AP1014AEC

7.0V Dual H-Bridge Motor Driver IC

1. Genaral Description

The AP1014AEC has four drive mode of forward, reverse, brake and standby by 2 channel H-bridge Motor Driver corresponding to operating voltage 7.0V. It is possible to set to the input logic which was suitable for the PWM drive with the SEL terminal. The AP1014AEC layout N-ch LDMOS FET in high side and low side in output circuit and realize a small WL-CSP package. Also it has under voltage detection and thermal shut down circuits. It is suitable for driving various small motor.

2. Features

- Control Supply Voltage 2.7V to 5.5V
- Wide Motor Drive Operating Voltage 2.0V to 7.0V
- Maximum Output Current (DC) 1.1A @Ta=25°C, 0.8A @Ta=85°C
- Maximum Output Current (Peak) 2.0A (Ta=25°C, 10ms/200ms)
- H-Bridge ON Resistance RON (TOP+BOT)=0.35Ω @Ta=25°C
- Built-in Under Voltage Detection Circuit Detect VC Supply Voltage under 2.2V
- Built-in Thermal Shut Down Circuit (Tj) 175°C
- Junction Temperature 150°C
- Package 16-pin WL-CSP (1.96mm×1.96mm)

3. Table of Contents

4. Block Diagram

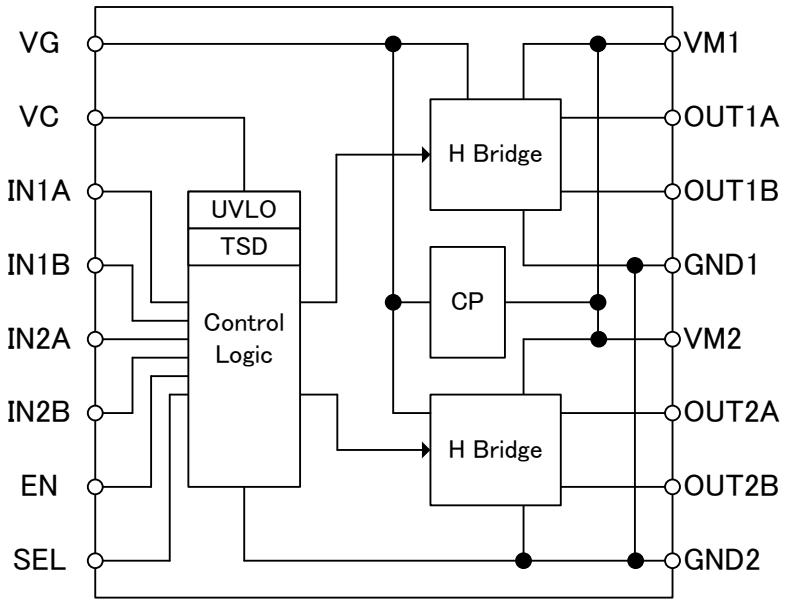


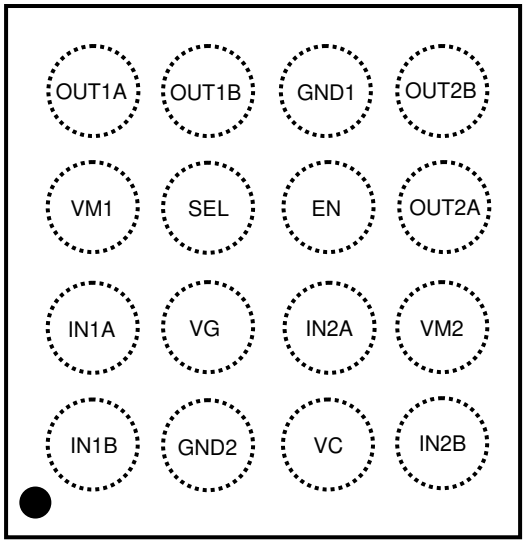
Figure 1. Block Diagram

5. Ordering Guide

AP1014AEC	-30~85℃	16-pin WL-CSP (1.96mm×1.96mm)

6. Pin Configurations and Functions

■ Pin Configurations



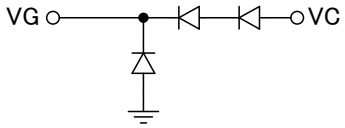
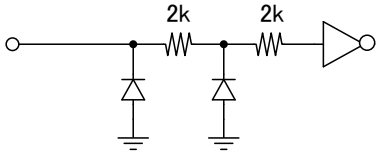
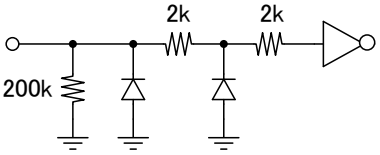
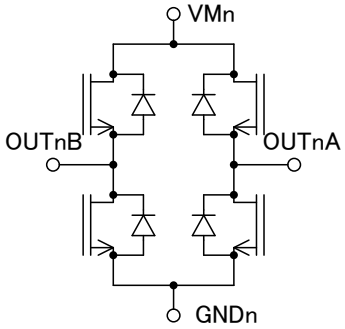
(Top View)

■ Function

Pin Number	Name	I/O (Note 1)	Functions	Remark
A1	IN1B	I	Control signal input terminal	
A2	IN1A	I	Control signal input terminal	
A3	VM1	P	Motor driver power supply	
A4	OUT1A	O	Motor driver output Terminal	
B1	GND2	P	Power ground terminal	
B2	VG	P	Charge pump output capacitor connection terminal	
B3	SEL	I	Input logic selection pin	200kΩ Pull-down
B4	OUT1B	O	Motor driver output Terminal	
C1	VC	P	Control power supply	
C2	IN2A	I	Control signal input terminal	
C3	EN	I	Enable signal input terminal	200kΩ Pull-down
C4	GND1	P	Power ground terminal	
D1	IN2B	I	Control signal input terminal	
D2	VM2	P	Motor driver power supply	
D3	OUT2A	O	Motor driver output Terminal	
D4	OUT2B	O	Motor driver output Terminal	

Note 1. I (Input terminal), O (Output terminal) and P (Power terminal)

■ Terminal Equivalent Circuit

Pin name	Name	Functions	Equivalent Circuits
C1	VC	Control power supply	
A3 D2	VM1 VM2	Motor driver power supply VM1 and VM2 are short-circuited inside IC.	
B2	VG	Charge pump output	
A2 A1 C2 D1	IN1A IN1B IN2A IN2B	Control signal input	
C3 B3	EN SEL	Logic input (Built-in 200kΩ pull-down resistor)	
A4 B4 D3 D4	OUT1A OUT1B OUT2A OUT2B	Motor driver output	
C4 B1	GND1 GND2	Ground terminal GND1 and GND2 are short-circuited inside IC.	

7. Absolute Maximum Ratings

Parameter	Symbol	min	max	Unit	Condition
Control supply voltage	VC	-0.5	6	V	
Motor supply voltage	VM	-0.5	7.5	V	VC = 2.7~5.5V
VC level terminal voltage (INnA, IN1nB, SEL and EN)	Vterminal1	-0.5	VC	V	
VM level terminal voltage (OUTnA and OUTnB)	Vterminal2	-0.5	VM	V	
VC+VM level terminal voltage (VG)	Vterminal3	-0.5	13.5	V	
Maximum output current @ 2ch drive	IloaddcMD	-	1.1	A/ch	Ta=25℃
		-	0.8	A/ch	Ta=85℃
Maximum output current @ 1ch drive	IloaddcMD	-	1.5	A	Ta=25℃
		-	1.1	A	Ta=85℃
Maximum output peak current	IloadpeakMD	-	2.0	A	Under 10ms in 200ms
Power dissipation	PD	-	1760	mW	Ta=25℃ (Note 3)
		-	915	mW	Ta=85℃ (Note 3)
Operating Temperature range	Ta	-30	85	℃	
Junction temperature	Tj		150	℃	
Storage temperature	Tstg	-65	150	℃	

Note 2. All above voltage is defined to GNDn=0V.

Note 3. When the 2-layer board is used. This is calculated RθJ = (71)°C /W.

WARNING: Operation at or beyond these limits may result in permanent damage to the device.
Normal operation is guaranteed at these extremes.

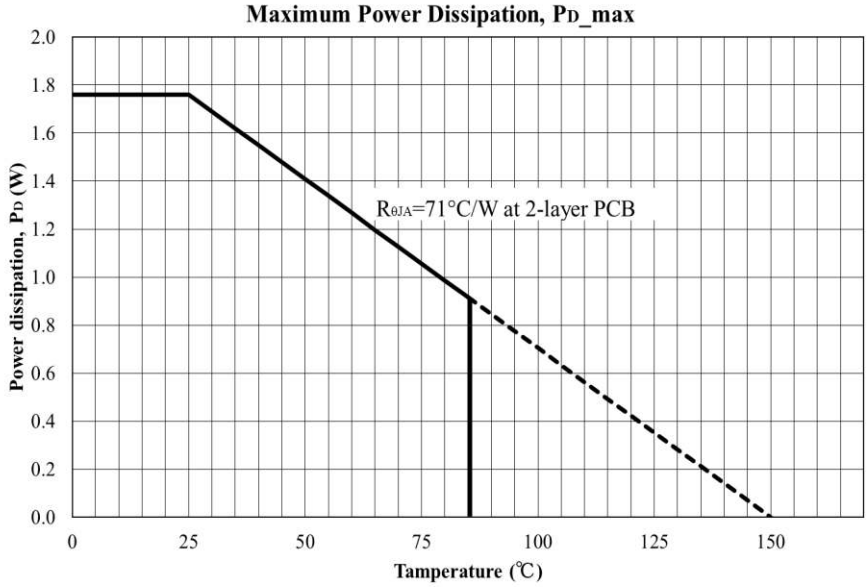


Figure 2. Maximum Power Dissipation

8. Recommended Operating Conditions

(Ta = 25℃, unless otherwise specified)

Parameter	Symbol	min	typ	max	Unit	Condition
Control supply voltage	VC	2.7	3.0	5.5	V	
Motor driver supply voltage	VM	2.0	5.0	7.0	V	
Input pulse frequency	Fin	-	-	200	kHz	50%duty

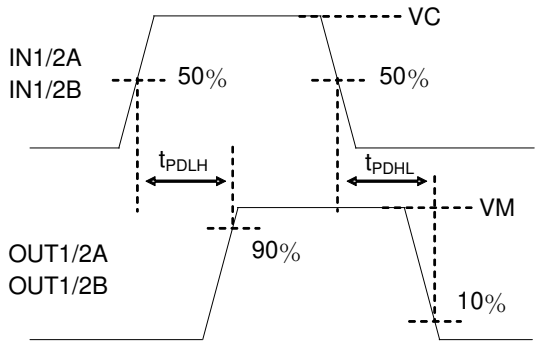
9. Electrical Characteristics

(Ta = 25℃, VM=5.0V, VC = 3.0V, unless otherwise specified)

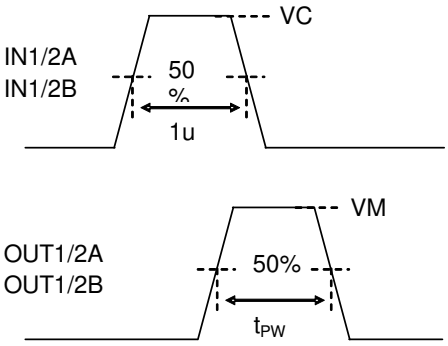
Parameter	Symbol	Condition	min	typ	max	Unit
Charge pump						
Charge pump voltage	VG	VG=VC+VM	7.0	7.5	8.0	V
Charge pump wake up time	tVG_{ON}	VG=VC+VM-1.0V	-	0.3	3.0	ms
VDET						
VC under voltage detect voltage	VC_{DETLV}		1.9	2.2	2.5	V
TSD						
Thermal shut down temperature (Note 4)	T_{DET}		150	175	200	℃
Temperature hysteresis (Note 4)	T_{DETHYS}		20	30	40	℃
Quiescent current						
VM quiescent current at power off	I_{VMPOFF}	EN="L" All internal circuits are power off.	-	-	1.0	μA
VC quiescent current at power off	I_{VCPOFF}		-	-	1.0	μA
VM quiescent current at standby	I_{VMSTBY}	EN="H", SEL="L" INnA="L", INnB="L"	-	40	200	μA
VC quiescent current at standby	I_{VCSTBY}		-	150	500	μA
VC quiescent current at PWM operation	I_{VCPWM}	f_{PWM}=200kHz, Duty=50%	-	0.5	1.5	mA
Motor Driver						
Driver on resistance (High side + Low side)	R_{ON1}	Iload=100mA, Ta=25℃	-	0.35	0.46	Ω
Driver on resistance (High side + Low side) (Note 4)	R_{ON2} Design certification	Iload=0.7A, Ta=25℃	-	0.38	0.53	Ω
Driver on resistance (High side + Low side) (Note 4)	R_{ON3} Design certification	Iload=0.7A, Ta=85℃	-	0.48	0.72	Ω
Body diode forward voltage	V_{FMD}	I_F=100mA	-	0.8	1.2	V
Control logic						
Input High level voltage (INnA, INnB, SEL and EN)	V_{IH}	VC=2.7V~5.5V	0.7×VC	-	-	V
Input Low level voltage (INnA, INnB, SEL and EN)	V_{IL}		-	-	0.3×VC	V
Input High level current (SEL and EN)	IIH	V_{IH}=3.0V	9	15	21	μA

Parameter	Symbol	Condition	min	typ	max	Unit
Input Low level current (INnA and INnB)	IIL	V_{IL}=0V	-1.0	-	-	µA
Input pulse rize time (INnA and INnB)	tr	VC=2.7V~5.5V	-	-	1.0	µs
Input pulse fall time (INnA and INnB)	tf		-	-	1.0	µs
H-Bridge propagation delay time (INnB="L"→OUTnA="H") (Figure 3(a))	tPDLH	1kΩ Load between OUTnA and OUTnB. SEL="L", NnA = "H", INnB = 200kHz	-	-	0.5	µs
H-Bridge propagation delay time (INnB="H"→OUTnA="L") (Figure 3(a))	tPDHL		-	-	0.5	µs
H-Bridge propagation delay time (Hi-Z→"H") (Note 4) (Figure 3(c))	tPDZH	10Ω Load between OUTnA/B and GND. 10Ω Load between OUTnA/B and VM. The time from 50% input to 90% output	-	-	0.5	µs
H-Bridge propagation delay time (Hi-Z→"L") (Note 4) (Figure 3(d))	tPDZL	10Ω Load between OUTnA/B and GND. 10Ω Load between OUTnA/B and VM. The time from 50% input to 10% output	-	-	0.5	µs
H-bridge output pulse width (Note 4) (Figure 3 (b))	tPW	20Ω Load between OUTA and OUTB. input pluse width : 1µs	0.7	-	1.5	µs

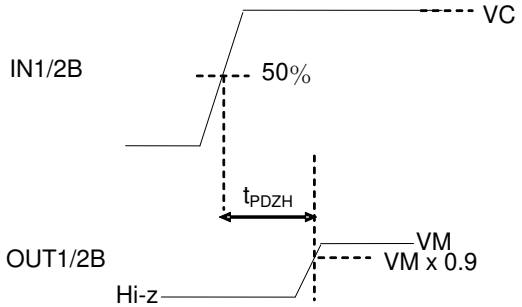
Note 4. Not tested in production.



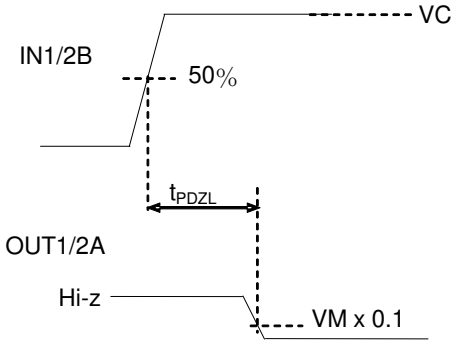
(a) Propagation delay time



(b) Pulse width



(c) Hi-z →"H" :Propagation delay time
(SEL pin = "L", INnA = "L")



(d) Hi-z→"L" :Propagation delay time
(SEL pin = "L", INnA = "L")

Figure 3. Time chart of propagation delay time and pulse width

10. Description

The relations of the input and output with each mode are as follows.

Table 1.

Input				Output		Motion
EN	SEL	INnA	INnB	OUTnA	OUTnB	
H	L	L	L	Z	Z	Standby (Idling)
		L	H	L	H	Reverse
		H	L	H	L	Forward
		H	H	L	L	Brake (Stop)
	H	L	X	L	L	Brake (Stop)
		H	L	H	L	Forward
		H	H	L	H	Reverse
L	X	X	X	Z	Z	Power off (Idling)

11. Recommended External Circuits

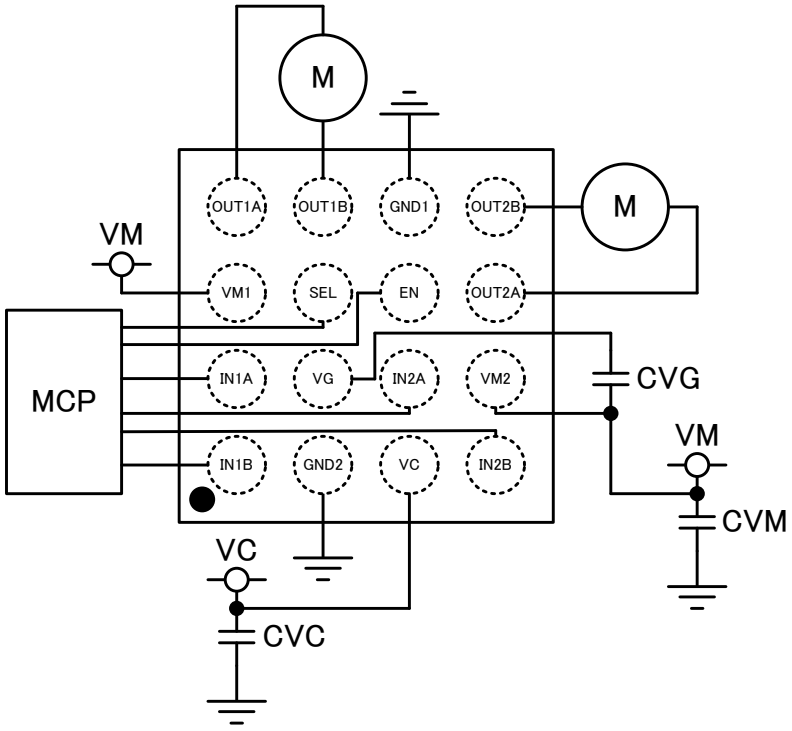


Figure 4. Recommended External Circuits (Top view)

Table 2. Recommended external components example

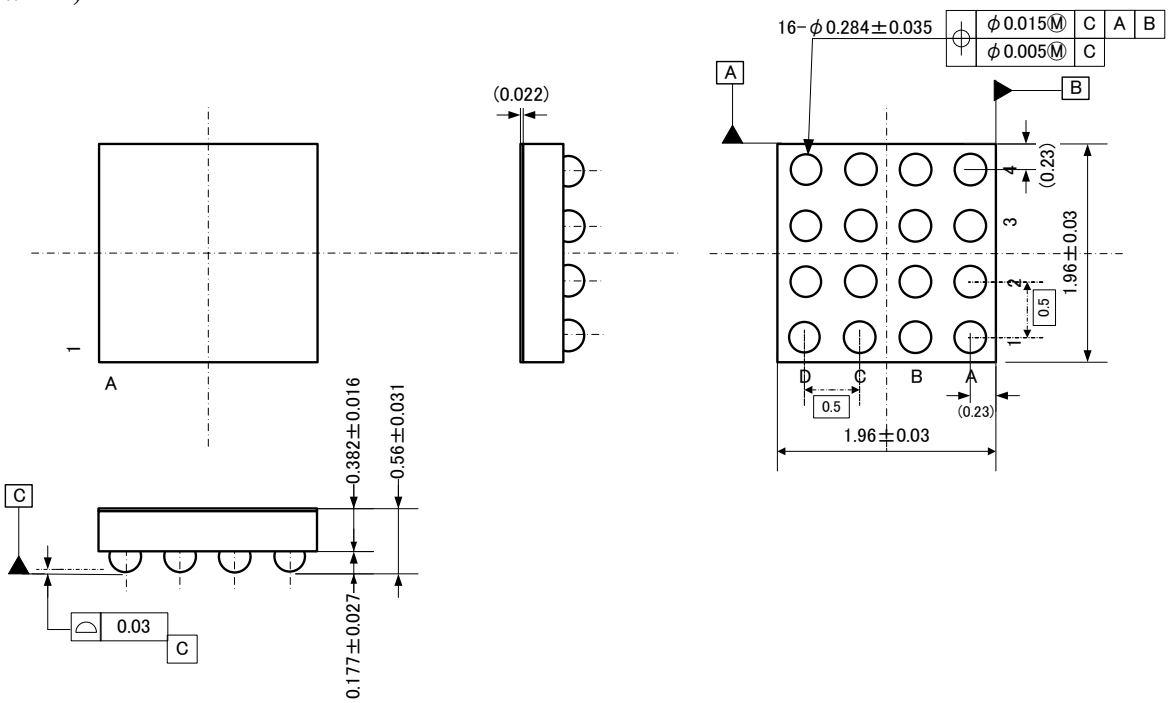
Items	Symbol	min	typ	max	unit	Comments
Motor driver power supply connection decupling capacitor	CVM	1.0	10	-	µF	(Note 6)
Control power supply connection bypass capacitor	CVC	0.1	1.0	-	µF	(Note 6)
Charge pump capacitance	CVG	0.047	0.1	0.22	µF	

Note 5. Above capacitance is an example. Please choose your best capacitance by checking load current profile, load capacitance and layout resistance and so on, on your own board before you apply.
Note 6. Please adjust the connecting capacitor of CVM and CVC depending on the load current profile, the load capacitance, the line resistance and etc. with each application boards.

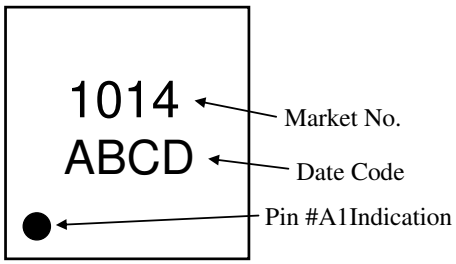
12. Package

■ Outline Dimensions

(Unit: mm)



■ Marking



YWWA: Date code (4 digit)
A: Manage number
WW: Producing week
Y: Producing year (Ex: 2014 → “4”)

13. Revise History

Date (YY/MM/DD)	Revision	Page	Contents
14/03/06	00		First edition
14/08/07	01	8	Propagation delay time (Hi-Z →"H", "H"→Hi-Z)Condition "Time to change from 50% to 75%" → "The time from 50% input to 90% output" "Time to change from 50% to 25%" → "The time from 50% input to 10% output"
		9	Figure3 (Time chart)was added.

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