SMART GRID AND E-METERING DESIGN CONSIDERATIONS

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Outline

» Smart Grid – What is it
» Smart Grid Eco-system
» Smart Meter Power Requirements
» TI solutions for Smart Meter SMPS
Smart Grid

- Power demand going up
  - Increasing cost
  - Grid handling - Challenge

- Increasing trend:
  - Active monitoring
  - Dynamic pricing of electricity and
  - Providing electricity in both directions with the intent of enabling consumers to use power in off-peak periods.

- Distributed Power generation – renewable energy
- Demand side electricity management – e-metering and smart appliances

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POWER FORUM

AVNET electronics marketing
Smart Grid Eco-system

Generation → Transmission/Distribution → Distributed Generation Monitoring → Consumption

Renewables: Distributed power, Fossil fuels

Data Concentrators, Power Monitoring

E-meters, Flow meters

Home energy, Gateways, Wireless sensor nodes

E-metering Power solutions Topic of today’s discussion
E-metering Power Supply Block diagram

- Bridge Rectifier
- PWM AC/DC
- System Power
- Metrology
- Processor
- Communications
Typical Power Requirements for Smart Meters

» Based on Switch mode power supplies
» Wide input voltage range
  » commercial 60VAC in to 580VAC
  » residential 85V to 480VAC
  » Up to 1200V DC for fault tolerance
» Typically power level is quite low, (typically 3 – 15W)
» Concerns on the EMI noise because of communication (PLC, Radio etc)
» Single and Multi-output designs
» Cost
» Component count

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TI Solutions for Smart Metering SMPS

» Existing Solutions
  » UCC28610: Green mode fly-back controller for Cascode Flyback
  » LM5021: Fixed frequency Fly-back
  » UCC28720: Industry first 700V Fly-back controller for driving bipolar power device with primary side regulation
UCC28610 – Cascode Flyback

**Features**

- Cascode operation enables operation with MOSFET or Bipolar power device
- Frequency and peak current modulation for optimum efficiency over the entire operating load
- Resonant valley turn-on for reduced EMI and switching loss
- No current sense resistor needed
- Advanced Over Current Protection limits input RMS current, controls maximum output current, and shuts down after a timed overload
- Thermal shutdown
- Brownout protection with maximum on time
- 8-pin SOIC package and PDIP

![Circuit Diagram](image-url)
Three phase E-meter AC/DC power supply

<table>
<thead>
<tr>
<th>Reference Design</th>
<th>TI Parts</th>
<th>$V_{in}$</th>
<th>Po</th>
<th>Vo/Io</th>
<th>Topology</th>
<th>Freq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three phase E-meter AC/DC power supply</td>
<td>UCC28610</td>
<td>AC65V-AC580V</td>
<td>10W</td>
<td>See below Table</td>
<td>Single end Flyback with BJT switcher</td>
<td>65kHZ or 100KHZ</td>
</tr>
</tbody>
</table>

- **UCC28610** Cascode structure makes it capable of directly driving BJT
- BJT has much lower cost and widely available

### Output Table

<table>
<thead>
<tr>
<th>Output</th>
<th>Voltage</th>
<th>Current</th>
<th>Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>5V</td>
<td>60mA</td>
<td>RS485</td>
</tr>
<tr>
<td>#2</td>
<td>13.5V</td>
<td>0.5A</td>
<td>GPRS/PLC</td>
</tr>
<tr>
<td>#3</td>
<td>12V</td>
<td>0.3A</td>
<td>System</td>
</tr>
</tbody>
</table>
LM5021 – Fixed Frequency PWM Controller

**Features**

- Low 25uA start up current
- 0.7A peak MOSFET Gate Driver
- Skip cycle mode
- Cycle by cycle Current Mode Control
- 80% Maximum Duty Cycle (LM5021-1) or 50% (LM5021-2)
- Programmable Fsw to 1MHz
- Externally Synchronizable
- Under-voltage lockout, soft start, Direct Opto Coupler Interface
- Packages: VSSOP-8 or PDIP-8

**Benefits**

- Minimizes power losses in start-up network
- Reduced power consumption during light loads
- High Current Capability
- Inherent Input voltage Feed Forward
- Supports Low Input Voltage and High Output voltage Combinations
- Optimize for Size or Efficiency
- Eliminates Beat Noise
**UCC28720 – Bipolar Driver**

**Constant Voltage, Constant Current PWM Controller with Primary-side Regulation**

**Features**

- Internal 700V HV Start-up JFET
- Primary Side Regulation (PSR) eliminates opto-coupler
- +/- 5% Voltage & Current regulation
- DCM with valley switching – reduced switching losses & maintains higher efficiency across the entire load
- 80 kHz max switching frequency – maintains peak current in transformer
- Current source drive output with scaled back current at lower power levels to reduce overdrive
- Patent pending frequency jitter scheme to ease EMI compliance
- Drive Output for Bipolar
- Protection Functions: Over Voltage, Low Line & Over Current - keeps primary and secondary component stresses in check
- Enables <10mW no load power
- SOIC-7 Package