               | Battery Temperature high level (50 or 55 °C) NTCbeta = 4200         | ntc_temp=0                                                              |      | 500 or 400  |                  | mV   |
| V <sub>BATTEMP_OFF</sub>              | Battery Temperature low level (45 or 50 °C) NTCbeta = 4200          | ntc_temp=1                                                              |      | 600 or 500  |                  | mV   |
| I <sub>BATTEMP</sub>                  | NTC Bias Current                                                    | 100kΩ NTC                                                               | -14% | 15          | +14%             | μA   |
| I <sub>BATTEMP</sub>                  | NTC Bias Current                                                    | 10kΩ NTC                                                                | -10% | 150         | +10%             | μA   |
| <b>IO characteristics</b>             |                                                                     |                                                                         |      |             |                  |      |
| V <sub>IL</sub>                       | SCL/CHG_DET, SDA/OTG_BOOST, USB500, XEN<br>Low Level input voltage  |                                                                         | -0.3 |             | 0.4              | V    |
| V <sub>IH</sub>                       | SCL/CHG_DET, SDA/OTG_BOOST, USB500, XEN<br>High Level input voltage |                                                                         | 1.4  |             | V <sub>BAT</sub> | V    |

## 7 Typical Operating Characteristics

$C_{VBAT}=10\mu F$ ,  $C_{VBUS}=10\mu F$ ,  $L=1\mu H$ ,

Figure 3. USB Current (100mA limit)

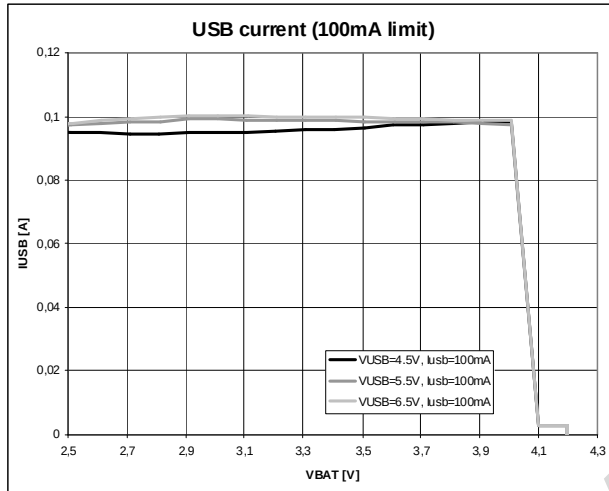


Figure 4. USB Current (500mA limit)

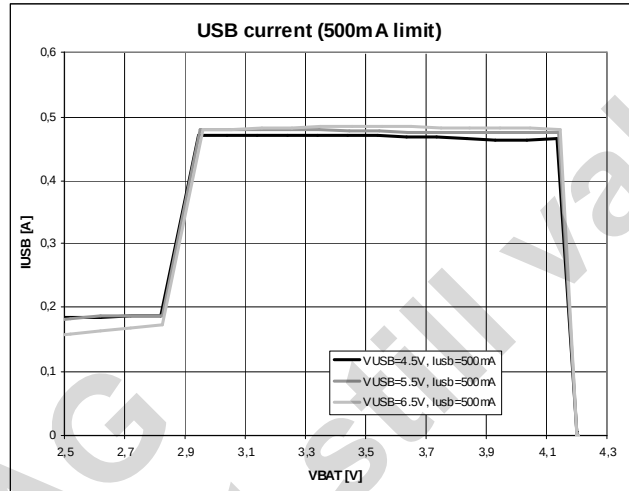


Figure 5. Current into Battery (100mA IUSB limit)

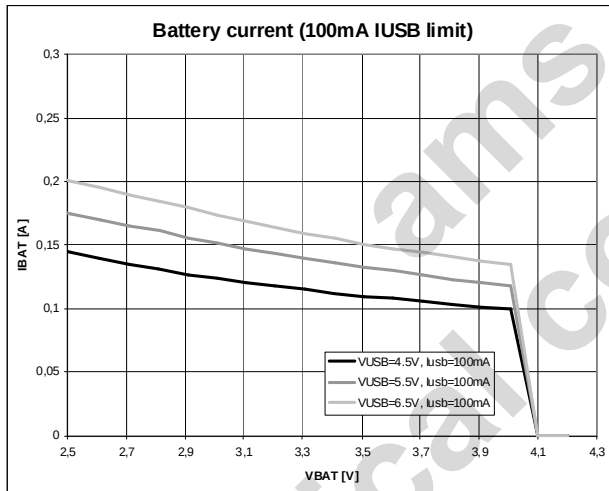


Figure 6. Current into Battery (500mA IUSB limit)

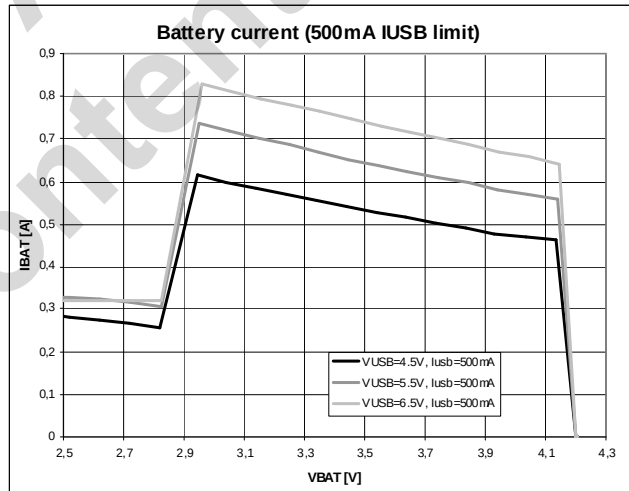




Figure 7. Charging Cycle 1

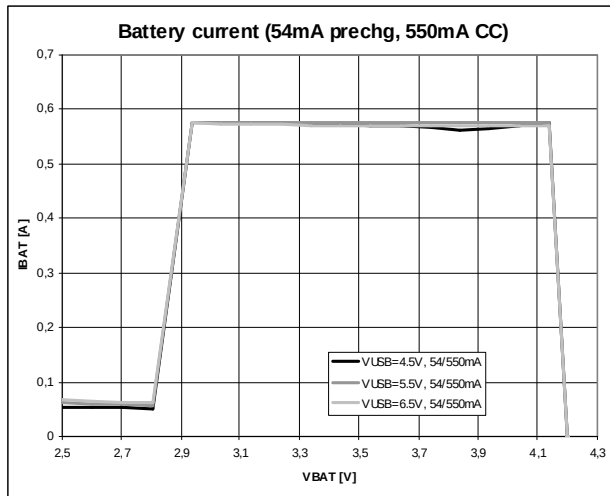


Figure 8. Charging Cycle 2

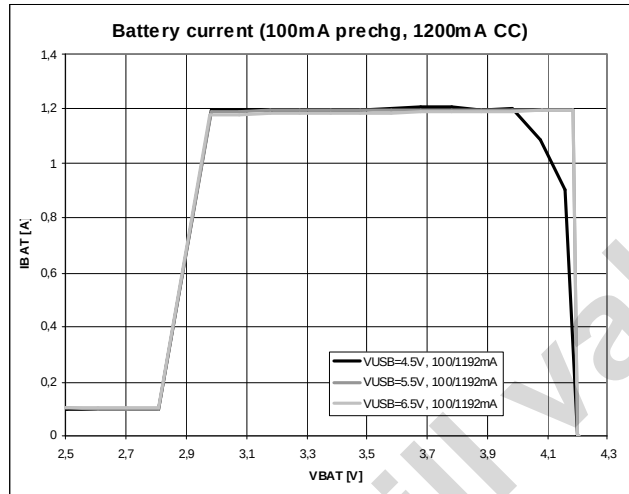


Figure 9. Efficiency @550mA

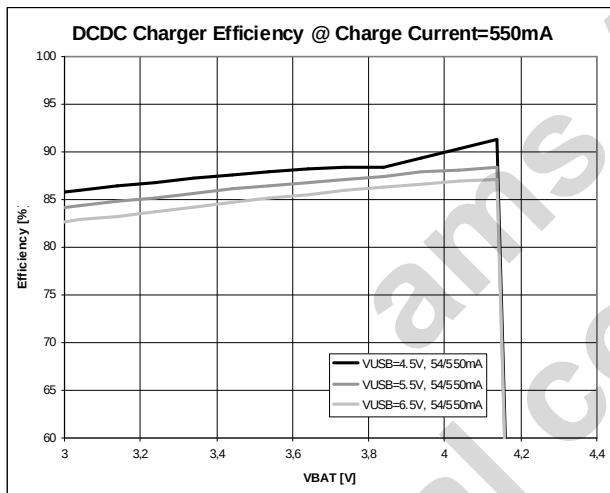


Figure 10. Efficiency @1.2A

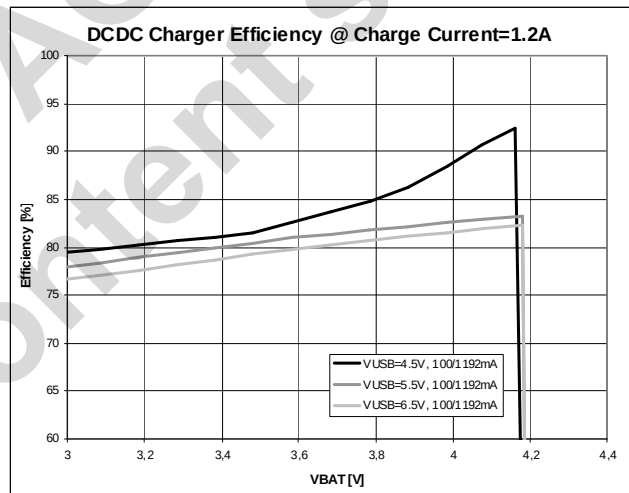


Figure 11. Boost Efficiency

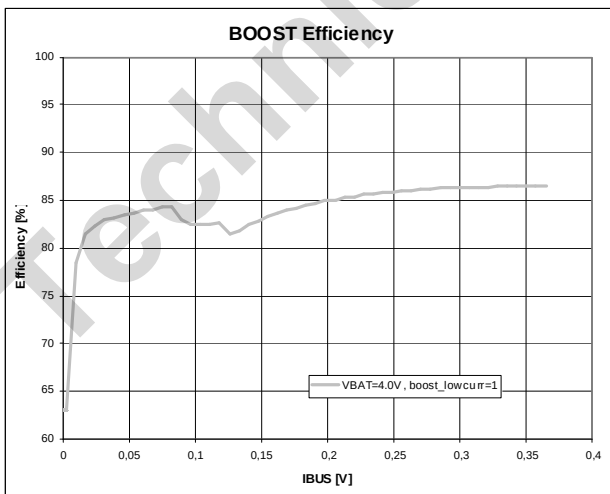
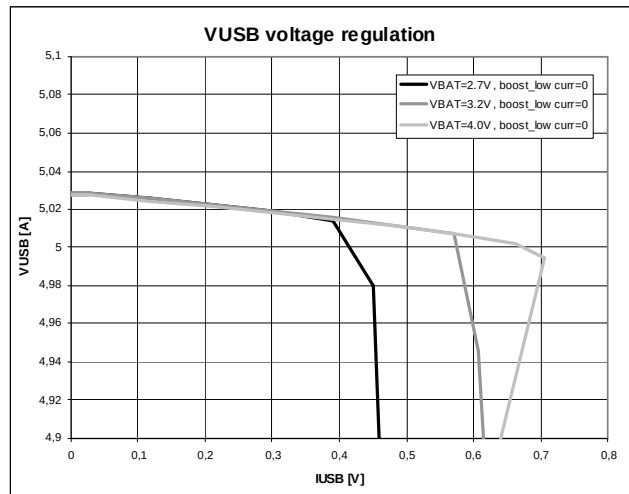


Figure 12. Booster Output Voltage



## 8 Detailed Description

### 8.1 Charge Controller

#### 8.1.1 General Description

The AS3610/11 device serves as a standalone battery charge controller supporting rechargeable Lithium Ion (Li+) batteries. Requiring only a few external components, a full-featured battery charger with a high degree of flexibility can easily be realized. The main features of the controller are:

- Charge adapter detection
- Internal voltage regulator
- Low current (soft) charging
- Low current (trickle) charging
- Constant current charging
- Constant voltage charging
- 22V input overvoltage protection
- Battery presence indication
- Operation without battery
- Input current limitation
- Input voltage drop regulation

Figure 13. Detailed Block Diagram

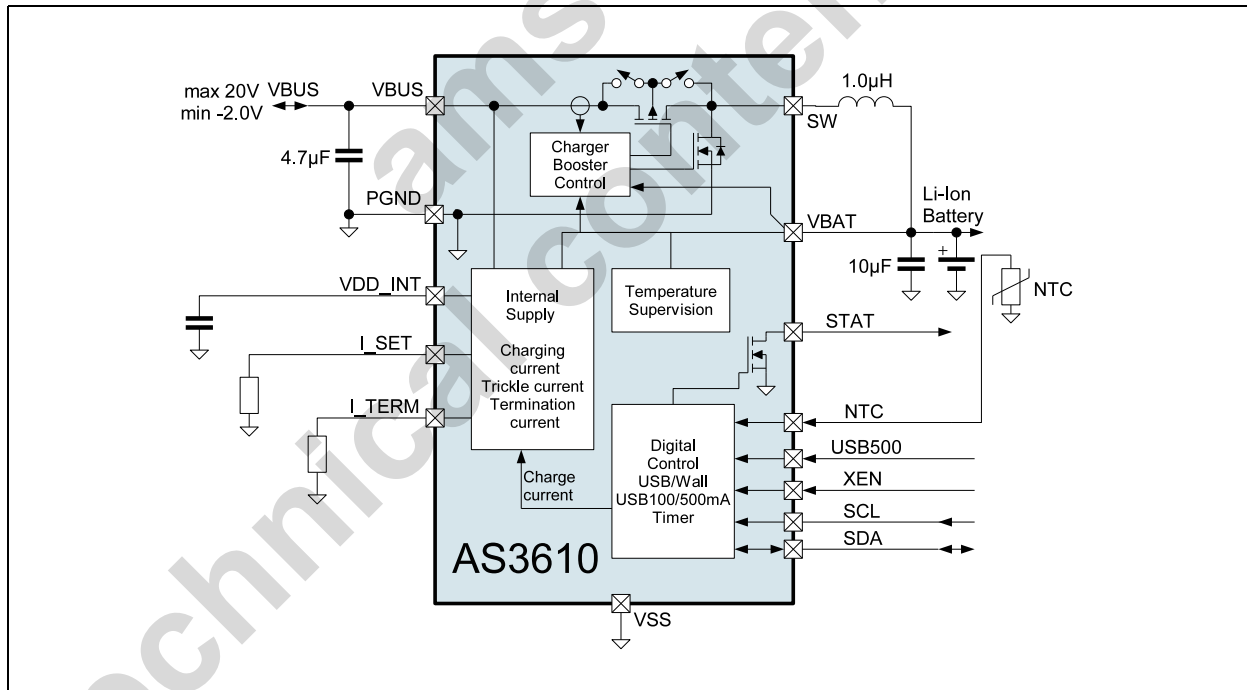
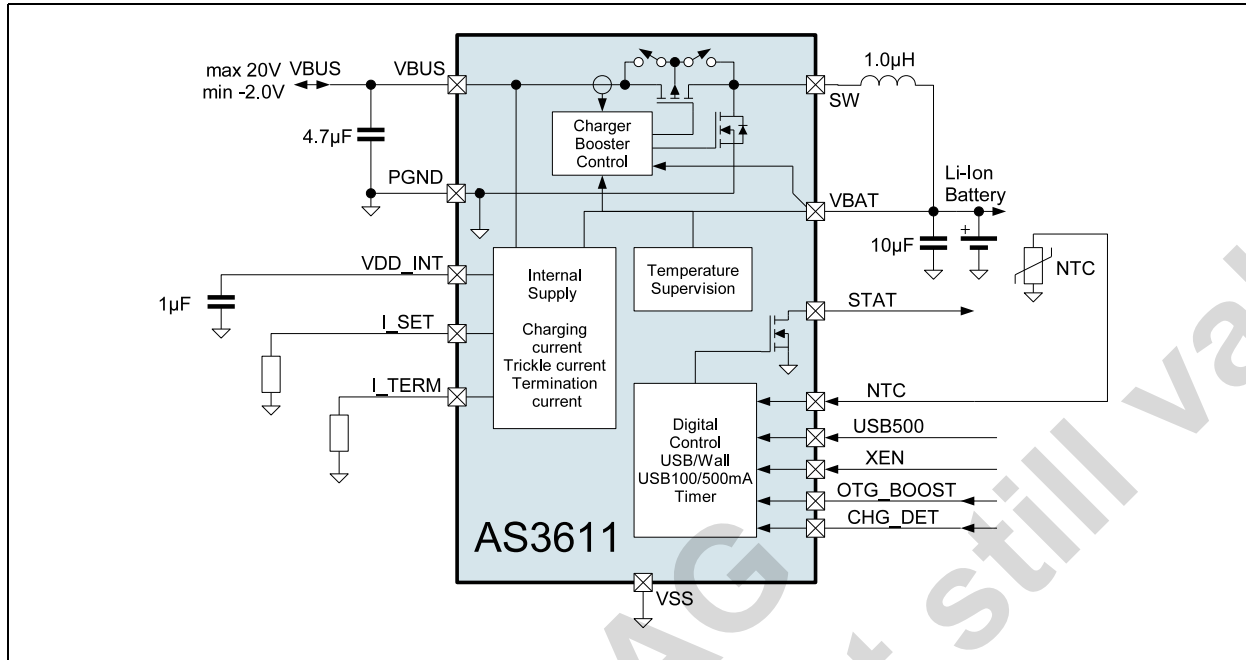


Figure 14. Detailed Block Diagram



## 8.1.2 Charging Cycle Description

### 8.1.2.1 Charge adapter detection

The charger uses an integrated detection circuit to determine if an external charge adapter has been applied to the VBUS pin. If the VBUS voltage exceeds the battery voltage at pin VBAT by  $V_{CHDET}$  the *ChDet* bit in the *ChargerStatus1* register will be set. That detection de-bounce time is approx. 300msec for rising *ChDet* and approx. 30msec for falling *ChDet* signal (*debounce\_timer*=00b).

### 8.1.2.2 Low current soft charging

When the charger is detected and enabled (*chg\_en*=1), no stop charging condition is active and the battery voltage is below  $V_{SOFT}$ , the charging cycle is started with soft\_charging. In that mode the charger is acting as a linear charger down to VBAT. With a current of  $I_{SOFT}$

### 8.1.2.3 (Trickle) Pre-charging

If the battery voltage exceeds  $V_{SOFT}$ , but is below  $V_{TRICKLE}$ , and the bit *prechg\_en* is set, the trickle charging is started.

In that mode the charging current is defined by the external resistor on pin *I\_TERM* or the input current limit if e.g. 100mA input current limit is active.

### 8.1.2.4 Constant current charging

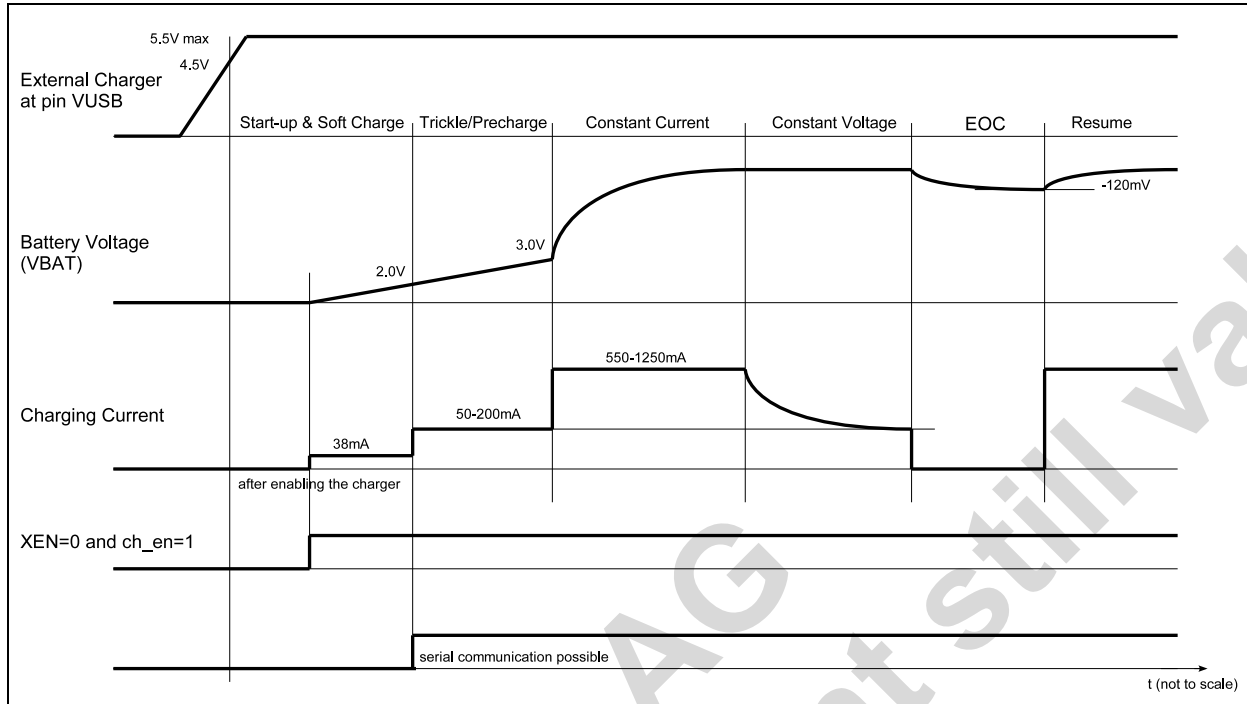
If the battery voltage is above  $V_{TRICKLE}$  and below  $V_{EOC}$  (or above  $V_{SOFT}$  if *prechg\_en*=0) the charging current is defined by the resistor on pin *I\_SET*. In addition the current can be reduced by I2C with the register setting of *constcurr*. (AS3610 only)

### 8.1.2.5 Constant voltage charging

Constant voltage charge mode is initiated, if the battery voltage has reached the  $V_{EOC}$  threshold.

The charge current is monitored during constant voltage charging. It will be decreasing from its initial value during constant current charging and eventually drop below the value set by the resistor on pin *I\_TERM*. If the measured charge current is less than or equal to  $I_{TERM}$ , the charging cycle is terminated and *EOC* is set. The termination current may be reduce by a factor of 2 by setting the *eocurr* bit to 1.

### 8.1.3 Charger States



#### 8.1.4 Stop charging conditions

There are multiple safety features implemented that trigger a stop\_charging condition:

These are the following:

- Battery temperature too high. If  $ntc\_on=1$  and voltage at pin NTC is below  $V_{BATTEMP}$
- Timeout timer expired (If  $ch\_timeout>0$  and charging time has been exceeded). Can be reset by unplugging the charger, setting  $chg\_en=0$  or writing  $charging\_tmax=0$
- $V_{BUS\_OV}$  exceeded
- $V_{BUS\_UVLO}$  reached
- Die temp  $> 140^{\circ}\text{C}$  ( $ov\_temp\_140$  set)

#### 8.1.5 Battery presence indication and operation without battery

After EOC state is reached a timer for NOBAT detection is started. If there is no battery present, the voltage will drop to  $V_{NOBAT\_REG}$ . Depending on the load on VBAT and the capacitor on VBAT this might take some milliseconds to 1 second. The charger will restart charging (ConstantCurrent charging) after 100msec.

The 100msec dead time is necessary to get a battery oscillation frequency of below 10Hz, if there is no battery present and NTC battery detection is not enabled.

If  $No\_bat\_det=1$  and the NOBAT detection timer is below 2 seconds after reaching EOC state, and this happens 2 times in serial, the state "operation without battery" is entered.

If the  $nobat\_ntc\_det$  bit is set the looping described above will be stopped and a NTC detection is started.

A pull up current of 0.5uA is applied to NTC. If the NTC voltage is above 1.8V, the state machine stays in the no bat state. If the  $BATTEMP$  voltage is below 1.8V, a charging cycle is restarted.

#### 8.1.6 VBUS undervoltage regulation

If the voltage on VBUS drops below  $V_{chg\_min}$  the current is regulated down to avoid overloading of the input source.

#### 8.1.7 Charger overvoltage protection

This blocks checks if the charger voltage VBUS is above  $V_{BUS\_OV}$ . In that case the bit  $stop\_charging$  is set and the charging is stopped until VBUS is below  $V_{BUS\_OV}$ .

### 8.1.8 NTC supervision

This charger block also features a supply for an external NTC resistor to measure the battery temperature while charging. If the temperature is too high (voltage on NTC pin is below VBATTEMP\_ON) the charger will stop operation (stop\_charging=1).

When the battery temperature drops, the voltage on NTC pin will rise above VBATTEMP\_OFF and the charger will start charging again. This is forming a temperature hysteresis of about 3 to 5°C to avoid an oscillation of the charger.

The levels for switching off the charger (**ntc\_temp**: 45°C or 55°C) as well as the type of NTC (**ntc\_10k**: 10k or 100k) can be selected via register settings. The battery temperature supervision via the NTC can be switched off (**ntc\_on** = 0).

The supply for the NTC will be only on when a charger is detected and **ntc\_on** bit is set.

## 8.2 Step up converter mode (OTG Boost)

The step down charger can also be used in a boost mode providing an output voltage VBOOST on pin VBUS typ 5.05V. In that mode the current direction is inverted to the charging mode providing current from the battery to the VBUS pin. To enable that mode, it's necessary that the charger is disabled (XEN=1 or chg\_en=0) and the bit boost\_en is set (and for AS3611 the pin OTG\_BOOST=1). The bit boost\_lowcurr selects the output current capability between 200mA and 500mA.

### 8.2.1 Softstart of OTG booster

There is a softstart implemented to reduced inrush current on the VBAT input. For approx. 1msec after the booster is enabled the output current is limited below 100mA. After that startup time the full current is available.

### 8.2.2 Short-circuit and overvoltage protection circuit

To protect the booster, the battery capacity and the circuit connected to VBUS there are multiple protection circuits implemented:

- VBAT drops below 2.6V (typ)
- VBUS is above 5.3V (typ)
- Booster is in current limit operation (e.g. output VBUS is overloaded or shorted to GND)

If one of these conditions is valid for more that 30msec debounce time (*debounce\_timer*=00b), the booster is stopped and the boost\_error bit is set. To restart the booster it's necessary to set boost\_en=0 and 1 again. (For AS3611 the OTG\_BOOST pin has to be set to 0 and 1 again).

If the die Temp is above 140deg the booster is stopped and restarted automatically when the die temperature drops.

## 8.3 2-Wire-Serial Control Interface

### 8.3.1 Feature List

- Fast-mode capability (max. SCL-frequency is 400 kHz)
- 7+1-bit addressing mode
- 60h x 8-bit data registers (word address 0x00 - 0x60)
- Write formats: Single-Byte-Write, Page-Write
- Read formats: Current-Address-Read, Random-Read, Sequential-Read
- SDA input delay and SCL spike filtering by integrated RC-components

### 8.3.2 Protocol

Table 4. 2-Wire Serial Symbol Definition

| Symbol | Definition                 | RW | Note             |
|--------|----------------------------|----|------------------|
| S      | Start condition after stop | R  | 1 bit            |
| Sr     | Repeated start             | R  | 1 bit            |
| DW     | Device address for write   | R  | 1000 1100b (8Ch) |
| DR     | Device address for read    | R  | 1000 1101b (8Dh) |
| WA     | Word address               | R  | 8 bit            |
| A      | Acknowledge                | W  | 1 bit            |
| N      | No Acknowledge             | R  | 1 bit            |

Table 4. 2-Wire Serial Symbol Definition

| Symbol   | Definition                        | RW | Note               |
|----------|-----------------------------------|----|--------------------|
| reg_data | Register data/write               | R  | 8 bit              |
| data (n) | Register data/read                | W  | 8 bit              |
| P        | Stop condition                    | R  | 1 bit              |
| WA++     | Increment word address internally | R  | during acknowledge |

Figure 15. Byte Write

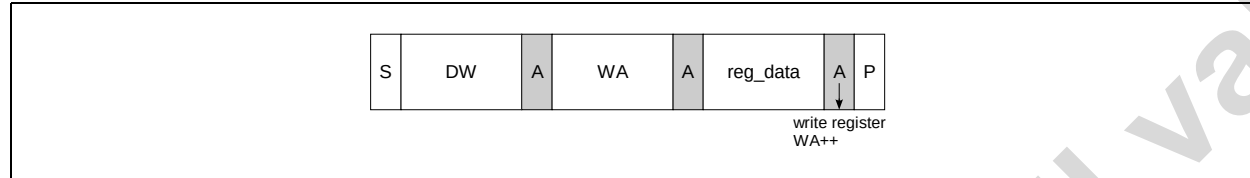
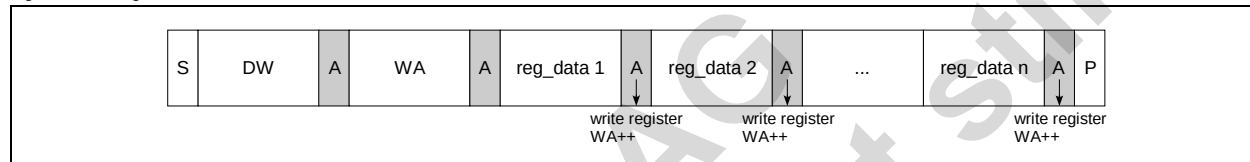


Figure 16. Page Write

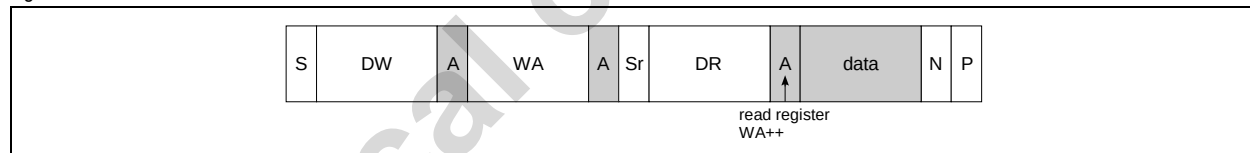


Byte Write and Page Write formats are used to write data to the slave.

The transmission begins with the START condition, which is generated by the master when the bus is in IDLE state (the bus is free). The device-write address is followed by the word address. After the word address any number of data bytes can be sent to the slave. The word address is incremented internally, in order to write subsequent data bytes on subsequent address locations.

For reading data from the slave device, the master has to change the transfer direction. This can be done either with a repeated START condition followed by the device-read address, or simply with a new transmission START followed by the device-read address, when the bus is in IDLE state. The device-read address is always followed by the 1st register byte transmitted from the slave. In Read Mode any number of subsequent register bytes can be read from the slave. The word address is incremented internally.

Figure 17. Random Read

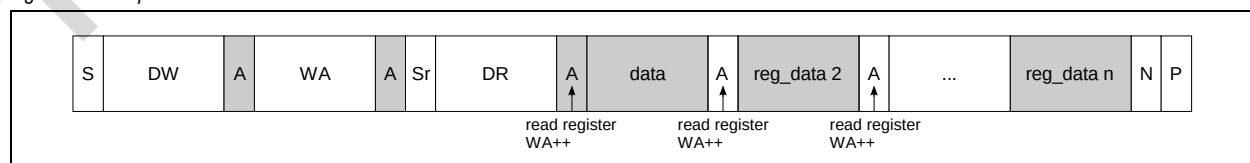


Random Read and Sequential Read are combined formats. The repeated START condition is used to change the direction after the data transfer from the master.

The word address transfer is initiated with a START condition issued by the master while the bus is idle. The START condition is followed by the device-write address and the word address.

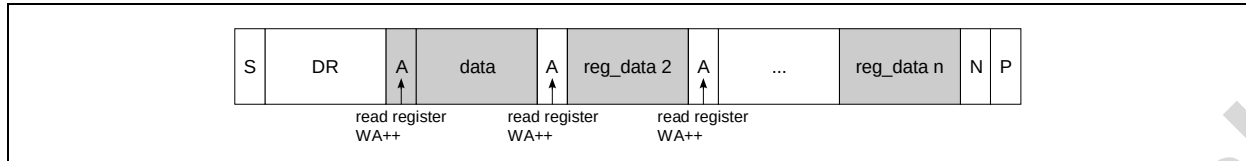
In order to change the data direction a repeated START condition is issued on the 1st SCL pulse after the acknowledge bit of the word address transfer. After the reception of the device-read address, the slave becomes the transmitter. In this state the slave transmits register data located by the previous received word address vector. The master responds to the data byte with a not-acknowledge, and issues a STOP condition on the bus.

Figure 18. Sequential Read



Sequential Read is the extended form of Random Read, as more than one register-data bytes are transferred subsequently. In difference to the Random Read, for a sequential read the transferred register-data bytes are responded by an acknowledge from the master. The number of data bytes transferred in one sequence is unlimited (consider the behavior of the word-address counter). To terminate the transmission the master has to send a not-acknowledge following the last data byte and generate the STOP condition subsequently.

Figure 19. Current Address Read



To keep the access time as small as possible, this format allows a read access without the word address transfer in advance to the data transfer. The bus is idle and the master issues a START condition followed by the Device-Read address. Analogous to Random Read, a single byte transfer is terminated with a not-acknowledge after the 1st register byte. Analogous to Sequential Read an unlimited number of data bytes can be transferred, where the data bytes has to be responded with an acknowledge from the master. For termination of the transmission the master sends a not-acknowledge following the last data byte and a subsequent STOP condition.

The AS3610 is compatible to the NXP two wire specification [http://www.nxp.com/acrobat\\_download2/literature/9398/39340011.pdf](http://www.nxp.com/acrobat_download2/literature/9398/39340011.pdf) Version 2.1 January 2000 for standard and fast mode (no high speed mode).

## 8.4 AS3611 pre-programmed variants

AS3611 is intended to work stand-alone with out an micro-controller. For this use case some of the basic configurations have to be pre-programmed into the device. Two basic configurations are shown in the tables below. Adaptations to these configurations are possible upon request.

Table 5. AS3611-A stand alone version for Li-Ion/LiPo, 100kOhm NTC

| Reg. Addr. | Value | Description                                                                               | Reg. Name               |
|------------|-------|-------------------------------------------------------------------------------------------|-------------------------|
| 0          | 7Fh   | standalone mode=1, Boost_en=1, prechg_en=1, nobat_det=0                                   | Charger Control         |
| 1          | 63h   | Veoc=4.2V, Vchg_min=4.2                                                                   | Charger Voltage Control |
| 2          | 00h   |                                                                                           | Charger Current Control |
| 3          | 05h   | 100kOhm NTC, low_temp range (45/50°C)                                                     | NTC Supervision         |
| 4          | 8Ah   | ch_timeout=5h, stat_mode: charging=on; EOC=1Hz blinking, stop_charging or boost_error=5Hz | Charger supervision     |

Table 6. AS3611-B stand alone version for Li-Ion/LiPo, 10kOhm NTC

| Reg. Addr. | Value | Description                                                                               | Reg. Name               |
|------------|-------|-------------------------------------------------------------------------------------------|-------------------------|
| 0          | 7Fh   | standalone mode=1, Boost_en=1, prechg_en=1, nobat_det=0                                   | Charger Control         |
| 1          | 63h   | Veoc=4.2V, Vchg_min=4.2                                                                   | Charger Voltage Control |
| 2          | 00h   |                                                                                           | Charger Current Control |
| 3          | 07h   | 10kOhm NTC, low_temp range (45/50°C)                                                      | NTC Supervision         |
| 4          | 8Ah   | ch_timeout=5h, stat_mode: charging=on; EOC=1Hz blinking, stop_charging or boost_error=5Hz | Charger supervision     |

Table 7. AS3611-C stand alone version for FePO4, 10kOhm NTC

| Reg. Addr. | Value | Description                                                                             | Reg. Name               |
|------------|-------|-----------------------------------------------------------------------------------------|-------------------------|
| 0          | 7Fh   | standalone mode=1, Boost_en=1, prechg_en=1, nobat_det=0                                 | Charger Control         |
| 1          | 47h   | Veoc=3.64V, Vchg_min=4.2                                                                | Charger Voltage Control |
| 2          | 01h   | eocurr=1                                                                                | Charger Current Control |
| 3          | 05h   | 100kOhm NTC, low_temp range (45/50°C)                                                   | NTC Supervision         |
| 4          | A6h   | ch_timeout=3h, stat_mode: ch_det=on; EOC=1Hz blinking, stop_charging or boost_error=5Hz | Charger supervision     |

## 8.5 Register Description

**Charger Control Register (Address 0).**

| Addr: 0 |              | Charger Control                                                               |        |                                                                                                                                                                                         |
|---------|--------------|-------------------------------------------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |              | This register controls the mode of the charger and the charger state machine. |        |                                                                                                                                                                                         |
| Bit     | Bit Name     | Default                                                                       | Access | Bit Description                                                                                                                                                                         |
| 0       | Chg_en       | 1b/ROM                                                                        | R/W    | ON/OFF control of USB charger input                                                                                                                                                     |
|         |              |                                                                               |        | 0 Charger disabled<br>1 <b>Charger enabled, if XEN=0</b>                                                                                                                                |
| 1       | Boost_en     | 0b/ROM                                                                        | R/W    | ON/OFF control of Step up for USB OTG<br>Normal operation (usb current=0..6):                                                                                                           |
|         |              |                                                                               |        | 0 <b>Step up disabled</b><br>1 Step up enabled                                                                                                                                          |
|         |              |                                                                               |        | AS3611 standalone charger operation only w/o I <sup>2</sup> C (usb current=7)                                                                                                           |
|         |              |                                                                               |        | 0 <b>Step up disabled</b><br>1 Step up enabled, if OTG_BOOST=1,<br>Step up disabled, if OTG_BOOST=0                                                                                     |
| 4:2     | usb_current  | 000b/ROM                                                                      | R/W    | USB input current limit, AS3610 I <sup>2</sup> C version only                                                                                                                           |
|         |              |                                                                               |        | 000b <b>100mA, if pin USB500=0</b><br><b>500mA, if pin USB500=1</b>                                                                                                                     |
|         |              |                                                                               |        | 001b 100mA<br>010b 500mA limit<br>011b 900mA limit<br>100b unlimited<br>101b NA<br>110b unlimited                                                                                       |
|         |              |                                                                               |        | 111b AS3611 stand alone charger only w/o I <sup>2</sup> C<br>CHG_DET=1 and USB500=0 → 100mA limit<br>CHG_DET=1 and USB500=1 → 500mA limit<br>CHG_DET=0 and USB500=1 → unlimited current |
|         |              |                                                                               |        |                                                                                                                                                                                         |
| 5       | prechg_en    | 1b/ROM                                                                        | R/W    | 0 Pre-charge (trickle charge) disabled. Charger starts with constant current, if V <sub>BAT</sub> >2.0V (current set by resistor I <sub>SET</sub> )                                     |
|         |              |                                                                               |        | 1 <b>Pre-charge (trickle charge) enabled. Charger starts with trickle current, if 2.9V&gt;V<sub>BAT</sub>&gt;2.0V (Current set by resistor I<sub>term</sub>)</b>                        |
| 6       | disable_toff | 1b/ROM                                                                        | R/W    | 0 Off time of step down charger enabled. If 100% pmos on mode is needed, off pulses are skipped                                                                                         |
|         |              |                                                                               |        | 1 <b>Off time of step down charger disabled. Smooth transition to 100% pmos on if needed (V<sub>BUS</sub>-V<sub>BAT</sub> is small)</b>                                                 |
| 7       | No_bat_det   | 1b/ROM                                                                        | R/W    | 0 Nobat detection disabled.                                                                                                                                                             |
|         |              |                                                                               |        | 1 <b>Nobat detection enabled. If No Battery is detected a small current through NTC (approx. 0.5μA), checks if a battery is connected again. A NTC is necessary for that setting.</b>   |



**Charger Voltage Control Register (Address 1).**

| Addr: 1 |          | Charger Voltage Control                      |        |                                                                                                    |
|---------|----------|----------------------------------------------|--------|----------------------------------------------------------------------------------------------------|
|         |          | This register controls the charger voltages. |        |                                                                                                    |
| Bit     | Bit Name | Default                                      | Access | Bit Description                                                                                    |
| 5:0     | Veoc     | 100011b/<br>ROM                              | R/W    | End of charge voltage on VBAT                                                                      |
|         |          |                                              |        | 0 3.5V                                                                                             |
|         |          |                                              |        | ... ..                                                                                             |
|         |          |                                              |        | 35 4.2V                                                                                            |
|         |          |                                              |        | ... ..                                                                                             |
| 7:6     | Vchg_min | 00b/ROM                                      | R/W    | Minimum charger (VBUS) voltage. Current is regulated down, if VBUS voltage drops below this level: |
|         |          |                                              |        | 0 VBAT < 3.9V                                                                                      |
|         |          |                                              |        | 1 VBAT < 4.2V                                                                                      |
|         |          |                                              |        | 2 VBAT < 4.5V                                                                                      |
|         |          |                                              |        | 3 VBAT < 4.7V                                                                                      |

**Charger Current Control Register (Address 2).**

| Addr: 2 |               | Charger Current Control                      |        |                                                                                                  |
|---------|---------------|----------------------------------------------|--------|--------------------------------------------------------------------------------------------------|
|         |               | This register controls the charger currents. |        |                                                                                                  |
| Bit     | Bit Name      | Default                                      | Access | Bit Description                                                                                  |
| 0       | eoccurr       | 0b/<br>ROM                                   | R/W    | Current ratio selection between trickle and EOC current (defined by resistor R <sub>TERM</sub> ) |
|         |               |                                              |        | 0 EOC current = I <sub>TERM</sub> , Trickle current = I <sub>TERM</sub>                          |
|         |               |                                              |        | 1 EOC current = I <sub>TERM</sub> / 2, Trickle current = I <sub>TERM</sub>                       |
| 2:1     | constcurr     | 00b/ROM                                      | R/W    | Constant Current setting                                                                         |
|         |               |                                              |        | 0 Constant Current = I <sub>CHARGE</sub>                                                         |
|         |               |                                              |        | 1 Constant Current = 0.81*I <sub>CHARGE</sub>                                                    |
|         |               |                                              |        | 2 Constant Current = 0.60*I <sub>CHARGE</sub>                                                    |
|         |               |                                              |        | 3 Constant Current = 0.40*I <sub>CHARGE</sub>                                                    |
| 3       | boost_lowcurr | 0b/ROM                                       | R/W    | Current selection for boost mode                                                                 |
|         |               |                                              |        | 0 500mA maximum current                                                                          |
|         |               |                                              |        | 1 200mA maximum current                                                                          |
| 4       | NA            | NA                                           | NA     | NA                                                                                               |
| 5       | en_pon        | 0b/ROM                                       | R/W    | Enables 100% on mode of PMOS                                                                     |
|         |               |                                              |        | 0 100% mode disabled (smooth 100% mode, if disable_toff=1)                                       |
|         |               |                                              |        | 1 100% mode enabled.                                                                             |
| 7:6     | deb_timer     | 00b/ROM                                      | R/W    | Select debounce timer                                                                            |
|         |               |                                              |        | 0 30msec debounce timer for comparator output                                                    |
|         |               |                                              |        | 1 3msec debounce timer                                                                           |
|         |               |                                              |        | 2 NA                                                                                             |
|         |               |                                              |        | 3 NA                                                                                             |

**NTC Supervision Register (Address 03).**

| Addr: 03 |          | NTC Supervision                                        |        |                                                                                        |
|----------|----------|--------------------------------------------------------|--------|----------------------------------------------------------------------------------------|
|          |          | These bits define the battery temperature supervision. |        |                                                                                        |
| Bit      | Bit Name | Default                                                | Access | Bit Description                                                                        |
| 0        | ntc_on   | 1b/ROM                                                 | R/W    | ON/OFF control of battery NTC supervision                                              |
|          |          |                                                        |        | 0 Disabled<br>1 <b>Enabled</b>                                                         |
| 1        | ntc_10k  | 1b/ROM                                                 | R/W    | Select NTC resistor type                                                               |
|          |          |                                                        |        | 0 100k $\Omega$<br>1 <b>10k<math>\Omega</math></b>                                     |
| 2        | ntc_temp | 1b/ROM                                                 | R/W    | Select NTC temperature shutdown                                                        |
|          |          |                                                        |        | 0 high temperature range (50 or 55 °C)<br>1 <b>low temperature range (45 or 50 °C)</b> |

**Charger Supervision Register (Address 04).**

| Addr: 04 |               | Charger Supervision                        |        |                                                                                   |
|----------|---------------|--------------------------------------------|--------|-----------------------------------------------------------------------------------|
|          |               | These bits define charging timer settings. |        |                                                                                   |
| Bit      | Bit Name      | Default                                    | Access | Bit Description                                                                   |
| 3:0      | ch_timeout    | 1010b/ROM                                  | R/W    | Charging timeout timer                                                            |
|          |               |                                            |        | 0 Charging timer disabled                                                         |
|          |               |                                            |        | 1 0.5 hour                                                                        |
|          |               |                                            |        | 2 1 hour                                                                          |
|          |               |                                            |        | 3 1.5 hour                                                                        |
|          |               |                                            |        | 4 2 hour                                                                          |
|          |               |                                            |        | 5 2.5 hour                                                                        |
|          |               |                                            |        | 6 3 hour                                                                          |
|          |               |                                            |        | 7 3.5 hour                                                                        |
|          |               |                                            |        | 8 4 hour                                                                          |
|          |               |                                            |        | 9 4.5 hour                                                                        |
|          |               |                                            |        | 10 <b>5 hour</b>                                                                  |
|          |               |                                            |        | 11 5.5 hour                                                                       |
|          |               |                                            |        | 12 6 hour                                                                         |
|          |               |                                            |        | 13 6.5 hour                                                                       |
|          |               |                                            |        | 14 7 hour                                                                         |
|          |               |                                            |        | 15 7.5 hour                                                                       |
| 4        | charging_tmax | 0b/ROM                                     | R/W    | 0 <b>Read: no timeout reached</b><br><b>Write: reset charger timeout counter</b>  |
|          |               |                                            |        | 1 t <sub>CHARGING,MAX</sub> timeout reached and charging stopped                  |
| 7:5      | stat_mode     | 010b/ROM                                   | R/W    | Function of Status pin:                                                           |
|          |               |                                            |        | 0 always off                                                                      |
|          |               |                                            |        | 1 ch_det=ON                                                                       |
|          |               |                                            |        | 2 ch_det=ON, stop_charging or boost_error=5Hz blinking                            |
|          |               |                                            |        | 3 Charging=ON, stop_charging or boost_error=5Hz blinking                          |
|          |               |                                            |        | 4 <b>Charging=ON, EOC=1Hz blinking, stop_charging or boost_error=5Hz blinking</b> |
|          |               |                                            |        | 5 ch_det =ON, EOC=1Hz blinking, stop_charging or boost_error=5Hz blinking         |

**Charger Status1 Register (Address 05).**

| Addr: 05 |            | Charger Status1                            |        |                                                                                                                                                              |
|----------|------------|--------------------------------------------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |            | These bits show the status of the charger. |        |                                                                                                                                                              |
| Bit      | Bit Name   | Default                                    | Access | Bit Description                                                                                                                                              |
| 0        | ChDet      | NA                                         | R      | Bit is set when charge adapter has been detected on pin VBUS                                                                                                 |
| 1        | CCM        | NA                                         | R      | Bit is set when charger is in Constant current mode                                                                                                          |
| 2        | Resume     | NA                                         | R      | Bit is set when battery voltage has dropped below resume level                                                                                               |
| 3        | Trickle    | NA                                         | R      | Bit is set when charger is in trickle charge mode                                                                                                            |
| 4        | CVM        | NA                                         | R      | Bit is set when charger is in top-off charge mode (constant voltage mode)                                                                                    |
| 5        | EOC        | NA                                         | R      | Bit is set when charging has been terminated. Bit is cleared automatically when chg_en is cleared or charging is resumed.                                    |
| 6        | Battemp_hi | NA                                         | R      | Bit is set, if temperature is greater than 50 or 55°C. Bit is evaluated if charger is detected.                                                              |
| 7        | NoBat      | NA                                         | R      | Bit is set when battery detection circuit indicates that no battery is connected to the system. This is done by measuring the NTC value. ntc_on has to be 1. |

**Charger Status2 Register (Address 06).**

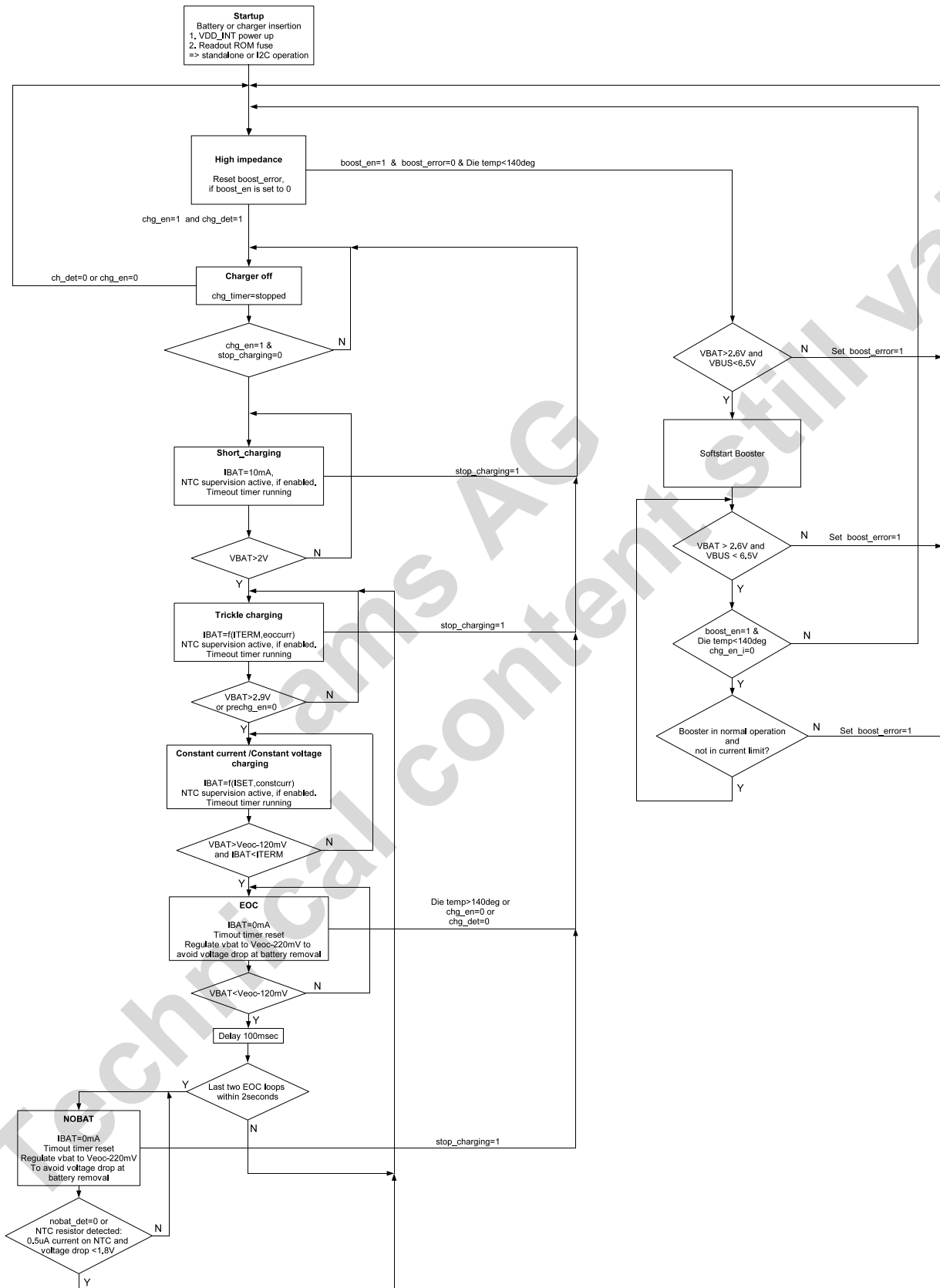
| Addr: 06 |               | Charger Status2                            |        |                                                                                                                                                                                                                  |
|----------|---------------|--------------------------------------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |               | These bits show the status of the charger. |        |                                                                                                                                                                                                                  |
| Bit      | Bit Name      | Default                                    | Access | Bit Description                                                                                                                                                                                                  |
| 0        | LowBat        | NA                                         | R      | Set, if VBAT<2V                                                                                                                                                                                                  |
| 1        | OVBat         | NA                                         | R      | Set, if VBAT> 1.17*V <sub>CHARGE</sub>                                                                                                                                                                           |
| 2        | LowBus        | NA                                         | R      | Set, if VBUS<3.8V                                                                                                                                                                                                |
| 3        | OVBUS         | NA                                         | R      | Set, if VBUS>6.5V                                                                                                                                                                                                |
| 4        | UVLBus        | NA                                         | R      | Set, if VBUS<3.3V                                                                                                                                                                                                |
| 5        | Boost_act     | NA                                         | R      | Set, if boost mode active                                                                                                                                                                                        |
| 6        | Boost_err     | NA                                         | R      | Set, if boost error active. (Overcurrent of booster for more than debounce time, VBAT<2.5V, VBUS>6.5V or current limit is active)                                                                                |
| 7        | Stop charging | NA                                         | R      | Set if charger is stopped because of the following reason:<br>- Timeout timer expired<br>- NTC temperature error (Hightemp)<br>- OVBUS set<br>- OVBat set<br>- UVLBus set<br>- Die temp>140deg (ov_temp_140 set) |

## 8.6 Register Overview

Table 8. Register table

| Register                   | dec | hex | Default | b7             | b6               | b5        | b4                | b3                | b2        | b1       | b0      |
|----------------------------|-----|-----|---------|----------------|------------------|-----------|-------------------|-------------------|-----------|----------|---------|
| ChargerControl1            | 0   | 0h  | E1h     | No_bat_d<br>et | disable_to<br>ff | prechg_en | usb_current<2:0>  |                   |           | Boost_en | Chg_en  |
| Charger Voltage<br>Control | 1   | 1h  | 63h     | Vchg_min       |                  | Veoc      |                   |                   |           |          |         |
| Charger Current<br>Control | 2   | 2h  | 10h     | deb_timer      |                  | en_pon    |                   | boost_low<br>curr | constcurr |          | eoccurr |
| NTC supervision            | 3   | 3h  | 01h     |                |                  |           |                   |                   | ntc_temp  | ntc_10k  | ntc_on  |
| Charger<br>supervision     | 4   | 4h  | 4Ah     | stat_mode      |                  |           | charging_t<br>max | ch_timeout        |           |          |         |
| ChargerStatus1             | 5   | 5h  | NA      | NoBat          | Battemp_<br>hi   | EOC       | CVM               | Trickle           | Resume    | CCM      | ChDet   |
| ChargerStatus2             | 6   | 6h  | NA      | bat_prech<br>g | Boost_err        | Boost_act | UVLBus            | OVBUS             | LowBus    | OVBat    | LowBat  |
|                            |     |     |         |                |                  |           |                   |                   |           |          |         |
| ASIC_ID1                   | 62  | 3Eh |         | 1              | 1                | 0         | 0                 | 1                 | 0         | 1        | 1       |
| ASIC_ID2                   | 63  | 3Fh |         | 0              | 1                | 0         | 1                 | revision          |           |          |         |

Figure 20. AS3610/11 State Diagram

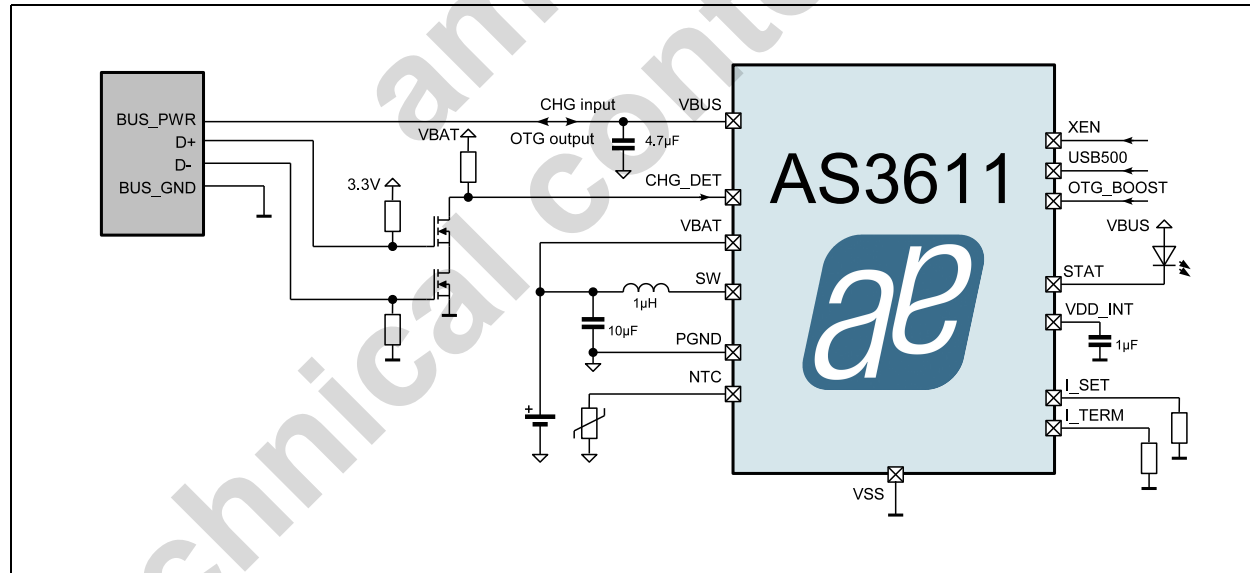


## 9 Application Information

Table 9. External Components

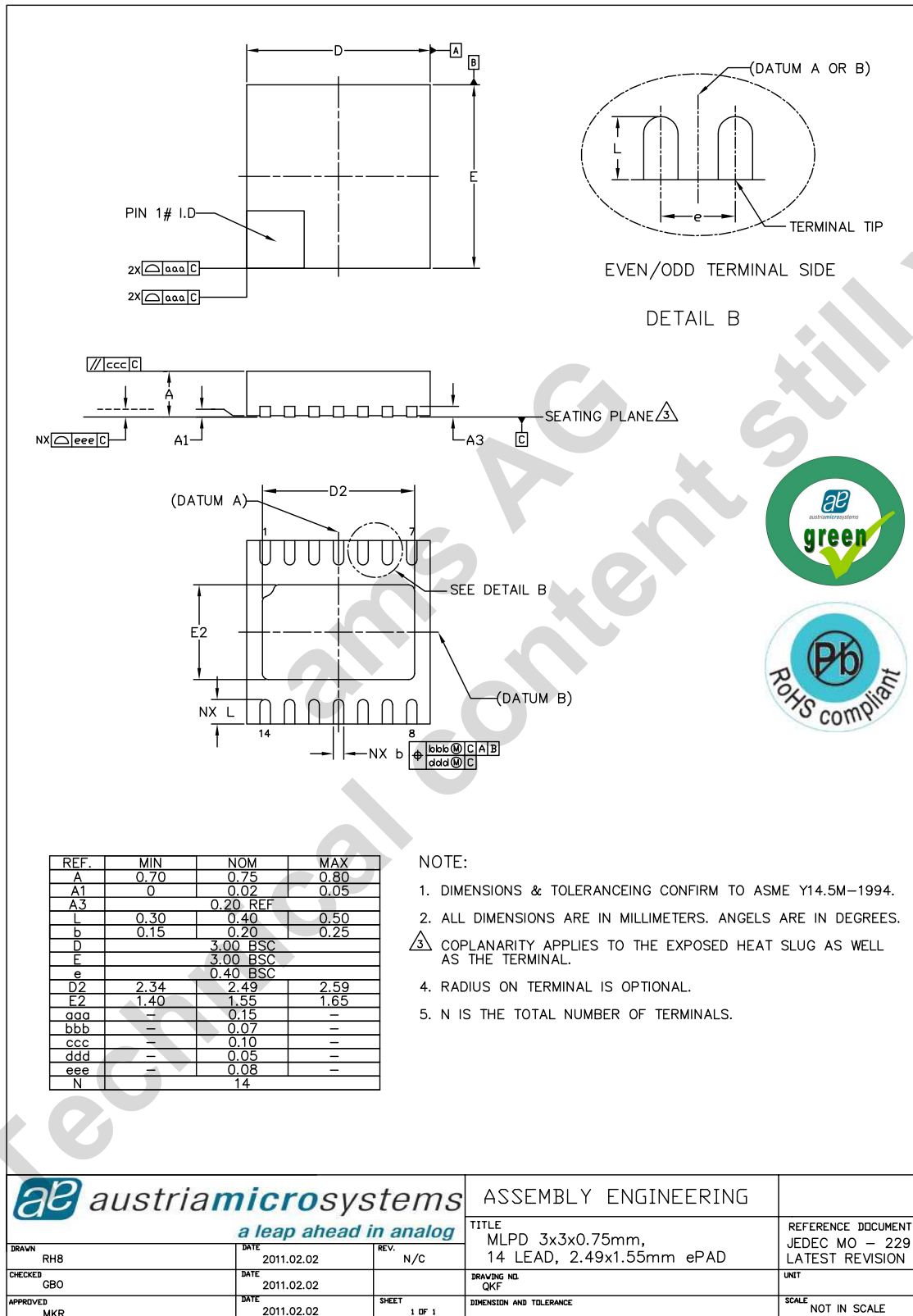
| Symbol         | Parameter                                  | Note                                                                                                 | Min  | Typ                                                          | Max   | Unit             |
|----------------|--------------------------------------------|------------------------------------------------------------------------------------------------------|------|--------------------------------------------------------------|-------|------------------|
| $C_{VBUS}$     | Input capacitor                            | Ceramic X5R or X7R, 16 or 25V                                                                        | -20% | 4.7                                                          | +120% | $\mu\text{F}$    |
| $C_{VBAT}$     | Output capacitor                           | Ceramic X5R or X7R, 6.3V                                                                             | -20% | 10                                                           | +120% | $\mu\text{F}$    |
| $C_{VDD\_INT}$ | Output capacitor                           | Ceramic X5R or X7R                                                                                   | -20% | 1                                                            | +100% | $\mu\text{F}$    |
| L              | Inductor (chip coil)                       | LQM2HPN1R0MJ0 (Murata), Isat=1.5A,<br>ESR=0.85mOhm<br>MLP2520S1R0M (TDK), Isat=1.5A,<br>ESR=0.85mOhm |      | 1                                                            |       | $\mu\text{H}$    |
| $R_{SET}$      | Resistor for CC current setting            | 550mA<br>650mA<br>750mA<br>850mA<br>950mA<br>1050mA<br>1150mA<br>1250mA                              |      | 39,0<br>33,0<br>28,6<br>25,2<br>22,6<br>20,4<br>18,7<br>17,2 |       | $\text{k}\Omega$ |
| $R_{TERM}$     | Resistor for trickle / EOC current setting | 50mA<br>100mA<br>150mA<br>200mA                                                                      |      | 24<br>12<br>8<br>6                                           |       | $\text{k}\Omega$ |
| $R_{NTC}$      | NTC Thermistor                             | @25°C                                                                                                |      | 10 / 100                                                     |       | $\text{k}\Omega$ |

Figure 21. AS3611 USB detection



## 10 Package Drawings and Markings

Figure 22. MLPD14 3x3mm Package Drawings and Dimensions



## Revision History

| Revision | Date       | Owner | Description                                                                  |
|----------|------------|-------|------------------------------------------------------------------------------|
| 0.6      | 11.5.2011  | pkm   | Initial draft                                                                |
| 0.7      | 1.9.2011   | pkm   | fixed typos, extended detailed description                                   |
| 0.9      | 16.9.2011  | pkm   | fixed typos, changed ESD level for STAT pin, removed 0.5% EOC voltage limits |
| 1.0      | 20.09.2011 | cwo   | update values for pre-programmed variants, final release                     |
| 1.01     | 28.12.2011 | cwo   | Typos correction                                                             |
| 1.1      | 15.3.2012  | pkm   | added C-Version for FePO4 batteries                                          |

**Note:** Typos may not be explicitly mentioned under revision history.



## 11 Ordering Information

The devices are available as the standard products shown in [Table 10](#).

Table 10. Ordering Information

| Ordering Code | Marking | Description                                                             | Delivery Form           | Package      |
|---------------|---------|-------------------------------------------------------------------------|-------------------------|--------------|
| AS3610-BDFP   | AS10    | Switching Charger for Li-Ion/LiPo/LiFePO4 powered devices (I2C control) | Tape & Reel in Dry Pack | MLPD14 3x3mm |
| AS3611-BDFP-A | AS1A    | Switching Charger for Li-Ion/LiPo powered devices (stand alone)         | Tape & Reel in Dry Pack | MLPD14 3x3mm |
| AS3611-BDFP-B | AS1B    | Switching Charger for Li-Ion/LiPo powered devices (stand alone)         | Tape & Reel in Dry Pack | MLPD14 3x3mm |
| AS3611-BDFP-C | AS1C    | Switching Charger for LiFePO4 powered devices (stand alone)             | Tape & Reel in Dry Pack | MLPD14 3x3mm |

**Note:** All products are RoHS compliant and austriamicrosystems green.

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