PWM driver for CD and MD players

BH6505K

The BH6505K is a 4-channel PWM driver designed for CD and MD player motor and actuator drives. The power MOSFET output stage allows for applications with low power consumption. This IC also has a charge pump circuit and standard operational amplifier (needed for power MOSFET gate drives), and so supports a wide spectrum of applications.

●Applications

Portable CD players, MD players

●Features

1) Low power consumption.
2) A minimum of attached components.
3) Good gain precision because of the voltage feedback circuit.
4) Internal mute function for channels 1 and 2.
5) Allows for free-running and clock synchronization operation.
6) Internal standard operational amplifier.
7) Internal charge pump circuit for gate drive.

●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
H bridge supply voltage	BATTERY	7	V
Control circuit supply voltage	Pre.Vcc	7	V
Predriver supply voltage	VG (pin18)	7	V
Driver output current	Io	500	mA
Power dissipation	Pd	500*1	mW
Operating temperature	Topr	−30～+85	℃
Storage temperature	Tstg	−55～+125	℃

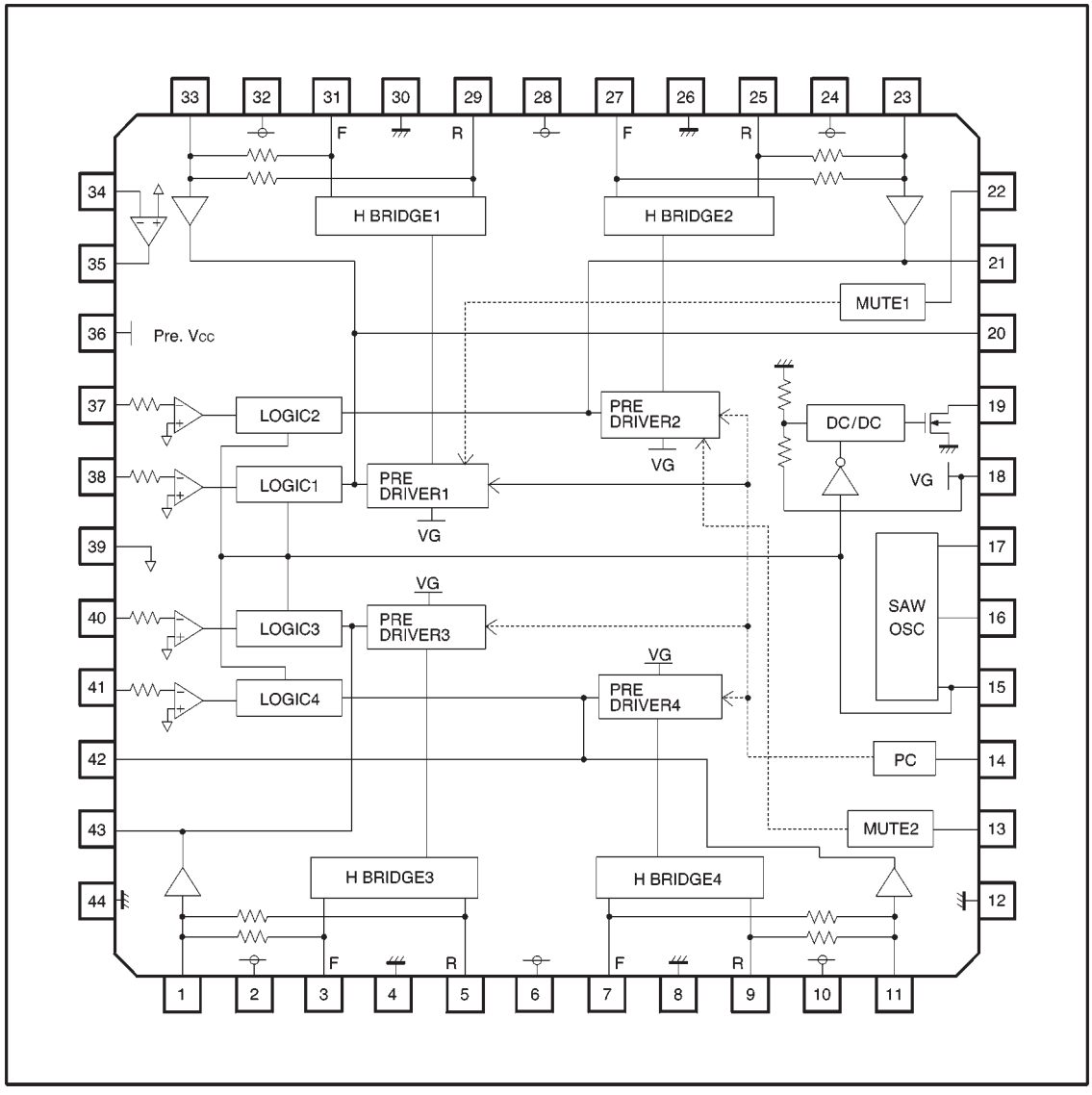
*1 Reduced by 5.0 mW for each increase in Ta of 1℃ over 25℃.

●Recommended operating conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
H bridge supply voltage	BATTERY	1.6	2.4	4.5	V
Control circuit supply voltage	Pre.Vcc	2.7	3.0	4.5	V
Predriver supply voltage*2	VG (pin18)	BATTERY +1.6	6.5	6.9	V
Ambient temperature	Ta	−10	25	70	℃

*2 When voltage is supplied externally without using an internal DC / DC converter.

●Block diagram

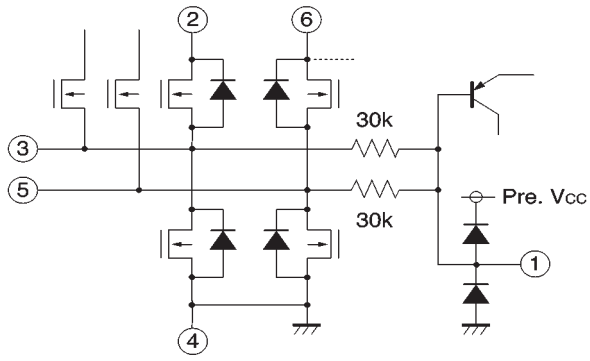
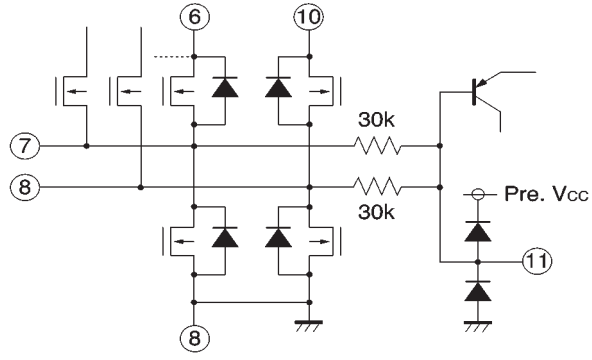
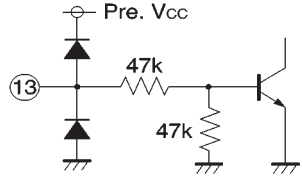
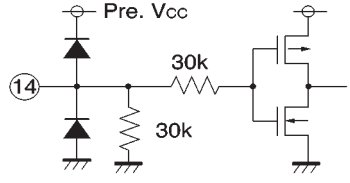


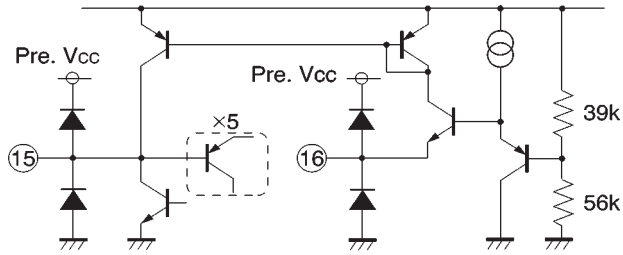
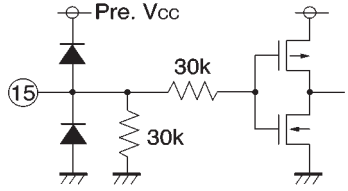
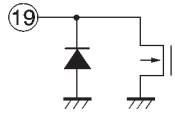
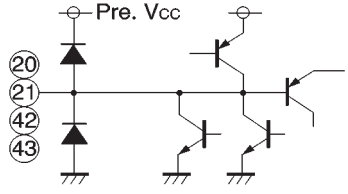
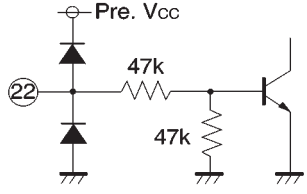
●Pin descriptions

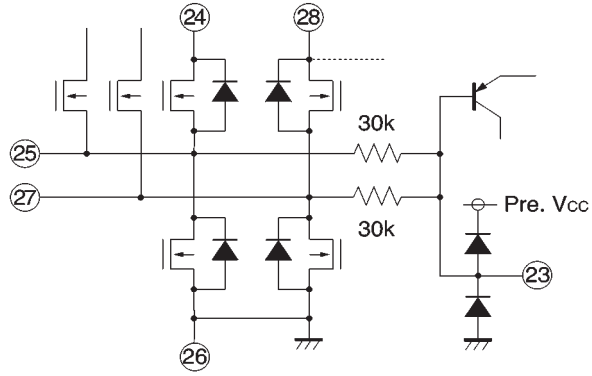
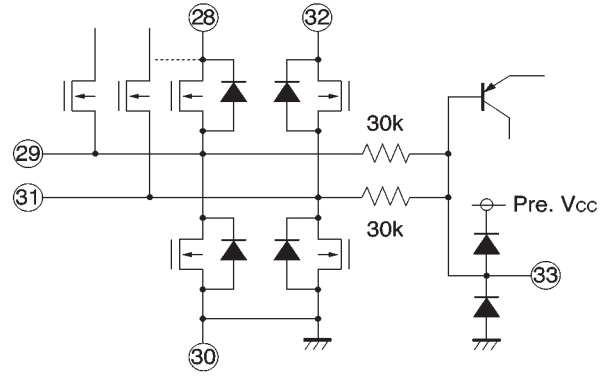
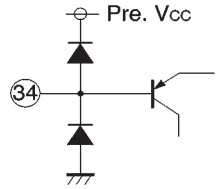
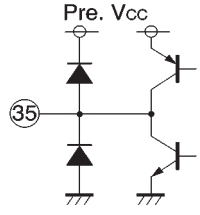
Pin No.	Pin name	Function	Pin No.	Pin name	Function
1	CO3	Channel 3 voltage feedback filter	23	CO2	Channel 2 voltage feedback filter
2	BATT3	Power amplifier power supply input	24	BATT2	Power amplifier power supply input
3	OUT 3F	Channel 3 positive output	25	OUT 2R	Channel 2 negative output
4	POWGND	Power amplifier power supply ground	26	POWGND	Power amplifier power supply ground
5	OUT 3R	Channel 3 negative output	27	OUT 2F	Channel 2 positive output
6	BATT34	Power amplifier power supply input	28	BATT12	Power amplifier power supply input
7	OUT 4F	Channel 4 positive output	29	OUT 1R	Channel 1 negative output
8	POWGND	Power amplifier power supply ground	30	POWGND	Power amplifier power supply ground
9	OUT 4R	Channel 4 negative output	31	OUT 1F	Channel 1 positive output
10	BATT 4	Power amplifier power supply input	32	BATT1	Power amplifier power supply input
11	CO4	Channel 4 voltage feedback filter	33	CO1	Channel 1 voltage feedback filter
12	D.GND	Predrive circuit power supply ground	34	OP—	Operational amplifier negative input
13	MUTE2	Channel 2 mute	35	OP OUT	Operational amplifier output
14	PC	All-driver output mute	36	Pre.V_{CC}	Input of the control circuit power supply
15	CT	Triangular wave output	37	ERR2	Input of the channel 2 control signal
16	RT	Setting the charging current	38	ERR1	Input of the channel 1 control signal
17	CLK	Input for synchronizing the external clock	39	VC	Reference voltage input
18	VG	Input of the predrive circuit power supply	40	ERR3	Input of the channel 3 control signal
19	LG	Attaching the DC / DC converter	41	ERR4	Input of the channel 4 control signal
20	CN1	Channel 1 phase compensation filter	42	CN4	Channel 4 phase compensation filter
21	CN2	Channel 2 phase compensation filter	43	CN3	Channel 3 phase compensation filter
22	MUTE1	Channel 1 mute	44	Pre.GND	Ground for the control circuit power supply

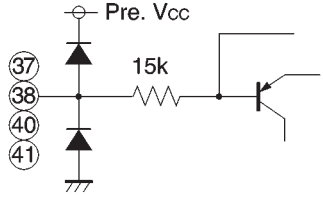
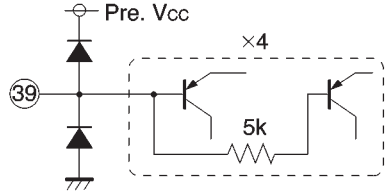
Note: Positive and negative output of the driver is relative to the polarity of the input pins.

●Input / output circuits

Pin name	Pin No.	Pin equivalent circuit
CO3 BATT3 OUT 3F POWGND OUT 3R BATT34	1 2 3 4 5 6	
OUT 4F POWGND OUT 4R BATT4 CO4	7 8 9 10 11	
D.GND	12	Predriver circuit ground pin
MUTE2	13	
PC	14	

Pin name	Pin No.	Pin equivalent circuit
CT RT	15 16	
CLK	17	
VG	18	Predriver circuit power supply pin
LG	19	
CN1 CN2 CN4 CN3	20 21 42 43	
MUTE1	22	

Pin name	Pin No.	Pin equivalent circuit
CO2 BATT2 OUT 2R POWGND OUT 2F BATT12	23 24 25 26 27 28	
OUT 1R POWGND OUT 1F BATT1 CO1	29 30 31 32 33	
OP −	34	
OP OUT	35	

Pin name	Pin No.	Pin equivalent circuit
Pre.Vcc	36	Control circuit power supply pin
ERR1 ERR2 ERR3 ERR4	38 37 40 41	
VC	39	
Pre.GND	44	Control circuit ground pin

●Electrical characteristics (unless otherwise noted, Ta = 25°C, BATTERY = 2.4V, Pre.V_{CC} = 3.0V, V_C = 1.5V, f_{CLK} = 176.4kHz, R_L = 8Ω–47μH)

Parameter		Symbol	Min.	Typ.	Max.	Unit	Conditions
Standby current		I_{ST}	—	—	3	μA	Pre.V_{CC}=OFF
Quiescent current dissipation		I_{CC1}	—	4.5	9	mA	Including DC / DC converter coil current
Operating current		I_{CC2}	—	7	14	mA	4-channel drive Including DC / DC converter coil current
〈PWM driver〉							
CH1 CH2 CH3 CH4	Output-on resistance	R_{ON}	—	1.3	2.0	Ω	Sum of top and bottom-on resistance
	Input offset voltage	V_{OI}	−5.0	0	5.0	mV	
	Output offset voltage	V_{OO}	−35	0	35	mV	
	Voltage gain	G_{VC1-4}	6.5	8.5	10.5	dB	
	Positive / negative voltage gain differ.	G_{VC}	−1.5	0	1.5	dB	
〈DC / DC converter*1〉							
Output voltage		VG	6.1	6.5	6.9	V	
Triangular wave generator							
Free-running oscill. frequency 1		f_{OSC1}	—	140	—	kHz	RT=39kΩ, CT=220pF
Synch. signal input frequency 1		f_{CLK1}	150	176	200	kHz	
Free-running oscill. frequency 2		f_{OSC2}	—	60	—	kHz	RT=39kΩ, CT=470pF
Synch. signal input frequency 2		f_{CLK2}	78	88	98	kHz	
〈Operational amplifier〉							
Input bias current		I_{BIAS}	—	—	300	nA	
Input offset voltage		V_{OIOP}	−5.5	0	5.5	mV	
Output high level voltage		V_{OHOP}	2.8	—	—	V	RL=OPEN
Output low level voltage		V_{OLOP}	—	—	0.2	V	RL=OPEN
Output drive current (source)		I_{SOU}	0.3	0.5	—	mA	50Ω at GND
Output drive current (sink)		I_{SIN}	1	3	—	mA	50Ω at V_{CC}
Open loop voltage gain		G_{VO}	—	70	—	dB	V_{IN}=−75dBV, f=1kHz
Slew rate		S_R	—	0.5	—	V/μs	
〈Control pin threshold〉							
MUTE1-on level input voltage		V_{MT1ON}	2.2	—	—	V	Channel 1 muted at the high level
MUTE1-off level input voltage		V_{MT1OFF}	—	—	0.5	V	
MUTE2-on level input voltage		V_{MT2ON}	2.2	—	—	V	Channel 2 muted at the high level
MUTE2-off level input voltage		V_{MT2OFF}	—	—	0.5	V	
PC-on level input voltage		V_{PCON}	2.2	—	—	V	All channels muted at the high level
PC-off level input voltage		V_{PCOFF}	—	—	0.5	V	

*1 DC / DC converter circuit

Pre.VCC is raised to 6.5 V by attaching an inductance, Schottky barrier diode, and capacitor.

This voltage is the power supply (VG) for the predriver circuit.

●Measurement circuit

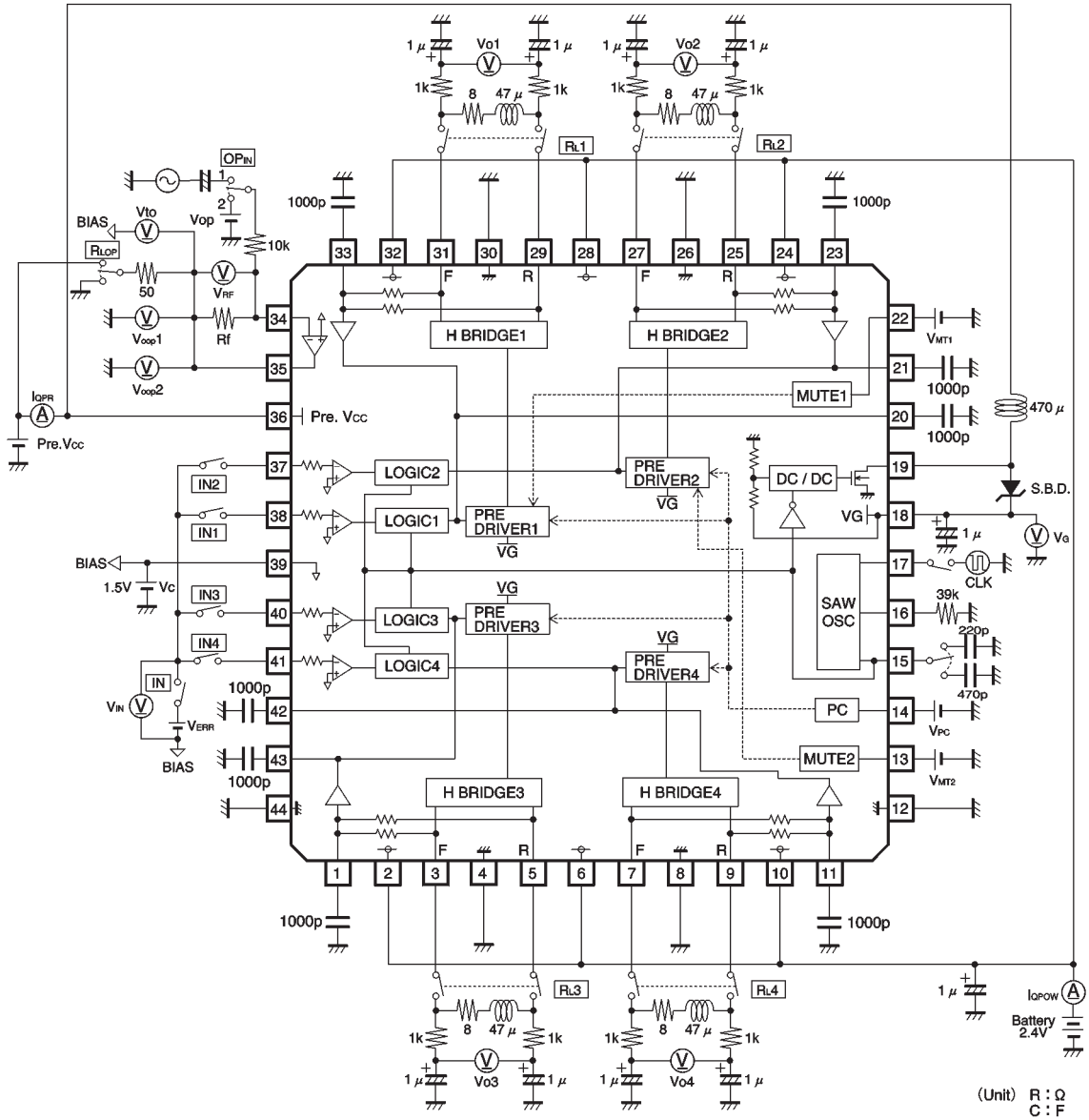


Fig. 1

●Circuit operation

(1) PWM driver

This is an H bridge driver with four N-type FETs in the output stage. Output polarity and PWM duty vary in proportion to the input differential voltage between V_C, and to the absolute value. The load is direct-PWM-driven by the square wave with this varying duty.

This is a voltage feedback driver and so delivers a constant gain regardless of battery voltage variation.

(2) DC/DC converter

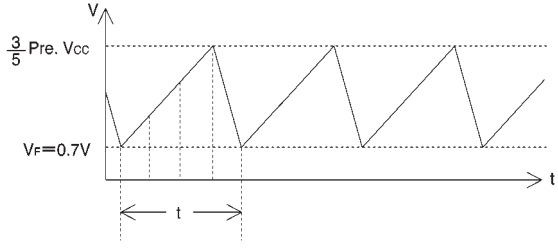
The DC/DC converter that generates the voltage needed to drive the FETs of the output-stage H bridge. Pre.V_{CC} is raised to 6.5V by attaching an inductance, Schottky barrier diode, and capacitor.

(3) Triangular wave generator

1) Freerunning

The free-running oscillation frequency of the triangular waves can be set with an attached resistor (Rt, between pin 16 and the ground) and capacitor (Ct, between pin 15 and the ground). The triangular wave has an amplitude of 3/5 × Pre.V_{CC} at the top and VF (approximately 0.7V) at the bottom. The ratio between rise time and fall time is 3 : 1. Free-running frequency (ft) is determined with the following equation:

$$ft = \frac{3}{4} \cdot \frac{1}{Ct \cdot Rt \left[1 - \frac{V_F}{\frac{3}{5} Pre.V_{CC}} \right]}$$



Freerunning frequency triangular wave form

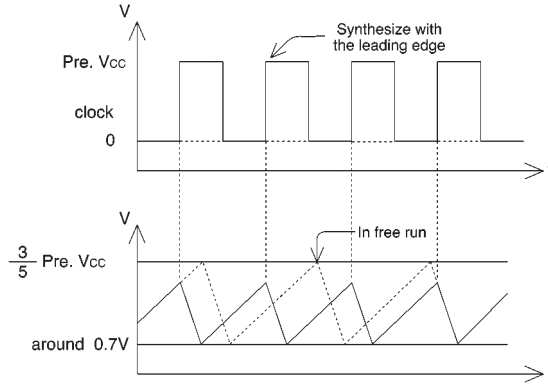
2) Clock synchronization

The triangular wave can be synchronized by inputting to the CLK pin (17 pin) a pulse wave equal to 0–Pre.V_{CC} (Vp-p). The following precautions should be kept in mind:

• The amplitude of the triangular wave decreases as the clock frequency rises.

• The PWM driver is a voltage feedback driver, which should preclude any problems unless the setting is such that the triangular wave has an extremely small amplitude.

• As mentioned above, a capacitor and resistor are also required during clock synchronization.



The triangular waveform during clock synchronization

●Operation notes

Attach a bypass capacitor (roughly 1μF) to the power supply, at the base of the IC.

●Application example

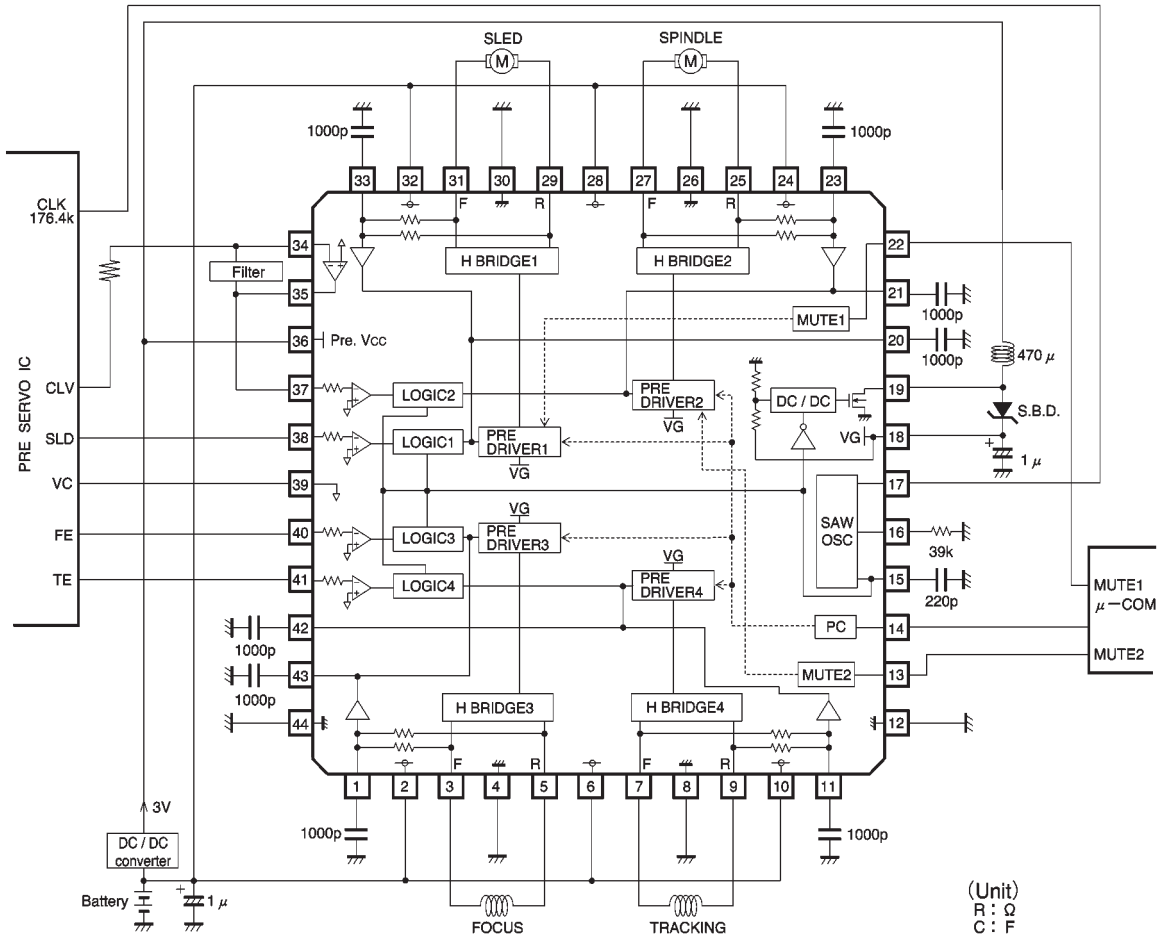


Fig. 2

●Electrical characteristic curves

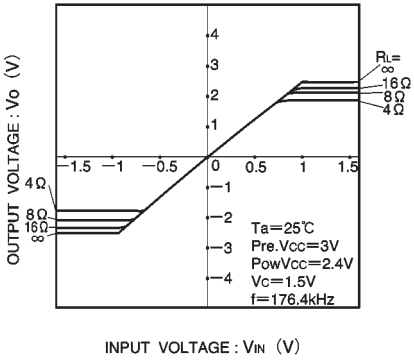


Fig. 3 Driver I / O characteristics (variable load)

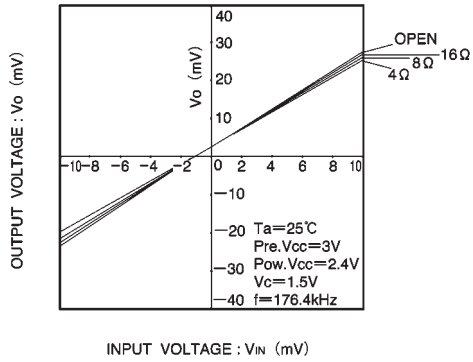


Fig. 4 I / O characteristics near the dead zone (variable load)

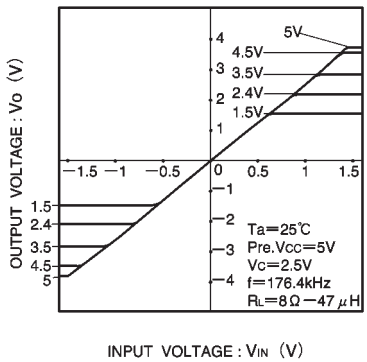
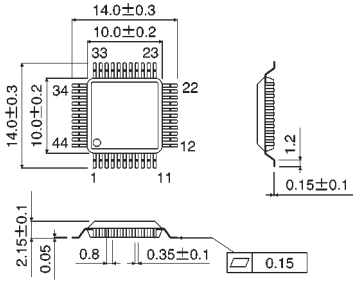


Fig. 5 I / O characteristics (variable power supply)

●External dimensions (Units: mm)



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