ACT518

Rev 0, 13-Jun-14

ActiveQR™ Quasi-Resonant PWM Power Switch

FEATURES

- **Integrated Power MOSFET**
- **CCM and Quasi-Resonant Operation**
- **Adjustable up to 75kHz Switching Frequency**
- **Integrated Patented Frequency Foldback Technique**
- **Integrated Patented Line Compensation**
- **Built-in Soft-Start Circuit**
- **OCP/OLP Protection**
- **Line Under-Voltage, Thermal, Output Over-voltage, Output Short Protections**
- **Current Sense Resistor Short Protection**
- **Transformer Short Winding Protection**
- **100mW Standby Power**
- **Complies with Global Energy Efficiency and CEC Average Efficiency Standards**
- **SOP-8 and DIP-7 Packages**

APPLICATIONS

- **Power Supplies for Portable Media Player, DSCs, Set-top boxes, DVD players, records**
- **Adaptors for Small home appliances**
- **Auxiliary Power Supply for PC,LCD TV and PDP TV**

GENERAL DESCRIPTION

ACT518 is a high performance peak current mode PWM power switch. It applies *ActiveQR™* and frequency foldback technique to reduce EMI and improve efficiency. Its maximum design switching frequency is set at 75kHz. Very low standby power, good dynamic response and accurate voltage regulation is achieved with an opto-coupler and the secondary side control circuit.

The Idle mode operation enables low standby power of 100mW with small output voltage ripple. By applying frequency foldback and *ActiveQR™* technology, The integrated power switch increases the average system efficiency compared to conventional solutions and exceeds the latest ES2.0 efficiency standard with good margin.

ACT518 integrates comprehensive protection. In case of over temperature, over voltage, short winding, short current sense resistor, open loop an d overload conditions, it would enter into auto restart mode including Cycle-by-Cycle current limiting.

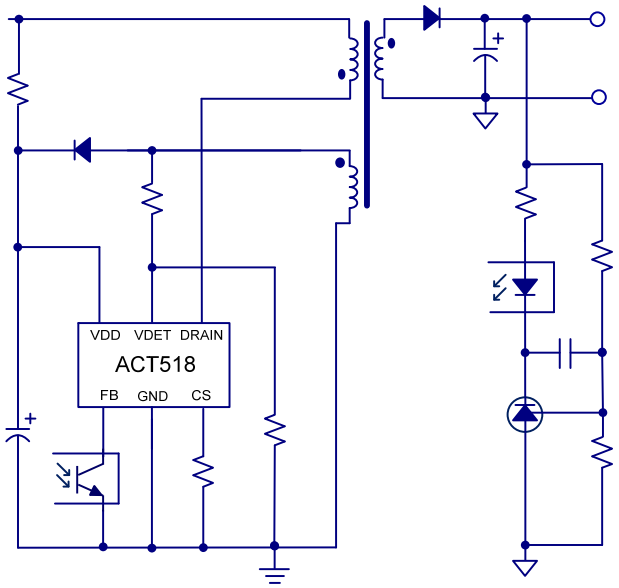
ACT518 is to achieve no overshoot and very short rise time even with big capacitive load with the built-in fast and soft start process.

In full load condition, ACT518 is able to be designed to work in both CCM mode and DCM mode to meet different types of applications. Quasi-Resonant (QR) operation mode can effectively improve efficiency during DCM operation, and reduce the EMI noise and further reduce the components in input filter.

ACT518SH is for application up to 10 Watt and ACT518DF is for application up to 18 Watt.

Figure 1:

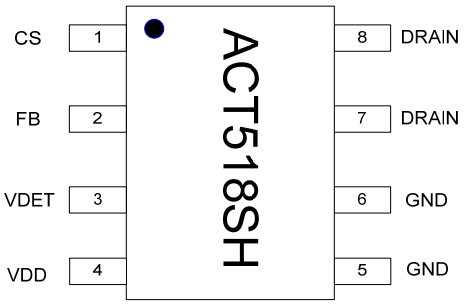
Simplified Application Circuit



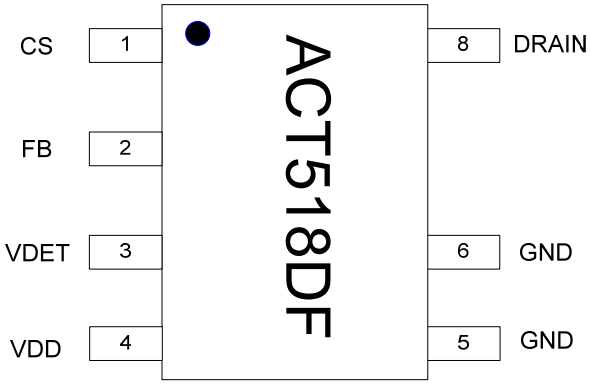
ORDERING INFORMATION

PART NUMBER	TEMPERATURE RANGE	PACKAGE	PINS	PACKING METHOD	TOP MARK
ACT518SH-T	-40°C to 85°C	SOP-8	8	TUBE & REEL	ACT518SH
ACT518DF	-40°C to 85°C	DIP-7	7	TUBE	ACT518DF

PIN CONFIGURATION



SOP-8
ACT518SH



DIP-7
ACT518DF

PIN DESCRIPTIONS

PIN	NAME	DESCRIPTION
1	CS	Current Sense Pin. Connect an external resistor (R_{CS}) between this pin and ground to set peak current limit for the primary switch.
2	FB	Feedback Pin. Connect this pin to optocouplers's collector for output regulation.
3	VDET	Valley Detector Pin. Connect this pin to a resistor divider network from the auxiliary winding to detect zero-crossing points for valley turn on operation.
4	VDD	Power Supply. This pin provides bias power for the IC during startup and steady state operation.
5,6	GND	Ground.
7,8	DRAIN	MOSFET Drain Pin.

ABSOLUTE MAXIMUM RATINGS①

PARAMETER		VALUE	UNIT
DRAIN to GND		-0.3 to + 650	V
FB, CS, VDET to GND		-0.3 to + 6	V
VDD to GND		-0.3 to + 28	V
Continuous Drain Current, T_C=25˚C	SOP-8	2	A
	DIP-7	4	A
Continuous Drain Current, T_C=100˚C	SOP-8	1.1	A
	DIP-7	2.9	A
Maximum Power Dissipation	SOP-8	0.95	W
	DIP-7	1.5	W
Junction to Ambient Thermal Resistance (θ_{JA})	SOP-8	105	˚C/W
	DIP-7	80	˚C/W
Operating Junction Temperature		-40 to 125	˚C
Storage Temperature		-55 to 150	˚C
Lead Temperature (Soldering, 10 sec)		300	˚C

①: Do not exceed these limits to prevent damage to the device. Exposure to absolute maximum rating conditions for long periods.

ELECTRICAL CHARACTERISTICS

(V_{DD} = 14V, L_M = 1.3mH, R_{CS} = 1.65Ω, V_{OUT} = 5V, N_P = 114, N_S =9, N_A =23, T_A = 25°C, unless otherwise specified.)

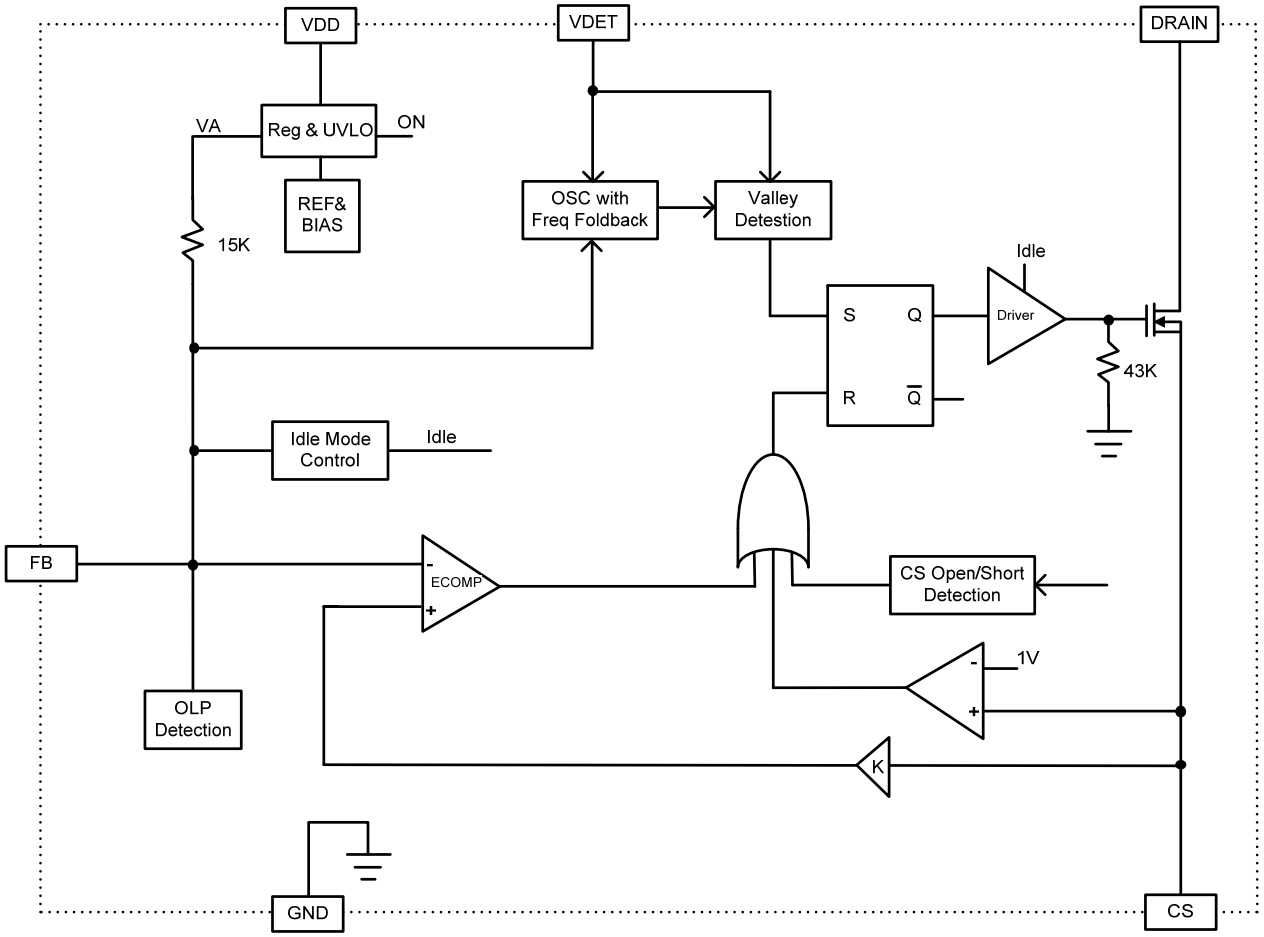
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Supply						
VDD Turn-On Voltage	V_{DDON}	V_{DD} Rising from 0V	11.3	12.3	13.3	V
VDD Turn-Off Voltage	V_{DDOFF}	V_{DD} Falling after Turn-on	6.7	7.4	8.1	V
VDD Over Voltage Protection	V_{DDOVP}	V_{DD} Rising from 0V		25		V
Start Up Supply Current	I_{DDST}	V_{DD} = 10V, before VDD Turn-on		8	15	μA
IDD Supply Current	I_{DD}	V_{DD} = 15V, after VDD Turn-on ,FB floating		0.6		mA
IDD Supply Current at Standby	I_{DDSTBY}	FB = 1.3V		0.4		mA
IDD Supply Current at Fault	$I_{DDFAULT}$	Fault mode, FB Floating		250		μA
Feedback						
FB Pull up Resistor	R_{FB}			15		kΩ
CS to FB Gain	A_{CS}			3		V/V
VFB at Max Peak Current				3 + V_{BE}		V
FB Threshold to Stop Switching	V_{FBBM1}			1.32		V
FB Threshold to Start Switching	V_{FBBM2}			1.41		V
Output Overload Threshold				4.2		V
OverLoad/Over Voltage Blanking Time	$T_{OVBLANK}$			320		ms

ELECTRICAL CHARACTERISTICS CONT'D

(V_{DD} = 14V, L_M = 1.3mH, R_{CS} = 1.65Ω, V_{OUT} = 5V, N_P = 114, N_S =9, N_A =23, T_A = 25°C, unless otherwise specified.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Power Mosfet						
Drain Source Breakdown Voltage	BV_{DSS}	V_{GS}=0V,I_D=250uA	650			V
Drain On Resistor	R_{DSON}	V_{GS}=10V,I_D=1A,SOP-8		5.1		Ω
		V_{GS}=10V,I_D=2A,DIP-7			3.6	Ω
Current Limit						
CS Current Limit Threshold	V_{CSLIM}		0.91	0.96	1.01	V
Leading Edge Blanking Time	$T_{CSBLANK}$		240	300	360	ns
Oscillator						
Maximum Switching Frequency	f_{MAX}			75		kHz
Switching Frequency Foldback	f_{MIN}	FB = 2.3V+V_{BE}		f_{MAX}/3		kHz
Maximum Duty Cycle	D_{MAX}		65	75		%
Valley Detection						
ZCD Threshold Voltage	$VDET_{TH}$			100		mV
Valley Detection Time Window		After valley detection time window, if no valley detected, forcedly turn-on main switch		3.5		μs
VDET Leakage Current				1		μA
Protection						
CS Short Waiting Time				2		μs
CS Short Detection Threshold				0.115		V
CS Open Threshold Voltage				1.73		V
Abnormal OCP Blanking Time				150		ns
Thermal Shutdown Temperature				135		˚C
Line UVLO	$I_{VDETUVLO}$			0.1		mA
Line OVP	$I_{VDETOVP}$			2		mA
VDET Over Voltage Protection	$V_{DETVOOVP}$		2.448	2.72	2.992	V
VDET Vo Short Threshold	$V_{DETVOshort}$		0.406	0.58	0.754	V

FUNCTIONAL BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

ACT518 is a high performance peak current mode PWM integrated power IC. It includes the most advance features that are required in the adaptor applications up to 12 Watt. Unique fast startup, frequency foldback, QR switching technique, accurate peak current line compensation, Idle mode, short winding protection, OCP, OTP, OVP and UVLO are included in the controller.

Startup

Startup current of ACT518 is designed to be very low so that VDD could be charged to V_{DDON} threshold level and device starts up quickly. A large value startup resistor can therefore be used to minimize the power loss yet reliable startup in application. For a typical AC/DC adaptor with universal input range design, two 1MΩ, 1/8 W startup resistors could be used together with a VDD capacitor(4.7uF) to provide a fast startup and yet low power dissipation design solution.
During startup period, the IC begins to operate with minimum Ippk to minimize the switching stresses for the main switch, output diode and transformers. And then, the IC operates at maximum power output to achieve fast rise time. After this, V_{OUT} reaches about 90% V_{OUT}, the IC operates with a 'soft-landing' mode(decrease Ippk) to avoid output overshoot.

Constant Voltage (CV) Mode Operation

In constant voltage operation, the ACT518 regulates its output voltage through secondary side control circuit . The output voltage information is sensed at FB pin through OPTO coupling. The error signal at FB pin is amplified through TL431 and OPTO circuit. When the secondary output voltage is above regulation, the error amplifier output voltage decreases to reduce the switch current. When the secondary output voltage is below regulation, the error amplifier output voltage increases to ramp up the switch current to bring the secondary output back to regulation. The output regulation voltage is determined by the following relationship:

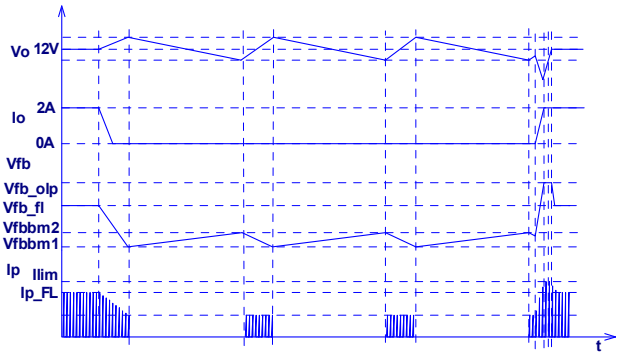
$$V_{OUTCV} = V_{REF\_TL431} \times (1 + \frac{R_{F1}}{R_{F2}}) \quad (1)$$

where R_{F1} (R13) and R_{F2} (R14) are top and bottom feedback resistor of the TL431.

No Load Idle Mode

In no load standby mode, the feedback voltage falls below V_{FBBM2} and reaches V_{FBBM1}, ACT518 stop switching. After it stops, as a result of a feedback reaction, the feedback voltage increases. When the feedback voltage reaches V_{FBBM2}, ACT518 start switching again. Feedback voltage drops again and output voltage starts to bounds back and forward with very small output ripple. ACT518 leaves Idle mode when load is added strong enough to pull feedback voltage exceed V_{FBBM2}.

Figure 2:
Idle Mode



Primary Inductor Current Limit Compensation

The ACT518 integrates a primary inductor peak current limit compensation circuit to achieve constant OLP over wide line and wide inductance.

Frequency Foldback

When the load drops to 75% of full load level, ACT518 starts to reduce the switching frequency, which is proportional to the load current ,to improve the efficiency of the converter.

ACT518's load adaptive switching frequency enables applications to meet all latest green energy standards. The actual minimum average switching frequency is programmable with output capacitance, feedback circuit and dummy load (while still meeting standby power).

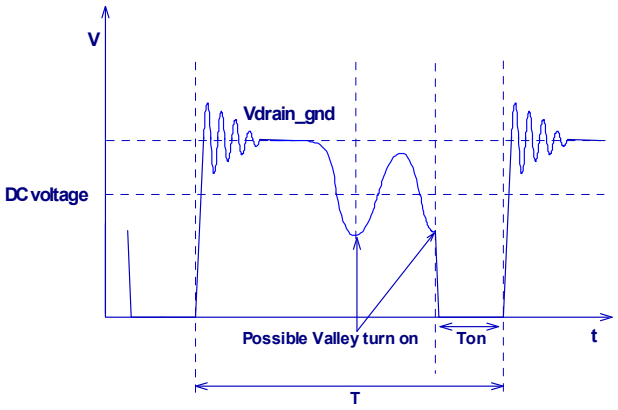
Valley Switching

ACT518 employed valley switching from no load to heavy load to reduce switching loss and EMI. In discontinuous mode operation, the resonant voltage between inductance and parasitic capacitance on MOSFET source pin is coupled by auxiliary winding and reflected on VDET pin through feedback network R6, R7. Internally, the VDET pin is connected to an zero-crossing detector to generate the switch turn on signal when the conditions are met.

FUNCTIONAL DESCRIPTION CONT'D

Figure 3:

Valley Switching



Protection Features

The ACT518 provides full protection functions. The following table summarizes all protection functions.

Auto-Restart Operation

ACT518 will enter into auto-restart mode when a fault is identified. There is a startup phase in the auto-restart mode. After this startup phase the conditions are checked whether the failure is still present. Normal operation proceeds once the failure mode is removed. Otherwise, new startup phase will be initiated again.

To reduce the power loss during fault mode, the startup delay control is implemented. The startup delay time increases over lines.

PROTECTION FUNCTIONS	FAILURE CONDITION	PROTECTION MODE
V_{DD} Over Voltage	V_{DD} > 25V (4 duty cycle)	Auto Restart
V_{VDET} Over Voltage/No Voltage	V_{VD} > 2.72V or No switching for 4 cycles	Auto Restart
Over Temperature	T > 135˚C	Auto Restart
Short Winding/ Short Diode	V_{CS} > 1.72V	Auto Restart
Over Load/Open Loop	IPK = I_{LIMIT} or V_{FB} = 3.5V + V_{BE} for 320ms	Auto Restart
Output Short Circuit	V_{DET} < 0.58V	Auto Restart
V_{DD} Under Voltage	V_{DD} < 7.4V	Auto Restart

Figure 4:
Universal VAC Input, 5V/2A Output Adaptor

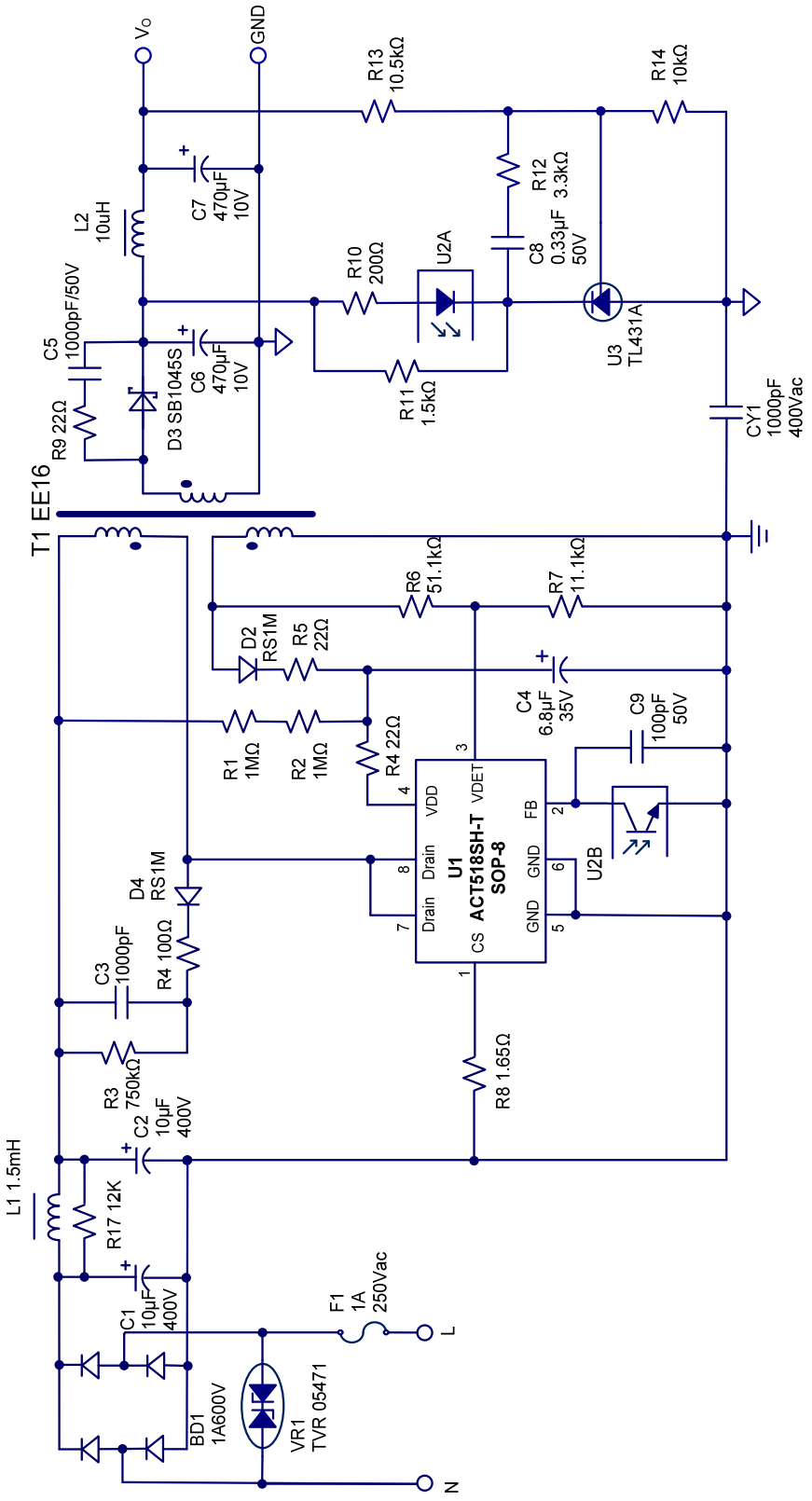
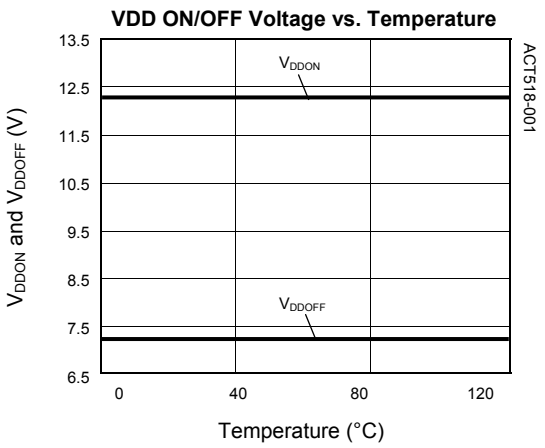


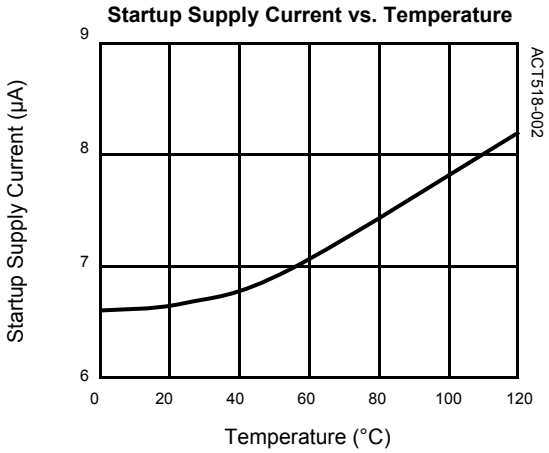
Table 1:

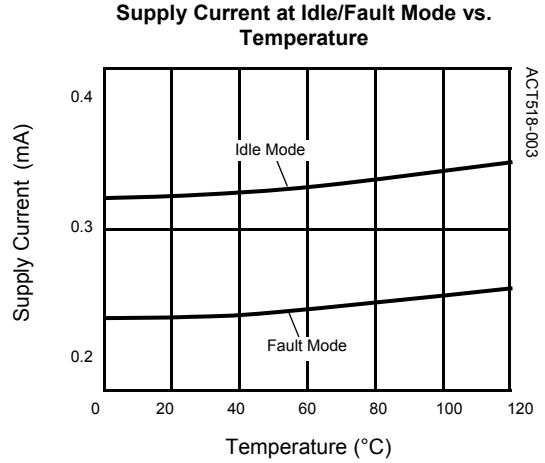
ACT518 5V10W Bill of Materials

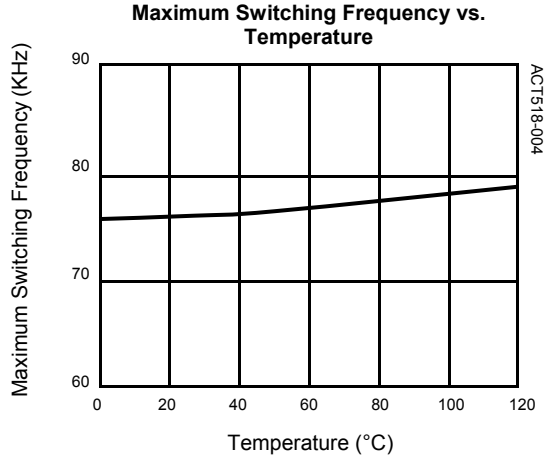
ITEM	REFERENCE	DESCRIPTION	QTY	MANUFACTURER
1	U1	IC, ACT518, SOP-8	1	Active-Semi
2	C1,C2	Capacitor, Electrolytic, 10μF/400V, 10 × 14mm	1	KSC
3	C3	Capacitor, Ceramic,1000pF/500V,0805,SMD	1	POE
4	C4	Capacitor, Electrolytic, 6.8μF/35V, 5 × 11mm	1	KSC
5	C7,C6	Capacitor, Electrolytic, 470μF/10V, 10 × 11.5mm	2	KSC
6	C8	Capacitor, Ceramic, 0.33μF/50V,0805,SMD	1	POE
7	C9	Capacitor, Ceramic,100pF/100V,0805,SMD	1	POE
8	C5	Capacitor, Ceramic,1000pF/50V,0805,SMD	1	POE
9	BD1	Diode, Rectifier ,1000V1A, MB6S, DO-4	1	Good-Ark
10	D2,D4	Diode, Ultra Fast, RS1M,1000V/1.0A, SMD	2	Good-Ark
11	D3	Diode, Schottky, 45V/10A, SB1045S, DO-201	1	Good-Ark
12	L1	DM Inductor, 1.5mH, DR5	1	SoKa
13	Bead1,2	T6*2*3, R5	2	SoKa
14	L2	DM Inductor, 10μH, DR5	1	SoKa
15	PCB1	PCB, L*W*T = 48.5x29x1.6mm, Cem-1, Rev:A	1	Jintong
16	F1	Fusible, 1A/250V	1	TY-OHM
17	R1,2	Chip Resistor, 1MΩ, 0805, 5%	2	TY-OHM
18	R3	Carbon Resistor, 750kΩ, 1206, 5%	1	TY-OHM
19	R11	Chip Resistor, 1.5kΩ, 0805, 5%	1	TY-OHM
20	R4,5,9	Chip Resistor, 22Ω, 0805, 5%	3	TY-OHM
21	R6	Chip Resistor, 51.1kΩ, 0805, 1%	1	TY-OHM
22	R7	Chip Resistor, 11.1kΩ, 0805, 1%	1	TY-OHM
23	R8	Chip Resistor, 1.65Ω, 1206, 1%	1	TY-OHM
24	R9	Chip Resistor, 0.87Ω,1W, 1%	1	TY-OHM
25	R10	Chip Resistor, 200Ω, 0805, 5%	1	TY-OHM
26	R12	Chip Resistor, 3.3kΩ, 0805, 5%	1	TY-OHM
27	R13	Chip Resistor, 10.5Ω, 0805, 1%	1	TY-OHM
28	R14	Chip Resistor, 10kΩ, 0805, 1%	1	TY-OHM
29	R17	Chip Resistor, 12kΩ, 0805, 5%	1	TY-OHM
30	T1	Transformer, L_P = 1.3mH, EE16	1	
31	NTC	Thermistor, SC053	1	TY-OHM
32	TVS	Varistor, 10471	1	TY-OHM
33	CY1	Y capacitance, 2200pF/400V,Y1	1	SEC
34	U2	Opto-coupler, PC817C CTR = 200%	1	Sharp
35	U3	Voltage Regulator, TL431A, V_{REF} = 2.5V	1	ST

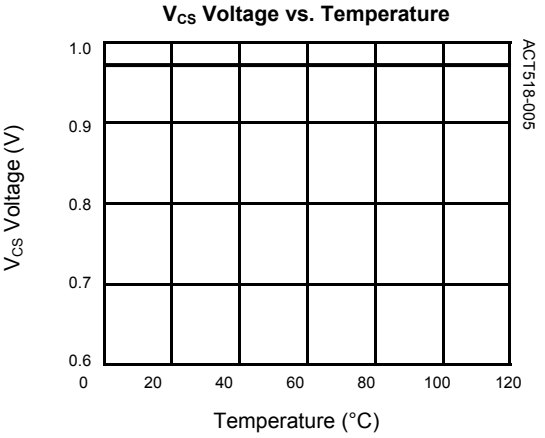
TYPICAL PERFORMANCE CHARACTERISTICS

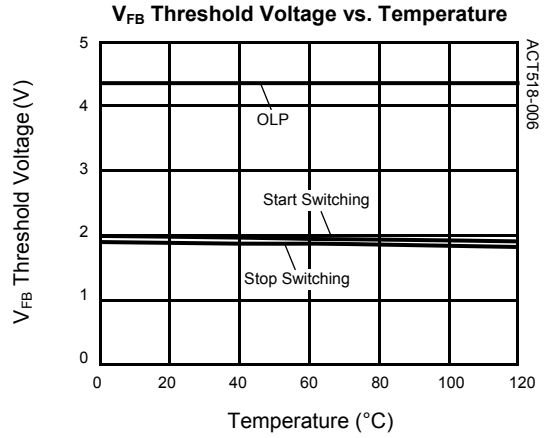






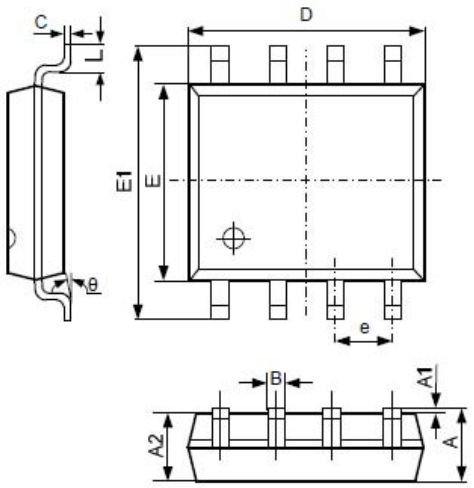






PACKAGE OUTLINE

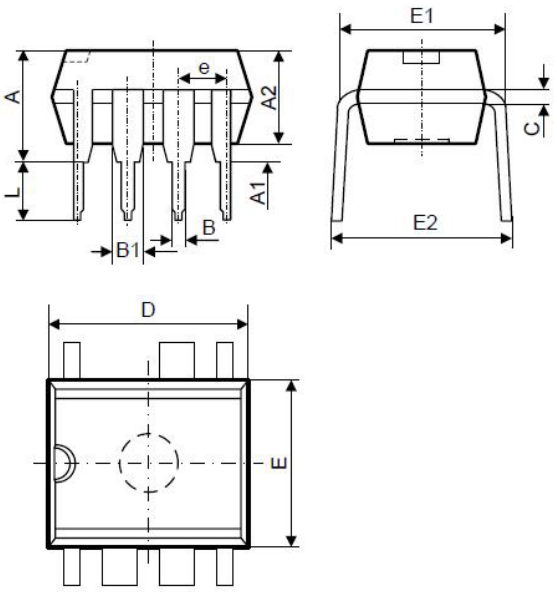
SOP-8 PACKAGE OUTLINE AND DIMENSIONS



SYMBOL	DIMENSION IN MILLIMETERS		DIMENSION IN INCHES	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270 TYP		0.050 TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

PACKAGE OUTLINE

DIP-7 PACKAGE OUTLINE AND DIMENSIONS



SYMBOL	DIMENSION IN MILLIMETERS		DIMENSION IN INCHES	
	MIN	MAX	MIN	MAX
A	3.710	4.310	0.146	0.170
A1	0.510		0.020	
A2	3.200	3.600	0.126	0.142
B	0.360	0.560	0.014	0.022
B1	1.524 TYP		0.060 TYP	
C	0.204	0.360	0.008	0.014
D	9.000	9.400	0.354	0.370
E	6.200	6.600	0.244	0.260
E1	7.620 TYP		0.300 TYP	
e	2.540 TYP		0.100 TYP	
L	3.000	3.600	0.118	0.142
E2	8.200	9.400	0.323	0.370