



# LA6503

## CD-ROM Drive Spindle Motor Driver + Sled Motor Driver + Sled Motion/Position Detector IC

### Overview

The LA6503 was developed for CAV control CD-ROM drives, and provides spindle motor driver, sled motor driver, and sled motion/position detection circuits.

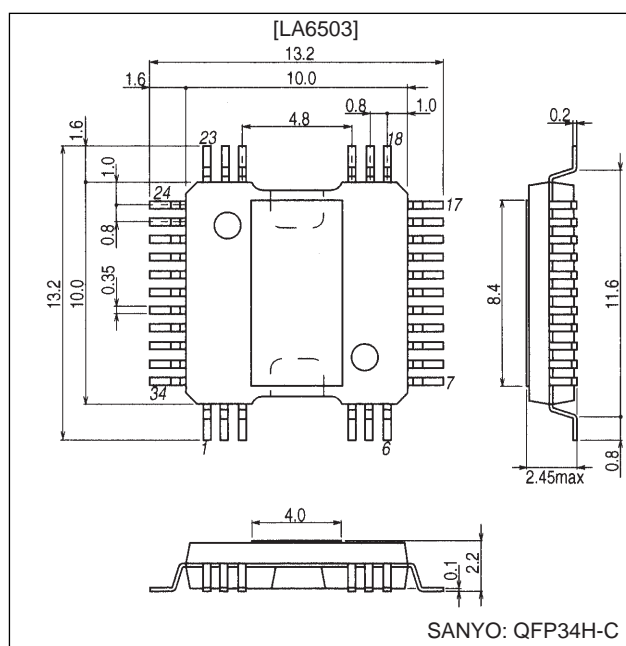
### Functions and Features

- CAV control spindle motor driver
  - Three-phase brushless motor driver
  - $I_{Omax} = 1\text{ A}$
  - Built-in FG output circuit (single Hall detection output)
  - Reverse braking circuit
  - Built-in start/stop circuit
  - Upper side current detection for minimal loss in the current detection resistor. Also, the voltage drop in this resistor reduces the IC internal power dissipation.
  - Built-in thermal shutdown circuit
- Sled motor driver
  - One built-in BTL driver channel
  - $I_{Omax} = 1\text{ A}$
  - Wide dynamic range
  - Built-in level shifting circuit
  - Muting (output on/off) circuit
  - Built-in thermal shutdown circuit
- Sled motion/position detection circuit
  - Circuit that provides a pulse output corresponding to sled motion and position
  - This circuit emits 96 pulses for each rotation from a 24-pole magnet and  $90^\circ$  phase difference Hall element motors, and thus detects the distance moved. It also provides two 48-pulse outputs with differing phases such that the motion direction can be detected from the phase difference between those signals.
- Hall bias power supply
  - Generates the Hall element 3-V bias voltage.
  - $I_{Omax} = 30\text{ mA}$ , typical

### Package Dimensions

unit: mm

#### 3219-QFP34H-C



## Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	$V_{CC}$ max		7	V
Supply voltage	$V_M$ max		14	V
Input voltage	$V_C$ max		$V_{CC}$	V
Output current	$I_O$ max	Spindle output, sled output	1	A
Allowable power dissipation	$P_d$ max	Independent IC	0.77	W
Operating temperature	$T_{opr}$		$-20$ to $+75$	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$		$-55$ to $+150$	$^{\circ}\text{C}$

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

Parameter	Symbol	Conditions	Ratings	Unit
Operating supply voltage range	$V_{CC}$		4.6 to 6.0	V
	$V_M$		4.6 to 13.0	V

### Operating Characteristics at $T_a = 25^{\circ}\text{C}$ , $V_{CC} = 5\text{ V}$ , $V_M = 12\text{ V}$ (unless otherwise specified)

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
[Power Supply Current]						
Current drain 1 ( $V_{CC}$ )	$I_{CC1}$	START/STOP = MUTE = 5 V		10	20	mA
Current drain 2 ( $V_M$ )	$I_{M1}$	START/STOP = MUTE = 5 V		25	50	mA
Quiescent current 1 ( $V_{CC}$ )	$I_{CC2}$	START/STOP = MUTE = 0 V		5	10	mA
Quiescent current 2 ( $V_M$ )	$I_{M2}$	START/STOP = MUTE = 0 V		1	5	mA
[Spindle Motor Block]						
[Output]						
Upper side saturation voltage 1	$V_{source}$	$I_O = -0.5\text{ A}$		1.0	1.5	V
Lower side saturation voltage 1	$V_{sink}$	$I_O = +0.5\text{ A}$		0.33	0.80	V
Current limiter voltage setting	$V_{CL}$	$R_{RE} = 0.43\ \Omega$		0.32		V
[Hall Amplifier]						
Common-mode input voltage range	$V_{HCOM}$		1.2		$V_{CC} - 1.0$	V
Input bias current	$V_{HIB}$			1		$\mu\text{A}$
Minimum Hall input level	$V_{HIN}$		60			mVp-p
[S/S Pin]						
High-level voltage	VS/SH		2.0		$V_{CC}$	V
Low-level voltage	VS/SL				0.7	V
Input current	IS/SI	VS/S = 5 V			200	$\mu\text{A}$
Leakage current	IS/SL	VS/S = 0 V	-30			$\mu\text{A}$
[Control]						
VC pin input current	$I_{VC}$	$V_C = V_{CREF} = 2.5\text{ V}$		1	5	$\mu\text{A}$
VCREF pin input current	$I_{VCREF}$	$V_C = V_{CREF} = 2.5\text{ V}$		1	5	$\mu\text{A}$
Voltage gain	$G_{VCO}$	$\Delta V_{RF}/\Delta V_C$		0.25		Times
Rising edge threshold voltage	$V_{CTH}$	$V_{CREF} = 2.5\text{ V}$	2.35		2.65	V
Rising edge threshold voltage difference	$\Delta V_{CTH}$	$V_{CREF} = 2.5\text{ V}$	50		150	mV
[Hall Comparator]						
Input offset voltage	$V_{HCIOFFSET}$				10	mV
Input hysteresis	$V_{HCHYS}$			8		mV
Output on voltage	$V_{OU}$				0.3	V
Output off voltage	$V_{OD}$	*	4.7			V
Output current (sink)	$I_{sink}$		3			mA

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
[Sled Motor Block]						
Output offset voltage	V <sub>OFF</sub>	Voltage difference between outputs	−50		+50	mV
Buffer input voltage range	V <sub>BIN</sub>		1.5		V <sub>CC</sub> − 1.5	V
Input voltage range	V <sub>IN</sub>		1.0		V <sub>CC</sub> − 1.5	V
Source output voltage	V <sub>O1</sub>	R <sub>L</sub> = 8 Ω	9.5	10.1		V
Sink output voltage	V <sub>O2</sub>	R <sub>L</sub> = 8 Ω		1.8	2.4	V
Closed-circuit voltage gain	V <sub>G</sub>	Bridge Amp		12		dB
Slew rate	S <sub>R</sub>			0.15		V/μs
Muting on voltage	V <sub>MUTE</sub>	The amplifier output is on when at the high level.	0.7	1.2	2.0	V
[Hall Bias (3-V Output Power Supply)]						
Output voltage	V <sub>HB-OUT</sub>	I <sub>OUT</sub> = 30 mA	2.5	3.0	3.5	V
Line regulation	V <sub>HB-LIN</sub>	V <sub>CC</sub> = 4.6 to 6 V, I <sub>OUT</sub> = 30 mA	−50		+50	mV
Load regulation	V <sub>HB-LOAD</sub>	I <sub>OUT</sub> = 5 to 30 mA, V <sub>CC</sub> = 5 V	−200		+200	mV

Note: For items marked with an asterisk (\*), the Hall comparator goes to the high level when the S/S pin is off (standby mode).

**Truth Table****(Spindle Motor Block)**

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

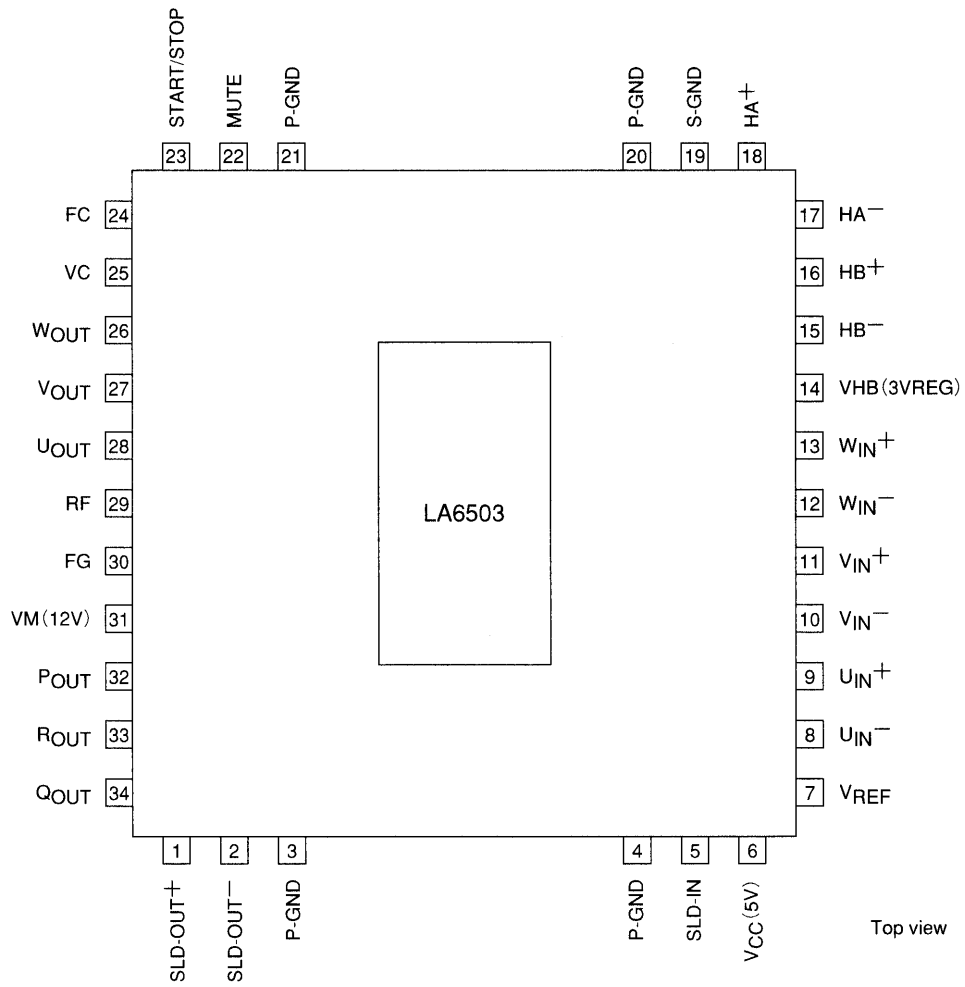
Inputs: The "H" state is when the + input of the corresponding phase is 0.2 V or more higher than the - input.  
The "L" state is when the + input of the corresponding phase is 0.2 V or more lower than the - input.

**(Sled Motor Block)**

Input ( $V_{IN}$ )	Mute	Output	
		SLD-OUT+	SLD-OUT-
H	H	H	L
	L	—	—
L	H	L	H
	L	—	—

Note: "—" indicates that the amplifier output is off.

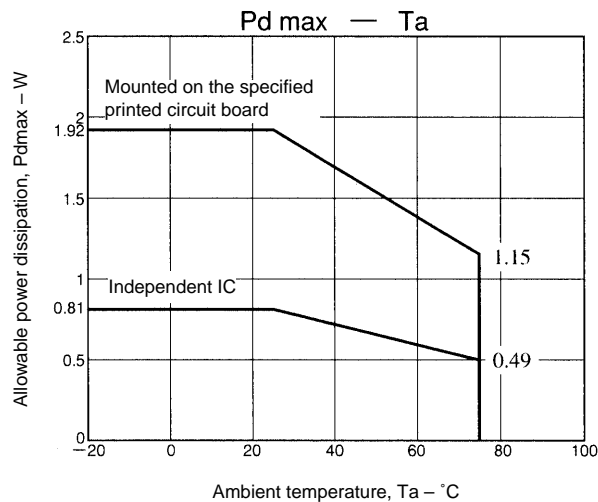
# Pin Assignment



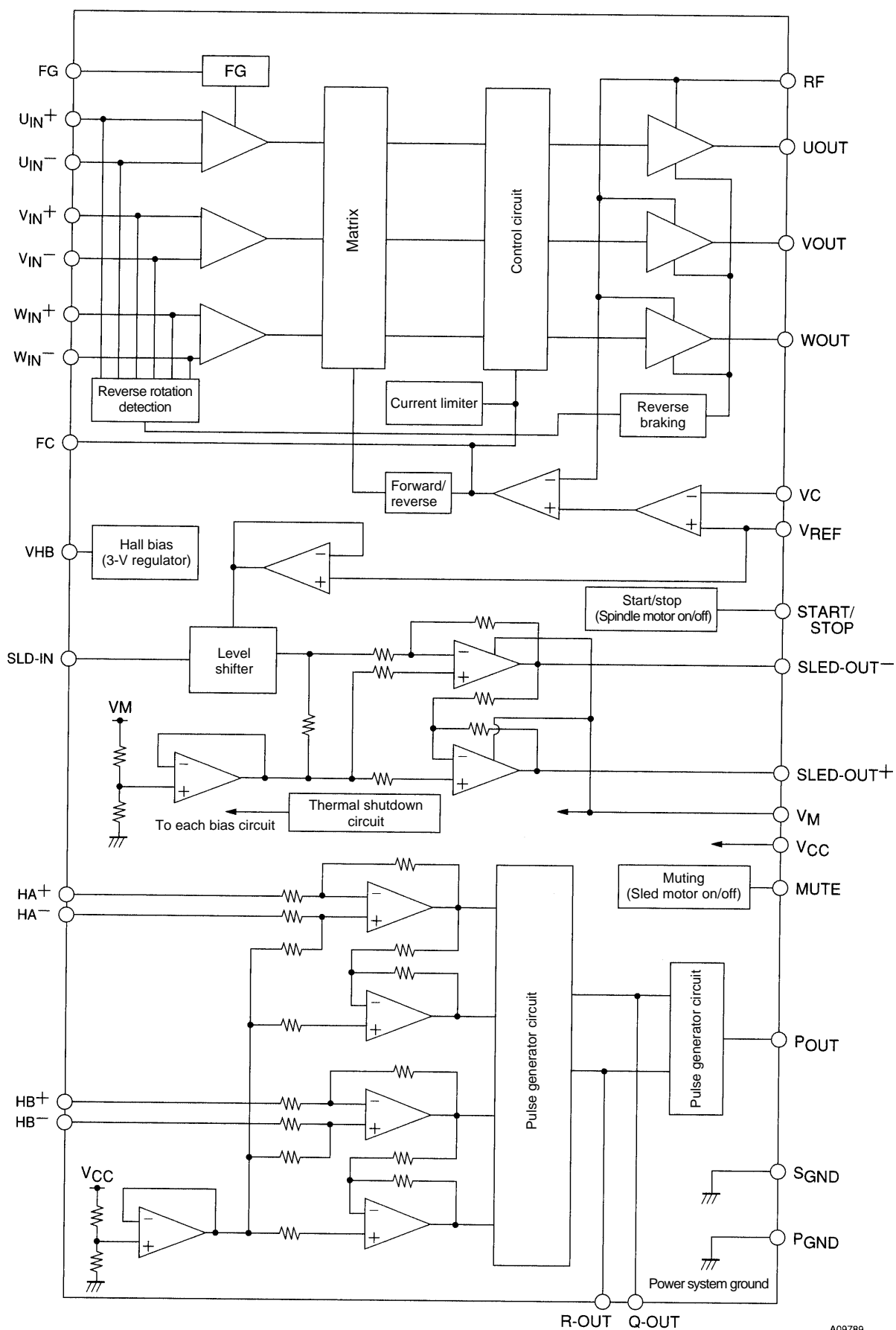
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## Pin Functions

Pin No.	Symbol	Function
1	SLED OUT <sup>+</sup>	Sled motor noninverted output
2	SLED OUT <sup>-</sup>	Sled motor inverted output
3	P-GND	Power system ground
4	P-GND	Power system ground
5	SLED-IN	Sled motor signal input (The gain is set with a resistor.)
6	V <sub>CC</sub> (5 V)	Signal system power supply (5 V)
7	V <sub>REF</sub>	Reference voltage input
8	U <sub>IN</sub> <sup>-</sup>	Three-phase spindle motor hall signal input pin (U phase -)
9	U <sub>IN</sub> <sup>+</sup>	Three-phase spindle motor hall signal input pin (U phase +)
10	V <sub>IN</sub> <sup>-</sup>	Three-phase spindle motor hall signal input pin (V phase -)
11	V <sub>IN</sub> <sup>+</sup>	Three-phase spindle motor hall signal input pin (V phase +)
12	W <sub>IN</sub> <sup>-</sup>	Three-phase spindle motor hall signal input pin (W phase -)
13	W <sub>IN</sub> <sup>+</sup>	Three-phase spindle motor hall signal input pin (W phase +)
14	VHB (3Vreg)	Hall bias output pin (3-V power supply output)
15	HB <sup>-</sup>	Sled motion distance detection hall element input (HB -)
16	HB <sup>+</sup>	Sled motion distance detection hall element input (HB +)
17	HA <sup>-</sup>	Sled motion distance detection hall element input (HA -)
18	HA <sup>+</sup>	Sled motion distance detection hall element input (HA +)
19	S-GND	Signal system ground
20	P-GND	Power system ground
21	P-GND	Power system ground
22	MUTE	Sled motor output muting (output on/off control)
23	START/STOP	Spindle motor output start/stop (output on/off control)
24	FC	Phase compensation capacitor connection
25	VC	Input for the spindle control signal from the ASP
26	WOUT	Three-phase spindle motor output (W phase output)
27	VOUT	Three-phase spindle motor output (V phase output)
28	UOUT	Three-phase spindle motor output (U phase output)
29	RF	Output current detection
30	FG	FG signal output
31	V <sub>M</sub> (12 V)	Motor power supply (12 V)
32	POUT	Sled motion position detection pulse output P (96 pulses)
33	ROUT	Sled motion position detection pulse output R (48 pulses)
34	QOUT	Sled motion position detection pulse output Q (48 pulses)



## Block Diagram

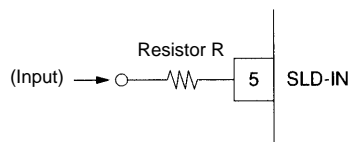


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## Notes on Gain Adjustment (Sled Motor Block)

- Gain setting

The sled motor block gain is set using an external resistor as shown below.



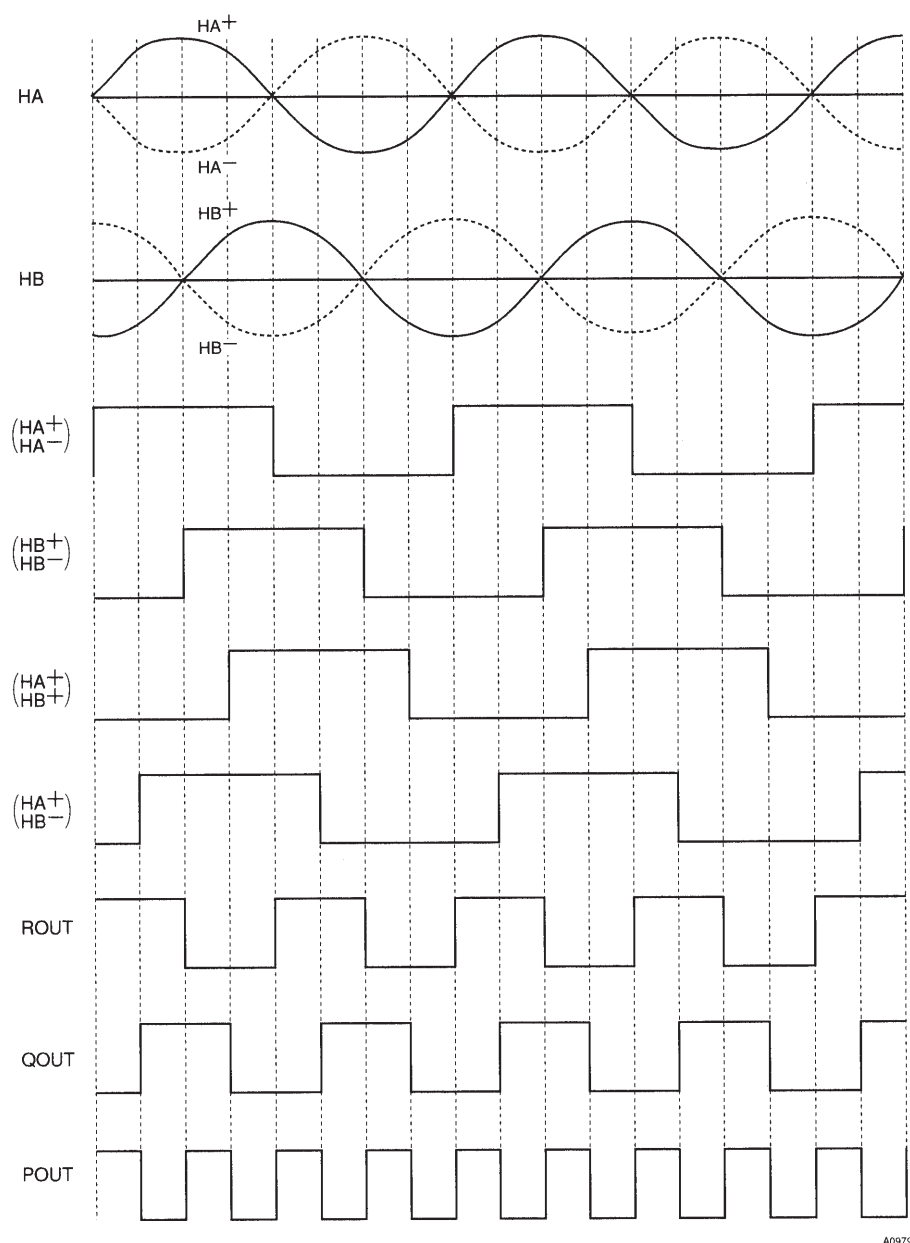
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For example, when the external resistor  $R$  is  $22\text{ k}\Omega$ , the gain will be  $0\text{ dB}$  when seen as an independent output amplifier and  $6\text{ dB}$  when seen as a BTL circuit (between outputs). Referenced to this  $22\text{-k}\Omega$  resistor, the independent output amplifier gain will be  $22\text{k}/R$  (as a multiple) or  $20 \log(22\text{k}/R)\text{ dB}$ . Similarly, the BTL gain will be  $2 \times 22\text{k}/R$  (as a multiple) or  $20 \log(22\text{k}/R)\text{ dB} + 3\text{ dB}$ . The level shifting circuits used in current models perform both current and voltage conversion, and thus have a different input type from normal operational amplifiers. The current that flows in the external resistor, that is, the potential difference, becomes the input to AMP1 and AMP2.

- Output offset voltage

The output offset voltage is  $1/2 V_M$  (typical). The  $V_O^-$  and  $V_O^+$  outputs are converted to outputs that are centered on this voltage.

## Sled Position Detection Pulse Waveforms



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Note: When the sled motor rotation direction changes (that is, when the HA and HB phase relationship changes), the R-OUT and Q-OUT phase relationship changes and the direction can be detected from that phase. The motion distance and position are detected from P-OUT.

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