

## 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

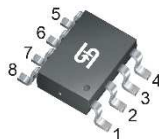
- Constant current accuracy  $< \pm 5\%$
- Flyback or Buck-Boost w/o photocoupler
- Good dimmer compatibility for 120/230V<sub>AC</sub> Lamps
- Boundary-mode PFC operation
- Built-in active power factor correction
- High voltage (500V) startup circuit
- Open-LED demagnetization (DMG) protection
- $V_{CC}$  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



**SOP-8**

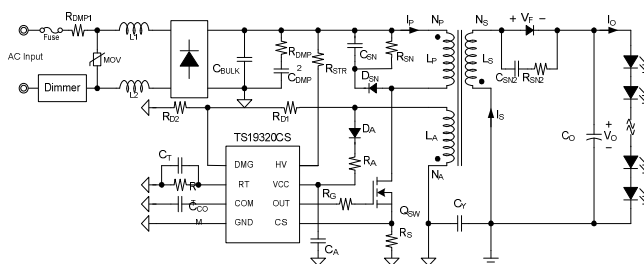


#### Pin Definition:

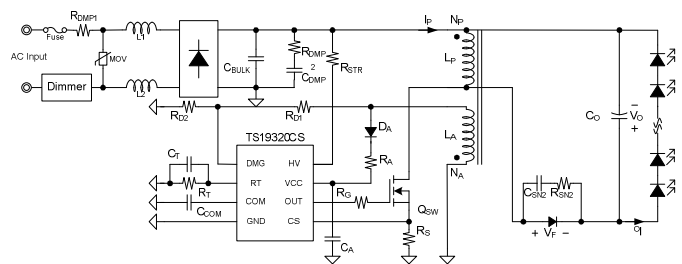
- |        |             |
|--------|-------------|
| 1. HV  | 8. GND      |
| 2. RT  | 7. OUT      |
| 3. CS  | 6. $V_{CC}$ |
| 4. COM | 5. DMG      |

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

### TYPICAL APPLICATION CIRCUIT



**Flyback Converter**



**Buck-Boost Converter**

<b>ABSOLUTE MAXIMUM RATINGS</b> ( $T_A = 25^\circ\text{C}$ 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

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

<b>RECOMMENDED OPERATING CONDITION</b> ( $T_A = 25^\circ\text{C}$ 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	$^\circ\text{C}$

<b>ELECTRICAL SPECIFICATIONS</b> ( $T_A = 25^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
<b>Supply Voltage</b>						
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	$\mu A$
Quiescent Current 2	$I_{Q2}$	Start-up @ 4.5kHz	--	570	770	$\mu A$
Operation Supply Current	$I_{CC}$		--	1.5	2.5	mA
<b>Protection</b>						
$V_{CC}$ 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
<b>Oscillator</b>						
Maximum on Time	$t_{ON\_MAX}$		14	15	16	$\mu s$
<b>GM Amplifier</b>						
Internal reference voltage	$V_{REF}$		362.6	370	377.4	mV
Transconductance	$G_m$		--	95	--	$\mu A/V$
Sink Current	$I_{COMP\_SINK}$		--	32	--	$\mu A$
Source Current	$I_{COMP\_SOU}$		--	32	--	$\mu A$
<b>Driver</b>						
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
<b>Thermal Section</b> (Note 5, 6)						
Thermal Shutdown			--	120	--	$^\circ C$

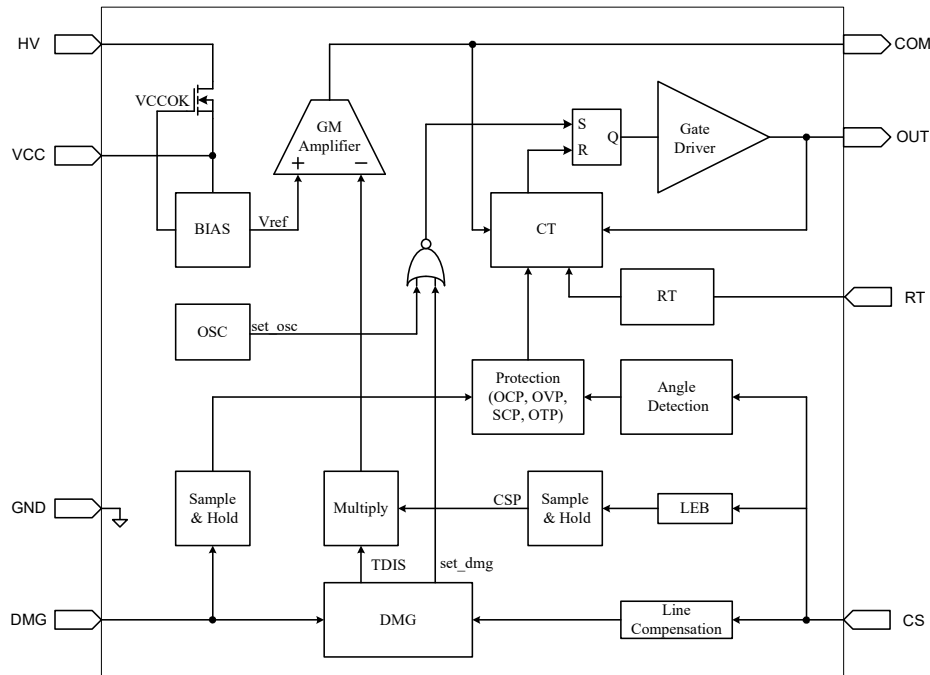
**Note:**

- 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.

## ORDERING INFORMATION

PART NO.	PACKAGE	PACKING
TS19320CS RLG	SOP-8	2,500pcs / 13"Reel

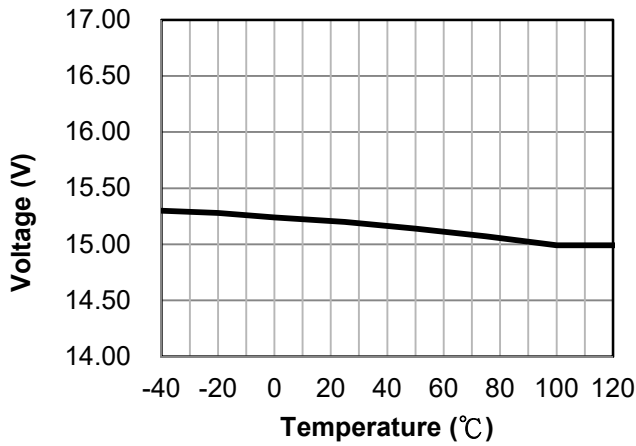
## FUNCTION BLOCK



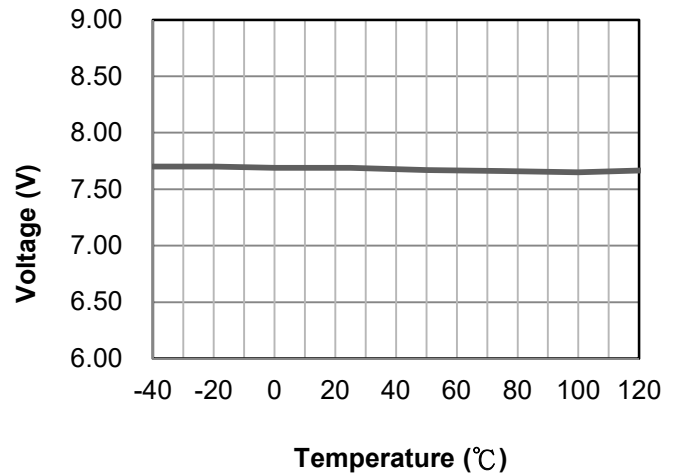
## PIN DESCRIPTION

PIN NO.	NAME	FUNCTION
1	HV	Pull high to line voltage for startup
2	RT	Maximum on time setting
3	CS	Input current sense pin.
4	COM	Output pin of error amplifier.
5	DMG	Zero current demagnetization sensing.
6	V <sub>CC</sub>	Power supply pin for all internal circuitry.
7	OUT	Power MOS output pin.
8	GND	Ground return for all internal circuitry.

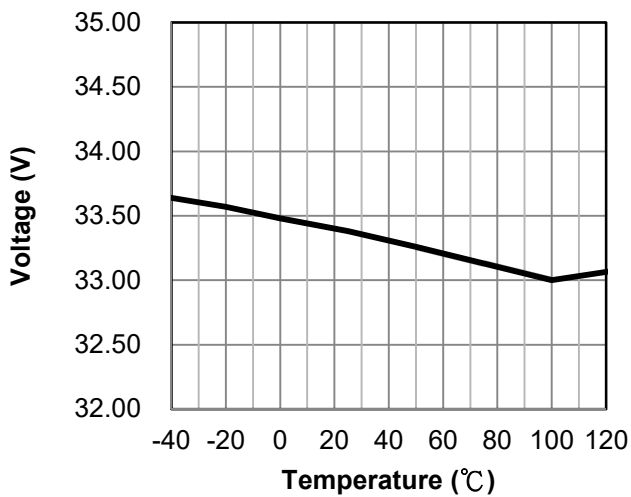
## CHARACTERISTICS CURVES



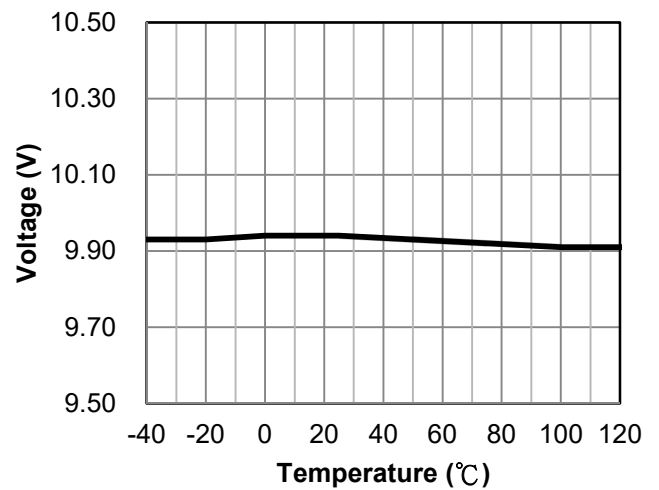
**Figure 1 - V<sub>CC\_ON</sub> vs. Junction Temperature**



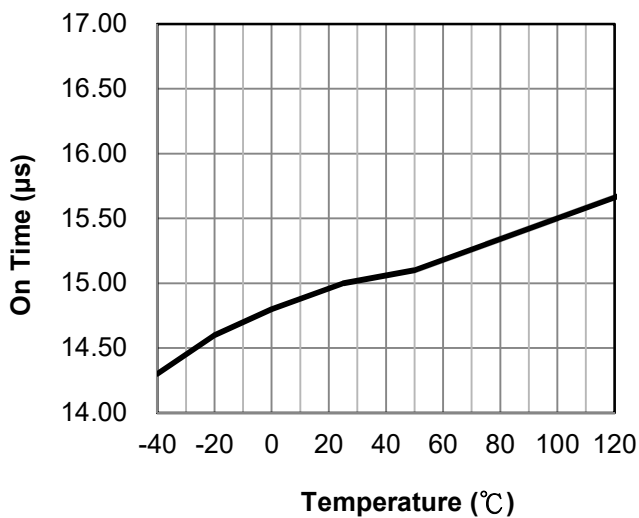
**Figure 2 - V<sub>CC\_OFF</sub> vs. Junction Temperature**



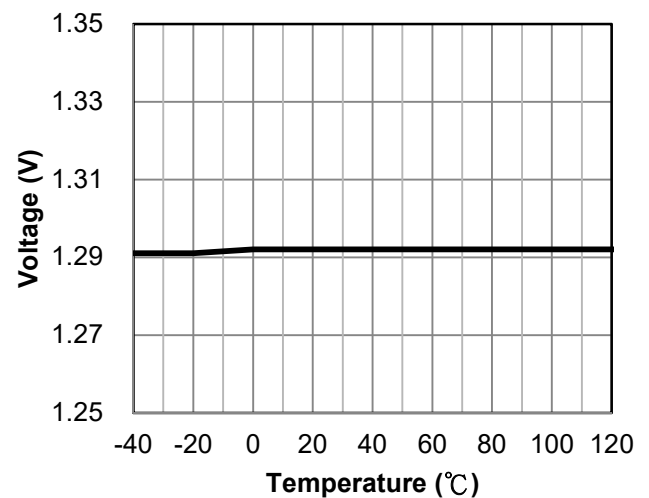
**Figure 3 - V<sub>OVP\_A</sub> vs. Junction Temperature**



**Figure 4 - V<sub>OVP\_S</sub> vs. Junction Temperature**



**Figure 5 - T<sub>ON\_MAX</sub> vs. Junction Temperature**



**Figure 6 - V<sub>OCP</sub> 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
- $\eta$  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 sence
- $R_S$  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

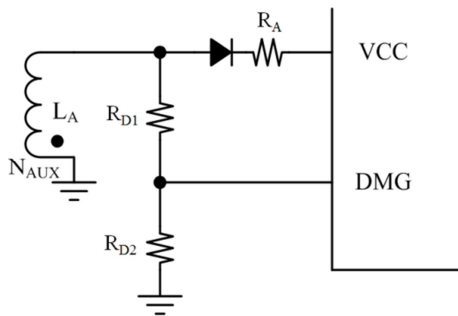
### Pin Definitions (Continue)

#### 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

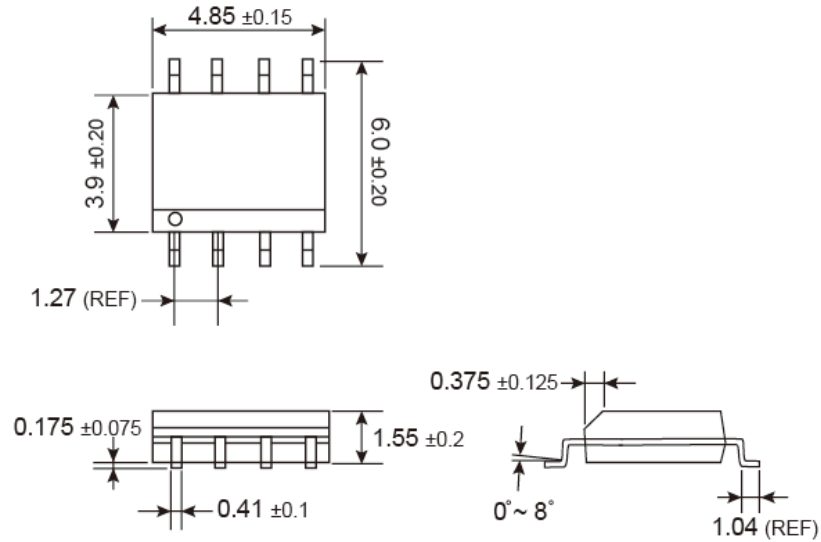
Gate drive for external MOSFET switch and is built-in gate clamp function.

#### GND Pin

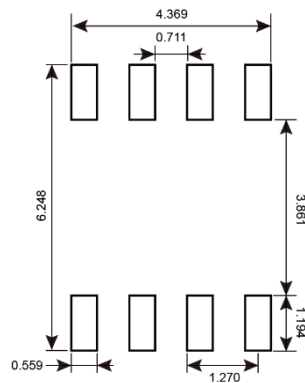
GND is the reference node of internal circuit.

**PACKAGE OUTLINE DIMENSIONS** (Unit: Millimeters)

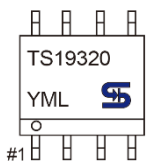
**SOP-8**



**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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