

DATASHEET

AXP209

Enhanced single Cell Li-Battery and Power System Management IC

X-Powers

1. INTRODUCTION

AXP209 is a highly integrated power management IC that provides easy and flexible power solution for applications that powered by single cell Li-battery (Li-ion or Li-polymer) and requiring multi-power outputs as well. It has fully met the increasingly complex needs of application processors on accurate power control.

AXP209 integrates an adaptive and USB-compatible PWM charger, two step-down converters (Buck DC-DC converter), five LDO regulators, multiple voltage/current/temperature 12-bit ADCs, and four configurable GPIOs. It also features protection circuitry such as over/under-voltage protection (OVP/UVLP), over-temperature protection (OTP), and over-current protection (OCP) to guarantee the power system security and stability.

The Intelligent Power Select (Intelligent Power Select, IPS™) of AXP209 can allocate power safely and transparently among USB, external AC adapter, Li-battery, and application loads. It also enables applications to work normally with the presence of only external input power and no batteries (or battery deeply discharged/damage).

AXP209 is capable of three input methods: external adaptor input, USB input and battery input. It also supports rechargeable backup batteries.

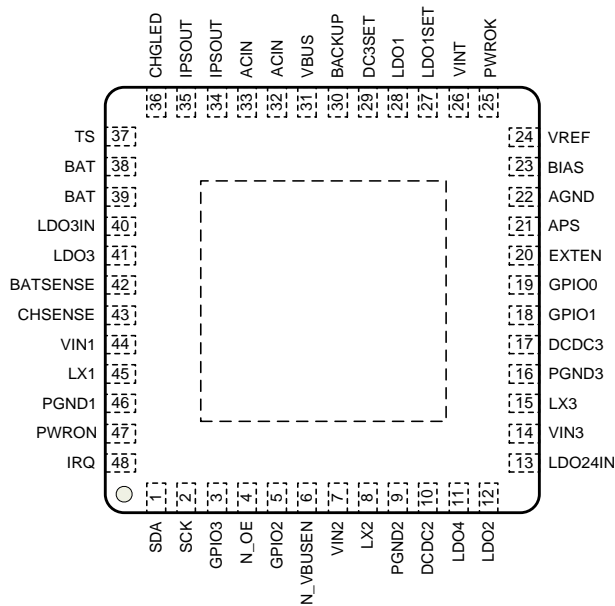
In addition, AXP209 comes with a Two Wire Serial Interface (TWSI), through which the application processor is capable of enabling/disabling some power outputs, programming the voltage, and visiting internal registers and measurement data (including Fuel Gauge). The high accuracy (1%, depending on the 1% accuracy of BIAS resistors) of power measurement enables consumers to know more about the real-time power consumption, providing them with unprecedented experience of power management.

AXP209 is available in 6mm x 6mm 48-pin QFN package.

APPLICATIONS

- Portable Devices: Smart Phone, PMP/MP4, Digital Camera, Camcorder, PND, PDA, PTV
- Mobile Internet Devices xPad, MID
- Digital Photo Frame, Portable DVD Player, Ultra-Mobile PC(UMPC) and UMPC-like, Entertaining and Education Machine
- Application Processor Systems
- Other battery and multi-power application systems

PIN DEFINITION

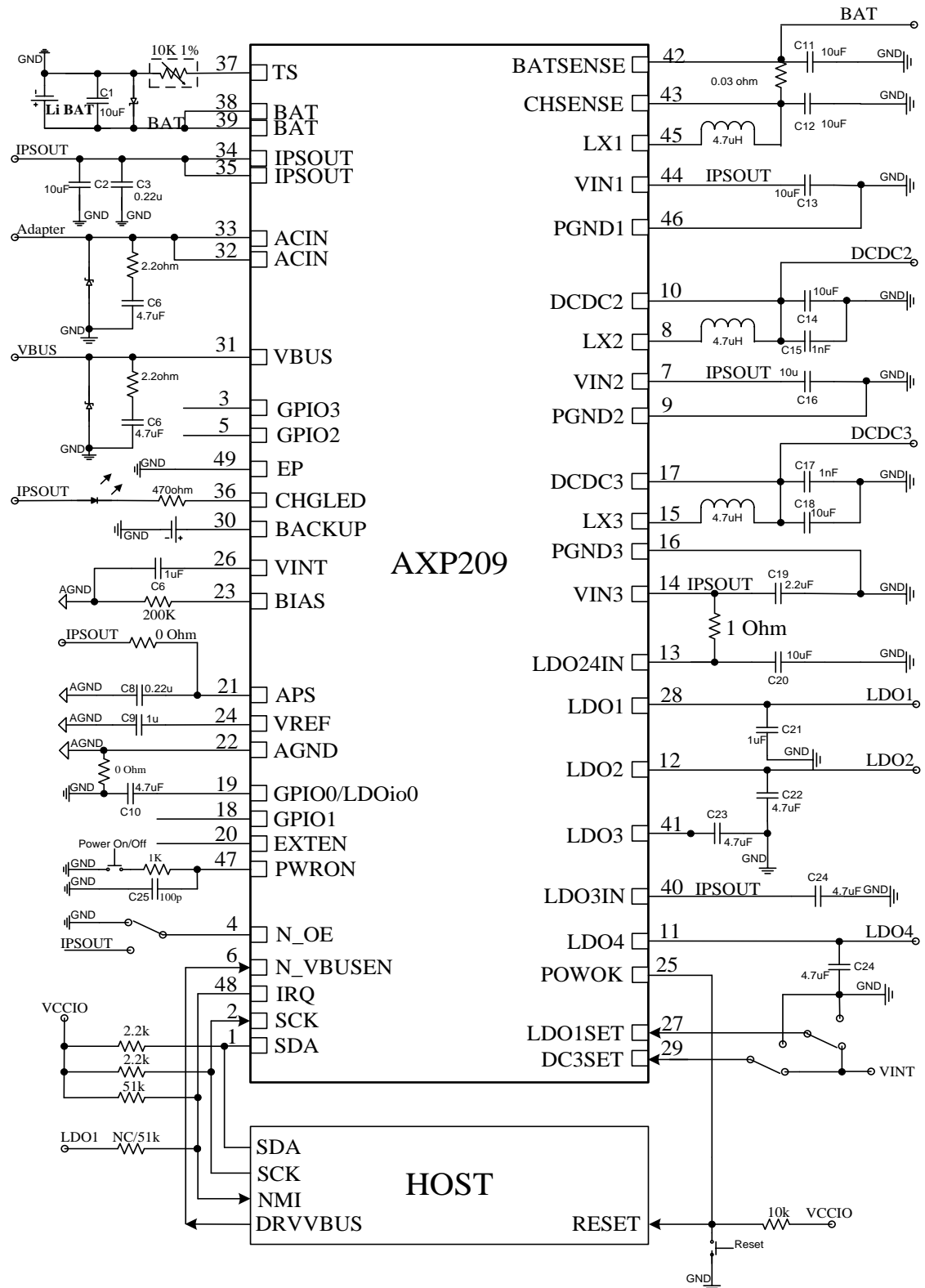


2. FEATURES

- Power Management IPS
 - ✧ Wide range of voltage input: 2.9V~6.3V (AMR: -0.3V~11V)
 - ✧ Configurable IPS™ system
 - ✧ Adaptive USB (supporting USB3.0) or AC adaptor
 - Voltage/current limit (4.4V/900mA/500mA/100mA)
 - ✧ Equivalent internal resistance of battery below 75mΩ.
- Fully Integrated PWM Charger
 - ✧ Maximum charge current up to 1.8A.
 - ✧ Support battery temperature monitoring
 - ✧ Fully support USB charging (including 3.0) complied with regulation
 - ✧ High charge accuracy, with error less than 0.5%
 - ✧ Support batteries of 4.1V/4.15V/4.2V/4.36V
 - ✧ Automatic charge process control
 - ✧ Directly drive LED to indicate charge status
 - ✧ Automatic scaling of charge current according to system load
- Backup Battery
 - ✧ Backup battery input for RTC
 - ✧ Support backup battery charging with configurable charge current
- 2 Synchronous Buck Converters (DC-DC)
 - ✧ DC-DC2: 0.7-2.275V adjustable, 25mV/step, driving ability 1.6A, support VRC (Voltage Ramp Control)
 - ✧ DC-DC3: 0.7-3.5V adjustable, 25mV/step, driving ability 1.2A
- 5 LDOs
 - ✧ LDO1: 30mA, always on

- ✧ LDO2: low noise LDO, 1.8V~3.3V adjustable, 100mV/step, driving ability 200mA
- ✧ LDO3: 0.7-3.5V adjustable, 25mV/step, driving ability 200mA
- ✧ LDO4: low noise LDO, 1.8V~3.3V adjustable, 100mV/step, driving ability 200mA
- ✧ LDO5: low noise LDO, 1.8V~3.3V adjustable, 100mV/step, driving ability 50mA
- Timer
 - ✧ 7-bit timer with 1~127 minutes timing range
 - ✧ Timer interrupt output
- Signal Capture System
 - ✧ Built-in twelve 12-bit ADCs
 - ✧ Two external signal inputs
 - ✧ Provide the voltage/current data of batteries and external input powers
 - ✧ Built-in highly accurate Coulomb Counter and Fuel gauge system
 - ✧ Provide rich power management information, such as instantaneous power consumption (mA or mW), remaining battery power (% or mA), charging status (%), remaining power life or charging time, etc.
 - ✧ Two-level low power warning and protection
 - ✧ Provide die temperature data
- Host Interface
 - ✧ Data exchange through TWSI interface.
 - ✧ Flexible interrupt and sleep management configuration
 - ✧ Flexible pin configuration: multiple GPIOs set as IO or ADC.etc.
 - ✧ Built-in configurable timer
 - ✧ Provide twelve registers for data storage during system shutdown
- System Management
 - ✧ Support soft reset and hard reset
 - ✧ Support soft shutdown and hard shutdown
 - ✧ Support external wakeup triggers
 - ✧ Support output voltage monitoring and self-diagnostic function
 - ✧ Output PWROK for system reset or shutdown indication
 - ✧ External power detection (insert/remove/driver capability deficiency)
 - ✧ Support soft booting.
 - ✧ Over/under-voltage protection (OVP/UVLP)
 - ✧ Over-current protection (OCP)
 - ✧ Over-temperature protection (OTP)
 - ✧ Support OTG VBUS power status setting/monitoring
- Full Integration
 - ✧ Internally produced reference voltage of high accuracy (0.5%).
 - ✧ Built-in MOSFET
 - ✧ Programmable timing and output voltage
- Decryption Module
 - ✧ 128-bit OTP code storage
 - ✧ Dynamic real-time decryption algorithm

3. TYPICAL APPLICATION



4. ABSOLUTE MAXIMUM RATINGS

| Symbol | Description | Value | Units |
|-------------------|---|------------|-------|
| ACIN | Input Voltage | -0.3 to 11 | V |
| VBUS | Input Voltage | -0.3 to 11 | V |
| T _J | Operating Temperature Range | -40 to 130 | °C |
| T _s | Storage Temperature Range | -40 to 150 | °C |
| T _{LEAD} | Maximum Soldering Temperature (at leads, 10sec) | 300 | °C |
| V _{ESD} | Maximum ESD stress voltage, Human Body Model | >4000 | V |
| P _D | Internal Power Dissipation | 2100 | mW |

5. ELECTRICAL CHARACTERISTICS

V_{IN} = 5V, BAT = 3.8V, T_A = 25°C

| SYMBOL | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNITS |
|------------------------|---|----------------------------|-------|------|-------|-------------------|
| ACIN | | | | | | |
| V _{IN} | ACIN Input Voltage | | 3.8 | | 6.3 | V |
| I _{OUT} | V _{OUT} Current Available Before Loading BAT | 500mV Voltage Drop | | 2500 | | mA |
| V _{UVLO} | ACIN Under Voltage Lockout | | | 3.8 | | V |
| V _{OUT} | IPS Output Voltage | | 2.9 | | 5.0 | V |
| R _{ACIN} | Internal Ideal Diode On Resistance | PIN to PIN, ACIN to IPSOUT | | | 170 | mΩ |
| VBUS | | | | | | |
| V _{IN} | VBUS Input Voltage | | 3.8 | | 6.3 | V |
| I _{OUT} | V _{OUT} Current Available Before Loading BAT | | | 500 | 900 | mA |
| V _{UVLO} | VBUS Under Voltage Lockout | | | 3.8 | | V |
| V _{OUT} | IPS Output Voltage | | 2.9 | | 5.0 | V |
| R _{VBUS} | Internal Ideal Diode On Resistance | PIN to PIN, VBUS to IPSOUT | | | 300 | mΩ |
| Battery Charger | | | | | | |
| V _{TRGT} | BAT Charge Target Voltage | | -0.5% | 4.2 | +0.5% | V |
| I _{CHRG} | Charge Current | | | 1200 | 1800 | mA |
| I _{TRKL} | Trickle Charge Current | | | 10% | | I _{CHRG} |

| | | | | | | |
|-----------------------|--|--|-----|-------|-------|---------------|
| | | | | | | mA |
| V_{TRKL} | Trickle Charge Threshold Voltage | | | 3.0 | | V |
| ΔV_{RECHG} | Recharge Battery Threshold Voltage | Threshold Voltage Relative to V_{TARGET} | | -100 | | mV |
| T_{TIMER1} | Charger Safety Timer Termination Time | Trickle Mode | | 40 | | Min |
| T_{TIMER2} | Charger Safety Timer Termination Time | CC Mode | | 480 | | Min |
| I_{END} | End of Charge Indication Current Ratio | CV Mode | | 10% | 15% | I_{CHRG} mA |
| Backup Battery | | | | | | |
| V_{TRGT} | Backup Battery Charge Target Voltage | | 2.5 | 3.0 | 3.1 | V |
| I_{CHRG} | Backup Battery Charge Current | | 50 | 200 | 400 | uA |
| I_{Backup} | Current when use Backup Battery | | | 10 | 15 | uA |
| NTC | | | | | | |
| V_{TL} | Cold Temperature Fault Threshold Voltage | Charge | 0 | 2.112 | 3.264 | V |
| | | Discharge | | 3.226 | | |
| V_{TH} | Hot Temperature Fault Threshold Voltage | Charge | 0 | 0.397 | 3.264 | V |
| | | Discharge | | 0.282 | | |
| V_{TE} | NTC Disable Threshold Voltage | Falling Threshold Hysteresis | | 0.2 | | V |
| Ideal Diode | | | | | | |
| $R_{ds(on)}$ | On Resistance(BAT to IPSOUT) | | | | 75 | mΩ |

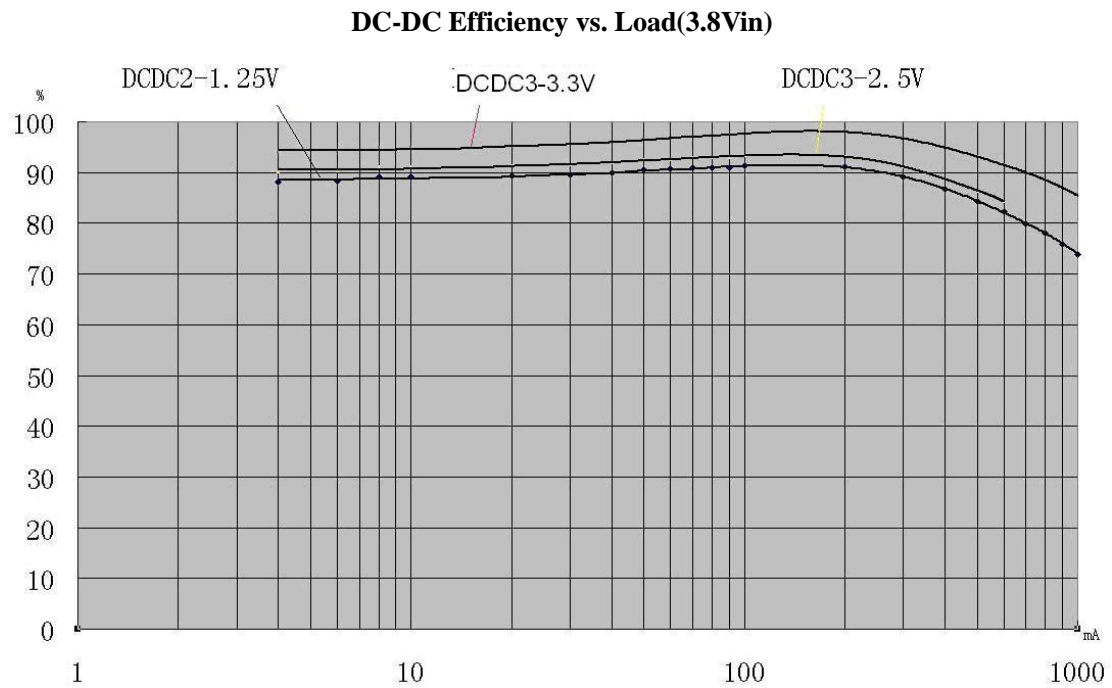
| SYMBOL | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNITS |
|-------------------------|-------------------------------|-------------------------------|-----|------|-----|-------|
| Off Mode Current | | | | | | |
| I_{BATOFF} | OFF Mode Current | BAT=3.8V | | 27 | | μA |
| $I_{SUSPEND}$ | USB VBUS suspend Mode current | BAT=3.8V, VBUS=5V, N_VBUSEN=1 | | 86 | | μA |
| Logic | | | | | | |
| V_{IL} | Logic Low Input Voltage | | | 0.3 | | V |
| V_{IH} | Logic High Input Voltage | | | 2 | | V |
| TWSI | | | | | | |
| V_{CC} | Input Supply Voltage | | | 3.3 | | V |
| ADDRES S | TWSI Address | | | 0x68 | | |

| | | | | | | |
|---------------------|---------------------------|-------------------|-----|------|-------|-----|
| f _{SCK} | Clock Operating Frequency | | | 400 | 1200 | kHz |
| t _f | Clock Data Fall Time | 2.2Kohm Pull High | | 60 | | ns |
| t _r | Clock Data Rise Time | 2.2Kohm Pull High | | 100 | | ns |
| DCDC | | | | | | |
| f _{OSC} | Oscillator Frequency | Default | | 1.5 | | MHz |
| DCDC2 | | | | | | |
| I _{LIM2} | PMOS Switch Current Limit | PWM Mode | | 2300 | | mA |
| I _{DC2OUT} | Available Output Current | PWM Mode | | | 1800 | mA |
| V _{DC2OUT} | Output Voltage Range | | 0.7 | | 2.275 | V |
| DCDC3 | | | | | | |
| I _{LIM3} | PMOS Switch Current Limit | PWM Mode | | 1400 | | mA |
| I _{DC3OUT} | Available Output Current | PWM Mode | | | 1000 | mA |
| V _{DC3OUT} | Output Voltage Range | | 0.7 | | 3.5 | V |

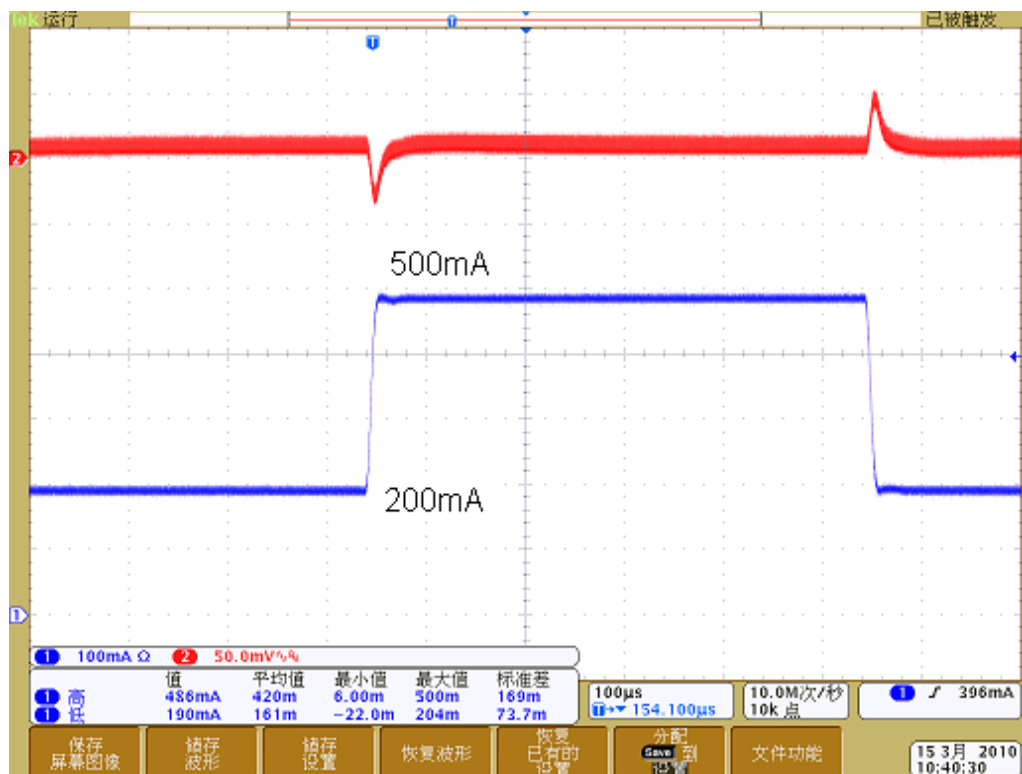
| SYMBOL | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNITS |
|-------------------|------------------------------|---|-----|------------|-----|-------------------|
| LDO1 | | | | | | |
| V _{LDO1} | Output Voltage | I _{LDO1} =1mA | -1% | 1.3 3.3 | 1% | V |
| I _{LDO1} | Output Current | | | 30 | | mA |
| LDO2 | | | | | | |
| V _{LDO2} | Output Voltage | I _{LDO2} =1mA | 1.8 | | 3.3 | V |
| I _{LDO2} | Output Current | | | 200 | | mA |
| PSRR | Power Supply Rejection Ratio | I _{LDO2} =60mA , 1KHz | | TBD | | dB |
| e _N | Output Noise,20-80KHz | V _o =3V , I _o =150mA | | 28 | | μV _{RMS} |
| LDO3 | | | | | | |
| V _{LDO3} | Output Voltage | I _{LDO3} =1mA | 0.7 | | 3.5 | V |
| I _{LDO3} | Output Current | | | 200 | | mA |
| PSRR | Power Supply Rejection Ratio | I _{LDO3} =10mA , 1KHz | | TBD | | dB |
| e _N | Output Noise,20-80KHz | V _o =1.8V , I _o =150mA | | TBD | | μV _{RMS} |
| LDO4 | | | | | | |
| V _{LDO3} | Output Voltage | I _{LDO3} =1mA | 1.8 | | 3.3 | V |
| I _{LDO3} | Output Current | | | 200 | | mA |
| PSRR | Power Supply Rejection Ratio | I _{LDO3} =10mA , 1KHz | | TBD | | dB |

| | | | | | | |
|-------------|------------------------------|----------------------------|-----|-----|-----|---------------|
| e_N | Output Noise,20-80KHz | $V_O=1.8V$ $I_O=150mA$ | | 18 | | μV_{RMS} |
| LDO5 | | | | | | |
| V_{LDO5} | Output Voltage | $I_{LDO5}=1mA$ | 1.5 | | 3.3 | V |
| I_{LDO5} | Output Current | | | 50 | | mA |
| PSRR | Power Supply Rejection Ratio | $I_{LDO5}=10mA$, 1KHz | | TBD | | dB |
| e_N | Output Noise,20-80KHz | $V_O=1.8V$, $I_O=30mA$ | | 18 | | μV_{RMS} |

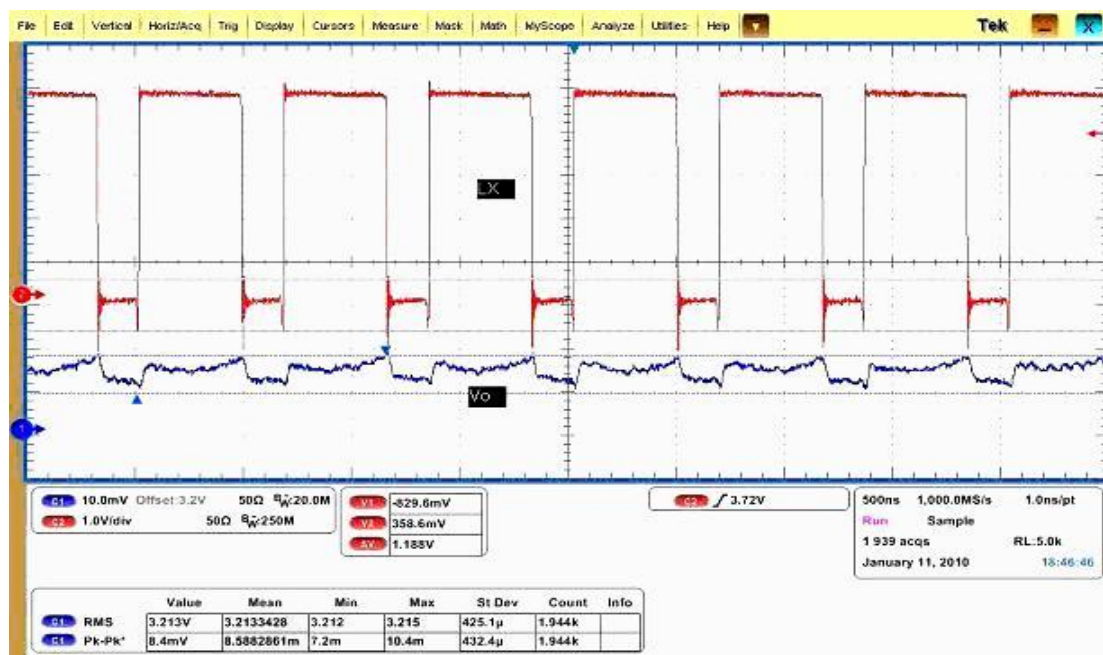
6. TYPICAL CHARACERISTICS



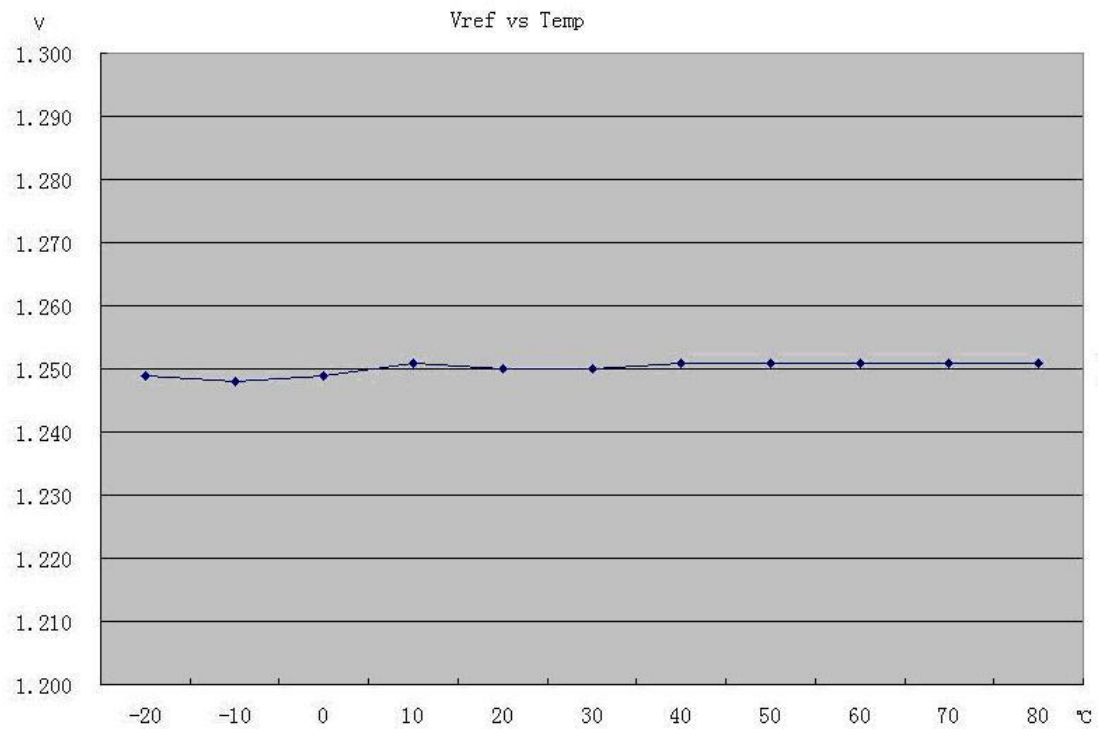
DC-DC Load Transient(Typical)



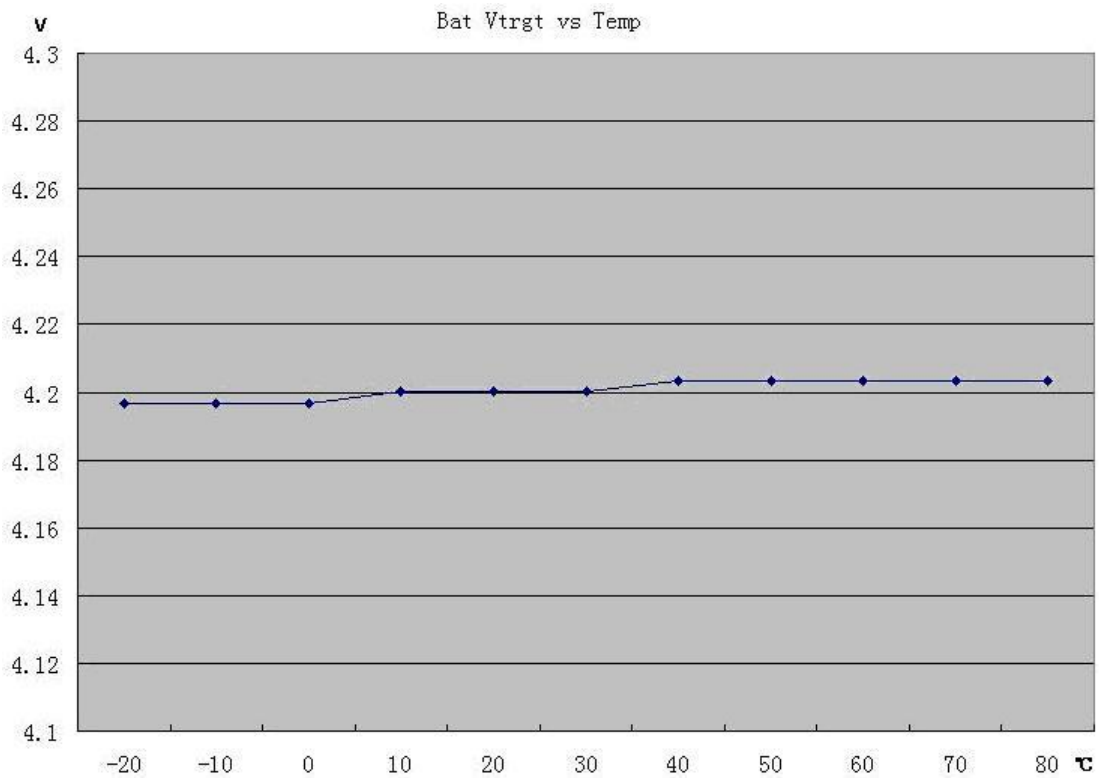
DC-DC Ripple



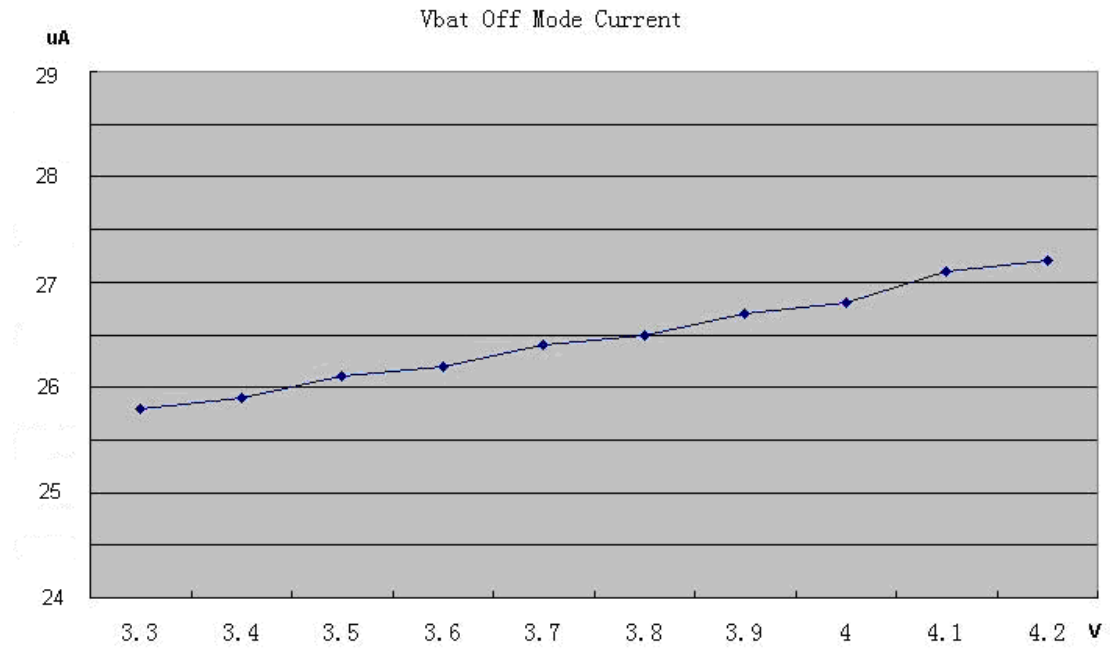
V_{REF} vs. Temperature



V_{TRGT} vs Temperature



Off Mode Current vs V_{BAT}

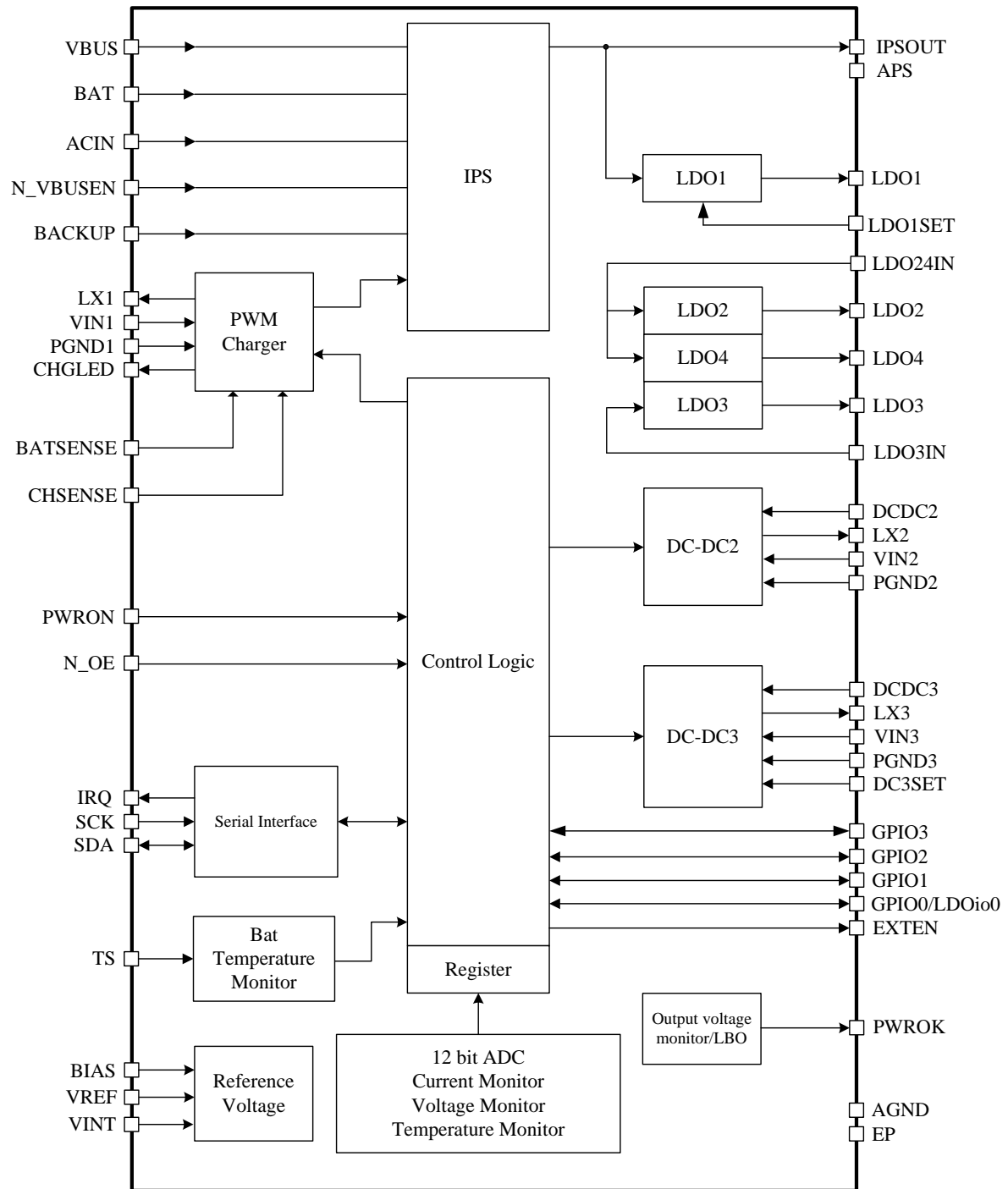


7. PIN DESCRIPTION

| Num | Name | Type | Condition | Function Description |
|-----|----------|------|-------------|--|
| 1 | SDA | IO | | Data pin for serial interface, normally it connects a 2.2K resistor to 3.3V I/O power |
| 2 | SCK | I | | Clock pin for serial interface, normally its connect a 2.2K resistor to 3.3V I/O power |
| 3 | GPIO3 | IO | REG9EH[7] | GPIO 3 |
| 4 | N_OE | I | | Power output on/off switch GND: on; IPSOUT: off |
| 5 | GPIO2 | IO | REG92H[2:0] | GPIO 2 |
| 6 | N_VBUSEN | I | | VBUS to IPSOUT Selection GND:IPSOUT select VBUS High: IPSOUT not select VBUS |
| 7 | VIN2 | PI | | DCDC2 input source |
| 8 | LX2 | IO | | Inductor Pin for DCDC2 |
| 9 | PGND2 | G | | NMOS Ground for DCDC2 |
| 10 | DCDC2 | I | | DC-DC2 feedback pin |
| 11 | LDO4 | O | | Output Pin of LDO4 |
| 12 | LDO2 | O | | Output Pin of LDO2 |
| 13 | LDO24IN | PI | | Input to LDO2 and LDO4 |
| 14 | VIN3 | PI | | DCDC3 input source |

| | | | | |
|--------|----------------|----|-------------|---|
| 15 | LX3 | IO | | Inductor Pin for DCDC3 |
| 16 | PGND3 | G | | NMOS GND for DCDC3 |
| 17 | DCDC3 | I | | Feedback to DCDC3 |
| 18 | GPIO1 | IO | REG93H[2:0] | GPIO 1 ADC Input |
| 19 | GPIO0 | IO | REG90H[2:0] | GPIO 0 Low noise LDO/Switch ADC Input |
| 20 | EXTEN | O | | External Power Enable |
| 21 | APS | PI | | Internal Power Input |
| 22 | AGND | G | | Analog Ground |
| 23 | BIAS | IO | | External 200Kohm 1% resistor |
| 24 | VREF | O | | Internal reference voltage |
| 25 | PWROK | O | | Power Good Indication Output |
| 26 | VINT | PO | | Internal logic power, 2.5V |
| 27 | LDO1SET | I | | It sets the LDO1 default voltage. |
| 28 | LDO1 | O | | LDO1 output, for Host RTC block |
| 29 | DC3SET | I | | It sets the DCDC3 default voltage |
| 30 | BACKUP | IO | | Backup battery pin |
| 31 | VBUS | PI | | USB VBUS input |
| 32, 33 | ACIN | PI | | Adapter input |
| 34, 35 | IPSOUT | IO | | Main Battery |
| 36 | CHGLED | O | | charger status indication |
| 37 | TS | I | | Battery Temperature sensor input or an external ADC input |
| 38, 39 | BAT | PO | | System power source |
| 40 | LDO3IN | O | | LDO3 input source |
| 41 | LDO3 | I | | Output Pin of LDO3 |
| 42 | BATSENSE | I | | Current sense port1 |
| 43 | CHSENSE | O | | Current sense port2 |
| 44 | VIN1 | PI | | DCDC1 input source |
| 45 | LX1 | IO | | Inductor Pin for DCDC1 |
| 46 | PGND1 | G | | NMOS Ground for DCDC1 |
| 47 | PWRON | I | | Power On-Off key input, Internal 100k pull high to APS |
| 48 | IRQ/ WAKEUP | IO | | IRQ output or wakeup |
| 49 | EP | G | | Exposed Pad, need to be connected to system ground |

8. FUNCTIONAL BLOCK DIAGRAM



9. CONTROL AND OPERATION

When AXP209 works, SCK/SDA pin of TWI interface are pulled up to the system IO power, so

Host can conduct flexible monitoring and adjustment for AXP209 operation via this interface.

NOTE:

- ✧ The " host " refers to the main processor of application system.
- ✧ The following " external power " includes ACIN and VBUS inputs.

9.1 Power On/Off and Reset

Power Enable Key (PEK)

A key can be connected between the PWRON pin of AXP209 and the GND to be an independent Power Enable Key (PEK) or Sleep/Wakeup Key. AXP209 can automatically identify the " long-press " and " short-press " of the key and then act accordingly.

Several Startup Sources

1. ACIN, BUS, and battery input
2. N_OE from high to low
3. PEK

Power On

The system can be started up in three ways:

When N_OE is low, AXP209 will be automatically powered on if satisfactory main power (ACIN or VBUS exceeds 3.8V, or the battery voltage is higher than shutdown voltage) is plugged in. (Whether or not AXP209 will automatically startup in external power presence can be modified accordingly.)

However, when N_OE is low and the system is shutdown, startup should be conducted through PEK. AXP209 can be powered on through PEK (the press time is longer than " ONLEVEL "). In practice, the alarm output signal of Host can be connected to PWRON as well—when parallel connected to PEK, valid Alarm signal (low level) can achieve the same result of pressing PEK and enables AXP209 startup,.

When external powers or batteries are available, N_OE changing from high to low can also bring about AXP209 startup.

After startup, DC-DC and LDO will be soft boot in preset timing sequence. After the boot, related power will be enabled / disabled via TWSI by Host.

Power Off

When the PEK long-press time is longer than IRQLEVEL, Host can write " 1 " to REG32H[7] register in PEK interrupt service routine to inform AXP209 to shutdown, in which case all other power inputs except LDO1 are disabled.

AXP209 will automatically shutdown in following cases:

1. Under-voltage protection for low input voltage;
2. overload protection for low voltage output due to overload;
3. overvoltage protection for high voltage input (See the “Power Path Management” section for details);
4. When N_OE changes from low to high, and the waiting time exceeds the preset time (2S by default);
5. When the press time of PEK is longer than OFFLEVEL (6S by default), system will automatically disable all other output except LDO1(Reset key can be omitted).

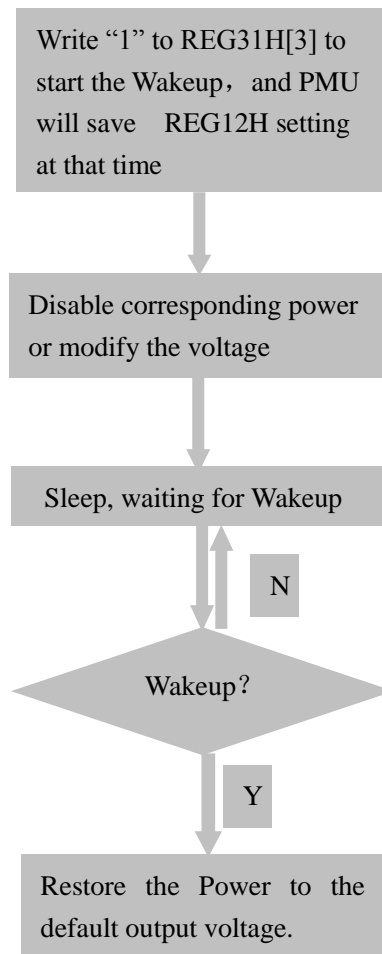
The automatic protection mechanism of AXP209 can protect the whole system by preventing irreversible damage to the power-supplied devices due to application system abnormality.

Sleep and Wakeup

When the running system needs to enter Sleep mode, one or more power outputs are disabled or have voltage modified, in that case, REG31H[3] can be used to decide whether to have the Wakeup triggered by PEK key signal, or the rising and/or falling edge of GPIO0、GPIO1、GPIO2、GPIO3 (To be the rising or falling edge, or both can be programmed by REG90H[7:6]、REG92H[7:6]、REG93H[7:6] and REG95H[7:6]), so that the output voltage can be restored to the default state by PMU and all disabled or modified power can be enabled in regulated sequence.

NOTE: PEK IRQ (REG42H[1])、GPIO0 INPUT Edge IRQ (REG44H[0])、GPIO1 INPUT Edge IRQ (REG44H[1])、GPIO2 INPUT Edge IRQ (REG44H[2])、GPIO3 INPUT Edge IRQ (REG44H[3]) should be “Enable” to notify the processor to exit Sleep Mode via IRQ PIN.

The control process in Sleep and Wakeup Modes is shown below.



System Reset and Output Monitoring (PWROK)

The PWROK in AXP209 can be used as reset signal of application system. During AXP209 startup, PWROK outputs low level, which will then be pulled high to startup and reset the system after each output voltage reaches the regulated value.

When application system works normally, AXP209 will be always monitoring the voltage and load status. If overload or under-voltage occurs, the PWROK will instantly output low level to reset the system and prevent malfunction or data errors.

9.2 Power Path Management (IPS)

Power input of AXP209 may come from Li-battery, USB VBUS input, external power ACIN (such as AC adapter). IPS can select proper power allotting method according to external power and Li-battery status.

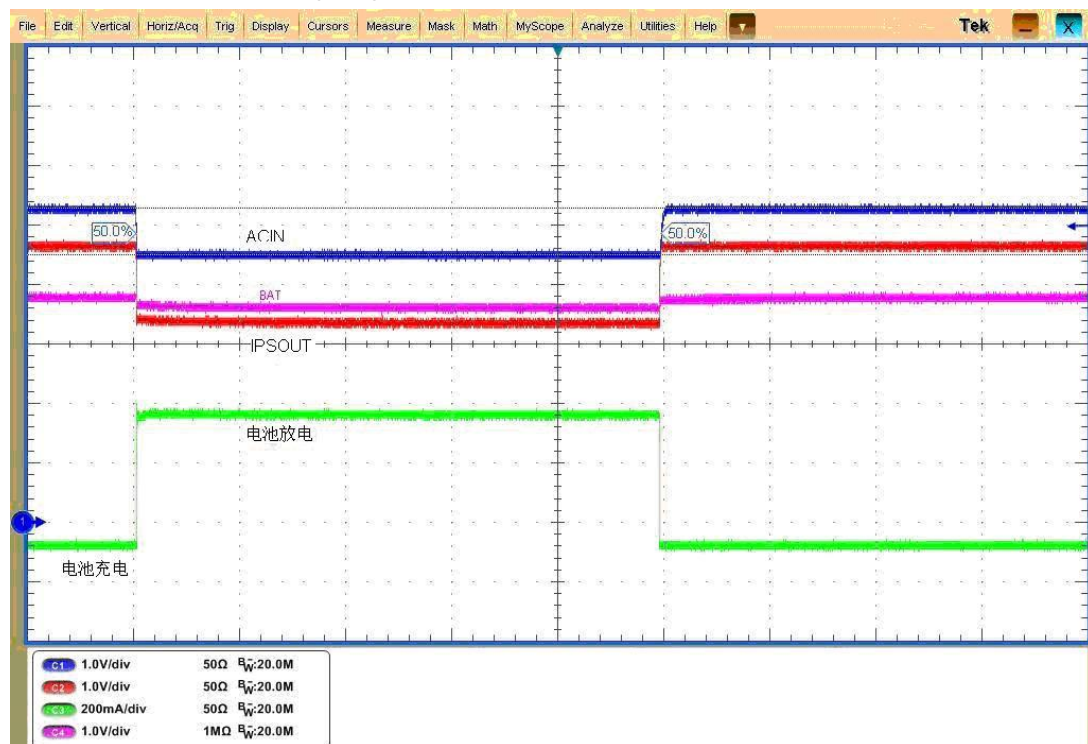
✧ If only Li-battery is available, and no external power input, Li-battery is used for power

input;

- ✧ If external power is available (VBUS or ACIN), it is preferred in power supply;
- ✧ If Li-battery is available, it is instantly selected for power supply as soon as external power is removed;
- ✧ When both VBUS and ACIN are available, ACIN is preferred, and Li-battery is charging;
- ✧ And if in the above case, ACIN cannot provide enough drive ability, VBUS should be enabled properly to achieve ACIN/VBUS common power supply;
- ✧ And if the drive capacity is still insufficient, charge current will be reduced to zero, and batteries are used for power supply;

Therefore, compatibility of the system with external powers of different drive ability can be dramatically improved, and no special customized adapters are required to be provided on the part of manufacturers.

Please refer to the following diagram.



As shown above, when ACIN provides insufficient load ability, IPSOUT voltage will fall, and BAT will change from charge to discharge to supply load current together with ACIN.

Host can set IPS parameters and read the feedback by visiting internal registers in AXP209 via TWIS.

Voltage-Limit/ Current-Limit Mode and Direct Mode

In order not to affect the USB communication, VBUS is always working in VBUS Voltage-Limit mode by default. In this mode, VBUS voltage remains above a configurable reference voltage VHOLD to meet the USB specification. The default VHOLD is 4.4V, adjustable in Reg30 H [5:3] register.

If the system has limit on current obtained from USB VBUS, a current-limit mode is provided (See REG30H [1] register), with 900mA/500mA/100mA (Reg30H [0]) selectable.

If the system just utilizes the USB for power supply rather than communication, or the USB power adapter is utilized, AXP209 can be set to “VBUS Direct Mode” by modifying register REG30H[6], and then AXP209 will give priority to the application power demand. When the drive ability of USB Host is insufficient or system power consumption is huge so that the VBUS voltage is lower than V_{HOLD}, AXP209 will release IRQ to indicate the weak power supply ability of Host VBUS, which may affect USB communication, and then Host software will follow up.

AXP209’s Reaction to External Power Source Enabling

When external power is inserted, AXP209 can automatically detect it, judge whether the power is usable or not, set the result in corresponding registers, and release IRQ to inform the Host at the same time.

The following table has listed the status bits and meanings of external power registers.

| Register Status Bits | Description |
|----------------------|---|
| REG00H[7] | Indicating the presence of external ACIN |
| REG00H[6] | Indicating whether the external ACIN is usable or not |
| REG00H[5] | Indicating the presence of external VBUS |
| REG00H[4] | Indicating whether the external VBUS is usable or not |
| REG00H[3] | Indicating whether the VBUS voltage is above V _{HOLD} when used |
| REG00H[1] | Indicating whether ACIN/VBUS short circuits on PCB or not |
| REG00H[0] | Indicating whether the system is triggered to startup by ACIN/VBUS or not |

The status bit of “indicating whether the VBUS voltage is above V_{HOLD} or not when used” enables the Host to judge when it receives IRQ7(indicating weak supply ability)whether VBUS is pulled low by system load input or the external power itself is below V_{HOLD}, which may facilitate Host software to decide either to keep on working in Voltage-Limit mode or switch to Direct mode.

When to Select VBUS as Input Power

When to select VBUS as the input power is determined by N_VBUSEN and register REG30H[7]:

| N_VBUSEN | REG30H[7] | Input Power | Description |
|----------|-----------|-------------|--|
| Low | 0 | VBUS | Select if VBUS is valid and no ACIN is available |
| Low | 1 | VBUS | Select if VBUS is valid |
| High | 1 | VBUS | |
| High | 0 | ACIN/BAT | Not select VBUS |

Under-Power Warning and Under-Power Protection (Automatic Shutdown)

AXP209 can set under-power warning voltage V_{WARNING} and automatic shutdown voltage V_{OFF} , and then compare them with the system power. If the system power is found to be lower than V_{WARNING} , IRQ19/IRQ20 will be released. If APS is lower than V_{OFF} , AXP209 will automatically enter Shutdown Mode, and disable all other outputs except LDO1.

V_{WARNING} has two set levels: LEVEL 1 and LEVEL 2, which have different indications in application. For example, LEVEL1 is used to indicate insufficient power while LEVEL 2 is used to indicate the oncoming shutdown.

The default values of V_{WARNING} and V_{OFF} can be respectively set in registers REG3AH、REG3BH and REG31H[2:0].

Over-Voltage Protection

When the external power voltage exceeds 6.3V, AXP209 will release IRQ1/4 for indication. When the external power voltage exceeds 7V, AXP209 will automatically shutdown.

9.3 Adaptive PWM Charger

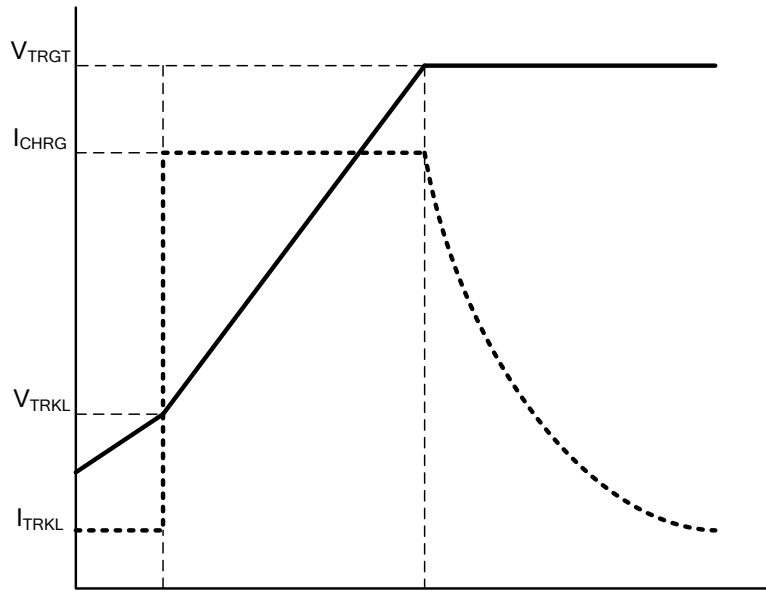
AXP209 integrates a constant current/voltage PWM charger to automatically control the charge cycle, with a built-in safety clock capable of automatic charge termination without processor intervention. This charger features automatic charge current scaling in accordance with the system power consumption, as well as battery detection, trickle charge and activation. In addition, the built-in temperature detection circuit can automatically decrease the charge current when the temperature is too high or too low.

Compared with traditional linear charge module, this PWM charger features dramatic efficiency increase and power consumption decrease in systems that require large power consumption and fast battery charging, and thus greatly improve the system temperature performance.

Adaptive Charge Startup

The default state of the charger is “Enable”. (It can be programmed via registers. Refer to register REG33H.) When external power is enabled, AXP209 will firstly judge whether it is chargeable. If the charger is suitable for the power, and the charge function is usable, AXP209 will automatically start the charge, and send IRQ to Host for indication. At the same time, GHGLED pin will output low level to drive external LED to indicate the charging state.

Charge Voltage/Current:



Two Symbolic Voltages

V_{TRGT} , charge target voltage. The V_{TRGT} is 4.2V by default, which can be set by register (Refer to “REG33H[6:5]”). At the same time, AXP209 will automatically adjust the charge target voltage when external power voltage is low.

V_{RCH} , automatic recharge voltage. $V_{RCH} = V_{TRGT} - 0.1V$.

Charge Current

The charge current is 500mA or 1200mA by default, which can be set by REG33H[3:0].

Charge Process

If the battery voltage is lower than 3.0V, the charger will automatically enter the pre-charge mode, with charge current be 1/10 of the preset value. If the battery voltage is still below 3.0V in 40 minutes (adjustable, see “REG34H”), charger will automatically enter the battery activate mode. Refer to “Battery Activate Mode” section for details.

Once the battery voltage exceeds 3.0V, the charger enters constant current mode. If the charge current is below 65% of the preset value, the system will release IRQ17 to indicate that “drive ability of external power is insufficient, as a result, the charge current is lower than the preset value, which may lead to longer charge time, so stronger power is preferred, or the power-consuming functions should be disabled to shorten the charge time.”

When the battery voltage reaches the V_{TRGT} , the charger will switch from the constant current mode to constant voltage mode, and the charge current will fall.

When the charge current is lower than 10% or 15% (adjustable, see register “REG33H”) of the preset value, a charge cycle ends, and AXP209 will release IRQ18 while the CHGLED pin

will stop indicating the charging state. When the battery voltage is below V_{RCH} again, the automatic charge will restart, and IRQ17 will be released.

In non-precharge mode, if the charge cycle doesn't end within 480 minutes (adjustable, refer to register "REG34H"), the charger will automatically enter the battery activate mode.

Battery Activate Mode

No matter it is from pre-charge mode or constant current mode to the battery activate mode (the timer expires), AXP209 will release IRQ10 in both cases to indicate that the battery may be damaged.

In battery activate mode, the charger always inputs relatively low current to batteries. In this case, if the battery voltage can reach V_{RCH} , AXP209 will exit activate mode and release IRQ11.

AXP209 will indicate whether the charger is in battery activate mode or not in register REG01H.

CHGLED

CHGLED pin is used to indicate charge state and warning. It has four states: charge, not charge, battery abnormality warning, and external power over-voltage warning. CHGLED is NMOS Open Drain output, so a LED can be directly driven by a current-limit resistor to show the four states. The following table has displayed its two operation modes.

| REG34H[4] | Status | Reaction | Remark |
|-----------|------------------|-----------------|---|
| 0 | Charge | Low Level | |
| | Not charge | High Resistance | |
| | Battery Abnormal | 1Hz flicker | The charger enters the battery activate mode, or the battery temperature is too high/low. |
| | Over-Voltage | 4Hz flicker | External voltage input is too high. |
| 1 | Charge | 1Hz flicker | |
| | Non-chargeable | High Resistance | No external power is available. |
| | Not charge | Low Level | |
| | Over-Voltage | 4Hz Flicker | External voltage input is too high, or the battery temperature is too high/low. |

Battery Temperature Detection

AXP209 can connect a temperature-sensitive resistor via the TS pin to monitor the battery temperature when the battery is charging or discharging. The diagram is shown below.

AXP209 supports backup battery charge and discharge. When no main power (BAT/ACIN/VBUS) is available, LDO1 will choose the backup battery to support the operation of some circuits, such as the system real-time clock, etc.

When there is a main power, REG35H[7] can be set to charge the backup battery, whose target voltage is 3.0V by default (adjustable via REG35H[6:5]) and charge current is 200uA by default (adjustable via REG35H[1:0]).

9.5 Multi-Power Outputs

The following table has listed the multi-power outputs and their functions of AXP209.

| Output Path | Type | Default Voltage | Application Examples | Drive Ability |
|-------------|------|-----------------|----------------------|---------------|
| DCDC2 | BUCK | Configurable | 1.25Vcore | 1600 mA |
| DCDC3 | BUCK | Configurable | 2.5Vddr | 700 mA |
| LDO1 | LDO | Configurable | RTC | 30 mA |
| LDO2 | LDO | Configurable | Analog/FM | 200 mA |
| LDO3 | LDO | Configurable | 1.3V PLL | 200 mA |
| LDO4 | LDO | Configurable | 1.8V HDMI | 200 mA |
| LDO5 | LDO | Configurable | Vmic | 50 mA |

AXP209 comes with two simultaneous step-down DC-DCs, five LDOs, as well as multiple timing and controlling methods. The work frequency of DC-DC is 1.5MHz by default, which is adjustable via registers. External small inductors and capacitors can be connected as well. In addition, both DC-DCs can be set in PWM mode or auto mode (automatically switchable according to the AXP209 load). See register REG80H.

DC-DC2/3

DCDC3 output voltage ranges from 0.7 V to 3.5V, and DCDC output voltage ranges from 2 0.7-2.275V, which can be programmed via registers.(Refer to register “REG23H 27H”).

DCDC2/3 output capacitor is recommended to use small ESR ceramic capacitors above 10uF X7R; when the output voltage is set above 2.5V, 2.2uH inductors is recommended; when the output voltage is set under 2.5V, 4.7uH inductors is recommended. Besides, the inductor saturation current should be larger than 50% of the largest demanded current in power circuitry.

The following is a list of recommended inductors and capacitors.

| Inductors | | |
|----------------------|-----------------------|------------------------|
| Module NO. | Current Specification | DC Internal Resistance |
| Murata LQH55PN2R2NR0 | 2100mA @2.2uH | 30mOhm |
| Murata LQH55PN4R7NR0 | 1400mA @4.7uH | 60mOhm |
| Murata LQH44PN2R2MP0 | 2000mA @2.2uH | 49mOhm |

| | | |
|--------------------------|------------------------------------|------------------|
| Murata LQH44PN4R7MP0 | 1700mA @2.2uH | 80mOhm |
| TDK VLF5010ST-2R2M2R3 | 2700mA @2.2uH | 41mOhm |
| TDK VLF5014ST-4R7M1R7 | 1700mA @4.7uH | 98mOhm |
| TDK SLF6045T-4R7N2R4-3PF | 2400mA @4.7uH | 27mOhm |
| Capacitors | | |
| Module NO. | Temperature Characteristics | Allowance |
| TDK C2012X5R0J475K | X5R/X7R | 10% @4.7uF |
| TDK C2012X5R0J106K | X5R/X7R | 10% @10uF |
| Murata GRM31E71A475K | X7R | 10% @4.7uF |
| Murata GRM21E71A106K | X7R | 10% @10uF |
| Murata GRM31E71A106K | X7R | 10% @10uF |

LDO 1

LDO is always powered on to supply continuous power for application RTC. Its drive ability is 30mA.

LDO2/3/4

LDO2/4 output noise is as low as 18uVrms, and can be used to supply power for analog circuits of application system. LDO3 can supply power for systems like SRAM or PLL. Their drive ability is 200mA.

LDO5

LDO5 also features the low noise design, and its drive ability is 50mA.

Soft Start

All DC-DCs and LDOs support soft start to avoid the impact of dramatic current change on the input path in system boot stage.

Self-Diagnosis: Load Monitoring and Current-Limit Protection

All DC-DCs and LDOs support load monitoring and current-limit functions. When the load current exceeds its drive ability, each output voltage will decrease to protect the internal circuits. When the two DC-DCs output voltage is lower than 85% of the set voltage, AXP209 will automatically shutdown. At the same time, the system will record the detailed output voltage that has led to automatic shutdown (refer to register REG46H[5:2]) and release corresponding IRQ.

All DC-DCs do not require external Schottky diodes and resistor divider feedback circuits. If a certain DC-DC is unnecessary in application, just float the corresponding LX pins.

9.6 Default Voltage/Timing Setting

AXP209 can set the default voltage and boot timing of each power.

Boot Timing includes eight levels, and the interval between each level can be set as 1、4、16 and 32mS.

Default voltage setting: each DC-DC/LDO setting ranges from the lowest voltage to the highest voltage.

LDO1SET PIN is used to set the initial voltage of LDO1:

| LDO1SET | LDO1SET connected to GND | LDO1SET connected to VINT |
|--------------|--------------------------|---------------------------|
| LDO1 Voltage | 1.3V | 3.3V |

DC3SET PIN is used to set the initial voltage of DC-DC3:

| DC3SET | DC3SET connected to GND | DC3SET connected to APS | DC3SET floating |
|----------------|-------------------------|-------------------------|-----------------|
| DC-DC3 Voltage | 1.8V | 3.3V/2.5V | 1.2V/1.5V |

As for more details, please refer to “Default Configuration Instruction”.

9.7 Signal Capture

Ordinary battery monitor is to estimate the battery energy by measuring the battery voltage. However, the multiple 12-bit ADCs in AXP209 can measure battery voltage, as well as battery current and external power voltage and current. It also integrates battery charge and discharge coulomb counter. According to these data, Host is capable of accurately calculate the battery energy and other battery data, such as the system real-time consumption, remaining battery energy, battery charge progress, remaining battery using time and charge time, etc.

The Enable state controlling and sampling rate of each ADC can be set via registers REG82H、83H、84H. The sampling results will be saved in corresponding registers, and reference can be made to the ADC data in Register Instruction section. The input range of GPIO[1:0] can be set via register REG85H while register REG00H[2] is used to indicate the battery charge/discharge current directions.

| Channel | 000H | STEP | FFFH |
|-----------------------|---------|---------|---------|
| Battery Voltage | 0mV | 1.1mV | 4.5045V |
| Bat discharge current | 0mA | 0.5mA | 4.095A |
| Bat charge current | 0mA | 0.5mA | 4.095A |
| ACIN voltage | 0mV | 1.7mV | 6.9615V |
| ACIN current | 0mA | 0.625mA | 2.5594A |
| VBUS voltage | 0mV | 1.7mV | 6.9615V |
| VBUS current | 0mA | 0.375mA | 1.5356A |
| Internal temperature | -144.7℃ | 0.1℃ | 264.8℃ |

| | | | |
|--------------|--------|-------|----------------|
| APS voltage | 0mV | 1.4mV | 5.733V |
| TS pin input | 0mV | 0.8mV | 3.276V |
| GPIO0 | 0/0.7V | 0.5mV | 2.0475/2.7475V |
| GPIO1 | 0/0.7V | 0.5mV | 2.0475/2.7475V |

9.8 Multi-Function Pin Description

GPIO[3:0]:

Can act as GPIO[3:0], ADC Input (monitoring external signals) , and LDO, etc. Please refer to REG90H-96H Instruction for details.

CHGLED:

Features charge state indication, over-temperature/over-voltage warning, and GPO. Please refer to REG32H Instruction section for details.

9.9 Timer

AXP209 features a 7-bit internal timer, whose values can be programmed via register REG8AH[6:0]: when the REG8AH[6:0] is full 0, the timer is disabled; when REG8AH[6:0]=A, the timer counts from 0 to A, and REG8AH[7] is set to 1, and timer interrupt is released at the same time. Writing 1 to REG8AH[7] can clear the flag and restart the counting, while only clearing the interrupt doesn't restart the counting. The minimum time step of timer is one minute, and the timing range is 1~127 minutes.

9.10 Decryption

AXP209 has a decryption module. It can be enabled by writing the data to be decrypted into REG300-REG30F on the part of Host, and then write 1 to register REGB8H[1]. After the decryption, AXP209 will set REGB8[0] to 1, and at that time, decrypted data can be read by Host from REG31x. The status bit will be automatically cleared by AXP209 when decryption is restarted.

9.11 Host Interface and Interrupt (TWSI and IRQ)

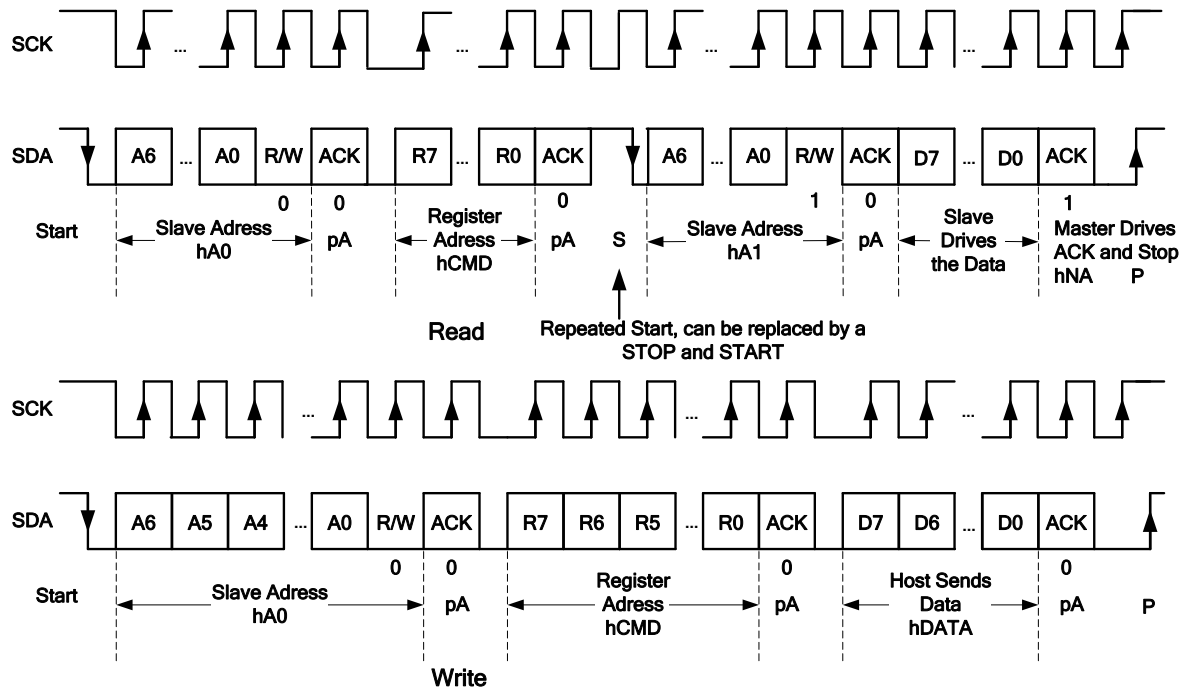


Fig.1 Single Read and Write

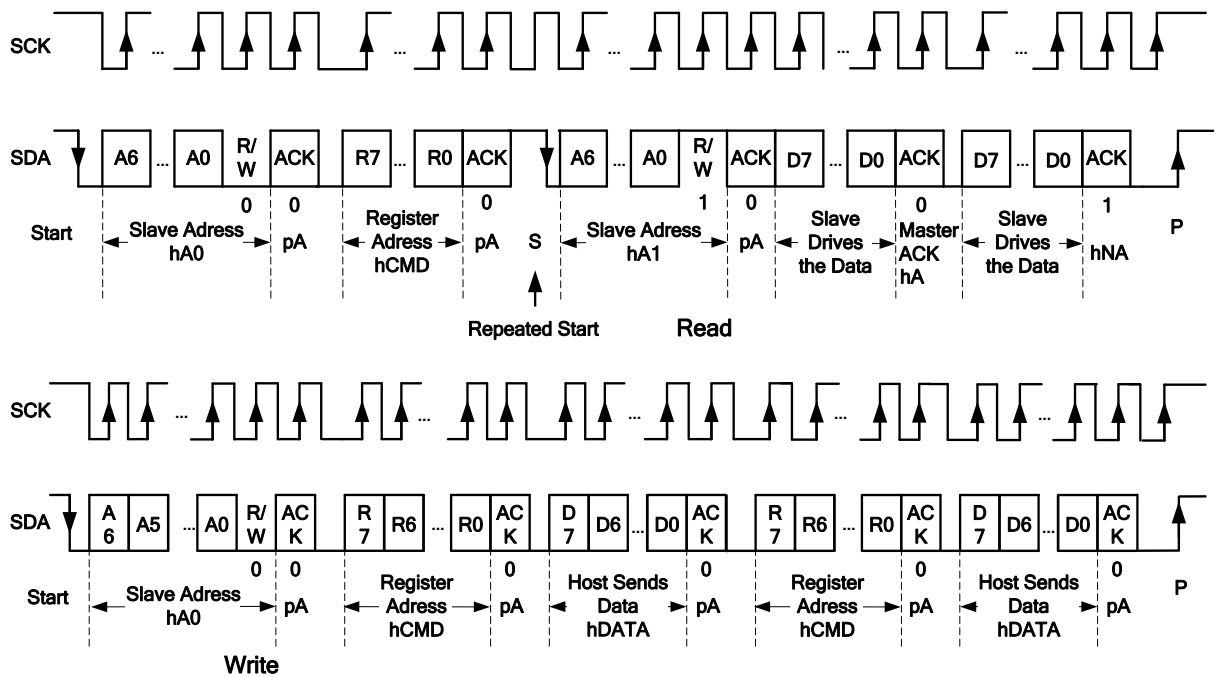


Fig.2 Multi Read and Write

Host can visit AXP209 registers via the TWSI interface, and the operation timing is listed

above. Standard 100KHz or 400KHz frequency is supported, and the highest rate can reach 1.2KHz. In addition, multi read and write operation is supported, and the device addresses are 69H (READ) and 68H (WRITE).

When certain events occur, AXP209 will inform Host by pulling down the IRQ interrupt mechanism, and the interrupt state will be reserved in interrupt state registers (See registers REG48H, REG49H, REG4AH, REG4BH and REG4CH). The interrupt can be cleared by writing 1 to corresponding state register bit. When there is no interrupt, IRQ output will be pulled high (51K resistance higher through the external). Each interrupt can be masked via interrupt control registers (Refer to registers REG40H, REG41H, REG42H, REG43H, and REG44H).

| Site | Interrupt NO. | Description | Site | Interrupt NO. | Description |
|-----------|---------------|---------------------------------------|-----------|---------------|--------------------------|
| REG48H[7] | IRQ1 | ACIN over-voltage | REG4AH[3] | IRQ20 | DCDC3 under-voltage |
| REG48H[6] | IRQ2 | ACIN connected | REG4AH[2] | Reserved | |
| REG48H[5] | IRQ3 | ACIN removed | REG4AH[1] | IRQ22 | PEK short-press |
| REG48H[4] | IRQ4 | VBUS over-voltage | REG4AH[0] | IRQ23 | PEK long-press |
| REG48H[3] | IRQ5 | VBUS connected | REG4BH[7] | IRQ24 | N_OE power-on |
| REG48H[2] | IRQ6 | VBUS removed | REG4BH[6] | IRQ25 | N_OE power-off |
| REG48H[1] | IRQ7 | VBUS voltage is lower than V_{HOLD} | REG4BH[5] | IRQ26 | VBUS valid |
| REG48H[0] | Reserved | | REG4BH[4] | IRQ27 | VBUS invalid |
| REG49H[7] | IRQ8 | Battery connected | REG4BH[3] | IRQ28 | VBUS Session Valid |
| REG49H[6] | IRQ9 | Battery removed | REG4BH[2] | IRQ29 | VBUS Session End |
| REG49H[5] | IRQ10 | Enter the battery activate mode | REG4BH[1] | IRQ30 | Low power warning LEVEL1 |
| REG49H[4] | IRQ11 | Exit the battery activate mode | REG4BH[0] | IRQ31 | Low Power Warning LEVEL2 |
| REG49H[3] | IRQ12 | Be charging | REG4CH[7] | IRQ32 | Timer interrupt |
| REG49H[2] | IRQ13 | Charge finished | REG4CH[6] | IRQ33 | PEK Rising edge |
| REG49H[1] | IRQ14 | Battery over-temperature | REG4CH[5] | IRQ34 | PEK Falling edge |
| REG49H[0] | IRQ15 | Battery under-temperature | REG4CH[4] | Reserved | |
| REG4AH[7] | IRQ16 | IC internal over-temperature | REG4CH[3] | IRQ35 | GPIO3input edge trigger |
| REG4AH[6] | IRQ17 | Insufficient charge current | REG4CH[2] | IRQ36 | GPIO2 input edge trigger |
| REG4AH[5] | IRQ18 | DCDC1under-voltage | REG4CH[1] | IRQ37 | GPIO1 input edge trigger |
| REG4AH[4] | IRQ19 | DCDC2 under-voltage | REG4CH[0] | IRQ38 | GPIO0 input edge trigger |

10. Registers

Group 1: Power Control

| Address | Register Description | R/W | Default Value |
|---------|---|-----|---------------|
| 00 | Power status register | R | |
| 01 | Power mode/ charge state register | R | |
| 02 | OTG VBUS state register | R | |
| 04-0F | Data cache register | R/W | 00H |
| 12 | DC-DC2/3 & LDO2/3/4&EXTEN control register | R/W | XXH |
| 23 | DC-DC2 voltage setting register | R/W | XXH |
| 25 | DC-DC2/LDO3voltage slope parameter setting register | R/W | 00H |
| 27 | DC-DC3voltage setting register | R/W | XXH |
| 28 | LDO2/3voltage setting register | R/W | XXH |
| 30 | VBUS-IPSOUT channel setting register | R/W | 60H |
| 31 | V _{OFF} shutdown voltage setting register | R/W | X3H |
| 32 | Shutdown, battery detection, CHGLED control register | R/W | 46H |
| 33 | Charge control register1 | R/W | CXH |
| 34 | Charge control register2 | R/W | 41H |
| 35 | Backup battery charge control register | R/W | 22H |
| 36 | PEK parameter control register | R/W | 5DH |
| 37 | DCDC converter work frequency setting register | R/W | 08H |
| 38 | battery charge low-temperature warning setting register | R/W | A5H |
| 39 | battery charge high-temperature warning setting register | R/W | 1FH |
| 3A | APS low-power Level1 setting register | R/W | 68H |
| 3B | APS low-power Level2 setting register | R/W | 5FH |
| 3C | battery discharge low-temperature warning setting register | R/W | FCH |
| 3D | battery discharge high-temperature warning setting register | R/W | 16H |
| 80 | DCDC work mode setting register | R/W | E0H |
| 82 | ADC enable setting register1 | R/W | 83H |
| 83 | ADC enable setting register2 | R/W | 80H |
| 84 | ADC sample rate setting, TS pin control register | R/W | 32H |
| 85 | GPIO [1:0] input range setting register | R/W | X0H |
| 86 | GPIO1 ADC IRQ rising edge threshold setting | R/W | FFH |
| 87 | GPIO1 ADC IRQ falling edge threshold setting | R/W | 00H |
| 8A | Timer control register | R/W | 00H |
| 8B | VBUS monitoring setting register | R/W | 00H |
| 8F | Over-temperature shutdown control register | R/W | 01H |

Group 2 GPIO control

| Address | Register Description | R/W | Default Value |
|---------|-------------------------------------|-----|---------------|
| 90 | GPIO0 control register | R/W | 07H |
| 91 | LDO5output voltage setting register | R/W | A0H |
| 92 | GPIO1 control register | R/W | 07H |
| 93 | GPIO2 control register | R/W | 07H |
| 94 | GPIO[2:0] signal status register | R/W | 00H |
| 95 | GPIO3 control register | R/W | 00H |

Group3 Interrupt control

| Address | Register Description | R/W | Default Value |
|---------|------------------------------|-----|---------------|
| 40 | IRQ enable control register1 | R/W | D8H |
| 41 | IRQ enable control register2 | R/W | FFH |
| 42 | IRQ enable control register3 | R/W | 3BH |
| 43 | IRQ enable control register4 | R/W | C1H |
| 44 | IRQ enable control register5 | R/W | 00H |
| 48 | IRQ status register1 | R/W | 00H |
| 49 | IRQ status register2 | R/W | 00H |
| 4A | IRQ status register3 | R/W | 00H |
| 4B | IRQ status register4 | R/W | 00H |
| 4C | IRQ status register5 | R/W | 00H |

Group4 ADC data

| Address | Register Description | R/W |
|---------|---|-----|
| 56[7:0] | ACIN voltage ADC data high 8 bits | R |
| 57[3:0] | ACIN voltage ADC data low 4 bits | R |
| 58[7:0] | ACIN current ADC data high 8 bits | R |
| 59[3:0] | ACIN current ADC data low 4 bits | R |
| 5A[7:0] | VBUS voltage ADC data high 8 bits | R |
| 5B[3:0] | VBUS voltage ADC data low 4 bits | R |
| 5C[7:0] | VBUS current ADC data high 8 bits | R |
| 5D[3:0] | VBUS current ADC data low 4 bits | R |
| 5E[7:0] | AXP209 internal temperature monitoring ADC data high 8 bits | R |
| 5F[3:0] | AXP209internal temperature monitoring ADC data low 4 bits | R |
| 62[7:0] | TS input ADC data high 8 bits, default monitoring battery temperature | R |
| 63[3:0] | TS input ADC data low 4 bits, default monitoring battery temperature | R |

| | | |
|---------|---|---|
| 64[7:0] | GPIO0 voltage ADC data high 8 bits | R |
| 65[3:0] | GPIO0 voltage ADC data low 4 bits | R |
| 66[7:0] | GPIO1 voltage ADC data high 8 bits | R |
| 67[3:0] | GPIO1 voltage ADC data low 4 bits | R |
| 70[7:0] | Battery instantaneous power high 8 bits | R |
| 71[7:0] | Battery instantaneous power middle 8 bits | R |
| 72[7:0] | Battery instantaneous power low 8 bits | R |
| 78[7:0] | Battery voltage high 8 bits | R |
| 79[3:0] | Battery voltage low 4 bits | R |
| 7A[7:0] | Battery charge current high 8 bits | R |
| 7B[3:0] | Battery charge current low 4 bits | R |
| 7C[7:0] | Battery discharge current high 8 bits | R |
| 7D[4:0] | Battery discharge current low 5 bits | R |
| 7E[7:0] | System IPSOUT voltage high 8 bits | R |
| 7F[3:0] | System IPSOUT voltage low 4 bits | R |

Note: the battery power formula:

$P_{bat} = 2 * \text{register value} * \text{Voltage LSB} * \text{Current LSB} / 1000.$

(Voltage LSB is 1.1mV; Current LSB is 0.5mA, and unit of calculation result is mW.)

| Address | Register Description | R/W | Default Value |
|---------|--|-----|---------------|
| B0 | battery charge coulomb counter data register[31:24] | R/W | 00H |
| B1 | battery charge coulomb counter data register[23:16] | R/W | 00H |
| B2 | battery charge coulomb counter data register[15:8] | R/W | 00H |
| B3 | battery charge coulomb counter data register[7:0] | R/W | 00H |
| B4 | battery discharge coulomb counter data register[31:24] | R/W | 00H |
| B5 | battery discharge coulomb counter data register[23:16] | R/W | 00H |
| B6 | battery discharge coulomb counter data register[15:8] | R/W | 00H |
| B7 | battery discharge coulomb counter data register[7:0] | R/W | 00H |
| B8 | Coulomb counter and encryption module control register | R/W | 00H |
| B9 | Power measurement result register | R/W | 00H |

Coulomb calculation formula:

$C = 65536 * \text{current LSB} * (\text{charge coulomb counter value} - \text{discharge coulomb counter value}) / 3600 / \text{ADC sample rate}.$

(Refer to REG84H setting for ADC sample rate; the current LSB is 0.5mA; unit of the calculation result is mAh.)

10.1 REG 00H : Input Power Status

| Bit | Description | R/W |
|-----|-------------|-----|
|-----|-------------|-----|

| | | |
|---|--|---|
| 7 | ACIN presence indication 0:ACIN not exist; 1:ACIN exists | R |
| 6 | Indicating whether ACIN is usable | R |
| 5 | VBUS presence indication 0:VBUS not exist; 1:VBUS exists | R |
| 4 | Indicating whether VBUS is usable | R |
| 3 | Indicating whether the VBUS voltage is above V_{HOLD} before used. | R |
| 2 | Indicating the battery current direction 0: the battery is discharging; 1: the battery is charging | R |
| 1 | Indicating whether ACIN and VBUS input short circuit on PCB | R |
| 0 | Indicating whether the boot source is ACIN or VBUS 0: Boot source isn't ACIN/VBUS; 1: Boot source is ACIN/VBUS. | R |

10.2 REG 01H: Power Work Mode and Charge Status Indication

| Bit | Description | R/W |
|-----|--|-----|
| 7 | Indicating whether AXP209 is over-temperature 0: not over-temperature; 1: over-temperature | R |
| 6 | Charge indication 0:not charge or charge finished; 1: in charging | R |
| 5 | Battery existence indication 0:no battery connected to AXP209; 1:battery already connected to AXP209 | R |
| 4 | Reserved and unchangeable | R |
| 3 | Indicating whether the battery enters the activate mode 0: not enter the activate mode; 1: already entered the activate mode | R |
| 2 | Indicating whether the charging current is lower than the expected current 0:actual charging current is the same as expected current; 1: actual charging current is lower than expected current | R |
| 1-0 | Reserved and unchangeable | R |

10.3 REG 02H: USB OTG VBUS Status Indication

| Bit | Description | R/W |
|-----|---|-----|
| 7-3 | Reserved and unchangeable | |
| 2 | Indicating whether VBUS is valid or not, 1 means "valid" | R |
| 1 | Indicating whether VBUS Session A/B is valid, 1 means "valid" | R |
| 0 | Indicating Session End status, 1 means "valid" | R |

10.4 REG 04-0FH: Data Cache

Note: As long as one of the external powers, batteries or backup batteries exists, this data will be reserved and free from the startup and shutdown influence.

10.5 REG 12H: Power Output Control

Default value: XXH

| Bit | Description | | R/W | Default Value |
|-----|-----------------------------------|-----------------------|-----|---------------|
| 7 | Reserved and unchangeable | | RW | X |
| 6 | LDO3 enable and disable control | 0: disable; 1: enable | RW | X |
| 5 | Reserved and unchangeable | | RW | X |
| 4 | DC-DC2 enable and disable control | 0: disable; 1:enable | RW | X |
| 3 | LDO4 enable and disable control | | RW | X |
| 2 | LDO2 enable and disable control | | RW | X |
| 1 | DC-DC3 enable and disable control | | RW | X |
| 0 | EXTEN enable and disable control | | RW | X |

10.6 REG 23H: DC-DC2 Output Voltage Setting

Default Value: XXH

| Bit | Description | | R/W | Default Value |
|-----|-------------------------------|--|-----|---------------|
| 7-6 | Reserved and unchangeable | | | |
| 5-0 | DC-DC2 output voltage setting | 0.7-2.275V, 25mV/step $V_{out}=[0.7+(Bit5-0)*0.025]V$ | RW | X |

10.7 REG 25H: DC-DC2/LDO3 Dynamic Voltage Scaling Parameter Setting

Default Value: 00H

| Bit | Description | | R/W | Default Value |
|-----|--|--|-----|---------------|
| 7-4 | Reserved and unchangeable | | | |
| 3 | LDO3 VRC ENABLING CONTROL 0: enable; 1: disable | | RW | 0 |
| 2 | DC-DC2 VRC enabling control 0: enable; 1: disable | | RW | 0 |
| 1 | LDO3 VRC voltage rising slope control | 0: 25mV/15.625us=1.6mV/us 1: 25mV/31.250us=0.8mV/us | RW | 0 |

| | | | | |
|---|---|--|----|---|
| 0 | DC-DC2 VRC voltage rising slope control | 0: 25mV/15.625us=1.6mV/us 1: 25mV/31.250us=0.8mV/us | RW | 0 |
|---|---|--|----|---|

10.8 REG 27H: DC-DC3 Output Voltage Setting

Default Value: XXH

| Bit | Description | | R/W | Default Value |
|-----|-------------------------------|--|-----|---------------|
| 7 | Reserved and unchangeable | | | |
| 6-0 | DC-DC3 output voltage setting | 0.7-3.5V, 25mV/step $V_{out}=[0.7+(\text{Bit}6-0)*0.025]\text{V}$ | RW | X |

10.9 REG 28H: LDO2/4 Output Voltage Setting

Default Value: XXH

| Bit | Description | | R/W | Default Value |
|-----|-----------------------------|---|-----|---------------|
| 7-4 | LDO2 output voltage setting | 1.8-3.3V, 100mV/step $V_{out}=[1.8+(\text{Bit}7-4)*0.1]\text{V}$ | RW | X |
| 3-0 | LDO4 output voltage setting | 1.25 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.5 2.7 2.8 3.0 3.1 3.2 3.3 | RW | X |

10.10 REG 29H: LDO3 Output Voltage Setting

Default Value: XXH

| Bit | Description | | R/W | Default Value |
|-----|---|--|-----|---------------|
| 7 | LDO3 Mode select: 0: LDO mode, voltage can be set by [6:0] 1: enable/disable control mode, and voltage is determined by LDO3IN. | | RW | 0 |
| 6-0 | LDO3 output voltage setting Bit6-Bit0 | 0.7-2.275V, 25mV/step $V_{out}=[0.7+(\text{Bit}6-0)*0.025]\text{V}$ | RW | X |

10.11 REG 30H: VBUS-IPSOUT Channel Management

Default Value: 6XH

| Bit | Description | | R/W | Default Value |
|-----|--|--|-----|---------------|
| 7 | the VBUS-IPSOUT path select control signal when VBUS is usable 0: whether to enable the path is decided by N_VBUSEN pin 1: VBUS-IPSOUT can be enabled, regardless of the N_VBUSEN status | | RW | 0 |

| | | | | |
|-----|---|---|----|-----|
| 6 | VBUS V _{HOLD} voltage-limit control 0: not limit the voltage; 1: limit the voltage | | RW | 1 |
| 5-3 | V _{HOLD} setting | $V_{HOLD} = [4.0 + (\text{Bit}5-3) * 0.1]V$ | RW | 100 |
| 2 | Reserved and unchangeable | | | |
| 1-0 | VBUS current-limit selection when current-limit is enabled 00:900mA ; 01:500mA; 10:100mA; 11:not limit | | RW | 0 |

10.12 REG 31H: V_{OFF} Shutdown Voltage Setting

Default Value: X3H

| Bit | Description | | R/W | Default Value |
|-----|---|---|-----|---------------|
| 7-4 | Reserved and unchangeable | | | |
| 3 | PEK or GPIO edge wakeup function enable setting in Sleep mode 0: disable 1: enable This bit will be automatically cleared to 0 after writing, so “1” should be rewritten whenever enters the Sleep mode. | | | |
| 2-0 | V _{OFF} setting | $V_{OFF} = [2.6 + (\text{Bit}2-0) * 0.1]V$ Default: 2.9V | RW | 011 |

10.13 REG 32H: Shutdown Setting, Battery Detection and CHGLED Pin Control

Default Value: 46H

| Bit | Description | | R/W | Default Value |
|-----|---|---|-----|---------------|
| 7 | Shutdown Control Writing “1” to this bit will disable the AXP209 output. | | RW | 0 |
| 6 | Battery monitoring function setting bit: 0: disable; 1: enable | | RW | 1 |
| 5-4 | CHGLED pin function setting | 00: high resistance 01: 25% 1Hz flicker 10: 25% 4Hz flicker 11: low level output | RW | 00 |
| 3 | CHGLED pin control setting | 0: controlled by charging 1: controlled by register REG 32H[5:4] | RW | 0 |
| 2 | Output disable timing control | 0: disable at the same time 1: contrary to the startup timing | RW | 0 |
| 1-0 | the delayed shutdown time of AXP209 after N_OE changes from low to high | 00: 128mS; 01: 1S; 10: 2S; 11: 3S | RW | 10 |

10.14 REG 33H: charging control 1

Default Value: CXH

| Bit | Description | R/W | Default Value |
|-----|--|-----|---------------|
| 7 | Charging enable control bit 0: disable, 1:enable | RW | 1 |
| 6-5 | Charging target-voltage setting 00:4.1V; 01:4.15V; 10:4.2V; 11:4.36V | RW | 10 |
| 4 | Charging end-current setting 0: end when the charge current is lower than 10% of the set value 1: end when the charge current is lower than 15% of the set value | RW | 0 |
| 3-0 | Charge current setting $I_{\text{charge}} = [300 + (\text{Bit}3-0) * 100] \text{ mA}$ | RW | X |

10.15 REG 34H: Charge Control 2

Default Value: 45H

| Bit | Description | R/W | Default Value |
|-----|---|-----|---------------|
| 7 | Pre-charge timeout setting Bit1 | RW | 0 |
| 6 | Pre-charge timeout setting Bit0 | | |
| 5 | Reserved | | |
| 4 | CHGLED mode selection 0: always bright when charging 1: flicker when charging | RW | 0 |
| 3-2 | Reserved and unchangeable | | |
| 1-0 | Constant-current mode timeout setting Bit1-0 | RW | 01 |

10.16 REG 35H: Backup Battery Charge Control

Default Value: 22H

| Bit | Description | R/W | Default Value |
|-----|--|-----|---------------|
| 7 | Backup battery charge enable control 0: disable; 1: enable | RW | 0 |
| 6-5 | Backup battery charge target-voltage setting 00:3.1V; 01:3.0V; 10:3.6V; 11:2.5V | RW | 01 |
| 4-2 | Reserved and unchangeable | | |

| | | | | |
|-----|---------------------------------------|---|----|----|
| 1-0 | Backup battery charge current setting | 00: 50uA; 01: 100uA; 10: 200uA; 11: 400uA | RW | 10 |
|-----|---------------------------------------|---|----|----|

10.17 REG 36H: PEK Key Parameters Setting

Default Value: 9DH

| Bit | Description | | R/W | Default Value |
|-----|---|-------------------------------------|-----|---------------|
| 7-6 | Startup time setting | 00: 128mS; 01: 3S; 10: 1S; 11: 2S. | RW | 01 |
| 5-4 | Long-press time setting | 00: 1S; 01: 1.5S; 10: 2S; 11: 2.5S. | RW | 01 |
| 3 | Automatic shutdown setting when the key press-time exceeds the shutdown time 0: disable; 1: enable | | RW | 1 |
| 2 | PWROK signal delay after the power startup 0:8mS; 1:64mS | | RW | 1 |
| 1-0 | Shutdown time setting | 00: 4S; 01: 6S; 10: 8S; 11: 10S. | RW | 01 |

10.18 REG 37H: DC-DC Work Frequency Setting

Default Value: 08H

| Bit | Description | | R/W | Default Value |
|-----|--|--|-----|---------------|
| 7-4 | Reserved and unchangeable | | | |
| 3-0 | DC-DC enable/disable frequency setting | Each level changes by 5% , Default Value1.5MHz F=[1+/- (Bit3-0)*5%)]*1.5MHz | RW | 1000 |

10.19 REG 38H: $V_{LTF-charge}$ Battery Charge Low-temperature Threshold Setting

Default Value: A5H

| Bit | Description | | R/W | Default Value |
|-----|---|---|-----|---------------|
| 7-0 | Battery low-temperature threshold setting when the battery is charging, M | M*10H, when M=A5H, corresponding voltage is 2.112V; corresponding voltage ranges from 0V~3.264V | RW | A5H |

$$V_{LTF-charge} = M * 10H * 0.0008V$$

10.20 REG 39H: $V_{HTF-charge}$ Battery Charge High-Temperature Threshold Setting

Default Value: 1FH

| Bit | Description | R/W | Default |
|-----|-------------|-----|---------|
|-----|-------------|-----|---------|

| | | | | Value |
|-----|--|--|----|-------|
| 7-0 | The battery high-temperature threshold setting when the battery is charging, N | N*10H, when N=1FH, the corresponding voltage is 0.397V ; corresponding voltage ranges from 0V~3.264V | RW | 1FH |

$$V_{\text{HTF-charge}} = N * 10H * 0.0008V$$

10.21 REG 3AH: System IPSOUT Vwarning Level1

Default Value: 68H

| Bit | Description | R/W | Default Value |
|-----|-------------------------------|-----|---------------|
| 7-0 | System IPSOUT Vwarning Level1 | RW | 68H |

10.22 REG 3BH: System IPSOUT Vwarning Level2

Default Value: 5FH

| Bit | Description | R/W | Default Value |
|-----|-------------------------------|-----|---------------|
| 7-0 | System IPSOUT Vwarning Level2 | RW | 5FH |

Corresponding voltage setting of REG3AH and REG3BH equals to (supposing the register value is n):

$$V_{\text{warning}} = 2.8672 + 1.4\text{mV} * n * 4$$

10.23 REG 3CH: $V_{\text{LTF-discharge}}$ Battery Discharging Low-Temperature Threshold Setting

Default Value: FCH

| Bit | Description | R/W | Default Value |
|-----|--|-----|---------------|
| 7-0 | battery low-temperature threshold setting when the battery is discharging, M | RW | FCH |

$$V_{\text{LTF-discharge}} = M * 10H * 0.0008V$$

10.24 REG 3DH: $V_{\text{HTF-discharge}}$ Battery Discharging Threshold Setting

Default Value: 16H

| Bit | Description | | R/W | Default Value |
|-----|------------------------------|----------------------------------|-----|---------------|
| 7-0 | The battery high-temperature | N*10H, when N=16H, corresponding | RW | 16H |

| | | | | |
|--|--|--|--|--|
| | threshold setting when the battery is discharging, N | voltage is 0.282V; corresponding voltage ranges from 0V~3.264V | | |
|--|--|--|--|--|

$$V_{LTF-discharge} = N * 10H * 0.0008V$$

10.25 REG 80H: DC-DC Work Mode Selection

Default Value: E0H

| Bit | Description | | R/W | Default Value |
|-----|---------------------------|---|-----|---------------|
| 7-3 | Reserved and unchangeable | | | |
| 2 | DC-DC2 work mode control | 0:PFM/PWM automatic switching 1: fixed PWM | RW | 0 |
| 1 | DC-DC3 work mode control | | RW | 0 |
| 0 | Reserved and unchangeable | | | |

10.26 REG 82H: ADC Enable 1

Default Value: 83H

| Bit | Description | | R/W | Default Value |
|-----|----------------------------|-----------------------|-----|---------------|
| 7 | Battery voltage ADC enable | 0: disable, 1: enable | RW | 1 |
| 6 | Battery current ADC enable | | RW | 0 |
| 5 | ACIN voltage ADC enable | | RW | 0 |
| 4 | ACIN current ADC enable | | RW | 0 |
| 3 | VBUS voltage ADC enable | | RW | 0 |
| 2 | VBUS current ADC enable | | RW | 0 |
| 1 | APS voltage ADC enable | | RW | 1 |
| 0 | TS pin ADC function enable | | RW | 1 |

10.27 REG 83H: ADC enable2

Default Value: 80H

| Bit | Description | | R/W | Default Value |
|-----|---|-----------------------|-----|---------------|
| 7 | AXP209 internal temperature monitoring ADC enable | 0: disable, 1: enable | RW | 1 |
| 6-4 | Reserved and unchangeable | | | |
| 3 | GPIO0 ADC function enable | 0: disable, 1: enable | RW | 0 |
| 2 | GPIO1 ADC function enable | | RW | 0 |
| 1-0 | Reserved and unchangeable | | | |

10.28 REG 84H: ADC Sample Rate Setting and TS Pin Control

Default Value: 32H

| Bit | Description | | R/W | Default Value |
|-----|--|---|-----|---------------|
| 7-6 | ADC sample rate setting | 25×2 ⁿ The sample rate is 25, 50, 100, 200Hz respectively. | RW | 0 |
| 5-4 | TS pin output current setting: 00:20uA; 01:40uA; 10:60uA; 11:80uA | | RW | 11 |
| 3 | Reserved and unchangeable | | | |
| 2 | TS pin function selection 0: battery temperature monitoring function, 1: external independent ADC input | | RW | 0 |
| 1-0 | TS pin current output method setting | 00: disable | RW | 1 |
| | | 01: current output when charging 10: input when the ADC is sampling, reducing the power consumption 11: always enable | RW | 0 |

10.29 REG 85H: ADC Input Range

Default Value: X0H

| Bit | Description | | R/W | Default Value |
|-----|---------------------------|---------------|-----|---------------|
| 7-2 | Reserved and unchangeable | | | |
| 1 | GPIO1 ADC Input Range | 0:0-2.0475V | RW | 0 |
| 0 | GPIO0 ADC Input Range | 1:0.7-2.7475V | RW | 0 |

10.30 REG 86H: GPIO1 ADC IRQ Rising Edge Threshold Setting

Default Value: FFH

| Bit | Description | R/W | Default Value |
|-----|----------------|-----|---------------|
| 7-0 | One LSB is 8mV | RW | FF |

10.31 REG 87H: GPIO1 ADC IRQ Falling Edge Threshold Setting

Default Value: 00H

| Bit | Description | R/W | Default Value |
|-----|----------------|-----|---------------|
| 7-0 | One LSB is 8mV | RW | 00 |

10.32 REG 8AH: Timer Control

Default Value: 00H

| Bit | Description | R/W | Default Value |
|-----|---|-----|---------------|
| 7 | The timer is timeout Write “1” to clear the status. | RW | 0 |
| 6-0 | Set the time, unit: minute Write full 0 to shutdown the timer. | RW | 0000000 |

10.33 REG 8BH: VBUS Pin Detection and SRP Function Control

Default Value: 00H

| Bit | Description | R/W | Default Value |
|-----|--|-----|---------------|
| 7-6 | Reserved and unchangeable | | |
| 5-4 | VBUS valid voltage setting 00:4.0V; 01:4.15V; 10:4.45V; 11:4.55V | RW | 00 |
| 3 | VBUS Valid detect function setting: 0: disable, 1: enable | RW | 0 |
| 2 | VBUS Session detect function setting: 0: disable, 1: enable | RW | 0 |
| 1 | Discharge VBUS discharge function setting 0: to disable the VBUS discharge resistance; 1: to enable the VBUS discharge resistance | RW | 0 |
| 0 | Charge VBUS charge function setting 0: disable the VBUS charge resistance; 1: enable the VBUS charge resistance and charge the VBUS | RW | 0 |

10.34 REG 8FH: Function Setting, Over-temperature Shutdown, etc.

Default Value: 21H

| Bit | Description | R/W | Default Value |
|-----|---|-----|---------------|
| 7-3 | Reserved and unchangeable | RW | 0 |
| 2 | AXP209 internal over-temperature shutdown setting 0: not shutdown; 1: shutdown | RW | 0 |
| 1-0 | Reserved and unchangeable | | |

10.35 REG 90H: GPIO0 function Setting

Default Value: 07H

| Bit | Description | | R/W | Default Value |
|-----|---|--|-----|---------------|
| 7 | GPIO0 rising edge IRQ or Wakeup function | 0: disable 1: enable | RW | 0 |
| 6 | GPIO0 falling edge IRQ or Wakeup function | | RW | 0 |
| 5-3 | Reserved and unchangeable | | RW | 0 |
| 2 | GPIO0 pin function setting Bit 2-0 | 000: output low 001: output high (3.3V) 010: general input function 011: low noise LDO5 100:ADC input 1XX: floating | RW | 1 |
| 1 | | | RW | 1 |
| 0 | | | RW | 1 |

10.36 REG 91H: LDO5 Output Voltage and EXTEN/GPIO Output High Level Setting

Default Value: A5H

| Bit | Description | | R/W | Default Value |
|-----|---|--|-----|---------------|
| 7-4 | LDO5 output voltage setting $V_{out} = [1.8 + (\text{Bit7-4}) * 0.1]V$; default = $1.8 + 10 * 0.1 = 2.8V$ | | RW | 1010 |
| 3 | Reserved and unchangeable | | | |
| 2-0 | EXTEN and GPIO[1:0] output high level setting 000: 1.8V; 001: 2.5V; 010: 2.8V; 011: 3.0V; 100: 3.1V; 101: 3.3V; 110: 3.4V; 111: 3.5V | | RW | 101 |

10.37 REG 92H: GPIO1 Function Setting

Default Value: 07H

| Bit | Description | | R/W | Default Value |
|-----|--|-------------------------|-----|---------------|
| 7 | GPIO1 rising edge IRQ or Wakeup function | 0: disable 1: enable | RW | 0 |
| 6 | GPIO1 rising edge IRQ or Wakeup function | | RW | 0 |
| 5-3 | Reserved and unchangeable | | RW | 0 |

| | | | | |
|-----|----------------------------|--|----|-----|
| 2-0 | GPIO1 pin function setting | 000: output low 001: output high (3.3V) 010: general input function 011: low noise LDO 100: ADC input 1XX: floating | RW | 111 |
|-----|----------------------------|--|----|-----|

10.38 REG 93H: GPIO2 Function Setting

Default Value: 07H

| Bit | Description | | R/W | Default Value |
|-----|---|--|-----|---------------|
| 7 | GPIO2 rising edge IRQ or Wakeup function | 0: disable 1: enable | RW | 0 |
| 6 | GPIO2 falling edge IRQ or Wakeup function | | RW | 0 |
| 5-3 | Reserved and unchangeable | | RW | 0 |
| 2-0 | GPIO2 pin function setting | 000: output low 001: floating 010: general input function XXX: floating | RW | 111 |

10.39 REG 94H: GPIO [2:0] Signal Status Setting and Monitoring

Default Value: 00H

| Bit | Description | | R/W | Default Value |
|-----|---------------------------|---|-----|---------------|
| 7 | Reserved and unchangeable | | R | |
| 6 | GPIO2 input status | 0: input low level 1: input high level | R | |
| 5 | GPIO1 input status | | R | |
| 4 | GPIO0 input status | | R | |
| 3-0 | Reserved and unchangeable | | | |

10.40 REG 95H: GPIO 3 Setting

Default Value: 00H

| Bit | Description | | R/W | Default Value |
|-----|---|-------------------------|-----|---------------|
| 7 | GPIO3 rising edge IRQ or Wakeup function | 0: disable 1: enable | RW | 0 |
| 6 | GPIO3 falling edge IRQ or Wakeup function | | RW | 0 |

| | | | | |
|-----|---------------------------|---|----|---|
| 5-3 | Reserved and unchangeable | | | |
| 2 | GPIO3 function setting | 0: NMOS Open Drain output 1: number input function | RW | 0 |
| 1 | GPIO3 output status | 0: output low level, NMOS enable 1: floating, NMOS disable | RW | 1 |
| 0 | GPIO3 input status | 0: input high level 1: input low level | R | |

10.41 REG 40H and 48H: IRQ enable1 and IRQ Status 1

IRQ enable1 and REG40H: Default Value: D8H

| Bit | Description | R/W | Default Value |
|-----|---|-----|---------------|
| 7 | ACIN over-voltage, IRQ enable | RW | 1 |
| 6 | ACIN connected, IRQ enable | RW | 1 |
| 5 | ACIN removed, IRQ enable | RW | 0 |
| 4 | VBUS over-voltage, IRQ enable | RW | 1 |
| 3 | VBUS connected, IRQ enable | RW | 1 |
| 2 | VBUS removed, IRQ enable | RW | 0 |
| 1 | VBUS is available, but lower than V_{HOLD} , IRQ enable | RW | 0 |
| 0 | Reserved and unchangeable | RW | 0 |

IRQ status 1, REG48H: Default Value: 00H

| Bit | Description | R/W | Default Value |
|-----|---|-----|---------------|
| 7-0 | The meaning of status bit respectively corresponds to each bit of 40H; For example: Bit7 is ACIN over-voltage IRQ status bit | RW | 0 |

10.42 REG 41H and 49H: IRQ enable2 and IRQ Status2

IRQ enable2, REG41H: Default Value: FFH

| Bit | Description | R/W | Default Value |
|-----|--|-----|---------------|
| 7 | Battery connected, IRQ enable | RW | 1 |
| 6 | Battery removed, IRQ enable | RW | 1 |
| 5 | Battery activate mode, IRQ enable | RW | 1 |
| 4 | Exit battery activate mode, IRQ enable | RW | 1 |
| 3 | Be charging, IRQ enable | RW | 1 |
| 2 | Charge finished, IRQ enable | RW | 1 |
| 1 | Battery over-temperature, IRQ enable | RW | 1 |
| 0 | Battery low-temperature, IRQ enable | RW | 1 |

IRQ status 2, REG49H: Default Value: 00H

| Bit | Description | R/W | Default Value |
|-----|--|-----|---------------|
| 7-0 | Meaning of the Status bit respectively corresponds to each bit of 41H. | RW | 0 |

10.43 REG 42H and 4AH: IRQ enable3 and IRQ Status 3

IRQ enable3, REG42H: Default Value: 03H

| Bit | Description | R/W | Default Value |
|-----|---|-----|---------------|
| 7 | AXP209 internal over-temperature, IRQ enable | RW | 0 |
| 6 | Charge current is lower than the set current, IRQ enable | RW | 0 |
| 5 | Reserved and unchangeable | | |
| 4 | DC-DC2 output voltage is lower than the set value, IRQ enable | RW | 0 |
| 3 | DC-DC3output voltage is lower than the set value, IRQ enable | RW | 0 |
| 2 | LDO3output voltage is lower than the set value, IRQ enable | | |
| 1 | PEK short press, IRQ enable | RW | 1 |
| 0 | PEK long press, IRQ enable | RW | 1 |

IRQ Status 3, REG4AH: Default Value: 00H

| Bit | Description | R/W | Default Value |
|-----|--|-----|---------------|
| 7-0 | Meaning of the Status bit respectively corresponds to each bit of 42H. | RW | 0 |

10.44 REG 43H and 4BH: IRQ enable4 and IRQ Status 4

IRQ enable4, REG43H: Default Value: 01H

| Bit | Description | R/W | Default Value |
|-----|--------------------------------------|-----|---------------|
| 7 | N_OE startup, IRQ enable | RW | 0 |
| 6 | N_OE shutdown, IRQ enable | RW | 0 |
| 5 | VBUS valid, IRQ enable | RW | 0 |
| 4 | VBUS invalid, IRQ enable | RW | 0 |
| 3 | VBUS Session A/B IRQ enable | RW | 0 |
| 2 | VBUS Session End IRQ enable | RW | 0 |
| 1 | APS low-voltage, IRQ enable (LEVEL1) | RW | 0 |
| 0 | APS low-voltage, IRQ enable (LEVEL2) | RW | 1 |

IRQ status 4, REG4BH: Default Value: 00H

| Bit | Description | R/W | Default Value |
|-----|--|-----|---------------|
| 7-0 | Meaning of the Status bit respectively corresponds to each bit of 43H. | RW | 0 |

10.45 REG 44H and 4C: IRQ Enable 5 and IRQ Status 5

IRQenable5, REG44H, Default Value: 00H;

| Bit | Description | R/W | Default Value |
|-----|--|-----|---------------|
| 7 | Timer timeout, IRQ enable | RW | 0 |
| 6 | PEK press rising edge, IRQ enable | RW | 0 |
| 5 | PEK press falling edge, IRQ enable | RW | 0 |
| 4 | Reserved and unchangeable | RW | 0 |
| 3 | GPIO3 input edge trigger, IRQ enable | RW | 0 |
| 2 | GPIO2input edge trigger, IRQ enable | RW | 0 |
| 1 | GPIO1input edge trigger or ADC input, IRQ enable | RW | 0 |
| 0 | GPIO0 input edge trigger, IRQ enable | RW | 0 |

IRQ status 5, REG4CH: Default Value: 00H

| Bit | Description | R/W | Default Value |
|-----|---|-----|---------------|
| 7-0 | Meaning of the Status bit respectively corresponds to each bit of 44H | RW | 0 |

Note: Writing 1 to all IRQ status register bits will clear corresponding status.

10.51 REG B8H: Coulomb Counter Control

Default Value: 00H

| Bit | Description | R/W | Default Value |
|-----|---|-----|---------------|
| 7 | coulomb counter enable/disable control | RW | 0 |
| 6 | Coulomb counter suspend control. Writing “1” to this bit will suspend the Coulomb counter, and this bit will be automatically cleared to 0 as well. | RW | 0 |
| 5 | Coulomb counter clear control. Writing “1” to this bit will clear the coulomb counter, and this bit will automatically be cleared to 0. | RW | 0 |
| 4-2 | Reserved and unchangeable | RW | 0 |
| 1-0 | Decrypt the start bit. Automatically clear to 0 after the decryption. | RW | 0 |
| 0 | Whether the decryption has finished or not 0: not finished 1: finished | RW | 0 |

10.52 REG B9H: Power Measurement Result

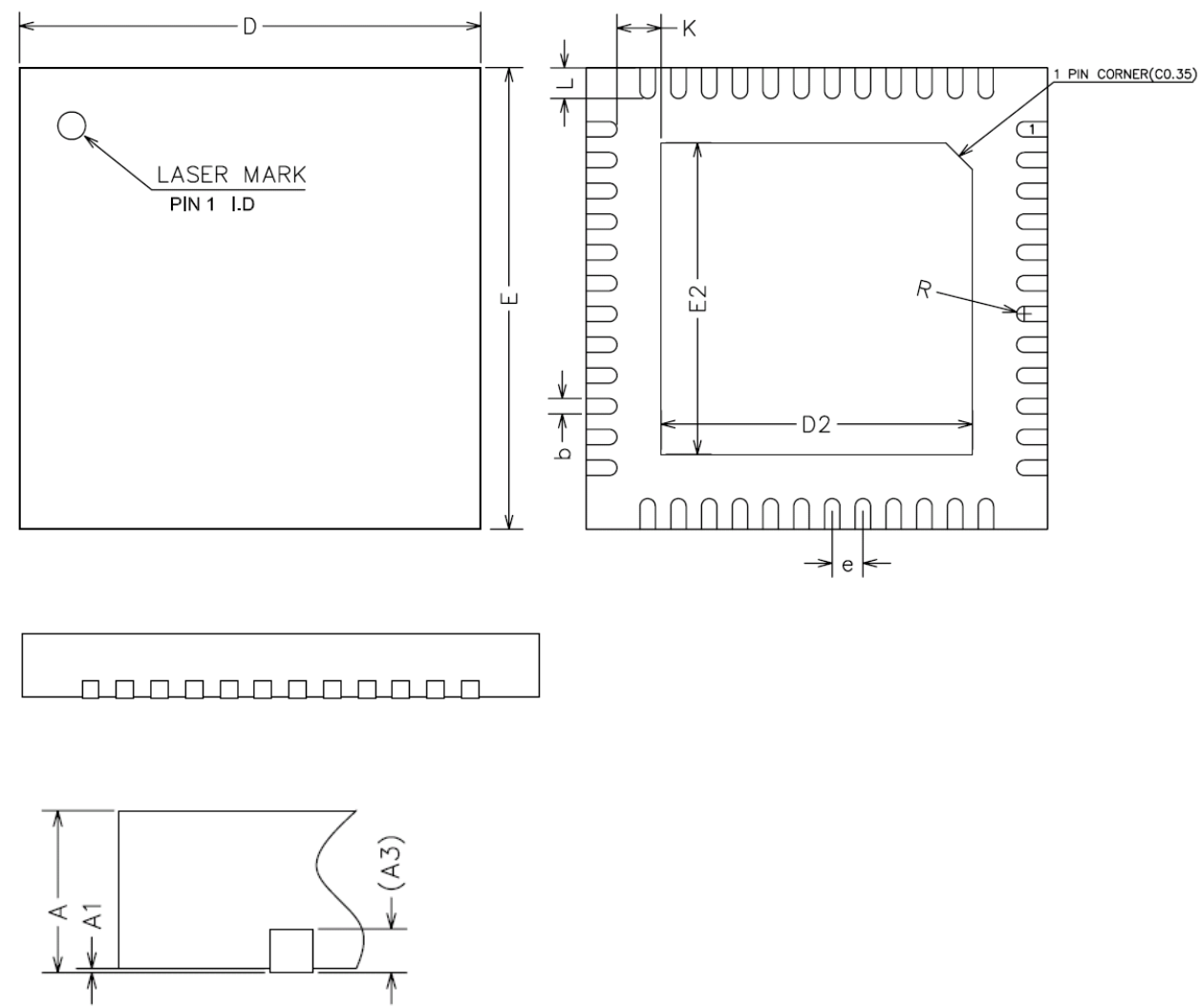
Default Value: 7FH

| Bit | Description | R/W | Default Value |
|-----|------------------------|-----|---------------|
| 7 | Measure system control | RW | 0 |

| | | | |
|-----|---|---|----|
| | 0: normal work mode 1: work suspension | | |
| 6-0 | Measure result, percentage | R | 7F |

11 . Package

AXP209: QFN48



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

| SYMBOL | MIN | NOM | MAX |
|--------|---------|------|------|
| A | 0.70 | 0.75 | 0.80 |
| A1 | 0 | 0.02 | 0.05 |
| A3 | 0.20REF | | |
| b | 0.15 | 0.20 | 0.25 |
| D | 5.90 | 6.00 | 6.10 |
| E | 5.90 | 6.00 | 6.10 |
| D2 | 3.95 | 4.05 | 4.15 |
| E2 | 3.95 | 4.05 | 4.15 |
| e | 0.35 | 0.40 | 0.45 |
| K | 0.20 | — | — |
| L | 0.35 | 0.40 | 0.45 |
| R | 0.09 | — | — |

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