Ordering number: EN5232

Monolithic Digital IC

No. 5232

LB1951V

3-phase Brushless Motor Driver for Portable VCR Capstan Use

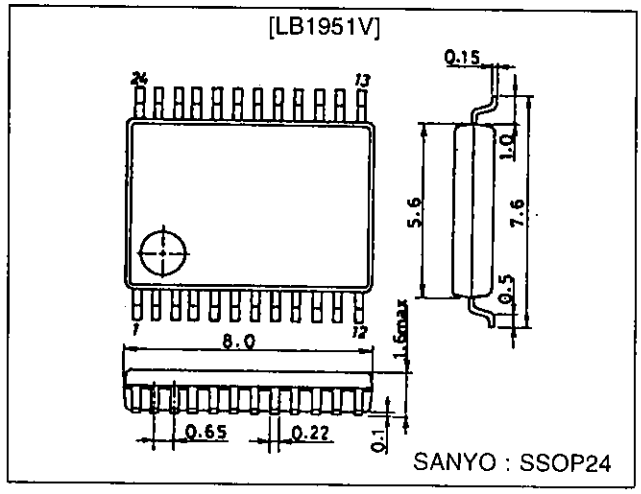
Functions

- 3-phase full-wave current linear drive system (120° voltage linear drive system).
- Torque ripple correction circuit built in (overlap correction).
- Speed control system using motor supply voltage control.
- FG comparator built in.
- Thermal shutdown circuit built in.

Package Dimensions

unit : mm

3175A-SSOP24



Specifications

Absolute Maximum Ratings at Ta = 25 °C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{CC}1$ max		10	V
	$V_{CC}2$ max		11	V
	Vs max	≦$V_{CC}2$	11	V
Applied output voltage	V_O max		V_S + 2	V
Maximum output current	I_O max		1.0	A
Allowable power dissipation	Pd max	Independent IC	440	mW
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
	$V_{CC}2$		3.5 to 9.0	V
	Vs		to $V_{CC}2$	V
Hall input amplitude	V_{HALL}	Between Hall inputs	±20 to ±80	mV_0-p

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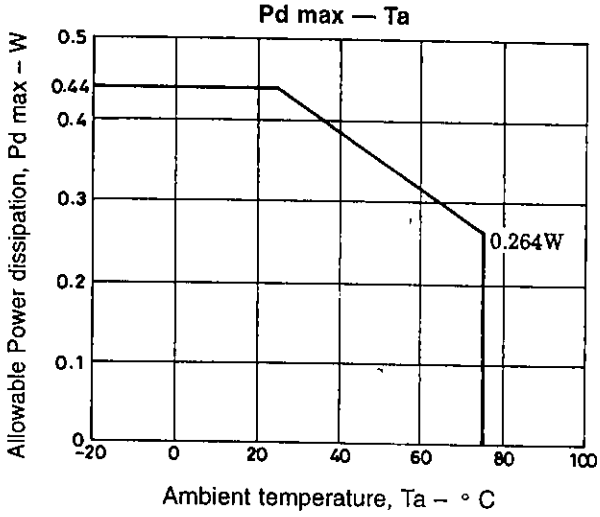
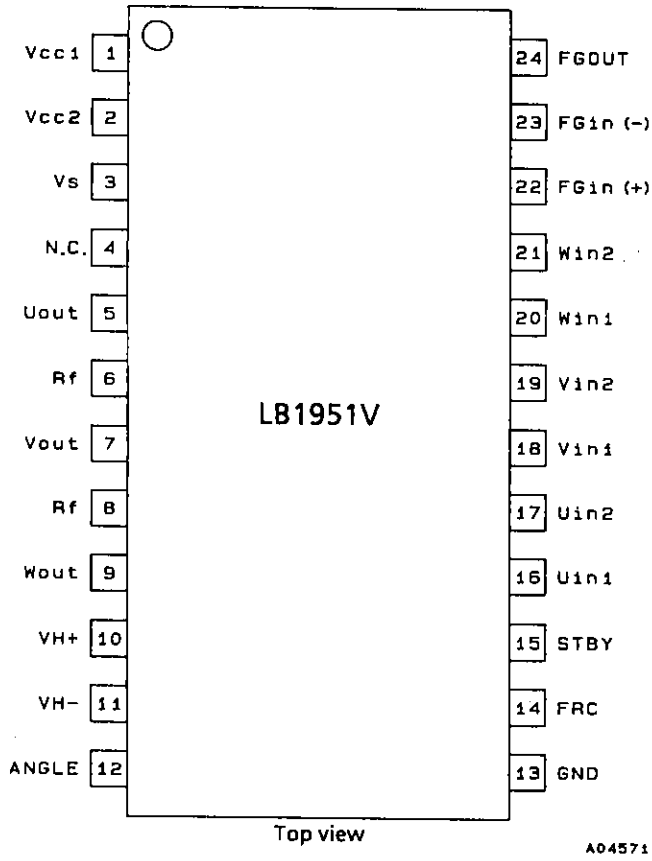
Electrical Characteristics at Ta = 25 °C, $V_{CC}1$ = 3 V, $V_{CC}2$ = 4.75 V, V_S = 1.5 V

Parameter	Symbol	Conditions	min	typ	max	Unit
[Supply Current]						
Supply current 1	$I_{CC}1$	Iout = 100 mA		3.0	5.0	mA
Supply current 2	$I_{CC}2$	Iout = 100 mA		7.0	10.0	mA
Static current 1	$I_{CCQ}1$	V_{STBY} = 0 V		1.5	3.0	mA
Static current 2	$I_{CCQ}2$	V_{STBY} = 0 V			100	μA
V_S static current	I_{SQ}	V_{STBY} = 0 V		40	100	μA
[VX1]						
Upper residual voltage	$V_{XH}1$	Iout = 0.2 A	0.15	0.22	0.29	V
Lower residual voltage	$V_{XL}1$	Iout = 0.2 A	0.16	0.21	0.26	V
[VX2]						
Upper residual voltage	$V_{XH}2$	Iout = 0.5 A		0.25	0.40	V
Lower residual voltage	$V_{XL}2$	Iout = 0.5 A		0.25	0.40	V
Output saturation voltage	Vosat	Iout = 0.8 A, Sink + Source			1.40	V
Overlap	O.L	R_L = 39 Ω × 3, R angle = 20 kΩ Note 1	70	77	84	%
[Hall Amplifier]						
Hall amplifier input offset voltage	V_{HOFF}	Note 2	−5		+5	mV
Hall amplifier common-mode input range	V_{HCM}	R angle = 20 kΩ	0.95		2.4	V
Hall amplifier I/O voltage gain	V_{GVH}	R angle = 20 kΩ	24.5	27.5	30.5	dB
[Standby Pin]						
Stand-by pin high-level voltage	V_{STH}		2.5			V
Standby pin low-level voltage	V_{STL}				0.4	V
Standby pin input current	I_{STIN}	V_{STBY} = 3 V		25	40	μA
Standby leakage current	I_{STLK}	V_{STBY} = 0 V			−30	μA
[FRC Pin]						
FRC pin high-level voltage	V_{FRCH}		2.5			V
FRC pin low-level voltage	V_{FRCL}				0.4	V
FRC pin input current	I_{FRCIN}	V_{FRC} = 3 V		20	30	μA
FRC pin leakage current	I_{FRCLK}	V_{FRC} = 0 V			−30	μA
[VH]						
Hall supply voltage	V_{HALL}	I_H = 5 mA, $V_H(+) - V_H(-)$	0.85	0.95	1.05	V
$V_H(-)$ pin voltage	$V_H(-)$	I_H = 5 mA	0.81	0.88	0.95	V
[FG Comparator]						
Input offset voltage	V_{FGOFF}		−3		+3	mV
Input bias current	I_{bFG}	$V_{FGIN}^+ = V_{FGIN}^-$ = 1.5 V			500	nA
Input bias current offset	ΔI_{bFG}	$V_{FGIN}^+ = V_{FGIN}^-$ = 1.5 V	−100		+100	nA
Common-mode input range	V_{FGCM}		1.2		2.5	V
Output high-level voltage	V_{FGOH}	At internal pull-up	2.8			V
Output low-level voltage	V_{FGOL}	At internal pull-up			0.2	V
Voltage gain	V_{GFG}	(Design target) Note 2		100		dB
Output current (Sink)	I_{FGOs}	With output pin "L"			5	mA
[TSD]						
TSD operating temperature	T-TSD	(Design target value) Note 2		180		°C
TSD temperature hysteresis width	ΔTSD	(Design target value) Note 2		20		°C

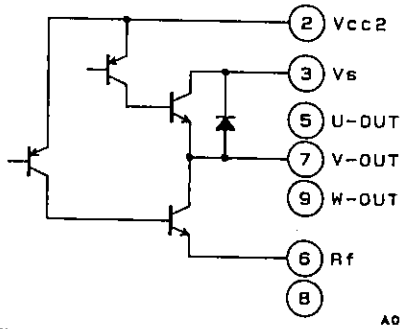
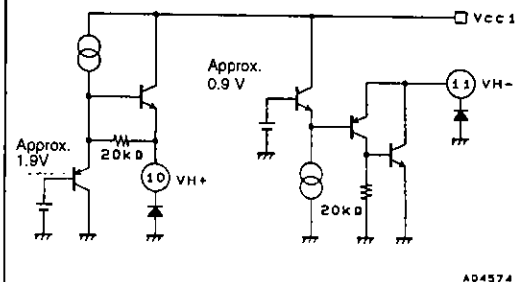
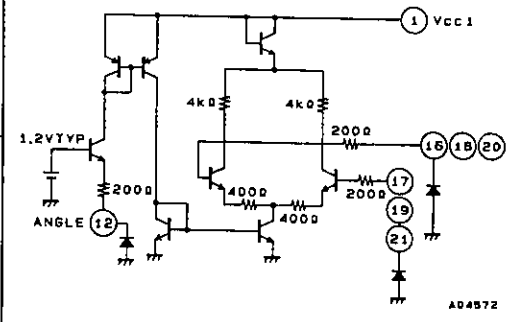
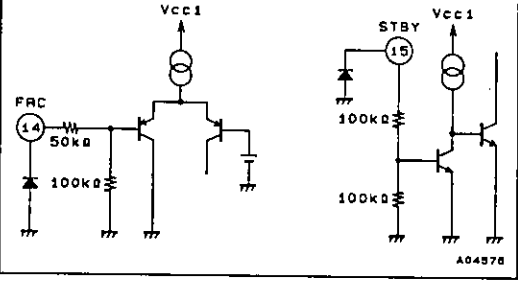
Note 1: Overlapping specifications are assumed to be test specifications.
Note 2: For parameters which have an entry of (Design target value) in the "Conditions" column, no measurements are made.



Pin Assignment



Pin Functions

Pin No.	Pin name	I/O equivalent circuit	Function
1	$V_{CC}1$		Power supply pin for supplying power to all circuits except amplitude control section in output section in IC.
2	$V_{CC}2$		Power supply pin for supplying power to all circuits of the amplitude control section and the output control section in IC.
3	V_S		Power supply pin for motor drive. Apply a voltage of $V_{CC}2$ or lower to this pin.
5 7 9	U-OUT V-OUT W-OUT		U-phase output pin V-phase output pin W-phase output pin (Spark killer diode built in)
6, 8	Rf		Pin for grounding output power transistor.
10 11	VH^+ VH^-		Pins for supplying the Hall element bias voltage. Voltage of 0.95 V (typ.) is generated between VH^+ and VH^-. (when I_H = 5 mA)
12	ANGLE		Pins for controlling the Hall input-output gain. The gain is controlled by a resistor between this pin and GND.
16 17 18 19 20 21	Uin1 Uin2 Vin1 Vin2 Win1 Win2		U-phase Hall element input pin; Logic "H" represents $IN^+ > IN^-$. V-phase Hall element input pin; Logic "H" represents $IN^+ > IN^-$. W-phase Hall element input pin; Logic "H" represents $IN^+ > IN^-$.
13	GND		Pin for grounding other than output transistors. Minimum potential of output transistors is equal to the level at Rf pin.
14	FRC		Forward/reverse select pin. The voltage on this pin is used for forward/reverse select. (with Hysteresis)
15	STBY		Pin for selecting the bias supply for all circuits except the FG comparator. "L" level on this pin cuts the bias supply.

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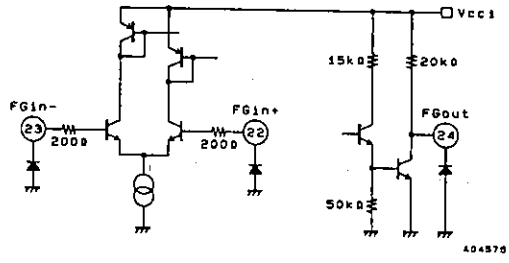
Pin No.	Pin name	I/O equivalent circuit	Function
22	FGin+		Noninverting input pin for the FG comparator. No bias is applied internally.
23	FGin–		Inverting input pin for the FG comparator. No bias is applied internally.
24	FGout		FG comparator output pin. A resistive load of 20 kΩ is provided internally.

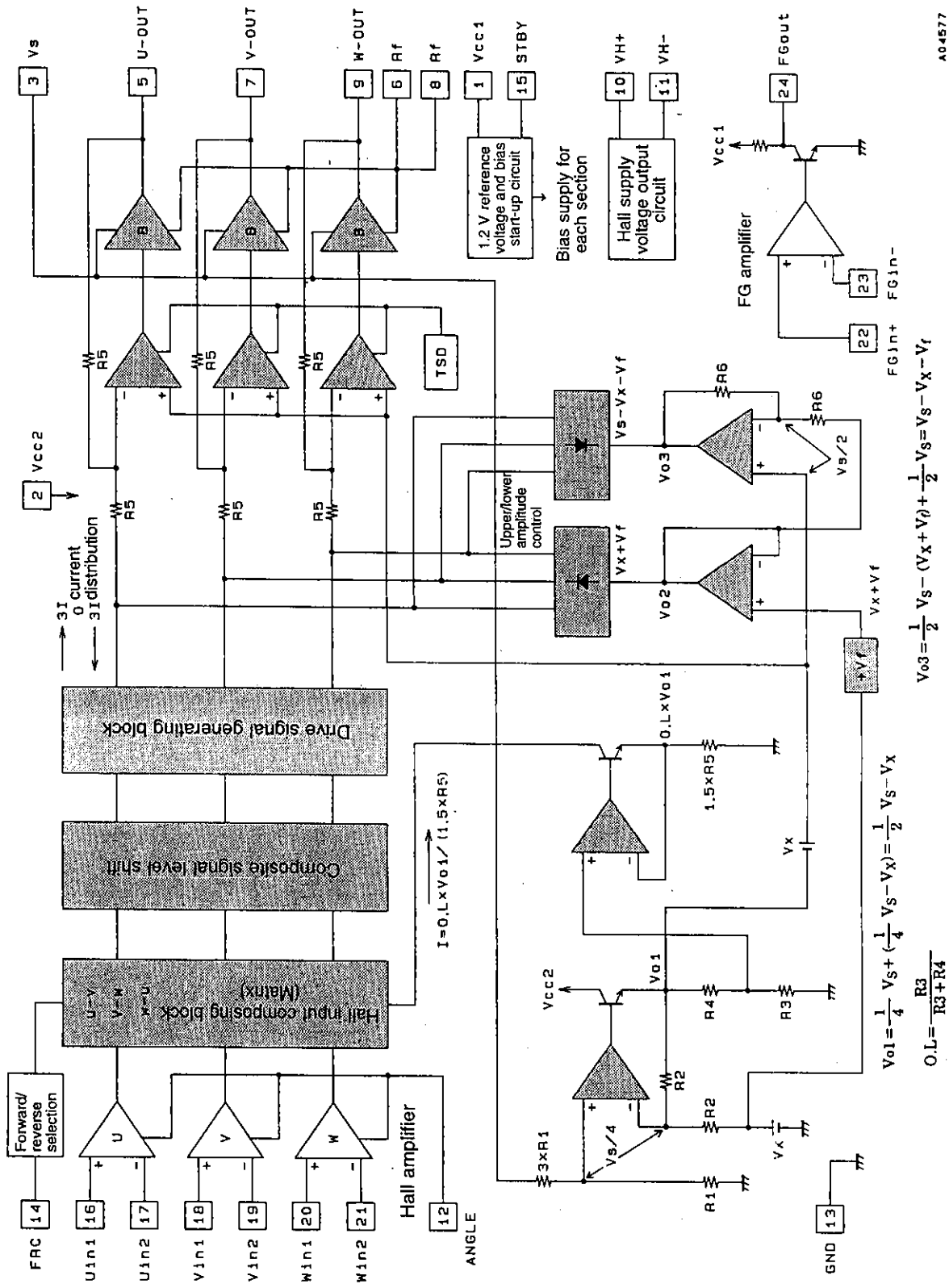
Truth Table

	Source → Sink	Hall input			FRC
		U	V	W	
1	V → W	H	H	L	H
	W → V				L
2	U → W	H	L	L	H
	W → U				L
3	U → V	H	L	H	H
	V → U				L
4	W → V	L	L	H	H
	V → W				L
5	W → U	L	H	H	H
	U → W				L
6	V → U	L	H	L	H
	U → V				L

Note: "H" in the FRC column represents a voltage of 2.5 V or more; "L" represents a voltage of 0.4 V or less. (At $V_{CC}1 = 3$ V)

Note: "H" in the Hall input columns represents a state in which "+" has a potential which is higher by 0.02 V or more than that of the "–" phase inputs. Conversely, "L" represents a state in which "+" has a potential which is lower by 0.02 V or more than that of the "–" phase input.

Block Diagram



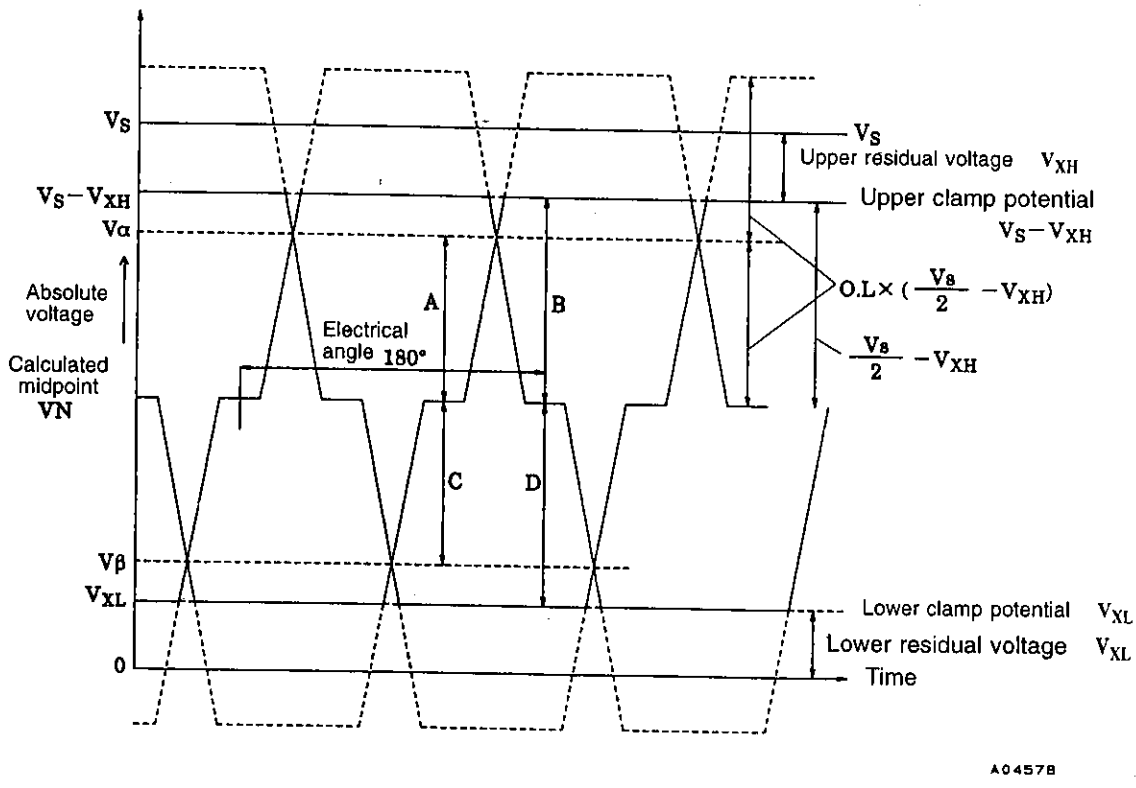
$$Vo1=\frac{1}{4}Vs+\left(\frac{1}{4}Vs-Vx\right)=\frac{1}{2}Vs-Vx$$

$$O.L=\frac{R3}{R3+R4}$$

$$Vo3=\frac{1}{2}Vs-(Vx+Vf)+\frac{1}{2}Vs=Vs-Vx-Vf$$

* For the shaded portions, power supply is from $V_{CC}2$.

Overlap Creation and Calculation



i) Overlap creation

Because the voltage generated in the amplitude controller is: $2 \times$ O.L. $\times$ (1/2 $V_S - V_X$) for each side, (using the midpoint as the reference point), the point at which the two waveforms cross each other is O.L. (1/2 $V_S - V_X$) from the midpoint.

Because that waveform is clamped at (1/2 $V_S - V_X$) with the midpoint as the reference point, the overlap equals A/B $\times$ 100, which equals O.L. $\times$ 100 (%).

ii) Overlap calculation

(1) Upper overlap amount

$$\text{Calculated midpoint VN} = \frac{(V_S - V_{XH} - V_{XL})}{2} + V_{XL} = \frac{(V_S - V_{XH} + V_{XL})}{2}$$

Because $A = V\alpha - VN$ and $B = V_S - V_{XH} - VN$, the upper overlap amount is calculated as follows:

$$\text{Overlap amount} = \frac{A}{B} = \frac{V\alpha - \{(V_S - V_{XH} + V_{XL})/2\}}{V_S - V_{XH} - \{(V_S - V_{XH} + V_{XL})/2\}} \times 100$$

$$= \frac{2V\alpha - (V_S - V_{XH}) - V_{XL}}{(V_S - V_{XH}) - V_{XL}} \times 100\ (\%)$$

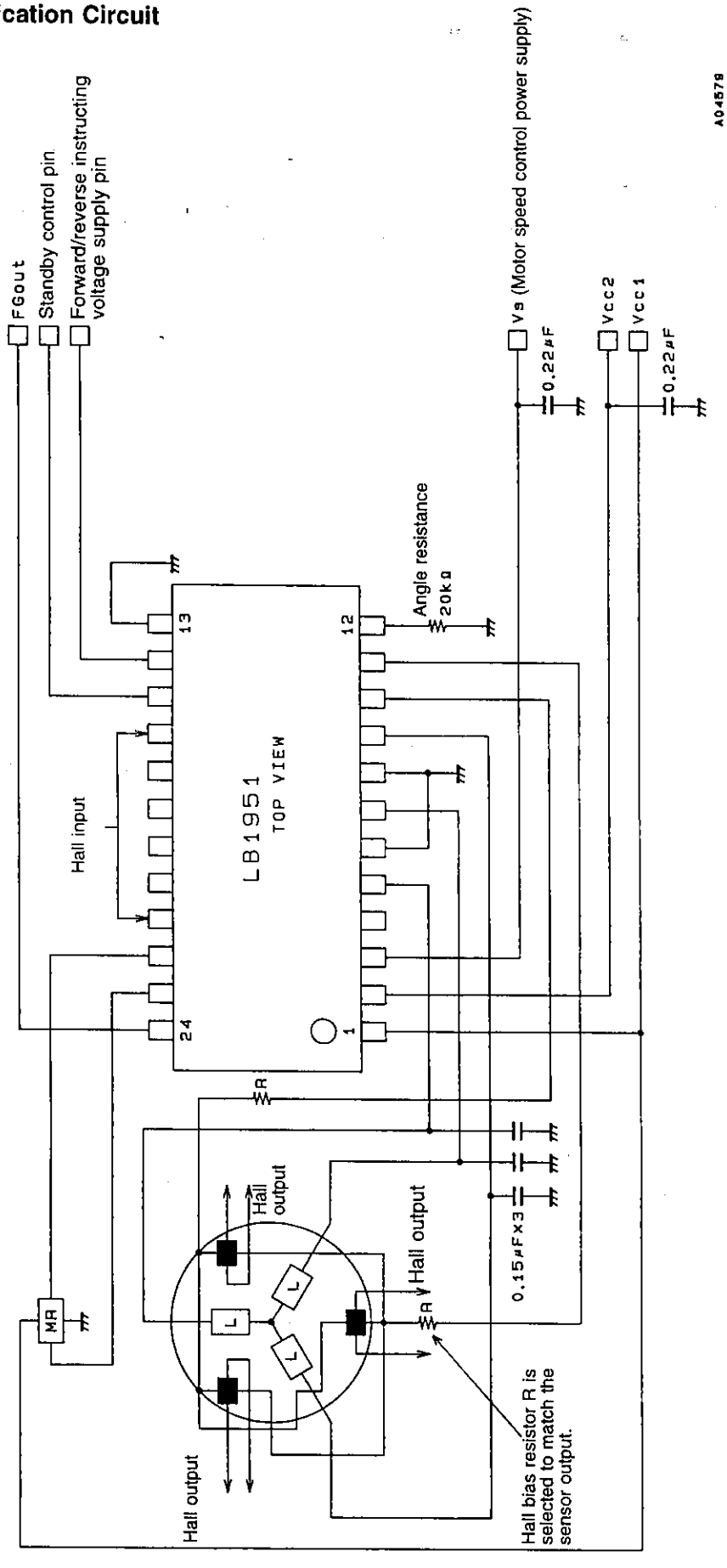
(2) Lower overlap amount

Because $C = VN - V\beta$ and $D = VN - V_{XL}$, the lower overlap amount is calculated as follows:

$$\text{Overlap amount} = \frac{C}{D} = \frac{\{(V_S - V_{XH} + V_{XL})/2\} - V\beta}{\{(V_S - V_{XH} + V_{XL})/2\} - V_{XL}} \times 100$$

$$= \frac{(V_S - V_{XH}) + V_{XL} - 2V\beta}{(V_S - V_{XH}) - V_{XL}} \times 100\ (\%)$$

Sample Application Circuit



Note: It should be noted that the constants specified herein are for example only, with no guarantee for characteristics implied.