

Single-Stage Flyback or Buck-Boost Current Control with Active PFC and Integrated High Voltage MOSFET

DESCRIPTION

TS19706CS is a very efficient constant current controller IC for low cost non-dimmable LED lighting applications. The TS19706CS is configurable for either isolated primary side Flyback regulation or non-isolated buck-boost current regulation topology. Integrated 630V Power MOSFET and active power factor correction in Flyback mode reduces the external components required and BOM for implementation. The IC achieves high power factor correction and low total harmonic distortion (THD) with Boundary Conduction Mode (BCM) operation. Temperature compensation of line/load regulation allows constant current accuracy to be maintained to $\pm 3\%$. TS19706CS also provides over temperature protection, V_{CC} overvoltage protection, and system output open and short circuit protection.

FEATURES

- Integrated 630V MOSFET
- Constant Current Accuracy within $\pm 3\%$
- Primary-Side Feedback Control
- Application Voltage Range $80 V_{AC} \sim 308 V_{AC}$
- Transition-Mode PFC Operation
- Built-in Active Power Factor Correction
- Good Line and Load Regulation
- Open-LED Protection on DMG pin
- Over-Voltage Protection on V_{CC} pin
- Short-LED Protection
- Cycle-by-Cycle Over Current Protection on CS pin
- Over-Temperature Protection
- Compliant to RoHS Directive 2011/65/EU and WEEE 2002/96/EC.
- Halogen-free according to IEC 61249-2-21.

APPLICATION

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

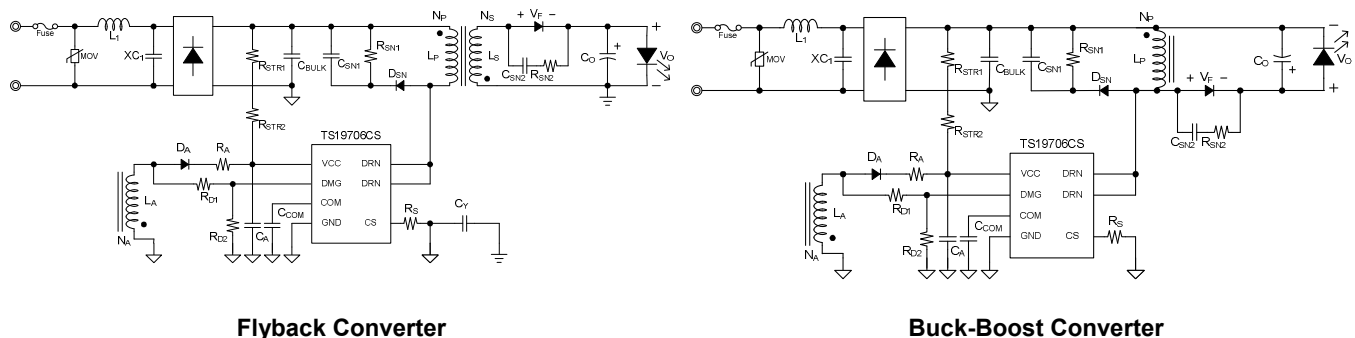


Pin Definition:

- | | |
|-------------|--------|
| 1. GND | 8. CS |
| 2. COM | 7. NC |
| 3. DMG | 6. DRN |
| 4. V_{CC} | 5. DRN |

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
DRN Pin Voltage to GND	V_{DRN}	630	V
Power supply pin	V_{CC}	40	V
DMG voltage to GND	V_{DMG}	-0.3 to 40	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	$^\circ\text{C}$
Power Dissipation @ $T_A=50^\circ\text{C}$	P_D	0.4	W
ESD Rating (Human Body Model) ^(Note 2)	ESD	2	kV

THERMAL PERFORMANCE ^(Note 3)			
PARAMETER	SYMBOL	LIMIT	UNIT
Thermal Resistance - Junction to Case	$R_{\theta JC}$	50	$^\circ\text{C/W}$
Thermal Resistance - Junction to Ambient	$R_{\theta JA}$	208	$^\circ\text{C/W}$

RECOMMENDED OPERATING CONDITION ($T_A = 25^\circ\text{C}$ unless otherwise specified) ^(Note 4)			
PARAMETER	SYMBOL	LIMIT	UNIT
DRN Pin Voltage to GND	V_{DRN}	600	V
Power supply pin	V_{CC}	33	V
DMG voltage to GND	V_{DMG}	-0.3 to 10	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 +125	$^\circ\text{C}$
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						
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}	$V_{CC}=12\text{V}$, @ V_{CC} off	--	25	37.5	μA
Quiescent Current 2	I_{Q2}	Start-up @ 4.5kHz	--	550	825	μA
Operation Supply Current	I_{CC}		--	1.5	2.5	mA
Protection						
VCC voltage protection	V_{OVPA}		32.3	34	35.7	V
Output voltage protection	V_{OVPS}		9.5	10	10.5	V
CS limit voltage	V_{OCP}		1.2	1.35	1.5	V
CS limit voltage (start-up)	V_{OCP_STR}		--	0.43	--	V
Short circuit protection ^(Note 5)	V_{SCP}		--	3.0	--	V

ELECTRICAL SPECIFICATIONS ($T_A = 25^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNIT
Oscillator						
Start-up Timer	t_{STR}		--	222	--	μs
GM Amplifier						
Reference voltage	V_{REF}		362.6	370	377.4	mV
Transconductance	G_m		--	60	--	$\mu\text{A/V}$
Sink Current	I_{COMP_SINK}		--	20	--	μA
Source Current	I_{COMP_SOU}		--	20	--	μA
Driver						
Dropout voltage	V_{OH}	$I_o = 10\text{mA}$	--	0.7	--	V
	V_{OL}	$I_o = -10\text{mA}$	--	0.2	--	V
Rising time	t_r	$V_{CC}=20\text{V}, C_o = 1\text{nF}$	--	60	--	ns
Falling time	t_f	$V_{CC}=20\text{V}, C_o = 1\text{nF}$	--	80	--	ns
Output clamp voltage	V_{O_CLAMP}		--	13	15.0	V
Leading edge blanking time ^(Note 5)	LEB_t		--	0.5	--	μs
MOSFET Section						
Drain-Source Breakdown Voltage	BV_{DS}		630	--	--	V
Drain-Source On-Resistance	$R_{DS(ON)}$	$V_{GS}=10\text{V}, I_D=1\text{A}$	--	3.2	3.8	Ω
Thermal Section ^(Note 5, 6)						
Thermal Shutdown			--	130	--	$^\circ\text{C}$

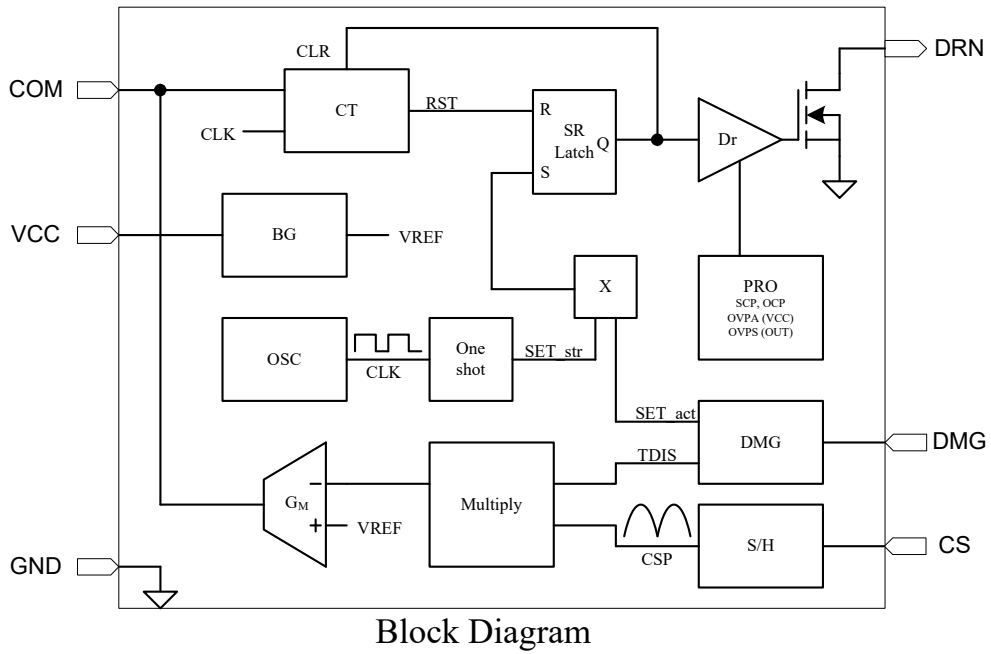
Note:

- Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. 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 remain possibility to affect device reliability.
- Devices are ESD sensitive. Handling precautions recommended.
- Thermal Resistance is specified with the component mounted on a low thermal conductivity test board in free air at $T_A=25^\circ\text{C}$.
- The device is not guaranteed to function outside its operating conditions.
- Guaranteed by design.
- Linear degeneration Type.

ORDERING INFORMATION

PART NO.	PACKAGE	PACKING
TS19706CS RLG	SOP-8	2,500pcs / 13"Reel

FUNCTION BLOCK



PIN DESCRIPTION

PIN NO.	NAME	FUNCTION
1	GND	Ground return for all internal circuitry.
2	COM	Output pin of error amplifier.
3	DMG	Zero current demagnetization sensing.
4	V _{CC}	Power supply pin for all internal circuitry.
5	DRN	Drain of the internal power MOSFET
6	DRN	Drain of the internal power MOSFET
7	NC	Not connected.
8	CS	Input current sense pin

CHARACTERISTICS CURVES

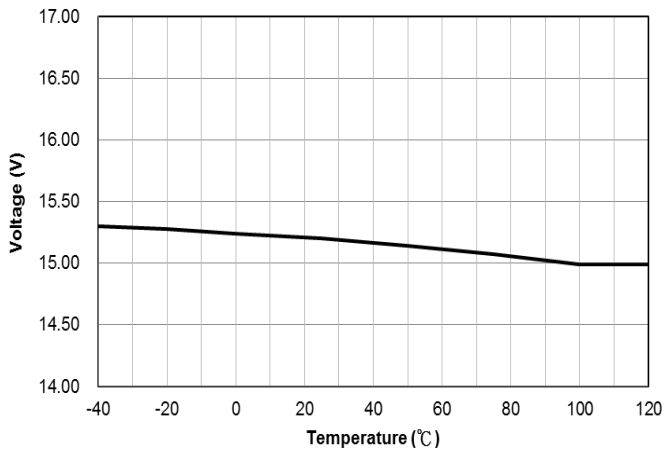


Figure 1 - V_{CC_ON} vs. Junction Temperature

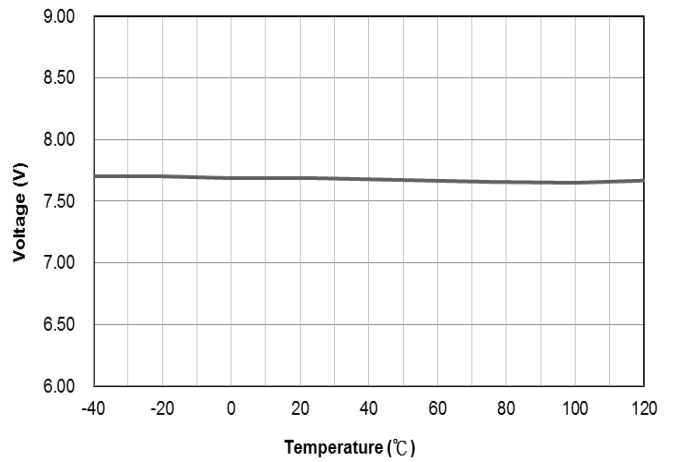


Figure 2 - V_{CC_OFF} vs. Junction Temperature

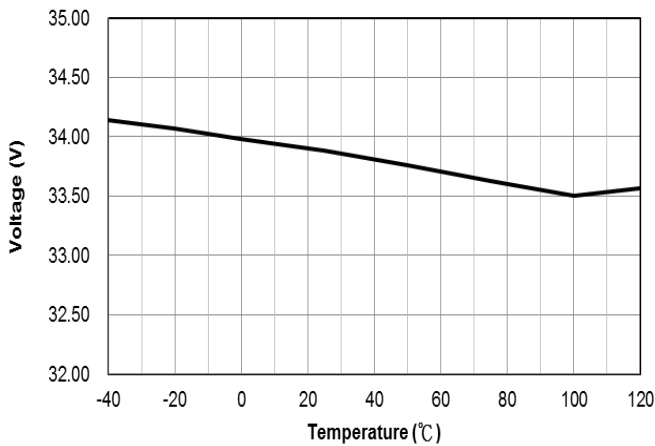


Figure 3 - V_{O_VPA} vs. Junction Temperature

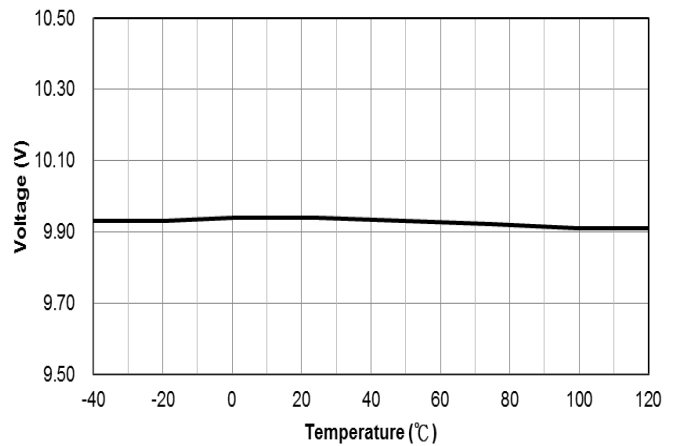


Figure 4 - V_{O_VPS} vs. Junction Temperature

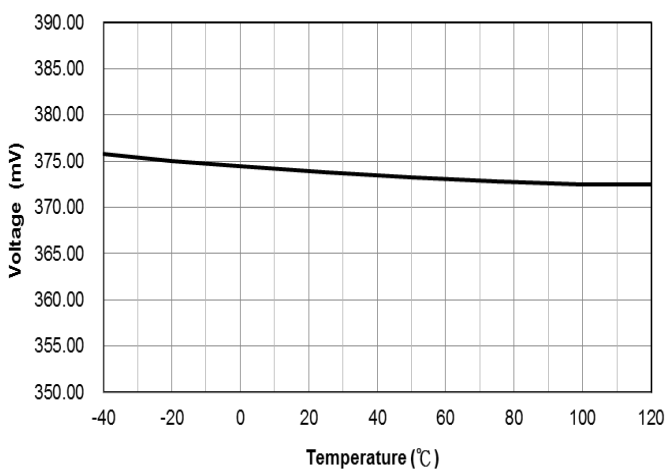


Figure 5 - V_{REF} vs. Junction Temperature

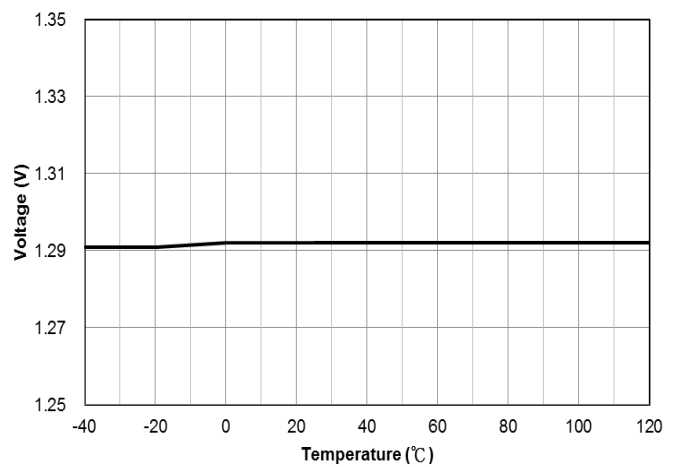


Figure 6 - V_{OCP} vs. Junction Temperature

APPLICATION INFORMATION

Function Description

The TS19706CS is configurable for either isolated primary side Flyback regulation or non-isolated buck-boost current regulation topologies. The IC active power factor correction in Flyback mode and achieves constant current accuracy and low total harmonic distortion (THD) using Boundary Conduction Mode (BCM) operation. An integrated 630V switching MOSFET reduces the external components required for application implementation. The TS19706CS has built-in V_{CC} over voltage protection, open LED protection, short LED protection, over temperature protection, and primary-side current limit.

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

COM (Compensation)

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

GND (Ground)

GND is the reference node of internal circuit.

CS (Current Sense)

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

$$I_{CS(LIMIT)} = \frac{1.35}{R_S}$$

Where:

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

DRN (Drain)

Internal Power MOSFET Drain.

V_{CC}

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 TS19706CS performs V_{CC} over voltage protection though V_{CC} pin. Once V_{CC} pin exceeds in 34V, TS19706CS turns off and latches out the MOSFET switcher until V_{CC} goes below V_{CC_OFF} .

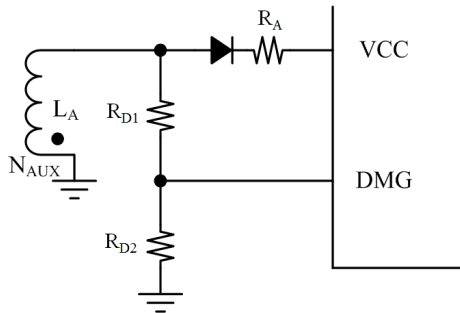
APPLICATION INFORMATION (CONTINUE)

DMG (Zero Current Demagnetization)

The output voltage is defined by the auxiliary winding (N_{AUX}) of the fly-back transformer. The DMG pin senses output information to protect against undervoltage ($V_O < V_{O_STR}$) and overvoltage ($V_O > V_{O_OVP}$).

When the DMG senses voltage under V_{O_STR} the circuit will operate in short circuit protection mode, $f_{STR}=1/t_{STR}$.

When the DMG senses voltage over V_{O_OVP} , the circuit will implement over-voltage protection latch until V_{CC} goes below V_{CC_OFF} .



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

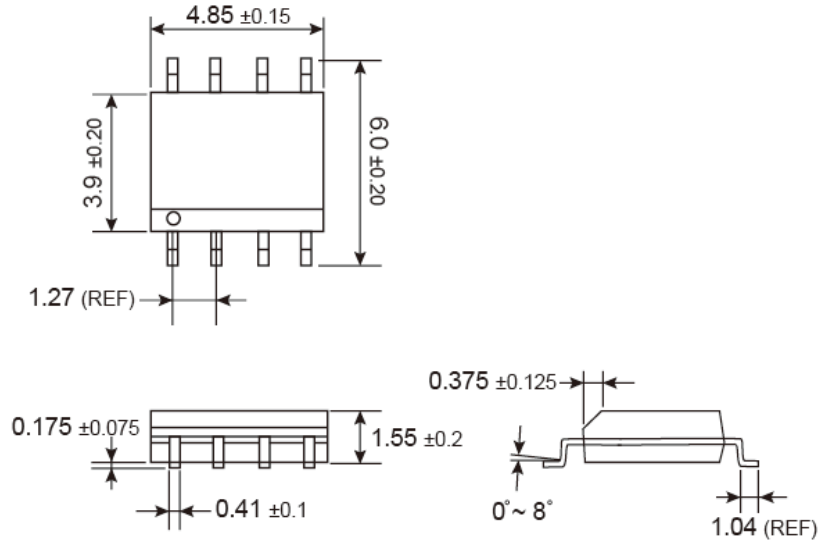
$$V_{O_STR} = \frac{N_{SEC}}{N_{AUX}} \times 3 \times \frac{R_{D1} + R_{D2}}{R_{D2}}$$

Where :

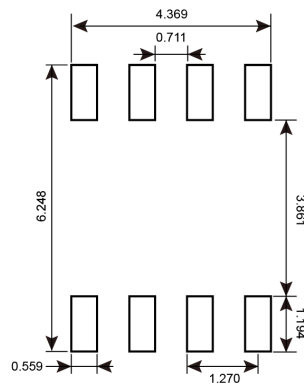
- V_{OUT_OVP} is the output-over-voltage protection point
- V_{OVPS} is the over voltage protection signal
- V_{O_STR} is the start-up timer
- N_{AUX} is the number of auxiliary-winding turns
- N_{SEC} is the number of secondary-winding turns

PACKAGE OUTLINE DIMENSIONS (Unit: Millimeters)

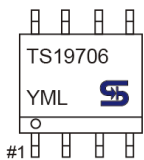
SOP-8



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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