Application Note

DA9063 Power Management Solution for the NXP i.MX8M Mini

AN-PM-125

Abstract

This document describes a power management solution using the Dialog Semiconductor DA9063 Power Management Integrated Circuit (PMIC) which is optimized for the NXP i.MX8M Mini system application processors.

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NXP i.MX8M Mini

Contents

Figures

Tables

DA9063 Power Management Solution for the NXP i.MX8M Mini

1 Terms and Definitions

BOM	Bill of materials
GUI	Graphical user interface
PMIC	Power management integrated circuit
DVC	Dynamic voltage control
DVS	Dynamic voltage scaling.
POR	Power-on reset
RTC	Real-time clock
SNVS	Secure non-volatile storage

2 References

[1] i.MX8M Mini - Arm® Cortex®-A53, Cortex-M4, Audio, Voice, Video,
https://www.nxp.com/products/processors-and-microcontrollers/arm-based-processors-and-mcus/i.mx-applications-processors/i.mx-8-processors/i.mx-8m-mini-arm-cortex-a53-cortex-m4-audio-voice-video:i.MX8MMINI [accessed 07/03/2019]

[2] Evaluation Kit for the i.MX8M Mini Applications Processor,
https://www.nxp.com/support/developer-resources/software-development-tools/i.mx-developer-resources/evaluation-kit-for-the-i.mx-8m-mini-applications-processor:8MMINILPD4-EVK
[accessed 07/03/2019]

[3] In-Circuit Programming of DA9061/2/3, AN-PM-080, Dialog Semiconductor

[4] i.MX8M Mini Family of Applications Processors Datasheet, IMX8MMCEC Rev. 0.1, 02/2019, NXP.

[5] DA9063, datasheet, Dialog Semiconductor

[6] The Linux Kernel Archives, https://kernel.org/ (DA9063 software driver) [accessed 30/3/2016]

[7] LabVIEW is a trademark of National Instruments Corporation, https://www.ni.com

3 Introduction

The NXP® i.MX8M Mini™ processor requires dedicated power management for a stable and reliable system. The Dialog DA9063 PMIC provides a convenient and flexible solution that meets the processor power requirements. Although system power consumption may vary due to the differing demands of peripherals, processor, and so on, the DA9063 has sufficient headroom to meet the power requirements of most i.MX8M Mini system implementations. The features of DA9063 enable significant power saving, such as dynamic voltage control (DVC) which intelligently manages voltage changes. The DA9063 significantly reduces system cost and footprint when compared to an equivalent discrete solution.

This document provides details of integrating the DA9063 into an i.MX8M Mini system, based on the 'i.MX8M Mini - Arm® Cortex®-A53, Cortex-M4, Audio, Voice, Video', platform [1]. General guidance can be found in the other NXP references listed in Section [2]. The focus here is on DA9063 as it creates the lowest cost solution.

4 i.MX8M Mini Power Requirements

All power domains of an i.MX8M Mini processor require precise power management to ensure reliable system operation. The main domains are:

+0v8_VDD_SOC and +0v9_VDD_ARM	supply the internal peripherals and the internal ARM™ cores
+0v8_VDD_SNVS	supply the SNVS regulator for the RTC and SNVS (secure non-volatile storage)

Additional supplies may be required for DDR memory, peripherals, I/O interfaces, USB, and so on. The power management system must also comply with the processor power-up and power-down sequence requirements.

4.1 DA9063 and i.MX8M Mini Power Rails

The supply rails for an i.MX8M Mini system powered by DA9063 are summarized in Table 1.

Table 1: i.MX8M Mini to DA9063 Power Rail Mapping

i.MX8M Mini Rail or System Rail	DA9063 Regulator	Voltage (V)	Sequence Slot	Notes
+0V8_VDD_SOC	Buck Core 1	0.8	4	
+0V9_VDD_DRAM&PU	Buck Core 2	0.9	5	
+0V9_VDD_ARM	Buck Pro	0.9	6	
+1V8	Buck Peri	1.8	7	
+1V1_NVCC_DRAM	Buck Mem	1.1	8	
+3V3	Buck IO	3.3	9	
+0V8_NVDD_SNVS	LDO1	0.8	2	
+0V9_VDD_PHY	LDO2	0.9	5	
+1V8_NVCC_SNVS	LDO3	1.8	1	
NVCC_SD	LDO4	3.3	11	
+1V2_VDD_PHY	LDO5	1.2	10	

DA9063 Power Management Solution for the NXP i.MX8M Mini

i.MX8M Mini Rail or System Rail	DA9063 Regulator	Voltage (V)	Sequence Slot	Notes
Peripherals	LDO6	Not used	0	
+1V5_LDO7	LDO7	1.5	13	
+1V8_LDO8	LDO8	1.8	12	
+2V5_LDO9	LDO9	2.5	13	
+1V0_LDO10	LDO10	1.0	13	
+1V8_VDDA	LDO11	1.8	6	

This mapping is illustrated in the interconnect block diagram of Figure 1.

+1V8_NVCC_SNVS is supplied by LDO3 and must be powered up first in the sequence.

The +0V8_VDD_SOC and +0v9_VDD_ARM domains have significant ohmic drops along these supply rails, the losses can be compensated for by slightly increasing the level. This is achieved by an I^2C software write to DA9063 control VBCORE1_A immediately after system power-up. Additionally, processor efficiency and lifetime can be optimized by reducing the voltage, for example to the recommended typical of 1.00 V, by I^2C register writes after system start-up.

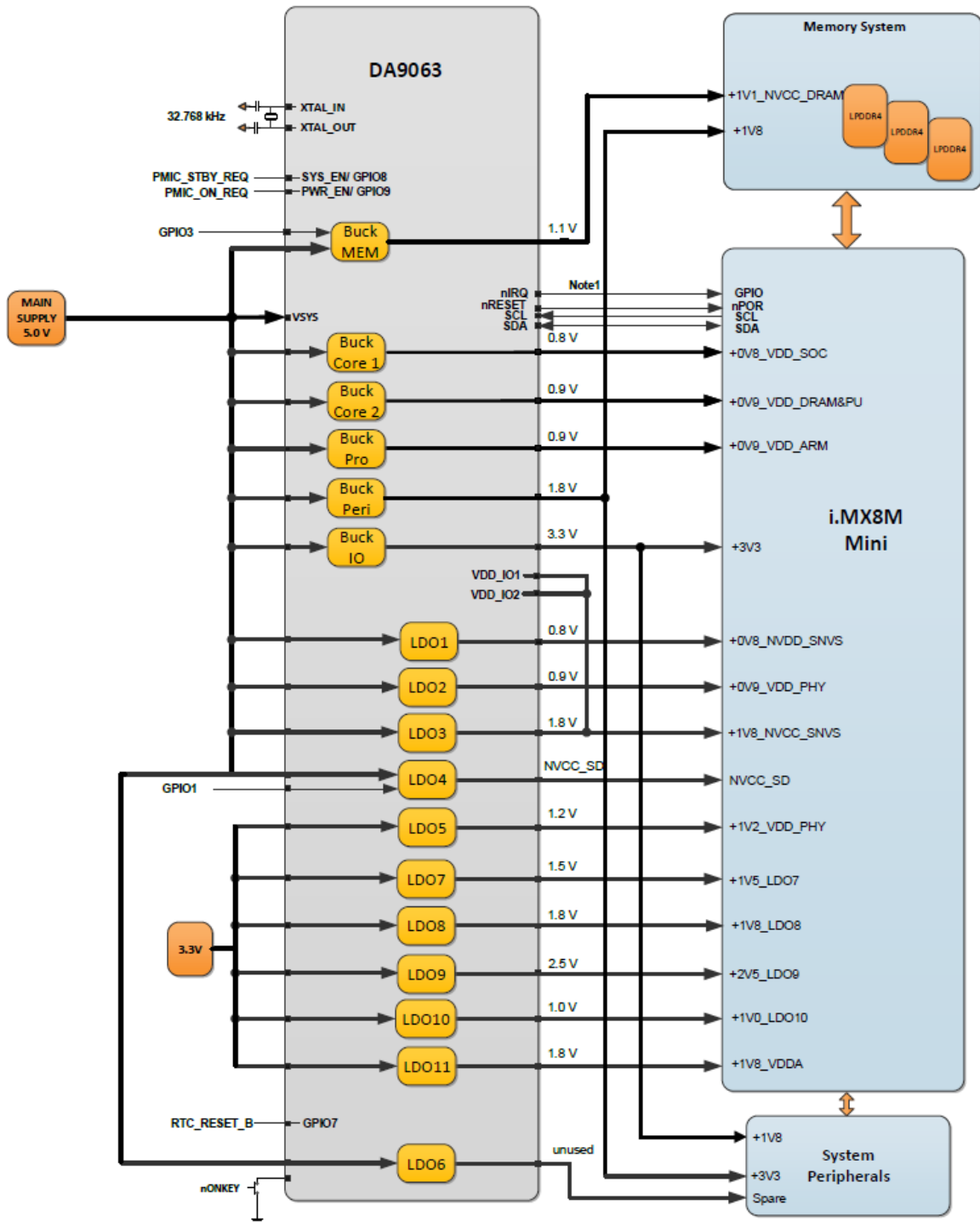# DA9063 Power Management Solution for the NXP i.MX8M Mini

Figure 1: DA9063 Connections to i.MX8M Mini

Note 1   Pull-up resistors for open-drain lines are not shown.

Note 2   DA9063 has the autoboot function enabled in OTP.

4.2   Power-Up Sequence

The sequence used by the standard variants DA9063-84 and DA9063-85 conforms to the requirements described in the i.MX8M Mini datasheet [1].

Figure 2 shows the power-up sequence generated by the DA9063-84 which meets the i.MX8M Mini start-up requirements.
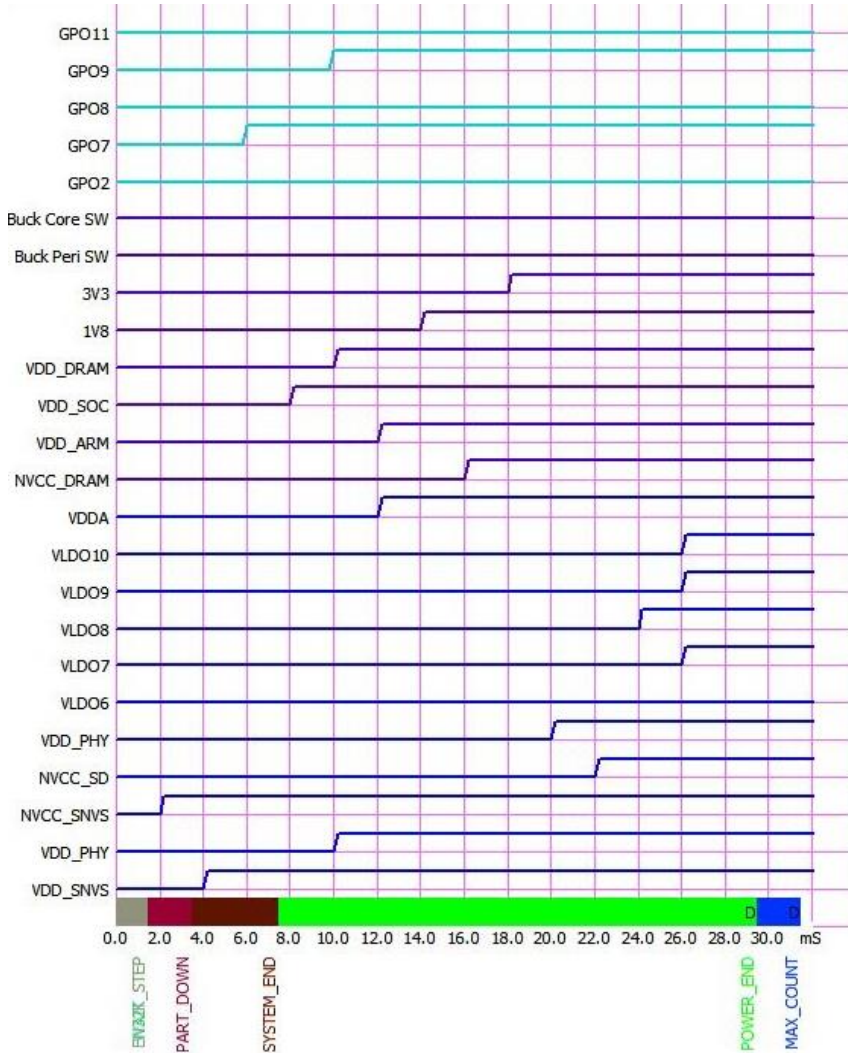

Figure 2: DA9063 Power-Up Sequence

4.3   Power-Down Sequence

The power-down sequence is the reverse of power-up. Therefore, the i.MX8M Mini requirement is met for VDD_SNVS_IN to be turned off last after any other power supply. Restrictions for other supplies are discussed in [1].

4.4   I²C Interface

An I²C interface between the i.MX8M Mini and the DA9063 device allows software, including the operating system kernel, to access the internal PMIC registers for control and monitoring. The slave address of the DA9063 is 0xB0.
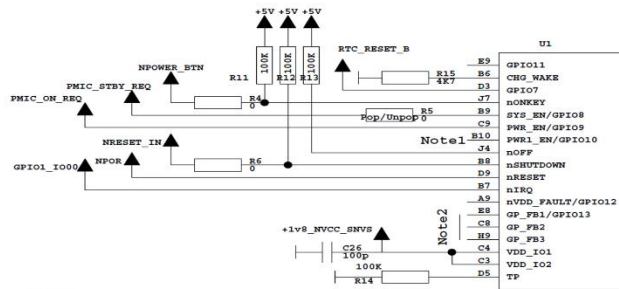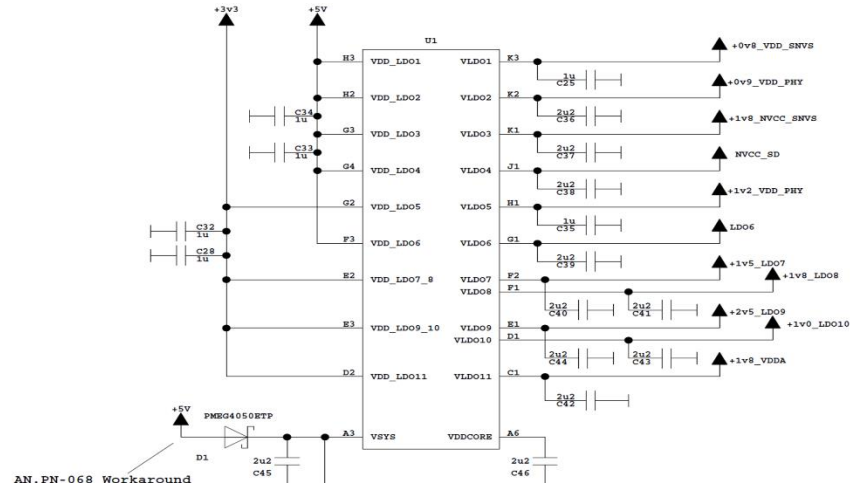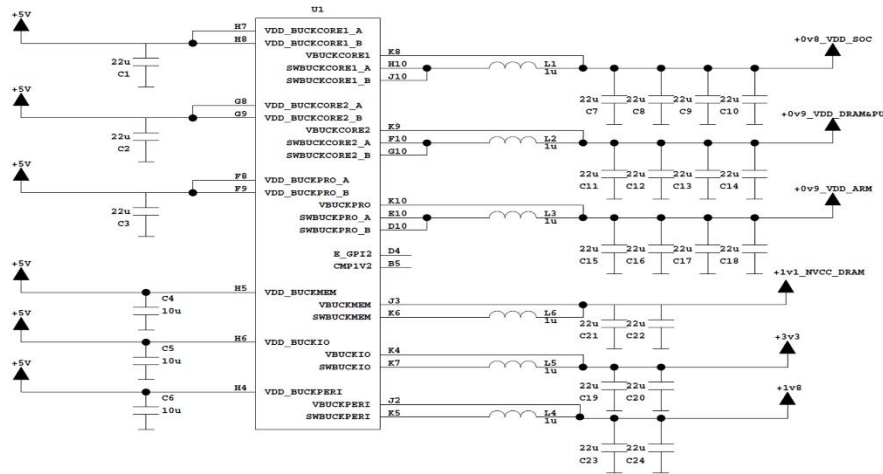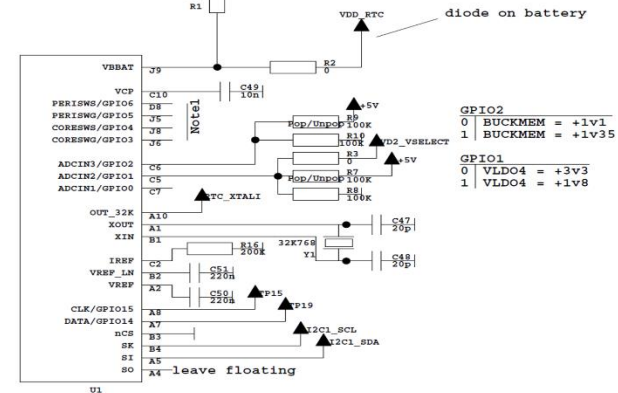
4.5   Typical Application Schematics

Figure 3: DA9063 i.MX8M Mini: Typical Application Schematics

4.6 Recommended External Components

For a list of recommended external components, please refer to the schematics depicted in Figure 3: DA9063 i.MX8M Mini: Typical Application Schematics, and the DA9063 datasheets [5]. The recommended values of inductors and capacitors must be used at the output of all bucks and LDOs to guarantee the closed-loop stability and optimum efficiency of the supplies.

Table 2: DA9063 i.MX8M Mini, External Component List

#	Ref Designator	Value	Tolerance	Rating	Dielectric	Manufacturer	Manufacturer Part Number
1	C1	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
2	C2	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
3	C3	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
4	C7	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
5	C8	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
6	C9	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
7	C10	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
8	C11	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
9	C12	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
10	C13	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
11	C14	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
12	C15	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
13	C16	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
14	C17	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
15	C18	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
16	C19	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
17	C20	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
18	C21	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11

Application Note   **Revision 1.1**   **16-Feb-2022**

#	Ref Designator	Value	Tolerance	Rating	Dielectric	Manufacturer	Manufacturer Part Number
19	C22	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
20	C23	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
21	C24	22u	±20%	6V3	X5R	Murata	GRM155R60J226ME11
22	C47	20p	±5%	50V	COG/NPO	Murata	GRM1555C1H200JA01D
23	C48	20p	±5%	50V	COG/NPO	Murata	GRM1555C1H200JA01D
24	C4	10u	±20%	6V3	X5R	Murata	GRM188R60J106ME47D
25	C5	10u	±20%	6V3	X5R	Murata	GRM188R60J106ME47D
26	C6	10u	±20%	6V3	X5R	Murata	GRM188R60J106ME47D
27	C49	10n	±10%	50V	X7R	Murata	GRM155R71H103KA88D
28	C25	1u	±20%	6V3	X7R	Murata	GRM155R70J105MA12
29	C28	1u	±20%	6V3	X7R	Murata	GRM155R70J105MA12
30	C32	1u	±20%	6V3	X7R	Murata	GRM155R70J105MA12
31	C33	1u	±20%	6V3	X7R	Murata	GRM155R70J105MA12
32	C34	1u	±20%	6V3	X7R	Murata	GRM155R70J105MA12
33	C35	1u	±20%	6V3	X7R	Murata	GRM155R70J105MA12
34	C26	100p	±10%	50V	X7R	Yageo	CC0402KRX7R9BB101
35	C50	220n	±10%	16V	X7R	Taiyo Yuden	EMK105B7224KV-FR
36	C51	220n	±10%	16V	X7R	Taiyo Yuden	EMK105B7224KV-FR
37	C36	2u2	±20%	6V3	X7T	Murata	GRM155D70J225ME44D
38	C37	2u2	±20%	6V3	X7T	Murata	GRM155D70J225ME44D
39	C38	2u2	±20%	6V3	X7T	Murata	GRM155D70J225ME44D
40	C39	2u2	±20%	6V3	X7T	Murata	GRM155D70J225ME44D

Application Note   **Revision 1.1**   **16-Feb-2022**

#	Ref Designator	Value	Tolerance	Rating	Dielectric	Manufacturer	Manufacturer Part Number
41	C40	2u2	±20%	6V3	X7T	Murata	GRM155D70J225ME44D
42	C41	2u2	±20%	6V3	X7T	Murata	GRM155D70J225ME44D
43	C42	2u2	±20%	6V3	X7T	Murata	GRM155D70J225ME44D
44	C43	2u2	±20%	6V3	X7T	Murata	GRM155D70J225ME44D
45	C44	2u2	±20%	6V3	X7T	Murata	GRM155D70J225ME44D
46	C45	2u2	±20%	6V3	X7T	Murata	GRM155D70J225ME44D
47	C46	2u2	±20%	6V3	X7T	Murata	GRM155D70J225ME44D
48	R1	1M5	±1%	250mW		Yageo	RC1206FR-071M5L
49	R7	100K	±1%	63mW		Yageo	RC0402FR-07100KL
50	R8	100K	±1%	63mW		Yageo	RC0402FR-07100KL
51	R9	100K	±1%	63mW		Yageo	RC0402FR-07100KL
52	R10	100K	±1%	63mW		Yageo	RC0402FR-07100KL
53	R11	100K	±1%	63mW		Yageo	RC0402FR-07100KL
54	R12	100K	±1%	63mW		Yageo	RC0402FR-07100KL
55	R13	100K	±1%	63mW		Yageo	RC0402FR-07100KL
56	R14	100K	±1%	63mW		Yageo	RC0402FR-07100KL
57	R15	4K7	±1%	63mW		Yageo	RC0402FR-074K7L
58	R2	0		250mW		Vishay	CRCW06030000Z0EAHP
59	R3	0		250mW		Vishay	CRCW06030000Z0EAHP
60	R4	0		250mW		Vishay	CRCW06030000Z0EAHP
61	R5	0		250mW		Vishay	CRCW06030000Z0EAHP
62	R6	0		250mW		Vishay	CRCW06030000Z0EAHP
63	R16	200K	±1%	63mW		Bourns	CRT0402-BY-2003GLF
64	L1	1u	±20%	Isat=3.1A		Taiyo Yuden	MAMK2520T1R0M
65	L2	1u	±20%	Isat=3.1A		Taiyo Yuden	MAMK2520T1R0M
66	L3	1u	±20%	Isat=3.1A		Taiyo Yuden	MAMK2520T1R0M

DA9063 Power Management Solution for the NXP i.MX8M Mini

#	Ref Designator	Value	Tolerance	Rating	Dielectric	Manufacturer	Manufacturer Part Number
67	L4	1u	±20%	Isat=3.1A		Taiyo Yuden	MAMK2520T1R0M
68	L5	1u	±20%	Isat=3.1A		Taiyo Yuden	MAMK2520T1R0M
69	L6	1u	±20%	Isat=3.1A		Taiyo Yuden	MAMK2520T1R0M
70	D1	PMEG4050ETP		40V 5A		NXP	PMEG4050ETP
71	Y1	32K768				Abracon	ABS06-32.768KHZ-9-T

5 Scalable Power Management Solutions

Some systems require more regulators than available from the DA9063. This is frequently due to the demands of the peripherals. In these circumstances, other Dialog PMICs in the same family (for example, DA9061, DA9062, and DA9063L) are likely to provide suitable solutions.

6 Software Driver

After the DA9063 has started the i.MX8M Mini system, software can read and write to the PMIC via the I^{2}C bus. This can be used for further PMIC configuration, such as the GPIOs, interrupt servicing, DVC, watchdog keep-alive writes, and so on. Dialog drivers for Linux™ are available in the Linux kernel from https://kernel.org/ [6] or, if interim assistance is required, from a Dialog Sales representative or via the Dialog Discussion Forum.

7 Development Support Tools and PMIC Configuration Files

To assist with hardware and software development, Dialog provides the following:

● DA9063 evaluation kit

The evaluation kit contains motherboard and daughterboard for hardware evaluation and LabVIEW™ [7] GUI

● LabVIEW GUI [7]

This PC-driven software provides easy access to a device under test (DUT). The GUI is used to exercise the DUT using the I^{2}C interface. Control or measurement of analog and digital pins is supported. LabVIEW supports the Dialog PMIC OTP configuration file format – .ini files.

● OTP configuration .ini files

These files define the configuration of the DA9063 at boot and define the different variants such as the -84 and -85. The following ini files are available from the Dialog Support Site:

　○ DA9063-84_iMX8M-Mini_autoboot_v01-23BC.ini (autoboot enabled)

　○ DA9063-85_iMX8M-Mini_non-autoboot_v01-6970.ini (autoboot disabled)

These ini files are opened using the LabVIEW GUI.

● Linux software driver, see [6]

8   Device Identification and Ordering

DA9063-84 has the autoboot feature enabled in OTP. The DA9063-85 has autoboot disabled and is therefore suited for systems requiring an ONKEY wake-up.

If the above standard variants prove unsuitable for your target i.MX8M Mini design, please contact a Dialog sales representative to discuss custom variants (minimum order quantities apply for custom variants) or consider OTP in-circuit programming as described in [3].

Table 3: Product Part Numbers

Part Number	Description (Note 1)
DA9063-84HO1 DA9063-84HO2	Autoboot
DA9063-85HO1 DA9063-85HO2	Non-autoboot

Note 1   See the DA9063 datasheets [5] for further information regarding part ordering. All parts are available in tray (x = 1) or Tape and Reel (x = 2).

Status Definitions

Status	Definition
DRAFT	The content of this document is under review and subject to formal approval, which may result in modifications or additions.
APPROVED or unmarked	The content of this document has been approved for publication.

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