TFC719

Switching Power Supply Controller

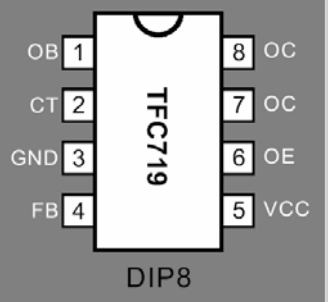
Brief Introduction

- With advanced anti-overload and anti-saturation technology and being a switching power supply controller capable of satisfying higher standard for environment protection, TFC719 is applicable for mini-watt switching power supply devices such as cell-phone chargers.

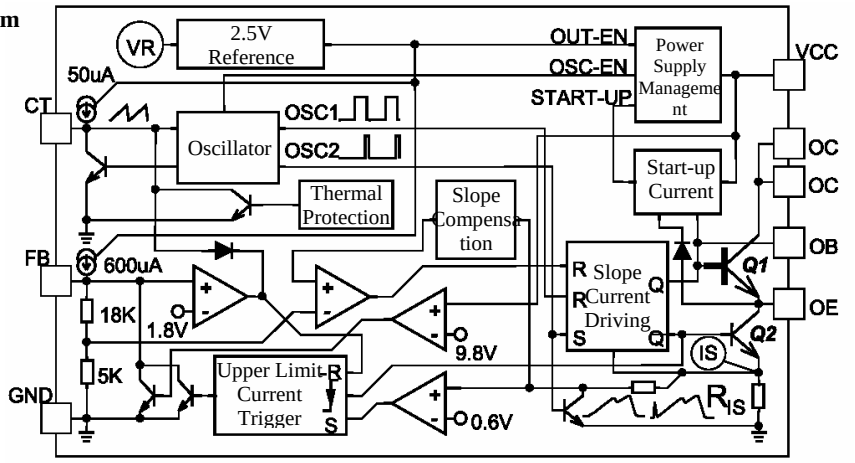
Features

- Being designed with advanced anti-overload and anti-saturation technology, capable of timely preventing failures such as overload, saturation of the switching transformer, output short circuit and etc.;
- Using built-in power triode as the switching tube, and at the same time completing the start-up by using its amplifying capacity to reduce the power consumption of the start-up resistor more than ten times;
- With built-in slope compensation circuit, thermal protection circuit and slope current driving circuit;
- Broad voltage output power up to 5.5W and 220V AC output power up to 8W; standby power consumption below 0.25W.

Connection Diagram



Block Diagram

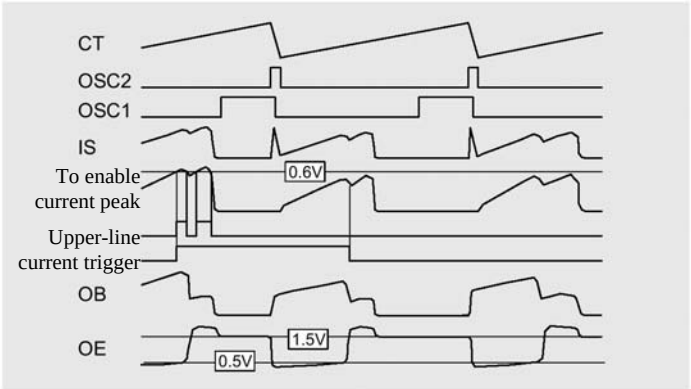


Pin	Symbol	Pin Description
1	OB	Base pin of the power tube, and enabling current control pin
2	CT	Oscillator C input pin.
3	GND	Ground pin
4	FB	Feedback input pin
5	VCC	Positive power supply pin
6	NC	Emitter pin of the power tube, and enabling current input pin
7	OC	Collector pin of the power tube
8	OC	Collector pin of the power tube
Internal test pin	VR	2.5V Reference
Internal test pin	IS	Power tube current

Description of the Operating Principle

- In the enabling stage, when power is on, VR has no output, triode Q2 is turned off, the pull-up current source FB is closed; external circuit inputs weak current (about 0.05 ~ 0.2mA) from OB to base of high voltage power tube Q1, the collector OC and emitter OE of Q1 inputs enabling current to VCC; OB internal circuit controls the base current of Q1, limits the collector current of Q1 (i.e. TFC719 enabling reception current, about 2mA), so as to ensure the safety of Q1; when VCC voltage raises up to 8.8 V, the enabling stage ends and it goes into the normal stage.
- In the normal stage, VCC voltage should be maintained at 4.75V to 9.8V, VR outputs 2.5V reference; FB pull-up current source is opened; the oscillator output OSC1 decides the maximum duty ratio, output OSC2 tries to trigger the power into open period, and the screened power tube turns on the current peak; if FB is below 1.8V (approximately between 1.2V and 1.8V), the oscillator period will then get wider until the stop of the oscillator (this feature will lower the stand-by power consumption of the switch power source); if the external feedback intends to make VCC higher than 9.8V, the internal circuit feedback to FB will stabilize VCC at 9.8V (with this feature, the internal circuit rather than the external feedback circuit will be used to stabilize the output voltage, but the stabilizing accuracy may be low); in the open period, Q1's base is in open current, Q2 pulls down the emitter of Q1 to IS, and uses the slope current driving (i.e. the Q1's base open current is the function of IS, when IS = 0V, the open current is approximately 24mA, then the open current will increase along with IS linearly, when IS raises to 0.6V, the open current is approximately 40mA, this feature will effectively utilize the open current and lower the power consumption of TFC719), if IS detects the specified current of FB, it goes into close period; in the close period, Q1's base pulls down, Q1 may not be turned off immediately, but OE clamps on 1.5V (after Q1 turns off, the base will be reverse bias and the voltage withstanding capacity of Q1 is increased); in the open or close period, if it detects the current exceeding upper limit of Q1, then the upper limit current trigger will be put at the preferential position, forcing FB to decrease and the duty ratio will turn smaller, so that Q1 and transformer will be protected; at the beginning of next close period edge or if FB is below 1.8V, the upper limit current trigger will reset. Besides, the built-in thermal protection of TFC719 will widen the oscillator period when the internal temperature is above 125ºC to ensure the temperature of TFC719 will not exceed 135ºC; the built-in slope compensation will stabilize the open/close period when TFC719 is at high duty ratio or in continuous current mode.
- When VCC lowers to about 4.4V, the oscillator will be closed, OSC1 and OSC2 will be at low level, and the power source will be maintained at close period; when VCC goes on lowering to about 3.8V, TFC719 will enter the enabling stage again.

Normal Stage Switching Cycle Oscillogram (Figure 1)



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Definitions of Electrical Characteristics

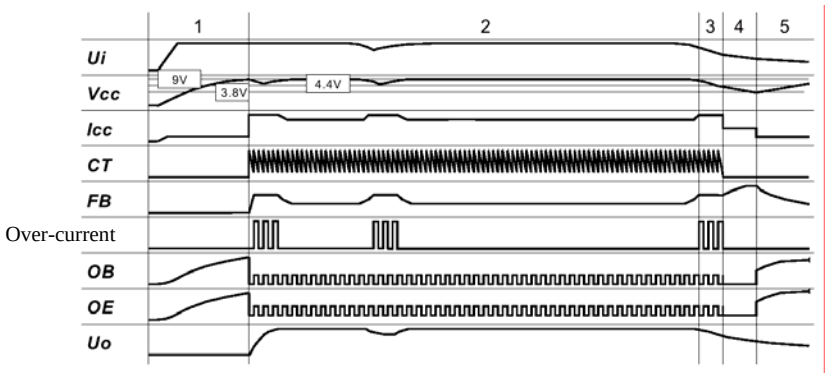
- Enabling reception current: The current on OE point when OB starts to have a 0.1mA pull-down current in the enabling stage.
- Enabling static current: The minimum power supply current when VCC connects to filter capacitor and adjustable power supply, CT connects to 330PF and other pins unconnected and to enable the oscillation of VCC (i.e. enable the start-up of TFC719)
- Enabling Voltage: The maximum VCC value of the above-mentioned VCC oscillation.
- Re-enabling voltage: The minimum VCC value during the oscillation of the above mentioned VCC.
  Oscillator turn-off voltage: The VCC value causing the stop of oscillator when the above-mentioned oscillation falls to the edge.
- Static current: VCC current when FB connects to ground through 1.8K resistor in normal stage.
- Oscillator pull-up/pull-down current: The pull-up/pull-down current at CT when FB = 2.5V, CT = 1.25V in normal stage.

Key Points to the Power Supply Design

(Refer to Application Cases)

- Designed in flyback current control type of switching power supply, and in non-continuous current operating mode;
- The power supply enabling current is selected to 0.5 ~ 2mA, the amplification of the power tube Q1 can be calculated based on 10, then the selection of start-up resistor (such as R2 in Figure 3) should ensure that the base current of the power tube should be 0.05 ~ 0.2mA at the time when the power supply starts. Therefore, it could reduce the power consumption of the start-up resistor by ten times and reduce the standby power consumption;
- In Figure 3, C3 = 330pF, the maximum operating frequency is about 66KHz;
- Switching transformer (T1 in Figure 3): The rectified output of the reference winding is 4.8 ~ 9.2V (the preferred value is 6V) providing working power supply to TFC719;
- The maximum primary peak current of the switching transformer is 0.3A, in broad voltage or 110V AC or 80V demagnetized voltage, the maximum output power may be more than 5.5W; The OC (Pin 7 and Pin 8) high voltage of TFC719, and
- No connection in OE (Pin 6, used for testing). So it is easy to separate slot between Pin 6 and Pin 7 of TFC719 on PCB board to meet installation requirement;
- Although TFC719 has been provided with thermal protection, in case of requirement for higher output power, if not considering the heat sinking on PCB board of TFC719, it may decrease the output power and output voltage.
- There are two sets of optional output voltage references inside the dash line in Figure 3. When using TL431 (U2, R5, R6, R7, R8, R9, C9) the reference accuracy will be higher and need no adjustment; when using voltage stabilizer tube (Z1, RZ) the reference accuracy will be low but in lower costs. The voltage stabilizer tube supplied in batches may be divided into several grades and used in adjusting and checking RZ. Each grade of voltage stabilizer tubes may correspond to one RZ.

Normal Stage Switching Cycle Oscillogram (Figure 1)



- FB pull-up current: In normal stage, when FB = 2.5V, loc = 0A, FB will be pull-up current.
- FB anti-upper limit current: In normal stage, when FB = 6V, loc = 0.3A, FB will be pull-down current.
- Internal feedback power supply voltage: No-external standby feedback circuit of the power source KD202. In normal stage, it is the VCC value.
- OC upper limit current: The minimum OC current when FB = 6V and there is pull-down current at FB.
- Oscillator Cycle: The function of external capacitor CT, about CT*48000 seconds.

Electrical Characteristics

Symbol	Item	Test Condition	Min	Typ	Max	Unit
Ics	Enabling Reception Current		1.6	2.0	2.4	mA
	Enabling Static Current			55	80	uA
	Enabling voltage	Vcc = 8V	8.6	8.8	9.0	V
	Oscillator Turn-off Voltage			4.4		V
	Re-enabling voltage			3.8		V
	Internal Feedback Power Supply Voltage		9.6	9.8	10	V
	Static Current			2.6		mA
VR	VR Reference Voltage		2.4	2.5	2.6	V
	Oscillator Cycle	CT * 24000	0.9	1	1.1	multiple
	Oscillator Pull-up Current	CT = 1.25V		50		uA
	Oscillator Pull-down Current	CT = 1.25V		450		uA
	Maximum Duty Ratio	CT = 330PF		57		%
	FB Pull-up Current	FB = 2.5V, loc = 0A		500		UA
	FB Anti-upper Limit Current	FB = 5V, loc = 0.3A		400		uA
	OC Upper Limit Current			0.3		A
	OE Clamp Voltage	OE = 0.001 ~ 0.3A		1.5		V
	OB Open Current	IS = 0.5V		40		mA
	OB Open Current	IS = 0.1V		24		mA
	OB Close Current	OB – IS = 1V		-120		mA
	OB Close Current	OB – IS = 0.5V		-6		mA
	OE Output Current	In open period, OE – IS =0.6V		-0.36		A
	OC Voltage Withstanding	In close period, loc = 1mA	700			A

Cell-phone Charger (Figure 3)