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 mΩ MAX. ($V_{IN} = V_{IH}$, I_O = 1.5A, Tch = 25°C)
- Built-in protection circuit
  — Current limitation
  — Overtemperature protection
- Built-in differential amplifier (gain = 8 times)
- Package: Power SOP 8

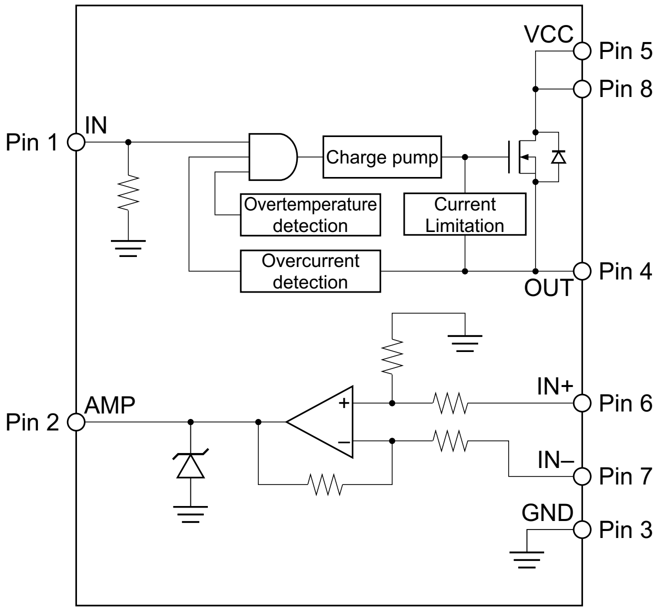
Application

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

Ordering Information

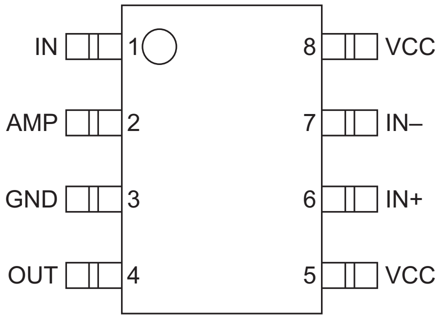
Part No.	Lead Plating	Packing	Package
μPD166015GR-E1-AY	Sn	Tape 2500 p/reel	Power SOP 8
μPD166015GR-E2-AY	Sn	Tape 2500 p/reel	Power SOP 8

Block Diagram



Pin Configuration

- Power SOP 8



(Top view)

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_{CC1}	–0.3 to +35	V	
	V_{CC2}	40	V	τ = 250 ms
IN input voltage	V_{IN1}	–0.5 to +7.0	V	IN pin
	V_{IN2}	5	V	V_{CC} = 0 V, t = 0.5 s, IN pin
IN input current	I_{IN}	±10	mA	
Amplifier input voltage	$V_{IN\pm}$	–1.1 to +18	V	R_{IN} = 1 kΩ, IN+/IN– pin
Amplifier input current	$I_{IN\pm}$	±10	mA	IN pin, IN+/IN– pin
Output current	I_{OA}	2	A	
Output negative voltage	V_{OA}	V_{CC}–60	V	
Power dissipation	P_D	1.50	W	Ta = 25°C [Note]
Operation temperature	Topt	–40 to +125	°C	
Storage temperature	Tstg	–55 to +175	°C	
Current monitor output voltage	V_{AMP}	8.0	V	
Current monitor output current	I_{AMP}	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

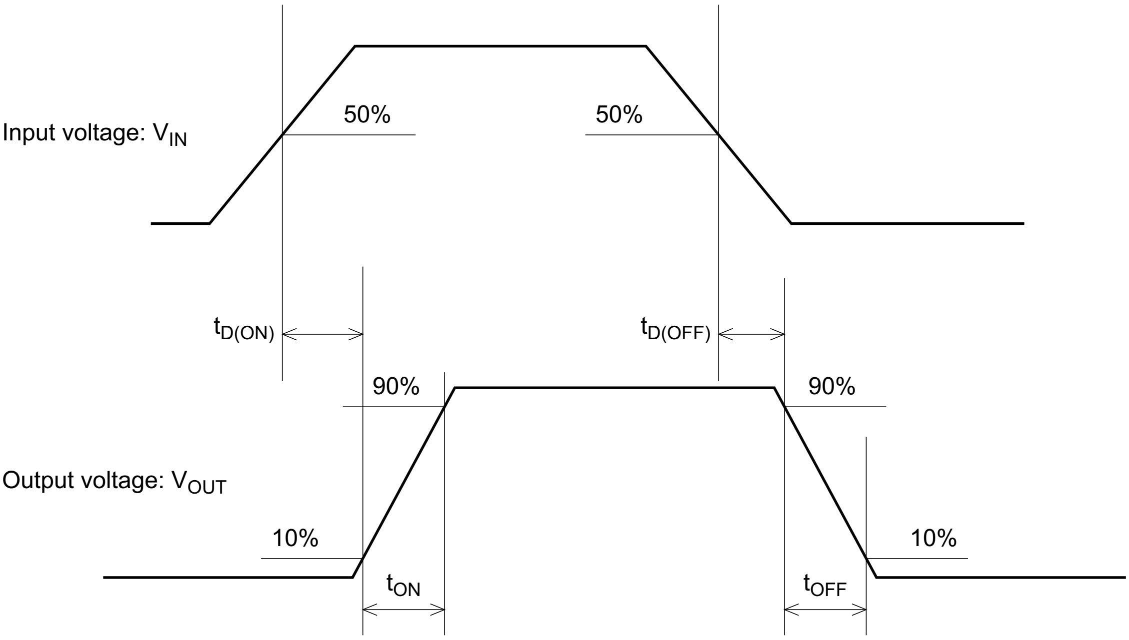
(V_{CC} = 8 to 16 V, Tch = –40 to +175°C, unless otherwise specified)

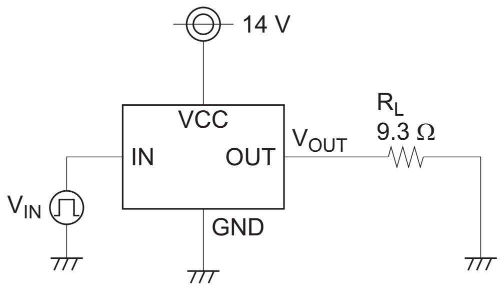
Item	Symbol	MIN.	TYP.	MAX.	Unit	Condition
Input voltage	V_{IH}	3.0	—	7.0	V	V_{CC} = 4.5 to 16 V
	V_{IL}	0	—	1.0	V	
Input current	I_{IH}	30	—	400	μA	V_{IN} = 5.5 V
	I_{IL}	–10	—	—	μA	V_{IN} = 0 V
Standby current	I_{CCH}	—	—	7	mA	V_{IN} = V_{IH} or V_{IL} Note 1
Output leakage current	I_{OL}	–0.24	—	—	mA	V_{IN} = V_{IL}, V_O = 0 V
Drain to source on-state resistance	$R_{DS(ON)}$	—	80	100	mΩ	V_{IN} = V_{IH}, I_O = 1.5 A; Tch = 25°C
		—	150	180	mΩ	Tch = 150°C
Overcurrent detection	I_S	2	—	(10)	A	Note 2
Overtemperature detection	Tth	(175)	—	—	°C	Note 2
Turn on delay time	$t_{D(ON)}$	—	5	50	μs	R_L = 9.3 Ω, V_{CC} = 14 V, V_{IN} = 5.0 V–0 V
Turn off delay time	$t_{D(OFF)}$	—	50	200	μs	
Rise time	t_{ON}	—	30	200	μs	
Fall time	t_{OFF}	—	20	200	μs	
Negative output voltage	$–V_O$	—	—	V_{CC}–50	V	I_O = –60 mA
At over current condition: Output oscillation cycle	t_S	—	—	14	ms	Overcurrent
At over current condition: Output on duty	D_S	—	—	30	%	Overcurrent
Amplifier output voltage range	V_{OAMP}	0	—	7.5	V	RL_{AMP} = 50 kΩ (connect to ground)
Amplifier output current	I_{OAMP} (SOURCE)	—	—	–0.1	mA	Rsh = 0.25 Ω, Ish = 1.50 A, V_{OAMP} × 0.977
	I_{OAMP} (SINK)	0.1	—	—	mA	Rsh = 0.25 Ω, Ish = 1.50 A, V_{OAMP} × 1.023
Amplifier slew rate	SR_{CM}	—	0.3	—	V/μs	RL_{AMP} = 50 kΩ (connect to ground)
Amplifier gain	GAIN	—	8	—	Times	
Current detection accuracy	$V_{OGAINW(0.05)}$	–47.0	—	47.0	%	Rsh = 0.25 Ω, V_{CC} = 8 to 16 V, RL_{AMP} = 50 kΩ (connect to ground); Ish = 0.05 A
	$V_{OGAINW(0.10)}$	–23.8	—	23.8	%	Ish = 0.10 A
	$V_{OGAINW(0.15)}$	–16.0	—	16.0	%	Ish = 0.15 A
	$V_{OGAINW(0.50)}$	–5.4	—	5.4	%	Ish = 0.50 A
	$V_{OGAINW(1.00)}$	–3.1	—	3.1	%	Ish = 1.00 A
	$V_{OGAINW(1.50)}$	–2.3	—	2.3	%	Ish = 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_{IN}	V_{OUT}
Normal operation	H	H
	L	L
Overtemperature detection	H	L
	L	L
Overcurrent detection	H	Chopping
	L	L

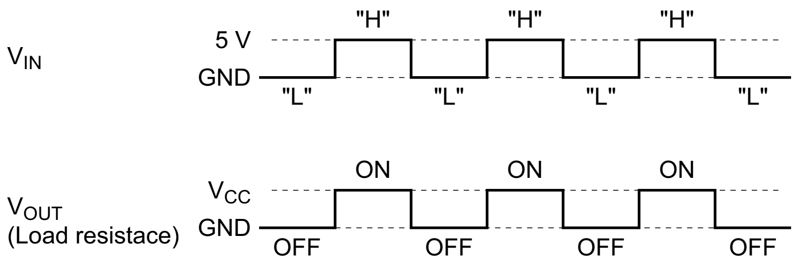
Outline of Functions

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.

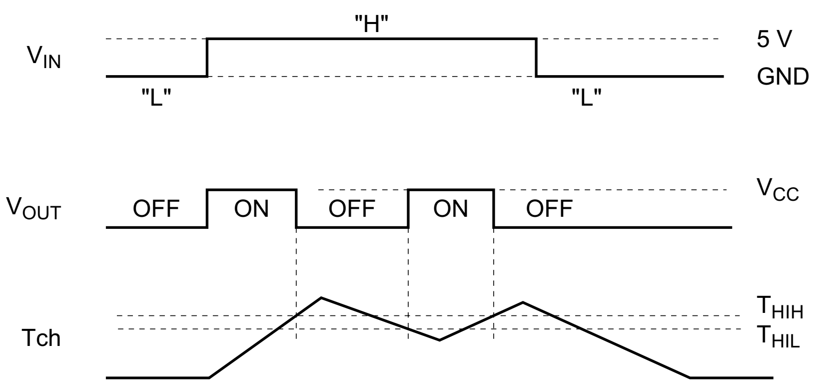
Current Limitation Circuit

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.

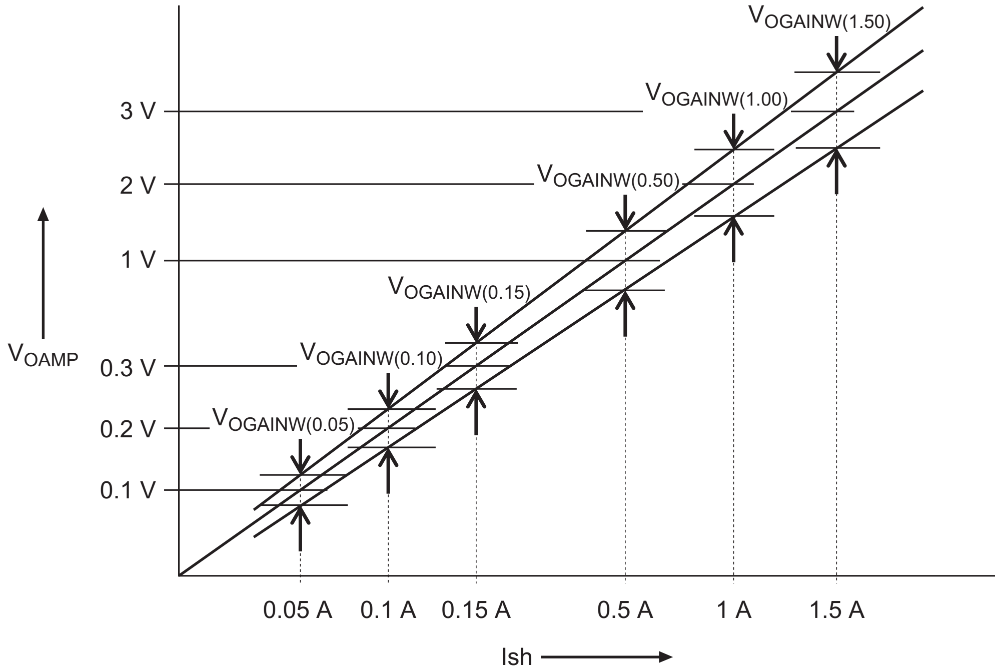
When the circuit detects overtemperature, the protection function of the control circuit operates and output is shutdown. Output MOS (Nch) automatically restarts when channel temperature cools down after shutdown.

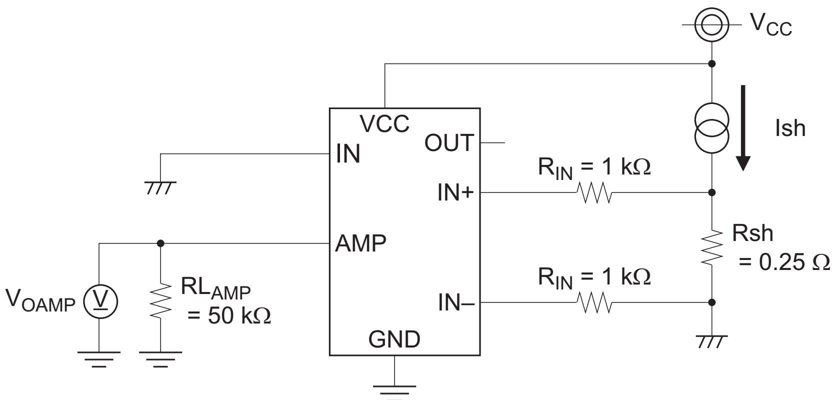


Differential Amplifier Circuit

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 (Rsh) 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.

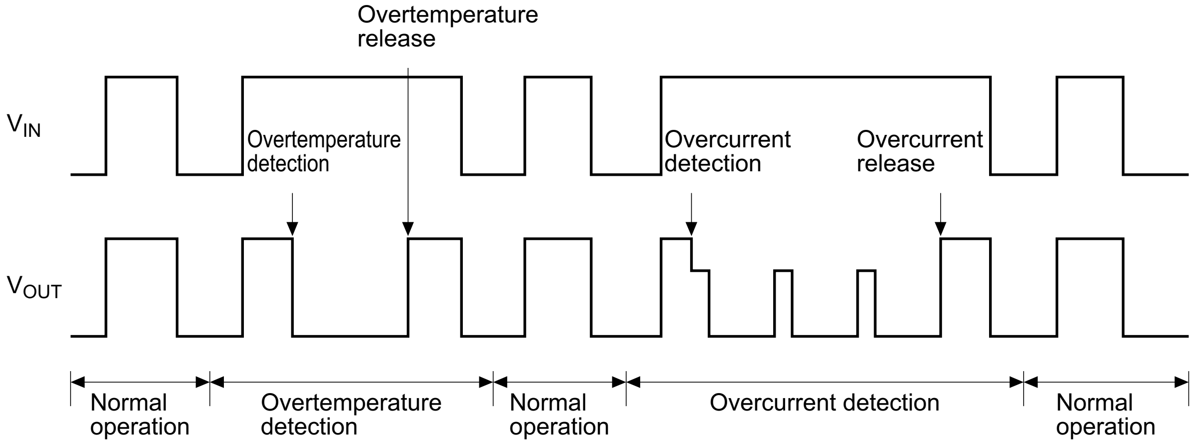
The linear solenoid driver monitors the current through the differential amplifier circuit, and drives constant current by controlling the PWM of the output MOS.



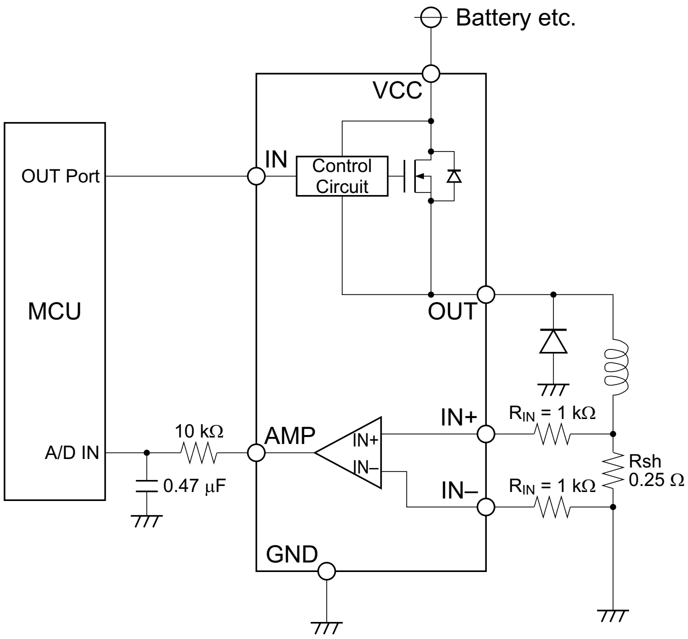


Amplifier Characteristic Measurement Circuit

Timing Chart

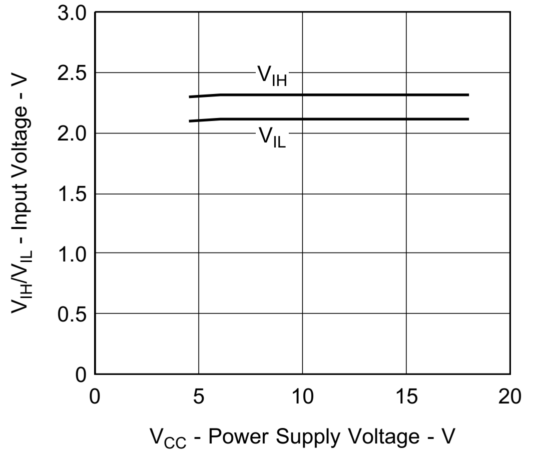


Example of Application Circuit

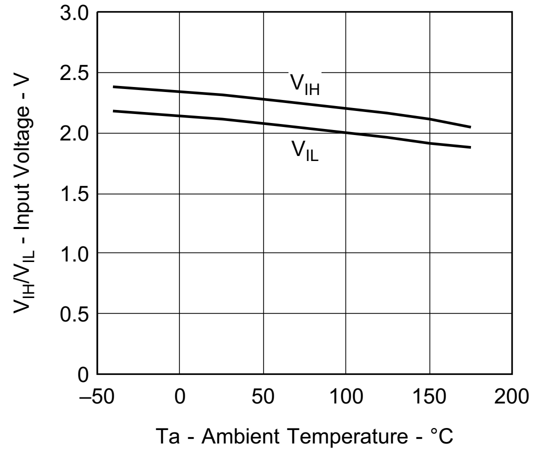


Typical Characteristics

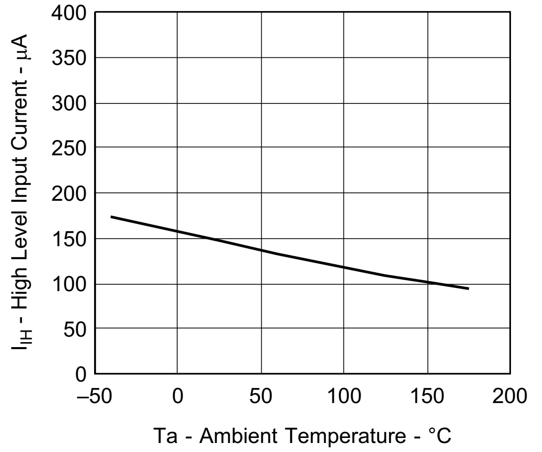
INPUT VOLTAGE vs.
POWER SUPPLY VOLTAGE



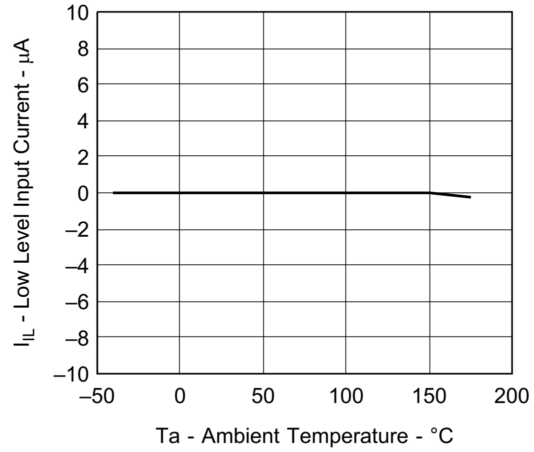
INPUT VOLTAGE vs.
AMBIENT TEMPERATURE



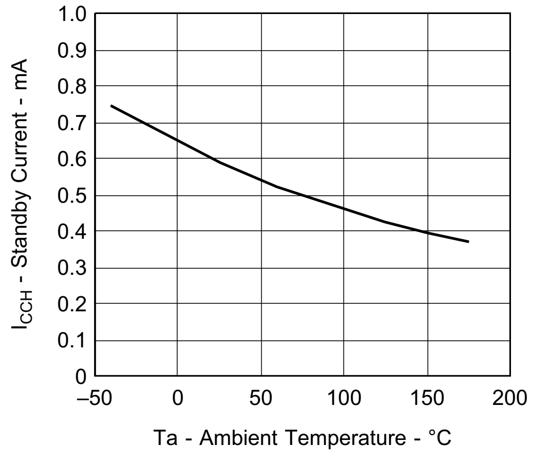
HIGH LEVEL INPUT CURRENT vs.
AMBIENT TEMPERATURE



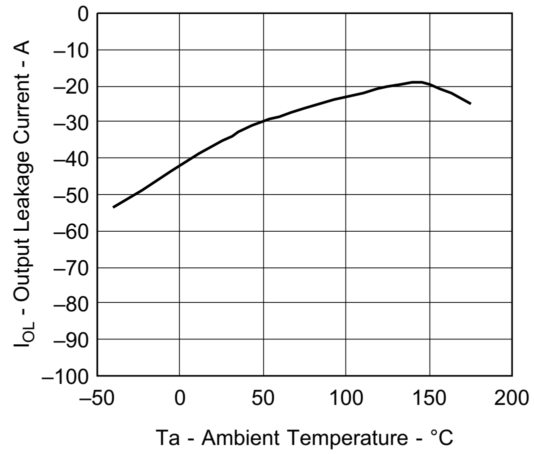
LOW LEVEL INPUT CURRENT vs.
AMBIENT TEMPERATURE



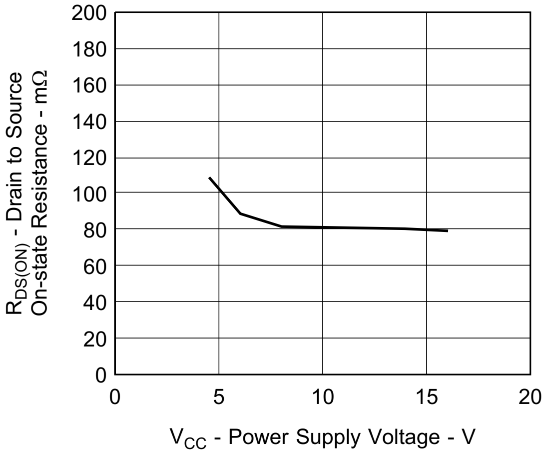
STANDBY CURRENT vs.
AMBIENT TEMPERATURE



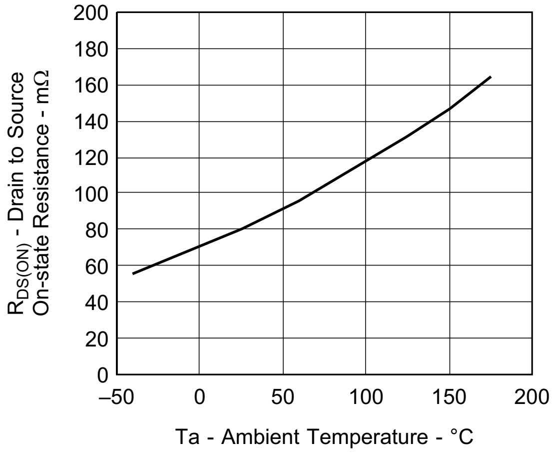
OUTPUT LEAKAGE CURRENT vs.
AMBIENT TEMPERATURE



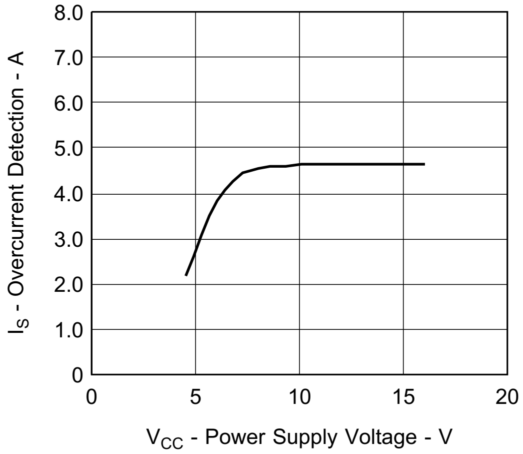
DRAIN TO SOURCE ON-STATE RESISTANCE vs.
POWER SUPPLY VOLTAGE



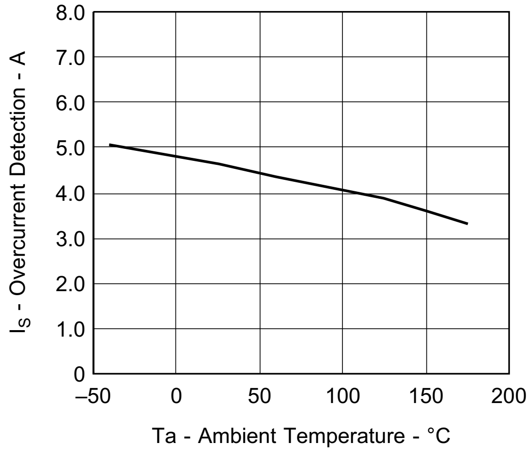
DRAIN TO SOURCE ON-STATE RESISTANCE vs.
AMBIENT TEMPERATURE



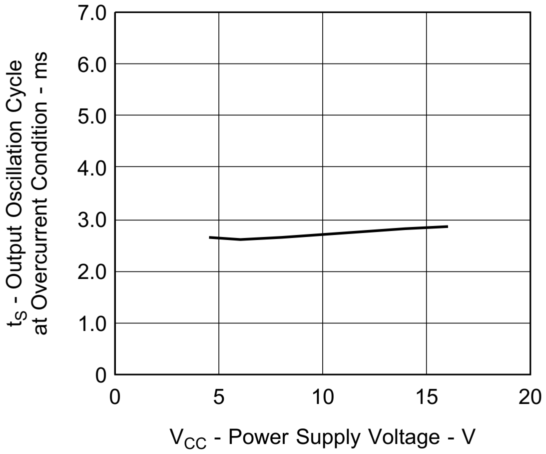
OVERCURRENT DETECTION vs.
POWER SUPPLY VOLTAGE



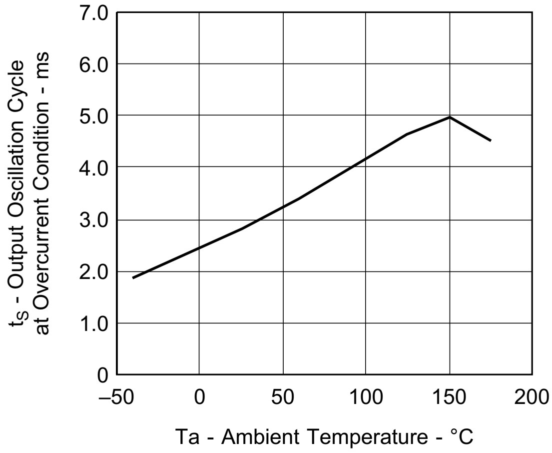
OVERCURRENT DETECTION vs.
AMBIENT TEMPERATURE



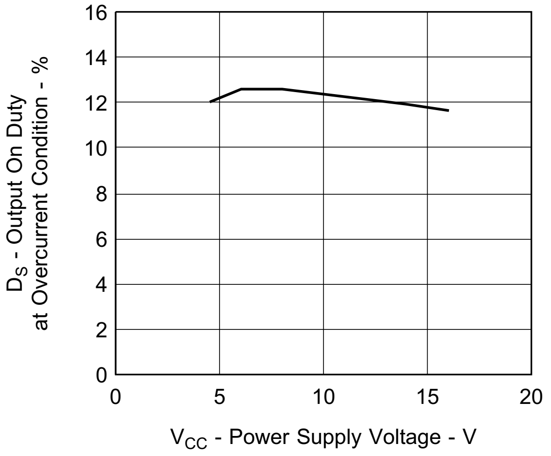
OUTPUT OSCILATION CYCLE AT OVERCURRENT
CONDITION vs. POWER SUPPLY VOLTAGE



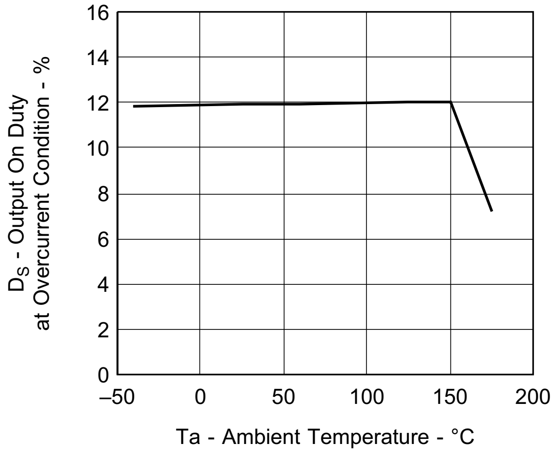
OUTPUT OSCILATION CYCLE AT OVERCURRENT
CONDITION vs. AMBIENT TEMPERATURE



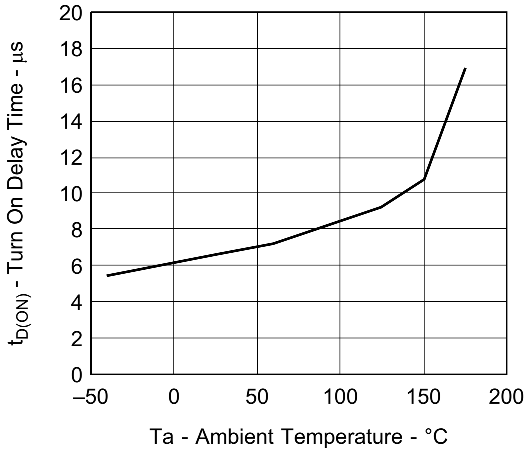
OUTPUT ON DUTY AT OVERCURRENT CONDITION vs.
POWER SUPPLY VOLTAGE



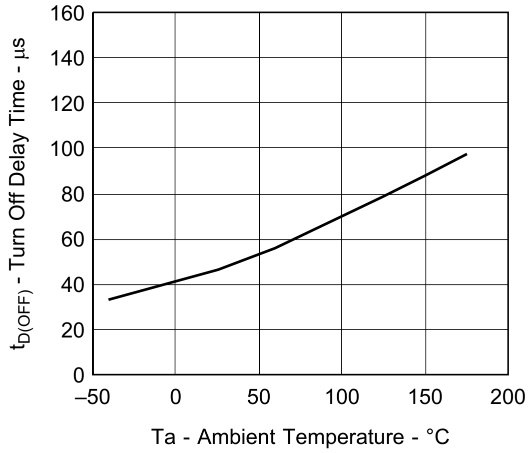
OUTPUT ON DUTY AT OVERCURRENT CONDITION vs.
AMBIENT TEMPERATURE



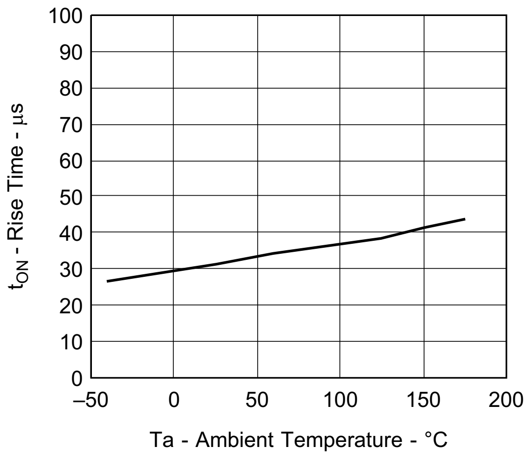
TURN ON DELAY TIME vs.
AMBIENT TEMPERATURE



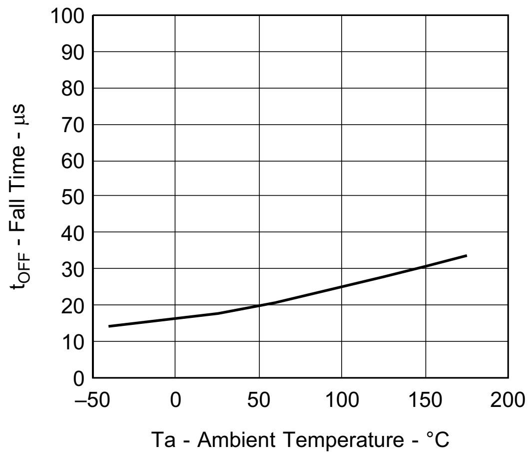
TURN OFF DELAY TIME vs.
AMBIENT TEMPERATURE



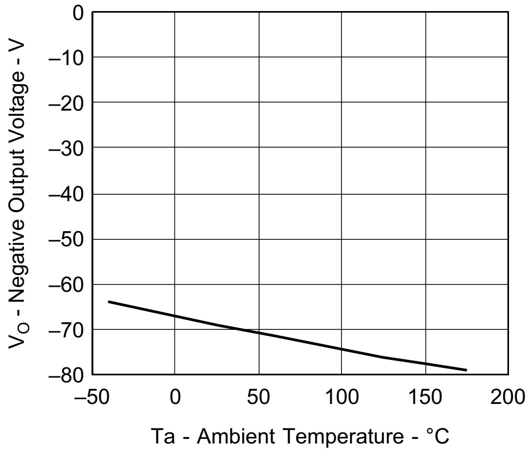
RISE TIME vs.
AMBIENT TEMPERATURE



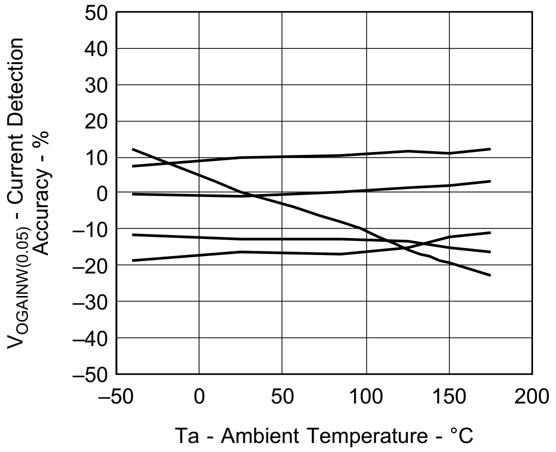
FALL TIME vs.
AMBIENT TEMPERATURE



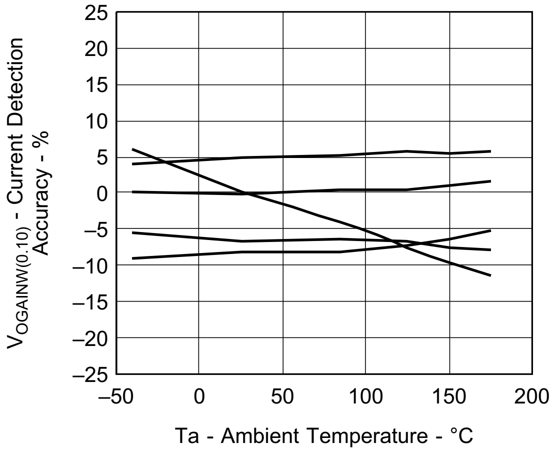
NEGATIVE OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE



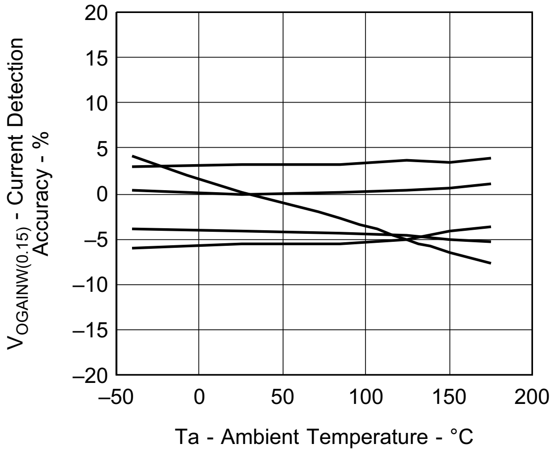
CURRENT DETECTION ACCURACY vs. AMBIENT TEMPERATURE



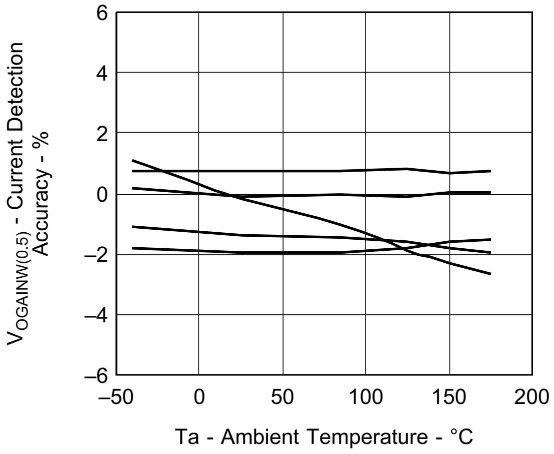
CURRENT DETECTION ACCURACY vs. AMBIENT TEMPERATURE

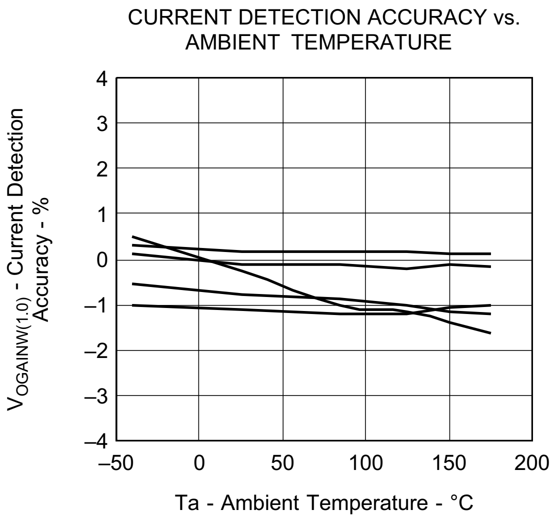


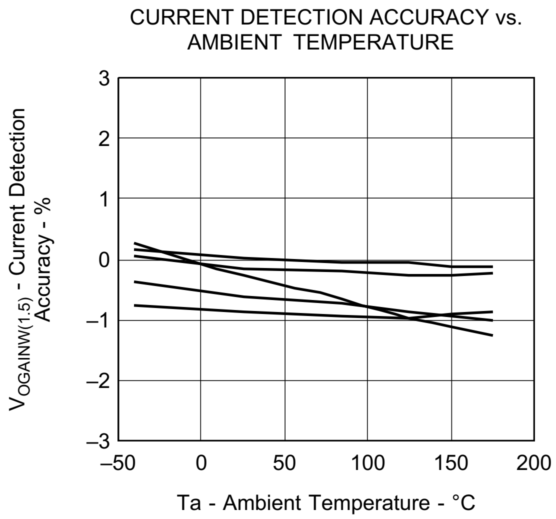
CURRENT DETECTION ACCURACY vs. AMBIENT TEMPERATURE



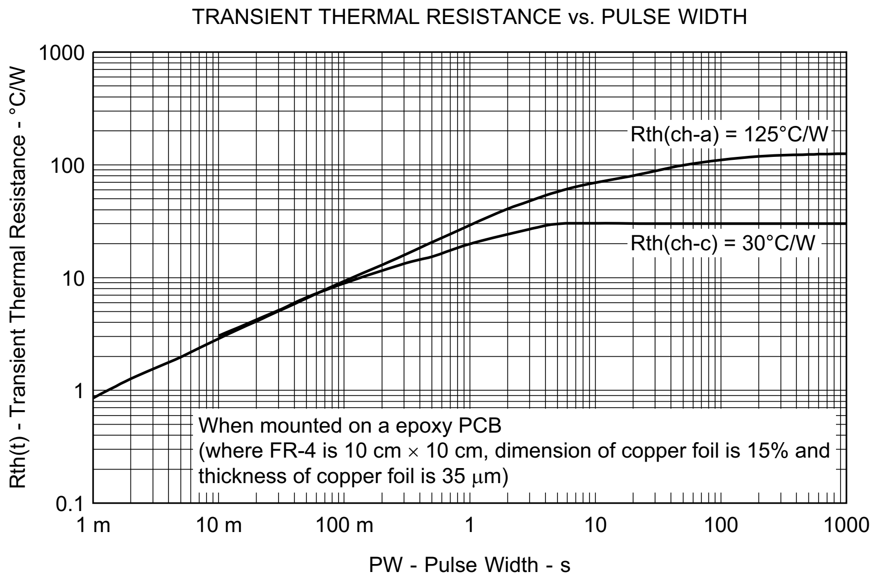
CURRENT DETECTION ACCURACY vs. AMBIENT TEMPERATURE



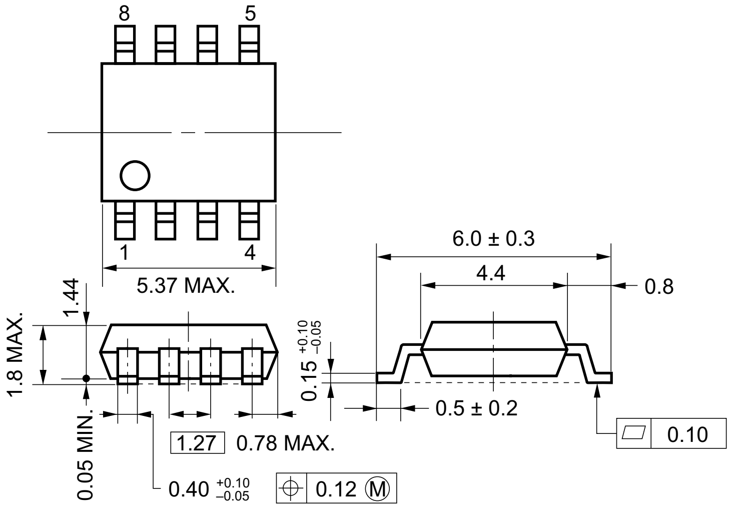




Transient Thermal Resistance Characteristics

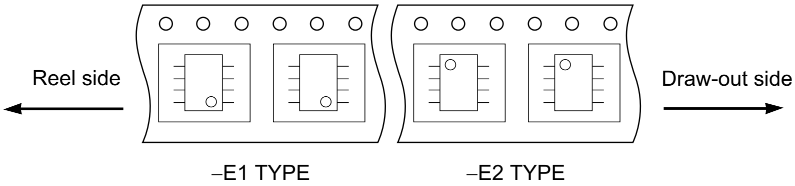


Package Drawing



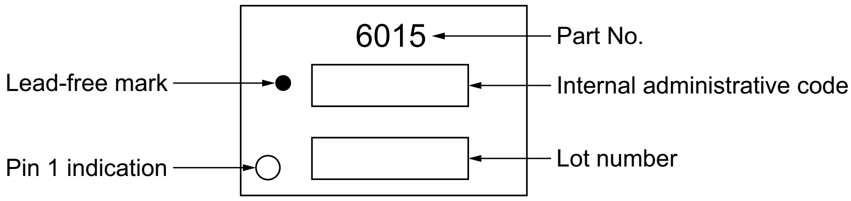
Taping Information

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 Note: Power SOP 8
- μPD166015GR-E2-AY Note: 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.)

Revision History	μPD166015GR Data Sheet

Rev.	Date	Description	
		Page	Summary
1.00	Jan 19, 2012	—	First Edition Issued

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Refer to "http://www.renesas.com/" for the latest and detailed information.

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Colophon 1.1