Ordering number:EN3295

Monolithic Digital IC

LB1693

3-Phase Brushless Motor Driver

Overview

The LB1693 is a driver IC for 3-phase brushless motors. It is ideally suited for office automation equipment and DC fan motors.

Features

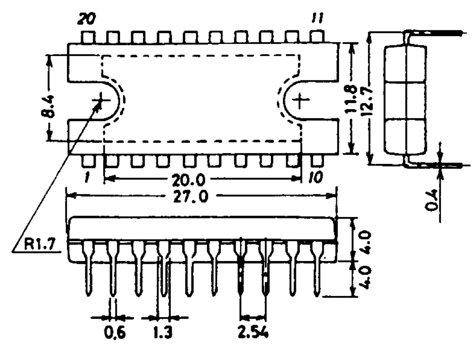
- 3-Phase brushless motor driver.
- 45V withstand voltage and 2.5A output current.
- PWM switch regulator control section.
- Current limitter.
- Overvoltage and overcurrent protection circuit.
- Thermal shutdown ciruict.
- Hall amp with hysteresis characteristic.

Package Dimensions

unit:mm

3037A-DIP20H

[LB1693]



SANYO : DIP20H

Specifications

Absolute Maximum Ratings at Ta = 25˚C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max		45	V
	V_M max		45	V
Maximum Output current	I_O		2.5	A
Allowable power dissipation	Pd max	Independent IC	3	W
		With infinte heat sink	20	W
Operating temperature	Topr		–20 to +80	˚C
Storage temperature	Tstg		–55 to +150	˚C

Allowable Operating Conditions at Ta = 25˚C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V_{CC}		9 to 36	V
	V_M		V_H to 41	V
Voltage regulator output current	I_{VH}		0 to 20	mA
V_H supply voltage	V_H		4.5 to 5.5	V
Comparator output current	I_{OSC}		0 to 30	mA

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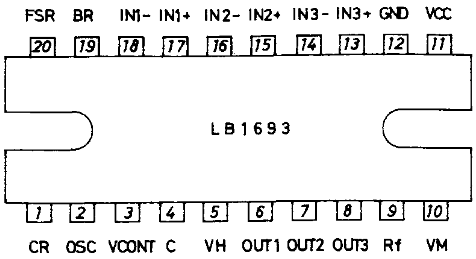
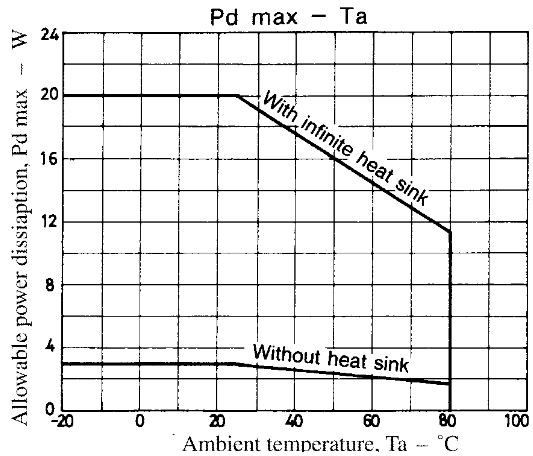
Electrical Characteristics at Ta = 25˚C, $V_{CC}=V_M=24V$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply current	$I_{CC}1$	Stop mode		5	8	mA
	$I_{CC}2$	Hall current=5mA		15	21	mA
Output saturation voltage	V_O sat1	I_O=1A, $V_{O(sink)}+V_{O(source)}$		2.1	3.0	V
	V_O sat2	I_O=2A, $V_{O(sink)}+V_{O(source)}$		3.0	4.2	V
Output leakage current	I_O leak				100	µA
Voltage regulator output voltage	V_H	I_{VH}=10mA	6.5	7.0	7.5	V
Voltage regulator load fluctuation	ΔV_{H1}	V_{CC}=9.5 to 36V		70	200	mV
Voltage regulator load fluctuation	ΔV_{H2}	I_{VH}=0 to 20mA		140	250	mV
Voltage Regulator temperature coefficient				–2		mV/˚C
[Hall amp]						
Input bias current	I_{HB}			1	4	µA
Common-mode input voltage range			1.5		V_H-1.8	V
Hysteresis width	ΔV_{IN}		28	38	46	mV
Low to high input voltage	V_{SLH}		8	20	32	mV
High to low input voltage	V_{SHL}		–32	–20	–8	mV
Oscillator						
High-level output voltage				3.45		V
Low-level output voltage				1.0		V
Oscillation frequency	f	R=36kΩ, C=4700pF		10		kHz
Amplitude			2.1	2.45	2.8	Vp-p
Temperature coefficient	Δf			0.1		%/˚C
Comparator						
Output voltage	V_{OSC}	I_{OSC}=30mA		1.1	1.5	V
Rising time	tr			0.5		µs
Falling time	tf			0.5		µs
Forward/Stop/Reverse						
Forward	$V_{FSR}1$			0	0.8	V
Stop	$V_{FSR}2$		2.1	2.5	2.9	V
Reverse	$V_{FSR}3$		4.2	5.0		V
Brake operation off	$V_{BR}1$				0.8	V
Brake operation on	$V_{BR}2$		2.0			V
Current limiter						
Limiter1	VR_f1		0.42	0.5	0.6	V
Lmiter2	VR_f2		0.34	0.4	0.48	V
Overvoltage protection votlage	V_{OVSD}		38	42	44.5	V
Hysteresis width	ΔV_{OVSD}		0.8	1.3	1.8	V
Thermal shutdown temperature	TSD	Design target	150	180		˚C
Hysteresis width	ΔTSD			25		˚C
Low-voltage protection voltage	V_{LVSD}		3.6	4.0	4.4	V
Hysteresis width	ΔV_{LVSD}		0.04	0.11	0.18	V
Upper diode voltage	V_F	I_O=1A	0.8	2.8	4.7	V

Pin Assignment





Pin Description

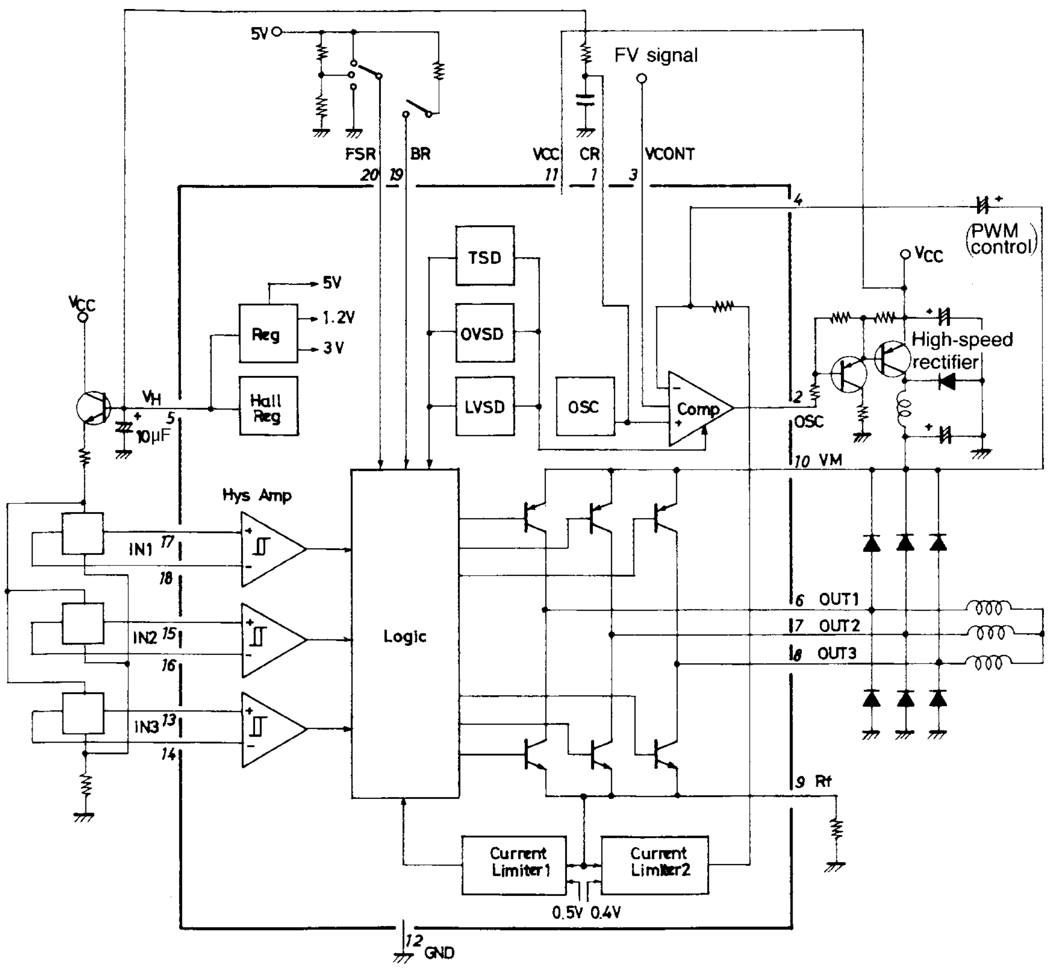
Pin Name	Pin No.	Description
$IN1^+$, $IN1^-$ $IN2^+$, $IN2^-$ $IN3^+$, $IN3^-$	17, 18 15, 16 13, 14	OUT1:Hall element input pins for Phase 1. High logic is the state when $IN1^+ > IN1^-$. OUT2: Hall element input pins for Phase 2. High" logic is the state when $IN1^+ > IN1^-$. OUT3: Hall element input pins for Phase 3. High logic is the state when $IN1^+ > IN1^-$.
OUT1 OUT2 OUT3	6 7 8	Output pin for Phase 1. Output pin for Phase 2. Output pin for Phase 3.
V_{CC}	11	Power supply pin for applying voltage to each section other than output section.
V_M	10	Power supply for output section.
R_f	9	Output current detect pin; R_f is inserted between this pin and ground to detect the output current as a voltage.
GND B_R	12 19	Ground for other output The minimum potential of output transistor is at the R_f pin. Brake pin The brake is switched on/off by setting this pin high (2V or more)/low (0.8V or less).
FSR	20	Forward/Stop/Reverse control pin. The motor is driven forward, stopped, or driven in reverse according to the voltage at this pin. Forward : 0 to 0.8V Stop : 2.1 to 2.9V Reverse : 4.2 to 5.0V
V_H	5	Power pin for Hall elements When using the internal (stabilized) power supply : V_H=7V typ. When using the external (stabilized) power supply : V_H=5V typ.
CR	1	Sets the oscillation frequency for the switching regulator/
OSC	2	Outputs duty-controlled pulsed ; open collector output.
V_{CONT}	3	Speed control pin ; varies the swithcing regulator output votlage.
C	4	Suppresses ripples in the motor current during operation of current limiter 2.

Truth Table

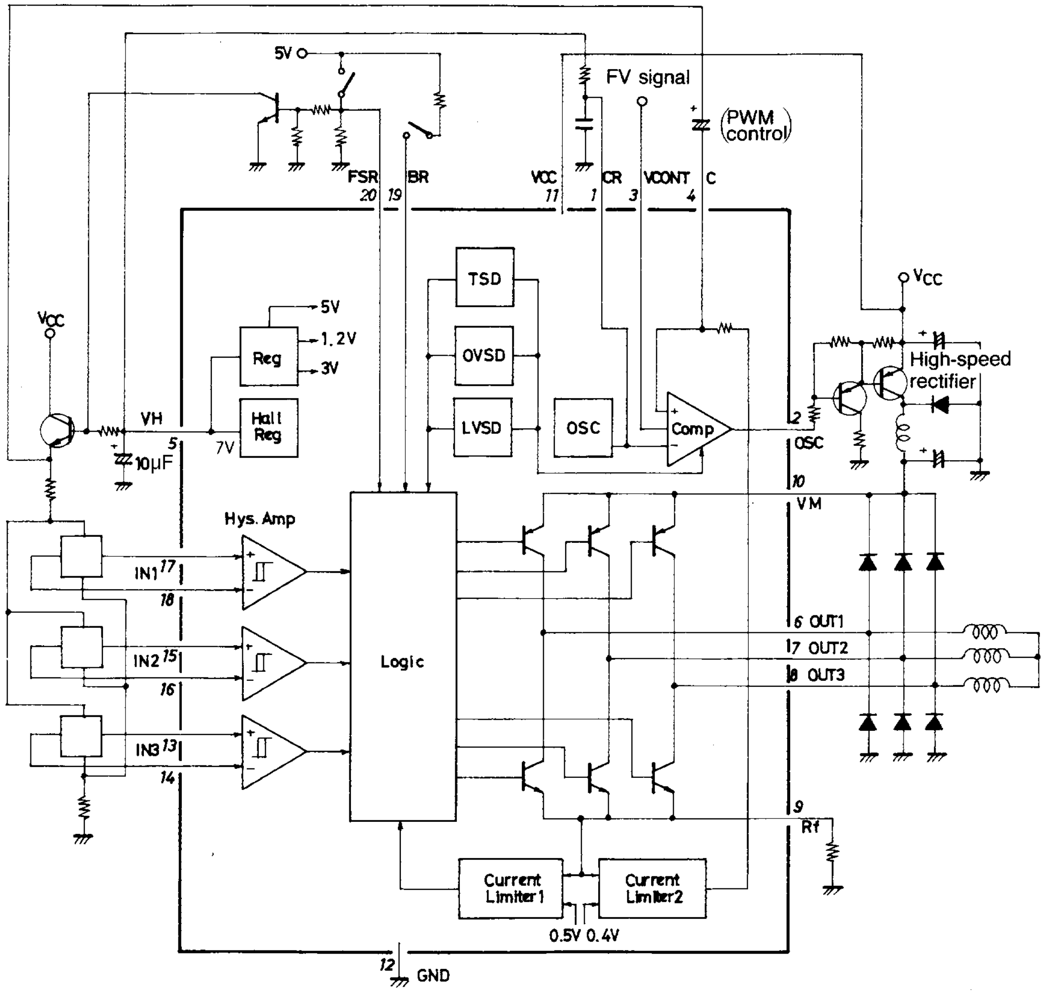
Item	Source Sink	Input IN1	Input IN2	Input IN3	Forward/Reverse Control
1	OUT3 → OUT2	H	H	L	L
	OUT2 → OUT3				H
2	OUT3 → OUT1	H	L	L	L
	OUT1 → OUT3				H
3	OUT2 → OUT3	L	L	H	L
	OUT3 → OUT2				H
4	OUT1 → OUT2	L	H	L	L
	OUT2 → OUT1				H
5	OUT2 → OUT1	H	L	H	L
	OUT1 → OUT2				H
6	OUT1 → OUT3	L	H	H	L
	OUT3 → OUT1				H

Block Diagram and Peripheral Circuit Diagram

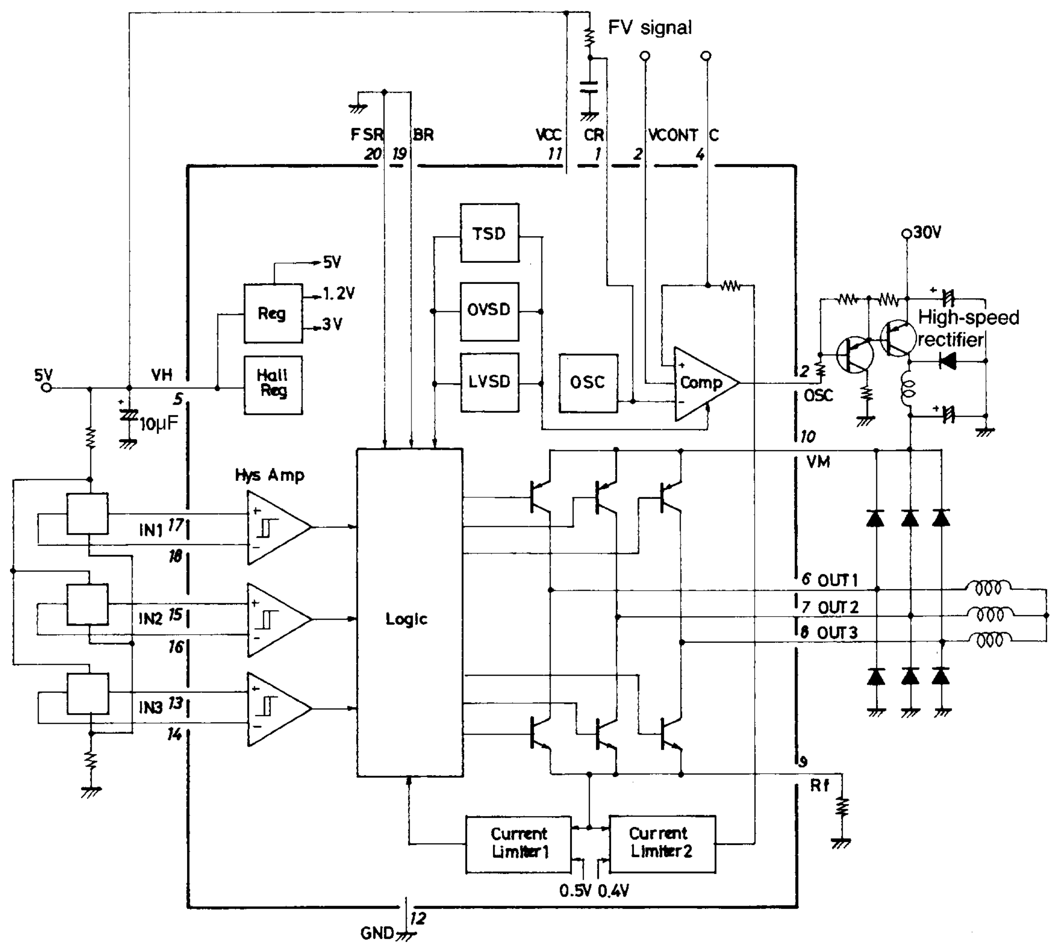
PWM control (1)



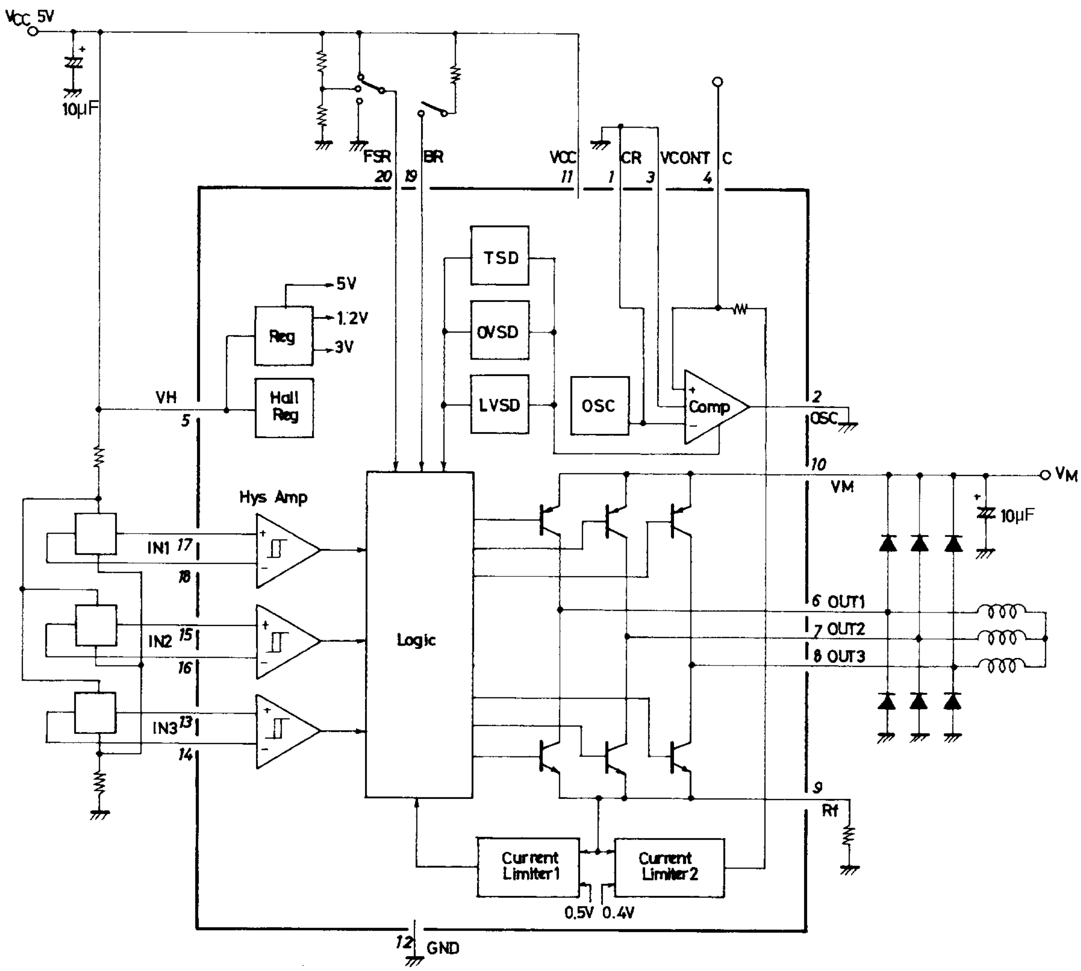
PWM control (2)



V_{CC}=V_H=5V PMW control



V_{CC}=5V, V_M are No speed control



1. Switching regulator oscillation circuit (PWM generation circuit)
   1-1. Oscillation circuit (40 to 50kHz max.)
   Figure 1 shows the oscillation circuit that generates the triangular waves. The oscillation frequency for this circuit is detemined by the following equation (with V_H=7V typ.)

$$f=\frac{1}{t_0 + t_1} \text{(Hz)}$$

$t_0 \simeq 0.56CR$ (charging)
$t_1 \simeq 1.34CR_N$ (discharging)

(R_N is the internal resistance of 1.4kΩ approx.)

In actual applications, R >> R_N is used to suppress the influence of variation in the IC's internal resistance.

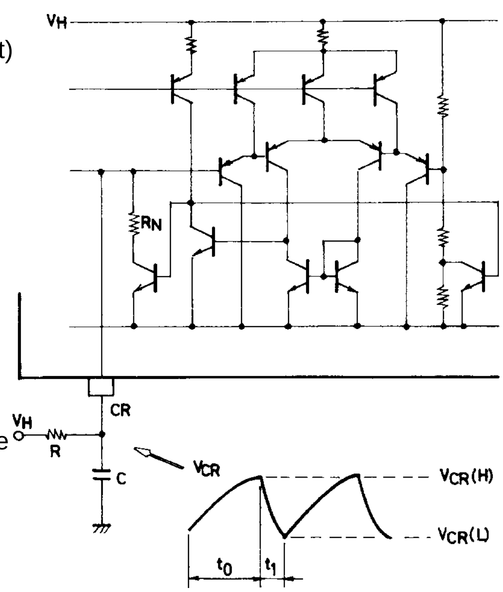


Figure 1 Oscillation Circuit

1-2. Comparator circuit

Figure 2 shows the comparator circuit for comparing the triangular wave output, the speed control signal, etc.

input terminals

CR   Input the triangular wave output.

V_{CONT} Input the speed control signal.

C   Goes high when current limiter 2 is operating.

(When $V_{C(H)} > V_{CR(H)}$, the OSC output is off.)

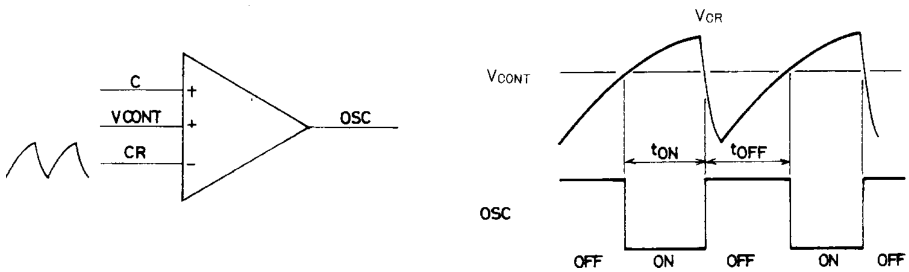


Figure 2   Comparator Circuit

2. Position detection circuit (Hall element input circuit)

The position detection circuit is a differential amp with hysteresis (38mV typ.). For the operating DC level, use within the common-mode phase input voltage range (1.5 to V_H–1.8V). Also it is recommended that the input level is at least three times (150 to 200mVp-p) the hysteresis.

3. V_H power supply circuit

The V_H power supply pins can be used to from the internal power supply or an external power supply. When using the internal power supply, the internal logic operates with V_H=7V typical (V_{CC}=24V). When using an external power supply, set V_{CC}=V_H=5V and operate the internal logic at 5V.

4. Current limiter circuits

4-1. Current limiter 1

The current is limited by moving the sink side transistor from saturated to undaturated, so ASO can be a problem.

$$I = \frac{V_{Rf}1}{R_f} \quad \text{(A)}$$

Therefore, design so that as much as possible current limiter 1 is not triggered.

Also, take particular care not to exceed the maximum output current (2.5A) when current limiter 1 is triggered.

4-2. Current limiter 2

This circuit limits the current by lowering the PWM output duty, thus lowering the V_M voltage.

When current limiter 2 is triggered, the output current is no greater than 2A.

$$I = \frac{V_{Rf}2}{R_f}$$

When not controlling the PWM, add a current limiter to the V_M power supply. (A current setting no greater than 60% to 70% of the current value of current limiter 1 and a short delay time are recommended.)

5. Protection circuits

5-1. Overvoltage protection circuit

If the voltage at the V_{CC} pin rises above the regulated votlage (38V), PWM output is inhibited and the sink side output driver is switched off.

5-2. Low-votlage protection circuit

If the voltage at the V_{CC} pin falls below the regulated voltage, just as in 5-1, PWM output is inhibited and the sink side output driver is switched off.

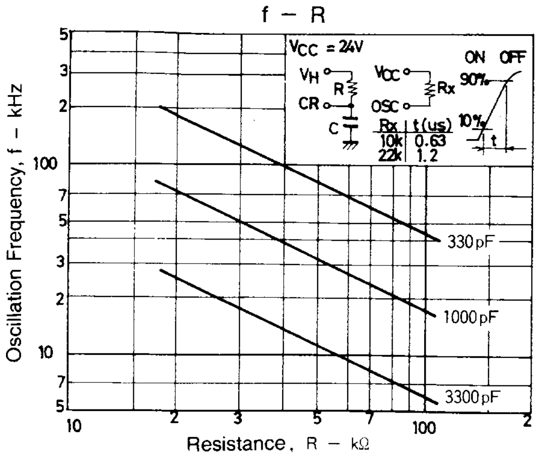
5-3. Thermal shutdown circuit

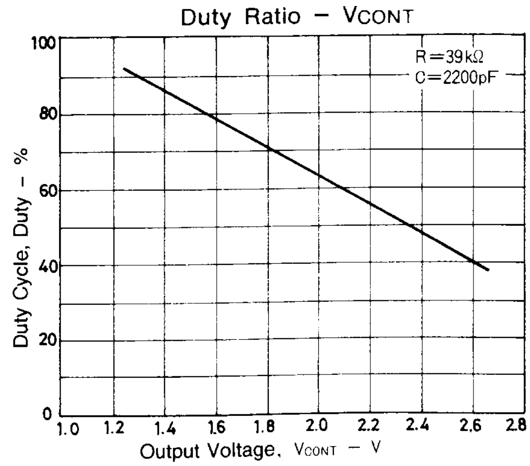
If the junction temperature rises above the regulated temperature, just as in 5-1, PMW output is inhibited and the sink output driver is switched off.

6. Minimum voltage at V_M power

Use a voltage greater than the V_H voltage for the V_M power supply votlage

$V_M \geq V_H$





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