iW1690

Low-Power Off-line Digital PWM Controller

1.0 Features

- Primary-side feedback eliminates opto-isolators and simplifies design
- Direct drive of BJT switching device
- Multi-mode operation for highest overall efficiency
- ±4% output voltage regulation
- No external compensation components required
- Complies with CEC/EPA no load power consumption and average efficiency regulations
- Built-in precise secondary constant-current control with primary-side feedback
- Low start-up current (10 µA typical)
- Built-in soft start
- Built-in short circuit protection
- AC line under/overvoltage and output overvoltage protection
- Fixed 65 kHz switching frequency
- Base current adjustment
- Dynamic base current control

2.0 Description

The iW1690 is a high performance AC/DC power supply controller which uses digital control technology to build peak current mode PWM flyback power supplies. The device directly drives a BJT switching device and provides high efficiency along with a number of key built-in protection features while minimizing the external component count and bill of material cost. The iW1690 removes the need for secondary feedback circuitry while achieving excellent line and load regulation. It also eliminates the need for loop compensation components while maintaining stability over all operating conditions. Pulse-by-pulse waveform analysis allows for a loop response that is much faster than traditional solutions, resulting in improved dynamic load response. The built-in power limit function enables optimized transformer design in universal off-line applications and allows for a wide input voltage range.

The ultra-low start-up power and operating current at light load ensure that the iW1690 is ideal for applications targeting the newest regulatory standards for average efficiency and standby power.

3.0 Applications

- Low power AC/DC adapter/chargers for cell phones, PDAs, digital still cameras
- Low power AC/DC adapter/chargers to replace RCC implementations

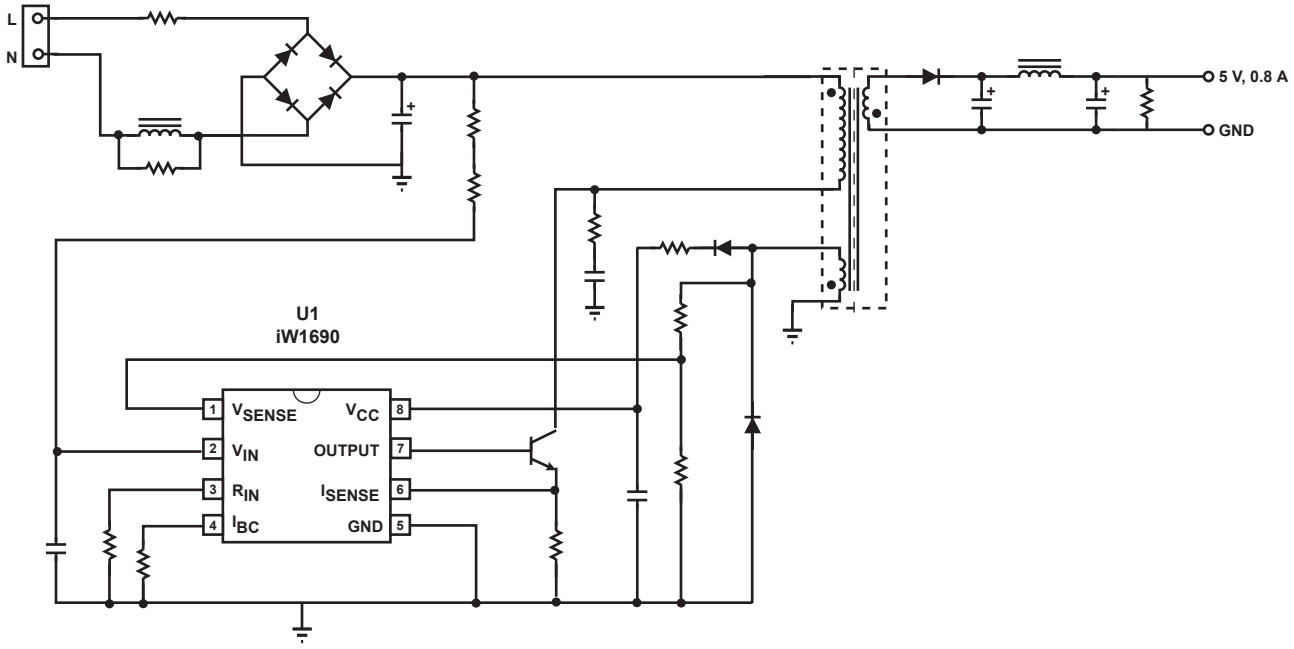
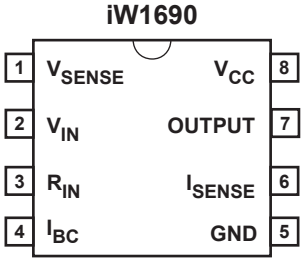


Figure 2.0.1 iW1690 Typical Application Circuit

4.0 Pinout Description



Pin #	Name	Type	Pin Description
1	V_{SENSE}	Analog Input	Auxiliary voltage sense (used for primary regulation and ZVS).
2	V_{IN}	Analog Input	Rectified AC line average voltage sense.
3	R_{IN}	Analog Input	Sense line input voltage, scale factor is 0.0043.
4	I_{BC}	Analog Input	Adjust maximum base current.
5	GND	Ground	Ground.
6	I_{SENSE}	Analog Input	Primary current sense. Used for cycle-by-cycle peak current control and limit.
7	OUTPUT	Output	Base drive for BJT
8	V_{CC}	Power Input	Power supply for control logic and voltage sense for power-on reset circuitry.

5.0 Absolute Maximum Ratings

Absolute maximum ratings are the parameteic values or ranges which can cause permanent damage if exceeded. For maximum safe operating conditions, refer to Electrical Characteristics in Section 6.0.

Parameter	Symbol	Value	Units
DC supply voltage range (pin 4, I_{CC} = 20mA max)	V_{CC}	-0.3 to 18	V
DC supply current at V_{CC} pin	I_{CC}	20	mA
Low voltage output (pin 3)		-0.3 to 18	V
V_{SENSE} input (pin 1)		-0.3 to 4.0	V
V_{IN} input (pin 5)		-0.3 to 18	V
Power dissipation at $T_A \leq 25°C$	P_D	526	mW
Maximum junction temperature	$T_{J\ MAX}$	125	°C
Storage temperature	T_{STG}	–65 to 150	°C
Lead temperature during IR reflow for ≤ 15 seconds	T_{LEAD}	260	°C
Thermal Resistance Junction-to-Ambient	θ_{JA}	160	°C/W
ESD rating per JEDEC JESD22-A114 (HBM)		2,000	V
Latch-Up test per JEDEC 78		±100	mA

6.0 Electrical Characteristics

V_{CC} = 12 V, -40°C ≤ T_A ≤ 85°C, unless otherwise specified (Note 1)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
V_{IN} SECTION (Pin 2)						
Start-up voltage low threshold	V_{INST}	T_A= 25°C, positive edge	366	407	448	mV
Start-up voltage high threshold	V_{INST}	T_A= 25°C, positive edge		1.87		V
Start-up current	$I_{IN(ST)}$	V_{CC} = 10 V		8	15	µA
Shutdown low voltage threshold	V_{UVDC}	T_A= 25°C, negative edge	216	240	264	mV
Shutdown high voltage threshold	V_{OVDC}	T_A= 25°C, positive edge	1.737	1.930	2.123	V
V_{SENSE} SECTION (Pin 1)						
Input leakage current	I_{BVS}	V_{SENSE} = 2 V			1	µA
Nominal voltage threshold	$V_{SENSE(NOM)}$	T_A=25°C, negative edge	1.507	1.538	1.569	V
Output OVP threshold	$V_{SENSE(MAX)}$	T_A=25°C, negative edge	1.667	1.700	1.734	V
OUTPUT SECTION (Pin 7)						
Output low level ON-resistance	$R_{DS(ON)LO}$	I_{SINK} = 5 mA		1.5	2.0	Ω
Output high level ON-resistance	$R_{DSON)HI}$	I_{SOURCE} = 5 mA		50	80	Ω
Rise time (Note 2, 4)	t_R	T_A = 25°C, C_L = 330 pF 10% to 90%		100		ns
Fall time (Note 2, 4)	t_F	T_A = 25°C, C_L = 330 pF 90% to 10%		10		ns
Output switching frequency (Note 3)	f_S	I_{LOAD} > 15% of maximum		65		kHz
V_{CC} SECTION (Pin 8)						
Maximum operating voltage	$V_{CC(MAX)}$				16	V
Start-up threshold	$V_{CC(ST)}$	V_{CC} rising	11	12	13	V
Undervoltage lockout threshold	$V_{CC(UVL)}$	V_{CC} falling	5.0	5.5	6.0	V
Quiescent current	I_{CCQ}	C_L = 330 pF, V_{SENSE} = 1.5 V			5.0	mA

Notes:

Note 1. Adjust V_{CC} above the start-up threshold before setting at 12 V.

Note 2. These parameters are not 100% tested, guaranteed by design and characterization.

Note 3. Frequency variation includes ±1.2% dithering for EMI suppression.

Note 4. Programmable output strength based on I_{BC} resistor.

6.0 Electrical Characteristics

V_{CC} = 12 V, -40°C ≤ T_A ≤ 85°C, unless otherwise specified (Note 1)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
I_{SENSE} SECTION (Pin 6)						
Peak limit threshold	V_{PEAK}			1.2		V
CC limit threshold	V_{CC-TH}			900		mV
R_{IN} SECTION (Pin 3)						
Input leakage current	I_{RIN}				1	mA
V_{IN} scale				0.0043		
I_{BC} SECTION (Pin 4)						
Constant current source			40		100	KΩ

Notes:

Note 1. Adjust V_{CC} above the start-up threshold before setting at 12 V.

Note 2. These parameters are not 100% tested, guaranteed by design and characterization.

Note 3. Frequency variation includes ±1.2% dithering for EMI suppression.

7.0 Typical Performance Characteristics

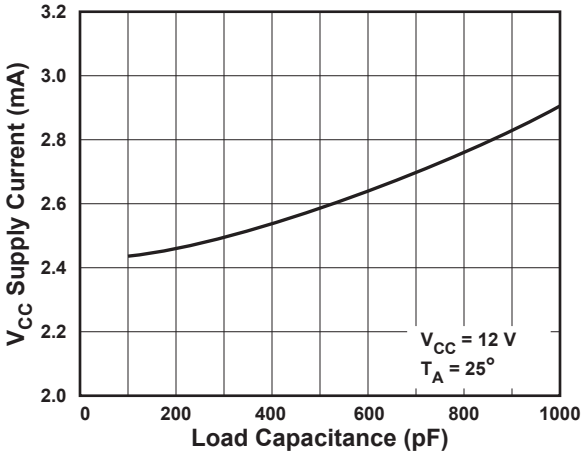


Figure 7.0.1 Supply Current vs. Load Capacitance

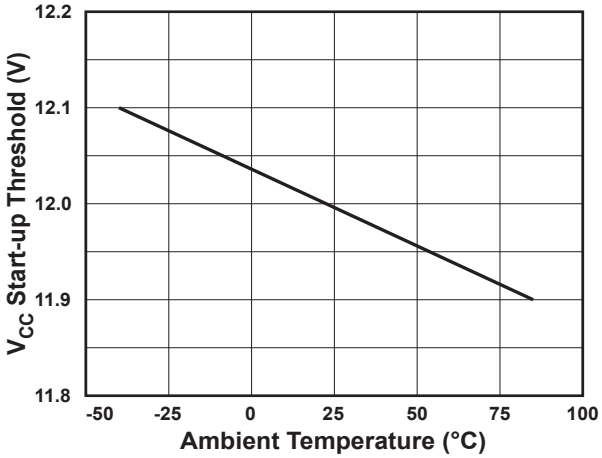


Figure 7.0.3 Start-Up vs. Temperature

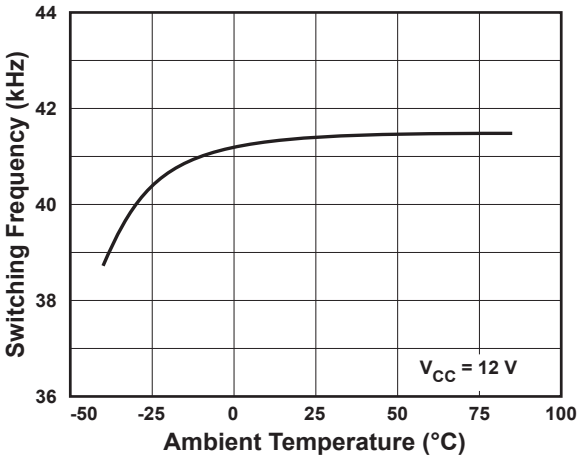


Figure 7.0.2 Switching Frequency vs. Temperature

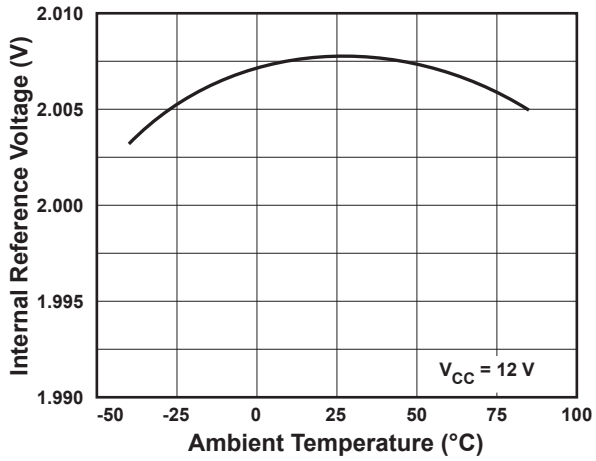


Figure 7.0.4 Internal Reference vs. Temperature

8.0 Functional Block Diagram

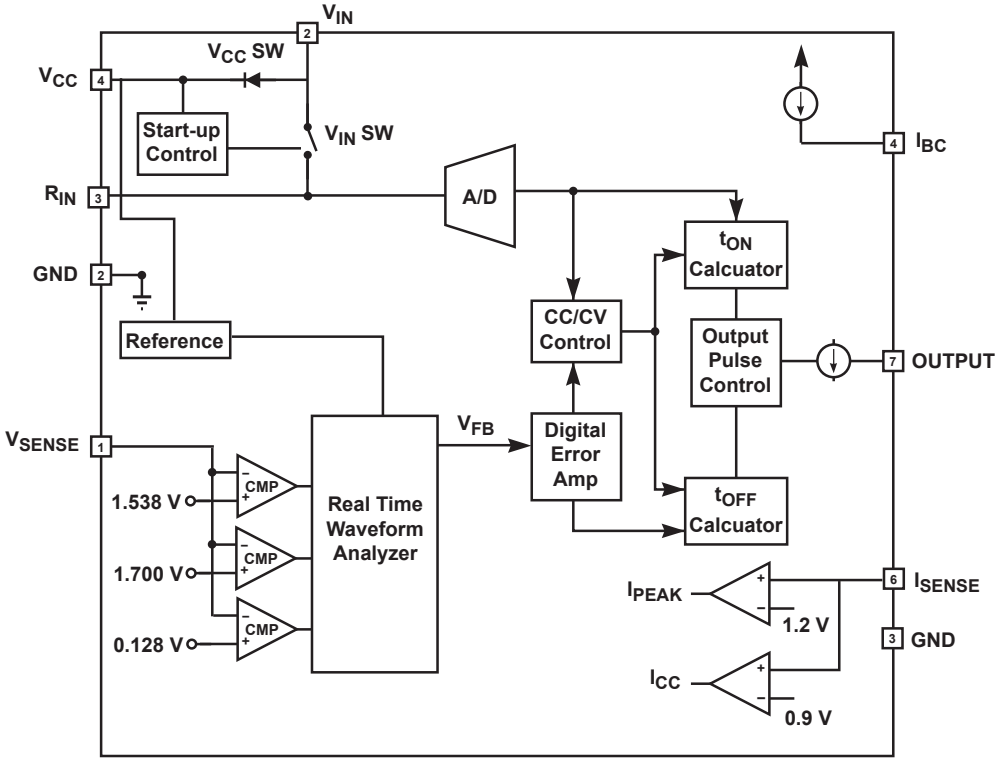


Figure 8.0.1 iW1690 Functional Block Diagram

9.0 Theory of Operation

The iW1690 is a digital controller which uses a new, proprietary primary-side control technology to eliminate the opto-isolated feedback and secondary regulation circuits required in traditional designs. This results in a low-cost solution for low power AC/DC adapters. The core PWM processor uses fixed-frequency Discontinuous Conduction Mode (DCM) operation at higher power levels and switches to variable frequency operation at light loads to maximize efficiency. Furthermore, iWatt's digital control technology enables fast dynamic response, tight output regulation, and full featured circuit protection with primary-side control.

Referring to the block diagram in Figure 8.0.1, the digital error amplifier and t_{ON}/t_{OFF} calculator blocks generate the switching on-time and off-time information based on the line voltage and the output voltage feedback signal. The system loop is automatically compensated internally by the digital error amplifier. Adequate system phase margin and gain margin are guaranteed by design and no external analog components are required for loop compensation. The iW1690 uses an advanced digital control algorithm to reduce system design time and improve reliability.

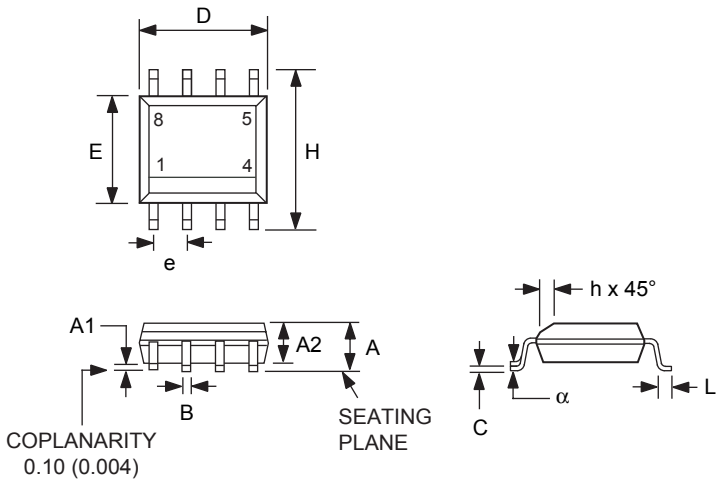
Furthermore, accurate secondary constant-current operation is achieved without the need for any secondary-side sense and control circuits.

The iW1690 uses PWM mode control at higher output power levels and switches to PFM mode at light load to minimize power dissipation to meet the Blue Angel specification. Additional built-in protection features include overvoltage protection (OVP), output short circuit protection (SCP) and soft-start.

iWatt's digital control scheme is specifically designed to address the challenges and trade-offs of power conversion design. This innovative technology is ideal for balancing new regulatory requirements for green mode operation with more practical design considerations such as lowest possible cost, smallest size and high performance output control.

12.0 Physical Dimensions

8-Lead Small Outline (SOIC) Package



Symbol	Inches		Millimeters	
	MIN	MAX	MIN	MAX
A	0.061	0.068	1.55	1.73
A1	0.0040	0.0098	0.127	0.250
A2	0.055	0.061	1.40	1.55
B	0.0138	0.0192	0.35	0.49
C	0.0075	0.0098	0.19	0.25
D	0.189	0.196	4.80	4.96
E	0.150	0.157	3.81	3.99
e	0.050 BSC		1.27 BSC	
H	0.230	0.244	5.84	6.20
h	0.010	0.016	0.25	0.41
L	0.41	0.89	0.41	0.89
a	0°	8°		

Compliant to JEDEC Standard MS-012AA
Controlling dimensions are in inches; millimeter dimensions are for reference only

Figure 12.0.1. Physical dimensions, 8-lead SOIC package

13.0 Ordering Information

Part Number	Package	Operating Temp. Range	Description
iW1690-00	SOIC-8	-40°C ≤ T_A ≤ 85°C	iW1690 PWM Controller -Tape & Reel[1]

Note 1: Tape & Reel packing quantity is 2,500 units.

About iWatt

iWatt Inc. is a fabless semiconductor company that develops intelligent power management ICs for computer, communication, and consumer markets. The company's patented *pulseTrain*™ technology, the industry's first truly digital approach to power system regulation, is revolutionizing power supply design.

Trademark Information

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