

LOW POWER PWM SWITCH FOR OFF-LINE SMPS

AP3902

General Description

The AP3902 PWM power switch consists of a fixed-frequency current-mode PWM controller and a high voltage transistor. It is specifically designed for high performance off-line switching power supplies or non-isolated small household applications. Compared to discrete MOSFET and PWM controller power supply solutions, AP3902 solution offers advantages such as fewer component numbers, smaller size, and lower total cost.

In normal operation, the AP3902 features with a fixed switching frequency. When the output power falls below a given level, the circuits automatically switches to a burst mode by skipping some switching cycles. In case of failure modes like open loop, over voltage or overload due to short circuit, the device switches into auto restart mode which is controlled by the internal protection unit.

This IC adopts frequency dithering technique to reduce EMI.

The AP3902 is available in DIP-8 package.

Features

- Built-in NPN Transistor with $700V_{CBO}$
- Current Mode Control with Skip Cycle Capability
- Low Operating Current: 0.45mA
- Fixed Switching Frequency: 60kHz
- Frequency Dithering for Low EMI
- Short Circuit Protection
- Open and Short Circuit Protection for Opto-Coupler
- Maximal Input Power less than 0.2W under no Load
- Output Power Range:
5W to 10W for Adapter with Outer Enclosure
5W to 13W for Open Frame Application

Applications

- Induction Cooker
- Set-Top Boxes/DVB
- Adapters
- Auxiliary Power Supplies
- DVD

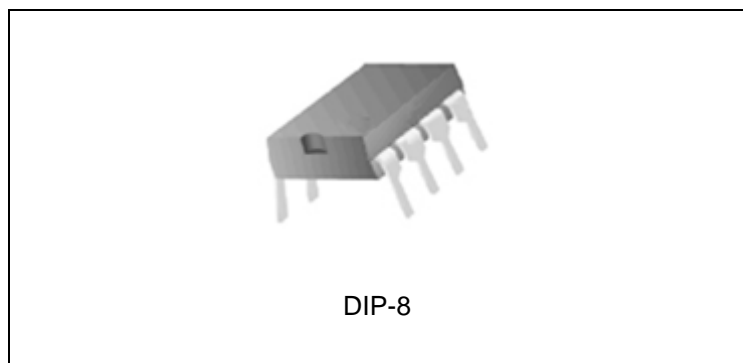


Figure 1. Package Type of AP3902

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Pin Configuration

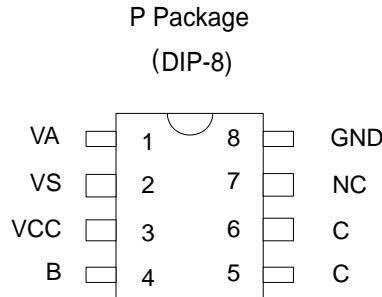


Figure 2. Pin Configuration of AP3902 (Top View)

Pin Description

Pin Number	Pin Name	Function
1	VA	This pin is used for short circuit protection, and it will be pulled to low level when short circuit happens at the load terminal
2,	VS	It is used for line voltage compensation, and PWM uses this pin to terminate the output switch conduction
3	VCC	The power supply of the IC and it is also used for the feedback control
4	B	It is internally connected with the base terminal of internal NPN transistor
5, 6	C	It is internally connected with the collector terminal of internal NPN transistor
7	NC	No connection to IC
8	GND	Supply ground



Functional Block Diagram

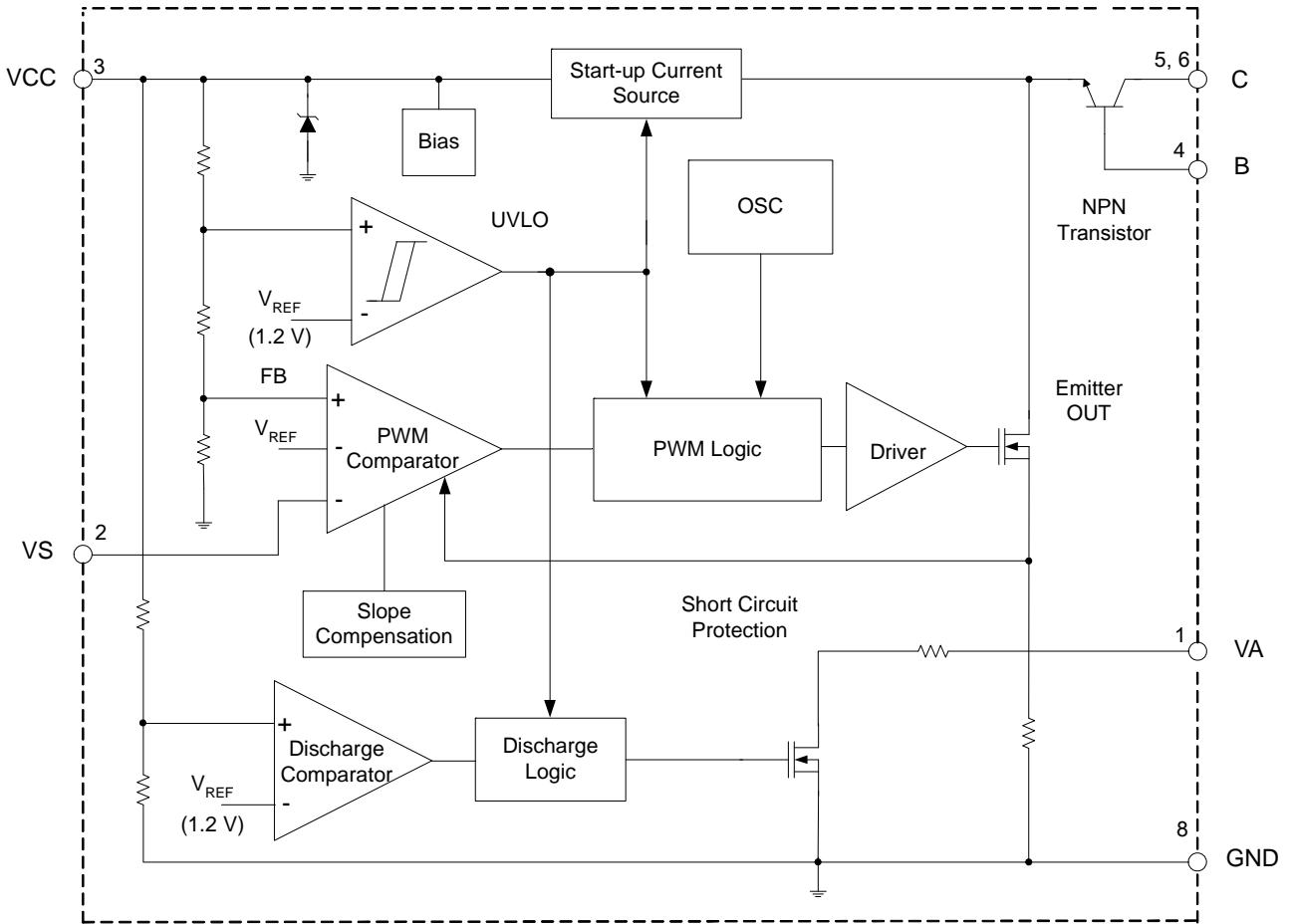


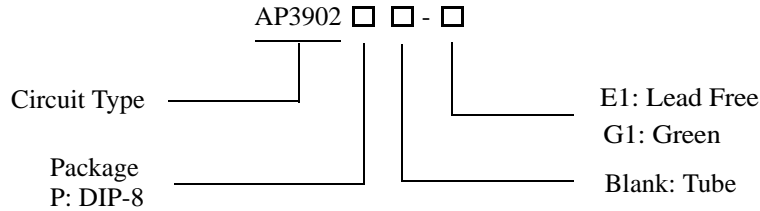
Figure 3. Functional Block Diagram of AP3902



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Ordering Information



Package	Temperature Range	Part Number		Marking ID		Packing Type
		Lead Free	Green	Lead Free	Green	
DIP-8	-40 to 85°C	AP3902P-E1	AP3902P-G1	AP3902P-E1	AP3902P-G1	Tube

BCD Semiconductor's Pb-free products, as designated with "E1" suffix in the part number, are RoHS compliant. Products with "G1" suffix are available in green packages.

Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Value	Unit
Collector Pin Voltage	V_{CES}	700	V
Voltage at the Emitter of Internal NPN Transistor	V_E	-0.3 to 40	V
Supply Voltage	V_{CC}	-0.3 to 6.3	V
Analog Input at VS	V_S	-0.3 to 6.3	V
VA Pin Voltage	V_A	-0.3 to 40	V
Continuous Collector Current		1	A
Power Dissipation		1.3	W
Operating Junction Temperature		150	°C
Storage Temperature		-65 to 150	°C
Lead Temperature (Soldering, 10s)		300	°C
ESD (Human Body Model)		3000	V

Note 1: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.



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Electrical Characteristics

($V_{CC}=4V$, $T_J=25^{\circ}C$, unless otherwise specified.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Power Transistor Section						
Collector-Emitter Breakdown Voltage	V_{CES}	$V_{BE}=0$, $I_{CE}=100\mu A$	700			V
Collector-Emitter Saturation Voltage	$V_{CE, SAT}$	$I_C=0.5A$, $I_B=0.1A$			0.3	V
DC Current Gain	h_{FE}	$I_C=0.5A$, $V_{CE}=2V$	13	18	30	
UVLO Section						
Turn on Threshold Voltage	$V_{CC(on)}$		5.00	5.25	5.50	V
Turn off Threshold Voltage	$V_{CC(off)}$		3.37	3.55	3.73	V
Discharge Voltage	V_{DIS}		2.7	2.9	3.1	V
Standby Current Section						
Start-up Current	I_{ST}	$V_{CC} = 4V$		0.22	0.4	mA
Operating Current	$I_{CC(op)}$			0.45	0.7	
VCC Zener Voltage	V_Z	$I_{CC}=5mA$	6.5			V
Dynamic Impedance	R_{VCC}	$V_{CC} = 3.8V$ to $4.8V$		18	26	k Ω
Internal Oscillator Section						
Switching Frequency	f_{SW}		55	60	70	kHz
Frequency Dithering			± 2	± 3.5	± 5	
Temperature Stability		-40 to $85^{\circ}C$		5	10	%
Driver and Output Section						
OUT Turn on Voltage	$V_{OUT(on)}$			8.5	11	V
OUT Turn off Voltage	$V_{OUT(off)}$		4.8	6	7.2	V
Rise Time	t_R	$C_L=1nF$, 15Ω pull-up		60		ns
Fall Time	t_F	$C_L=1nF$, 15Ω pull-up		30		
Maximum Duty Cycle	D_{MAX}	$V_{CC(off)} + 0.2V$	68	75	82	%
Minimum Duty Cycle		$V_{CC}=V_{CC(on)} - 0.2V$		3		
Driver OUT On-Resistance	R_{OUT}	$I_{OUT}=0.7A$		2.5	4	Ω
Switch Off Current		Driver off, $V_{OUT}=10V$		20	40	μA
Effective Current Limit	I_{LIM}	$V_{CC}=V_{CC(off)} + 0.5V$	680	800	920	mA



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Thermal Impedance

Parameter	Symbol	Value	Unit
Junction to Ambient	$R_{\theta JA}$	60	°C/W
Junction to Case	$R_{\theta JC}$	30	

Typical Performance Characteristics

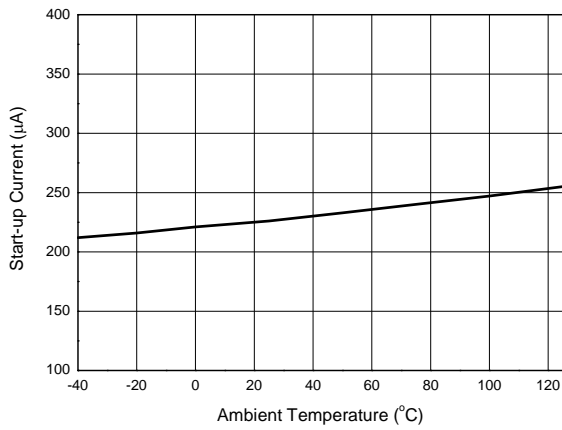


Figure 4. Start-up Current vs. Ambient Temperature

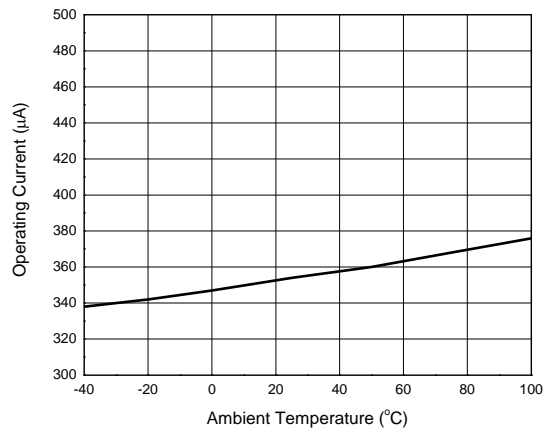


Figure 5. Operating Current vs. Ambient Temperature

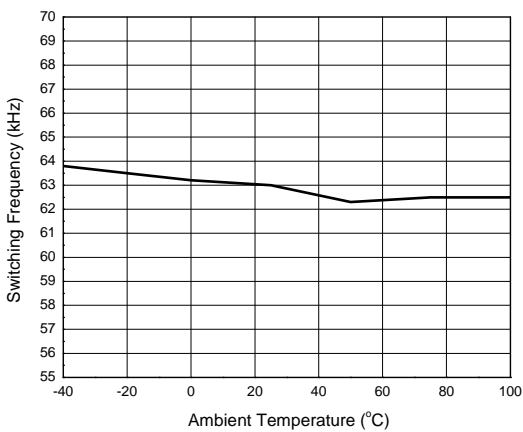


Figure 6. Switching Frequency vs. Ambient Temperature

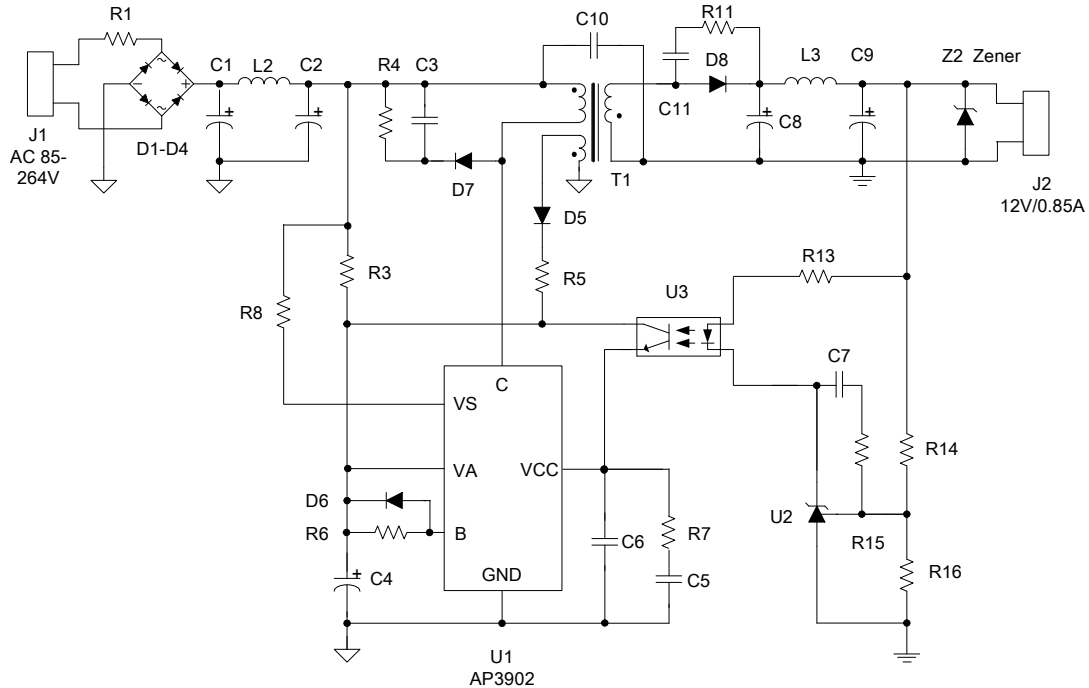
Typical Application


Figure 7. 12V/0.85A Off-Line Adapter Application Circuit

Part Type	Designator	Part Type	Designator
Resistor, NTC Resistor, 5 Ω	R1	Capacitor, 10 μ F/400V	C1, C2
Resistor, 2 M Ω , 1206	R3	Capacitor, 2200pF	C3
Resistor, 68 k Ω , 1206	R4	Capacitor, 10 μ F	C4, C5
Resistor, 3 Ω , 1206	R5	Capacitor, 22nF, 0805	C6
Resistor, 240 Ω , 0805	R6	Capacitor, 0.47 μ F, 0805	C7
Resistor, 2k Ω , 0805	R7	Electrolytic Capacitor, 1000 μ F	C8
Resistor, 5.1 M Ω	R8	Electrolytic Capacitor, 220 μ F	C9
Resistor, 15 Ω , 1206	R11	Y Capacitor, 2200pF	C10
Resistor, 200 Ω , 0805	R13	Capacitor, 1nF, 0805	C11
Resistor, 12k Ω , 0805	R14	AP3902, DIP-8	U1
Resistor, 4.7k Ω , 0805	R15	AZ431, TO-92	U2
Resistor, 3.1k Ω , 0805	R16	Opto-Coupler, PC817, DIP-4	U3
Diode, 1N4007, DO-41	D1 to D4	Inductor, 300 μ H/0.3A	L2
Diode, 1N4148	D5, D6	Inductor, 10 μ H/1A	L3
Diode, FR107, DO-15	D7	Transformer, EE-20	T1
Diode, 3100, DO-201	D8	Zener, 13V/1W	Z2



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