PMIC Optimized For Multi-Core High-Performance System

# AXP228

# Datasheet

**Revision 1.1**

**2013.01.06**

# Version history

| Version | Modify Time | Author | Description |
|---|---|---|---|
| Revision 1.0 | 2012.12.12 | | Initial version |
| Revision 1.1 | 2013.01.06 | | |

# Catalog





# 1 Overview

## Description

AXP228 is a highly integrated PMIC targeting at single cell Li-battery(Li-ion or Li-polymer)applications that require multi-channel power conversion outputs. It provides an easy and flexible power management solution for multi-core processors to meet the increasingly complex and accurate requirements on power control.

AXP228 comes with an adaptive USB3.0-compatible Flash Charger that supports up to 94% efficiency and 2.2A charge current. It also supports 21 channels power outputs (including 5-CH DCDC, with efficiency up to 95%). To ensure the security and stability of the power system, AXP228 provides multiple channels 12-bit ADC for voltage/current/temperature monitor and integrates protection circuits such as OVP,UVP,OTP,OCP. Moreover, AXP228s features a unique E-Gauge™ system, making power gauge easy and exact.

In addition, AXP228 embraces a fast interface for the system to dynaically adjust output voltage and enable work mode switch so that the battery life can be extended to the largest extent.

Besides, AXP228 features an IPS™ (Intelligent Power Select) circuit to transparently select power path among USB, external adaptor, Li-battery, and system load, making it possible for the system to work normally when only external input power but no battery is available.

Lastly, AXP228 is available in 8mm x 8mm x0.75mm 68-pin QFN package.

## Applications

- Tablet, Smartphone, DVR
- UMPC-like, Student Computer



# 2 Feature

## Features

• IPS™
- Input voltage range: 2.9V~6.3V (AMR: 0.3V~11V)
- Configurable IPS™ system
- Adaptive USB/AC adaptor voltage/current limit (4.4V/900mA/500mA)

• Flash Charger
- Integrated MOSFET charge current up to 2.2A
- Battery temperature monitor
- Fully support USB charge
- High charge accuracy, ±0.5% accuracy
- Support 4.1V/4.2V/4.22V/4.24V battery
- Automatic charge control
- Support LED to indicate charge status
- Automatic charge current adjustment based on system load

• Buck DC-DC Converters (5-CH)
- DC-DC1: 1.6V~3.4V adjustable,100mV/step, load current up to 1.4A
- DC-DC2: 0.6V~1.54V adjustable,20mV/step, load current up to 2.5A, support VRC (Voltage Ramp Control)
- DC-DC3: 0.6V-1.86V adjustable, 20mV/step, load current up to 2.5A
- DC-DC4: 0.6V-1.54V adjustable, 20mV/step, load current up to 0.6A
- DC-DC5: 1.0V-2.55V adjustable, 50mV/step, load current up to 2A

• LDOs (14-CH)
- RTC_VCC: 30mA, always alive
- ALDO1/2: low noise LDO,0.7V~3.3V adjustable, 100mV/step, load current up to 300mA
- ALDO3: low noise LDO,0.7V~3.3V adjustable,100mV/step, load current up to 200mA
- LDOIO0/LDOIO1: low noise LDO, 0.7V~3.3V adjustable, 100mV/step, load current up to100mA
- DLDO1/ ELDO1:0.7~3.3V djustable,100mV/step, load current up to 400mA
- DLDO2/ DLDO3/ ELDO2/ ELDO3: 0.7~3.3V adjustable,100mV/step,load current up to 200mA
- DLDO4: 0.7V~3.3V adjustable,100mV/step,load current up to 100mA
- DC5LDO: 0.7V~1.4V adjustable,100mV/step,load current up to 200mA

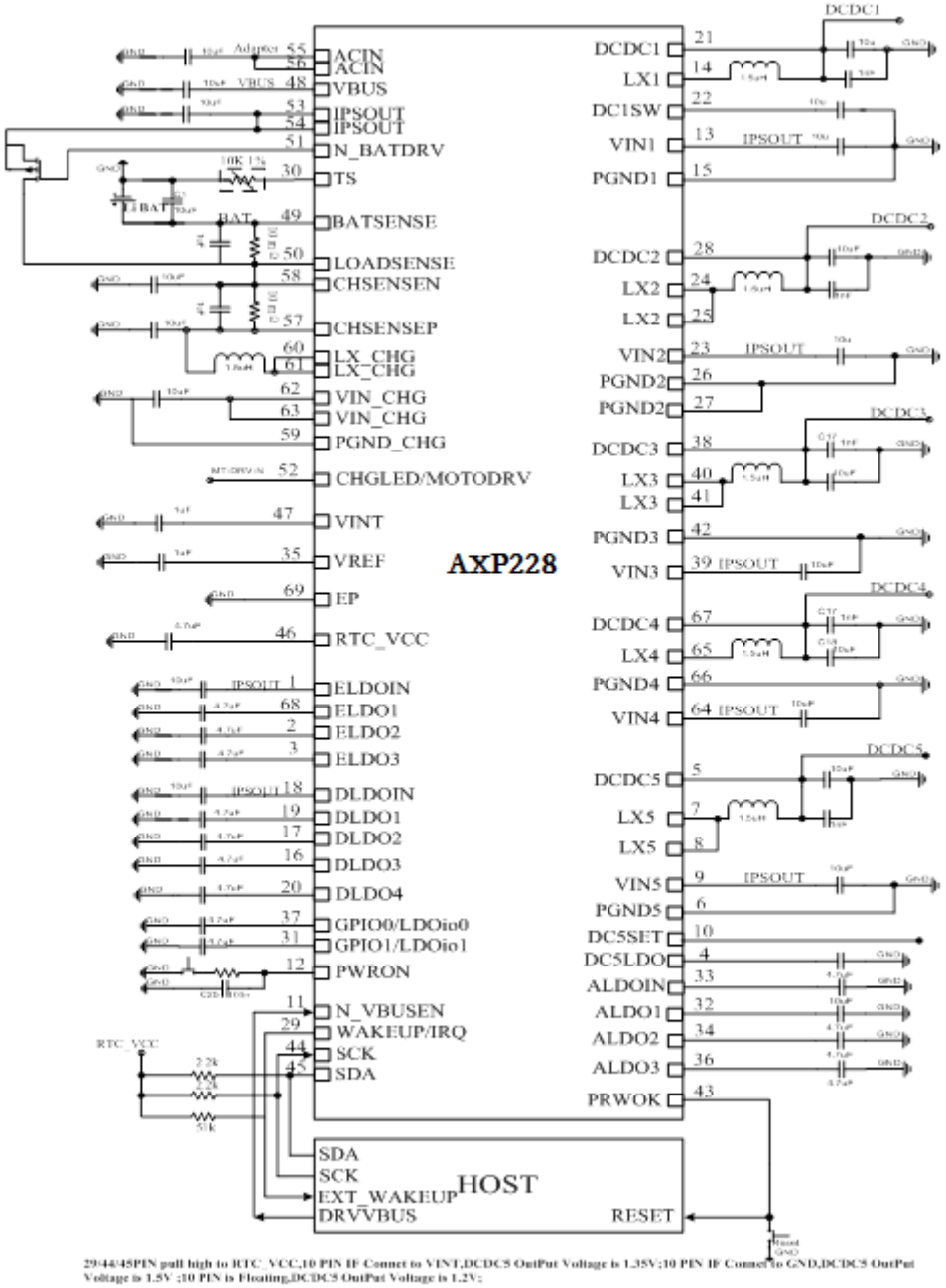
• Switch(2-CH)
- DC1SW: internal resistance 100mOhm, power sourced from DCDC1
- CHGLED:100mA sink strength, can be used to drive the motor and charging LED

• Host Interface
- P2WI(Push-Pull Two Wire Interface) for host communication
- Configurable interrupt management
- Flexible pin function configuration: 2 GPIOs can be set as IO or LDO, etc
- Integrated timer



# 3 Typical Application



# 4 PIN

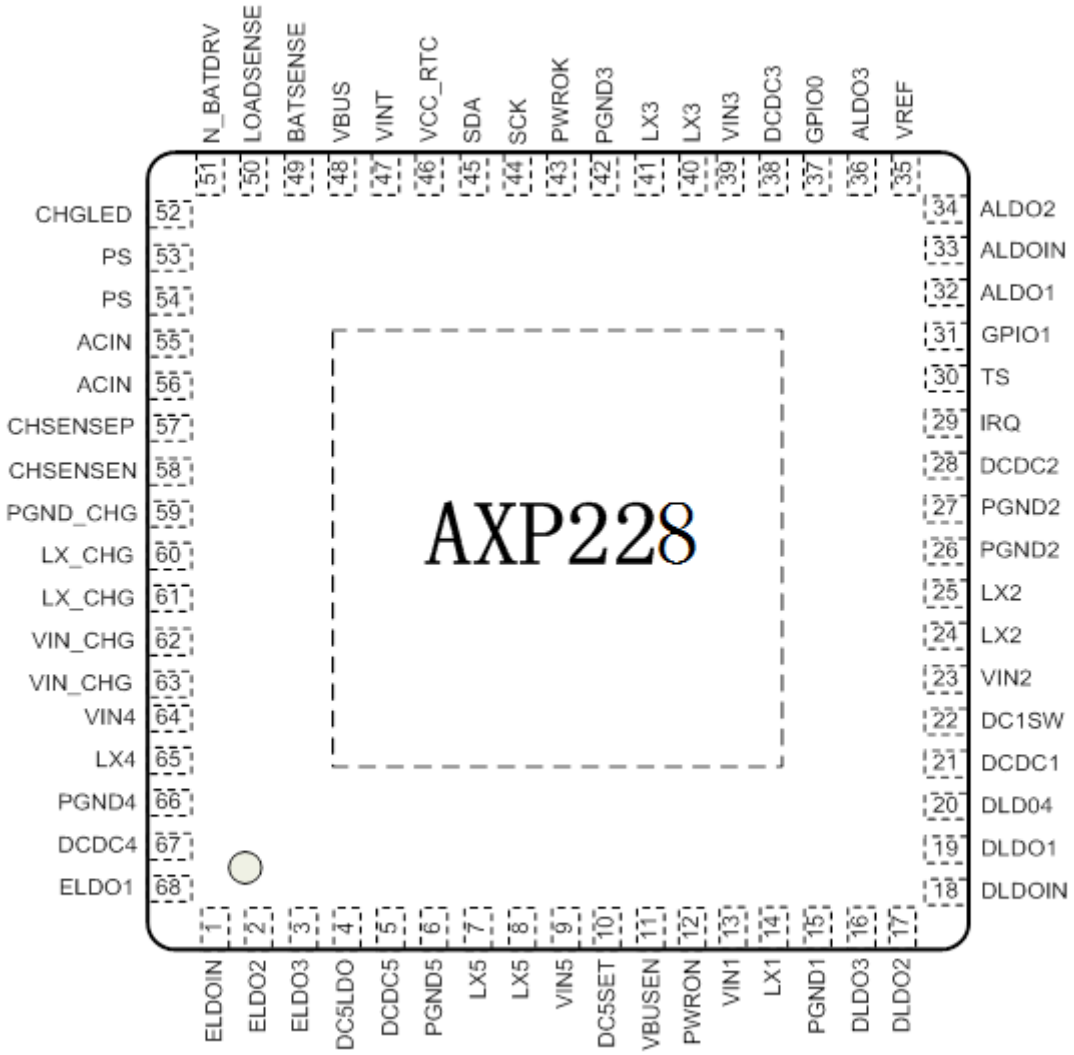



**Figure 4-1. AXP228 PIN**

# 5 Pin List

| Num | Name | Type | Condition | Description |
|---|---|---|---|---|
| 1 | ELDOIN | PI | | ELDO Input source |
| 2 | ELDO2 | O | | Output Pin of ELDO2 |
| 3 | ELDO3 | O | | Output Pin of ELDO3 |
| 4 | DC5LDO | O | | Output Pin of DC5LDO |
| 5 | DCDC5 | I | | DC-DC5 feedback pin |
| 6 | PGND5 | G | | NMOS Ground for DCDC5 |
| 7,8 | LX5 | IO | | Inductor Pin for DCDC5 |
| 9 | VIN5 | PI | | DCDC5 input source |
| 10 | DC5SET | I | | Setting DCDC5 Output Voltage |
| 11 | N_VBUSEN | IO | Input | VBUS to IPSOUT Selection<br>GND: IPSOUT selects VBUS<br>High: IPSOUT does not select VBUS |
| | | | Output | VBUS to IPSOUT Selection<br>IPSOUT selects VBUS : GND<br>IPSOUT does not select VBUS: High |
| 12 | PWRON | I | | Power On-Off key input，Internal 100k pull high to APS |
| 13 | VIN1 | PI | | DCDC1 Input Source |
| 14 | LX1 | IO | | Inductor Pin for DCDC1 |
| 15 | PGND1 | G | | NMOS GND for DCDC1 |
| 16 | DLDO3 | O | | Output Pin of DLDO3 |
| 17 | DLDO2 | O | | Output Pin of DLDO2 |
| 18 | DLDOIN | PI | | DLDO Input Source |
| 19 | DLDO1 | O | | Output Pin of DLDO1 |
| 20 | DLDO4 | O | | Output Pin of DLDO4 |
| 21 | DCDC1 | I | | DC-DC1 feedback pin |
| 22 | DC1SW | O | | DCDC1 Switch Output Pin |
| 23 | VIN2 | PI | | DCDC2 Input Source |
| 24,25 | LX2 | IO | | Inductor Pin for DCDC2 |
| 26，27 | PGND2 | G | | NMOS Ground for DCDC2 |
| 28 | DCDC2 | I | | DC-DC2 Feedback Pin |
| 29 | IRQ/WAKEUP | IO | | IRQ Output or Wakeup |
| 30 | TS | I | | Battery Temperature Sensor Input or an External ADC Input |
| 31 | GPIO1/PWREN | IO | REG 92H[2:0] | GPIO1 or Low noise LDO |
| | | | | PWREN function set by internal program |



| Num | Name | Type | Condition | Description |
|---|---|---|---|---|
| | | | | memory |
| 32 | ALDO1 | O | | Output Pin of ALDO1 |
| 33 | DLDOIN | PI | | ALDO Input Source |
| 34 | ALDO2 | O | | Output Pin of ALDO2 |
| 35 | VREF | O | | Internal reference voltage |
| 36 | ALDO3 | O | | Output pin of ALDO3 |
| 37 | GPIO0 | IO | REG 90H[2:0] | GPIO0<br>Low noise LDO |
| 38 | DCDC3 | I | | DC-DC3 feedback pin |
| 39 | VIN3 | PI | | DCDC3 Input Source |
| 40，41 | LX3 | IO | | Inductor Pin for DCDC3 |
| 42 | PGND2 | G | | NMOS Ground for DCDC2 |
| 43 | PWROK | O | | Power Good Indication Output |
| 44 | SCK | I | | Clock pin for serial interface. Normally, it connects a 2.2K resistor to 3.3V I/O power |
| 45 | SDA | IO | | Data pin for serial interface. Normally, it connects a 2.2K resistor to 3.3V I/O power |
| 46 | VCC_RTC | O | | Output Pin of VCC_RTC |
| 47 | VINT | PO | | Internal logic power, 1.8V |
| 48 | VBUS | PI | | VBUS input |
| 49 | BATSENSE | I | | PWM Charger Current Sense Resistance Positive Input |
| 50 | LOADSENSE | I | | PWM Charger Current Sense Resistance Negative Input |
| 51 | N_BATDRV | O | | BAT to PS extern PMOS driver |
| 52 | CHGLED | O | | charger status indication |
| 53,54 | IPSOUT | PO | | System power source |
| 55，56 | ACIN | PI | | Adapter input |
| 57 | CHSENSEP | I | | PWM Charger Current Limit Sense Resistance Positive Input |
| 58 | CHSENSEN | I | | PWM Charger Current Limit Sense Resistance Negative Input |
| 59 | PGND_CHG | G | | NMOS Ground for PWM Charger |
| 60,61 | LX_CHG | IO | | Inductor Pin for PWM Charger |
| 62,63 | VIN_CHG | I | | Charger Input source |
| 64 | VIN4 | I | | DCDC4 input source |
| 65 | LX4 | IO | | Inductor Pin for DCDC4 |
| 66 | PGND4 | G | | NMOS Ground for DCDC4 |
| 67 | DCDC4 | I | | Feed back to DCDC4 |
| 68 | ELDO1 | O | | Output Pin of ELDO1 |
| 69 | EP | G | | Exposed Pad, need to be connected to system ground |



# 6 Block Diagram

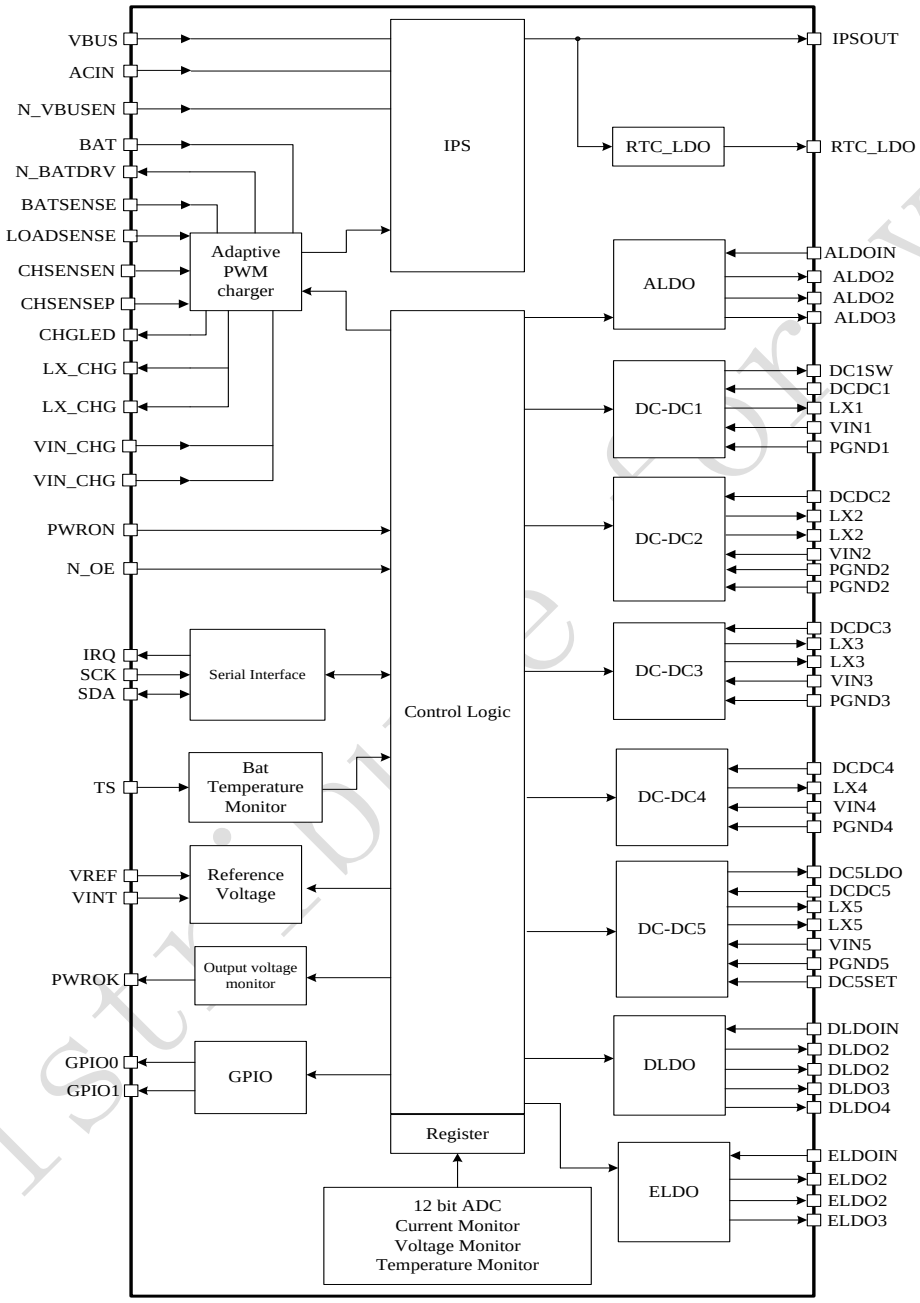



**Figure 6-1. Block Diagram**



# 7 Absolute Maximun Ratings

| SYMBOL | DESCRIPTION | VALUE | UNITS |
|---|---|---|---|
| ACIN | Input Voltage | -0.3 ~ 11 | V |
| VBUS | Input Voltage | -0.3 ~ 11 | V |
| $T_J$ | Operating Temperature Range | -40 ~ 130 | ℃ |
| Ts | Storage Temperature Range | -40 ~150 | ℃ |
| $T_{LEAD}$ | Maximum Soldering Temperature (at leads，10sec) | 300 | ℃ |
| $V_{ESD}$ | Maximum ESD stress voltage，Human Body Model | >4000 | V |
| $P_D$ | Internal Power Dissipation | 2700 | mW |

**Figure 0-1. Absolute ratings**



# 8 Electrical Characteristics

$V_{IN}$ =5V， BAT=3.8V， $T_A$= 25℃

| 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 | | 3500 | | mA |
| $V_{UVLO}$ | ACIN Under Voltage Lockout | | | 3.8 | | V |
| $V_{OUT}$ | IPS Output Voltage | | 2.9 | | 5.0 | V |
| $R_{ACIN}$ | Internal Ideal Resistance | PIN to PIN, ACIN to IPSOUT | | | 120 | mΩ |
| **VBUS** | | | | | | |
| $V_{IN}$ | VBUS Input Voltage | | 3.8 | | 6.3 | V |
| $I_{OUT}$ | $V_{OUT}$ Current Available Before Loading BAT | | | 1500 | 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 Resistance | PIN to PIN, VBUS to IPSOUT | | | 160 | mΩ |
| **Battery Charger** | | | | | | |
| $V_{TRGT}$ | BAT Charge Target Voltage | | -0.5% | 4.2 | +0.5% | V |
| $I_{CHRG}$ | Charge Current | | | 1200 | 2200 | mA |
| $I_{TRKL}$ | Trickle Charge Current | | | 10% | | $I_{CHRG}$ mA |
| $V_{TRKL}$ | Trickle Charge Threshold Voltage | | | 3.0 | | V |
| $\Delta V_{RECHG}$ | Recharge Battery Threshold Voltage | Threshold Voltage Relative to $V_{TARGET}$ | | -100 | | mV |
| $T_{TIMER1}$ | Charger Safety Timer Termination Time | Trickle Mode | | 50 | | 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 |
| **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 | Falling Threshold | | 0.2 | | V |



| | | | | | | |
|---|---|---|---|---|---|---|
| | Voltage | Hysteresis | | | | |

| SYMBOL | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **Off Mode Current** | | | | | | |
| $I_{BATOFF}$ | OFF Mode Current | BAT=3.8V | | 40 | | 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 | | | 1.2 | | V |
| **TWSI** | | | | | | |
| $V_{CC}$ | Input Supply Voltage | | 1.8 | | 3.3 | V |
| ADDRESS | 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 | | 3 | | MHz |
| **DCDC1** | | | | | | |
| $I_{VIN1}$ | Input Current | PFM Mode $I_{DC1OUT}$ =0 | | 50 | | μA |
| $I_{LIM1}$ | PMOS Switch Current Limit | PWM Mode | | 2200 | | mA |
| $I_{DC1OUT}$ | Available Output Current | PWM Mode | | 1400 | | mA |
| $V_{DC1OUT}$ | Output Voltage | Default | 1.6 | 3.0 | 3.4 | V |
| **DCDC2** | | | | | | |
| $I_{VIN2}$ | Input Current | PFM Mode $I_{DC2OUT}$ =0 | | 50 | | μA |
| $I_{LIM2}$ | PMOS Switch Current Limit | PWM Mode | | 3000 | | mA |
| $I_{DC2OUT}$ | Available Output Current | PWM Mode | | 2500 | | mA |
| $V_{DC2OUT}$ | Output Voltage Range | | 0.6 | 1.1 | 1.54 | V |
| **DCDC3** | | | | | | |
| $I_{VIN3}$ | Input Current | PFM Mode $I_{DC3OUT}$ =0 | | 50 | | uA |
| $I_{LIM3}$ | PMOS Switch Current Limit | PWM Mode | | 3000 | | mA |
| $I_{DC3OUT}$ | Available Output Current | PWM Mode | | 2500 | | mA |
| $V_{DC3OUT}$ | Output Voltage Range | | 0.6 | 1.1 | 1.86 | V |
| **DCDC4** | | | | | | |
| $I_{VIN3}$ | Input Current | PFM Mode $I_{DC3OUT}$ =0 | | 42 | | uA |



| | | | | | | |
|---|---|---|---|---|---|---|
| $I_{LIM3}$ | PMOS Switch Current Limit | PWM Mode | | 1200 | | mA |
| $I_{DC3OUT}$ | Available Output Current | PWM Mode | | 600 | | mA |
| $V_{DC3OUT}$ | Output Voltage Range | | 0.6 | 1.1 | 1.54 | V |
| **DCDC5** | | | | | | |
| $I_{VIN3}$ | Input Current | PFM Mode<br>$I_{DC3OUT}$ =0 | | 45 | | uA |
| $I_{LIM3}$ | PMOS Switch Current Limit | PWM Mode | | 2600 | | mA |
| $I_{DC3OUT}$ | Available Output Current | PWM Mode | | 2000 | | mA |
| $V_{DC3OUT}$ | Output Voltage Range | | 1.0 | 1.5 | 2.55 | V |

| SYMBOL | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **RTC_VCC** | | | | | | |
| $V_{RTC\_VCC}$ | Output Voltage | $I_{RTC\_VCC}$=1mA | -1% | 1.2 | 1% | V |
| $I_{RTC\_VCC}$ | Output Current | | | 100 | | mA |
| **ALDO1** | | | | | | |
| $V_{ALDO1}$ | Output Voltage | $I_{ALDO1}$=1mA | -1% | 0.7 | 1% | V |
| $I_{ALDO1}$ | Output Current | | | 300 | | mA |
| $I_Q$ | Quiescent Current | | | 67 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{ALDO1}$=60mA，1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V , Io=20mA | | 31 | | $\mu V_{RMS}$ |
| **ALDO2** | | | | | | |
| $V_{ALDO2}$ | Output Voltage | $I_{ALDO2}$=1mA | -1% | 1.8 | 1% | V |
| $I_{ALDO2}$ | Output Current | | | 300 | | mA |
| $I_Q$ | Quiescent Current | | | 67 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{ALDO2}$=10mA,1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V , Io=20mA | | 31 | | $\mu V_{RMS}$ |
| **ALDO3** | | | | | | |
| $V_{ALDO3}$ | Output Voltage | $I_{ALDO3}$=1mA | -1% | 3.0 | 1% | V |
| $I_{ALDO3}$ | Output Current | | | 200 | | mA |
| $I_Q$ | Quiescent Current | | | 67 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{ALDO3}$=10mA，1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V, Io=20mA | | 43 | | $\mu V_{RMS}$ |
| **DLDO1** | | | | | | |
| $V_{DLDO1}$ | Output Voltage | $I_{DLDO1}$=1mA | -1% | 0.7 | 1% | V |
| $I_{DLDO1}$ | Output Current | | | 400 | | mA |
| $I_Q$ | Quiescent Current | | | 60 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{DLDO1}$=10mA，1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V, Io=20mA | | 100 | | $\mu V_{RMS}$ |
| **DLDO2** | | | | | | |
| $V_{DLDO2}$ | Output Voltage | $I_{DLDO2}$=1mA | -1% | 0.7 | 1% | V |
| $I_{DLDO2}$ | Output Current | | | 200 | | mA |
| $I_Q$ | Quiescent Current | | | 60 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{DLDO2}$=10mA，1KHz | | TBD | | dB |



| | | | | | | |
|---|---|---|---|---|---|---|
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V, Io=20mA | | 100 | | $\mu V_{RMS}$ |
| **DLDO3** | | | | | | |
| $V_{DLDO3}$ | Output Voltage | $I_{DLDO3}$=1mA | -1% | 3.0 | 1% | V |
| $I_{DLDO3}$ | Output Current | | | 200 | | mA |
| $I_Q$ | Quiescent Current | | | 60 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{DLDO3}$=10mA，1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V, Io=20mA | | 100 | | $\mu V_{RMS}$ |
| **DLDO4** | | | | | | |
| $V_{DLDO4}$ | Output Voltage | $I_{DLDO4}$=1mA | -1% | 3.0 | 1% | V |
| $I_{DLDO4}$ | Output Current | | | 100 | | mA |
| $I_Q$ | Quiescent Current | | | 60 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{DLDO4}$=10mA，1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V, Io=20mA | | 100 | | $\mu V_{RMS}$ |
| **ELDO1** | | | | | | |
| $V_{ELDO1}$ | Output Voltage | $I_{ELDO1}$=1mA | -1% | 0.7 | 1% | V |
| $I_{ELDO1}$ | Output Current | | | 400 | | mA |
| $I_Q$ | Quiescent Current | | | 60 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{ELDO1}$=10mA，1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V, Io=20mA | | 100 | | $\mu V_{RMS}$ |
| **ELDO2** | | | | | | |
| $V_{ELDO2}$ | Output Voltage | $I_{ELDO2}$=1mA | -1% | 0.7 | 1% | V |
| $I_{ELDO2}$ | Output Current | | | 200 | | mA |
| $I_Q$ | Quiescent Current | | | 60 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{ELDO2}$=10mA，1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V, Io=20mA | | 100 | | $\mu V_{RMS}$ |
| **DLDO3** | | | | | | |
| $V_{ELDO3}$ | Output Voltage | $I_{ELDO3}$=1mA | -1% | 0.7 | 1% | V |
| $I_{ELDO3}$ | Output Current | | | 200 | | mA |
| $I_Q$ | Quiescent Current | | | 60 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{ELDO3}$=10mA，1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V, Io=20mA | | 100 | | $\mu V_{RMS}$ |
| **DC5LDO** | | | | | | |
| $V_{DC5LDO}$ | Output Voltage | $I_{DC5LDO}$=1mA | -1% | 0.7 | 1% | V |
| $I_{DC5LDO}$ | Output Current | | | 200 | | mA |
| $I_Q$ | Quiescent Current | | | 60 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{DC5LDO}$=10mA ， 1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V, Io=20mA | | 100 | | $\mu V_{RMS}$ |
| **LDOio0** | | | | | | |
| $V_{LDOio0}$ | Output Voltage | $I_{LDOio0}$=1mA | -1% | 3.3 | 1% | V |
| $I_{LDOio0}$ | Output Current | | | 100 | | mA |
| $I_Q$ | Quiescent Current | | | 40 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{LDOio0}$=10mA，1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V, Io=20mA | | 40 | | $\mu V_{RMS}$ |



| | | | | | | |
|---|---|---|---|---|---|---|
| **LDOio1** | | | | | | |
| $V_{LDOio1}$ | Output Voltage | $I_{LDOio1}$=1mA | -1% | 3.3 | 1% | V |
| $I_{LDOio1}$ | Output Current | | | 100 | | mA |
| $I_Q$ | Quiescent Current | | | 40 | | μA |
| PSRR | Power Supply Rejection Ratio | $I_{LDOio1}$=10mA，1KHz | | TBD | | dB |
| $e_N$ | Output Noise,20-80KHz | Vo=3.3V, Io=20mA | | 40 | | $\mu V_{RMS}$ |
| **DC1SW** | | | | | | |
| $R_{DC1SW}$ | Internal Ideal Resistance | PIN to PIN，DCDC1同 DC1SW | | 156 | | mΩ |
| $I_Q$ | Quiescent Current | | | 40 | | μA |
| **CHGLED** | | | | | | |
| $R_{DC1SW}$ | Internal Ideal Resistance | Vin =0.3V | | 2000 | | mΩ |



# 9 Control and Operation

Once AXP228 is powered on, SCK/SDA pin of TWSI will be pulled up to IO Power and then Host can adjust and monitor AXP228 with rich feedback information.

Remarks: “Host” here refers to system processor.
Remarks: “External Power” below includes ACIN and VBUS input.

## 9.1 Power On/Off & Reset

**Power Enable Key (PEK)**
The Power Key (PEK) can be connected between PWRON pin and GND of AXP228. AXP228 can automatically identify the four status (Long-press ,Short-press ,Key Down ,Key Up) and then correspond respectively.

**Power on Source**

1. ACIN、VBUS Insert
2. PEK

**Power On**
System power-on is initiated whenever the following conditions occur:

1. If a valid power source has plugged in (ACIN or VBUS>3.8V), AXP228 will be turned on or not by the default the configure module configuration.

2. Press PEK can power on AXP228.

After power on, DC-DC and LDO will be soft booted in preset timing sequence, and then either Host or PWREN pin can enable/disable corresponding power.

**Power Off**
When you push-and-hold PEK longer than IRQLEVEL, HOST can write “1” into“REG32H [7]” to inform AXP228 to shutdown, which can disable all power output except LDO1.

System power-off is initiated whenever the following conditions occur:

1. input voltage is too low( Low-Power Protection)
2. Power output voltage(DCDC) is too low due to overload( Overload Protection)
3. Input voltage is too high( Overvoltage Protection)( See more details in chapter “ Intelligent Power Select”
4. Push PEK longer more than OFFLEVEL( Default 6s), and system will cut off all power output except LDO1( there is no need for an extra RESET key)

Remarks: With the automatic protection mechanism, AXP228 can protect whole system by preventing components from damage due to system abnormality.



**Sleep and wakeup**

When the running system needs to enter Sleep mode, Maybe one or several power outputs should be disabled or change to other voltage. Wakeup can be initiated by the following sources:

1.,ACIN/VBUS insert/remove

2,PEK short/long press

3,PEK nedge

4,Low power warning level1/2

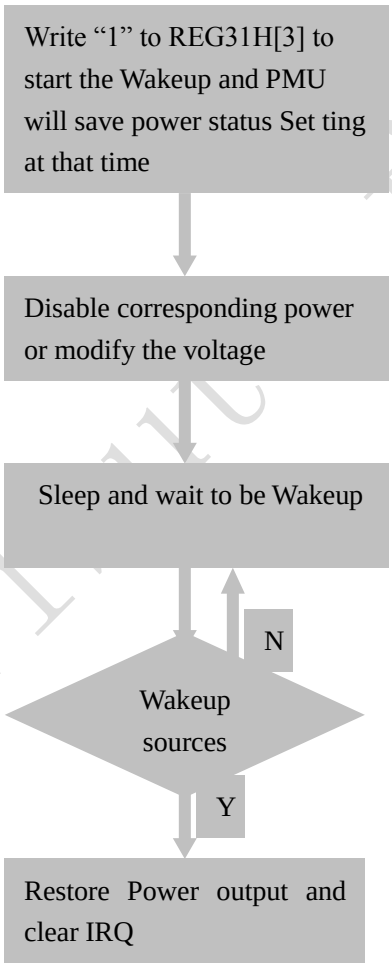
5,GPIO[1:0] Posedg or negedge

6,Software wakeup by Set the REG31H[5]

7,IRQ from high go low

These sources will make the PMU wakeup and all power outputs resume to default voltage in default power on timing sequence.

See control process under sleep and wakeup modes as below:




**System Reset and Output Monitoring (PWROK)**

The PWROK pin can be used as the reset signal of application system. During AXP228 startup, PWROK outputs low level, which will then be pulled high to startup the system after output voltage reaches the regulated value.

When application system works normally, AXP228 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)

The input sources of AXP228 include Li- Battery, external power ACIN (such as AC adapter or USB VBUS input). 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 will "Seamlessly" switch to Li- Battery once external power is removed
- When both VBUS and ACIN are available, ACIN will be applied to supply power in priority, and Li-Battery will be charged.
- If the current of ACIN path is not enough, VBUS will be enabled to achieve ACIN/VBUS common power supply
- If the current is still insufficient, charge current will be reduced to zero, and Battery is used for one of power sources

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 status to discharge to supply load current together with ACIN.

Host can set IPS parameters and read the feedback by visiting internal registers in AXP228 via TWSI.

**Voltage-Limit/ Current-Limit Mode and Direct Mode**

In order not to affect the USB communication, VBUS is always working under VBUS Voltage-Limit mode by

default. In this mode, AXP228 ensures that VBUS voltage remains above a configurable reference voltage VHOLD which can meet the USB specification. The default VHOLD is 4.4V, adjustable in Reg30H [5:3] register.

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

If the system just utilizes the USB for power supply rather than communication, or the USB power adapter is utilized, AXP228 can be Set to "VBUS Direct Mode" by modifying register REG30H[6], and then AXP228 will give priority to the application power demand. When the drive ability of USB Host is insufficient or system power consumption is large so that the VBUS voltage is lower than VHOLD, AXP228 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.

**AXP228's Reaction to External Power Supply Plugin**

AXP228 can automatically detect the plug-in of external powers and judge whether the power is usable or not. The result will be set in corresponding registers, and IRQ will be released 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**

N_VBUSEN and register REG30H[7]: is used to determined when shall VBUS be used as power supply.

| REG30_[7] | REG8F_[4] | N_VBUSEN | REG30H[2] | 是否选用 |
|---|---|---|---|---|
| 0 | 0 | High | 0 | No |
| 0 | 0 | Low | 1 | Yes |
| 0 | 1 | High | X | No |
| 0 | 1 | Low | X | Yes |
| 1 | X | X | X | Yes |



**Low-Power Warning and Low-Power Protection (Automatic Power-off)**

With AXP228, the value of $V_{WARNING(}$low-power warning voltage) and $V_{OFF(}$automatic shutdown voltage) can be Set . If the Battery level is found to be lower than $V_{WARNING,}$ IRQ20/IRQ21 will be released. If ALDOIN is lower than $V_{OFF,}$ AXP228 will automatically enter Shutdown Mode, and disable all other outputs except LDO1.

The two $V_{WARNING}$, namely, LEVEL 1 and LEVEL 2, which can be defined differently in applications. For example, use LEVEL1 to indicate insufficient power while LEVEL 2 can be used to indicate the oncoming shutdown.

**Over-Voltage Protection**

If the external power voltage exceeds 6.3V, AXP228 will release IRQ1/4 for indication. If the external power voltage exceeds 7V, AXP228 will automatically shutdown the system.

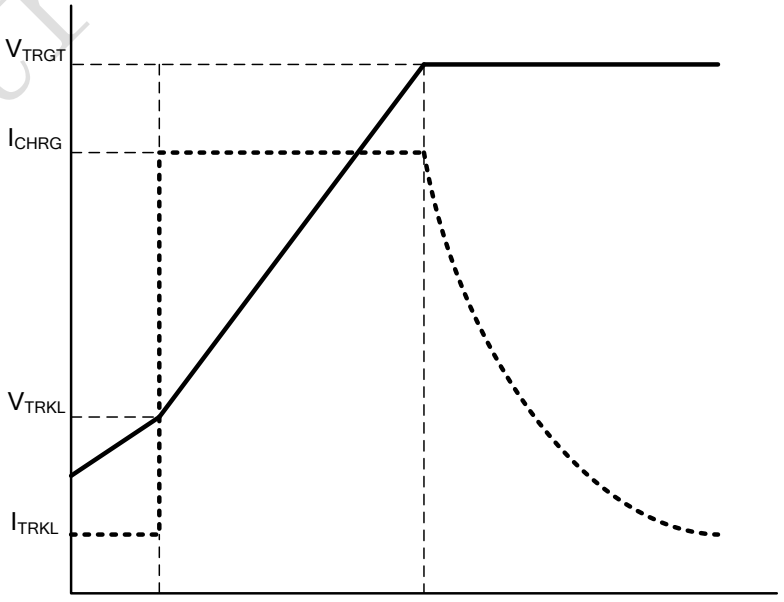
## 9.3 Adaptive Flash Charger

AXP228 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 stop the charge current when the temperature is too high or too low.

**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 plugged in, AXP228 will automatically start the charge, and send IRQ to Host for indication. At the same time, CHGLED 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, AXP228 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 450mA 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 40 minutes later (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 pre-set 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 AXP228 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 is not ending after 480 minutes (adjustable, refer to register "REG34H"), the charger will automatically enter the Battery activate mode.

**Battery Activate Mode**

At the enterring the Battery activate mode from either pre-charge mode or constant current mod (the timer expires), AXP228 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. AXP228 will exit activate mode and release IRQ11 only if the Battery voltage has reached $V_{RCH.}$

AXP228 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. There are four states, namely, charging, not charging, Battery abnormal 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.



类型 A

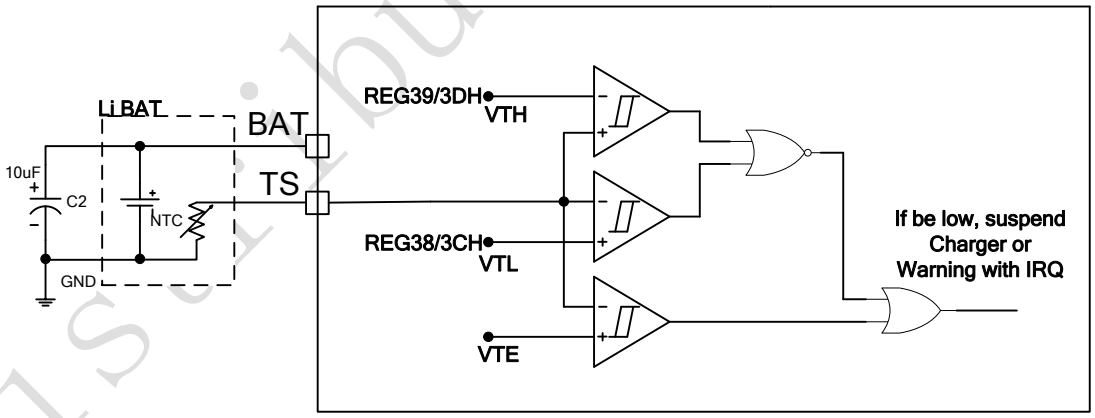
| Status | 表现 | 注释 |
|---|---|---|
| 正在 Charge | 低电平 | |
| 不在 Charge | 高阻 | |
| Battery 异常 | 25% duty 1Hz 跳变 | Charge 器进入 Battery 激活模式，或者 Battery 温度过高、过低 |
| 过压 | 25% duty 4Hz 跳变 | 外部 Power 输入 Voltage 过高 |

类型 B

| Status | 表现 | 注释 |
|---|---|---|
| 正在 Charge | 25% duty 1Hz 跳变 | |
| 不在 Charge | 高阻 | |
| Battery 异常及输入过压 | 25% duty 1Hz 跳变 | Charge 器进入 Battery 激活模式，或者 Battery 温度过高、过低以及 Output Voltage 过高 |
| 无 Battery | 低电平 | 无 Battery 接入 |

**Battery Temperature Detection**

AXP228 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.




In the diagram above, VTH/VTL refer to the high temperature threshold and low temperature threshold, which is programmable via registers REG38H/39H/3CH/3DH respectively. VTE=0.2V. The temperature-sensitive resistor is suggested to choose the NTC temperature-sensitive resistor, which is 10Kohm and 1% accuracy at 25℃. AXP228 will send constant current via TS pin, and the current can be Set as 20uA、40uA、60uA、and 80uA (See registerREG84H) to adapt to different NTC resistors. When the current goes through the temperature-sensitive resistor, a test voltage is generated, which will be measured by ADC, and compared with regulated value to release corresponding IRQ or suspend the charge.



If the resistance value of temperature-sensitive resistor is too high or too low, extra resistors can be serial or parallel connected to expand the detect extent.

If the Battery is free from temperature-sensitive resistor, TS pin can be linked to the ground, and in that case, AXP228 will automatically disable the Battery temperature monitoring function.

**Battery Detection**

AXP228 will automatically detect the Battery presence, record the result in registers (refer to REG01H) and release IRQ8, IRQ9.

The Battery detection can be enabled and disabled by Host. (Refer to register REG32H.)

## 9.4 Multi-Power Outputs

The following table has listed the multi-power outputs and their functions of AXP228.

| Output Path | 类型 | 默认 Voltage | 启动步骤 | 应用举例 | 最大驱动能力 |
|---|---|---|---|---|---|
| DCDC1 | BUCK | 3.3V | 1 | 3.3V I/O | 1400 mA |
| DCDC2 | BUCK | 1.1V | 1 | 1.1V CPU | 2500 mA |
| DCDC3 | BUCK | 1.1V | 1 | 1.1VGPU | 2500 mA |
| DCDC4 | BUCK | 1.1V | 1 | 1.1V Core | 600mA |
| DCDC5 | BUCK | 1.5/DC5SET 设定 | 1 | 1.5V DDR | 2000mA |
| RTC-LDO | LDO | 3.0V | 1 | RTC | 30 mA |
| ALDO1 | LDO | OFF | OFF | N/A | 300 mA |
| ALDO2 | LDO | 1.8V | 1 | N/A | 300 mA |
| ALDO3 | LDO | 3.0V | 1 | N/A | 200mA |
| $LDO_{IO0}$ | LDO | OFF | OFF | N/A | 100 mA |
| $LDO_{IO1}$ | LDO | OFF | OFF | N/A | 100 mA |
| DLDO1 | LDO | OFF | OFF | N/A | 400 mA |
| DLDO2 | LDO | OFF | OFF | N/A | 200 mA |
| DLDO3 | LDO | OFF | OFF | N/A | 200mA |
| DLDO4 | LDO | OFF | OFF | N/A | 200 mA |
| ELDO1 | LDO | OFF | OFF | N/A | 400 mA |
| ELDO2 | LDO | OFF | OFF | N/A | 200 mA |
| ELDO3 | LDO | OFF | OFF | N/A | 200mA |
| DC5LDO | LDO | 1.1V | 1 | N/A | 200mA |
| DC1SW | Switch | OFF | OFF | N/A | 400mA |

AXP228 includes five synchronous step-down DC-DCs, fourteen LDOs, two switches, as well as multiple timing and controlling configuration. The work frequency of DC-DC is 3MHz 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 fixed PWM mode or auto mode (automatically switchable according to the load). See register REG80H.



**DC-DC1/2/3/4/5**

DCDC3 output voltage ranges from0.6 V to 1.86V，and output voltage of DCDC2 is ranged from 0.6-1.54V，which can be programmed via registers.( refer to " register REG23H 27H").

The output capacitor is recommended to use small ESR ceramic capacitors, for example 10uF X7R.The saturation current of inductors used must 50% higher than the output current.

**LDO 1**

LDO1 is always on and can be used to supply continuous power for application RTC with 30mA drive ability 30mA.

**ALDO1/2/3**

Low noise LDO, output current is 300mA/300mA/200mA

**LDOio0/LDOio1**

Low noise LDO, output current is 100mA

**Soft Start**

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

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

## 9.5 Default Voltage/Timing Set ting

The default voltage and power on/off sequence of each power can be Set by AXP228.

Power on Timing includes eight levels, and the interval between each level can be Set as 1、2、4、16 and 32mS.

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

**DC3SET PIN is used to Set the default voltage of DC-DC3：**

| DC3SET | DC3SETGND | DC3SETto OAPS | DC3SET floating |
|---|---|---|---|
| DC-DC3 voltage | 1.8V | 3.3V/2.5V | 1.2V/1.5V |

## 9.6 E-Gauge system

Ordinary Battery monitor is to estimate the Battery energy by measuring the Battery voltage. However, the multiple 12-bit ADCs in AXP228 can measure Battery voltage, as well as Battery current. It also integrates the gauge algorithm. According to these data, Host can get the remaining percentage 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 register 84H. The sampling results will be saved in corresponding registers, 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 | 1mA | 4.095A |
| Bat charge current | 0mA | 1mA | 4.095A |
| Internal temperature | -267.7℃ | 0.1℃ | 165.8℃ |
| TS pin input | 0mV | 0.8mV | 3.276V |

## 9.7 Multi-Function Pin Description

**GPIO[1:0]**

Can be defined as GPIO[1:0], or LDO, etc. Please refer to REG90H-92H Instruction for details

**CHGLED**

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

## 9.8 Timer

AXP228 features a 7-bit internal timer, whose values can be programmed via register REG8AH[6:0]. The minimum time step of timer is one minute, and the timing range is 1~127 minutes.



## 9.9 TWSI and IRQ

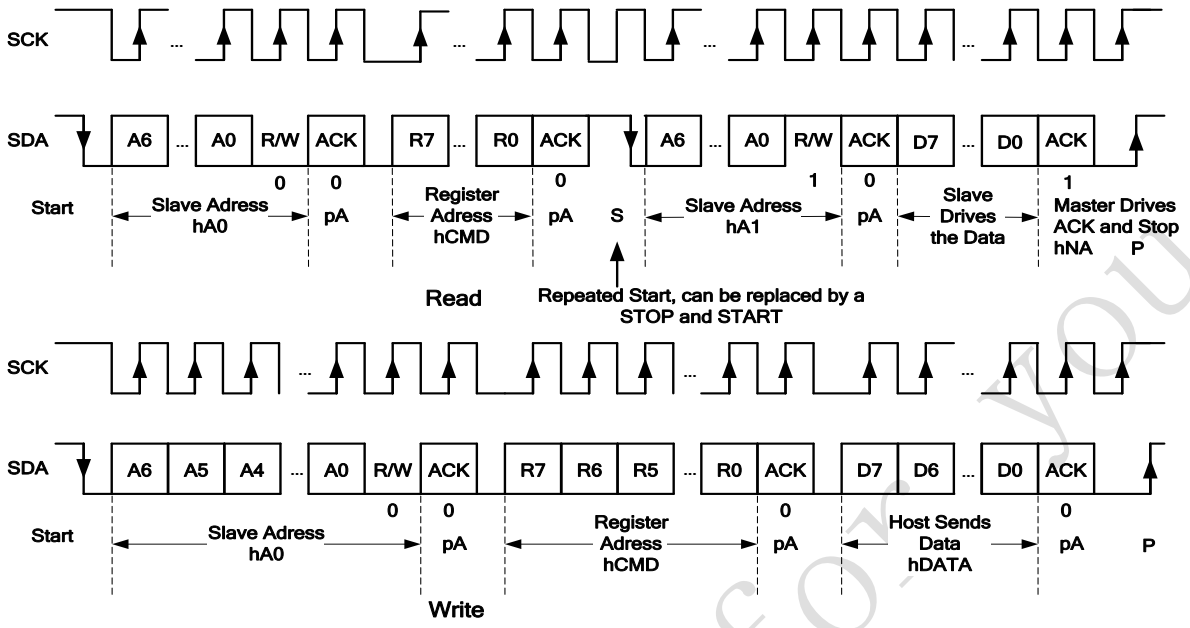



**Figure9-1: Single Read and Write**

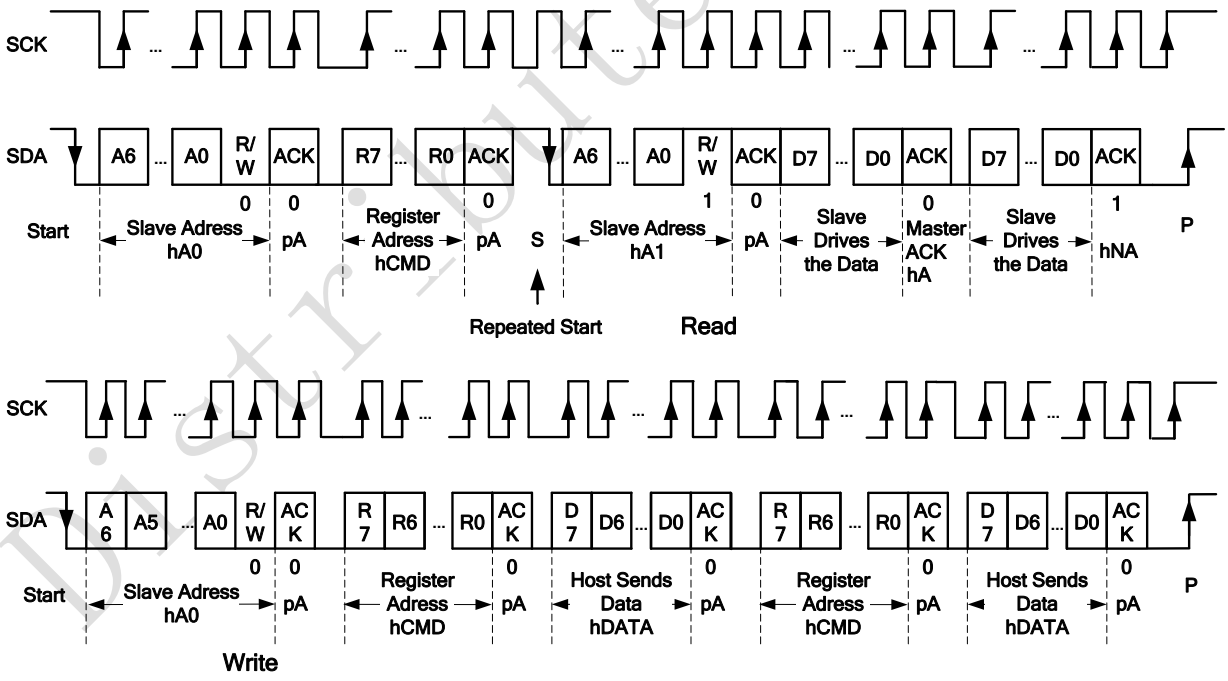



**Figure 9-2. Multi Read and Write**

Host can communication with AXP228 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 1.2MHz. In addition, multi read and write operation is supported, and the device addresses are 69H (READ) and 68H (WRITE).



When certain events occur, AXP228 will inform Host by pulling down to 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).

| Bit | IRQ | DESCRIPTION | Bit | IRQ | DESCRIPTION |
|---|---|---|---|---|---|
| REG48_[7] | IRQ1 | ACIN over voltage | REG4B_[7] | Reserved | |
| REG48_ [6] | IRQ2 | ACIN insert | REG4B_ [6] | | |
| REG48_ [5] | IRQ3 | ACIN remove | REG4B_ [5] | | |
| REG48_ [4] | IRQ4 | VBUS over voltage | REG4B_ [4] | | |
| REG48_ [3] | IRQ5 | VBUS insert | REG4B_ [3] | | |
| REG48_ [2] | IRQ6 | VBUS remove | REG4B_ [2] | | |
| REG48_ [1] | IRQ7 | VBUS lower than $V_{HOLD}$ | REG4B_ [1] | IRQ20 | Battery low level warning1 |
| REG48_ [0] | reversed | | REG4B_ [0] | IRQ21 | Battery low level warning2 |
| REG49_[7] | IRQ8 | Battery present | REG4C_[7] | IRQ22 | Timer timeout |
| REG49_ [6] | IRQ9 | Battery remove | REG4C_ [6] | IRQ23 | PEK posedge |
| REG49_ [5] | IRQ10 | Battery active mode | REG4C_ [5] | IRQ24 | PEK negedge |
| REG49_ [4] | IRQ11 | Exit Battery active mode | REG4C_ [4] | Reserved | |
| REG49_ [3] | IRQ12 | Charging | REG4C_ [3] | | |
| REG49_ [2] | IRQ13 | Charge finish | REG4C_ [2] | | |
| REG49_ [1] | IRQ14 | Battery over temperature | REG4C_ [1] | IRQ25 | GPIO1 edge trigger |
| REG49_ [0] | IRQ15 | Battery under temperature | REG4C_ [0] | IRQ26 | GPIO0 edge trigger |
| REG4A_ [7] | IRQ16 | IC over temperature | | | |
| REG4A_ [6] | IRQ17 | Charge current not enough | | | |
| REG4A_ [5] | Reserved | | | | |
| REG4A_ [4] | | | | | |
| REG4A_ [3] | | | | | |
| REG4A_ [2] | | | | | |
| REG4A_ [1] | IRQ18 | PEK short press | | | |
| REG4A_ [0] | IRQ19 | PEK long press | | | |
| | | | | | |



# 10 REGISTER

## Control Register List

| Address | Description | R/W | Default |
|---|---|---|---|
| 00 | Status REG | R | |
| 01 | Mode and charge status REG | R | |
| 04-0F | Data bugger REG | R/W | 00H |
| 10 | DCDC1/2/3/4/5&ALDO1/2&DC5LDO Control REG | R/W | BFH |
| 12 | ELDO1/2/3&DLDO1/2/3/4&DC1SW Control REG | R/W | 00H |
| 13 | ADLDO1/2/3 woke mode REG | R/W | 81H |
| 15 | DLDO1 Voltage Set REG | R/W | 00H |
| 16 | DLDO2 Voltage Set REG | R/W | 00H |
| 17 | DLDO3 Voltage Set REG | R/W | 00H |
| 18 | DLDO4 Voltage Set REG | R/W | 00H |
| 19 | ELDO1 Voltage Set REG | R/W | 00H |
| 1A | ELDO2 Voltage Set REG | R/W | 00H |
| 1B | ELDO3 Voltage Set REG | R/W | 00H |
| 1C | DC5LDO Voltage Set REG | R/W | 04H |
| 21 | DC-DC1 Voltage Set REG | R/W | 11H |
| 22 | DC-DC2 Voltage Set REG | R/W | 19H |
| 23 | DC-DC3 Voltage Set REG | R/W | 19H |
| 24 | DC-DC4 Voltage Set REG | R/W | 19H |
| 25 | DC-DC5 Voltage Set REG | R/W | 0AH |
| 27 | DC-DC2/3 Ramp control REG | R/W | 00H |
| 28 | ALDO1 Voltage Set REG | R/W | 00H |
| 29 | ALDO2 Voltage Set REG | R/W | 0BH |
| 2A | ALDO3 Voltage Set REG | R/W | 17H |
| 30 | VBUS-IPSOUT Path control REG | R/W | 60H |
| 31 | Sleep/wakeup and power off control REG | R/W | 03H |
| 32 | Power off and Battery detection REG | R/W | 43H |
| 33 | Charge control REG1 | R/W | C6H |
| 34 | Charge control REG2 | R/W | 45H |
| 35 | Charge control REG3 | R/W | 0EH |
| 36 | PEK parameter Set REG | R/W | 5DH |
| 37 | DCDC converter work frequency REG | R/W | 08H |
| 38 | Battery under temperature Set REG when charging | R/W | A5H |
| 39 | Battery over temperature Set REG when charging | R/W | 1FH |
| 3C | Battery under temperature Set REG when discharging | R/W | FCH |
| 3D | Battery over temperature Set REG when | R/W | 16H |



| Address | Description | R/W | Default |
|---|---|---|---|
| | discharging | | |
| 80 | DCDC work mode Set REG | R/W | E0H |
| 82 | ADC Enable Set REG1 | R/W | E0H |
| 84 | ADC Sample rate, TS pin Control REG | R/W | 32H |
| 85 | TS ADC sample rate Set REG | R/W | 00H |
| 8A | Timer Set REG | R/W | 00H |
| 8C/8D | PWREN Set REG | R/W | 00H |
| 8F | Over temperature operation Set REG | R/W | 01H |

## GPIO Set Register List

| Address | Description | R/W | Default |
|---|---|---|---|
| 90 | GPIO0 Set REG | R/W | 07H |
| 91 | GPIO0 LDO mode output voltage Set REG | R/W | 1FH |
| 92 | GPIO1 control REG | R/W | 07H |
| 93 | GPIO1 LDO mode output voltage Set REG | R/W | 1FH |
| 94 | GPIO[1:0] signal REG | R/W | 00H |
| 97 | GPIO[1:0] pull down Set REG | R/W | 00H |

## Interrupt Register List

| Address | Description | R/W | Default |
|---|---|---|---|
| 40 | IRQ enable Set REG1 | R/W | D8H |
| 41 | IRQ enable Set REG2 | R/W | FFH |
| 42 | IRQ enable Set REG3 | R/W | 03H |
| 43 | IRQ enable Set REG4 | R/W | 03H |
| 44 | IRQ enable Set REG5 | R/W | 00H |
| 48 | IRQ status REG1 | R/W | 00H |
| 49 | IRQ status REG2 | R/W | 00H |
| 4A | IRQ status REG3 | R/W | 00H |
| 4B | IRQ status REG4 | R/W | 00H |
| 4C | IRQ status REG5 | R/W | 00H |

## ADC Data Register List

| Address | Description | R/W |
|---|---|---|
| 56 | AXP228 internal temperature monitor ADC Data highest 8 bit | R |
| 57 | AXP228 internal temperature monitor ADC Data lowest 4 bit | R |
| 58 | TS ADC Data highest 8 bit, Battery temperature | R |
| 59 | TS ADC Data lowest 4 bit, Battery temperature | R |
| 78 | Battery voltage highest 8 bit | R |



| | | |
|---|---|---|
| 79 | Battery voltage lowest 4 bit | R |
| 7A | Charge current highest 8 bit | R |
| 7B | Charge current lowest 5 bit | R |
| 7C | Discharge current highest 8 bit | R |
| 7D | Discharge current lowest 5 bit | R |

| Address | Description | R/W | Default |
|---|---|---|---|
| B8 | Coulomb counter control REG | R/W | 00H |
| B9 | Gauge result (%) | R | 64H |
| E0 | Battery full capacity bit[14:8] | R/W | 00H |
| E1 | Battery full capacity bit[7:0] | R/W | 00H |
| E6 | Battery low level warning Set REG | R/W | A0H |

Note： Battery full capacity unit :1.456mAH

# Register Description

REG 00H: Power Input Status

| Bit | Description | R/W |
|---|---|---|
| 7 | ACIN presence indication<br>0:ACIN not exist；1:ACIN exists | R |
| 6 | Indicating whether ACIN is usable | R |
| 5 | VBUS presence indication<br>0:VBUS not exist；1:VBUS exists | R |
| 4 | Indicating whether VBUS is usable | R |
| 3 | Indicating whether the VBUS voltage is above VHOLD before used. | R |
| 2 | Indicating the Battery current direction<br>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<br>0: Boot source isn't ACIN/VBUS； 1: Boot source is ACIN/VBUS. | R |

REG 01H: Power Working Mode and Charge Status Indication

| Bit | Description | R/W |
|---|---|---|
| 7 | Indicating whether AXP202 is over-temperature<br>0: not over-temperature； 1: over-temperature | R |
| 6 | Charge indication<br>0:not charge or charge finished； 1: in charging | R |
| 5 | Battery existence indication<br>0:no Battery connected to AXP202； 1: Battery already connected to AXP202 | R |



| | | |
|---|---|---|
| 4 | Reserved and unchangeable | R |
| 3 | Indicating whether the Battery enters the activate mode<br>0: not enter the activate mode； 1: already entered the activate mode | R |
| 2-0 | Reserved and unchangeable | R |

## REG 04-0FH: Data Buffer

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.

## REG 10H: DCDC1/2/3/4/5&ALDO1/2&DC5LDO Enable Set

Default: XXH

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | ALDO2 Enable Set | 0:Off； 1:On | RW | X |
| 6 | ALDO1 Enable Set | | RW | X |
| 5 | DC-DC5 Enable Set | | RW | X |
| 4 | DC-DC4 Enable Set | | RW | X |
| 3 | DC-DC3 Enable Set | | RW | X |
| 2 | DC-DC2 Enable Set | | RW | X |
| 1 | DC-DC1 Enable Set | | RW | X |
| 0 | DC5LDO Enable Set | | RW | X |

Note：X means that decided by the internal memory Set

## REG 12H: Power Output Control

Default: XXH

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | DC1SW Enable Set | 0:Off； 1:On | RW | 0 |
| 6 | DLDO4 Enable Set | | RW | 0 |
| 5 | DLDO3 Enable Set | | RW | 0 |
| 4 | DLDO2 Enable Set | | RW | 0 |
| 3 | DLDO1 Enable Set | | RW | X |
| 2 | ELDO3 Enable Set | | RW | 0 |
| 1 | ELDO2 Enable Set | | RW | 0 |
| 0 | ELDO1 Enable Set | | RW | X |



REG 13H:Power Output Control

Default:01H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | ALDO3 Enable Set | 0:Off； 1:On | RW | 0 |
| 6-0 | Reserved and unchangeable | | RW | 0 |

REG 15H:DLDO1 Output Voltage Set

Default: 00H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | DLDO1 Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 0 |
| 3 | DLDO1 Output Voltage Set Bit3 | | RW | 0 |
| 2 | DLDO1 Output Voltage Set Bit2 | | RW | 0 |
| 1 | DLDO1 Output Voltage Set Bit1 | | RW | 0 |
| 0 | DLDO1 Output Voltage Set Bit0 | | RW | 0 |

REG 16H:DLDO2 Output Voltage Set

Default: 00H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | DLDO2 Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 0 |
| 3 | DLDO2 Output Voltage Set Bit3 | | RW | 0 |
| 2 | DLDO2 Output Voltage Set Bit2 | | RW | 0 |
| 1 | DLDO2 Output Voltage Set Bit1 | | RW | 0 |
| 0 | DLDO2 Output Voltage Set Bit0 | | RW | 0 |

REG 17H:DLDO3 Output Voltage Set

Default: 00H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | DLDO3 Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 0 |
| 3 | DLDO3 Output Voltage Set Bit3 | | RW | 0 |
| 2 | DLDO3 Output Voltage Set Bit2 | | RW | 0 |
| 1 | DLDO3 Output Voltage Set Bit1 | | RW | 0 |



| | | | | |
|---|---|---|---|---|
| 0 | DLDO3 Output Voltage Set Bit0 | | RW | 0 |

REG 18H: DLDO4 Output Voltage Set

Default: 00H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | DLDO4 Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 0 |
| 3 | DLDO4 Output Voltage Set Bit3 | | RW | 0 |
| 2 | DLDO4 Output Voltage Set Bit2 | | RW | 0 |
| 1 | DLDO4 Output Voltage Set Bit1 | | RW | 0 |
| 0 | DLDO4 Output Voltage Set Bit0 | | RW | 0 |

REG 19H: ELDO1 Output Voltage Set

Default: 00H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | ELDO1 Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 0 |
| 3 | ELDO1 Output Voltage Set Bit3 | | RW | 0 |
| 2 | ELDO1 Output Voltage Set Bit2 | | RW | 0 |
| 1 | ELDO1 Output Voltage Set Bit1 | | RW | 0 |
| 0 | ELDO1 Output Voltage Set Bit0 | | RW | 0 |

REG 1AH:ELDO2 Output Voltage Set

Default: 00H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | ELDO2 Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 0 |
| 3 | ELDO2 Output Voltage Set Bit3 | | RW | 0 |
| 2 | ELDO2 Output Voltage Set Bit2 | | RW | 0 |
| 1 | ELDO2 Output Voltage Set Bit1 | | RW | 0 |
| 0 | ELDO2 Output Voltage Set Bit0 | | RW | 0 |

REG 1BH:ELDO3 Output Voltage Set

Default: 00H

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



| | | | | |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | ELDO3 Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 0 |
| 3 | ELDO3 Output Voltage Set Bit3 | | RW | 0 |
| 2 | ELDO3 Output Voltage Set Bit2 | | RW | 0 |
| 1 | ELDO3 Output Voltage Set Bit1 | | RW | 0 |
| 0 | ELDO3 Output Voltage Set Bit0 | | RW | 0 |

REG 1CH:DC5LDO Output Voltage Set

Default: 04H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-3 | Reserved and unchangeable | | | |
| 2 | DC5LDO Output Voltage Set Bit2 | 0.7-1.4V,100mV/step | RW | 1 |
| 1 | DC5LDO Output Voltage Set Bit1 | | RW | 0 |
| 0 | DC5LDO Output Voltage Set Bit0 | | RW | 0 |

REG 21H: DC-DC1 Output Voltage Set

Default: 11H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | DC-DC1 Output Voltage Set Bit4 | 1.6-3.4V，100mV/step | RW | 1 |
| 3 | DC-DC1 Output Voltage Set Bit3 | | RW | 0 |
| 2 | DC-DC2 Output Voltage Set Bit2 | | RW | 0 |
| 1 | DC-DC2 Output Voltage Set Bit1 | | RW | 0 |
| 0 | DC-DC2 Output Voltage Set Bit0 | | RW | 1 |

REG 22H: DC-DC2 Output Voltage Set

Default:19H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-6 | Reserved and unchangeable | | | |
| 5 | DC-DC2 Output Voltage Set Bit5 | 0.6-1.54V，20mV/step | RW | 0 |
| 4 | DC-DC2 Output Voltage Set Bit4 | | RW | 1 |
| 3 | DC-DC2 Output Voltage Set Bit3 | | RW | 1 |
| 2 | DC-DC2 Output Voltage Set Bit2 | | RW | 0 |
| 1 | DC-DC2 Output Voltage Set Bit1 | | RW | 0 |
| 0 | DC-DC2 Output Voltage Set Bit0 | | RW | 1 |



REG 23H: DC-DC3 Output Voltage Set

Default: 19H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-6 | Reserved and unchangeable | | | |
| 5 | DC-DC3 Output Voltage Set Bit5 | 0.6-1.86V，20mV/step | RW | 0 |
| 4 | DC-DC3 Output Voltage Set Bit4 | | RW | 1 |
| 3 | DC-DC3 Output Voltage Set Bit3 | | RW | 1 |
| 2 | DC-DC3 Output Voltage Set Bit2 | | RW | 0 |
| 1 | DC-DC3 Output Voltage Set Bit1 | | RW | 0 |
| 0 | DC-DC3 Output Voltage Set Bit0 | | RW | 1 |

REG 24H: DC-DC4 Output Voltage Set

Default: 19H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-6 | Reserved and unchangeable | | | |
| 5 | DC-DC4 Output Voltage Set Bit5 | 0.6-1.54V，20mV/step | RW | 0 |
| 4 | DC-DC4 Output Voltage Set Bit4 | | RW | 1 |
| 3 | DC-DC4 Output Voltage Set Bit3 | | RW | 1 |
| 2 | DC-DC4 Output Voltage Set Bit2 | | RW | 0 |
| 1 | DC-DC4 Output Voltage Set Bit1 | | RW | 0 |
| 0 | DC-DC4 Output Voltage Set Bit0 | | RW | 1 |

REG 25H: DC-DC5 Output Voltage Set

Default:0AH

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | DC-DC5 Output Voltage Set Bit4 | 1.0-2.55V，50mV/step | RW | 0 |
| 3 | DC-DC5 Output Voltage Set Bit3 | | RW | 1 |
| 2 | DC-DC5 Output Voltage Set Bit2 | | RW | 0 |
| 1 | DC-DC5 Output Voltage Set Bit1 | | RW | 1 |
| 0 | DC-DC5 Output Voltage Set Bit0 | | RW | 0 |

REG 27H: DC-DC2/3 Dynamic Voltage Scaling Parameter Set

Default: 00H

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



| | | | | |
|---|---|---|---|---|
| 7-4 | Reserved and unchangeable | | | |
| 3 | DC-DC3 VRC Enable Control<br>0:On； 1:Off | | RW | 0 |
| 2 | DC-DC2 VRC Enable Control<br>0:On； 1:Off | | RW | 0 |
| 1 | DC-DC3 VRC Voltage ramp Control | 0: 20mV/15.625us=1.6mV/us<br>1: 20mV/31.250us=0.8mV/us | RW | 0 |
| 0 | DC-DC2 VRC Voltage ramp Control | 0: 20mV/15.625us=1.6mV/us<br>1: 20mV/31.250us=0.8mV/us | RW | 0 |

REG 28H: ALDO1 Output Voltage Set

Default: 00H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | ALDO1 Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 0 |
| 3 | ALDO1 Output Voltage Set Bit3 | | RW | 0 |
| 2 | ALDO1 Output Voltage Set Bit2 | | RW | 0 |
| 1 | ALDO1 Output Voltage Set Bit1 | | RW | 0 |
| 0 | ALDO1 Output Voltage Set Bit0 | | RW | 0 |

REG 29H: ALDO2 Output Voltage Set

Default: 0BH

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | ALDO2 Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 0 |
| 3 | ALDO2 Output Voltage Set Bit3 | | RW | 1 |
| 2 | ALDO2 Output Voltage Set Bit2 | | RW | 0 |
| 1 | ALDO2 Output Voltage Set Bit1 | | RW | 1 |
| 0 | ALDO2 Output Voltage Set Bit0 | | RW | 1 |

REG 2AH:ALDO3 Output Voltage Set

Default: 17H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | ALDO3 Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 1 |



| | | | | |
|---|---|---|---|---|
| 3 | ALDO3 Output Voltage Set Bit3 | | RW | 0 |
| 2 | ALDO3 Output Voltage Set Bit2 | | RW | 1 |
| 1 | ALDO3 Output Voltage Set Bit1 | | RW | 1 |
| 0 | ALDO3 Output Voltage Set Bit0 | | RW | 1 |

REG 30H: VBUS-IPSOUT Path set

Default: 6XH

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | VBUS-IPSOUT Path select Control when VBUS valid<br>0:decided by N_VBUSEN pin, N_VBUSEN=0,the path is on<br>1:VBUS-IPSOUT Path is On | | RW | 0 |
| 6 | VBUS $V_{HOLD}$ voltage limit set<br>0:not limited； 1:limited | | RW | 1 |
| 5 | $V_{HOLD}$ Set Bit 2 | 000: 4.0V； 001: 4.1V； 010: 4.2V<br>011: 4.3V； 100: 4.4V； 101: 4.5V<br>110: 4.6V； 111: 4.7V | RW | 1 |
| 4 | $V_{HOLD}$ Set Bit 1 | | RW | 0 |
| 3 | $V_{HOLD}$ Set Bit 0 | | RW | 0 |
| 2 | DRIVEVBUS as GPO, Output Control<br>0： Output Low 1： Output High（IPSOUT） | | RW | 0 |
| 1:0 | VBUS current limit Control Set<br>00 -900mA；01-500mA；1x-no current limit | | RW | X |

REG 31H: Wakeup Control and Voff Voltage Set

Default:X3H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | PWROK status when Wakeup<br>0：do not output low 1：output low | | RW | 0 |
| 6 | Soft re-startup Control, write 1 to re-startup, then it self-clear | | RW | 0 |
| 5 | Software Wakeup Control, write 1 to restore the output voltage, then it self-clear | | RW | 0 |
| 4 | When Wakeup function Enabled, IRQ triggered PMU Wakeup and IRQ masked or not when Wakeup<br>0: IRQ triggered Wakeup，When Wakeup，all IRQ masked<br>1：IRQ work normal, but not triggered Wakeup | | | |
| 3 | Wakeup Function Enable Set when Sleep<br>0： Wakeup function Off<br>1： Wakeup function On<br>It self-clear after write 1 | | | |
| 2 | $V_{OFF}$ Set Bit2 | 000-2.6V； 001-2.7V； 010-2.8V；<br>011-2.9V； 100-3.0V； 101-3.1V； | RW | 0 |
| 1 | $V_{OFF}$ Set Bit1 | | RW | 1 |



| | | | | |
|---|---|---|---|---|
| 0 | $V_{OFF}$ Set Bit0 | 110-3.2V； 111-3.3V | RW | 1 |

REG 32H: Power off Set 、 Battery detection and CHGLED Control

Default:43H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | Power off Control<br>Write 1 to power off all output except LDO1 | | RW | 0 |
| 6 | Battery detection Set : 0:Off； 1:On | | RW | 1 |
| 5-4 | CHGLED PIN Set | 00: High-Z<br>01: 25% 0.5Hz toggle<br>10: 25% 2Hz toggle<br>11: Output Low | RW | 00 |
| 3 | CHGLED PIN Control Set | 0: REGREG 32HBit[5:4] Control<br>1: Controlled by charge module | RW | 0 |
| 2 | Sequence when Power Output Off<br>0：All Power Output Off at the same time<br>1：Reverse to the power on sequence | | RW | 0 |
| 1-0 | PWROK delay after Power Output ready | 00: 8ms； 01: 16ms；<br>10: 32ms； 11:64ms | RW | 10 |

REG 33H: Charge Control1

Default: CXH

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | Charge Enable Control<br>0:Off， 1:On | RW | 1 |
| 6:5 | Charge Voltage Set<br>00:4.1V； 01:4.22V； 10:4.2V； 11:4.24V | RW | 10 |
| 4 | Charge end current Set<br>0: 10%<br>1: 15% | RW | 0 |
| 3-0 | Charge current Set<br>0000:300mA； 0001:450mA； 0010:600mA； 0011:750mA；<br>0100:900mA； 0101:1050mA； 0110:1200mA； 0111:1350mA；<br>1000:1500mA； 1001:1650mA； 1010:1800mA； 1011:1950mA；<br>1100:2100mA； 1101:2250mA； 1110:2400mA； 1111:2550mA | RW | X |



REG 34H: Charge Control2

Default: 45H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | Pre-Charge timeout Set Bit1 | 00: 40 min； 01: 50min；<br>10: 60min； 11: 70min | RW | 0 |
| 6 | Pre-Charge timeout Set Bit0 | | RW | 1 |
| 5 | Charge Output Off or On when charge finished<br>0：Off； 1：On | | RW | 000 |
| 4 | CHGLED function type<br>0：A 1：B | | | 0 |
| 3 | Reserved and unchangeable | | | 0 |
| 2 | Charge target voltage follow with the charge current or not<br>0：On 1：Off | | | 0 |
| 2 | Charge external Path Enable Set<br>0:Off； 1:On | | RW | 0 |
| 1 | Constant Current timeout set Bit1 | 00: 6Hours； 01: 8Hours；<br>10: 10Hours； 11: 12Hours | RW | 0 |
| 0 | Constant Current timeout set Bit0 | | RW | 1 |

REG 35H: Charge Control3

Default: 22H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7：4 | Reserved and unchangeable | | |
| 3:0 | Charge loop current limit Set<br>0000:300mA； 0001:450mA； 0010:600mA； 0011:750mA；<br>0100:900mA； 0101:1050mA； 0110:1200mA； 0111:1350mA；<br>1000:1500mA； 1001:1650mA； 1010:1800mA； 1011:1950mA；<br>1100:2100mA； 1101:2250mA； 1110:2400mA； 1111:2550mA | RW | 1110 |

REG 36H:PEK Parameter Set

Default:5DH

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | Power on Time Set Bit1 | 00: 128mS； 01: 1S；<br>10: 2S； 11: 3S. | RW | 0 |
| 6 | Power on Time Set Bit0 | | RW | 1 |
| 5 | Long key Time Set Bit1 | 00: 1S； 01: 1.5S；<br>10: 2S； 11: 2.5S. | RW | 0 |
| 4 | Long key Time Set Bit0 | | RW | 1 |
| 3 | Hardwar Power off function Set when key down time longer than Power off Time<br>0:Off； 1:On | | RW | 1 |



| | | | | |
|---|---|---|---|---|
| 2 | Re-startup or not after hardware power off<br>0:no； 1:yes | | RW | 1 |
| 1 | Power off time Set Bit1 | 00: 4S； 01: 6S；<br>10: 8S； 11: 10S | RW | 0 |
| 0 | Power off time Set Bit0 | | RW | 1 |

REG 37H:DC-DC work frequency Set

Default: 08H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | DC-DC and charger frequency-spread Set<br>0：Off 1：On | | | 0 |
| 6 | DC-DC and charger spread frequency Set<br>0：50KHz 1：100KHz | | | 0 |
| 5 | Reserved and unchangeable | | | |
| 4 | DC-DC 2&3 Poly-phase Function Set<br>0：Off 1：On | | | X |
| 3 | DC-DCSwitch frequency Set Bit 3 | 5%/step，Default 3MHz | RW | 1 |
| 2 | DC-DCSwitch frequency Set Bit 2 | | RW | 0 |
| 1 | DC-DCSwitch frequency Set Bit 1 | | RW | 0 |
| 0 | DC-DCSwitch frequency Set Bit 0 | | RW | 0 |

REG 38H:VLTF-charge Battery Charge under temperature Set

Default:A5H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-0 | Battery under temperature Set when charge，M | M*10H<br>M=A5H:2.112V<br>Range:0V~3.264V | RW | A5H |

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

REG 39H:VHTF-charge Battery Charge over temperature Set

Default:1FH

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-0 | Battery over temperature Set when charge，N | N*10H<br>N=1FH:0.397V<br>range:0V~3.264V | RW | 1FH |

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



REG 3CH:VLTF-discharge Battery under temperature Set

Default: FCH

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-0 | Battery under temperature Set when discharge，M | M*10H<br>M=FCH:3.226V<br>Range:0V~3.264V | RW | FCH |

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

REG 3DH:VHTF-discharge Battery over temperature Set

Default:16H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-0 | Battery over temperature Set when discharge，N | N*10H<br>N=16H:0.282V<br>Range:0V~3.264V | RW | 16H |

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

REG 80H:DC-DC Work mode

Default:80H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | DC-DC5 Work mode Control | 0:PFM/PWM auto switch<br>1:fixed PWM | RW | 0 |
| 3 | DC-DC4 Work mode Control | | RW | 0 |
| 2 | DC-DC3 Work mode Control | | RW | 0 |
| 1 | DC-DC2 Work mode Control | | RW | 0 |
| 0 | DC-DC1 Work mode Control | | RW | 0 |

REG 82H:ADC Enable

Default:83H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | Battery Voltage ADC Enable | 0:Off， 1:On | RW | 1 |
| 6 | Battery Current ADC Enable | | RW | 0 |
| 5 | Internal temperature ADC Enable | | RW | 0 |
| 4-1 | Reserved and unchangeable | | | |
| 0 | TS Pin ADC Enable | 0:Off， 1:On | RW | 1 |



REG 84H:ADC Sample rate Set , TS Pin Control

Default:32H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | ADC Sample rate Set Bit 1 | $10\times2^n$<br>Sample rate:<br>100， 200， 400， 800Hz | RW | 0 |
| 6 | ADC Sample rate Set Bit 0 | | RW | 0 |
| 5-4 | TS Pin Output Current Set :<br>00:20uA； 01:40uA； 10:60uA； 11:80uA | | RW | 11 |
| 3 | Reserved and unchangeable | | | |
| 2 | TS Pin function<br>0: Battery temperature detection，1:ADC Input | | RW | 0 |
| 1-0 | TS Pin Current Output Set | 00:Off<br>01: Output Current when charging<br>10:Output Current when ADC sample<br>11: always On | RW<br>RW | 1<br>0 |

REG 85H:TS ADC Sample rate set

Default:X0H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | TS ADC Sample rate Set 1 | $10\times2^n$<br>Sample rate 分别为100，200，400，800Hz | RW | 0 |
| 6 | TS ADC Sample rate Set 0 | | RW | 0 |
| 5-0 | Reserved and unchangeable | | | |

REG 8AH:Timer Control

Default:00H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | Timer Timeout status:<br>1:timeout<br>Write 1 to clear this bit | RW | 0 |
| 6-0 | Timer set，1min/step<br>Write 0 to disable the timer | RW | 0000000 |

REG 8CH:PWRENControl Set 1

Default:00H



| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | DC-DC1 controlled by PWREN | 0：yes 1：no | RW | 0 |
| 6 | DC-DC2 controlled by PWREN | | RW | 0 |
| 5 | DC-DC3 controlled by PWREN | | RW | 0 |
| 4 | DC-DC4 controlled by PWREN | | RW | 0 |
| 3 | DC-DC5 controlled by PWREN | | RW | 0 |
| 2 | ALDO1 controlled by PWREN | | RW | 0 |
| 1 | ALDO2 controlled by PWREN | | RW | 0 |
| 0 | ALDO3 controlled by PWREN | | RW | 0 |

REG 8DH:PWRENControl Set 2

Default:00H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | DLDO1 controlled by PWREN | 0：yes 1：no | RW | 0 |
| 6 | DLDO2 controlled by PWREN | | RW | 0 |
| 5 | DLDO3 controlled by PWREN | | RW | 0 |
| 4 | DLDO4 controlled by PWREN | | RW | 0 |
| 3 | ELDO1 controlled by PWREN | | RW | 0 |
| 2 | ELDO2 controlled by PWREN | | RW | 0 |
| 1 | ELDO3 controlled by PWREN | | RW | 0 |
| 0 | DC5LDO controlled by PWREN | | RW | 0 |

REG 8FH:IC over temperature Power off function Set

Default:01H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | IRQ PIN triggered Power on or Wakeup function Set<br>0：Off 1：On | RW | 0 |
| 6 | ACIN/VBUS In-short function Set<br>0：auto detection 1：set by REG8F_[5] | RW | 0 |
| 5 | ACIN/VBUS In-short status and Set<br>0：not In-short 1：In-short | RW | 0 |
| 4 | N_VBUSEN PIN function Control<br>0： Output Pin ，as DRIVEVBUS function（Output to enable the OTG 5V Boost module）<br>1：Input Pin ， Control VBUS Path | RW | X |
| 3 | Reserved and unchangeable | | |
| 2 | AXP228 internal over temperature Power off function Set<br>0:do not Power off ； 1: Power off | RW | 0 |
| 1-0 | Reserved and unchangeable | RW | 01 |



REG 90H:GPIO0 function Set

Default:07H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | GPIO0 posedge triggered IRQ/wakeup or not when as input<br>0：no 1： yes | | RW | 0 |
| 6 | GPIO0 negedge triggered IRQ/wakeup or not when as input<br>0：no 1： yes | | RW | 0 |
| 5-3 | Reserved and unchangeable | | | |
| 2 | GPIO0 Pin Function Set Bit 2 | 000: Output low<br>001: Output High<br>010:input Function<br>011: low noise LDO Function On<br>100:low noise LDO Function Off<br>101-111: floating | RW | 1 |
| 1 | GPIO0 Pin Function Set Bit 1 | | RW | 1 |
| 0 | GPIO0 Pin Function Set Bit 0 | | RW | 1 |

REG 91H:GPIO0 work as LDO mode and Output voltage Set

Default:1FH

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | GPIO0 LDO Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 0 |
| 3 | GPIO0 LDO Output Voltage Set Bit3 | | RW | 0 |
| 2 | GPIO0 LDO Output Voltage Set Bit2 | | RW | 0 |
| 1 | GPIO0 LDO Output Voltage Set Bit1 | | RW | 0 |
| 0 | GPIO0 LDO Output Voltage Set Bit0 | | RW | 0 |

REG 92H:GPIO1 Function Set

Default:07H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | GPIO1 posedge triggered IRQ/wakeup or not when as input<br>0：no 1： yes | RW | 0 |
| 6 | GPIO1 negedge triggered IRQ/wakeup or not when as input<br>0：no 1： yes | RW | 0 |



| | | | | |
|---|---|---|---|---|
| 5-3 | Reserved and unchangeable | | | |
| 2 | GPIO1 Pin Function Set Bit 2 | 000: Output low<br>001: Output High<br>010: input Function<br>011: low noise LDO Function On<br>100:low noise LDO Function Off<br>101-111: floating | RW | 1 |
| 1 | GPIO1 Pin Function Set Bit 1 | | RW | 1 |
| 0 | GPIO1 Pin Function Set Bit 0 | | RW | 1 |

REG 93H:GPIO1 work as LDO mode and Output voltage Set

Default:1FH

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-5 | Reserved and unchangeable | | | |
| 4 | GPIO1 LDO Output Voltage Set Bit4 | 0.7-3.3V,100mV/step | RW | 0 |
| 3 | GPIO1 LDO Output Voltage Set Bit3 | | RW | 0 |
| 2 | GPIO1 LDO Output Voltage Set Bit2 | | RW | 0 |
| 1 | GPIO1 LDO Output Voltage Set Bit1 | | RW | 0 |
| 0 | GPIO1 LDO Output Voltage Set Bit0 | | RW | 0 |

REG 94H:GPIO[1:0] input status

Default:00H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-2 | | | | |
| 1 | GPIO1 input status | 0:Low<br>1:High | R | |
| 0 | GPIO0input status | | R | |

REG 97H:GPIO[1:0] pull down resister Set

Default:00H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7-2 | Reserved and unchangeable | | | |
| 1 | GPIO1 pull down Control when work as input | 0:pull down resistor off<br>1:pull down resistor on | RW | 0 |



| | | | | |
|---|---|---|---|---|
| 0 | GPIO0 pull down Control when work as input | | RW | 0 |

REG 40H:IRQ Enable 1

Default:D8H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | ACIN over voltage IRQ Enable | RW | 1 |
| 6 | ACIN insert IRQ Enable | RW | 1 |
| 5 | ACIN remove IRQ Enable | RW | 0 |
| 4 | VBUS over voltage IRQ Enable | RW | 1 |
| 3 | VBUS insert IRQ Enable | RW | 1 |
| 2 | VBUS remove IRQ Enable | RW | 0 |
| 1 | VBUS valid but lower than $V_{HOLD}$IRQ Enable | RW | 0 |
| 0 | Reserved and unchangeable | RW | 0 |

REG 41H:IRQ Enable 2

Default:FFH

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | Battery present IRQ Enable | RW | 1 |
| 6 | Battery remove IRQ Enable | RW | 1 |
| 5 | Battery enter active mode IRQ Enable | RW | 1 |
| 4 | Exit Battery active mode IRQ Enable | RW | 1 |
| 3 | Charging IRQ Enable | RW | 1 |
| 2 | Charge finished IRQ Enable | RW | 1 |
| 1 | Battery over temperature IRQ Enable | RW | 1 |
| 0 | Battery under temperature IRQ Enable | RW | 1 |

REG 42H:IRQ Enable 3

Default:3BH

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | AXP228 internal over temperature IRQ Enable | RW | 0 |
| 6-2 | Reserved and unchangeable | | |
| 1 | Short key IRQ Enable | RW | 1 |
| 0 | Long key IRQ Enable | RW | 1 |



REG 43H:IRQ Enable 4

Default:C1H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7-2 | Reserved and unchangeable | | |
| 1 | Battery energy low warning level 1 IRQ Enable(information) | RW | 1 |
| 0 | Battery energy low warning level 2 IRQ Enable(need to Power off） | RW | 1 |

REG 44H:IRQ Enable 5

Default:00H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | Timer Timeout IRQ Enable | RW | 0 |
| 6 | PEK posedge IRQ Enable | RW | 0 |
| 5 | PEK negedge IRQ Enable | RW | 0 |
| 4-2 | Reserved and unchangeable | | |
| 1 | GPIO1 edge IRQ Enable | RW | 0 |
| 0 | GPIO0 edge IRQ Enable | RW | 0 |

REG 48H:IRQ Status 1

Default:00H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | ACIN over voltage IRQ | RW | 0 |
| 6 | ACIN insert IRQ | RW | 0 |
| 5 | ACIN remove IRQ | RW | 0 |
| 4 | VBUS over voltage IRQ | RW | 0 |
| 3 | VBUS insert IRQ | RW | 0 |
| 2 | VBUS remove IRQ | RW | 0 |
| 1 | VBUS valid but lower than $V_{HOLD}$IRQ | RW | 0 |
| 0 | Reserved and unchangeable | RW | 0 |

REG 49H:IRQ Status 2

Default:00H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | Battery present IRQ | RW | 0 |
| 6 | Battery remove IRQ | RW | 0 |
| 5 | Battery enter active mode IRQ | RW | 0 |



| | | | |
|---|---|---|---|
| 4 | Exit Battery active mode IRQ | RW | 0 |
| 3 | Charging IRQ | RW | 0 |
| 2 | Charge finished IRQ | RW | 0 |
| 1 | Battery over temperature IRQ | RW | 0 |
| 0 | Battery under temperature IRQ | RW | 0 |

REG 4AH:IRQ Status 3

Default:00H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | AXP228 internal over temperature IRQ | RW | 0 |
| 6-2 | Reserved and unchangeable | | |
| 1 | Short key IRQ | RW | 0 |
| 0 | Long key IRQ | RW | 0 |

REG 4BH:IRQ Status 4

Default:00H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7-2 | Reserved and unchangeable | | |
| 1 | Battery energy low warning level 1 IRQ (information) | RW | 0 |
| 0 | Battery energy low warning level 2 IRQ (need to Power off) | RW | 0 |

REG 4CH:IRQ Status 5

Default:00H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | Timer Timeout IRQ | RW | 0 |
| 6 | PEK posedge IRQ | RW | 0 |
| 5 | PEK negedge IRQ | RW | 0 |
| 4-2 | Reserved and unchangeable | | |
| 1 | GPIO1 edge IRQ | RW | 0 |
| 0 | GPIO0 edge IRQ | RW | 0 |

Note:Write 1 to these bit will clear the IRQ status

REG B8H:E-Gauge Control

Default:C0H



| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | Gauge system Enable Control<br>0：Off 1：On | RW | 1 |
| 6 | Coulomb counter Enable Control<br>0：Off 1：On | RW | 1 |
| 5 | Battery full capacity calibration Function Enable<br>0：Off 1：On | RW | 1 |
| 4 | Battery capacity calibration Status<br>0：do not at calibration status 1：calibrating now | RW | 0 |
| 3-0 | Reserved and unchangeable | RW | 0 |

REG B9H: Battery Gauge result

Default:64H

| Bit | Description | | R/W | Default |
|---|---|---|---|---|
| 7 | Battery result indication<br>0：be calculated yet 1: calculating now | | R | 0 |
| 6-0 | Battery gauge result | 0%~100% | R | 64 |

REG E0H: Battery full design capacity Set 1

Default:00H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7 | Battery full design capacity configured or not<br>0：not be configured 1:has been configured | RW | 0 |
| 6-0 | Battery full design capacity bit[14:8] | RW | |

Battery full design capacity = Value * 1.456mAh

REG E1H: Battery full design capacity Set 2

Default:00H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7-0 | Battery full design capacity bit[7:0] | RW | |

REG E6H: Battery low power warning level Set

Default:A0H

| Bit | Description | R/W | Default |
|---|---|---|---|
| 7:4 | Battery low power warning level 1 Set | RW | 1010 |



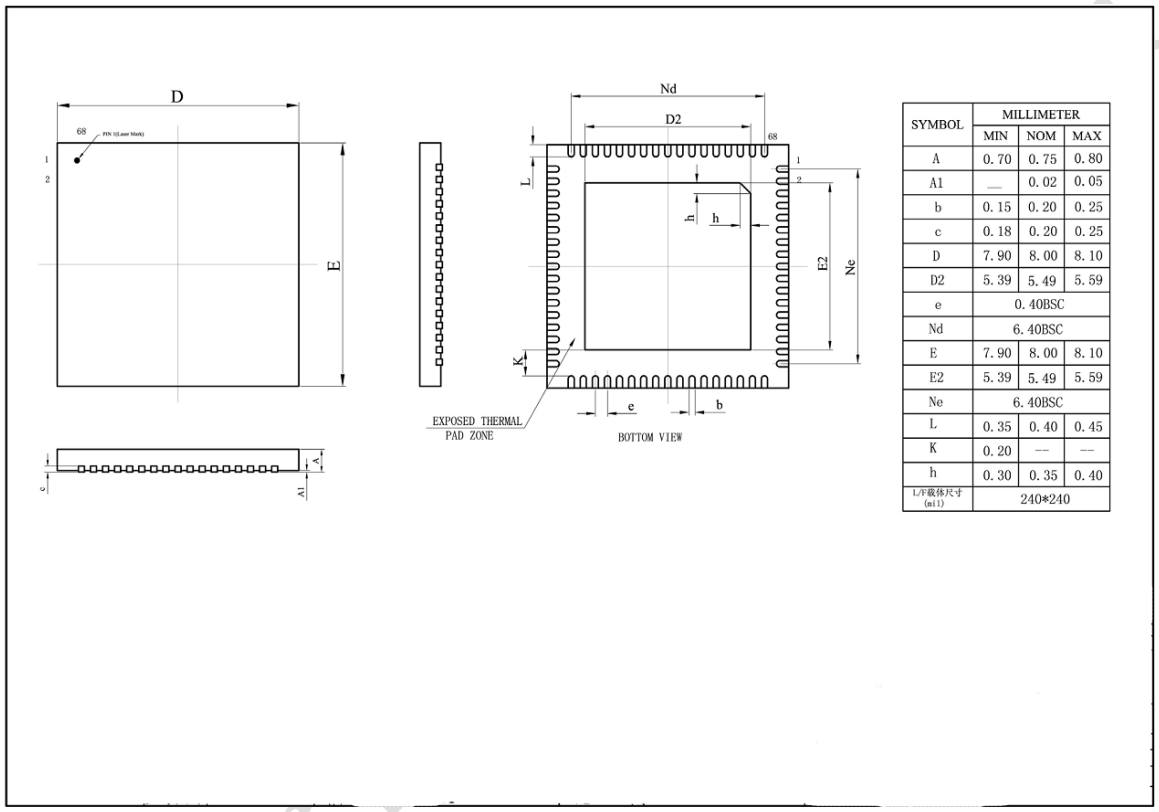
  

| | | | |
|---|---|---|---|
| | 0000-1111：5%-20% | | |
| 6-0 | Battery low power warning level 2 Set<br>0000-1111：0%-15% | RW | 0000 |



# 11 PACKAGE




| SYMBOL | MILLIMETER | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 0.70 | 0.75 | 0.80 |
| A1 | — | 0.02 | 0.05 |
| b | 0.15 | 0.20 | 0.25 |
| c | 0.18 | 0.20 | 0.25 |
| D | 7.90 | 8.00 | 8.10 |
| D2 | 5.39 | 5.49 | 5.59 |
| e | 0.40BSC | | |
| Nd | 6.40BSC | | |
| E | 7.90 | 8.00 | 8.10 |
| E2 | 5.39 | 5.49 | 5.59 |
| Ne | 6.40BSC | | |
| L | 0.35 | 0.40 | 0.45 |
| K | 0.20 | — | — |
| h | 0.30 | 0.35 | 0.40 |
| L/F载体尺寸 (mil) | 240*240 | | |

