JWH3515

Integrated DC-DC Converter Power

DESCRIPTION

The JWH3515 is an offline miniature high-voltage power switching regulators with on-chip power switch and startup circuits. The JWH3515 integrates all the active power, control logic and protection circuitry. The JWH3515 can be configured in any single-ended topology such as forward or flyback, and the controller is targeted for applications requiring up to 6 W.

The internal error amplifier allows the JWH3515 to be easily configured for secondary or primary side regulation operation in isolated and non-isolated configurations. The fixed frequency oscillator is optimized for operation up to 1 MHz. In addition, the JWH3515 has the line undervoltage and overvoltage detectors, cycle by cycle current limit and thermal shutdown to protect the controller under fault conditions.

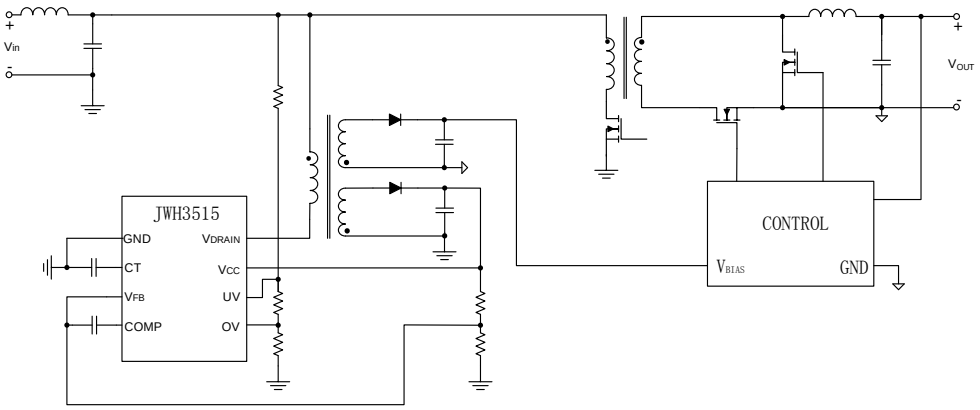
FEATURES

- Integrated 200 V Power Switch Circuit and Startup Circuit
- Operation up to 1 MHz
- External Frequency Synchronization Capability
- Line Undervoltage and Overvoltage Detectors
- Cycle by Cycle Current Limit
- Overtemperature Protection
- Internal Error Amplifier
- Pb-Free Packages are Available

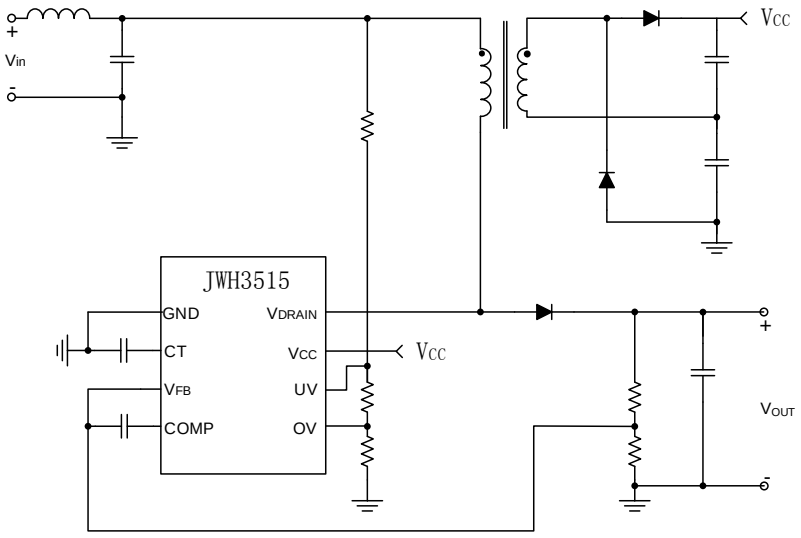
APPLICATIONS

- POE (Power Over Ethernet)/PD.
- Secondary Side Bias Supply
- Stand Alone Low Power dc-dc Converter
- Low Power Bias Supply
- Low Power Boost Converter

TYPICAL APPLICATION



Secondary Side Bias Supply Configuration



Boost Circuit Configuration

ORDER INFORMATION

DEVICE[1)]	PACKAGE	TOP MARKING[2)]	ENVIRONMENTAL[3)]
JWH3515DFNI#TR	DFN4X4-8	JWH3515 YW□□□□□□	Green
JWH3515SOPB#TR	SOP8	JWH3515 YW□□□□□□	Green
JWH3515MSOPB#TR	MSOP8	JWH3515 YW□□□□□□	Green

Notes:

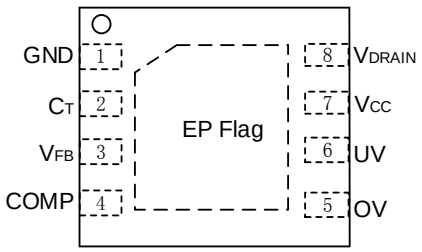
1) JW□□□□#TR
- Tape and Reel (If TR is not shown, it means Tube)
- Package Code
- Part No.

2) Line1: JW □□□□
- Product code
- JoulWatt LOGO

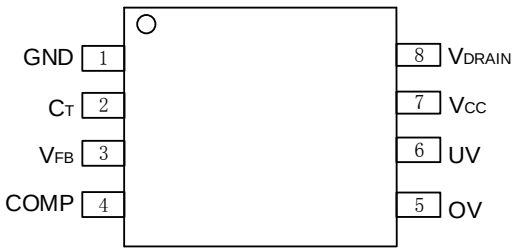
Line2: YW □□□□□
- Lot number
- Week code
- Year code

3) All JoulWatt products are packaged with Pb-free and Halogen-free materials and compliant to RoHS standards.

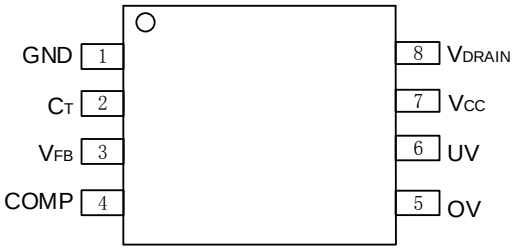
PIN CONFIGURATION



DFN4X4-8 (Top View)



SOP-8 (Top View)



MSOP-8 (Top View)

ABSOLUTE MAXIMUM RATING[1)]

Rating	Symbol	Value	Unit
Power Switch and Startup Circuits Voltage	V_{DRAIN}	-0.3 to 200	V
Power Switch and Startup Circuits Input Current	I_{DRAIN}	2.0	A
V_{CC} Voltage Range	V_{CC}	-0.3 to 16	V
C_T Voltage Range	V_{CT}	-0.3 to 7	V
All Other Inputs/Outputs Voltage Range	V_{IO}	-0.3 to 10	V
V_{CC} and All Other Inputs/Outputs Current	I_{IO}	100	mA
Maximum Operating Junction Temperature[2) 3)]	T_J	-40 to 150	ºC
Lead Temperature	T_L	260	ºC
Storage Temperature	T_{stg}	-55 to 150	ºC
ESD Capability (Human Body Model)		>2000	V
ESD Capability (Charge Device Model)		>500	V

RECOMMENDED OPERATING CONDITIONS

VCC Voltage.....9 to 14V

Operation Junction temperature[2)]..... -40ºC to 125ºC

THERMAL PERFORMANCE[4)]

	θ_{JA}	$\theta_{JC(bot)}$
DFN4X4-8	42	3.2ºC/W
	θ_{JA}	$\theta_{JC(top)}$
SOP-8	116.7	62.4ºC/W
MSOP-8	184.7	76.8ºC/W

Note:

1) Exceeding these ratings may damage the device. These stress ratings do not imply function operation of the device at any other conditions beyond those indicated under RECOMMENDED OPERATING CONDITIONS.

2) The JWH3515 includes thermal protection that is intended to protect the device in overload conditions. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.

3) The device is not guaranteed to function outside of its operating conditions.

4) Measured on JESD51-7, 4-layer PCB.

ELECTRICAL CHARACTERISTICS

V_{DRAIN} = 48 V, VCC = 12 V, C_{CT} = 560 pF, V_{UV} = 3 V, V_{OV} = 2 V, V_{FB} = 2.3 V, V_{COMP} = 2.5 V, T_J = -40°C to 125°C, typical values shown are for T_J = 25°C, unless otherwise stated

Item	Symbol	Condition	Min.	TYP.	Max.	Units
STARTUP CONTROL						
Startup Circuit Output Current	I_{START}	V_{FB} = V_{COMP} V_{CC}=0 V T_J=-40°C to 125°C	11	18	23	mA
		V_{FB} = V_{COMP} V_{CC}=$V_{CC(ON)}$-0.2 V T_J=-40°C to 125°C	9	17	22	
Turn-On Threshold Voltage	$V_{CC(ON)}$	V_{CC} Increasing V_{FB}=2.7V	9.6	10.2	10.6	V
Turn-Off Threshold Voltage	$V_{CC(OFF)}$	V_{CC} Decreasing V_{FB}=2.7V	7.0	7.6	8.0	V
Reset Voltage	$V_{CC(RESET)}$	V_{CC} Decreasing V_{FB} = V_{COMP}	6.0	6.6	7.0	V
Minimum Startup Voltage	$V_{START(MIN)}$	I_{START} = 0.5 mA, V_{CC} =$V_{CC(ON)}$ - 0.2 V	-	-	16.5	V
ERROR AMPLIFIER						
Reference Voltage	V_{REF}	V_{COMP}=V_{FB} T_J=-40℃ to 125℃	2.45	2.5	2.55	V
Line Regulation	REG_{LINE}	V_{CC}=8V to 16V, T_J=25℃	-	1.0	5.0	mV
Input Bias Current	I_{VFB}	V_{FB}=2.3V	-	0.1	1.0	uA
COMP Source Current	I_{SRC}	V_{FB}=2.3V	80	110	160	uA
COMP Sink Current	I_{SNK}	V_{FB}=2.7V	480	570	660	uA
COMP Maximum Voltage	$V_{C(MAX)}$	V_{FB}=2.3V	4.5	-	-	V
COMP Minimum Voltage	$V_{C(MIN)}$	V_{FB}=2.7V	-	-	1.5	V

Open Loop Voltage Gain (Note 5)	A_{VOL}		-	80	-	dB
Gain Bandwidth Product (Note 5)	GBW		-	1.0	-	MHz
LINE UNDER/OVERVOLTAGE DETECTOR						
Undervoltage Threshold	V_{UV}	$V_{COMP}=V_{FB}$ V_{UV} Increasing	2.400	2.550	2.700	V
Undervoltage Hysteresis	$V_{UV(HYS)}$	$V_{COMP}=V_{FB}$	-	0.175	-	V
UV Input Bias Current	I_{UV}	$V_{COMP}=V_{FB}$	-	0.1	1.0	uA
Overvoltage Threshold	V_{OV}	$V_{COMP}=V_{FB}$ V_{UV} Increasing	2.400	2.550	2.700	V
Overvoltage Hysteresis	$V_{OV(HYS)}$	$V_{COMP}=V_{FB}$	-	0.175	-	V
OV Input Bias Current	I_{OV}	$V_{COMP}=V_{FB}$	-	0	1.0	uA
OSCILLATOR						
Frequency	F_{osc1}	C_T=560 pF T_J=25℃	275	300	325	KHz
		C_T=560 pF T_J=-40℃ to 125℃	260	-	325	
	F_{osc2}	C_T=242 pF T_J=25℃	-	528	-	
	F_{osc3}	C_T=124 pF T_J=25℃	-	735	-	
Charge Current	$I_{CT(C)}$	V_{CT}=3.25V	-	150	-	uA
Discharge Current	$I_{CT(D)}$	V_{CT}=3.25V	-	450	-	uA
Oscillator Ramp Peak Voltage	V_{RPK}		3.3	3.5	3.7	V
Oscillator Ramp Valley Voltage	V_{RVLY}		2.8	3.0	3.2	V
PWM COMPARATOR						

Maximum Duty Cycle	DC_{MAX}		70	75	80	%
POWER SWITCH CIRCUIT						
MOS $R_{DS(ON)}$	$R_{DS(ON)}$	I_D=100 mA T_J=25℃	-	2.1	3.0	Ω
		I_D=100 mA T_J=125℃	-	3.4	5.0	Ω
Breakdown Voltage	$V_{(BR)DS}$	I_D=100 uA T_J=25℃	200	-	-	V
Off-State Leakage Current	$I_{DS(OFF)}$	V_{DRAIN}=190 V, V_{UV}=2.0 V T_J=-40℃ to 125℃	-	-	30	uA
Switching Rise Time	t_r	V_{DS}=48 V, R_L=100 Ω	-	22	-	nS
Switching Fall Time	t_f	V_{DS}=48 V, R_L=100 Ω	-	45	-	nS
CURRENT LIMIT AND OVER TEMPERATURE PROTECTION						
Current Limit Threshold	I_{LIM}	TJ=25℃	850	1020	1200	mA
Propagation Delay, Current Limit Threshold to Power Switch Circuit Output	t_{PLH}	T_J=-40℃ to 125℃	750	1020	1300	ns
Propagation Delay, Current Limit Threshold to Power Switch Circuit Output	t_{PLH}		-	100	-	ns
Thermal Shutdown (Note 6)	T_{SHDN}	Temperature increasing	-	150	-	℃
Thermal Shutdown Hysteresis (Note 6)	T_{HYS}		-	20	-	℃
TOTAL DEVICE						
Supply Current	I_{CC1}	Power Switch Enabled	-	1.8	3	mA
	I_{CC2}	Power Switch Disabled	-	1.3	1.8	

		Non-Fault condition (V_{FB}=2.7V)				
	I_{CC3}	Power Switch Disabled Fault condition (V_{FB}=2.7 V, V_{UV}=2.0 V)	-	0.82	1.2	

Note：

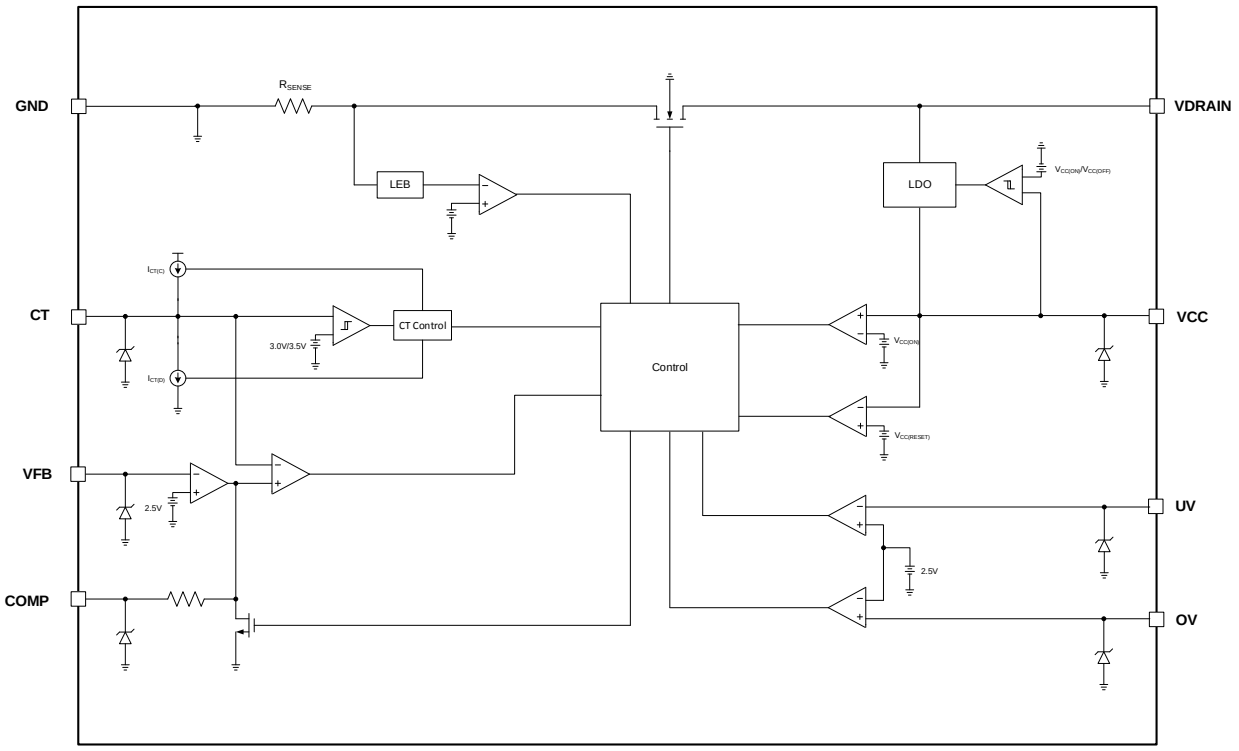
5) Guaranteed by Design.

6) Derived from bench characterization. Not tested in production.

PIN DESCRIPTION

PIN DFN4X4-8	NAME	DESCRIPTION
1	GND	The ground of the IC.
2	C_T	An external capacitor connected to this pin sets the oscillator frequency.
3	V_{FB}	The regulated voltage is scaled down to 2.5 V by means of a resistor divider. Regulation is achieved by comparing the scaled voltage to an internal 2.5 V reference.
4	COMP	Requires external compensation network between COMP and VFB pins.
5	OV	Over-voltage protection. When this pin is biased beyond 2.5 V, all pulses immediately stop. If no OVP is used connect this pin to AGND.
6	UV	Line voltage is scaled down using an external resistor divider such that the UV voltage reaches 2.5 V when line voltage reaches its minimum operating voltage.
7	V_{CC}	Bias power input to the controller. A hold-up capacitor to GND is required.
8	V_{DRAIN}	The drain of inner power MOSFET

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

The JWH3515 is an offline miniature high-voltage power switching regulators with on-chip power switch and startup circuits. The internal startup circuit and the MOSFET are rated at 200 V, making them ideal for 48 V telecom and 42 V automotive applications. The JWH3515 has the line undervoltage and overvoltage detectors, cycle by cycle current limit and thermal shutdown to protect the controller under fault conditions. The JWH3515 is targeted for applications up to 6 W.

1. Start-Up

The JWH3515 contains an internal 200 V startup regulator. The startup regulator consists of a constant current source that supplies current from a high−voltage rail to the capacitor on the VCC pin. The startup circuit current is 18 mA. The internal high voltage startup circuit eliminates the need for external startup components. In addition, this regulator reduces no−load power and increases the system efficiency as it uses negligible power in the normal operation mode.

As soon as V_{CC} reaches turn-on threshold $V_{CC(ON)}$, the internal startup circuit is disabled. The controller is enabled and the converter starts switching. If V_{CC} falls below $V_{CC(OFF)}$, the device enters a re-start mode. While in the re-start mode, the V_{CC} capacitor is allowed to discharge to $V_{CC(RESET)}$ while the Power Switch is enabled. Once the $V_{CC(RESET)}$ threshold is reached, the Power Switch Circuit is disabled and the startup regulator is enabled to charge the VCC capacitor. The Power Switch is enabled again once the VCC voltage reaches $V_{CC(ON)}$.

2. Error Amplifier

The internal error amplifier (EA) regulates the output voltage of the bias supply. It compares a scaled output voltage signal to an internal VREF connected to its non-inverting input. The scaled signal is fed into the feedback pin (VFB) which is the inverting input of the error amplifier.

The error amplifier output source and sink currents are typically 127uA and 570uA, respectively.

3. Line Under and Overvoltage Detector

The JWH3515 incorporates individual line undervoltage (UV) and overvoltage (OV) shutdown circuits. When the UV is below 2.5 V or if the OV voltage is above 2.5 V. It immediately stops switching pulses and internally pulls down the COMP. The UV/OV circuits can be biased using an external resistor divider from the input line as shown in Figure 1.

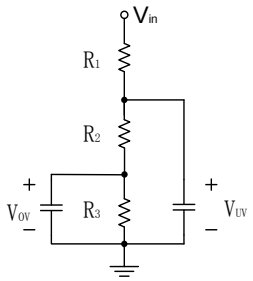


Figure 1. UV/OV resistor divider from the input line

4. Oscillator

The oscillator frequency is set by the external timing capacitor (C_T) connected to the C_T pin. The oscillator has two modes of operation, free running and synchronized (sync). While in free running mode, an internal current source charges and discharges CT generating a voltage ramp between 3.0 V and 3.5 V. Under normal operating conditions, the charge ($I_{CT(C)}$) and discharge ($I_{CT(D)}$) currents are typically 150uA

and 450uA, respectively. The Power Switch is disabled while CT is discharging, guaranteeing a maximum duty cycle of 75 % as shown in Figure 2.

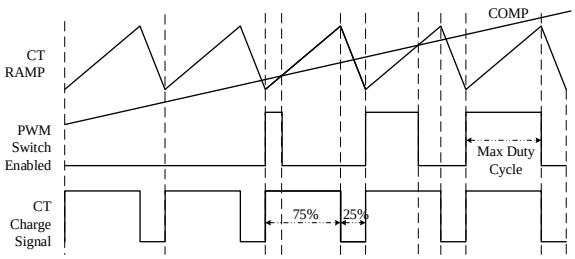


Figure 2. Duty cycle vs COMP

Figure 3 shows the relationship between the operating frequency and C_T. The oscillator can be synchronized to a higher frequency by capacitively coupling a synchronization pulse into the C_T pin. Figure 4 shows pulsing the CT pin before it reaches 3.5 V to trigger the internal comparator and complete the CT charging period.

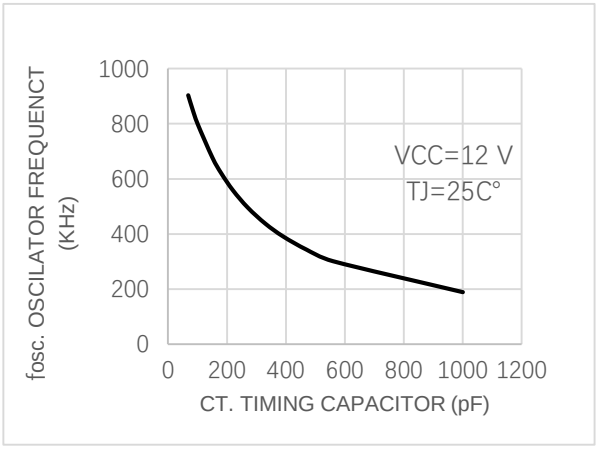


Figure 3. Oscillator frequency vs C_T

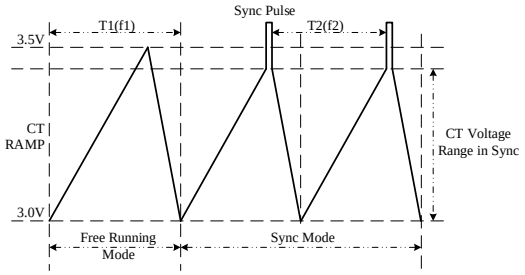


Figure 4. External frequency synchronization waveforms

The oscillator frequency should be set no more that 25% below the target sync frequency to maintain an adequate voltage range and provide good noise immunity. Figure 5 shows the recommended C_T circuit for synchronize the oscillator.

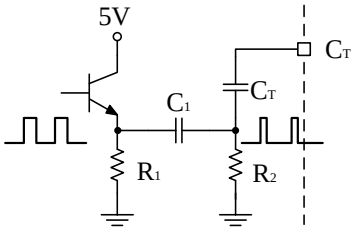


Figure 5. External frequency synchronization circuit

5. PWM Comparator and Latch

The Pulse Width Modulator (PWM) Comparator compares the error amplifier output (COMP) to the C_T Ramp and generates a proportional duty cycle. Figure 2 shows the relationship between the duty cycle and COMP. The Power Switch is disabled while the C_T Ramp is higher than COMP. The Power Switch is enabled while the C_T Ramp is below COMP. If COMP is at the bottom of the C_T Ramp, the converter operates at minimum duty cycle. While COMP increases, the duty cycle increases, until COMP reaches the peak of the C_T Ramp, at which point the controller operates at maximum duty cycle.

6. Current Limit Comparator and Power Switch Circuit

The drain current is monitored by sampling the voltage of the built-in sense element, RSENSE. If the sense voltage exceeds the reference level, the comparator resets the PWM Latch and switching is terminated.

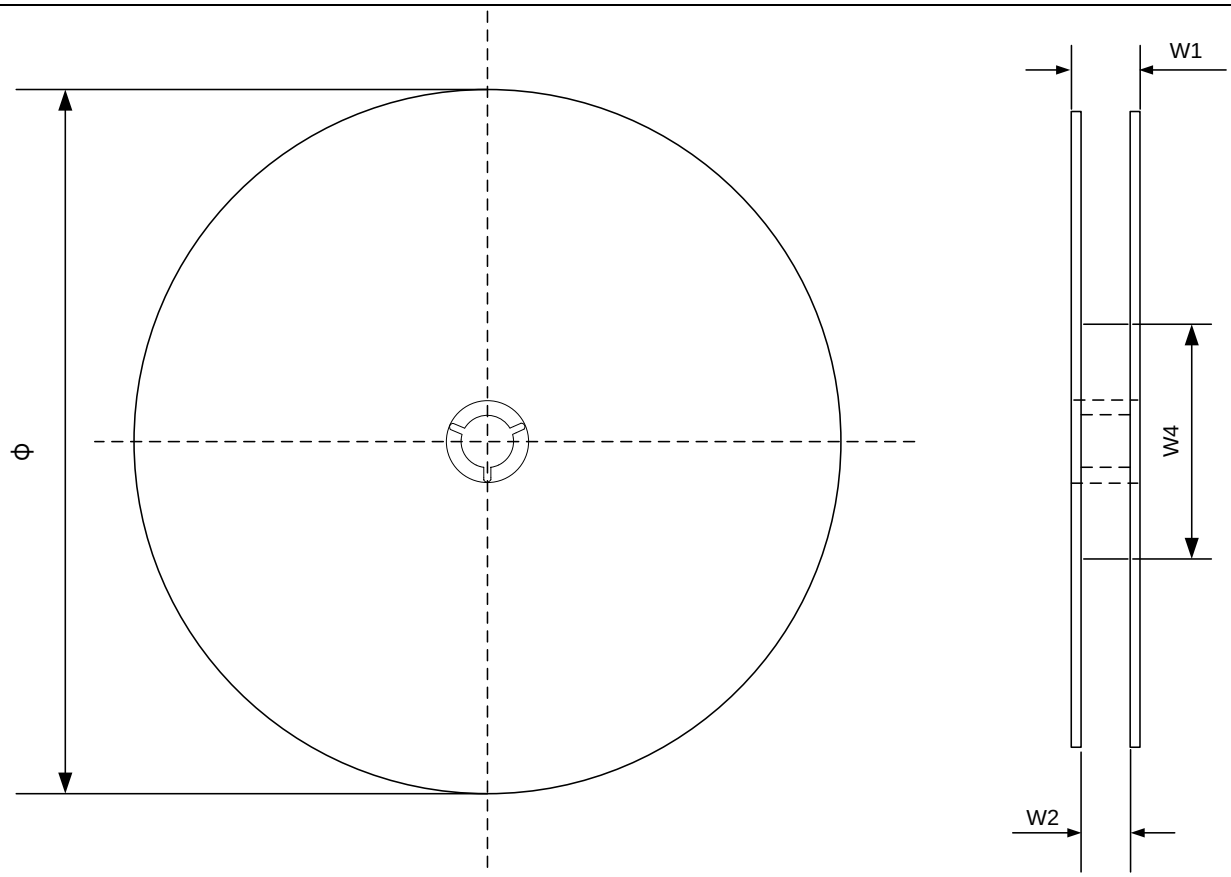
In order to avoid the premature termination of the switching pulse due to the parasitic capacitance, an internal leading-edge blanking (t_{PLH}) is used. The current comparator is disabled and can't turn off the MOSFET during the blanking time.

7. Thermal Shutdown

The internal over-temperature protection threshold is 150°C. If the junction temperature of the device reaches this threshold the device shuts down. When the junction temperature falls to 130°C, the device is allowed to resume normal operation.

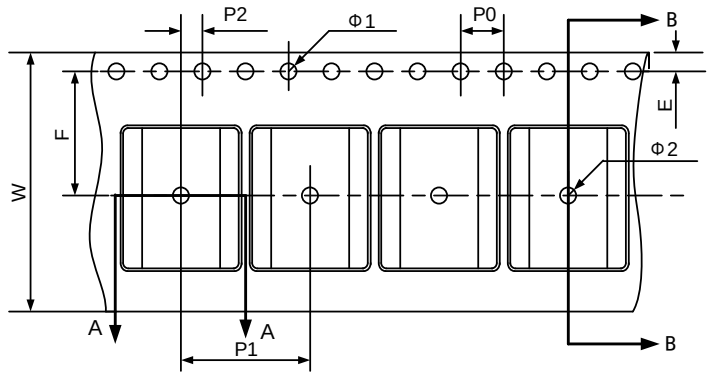
TAPE AND REEL INFORMATION

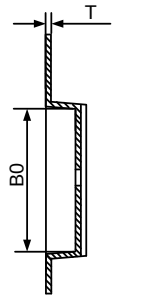
Reel UNIT: mm



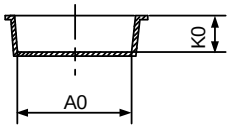
Package	Diameter Φ	Thickness W1	Width W2	W4
DFN4X4-8	330±2	17.6±2	12.4±2	100±2
SOP-8	330±2	17.6±2	12.4±2	100±2
MSOP-8	330±2	17.6±2	12.4±2	100±2

Carrier Tape UNIT: mm





SECTION B-B



SECTION A-A

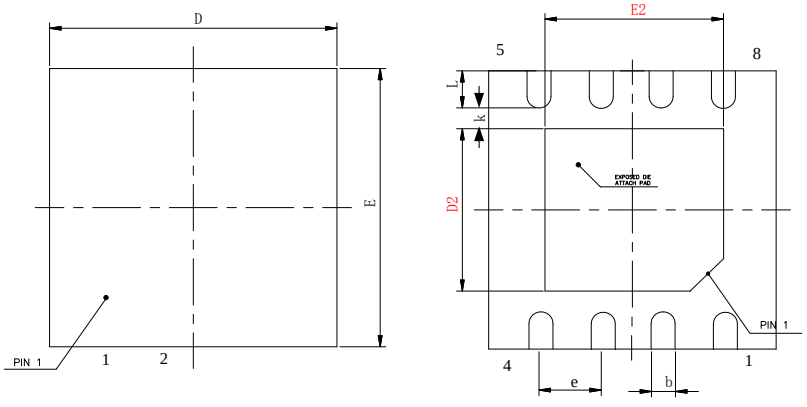
Note :

1) The carrier type is black, and colorless transparent.
2) Carrier camber is within 1mm in 100mm.
3) 10 pocket hole pitch cumulative tolerance:±0.20.
4) All dimensions are in mm.

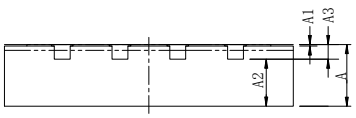
Package	Tape dimensions(mm)											
	P0	P2	P1	A0	B0	W	T	K0	Φ1	Φ2	E	F
DFN4X4-8	4.0±0.10	2.0±0.10	8.0±0.2	4.30±0.2	4.30±0.2	12.0±0.3	0.25±0.10	1.10±0.2	1.50±0.10	1.50±0.25	1.75±0.1	5.50±0.10
SOP-8	4.0±0.1	2.0±0.1	8.0±0.1	6.40±0.3	5.35±0.3	12.0±0.3	0.25±0.2	2.00±0.2	1.50min	1.50min	1.75±0.1	5.50±0.10
MSOP-8	4.0±0.1	2.0±0.10	8.0±0.1	5.2±0.1	3.3±0.1	12±0.30	0.25±0.10	1.20±0.1	1.5±0.10	1.5±0.25	1.75±0.1	5.50±0.10

PACKAGE OUTLINE

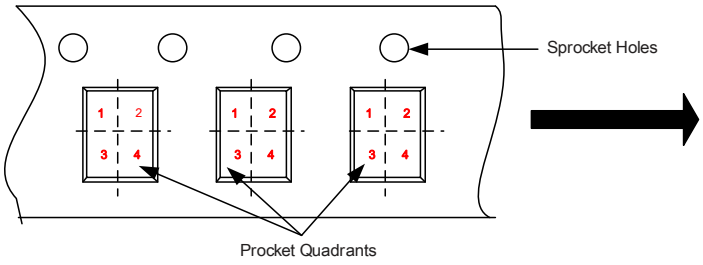
DFN4X4-8 UNIT: mm



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.80	0.85	0.90
A1	0.00	0.02	0.05
A2	---	0.65	---
A3		0.203 REF	
b	0.25	0.30	0.35
D		4 BSC	
E		4 BSC	
e		0.8 BSC	
D2	2.19	2.29	2.39
E2	2.01	2.11	2.21
L	0.30	0.40	0.50
K		0.455 REF	

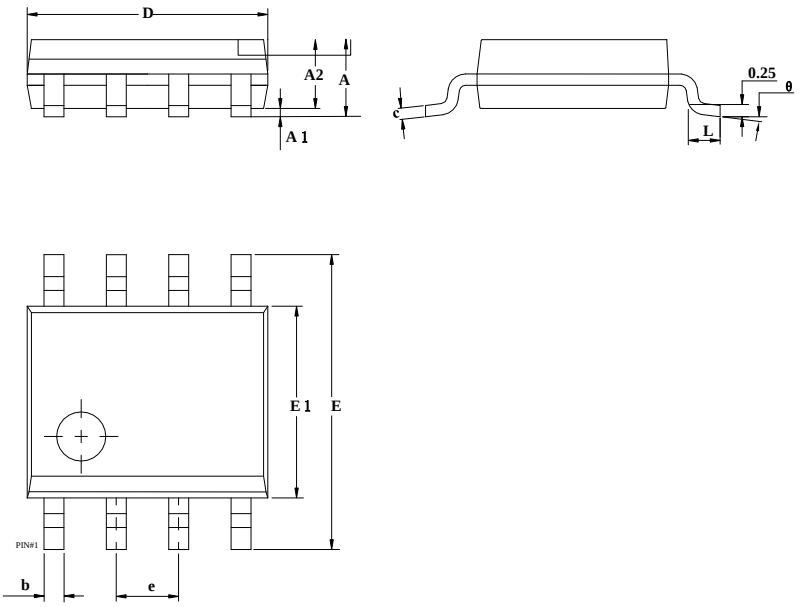


QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPAE



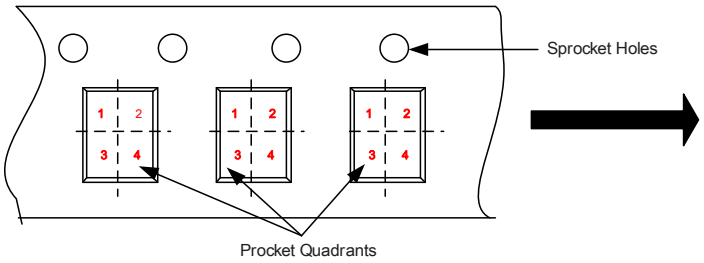
Package Type	Pin1 Quadrant
DFN4X4-8	1

SOP-8 UNIT: mm



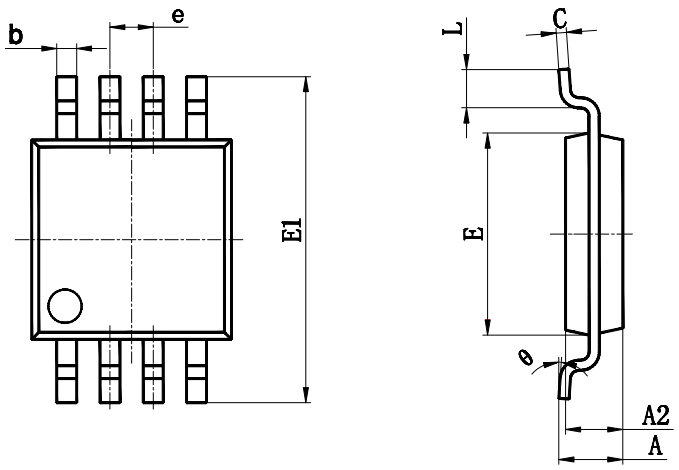
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	1.45	1.60	1.75
A1	0.10	---	0.25
A2	1.35	1.45	1.55
b	0.33	0.42	0.51
c	0.17	0.203	0.25
e	1.27BSC		
D	4.70	4.90	5.10
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
L	0.40	---	1.27
θ	0°	--	8°

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPAE



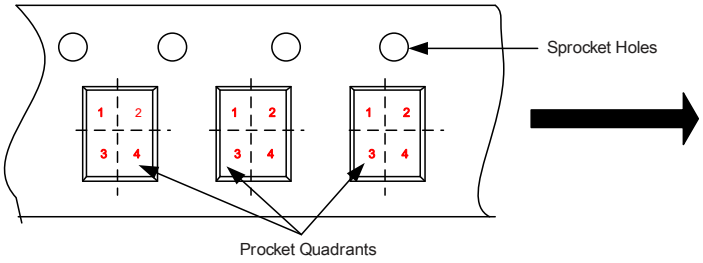
Package Type	Pin1 Quadrant
SOP-8	1

MSOP-8 UNIT: mm



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	---	---	1.10
A1	0.02	---	0.15
A2	0.75	0.85	0.95
b	0.25	---	0.38
c	0.09	---	0.23
D	2.90	3.00	3.10
e	0.65 BSC		
E	2.90	3.00	3.10
E1	4.75	4.90	5.05
L	0.40	0.60	0.80
θ	0°	---	6°

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPAE



Package Type	Pin1 Quadrant
MSOP-8	1

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