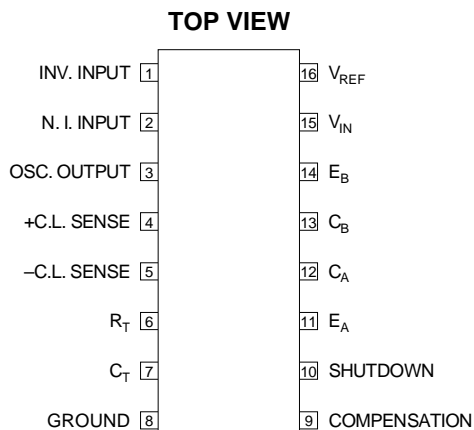


## REGULATING PULSE WIDTH MODULATORS



**J Package – 16 Pin Ceramic DIP**  
**N Package – 16 Pin Plastic DIP**  
**D Package – 16 Pin Plastic (300) SOIC**

### FEATURES

- Pin Compatible with IP1524 Series
- 7 to 40 volt operation
- 5 volt reference trimmed to  $\pm 1\%$
- Undervoltage lockout
- Excellent external sync capability
- Wide current limit common mode range
- +5 Volt error amplifier common mode
- PWM data latch
- Full double-pulse suppression logic
- 50ns shutdown function
- Dual 200mA, 60V output transistors
- Fully specified over temperature

### Order Information

Part Number	J-Pack 16 Pin	N-Pack 16 Pin	D-16 16 Pin	Temp. Range	<b>Note:</b> To order, add the package identifier to the part number. eg. IP1524BJ IP3524BD-16
IP1524B	✓			-55 to +125°C	
IP2524B	✓	✓	✓	-25 to +85°C	
IP3524B	✓	✓	✓	0 to +70°C	

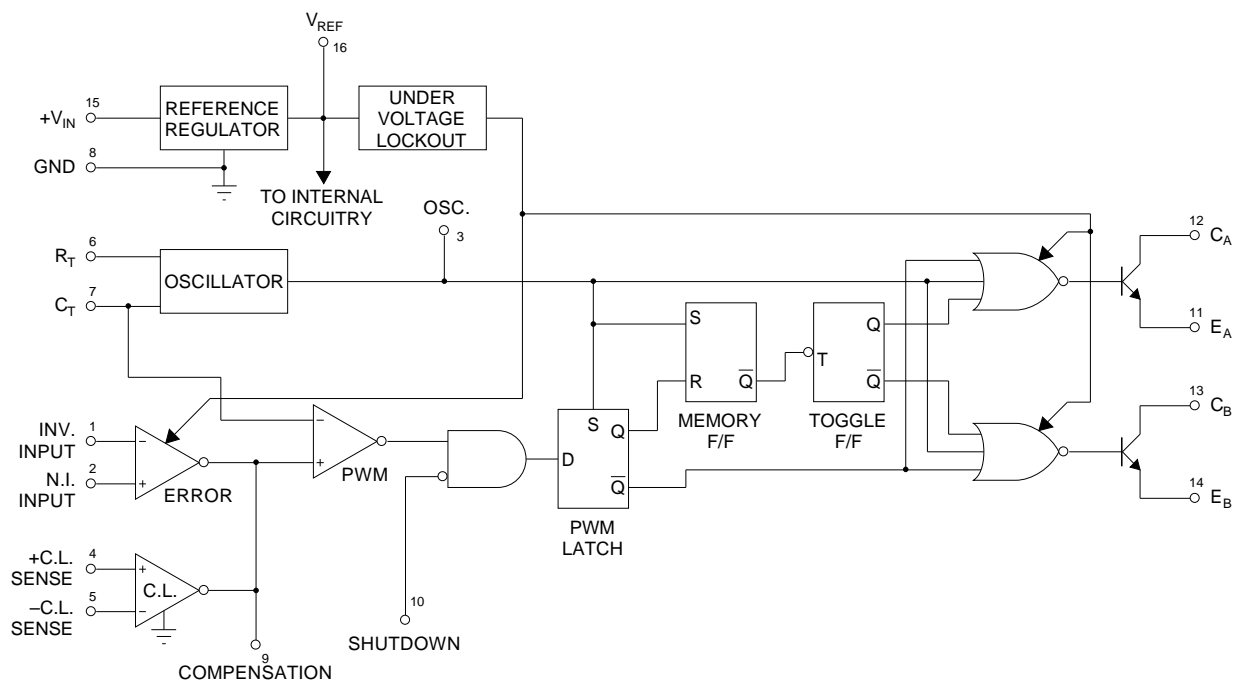
### ABSOLUTE MAXIMUM RATINGS ( $T_{case} = 25^{\circ}C$ unless otherwise stated)

$+V_{IN}$	Input Voltage		+40V
	Collector Voltage		+60V
	Logic Inputs		-0.3 to +5.5V
	Current Limit Sense Inputs		-0.3 to $+V_{IN}$
	Oscillator Charging Current		5mA
$P_D$	Power Dissipation	$T_A = 25^{\circ}C$	1W
		Derate @ $T_A > 50^{\circ}C$	10mW/ $^{\circ}C$
$P_D$	Power Dissipation	$T_C = 25^{\circ}C$	2W
		Derate @ $T_C > 25^{\circ}C$	16mW/ $^{\circ}C$
$T_J$	Operating Junction Temperature		See Ordering Information
$T_{STG}$	Storage Temperature Range		-65 to +150°C
$T_L$	Lead Temperature	(soldering, 10 seconds)	+300°C

**DESCRIPTION**

The IP1524B is a pulse width modulator for switching power supplies which features improved performance over industry standards like the SG1524. A direct pin-for-pin replacement for the earlier device, it combines advanced processing techniques and circuit design to provide improved reference accuracy/ and extended common mode range at the error amplifier and current limit inputs. A DC-coupled flip-flop eliminates triggering and glitch problems, and a PWM data latch prevents edge oscillations. The circuit incorporates true digital shutdown for high speed response, while an undervoltage lockout circuit prevents spurious outputs when the supply voltage is too low for stable operation. Full double-pulse suppression logic insures alternating output pulses when the shutdown pin is used for pulse-by-pulse current limiting.

**BLOCK DIAGRAM**



**RECOMMENDED OPERATING CONDITIONS**

$V_{IN}$	Input Voltage	+7 to +40V
	Collector Voltage	0 to +60V
	Error Amp Common Mode Range	+2.3 to $V_{REF}$
	Current Limit Sense Common Mode Range	0 to $V_{IN} - 2.5V$
	Output Current (each transistor)	0 to 200mA
	Reference Load Current	0 to 20mA
	Oscillator Charging Current	25 $\mu$ A to 1.8mA
	Oscillator Frequency Range	50Hz to 500kHz
$R_T$	Oscillator Timing Resistor	2k $\Omega$ to 150k $\Omega$
$C_T$	Oscillator Timing Capacitor	1nF to 0.1 $\mu$ F
	Operating Ambient Temperature Range	IP1524B IP2524B IP3524B
		-55 to +125°C -25 to +85°C 0 to +70°C

**ELECTRICAL CHARACTERISTICS** ( $T_J$  = Over Operating Temperature Range unless otherwise stated)

Parameter	Test Conditions <sup>1</sup>	IP1524B IP2524B			IP3524B			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	
<b>TURN-ON CHARACTERISTICS</b>								
$V_{IN}$ Undervoltage Threshold	$V_{IN}$ Rising	4.3	5.2	6.5	4.3	5.2	6.5	V
Turn-on Hysteresis		0.1	0.3	0.6	0.1	0.3	0.6	mA
Operating Current	$V_{IN} = 7$ to 40V		7	10		7	10	
<b>REFERENCE SECTION</b>								
Output Voltage	$T_J = 25^\circ\text{C}$	4.95	5.00	5.05	4.90	5.00	5.10	V
	$V_{IN} = 7$ to 40V $I_L = 0$ to 20mA	4.90		5.10	4.85		5.15	
Line Regulation	$V_{IN} = 7$ to 40V		1	10		1	15	mV
Load Regulation	$I_L = 0$ to 20mA		5	15		5	25	
Temperature Stability			40	75		40	75	
Short Circuit Current	$V_{REF} = 0$	25	70	120	25	70	120	mA
Long Term Stability	$T_J = 25^\circ\text{C}$		1	10		1		mV / khr
<b>OSCILLATOR SECTION <sup>2</sup></b>								
Initial Accuracy	$T_J = 25^\circ\text{C}$	41	43	45	39	43	47	kHz
Voltage Stability	$V_{IN} = 7$ to 40V		0.1	1		0.1	1	%
Temperature Stability			1	2		1	2	
Minimum Frequency	$R_T = 150\text{k}\Omega$ $C_T = 0.1\mu\text{F}$		80	140		80	140	Hz
Maximum Frequency	$R_T = 2\text{k}\Omega$ $C_T = 470\text{pF}$	400	700		400	700		kHz
Clock Amplitude	Output, Pin 3 $C_T = 0.01\mu\text{F}$	3.0	4.0		3.0	4.0		V
Clock Pulse Width	Output, Pin 3 $C_T = 0.01\mu\text{F}$	0.4	0.5	1.2	0.4	0.5	1.2	$\mu\text{s}$
Sawtooth Peak Voltage	$C_T = 0.01\mu\text{F}$		3.7	4.0		3.7	4.0	V
Sawtooth Valley Voltage	$C_T = 0.01\mu\text{F}$	0.6	1	1.1	0.6	1	1.1	
Sawtooth Valley T.C.	$T_J = 25^\circ\text{C}$		-1			-1		mV/ $^\circ\text{C}$
<b>ERROR AMP SECTION</b>								
Input Offset Voltage	$V_{CM} = 2.3$ to $V_{REF}$		0.1	5		2	10	mV
Input Bias Current	$V_{CM} = 2.3$ to $V_{REF}$		1	5		1	10	$\mu\text{A}$
Input Offset Current	$V_{CM} = 2.3$ to $V_{REF}$		0.1	1		0.1	1	

**NOTES**

1. Test Conditions unless otherwise stated:

$$V_{IN} = 20\text{V}, I_{REF} = 0.$$

$$T_J = -55 \text{ to } +125^\circ\text{C} \text{ for IP1524B}$$

$$T_J = -25 \text{ to } +85^\circ\text{C} \text{ for IP2524B}$$

$$T_J = 0 \text{ to } +70^\circ\text{C} \text{ for IP3524B}$$

2.  $R_T = 2.7\text{k}\Omega$ ,  $C_T = 0.01\mu\text{F}$  unless otherwise stated.

**ELECTRICAL CHARACTERISTICS** ( $T_J$  = Over Operating Temperature Range unless otherwise stated)

Parameter	Test Conditions <sup>1</sup>	IP1524B IP2524B			IP3524B			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	
<b>ERROR AMP SECTION (cont.)</b>								
DC Open Loop Gain	$\Delta V_O = 1$ to $3V$ $R_L \geq 10M\Omega$	60	75		60	75		dB
Common Mode Rejection	$V_{CM} = 2.3$ to $V_{REF}$	70	90		70	90		
Supply Voltage Rejection	$V_{IN} = 7$ to $40V$	76	120		76	120		
Output Low Level	$I_{SINK} = 100\mu A$		0.2	0.5		0.2	0.5	V
Output High Level	$I_{SOURCE} = 100\mu A$	3.8	4.2		3.8	4.2		
Gain Bandwidth Product	$T_J = 25^\circ C$	1	2		1	2		MHz
<b>PWM COMPARATOR</b>								
Minimum Duty Cycle	$V_{PIN1} - V_{PIN2} \geq 150mV$			0			0	%
Maximum Duty Cycle	$V_{PIN2} - V_{PIN1} \geq 150mV$	45	49		45	49		
<b>CURRENT LIMIT AMPLIFIER</b>								
Sense Voltage	$V_{CM} = 0$ to $17.5V$ $V_{IN} = 7$ to $40V$	180	200	220	180	200	220	mV
Input Bias Current	$V_{CM} = 0$ to $17.5V$ $V_{IN} = 7$ to $40V$		-1	-10		-1	-10	$\mu A$
<b>SHUTDOWN INPUT</b>								
High Input Voltage		2.0			2.0			V
High Input Current	$V_{SHUTDOWN} = 5V$		0.1	1		0.1	1	mA
Low Input Voltage				0.6			0.6	V
Shutdown Delay	Pin 10 to output $T_J = 25^\circ C$		50			50		ns
<b>OUTPUT SECTION (each transistor)</b>								
Collector Leakage Current	$V_{CE} = 60V$		0.1	20		0.1	20	$\mu A$
Collector Saturation Voltage	$I_C = 20mA$		0.2	0.4		0.2	0.4	V
	$I_C = 200mA$		1.0	2.2		1.0	2.2	
Emitter Output Voltage	$I_E = 50mA$	17	19		17	19		V
	$I_E = 200mA$	16.5	18		16.5	18		
Emitter Voltage Rise Time	$R_E = 2k\Omega$ $T_J = 25^\circ C$		0.2	0.4		0.2		$\mu s$
Collector Voltage Fall Time	$R_C = 2k\Omega$ $T_J = 25^\circ C$		0.1	0.2		0.1		

**NOTES**

1. Test Conditions unless otherwise stated:

$$V_{IN} = 20V, I_{REF} = 0.$$

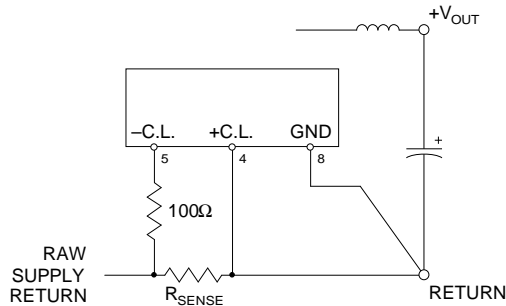
$$T_J = -55 \text{ to } +125^\circ C \text{ for IP1524B}$$

$$T_J = -25 \text{ to } +85^\circ C \text{ for IP2524B}$$

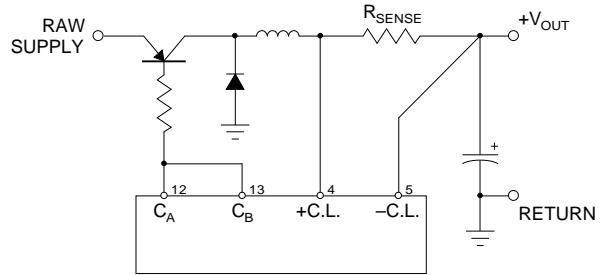
$$T_J = 0 \text{ to } +70^\circ C \text{ for IP3524B}$$

**APPLICATIONS INFORMATION**

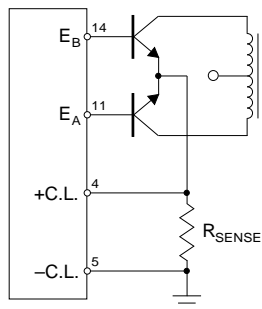
**Current Sensing in the Ground Line**



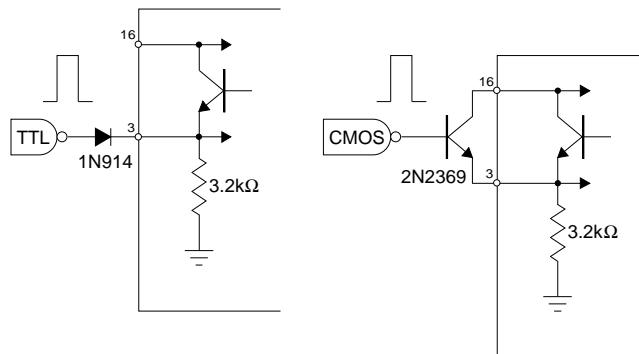
**Current Sensing in the Output Line**



**Sensing Primary Current with an Emitter Resistor**



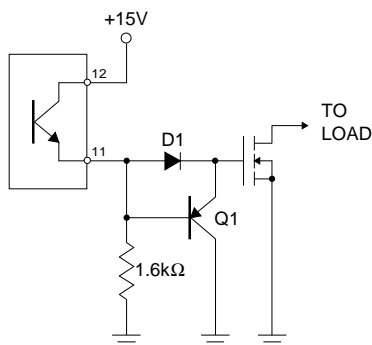
**Oscillator Sync to an External Clock**



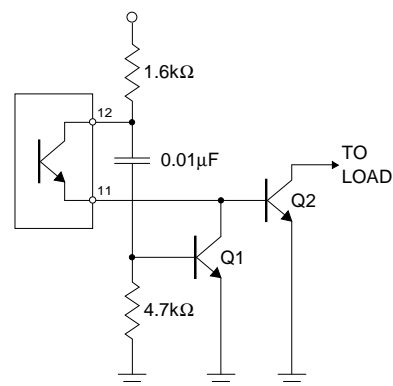
A. TTL Logic

B. 5 Volt CMOS Logic

**Driving Power MOSFETs**

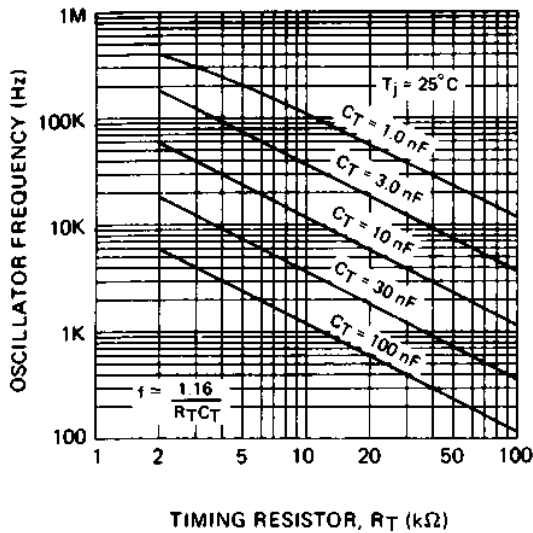


**Driving Power Bipolar Transistors**

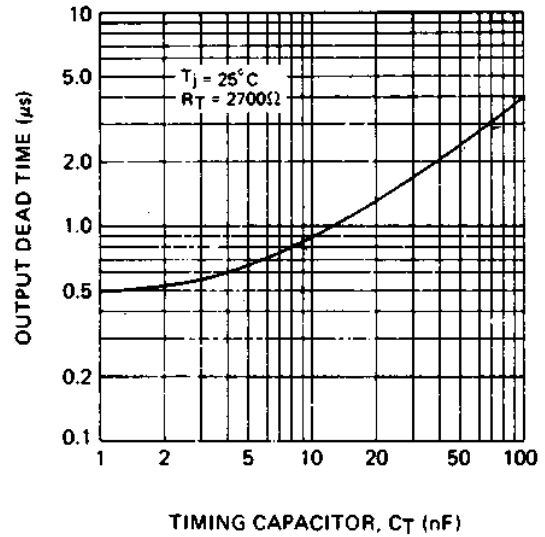


**TYPICAL PERFORMANCE CHARACTERISTICS**

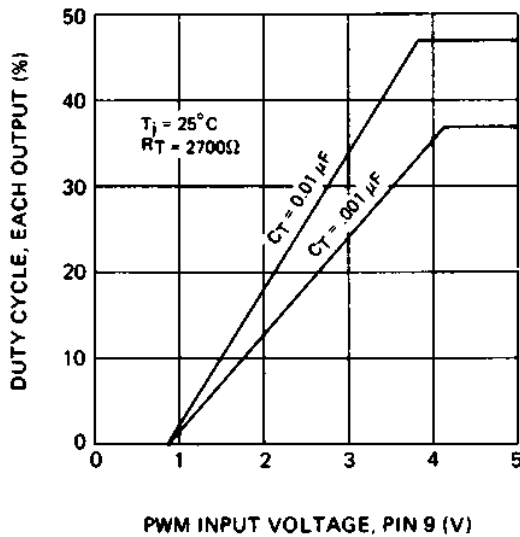
**Oscillator Frequency vs. Timing Components**



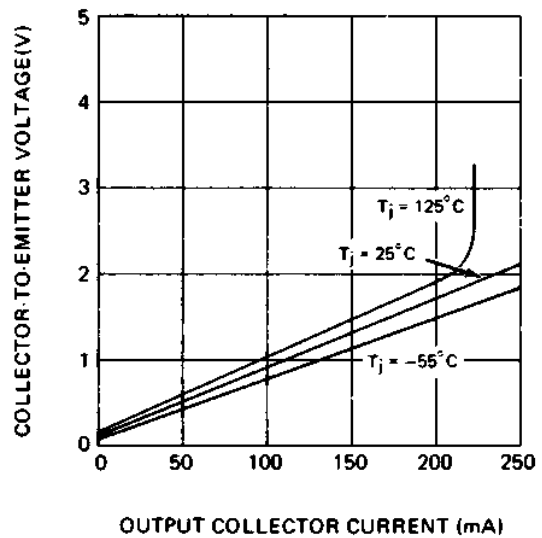
**Output Dead Time vs. Timing Capacitance Value**



**Pulse Width Modulation Transfer Function**

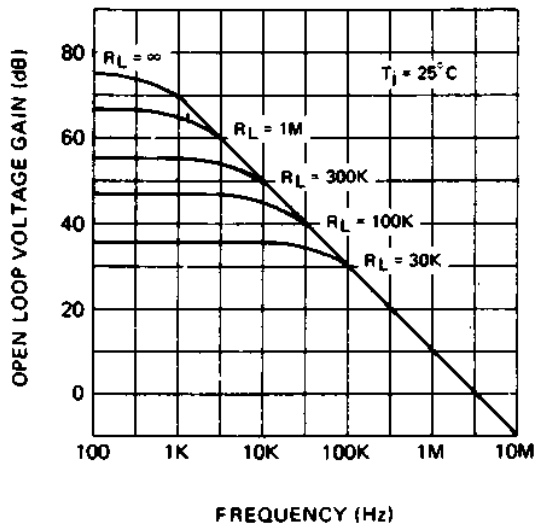


**Output Saturation Voltage**



**TYPICAL PERFORMANCE CHARACTERISTICS**

**Error Amplifier Voltage Gain vs. Frequency**



**Undervoltage Lockout Characteristics**

