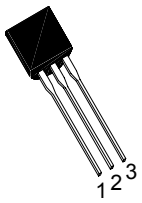
AX950

Current-Mode PWM Power Supply Controller

AX950 Pin Assignment



3-Lead Plastic **TO-92**
Package Code: A
Pin 1: FB/VDD
Pin 2: GND
Pin 3: SW

Description

The AX950 is a current-mode PWM power supply controller. The Main components include a current-mode PWM control circuitry, a 3.0Ω power MOSFET, a bandgap reference, an oscillator, and voltage detector circuitry. It 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. Operating at 60KHz switching frequency, the AX950 is capable of delivering up to 5W yet consumes under 0.3W in standby. Its safety features include over-current and under-voltage protection mechanisms.

Features

- Current-Mode PWM
- TO-92 Package, Lowest Total Cost Solution
- Consumes under 0.3W in Standby
- Emitter Drive of External NPN
- Low EMI
- Over-Current and under-Voltage Protection
- 60KHz Switching Frequency

Applications

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

Pin Connections

Pin No.	Pin Name	Pin Description
1	FB/VDD	Feedback input and supply voltage. Connect to opto-coupler's emitter. Internally limited to 5.7V.
2	GND	Ground
3	SW	Switch Output. Connect to emitter of the high voltage NPN.

Absolute Maximum Rating

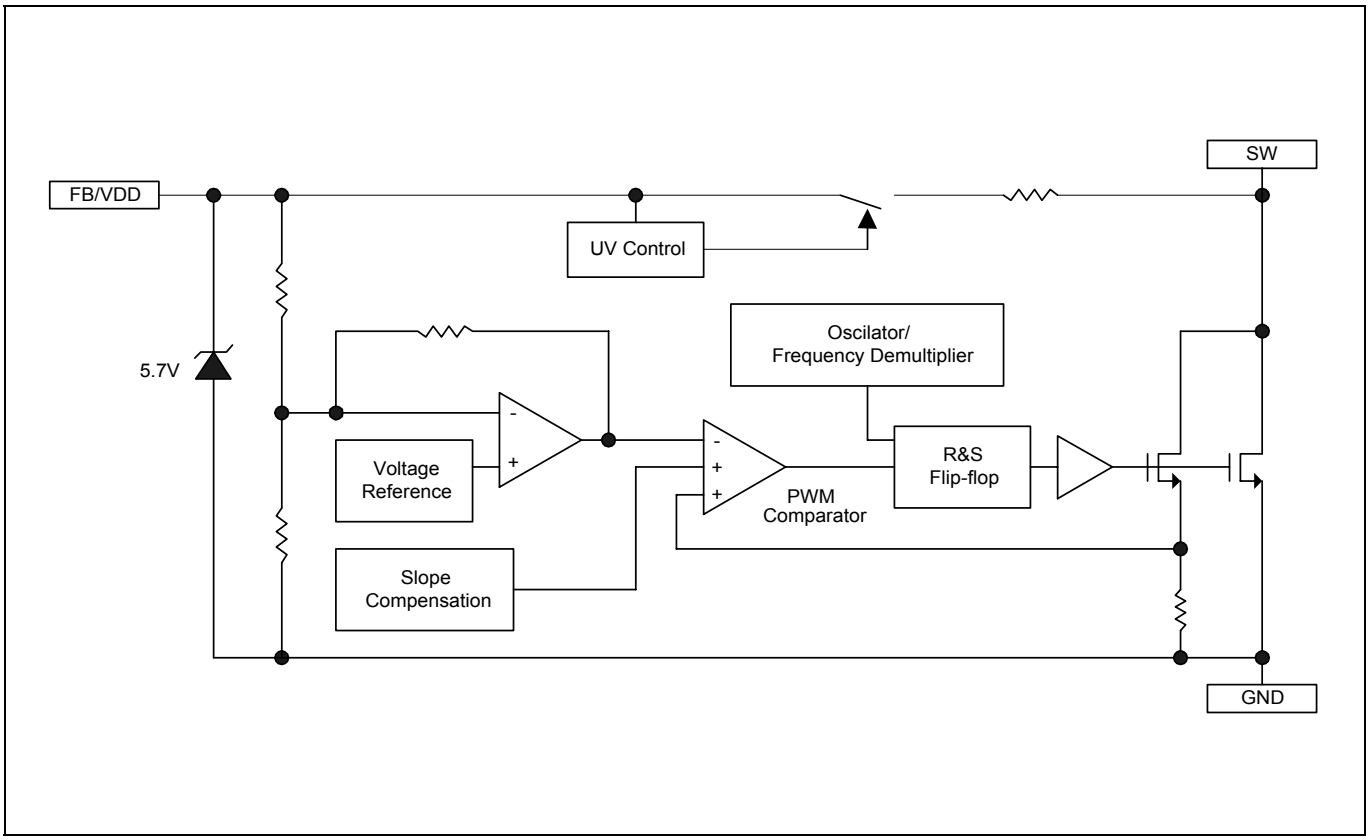
Parameter	Value	Unit
FB/VDD Supply Voltage	-0.3~5.9	V
FB/VDD Current	20	mA
SW Voltage	-0.3~18	V
Continuous SW Current	Internally Limited	mA
Maximum Power Dissipation	0.6	W
Operating Temperature	-40~+85	°C
Operating Junction Temperature	-40~+150	°C
Storage Temperature Range	-55~+150	°C

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

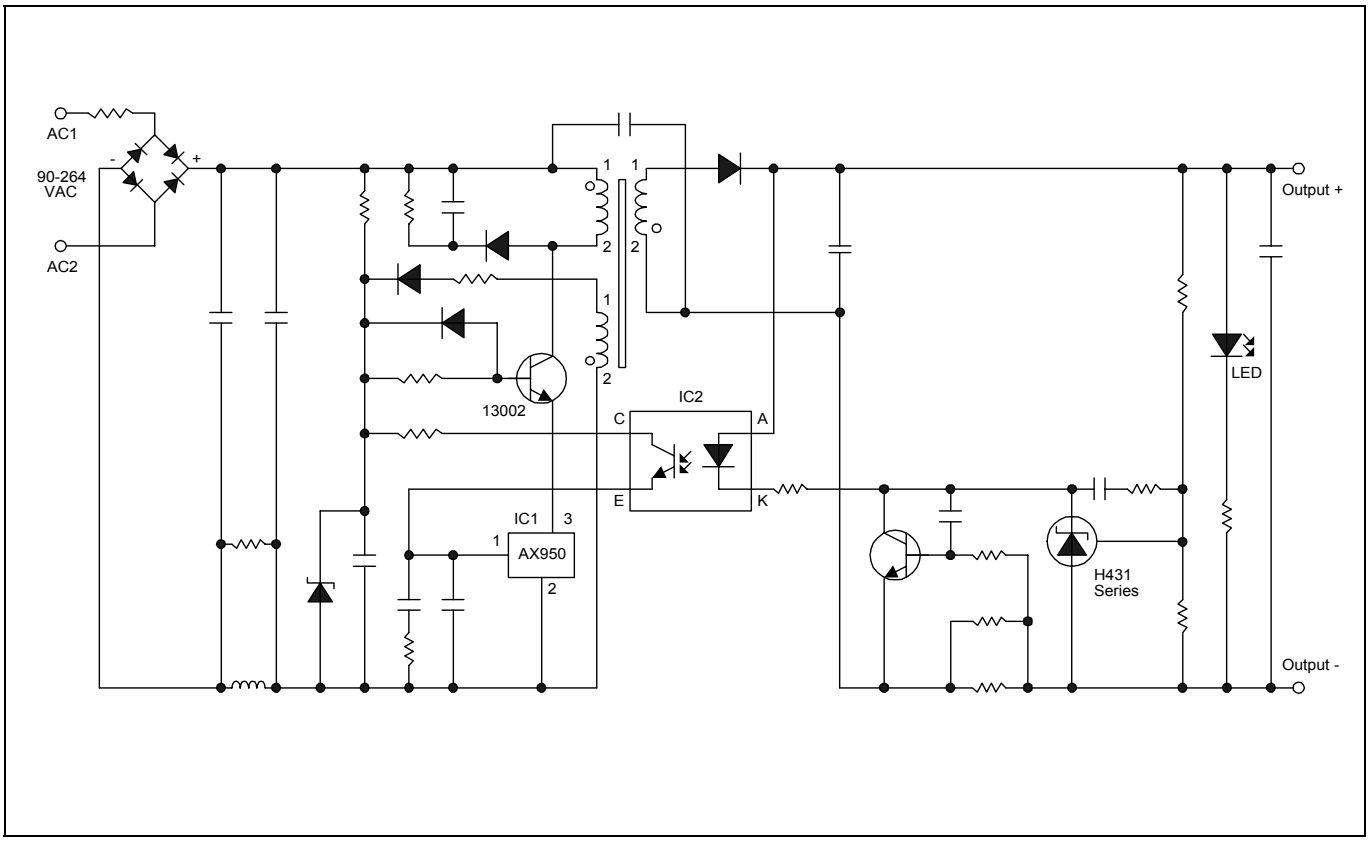
Electrical Characteristics ($V_{FB/VDD}$=4V, T_A=25°C, unless otherwise specified)

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
FB/VDD Start Voltage	V_{START}	Rising edge	4.5	5	5.7	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}	-	6.8	11.5	V
FB/VDD Under-voltage Threshold	V_{UV}	Falling edge	3.4	3.6	4.2	V
FB/VDD Clamp Voltage	V_Z	10mA	5.53	5.72	5.9	V
Startup Supply current	$I_{DDSTART}$	$V_{FB/VDD}$=4V before V_{UV}	-	0.18	0.24	mA
Supply Current	I_{DD}		-	0.4	0.8	mA
Switching Frequency	f_{SW}		50	60	70	KHz
Maximum Duty Cycle	D_{MAX}	$V_{FB/VDD}$=4V, I_{SW}=10mA	60	75	85	%
Minimum Duty Cycle	D_{MIN}	$V_{FB/VDD}$=4.6V, I_{SW}=100mA	-	3.8	-	%
Current Limit	I_{LIM}	$V_{FB/VDD}$=V_{UV}+0.1V	-	370	-	mA
Switch On-Resistance	R_{SW}	I_{SW}=50mA	-	3.0	-	Ω
SW Switch Off Current	I_{off}	Switch in off-state, V_{SW}=10V	-	25	30	uA

Block Diagram



Typical Application Circuit



Function Description

The Block Diagram shows the main components and switching control logic, including two power MOSFETs with current sensor, driver, oscillator/Frequency Demultiplier, UV control, Voltage Reference, Slope compensation and clamp zener diode at FB/VDD terminal.

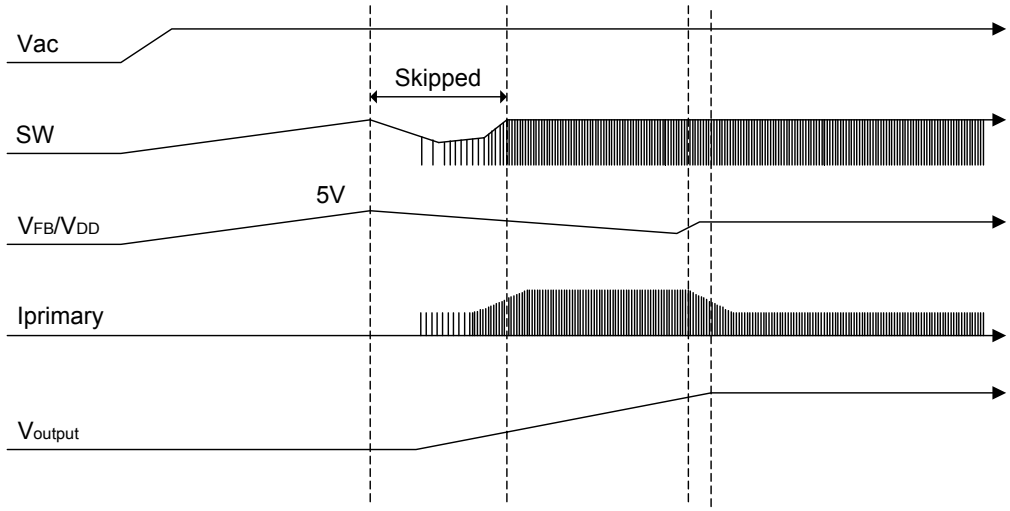
There FB/VDD is the power supply and feedback terminal, SW is driver output that can drive the emitter of an external high voltage NPN transistor or N-MOSFET. This emitter-drive method takes advantage of the high VCBO of the transistor, it is differ from base-drive method using VCEO of transistor.

The driver peak current is designed to have a negative voltage coefficient with respect to supply voltage FB/VDD, so that lower FB/VDD voltage results in higher SW peak current, but the current can not higher than 370mA. In this way, the feedback loop can control the driver current directly.

Startup Sequence

As seen in Block Diagram, initially, a small current through the SW charges up the capacitor on FB/VDD terminal. When FB/VDD crosses 5.0V the FB/VDD charge current is stopped and the FB/VDD voltage begins to drop due to its current consumption, the AX950 starts to work with increasing SW current. When the output voltage reaches regulation point, the photocoupler feedback loop stops FB/VDD from decreasing further, and AX950 works continually.

Even though up to 3MΩ startup resistor can be used due to the very low startup current, the actual startup resistor value should be chosen as a compromise between standby power and startup time delay.



Startup Waveforms

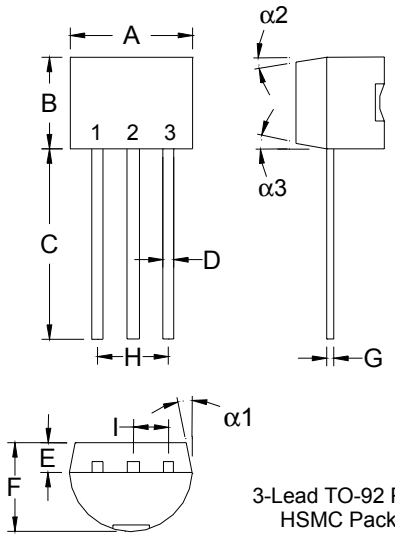
Pulse Skipping

At very light load, the FB/VDD voltage is around 5.0V, the AX950 operates at minimum duty cycle condition, some pulses will be skipped to keep output voltage is constant. This results low power consumption due to the reduced operate pulses. Typical system standby power consumption is 0.2W.

Short Circuit Hiccup

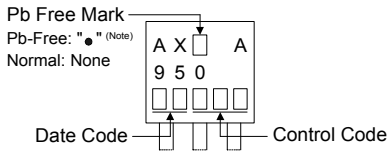
When the output is shorted, the AX950 enters hiccup mode operation. In this condition, the auxiliary supply voltage collapses. An on-chip detector compares SW voltage during the off-time of each cycle to 6.8V. If SW voltage is below 6.8V, the AX950 will not start the next cycle, causing both the auxiliary supply voltage and FB/VDD to reduce further. The circuit enters starup mode when FB/VDD drops below 3.4V. This hiccup behavior continues until the short circuit is removed. In this behavior, the effective duty cycle is very low resulting in very low short circuit current.

TO-92 Dimension



3-Lead TO-92 Plastic Package
HSMC Package Code: A

Marking:



Note: Green label is used for pb-free packing

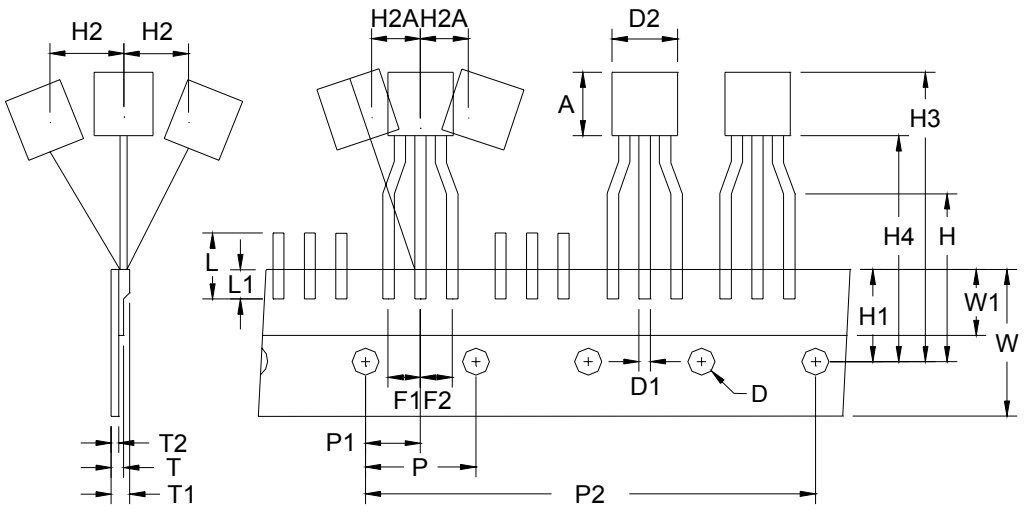
Pin Style: 1.FB/VDD 2.GND 3.SW

Material:
- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	4.33	4.83
B	4.33	4.83
C	12.70	-
D	0.36	0.56
E	-	*1.27
F	3.36	3.76
G	0.36	0.56
H	-	*2.54
I	-	*1.27
α1	-	*5°
α2	-	*2°
α3	-	*2°

*: Typical, Unit: mm

TO-92 Taping Dimension



DIM	Min.	Max.
A	4.33	4.83
D	3.80	4.20
D1	0.36	0.53
D2	4.33	4.83
F1,F2	2.40	2.90
H	15.50	16.50
H1	8.50	9.50
H2	-	1
H2A	-	1
H3	-	27
H4	-	21
L	-	11
L1	2.50	-
P	12.50	12.90
P1	5.95	6.75
P2	50.30	51.30
T	-	0.55
T1	-	1.42
T2	0.36	0.68
W	17.50	19.00
W1	5.00	7.00

Unit: mm

Head Office And Factory:

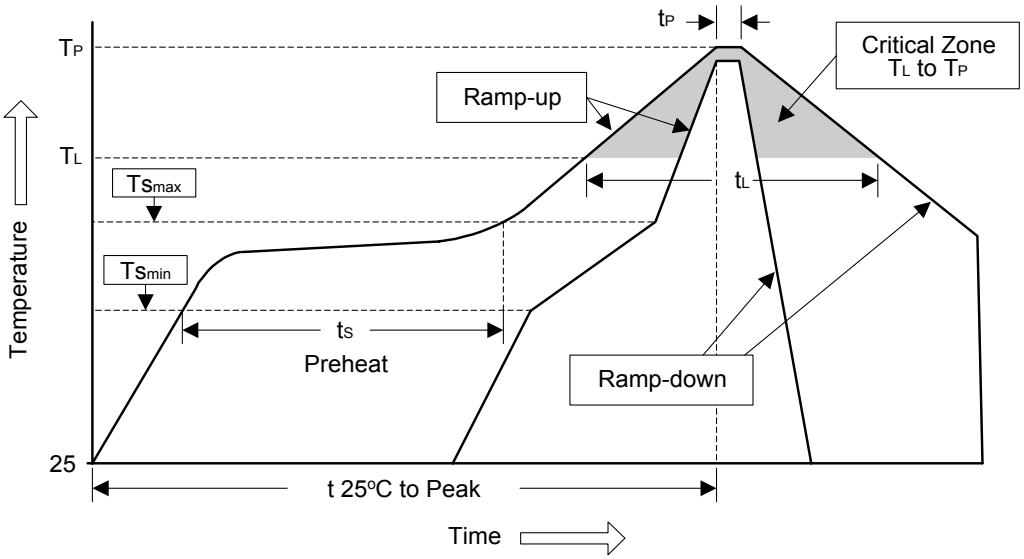
- **Head Office** (Hi-Sincerity Microelectronics Corp.): 10F.,No. 61, Sec. 2, Chung-Shan N. Rd. Taipei Taiwan R.O.C.
  Tel: 886-2-25212056 Fax: 886-2-25632712, 25368454
- **Factory 1:** No. 38, Kuang Fu S. Rd., Fu-Kou Hsin-Chu Industrial Park Hsin-Chu Taiwan. R.O.C
  Tel: 886-3-5983621~5 Fax: 886-3-5982931

Soldering Methods for HSMC's Products

1. Storage environment: Temperature=10°C~35°C Humidity=65%±15%

2. Reflow soldering of surface-mount devices

Figure 1: Temperature profile



Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	<3°C/sec	<3°C/sec
Preheat - Temperature Min (Ts_{min}) - Temperature Max (Ts_{max}) - Time (min to max) (ts)	 100°C 150°C 60~120 sec	 150°C 200°C 60~180 sec
Tsmax to T_L - Ramp-up Rate	 <3°C/sec	 <3°C/sec
Time maintained above: - Temperature (T_L) - Time (t_L)	 183°C 60~150 sec	 217°C 60~150 sec
Peak Temperature (T_P)	240°C +0/-5°C	260°C +0/-5°C
Time within 5°C of actual Peak Temperature (t_P)	10~30 sec	20~40 sec
Ramp-down Rate	<6°C/sec	<6°C/sec
Time 25°C to Peak Temperature	<6 minutes	<8 minutes

3. Flow (wave) soldering (solder dipping)

Products	Peak temperature	Dipping time
Pb devices.	245°C ±5°C	10sec ±1sec
Pb-Free devices.	260°C ±5°C	10sec ±1sec