



LB1895, 1895D

3-Phase Brushless Motor Driver for CD-ROM Spindle Motors

Overview

The LB1895 and LB1895D are 3-phase brushless motor drivers for use in CD-ROM spindle motors.

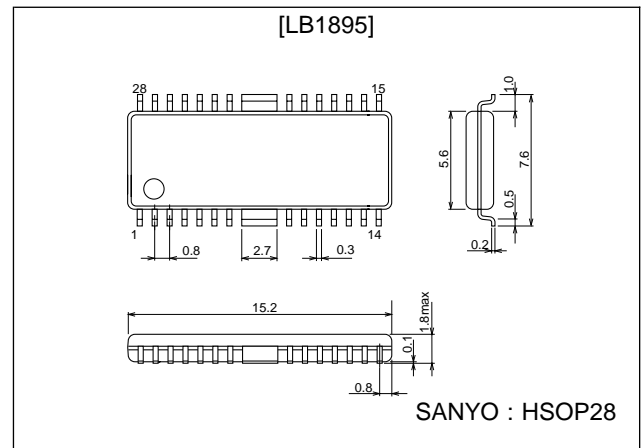
Functions and Features

- Current linear drive
- V-type control amplifier built in
- Because the power supply for the bias circuit on the upper output side is separate, output with low saturation can be attained by boosting only that power supply. (Effective when $V_{CC} = 5\text{ V}$)
- Because current is detected on the upper side, there is no voltage loss due to the RF resistance. In addition, the RF voltage reduces the power dissipation within the IC. (Effective when $V_{CC} = 5\text{ V}$)
- Start/Stop function built in
- Thermal shutdown circuit built in
- Overcurrent protection circuit built in
- Two-channel Hall signal comparator built in. (For detecting rotation direction and Hall FG output)
- Hall device bias built in

Package Dimensions

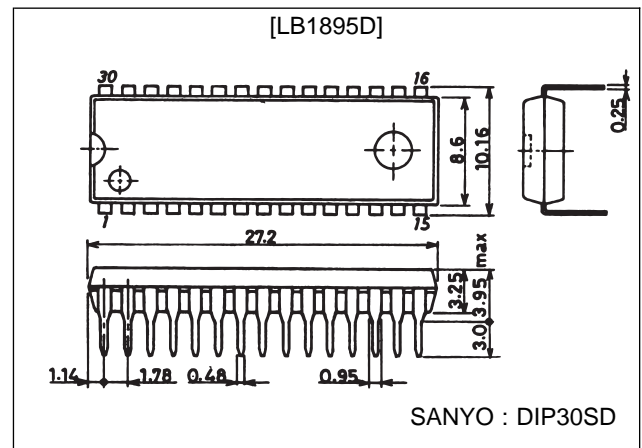
unit : mm

3222-HSOP28



unit : mm

3196-DIP30SD



Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage 1	$V_{CC1\text{ max}}$		7	V
Maximum supply voltage 2	$V_{CC2\text{ max}}$		14.4	V
Maximum supply voltage 3	$V_{CC3\text{ max}}$		14.4	V
Applied output voltage	$V_O\text{ max}$		14.4	V
Applied input voltage	$V_I\text{ max}$		V_{CC1}	V
Output current	$I_O\text{ max}$		1.0	A
Allowable power dissipation	$P_d\text{ max}$	Indepent IC [LB1895]	0.5	W
		Glass epoxy board (114.3 × 762 × 1.5 mm) [LB1895D]	2.4	W
Operating temperature	T_{opr}		-20 to +75	$^\circ\text{C}$
Storage temperature	T_{stg}		-55 to +150	$^\circ\text{C}$

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

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V_{CC1}		4 to 6	V
	V_{CC2}	$\cong V_{CC1}$	4 to 13.6	V
	V_{CC3}		2 to 13.6	V

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

(1) 12 V model

Power supply pins	Conditions	Ratings	Unit
V_{CC1}	REG. voltage	4 to 6	V
$V_{CC2} = V_{CC3}$	UN-REG. voltage	4 to 13.6	V

(2) 5 V model

Power supply pins	Conditions	Ratings	Unit
$V_{CC1} = V_{CC3}$	REG. voltage	4 to 6	V
V_{CC2}	Boost voltage or REG. voltage (Note)	4 to 13.6	V

Note: If V_{CC2} is used as the boost voltage, output with low saturation can be used.

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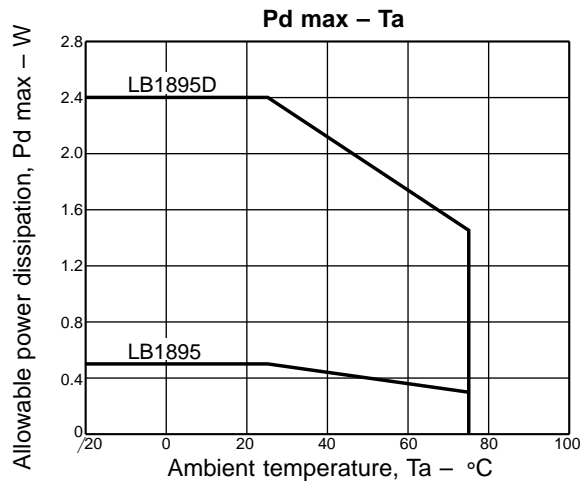
Electrical Characteristics at $T_a = 25\text{ }^\circ\text{C}$, $V_{CC1} = 5\text{ V}$, $V_{CC2} = V_{CC3} = 12\text{ V}$ (Unless otherwise specified)

Parameter	Symbol	Conditions	min	typ	max	Unit
[Supply current]						
Supply current 1	I_{CC1}	$V_C = V_{CREF}$		4	7	mA
Supply current 2	I_{CC2}	$V_C = V_{CREF}$		0	0.5	mA
Supply current 3	I_{CC3}	$V_C = V_{CREF}$		150	250	μA
Output quiescent current 1	I_{CC1OQ}	$V_{S/S} = 0\text{ V}$			200	μA
Output quiescent current 2	I_{CC2OQ}	$V_{S/S} = 0\text{ V}$			30	μA
Output quiescent current 3	I_{CC3OQ}	$V_{S/S} = 0\text{ V}$			30	μA
[Output]						
Upper saturation voltage 1	V_{OU1}	$I_O = -0.5\text{ A}$, $V_{CC1} = 5\text{ V}$, $V_{CC2} = V_{CC3} = 12\text{ V}$		0.8	1.3	V
Lower saturation voltage 1	V_{OD1}	$I_O = 0.5\text{ A}$, $V_{CC1} = 5\text{ V}$, $V_{CC2} = V_{CC3} = 12\text{ V}$		0.3	0.5	V
Upper saturation voltage 2	V_{OU2}	$I_O = -0.5\text{ A}$, $V_{CC1} = V_{CC3} = 5\text{ V}$, $V_{CC2} = 12\text{ V}$		0.3	0.5	V
Lower saturation voltage 2	V_{OD2}	$I_O = 0.5\text{ A}$, $V_{CC1} = V_{CC3} = 5\text{ V}$, $V_{CC2} = 12\text{ V}$		0.3	0.5	V
Current limiter setting voltage	V_{CL}	$RRF = 0.43\ \Omega$	0.25	0.32	0.4	V
[Hall Amplifier]						
Hall amplifier common-mode input voltage range	V_{HCOM}		1.2		$V_{CC1} - 1.0$	V
Hall amplifier input bias current	I_{HIB}			1	2	μA
Minimum Hall input level	V_{HIN}		60			mVp-p
[S/S pin]						
High-level voltage	$V_{S/SH}$		2.0		V_{CC1}	V
Low-level voltage	$V_{S/SL}$				0.7	V
Input current	$I_{S/SI}$	$V_{S/S} = 5\text{ V}$			200	μA
LEAK current	$I_{S/SL}$	$V_{S/S} = 0\text{ V}$	-30			μA
[Control stage]						
VC pin input current	I_{VC}	$V_C = V_{CREF} = 2.5\text{ V}$		1	3	μA
V_{CREF} pin input current	I_{VCREF}	$V_C = V_{CREF} = 2.5\text{ V}$		1	3	μA
Voltage gain	V_{GCO}	$\Delta V_{RF}/\Delta V_C$	0.2	0.25	0.3	Times
Rising threshold voltage	V_{CTH}	$V_{CREF} = 2.5\text{ V}$	2.35		2.65	V
Rising threshold voltage width	ΔV_{CTH}	$V_{CREF} = 2.5\text{ V}$	50		150	mV
[Hall supply]						
Hall supply voltage	V_H	$I_H = 5\text{ mA}$		1.0	1.6	V
Allowable current	I_H		20			mA
[Thermal shutdown]						
Operating temperature	T_{TSD}	*D	150	180	210	$^\circ\text{C}$
Hysteresis	ΔT_{TSD}	*D		15		$^\circ\text{C}$
[Hall comparator]						
Input offset voltage	$V_{HCIoffset}$				10	mV
Input hysteresis	V_{HCIhys}		3	8	15	mV
Output ON voltage	V_{OU}				0.3	V
Output OFF voltage	V_{OD}	Note	4.7			V
Output current (sink)	I_{SINK}		3			mA

Note: When in S/S OFF (standby) state, the Hall comparator goes high.

*D stands for design target; this value is not measured.

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Truth Table

	Source → sink	Input			Control VC
		U	V	W	
1	W phase → V phase	H	H	L	H
	V phase → W phase				L
2	W phase → U phase	H	L	L	H
	U phase → W phase				L
3	V phase → W phase	L	L	H	H
	W phase → V phase				L
4	U phase → V phase	L	H	L	H
	V phase → U phase				L
5	V phase → U phase	H	L	H	H
	U phase → V phase				L
6	U phase → W phase	L	H	H	H
	W phase → U phase				L

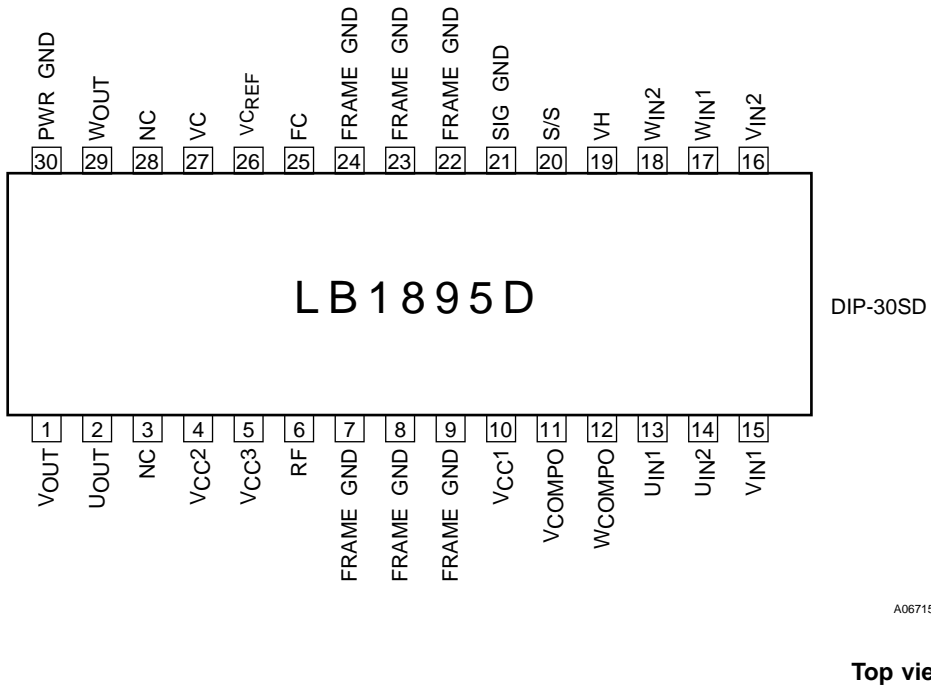
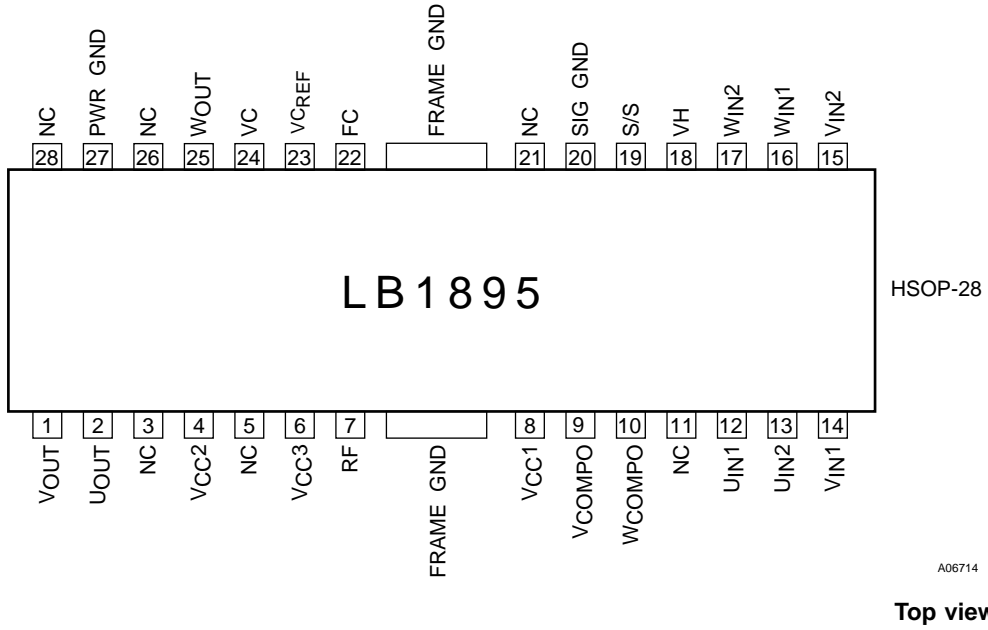
Inputs

H: For each phase input 2, phase input 1 is at a higher electric potential of 0.2 V or more.

L: For each phase input 2, phase input 1 is at a lower electric potential of 0.2 V or more.

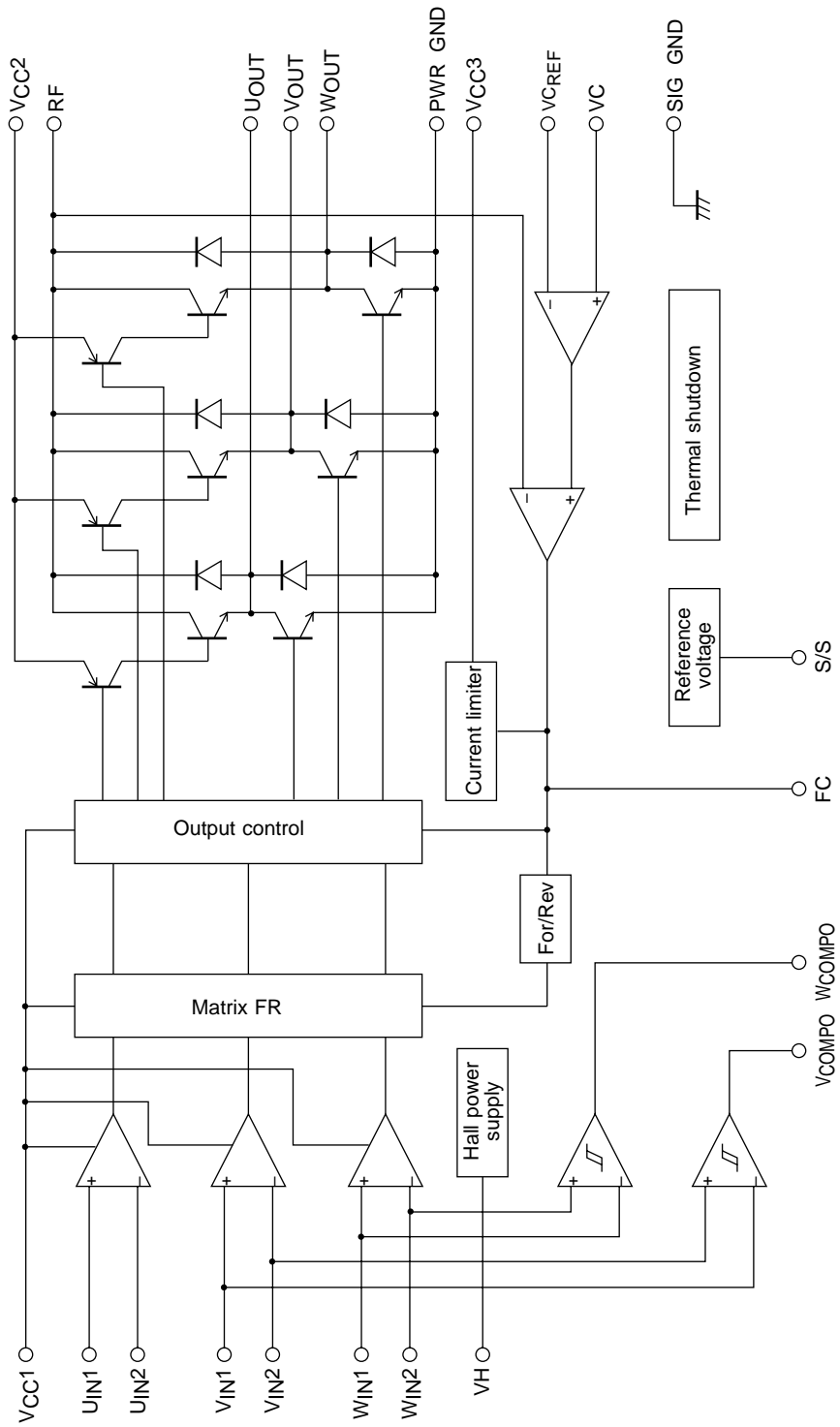
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LB1895 Pin Assignment



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LB1895 Block Diagram



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Pin Descriptions

Note: Numbers within () are for LB1895D

Pin No.	Symbol	Voltage	Equivalent circuit	Description
4	V_{CC2}	4 V to 13.6 V		Supply pin that provides pre-drive voltage for the source side.
6 (5)	V_{CC3}	2 V to 13.6 V		Supply pin that provides voltage for the constant current control amplifier.
8 (10)	V_{CC1}	4 V to 6 V		Supply pin that provides voltage for all circuits except the output transistor, source-side pre-drive, and constant current control amplifier.
9 (11)	V_{COMPO}			V-phase Hall element waveform Schmitt comparator output pin.
10 (12)	W_{COMPO}			W-phase Hall element waveform Schmitt comparator output pin.
12 (13)	U_{IN1}	1.2 V to $V_{CC1} - 1$ V		U-phase Hall element input pin. Logic HIGH is represented by $U_{IN1} > U_{IN2}$.
13 (14)	U_{IN2}			
14 (15)	V_{IN1}	1.2 V to $V_{CC1} - 1$ V		V-phase Hall element input pin, and V-phase Schmitt comparator input pin for reverse detection. Logic HIGH is represented by $V_{IN1} > V_{IN2}$.
15 (16)	V_{IN2}			
16 (17)	W_{IN1}			
17 (18)	W_{IN2}			
18 (19)	V_H			This pin provides the lower bias voltage for the Hall element.

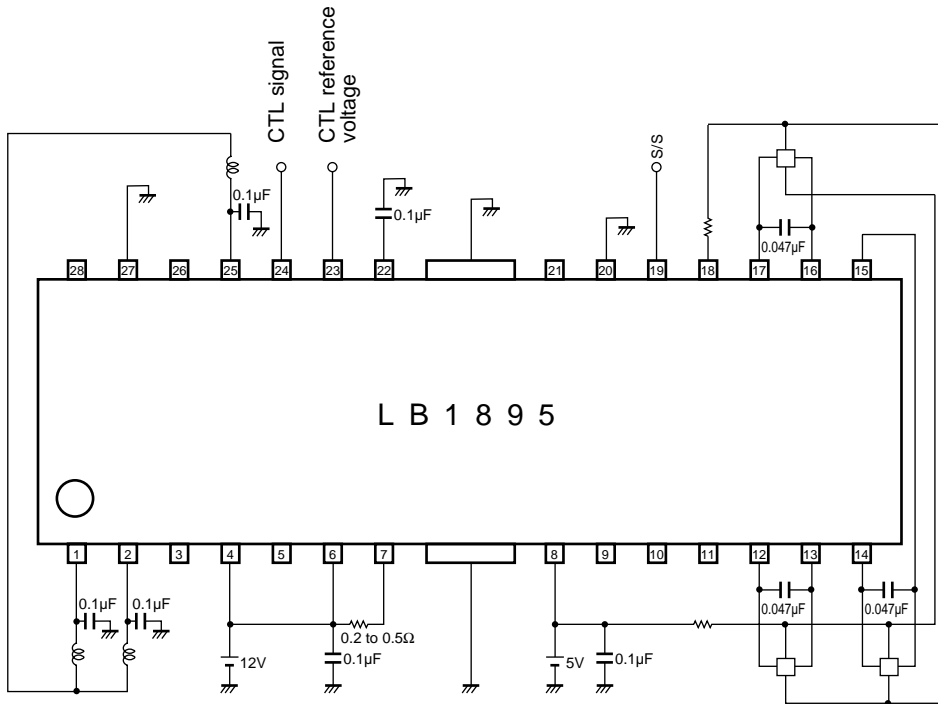
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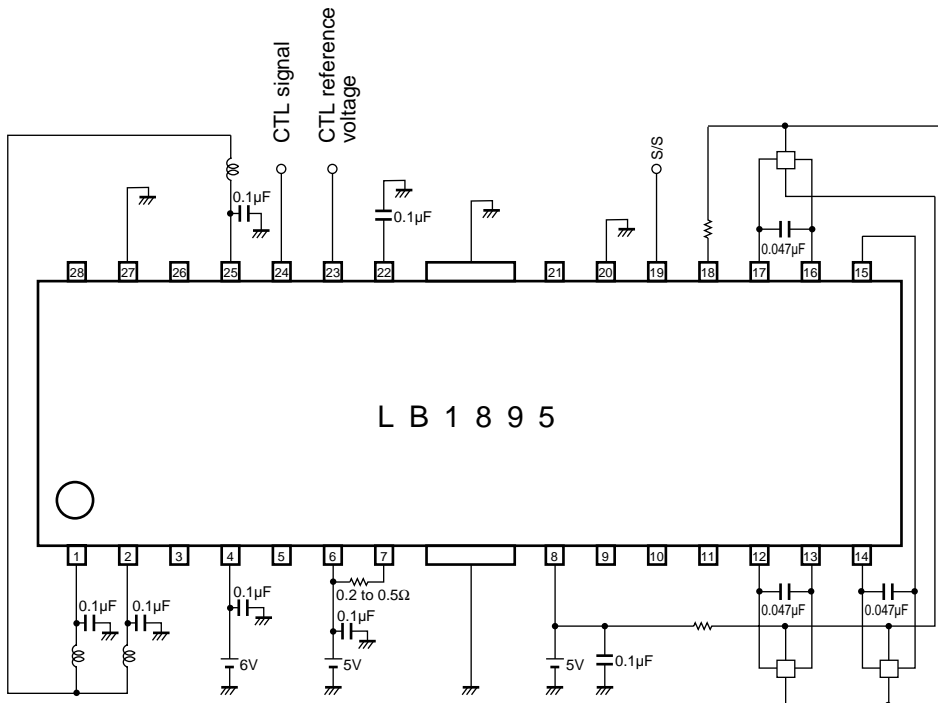
Pin No.	Symbol	Voltage	Equivalent circuit	Description
19 (20)	S/S	0 V to V_{CC1}	<p style="text-align: right;">A06721</p>	None of the circuits operate if the voltage on this pin is 0.7 V or less, or if this pin is open. When driving the motor, the voltage on this pin must be 2 V or more.
20 (21)	SIG GND			Ground connection for all circuits except the outputs.
22 (25)	FC		<p style="text-align: right;">A06722</p>	Control loop frequency characteristics compensation pin. Connect a capacitor between this pin and GND to stop closed loop oscillation in the current control system.
23 (26)	V_{CREF}	2 V to 3 V	<p style="text-align: right;">A06723</p>	Control reference voltage application pin. This voltage determines the control start voltage.
24 (27)	VC	0 V to V_{CC1}		Speed control voltage application pin. V-type control, where: $VC > V_{CREF}$ = forward and $VC < V_{CREF}$ = reverse
25 (29)	W_{OUT}		<p style="text-align: right;">A06724</p>	W-phase output pin.
27 (30)	PWR GND			Output transistor ground.
1	V_{OUT}			V-phase output pin.
2	U_{OUT}			U-phase output pin.
7 (6)	RF			Upper output NPN transistor collector pin (three-phase common). Connect a resistor between V_{CC3} and the RF pin for current detection. When this voltage is detected, the constant current control and current limiter circuits function.

LB1895 Sample Application Circuit (1)



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LB1895 Sample Application Circuit (2)

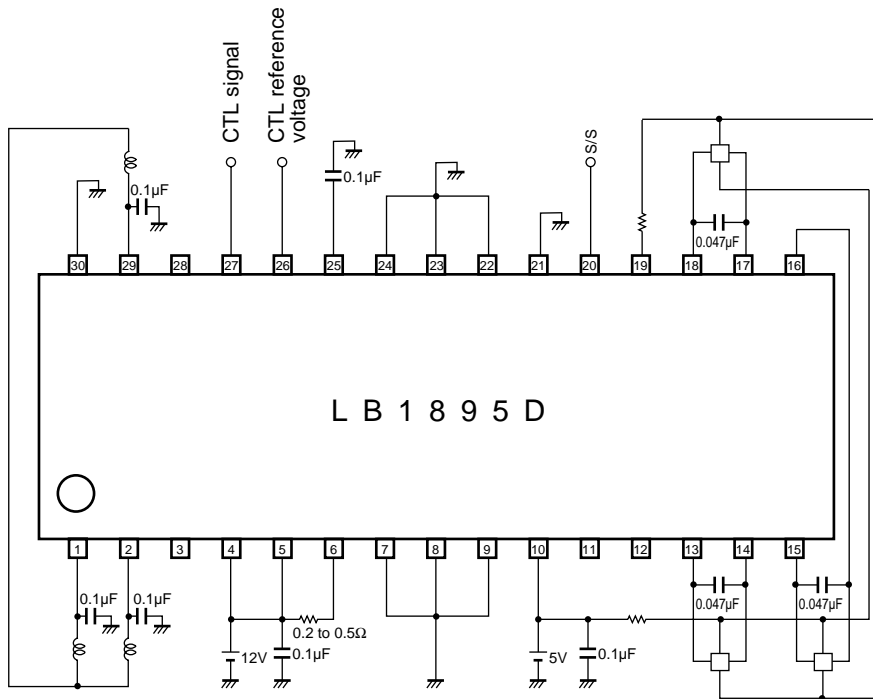


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Between power supply and GND, Output and GND, and between Hall inputs:
 The capacitors may change, depending on the motor.
 The capacitor between the Hall inputs in particular may not be required with some motors.

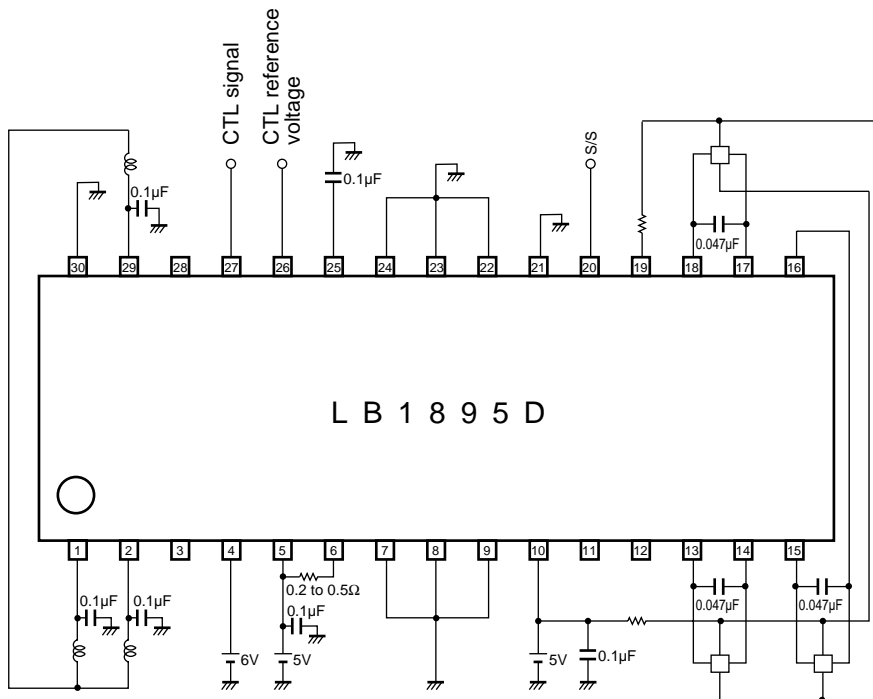
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LB1895D Sample Application Circuit (1)



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LB1895D Sample Application Circuit (2)



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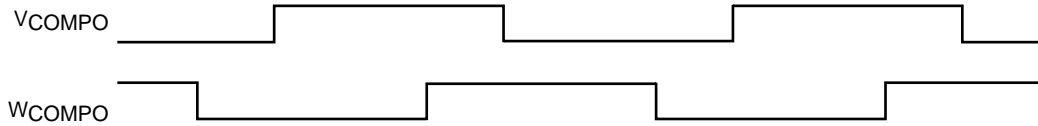
Between power supply and GND, Output and GND, and between Hall inputs:

The capacitors may change, depending on the motor.

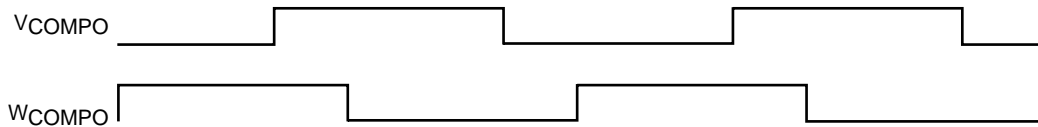
The capacitor between the Hall inputs in particular may not be required with some motors.

LB1895,1895D — Example of using a comparator to detect the direction of rotation

When $VC \geq VC_{REF}$



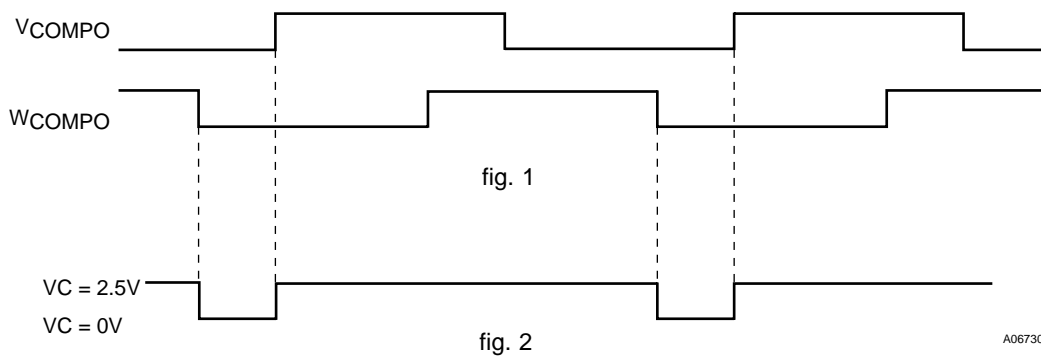
When $VC \leq VC_{REF}$



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When the phasing is as shown above, the direction of rotation is determined to be “forward” if W_{COMPO} is low at the rising edge of V_{COMPO} , and “reverse” if W_{COMPO} is high at the rising edge of V_{COMPO} .

- 1) Reverse full braking method
Braking is applied with $VC = L$ until reverse rotation is detected. The moment that reverse rotation is detected, the driving power is turned off or a short pulse is input.
- 2) Intermittent braking method



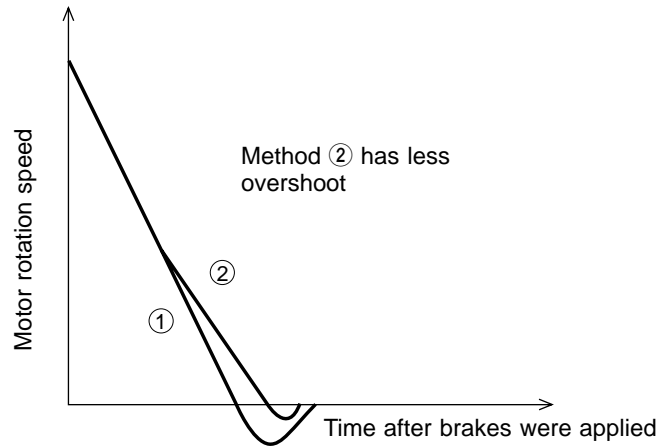
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If braking is applied according to the value obtained by OR logic in V_{COMPO} and W_{COMPO} together, for example, reverse braking is applied according to the following timing.

As a result, when the rotation speed is fast, braking is applied many times; at slower speeds, braking is applied fewer times. Furthermore, if the V_{COMPO} and W_{COMPO} logic combination is changed, the duty of $VC = 0V - 2.5V$ also changes.

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The following graph illustrates the change in the rotation speed after braking is applied under methods 1 and 2 described above.



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