

# Precision Low Dropout Linear Controllers

## FEATURES

- Precision 1% Reference
- Over-Current Sense Threshold Accurate to 5%
- Programmable Duty-Ratio Over-Current Protection
- 4.5V to 36V Operation
- 100mA Output Drive, Source or Sink
- Under-Voltage Lockout

Additional Features of the UC1832 series:

- Adjustable Current Limit to Current Sense Ratio
- Separate +VIN terminal
- Programmable Driver Current Limit
- Access to VREF and E/A(+)
- Logic-Level Disable Input

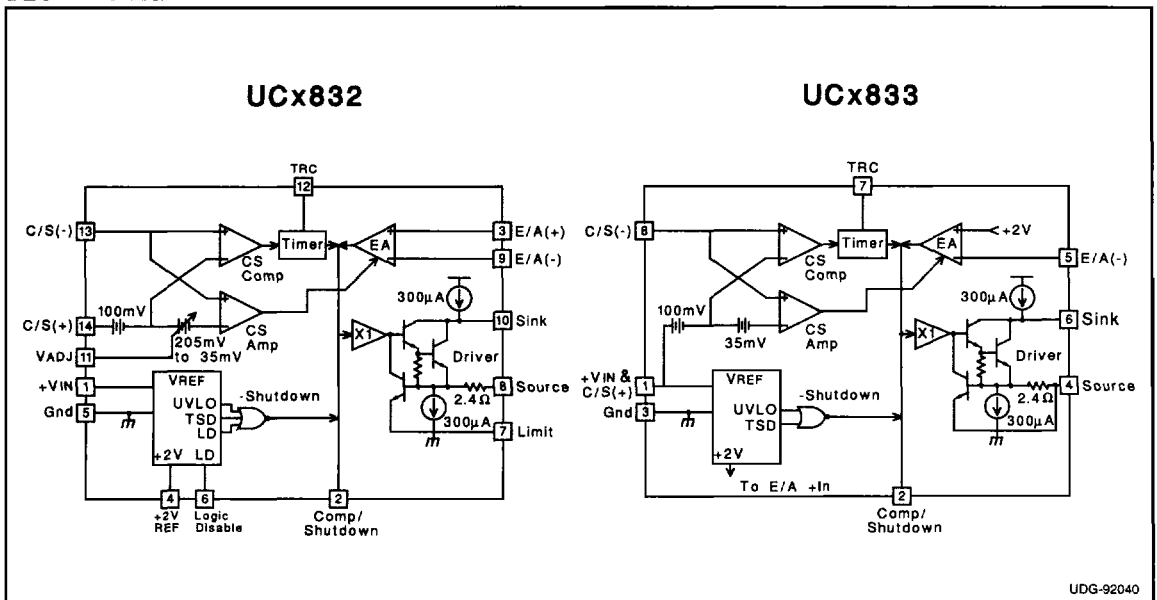
## DESCRIPTION

The UC1832 and UC1833 series of precision linear regulators include all the control functions required in the design of very low dropout linear regulators. Additionally, they feature an innovative duty-ratio current limiting technique which provides peak load capability while limiting the average power dissipation of the external pass transistor during fault conditions. When the load current reaches an accurately programmed threshold, a gated-astable timer is enabled, which switches the regulator's pass device off and on at an externally programmable duty-ratio. During the on-time of the pass element, the output current is limited to a value slightly higher than the trip threshold of the duty-ratio timer. The constant-current-limit is programmable on the UCx832 to allow higher peak current during the on-time of the pass device. With duty-ratio control, high initial load demands and short circuit protection may both be accommodated without extra heat sinking or foldback current limiting. Additionally, if the timer pin is grounded, the duty-ratio timer is disabled, and the IC operates in constant-voltage/constant-current regulating mode.

These IC's include a 2 Volt ( $\pm 1\%$ ) reference, error amplifier, UVLO, and a high current driver that has both source and sink outputs, allowing the use of either NPN or PNP external pass transistors. Safe operation is assured by the inclusion of under-voltage lockout (UVLO) and thermal shutdown.

The UC1833 family includes the basic functions of this design in a low-cost, 8-pin mini-dip package, while the UC1832 series provides added versatility with the availability of 14 pins. Packaging options include plastic (N suffix), or ceramic (J suffix). Specified operating temperature ranges are: commercial ( $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ ), order UC3832/3 (N or J); industrial ( $-25^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ ), order UC2832/3 (N or J); and military ( $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ ), order UC1832/3J. Surface mount packaging is also available.

## BLOCK DIAGRAMS



**ABSOLUTE MAXIMUM RATINGS**

Supply Voltage +VIN	40V
Driver Output Current (Sink or Source)	450mA
Driver Sink to Source Voltage	40V
TRC Pin Voltage	-0.3V to 3.2V
Other Input Voltages	-0.3V to +VIN
Operating Junction Temperature (note 2)	-55°C to +150°C
Storage Temperature	-65°C to +150°C
Lead Temperature (Soldering, 10 Seconds)	300°C

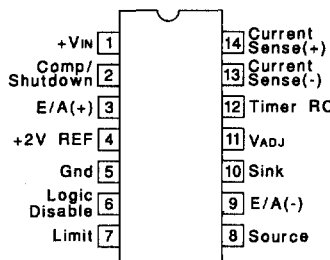
Note 1: Unless otherwise indicated, voltages are referenced to ground and currents are positive into, negative out of, the specified terminals.

Note 2: See Unitorde Integrated Circuits databook for information regarding thermal specifications and limitations of packages.

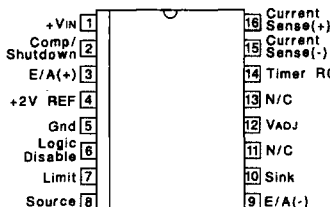
**CONNECTION DIAGRAMS**

**UC1832**

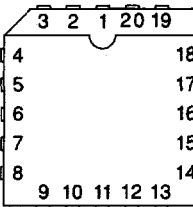
**DIL-14 (Top View)  
J Or N Package**



**SOIC-16 (Top View)  
DW Package**



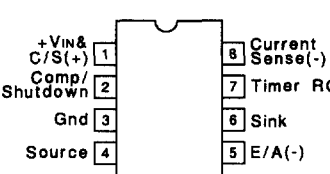
**LCC-20 & PLCC-20  
L & Q Package  
(Top View)**



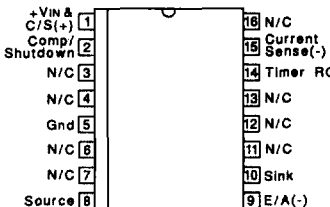
PACKAGE PIN FUNCTION	
FUNCTION	PIN
N/C	1
+VIN	2
Comp/Shutdown	3
E/A(+)	4
+2V REF	5
N/C	6
Gnd	7
Logic Disable	8
Limit	9
Source	10
N/C	11
E/A(-)	12
Sink	13
VADJ	14
N/C	15-17
Timer RC	18
Current Sense(-)	19
Current Sense(+)	20

**UC1833**

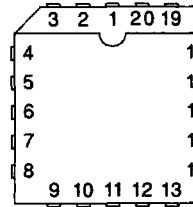
**DIL-8 (Top View)  
J Or N Package**



**SOIC-16 (Top View)  
DW Package**



**LCC-20 & PLCC-20  
L & Q Package  
(Top View)**



PACKAGE PIN FUNCTION	
FUNCTION	PIN
+VIN & C/S(+)	1
N/C	2
N/C	3
N/C	4
Comp/Shutdown	5
Gnd	6
N/C	7
N/C	8
N/C	9
Source	10
N/C	11
E/A(-)	12
N/C	13
N/C	14
Sink	15
Timer RC	16
Current Sense(+)	17
N/C	18-20



LINEAR REGULATORS

**ELECTRICAL CHARACTERISTICS:** Unless otherwise stated, specifications hold for  $T_A = 0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$  for the UC3832/3,  $-25^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  for the UC2832/3, and  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  for the UC1832/3,  $+V_{IN} = 15\text{V}$ , Driver sink =  $+V_{IN}$ , C/S(+) voltage =  $+V_{IN}$ .  $T_A = T_J$ .

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Input Supply</b>					
Supply Current	$+V_{IN} = 6\text{V}$		6.5	10	mA
	$+V_{IN} = 36\text{V}$		9.5	15	mA
	Logic Disable = 2V (UCx832 only)		3.3		mA
<b>Reference Section</b>					
Output Voltage (Note 3)	$T_J = 25^{\circ}\text{C}$ , $I_{DRIVER} = 10\text{mA}$	1.98	2.00	2.02	V
	over temperature, $I_{DRIVER} = 10\text{mA}$	1.96	2.00	2.04	V
Load Regulation (UCx832 only)	$I_{OUT} = 0$ to $10\text{mA}$	-10	-5.0		mV
Line Regulation	$+V_{IN} = 4.5$ to $36\text{V}$ , $I_{DRIVER} = 10\text{mA}$		0.033	0.5	mV/V
Under-Voltage Lockout Threshold			3.6	4.5	V
<b>Logic Disable Input (UCx832 only)</b>					
Threshold Voltage		1.3	1.4	1.5	V
Input Bias Current	Logic Disable = 0V	-5.0	-1.0		$\mu\text{A}$
<b>Current Sense Section</b>					
Comparator Offset		95	100	105	mV
	Over Temperature	93	100	107	mV
Amplifier Offset (UCx833 only)		110	135	170	mV
Amplifier Offset (UCx832 only)	$V_{ADJ} = \text{Open}$	110	135	170	mV
	$V_{ADJ} = 1\text{V}$	180	235	290	mV
	$V_{ADJ} = 0\text{V}$	250	305	360	mV
Input Bias Current	$V_{CM} = +V_{IN}$	65	100	135	$\mu\text{A}$
Input Offset Current (UCx832 only)	$V_{CM} = +V_{IN}$	-10		10	$\mu\text{A}$
Amplifier CMRR (UCx832 only)	$V_{CM} = 4.1\text{V}$ to $+V_{IN} + 0.3\text{V}$		80		dB
Transconductance	$I_{COMP} = \pm 100\mu\text{A}$		65		mS
$V_{ADJ}$ Input Current (UCx832 only)	$V_{ADJ} = 0\text{V}$	-10	-1		$\mu\text{A}$
<b>Timer</b>					
Inactive Leakage Current	C/S(+) = C/S(-) = $+V_{IN}$ ; TRC pin = 2V		0.25	1.0	$\mu\text{A}$
Active Pullup Current	C/S(+) = $+V_{IN}$ , C/S(-) = $+V_{IN} - 0.4\text{V}$ ; TRC pin = 0V	-345	-270	-175	$\mu\text{A}$
Duty Ratio (note 4)	ontime/period, $R_T = 200\text{k}$ , $C_T = 0.27\mu\text{F}$		4.8		%
Period (notes 4,5)	ontime + offtime, $R_T = 200\text{k}$ , $C_T = 0.27\mu\text{F}$		36		ms
Upper Trip Threshold ( $V_U$ )			1.8		V
Lower Trip Threshold ( $V_L$ )			0.9		V
Trip Threshold Ratio	$V_U/V_L$		2.0		V/V
<b>Error Amplifier</b>					
Input Offset Voltage (UCx832 only)	$V_{CM} = V_{COMP} = 2\text{V}$	-8.0		8.0	mV
Input Bias Current	$V_{CM} = V_{COMP} = 2\text{V}$	-4.5	-1.1		$\mu\text{A}$
Input Offset Current (UCx832 only)	$V_{CM} = V_{COMP} = 2\text{V}$	-1.5		1.5	$\mu\text{A}$
AVOL	$V_{COMP} = 1\text{V}$ to $13\text{V}$	50	70		dB
CMRR (UCx832 only)	$V_{CM} = 0\text{V}$ to $+V_{IN} - 3\text{V}$	60	80		dB
PSRR (UCx832 only)	$V_{CM} = 2\text{V}$ , $+V_{IN} = 4.5$ to $36\text{V}$		90		dB
Transconductance	$I_{COMP} = \pm 10\mu\text{A}$		4.3		mS
VOH	$I_{COMP} = 0$ , Volts below $+V_{IN}$		.95	1.3	V
VOL	$I_{COMP} = 0$		.45	0.7	V
IOH	$V_{COMP} = 2\text{V}$	-700	-500	-100	$\mu\text{A}$

**ELECTRICAL CHARACTERISTICS (cont.)**

Unless otherwise stated, specifications hold for  $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$  for the UC3832/3,  $-25^\circ\text{C}$  to  $85^\circ\text{C}$  for the UC2832/3, and  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  for the UC1832/3,  $+V_{IN} = 15\text{V}$ , Driver sink =  $+V_{IN}$ , C/S(+/-) voltage =  $+V_{IN}$ ,  $T_A = T_J$ .

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Error Amplifier (cont.)</b>					
IOL	$V_{COMP} = 2\text{V}$ , C/S(-) = $+V_{IN}$	100	500	700	$\mu\text{A}$
	$V_{COMP} = 2\text{V}$ , C/S(-) = $+V_{IN} - 0.4\text{V}$	2	6		mA
<b>Driver</b>					
Maximum Current	Driver Limit & Source pins common; $T_J = 25^\circ\text{C}$	200	300	400	mA
	Over Temperature	100	300	450	mA
Limiting Voltage (UCx832 only)	Driver Limit to Source voltage at current limit, $I_{SOURCE} = -10\text{mA}$ ; $T_J = 25^\circ\text{C}$ (Note 6)		.72		V
Internal Current Sense Resistance	$T_J = 25^\circ\text{C}$ (Note 6)		2.4		$\Omega$
Pull-Up Current at Driver Sink	Compensation/Shutdown = 0.4V; Driver Sink = $+V_{IN} - 1\text{V}$	-800	-300	-100	$\mu\text{A}$
	Compensation/Shutdown = 0.4V, $+V_{IN} = 36\text{V}$ ; Driver Sink = 35V	-1000	-300	-75	$\mu\text{A}$
Pull-Down Current at Driver Source	Compensation/Shutdown = 0.4V; Driver Source = 1V	150	300	700	$\mu\text{A}$
Saturation Voltage Sink to Source	Driver Source = 0V; Driver Current = 100mA		1.5		V
Maximum Source Voltage	Driver Sink = $+V_{IN}$ , Driver Current = 100mA Volts below $+V_{IN}$		3.0		V
UVLO Sink Leakage	$+V_{IN} = C/S(+/-) = 2.5\text{V}$ , Driver Sink = 15V, Driver Source = 0V, $T_A = 25^\circ\text{C}$		25		$\mu\text{A}$
Maximum Reverse Source Voltage	Compensation/Shutdown = 0V; $I_{SOURCE} = 100\mu\text{A}$ , $+V_{IN} = 3\text{V}$		1.6		V
Thermal Shutdown			160		$^\circ\text{C}$

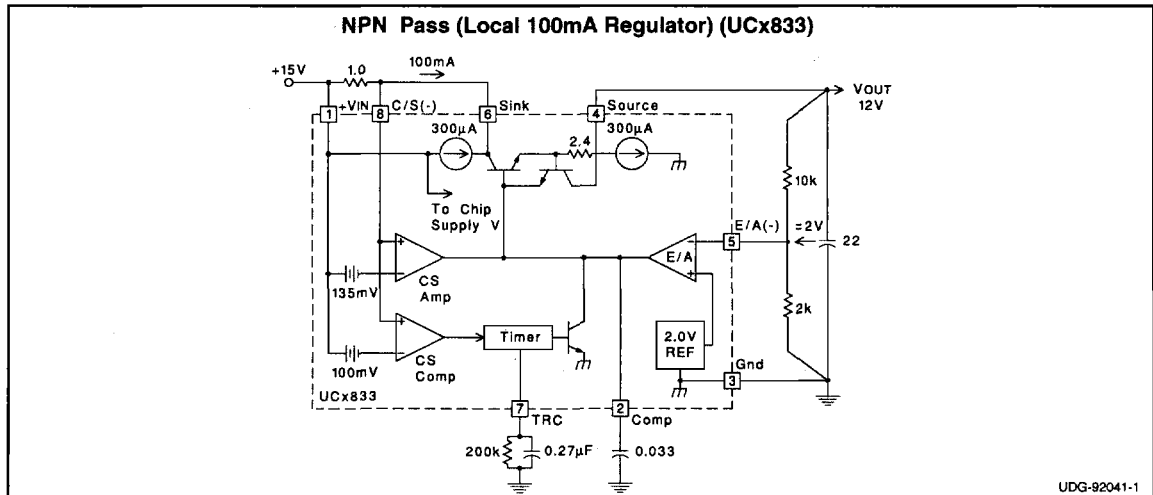
Note 3: On the UCx833 this voltage is defined as the regulating level at the error amplifier inverting input, with the error amplifier driving  $V_{SOURCE}$  to 2V.

Note 4: These parameters are first-order supply-independent, however both may vary with supply for  $+V_{IN}$  less than about 4V. This supply variation will cause a slight change in the timer period and duty cycle, although a high off-time/on-time ratio will be maintained.

Note 5: With recommended  $R_T$  value of 200k,  $T_{OFF} \approx R_T C_T \cdot \ln(V_U/V_L) \pm 10\%$ .

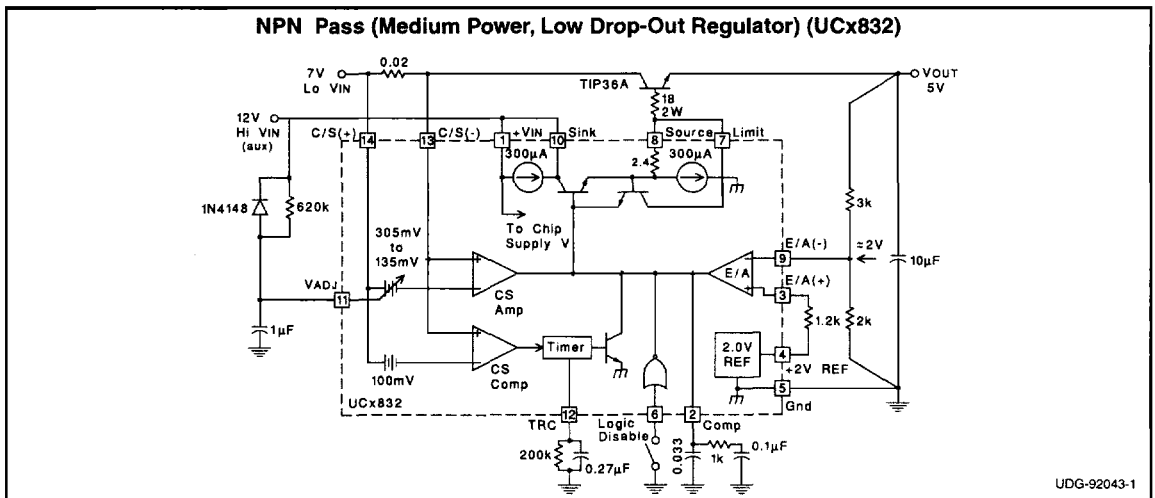
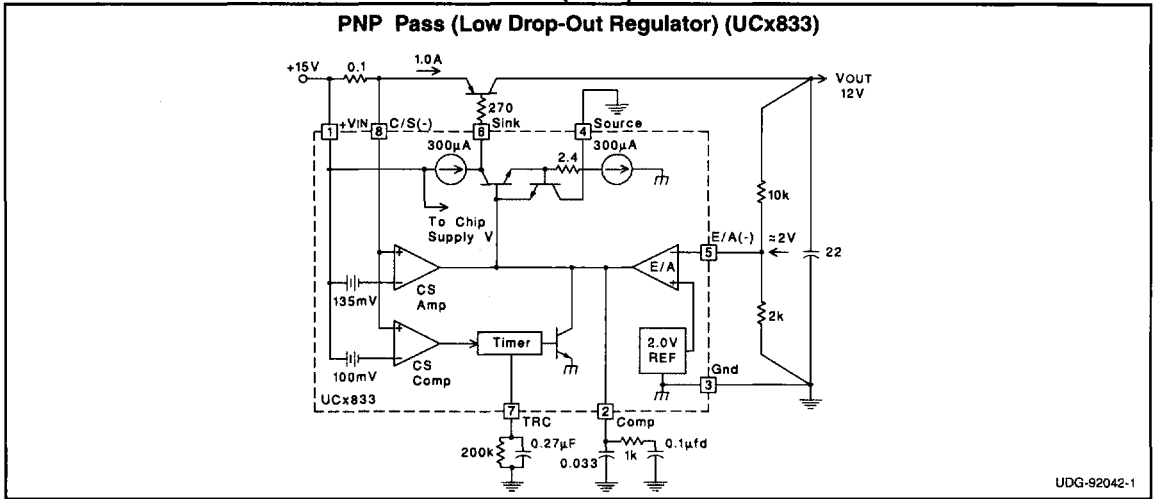
Note 6: The internal current limiting voltage has a temperature dependence of approximately  $-2.0\text{mV}/^\circ\text{C}$ , or  $-2800\text{ppm}/^\circ\text{C}$ . The internal  $2.4\Omega$  sense resistor has a temperature dependence of approximately  $+1500\text{ppm}/^\circ\text{C}$ .

**APPLICATION AND OPERATION INFORMATION**



LINEAR REGULATORS

**APPLICATION AND OPERATION INFORMATION (cont.)**



**Estimating Maximum Load Capacitance**

For any power supply, the rate at which the total output capacitance can be charged depends on the maximum output current available and on the nature of the load. For a constant-current current-limited power supply, the output will come up if the load asks for less than the maximum available short-circuit limit current.

To guarantee recovery of a duty-ratio current-limited power supply from a short-circuited load condition, there is a maximum total output capacitance which can be charged for a given unit ON time. The design value of ON time can be adjusted by changing the timing capacitor. Nominally,  $T_{ON} = 0.693 \times 10k \times C_T$ .

Typically, the IC regulates output current to a maximum of  $I_{MAX} = K \times I_{TH}$ , where  $I_{TH}$  is the timer trip-point current,

and 
$$K = \frac{\text{Current Sense Amplifier Offset Voltage}}{100mA}$$

$\approx 1.35$  for UCx833, and is variable from 1.35 to 3.05 with  $V_{ADJ}$  for the UCx832.

For a worst-case constant-current load of value just less than  $I_{TH}$ ,  $C_{MAX}$  can be estimated from:

$$C_{MAX} = ((K-1)I_{TH}) \left( \frac{T_{ON}}{V_{OUT}} \right),$$

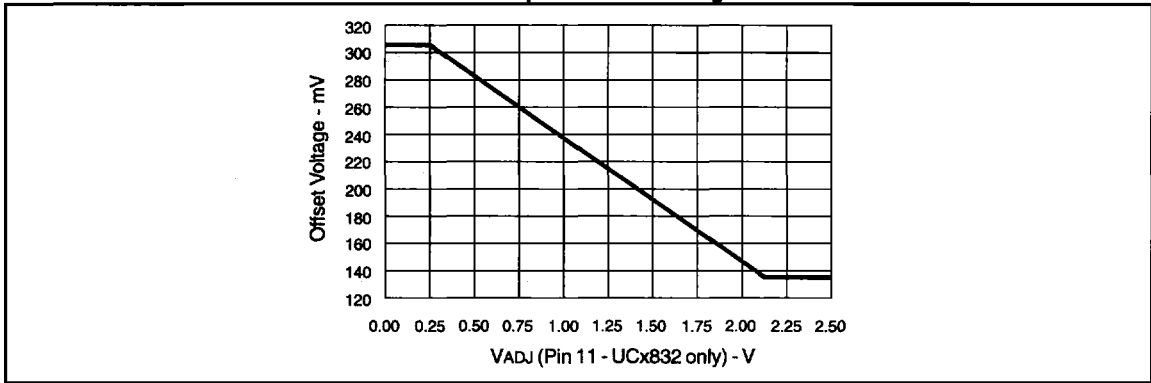
where  $V_{OUT}$  is the nominal regulator output voltage.

For a resistive load of value  $R_L$ , the value of  $C_{MAX}$  can be estimated from:

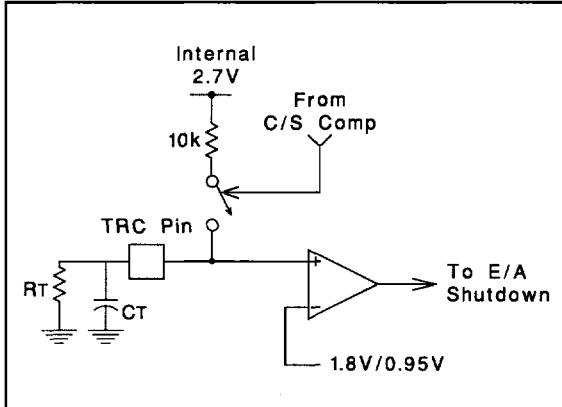
$$C_{MAX} = \frac{T_{ON}}{R_L} \cdot \frac{1}{\ln \left[ \left( 1 - \frac{V_{OUT}}{K \cdot I_{TH} \cdot R_L} \right)^{-1} \right]}$$

APPLICATION AND OPERATION INFORMATION (cont.)

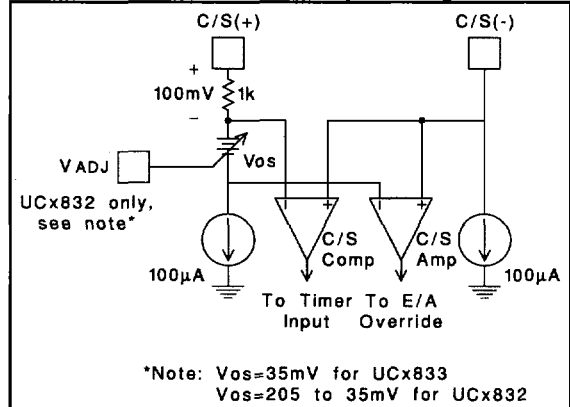
Current Sense Amplifier Offset Voltage vs V<sub>ADJ</sub>



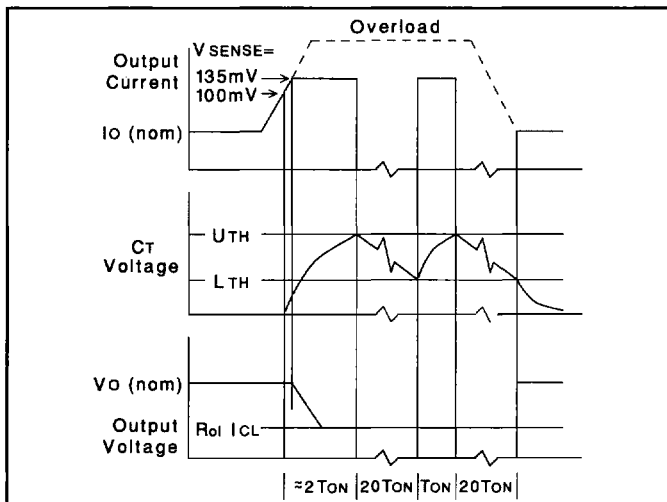
UCx832/33 Timer Function



UCx832/33 Current Sense Input Configuration



Load current, timing capacitor voltage, and output voltage of the regulator under fault conditions.



LINEAR REGULATORS

APPLICATION AND OPERATION INFORMATION (cont.)

