

# μPD166015GR

## MOS INTEGRATED CIRCUIT

 R07DS0595EJ0100  
 Rev.1.00  
 Jan 19, 2012

### Description

The μPD166015 is an N-channel high side driver with built-in charge pump and embedded protection function. It is also a linear solenoid driver with a built-in differential amplifier.

When device is overtemperature or overcurrent is generated in output MOS, the protection function operates to prevent destruction and degradation of the product. When the current flows through the external shunt resistor near the input part of the differential amplifier, the voltage drops at each end of the resistor. The output current can be monitored when the microcomputer reads the output voltage from the amplifier.

### Features

- High temperature operation (Tch = 175°C MAX.)
- Built-in charge pump circuit
- Low on-state resistance  
 $R_{DS(ON)} = 100 \text{ m}\Omega \text{ MAX. (} V_{IN} = V_{IH}, I_O = 1.5\text{A, Tch} = 25^\circ\text{C)}$
- Built-in protection circuit
  - Current limitation
  - Overtemperature protection
- Built-in differential amplifier (gain = 8 times)
- Package: Power SOP 8

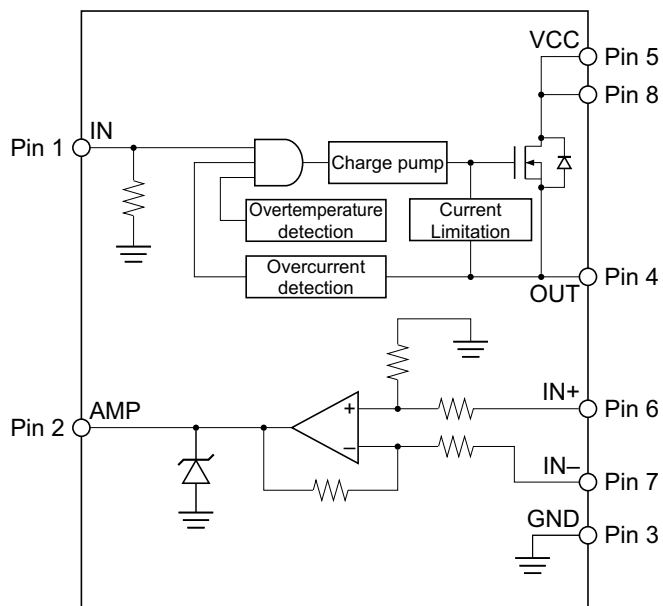
### Application

- Switching of all types of 14 V DC grounded loads, such as inductor, resistor and capacitor

### Ordering Information

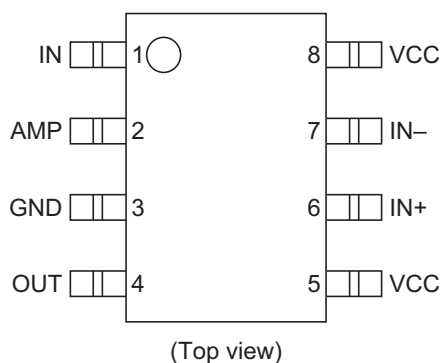
Part No.	Lead Plating	Packing	Package
μPD166015GR-E1-AY	Sn	Tape 2500 p/reel	Power SOP 8
μPD166015GR-E2-AY	Sn	Tape 2500 p/reel	Power SOP 8

## Block Diagram



## Pin Configuration

- Power SOP 8



## Pin Functions

Pin No.	Pin Name	Function
1	IN	Input pin
2	AMP	Differential amplifier output pin
3	GND	Ground pin
4	OUT	High side output pin
5	VCC	Power supply pin
6	IN+	Differential amplifier + input pin
7	IN-	Differential amplifier - input pin
8	VCC	Power supply pin

## Absolute Maximum Ratings

(Ta = 25°C, unless otherwise specified)

Item	Symbol	Rating	Unit	Condition
Power supply voltage	V <sub>CC1</sub>	-0.3 to +35	V	
	V <sub>CC2</sub>	40	V	τ = 250 ms
IN input voltage	V <sub>IN1</sub>	-0.5 to +7.0	V	IN pin
	V <sub>IN2</sub>	5	V	V <sub>CC</sub> = 0 V, t = 0.5 s, IN pin
IN input current	I <sub>IN</sub>	±10	mA	
Amplifier input voltage	V <sub>IN±</sub>	-1.1 to +18	V	R <sub>IN</sub> = 1 kΩ, IN+/IN- pin
Amplifier input current	I <sub>IN±</sub>	±10	mA	IN pin, IN+/IN- pin
Output current	I <sub>OA</sub>	2	A	
Output negative voltage	V <sub>OA</sub>	V <sub>CC</sub> -60	V	
Power dissipation	P <sub>D</sub>	1.50	W	Ta = 25°C <sup>Note</sup>
Operation temperature	T <sub>opt</sub>	-40 to +125	°C	
Storage temperature	T <sub>stg</sub>	-55 to +175	°C	
Current monitor output voltage	V <sub>AMP</sub>	8.0	V	
Current monitor output current	I <sub>AMP</sub>	10	mA	

Note: When mounted on a epoxy PCB (where FR-4 is 10 cm × 10 cm, dimension of copper foil is 15% and thickness of copper foil is 35 μm), PW = 10 s

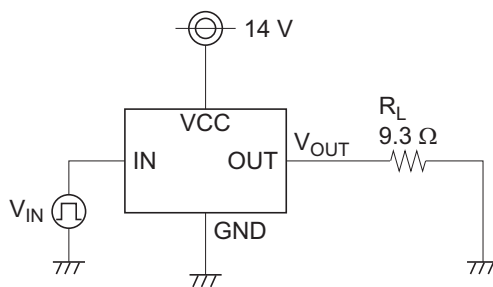
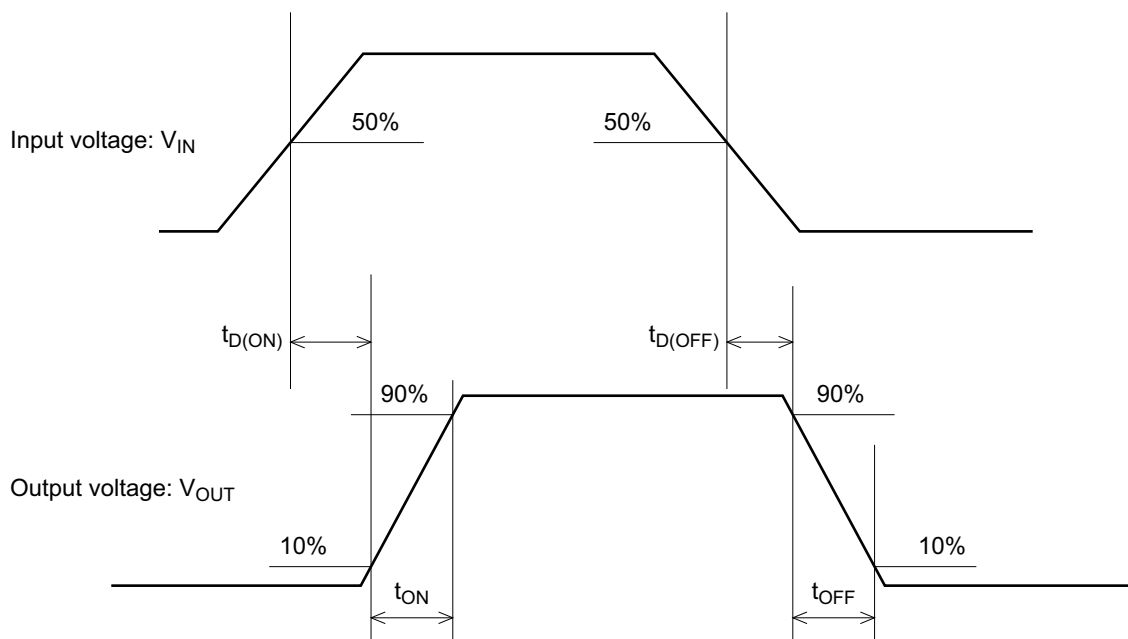
**Electrical Characteristics**

(V<sub>CC</sub> = 8 to 16 V, T<sub>ch</sub> = -40 to +175°C, unless otherwise specified)

Item	Symbol	MIN.	TYP.	MAX.	Unit	Condition	
Input voltage	V <sub>IH</sub>	3.0	—	7.0	V	V <sub>CC</sub> = 4.5 to 16 V	
	V <sub>IL</sub>	0	—	1.0	V		
Input current	I <sub>IH</sub>	30	—	400	μA	V <sub>IN</sub> = 5.5 V	
	I <sub>IL</sub>	-10	—	—	μA	V <sub>IN</sub> = 0 V	
Standby current	I <sub>CCH</sub>	—	—	7	mA	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> <sup>Note 1</sup>	
Output leakage current	I <sub>OL</sub>	-0.24	—	—	mA	V <sub>IN</sub> = V <sub>IL</sub> , V <sub>O</sub> = 0 V	
Drain to source on-state resistance	R <sub>DS(ON)</sub>	—	80	100	mΩ	V <sub>IN</sub> = V <sub>IH</sub> , I <sub>O</sub> = 1.5 A	
		—	150	180	mΩ		T <sub>ch</sub> = 150°C
Overcurrent detection	I <sub>S</sub>	2	—	(10)	A	Note 2	
Overtemperature detection	T <sub>th</sub>	(175)	—	—	°C	Note 2	
Turn on delay time	t <sub>D(ON)</sub>	—	5	50	μs	R <sub>L</sub> = 9.3 Ω, V <sub>CC</sub> = 14 V, V <sub>IN</sub> = 5.0 V-0 V	
Turn off delay time	t <sub>D(OFF)</sub>	—	50	200	μs		
Rise time	t <sub>ON</sub>	—	30	200	μs		
Fall time	t <sub>OFF</sub>	—	20	200	μs		
Negative output voltage	-V <sub>O</sub>	—	—	V <sub>CC</sub> -50	V	I <sub>O</sub> = -60 mA	
At over current condition	Output oscillation cycle	t <sub>S</sub>	—	—	14	ms	Overcurrent
	Output on duty	D <sub>S</sub>	—	—	30	%	Overcurrent
Amplifier output voltage range	V <sub>OAMP</sub>	0	—	7.5	V	R <sub>LAMP</sub> = 50 kΩ (connect to ground)	
Amplifier output current	I <sub>OAMP</sub> (SOURCE)	—	—	-0.1	mA	R <sub>sh</sub> = 0.25 Ω, I <sub>sh</sub> = 1.50 A, V <sub>OAMP</sub> × 0.977	
	I <sub>OAMP</sub> (SINK)	0.1	—	—	mA	R <sub>sh</sub> = 0.25 Ω, I <sub>sh</sub> = 1.50 A, V <sub>OAMP</sub> × 1.023	
Amplifier slew rate	SR <sub>CM</sub>	—	0.3	—	V/μs	R <sub>LAMP</sub> = 50 kΩ (connect to ground)	
Amplifier gain	GAIN	—	8	—	Times		
Current detection accuracy	V <sub>OGAINW(0.05)</sub>	-47.0	—	47.0	%	R <sub>sh</sub> = 0.25 Ω V <sub>CC</sub> = 8 to 16 V R <sub>LAMP</sub> = 50 kΩ (connect to ground)	I <sub>sh</sub> = 0.05 A
	V <sub>OGAINW(0.10)</sub>	-23.8	—	23.8	%		I <sub>sh</sub> = 0.10 A
	V <sub>OGAINW(0.15)</sub>	-16.0	—	16.0	%		I <sub>sh</sub> = 0.15 A
	V <sub>OGAINW(0.50)</sub>	-5.4	—	5.4	%		I <sub>sh</sub> = 0.50 A
	V <sub>OGAINW(1.00)</sub>	-3.1	—	3.1	%		I <sub>sh</sub> = 1.00 A
	V <sub>OGAINW(1.50)</sub>	-2.3	—	2.3	%		I <sub>sh</sub> = 1.50 A

- Notes: 1. OUT current is not included.  
2. Not subject to production test, specified by design.

### Definition of Switching Time



**Switching Measurement Circuit**

### Truth Table

Item	V <sub>IN</sub>	V <sub>OUT</sub>
Normal operation	H	H
	L	L
Overtemperature detection	H	L
	L	L
Overcurrent detection	H	Chopping
	L	L

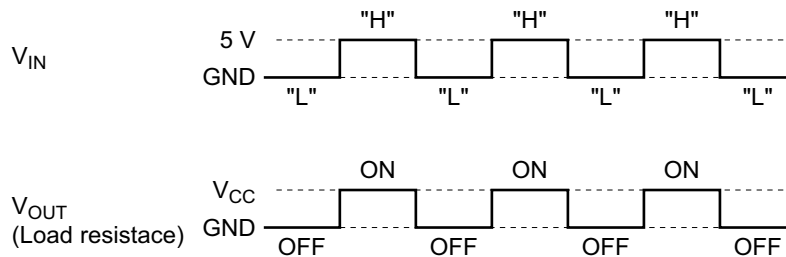
## Outline of Functions

### Pre-Driver (Charge Pump Circuit) ON/OFF Control

When the input voltage of the input pin (IN) is high level (3.0 V or more), the output MOS (Nch) turns on.

When the output voltage of the input pin (IN) is low level (1.0 V or less), the output MOS (Nch) turns off.

Charge pump circuit is built-in to drive the output MOS (Nch) that is connected to the high side.



### Overcurrent Detection Circuit

This circuit detects overcurrent to output pin (OUT) caused by short circuit etc., and feeds back detection signal to control circuit.

When the overcurrent is detected, the current limitation circuit and the control circuit start operation. The output current is restricted and chopping operation begins.

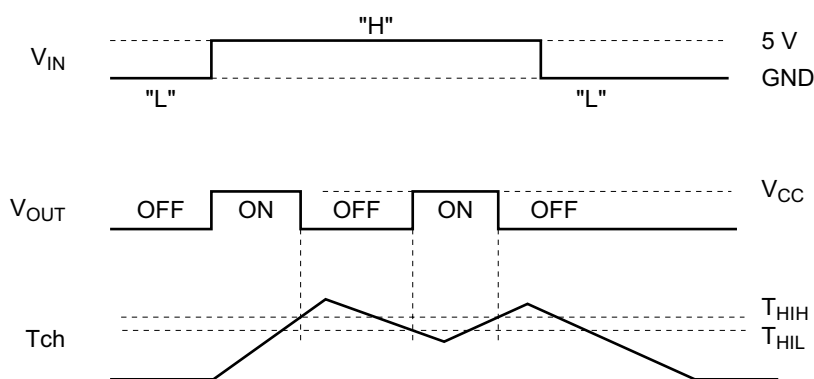
### Current Limitation Circuit

This circuit limits the output current by using the detection signal from the overcurrent detection circuit, preventing destruction and degradation of the product.

### Overtemperature Detection Circuit

This circuit detects overtemperature by output MOS (Nch) driving, and feeds back detection signal to control circuit.

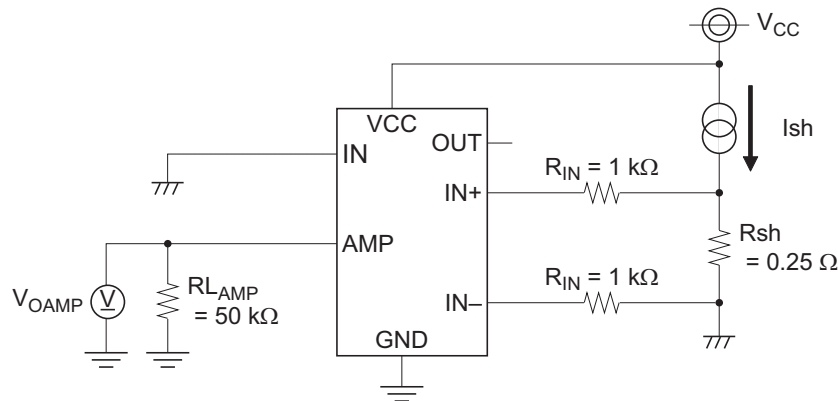
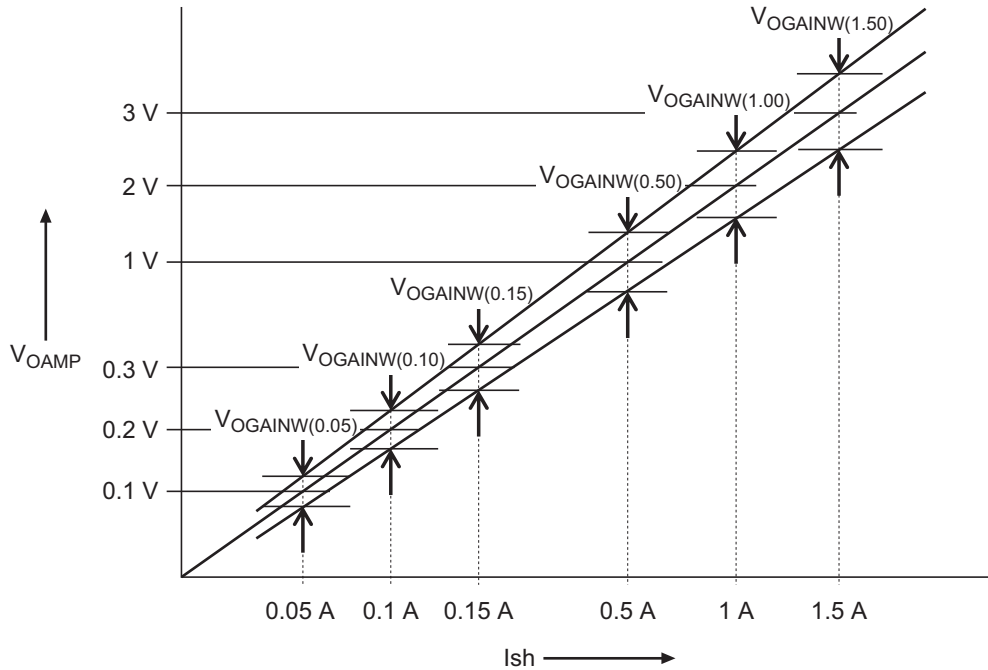
When the circuit detects overtemperature, the protection function of the control circuit operates and output is shutdown. Output MOS (Nch) automatically restarts when channel temperature cools down after shutdown.



### Differential Amplifier Circuit

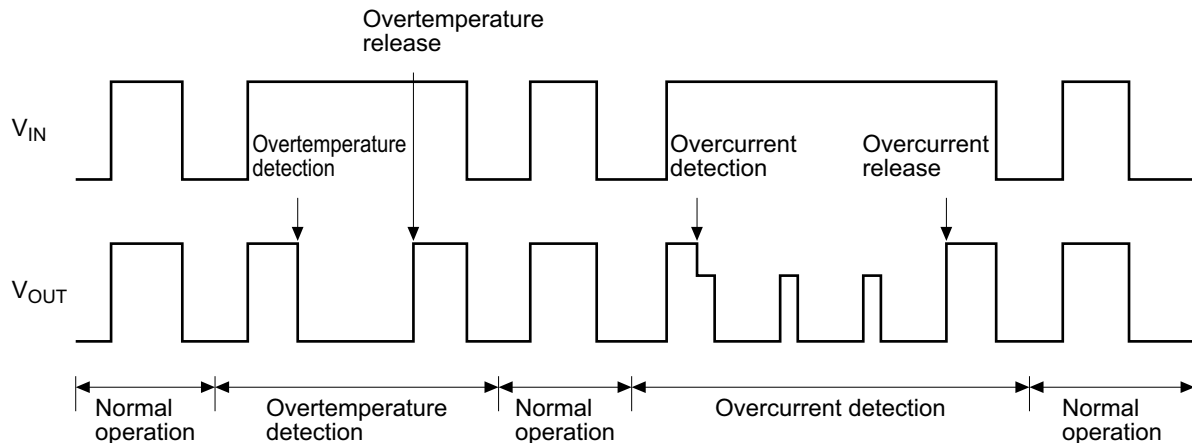
This amplifier circuit amplifies the differential input voltage ( $IN+$  and  $IN-$ ) to the differential amplifier eight times. When the current flows through the external shunt resistor ( $R_{sh}$ ) near the input part of the differential amplifier, the voltage drops at each end of the resistor. The output current can be monitored when the A/D converter in the microcomputer reads the output voltage from the amplifier.

The linear solenoid driver monitors the current through the differential amplifier circuit, and drives constant current by controlling the PWM of the output MOS.

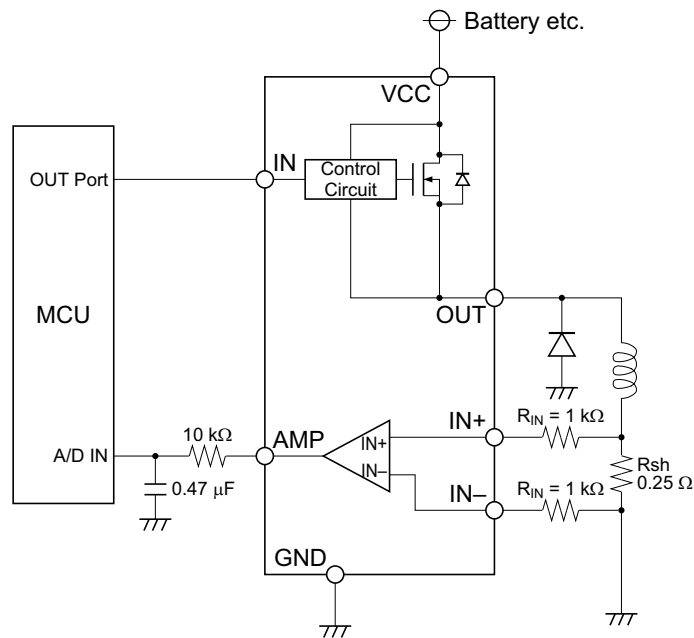


**Amplifier Characteristic Measurement Circuit**

### Timing Chart

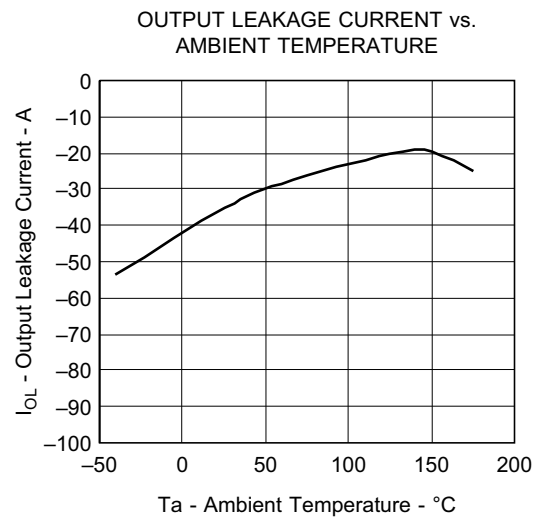
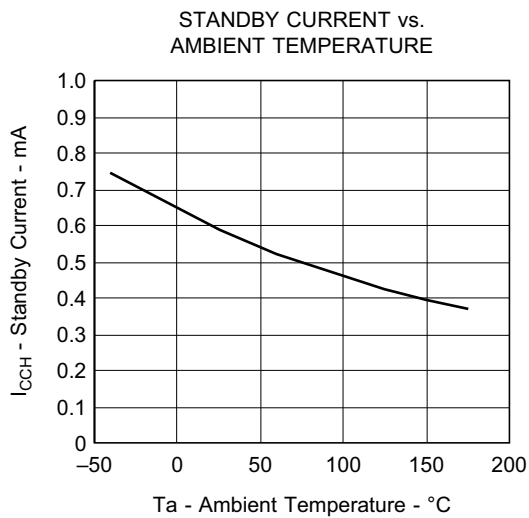
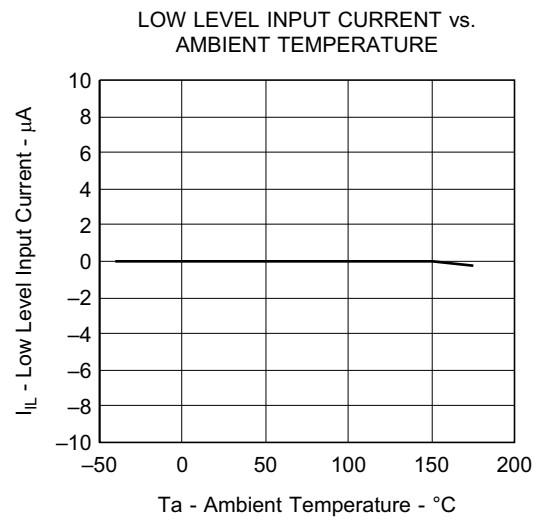
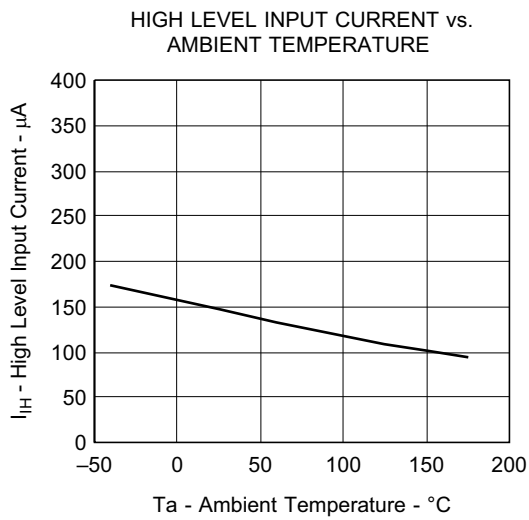
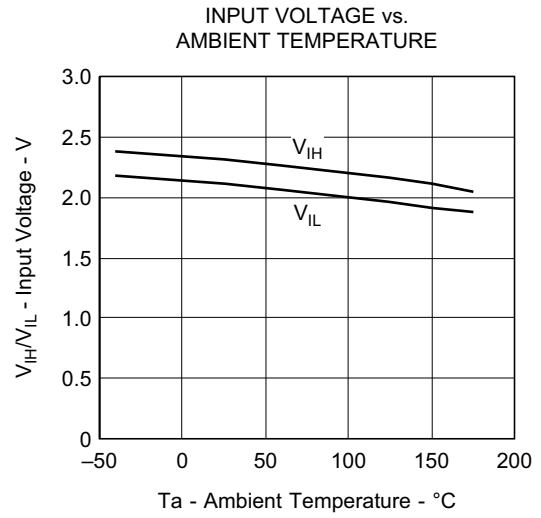
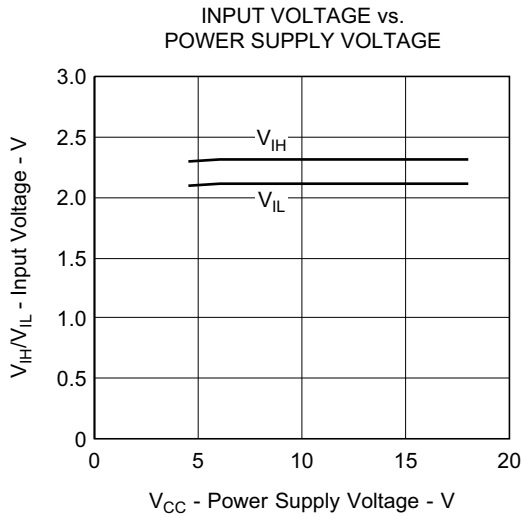


### Example of Application Circuit

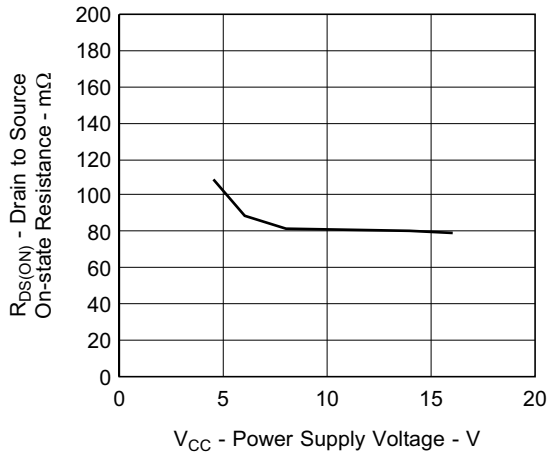




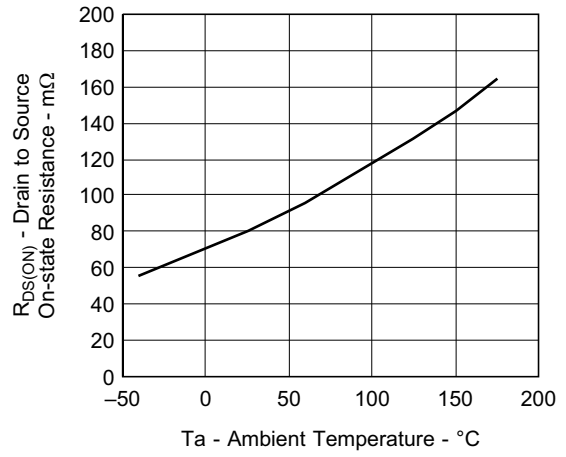
### Typical Characteristics



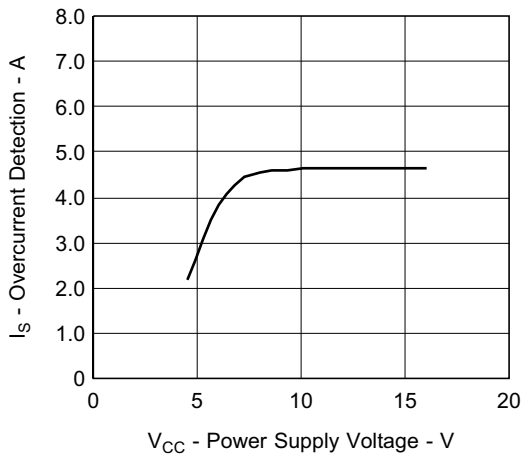
DRAIN TO SOURCE ON-STATE RESISTANCE vs. POWER SUPPLY VOLTAGE



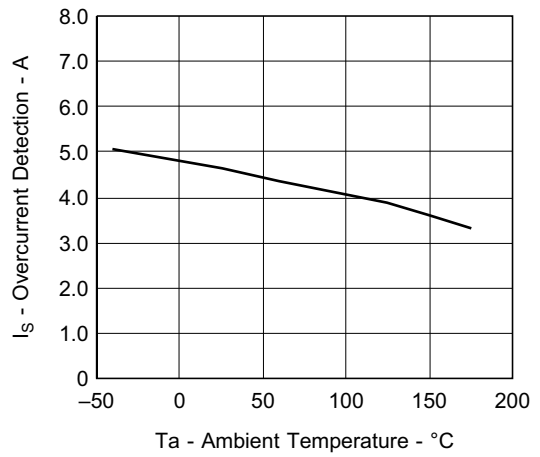
DRAIN TO SOURCE ON-STATE RESISTANCE vs. AMBIENT TEMPERATURE



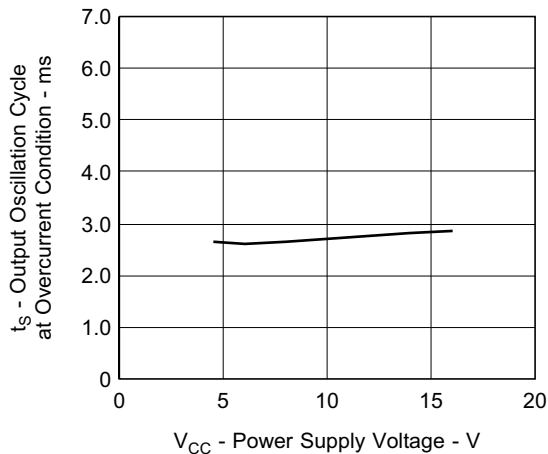
OVERCURRENT DETECTION vs. POWER SUPPLY VOLTAGE



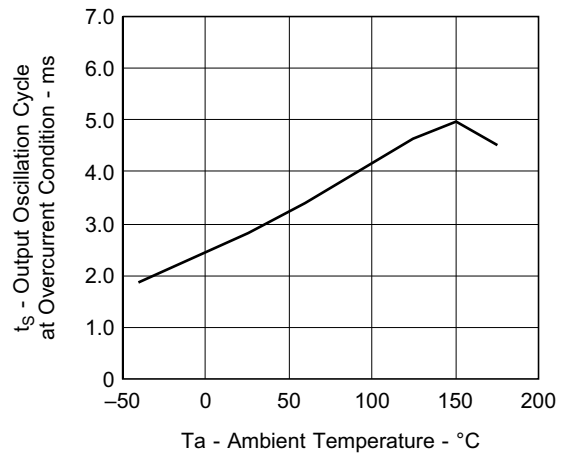
OVERCURRENT DETECTION vs. AMBIENT TEMPERATURE



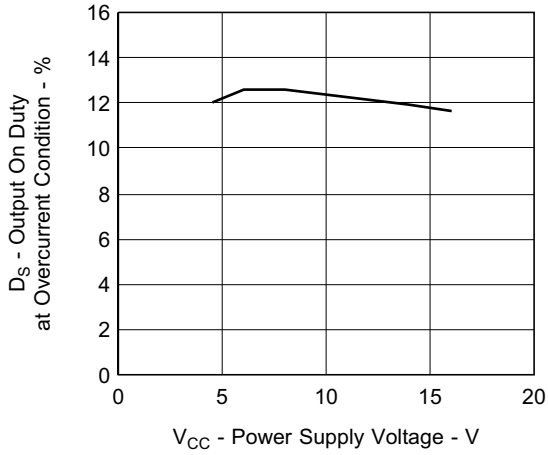
OUTPUT OSCILLATION CYCLE AT OVERCURRENT CONDITION vs. POWER SUPPLY VOLTAGE



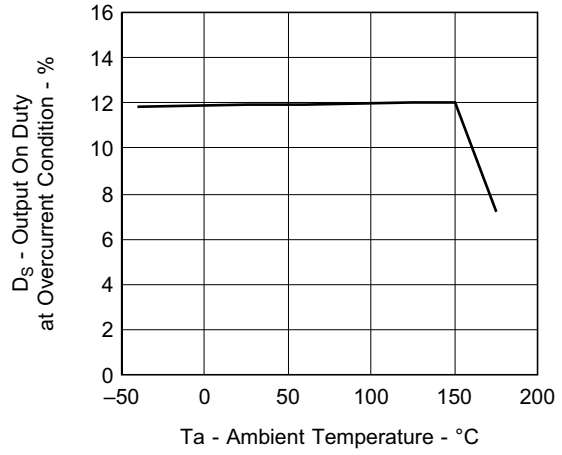
OUTPUT OSCILLATION CYCLE AT OVERCURRENT CONDITION vs. AMBIENT TEMPERATURE



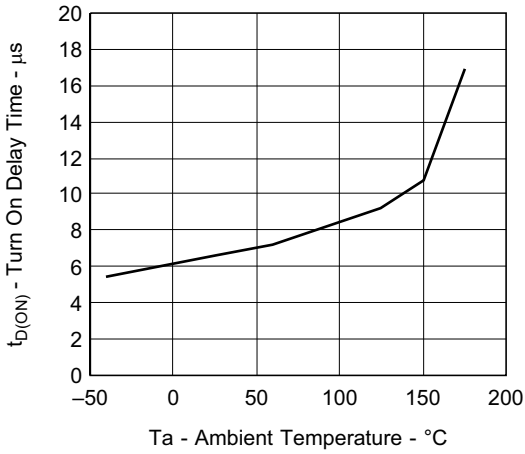
OUTPUT ON DUTY AT OVERCURRENT CONDITION vs. POWER SUPPLY VOLTAGE



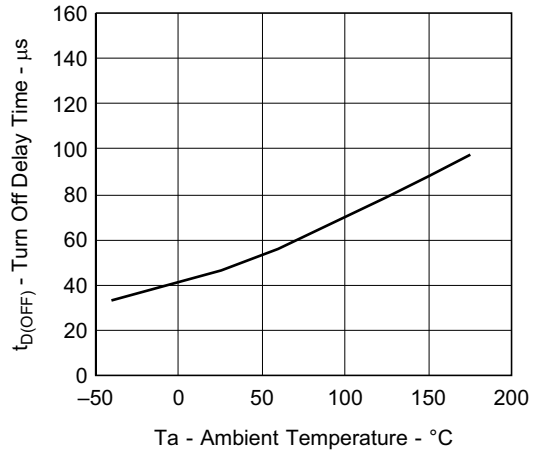
OUTPUT ON DUTY AT OVERCURRENT CONDITION vs. AMBIENT TEMPERATURE



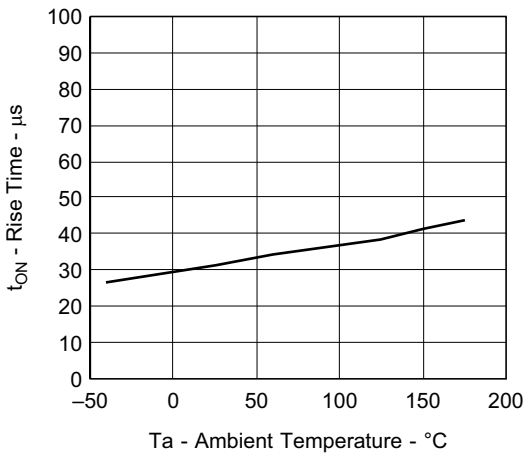
TURN ON DELAY TIME vs. AMBIENT TEMPERATURE



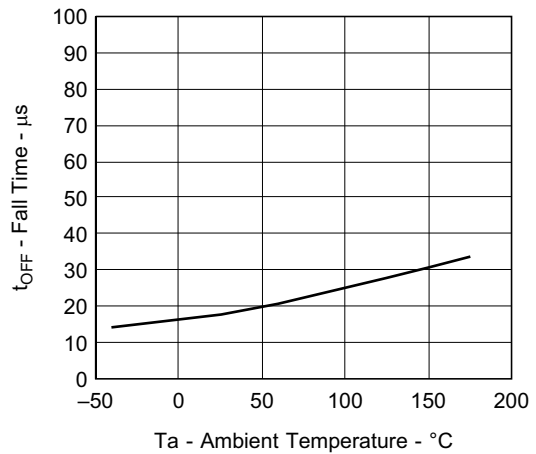
TURN OFF DELAY TIME vs. AMBIENT TEMPERATURE



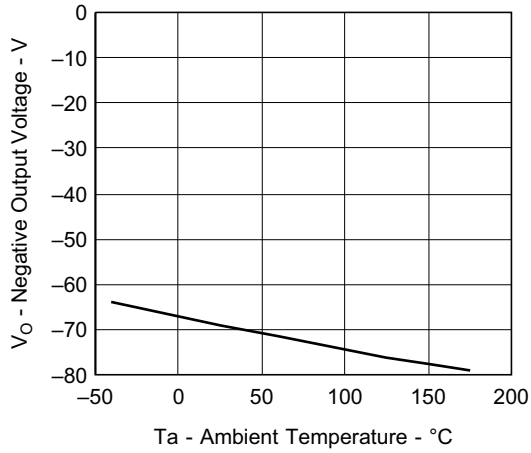
RISE TIME vs. AMBIENT TEMPERATURE



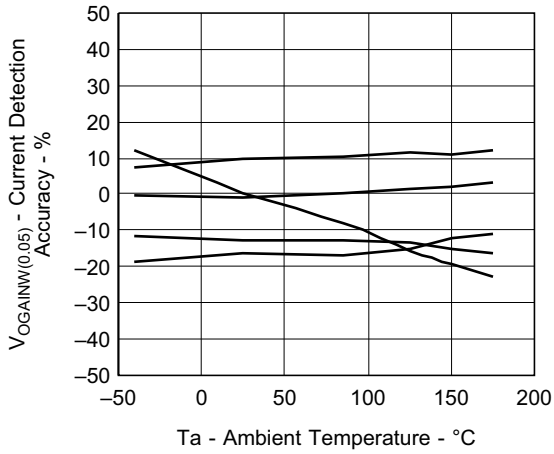
FALL TIME vs. AMBIENT TEMPERATURE



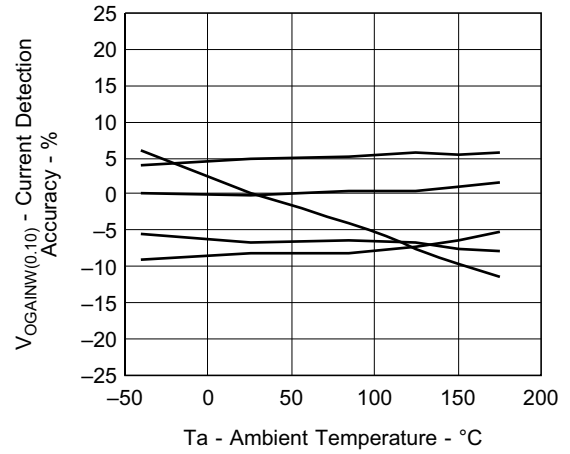
NEGATIVE OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE



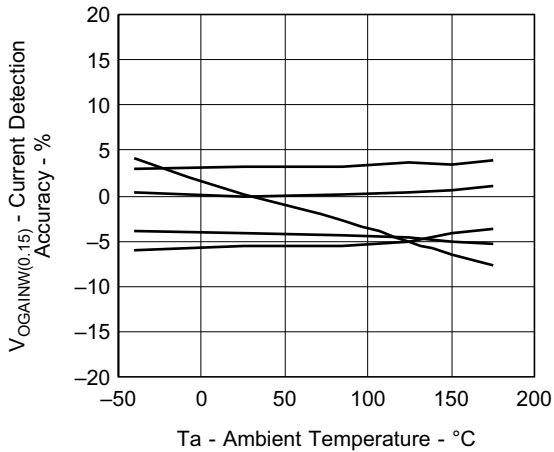
CURRENT DETECTION ACCURACY vs. AMBIENT TEMPERATURE



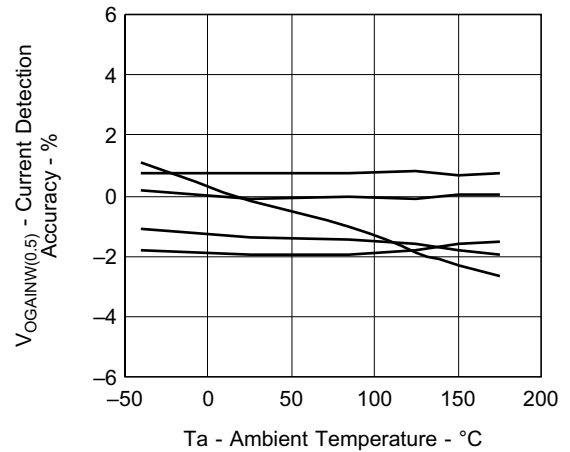
CURRENT DETECTION ACCURACY vs. AMBIENT TEMPERATURE

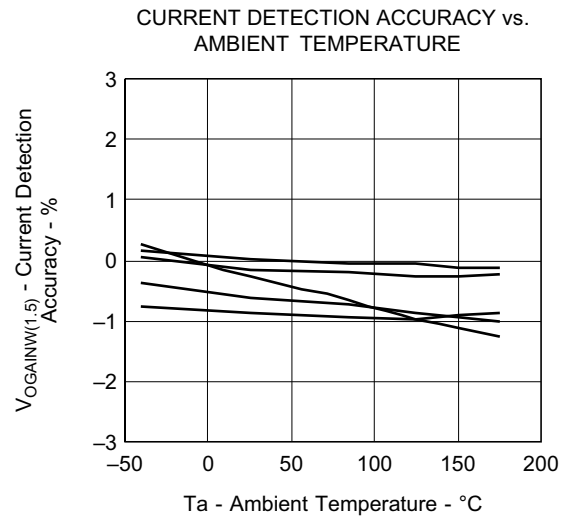
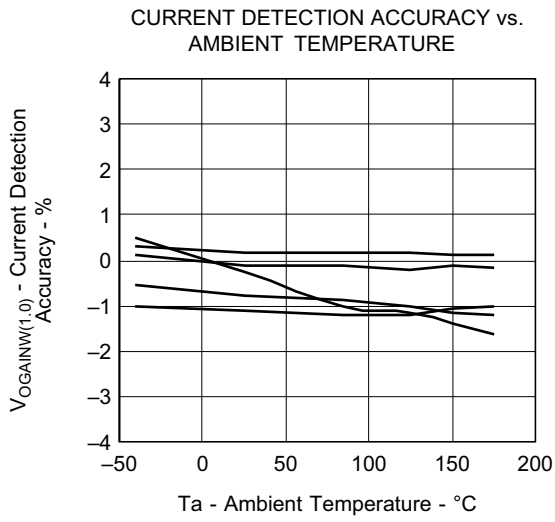


CURRENT DETECTION ACCURACY vs. AMBIENT TEMPERATURE

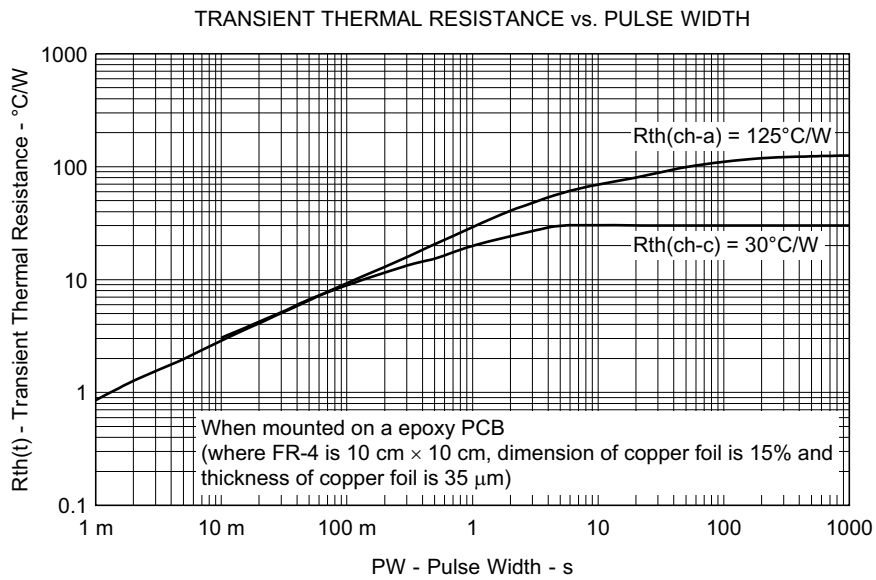


CURRENT DETECTION ACCURACY vs. AMBIENT TEMPERATURE

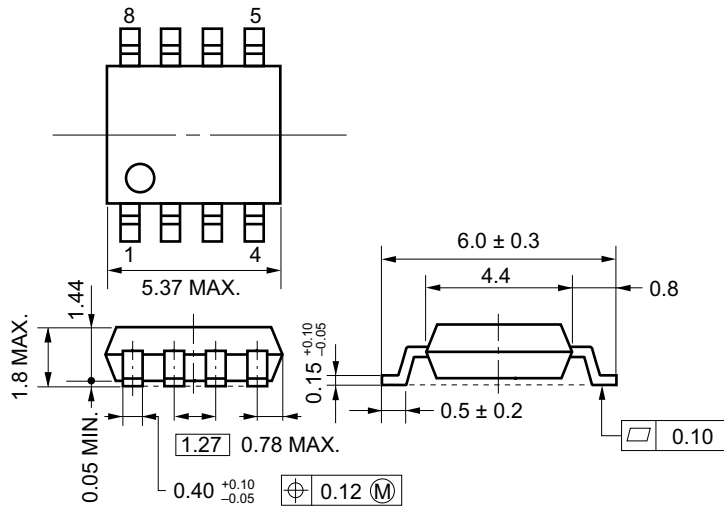




### Transient Thermal Resistance Characteristics

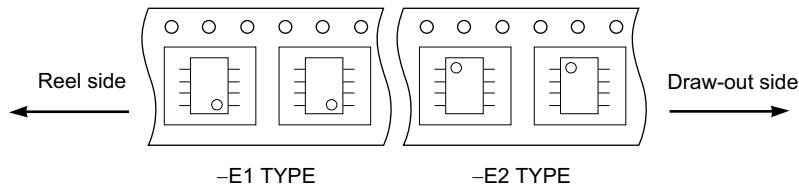


### Package Drawing



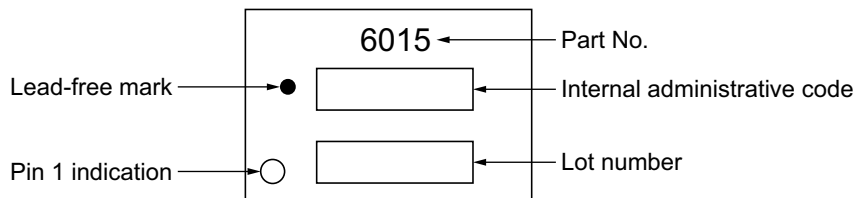
### Taping Information

There are two types (-E1, -E2) of taping depending on the direction of the device.



### Marking Information

This figure indicates the marking items and arrangement. However, details of the letterform, the size and the position aren't indicated.



## Recommended Soldering Conditions

The μPD166015 should be soldered and mounted under the following recommended conditions.

For soldering methods and conditions other than those recommended below, contact a Renesas Electronics sales representative.

For technical information, see the following website.

Semiconductor Package Mount Manual (<http://www.renesas.com/prod/package/manual/>)

- μPD166015GR-E1-AY <sup>Note</sup>: Power SOP 8
- μPD166015GR-E2-AY <sup>Note</sup>: Power SOP 8

Process	Conditions	Symbol
Infrared reflow	Maximum temperature (package's surface temperature): 260°C or below, Time at maximum temperature: 10 seconds or less, Time at temperature higher than 220°C: 60 seconds or less, Preheating time at 160°C to 180°C: 60 to 120 seconds, Times: Three times, Flux: Rosin flux with low chlorine (0.2 Wt% or below) recommended.	IR60-00-3
Partial Heating Method	Pin temperature: 300°C or below, Heat time: 3 seconds or less (Per each side of the device), Flux: Rosin flux with low chlorine (0.2 Wt% or below) recommended.	—

Note: Pb-free (This product does not contain Pb in the external electrode.)

<b>Revision History</b>	<b>μPD166015GR Data Sheet</b>
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Rev.	Date	Description	
		Page	Summary
1.00	Jan 19, 2012	—	First Edition Issued

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