

SANYO**LB1860,1860M,1861,1861M****Variable Speed Fan Motor Driver****Overview**

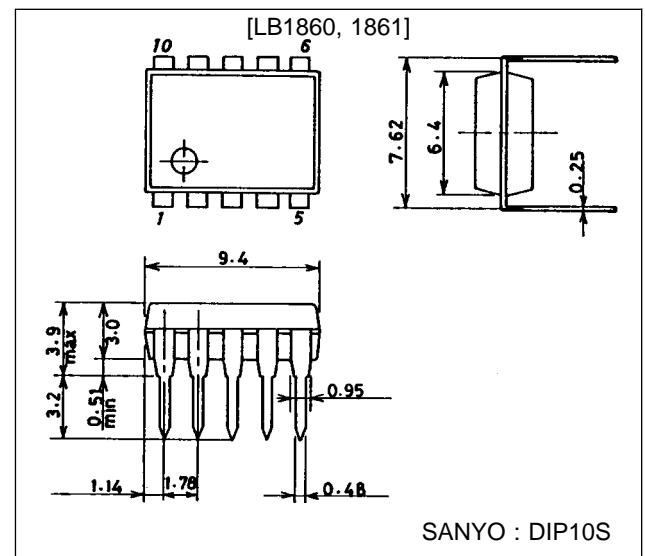
The LB1860 series ICs are drivers for two-phase unipolar drive DC brushless fan motors. They have functions such as driving, lock protection, restart and speed control.

Features and Functions

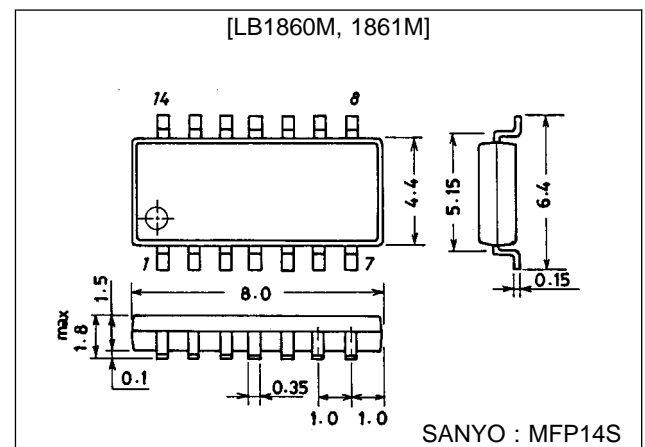
- Two-speed mode select function requiring less external component additions: Full speed and Low speed. Or, thermistor-controlled continuous variable-speed function according to ambient operation temperatures.
→ Motor starts rotating at a low speed.
- Motor lock protection and automatic return circuit built in
- Output transistors: Output current $I_O = 1.5$ A, output circuit protection Zener diodes (LB1860: M-Vz = 57 V/ LB1861: M-Vz = 32 V)
→ Enables low-level noise protection with chip capacitor.
- Built-in thermal shutdown circuit
- Built-in rotation detect function
(Drive mode: "L", Stop mode: "H")
- The LB1860 series can be operated from either 12 V or 24 V power supply by changing an external resistor.
(Strong protection against power supply surge)
- Connectable direct to a Hall element

Package Dimensions

unit: mm

3098B-DIP10S

unit: mm

3111-MFP14S

Specifications

Absolute Maximum Ratings at Ta = 25 °C, (): LB1860M, LB1861M

Parameter	Symbol	Conditions	Ratings	Unit
Maximum input current	I _{CC} max	t ≤ 20 ms	200	mA
Output supply voltage	V _{OUT}		Internal	V
Output current	I _{OUT}		1.5	A
RD flow-in current	I _{RD}		10	mA
RD supply voltage	V _{RD}		50	V
Allowable power dissipation	Pd1 max		1.1	W
	Pd2 max	Mounted on 20 × 15 × 1.5 mm glass epoxy board	(0.8)	W
Operating temperature	Topr		-30 to +80	°C
Storage temperature	Tstg		-55 to +125	°C

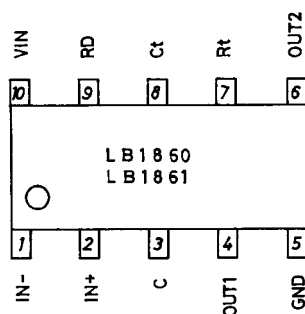
Allowable Operating Ranges at Ta = 25 °C

Parameter	Symbol	Conditions	Ratings	Unit
Input current range	I _{CC}		6.0 to 50	mA
Common-mode input voltage range	V _{ICM}		0 to V _{IN} - 1.5	V

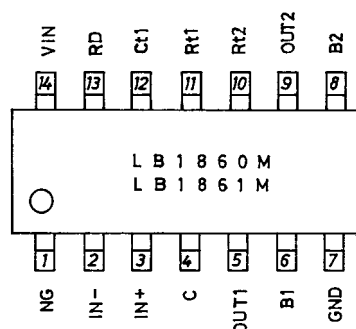
Electrical Characteristics at Ta = 25 °C, I_{CC} = 10 mA

Parameter	Symbol	Conditions	min	typ	max	Unit
Output limiting voltage	V _{OLM1}	LB1860, 1860M: I _O = 0.1 A	54	57	60	V
		LB1861, 1861M: I _O = 0.1 A	30	32	34	V
Output saturation voltage	V _{O sat1}	I _O = 0.5 A		0.95	1.2	V
	V _{O sat2}	I _O = 1.0 A		1.15	1.5	V
	V _{O sat3}	I _O = 1.5 A		1.4	2.0	V
Input voltage	V _{IN}	I _{CC} = 7.0 mA	6.4	6.7	7.0	V
Amp input offset voltage	V _{OFF}		-7.0	0	7.0	mV
Amp input bias current	I _{BA}		-250			nA
RD output saturation voltage	V _{RD} (sat)	I _{RD} = 5 mA		0.15	0.3	V
C flow-out current	I _{C1}	C = GND	2.7	3.9	5.0	μA
C discharge current	I _{C2}	C = V _{IN}	0.35	0.50	0.65	μA
Comparator input threshold voltage	V _{TH1}		0.77	0.8 V _{IN}	0.83	V
	V _{TH2}		0.44	0.47 V _{IN}	0.50	V
Ct discharge voltage	V _{ct}		0.18	0.2 V _{IN}	0.22	V
Rt input current	I _{RT}	V _{RT} = GND	-440	-350	-240	μA
Rt comparator voltage	V _{RT}	R _T = OPEN	0.59	0.62 V _{IN}	0.65	V
Thermal protection circuit operating voltage	TSD	Design target		180		°C
Thermal protection circuit hysteresis	ΔTSD	Design target		40		°C

Pin Assignments

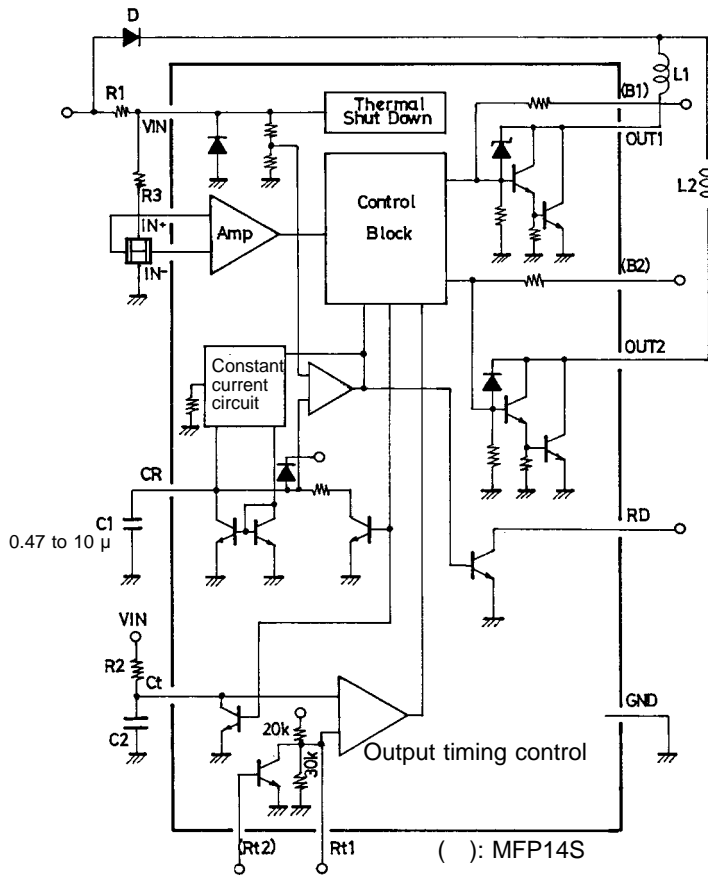


Top view



Top view

Block Diagram and Application Circuit



Unit (resistance: Ω, capacitance: F)

Figure 1

Truth Table

(): LB1860M, 1861M

IN ⁺	IN ⁻	Ct	Rt1	Rt2	CR	OUT1	OUT2	RD	Mode
H	L	H	L	—	L	H	L	L	Full speed
L	H	H	L	—	L	L	H	L	Full speed
(H)	(L)	—	—	(H)	(L)	(H)	(L)	(L)	(Full speed)
(L)	(H)	—	—	(H)	(L)	(L)	(H)	(L)	(Full speed)
—	—	L	H	L	L	H	H	L	Low speed
—	—	—	—	—	H	H	H	H	Lock protection

Designer's Notes

- (1) Variable-speed circuit (Rt and Ct pins) — Refer to the application circuit diagram
- The time constant gained by external components C2 and R2 is used to set the length of an 'off' operation time period after phase switching. This means that the variable-speed operations can be performed by changing the 'on' operation time of each phase through the duty control.
- The sawtooth waveform signals are generated by the C2-R2 time constant. The voltage of this signal (Ct pin voltage) increases from 1.3 V to 4.0 V (Vct) at each phase switching. That is, during this period, the driver becomes inactive (t_{off}), in which output circuit is turned off.
- If V_{CC} ≥ 4.0 V, the driver IC remains active (t_{on}) until the next phase switching. During this period, output circuit is turned on.
- If the active drive time of each phase is assumed to 't_o', the following relation can be established:

$$t_o = t_{off} + t_{on}$$

↑ ↑
 Fixed Rotation speed
 constant proportional constant

$$t_{off} = 0.69 \cdot C2 \cdot R2 \dots\dots\dots \textcircled{1}$$

- ① When a fan is rotating, the capacitor is charged at 4 μA (typ) and discharged through the C with pulses according to the rotational speed.
 - ② When a fan is locked, no discharge occurs through the C and the C voltage rises, turning OFF the output at $0.8 \times V_{IN}$.
 - ③ When the output is turned OFF, discharge occurs through the C at 0.5 μA (typ). If the lock is not released when the C voltage drops to V_{TH2} , the capacitor is charged to V_{TH1} again. (At this moment, the output is turned ON.) These operations ② and ③ repeated at a cycle of approximately $t_{on} : t_{off} = 1:6$ protect a motor.
 - ④ If the lock is released when the C voltage drops to V_{TH2} , the output is turned ON, starting rotation.
- (6) Rotation detect signal (RD pin)
 - Open collector output (Drive mode: "L", Stop mode: "H")
 - (7) Radio noise reducing (Pins B1, B2)
 - Base pin of Darlington connection output transistor
 - If radio noises need to be processed properly, the following actions should be taken:
 - ① Connect a capacitor of 0.01 μ to 0.1 μF between B1 and B2.
 - ② Connect a capacitor of 0.001 μ to 0.01 μF between OUT and B.
 If output causes oscillation, add a resistor of 200 Ω to 1 kΩ in series with a capacitor.
 - (8) Thermal shutdown function
 - Shutdown the driver output in case of coil short-circuiting and abnormal IC heating.

Thermistor-controlled Application Circuit Example

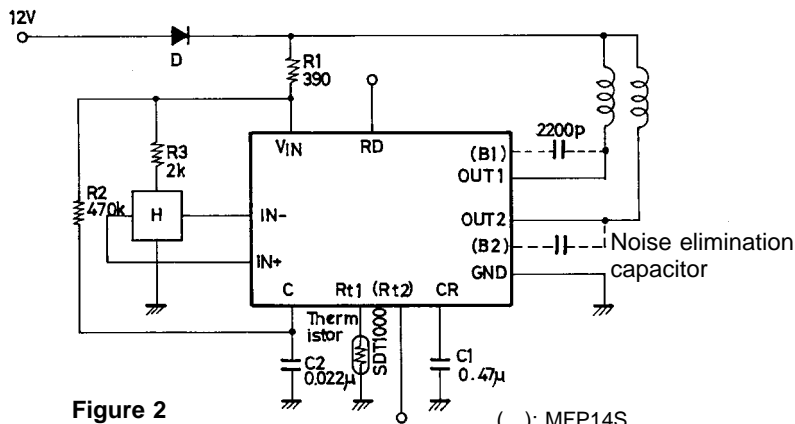


Figure 2

() : MFP14S

Unit (resistance: Ω, capacitance: F)

Use of a thermistor enables motor speed to be sensitive to the operating ambient temperature.

The R_t pin voltage at $T_a = 20\text{ }^\circ\text{C}$ has 1.42 ms of 't_{off}' as calculated in expression 4 with the application constant of Figure 2. However, the R_t pin voltage at $T_a = 40\text{ }^\circ\text{C}$ is reduced into less than the V_{ct} (= 1.3 V) level, which results in a 0 of 't_{off}'. This means the 100% duty.

$$t = -C2 \cdot R2 \cdot \ln \frac{(V_{IN} - V_{Rt})}{V_{IN} - V_{Ct}} \dots\dots\dots ④$$

Output Timing Chart

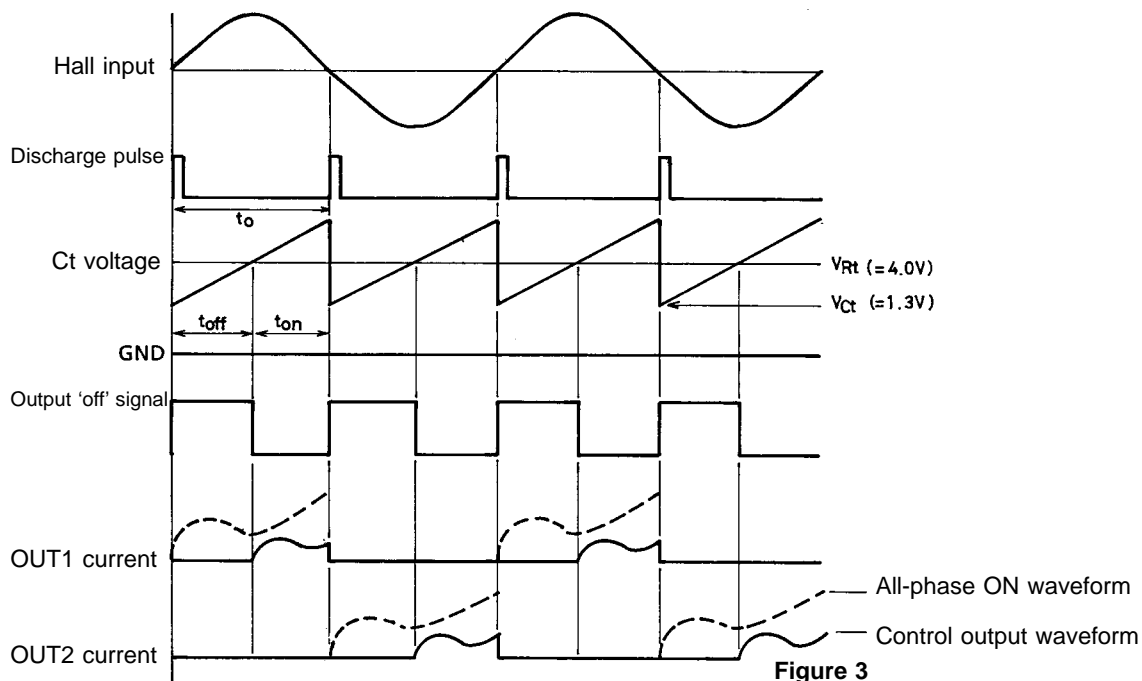
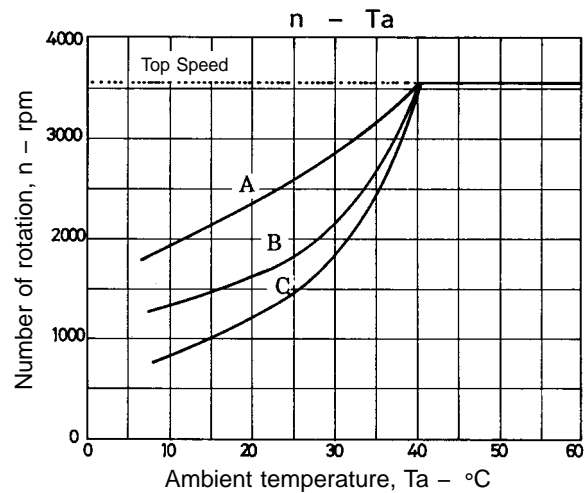


Figure 3



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