

POWER MANAGEMENT SYSTEM DEVICE

RN5T618-XXXX

Product Brief

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RICOH

RICOH COMPANY, LTD.
Electronic Devices Company

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1. Outline

This IC is the power management IC for GPS-PND/MID.

It integrates three high-efficiency step-down DCDC converters, seven low dropout regulators, power control logic, Li-ion Battery Charger, I2C-Bus Interface, voltage detections, thermal shut-down, and etc.

2. Feature

- System
 - ✓ I2C-Bus interface @3.4MHz and 400kHz
 - ✓ Detector Function (System/IO/Battery-Voltage-detector, UVLO)
 - ✓ Thermal Shutdown Function
 - ✓ Watchdog timer
 - ✓ Power on key input for System's power up
 - ✓ Power on reset output for CPU
 - ✓ Flexible power-on/off sequence by OTP
 - ✓ Flexible DCDCx and LDOx default-on/off control by OTP
- High Efficiency Step-down DC/DC Converters
 - ✓ DC/DC1 0.6-3.5V Max 3000mA
 - ✓ DC/DC2 0.6-3.5V Max 2000mA
 - ✓ DC/DC3 0.6-3.5V Max 2000mA
 - ✓ Soft-start circuit
- Low Drop Voltage Regulators
 - ✓ LDO1 0.9-3.5V Max 300mA
 - ✓ LDO2 0.9-3.5V Max 300mA
 - ✓ LDO3 0.6-3.5V Max 300mA
 - ✓ LDO4 0.9-3.5V Max 200mA
 - ✓ LDO5 0.9-3.5V Max 200mA
 - ✓ LDORTC1 1.7-3.5V Max 10mA (AlwaysOn, For coin battery)
 - ✓ LDORTC2 0.9-3.5V Max 10mA (AlwaysOn)
 - ✓ Over current Protection and Short circuit Protection.
- Li-ion Battery Charger
 - ✓ Supports AC adapter charging and USB charging in an individual port
 - ✓ With the current limit protection and charge current control.
 - ✓ The system can power on even when Li-ion Battery is low voltage or open.
 - ✓ Rapid timer and Trickle timer.
 - ✓ Power-path control.
 - ✓ Over temperature protection
- Fuel Gauge
 - ✓ 12-bit resolution.
 - ✓ 1 second integration.
- ADC
 - ✓ 12-bit resolution A/D converter
 - ✓ Eight channels: LIMMON, VADP, VUSB, VBAT, VSYS, THERMBAT and two external(GPIO) pins.
 - ✓ Single/Auto conversion mode
 - ✓ Detect high/low thresholds which can be set
- 4ch-GPIO
 - ✓ Supports interrupt function (level/edge) for input signals
 - ✓ Outputs power-on signal for external devices
 - ✓ Power on/off input for System's power up/down
 - ✓ DCDCx and LDOx can be controlled by external input
 - ✓ GPIO2 can output LDORTC2
 - ✓ GPIO0 and GPIO1 have input to ADC for voltage monitor
 - ✓ GPIO0 and GPIO1 have maximum 15mA sink for LED.
- Interrupt Controller (INTC)
- Package QFN0606-48(0.4mm pitch)
- Process CMOS

3. Block Diagram

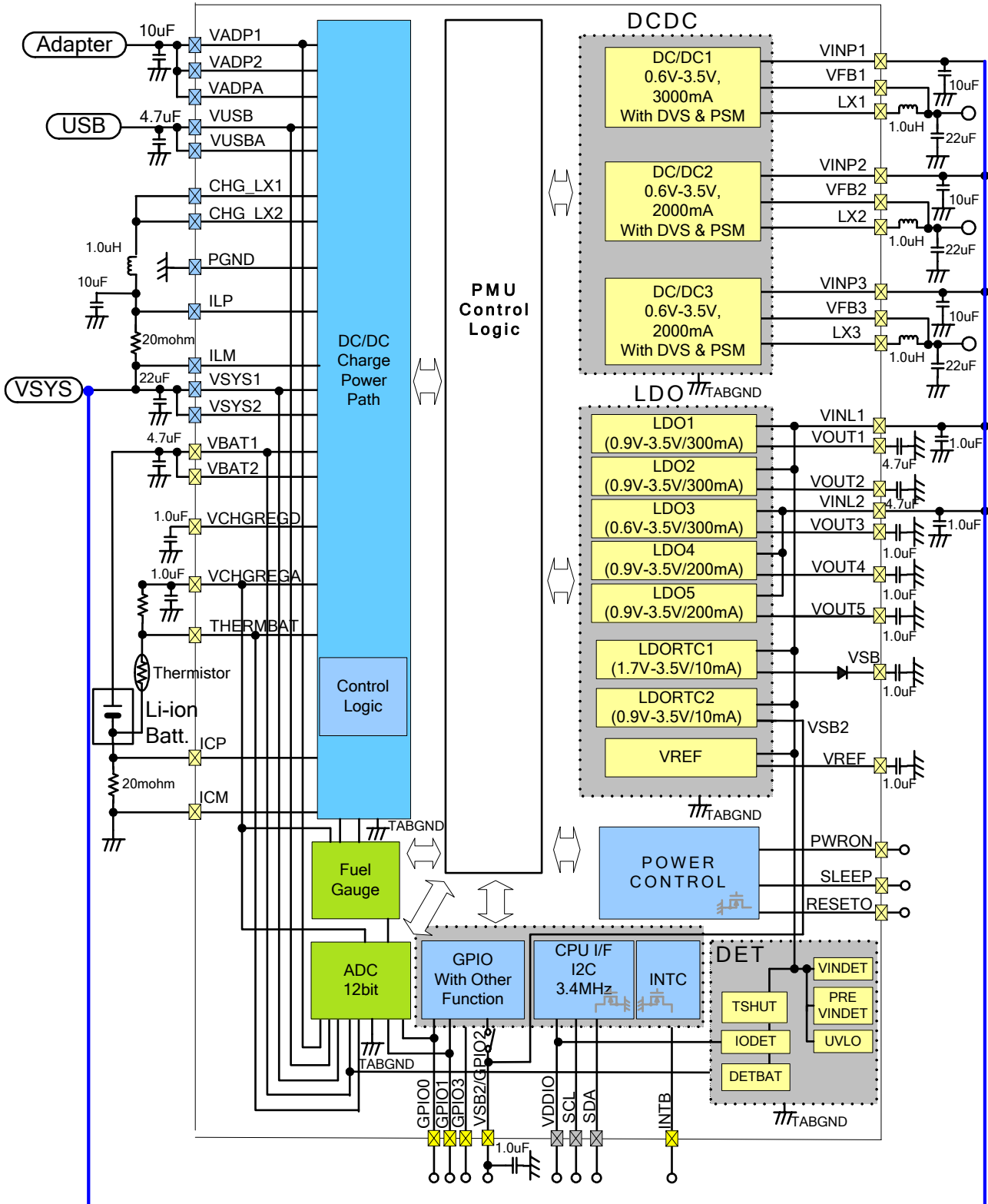


Fig 3-1 Block Diagram

4. Electrical Characteristics

4.1 Absolute Maximum Ratings

Exposure to the condition exceeded absolute maximum ratings may cause the permanent damages and affect the reliability and safety of both device and systems using the device. The functional operations cannot be guaranteed beyond specified values in the recommended conditions.

Symbol	Parameter	Condition	Min	Max	Units
V _{PS1}	Power Supply Voltage 1	VADP*, VUSB* pin	-0.3	7.0	V
V _{PS2}	Power Supply Voltage 2	VINP1-3, VINL1-2, VSYS1-2, VBAT1-2 pin	-0.3	6.0	V
V _{PS3}	Power Supply Voltage 3	VDDIO pin	-0.3	4.5	V
V _{INPUT}	Input Voltage Range	PWRON, RESET0, INTB, SLEEP pin	-0.3	VSYS + 0.3	V
		SDA, SCL pin	-0.3	VDDIO + 0.3	V
		GPIO0-1 pin	-0.3	VSYS + 0.3 / VDDIO + 0.3	V
		GPIO2-3 pin	-0.3	VSYS + 0.3	V
		AIN0-1(GPIO0-1) pin	-0.3	2.8	V
T _{stg}	Storage Temperature	-	-55	125	degrees C
PD	Package Allowable Dissipation	T _a = 25 degrees C	0	4500	mW

Table 4-1 Absolute Maximum Ratings

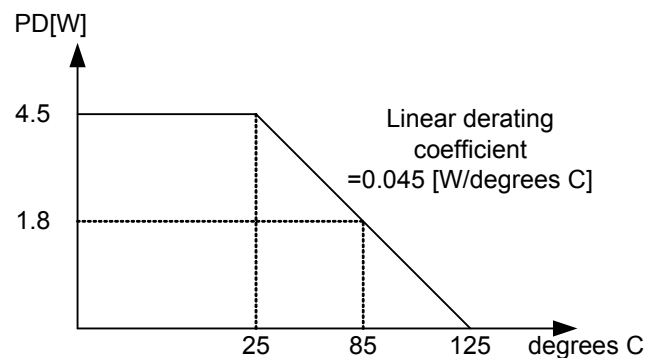


Fig 4-1 Maximum Package Allowable Dissipation

4.2 Recommendation of Operating Conditions

Symbol	Parameter	Condition	Min	Typ	Max	Units
VADP	Power Supply Voltage	VADP* pin	4.5	5.0	5.5	V
VUSB	Power Supply Voltage	VUSB* pin	4.5	5.0	5.5	V
VSYS	Power Supply Voltage	VINP1-3, VINL1 VSYS1-2, VBAT1-2 pin	2.7	3.6	5.5	V
VINL2	Power Supply Voltage	VINL2	1.7	3.6	5.5	V
VDDIO	Power Supply Voltage	VDDIO pin (VSYS > VDDIO)	1.7	1.8	3.4	V
GND	Ground	GND		0		V
Ta	Temperature of Operation	-	-40		85	degrees C

Table 4-2 Recommendation of Operating Conditions

4.3 I/O Electrical Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Units
<i>VSYS NMOS Input Pin: PWRON, SLEEP, GPIO0, GPIO1, GPIO2, GPIO3</i>						
VIL	Low level input voltage				0.4	V
VIH	High level input voltage		1.4		VSYS	V
<i>VSYS Nch Open Drain output Pin : RESET0</i>						
VOL	Low level output voltage	Iout = 2mA			0.4	V
Vto	Tolerant				VSYS	V
<i>VSYS CMOS input/output Pin : GPIO0, GPIO1, GPIO2, GPIO3</i>						
VIL	Low level input voltage				VSYS*0.2	V
VIH	High level input voltage		VSYS*0.8		VSYS	V
VOL	Low level output voltage	Iout = 4mA			0.4	V
VOH	High level output voltage	Iout = -4mA	VSYS-0.4			V
<i>VSYS Nch Open Drain output Pin : INTB, GPIO0, GPIO1, GPIO2, GPIO3</i>						
VOL	Low level output voltage	Iout = 4mA			0.4	V
Vto	Tolerant				VSYS	V
<i>VSYS Nch Open Drain output Pin: GPIO0, GPIO1(for LED)</i>						
VOL	Low level output voltage	Iout = 15mA			0.4	V
Vto	Tolerant				VSYS	V

Symbol	Parameter	Condition	Min	Typ	Max	Units
<i>VDDIO CMOS input Pin (Schmitt Input): SCL</i>						
VIL	Low level input voltage				VDDIO*0.3	V
VIH	High level input voltage		VDDIO*0.7		3.4	V
ΔVI	Hysteresis		VDDIO*0.1			V
<i>VDDIO CMOS input/output Pin(Schmitt Input / Nch Open Drain output) : SDA</i>						
VIL	Low level input voltage				VDDIO*0.3	V
VIH	High level input voltage		VDDIO*0.7		3.4	V
ΔVI	Hysteresis		VDDIO*0.1			V
VOL	Low level output voltage	Iout = 3mA			0.4	V
<i>VDDIO CMOS input/output Pin : GPIO0, GPIO1</i>						
VIL	Low level input voltage				VDDIO*0.2	V
VIH	High level input voltage		VDDIO*0.8		VDDIO	V
VOL	Low level output voltage	Iout = 4mA			0.4	V
VOH	High level output voltage	Iout = -4mA	VDDIO-0.4			V

Table 4-3 I/O Electrical Characteristics

4.4 Consumption Current

Operating Conditions (unless otherwise specified) $T_a = 25$ degrees C, $V_{IN} = 3.6V$, No-load

Symbol	Parameter	Condition	Min	Typ	Max	Units
I_{ST}	Standby current	PowerOff (Note*1)		13		μA
I_{OP}	Operating current	PowerOn (Note*1)		380		μA
I_{SLP}	Sleep current	Sleep (Note*1)		132		μA

Table 4-4 Consumption Current

Note*1) Each condition is below (Not include the current of thermistor)

	PowerOFF	PowerON	Sleep
LDO1	-	○	-
LDO2	-	○	-
LDO3	-	○	○
LDO4	-	○	○
LDO5	-	○	-
LDORTC1	○	○	○
LDORTC2	-	-	-
VREF	○	○	○
DCDC1	-	○	-
DCDC2	-	○	○(ECO)
DCDC3	-	-	-
UVLO	○	○	○
VINDET	○	○	○
IODET	○	○	○
PREVINDET	-	○	○
TSHUT	-	○	○
ADC	-	-	-
Fuel Gauge	-	○	○
VCHGREGD	○	○	○
VCHGREGA	-	○	○
CHG_DCDC	-	○	○
Internal Logic	○	○	○

5. Package Diagram

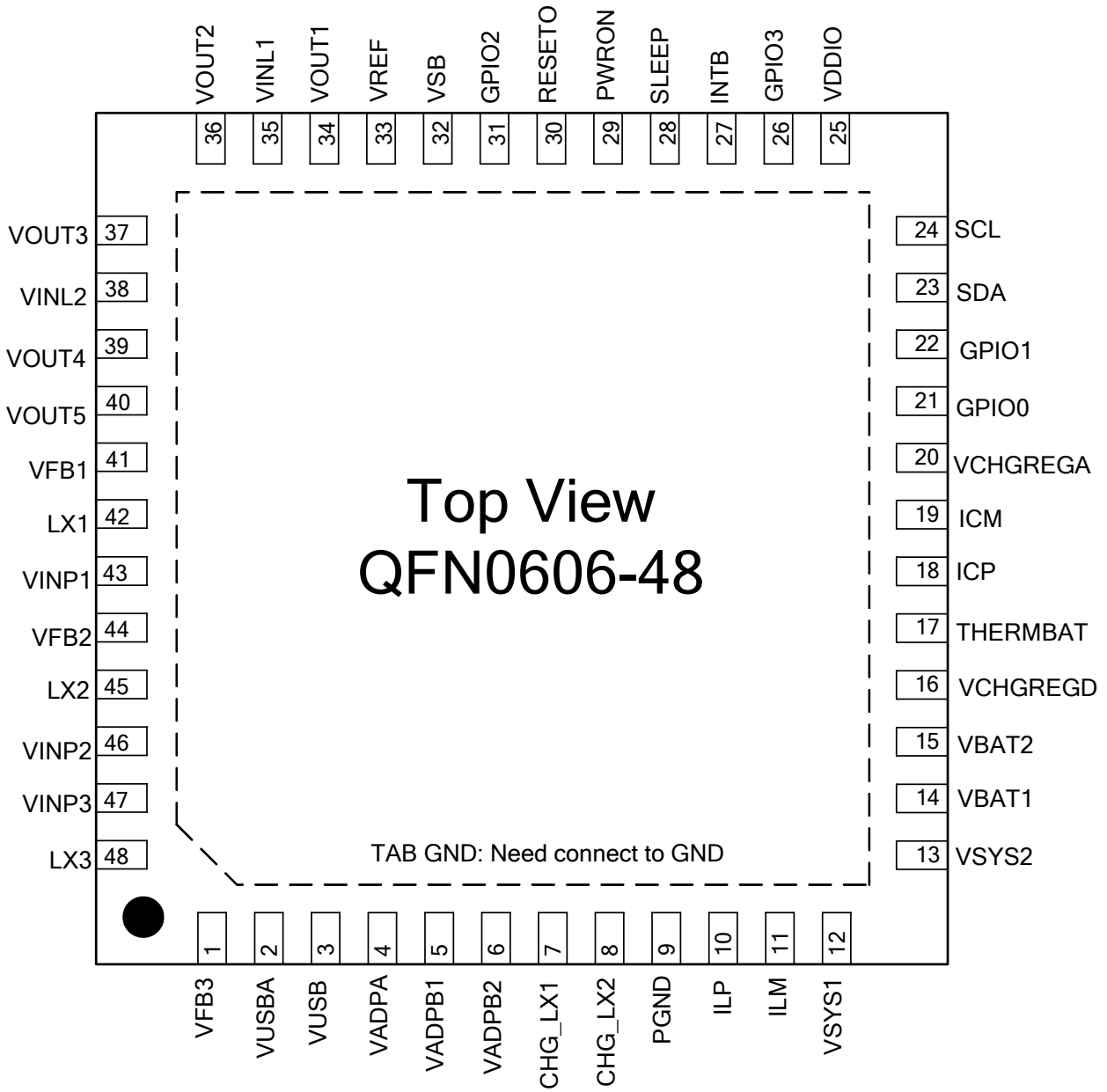


Fig5-1 Pin Configuration

6. Pin Description

No.	Pin Name	Function	I/O (*1)	D/A (*2)	Reset State (*3)		Vinmax [V] (*4)	Note
1	VFB3	DC/DC3 Output voltage feedback input	I/O	A				
2	VUSBA	Connected to USB	-	P				
3	VUSB	Connected to USB	-	P				
4	VADPA	Connected to AC Adapter	-	P				
5	VADP1	Connected to AC Adapter	-	P				
6	VADP2	Connected to AC Adapter	-	P				
7	CHG_LX1	Output VADP side for charge	O	A				
8	CHG_LX2	Output VUSB side for charge	O	A				
9	PGND	Ground	-	G				
10	ILP	Sense resistance connection pin for limit current monitor (+)	I	A				
11	ILM	Sense resistance connection pin for limit current monitor (+)	I	A				
12	VSYS1	System power supply	-	P				
13	VSYS2	System power supply	-	P				
14	VBAT1	Li-ion battery input/output	-	P				
15	VBAT2	Li-ion battery input/output	-	P				
16	VCHGREGD	Capacitor connection for built-in Regulator	O	A				
17	THERMBAT	Sense pins for Battery temperature	I	A				
18	ICP	Sense resistance connection pin for charge current monitor (+)	I	A				
19	ICM	Sense resistance connection pin for charge current monitor (-)	I	A				
20	VCHGREGA	Capacitor connection for built-in Regulator	O	A				
21	GPIO0	General purpose I/O Note*	I/O	D	*5	*5	VSYS+0.3/ VDDIO+0.3	*5
22	GPIO1	General purpose I/O Note*	I/O	D	*5	*5	VSYS+0.3/ VDDIO+0.3	*5
23	SDA	I2C-Bus Data input/Output	I/O	D	I	-	VDDIO+0.3	Schmitt, NOD
24	SCL	I2C-Bus Clock input	I	D	I	-	VDDIO+0.3	CMOS
25	VDDIO	Power supply for CPU IF	-	P				
26	GPIO3	General purpose I/O Note*	I/O	D	*5	*5	VSYS+0.3	*5
27	INTB	Interrupt request output	O	D	O	Hi-z	VSYS+0.3	NOD
28	SLEEP	Stand-by mode control signal input	I	D	I	-	VSYS+0.3	1.4V to VSYS
29	PWRON	External power on signal input	I	D	I	-	VSYS+0.3	1.4V to VSYS

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30	RESET0	Host Reset output	O	D	O	Low	VSYS+0.3	NOD/CMOS
31	VSB2/GPIO2	General purpose I/O Note*	I/O	D	*5	*5	VSYS+0.3	*5
32	VSB	LDORTC1 output	O	A				
33	VREF	Bypass capacitor connecting pin	O	A				
34	VOUT1	LDO1 output	O	A				
35	VINL1	Power supply for LDOs	-	P				
36	VOUT2	LDO2 output	O	A				
37	VOUT3	LDO3 output	O	A				
38	VINL2	Power supply for LDOs	-	P				
39	VOUT4	LDO4 output	O	A				
40	VOUT5	LDO5 output	O	A				
41	VFB1	DC/DC1 Output voltage feedback input	I/O	A				
42	LX1	DC/DC1 switch output	O	A				
43	VINP1	Power supply for DC/DC	-	P				
44	VFB2	DC/DC2 Output voltage feedback input	I/O	A				
45	LX2	DC/DC2 switch output	O	A				
46	VINP2	Power supply for DC/DC2	-	P				
47	VINP3	Power supply for DC/DC3	-	P				
48	LX3	DC/DC3 switch output	O	A				

Note*1: I:Input, O:Output

Note*2: A:Analog, D:Digital, P:Power, G:Ground

Note*3: Reset State: RESET0=Low.

Note*4: Vinmax:Maximum input voltage

Note*5: GP00-GP03 : "Input" or "Output" is selectable by OTP. Input/Output type (CMOS or NMOS or Analog or Nch Open Drain Output) is selectable by OTP. Refer to the chapter of GPIO for detail.

Table 6-1 Pin Description

7. Power Control

This PMU has the power-on/off sequence that can be flexibly set by OTP. The default on/off, timing, and voltage of DCDCx and LDOx are programmable. In addition, GPIO0-GPIO3 pins output the power-on/off signal to external LDO/DCDC by the setting of OTP.

7.1 State Machine Diagram

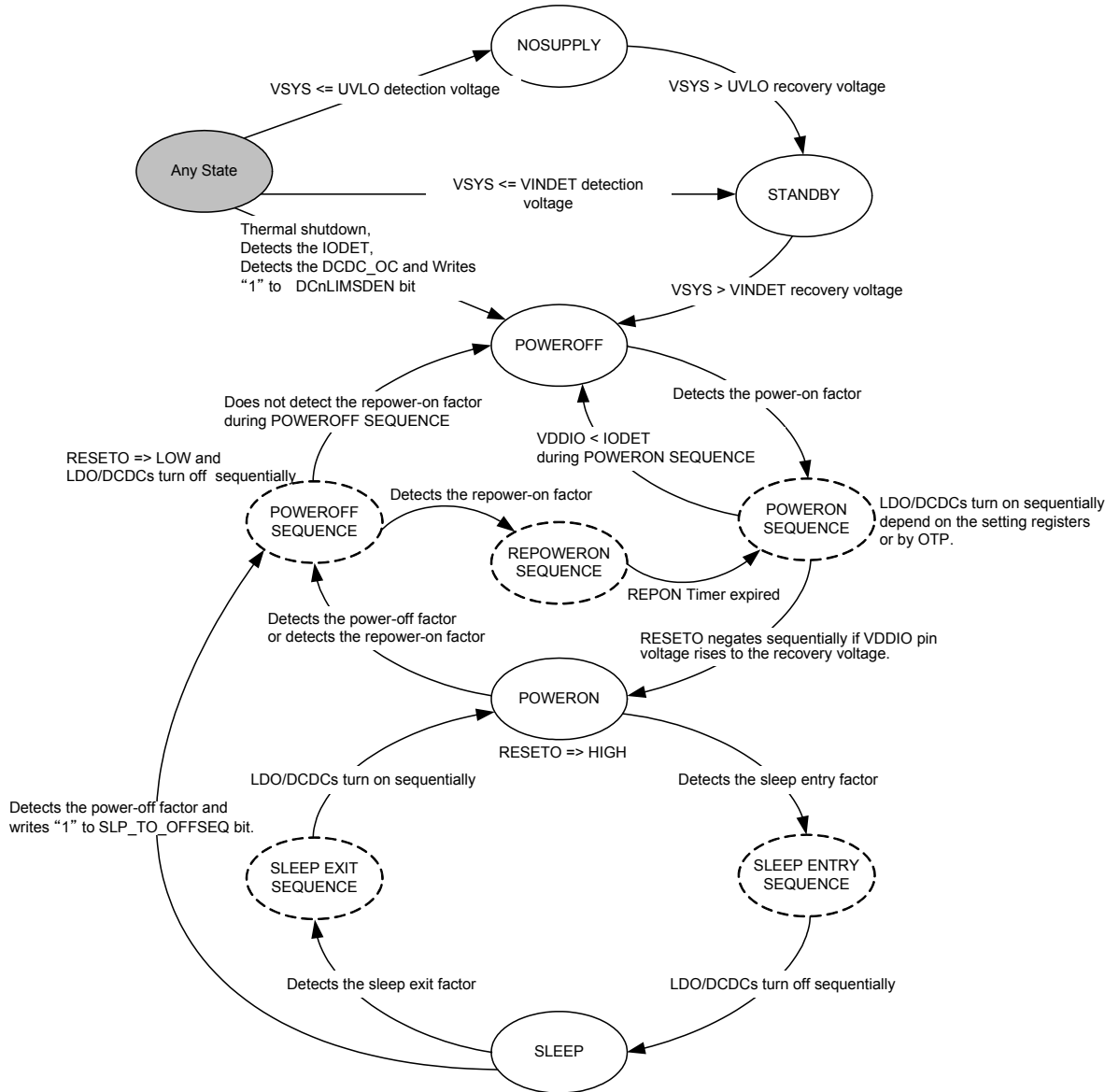


Fig 7-1 Power Control State Machine Diagram

8. Regulators

8.1 Regulators Table

Symbol	DCDC1	DCDC2	DCDC3	
Initial Output Voltage	0.6-3.5V	0.6-3.5V	0.6-3.5V	
Maximum Output Current	3000mA	2000mA	2000mA	
External Inductor	1.0 μ H	1.0 μ H	1.0 μ H	
External Capacitor	22 μ F	22 μ F	22 μ F	
Output Control	I2C	I2C	I2C	

Table 8-1 Regulator Table (DC/DC)

Symbol	LDO1	LDO2	LDO3	LDO4
Initial Output Voltage	0.9-3.5V	0.9-3.5V	0.6-3.5V	0.9-3.5V
Maximum Output Current	300mA	300mA	300mA	200mA
External Capacitor	4.7 μ F	4.7 μ F	1 μ F	1 μ F
Output Control	I2C	I2C	I2C	I2C

Symbol	LDO5	LDORTC1	LDORTC2	
Initial Output Voltage	0.9-3.5V	1.7-3.5V	0.9-3.5V	
Maximum Output Current	200mA	10mA	10mA	
External Capacitor	1 μ F	1 μ F	1 μ F	
Output Control	I2C	Always-On/I2C	Always-On/I2C	

Table 8-2 Regulator Table (LDO)

9. Li-ion Battery Charger

This PMU integrates Li-ion battery charger with the power path control, and supports the following functions.

- ✓ Two external power input ports. (VADP port for AC adapter , VUSB port for USB bus power)
- ✓ The charging current limit setting for the battery. (max 1.8A)
- ✓ The output current limit setting for system load. (max 2.5A for AC adapter input)
- ✓ Integrated MOSFET of battery side. (No external MOSFET required.)
- ✓ The full charging voltage setting for the various batteries. (from 4.05V to 4.35V)

The thermistor monitor for voltage control compliant with JEITA.

9.1 Li-ion Battery Charger Block Diagram

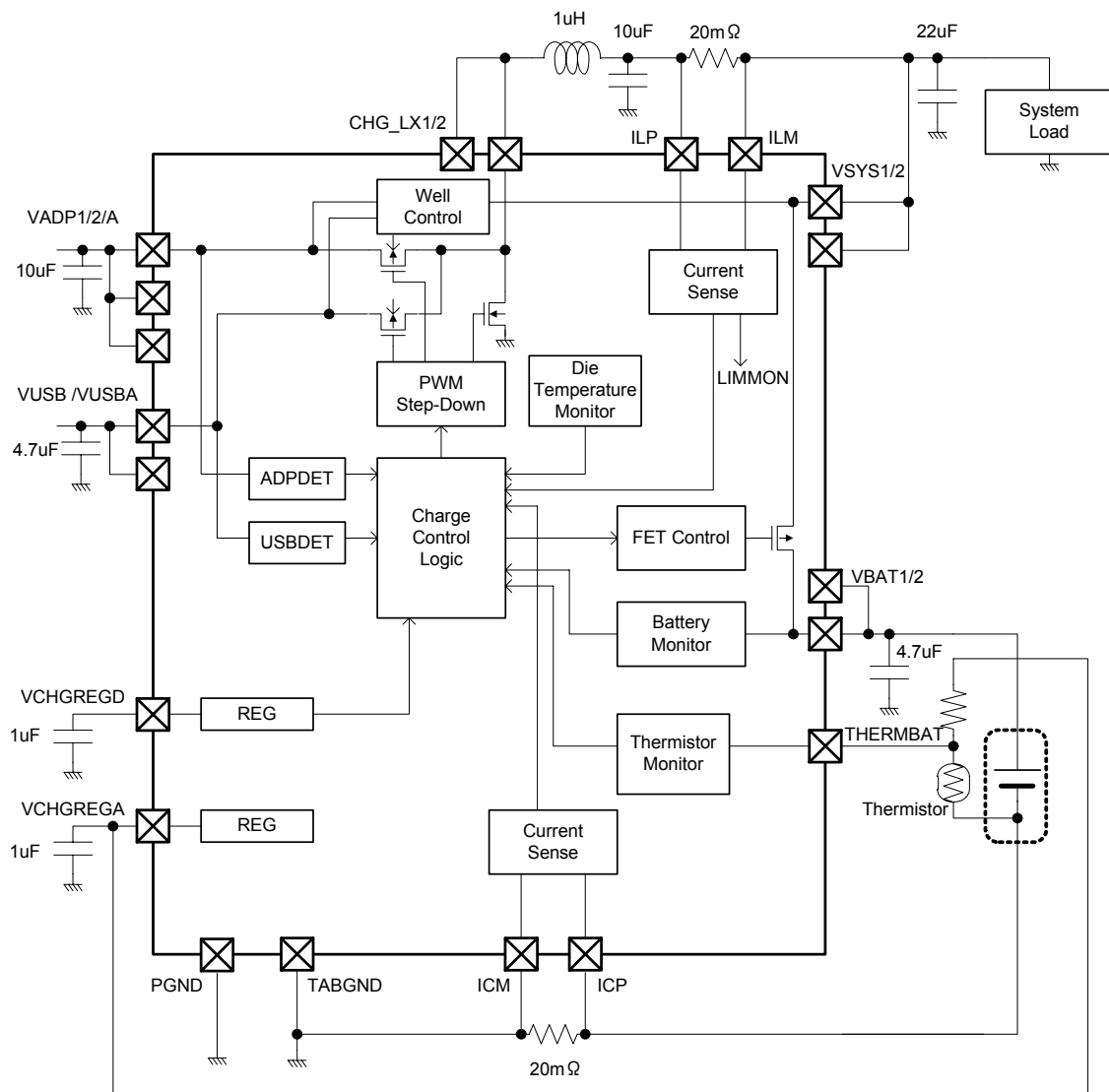


Fig 9-1 Li-ion Battery Charger Block Diagram

10. Fuel Gauge

This PMU integrates a Fuel Gauge.

- Battery Fuel Gauge for 1-Series Li-ion applications
- Measure battery voltage and temperature by AD converter (12bit)
- Measure battery current by original coulomb counter include offset cancel circuit
- Calculate remaining battery capacity compensate change that depends on temperature and aging
- Predict remaining battery life at present rate of discharge
- Predict remaining time until battery reaches full charge
- Display battery aging state

10.1 Fuel Gauge Block Diagram

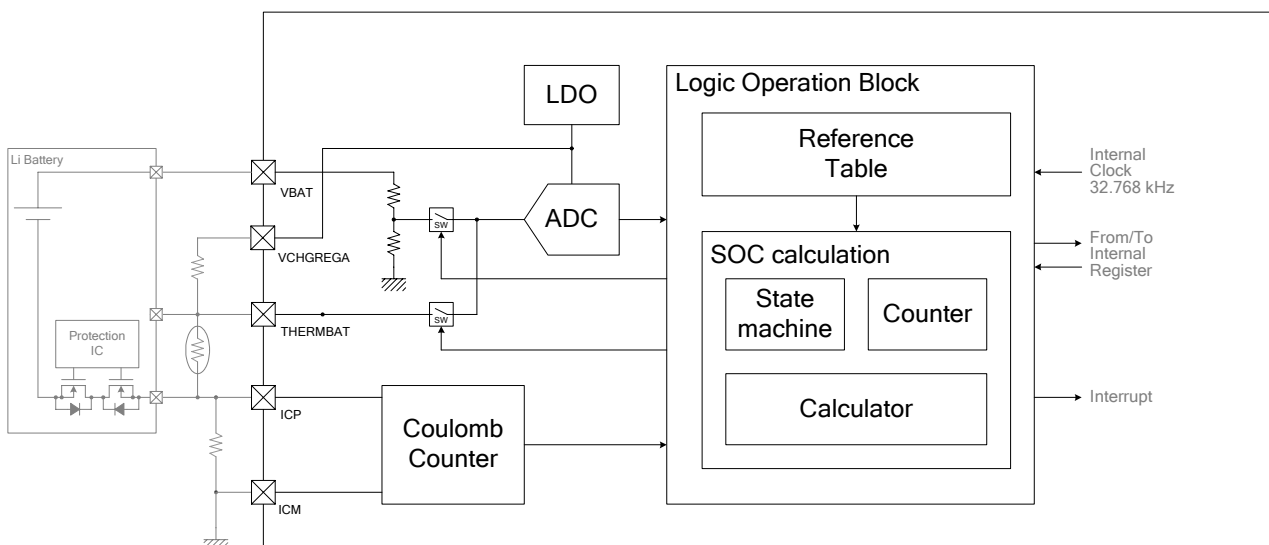


Fig 10-1 Fuel Gauge Block diagram

11. ADC

This PMU has 12-bit A/D converter with 8-channel multiplexer.

- The eight inputs are LIMMON, VBAT, VADP, VUSB, VSYS, THERMBAT and two external pins.
- Built in voltage divider (VBAT, VADP, VUSB and VSYS).
- Single-mode / Auto-mode with the average calculation.
- In single-mode, ADC generates the interrupt signal at the end of conversion.
- In auto-mode, the interval of each conversion is programmable.
- In auto-mode, High/Low thresholds for ADC conversion result to generate the interrupt signal.

11.1 Block Diagram

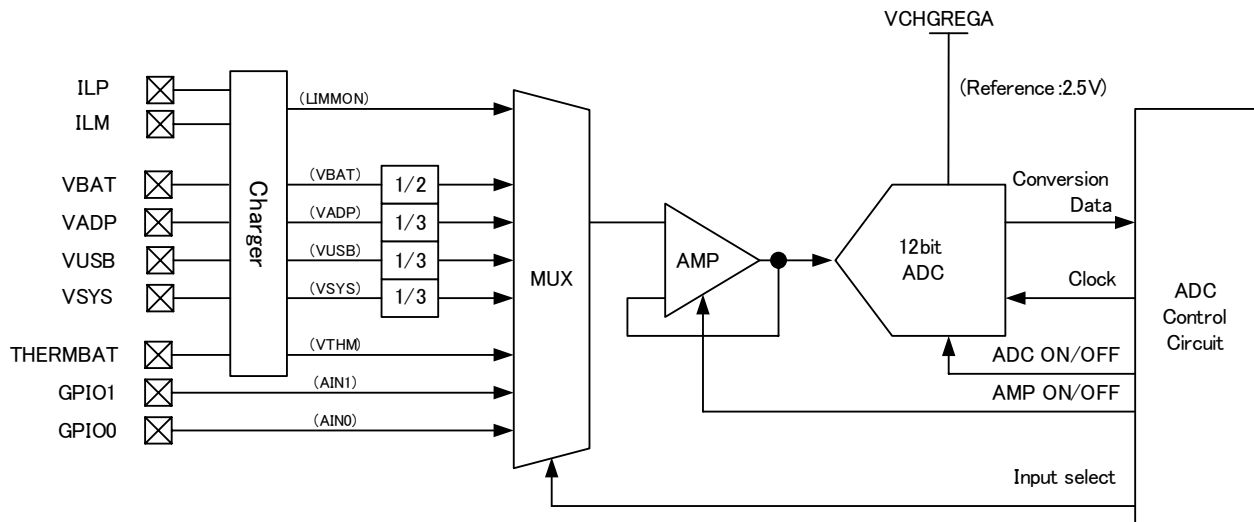


Fig 11-1 ADC Block Diagram

12. GPIO

This PMU supports four channels of general purpose input/output.
GPIO0,1,2,3 pins have the function selected by OTP as shown below.

Name	Function	Input,*1,*2	Output,*1,*2	Power,*3	GPIO			
					0	1	2	3
AIN0	ADC Input	A	-	-	○	-	-	-
AIN1	ADC Input	A	-	-	-	○	-	-
N_OE	External power off	N	-	VSYS	○	○	○	○
GPIO0	General purpose I/O	C or N	C or N	VSYS or VDDIO	○	-	-	-
GPIO1	General purpose I/O	C or N	C or N	VSYS or VDDIO	-	○	-	-
GPIO2	General purpose I/O	C or N	C or N	VSYS	-	-	○	-
GPIO3	General purpose I/O	C or N	C or N	VSYS	-	-	-	○
ONOB	PWRON pin monitor	-	N	VSYS	○	○	○	○
PSO0	Power-on signal output function	-	C or N	VSYS or VDDIO	○	-	-	-
PSO1	Power-on signal output function	-	C or N	VSYS or VDDIO	-	○	-	-
PSO2	Power-on signal output function	-	C or N	VSYS	-	-	○	-
PSO3	Power-on signal output function	-	C or N	VSYS	-	-	-	○
VUSBDET	VUSB voltage detector output	-	N	VSYS	○	○	○	○
VBATDET	VBAT voltage detector output	-	N	VSYS	○	○	○	○
LDORTC2	LDORTC2 output	-	A	-	-	-	○	-
CLK32KIN	32 kHz clock input for Fuel Gauge	C	-	VSYS or VDDIO	○	○	-	-
				VSYS	-	-	○	○
LED	LED function	-	N	VSYS	○	○	-	-
PSHOLD	PSHOLD (power-on hold) function	N	-	VSYS	○	○	○	○
ON_EXTIN	External input for on factor	N	-	VSYS	○	○	○	○
**EXON	External LDO*/DCDC* on/off input	N	-	VSYS	*4	*4	*4	*4

Note*1: Explanation of column of "Input" and "Output" :

A : Analog Input/Output.

C : CMOS Input/Output.

N : NMOS Input(VSYS only)/ Nch Open Drain Output.

Note*2: CMOS or Nch is selectable by OTP.

Note*3: VSYS or VDDIO is selectable by OTP.

Note*4: Refer to the chapter of Mode.

Table 12-1 The function of GPIO0-3 pins

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