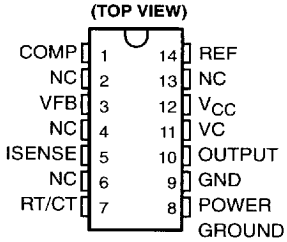
SLVS038B – JANUARY 1989 – REVISED AUGUST 1995

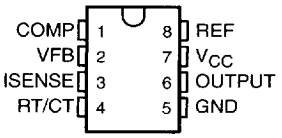
- **Optimized for Off-Line and dc-to-dc Converters**
- **Low Start-Up Current (<1 mA)**
- **Automatic Feed-Forward Compensation**
- **Pulse-by-Pulse Current Limiting**
- **Enhanced Load-Response Characteristics**
- **Undervoltage Lockout With Hysteresis**
- **Double Pulse Suppression**
- **High-Current Totem-Pole Output**
- **Internally Trimmed Bandgap Reference**
- **500-kHz Operation**
- **Error Amplifier With Low Output Resistance**
- **Designed to Be Interchangable With Unitrode UC2842 and UC3842 Series**

D PACKAGE
(TOP VIEW)



NC – No internal connection

P PACKAGE
(TOP VIEW)



description

The UC2842 and UC3842 series of control integrated circuits provide the features that are necessary to implement off-line or dc-to-dc fixed-frequency current-mode control schemes with a minimum number of external components. Some of the internally implemented circuits are an undervoltage lockout (UVLO) featuring a start-up current of less than 1 mA and a precision reference trimmed for accuracy at the error amplifier input. Other internal circuits include logic to ensure latched operation, a pulse-width modulation (PWM) comparator (which also provides current-limit control), and a totem-pole output stage designed to source or sink high-peak current. The output stage, suitable for driving N-channel MOSFETs, is low when it is in the off state.

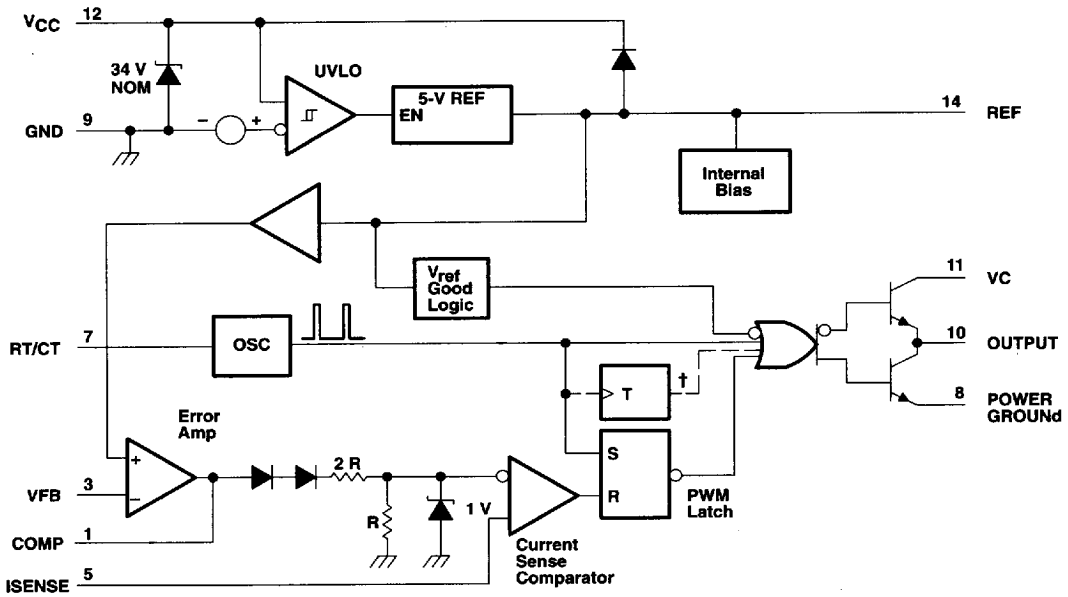
The primary difference between the UC2842-series devices and the UC3842-series devices is the ambient operating temperature range. The UC2842-series devices operate between −40°C and 85°C; the UC3842-series devices operate between 0°C and 70°C. Major differences between members of these series are the UVLO thresholds and maximum duty cycle ranges. Typical UVLO thresholds of 16 V (on) and 10 V (off) on the UCx842 and UCx844 devices make them ideally suited to off-line applications. The corresponding typical thresholds for the UCx843 and UCx845 devices are 8.4 V (on) and 7.6 V (off). The UCx842 and UCx843 devices can operate to duty cycles approaching 100%. A duty cycle range of 0 to 50% is obtained by the UCx844 and UCx845 by the addition of an internal toggle flip-flop, which blanks the output off every other clock cycle.

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES		CHIP FORM (Y)
	SMALL OUTLINE (D)	PLASTIC DIP (P)	
0°C to 70°C	UC3842D	UC3842P	UC3842Y
	UC3843D	UC3843P	UC3843Y
	UC3844D	UC3844P	UC3844Y
	UC3845D	UC3845P	UC3845Y
−40°C to 85°C	UC2842D	UC2842P	—
	UC2843D	UC2843P	—
	UC2844D	UC2844P	—
	UC2845D	UC2845P	—

The DW package is available taped and reeled. Add the suffix R to the device type, (i.e., LT1054CDWR).

functional block diagram



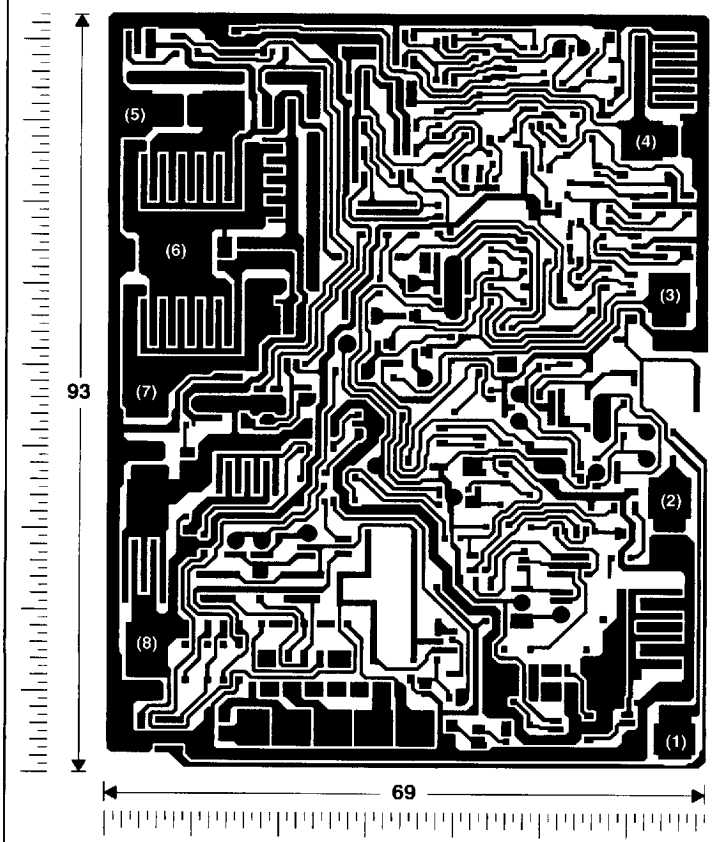
† The toggle flip-flop is present only in UC2844, UC2845, UC3844, and UC3845.
NOTE A: Terminal numbers apply to the D package only.

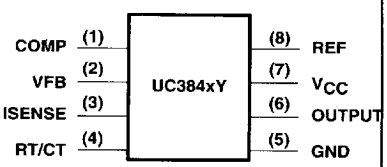
TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

UC384xY chip information

This chip, when properly assembled, displays characteristics similar to the UC384x. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. The chip may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS:
15 MILS TYPICAL

BONDING PADS:
4 × 4 MILS MINIMUM

$T_J$max = 150°C

TOLERANCES ARE ±10%.

ALL DIMENSIONS ARE IN MILS.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage (see Note 1) (I_{CC} < 30 mA) ..... Self Limiting
Analog input voltage range, V_I (VFB and ISENSE terminals) ..... – 0.3 V to 6.3 V
Output voltage, V_O (OUTPUT terminal) ..... 35 V
Input voltage, V_I, (VC terminal, D package only) ..... 35 V
Supply current, I_{CC} ..... 30 mA
Output current, I_O ..... ±1 A
Error amplifier output sink current ..... 10 mA
Continuous total power dissipation ..... See Dissipation Rating Table
Output energy (capacitive load) ..... 5 µJ
Operating free-air temperature range, T_A: UC284x ..... – 40°C to 85°C
UC384x ..... 0°C to 70°C
Storage temperature range, T_{stg} ..... – 65°C to 150°C
Lead temperature, 1,6 mm (1/16 inch) from case for 10 seconds ..... 260°C

† Stresses beyond 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-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltages are with respect to the device GND terminal.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATE ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING
D	950 mW	7.6 mW/°C	608 mW	494 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW

recommended operating conditions

	UC284x			UC384x			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC} and V_C†			30			30	V
Input voltage, V_I, RT/CT	0		5.5	0		5.5	V
Input voltage, V_I, VFB and ISENSE	0		5.5	0		5.5	V
Output voltage, V_O, OUTPUT	0		30	0		30	V
Output voltage, V_O, POWER GROUND†	–0.1		1	–0.1		1	V
Supply current, externally limited, I_{CC}			25			25	mA
Average output current, I_O			200			200	mA
Reference output current, $I_{O(ref)}$			–20			–20	mA
Timing capacitance, C_T				1			nF
Oscillator frequency, f_{osc}		100	500		100	500	kHz
Operating free-air temperature, T_A	–40		85	0		70	°C

† These recommended voltages for V_C and POWER GROUND apply only to the D package.

electrical characteristics, V_{CC} = 15 V (see Note 2), R_T = 10 kΩ, C_T = 3.3 nF, T_A = full range (unless otherwise specified)

reference section

PARAMETER	TEST CONDITIONS	UC284x			UC384x			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
Output voltage	I_O = 1 mA, T_J = 25°C	4.95	5	5.05	4.9	5	5.1	V
Line regulation	V_{CC} = 12 V to 25 V		6	20		6	20	mV
Load regulation	I_O = 1 mA to 20 mA		6	25		6	25	mV
Temperature coefficient of output voltage			0.2	0.4		0.2	0.4	mV/°C
Output voltage with worst-case variation	V_{CC} = 12 V to 25 V, I_O = 1 mA to 20 mA	4.9		5.1	4.82		5.18	V
Output noise voltage	f = 10 Hz to 10 kHz, T_J = 25°C		50			50		μV
Output voltage long-term drift	After 1000 h at T_A = 25°C		5	25		5	25	mV
Short-circuit output current		−30	−100	−180	−30	−100	−180	mA

† All typical values are at T_J = 25°C.

NOTE 2: Adjust V_{CC} above the start threshold before setting it to 15 V.

oscillator section

PARAMETER	TEST CONDITIONS	UC284x			UC384x			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
Oscillator frequency (see Note 3)	T_J = 25°C	47	52	57	47	52	57	kHz
Frequency change with supply voltage	V_{CC} = 12 V to 25 V		2	10		2	10	Hz/kHz
Frequency change with temperature	$T_A = T_{MIN}$ to T_{MAX}		50			50		Hz/kHz
Peak-to-peak amplitude at RT/CT			1.7			1.7		V

† All typical values are at T_J = 25°C.

NOTES: 2. Adjust V_{CC} above the start threshold before setting it to 15 V.

3. Output frequency equals oscillator frequency for the UCx842 and UCx843. Output frequency is one-half oscillator frequency for the UCx844 and UCx845.

error amplifier section

PARAMETER	TEST CONDITIONS	UC284x			UC384x			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
Feedback input voltage	COMP at 2.5 V	2.45	2.50	2.55	2.42	2.50	2.58	V
Input bias current			−0.3	−1		−0.3	−2	μA
Open-loop voltage amplification	V_O = 2 V to 4 V	65	90		65	90		dB
Gain-bandwidth product		0.7	1		0.7	1		MHz
Supply voltage rejection ratio	V_{CC} = 12 V to 25 V	60	70		60	70		dB
Output sink current	VFB at 2.7 V, COMP at 1.1 V	2	6		2	6		mA
Output source current	VFB at 2.3 V, COMP at 5 V	−0.5	−0.8		−0.5	−0.8		mA
High-level output voltage	VFB at 2.3 V, R_L = 15 kΩ to GND	5	6		5	6		V
Low-level output voltage	VFB at 2.7 V, R_L = 15 kΩ to GND		0.7	1.1		0.7	1.1	V

† All typical values are at T_J = 25°C.

NOTE 2: Adjust V_{CC} above the start threshold before setting it to 15 V.

electrical characteristics, V_{CC} = 15 V (see Note 2), R_T = 10 kΩ, C_T = 3.3 nF, T_A = full range (unless otherwise specified) (continued)

current sense section

PARAMETER	TEST CONDITIONS	UC284x			UC384x			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
Voltage amplification	See Notes 4 and 5	2.85	3	3.13	2.85	3	3.15	V/V
Current sense comparator threshold	COMP at 5 V, See Note 4	0.9	1	1.1	0.9	1	1.1	V
Supply voltage rejection ratio	V_{CC} = 12 V to 25 V, See Note 4		70			70		dB
Input bias current			−2	−10		−2	−10	μA
Delay time to output			150	300		150	300	ns

† All typical values are at T_J = 25°C.

NOTES: 2. Adjust V_{CC} above the start threshold before setting it to 15 V.
4. These parameters are measured at the trip point of the latch with VFB at 0 V.
5. Voltage amplification is measured between ISENSE and COMP with the input changing from 0 V to 0.8 V.

output section

PARAMETER	TEST CONDITIONS	UC284x			UC384x			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
High-level output voltage	I_{OH} = −20 mA	13	13.5		13	13.5		V
	I_{OH} = −200 mA	12	13.5		12	13.5		
Low-level output voltage	I_{OL} = 20 mA		0.1	0.4		0.1	0.4	V
	I_{OL} = 200 mA		1.5	2.2		1.5	2.2	
Rise time	C_L = 1 nF, T_J = 25°C		50	150		50	150	ns
Fall time	C_L = 1 nF, T_J = 25°C		50	150		50	150	ns

† All typical values are at T_J = 25°C.

NOTE 2. Adjust V_{CC} above the start threshold before setting it to 15 V.

undervoltage lockout section

PARAMETER	TEST CONDITIONS	UC284x			UC384x			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
Start threshold voltage	UCx842, UCx844	15	16	17	14.5	16	17.5	V
	UCx843, UCx845	7.8	8.4	9	7.8	8.4	9	
Minimum operating voltage after start-up	UCx842, UCx844	9	10	11	8.5	10	11.5	V
	UCx843, UCx845	7	7.6	8.2	7	7.6	8.2	

† All typical values are at T_J = 25°C.

NOTE 2. Adjust V_{CC} above the start threshold before setting it to 15 V.

pulse-width-modulator section

PARAMETER	TEST CONDITIONS	UC284x			UC384x			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
Maximum duty cycle	UCx842, UCx843	95%	97%	100%	95%	97%	100%	
	UCx844, UCx845	46%	48%	50%	46%	48%	50%	
Minimum duty cycle				0			0	

† All typical values are at T_J = 25°C.

NOTE 2. Adjust V_{CC} above the start threshold before setting it to 15 V.

supply voltage

PARAMETER	TEST CONDITIONS	UC284x			UC384x			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
Start-up current			0.5	1		0.5	1	mA
Operating supply current	VFB and ISENSE at 0 V		11	17		11	17	mA
Limiting voltage	I_{CC} = 25 mA		34			34		V

† All typical values are at T_J = 25°C.

NOTE 2. Adjust V_{CC} above the start threshold before setting it to 15 V.

electrical characteristics, V_{CC} = 15 V (see Note 2), R_T = 10 kΩ, C_T = 3.3 nF, T_J = 25°C (unless otherwise specified)

reference section

PARAMETER	TEST CONDITIONS	UC384xY			UNIT
		MIN	TYP	MAX	
Output voltage	I_O = 1 mA		5		V
Line regulation	V_{CC} = 12 V to 25 V		6		mV
Load regulation	I_O = 1 mA to 20 mA		6		mV
Temperature coefficient of output voltage			0.2		mV/°C
Output noise voltage	f = 10 Hz to 10 kHz		50		μV
Output voltage long-term drift	After 1000 h at T_A = 25°C		5		mV
Short-circuit output current			−100		mA

NOTE 2. Adjust V_{CC} above the start threshold before setting it to 15 V.

oscillator section

PARAMETER	TEST CONDITIONS	UC384xY			UNIT
		MIN	TYP	MAX	
Oscillator frequency (see Note 3)			52		kHz
Frequency change with supply voltage	V_{CC} = 12 V to 25 V		2		Hz/kHz
Frequency change with temperature			5		Hz/kHz
Peak-to-peak amplitude at RT/CT			1.7		V

NOTES: 2. Adjust V_{CC} above the start threshold before setting it to 15 V.
3. Output frequency equals oscillator frequency for the UCx842 and UCx843. Output frequency is one-half oscillator frequency for the UCx844 and UCx845.

error amplifier section

PARAMETER	TEST CONDITIONS	UC384xY			UNIT
		MIN	TYP	MAX	
Feedback input voltage	COMP at 2.5 V		2.50		V
Input bias current			−0.3		μA
Open-loop voltage amplification	V_O = 2 V to 4 V		90		dB
Gain-bandwidth product			1		MHz
Supply voltage rejection ratio	V_{CC} = 12 V to 25 V		70		dB
Output sink current	VFB at 2.7 V, COMP at 1.1 V		6		mA
Output source current	VFB at 2.3 V, COMP at 5 V		−0.8		mA
High-level output voltage	VFB at 2.3 V, R_L = 15 kΩ to GND		6		V
Low-level output voltage	VFB at 2.7 V, R_L = 15 kΩ to GND		0.7		V

NOTE 2. Adjust V_{CC} above the start threshold before setting it to 15 V.

current sense section

PARAMETER	TEST CONDITIONS	UC384xY			UNIT
		MIN	TYP	MAX	
Voltage amplification	See Notes 4 and 5		3		V/V
Current sense comparator threshold	COMP at 5 V, See Note 4		1		V
Supply voltage rejection ratio	V_{CC} = 12 V to 25 V, See Note 4		70		dB
Input bias current			−2		μA
Delay time to output			150		ns

NOTES: 2. Adjust V_{CC} above the start threshold before setting it to 15 V.
4. These parameters are measured at the trip point of the latch with VFB at 0 V.
5. Voltage amplification is measured between ISENSE and COMP with the input changing from 0 V to 0.8 V.

electrical characteristics, V_{CC} = 15 V (see Note 2), R_T = 10 kΩ, C_T = 3.3 nF, T_J = 25°C (unless otherwise specified) (continued)

output section

PARAMETER	TEST CONDITIONS	UC384xY			UNIT
		MIN	TYP	MAX	
High-level output voltage	I_{OH} = −20 mA		13.5		V
	I_{OH} = −200 mA		13.5		
Low-level output voltage	I_{OL} = 20 mA		0.1		V
	I_{OL} = 200 mA		1.5		
Rise time	C_L = 1 nF		50		ns
Fall time	C_L = 1 nF		50		ns

NOTE 2. Adjust V_{CC} above the start threshold before setting it to 15 V.

undervoltage lockout section

PARAMETER	TEST CONDITIONS		UC384xY			UNIT
			MIN	TYP	MAX	
Start threshold voltage	UC3842Y,	UC3844Y		16		V
	UC3843Y,	UC3845Y		8.4		
Minimum operating voltage after start-up	UC3842Y,	UC3844Y		10		V
	UC3843Y,	UC3845Y		7.6		

NOTE 2. Adjust V_{CC} above the start threshold before setting it to 15 V.

pulse-width-modulator section

PARAMETER	TEST CONDITIONS		UC384xY			UNIT
			MIN	TYP	MAX	
Maximum duty cycle	UC3842Y,	UC3843Y		97%		
	UC3844Y,	UC3845Y		48%		

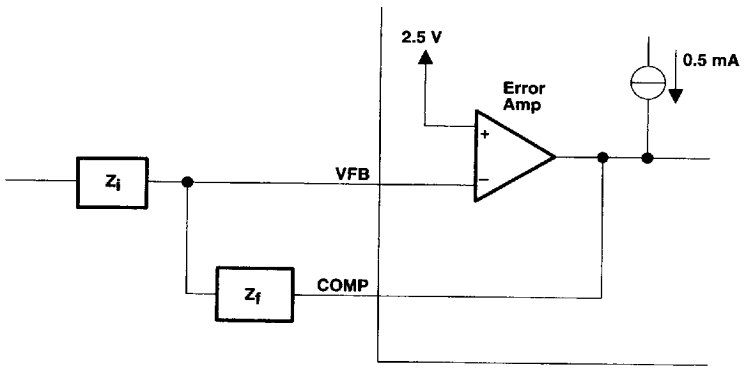
NOTE 2. Adjust V_{CC} above the start threshold before setting it to 15 V.

supply voltage

PARAMETER	TEST CONDITIONS	UC384xY			UNIT
		MIN	TYP	MAX	
Start-up current			0.5	1	mA
Operating supply current	VFB and ISENSE at 0 V		11	17	mA
Limiting voltage	I_{CC} = 25 mA		34		V

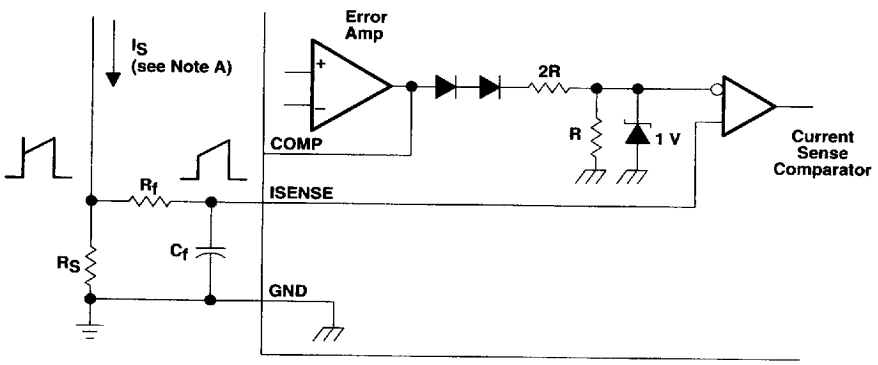
NOTE 2. Adjust V_{CC} above the start threshold before setting it to 15 V.

APPLICATION INFORMATION



NOTE A. Error amplifier can source or sink up to 0.5 mA.

Figure 1. Error Amplifier Configuration



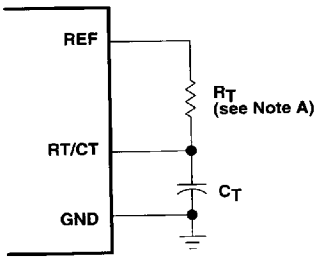
NOTE A: Peak current (I_S) is determined by the formula:

$$I_{S(max)} = \frac{1\ V}{R_S}$$

A small RC filter formed by resistor R_f and capacitor C_f may be required to suppress switch transients.

Figure 2. Current Sense Circuit

APPLICATION INFORMATION



NOTE A: For $R_T > 5\ K\Omega$ $\quad f \approx \frac{1.72}{R_T C_T}$

Figure 3. Oscillator Section

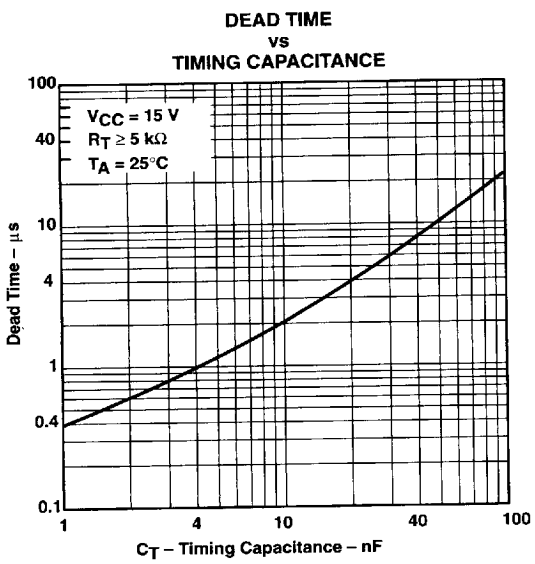


Figure 4

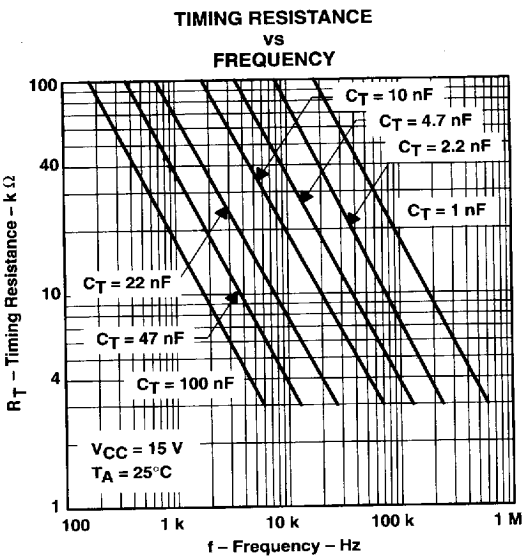


Figure 5

APPLICATION INFORMATION

open-loop laboratory test fixture

In the open-loop laboratory test fixture shown in Figure 6, high-peak currents associated with loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected close to the GND terminal in a single-point ground. The transistor and 5-kΩ potentiometer sample the oscillator waveform and apply an adjustable ramp to the ISENSE terminal.

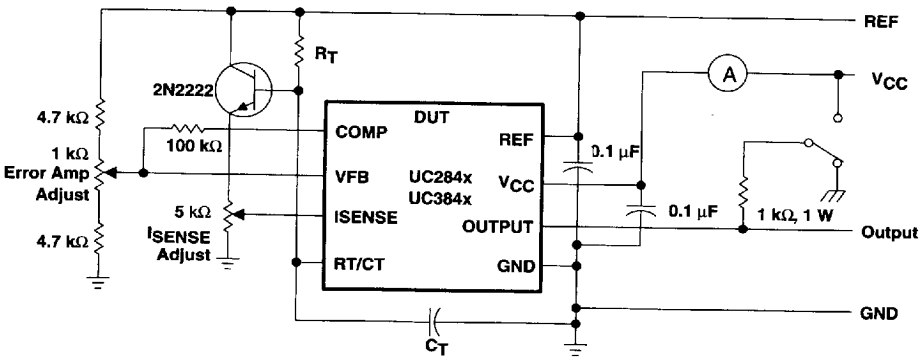


Figure 6. Open-Loop Laboratory Test Fixture

shutdown technique

Shutdown of the PWM controller (see Figure 7) can be accomplished by two methods: either raise the voltage at ISENSE above 1 V or pull the COMP terminal below a voltage two diode drops above ground. Either method causes the output of the PWM comparator to be high (refer to block diagram). The PWM latch is reset dominant so that the output remains low until the next clock cycle after the shutdown condition at the COMP or ISENSE terminal is removed. In one example, an externally latched shutdown may be accomplished by adding an SCR that resets by cycling V_{CC} below the lower UVLO threshold. At this point the reference turns off, allowing the SCR to reset.

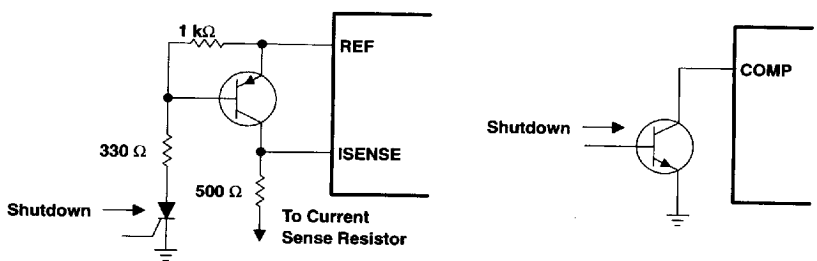


Figure 7. Shutdown Techniques

APPLICATION INFORMATION

A fraction of the oscillator ramp can be resistively summed with the current sense signal to provide slope compensation for converters requiring duty cycles over 50% (see Figure 8). Note that capacitor C forms a filter with R2 to suppress the leading-edge switch spikes.

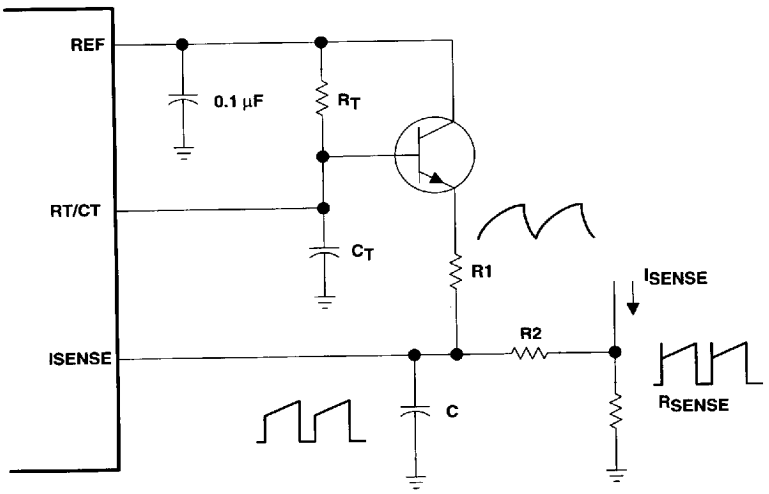


Figure 8. Slope Compensation