ROHM Power Management Integrated Circuit Solutions

Evaluation Board: Power Management Integrated Circuit (PMIC)

BD71815AGW-EVK-101

No.000000000

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

- **Description**
  The BD71815AGW is a Power Management Integrated Circuit (PMIC) designed for battery-powered portable devices. Integrated components include 5 buck regulators, 8 LDOs, a boost driver for the LED driver, 500mA single-cell linear charger, Coulomb counter, RTC, 32kHz crystal circuit, and general-purpose output control. This PMIC is designed to support the specific power requirements of NXP's i.MX7 Solo and iMX7 Dual platforms at minimal cost. Given the flexibility of different OTP memory, this PMIC can also be used to power many other ARM core System On Chips (SOC) beside NXP's i.MX7 family.

- **Applications**
  Industrial human machine interface and consumer battery powered devices

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

Voltage Rails

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

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

■ LDO for SD Card with Dedicated Enable Terminal
- LDO4: 3.3V, 0.8V –3.3V/ 50mV step programmable, IOMAX = 400mA

■ LDO for SD Card Interface with Dedicated Terminal to Dynamically Change the Output Voltage
- 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 via 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 Gauge
- 15-bit ΔΣ-ADC with external current sense resistor (10mΩ, ±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 (selectable Open Drain or CMOS output)

1 GPO
- GPO (selectable Open Drain or CMOS output)

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**

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

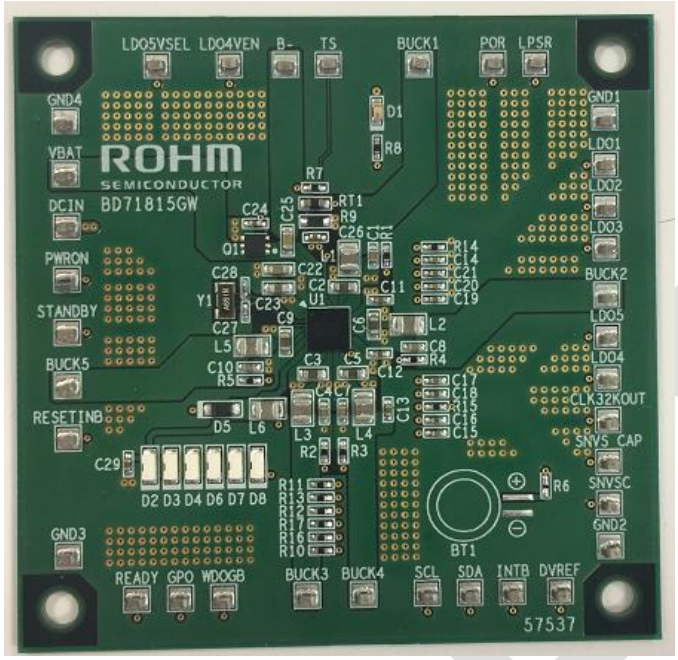
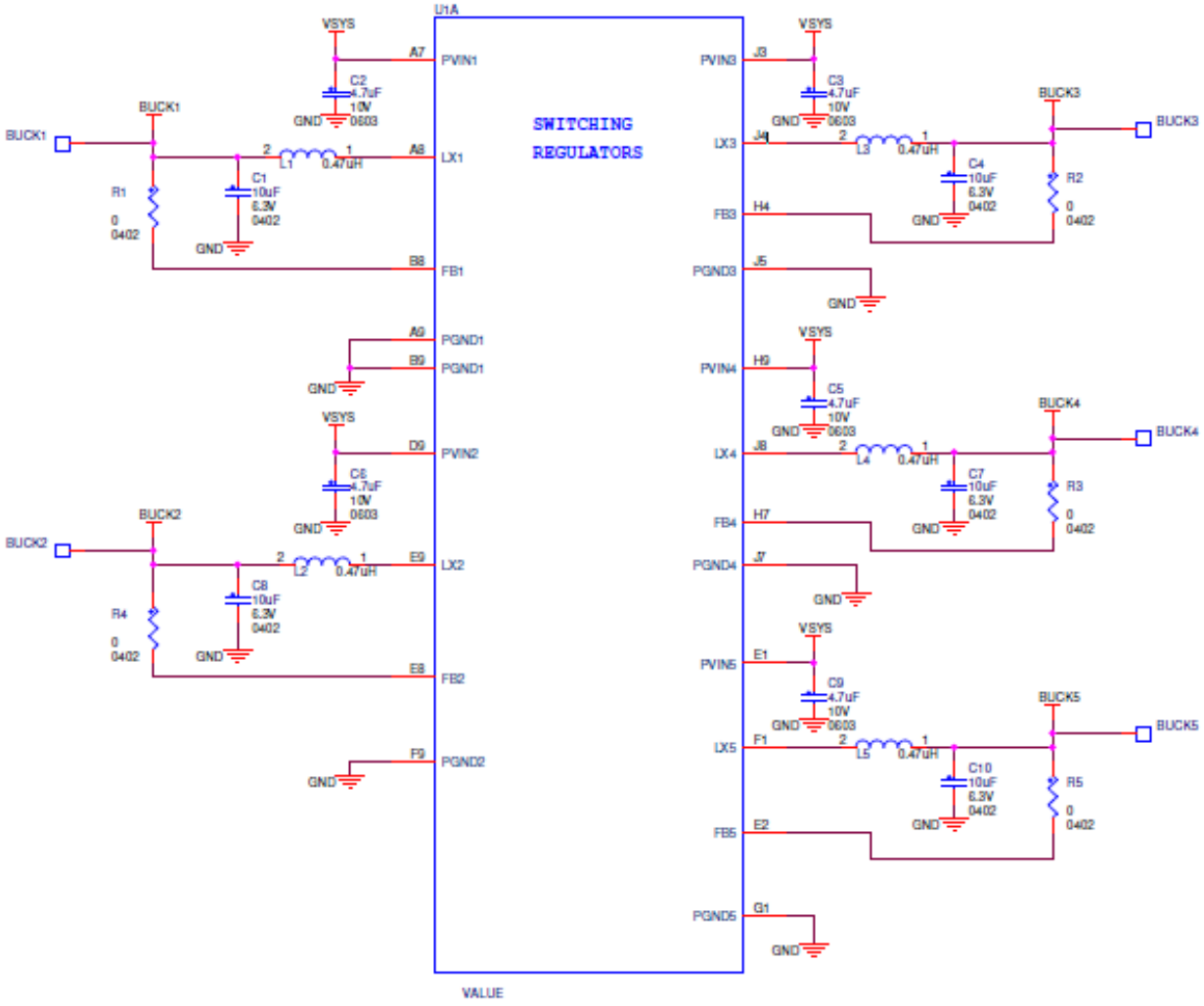
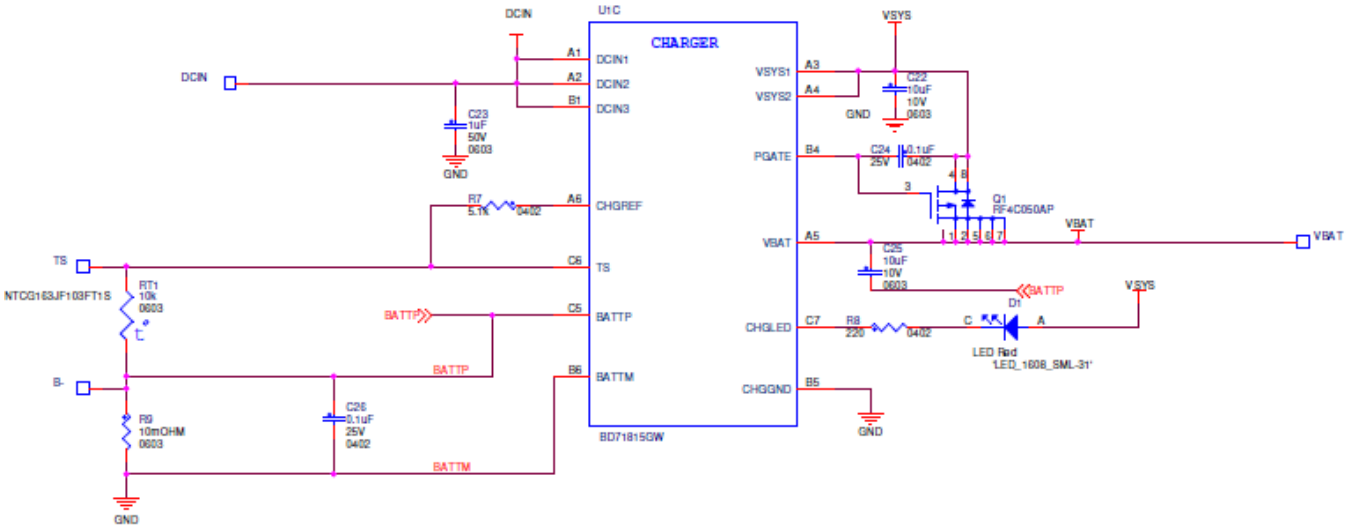
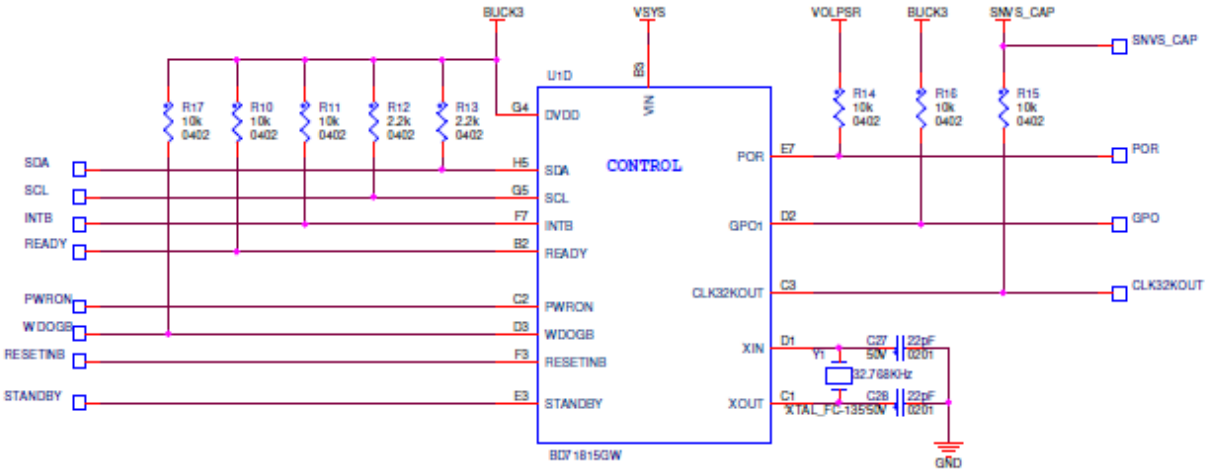


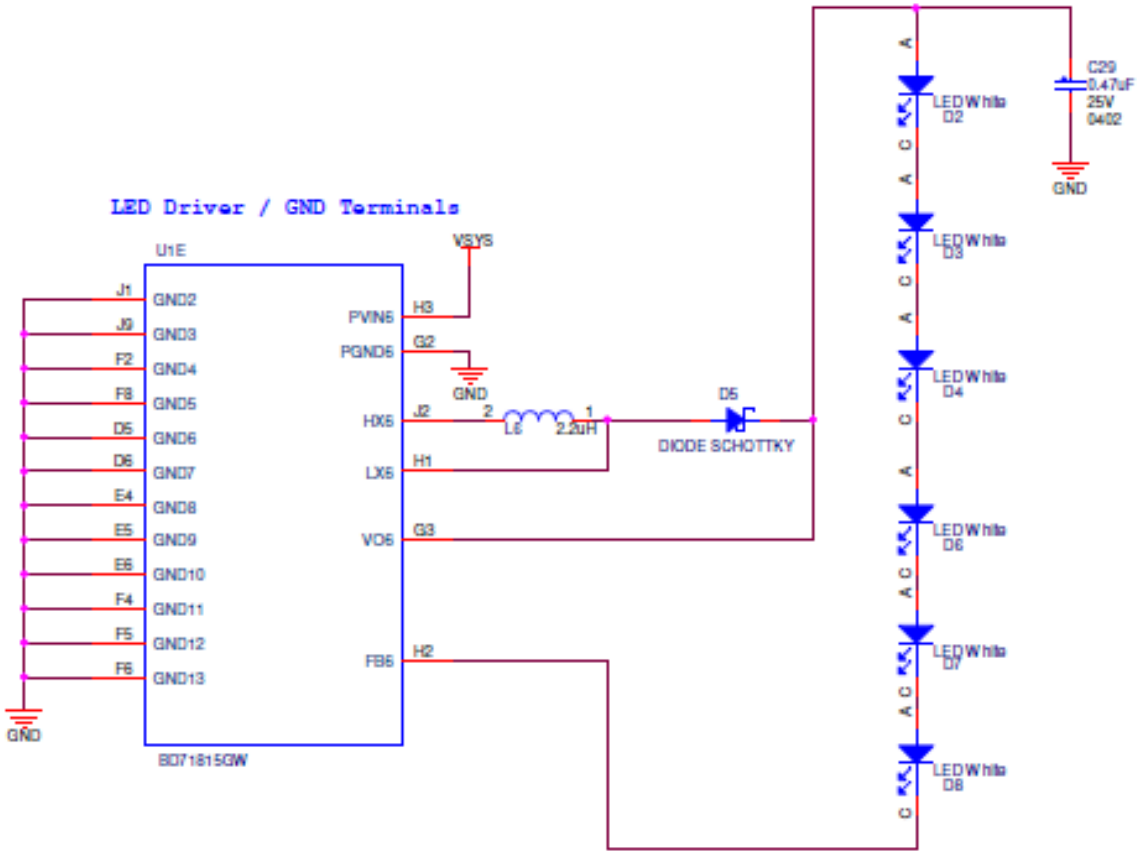
Fig 1: BD71815AGW Evaluation Board

- **Evaluation Board Schematic**
  The following is 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
GND
PVIN1
PVIN2
PVIN3
PVIN4
PVIN5
LX1
LX2
LX3
LX4
LX5
FB1
FB2
FB3
FB4
FB5
PGND1
PGND2
PGND3
PGND4
PGND5
C1 10uF 6.3V 0402
C2 4.7uF 10V 0603
C3 4.7uF 10V 0603
C4 10uF 6.3V 0402
C5 4.7uF 10V 0603
C6 4.7uF 10V 0603
C7 10uF 6.3V 0402
C8 10uF 6.3V 0402
C9 4.7uF 10V 0603
C10 10uF 6.3V 0402
L1 0.47uH
L2 0.47uH
L3 0.47uH
L4 0.47uH
L5 0.47uH
R1 0 0402
R2 0 0402
R3 0 0402
R4 0 0402
R5 0 0402


U1C
CHARGER
DCIN
DCIN1
DCIN2
DCIN3
C23
1uF
50V
0603
GND
R7
5.1K
0402
CHGREF
TS
NTCG163JF103FT1S
RT1
10k
0603
C6
TS
BATTP
C5
BATTM
B6
R9
10mOHM
0603
C26
0.1uF
25V
0402
B-
BD71815GW
VSYS
VSYS1
VSYS2
C22
10uF
10V
0603
PGATE
C24
0.1uF
25V
0402
Q1
RF4C050AP
VBAT
C25
10uF
10V
0603
CHGLED
C7
R8
220
0402
D1
LED Red
LED_1608_SML-31
CHGGND
B5


U1D
CONTROL
BUCK3
VSYS
VOLPSR
SNVS_CAP
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
DVDD
SDA
SCL
INTB
READY
PWRON
WDOGB
RESETINB
STANDBY
POR
GPO1
CLK32KOUT
XIN
XOUT
Y1
32.768KHz
C27
22pF
50V
0201
C28
22pF
0201
XTAL_FC-135SV
BD71815GW
GND



- **Bill of Material for the 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.

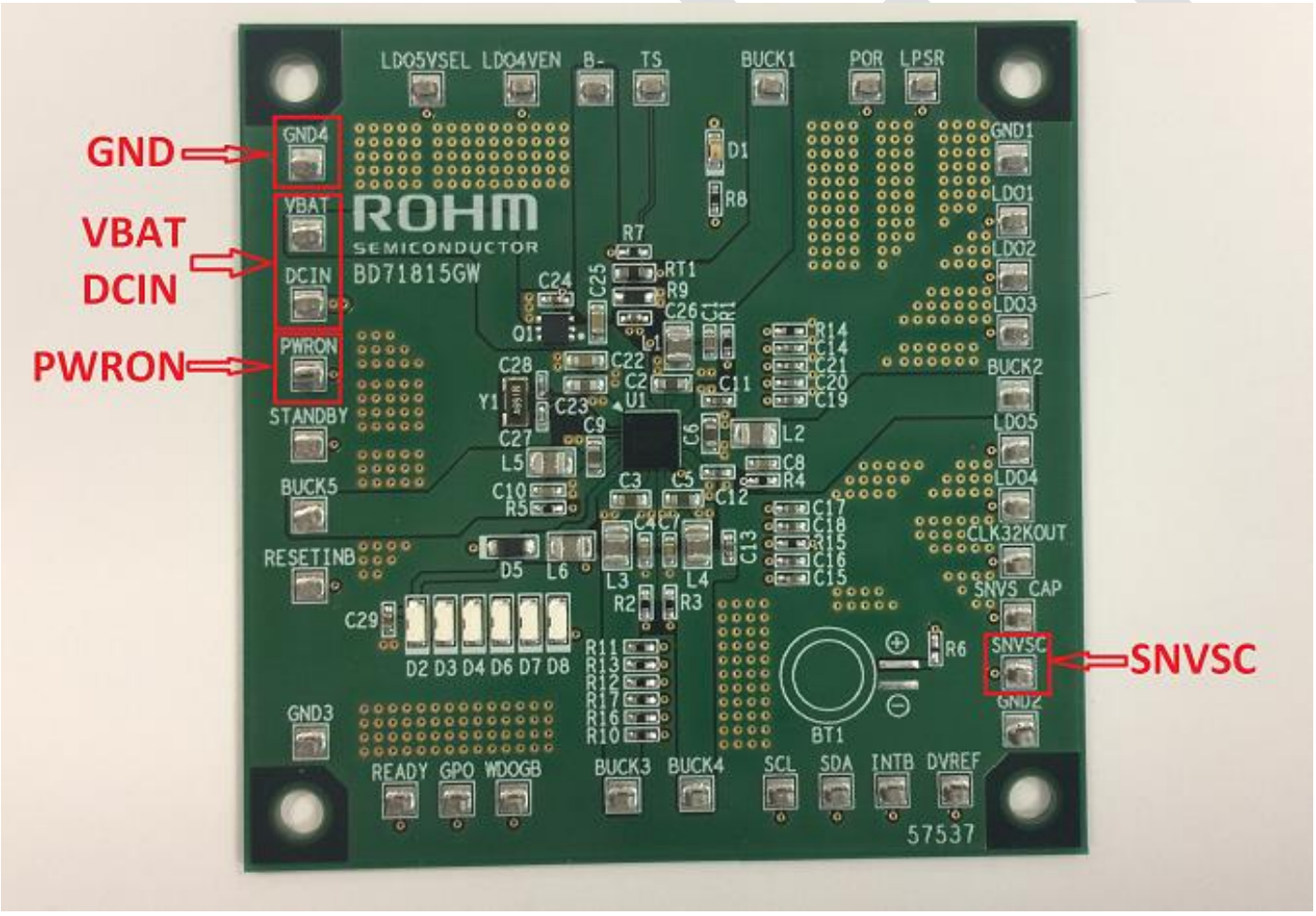
     - PMIC is now in "SNVS" state.

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

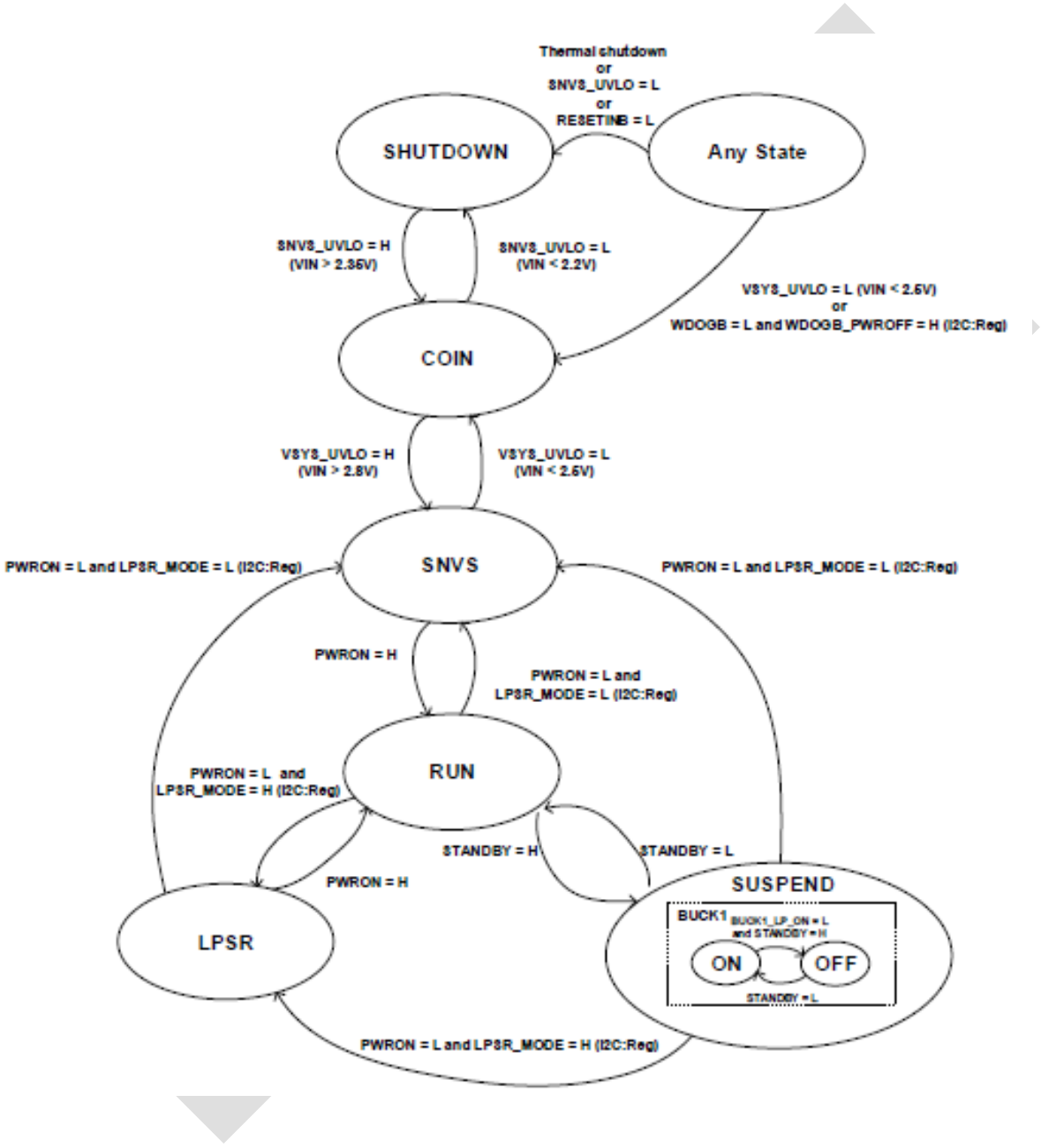
  3. Connect a jumper from SNVSC terminal to PWRON terminal in-order to start the PMIC operation.

     - 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.

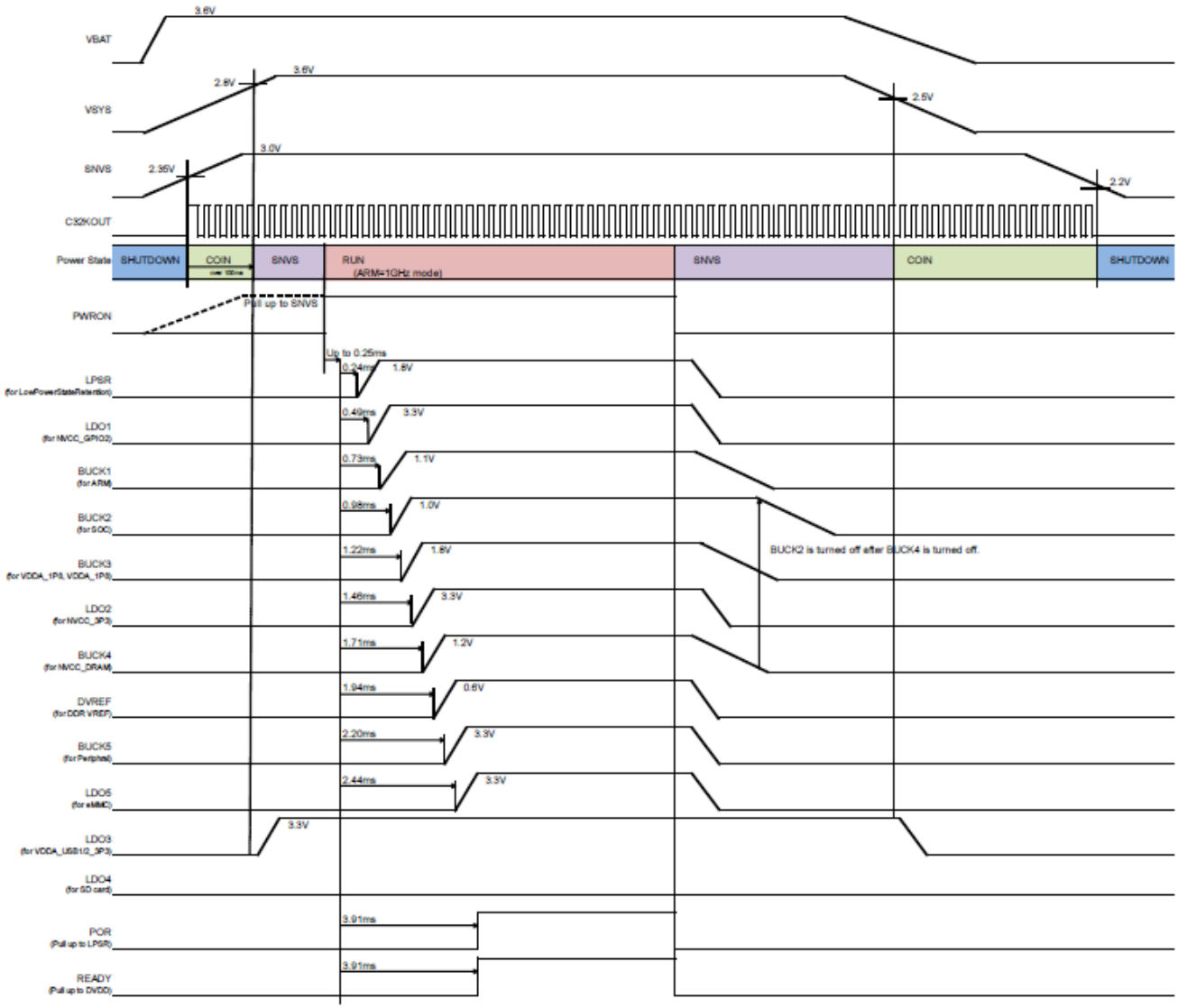


- **States of Operation**
  Below picture show's the different states of the PMIC and how each state is entered. More details on each state can be found on the datasheet at Rohm.com or at the below link.
  http://www.rohm.com/web/global/datasheet/BD71815AGW



- **Power ON/OFF Sequence**
  Below shows the power ON/OFF sequence for each rail within the PMIC.

Power ON/OFF Sequence



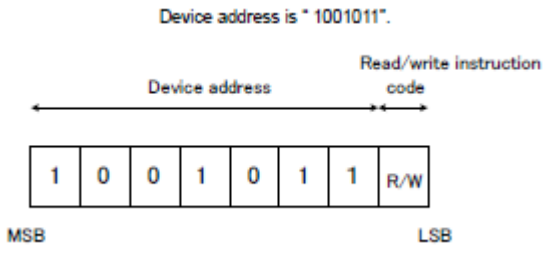
- **Voltage Rail ON/OFF State**
  The following table shows the state of each output rail in each PMIC state.

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
VODVREF	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. Users can connect the I2C host to the SCL, SDA, and GND terminals and access I2C registers.

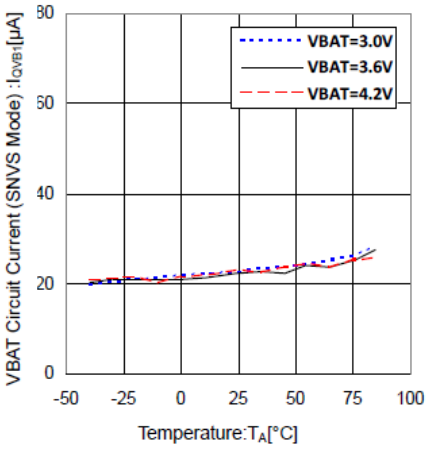
  I2C device address:

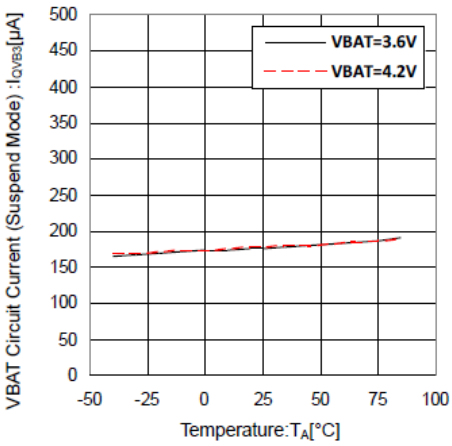


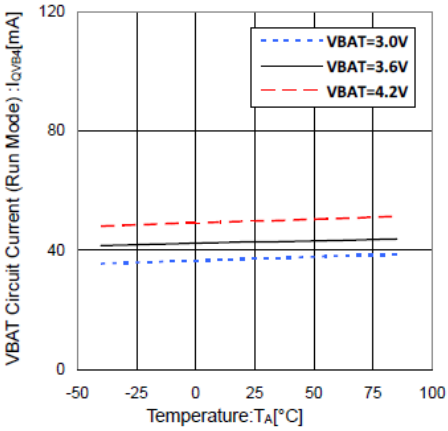
  Details on the full set of I2C registers and their descriptions can be found in the datasheet at ROHM.com or at the below link.
  http://www.rohm.com/web/global/datasheet/BD71815AGW

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

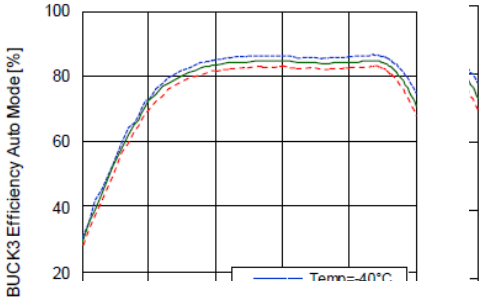
Circuit Current in Different PMIC States (SNVS, Suspend, Run Mode).

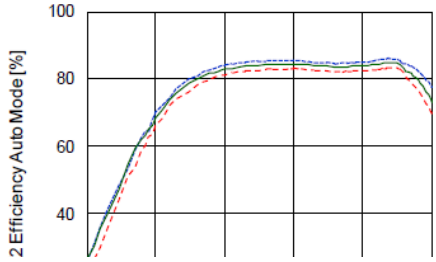


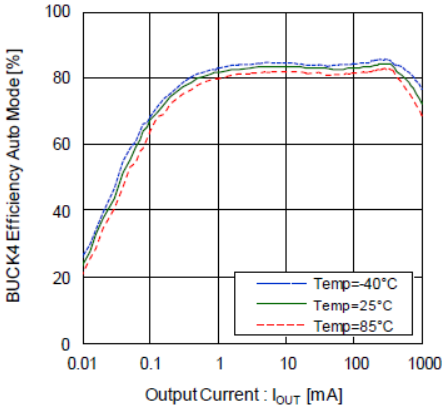


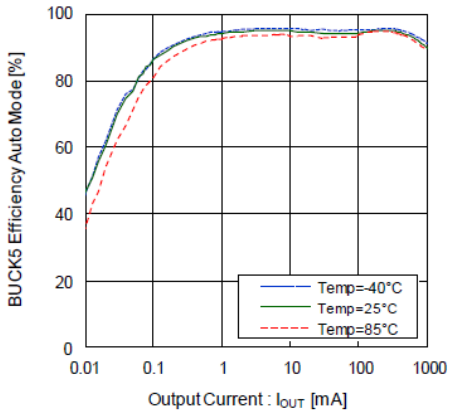


Buck Regulator Efficiency









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