

**SANYO**

**Three-Phase Brushless Sensorless Motor Driver**

**Overview**

The LB1950V is a 3-phase brushless sensorless motor driver IC that is particularly well-suited to driving camcorder drum motors.

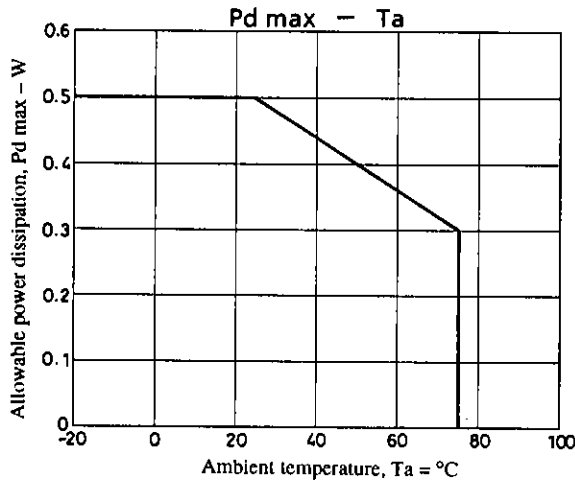
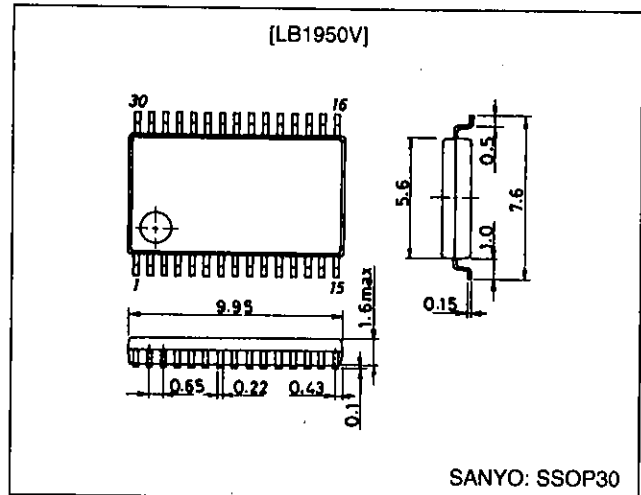
**Features**

- Drives 3-phase full-wave brushless sensorless motors
- Soft switching drive
- Speed control using motor power-supply voltage control for reduced power
- Allows operation from a 3-V power supply.
- The residual output voltage can be set to one of four values.
- Supports bidirectional rotation.
- Standby function (only the FG and PG amplifiers operate)
- Brake circuit
- Thermal shutdown circuit
- FG and PG amplifiers

**Package Dimensions**

unit: mm

**3191-SSOP30**



## Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CC1}$ max		7	V
	$V_{CC2}$ max		12	V
	$V_S$ max		$V_{CC2}$	V
Output voltage	$V_O$ max		$V_S + 2$	V
	$V_{I1}$ max	Control system	$-0.3$ to $V_{CC1} + 0.3$	V
Input voltage	$V_{I2}$ max	U, V, W, COM	$V_S + 2$	V
Output current	$I_O$ max		1.0	A
Allowable power dissipation	$P_d$ max		0.5	W
Operating temperature	$T_{opr}$		$-20$ to $+75$	$^\circ\text{C}$
Storage temperature	$T_{stg}$		$-55$ to $+150$	$^\circ\text{C}$

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

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	$V_{CC1}$		2.7 to 6.0	V
	$V_{CC2}$		2.7 to 10.0	V
	$V_S$		0 to $V_{CC2}$	V

Electrical Characteristics at  $T_a = 25^\circ\text{C}$ ,  $V_{CC1} = 3\text{ V}$ ,  $V_{CC2} = 4.75\text{ V}$ ,  $V_S = 1\text{ V}$ 

Parameter	Symbol	Conditions	min	typ	max	Unit
Current drain	$I_{CC1}$	$I_O = 100\text{ mA}$ , RSAT1 = RSAT2 = GND		4.5	7	mA
	$I_{CC2}$	$I_O = 100\text{ mA}$ , RSAT1 = RSAT2 = GND		1.2	2.5	mA
Output quiescent current	$I_{CC10Q}$	$V_{STBY} = 0\text{ V}$		1	1.5	mA
	$I_{CC20Q}$	$V_{STBY} = 0\text{ V}$			10	$\mu\text{A}$
	$I_{S30Q}$	$V_{STBY} = 0\text{ V}$			10	$\mu\text{A}$
Lower side output saturation voltage	$V_{OU1}$	$I_O = 0.1\text{ A}$ , RSAT1 = RSAT2 = open			0.11	V
	$V_{OU2}$	$I_O = 0.4\text{ A}$ , $V_S = 3\text{ V}$ , RSAT1 = RSAT2 = open			0.33	V
Upper side output saturation voltage	$V_{OD1}$	$I_O = 0.1\text{ A}$ , RSAT1 = RSAT2 = open			0.11	V
	$V_{OD2}$	$I_O = 0.4\text{ A}$ , $V_S = 3\text{ V}$ , RSAT1 = RSAT2 = open			0.33	V
COM pin common-mode input voltage range	$V_{IC}$		0.3		$V_{CC2} - 0.9$	V
Standby pin high-level voltage	$V_{STBYH}$		2		$V_{CC1}$	V
Standby pin low-level voltage	$V_{STBYL}$		-0.2		+0.7	V
Standby pin input current	$I_{STBYI}$	$V_{STBY} = 3\text{ V}$			50	$\mu\text{A}$
Standby pin leakage current	$I_{STBYL}$	$V_{STBY} = 0\text{ V}$	-10			$\mu\text{A}$
Brake pin high-level voltage	$V_{BRH}$		2		$V_{CC1}$	V
Brake pin low-level voltage	$V_{BRL}$		-0.2		+0.7	V
Brake pin input current	$I_{BRI}$	$V_{BR} = 3\text{ V}$			50	$\mu\text{A}$
Brake pin leakage current	$I_{BRL}$	$V_{BR} = 0\text{ V}$	-10			$\mu\text{A}$
FRC pin high-level voltage	$V_{FRCH}$		2		$V_{CC1}$	V
FRC pin low-level voltage	$V_{FRCL}$		-0.2		+0.7	V
FRC pin input current	$I_{FRCI}$	$V_{FRC} = 3\text{ V}$			50	$\mu\text{A}$
FRC pin leakage current	$I_{FRCL}$	$V_{FRC} = 0\text{ V}$	-10			$\mu\text{A}$
Slope pin source current ratio	$R_{SOURCE}$	ICSLP1SOURCE/ICSLP2SOURCE	-12		+12	%
Slope pin sink current ratio	$R_{SINK}$	ICSLP1SINK/ICSLP2SINK	-12		+12	%
CSLP1 source and sink current ratios	$R_{CSLP1}$	ICSLP1SOURCE/ICSLP1SINK	-35		+15	%
CSLP2 source and sink current ratios	$R_{CSLP2}$	ICSLP2SOURCE/ICSLP2SINK	-35		+15	%
Startup frequency	Freq	$C_{OSC} = 0.1\text{ }\mu\text{F}$ , OSC frequency: *		11.5		Hz
Phase delay width	Dwidth	*		30		deg
Thermal shutdown temperature	$T_{TSD}$	*	150	180	210	$^\circ\text{C}$
Thermal shutdown hysteresis	$\Delta T_{TSD}$	*		15		$^\circ\text{C}$

Note: \* Items marked with an asterisk are design target values and are not tested.

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# LB1950V

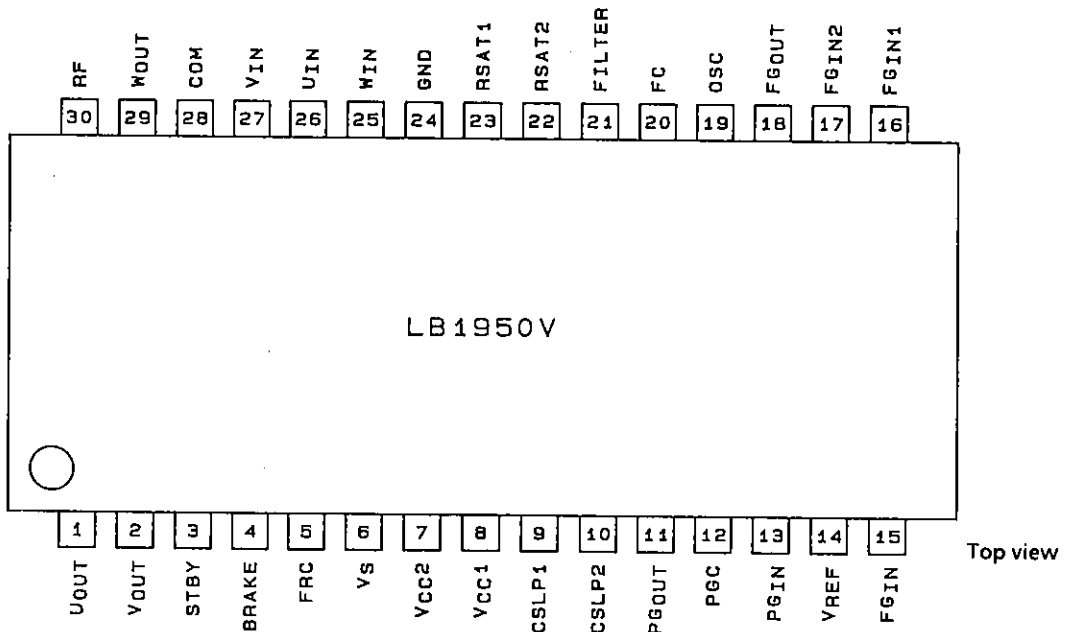
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Parameter	Symbol	Conditions	min	typ	max	Unit
<b>[FG Amplifier]</b>						
Input offset voltage	$V_{IO}$	*		$\pm 1$	$\pm 5$	mV
Input bias current	$I_B$	*			250	nA
Common-mode input voltage range	$V_{ICOM}$	*	1		2	V
Output on voltage	$V_{OL}$	When $I_O = 10 \mu A$			0.4	V
Output off voltage	$V_{OH}$	When $I_O = 10 \mu A$	$V_{CC1} - 0.5$			V
Schmitt amplifier hysteresis	$V_{SHIS}$	*		50		mV
Output duty	Duty	When the input signal level = 20 mVp-p and the input frequency = 720 Hz.	30		70	%
Reference voltage	$V_{REF}$		1.15	1.30	1.45	V
<b>[PG Amplifier]</b>						
Input offset voltage	$V_{IO}$	*		$\pm 1$	$\pm 5$	mV
Input bias current	$I_B$	*			500	nA
Common-mode input voltage range	$V_{ICOM}$	*	1		2	V
Output on voltage	$V_{OL}$	When $I_O = 10 \mu A$			0.4	V
Output off voltage	$V_{OH}$	When $I_O = 10 \mu A$	$V_{CC1} - 0.5$			V
Schmitt amplifier hysteresis	$V_{SHIS}$	*		20		mV

Note: \* Items marked with an asterisk are design target values and are not tested.

## Pin Assignment



A05063

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## Pin Functions

Pin No.	Symbol	Pin voltage	Equivalent circuit	Function
3	STBY	$V_{CC1} \text{ max} - 0.2 \text{ V min}$	<p style="text-align: right;">A05065</p>	<ul style="list-style-type: none"> <li>The LB1950V is set to a mode in which only the FG and PG amplifiers operate when this pin is open or set to a voltage 0.7 V or lower.</li> <li>This pin must be set to a voltage 2.0 V or higher in the motor drive state.</li> </ul>
4	BR	$V_{CC1} \text{ max} - 0.2 \text{ V min}$	<p style="text-align: right;">A05065</p>	<ul style="list-style-type: none"> <li>Braking is applied to the motor if a voltage 2.0 V or higher is applied to this pin.</li> <li>This pin must be open or set to a voltage 0.7 V or lower to set the LB1950V to the motor drive state.</li> </ul>
5	FRC	$V_{CC1} \text{ max} - 0.2 \text{ V min}$	<p style="text-align: right;">A05067</p>	<ul style="list-style-type: none"> <li>Motor forward/reverse switching input</li> <li>Low level: forward (-0.2 to 0.7 V or open)</li> <li>High level: reverse (2 V to <math>V_{CC1}</math>)</li> </ul>
6	$V_S$	0 V to $V_{CC2}$		<ul style="list-style-type: none"> <li>Power supply that provides the motor voltage and determines the output amplitude.</li> <li>This voltage must be lower than <math>V_{CC2}</math>.</li> </ul>
7	$V_{CC2}$	2.7 to 10 V		Power supply that provides the source side pre-drive voltage and the coil waveform detection comparator voltage.
8	$V_{CC1}$	2.7 to 6 V		Power supply that provides the voltages other than the motor voltage, the source side predrive voltage, and the coil waveform detection comparator voltage.
9 10	CSLP1 CSLP2		<p style="text-align: right;">A05068</p>	Connection for the triangular wave generator. The coil output waveform is made to operate in a soft switching manner by this triangular wave.

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Pin No.	Symbol	Pin voltage	Equivalent circuit	Function
11	PG <sub>OUT</sub>			PG amplifier output
12	PGC			Connection for the PG amplifier peak-hold capacitor
13	PG <sub>IN</sub>	2.0 V max 1.0 V min (when V <sub>CC1</sub> = 3 V)		<ul style="list-style-type: none"> <li>PG amplifier input</li> <li>Connect the PG coil between this pin and V<sub>REF</sub>.</li> </ul>
14	V <sub>REF</sub>			<ul style="list-style-type: none"> <li>Internal 1.3-V reference voltage</li> <li>This voltage is used as the FG and PG amplifier reference voltage.</li> </ul>
15	FG <sub>IN</sub>			FG amplifier input Connect the FG coil between this pin and V <sub>REF</sub> .
16	FG <sub>IN1</sub>	2.0 V max 1.0 V min (when V <sub>CC1</sub> = 3 V)		Connection for an FG amplifier input signal noise filter capacitor
17	FG <sub>IN2</sub>			Connection for an FG amplifier input signal noise filter capacitor

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Pin No.	Symbol	Pin voltage	Equivalent circuit	Function
18	FGOUT			FG amplifier output
19	OSC			Connection for the triangular wave oscillator capacitor that is used to forcibly generate the motor startup waveform at startup.
20	FC			<ul style="list-style-type: none"> <li>• Frequency characteristics correction</li> <li>• Current control system closed loop oscillation can be stopped by connecting a capacitor between this pin and ground.</li> </ul>
21	FILTER			Connecting a capacitor between this pin and ground causes the coil output saturation prevention function to operate. In this state, the motor voltage is controlled by controlling the VS pin. Also, the torque ripple correction can be adjusted by changing the value of the external capacitor.
22 23	RSAT1 RSAT2			The residual output voltage setting can be increased by connecting one, the other, or both of these pins to ground.
24	GND			Ground for all systems other than the output system.

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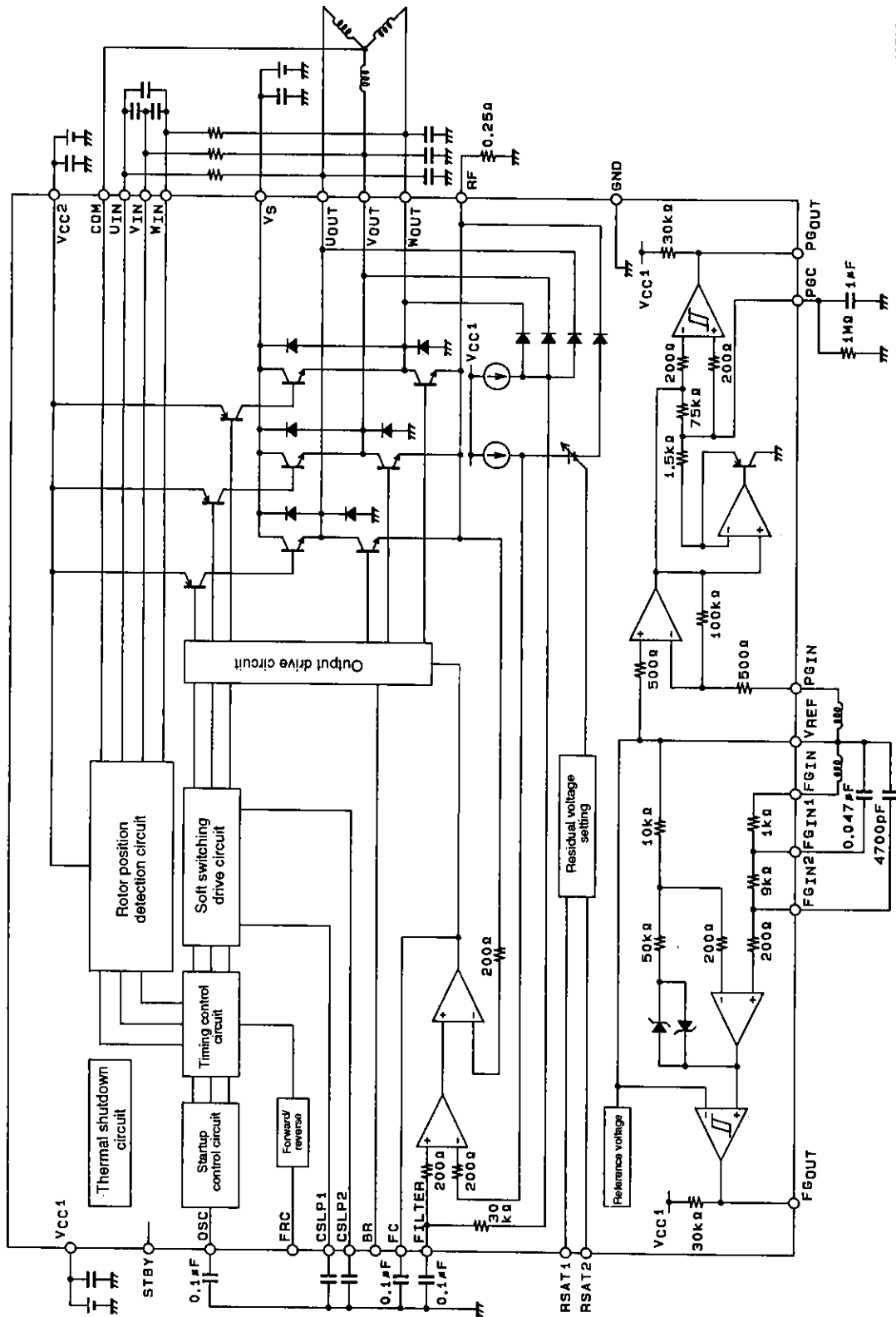
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Pin No.	Symbol	Pin voltage	Equivalent circuit	Function
25 26 27	$W_{IN}$ $U_{IN}$ $V_{IN}$			Coil waveform detector comparator input
28	COM			<ul style="list-style-type: none"> <li>• Motor coil center tap input</li> <li>• The LB1950V detects the coil voltage waveform taking this voltage as the reference.</li> </ul>
29 1 2	$W_{OUT}$ $U_{OUT}$ $V_{OUT}$			<ul style="list-style-type: none"> <li>• W-phase coil output</li> <li>• U-phase coil output</li> <li>• V-phase coil output</li> </ul>
30	RF			<ul style="list-style-type: none"> <li>• Output transistor ground</li> <li>• The LB1950V implements fixed-current drive by detecting the voltage on this pin.</li> </ul>

Block Diagram



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Note: (The values of external components vary depending on the motor used.)  
 The FGIN and PGIN pins must be connected to the VREF pin if the FG and PG amplifiers are not used.



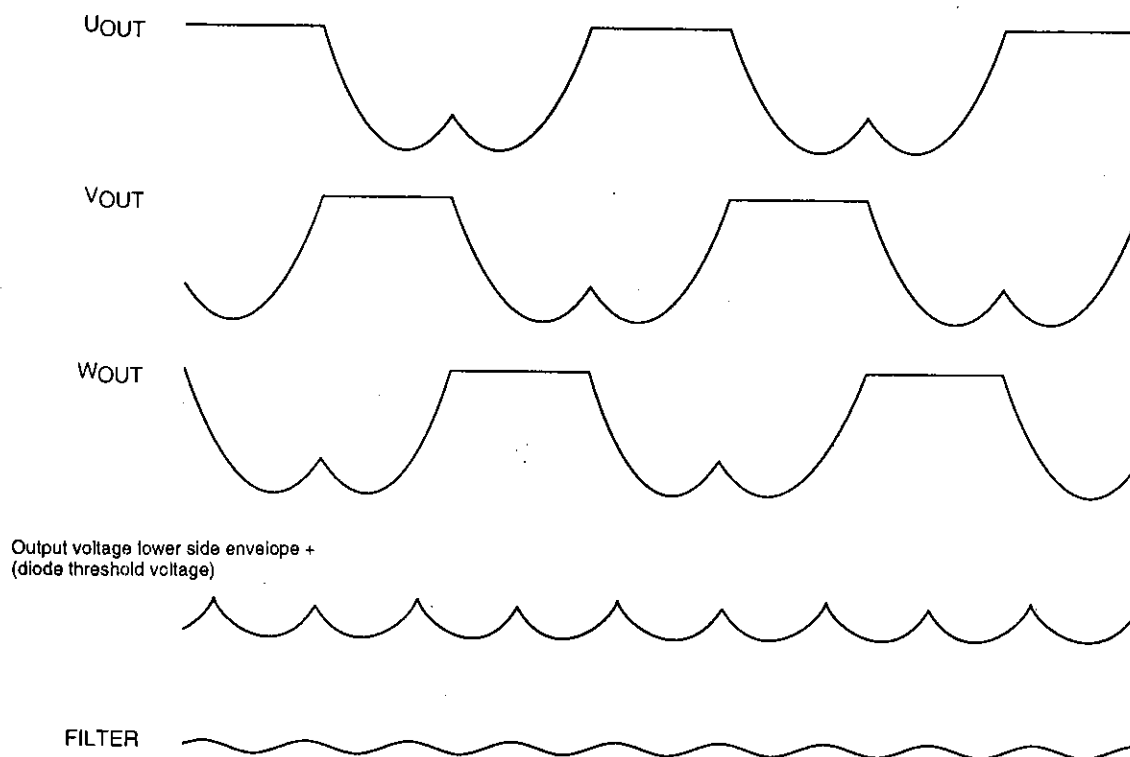
## Control System Operation

The LB1950V is a current-linear drive motor driver. It implements motor power-supply voltage based speed control by continually preventing coil output saturation and maintaining the output saturation voltage at the value set by the circuit.

1. The LB1950V detects the sum of the coil output voltage lower side envelope and the diode threshold voltage.
2. The low-pass filter formed by the internal 30-k $\Omega$  resistance and the capacitor connected between the FILTER and GND pins cuts the high-frequency components of the envelope waveform. (The cutoff frequency is  $1/2\pi CR$ .)
3. The FILTER pin voltage is input to the control amplifier + pin. The reference voltage is input to the control amplifier - pin, and the control amplifier operates to force the FILTER pin voltage to the same potential as the reference voltage. The coil output operates in the unsaturated region if this reference voltage is higher than the output transistor saturation voltage.
4. Also, since the second control amplifier stage controls the RF voltage to a fixed level, the output current (i.e., the RF current) becomes a fixed current drive.

Supplement: The low-frequency components that are not filtered out by the RC filter on the FILTER pin function to correct motor torque ripple.

## Control System Signals



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