Texas Instruments

System Power Design for Wall-Powered Application

Dec, 18th - 22nd, 2006
Kevin Lin
HPA Asia Market Development

Technology for Innovators™
Utility AC Line-Powered Systems

- AC Line
- Power Factor Correction
- PWM Controllers
- MOSFET Drivers
- Isolated Plug-in Module
- Fusion™ Digital Power Solutions

- Backplane

- Hot Swap and Power-over-Ethernet
- Non-isolated Plug-in Module POLA

- Power Switches
- USB Express Card/PCMCIA

- System Voltage

- DC/DC Controller
- DC/DC Converter
- Supply Voltage Supervisor
- Low Dropout Regulator

- USB Peripheral

- Hard Drive
- DSP
- Memory

48 V

48 V or 24 V DC Input

48 V or 24 V DC Input
Texas Instruments Power History

TI has Built the leading Power Management Business

- **Unitrode**
  - Power Supply Control
  - Battery Management
  - Power Interface
  - Reputation

- **Burr Brown**
  - Linear Regulators
  - Power Switches

- **Power Trends**
  - DC/DC Modules

- **Texas Instruments**
  - Process Technology
  - Manufacturing capacity
  - Sales Engineering force
  - Multiple Products

Technology for Innovators™
Content

- AC-DC PFC Introduction & Design Considerations
- Isolated PWM Solutions Introduction
- DC-DC Buck Design Software Introduction
What is Power Factor Correction?

Power Factor = \frac{\text{Real Power}}{\text{Apparent Power}}

Displacement PF = \cos(\phi)

Distortion PF = \frac{I_1}{I_{\text{total}}}

\[ \text{PF} = \frac{\cos(\phi)}{\sqrt{1 + \text{THD}}} \]
Benefits for PFC Circuits

- **Look at Available System Power:**
  - Assume 15A Breaker, 98% Rectifier, PF=0.55 (Typical Rectifier w/o PFC)
    \[ P = 120 \text{ Vrms} \times 15 \text{ A} \times 0.55 \times 0.98 = 970 \text{ W} \]
  - If PF = 0.99 Available Power = 1746 W
    Increases “Available” Line Power of 80%

Power Factor Correction is Widely Used

- Increases Current Available from Line
- Reduces 3rd Harmonic Distortion
- European Market Requirement
  - EN 61000-3-2 is following standard
- Enables Universal Line Operation w/o Mech-Switches
  - No need for switches to handle 120V vs... 240V line voltage
- Easier to Meet Hold-up Time Requirements
  - Energy is stored at a higher voltage of bulk capacitor
- Can make Second Stage Design Easier
**Power Factor Correction**

- **Simple Structure**
- **No Regulation**
- **Large Harmonics**
- **Low Power Factor**

- **Relative Complex**
- **Regulated Output**
- **Low Harmonics**
- **High Power Factor**
Boost Topology for PFC

- Most Popular Topology
- Vout > Vin Ideal for Universal Line
- Inductor Current = Input Current
- Many Control ICs Available

\[ D = \frac{t_{on}}{T_S}; V_L = D \times V_{in} = (1 - D) \times (V_{out} - V_{in}) \]

\[ V_{out} = (V_{in} + V_L); V_{out} = V_{in} \times \frac{1}{(1 - D)} \]

With Active PFC (PF= 1.0)

- Line Voltage - \( V_{in} \)
- Line Current - \( I_{in} \)
PFC Design Considerations

◆ **Trade-Off in between Performance and Total System Cost**
  - Optimum control method – Average Current Mode (ACM)
  - Simpler inexpensive control – Transition Mode or Critical Mode (DCM)
  - High-efficiency & performance – Zero Voltage Transition Mode (ZVT)

◆ **To Meet System Operation Requirement**
  - Higher PF and lower THD features – input current harmonics shall comply with IEC 61000-3-2.
  - PFC bulk capacitor design – hold up time; Iripple & voltage rating
  - Appropriate DC filtering capacitor – bypass current ripple noise
  - Power sequencing techniques for PFC & PWM stages
  - Safety and EMI requirements (conduction & radiation)

◆ **System-Board Space & Development Time Limitation**
  - Layout & placement issue – guideline
  - Thermal dissipation management

◆ **Stability and Reliability**
  - Protection features (OVP, SCP, UVP, OCP, OTP)
Transition Mode (TM/ DCM) PFC

- Constant On Time Control
- No Reverse Recovery Current on Boost Diode
- MOSFET ZVS Turn On is Possible
- Smaller Inductor Value
- Variable Switching Frequency
- Large Ripple Current Requires Larger Input Filter
- High Current Stress and High Conduction Loss on MOSFET
TM PFC Operation Principle

In each Switching Cycle

\[ I_{\text{avg}} = \frac{1}{2} I_{pk} = \frac{1}{2} \frac{V_{in}}{L} t_{on} \]

➢ Input Voltage is Sinusoidal, Inductor Average Current is also Sinusoidal if Ton is Constant
Switching Performance Estimation

Because of Resonance between Boost Inductor and MOSFET Junction Capacitor, Less Turn on Loss can be Realized

ZVS can be Achieved if Input Voltage is Less than Half of the Output Voltage

Less Turn On Loss is Expected Comparing with CCM Mode

- Because of Transition Mode Operation, No Reverse Recovery Loss
- Low cost, Standard Diode can be Used
- Because of Resonance between Boost Inductor and MOSFET Junction Capacitor, Less Turn on Loss can be Realized
- ZVS can be Achieved if Input Voltage is Less than Half of the Output Voltage
- Less Turn On Loss is Expected Comparing with CCM Mode
UCC3818A - 16 Pin CCM PFC Controller

- Input Voltage Sine Waveform
- Real Current Waveform
- Output Bus Voltage
- PWM Command
- Current Follow & Commend
- With Active PFC (PF= 1.0)
- Line Voltage - $V_{IN}$
- Line Current - $I_{IN}$
- Regulation & Constant Power

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**Average Current vs. TM Mode**

- Smaller Ripple Current
- Smaller RMS Current
- Smaller EMI Filter
- Constant Switching Frequency
- Suitable for High Power Level
- Large Switching Loss because of Diode Reverse Recovery Current
- High Cost Components to Maintain High Efficiency

- No Reverse Recovery Loss
- Low Cost Solution
- Soft Switching Possible
- Large Current Ripple, Increasing Conduction Loss and Switching Loss
- Large EMI Filter
- Variable Switching Frequency
- Normally Limited to Low Power Level
**Features**

- Slew Rate Comparator for Improved Transient Response
- Zero Power Detect to Prevent Over Voltage Conditions under Light Load
- Over Voltage Protection
- Open Feedback Protection and Enable Circuits
- Low Startup & Operating Current
- 750mA Source/ Sink Peak Gate Drive to Reduce Switching Losses
- UCC38051 Implements Lower UVLO Start-up Voltage for Compatibility (Typical application: AC Adapters)
- SOIC/ PDIP Package

**Applications**

- LCD-TV Power Board
- AC-DC Open Frame Power
- Mid to High Power AC Adapters

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**EVM and Sample**

ES: Now  
RTP: Now  

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UC2853A - 8 Pin CCM (ACM) PFC Controller

**Features**

- Complete 8-pin Power Factor Solution
- Reduced External Components
- 500mA Source/Sink Peak Gate Drive to Reduce Switching Losses
- Traditional Multiplier Line Voltage Compensation
- Internal 63KHz Synchronizable Oscillator
- Average Current Mode Control with Improved Noise Immunity
- Over Voltage Protection Comparator
- 8-pin PDIP (P) and (SOIC) (D) packages

**Applications**

- ATX PC Power
- LCD-TV and PDP-TV
- Hi-Power Adapters

**Diagram**

- Internal 63KHz Oscillator
- Over Voltage Protection
- Average Current Mode
- 500mA Source/Sink
- Traditional Multiplier Line Voltage Follow
- Maximum Vcc: 40V

EVM and Sample
ES: Now
RTP: Now
### UCC28510 -17 PFC/ PWM Combo Controllers

End Applications:
- Desktop and Server Computer Power Converters
- Distribution Power System Front Ends

<table>
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<tr>
<th>Feature</th>
<th>Benefit</th>
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<td><strong>PFC &amp; PWM Stages</strong></td>
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<tr>
<td>Combined PFC and PWM Power Stages in One Chip</td>
<td>Built-In Sequencing for Reduced complexity and Cost</td>
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<tr>
<td>Trailing Edge/Leading Edge Modulation</td>
<td>Minimize Ripple Current in Boost Capacitor</td>
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<tr>
<td>3A Sink / 2A Source Gate Drives</td>
<td>MOSFET Switching Efficiency</td>
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<tr>
<td>Multiple UVLO Options</td>
<td>Optimizes Start-up and Turn-off behaviors for Differing Biasing Schemes and Load Transient Requirements</td>
</tr>
<tr>
<td><strong>PFC Stage</strong></td>
<td></td>
</tr>
<tr>
<td>Transconductance Amplifier</td>
<td>Enhanced Transient Response</td>
</tr>
<tr>
<td>Improved Multiplier</td>
<td>Improved Power Factor and THD</td>
</tr>
<tr>
<td><strong>PWM Stage</strong></td>
<td></td>
</tr>
<tr>
<td>Programmable Max Duty Cycle</td>
<td>Protects Downstream Power Stage</td>
</tr>
<tr>
<td>1x:2x PFC:PWM Frequency</td>
<td>Flexibility for Different PWM Topologies</td>
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# Power Factor Correction Controllers

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<thead>
<tr>
<th>Specialized PFC Controllers</th>
<th>UCC3819/A</th>
<th>Avg. I-Mode</th>
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<tr>
<td></td>
<td>Tracking</td>
<td>Transition Mode</td>
</tr>
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<td></td>
<td>Boost PFC</td>
<td>ZVT</td>
</tr>
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<table>
<thead>
<tr>
<th>Zero Voltage Switching PFC</th>
<th>UC3855A/B</th>
<th>UCC28510-17</th>
<th>UCC28512</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Telecom Rectifiers, &gt;1kW</td>
<td>ZVT, High</td>
<td>PFC+PWM,</td>
<td></td>
</tr>
<tr>
<td>High Power)</td>
<td>Frequency</td>
<td>LEM/TEM,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prog.MaxDC</td>
<td></td>
</tr>
</tbody>
</table>

| PFC+PWM Combination        | UCC38500-03 | UCC28018/19 | UCC28070 |
| Controllers (Desktops,     |              |             |          |
| Flyback, Boost)            |              | Interleaved CCM PFC |          |
|                            |              |              |          |

| General Purpose Average    | UCC3817/18;  | UCC28018/19 | UCC28070 |
| Current Mode CCM PFC       | UCC3817A/18A |              |          |
|                            | BiCMOS      |              |          |
|                            | UC3854A, LEM|              |          |

| Transition Mode or         | UC2854A/B   | UC2853A     | UCC28060 |
| Boundary Mode (Adapters,    | Improved 16-pin CCM | 8-pin CCM <65KHZ | Interleaved TM PFC |
| Lighting Ballasts)         |            |             |          |

<table>
<thead>
<tr>
<th>UCC28050/51</th>
<th>Improved Transient Resp., Industry Std. Pinout</th>
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<th>Existing Products</th>
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- AC-DC PFC Introduction & Design Considerations
- Isolated PWM Solutions Introduction
- DC-DC Buck Design Software Introduction
## Isolated PWM Solutions by Topologies (1)

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<th>Topology</th>
<th>Controllers:</th>
<th>Application Notes:</th>
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<td><strong>FLYBACK</strong></td>
<td>UCC35701, UCC28220</td>
<td>Design of Flyback Transformers and Inductors (SEM400)</td>
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<td></td>
<td>UCC3800, UCC3809-1</td>
<td>Discontinuous Current Flyback Converter Design (SEM300)</td>
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<td></td>
<td>UCC38C42, UCC2881</td>
<td></td>
</tr>
<tr>
<td><strong>FORWARD</strong></td>
<td>UCC35701, UCC28220</td>
<td>25-W Forward Converter Design Review (SLUA276)</td>
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<td></td>
<td>UCC3800, UCC3809-1</td>
<td>Multiple Output Forward Converter Design (SEM1200)</td>
</tr>
<tr>
<td></td>
<td>UCC38C42, UCC2881</td>
<td></td>
</tr>
<tr>
<td><strong>2 SWITCH FORWARD</strong></td>
<td>UCC35701, UCC28220</td>
<td>150-W Off-Line Forward Converter Design Review (SEM400)</td>
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<td></td>
<td>UCC3800, UCC3809-1</td>
<td>Practical Considerations in Current Mode Power Supplies (SLUA110)</td>
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<tr>
<td></td>
<td>UCC38C42, UCC2881</td>
<td></td>
</tr>
<tr>
<td><strong>ACTIVE CLAMP FORWARD</strong></td>
<td>UCC2891, 2, 3, A, 7</td>
<td>Active Clamp and Reset Technique Enhances Forward Converter Performance (SEM1000)</td>
</tr>
<tr>
<td></td>
<td>UCC3580-1, UCC3584</td>
<td>Design Considerations for Active Clamp and Reset Technique (SEM1100)</td>
</tr>
</tbody>
</table>

**Note:**
- SEM400: Design of Flyback Transformers and Inductors
- SEM300: Discontinuous Current Flyback Converter Design
- SLUA276: 25-W Forward Converter Design Review
- SEM1200: Multiple Output Forward Converter Design
- SLUA110: Practical Considerations in Current Mode Power Supplies
- SEM400: 150-W Off-Line Forward Converter Design Review
- SEM1000: Active Clamp and Reset Technique Enhances Forward Converter Performance
- SEM1100: Design Considerations for Active Clamp and Reset Technique
**Isolated PWM Solutions by Topologies (2)**

### Controllers:
- **Half Bridge**
  - UCC28025
  - UCC3806
  - UCC3808A
  - UC3825A, B
  - UCC38083

- **Push Pull**
  - UCC28025
  - UCC3806
  - UCC3808A
  - UC3825A, B
  - UCC38083

- **Full Bridge**
  - UCC28025
  - UCC3806
  - UCC3808A
  - UC3825A, B
  - UCC38083

- **Phase Shift ZVT**
  - UCC3885
  - UC3879
  - UC3875

### Application Notes:

- **Half Bridge**
  - Practical Considerations in Current Mode Power Supplies (SLUA110)
  - Zero Voltage Switching Resonant Power Conversion (SLUA153)

- **Push Pull**
  - 1.5 MHz Current Mode IC Controlled 50-Watt Power Supply (SLUA053)
  - The UC3823A, B and UC3825A, B Enhanced Generation of PWM Controllers (SLUA125)

- **Full Bridge**
  - The UC3823A, B and UC3825A, B Enhanced Generation of PWM Controllers (SLUA125)
  - Practical Considerations in Current Mode Power Supplies (SLUA110)

- **Phase Shift ZVT**
  - Designing a Phase Shifted Zero Voltage Transition Power Converter (SEM900)
  - Design Review: 500-W, 40-W/in3 Phase Shifted ZVT Power Converter (SEM900)
# Analysis of Isolated PWM Topologies

<table>
<thead>
<tr>
<th>Topology</th>
<th>Power Level</th>
<th>Benefits</th>
<th>Drawbacks</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flyback</td>
<td>&lt;120 W</td>
<td>Low parts count&lt;br&gt;Single magnetic&lt;br&gt;Wide input-voltage range&lt;br&gt;Low output power</td>
<td>Poor efficiency at high power levels&lt;br&gt;High peak currents&lt;br&gt;Cross regulation problems&lt;br&gt;High-voltage power switch</td>
<td>Lowest</td>
</tr>
<tr>
<td>1 Switch Forward</td>
<td>150 W to 350 W</td>
<td>Medium output power&lt;br&gt;Good cross regulation with coupled inductor&lt;br&gt;Potential for &gt;50% duty-cycle</td>
<td>Limited input range&lt;br&gt;Power switch = 2 ( V_{\text{IN}} )&lt;br&gt;Transformer reset</td>
<td>Moderate</td>
</tr>
<tr>
<td>2 Switch Forward</td>
<td>400 W to 800 W</td>
<td>Medium output power&lt;br&gt;Power switch = ( V_{\text{IN}} )&lt;br&gt;Coupled inductor&lt;br&gt;Clamped transformer reset</td>
<td>Limited input range&lt;br&gt;High-side drive circuit required&lt;br&gt;50% duty-cycle limit&lt;br&gt;Larger inductor value</td>
<td>Moderate</td>
</tr>
<tr>
<td>Half-Bridge</td>
<td>300 W to 600 W</td>
<td>Medium output power&lt;br&gt;Power switch = ( V_{\text{IN}} )&lt;br&gt;Coupled inductor&lt;br&gt;Max duty-cycle &lt; 100%</td>
<td>Limited input range&lt;br&gt;High-side drive&lt;br&gt;Volt-second balance of transformer&lt;br&gt;Center-tapped secondary</td>
<td>Moderate</td>
</tr>
<tr>
<td>Push-Pull</td>
<td>50 W to 300 W</td>
<td>Good core utilization&lt;br&gt;Coupled inductor&lt;br&gt;Both switches ground referenced&lt;br&gt;Small output inductor&lt;br&gt;Max duty-cycle &lt; 100%</td>
<td>Power switch = 2 ( V_{\text{IN}} )&lt;br&gt;Limited input range&lt;br&gt;Center-tapped primary&lt;br&gt;Volt-second balance</td>
<td>Moderate</td>
</tr>
<tr>
<td>Full Bridge</td>
<td>&gt;800 W</td>
<td>Resonant switching can improve efficiency&lt;br&gt;Power switch = ( V_{\text{IN}} )&lt;br&gt;Coupled inductor&lt;br&gt;Very high output power&lt;br&gt;Max duty-cycle &lt; 100%&lt;br&gt;Efficient transformer design</td>
<td>4-power switches&lt;br&gt;Top FET drive&lt;br&gt;Volt-second balance</td>
<td>High</td>
</tr>
</tbody>
</table>
Switching frequency delay turn-on until both $F_{\text{max}}$ and $V_{\text{DS}}$ turn-on when resonates to minimum voltage and $I_{\text{DS}} = 0$

Switching frequency clamps variable within a range of 40 kHz to 130 kHz at maximum for higher line and/or lighter load conditions

Turn-off by peak current PWM control
**UCC28600 - QR Green Mode Controller**

**Features**
- Full Green Mode Capability in 8-Pins; Multi-Mode Operation Provides Advanced Energy Saving Capability
- Low Standby Current for System No-Load Power Consumption to 150mW
- Low Frequency (40KHz); Burst Mode for Better Efficiencies at No-Load Operation
- Programmable Over Voltage Protection, Line and Load; Over-Current Hiccup Restart Mode
- Green Mode STATUS Pin Disables PFC Function during Light Load for Energy Savings (Can Disable PFC)
- +1ATrueDrive Gate Drive Output

**Applications**
- Bias Supplies for LCD-Monitors, LCD-TV, PDP-TV, Set Top Boxes
- AC/DC Adapters & Off-line Battery Chargers
- Energy efficient power supplies up to 200W

**Diagram Details**
- Quasi-Resonant Mode Operation
- Green Mode STATUS Pin for PFC Disable
- Soft Start Programmable
- Low Standby Current; No-Load Power Consumption to 150mW
- Over Voltage Protection
- Pinless Demagnetizing Sense Circuit
- ZCS Detection
- +1A Sink/ 0.75A Source Gate Drive
- Current Feedback

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Benefits of Active Clamp Topology

- **Lossless Transformer Reset**
  - Magnetizing energy can be recycled
  - Higher efficiency

- **Higher Max Duty Cycle**
  - Possible to go beyond 50% duty cycle that reduces average switching current
  - Wider input voltage range and higher turn ratio
  - Current stresses on the primary side and voltage stresses on the secondary side can be reduced significantly

- **Switch Voltage is Clamped to Control Level, Resulting in Lower Stress Switching Device**

- **ZVS of the Main Switching is Possible, Leading to**
  - Lower switching losses
  - Higher frequency operation
  - Lower EMI/RFI

- **Transformer Waveform Allows for Easy Implementation of Sync-Rectification on the Secondary Side.**
Active Clamp Reset Technique

(a)

(b)

(c)

(d)
Why there is no ZVS when Main Switch turns on?

If the secondary side leakage is small the magnetizing energy necessary to turn D1 on will be diverted through D3 (Q3) during the reverse recovery of D4 (or Q4 reverse conduction).

After the reverse recovery of D4, the magnetizing energy will continue discharging through the loop shown in blue.

Since there is no energy to turn D1 ON, ZVS of Q1 does not take place.
UCC2891/2/3/4/7 – Active Clamp Controllers

Performance / Efficiency:
- ±2-A TrueDrive™ Gate Drives

Flexibility:
- Telecom bus compatible
- Built-in 110V Start-up Circuit
- Prog. Internal Slope Comp
- Bidirectional Oscillator Synchronization
- -40°C to +125°C Operation

Protection:
- Incorporates 0.5V Cycle by Cycle Current Limit
- 0.75V Second Level Hiccup Mode Threshold
- Accurate Input Line UV and OV Protection Monitors

<table>
<thead>
<tr>
<th>Product</th>
<th>Control</th>
<th>Gate Drive (Sink/Source)</th>
<th>HV Startup Circuit</th>
<th>SYNC</th>
<th>LINE Monitor</th>
<th>Auxiliary Output</th>
<th>CS1 Threshold</th>
<th>CS2 Threshold</th>
<th>Slope Comp</th>
<th>Max. Osc. Freq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCC2891</td>
<td>CMC</td>
<td>±2A TrueDrive™</td>
<td>✓</td>
<td>✓</td>
<td>✓ (UV)</td>
<td>P-Ch</td>
<td>0.75V</td>
<td>-</td>
<td>✓</td>
<td>1MHz</td>
</tr>
<tr>
<td>UCC2892</td>
<td>CMC</td>
<td>±2A TrueDrive™</td>
<td>-</td>
<td>✓</td>
<td>✓ (UV,OV)</td>
<td>P-Ch</td>
<td>1.27V</td>
<td>-</td>
<td>✓</td>
<td>1MHz</td>
</tr>
<tr>
<td>UCC2893</td>
<td>CMC</td>
<td>±2A TrueDrive™</td>
<td>✓</td>
<td>✓</td>
<td>✓ (UV)</td>
<td>N-Ch</td>
<td>0.75V</td>
<td>-</td>
<td>✓</td>
<td>1MHz</td>
</tr>
<tr>
<td>UCC2894</td>
<td>CMC</td>
<td>±2A TrueDrive™</td>
<td>-</td>
<td>✓</td>
<td>✓ (UV,OV)</td>
<td>N-Ch</td>
<td>1.27V</td>
<td>-</td>
<td>✓</td>
<td>1MHz</td>
</tr>
<tr>
<td>UCC2897</td>
<td>CMC</td>
<td>±2A TrueDrive™</td>
<td>✓</td>
<td>✓</td>
<td>✓ (UV,OV)</td>
<td>P-Ch or N-Ch</td>
<td>0.5V, 0.75V</td>
<td>✓</td>
<td></td>
<td>1MHz</td>
</tr>
<tr>
<td>UCC3580</td>
<td>VMC</td>
<td>+1A / -0.5A</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>N/A</td>
<td>400kHz</td>
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</tr>
</tbody>
</table>
## PWM Controllers (50W –>1KW)

### Existing Products

#### Technology for Innovators™

- **2006+**

### Soft-Switching, ZVT, ZVS
(Phase-Shifted Full-Bridge, Resonant, Active-Clamp Forward)

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<th>Controllers</th>
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<tr>
<td>UC3875-8 w/ Drivers</td>
<td>UCC3895 Adv. φ-Shift</td>
</tr>
<tr>
<td>UC3879 w/o Drivers</td>
<td>UCC2891-4 I-Mode Act-Clamp, HVStart</td>
</tr>
<tr>
<td>UC3861-8 Resonant Mode Controllers</td>
<td>UCC2897 Adv. I-Mode Act-Clamp, HVStart</td>
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### Dual-Complementary Outputs
(Push-Pull, Half-Bridge, Full Bridge, Current-Fed/Voltage-Fed Push-Pull, Two Independent Flybacks/Forwards)

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<th>Controllers</th>
<th>Functions</th>
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<tr>
<td>UC3846 UC3856</td>
<td>UCC3806</td>
</tr>
<tr>
<td>UC3825</td>
<td>UCC3825A/B</td>
</tr>
</tbody>
</table>

### Secondary Side Control; Post Regulation
(Forward, Buck, Synchronous Buck)

<table>
<thead>
<tr>
<th>Controllers</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC3524A UC3525A UC3526A</td>
<td>UCC3810 2 Independent Channels, ≤50%DC</td>
</tr>
<tr>
<td>UC3849 Avg. I-Mode w/ LS</td>
<td>UCC3808/A 8-pin P-P</td>
</tr>
<tr>
<td>UC3827 I/V-Fed P-P</td>
<td>UCC28089 Push-Pull Osc</td>
</tr>
<tr>
<td>UC3583 UC3854 SSPR</td>
<td>UCC28220/1 Interleaved Fwd/Flyback Prog MaxDC &gt;50%</td>
</tr>
<tr>
<td>UCC3827 I/V-Fed P-P</td>
<td>UCC2540 Sec. Side Sync-Buck, PGD™</td>
</tr>
<tr>
<td>UCC3824</td>
<td>UCC28089 Sec. Side Sync-Buck</td>
</tr>
</tbody>
</table>

### General Purpose Single Ended PWM
(Forward, Flyback, Buck, Boost, SEPIC, Cuk)

<table>
<thead>
<tr>
<th>Controllers</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC3824</td>
<td>UCC3960/61 Primary Side Start-up</td>
</tr>
<tr>
<td>UCC3800-5 UCC3813</td>
<td>UCC3580 SR Control</td>
</tr>
<tr>
<td>UC3839 Avg. I-Mode</td>
<td>UCC3884 Freq. Foldback, V*S Clamp</td>
</tr>
</tbody>
</table>

### Green-Mode PWM and Off-line Bias Regulators
(Flyback, Forward, QR Flyback)

<table>
<thead>
<tr>
<th>Controllers</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC3842-5 UC3842A-5A</td>
<td>UCC3888/89 Off-line Bias Regulators</td>
</tr>
<tr>
<td>UC3842-5 UC3842A-5A</td>
<td>UCC3581 Micro Power Green PWM</td>
</tr>
<tr>
<td>UC3842-5 UC3842A-5A</td>
<td>UCC3884 Freq. Foldback, V*S Clamp</td>
</tr>
</tbody>
</table>

### Miscellaneous

- UC28025 Interleaved Fwd/Flyback Prog MaxDC >50%
- UC3581 Micro Power Green PWM
- UC2540 Sec. Side Sync-Buck, PGD™
➢ AC-DC PFC Introduction & Design Considerations

➢ Isolated PWM Solutions Introduction

➢ DC-DC Buck Design Software Introduction
TPS5430/31 - High-Vin Non-Sync. Converter

Features

- 5.5~36V (5.5~23V) Input Range; 8pin Power Pad SOIC
- Integrated 110mΩ Rds(on) High Side Switch for 3A Continuous Output Current
- Adjustable Output Voltages down to 1.22V with 1.5% Accuracy
- Internal Compensation Allows Lower External Part Count
- Internal Slow-start, Under-voltage Lockout, Current limit, Thermal shutdown and Enable

Applications

- Consumer: LCD-TV, PDP-TV, P-DVD Player, Car-TV,
- IP-STB, Video Phone
- Industrial: Point-of-Load Regulation for 3.3/5V Logic
- Telecom CPE Side and Automotive Power Supplies

5.5V~36V (5.5~23V) Input Voltage Range

110mΩ Rds(on) Continuous 3A Output

Down to 1.22V & Reference with 1.5% Accuracy

Voltage Feed Forward

Switching Frequency Fsw: 500KHz

Enable ON/OFF Control

Internal Bootstrap Diode

Internal Compensation & Slow Start

Technology for Innovators™

TEXAS INSTRUMENTS
Design Tool (Software) Introduction

Designer Software Tool:

- **TI Web** – [power.ti.com](http://power.ti.com)

Design Software Includes:

- Completed Circuitry, Components Value and Database
- Power Specification & Key Parts Stress Analysis
- Loop Response & System Stability Analysis
- Efficiency Curve & Bill of Material
- PCB & Power PAD Layout Guideline

TPS40K Design Software

SWIFT Design Software

Technology for Innovators™
Thanks for Your Time!

Website: power.ti.com