REGULATING PULSE WIDTH MODULATOR

IP1524, IP3524

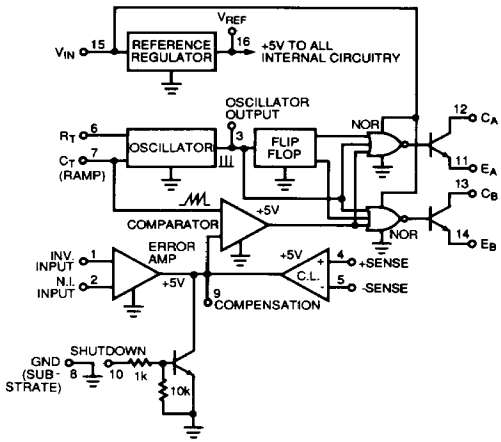
DESCRIPTION

The IP1524 series of PWM switching regulator control circuits contains all the functions required to implement single-ended or push-pull switching regulators. Included are voltage reference, error amplifer, oscillator, PWM comparator, output drivers, current limiting and shutdown circuitry.
Although functionally indentical to the SG1524 series, Seagate Microelectronics has incorporated several improvements to the IP1524 allowing tighter and more complete specification of electrical performance.

FEATURES

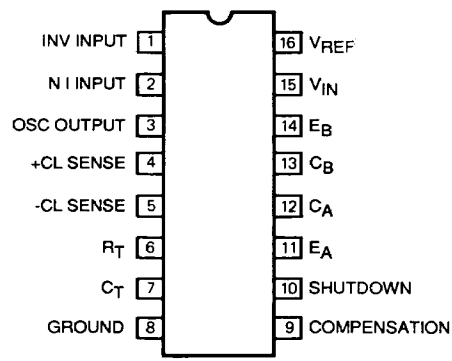
- Guaranteed ± 2% reference tolerance
- Guaranteed ± 6% oscillator tolerance
- Fully specified temperature performance
- Guaranteed 10 mV/1000 hours long term stability
- Interchangeable with SG1524 series

BLOCK DIAGRAM



CONNECTIONS

(Top View)



N, J and D (150) Package

REGULATING PULSE WIDTH MODULATOR

ABSOLUTE MAXIMUM RATINGS

Input Voltage ($+V_{IN}$) +40V
Collector Voltage +40V
Output Current (each transistor) 100mA
Reference Load Current Internally Limited
Oscillator Charging Current 5mA
Shut Down Pin Voltage +5.5V
Current Limit Sense Common Mode Range −1.0V to +1.0V

Power Dissipation at
T_A = +25°C (Note 1) 1000mW
T_C = +25°C (Note2) 2000mW

Operating Junction Temperature −55°C to +150°C
Storage Temperature Range −65°C to +150°C
Lead Temperature (Soldering, 10 seconds) +300°C

Absolute maximum ratings are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits. The electrical characteristics provide conditions for actual device operation.

RECOMMENDED OPERATING CONDITIONS (Note 3)

Input Voltage (V_{IN}) +8V to +40V
Collector Voltage 0V to +40V
Error Amp Common Mode Range +1.8V to +3.4V
Output Current (each transistor) 0 to 100mA
Reference Load Current 0 to 20mA
Oscillator Charging Current 30μA to 2.0mA

Oscillator Frequency Range 50Hz to 500kHz
Oscillator Timing Resistor (R_T) 1.8kΩ to 100kΩ
Oscillator Timing Capacitor (C_T) 1nF to 0.1μF
Operating Ambient Temperature Range
IP1524 −55°C to +125°C
IP3524 −O°C to + 70°C

Note 1. Derate at 10mW/°C for ambient temperatures above +50°C.
Note 2. Derate at 16mW/°C for case temperatures above +25°C.
Note 3. Range over which the device is functional and parameter limits are guaranteed.

ELECTRICAL CHARACTERISTICS

$+V_{IN}$ = 20V, I_{REF} = 0mA unless otherwise specified

Parameter	Test Conditions		IP1524 Min	IP1524 Typ	IP1524 Max	IP3524 Min	IP3524 Typ	IP3524 Max	Units
Reference Section									
Output Voltage		•	4.90	5.00	5.10	4.60	5.00	5.40	V
Line Regulation	$+V_{IN}$ = 8 to 40 Volts	•		1	10		10	30	mV
Load Regulation	I_L = 0 to 20 mA	•		5	20		20	50	mV
Ripple Rejection	f = 120 Hz			80			66		dB
Short Circuit Current	V_{REF} = 0 Volts	•	25	50	120		100		mA
Temperature Stability (Note 6)	Over Operating Range	•		0.3	1		0.3	1	%
Long Term Stability (Note 6)	T_j = 125°C			1	10		20		mV/khr
Oscillator Section									
Initial Accuracy	R_T = 2.7kΩ, C_T = 0.01 μF				6		5		%
Voltage Stability	$+V_{IN}$ = 8 to 40 Volts			0.1	1		0.5	1	%
Temperature Stability (Note 6)	Over Operating Range	•		1	2			2	%

REGULATING PULSE WIDTH MODULATOR

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter	Test Conditions		IP1524 Min	IP1524 Typ	IP1524 Max	IP3524 Min	IP3524 Typ	IP3524 Max	Units
Minimum Frequency	$R_T = 100K\Omega$, $C_T = 0.1\mu F$	•		120	240		120		Hz
Maximum Frequency	$R_T = 2k\Omega$, $C_T = 0.001\ \mu F$	•	200	300			300		kHz
Sawtooth Peak Voltage	$C_T = 0.01\mu F$			3.6			3.6		V
Sawtooth Valley Voltage	$C_T = 0.01\mu F$		0.6	1			1		V
Clock Amplitude	Output, Pin 3, $C_T = 0.01\mu F$	•	3.0	4.0			3.5		V
Clock Pulse Width	Output, Pin 3, $C_T = 0.01\mu F$		0.3	0.5	1.0		0.5		µs
Error Amplifier Section (Note 4)									
Input Offset Voltage		•		0.1	5		2	10	mV
Inputr Bias Current		•		1	2		1	10	µA
Input Offset Current		•			0.5			1	µA
DC Open Loop Gain		•	72	80		60	80		dB
Output Low Level	$V_{PIN\ 1} - V_{PIN\ 2} \geq 150mV$				0.5			0.5	V
Output High Level	$V_{PIN\ 2} - V_{PIN\ 1} \geq 150mV$		3.8			3.8			V
Common Mode Rejection			70	90			70		dB
Supply Voltage Rejection	$+V_{IN}$ = 8 to 40 Volts		70	100			70		dB
Gain Bandwidth Product Note 6				3			3		MHz
PWM Comparator									
Minimum Duty Cycle	$V_{PIN\ 1} - V_{PIN\ 2} \geq 150mV$	•			0			0	%
Maximum Duty Cycle	$V_{PIN\ 2} - V_{PIN\ 1} \geq 150mV$	•	45	49		45	49		%
Current Limit Amplifier (Note 5)									
Sense Voltage	$V_{CM} = 0V$		190	200	210	180	200	220	mV
Sense Voltage	$V_{CM} = 0V$	•	170	200	230		200		mV
Shutdown Input									
High Input Voltage	$V_{PIN\ 9} \leq 0.6V$	•	1.2			1.2			V
High Input Current	$V_{SHUTDOWN}$ = +5.0 Volts	•		4	8		4		mA
Low Input Voltage	$V_{PIN\ 9} \geq 3.5V$	•			0.3			0.3	V
Output Section (Each Transistor)									
Collector-Emitter Voltage	$I_C = 50\mu A$	•	40			40			V
Collector Leakage Current	V_{CE} = 40 Volts	•		0.1	50		0.1	50	µA
Collector Saturation Voltage	$I_C = 50mA$	•		1	2		1	2	V
Emitter Output Voltage	$V_{IN} = 20V$	•	17	18		17	18		V
Emitter Voltage Rise Time	$R_E = 2k$			0.2	0.4		0.2		µs
Collector Voltage Fall Time	$R_C = 2k$			0.1	0.2		0.1		µs
Power Consumption									
Standby Current	$+V_{IN}$ = 40 Volts	•		5	10		5	10	mA

The • denotes the specifications which apply over the full operating temperature range, all others apply at T_j = 25°C unless otherwise specified.

Note 4: V_{CM} = +1.8 to +3.4V
Note 5: V_{CM} = -1 to +1V
Note 6: These parameters, although guaranteed conditions, are not 100% tested in production.

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TYPICAL PERFORMANCE CHARACTERISTICS

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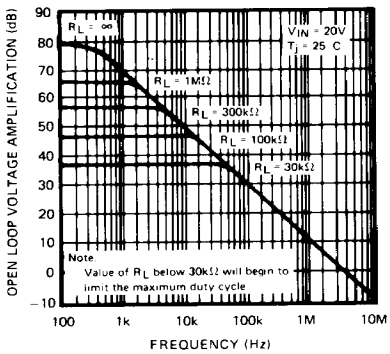
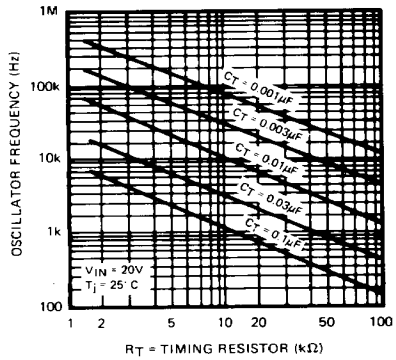
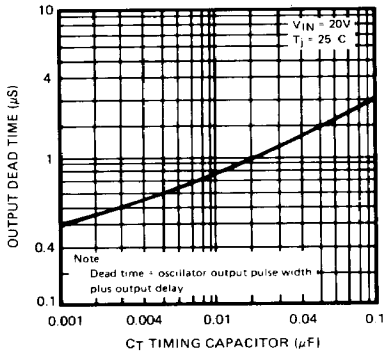
Open-Loop Voltage Amplification of Error Amplifier vs. Frequency



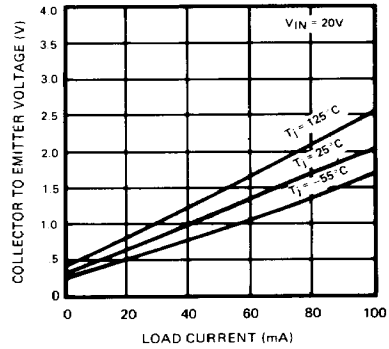
Oscillator Frequency vs. Timing Components



Output Dead Time vs. Timing Capacitance Value



Output Saturation Voltage vs. Load Current



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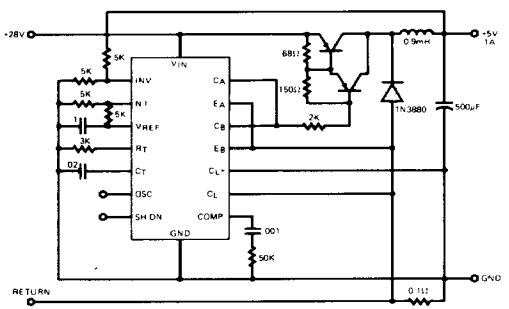
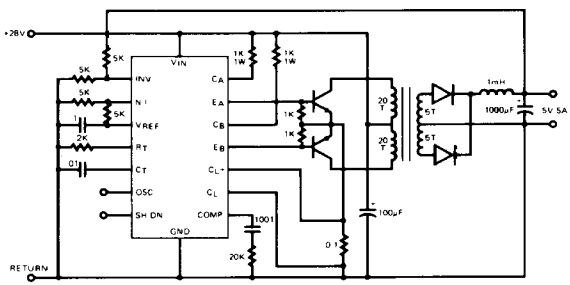
APPLICATIONS INFORMATION

The IP1524 is a fixed-frequency pulse-width modulation voltage regulator control circuit. The regulator operates at a frequency that is programmed by one timing resistor (R_T) and one timing capacitor (C_T). R_T establishes a constant charging current for C_T, which is fed to the comparator providing linear control of the output pulse width by the error amplifier. The IP1524 contains an on-board 5V regulator that serves as a reference as well as powering the IP1524's internal control circuitry and is also useful in supplying external support functions. This reference voltage is lowered externally by a resistor divider to provide a reference within the common-mode range of the error amplifier or an external reference may be used. The power supply output is sensed by a second resistor divider network to generate a feedback signal to the error amplifier. The amplifier output voltage is then compared to the linear voltage ramp at C_T. The resulting modulated pulse out of the high-gain comparator is then steered to the appropriate output pass transistor (Q_1 or Q_2) by the pulse-steering flip-flop, which is synchronously toggled by the oscillator output. The oscillator output pulse also serves as a blanking pulse to assure both outputs are never on simultaneously during the transition times. The width of the blanking pulse is controlled by the value of the C_T. The outputs may be applied in a push-pull configuration in which their frequency is half that of the base oscillator, or paralled for single-ended applications in which the frequency is equal to that of the oscillator. The output of the error amplifier shares a common input to the comparator with the current limiting and shutdown circuitry and can be overridden by signals from either of these inputs. This common point is also available externally and may be employed to control the gain of, or to compensate, the error amplifier, or to provide additional control to the regulator.



In this conventional single-ended regulator circuit, the two outputs of the IP1524 are connected in parallel for effective .0-90% duty cycle modulation. The use of an output inductor requires an R-C phase compensation network for loop stability.



Push-pull outputs are used in this transformer-coupled DC-DC regulating converter. Note that the oscillator must be set at twice the desired output frequency as the IP1524's internal flip-flop divides the frequency by 2 as it switches the PWM signal from one output to the other. Current limiting is done in the primary so that the pulse width will be reduced should transformer saturation occur.

ORDER INFORMATION

Part Number	Temperature Range	Package
IP1524J	−55°C to +125°C	16 Pin Ceramic DIP
IP3524D	0°C to + 70°C	16 Pin Plastic (150) SOIC
IP3524J	0°C to + 70°C	16 Pin Ceramic DIP
IP3524N	0°C to + 70°C	16 Pin Plastic DIP