

3A OUTPUT PROGRAMMABLE POWER OSCILLATOR

FEATURES

- Controllable Duty Cycle
- Wide Operating Range 5V to 18V
- High Peak Output Current 3A
- High Capacitive Load Drive Capability 1800pF in 20nsec
- Short Delay Time < 150nsec Typ

APPLICATIONS

- Fixed Frequency Power Oscillator
- Voltage Controlled Oscillator
- Low Power Buck Regulator Supply
- MOSFET Driver
- Simple diode inverters and doublers

ORDERING INFORMATION

Part No.	Package	Operating Temp Range
TC96C555COA	8-Pin SOIC	0°C to +70°C
TC96C555CPA	8-Pin Plastic DIP	0°C to +70°C
TC96C555EOA	8-Pin SOIC	-40°C to +85°C
TC96C555EPA	8-Pin Plastic DIP	-40°C to +85°C
TC96C555MJA	8-Pin CerDIP	-55°C to +125°C

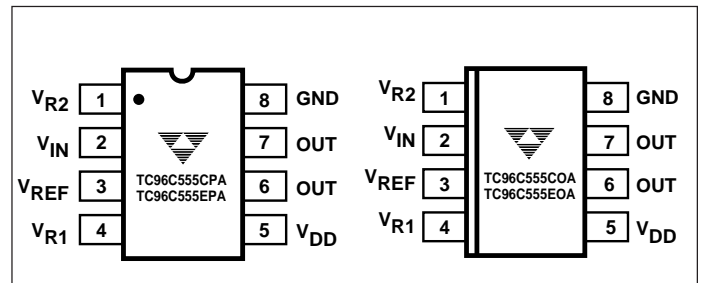
GENERAL DESCRIPTION

The TC96C555 Power Oscillator is an easily programmed IC that can be used in simple switch-mode power supplies, diode doublers and inverters, and similar circuits where high-current pulses are needed in an economical form.

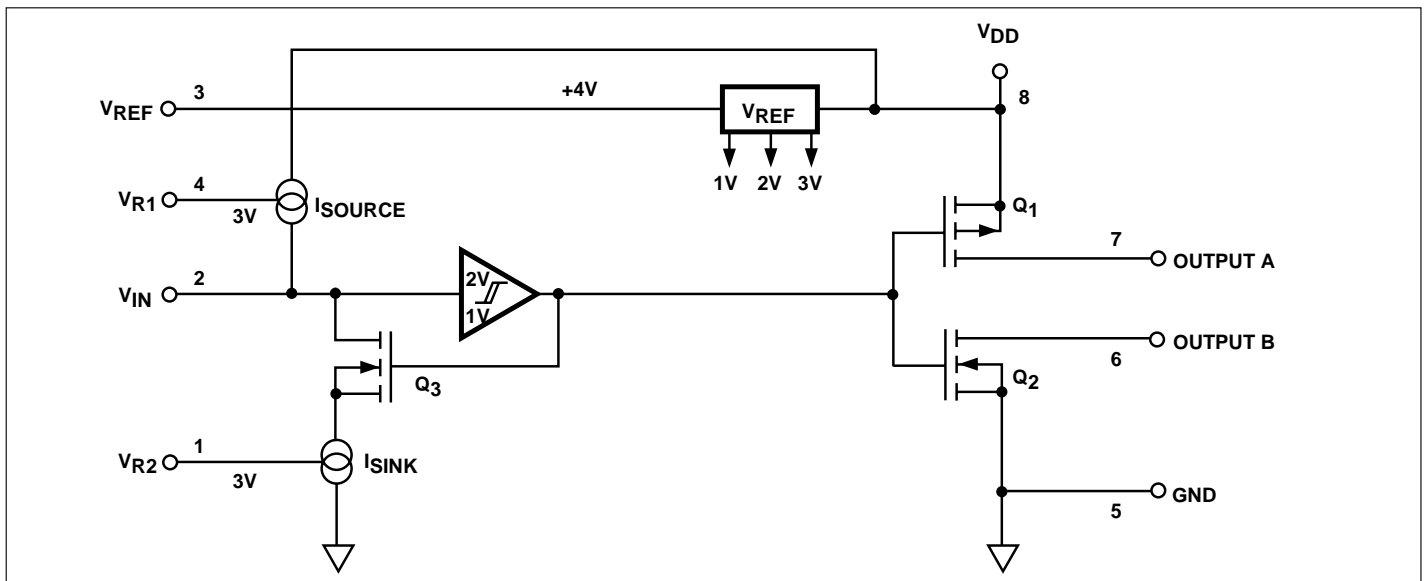
The TC96C555 uses TelCom Semiconductors' new Tough CMOS™ process. The output drive capability is similar to the TC4423/4/5 MOSFET Drivers, which can switch in 25nsec into a capacitive load of 1,800pF. The TC96C555 will not latch up under any conditions within their power and voltage ratings. They can accept, without damage, up to 1.5A of reverse current (of either polarity) being forced back into the output. All terminals are also fully protected against up to 4kV of electrostatic discharge. The peak output is rated at 3A. Split outputs permits driving of an external pair of MOSFETS, with controllable cross conduction between upper and lower devices.

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PIN CONFIGURATIONS (DIP and SOIC)



FUNCTIONAL BLOCK DIAGRAM



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TC96C555

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	+20V
Input Voltage, Pin 1 or 4	$V_{DD} + 0.3$ to GND -0.3
Maximum Chip Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Package Thermal Resistance	
CerDIP $R_{\theta J-A}$	150°C/W
CerDIP $R_{\theta J-C}$	50°C/W
PDIP $R_{\theta J-A}$	125°C/W
PDIP $R_{\theta J-C}$	42°C/W

SOIC $R_{\theta J-A}$	155°C/W
SOIC $R_{\theta J-C}$	45°C/W
Operating Temperature Range	
C Version	0°C to +70°C
E Version	-40°C to +85°C
M Version	-55°C to +125°C
Package Power Dissipation ($T_A \leq 70^\circ\text{C}$)	
Plastic DIP	730mW
CerDIP	800mW
SOIC	470mW

ELECTRICAL CHARACTERISTICS: unless otherwise specified $T_A = +25^\circ\text{C}$ with $5\text{V} \leq V_{DD} \leq 18\text{V}$.

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
Programmable Current Range						
	Pin 4 Input Current for I_{SOURCE} Control	$(V_{REF} - V_{R1}) / R_{CHG}$ Fig. 2	5.0	—	150	μA
	Pin 1 Input Current for I_{SINK} Control	$(V_{REF} - V_{R2}) / R_{DIS}$ Fig. 2	5.0	—	150	μA
Reference Section						
	V_{REF}	$V_{DD} = 15\text{V}$, $I_{REF} = 10\mu\text{A}$	3.8	4	4.2	V
	Line Regulation of V_{REF}	$V_{DD} = 7\text{V}$ to 18V	—	0.6	1	%/V
	Load Regulation of V_{REF}	$I_{REF} = 0$ to 1mA	—	0.1	0.2	%/mA
V_{DRIFT}	V_{REF} Drift Over Lifetime		—	—	5	%
TCV_{REF}	V_{REF} Tempco	$-55 \leq \text{Temp} \leq 125^\circ\text{C}$	—	1100	2000	ppm/ $^\circ\text{C}$
V_{R1}, V_{R2}	Voltage at Pin 1 & 4		2.85	3.0	3.15	V
$V_{REF} - V_R$	Voltage Across R_{CHG} and R_{DIS}		0.85	1	1.15	V
V_{ih}	Pin 2, High Switching Threshold	$V_{DD} = 15\text{V}$	1.8	2	2.2	V
V_{il}	Pin 2, Low Switching Threshold	$V_{DD} = 15\text{V}$	0.8	1	1.2	V
$V_{ih} - V_{il}$	Delta High to Low Threshold	$V_{DD} = 15\text{V}$	0.9	1.0	1.1	V
I_{REF}	V_{REF} Pin 3 Short to GND Pin 5	$V_{DD} = 15\text{V}$	—	8	15	mA

ELECTRICAL CHARACTERISTICS: unless otherwise specified $T_A = +25^\circ\text{C}$ with $10\text{V} \leq V_{DD} \leq 18\text{V}$:

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
Oscillator						
	Voltage Stability	$V_{DD} = 7$ to 18V	—	1	5	%/V
	Temperature Stability	$-55 \leq \text{Temp} \leq 125^\circ\text{C}$	—	0.4	—	%/ $^\circ\text{C}$
Power Supply						
	Power Supply Current	$I_{DD0} \leq V_{IN} \leq 3\text{V}$	—	2	3	mA
Switching Time¹						
t_R	Rise Time	$C1 = 1800\text{pF}$	—	23	30	nsec
t_F	Fall Time	$C1 = 1800\text{pF}$	—	20	30	nsec
t_{D1}	Delay Time	$C1 = 1800\text{pF}$	—	140	180	nsec
t_{D2}	Delay Time	$C1 = 1800\text{pF}$	—	100	140	nsec
Output						
V_{OH}	High Output Voltage		$V_{DD} - 0.025$	—	—	V
V_{OL}	Low Output Voltage		—	—	0.025	V
R_O	Output Res Hi State	$V_{DD} = 15\text{V}$	—	3.5	5	Ω
R_O	Output Res Lo State	$V_{DD} = 15\text{V}$	—	2.5	5	Ω
I_{PK}	Peak Output Current	$V_{DD} = 18\text{V}$	—	3	—	A

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ELECTRICAL CHARACTERISTICS: specifications over operating temperature range unless otherwise specified $5.0V < V_{DD} < 18V$.

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit	
Programmable Current Range							
	Pin 4 Input Current for I_{SOURCE} Control	$(V_{REF}-V_{R1}) / R_{CHG}$ Fig. 2	5.0	–	100	μA	
	Pin 1 Input Current for I_{SINK} Control	$(V_{REF}-V_{R2}) / R_{DIS}$ Fig. 2	5.0	–	100	μA	
Reference Section							
V_{REF}	$V_{DD} = 15V$	$I_{REF} = 10\mu A$	3.6	4	4.4	V	
$V_{DD} = 7$ to 18V	Line Regulation of V_{REF}		–	0.9	1.5	%/V	
$I_{REF} = 0$ to 1mA	Load Regulation of V_{REF}		–	0.1	0.4	%/mA	
V_{DRIFT}	V_{REF} Drift Over Lifetime		–	–	5	%	
TCV_{REF}	V_{REF} Tempco		–	1100	2000	ppm/ $^{\circ}C$	
V_{R1}, V_{R2}	Voltage Pin at 1 and 4		$V_{DD} = 15V$	2.7	3	3.3	V
$V_{REF}-V_R$	Voltage Across R_{CHG} and R_{DIS}			0.8	1	1.2	V
V_{ih}	Pin 2, High Switching Threshold		$V_{DD} = 15V$	1.75	2	2.25	V
V_{il}	Pin 2, Low Switching Threshold		$V_{DD} = 15V$	0.75	1	1.25	V
V_{ih} to V_{il}	Delta High to Low Threshold		$V_{DD} = 15V$	0.9	1.0	1.1	V
I_{REF}	V_{REF} Pin 3 Short to GND Pin 5		$V_{DD} = 15V$	–	–	18	mA
Oscillator							
Voltage Stability		$V_{DD} = 7V$ to 18V	–	1	8	%/V	
Temperature Stability		$-55 \leq Temp \leq 125^{\circ}C$	–	0.4	–	%/ $^{\circ}C$	
Power Supply							
I_{DD}	Power Supply Current		$0 \leq V_{IN} \leq 3V$	–	–	4	mA
Switching Time¹							
t_R	Rise Time		$C1 = 180pF$, Fig. 1	–	33	40	nsec
t_F	Fall Time		$C1 = 1800pF$, Fig. 1	–	30	40	nsec
t_{D1}	Delay Time		Fig. 1	–	180	220	nsec
t_{D2}	Delay Time		Fig. 1	–	160	200	nsec
Output							
V_{OH}	High Output Voltage		$V_{DD} - 0.025$	–	–	V	
V_{OL}	Low Output Voltage		–	–	0.025	V	
R_O	Output Res Hi State		$V_{DD} = 15V$	–	4.5	6	Ω
R_O	Output Res Lo State		$V_{DD} = 15V$	–	3.4	6	Ω
I_{PK}	Peak Output Current		$V_{DD} = 18V$	–	2	–	A

NOTE : ¹Switching times guaranteed by design.
The typical values are from 125 $^{\circ}C$ measurements.

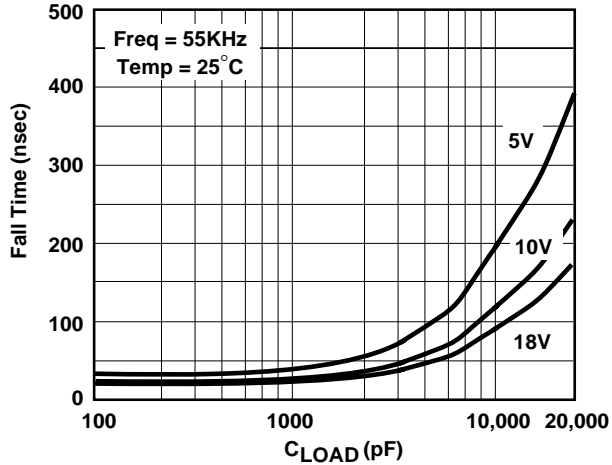
Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the Operational Specifications is not implied. Any exposure to Absolute Maximum Rating Conditions may affect device reliability.

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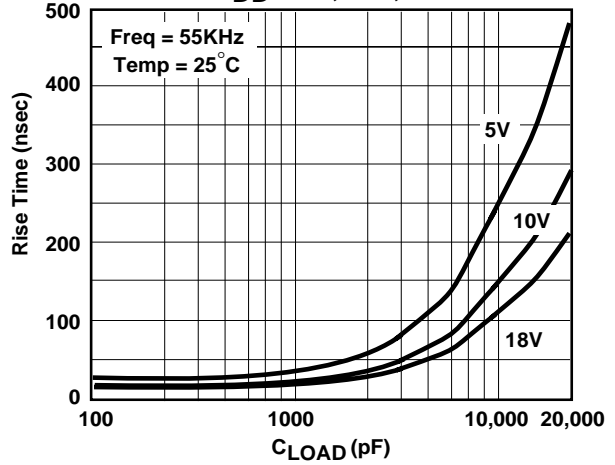
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TYPICAL CHARACTERISTICS

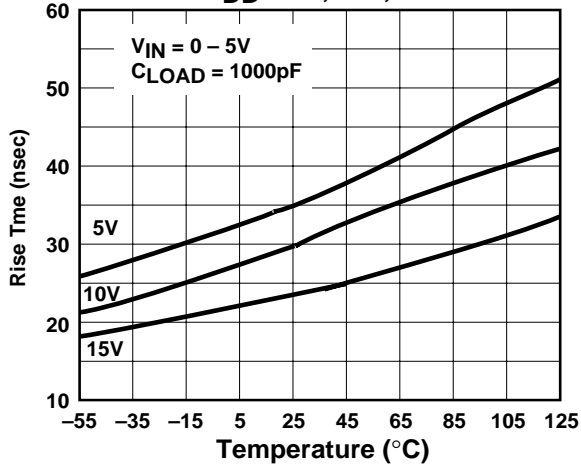
Fall Time vs. Capacitive Load
VDD = 5V, 10V, 18V



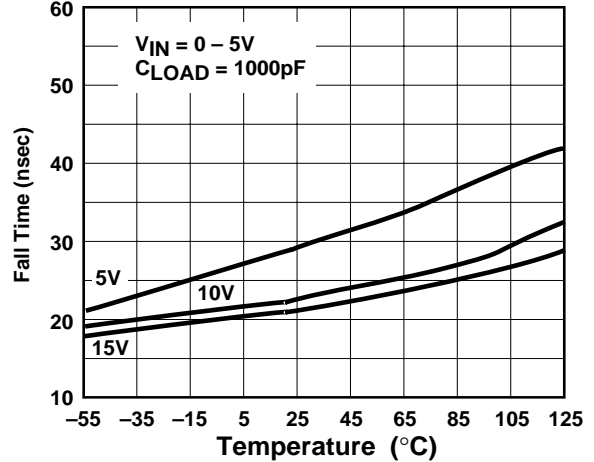
Rise Time vs. Capacitive Load
VDD = 5V, 10V, 18V



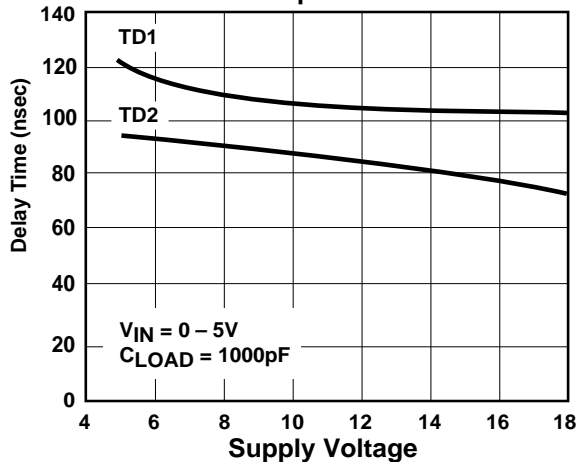
Rise Time vs. Temperature
VDD = 5V, 10V, 15V



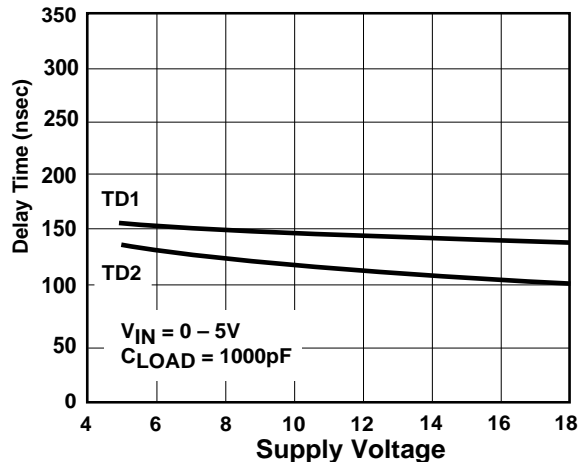
Fall Time vs. Temperature
VDD = 5V, 10V, 15V



Delay Time vs. Supply Voltage
Temp = -55°C



Delay Time vs. Supply Voltage
Temp = 25°C

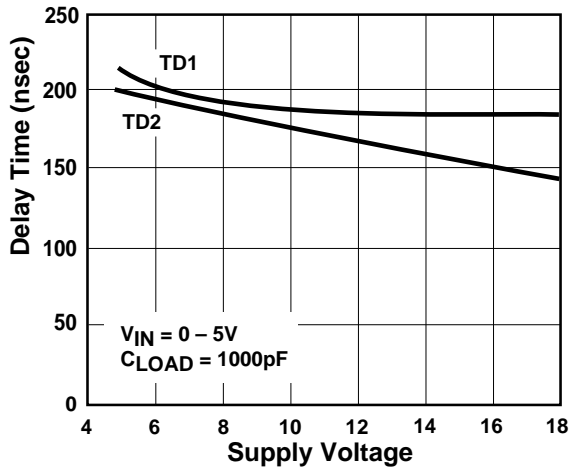


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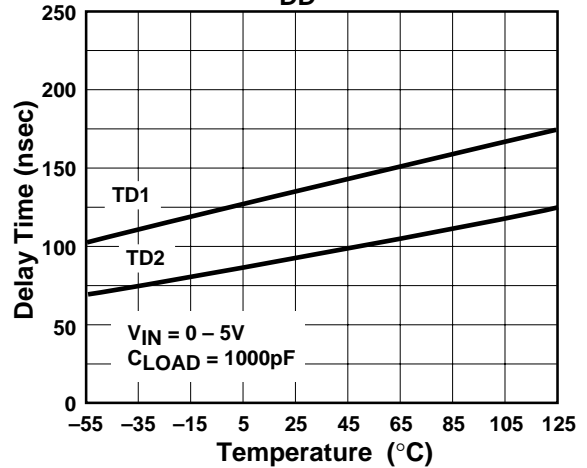
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TYPICAL CHARACTERISTICS (Cont.)

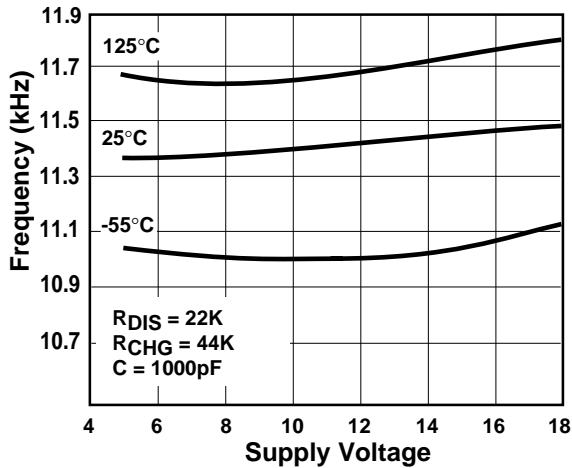
Delay Time vs. Supply Voltage
Temp = 125°C



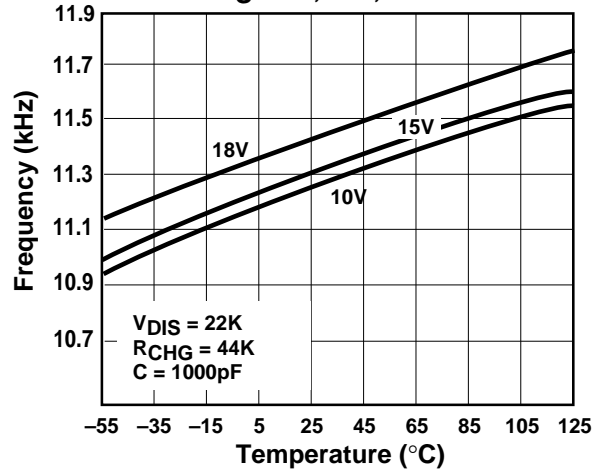
Delay Time vs. Temperature
VDD = 18V



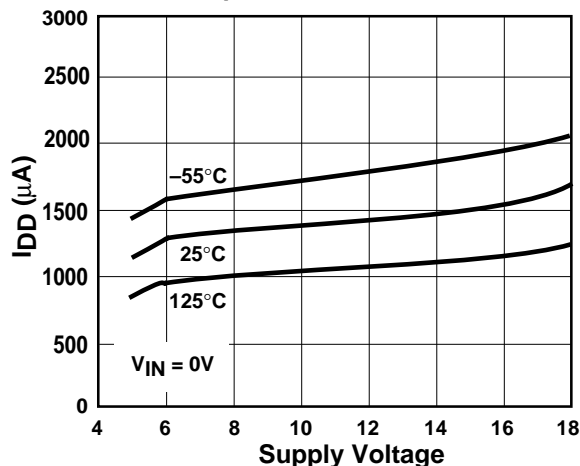
Oscillation Frequency vs. Supply Voltage
Temp at 25°C, -55°C, 125°C



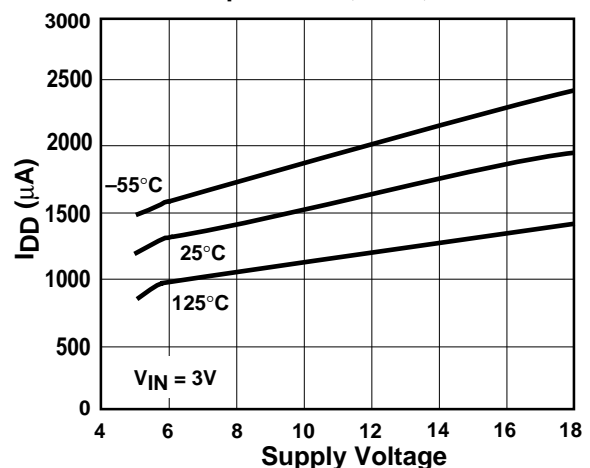
Oscillation Frequency vs. Temperature
VS = 5V, 10V, 18V



IDD vs. Supply Voltage
Temp = -55°C, 25°C, 125°C



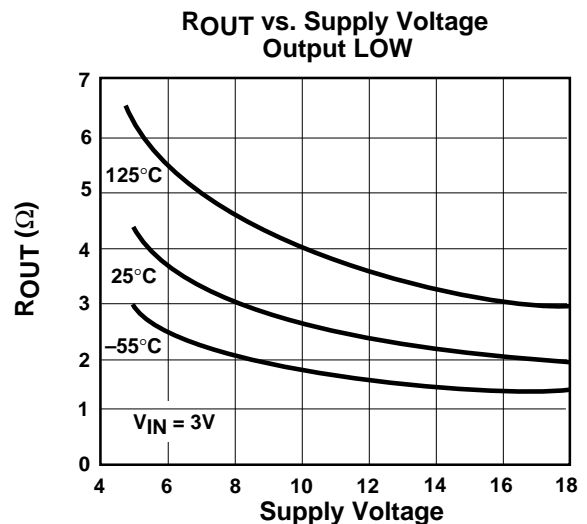
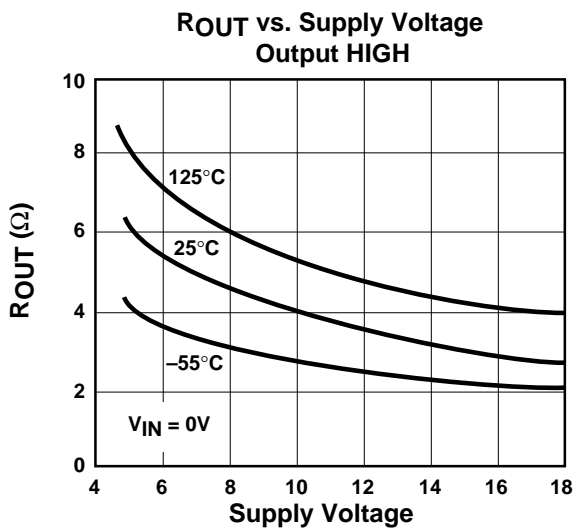
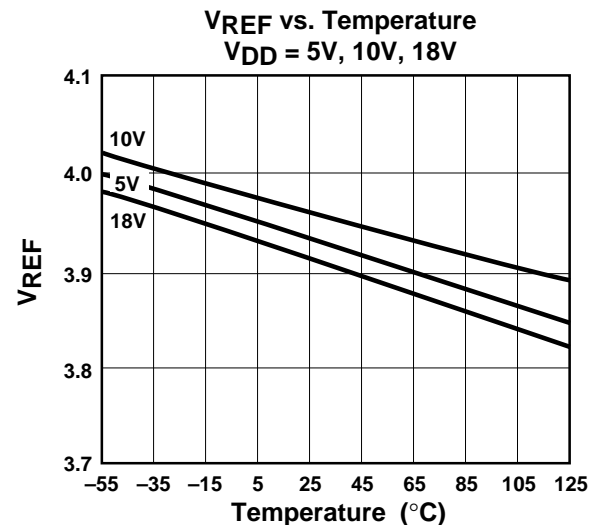
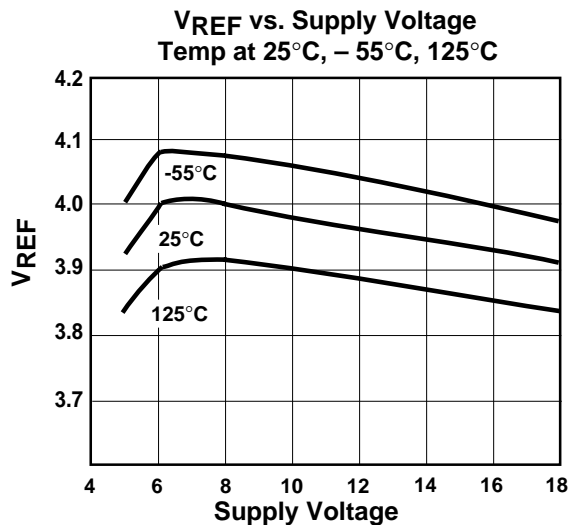
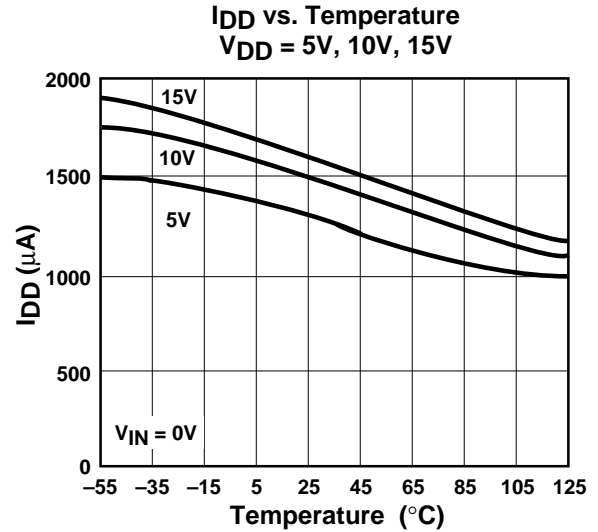
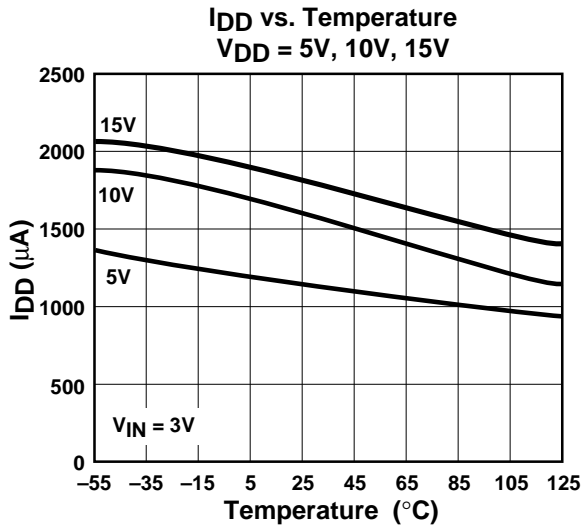
IDD vs. Supply Voltage
Temp = -55°C, 25°C, 125°C



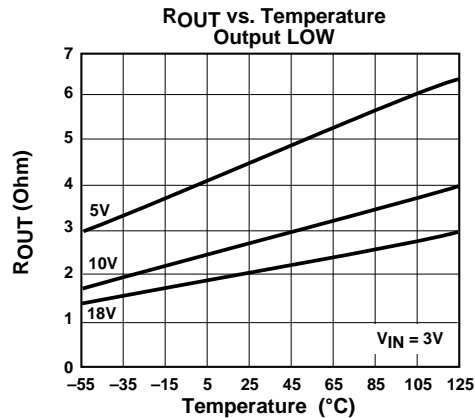
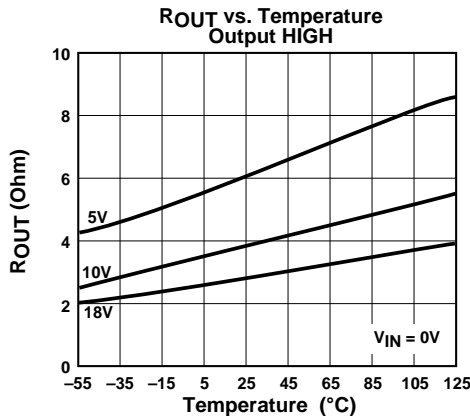
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TYPICAL CHARACTERISTICS (Cont.)



TYPICAL CHARACTERISTICS (Cont.)



APPLICATIONS

The oscillator timing can easily be controlled by two external resistors, R_{CHG} and R_{DIS} , and capacitor C . R_{CHG} and R_{DIS} set the two constant current sources for charging and discharging C . The source current is always flowing when in operation. When the capacitor has charged to a 2V threshold, the current sink circuit is enabled to discharge the

capacitor to the 1V threshold. When 1V is reached, the current sink turns OFF to start another cycle.

Resistor R_{CHG} is connected from V_{REF} at Pin 3 to V_{R1} Pin 4 to program the charging current. Current is set with resistor R_{DIS} connected from V_{REF} Pin 3 to V_{R2} Pin 1. Both currents can range from $5\mu A$ to $150\mu A$.

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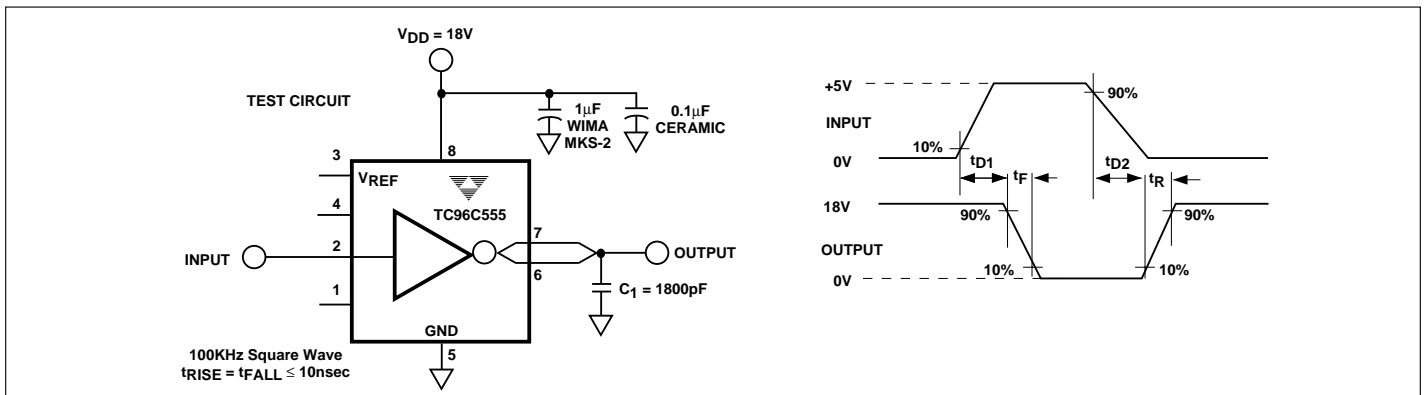


Figure 1. Output Switching Time

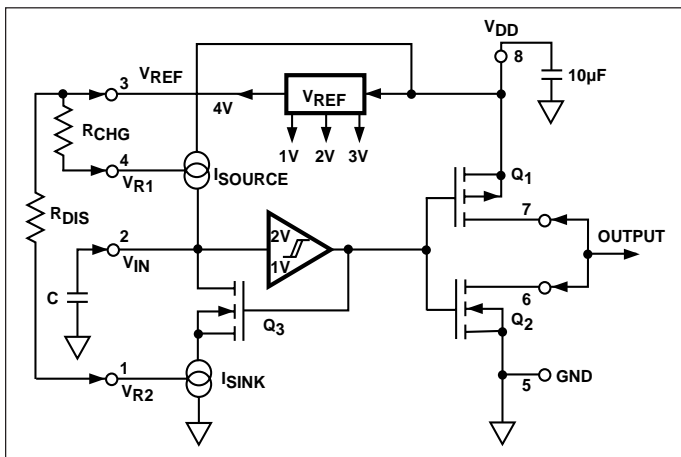


Figure 2. Fixed Frequency Power Oscillator

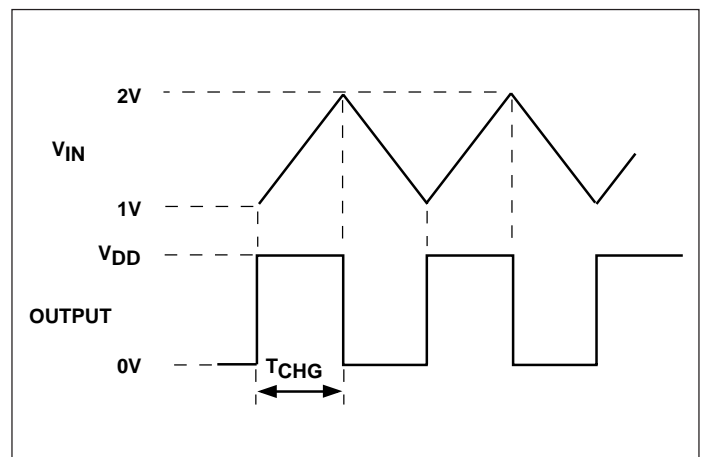


Figure 3. V_{IN} and Output Waveform

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APPLICATIONS (Cont.)

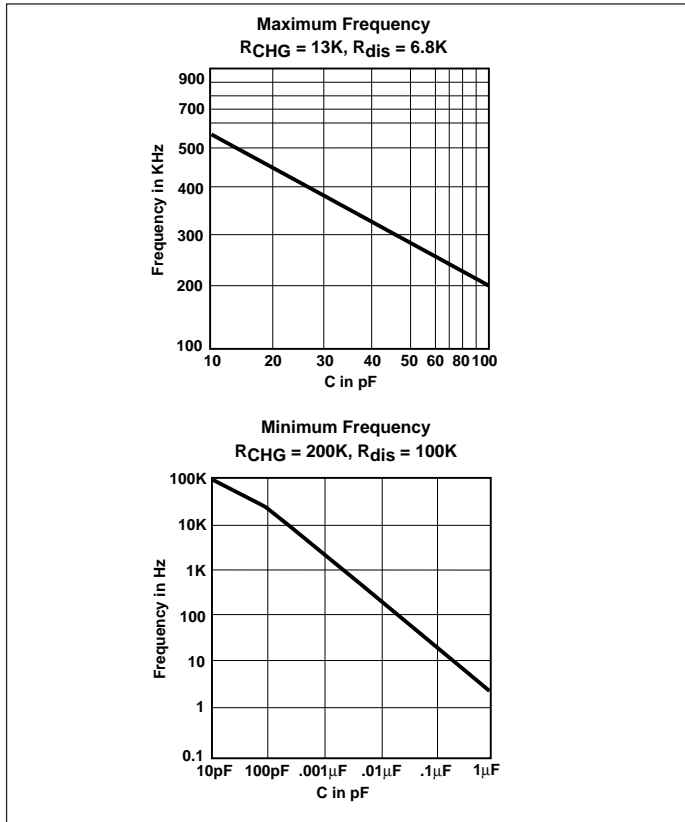


Figure 4. Typical Maximum and Minimum Operating Frequency vs. Capacitor

This circuit will convert a 6 to 15V input to a 5V output of 200 milliamps. Normal operating frequency is 50kHz. Peak to peak ripple is 50 millivolts. A change from 100mA to 200mA produces a 50mV peak change in V_{OUT} , with recovery in 200μs.

The TC96C555 is used here as a duty cycle modulator in a buck output circuit. The source current is modulated to control the duty cycle. Sink current is fixed at 100μA with a resistor (R4) of 10K. Transistor Q1, (2N2907A), is used for current modulation into TC96C555 Pin 4, the charge current program input. Shunt regulator TL431 is used for voltage sense and regulation feedback. The TL431 has an internal reference of 2.495V. Terminal R is compared with this reference to control conduction of cathode C to anode A. R2 and R3 are selected to give proper bias current to the TL431. C2 and R7 are for loop compensation and are optimized for a recovery time of 200μs. The TC96C555 outputs, Pin 7 and 6, are tied together so that when output is HIGH, current conducts from V_{DD} Pin 8 to output Pin 7 to charge the inductor, L1. When output is OFF or LOW, energy stored in L1 will continue to conduct through TC96C555 Pin 6 to the lower internal MOSFET and out to Pin 5, the ground return. This circuit does not have current limiting. A fuse is recommended for protection. Figure 6 shows the duty cycle as a function of the source current. Figure 8 shows the frequency vs control voltage.

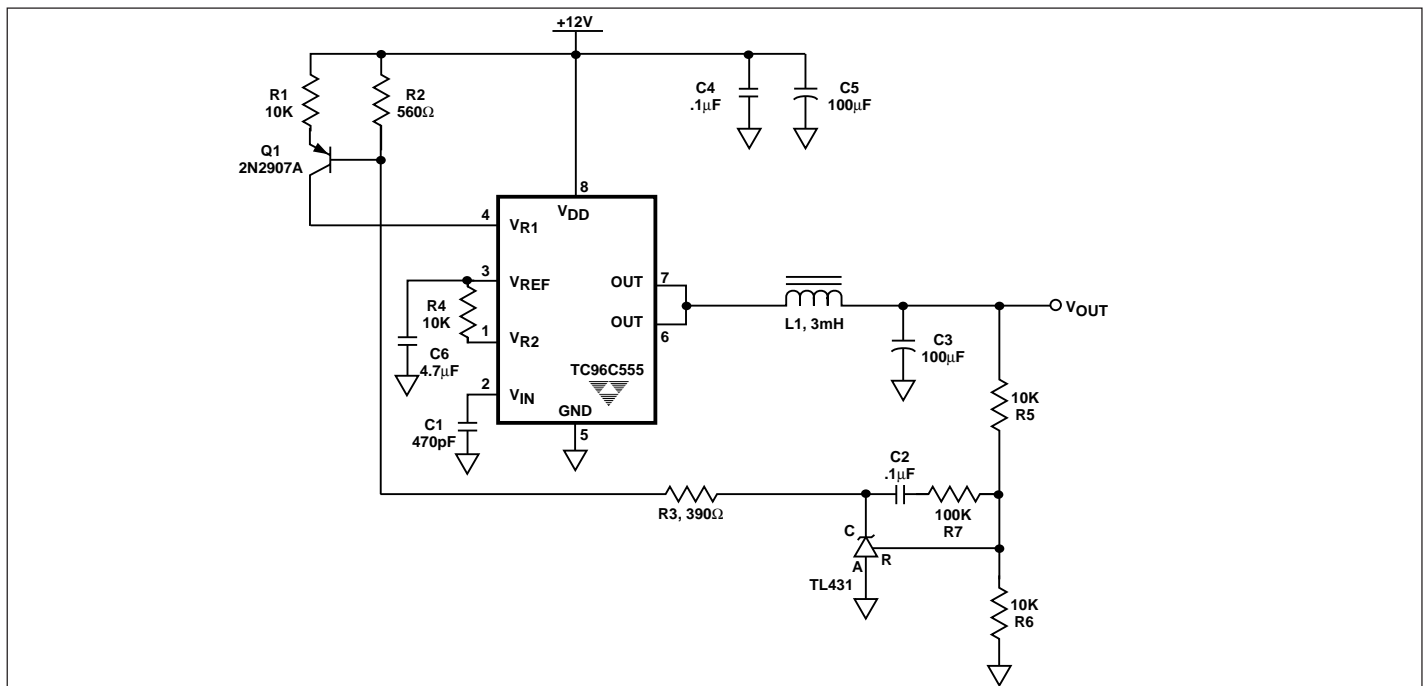


Figure 5. +5V Buck Regulator Power Supply with 82% Efficiency at 200mA Output

APPLICATIONS (Cont.)

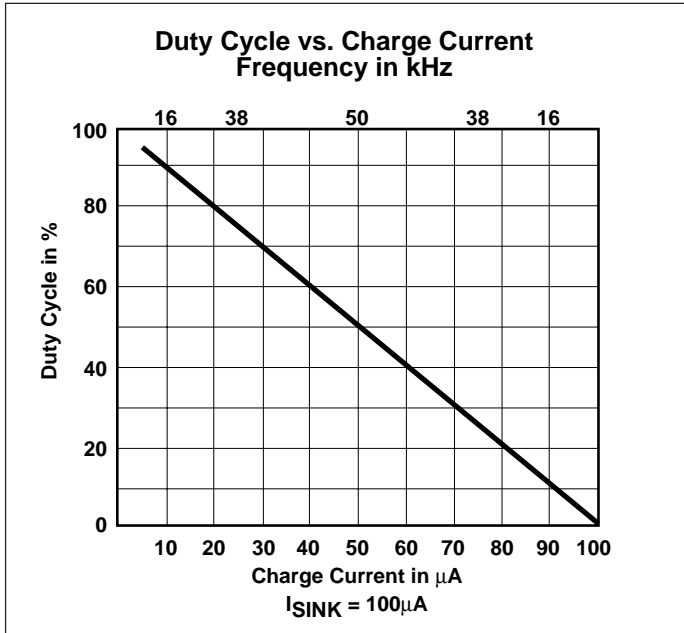


Figure 6. Duty Cycle vs. Charge Current

By connecting both resistors, R_{CHG} and R_{DIS} , to a voltage source instead of connecting to the 4V reference of Pin 3, one can increase or decrease the output frequency. Increasing the voltage source to 5V will double the oscillator frequency by doubling the voltage across both R_{CHG} and R_{DIS} . Decreasing the voltage source to 3.5V will drop the frequency in half.

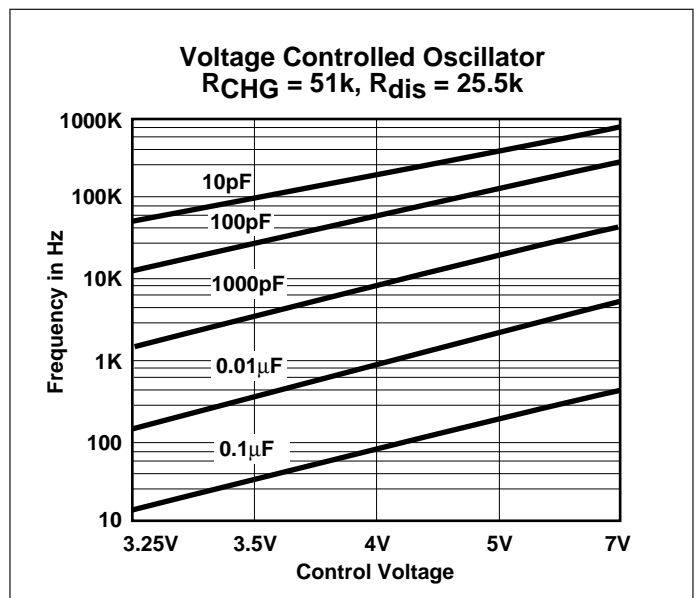


Figure 8. Frequency vs Control

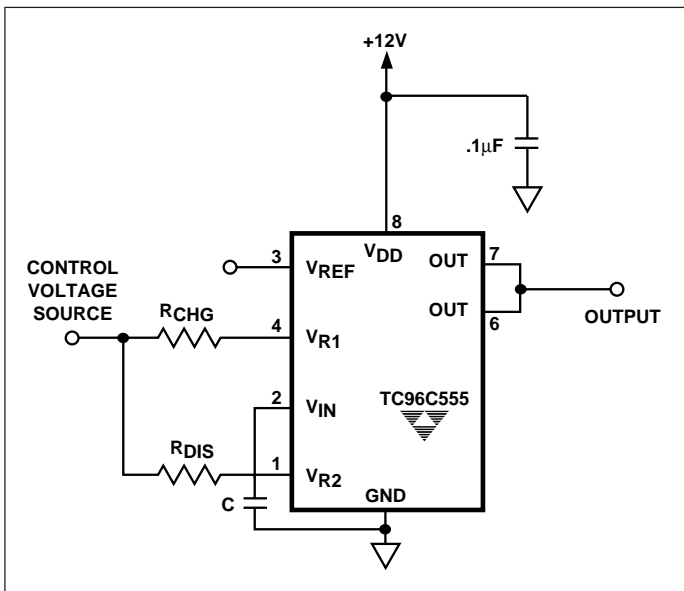


Figure 7. Voltage Controlled Power Oscillator