Ordering number : ENN6216A

Monolithic Digital IC

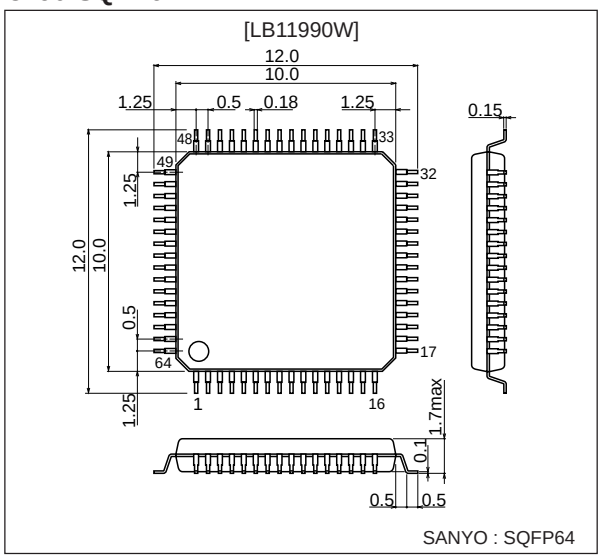
LB11990W

Three-Phase Brushless Motor Driver

Package Dimensions

unit: mm

3190-SQFP64



Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage 1	$V_{CC}1$ max		7	V
Maximum supply voltage 2	$V_{CC}2$ max		8.5	V
Maximum supply voltage 3	VS_C max	Capstan motor driver	7.0	V
Maximum supply voltage 4	VS_D max	Drum motor driver	7.0	V
Maximum supply voltage 5	VS_L max	Loading motor driver	7.0	V
Applied output voltage	Vo max		8.0	V
Applied input voltage	VI1 max	Control circuits	–0.3 to $V_{CC}1$ + 0.3	V
	VI2 max	U, V, W, COM	8.0	V
Capstan motor output current	IOC max		1.0	A
Drum motor output current	IOD max		1.0	A
Loading motor output current	IOL max		0.6	A
Allowable power dissipation	Pd max	IC only	0.6	W
Operating temperature	Topr		–20 to +75	°C
Storage temperature	Tstg		–55 to +150	°C

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Allowable Operating Ranges at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Power supply voltage 1	$V_{CC}1$	$V_{CC}1 \leq V_{CC}2$	2.7 to 6.0	V
Power supply voltage 2	$V_{CC}2$		3.5 to 8.5	V
Power supply voltage 3	VS_C	VS_C ≤ $V_{CC}2$	to 7.0	V
Power supply voltage 4	VS_D	VS_D ≤ $V_{CC}2$	to 7.0	V
Power supply voltage 5	VS_L	VS_L ≤ $V_{CC}2$	2.2 to 7.0	V
Hall input amplitude	VHALL	Capstan motor	±20 to ±80	mVp–p

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

	Parameter	Symbol	Conditions	Ratings			Unit
				min	typ	max	
Power supply current	Vcc1 power supply current	Icc1	Iout = 100 mA VSTBY_C = 3V		4	8	mA
	Vcc2 power supply current	Icc2	Iout = 100 mA VSTBY_C = 3V		6	12	mA
	Vcc1 idle current	Icc1Q	VSTBY_C = 0V		2.1	4	mA
	Vcc2 idle current	Icc2Q	VSTBY_C = 0V			100	μA
	Vs idle current	IsQ	VSTBY_C = 0V		75	100	μA
VX1	Upper side residual voltage	VXH1	Iout = 0.2A	0.15	0.22	0.29	V
	Lower side residual voltage	VXL1	Iout = 0.2A	0.15	0.20	0.25	V
VX2	Upper side residual voltage	VXH2	Iout = 0.5A		0.25	0.40	V
	Lower side residual voltage	VXL2	Iout = 0.5A		0.25	0.40	V
	Output saturation voltage	Vosat	Iout = 0.8A, Sink + Source			1.40	V
	Overlap amount	O.L	RL = 39Ω × 3, Rangle = 20 kΩ Note 2	73	80	87	%
Hall amplifier	Input offset voltage	VHOFF	Note 1 Design target value	–5		+5	mV
	Common mode input range	VHCM	Rangle = 20 kΩ	0.95		2.1	V
	Input/output voltage gain	VGVH	Rangle = 20 kΩ	24.5	27.5	30.5	dB
Standby pin	High level voltage	VSTH		2.5		$V_{CC}1$	V
	Low level voltage	VSTL		–0.2		+0.7	V
	Input current	ISTIN	VSTBY_C = 3V			50	μA
	Leakage current	ISTLK	VSTBY_C = 0V			–30	μA
FRC pin	High level voltage	VFRCH		2.5		$V_{CC}1$	V
	Low level voltage	VFRCL		–0.2		+0.4	V
	Input current	IFRCIN	VFRC_C = 3V		20	30	μA
	Leakage current	IFRCLK	VFRC_C = 0V			–30	μA
VH	Hall power supply voltage	VHALL	IH = 5 mA, VH(+) – VH(–)	0.75	0.85	0.95	V
	(–) pin voltage	VH(–)	IH = 5 mA	0.81	0.88	0.95	V
FG comparator	Input offset voltage	VFGOFF		–3		+3	mV
	Input bias current	IbFG	VFGIN+ = VFGIN– = 1.5V			500	nA
	Input bias current offset	ΔIbFG	VFGIN+ = VFGIN– = 1.5V	–100		+100	nA
	Common mode input range	VFGCM		1.2		2.5	V
	High level output voltage	VFGOH	With internal pull-up	2.8			V
	Low level output voltage	VFGOL	With internal pull-up			0.2	V
	Voltage gain	VGFG	Note 1 Design target value		100		dB
	Output current (Sink)	IFGOs	At output pin “L”			5	mA

Note 1: Design target value, not measured

Note 2: The overlap amount specification is taken as the measurement specification.

Cylinder Motor Driver Block at Ta = 25°C, $V_{CC}1$ = 3V, $V_{CC}2$ = 4.75V, V_S = 3V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Power supply current 4	ICC2	IO = 76 mA VSTBY_D = 3V VSTBY_C = 0V		0.75	2.5	mA
Output idle current 4	ICC2Q	VSTBY D = VSTBY_C = 0V			100	μA
Output idle current 5	IS(D)Q	VSTBY D = VSTBY_C = 0V		100	300	μA
Output saturation voltage, upper side 1	VOU1	IO = 0.1A RF = 0.25Ω		0.3	0.5	V
Output saturation voltage, lower side 1	VOD1	IO = 0.1A RF = 0.25Ω		0.3	0.5	V
Output saturation voltage, upper side 2	VOU2	IO = 0.4A, VS = 3V RF = 0.25Ω		0.5	0.8	V
Output saturation voltage, lower side 2	VOD2	IO = 0.4A, VS = 3V RF = 0.25Ω		0.5	0.8	V
COM pin common mode input voltage range	VIC		0.3		$V_{CC}2$–0.9	V
Standby pin High level voltage	VSTBYH		2		$V_{CC}1$	V
Standby pin Low level voltage	VSTBYL		–0.2		+0.7	V
Standby pin input current	ISTBYH	VSTBY_D = 3V			50	μA
Standby pin leakage current	ISTBYL	VSTBY_D = 0V	–10			μA
FRC pin High level voltage	VFRCH		2		$V_{CC}1$	V
FRC pin Low level voltage	VFRCL		–0.2		+0.7	V
FRC pin input current	IFRCI	VFRC_D = 3V			50	μA
FRC pin leakage current	IFRCL	VFRC_D = 0V	–10			μA
Slope pin source current ratio	RSOURCE	ICSLP1SOURCE/ICSLP2SOURCE	–15		+15	%
Slope pin sink current ratio	RSINK	ICSLP1SINK/ICSLP2SINK	–15		+15	%
CSLP1 source/sink current ratio	RCSLP1	ICSLP1SOURCE/ICSLP1SINK	–35		+15	%
CSLP2 source/sink current ratio	RCSLP2	ICSLP2SOURCE/ICSLP2SINK	–35		+15	%
Startup frequency	Freq	Cosc = 0.1 μF, OSC frequency (Target)		11.5		Hz
Phase delay-width	Dwidth	(Target)		30		deg
SELCSLP pin High level voltage	VSELH		2		$V_{CC}1$	V
SELCSLP pin Low level voltage	VSELL		–0.2		+0.7	V
SELCSLP pin input current	ISELH	VSELCSLP = 3V			50	μA
SELCSLP pin leakage current	ISELL	VSELCSLP = 0V	–10			μA

Note) Items shown to be “Target” are not measured.

FG/PG Amplifier Block at Ta = 25°C, $V_{CC}1$ = 3V, $V_{CC}2$ = 4.75V, V_S = 3V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
[FG amplifier]						
Input offset voltage	VIO	(Target)		±1	±5	mA
Input bias current	IBIN–	(Target)			250	nA
Common mode input voltage range	VICOM	(Target)	1		2	V
Open loop gain	GVFG	f = 1 kHz (Target)		55		dB
Output ON voltage	VOL	At IO = 10 μA			0.4	V
Output OFF voltage	VOH	At IO = 10 μA	$V_{CC}1$–0.5			V
Schmitt amplifier hysteresis width	VSHIS	(Target)		50		mV
Reference voltage	VREF		1.15	1.30	1.45	V
[PG amplifier]						
Input offset voltage	VIO	(Target)		±1	±5	mV
Input bias current	IBIN–	(Target)			250	nA
Common mode input voltage range	VICOM	(Target)	1		2	V
Open loop gain	GVPG	f = 1 kHz (Target)		55		dB
Output ON voltage	VOL	At IO = 10 μA			0.4	V
Output OFF voltage	VOH	At IO = 10 μA	$V_{CC}1$–0.5			V
Schmitt amplifier hysteresis width	VSHIS	(Target)		50		mV

Note) Items shown to be “Target” are not measured.

Loading Motor Driver Block at Ta = 25°C, $V_{CC}1$ = 3V, $V_{CC}2$ = 4.75V, V_S = 3V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
VCC1 power supply current 1	ICC11	VSTBY_C = VSTBY_D = 0V (standby)		2.1	4	mA
VCC1 power supply current 2	ICC12	VSTBY_C = VSTBY_D = 0V (forward/reverse)		14	19	mA
VCC1 power supply current 3	ICC13	VSTBY_C = VSTBY_D = 0V (at braking)		10	14	mA
VCC2 power supply current 1	ICC21	VSTBY_C, D = 0V (standby ($V_{CC}1$ = OPEN))			100	µA
VCC2 power supply current 2	ICC22	VSTBY_C, D = 0V (standby ($V_{CC}1$ = 3.0V))			100	µA
VCC2 power supply current 3	ICC23	VSTBY_C, D = 0V (forward/reverse)		15.0	25	mA
VS L power supply current	I VS L	VSTBY_C, D = 0V (standby)			20	µA
[Logic input (DEC1 pin, DEC2 pin)]						
High level input voltage	VINH	$V_{CC}1$ = 2.7 to 4.0V	2.0		$V_{CC}1$	V
High level flowing current	IINH	VIN = 3.0V		41	65	µA
Low level input voltage	VINL	$V_{CC}1$ = 2.7 to 4.0V	–0.2		0.6	V
Low level flowing current	IINL	VIN = 0.6V		5	10	µA
[Loading motor driver]						
Output saturation voltage 1	VOH	IO = 200 mA (upper/lower composition)		0.2	0.3	V
Output saturation voltage 2	VSHIS	IO = 400 mA (upper/lower composition)		0.4	0.6	V
[Reel FG amplifier]						
Input offset voltage	VIO			±1	±5	mV
Input bias current	IB				1	µA
Common mode input voltage range	VICM		1		2	V
Open loop gain	GV1			55		dB
[Thermal shutdown circuit]						
TSD operating temperature	T-TSD	(Target)		180		°C
TSD temperature hysteresis width	ΔTSD	(Target)		15		°C

Note) Items shown to be “Target” are not measured.

Truth Table

Capstan Motor 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

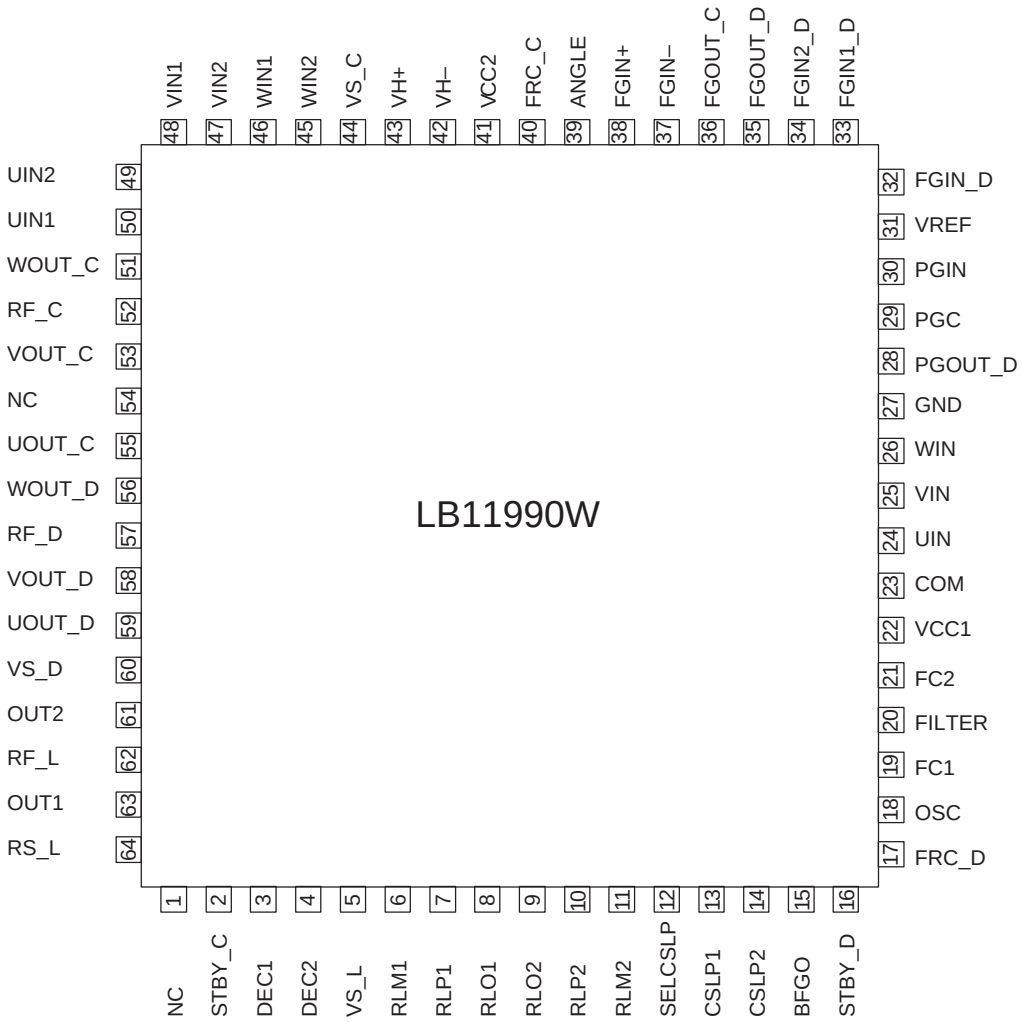
Note: “H” for FR means a voltage of 2.50V or above. “L” for FR means a voltage of 0.4V or below.
(Vcc1 = 3V)

Note: At the Hall input, “H” means that the potential of the (+) terminal for each phase input is at least 0.02V higher than the (–) terminal.
“L” means that the potential of the (+) terminal for each phase input is at least 0.02V lower than the (–) terminal.

Loading Motor Truth Table

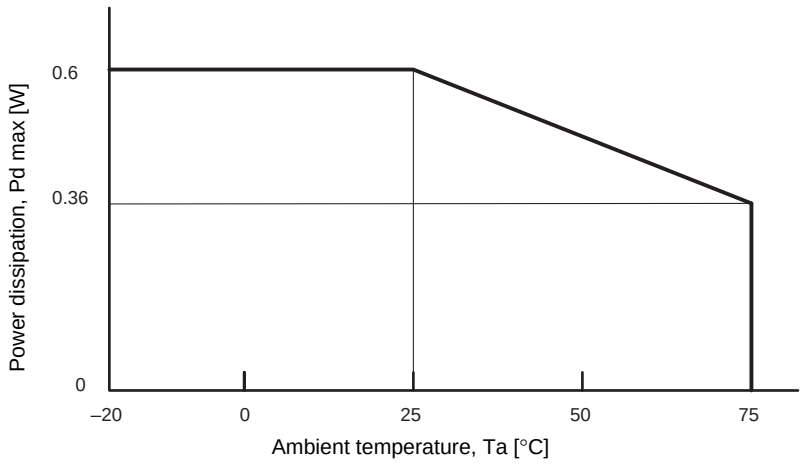
Input		Output		Mode
DEC1	DEC2	OUT1	OUT2	
L	L	Off	Off	Standby
H	L	H	L	Forward
L	H	L	H	Reverse
H	H	L	L	Brake

Pin Assignment

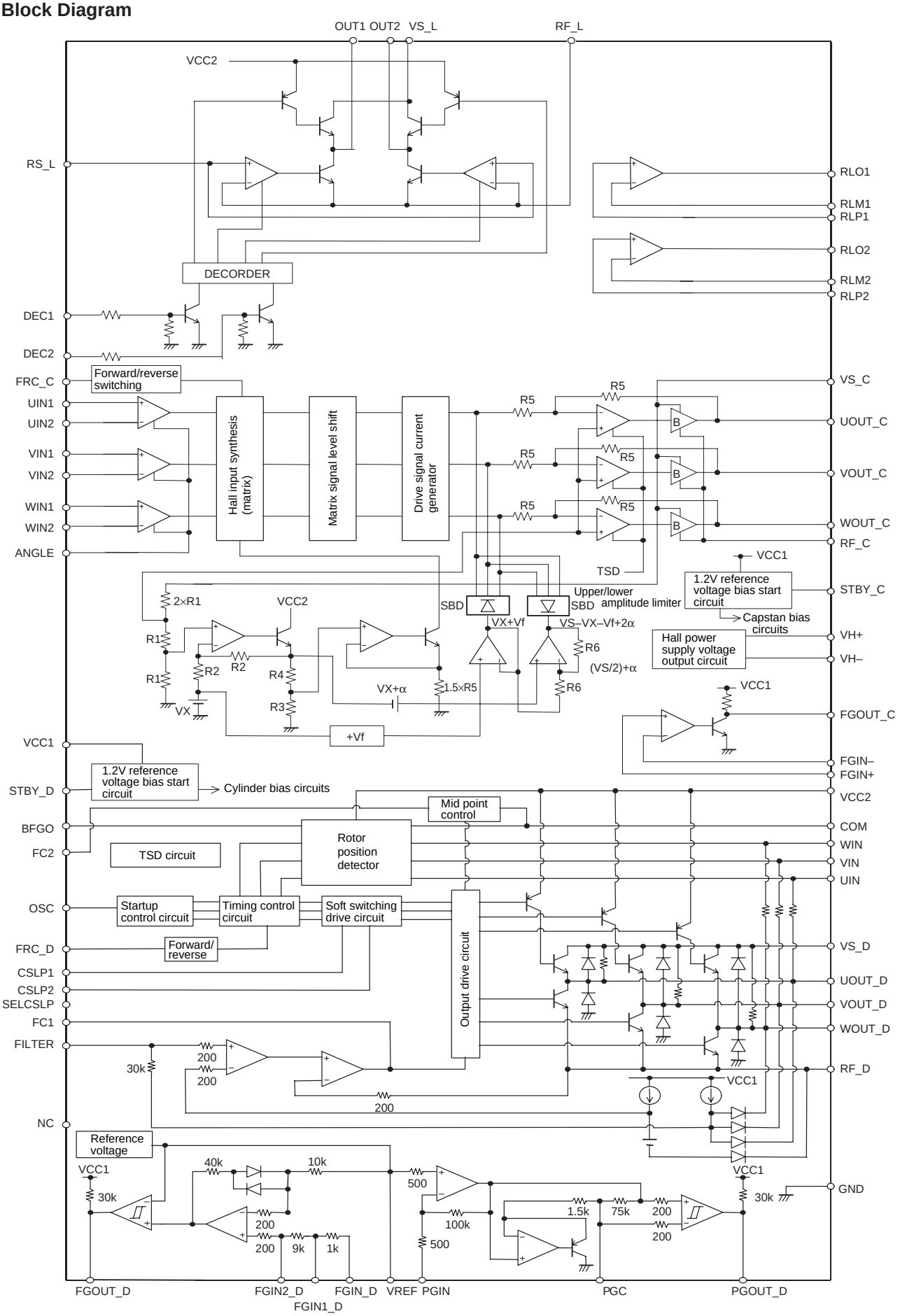


Top view

Pd max – Ta

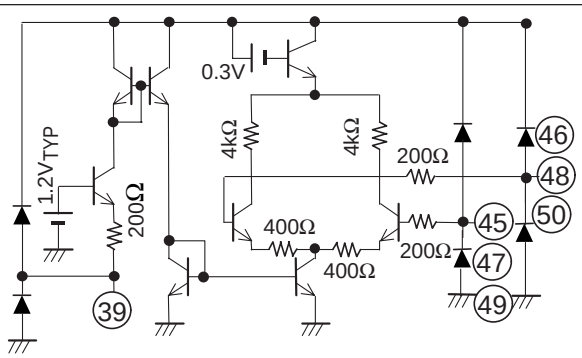
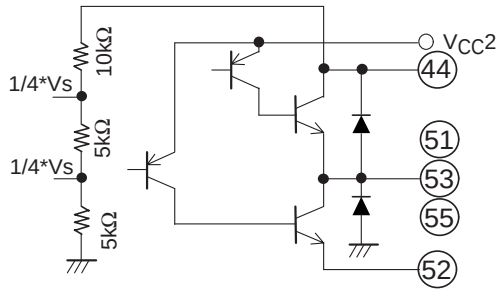
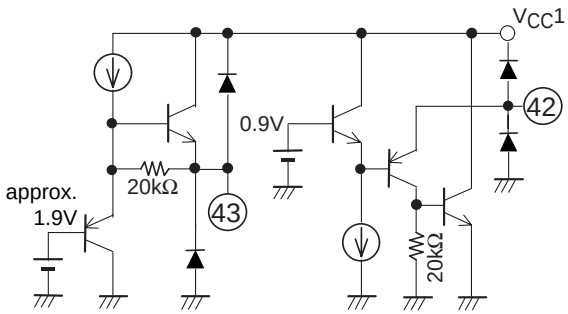


Block Diagram



Unit (resistance: Ω)

Pin Description

Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
50 49 48 47 46 45	Uin1 Uin2 Vin1 Vin2 Win1 Win2	0 to $V_{CC}1$		Capstan motor driver U, V, W phase Hall element input/output pins. Logic High means IN1 > IN2.
39	ANGLE			
44	VS_C	0 to $V_{CC}2$		Capstan motor output amplitude control power supply pins. Voltage must be lower than $V_{CC}2$.
55 53 51 52	U-OUT_C V-OUT_C W-OUT_C RF_C			Capstan motor driver U, V, W phase output pins.
43	VH+			Hall element bias voltage supply pins. A voltage of 0.85V (typ.) is generated between VH+ and VH– (at IH = 5 mA).
42	VH–			

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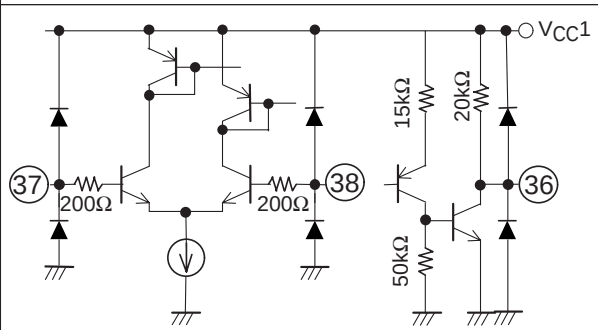
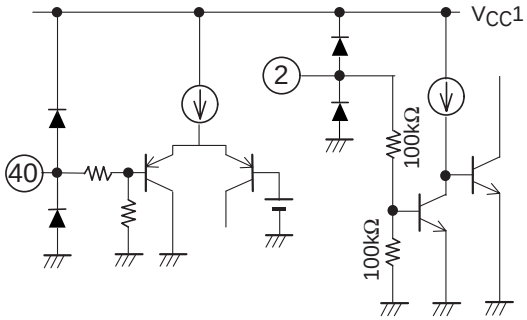
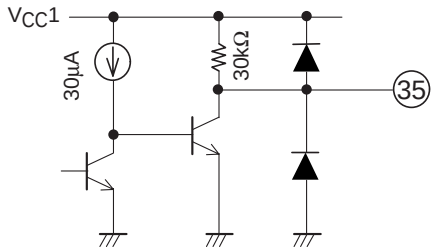
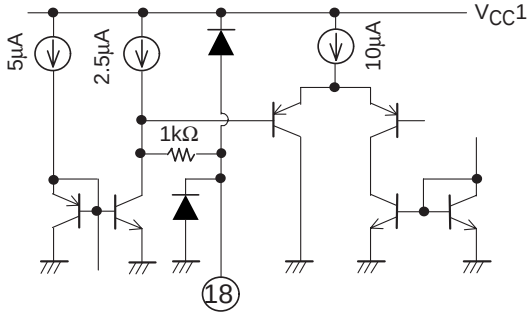
Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
37	FGIN–	0 to $V_{CC}1$		FG comparator inverted input pin. No internal bias is applied.
38	FGIN+			FG comparator non-inverted input pin. No internal bias is applied.
36	FGOUT_C			FG comparator output pin. Internal load impedance is 20 kΩ.
40	FRC_C	0 to $V_{CC}1$		Capstan motor forward/reverse select pin. The voltage at this pin (with hysteresis) selects forward or reverse rotation.
2	STBY_C			This pin selects bias supply to capstan circuits other than FG comparator. Setting the pin to Low cuts off the bias supply. Capstan motor standby pin.
35	FGOUT_D			FG amplifier output pin.
18	OSC			Pin for connecting triangular wave oscillator capacitor. Serves for forced startup waveform generation.

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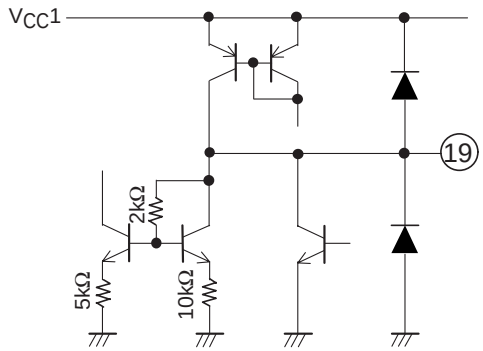
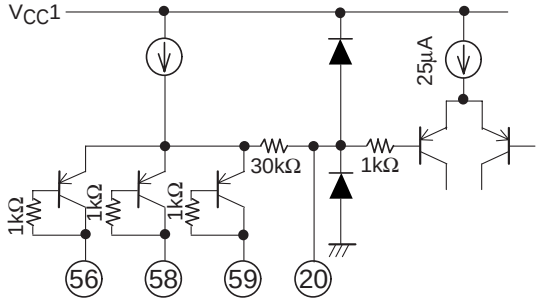
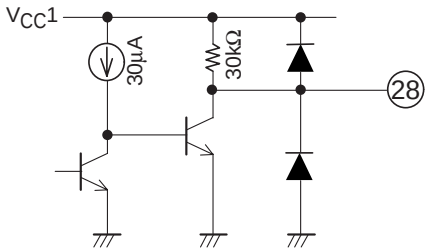
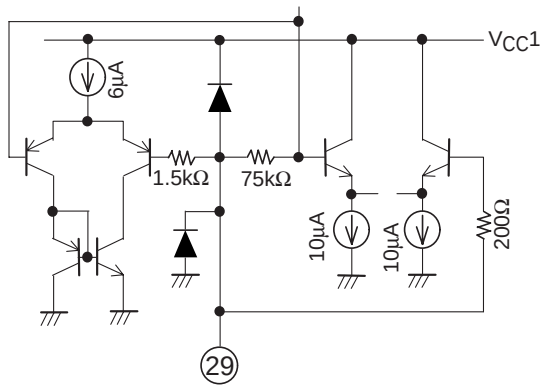
Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
19	FC1			Frequency characteristics pin. Connecting a capacitor between this pin and ground serves to prevent closed-loop oscillation in the current control circuitry.
20	FILTER			Connecting a capacitor between this pin and ground activates the coil output saturation prevention function. In this condition, the VS pin is controlled for motor voltage control. By adjusting the external capacitor, torque ripple compensation can be varied.
28	PGOUT D			PG amplifier output pin.
29	PGC			PG amplifier peak hold capacitor connection pin.

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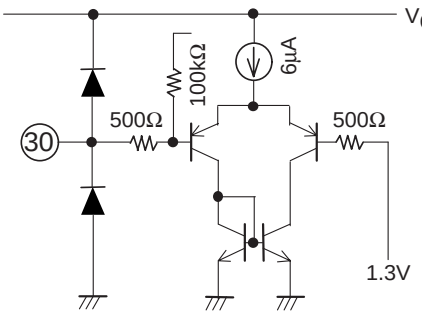
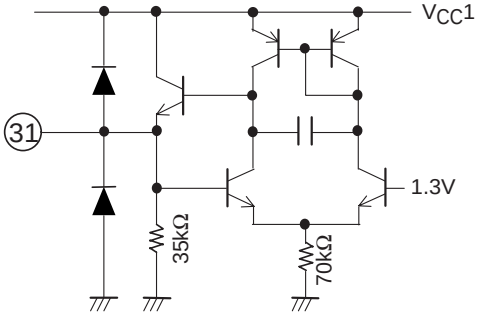
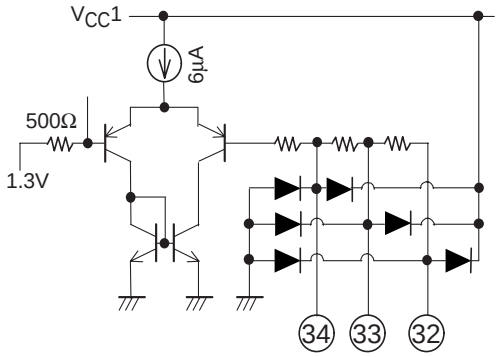
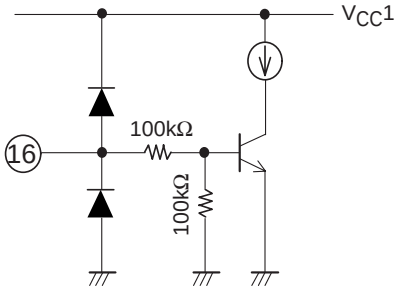
Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
30	PGIN	max2.0V min1.0V (At V_{CC} = 3V)		PG amplifier input pin. Connect PG coil between this pin and VREF.
31	VREF			Internal 1.3V reference voltage. Used as reference voltage for FG and PG amplifiers.
32	FGIN_D	max2.0V min1.0V (At $V_{CC}1$ = 3V)		FG amplifier input pin. Connect FG coil between this pin and VREF.
33	FGIN1_D			FG amplifier input signal noise filter capacitor connection.
34	FGIN2_D			FG amplifier input signal noise filter capacitor connection.
16	STBY_D	0 to $V_{CC}1$		When this pin is at 0.7V or lower or when it is open, only the FG/PG amplifier operates. In the motor drive state, the pin should be at 2V or higher. Drum motor standby pin.

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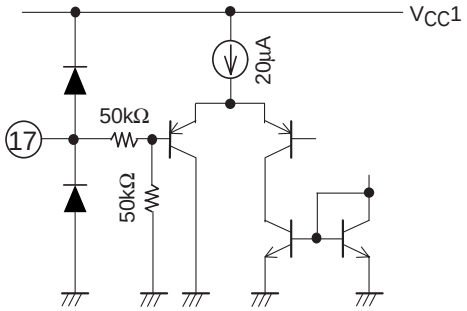
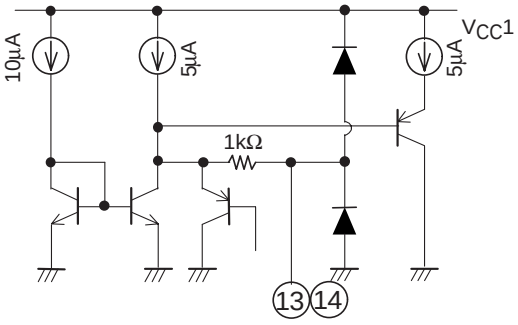
Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
17	FRC_D	0 to $V_{CC}1$		Drum motor forward/reverse rotation select pin. Low: forward (–0.2V to 0.7V or open) High: reverse (2V to $V_{CC}1$)
60	VS_D	0V to VCC2		Power supply pin for determining output amplitude by supplying drum motor voltage. Must be lower than VCC2 voltage.
41	$V_{CC}2$	3.5V to 8.5V		Power supply pin for supplying source side predriver voltage and coil waveform detect comparator voltage. Common for loading, capstan, and drum motors.
22	$V_{CC}1$	2.7V to 6V		Power supply pin for circuits except motor voltage, source side predriver voltage, and coil waveform detect comparator voltage. Common for loading, capstan, and drum motors.
13 14	CSLP1 CSLP2			Pins for connecting triangular wave oscillator capacitor. This triangular wave coil output performs waveform soft switching.
27	GND			Ground pin for all circuits except output.

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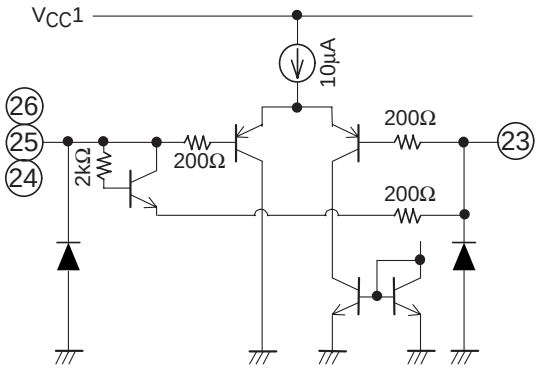
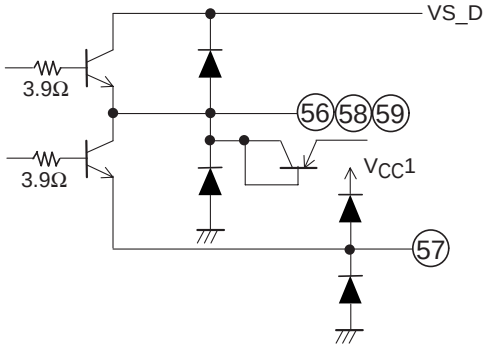
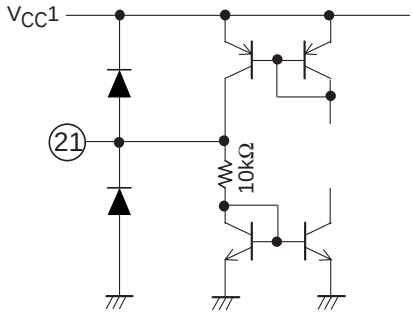
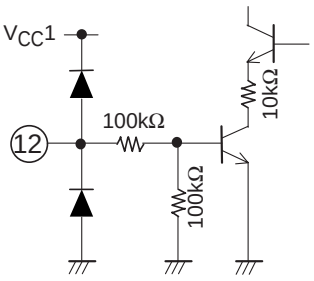
Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
26 24 25	WIN UIN VIN			Coil waveform detect comparator input pins.
23	COM			Motor coil midpoint input pin. Using this voltage as a reference, the coil voltage waveform is detected.
56 59 58	WOUT_D UOUT_D VOUT_D			U, V, W phase coil output pins.
57	RF_D			Drum motor driver output transistor ground. Constant current drive is performed by detecting the voltage at this pin.
21	FC2			Output midpoint control. Oscillation prevention capacitor connection pin.
12	SELCSLP	0 to $V_{CC}1$		When High, this pin sets CSLP slant to 15 times the slant at Low. When $V_{CC}1$ = 3.0V 2.0V or higher: High 0.7V or lower: Low

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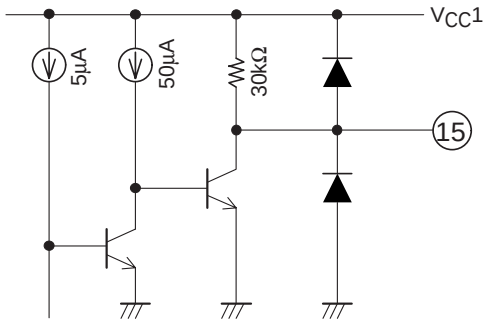
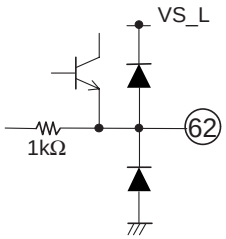
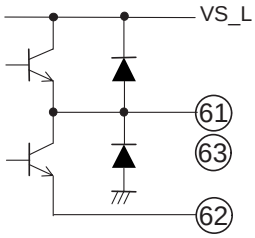
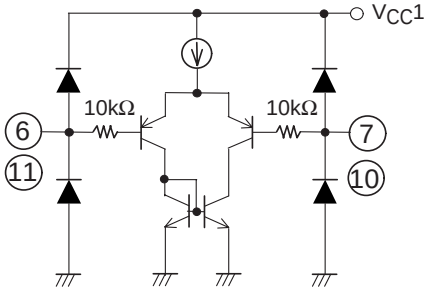
Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
15	BFGO			Motor counter EMF voltage FG pulse pin. Outputs a pulse using W phase counter EMF voltage as FG. Connect to ground if not used.
5	VS_L	2.2 to $V_{CC}2$		Loading motor power supply pin. Stabilize against noise in the same way as for VCC2.
62	RF_L			Output transistor P–GND Output current can be detected for motor current control by inserting a resistor between Rf pin and ground.
63 61	OUT1 OUT2			Loading motor driver output pins. Connect to loading motor.
6 7 11 10	RLM1 RLP1 RLM2 RLP2	0 to $V_{CC}1$		L–FG amplifier input pins. RLM1 and RLM2 are negative input. RLP1 and RLP2 are positive input.

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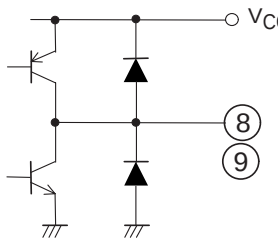
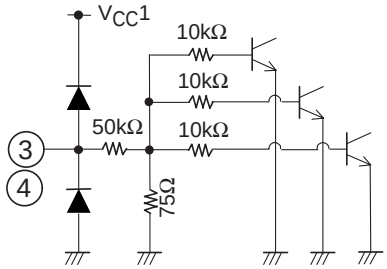
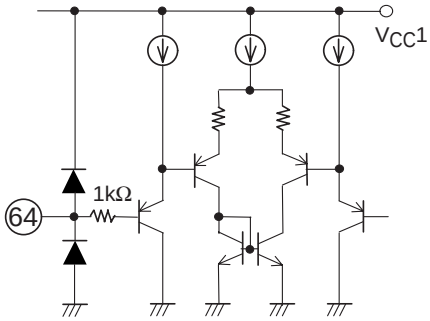
Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
8 9	RLO1 RLO2			R–FG amplifier output pins.
3 4	DEC1 DEC2	0 to $V_{CC}1$		Loading motor input pins. When VCC1 = 3.0V 2.0V or higher: High 0.6V or lower: Low
64	RS_L	0 to $V_{CC}1$ –1.5V		Current limiter setting pin. Set voltage between RF pin and ground, for limiting current.