Pre Driver IC
for single phase Brushless Motor

KA44171A
Product Brief

For additional information or question, please contact Nuvoton Technology Corporation Japan.
www.nuvoton.co.jp

IMPORTANT NOTICE

Regarding the specifications of this product, it is considered that you have agreed to the quality level and disclaimer described below.

Support for industry standards and quality standards

Functional safety standards for automobiles ISO26262	**No**
AECQ-100	**No**
Market failure rate	**50 Fit**

Disclaimer

1. When the application system is designed using this IC, please design the system at your own risk. Please read, consider, and apply appropriate usage notes and description in this standard.
2. When designing your application system, please take into the consideration of break down and failure mode occurrence and possibility in semiconductor products. Measures on the systems such as, but not limited to, redundant design, mitigating the spread of fire, or preventing glitch, are recommended in order to prevent physical injury, fire, social damages, etc. in using the Nuvoton Technology Japan Corporation (hereinafter referred to as NTCJ) products.
3. When using this IC, for each actual application systems, verify the systems and the all functionality of this IC as intended in application systems and the safety including the long-term reliability at your own risk
4. Please use this IC in compliance with all applicable laws, regulations and safety-related requirements that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. NTCJ shall not be held responsible for any damage incurred as a result of this IC being used not in compliance with the applicable laws, regulations and safety-related requirements.
5. This IC does not have any security functions using cryptographic algorithms, such as authentication, encryption, tampering detection.
6. Unless this IC is indicated by NTCJ to be used in applications as meeting the requirements of a particular industry standard (e.g., ISO 9001, IATF 16949, ISO 26262, etc.), this IC is neither designed nor intended for use in such environments for that applications. NTCJ shall not be held responsible for not meeting the requirements of a particular industry standard.
7. Using IC that have been indicated as compliant with industry functional safety standards does not warrant that the application meets the requirements of industry functional safety standards. NTCJ shall not be held responsible for the application compliance with requirements of the particular industry functional safety standard.
8. Unless this IC is indicated by NTCJ to be used in applications as meeting the requirements of a particular quality standard (e.g., AECQ-100, etc.), this IC is neither designed nor intended for use in such the environments for that applications. NTCJ shall not be held responsible for not meeting the requirements of a particular quality standard.
9. In case of damages, costs, losses, and/or liabilities incurred by NTCJ arising from customer's non-compliance with above from 1 to 8, customer will indemnify NTCJ against every damages, costs, losses and responsibility.

Pre Driver IC for single phase Brushless Motor

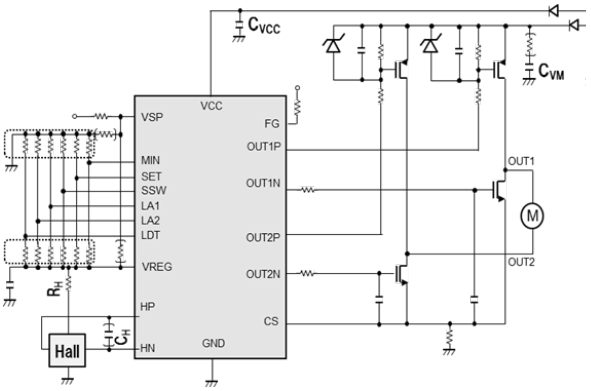
FEATURES

- KA44171A is Pre Driver IC for single phase Brushless Motor. it can apply DC or PWM signal for Motor speed control input. PWM soft switching function and Motor current phase setting can makes Motor current direction switch smoothly, high efficiency and silent driving.
- Wide supply voltage range can use various external power MOSFET. it can drive various Motor using 12V,24,and 48V power supply.
  - Supply voltage range: 5.0V to 36 V
  - Pre Driver for single phase Motor(Pch /Nch MOS FET driving)
  - Phase shift function and Soft switching make high efficiency and silent driving.
  - Some variable functions by A/D input (6ports 5bit) accept various applications.
    Soft switching period, Phase shift, Minimum speed,
    Motor lock detection / release time, Soft start time,
    PWM output frequency.
  - FG pulse or LD (Motor lock detection) output can be selected.
  - Various protection functions.
    Under voltage lock out (UVLO), Thermal protection
    Current limiter, Motor lock detection
  - Small package: QFN 20L (3x3x0.8mm3, Lead Pitch 0.4mm)

APPLICATION

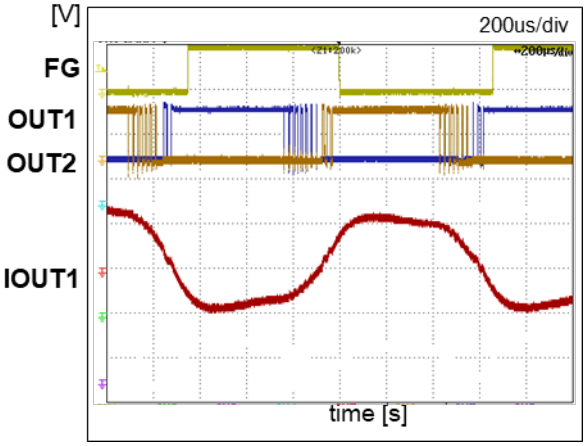
Server, Cellular Base station, Factory automation, Home appliance

TYPICAL APPLICATION



Note: The application circuit is an example. The operation of the mass production set is not guaranteed. Sufficient evaluation and verification is required in the design of the mass production set. The Customer is fully responsible for the incorporation of the above illustrated application circuit in the design of the equipment.

MOTOR DRIVE WAVEFORM



Condition:
VCC = 12V, PWM input duty =100%
CVCC = 10μF

Table of Contents

1. ELECTRICAL CAHARACTERISTICS

1.1 ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit	Notes
Supply voltage	V_{CC}	–0.3 to +39	V	*1
Operating ambient temperature	T_{opr}	–40 to +105	°C	*2
Junction temperature	T_j	–40 to +150	°C	*2
Storage temperature	T_{stg}	–55 to +150	°C	*2
Input Voltage Range	V_{VSP}, V_{HP}, V_{HN}	–0.3 to +6	V	—
	V_{CS}	+6	V	—
	V_{MIN}, V_{SET}, V_{SSW}, V_{LA1}, V_{LA2}, V_{LDT}	–0.3 to V_{REG}+0.3	V	—
Input Current Range	I_{VSP}	-1 to +1	mA	—
Output Voltage Range	V_{FG}	–0.3 to +39	V	—
	V_{OUT1P}, V_{OUT2P}	+39	V	*3
	V_{OUT1N}, V_{OUT2N}	+15	V	*3
	V_{REG}	–0.3 to +6	V	*3
Output Current Range	I_{OUT1P}, I_{OUT1N}, I_{OUT2P}, I_{OUT2N}	–30 to +30	mA	*4
	I_{FG}	–1 to +10	mA	—
	I_{VREG}	–20 to 0	mA	*4
ESD	HBM	2	kV	—
	MM	200	V	—

Note: This product may sustain permanent damage if subjected to conditions higher than the above stated absolute maximum rating. This rating is the maximum rating and device operating at this range is not guaranteed as it is higher than our stated recommended operating range. When subjected under the absolute maximum rating for a long time, the reliability of the product may be affected.

*1: The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

*2: Except for the power dissipation, operating ambient temperature, and storage temperature, all ratings are for Ta = 25℃.

*3: Applying external voltage into these pins is prohibited. Do not exceed the stated ratings even in transient state.

*4: Applying external current into these pins is prohibited. Do not exceed the stated ratings even in transient state.

1.2 POWER DISSIPATION RATING

Package	θj-a	P_D (Ta=25℃)	P_D (Ta=105℃)
QFN 20L (3x3x0.8mm3, Lead Pitch0.4mm)	83.6°C/W	1.494W	0.538W

Note: For the actual usage, follow the power supply voltage, load and ambient temperature conditions to ensure that there is enough margin and the thermal design does not exceed the allowable value.

* Glass-Epoxy Substrate (2 Layers) [50 x 50 x 0.8 t](mm),

Heat dissipation fin: Die-pad, Soldered. (Heat dissipation via 2 layer board)

CAUTION

Although this IC has built-in ESD protection circuit, it may still sustain permanent damage if not handled properly. Therefore, proper ESD precautions are recommended to avoid electrostatic damage to the MOS gates.

1.3 RECOMMENDED OPERATING CONDITIONS

Parameter	Pin Name	Min.	Typ.	Max.	Unit	Notes
Supply voltage range	V_{CC}	5.0	—	36	V	*1
Input Voltage Range	V_{HP}, V_{HN}	0	—	1.5	V	*2
	V_{VSP}	0	—	5	V	*2
	V_{MIN}, V_{SET}, V_{SSW}, V_{LA1}, V_{LA2}, V_{LDT}	0	—	V_{REG}	V	*2
External constants	C_{VM}	—	10	—	μF	*3
	C_{VCC}	—	0.1	—	μF	*3
	C_{VREG}	—	0.1	—	μF	*3

Note:

*1: It is a value under the conditions which do not exceed the absolute maximum rating and the power dissipation.

*2: For setting range of input control voltage, refer to Electrical Characteristics and Operation.

*3: Operation of mass production set is not guaranteed. Perform enough evaluation and verification on the design of mass production set. If the VCC terminal voltage is raised by the regenerative current, at the time of start-up or stop operating Please make countermeasure, Application information is shown at Page.25,26.

1.4 ELECTRICAL CHARACTERISTICS

at VCC = 12.0 V,

Note: Ta = 25℃±2℃ unless otherwise noted.

Parameter	Symbol	Condition	Limits			Unit	Notes
			Min.	Typ.	Max.		
CIRCUIT CURRENT							
V_{CC} current	I_{CC}	V_{CC}= 24V	1.5	2.7	3.5	mA	—
REGULATOR BLOCK							
Output voltage	V_{REG}	—	3.1	3.3	3.5	V	—
Output impedance	Z_{VREG}	I_{VREG} = –5mA	—	—	10	Ω	—
FG(LD) BLOCK							
Low-level output voltage	V_{OLFG}	I_{FG} = 5mA	—	0.1	0.3	V	—
Output leak current	I_{LFG}	V_{FG} = 36V	—	—	5	μA	—
HALL BLOCK							
Input dynamic range	V_{HAD}	—	0	—	1.5	V	—
Pin input current	I_{HAC}	—	–2	0	2	μA	—
Minimum input voltage amplitude	V_{HAA}	—	25	—	—	mV	—
Hysteresis width	V_{HAHYS}	—	—	10	20	mV	—
VSP speed control Block							
Low-level input current	I_{VSPL}	VSP=0V	–2	0	2	μA	—
High-level input current	I_{VSPH}	VSP=5V	25	40	55	μA	—
Stop control input voltage ratio (DC input mode)	V_{VSPMIN}	V_{MIN} = VREG, VSP / VREG	63	66.4	70	%	—
Maximum speed input voltage ratio (DC input mode)	V_{VSPMAX}	V_{MIN} = VREG, VSP / VREG	18	21.1	24	%	—
Stop control duty (PWM input mode)	D_{PWMMIN}	V_{MIN} = 0V	2	4	6	%	—
Maximum speed input duty (PWM input mode)	D_{PWMMAX}	V_{MIN} = 0V	—	100	—	%	*1*2
Low-level input voltage (PWM input mode)	V_{PWML}	V_{MIN} = 0V	—	—	0.8	V	—
High-level input voltage (PWM input mode)	V_{PWMH}	V_{MIN} = 0V	2.0	—	—	V	—
Input frequency range (PWM input mode)	F_{PWM}	V_{MIN} = 0V	15	—	60	kHz	—
Motor driving setting 5bit ADC input (MIN, SET, LDT, LA1, LA2, SSW)							
Pin input current	I_{AD}	—	–2	0	2	μA	—
5bit AD input range	V_{ADD}	—	0	—	V_{REG}	V	—
DNL	V_{DNL}	—	-1.0	0.0	1.0	LSB	—
INL	V_{INL}	—	-1.0	0.0	1.0	LSB	—

at VCC = 12.0 V,

Note: Ta = 25℃±2℃ unless otherwise noted.

Parameter	Symbol	Condition	Limits			Unit	Notes
			Min.	Typ.	Max.		
Motor Lock Protection							
Lock detection time	t_{LOCK1}	—	0.75	1.0	1.25	s	—
Lock release time	t_{LOCK2}	—	7.5	10.0	12.5		
Lock protection time ratio	L_{RATIO}	$L_{RATIO} = t_{LOCK2} / t_{LOCK1}$	9.5	10	10.5	—	
Soft start Block							
Soft start time	t_{SS}	—	0.6	0.8	1.0	s	—
External FET gate drive output							
Upper FET gate drive “Low” output current	I_{OUTPL}	V_O = 24V, V_{CC}=24V	12.7	17	21.3	mA	—
Upper FET gate drive “Low” output voltage	V_{OUTPL}	I_O = 5mA, V_{CC}=24V	—	0.3	0.5	V	—
Upper FET gate drive “High” output voltage	V_{OUTPH}	I_O = –5mA, V_{CC}=24V	V_{CC} –0.6	V_{CC} –0.35	—	V	—
Lower FET gate drive “Low” output voltage	V_{OUTNL}	I_O = 5mA, V_{CC}=24V	—	0.3	0.5	V	—
Lower FET gate drive “High” output voltage	V_{OUTNH}	I_O = –5mA, V_{CC}=24V	8.5	10.5	12.5	V	—
Lower FET gate drive “High” output voltage (Vcc=5V)	V_{OUTNHL}	I_O = –5mA, V_{CC}=5V	V_{CC} –2.0	V_{CC} –1.0	V_{CC} –0.5	V	—
PWM output frequency 1	F_{PWMDO1}	V_{SET} = V_{REG}	30	40	50	kHz	—
PWM output frequency 2	F_{PWMDO2}	V_{SET} = 0 V	22.5	30	37.5	kHz	—
Thermal protection							
Protection operating temperature	TSD_{ON}	—	—	160	—	°C	*1*2
Hysteresis width	TSD_{HYS}	—	—	25	—	°C	*1*2
Under voltage lock out							
Protection operating voltage	V_{LVON}	—	—	3.5	—	V	*1*2
Hysteresis width	V_{LVOHYS}	—	—	0.2	—	V	*1*2
Motor current limiter							
Detection voltage 1	V_{CS1}	Normal driving mode	135	150	165	mV	—
Detection voltage 2	V_{CS2}	Start-up driving mode	70	90	110	mV	—

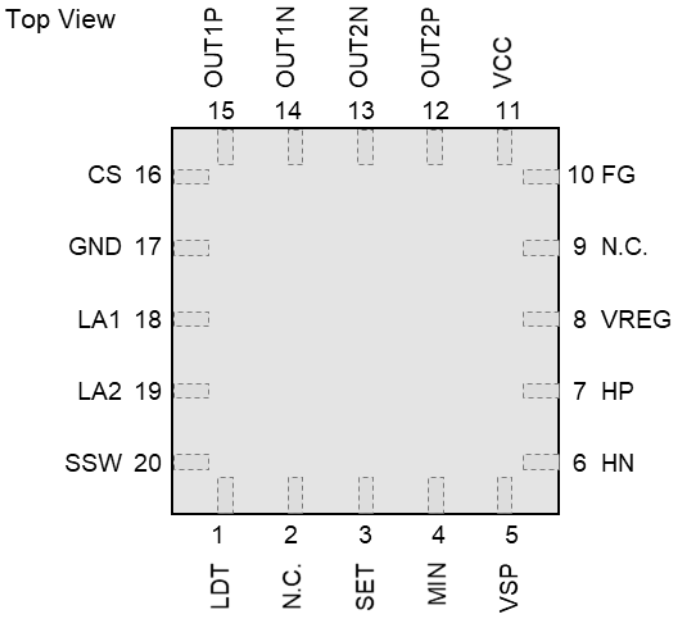
Note:

*1: These are values checked by design but not production tested.

*2: Typical design value.

2. PIN CONFIGURATION

2.1 PIN ASSIGNMENT



2.2 PIN FUNCTIONS

Pin No.	Pin name	Type	Description
1	LDT	Input	ADC input. Motor lock protection setting. FG or LD output setting.
2	N.C.	—	Non connection
3	SET	Input	ADC input. Soft start time setting. PWM output frequency setting.
4	MIN	Input	ADC input. Minimum speed setting. VSP input mode setting.
5	VSP	Input	Motor speed control input.
6	HN	Input	Hall amplifier input (-).
7	HP	Input	Hall amplifier input (+).
8	VREG	Output	Internal reference voltage.
9	N.C.	—	Non connection
10	FG	Output	FG or LD output.
11	VCC	Power	Power supply voltage input.
12	OUT2P	Output	OUT2 Upper FET gate drive output.
13	OUT2N	Output	OUT2 Lower FET gate drive output.
14	OUT1N	Output	OUT1 Upper FET gate drive output.
15	OUT1P	Output	OUT1 Lower FET gate drive output.
16	CS	Input	Motor current detection input.
17	GND	Ground	Ground.
18	LA1	Input	ADC input. VSP reference setting at Motor drive phase shift operating.
19	LA2	Input	ADC input. Maximum Motor drive phase shift setting.
20	SSW	Input	ADC input. Soft switching period setting.

3. RECOMMENDED CIRCUIT

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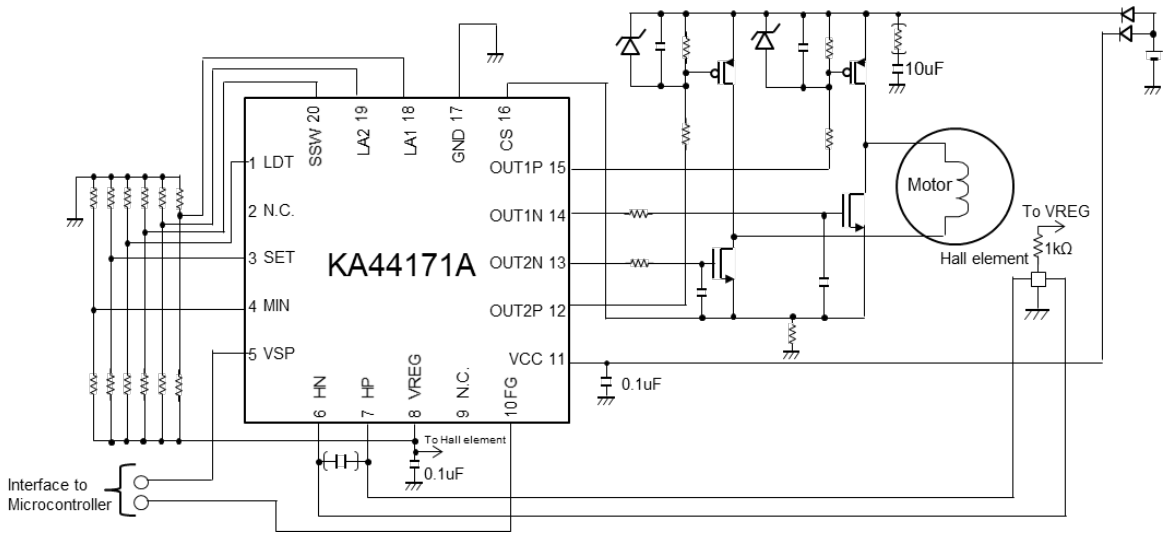
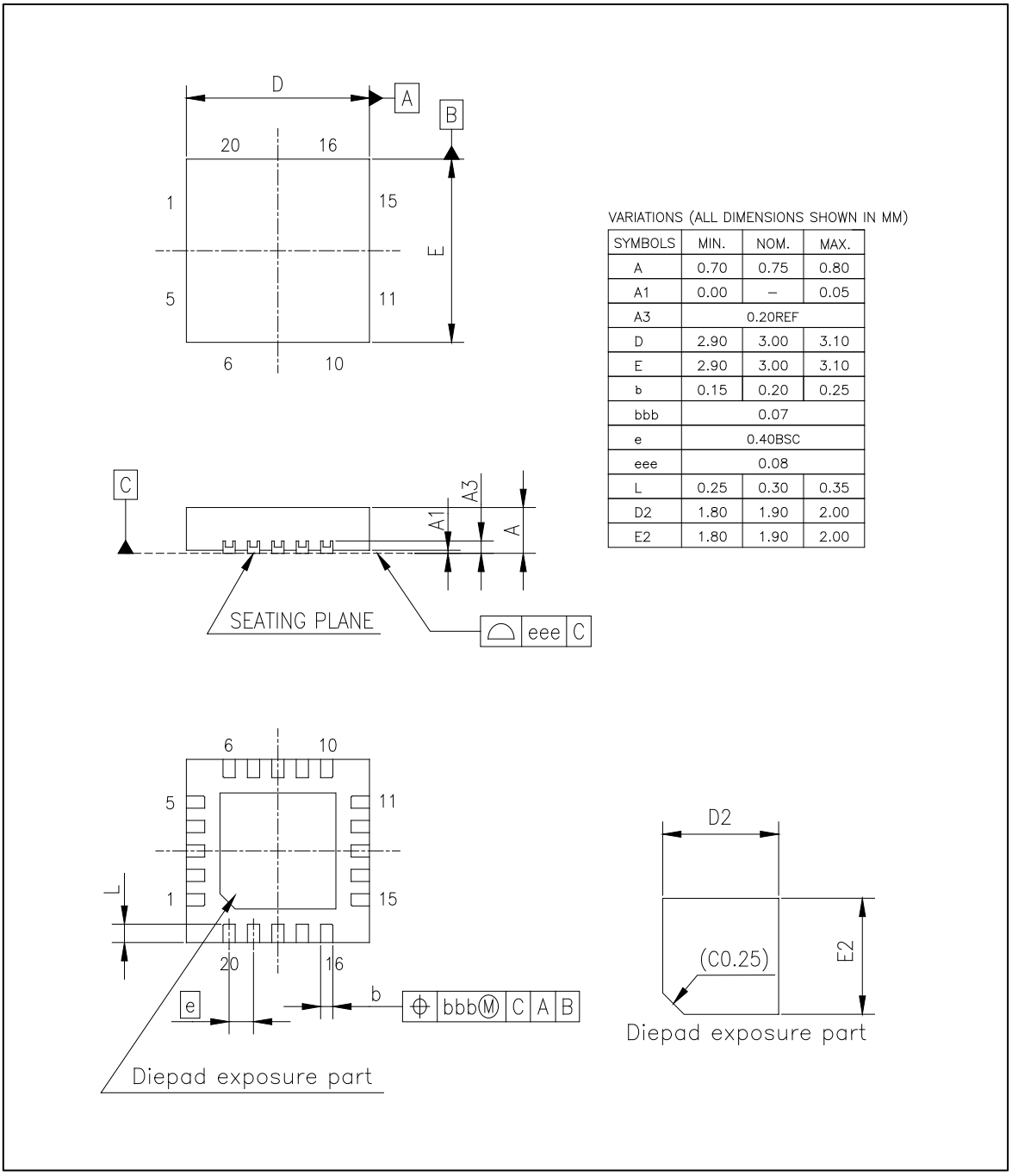


Note: The recommended circuit is an example. The operation of the mass production set is not guaranteed. Sufficient evaluation and verification is required in the design of the mass production set. Customer is fully responsible for the incorporation of the above illustrated application circuit in the production.

4. PACKAGE INFORMATION

QFN 20L 3x3mm2, Thickness 0.8mm, Lead Pitch 0.4mm,
Lead Length 0.3mm, EP Size 1.9x1.9mm



VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

SYMBOLS	MIN.	NOM.	MAX.
A	0.70	0.75	0.80
A1	0.00	–	0.05
A3		0.20REF	
D	2.90	3.00	3.10
E	2.90	3.00	3.10
b	0.15	0.20	0.25
bbb		0.07	
e		0.40BSC	
eee		0.08	
L	0.25	0.30	0.35
D2	1.80	1.90	2.00
E2	1.80	1.90	2.00

5. USAGE NOTES

1. Pay attention to the direction of the IC. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might be damaged.
2. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins.
   In addition, refer to the Pin Description for the pin configuration.
3. Perform visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as solder-bridge between the pins of the IC. Also, perform full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the IC during transportation.
4. Take notice in the use of this IC that it might be damaged when an abnormal state occurs such as output pin-VCC short (Power supply fault), output pin-GND short (Ground fault), or output-to-output-pin short (load short). Safety measures such as installation of fuses are recommended because the extent of the above-mentioned damage will depend on the current capability of the power supply.
5. This IC may be changed in order to improve the performance without notice, please make sure the latest specification is used before your final design.

6. REVISION HISTORY

Date	Revision	Description
2021.2.8	1.00	1. initially issued.
2021.2.24	1.03	1. initially issued as Datasheet
2022.1.11	1.05	1. Added important notice on page2 2. Operating ambient temperature max " 95°C"-> " 105°C" on page.5 3. POWER DISSIPATION RATING PD(Ta=95°C) 0.657W -> PD(Ta=105°C) 0.538W on page.6 4. Remove important notice page from previous version page 13

Important Notice

Nuvoton Products are neither intended nor warranted for usage in systems or equipment, any malfunction or failure of which may cause loss of human life, bodily injury or severe property damage. Such applications are deemed, "Insecure Usage".

Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.

All Insecure Usage shall be made at customer's risk, and in the event that third parties lay claims to Nuvoton as a result of customer's Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.