36V, 2A/3A Synchronous Step-Down Regulator with 5μA Quiescent Current

AWK6612Q1/AWK6613Q1

FEATURES

- Wide Input Voltage Range: 3.0V to 36V
- Frequency: 400kHz, 2.1MHz
- **3A** Output Current Capability
- Ultralow Operating Quiescent Current: **5μA** (Typ.) From $12V_{IN}$ to $3.3V_{OUT}$
- ±1.5% 1V Reference Over -40°C~125°C
- Peak Eff. **>93%** (Typ.) From $12V_{IN}$ to $5V_{OUT}$
- Minimum On Time: **35ns** (Typ.)
- **Spread Spectrum Frequency Modulation for Low EMI**
- Internal Compensation
- Precision Enable
- Cycle by Cycle Current Limit and Hiccup When Overload or Short Circuit
- Thermal Shutdown and Auto Recovery
- **AEC-Q100** for automotive applications

APPLICATION

- Automotive System: Cockpit, ADAS
- Battery Powered System: Power Tools, Home Appliance, Drone, GPS Tracker etc.
- Industrial and Medical Power Supplies

DESCRIPTION

The AWK6612Q1/AWK6613Q1 is a high efficiency synchronous monolithic step-down switching regulator with integrated internal high-side and low-side MOSFETs. It provides up to 2A/3A output current with peak current mode control for fast loop response.

The AWK6612Q1/AWK6613Q1 operates over a wide input voltage range from 3.0V to 36V with only 5μA ultralow quiescent current at the application from $12V_{IN}$ to $3.3V_{OUT}$. It is ideal for automotive input environments and battery power system due to its extremely low quiescent current.

Standard features include thermal shutdown, UVLO, enable (EN) control and power good (PG) indicator.

During the overload or output short circuit, the cycle by cycle current limit and hiccup protection are provided. Thermal shutdown provides reliable and fault-tolerant operation.

Device Information

DEVICE	PACKAGE	BODY SIZE(NOM)
AWK6612Q1/AWK6613Q1	ESOP8L	5.00mm × 4.00mm

TYPICAL APPLICATION

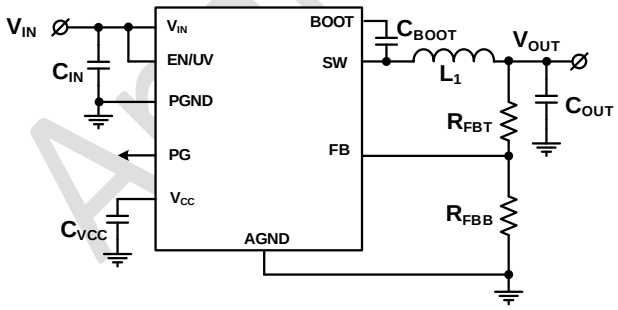

Fig.1 Schematic Diagram

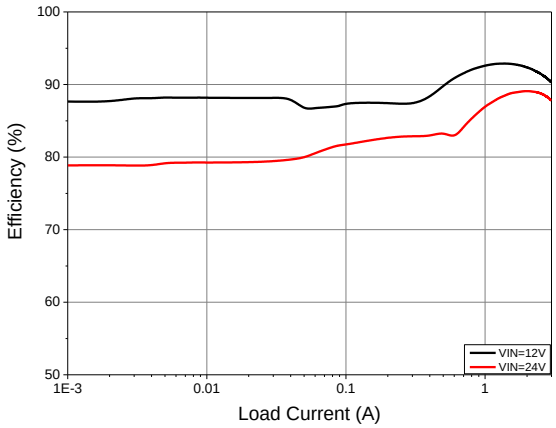

Fig.2 Efficiency vs. Output Current
At V_{OUT}=5V, f_{SW}=2.1MHz

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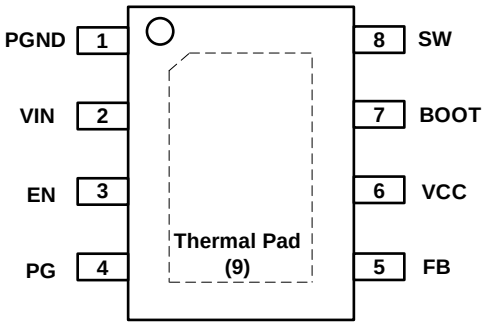
PIN CONFIGURATION

Package	Pin Configuration (Top View)
ESOP8L	

PIN DESCRIPTION

No.	Pin	I/O	Description
1	PGND	G	Power Ground
2	VIN	P	Input Voltage
3	EN	I	Enable Input
4	PG	I/O	Power Good Signal
5	FB	I	Feedback Volage
6	VCC	O	Internal Supply for Control Circuits
7	BOOT	I/O	Bootstrap Supply Voltage
8	SW	I/O	Switching Node Output
9	THERMAL PAD	G	Analog Ground

Table 1. AWK6612Q1/AWK6613Q1 ESOP8L Pin Description

ABSOLUTE MAXIMUM RATINGS

		Min	Max	Units
Input Voltages	VIN, EN to GND	-0.3	42	V
	FB to GND	-0.3	5.5	
	PG to GND	-0.3	26	
	BOOT to SW	-0.3	5.5	
Output Voltages	SW to GND	-0.3	42	V
	VCC to GND	-0.3	5.5	
T_J	Junction temperature	-40	150	°C
T_S	Storage temperature	-55	150	

RECOMMENDED OPERATING CONDITIONS

		Min	Max	Units
Buck Regulator	VIN	3.0	36	V
	SW		36	
	VCC	0	5	
	FB	0	5	
Control	EN	0	36	V
	PG	0	22	
T_J	Junction temperature	-40	125	°C

ESD RATINGS

Symbol	Definition	Value	Units
V_{ESD}	HBM	±2000	V
	CDM	±750	

ELECTRICAL CHARACTERISTICS

Limits apply over the recommended operating junction temperature range of –40°C to +125°C, unless otherwise stated. Minimum and Maximum limits are specified through test, design or statistical correlation. Typical values represent the most likely parametric norm at T_J = 25°C, and are provided for reference purposes only. Unless otherwise stated the following conditions apply: V_{IN} = 12 V. V_{OUT} is converter output voltage.

Symbol	Parameter	Condition	Min	Typ	Max	Unit
Power Supply						
V_{IN_MIN}	Minimum Operating Input Voltage	T_A=25℃			3.0	V
V_{IN_UV}	Under Voltage Lockout Thresholds	Rising Threshold		2.85	3.2	V
		Hysteresis		200		mV
I_{SD}	Shutdown Supply Current	V_{EN}=0V		2.9	8	μA
I_Q	Non-Switching Quiescent Current	V_{FB}=1.05V		3.0	9	μA
Enable						
V_{EN_H}	Enable High Threshold		1.16	1.235	1.285	V
V_{EN_HYS}	Enable Hysteresis Threshold			200		mV
V_{EN_LKG}	Enable Pin Leakage Current	V_{EN}=2V		-0.6		nA

Soft Start						
T_{SS}	Internal Soft-Start Time		2	5	10	ms
Voltage Reference						
V_{FB}	Feedback voltage		0.985	1.00	1.015	V
I_{FB}	Current into FB pin	V_{FB}=1V			40	nA
MOSFETs						
R_{DSON_H}	High Side MOSFET ON Resistance	I_{SW}=500mA		117	210	mΩ
R_{DSON_L}	Low Side MOSFET ON Resistance	I_{SW}=500mA		75	135	mΩ
Current Limits						
I_{LIMIT_H}	High Side MOSFET Current Limit (1) (2)	AWK6612Q1	2.5	3.4	4.5	A
		AWK6613Q1	3.5	4.4	5.5	A
I_{LIMIT_L}	Low Side MOSFET Current Limit (2)	AWK6612Q1	1.8	2.3		A
		AWK6613Q1	2.8	3.3		A
I_{PK_MIN}	Min. Peak Inductor Current (3)	I_{LOAD}=0A		0.91		A
I_{ZC}	Zero Current Detector Threshold			0.1		A
Internal Voltage						
V_{CC}	Internal Power Supply	V_{IN}≥4V	3.32	3.5	3.68	V
$V_{BOOT-UVLO}$	Bootstrap Voltage UVLO threshold			2.3		V
Power Good						
V_{PG_H}	PG High Threshold Offset from V_{FB}	V_{FB} Rising	4.5	7	9.5	%
		V_{FB} Falling	2	4	7	%
V_{PG_L}	PG Low Threshold Offset from V_{FB}	V_{FB} Rising	-8	-6	-3	%
		V_{FB} Falling	-10.5	-8	-5.5	%

R_{PG}	PG Pull-Down Resistance	V_{EN}=4V		95	250	Ω
		V_{EN}=0V		85	200	
t_{PG}	Power Good Glitch Filter Delay		30		160	μs
V_{IN-PG}	Min. Input Voltage for PG Function				1.6	V
V_{PG}	PG Logic Low Output				0.2	V
Switching Frequency Timing						
f_{SW}	Switching Frequency (4)	AWK6612AAQ1/ AWK6613AAQ1	340	400	460	kHz
		AWK6612CAQ1/ AWK6613CAQ1	1.8	2.1	2.4	MHz
Thermal						
T_{SD}	Thermal Shutdown			165		°C
T_{SD_HYS}	Thermal Shutdown Hysteresis			15		°C
System Characteristics (5)						
T_{ON_MIN}	Min. Turn On-Time			35		ns
T_{OFF_MIN}	Min. Turn Off-Time			100		ns
T_{ON_MAX}	Max. Turn On-Time			8		μs
V_{HC}	FB Voltage to Trip Hiccup Mode			0.51		V
t_{HC}	Interval Time between Hiccup Burst			32		ms
D_{MAX}	Maximum Duty Cycle	V_{IN}=V_{OUT}=12V, I_{OUT}=1A		98.5		%
V_{DROP}	Dropout Voltage (V_{IN} -V_{OUT})	V_{IN}=V_{OUT}=5V, I_{OUT}=1A		200		mV

(1) The Current Limits of MOSFETs are tested at duty cycle of 40%.

(2) The Current Limits of MOSFETs are tested in open-loop, in production. They may differ from those tested in a closed loop application.

(3) The minimum peak inductor current is tested at AWK6613Q1CAFAR with XAL5030_222MEC.

(4) This frequency is the lowest frequency set at factory, due to the spread spectrum mode, the highest possible frequency is practice will be 13%-15% higher.

(5) These parameters are not tested in production.

FUNCTIONAL DIAGRAM

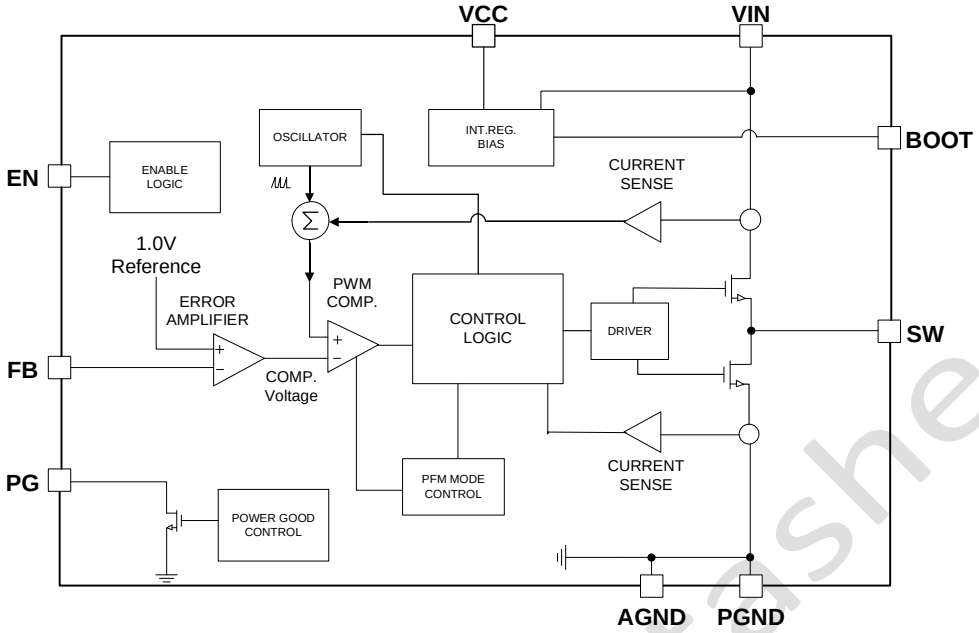


Fig.3 Functional Diagram

TYPICAL CHARACTERISTICS

Unless otherwise specified the following conditions apply: V_{IN} =12V, V_{OUT} =5V, f_{SW} =2.1MHz, L=2.2uH, C_{OUT} =44uF, T_J =25°C

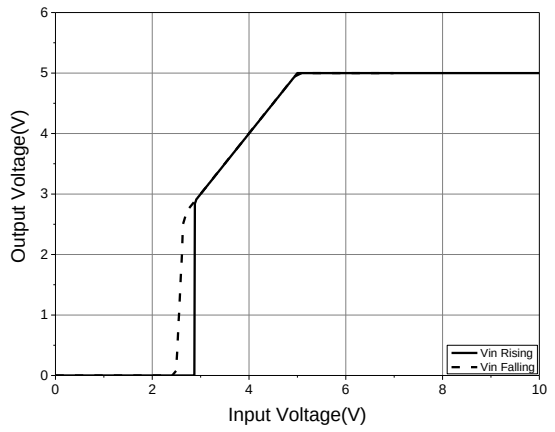


Fig.4 UVLO Thresholds

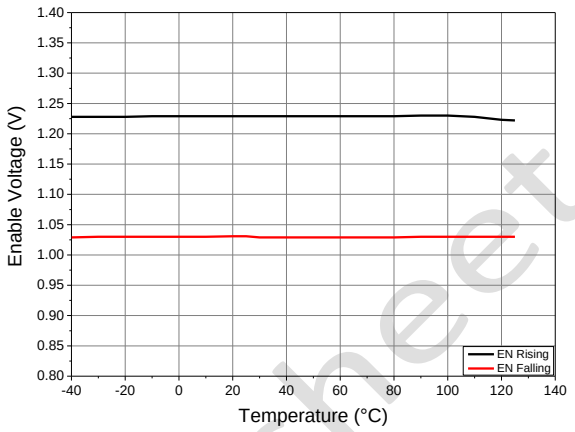


Fig.5 Enable Threshold Vs. Temperature

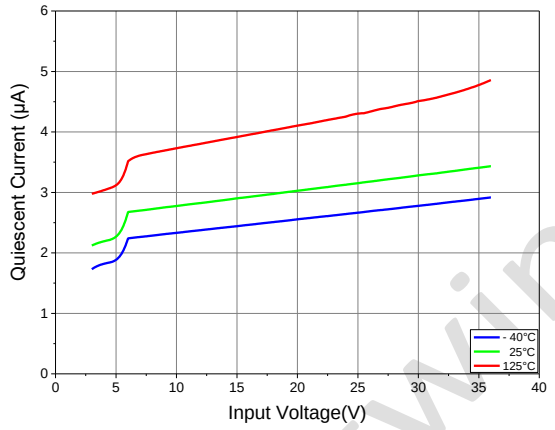


Fig.6 Quiescent Current Vs. Temperature

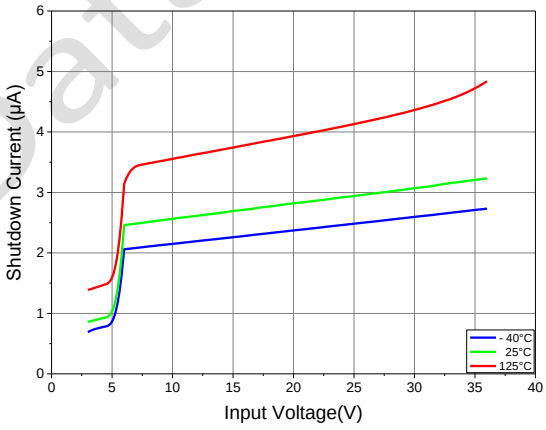


Fig.7 Shutdown Current VS. Temperature

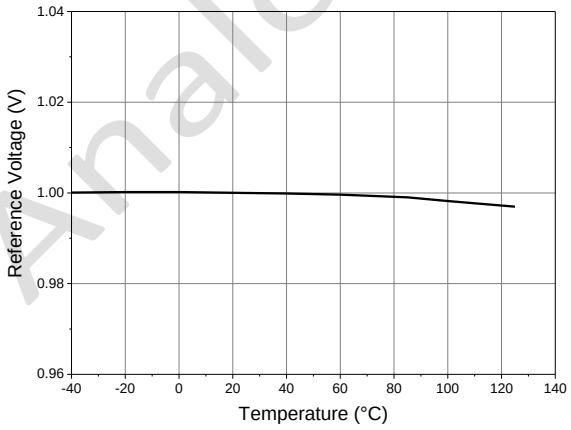


Fig.8 Feedback Voltage Vs Temperature

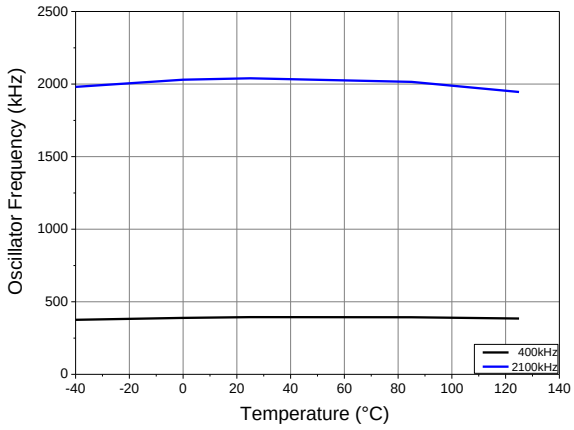


Fig.9 Switching Frequency Vs Temperature

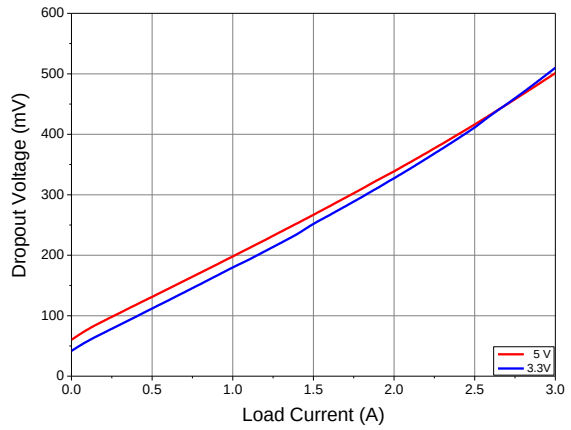


Fig.10 Dropout Voltage VS. Output Current

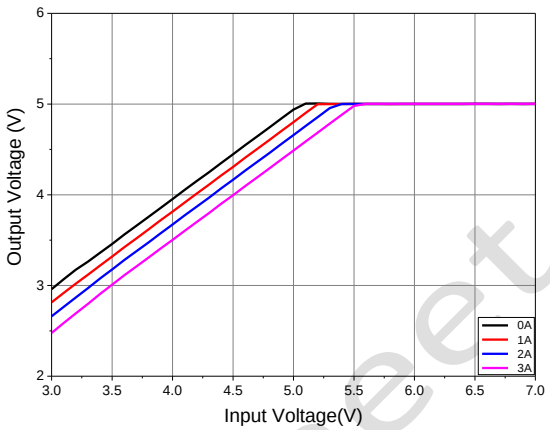


Fig.11 Output Voltage VS. Input Voltage

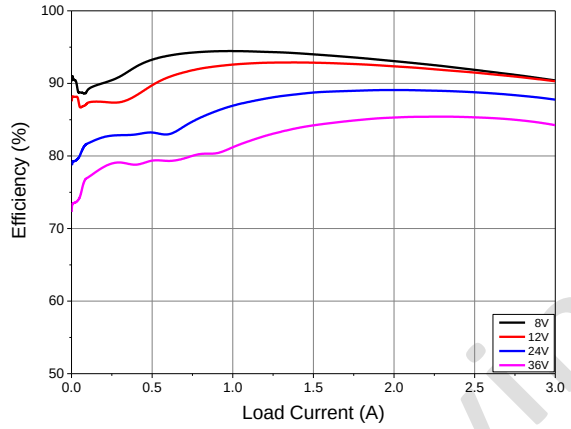


Fig. 12 Eff. VS Load Current
at V_{OUT} = 5V, fsw = 2.1MHz

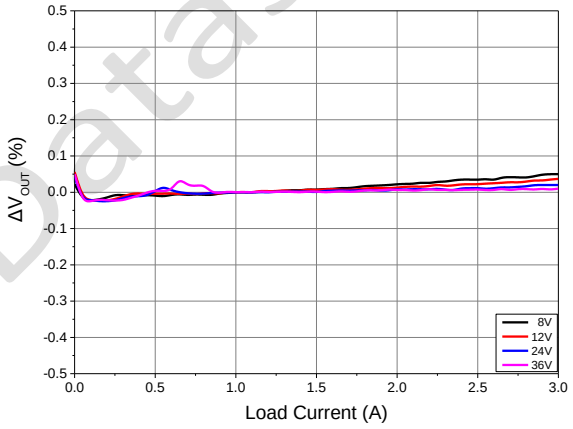


Fig.13 Load Regulation
at V_{OUT} = 5V, fsw = 2.1MHz

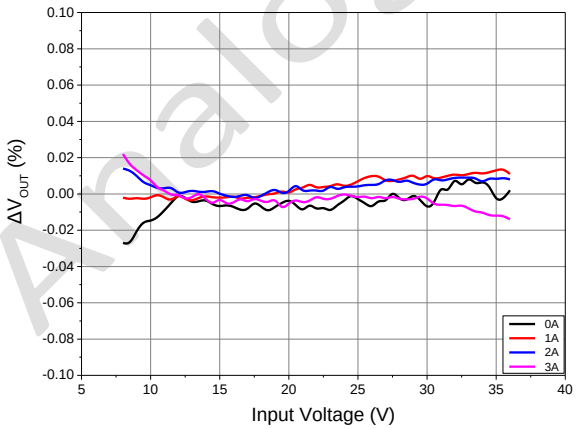


Fig. 14 Line Regulation
at V_{OUT} = 5V, fsw = 2.1MHz

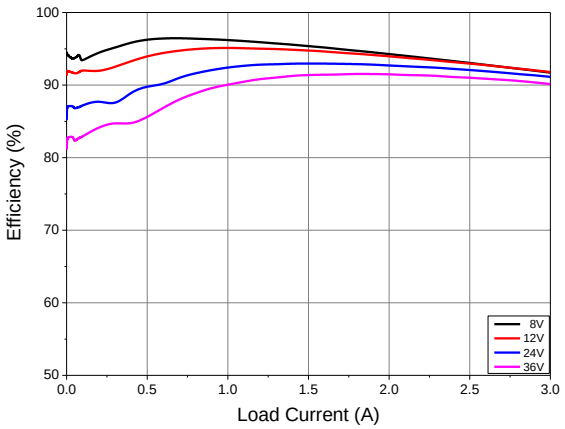


Fig.15 Eff. VS Load Current
at V_{OUT} = 5V, fsw = 400kHz

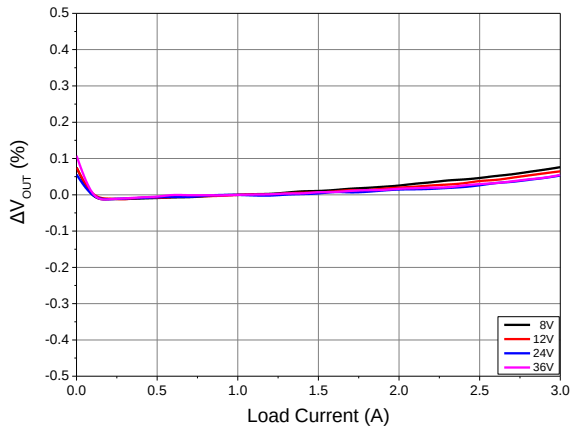


Fig.16 Load Regulation
at V_{OUT} = 5V, fsw = 400kHz

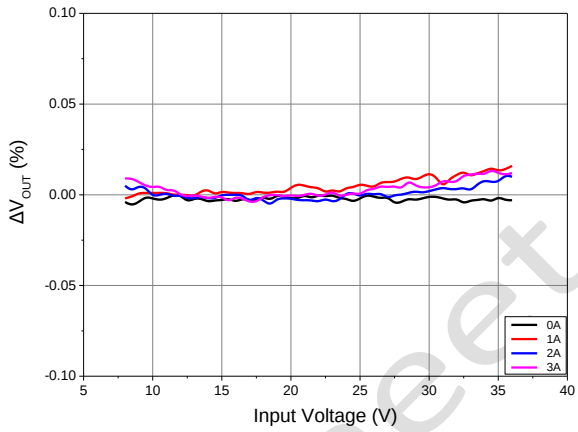


Fig.17 Line Regulation
at V_{OUT} = 5V, fsw = 400kHz

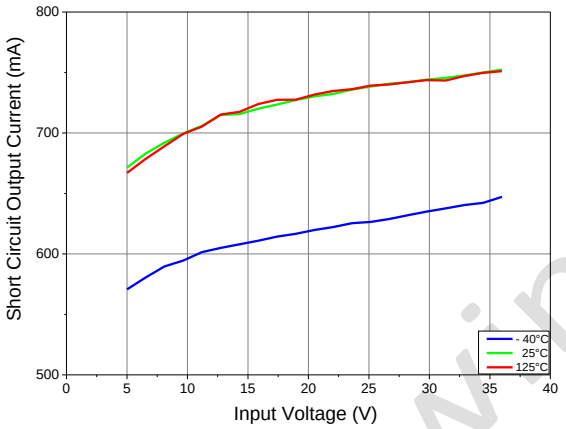


Fig.18 Short Circuit Output Current

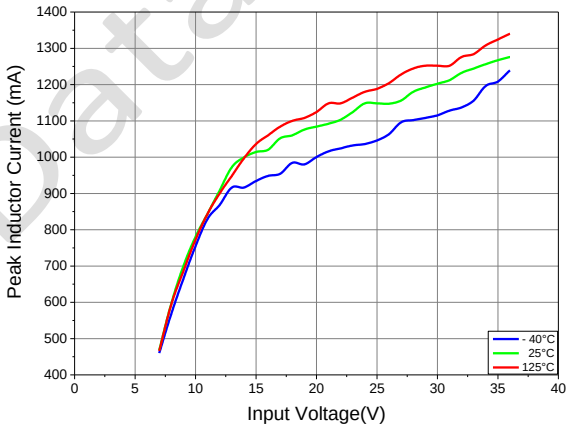


Fig.19 Peak Inductor Current
at V_{OUT} = 5V,fsw = 2.1MHz

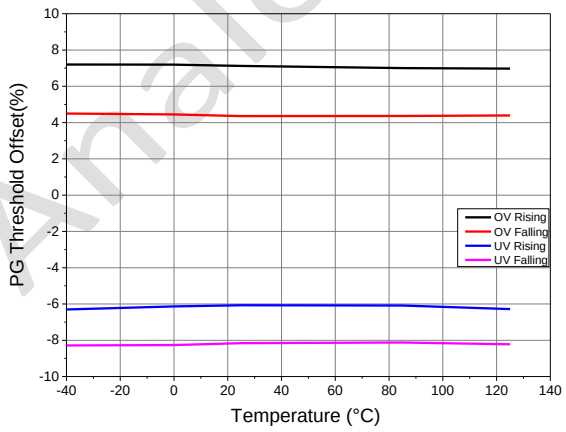


Fig.20 PGOOD Thresholds

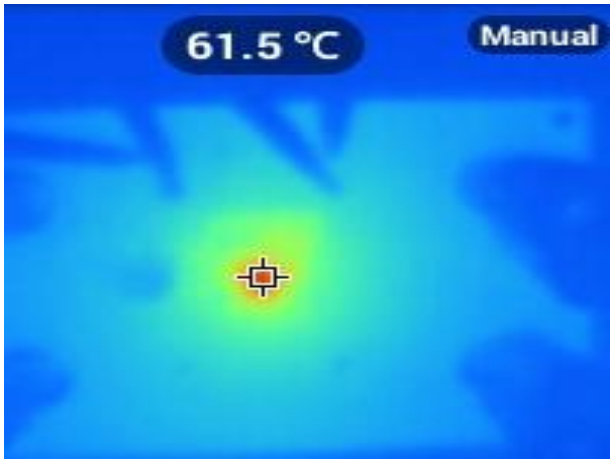


Fig.21 Thermal Performance
at V_{OUT} = 5V,I_{OUT} = 3A,fsw = 2.1MHz

PRODUCT OVERVIEW

The AWK6612Q1/AWK6613Q1 is a synchronous, step-down, switching regulator with integrated high-side and low-side power MOSFETs. The AWK6612Q1/AWK6613Q1 can provide 2A/3A of output current with very high efficiency from light load to full load. The AWK6612Q1/AWK6613Q1 features a wide input voltage from 3.0V to 36V, selective switching frequency 400kHz and 2.1MHz for difference version part. The internal soft start limits inrush current during power on. The AWK6612Q1/AWK6613Q1 also integrated compensation circuit inside the chip to simplify the loop design. Another highlighted feature is its very low operational quiescent current which makes it suitable for battery powered applications.

Feature Description

Fixed Frequency Peak Current Mode Control

The AWK6612Q1/AWK6613Q1 adopts fixed frequency peak current mode control. The feedback voltage is sensed from the resistor divider through FB pin to compare with internal voltage reference by an error amplifier. By adjusting the peak current's value with different output voltage deviation, this voltage control loop is designed to obtain accurate DC voltage regulation. The output of the error amplifier is compared with the sensed peak current by PWM comparator and controls the on time of high-side power switch. The device also integrates the voltage feedback loop’s compensation to save external components and ensure control loop’s stability in various working conditions.

An internal oscillator controls the switching frequency and initiates the turn on of the integrated high-side power switch in each duty cycle. During this high-side on period, SW voltage rises to approximately input voltage and the inductor current increases linearly. Once the sensed current through high-side switch reaches the threshold level set by COMP voltage of the error amplifier, the PWM comparator turns off the high-side switch. The low-side power switch is turned on after a short dead time and the inductor current is discharged linearly by the low-side power switch. The device also utilizes an internal ramp compensation control to avoid sub-harmonic oscillations when duty cycle is larger than 50%. The COMP voltage is also clamped for current limit condition and light load operation.

Light Load Operation

The AWK6612Q1/AWK6613Q1 utilizes advanced Pulse Frequency Modulation (PFM) control to improve efficiency in light load working condition. When the loading current decreases, the device approaches discontinuous conduction mode first and the COMP voltage decreases accordingly. The low-side power switch is turned off when the zero current detection is triggered to improve system efficiency. When the COMP voltage drops to the low clamped threshold voltage, the device will skip pulse and decrease switching frequency by extend the non-switching period. During this period, the output voltage decreases due to load current or capacitor discharge. The high-side power switch will resume to turn on once the COMP voltage is higher than the threshold. The device will try to obtain few switching pulses with minimum peak inductor current to reduce the output ripple and the COMP voltage will drop to the clamped value again and trigger another non-switching period.

During the non-switching period, most internal circuits will be shut down, except some protection blocks, to reduce the power consumption. The AWK6612Q1/AWK6613Q1 features typical 5μA quiescent current and can also ensure relatively high efficiency in ultra-low light load condition and release smooth transition between CCM, DCM and PSM mode.

Soft-Start with Pre-Biased Capability

The AWK6612Q1/AWK6613Q1 implements a soft-start circuits to prevent the inrush current during start up. The soft-start time is fixed internally. When the start-up period begins, the output voltage slowly ramps up.

The AWK6612Q1/AWK6613Q1 also supports a monotonic start-up with pre-biased loads. If output voltage is pre-biased to a certain value during start-up, the device disables switching for both high-side and low-side power switches until soft-start reference voltage exceeds the feedback voltage.

Low Drop-out Mode

As the duty cycle is increasing, where the input voltage approaches the output voltage level, the required off time of high-side power switch will approach its minimum off time. When the minimum off time is reached, the AWK6612Q1/AWK6613Q1 will automatically extend the high-side on time and reduce the switching frequency. The device can realize 98.5% max duty cycle in drop-out condition. In this condition, the dropout voltage difference between input and output is influenced by the on-resistance of power switch, the DCR of power inductor, and the maximum duty cycle achieved.

Minimum On Time

As the duty cycle is decreasing, where the conversion ratio is very low, the required on time of high-side power switch will approach its minimum on time. The AWK6612Q1/AWK6613Q1 features typical 35ns ultra-low minimum on time and can support smaller duty cycle for high frequency power systems. Also, the device can automatically reduce the switching frequency, when the minimum on time is reached.

Power Good

The device employs an open-drain output PGOOD signal to check whether the output voltage is operating within the normal range. The external pull up voltage resource is recommended to be less than 5.5V (such as VCC) with a 100kΩ resistor. Once the feedback voltage is within the 92% and 107% of internal reference voltage, the PGOOD pull-down will be disabled and pulled up by the externally resistor. Once the feedback voltage is lower than 92% or greater than 107% of internal reference voltage, the PGOOD will be pulled low. To prevent glitching both the upper and lower thresholds include about 2% of hysteresis. Also, if UVLO, over temperature protection or EN pin is pulled low, the PGOOD will be pulled low accordingly.

Over Current Protection and Hiccup Mode

The AWK6612Q1/AWK6613Q1 has cycle-by-cycle over current limit when the inductor current peak value exceeds the set current limit threshold. If, during current limit, the voltage on the FB input falls below about 0.51 V due to a short circuit, the device enters into hiccup mode. In this mode, the device stops switching for about 32ms and then goes through a normal re-start with soft start. If the short-circuit condition remains, the device runs in current limit for about 5 ms (typical) and then shuts down again. This cycle repeats as long as the short circuit-condition persists. This mode of operation helps reduce the temperature rise of the device during a hard short on the output. The output current is greatly reduced during hiccup mode. Once the output short is removed and the hiccup delay is passed, the output voltage recovers normally.

Spread Spectrum Mode

Spread Spectrum Mode (SSM) is a factory option. For most automatic application, reduced EMI operation may be desirable, which can be achieved through spread spectrum modulation. This mode operates with the switching frequency is modulated up and down by a 2.15kHz triangle wave. The modulation has the natural frequency which is fixed by factory, and modulates up to approximately 15% higher than the natural frequency.

APPLICATION

Fig.22 shows a typical application circuit for the AWK6612Q1/AWK6613Q1. Thanks to the high integration in the AWK6612Q1/AWK6613Q1, the application circuit based on AWK6612Q1/AWK6613Q1 only need input capacitor, output capacitor, output inductor and feedback resistors which are need to be selected based on applications specifications. Table 2 shows some typical external component values.

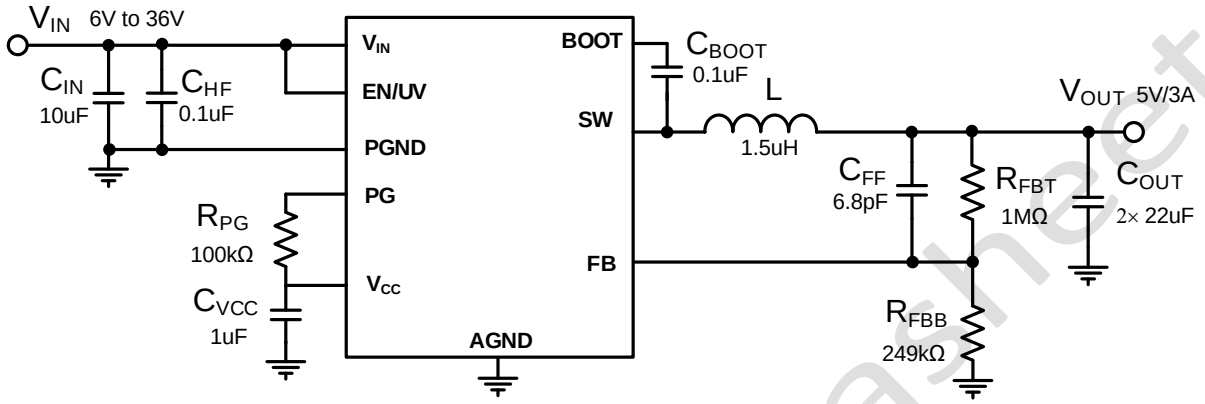


Fig.22 Typical Application Circuit (2100kHz)

f_{sw}(kHz)	V_{OUT}(V)	L(μH)	C_{OUT}(RATED CAPACITANCE)	R_{FBT} (kΩ)	R_{FBB} (kΩ)	C_{IN}+C_{HF}	C_{BOOT}	C_{VCC}	C_{FF}
400	3.3	6.8	2*47μF	1000	430	10μF+100nF	100nF	1μF	8.2pF
400	5	8.2	2*47μF	1000	249	10μF+100nF	100nF	1μF	10pF
2100	3.3	1.2	2*22μF	1000	430	10μF+100nF	100nF	1μF	3.9pF
2100	5	1.5	2*22μF	1000	249	10μF+100nF	100nF	1μF	6.8pF

Table.2 Typical External Component Values

Setting Output Voltage

The external feedback resistors connected to FB sets the output voltage. The feedback resistors value can be calculated with the below equation.

$$\boldsymbol{R_{FBB} = \frac{V_{REF} R_{FBT}}{V_{OUT} - V_{REF}}}$$

While R_{FBT}=1MΩ, V_{REF}=1V, V_{OUT}=5V

Calculate R_{FBB}=249kΩ

Inductor Selection

For higher efficiency, choose an inductor with a lower DC resistance. A larger-value inductor results in less ripple current and a lower output ripple voltage, but also has a larger physical size, higher series resistance, and lower saturation current. A good rule for determining the inductor value is to allow the inductor ripple current to be approximately 20% to 40% of the maximum load current. The minimum inductance value can be calculated with the below equation.

$$L_{MIN} = \frac{V_{OUT}(1-D)}{f_{SW} \times \Delta I_L}$$

While V_{OUT}=5V, f_{SW}=2100kHz, ΔI_L=30%×3A=0.9A, D=5V/12V=0.417
Calculate L=1.5uH.

This equation has limitations due to the inclusion of the duty cycle parameter. It is recommended that the following equation be used to calculate the inductance value.

$$L = \frac{V_{OUT} - V_{Drop}}{f_{SW}}$$

V_{DROP} is the bottom switch drop voltage, which can be estimated as the Bottom MOSFETs Rdson multiplied by maximum load current.

Output Capacitor Selection

The output capacitor maintains the DC output voltage. Ceramic, tantalum, or low ESR electrolytic capacitors are recommended. For best results, use low ESR capacitors to keep the output voltage ripple low. The output voltage ripple can be estimated with equation. Generally, required the output voltage ripple is less than 1% of the output voltage.

$$\Delta V_{OUT} = \frac{V_{OUT} \times (1-D)}{8 \times {f_{SW}}^2 \times L \times C_{OUT}}$$

Input Capacitor Selection

The input capacitor can be electrolytic, tantalum, or ceramic. When using electrolytic or tantalum capacitors, add a small, high-quality ceramic capacitor (like X7R,C0G etc.) as close to the IC as possible. When using ceramic capacitors, ensure that they have enough capacitance to provide a sufficient charge to prevent excessive voltage ripple at the input. From the below equation, can easily calculate the input voltage ripple. Generally, required the input voltage ripple is less than 10% of the input voltage.

$$\Delta V_{IN} = \frac{I_O \times D \times (1-D)}{f_{SW} \times C_{IN}}$$

C_{FF} Capacitor Selection

When some cases need improvement of load transient response or the margin of loop-phase, a feedforward capacitor can be used across R_{FBT}, especially when values of R_{FBT} > 1000kΩ are used. The minimum capacitation value can be calculated with the below equation

$$C_{FF} \leq \frac{C_{OUT} \times V_{OUT}}{110 \times R_{FBT} \times \sqrt{\frac{R_{FBB}}{R_{FBT} + R_{FBB}}}}$$

Bootstrap Capacitor Selection

A bootstrap capacitor connected between the BOOT pin and the SW pin. This capacitor stores energy that is used to supply the gate drivers for the internal MOSFETs. A ceramic capacitor of 0.1uF and 16V voltage rating is required.

VCC Capacitor Selection

The VCC pin is the output of the internal LDO used to supply the control circuits of the converter. This output requires a 1μF, 16V ceramic capacitor connected from VCC to AGND for proper operation. In general, avoid loading this output with any external circuitry. However, this output can be used to supply the pullup for the PGOOD function. The nominal output voltage on VCC is 3.5 V. Do not short this output to ground or any other external voltage. Also, if over temperature protection or EN pin is pulled low, the VCC pin output will be low.

EN Resistor Selection

The AWK6612Q1/AWK6613Q1 has undervoltage lockout feature with default rising threshold of 2.85 V. It can be adjusted by using EN pin with external resistor divider. The UVLO threshold integrates a 200mV hysteresis to make a desired hysteresis for input voltage.
V_{UVLO_R} is the desired system level undervoltage protection rising threshold voltage, V_{UVLO_F} is the desired system level undervoltage protection falling threshold voltage. The R_{ENT} and R_{ENB} value can be calculated with the below equation

$$V_{UVLO\_R} = \left(\frac{R_{ENT}}{R_{ENT} + R_{ENB}}\right) \times V_{ENR}$$

$$V_{UVLO\_F} = \left(\frac{R_{ENT}}{R_{ENT} + R_{ENB}}\right) \times (V_{ENR} - 0.2)$$

APPLICATION WAVEFORMS

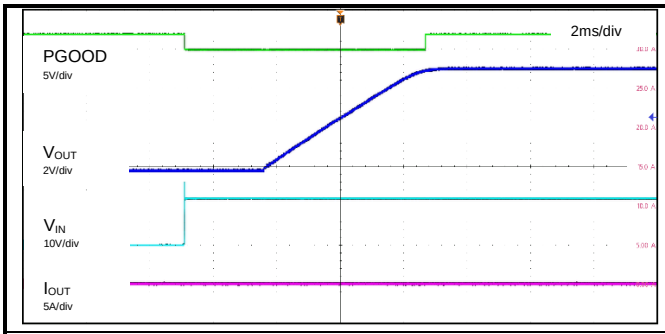


Fig.23 Soft Start by Vin at Io=3A

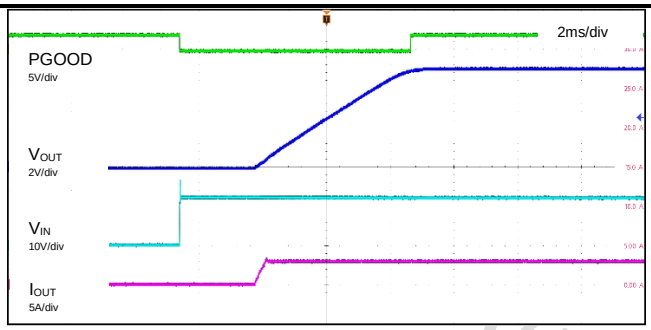


Fig.24 Soft Start by Vin at Io=3A

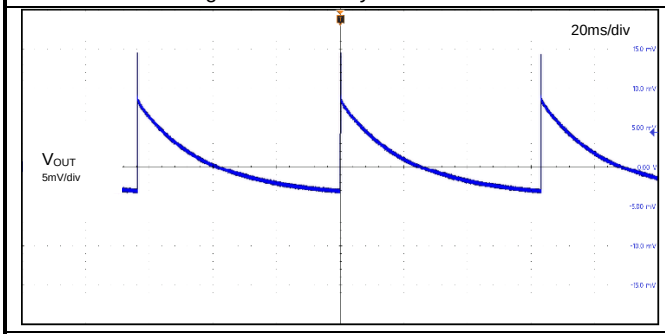


Fig.25 Output Ripple at Io=0A

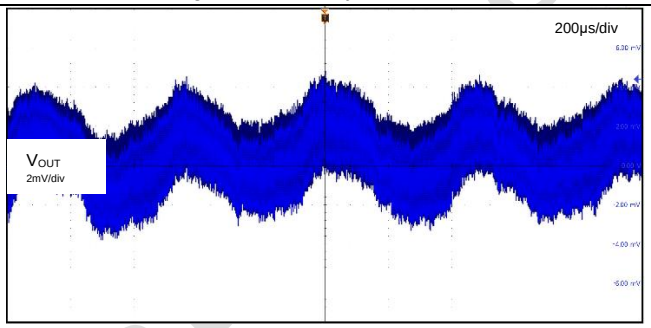


Fig.26 Output Ripple at Io=3A

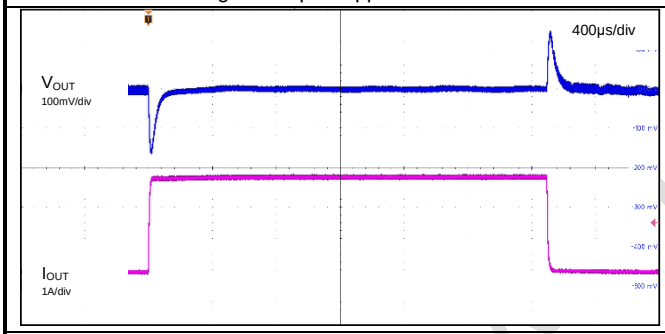


Fig.27 Load Transient @Vin=12V (1A/us)

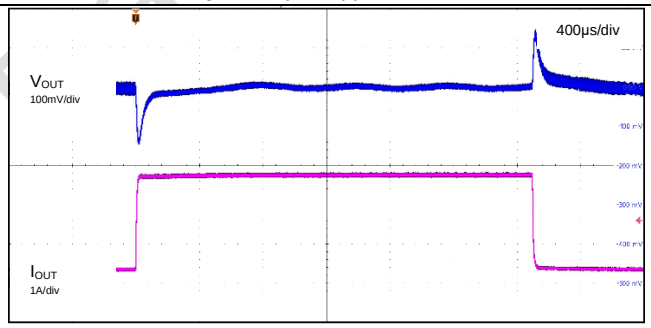


Fig.28 Load Transient @Vin=24V (1A/us)

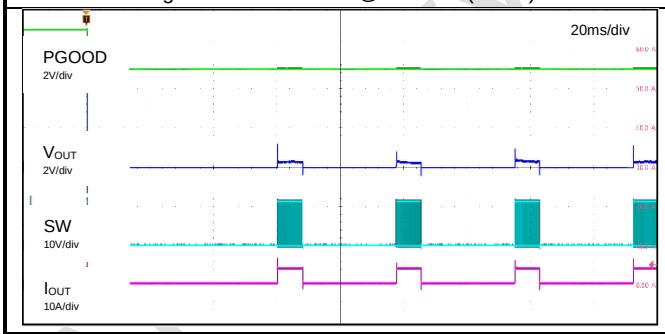


Fig.29 Short Circuit at Io=0A

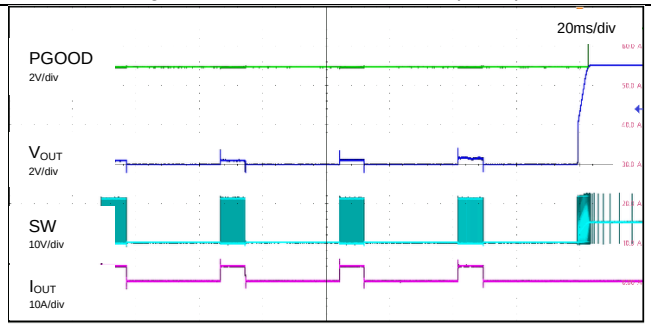


Fig.30 Short Circuit Recovery at Io=0A

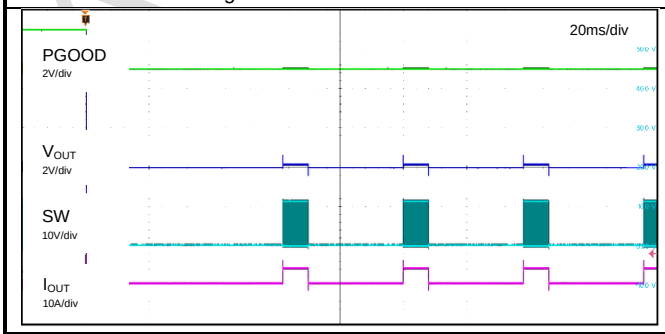


Fig.31 Short Circuit at Io=3A

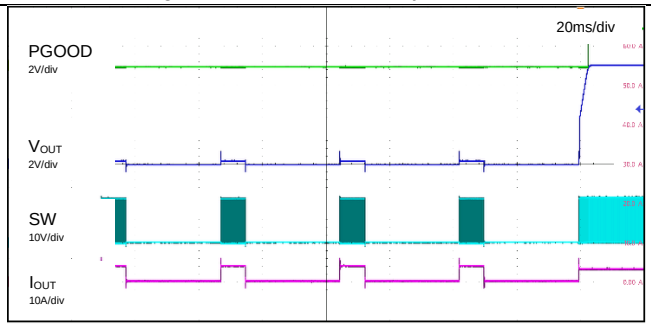


Fig.32 Short Circuit Recovery at Io=3A

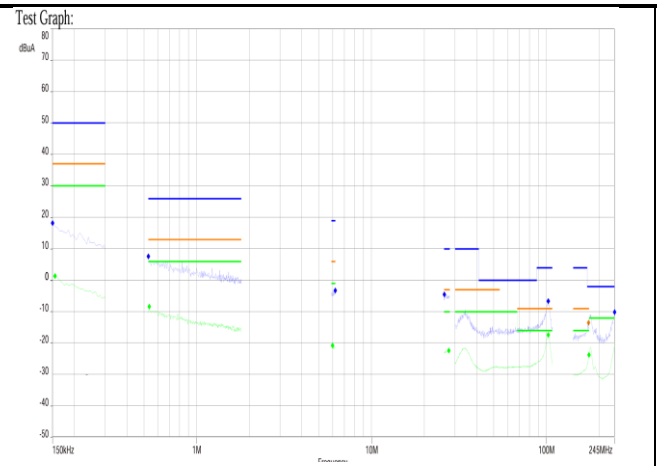


Fig.33 Conducted Current Measurements
0.15MHz to 245MHz at the distance of 50mm
V_{IN}=13.5V, V_{OUT}=5V, I_{OUT}=3A, f_{SW}=400kHz, with SSM

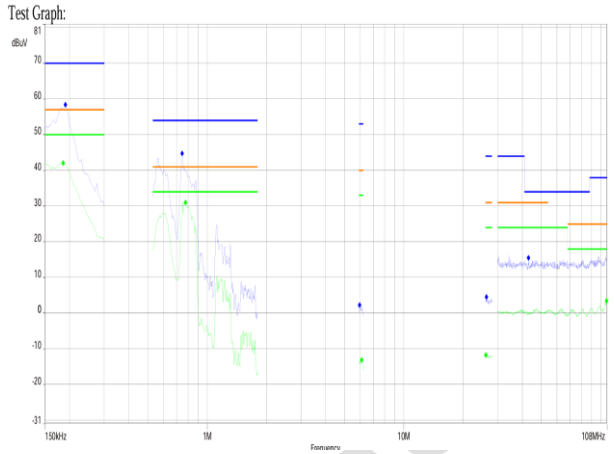


Fig.34 Conducted Voltage Measurements
0.15MHz to 108MHz at Negative Pole
V_{IN}=13.5V, V_{OUT}=5V, I_{OUT}=3A, f_{SW}=400kHz, with SSM

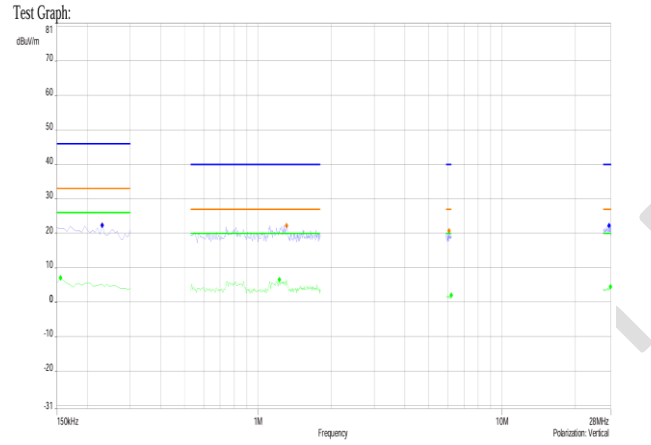


Fig.35 Radiated EMI
0.15MHz to 30MHz in Vertical
V_{IN}=13.5V, V_{OUT}=5V, I_{OUT}=3A, f_{SW}=400kHz, with SSM

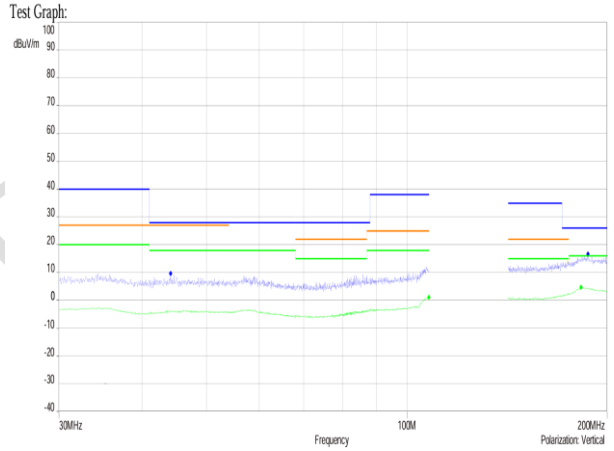


Fig.36 Radiated EMI
30MHz to 200MHz in Vertical
V_{IN}=13.5V, V_{OUT}=5V, I_{OUT}=3A, f_{SW}=400kHz, with SSM

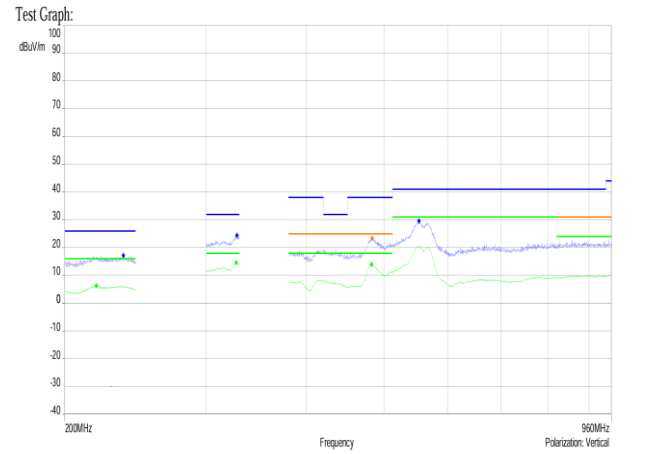


Fig.37 Radiated EMI
200MHz to 1000MHz in Vertical
V_{IN}=13.5V, V_{OUT}=5V, I_{OUT}=3A, f_{SW}=400kHz, with SSM

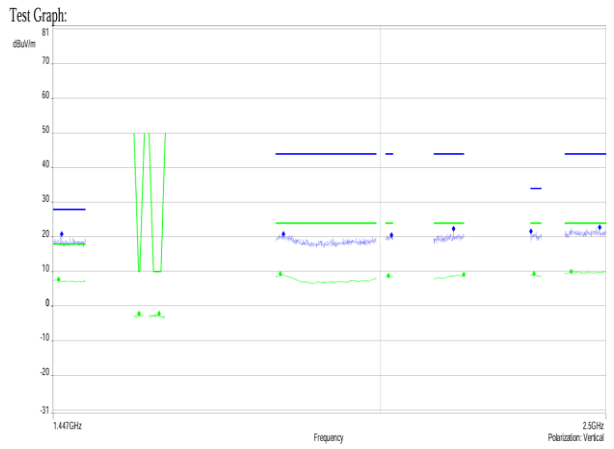


Fig.38 Radiated EMI
1000MHz to 2500MHz in Vertical
V_{IN}=13.5V, V_{OUT}=5V, I_{OUT}=3A, f_{SW}=400kHz, with SSM

PCB LAYOUT GUIDELINES

PCB layout is critical for stable operation of switching regulator AWK6612Q1/AWK6613Q1, especially for thermal design and EMI design. A four-layer layout is strongly recommended to achieve better thermal performance and EMI performance. For best results, please refer to Fig. 39 – Fig. 42 and follow the guidelines below.

1. Place a low ESR ceramic capacitor as close to VIN pin and the ground as possible.
2. Make sure top switching loop with power have lowest impendence of grounding.
3. Use a large ground plane to connect to PGND directly. And add vias near PGND.
4. For the maximum EMI performance, it is highly recommended that the ground of current loop should be separated from other clean ground .
5. Output inductor should be placed close to the SW pin to minimize the SW area.
6. The FB terminal is sensitive to noise so the feedback resistor should be located as close as possible to the IC.
7. Keep the connection of the input capacitor and VIN as short and wide as possible.
8. Use a four-layer board with the copper thickness for the four layers, starting from the top as: 2 oz / 1 oz / 1 oz / 2 oz.

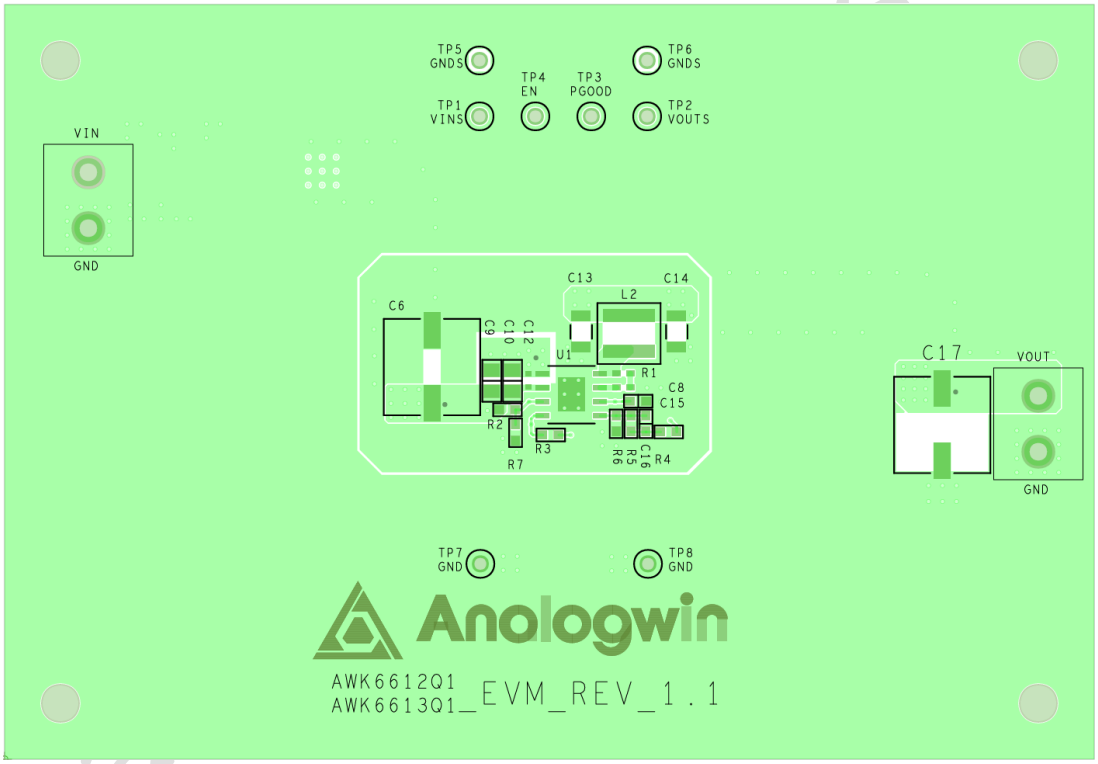


Fig.39 TOP Layout Example

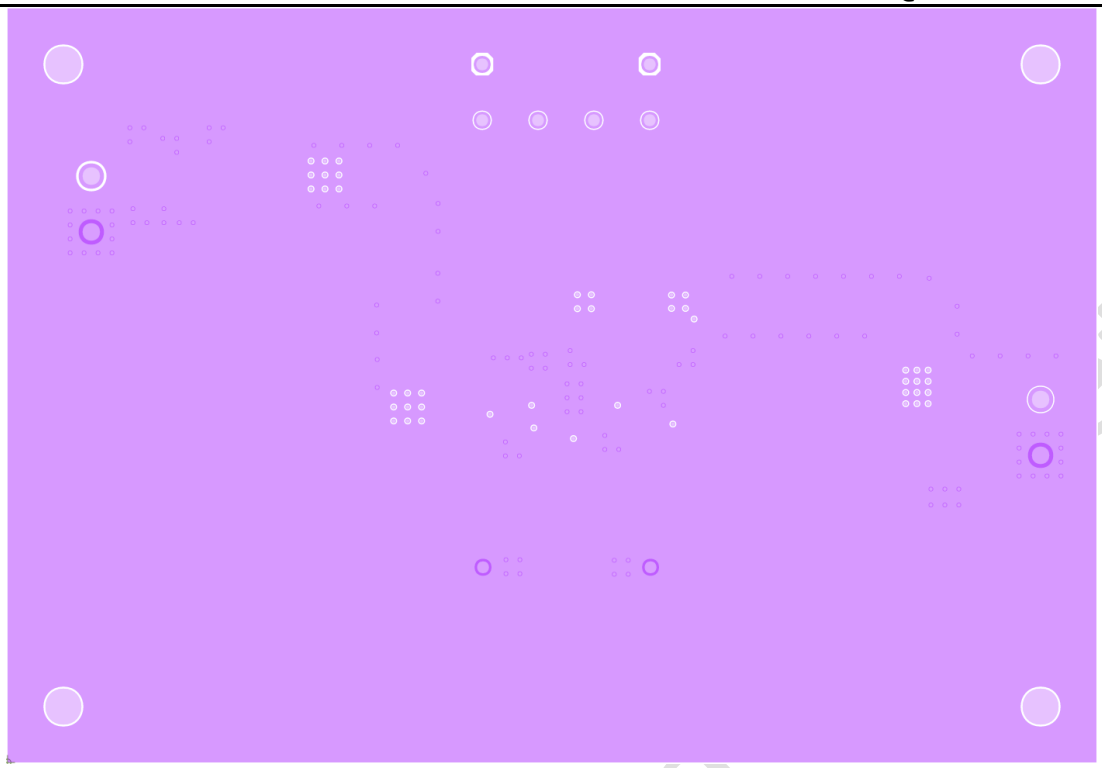


Fig.40 2nd Layout Example

Fig.41 3rd Layout Example

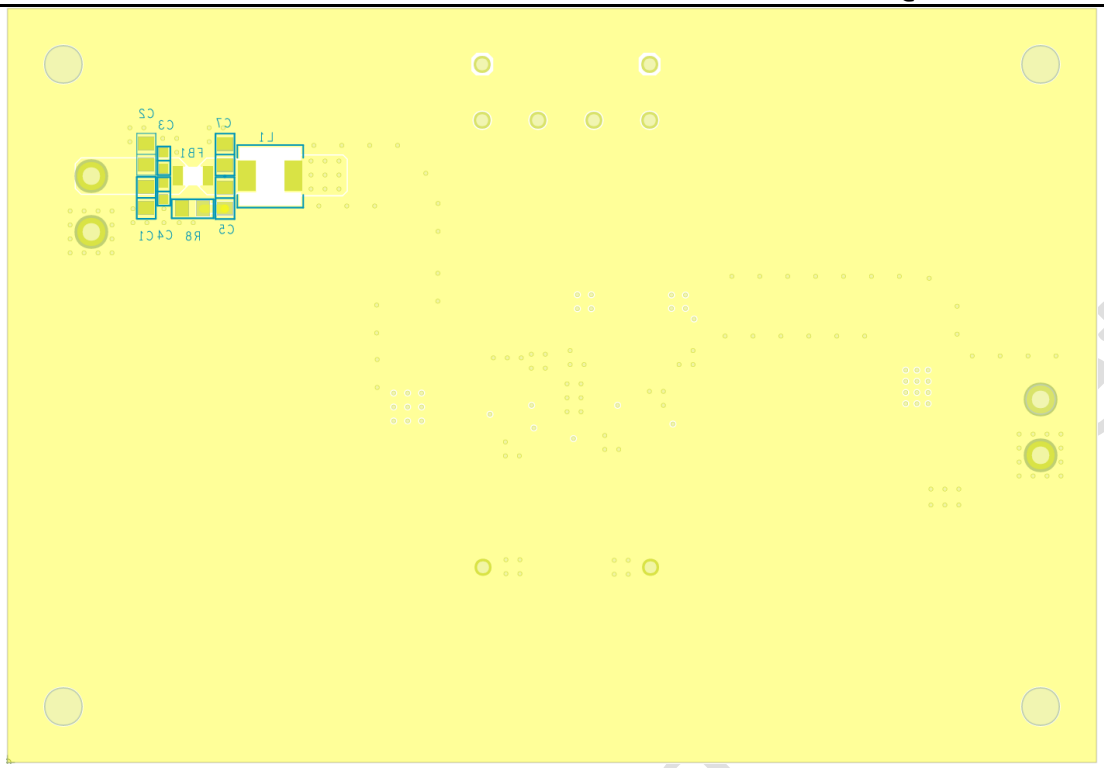


Fig.42 Bottom Layout Example

PACKAGE INFORMATION

Package Top marking

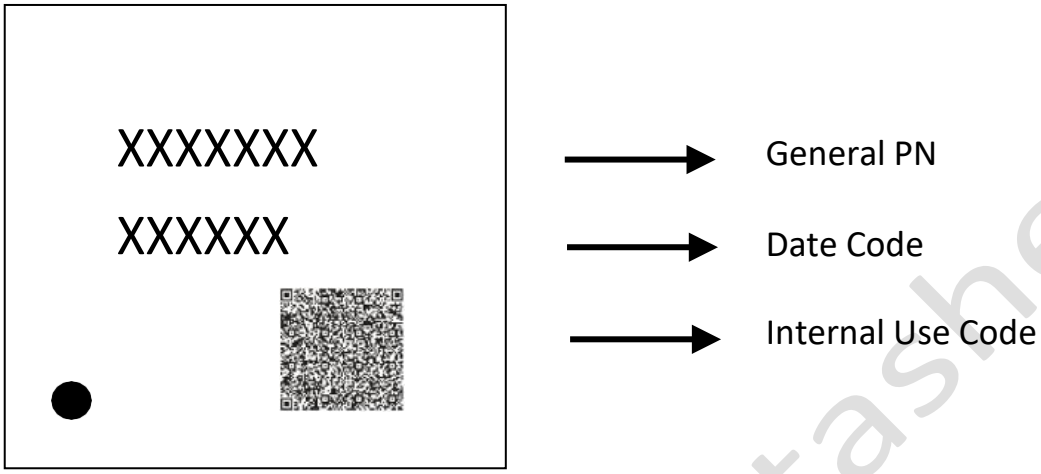


Fig.43 Package Top Marking

Tape and Reel Box Information

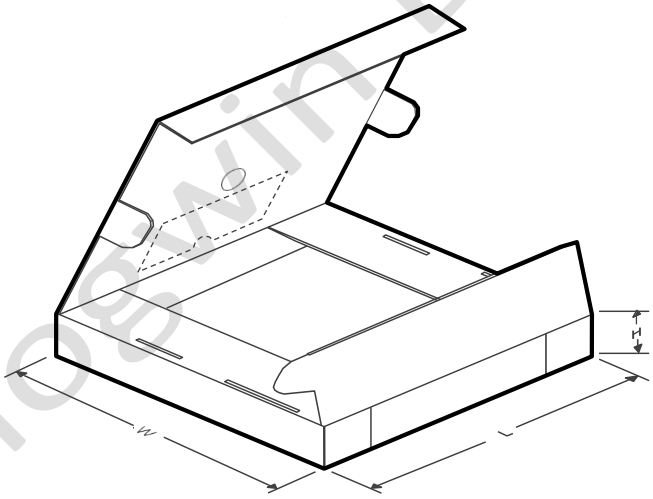


Fig.44 Tape and Reel Box Information

DEVICE	PACKAGE TYPE	PACKAGE DRAWING	PINS	SPQ	LENG (mm)	WIDTH (mm)	HEIGHT (mm)
AWK6612Q1 /AWK6613Q1	ESOP8L	FA	8	4000	320.0	320.0	48.0

Tape and Reel Information

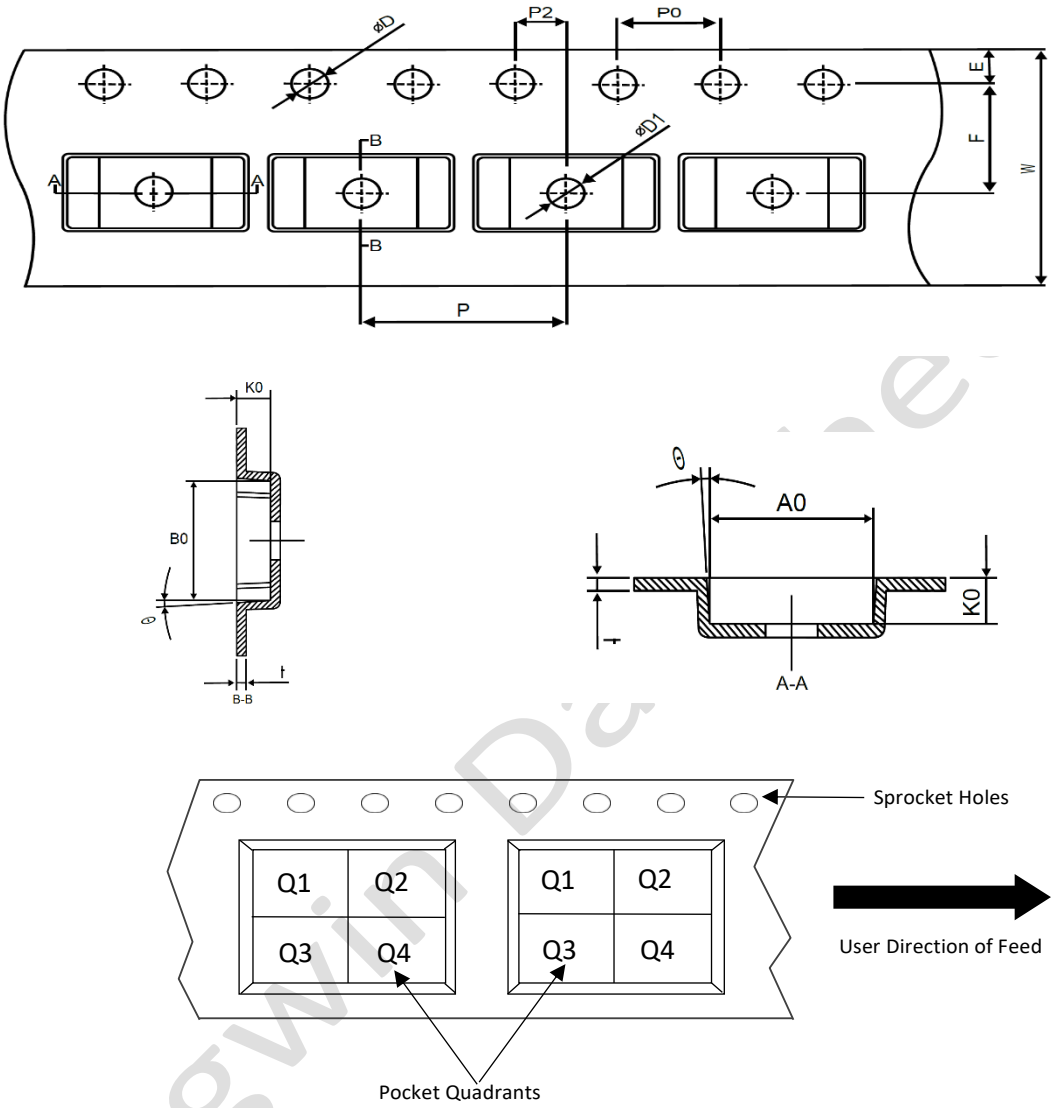


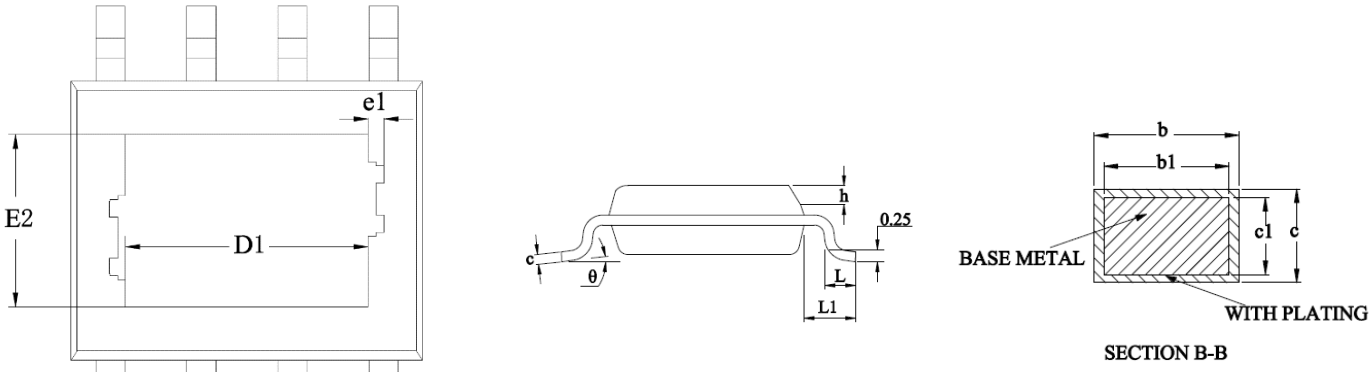
Fig.45 TAPE and Reel Information

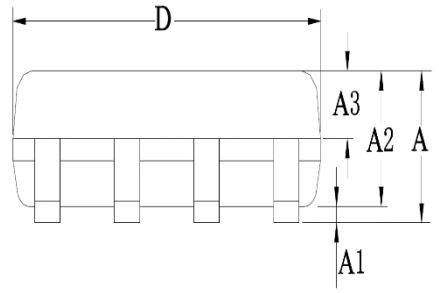
DIMENSIONS AND PIN1 ORIENTATION

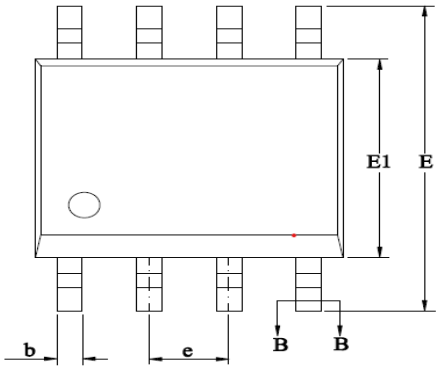
Device	Package Type	A0 (mm)	B0 (mm)	K0 (mm)	P (mm)	P0 (mm)	W (mm)	Pin1 Quadrant	Quantity
AWK6612Q1/ AWK6613Q1	ESOP8L	6.55	5.30	2.00	8.00	4.00	12.00	Q1	4000

All dimensions are nominal

Package Outlines







SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A			1.65
A1	0.00	—	0.10
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	—	0.50
L1	1.05REF		
L	0.30	0.40	0.50

Fig.46 ESOP8L Package

Size(mm)	D1	E2	e1
	2.09REF	2.09REF	0.16REF

ORDERING INFORMATION

Device	Order Part No.	Frequency	Package	QTY
AWK6612Q1	AWK6612AAFARQ1	400kHz	ESOP8L, Pb-Free	4000/Reel
	AWK6612CAFARQ1	2.1MHz	ESOP8L, Pb-Free	4000/Reel
AWK6613Q1	AWK6613AAFARQ1	400kHz	ESOP8L, Pb-Free	4000/Reel
	AWK6613CAFARQ1	2.1MHz	ESOP8L, Pb-Free	4000/Reel

REVISION HISTORY

DATE	REVISION	NOTES
Dec. 2024	1.0	Initial release