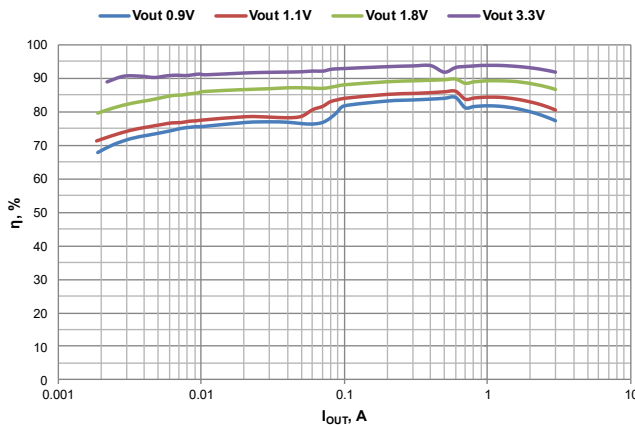


2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER
Description

The AM32102 is a programmable step-down converter with an input voltage range of 2.4V to 5.5V. The maximum output current is 2A, and the output voltage ranges from 0.6V to 3.8V. Key features include an ultra-low 16 μ A quiescent current, selectable operating modes (Auto, FPWM, Sleep and USM), and a configurable switching frequency ranging from 2MHz to 3MHz. Integrated power transistors, precision regulation ($\pm 1\%$) in PWM, and protection functions (UVLO, OVP, SCP, thermal shutdown) make the AM32102 ideal for space-constrained and battery-powered systems.

Applications

- IoT devices
- Cell Phones
- Portable Devices
- Optical Modules


Efficiency vs Output Current,

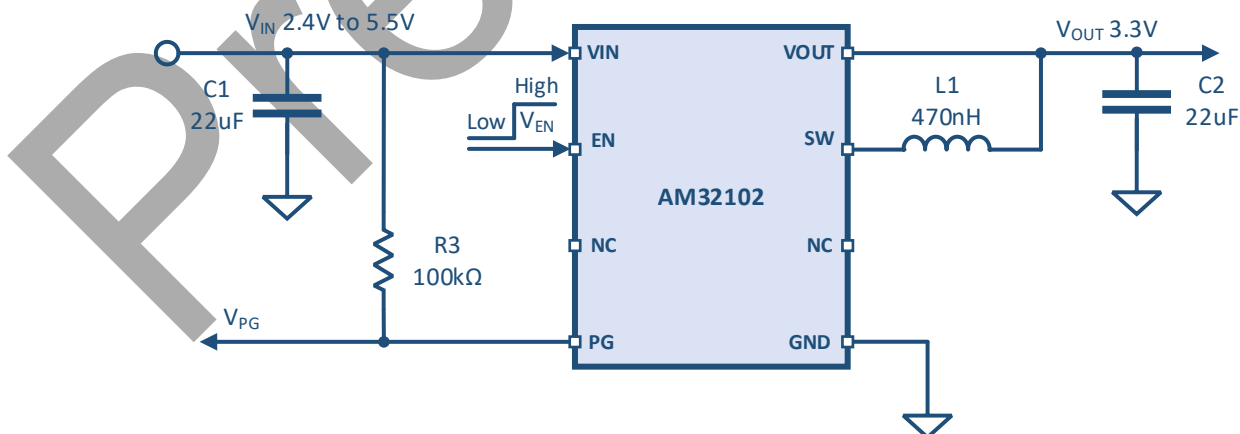
$V_{IN}=5.0V$, $F_{sw}=2.6MHz$, Mode=Auto, Internal Divider

Features

- 2.4V to 5.5V input voltage range
- Flexible Output Voltage Selection:
 - Internal voltage dividers: 0.6V, 0.9V, 1.1V, 1.8V, 2.5V, or 3.3V, simplifying design and reducing external components
 - External resistor divider for custom output voltages. 0.6V to 3.8V
- I_{OUT} : 2A Continuous
- 1% Output Voltage Tolerance in PWM
- 16 μ A Quiescent Current
- Operating Modes:
 - Auto Mode (PFM/PWM) – optimized for battery-powered applications
 - Sleep mode
 - FPWM Mode – ensures low output voltage ripple
 - USM (Ultra Sonic Mode)
- Configurable CCM Switching Frequency: 2MHz to 3MHz with step 0.2MHz
- Power Good Signal: Provides system monitoring capability
- Output Discharge
- Protection Circuitry
 - Under-Voltage Lockout
 - V_{IN} Overvoltage Protection
 - Peak Current Limit
 - Valley Current Limit
 - Short Circuit Protection (Hiccup Mode)
 - Thermal Shutdown

Device Information

P/N	Package	Size
AM32102	TQFN-8	1.8 mm x 1.8 mm x 0.55 mm, pitch 0.5 mm


Typical Application Circuit (Internal Divider)



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

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2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

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Preliminary



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

1. Pin Configuration

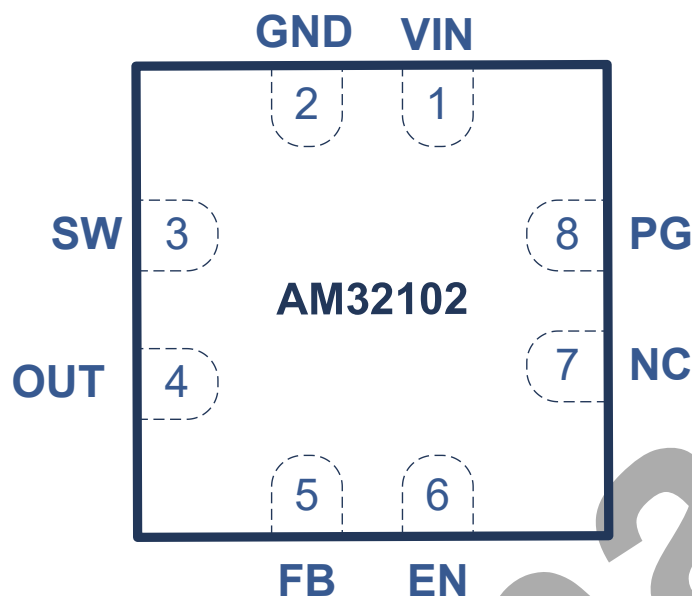


Figure 1-1. Pin Configuration (Top View)

Table 1.1. Pin Description

PIN Number	PIN Name	Function
1	VIN	Input Voltage. VIN supplies the power to the IC. Drive VIN with a 2.4V to 5.5V power source. Bypass VIN to GND with a suitably large capacitor to eliminate noise due to the switching of the IC.
2	GND	Power Ground.
3	SW	Power Switching Output. SW is the switching node that supplies power to the output. Connect the external inductor to this pin.
4	OUT	This pin serves as a sense pin for monitoring the output voltage when selecting the internal output voltage. No capacitor is needed near this pin. Please leave as "Not connected" when the external divider is used.
5	FB	Feedback sensing terminal for the output voltage. Connect this pin to the resistive divider of the output. Please leave as "Not connected" when the internal divider is used.
6	EN	Enable Input. EN is a digital input that turns the regulator ON or OFF. Drive EN high to turn ON the regulator and low to turn it OFF. Do not leave as floating.
7	NC	Not Connected. NC is floating.
8	PG	Power Good. Open drain power-good output that is pulled to GND when the output voltage is out of regulation or during soft-start.



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

1. Ordering Information

The base part number is always **AM32102**. It is followed by a sequence of characters that define the specific configuration of the device. The order of these parameters is fixed and must be followed exactly:

Table 1.1. Part Number Decoding

Base Part Number	Switching Frequency (MHz)	Voltage Divider	Operation Mode
AM32102	2.0, 2.2, 2.4, 2.6, 2.8, 3.0	06, 09, 11, 18, 25, 33, XX	A, F, U

- **Switching Frequency:** 20 = 2.0 MHz, 22 = 2.2 MHz, 24 = 2.4 MHz, 26 = 2.6 MHz, 28 = 2.8 MHz, 30 = 3 MHz
- **Voltage Divider:** 06 = 0.6V, 09 = 0.9V, 11 = 1.1V, 18 = 1.8V, 25 = 2.5V, 33 = 3.3V, XX = External divider
- **Operation Mode:** A = Auto, F = FPWM, U = USM

The full part number follows this format:

AM32102 + (Switching Frequency) + (Voltage Divider) + (Operation Mode)

Table 1.2. Part Number Configurations

Part Number	Switching Frequency	Voltage Divider	Operation Mode
AM3210220XXA	2	External divider	Auto
AM3210220XXF			FPWM
AM3210220XXU			USM
AM3210230XXA	3		Auto
AM3210230XXF			FPWM
AM3210230XXU			USM
AM321022009A	2	0.9V(Internal Divider)	Auto
AM321022009F			FPWM
AM321022009U			USM
AM321023009A	3		Auto
AM321023009F			FPWM
AM321023009U			USM
AM321022011A	2	1.1V(Internal Divider)	Auto
AM321022011F			FPWM
AM321022011U			USM
AM321023011A	3		Auto
AM321023011F			FPWM
AM321023011U			USM
AM321022018A	2	1.8V(Internal Divider)	Auto
AM321022018F			FPWM
AM321022018U			USM
AM321023018A	3		Auto
AM321023018F			FPWM
AM321023018U			USM
AM321022033A	2	3.3V(Internal Divider)	Auto
AM321022033F			FPWM
AM321022033U			USM
AM321023033A	3		Auto
AM321023033F			FPWM
AM321023033U			USM

Note 1. There are 126 unique part numbers based on the different possible configurations of frequency, voltage divider, and mode options.



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

2. Electrical Specifications

2.1. Absolute Maximum Conditions

Table 2.1. Absolute Maximum Conditions

Parameter	Parameter	Min.	Max.	Unit
V _{IN}	Power Input Voltage	-0.3	7.0	V
V _{FB}	Feedback Voltage	-0.3	V _{IN} + 0.3	V
V _{SW_DC}	Switch Node (DC)	-0.3	V _{IN} + 0.3	V
T _{ST}	Storage Temperature	-65	150	°C
T _J	Junction Temperature	--	150	°C
T _L	Lead Temperature	--	260	°C
HBM	ESD Protection (Human Body Model)	--	+/-2000	V
CDM	ESD Protection (Charged Device Model)	--	+/-1300	V
MSL	Moisture Sensitivity Level	1		

Note 2. Stresses greater than the Absolute Maximum Ratings specified above can cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions exceeding those indicated in this specification is not implied. Device reliability can be affected by exposure to absolute maximum rating conditions for extended periods.

Note 3. Semiconductor devices are ESD-sensitive and can be damaged by exposure to ESD events. Suitable ESD precautions should be taken when handling and transporting these devices.

2.2. Thermal Resistance

Table 2.2. Thermal Resistance

Symbol	Parameter	Rating	Unit
θ _{JA}	Junction to Ambient	73.6	°C/W

2.3. Recommended Operating Conditions

Table 2.3. Recommended Operating Conditions

Symbol	Parameter	Min.	Max.	Unit
V _{IN}	Input Voltage	2.4	5.5	V
V _{OUT}	Output Voltage	0.6	3.8	V
I _{OUT}	Output Current	0	2	A
T _A	Operating Ambient Temperature	-40	85	°C
T _J	Operating Junction Temperature	-40	125	°C

Note 4. The device function is not guaranteed outside of the recommended operating conditions.

2.4. Electrical Characteristics

@ V_{IN} = 2.4V to 5.5V, T_A = -40 °C to +85 °C. Typical values are at T_A = 25°C and V_{IN} = 5V (unless otherwise noted)

Table 2.4. Electrical Characteristics

Symbol	Parameter	Condition/Note	Min.	Typ.	Max.	Unit
Current Consumption						
I _{SHDN}	Shutdown Current	EN = LO	0.014	0.09	2	μA
I _Q	Quiescent Current ⁽⁴⁾	EN = HI, no load, no switching	--	16	25	μA
Switch FET Resistance						
R _{HS}	High-side FET on Resistance	I _{LOAD} =10mA	33	35	36	mΩ
R _{LS}	Low-side FET on Resistance	I _{LOAD} =10mA	13.3	14.2	14.4	mΩ



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

Symbol	Parameter	Condition/Note	Min.	Typ.	Max.	Unit
Power Good and Soft-start						
V _{PG}	Power Good Lower Threshold (% of Output Regulation)	V _{FB} Falling	88.7	90	90.2	%
		V _{FB} Rising	95	95.7	96.7	%
	Power Good Upper Threshold (% of Output Regulation)	V _{FBT} Rising	110	111	111.7	%
		V _{FB} Falling	103.5	104	105	%
	Power Good Output Logic Low	I _{PG} = -50uA	--	--	30u	V
t _{PG_EN}	Power good deglitch delay during operation	High-to-low or low-to-high transition on the PG pin	--	40	--	μs
t _{SS}	Soft-start time ⁽⁵⁾		0.42	0.46	0.51	ms
t _{d(EN)}	Enable Delay Time ⁽⁴⁾	VIN = HIGH, EN is rising	0.5	0.7	1.3	ms
t _{d(PG)}	Power Good Delay at Start-Up ⁽³⁾	Low to High PG during Start-Up	--	40	--	μs
Output Voltage						
V _{OUT}	Output Voltage Accuracy	Internal Divider 1.1V, PWM mode	-1%	1.1	+1%	V
		Internal Divider 1.8V, PWM mode	-1%	1.8	+1%	V
		Internal Divider 2.5V, PWM mode	-1%	2.5	+1%	V
		Internal Divider 3.3V, PWM mode	-1%	3.3	+1%	V
Switch Frequency						
F _{SW}	PWM Switching Frequency	I _{OUT} = 1A, V _{OUT} = 1.8V(Internal)	-10%	2	+10%	MHz
			-10%	3	+10%	
EN Digital Logic						
V _{EN_H}	EN Logic High Threshold		0.6	--	--	V
V _{EN_HYS}	EN Logic Hysteresis		--	50	--	mV
Protection Features						
I _{HS_Limit}	HS Peak Current Limit ⁽⁶⁾	From Source to Drain	--	4.7	--	A
I _{LS_Limit}	LS Valley Current Limit ⁽⁶⁾	From Source to Drain	--	2.2	--	A
V _{OV}	Overvoltage Protection, Rising	V _{OV} _RISING	6.3	6.35	6.38	V
	Overvoltage Protection, Hysteresis	V _{OV} _HYS	270	284	300	mV
V _{UVLO}	Undervoltage Protection, Rising	V _{UVLO} _RISING	2.28	2.3	2.32	V
	Undervoltage Protection, Hysteresis	V _{UVLO} _HYS	--	100	--	mV
T _{SD}	Thermal Shutdown (Junction Temperature)		150	153	155	°C
T _{HYS}	Thermal Shutdown Hysteresis		25	27	28	°C
R _{DIS}	Output Discharge Resistor		130	135	142	Ω

Note 5. t_{d(EN)} measure between V_{EN_H} and V_{OUT_TARGET}*10%.

Note 6. t_{d(PG)} measure between V_{OUT_TARGET}*95% and V_{PG_TARGET}*10%.

Note 7. Compliance with the datasheet limits is ensured through one or more approaches, including production testing, characterization, and/or design verification.



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

3. Typical Characteristics

3.1. Typical Electrical Characteristics

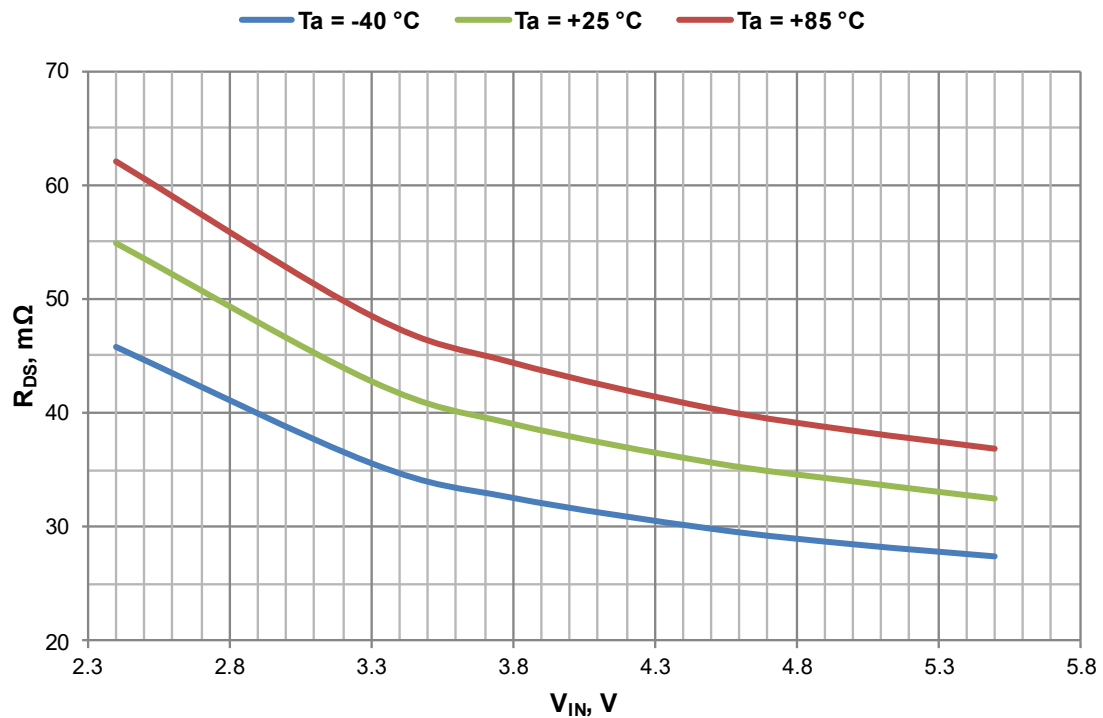


Figure 3-1. High Side FET On-Resistance

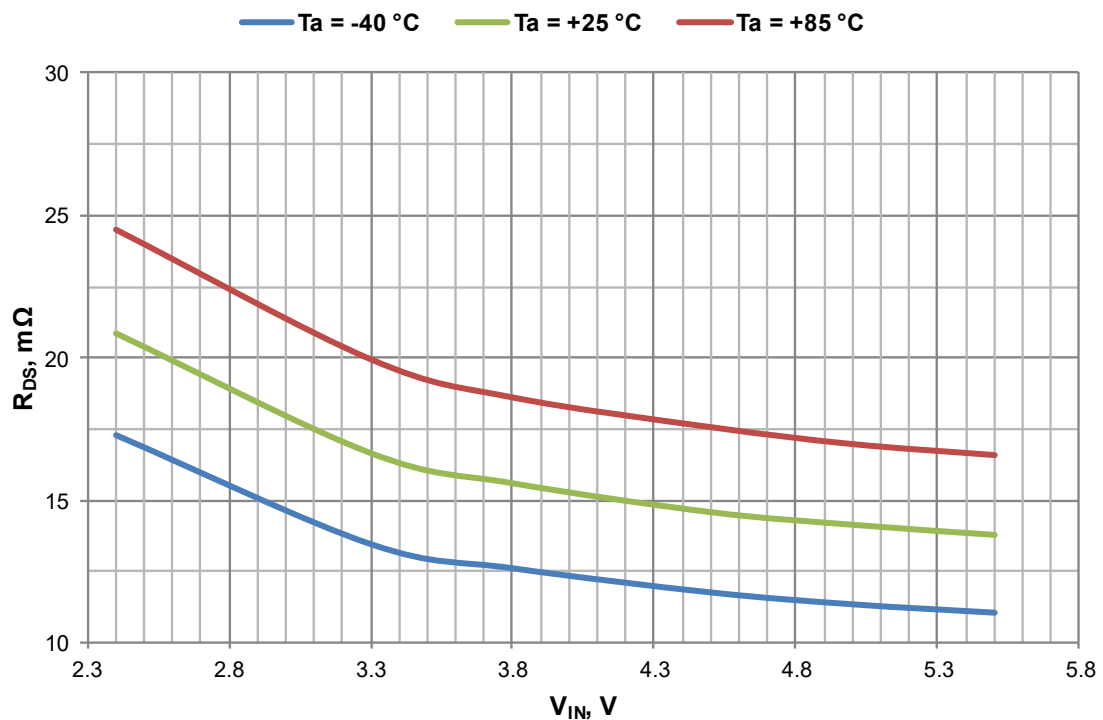


Figure 3-2. Low Side FET On-Resistance



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

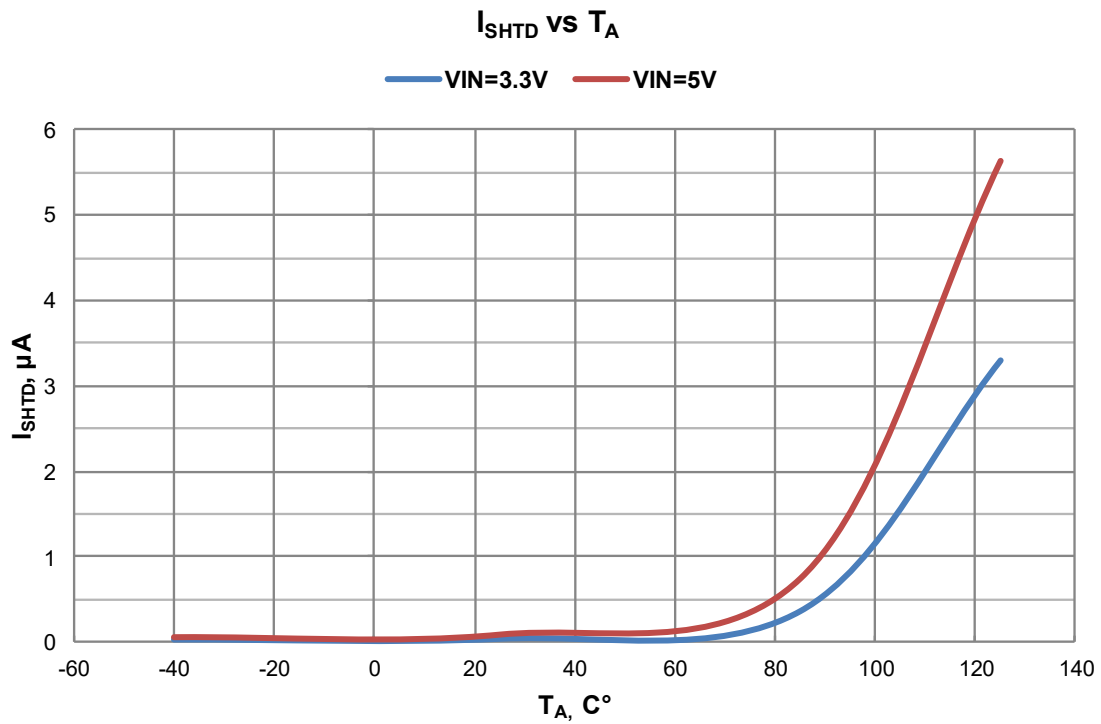


Figure 3-3. Shutdown Current

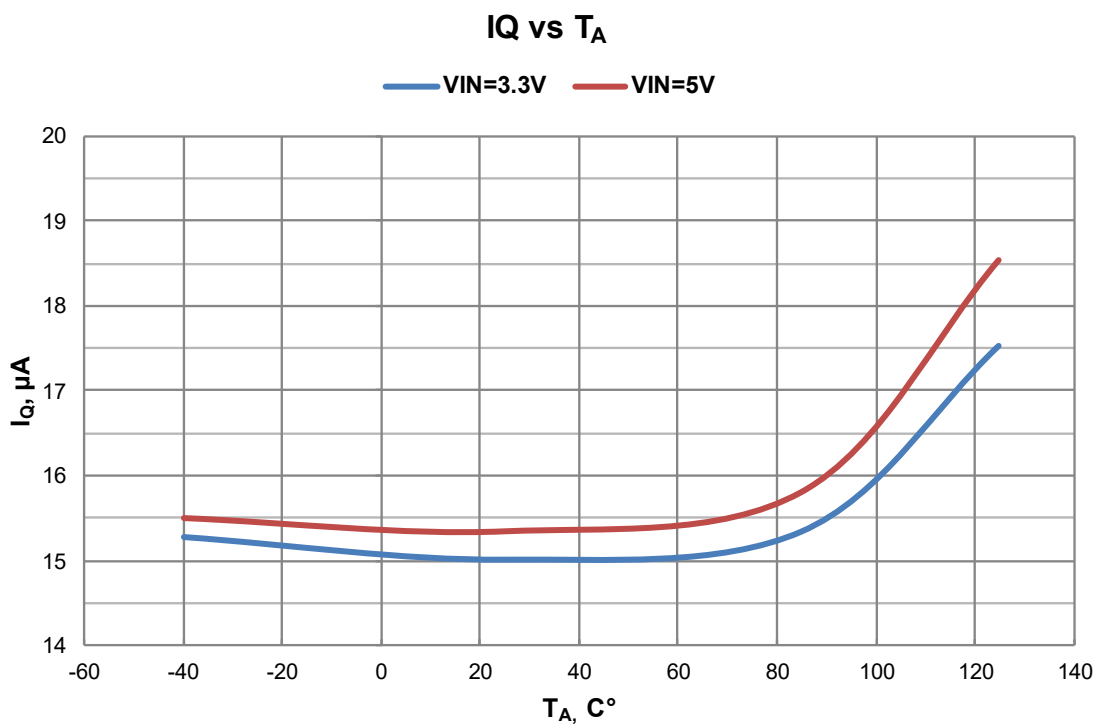


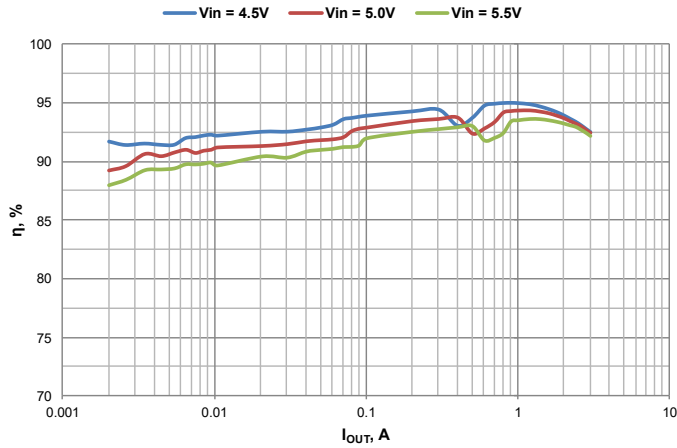
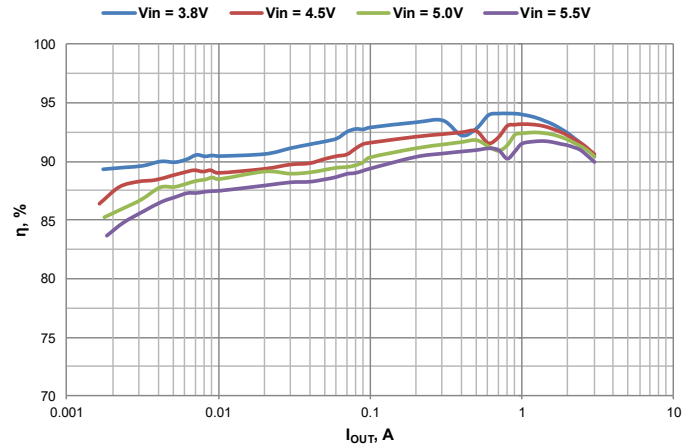
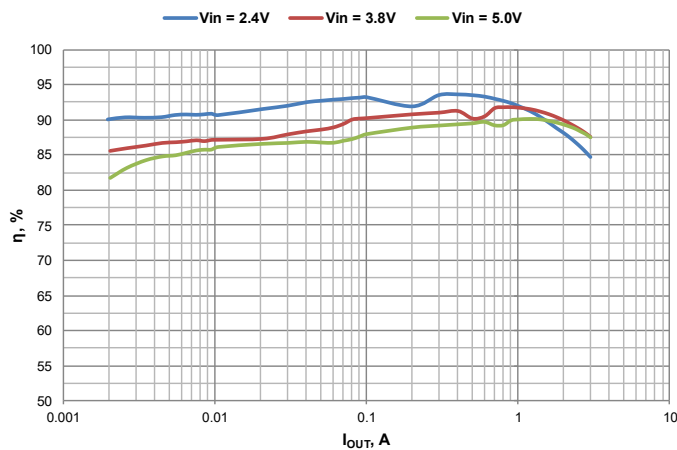
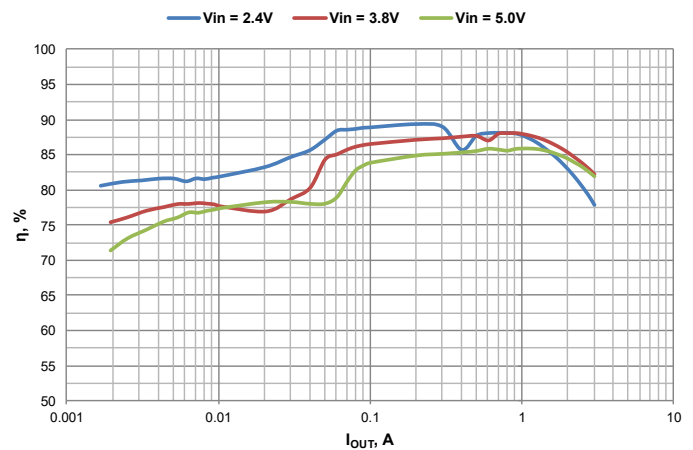
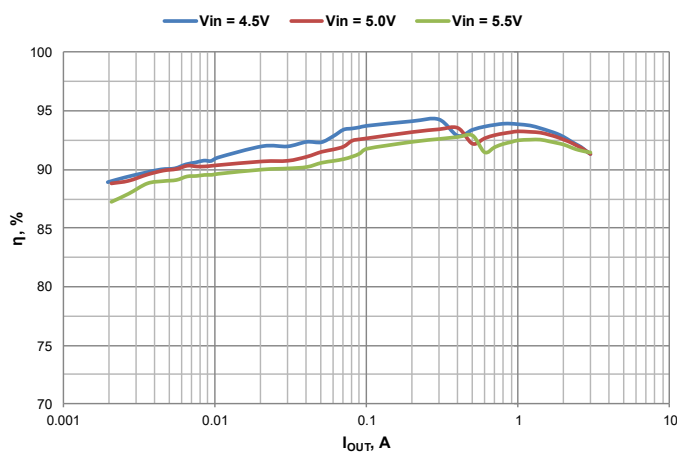
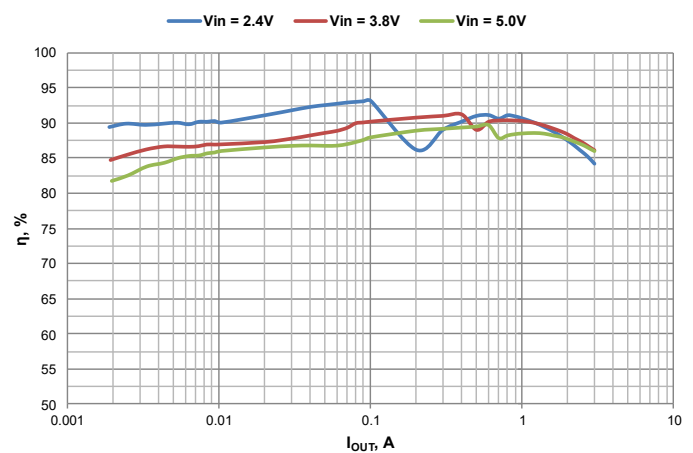
Figure 3-4. Quiescent Current



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

3.2. Typical Performance Characteristics

Conditions: $L=470\text{nH}$, $\text{DCR}=22\text{m}\Omega$, $C_{\text{IN}}=22\mu\text{F}+22\mu\text{F}+47\mu\text{F}$, $C_{\text{OUT}}=22\mu\text{F}$, $F_{\text{SW}} = [2\text{MHz}, 3\text{MHz}]$ in PWM.

Figure 3-5. Efficiency vs Load, $F_{\text{SW}}=2\text{MHz}$ AUTO, $V_{\text{OUT}}=3.3\text{V}$ Figure 3-6. Efficiency vs Load, $F_{\text{SW}}=2\text{MHz}$ AUTO, $V_{\text{OUT}}=2.5\text{V}$ Figure 3-7. Efficiency vs Load, $F_{\text{SW}}=2\text{MHz}$ AUTO, $V_{\text{OUT}}=1.8\text{V}$ Figure 3-8. Efficiency vs Load, $F_{\text{SW}}=2\text{MHz}$ AUTO, $V_{\text{OUT}}=1.1\text{V}$ Figure 3-9. Efficiency vs Load, $F_{\text{SW}}=3\text{MHz}$ AUTO, $V_{\text{OUT}}=3.3\text{V}$ Figure 3-10. Efficiency vs Load, $F_{\text{SW}}=3\text{MHz}$ AUTO, $V_{\text{OUT}}=1.8\text{V}$



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

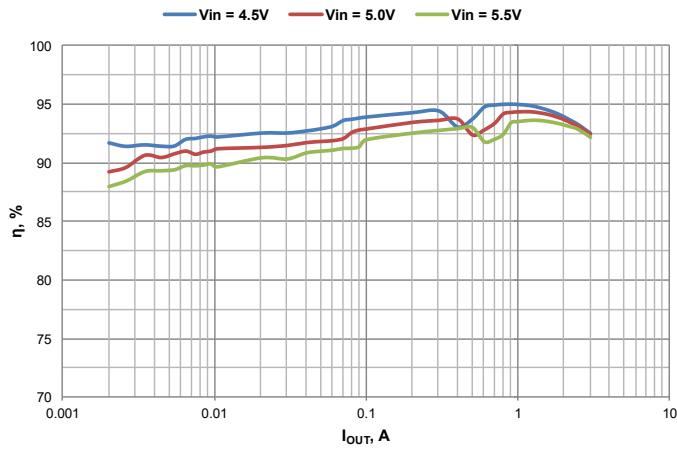
INTERNAL Divider, $V_{OUT} = 3.3V$, $F_{SW} = 2MHz$ 

Figure 3-11. Efficiency vs Load, AUTO mode

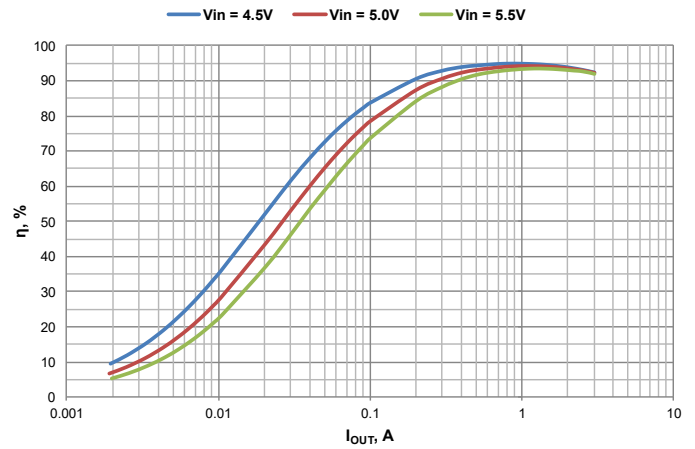


Figure 3-12. Efficiency vs Load, FPWM mode

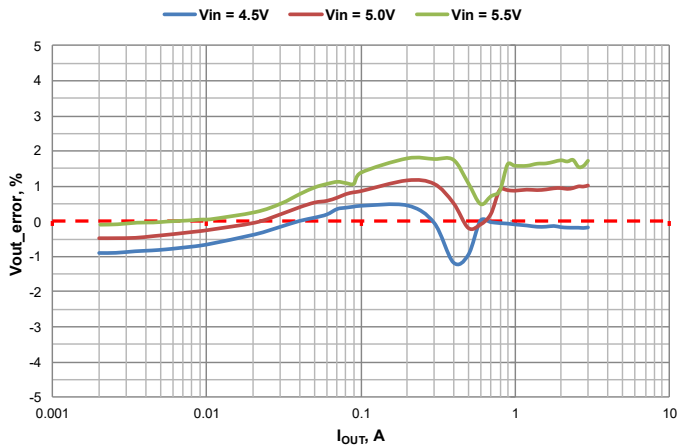


Figure 3-13. Load Regulation, AUTO mode

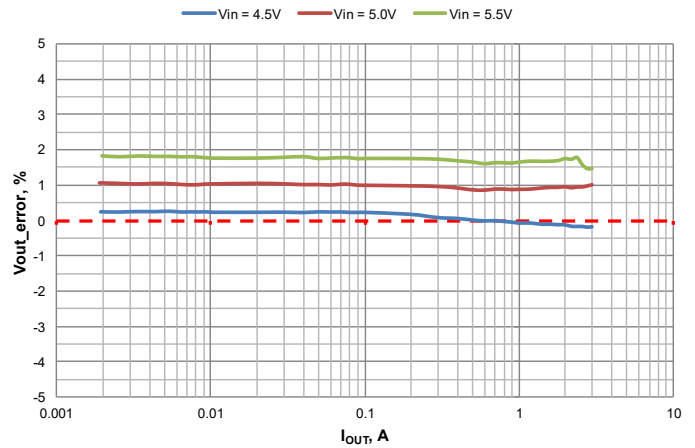


Figure 3-14. Load Regulation, FPWM mode

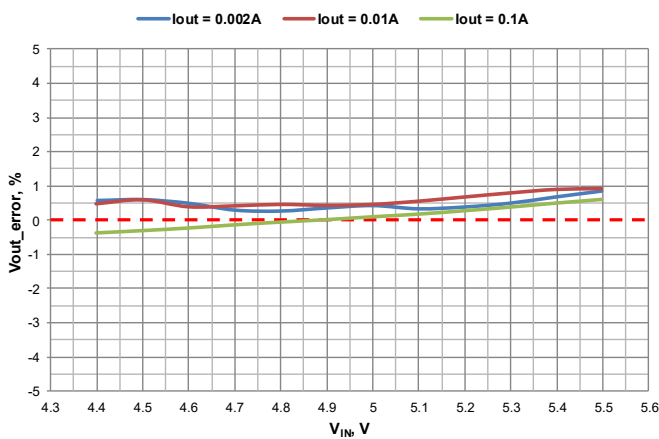


Figure 3-15. Line Regulation, AUTO mode

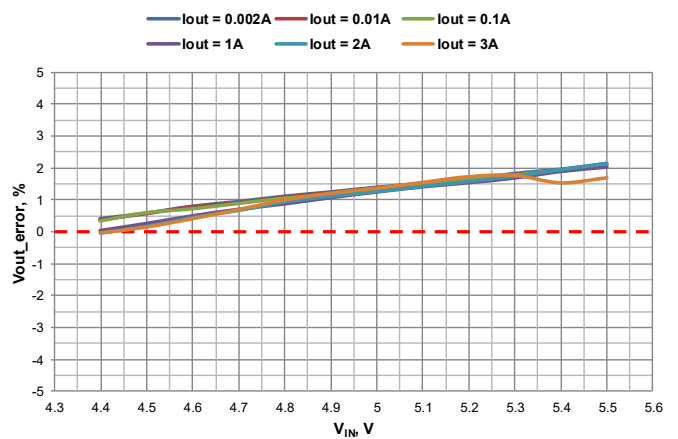


Figure 3-16. Line Regulation, FPWM mode



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

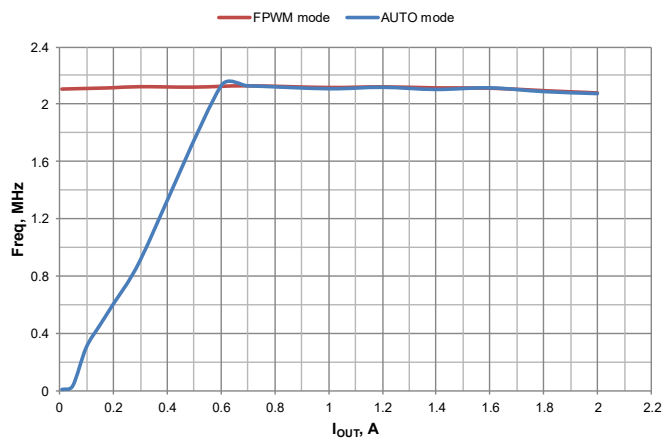
INTERNAL Divider, $V_{IN}=5.0V$, $V_{OUT}=3.3V$, $F_{SW}=2MHz$,

Figure 3-17. Switching Frequency VS Load

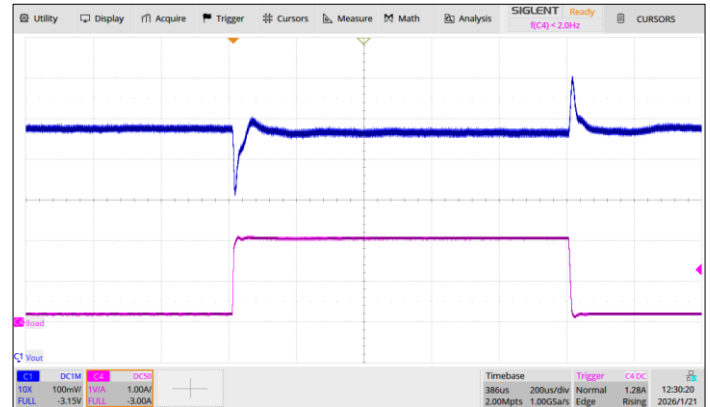


Figure 3-18. Load Transient, Load Slew rate 1A/us

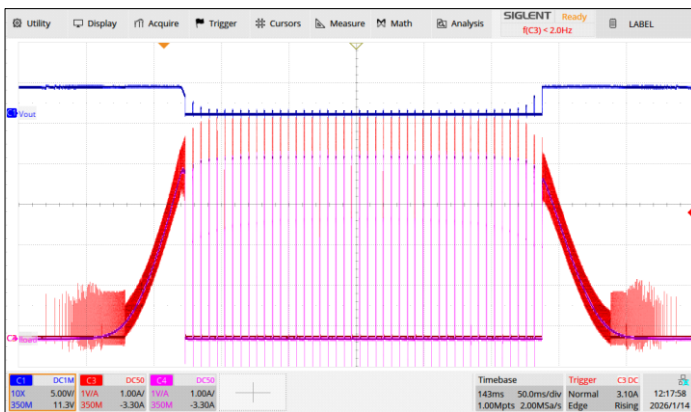


Figure 3-19. Output Short Protection & Hiccup mode



Figure 3-20. Vout Ripple, Sleep mode, Load =0A

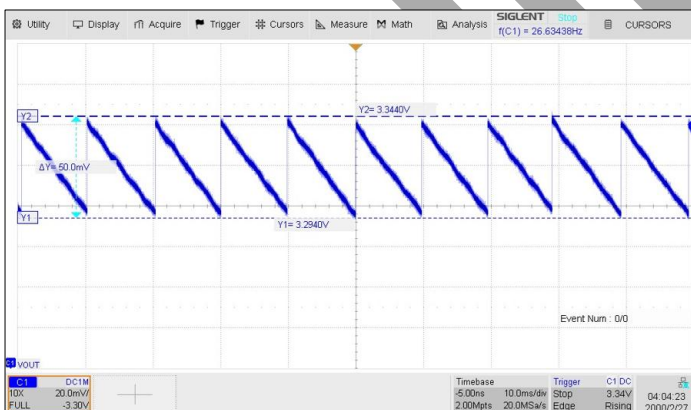


Figure 3-21. Vout Ripple, Sleep mode Disable

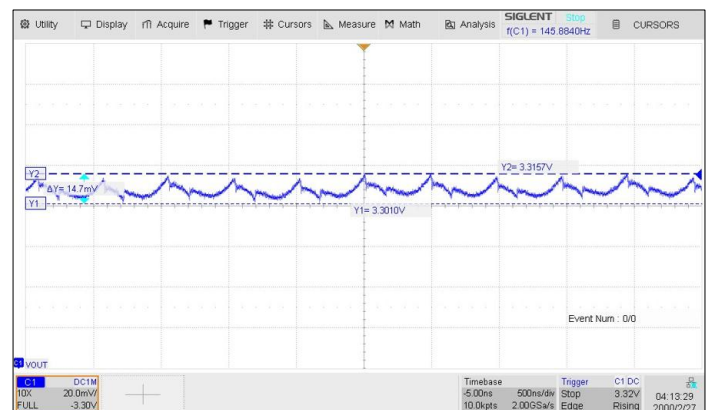


Figure 3-22. Vout Ripple, PWM mode Load=2A



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

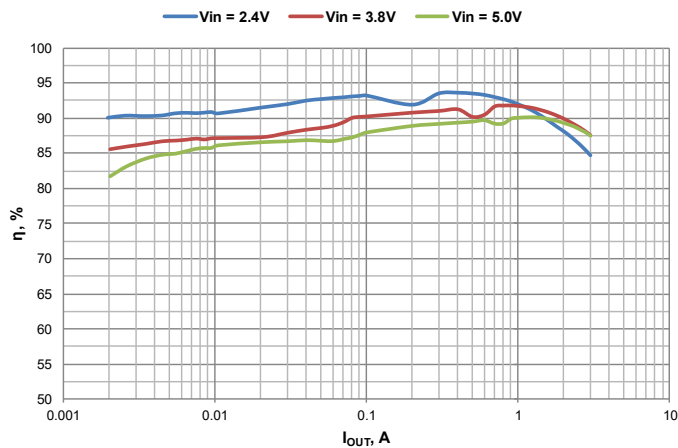
INTERNAL Divider, $V_{OUT} = 1.8V$, 2MHz

Figure 3-23. Efficiency vs Load, AUTO mode

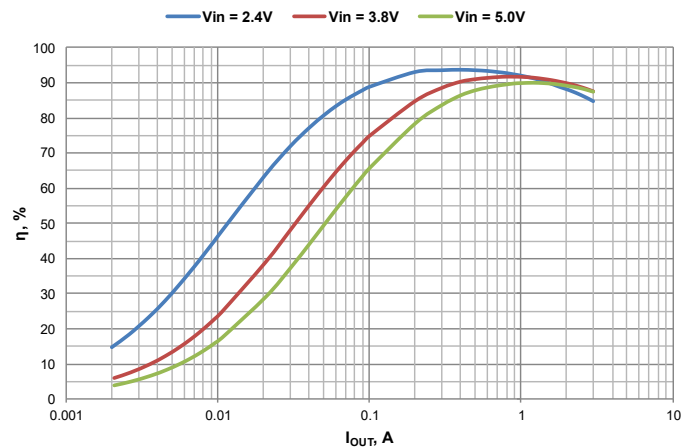


Figure 3-24. Efficiency vs Load, FPWM mode

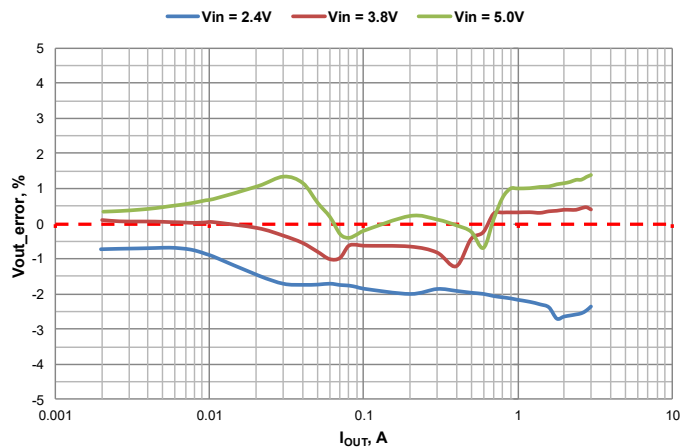


Figure 3-25. Load Regulation, AUTO mode

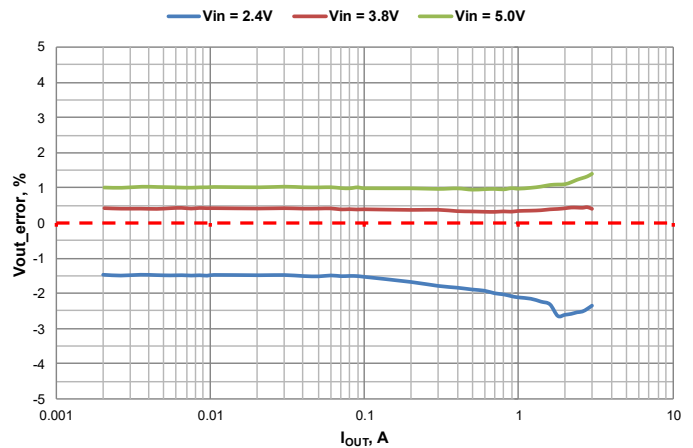


Figure 3-26. Load Regulation, FPWM mode

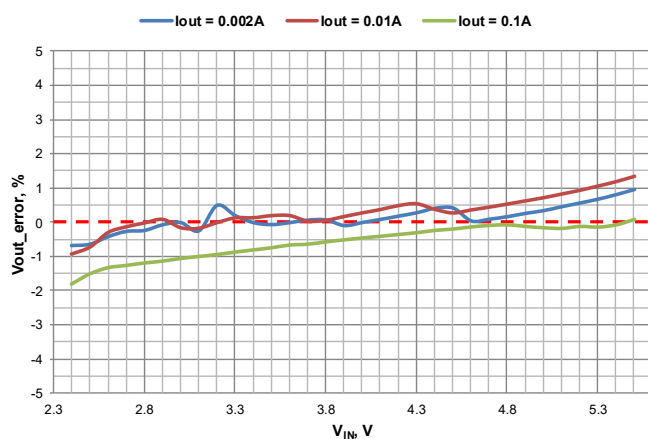


Figure 3-27. Line Regulation, AUTO mode

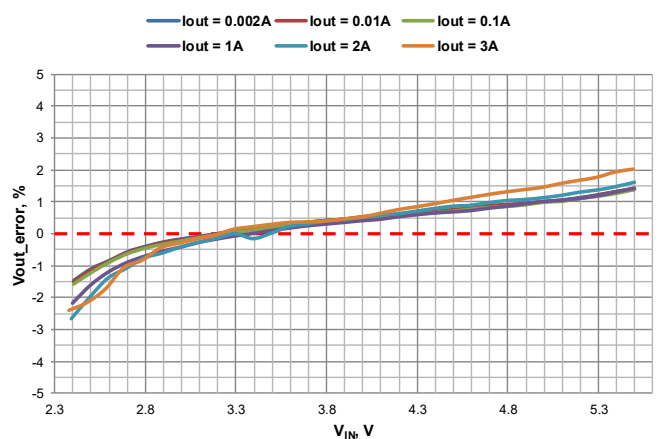


Figure 3-28. Line Regulation, FPWM mode



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

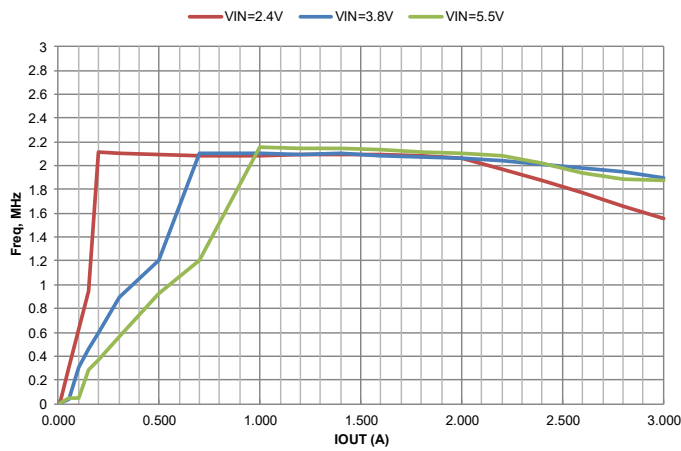
INTERNAL Divider, $V_{OUT} = 1.8V$, 2MHz

Figure 3-29. Switching Frequency vs Load

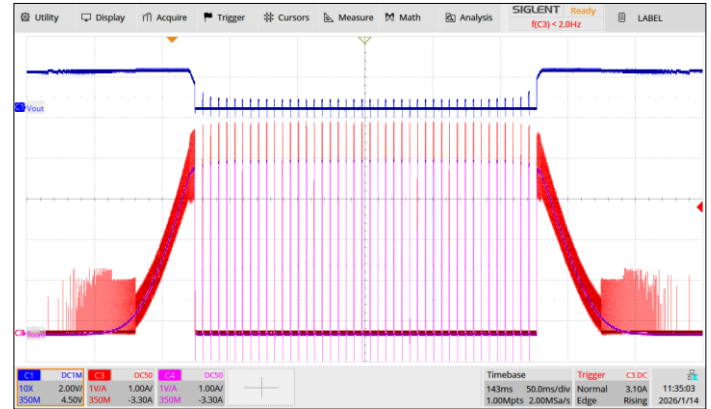


Figure 3-30 Output Short Protection & Hiccup mode

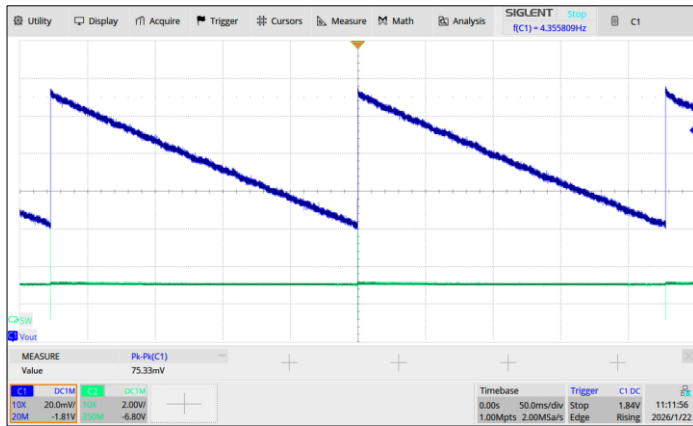
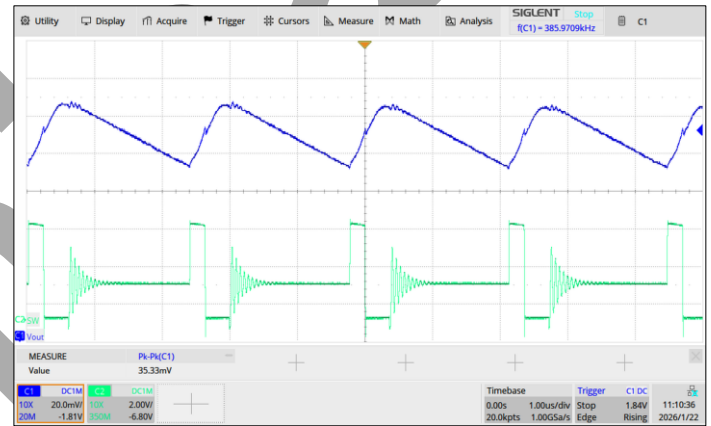
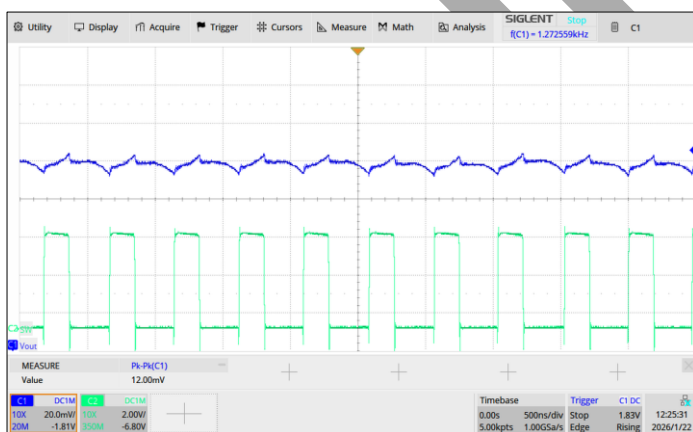
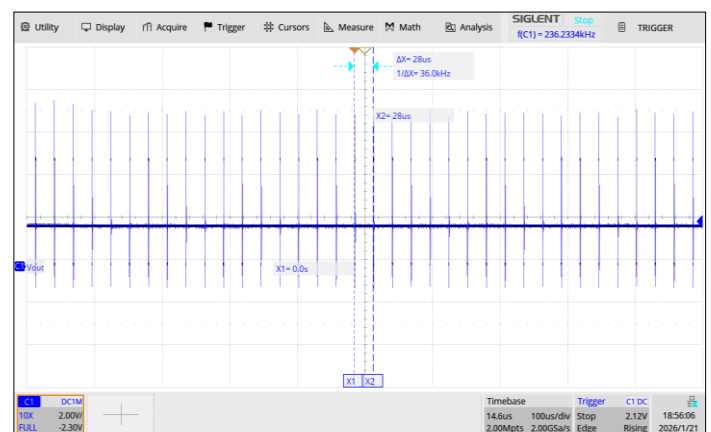
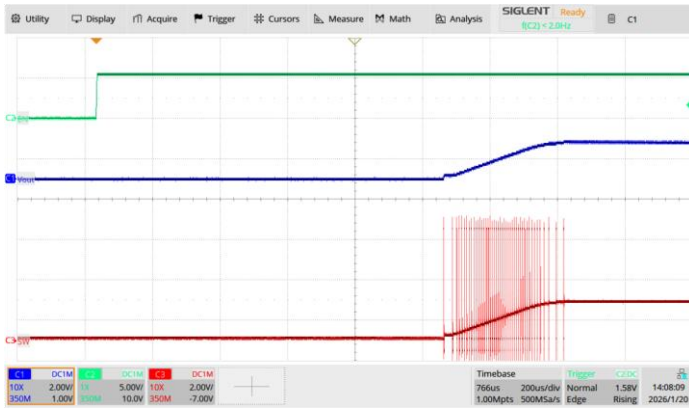
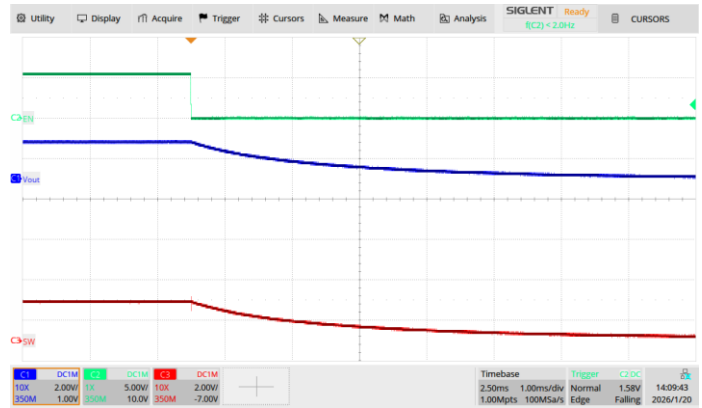
Figure 3-31. V_{OUT} Ripple, Sleep mode, Load =0AFigure 3-32. V_{OUT} Ripple, PFM mode, Load =0.2AFigure 3-33. V_{OUT} Ripple, PWM mode, Load =2A

Figure 3-34. USM mode



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

INTERNAL Divider, $V_{OUT} = 1.8V$, 2MHzFigure 3-35. Start-up, $V_{IN}=5.5V$, Load=0AFigure 3-36. Shutdown, $V_{IN}=5.5V$, Load=0AFigure 3-37. Start-up, $V_{IN}=5.5V$, Load=2AFigure 3-38. Shutdown, $V_{IN}=5.5V$, Load=2A



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

4. Functional Description

4.1. Control Architecture

The AM32102 is a highly efficient, synchronous buck converter with integrated power transistors. It is designed for a wide range of applications, offering programmable operating modes to suit different load conditions. For light loads, it operates in Pulse-Frequency Modulation (PFM) mode, optimizing efficiency and minimizing current consumption. For medium and heavy loads, it switches to Pulse Width Modulation (PWM) mode, which helps reduce output ripple. Additionally, the AM32102 features a forced PWM mode, which ensures low ripple independent of the load, making it ideal for noise-sensitive applications.

The AM32102 allows users to program key parameters such as PWM frequency (2 MHz to 3 MHz) and output voltage levels. During mass production or large-volume sampling, the required configurations are programmed during factory testing, ensuring that the device arrives pre-configured to meet user specifications.

For detailed information on all features and settings, please refer to the following subsections.

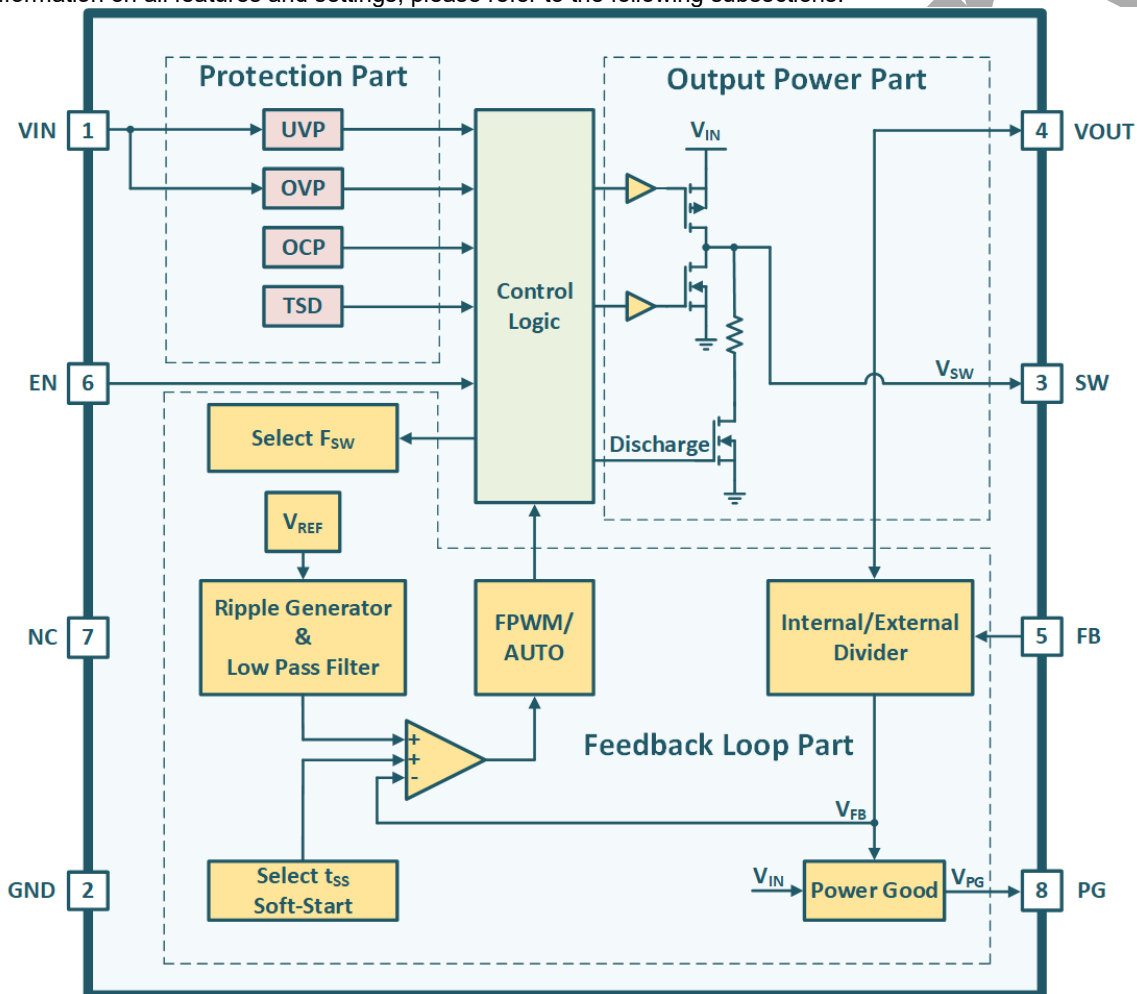


Figure 4-1. Functional Block Diagram

4.1.1. Adaptive Constant On-Time

The AM32102 is an adaptive constant-on-time, synchronous step-down converter. An adaptive on-time control scheme is employed for a constant switching frequency irrespective of input voltage, simplifying control scheme.

During steady-state operation the V_{FB} amplifier senses the feedback voltage and compares to the voltage reference. When the feedback voltage falls below the reference voltage the on-time period is triggered.

During a change in load transient the constant-on-time architecture will modify the switching frequency (T_{OFF} varies) but return to nominal fixed frequency once V_{OUT} has stabilized.



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4.1.2. PFM Mode

When the load drops below half of the peak-to-peak current of the inductor, Discontinuous Conduction Mode (DCM) is activated, and the switching frequency becomes variable; the lower the load, the lower the frequency. The on-time still depends on the ratio of the output to input voltage. Still, during the remaining time, the power transistors are off, and only the output capacitor provides the output voltage. The next switching cycle begins when the voltage at the feedback loop falls below the reference voltage.

4.1.2.1. Sleep Mode

In Sleep Mode, the IC operates similarly to DCM but at reduced switching frequencies. A low-power sleep comparator replaces the main comparator to reduce power consumption. This improves efficiency at light loads, but results in increased output voltage ripple and degraded line regulation compared to DCM with Sleep Mode disabled.

Note 8. During Sleep Mode, the Thermal Shutdown is OFF

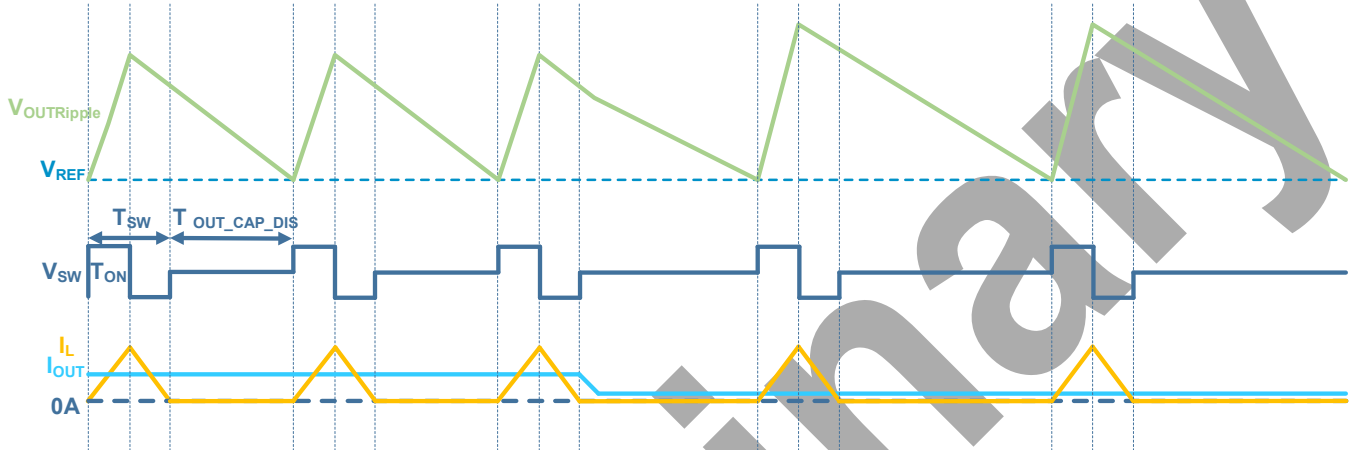


Figure 4-2. Adaptive COT during Steady-State (PFM) Light Loads

4.1.2.2. Ultrasonic Mode

The ultrasonic mode (USM) is an optional control feature that maintains a switching frequency above the audible range at low load conditions. When enabled, this feature maintains a frequency higher than the audible frequency range by adding small switching pulses. This mode leads to improved low-load regulation at the tradeoff of greater quiescent current.

Table 4.1. Ultrasonic mode. Programmable Minimum Frequency Limits

Signal Function	Min.	Typ.	Max.	Unit
Ultrasonic mode	54	60	66	kHz
	25	30	37	kHz

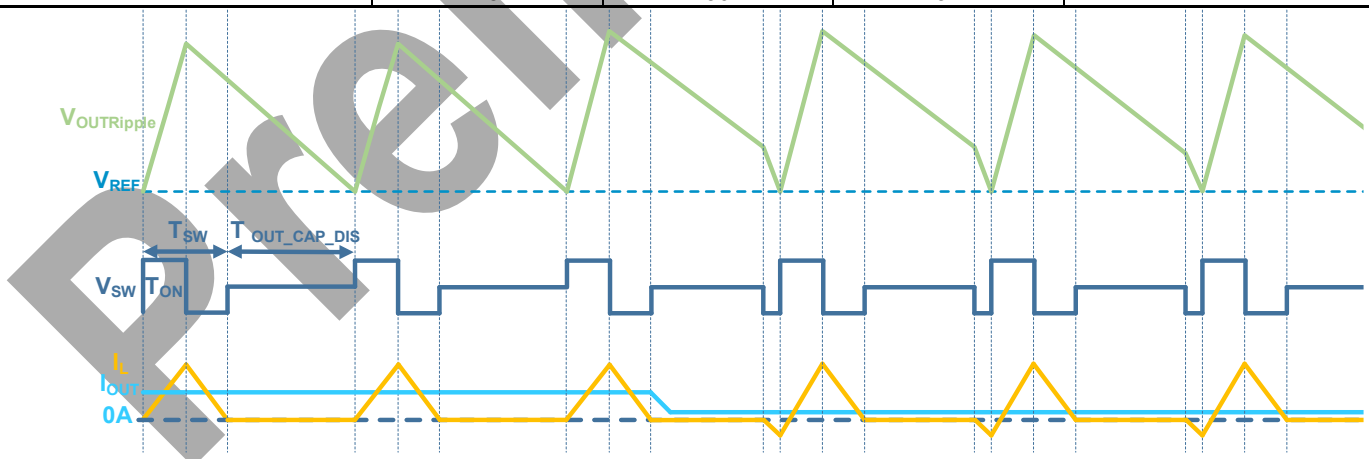


Figure 4-3. Ultrasonic Mode

Note 9. The USM mode is disabled by default.

Note 10. The USM mode is suitable when duty cycle < 70%.



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

4.1.3. PWM Mode

When the load exceeds half of the peak-to-peak current of the inductor, it indicates Continuous Conduction Mode (CCM), and the converter adjusts the pulse width while keeping the frequency stable in the steady state.

Please review the two formulas below: the first calculates the constant on-time in CCM mode, and the second determines the transition point from Discontinuous Conduction Mode (DCM) to CCM.

$$T_{ON} = \frac{V_{OUT}}{V_{IN} \cdot F_{SW}} \quad (1)$$

Where:

- V_{OUT} – output voltage (V)
- V_{IN} – input voltage (V)
- F_{SW} – switching frequency (Hz)

$$I_{LOAD} = \left(\frac{V_{IN} - V_{OUT}}{2L} \right) \cdot T_{ON} \quad (2)$$

Where:

- L – inductor value (H)

The second formula shows that the transition point depends on the inductance. Therefore, caution must be exercised when selecting a small inductance, as a compromise between inductance and DCR (Direct Current Resistance) is always necessary.

Please review the time diagrams below for better understanding:

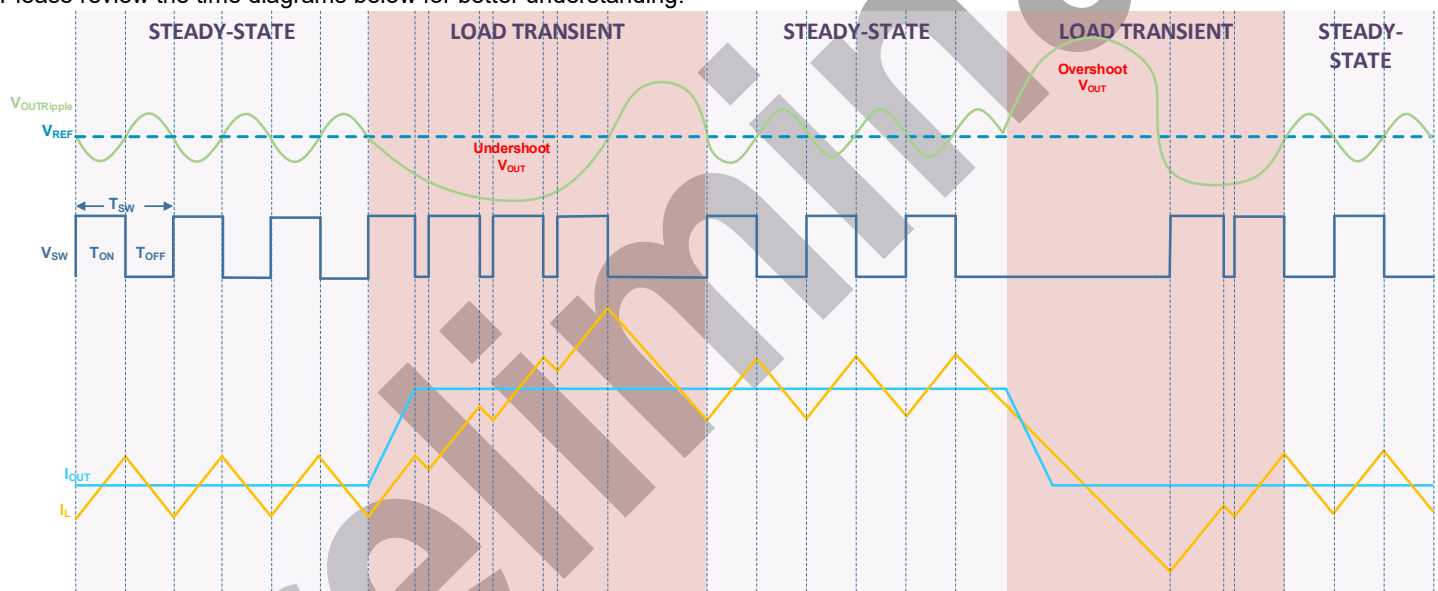
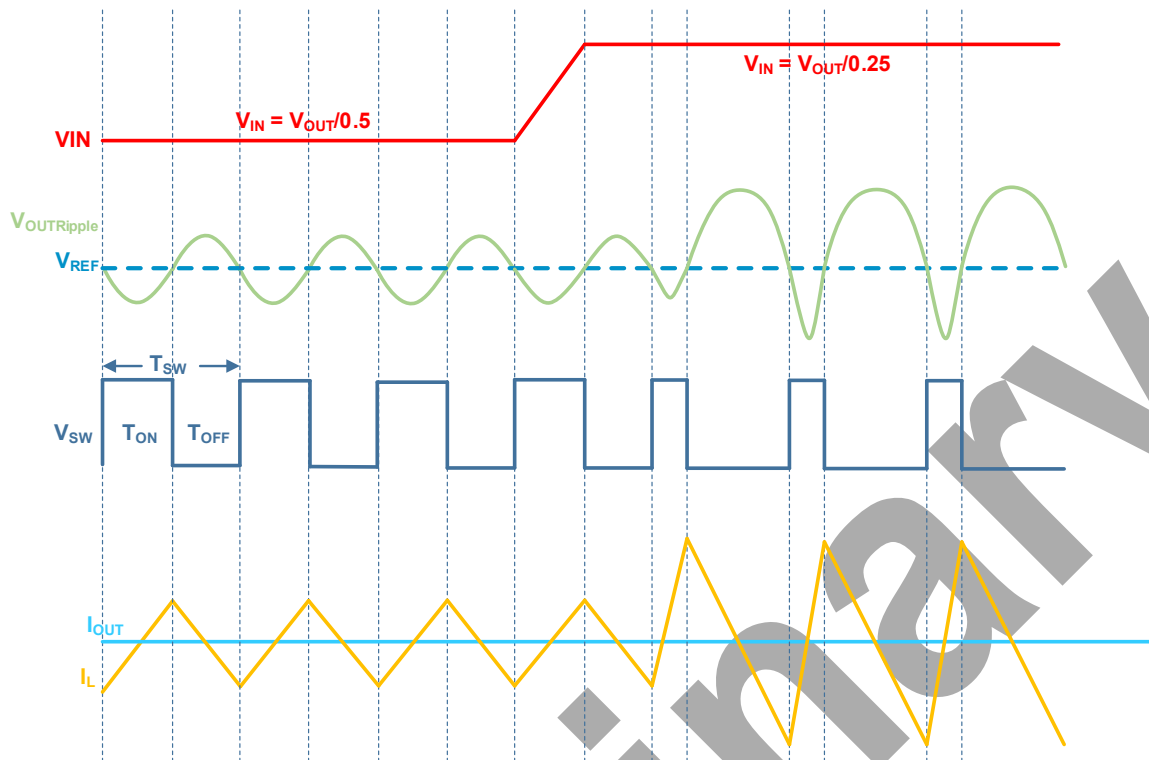


Figure 4-4. Adaptive COT during Steady-State (PWM) and Load Transient events, Middle-Heavy Loads

From the timing diagram above, during the transition process, the on-time is constant while the off-time varies, which in turn changes the frequency.



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Figure 4-5. Adaptive COT during Steady-State (PWM) V_{IN} changing

The timing diagrams above illustrate how the Constant-ON Time adapts to the ratio of V_{OUT}/V_{IN} .

4.1.3.1. Forced PWM mode

Forced-PWM mode is a configurable option for the AM32102. In this mode, the AM32102 will stay in PWM mode regardless of output current, thereby maintaining a constant switching frequency but increasing quiescent current consumption at lower output current. The AM32102 can be set into forced PWM mode by configuring the non-volatile memory or when the EN pin receives a logic high voltage that is less than $V_{IN} - 250$ mV.

AM32102 has 3 configurations:

- **FPWM Always Enabled** - PWM is enabled via non-volatile memory. The device maintains a constant switching frequency regardless of load.
- **FPWM Enabled via EN pin** - when the EN pin receives a logic high voltage that is less than $V_{IN} - 250$ mV.
- **FPWM Disabled** - The FPWM function can now be entirely disabled, meaning the device operates in auto mode only, transitioning between PWM and PFM as needed based on load conditions. This mode results in improved efficiency at light loads due to reduced switching activity. Disabling FPWM is done by configuration and results in no FPWM behavior, regardless of the EN pin state.

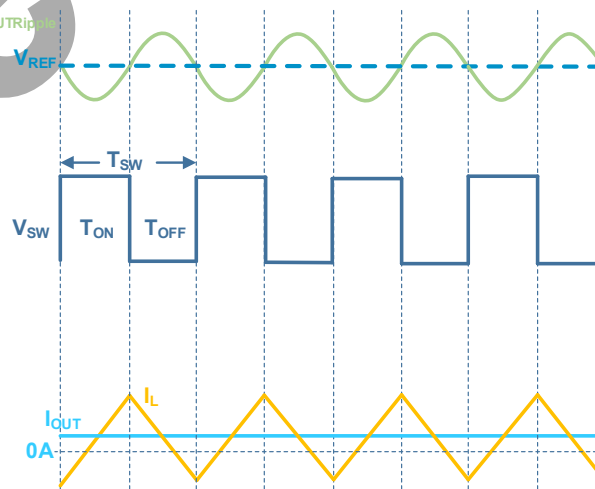


Figure 4-6. FPWM mode



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

4.2. Enable (EN)

The device is enabled by setting the EN pin to logic HIGH. Conversely, the AM32102 is shut down if the EN pin is pulled low. In shutdown mode, internal control circuitry is turned off, as well as the internal power switches. For the correct operation, do not leave the enable pin floating.

The device operates in PFM mode when the EN pin receives a logic high voltage that is greater than $V_{IN} - 250\text{mV}$. In contrast, the device switches to PWM mode, regardless of the output load, when the EN pin receives a logic high voltage that is less than $V_{IN} - 250\text{mV}$.

Note 11. When feature FPWM is using EN: disabled in NVM, the EN value has no effect.

Note 12. When FPWM is selected in NVM, the EN value has no effect.

4.3. Power Good (PG)

The PG pin of AM32102 is an open-drain output that is actively held low during the soft-start period until the output voltage reaches 95% of its target value. When the output voltage is outside of its regulation by $\pm 10\%$, PG pulls low until the output returns within 5% of its set value. The PG rising edge transition is delayed by $40\mu\text{s}$.

Please see the timing diagram below during the start-up stage.

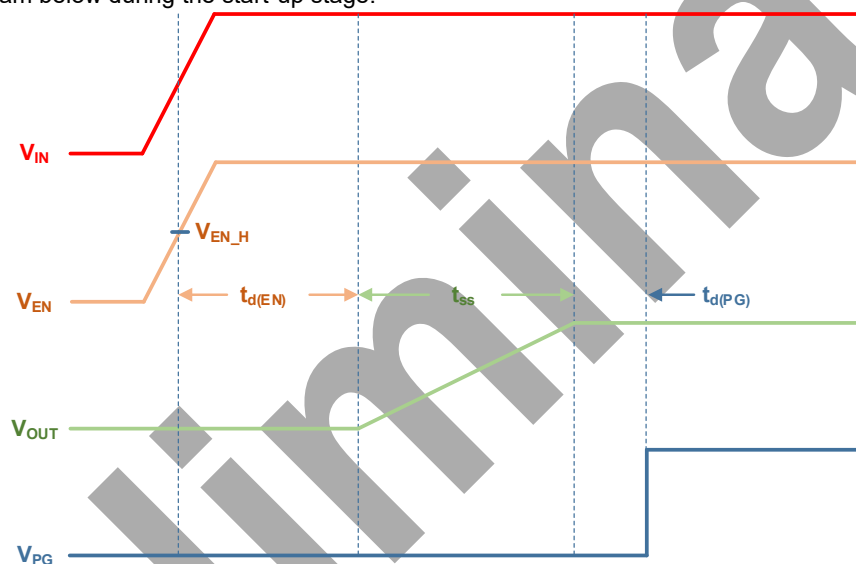


Figure 4-7. Start-Up Timing



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

4.4. Soft-Start Time

The AM32102 has an optional soft-start configuration for applications that need to reduce in-rush current. If enabled, the soft-start will limit the rate of the output voltage ramp in relation to the chosen soft-start value. By default, soft-start is 0.5ms. Programmable soft-start options are:

Table 4.2. Soft-Start times

Function	Time	Min.	Typ.	Max.	Unit
Soft start time	Disable	0.044	0.047	0.050	ms
	0.5	0.42	0.46	0.51	
	1.0	0.86	0.91	0.95	
	2.0	1.79	1.92	2.03	

4.5. Protection Mechanisms

4.5.1. Undervoltage Lockout

Undervoltage lockout is implemented to protect the IC from insufficient input voltages. The AM32102 is disabled if the input voltage falls below 2.2V. In this UVLO event, both the high-side and low-side power MOSFETs turn off, and the 140Ω active discharge enables to discharge of the output voltage to the ground. Please see picture below:



Figure 4-8. UVLO Mechanism

Note 13. $V_{EN} = V_{IN}$.

4.5.2. V_{IN} Overvoltage Protection

Similarly, input overvoltage protection is implemented to protect the IC from excess input voltages. The AM32102 disables out if the input voltage rises above 6.3V. In this OVP event, both the high-side and low-side power MOSFETs turn off and the 140Ω active discharge enables the discharge of the output voltage to the ground.

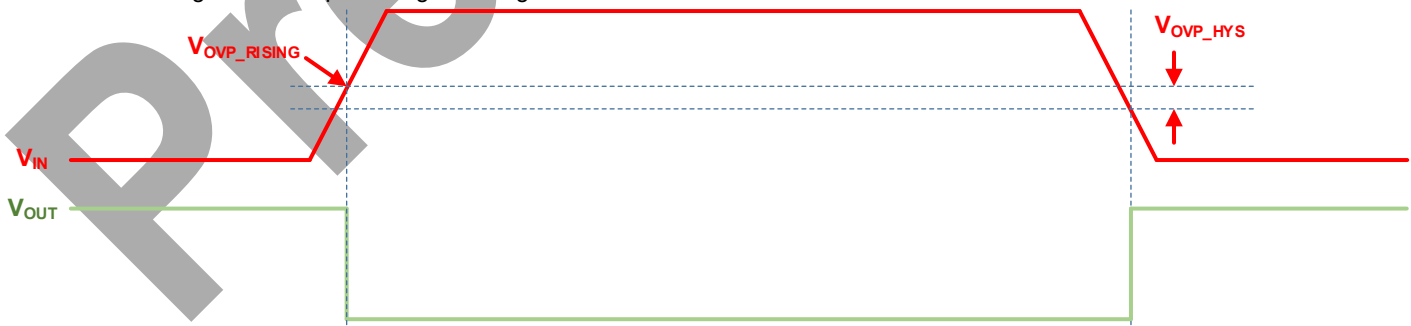


Figure 4-9. OVP Mechanism

Note 14. $V_{EN} = V_{IN}$.



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

4.5.3. Current Limit

The AM32102 implements cycle-by-cycle current protection by sensing the current through internal MOSFETs.

As the output current gradually increases, see the figure below. When the current through the LS FET exceeds its Valley Current Limit, the LS FET remains on until the inductor current falls back to the limit. Only then can a new high-side on-time start. As the load current continues to rise, the inductor peak-to-peak current increases and the effective switching frequency decreases due to repeated activation of the low valley current limit.

If the output current increases further and the current through the HS FET reaches the High-Side Peak Current Limit, the HS FET is turned off immediately. The LS FET then conducts until the inductor current drops to the low valley limit, after which the HS FET may turn on again. In this condition, the output voltage starts to decrease.

When the feedback voltage (FB) falls to 0.4 V, Output Short Protection is triggered, and the converter enters Hiccup Mode. In Hiccup Mode, the IC waits for $13.6 \times$ Soft-Start time before attempting to restart and ramp up V_{OUT} again. This operation reduces power dissipation during output overcurrent or short-circuit conditions.

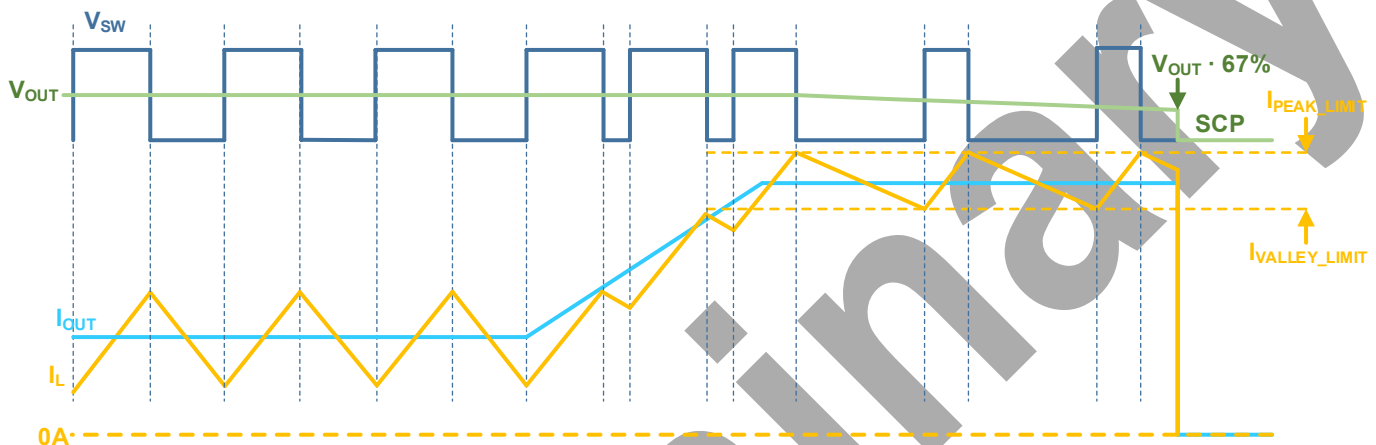


Figure 4-10. Peak, Valley Current Limits, and Hiccup Mode

4.5.4. Thermal Shutdown

If the device's junction temperature reaches the thermal shutdown limit of (+160°C typical), the AM32102 shuts down both its high-side and low-side power MOSFETs. When the junction temperature reduces to the required level (+130°C typical), the device initiates a normal power-up cycle, including soft-start if enabled. Please see the picture below:



Figure 4-11. Thermal Shutdown Mechanism



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

5. Application Information

The AM32102 can operate in two configurations: with a pre-selected internal feedback divider, or, if a specific output voltage is required or maximum precision is desired, with an external feedback divider. For more detailed information on component selection, refer to the following subsections.

5.1. Typical Application

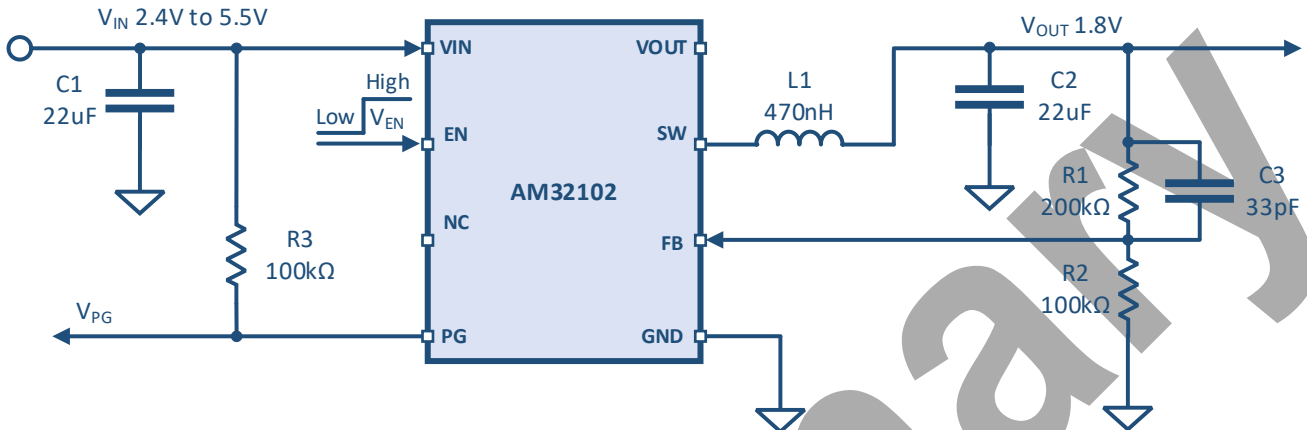


Figure 5-1. Typical Application Circuit for External Divider

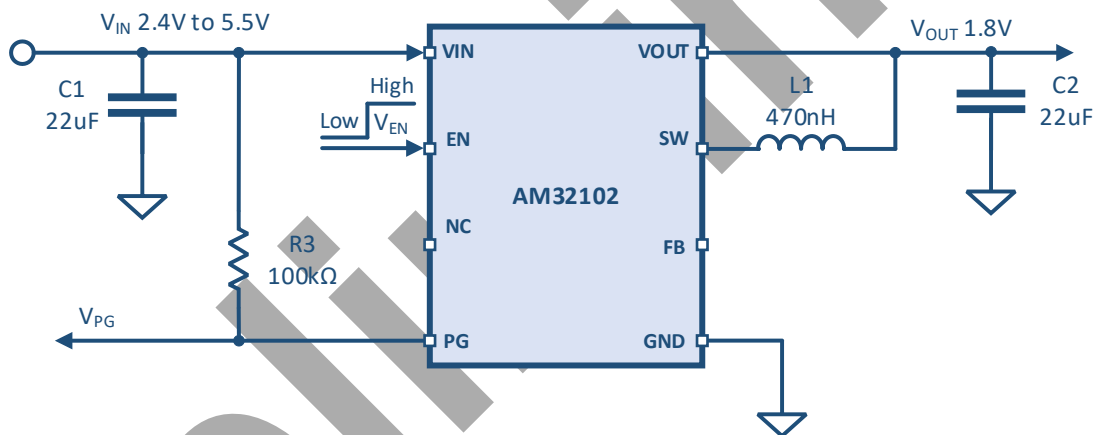


Figure 5-2. Typical Application Circuit for Internal Divider



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

5.2. Setting the Output Voltage

The AM32102 can select the output voltage in two ways:

5.2.1. Internal Voltage Selection

The output voltage can be selected from a predefined set of internal voltage levels. This method does not require external feedback components.

Available internal voltage options:

- 0.6 V
- 0.9 V
- 1.1 V
- 1.8 V
- 2.5 V
- 3.3 V

5.2.2. External Voltage Selection

The Output Voltage can be selected with the help of the external resistor divider according to the equation below:

$$R_{LFB} = \frac{0.6 \cdot R_{HFB}}{V_{OUT} - 0.6} \quad (3)$$

R_{HFB} - connected between V_{OUT} and FB nodes. Typical value is 200k Ω 1%

R_{LFB} - connected between FB and GND nodes.

Please see Table 5.1. below for selection the typical output voltage values:

Table 5.1. V_{OUT} Selection. External method

Output Voltage (V)	R_{HFB} (k Ω)	R_{LFB} (k Ω)
1.0	200.0	301.0
1.2	200.0	200.0
1.5	200.0	133.0
1.8	200.0	100.0
2.5	200.0	63.2
3.3	200.0	44.2

5.3. Selecting the Inductor

Determining the inductance is a key aspect of designing a buck converter. The equation below is the most common way to calculate an inductance:

$$L = \frac{V_{OUT} \cdot (V_{IN} - V_{OUT})}{V_{IN} \cdot f_{SW} \cdot \Delta I_L} \quad (4)$$

ΔI_L – is the inductor current ripple. The inductor current is chosen at approximately 30% of the maximum load current.

f_{SW} – is the buck converter switching frequency

The peak current of the inductor, which affects its saturation, is also determined. The following equation shows how to calculate the peak inductor current:

$$I_{Lpeak} = I_{OUT(MAX)} + \frac{\Delta I_L}{2} \quad (5)$$



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

5.4. Selecting the Output Capacitor

The output capacitor plays a crucial role in reducing the output voltage ripple, ensuring the stability of the feedback loop, and minimizing both overshoots and undershoots of the output voltage during load transients. To achieve the best performance, an output capacitor with large capacitance and low ESR is recommended. For most applications, a ceramic capacitor with a value between 10 μ F and 22 μ F is sufficient.

Important: Always check the DC bias voltage curve for your output capacitors to ensure they will perform as expected across the operating range.

5.5. Selecting Input Capacitor

The input capacitor minimizes input voltage ripple, suppresses input voltage spikes, and provides a stable system rail for the device. Use low ESR capacitors for the best performance. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. Generally, 10 μ F or 22 μ F input capacitors are sufficient for most applications. Additionally, larger sizes result in higher parasitic inductance, which has a negative impact, but they offer improvements in electrical parameters such as capacitance and voltage rating.

5.6. Selecting Feed Forward Capacitor

A common method to improve the stability and bandwidth of a power supply is to use a feedforward capacitor, which is a capacitor placed across the high-side feedback resistor. We recommend using 33pF as a feed-forward capacitor.

5.7. Recommended Component Selection

Table 5.2. Recommended Component Selection

Output Voltage (V)	R _{HFB} (k Ω)	R _{LFB} (k Ω)	C _{IN} (μ F)	C _{OUT} (μ F)	L (nH)	C _{FF} (pF)
0.6	200	--	10+0.1	22	470	33
0.9	200	400	10+0.1	22	470	33
1.1	200	240	10+0.1	22	470	33
1.8	200	100	10+0.1	22	470	33
2.5	200	63.2	10+0.1	22	470	33
3.3	200	44.4	10+0.1	22	470	33

Note 15. Resistor Accuracy: The feedback resistors should be chosen with a minimum accuracy of 1%.

Note 16. Choose the input and output capacitors with a voltage rating that is 20% higher than the maximum V_{IN} and V_{OUT} voltage values.

The capacitor size and temperature coefficient depend on the application and should be selected accordingly.

Note 17. If the internal voltage divider is selected, the FB pin should be left floating.

Table 5.3. List of components

Reference	Description	Manufacturer
IC	AM32102	Atlas Magnetics
L	74479275147	Würth Elektronik
C _{IN1}	885012105020	Würth Elektronik
C _{IN2}	885012205006	Würth Elektronik
C _{OUT}	885012107011	Würth Elektronik
C _{FF}	885012005010	Würth Elektronik
R1	Depending on V _{OUT}	Any
R2	Depending on V _{OUT}	Any
R3	100k Ω	Any



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

6. Recommended PCB Layout

6.1. Layout Guidelines

An efficient PCB layout of the switching power supplies is critical for stable operation. For the high-frequency switching converter, a poor layout design can result in poor line or load regulation and stability issues

1. Place the input capacitors as closely across V_{IN} and GND as possible. This is the most crucial placement of the components.
2. Place the output capacitors as closely across V_{OUT} and GND as possible.
3. Place the feedback components as close to FB as possible.
4. If using four or more layers, use at least the 2nd and 3rd layers as GND to maximize thermal performance and reduce EMI.
5. Use multiple vias to link the internal PGND planes with the PGND plane on the top layer

6.2. Layout Example

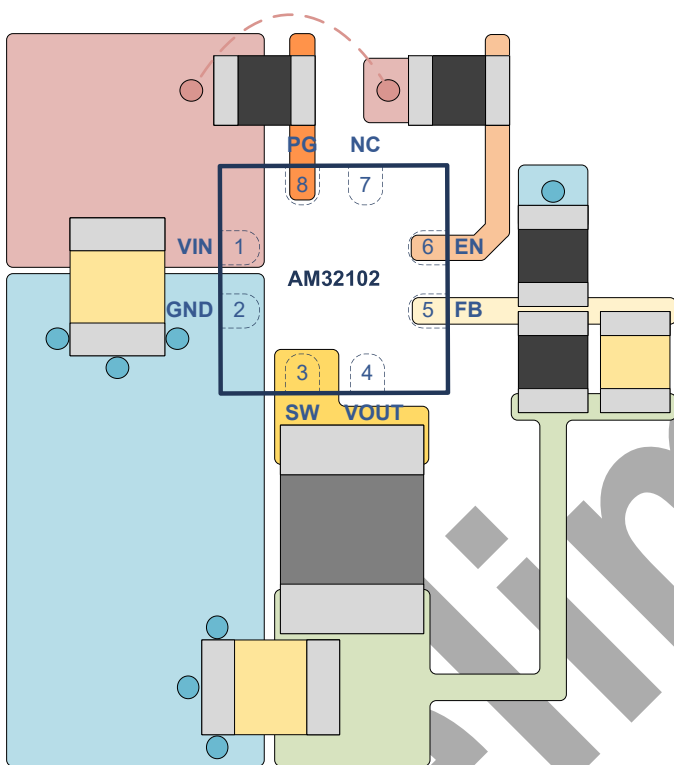


Figure 6-1. Recommended PCB Layout
(External Feedback)

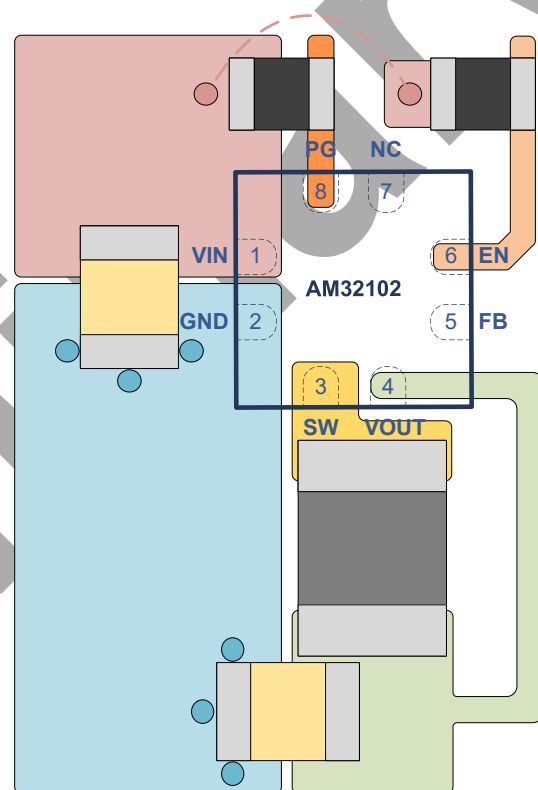
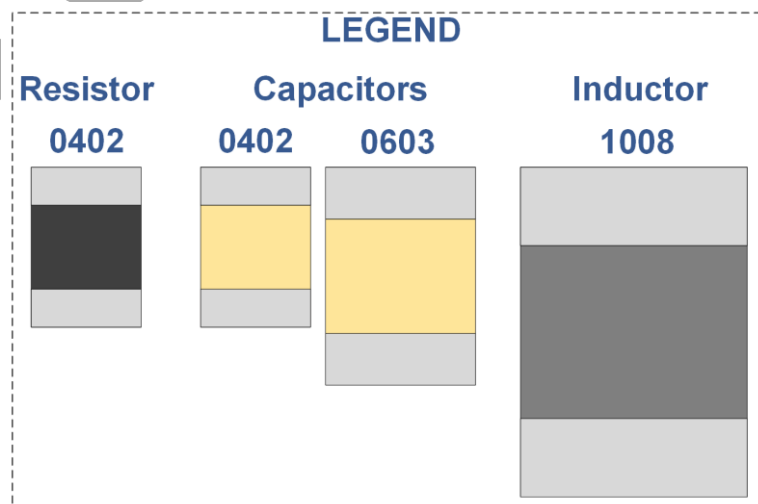


Figure 6-2. Recommended PCB Layout
(Internal Feedback)





2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

6.3. Layout Stack-Up Proposal

A well-designed PCB layer stack-up is critical for DC-DC converters. It ensures low impedance power and ground paths, minimizes EMI, improves thermal performance, and supports reliable high-frequency switching operation. Proper stack-up design directly impacts efficiency, noise performance, and overall system stability. Please check our proposal below:

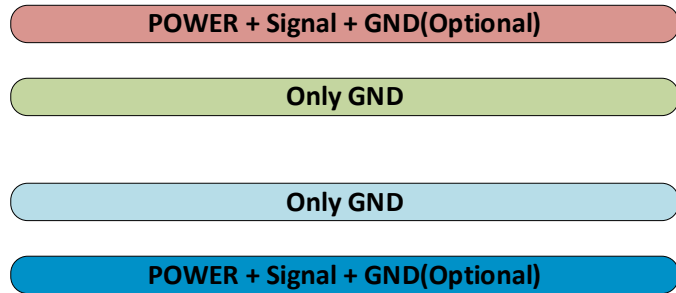


Figure 6-3. Layer stack-up of a four-layer board (Better for EMI performance)

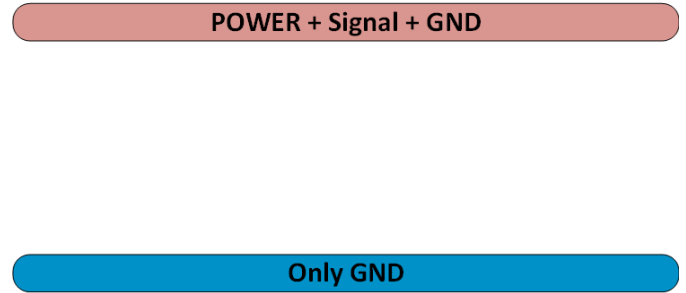
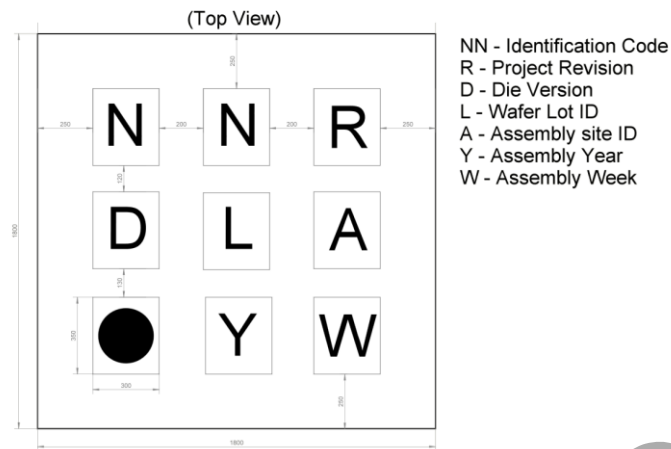


Figure 6-4. Layer stack-up of a two-layer board

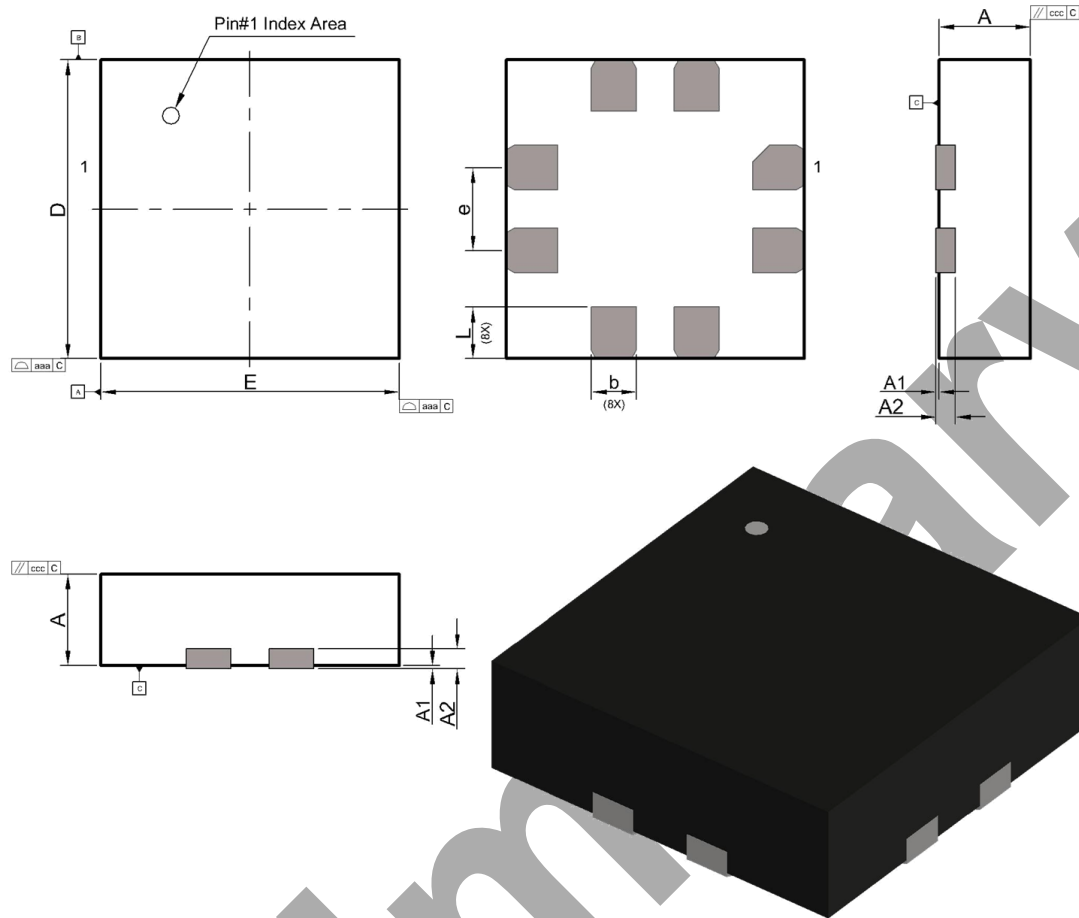


7. Package Top Marking System Definition





8. Package Drawing and Dimensions

**TQFN-8**

Symbol	Min.	Typ.	Max.	Symbol	Min.	Typ.	Max.
A	0.500	0.550	0.600	L	—	0.310	—
A1	—	0.020	—	b	—	0.270	—
A2	0.100	0.120	0.140	e	—	0.500	—
D	1.750	1.800	1.850	aaa	—	0.050	—
E	1.750	1.800	1.850	ccc	—	0.050	—

All Dimensions in mm



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

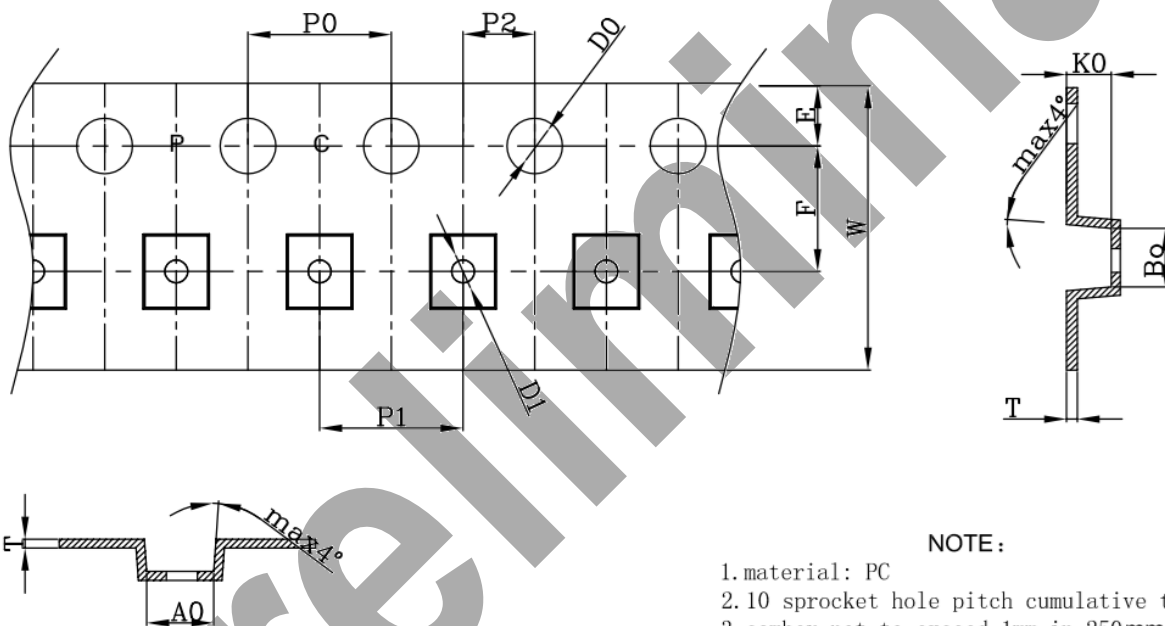
9. Tape and Reel Specifications

Table 9.1. Tape and Reel Specifications

Package Type	# of Pins	Nominal Package Size, mm	Max Units		per Reel & Hub Size, mm	Leader (min)		Trailer (min)		Tape Width, mm	Part Pitch, mm
			per Reel	per Box		Pockets	Length, mm	Pockets	Length, mm		
TQFN Error! Unknown document property name.L 0.5P FC	8	1.8× 1.8× 0.55	3000	3000	178/55	130	520	130	520	8	4

Table 9.2. Carrier Tape Drawing and Dimensions

Package Type	A0	B0	K0	P0	P1	P2	T	E	F	D0	D1	W
QFN1818-8	2.00	2.00	0.75	4.00	4.00	2.00	0.20	1.75	3.50	1.50	0.80	8.00



NOTE:

1. material: PC
2. 10 sprocket hole pitch cumulative tolerance ± 0.2 ;
3. camber not to exceed 1mm in 250mm;
4. all dimension should met the requirements of EIA-481-D

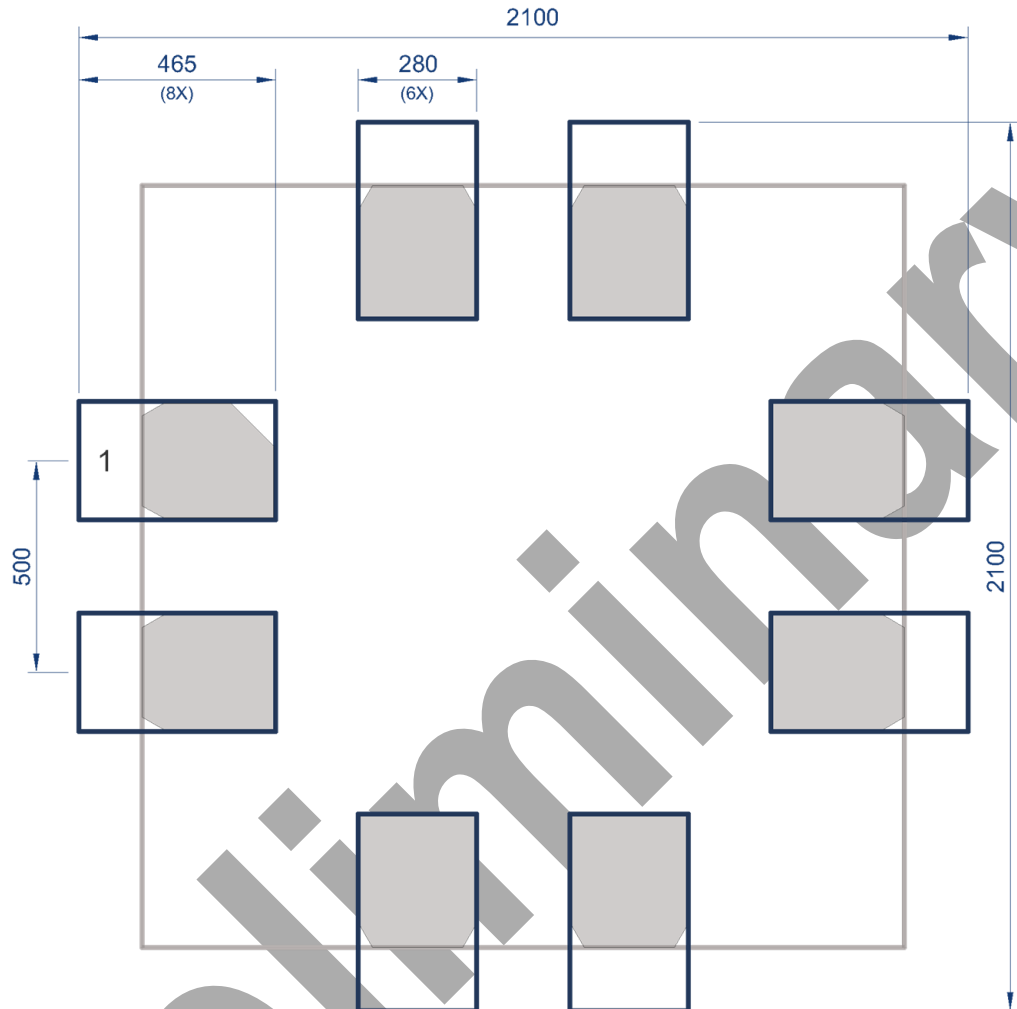
**10. Recommended Land Pattern**

Figure 10-1. Recommended Land Pattern (Top View). Unit: μm

**11. Recommended Reflow Soldering Profile**

Please see IPC/JEDEC J-STD-020: latest revision for reflow profile based on package volume of 0.504 mm³ (nominal). More information can be found at www.jedec.org.

Preliminary

**12. Mechanical Data**

- Moisture Sensitivity: Level 1 per J-STD-020
- Weight: 0.005008 grams (Approximate)

Preliminary



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

13. Revision History

Date	Version	Changes
6/17/2025	Rev.001	Initial release
7/1/2025	Rev.002	Update POD dimension values
8/15/2025	Rev.003	Added min/max limits to POD
2/18/2026	Rev.004	Add Typical Characteristics
3/30/2026	Rev. 005	Add Thermal resistance results



2.4V TO 5.5V INPUT, PROGRAMMABLE 2A BUCK CONVERTER

14. Worldwide Sales and Customer Support

Atlas Magnetics has established a vast network of offices, partners, distributors, and manufacturer's representatives. Feel free to contact any of the listed contacts to get in touch with us.

WEB support:

atlas-magnetics.com/contact

AM direct contacts:

Americas:

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