SONY

CX20036

## Capstan Motor Drive

Description

The CX20036 is a bipolar IC designed for the brushless motor drive of a 3-phase bidirectional conducting system and has the following components:

Hole element amp., Conducting angle switching circuit, Motor driver, Hole element power supply input amp., Control amp., PWM control circuit, Current limiter circuit, Voltage limiter circuit, Power saving circuit and Rotational direction switching circuit.

28 pin SOP (Plastic)
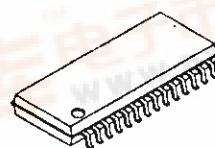
Features

• Low power consumption
• Maximum motor current: 850 mA
• PWM control circuit incorporated
• Operating power supply voltage: 4 to 9V
• Built-in current limiter
• Built-in hole element power supply
• Power saving function incorporated

Structure

Bipolar silicon monolithic IC

Absolute Maximum Ratings (Ta=25˚C)

• Power supply voltage   Vcc   10   V
• Operating temperature   Topr   −20 to +75   ˚C
• Storage temperature   Tstg   −55 to +150   ˚C
• Allowable power dissipation Pd   1.0   W

Recommended Operating Condition

4 to 9   V

— 1 —

Block Diagram
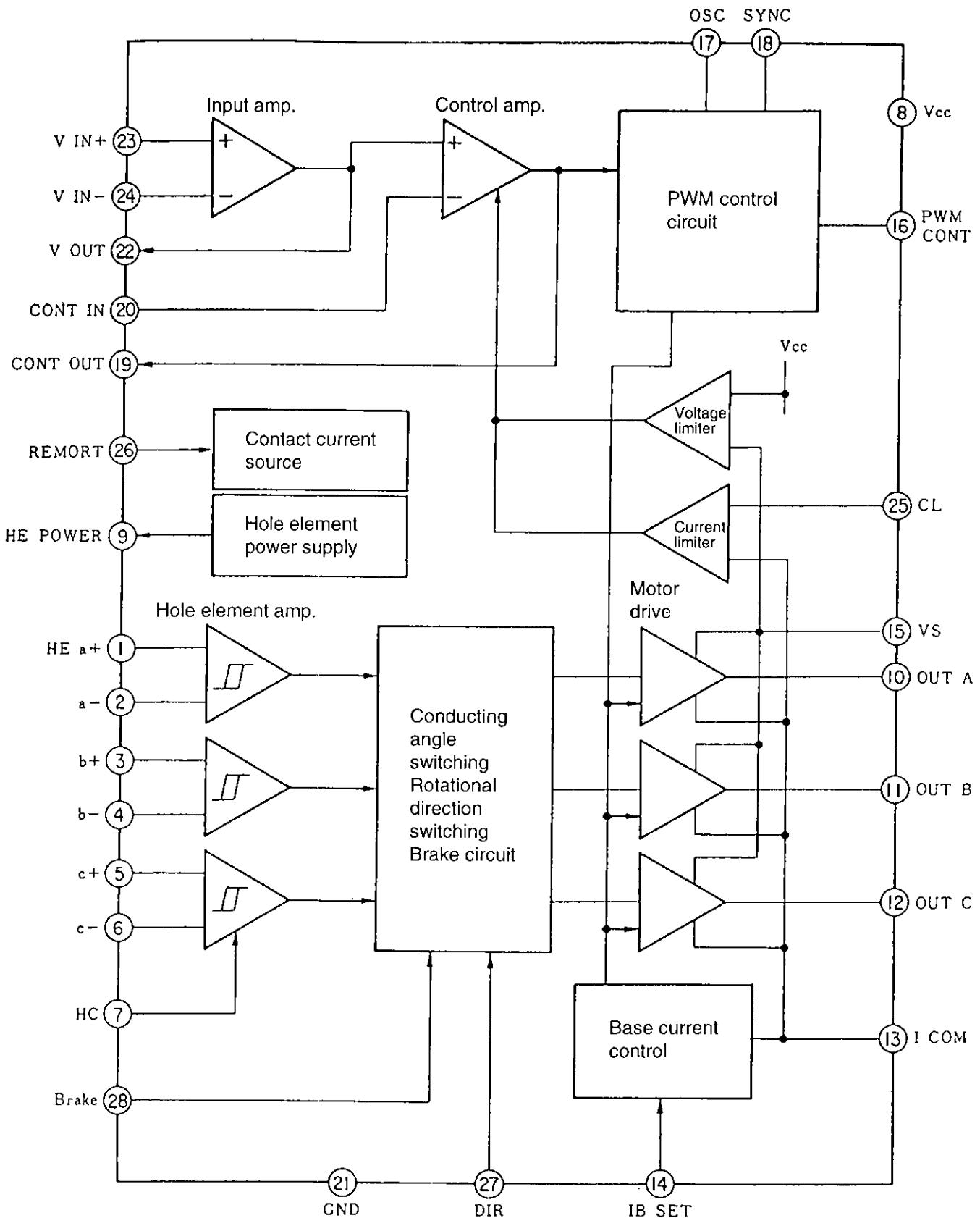
Pin Description and Equivalent Circuit

No.	Name	Function
1	HE a$^+$	
2	HE a$^-$	
3	HE b$^+$	
4	HE b$^-$	Hole element amplifier input terminal with 3-phase differential input
5	HE c$^+$	
6	HE c$^-$	
7	HC	Hysterisis cancelling terminal. Cancel by connecting to Vcc. Usually set to open.
8	Vcc	
9	HE POWER	Hole element power supply. It switches off in the power saving mode (Pin 26 → GND). Current limiter incorporated.
10	OUTPUT A	
11	OUTPUT B	Terminal for motor connection
12	OUTPUT C	
13	I COM	Monitor terminal for the motor current Voltage for setting the base current of power Tr, and current limiter
14	IB SET	Terminal for setting the base current of power Tr. $R_{14} = 1.35 \times 10^4$ REF', RNF': Pin 13 external resistor +50 mΩ (IC internal resistance)
15	VS	Motor input voltage terminal. Voltage after passing the PWM output through LPF is added.
16	PWMCONT	Output terminal of the PWM control signal. Power control Tr is input externally.
17	OSC	Capacitor connection terminal for setting the oscillation frequency of a PWM oscillator. Oscillation range: 50 to 200 kHz. $c = \dfrac{1}{fs} \times 6.8 \times 10^7$ (pF) fs = Oscillation frequency
18	SYNC	Input/output terminal for synchronizing the PWM oscillation frequency with an external signal or oscillation frequency
19	CONT OUT	
20	CONT IN	Input/output terminal for setting the PWM loop gain with an external resistor
21	GND	
22	V OUT	
23	V IN$^+$	Servo signal buffer to set the servo gain with an external resistor
24	V IN$^-$	

No.	Name	Function
25	CL	Maximum motor current setting terminal to input voltage externally $V_{CL} = R_{NF}' \cdot I_{ML}$ V_{CL} • Input voltage R_{NF}' • Pin-13 external resistor + 50 mΩ I_{ML} • Maximum motor current
26	REMORT	Usually connected to Vcc for normal circuit operation. When connected to GND, the standby mode saves power.
27	DIR	Motor rotational direction control terminal. When connected to GND, the motor turns in reverse. Usually kept open.
28	BRAKE	Brake terminal. Current only flows in one phase and is locked. Operates when the input is at the high level. Set so that about 50 μA is input.

Electrical Characteristics

(Ta = 25°C, Vcc = 6V. See Measurement Circuit Diagram.)

No.	Measuring item	Symbol	Measuring contents	Min.	Typ.	Max.	Unit
1	Circuit current 1	I_{CC1}	Current when REMOTE 26 is set to High.	3.8	5.2	6.6	mA
2	Standby current	I_{CCL}	Standby current when REMOTE 26 is set to Low		0	6.0	μA
3	Circuit current 2	I_{CC2}	Circuit current when output Tr is in operation	22	33	45	mA
4	Output saturation voltage 1U	V_{sat1U}	Output characteristics when one of the three phases is in operation		300	410	mV
5	Output saturation voltage 1L	V_{sat1L}			250	350	mV
6	Output current 1	I_{OUT1}		420	470	515	mA
7	Leakage current 1	I_{LEAK1}			0	1.6	mA
8	Common current 1	I_{COM1}		460	500	540	mA
9	Output saturation voltage 2U	V_{sat2U}	Output characteristics when another phase is in operation after input signal switching		300	410	mV
10	Output saturation voltage 2L	V_{sat2L}			250	350	mV
11	Output current 2	I_{OUT2}		420	470	515	mA
12	Leakage current 2	I_{LEAK2}			0	1.6	mA
13	Common current 2	I_{COM2}		460	500	540	mA
14	Output saturation voltage 3U	V_{sat3U}	Characteristics for each combination are as follows:		300	410	mV
15	Output saturation voltage 3L	V_{sat3L}			250	350	mV
16	Output current 3	I_{OUT3}		420	470	515	mA
17	Leakage current 3	I_{LEAK3}			0	1.6	mA
18	Common current 3	I_{COM3}		460	500	540	mA
19	Output saturation voltage 4U	V_{sat4U}			300	410	mV
20	Output saturation voltage 4L	V_{sat4L}			250	350	mV
21	Output current 4	I_{OUT4}		420	470	515	mA
22	Leakage current 4	I_{LEAK4}			0	1.6	mA
23	Common current 4	I_{COM4}		460	500	540	mA
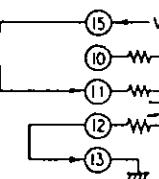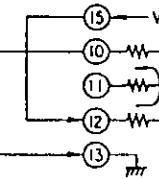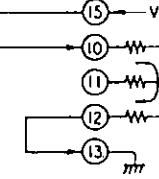
(Measurement circuit: pin ⑮ → VS, Substitute for motor coil; pins ⑩, ⑪, ⑫ with resistors; pin ⑬ to ground.)

No.	Measuring item	Symbol	Measuring contents	Min.	Typ.	Max.	Unit
24	Output saturation voltage 5U	Vsat₅U			300	410	mV
25	Output saturation voltage 5L	Vsat₅L			250	350	mV
26	Output current 5	Iout₅		420	470	515	mA
27	Leakage current 5	Ileak₅			0	1.6	mA
28	Common current 5	Icom₅		460	500	540	mA
29	Output saturation voltage 6U	Vsat₆U			300	410	mV
30	Output saturation voltage 6L	Vsat₆L			250	350	mV
31	Output current 6	Iout₆		420	470	515	mA
32	Leakage current 6	Ileak₆			0	1.6	mA
33	Common current 6	Icom₆		460	500	540	mA
34	Output saturation voltage difference 1	ΔVsat₁	Vsat₁U − Vsat₂U	−20	7	+30	mV
35	Output saturation voltage difference 2	ΔVsat₂	Vsat₂U − Vsat₃U	−20	13	+30	mV
36	Output saturation voltage difference 3	ΔVsat₃	Vsat₃L − Vsat₁L	−20	13	+30	mV
37	Output saturation voltage difference 4	ΔVsat₄	Vsat₁L − Vsat₂L	−20	7	+30	mV
38	Output saturation voltage 7U	Vsat₇U	With DIR terminal 27 set low, check the mode when the direction of rotation reverses. Input condition is same as T24 to 28 but the current is reversed.		300	410	mV
39	Output saturation voltage 7L	Vsat₇L			250	350	mV
40	Output current 7	Iout₇		420	470	515	mA
41	Leakage current 7	Ileak₇			0	1.6	mA
42	Common current 7	Icom₇		460	500	540	mA

No.	Measuring item	Symbol	Measuring contents	Min.	Typ.	Max.	Unit
43	Output saturation voltage 8U	Vsat8U	As above. Input condition same as T29 to 33.		300	410	mV
44	Output saturation voltage 8L	Vsat8L			250	350	mV
45	Output current 8	Iout8		420	470	515	mA
46	Leakage current 8	Ileak8			0	1.6	mA
47	Common current 8	Icom8		460	500	540	mA
48	Output saturation voltage 9U	Vsat9U	As above. Input condition same as T19 to 23.		300	410	mV
49	Output saturation voltage 9L	Vsat9L			250	350	mV
50	Output current 9	Iout9		420	470	515	mA
51	Leakage current 9	Ileak9			0	1.6	mA
52	Common current 9	Icom9		460	500	540	mA
53	Output saturation voltage 10UB	Vsat10UB	When BRAKE terminal pin-28 is set to Low, current only flows in one phase in any input condition.		300	410	mV
54	Output saturation voltage 10LB	Vsat10LB			250	350	mV
55	Output current 10B	Iout10B		420	470	515	mA
56	Leakage current 10B	Ileak10B			0	1.6	mA
57	Common current 10B	Icom10B		460	500	540	mA
58	Output saturation voltage 11UB	Vsat11UB	As above. DIR terminal low.		300	410	mV
59	Output saturation voltage 11LB	Vsat11LB			250	350	mV
60	Output current 11B	Iout11B		420	470	515	mA
61	Leakage current 11B	Ileak11B			0	1.6	mA
62	Common current 11B	Icom11B		460	500	540	mA
63	PWM amp test 1	Tpwm1	PWM amplifier DC gain	0.90	1.00	1.10	V
64	PWM amp test 2	Tpwm2		2.70	3.00	3.40	V
65	PWM amp test 3	Tpwm3		2.00	2.20	2.45	V
66	PWM amp test 4	Tpwm4		1.60	1.87	2.10	V
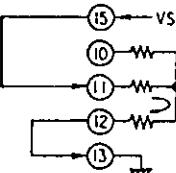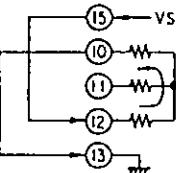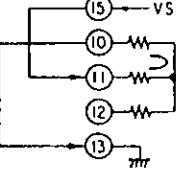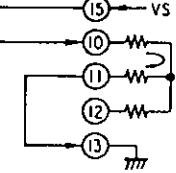
No.	Measuring item	Symbol	Measuring contents	Min.	Typ.	Max.	Unit
67	PWM amp test 5	T_{PWM5}	OSC2 100 Hz 200 mVp-p AC gain	180	200	220	mVp-p
68	PWM amp test 6	T_{PWM6}		1.90	2.10	2.30	Vp-p
69	PWM amp test 7	T_{PWM7}		360	410	440	mVp-p
70	PWM drive current 1	I_{D1}	PWM maximum drive current	31	40	58	mA
71	PWM drive current 2	I_{D2}	PWM drive off		0	10	μA
72	PWM drive current 3	I_{D3}	Check the protection circuit when the external C is shorted.		0	10	μA
73	PWM oscillation frequency	f_{SW}	Check OSC frequency.	70	85	110	kHz
74	Current limiter	I_{CL}	Check the current limiter operation (maximum motor current).	333	385	423	mA
75	Voltage limiter	V_L	Check the voltage limiter (when Vs is higher than Vcc).	5.15	5.50	5.90	V
76	HE power supply saturation voltage	V_{Hsat}	Check the saturation voltage of hole element power supply.		135	210	mV
77	HE power supply current limiter	I_{HCL}	Check the current limiter when the hole element is shorted.	9.5	16	21	mA
78	Bias current 26	I_{H26}	Pin-26 remote terminal drive current	240	305	400	μA
79	Bias current 28	I_{L28}	Pin-28 brake terminal maximum current	0.75	1.0	1.4	mA
80	Bias current 27	I_{L27}	Pin-27 DIR drive current	−81	−62	−42	μA
81	Bias current 25	I_{H25}	Pin-25 current limiter leakage current	−2.0	0	2.0	μA
82	Hysteresis current A	1_{HA}	Hole element amplifier hysteresis current A	7.8	9.7	12.5	μA
83	Hysteresis current B	1_{HB}	Hole element amplifier hysteresis current B	7.8	8.2	12.5	μA
84	Hysteresis current C₁	1_{HC1}	Hole element amplifier hysteresis current C	7.8	8.2	12.5	μA
85	Hysteresis current C₂	1_{HC2}	Hysteresis cancel operation check C	−2.0	0	2.0	μA

Item	Measuring item	Symbol	Measuring contents	Min.	Typ.	Max.	Unit
86	Phase characteristics 1AF	t_1AF		−15		15	μS
87	Phase characteristics 1CR	t_1CR		−15		15	μS
88	Phase characteristics 2BF	t_2BF		40	70	100	μS
89	Phase characteristics 2CR	t_2CR		40	70	100	μS
90	Phase characteristics 3AR	t_3AR		−15		15	μS
91	Phase characteristics 3BF	t_3BF		−15		15	μS
92	Phase characteristics 4AR	t_4AR	T₁AF is the delay time against t₁.	40	70	100	μS
93	Phase characteristics 4CF	t_4CF		40	70	100	μS
94	Phase characteristics 5BR	t_5BR		−15		15	μS
95	Phase characteristics 5CF	t_5CF		−15		15	μS
96	Phase characteristics 6AF	t_6AF		40	70	100	μS
97	Phase characteristics 6BF	t_6BF		40	70	100	μS
98	Phase characteristics 1AR	t_1AR	Phase characteristics when reversed with DIR terminal Pin-27 set low. TIME CHART will be changed as follows by the output voltage of T86 to 97.	−15		+15	μS
99	Phase characteristics 2AR	t_2AR		40	70	100	μS
100	Phase characteristics 3BF	t_3BF		−15		+15	μS
101	Phase characteristics 4AF	t_4AF	DIR Hi DIR Lo	40	70	100	μS
102	Phase characteristics 5AF	t_5AF		−15		15	μS
103	Phase characteristics 6BR	t_6BR		40	70	100	μS
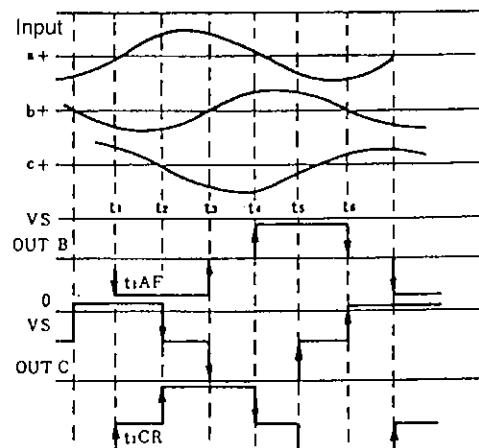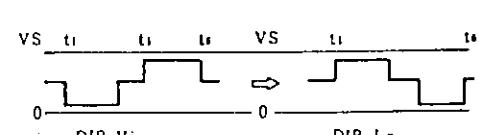
Electrical Characteristics Measurement Condition

No.	Symbol	SW condition																Bias voltage					Measurement point
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	E1	E2	E3	E4	E5	
1	Icc1	b	b	b	b	b	a	b	b	a	a	a	a	a	t	a	b	1V	0V	0V	–	–	I11
2	IccL	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	b	↓	↓	↓	↓	↓	↓			↓
3	Icc2	↓	a	↓	↓	↓	↓	c	↓	↓	↓	↓	↓	a	↓	↓	↓	↓	↓	↓			↓
4	Vsat1U																						V1
5	Vsat1L																						V5
6	Iout1																						V7
7	Ileak1																						I9
8	Icom1																						I6
9	Vsat2U	b	b	a																			V2
10	Vsat2L																						V6
11	Iout2																						I8
12	Ileak2																						I7
13	Icom2																						I6
14	Vsat3U	a	b	b																			V3
15	Vsat3L																						V4
16	Iout3																						I9
17	Ileak3																						I8
18	Icom3																						I6
19	Vsat4U	b	a	a																			V1
20	Vsat4L																						V6
21	Iout4																						I7
22	Ileak4																						I8
23	Icom4																						I6
24	Vsat5U	a	b	a																			V2
25	Vsat5L																						V4
26	Iout5																						I8
27	Ileak5																						I9
28	Icom5																						I6
29	Vsat6U	a	a	b																			V3
30	Vsat6L																						V5
31	Iout6																						I9
32	Ileak6																						I7
33	Icom6												↓										I6

No.	Symbol	SW condition																Bias voltage					Measurement point
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	E_1	E_2	E_3	E_4	E_5	
34	ΔV_{sat1}	a	a	b	b	b	a	c	b	a	a	a	b	a	b	a	b	1	0	0V	–	–	
35	ΔV_{sat2}																						
36	ΔV_{sat3}																						
37	ΔV_{sat4}																						
38	V_{sat7U}	a	b	a		a																	
39	V_{sat7L}																						
40	I_{OUT7}																						
41	I_{LEAK7}																						
42	I_{COM7}																						
43	V_{sat8U}	a	a	b																			
44	V_{sat8L}																						
45	I_{OUT8}																						
46	I_{LEAK8}																						
47	I_{COM8}																						
48	V_{sat9U}	b	a	a																			
49	V_{sat9L}																						
50	I_{OUT9}																						
51	I_{LEAK9}																						
52	I_{COM9}																						
53	$V_{sat10UB}$	b	b	b		b												1V	0V	5V	–	–	
54	$V_{sat10LB}$																						
55	I_{OUT10B}																						
56	$I_{LEAK10B}$																						
57	I_{COM10B}																						
58	$V_{sat11VB}$	b	b	b		a														5V			
59	$V_{sat11LB}$																						
60	I_{OUT11B}																						
61	$I_{LEAK11B}$																						
62	I_{COM11B}																						
63	T_{PWM1}	b	b	b	b	b	a	a	a	a	a	a	a	a	b	a	a		2V	0V	0.8		V_{10}
64	T_{PWM2}																						V_{11}
65	T_{PWM3}			a																			V_8
66	T_{PWM4}			a					b				b				b				–		V_7

No.	Symbol	SW condition																Bias voltage					Measurement point
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	E1	E2	E3	E4	E5	
67	TPWM5	b	b	b a	b	b	a	a	b	a	a	a	b	a	b	a b	b a	1V	2V	0V	– / 0.7V	–	V10
68	TPWM6			↓													↓						V11
69	TPWM7			a			↓	↓			↓					↓	b				↓	↓	V7
70	ID1			b			b	b			d				a	a					0V	375mV	I10
71	ID2												↓								2V		I10
72	ID3												a								0V		I10
73	fSW			↓			↓	↓			↓		b			↓		↓	↓		0.8V	↓	TP4
74	ICL			a			a	a		↓	a	↓					b	0.2V	4V		–	–	I6
75	VL			↓				↓		b	b	b		↓				1V	↓		·		V7
76	VHsat			b.				b		a	a	a			a				0V				V9
77	IHCL														c								I13
78	IH26														b						↓		
79	IL28					↓															5V		
80	IL27					a															0V		
81	IB25	↓				b																	
82	1HA	a	↓																				
83	1HB	b	a	↓																			
84	1HC1	↓		a	↓																		
85	1HC2	↓	↓	↓	a			↓											↓				
86	t1AF	c	c	c	b			a											3V				TP1
87	t2CR																						TP3
88	t2BF																						TP2
89	t3CR																						TP3
90	t3AR																						TP1
91	t4BF																						TP2
92	t4AR																						TP1
93	t5CF																						TP3
94	t5BR																						TP2
95	t6CF																						TP3
96	t6AF																						TP1
97	t1BF					↓															↓	↓	TP2
98	t2AR					b a															–	–	TP1
99	t3AR																						↓
100	t4BF																						TP2
101	t5AF																						TP1
102	t5AF																						↓
103	t6BR	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓				↓	↓	TP2

Electrical Characteristics Measurement Circuit
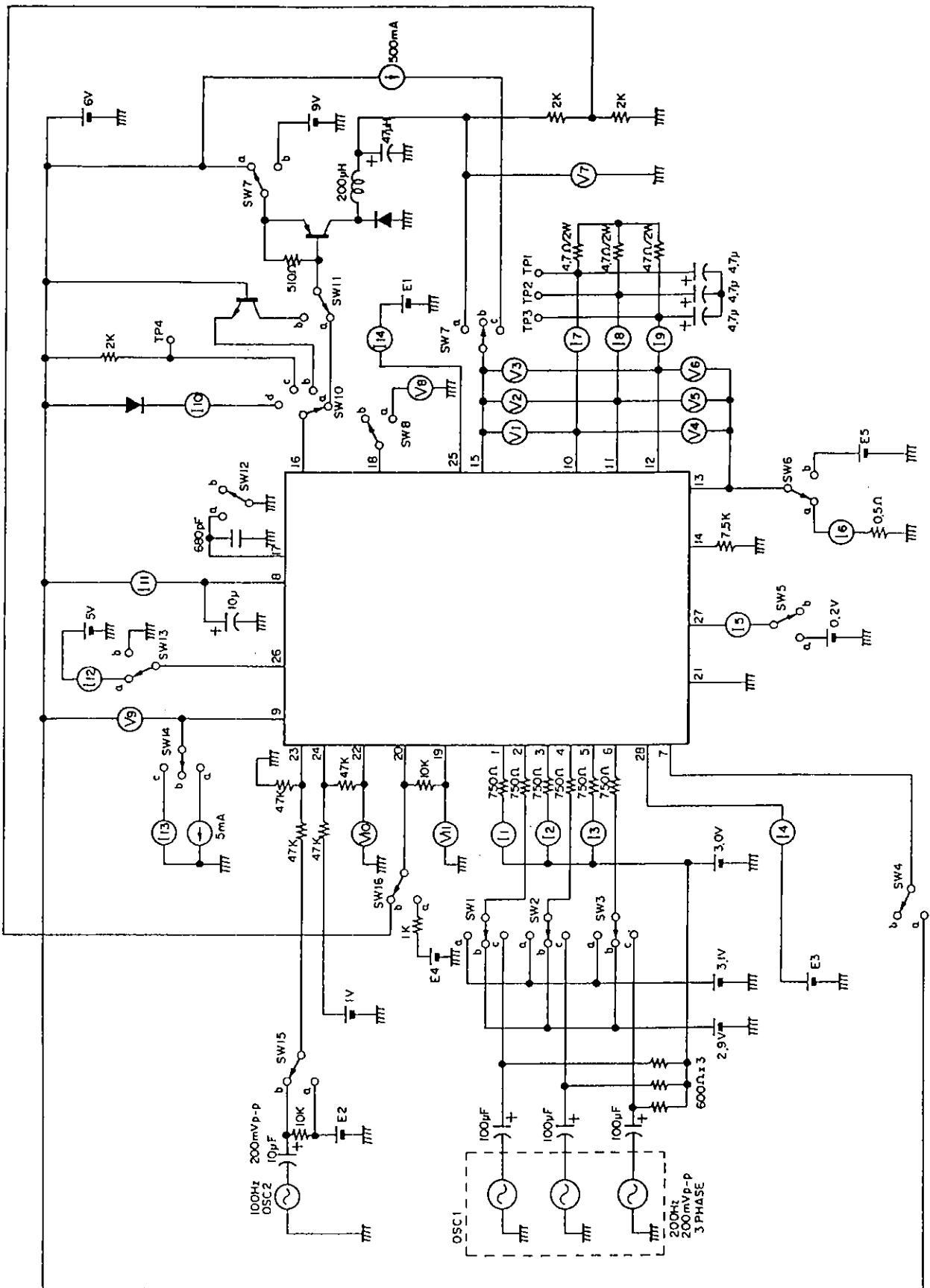
Standard Circuit Design Reference   Truth Table

HE input a	HE input b	HE input c	DIR	OUTPUT A	OUTPUT B	OUTPUT C
H	L	H	H	L	H	OFF
H	L	L	H	L	OFF	H
H	H	L	H	OFF	L	H
L	H	L	H	H	L	OFF
L	H	H	H	H	OFF	L
L	L	H	H	OFF	H	L
H	L	H	L	H	L	OFF
H	L	L	L	H	OFF	L
H	H	L	L	OFF	H	L
L	H	L	L	L	H	OFF
L	H	H	L	L	OFF	H
L	L	H	L	OFF	L	H

Standard Terminal Voltage   *External input

Pin No.	Pin Voltage	Pin No.	Pin Voltage
1	* 0.3 to Vcc-1.5V	15	* 1 to Vcc
2	* 0.3 to Vcc-1.5V	16	1 to Vcc
3	* 0.3 to Vcc-1.5V	17	
4	* 0.3 to Vcc-1.5V	18	
5	* 0.3 to Vcc-1.5V	19	1 to Vcc-1V
6	* 0.3 to Vcc-1.5V	20	* 0 to Vcc-2V
7	Vcc-0.7	21	GND
8	* Vcc	22	* 0.15 to Vcc-0.7
9	Vcc-0.25	23	* 0.3 to Vcc-1.5
10	0 to Vs	24	* 0.3 to Vcc-1.5
11	0 to Vs	25	* 0 to Vcc-2V
12	0 to Vs	26	* 0 or Vcc
13	0 to 0.4	27	* 0 or 1V (open)
14	0 to 0.4	28	* 0 or 1V (when current supply is connected)

Application Circuit Example

Input VIM maximum voltage

Set the current limiter value.

$C_1 = \frac{1}{f_s} \cdot 6.8 \times 10^7 (pF)$

$f_s = 50k \sim 200kHz$

VCC

○VCC
6V
(4~9V)

R1 to R5 determine the servo gain and control amp. gain. Set a proper vallue.

Decoupling capacitor

$f_s = 50k \sim 200kHz$

C2 22μ

C1 680pF

CX-20036

VCC

(24V) OSC SYNC

17 18

300~1k

I = 1A class ~

Control+ Input −

R1 100k

V IN+ 23

V IN− 24

16 PWM CONT

Q1

L1

R3 2k

100k R2

V OUT 22

CONT IN 20

D1

C6

CONT OUT 19

R4 2k

R5 10k REMORT 26

CURRENT SOURCE

25 CL REF

POWEROFF (5V)

POWEROFF (GND) HALL ELEMENT

(5.8V) HE POWER 9

15 VS

H1

HE o+ 1

MOTER COIL

HE o− 2

HE b+ 3

HE AMP

180°~120° LOGIC

DRIVER

10 OUT A

H2

HE b 4

11 OUT B

H3

HE C+ 5

12 OUT C

HE C− 6

13 I COM

I_B 50μA

VB R

BRAKE 28

I CONT

I~10ΩX3 RB~10
4.7~47μF X 3
C3~5

$R = V_B - 0.63 / R + 5700$

7 I IC

Motor current ↓ I_M

Break is applied when IB is set to around 50μA. Usually connected to GND.

LO (NOR)

21 GND

27 DIRECTION

14 IB SET

←$V_{IM} = I_M \times (R_{13} + 50m\Omega)$

R14

R13 0.2~1Ω

$R_{14} = 1.35 \times 10^4 \cdot RNF'$ $RNF' = R_{13} + 50m\Omega$

Control of rotational direction

HI (REV)

LO (NOR)

L_1C_6

$L_1 = \frac{V_{cc} \cdot V_s}{I_{Mmax}}$

TC (H)
TC POWER ON time
I_M 850 mA max.

Details on Pin-18 sync.

• Sync. from external

I_B 2~10μA

$C_6 = \frac{I_{Mmax} T_D + I_{LOAD} \cdot T_I}{V \, ripple}$

Sync. to external

10k

2.4V

0.6V

L_1 current

47k

Output 0

Tc Tb Ti

Tb: discharge time
Ti: idling time
V ripple: Output ripple voltage

Application circuits shown are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party patent and other right due to same.

## Output Saturation Voltage vs. I$_{BSET}$ Resistance

Vcc = 6V
I$_M$ = 500mA
R⑬ = 0.5Ω

R 14   I$_{BSET}$ resistance (kΩ)
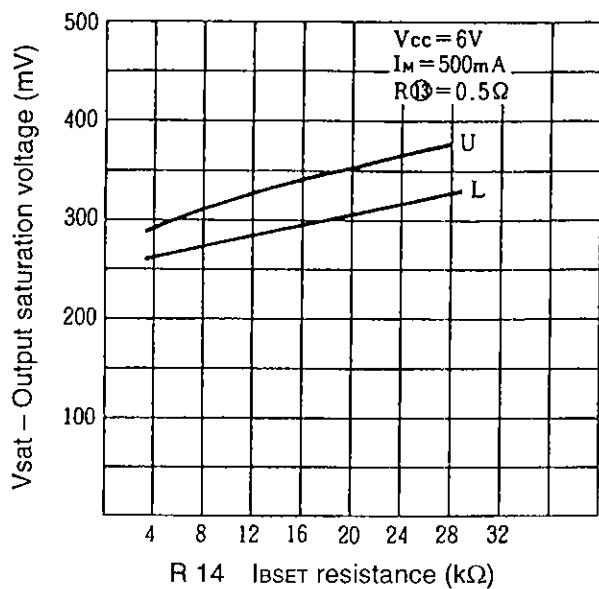
Circuit Current vs. I$_{BSET}$ Resistance

Vcc = 6V
R⑬ = 0.5Ω

I$_M$ = 500mA

I$_M$ = 200mA

R 13   I$_{BSET}$ resistance (kΩ)
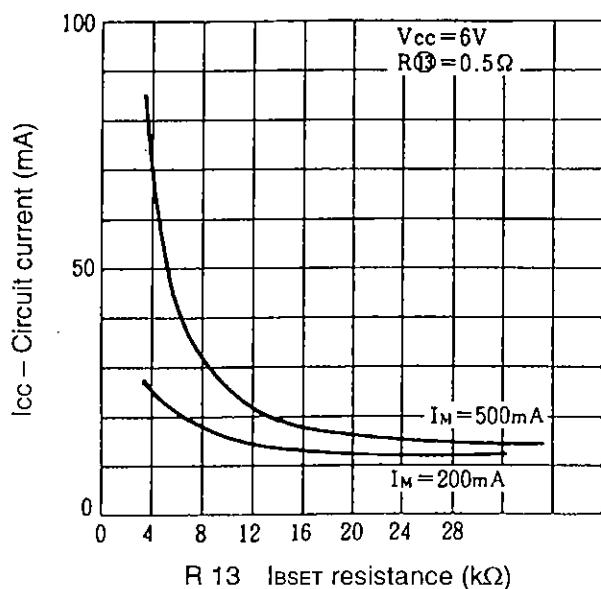
Circuit Current vs. Power Supply Voltage

I$_M$ = 0mA

Vcc – Power supply voltage (V)
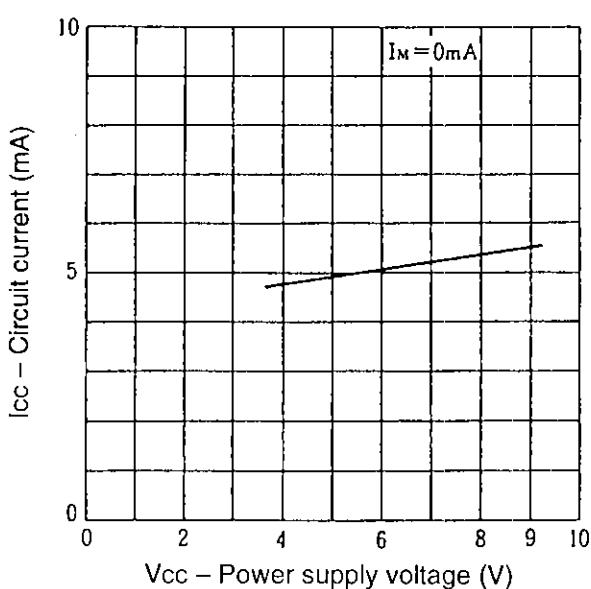
Output Saturation Voltage vs. Output Current

R⑭ = 7.5kΩ
R⑬ = 0.5Ω

U

L

I$_{OUT}$ – Output current (mA)
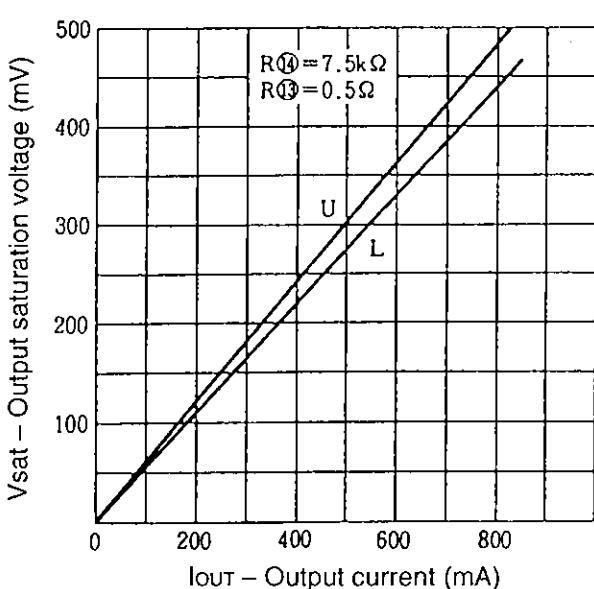
Circuit Current vs. Ambient Temperature
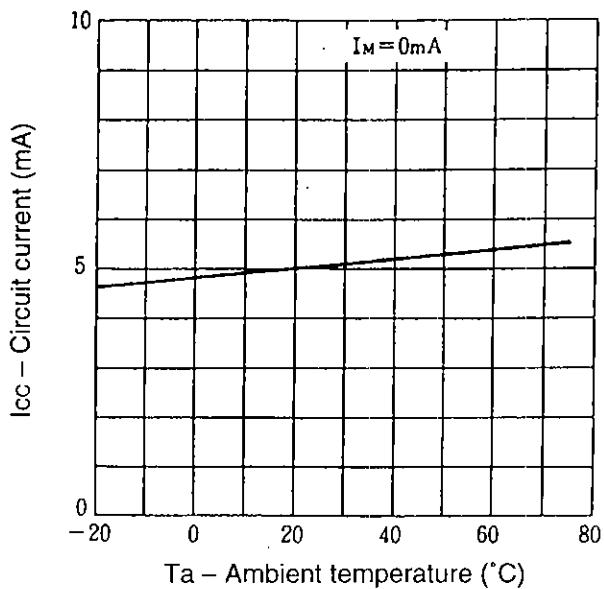
## Output Saturation Voltage vs. Ambient Temperature
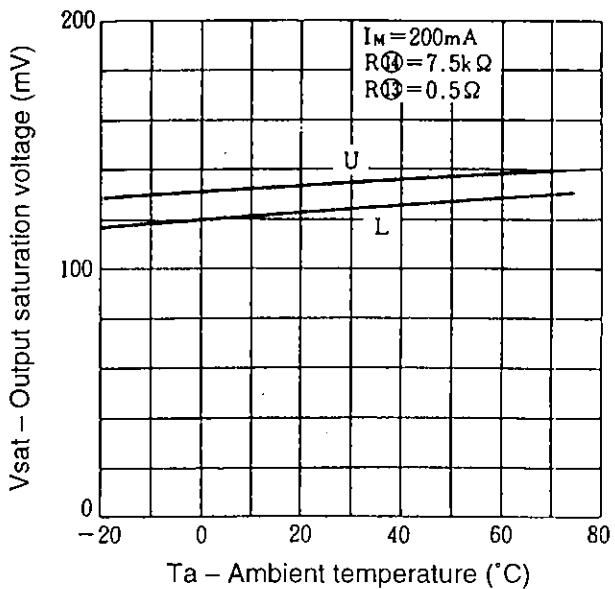

PWM Oscillation Frequency vs. Power Supply Voltage
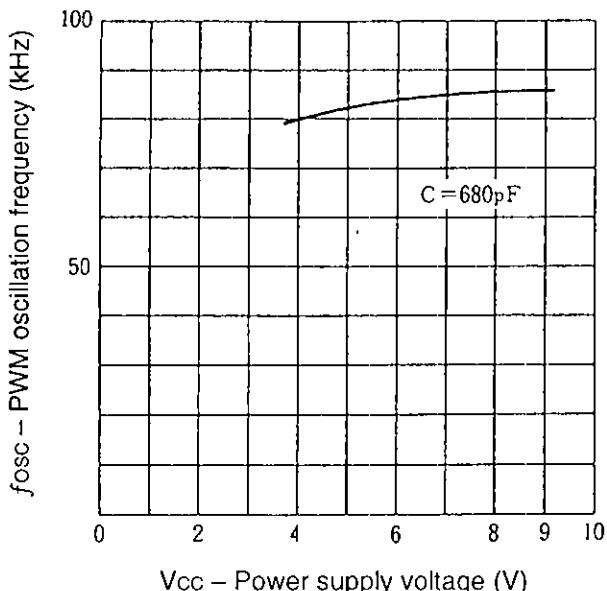
## PWM Oscillation Frequency vs. Ambient Temperature
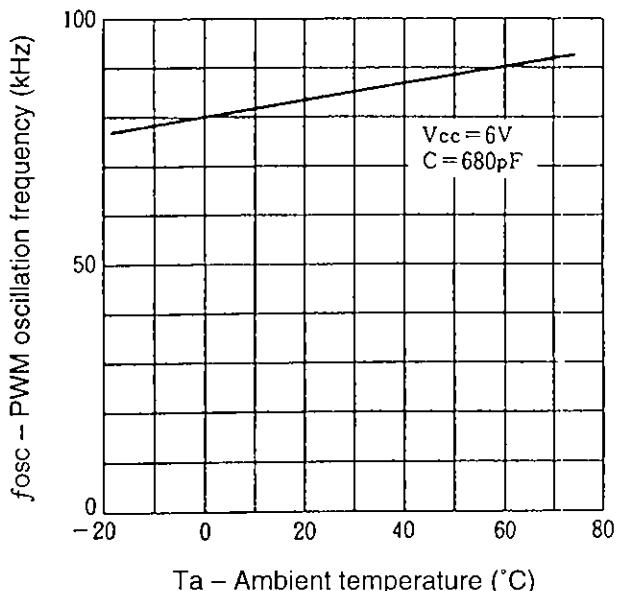
PWM Oscillation Frequency vs. C 17
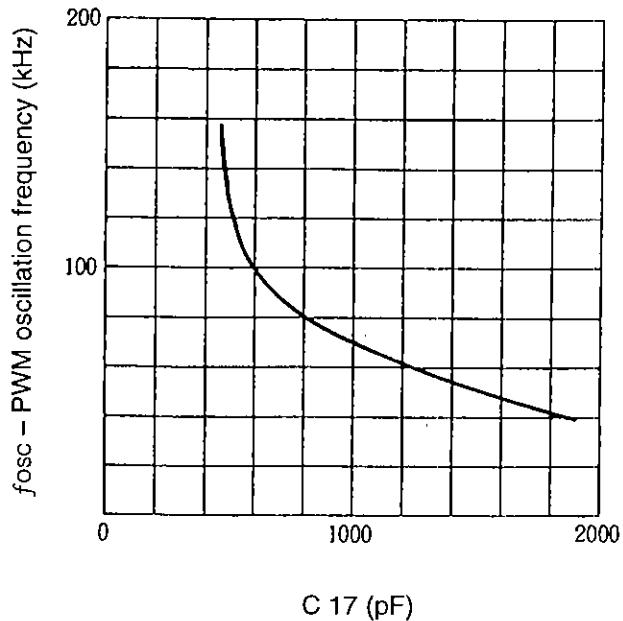
Transit Thermal Resistance vs. Time

[Graph: Y-axis: f_{osc} – PWM oscillation frequency (kHz), ranging 0 to 200; X-axis: C 17 (pF), ranging 0 to 2000]

C 17 (pF)

[Graph: Y-axis: P_D – Power dissipation (W), ranging 0 to 1.6; X-axis: Ta – Ambient temperature (°C), ranging 0 to 140; labeled "free air"]

Ta – Ambient temperature (°C)
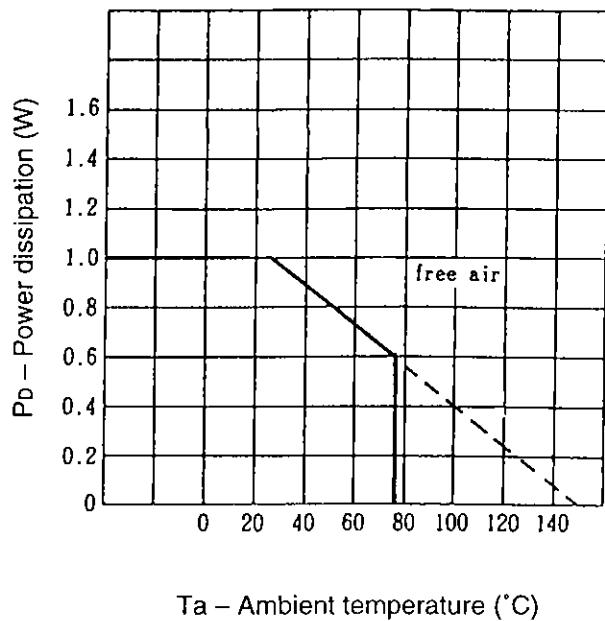
Allowable Power Dissipation Decrement Curve

[Graph: Y-axis: $\theta\gamma$ – Transit thermal resistance (°C/W), ranging 0 to 100; X-axis: t – Time (sec.), ranging 0 to 1000]

t – Time (sec.)
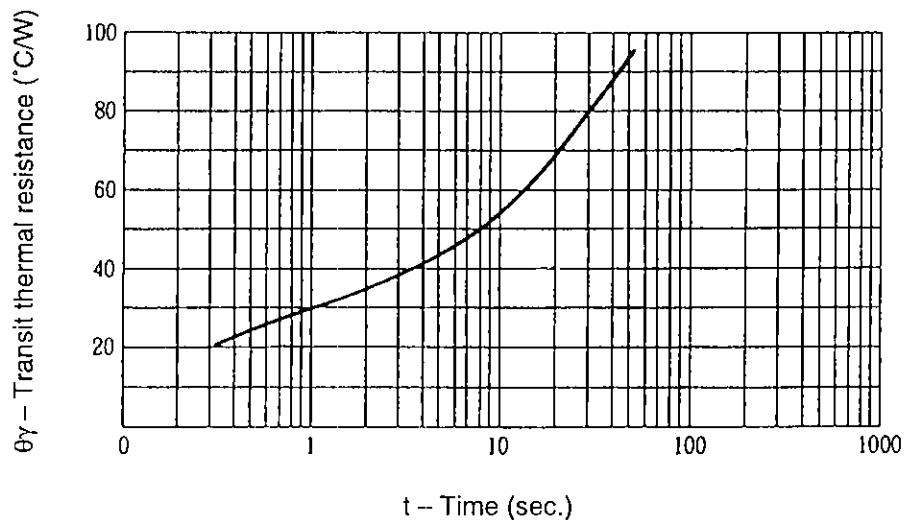
Package Outline   Unit : mm

28PIN SOP (PLASTIC) 375MIL

PACKAGE STRUCTURE
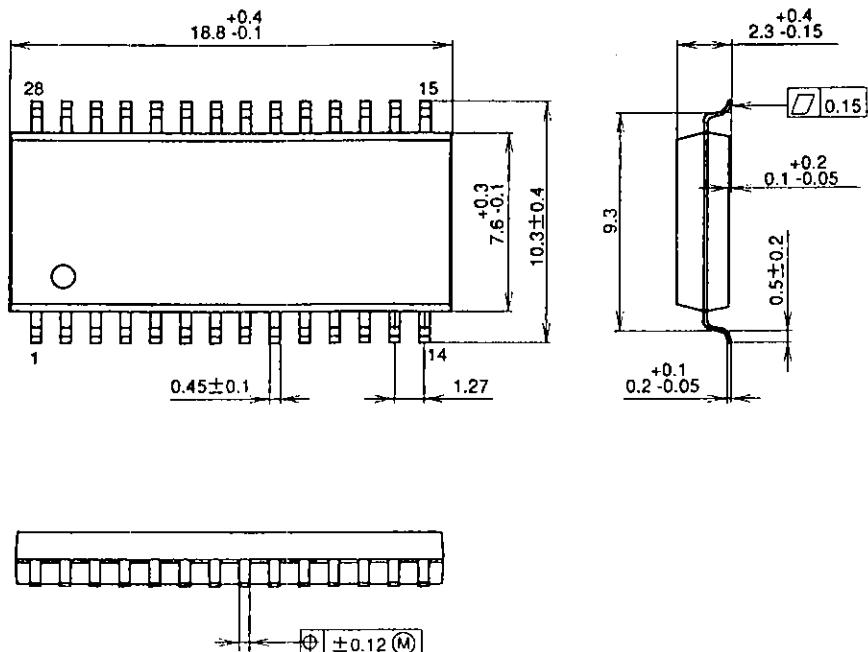
SONY CODE	SOP-28P-L04
EIAJ CODE	*SOP028-P-0375-D
JEDEC CODE	————

PACKAGE MATERIAL	EPOXY RESIN
LEAD TREATMENT	SOLDER PLATING
LEAD MATERIAL	42 ALLOY
PACKAGE WEIGHT	0.7g