



IP9001

4-CH MOTOR DRIVE IC FOR PORTABLE CDP

DESCRIPTIONS

The IP9001 is a monolithic integrated circuit, and suitable for a 4-CH motor driver which drives focus actuator, tracking actuator, sled motor, spindle motor of portable CDP, VCDP systems. And it also provides DC/DC converter, reset, recharge, and short circuit protection.



FEATURES

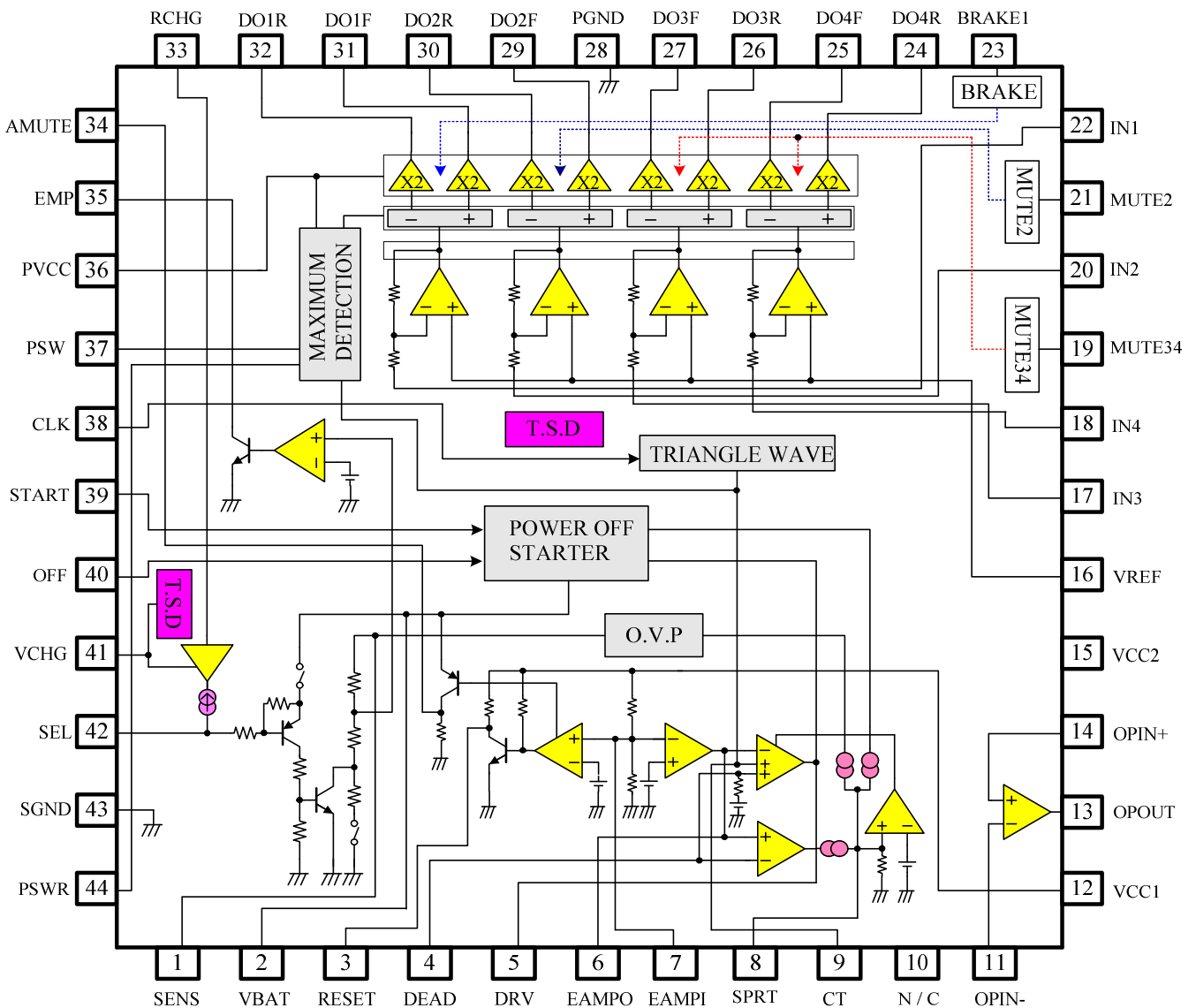
- 4ch BTL(Balanced Transformerless) driver.
- Built-in DC/DC converter control circuit.
- Built-in reset circuit.
- Built-in battery charging circuit.
- Built-in short circuit protection.
- Built-in normal OP AMP.
- Built-in thermal shut down circuit.

ORDER INFORMATION

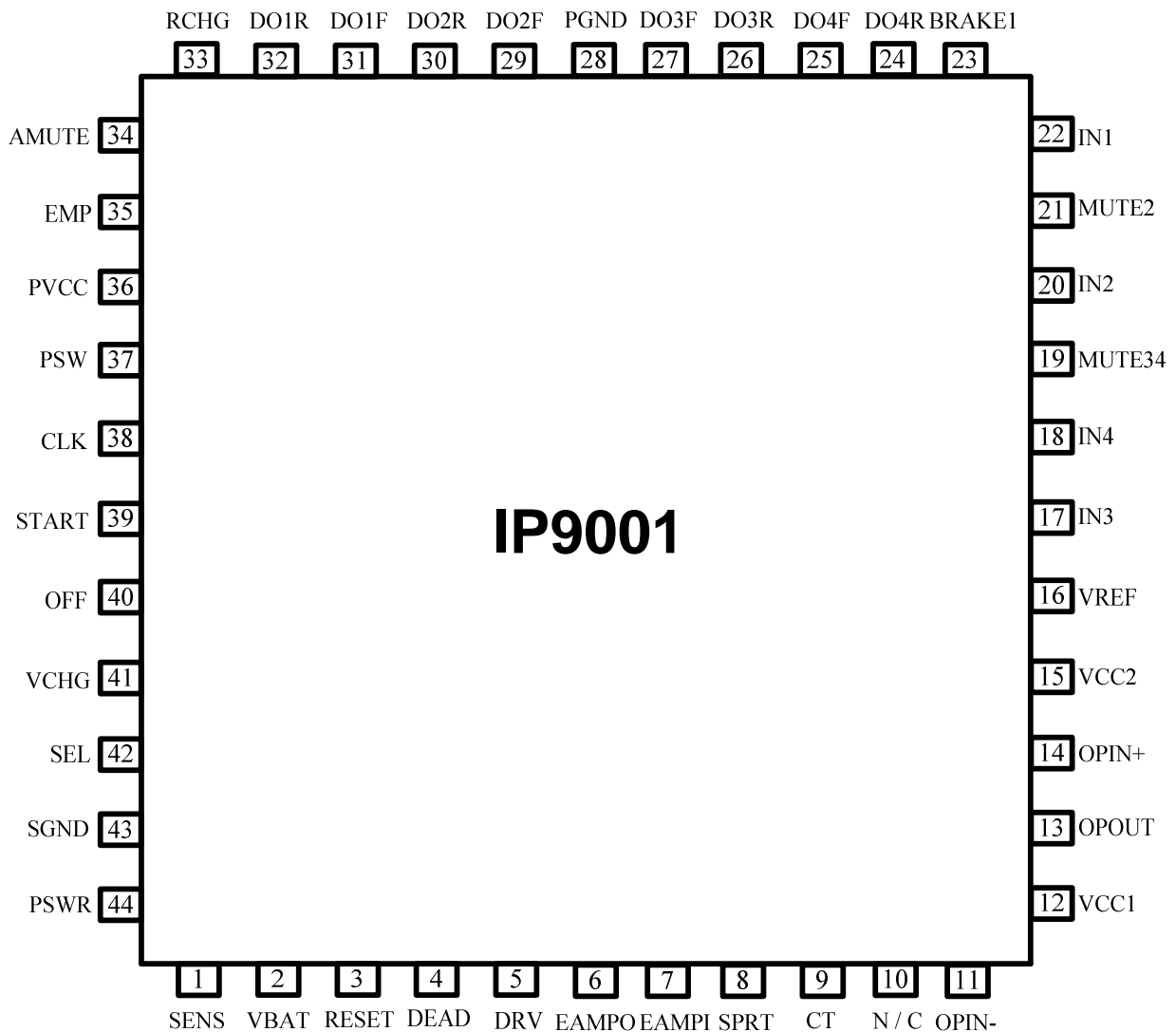
Device	Package	Operating Temp
IP9001	44QFP-1010B	-35°C ~ +85°C



BLOCK DIAGRAM



PIN CONNECTIONS



PIN DESCRIPTIONS

NO	SYMBOL	I/O	DESCRIPTION	NO	SYMBOL	I/O	DESCRIPTION
1	SENS	I	BATTERY SENSE	23	BRAKE1	I	BRAKE FOR CH1
2	VBAT	-	BATTERY	24	VO4R	O	CH4 REVERSE OUTPUT
3	RESET	O	RESET OUTPUT	25	VO4F	O	CH4 FORWARD OUTPUT
4	DEAD	I	DEAD TIME SETTING	26	VO3R	O	CH3 REVERSE OUTPUT
5	DRV	O	TRANSISTOR DRIVE	27	VO3F	O	CH3 FORWARD OUTPUT
6	EAMPO	O	ERROR AMP OUTPUT	28	PGND	-	POWER GROUND
7	EAMPI	I	ERROR AMP INPUT	29	VO2F	O	CH2 FORWARD OUTPUT
8	SPRT	I	SHORT CIRCUIT PROTECTION SETTING	30	VO2R	O	CH2 REVERSE OUTPUT
9	CT	I	TRIANGULAR WAVE OUTPUT	31	VO1F	O	CH1 FORWARD OUTPUT
10	N/C	-	NO CONNECTION	32	VO1R	O	CH1 REVERSE OUTPUT
11	OPIN-	I	OPAMP INPUT (-)	33	RCHG	I	CHARGE CURRENT SETTING
12	VCC1	-	POWER SUPPLY1	34	AMUTE	O	RESET INVERTING OUTPUT
13	OPOUT	O	OPAMP OUTPUT	35	EMP	O	EMPTY DETECTION OUTPUT
14	OPIN+	I	OPAMP INPUT (+)	36	PVCC	-	H-BRIDGE POWER SUPPLY
15	VCC2	-	POWER SUPPLY2	37	PSW	O	PWM TRANSISTOR DRIVE
16	VREF	I	REFERENCE VOLTAGE	38	CLK	I	EXTERNAL CLOCK INPUT
17	IN3	I	CH3 INPUT	39	START	I	DC/DC CONVERTER START
18	IN4	I	CH4 INPUT	40	OFF	I	DC/DC CONVERTER OFF
19	MUTE34	I	MUTE FOR CH3, 4	41	VCHG	-	CHARGER CIRCUIT POWER SUPPLY
20	IN2	I	CH2 INPUT	42	SEL	I	EMPTY DETECTION LEVEL SET
21	MUTE2	I	MUTE FOR CH2	43	SGND	-	SIGNAL GROUND
22	IN1	I	CH1 INPUT	44	PSWR	I	PWM ERROR COMPENSATION



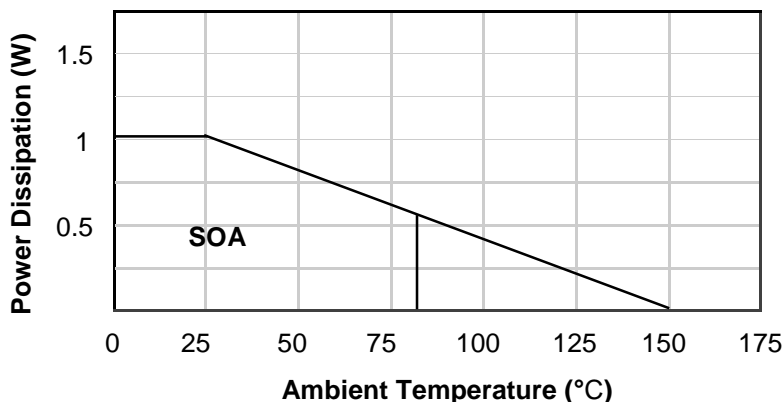
ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS	SYMBOL	VALUE	UNIT
Maximum supply voltage	SVCC1max	13.5	V
	SVCC2max	13.5	V
	HVCCmax	13.5	V
	CHGVCCmax	13.5	V
Power dissipation	Pd	1 *(Note)	W
Operating temperature	Topr	-35 ~ +85	°C
Storage temperature	Tstg	-55 ~ 150	°C
Maximum output current	Iomax	0.5	A

Note>

1. When mounted on 50mm X 50mm X 1mm PCB (Phenolic resin material).
2. Power dissipation reduces 8 mW/°C for using above Ta=25°C
3. Do not exceed Pd and SOA.

POWER DISSIPATION CURVE



RECOMMENDED OPERATING CONDITIONS

CHARACTERISTICS	SYMBOL	VALUE	UNIT
Operating supply voltage	VBAT	1.5 ~ 8.0	V
	VCC1	2.7 ~ 5.5	V
	VCC2	2.7 ~ 5.5	V
	PVCC	~ VBAT	V
	VCHG	3.0 ~ 8.0	V
Ambient temperature	Ta	-10°C ~ +70°C	



ELECTRICAL CHARACTERISTICS

(Ta = 25°C, VCC1=VCC2=3.2V, VBAT=2.4V, VREF=1.6V,
VCHG=0V, fclk=88.2KHz unless otherwise specified.)

CHARACTERISTICS	SYM-BOL	CONDITIONS	MIN	TYP	MAX	UNIT
VBAT standby current	I _{ST}	VBAT=9V, VCC1,2=VREF=0V	-	0	3	uA
VBAT no-load power supply current	I _{BAT}	PVCC=0.45V, MUTE34=3.2V	-	-	4.5	mA
VCC1 no-load power supply current	I _{CC1}	PVCC=0.45V, MUTE34=3.2V, E RRI=0V	-	-	6.5	mA
VCC2 no-load power supply current	I _{CC2}	PVCC=0.45V, MUTE34=3.2V	-	-	5.5	mA
VCHG no-load power supply current	I _{VCHG}	VCHG=4.5V, ROUT=OPEN	-	-	2.0	mA
[BTL DRIVE PART]						
CH1,3,4 Closed-loop voltage gain	G _{V134}	-	12	14	16	DB
CH2 Closed-loop voltage gain	G _{V2}	-	21.5	23.5	24.5	
Voltage gain difference	ΔG _{VC}	-	-2	0	2	
CH1,3,4 input resistance	R _{I134}	IN=1.7v & 1.8v	-	11	-	K ohm
CH2 input resistance	R _{I2}		-	7.5	-	
Maximum output voltage	V _{OM}	RL=8ohm, VCC1=VCC2=3.8V, PVCC=2.9V, VREF=1.9V, IN=0 & 3.8V	2.1	2.4	-	V
CH1,3,4 output offset voltage	V _{OO134}	VREF=IN=1.6V	-50	0	50	mV
CH2 output offset voltage	V _{OO2}		-130	0	130	
Dead band width	V _{DB}	-	-10	0	10	
CH1 brake on voltage	V _{BRKON}	IN1=1.8V	2.0	-	-	V
CH1 brake off voltage	V _{BRKOFF}	IN1=1.8V	-	-	0.8	V
BRAKE 1 VBAT current	I _{BRKBAT}	-	4	7	10	mA

ELECTRICAL CHARACTERISTICS - - - continued

(Ta = 25°C, VCC1=VCC2=3.2V, VBAT=2.4V, VREF=1.6V,
VCHG=0V, fclk=88.2KHz unless otherwise specified.)

CHARACTERISTICS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
[BTL DRIVE PART] - - - continued						
CH2 mute on voltage	V _{M2ON}	IN2=1.8V	2.0	-	-	V
CH2 mute off voltage	V _{M2OFF}	IN2=1.8V	-	-	0.8	
CH34 mute on voltage	V _{M34ON}	IN3=IN4=1.8V	-	-	0.8	
CH34 mute off voltage	V _{M34OFF}	IN3=IN4=1.8V	2.0	-	-	
VREF all mute on voltage	V _{REFON}	IN1=IN2=IN3=IN4=1.8V	1.2	-	-	
VREF all mute off voltage	V _{REFOFF}	IN1=IN2=IN3=IN4=1.8V	-	-	0.8	
[PWM POWER SUPPLY DRIVE PART]						
PWM sink current	I _{PWM}	IN1=2.1V	10	13	17	mA
PVCC level shift voltage	V _{SHIF}	IN1=1.8V,PVCC-OUT1F	0.35	0.45	0.55	V
PWM amp transfer gain	G _{PWM}	IN1=1.8V,PVCC=1.2~1.4V	16.7	20	25	uA/V
[DC/DC CONVERTER PART - - - Error AMP]						
VCC1 threshold voltage	V _{S1TH}	-	3.05	3.20	3.35	V
EAMPO output high level voltage	V _{EOH}	EAMPI=0.7V,IO= -100uA	0.9	1.1	-	
EAMPO output low level voltage	V _{EOL}	EAMPI=1.3V,IO= 100uA	-	-	0.3	
[DC/DC CONVERTER PART - - - Short circuit protection]						
SPRT voltage normal	V _{SPR}	EAMPI=1.3V	-	0	0.1	V
SPRT current1	I _{SPR1}	EAMPI=0.7V	6	10	16	uA
SPRT current2	I _{SPR2}	EAMPI=1.3V,OFF=0V	12	20	32	uA
SPRT current3	I _{SPR3}	EAMPI=1.3V,VBAT=9.5V	12	20	32	uA
SPRT impedance	R _{SPR}	-	175	220	265	K ohm
SPRT threshold voltage	V _{SCPTH}	EAMPI=0.7,CT=470pF	1.10	1.20	1.30	V
Oversvoltage protection detection voltage	V _{OVF}	OVP VOLTAGE	8	8.4	9.0	V
SENS resistance	R _{SENS}	SEL=0V	17	24	30	K ohm

ELECTRICAL CHARACTERISTICS - - - continued

(Ta = 25°C, VCC1=VCC2=3.2V, VBAT=2.4V, VREF=1.6V,
VCHG=0V, fclk=88.2KHz unless otherwise specified.)

CHARACTERISTICS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
[DC/DC CONVERTER PART - - - Transistor drive]						
DRV output high level voltage1	V _{DRHS}	VBAT=CT=1.5V VCC1=VCC2=0V, IO=-2mA at start	0.78	0.98	1.13	V
DRV output high level voltage2	V _{DRH}	CT=0V,ERRI=0.7V, IO=-10mA ,SCP=0V	1.0	1.50	-	
DRV output low level voltage2	V _{DRL}	CT=2V,IO=10mA	-	0.3	0.45	
DRV oscillator frequency1	f _{DR1}	CT=470pF, VCC1=VCC2=0V, at start	65	80	95	KHz
DRV oscillator frequency2	f _{DR2}	CT=470pF,CLK=0V	60	70	82	
DRV oscillator frequency3	f _{DR3}	CT=470pF,	-	88.2	-	
DRV oscillator minimum pulse width	T _{MIN}	CT=470pF, EAMPO=0.7 ~ 0.5 sweep	0.01	-	0.6	usec
Pulse duty at start	D _{DR1}	CT=470pF, VCC1=VCC2=0V	40	50	60	%
Maximum duty at free run	D _{DR2}	EAMPI=0.7V,CT=470pF,CL K=0V	70	80	90	
Maximum duty with synchronized clock	D _{DR3}	EAMPI=0.7V,CT=470pF	65	75	85	
[DC/DC CONVERTER PART - - - Interface]						
OFF threshold voltage	V _{STPTH}	EAMPI=1.3V	-	-	1.2	V
OFF bias current	I _{STP}	OFF=0V	75	95	115	uA
START on voltage	V _{STRTON}	VCC1=VCC2=0V, CT=2V	-	-	1.4	V
START off voltage	V _{STRTOFF}	VCC1=VCC2=0V, CT=2V	2.1	-	-	V
START bias current	I _{BSTRT}	START=0V	-	16	-	uA
CLK on voltage	V _{CLKON}	-	2.0	-	-	V
CLK off voltage	V _{CLKOFF}	-	-	-	0.8	V
CLK bias current	I _{CLK}	CLK=3.2V	-	-	10	uA

ELECTRICAL CHARACTERISTICS - - - continued

(Ta = 25°C, VCC1=VCC2=3.2V, VBAT=2.4V, VREF=1.6V,
VCHG=0V, fclk=88.2KHz unless otherwise specified.)

CHARACTERISTICS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
[DC/DC CONVERTER PART - - - Dead time]						
DEAD impedance	R _{DEAD}	-	52	65	78	K ohm
DEAD output voltage	V _{DEAD}	-	0.78	0.88	0.98	V
[DC/DC CONVERTER PART - - - Start]						
Start switching voltage	V _{SSV}	VCC1=VCC2=0V~3V sweep, START=0V	2.3	2.5	2.7	V
Start switching hysteresis voltage	V _{SSHS}	START=0V	130	200	300	mV
Discharge release voltage	V _{DIS}	-	1.63	1.83	2.03	V
[EMPTY DETECT ION PART]						
Empty detect voltage1	V _{EMPT1}	VSEL=0V	2.1	2.2	2.3	V
Empty detect hysteresis1	V _{EMPHS1}	VSEL=0V	25	50	100	mV
Empty detect voltage2	V _{EMPT2}	ISEL=-2uA	1.7	1.8	1.9	V
Empty detect hysteresis2	V _{EMPHS2}	ISEL=-2uA	25	50	100	mV
Empty output voltage	V _{EMP}	IO=1mA, SENS=1V	-	-	0.5	V
SEL detect voltage	V _{SELTH}	VSELTH=VBAT-SEL, SENS=2V	1.5	-	-	V
SEL detect current	I _{SEL}	-	-2	-	-	uA

ELECTRICAL CHARACTERISTICS - - - continued

(Ta = 25°C, VCC1=VCC2=3.2V, VBAT=2.4V, VREF=1.6V,
VCHG=0V, fclk=88.2KHz unless otherwise specified.)

CHARACTERISTICS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
[RESET PART]						
VCC1 reset threshold voltage ratio	R _{RSTOTH}	Ratio to error amplifier threshold voltage	85	90	95	%
RESET detect hysteresis width	V _{RSTHS}	-	25	50	100	mV
RESET output voltage	V _{RST}	IO=1mA, SVCC1=SVCC2=2.8V	-	-	0.5	V
RESET pull-up resistance	R _{RST}	-	72	90	108	K ohm
AMUTE output voltage1	V _{AMO1}	IO=1mA, SVCC1=SVCC2=2.8V	2.0	-	2.4	V
AMUTET output voltage2	V _{AMO2}	IO=1mA, SVCC1=SVCC2=2.8V, START=0V	2.0	-	2.4	
AMUTE pull-down resistance	R _{AMU}	-	77	95	113	K ohm
[OP-AMP]						
Input bias current	I _{BIAS}	OPIN+=1.6V	-	-	300	nA
Input offset voltage	V _{OFOP}	OPIN+=1.6V	-5.5	0	5.5	mV
High level output voltage	V _{OHOP}	RL=OPEN	2.8	-	-	V
Low level output voltage	V _{OLOP}	RL=OPEN	-	-	0.2	
Output source current	I _{SRC}	50ohm, GND	-	-6.5	-3.0	mA
Output sink current	I _{SNK}	50ohm, SVCC	3	6	-	
Open loop voltage gain	G _{VO}	VIN=-75dB, f=1KHz	-	70	-	dB
Slew rate	SR	-	-	0.5	-	V/uS

ELECTRICAL CHARACTERISTICS - - - continued

(Ta = 25°C, VCC1=VCC2=3.2V, VBAT=2.4V, VREF=1.6V,
VCHG=0V, fclk=88.2KHz unless otherwise specified.)

CHARACTERISTICS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
[BATTERY CHARGING PART]						
RCHG bias voltage	V _{RCHG}	VCHG=4.5V, RCHG=1.8K ohm	0.71	0.81	0.91	V
RCHG output resistance	R _{RCHG}	VCHG=4.5V, RCHG=0.5 and 0.6V	0.75	0.95	1.20	K ohm
SEL leakage current1	I _{SELLEAK1}	VCHG=4.5V, RCHG=OPEN	-	-	1.0	uA
SEL leakage current2	I _{SELLEAK2}	VCHG=0.6V, RCHG=1.8K ohm	-	-	1.0	
SEL saturation voltage	V _{SELSAT}	VCHG=4.5V, IO=300mA, RCHG=0 ohm	-	0.45	1.0	V

APPLICATION SUMMARY

1. BTL driver

- Mute function using the MUTE and BRAKE pin (Channel mute)

Mute function for each channels can be obtained using the MUTE pin (pin19, pin21) and BRAKE pin (pin23).
 * When the voltage of the pin19 becomes low, the bias currents for CH3, CH4 are shut down and those corresponding channels are muted. On the contrary, when the voltage of the pin19 becomes high, the channel drivers operate normally.
 * When the voltage of the pin21, 23 become high, the bias currents for CH1, CH2 are shut down and those corresponding channels are muted. On the contrary, when the voltage of the pin21, 23 become low, the channel drivers operate normally.

	MUTE34(pin19)	MUTE2(pin21)	BRAKE1(pin23)
HIGH	CH3, CH4 normal operation	CH2 shut down	CH1 shut down
LOW	CH3, CH4 shut down	CH2 normal operation	CH1 normal operation

Table1. Channel mute & brake

- All mute function using the REF pin (Reference all mute)

Muting all channel drivers can be obtained using the REF (signal reference) pin.
 * When the input voltage of the signal reference pin (pin16) is below 1.0V, the bias currents of all channel drivers are shut down.

	VREF(Pin16)
Above 1.0V	CH1, CH2, CH3, CH4 normal operation
Below 1.0V	CH1, CH2, CH3, CH4 shut down

Table2. Reference all mute

- Thermal shutdown (TSD)

The IP9001 has a thermal protection.
 If the chip temperature rises above 175°C, then the main bias current will be shut down by the protection circuit. The hysteresis temperature is 25°C

Temperature	All channel mute
Above 175 °C	on
Falls below 150 °C	off
Hysteresis	25 °C

Table3. Thermal shut down



APPLICATION SUMMARY (Continued)

- Voltage gain of each channel

4-CH input resistances are as follows,

CH1, CH3, CH4 : 11K ohm

CH2 : 7.5K ohm

So, the voltage gain is calculated as following equation.

$$GV134 = 20 \log \left| \frac{55K}{R + 11K} \right|$$

$$GV2 = 20 \log \left| \frac{110K}{R + 7.5K} \right|$$

* R is an external resistor which is connected to input pins (pin17,18,20,22)

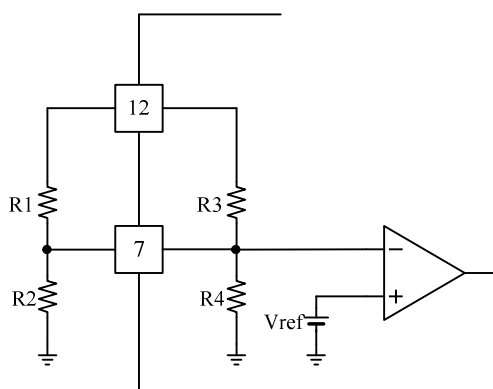
- Power supply voltage

IP9001 has two kinds of power supply pins. One is power supply for output stage(pin36), the others are signal power supply for pre driver(pin12, pin15). All power supply pins should be attached by-pass capacitor with each other.

2. DC/DC converter

- Output voltage

IP9001 has internal buck/boost control circuit and the output voltage is calculated as follows,



$$VCC1 = Vref \times \left(1 + \frac{\frac{R1 \times R3}{R2 \times R4}}{R2 + R4} \right)$$

- * vref = 1.2V
- * R1 : External resistor
- * R2 : External resistor
- * R3 : 35K ohm
- * R4 : 21K ohm

If there is no external resistor,
Then default VCC1 value is as follows,

$$VCC1_{default} = Vref \times \left(1 + \frac{R3}{R4} \right) = 1.2 \times \left(1 + \frac{35K}{21K} \right) = 3.2V$$

Figure1. output voltage set up method



APPLICATION SUMMARY (Continued)

- Short circuit protection

When the output voltage of error amp holds “H” status, then IP9001 starts charging to “CSPRT” with constant current “ISPRT”.

If the voltage of the CSPRT rises above 1.2V, then the DC/DC converter circuit is disabled.

Disable time is dependent on the external capacitor “CSPRT”, Threshold voltage “VTH”, and internal constant current source “ISPRT”.

$$t = CSPRT \times \frac{VTH}{ISPRT} (\text{sec})$$

* VTH=1.2V, ISPRT=10uA

- Soft start circuit

IP9001 accomplishes soft-start-function by attaching external capacitor between DEAD pin and GND. Maximum duty can be changed by adding external resistor to DEAD pin (pin 4).

$$t = CDEAD \times (R_{int} + R_{ext}) (\text{sec})$$

* Rint=65K ohm, Rext=external resistor

- Power off function

When the input voltage of OFF(pin40) is low, then IP9001 starts charging to “CSPRT” with constant current “IOFF”.

If the voltage of the CSPRT rises above 1.2V, then the DC/DC converter circuit is disabled.

Disable time is dependent on the external capacitor “CSPRT”, Threshold voltage “VTH”, and internal constant current source “IOFF”.

$$t = CSPRT \times \frac{VTH}{IOFF} (\text{sec})$$

* VTH=1.2V, IOFF=20uA

- Over voltage protection

When the sensing voltage of SENS(pin1) is above 8.4V, then IP9001 starts charging to “CSPRT” with constant current “IHV”.

If the voltage of the CSPRT rises above 1.2V, then the DC/DC converter circuit is disabled.

Disable time is dependent on the external capacitor “CSPRT”, Threshold voltage “VTH”, and internal constant current source “IHV”.

$$t = CSPRT \times \frac{VTH}{IHV} (\text{sec})$$

* VTH=1.2V, IOFF=20uA



APPLICATION SUMMARY (Continued)

3. PWM power supply driving circuit

Power supply driving circuit detects a maximum output voltage among the 4-CH output pins, and then control external PNP TR to reduce the power consumption.

This buck converter consists of external PNP TR, Schottky barrier diode, Inductor, and capacitors.

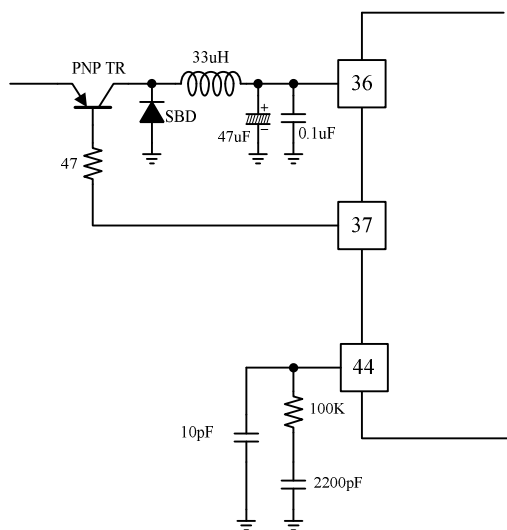


Figure2. PWM power supply driving circuit

4. Empty detector circuit

When the sensing voltage of SENS(pin1) falls below detecting voltage, then EMP(pin35) goes from High level to low level. The detector voltage has 50mV hysteresis.

According to the SEL(pin42) voltage level, the detector voltage varies as following table,

SEL	Detector voltage	Return voltage
LOW	2.2V typ	2.25V typ
High-impedance	1.8V typ	1.85V typ

Table4. EMP detector voltage



APPLICATION SUMMARY (Continued)

5. Reset circuit

When the output voltage of the DC/DC converter reaches 90% of the VCC1, then RESET goes from LOW to HIGH level and AMUTE goes from HIGH to LOW level. Hysteresis voltage of each pin is 50mV

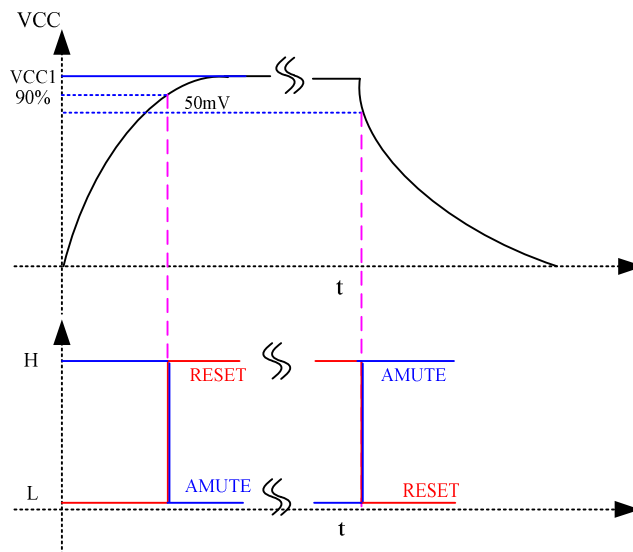
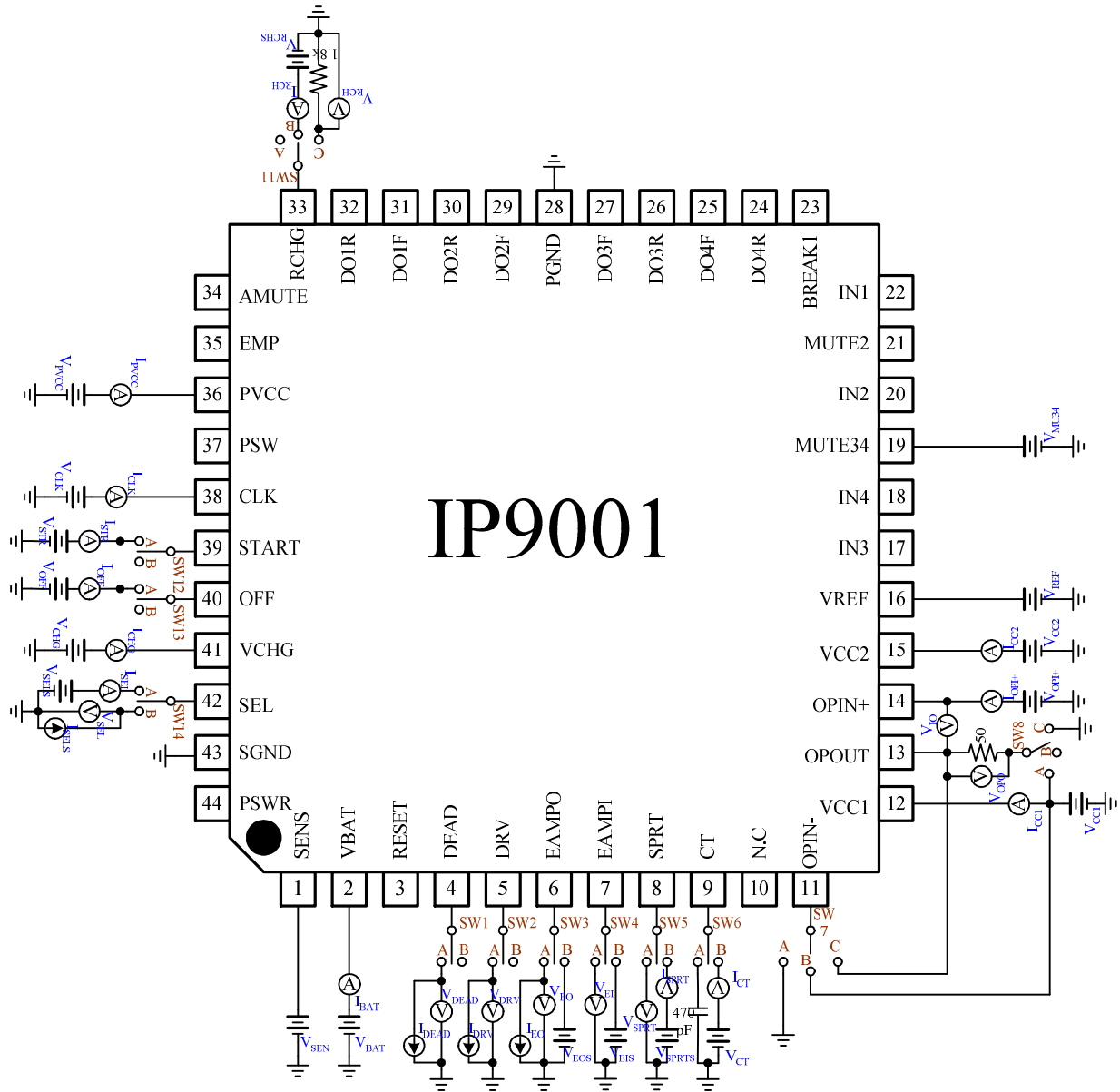


Figure3. RESET & AMUTE

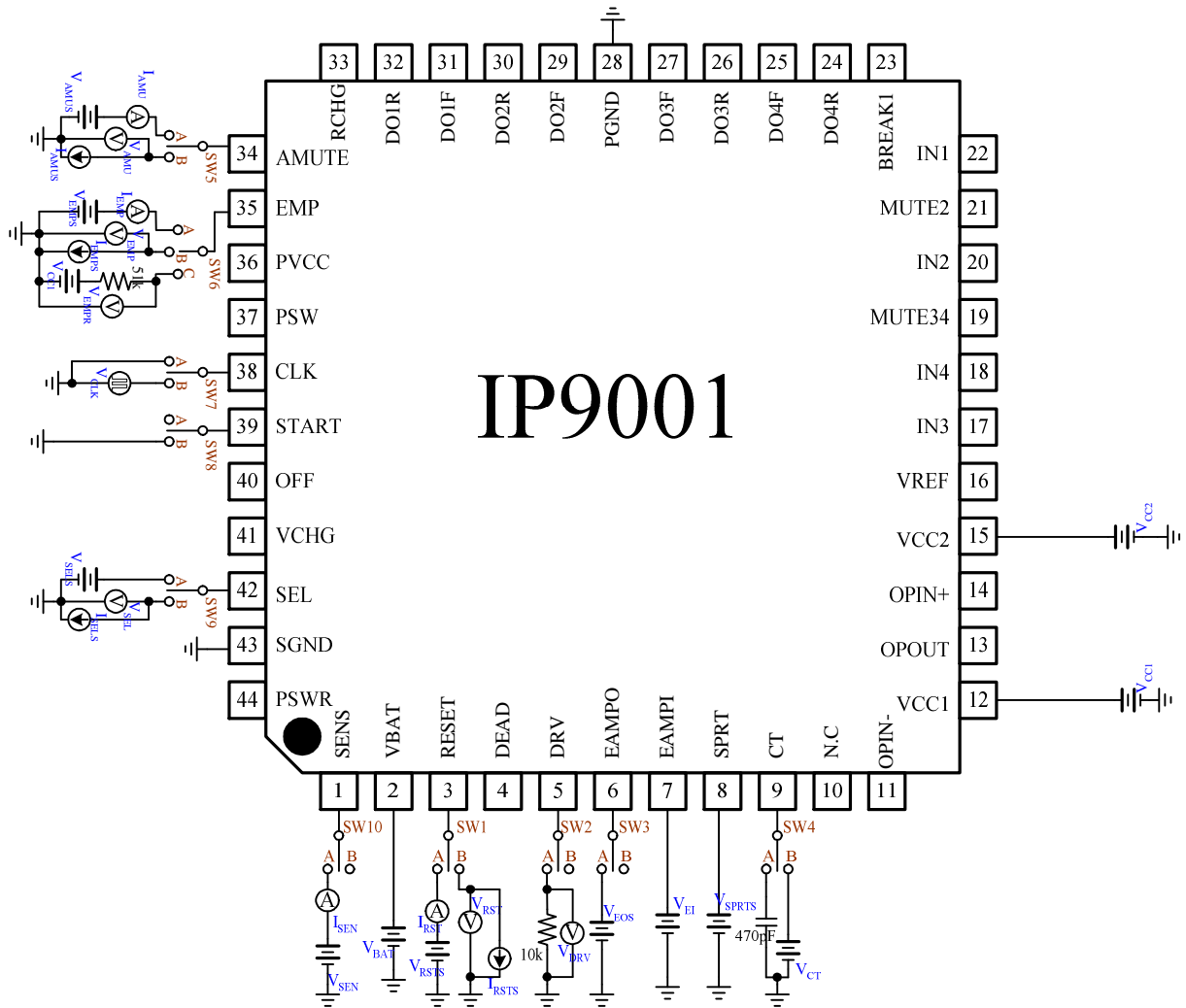
6. Charging circuit

IP9001 has a charging circuit and it is independent from any other circuit. Its power supply pin is CHGVCC which is directly connected to adapter. Battery charging current is controlled by changing RCHG (between RCHG(pin33) and GND). It also has an independent TSD circuit which has shut down temperature of 175°C and the hysteresis temperature is 25°C

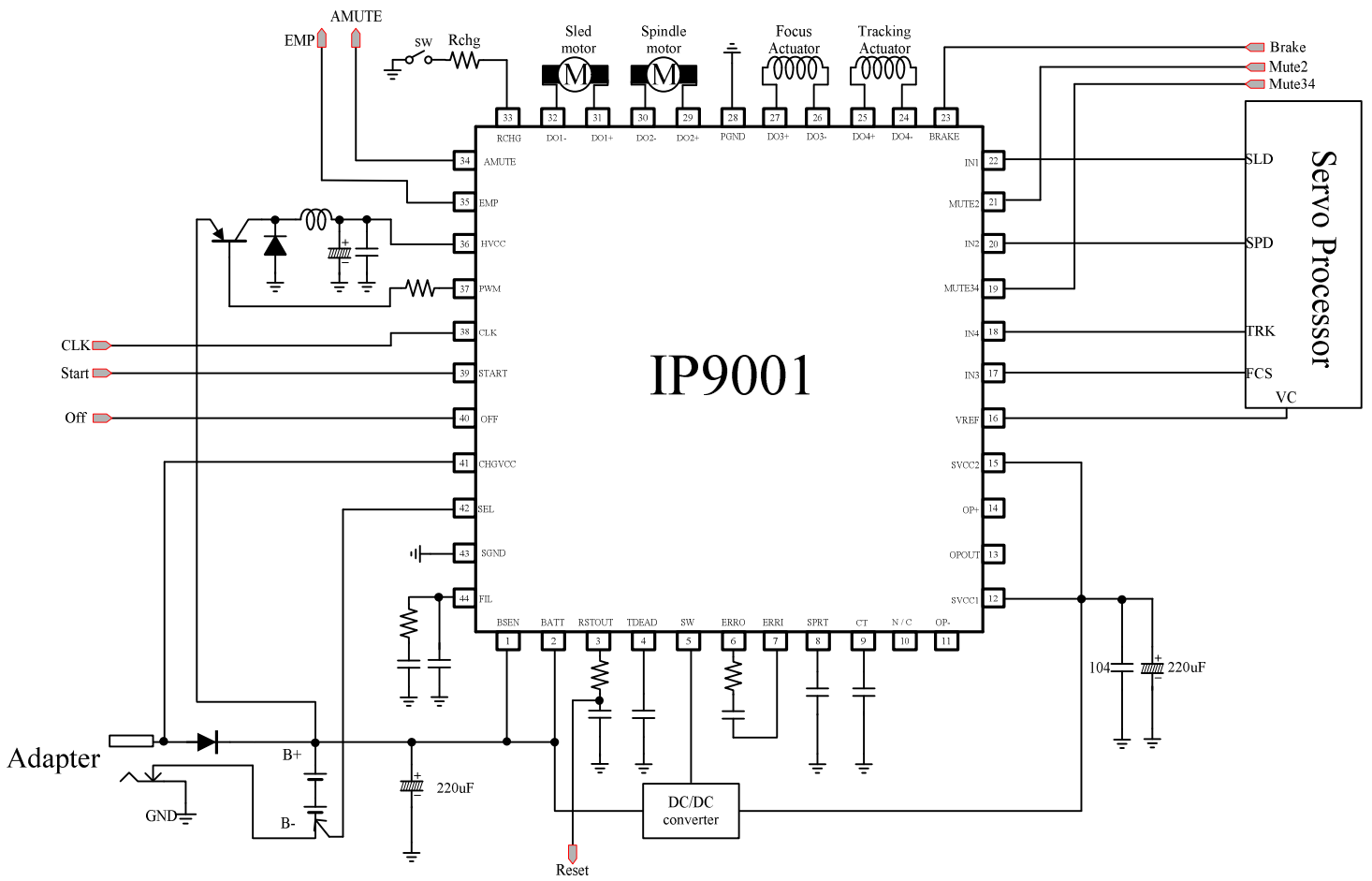
TEST CIRCUIT



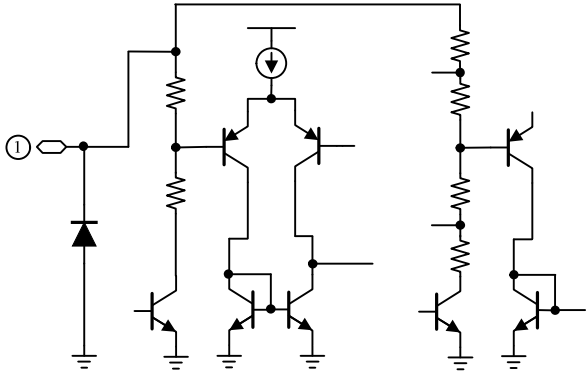
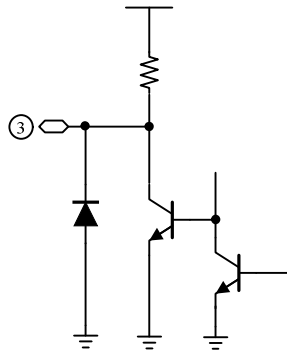
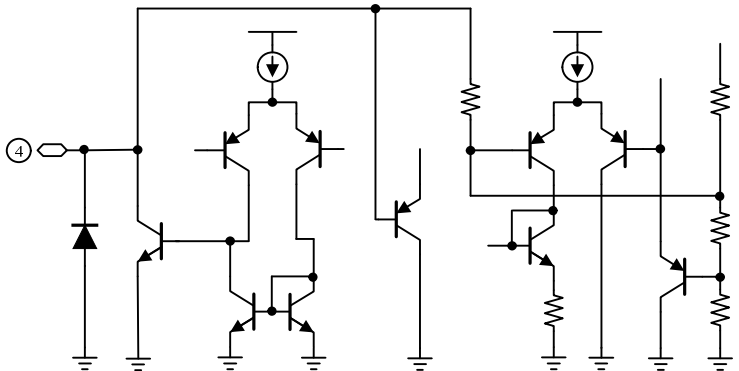
TEST CIRCUIT (Continued)



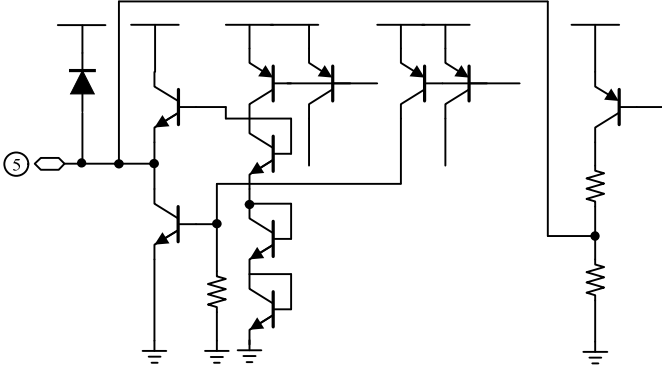
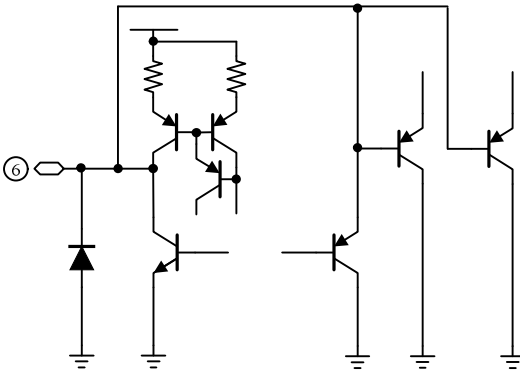
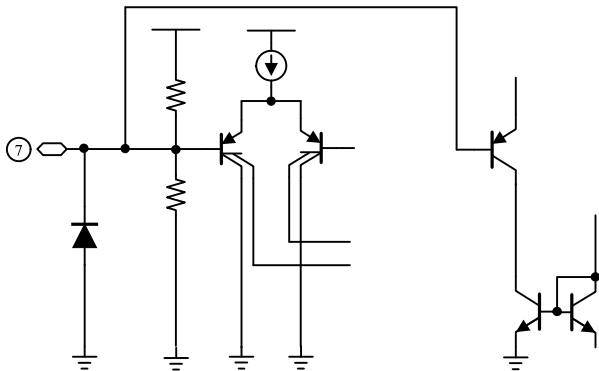
TYPICAL APPLICATION CIRCUIT



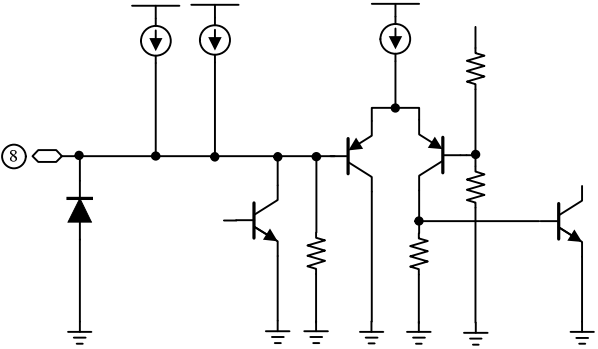
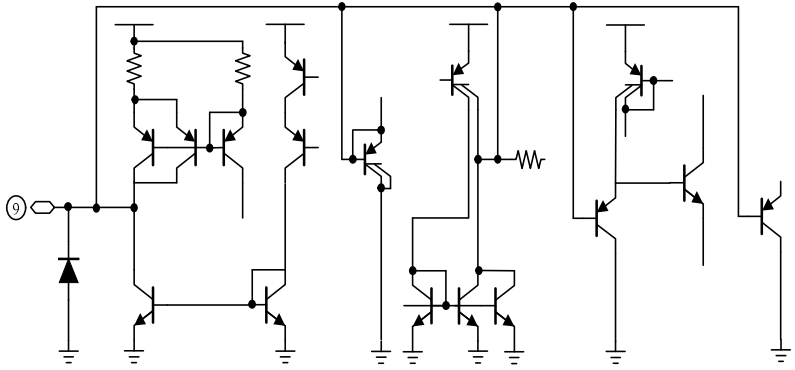
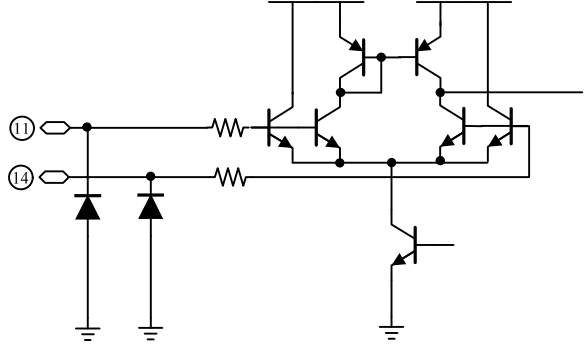
INTERNAL CIRCUIT

Pin no	Pin name	Internal circuit
1	SENS	
3	RESET	
34	DEAD	

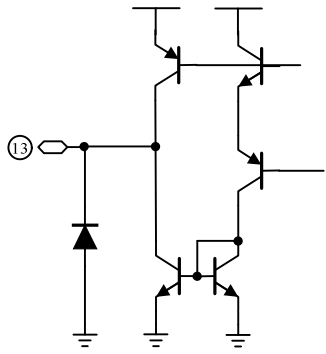
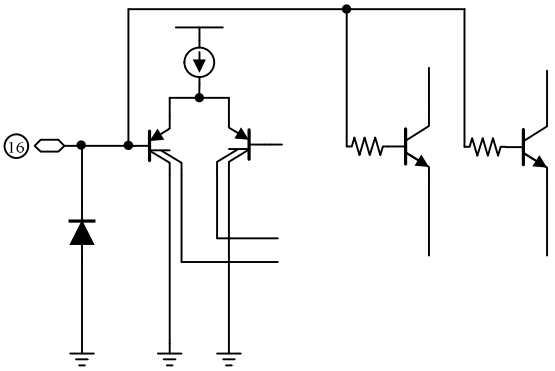
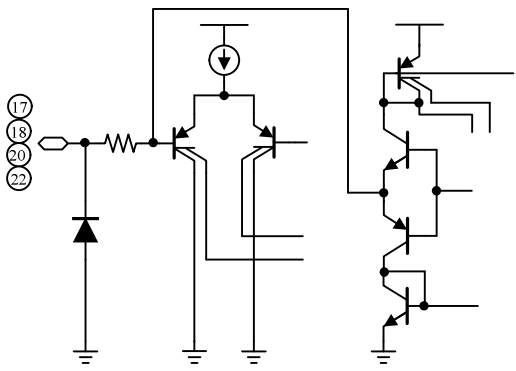
INTERNAL CIRCUIT (Continued)

Pin no	Pin name	Internal circuit
5	DRV	
6	EAMPO	
7	EAMPI	

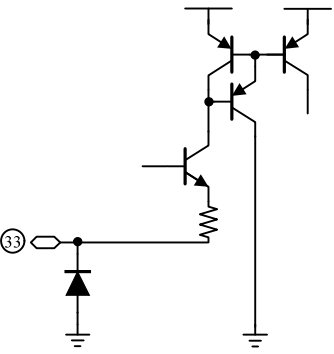
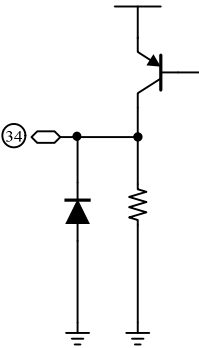
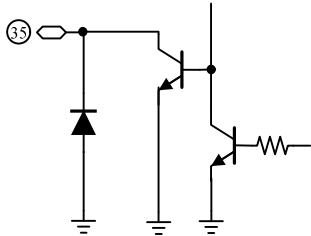
INTERNAL CIRCUIT (Continued)

Pin no	Pin name	Internal circuit
8	SPRT	
9	CT	
11,14	OPIN-, OPIN+	

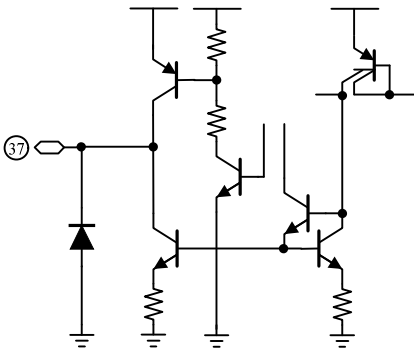
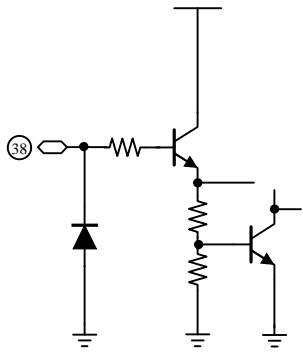
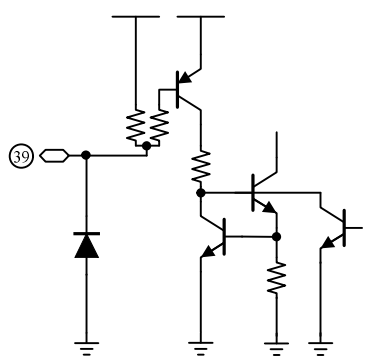
INTERNAL CIRCUIT (Continued)

Pin no	Pin name	Internal circuit
13	OPOUT	
16	VREF	
17, 18, 20, 22	IN3, IN4, IN2, IN1	

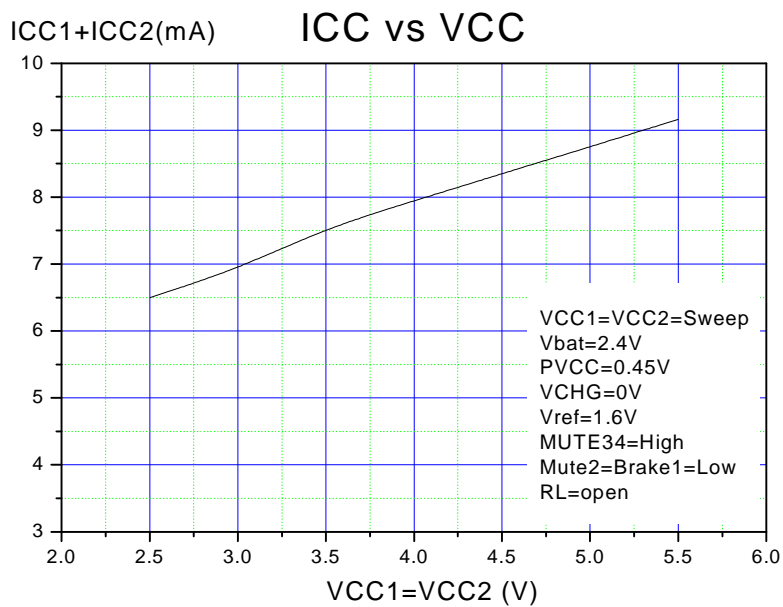
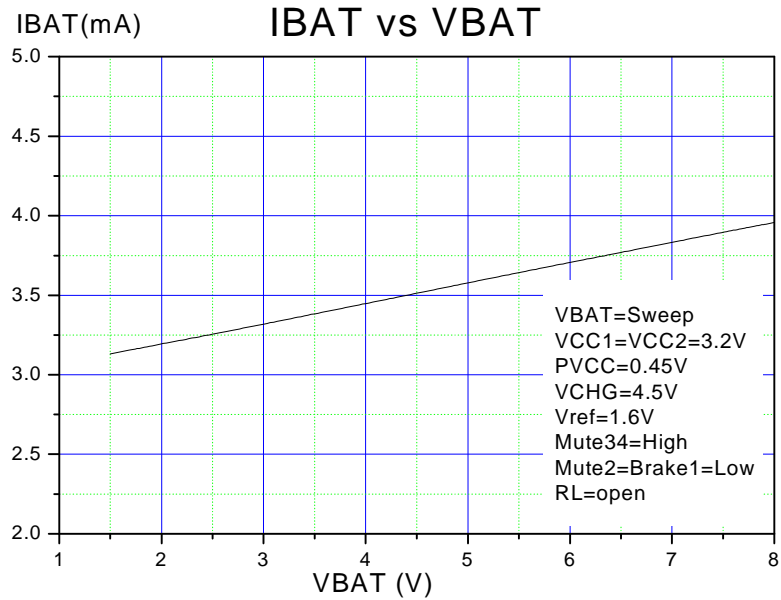
INTERNAL CIRCUIT (Continued)

Pin no	Pin name	Internal circuit
33	RCHG	
34	AMUTE	
35	EMP	

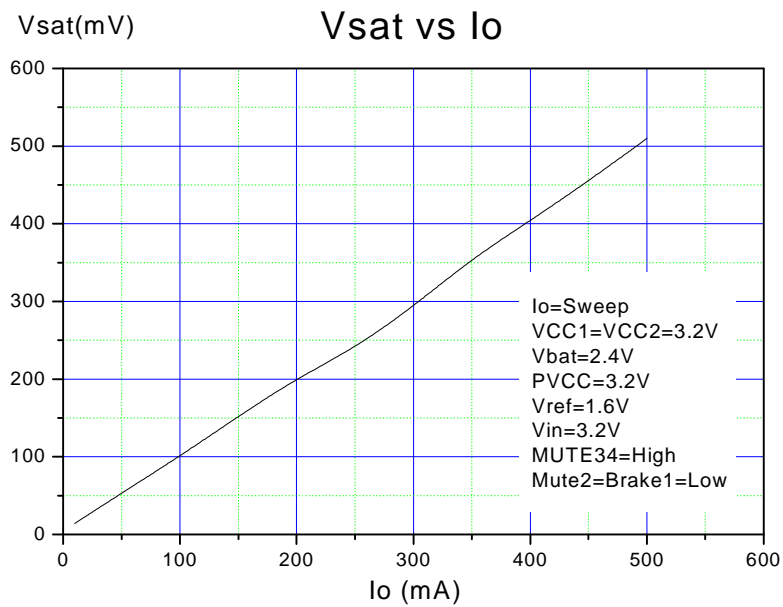
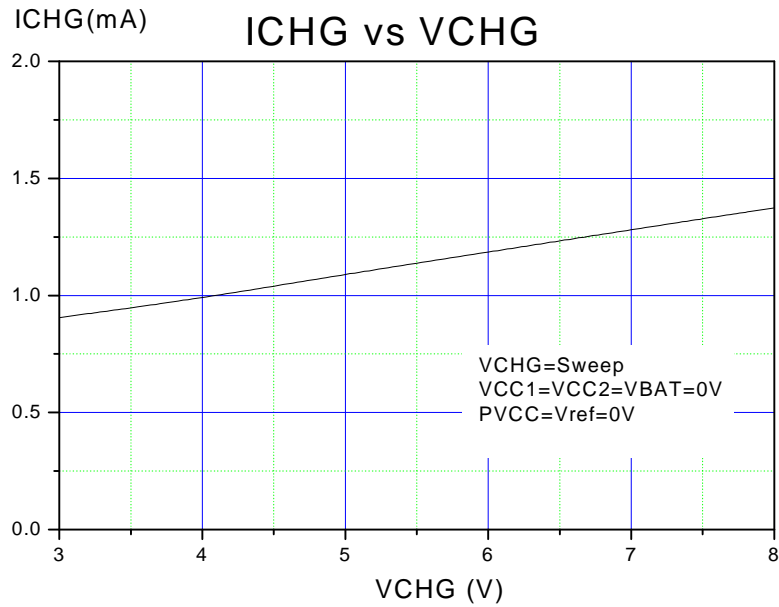
INTERNAL CIRCUIT (Continued)

Pin no	Pin name	Internal circuit
37	PSW	
38	CLK	
39	START	

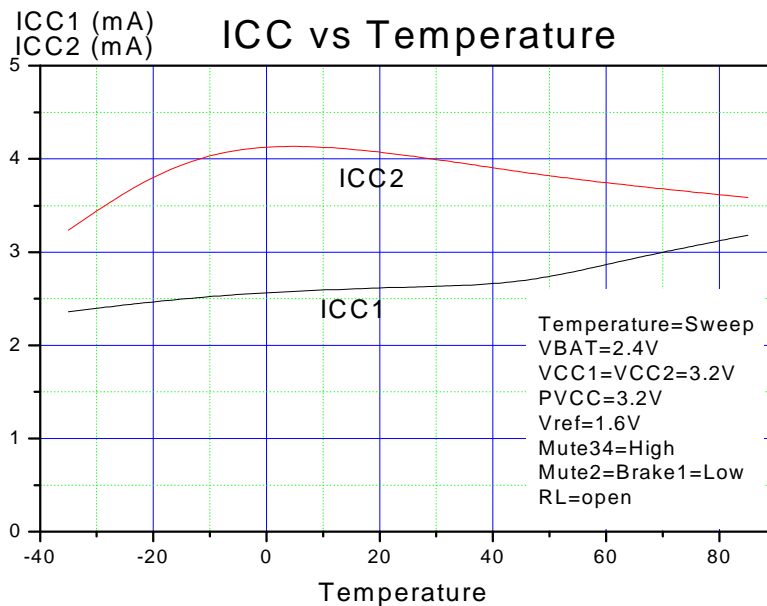
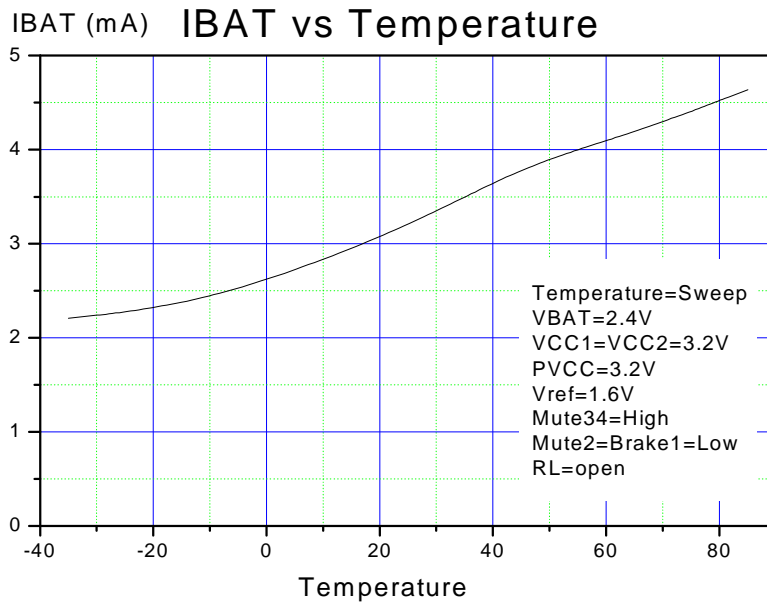
ELECTRICAL CHARACTERISTICS CURVES



ELECTRICAL CHARACTERISTICS CURVES (Continued)



ELECTRICAL CHARACTERISTICS CURVES (Continued)



PACKAGE DIMENSION

44-QFP-1010B

