



# LB1998

## Three-Phase Brushless Motor Driver for CD-ROM Spindle Drive

### Overview

The LB1998 is a three-phase brushless motor driver especially suited for CD-ROM spindle motor drives.

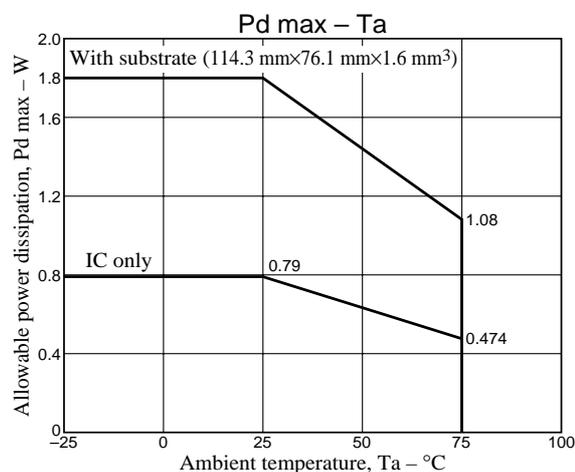
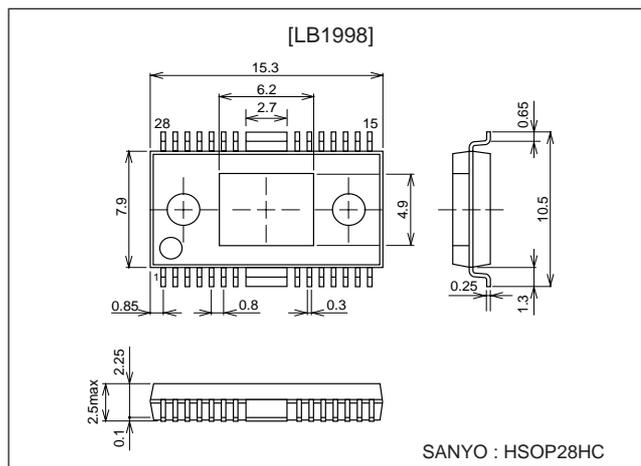
### Functions

- Current linear drive
- Control V type amplifier
- Top side current detection technique reduces loss voltage of current detection resistor. Voltage effect of this resistor reduces internal current drain of IC.
- Built-in current limiter circuit
- Built-in reverse blocking circuit
- Hall FG output
- Built-in 1 Hall FG/3 Hall FG switching circuit
- Built-in short braking circuit
- Built-in Hall bias circuit
- Built-in thermal shutdown circuit
- Built-in S/S function
- Built-in 3 mode gain switching function ensures compatibility with 8/12 cm CAV and CLV discs

### Package Dimensions

unit: mm

#### 3234-HSOP28HC



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## Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
Power supply voltage	$V_{CC1}$ max		7.0	V
	$V_{CC2}$ max		14.4	V
	$V_{CC3}$ max		14.4	V
Applied output voltage	$V_O$ max		14.4	V
Applied input voltage	$V_{IN}$ max		$V_{CC1}$	V
Output current	$I_O$ max		1.3	A
Allowable power dissipation	Pd max	IC only	0.79	W
		with substrate ( $114.3 \times 76.1 \times 1.6 \text{ mm}^3$ , glass epoxy)	1.80	W
Operating temperature	Topr		-20 to +75	$^\circ\text{C}$
Storage temperature	Tstg		-55 to +150	$^\circ\text{C}$

### Operating Conditions at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Power supply voltage	$V_{CC1}$		4 to 6	V
	$V_{CC2}$	$\geq V_{CC1}$	4 to 13.6	V

### Sample Application at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
12V type	$V_{CC1}$	Regulated voltage	4 to 6	V
	$V_{CC2}$	Unregulated voltage	4 to 13.6	V

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## Electrical Characteristics at Ta = 25°C, V<sub>CC1</sub> = 5V, V<sub>CC2</sub> = 12V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
[Power supply current]						
Power supply current	I <sub>CC1</sub>	V <sub>CIN</sub> = V <sub>CREF</sub>		8		mA
	I <sub>CC2</sub>	V <sub>CIN</sub> = V <sub>CREF</sub>		250	300	mA
Output idle current	I <sub>CC1OQ</sub>	V <sub>S/S</sub> = 0V			200	μA
	I <sub>CC2OQ</sub>	V <sub>S/S</sub> = 0V			60	μA
[Output]						
Saturation voltage, upper side 1	V <sub>OU1</sub>	I <sub>O</sub> = -0.5A, V <sub>CC1</sub> = 5V, V <sub>CC2</sub> = 12V		1.0		V
Saturation voltage, lower side 1	V <sub>OD1</sub>	I <sub>O</sub> = 0.5A, V <sub>CC1</sub> = 5V, V <sub>CC2</sub> = 12V		0.3		V
Current limiter setting voltage	V <sub>CL</sub>	R <sub>RF</sub> = 0.25Ω		0.25		V
[Hall amplifier]						
Common mode input voltage range	V <sub>HCOM</sub>		1.2		V <sub>CC1</sub> -1.0	V
Input bias current	I <sub>HIB</sub>			1		μA
Minimum Hall input level	V <sub>HIN</sub>		60			mV <sub>P-P</sub>
[S/S pin]						
High level voltage	V <sub>S/SH</sub>		2.0		V <sub>CC1</sub>	V
Low level voltage	V <sub>S/SL</sub>				0.7	V
Input current	I <sub>S/SI</sub>	V <sub>S/S</sub> = 5V			200	μA
Leak current	I <sub>S/SL</sub>	V <sub>S/S</sub> = 0V	-30			μA
[Control]						
V <sub>CIN</sub> pin input current	I <sub>VC</sub>	V <sub>CIN</sub> = V <sub>CREF</sub> = 1.65V			1	μA
V <sub>CREF</sub> pin input current	I <sub>VCREF</sub>	V <sub>CIN</sub> = V <sub>CREF</sub> = 1.65V			1	μA
Voltage gain	G <sub>VCO</sub>	ΔV <sub>RF</sub> /ΔV <sub>C</sub> , Note 1		0.25		times
Startup voltage	V <sub>CTH</sub>	V <sub>CREF</sub> = 1.65V, Note 1	1.55		1.85	V
Startup voltage width	ΔV <sub>CTH</sub>	V <sub>CREF</sub> = 1.65V, Note 1	100		200	mV
[Gain switching amplifier]						
Input offset voltage	V <sub>GCOFFSET</sub>	Design target value	-8		+8	mV
OPEN LOOP voltage gain	G <sub>VGC</sub>	f = 10 kHz, Design target value		43		dB
Same-phase input voltage range	V <sub>GCOM</sub>		0		3.5	V
[Hall power supply]						
Hall power supply voltage	V <sub>H</sub>	I <sub>H</sub> = 5 mA		0.8		V
Allowable current	I <sub>H</sub>		20			mA
[Thermal shutdown]						
Operating temperature	T <sub>TSD</sub>	Design target value	150	180	210	°C
Hysteresis	ΔT <sub>TSD</sub>	Design target value		15		°C
[Short braking]						
Brake pin at High level	V <sub>BRH</sub>		4		5	V
Brake pin at Low level	V <sub>BRL</sub>		0		1	V
[1 Hall FG/3 Hall FG switching]						
FG <sub>SEL</sub> pin at High level	V <sub>FSH</sub>		4		5	
FG <sub>SEL</sub> pin at Low level	V <sub>FSL</sub>		0		1	
[Gain switching analog switch]						
Analog switch at High level	R <sub>INH</sub>		V <sub>CC</sub> -0.5		V <sub>CC1</sub>	
Analog switch at Low level	R <sub>INL</sub>		0		0.2	

Note:

- During S/S OFF (standby), the Hall comparator is at High.
- Gain switching amplifier operated at a factor of 1.
- Design target values are not measured.

**Truth Table**

	Source → Sink	Hall input			Control $V_{CIN}$
		U	V	W	
1	Phase W → Phase V	H	H	L	H
	Phase V → Phase W				L
2	Phase W → Phase U	H	L	L	H
	Phase U → Phase W				L
3	Phase V → Phase W	L	L	H	H
	Phase W → Phase V				L
4	Phase U → Phase V	L	H	L	H
	Phase V → Phase U				L
5	Phase V → Phase U	H	L	H	H
	Phase U → Phase V				L
6	Phase U → Phase W	L	H	H	H
	Phase W → Phase U				L

Input:

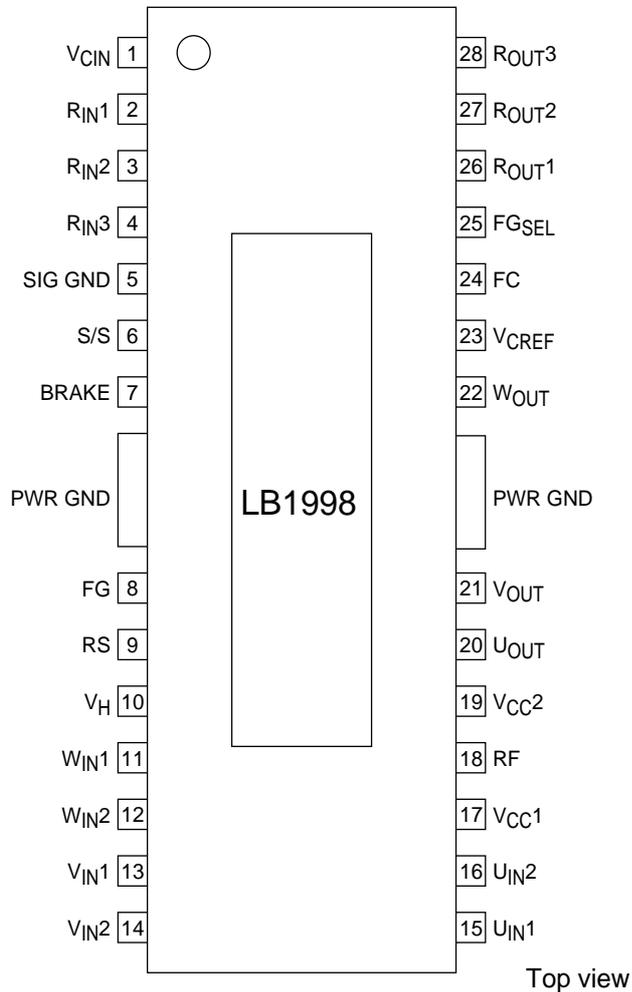
H: Input 1 is higher in potential than input 2 by at least 0.2V.

L: Input 1 is lower in potential than input 2 by at least 0.2V.

**Brake Mode Switching Truth Table**

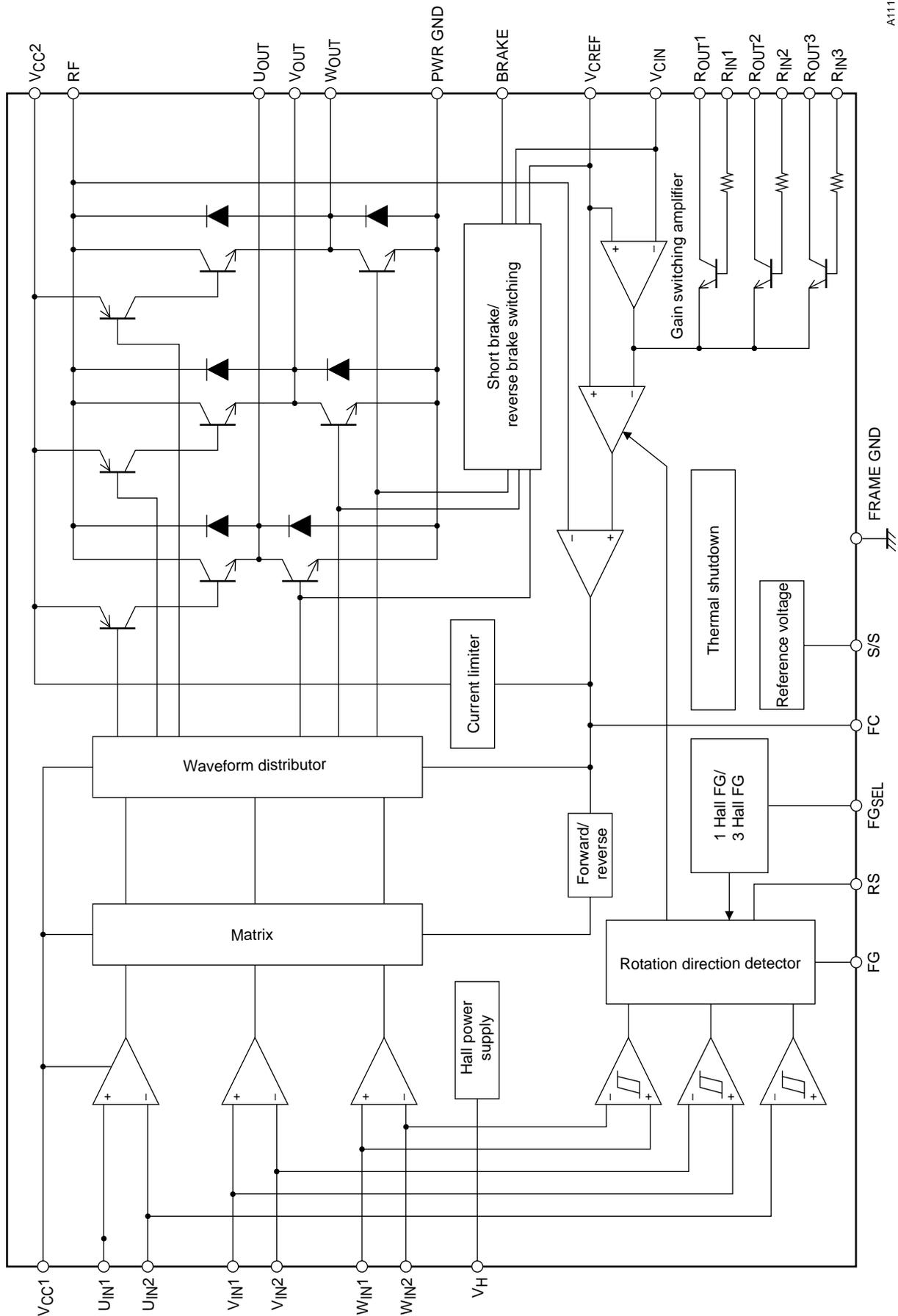
BRAKE pin	$V_{CIN} > V_{CREF}$	$V_{CIN} < V_{CREF}$
L, OPEN	Foward	Reverse brake
H	Foward	Short brake

**Pin Assignment**



Top view

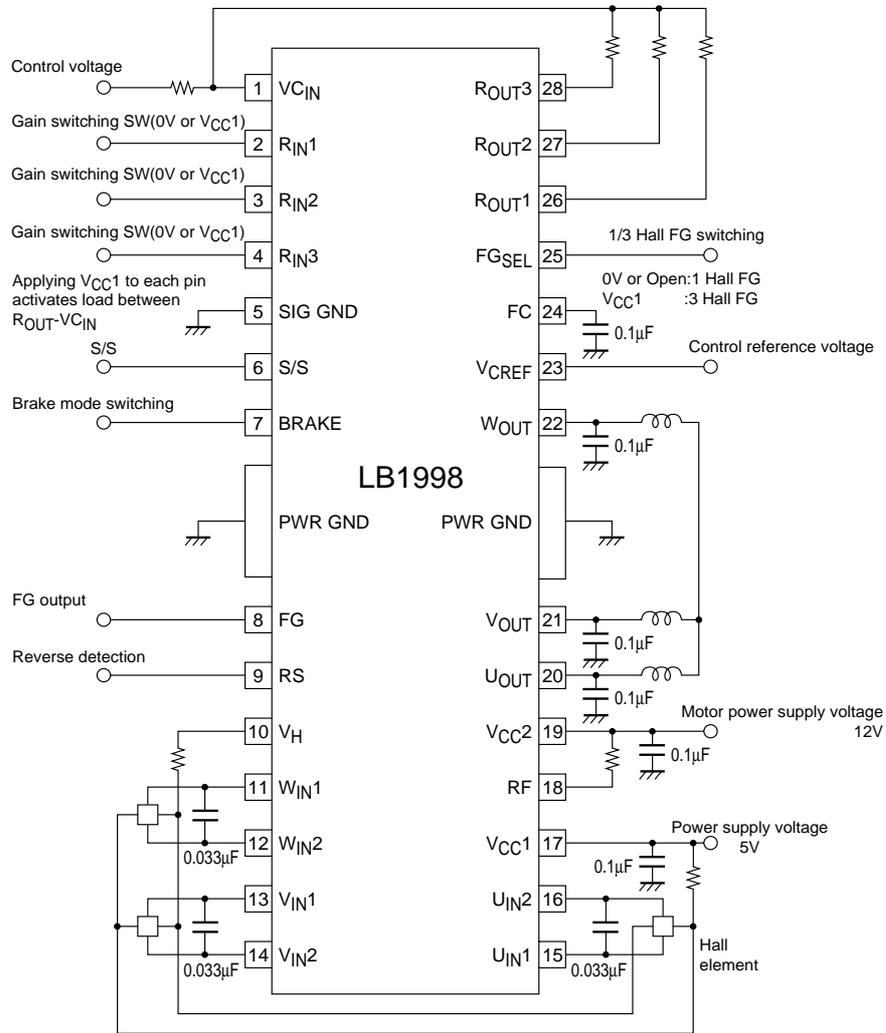
Block Diagram



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## Sample Application Circuit



A11195

Pin Descriptions

Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
19	V <sub>CC2</sub>	4V to 13.6V		Source side predrive voltage and constant current control amplifier voltage supply pin
17	V <sub>CC1</sub>	4V to 6V		Power supply pin for all circuits except output transistors, source predriver, and low current control amplifier
9	RS			Reverse detector pin Forward rotation: High Reverse rotation: Low
8	FG			1 Hall or 3 Hall element waveform Schmitt comparator combined output
15 16	U <sub>IN1</sub> U <sub>IN2</sub>	1.2V to V <sub>CC1</sub> -1V		U phase Hall element input and reverse detector U phase Schmitt comparator input pin Logic High indicates U <sub>IN1</sub> > U <sub>IN2</sub> .
13 14	V <sub>IN1</sub> V <sub>IN2</sub>			V phase Hall element input and reverse detector V phase Schmitt comparator input pin Logic High indicates V <sub>IN1</sub> > V <sub>IN2</sub> .
11 12	W <sub>IN1</sub> W <sub>IN2</sub>			W phase Hall element input and reverse detector W phase Schmitt comparator input pin Logic High indicates W <sub>IN1</sub> > W <sub>IN2</sub> .
10	V <sub>H</sub>			Hall element lower side bias voltage supply pin
6	S/S	0V to W <sub>CC1</sub>		When this pin is at 0.7V or lower, or when it is open, all circuits are inactive. When driving motor, set this pin to 2V or higher.
5	SIG GND			GND pin for all circuits except output
24	FC			Control loop frequency compensator pin. Connecting a capacitor between this pin and GND prevents closed loop oscillation in current limiting circuitry.

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Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
23	V <sub>CREF</sub>	0V to 3.5V		Control reference voltage supply pin. Determines control start voltage.
1	V <sub>CIN</sub>	0V to 3.5V		Speed control voltage supply pin V type control technique V <sub>C</sub> > V <sub>CREF</sub> : Forward V <sub>C</sub> < V <sub>CREF</sub> : Slowdown (Reverse-blocking circuit prevents reverse rotation.)
22	W <sub>OUT</sub>			W phase output
	PWR GND			Output transistor GND
21	V <sub>OUT</sub>			V phase output
20	U <sub>OUT</sub>			U phase output
18	RF			Upper side output PNP transistor collector pin (common for all 3 phases). For current detection, connect resistor between V <sub>CC3</sub> pin and RF pin. Constant current control and current limiter works by detecting this voltage.
25	FG <sub>SEL</sub>			1 Hall FG/3 Hall FG output, switching pin: High → 3 Hall FG Low/Open → 1 Hall FG
7	BRAKE			Brake mode switching pin BRAKE: High → Short brake Low/Open → Reverse brake Brake mode changes when V <sub>CIN</sub> > V <sub>CREF</sub> .

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Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
2	R <sub>IN1</sub>	0 to V <sub>CC1</sub> Low: 0V High: V <sub>CC1</sub>		Gain switching selector pin When set to High (V <sub>CC1</sub> ), resistor connected between R <sub>OUT1</sub> and V <sub>CIN</sub> is selected as negative feedback resistor.
3	R <sub>IN2</sub>			Gain switching selector pin When set to High (V <sub>CC1</sub> ), resistor connected between R <sub>OUT2</sub> and V <sub>CIN</sub> is selected as negative feedback resistor.
4	R <sub>IN3</sub>			Gain switching selector pin When set to High (V <sub>CC1</sub> ), resistor connected between R <sub>OUT3</sub> and V <sub>CIN</sub> is selected as negative feedback resistor.
26	R <sub>OUT1</sub>			Negative feedback resistor connector pins Connect negative feedback resistors between these pins and V <sub>CIN</sub> .
27	R <sub>OUT2</sub>			
28	R <sub>OUT3</sub>			

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