

## General Description

SY8809 is a highly integrated chip designed for TWS charging case. It integrates charging and discharge module. Charging module adopts NVDC architecture, and charging current is adjusted by I2C; The discharge output also can be adjusted by I2C, with integrating two limited current switch, and it also supports load-existing detection, load-in detection and output current detection. By integrating NTC protection, the chip can be used safely.

SY8809 integrates the standard I2C interface and interrupt, which easily communicate with MCU that controls the charging and discharging.

SY8809 integrates the communication port, which can communicate between MCU and headset at high speed, It is very suitable for the design of TWS charging case. The high integration greatly simplifies the peripheral circuits and components, and provides an easy-to-use solution for the application of TWS charging case.

The package of SY8809 is QFN4x4-24.

## Application

TWS charging case

Portable lithium battery apply

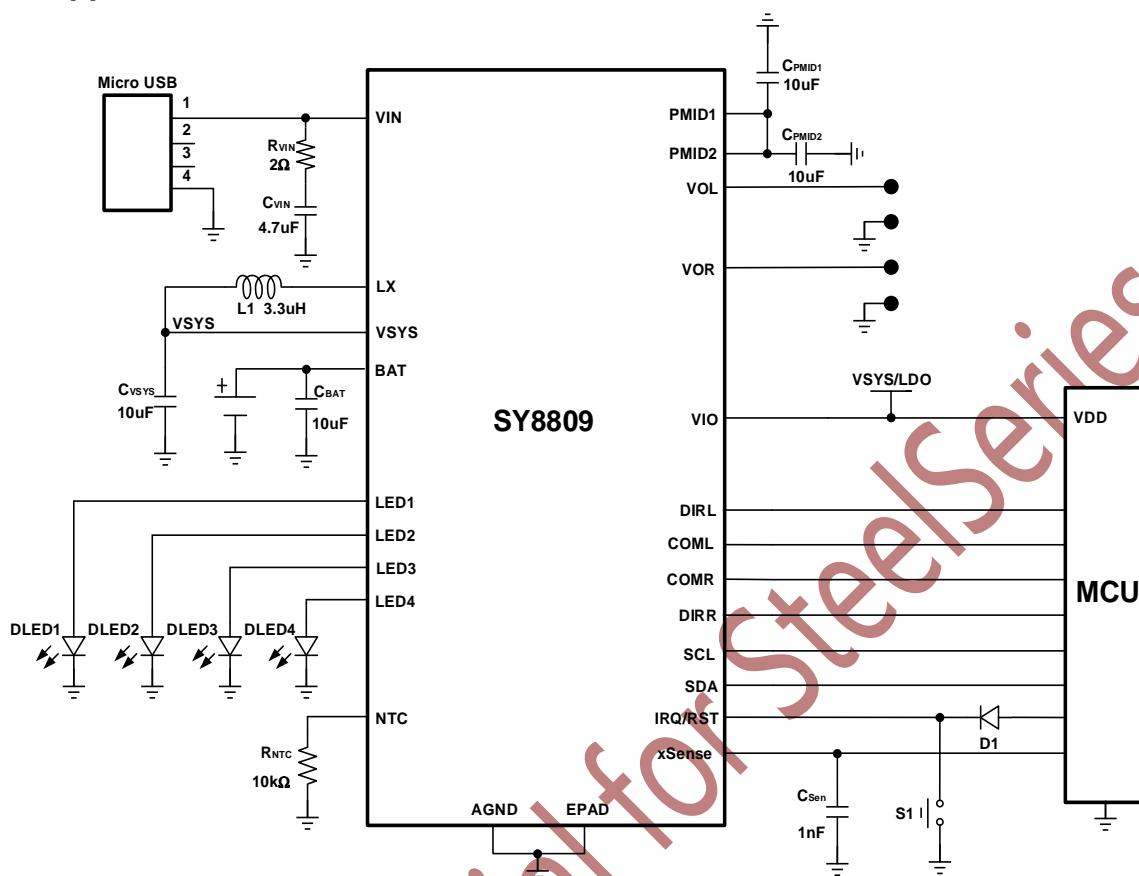
Other small power apply

## Features

- ◆ VIN voltage withstand up to 28V
- ◆ Intelligently identified current:7uA
- ◆ BAT charging current is set by I2C, maximum charging current:2.2A

- ◆ BAT trickle and terminated current set by I2C
- ◆ Charging current automatically adjusts by temperature, and decreases when temperature is rising
- ◆ Automatical recharging when charging is terminated
- ◆ Terminated charging voltage set by I2C, and the accuracy is up to  $\pm 0.5\%$
- ◆ Supporting NVDC, which is a portable supply for MCU
- ◆ Synchronous boost output set by I2C, and efficiency is up to 93%@0.1A
- ◆ Supporting load in detection
- ◆ Supporting dual outputs which discharge independently
- ◆ Supporting light load detection, light load current which is adjustable
- ◆ Possessing two levels of protection of load detection
- ◆ Boost output adjusted through thermal
- ◆ Discharge module possesses over-current, short, over-voltage、over-temperature protection
- ◆ Integrating LED display driving and breathing light inside
- ◆ Integrating high speed communication port, each port controls data to send/received independently;
- ◆ Voltage code/current code which is received is freely configurated, current code mode supports 1kbps communication rate
- ◆ Integrating NTC protection

### Typical Application Circuit



Typical Application Circuit Diagram

(Charge current:1.5A; Charge terminal current:2mA; Temperature Range:charge0°C~45°C; discharge-10°C~60°C)

(Note: If NTC is selected, it must select that the NTC resistor has 1% accuracy, 10K resistance value and  $\beta = 3950$ )

## Pin Configuration

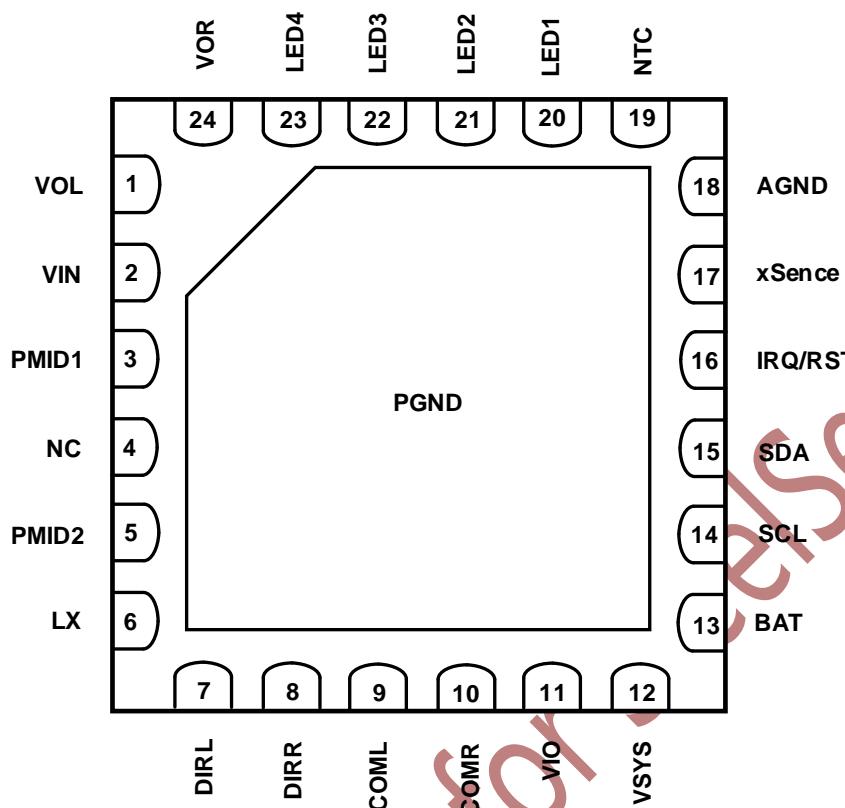


Fig.1. Pin Configuration Map

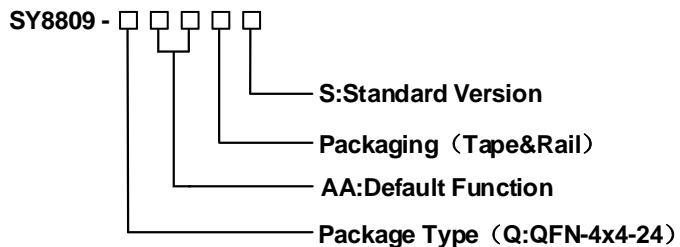
## Pin Function

Pin Name	Port	I/O	Description
VOL	1	O	Left headset supply
VIN	2	I	Adapter input
PMID1	3	O	VOL/VOR application supply
NC	4	-	No connection, can use for GND
PMID2	5	O	Boost output
LX	6	O	Switch output
DIRL	7	I	COML communication direction controlling, no pull up/down resistor inside. Please connect with GND if not used, (high level connects with VIO). 1:data is transmitted from VOL to COML 0:data is transmitted from COML to VOL
DIRR	8	I	COMR communication direction controlling, no pull up/down resistor inside. Please connect with GND if not used, (high level connects with VIO). 1:data is transmitted from VOR to COMR 0:data is transmitted from COMR to VOR
COML	9	I/O	Left headset communication port, default setting 3.2K pull up resistor to VIO inside, open-drain output; Data transmission controlled by DIRL

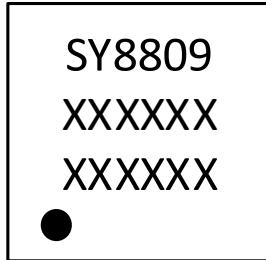
**Pin Function (Continued Table)**

Pin Name	Port	I/O	Description
COMR	10	I/O	Right headset communication port, default setting 3.2K pull up resistor to VIO inside, open-drain output; Data transmission controlled by DIRR
VIO	11	I	Communication IO supply, supply is same as outer MCU
VSYS	12	I	Outer system supply, also can supply for MCU
BAT	13	I	battery positive input
SCL	14	I	I2C clock input, default setting 10K pull up resistor to VIO inside
SDA	15	I	I2C data input, default setting 10K pull up resistor to VIO inside
IRQ/RST	16	O	Interrupt output, open-drain output/hardware reset pin, pull up 100K inside, supply depends on which VIO or BAT is higher
xSense	17	O	Multi selected sampling output
AGND	18	-	Analog GND
NTC	19	I	NTC temperature sensor output
LED1	20	O	LED output 1, PMOS OD output
LED2	21	O	LED output 2, PMOS OD output
LED3	22	O	LED output 3, PMOS OD output
LED4	23	O	LED output 4, PMOS OD output
VOR	24	O	Right headset supply
PGND	EPAD	-	Power GND

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**Ordering Information**

Part Number	Package	Quantity
SY8809-QAARS	QFN24	3000

**Silk-screen Description**

1. The six characters is part number at the first line;
2. The first four of six characters are year and week, the latter two are manufacture code at the second line;
3. The six characters is batch number at the third line;

## Function Diagram

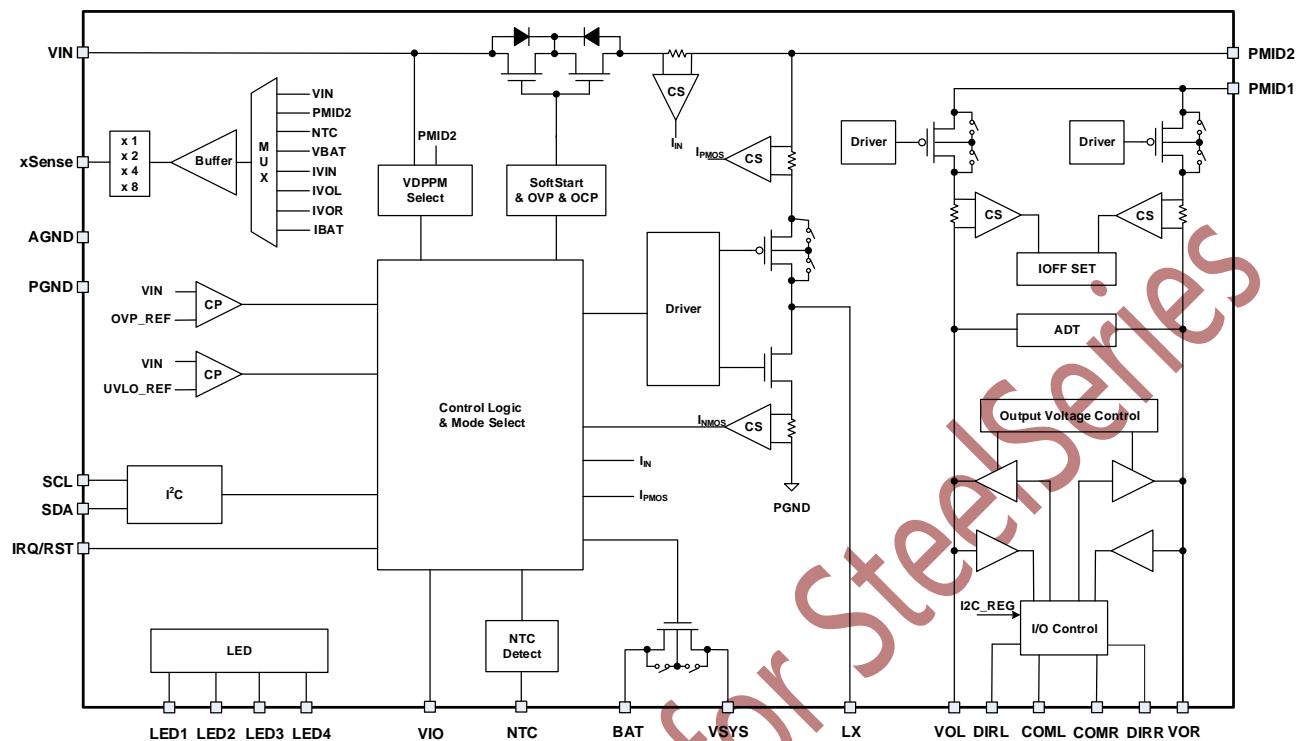


Fig.2. Function diagram

## Electrical Characteristics

### Absolute ratings<sup>(1)</sup>

Parameter	Min	Max	Unit
VIN Pin to GND	-0.3	+28	V
LX Pin to GND	-0.3	8	V
The others pin to GND	-0.3	+6	V
Storage temperature range	-65	150	°C
Operation temperature range	-20	85	°C
Junction temperature range	-40	150	°C
HBM (Human Body Model)	4000	-	V
MM (Machine Model)	350	-	V
CDM (Charged Device Model)	2000	-	V

### Recommend operation conditions<sup>(2)</sup>

- Input voltage----- 2.9V to 5.5V  
Junction temperature range----- -40°C to 125°C  
Operation temperature range----- -20°C to 85°C

#### Note:

- (1)Exceeding these rating may damage the device.  
(2)The device is not guaranteed to function outside of its operating conditions.

## Typical Characteristics

(without special explanation, VIN=5V, VBAT=3.7V, Ta=25°C, L1=3.3uH)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I <sub>STDB</sub>	Quiescent current		-	7		µA
I <sub>SHIP</sub>	Ship-mode standby current			3		uA
<b>Input</b>						
VIN	Adapter input voltage		4.4	5.0	6.0	V
V <sub>INOVP</sub>	VIN OVP threshold	Register configurable	5.6	5.8	6	V
T <sub>OVP</sub>	Input OVP detection time			3		uS
V <sub>INUV</sub>	VIN UVLO threshold			4.2		V
V <sub>INUVSCHM</sub>	VIN UVLO hysteresis (upper hysteresis )	Exit VIN UVLO hysteresis		0.2		V
T <sub>UV</sub>	VIN UVLO restored time			120		mS
V <sub>INDPPM</sub>	Dynamic power path management for VIN	Register configurable	4.5	4.6	4.7	V
I <sub>INDPPM</sub>	VIN input current limited adjustable	Register configurable	2.3	2.5	2.9	A
V <sub>PMD</sub> <sub>SHORT</sub>	PMID protected voltage when shorted	Both charge and discharge	3.9	4	4.1	V
		Discharge	-	4.5	-	V
R <sub>IN</sub>	Vin limited current switch ON resistor	VIN=5V	-	100	-	mΩ
R <sub>PMOS</sub>	Upper PMOS conductive resistor		-	70	-	mΩ
R <sub>NMOS</sub>	Lower NMOS conductive resistor		-	60	-	mΩ
I <sub>PPMOS</sub>	Upper PMOS current peak		-	3.8	-	A
I <sub>PNMOS</sub>	Lower NMOS current peak			2.2		A
I <sub>LEAKAGE</sub>	Leaked current from PMID to VIN		-	0	5	uA
T <sub>ov</sub>	protected temperature		-	150	-	°C
T <sub>HYS</sub>	protected temperature hysteresis		-	30	-	°C
<b>Charge</b>						
F <sub>CHAEGER</sub>	Switch frequency in charging		0.8	1	1.2	MHz
V <sub>FLOAT</sub>	Terminated charge voltage	Register configurable	4.158	4.2	4.242	V
I <sub>BATF</sub>	BAT quiescent current when BAT is charging fully			18		uA
ΔV <sub>RECHRG</sub>	Recharge hysteresis	Register configurable	94	96		%
I <sub>cc</sub>	CC mode charge current	BAT charging-current, Register configurable	0.95	1	1.05	A
A <sub>cc</sub>	Accuracy with ICC			5		%

## Typical Characteristics (Continued Table)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I <sub>TRIKL</sub>	TC mode charge current	BAT charging-current, Register configurable		0.02		A
η	Efficiency in CC mode	V <sub>BAT</sub> =3.7V@1.5A	90%			
V <sub>PRECHG</sub>	Pre-charged voltage threshold	V <sub>BAT</sub> rising, pre-charge to TC mode		2.35		V
I <sub>PRCHG</sub>	Pre-charged current	BAT charge current		20		mA
V <sub>TRIKL</sub>	TC mode voltage threshold	V <sub>BAT</sub> rising, TC to CC	2.9	3.0	3.1	V
V <sub>TRHYS</sub>	TC mode voltage hysteresis	V <sub>BAT</sub> down, CC to TC		200		mV
I <sub>TERM</sub>	Terminated current	Register configurable		20		mA
<b>Discharge</b>						
VPMID	Boost output	Register configurable	4.8	5	5.2	V
I <sub>BT</sub>	No-load current	No-load		110		uA
VUV_BAT	BAT UVLO threshold	Register configurable	2.7	2.8	2.9	V
VHYS_BAT	BAT UVLO hysteresis		0.05	0.1	0.15	V
D <sub>MAX</sub>	Maximum duty cycle		-	85	-	%
V <sub>RIPPLE</sub>	Output ripple voltage	VPMID2=5V&I <sub>OUT</sub> =1A	-	100	-	mV
		No-load		30		mV
VPMIDovP	Output voltage protection		-	5.5	-	V
T <sub>ss</sub>	Soft start time		-	2	-	ms
V <sub>ST</sub>	Auto identified quiescent voltage			VBAT		V
I <sub>AD</sub>	Auto detected current	Register configurable	4	5	6	uA
I <sub>Max</sub>	Maximum output current	Register configurable	225	250	275	mA
I <sub>END</sub>	Lighted load detected current	Register configurable	1.8	2	2.2	mA
VOXSHORT	Protected voltage when shorted		-	4.5	-	V
R <sub>OUT</sub>	Resistance value When switch is conductive	VPMID2=5V and output current >10mA	-	0.5	-	Ω
		Output current<10mA	-	2	-	Ω
<b>NTC</b>						
T <sub>cold1</sub>	Cold temperature detection 1		-11	-10	-9	℃
T <sub>cold2</sub>	Cold temperature detection 2		-1	0	1	℃
T <sub>warm1</sub>	Warm temperature detection1		9	10	11	℃

## Typical Characteristics (Continued Table)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
T <sub>norm</sub>	Normal temperature detection		44	45	46	°C
T <sub>hot</sub>	Hot temperature detection		59	60	61	°C
<b>BFET</b>						
V <sub>SYS_MIN</sub>	The lowest voltage for VSYS	Register configurable	3.6	3.65	3.7	V
V <sub>SYS_Short</sub>	VSYS shorted protection voltage			2.2		V
V <sub>IdealDiode</sub>	Voltage between VSYS and VBAT at Ideal Diode mode			30		mV
I <sub>BATSC</sub>	BFET shorted protection current			5		A
R <sub>ON_BFET</sub>	BFET conductive resistance value			50		mΩ
<b>xSense</b>						
V <sub>OUTH</sub>	Output the highest level			2.5		V
V <sub>OUTL</sub>	Output the lowest level			0		V
V <sub>OS</sub>	Input offset			1		mV
I <sub>OxSense</sub>	Output current maximum			280		uA
xSense/ IBAT	BAT charging current sampling percentage	IBAT ≥ 640mA		0.5		V/A
	BAT charging current sampling percentage	160mA ≤ IBAT < 640mA		2		V/A
	BAT charging current sampling percentage	IBAT < 160mA		4		V/A
xSense/IVIN	VIN charging current sampling percentage			0.45		V/A
xSense/ IVOX	Headset current sampling percentage	IO=100mA, IO>26mA ↑		2		V/A
	Headset current sampling percentage	IO=10mA, IO<18mA ↓		30		V/A
xSense/VIN	VIN voltage sampling percentage	VIN=5V		1/8		V/V
xSense/ PMID2	PMID voltage sampling percentage	PMID=5V		1/8		V/V
xSense/ VBAT	BAT voltage sampling percentage	VBAT=3.6V		1/4		V/V
xSense/ NTC	NTC voltage sampling percentage	ntc_mode reg configures 2b'11		1		V/V

## Typical Characteristics (Continued Table)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Interface</b>						
R <sub>RST</sub>	Reset pull up resistor			100K		Ω
T <sub>RST</sub>	Hardware reset time			200		ms
T <sub>RST_S</sub>	Long press reset time	Register configurable		1		s
T <sub>RST_L</sub>	Super long press reset time	Register configurable		10		s
R <sub>COML</sub>	COML pull up resistor	Register configurable		3.2K		Ω
R <sub>COMR</sub>	COMR pull up resistor	Register configurable		3.2K		Ω
R <sub>SCL</sub>	SCL pull up resistor	Register configurable		10K		Ω
R <sub>SDA</sub>	SDA pull up resistor	Register configurable		10K		Ω
I <sub>LED</sub>	LED1~LED4 output current	Register configurable		0.5		mA

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## Function Description:

### Dynamic Power Path Management

The main function of VIN current limiting switch is to withstand the high voltage of VIN, limit the maximum VIN current, and prevent leakage between VIN and PMID2. The VIN current limiting switch have input under-voltage protection, overvoltage protection, charge and discharge path management, soft start, overcurrent protection and short circuit protection.

When VIN voltage is greater than 4.4V and less than 6V, the current limiting switch starts to work. In order to prevent a relatively large peak current when VIN is inserted, the switch integrates the soft start function, which effectively limits the starting current. When the VIN voltage is less than 4.2V or greater than 6V, the switch is automatically turned off, and the charging BUCK also.

When VIN voltage is greater than 4.4V and less than 6V, PMID2 is directly powered by VIN, and VOL/R can also be charged and discharged at the same time through PMID1.

VIN integrated current detection function, used for the limited current of charging Buck. The VIN limited current can be configured by the I2C register.

VIN is also integrated with the overcurrent protection function. When the input current exceeds VIN protection current, the switch and Buck will stop working and enter the hiccup mode. In this mode, the chip is restarted every 200mS and detect whether the anomaly exists at the same time until the anomaly is disappear.

When the switch is turned on, the chip will also detect the PMID2. When the PMID2 is lower than the short-circuit protection voltage, the switch and BUCK will stop working and enter the burp mode.

### Charge Mode

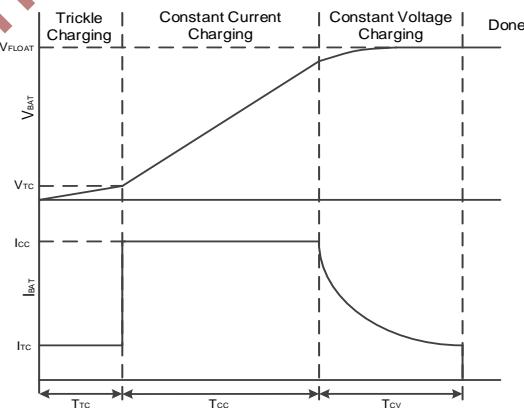


Fig.3. Charging Mode figure

When the chip detects that VIN UVLO is normal, the input current limiting switch and Buck are automatically enabled to supply for VSYS. After delaying 100ms,it is determined to charge state by the Control of BFET and battery voltage. A complete PWM NVDC charging module is integrated inside the

chip to adjust and control the battery charging current, and use the power tube inside the chip to pre-charge the battery, trickle, constant current and constant voltage charging. The charging current is adjusted through the register, the maximum charging current is 2.2A, and the internal register can control the charging current.

In trickle mode, Buck is turned on and BFET adopts linear charging. Trickle charging current register can be configured. In constant current mode, Buck is turned on, BAT voltage reaches VSYS\_MIN, BFET is fully on, constant current charging current defaults to 200mA, registers can be configured; In constant voltage mode, the charging current gradually decreases, and when the charging current decreases below the charging cut-off current (controlled by the charging cut-off current register), the charging cycle ends.

NVDC function: The BFET module supports the reverse power supply function. If the VSYS voltage is lower than the battery voltage, the reverse power supply function is enabled and the BFET enters the power supply mode. When the VSYS voltage is higher than the BAT voltage, the BFET automatically exits the power supply mode and enters the normal charging mode.

The VSYS voltage can be set to a minimum VSYS\_MIN by I2C. In charging mode, when the VSYS voltage is low to VSYS\_MIN, the chip adjusts the BFET to automatically reduce the charging current and maintain the VSYS voltage not lower than VSYS\_MIN. This function can ensure the normal power supply of MCU when the battery is charged at zero voltage.

Charging of the protection and functions are :VINDPM, IINDPM, soft start current function, overtemperature current limit function and charging timing function, while supporting watchdog charging mode (register optional, default closed).

VSYS short protection: When VSYS shorts, BFET will trigger the overcurrent protection. After the BFET overflows, it will directly shut down BFET and enter the hiccup state. After 200ms, restart BFET and check whether VSYS is out of the short-circuit state again. At the same time, when the VSYS voltage is less than 2.2V, VIN current is limited to about 250mA.

VINDPM function: When the VIN power output capacity is limited and the charging current is too large, the VIN voltage will gradually decrease. When the VIN voltage drops to 4.6V (register can be configured), the Buck loop starts to gradually reduce the VSYS voltage. When the VSYS voltage drops to VSYS\_MIN (register can be configured) or close to the battery voltage, the charging current gradually decreases and the VIN voltage is maintained at around 4.6V so as not to damage the adapter.

IINDPM function: When the VIN current is too large and reaches the IINDPM (register can be configured) current set in the register, the Buck loop starts to gradually reduce the VSYS voltage. When the VSYS voltage drops to VSYS\_MIN or close to the battery voltage, the charging current gradually decreases. Maintain VIN current around IINDPM so as not to damage the adapter.

Over-temperature current limiting function: When the chip temperature exceeds the chip internal

setting temperature of 110°C, the Buck loop begins to gradually reduce the VSYS voltage, when the VSYS voltage drops to VSYS\_MIN or close to the battery voltage, the charging current gradually decreases, maintain the chip temperature at 110°C, to ensure that the chip charging heat will not be too serious.

Charging timeout function: the trickle/constant current charging timeout function can be configured through register <0x24>CHG\_Config4, which is disabled by default. Set the corresponding time to operate the register to enable the timeout function. When the trickle/constant current charging time exceeds the configured time, the BFET will be shut down to stop charging the battery, and the corresponding timeout flag will be set. Trickle current and constant current charge timeout functions are independent of each other.

Register<0x24>CHG_Config4	Timeout Configurable
B <5:4>	Charging Timeout configurable in CC mode 00:close charging timeout protection in CC mode. 01:4h 10:8h 11:2h
B<3:2>	Charging Timeout configurable in TC mode 00: close charging timeout protection in TC mode. 01:1h 10:2h 11:0.5h

## Discharge Mode

### Boost Output

The chip provides a synchronous boost output, integrated power MOS, can provide 5V/1A output (the output voltage register is adjustable), efficiency up to more than 90%. The chip adopts a switching frequency of 1MHz, which can effectively reduce the size of external components.

In the standby state, the automatic identification load module of VOL and VOR ports is turned on, and the quiescent current of the chip is 7uA. When VOL and VOR detect load, load-in and Load-ON signals are generated inside the chip, and interrupt signals are sent to notify MCU, which enables Boost and VOL/R to discharge.

The discharge module integrates two working modes: constant voltage and peak/valley current limiting. When the discharge current is less than 1A, the constant voltage output 5V, when the output current needs to be greater than 1A, the chip enters the weekly period current mode, limit the output peak current, output voltage begins to decrease. When the load current gradually decreases, the system will enter intermittent output mode (PFM) to ensure the output voltage adjustment capability. Boost output voltage takes the higher of the register configuration value and BAT voltage plus 0.6V.

The chip integrates the output voltage configuration, output soft start, over current, over voltage, short circuit, overheating and battery under voltage and other functions.

### VOL/R Output

VOL/R pin is used for the output port to charge the earphone. On this port, the chip integrates automatic load identification function, earphone automatic recharging function, output current limiting function and light load detection function. VOL and VOR ports can be controlled independently.

In the standby state, when the automatic load identification function is turned on, VOL/R is pulled up to the battery voltage, when the load put in, if the load current is greater than the automatic identification current, the internal circuit detects the load putting in, internally generates load-in and load-on signals, load-in is used to identify the load put in the action, the lock exists in the register; Load-on is used to check whether loads exist in real time. According to these two signals, the user can judge the loading action and the existence state, thus controlling the discharge output.

VOL/R output support output current detection, used for output current-limiting protection and light load detection, the output current-limiting value register can be configured, when the output current exceeds the current-limiting value, the chip triggers the over-current protection function, into the hiccup state, 200ms after the restart output, again to see whether the VOL/R short is removed; When the charging current of the headphone terminal is less than the IOFF current (register adjustable), the chip

sends an interrupt signal and notifies MCU, which decides whether to shut down the output.

VOL/R port supports communication. In communication mode, the chip supports two-way communication between COML/COMR and VOL/VOR.

## Battery Temperature protection (NTC)

The NTC protection function is used to detect the battery temperature and then control the charge and discharge of the chip. NTC protection supports four modes (register control): JEITA, Common mode, output temperature interval mode and xSense sampling output mode. Table 1 shows the protection ranges and protection behaviors of JEITA and common modes.

Table1 NTC Temperature Range

<0x16>Value	Temperature Range	JEITA		Normal Mode	
		charge	discharge	charge	discharge
1111	<-10°C	No	No	No	No
1011	-10°C < T < 0°C	No	Yes	No	Yes
0011	0°C < T < 10°C	0.5*ICC charge	Yes	Yes	Yes
0001	10°C < T < 20°C	Yes	Yes	Yes	Yes
0000	20°C < T < 45°C	Yes	Yes	Yes	Yes
0100	45°C < T < 60°C	VFLOAT is 4.05V	Yes	No	Yes
1100	>60°C	No	No	No	No

**Output temperature interval mode:** the chip register only outputs the temperature interval without controlling the charging current and discharge. The "temperature interval" is shown in Table1.

**XSense sampling and output mode:** in this mode, the constant current source inside the IC flows into the external NTC resistor, and the voltage on the NTC resistor is output through xSense. After sampling by ADC of MCU, the charging and discharging state is controlled by MCU.

**NTC FAULT:** In JEITA mode and normal mode, if the temperature exceeds the normal range, the NTC module controls the charging current and voltage and sends NTC FAULT signals.

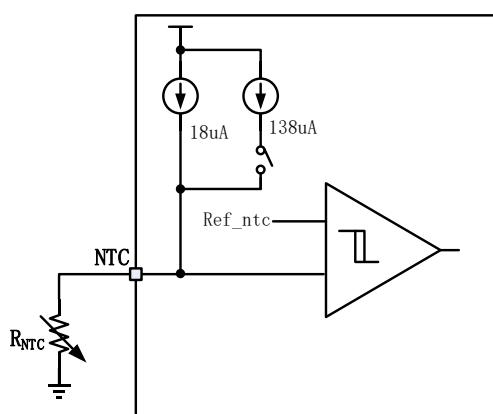


Fig.4. NTC protection figure

In "output temperature interval mode", the current and voltage are not controlled and no NTC FAULT signal is given. In "xSense mode", only the output current sampled by NTC is controlled, the temperature range is not given, the current and voltage are not controlled, and no FAULT signal is given to NTC.

The NTC detection circuit is shown in Figure 4. Constant current flows through the NTC resistance inside the chip, and the battery temperature is detected by detecting the voltage on the NTC resistance. High and low temperature thresholds are set inside the chip to provide NTC protection. Therefore, for applications requiring NTC protection, the NTC resistor must be 10K and  $\beta = 3950$ ; If NTC protection is not required, you need to disable the NTC function by configuring registers.

## LED Display

The main functions of LED module are: LED switch and display mode control, drive current adjustment, external drive current adjustment, integrated breathing lamp display, different breathing light effect, etc. LED display driver uses constant current source to drive common cathode LED, and THE power supply of LED driver chooses VSYS, so when VSYS is shorted, LED display will be abnormal.

All functions of LED are controlled by registers. Register <0x40>LED\_Config0 mainly controls the switch and display mode control of LED. Registers <0x41>LED\_Config1 and <0x42>LED\_Config2 are mainly responsible for the lamp effect control of the integrated breathing light, such as the gradual change time of the breathing lamp, steady on, often off, etc. Register <0x43>LED\_Config3 is mainly responsible for driving current and brightness adjustment of LED.

**Note:** The details of LED parameter control, refer to the description of register <0x40-0x43> LED\_config0-3

## Inductance shorted protection

SY8809 internal integrated inductor shorted protection, no matter in charge or discharge state, as long as the inductor shorted, SY8809 will stop charging/discharging and keep locked state, to avoid IC damage; The VIN needs to be re-inserted to release the lock. (Register <0x37> OCP\_config1.B<7> can be used to configure whether to enable this function.)

## xSense Output

The xSense pin outputs the internal analog signal to the outside of the chip for sampling the MCU. Optional xSense sampling signals include :VIN, PMID, NTC, VBAT, IVIN, IVOL, IVOR, IBAT, by the I2C register to select signals; After the xSense module is enabled, the ratio of output parameters is as follows: If the sampled data is too small, you can configure xSense gain amplification. For details, see register <0x31>xSense\_Config

0x31registerB<3:0>	Output Signal Type	Each Signal Percentage Description
0000	Output IVOL Current Sampling result	When IVOL<20mA (st_iloadl=0) , Sampling Percentage is 1mA/30mV; When IVOL>30mA (st_iloadl=1) , Sampling Percentage is 1mA/2mV
0001	Output IVOR Current Sampling Result	When IVOR<20mA (st_iloadr=0) , Sampling Percentage is 1mA/30mV; When IVOR>30mA (st_iloadr=1) , Sampling Percentage is 1mA/2mV
0010	Reserve	Reserve
0011	Output IBAT Current Sampling Result	IBAT<160mA, xSense(mV)/IBAT(mA)=4; 160mA ≤ IBAT < 640mA, xSense(mV)/IBAT(mA)=2; IBAT ≥ 640mA, xSense(mV)/IBAT(mA)=0.5
0100	Output NTC Voltage Sampling Result	Setting ntc_mode at 11 mode firstly
0101	Output VIN Voltage Sampling Result	Output VIN / 8 voltage
0110	Output VBAT Voltage Sampling Result	Output VBAT / 4 voltage
0111	Output IVIN Current Sampling result	Output IVIN current sampling result, IVIN=1mA, xSense=0.45mV
1000	Output PMID Sampling result	Output PMID/8 voltage

## Reset

In order to prevent software crash in MCU, the chip integrates hardware reset function, software reset function and VIN reset function.

Ultra-long press RST to pull down for 10S (registers can be configured), the chip enters the hardware reset action, shut down BFET, and pull down VSYS 200ms to reset MCU, and then re-power VSYS. At the same time, a write clear flag is set in the register to indicate that the system has been reset by hardware.

Software reset instructions reset the chip to its initial configuration state.

Insert VIN reset MCU function register can be configured, not enabled by default; When enabled, after VIN is inserted, BFET is closed and VSYS 200ms is pulled down. Then BFET is restarted to power VSYS and buck is turned on to charge the battery. At the same time, a write clear flag is set in the register to indicate that the system has been reset.

## Shipmode

The internal register of the chip is set with the shipmode control bit. When MCU writes 1 to this register, the chip will delay for 4S (the register can be configured) before entering the shipmode. If BFET is turned off, VSYS will be powered off, MCU will also enter the power off state, and the system will be in a low power consumption state. At this point, the chip only starts VIN detection and RST detection modules, and a write clear flag is set in the register to indicate that the system has entered shipmode.

Exiting shipmode can only insert VIN or hold RST 1S (register configuration). After exiting the shipmode, the chip enters the charging state or standby state again.

## WatchDog

The WatchDog function is designed to prevent the MCU software from crashing. After WD timeout protection, the protection action provides two schemes (register can be selected) :

(1) After WD timeout protection, the internal register value is cleared to the default value, and a WD timeout flag bit is generated, and the flag bit is written out; At the same time, the chip pulls down the voltage of VSYS to 0V for 200ms, and then supplies power to VSYS again, thus completing the reset action to MCU.

(2) After WD timeout protection, the chip only clears the internal register value to the default value, generates a WD timeout flag bit, only completes the protection action for SY8809 itself, and does not close BFET. (Default state)

The timeout protection time of WD is controlled by registers. Default value: off. You can set the timeout protection time to 40S, 80S, or 160S. In standby state, considering power consumption requirements, I2C needs to actively disable WD function to keep the chip in low power state.

## IRQ Interrupt Warning Function

SY8809 supports IRQ output, IRQ is pulled up to BAT by default. When IRQ event is triggered, IRQ will be pulled down for about 8mS, which is used to prompt MCU SY8809 internal state change, and MCU can make timely processing according to relevant warnings. The IRQ warning list is as follows:

IRQ Events	Events Description	posedge	negedge	Double edge
st_ntc_fault	NTC abnormal	✓		
st_vsys_ocp	vsys ocp			✓
st_vor_ocp	vor ocp			✓
st_vol_ocp	vol ocp			✓
st_pimd_ocp_osp	pmid ocp			✓
st_icctimeout	Charging timeout at CC mode	✓		
st_itctimeout	Charging timeout at TC mode	✓		
st_batovp	batovp			✓
st_vin_ok	Vin insert			✓
chg_end	Charge full			✓
st_lowbat	Low battery	✓		
st_batuvlo	bat uvlo	✓		
st_vor_level	Level from high to low		✓	
st_vol_level	Level from low to high		✓	
st_vor_ioff	Load changed at vor			✓
st_vol_ioff	Load changed at vol			✓
st_vor_loadon	Right earphone in case			✓
st_vol_loadon	Left earphone in case			✓
st_vor_loadin	Right earphone load-in	✓		
st_vol_loadin	Left earphone load-in	✓		
ntc_refile[2:0]	NTC range changed			✓
st_negedgevor	recharge request at vor	✓		
st_nedgenvol	recharge request at vol	✓		
st_ind_os	Inductance shorted	✓		
st_wdtvsys	Watchdog timeout	✓		
st_iloadr	Vor resistor changed			✓
st_iloadl	Vol resistor changed			✓

## Communication

SY8809 supports bidirectional and independent communication between headset and charge case. It receives and sends signals through VOL/R connection, interacts with MCU through COML/COMR, controls receiving and sending mode through DIRL/DIRR, and controls entering and exiting communication mode through registers.

SY8809 communication functions mainly include isolated communication, communication level conversion, communication function forced entry and exit, receiving current/voltage back code mode control, receiving and transmitting mode, etc.

Isolated communication function: Under normal circumstances, the communication mode is off, VOL/R is used to detect the headset load and charge the headset, and all communication detection functions are off. After the SY8809 enters the communication mode through register operation, disable the discharge function of VOL/R to isolate the SYSTEM and force the SY8809 to enter the communication detection mode.

Forced entry and exit of communication function: No matter SY8809 is in charging, discharging or automatic identification state, VOL/R can be forced into communication mode through register <0x27>EN\_Config0. B<4:3> corresponding position 1, and all functions of VOL/R are independent of each other. If VOL is forced into and out of communication mode, the discharge, load identification, communication receiving and receiving status of VOR will not be affected, and vice versa.

Communication back code mode: The mode of communication mode can be controlled by <0x26> IO\_config1.b <3>. The default two-way communication adopts voltage communication; Set1:bidirectional communication adopts the mixed mode of sending code voltage and receiving code current. When the headphone box sends data to the headphone, it communicates by voltage. The high level register can be configured, and the low level is 0V. The earphone communicates with current when sending data to the earphone box, supporting 1kbps communication rate; The current threshold is output by IOFF comparator and the register can be configured.

Communication transceiver code mode control: DIRL/DIRR=1; receiving mode: data is sent from VOL/R to COML/R; DIRL/DIRR=0, sending mode: data is sent from COML/R to VOL/R. DIRL and DIRR are independent of each other. When VOL is in receiving mode, VOR can be in sending mode or receiving mode, and vice versa. (1 indicates high level, and it is recommended to pull up to VIO; 0 indicates low level, and it is recommended to pull down to GND)

Communication level conversion: SY8809 communication module is integrated with communication level conversion circuit, the default communication level is 2.5V, can change the communication level through register <0x25>IO\_Config0. B<4:2>, to meet the application of different communication levels.

Register	Communication Level
<0x25>IO_Config0. B<4:2>	000:enable 2.5V communication 001: enable 3.0V communication 010:enable PMID(default 5.0V) communicate 011: enable 1.8V communication 100: enable 3.3V communication 101: enable 1.2V communication 110: enable VIO communication 111: enable VSYS communication

**Note:** Communication register is related to <0x25>IO\_Config0, <0x26>IO\_Config1, <0x27>EN\_Config0)

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## I<sup>2</sup>C interface

The SY8809 device operates as a slaver, receiving control inputs from the MCU controller host through the I<sup>2</sup>C interface. The device address is 0b0000110X, where X is the read/write bit.

## I<sup>2</sup>C Register

Register type	
Type	Description
R/WC	Read/write 1 clear register
R	Readable only
R/W	Readable/writable
W	Writable only

Reset source description	
Reset source	Description
POR	Power failure reset
SRST	Software reset
RST	Hardware reset
VIN	VIN power-on reset
WD	WatchDog time out reset

&lt;0x10&gt;FAULT\_STA0

Register	Type	BIT	Name	Default	Reset source	Description
0x10	R/WC	B<7>	ST_BATOVP_W	0	POR+SRST	BATOV even pending; Write 1 to clear. 0:Normal state. 1:Abnormal state.
		B<6>	ST_BATUVLO_W	0		BATUVLO even pending; Write 1 to clear. Internal lock, need to insert VIN and BAT is normal, write 1 to clear. 0:Normal state. 1:Abnormal state.
		B<5>	ST_VINOVP_W	0		VINOVP even pending; Write 1 to clear. 0:Normal state. 1:Abnormal state.
		B<4>	ST_NTC_Fault_W	0		NTC even pending; Write 1 to clear. 0:Normal state. 1:Abnormal state.
		B<3>	ST_VSYS_OCP_W	0		Over-current protection of VSYS even pending; Write 1 to clear. (Every hiccup when VSYS is abnormal) 0:Normal state. 1:Abnormal state.
		B<2>	ST_VOR_OCP_W	0		Over-current or short-circuit protection of VOR even pending; Write 1 to clear. (Every hiccup when VOR is abnormal) 0:Normal state. 1:Abnormal state.
		B<1>	ST_VOL_OCP_W	0		Over-current protection of VOL even pending; Write 1 to clear. (Every hiccup when VOL is abnormal) 0:Normal state. 1:Abnormal state.
		B<0>	ST_PMid_OCP_osp_W	0		Over-current or short-circuit protection of PMID even pending; Write 1 to clear. 0:Normal state. 1:Abnormal state.

&lt;0x11&gt;FAULT\_STA1

Register	Type	BIT	Name	Default	Description
0x11	R	B<7>	ST_IND_OS	0	Indication of inductance short-circuit protection status during charging/discharging: 0:Normal state. 1:Inductance short-circuit state.
		B<6>	ST_NTC_OVT	0	Indication of NTC fault signal 0:NTC temperature is normal. 1:NTC temperature is out of range.
		B<5>	ST_VSYS_OCP	0	Over-current and short-circuit protection of VSYS; (Hip protection when VSYS is abnormal) 0:Normal state. 1:Abnormal state.
		B<4>	ST_VOR_OCP	0	Over-current and short-circuit protection of VOR; (Hiccup protection when VOR is abnormal) 0:Normal state. 1:Abnormal state.
		B<3>	ST_VOL_OCP	0	Over-current and short-circuit protection of VOL; (Hiccup protection when VOL is abnormal) 0:Normal state. 1:Abnormal state.
		B<2>	ST_PMid_OCP_OSP	0	Over-current or short-circuit protection of PMID; (Hiccup protection when PMID is abnormal) 0:Normal state. 1:Abnormal state.
		B<1>	ST_ICCTimeOut	0	Battery terminal constant current ICC charging timeout flag, this bit turns from 0 to 1, which can trigger IRQ interrupt. 0: Constant current ICC charging has not timed out. 1: Constant current ICC charging has timed out .SY8809 will stop charging and turn off the MOSFET from VSYS to VBAT. At this time, ST_ITCTimeOut can be clear and charger will be restart by reinserting the VIN or flipping the DIS_CHG bit (writing DIS_CHG=1 and then DIS_CHG=0).
		B<0>	ST_ITCTimeOut	0	Trickle ITC charging timeout flag, this bit turns from 0 to 1, which can trigger IRQ interrupt. 0: Trickle ITC charging has not timed out 1: Trickle ITC charging has timed out.Then stop charging and turn off MOSFET from VSYS to VBAT. At this time, ST_ITCTimeOut will be clear and charging will be restart by reinserting the VIN or flipping the DIS_CHG bit (writing DIS_CHG=1 and then DIS_CHG=0).

&lt;0x12&gt;CHG\_STA

Register	Type	BIT	Name	Default	Description
0x12	R	B<7>	ST_DeadBat	0	Indication that the battery voltage is lower than 2.2V: 0:VBAT>2.2V 1:VBAT<2.2V
		B<6:5>	ST_IBAT_SNS<1:0>	00	Sampling ratio of charging current corresponding to IBAT in xSense during charging: 00:xSense(mV) / IBAT(mA) = 4.0 01:xSense(mV) / IBAT(mA) = 2.0 10:xSense(mV) / IBAT(mA) = 0.5 11:xSense(mV) / IBAT(mA) = 0.5
		B<4>	ST_VBAT_OVP	0	Over voltage state of VBAT; When the state changes, IRQ is triggered. 0:VBAT voltage is less than OVP voltage. 1:VBAT voltage is greater than or equal to OVP. (BAT OVP is not detected during discharge)
		B<3>	ST_VINOVP	0	Indication of VIN voltage; According to the actual status display. When the state changes, IRQ is triggered. 0:VIN voltage is less than OVP voltage. 1:VIN voltage is greater than OVP voltage.
		B<2>	ST_VINOK	0	VIN OK; When the state changes, IRQ is triggered. 0:VIN voltage is less than UVLO or greater than OVP. 1:VIN voltage is normal.
		B<1:0>	ST_CHG_STAT<1:0>	0	Indication of charging state; In ST_ChipMode =001 (Charge)operation mode, register <0x12> is valid. 00:no charge. (VIN<VIN_UVLO) 01:Trickle charging. 10:Constant current charging. 11:The battery is fully charged.

&lt;0x13&gt;BST\_STA

Register	Type	BIT	Name	Default	Description
0x13	R	B<7:4>			
		B<3>	ILOADL	0	indication of VOL resistance: 0: VOL resistance is 2Ω, and current sampling ratio: $ILOADL(\text{mA}) = xSense(\text{mV}) / 30$ 1: VOL resistance is 0.5Ω, and current sampling ratio: $ILOADL(\text{mA}) = xSense(\text{mV}) / 2$
		B<2>	ILOADR	0	indication of VOR resistance: 0: VOR resistance is 2Ω, current sampling ratio: $ILOADR (\text{mA}) = xSense(\text{mV}) / 30$ 1: VOR resistance is 0.5Ω, current sampling ratio: $ILOADR (\text{mA}) = xSense(\text{mV}) / 2$
		B<1>	ST_LowBAT	0	Low battery alarm state: 0: VBAT is normal. 1: VBAT is low battery state.
		B<0>	ST_BAT_UVLO	0	VBAT UVLO state. 0: VBAT voltage is normal. 1: VBAT is UVLO state. Note: when the bit is 1, VIN must be larger than VINUVLO and the battery voltage is normal before it can be cleared

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&lt;0x14&gt;VOx\_STA

Register	Type	BIT	Name	Default	Description
0x14	R	B<7>	ST_VOR_Level	1	VOR voltage state. This bit turns from 1 to 0, which can trigger IRQ interrupt. The "0" or "1" status of VOR will be indicated only when EnVORLevelChk=1 is required; If EnVORLevelChk=0, turn off the indicator function of VOR voltage. 0:VOR<0.7V 1:VOR>0.8V
		B<6>	ST_VOL_Level	1	VOL voltage state. This bit turns from 1 to 0, which can trigger IRQ interrupt. The "0" or "1" status of VOL will be indicated only when EnVOLLevelChk=1 is required; If EnVOLLevelChk=0, turn off the indicator function of VOL level. 0:VOL<0.7V 1:VOL>0.8V
		B<5>	ST_VOR_Ioff	0	VOR light load state; This bit from 0 to 1, or from 1 to 0, can trigger IRQ interrupt. 0:VOL overload state (when IOR > IOFF) 1:VOL light load state (when IOR < IOFF) (Note: This bit is meaningful only when the VOR outputs 5V)
		B<4>	ST_VOL_Ioff	0	VOL light load state; This bit from 0 to 1, or from 1 to 0, can trigger IRQ interrupt. 0:VOL overload state (when IOL > IOFF) 1:VOL light load state (when IOL < IOFF) (Note: This bit is meaningful only when the VOL outputs 5V)
		B<3>	ST_VOR_Loadon	0	VOR load presence status; This bit from 0 to 1, or from 1 to 0, can trigger IRQ interrupt. 0:VOR no-load status 1:VOR is in load state (uA level current. As long as there is a load, this bit=1)
		B<2>	ST_VOL_Loadon	0	VOL load presence status; This bit from 0 to 1, or from 1 to 0, can trigger IRQ interrupt. 0:VOL no-load status 1:VOL has load status (uA level current. As long as there is a load, this bit=1)
		B<1>	ST_VOR_LoadIn	0	VOR load insertion status; The change of this bit from 0 to 1 can trigger the IRQ interrupt. 0:VOR no-load insertion action 1:VOR has load insertion action (when this bit=1 and then EN_VOR=1, clear this bit)
		B<0>	ST_VOL_LoadIn	0	VOL load insertion status; The change of this bit from 0 to 1 can trigger the IRQ interrupt. 0:VOL no-load insert action 1:VOL has load insertion action (when this bit=1 and then EN_VOL=1, clear this bit)

## &lt;0x15&gt; ChipMode

Register	Type	BIT	Name	Default	Description
0x15	R	B<7:4>	-		-
		B<3:1>	ST_ChipMode	0	Indication of working mode; 000: Standby mode. 001: Charge mode. 010: Discharge mode. 011: Deepsleep mode. 100: Shipmode mode. Other: Standby mode.
		B<0>	INIT_OK	0	Chip initialization completion status 0: Initialization was not completed. 1: Complete initialization.

## &lt;0x16&gt;NTC\_STA

Register	Type	BIT	Name	Default	Description
0x16	R	B<7:4>	-		-
		B<3:0>	ntc_pre<3:0>	0000	Indicate the NTC temperature range, and indicate the current temperature range in real time. IRQ is triggered once when each state transitions. 1111: <-10°C 1011: -10°C < T < 0°C 0011: 0°C < T < 10°C 0001: 10°C < T < 20°C 0000: 20°C < T < 45°C 0100: 45°C < T < 60°C 1100: > 60°C

&lt;0x17&gt;RST\_STA

Register	Type	BIT	Name	Default	Reset source	Description
0x17	R/WC	B<7:6>			POR +SRST	
		B<5>	NegedgeVOR_W	0		Used for earphone recharge detection or communication detection. Trigger IRQ when 0->1 jumps. Write 1 to clear ,When EnVORLevelChk=1 0:VOR does not detect low-level 100ms pulse. 1:VOR once detected a low-level 100ms pulse.
		B<4>	NegedgeVOL_W	0		Used for earphone recharge detection or communication detection. Trigger IRQ when 0->1 jumps. Write 1 to clear ,When EnVOLLevelChk= 1 0:VOL does not detect low-level 100ms pulse. 1:VOL once detected a low-level 100ms pulse.
		B<3>	LLRSTVSYS_W	0		This flag is set to 1 when register LLRst_EN=1 and VSYS is reset by long pressing RST . Write 1 to clear. 0: Long pressing RST is not detected. 1: It has been detected that pressing RST for too long.
		B<2>	VINPlusInRstVSYS_W	0		This flag is set to 1 when register VSYSRstAsVINPlugIn = 1 ,and VIN is from UVLO to normal state . Trigger IRQ when 0->1 jumps. Write 1 to clear. 0: VIN insertion not detected. 1: VIN insertion has been detected.
		B<1>	WatchDogRstVSYS_W	0		WatchDog reset flag bit. Write 1 to clear. 0:WatchDog is not reset. 1:WatchDog has been reset.
		B<0>	ShipMode_W	0		After entering shipmode, this flag is set to 1. Write 1 to clear. 0: Not being shipmode 1: Being shipmode.

Note: After 0x17 each bit is set to 1, it needs to clear 0, then IRQ can be triggered again by this even.

&lt;0x20&gt;CHG\_Config0

Register	Type	BIT	Name	Default	Reset source	Description
0x20	R/W	B<7:5>	IINDPM<2:0>	100	POR+SRST +RST +WD+VIN	Enter VIN current limit setting; 000: 0.25A 001: 0.50A 010: 1.00A 011: 1.50A 100: 2.00A 101: 2.50A Others:2.50A
		B<4>	VBATFRechg	0		Recharge voltage; 0: 96%VBF 1: 94%VBF
		B<3>	VINOVP	0		VIN OVP voltage selection; 0:5.8V up, 5.6V down 1:6.4V up, 6.2V down
		B<2>	DPPM_Sel	0		Selection of DPPM PIN: 0:VIN as the charging adaptive voltage point 1:PMID2 as the charging adaptive voltage point
		B<1:0>	Vdppm<1:0>	00		VDPPM: 00: 4.60V 01: 4.70V 10: 4.80V 11: 4.50V

## &lt;0x21&gt;CHG\_Config1

Register	Type	BIT	Name	Default	Reset source	Description
0x21	R/W	B<7:4>	-	-	-	-
		B<3:0>	VBF_Set<3:0>	0011	POR+SRST +RST +WD+VIN	Floating voltage VBF setting 0000:4.05V 0001:4.10V 0010:4.15V 0011:4.20V 0100:4.25V 0101:4.30V 0110:4.35V 0111:4.40V 1000:4.45V 1001:4.50V Others:4.2V

## &lt;0x22&gt;CHG\_Config2

Register	Type	BIT	Name	Default	Reset source	Description
0x22	R/W	-	-	-	-	-
		B<6:0>	ICC_SET<6:0>	0001010	POR+SRST +RST +WD+VIN	Constant current set: (Default value 200mA, Step size 20mA) 0000000:0mA 0001010:200mA 1101110:2.2A Others:2.2A

## &lt;0x23&gt;CHG\_Config3

Register	Type	BIT	Name	Default	Reset source	Description
0x23	R/W	B<7:4>	ITC_SET<3:0>	0000	POR+SRST +RST +WD+VIN	Trickle charging current set: (Default value 20mA, step size 20mA) 0000:20mA . . . 1111: 320mA
		B<3:0>	IEND_SET<3:0>	0000		End of charge current set: (Default value 20mA, Step size 20mA) 0000:20mA . . . 1111:320mA

## &lt;0x24&gt;CHG\_Config4

Register	Type	BIT	Name	Default	Reset source	Description
0x24	R/W	B<7:6>	-	-	POR+SRST +RST +WD+VIN	-
		B <5:4>	TIMER_CC<1:0>	00		Time-out configuration of ICC phase 00: Turn off the charging constant current timeout protection function. 01:4h 10:8h 11:2h
		B<3:2>	TIMER_TC<1:0>	00		Time-out configuration of ITC phase: 00:Turn off the charging trickle timeout protection function. 01:1h 10:2h 11:0.5h
		B<1:0>	VSYS_MIN<1:0>	10		Selection of VSYS_MIN: 00:3.35V 01:3.45V 10:3.65V 11:3.85V

&lt;0x25&gt;IO\_Config0

Register	Type	BIT	Name	Default	Reset source	Description
0x25	R/W	B<7>	EnCOMxODPullup	1	POR+SRST +RST +WD+VIN	Pull-up selection when COML/COMR is configured as OD output mode: 0:When COML/COMR is configured as OD output, there is no pull-up resistor inside the chip. At this point, it is necessary to externally connect the pull-up resistor to the MCU power supply terminal. 1:When COML/COMR is configured as OD output, 3.2K resistor is pulled up to VIO inside the chip.
		B<6>	EnCOMxOD	1		COML/COMR output mode configuration: 0:COML/COMR as output is configured as push-pull output. 1:COML/COMR as output is configured as OD output.
		B<5>	EnSCLSDAPullup	1		I2C interface pull-up enable control: 0: SCL and SDA pins have no pull-up resistance. 1:SCL and SDA pins have an internal 10K pull-up resistance.
		B<4:2>	V_COM<2:0>	000		Voltage selection for voltage mode communication.  000: enable 2.5V voltage 001: enable 3V voltage 010: enable PMID voltage 011: enable 1.8V voltage 100: enable 3.3V voltage 101: enable 1.2V voltage 110: enable VIO voltage 111: enable VSYS voltage  Note 1: When used with SY5500, the communication level needs to be configured as 110(VIO) or 100(3.3V) Note 2: Downlink: Send data from SY8809 to headphones. Control VOL/VOR voltage. Note 3: Uplink: SY8809 receives the data sent by headphones. The VOL/VOR receives the data of the earphone by pulling up to the

						corresponding logic level internally, and feeds it back to the pin COML/COMR and the register bit ST_COML/ST_COMR.
	B<1:0>	ICOM<1:0>	00			Only for MD1 mode and being receiving phase(such as DIRL/R=1); Setting of pull-up resister when VOL/VOR is used as input; 00:100K 01:1K 10:200Ω 11:Floating

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&lt;0x26&gt;IO\_Config1

Register	Type	BIT	Name	Default	Reset source	Description
0x26	R/W	B<7>	-	-	POR+SRST +RST +WD+VIN	-
		B<6>	DIS_ADTL	0		VOL automatically identifies load enable control 0: enable automatic identification function. 1. disable the automatic identification function
		B<5>	DIS_ADTR	0		VOR automatic identification load enable control 0: enable automatic identification function. 1. disable the automatic identification function
		B<4>	MODE_COM<1>	0		NC
		B<3>	MODE_COM<0>	0		Communication mode selection; 0: bidirection communication uses voltage to communicate. The high level register can be configured by V_COM<2:0>, and the low level is 0V. 1: bidirection communication of which sending data by voltage and receiving data by current . When sending data to the earphone box ,the earphone should change itself load current .This mode supports the communication rate of 1kbps. The communication current threshold can be configured by IOFF_Base<2:0>.
		B<2>	EnVOxLevelIRQ	0		negedge of VOL/VOR can interrupt IRQ : 0: disable. 1: enable.
		B<1>	EnVORLevelChk	0		VOR logic level detection enable; When VOR enable the "automatic load identification", the logic level detection function of the VOL will be effective only when EnVORLevelChk=1. 0:disable 1:enable
		B<0>	EnVOLLevelChk	0		VOL logic level detection enable; When VOL enters the "automatic load identification", the logic level detection function of the VOL will be effective only when EnVOLLevelChk=1. 0:disable 1:enable

&lt;0x27&gt;EN\_Config0

Register	Type	BIT	Name	Default	Reset source	Description
0x27	R/W	B<7:6>	WatchDog<1:0>	00	POR+SRS T +RST +WD+VIN	Watchdog configuration. 00:disable 01:40s 10:80s 11:160s Note 1: I2C can be used to switch watchdog during charging, discharging and standby, and watchdog will be automatically turned off under shipmode.
		B<5>	I2CWDT	0		I2C SDA WatchDog function: 0:disable 1:enable .When SDA is 0 and lasts for 1s, I2C will be reset automatically.
		B<4>	EnCOMVOR	0		enable VOR communication : 0: disable. 1: enable.
		B<3>	EnCOMVOL	0		enable VOL communication : 0: disable. 1: enable.
		B<2>	EN_VOR	0		VOR switch control; 0:Turn off VOR switch 1:Enable VOR switch
		B<1>	EN_VOL	0		VOL switch control; 0:Turn off the VOL switch 1:Enable the VOL switch
		B<0>	EN_BT	0		boost enable; 0: disable the boost 1: enable the boost

## &lt;0x2E&gt;EN\_Conf1

Register	Type	BIT	Name	Default	Reset source	Description
0x2E	W	B<7:1>	-	-	-	-
		B<0>	DISABLE_CHG	0x50_B<7>	POR+SRST +RST +WD+VIN	Charging control: 0: enable. 1: disable charging even VIN status is OK.

## &lt;0x2F&gt;WDT\_RST

Register	Type	BIT	Name	Default	Reset source	Description
0x2F	W	B<7:0>	WDT_RST	0	POR+SRST +RST +WD+VIN	Writing WDT_RST = 0x94 will clear the WatchDog Timer,

## &lt;0x30&gt;BST\_Config

Register	Type	BIT	Name	Default	Reset source	Description
0x30	R/W	B<7:4>	VPMID <3:0>	1010	POR+SRST +RST +WD+VIN	Boost voltage of PMID. 0000:4.0V 0001:4.1V 0010:4.2V 0011:4.3V 0100:4.4V 0101:4.5V 0110:4.6V 0111:4.7V 1000:4.8V 1001:4.9V 1010:5.0V 1011:5.1V 1100:5.2V Other values:5.0V
		B<3:2>	BAT_UVLO<1:0>			BAT UVLO voltage (Lower threshold, Upper threshold through hysteresis 0.1V); 00:2.80V 01:3.00V 10:3.20V 11:3.40V
		B<1:0>	LowBAT_Set<1:0>			Low battery alarm voltage; 00:3.2V 01:3.3V 10:3.4V 11:3.5V

&lt;0x31&gt;xSense\_Config

Register	Type	BIT	Name	Default	Reset source	Description
0x31	R/W	B<7>	EN_FB_RES	0	POR+SRST +RST +WD+VIN	Reserved
		B<6>	ENxSense	0		enable xSense output 0: disable. 1: enable.
		B<5:4>	Gain_xSense<1:0>	00		Gain configuration of xSense: 00:x1 01:x2 10:x4 11:x8
		B<3:0>	xSense_ChxSel<3:0>	0000		xSense select output:
				0000	Output the current sampling of IVOL. When IVOL<20mA (st_iloadl=0), the sampling ratio is 1mA/30mV; When IVOL>30mA (st_iloadl=1), the sampling ratio is 1mA/2mV.	
				0001	Output the current sampling of IVOR. When IVOR<20mA (st_iloadr=0), the sampling ratio is 1mA/30mV; When IVOL>30mA (st_iloadr=1), the sampling ratio is 1mA/2mV.	
				0010	Reserved	
				0011	Output the charging current sampling of IBAT. IBAT<160mA, then xSense(mV)/IBAT(mA)=4; 160mA ≤ IBAT < 640mA, then xSense(mV)/IBAT(mA)=2; IBAT ≥ 640mA, then xSense(mV)/IBAT(mA)=0.5	
				0100	Output NTC PIN voltage. Need to set NTC_Mode<1:0>=11 first.	
				0101	Output VIN/8 voltage.	
				0110	Output VBAT/4 voltage	
				0111	Output the current sampling of IVIN, IVIN=1mA , then xSense=0.45mV	
				1000	Output PMID/8 voltage	
				Other off by default		

&lt;0x32&gt;VOx\_Config0

Register	Type	BIT	Name	Default	Reset source	Description
0x32	R/W	B<7:5>	lcp_VO<2:0>	000	POR+SRST +RST +WD+VIN	OCP of VOL and VOR: 000:250mA 001:300mA 010:350mA 011:400mA 100:500mA 101:200mA 110:150mA 111:100mA
		B<4:2>	Istart<2:0>	000		current 2 for automatic identification of load detection function 000:15uA 001:35uA 010:50uA 011:70uA 100:1uA 101:2uA 110:5uA 111:10uA
		B<1:0>	Idet<1:0>	00		current 1 for automatic identification of load detection function 00:5uA 01:2uA 10:1uA 11:10uA

&lt;0x33&gt;VOx\_Config1

Register	Type	BIT	Name	Default	Reset source	Description
0x33	R/W	B<7>	IVO_SWEEP	0	POR+SRST +RST +WD+VIN	VOX light current detection mode configuration 0:When the VOx current is less than the current configured by <0x44>.MODE_SWEEP, the scanning mode is automatically entered. VOx has low no-load power consumption, but slow response speed. 1:Vox output current is always in detection state. VOx consumes a lot of no-load power, but its response speed is fast.
		B<6:4>	IOFF_Base<2:0>	000		IOFF setting of VOL/VOR 000:2mA 001:3mA 010:4mA 011:5mA 100:6mA 101:8mA 110:10mA 111:12mA Accuracy ±10%
		B<3:2>	TD_L2H<1:0>	10		Light load switch to heavy load detection filtering time 00:5ms 01:10ms 10:100ms 11:200ms
		B<1:0>	TD_H2L<1:0>	01		Heavy load switch to light load detection filtering time 00:100us 01:1ms 10:10ms 11:50ms

## &lt;0x34&gt;Shipmode\_Config1

Register	Type	BIT	Name	Default	Reset source	Description
0x34	R/W	B<7:5>			POR +SRST	
		B<4:3>	TD_EnterShipeMode<1:0>	10		Delay time of entering Shipmode: 00:256us 01:2s 10:4s 11:8s
		B<2>	ShipmodeExit_Debounce	0		RST PIN press time to exit Shipmode; 0:1s 1:2s
		B<1>	ShipmodeExit_En	0		Enable the function of "Long press RST to exit Shipmode": 0:enable 1:disable
		B<0>	EnShipMode	0		enable Shipmode ; 0:disable. 1:enable. When VIN is invalid, set EnShipMode=1, then enter Shipmode mode.

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## &lt;0x35&gt;RST\_Config1

Register	Type	BIT	Name	Default	Reset source	Description
0x35	R/W	B<7>			POR +SRST	
		B<6>	EnRstVSYSByWD	0		Watchdog timeout can reset VSYS 0:disable. 1:enable
		B<5>	VSYSRstAsVINPlugIn	0		VIN inserting can reset VSYS; 0:disable. 1:enable.
		B<4>	LLRstVSYSWithVIN	0		VSYS reset by VIN: 0:When LLRstVSYSWithVIN=0, only when VINOK=0, ultra-long press RST to reset VSYS. 1:When LLRstVSYSWithVIN=1, pressing RST for a ultra-long time will reset VSYS regardless of the status of VIN.
		B<3:1>	LLRstVSYS_Debounce<2:0>	001		The Debounce time of ultra-long press RST to reset VSYS, 000:8s 001:10s 010:12s 011:16s 100:20s 101:24s 110:28s 111:32s
		B<0>	LLRst_EN	1		RST ultra-long press reset VSYS function configuration 0:disable 1:enable

&lt;0x36&gt;NTC\_Config1

Register	Type	BIT	Name	Default	Reset source	Description
0x36	R/W	B<7:6>			POR+SRST +RST +WD+VIN	
		B<5>	NTC_20CSEL	0		Selection of NTC temperature point: 0: 20°C 1: 15°C
		B<4>	NTC_En	0	POR+SRST +RST +WD+VIN	NTC function enable bit: 0:disable 1:enable
		B<3:2>	NTC_Mode<1:0>	00		NTC protection mode configuration. 00:Configured as JEITA standard .The bit0~bit4 of register < NTC_STAT > will change in real time and interrupt IRQ. 01:Configured as general standard .Charging 0 ~45 °C is normal, discharging -10 ~60 °C is normal ,and bit0~bit4 of register < NTC_STAT > will change in real time and interrupt IRQ. 10:Only the NTC PIN voltage is detected ,but the built-in protection of NTC is turned off. The bit0~bit4 of register < NTC_STAT > will change in real time, and the user can control charging and discharging according to the current temperature state. 11:Turn off NTC detection and turn off the built-in protection of NTC. The NTC pin voltage is output through the xSence pin. The pull-up current of NTC pin is configured by NTC_Isrc.
		B<1:0>	NTC_Isrc<1:0>	00		When NTC_MODE<1:0>=11 , configure the pull-up current source of NTC pin 00:150uA 01:50uA 10:20uA 11:0uA

## &lt;0x37&gt;OCP\_Config1

Register	Type	BIT	Name	Default	Reset source	Description
0x37	R/W	B<7>	IND_OS	1	POR+SRST +RST +WD+VIN	Inductance short-circuit protection function during charging/discharging: 0:disable 1:enable
		B<6>	OS_MODE	0		Selection of protection mode after short circuit and over current: 0:Always burp after protection. 1:Lock after 7 times of protection.
		B<5:4>	T_VIN_OC_Filter<1:0>	00		The first-stage over current detection time of VIN, and second-stage short-circuit protection time is 100us. 00:1ms 01:4ms 10:250us 11:500us
		B<3:2>	T_BFET_OC_Filter<1:0>	00		The first-stage over current detection time of BFET, and the second-stage short-circuit protection time is 100us. 00:1ms 01:4ms 10:250us 11:500us
		B<1:0>	T_VOxOC_Filter<1:0>	00		The first-stage over current detection time of VOL/VOR. Secondary short-circuit protection time is 60us. 00:0.5ms 01:2ms 10:4ms 11:200us

## &lt;0x40&gt;LED\_Config0

Register	Type	BIT	Name	Default	Reset source	Description
0x40	R/W	B<7:4>	LED_Mode<3:0>	0000	POR+SRST +RST +WD+VIN	LED mode configuration; 0000: all LEDx are normal . xxx1:LED1 is configured as breathing light output. xx1x:LED2 is configured as breathing light output. x1xx:LED3 is configured as breathing light output. 1xxx:LED4 is configured as breathing light output.
		B<3:0>	LED_I2C_ST<3:0>	0000		I2C control LED status; 0000: all LEDxs off . xxx1:LED1 is on. xx1x:LED2 is on. x1xx:LED3 is on. 1xxx:LED4 is on.

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## &lt;0x41&gt;LED\_Config1

Register	Type	BIT	Name	Default	Reset source	Description
0x41	R/W	B<7:6>	-	-	POR+SRST +RST +WD+VIN	-
		B<5:3>	LED_OnTime<2:0>	000		Full brightness time of breathing light 000:0s 001:0.12s 010:0.25s 011:0.5s 100:1.0s 101:2.0s 110:4.0s 111:8.0s
		B<2:0>	LED_OffTime<2:0>	000		Full off time of breathing light 000:0s 001:0.12s 010:0.25s 011:0.5s 100:1.0s 101:2.0s 110:4.0s 111:8.0s

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## &lt;0x42&gt;LED\_Config2

Register	Type	BIT	Name	Default	Reset source	Description
0x42	R/W	B<7:6>	-	-	POR+SRST +RST +WD+VIN	-
		B<5:3>	LED_FallTime<2:0>	011		The falling time of breathing LED 000:0s 001:0.25s 010:0.5s 011:1.0s 100:1.5s 101:2.0s 110:3.0s 111:4.0s
		B<2:0>	LED_RiseTime<2:0>	011		The rising time of breathing LED 000:0s 001:0.25s 010:0.5s 011:1.0s 100:1.5s 101:2.0s 110:3.0s 111:4.0s

## &lt;0x43&gt;LED\_Config3

Register	Type	BIT	Name	Default	Reset source	Description
0x43	R/W	B<7:4>	-	-	POR+SRST +RST +WD+VIN	-
		B<3>	LED_lum_sel	0		Selection of respiratory light brightness scheme: 0:Normal brightness 1:Diminished brightness
		B<2:0>	LED_Ion<2:0>	000		LED brightness adjustment; 000:0.5mA 001:1mA 010:2mA 011:4mA 1xx:Straight through, external series resistance current limiting

&lt;0x44&gt;VOx\_Conf1

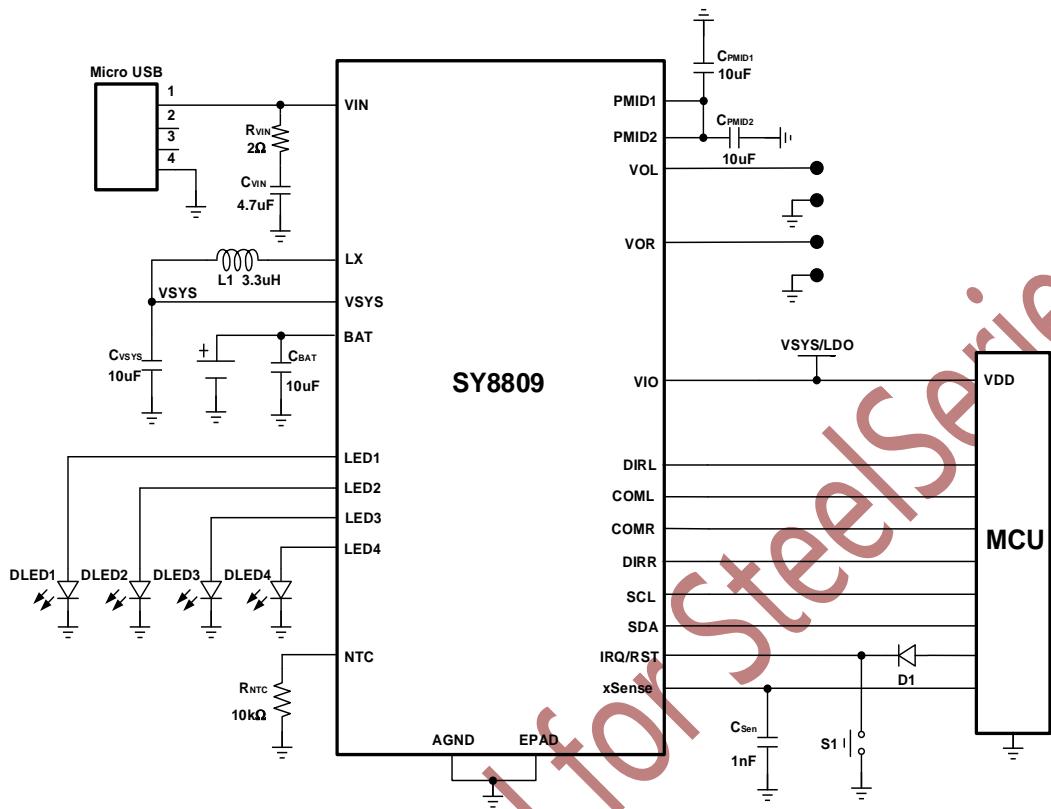
Register	Type	BIT	Name	Default	Reset source	Description
0x44	R/W	B<7:6>	RESERVED	00	POR+SRST +RST +WD+VIN	Reserved
		B<5>	DET_CURRENT	0		IOFF threshold selection : 0:250uA 1:100uA Accuracy ±10% Note: the DET_CURRENT bit is valid only when LOADDET_ACC_R or LOADDET_ACC_L is set to 1. At this time, If DET_CURRENT =0, the IOFF of VOL/VOR is 250 uA; If DET_CURRENT =1, the IOFF of VOL/VOR is 100 uA.
		B<4>	IDP_VOX	0		VOL/VOR switch mode: 0:The control is not independent. Only when VIN is charging or boost is started can the VOL/R output be turned on. 1:Independent control of VOL/R output, PMID1 can be powered by external power supply.
		B<3>	VOST_DISADT	0		When automatic load identification is turned off, VOL/VOR state mode: 0:1K resistor pull-down. 1:VOL/VOR high impedance.
		B<2>	LOADDET_ACC_L	0		impedance of VOL as EN_VOR=1: 0:default output impedance (for heavy current load). 1:increase the VOL resister to 8x.
		B<1>	LOADDET_ACC_R	0		With EN_VOR enabled, control the output impedance of VOR to improve the current detection accuracy: 0:Default output impedance (for heavy current load). 1: increase the VOL resister to 8x.
		B<0>	MODE_SWEEP	0		VOL/VOR Sweep mode control: 0:When the output current of VOL/R is less than 20mA, the scanning mode is started. 1:When the VOL/R output current is less than IOFF, the scanning mode is started.

&lt;0x4F&gt;CMD\_RST

Register	Type	BIT	Name	Default	Description
0x4F	R/W	B<7:0>	CMD_RST[7:0]		When CMD_RST = 0x17 is written to reset the software.

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## Schematic diagram of application scheme



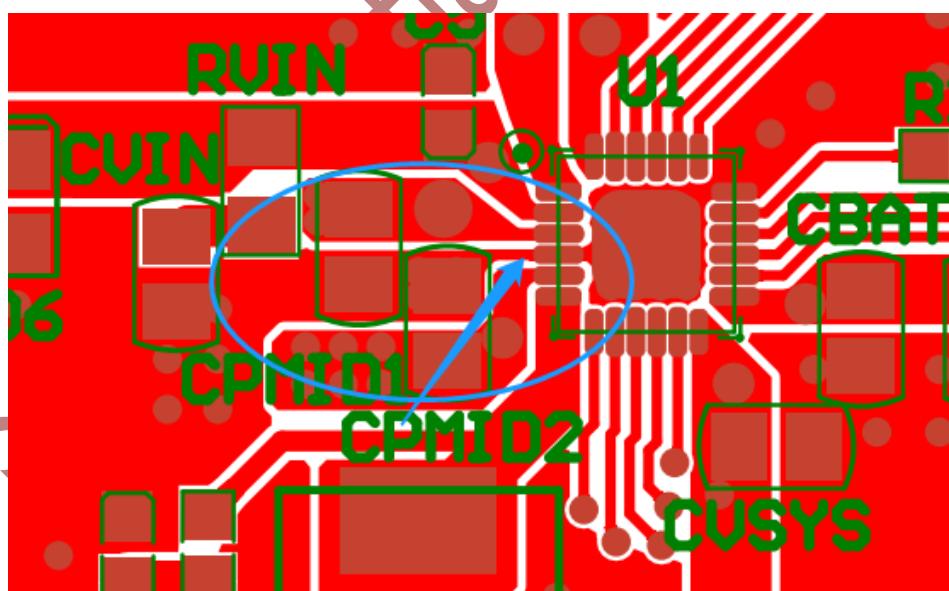
## Typical circuit components

Components	Device type	Device description	Manufacturer	Quantity
U1	IC	SY8809 QFN24	Thinkplus semiconductor	1
S1	Touch switch	Key	-	1
L1	Chip inductor	CD7530 package, inductance 3.3μH, accuracy:±20%, rated saturation current >3.5A	-	1
DLED1~DLED4	LED indicator	LED/0603/LED lights of any color	-	4
RVIN	Chip resistor	RES0805/2R/5%	-	1
CVIN	Chip capacitor	CAP0805/4.7μF/X5R/20%/35V	Samsung or equivalent	1
CPMID1、CPMID2、CVSYS、CBAT	Chip capacitor	CAP0805/10μF/X5R/20%/10V	Samsung or equivalent	1
CSEN	Chip capacitor	CAP0603/1nF/X5R/10%/10V	Samsung or equivalent	1
D1	SMD diode	IN4148WS SOD323	-	1

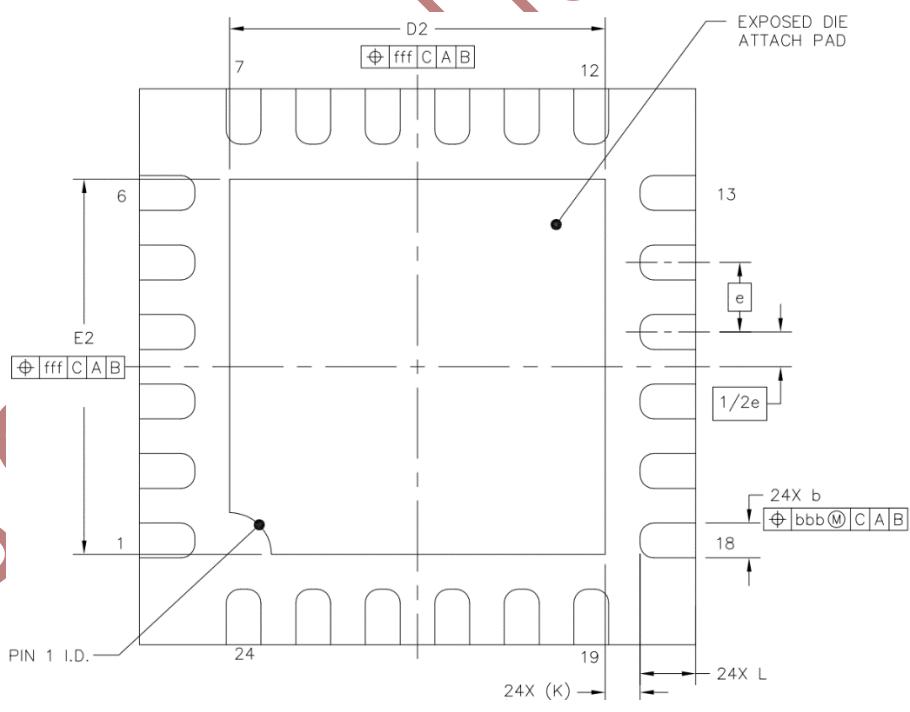
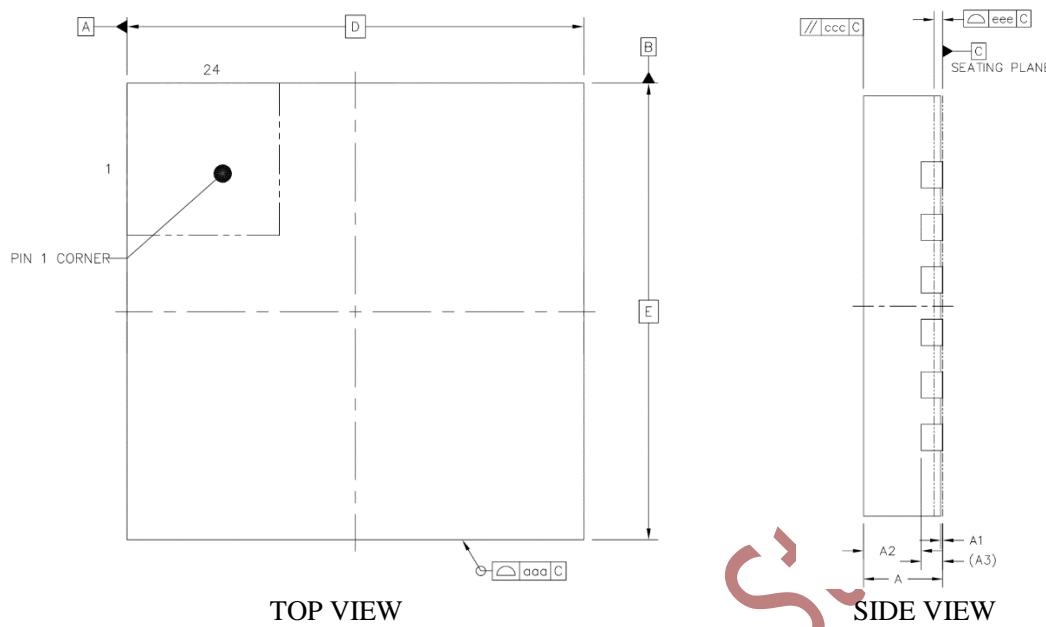
(Note: if NTC function is selected, NTC resistor with accuracy of 1%, resistance of 10K and  $\beta = 3950$  must be selected; In applications that do not need NTC protection function, it is necessary to turn off the NTC function through register configuration)

## PCB wiring precautions

1. The capacitor is placed as close as possible to the chip pin, and all the wires are routed through the capacitor and then to the IC pin.
2. There is high frequency oscillation between the inductor L1 and LX pin, which must be close to each other and minimize the wiring area; Other sensitive devices must be far away from inductance to reduce coupling effect.
3. Via will cause high impedance of the path. If a large current needs to pass through the via in the design, it is recommended to use multiple vias to reduce the impedance.
4. The chip GND is directly connected to the system ground, and the connected copper foil needs to be short, thick and intact as far as possible, without being cut off by other traces.
5. The copper-clad area of ground wire of PCB should be as large as possible to facilitate heat dissipation, and the heat dissipation pad at the bottom of the chip should have good contact with the copper-clad ground wire to ensure good heat dissipation.
6. The capacitor used in the application must be made of X5R or higher.
7. If there are other magnetic elements, it is recommended to place them away from the inductor L1.
8. CPMID2 is placed as close as possible to PMID2, and on the same side as SY8809. It is connected to EPAD PGND through NC PIN to reduce the output current loop and the influence on the output.  
(As shown in the circle below)



QFN package appearance drawing

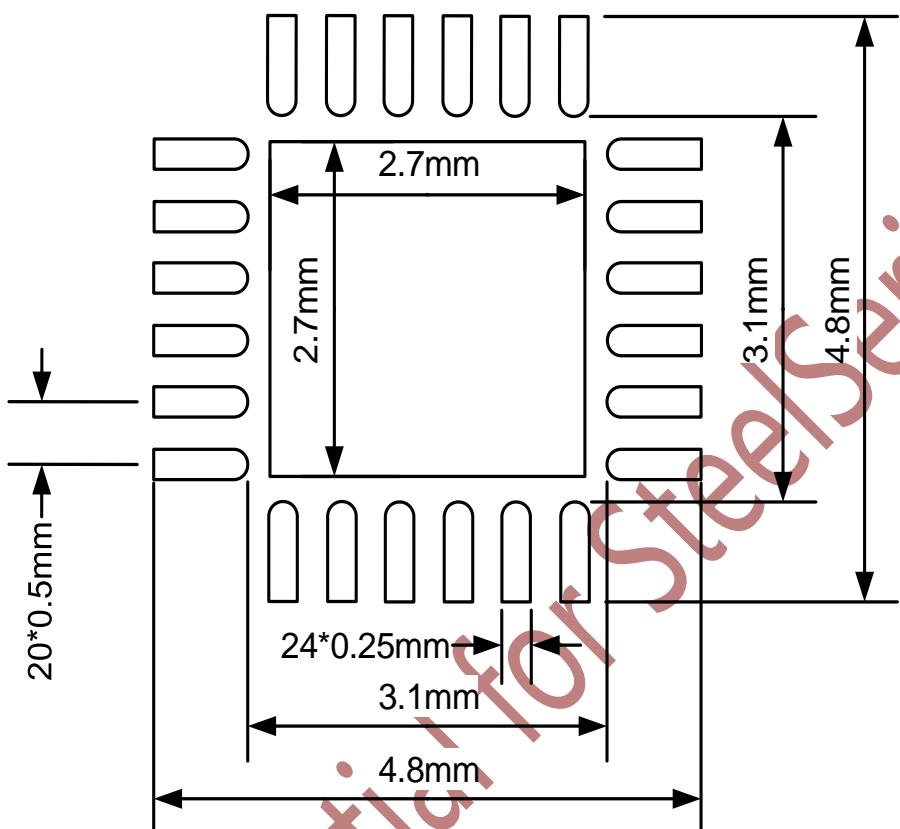


Unit:mm

		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.7	0.75	0.8
STANK OFF		A1	0	0.02	0.05
MOLD THICKNESS		A2	---	0.55	---
L/F THICKNESS		a3		0.203 REF	
LEAD WIDTH		b	0.2	0.25	0.3
BODY SIZE	X	D		4 BSC	
	Y	E		4 BSC	
LEAD PITCH		e		0.5 BSC	
EP SIZE	X	D2	2.6	2.7	2.8
	Y	E2	2.6	2.7	2.8
LEAD LENGTH		L	0.3	0.4	0.5
LEAD TIP TO EXPOSED PAD EDGE		K		0.2 min	
PACKAGE EDGE TOLERANGE		aaa		0.1	
MOLD FLATNESS		ccc		0.1	
COPLANARITY		eee		0.08	
LEAD OFFSET		bbb		0.1	
EXPOSED PAD OFFSET		fff		0.1	

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Schematic diagram of PCB package



All specs and applications shown above subject to change without prior notice.

**Version history**

Version	Date	Description
Rev1.0	2022/03/21	First edition release

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