CAP300DG
CAPZero™-3

Zero³ Loss Automatic X Capacitor Rapid Discharge IC

**Product Highlights**
- Meets IEC 60335 X capacitor discharge of <34 V in <1 sec
- One part to cover X capacitor values up to 6 µF
- Blocks current through X capacitor discharge resistors when AC voltage is connected
- Automatically discharges X capacitors through discharge resistors when AC is disconnected
- Simplifies EMI filter design – larger X capacitor allows smaller inductive components with no change in consumption
- Only two terminals – meets safety standards for use before or after system input fuse
- >4 mm creepage on package and PCB
- Self supplied – no external bias required
- High common mode surge immunity – no external ground connection
- High differential surge withstand – 1000 V internal MOSFETs
- NEMKO and CB certification

**EcoSmart™— Energy Efficient**
- <5 mW consumption at 230 VAC for all X capacitor values

**Applications**
- All AC-DC converters with X capacitors of 100 nF up to 6 µF
- Appliances requiring ErP Lot 6 compliance
- Adapters requiring ultra low no-load consumption
- All converters requiring very low standby power
- Lossless generation of zero crossing signal

**Description**
When AC voltage is applied, CAP300DG blocks current flow in the X capacitor safety discharge resistors, reducing the power loss to less than 5 mW, or essentially zero³ at 230 VAC. When AC voltage is disconnected, CAP300DG automatically discharges the X capacitor by connecting the series discharge resistors. This operation allows total flexibility in the choice of the X capacitor to optimize differential mode EMI filtering and reduce inductor costs, with no change in power consumption.

Designing with CAP300DG is simply a matter of selecting the appropriate external resistor values for the X capacitor value being used to achieve the necessary time constant. The simplicity and ruggedness of the two terminal CAP300DG IC makes it an ideal choice in systems designed to meet ErP Lot 6 requirements.

**Component Table**

<table>
<thead>
<tr>
<th>Product ³</th>
<th>BV_{dss}</th>
<th>Total X Capacitance</th>
<th>Total Series Resistance² (R1 + R2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAP300DG</td>
<td>1000 V</td>
<td>200 nF to 6 µF</td>
<td>54 kΩ Minimum</td>
</tr>
</tbody>
</table>

Table 1. Component Table.

Notes:
1. IEC 62301 clause 4.5 rounds standby power use below 5 mW to zero.
2. Values are nominal. RC time constant is <1 second.

Figure 1. Typical Application – Not a Simplified Circuit.

Figure 2. SO-8 D Package.

www.power.com

This Product is Covered by Patents and/or Pending Patent Applications.
**Pin Functional Description**

The pin configuration of Figure 3 ensures that the width of the SO-8 package is used to provide creepage and clearance distance of over 4 mm.

![D Package (SO-8)](PI-5608-020515)

Figure 3. Pin Configuration.

Although electrical connections are only made to pins 2, 3, 6 and 7, it is recommended that pins 1-4 and pins 5-8 are coupled together on the PCB – see Applications Section.

**Key Application Considerations**

**Breakdown Voltage Selection**

The system configuration variables include the placement of the system MOV and X capacitor(s) as well as the differential surge voltage specifications of the application.

As shown in Table 1, the CAP300DG has a breakdown voltage of 1000 V. For applications where the system MOV is placed in position 1 (MOV POS1 in Figure 4), the CAP300DG will provide adequate voltage withstand for surge requirements of 3 kV or higher.

For MOV placement that is not directly across the X Capacitor1 (for example MOV POS2 in Figure 4) the CAP300DG devices can be used up to a surge specification of 1.5 kV. For differential surge voltage specifications of >1.5 kV it is recommended that the MOV is always placed in the location shown in Figure 4 as MOV POS1.

![Placement Options of MOV](PI-7508a-082019)

Figure 4. Placement Options of MOV.
**PCB Layout and External Resistor Selection**

Figure 5 shows a typical PCB layout configuration for CAP300DG. The external resistors in this case are divided into two separate surface mount resistors to distribute loss under fault conditions – for example where a short-circuit exists between CAP300DG terminals D1 and D2.

Resistors R1 and R2 should also be rated for 50% of the system input voltage again to allow for the short-circuitry of CAP300DG D1 to D2 pins during single point fault testing.

If lower dissipation or lower voltage across each resistor is required during fault tests, the total external resistance can be divided into more discrete resistors, however the total resistance must be equal to or greater than 54 kΩ.

**Safety**

CAP300DG meets safety requirements even if placed before the system input fuse. If a short-circuit is placed between D1 and D2 terminals of CAP300DG, the system is identical to existing systems where CAP300DG is not used.

With regard to open circuit tests, it is not possible to create a fault condition through a single pin fault (for example lifted pin test) since there are two pins connected to each of D1 and D2. If several pins are lifted to create an open circuit, the condition is identical to an open circuit X capacitor discharge resistor in existing systems where CAP300DG is not used. If redundancy against open circuit faults is required, two CAP300DG and R1 / R2 configurations can be placed in parallel.

**Discharge Operation**

To meet the safety regulations of appliances, when the AC supply is disconnected, CAP300DG will discharge the X capacitor to <34 V levels according to the above functional description.

---

Figure 5. Typical PCB Layout.
Absolute Maximum Ratings

- **DRAIN Pin Voltage**: 1000 V
- **DRAIN Peak Current**: 10.9 mA
- **Storage Temperature**: -65 °C to 150 °C
- **Lead Temperature**: 260 °C
- **Operating Ambient Temperature**: -10 °C to 105 °C
- **Maximum Junction Temperature**: -10 °C to 110 °C

Notes:
1. Voltage of D1 pin relative to D2 pin in either polarity.
2. The peak DRAIN current is allowed while the DRAIN voltage is simultaneously less than 400 V.
3. 1/16 in. from case for 5 seconds.
4. The Absolute Maximum Ratings specified may be applied one at a time without causing permanent damage to the product. Exposure to Absolute Maximum Rating conditions for extended periods of time may affect product reliability.

Thermal Resistance

Thermal Resistance: D Package:
- \( (\theta_JA) \): 160 °C/W (Single layer JEDEC PCB)
- \( (\theta_JC) \): 75 °C/W (Top)
- \( (\theta_JC) \): 40 °C/W (Bottom)

Notes:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Functions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC Removal Detection Time</td>
<td>( t_{DETECT} )</td>
<td>Line Cycle Frequency 47-63 Hz</td>
<td>22</td>
<td></td>
<td>31.4</td>
<td>ms</td>
</tr>
<tr>
<td>Drain Saturation Current(^{a,b})</td>
<td>( I_{SAT} )</td>
<td>CAP300DG</td>
<td>6.3</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Supply Current</td>
<td>( I_{SUPPLY} )</td>
<td>( T_A = 25 °C )</td>
<td>21.7</td>
<td></td>
<td></td>
<td>( \mu A )</td>
</tr>
</tbody>
</table>

Notes:
A. Saturation current specifications ensure a natural RC discharge characteristic at all voltages up to 265 VAC peak with the external resistor values specified in Table 1.
B. Specifications are guaranteed by characterization and design.
Typical Performance Characteristics

Figure 6. $I_{\text{supply}}$ vs. Temperature.
SO-8 (D Package)

Notes:
1. JEDEC reference: MS-012.
2. Package outline exclusive of mold flash and metal burr.
3. Package outline inclusive of plating thickness.
4. Datums A and B to be determined at datum plane H.
5. Controlling dimensions are in millimeters. Inch dimensions are shown in parenthesis. Angles in degrees.
Part Ordering Information

- CAP300DG
- Series Number
- Package Identifier
  - D  Plastic SO-8
- Package Material
  - G  GREEN: Halogen Free and RoHS Compliant
- Tape & Reel and Other Options
  - Blank  Standard Configurations
  - TL  Tape & Reel, 2.5 k pcs.
For the latest updates, visit our website: www.power.com
Power Integrations reserves the right to make changes to its products at any time to improve reliability or manufacturability. Power Integrations does not assume any liability arising from the use of any device or circuit described herein. POWER INTEGRATIONS MAKES NO WARRANTY HEREIN AND SPECIFICALLY DISCLAIMS ALL WARRANTIES INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF THIRD PARTY RIGHTS.

Patent Information
The products and applications illustrated herein (including transformer construction and circuits external to the products) may be covered by one or more U.S. and foreign patents, or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Integrations patents may be found at www.power.com. Power Integrations grants its customers a license under certain patent rights as set forth at www.power.com/ip.htm.

Life Support Policy
POWER INTEGRATIONS PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF POWER INTEGRATIONS. As used herein:

1. A Life support device or system is one which, (i) is intended for surgical implant into the body, or (ii) supports or sustains life, and (iii) whose failure to perform, when properly used in accordance with instructions for use, can be reasonably expected to result in significant injury or death to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

Power Integrations, the Power Integrations logo, CAPZero, ChiPhy, CHY, DPA-Switch, EcoSmart, E-Shield, eSIP, eSOP, HiperPLC, HiperPFS, HiperTFS, InnoSwitch, Innovation in Power Conversion, InSOP, LinkSwitch, LinkZero, LYTSwitch, SENZero, TinySwitch, TOPSwitch, PI, PI Expert, PowiGaN, SCALE, SCALE-1, SCALE-2, SCALE-3 and SCALE-iDriver, are trademarks of Power Integrations, Inc. Other trademarks are property of their respective companies. ©2020, Power Integrations, Inc.

For the latest updates, visit our website: www.power.com

<table>
<thead>
<tr>
<th>Revision</th>
<th>Notes</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Code A release.</td>
<td>08/19</td>
</tr>
<tr>
<td>C</td>
<td>Updated per Nemko and CB certification.</td>
<td>02/20</td>
</tr>
</tbody>
</table>

Power Integrations Worldwide Sales Support Locations

**World Headquarters**
5245 Hellyer Avenue
San Jose, CA 95138, USA
Main: +1-408-414-9200
Customer Service:
Worldwide: +1-650-635-64480
Americas: +1-408-414-9621
e-mail: usasales@power.com

**China (Shanghai)**
Rm 2410, Charity Plaza, No. 88 North Caohui Road
Shanghai, PRC 2000030
Phone: +86-21-6354-6323
e-mail: chinasesales@power.com

**China (Shenzhen)**
17/F, Hivac Building, No. 2, Keji Nan 8th Road, Nanshan District, Shenzhen, China, 518057
Phone: +86-755-8672-8689
e-mail: chinasesales@power.com

**Germany (AC-DC/LED Sales)**
Einsteinring 24
85609 Dornach/Aschheim
Germany
Tel: +49-89-5527-39100
e-mail: eurosales@power.com

**Germany (Gate Driver Sales)**
HellwegForum 1
59469 Ense
Germany
Tel: +49-2938-64-39990
e-mail: igtbdriver.sales@power.com

**India**
#1, 14th Main Road
Vasanthanagar
Bangalore-560052 India
Phone: +91-80-4113-8020
e-mail: indiasales@power.com

**Italy**
Via Milanese 20, 3rd. Fl.
20099 Sesto San Giovanni (MI) Italy
Phone: +39-024-550-8701
e-mail: eurosales@power.com

**Japan**
Yusen Shin-Yokohama 1-chome Bldg.
1-7-9, Shin-Yokohama, Kohoku-ku
Yokohama-shi,
Kanagawa 222-0033 Japan
Phone: +81-45-471-1021
e-mail: japansales@power.com

**Korea**
RM 602, 6FL
Korea City Air Terminal B/D, 159-6
Samsung-Dong, Kangnam-Gu,
Seoul, 135-728, Korea
Phone: +82-2-2016-6610
e-mail: koreasales@power.com

**Singapore**
51 Newton Road #19-01/05 Goldhill Plaza
Singapore, 308900
Phone: +65-6358-2160
e-mail: singaporesales@power.com

**Taiwan**
5F, No. 318, Nei Hu Rd., Sec. 1
Nei Hu Dist.
Taipei 11493, Taiwan R.O.C.
Phone: +886-2-2659-4570
e-mail: taiwansales@power.com

**UK**
Building 5, Suite 21
The Westbrook Centre
Milton Road
Cambridge
CB4 1YG
Phone: +44 (0) 7823-557484
e-mail: eurosales@power.com