Ordering number : EN5340

Monolithic Digital IC

No. 5340

LB1950V

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.

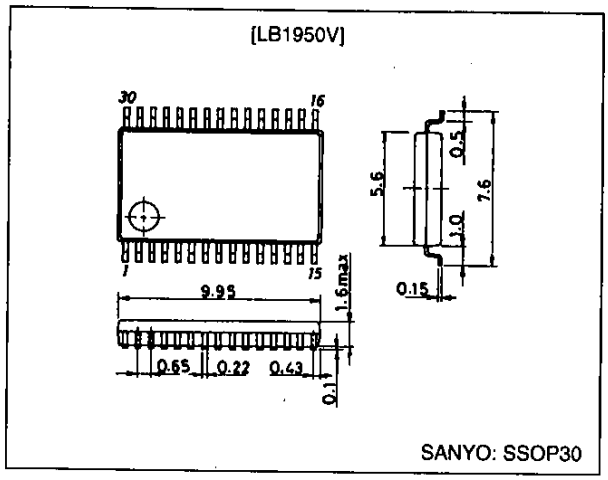
Features

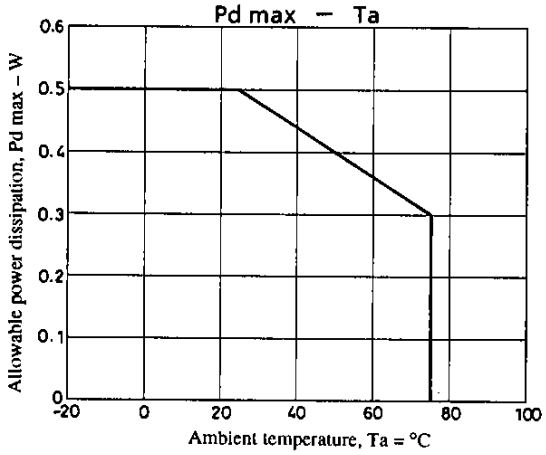
- Drives 3-phase full-wave brushless sensorless motors
- Soft switching drive
- Speed control using motor power-supply voltage control for reduced power
- Allows operation from a 3-V power supply.
- The residual output voltage can be set to one of four values.
- Supports bidirectional rotation.
- Standby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

Package Dimensions

unit: mm

3191-SSOP30





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Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CC}1$ max		7	V
	$V_{CC}2$ max		12	V
	V_S max		$V_{CC}2$	V
Output voltage	V_O max		V_S + 2	V
	V_I1 max	Control system	−0.3 to $V_{CC}1$ + 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	Pd max		0.5	W
Operating temperature	Topr		−20 to +75	°C
Storage temperature	Tstg		−55 to +150	°C

Allowable Operating Ranges at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	$V_{CC}1$		2.7 to 6.0	V
	$V_{CC}2$		2.7 to 10.0	V
	V_S		0 to $V_{CC}2$	V

Electrical Characteristics at Ta = 25°C, $V_{CC}1$ = 3 V, $V_{CC}2$ = 4.75 V, V_S = 1 V

Parameter	Symbol	Conditions	min	typ	max	Unit
Current drain	$I_{CC}1$	I_O = 100 mA, RSAT1 = RSAT2 = GND		4.5	7	mA
	$I_{CC}2$	I_O = 100 mA, RSAT1 = RSAT2 = GND		1.2	2.5	mA
Output quiescent current	I_{CC10Q}	V_{STBY} = 0 V		1	1.5	mA
	I_{CC20Q}	V_{STBY} = 0 V			10	µA
	I_{S30Q}	V_{STBY} = 0 V			10	µA
Lower side output saturation voltage	$V_{OU}1$	I_O = 0.1 A, RSAT1 = RSAT2 = open			0.11	V
	$V_{OU}2$	I_O = 0.4 A, V_S = 3 V, RSAT1 = RSAT2 = open			0.33	V
Upper side output saturation voltage	$V_{OD}1$	I_O = 0.1 A, RSAT1 = RSAT2 = open			0.11	V
	$V_{OD}2$	I_O = 0.4 A, V_S = 3 V, RSAT1 = RSAT2 = open			0.33	V
COM pin common-mode input voltage range	V_{IC}		0.3		$V_{CC}2$ − 0.9	V
Standby pin high-level voltage	V_{STBYH}		2		$V_{CC}1$	V
Standby pin low-level voltage	V_{STBYL}		−0.2		+0.7	V
Standby pin input current	I_{STBYI}	V_{STBY} = 3 V			50	µA
Standby pin leakage current	I_{STBYL}	V_{STBY} = 0 V	−10			µA
Brake pin high-level voltage	V_{BRH}		2		$V_{CC}1$	V
Brake pin low-level voltage	V_{BRL}		−0.2		+0.7	V
Brake pin input current	I_{BRI}	V_{BR} = 3 V			50	µA
Brake pin leakage current	I_{BRL}	V_{BR} = 0 V	−10			µA
FRC pin high-level voltage	V_{FRCH}		2		$V_{CC}1$	V
FRC pin low-level voltage	V_{FRCL}		−0.2		+0.7	V
FRC pin input current	I_{FRCI}	V_{FRC} = 3 V			50	µA
FRC pin leakage current	I_{FRCL}	V_{FRC} = 0 V	−10			µA
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 µF, OSC frequency: *		11.5		Hz
Phase delay width	Dwidth	*		30		deg
Thermal shutdown temperature	T_{TSD}	*	150	180	210	°C
Thermal shutdown hysteresis	ΔT_{TSD}	*		15		°C

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

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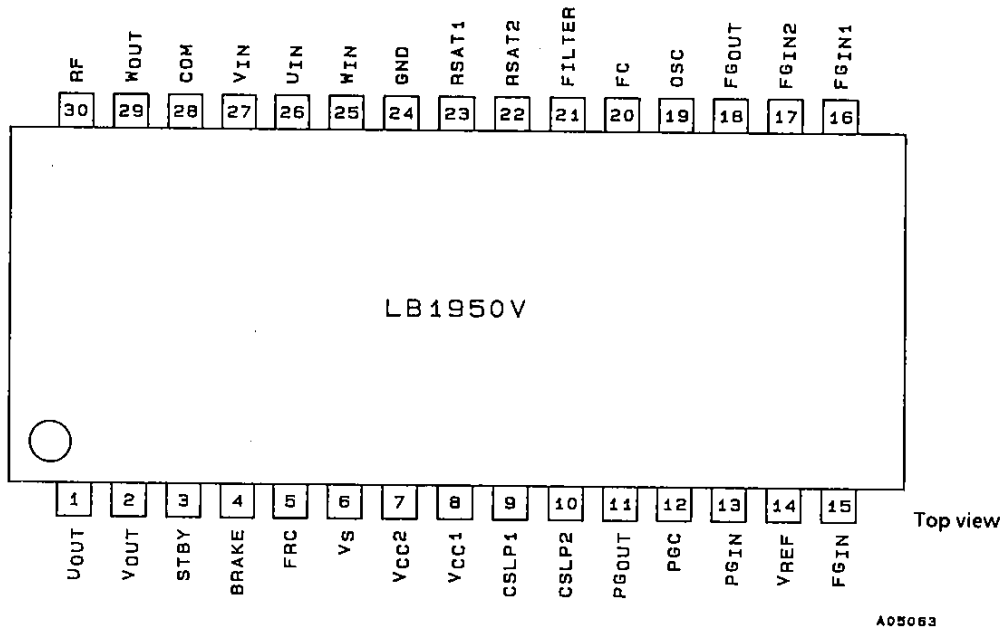
Parameter	Symbol	Conditions	min	typ	max	Unit
[FG Amplifier]						
Input offset voltage	V_{IO}	*		±1	±5	mV
Input bias current	I_B	*			250	nA
Common-mode input voltage range	V_{ICOM}	*	1		2	V
Output on voltage	V_{OL}	When I_O = 10 µA			0.4	V
Output off voltage	V_{OH}	When I_O = 10 µA	$V_{CC}1 - 0.5$			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
[PG Amplifier]						
Input offset voltage	V_{IO}	*		±1	±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 µA			0.4	V
Output off voltage	V_{OH}	When I_O = 10 µA	$V_{CC}1 - 0.5$			V
Schmitt amplifier hysteresis	V_{SHIS}	*		20		mV

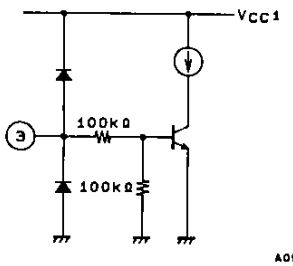
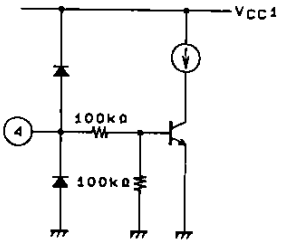
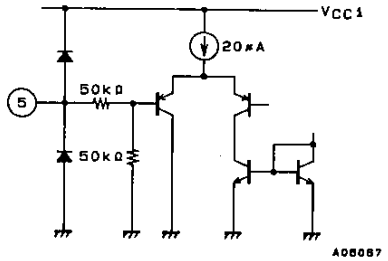
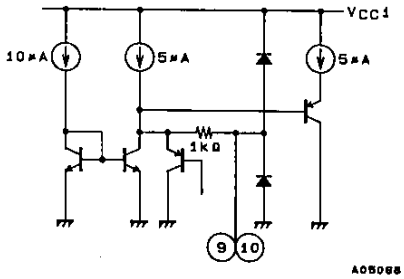
Note: * Items marked with an asterisk are design target values and are not tested.

Pin Assignment



Top view

Pin Functions

Pin No.	Symbol	Pin voltage	Equivalent circuit	Function
3	STBY	$V_{CC}1$ max – 0.2 V min		• 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. • This pin must be set to a voltage 2.0 V or higher in the motor drive state.
4	BR	$V_{CC}1$ max – 0.2 V min		• Braking is applied to the motor if a voltage 2.0 V or higher is applied to this pin. • This pin must be open or set to a voltage 0.7 V or lower to set the LB1950V to the motor drive state.
5	FRC	$V_{CC}1$ max – 0.2 V min		• Motor forward/reverse switching input • Low level: forward (–0.2 to 0.7 V or open) • High level: reverse (2 V to $V_{CC}1$)
6	V_S	0 V to $V_{CC}2$		• Power supply that provides the motor voltage and determines the output amplitude. • This voltage must be lower than $V_{CC}2$.
7	$V_{CC}2$	2.7 to 10 V		Power supply that provides the source side pre-drive voltage and the coil waveform detection comparator voltage.
8	$V_{CC}1$	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			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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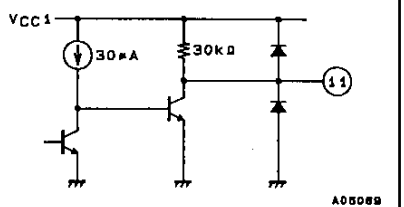
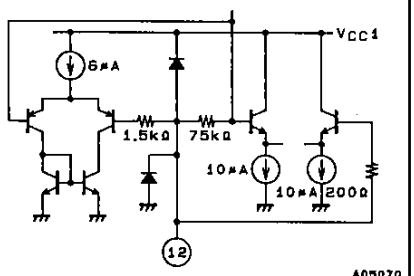
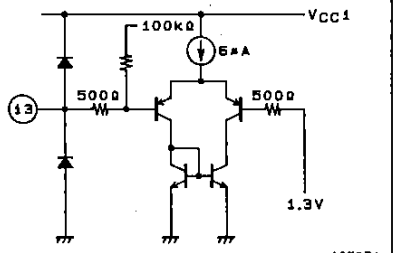
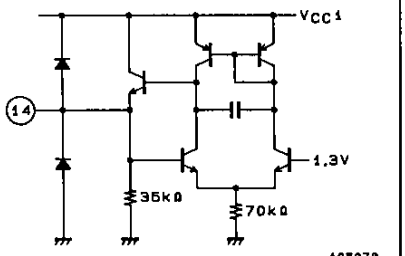
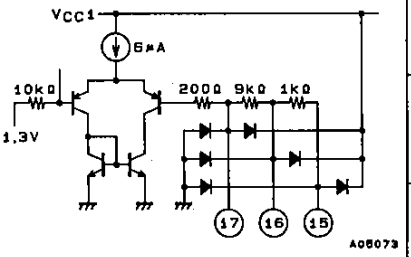
Pin No.	Symbol	Pin voltage	Equivalent circuit	Function
11	PG_{OUT}			PG amplifier output
12	PGC			Connection for the PG amplifier peak-hold capacitor
13	PG_{IN}	2.0 V max 1.0 V min (when $V_{CC}1$ = 3 V)		• PG amplifier input • Connect the PG coil between this pin and V_{REF}.
14	V_{REF}			• Internal 1.3-V reference voltage • This voltage is used as the FG and PG amplifier reference voltage.
15	FG_{IN}	2.0 V max 1.0 V min (when $V_{CC}1$ = 3 V)		FG amplifier input Connect the FG coil between this pin and V_{REF}.
16	$FG_{IN}1$			Connection for an FG amplifier input signal noise filter capacitor
17	$FG_{IN}2$			Connection for an FG amplifier input signal noise filter capacitor

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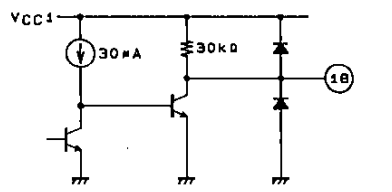
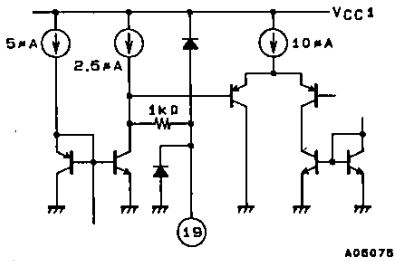
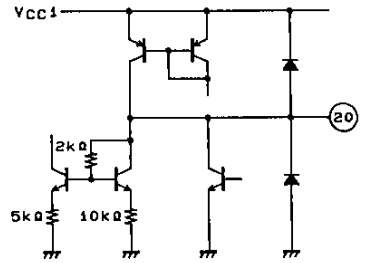
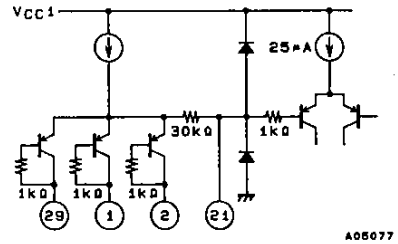
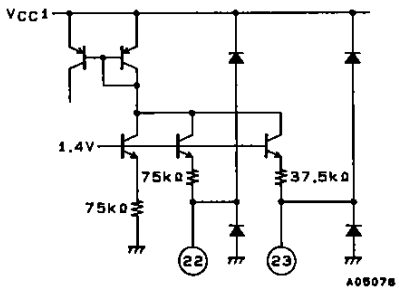
Pin No.	Symbol	Pin voltage	Equivalent circuit	Function
18	FG_{OUT}			FG amplifier output
19	OSC			Connection for the triangular wave oscillator capacitor that is used to forcibly generate the motor startup waveform at startup.
20	FC			• Frequency characteristics correction • Current control system closed loop oscillation can be stopped by connecting a capacitor between this pin and ground.
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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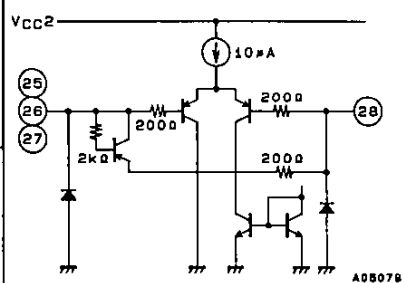
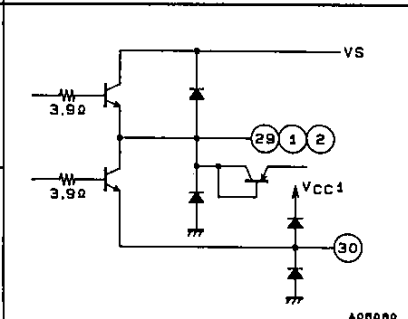
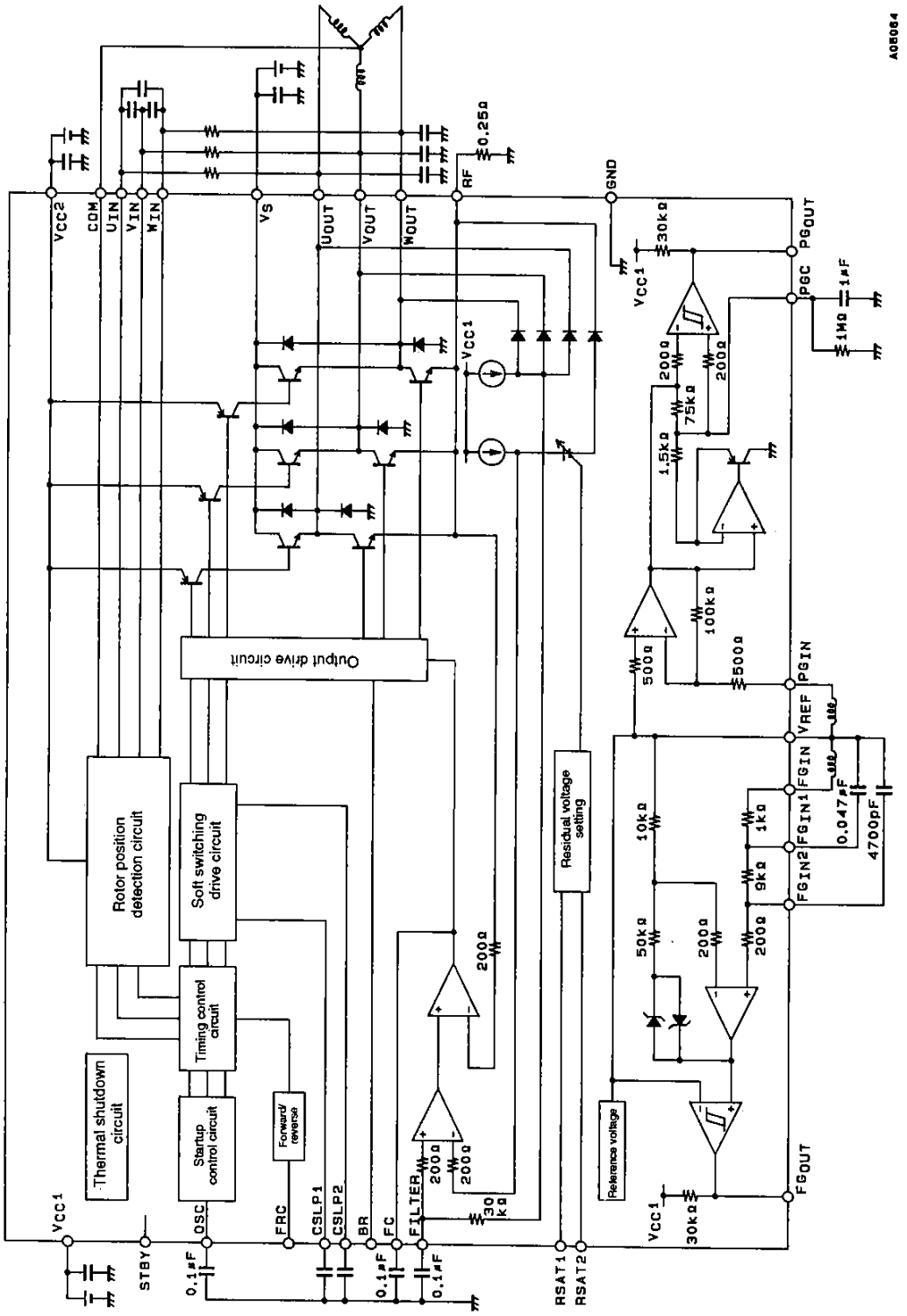
Pin No.	Symbol	Pin voltage	Equivalent circuit	Function
25 26 27	W_{IN} U_{IN} V_{IN}			Coil waveform detector comparator input
28	COM			• Motor coil center tap input • The LB1950V detects the coil voltage waveform taking this voltage as the reference.
29 1 2	W_{OUT} U_{OUT} V_{OUT}			• W-phase coil output • U-phase coil output • V-phase coil output
30	RF			• Output transistor ground • The LB1950V implements fixed-current drive by detecting the voltage on this pin.

Block Diagram



Note: (The values of external components vary depending on the motor used.)
The FG_{IN} and PG_{IN} pins must be connected to the V_{REF} 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-kΩ 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