Linear Regulator Series

BD00EA5 Series Dropout Voltage

This application note provides design values of the “Dropout voltage” that are necessary for designing circuits. From the operating temperature and output current of the target specification, check the maximum value of the input/output voltage difference in the next page and use it as the circuit design value. The values listed in this material are “design reference values” that are necessary for designing devices, and the values are not guaranteed. Check the latest data sheet for the guaranteed values.

What is dropout voltage

The dropout voltage ΔV_d is the difference between the input and output voltages that is necessary for the stabilizing operation of a linear regulator. When the input voltage approaches the output voltage, stabilizing operation cannot be maintained and the output starts dropping in proportion to the input. The voltage at which this situation starts, i.e., the difference between the input and output voltages that is necessary for the stabilizing operation, is referred to as the dropout voltage (Figure 1).

Figure 2 shows the relation between the input and output voltages and the dropout voltage. The dropout voltage varies with the circuit configuration of ICs. Compared with a standard linear regulator, an LDO has a smaller dropout voltage. Simply stated, the operation can be performed with the input voltage closer to the output voltage as the dropout voltage is smaller. On the other hand, the dropout voltage is not important in an application where 5 V is generated from 12 V.

For example, Figure 3 shows the relation between the output current and temperature. It can be said that the dropout voltage is a parameter that varies with the output current and temperature. Therefore, if only the specifications at ordinary temperature are considered in the design, the circuit may not work at high temperature.

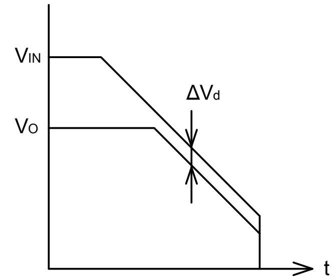


Figure 1. Dropout voltage

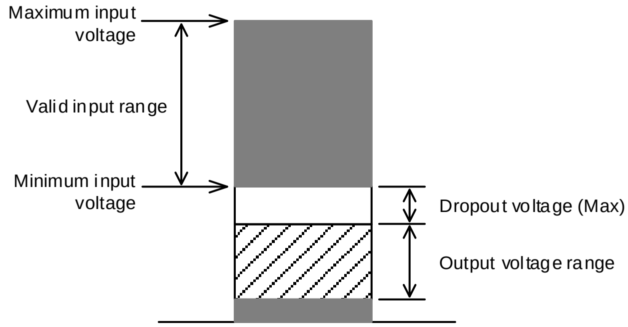


Figure 2. Relation between the input and output voltages

Study of dropout voltage and characteristics

The minimum value of the input voltage is determined by adding the output voltage to the dropout voltage at the load current to be used. At this time, the operation can work as DC, but the control performance is degraded. When there are fluctuations in the load, a large current cannot be supplied in a short period of time from input to output, as the dropout voltage is small. In other words, the load responsiveness will slow down. The slowness in responsiveness will also show up as a degradation in the PSRR characteristics. If only the minimum voltage amount of the dropout voltage is secured in order to focus on efficiency, the expected characteristics of the LDO will not be achieved. Increase the input voltage until the high-speed load responsiveness and PSRR performance is achieved, and find a trade-off between efficiency and each characteristic.

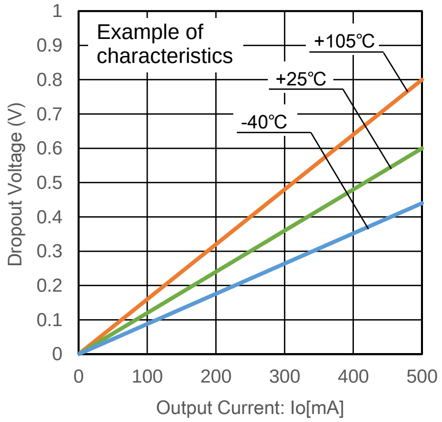
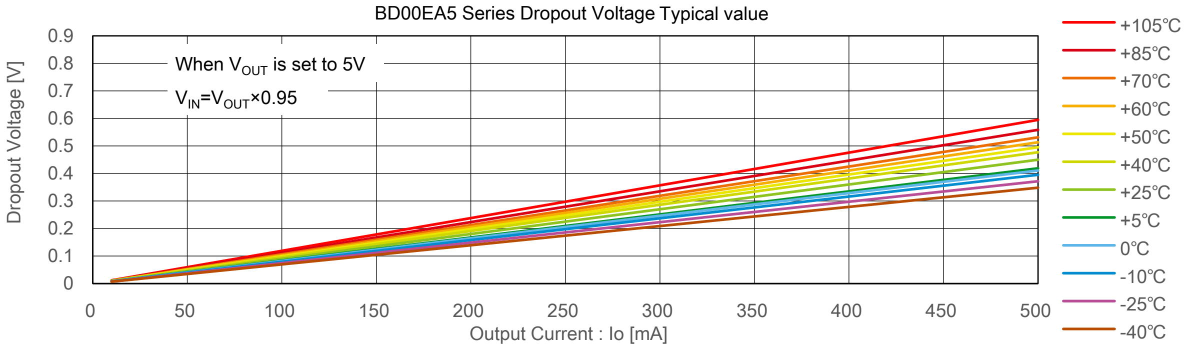


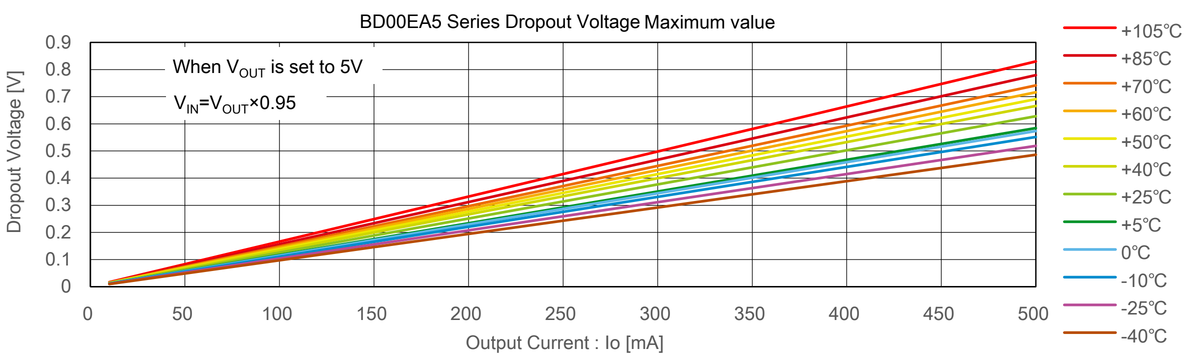
Figure 3. Relation with the output current and temperature

Typical value, when V_{OUT} is set to 5V



I_O [mA]	Dropout Voltage Typical Value [V]											
	-40℃	-25℃	-10℃	0℃	+5℃	+25℃	+40℃	+50℃	+60℃	+70℃	+85℃	+105℃
10	0.007	0.007	0.008	0.008	0.008	0.009	0.010	0.010	0.010	0.011	0.011	0.012
50	0.035	0.037	0.040	0.041	0.042	0.045	0.048	0.050	0.051	0.053	0.056	0.059
100	0.070	0.074	0.079	0.082	0.084	0.090	0.095	0.099	0.103	0.106	0.112	0.119
150	0.104	0.112	0.119	0.123	0.126	0.135	0.143	0.149	0.154	0.159	0.168	0.178
200	0.139	0.149	0.158	0.164	0.167	0.180	0.191	0.198	0.205	0.213	0.223	0.238
250	0.174	0.186	0.198	0.205	0.209	0.225	0.239	0.248	0.257	0.266	0.279	0.297
300	0.209	0.223	0.237	0.247	0.251	0.270	0.286	0.297	0.308	0.319	0.335	0.357
350	0.244	0.260	0.277	0.288	0.293	0.315	0.334	0.347	0.359	0.372	0.391	0.416
400	0.279	0.297	0.316	0.329	0.335	0.360	0.382	0.396	0.411	0.425	0.447	0.476
450	0.313	0.335	0.356	0.370	0.377	0.405	0.429	0.446	0.462	0.478	0.503	0.535
500	0.348	0.372	0.395	0.411	0.419	0.450	0.477	0.495	0.513	0.531	0.559	0.595

Maximum value, when V_{OUT} is set to 5V



I_O [mA]	Dropout Voltage Maximum Value [V]											
	-40℃	-25℃	-10℃	0℃	+5℃	+25℃	+40℃	+50℃	+60℃	+70℃	+85℃	+105℃
10	0.010	0.010	0.011	0.011	0.012	0.013	0.013	0.014	0.014	0.015	0.016	0.017
50	0.049	0.052	0.055	0.057	0.058	0.063	0.067	0.069	0.072	0.074	0.078	0.083
100	0.097	0.104	0.110	0.115	0.117	0.126	0.133	0.138	0.143	0.148	0.156	0.166
150	0.146	0.156	0.165	0.172	0.175	0.188	0.200	0.207	0.215	0.222	0.234	0.249
200	0.194	0.208	0.221	0.229	0.234	0.251	0.266	0.276	0.287	0.297	0.312	0.332
250	0.243	0.259	0.276	0.287	0.292	0.314	0.333	0.346	0.358	0.371	0.390	0.415
300	0.292	0.311	0.331	0.344	0.351	0.377	0.400	0.415	0.430	0.445	0.468	0.498
350	0.340	0.363	0.386	0.401	0.409	0.440	0.466	0.484	0.501	0.519	0.546	0.581
400	0.389	0.415	0.441	0.459	0.467	0.502	0.533	0.553	0.573	0.593	0.624	0.664
450	0.437	0.467	0.496	0.516	0.526	0.565	0.599	0.622	0.645	0.667	0.702	0.747
500	0.486	0.519	0.552	0.573	0.584	0.628	0.666	0.691	0.716	0.742	0.780	0.830

These values are “design reference values” that are necessary for circuit design, and the values are not guaranteed. Check the latest data sheet for the guaranteed values.

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