GigaDevice Semiconductor Inc.

GD32 MCU Power Consumption Testing Process

Application Note
AN105

Revision 1.1

(Oct. 2026)

Table of Contents

Table of Contents 1
List of Figures 2
List of Tables 3
1. Introduction 4
2. Power consumption testing process 5
2.1. Preparation of test tools 5
2.2. Power consumption testing setting 5
2.3. Testing process 6
2.4. General Problems 8
2.5. Case description 9
3. Summary 11
4. Revision history 12

List of Figures

Figure 2-1. Schematic diagram of hardware connection for test 7
Figure 2-2. Hardware cable connections for Battery supply test 8
Figure 2-3. Power consumption characteristic 10

List of Tables

Table 4-1. Revision history 12

1. Introduction

This application note is provided for GD32 MCUs. It mainly describes the power consumption test procedure, including instrument selection and usage requirements, hardware circuit design, software code usage, and test data recording, so as to obtain accurate power consumption data.

Note: This application note is for reference only. In case of any conflict with the user manual or datasheet, the user manual or datasheet shall prevail.

2. Power consumption testing process

2.1. Preparation of test tools

MCU power consumption testing generally requires the following tools:

1. MCU samples under test. In general, at least three samples from the same batch and process should be selected as devices under test. After receiving the samples, first check whether the package marking is clear and whether the pins are clean, not bent, and not damaged.

2. Minimum system board. Only the power supply, crystal input pins, reset, download interface, and BOOT pins should be retained, so that unnecessary external circuit current does not affect the test result.

3. Multimeter, used to measure the input current of the MCU under test. A multimeter with at least 4.5 digits should be used. If possible, an instrument with a higher resolution is recommended to ensure accurate and reliable test data. During the test, connect the multimeter probes according to the current measurement method and set the instrument to the DC current range.

4. Signal generator, used to provide an external active clock for the MCU under test in some test scenarios. A signal generator with a frequency of 30 MHz, 16-bit resolution, and a sampling rate above 250 Msa/s is recommended.

5. DC digital power supply, adjusted according to the test requirements.

6. J-Link debugger, used for downloading test code.

7. If batch testing or automatic data recording is required, the above tools may be supplemented with a multimeter or power analyzer that supports remote reading, a debugger, a register description file matching the MCU under test, and a test environment capable of register access and instrument communication. Such auxiliary conditions are used to improve repeated testing and data recording efficiency. Before testing, still confirm that the instrument range, current input wiring, and target board power supply path meet the power consumption test requirements.

2.2. Power consumption testing setting

Hardware configuration

Based on a comprehensive consideration of the user's performance and power consumption requirements, select an appropriate supply voltage and crystal input by referring to the clock tree in the User Manual and the Power Consumption section of the Datasheet, and configure the clock source to the desired main frequency by operating the frequency dividers and multipliers.

Select a stable voltage source appropriate for the specific product and adjust the voltage to 3.3 V / 5 V. Most products operate on a 3.3 V supply, while some automotive-grade devices support both 5 V and 3.3 V supply voltages. The crystal input supports both crystal resonators and active oscillator modules; refer to the crystal input range specified in the clock tree section of the chip's User Manual to select a suitable crystal. When using a signal generator, connect its ground to the target board ground and its output to the designated MCU clock input pin. Enable the MCU's oscillator bypass mode as specified in the device manual. After confirming that the target device supports the corresponding frequency and input level, a 2 MHz or 4 MHz square wave with a 50% duty cycle may be used. Set the signal generator's load option to High-Z; if the target input accepts a 0–3.3 V clock signal, set the peak-to-peak voltage to 3.3 V with a DC offset of 1.65 V, and verify the actual voltage and waveform at the MCU pin.

Software configuration

Peripheral configuration. Software developers should enable or disable the corresponding peripheral clocks through library functions or registers according to the user manual, and clearly define the state of the peripherals involved under each test condition. If peripheral power consumption comparison is required, only the target peripheral state should be changed while the supply voltage, system clock, GPIO configuration, low-power mode, and test temperature remain consistent. If conditions allow, read the related registers to confirm that the configuration has taken effect. If the peripheral state difference is tested in Sleep mode, it is recommended that the firmware complete the basic initialization and then enter Sleep mode after a delay. During the test, allow sufficient time for the current to stabilize before taking measurements.

I/O port configuration. Before entering low power mode, all unused I/O pins need to be configured as analog inputs. For a device in a smaller package, apply the GPIO configuration for the largest package of the same device, including unused GPIOs that are implemented and configurable but not bonded out in the selected package. Add a delay before reconfiguring the debug pins to allow the debugger to connect for subsequent firmware downloads.

Low-power mode selection. Configure the firmware for the required low-power mode according to the test conditions specified in the Power Consumption section of the datasheet. After entering the low power mode, the power consumption is close to that of the datasheet.

2.3. Testing process

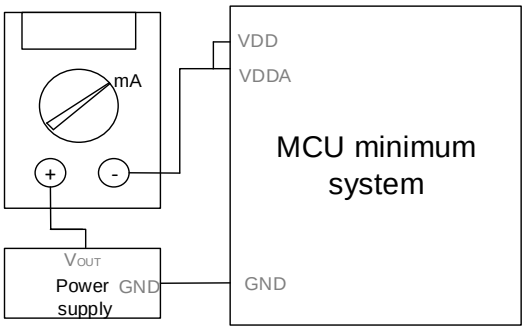
The hardware and software test conditions of each mode are different. After understanding the basic requirements of each mode, you can perform the test in the following sequence to simplify the process, save time and cost, and reduce wear caused by repeated connection and disconnection.

Main Power Supply Test (VDD/VDDA)

Select appropriate power supply, external crystal / signal source, and configure BOOT pins to form the MCU minimum system. The actual power consumption of "I_{VDD}+I_{VDDA}" under different

power consumption modes can be tested by connecting the ammeter in series in the minimum system of power supply and MCU according to the power consumption section of the datasheet, as shown in ***Figure 2-1. Schematic diagram of hardware connection for test.*** The test code is generally prepared by the software developers and written according to the power mode conditions specified in the datasheet. If there are special values for clock frequency or supply voltage, the test conditions must be configured separately. Download the code into the MCU, then disconnect the minimum system board from the debugging tool. Power off and restart the power supply to generate a power-on reset and disable the internal debug circuitry. Measure the corresponding power consumption, and wait for the ammeter reading to stabilize before recording the data.

Figure 2-1. Schematic diagram of hardware connection for test

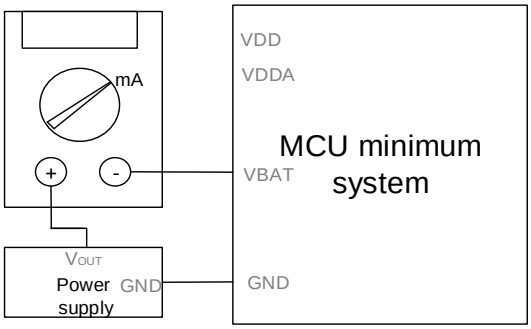


VBAT Power Supply Test

As shown in ***Figure 2-2. Hardware cable connections for Battery supply test***, for devices that support VBAT supply, after the main power supply is removed, the backup domain can be powered by a battery or other backup power source connected to the VBAT pin. During testing, VBAT should be connected and confirmed to be supplying power normally before the main power supply is removed. For devices that support four LXTAL drive strength levels, test all four drive configurations under VBAT power: LXTAL high drive, LXTAL medium-high drive, LXTAL medium-low drive, and LXTAL low drive. Each LXTAL drive level should be configured and tested separately.

First, with VDD and VDDA normally powered, download and run the initialization program to complete the backup domain configuration required for this test, and wait for the LXTAL oscillator to start up and stabilize. After confirming that VBAT is supplying power normally, disconnect the debugger and any other connections that may back-feed the MCU through external pins, then remove the VDD and VDDA main power supplies while keeping VBAT continuously powered. After the current stabilizes, measure and record the VBAT input current. When changing the VBAT test voltage, ensure that the power supply is not interrupted and that the voltage remains within the operating range specified for the device. If a power loss or reset occurs in the backup domain, restore the main power supply and repeat the initialization before proceeding with the measurement.

Figure 2-2. Hardware cable connections for Battery supply test



Peripheral Power Consumption Comparison

The above procedure obtains the overall current under a certain power mode. If it is necessary to further analyze the impact of a single peripheral or peripheral clock on the overall power consumption, peripheral power consumption comparison can be performed under the same hardware power supply, clock configuration, and low-power mode. This test keeps the overall power consumption test conditions unchanged and changes only the enabled or disabled state of the target peripheral, so as to evaluate the incremental impact of the peripheral on the system current.

Before testing, confirm that the MCU under test, test firmware, instrument connection, and peripheral configuration method are consistent. Peripheral test items should be configured in enabled and disabled pairs. Before each test, perform the same initialization and ensure that the same preconditions are met, then set the target peripheral to the enabled or disabled state. If necessary, read the related registers to confirm the configuration result, and then collect the current after the MCU enters a stable state.

For the same peripheral, multiple samples may be collected and averaged. The sampling interval and waiting time should be determined according to the instrument response speed, peripheral stabilization time, and low-power mode entry time. The incremental power consumption of a single peripheral can be calculated by subtracting the disabled-state current from the enabled-state current, namely $I_{peripheral} = I_{ON} - I_{OFF}$. If there are many test items, record the peripheral name, enabled current, disabled current, incremental current, test voltage, system clock, and test temperature in a unified format for later comparison with the datasheet, samples from the same batch, and historical test results.

2.4. General Problems

Code download exception

"No Cortex-M SW Device Found" is displayed. Check whether all the connections are correct and whether there is bad contact; Check whether the SWD/JTAG pins have been reconfigured as analog inputs. If the first download is normal and the second download is abnormal, check whether the system clock Settings and waiting time are correct. If the Settings are not correct, the download port will be configured as an analog input mode after the program is downloaded for the first time, making the MCU no longer recognized and unable to perform

subsequent downloads. At this point, we need to put MCU into ISP mode and erase the main Flash memory using an appropriate tool. Correct the code configuration and download the firmware again.

The message "Cannot Load Flash Device Description" is displayed. Verify that the appropriate device support pack is installed and that the correct MCU model is selected in Keil's Options for Target dialog. Check all connections for missing jumpers or poor contact.

The message "Cannot Load Flash Programing Algorithm" is displayed. In Keil's Flash Download settings, verify that the selected programming algorithm matches the target MCU and Flash size, and that the RAM for Algorithm settings are correct.

Data deviation

Each test item has a reference value. When the measured value has a large deviation from the reference value, check the following items: whether there are other external conductive paths in the hardware test system causing leakage current; whether the source of the reference value is clear; whether power consumption differences are caused by power reduction optimization or functional changes; and whether the code meets the power consumption test requirements, such as whether GPIOs are configured as analog inputs, whether all peripherals are enabled or disabled as required, whether registers are configured successfully, and whether the system clock is configured correctly. To check whether the system clock is configured correctly, first check whether the code parameters are correct, and then output the system clock on PA8 and observe the clock frequency with an oscilloscope. If peripheral power consumption comparison is performed, also check whether the target peripheral enabled / disabled test items are paired, whether the preconditions are consistent, whether the related register configuration has taken effect, whether the peripheral is reconfigured by the firmware, and whether the MCU has entered the expected low-power mode. If the instrument reading fluctuates greatly, check the current range, sampling interval, test delay, power cable contact, and whether there are other leakage paths on the minimum system board.

2.5. Case description

Take the GD32F303 series as an example. Configure the test setup according to the conditions specified in the datasheet, as shown in ***Figure 2-3. Power consumption characteristic.*** Use a 3.3 V MCU supply and an 8 MHz external crystal resonator. Configure the LDO in low-power mode, disable IRC40K and the RTC, and configure all GPIOs as analog inputs before entering deep-sleep mode. At 25 °C, the referenced datasheet specifies a typical current of 159.8 μA and a maximum current of 1100 μA under these conditions. The typical value must not be used as a lower acceptance limit.

Figure 2-3. Power consumption characteristic

Symbol	Parameter	Conditions	Typ(1)		Max	Unit
			T_A= 25℃	T_A= 85℃	T_A= 25℃	
		V_{DD} = V_{DDA} = 3.3 V, HXTAL = 8 MHz, System Clock = 8 MHz, CPU clock off, All peripherals disabled	2.2	3.4	—	mA
	Supply current (Deep-Sleep mode)	V_{DD} = V_{DDA} = 3.3 V, LDO in run mode, IRC40K off, RTC off, All GPIOs analog mode	189.5	1159.3	1100	µA
		V_{DD} = V_{DDA} = 3.3 V, LDO in low power mode, IRC40K off, RTC off, All GPIOs analog mode	159.8	1124.0	1100	µA
		V_{DD} = V_{DDA} = 3.3 V, Main LDO in under drive mode, IRC40K off, RTC off, All GPIOs analog mode	162.8	944.0	1100	µA
		V_{DD} = V_{DDA} = 3.3 V, Low Power LDO in under drive mode, IRC40K off, RTC off, All GPIOs analog mode	133.0	910.3	1100	µA

3. Summary

Based on the measured application time and current consumption of the MCU in each mode, the average current consumption can be estimated in the actual application, enabling the user to calculate how long the MCU can operate continuously under battery power. In general, test results obtained through the standard test procedure are close to the datasheet values; due to individual device variations, the measured current may deviate from the typical values in the datasheet. Whether the device meets the specification should be determined based on the corresponding test conditions and the limits specified in the datasheet; a measurement that exceeds the applicable limits should not simply be attributed to individual device variation.

4. Revision history

Table 4-1. Revision history

Revision No.	Description	Date
1.0	Initial Release	Apr.7, 2023
1.1	Added peripheral power consumption comparison test description	July.11, 2026

Important Notice

This document is the property of GigaDevice Semiconductor Inc. and its subsidiaries (the "Company"). This document, including any product of the Company described in this document (the “Product”), is owned by the Company according to the laws of the People’s Republic of China and other applicable laws. The Company reserves all rights under such laws and no Intellectual Property Rights are transferred (either wholly or partially) or licensed by the Company (either expressly or impliedly) herein. The names and brands of third party referred thereto (if any) are the property of their respective owner and referred to for identification purposes only.

To the maximum extent permitted by applicable law, the Company makes no representations or warranties of any kind, express or implied, with regard to the merchantability and the fitness for a particular purpose of the Product, nor does the Company assume any liability arising out of the application or use of any Product. Any information provided in this document is provided only for reference purposes. It is the sole responsibility of the user of this document to determine whether the Product is suitable and fit for its applications and products planned, and properly design, program, and test the functionality and safety of its applications and products planned using the Product. The Product is designed, developed, and/or manufactured for ordinary business, industrial, personal, and/or household applications only, and the Product is not designed or intended for use in (i) safety critical applications such as weapons systems, nuclear facilities, atomic energy controller, combustion controller, aeronautic or aerospace applications, traffic signal instruments, pollution control or hazardous substance management; (ii) life-support systems, other medical equipment or systems (including life support equipment and surgical implants); (iii) automotive applications or environments, including but not limited to applications for active and passive safety of automobiles (regardless of front market or aftermarket), for example, EPS, braking, ADAS (camera/fusion), EMS, TCU, BMS, BSG, TPMS, Airbag, Suspension, DMS, ICMS, Domain, ESC, DCDC, e-clutch, advanced-lighting, etc.. Automobile herein means a vehicle propelled by a self-contained motor, engine or the like, such as, without limitation, cars, trucks, motorcycles, electric cars, and other transportation devices; and/or (iv) other uses where the failure of the device or the Product can reasonably be expected to result in personal injury, death, or severe property or environmental damage (collectively "Unintended Uses"). Customers shall take any and all actions to ensure the Product meets the applicable laws and regulations. The Company is not liable for, in whole or in part, and customers shall hereby release the Company as well as its suppliers and/or distributors from, any claim, damage, or other liability arising from or related to all Unintended Uses of the Product. Customers shall indemnify and hold the Company, and its officers, employees, subsidiaries, affiliates as well as its suppliers and/or distributors harmless from and against all claims, costs, damages, and other liabilities, including claims for personal injury or death, arising from or related to any Unintended Uses of the Product.

Information in this document is provided solely in connection with the Product. The Company reserves the right to make changes, corrections, modifications or improvements to this document and the Product described herein at any time without notice. The Company shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to them. Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2026 GigaDevice Semiconductor Inc. – All rights reserved