A novel resonant topology for offline power conversion enabled by advanced mixed signal control

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Topics

Market perspective
- Current solutions

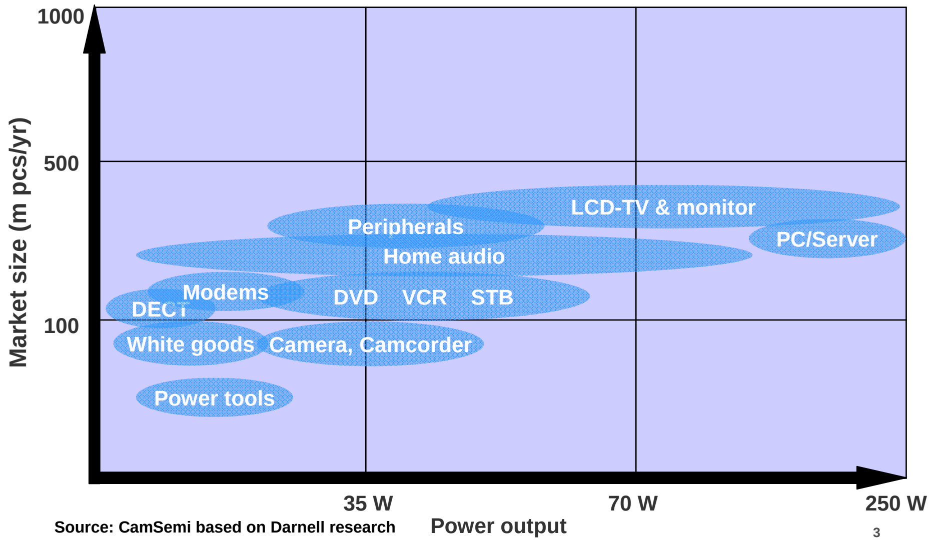
Introduction to Resonant Discontinuous Forward Converter (RDFC)
- Modes of operation
- Key switching waveforms
- EMI performance
- Standby and efficiency

Advanced mixed signal controller
- Analogue and digital architecture

Summary

Market perspective

CamSemi



Source: CamSemi based on Darnell research

Current solutions

CamSemi

Iron-cored linear transformers

- × Poor efficiency
- × Poor standby performance
- × Rising cost of materials especially copper
- ✓ Low EMI

Ringing choke converters

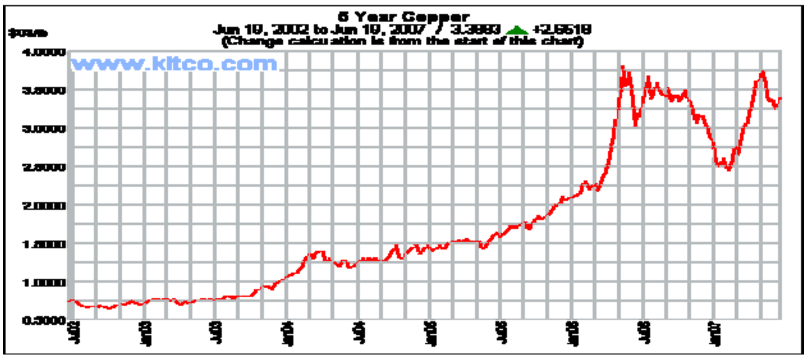
- × High BoM count/cost
- ✓ Universal input and Vreg but not always a requirement
- ? EMI can be difficult to resolve

Fly-back Converters

- × High cost
- ✓ Universal input, Vreg
- × EMI difficult

Rising raw material costs

Copper prices ($) 2002 - Jun 2007



RDFC benefits

Resonant Discontinuous Forward Converter offers:

- High efficiency and low standby from:
  - Resonant operation
  - Zero voltage switching
  - Multi-mode controller operation
- Low EMI due to resonant operation
- Low system cost from:
  - Use of Bipolar switch
  - Smaller transformer
  - Elimination of Y capacitor & simpler filtering for radiated EMI
- Low BoM count through:
  - Nature of topology
  - Feature integration into controller e.g. current limit
- Lower cost replacement linear transformer applications
  - Single rail input
  - ‘Static’ applications

RDFC topology

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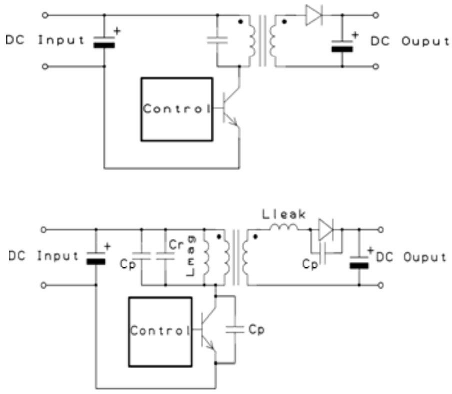
Forward converter
- Without freewheel diode or output choke

Leakage inductance and capacitance

Turns ratio
- Determines output voltage

Resonant circuit
- Determines switching frequency

Low EMI



Modes of operation

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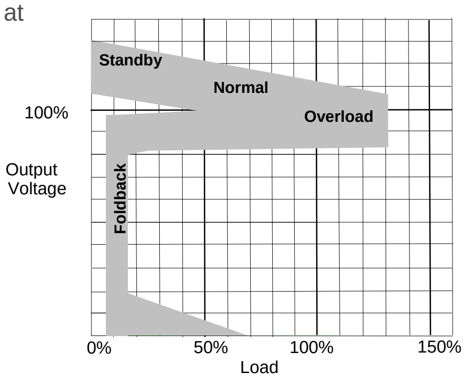
Standby
- Reduces power consumption at low loads

Normal
- Fully resonant waveform

Overload
- On-time terminated early to reduce output voltage

Foldback
- Reduces on/off duty
- Power burst



Resonant topology

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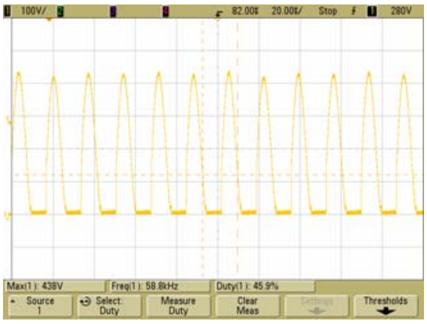
Half sine wave has minimal high frequency content
- Results in low EMI

Natural jitter
- As ‘DC’ rail on bulk capacitor varies, the resonant frequency shifts slightly
  = further EMI improvement

Zero voltage switching
- Negligible switching loss allows use of low cost bipolar transistor



EMI performance

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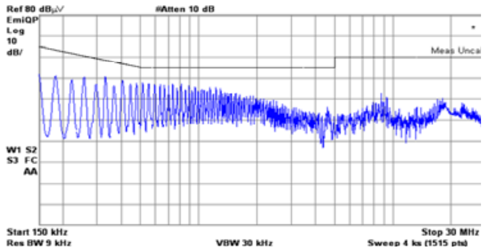
Allows removal of Y capacitor
- Possible up to 20 W

Output diode
- The turn-off may need a small snubber in some applications

Care with layout
- As always layout and transformer construction requires care and attention



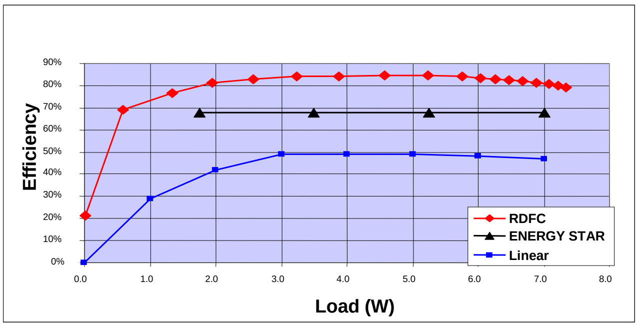
Standby and efficiency

Standby performance

- 100 mW

Average efficiency

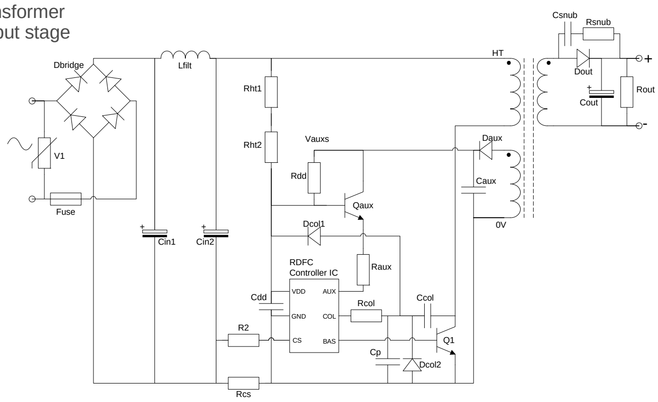
- 82 % for 7 W unit
- 90 % for 36 W unit



Circuit

Typical schematic for a 12 W application

- Standard input and small pi filter
- Boot strap circuit
- Auxiliary circuit
- Base drive
- Transformer
- Output stage



Advanced mixed signal control

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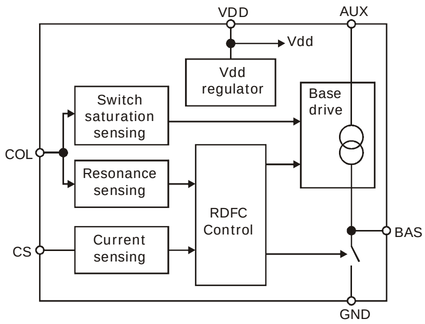
- Digital filtering for small noisy analogue signals
- Automatic lock to transformer resonant frequency
  - no internal oscillator trimming
- Resonance sensing to control duty cycle
- Current sensing to control modes (on/off duty)
- Over voltage/current protection for switch and transformer



- PID base drive controller
- Internal Vdd regulator allows low cost 3.3 V process usage

Comparative benefits summary

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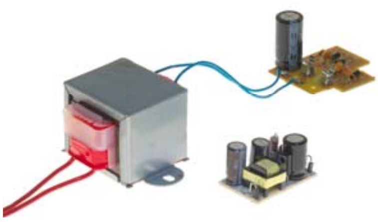

	SMPS	RCC	Linear	RDFC
Cost	Red	Orange	Orange	Green
Size	Green	Green	Red	Green
Voltage reg	Green	Green	Red	Orange
Current reg	Green	Green	Red	Orange
Universal input	Green	Orange	Red	Red
Standby	Green	Orange	Red	Green
Efficiency	Green	Green	Red	Green
Safety	Orange	Orange	Green	Green
EMI	Red	Red	Green	Orange
Protection	Green	Orange	Red	Green
Over voltage	Red	Red	Green	Green

Thank you