IPD Product Group

IPD Products (uPD1660xx, RAJ28000xx, RAJ2810024)

Application Note

Contents

1. Introduction

With the shift to an E/E architecture in automobiles, communication and control networks in vehicles are undergoing a major transformation with adoption of CAN and Gigabit Ethernet. To achieve a safer system, power distribution networks must be similarly transformed to become more hierarchical, redundant, and with protection features.

In conventional power distribution networks, fuses and mechanical relays are used to distribute and switch power. Recently, microcomputer-based power control is being used to achieve more detailed control of power distribution and safety functions, and fuses and mechanical relays are also being replaced with semiconductor switches. Renesas has made a contribution to the innovation of power distribution networks in automobiles by offering an intelligent power device (IPD) that is integrated with semiconductor switches and various protection/diagnostic circuits in a single package, which is more durable than conventional fuses and mechanical relays.

Conventional fuses and mechanical relays have durability, quietness, and component size and weight issues compared with semiconductor switches.

Fuses protect from short-circuit and over-current problems by blowing out and cutting off the power supply to the connected circuits. In addition, mechanical relays are operated by electromagnets to supply power through physical contact between movable and fixed contacts, thus mechanical durability as well as electrical durability should be considered. With these characteristics, fuses and mechanical relays need to be replaced on more frequent cycles. For this reason, these components were installed in a fuse/relay box in the engine room and under the passenger's feet for ease of maintenance.

Wire harnesses were thicker and heavier, as fuses and mechanical relays located at the front of the vehicle supplied power to the entire vehicle.

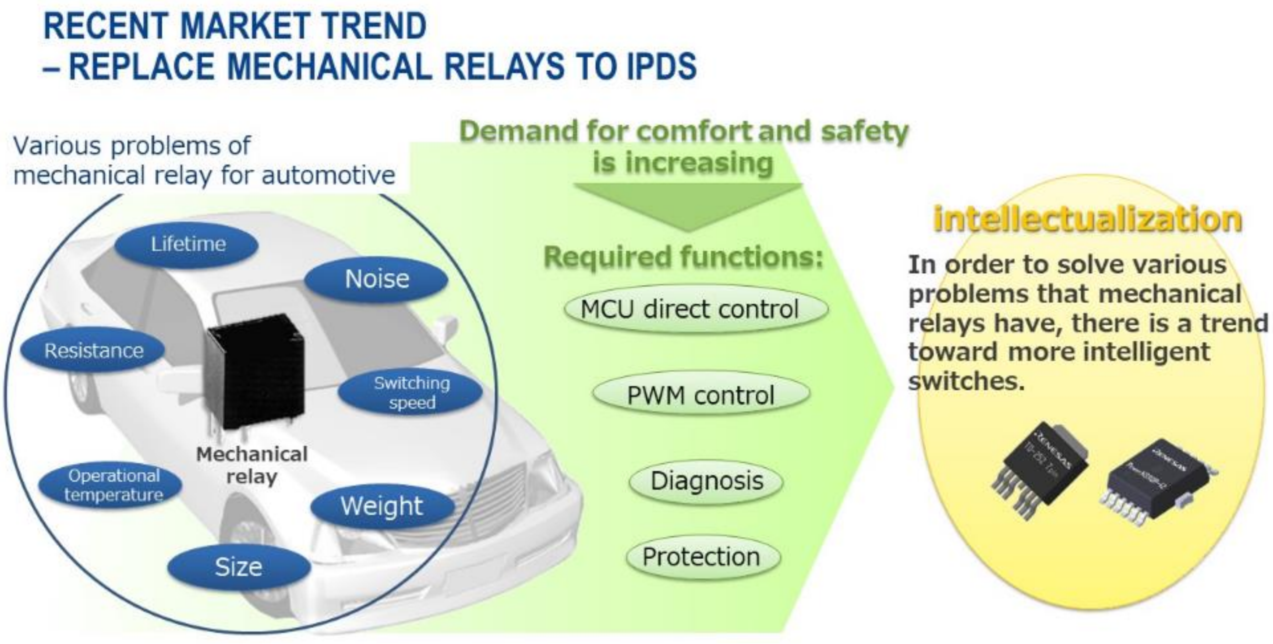


Figure 1. Recent Market trend

In recent automobiles, many switches are used. There are many circuits that supply the power even when the ignition is turned off (lights, door locks, etc.), and it is also important to consider the power during standby, since the battery supplies power to maintain the vehicle system when the engine is not in use. Renesas' IPDs are designed with the concept of low power consumption in standby conditions, so battery consumption can be kept low even when many IPDs are used in a hierarchical power network in the E/E architecture.

1.1 Target products

uPD1660xx : uPD166023T1J, uPD166025T1J, uPD166027T1J,
uPD166029T1J, uPD166031AT1U, uPD166032T1U,
uPD166033T1U, uPD166034T1U, uPD166037T1J, uPD166038T1J

RAJ28000xx : RAJ2800024H11HPF, RAJ2800024H12HPF, RAJ2800034H12HPF,RAJ2800044H12HPF

RAJ2810024 : RAJ2810024H12HPD

Note1: In this document, it is written as uPD1660xx, RAJ28000xx, RAJ2810024 for 3 products family.

Note2: Contents in this note are subject to change. Please refer to the latest data sheet of each product for details.

2. General IPD features

As semiconductor switches such as our IPDs are more durable than conventional fuses and mechanical relays and do not require frequent replacement, it allows to place an ECU with a MCU and IPD close to the load in an E/E architecture, thus contributing to the optimization of the wire diameter and weight reduction of the harness.

In addition, Renesas IPD has a protection/diagnostic function that detects overcurrent and overtemperature. Those function can safely control the output of the IPD and notify the MCU, in case problem such as short circuit or harness damage occurs.

The IPD notifies the MCU above problem by the protection/diagnostic circuitry, therefore it enables the MCU to control the load keeping within a safe range and alert the driver for an early inspection at the dealership. In this way, the IPD can realize the safe vehicle system that cannot be achieved with conventional fuses which immediately shut down the output.

2.1 Common features

Common features of Renesas IPD products are as follows. Please see each product in detail.

- Built-in charge pump
- Low standby current
- 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
- AEC Qualified
- RoHS compliant

2.2 Target application

Renesas IPD products are designed for Automotive 12V Battery system.

Target application examples are as follows.

-Power distribution box（relay and fuse replacement）

-High current load driver with protection and Diagnosis function

-Ramp operation

-Sheet heater, Defogger(Defroster), Fan motor drive for HVAC * etc.

*HVAC: Heating Ventilation and Air Conditioning.
Free-wheel diode is needed if necessary to protect from inductive load operation

-Many ECU boards

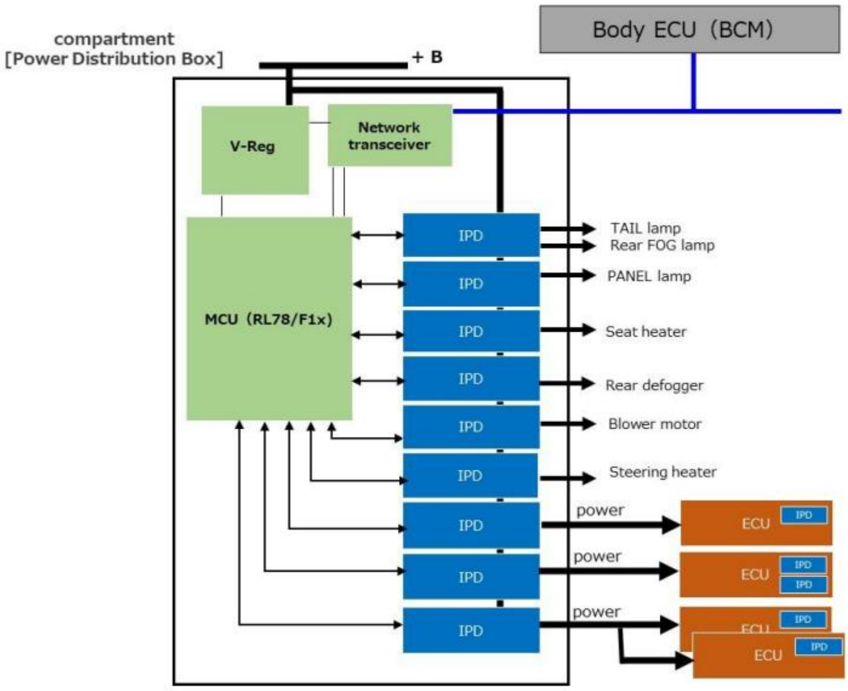


Figure 2. Target application example (Voltage driven)

3. Product line differences

Renesas IPD 3 products (uPD1660xx, RAJ28000xx and RAJ2810024) have functionality differences. Main items are listed on the below table. For more details, please refer to each Datasheet. The high current operation series is available in two drive types depending on the application: the RAJ28000xxH12 is a voltage-driven type that is controlled by voltage from a MCU's GPIO port, etc., and the RAJ2800024H11 is a current-driven type for use in applications controlled by a switch connected to a 12V battery line.

Table 1. Target application example

Family	Robust and Safety	High current operation	
Part number	uPD1660xx	RAJ28000xx	RAJ2810024
Package	TO252-7pin / HSSOP-12pin	TO263-7pin	TO252-7pin
On Resistance range (Typ. 25degC)	1CH products: 6mohm to 16mohm 2CH products: 20mohm to 70mohm	1.6mohm to 3.8mohm	2.3mohm
On Resistance range at cranking (Max. 25degC)	None	8mohm to 20mohm	4mohm
Drive type	Voltage Driven	Voltage Driven / Current Driven	Voltage Driven
Delta-Tch protect	Auto restart	Auto restart	None
Absolute-Tch protect	Auto restart	OFF-Latch	OFF-Latch
Reverse battery protection by turn on output	uPD166033/34 : Support Others : None	Support	Support
OPEN load detection during OFF	Support	None	None
Current sense accuracy improvement function	None	None	Support
Power limitation mode	Support	Support	None
Overcurrent / Over load protection	Support	Support	Support

4. Protection related functions

4.1 Load dump

Renesas handles load dump by Parameter "VCC voltage under Load Dump condition($V_{load\ dump}$)". As an example, a block diagram of RAJ2810024 is shown below. In case of supply voltage greater than $V_{load\ dump}$, logic part is clamped by ZD_{AZ} (35V min). And current through of logic part is limited by external ground resistor. In addition, the power transistor switches off in order to protect the load from over voltage. Permanent supply voltage than $V_{load\ dump}$ must not be applied to VCC. The circuit configuration and pin functions may differ for each product, so please refer to the datasheet of each product for details.

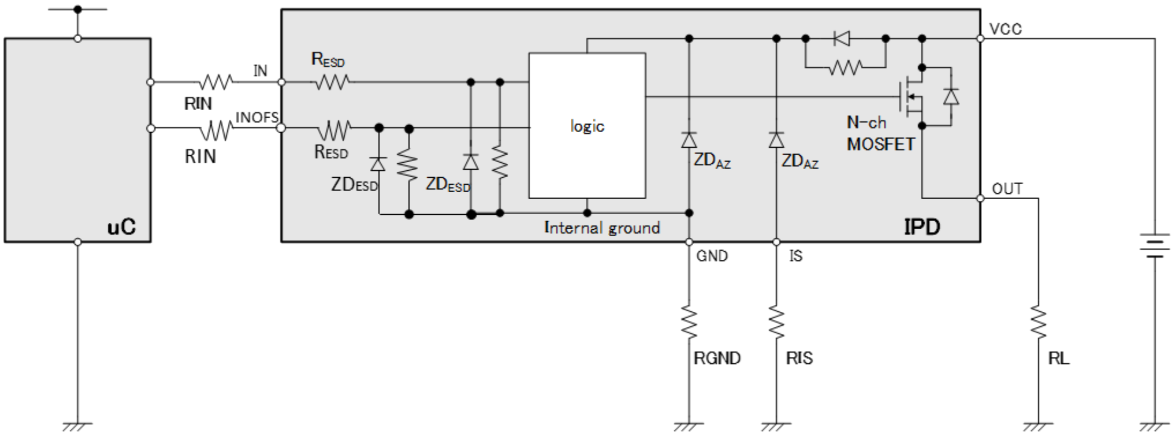


Figure 3. Application example on RAJ2810024

4.2 Under voltage lock out

Renesas IPD 3 products family(uPD1660xx, RAJ28000xx and RAJ2810024) handles the under voltage lock out function in different cases below.

4.2.1 uPD1660xx and RAJ28000xxH12(voltage driven) case

uPD1660xx and RAJ28000xxH12(voltage driven) are in same case. If voltage supply (Vcc) goes down under $V_{CC(Uv)}$, the device outputs shuts down. If Vcc increase over $V_{CC(CPr)}$, the device output turns back on automatically.

The device keeps off state after under voltage shutdown. The IS output is cleared during off-state. Please refer to the latest datasheet for detailed parameters.

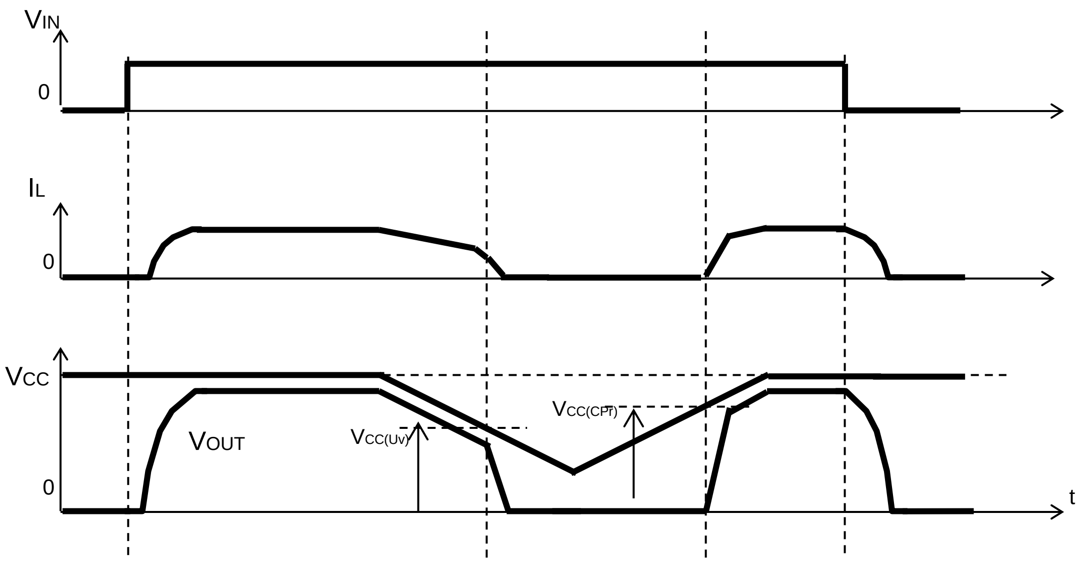
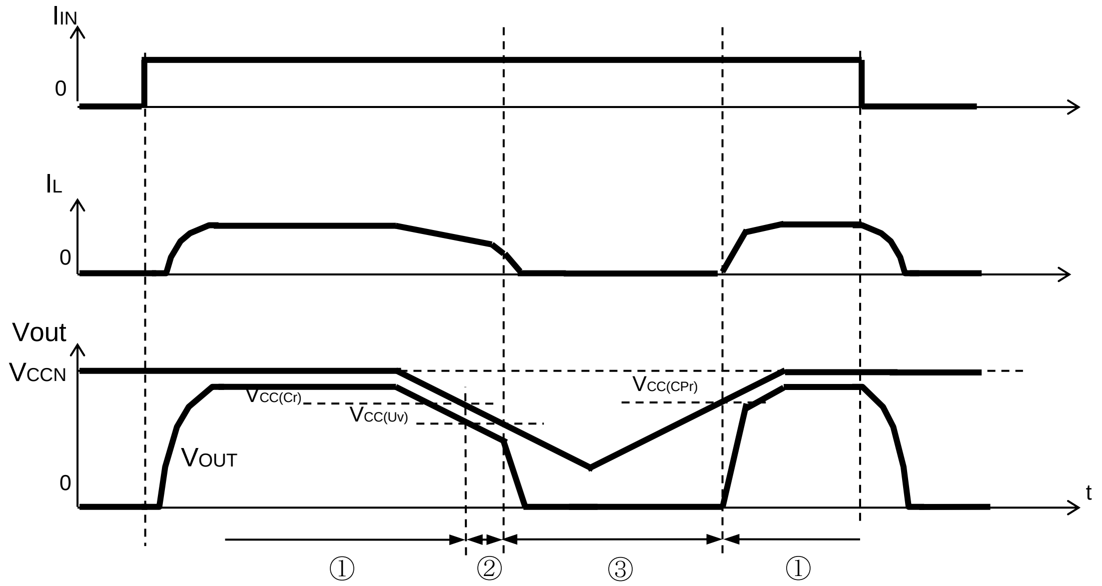


Figure 4. Under voltage lock out for uPD1660xx



① : Normal operating mode

② : Cranking mode

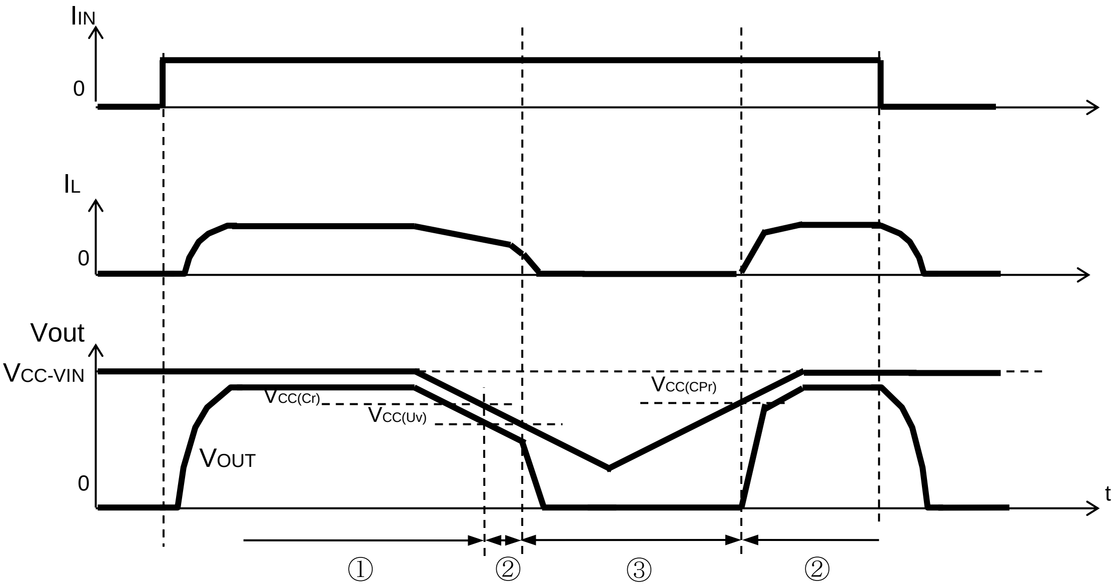
③ : Under voltage mode

Figure 5. Under voltage lock out for RAJ28000xxH12(voltage driven)

4.2.2 RAJ2800024H11(current driven) case

If the voltage supply (V_{CC} -V_{IN}) goes down under $V_{CC(Uv)}$, the device outputs shuts down. If voltage supply (V_{CC} -V_{IN}) increase over $V_{CC(CPr)}$, the device outputs turns back on automatically.

The device keeps off state after under voltage shutdown. The IS output is cleared during off-state.



① : Normal operating mode

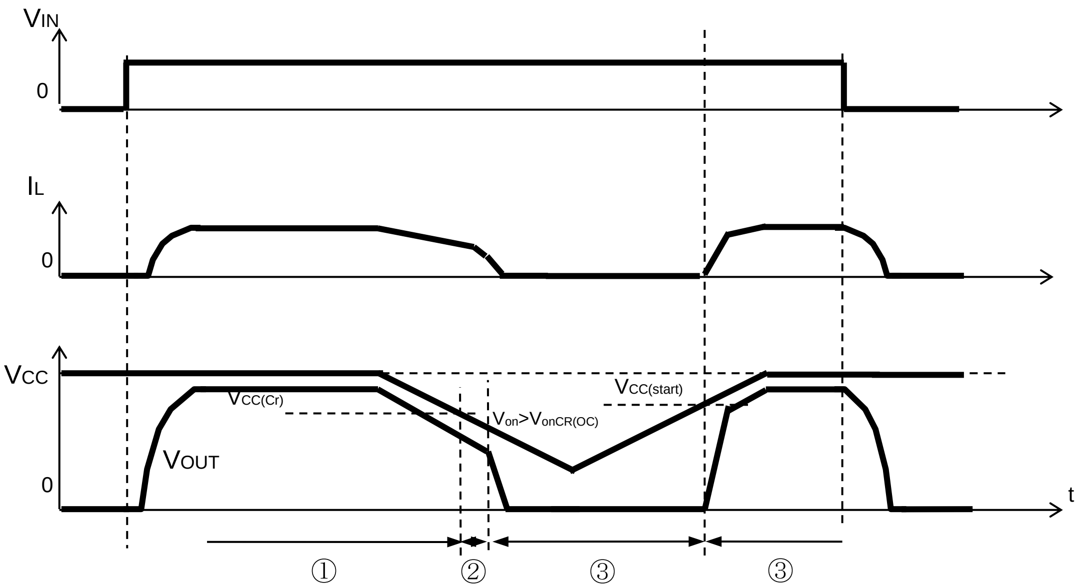
② : Cranking mode

③ : Under voltage mode

Figure 6. Under voltage lock out for RAJ2800024H11(current driven)

4.2.3 RAJ2810024 case

RAJ2810024 handles in a slightly different way, If the voltage supply (V_{CC}) goes down under $V_{CC(Cr)}$, the device outputs shuts down in case of V_{on} > $V_{onCR(OC)}$. If voltage supply (V_{CC}) increase over $V_{CC(start)}$, the device outputs turns back on automatically.
The IS output is cleared during off-state. Please refer to the latest datasheet for detailed parameters.



① : Normal operating mode

② : Cranking mode

③ : Shut down mode

Figure 7. Under voltage lock out for RAJ2810024

4.3 Reverse battery protection

Reverse battery protection is included to protect device. RAJ28000xx and RAJ2810024 have reverse battery protection by self-turn ON function. And some products(uPD166033/34) of uPD1660xx have this function. As an example, a block diagram of RAJ2810024 is shown below. In case of RAJ2810024, when reverse battery is applied to the device, the N-ch MOSFET will turn on only if reverse current flow from GND pin. The reverse current through the N-ch MOSFET has to be limited by the connected load. IGND(rev) is limited internally approx. 2mA even without external RGND. Reverse current flow from IN, INOFS, IS should be limited by external component such as recommendation value in Datasheet. The circuit configuration and pin functions may differ for each product, so please refer to the datasheet of each product for details.

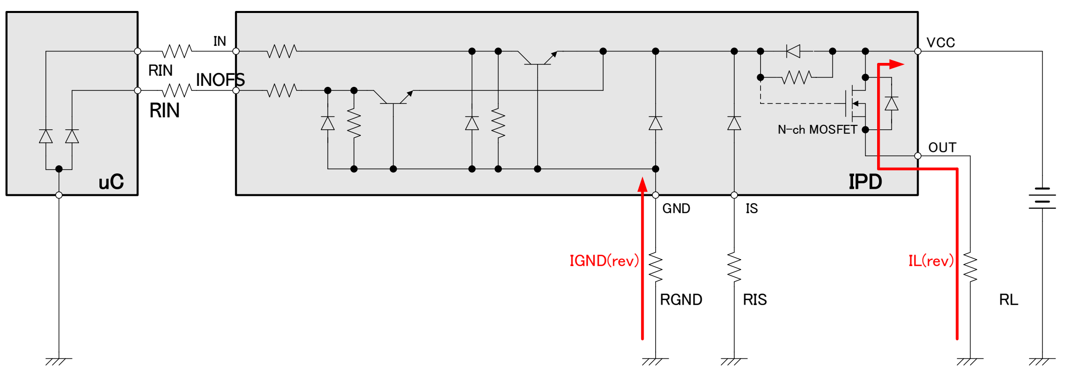


Figure 8. Reverse battery protection

4.4 Current sense

The Renesas IPD 3 products have the current sense feature. In this feature, the current of OUT pin can be diagnosed by detecting the proportional load current of R_{IS}. In the figure below the current sense circuit is shown. The principle is to compare two current flow paths: one is the sense path(I_S) made up by the parallel of m-cells PowerMOSFET and the sense resistor, another one is the main path(I_L) made up by the parallel of M-cells PowerMOSFET and the connected load.

During the on-state condition the load current creates a voltage drop on the OUT pin, the OpAmp control to the voltage drop of Main PowerMOSFET and the voltage drop of Sense PowerMOSFET have the same potential.

Therefore, the current ratio is defined as KILIS. KILIS=I_L / I_S.

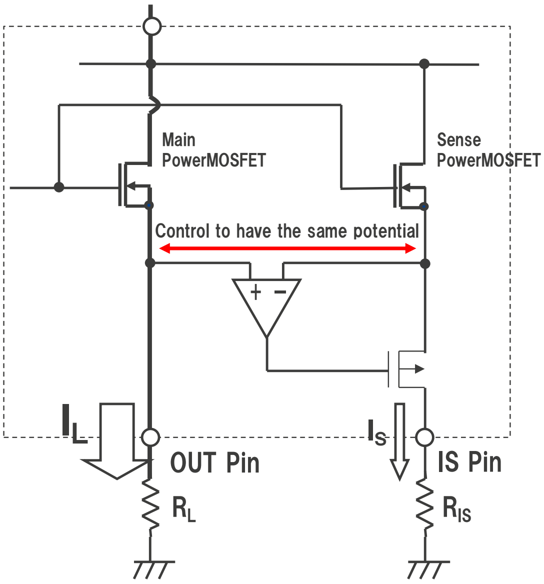


Figure 9. Current sense

4.4.1 Comparison of Renesas IPD 3 products

Below is a comparison of the IPD 3 products. RAJ2810024 has new features than the other 2 products.

Table 2. Current sense comparison

	Pin function	High-precision current sense
uPD1660xx	Terminal Name: ISn Pin function: ・ Current sense and Diagnosis output signal channel n (n=1 to 2) Recommended connection: ・ Connected to GND through a 0.67kohm to 5kohm resistor	Not available
RAJ28000xx	Terminal Name: IS Pin function: ・ Current sense and Diagnosis output signal Recommended connection: ・ Connected to GND through a 1kohm to 6kohm resistor	Not available
RAJ2810024	Terminal Name: IS Pin function: ・ Current sense and Diagnosis output signal Recommended connection: ・ To use high-precision current sense Connected to GND through a 1kohm to 6kohm resistor with parallel 0.1uF capacitor. ・ Not to use high-precision current sense Connected to GND through a 1kohm to 6kohm resistor. ・ Connect the resistor even if this pin is not used	Available

4.4.2 About RAJ2810024 diagnostic signal

RAJ2810024 is available for “high-precision current sense” that improves current detection accuracy.

Below is the truth table for RAJ2810024 high-precision current sense.

Table 3. RAJ2810024 diagnostic signal

	Input (IN)	Input (INOFS) 5)	Output (OUT)	Diagnostic output (IS)
Normal Operation	H	H	VCC	IIS = IL/KILIS3)
		L		IIS = IL/KILIS4)
	L	H	L1)	L2)
		L		

1) In case of OUT terminal is connected to GND via load.
2) In case of IS terminal is connected to GND via resister.
3) The current sense ratio(KILIS) is the value when the high-precision current sense is used.
4) The current sense ratio(KILIS) is the value when the high-precision current sense is not used.
5) INOFS pin: Input signal for high-precision current sense activation Active high.
-To use high-precision current sense
Connected to MCU’s output port through a 2kohm to 50kohm serial resistor.
-Not to use high-precision current sense
This pin should be open.

4.5 Inductive loads

Below is the switching waveform example of an inductive load case.

Protection functionality is included to protect the V_{OUT} negative voltage that occurs when an inductive load is applied. The protection method of uPD1660xx, RAJ28000xx and RAJ2810024 is different. uPD1660xx and RAJ28000xx are protected by dynamic clamp. RAJ2810024 is protected by avalanche.

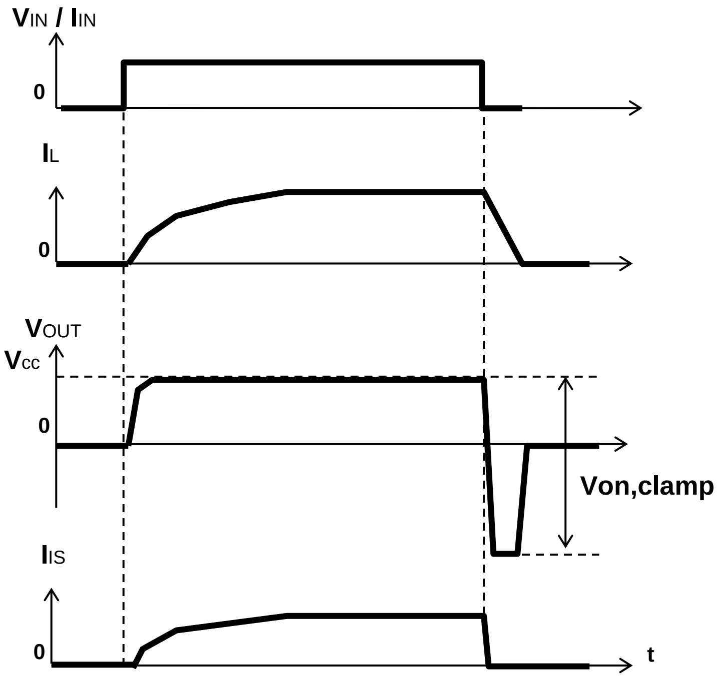


Figure 10. Inductive loads waveform

4.5.1 uPD1660xx and RAJ28000xx case

The dynamic clamp circuit works only when the inductive load is switched off. When the inductive load is switched off, the voltage of OUT falls below 0V. The gate voltage of SW1 is then nearly equal to GND. Next, the voltage at the source of SW1 (= gate of output MOS) falls below the GND voltage.

SW1 is turned on, and the clamp diode is connected to the gate of the output MOS, activating the dynamic clamp circuit.

When the over-voltage is applied to V_{CC}, the gate voltage and source voltage of SW1 are both nearly equal to GND. SW1 is not turned on, the clamp diode is not connected to the gate of the output MOS, and the dynamic clamp circuit is not activated.

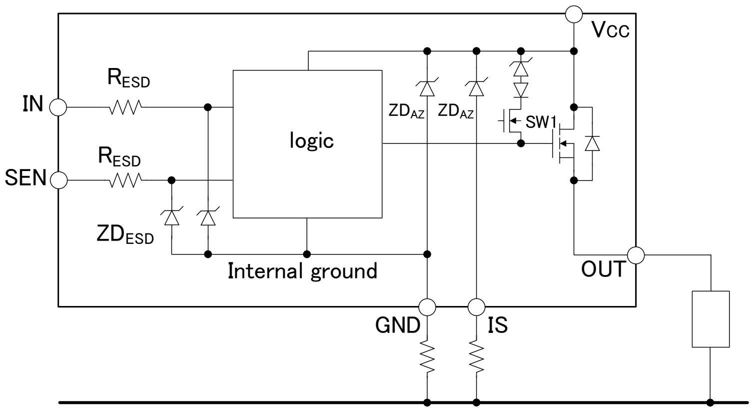


Figure 11. Dynamic clamp circuit on uPD1660xx and RAJ28000xx

4.5.2 RAJ2810024 case

When the inductive load is switched off, the voltage of OUT falls below 0V.
The MOS go into avalanche breakdown and keep the voltage Von,clamp (Typ. 43V).

4.6 Short Circuit

4.6.1 Short Circuit protection classification

Renesas IPDs offers some Short Circuit protections. Here in application note we classifies by condition. For more details, please refer to each datasheet.

4.6.2 Turn-on in an over load condition including short circuit condition (uPD1660xx and RAJ28000xx case)

The device shuts down automatically when Iload condition is over Short Circuit current threshold ”IL(SC)”. The sense pin output Iis,fault value to indicate fault state. Shutdown is latched until the next reset via input pin. The device shuts down automatically when delta Tch is more than power limitation thermal shutdown temperature “dTth”. The device restarts automatically in power limitation mode. The device shuts down automatically when Tch is more than absolute thermal shutdown temperature “aTth”. After this shutdown, uPD1660xx restarts automatically. On the other hand, RAJ28000xx keep latch off.

4.6.3 Over load condition including short circuit condition during on-state (uPD1660xx and RAJ28000xx case)

The device runs automatically into power limitation mode when Von (Driver drain-source voltage) exceeds Von(CL2) threshold once after Von < Von(CL2). The device shuts down automatically when delta Tch is more than power limitation thermal shutdown temperature “dTth”. The device restarts automatically in power limitation mode.

For uPD1660xx, the device shuts down automatically when Tch is more than absolute thermal shutdown temperature “aTth” and restarts automatically in absolute thermal toggling mode. The sense pin output Iis,fault during power limitation mode or thermal toggling mode.

For RAJ28000xx, the sense pin output Iis,fault during power limitation mode.
The device shuts down automatically when Tch is more than absolute thermal shutdown temperature “aTth”, or Iload condition is over Short Circuit current threshold ”IL(SC)”. The sense pin output Iis,fault.
Shutdown is latched until the next reset via input pin.

4.6.4 Power limitation control (uPD1660xx case)

Current limitation control with IL(CL) when auto restart from deltaTch protection. During the current limitation operation and Von>Von(CL1), the sense pin outputs Iis,fault. Even auto restart from delta Tch protection, if Von<Von(CL2) depends on short circuit impedance condition, the device does not operate as current limitation with IL(CL). In this case, the sense pin output sense current at on-state, Iis,fault at off-state during toggling operation with power limitation mode.

4.6.5 Power limitation control (RAJ28000xx case)

Current limitation control with IL(CL) when auto restart from deltaTch protection. During toggling mode due to Delta Tch protection, if Von>Von(CL1) or if the current is limited to IL(CL), the sense pin output Iis, fault. If Von<Von(CL2) and if the short current is not high enough to reach IL(CL) during toggling mode with delta Tch protection, then the sense pin outputs sense current at on-state and Iis,fault at off state.

4.6.6 Integrated Over current protection (RAJ28100xx case)

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

4.7 Diagnostic signal during protection

Renesas IPDs offers diagnostic signal during protection, to indicate fault state to MCUs.

The voltage during fault condition defined as Iis,fault. or Vis,fault.

It differs by IPD series and tables below summarize the condition and each signals.

4.7.1 uPD1660xx diagnostic during fault

Table 4. uPD1660xx diagnostic during fault

<table>
<tr><th></th><th>SEN</th><th>Input</th><th>Output</th><th>Diagnostic output[2)]</th></tr>
<tr><td rowspan="2">Shutdown by over current detection</td><td rowspan="12">H</td><td>H</td><td>L [1)]</td><td>Iis,fault [3)]</td></tr>
<tr><td>L</td><td>L [1)]</td><td>< 1uA (Iis,dis)</td></tr>
<tr><td rowspan="4">Power limitation</td><td rowspan="3">H</td><td rowspan="2">VOUT [6)]</td><td>IIS = IL/KILIS in case of Von<Von(CL1)</td></tr>
<tr><td>Iis,fault [4)] in case of Von>Von(CL1)</td></tr>
<tr><td>L [1)]</td><td>Iis,fault [4)]</td></tr>
<tr><td>L</td><td>L [1)]</td><td>< 1uA (Iis,dis)</td></tr>
<tr><td rowspan="4">Thermal toggling</td><td rowspan="3">H</td><td rowspan="2">VOUT [6)]</td><td>IIS = IL/KILIS in case of Von<Von(CL1)</td></tr>
<tr><td>Iis,fault [5)] in case of Von>Von(CL1)</td></tr>
<tr><td>L [1)]</td><td>Iis, fault [5)]</td></tr>
<tr><td>L</td><td>L [1)]</td><td>< 1uA (Iis,dis)</td></tr>
<tr><td rowspan="2">Short circuit to VCC</td><td>H</td><td>VCC</td><td>< 2uA (Iis,offset)</td></tr>
<tr><td>L</td><td>VOUT [7)]</td><td>Iis,fault in case of VOUT>VOUT(OL)</td></tr>
</table>

1) In case of OUT terminal is connected to GND via load.
2) In case of IS terminal is connected to GND via resister.
3) IS terminal keeps Iis,fault as long as input signal activate after the over current detection.
4) IS terminal keeps Iis,fault during power limitation if Von>Von(CL1).
5) IS terminal keeps Iis,fault during thermal toggling if Von>Von(CL1)..
6) VOUT depends on the short circuit condition

4.7.2 RAJ28000xx diagnostic during fault

Table 5. RAJ28000xx diagnostic during fault

	Input current	Output	Diagnostic output
Shutdown by over current detection	H	L [1]	Iis,fault [3]
	L	L [1]	L [2]
Power limitation	H	VOUT [6]	IIS = IL/KILIS in case of Von<Von(CL1)
			Iis,fault [4] in case of Von>Von(CL1)
		L [1]	Iis,fault [4]
	L	L [1]	L [2]
Shutdown by over absolute channel temperature detection	H	L [1]	Iis,fault 5)
	L	L [1]	L [2]
Short circuit to VCC	H	VCC	<IIS
	L	VOUT [7]	L [2]

1) In case of OUT terminal is connected to GND via load.
2) In case of IS terminal is connected to GND via resister.
3) IS terminal keeps Iis,fault as long as input signal activate after the over current detection.
4) IS terminal keeps Iis,fault during power limitation if Von>Von(CL1).
5) IS terminal keeps Iis,fault as long as input signal activate after over absolute channel temperature detection.
6) VOUT depends on the short circuit condition.
7) VOUT depends on the ratio of VCC-OUT-GND resistive component.

4.7.3 RAJ28100xx diagnostic during fault

Table 6. RAJ28100xx diagnostic during fault

	Input(IN)	Input(INOFS)	Output(OUT)	Diagnostic output(IS)
Shutdown by over current detection[1]	H	H	L [2]	Vis,fault [4]
		L		
	L	H	L [2]	L [3]
		L		
Shutdown by over absolute channel temperature detection	H	H	L [2]	Vis,fault [5]
		L		
	L	H	L [2]	L [3]
		L		
Short circuit to VCC	H	H	VCC	<IIS
		L		
	L	H	VOUT [6]	L [3]
		L		

1) Over Current detection is included IL1(SC),IL2(SC),Von(OC)afterTdOC(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.

5. How to use/Hint

This chapter contains instructions and tips for using Renesas IPD products.

5.1 Current sense output on IS pin

The current value flowing in the IPD can be determined by reading the IS pin of the Renesas IPD with the GPIO of the MCU or other devices. The ratio of the current flowing in the IPD "I_L" and the sense current output "I_{IS}" on the IS pin is described in the datasheet as the current sense ratio parameter "KILIS".

The following graph is described in the datasheet to explain this current sense ratio.

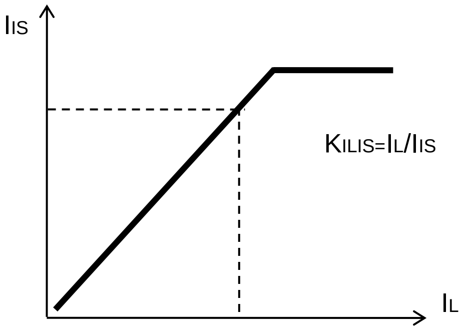


Figure 12. Current sense output on IS pin

In this graph, the I_{IS} value is depicted as saturated as the I_L value increases.

However, the current sense output I_{IS} from the IS pin does not saturate because the output is limited by the overcurrent detection in the IPD.

Table 7. KILIS parameter on RAJ2800024H12HPF datasheet

Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Current sense ratio	KILIS	35000	70000	110000		IL= 16.5 A
		40000	70000	105000		IL= 33 A

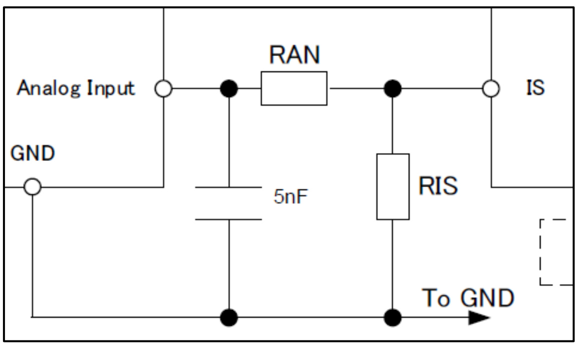


Figure 13. Application example on RAJ2800024H12HPF datasheet

For example, if the value of KILIS is 70,000 and the resistor RIS connected to the IS pin is 5.1kohm, a 20 A current can be read by the MCU as a voltage of 1.45 V under typical conditions.

$$V = \frac{IL}{KILIS} \times RIS$$

5.2 How to reduce the standby current of the entire Power distribution unit or ECU

Due to the recent hierarchical and decentralized automotive power distribution system with E/E architecture, ECUs or Power distribution units are equipped with many switches. Traditional mechanical relays require excitation current while the switch is on and no current when the switch is off.

IPDs require less current when turned on than relays, but a standby current is drawn when they are turned off. IPDs are designed to have a low standby current; however, the total standby current of the entire ECU may never be small.

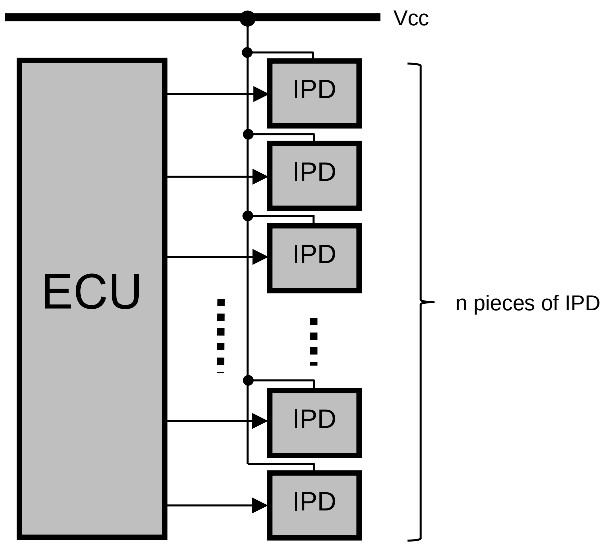


Figure 14. example structure of IPD use case

For example, as shown in the figure above, if n IPDs are connected to the MCU in the ECU, the standby current of the ECU is [MCU standby current + (IPD standby current $I_{CC(off)}$ x n)].

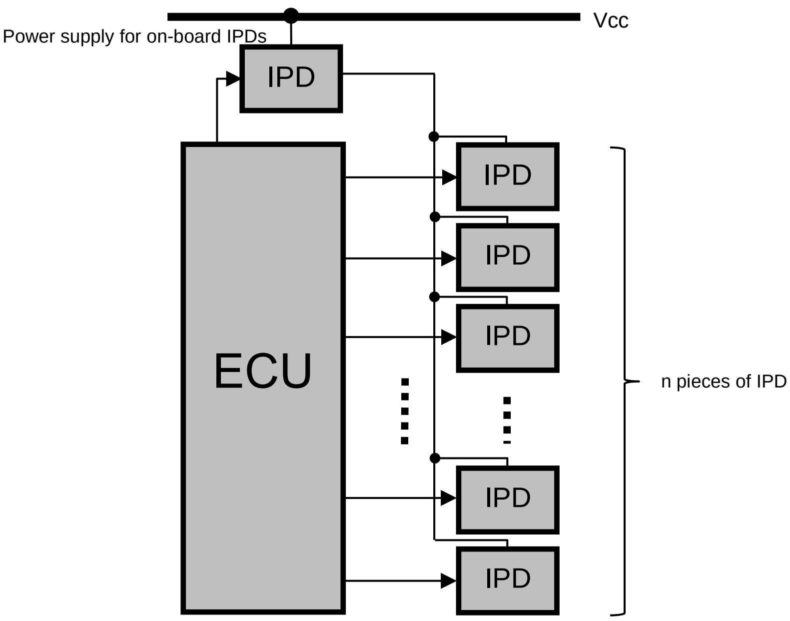


Figure 15. Reduced standby current case

Adding IPDs that control the power supply to IPDs in the ECU, as shown in the figure above, can reduce the standby current of the entire ECU.

5.3 How much current can your board handle with Renesas IPD?

This chapter describes how much current you can handle with Renesas IPDs on your board.

The current output of IPDs generates heat; the temperatures that IPDs can tolerate are specified in the datasheet as absolute maximum ratings, with a maximum channel temperature Tch of 150 degree C.

At the actual use of IPD, the IPD is mounted on a PCB; the copper layer of the PCB acts as a heat sink, so the current value that the IPD can handle in the mounted condition depends on the PCB configuration.

The thermal characteristics of IPD are described in the datasheet as two parameters, Rth(ch-c) and Rth(ch-a). Rth(ch-c) is a thermal resistance between channels and case, and Rth(ch-a) is a thermal resistance between channels and ambient temperature.

Table 8. Thermal characteristics parameter on RAJ2800024H12HPF datasheet

Parameter	Symbol	Min	Typ	Max	Unit	Test Condition
Thermal characteristics	Rth(ch-a)		21		degree C/W	According to JEDEC JESD51-2, -5, -7 on FR4 2s2p board
	Rth(ch-c)		0.21		degree C/W	

To consider the current value that IPD can handle with the board mounted, this Rth(ch-a) value is used, and the data sheet of Renesas IPD products describes the value with FR4 2s2p board compliant with JEDEC JESD51-2, -5, -7.

The following is an example of the calculations of the generated heat when the RAJ2800024H12HPF deals 30A (IL) current under an ambient temperature (Ta) of 50 degree C.

$$Ta + \frac{RON(MAX) \times IL^2}{1000} \times Rth(ch-a)$$

=119.93 degree C

As a result, the IPD temperature is 119.93 degree C when handling a 30A current at an ambient temperature of 50 degrees C, which is within the range of the channel temperature Tc specified as the absolute maximum rating of RAJ2800024H12HPF, which means that a 30A current can be handled with this ambient temperature.

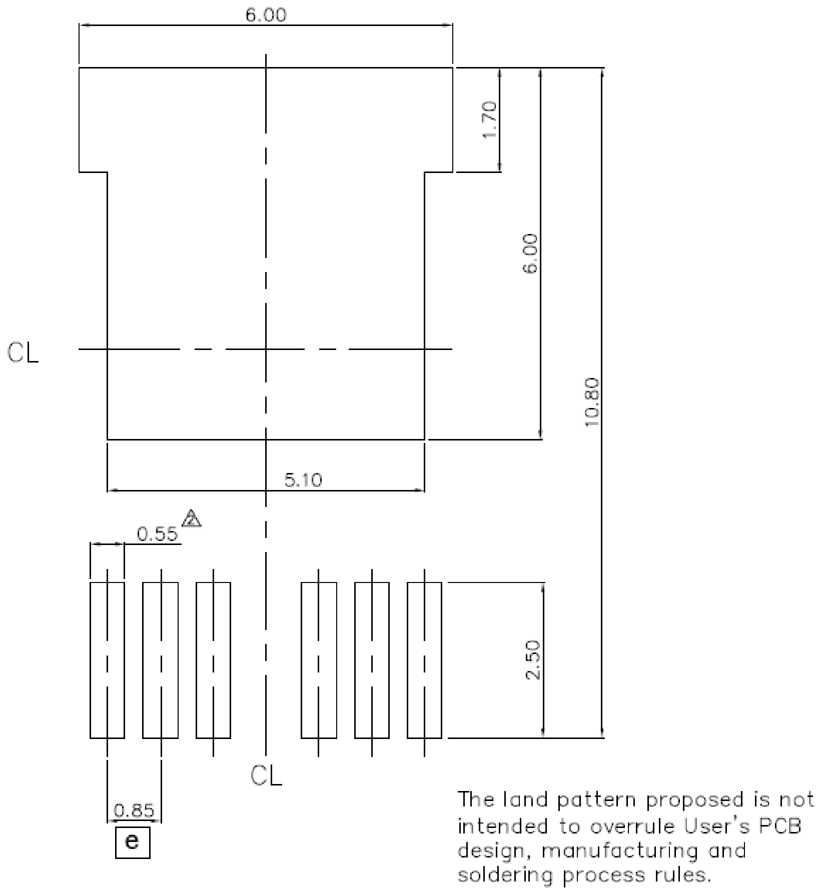
The value of Rth(ch-a) depends on the PCB configuration. When calculating whether Renesas IPD can handle the required current, please measure the Rth(ch-a) on the target PCB and calculate it.

5.4 Recommend footprint

This chapter describes the recommended footprint of the packages used by Renesas IPD products.

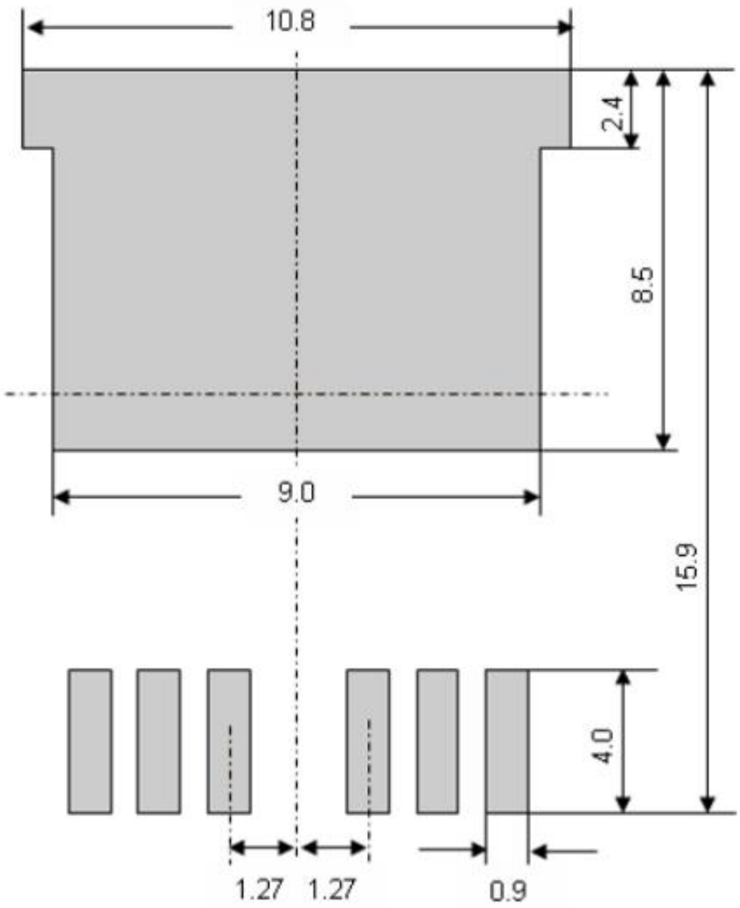
5.4.1 TO-252 recommend footprint

The recommended footprint of the TO-252 package used in uPD1660xx and RAJ2810024 is as below.



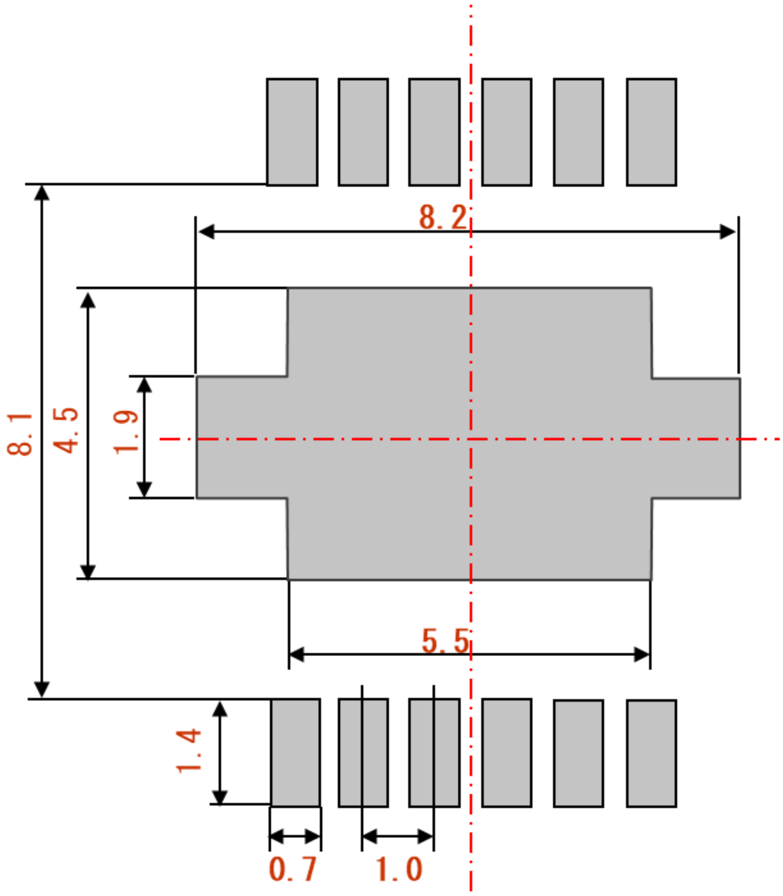
5.4.2 TO-263 recommend footprint

The recommended footprint of the TO-263 package used in RAJ28000xx is as below.



5.4.3 HSSOP 12pin recommend footprint

The recommended footprint of the HSSOP 12pin package used in uPD1660xx is as below.



6. Conclusion

Renesas IPD 3 products (uPD1660xx, RAJ28000xx and RAJ2810024) can contribute the optimization of wire harness weight and cost reduction by replacing conventional mechanical relays and fuse set.

Sufficient protection/diagnostic function for general IPD is implemented to Renesas IPD products.
Those features will contribute to make our customer's products more efficient one.

Regarding MOS FET application note for your reference, please refer to R07AN0007 on Renesas website.

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Apr. 15, 2024	–	First Issue

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