AN0002.2: EFM32 and EFR32 Wireless Gecko Series 2 Hardware Design Considerations

This application note details hardware design considerations for EFM32 and EFR32 Wireless Gecko Series 2 devices. For hardware design considerations for EFM32 and EZR32 Wireless MCU Series 0 and EFM32 and EFR32 Wireless Gecko Series 1 devices, refer to AN0002.0: EFM32 and EZR32 Wireless MCU Series 0 Hardware Design Considerations and AN0002.1: EFM32 and EFR32 Wireless MCU Series 1 Hardware Design Considerations, respectively.

Topics specifically covered are supported power supply configurations, supply filtering considerations, debug interface connections, and external clock sources.

For more information on hardware design considerations for the radio portion of EFM32 and EFR32 Wireless Gecko Series 2 devices, see AN930.2: EFR32 Series 2 2.4 GHz Matching Guide, AN933.2: EFR32 Series 2 2.4 GHz Minimal BOM, and AN928.2: EFR32 Series 2 Layout Design Guide.

KEY POINTS

- Decoupling capacitors are crucial to ensuring the integrity of the device's power supplies.
- The debug interface consists of two communication pins (SWCLK and SWDIO).
- External clock sources must be connected to the device correctly for proper operation.

1. Device Compatibility

This application note supports multiple device families, and some functionality is different depending on the device.

EFR32 Wireless Gecko Series 2 consists of:

- EFR32BG21
- EFR32MG21
- EFR32BG22
- EFR32FG22
- EFR32MG22
- EFR32FG23
- EFR32ZG23

EFM32 Series 2 consists of:

- EFM32PG22

2. Power Supply Overview

2.1 Introduction

Although the EFM32 and EFR32 Wireless Gecko Series 2 devices have very low average current consumption, proper decoupling is crucial. As for all digital circuits, current is drawn in short pulses corresponding to the clock edges. Particularly when several I/O lines are switching simultaneously, transient current pulses on the power supply can be on the order of several hundred mA for a few nanoseconds, even though the average current consumption is quite small.

These kinds of transient currents cannot be properly delivered over high impedance power supply lines without introducing considerable noise in the supply voltage. To reduce this noise, decoupling capacitors are employed to supplement the current during these short transients.

2.2 Decoupling Capacitors

Decoupling capacitors make the current loop between supply, MCU, and ground as short as possible for high frequency transients. Therefore, all decoupling capacitors should be placed as close as possible to each of their respective power supply pins, ground pins, and PCB (Printed Circuit Board) ground planes.

All external decoupling capacitors should have a temperature range reflecting the environment in which the application will be used. For example, a suitable choice might be X5R ceramic capacitors with a change in capacitance of ±15% over the temperature range -55 to +85 °C (standard temperature range devices) or -55 to +125 °C (extended temperature range devices).

For regulator output capacitors (DECOUPLE, VREGSW, and VREGO, if available), the system designer should pay particular attention to the characteristics of the capacitor over temperature and bias voltage. Some capacitors (particularly those in smaller packages or using cheaper dielectrics) can experience a dramatic reduction in capacitance value across temperature or as the DC bias voltage increases. Any change pushing the regulator output capacitance outside the data sheet specified limits may result in output instability on that supply.

2.3 Power Supply Requirements

An important consideration for all devices is the voltage requirements and dependencies between the power supply pins. The system designer needs to ensure that these power supply requirements are met, regardless of power configuration or topology. These internal relationships between the external voltages applied to the various EFM32 and EFR32 supply pins are defined below. Failure to observe the below constraints can result in damage to the device and/or increased current draw. Refer to the device data sheet for absolute maximum ratings and additional details regarding relative system voltage constraints.

EFM32 Series 2 Power Supply Requirements

- AVDD and IOVDD — No dependency on each other or any other supply pin
- VREGVDD ≥ DVDD
- DVDD ≥ DECOUPLE

EFR32 Wireless Gecko Series 2 Power Supply Requirements

- AVDD and IOVDD — No dependency on each other or any other supply pin
- VREGVDD ≥ DVDD
- DVDD ≥ DECOUPLE
- PAVDD ≥ RFVDD

Note: To use an EFR32 Wireless Gecko Series 2 as a MCU in a non-wireless application, connect the radio-related pins as follows:
- PAVDD = RFVDD = DVDD
- RF2G4_IO P/N = NC

Note:
- EFR32xG21 devices do not have an on-chip DC-to-DC converter and thus do not have a VREGVDD supply pin.

Power Supply Pin Overview

Note that not all supply pins exist on all devices. The table below provides an overview of the available power supply pins.

Table 2.1. Power Supply Pin Overview

Pin Name	Product Family	Description
AVDD	All devices	Supply to analog peripherals
DECOUPLE	All devices	Output of the internal digital LDO and digital logic supply input
IOVDD	All devices	GPIO supply voltage
VREGVDD	All DC-DC-enabled devices	Input to the DC-DC converter
VREGSW	All DC-DC-enabled devices	DC-DC powertrain switching node
VREGVSS	All DC-DC-enabled devices	DC-DC ground
DVDD	All devices	Input to the internal digital LDO
RFVDD	EFR32 Wireless Gecko Series 2 only	Supply to radio analog and HFXO
PAVDD	EFR32 Wireless Gecko Series 2 only	Supply to radio power amplifier

2.4 DVDD and DECOUPLE

All EFM32 and EFR32 Wireless Gecko Series 2 devices include an internal linear regulator that powers the core digital logic. The DECOUPLE pin is the output of the digital LDO and requires a 1 µF capacitor. For better high frequency noise suppression, a 0.1 µF capacitor can be placed in parallel with the 1 µF capacitor on the DECOUPLE pin.

As mentioned in section 2.2 Decoupling Capacitors, care should be taken in the selection of regulator output decoupling capacitors, such as for DECOUPLE, to ensure that changes in system temperature and bias voltage do not cause capacitance changes that fall outside of the data sheet specified limits and which could destabilize the regulator output.

EFM32 and EFR32 Wireless Gecko Series 2 DVDD Pin

On EFM32 and EFR32 Wireless Gecko Series 2 devices, the input supply to the digital LDO is the DVDD pin and the DECOUPLE pin is the output of the LDO. Decoupling of DVDD should include a bulk capacitor of C_{DVDD} and this bulk capacitor should be at least 2.7 µF (2.2 µF for EFR32xG21). For better high frequency noise suppression a 0.1 µF capacitor (C_{DVDD1}) can be placed in parallel with the C_{DVDD} capacitor on the DVDD pin. A similar 0.1 µF capacitor may also be added in parallel with $C_{DECOUPLE}$ to further improve high frequency noise suppression.

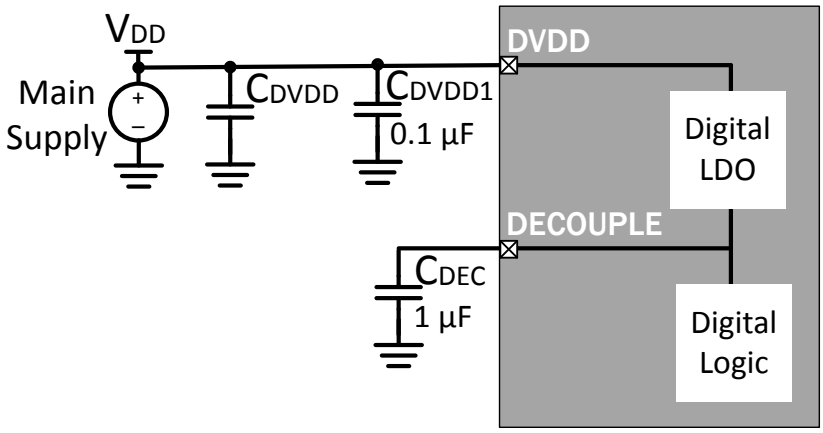

Figure 2.1. DVDD and DECOUPLE on EFM32 and EFR32 Wireless Gecko Series 2 Devices

Note:

- The DECOUPLE pin cannot be used to power any external circuitry. Although DECOUPLE is connected to the output of the internal digital LDO, it is provided solely for the purpose of decoupling this supply and is not intended to power anything other than the internal digital logic of the device.
- When the on-chip DC-to-DC converter is used to power DVDD, the 1 µF C_{DVDD} bulk capacitor is not required. Instead, decoupling of DVDD is provided by the 4.7 µF C_{DCDC} load capacitor as shown in 3.4 EFM32 and EFR32 Wireless Gecko Series 2 — DCDC Example. This capacitor should be placed close to the L_{DCDC} inductor and the VREGSW pin.

2.5 IOVDD

The IOVDD pin(s) provide decoupling for all of the GPIO pins on the device. For proper decoupling when powering IOVDD from the main supply, include a 0.1 µF capacitor per IOVDD pin, along with a 1 µF bulk capacitor. Increase the bulk capacitor value in applications using GPIO to drive heavy and dynamic loads.

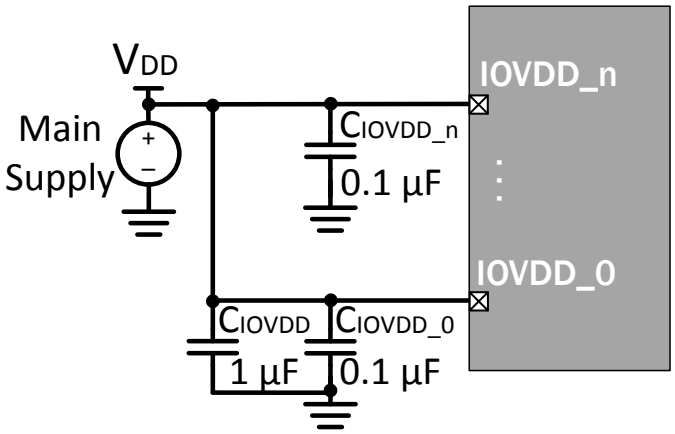

Figure 2.2. IOVDD Decoupling

IOVDD can optionally be driven by the output of the DC-to-DC converter when present on a device. This is primarily used when connecting to external devices with different operating voltages than the microcontroller. When powering IOVDD from the output of the DC-to-DC converter, the bulk 1 µF capacitor is not required because the DCDC's 4.7 µF load capacitor fulfills this requirement.

Note: When powering IOVDD from the output of the DCDC, the debug interface must connect the V_{target} pin to IOVDD, and not the main supply. See the 4. Debug Interface and External Reset Pin section for information on the V_{target} pin.

2.6 AVDD

The analog peripheral performance of the device is impacted by the quality of the AVDD power supply. For applications with less demanding analog performance, a simpler decoupling scheme for AVDD may be acceptable. For applications requiring the highest quality analog performance, more robust decoupling and filtering is required.

Note that the number of AVDD analog power pins may vary by device and package.

2.6.1 AVDD Standard Decoupling

The figure below illustrates a standard approach for decoupling the AVDD pin(s). In general, one 1 µF bulk capacitor (C_{AVDD}), as well as one 10 nF capacitor for each AVDD pin (C_{AVDD_0} through C_{AVDD_n}), must be provided.

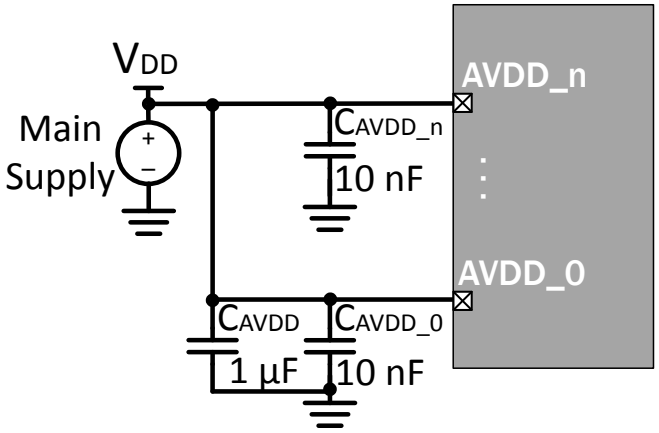

Figure 2.3. AVDD Standard Decoupling

2.6.2 AVDD Improved Decoupling

The figure below illustrates an improved approach for decoupling and filtering the AVDD pin(s). In general, one 1 µF bulk capacitor (C_{AVDD}), as well as one 10 nF capacitor for each AVDD pin (C_{AVDD_0} through C_{AVDD_n}), must be provided. In addition, a ferrite bead and series 1 Ω resistor provide additional power supply filtering and isolation and is preferred when higher ADC accuracy is required.

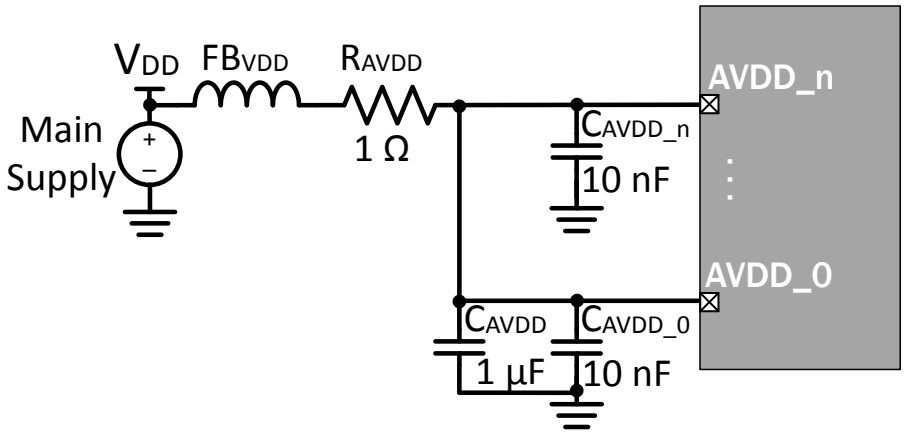

Figure 2.4. AVDD Improved Decoupling

Note: AVDD can be driven by the output of the DCDC, when present on a device, so long as analog peripheral inputs are limited to the lower of AVDD and IOVDD. For example, in a system with 3.3 V digital I/O, the current draw of analog peripherals, such as the IADC, can be reduced by allowing the DCDC to supply AVDD and by limiting analog inputs to 1.8 V.

The table below lists some recommended ferrite bead part numbers suitable for AVDD filtering.

Table 2.2. Recommended Ferrite Beads

Manufacturer	Part Number	Impedance	I_{MAX} (mA)	DCR (Ω)	Operating Temperature (°C)	Package
Würth Electronics	74279266	1 kΩ @ 100 MHz	200	0.600	-55 to +125	0603/1608
Würth Electronics	742692004	240 Ω @ 100 MHz	200	0.750	-55 to +125	0201/0603
Murata	BLM21BD102SN1D	1 kΩ @ 100 MHz	200	0.400	-55 to +125	0805/2012

2.7 DC-to-DC Converter

Some EFM32 and EFR32 Wireless Gecko Series 2 devices provide an on-chip DC-to-DC converter (DCDC) that can be used for improved energy efficiency. However, the additional switching noise present on the DCDC output (V_{DCDC}), necessitates the use of specific filtering components.

2.7.1 DCDC — Unused

When the DCDC is not used, the DVDD pin is shorted to the VREGVDD pin. VREGSW must be left floating, and VREGVSS is grounded.

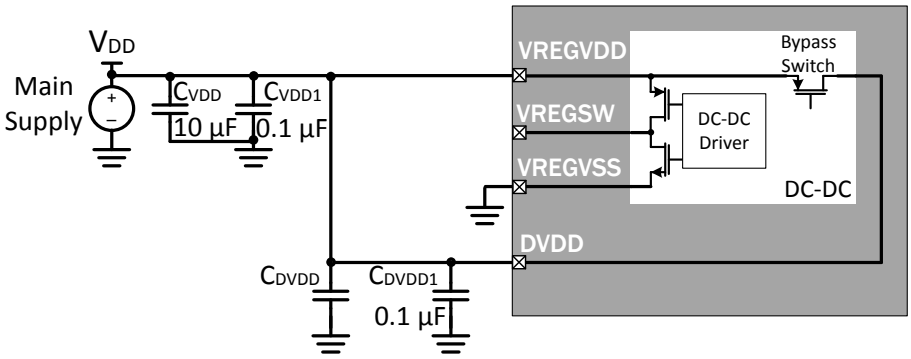

Figure 2.5. Configuration when the DC-DC converter is unused

Note: The bulk capacitor C_{DVDD} is not necessary when VREGVDD is shorted to DVDD and there is a large bulk capacitor (10 µF in this figure) present on VREGVDD.

2.7.2 DCDC — Powering DVDD

For improved energy effiency, the DCDC can be used to power the DVDD supply (as well as RFVDD and PAVDD on EFR32 Wireless Gecko Series 2) as shown in the figure below. In this configuration, the DC-to-DC converter output (V_{DCDC}) is connected to DVDD. In addition to providing the DCDC feedback path, the DVDD pin powers the internal digital LDO, which in turn powers the core digital logic.

The system designer should pay particular attention to the characteristics of the DCDC output capacitor (C_{DCDC}) over temperature and bias voltage. Some capacitors, particularly those in smaller packages or using cheaper dielectrics, can experience a dramatic reduction in nominal capacitance in response to temperature changes or as the DC bias voltage increases. Any change that pushes the DCDC output capacitance outside of the data sheet specified limits may impact the stability of the connected supplies (e.g., DVDD, RFVDD, and PAVDD).

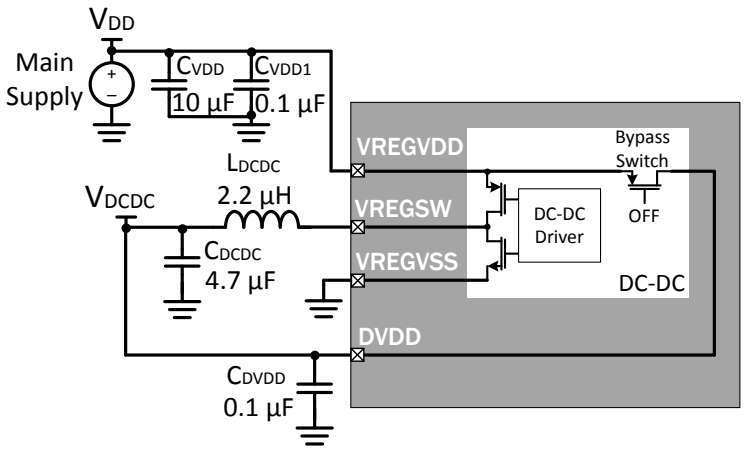

Figure 2.6. DC-to-DC Converter Powering DVDD

Note: For some Series 2 devices, there are additional DC-DC operating limits which should be observed for performance and reliability. Refer to the device data sheet for additional details.

2.8 Radio (RFVDD & PAVDD) — EFR32 Wireless Gecko Series 2

On all EFR32 Wireless Gecko Series 2 devices, the PAVDD ≥ RFVDD relationship listed in 2.3 Power Supply Requirements is necessary for proper operation. Consequently, in systems where it is possible to run RFVDD at a lower voltage than PAVDD, e.g., a 1.8 V supply is present for DVDD, the lowest current draw is achieved when this option is used.

An application's maximum transmit power determines the required voltage for PAVDD. When greater than 14 dBm is needed and supported by the specific device, operation with PAVDD = 3.3 V is required. Otherwise, PAVDD = 1.8 V achieves the lowest current draw.

This guidance is unchanged when using the DC-to-DC converter integrated on some devices. In other words, connect RFVDD to the DCDC output for the best efficiency. For greater than 14 dBm transmit power on supported devices, PAVDD = 3.3 V is required; otherwise also connect PAVDD to the DCDC output.

2.8.1 RFVDD and PAVDD — Powered from Main Supply

PAVDD and RFVDD can be powered directly from the main supply on EFR32 Wireless Gecko Series 2 devices. The component values for each device can be found in Table 2.4 RFVDD & PAVDD Decoupling Values on page 10

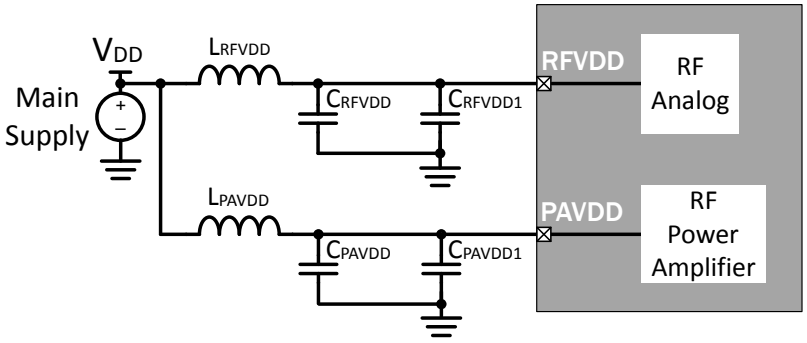

Figure 2.7. RFVDD and PAVDD Decoupling (2.4 GHz application, both supplies powered from main supply)

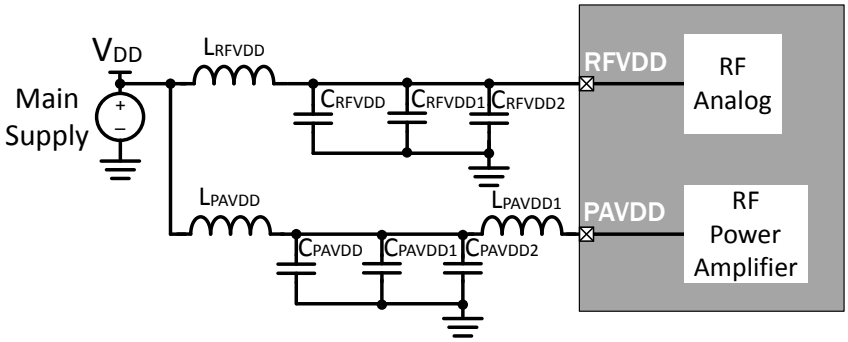

Figure 2.8. RFVDD and PAVDD Decoupling (sub-GHz application, both supplies powered from main supply)

Table 2.3. RFVDD & PAVDD Decoupling Values

Device	Application	L_{RFVDD}	C_{RFVDD}	C_{RFVDD1}	L_{PAVDD}	C_{PAVDD}	C_{PAVDD1}
EFR32xG21	2.4 GHz	9.1 nH	47 nF	12 pF	9.1 nH	47 nF	12 pF
EFR32xG22		Ferrite bead (BLM15AG102 SN1 or similar)	100 nF	120 pF	Ferrite bead (BLM15AG102 SN1 or similar)	100 nF	120 pF
EFR32xG23	Sub-GHz	Ferrite bead (BLM03AG700 SN1 or similar)	1.0 µF	100 pF	Ferrite bead (BLM03PG330 SN1 or similar)	0.47 µF	100 pF

2.8.2 RFVDD and PAVDD — Powered from DCDC

On EFR32xG22 and EFR32xG23 devices, improved power efficiency is achieved using the on-chip DC-DC converter to supply RFVDD and PAVDD.

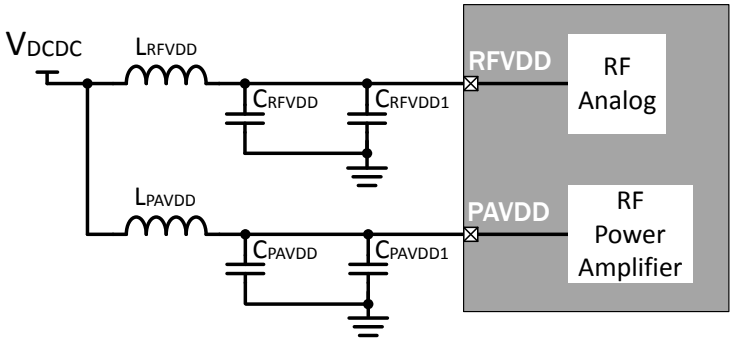

Figure 2.9. RFVDD and PAVDD Decoupling (2.4 GHz application, both supplies powered from DC-DC converter output)

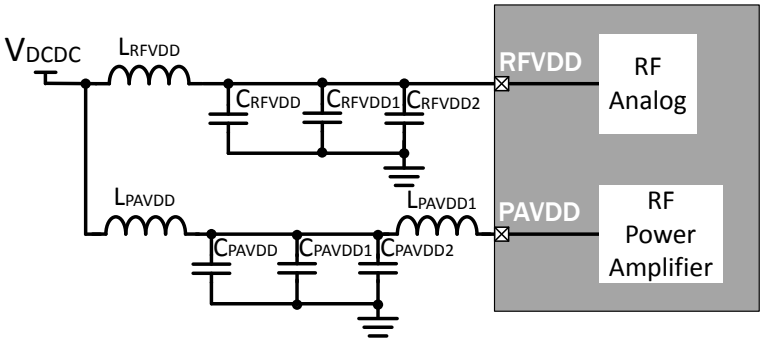

Figure 2.10. RFVDD and PAVDD Decoupling (sub-GHz application, both supplies powered from DC-DC converter output)

Table 2.4. RFVDD & PAVDD Decoupling Values

Device	Application	L_{RFVDD}	C_{RFVDD}	C_{RFVDD1}	L_{PAVDD}	C_{PAVDD}	C_{PAVDD1}
EFR32xG21	2.4 GHz	9.1 nH	47 nF	12 pF	9.1 nH	47 nF	12 pF
EFR32xG22		Ferrite bead (BLM15AG102 SN1 or similar)	100 nF	120 pF	Ferrite bead (BLM15AG102 SN1 or similar)	100 nF	120 pF
EFR32xG23	Sub-GHz	Ferrite bead (BLM03AG700 SN1 or similar)	1.0 µF	100 pF	Ferrite bead (BLM03PG330 SN1 or similar)	0.47 µF	100 pF

3. Example Power Supply Configurations

3.1 EFM32 and EFR32 Wireless Gecko Series 2 — Standard Decoupling Example

The figure below illustrates a standard approach for decoupling an EFM32 and EFR32 Wireless Gecko Series 2 device. The component values for RFVDD and PAVDD for each EFR32 Wireless Gecko Series 2 and application can be found in the 2.8 Radio (RFVDD & PAVDD) — EFR32 Wireless Gecko Series 2 section. Refer to 2.4 DVDD and DECOUPLE section for the C_{DVDD} component value.

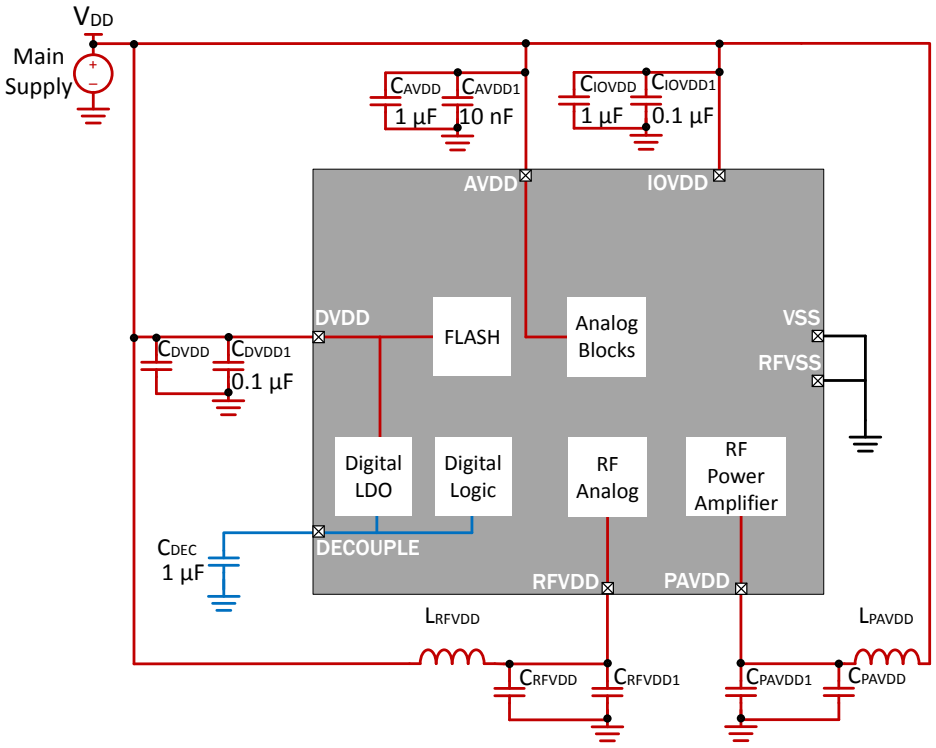

Figure 3.1. EFM32 and EFR32 Wireless Gecko Series 2 Standard Decoupling Example

Note: The RFVDD and PAVDD supplies and the blocks they power are only present on EFR32 Wireless Gecko Series 2 devices. The figure above shows the PAVDD supply filter for 2.4 GHz applications. For sub-GHz applications, L_{PAVDD} should be placed next to the PAVDD pin. See the Radio (RFVDD & PAVDD) section for details.

Table 3.1. C_{DVDD} Component Values

Device	C_{DVDD}	C_{DVDD1}
EFR32xG21	2.2 µF	0.1 µF
EFR32xG22	2.7 µF	0.1 µF
EFM32PG22	2.7 µF	0.1 µF
EFR32xG23	2.7 µF	0.1 µF

Table 3.2. RFVDD & PAVDD Decoupling Values

Device	Application	L_{RFVDD}	C_{RFVDD}	C_{RFVDD1}	L_{PAVDD}	C_{PAVDD}	C_{PAVDD1}
EFR32xG21	2.4 GHz	9.1 nH	47 nF	12 pF	9.1 nH	47 nF	12 pF
EFR32xG22		Ferrite bead (BLM15AG102 SN1 or similar)	100 nF	120 pF	Ferrite bead (BLM15AG102 SN1 or similar)	100 nF	120 pF
EFR32xG23	Sub-GHz	Ferrite bead (BLM03AG700 SN1 or similar)	1.0 µF	100 pF	Ferrite bead (BLM03PG330 SN1 or similar)	0.47 µF	100 pF

3.2 EFM32 and EFR32 Wireless Gecko Series 2 — Improved AVDD Filtering Example

In the following figure, a decoupling approach providing better noise suppression and isolation between the digital and analog power pins using a ferrite bead and a resistor is illustrated. This configuration is preferred when higher ADC accuracy is required. Refer to Table 2.2 Recommended Ferrite Beads on page 7 for recommended ferrite bead part numbers.

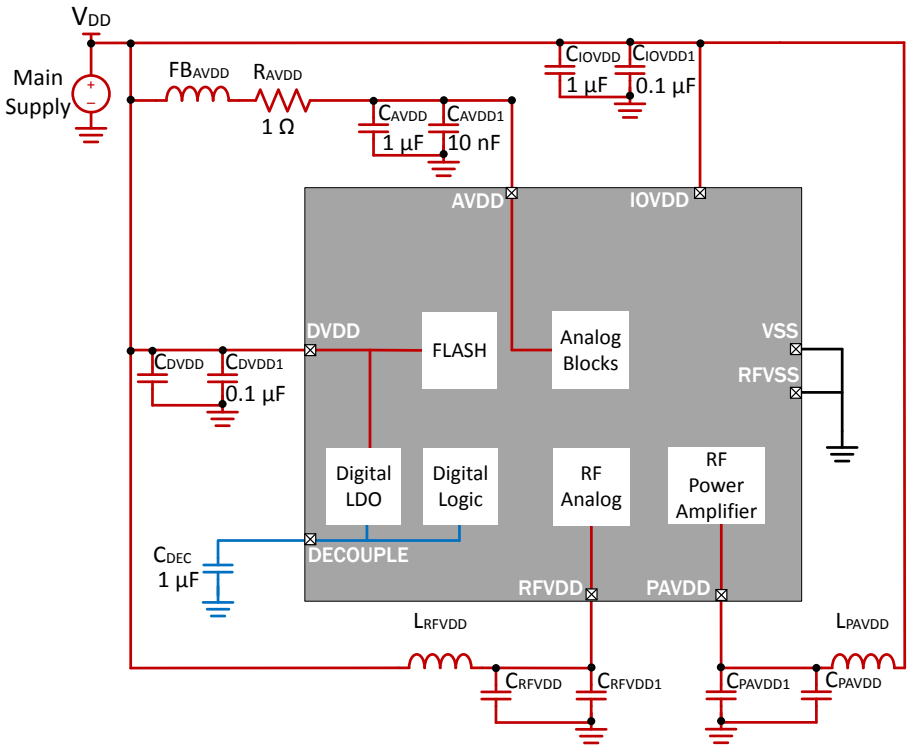

Figure 3.2. EFM32 and EFR32 Wireless Gecko Series 2 Improved AVDD Filtering Example

Note: Note that during power-on for EFM32 and EFR32 Wireless Gecko Series 2 devices, the AVDD_x pins must not be powered up after the IOVDD_x and DVDD pins. If the rise time of the power supply is short, the filter in the figure above can cause a significant rise time delay on the AVDD_x pins.

Note: The RFVDD and PAVDD supplies and the blocks they power are only present on EFR32 Wireless Gecko Series 2 devices. The figure above shows the PAVDD supply filter for 2.4 GHz applications. For sub-GHz applications, L_{PAVDD} should be placed next to the PAVDD pin. See the Radio (RFVDD & PAVDD) section for details.

Table 3.3. C_{DVDD} Component Values

Device	C_{DVDD}	C_{DVDD1}
EFR32xG21	2.2 µF	0.1 µF
EFR32xG22	2.7 µF	0.1 µF
EFM32PG22	2.7 µF	0.1 µF
EFR32xG23	2.7 µF	0.1 µF

Table 3.4. RFVDD & PAVDD Decoupling Values

Device	Application	L_{RFVDD}	C_{RFVDD}	C_{RFVDD1}	L_{PAVDD}	C_{PAVDD}	C_{PAVDD1}
EFR32xG21	2.4 GHz	9.1 nH	47 nF	12 pF	9.1 nH	47 nF	12 pF
EFR32xG22		Ferrite bead (BLM15AG102 SN1 or similar)	100 nF	120 pF	Ferrite bead (BLM15AG102 SN1 or similar)	100 nF	120 pF
EFR32xG23	Sub-GHz	Ferrite bead (BLM03AG700 SN1 or similar)	1.0 µF	100 pF	Ferrite bead (BLM03PG330 SN1 or similar)	0.47 µF	100 pF

3.3 EFM32 and EFR32 Wireless Gecko Series 2 — No DCDC Example

For space or cost-sensitive applications or when power efficiency is not a factor, the DC-to-DC converter may be left unused. In this configuration:

- The DVDD pin must be shorted to VREGVDD
- In addition, AVDD, IOVDD, RFVDD, and PAVDD are all connected to the main supply.
- VREGSW should be left disconnected.

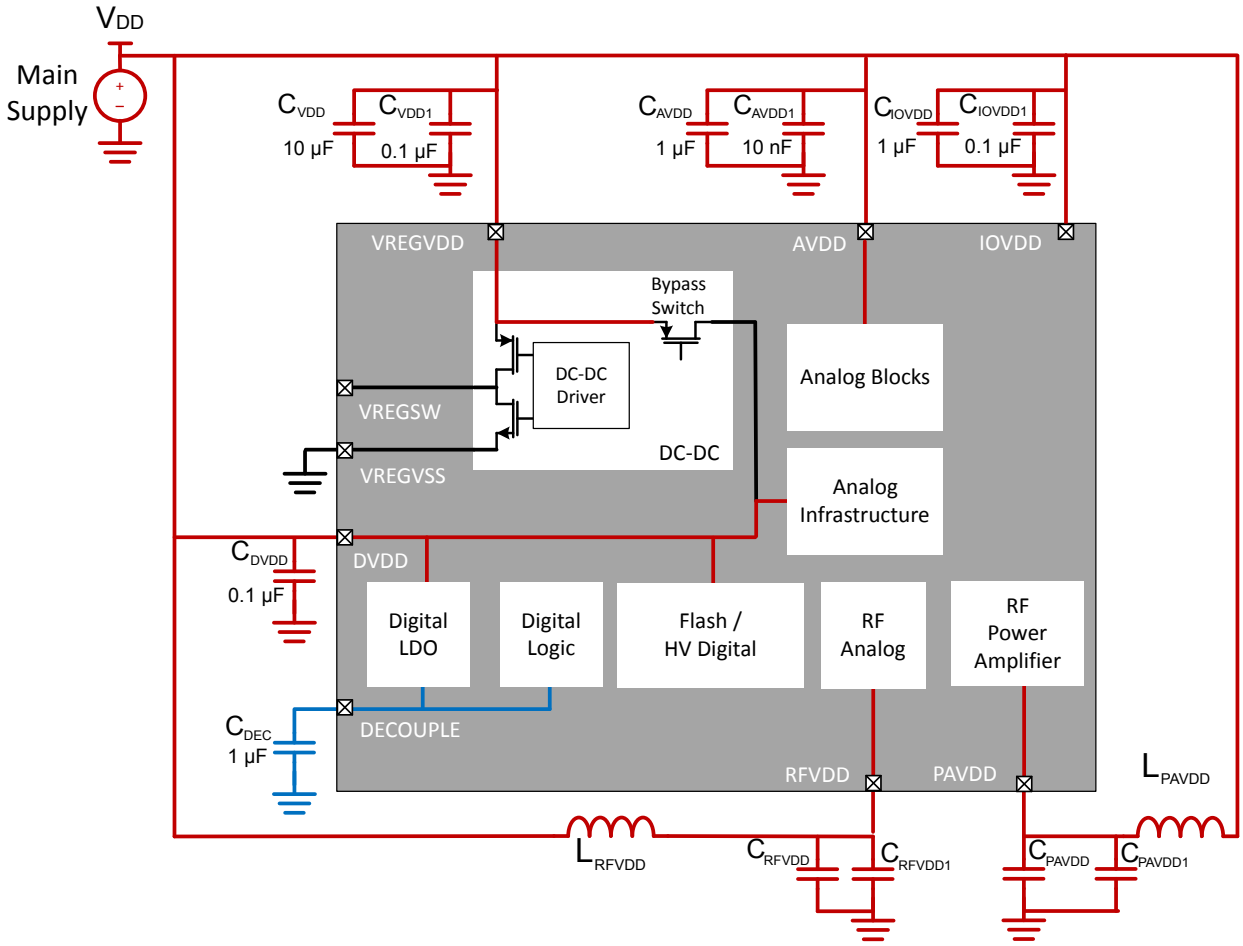

Figure 3.3. EFM32 and EFR32 Wireless Gecko Series 2 No DC-DC

Note: The RFVDD and PAVDD supplies and the blocks they power are only present on EFR32 Wireless Gecko Series 2 devices. The figure above shows the PAVDD supply filter for 2.4 GHz applications. For sub-GHz applications, L_{PAVDD} should be placed next to the PAVDD pin. See the Radio (RFVDD & PAVDD) section for details.

Table 3.5. RFVDD & PAVDD Decoupling Values

Device	Application	L_{RFVDD}	C_{RFVDD}	C_{RFVDD1}	L_{PAVDD}	C_{PAVDD}	C_{PAVDD1}
EFR32xG21	2.4 GHz	9.1 nH	47 nF	12 pF	9.1 nH	47 nF	12 pF
EFR32xG22		Ferrite bead (BLM15AG102 SN1 or similar)	100 nF	120 pF	Ferrite bead (BLM15AG102 SN1 or similar)	100 nF	120 pF

Device	Application	L_{RFVDD}	C_{RFVDD}	C_{RFVDD1}	L_{PAVDD}	C_{PAVDD}	C_{PAVDD1}
EFR32xG23	Sub-GHz	Ferrite bead (BLM03AG700 SN1 or similar)	1.0 µF	100 pF	Ferrite bead (BLM03PG330 SN1 or similar)	0.47 µF	100 pF

3.4 EFM32 and EFR32 Wireless Gecko Series 2 — DCDC Example

EFM32 and EFR32 Wireless Gecko Series 2 applications should use the DCDC to maximize power savings when it is present on a device. When the DCDC is used, supply voltages up to 3.3 V are supported without restriction. For supply voltages between 3.3 V and 3.8 V, see the device data sheet. In addition to the standard decoupling capacitors on each supply net, the DCDC requires an external inductor and output load capacitor. For detailed information on DC-to-DC converter operation, emlib programming, recommended components, and supported power configurations, see application note AN0948.2: EFR32 Series 2 Power Configurations and DC-DC.

When transmit power levels allow doing so, radio applications should use the DCDC to supply DVDD, as well as RFVDD and PAVDD for the best energy efficiency. In this configuration:

- The DCDC output (V_{DCDC}) is connected to DVDD, which powers the internal digital LDO.
- Both radio power supplies (RFVDD and PAVDD) are also powered from the DCDC output.
- AVDD and IOVDD are connected to the main supply to support higher voltage external interfaces.

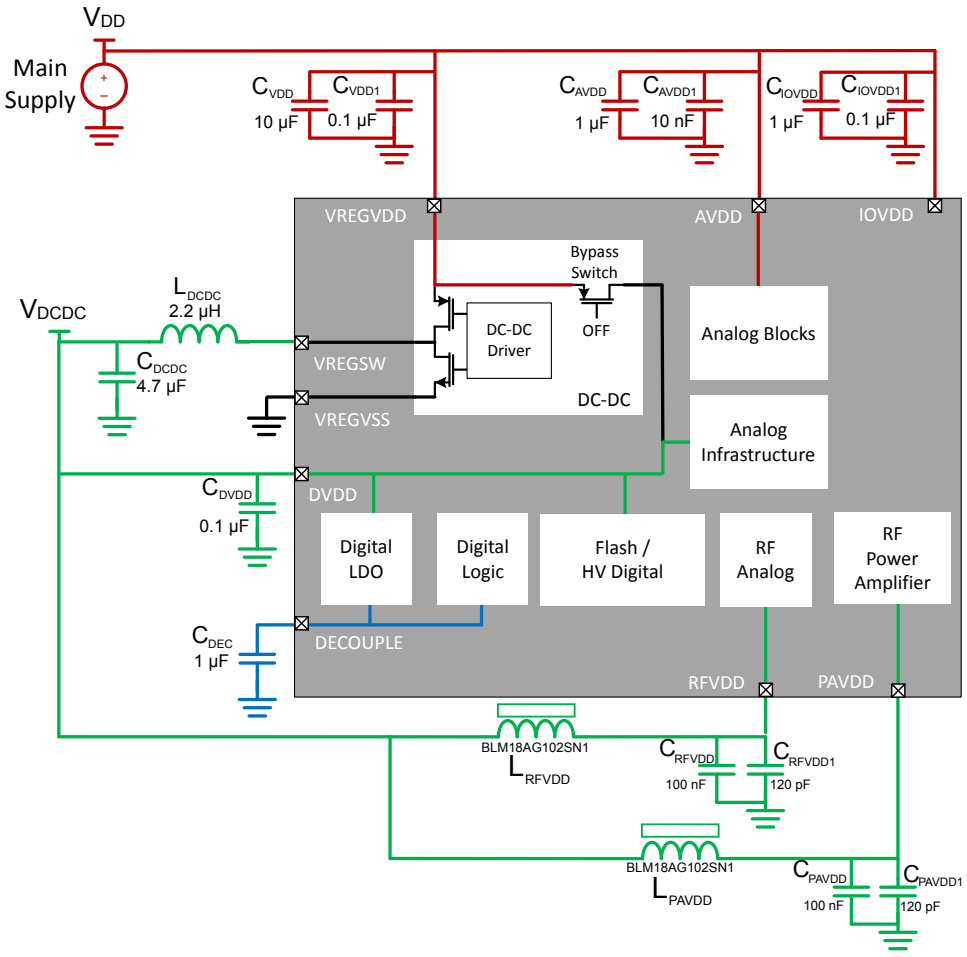

Figure 3.4. EFR32xG22 Example 2.4 GHz DCDC Power Configuration

Note: The component values shown in this figure are for 2.4 GHz operation on EFR32xG22. The filter component values for RFVDD and PAVDD differ on other devices and for other radio configurations. See the Radio (RFVDD & PAVDD) section for details.

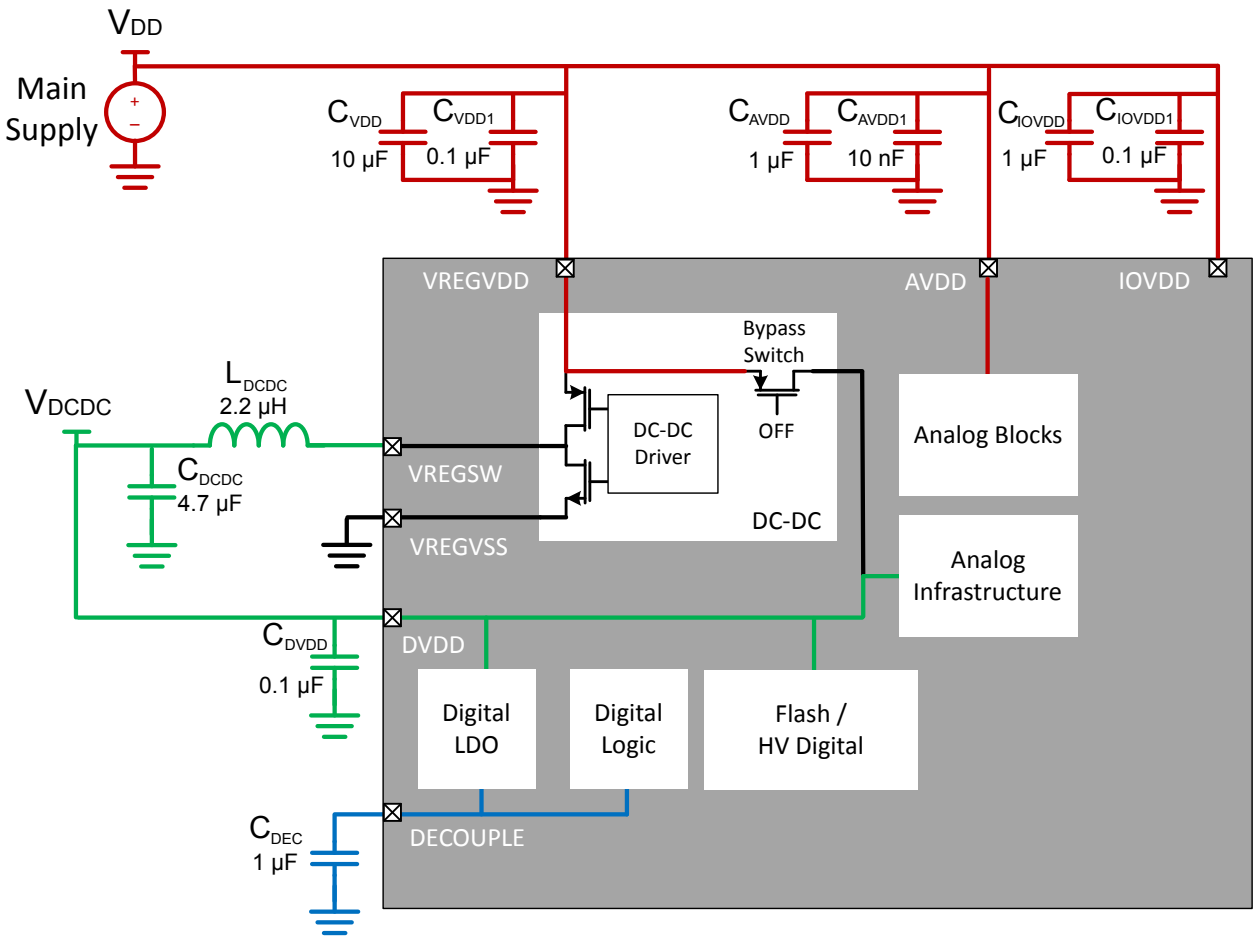

Figure 3.5. EFM32PG22 Example DCDC Power Configuration

4. Debug Interface and External Reset Pin

4.1 Serial Wire Debug

The Serial Wire Debug (SWD) interface is supported by all EFM32 and EFR32 Wireless Gecko Series 2 devices and consists of the SWCLK (clock input) and SWDIO (data in/out) lines, in addition to the optional SWO/SWV (serial wire output/serial wire viewer). The SWO/SWV line is used for instrumentation trace and program counter sampling, and is not needed for flash programming and normal debugging. However, it can be valuable in advanced debugging scenarios, and designers are strongly encouraged to include this along with the other SWD signals.

Connections to the standard ARM 20-pin debug header are shown in the following figure. Pins that are not connected to the microcontroller, power supply, or ground should be left unconnected.

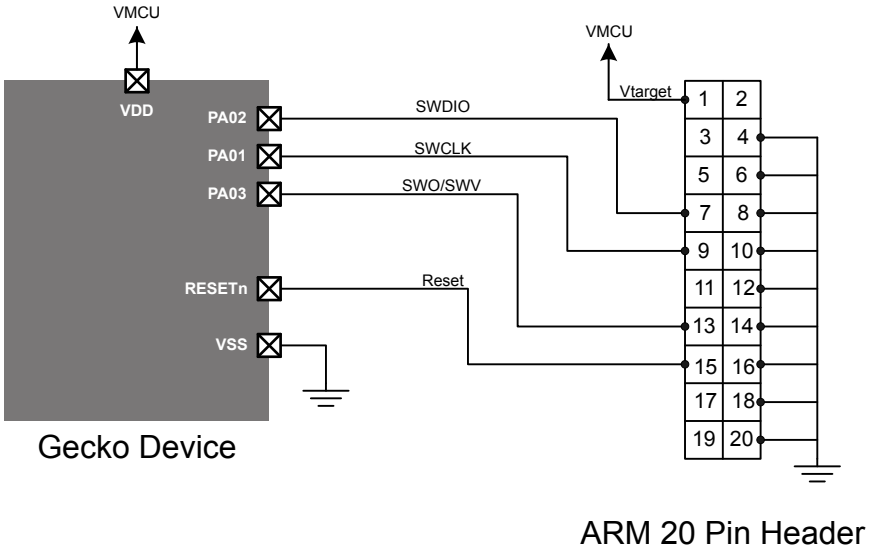

Figure 4.1. EFM32 and EFR32 Wireless Gecko Series 2 SWD Connection to the ARM 20-pin Debug Header

Note: The V_{target} connection does not supply power. The debugger uses V_{target} as a reference voltage for its level translators. If IOVDD is powered by the DC-DC output, V_{target} should be connected to IOVDD, not the main supply.

For additional debug and programming interfaces, see Application Note AN958: Debugging and Programming Interfaces for Custom Designs.

4.2 JTAG Debug

EFM32 and EFR32 Wireless Gecko Series 2 devices optionally support JTAG debug using the TCK (clock), TDI (data input), TDO (data output), and TMS (test mode select) lines. TCK is the JTAG interface clock. TDI carries input data and is sampled on the rising edge of TCK. TDO carries output data and is shifted out on the falling edge of TCK. Finally, TMS is the test mode select signal and is used to navigate through the Test Access Port (TAP) state machine.

Note: The JTAG implementation on EFM32 and EFR32 Wireless Gecko Series 2 devices does not support boundary scan. It can operate in pass-through mode and participate in a chain with other devices that do implement JTAG for firmware programming or boundary scan purposes.

The connection to an ARM 20-pin debug connector is shown in the following figure. Pins with no connection should be left unconnected.

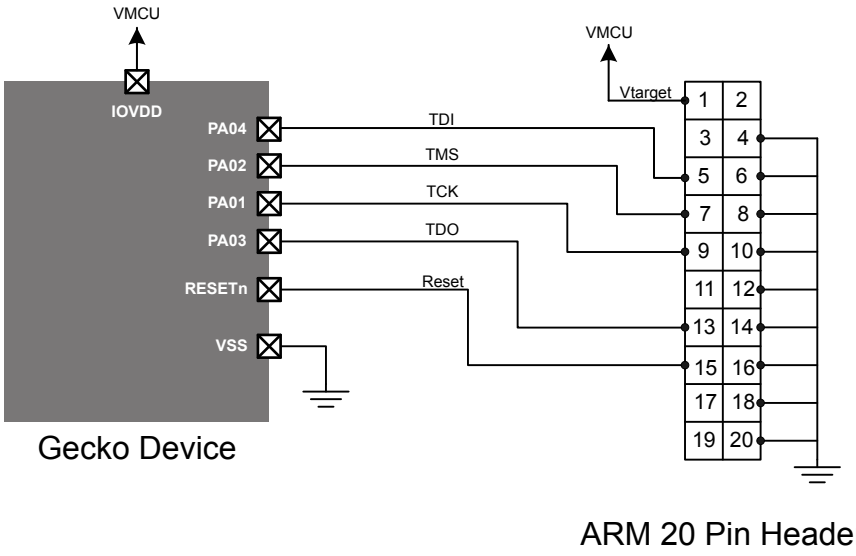

Figure 4.2. EFM32 and EFR32 Wireless Gecko Series 2 JTAG Connection to the ARM 20-pin Debug Header

Note: The V_{target} connection does not supply power. The debugger uses V_{target} as a reference voltage for its level translators.

For additional debug and programming interfaces, see Application Note AN958: Debugging and Programming Interfaces for Custom Designs.

4.3 External Reset Pin (RESETn)

EFM32 and EFR32 Wireless Gecko Series 2 processors are reset by driving the RESETn pin low. A weak internal pull-up device holds the RESETn pin high, allowing it to be left unconnected if no external reset source is required. Also connected to RESETn is a low-pass filter that prevents noise glitches from causing unintended resets. The characteristics of the pull-up device and input filter are identical to those present on any GPIO pin and are specified in the device data sheet.

Note:

1. The internal pull-up ensures that the reset is released. When the device is not powered, RESETn must not be connected through an external pull-up to an active supply or otherwise driven high as this could damage the device.
2. The RESETn pin is pulled up internally to DVDD. In the case where RESETn is connected to an external signal capable of driving the pin at a voltage different from V_{DVDD}, this internal pull up represents a possible current path, which could cause unwanted power consumption. Examples include connection of RESETn to an external supply/reset monitor, debugger, or coprocessor/multi-chip design. It is recommended that if RESETn is connected to an external device, it be connected only to open drain signals in order to avoid unwanted current consumption when RESETn is not being driven low.

5. External Clock Sources

5.1 Introduction

EFM32 and EFR32 Wireless Gecko Series 2 devices support different external clock sources to provide the high- and low-frequency clocks in addition to the internal LF and HF RC oscillators. Possible external clock sources for both the LF and HF domains are crystals and external oscillators (square or sine wave). This section describes how external clock sources are connected.

For additional information on the external oscillators, refer to the application note, AN0016.2: Oscillator DesignConsiderations . Application notes can be found on the Silicon Labs website (www.silabs.com/32bit-appnotes) or in Simplicity Studio.

5.2 Low-Frequency Clock Sources

An external low-frequency clock can be supplied from a crystal or from an external clock source.

5.2.1 Low-Frequency Crystals

A crystal is connected as shown in the figure below across the LFXTAL_I and LFXTAL_O pins on EFM32 and EFR32 Wireless Gecko Series 2 devices.

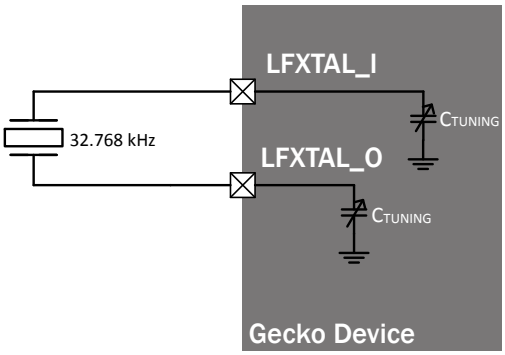

Figure 5.1. Low-Frequency Crystal Oscillator

Low frequency crystals connected to EFM32 and EFR32 Wireless Gecko Series 2 devices do not require external load capacitors, as these load capacitors are included on-chip and can be tuned by register bit fields under software control, thus reducing BOM cost and saving space in the PCB footprint. The EFM32 and EFR32 Wireless Gecko Series 2 LFXO supports 32.768 kHz crystals. Check device-specific data sheets for supported crystal load capacitance and ESR values and refer to device-specific reference manuals for on-chip load capacitor tuning instructions.

5.2.2 Low-Frequency External Clocks

EFM32 and EFR32 Wireless Gecko Series 2 devices can source a low-frequency clock from an external source such as a TCXO or VCXO. To select a proper external oscillator, consider specifications such as frequency, aging, stability, voltage sensitivity, rise and fall time, duty cycle, and signal levels. The external clock signal can be either a square wave or a sine wave with a frequency of 32.768 kHz. The external clock source must be connected as shown in Figure 5.2 Low-Frequency External Clock on page 22.

Bypass and buffered input modes are supported for external clock sources. A CMOS square wave that toggles between 0 and V_{IOVDD} volts with a duty cycle of 50% can be used when LFXO_CFG_MODE = DIGEXTCLK, which bypasses the LFXO. An external sine wave source (LFXO_CFG_MODE = BUFEXTCLK) having minimum and maximum amplitudes of 100 mV and 500 mV, respectively, can be connected in series with the LFXTAL_I pin and is ac-coupled internally. The sine wave minimum voltage must be higher than ground and the maximum voltage less than V_{IOVDD} . When using either DIGEXTCLK or BUFEXTCLK mode, the LFXTAL_O pin is free to be used as a general purpose GPIO.

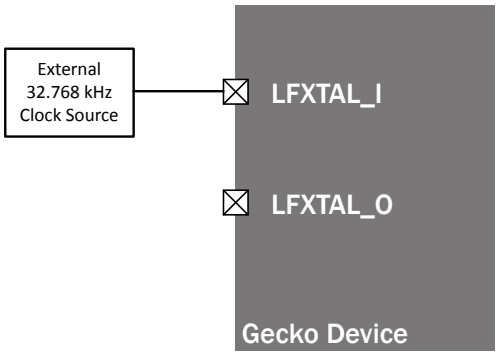

Figure 5.2. Low-Frequency External Clock

5.3 High Frequency Clock Sources

An external high-frequency clock can be supplied from a crystal or from an external clock source.

5.3.1 High-Frequency Crystals

A crystal is connected as shown in Figure 5.3 High-Frequency Crystal Oscillator on page 22 across the HFXTAL_I and HFXTAL_O pins on EFM32 and EFR32 Wireless Gecko Series 2 devices.

External load capacitors are not required on EFM32 and EFR32 Wireless Gecko Series 2 devices. These have been moved on-chip and can be tuned by register bit fields under software control, thus reducing BOM cost and saving space in the PCB footprint. Check device-specific data sheets for the supported range of crystal frequencies, load capacitance tuning, and ESR values. In particular, specific crystal frequencies are mandatory when using on-chip radios and their associated protocol stacks; use of other values is expressly **not** supported.

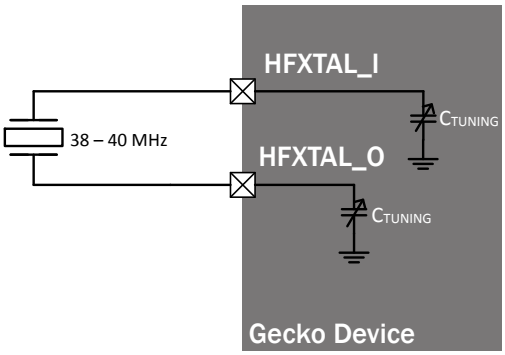

Figure 5.3. High-Frequency Crystal Oscillator

5.3.2 High-Frequency External Clocks

EFM32 and EFR32 Wireless Gecko Series 2 devices can source a high-frequency clock from an external source such as a TCXO or VCXO. To select a proper external oscillator, consider specifications such as frequency, aging, stability, voltage sensitivity, rise and fall time, duty cycle, and signal levels. The external clock signal can be either a square wave or a sine wave with a frequency in accordance with the device data sheet. The external clock source must be connected as shown in Figure 5.4 High-Frequency External Clock on page 23.

Unlike the LFXO, which has specific modes for a buffered or digital external clock, the HFXO has more limited external clock input flexibility. When a crystal is not used, the external clock signal must be a sine wave (HFXO_CFG_MODE = EXTCLK) having minimum and maximum amplitudes of 300 mV and 600 mV, respectively, and must be connected in series with the HFXTAL_I pin. EFM32 and EFR32 Wireless Gecko Series 2 devices support both external and internal ac coupling of the input clock signal. The sine wave minimum voltage must be higher than ground and the maximum voltage less than 1.2 V.

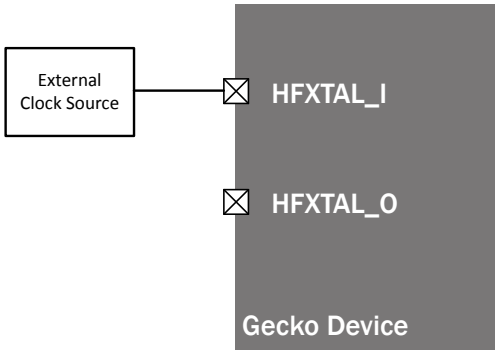

Figure 5.4. High-Frequency External Clock

6. Revision History

Revision 0.80

December, 2021

- Added EFR32ZG23 to 1. Device Compatibility.
- Updated Figure 3.1 EFM32 and EFR32 Wireless Gecko Series 2 Standard Decoupling Example on page 11 and Figure 3.2 EFM32 and EFR32 Wireless Gecko Series 2 Improved AVDD Filtering Example on page 13 recommended CAVDD value to 1.0 µF.
- Updated Radio (RFVDD & PAVDD) frequency application and fixed typographic error for PAVDD filtering capacitor component value.
- Updated voltage specifications in 5.3.2 High-Frequency External Clocks.

Revision 0.601

September, 2021

- Removed EFR32BG23 and EFR32MG23 from 1. Device Compatibility.
- Restored EFM32PG22 content from revision 0.51 that was not present in revision 0.60.

Revision 0.60

August, 2020

- Added EFR32xG23 to 1. Device Compatibility.
- Added sub-GHz RFVDD and PAVDD power configurations and component values in Radio (RFVDD & PAVDD).
- Added EFR32xG23 radio power configuration options to Radio (RFVDD & PAVDD).
- Improved clarity of figures and descriptions throughout.

Revision 0.51

January, 2021

- EFM32PG22 added to 1. Device Compatibility.
- Added EFM32PG22 to Power Supply and Example Power Supply Configurations.
- Added new notes in 2.3 Power Supply Requirements section to provide clarity.
- Improved clarity of figures and descriptions throughout.

Revision 0.5

June, 2020

- Added required amplitude of a sine wave oscillator input in 5.2.2 Low-Frequency External Clocks and 5.3.2 High-Frequency External Clocks.

Revision 0.4

April, 2020

- Added information about EFR32xG22 in 2.4 DVDD and DECOUPLE, 2.5 IOVDD and 2.6 AVDD sections.
- Added reference to 2.4 DVDD and DECOUPLE section for C_{DVDD} value in 3.1 EFM32 and EFR32 Wireless Gecko Series 2 — Standard Decoupling Example and 3.1 EFM32 and EFR32 Wireless Gecko Series 2 — Standard Decoupling Example sections.
- Updated C_{IOVDD} value in 3.3 EFM32 and EFR32 Wireless Gecko Series 2 — No DCDC Example and 3.4 EFM32 and EFR32 Wireless Gecko Series 2 — DCDC Example sections.

Revision 0.3

March, 2020

- Added reference to AN933.2 in the front page.
- Added EFR32xG22 to 1. Device Compatibility..
- Added 2.7 DC-to-DC Converter to add support for EFR32xG22.
- Added information regarding powering RFVDD and PAVDD from Main Supply and DC-DC converter output in 2.8 Radio (RFVDD & PAVDD) — EFR32 Wireless Gecko Series 2.
- Added information about EFR32xG22 in 3. Example Power Supply Configurations.
- Removed references to ceramic resonator in 5. External Clock Sources.
- Removed references to external square wave source in 5.3 High Frequency Clock Sources.

Revision 0.2

December, 2019

- Added reference to AN958 in 4.1 Serial Wire Debug and 4.2 JTAG Debug.

Revision 0.1

February, 2019

- Initial revision.

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