Low Noise 150 mA LDO Regulator

No. EA-173-230725

OUTLINE

The RP130x is a voltage regulator IC with high ripple rejection, low dropout voltage, high output voltage accuracy and extremely low supply current. The IC consists of a voltage reference unit, an error amplifier, a resistor-net for voltage setting, a short current limit circuit and a chip enable circuit.
This IC has an excellent low supply current performed by CMOS process, moreover they perform with low dropout voltage due to built-in low on-resistance. A chip enable function prolongs the battery life.
The input transient response, the load transient response and the ripple rejection have been improved in the RP130x compared with the conventional products. Besides achieving low supply current (Typ.38 μA).
The range of the operation voltage is capable from 1.7 V to 6.5 V and the range of the output voltage is capable from 1.2 V to 5.3 V for this product, which is wider range as our conventional product R1114x.
The output voltage of this IC is fixed with high accuracy. Since the packages for this IC are DFN(PL)1010-4, SOT-23-5 and SC-82AB, therefore high density mounting of the IC on board is possible.

FEATURES

- Supply Current ..... Typ. 38 μA
- Standby Current ..... Typ. 0.1 μA
- Ripple Rejection ..... Typ. 80 dB (f = 1 kHz)
- Input Voltage Range (Maximum Rating) ..... 1.7 V to 6.5 V (7.0 V)
- Output Voltage Range ..... 1.2 V to 5.3 V (0.1 V step[1])
- Output Voltage Accuracy ..... ±1.0% (V_{OUT} > 2.0 V, Ta = 25°C)
- Temperature-Drift Coefficient of Output Voltage ..... Typ. ±20 ppm/°C
- Dropout Voltage ..... Typ. 0.32 V (I_{OUT} = 150 mA, V_{OUT} = 2.8 V)
- Line Regulation ..... Typ. 0.02%/V
- Packages ..... DFN(PL)1010-4, SC-82AB, SOT-23-5
- Built-in Fold Back Protection Circuit ..... Typ. 40 mA
- Ceramic capacitors are recommended to be used with this IC .....0.47 μF or more

APPLICATIONS

- Power source for battery-powered equipment.
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for high stable reference voltage.

[1] For other voltages, please refer to *SELECTION GUIDE*.

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SELECTION GUIDE

The set output voltage, chip enable polarity, auto-discharge function[1], and packages for the IC can be selected at the user's request.

Selection Guide

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP130Kxx1∗-TR	DFN(PL)1010-4	10,000 pcs	Yes	Yes
RP130Qxx1∗-TR-FE	SC-82AB	3,000 pcs	Yes	Yes
RP130Nxx1∗-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

xx : Set Output Voltage (V_{SET})
Fixed Type: 12 to 53 Stepwise setting with 0.1 V increment in the range from 1.2 V to 5.3 V
Exception: 1.25 V = RP130x121∗5
1.85 V = RP130x181∗5
2.85 V = RP130x281∗5
3.45 V = RP130x341∗5
4.25 V = RP130x421∗5

∗ : CE pin polarity and auto-discharge function at off state are options as follows.
A: active low, without auto-discharge function at off state.
B: active high, without auto-discharge function at off state.
D: active high, with auto-discharge function at off state.

[1] Auto-discharge function quickly lowers the output voltage to 0 V by releasing the electrical charge in the external capacitor when the chip enable signal is switched from the active mode to the standby mode.

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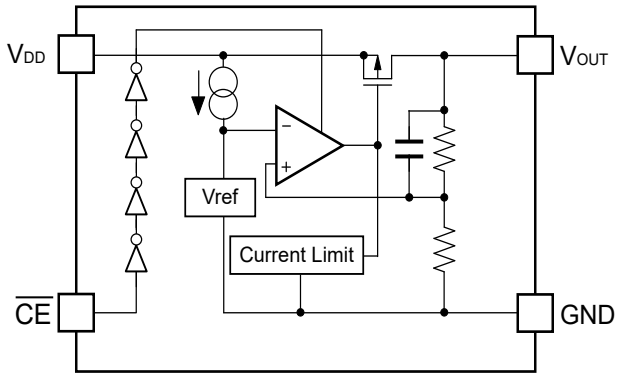
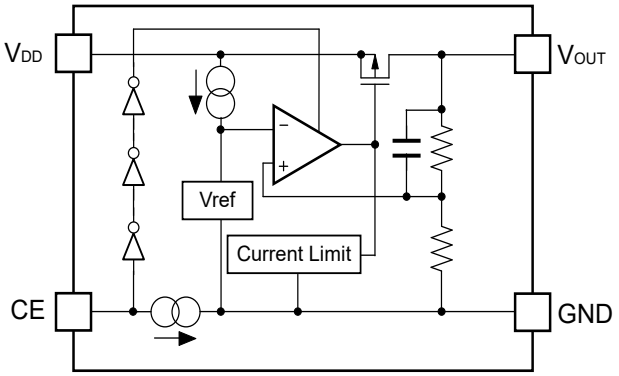
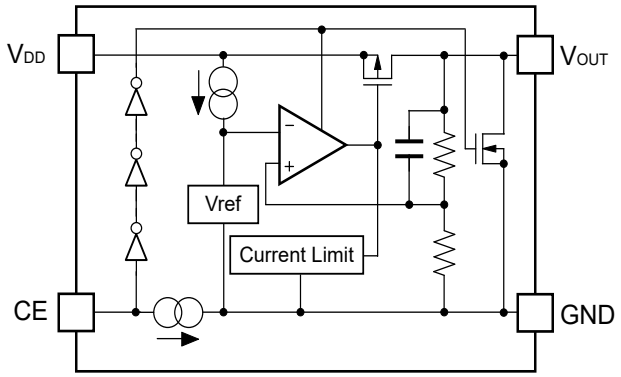
BLOCK DIAGRAMS



RP130xxx1A Block Diagram



RP130xxx1B Block Diagram



RP130xxx1D Block Diagram

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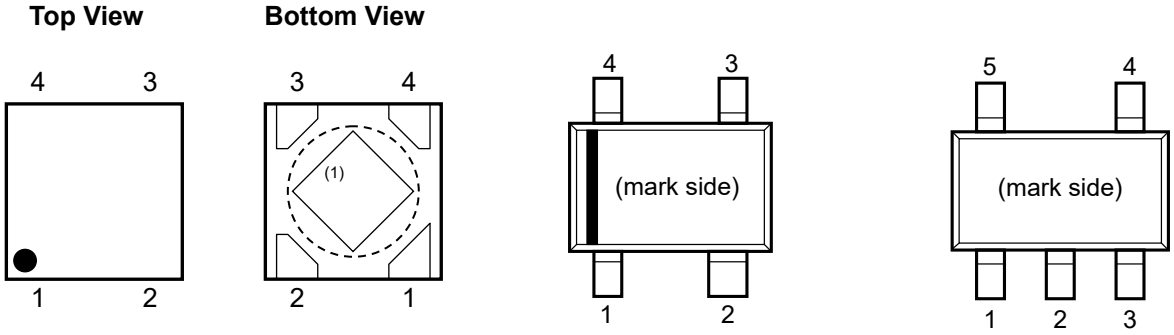
PIN DESCRIPTIONS



DFN(PL)1010-4 Pin Configuration **SC-82AB Pin Configuration** **SOT-23-5 Pin Configuration**

DFN(PL)1010-4 Pin Description

Pin No	Symbol	Pin Description
1	VOUT	Output Pin
2	GND	Ground Pin
3	$\overline{CE}$ / CE	Chip Enable Pin ("L" Active / "H" Active)
4	VDD	Input Pin

SC-82AB Pin Description

Pin No	Symbol	Pin Description
1	$\overline{CE}$ / CE	Chip Enable Pin ("L" Active / "H" Active)
2	GND	Ground Pin
3	VOUT	Output Pin
4	VDD	Input Pin

SOT-23-5 Pin Description

Pin No	Symbol	Pin Description
1	VDD	Input Pin
2	GND	Ground Pin
3	$\overline{CE}$ / CE	Chip Enable Pin ("L" Active / "H" Active)
4	NC	No Connection
5	VOUT	Output Pin

(1) Tab is GND level (they are connected to the reverse side of this IC). The tab is better to be connected to the GND, but leaving it open is also acceptable.

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ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings

Symbol	Item			Rating	Unit
V_{IN}	Input Voltage			7.0	V
V_{CE}	Input Voltage (CE Pin)			−0.3 to 7.0	V
V_{OUT}	Output Voltage			−0.3 to V_{IN} + 0.3	V
I_{OUT}	Output Current			200	mA
P_D	Power Dissipation[1]	DFN(PL)1010-4	JEDEC STD. 51-7 Test Land Pattern	800	mW
		SC-82AB	Standard Test Land Pattern	380	
		SOT-23-5	JEDEC STD. 51-7 Test Land Pattern	660	
Tj	Junction Temperature Range			−40 to 125	°C
Tstg	Storage Temperature Range			−55 to 125	°C

ABSOLUTE MAXIMUM RATINGS
Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings are not assured.

RECOMMENDED OPERATING CONDITIONS

Recommended Operating Conditions

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	1.7 to 6.5	V
Ta	Operating Temperature Range	−40 to 85	°C

RECOMMENDED OPERATING CONDITIONS
All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

[1] Refer to *POWER DISSIPATION* for detailed information.

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ELECTRICAL CHARACTERISTICS

V_{IN} = V_{SET} + 1 V (V_{OUT} > 1.5 V), V_{IN} = 2.5 V (V_{OUT} ≤ 1.5 V), I_{OUT} = 1 mA, C_{IN} = C_{OUT} = 0.47 µF, unless otherwise noted.
The specifications surrounded by ☐ are guaranteed by design engineering at −40ºC ≤ Ta ≤ 85°C.

RP130xxx1A Electrical Characteristics (Ta = 25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	Ta = 25°C	V_{SET} > 2.0 V	x 0.99		x 1.01	V
			V_{SET} ≤ 2.0 V	−20		20	mV
		−40°C ≤ Ta ≤ 85°C	V_{SET} > 2.0 V	x0.985		x1.015	V
			V_{SET} ≤ 2.0 V	−30		30	mV
I_{LIM}	Output Current Limit			150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	1 mA ≤ I_{OUT} ≤ 150 mA			10	30	mV
V_{DIF}	Dropout Voltage	I_{OUT} = 150 mA	1.2 V ≤ V_{SET} < 1.5 V		0.67	1.00	V
			1.5 V ≤ V_{SET} < 1.7 V		0.54	0.81	
			1.7 V ≤ V_{SET} < 2.0 V		0.46	0.68	
			2.0 V ≤ V_{SET} < 2.5 V		0.41	0.60	
			2.5 V ≤ V_{SET} < 4.0 V		0.32	0.51	
			4.0 V ≤ V_{SET}		0.24	0.37	
I_{SS}	Supply Current	I_{OUT} = 0 mA			38	58	µA
Istandby	Supply Current (Standby)	V_{CE} = V_{IN}			0.1	1.0	µA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{SET} + 0.5 V ≤ V_{IN} ≤ 6.5 V			0.02	0.10	%/V
RR	Ripple Rejection	f = 1 kHz, Ripple 0.2 Vp-p V_{IN} = V_{SET} + 1 V I_{OUT} = 30 mA (In case that V_{OUT} ≤ 2.0 V, V_{IN} = 3.0 V)			80		dB
V_{IN}	Input Voltage			1.7		6.5	V
$\Delta V_{OUT}/\Delta Ta$	Output Voltage Temperature Coefficient	−40°C ≤ Ta ≤ 85°C			±20		ppm/°C
I_{SC}	Short Current Limit	V_{OUT} = 0 V			40		mA
V_{CEH}	$\overline{CE}$ Input Voltage "H"			1.0			µA
V_{CEL}	$\overline{CE}$ Input Voltage "L"					0.4	
en	Output Noise	BW = 10 Hz to 100 kHz I_{OUT} = 30 mA			20 xV_{SET}		µVrms

All test items listed under *Electrical Characteristics* are done under the pulse load condition (Tj ≈ Ta = 25°C) except for Output Noise, Ripple Rejection, and Output Voltage Temperature Coefficient.

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ELECTRICAL CHARACTERISTICS (continued)

V_{IN} = V_{SET} + 1 V (V_{OUT} > 1.5 V), V_{IN} = 2.5 V (V_{OUT} ≤ 1.5 V), I_{OUT} = 1 mA, C_{IN} = C_{OUT} = 0.47 µF, unless otherwise noted.
The specifications surrounded by ☐ are guaranteed by design engineering at −40ºC ≤ Ta ≤ 85°C.

RP130xxx1B/D Electrical Characteristics (Ta = 25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	Ta = 25°C	V_{SET} > 2.0 V	x 0.99		x 1.01	V
			V_{SET} ≤ 2.0 V	−20		20	mV
		−40°C ≤ Ta ≤ 85°C	V_{SET} > 2.0 V	x 0.985		x 1.015	V
			V_{SET} ≤ 2.0 V	−30		30	mV
I_{LIM}	Output Current Limit			150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	1 mA ≤ I_{OUT} ≤ 150 mA			10	30	mV
V_{DIF}	Dropout Voltage	I_{OUT} = 150 mA	1.2 V ≤ V_{SET} < 1.5 V		0.67	1.00	
			1.5 V ≤ V_{SET} < 1.7 V		0.54	0.81	
			1.7 V ≤ V_{SET} < 2.0 V		0.46	0.68	
			2.0 V ≤ V_{SET} < 2.5 V		0.41	0.60	
			2.5 V ≤ V_{SET} < 4.0 V		0.32	0.51	
			4.0 V ≤ V_{SET}		0.24	0.37	
I_{SS}	Supply Current	I_{OUT} = 0 mA			38	58	µA
Istandby	Standby Current	V_{CE} = 0 V			0.1	1.0	µA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{SET} + 0.5 V ≤ V_{IN} ≤ 6.5 V			0.02	0.10	%/V
RR	Ripple Rejection	f = 1 kHz, Ripple 0.2 Vp-p V_{IN} = V_{SET} + 1 V, I_{OUT} = 30 mA (In case that V_{OUT} ≤ 2.0 V, V_{IN} = 3.0 V)			80		dB
V_{IN}	Input Voltage			1.7		6.5	V
$\Delta V_{OUT}/\Delta Ta$	Output Voltage Temperature Coefficient	−40°C ≤ Ta ≤ 85°C			±20		ppm/°C
I_{SC}	Short Current Limit	V_{OUT} = 0 V			40		mA
I_{PD}	CE Pull-down Current				0.4		µA
V_{CEH}	$\overline{CE}$ Input Voltage "H"			1.0			µA
V_{CEL}	$\overline{CE}$ Input Voltage "L"					0.4	
en	Output Noise	BW = 10 Hz to 100 kHz I_{OUT} = 30 mA			20 xV_{SET}		µVrms
R_{LOW}	Nch ON Resistance for Auto Discharge (RP130xxx1D)	V_{IN} = 4.0 V V_{CE} = 0 V			30		Ω

All test items listed under *Electrical Characteristics* are done under the pulse load condition (Tj≈Ta=25ºC) except for Output Noise, Ripple Rejection, and Output Voltage Temperature Coefficient.

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The specifications surrounded by ☐ are guaranteed by design engineering at −40ºC ≤ Ta ≤ 85°C.

Product-specific Electrical Characteristics (Ta = 25°C)

Product Name	V_{OUT} [V] (Ta = 25°C)			V_{OUT} [V] (Ta = −40°C to 85°C)			V_{DIF} [V]	
	Min.	Typ.	Max.	Min.	Typ.	Max.	Typ.	Max.
RP130x121x	1.180	1.2	1.220	1.170	1.2	1.230	0.67	1.00
RP130x121x5	1.230	1.25	1.270	1.220	1.25	1.280		
RP130x131x	1.280	1.3	1.320	1.270	1.3	1.330		
RP130x141x	1.380	1.4	1.420	1.370	1.4	1.430		
RP130x151x	1.480	1.5	1.520	1.470	1.5	1.530	0.54	0.81
RP130x161x	1.580	1.6	1.620	1.570	1.6	1.630		
RP130x171x	1.680	1.7	1.720	1.670	1.7	1.730	0.46	0.68
RP130x181x	1.780	1.8	1.820	1.770	1.8	1.830		
RP130x181x5	1.830	1.85	1.870	1.820	1.85	1.880		
RP130x191x	1.880	1.9	1.920	1.870	1.9	1.930		
RP130x201x	1.980	2.0	2.020	1.970	2.0	2.030	0.41	0.60
RP130x211x	2.079	2.1	2.121	2.069	2.1	2.132		
RP130x221x	2.178	2.2	2.222	2.167	2.2	2.233		
RP130x231x	2.277	2.3	2.323	2.266	2.3	2.335		
RP130x241x	2.376	2.4	2.424	2.364	2.4	2.436		
RP130x251x	2.475	2.5	2.525	2.463	2.5	2.538	0.32	0.51
RP130x261x	2.574	2.6	2.626	2.561	2.6	2.639		
RP130x271x	2.673	2.7	2.727	2.660	2.7	2.741		
RP130x281x	2.772	2.8	2.828	2.758	2.8	2.842		
RP130x281x5	2.822	2.85	2.879	2.807	2.85	2.893		
RP130x291x	2.871	2.9	2.929	2.857	2.9	2.944		
RP130x301x	2.970	3.0	3.030	2.955	3.0	3.045		
RP130x311x	3.069	3.1	3.131	3.054	3.1	3.147		
RP130x321x	3.168	3.2	3.232	3.152	3.2	3.248		
RP130x331x	3.267	3.3	3.333	3.251	3.3	3.350		
RP130x341x	3.366	3.4	3.434	3.349	3.4	3.451		
RP130x341x5	3.416	3.45	3.485	3.398	3.45	3.502		
RP130x351x	3.465	3.5	3.535	3.448	3.5	3.553		
RP130x361x	3.564	3.6	3.636	3.546	3.6	3.654		
RP130x371x	3.663	3.7	3.737	3.645	3.7	3.756		
RP130x381x	3.762	3.8	3.838	3.743	3.8	3.857		
RP130x391x	3.861	3.9	3.939	3.842	3.9	3.959		
RP130x401x	3.960	4.0	4.040	3.940	4.0	4.060	0.24	0.37
RP130x411x	4.059	4.1	4.141	4.039	4.1	4.162		
RP130x421x	4.158	4.2	4.242	4.137	4.2	4.263		
RP130x421x5	4.208	4.25	4.293	4.186	4.25	4.314		
RP130x431x	4.257	4.3	4.343	4.236	4.3	4.365		
RP130x441x	4.356	4.4	4.444	4.334	4.4	4.466		
RP130x451x	4.455	4.5	4.545	4.433	4.5	4.568		
RP130x461x	4.554	4.6	4.646	4.531	4.6	4.669		
RP130x471x	4.653	4.7	4.747	4.630	4.7	4.771		
RP130x481x	4.752	4.8	4.848	4.728	4.8	4.872		
RP130x491x	4.851	4.9	4.949	4.827	4.9	4.974		
RP130x501x	4.950	5.0	5.050	4.925	5.0	5.075		
RP130x511x	5.049	5.1	5.151	5.024	5.1	5.177		
RP130x521x	5.148	5.2	5.252	5.122	5.2	5.278		
RP130x531x	5.247	5.3	5.353	5.221	5.3	5.380		

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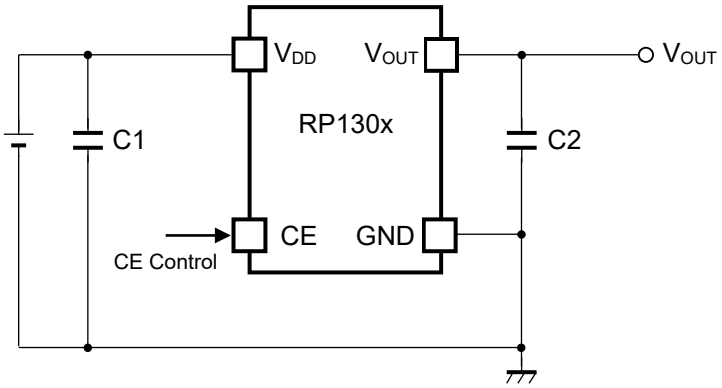
APPLICATION INFORMATION

TYPICAL APPLICATION



RP130x Typical Application

External Components

Symbol	Descriptions
C1, C2	0.47 μF, Ceramic Capacitor, Murata, GRM155B30J474KE18B

TECHNICAL NOTES

Phase Compensation

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a capacitor C2 with 0.47 μF or more. If a tantalum capacitor is used, and its ESR (Equivalent Series Resistance) of C2 is large, the loop oscillation may result. Because of this, select C2 carefully considering its frequency characteristics.

PCB Layout

Make VDD and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 0.47 μF or more between VDD and GND pin, and as close as possible to the pins. Set external components, especially the output capacitor C2, as close as possible to the ICs, and make wiring as short as possible.

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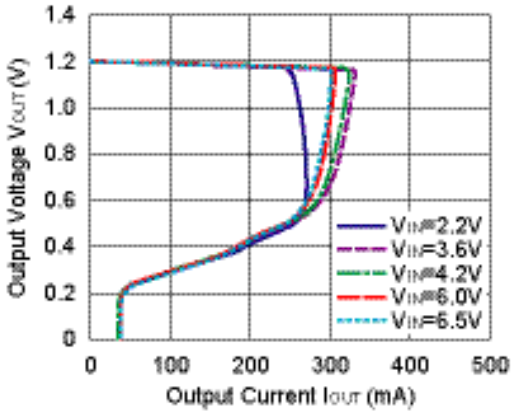
TYPICAL CHARACTERISTICS

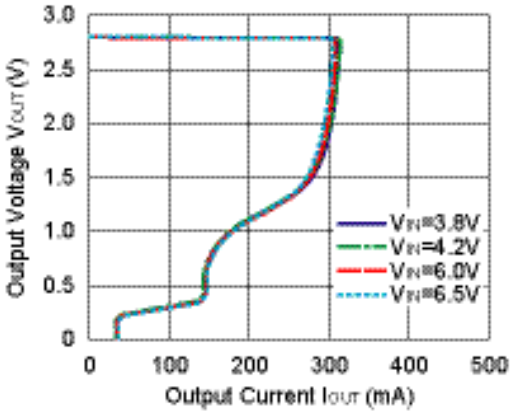
Typical characteristics are intended to be used as reference data, they are not guaranteed.

1) Output Voltage vs. Output Current (C1 = 0.47 µF, C2 = 0.47 µF, Ta = 25°C)

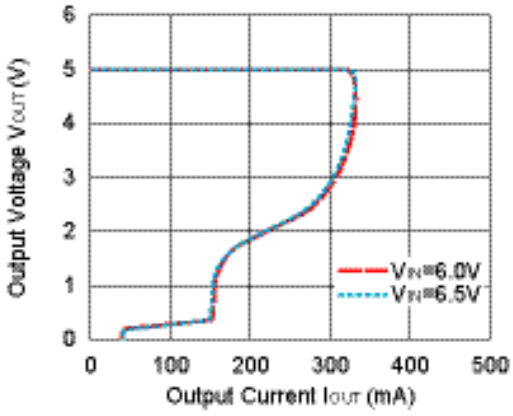
RP130x121x



RP130x281x

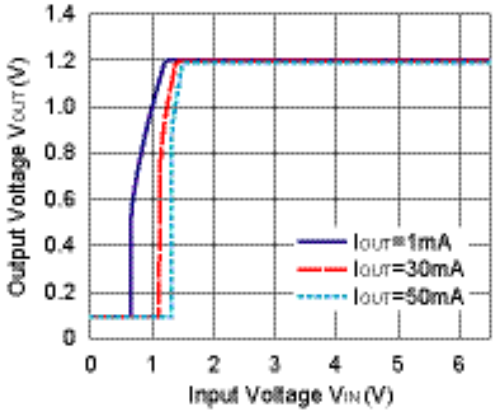


RP130x501x

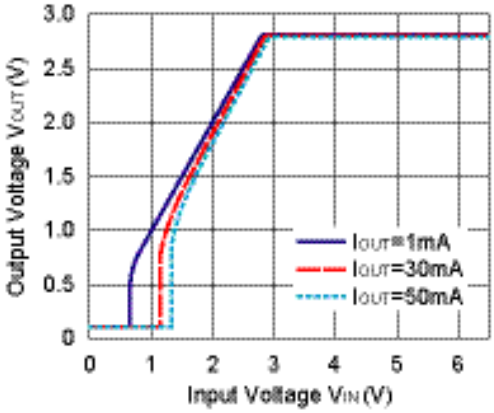


2) Output Voltage vs. Input Voltage (C1 = 0.47 µF, C2 = 0.47 µF, Ta = 25°C)

RP130x121x



RP130x281x



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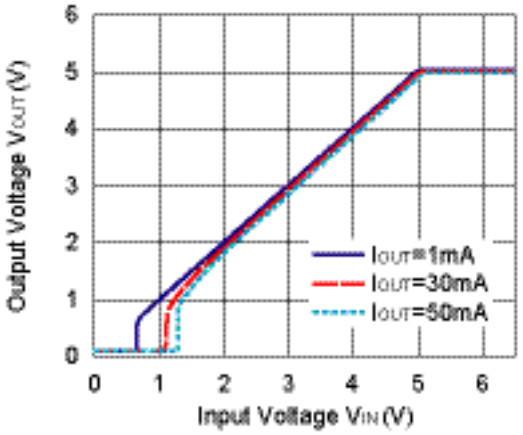
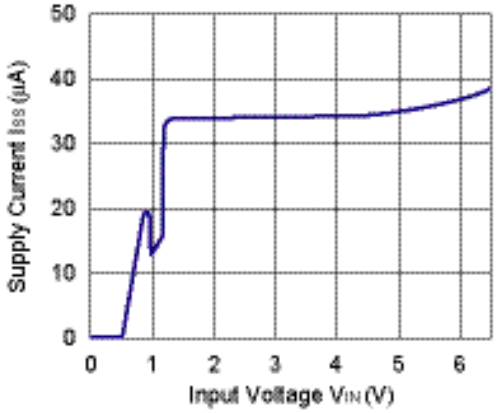
RP130x501x

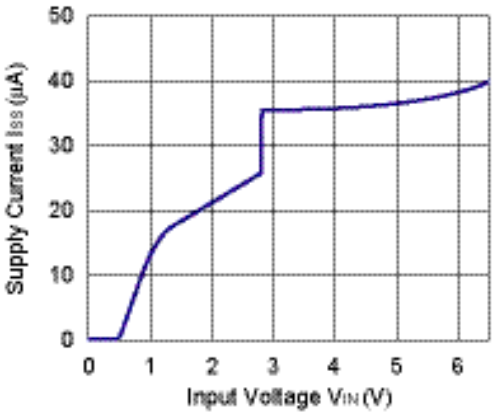


3) Supply Current vs. Input Voltage (C1 = 0.47 μF, C2 = 0.47 μF, Ta = 25°C)

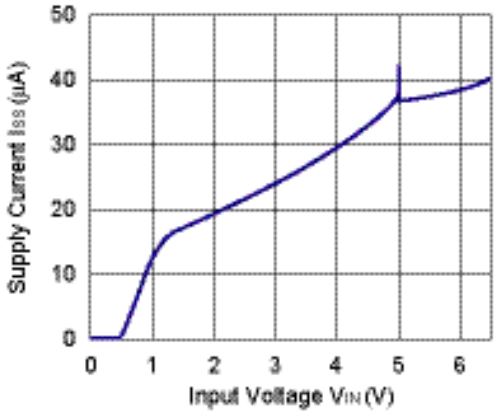
RP130x121x



RP130x281x



RP130x501x



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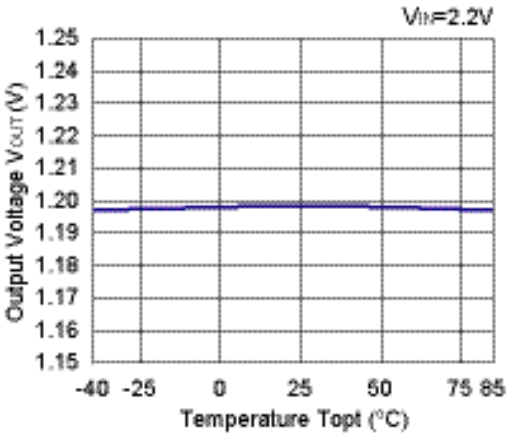
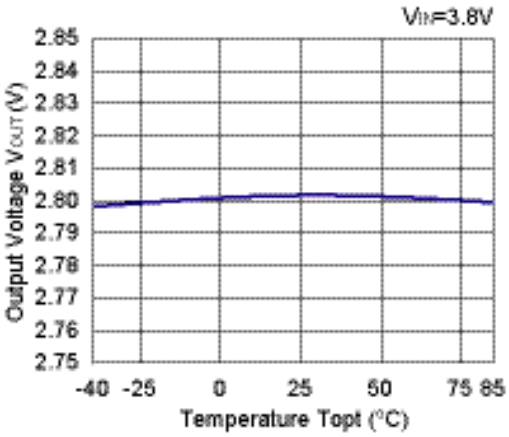
4) Output Voltage vs. Temperature (I_{OUT} = 1 mA, C1 = 0.47 µF, C2 = 0.47 µF)

RP130x121x



RP130x281x



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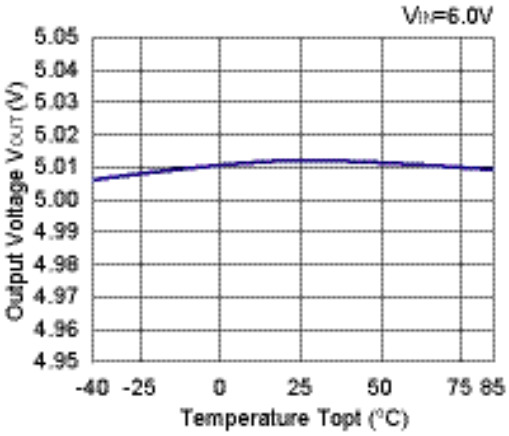
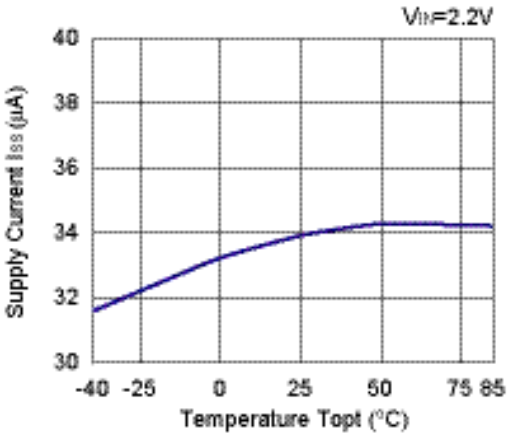
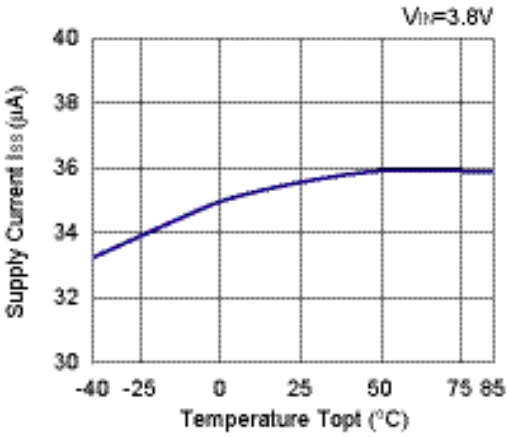


5) Supply Current vs. Temperature (IOUT = 0 mA, C1 = 0.47 µF, C2 = 0.47 µF)

RP130x121x

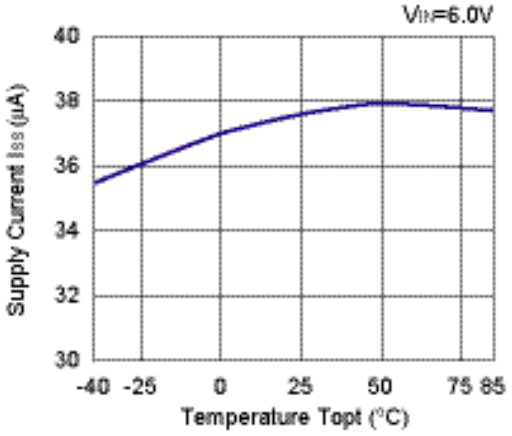


RP130x281x



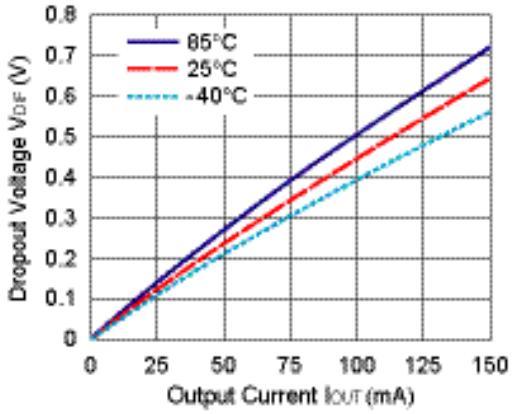
Downloaded from Arrow.com.

RP130x501x

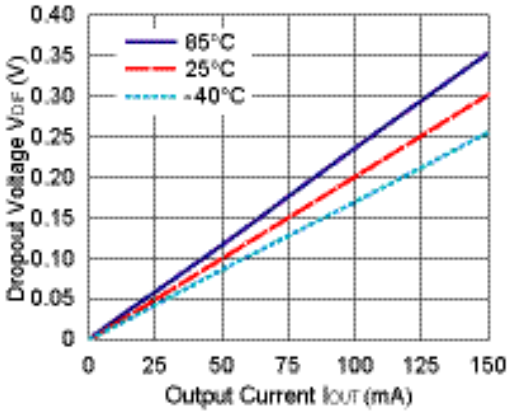


6) Dropout Voltage vs. Output Current (C1 = 0.47 μF, C2 = 0.47 μF)

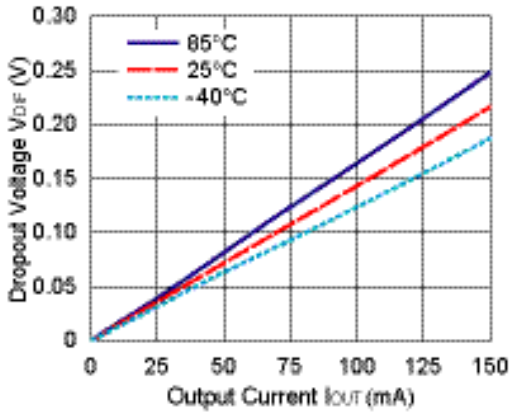
RP130x121x



RP130x281x



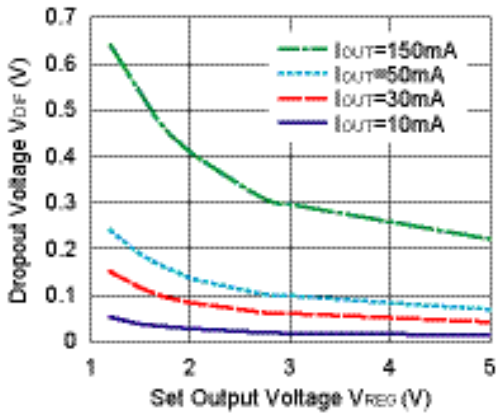
RP130x501x



Downloaded from Arrow.com.

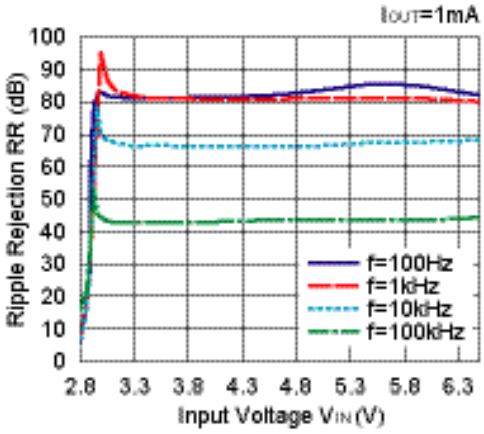
7) Dropout Voltage vs. Set Output Voltage (C1 = 0.47 µF, C2 = 0.47 µF)

RP130x501x

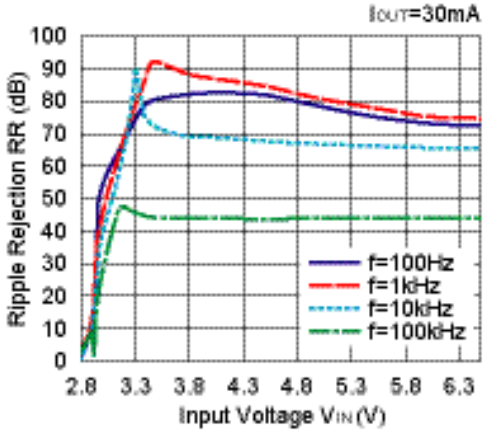


8) Ripple Rejection vs. Input Bias Voltage (C1 = none, C2 = 0.47 µF, Ripple = 0.2 Vp-p, Ta = 25°C)

RP130x281x

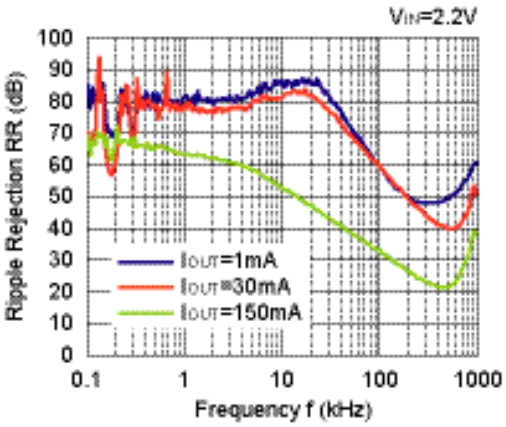


RP130x281x

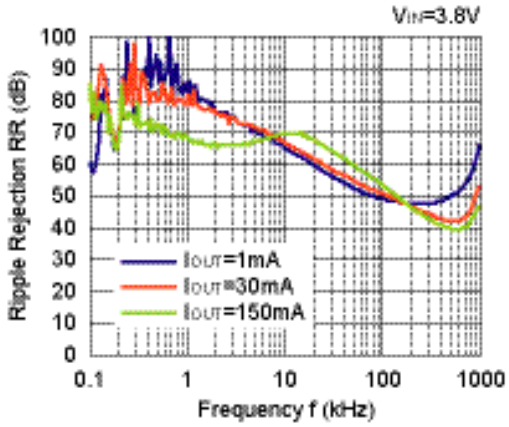


9) Ripple Rejection vs. Frequency (C1 = none, C2 = 0.47 µF, Ripple = 0.2 Vp-p, Ta = 25°C)

RP130x121x

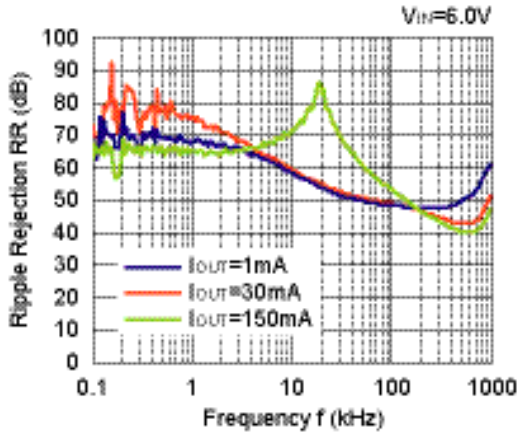


RP130x281x



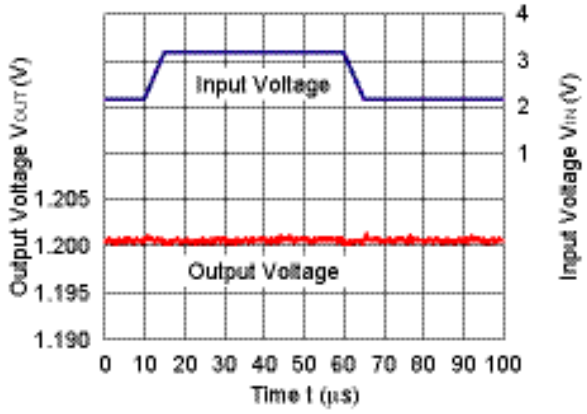
Downloaded from Arrow.com.

RP130x501x

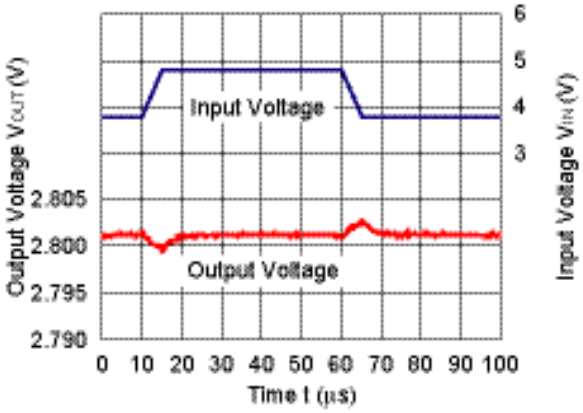


10) Input Transient Response (I_{OUT} = 30 mA, tr = tf = 5 µs, C1 = none, C2 = 0.47 µF, Ta = 25°C)

RP130x121x



RP130x281x



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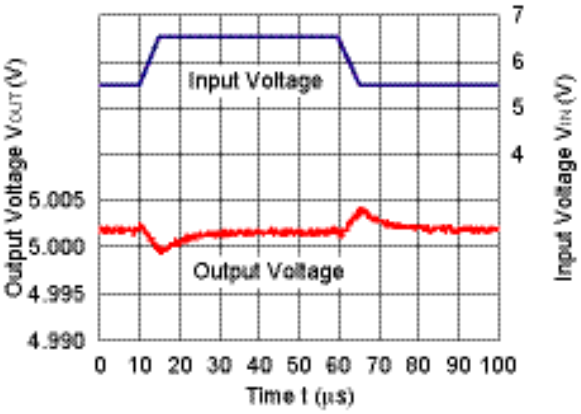
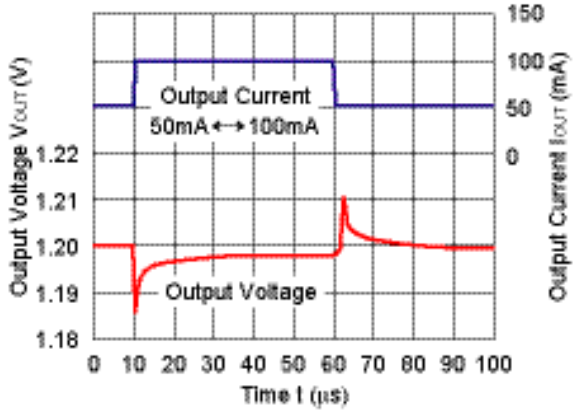


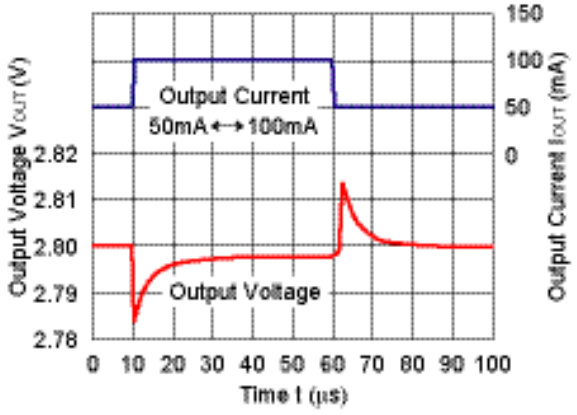
Downloaded from Arrow.com.

11) Load Transient Response
(tr = tf = 0.5 µs, C1 = 0.47 µF, C2 = 0.47 µF, I_{OUT} = 50mA ↔ 100 mA, Ta = 25°C)

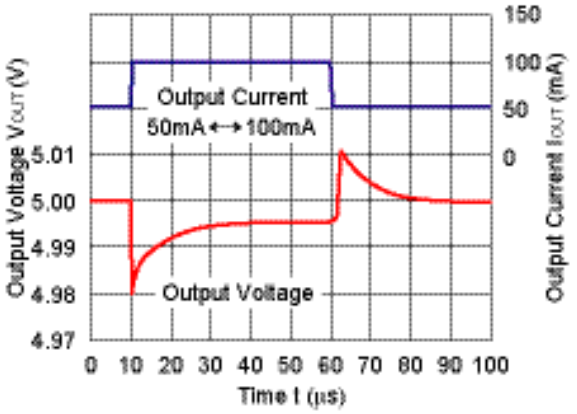
RP130x121x



RP130x281x

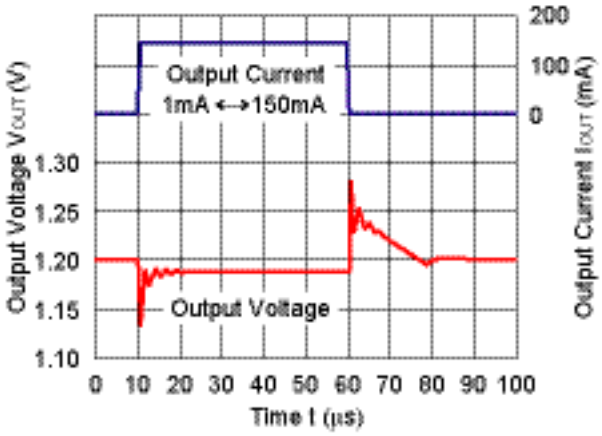


RP130x501x

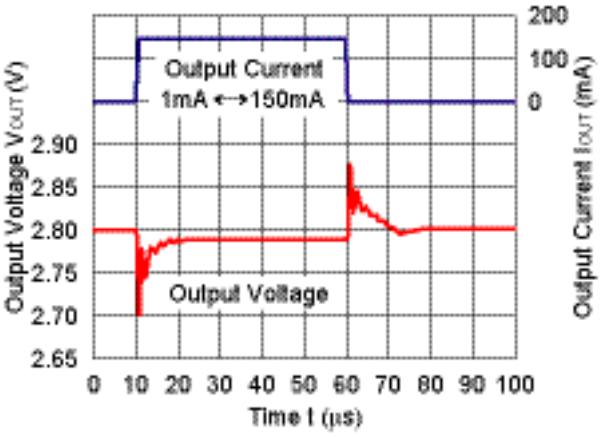


12) Load Transient Response
(tr = tf = 0.5 µs, C1 = 0.47 µF, C2 = 0.47 µF, I_{OUT} = 1 mA ↔ 150mA, Ta = 25°C)

RP130x121x

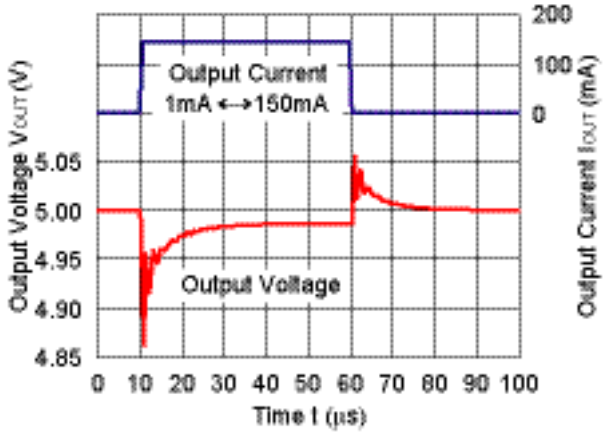


RP130x281x



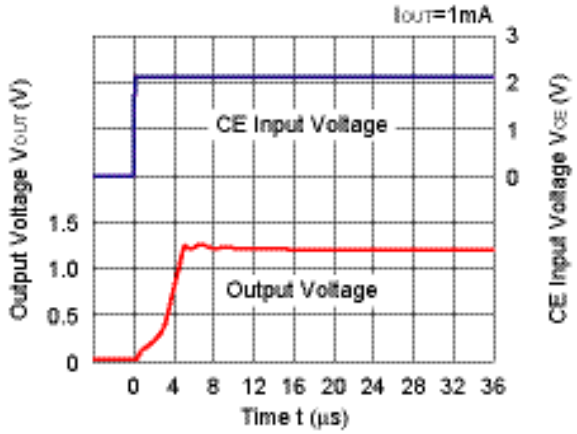
Downloaded from Arrow.com.

RP130x501x

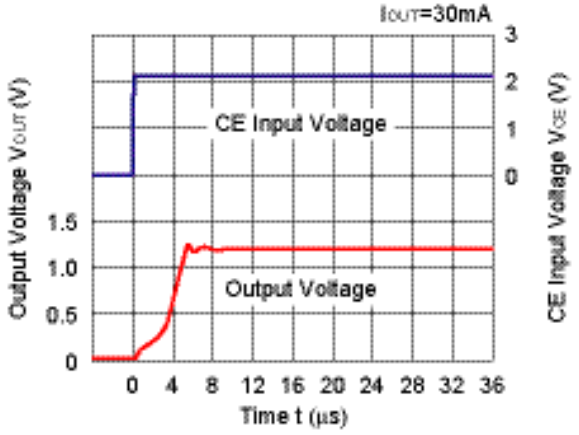


13) Turn On Speed with CE pin (C1 = 0.47 µF, C2 = 0.47 µF, Ta = 25°C)

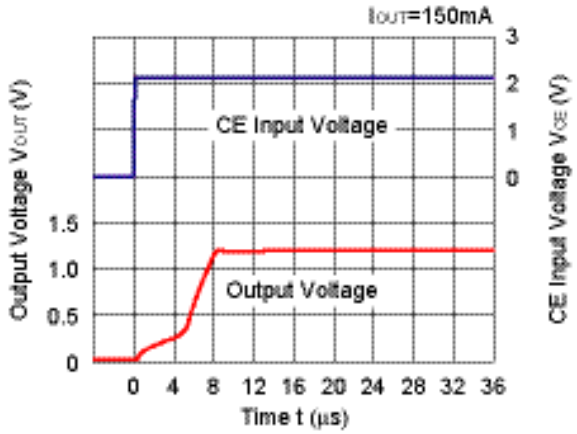
RP130x121x



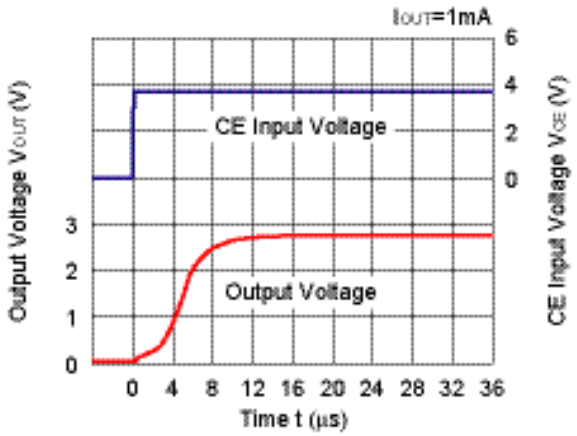
RP130x121x



RP130x121x

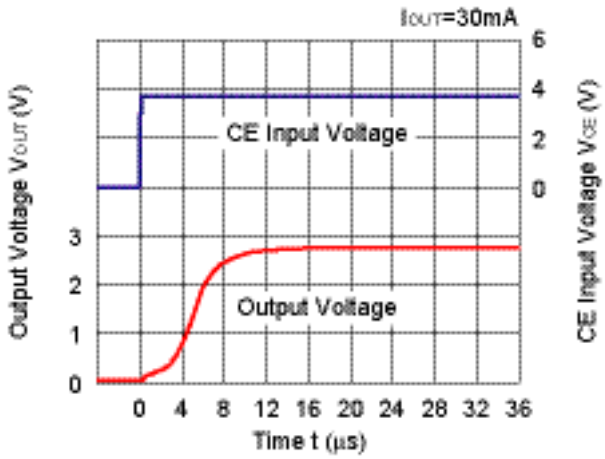


RP130x281x



Downloaded from Arrow.com.

RP130x281x



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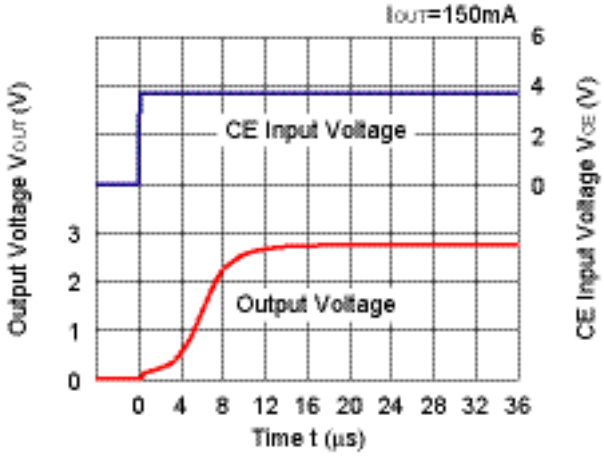

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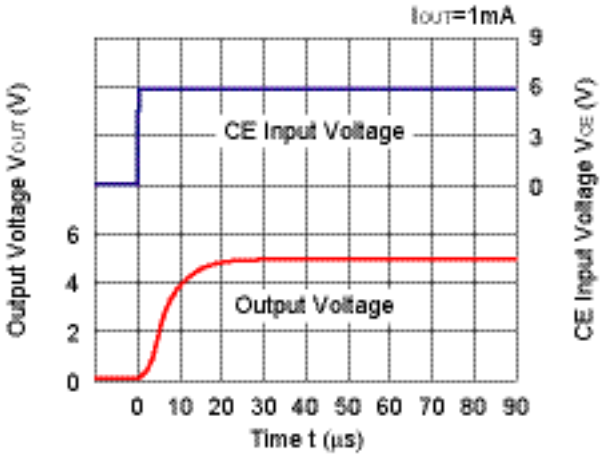

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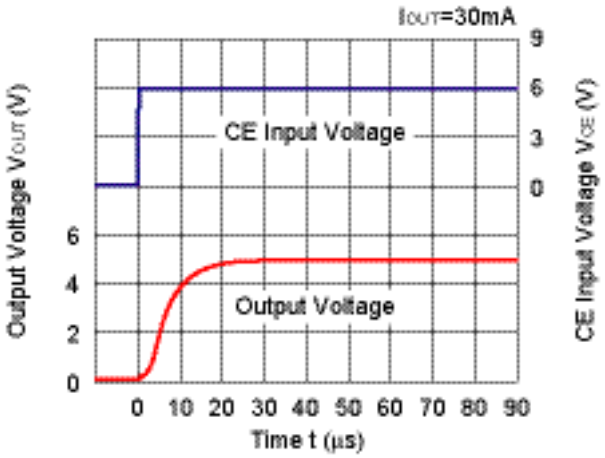

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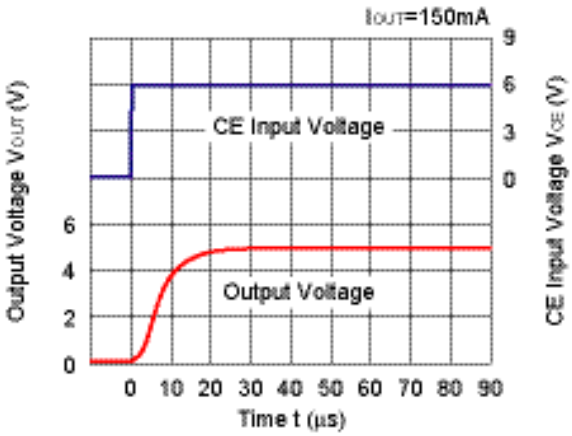

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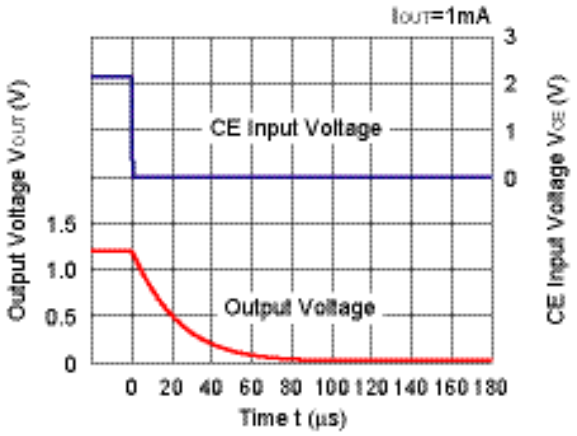
14) Turn Off Speed with CE pin (RP130xxx1D) (C1 = 0.47 μF, C2 = 0.47 μF, Ta = 25°C)

RP130x121D



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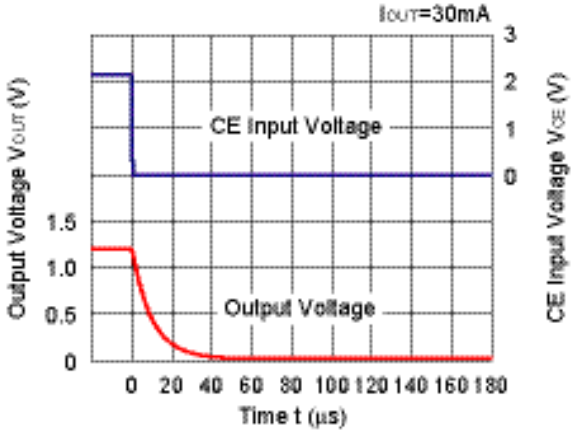
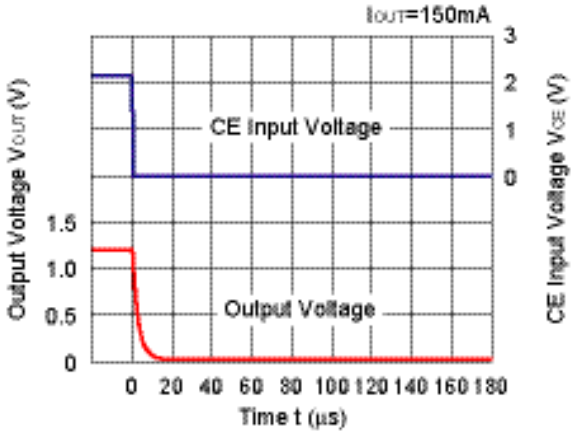
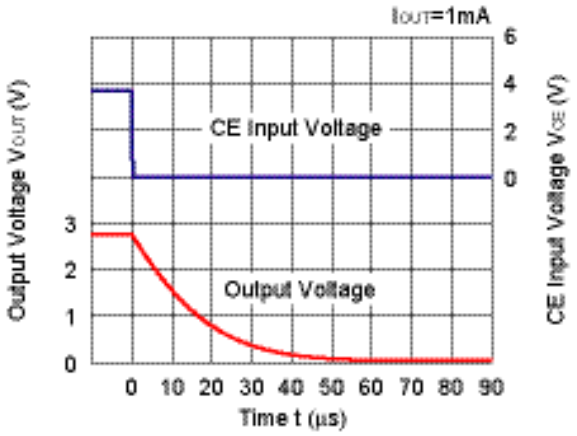


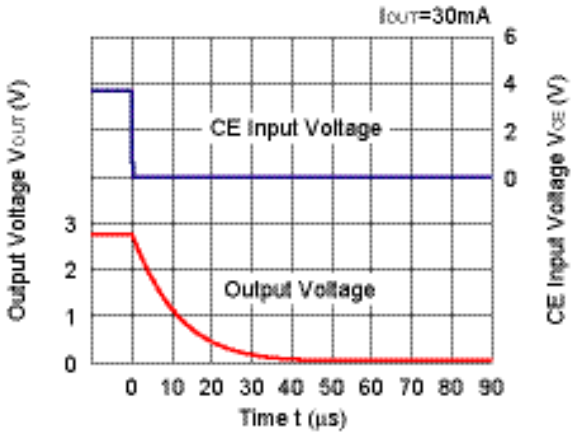
RP130x121D



RP130x281D



RP130x281D



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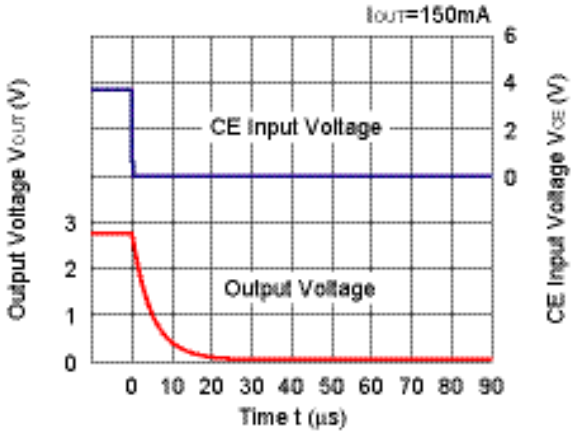

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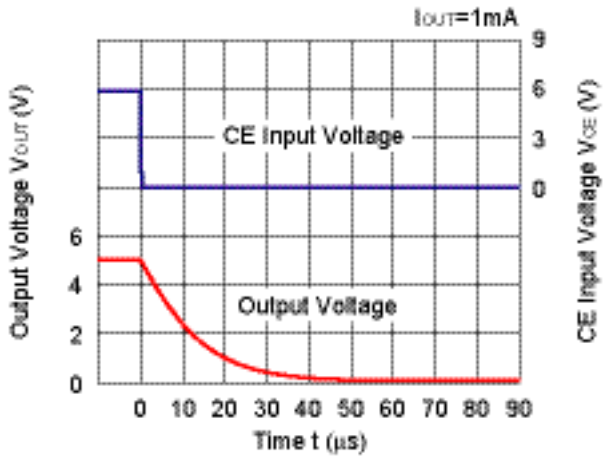
RP130x501D



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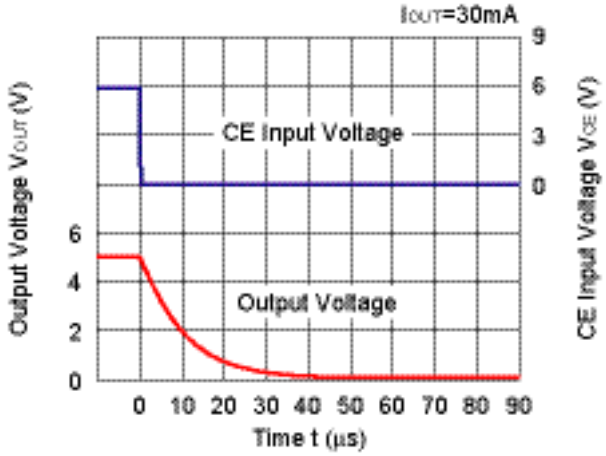

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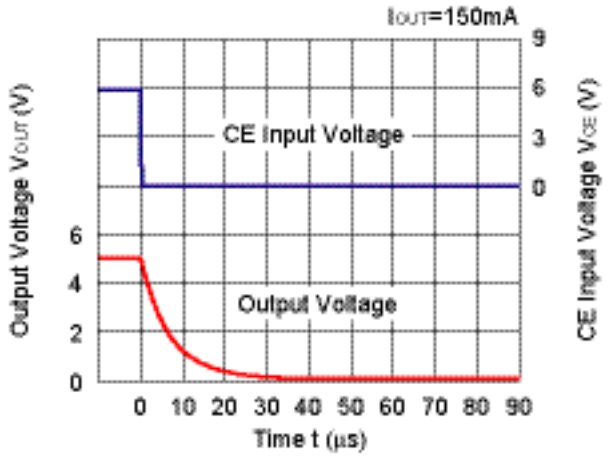
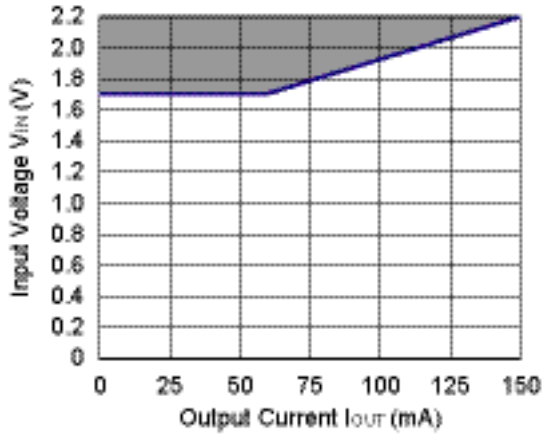


15) Minimum Operating Voltage (C1 = 0.47 µF, C2 = 0.47 µF)



Hatched area is available for 1.2 V output.

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ESR vs. Output Current

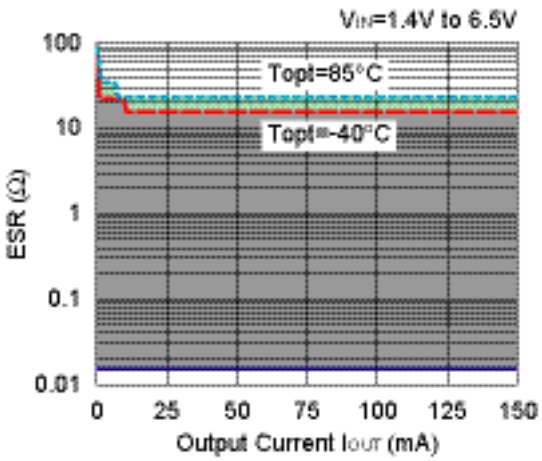
When using these ICs, consider the following points:

The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.
The conditions when the white noise level is under 40 μV (Avg.) are marked as the hatched area in the graph.

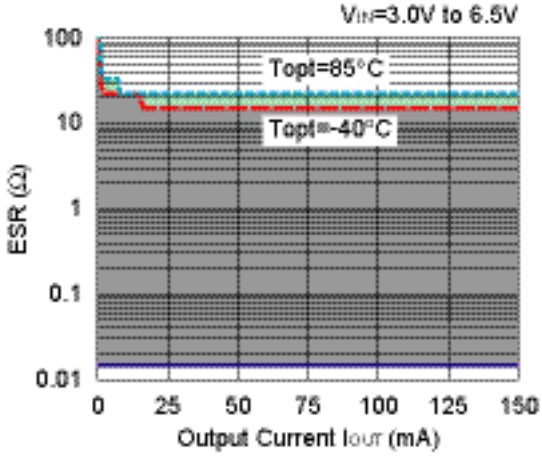
Measurement conditions

Frequency Band : 10 Hz to 3 MHz
Temperature : –40°C to 85°C
C1, C2 : 0.47 μF

RP130x121x



RP130x281x



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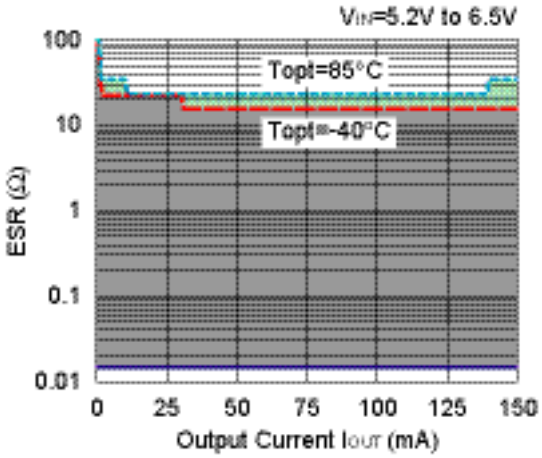

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PD-DFN(PL)1010-4-(85125150)-JE-B

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51.

Measurement Conditions

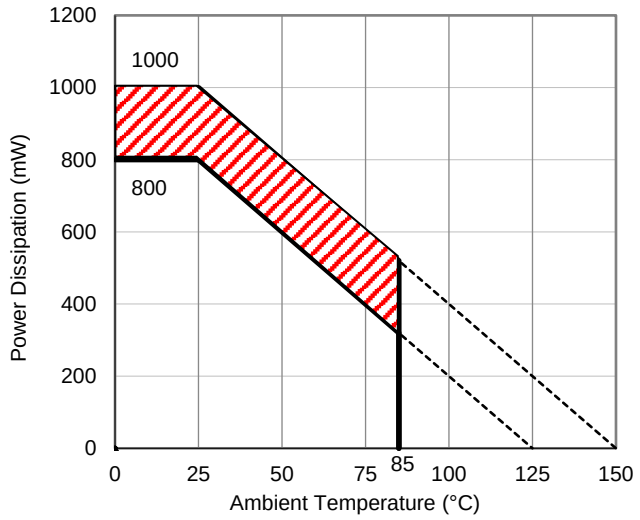
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.2 mm × 21 pcs

Measurement Result (Ta = 25°C, Tjmax = 125°C)

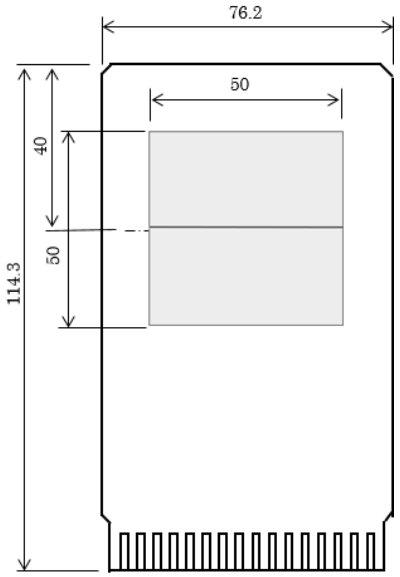
Item	Measurement Result
Power Dissipation	800 mW
Thermal Resistance (θja)	θja = 125°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 58°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

Total Hours of Use	Total Years of Use (4 hours/day)
13,000 hours	9 years

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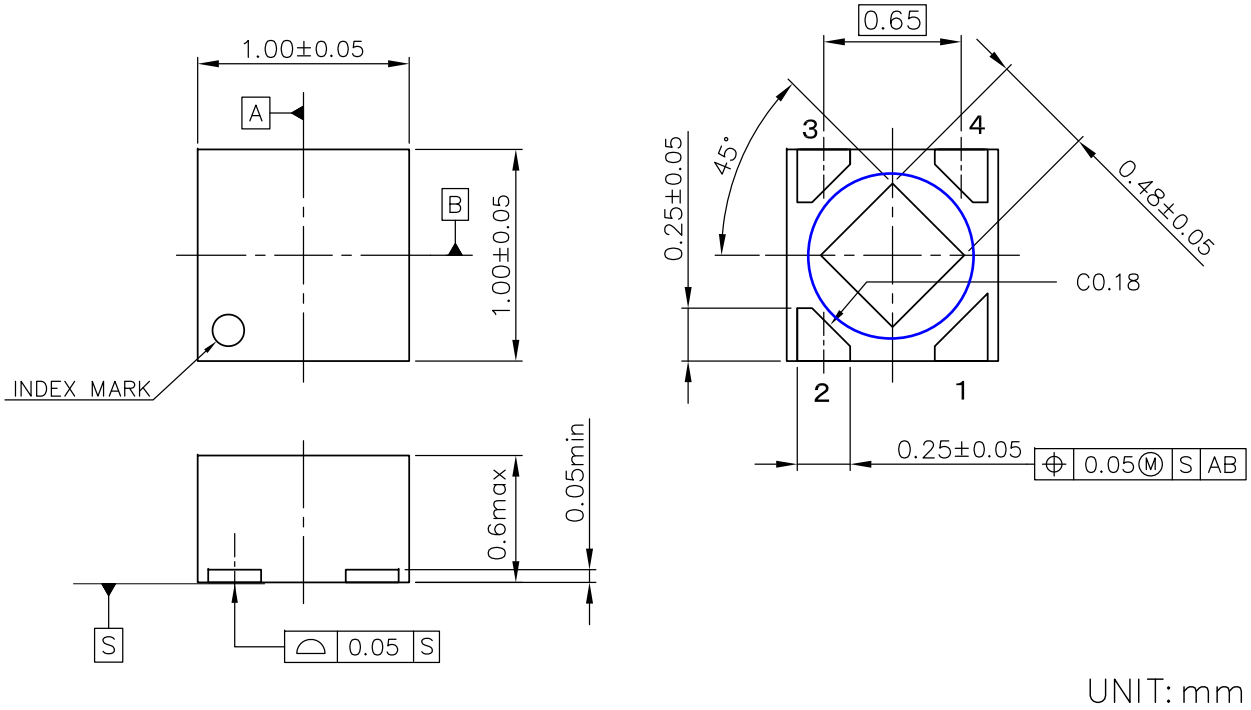

DFN(PL)1010-4 Package Dimensions

* The tab on the bottom of the package shown by blue circle is a substrate potential (GND). It is recommended that this tab be connected to the ground plane on the board but it is possible to leave the tab floating.

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Ver. A

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

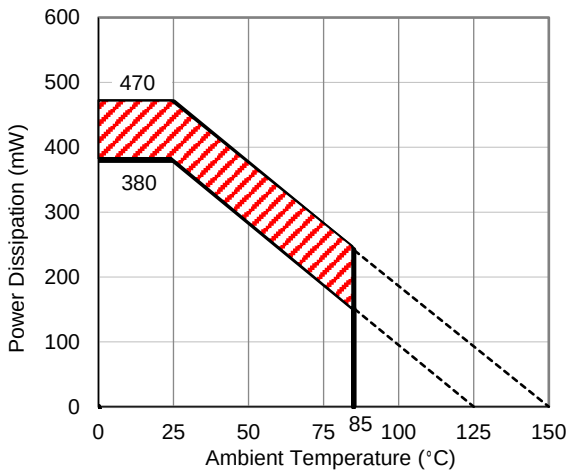
Measurement Conditions

Item	Standard Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-Sided Board)
Board Dimensions	40 mm × 40 mm × 1.6 mm
Copper Ratio	Top Side: Approx. 50% Bottom Side: Approx. 50%
Through-holes	ϕ 0.5 mm × 44 pcs

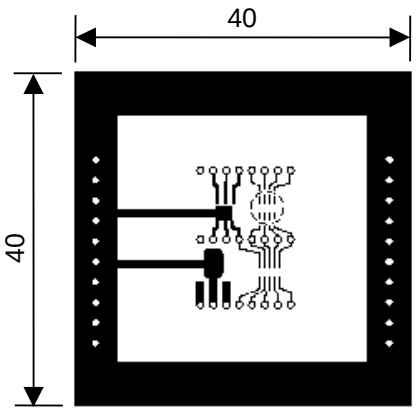
Measurement Result (Ta = 25°C, Tjmax = 125°C)

Item	Standard Land Pattern
Power Dissipation	380 mW
Thermal Resistance (θja)	θja = 263°C/W

θja: Junction-to-Ambient Thermal Resistance



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

Total Hours of Use	Total Years of Use (4 hours/day)
13,000 hours	9 years

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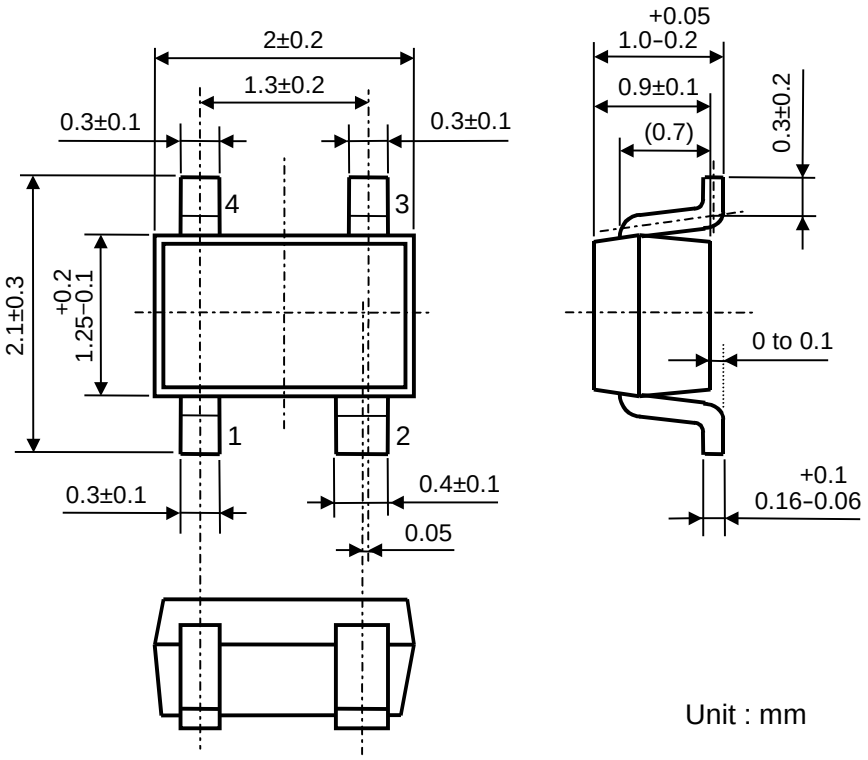
Ver. A



SC-82AB Package Dimensions

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The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

Measurement Conditions

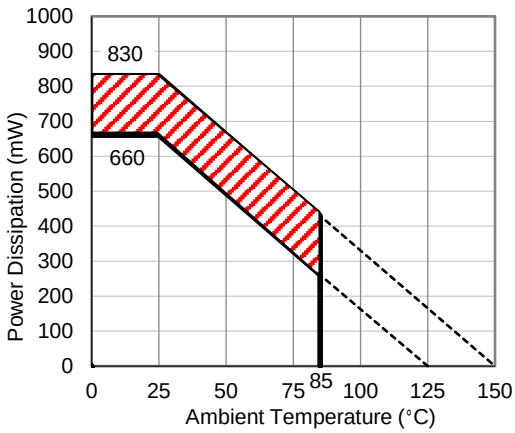
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 7 pcs

Measurement Result (Ta = 25°C, Tjmax = 125°C)

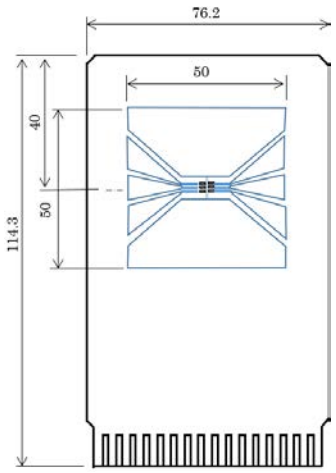
Item	Measurement Result
Power Dissipation	660 mW
Thermal Resistance (θja)	θja = 150°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 51°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

Total Hours of Use	Total Years of Use (4 hours/day)
13,000 hours	9 years

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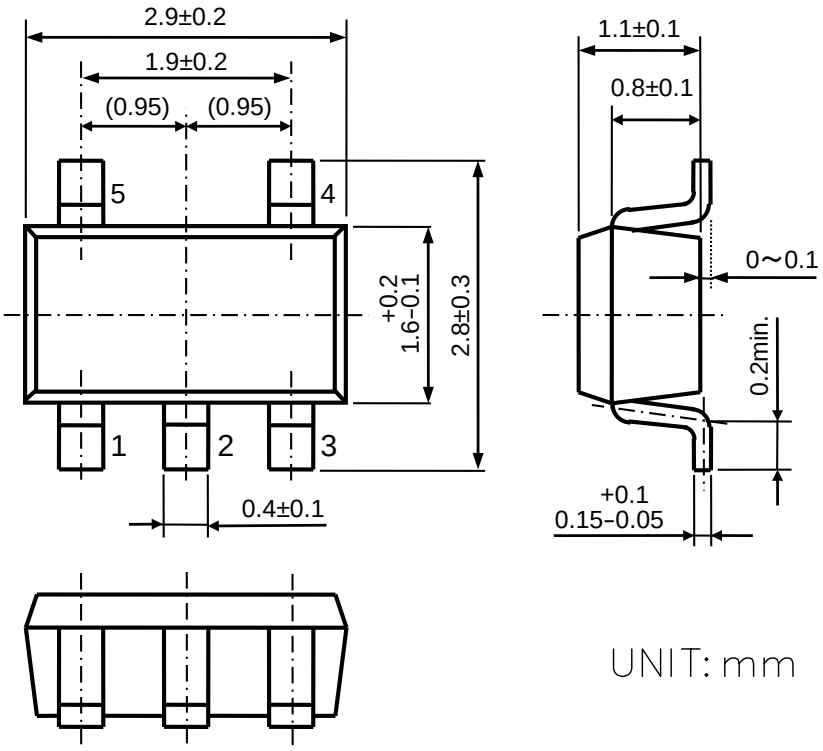

SOT-23-5 Package Dimensions

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   8-1. Quality Warranty Period

   In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.

   8-2. Quality Warranty Remedies

   When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.

   Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.

   8-3. Remedies after Quality Warranty Period

   With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
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