Datasheet
Rev 0, 6/2004
Advanced Information

ACT30

ACT30 EFFICIENT LOW POWER OFF-LINE CONTROLLER

FEATURES

- **Lowest Total Cost Solution**
- **Emitter Drive with Higher NPN Breakdown than RCC**
- **<0.25W Standby Power**
- **Hiccup Mode Short Circuit**
- **Frequency Dither for Lowest EMI**
- **Current Mode PWM**
- **Over-Current Protection**
- **Under-voltage Protection with Auto-restart**
- **TO-92 Package**
- **65kHz or 130kHz Switching Frequency**

APPLICATIONS

- **Battery Chargers**
- **Power Adaptors**
- **Standby Power Supplies**
- **Appliances**
- **Universal Off-line Power Supplies**

GENERAL DESCRIPTION

The ACT30 is a current-mode PWM power supply controller that drives an external NPN transistor for high voltage switching. This architecture enables many advanced features to be integrated into a 3-pin TO-92 package, resulting in lowest total cost solution.

The ACT30 allow a low-cost NPN such as '13002 or '13003 to operate at higher voltage than in a base-drive architecture such as RCC.

Operating at 65kHz switching frequency, the ACT30A is capable of delivering up to 5W yet consumes only 0.25W in standby. The ACT30B/C switches at 130kHz and is capable of delivering up to 24W. Their safety features include over-current and under-voltage protection mechanisms.

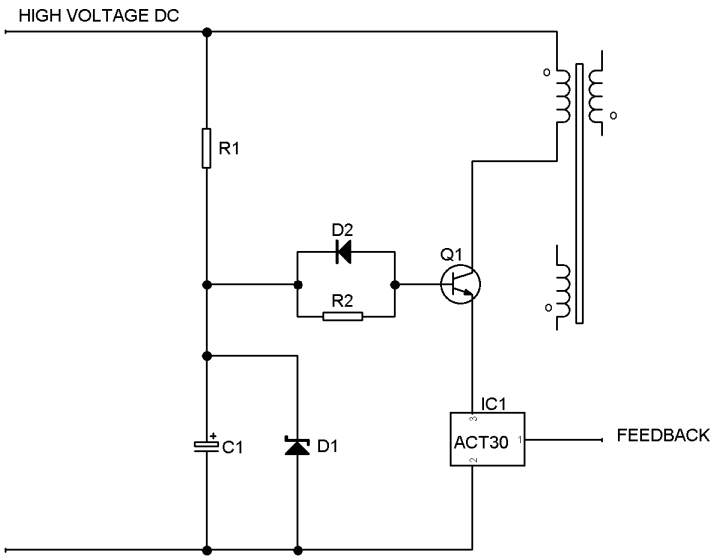
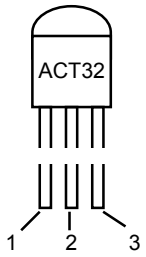


Figure 1. Simplified Application Circuit

ORDERING INFORMATION

PART NUMBER	SWITCHING FREQUENCY	CURRENT LIMIT	TEMPERATURE RANGE	PACKAGE	PINS
ACT30AHT	65kHz	400mA	-40°C to 85°C	TO-92	3
ACT30BHT	130kHz	400mA	-40°C to 85°C	TO-92	3
ACT30CHT	130kHz	800mA	-40°C to 85°C	TO-92	3

PIN CONFIGURATION



TO-92

PIN DESCRIPTION

PIN NUMBER	PIN NAME	PIN DESCRIPTION
1	FB/VDD	Feedback Input and Supply Voltage. Connect to opto-coupler's emitter. Internally limited to 5.5V.
2	GND	Ground
3	SW	Switch Output. Connect to emitter of the high voltage NPN.

ABSOLUTE MAXIMUM RATINGS

(Note: Do not exceed these limits to prevent damage to the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

PARAMETER	VALUE	UNIT
FB/VDD Supply Voltage	-0.3 to 6	V
FB/VDD Current	20	mA
SW Voltage	-0.3 to 18	V
Continuous SW Current	Internally limited	A
Maximum Power Dissipation	0.6	W
Operating Junction Temperature	-40 to 150	°C
Storage Temperature	-55 to 150	°C
Lead Temperature (Soldering, 10 sec)	300	°C

ELECTRICAL CHARACTERISTICS

($V_{FB/VDD}$ = 4V, T_J = 25°C unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT
FB/VDD Start Voltage	V_{START}	Rising edge		4.75	5	5.25	V
SW Start Voltage	$V_{SWSTART}$	SW must be higher than this voltage during start up in order to charge FB/VDD to V_{START}			8.6	10.5	V
SW Under-voltage Threshold	V_{SWMIN}				5.6		V
FB/VDD Under-voltage Threshold	V_{UV}	Falling edge		3.17	3.35	3.53	V
FB/VDD Clamp Voltage		10mA		5.15	5.45	5.75	V
Startup Supply Current	$I_{DDSTART}$	$V_{FB/VDD}$ = 4V before V_{UV}			0.23	0.45	mA
Supply Current	I_{DD}				0.7	1	mA
Switching Frequency	f_{SW}	ACT30A		50	65	85	kHz
		ACT30B/C		95	130	170	
Maximum Duty Cycle	D_{MAX}	$V_{FB/VDD}$ = 4V, I_{SW} = 10mA		67	75	83	%
Minimum Duty Cycle	D_{MIN}	$V_{FB/VDD}$ = 4.6V, I_{SW} = 100mA			3.5		%
Current Limit	I_{LIM}	$V_{FB/VDD}$ = V_{UV} + 0.1V	ACT30A/B		400		mA
			ACT30C		800		
FB/VDD to SW Current Gain	G_{FB}	ACT30A/B			-0.29		A/V
		ACT30C			-0.15		
FB/VDD Dynamic Impedance	$R_{FB/VDD}$				9		kΩ
Switch On-Resistance	R_{SW}	I_{SW} = 0.05A	ACT30A/B		3.6		Ω
			ACT30C		1.8		
SW Rise Time		1nF load, 15Ω pull-up			30		ns
SW Fall Time		1nF load, 15Ω pull-up			20		ns
SW Switch Off Current		Switch in off-state, V_{SW} = 10V			12	30	μA

FUNCTIONAL DESCRIPTION

Figure 2 is a *Functional Block Diagram* of the ACT30. The main components include a current-mode PWM control circuitry, an on-chip MOSFET, a bandgap reference, an oscillator, and voltage detector circuitry.

The internal power MOSFET drives the emitter of an external high voltage NPN transistor. This allows faster switching action because the external device turn-off storage time is reduced. In addition, the emitter-drive method takes advantage of the high V_{CBO} of the transitor, allowing a low cost transistor such as '13003 (V_{CBO} = 700V) or '13002 (V_{CBO} = 600V) to be used for wide AC input range. An additional advantage of using an external NPN is lower EMI. (See *External Power Transistor* in *Application Information* section).

STARTUP SEQUENCE

Figure 1 shows a *Simplified Application Circuit* for the ACT30. Initially, the small current through resistor R1 charges up the capacitor C1, and the BJT or N-MOSFET acts as a follower to bring up the SW voltage. An on-chip switch pulls FB/VDD voltage towards SW. When FB/VDD voltage reaches the V_{START} = 5V, the internal SW-FB/VDD startup switch opens and FB/VDD starts decreasing due to its current consumption. As FB/VDD voltage decreases below 4.75V, the IC starts to enter constant frequency PWM mode with increasing switch current for lower FB/VDD voltage. When the output voltage reaches regulation point, the opto-coupler supplies FB/VDD current from C1. The switching action also allows the auxiliary windings to take over in supplying the C1 capacitor. Figure 3 shows a typical startup sequence for the ACT30.

CURRENT-MODE FEEDBACK CONTROL

The current-mode feedback function is accomplished by connecting FB/VDD to the emitter of the opto-coupler to detect the regulation voltage. The FB/VDD voltage controls the MOSFET peak current according to the following transfer function equation:

$I_{SWPEAK} = -G_{FB} \bullet (4.75V - V_{FB/VDD})$

for $V_{FB/VDD}$ < 4.75V and duty cycle < 50%

When the output voltage is lower than regulation, the current into FB/VDD pin is zero and FB/VDD voltage decreases. At $V_{FB/VDD} = V_{UV}$ = 3.35V, the peak SW current has maximum value of 400mA.

PULSE SKIPPING

In standby (no load), the FB/VDD voltage is around 4.75V. The energy delivered by each switching cycle (with minimum on time of 500ns) to the output causes FB/VDD voltage to increase slightly above 4.75V and the IC stops switching until FB/VDD is below 4.75V again. This pulse-skipping action results is low power consumption in standby mode because the switching frequency is reduced.

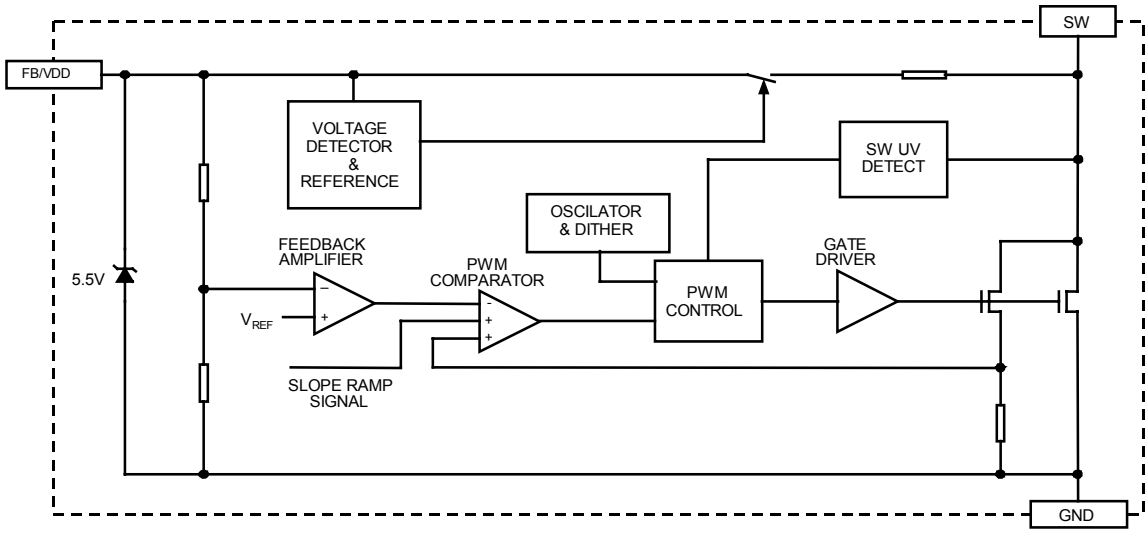


Figure 2. Functional Block Diagram

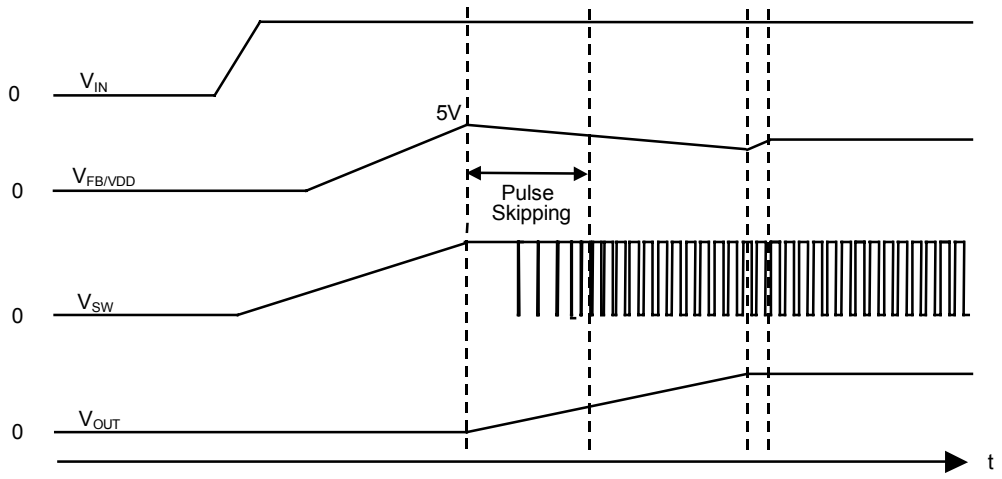


Figure 3. Startup Waveforms

SHORT CIRCUIT HICCUP

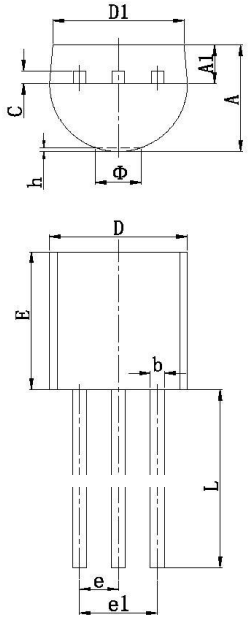
When the output is short circuited, the ACT30 enters hiccup mode operation. As seen from Figure 2, the SW Under-voltage Detector compares SW voltage to 5.6V during the off-time of each cycle. If SW voltage does not go above 5.6V, the PWM Controller will not start the next cycle. The FB/VDD voltage will then fall below Under-Voltage Lockout and reset the IC. The circuit then goes into a restart mode and continues this hiccup behavior until the short circuit is removed. Because the effective duty cycle is very low, the short circuit current is only (TBD) mA.

FREQUENCY DITHER

The ACT30 switching frequency is dithered ±5.6kHz with modulation frequency of 1kHz to reduce EMI peaks at the switching frequency and at its harmonics.

PACKAGE OUTLINE

TO-92 PACKAGE OUTLINE AND DIMENSIONS



SYMBOL	DIMENSION IN MILIMETERS		DIMENSION IN INCHES	
	MIN	MAX	MIN	MAX
A	3.300	3.700	0.130	0.146
A1	1.100	1.400	0.043	0.055
b	0.380	0.550	0.015	0.022
c	0.360	0.510	0.014	0.020
D	4.400	4.700	0.173	0.185
D1	3.430		0.135	
E	4.300	4.700	0.169	0.185
e	1.270 TYP		0.050 TYP	
e1	2.440	2.640	0.096	0.104
L	14.100	14.500	0.555	0.571
Φ		1.600		0.063
h	0.000	0.380	0.000	0.015