ROHM Power Mangement Integrated Circuit (PMIC)

Evaluation Board: Power Management Integrated Circuit

BD71815GW-EVK-101

No.000000000

- **Introduction**
  This application note will provide the steps necessary to operate and evaluate ROHM's BD71815AGW PIMC using the evaluation board. Component selection, board layout recommendations, operation procedures and application data are provided within this application note.

- **Description**
  BD71815AGW is a Power Management Integrated Circuit (PMIC) for battery powered portable devices. This PMIC integrates 5 buck regulators, 8 Ldo's, a boost driver for led driver, 500mA single cell linear charger, Coulomb counter, RTC, 32 kHz crystal circuit and general purpose output control. This PMIC is designed to support specific power requirement of NXP's i.MX7 Solo and iMX7 Dual platforms with minimum cost requirement. With the flexibility of different OTP memory, this PMIC can also be used to power many other ARM core system on chips (SOC) beside the NXP's i.MX7 family.

- **Applications**
  Industrial Human Machine Interface devices.
  Consumer battery powered devices.
  Battery powered equipment.

- **System Features**
  BD71815AGW is used to supply the required power to the SoC and peripheral devices. Once powered up, the PMIC can be controlled by I2C bus to determin and change internal settings. The following explains the features implemented in this PMIC.

Voltage Rails

■ 5 Buck regulators
  - o BUCK1: Initial 1.100V, 0.800V –2.000V/ 25mV step DVS, IOMAX = 800mA
  - o BUCK2: Initial 1.000V, 0.800V –2.000V/ 25mV step DVS, IOMAX = 1000mA
  - o BUCK3: 1.800V, 1.200V –2.700V/ 50mV step programmable, IOMAX = 500mA
  - o BUCK4: 1.200V, 1.000V –1.850V/ 50mV step programmable, IOMAX = 1000mA
  - o BUCK5: 3.300V, 1.800V –3.300V/ 50mV step programmable, IOMAX = 1000mA

■ 3 LDO regulators (General purpose)
  - o LDO1: 3.3V, 0.8V –3.3V/ 50mV step programmable, IOMAX = 100mA
  - o LDO2: 3.3V, 0.8V –3.3V/ 50mV step programmable, IOMAX = 100mA
  - o LDO3: 3.3V, 0.8V –3.3V/ 50mV step programmable, IOMAX = 50mA

■ LDO for SD Card with dedicated enable terminal
  - o LDO4: 3.3V, 0.8V –3.3V/ 50mV step programmable, IOMAX = 400mA

■ LDO for SD Card Interface with dedicated terminal to dynamically change output voltage
  - o LDO5: 1.8V / 3.3V, 0.8V –3.3V/ 50mV step programmable, IOMAX = 250mA

- LDO for DDR Reference Voltage
  - VODVREF: DVREFIN/2, IOMAX = 10mA

- LDO for Secure Non-Volatile Storage
  - SNVSC: 3.0V, IOMAX = 25mA

- LDO for Low-Power State Retention
  - LDOLPSR: 1.8V, IOMAX = 100mA

White LED Boost Converter

- ~ 25mA LED Boost Converter

Single-cell Linear LIB Charger with 30V OVP

- Selectable Charging Voltage: 3.72V –4.34V
- Programmable Charge Current: 100mA –500mA
- Support for up to 2000mA charge current using external MOSFET
- DCIN Over Voltage Protection
- Battery Over Voltage Protection
- Support Battery Supplement Mode
- Battery Short Circuit Detection

Voltage Measurement for Thermistor

- CHGREF: Bias Voltage Output for External Thermistor

Embedded Coulomb Counter for Battery Fuel Gauging

- 15-bit ΔΣ-ADC with External Current Sense Resistor (10 mΩ, ±1%)
- 1sec cycle, 28-bit Accumulation
- Coulomb Count while Charging/Discharging

Battery Monitoring and Alarm Output

- Under Voltage Alarm while Discharging
- Over Discharge Current Alarm
- Over/Under Temperature Alarm
- Programmable Thresholds and Time Durations

Real Time Clock with 32.768kHz Crystal Oscillator

- CLK32KOUT: 32.768kHz Clock Output (Open Drain or CMOS Output Selectable)

1 GPO

- GPO (Open Drain or CMOS Output Selectable)

Power Control I/O

- PWRON: Power ON/OFF Control Input
- STANDBY: Standby Input for Switching ON / STANDBY Mode
- RESETINB: Reset Input to Reset Hung PMIC
- POR: Power ON Reset Output

Serial Interface

- I2C interface provides access to configuration registers.

- **Evaluation Board**

  Below picture shows the evaluation board with the BD71815AGW PMC. Design files for the layout can be downloaded from the following GITHUB location:

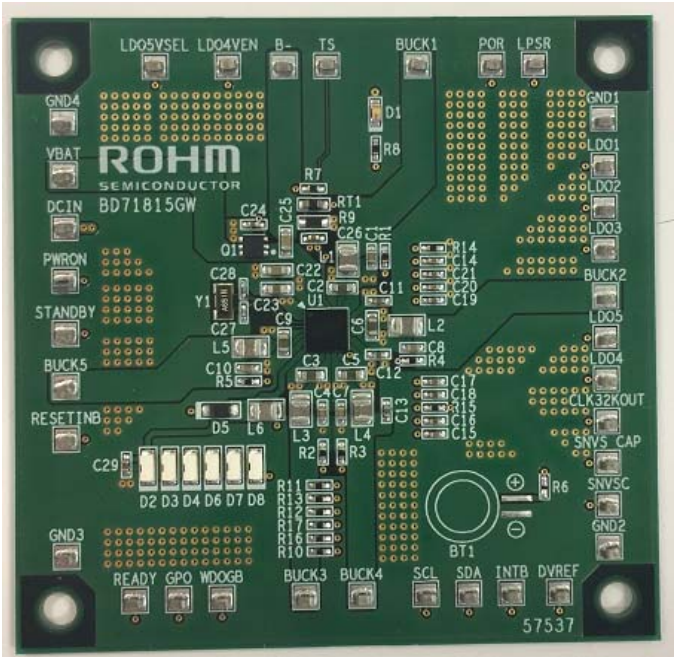
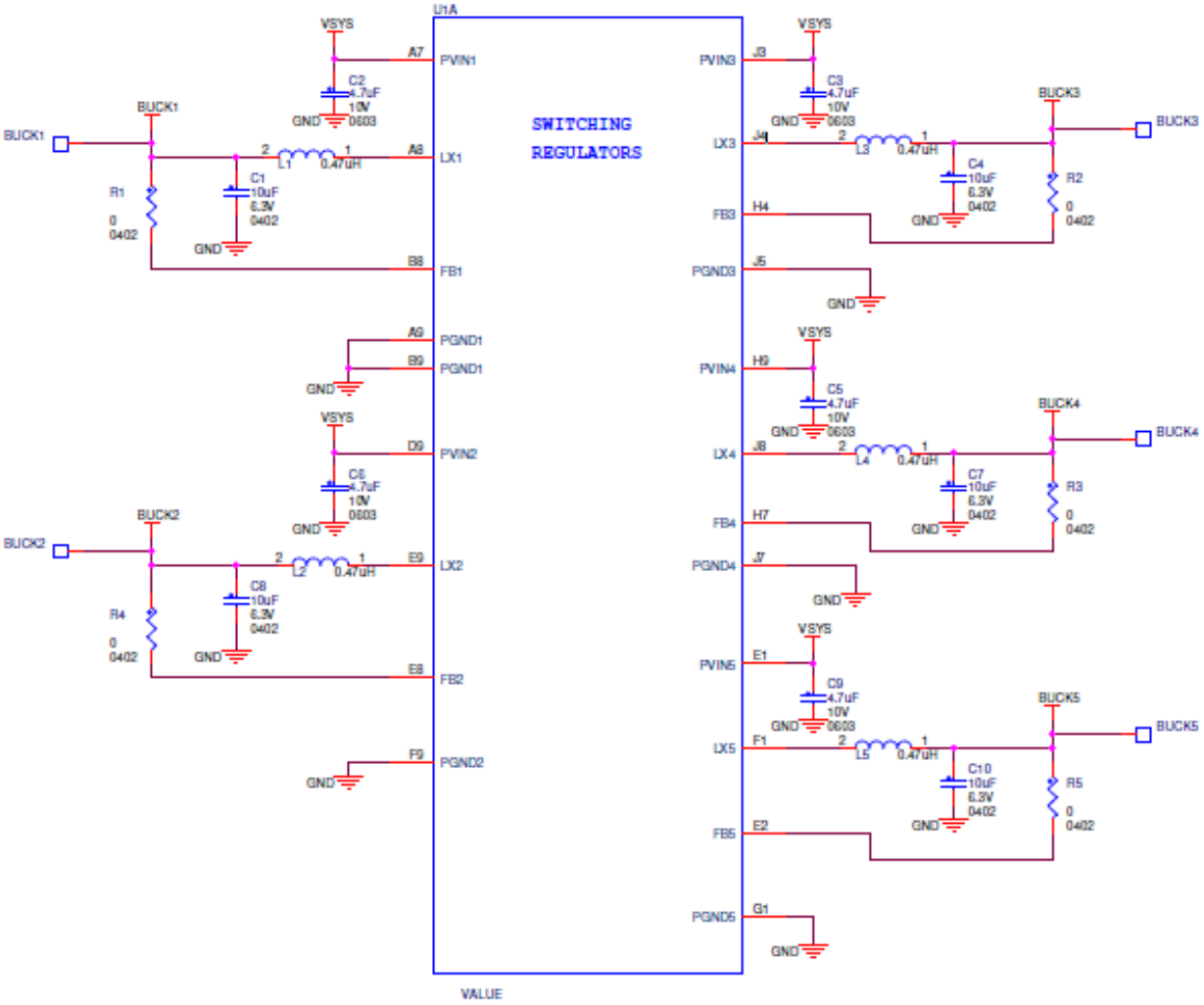
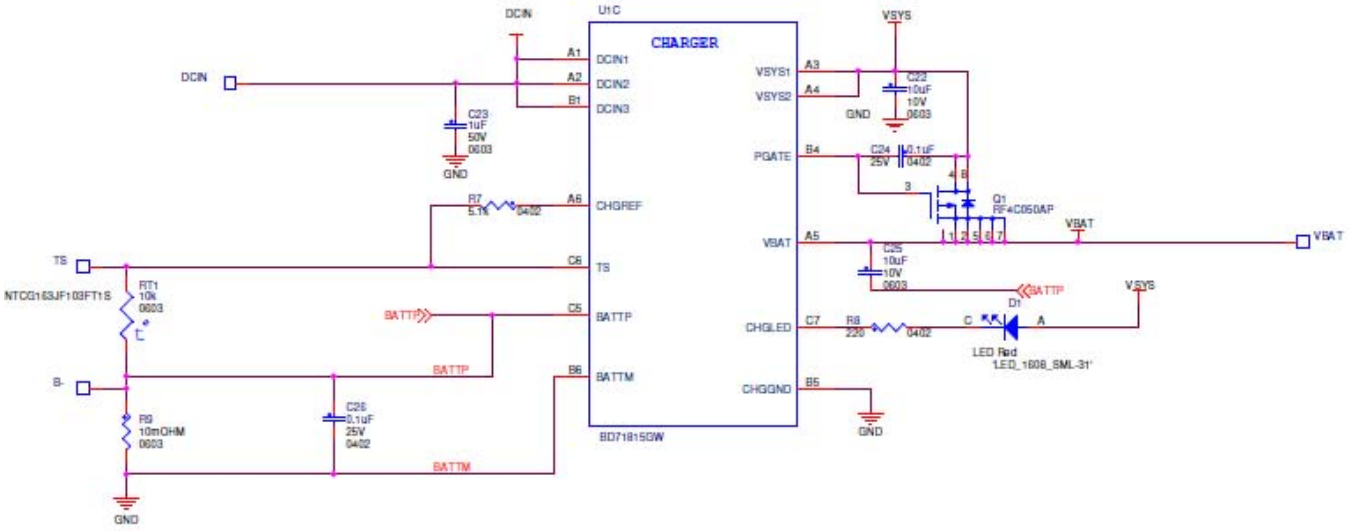


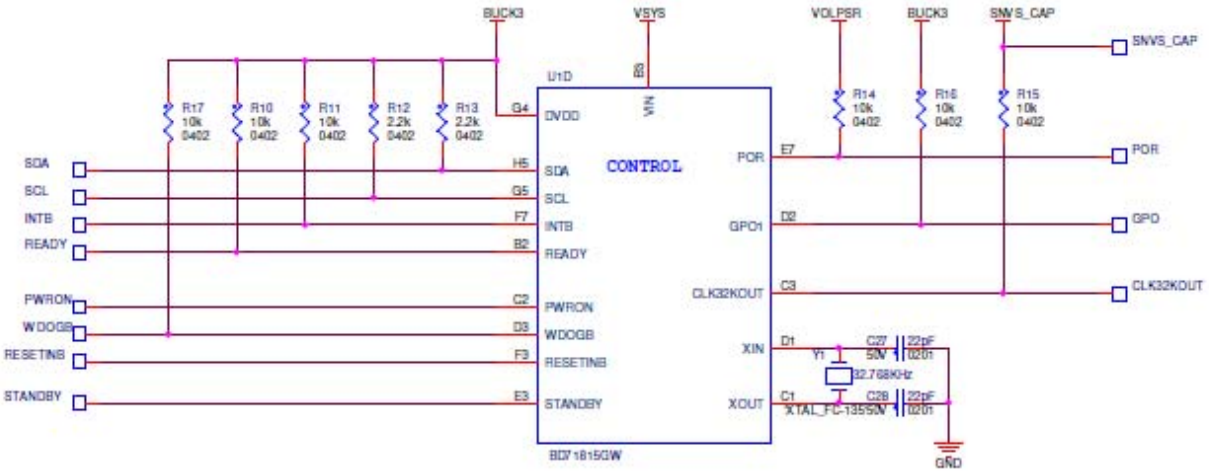
Fig 1: BD71815GW Evaluation Board

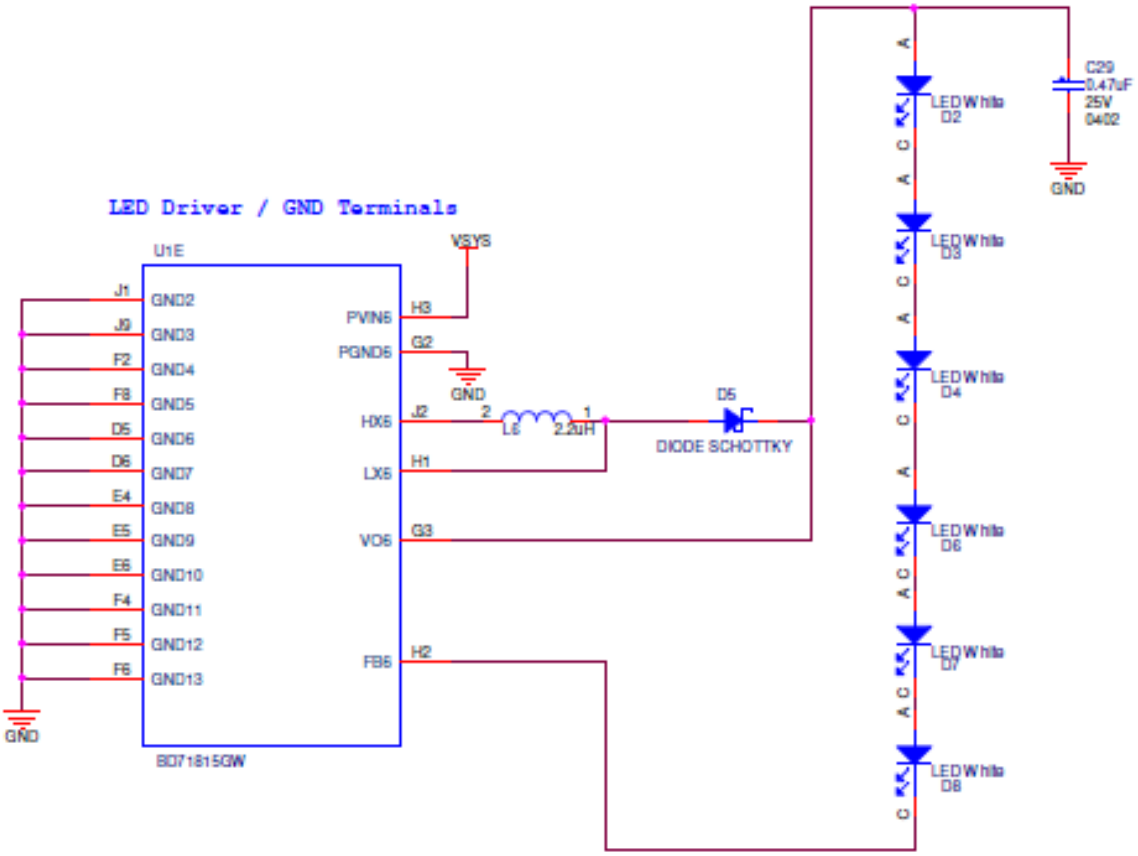
- **Evaluation Board Schematic**

  Below picture shows the schematic design for the above board. Design and pdf files for the schematic can be downloaded from the following GITHUB location:


U1A
SWITCHING
REGULATORS
VALUE
VSYS
BUCK1
BUCK2
BUCK3
BUCK4
BUCK5
PVIN1
PVIN2
PVIN3
PVIN4
PVIN5
LX1
LX2
LX3
LX4
LX5
FB1
FB2
FB3
FB4
FB5
PGND1
PGND2
PGND3
PGND4
PGND5
GND
L1 0.47uH
L2 0.47uH
L3 0.47uH
L4 0.47uH
L5 0.47uH


U1C
CHARGER
DCIN
DCIN1
DCIN2
DCIN3
CHGREF
TS
BATTP
BATTM
VSYS1
VSYS2
PGATE
VBAT
CHGLED
CHGGND
BD71815GW
NTCG163JF103FT1S
LED Red
LED_1608_SML-31


BUCK3
VSYS
VOLPSR
BUCK3
SNVS_CAP
SNVS_CAP
U1D
CONTROL
SDA
SCL
INTB
READY
PWRON
WDOGB
RESETINB
STANDBY
DVDD
VIN
POR
GPO1
CLK32KOUT
XIN
XOUT
R17 10k 0402
R10 10k 0402
R11 10k 0402
R12 2.2k 0402
R13 2.2k 0402
R14 10k 0402
R16 10k 0402
R15 10k 0402
POR
GPO
CLK32KOUT
C27 22pF 50V 0201
Y1
32.768KHz
C28 22pF 0201
XTAL_FC-135SV
GND
BD71815GW


LED Driver / GND Terminals
U1E
VSYS
GND2
GND3
GND4
GND5
GND6
GND7
GND8
GND9
GND10
GND11
GND12
GND13
PVIN5
PGND5
HX5
LX5
VO5
FB5
L2 2.2uH
D5
DIODE SCHOTTKY
C29 0.47uF 25V 0402
LED White D2
LED White D3
LED White D4
LED White D6
LED White D7
LED White D8
GND
BD71815GW

- **Bill of material for Evaluation Board.**

No.	Reference	Contents	Parts Number	Characteristic [Unit:inch]	Qty.	Manufacturer
1	U1	PMIC	BD71815GW		1	ROHM
2	L1,L2,L3,L4,L5	Inductor	DFE201612E-R47M	0.47uH, 4.5A, 0806	5	TOKO
3	L6	Inductor	DFE201612E-2R2M	2.2uH, 1.8A, 0806	1	TOKO
4	R9	Resistor	PMR03EZPFU 10L0	10mohm, 0603	1	ROHM
5	R1,R2,R3,R4,R5	Resistor	MCR01MRTJ000	0, 0402	5	ROHM
6	R6	Resistor	MCR01MRTF1000	100, 0402	1	ROHM
7	R8	Resistor	MCR01MRTF1002	220, 0402	1	ROHM
8	R12,R13	Resistor	MCR01MRTF2201	2.2k, 0402	2	ROHM
9	R7	Resistor	MCR01MRTD5101	5.1k, 0402	1	ROHM
10	R10,R11,R14,R15,R16,R17	Resistor	MCR01MRTF1002	10k, 0402	6	ROHM
11	C27,C28	Capacitor	GRM0332C1H220GA01	22pF, 50V, 0201	2	MURATA
12	C24,C26	Capacitor	TMK105BJ104KV-F	0.1uF, 25V, 0402	2	TAIYO YUDEN
13	C29	Capacitor	GRM155R61E474KE01D	0.47uF, 25V, 0402	1	Murata
14	C23	Capacitor	GRM188B31H105KAALD	1uF, 50V, 0603	1	Murata
15	C11,C12,C13,C14,C15,C16,C17,C19,C20,C21	Capacitor	LMK107BJ105MA-T	1uF, 10V, 0402	10	TAIYO YUDEN
16	C18	Capacitor	GRM155R61A225KE95	2.2uF, 10V, 0402	1	Murata
17	C2,C3,C5,C6,C9	Capacitor	LMK107BJ475MA-T	4.7uF, 10V, 0603	5	TAIYO YUDEN
18	C1,C4,C7,C8,C10	Capacitor	GRM155R60J106ME44	10uF, 6.3V, 0402	5	Murata
19	C22,C25	Capacitor	GRM188B31A106ME69D	10uF, 10V, 0603	2	Murata
20	RT1	Thermister	NTCG163JF103FT1S	10k, 0603	1	TDK
21	D1	LED Red	SML-310VTT86	Red, 0603	1	ROHM
22	D2,D3,D4,D6,D7,D8	LED White	CSL0406WBC W12	White, 0605	6	ROHM
23	D5	Schottky Diode	RB550VA-30		1	ROHM
24	Q1	MOSFET	RF4C050AP	Pch	1	ROHM
25	Y1	Cristal	FC-135	32.768kHz	1	SEIKO EPSON
26	BT1	Coin Battery	VL621/F9D	3V, 1.5mAh	1	Panasonic
27	GND1,LDO1,LDO2,LDO3,BUCK2,LDO5,LDO4,CLK32KOUT,SNVS_CAP,SNVSC,GND2,DVREF,INTB,SDA,SCL,BUCK4,BUCK3,WDOGB,GPO,READY,GND3,RESENTINB,BUCK5,STANDBY,PWRON,DCIN,VBAT,GND4,LDO5VSEL,LDO4VEN,B-,TS,BUCK1,POR,LPSR	Test points	A106145RT	Test point	34	Tyco

- **Evaluation Board Operation Procedures**

Below is the procedure to operate the evaluation board.

1. Connect power supply's GND terminal to GND4 test point on the evaluation board.
2. Connect power supply's V_{CC} terminal to DCIN or VBAT terminal. Voltage range for DCIN terminal is between 3.5V to 28V. Voltage range for VBAT terminal is 0.6V to 5.6V.

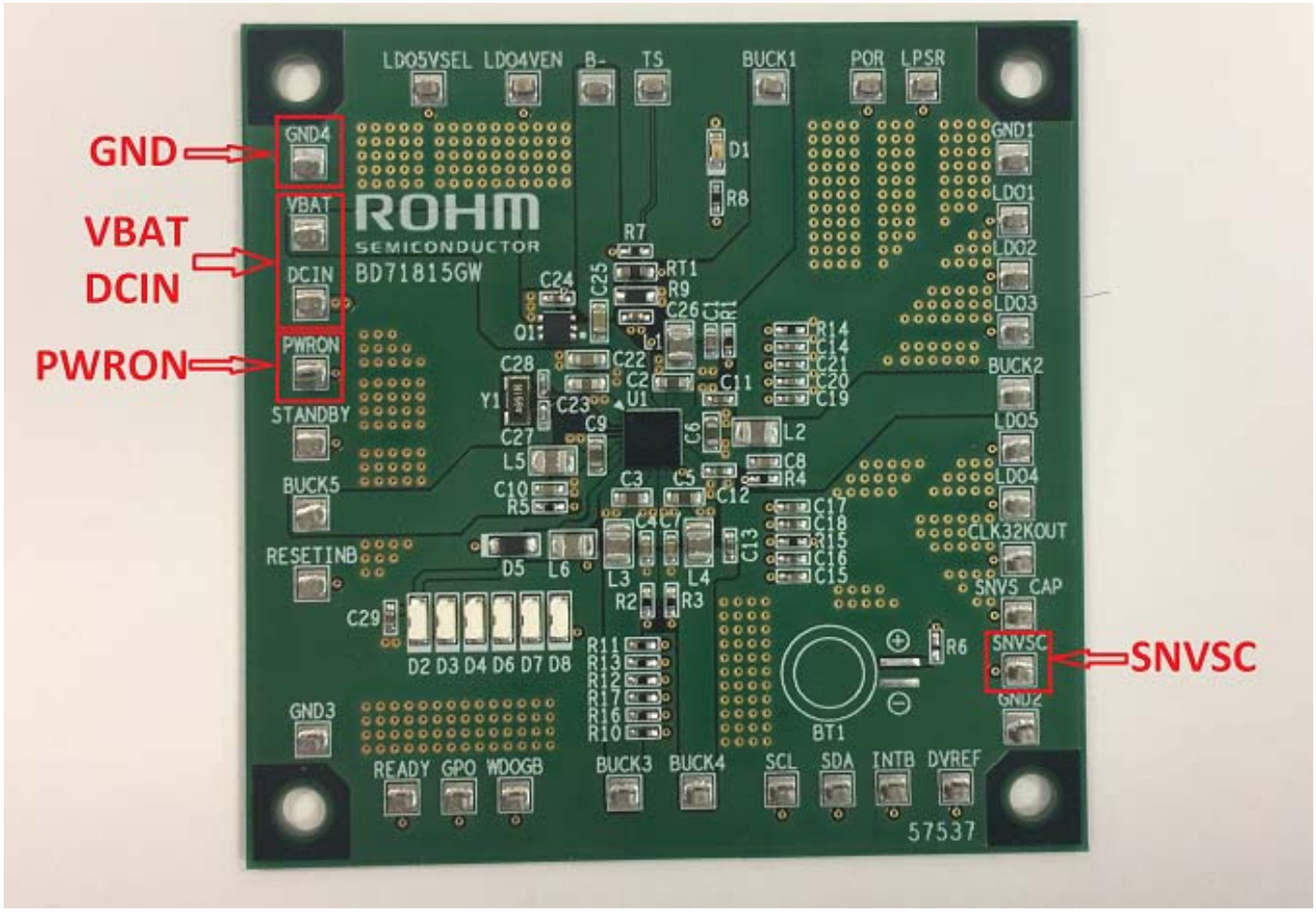
    - PMIC is now in "SNVS" state.

Certain voltage rails are turned on in SNVS state. Refer to voltage rail on/off table on page 10.

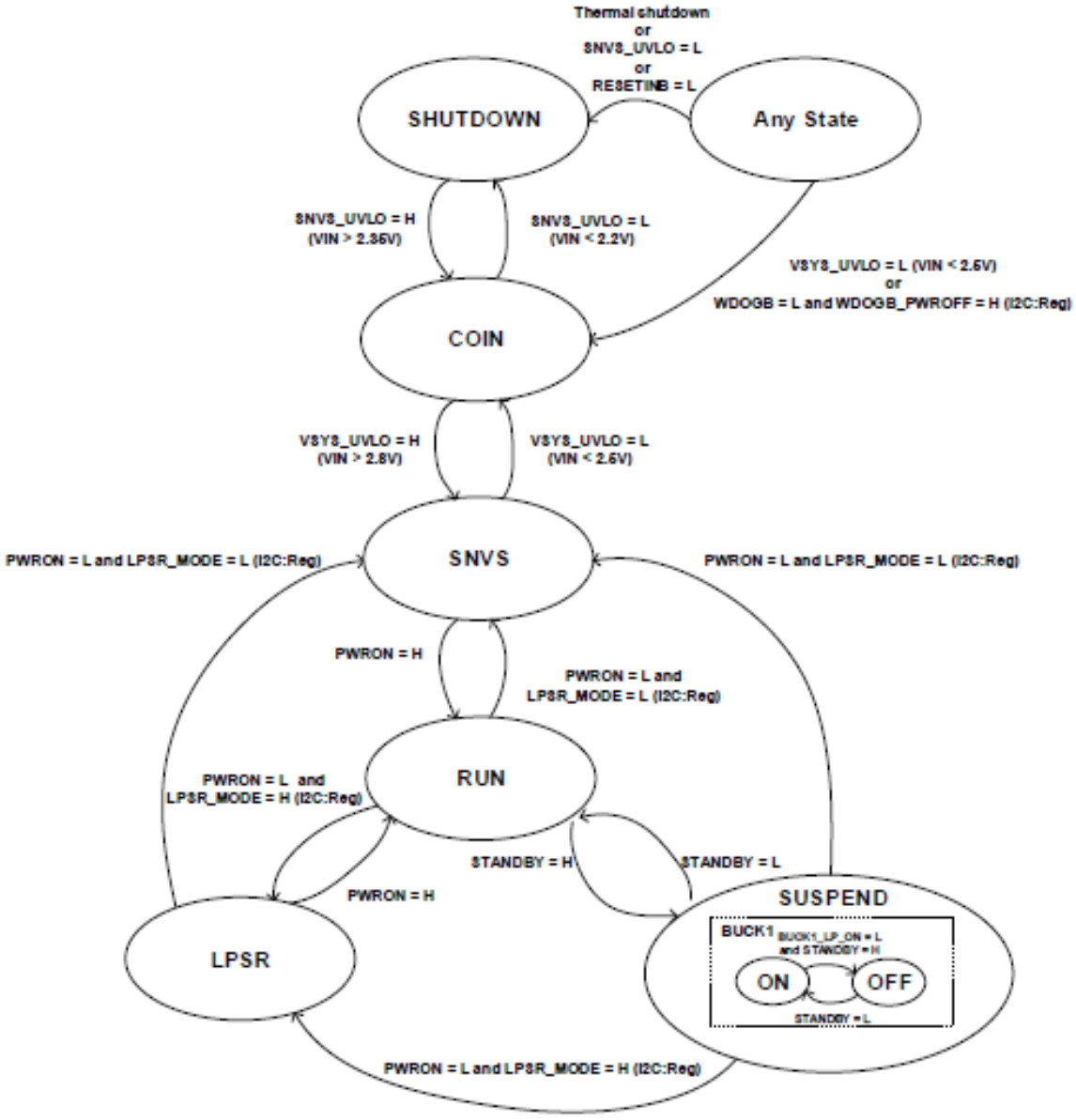
3. Connect a jumper from SNVSC terminal to PWRON terminal in-order to start the PMIC operation.

    - PMIC should now be in "RUN" state.

Certain voltage rails are turned on in RUN state. Refer to voltage rail on/off table on page 10.

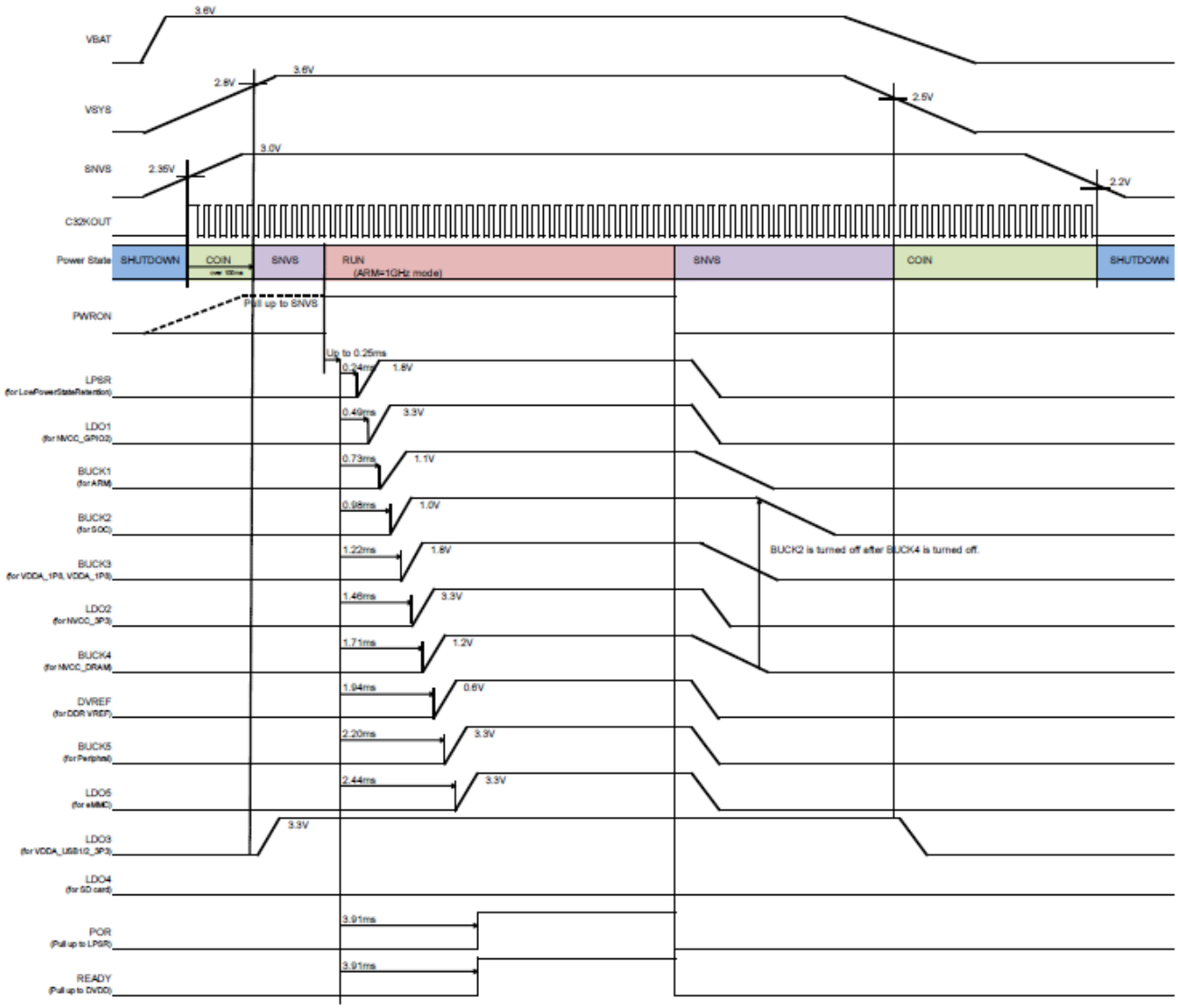


- **States of Operation**
  Below picture show's the different states of the PMIC and how each state is entered. More details on each state can be found on the datasheet at Rohm.com or at the below link.
  http://www.rohm.com/web/global/datasheet/BD71815AGW



- **Power ON/OFF Sequence**
  Below picture shows the power on/off sequence for each rail in this PMIC.

Power ON/OFF Sequence



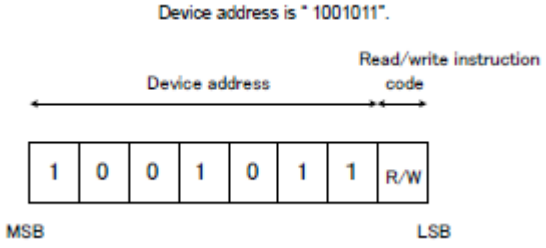
- **Votlage Rail ON/OFF state**
  Below table shows the state of each output rail in each of the different PMIC state.

BD71815AGW Function	Power Mode						Output Control	
	Shutdown	Coin	SNVS	LPSR	RUN	SUSPEND	ON/OFF	Sequence order
BUCK1	OFF	OFF	OFF	OFF	Auto	Auto	State or I2C register	2
BUCK2	OFF	OFF	OFF	OFF	Auto	Auto	State or I2C register	3
BUCK3	OFF	OFF	OFF	OFF	Auto	Auto	State or I2C register	4
BUCK4	OFF	OFF	OFF	OFF	Auto	Auto	State or I2C register	6
BUCK5	OFF	OFF	OFF	OFF	Auto	Auto	State or I2C register	8
LDO1	OFF	OFF	OFF	ON	ON	ON	State or I2C register	1
LDO2	OFF	OFF	OFF	OFF	ON	ON	State or I2C register	5
LDO3	OFF	OFF	ON	ON	ON	ON	State or I2C register	9
LDO4	OFF	OFF	OFF	OFF/ON	OFF/ON	OFF/ON	LDO4VEN	9
LDO5	OFF	OFF	OFF	OFF	ON	ON	State or I2C register	9
VOD/VREF	OFF	OFF	OFF	OFF	ON	ON	State or I2C register	7
SNVSC	OFF	ON	ON	ON	ON	ON	State or I2C register	-
LDO LPSR	OFF	OFF	OFF	ON	ON	ON	State or I2C register	0
White LED Driver	OFF	OFF	OFF	OFF	OFF	OFF	State or I2C register	-
I2C	Reset	Disable	Disable	Disable	Enable	Enable	State	-
RTC	OFF	ON	ON	ON	ON	ON	State	-
Charger	OFF	OFF	ON/OFF	ON/OFF	ON/OFF	ON/OFF	DCIN	-
Coulomb Counter	OFF	OFF	ON	ON	ON	ON	State	-
SNVS/VSYS Voltage monitor	ON	ON	ON	ON	ON	ON	-	-

(Note) Auto : PWM/PFM mode change automatically depending on the load current

- **I2C access**
  The PMIC's internal registers can be accessed through standard I2C bus. User can connect the I2C host to SCL, SDA, and GND terminal and access I2C registers.

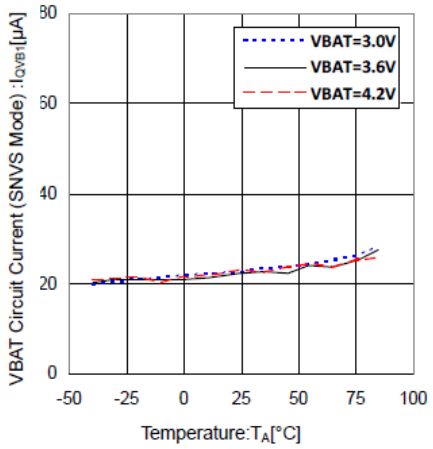
  I2C device address:

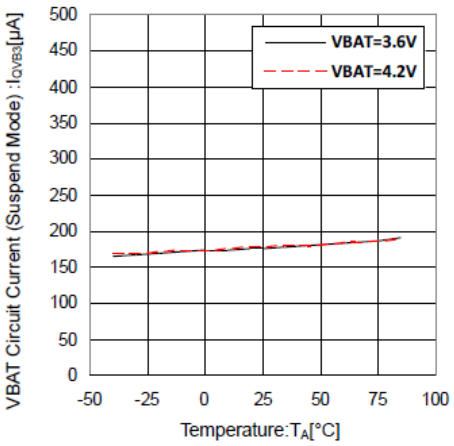


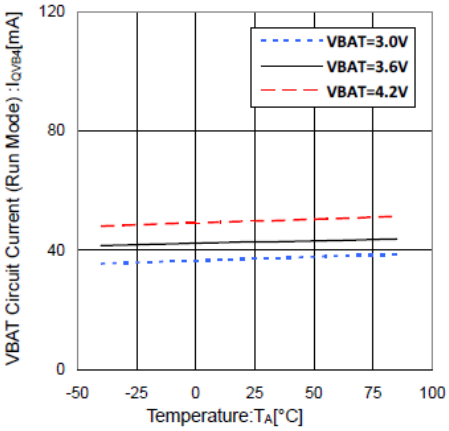
Details on the full set of I2C registers and their descriptions can be found on the datasheet at Rohm.com or at the below link.
http://www.rohm.com/web/global/datasheet/BD71815AGW

- **Reference Application Data for BD71815AGW-E PMIC.**
  Detailed performance data can be found on the BD71815AGW datasheet. Below are some of the highlighted performance curves for this PMIC.

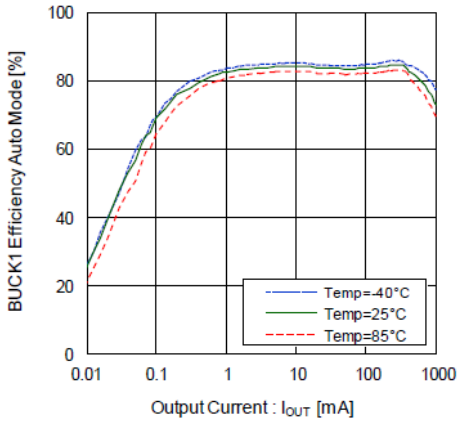
Circuit Current in different PMIC States (SNVS, Suspend, Run mode).

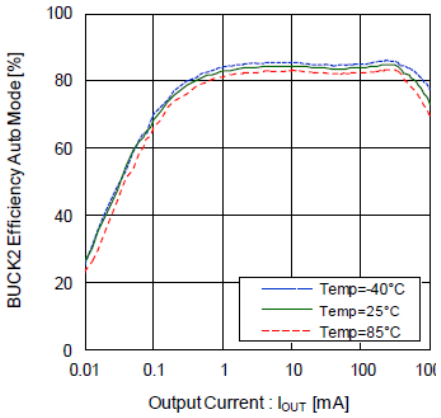


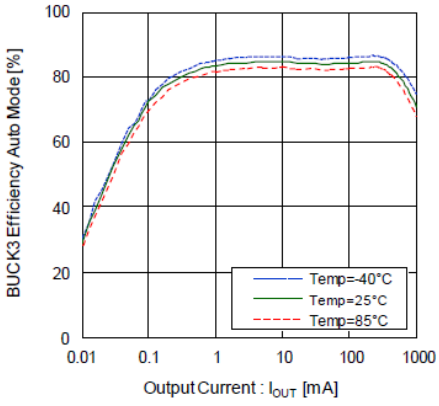


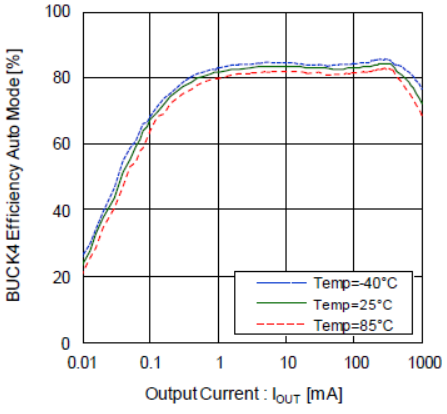


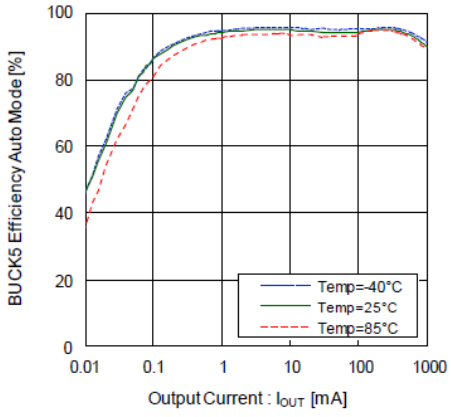
Efficiency of Buck Regulators.











Notes

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ROHM SEMICONDUCTOR

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