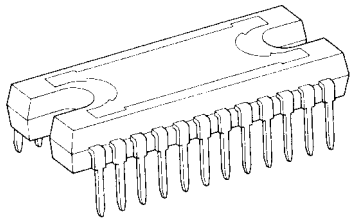
TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

TA8411L

Biphase Bipolar Stepper and Push-Pull Driver

The TA8411L incorporates drivers for bipolar stepping motors (chopper type) and a DC motor driver. Its input section is a serial input type and has a shift register with a 12-bit latch.
Its output section has a push-pull driver that can supply up to 0.6 A and two sets of 8 bipolar drivers that can supply up to 0.8 A. It can control two bipolar stepping motors and one brushed motor or solenoid.
The $V_{M\text{-}AB}$, $V_{M\text{-}CD}$, $V_{M\text{-}E}$ and V_{CC} power supply voltages are independent of one another, and they can have any voltage relationship among them.
Because the output section incorporates a circuit that can switch at high speed, it can support a PWM frequency of up to 200 kHz.



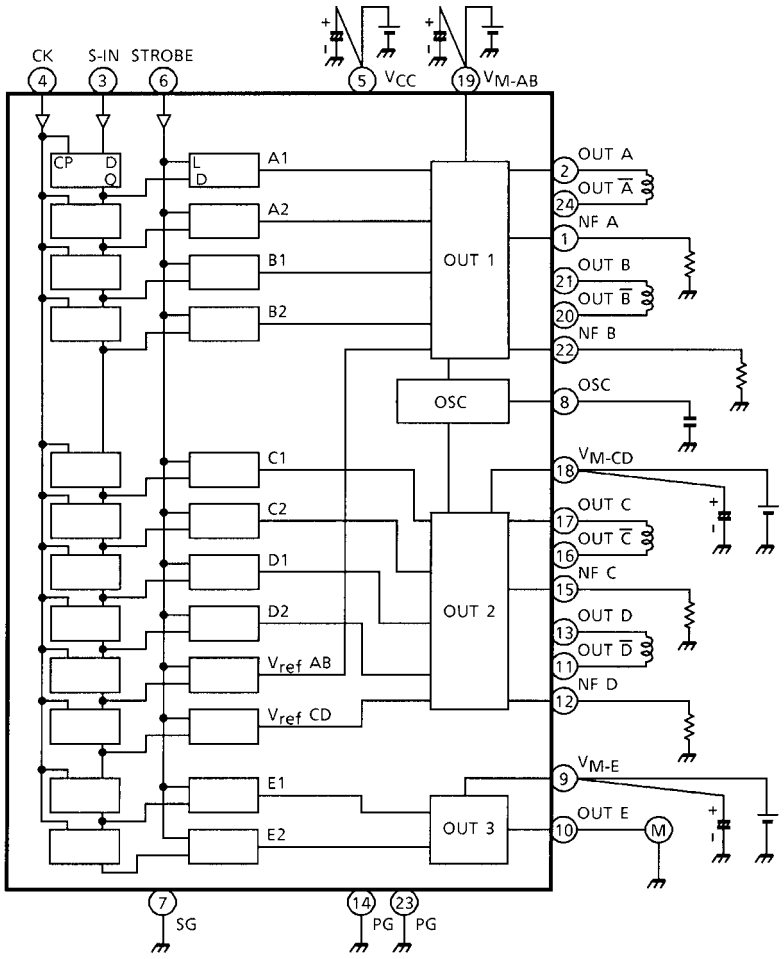
HDIP24-P-500-2.00

Weight: 4.30 g (typ.)

Features

- CMOS-compatible input level (built-in pull-down resistor)
- Two built-in biphase, bipolar stepping motor drivers (bipolar driving and chopper type)
- Built-in push-pull driver
- Built-in register reset circuit
- Operating output voltage range: V_M = 0 to 27 V
- Operating supply voltage range: V_{CC} = 4.5 to 5.5 V

Block Diagram



Note 1: Capacitance connect to each Power Supply Terminal is required to change to optimum value for noise elimination and also required to connect directly to each Power Supply Terminal (V_{CC}, $V_{M1, 2}$) and the corresponding GND Terminal (See Table 1) for stable operations.

Table 1

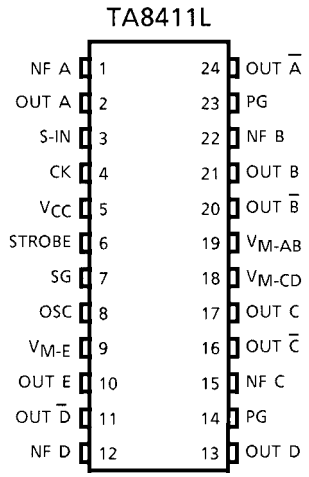
GND	Power Supply
Pin (7) (SG)	Pin (5) (V_{CC})
Pin (23) (PG)	Pin (19) (V_{M-AB})
Pin (14) (PG)	Pin (18) (V_{M-CD}), Pin (9) (V_{M-E})

Note 2: Be careful when mounting a heat radiator because the heat sink is grounded via a low resistance.

Pin Function

PIN No.	Symbol	Functional Description
1	NF A	A channel current detection output terminal.
2	OUT A	OUTPUT A
3	S−IN	Serial signal input terminal.
4	CK	Clock signal input terminal.
5	V_{CC}	Supply voltage terminal for control circuit.
6	STROBE	STROBE signal input terminal.
7	SG	Signal GND terminal.
8	OSC	Internal osc frequency setting terminal.
9	V_{M-E}	E channel power supply input terminal.
10	OUT E	E channel output terminal. (pushpull output)
11	OUT $\overline{D}$	OUTPUT $\overline{D}$
12	NF D	D channel current detection output terminal.
13	OUT D	OUTPUT D
14	PG	Power GND terminal.
15	NF C	C channel current detection output terminal.
16	OUT $\overline{C}$	OUTPUT $\overline{C}$
17	OUT C	OUTPUT C
18	V_{M-CD}	Supply voltage terminal for C channel D channel.
19	V_{M-AB}	Supply voltage terminal for A channel B channel.
20	OUT $\overline{B}$	OUTPUT $\overline{B}$
21	OUT B	OUTPUT B
22	NF B	B channel current detection output terminal.
23	PG	Power GND terminal.
24	OUT $\overline{A}$	OUTPUT $\overline{A}$

Pin Connection

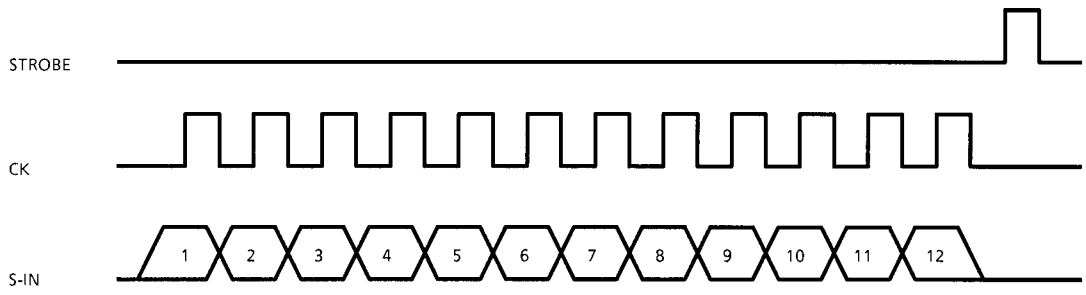


Input Serial Pulse Train (Pin (3)) and Power Output States

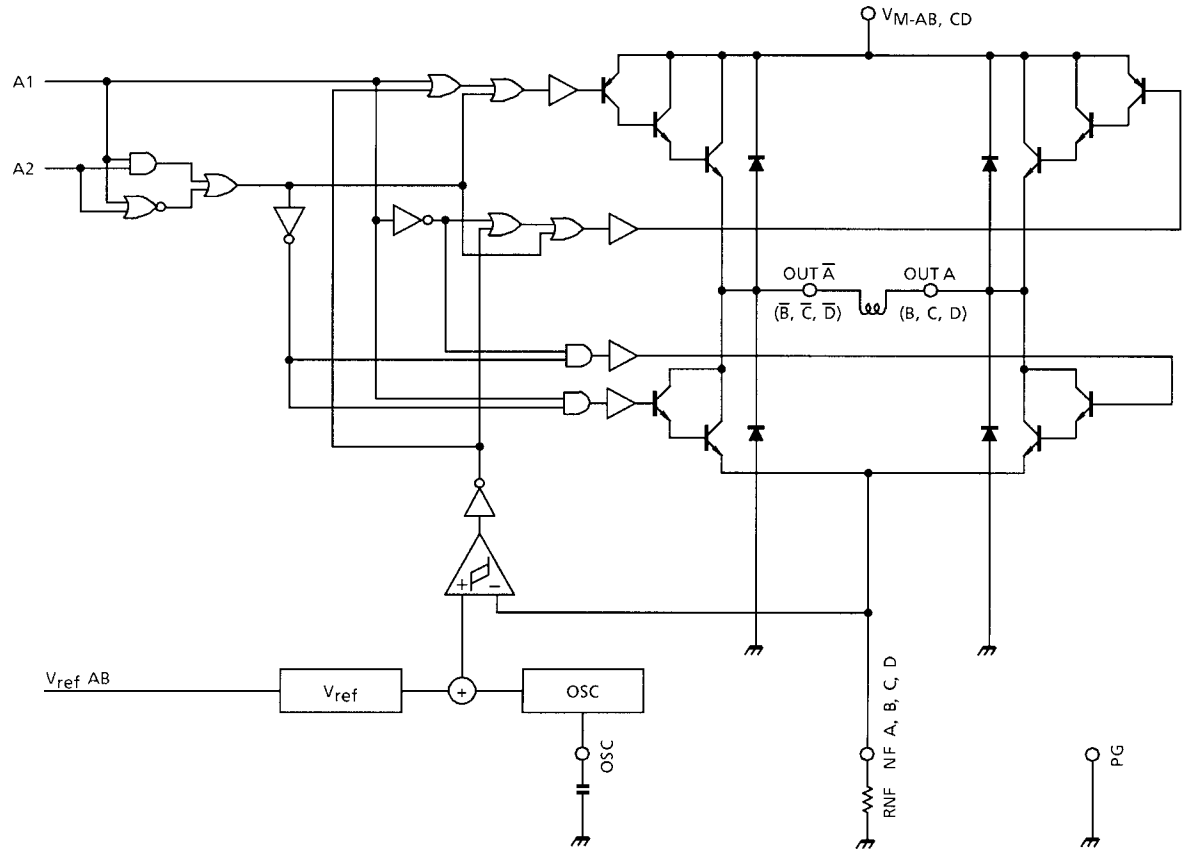
<table>
<tr><th colspan="3">Serial Input
Signal Train</th><th>Control</th><th>Operation</th></tr>
<tr><td rowspan="12"></td><td>1</td><td>E2</td><td rowspan="2">DC Motor Control</td><td rowspan="2">
<table>
<tr><th colspan="2">Input</th><th>Output</th><th rowspan="2">Mode</th></tr>
<tr><th>E1</th><th>E2</th><th>E</th></tr>
<tr><td>L</td><td>L</td><td>∞</td><td>STOP</td></tr>
<tr><td>H</td><td>L</td><td>H</td><td>CW/CCW</td></tr>
<tr><td>L</td><td>H</td><td>L</td><td>Brake</td></tr>
<tr><td>H</td><td>H</td><td>∞</td><td>STOP</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>E1</td></tr>
<tr><td>3</td><td>V_{ref} CD</td><td>Stepping motor 2 chopping rate control (V_{ref} CD)</td><td rowspan="2">V_{ref} = 0.7 V Typ. (at “H” Mode)
= 0.55 V Typ. (at “L” Mode)</td></tr>
<tr><td>4</td><td>V_{ref} AB</td><td>Stepping motor 1 chopping rate control (V_{ref} AB)</td></tr>
<tr><td>5</td><td>D2</td><td rowspan="4">Stepping motor 2 control (OUT C, D)</td><td rowspan="4">
<table>
<tr><th colspan="2">Input</th><th colspan="2">Output</th><th rowspan="2">Mode</th></tr>
<tr><th>A1</th><th>A2</th><th>A</th><th>$\overline{A}$</th></tr>
<tr><td>L</td><td>L</td><td>∞</td><td>∞</td><td>STOP</td></tr>
<tr><td>H</td><td>L</td><td>H</td><td>L</td><td>CW/CCW</td></tr>
<tr><td>L</td><td>H</td><td>L</td><td>H</td><td>CCW/CW</td></tr>
<tr><td>H</td><td>H</td><td>∞</td><td>∞</td><td>STOP</td></tr>
</table>
B1, B2 → B, $\overline{B}$
C1, C2 → C, $\overline{C}$
D1, D2 → D, $\overline{D}$ are all the same.
</td></tr>
<tr><td>6</td><td>D1</td></tr>
<tr><td>7</td><td>C2</td></tr>
<tr><td>8</td><td>C1</td></tr>
<tr><td>9</td><td>B2</td><td rowspan="4">Stepping motor 1 control (OUT A, B)</td></tr>
<tr><td>10</td><td>B1</td></tr>
<tr><td>11</td><td>A2</td></tr>
<tr><td>12</td><td>A1</td></tr>
</table>

∞: High impedance

Serial I/F Timing Chart



Output Stage 1, 2 1/2 Circuit



Function (Comp.$^{+}$ > Comp.$^{-}$)

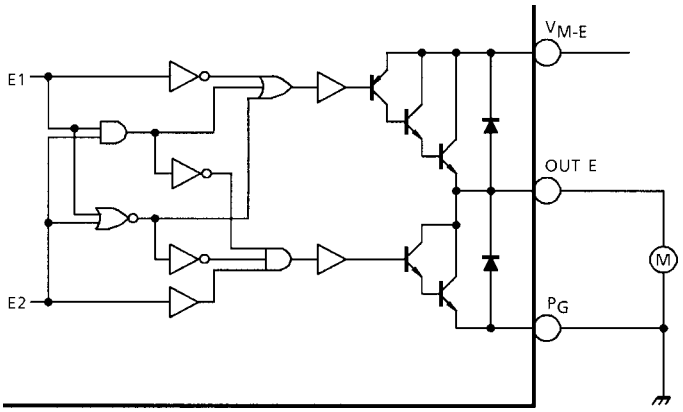
A1	A2	A	$\overline{A}$	Mode
L	L	∞	∞	STOP
H	L	H	L	CW/CCW
L	H	L	H	CCW/CW
H	H	∞	∞	STOP

∞: High impedance

Note 1: In case of Comp.$^{+}$ < Comp.$^{-}$, Upper side Power Transistor turned off.

Note 2: Flywheel diode connects between Output A terminal and GND is required for stable operations. And also recommend to connect flywheel diodes other Output terminals for reliable operations.

Output Stage 3

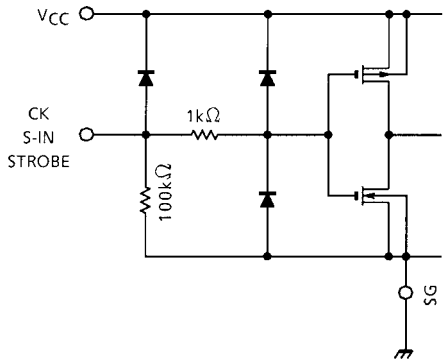


Function

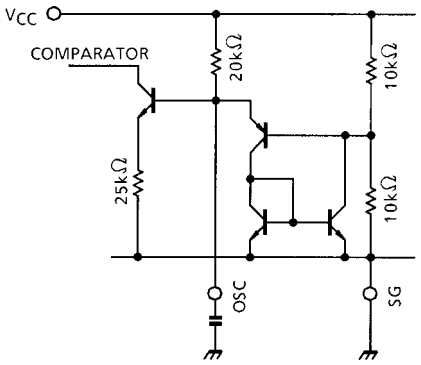
E1	E2	E	Mode
L	L	∞	STOP
H	L	H	CW
L	H	L	BRAKE
H	H	∞	STOP

∞: High impedance

Input Stage (CK, S−IN, STROBE)



OSC Stage (OSC)



$$f_{OSC} = \frac{1}{21.4C_{OSC}} \langle kHz \rangle$$

C_{OCS} : μF

Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Supply voltage (motor)	V_M	30	V
Supply voltage (control)	V_{CC}	5.5	V
Input voltage	V_{IN}	5.5	V
Output current	I_{O1}, I_{O2}	0.8	A
	I_{O3}	0.6	
Power dissipation	P_D	16.2 (Note 1)	W
		2.5 (Note 2)	
Operating temperature	T_{opr}	−40 to 85	°C
Storage temperature	T_{stg}	−55 to 150	°C

Note 1: Tc = 85°C

Note 2: No heat sink

Recommended Operation Condition

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Supply voltage (control)		V_{CC}	—	4.5	5.0	5.5	V
Supply voltage (motor)		V_M	—	21.6	24	26.4	V
Input voltage		V_{IN}	—	0	—	V_{CC}	V
Output current	I_{OUT} A, B, C, D	I_{OUT}	Ta = 0 to 70°C V_{CC} = 5 V V_M = 24 V	—	—	0.7	A
	I_{OUT} E			—	—	0.4	
Clock frequency		f_{CK}		—	—	1.0	MHz
		f_{STROBE}		—	—	1.0	
Clock pulse width		$t_{w\,CK}$		500	—	—	ns
		$t_{w\,STROBE}$		500	—	—	
Data set up time		t_{su}		250	—	—	ns
Data hold time		t_H		250	—	—	ns
PWM oscillation frequency		f_{PWM}		20	—	100	kHz

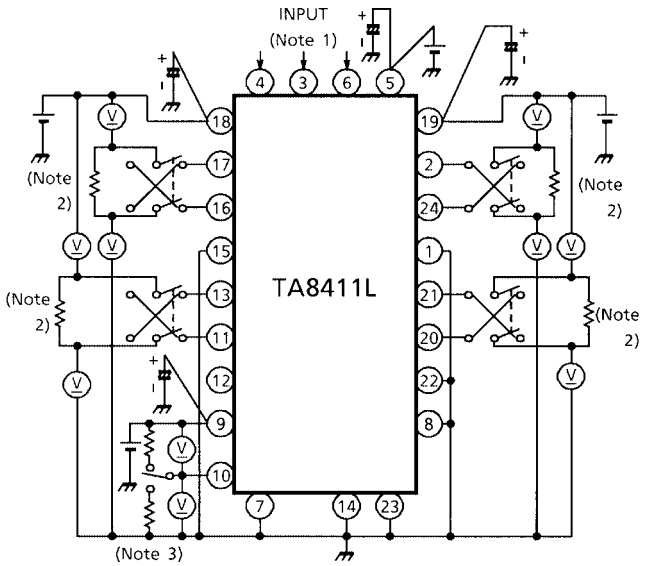
Electrical Characteristics
Output stage (Ta = 25°C, V_{CC} = 5 V, V_M = 24 V)

Characteristics		Symbol	Test Circuit	Test Condition		Min	Typ.	Max	Unit
Operation power supply voltagege		$V_{M\,(opr)}$	—	—		0	—	27	V
Saturation voltage	AB DC	$V_{CE\,(SAT)}$ upper	1	I_{OUT} = 0.7 A	Output − V_{CC}	—	2.0	2.5	V
				I_{OUT} = 0.5 A		—	1.8	2.3	
	AB CD	$V_{CE\,(SAT)}$ lower	1	I_{OUT} = 0.7 A	Output − NF	—	1.5	2.0	
				I_{OUT} = 0.5 A		—	1.3	1.8	
	E	$V_{CE\,(SAT)}$ upper	1	I_{OUT} = 0.5 A	Output − V_{CC}	—	1.8	2.3	
				I_{OUT} = 0.3 A		—	1.7	2.2	
	E	$V_{CE\,(SAT)}$ lower	1	I_{OUT} = 0.5 A	Output − NF	—	1.5	2.0	
				I_{OUT} = 0.3 A		—	1.2	1.7	
Output leak current		I_{OL-H}	2	V_{CE} = 30 V		—	—	50	μA
		I_{OL-L}				—	—	50	
Clamp diode forward voltage	AB CD	V_{F-U}	3	I_F = 700 mA	Output A to D	—	1.6	2.0	V
		V_{F-L}				—	1.6	2.0	
	E	V_{F-U}	3	I_F = 500 mA	Output E	—	1.5	1.9	
		V_{F-L}				—	1.7	2.1	
Propagation delay time (ST−OUT)		t_P	7	—		—	600	—	ns

Small signal stage (Ta = 25°C, V_{CC} = 5 V, V_M = 24 V)

Characteristics		Symbol	Test Circuit	Test Condition		Min	Typ.	Max	Unit
Operating supply voltage		$V_{(opr)}$	—	—		4.5	—	5.5	V
Quiescent current		I_{CC1}	4	V_{CC} = 5 V output open	Output off mode	—	26.0	40	mA
		I_{CC2}			Output on mode: output stage 1 or 2	—	26.0	40	
		I_{CC3}			Output on mode: output stage 1 and 2	—	24.0	37	
		I_{CC4}			Output on mode: output stage 3	—	25.0	38	
Input voltage	"H" level	$V_{IN\,H}$	—	V_{CC} = 5.0 V	CK, S−IN STROBE	3.5	—	V_{CC}	V
	"L" level	$V_{IN\,L}$				−0.4	—	1.5	
Input current	"H" level	$I_{IN\,H}$	5	V_{CC} = 5.0 V	$V_{IN\,H}$ = 5.5V	—	55	150	μA
					$V_{IN\,H}$ = 3.5V	—	35	100	
	"L" level	$I_{IN\,L}$			$V_{IN\,L}$ = 1.5V	—	15	50	
V_{ref}	"H" level	$V_{ref\,H}$	6	Tj = − 40~125°C C_{OSC} = 3300 pF R_{NF} = 3.3 Ω L = 19.5 mH	$V_{ref\,IN}$ = "H"	0.6	0.7	0.8	V
	"L" level	$V_{ref\,L}$			$V_{ref\,IN}$ = "L"	0.45	0.55	0.65	
V_{ref} level differential voltage		ΔV_{ref}	6	$V_{ref\,(H)}$ − $V_{ref\,(L)}$		—	0.15	—	V
Reset voltage		V_{CCR}	—	—		3.4	3.9	4.4	V
PWM oscillation frequency		f_{PWM}	—	—		10	—	200	kHz
Clock frequency		f_{CK}	7	—		—	—	1.5	MHz
		f_{STROBE}	7	—		—	—	1.5	
Min. clock width		t_{CK}	7	—		340	—	—	ns
		t_{STROBE}	7	—		340	—	—	
Data set up time		t_{SU}	7	—		170	—	—	ns
Data hold up time		t_H	7	—		170	—	—	ns

Test Circuit 1 $V_{CE\ (SAT)}$ Upper, Lower

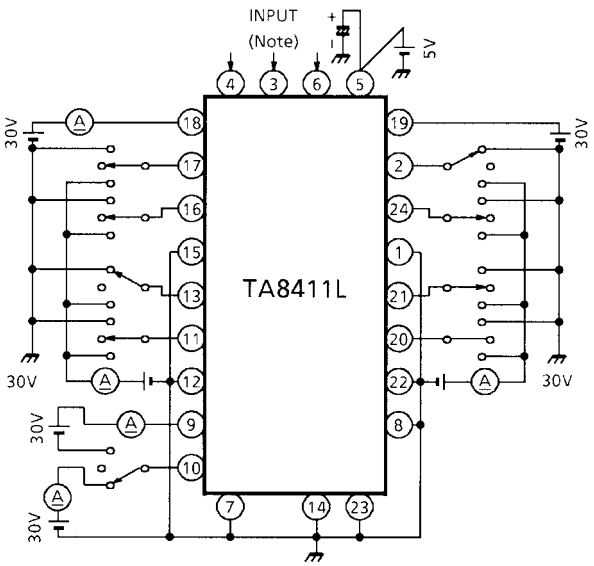


Note 1: Set up a mode in such a way that the transistor at the output stage is turned on.

Note 2: Calibrate Output Current becomes 0.5 A (or 0.7A) with this resistor.

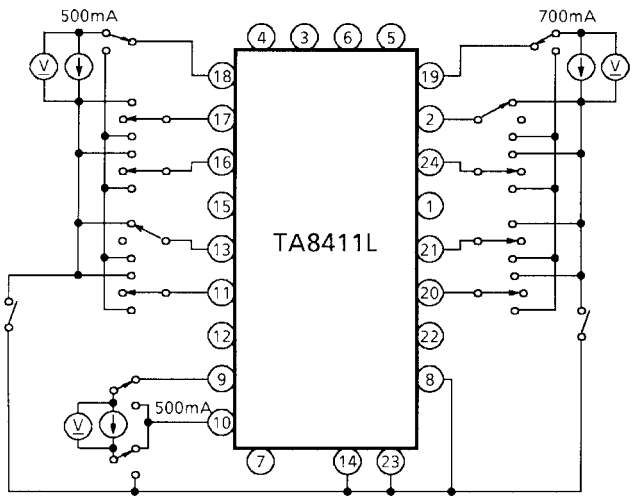
Note 3: Calibrate Output Current becomes 0.3 A (or 0.5A) with this resistor.

Test Circuit 2 I_{OL-H}, I_{OL-L}

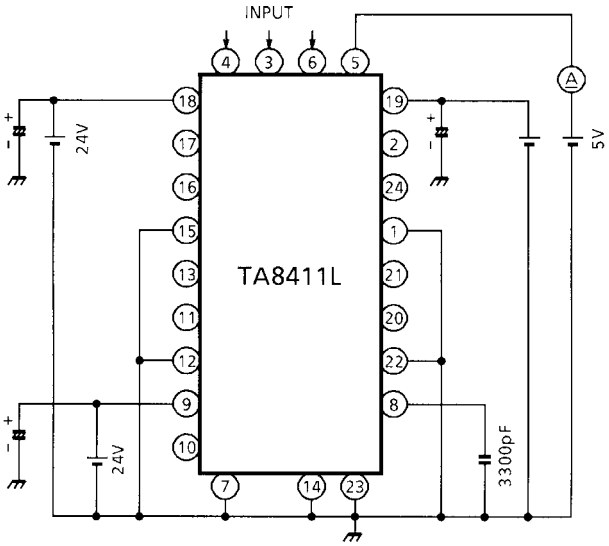


Note: Keep the output off by supplying a low level to all of the S-IN, CK, and STROBE signal pins.

Test Circuit 3 V_{F-U}, V_{F-L}

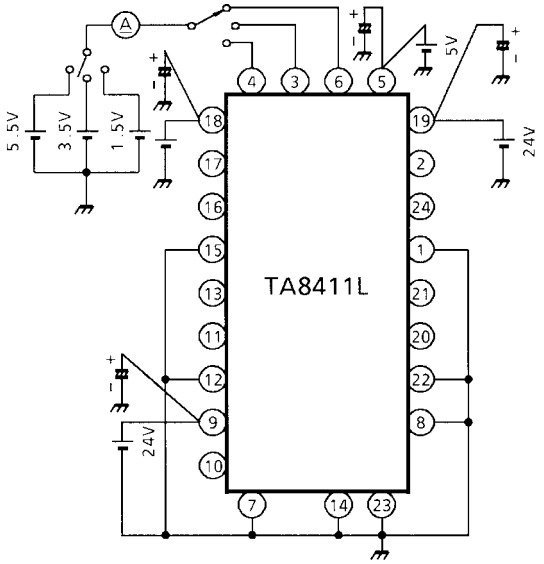


Test Circuit 4 $I_{CC1, 2, 3, 4}$

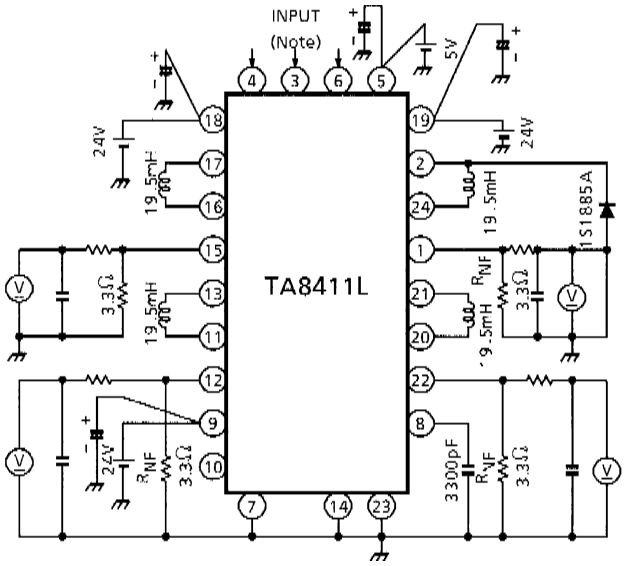


Note: Not to take a GND with any non−connecting Pins.

Test Circuit 5 I_{INH}, I_{INL}



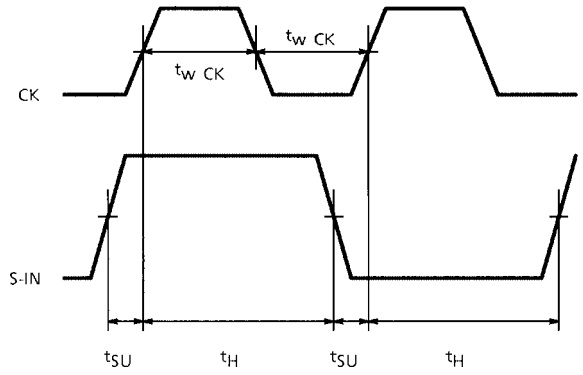
Test Circuit 6 V_{ref-H}, V_{ref-L}, ΔV_{ref}



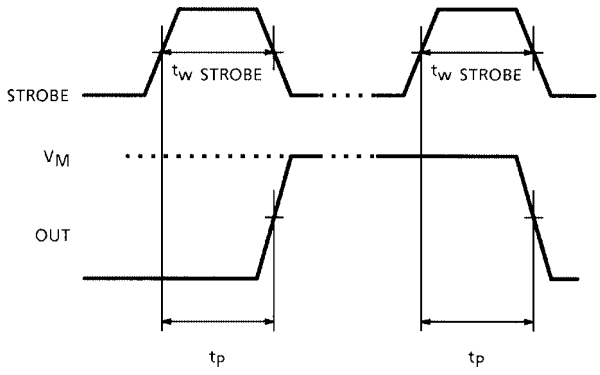
Note: Hold the state (2 Phase excitation mode) and measure.

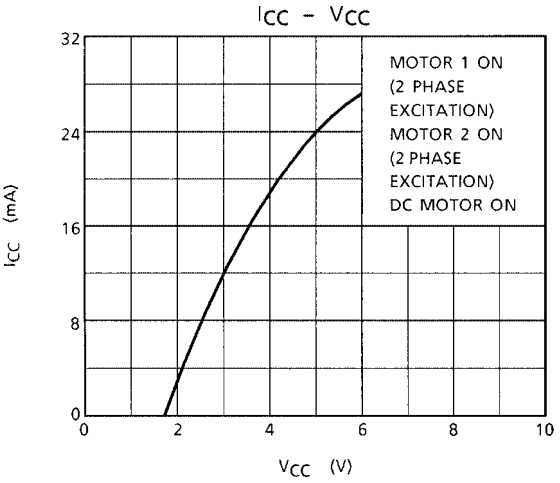
AC Electrical Characteristic Measurement Waveform

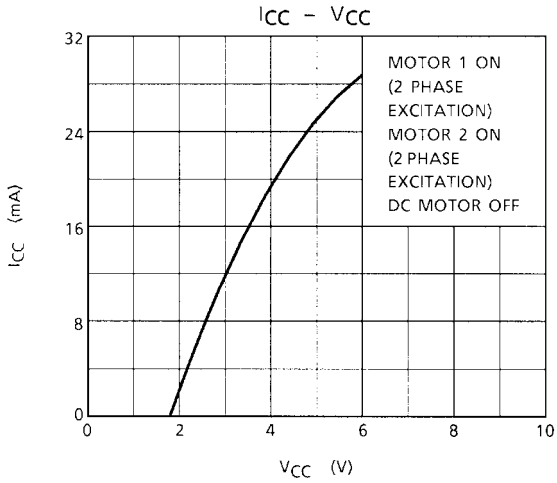
7-1 CK-S-IN

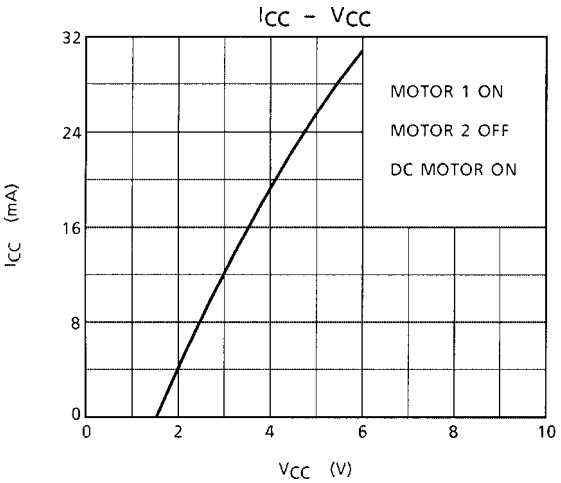


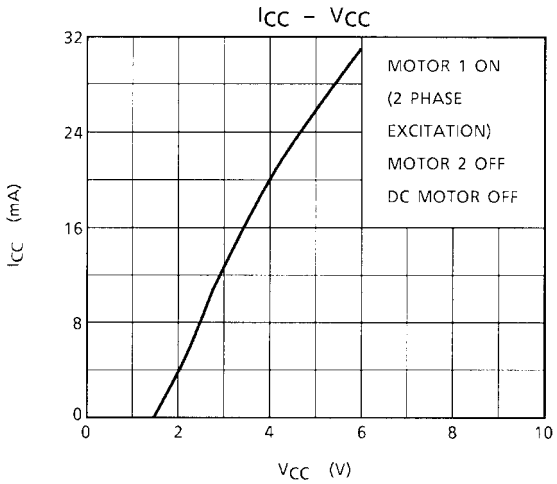
7-2 STROBE-OUT

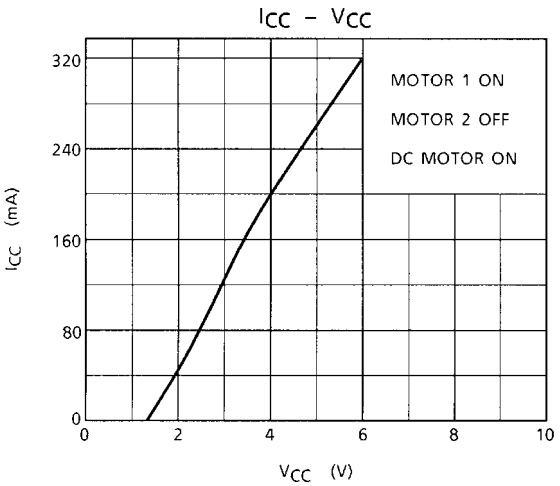


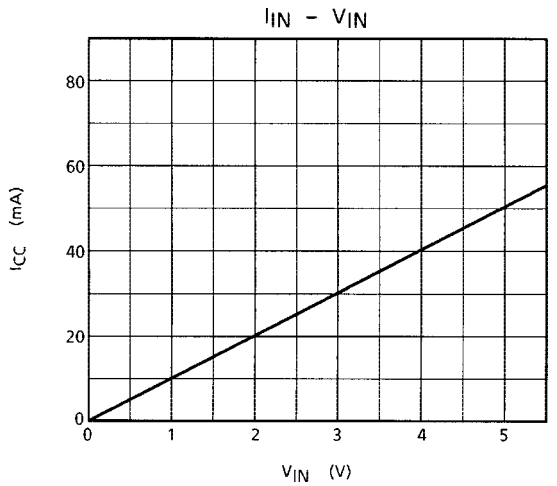

ICC – VCC
MOTOR 1 ON
(2 PHASE
EXCITATION)
MOTOR 2 ON
(2 PHASE
EXCITATION)
DC MOTOR ON
ICC (mA)
VCC (V)
0
8
16
24
32
0
2
4
6
8
10


ICC – VCC
MOTOR 1 ON
(2 PHASE
EXCITATION)
MOTOR 2 ON
(2 PHASE
EXCITATION)
DC MOTOR OFF
ICC (mA)
VCC (V)
0
8
16
24
32
0
2
4
6
8
10

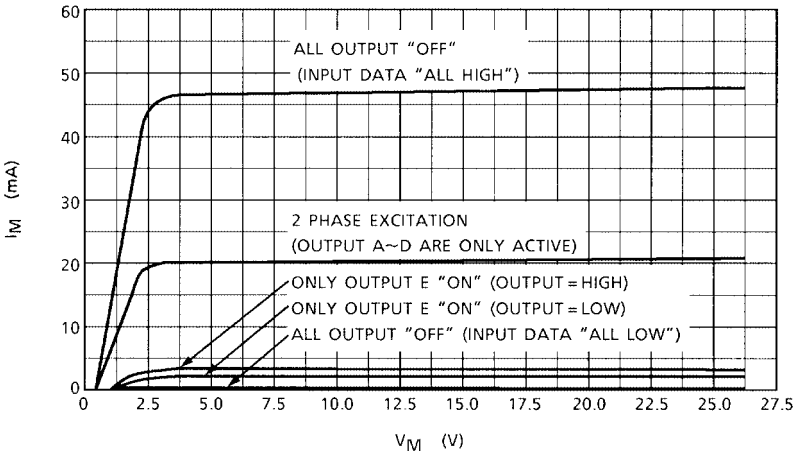

ICC – VCC
MOTOR 1 ON
MOTOR 2 OFF
DC MOTOR ON
ICC (mA)
VCC (V)
0
8
16
24
32
0
2
4
6
8
10


ICC – VCC
MOTOR 1 ON
(2 PHASE
EXCITATION)
MOTOR 2 OFF
DC MOTOR OFF
ICC (mA)
VCC (V)
0
8
16
24
32
0
2
4
6
8
10


ICC – VCC
MOTOR 1 ON
MOTOR 2 OFF
DC MOTOR ON
ICC (mA)
VCC (V)
0
80
160
240
320
0
2
4
6
8
10

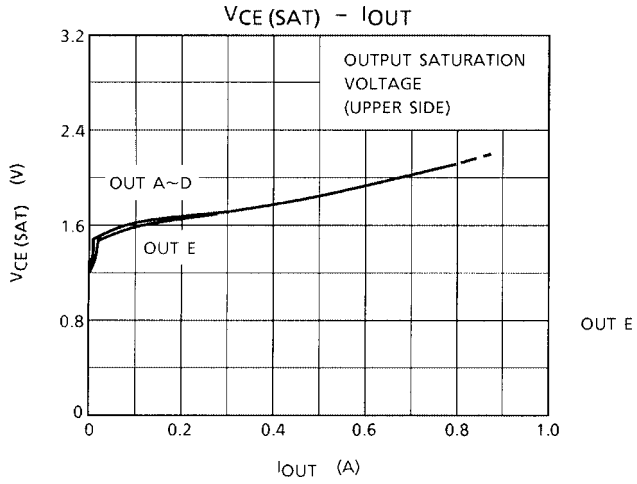

IIN – VIN
ICC (mA)
VIN (V)
0
20
40
60
80
0
1
2
3
4
5

I_M – V_M (OUTPUT "OPEN")



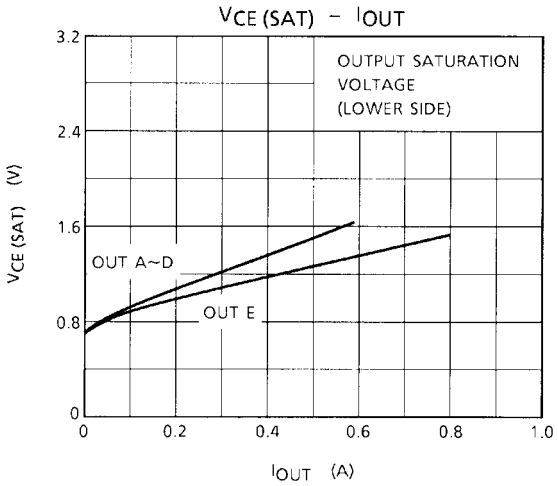
Note: $I_M = I_{M-AB} + I_{M-CD} + I_{M-E}$

$V_{CE(SAT)}$ – I_{OUT}

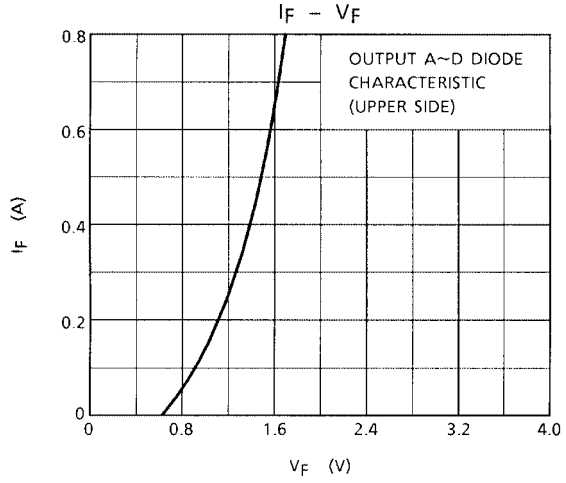


OUT E

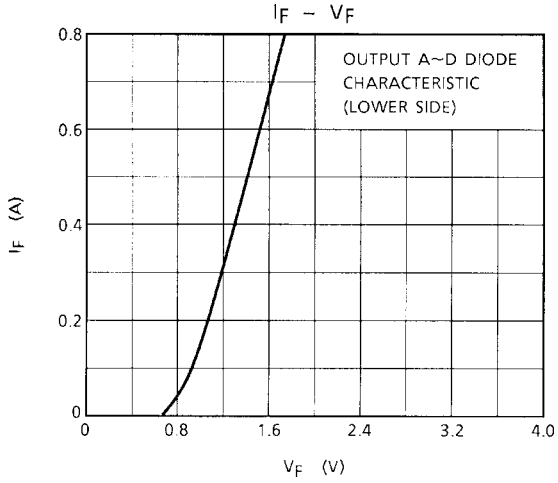
$V_{CE(SAT)}$ – I_{OUT}



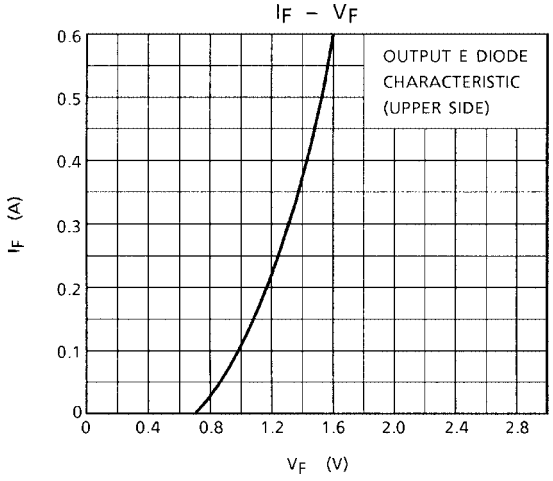
I_F – V_F



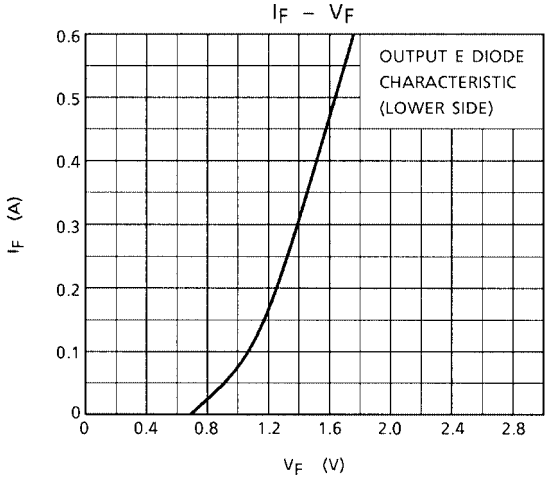
I_F – V_F



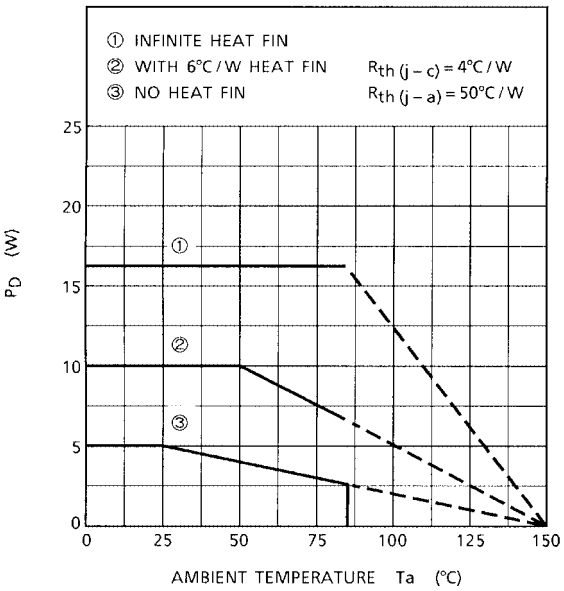
$I_F - V_F$



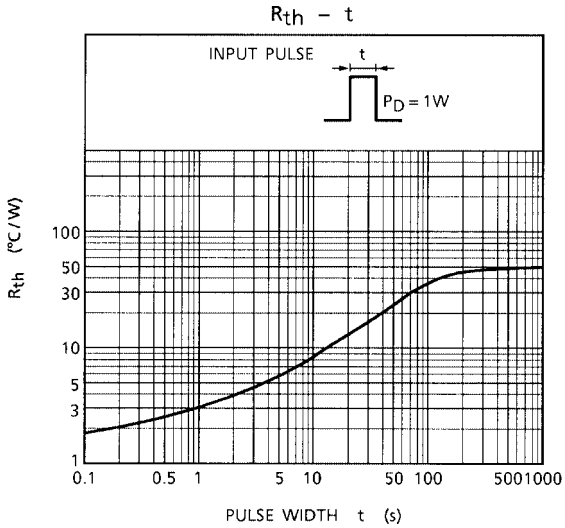
$I_F - V_F$



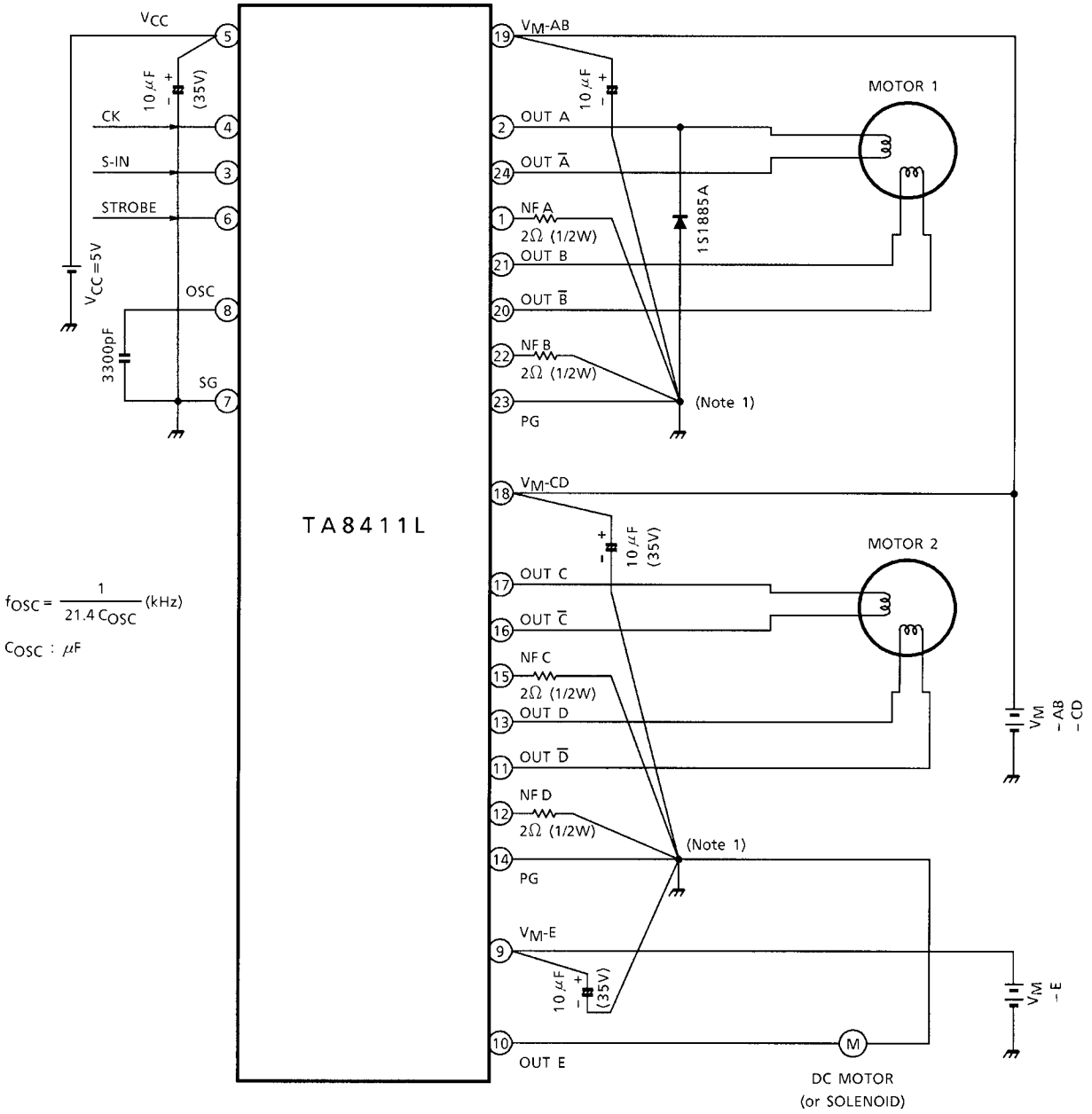
$P_D - Ta$



$R_{th} - t$



Application Circuit

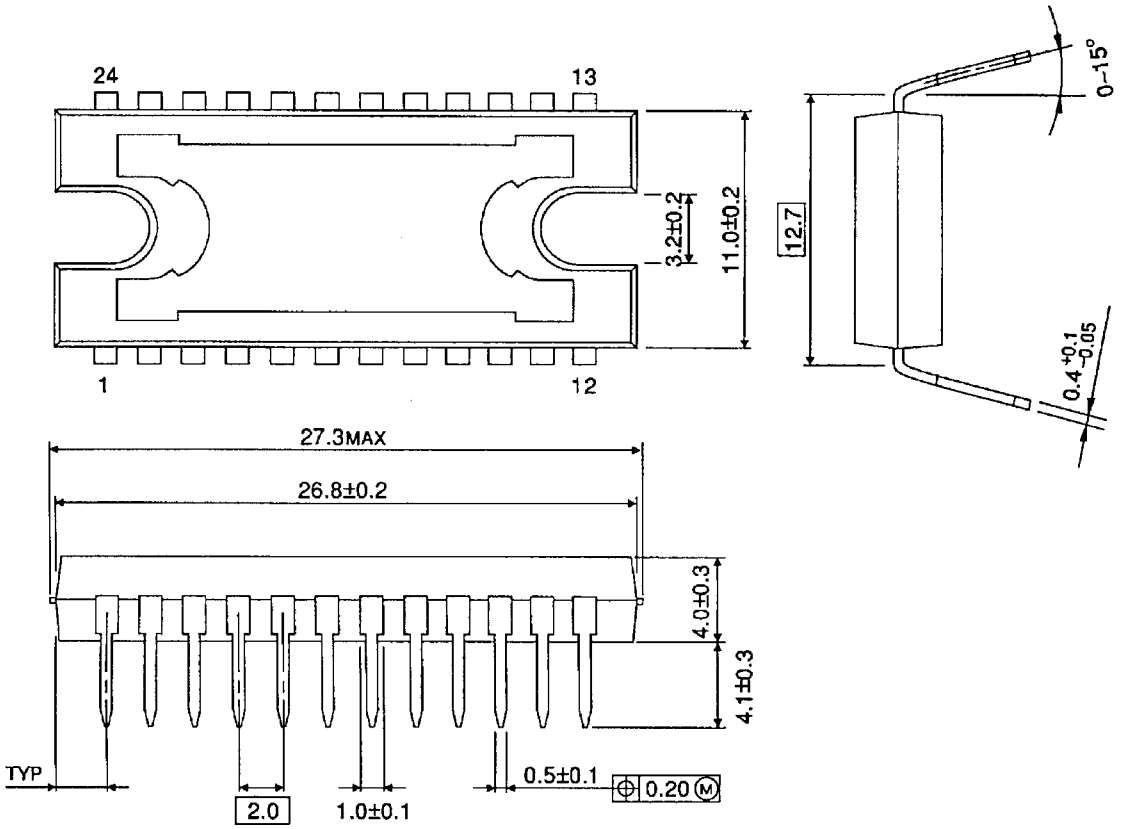


Note 1: We recommend that each NF pin be grounded at only one PG pin separately from the other NF pins. Always connect a flywheel diode across the OUT A pin and a ground. It is recommended that a flywheel diode be connected also between each of the other output pins and a ground

Note 2: Utmost care is necessary in the design of the output line, V_{CC} (V_M, V_S, V_{EE}) and GND line since IC may be destroyed due to short−circuit between outputs, to supply, or to ground.

Package Dimensions

HDIP24-P-500-2.00 Unit : mm



Weight: 4.30 g (typ.)

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030619EBA

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