

## SWITCHING REGULATOR CONTROL CIRCUIT

## ■ GENERAL DESCRIPTION

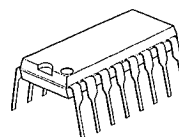
The NJM3524 of regulating pulse width modulators contains all of the control circuitry necessary to implement switching regulators of either polarity, transformer coupled DC to DC converters, transformer-less polarity converters and voltage doublers, as well as other power control applications. This device includes a 5V voltage regulator capable of supplying up to 50mA to external circuitry a control amplifier, an oscillator, a pulse width modulator, a phase splitting flip-flop, dual alternating output switch transistors, and current limiting and shut-down circuitry. Both the regulator output transistor and each output switch are internally current limited and, to limit junction temperature, an internal thermal shut-down circuit is employed.

## ■ FEATURES

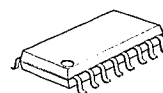
- Operating Voltage (8V~40V)
- Complete PWM Power Control Circuitry
- Uncommitted Outputs for Single-Ended or Push-Pull Applications
- Low Standby Current
- Package Outline
- Bipolar Technology

DIP16, DMP16, SSOP16

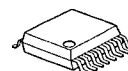
## ■ PACKAGE OUTLINE



NJM3524D



NJM3524M

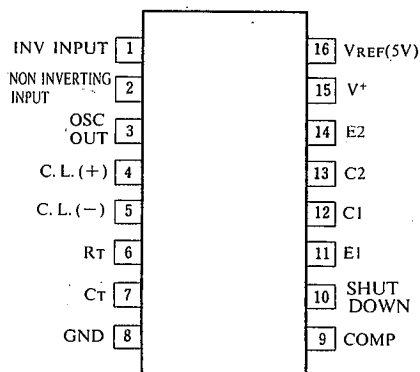


NJM3524V

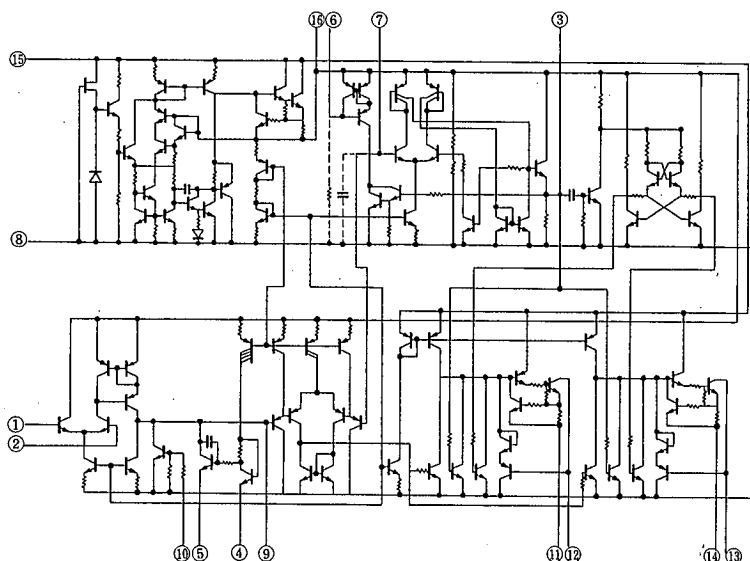
## ■ RECOMMEND OPERATING CONDITION

Parameter	Symbol	Min.	Typ.	Max.	Unit
Operating Voltage	$V^+$	8	20	40	V
Output Reference Current	$I_{REF}$	0	—	50	mA
Timing Resistance	$R_T$	1.8	—	100	k $\Omega$
Timing Capacitor	$C_T$	—	—	0.1	$\mu F$
Operating Temperature Range	$T_{opr}$	-20	25	75	$^{\circ}C$

## ■ PIN CONFIGURATION



## ■ EQUIVALENT CIRCUIT



## ■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V <sup>+</sup>	40	V
Output Current	I <sub>o</sub>	100	mA
Output Reference Current	I <sub>REF</sub>	50	mA
Power Dissipation	P <sub>D</sub>	(DIP16) 700	mW
		(DMP16) 300	mW
Operating Temperature Range	T <sub>opr</sub>	-20~+75	°C
Storage Temperature Range	T <sub>stg</sub>	-40~+125	°C

## ■ ELECTRICAL CHARACTERISTICS

Electrical characteristics over recommended operating free-air temperature range, V<sup>+</sup>=20V, f=20kHz  
(unless otherwise noted).

## Reference Section

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	V <sub>REF</sub>	V <sup>+</sup> =20V	4.6	5.0	5.4	V
Line Regulation	ΔV <sub>REF</sub> -V <sup>+</sup>	V <sup>+</sup> =8~40V	—	10	30	mV
Load Regulation	ΔV <sub>REF</sub> -I <sub>REF</sub>	V <sup>+</sup> =10V, I <sub>REF</sub> =0~20mA	—	20	50	mV
Ripple Rejection	RR	V <sup>+</sup> =20V, f=120Hz	—	66	—	dB
Temperature Coefficient	T.C.	Ta=-20~+75°C	—	-1	—	mV/°C
Short Circuit Output Current	I <sub>REF S</sub>		—	100	—	mA

## Error Amplifier Section

Input Offset Voltage	V <sub>IO</sub>	V <sub>IC</sub> =2.5V	—	2	10	mV
Input Bias Current	I <sub>B</sub> (1)	V <sub>IC</sub> =2.5V	—	2	10	μA
Open Loop Voltage Gain	A <sub>V</sub>		60	80	—	dB
Input Common Mode Voltage Range	V <sub>CM</sub>	Ta=25°C	1.8	—	3.4	V
Common Mode Rejection Ratio	CMR		—	70	—	dB
Unity Gain Bandwidth	—		—	3	—	MHz
Output Voltage Swing	—		0.5	—	3.8	V

## Oscillator Section

Frequency	f <sub>osc</sub>	C <sub>T</sub> =0.01μF, R <sub>T</sub> =2kΩ	—	30	—	kHz
Frequency Change with Voltage	—	V <sup>+</sup> =8~40V	—	—	1	%
Frequency Change with Temperature	—	Ta=-20~+75°C	—	—	3	%
Output Pulse Width(Pin 3)	—	C <sub>T</sub> =0.01μF	—	0.5	—	μS
Output Amplitude(Pin 3)	—		—	3.5	—	V

Comparator Section

Maximum Duty Cycle	—		0	—	45	%
Input Threshold (Pin 9)	$V_{IH}$	"0" duty cycle	—	1.0	—	V
Input Threshold (Pin 9)	$V_{IH}$	"Max" duty cycle	—	3.5	—	V
Input Bias Current	$I_{B(2)}$		—	1	—	$\mu A$

Current Limiting Section

Input Voltage Range	—		-0.7	—	+1.0	V
Sense Voltage	—	$V_{(2)} - V_{(1)} \geq 50mV$	180	200	220	mV
Sense Voltage Temperature Coefficient	—		—	0.2	—	mV/°C

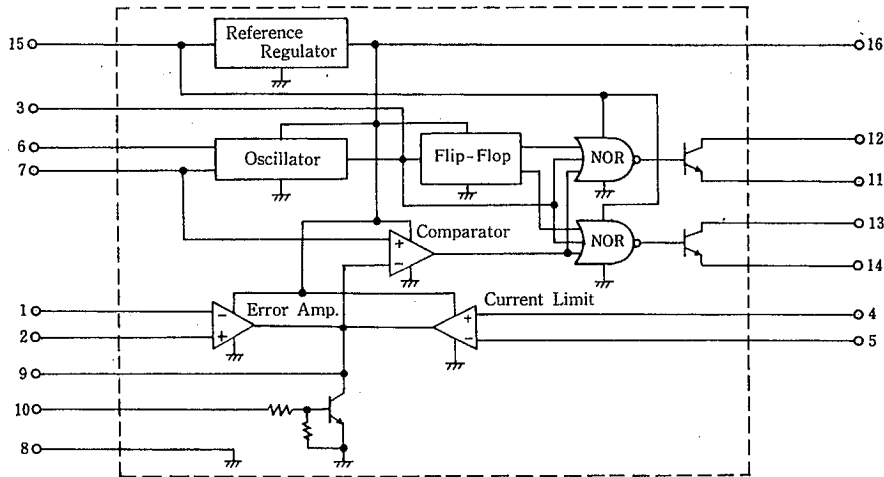
Output Section

Collector-Emitter Breakdown Voltage	$V_{CER}$		40	—	—	V
Collector Leakage Current	$I_{CER}$	$V_{CE}=40V$	—	0.1	50	$\mu A$
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$	$I_O=50mA$	—	1	2	V
Emitter Output Voltage	—	$V^+=20V, I_F=-250\mu A$	17	18	—	V
Turn-off Voltage Rise Time	$T_r$	$R_C=2k\Omega$	—	0.2	—	$\mu S$
Turn-on Voltage Fall Time	$T_f$	$R_C=2k\Omega$	—	0.1	—	$\mu S$

Total Device

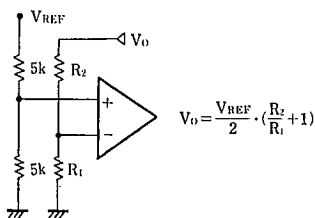
Standby Current	$I_O$	$V^+=40V, Pin_{(2)}=2V$ 1,4,7,8,9,11,14=GND All Other Inputs and Outputs Open	—	8	10	mA
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■ BLOCK DIAGRAM

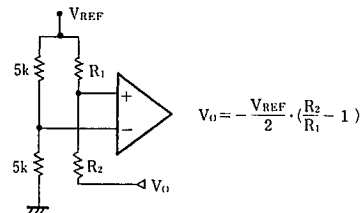


## ■ ERROR AMPLIFIER BIAS CIRCUITS

(A) Positive Output

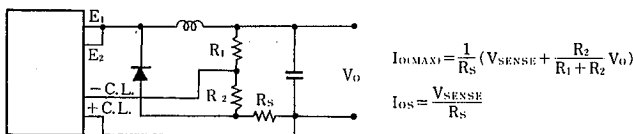


(B) Negative Output



## ■ CURRENT LIMIT

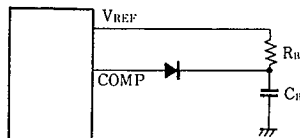
- Take the detection output from the ground line side, because the input voltage range is  $-0.7V \sim +1.0V$ .
- The sensing voltage is 200mV typical.



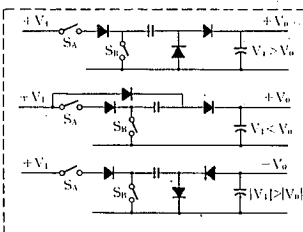
## ■ SOFT START METHOD

It is possible that the output stage is broken due to a wrong operation of circuits simultaneously when supply voltage was applied. This failure can be prevented by setting the error amplifier output to a low level for a certain time as shown in the right figure.

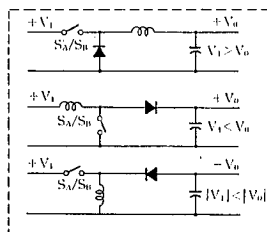
In this case, the soft start time is determined by the time constant of  $R_B$  and  $C_B$ .



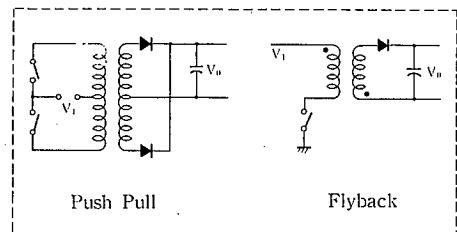
## ■ OUTPUT CONFIGURATIONS



Capacitor-Diode-Coupled  
Voltage Multiplier Output stage



Single-Ended Inductor Circuit



Push Pull  
Flyback  
Transformer-Coupled Outputs

## ■ TYPICAL APPLICATIONS

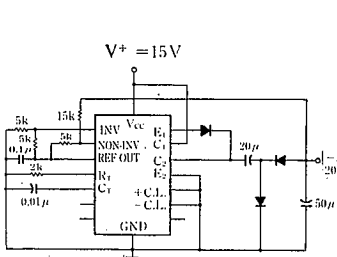


Fig. 1 Capacitor-Diode Output Circuit

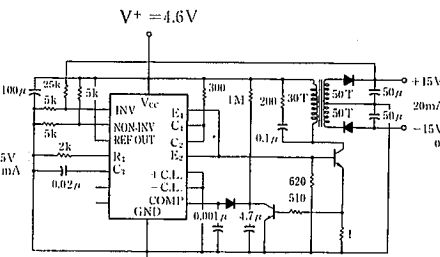


Fig. 2 Flyback Converter Circuit

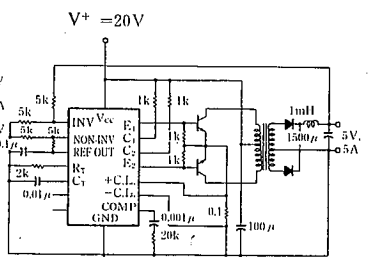
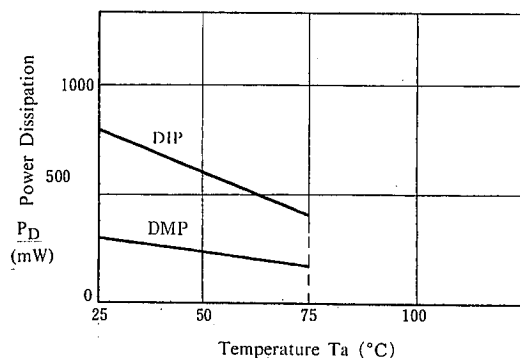
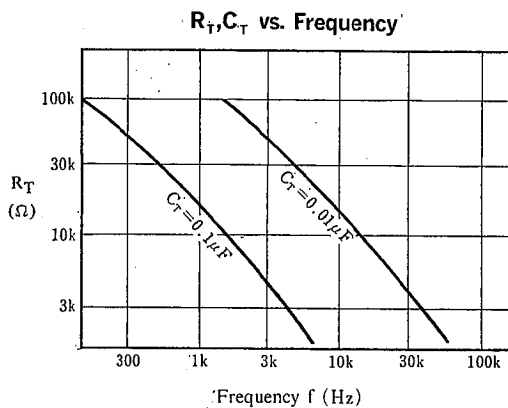
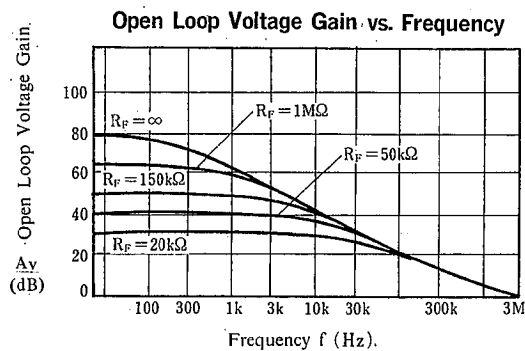
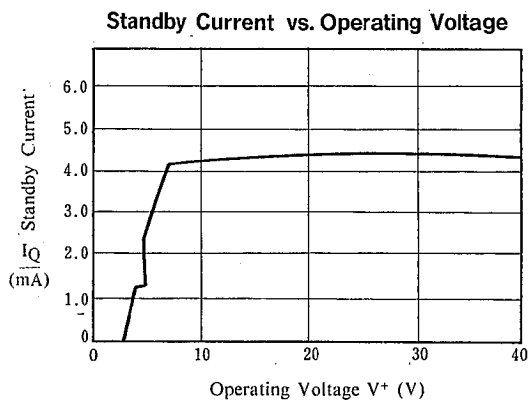
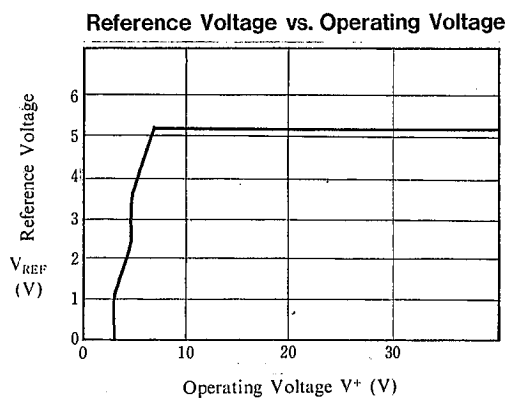


Fig. 3 Push-Pull  
Transformer-Coupled Circuit

## ■ POWER DISSIPATION VS. AMBIENT TEMPERATURE



## ■ TYPICAL CHARACTERISTICS



## MEMO

**[CAUTION]**

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