

Phase-Cut Dimmable Flyback or Buck-Boost Current Control with Active PFC for LED lighting

DESCRIPTION

The TS19320CS is a phase-cut (TRIAC) dimmable constant current control IC with active power factor correction isolated or non-isolated AC-DC LED lighting control. The TS19320CS is configurable as an isolated, primary-side-regulated Flyback controller or non-isolated Buck-Boost converter. It is compatible with many types of TRIAC dimmers including leading-edge and trailing-edge. The IC achieves a high power factor and low total harmonic distortion (THD) and guarantees constant current accuracy to $\pm 5\%$ using Boundary Conduction Mode (BCM) operation. The TS19320CS has built-in protection circuits such as gate voltage clamping, over temperature protection by current degeneration, V_{CC} overvoltage protection and system output open/short circuit protection.

FEATURES

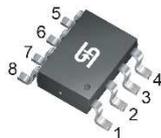
- Constant current accuracy $< \pm 5\%$
- Flyback or Buck-Boost w/o photocoupler
- Good dimmer compatibility for 120/230V_{AC} Lamps
- Boundary-mode PFC operation
- Built-in active power factor correction
- High voltage (500V) startup circuit
- Open-LED demagnetization (DMG) protection
- V_{CC} over-voltage protection (OVP)
- Over-temperature protection (OTP)
- Shorted-LED Protection
- Cycle-by-cycle current limit
- Gate drive voltage clamping
- Compliant to RoHS Directive 2011/65/EU and in accordance to WEEE 2002/96/EC.
- Halogen-free according to IEC 61249-2-21

APPLICATION

- LED lighting
- Down lights, Tube lamps, PAR Lamps, Bulbs



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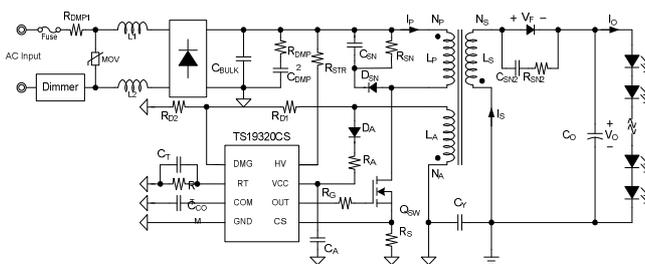


Pin Definition:

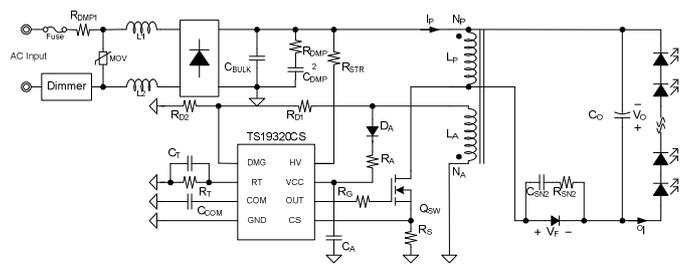
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|--------|-------------|
| 1. HV | 8. GND |
| 2. RT | 7. OUT |
| 3. CS | 6. V_{CC} |
| 4. COM | 5. DMG |

Notes: MSL 3 (Moisture Sensitivity Level) per J-STD-020

TYPICAL APPLICATION CIRCUIT



Flyback Converter



Buck-Boost Converter

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$ unless otherwise specified) ^(Note 1)			
PARAMETER	SYMBOL	LIMIT	UNIT
HV Pin Voltage to GND	V_{HV}	600	V
Power Supply Pin	V_{CC}	40	V
DMG voltage to GND	V_{DMG}	-0.3 to 40	V
OUT voltage to GND	V_{OUT}	-0.3 to 40	V
RT voltage to GND	V_{CS}	-0.3 to 5.5	V
CS voltage to GND	V_{CS}	-0.3 to 5.5	V
COM voltage to GND	V_{COM}	-0.3 to 5.5	V
Junction Temperature Range	T_J	-40 to +150	$^\circ\text{C}$
Storage Temperature Range	T_{STG}	-65 to +150	$^\circ\text{C}$
Lead Temperature (Soldering 10 sec)	T_{LEAD}	260	$^\circ\text{C}$
Power Dissipation @ $T_A=50^\circ\text{C}$	P_D	0.4	W
ESD Rating (Human Body Mode) ^(Note 2)	HBM	2	kV
ESD Rating (Machine Mode) ^(Note 2)	MM	200	V

THERMAL PERFORMANCE ^(Note 3)			
PARAMETER	SYMBOL	LIMIT	UNIT
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	160	$^\circ\text{C/W}$

RECOMMENDED OPERATING CONDITION ($T_A = 25^\circ\text{C}$ unless otherwise specified) ^(Note 4)			
PARAMETER	SYMBOL	LIMIT	UNIT
HV Pin Voltage to GND	V_{HV}	-0.3 to 450	V
Power Supply Pin	V_{CC}	33	V
DMG voltage to GND	V_{DMG}	-0.3 to 10	V
OUT voltage to GND	V_{OUT}	-0.3 to 13	V
RT voltage to GND	V_{CS}	-0.3 to 5	V
CS voltage to GND	V_{CS}	-0.3 to 5	V
COM voltage to GND	V_{COM}	-0.3 to 5	V
Operating Junction Temperature Range	T_J	-40 to +150	$^\circ\text{C}$
Operating Ambient Temperature Range	T_{OPA}	-40 to +85	$^\circ\text{C}$

ELECTRICAL SPECIFICATIONS ($T_A = 25^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Supply Voltage						
Supply current from HV pin	I_{HV}	$V_{DC}=120V$ $10\mu F@V_{CC}$ Pin	--	2.4	--	mA
Turn-on Voltage	V_{CC_ON}		14.3	15.3	16.3	V
Turn-off Voltage	V_{CC_OFF}		7.3	7.8	8.3	V
Quiescent Current 1	I_{Q1}	$V_{CC}=12V, @ V_{CC}$ off	--	68	100	μA
Quiescent Current 2	I_{Q2}	Start-up @ 4.5kHz	--	570	770	μA
Operation Supply Current	I_{CC}		--	1.5	2.5	mA
Protection						
V_{CC} voltage protection	V_{OVPA}		32	33.5	35	V
Output voltage protection	V_{OVPS}		9.5	10	10.5	V
CS limit voltage	V_{OCP}		1.2	1.3	1.4	V
CS limit voltage (start-up)	V_{OCP_STR}		--	0.4	--	V
Short circuit protection ^(Note 5)	V_{SCP}		--	3.0	--	V
Oscillator						
Maximum on Time	t_{ON_MAX}		14	15	16	μs
GM Amplifier						
Internal reference voltage	V_{REF}		362.6	370	377.4	mV
Transconductance	G_m		--	95	--	$\mu A/V$
Sink Current	I_{COMP_SINK}		--	32	--	μA
Source Current	I_{COMP_SOU}		--	32	--	μA
Driver						
Dropout voltage	V_{OH}	$I_o = 10mA$	--	0.68	--	V
	V_{OL}	$I_o = -10mA$	--	0.18	--	V
Rise time	t_r	$V_{CC}=20V, C_o = 1nF$	--	60	--	ns
Fall time	t_f	$V_{CC}=20V, C_o = 1nF$	--	80	--	ns
Output clamp voltage	V_{O_CLAMP}		--	13	15	V
Leading edge blanking time ^(Note 5)	LEB_t		--	0.5	--	ns
Thermal Section ^(Note 5, 6)						
Thermal Shutdown			--	120	--	$^\circ C$

Note:

- Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
- Devices are ESD sensitive. Handling precautions are recommended.
- Thermal resistance is specified with the component mounted on a test board in free air with low effective thermal conductivity at $T_A=25^\circ C$.
- The device is not guaranteed to function outside its operating conditions.
- Guaranteed by design.
- Linear degeneration type.

CHARACTERISTICS CURVES

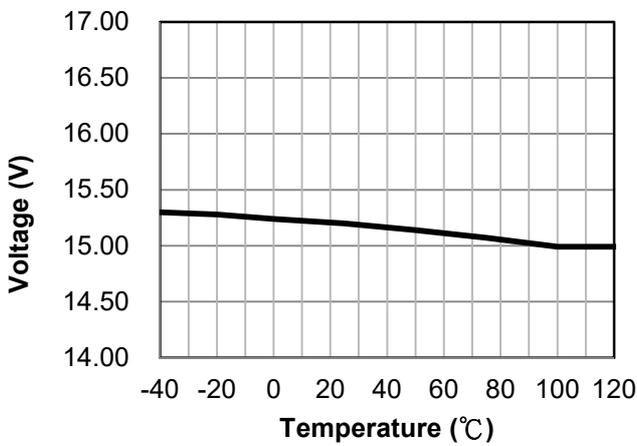


Figure 1 - V_{CC_ON} vs. Junction Temperature

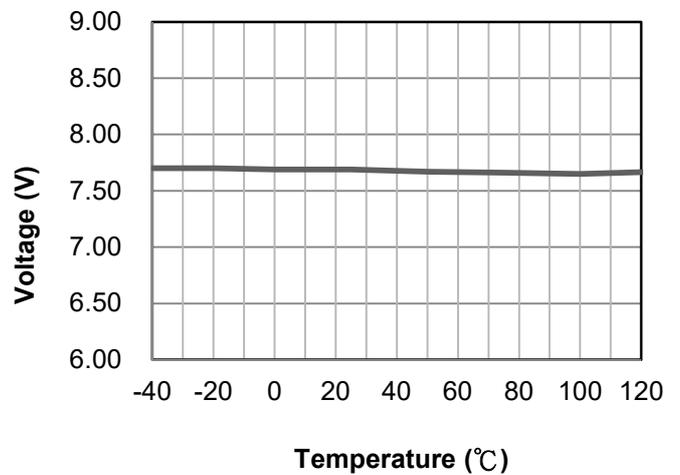


Figure 2 - V_{CC_OFF} vs. Junction Temperature

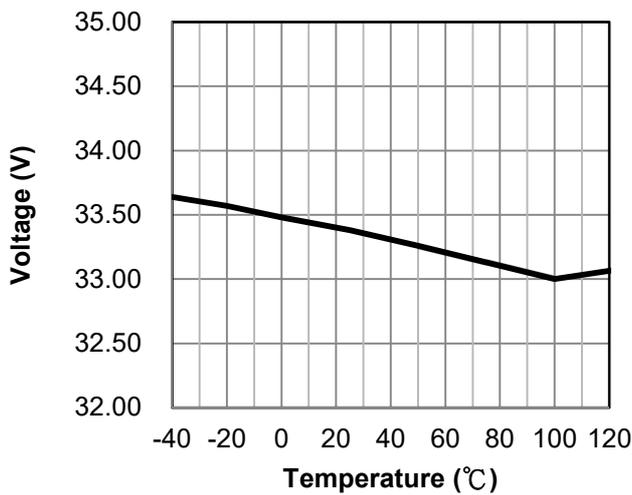


Figure 3 - V_{OVPA} vs. Junction Temperature

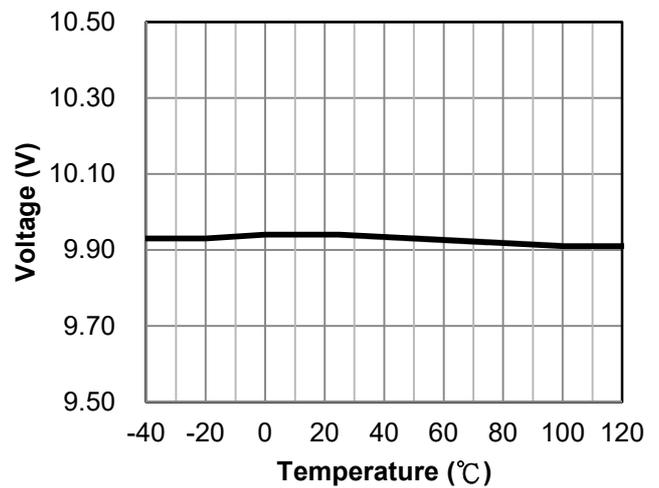


Figure 4 - V_{OVPS} vs. Junction Temperature

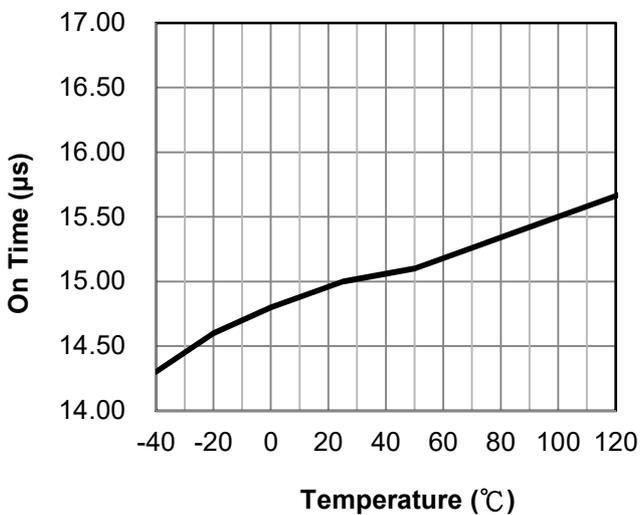


Figure 5 - T_{ON_MAX} vs. Junction Temperature

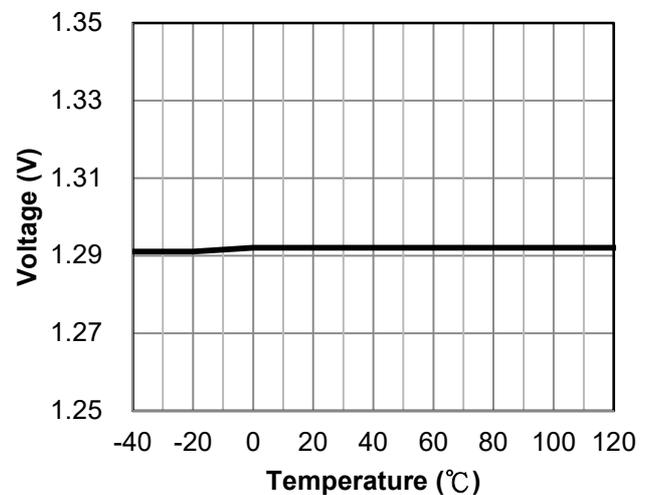


Figure 6 - V_{OVCP} vs. Junction Temperature

APPLICATION INFORMATION

PSR Function Description

As a constant current primary-side controller with phase-cut dimmable and PFC function for LED lighting applications, the controller operates in boundary conduction mode (BCM) with constant on-time based regulation designed to achieve high power factor performance. The TS19320 has built-in high voltage (500V) startup circuit, V_{CC} over voltage protection, open LED protection, short LED protection, over temperature protection, primary-side current limit, and gate clamp function.

The average output current can be expressed as below.

$$I_{OUT_avg} = \frac{N_P}{N_S} \times \frac{0.370 * \eta}{2 \times R_S}$$

Where:

- I_{OUT_avg} is the average output current
- N_P is the primary-side turn ratio
- N_S is the secondary-side turn ratio
- η is the efficiency
- R_S is the sensing resistor connected between the MOSFET source and the GND

Pin Definitions

HV Pin

Connect this pin to positive terminal of bulk capacitor to provide the startup current for the controller during V_{CC_ON} trigger on before.

RT Pin

This pin is to program the maximum on time by connecting a resistor to ground. Reference formula as below.

$$T_{ON} = \frac{14\mu}{300k} \times (R_T - 100k) + 1\mu$$

CS Pin

MOSFET current signal sensing for multiplication and current limit setting function.

$$I_{CS(LIMIT)} = \frac{1.3}{R_S}$$

Where:

- $I_{CS(LIMIT)}$ is the input current sense
- R_S is the sensing resistor connected between the MOSFET source and GND

COM Pin

This is the output of the g_m amplifier. Connect with a suitable RC network to ground.

V_{CC} Pin

Power supply for the controller during normal operation. The controller will start up when V_{CC} reaches 15.3V (typical) and will shut-down when V_{CC} voltage is below 7.8V (typical). A decoupling capacitor should be connected between the V_{CC} and GND pin as close as possible.

The TS19320 performs V_{CC} over voltage protection though V_{CC} pin. Once V_{CC} pin exceeds in 33.5V, TS19320 turns off and latches out the MOSFET switcher until V_{CC} goes below V_{CC_OFF} .

APPLICATION INFORMATION

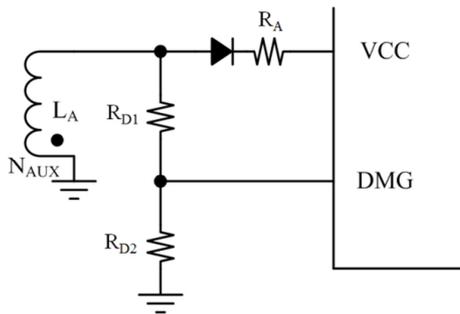
Pin Definitions (Continue)

DMG

The Output voltage is reflected by the auxiliary winding (N_{AUX}) voltage of fly-back transformer, the DMG pin can sense output information to depart from start up voltage (V_{O_STR}) and protect voltage (V_{O_OVP}).

When the DMG sense voltage under V_{O_STR} , the circuit will work on short circuit protection, $f_{STR}=1/t_{STR}$.

When the DMG sense voltage over V_{O_OVP} , the circuit will work on over voltage protection, it will latch out until V_{CC} goes below V_{CC_OFF} .



$$V_{O_OVP} = \frac{N_{SEC}}{N_{AUX}} \times V_{OVPS} \times \frac{R_{D1} + R_{D2}}{R_{D2}}$$

$$V_{O_STR} = \frac{N_{SEC}}{N_{AUX}} \times 3 \times \frac{R_{D1} + R_{D2}}{R_{D2}}$$

Where :

- V_{OUT_OVP} is the output-over-voltage protection point
- V_{OVPS} is the over voltage protection signal
- V_{O_STR} is the start-up timer
- N_{AUX} is the number of auxiliary-winding turns
- N_{SEC} is the number of secondary-winding turns

OUT Pin

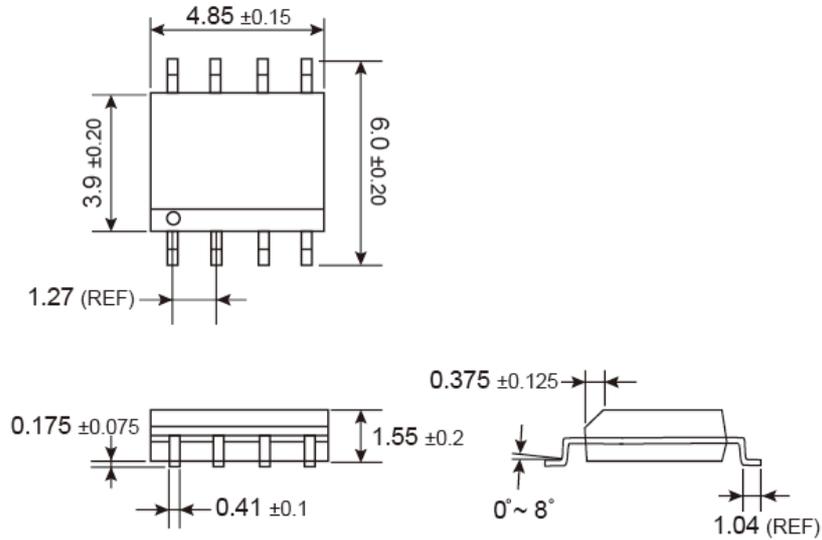
Gate drive for external MOSFET switch and is built-in gate clamp function.

GND Pin

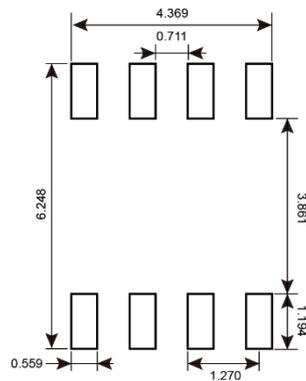
GND is the reference node of internal circuit.

PACKAGE OUTLINE DIMENSIONS (Unit: Millimeters)

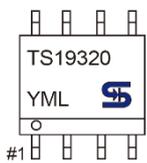
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SUGGESTED PAD LAYOUT (Unit: Millimeters)



MARKING DIAGRAM



- Y** = Year Code
- M** = Month Code for Halogen Free Product
 - O** =Jan **P** =Feb **Q** =Mar **R** =Apr
 - S** =May **T** =Jun **U** =Jul **V** =Aug
 - W** =Sep **X** =Oct **Y** =Nov **Z** =Dec
- L** = Lot Code (1~9, A~Z)

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