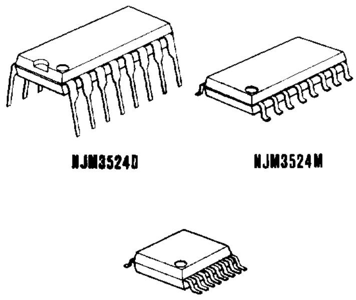
SWITCHING REGULATOR CONTROL CIRCUIT

■ 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.

■ PACKAGE OUTLINE



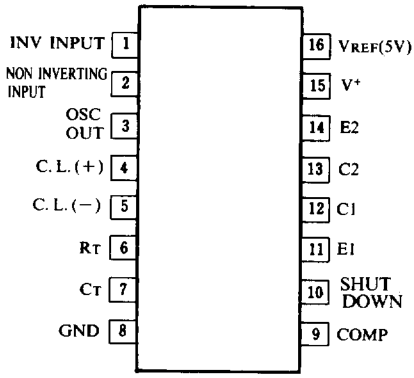
■ FEATURES

- Operating Voltage (8V~40V)
- Complete PWM Power Control Circuitry
- Uncommitted Outputs for Single-Ended or Pash-Pull Appli Cutions
- Low Stardby Current
- Package Outline DIP16, DMP16, SSOP16
- Bipolar Technology

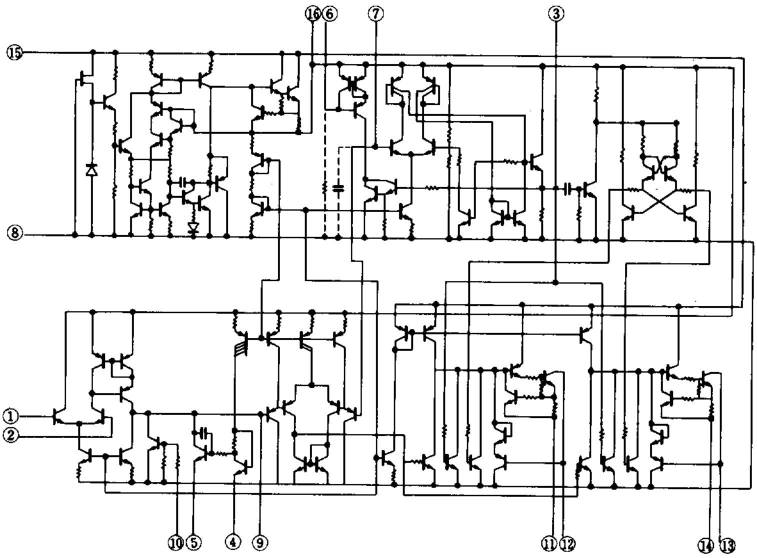
■ RECOMMEND OPERATING CONDITION

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	kΩ
Timing Capacitor	C_T		—	0.1	μF
Operating Temperature Range	T_{opr}	−20	25	75	°C

■ PIN CONFIGURATION



■ EQUIVALENT CIRCUIT



■ ABSOLUTE MAXIMUM RATINGS

(Ta=25℃)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V^+	40	V
Output Current	I_O	100	mA
Output Reference Current	I_{REF}	50	mA
Power Dissipation	P_D	(DIP16) 700 (DMP16) 300	mW mW
Operating Temperature Range	T_{opr}	−20∼+75	℃
Storage Temperature Range	T_{stg}	−40∼+125	℃

■ ELECTRICAL CHARACTERISTICS

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

Reference Section

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Voltage	V_{REF}	V^+=20V	4.6	5.0	5.4	V
Line Regulation	ΔV_{REF}-V^+	V^+=8∼40V	—	10	30	mV
Load Regulation	ΔV_{REF}-I_{REF}	V^+=10V, I_{REF}=0∼20mA	—	20	50	mV
Ripple Rejection	RR	V^+=20V, f=120Hz	—	66	—	dB
Temperature Coefficient	T.C.	Ta=−20∼+75°C	—	−1	—	mV/°C
Short Circuit Output Current	$I_{REF\ S}$		—	100	—	mA

Error Amplifier Section

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Offset Voltage	V_{IO}	V_{IC}=2.5V	—	2	10	mV
Input Bias Current	$I_B(1)$	V_{IC}=2.5V	—	2	10	μA
Open Loop Voltage Gain	A_V		60	80	—	dB
Input Common Mode Voltage Range	V_{CM}	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

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Frequency	f_{osc}	C_T=0.01μF, R_T=2kΩ	—	30	—	kHz
Frequency Change with Voltage	—	V^+=8∼40V	—	—	1	%
Frequency Change with Temperature	—	Ta=−20∼+75°C	—	—	3	%
Output Pulse Width(Pin 3)	—	C_T=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	—	μA

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

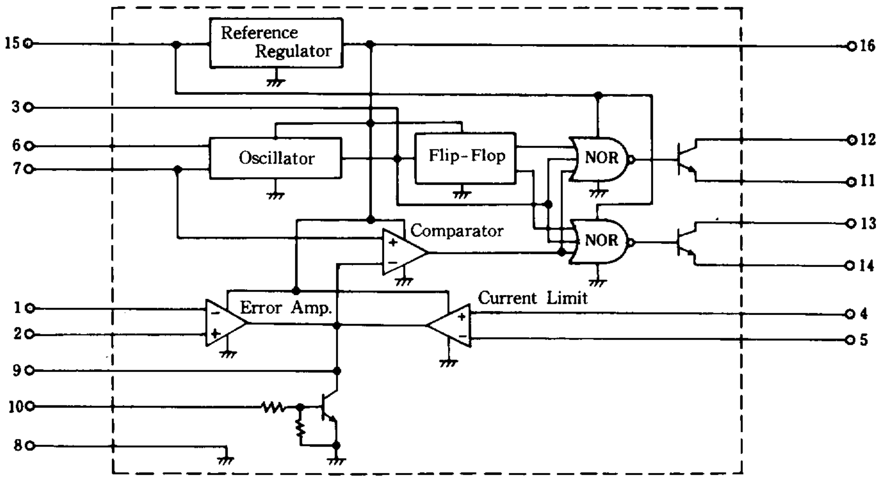
Output Section

Collector-Emitter Breakdown Voltage	V_{CER}		40	—	—	V
Collector Leakage Current	I_{CER}	$V_{CE}=40V$	—	0.1	50	μA
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	—	μS
Turn-on Voltage Fall Time	T_f	$R_C=2k\Omega$	—	0.1	—	μS

Total Device

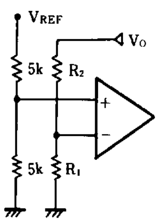
Standby Current	I_Q	$V^+=40V$, $Pin_{(2)}=2V$ 1,4,7,8,9,11,14=GND All Other Inputs and Outputs Open	—	8	10	mA

■ BLOCK DIAGRAM



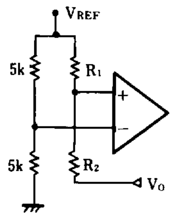
■ ERROR AMPLIFIER BIAS CIRCUITS

(A) Positive Output



$$V_O = \frac{V_{REF}}{2}\cdot\left(\frac{R_2}{R_1}+1\right)$$

(B) Negative Output

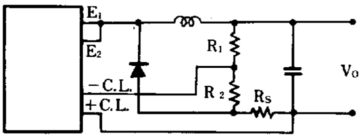


$$V_O = -\frac{V_{REF}}{2}\cdot\left(\frac{R_2}{R_1}-1\right)$$

■ CURRENT LIMIT

(a) Take the detection output from the ground line side, because the input voltage range is −0.7V ~+1.0V.

(b) The sensing voltage is 200mV typical.



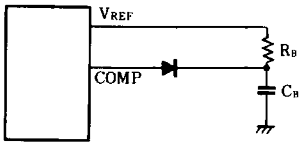
$$I_{O(MAX)} = \frac{1}{R_S}\left(V_{SENSE} + \frac{R_2}{R_1+R_2}V_O\right)$$

$$I_{OS} = \frac{V_{SENSE}}{R_S}$$

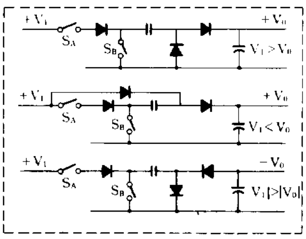
■ SOFT START METHOD

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.

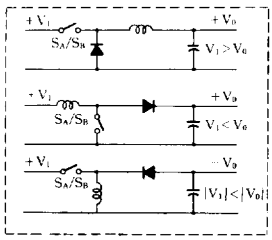
In this case, the soft start time is determined by the time constant of R_B and C_B.



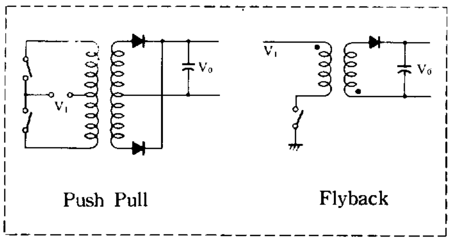
■ OUTPUT CONFIGURATIONS



Capacitor-Diode-Coupled
Voltage Multiplier Output stage



Single-Ended Inductor Circuit



Transformer-Coupled Outputs

■ TYPICAL APPLICATIONS

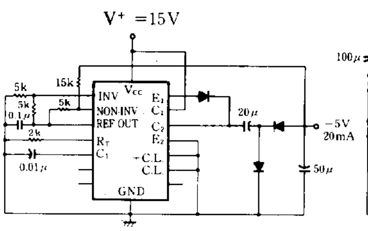


Fig. 1 Capacitor-Diode Output Circuit

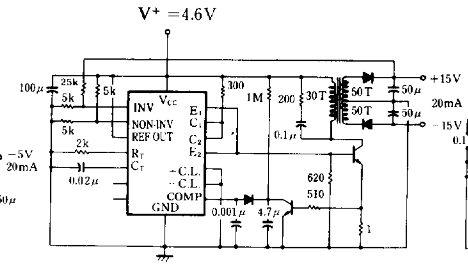


Fig. 2 Flyback Converter Circuit

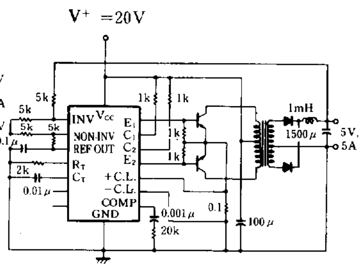
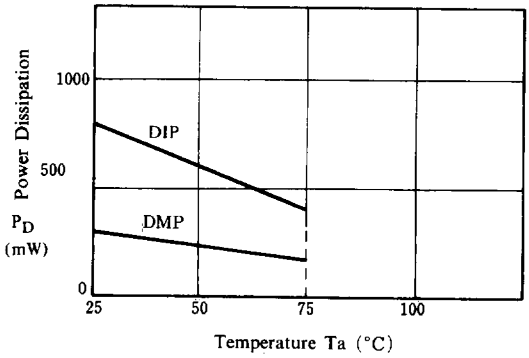


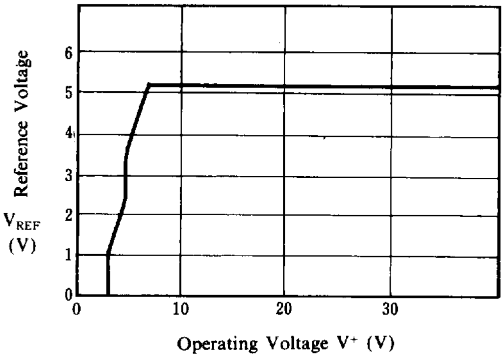
Fig. 3 Push-Pull Transformer-Coupled Circuit

■ POWER DISSIPATION VS. AMBIENT TEMPERATURE

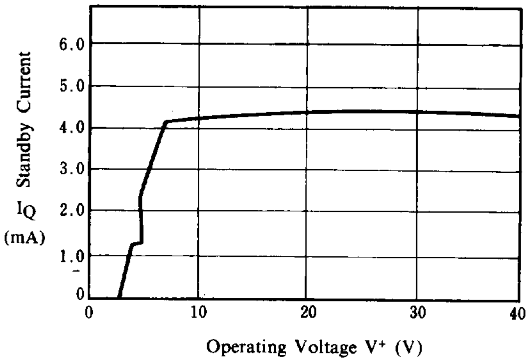


■ TYPICAL CHARACTERISTICS

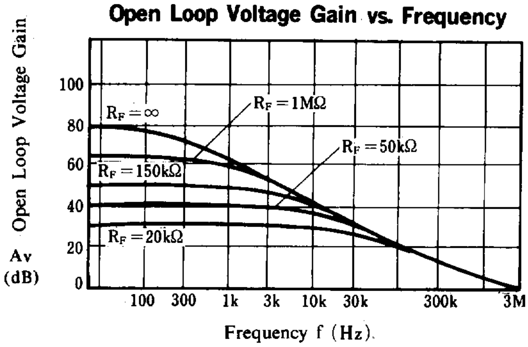
Reference Voltage vs. Operating Voltage



Standby Current vs. Operating Voltage



Open Loop Voltage Gain vs. Frequency



R_T,C_T vs. Frequency