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Power Consumption and Measurement of i.MXRT1015

Rev. 1 — 09/2020 Application Note

Contents

1 Introduction

This document describes the power consumption of the i.MX RT1015 MCUs. It includes the following:

- i.MX RT1015 overview
- Run mode definition and configuration
- Low-power mode definition and configuration
- How to measure the power consumption based on the MIMXRT1015 EVK board
- Power consumption in different power modes

The IAR Embedded Workbench® IDE is used for this application note. The hardware environment is the MIMXRT1015 EVK board (Rev. B).

2 Chip overview

2.1 i.MX RT1015 overview

The i.MX RT1015 MCU is an Arm® Cortex®-M7-based chip that operates at speeds of up to 500 MHz to provide high CPU performance and the best real-time response.

- 128 KB of on-chip RAM, which can be flexibly configured as a TCM or general-purpose on-chip RAM
- Advanced power management module with a DCDC and LDOs to reduce the complexity of the external power supply and simplify the power sequencing
- Rich memory interfaces, including SPI NOR FLASH and a single/dual-channel quad SPI flash with XIP
- Various interfaces for connecting peripherals, such as Bluetooth™ and GPS
- Audio features, including the SPDIF and I^2S audio interfaces
- Rich set of peripheral modules, such as SPI, I^2C, Flex-Timers, ADC, and other
- Targeted at industrial HMI, motor control, and home appliance areas

3 Low power overview

3.1 Power supply

Table 1 shows the power supply rails of the i.MX RT1015 MCUs.

Table 1. External power supply rails

Power rail	Description	MIN (V)	TYP (V)	MAX (V)
DCDC_IN	Power for DCDC	3	3.3	3.6
SOC_IN	Power for SOC	0.925	—	1.3
VDD_HIGH_IN	Power for analog	3	3.3	3.6
VDD_SNVS_IN	Power for SNVS and RTC	2.4	3.0	3.6
USB_OTG_VBUS	Power for USB VBUS	4.4	5.0	5.5
VDDA_ADC	Power for 12-bit ADC	3	3.3	3.6
NVCC_GPIO	IO power for GPIO in NVCC_GPIO bank	3	3.3	3.6

3.2 Run mode

3.2.1 Run mode definition

Table 2. Run mode definition

Run mode	Definition
Overdrive run	• The CPU runs at 500 MHz and the overdrive voltage is 1.275 V. • The bus frequency is 166 MHz. • The whole peripheral is enabled and runs at the target frequency. • All PLLs are enabled.
Full-speed run	• The CPU runs at 396 MHz (full load) and the voltage is 1.15 V. • The bus frequency is 132 MHz. • The whole peripheral is enabled and runs at the target frequency. • All PLLs are enabled.
Low-speed run	• The CPU runs at 132 MHz and the voltage is 1.15 V. • The internal bus frequency is 66 MHz. • Some PLLs are powered down. • 20 % of the peripherals are active, and others are in the low-power mode.
Low-power run	• The CPU runs at 24 MHz and the voltage is 0.95 V. • The internal bus frequency is 12 MHz. • All PLLs are powered down, the OSC24M is powered down, and the RCOSC24 is enabled. • The high-speed peripherals are powered down.

3.2.2 Run mode configurations

Table 3. Run mode configurations

—	Overdrive run	Full-speed run	Low-speed run	Low-power run
CCM LPM mode	RUN	RUN	RUN	RUN
CPU core	500 MHz	396 MHz	132 MHz	24 MHz
L1 cache	ON	ON	ON	ON
FlexRAM	ON	ON	ON	ON
SOC voltage	1.275 V	1.15 V	1.15 V	0.95 V
Analog LDO	ON	ON	ON	In weak mode
24-MHz XTAL OSC	ON	ON	ON	OFF
24-MHz RC OSC	OFF	OFF	OFF	ON
System PLL	ON	ON	ON	OFF
All other PLLs	ON	ON	On as needed	On as needed
Module clock	ON	ON	On as needed	Peripheral clock off
RTC32K	ON	ON	ON	ON

3.3 Low-power mode

3.3.1 Low-power mode definition

Table 4. Low-power mode definition

Low-power mode	Definition
System idle	• The CPU can automatically enter this mode when no thread is running. • All the peripherals can remain active. • The CPU only enters the WFI mode. It has its state retained, so the interrupt response can be very short.
Low-power idle	• This mode has much lower power than the system idle mode and a longer exit time. • All PLLs are shut off and the analog modules run in a low-power mode. • All high-speed peripherals are power-gated and the low-speed peripherals can remain running at a low frequency.
Suspend	• The most power-saving mode with the longest exit time. • All PLLs are shut off, the XTALs are off, and all clocks are shut off (except for the 32-KHz clock). • All high-speed peripherals are power-gated and the low-speed peripherals are clock-gated.

Table continues on the next page...

Table 4. Low-power mode definition (continued)

Low-power mode	Definition
SNVS	• The whole SOC digital logic and the analog modules are shut off (except for the SNVS domain). • The 32-KHz RTC is alive.

3.3.2 Low-power mode configurations

Table 5. Low-power mode configurations

—	System idle	Low-power idle	Suspend	SNVS
CCM LPM Mode	WAIT	WAIT	STOP	—
Arm core (PDM7)	WFI	WFI	Power down	OFF
L1 cache	ON	ON	Power down	OFF
FlexRAM	ON	ON	ON	OFF
SOC voltage	1.15 V	0.95 V	0.925 V	OFF
System PLL	ON	Power down	Power down	OFF
Other PLL	Power down	Power down	Power down	OFF
24-MHz XTAL OSC	ON	OFF	OFF	OFF
24-MHz RC OSC	OFF	ON	OFF	OFF
LDO2P5	ON	OFF	OFF	OFF
LDO1P1	ON	OFF	OFF	OFF
WEAK2P5	OFF	ON	OFF	OFF
WEAK1P1	OFF	ON	OFF	OFF
Bandgap	ON	OFF	OFF	OFF
Low-power bandgap	ON	ON	ON	OFF
AHB clock	33 MHz	12 MHz	OFF	OFF
IPG clock	33 MHz	12 MHz	OFF	OFF
PER clock	33 MHz	12 MHz	OFF	OFF
Module clocks	ON as needed	ON as needed	OFF	OFF
RTC32K	ON	ON	ON	ON

3.3.3 Wakeup source

Table 6. Wakeup source

—	System idle	Low-power idle	Suspend	SNVS
GPIO wakeup	YES	YES	YES	NO
RTC wakeup	YES	YES	YES	YES
USB remote wakeup	YES	YES	YES	NO
Other wakeup sources	YES	YES	YES	NO

NOTE

No matter whether in the system idle, low-power idle, or suspend mode, enable the wakeup interrupt in the GPC module or the wakeup fails.

4 How to measure power consumption on MIMXRT1015 EVK

4.1 Current measurements on EVK

In this application note, the current value of `DCDC_IN` (**J37**), `VDD_HIGH_IN` (**J5**), and `VDD_SNVS_IN` (**J6**) is measured.

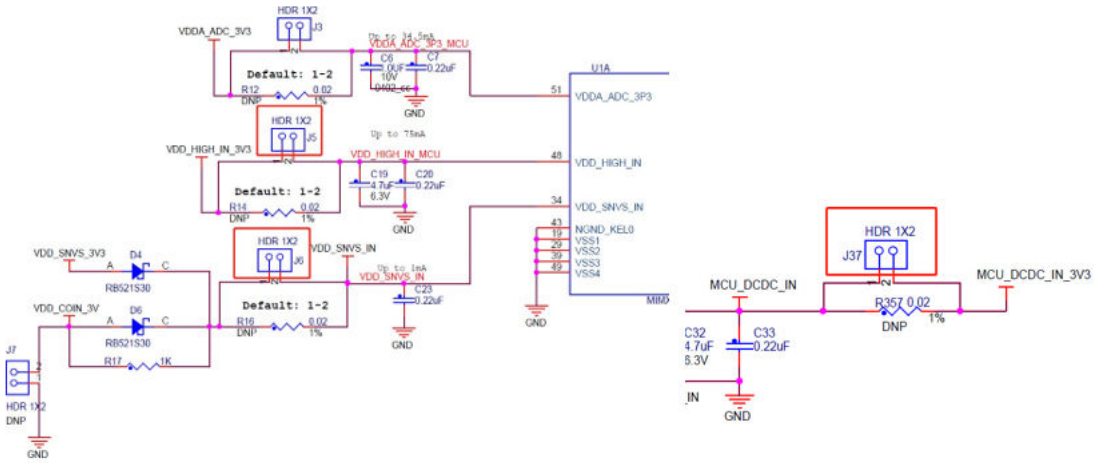

Figure 1. Test points for DCDC_IN, VDD_HIGH_IN, and VDD_SNVS_IN

4.2 How to measurement an accurate value for SNVS domain

To measure the accurate current value of the SNVS, remove resistors R22 and R401. These circuits consume more current.

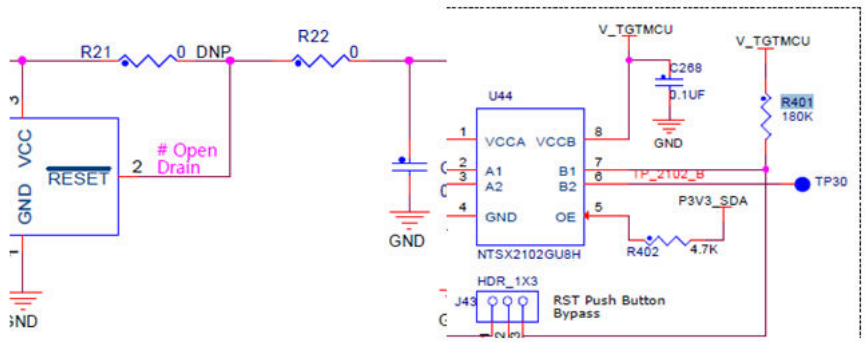

Figure 2. Removing resistors R22 and R401

5 Power consumption results

5.1 Run mode

The power consumption in Table 7 is measured with the CoreMark benchmark project.

Table 7. Power consumption results

Power rail[1]	Overdrive1 (500 MHz)[2]			Full-speed run2 (396 MHz)[3]			Low-speed run3 (132 MHz)[4]			Low-power run4 (24 MHz)[5]		
	Voltage (V)	Current (mA)	Power (mW)	Voltage (V)	Current (mA)	Power (mW)	Voltage (V)	Current (mA)	Power (mW)	Voltage (V)	Current (mA)	Power (mW)
DCDC_IN	3.3000	51.9517	171.4405	3.3000	38.011	125.435	3.3000	17.3879	57.3799	3.3000	4.8158	15.8921
VDD_HIGH_IN	3.3000	13.2427	43.7007	3.3000	13.1679	43.4540	3.3000	6.5346	21.5641	3.3000	0.2564	0.8460
VDD_SNVS_IN	3.3000	0.0430	0.1419	3.3000	0.0443	0.1461	3.3000	0.0302	0.0997	3.3000	0.0432	0.1424

1. All the power consumption values are typical for the silicon at 25 °C.
2. Overdrive: The CPU runs at 500 MHz, all peripherals are enabled and running at the target frequency.
3. Full-speed run: The CPU runs at 396 MHz, all peripherals are enabled and running at the target frequency.
4. Low-speed run: The CPU runs at 132 MHz and 20 % of the peripherals are active.
5. Low-power run: The CPU runs at 24 MHz and only the low-speed peripherals are active (such as UART/I2C).

5.2 Low-power mode

The power consumption in Table 8 is measured with the power mode switch project. The demo project is in the attachments.

NOTE

Because the Discontinuous Conduction Mode (DCM) can increase the efficiency of the DCDC in the case of low current loading, it is always recommended.

Table 8. Power consumption results

Power rail[1]	System idle			Low-power idle			Suspend			SNVS2[2]		
	Voltage (V)	Current (mA)	Power (mW)	Voltage (V)	Current (mA)	Power (mW)	Voltage (V)	Current (mA)	Power (mW)	Voltage (V)	Current (mA)	Power (mW)
DCDC_IN	3.3000	5.7722	19.0483	3.3000	0.9858	3.2530	3.3000	0.1743	0.575	0	0	0
VDD_HIGH_IN	3.3000	5.1737	17.0731	3.3000	0.2404	0.7933	3.3000	0.0191	0.063	0	0	0
VDD_SNVS_IN	3.3000	0.0221	0.0730	3.3000	0.0417	0.1376	3.3000	0.0161	0.053	3.3000	0.01376	0.04541

1. All the power consumption values are typical for the silicon at 25 °C.
2. SNVS: SNVS mode with the RTC working.

NOTE

To reduce power consumption, VDD_SNVS_IN is powered by VDD_HIGH_IN, except for the low-power idle, suspend, and SNVS modes.

6 Conclusion

This document describes how to measure the power consumption on the i.MX RT based on the MIMXRT1015 EVK (Rev B) board. For more details on designing low-power applications, see *How to use iMXRT Low Power Feature* (document AN12085).

7 Revision history

Table 9. Revision history

Rev.	Date	Description
0	02/2019	Initial release
1	09/2020	Updated Table 8

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Date of release: 09/2020

Document identifier: AN12345

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