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# Maximum Load: The Wrong Specification for Pulsed Power

Jerrad Choi
*Field Application Engineer*

# Agenda

- **Power Averaging:** Definition and Criteria
- **Power Configuration**: Typical Approach vs. Averaging Approach
- **Solution Sizing**: Capacitor & Power Supply Selection
- **Power Averaging:** Configuration Example
- Conclusions

# **Power Averaging:** Definition

- Configuring the power supply
  to deliver the average power to the load

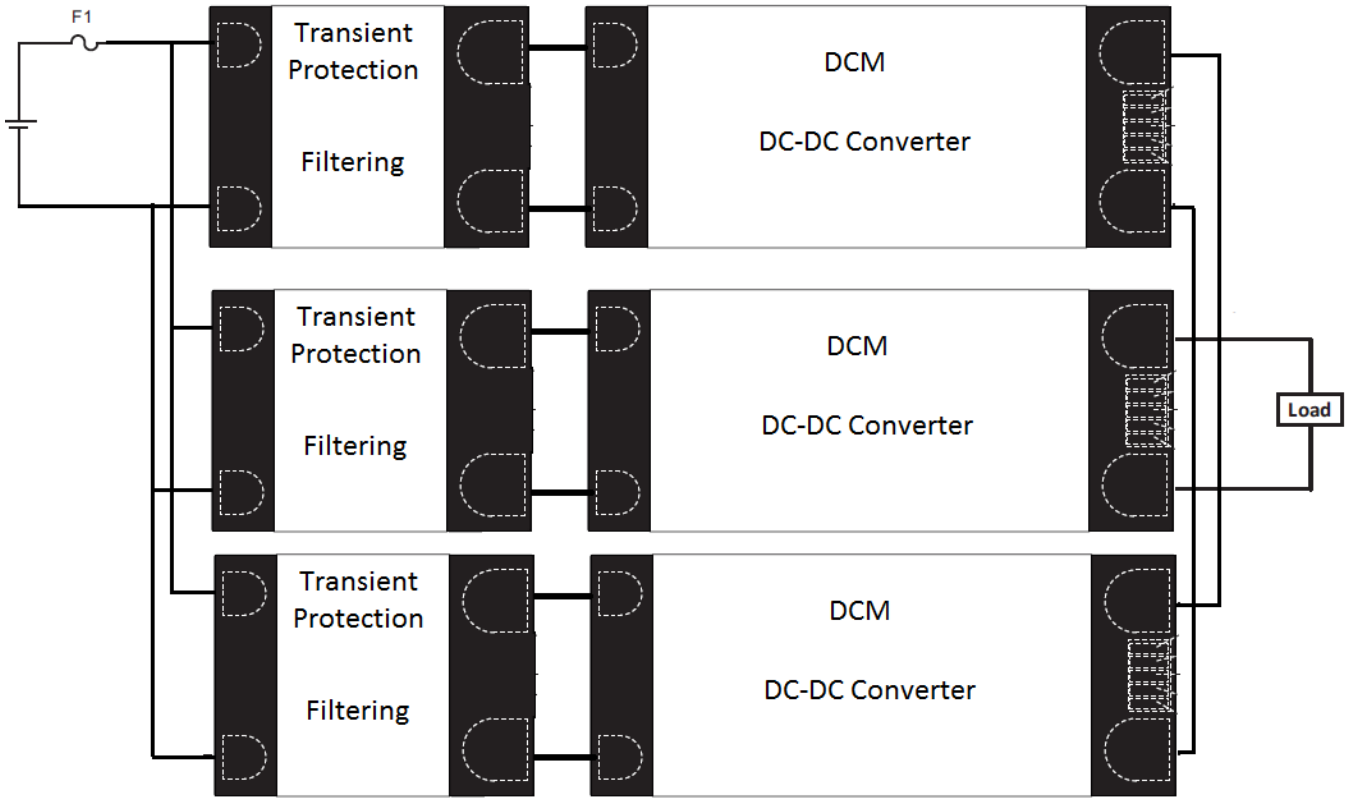
- A capacitor is used
  to deliver the peak power to the load

# **Power Averaging:** Criteria

- Periodic load
- The load has a wide input range
- The max on-time and min off-time are known
- Space and weight are critical

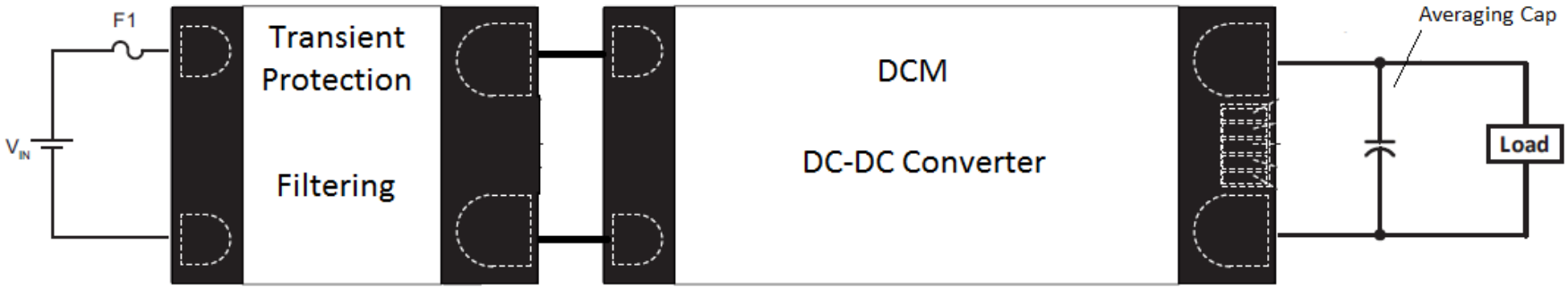
# Power Configuration: Typical Approach

## 900 Watt Periodic Load 25% Duty Cycle



# **Power Configuration:** Averaging Approach

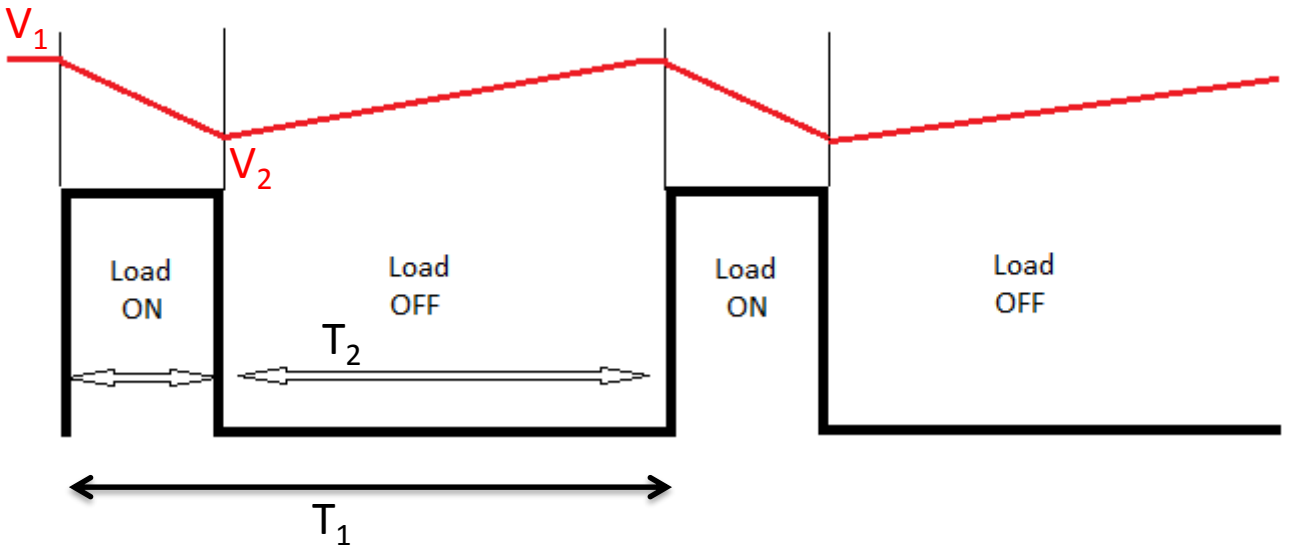
## 900 Watt Periodic Load 25% Duty Cycle



# **Solution Sizing:** Capacitor Selection

- Peak load power
- Maximum load on time
- Minimum load off time
- Load input voltage range

# **Solution Sizing:** Capacitor Selection




$$C = 2 \times \frac{P \times (T_1 - T_2)}{(V_1 - V_2)^2}$$

C = capacitor value

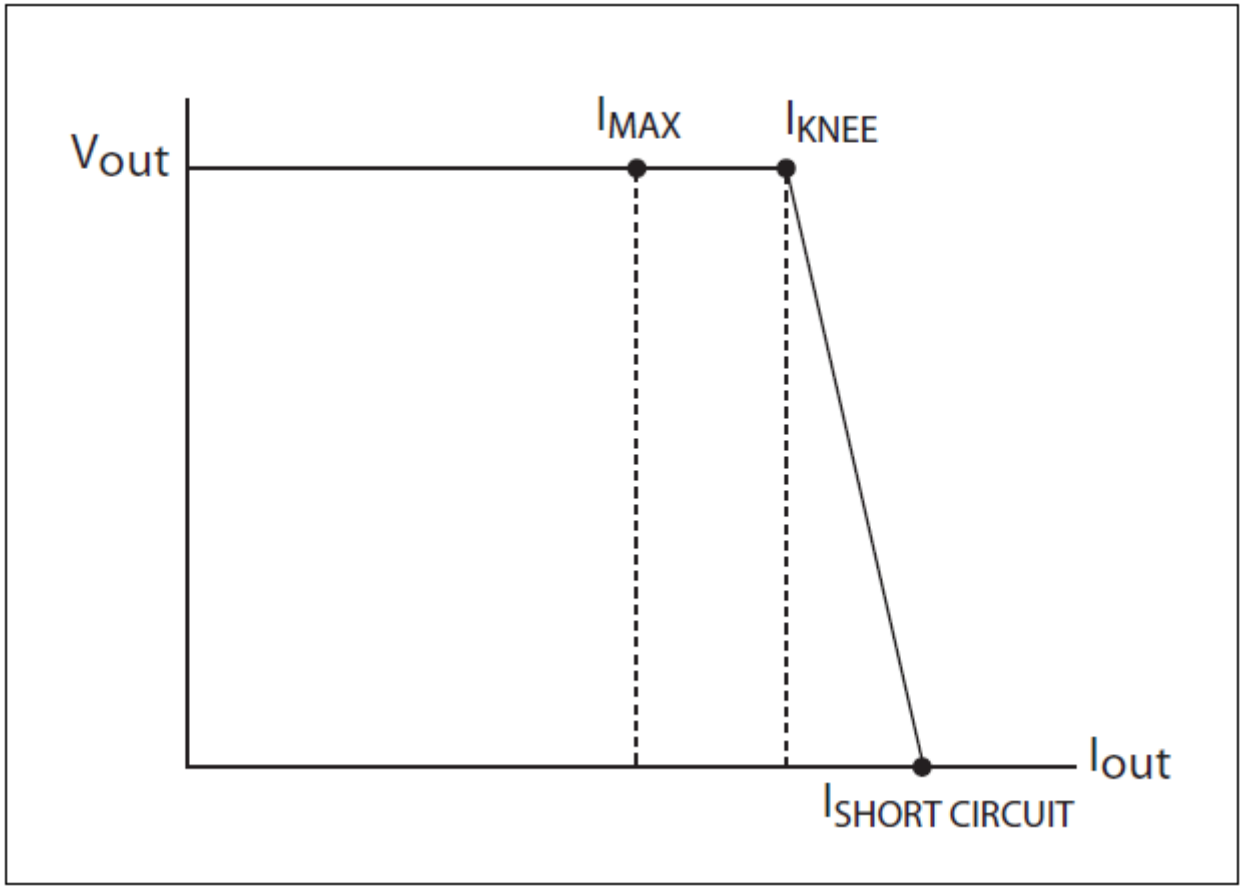
$T_1 - T_2$ = load ON duration

$V_1 – V_2$ = voltage drop at capacitor during load ON

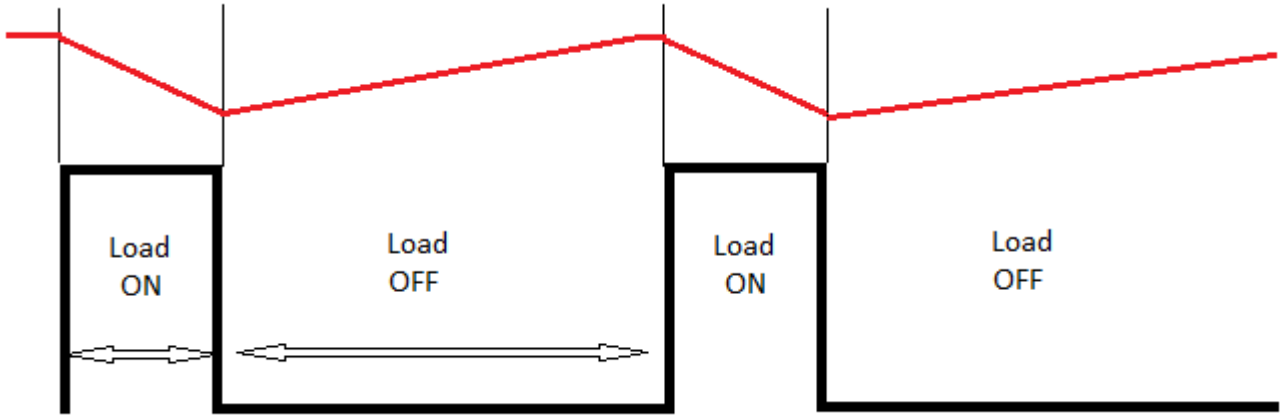
# **Solution Sizing:** Power Supply Selection

- Capable of recharging the capacitor to initial voltage
- **Must be** stable during operation
- **Must be** capable of operating in current limit
- **Must be** capable of operating in power limit

# **Solution Sizing:** Power Supply Selection

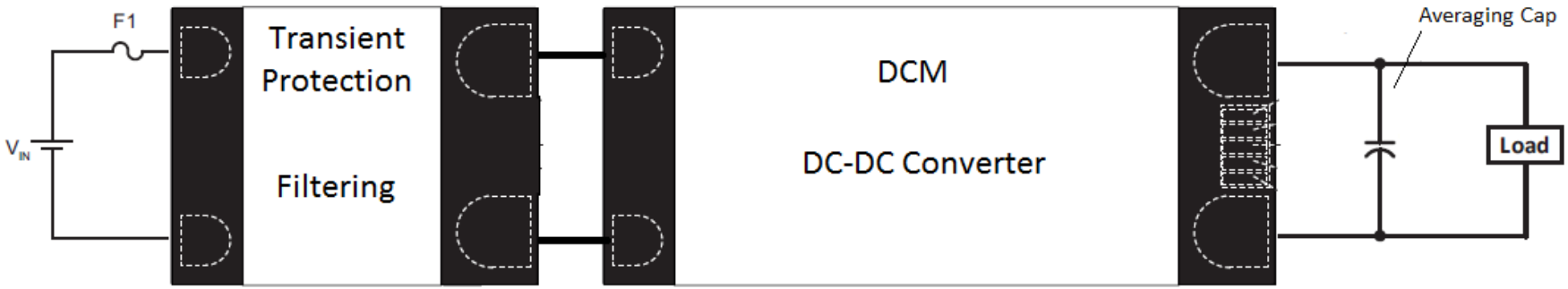


# **Solution Sizing:** Power Supply Selection

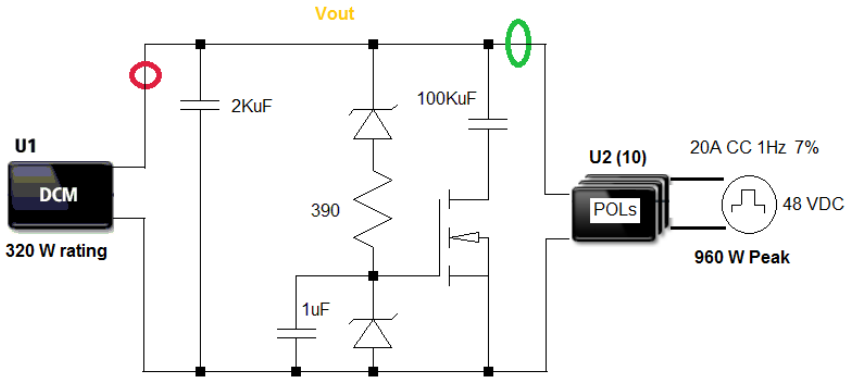


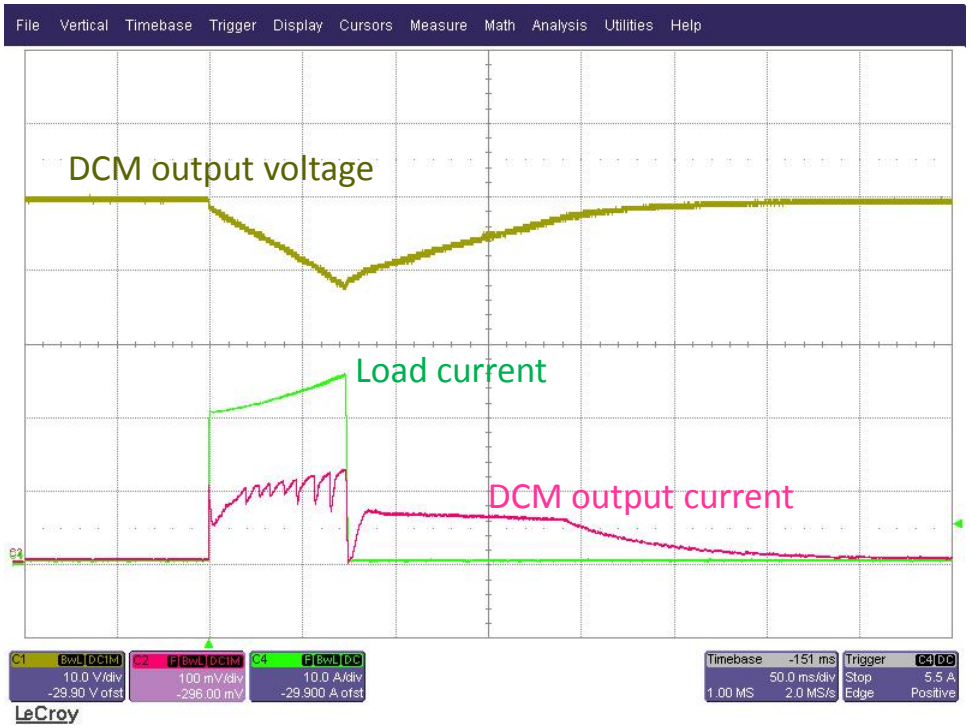

$$I = C \times \frac{dV}{dt}$$

# **Power Averaging:** Configuration



# **Power Averaging:** Example



## Power System Designer™

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***Vicor's Power System Designer provides system designers unprecedented flexibility to architect and optimize end-to-end power subsystems. Choose to find a solution for a single output or multiple outputs. Vicor's Power System Designer can do both.***

○ **Search for a single output solution**

◉ **Search for a multiple output solution**

**Enter**

### Power Requirements

**Input Specifications**

| Supply | Min (Vdc) | Nom (Vdc) | Max (Vdc) |
|---|---|---|---|
| ○ AC<br>◉ DC | 270 | 335 | 400 |

**Multiple Output Specifications**

| Output(s) | Min (V) | Nom (V) | Max (V) | Power/Current | Regulation | Isolation From Source | Output Return |
|---|---|---|---|---|---|---|---|
| Output 1 | | 48 | | ◉ Watts ○ Amps 225 | ◉ Regulated ○ Fixed Ratio | ☐ Required | -OUT1 |

Add Output | Reset | Search for a System ›

**View**

### Available Solutions

| Solution | Total Footprint ($cm^2$) | Front End Footprint ($cm^2$) | POL Footprint ($cm^2$) | Total Efficiency (%) | Front End Efficiency (%) | POL Efficiency (%) | Solution Price 1 Unit | Solution Price 500 Units | Solution Component Count | Figure of Merit |
|---|---|---|---|---|---|---|---|---|---|---|
| Solution 1 | 11 | 0 | 11 | 91.1 | 0.0 | 91.1 | $193.00 | $132.00 | 1 | Lowest Component Count<br>Lowest Price<br>Recommended Best Fit<br>Smallest Footprint |
| Solution 2 | 36 | 14 | 21 | 91.3 | 97.2 | 93.9 | $364.72 | $223.42 | 4 | Highest Operating Efficiency |

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Reference

## Your Entered Power Requirements

| Input Supply | Min (Vdc) | Nom (Vdc) | Max (Vdc) |
|---|---|---|---|
| DC | 270.0 | 335.0 | 400.0 |

| Output(s) | Min (V) | Nom (V) | Max (V) | Power/Current | Regulation | Isolation From Source | Output Return |
|---|---|---|---|---|---|---|---|
| Output 1 | 48.0 | 48.0 | 48.0 | 225.0 W | Regulated | N | -OUT1 |

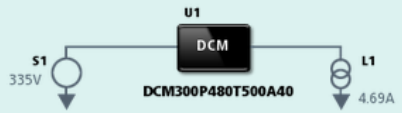
| Solution | Total Footprint ($cm^2$) | Front End Footprint ($cm^2$) | POL Footprint ($cm^2$) | Total Efficiency (%) | Front End Efficiency (%) | POL Efficiency (%) | Solution Price 1 Unit | Solution Price 500 Units | Solution Component Count | Figure of Merit |
|---|---|---|---|---|---|---|---|---|---|---|
| ◉ Solution 1 | 11 | 0 | 11 | 91.1 | 0.0 | 91.1 | $193.00 | $132.00 | 1 | Lowest Component Count<br>Lowest Price<br>Recommended Best Fit<br>Smallest Footprint |
| ○ Solution 2 | 36 | 14 | 21 | 91.3 | 97.2 | 93.9 | $364.72 | $223.42 | 4 | Highest Operating Efficiency |

View

### Solution 1 : Total System

*Click image to enlarge*

Analyze >



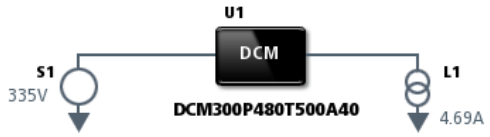

Display

### Outputs

◉ Output 1 (L1)

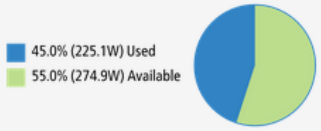
Analyze

### Output 1 (L1)




| Part Number | Quantity | Online Simulation |
|---|---|---|
| DCM300P480T500A40 | 1 | View |

**Power Utilization**



# Conclusion

## Power Averaging

1. **Saves** system weight
2. **Saves** system space
3. **Saves** system cost

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Thank You