RENESAS

RAJ2810024H12HPD

Intelligent Power Device for automotive application

1. Overview

RAJ2810024H12HPD is a 2.3m Ω single channel Intelligent Power Device (IPD) available in a TO252-7 package. This device is a 4.5V to 28V N-channel High-Side Switch (HSS) with a charge pump, diagnostic feedback and integrated protection function. It is designed for use in automotive 12V systems.

The RAJ2810024H12HPD helps reduce power losses in the vehicle thanks to its 0.5uA standby current, which makes it suitable for use in power distribution switches, heaters, and glow plugs.

1.1 Features

- Improved current sense accuracy with offset cancelation (+9.5%/-11% @30A)
- Keep on-resistance during cranking condition (max 4mΩ@3.2V/24ms/25°C)
- Low standby current (0.5uA max @25°C)
- Short circuit protection
 - Shutdown by over current detection
- Shutdown by absolute channel over temperature detection
- Built-in diagnostic function
 - Proportional load current sensing
- Defined fault signal in case of abnormal load condition
- Reverse battery protection by self-turn ON
- Loss of ground protection
- Von clamp operation at inductive load switch-off
- AEC-Q100 Grade 1 qualified
- Built-in charge pump

Parameter

single pulse

repetitive pulse

Operating Voltage

- 3.3V compatible logic interface

1.2 Product summary

On-state resistance at 25°C

Inductive load switch-off energy dissipation EAS

Table 1

2. Ordering Information

Over current detection current1

Over current detection current2

Inductive load switch-off energy dissipation

Current sense ratio with offset cancel at IL=30A

Table 2 Ordering Information									
Part No.	Lead plating	Packing	Package						
RAJ2810024H12HPD	Pure Matte Sn	Tape 2500pcs/reel	TO252-7						

Product summary

Symbol

Vcc

Ron

EAR

IL1(SC)

IL2(SC)

KILIS

Values

170mJ

50mJ

4.5V to 28V

Typ. 2.3 mΩ, Max. 3.0 mΩ

Min. 57000 Typ. 64000, Max. 70000

Min. 70A, Typ. 106A Min. 95A, Typ. 125A

All information contained in these materials, including products and product specifications, represents information on the product at the time of publication and is subject to change by Renesas Electronics Corp. without notice. Please review the latest information published by Renesas Electronics Corp. through various means, including the Renesas Electronics Corp. website (http://www.renesas.com).





- 3. Specification
- 3.1 Block Diagram
- 3.1.1 Nch High-side Single Channel Device Block Diagram



Figure 1 Block Diagram of RAJ2810024H12HPD

3.1.2 Voltage and Current Definition



Figure 2 Voltage and Current Definition



3.2 Pin Configuration

Table 3 T	O252-7 Pin Configuration
Pin	Terminal Name
NO.	
1	OUT
2	GND
3	IN
4, Tab	VCC
5	IS
6	INOFS
7	OUT



Figure 3 Pin Configuration

Terminal Name	Pin function	Recommended connection					
		Sense current improved accuracy function enabled	Sense current improved accuracy function disabled				
GND	Ground connection	Connected to GND through a	47Ω resistor				
IN	Input signal for channel activation Active high	Connected to MCU's output p resistor	oort through a 2k-50kΩ serial				
IS	Current sense and Diagnosis output signal	Connected to GND through a 1k- $6k\Omega$ resistor with LPF. Refer to chapter 6.	Connected to GND through a 1k-6kΩ resistor.				
		Connect the resistor even if this pin is not used.					
OUT	Protected high-side power output	Connected to load with 50-10	0nF capacitor in parallel.				
VCC	Positive power supply for logic supply as well as output power supply	Connected to battery voltage parallel. Refer to chapter 6.	with 22nF capacitor in				
INOFS	Input signal for sense current improved accuracy Active high	Connected to MCU's output port through a $2k-50k\Omega$ serial resistor to use sense current improved accuracy function.	This pin should be open.				

Table	4	Pin	func	tion
_				_



3.3 Absolute Maximum Ratings

Stress values that exceed those listed here may cause permanent damage to the device. Exposure to absolute maximum rating condition for extended periods may affect device reliability. Integrated protection functions are designed to prevent IC destruction under fault condition described in the data sheet. Fault conditions are considered as out of normal operation.

Table 5Absolute Maximum RatingsTa=25°C, unless otherwise specie									
Parameter	Symbol	Min.	Тур.	Max.	Unit	Test Condition			
VCC Voltage	Vcc	-	-	28	V				
VCC Voltage at reverse battery condition	-Vcc	-	-	16	V	At nominal load current, t<2min, RIN=2kΩ, RIS=1kΩ, RGND=47Ω			
VCC voltage under Load Dump condition	Vload dump	-	-	35	V	RI=1Ω, R _L =Nominal load, RIS=1kΩ, RIN=2kΩ, RGND=47Ω, td=400ms			
Load Current	IL	-	-	Self- limited	A				
Total power dissipation for whole device (DC)	PD	-	-	1.85	W	Ta=85°C Device on 50mmx50mmx1.5mm epoxy PCB FR4 with 6 cm2 of 70 um copper area			
Voltage at IN/INOFS pin	Vin	-2	-	16	V	DC RIN=2kΩ			
	VINOFS	-16	-	-		At reverse battery condition, t<2min, RIN=2kΩ			
IN/INOFS pin current	lin Iinofs	-	-	10	mA	DC			
Voltage at IS pin	Vis	-2	-	VCC	V	DC RIS=1kΩ			
		-16	-	-	V	At reverse battery condition, t<2min, RL= Nominal load, RIS=1k Ω			
Channel Temperature	Tch	-40	-	150	°C				
Storage Temperature	Tstg	-55	-	150	°C				
Inductive load switch-off energy dissipation single pulse	EAS	-	-	170	mJ	Vcc=13.5V, T _{ch} , _{start} 1) <150°C, R∟=Nominal load, Refer to 3.7.12			
Inductive load switch-off energy dissipation repetitive pulse	EAR	-	-	50	mJ	Vcc=13.5V, T _{ch,start} ¹⁾ =85°C, RL=Nominal load, Refer to 3.7.12			

Remark) All voltages refer to ground pin of the device.

1) Tch, start means Tch at the start of the test.

3.4 ESD

Table 6 ESD

Parameter	Symbol	Min.	Тур.	Max.	Unit	Test Co	ndition	
ESD susceptibility	VESD	-2000	-	2000	V	HBM	AEC-Q100-002 std.	All pin
							R=1.5kΩ, C=100pF	
		-4000	-	4000			IEC61000-4-2 std.	VCC,
							R=330Ω, C=150pF,	OUT
							100nF at VCC and OUT	

3.5 Thermal Characteristics

Table 7 Thermal Characteristics

Parameter	Symbol	Min.	Тур.	Max.	Unit	Test Condition
Thermal characteristics	Rth(ch-a)	-	35	-	°C/W	According to JEDEC JESD51-2, -5, -7 on FR4
						2s2p board
	Rth(ch-c)	-	0.65	-	°C/W	



3.6 Electrical Characteristics

Table 8Operation function

 T_{ch} =-40 to 150°C, Vcc=7 to 18V, unless otherwise specified

			<u>iyp. icn-</u>	-23 0, 1			specifica
Parameter	Symbol	Min	Тур	Max	Unit	Test Condition	
Operating Voltage	Vcc	4.5	-	28		VIN=4.5V,	
						R _L =Nominal load,	Refer to 3.7.12
Operating current	Ignd	-	3.4	6.8	mA	VIN =4.5V	
Output Leakage current	IL (off)	-	-	0.2	μA	Tch=25°C	Vcc =13.5V, VIN=0V,
							VINOFS=0V, VIS=0V,
		-	-	5		Tch=-40 to 125°C	VOUT=0V, VGND=0V
Standby current		-	-	0.5	μA	Tch=25°C	$V_{CC} = 13.5 V$ $V_{IN} = 0 V$
				0.0	μ. τ		VINOES=0V VIS=0V
							VOLITEOV VGNDEOV
		-	-	1.5		Tch=-40 to 85°C	All functions stopped
On-state resistance	Ron	-	2.3	3.0	mΩ	Tch=25°C	IL= Nominal current,
		-	-	4.8		Tch=150°C	Refer to 3.7.12,
							Vin>2.5V
Low level IN/INOFS pin	VIL	-	-	0.8	V		
voltage	VILOFS						
High level IN/INOFS pin	Vih	2.5	-	-	V		
voltage	VIHOFS						
Low level IN/INOFS pin	liL	2	-	30	μA	VIN=0.8V	
current	lilofs					VINOFS=0.8V	
High level IN/INOFS pin	Ін	2	-	30	μA	VIN=2.5V	
current	lihofs					VINOFS=2.5V	
			0				
	VZIN	5	6	-	V		
	VZINOFS		0.5		•		170
Operating current	IGND (cr)	-	0.5	-	mA	VCC=3.2V, RGND	$=4/\Omega,$
at cranking						RL= Nominal load,	Pulse duration=24ms,
One of the second se				4.5	N/	Relef to 3.7.12	
Cranking mode voltage	VCC (cr)	-	-	4.5	V		170 T . 05%0
On-state resistance	Kon(cr)	-	-	4.0	mΩ	VCC=3.2V, RGND	= $4/\Omega$, Ich= $25^{\circ}C$,
at cranking						RL= Nominal load	a, Pulse duration=24ms,
Operating Voltage		2.0			V		5.7.1Z
operating voltage		3.2	-	-	v	RGND-4712, Icn-	20 C, ma Bi - Nominal load
						Puise duration-24	IIIS, RL-NOITIITAI IOAU,
Operation start voltage	Vcc (start)			15	V		
	ton	-	-	4.5	V	1/00-12 51/ DI-N	ominal load
	td(op)	-	200	150	μ5	Pefer to 3 7 12	
Turn off time		-	100	100	μs	Tch-25°C to150°C	
	td(aff)	-	190	420	μs		
Turn oπ delay time		-	135	290	μs	-	
Slew rate on	dV/dton	-	0.10	0.4	v/µs	-	
Slew rate off	-dV/dtoff	-	0.28	0.83	V/µs		
Turn on time	ton	-	250	550	μs	VCC=13.5V, RL=N	ominal load,
lurn on delay time	td(on)	-	80	160	μs	Refer to 3.7.12	
Turn off time	toff	-	220	550	μs	I ch=-40°C	
Turn off delay time	td(off)	-	165	430	μs	-	
Slew rate on	dV/dton	-	0.12	0.4	V/µs	1	
Slew rate off	-dV/dtoff	-	0.29	0.83	V/µs		
Turn on energy loss ¹⁾	Eon	-	15	-	mJ	Vcc=13.5V, Tch=2	25°C, R∟=Nominal load,
Turn off energy loss 1)	Eoff	-	5	-	mJ	Refer to 3.7.12	
Driving capability 1)	Dr(capa)	153	-	-	mΩ	VCC=16.0V, Tch=2	5°C

Remark) All voltages refer to ground pin of the device.

1) not subjected production test, guaranteed by design



Table 9 **Protection function**

 T_{ch} =-40 to 150°C, Vcc=7 to 18V, unless otherwise specified Typ: T_{ch} =25°C. Vcc=13.5V unless otherwise specified

r		. ı y	p. r cn-z								
Parameter	Symbol	Min	Тур	Max	Unit	Test Condition					
Over current detection current1	IL1(SC)	70	106	-	A	Vcc=13.5V, Von=5V, Tch=25°C					
Over current detection Current2	IL2(SC)	95	125	-	A	Vcc=13.5V, Von <von(kilis), tch="25°C</td"></von(kilis),>					
Sense current output trigger threshold	Von(kilis)	-	0.5	-	V	Vcc=13.5V, Tch=25°C					
Von check in over current state	Von (OC)	-	0.4	-	V	Vcc=13.5V, Tch=25°C					
Turn on check delay in over current state	tdOC (OC)	0.8	1.4	2.1	ms	Vcc=13.5V, Tch=25°C, Over Current state					
Von check at cranking in over current state	VonCR (OC)	-	0.2	-	V	Vcc=3.2V, Tch=25°C					
Absolute thermal shutdown temperature	aTth	150	-	-	°C						
Von clamp voltage at inductive load switch-off	V _{on,clamp}	35	43	47	V	Vcc=13.5V, IL=40mA, Tch=25°C					
Output current while GND disconnection	IL(GND)	-	-	1	mA	IIN=0A, IGND=0A, IIS=0A, IINOFS=0A					
On-state resistance at	Ron(rev)	-	2.3	3.0	mΩ	Tch=25°C Vcc=-13.5V, IL=Nominal					
reverse battery condition		-	-	4.8		T _{ch} =150°C current, Refer to 3.7.12					
GND current at reverse battery condition	IGND (rev)	-	-2	-	mA	Vcc =-16V, Tch=25 °C					

Remark) All voltages refer to ground pin of the device. Protection functionality is kept VCC=6V min.



Table 10 Diagnosis function Tch=-40 to 150°C, Vcc=7 to 18V, VIN=4.5V, unless otherwise specified Tvp: Tch=25°C, Vcc=13.5V unless otherwise specified

Parameter	Symbol	Min		Max	Unit	Test Condition
Current sense ratio	KILIS	56000	64000	70500	-	li =4A
	TULIO	00000	0.000	10000		VINOFS=4.5V
						(use improved accuracy func)
		57000	64000	70000	-	$\mu = 10A$
			0.000			VINOFS=4.5V
						(use improved accuracy func) ¹⁾
		57000	64000	70000	-	IL=15A.
						VINOFS=4.5V
						(use improved accuracy func) ¹⁾
		57000	64000	70000	-	IL=30A,
						VINOFS=4.5V
						(use improved accuracy func)
		28000	64000	105000	-	IL=4A,
						VINOFS=0V
						(no use improved accuracy func)
		42000	64000	86000	-	IL=10A,
						VINOFS=0V
						(no use improved accuracy func) ¹⁾
		48000	64000	80000	-	I∟=15A,
						VINOFS=0V
						(no use improved accuracy func) ¹⁾
		53000	64000	75000	-	IL=30A,
						VINOFS=0V
						(no use improved accuracy func)
Current sense drift depends	dKILIS	-6	-	4	%	VCC=13.5V, Tch, start=25°C,
on temperature						IL=30A, VINOFS=4.5V (use improved
				10		accuracy func), Refer to 3.7.12
		-10	-	10	%	VCC=13.5V, Tch, start=25°C,
						IL=30A, VINOFS=0V (no use improved
Offect ourrent of conce	lie offent			25		
current	lis,onset	-	-	2.5	μΑ	IL-UA, I ch -25 C, VINOFS-4.5V
Garrent				20		(use inproved accuracy func)
		-	-	20	μΑ	(no use improved accuracy func)
Sense voltage	Vis fault	15	5.6	7.0	V	RIS=1kO
under fault condition	vis,iaut	4.5	5.0	7.0	v	
Sense current settling time	tsis(on)		460	700	115	$V_{CC}=13.5V$ $V_{IN}=0V$ to 4.5V
after input signal positive	1010(011)		400	100	μο	IL/IIS=KILIS, RL=Nominal load,
slope						No LPF ²⁾ , Refer to 3.7.12
Sense current settling time	tsis(off)	-	5	10	μs	VIN=4.5V to 0V, No LPF ²⁾
after input signal negative	. ,				•	
slope ¹⁾						
Fault signal delay after over	tdsc(fault)1	-	5	15	μs	VIN=0V to 4.5V,
current detection1 ¹⁾						I∟=IL1(SC)
						No LPF ²⁾
Fault signal delay after over	tdsc(fault)2	-	30	55	μs	VIN=0V to 4.5V,
current detection2 ¹⁾						IL=IL2(SC)
						No LPF ²⁾
Fault signal delay after	tdot(fault)	-	8	18	μs	Refer to Figure 12, No LPF ²⁾
absolute thermal shutdown 1)			-	4.0	1	
rault signal off delay after	tdoff(fault)	-	5	10	μs	VIN=4.5V to UV, NO LPF 27
input negative slope ?	1					

Remark) All voltages refer to ground pin of the device.

1) Not subjected production test, guaranteed by design

2) Refer to chapter 6 Application example in principle

Diagnosis functionality is kept VCC=6V min.



3.7 Feature Description

3.7.1 Driving Circuit

The high-side output is turned on if the input pin is over VIH. The high-side output is turned off, if the input pin is open or the input pin is below VIL. Threshold is designed between VIH min and VIL max with hysteresis. IN terminal is pulled down with a constant current source.



Figure 4 Driving Circuit



Figure 5-a Switching waveform





Figure 5-b Switching waveform

When the inductive load is switched off, the voltage of OUT falls below 0V. The internal MOSFET goes into breakdown state and keeps the voltage Von,clamp.



3.7.2 Device behavior at over voltage condition

In case of supply voltage greater than V_{load dump}, logic circuitry is clamped by ZD_{AZ} (35V min). The current through the logic circuitry is limited by external ground resistor (RGND). In addition, N-ch MOSFET switches off to protect the load from over voltage. Test conditions of V_{load dump} are specified in Table 5.



Figure 6 Device behavior at over voltage condition



3.7.3 Device behavior at low voltage condition

If the voltage supply (Vcc) goes down under Vcc(cR), the device outputs shut down in case of $V_{on} > V_{onCR (OC)}$. If voltage supply (Vcc) increases over Vcc (start), the device outputs turn back on automatically. The IS output is cleared during off-state.



Figure 7 Device behavior at low voltage condition

Table 11	Function a	and protection	availability	by mode
----------	------------	----------------	--------------	---------

				○: Enable, ×: Disable,
Function/Protoction	Mode	es of Fig	jure 7	Noto
Function/Frotection	I, I'	Π	III	Note
Turn on	0	×	×	
Turn off	0	0	×	
Keep on-state	0	O (*1)	×	^(*1) Ron is defined as Ron (Cr).
KILIS function	0	×	×	In case of Von < Von(kilis)
Over current detection current1 : IL1(SC)	O (*2)	×	×	^(*2) Disabled when Vcc<6V(max), Rafer to 3.7.6
Over current detection current2 : IL2(SC)	○ (*3)	×	×	^(*3) Disabled when Vcc<6V(max), Rafer to 3.7.6
Von check in over current state: Von (OC), Turn on check delay in over current state: tdOC (OC)	0	×	×	Von > Von (OC) after tdoc(OC), Refer to 3.7.6
Von check at cranking in over current state : VonCR (OC)	×	0	×	Von> VonCR (OC) at cranking mode, Refer to 3.7.6
Absolute thermal shutdown temperature : aTth	0	0	×	T _{ch} > aTth, Refer to 3.7.6



3.7.4 Definition of on-state resistance at cranking

On-state resistance at Cranking (Figure 7, mode II) is defined Ron (CR) as shown in Figure 8. Ron(CR) is adapted in the condition of Vcc > 3.2V and within 24ms.



Figure 8 Definition of on-state resistance at cranking

3.7.5 Loss of Ground protection

In case of complete loss of the device ground connection with or without load, the device securely changes to off if VIN was initially greater than VIH state or keeps the off state if VIN was initially lower than VIL state. In case of loss of ground, there is a potential that the current flow from IN terminal to MCU. Therefore, insert a protective resistor between MCU and IN terminal.

3.7.6 Over Current protection

The N-ch MOSFET switches off automatically when condition (a), (b), (c), (d) or (e) is detected. In case of (a), (b), (c), (d), the IS pin outputs Vis,fault. The MOSFET maintains off state until the IN pin turns low level (VIL).

- (a) IL > IL1(SC)
- (b) IL > IL2(SC)
- (c) Von > Von (OC) after tdoc (OC)
- (d) Tch > aTth
- (e) Von> VonCR (OC) at cranking mode



3.7.7 Diagnostic signal

Table 12 Truth table

	Input	Input	Output	Diagnostic output
	(IN)	(INOFS)	(OUT)	(IS)
Normal Operation	н	Н	Vcc	IIS = IL/KILIS ⁷⁾
		L		IIS = IL/KILIS ⁸⁾
	L	Н	L ²)	L 3)
		L		
Shutdown by over current detection ¹⁾	н	Н	L ²⁾	Vis,fault ⁴⁾
		L		
	L	Н	L ²⁾	L 3)
		L		
Shutdown by over absolute channel temperature detection	н	Н	L ²⁾	Vis,fault ⁵⁾
		L		
	L	Н	L ²⁾	L ³⁾
		L		
Short circuit to Vcc	Н	Н	Vcc	<iis< td=""></iis<>
		L		
	L	H	Vout ⁶⁾	1 3)
		L		L '

- 1) Over Current detection is included IL1(SC), IL2(SC), Von (OC)after tdOC (OC) or VonCR (OC).
- 2) In case of OUT terminal is connected to GND via load.
- 3) In case of IS terminal is connected to GND via resister.
- 4) IS terminal keeps Vis, fault as long as input signal activate after the over current detection.
- 5) IS terminal keeps Vis, fault as long as input signal activate after over absolute channel temperature detection.
- 6) VOUT depends on the ratio of Vcc -OUT-GND resistive component.
- 7) The current sense ratio (KILIS) is the value when the improved accuracy function is used.
- 8) The current sense ratio (KILIS) is the value when the improved accuracy function is not used.

3.7.8 Current sense output

The device outputs analog feedback current proportional to output current from IS pin. In the case of much higher current than nominal load current, current sense output is saturated at Vis,fault.



Figure 9 Current sense output



3.7.9 Timings







Figure 11 Fault signal delay time at over current detection and input negative slope





Figure 12 Fault signal delay time at over absolute channel temperature detection and input negative slope

3.7.10 Measurement condition



Figure 13 Switching waveform of OUT terminal





Figure 14 Measurement condition for Turn on check in over current state

3.7.12 Nominal load and nominal current

Table 13 Nominal load and nominal current					
Parameter	Values	Condition			
Nominal load	0.45 Ω	Tch ≤150°C (Vcc=13.5V)			
Nominal current	30 A	Tch =25°C			
Nominal current 2	19.6A	Ta=85°C, Tch ≤150°C			

Table 13 Nominal load and nominal current



3.7.13 Driving Capability

Driving Capability is specified as load impedance. Over current detection characteristics is designed above Driving Capability characteristics. If the estimated load impedance which comes from peak inrush current is lower than Driving Capability characteristics, then the device does not detect inrush current as over current and does not shutdown the output. If estimated load impedance which comes from peak inrush current is higher than Driving Capability characteristics and reach the IL1(SC) or IL2(SC) thresholds level, then the device detects inrush current as over current and shutdown the output.



Figure 15 Driving capability

3.7.14 Cross current protection in case of H-bridge high side usage

In case of using High side driver in H-bridge circuit, the High side driver protects itself and the low side driver from high power dissipation by cross current when low side driver switches on.



Figure 16 Cross current protection in case of H-bridge high side usage



3.7.15 Reverse Battery Protection by turning on the output

In case a reverse battery is applied to the device, the N-ch MOSFET will turn on only if reverse current flow into the GND pin. The reverse current through the N-ch MOSFET must be limited by the connected load. IGND (rev) is limited internally approx. 2mA even without external RGND. Reverse current flow from IN, INOFS and IS should be limited by external components such as recommendation value in Pin function, refer to 3.2 Pin configuration.



Figure 17 Reverse Battery Protection by turning on the output



3.8 Package drawing (TO252-7)



Figure 18 TO252-7 Package Outline



3.9 Taping information



Figure 19 Taping information

3.10 Marking information







4 Typical characteristics





Channel Temperature Tch [degreeC]

100

150

200

50



Channel Temperature Tch [degreeC]

100

150

0

-50



-50

0

50

200

6.0

3.0 2.0

> 1.0 0.0

-50

0



ton 005 [us]

200

100

0

-50

0



Channel Temperature Tch [degreeC]

100

150

200

50







50

100

Channel Temperature Tch [degreeC]

150

200















Figure 38. IL1(SC)





Figure 39. IL2(SC)





Figure 41. lis,offset (use improved accuracy func)



Figure 43. Vis, fault



Senese current offset current(without offset cancel) VS. Channel TEMPERATURE



Figure 42. lis,offset (no use improved accuracy func)

5 Thermal characteristics

5.1 Thermal characteristics board condition(2s2p)



Figure 44 Cross section 2s2p board



Figure 45: Botom layer pattern







5.2 2nd layer connected condition metallization dependency







Figure 48 2nd layer metallization depedency



6 Application example in principle



Figure 45 Application example in principle

RIN values are in range of 2k to $50k\Omega$ depending on microcontroller while R_L value is typically $4k\Omega$.

RIS values are in range of 1k to $6k\Omega$.

Time constant parameter of LPF for KILIS improved accuracy function T(kilis) is represented as follows. T(kilis) = (R1+RIS) x C1

Time constant parameter of LPF for Vis,fault function T(fault) is represented as follows.

T(fault) = R1 x C1

R1 values are in range of over $2k\Omega$.

100us or more is recommended as T(kilis), considering T(fault) parameter.

If necessary to raise HBM tolerated dose, adding a resister between OUT terminal and Ground is effective, the resister's value is typically $100k\Omega$.

Additional snubber circuit is recommended if necessary, to prevent VCC drop less than minimum operating voltage threshold, by parasitic inductance (Lp) and parasitic resistance (Rp) resonance.

Recommended values are as follows:

CVCC : 22nF

RSNB¹) : RSNB=√(Lp/CVCC). 0.125W (ex. Lp:3.94uH -> RSNB=10Ω)

CSNB²: 1.0uF (ex. GCM21BR71H105MA03(Murata Manufacturing Co.Ltd.)).

- 1) High pulse withstands resistor.
- 2) High pulse withstands capacitor.

RGND is recommended if necessary for unexpected external surge protection. 47 ohm is recommended as RGND.



7 Revision History

		Description		
Rev.	Date	Page	Summary	
1.0	May.13.2024		Initial release	



Notice

- Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
- 2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
- 3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
- 4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
- 5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
- 6. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
 - "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
 - "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.

- 7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION ("Vulnerability Issues"). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
- 8. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
- 9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for implementing, you are responsible for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
- 10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
- 11. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
- 12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
- 13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
- 14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.
 (Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 October 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit: <u>www.renesas.com/contact/</u>.

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

Renesas Electronics:

RAJ2810024H12HPD#GB0