High Primary Side Control IC For Off-line Battery Chargers ME8300

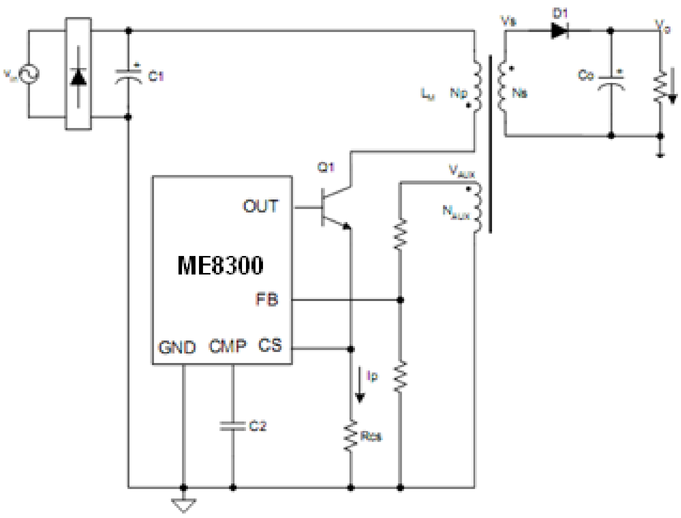
General Description

The ME8300 is a high performance AC/DC power supply controller for battery charger and adapter applications. The device uses Pulse Frequency Modulation (PFM) method to build discontinuous conduction mode (DCM) flyback power supplies. The ME8300 provides accurate constant voltage, constant current (CV/CC) regulation without requiring the opto-coupler and the secondary control circuitry. It also eliminates the need of loop compensation circuitry while maintaining stability. The ME8300 achieves excellent regulation and high power efficiency, the no-load power consumption is less than 200mW at 265VAC input. The ME8300 is available in SOP-8 package.

Features

- Primary Side Control for Rectangular Constant Current and Constant Voltage Output
- Eliminates Opto-Coupler and Secondary CV/CC Control Circuitry
- Eliminates Control Loop Compensation Circuitry
- Output Cable Resistor Compensation
- Flyback Topology in DCM Operation
- Random Frequency Modulation to Reduce System EMI
- Valley Turn on of External Power NPN Transistor
- Built-in Soft Start
- Over Voltage Protection
- Short Circuit Protection

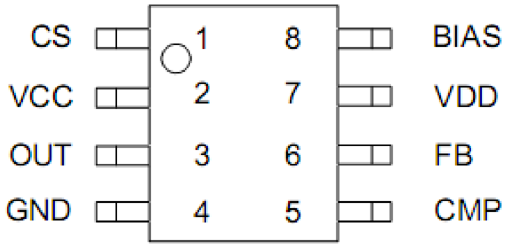
Typical Application Circuit



Typical Application

- Adapters/Chargers for Cell/Cordless Phones, PDAs, MP3 and Other Portable Apparatus
- Standby and Auxiliary Power Supplies

Pin Configuration



SOP8

Pin Assignment

Pin Number	Pin Name	Function
1	CS	The primary current sense
2	VCC	Supply voltage
3	OUT	This pin drives the base of external power NPN switch
4	GND	Ground
5	CMP	This pin connects a capacitor for output cable compensation
6	FB	The voltage feedback from the auxiliary winding
7	VDD	The 5V output of the internal voltage regulator
8	BIAS	This pin sets the bias current inside ME8300 with an external resistor to GND

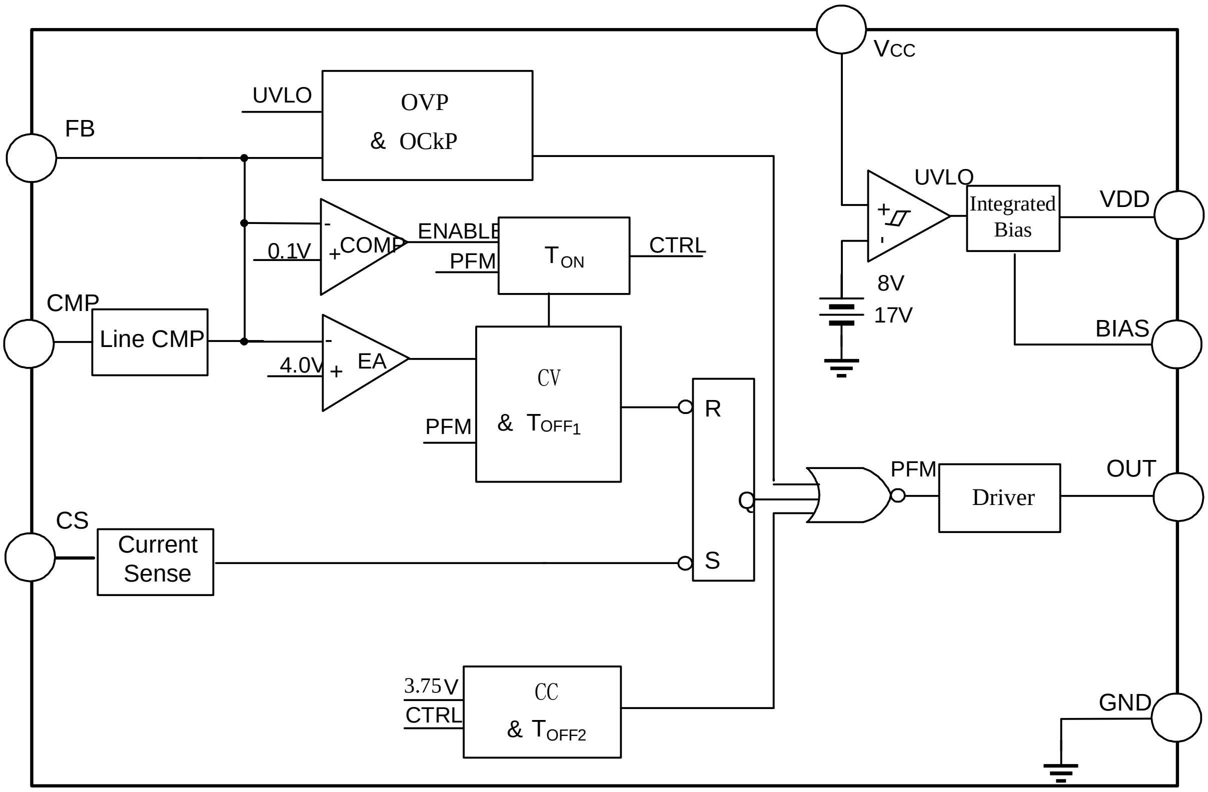
Absolute Maximum Ratings (Note 1)

Parameter	Value	Unit
Supply Voltage VCC	-0.3 to 30	V
Voltage at CS, BIAS, OUT, VDD, CMP to GND	-0.3 to 7	V
FB input (Pin 6)	-40 to 10	V
Output Current at OUT	Internally limited	A
Power Dissipation at TA=25℃	0.657	W
Operating Junction Temperature	150	℃
Storage Temperature	-65 to 150	℃
Lead Temperature (Soldering, 10s)	300	℃
Thermal Resistance Junction-to-Ambient	190	℃/W
ESD (Human Body Model)	2000	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.

Block Diagram

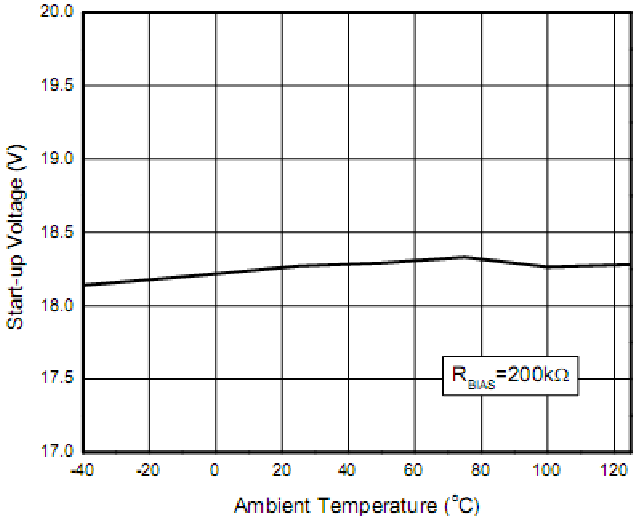


Electrical Characteristics

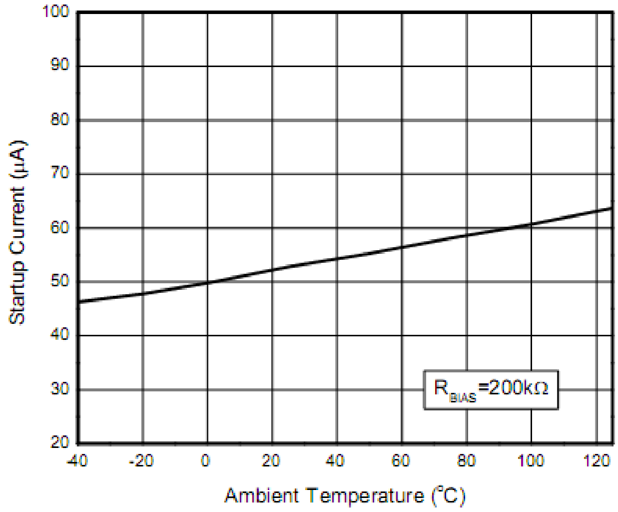
(V_{CC}=15V, TA=25℃, unless otherwise specified.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
UVLO SECTION						
Start-up Threshold	$V_{TH\ (ST)}$		17	18.5	20	V
Minimal Operating Voltage	$V_{OPR(min)}$	After turn on	7	7.7	8.4	V
REFERENCE VOLTAGE SECTION						
BIAS Pin Voltage	V_{BIAS}	R_{BIAS}=200kΩ, Before turn on	1.105	1.126	1.150	V
V_{DD} Pin Voltage	V_{DD}		4.90	5.026	5.10	V
STANDBY CURRENT SECTION						
Start-up Current	I_{ST}	$V_{CC} = V_{TH\ (ST)}$-0.5V, R_{BIAS}=200kΩ, Before turn on		50	65	μA
Operating Current	$I_{CC(OPR)}$	R_{BIAS}=200kΩ		550	700	μA
DRIVE OUTPUT SECTION						
OUT Maximum Current Sink	I_{OUT}	R_{BIAS}=200kΩ	50			mA
OUT Maximum Current Source	I_{OUT}	R_{BIAS}=200kΩ	25	30		mA
CURRENT SENSE SECTION						
Current Sense Threshold	V_{CS}		490	505	520	mV
Pre-Current Sense	$V_{CS(PRE)}$		444	458	472	mV
Leading Edge Blanking				430		ns
FEEDBACK INPUT SECTION						
Feedback Pin Input Leakage Curren	I_{FB}	V_{FB}=4V	1.72	2.15	2.58	μA
Feedback Threshold Voltage	V_{FB}		4	4.04	4.08	V
Enable Turn-on Voltage	$V_{FB(EN)}$		-1.1	-0.7	-0.5	V
Cable Compensation Voltage		f_{SW}=60kHz		0.40		V
PROTECTION SECTION						
Over Voltage Protection	$V_{FB(OVP)}$		7	8	9	V

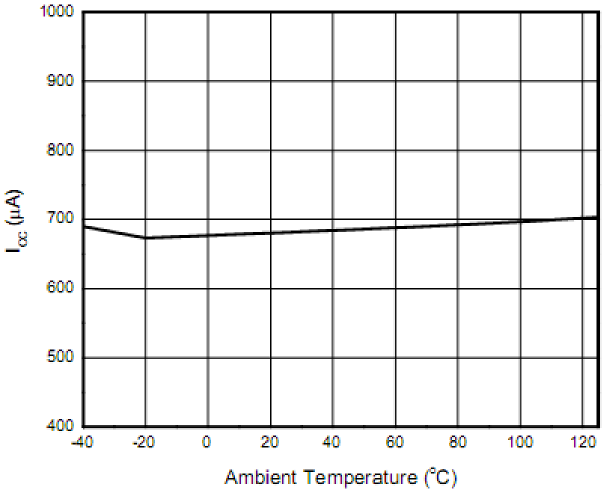
Type Characteristics



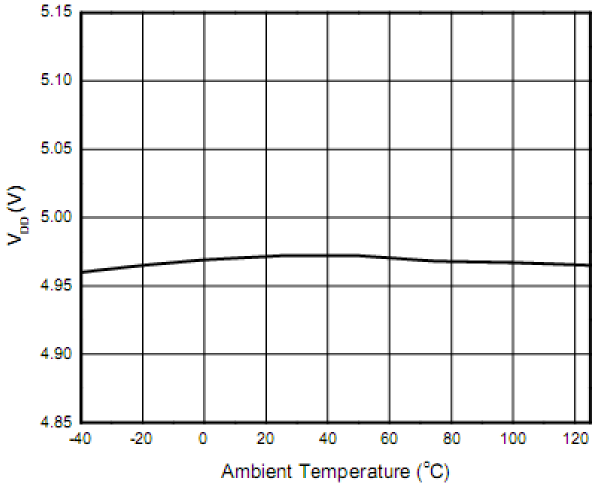
Start-up Voltage vs. Ambient Temperature



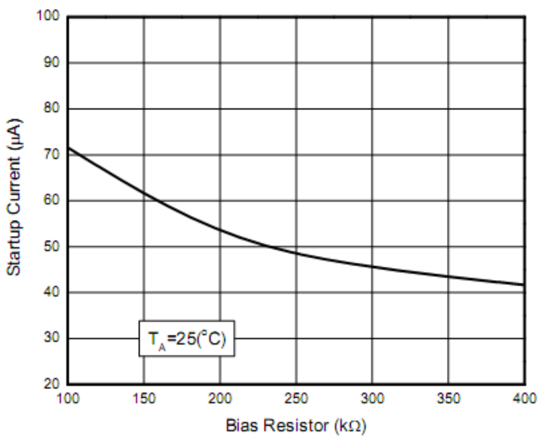
Start-up Current vs. Ambient Temperature



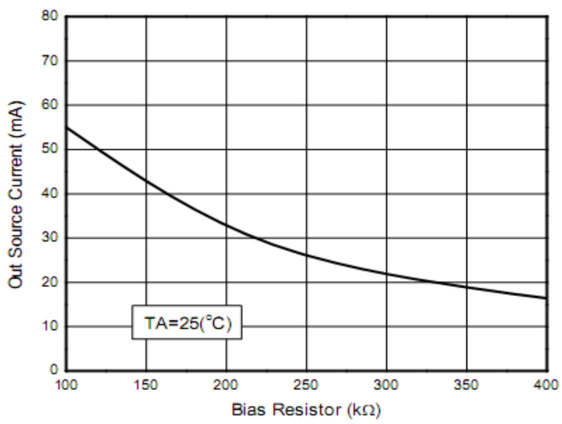
Operating Current vs. Ambient Temperature



VDD vs. Ambient Temperature

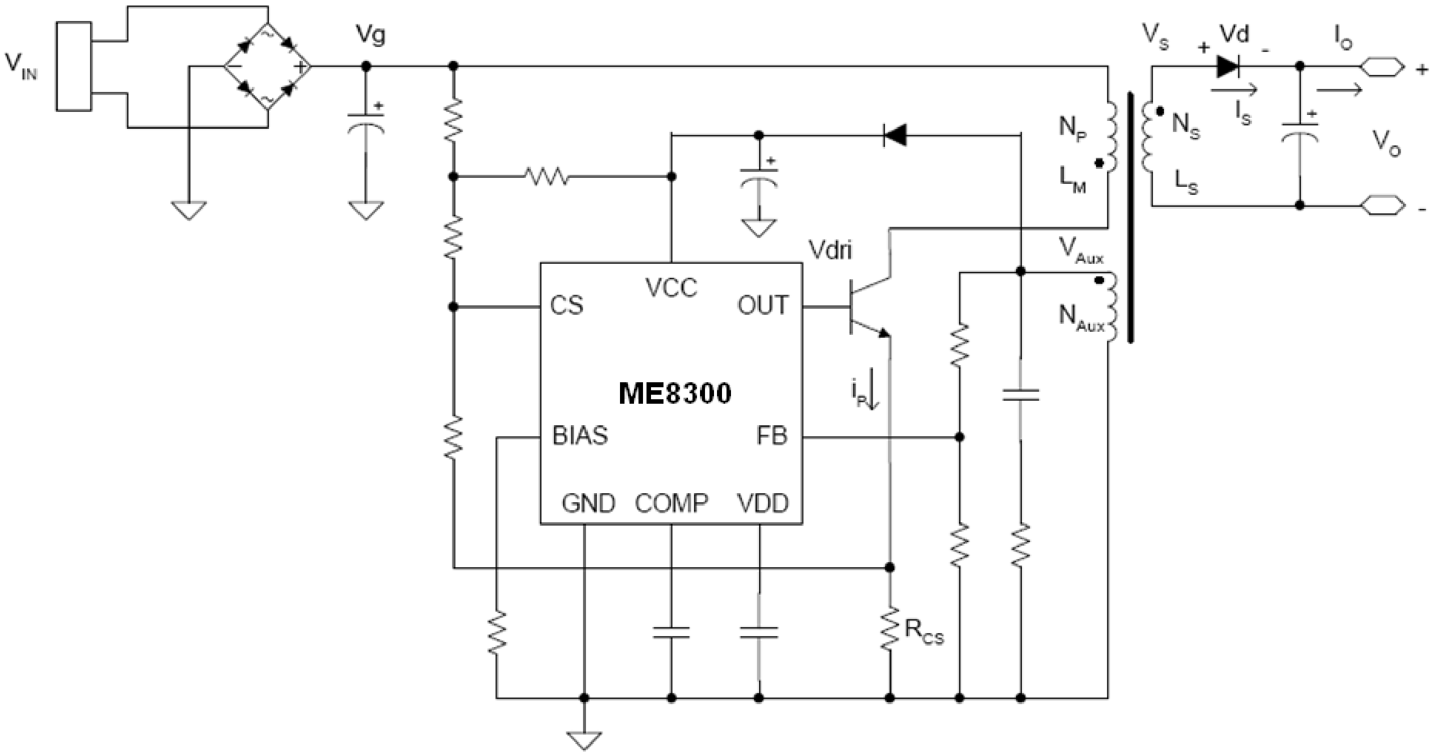


Start-up Current vs. Bias Resistor



OUT Source Current vs. Bias Resistor

Operation Description



➢ **Constant Primary Peak Current**

The primary current ip(t) is sensed by a current sense resistor RCS as shown in Figure 10.

The current rises up linearly at a rate of:

$$\frac{dip(t)}{dt}=\frac{vg(t)}{L_M} \qquad ......(1)$$

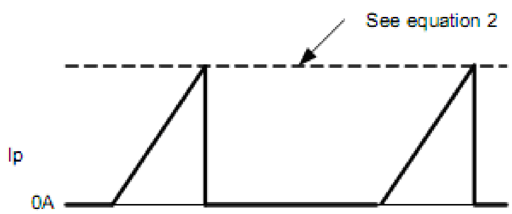


Figure 11. Primary Current Waveform

As illustrated in Figure 11, when the current ip(t) rises up to Ipk, the switch Q1 turns off. The constant peak current is given by:

$$Ipk=\frac{Vcs}{Rcs} \qquad ......(2)$$

The energy stored in the magnetizing inductance LM each cycle is therefore:

$$Eg=\frac{1}{2}\times L_M\times Ipk^2 \qquad ......(3)$$

So the power transferring from the input to the output is given by:

$$P=\frac{1}{2}\times L_M\times Ipk^2\times f_{SW} \qquad ......(4)$$

where fSW is the switching frequency. When the peak current Ipk is constant, the output power depends on the switching frequency fSW.

➢ Constant Voltage Operation

The ME8300N/P captures the auxiliary winding feedback voltage at FB pin and operates in constant-voltage (CV) mode to regulate the output voltage. Assuming the secondary winding is master, the auxiliary winding is slave during the D1 on-time. The auxiliary voltage is given by:

$$V_{AUX} = \frac{N_{AUX}}{N_S} \times (Vo + Vd) \quad ....(5)$$

➢ Operation Description (Continued)

where Vd is the diode forward drop voltage.

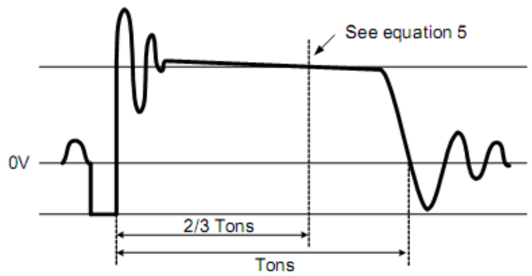


Figure 12. Auxiliary Voltage Waveform

The output voltage is different from the secondary voltage in a diode forward drop voltage that depends on the current. If the secondary voltage is always detected at a fixed secondary current, the difference between the output voltage and the secondary voltage will be a fixed Vd. The voltage detection point is at two-thirds of the D1 on-time. The CV loop control function of ME8300N/P then generates a D1 off-time to regulate the output voltage.

➢ Constant Current Operation

Figure 13 shows the secondary current waveforms.

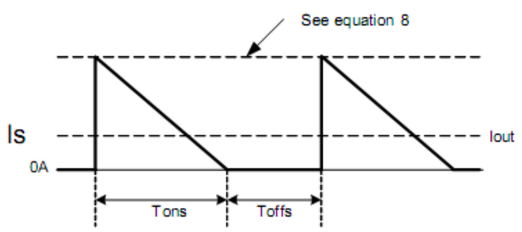


Figure 13. Secondary Current Waveform

In CC operation, the CC loop control function of ME8300N/P will keep a fixed proportion between D1 on-time Tons and D1 off-time Toffs by discharging or charging the capacitance connected in CMP pin. The fixed proportion is:

$$\frac{Tons}{Toffs} = \frac{4}{3} \quad ......(6)$$

The relationship between the output constant-current and secondary peak current Ipks is given by:

$$Iout = \frac{1}{2} \times Ipks \times \frac{Tons}{Tons + Toffs} \quad ......(7)$$

At the instant of D1 turn-on, the primary current transfers to the secondary at an amplitude of:

$$Ipks = \frac{N_P}{N_S} \times Ipk \quad ......(8)$$

Thus the output constant-current is given by:

$$Iout = \frac{1}{2} \times \frac{N_P}{N_S} \times Ipk \times \frac{Tons}{Tons + Toffs} = \frac{2}{7} \times \frac{N_P}{N_S} \times Ipk \quad ......(9)$$

Leading Edge Blanking

When the power switch is turned on, a turn-on spike will occur on the sense-resistor. To avoid false-termination of the switching pulse, a 430ns leading-edge blanking is built in. During this blanking period, the current sense comparator is disabled and the gate driver can not be switched off.

➢ CCM Protection

The ME8300N/P is designed to operate in discontinuous conduction mode (DCM) in both CV and CC modes. To avoid operating in continuous conduction mode (CCM), the ME8300N/P detects the falling edge of the FB input voltage on each cycle. If a 0.1V falling edge of FB is not detected, the ME8300N/P will stop switching.

OVP & OCkP

The ME8300N/P includes output over-voltage protection (OVP) and open circuit protection (OCkP) circuitry as shown in Figure 14. If the voltage at FB pin exceeds 8V, 100% above the normal detection voltage, or the -0.7V falling edge of the FB input can not be monitored, the ME8300N/P will immediately shut off and enter hiccup mode. The ME8300N/P sends out a fault detection pulse every 32ms in hiccup mode until the fault has been removed.

Operation Description (Continued)

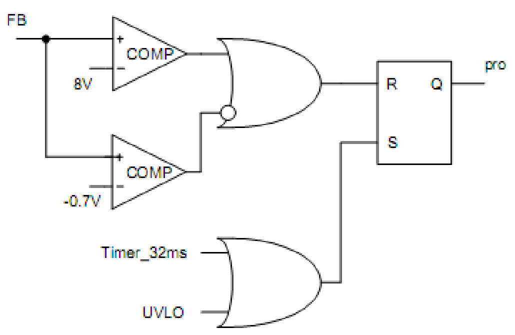


Figure 14. OVP and OCkP Function Block

Output Cable Compensation

The ME8300N/P integrates the output cable compensation circuitry as shown in Figure 15. Tons shows the variation for FB flyback voltage.

Tons can be converted to a DC voltage by a low-pass filter. When system load current Iout changed from open load to full load Iload, The amplified voltage Vout1 through a rail-to-rail operation amplifier is obtained:

$$V_{OUT1} = (1+\frac{RB}{RA})\times 3.65V - \frac{RB}{RA}\times V_{CMP} \quad ......(10)$$

Through the internal RA and RB, the FB voltage can be compensated by the Vout1, the compensation voltage is 0.4V when full load switch frequency is 60kHz.

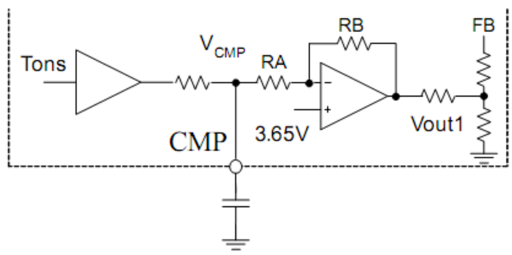


Figure 15. Output Cable Compensation Function Block

Packaging Information:

SOP-8