

High Efficiency Step-Up Converter with a 4A Switch

Features

- Input Voltage Range: 2.4V to 5.5V
- 2.5V minimum input voltage for start-up
- Fixed Output Voltage: 5.25V and 5.4V
- $I_{OUT} \geq 1.5A$ at $V_{IN} \geq 3.3V$
- Up to 93% Efficiency
- 35 μ A Quiescent Current
- 4A switching valley current limit
- Light Load Power Save Mode
- Build-in OVP, OTP, UVLO, Short-circuit Protection
- True Load Disconnect During Shutdown
- WLCSP 1.253mm x 1.253mm-9B Package

Applications

Cell Phones, Smart Phones, PADs, Wearable
Power Bank
USB On-The-Go Device
Digital Camera

General Description

The AW3615X is a large current, high-efficiency synchronous boost regulator with adjustable output voltage. With a wide input voltage range of 2.4V to 5.5V, the device supports applications powered by Li-Ion batteries with extended voltage range.

The AW3615X operates at a quasi-constant 2.5MHz switching frequency and enters power save mode operation at light load currents to maintain high efficiency over the entire load current range. The PSM mode extends the battery life by reducing the quiescent current during light load operation.

The AW3615X operates in pass-through mode when input voltage is higher than output voltage. When it enters pass-through mode and the device stops switching. The rectifying PMOS constantly turns on and low-side switch constantly turns off.

The AW36151 and AW36152 are preset for outputting 5.25V and 5.4V respectively.

The AW3615X is available in a tiny WLCSP 1.253mm x 1.253mm-9B package.

Typical Application Circuit

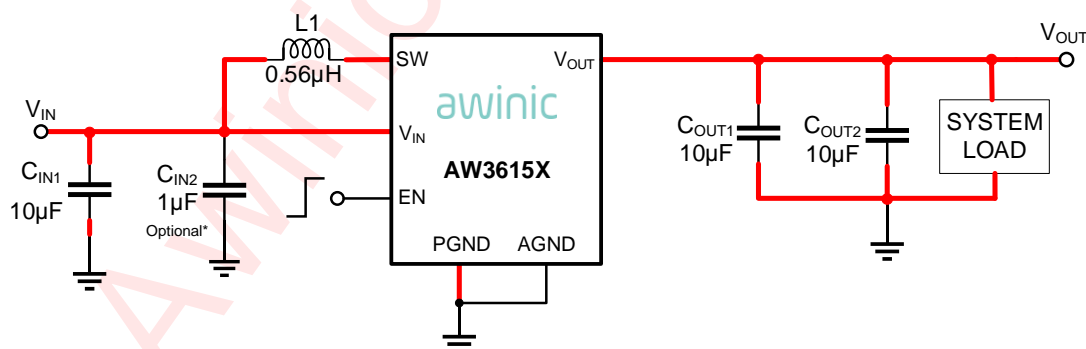
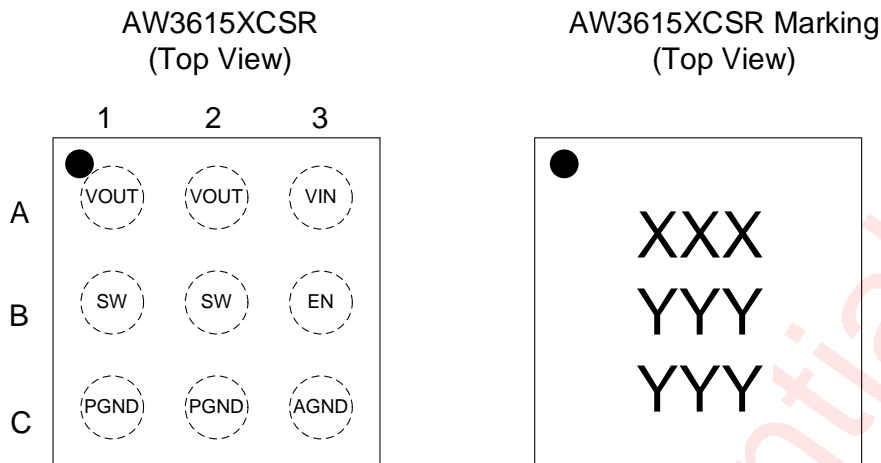


Figure 1 AW3615X typical application circuit

Pin Configuration And Top Mark

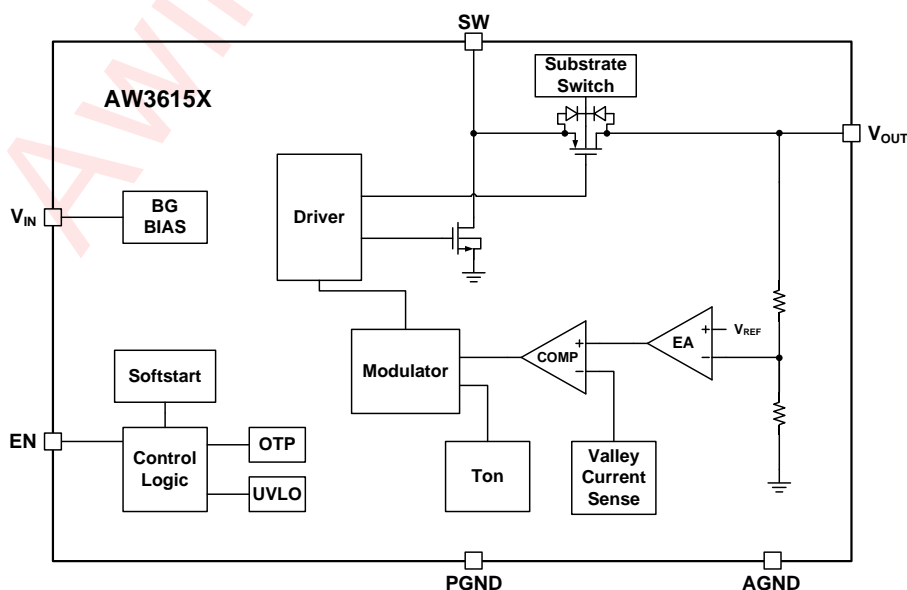


XXX - AW36151CSR/AW36152CSR
YYY/YYY - Production Tracing Code

Pin Definition

No.	NAME	DESCRIPTION
A1, A2	V _{OUT}	Output terminal. Should be bypassed with a C _{OUT} capacitor.
A3	V _{IN}	Power Supply. Connect directly to C _{IN} .
B1, B2	SW	Switching Node. Connected to inductor.
B3	EN	Enable. When this pin is high, the circuit is enabled. A 5MΩ pull-down resistor is integrated.
C1, C2	PGND	Power Ground. This is the power return for the IC, C _{OUT} capacitor should be returned with the shortest path possible to these pins.
C3	AGND	Analog Ground.

Functional Block Diagram



Typical Application Circuit

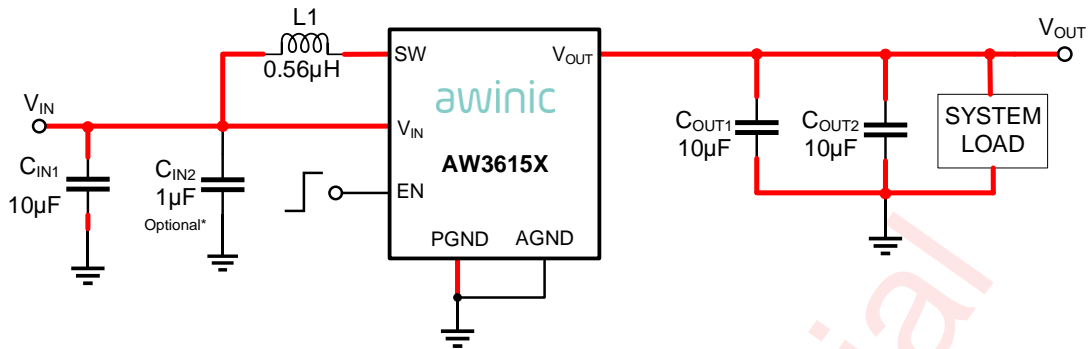


Figure 2 AW3615X typical application circuit

Notice for typical application circuits:

Note1: Inductor L1 is recommended to choose 0.56µH.

Note2: The large current path is used red line. For the sake of driving capability, the routes V_{IN} -SW should be short and wide. The proposed width of V_{IN} -SW route is 100mil, and the V_{OUT} trace 60mil.

Note3: Place C_{IN1} and inductor close to V_{IN} pin, an optional C_{IN2} should added if C_{IN1} is far from V_{IN} pin. Place C_{OUT1} and C_{OUT2} close to V_{OUT} , the distance between C_{OUT} and V_{OUT} pin must not beyond 5mm. The C_{OUT} of 20µF is recommended. When the input and output voltage differential is less than 0.4V, it is recommended to increase the output capacitor to 44µF.

Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW36151CSR	-40°C~85°C	WLCSP 1.253mmX1.253mm -9B	9KG	MSL1	ROHS+HF	3000 units/ Tape and Reel
AW36152CSR	-40°C~85°C	WLCSP 1.253mmX1.253mm -9B	VE7	MSL1	ROHS+HF	3000 units/ Tape and Reel

Absolute Maximum Ratings^(NOTE1)

PARAMETERS		RANGE
Input voltage range	V _{IN} , FB, EN	-0.3V to 6.5V
Output voltage range	V _{OUT}	-0.3V to 7V
SW	DC	-0.3V to 7V
	Transient: 10ns, 3MHz	-1V to 8V
Junction-to-ambient thermal resistance θ_{JA}		69.5°C /W
Maximum operating junction temperature T _{JMAX}		150°C
Operating free-air temperature range		-40°C to 85°C
Storage temperature T _{STG}		-65°C to 150°C
Lead temperature (soldering 10 seconds)		260°C

NOTE1: Conditions out of those ranges listed in "absolute maximum ratings" may cause permanent damages to the device. In spite of the limits above, functional operation conditions of the device should be within the ranges listed in "recommended operating conditions". Exposure to absolute-maximum-rated conditions for prolonged periods may affect device reliability.

Recommended Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V _{IN}	Input Voltage Range	2.4		5.5	V
V _{OUT}	Output Voltage Range	AW36151	5.25		V
		AW36152	5.4		V
L	Inductance		0.56		μH
C _{OUT}	Output Capacitor		20		μF

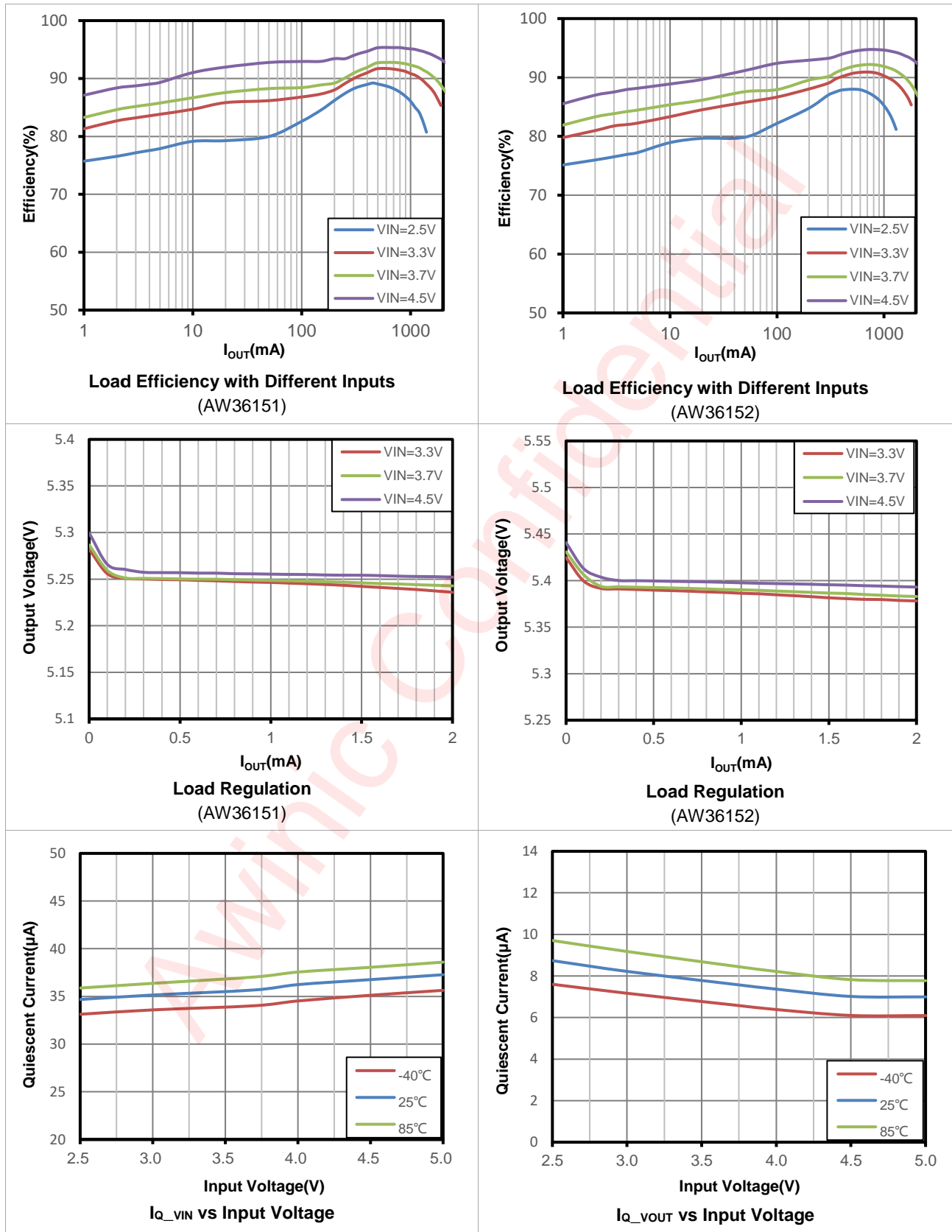
Electrical Characteristics

$V_{IN}=2.4V\sim 5.5V$, typical values are at $V_{IN}=3.7V$ and $T_A=25^{\circ}C$, unless otherwise noted.

PARAMETER	TEST CONDITION	MIN	TYP	MAX	UNIT		
SUPPLY CURRENT							
I_Q	Quiescent current (Device Normal Switching)	$EN=V_{IN},$ $I_{OUT}=0$	AW36151		47	μA	
			AW36152		49	μA	
I_{Q_VIN}	Quiescent current (Device Not Switching)	$EN=V_{IN}, I_{OUT}=0,$ not switching		35		μA	
I_{Q_VOUT}				7			
I_{SD}	Shutdown current	$EN=0$		0.3		μA	
V_{UVLO}	Under-Voltage Lockout	V_{IN} Rising		2.4		V	
V_{UVLO_HYS}	Under-Voltage Lockout Hysteresis			100		mV	
OUTPUT VOLTAGE							
V_{OUT}	Output Voltage Range	PWM mode, $I_{OUT}=300mA$	AW36151	5.15	5.25	5.36	V
			AW36152	5.29	5.40	5.51	V
V_{OVP}	Output overvoltage protection threshold	V_{OUT} rising	6.2	6.4	6.65	V	
	OVP hysteresis			100	200	mV	
R_{DIS}	V_{OUT} discharge resistor	$V_{IN}=3.7V, EN=0V$		20		k Ω	
POWER SWITCHES							
fsw	Switching Frequency	$V_{IN}=3.7V, I_{OUT}=500mA$		2.5		MHz	
$R_{DS(on)_LS}$	Low side switch on resistance			40		m Ω	
$R_{DS(on)_HS}$	Rectifier on resistance			50		m Ω	
I_{LIM_SW}	Switching valley current limit			4		A	
	Startup current limit			0.5		A	
CONTROL LOGIC							
V_{EN_H}	Enable High voltage		0.9			V	
V_{EN_L}	Enable Low voltage			0.3		V	
R_{EN}	EN pin Pull-down resistor			5		M Ω	
I_{EN_LKG}	Leakage current into EN pin	$V_{EN} = 5.0V$		1.4		μA	
T_{OTP}	Over temperature protection			150		$^{\circ}C$	
T_{OTP_HYS}	OTP hysteresis			20		$^{\circ}C$	

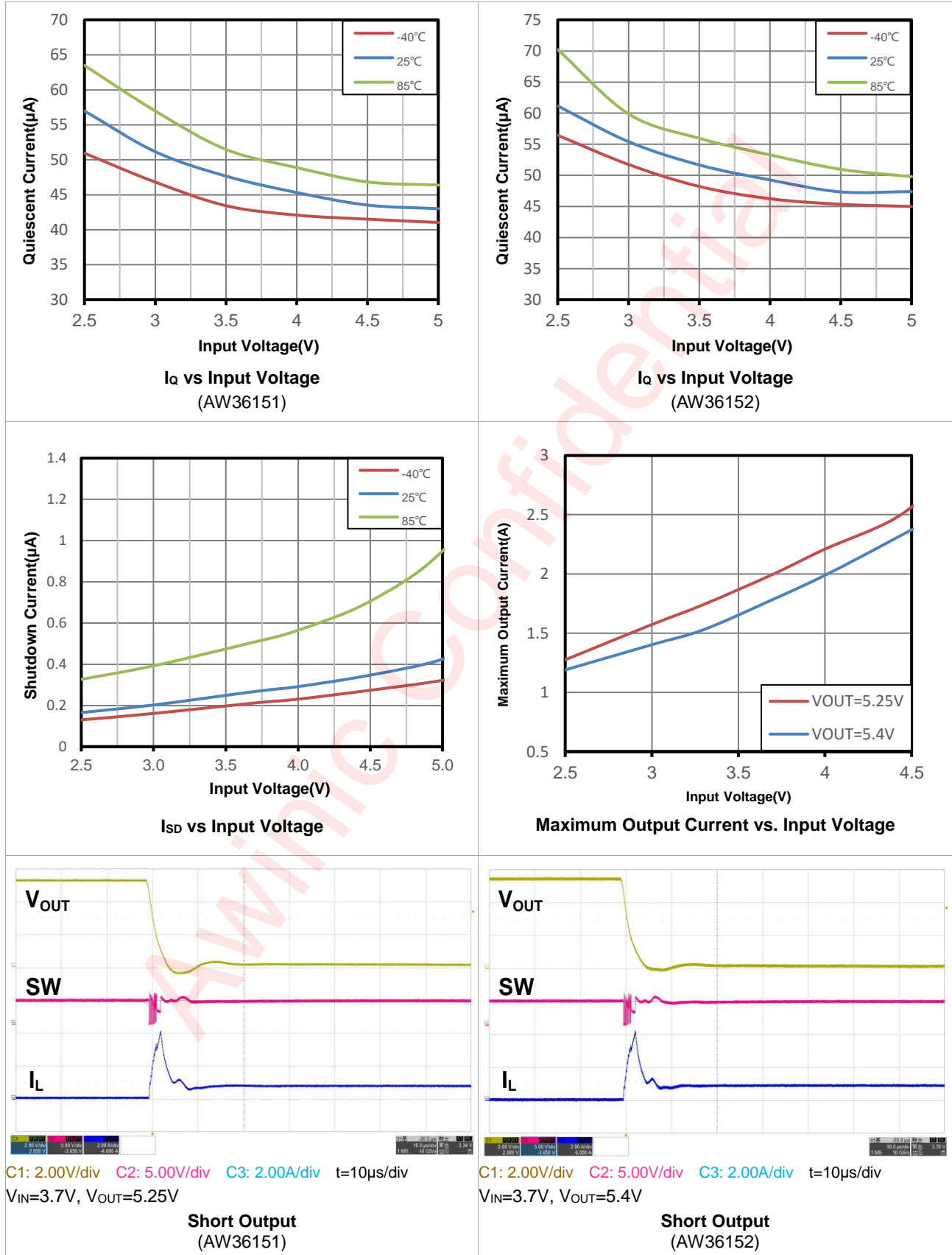
Typical Characteristics

$T_A=25^{\circ}\text{C}$, $C_{IN} = 10\mu\text{F}$, $C_{OUT} = 20\mu\text{F}$, $V_{IN}=3.7\text{V}$, unless otherwise noted.



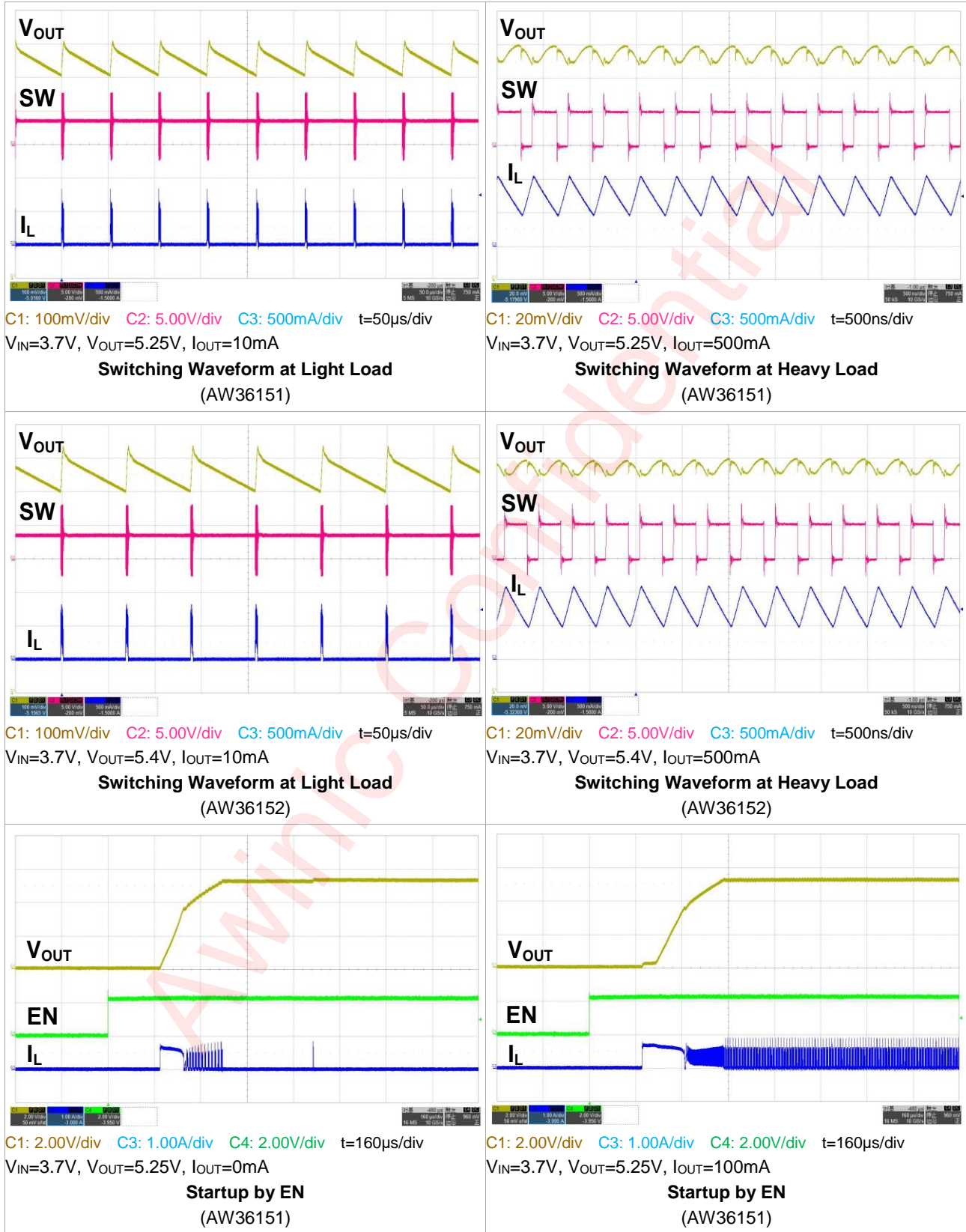
Typical Characteristics(Continue)

$T_A=25^{\circ}\text{C}$, $C_{IN} = 10\mu\text{F}$, $C_{OUT} = 20\mu\text{F}$, $V_{IN}=3.7\text{V}$, unless otherwise noted.



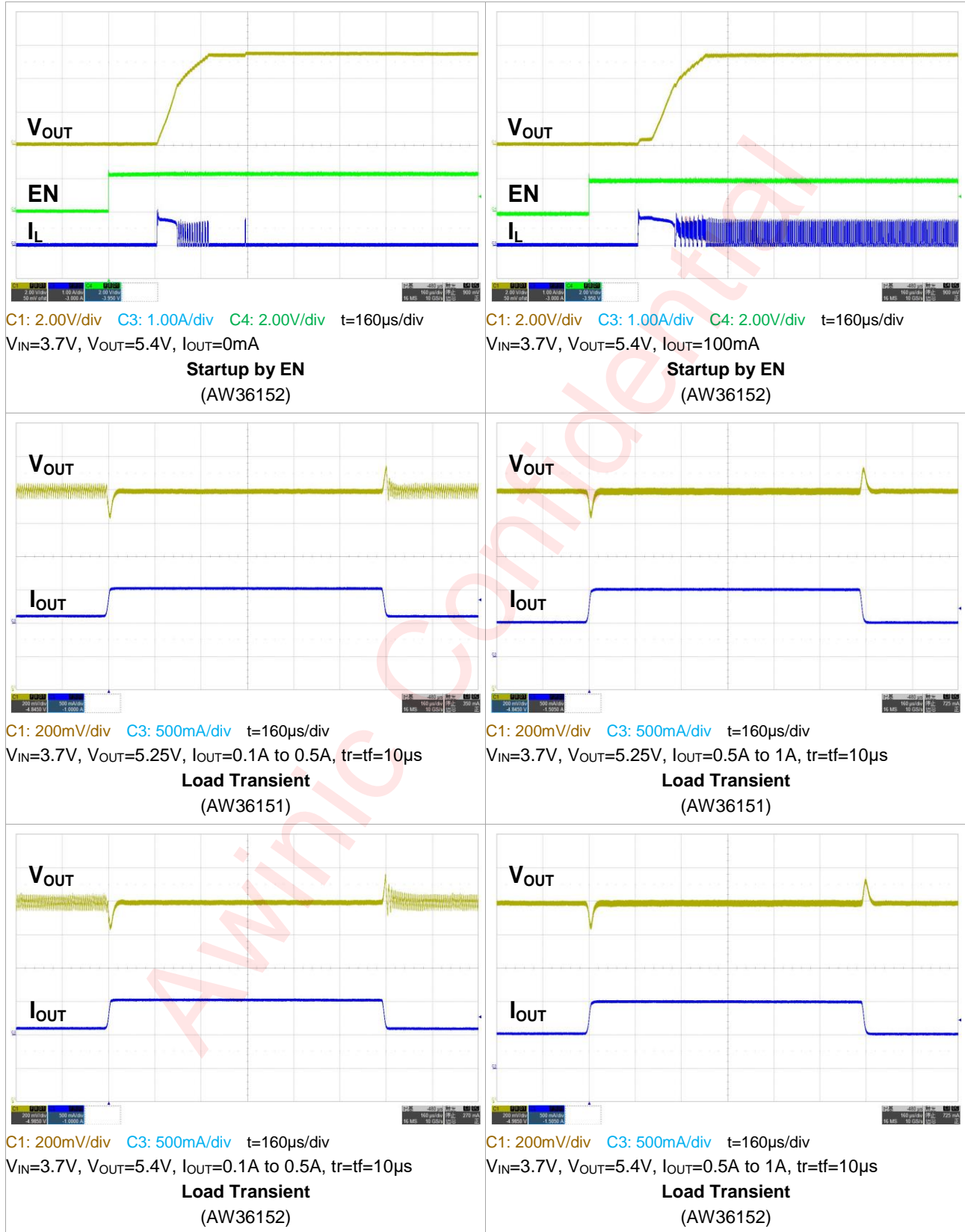
Typical Characteristics(Continue)

$T_A=25^{\circ}\text{C}$, $C_{IN} = 10\mu\text{F}$, $C_{OUT} = 20\mu\text{F}$, $V_{IN}=3.7\text{V}$, unless otherwise noted.



Typical Characteristics(Continue)

$T_A=25^{\circ}\text{C}$, $C_{IN} = 10\mu\text{F}$, $C_{OUT} = 20\mu\text{F}$, $V_{IN}=3.7\text{V}$, unless otherwise noted.



Detailed Functional Description

AW3615X is a high current and high efficiency synchronous step-up converter, which can supply up to 1.5A@ $V_{IN}=3.3V$.

AW3615X adopts valley current mode which can use a very small size LC filter circuit and has a good load transient response characteristics. The internal soft-start circuit and loop compensation circuitry also reduces the number of external components and system costs, and simplifies the design.

AW3615X integrates low $R_{DS(on)}$ Power MOSFETs (low-side NMOS and high-side PMOS). In medium and heavy load conditions, the chip operates at a quasi-constant 2.5MHz frequency in the continuous conduction of the PWM mode. In light load conditions, the chip will automatically switch to the Power Save mode which can optimize the efficiency of light load. In the PSM mode, which will close or de-biased most of the circuit except the output voltage detection module, only when V_{OUT} dropped to a target voltage threshold, the circuit began to resume work. AW3615X achieves the high efficiency in all load range by reducing the conduction loss and switching losses.

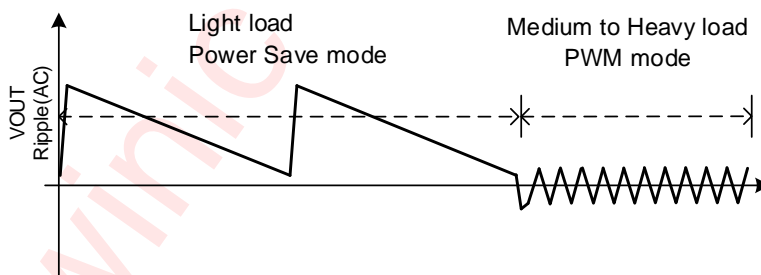
PWM mode

In medium and heavy load conditions, AW3615X operates at a quasi-constant 2.5MHz frequency (typ.). At the beginning of the switching cycle, the low-side NMOS switch is turned-on and the inductor current ramps up to a peak current that is defined by the on-time and the inductance. In the second phase, once the on-timer has expired, the rectifier is turned-on and the inductor current decays to a preset valley current threshold. Finally, the switching cycle repeats by setting the on timer again and activating the low-side NMOS switch.

Power Save Mode

AW3615X integrates a Power Save Mode to improve efficiency at light load. In Power Save mode, the converter only operates when the output voltage trips below a set threshold voltage. It ramps up the output voltage and goes into power save mode once the output voltage exceeds the set threshold voltage.

The following figure shows the V_{OUT} ripple in PWM mode and Power Save mode.



Soft Start

AW3615X integrates soft start function in order to limit the surge current during the start of the power supply. During the start-up period, the chip linearly activates output terminal using the internal constant current source to charge the V_{OUT} to allow V_{OUT} rise gradually. When V_{OUT} is close to V_{IN} , the converter starts to switch. When the V_{OUT} reaches to the target value, the loop stabilizes V_{OUT} at the target value. In order to avoid inrush current and overshoot on V_{OUT} , during soft start phase, the valley current limit is limited to 0.5A. Thus, it is recommended to add load after the AW3615X has completed start-up process. If the device is started with a load, it is recommended that the load does not exceed 400mA(typ.).

True Isolation and Reverse Current Protection

AW3615X through the substrate selection circuit to truly achieve the electrical isolation of V_{IN} and V_{OUT} . When

the chip is turn-off, V_{OUT} will drop to 0V, and will not draw current from V_{IN} , meanwhile, when supply voltage to V_{OUT} , it also will not lead current flow from V_{OUT} to V_{IN} .

Current Limit Operation

AW3615X provides a cycle by cycle valley current limiting function to protect the switch FET. When the inductor valley current reaches the current limit threshold, the current limiting circuit turns off the power MOSFET to allow the current to decrease to this threshold before the next cycle turns on. When the current limit is reached, the output voltage decreases during further load increase.

The current limit function is implemented by the scheme, refer to Figure 3.

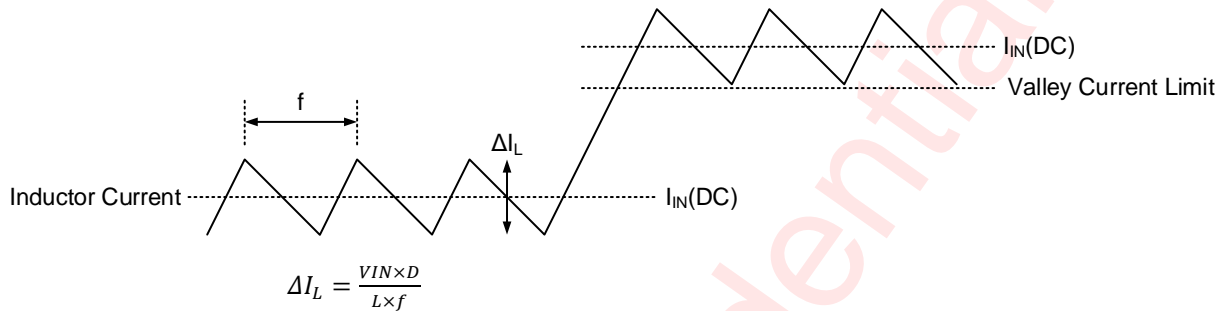


Figure 3. Inductor Currents In Current Limit Operation

Enable and Disable

The AW3615X operates when the input voltage is above UVLO rising threshold and the EN is high. In shutdown mode with a low EN voltage, the device stops switching and the rectifying PMOS turns off as well. This isolates the load from the input, so that the output voltage can drop below the input voltage during shutdown. In shutdown mode, input current is less than 0.3μA.

UVLO

UVLO circuit prevents the malfunction when the chip operate in low voltage. When V_{IN} drops to under-voltage protection threshold V_{UVLO} (typ: 2.3V), it turns off. When V_{IN} rises to 100mV higher than V_{UVLO} (typ: 2.4V), it resumes operate.

Over-Voltage Protection

AW3615X features over-voltage protection(OVP) for maximum safety. When the output voltage of the AW3615X exceeds the OVP threshold of 6.4V, the device stops switching. The device will start operating again until the output voltage falling to 6.3V.

Pass-Through Mode

The AW3615X works in pass-through mode when V_{IN} is higher than V_{OUT} . With V_{IN} raising, the AW3615X automatically into pass-through mode. During the pass-through mode, the high-side FET is fully turned on and the low side switch is turned off. The output voltage follows input voltage with the drop caused by the inductor resistance and the high-side FET resistance.

In the pass-through mode, the current limit is about 0.7A. When the load rises quickly, the system exits the pass-through mode due to the output voltage falling rapidly, and the time of exiting the pass-through mode is less than the internal current limit signal flip time(typ:15μs), then the circuit works in boost mode. When the load rises slowly, the internal current limit signal flips normally, then the output voltage gradually drops to 0V, and the circuit constantly tries to restart.

Thermal Shutdown

The AW3615X has an integrated thermal protection. The protection circuit senses the internal temperature of the chip and stop switching when temperature reaches 150°C. After the temperature returns to a safe value 20°C below the shutdown temperature, the system starts operating again.

Application Information

Maximum Output Current

The maximum output current of the AW3615X can be estimated by following Equation. It determined by the input to output ratio and the current limit of the step-up converter.

$$I_{OUT(MAX)} = \frac{VIN \cdot \left(I_{LIM} - \frac{\Delta I_L}{2} \right) \cdot \eta}{VOUT}$$

Where η is the conversion efficiency, using 85% for estimation; ΔI_L is the current ripple value and I_{LIM} is the switch current limit.

Voltage across the DCR decreases the effective voltage across the inductor, which will affects the maximum output current. Especially at low input voltage, the voltage across the DCR and the low-side switch become large enough that could not be ignored for the effect on maximum output current.

Inductor Selection

Inductor is the most important component in power regulator design. In order to ensure proper operation of the steady state, transient behavior, and loop stability, inductor value, saturation current, and dc resistance (DCR) deserve careful consideration.

The inductor peak current varies as a function of the load, the input and output voltages. It can be estimated using follow equations.

$$I_{IN} = \frac{VOUT \times I_{OUT}}{VIN \times \eta} \quad (1)$$

$$\Delta I_L = \frac{VIN \times D}{L \times f} \quad (2)$$

$$D = 1 - \frac{VIN}{VOUT} \quad (3)$$

$$I_{LIM} = I_{IN} + \frac{1}{2} \times \Delta I_L \quad (4)$$

For example, $V_{IN}=3.3V$, $V_{OUT}=5.25V$, $I_{OUT}=1.5A$, converter efficiency=90%, Frequency=2.5MHz.

The recommended nominal inductance value is 0.56 μ H. It is recommended to use inductor with DC saturation current $\geq 3A$. However, considering the short condition, we recommend that the saturation current is greater than 5A.

Input Capacitor Selection

Multilayer ceramic capacitors are an excellent choice for input decoupling of the step-up converter since they have extremely low ESR and are available in small footprints. Input capacitors should be placed as close as possible to the device. While a 10 μ F input capacitor is sufficient for most applications, larger values can be used to reduce input current ripple without limitations.

A 47 μ F or higher capacitance capacitor is recommended to damp the wiring harness inductance, while the AW3615X is located far away from the input source.

Output Capacitor Selection

For the output capacitor, it is recommended to use small ceramic capacitors placed as close as possible to the V_{OUT} and GND pins of the IC. The output capacitors of step-up converter dictate the output voltage ripple and load transient response.

To get an estimate of the recommended minimum output capacitance, equation 5 can be used. where ΔV is the maximum allowed output ripple.

$$C_{MIN} = \frac{I_{OUT} \times (V_{OUT} - V_{IN})}{f \times \Delta V \times V_{OUT}} \quad (5)$$

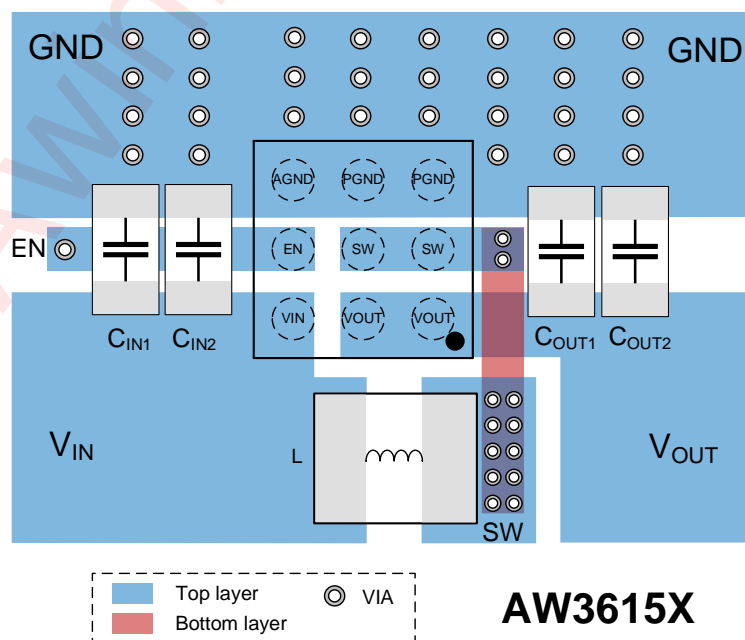
The value of $20\mu\text{F}$ is recommended. Due to the DC bias nature of ceramic capacitors, care should be taken by verifying manufacture's datasheet to ensure enough effective capacitance at desired output voltage. When the input and output voltage differential is less than 0.4V , it is recommended to increase the output capacitor to $44\mu\text{F}$.

DC bias effect: ceramic capacitors exhibit DC bias effects, which have a strong influence on the effective capacitance of the device. Therefore, the right capacitor value has to be chosen very carefully. Package size and voltage rating in combination with material are responsible for differences between the rated capacitor value and effective capacitance. For instance, a $10\mu\text{F}$ X5R 10V 0603 MLCC capacitor would typically show an effective capacitance of less than $4\mu\text{F}$ under 5.25V bias condition.

PCB Layout Consideration

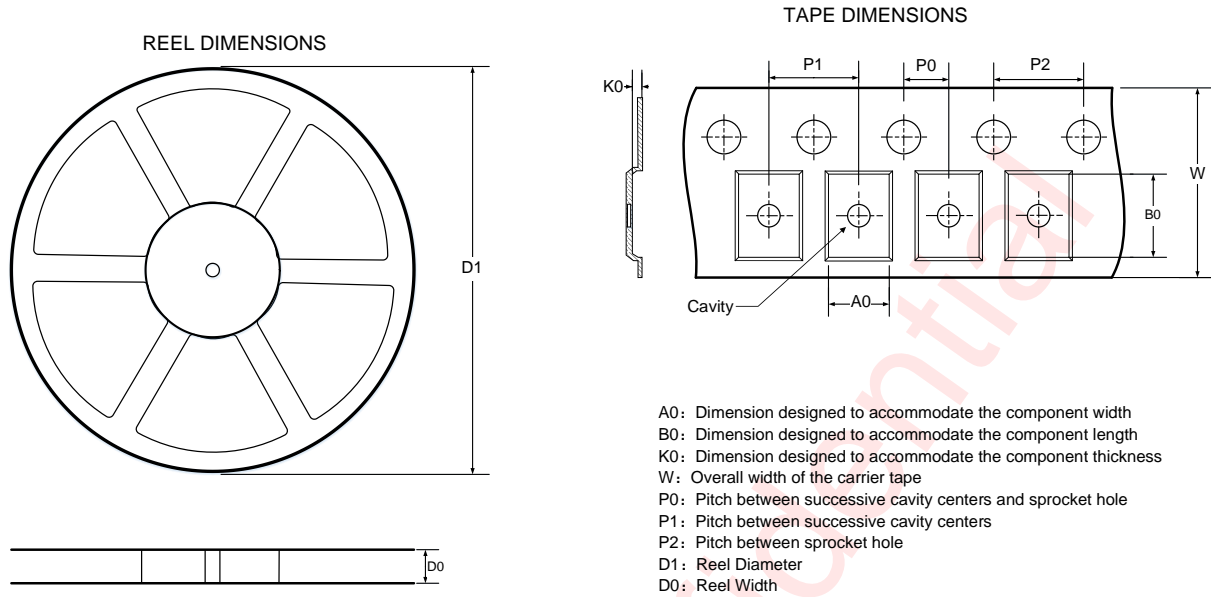
AW3615X is a boost convert, to obtain the optimal performance, PCB layout should be considered carefully. Here are some guidelines:

1. C_{IN1} , C_{IN2} , C_{OUT1} , C_{OUT2} should be placed as close to chip as possible.
2. Wide and short traces should be used for main current path and the power ground paths.
3. For thermal reasons, it is suggested to maximize the pour area for V_{IN} , V_{OUT} and PGND. Especially the ground pour should be set to fill all available PCB surface area and tied to internal layers with a cluster of thermal vias.
4. For step-up converter, the current loop of the output capacitor's from V_{OUT} pin back to the GND pin should be as small as possible.
5. It is recommended to use a four-layer board to improve the stability of the circuit.

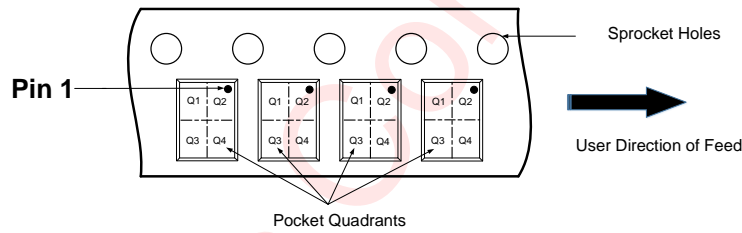


Tape And Reel Information

AW36151CSR



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



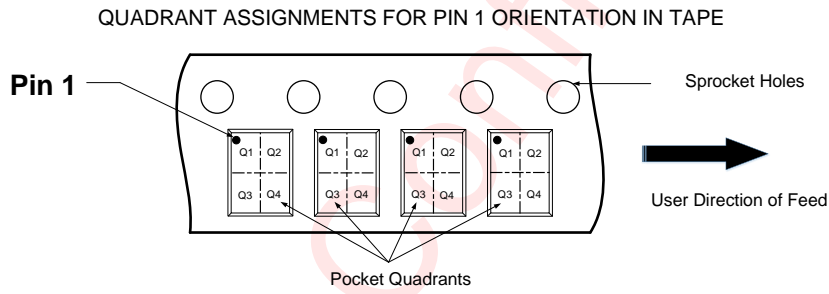
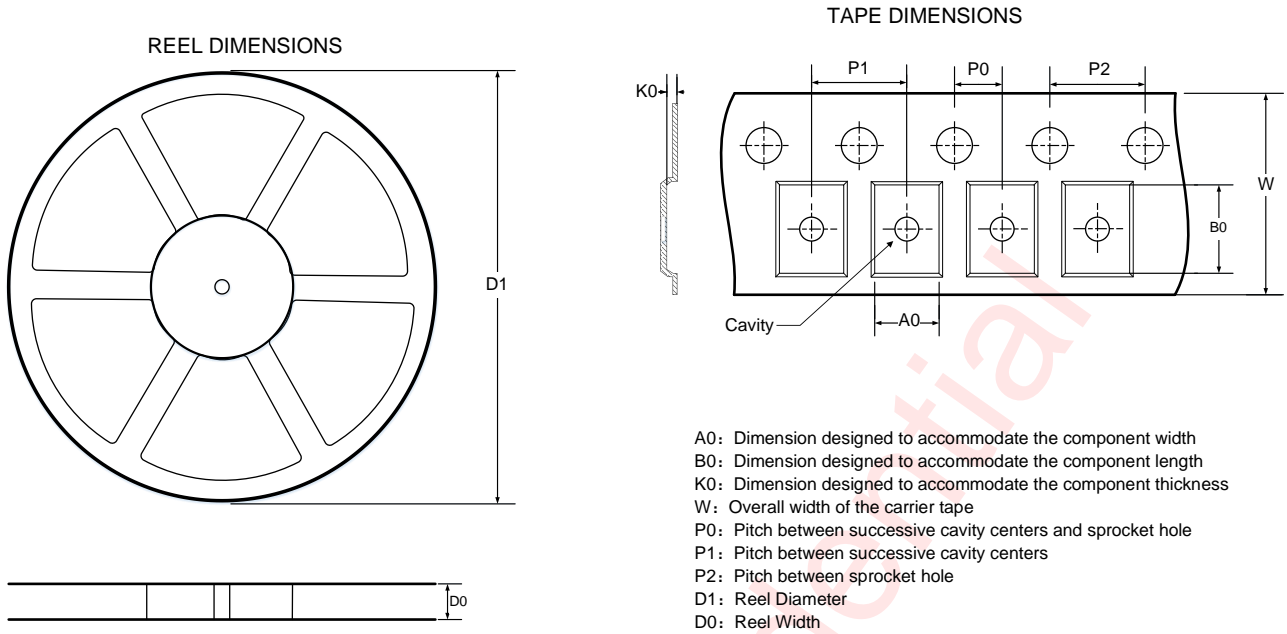
Note: The above picture is for reference only. Please refer to the value in the table below for the actual size

DIMENSIONS AND PIN1 ORIENTATION

D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
180.00	8.60	1.38	1.38	0.65	2.00	4.00	4.00	8.00	Q2

All dimensions are nominal

AW36152CSR



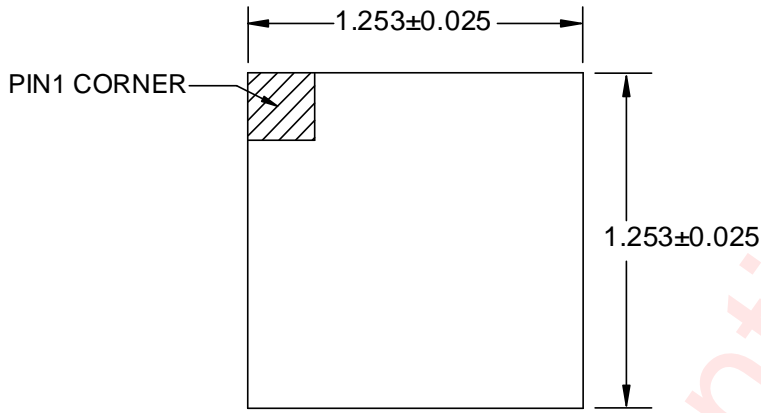
Note: The above picture is for reference only. Please refer to the value in the table below for the actual size

DIMENSIONS AND PIN1 ORIENTATION

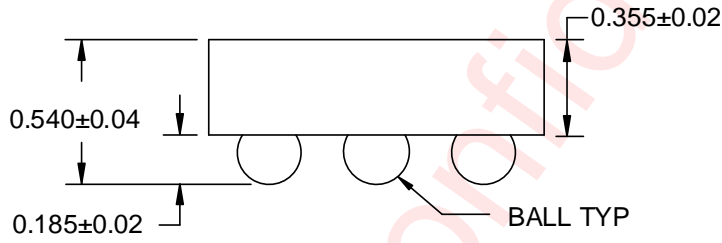
D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
180.00	8.60	1.38	1.38	0.65	2.00	4.00	4.00	8.00	Q1

All dimensions are nominal

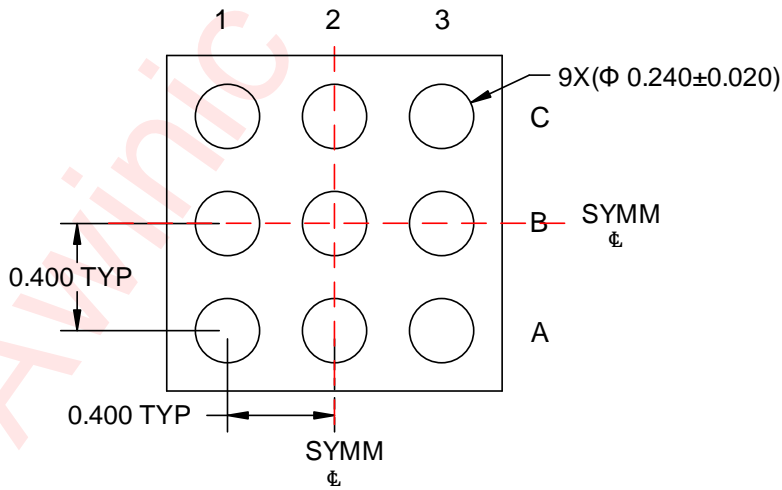
Package Description



Top View



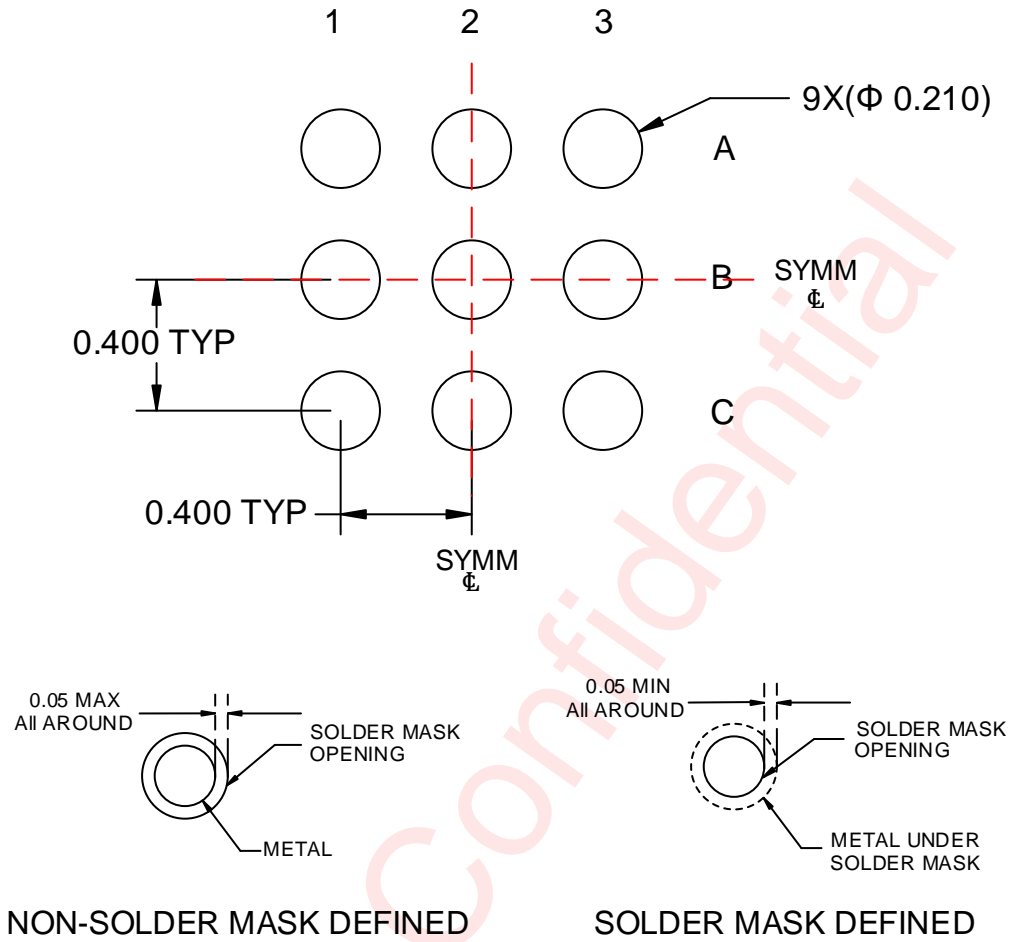
Side View



Bottom View

Unit: mm

Land Pattern Data



Unit: mm

Revision History

Version	Date	Change Record
V1.0	Dec. 2025	Officially released
V1.1	Dec. 2025	Add the Typical Characteristics(P6~P9)

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