DATA SHEET

NEC

Phase-out/Discontinued

MOS INTEGRATED CIRCUIT

μPD16855A/B/C/D

DUAL HIGH-SIDE SWITCH FOR USB APPLICATION

DESCRIPTION

This product is the power switch IC with over current limit, used for the power supply bus of the Universal-Serial-Bus (USB).

2 circuit builds in the Pch power MOSFET in the switch part, and this product realizes low on resistance (100 mΩ TYP.) respectively.

And the over current detection, the thermal-shutdown circuit, an under voltage locked-out (UVLO) circuit whose functions are necessary in the Host/HUB-controller of the USB standard are built in.

And the over-current-detect result can be reported to the controller by flag-pin.

This product builds in each two circuits of the power switch, control-pins and flag-pins, and this IC can be able to control the power supply bus in 2 USB port.

There are four kinds of this product by the input logic of the control signal and switch operation in over-current detect.

FEATURES

- Pch power MOSFET, 2 circuit building in
- Over-current detection circuit is built in and its result is outputted from flag-pin (“L” active)
- Prevent from dropping power supply by over current limit circuit
- Thermal shutdown circuit building in
- Under Voltage Locked Out (UVLO) circuit building in
- Switch on/off control is possible by the control-pin.
- 8 pin DIP/SOP package

ORDERING INFORMATION

PART NO.	PACKAGE
μPD16855BC	8-pin plastic DIP (300mil)
μPD16855AG	8-pin plastic SOP (225mil)
μPD16855BG	8-pin plastic SOP (225mil)
μPD16855CG	8-pin plastic SOP (225mil)
μPD16855DG	8-pin plastic SOP (225mil)

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.
Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

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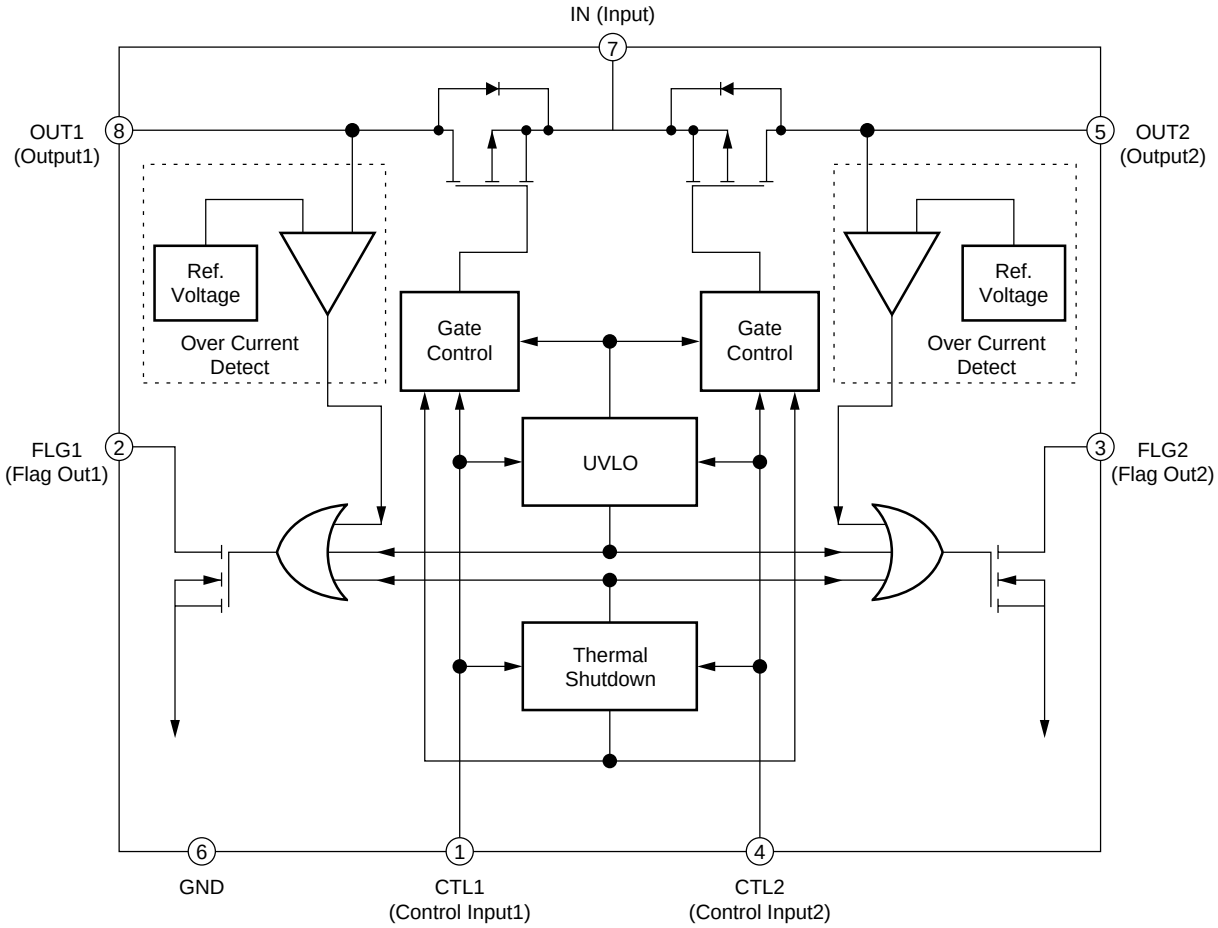
BLOCK DIAGRAM



Note The internal resister doesn't connect to input terminal of CTL1 (1 pin) and CTL2 (4 pin). Therefore the input level must be "H" or "L" even if these pins aren't used.

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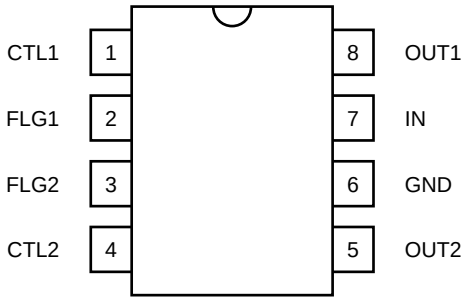
CONNECTION DIAGRAM (TOP VIEW)



8-Pin DIP/SOP

PIN CONFIGURATION

PIN No.	SYMBOL	I/O	FUNCTION
1/4	CTL1/CTL2	Input	Control : TTL Input
2/3	FLG1/FLG2	Output	Over Current Detect Flag : Active-L, Nch open-drain
6	GND	Power	Ground
7	IN	Power (Input)	Power Supply : Source of MOSFET
8/5	OUT1/OUT2	Output	Output of Switch : Drain of MOSFET

DESCRIPTION of μPD16855A/B/C/D FUNCTION

PART No.	Abstract of Function	
	CTL Input Logic	Switch Operation with Over-Current Detect
μPD16855AG	"H" active	Over-Current Limit Operation. Switch Off with CTL Input "L"
μPD16855BC/BG	"L" active	Over-Current Limit Operation. Switch Off with CTL Input "H"
μPD16855CG	"H" active	Switch Off regardless of CTL Input
μPD16855DG	"L" active	

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PIN CONFIGURATION (H:Hi-level, L:Low-level, ON:output ON state, OFF:output OFF state, X:H or L)

μPD16855AG (Active-H)

CTL1	FLG1	OUT1	CTL2	FLG2	OUT2	Operating mode
H	H	ON	H	H	ON	normal mode
H	H	ON	L	H	OFF	only OUT1 is ON
L	H	OFF	H	H	ON	only OUT2 is ON
L	H	OFF	L	H	OFF	standby mode
H	L	ON	H	H	ON	only OUT1 is over-current detect
H	H	ON	H	L	ON	only OUT2 is over-current detect
X	L	OFF	X	L	OFF	TSD mode
X	L	OFF	X	L	OFF	UVLO mode

μPD16855BC/BG (Active-L)

CTL1	FLG1	OUT1	CTL2	FLG2	OUT2	Operating mode
L	H	ON	L	H	ON	normal mode
L	H	ON	H	H	OFF	only OUT1 is ON
H	H	OFF	L	H	ON	only OUT2 is ON
H	H	OFF	H	H	OFF	standby mode
L	L	ON	L	H	ON	only OUT1 is over-current detect
L	H	ON	L	L	ON	only OUT2 is over-current detect
X	L	OFF	X	L	OFF	TSD mode
X	L	OFF	X	L	OFF	UVLO mode

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μPD16855CG (Active-H and Switch off with over-current detect)

CTL1	FLG1	OUT1	CTL2	FLG2	OUT2	Operating mode
H	H	ON	H	H	ON	normal mode
H	H	ON	L	H	OFF	only OUT1 is ON
L	H	OFF	H	H	ON	only OUT2 is ON
L	H	OFF	L	H	OFF	standby mode
H	L	OFF	H	H	ON	only OUT1 is over-current detect
H	H	ON	H	L	OFF	only OUT2 is over-current detect
X	L	OFF	X	L	OFF	TSD mode
X	L	OFF	X	L	OFF	UVLO mode

μPD16855DG (Active-L and Switch off with over-current detect)

CTL1	FLG1	OUT1	CTL2	FLG2	OUT2	Operating mode
L	H	ON	L	H	ON	normal mode
L	H	ON	H	H	OFF	only OUT1 is ON
H	H	OFF	L	H	ON	only OUT2 is ON
H	H	OFF	H	H	OFF	standby mode
L	L	OFF	L	H	ON	only OUT1 is over-current detect
L	H	ON	L	L	OFF	only OUT2 is over-current detect
X	L	OFF	X	L	OFF	TSD mode
X	L	OFF	X	L	OFF	UVLO mode

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ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C)

Parameter		Symbol	Conditions	Ratings	Unit
Input Voltage		V_{IN}		–0.3 to +6	V
Flag Voltage		V_{FLG}		–0.3 to +6	V
Flag Current		I_{FLG}		50	mA
Output Voltage		V_{OUT}		V_{IN} + 0.3	V
Output Current		I_{OUT}	DC	+0.5(V_{IN} = V_{CTL} =5 V) –0.1 (V_{IN} = 0V, V_{OUT} = 5V)	A
			Pulse Width ≤ 100μs Single Pulse	+3	
Control Input Voltage		V_{CTL}		–0.3 to +6	V
Power Dissipation	DIP	P_D		400	mW
	SOP			300	
Operating Temperature Range		T_A		–40 to +85	°C
Channel Temperature Range		$T_{CH\ MAX}$		+150	°C
Storage Temperature Range		T_{stg}		–55 to +150	°C

Note The thermal shutdown circuit (operating temperature is more than 150 °C typ.) builds in this product.

RECOMMENDED OPERATING RANGE

Parameter	Symbol	Min	Typ	Max	Unit
Input Voltage	V_{IN}	+4		+5.5	V
Operating Temperature Range	T_A	0		+70	°C

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ELECTRICAL CHARACTERISTICS

DC CHARACTERISTICS (Unless otherwise specified, V_{IN} = +5V; T_A = +25°C)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Circuit Current (only μPD16855A/C)	I_{DD}	V_{CTL} = 0V (both 1 pin & 4 pin), OUT = open			1	5	μA
		V_{CTL} = V_{IN}, OUT = open			1	1.5	mA
Circuit Current (only μPD16855B/D)	I_{DD}	V_{CTL} = V_{IN} (both 1 pin & 4 pin), OUT = open			1	5	μA
		V_{CTL} = 0V, OUT = open			1	1.5	mA
Low-level Input Voltage	V_{IL}	CTL Pin				1.0	V
High-level Input Voltage	V_{IH}	CTL Pin		2.0			V
Input Current of CTL pin	I_{CTL}	V_{CTL} = 0V			0.01	1	μA
		V_{CTL} = V_{IN}			0.01	1	μA
Output MOSFET On Resistance	R_{ON}	T_A = 0 to +70 °C, I_{OUT} = 500 mA	DIP		100	140	mΩ
			SOP		100	130	
Output Leak Current	$I_{O\ LEAK}$					10	μA
Over Current Detect Threshold	I_{TH}	T_A = 0 to +70 °C		0.6	0.9	1.25	A
Flag Output Resistance	$R_{ON\ F}$	I_L = 10 mA			10	25	Ω
Flag Leak Current	$I_{O\ LEAK\ F}$	V_{FLAG} = 5 V			0.01	1	μA
Operating Voltage of Under Voltage Locked Out Circuit	V_{UVLO}	V_{IN} : Up		3.2	3.5	3.7	V
		V_{IN} : Down		3.0	3.3	3.5	V
		Hysteresis		0.1	0.2	0.3	V

AC CHARACTERISTICS (Unless otherwise specified, V_{IN} = +5 V; T_A = +25 °C)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Output Transition Rising Time	t_{RISE}	R_L = 10 Ω each output	2.5		12	ms
Output Transition Falling Time	t_{FALL}	R_L = 10 Ω each output			10	μs
Over Current Detect Delay Time	t_{OVER}		5		20	μs
CTL Input Low-Level Time (only μPD16855A/C)	t_{CTL}	CTL : H→L→H	20			μs
CTL Input High-Level Time (only μPD16855B/D)	t_{CTL}	CTL : L→H→L	20			μs

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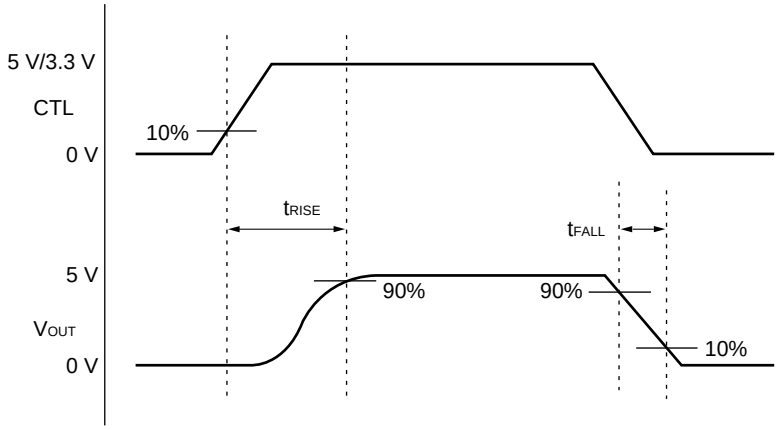
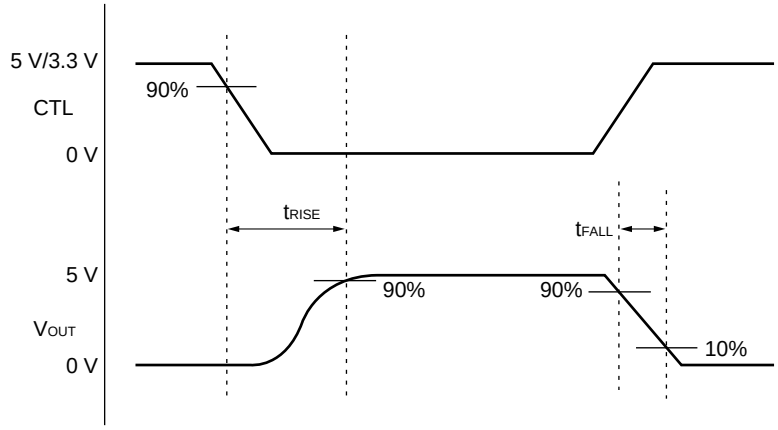
MEASUREMENT POINT

Output Transition Rising Time (at ON)/Output Transition Falling Time (at OFF)

at the timing of CTL changing “L” to “H”/“H” to “L” for μPD16855A/C



at the timing of CTL changing “H” to “L”/“L” to “H” for μPD16855A/C



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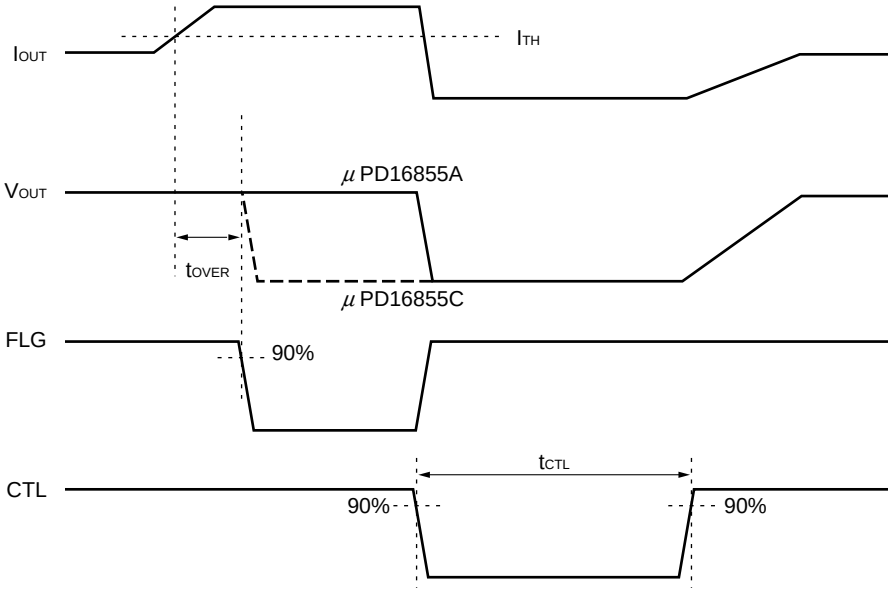
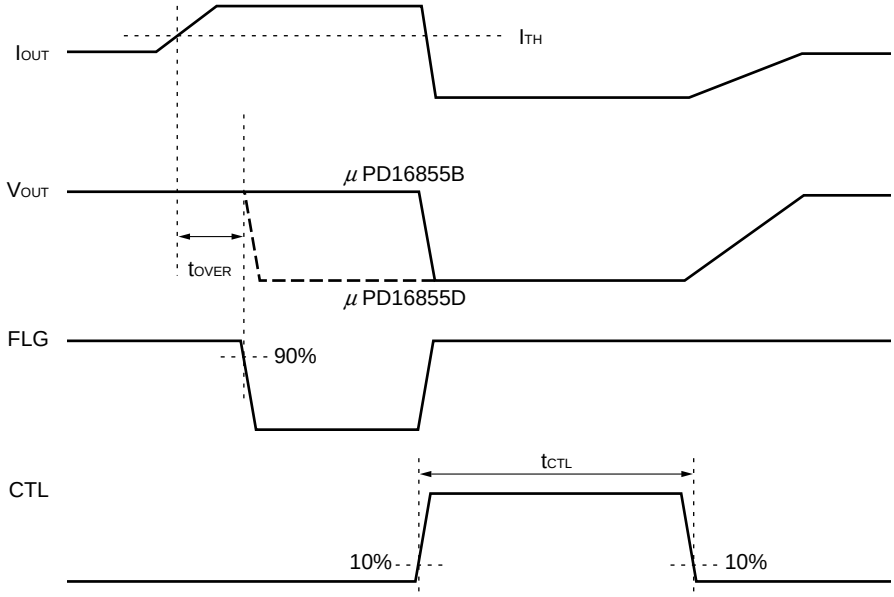
Over Current Detect Delay Time/CTL Input Low-Level Time for μPD16855A/C



Over Current Detect Delay Time/CTL Input High-Level Time for μPD16855B/D



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FUNCTION DESCRIPTION

1. Over current detection

The specification of over current detect is 0.6 to 1.25 A (typ. 900mA) in this IC. (500 mA max. in USB standard)

This function is that flag-pin turns to Low-level and reports to the USB controller when over current is detected.

At this time, output of IC is operated as followed.

- μPD16855A/B : Output keep ON-state and over current limited circuit is operated. This function can be prevented from being long-time over current state.
- μPD16855C/D : Output turns to off, and isn't based on the state of CTL-pin.

When CTL-pin turns to non-active, FLG-pin returns to High-level and Output-pin turn to OFF-state.

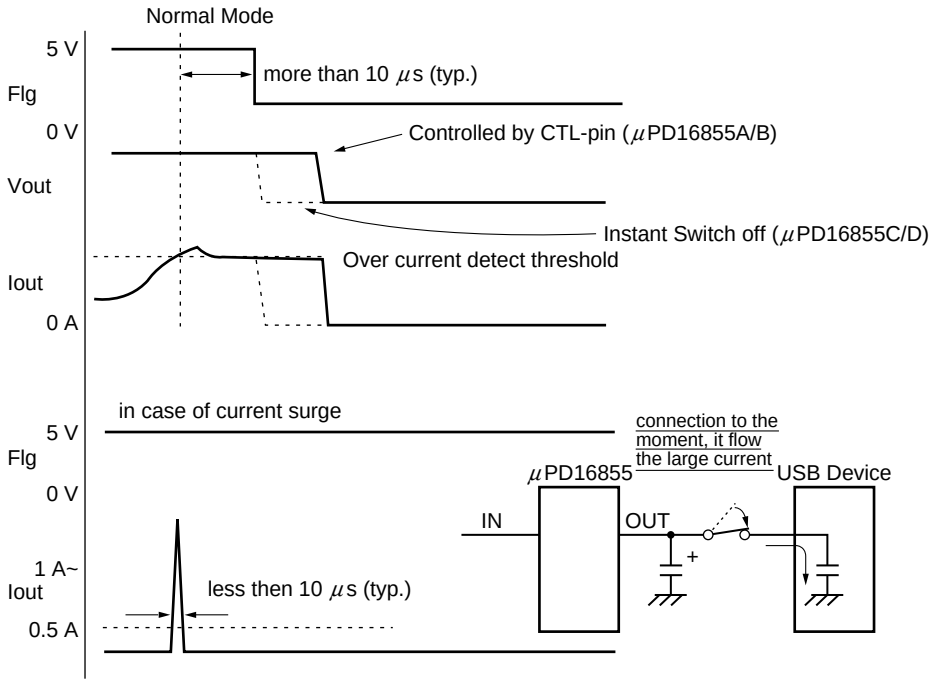
Immediately the controller should be inputted non-active level to CTL-pin after detecting FLG = “L” not to reach to the state of thermal shutdown.

Then, in the case of FLG-pin is High-level and CTL-pin is active level, Output-pin turns to ON-state.

To prevent from detecting wrongly the current to the moment, over current detect delay time is set up.

This delay time is 10 μs (typ.).

Power consumption in this device increases rapidly at the time of current-limitter circuit operation, and channel temperature Tch is likely to escalate. Make a CTL signal non-active, and make switch turn off before Tch of this device exceed absolute maximum rating.



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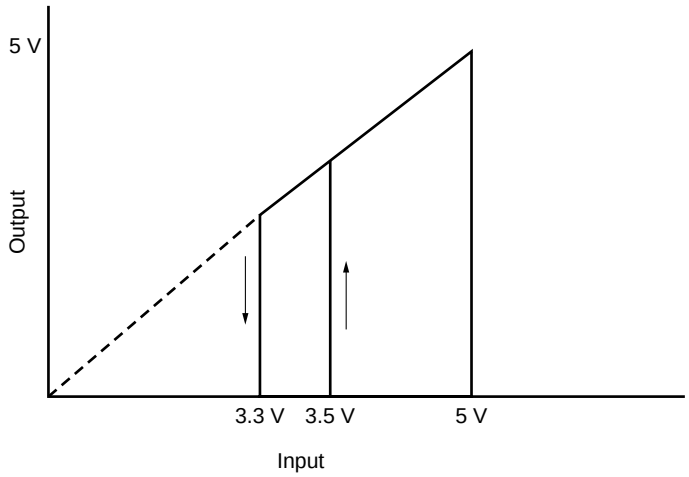
2. Under Voltage Locked Out (UVLO) Circuit

UVLO is the circuit for preventing malfunction of the switch by voltage variation.

In the Power Up : less than 3.5 V (typ.) and in the Power Down : less than 3.3 V (typ.)

OUT : OFF

FLG : “L” (= 0V)

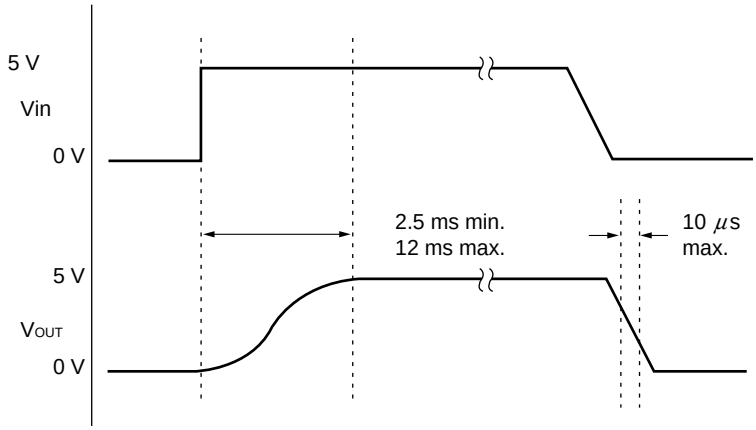


3. Behavior in the case of Power ON

This IC is slowly started up by Soft-Start Operation when IC is powered on.

This function is to prevent from flowing large current in the period of charging the capacitor which is connected to Output-pin.

In Power ON state, Soft-Start Time is 5ms (typ.)



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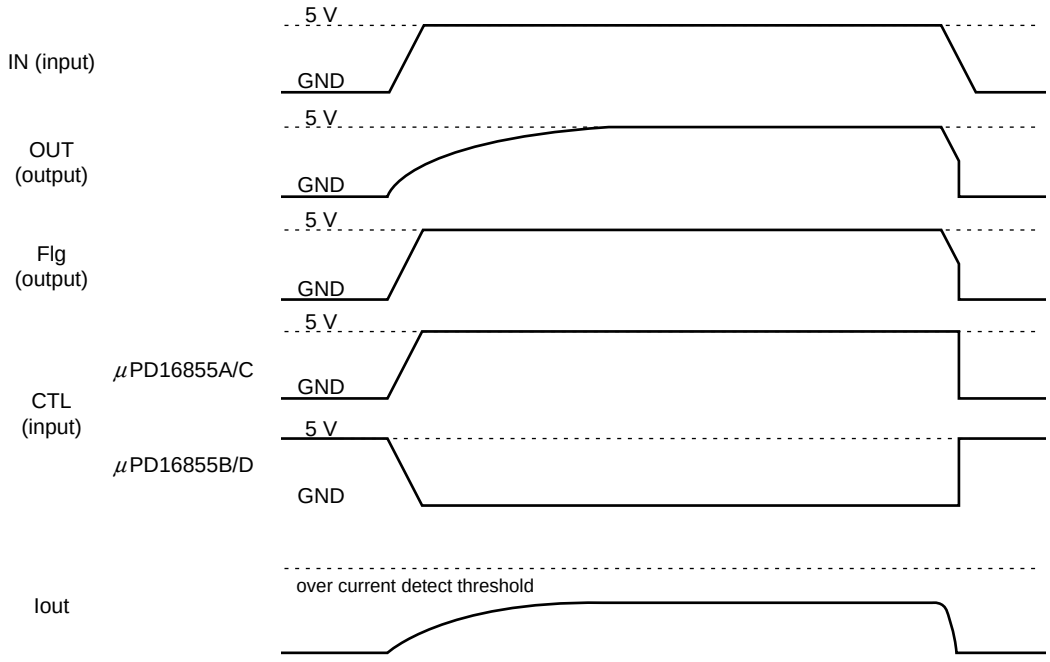
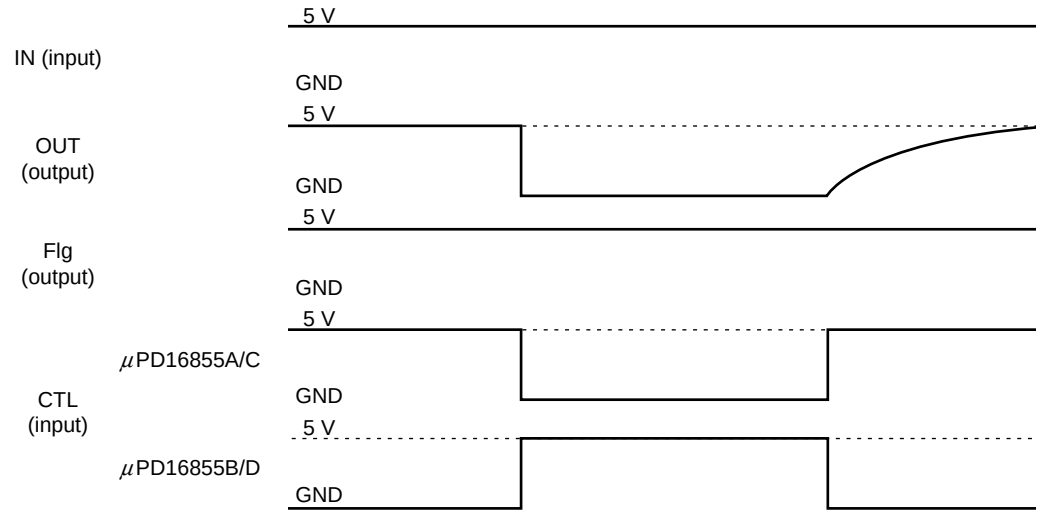
OPERATING SEQUENCE

Power On/Power Off



Note If CTL-pin is active level after IC is powered on, This IC's Output is started Soft-Start Operation (Output Transition Rising Time : 12ms max.).
When Power-voltage is less than UVLO operating voltage, FLG-pin is fixed on Low-Level.
If CTL1 and CTL2 pins are non-active level, this IC moves to Stand-by mode (I_{DD} = 5 μA max.)

Input controlled-signal



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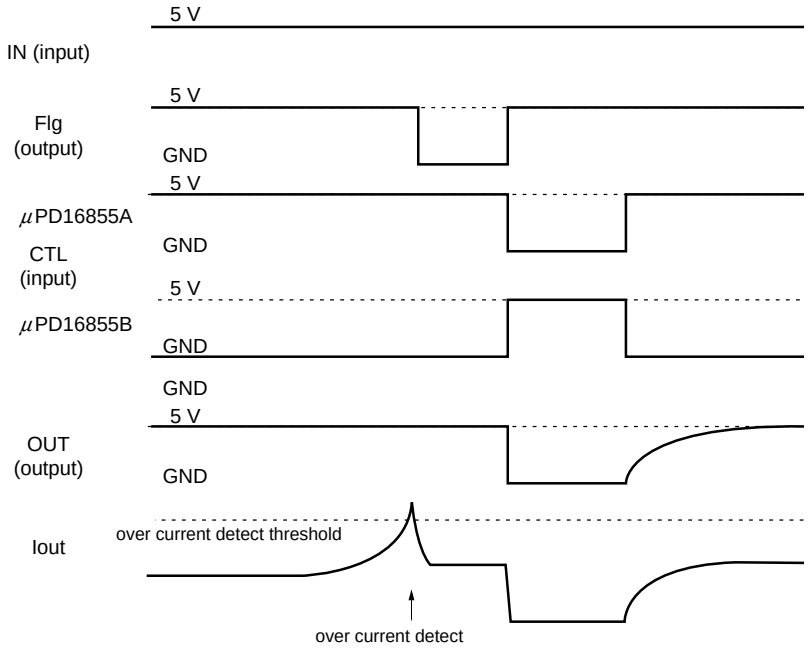
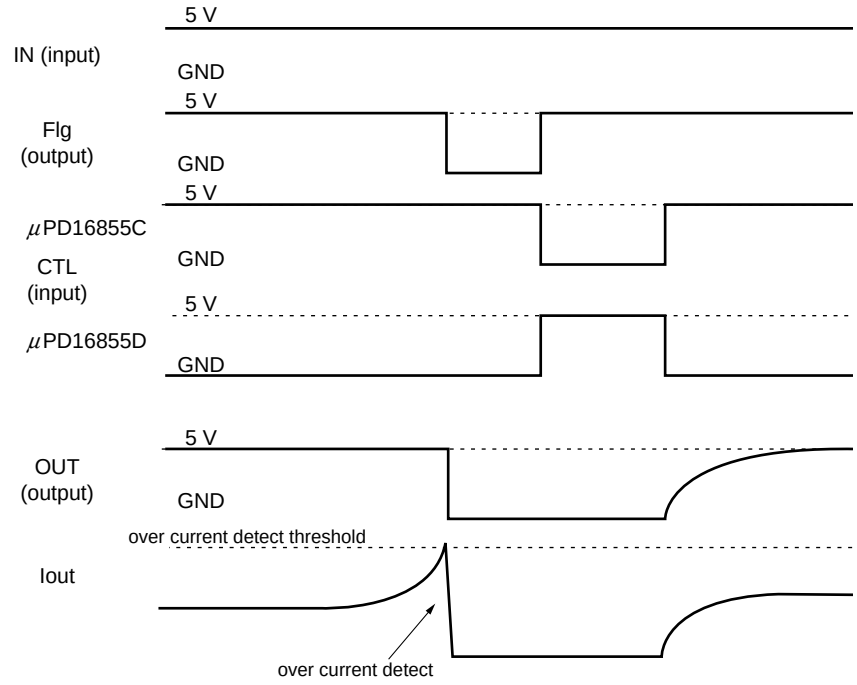
Over current detect

μPD16855A/B



μPD16855C/D



Note If Over current detect circuit is operated, FLG-pin is Low-Level and over current limit circuit is operated. At this time, output's operation is as followed.

μPD16855A/B : output is OFF and Flg-pin is High-Level when CTL-pin is non-active level.

μPD16855C/D : output synchronizes in Flg-pin = “L”, and is OFF.
Flg-pin is High-Level when CTL-pin is non-active level.

And then when CTL-pin turns to active level again, if UVLO and TSD are not operated, Output-pin is reset to ON-state.

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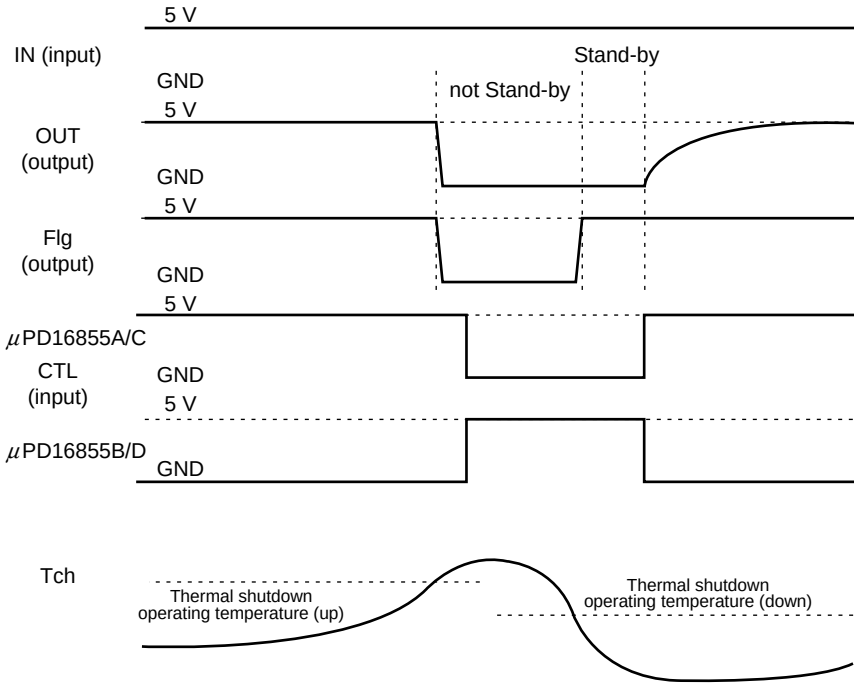
Thermal shutdown



Note In operating the thermal shutdown, the status of output-pin is OFF.
In this case, however, if CTL-pin is kept non-active level, this IC isn't in stand-by mode.
And, thermal shutdown circuit can not be operated in both CTL1-pin and CTL2-pin are non-active level (equal to stand-by mode), if junction-temperature of this IC exceed 150 degree (typ.).

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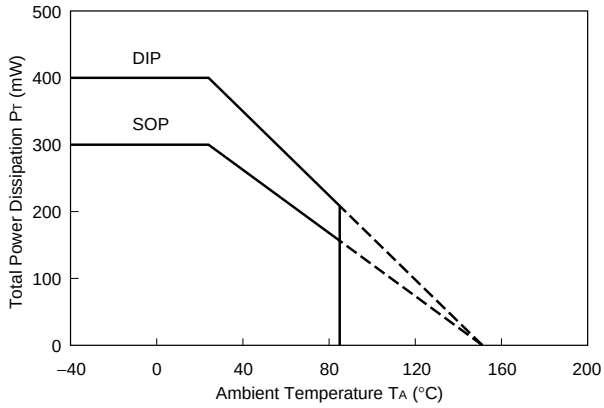
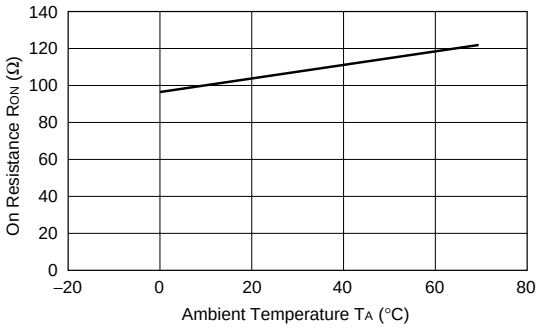
CHARACTERISTICS CURVES (unless otherwise specified, T_A = 25 °C, V_{IN} = 5 V) (Nominal)

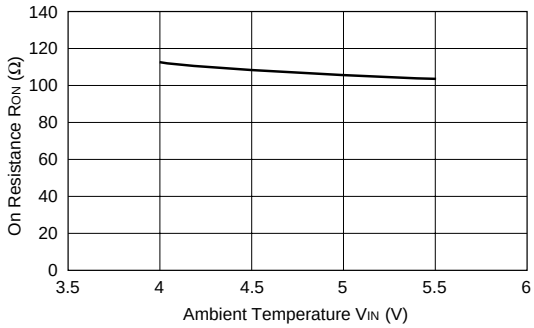
P_T - T_A Rating



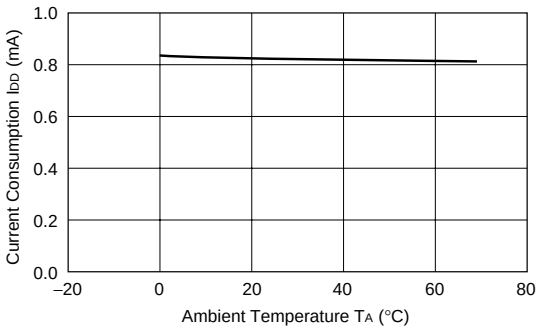
R_{ON} - T_A Characteristics [Note]



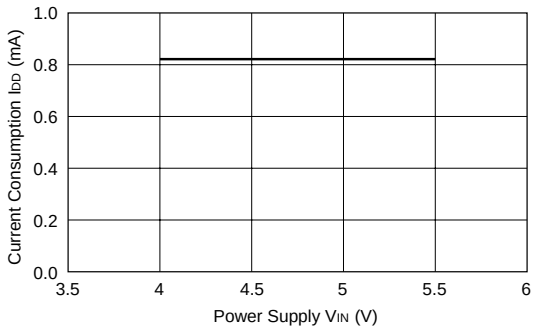
R_{ON} - V_{IN} Characteristics [Note]



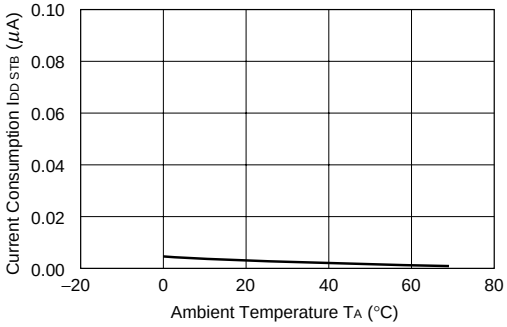
I_{DD} - T_A Characteristics



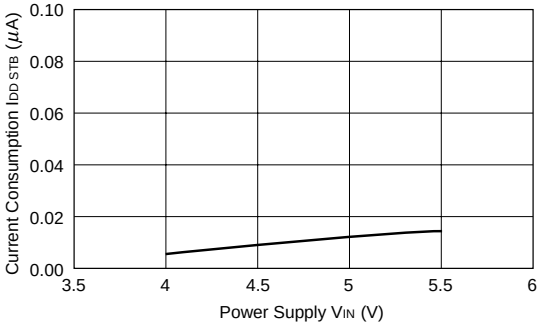
I_{DD} - V_{IN} Characteristics



$I_{DD\ STB}$ - T_A Characteristics



$I_{DD\ STB}$ - V_{IN} Characteristics



Note R_{ON} –T_A Characteristics and R_{ON} – V_{IN} Characteristics show the characteristics for SOP Package.

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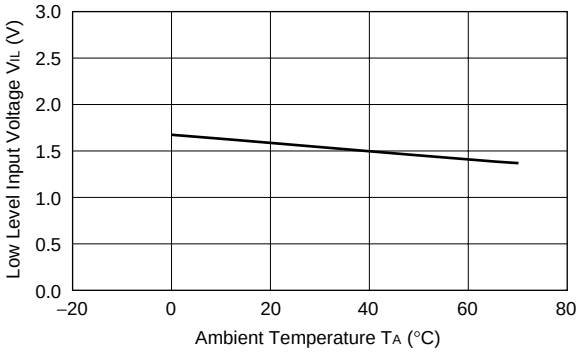
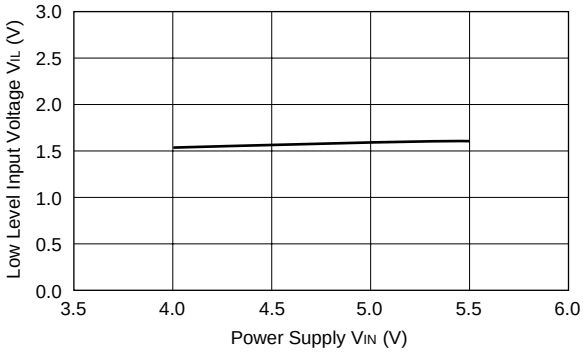
CHARACTERISTICS CURVES (unless otherwise specified, T_A = 25 °C, V_{IN} = 5 V) (Nominal)

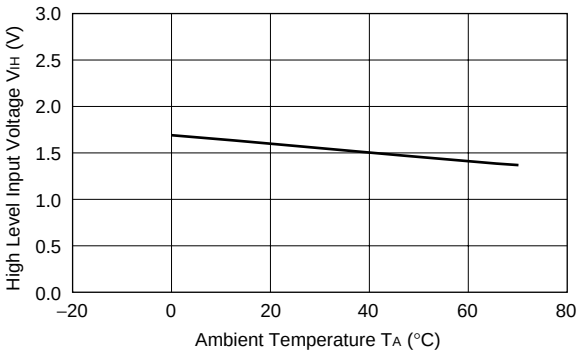
V_{IL} - T_A Characteristics



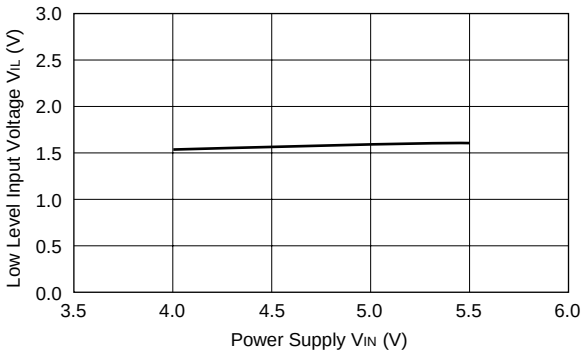
V_{IL} - V_{IN} Characteristics



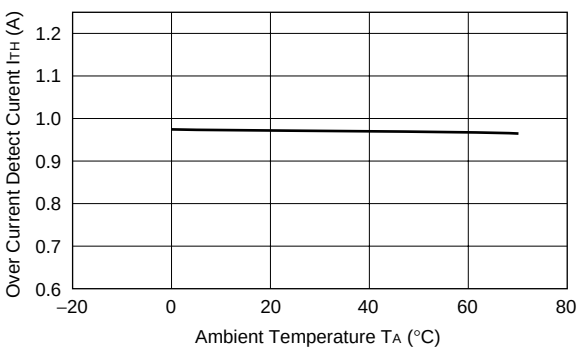
V_{IH} - T_A Characteristics



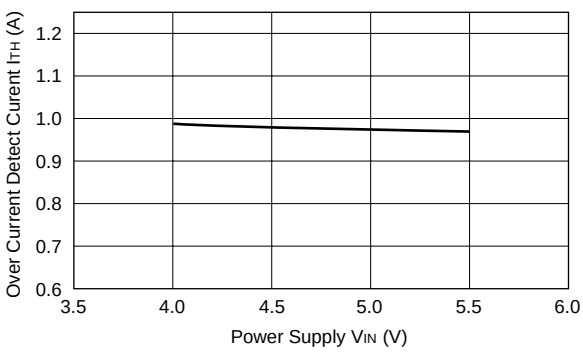
V_{IH} - V_{IN} Characteristics



I_{TH} - T_A Characteristics



I_{TH} - V_{IN} Characteristics



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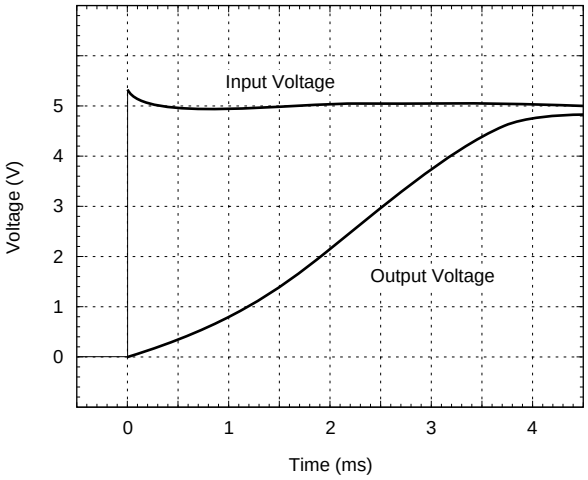
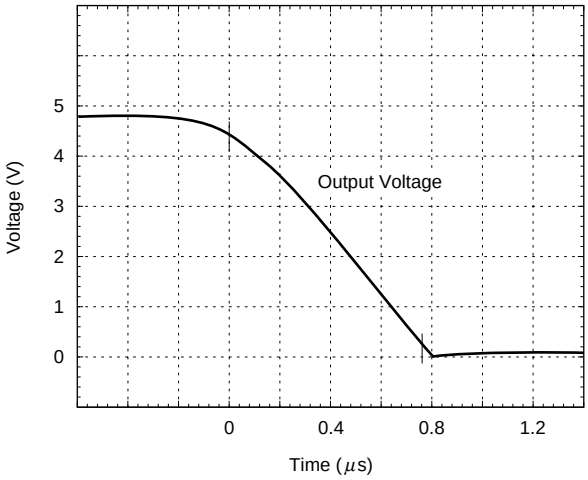
CHARACTERISTICS CURVES (unless otherwise specified, T_A = 25 °C, V_{IN} = 5 V) (Nominal)

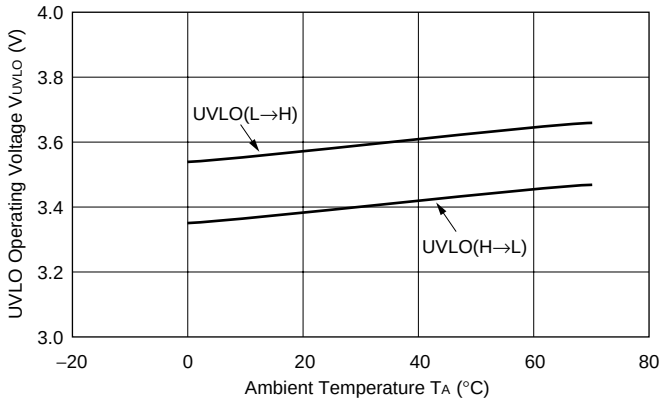
Output Transition Rising Time



Output Transition Falling Time



UVLO circuit operating voltage Characteristics



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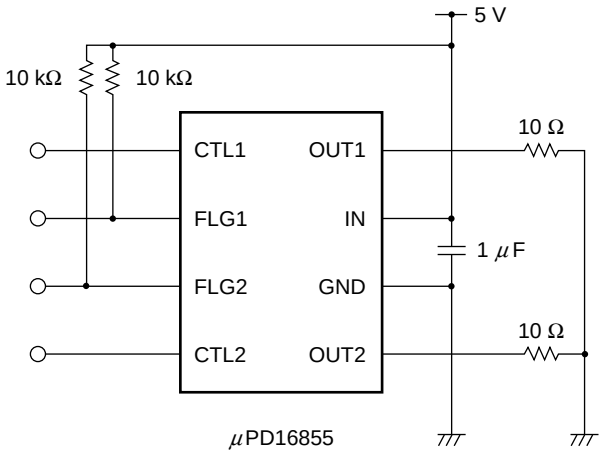
MEASUREMENT CIRCUIT



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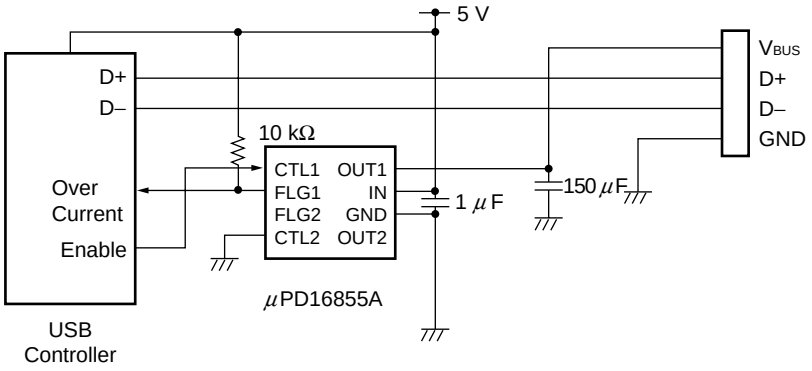
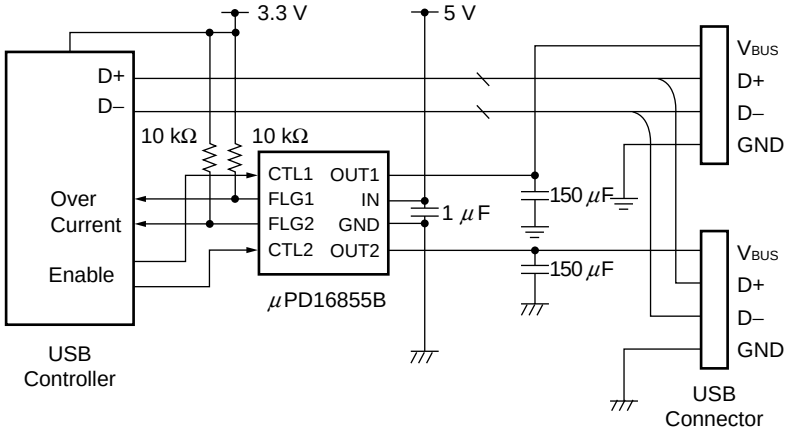
APPLICATION CIRCUIT

Example 1



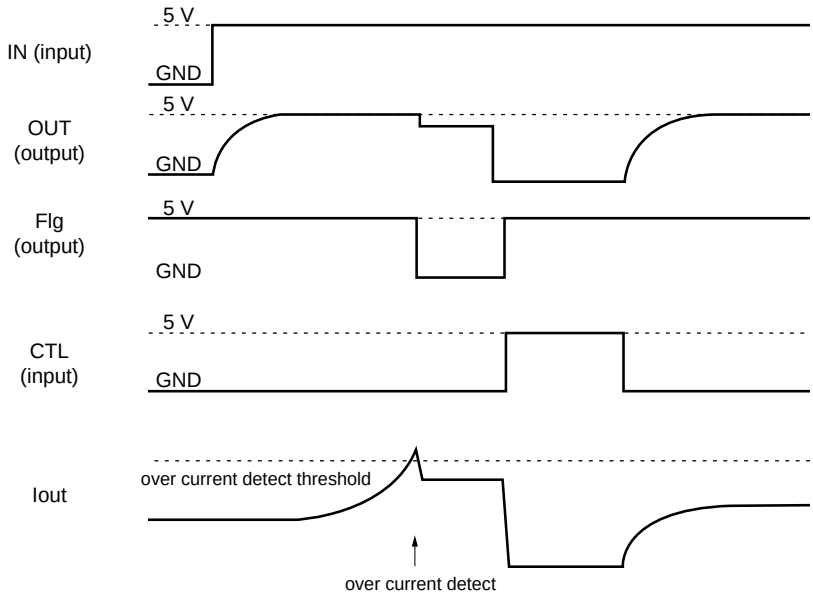
USB OUTPUT Port : 1 port
Use μPD16855A
Not need to control by USB-controller (CTL-input is "H"-active)

Example 2



USB OUTPUT Port : 2 port
Use μPD16855B
controllable by USB-controller (CTL-input is "L"-active)

Timing chart Example 2



The application circuits and their parameters are for references only and are not intended for use in actual designin's.

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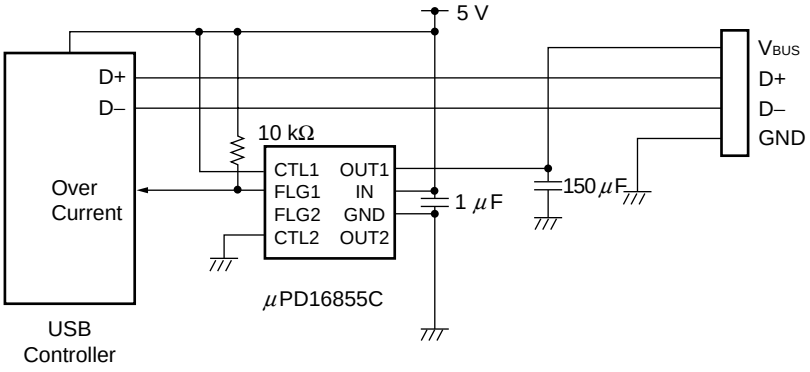
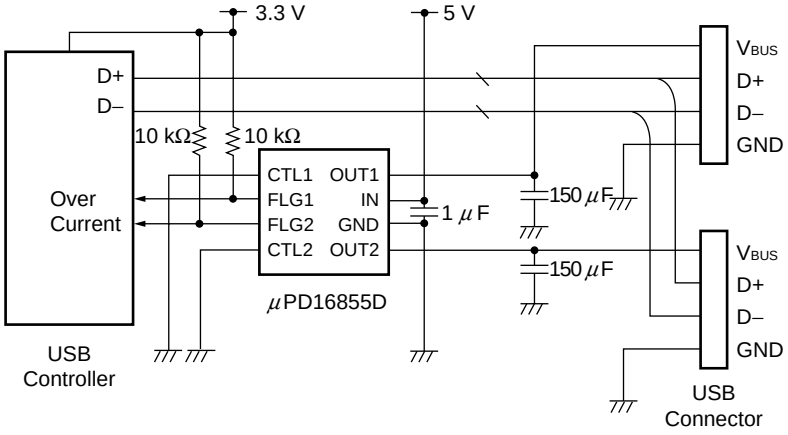
APPLICATION CIRCUIT

Example 3



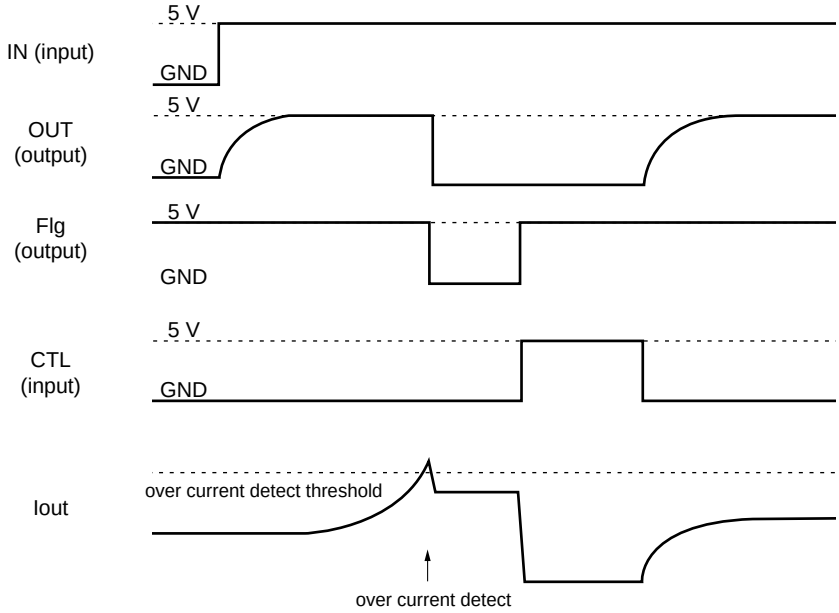
USB OUTPUT Port : 1 port
Use μPD16855C
controllable by USB-controller

Example 4



USB OUTPUT Port : 2 port
Use μPD16855D
Not need to control by USB-controller

Timing chart Example 4



The application circuits and their parameters are for references only and are not intended for use in actual designin's.

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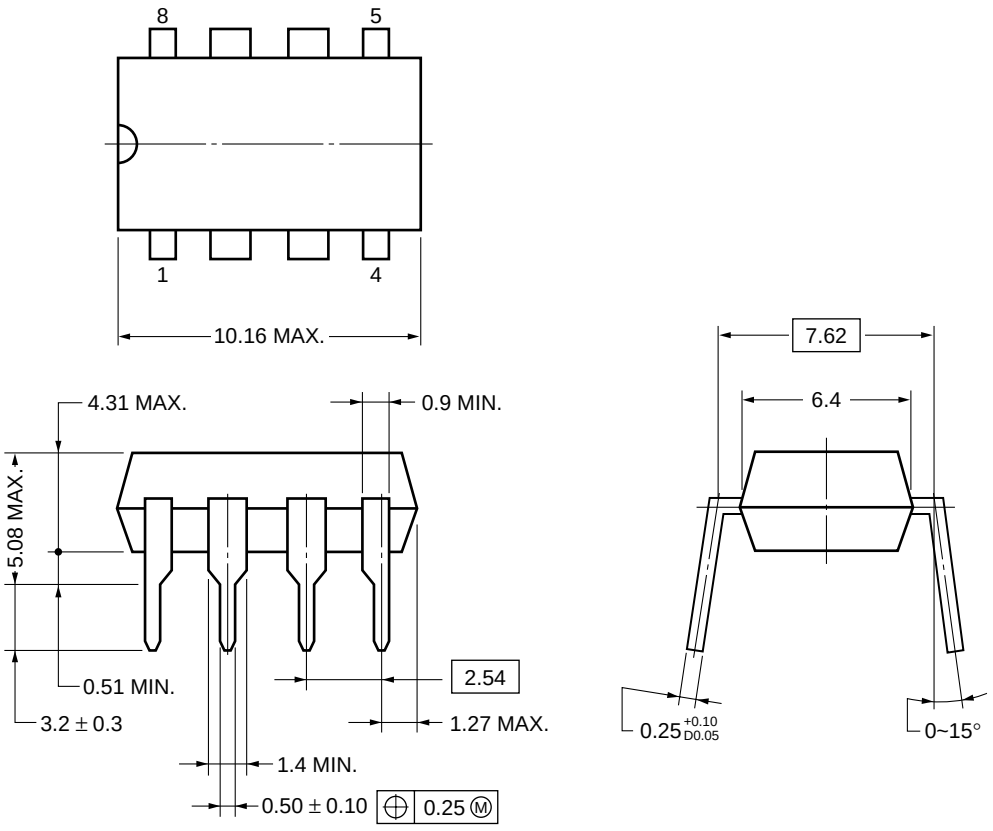
PACKAGE DRAWING

8 PIN PLASTIC DIP (300 mil)



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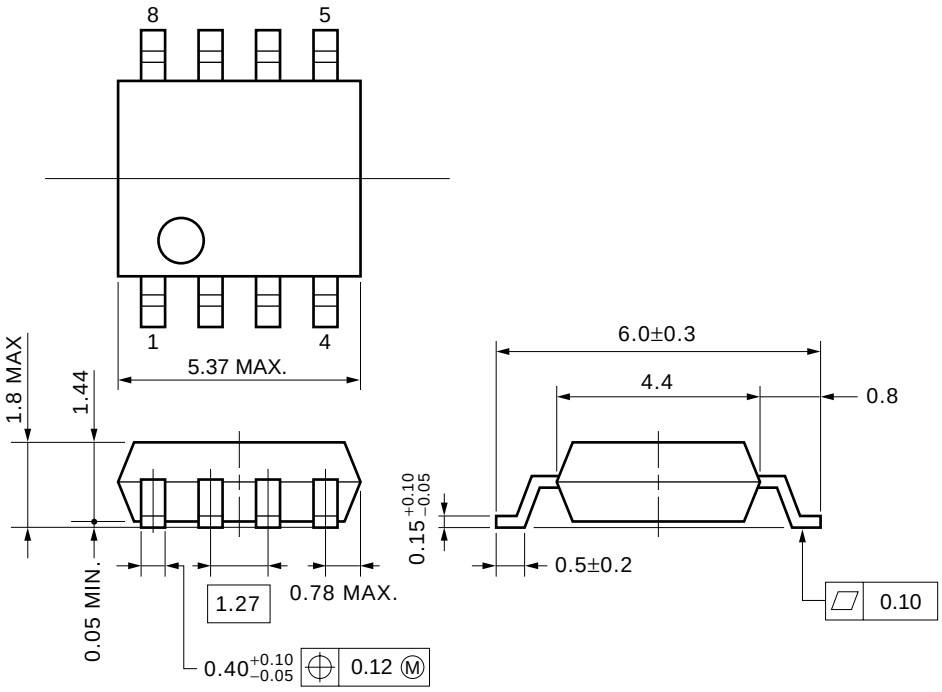
8 PIN PLASTIC SOP (225 mil)



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RECOMMENDED SOLDERING CONDITIONS

Soldering the μPD16855 under the conditions listed in the table below is recommended.
For soldering methods and conditions other than those recommended, consult NEC.

Surface Mount Type

For the details of the recommended soldering conditions of the surface mount type, refer to information document "Semiconductor Device Mounting Technology MANUAL" (C10535E)

μPD16855AG, μPD16855BG, μPD16855CG, μPD16855DG

Soldering process	Soldering conditions	Symbol
Infrared ray reflow	Package peak temperature : 235 °C, Time : 30 seconds MAX.(210 °C MIN.), Number of times : 2 , Number of days : not limited*	IR35-00-2
VPS	Package peak temperature : 215 °C , Time : 40 seconds MAX.(200 °C MIN.), Number of times : 2 , Number of days : not limited*	VP15-00-2
Wave soldering	Soldering bath temperature : 260 °C MAX. , Time : 10 seconds MAX., Number of times : 1 , Number of days : not limited*	WS60-00-1
Partial heating method	Pin temperature : 300 °C MAX. (lead temperature), Time : 3 seconds MAX. (per lead pin), Number of days : not limited*	

* The number of days the devices can be stored at 25 °C, 65 % RH MAX. after the dry pack has been opened.

Caution Do not use two or more soldering methods in condition(except the pin partial heating method).

Throught-hole Type

μPD16855BC

Soldering process	Soldering conditions	Symbol
Wave soldering	Soldering bath temperature : 260 °C MAX., Time : 10 seconds MAX.	

REFERENCE

Document Name	Document No.
NEC semiconductor device reliability/quality control system	IEI-1212
Quality grade on NEC semiconductor devices	C11531E
Semiconductor device mounting technology manual	C10535E
NEC IC Package Manual (CD-ROM)	C13388E
Guide to quality assurance for semiconductor devices	MEI-1202
Semiconductor selection guide	X10679E

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NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note: Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note: No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS device behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note: Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

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Phase-out/Discontinued

[MEMO]

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[MEMO]

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- NEC devices are classified into the following three quality grades:
  "Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.
  - Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots
  - Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)
  - Specific: Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

  The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.

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