



# LB1989

## Three-Phase Sensorless VCR Drum Motor Driver

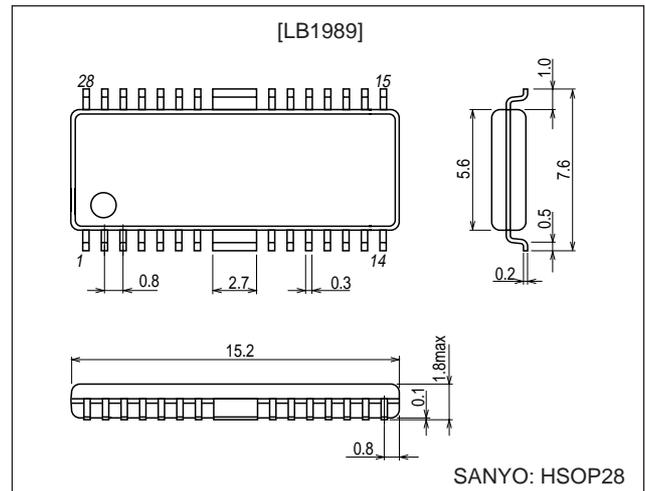
### Functions and Features

- Soft switching drive
- No Hall sensors required.
- No FG sensors required.
- Built-in PG amplifier
- Thermal shutdown circuit
- Current limiter circuit

### Package Dimensions

unit: mm

3222-HSOP28



### Specifications

Absolute Maximum Ratings at  $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CCmax}$		14.5	V
Maximum output voltage	$V_{Omax}$		14.5	V
Maximum input voltage	$V_{I1max}$		$-0.3 \text{ to } V_{CC1} + 0.3$	V
Maximum cylinder current	$I_{Omax}$		1.0	A
Allowable power dissipation	$P_{dmax}$	Independent IC	0.6	W
Operating temperature	$T_{opr}$		$-20 \text{ to } +75$	$^\circ\text{C}$
Storage temperature	$T_{stg}$		$-55 \text{ to } +150$	$^\circ\text{C}$

Allowable Operating Ranges at  $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	$V_{CC}$		8 to 13.8	V

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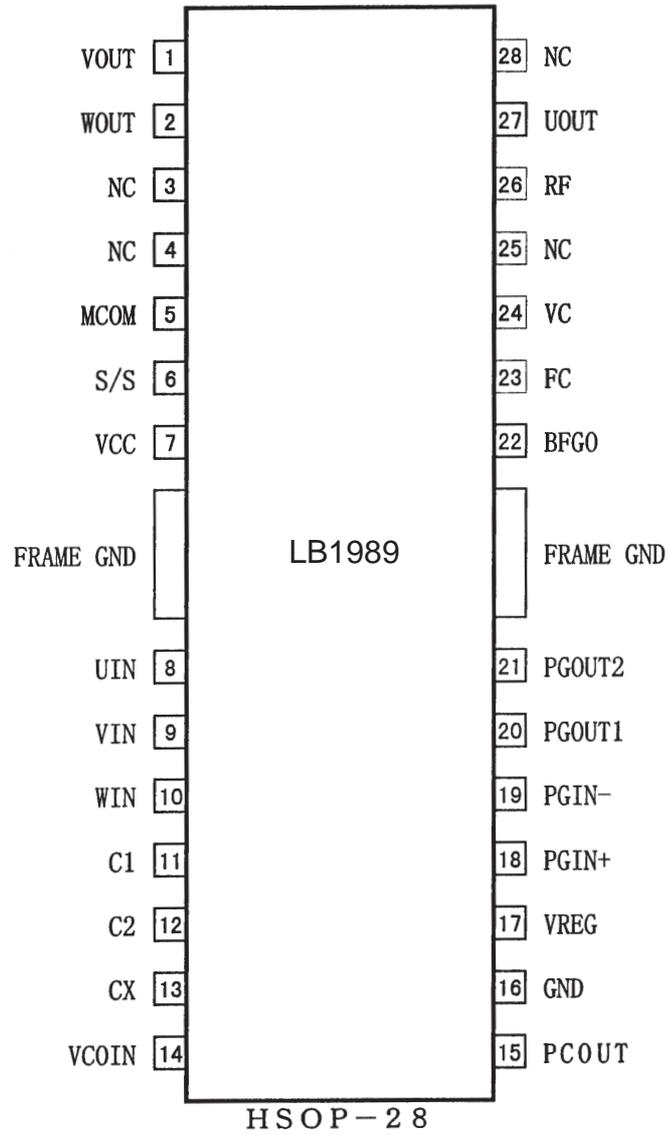
Electrical Characteristics at  $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 12\text{ V}$

Parameter	Symbol	Conditions	Ratings			Unit	Test circuit
			min	typ	max		
Current drain	$I_{CC}$	$V_C = 0\text{ V}$		15	20	mA	1
Internal power supply	$V_{REG}$	$V_C = 0\text{ V}$	4.6	5.0	5.4	V	2
Output saturation voltage 1	$V_{OSAT1}$	$I_O = 0.4\text{ A}$ , Source + Sink		1.4	2.0	V	3
Output saturation voltage 2	$V_{OU2}$	$I_O = 0.8\text{ A}$ , $R_F = 0\ \Omega$ , Source + Sink		1.8	2.6	V	4
MC pin common-mode input voltage range	$V_{IC}$		0		$V_{CC} - 2$	V	5
VC pin input bias current	$I_{VC}$	$V_C = 0\text{ V}$	-2	-1		$\mu\text{A}$	6
Control start voltage	$V_{THVC}$		2.3	2.55	2.8	V	7
Closed-loop control gain	$GMVC$	$R_F = 0.5\ \Omega$	0.75	0.95	1.15	A/V	8
PCOUT output current 1	$I_{PCOU}$	Source side		-90		$\mu\text{A}$	9
PCOUT output current 2	$I_{PCOD}$	Sink side		90		$\mu\text{A}$	10
VCOIN input current	$I_{VCOIN}$	$V_{COIN} = 5\text{ V}$		0.1	0.2	$\mu\text{A}$	11
Minimum VCO frequency	$f_{VCOMIN}$	$C_x = 0.022\ \mu\text{F}$ , With $V_{COIN}$ open		400		Hz	12
Maximum VCO frequency	$f_{VCOMAX}$	$C_x = 0.022\ \mu\text{F}$ , $V_{COIN} = 5\text{ V}$		18.5		kHz	13
C1/C2 source current ratio	$RSOURCE$	$IC1SOURCE / IC2SOURCE$	-12		+12	%	14
C1/C2 sink current ratio	$RSINK$	$IC1SINK / IC2SINK$	-12		+12	%	15
C1 source/sink current ratio	$RC1$	$IC1SOURCE / IC1SINK$	-35		+15	%	16
C2 source/sink current ratio	$RC2$	$IC2SOURCE / IC2SINK$	-35		+15	%	17
S/S pin high level voltage	$V_{SSH}$		4			V	18
S/S pin low level voltage	$V_{SSL}$				0.7	V	19
S/S pin input current	$I_{SSI}$	$V_{S/S} = 5\text{ V}$			200	$\mu\text{A}$	20
Thermal shutdown circuit operating temperature	$TTSD$		150	180	210	$^\circ\text{C}$	*
Thermal shutdown circuit hysteresis	$\Delta TTSD$			15		$^\circ\text{C}$	*
[FG/PG Amplifier Block]							
Back EMF FG							
Output on voltage	$V_{OL}$				0.4	V	21
Output off voltage	$V_{OH}$		$V_{REG} - 0.5$			V	22
PG amplifier							
Input offset voltage	$V_{IO}$		-8		+8	mV	23
Input bias current	$I_{BIN^-}$		-250			nA	24
Common-mode input voltage range	$V_{ICOM}$		0		$V_{REG} - 1.5$	V	*
Open-loop gain	$G_{VPG}$	$f = 1\text{ kHz}$		55		dB	25
Output on voltage	$V_{OL}$				0.4	V	26
Output off voltage	$V_{OH}$		$V_{REG} - 0.5$			V	27
Schmitt amplifier hysteresis	$V_{SHIS}$		70	93	115	mV	28

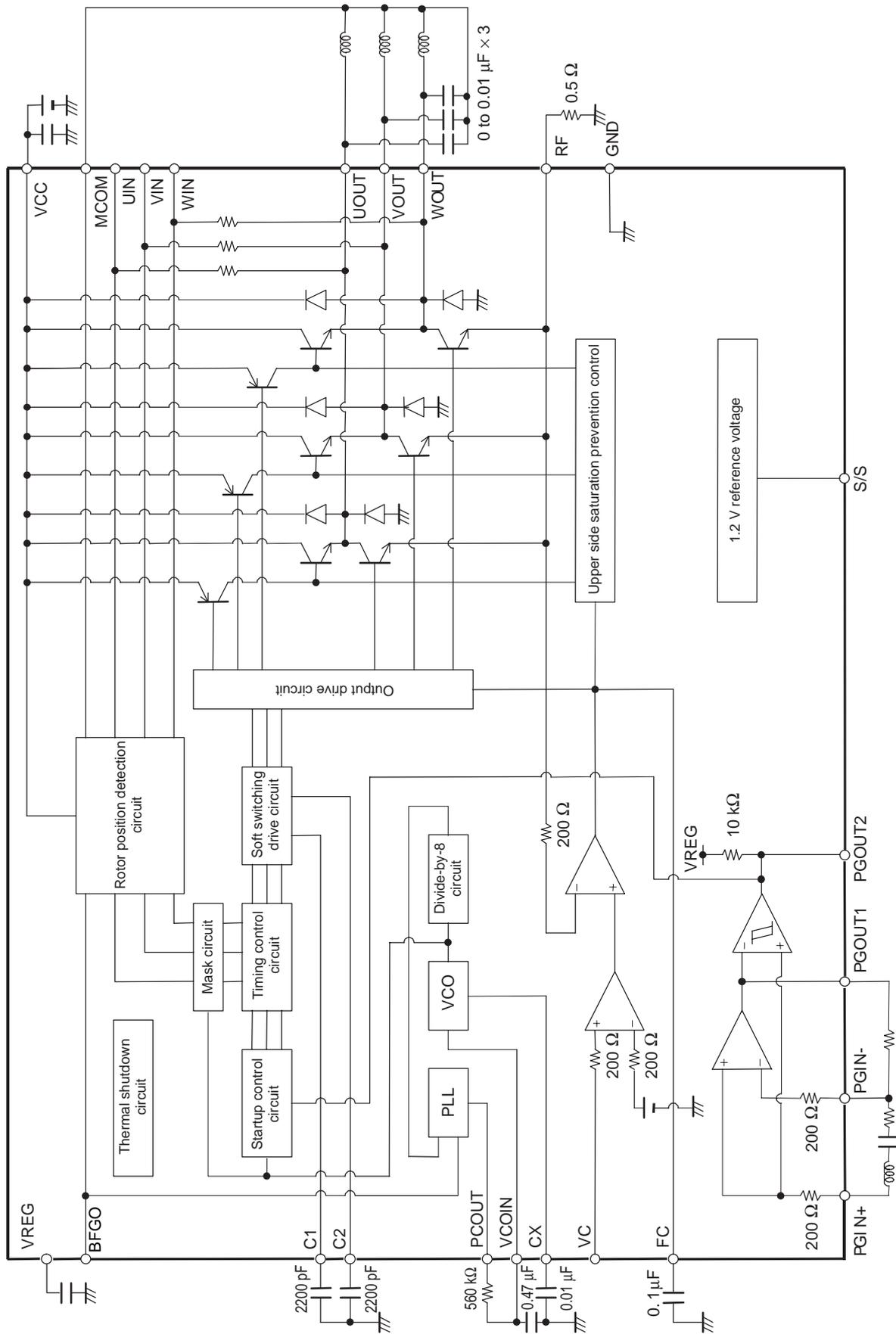
Note \* : These are design target values and are not measured.

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## Pin Assignment



Block Diagram (Note that the external constants will vary depending on the motor used.)



Pin Functions

Pin No.	Pin	Pin voltage	Equivalent circuit	Function	
27	UOUT			Drum motor driver outputs	
1	VOUT				
2	WOUT				
26	RF			<p>The lowest potential of the drum motor driver output transistors. Constant-current control is implemented by detecting this voltage.</p> <p>The current limiter also operates by detecting this voltage.</p>	
26	S/S			<p>Driver start/stop control</p> <p>High: Motor drives operating state</p> <p>Low: Standby state (power saving mode)</p>	
7	V <sub>CC</sub>	8 to 13.8 V		Power supply	
5	MCOM			<p>Motor coil center input</p> <p>The coil voltage waveform is detected referenced to this voltage.</p>	
8	UIN				<p>Coil waveform detection comparator inputs</p> <p>Each phase output is connected through an internal 10 kΩ resistor.</p>
9	VIN				
10	WIN				
11	C1			<p>Sawtooth waveform generator capacitor connection</p> <p>This sawtooth waveform is used for soft switching in the coil output waveform.</p>	
12	C2				

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Pin No.	Pin	Pin voltage	Equivalent circuit	Function
13	CX			<p>The value of the capacitor connected between this pin and ground determines the operating frequency range and the minimum operating frequency for the VCO circuit.</p>
14	VCOIN			<p>VCO circuit voltage input The PCOUT pin voltage is RC filtered and the result is input to this pin.</p>
15	PCOUT			<p>VCO circuit PLL output</p>
16	GND			<p>Ground for all circuits other than the output transistor</p>
17	VREG			<p>Internal 5 V regulator This pin provides the control system power.</p>

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Pin No.	Pin	Pin voltage	Equivalent circuit	Function
18	PGIN+			PG amplifier positive (+) input This pin is biased internally by 1/2 VREG.
19	PGIN-			PG amplifier negative (-) input
20	PGOUT1			PG amplifier linear output
21	PGOUT2			PG Schmitt amplifier output
22	BFGO			Motor back EMF detection FG output (synthesized from 3 phases)

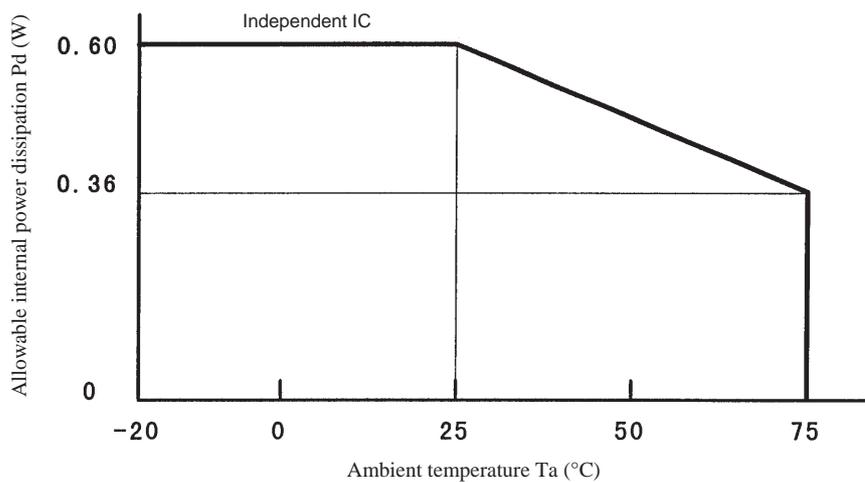
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Pin No.	Pin	Pin voltage	Equivalent circuit	Function
23	FC			<p>Frequency characteristics correction</p> <p>Current control system closed loop oscillation can be stopped by inserting a capacitor between this pin and ground.</p>
24	VC	0 to V <sub>CC</sub>		<p>Speed control</p> <p>This IC implements constant-current control by applying feedback from RF.</p>

### Allowable Internal Power Dissipation



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