500kHz, 18V, 2A/3A Synchronous Step-Down Converter

FEATURES

- High Efficiency: Up to 93%@5V
- 500kHz Switching Frequency
- STI3482: 2.0A Output Current
- STI3484: 3.0A Output Current
- No Schottky Diode Required
- 4.5V to 18V Input Voltage Range
- 0.923V Feedback Voltage
- Slope Compensated Current Mode Control for Excellent Line and Load Transient Response
- Integrated internal compensation
- Stable with Low ESR Ceramic Output Capacitors
- Over Current Protection with Hiccup-Mode
- Input overvoltage protection (OVP)
- Thermal Shutdown
- Inrush Current Limit and Soft Start
- STI3482: SOP8 Package
- STI3484: ESOP8 Package

GENERAL DESCRIPTION

The STI3482 and STI3484 are fully integrated, high–efficiency 2A and 3A synchronous rectified step-down converter. The STI3482 and STI3484 operates at high efficiency over a wide output current load range.

This device offers two operation modes, PWM control and PFM Mode switching in light load condition, which allows a high efficiency over the wider range of the load.

The STI3482 and STI3484 require a minimum number of readily available standard external components and is available in SOP8 and ESOP8 ROHS compliant package.

APPLICATIONS

- Vehicle USB Power Chargers
- Distributed Power Systems
- Digital Set Top Boxes
- Flat Panel Television and Monitors
- Notebook computer
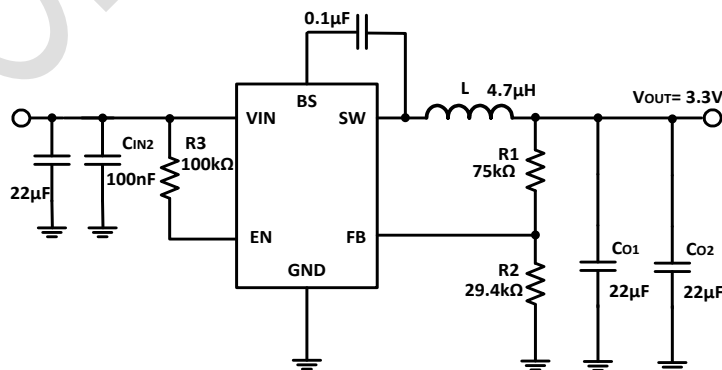- Wireless and DSL Modems

TYPICAL APPILCATION

Figure 1. Basic Application Circuit

ABSOLUTE MAXIMUM RATINGS (Note 1)

Parameter	Value	Unit
Input Supply Voltage, EN	-0.3~21	V
SW Voltages	-0.3~V_{IN}+0.3	V
FB Voltage	-0.3~6	V
BS Voltage	-0.6~25	V
Storage Temperature Range	-65~150	°C
Junction Temperature	160	°C
Power Dissipation (T_A=25°C) (Note2)	2	W
Lead Temperature (Soldering,10s)	260	°C

PACKAGE/ORDER INFORMATION

SOP8
STI3482
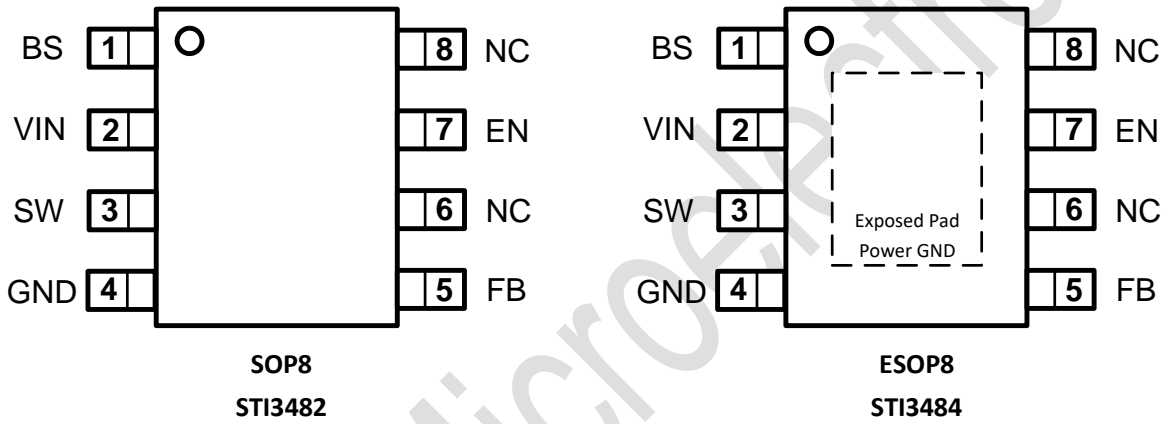
ESOP8
STI3484

Top Mark: S3482/YYXXX (S3482: Device Code, YYXXX: Inside Code)
Top Mark: S3484/YYXXX (S3484: Device Code, YYXXX: Inside Code)

Part Number	Package	Top mark	Quantity/ Reel
STI3482	SOP8	S3482 YYXXX	3000
STI3484	ESOP8	S3484 YYXXX	3000

STI3482 and STI3484 devices are Pb-free and RoHS compliant.

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PIN FUNCTIONS

Pin	Name	Function
1	BS	Bootstrap. A capacitor connected between SW and BS pins is required to form a floating supply across the high-side switch driver.
2	VIN	Power supply Pin
3	SW	Switching Pin
4	GND	Ground
5	FB	Output Voltage feedback input. Connect FB to the center point of the external resistor divider.
6	NC	No Connection
7	EN	Drive this pin to a logic-high to enable the IC. Drive to a logic-low to disable the IC and enter micro-power shutdown mode. Don't floating this pin.
8	NC	No Connection

ESD RATING

Items	Description	Value	Unit
V_{ESD}	Human Body Model for all pins	±2000	V

JEDEC specification JS-001

RECOMMENDED OPERATING CONDITIONS

Items	Description	Min	Max	Unit
Voltage Range	IN	3.5	18	V
T_J	Operating Junction Temperature	-40	125	°C

ELECTRICAL CHARACTERISTICS

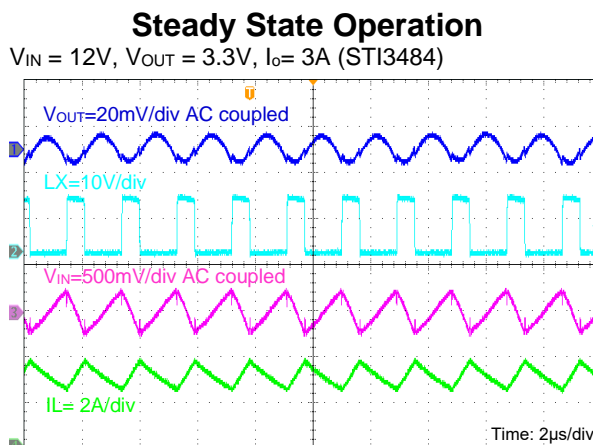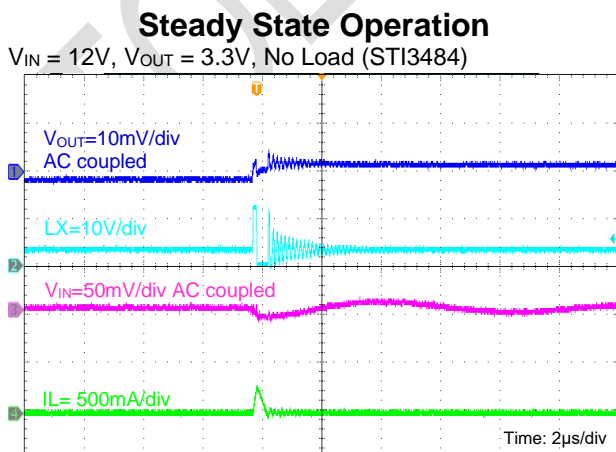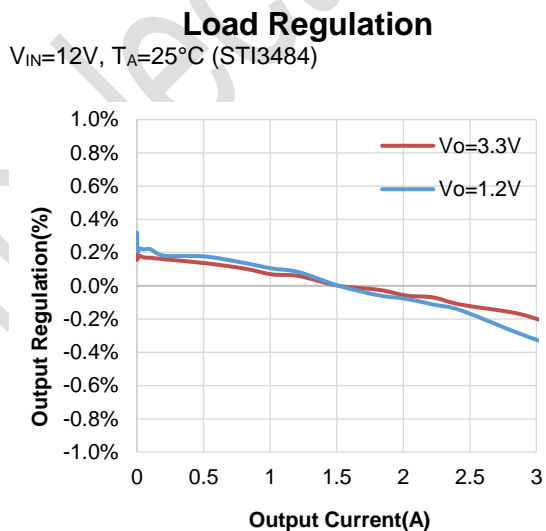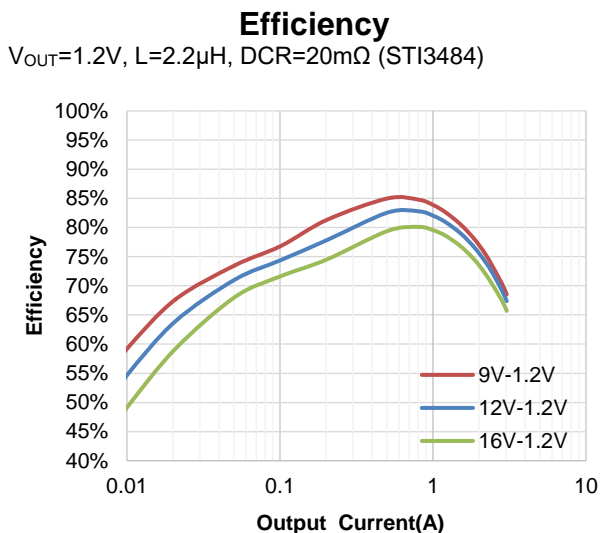**(V_{IN}=12V, V_{OUT}=5V, T_A = 25°C, unless otherwise noted.)**

Parameter	Conditions	Min	Typ	Max	Unit
Input Voltage Range		4.5		18	V
OVP Threshold			19		V
UVLO Threshold		3.0			V
Supply Current in Operation	V_{EN}=2.0V, V_{FB}=1.1V		400	600	µA
Supply Current in Shutdown	V_{EN} =0		2		µA
Regulated Feedback Voltage	T_A = 25°C,3.5V≤V_{IN} ≤18V	0.905	0.923	0.940	V
High-Side Switch On-Resistance			110		mΩ
Low-Side Switch On-Resistance			70		mΩ
High-Side Switch Leakage Current	V_{EN}=0V, V_{SW}=0V		0	10	µA
Upper Switch Current Limit	STI3482		3		A
	STI3484		4		A
Oscillation Frequency			500		kHz
Maximum Duty Cycle			95		%
EN High-Level Input Voltage		1.4			V
EN Low-Level Input Voltage				0.3	V
Minimum On-Time			80		ns
Thermal Shutdown Threshold (Note 3)			160		°C
Thermal Shutdown Hysteresis (Note 3)			30		°C

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = T_A + P_D \times \theta_{JA}$. The maximum allowable continuous power dissipation at any ambient temperature is calculated by $P_{D (MAX)} = (T_{J(MAX)}-T_A)/\theta_{JA}$.

Note 3: Thermal shutdown threshold and hysteresis are guaranteed by design.

Typical Performance Characteristics

Efficiency
V_OUT =3.3V, L=4.7μH, DCR=30mΩ (STI3484)

Efficiency
V_OUT =5V, L=4.7μH, DCR=30mΩ (STI3484)

Efficiency
V_OUT=1.2V, L=2.2μH, DCR=20mΩ (STI3484)
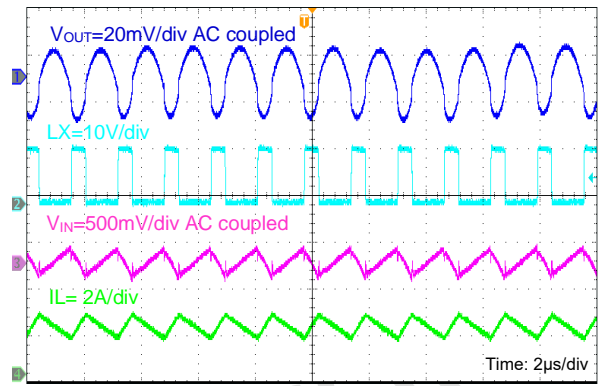

Load Regulation
V_IN=12V, T_A=25°C (STI3484)

Steady State Operation
V_IN = 12V, V_OUT = 3.3V, No Load (STI3484)

Steady State Operation
V_IN = 12V, V_OUT = 3.3V, I_o= 3A (STI3484)

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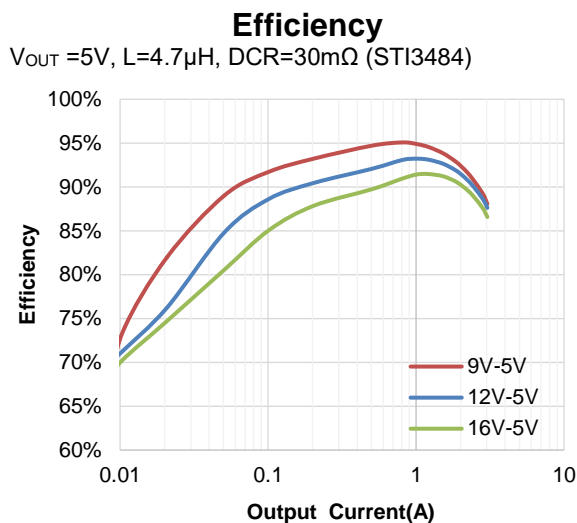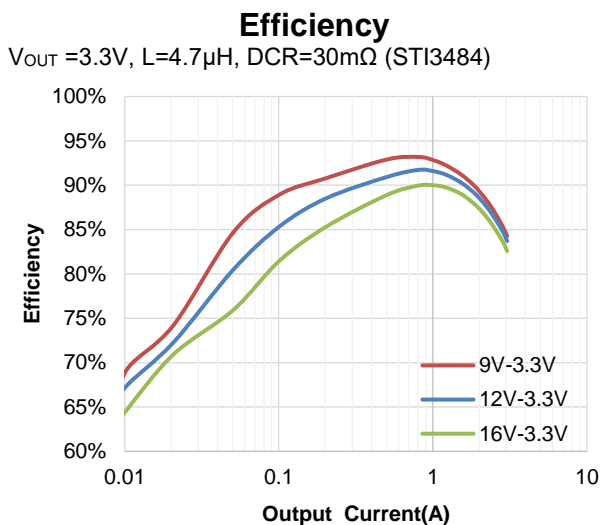
Typical Performance Characteristics(continued)

Steady State Operation
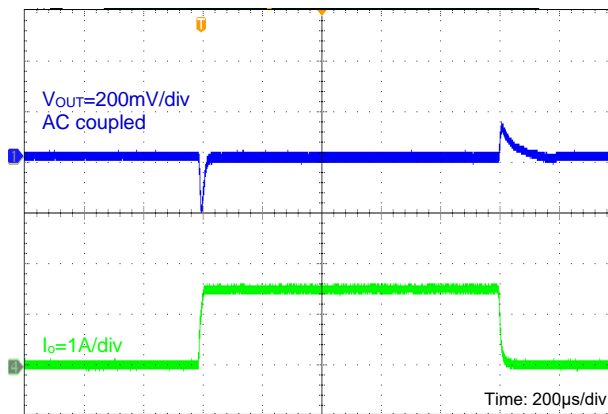V_{IN} = 12V, V_{OUT} = 3.3V, No Load(STI3482)
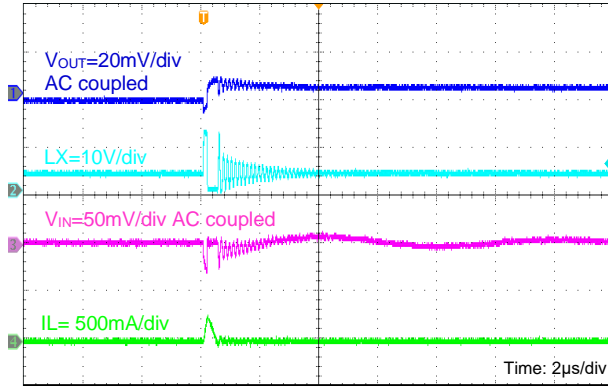
Steady State Operation
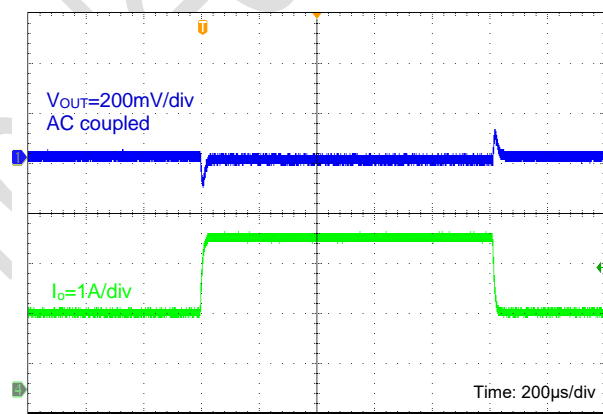V_{IN} = 12V, V_{OUT} = 3.3V, I_o= 2A(STI3482)

Load Transient
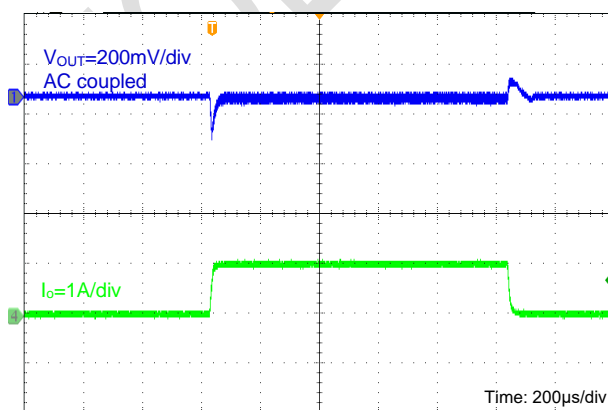V_{IN} = 12V, V_{OUT} = 3.3V, I_o = 0A to 1.5A(STI3484)

Load Transient
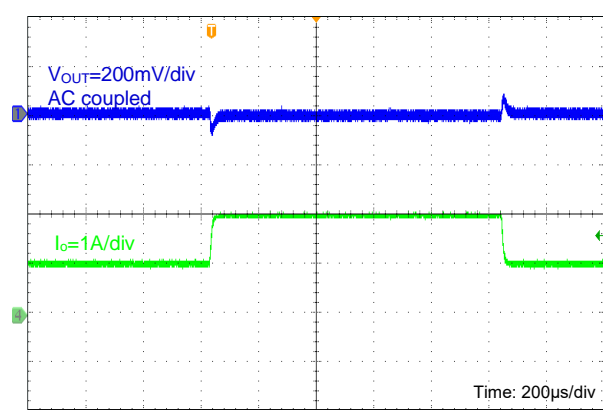V_{IN} = 12V, V_{OUT} = 3.3V, I_o = 1.5A to 3A(STI3484)

Load Transient
V_{IN} = 12V, V_{OUT} = 3.3V, I_o = 0A to 1A(STI3482)

Load Transient
V_{IN} = 12V, V_{OUT} = 3.3V, I_o = 1A to 2A(STI3482)

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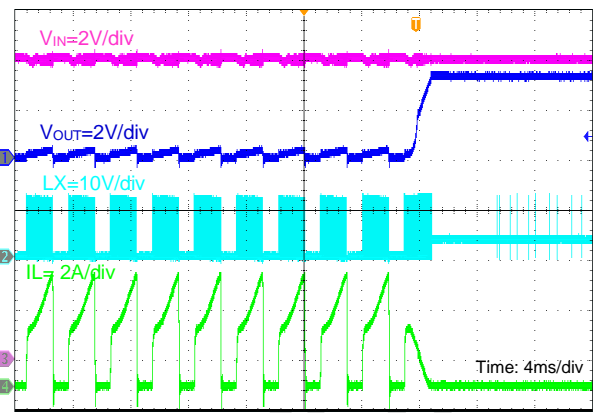## Typical Performance Characteristics(continued)

Output Short Entry
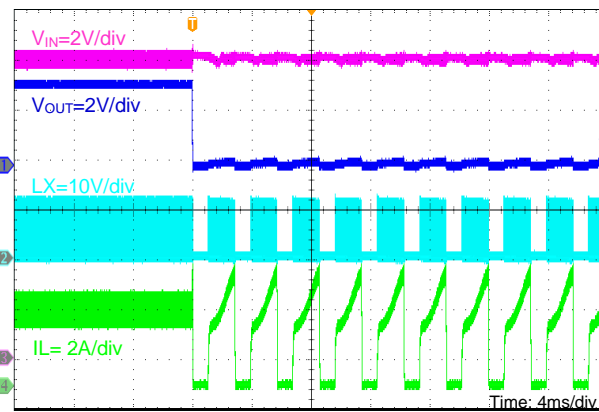V_{IN} =12V, V_{OUT} = 3.3V, No Load
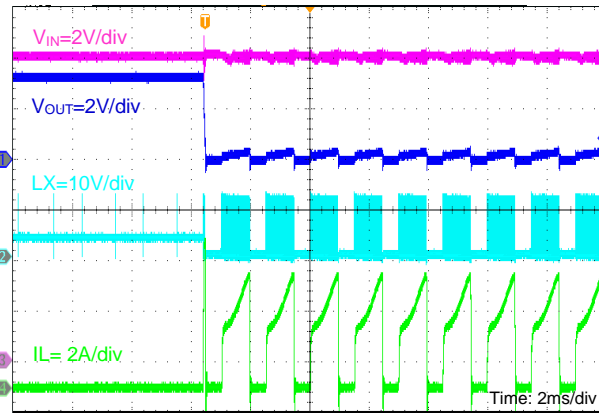
Output Short Recovery
V_{IN}=12V, V_{OUT} = 3.3V, No Load

Output Short Entry
V_{IN} =12V, V_{OUT} = 3.3V, I_o = 2A

Output Short Recovery
V_{IN}=12V, V_{OUT} = 3.3V, I_o = 2A
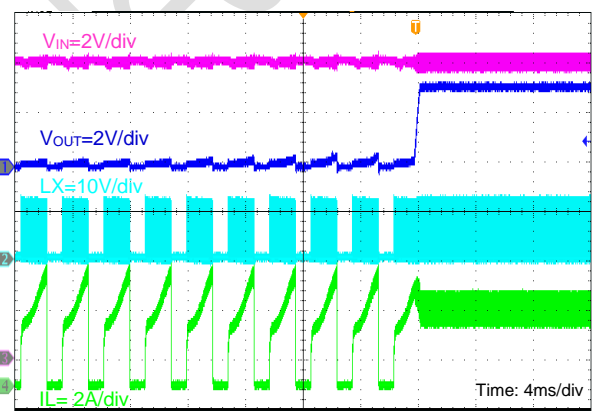
Input Power On
V_{IN} =12V, V_{OUT} = 3.3V, I_o = No Load
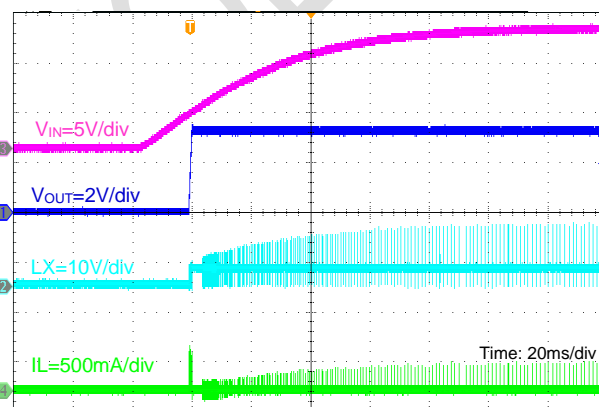
Input Power Down
V_{IN} =12V, V_{OUT} = 3.3V, I_o = No Load

Typical Performance Characteristics(continued)

EN Enable

V_{IN} =12V, V_{OUT} = 3.3V, I_o = 3A (STI3484)

EN=1V/div

V_{OUT}=2V/div

LX=10V/div

IL=2A/div

Time: 2ms/div

EN Disable

V_{IN} =12V, V_{OUT} = 3.3V, I_o = 3A(STI3484)

EN=1V/div

V_{OUT}=2V/div

LX=10V/div

IL=2A/div

Time: 20µs/div
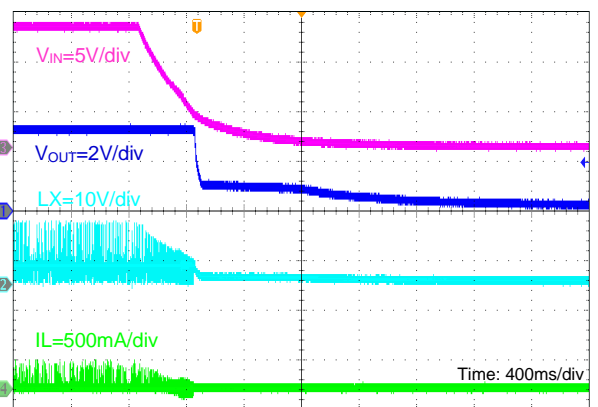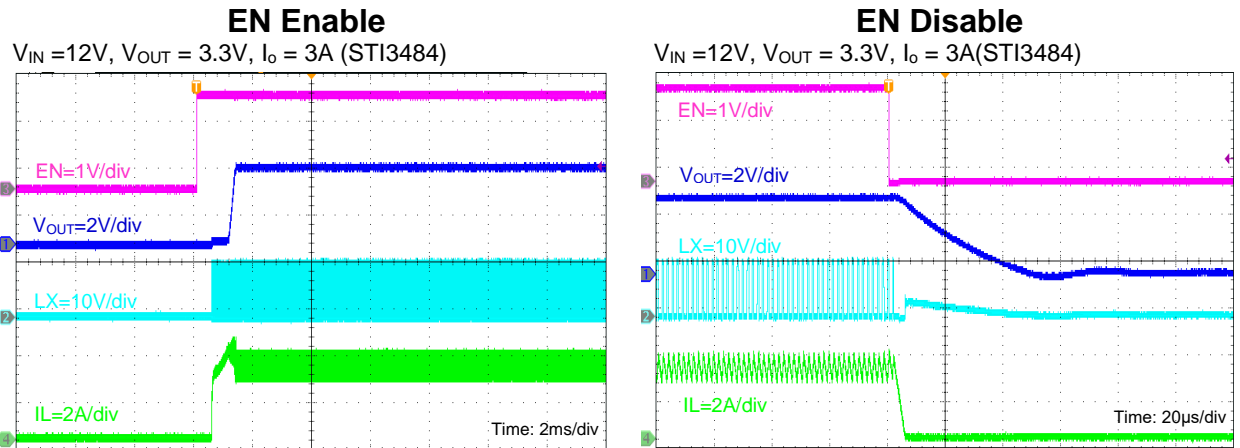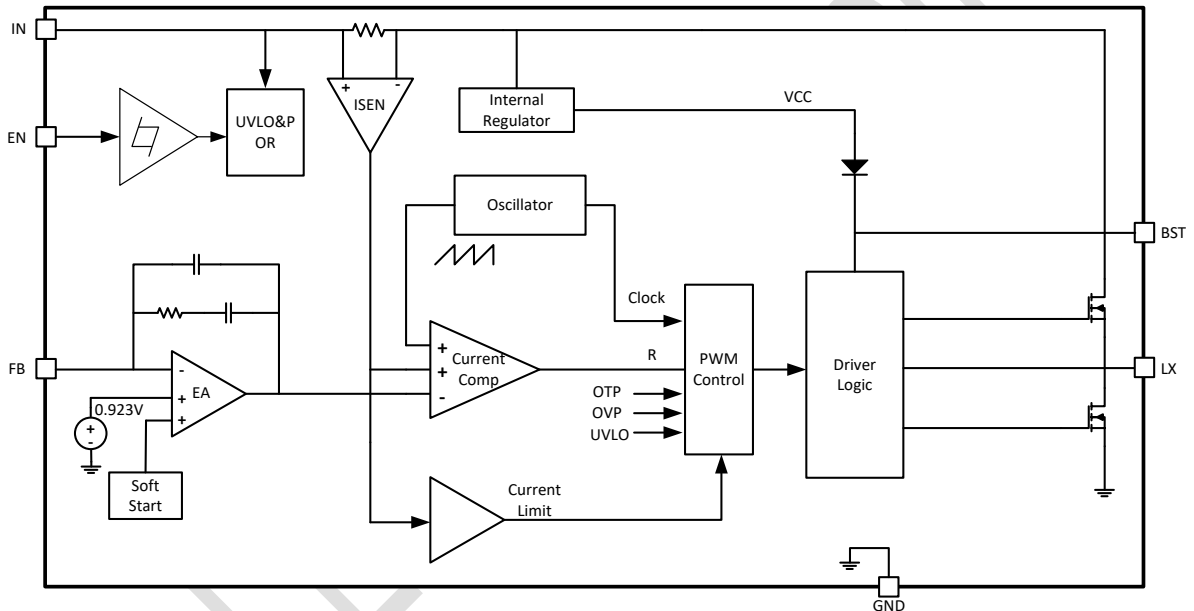
Block Diagram

Figure 1. STI3482 and STI3484 Block Diagram

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OPERATION DESCRIPTION

Internal Regulator

The STI3482 and STI3484 are current mode step down DC/DC converter that provides excellent transient response with no extra external compensation components. This device contains an internal, low resistance, high voltage power MOSFET, and operates at a high 500kHz operating frequency to ensure a compact, high efficiency design with excellent AC and DC performance.

Error Amplifier

The error amplifier compares the FB pin voltage with the internal FB reference (V_{FB}) and outputs a current proportional to the difference between the two. This output current is then used to charge or discharge the internal compensation network to form the COMP voltage, which is used to control the power MOSFET current. The optimized internal compensation network minimizes the external component counts and simplifies the control loop design.

Internal Soft-Start

The soft-start is implemented to prevent the converter output voltage from overshooting during startup. When the chip starts, the internal circuitry generates a soft-start voltage (SS) ramping up from 0V to 0.923V. When it is lower than the internal reference (REF), SS overrides REF so the error amplifier uses SS as the reference. When SS is higher than REF, REF regains control. The SS time is internally fixed to 1ms.

Over-Current-Protection and Hiccup

The STI3482 and STI3484 have cycle-by-cycle over current limit when the inductor current peak value exceeds the set current limit threshold. Meanwhile, output voltage starts to drop until FB is below the Under-Voltage (UV) threshold, typically 30% below the reference. Once a UV is triggered, the STI3482 and STI3484 enter hiccup mode to periodically restart the part. This protection mode is especially useful when the output is dead-short to ground. The average short circuit current is greatly reduced to alleviate the thermal issue and to protect the regulator. The STI3482 and STI3484 exit the hiccup mode once the over current condition is removed.

Startup and Shutdown

If both VIN and EN are higher than their appropriate thresholds, the chip starts. The reference block starts first, generating stable reference voltage and currents, and then the internal regulator is enabled. The regulator provides stable supply for the remaining circuitries. Three events can shut down the chip: EN low, VIN low and thermal shutdown. In the shutdown procedure, the signaling path is first blocked to avoid any fault triggering. The COMP voltage and the internal supply rail are then pulled down. The floating driver is not subject to this shutdown command.

APPLICATION INFORMATION

Setting the Output Voltage

The external resistor divider is used to set the output voltage (see Typical Application on page 1). The feedback resistor R1 also sets the feedback loop bandwidth with the internal compensation capacitor. Choose R1 to be around 75kΩ for optimal transient response. R2 is then given by:

$$R_2 = \frac{R_1}{V_{out}/V_{FB} - 1}$$

Use a T-type network for when V_{OUT} is low.

V_{OUT}	R1(kΩ)	R2(kΩ)
5.0V	75	16.9
3.3V	75	29.4
2.5V	75	43.2
1.8V	75	78.7

Inductor Selection

A DC current rating of at least 25% percent higher than the maximum load current is recommended for most applications. Inductance value is related to inductor ripple current value, input voltage, output voltage setting and switching frequency. The inductor value can be derived from the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

Where ΔI_L is inductor ripple current. Large value inductors result in lower ripple current and small value inductors result in high ripple current, so inductor value has effect on output voltage ripple value. DC resistance of inductor which has impact on efficiency of DC/DC converter should be taken into account when selecting the inductor. The maximum inductor peak current is:

$$I_{L(MAX)} = I_{LOAD} + \frac{\Delta I_L}{2}$$

Under light load conditions below 100mA, larger inductance is recommended for improved efficiency.

Output Capacitor Selection

The output capacitor (C_{OUT}) is required to maintain the DC output voltage. Ceramic, tantalum, or low ESR electrolytic capacitors are recommended. Low ESR capacitors are preferred to keep the output voltage ripple low. The output voltage ripple can be estimated by:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_S \times L} \times \left[1 - \frac{V_{OUT}}{V_{IN}}\right] \times \left[R_{ESR} + \frac{1}{8 \times f_S \times C_2}\right]$$

Where L is the inductor value and R_{ESR} is the equivalent series resistance (ESR) value of the output capacitor. In the case of ceramic capacitors, the impedance at the switching frequency is dominated by the capacitance. The output voltage ripple is mainly caused by the capacitance. For simplification, the output voltage ripple can be estimated by:

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$$\Delta V_{OUT} = \frac{V_{OUT}}{8 \times f_S^2 \times L \times C_2} \times \left[1 - \frac{V_{OUT}}{V_{IN}}\right]$$

In the case of tantalum or electrolytic capacitors, the ESR dominates the impedance at the switching frequency. For simplification, the output ripple can be approximated to:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_S \times L} \times \left[1 - \frac{V_{OUT}}{V_{IN}}\right] \times R_{ESR}$$

The characteristics of the output capacitor also affect the stability of the regulation system. The TMI3482H can be optimized for a wide range of capacitance and ESR values.

Layout Consideration

PCB layout is very important to achieve stable operation. please follow these guidelines for reference.
1) Keep the path of switching current short and minimize the loop area formed by Input capacitor, high-side MOSFET and low-side MOSFET.
2) Bypass ceramic capacitors are suggested to be put close to the IN Pin.
3) Ensure all feedback connections are short and direct. Place the feedback resistors as close to the chip as possible.
4) VOUT, SW away from sensitive analog areas such as FB.
5) Connect VIN, SW, and especially GND respectively to a large copper area to cool the chip to improve thermal performance and long-term reliability.
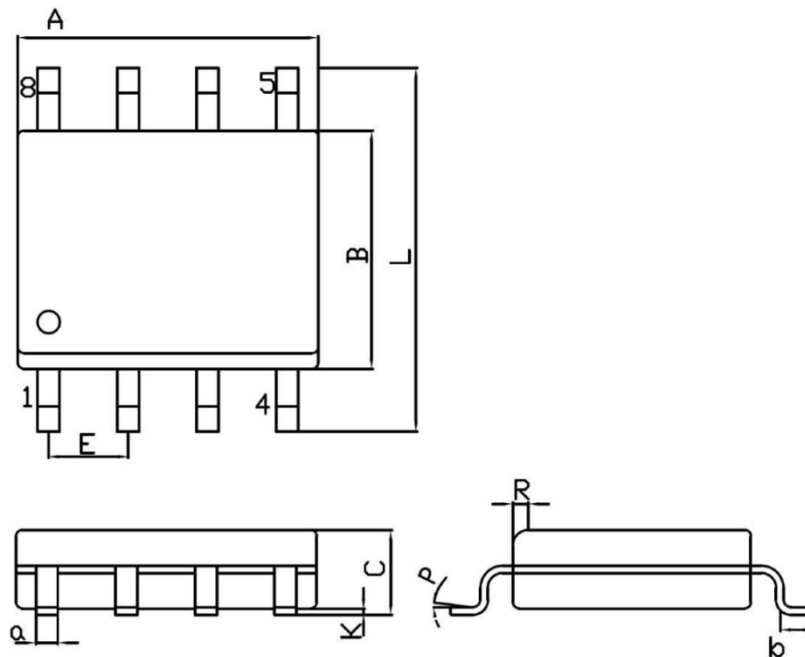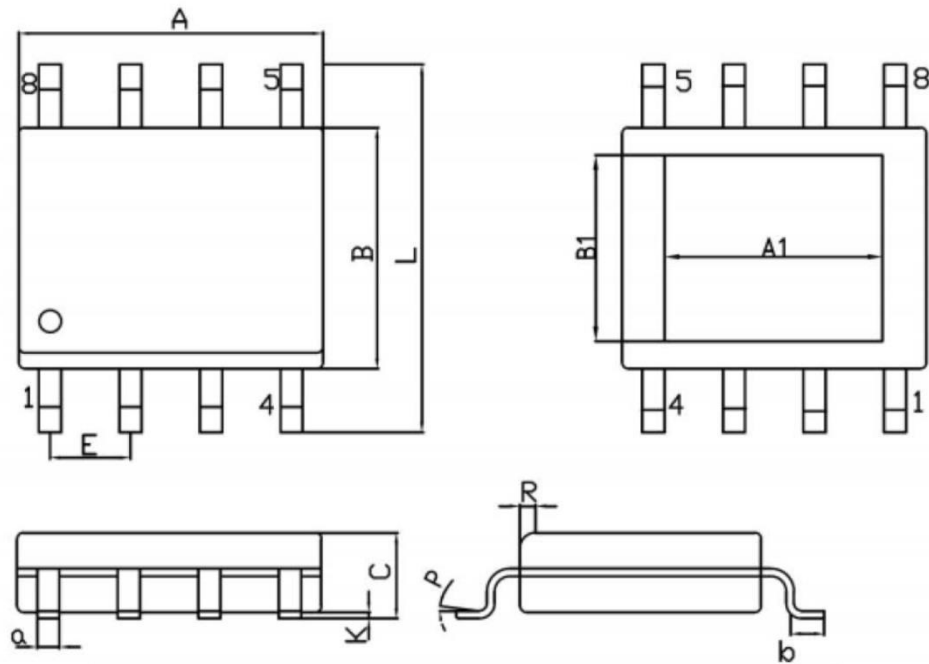
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PACKAGE INFORMATION

SOP8

Unit: mm

Symbol	Dimensions In Millimeters		Symbol	Dimensions In Millimeters	
	Min	Max		Min	Max
A	4.70	5.10	C	1.35	1.75
B	3.70	4.10	a	0.35	0.49
L	6.00	6.40	R	0.30	0.60
E	1.27 BSC		P	0°	7°
K	0.12	0.22	b	0.40	1.25

Note:

1) All dimensions are in millimeters.

2) Package length does not include mold flash, protrusion or gate burr.

3) Package width does not include inter lead flash or protrusion.

4) Lead popularity (bottom of leads after forming) shall be 0.10 millimeters max.

5) Pin 1 is lower left pin when reading top mark from left to right.

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PACKAGE INFORMATION

ESOP8

Unit: mm

Symbol	Dimensions In Millimeters		Symbol	Dimensions In Millimeters	
	Min	Max		Min	Max
A	4.70	5.10	C	1.35	1.75
B	3.70	4.10	a	0.35	0.49
L	6.00	6.40	R	0.30	0.60
E	1.27 BSC		P	0°	7°
K	0.02	0.10	b	0.40	1.25
A1	3.1	3.5	B1	2.2	2.6

Note:
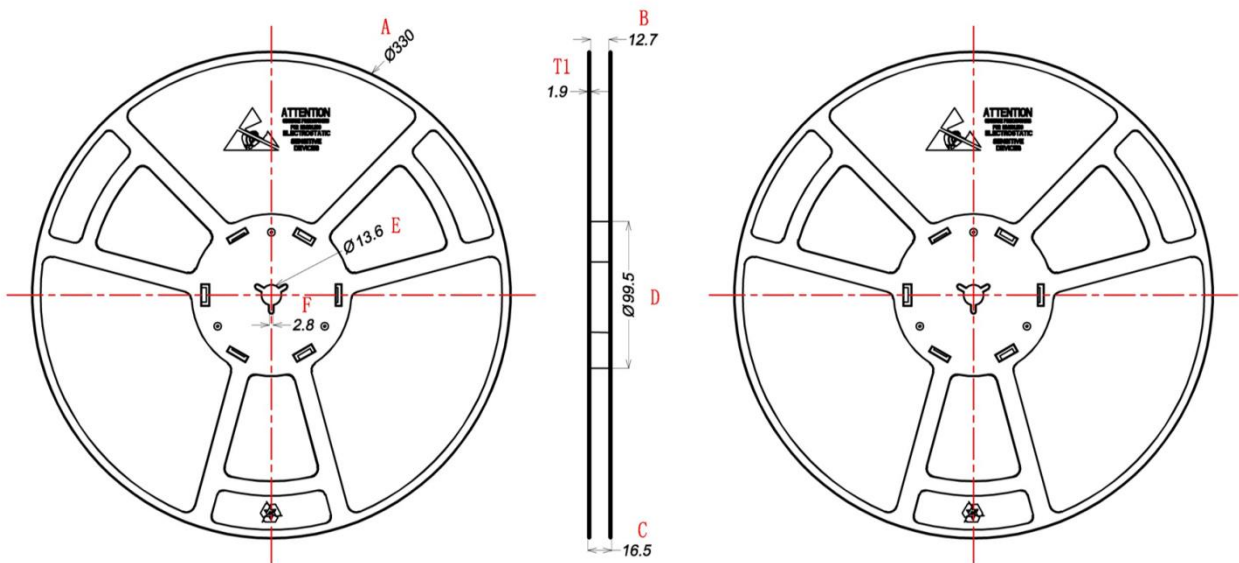
1) All dimensions are in millimeters.

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3) Package width does not include inter lead flash or protrusion.

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5) Pin 1 is lower left pin when reading top mark from left to right.

STI3482
STI3484

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TAPE AND REEL INFORMATION

TAPE DIMENSIONS: SOP8

Direction of feed →
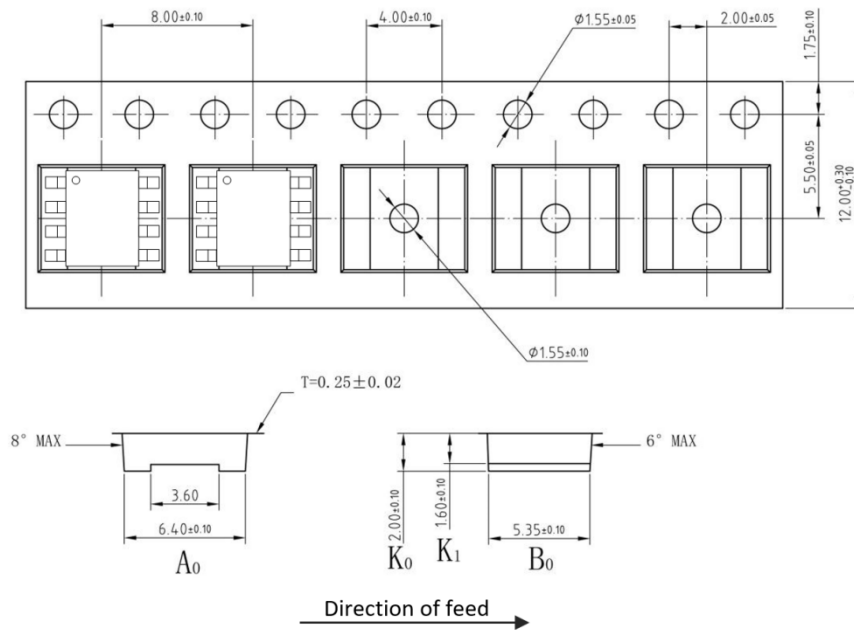
REEL DIMENSIONS: SOP8

Unit: mm

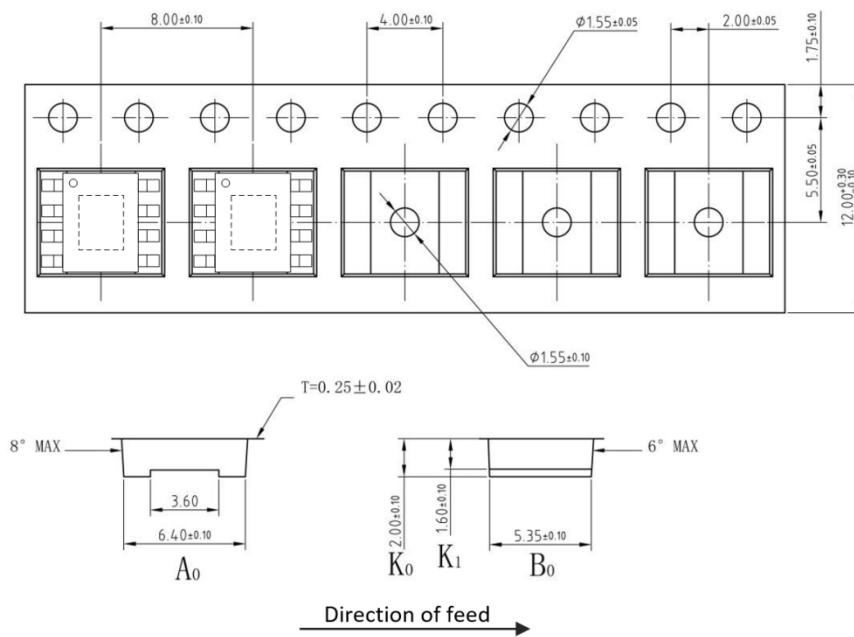| A	B	C	D	E	F	T1
Ø 330±1	12.7±0.5	16.5±0.3	Ø 99.5±0.5	Ø 13.6±0.2	2.8±0.2	1.9±0.2

Note:

1) All Dimensions are in Millimeter

2) Quantity of Units per Reel is 3000

3) MSL level is level 3.

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TAPE AND REEL INFORMATION

TAPE DIMENSIONS: ESOP8

Direction of feed

REEL DIMENSIONS: ESOP8
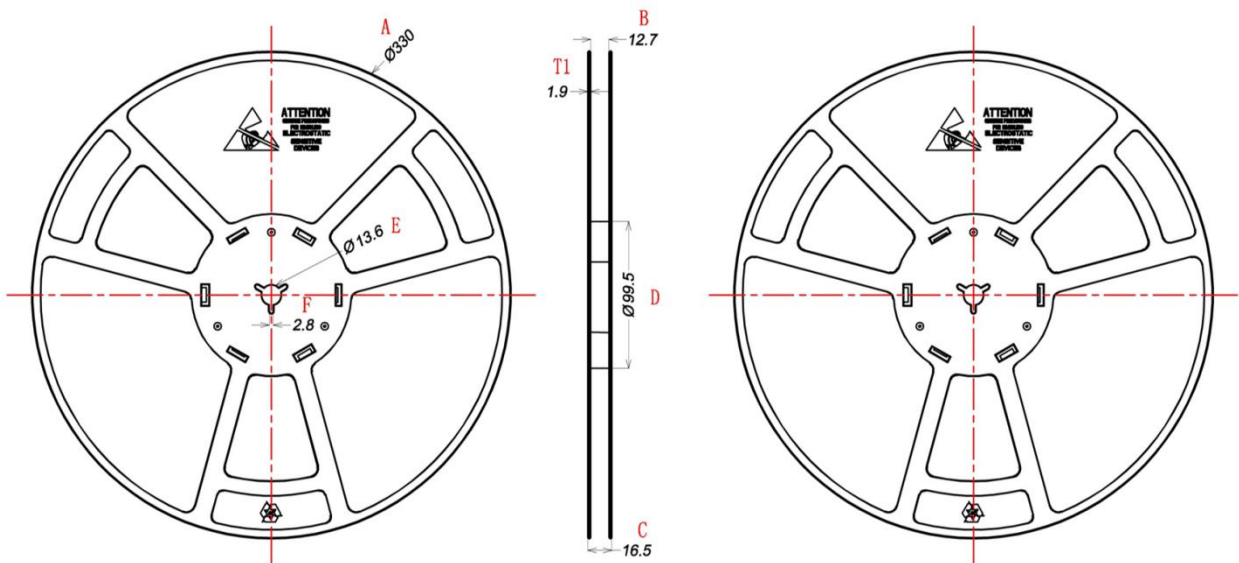
Unit: mm

A	B	C	D	E	F	T1
Ø 330±1	12.7±0.5	16.5±0.3	Ø 99.5±0.5	Ø 13.6±0.2	2.8±0.2	1.9±0.2

Note:

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