UNITRODE

UCC1808-1/-2
UCC2808-1/-2
UCC3808-1/-2

Low Power Current Mode Push-Pull PWM

FEATURES

- 130µA Typical Starting Current
- 1mA Typical Run Current
- Operation to 1MHz
- Internal Soft Start
- On Chip Error Amplifier With 2MHz Gain Bandwidth Product
- On Chip VDD Clamping
- Dual Output Drive Stages In Push-Pull Configuration
- Output Drive Stages Capable Of 500mA Peak Source Current, 1A Peak Sink Current

DESCRIPTION

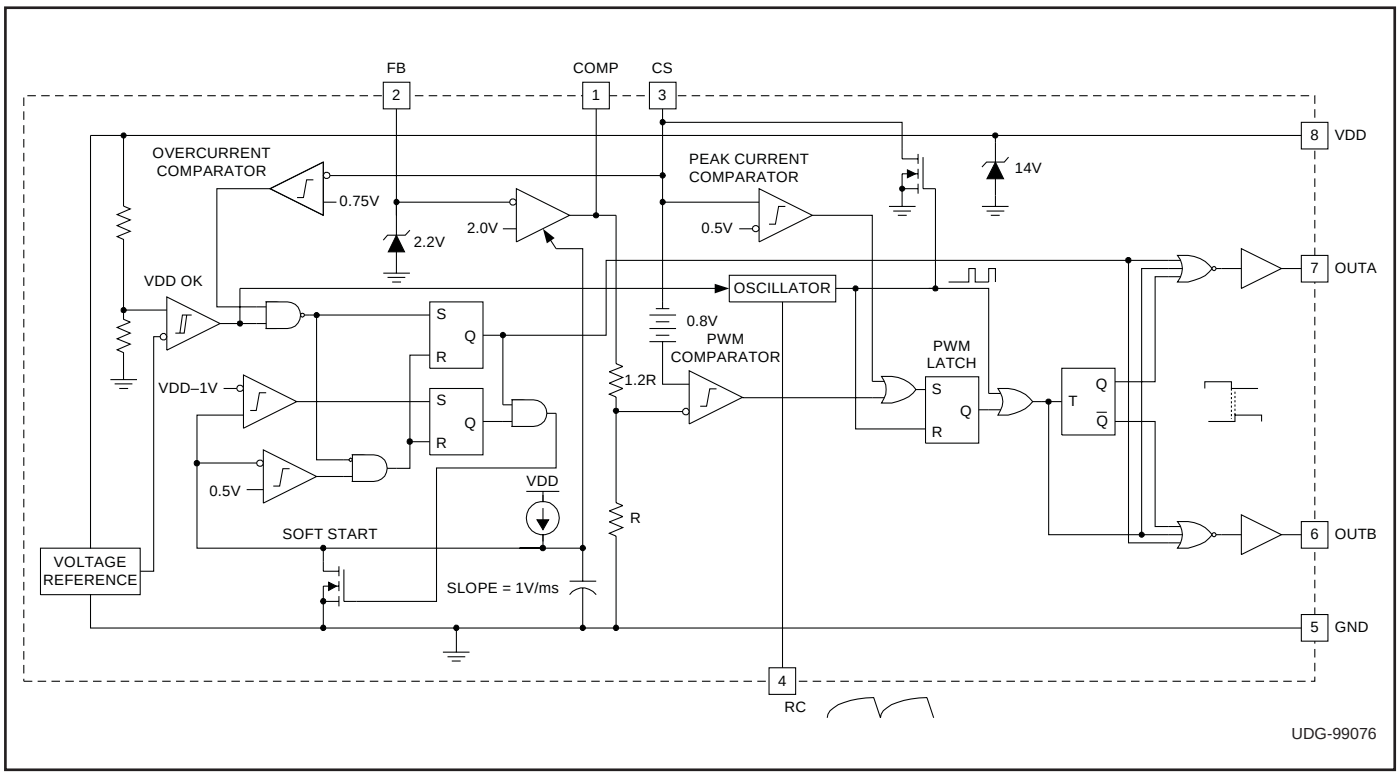
The UCC3808 is a family of BiCMOS push-pull, high-speed, low power, pulse width modulators. The UCC3808 contains all of the control and drive circuitry required for off-line or DC-to-DC fixed frequency current-mode switching power supplies with minimal external parts count.

The UCC3808 dual output drive stages are arranged in a push-pull configuration. Both outputs switch at half the oscillator frequency using a toggle flip-flop. The dead time between the two outputs is typically 60ns to 200ns depending on the values of the timing capacitor and resistors, thus limits each output stage duty cycle to less than 50%.

The UCC3808 family offers a variety of package options temperature range options, and choice of undervoltage lockout levels. The family has UVLO thresholds and hysteresis options for off-line and battery powered systems. Thresholds are shown in the table below.

Part Number	Turn on Threshold	Turn off Threshold
UCCx808-1	12.5V	8.3V
UCCx808-2	4.3V	4.1V

BLOCK DIAGRAM



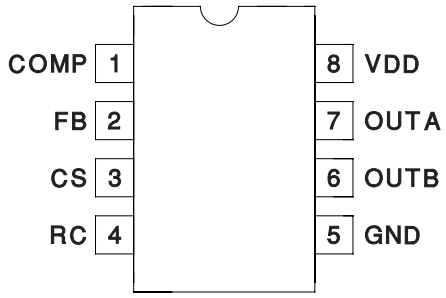
ABSOLUTE MAXIMUM RATINGS

Supply Voltage (IDD ≤ 10mA) 15V
Supply Current 20mA
OUTA/OUTB Source Current (peak) . . . . . –0.5A
OUTA/OUTB Sink Current (peak) 1.0A
Analog Inputs (FB, CS) . –0.3V to VDD+0.3V, not to exceed 6V
Power Dissipation at T_A = 25°C (N Package). 1W
Power Dissipation at T_A = 25°C (D Package) 650mW
Storage Temperature . . . . . –65°C to +150°C
Junction Temperature. . . . . –55°C to +150°C
Lead Temperature (Soldering, 10sec.) . . . . . +300°C

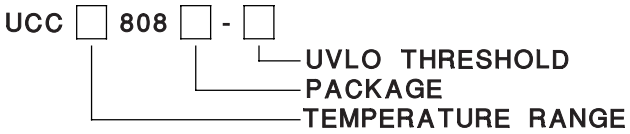
Currents are positive into, negative out of the specified terminal. Consult Packaging Section of Databook for thermal limitations and considerations of package.

CONNECTION DIAGRAM

DIL-8, SOIC-8 (Top View)
J or N Package, D Package



ORDER INFORMATION



ELECTRICAL CHARACTERISTICS: Unless otherwise specified, T_A = 0°C to 70°C for the UCC3808-X, –40°C to 85°C for the UCC2808-X and –55°C to 125°C for the UCC1808-X, VDD = 10V (Note 6), 1µF capacitor from VDD to GND, R = 22kΩ, C = 330pF. $T_A = T_J$.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Oscillator Section					
Oscillator Frequency		175	194	213	kHz
Oscillator Amplitude/VDD	(Note 1)	0.44	0.5	0.56	V/V
Error Amplifier Section					
Input Voltage	COMP = 2V	1.95	2	2.05	V
Input Bias Current		–1		1	µA
Open Loop Voltage Gain		60	80		dB
COMP Sink Current	FB = 2.2V, COMP = 1V	0.3	2.5		mA
COMP Source Current	FB = 1.3V, COMP = 3.5V	–0.2	–0.5		mA
PWM Section					
Maximum Duty Cycle	Measured at OUTA or OUTB	48	49	50	%
Minimum Duty Cycle	COMP = 0V			0	%
Current Sense Section					
Gain	(Note 2)	1.9	2.2	2.5	V/V
Maximum Input Signal	COMP = 5V (Note 3)	0.45	0.5	0.55	V
CS to Output Delay	COMP = 3.5V, CS from 0 to 600mV		100	200	ns
CS Source Current		–200			nA
CS Sink Current	CS = 0.5V, RC = 5.5V (Note 7)	5	10		mA
Over Current Threshold		0.7	0.75	0.8	V
COMP to CS Offset	CS = 0V	0.35	0.8	1.2	V
Output Section					
OUT Low Level	I = 100mA		0.5	1	V
OUT High Level	I = –50mA, VDD – OUT		0.5	1	V
Rise Time	C_L = 1nF		25	60	ns
Fall Time	C_L = 1nF		25	60	ns
Undervoltage Lockout Section					
Start Threshold	UCCx808-1 (Note 6)	11.5	12.5	13.5	V
	UCCx808-2	4.1	4.3	4.5	V

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PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Undervoltage Lockout Section (cont.)					
Minimum Operating Voltage After Start	UCCx808-1	7.6	8.3	9	V
	UCCx808-2	3.9	4.1	4.3	V
Hysteresis	UCCx808-1	3.5	4.2	5.1	V
	UCCx808-2	0.1	0.2	0.3	V
Soft Start Section					
COMP Rise Time	FB = 1.8V, Rise from 0.5V to 4V		3.5	20	ms
Overall Section					
Startup Current	VDD < Start Threshold		130	260	µA
Operating Supply Current	FB = 0V, CS = 0V (Note 5 and 6)		1	2	mA
VDD Zener Shunt Voltage	IDD = 10mA (Note 4)	13	14	15	V

Note 1: Measured at RC. Signal amplitude tracks VDD.

Note 2: Gain is defined by $A = \frac{\Delta V_{COMP}}{\Delta V_{CS}}$, $0 \le V_{CS} \le 0.4V$.

Note 3: Parameter measured at trip point of latch with FB at 0V.

Note 4: Start threshold and Zener Shunt threshold track one another.

Note 5: Does not include current in the external oscillator network.

Note 6: For UCCx808-1, set VDD above the start threshold before setting at 10V.

Note 7: The internal current sink on the CS pin is designed to discharge an external filter capacitor. It is not intended to be a DC sink path.

PIN DESCRIPTIONS

COMP: COMP is the output of the error amplifier and the input of the PWM comparator. The error amplifier in the UCC3808 is a true low-output impedance, 2MHz operational amplifier. As such, the COMP pin can both source and sink current. However, the error amplifier is internally current limited, so that zero duty cycle can be externally forced by pulling COMP to GND.

The UCC3808 family features built-in full cycle soft start. Soft start is implemented as a clamp on the maximum COMP voltage.

CS: The input to the PWM, peak current, and overcurrent comparators. The overcurrent comparator is only intended for fault sensing. Exceeding the overcurrent threshold will cause a soft start cycle. An internal MOSFET discharges the current sense filter capacitor to improve dynamic performance of the power converter.

FB: The inverting input to the error amplifier. For best stability, keep FB lead length as short as possible and FB stray capacitance as small as possible.

GND: Reference ground and power ground for all functions. Due to high currents, and high frequency operation of the UCC3808, a low impedance circuit board ground plane is highly recommended.

OUTA and OUTB: Alternating high current output stages. Both stages are capable of driving the gate of a power MOSFET. Each stage is capable of 500mA peak source current, and 1A peak sink current.

The output stages switch at half the oscillator frequency, in a push/pull configuration. When the voltage on the RC pin is rising, one of the two outputs is high, but during fall time, both outputs are off. This “dead time” between the two outputs, along with a slower output rise time than fall time, insures that the two outputs can not be on at the same time. This dead time is typically 60ns to 200ns and depends upon the values of the timing capacitor and resistor.

The high-current output drivers consist of MOSFET output devices, which switch from VDD to GND. Each output stage also provides a very low impedance to overshoot and undershoot. This means that in many cases, external schottky clamp diodes are not required.

RC: The oscillator programming pin. The UCC3808’s oscillator tracks VDD and GND internally, so that variations in power supply rails minimally affect frequency stability. Fig. 1 shows the oscillator block diagram.

Only two components are required to program the oscillator, a resistor (tied to the VDD and RC), and a capacitor (tied to the RC and GND). The approximate oscillator frequency is determined by the simple formula:

PIN DESCRIPTIONS (cont.)

$$f_{OSCILLATOR} = \frac{1.41}{RC}$$

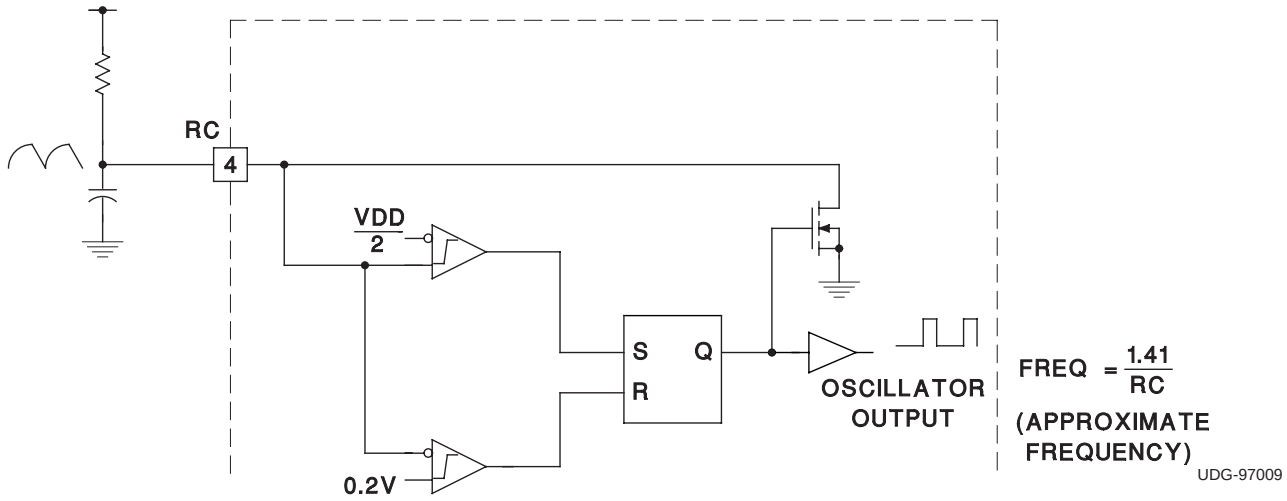
where frequency is in Hertz, resistance in Ohms, and capacitance in Farads. The recommended range of timing resistors is between 10kΩ and 200kΩ and range of timing capacitors is between 100pF and 1000pF. Timing resistors less than 10kΩ should be avoided.

For best performance, keep the timing capacitor lead to GND as short as possible, the timing resistor lead from VDD as short as possible, and the leads between timing components and RC as short as possible. Separate ground and VDD traces to the external timing network are encouraged.

VDD: The power input connection for this device. Although quiescent VDD current is very low, total supply current will be higher, depending on OUTA and OUTB current, and the programmed oscillator frequency. Total VDD current is the sum of quiescent VDD current and the average OUT current. Knowing the operating frequency and the MOSFET gate charge (Qg), average OUT current can be calculated from

I_{OUT} = Qg • F, where F is frequency.

To prevent noise problems, bypass VDD to GND with a ceramic capacitor as close to the chip as possible along with an electrolytic capacitor. A 1µF decoupling capacitor is recommended.



The oscillator generates a sawtooth waveform on RC. During the RC rise time, the output stages alternate on time, but both stages are off during the RC fall time. The output stages switch a ½ the oscillator frequency, with guaranteed duty cycle of < 50% for both outputs.

Figure 1. Block diagram for oscillator.

APPLICATION INFORMATION

A 200kHz push-pull application circuit with a full wave rectifier is shown in Fig. 2. The output, V_O, provides 5V at 75W maximum and is electrically isolated from the input. Since the UCC3808 is a peak current mode controller the 2N2222A emitter following amplifier (buffers the CT waveform) provides slope compensation which is necessary for duty ratios greater than 50%. Capacitor decoupling is very important with a single ground IC controller and a 1µF is suggested as close to the IC as possible. The controller supply is a series RC for startup, paralleled with a bias winding on the output inductor used in steady state operation.

Isolation is provided by an optocoupler with regulation done on the secondary side using the UC3965 Precision Reference with Low Offset Error Amplifier. Small signal compensation with tight voltage regulation is achieved using this part on the secondary side. Many choices exist for the output inductor depending on cost, volume, and mechanically strength. Several design options are iron powder, molypermalloy (MPP), or a ferrite core with an air gap as shown here. The main power transformer is a low profile design, EFD size 25, using Magnetics Inc. P material which is a good choice at this frequency and temperature. The input voltage may range from 36V dc to 72V dc. Refer to application note U-170 for addition design information.

APPLICATION INFORMATION (cont.)

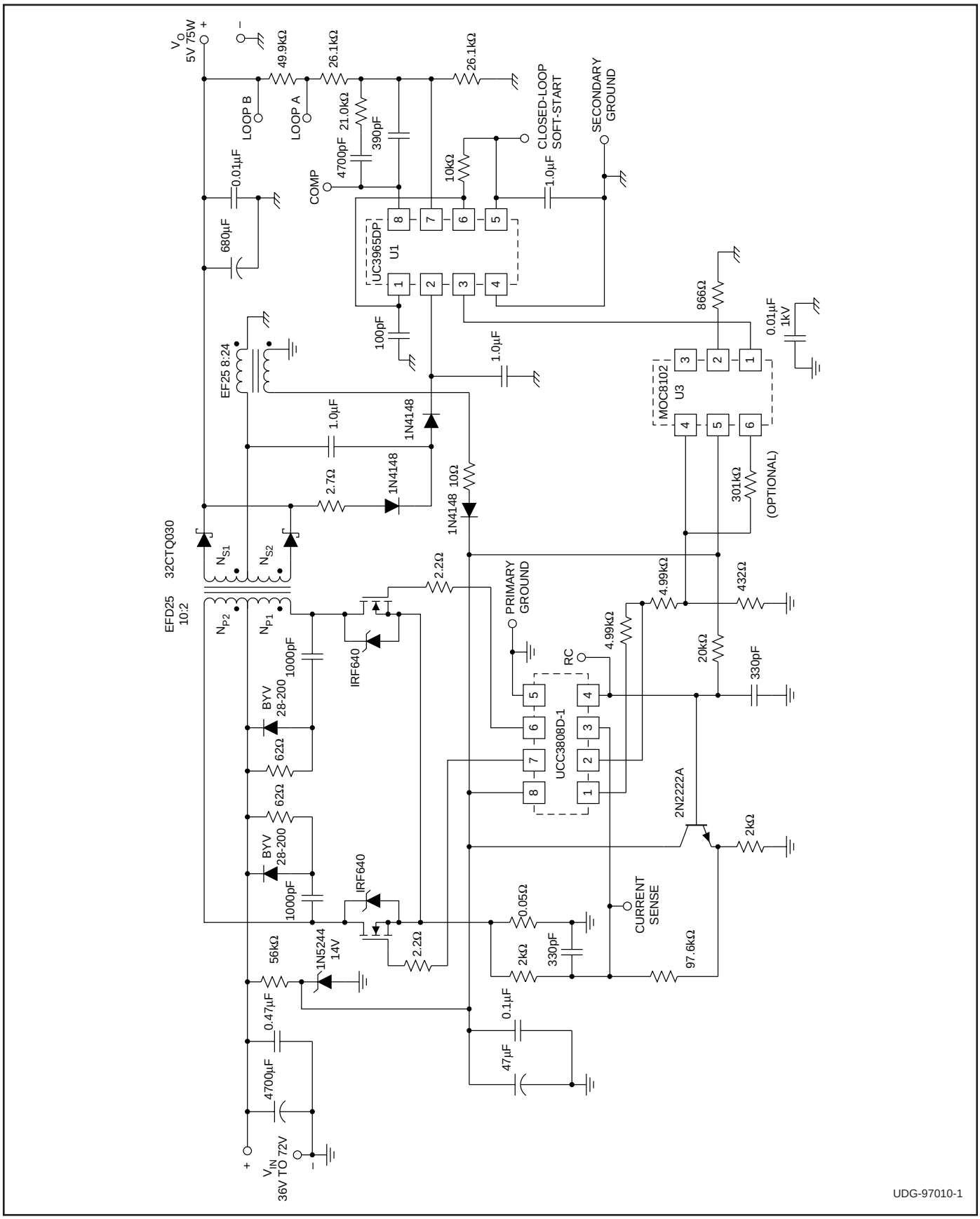


Figure 2. Typical application diagram.

TYPICAL CHARACTERISTIC CURVES

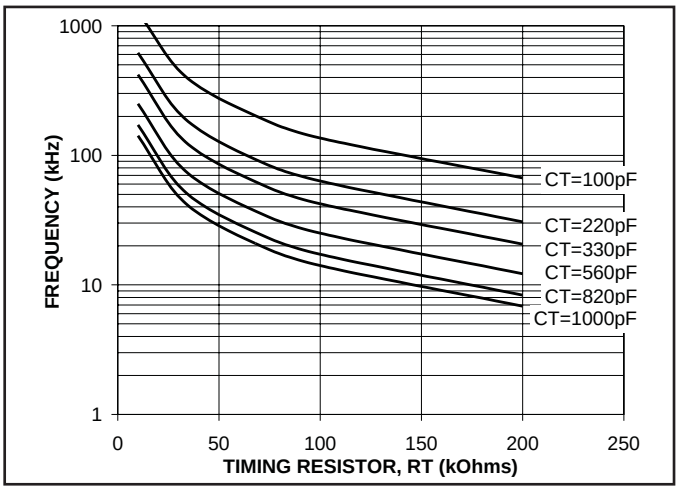


Figure 3. Typical oscillator frequency.

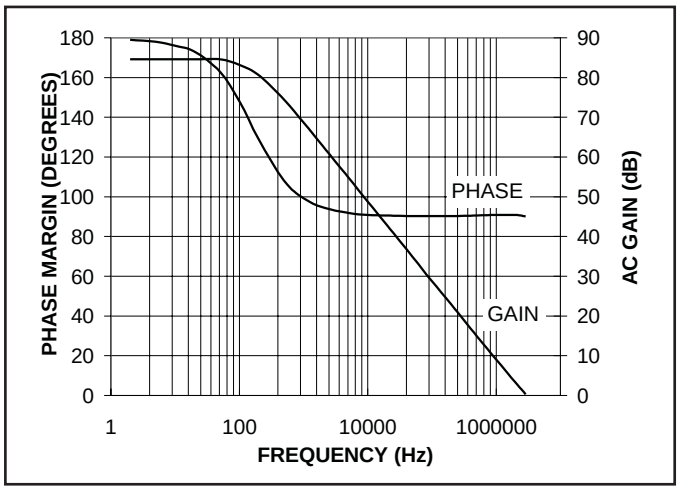


Figure 6. Typical error amplifier response.

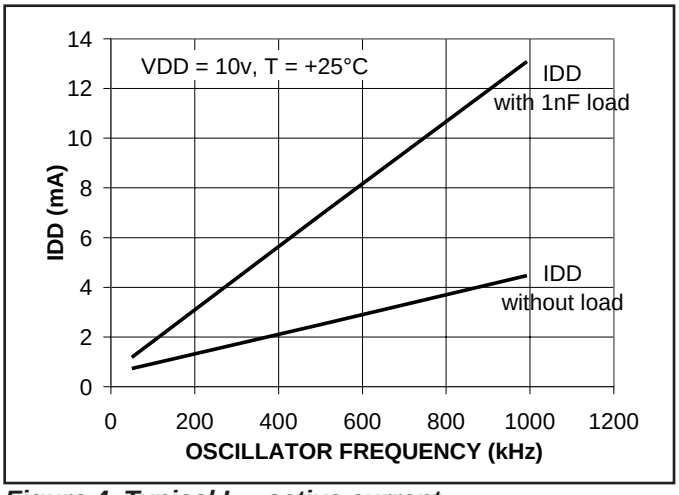


Figure 4. Typical I_{DD} active current.

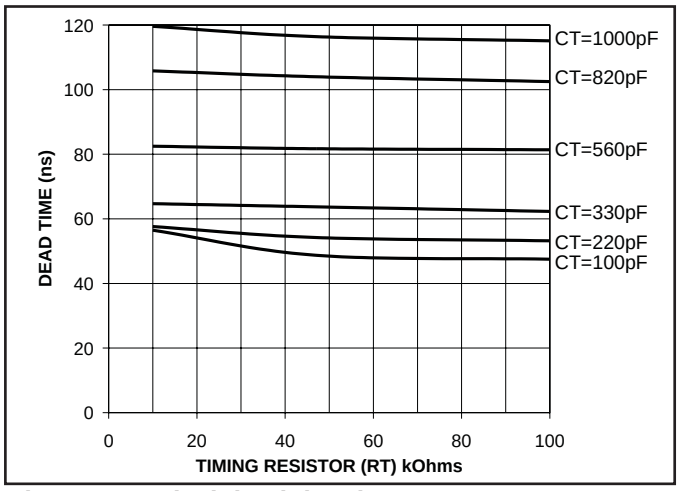


Figure 7. Typical dead time between output stages.

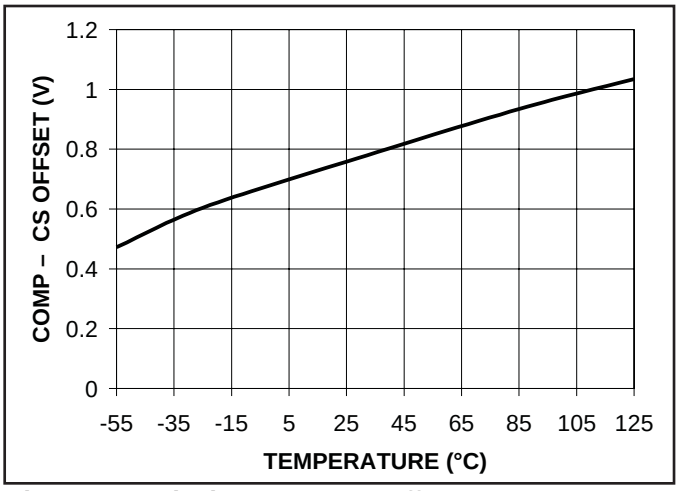


Figure 5. Typical COMP to CS offset vs. temperature.

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