CogniPOWER
power smarter

# New Techniques for Achieving Ultra-Low Standby Current


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Founder and President

# *Vampire Power Differentiates SMPCs*

Market and regulatory pressures demand lowered standby power in Switched Mode Power Converters (SMPCs)

Vampire power reduction is most pressing for always-on power converters such as standby supplies, IoT applications, and wall chargers, which tend to be left plugged in even when not in use

Adding circuitry for vampire power reduction adds cost, size, and another potential point of failure

We favor vampire power reduction through simplification

# *Start with DPR - Simpler AC/DC Topology*

Demand Pulse Regulation is a new approach for low-power AC/DC supplies

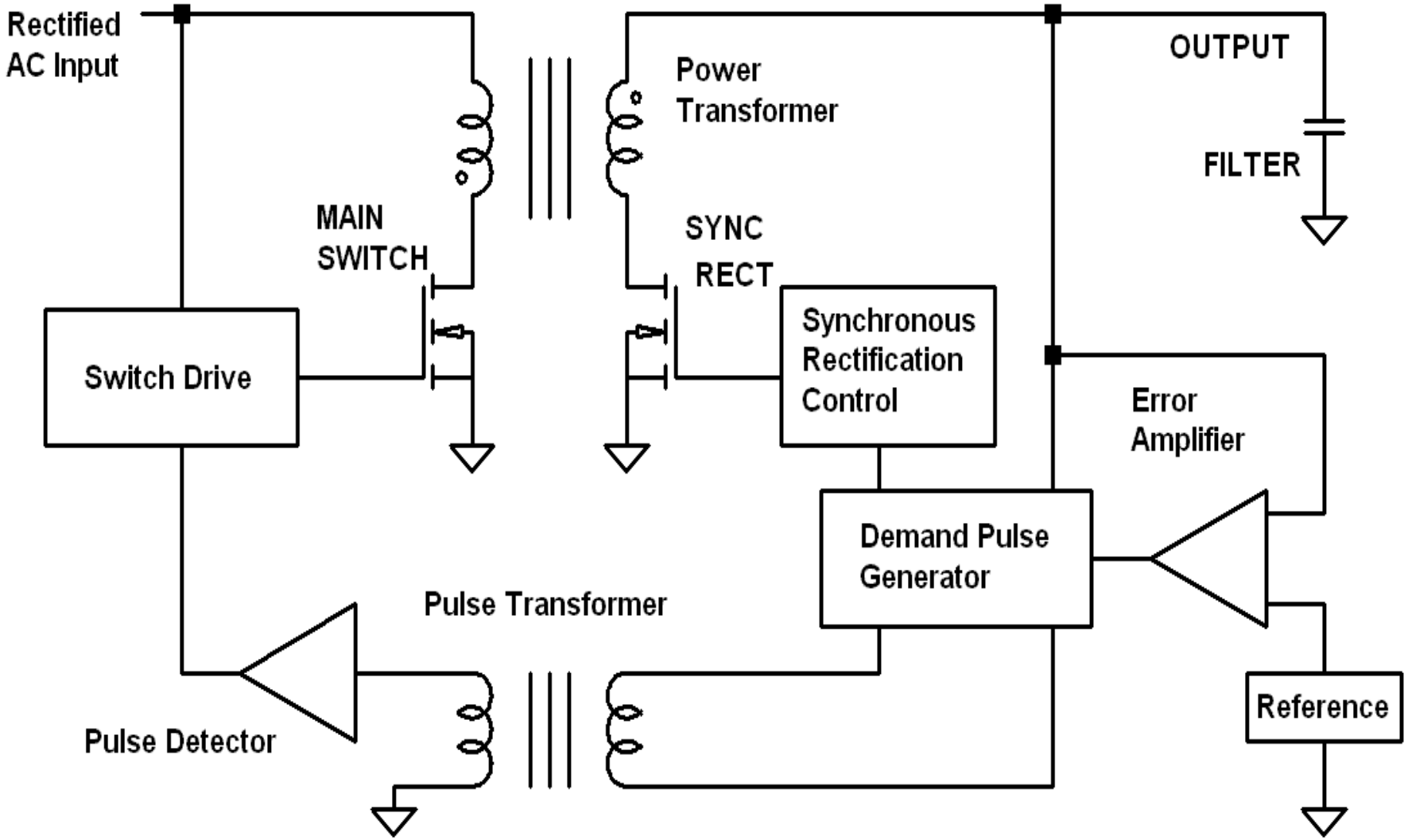
DPR provides the simplest, most robust structure yet devised for controlling such power converters

Most of the control is on the secondary side, where the electrical environment is easier to deal with

Regulation and transient response are uncompromised and digital interfacing is easy

DPR converters maintain regulation down to zero load without adding complexity or a standby mode

# Block Diagram of DPR Power Converter



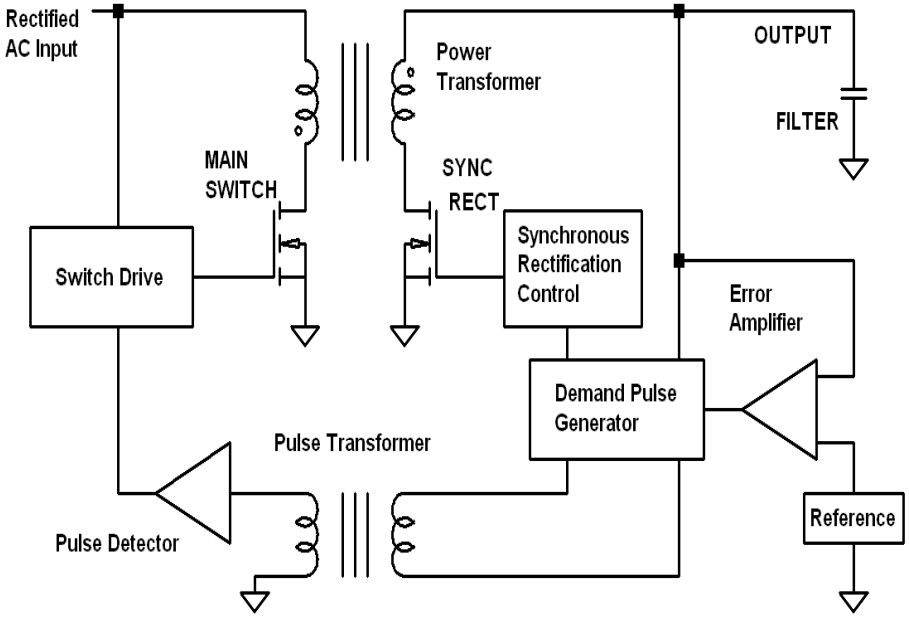
# *DPR Operation Summary*

The primary-side switch is turned on by demand pulses sent through the pulse transformer

The primary-side switch is turned off by the switch drive control on the basis of the primary current or time

The decision to turn on the switch is made at the optimum point through a simple comparison

The only information that needs to cross the barrier is an instant in time



# *DPR Vampire Power and Efficiency*

Standby power can be held to under 400 microwatts

Measured efficiency of a 10-volt output prototype:

**95.6% at 12.5% of full load**

Newer designs exceed 96% efficiency at 5 volts output from 10% to 100% of full load

Efficiency holds up at low load because of the minuscule no-load power consumption

Secondary-side control enables simpler, more efficient, synchronous rectification as an added bonus

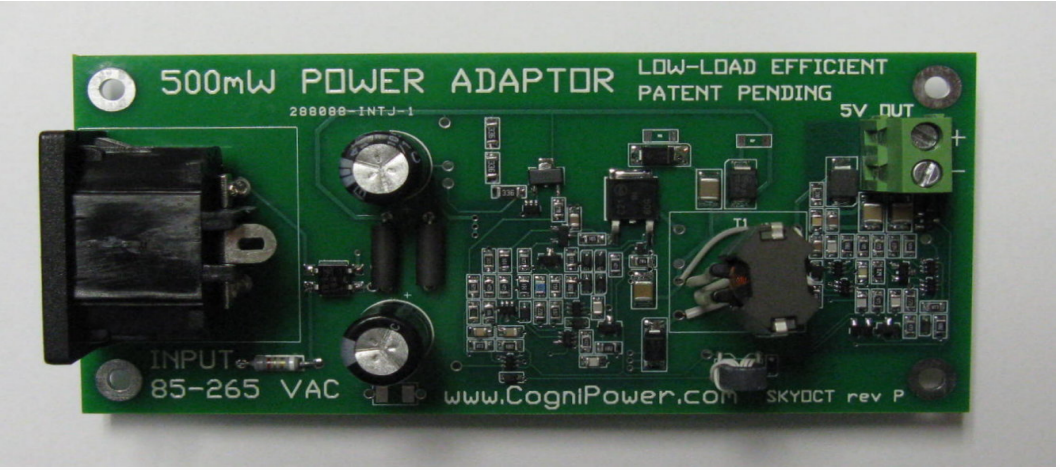
# *Digital Interfacing*

Because the regulation intelligence resides on the secondary side, digital interfacing is straightforward

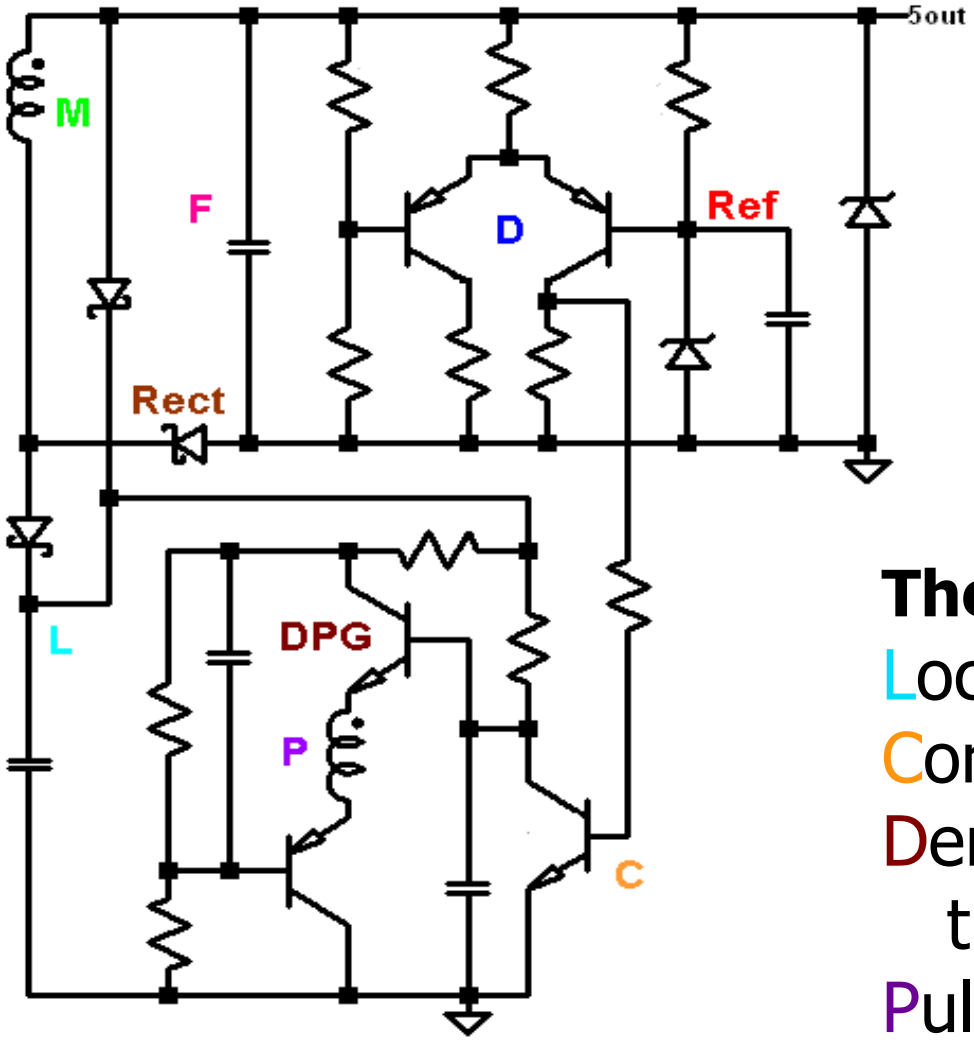
Additional communication across the isolation barrier is not required when adding digital protocols

There is no compensated feedback loop for regulation so the output can be set to an arbitrary, digitally chosen voltage

The key is the secondary-side circuitry



# *Actualized Secondary-Side DPR Controller*




**The upper block:**

Reference

Differential error amp

Main transformer secondary winding

Rectifier and Filter

**The lower block:**

Local power supply

Control from error amp

Demand Pulse Generator trigger circuit

Pulse transformer primary

# *Functions Provided by the DP Generator*

The DPG makes a very fast current pulse from a slowly changing error signal, while using practically no power

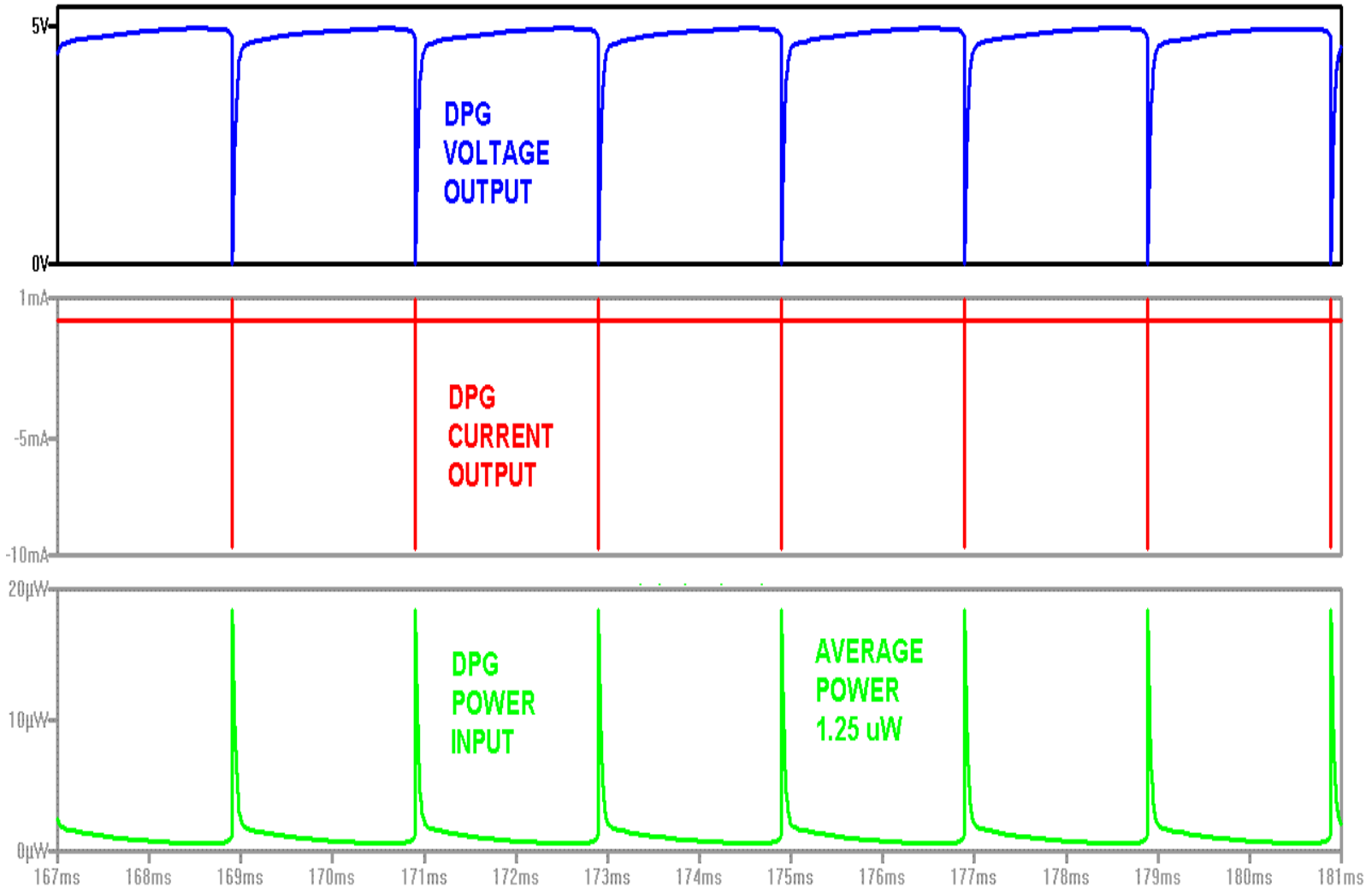
That very fast edge propagates easily through a tiny, inexpensive, non-critical pulse transformer

The DPG sets the maximum frequency of operation

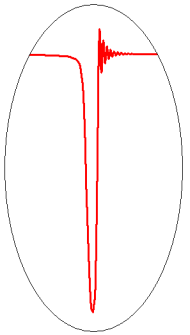
The DPG output frequency is in proportion to the magnitude of the error signal, allowing smooth operation, even into and out of continuous conduction

And, the DPG itself does not require regulated power

# Demand Pulse Generator Waveforms




10mA pulse



40ns wide

# *Summary of DPR Advantages*

Ultra-low vampire power enables unmatched low-load efficiency

No slow, power-hungry, aging-prone optocouplers

No need for measuring reflected voltages, which relieves demands on transformer construction that conflict with maximizing efficiency

Advance notice from secondary-side control enables simpler, more efficient synchronous rectification

Simple, efficient circuitry means less waste heat, smaller size, higher reliability, and **lower cost**

# *Uses for DPR Power Converters*

Any device that includes circuitry that is always on can benefit from lower standby power, including:

- USB chargers
- IoT
- Computer standby supplies
- Smart appliances
- Smart LED lighting
- TVs and other equipment turned on by a remote
- Communications infrastructure

# *Other Uses for the DPG Trigger Circuit*

A buffer circuit can be made from a pair of DPG trigger circuits

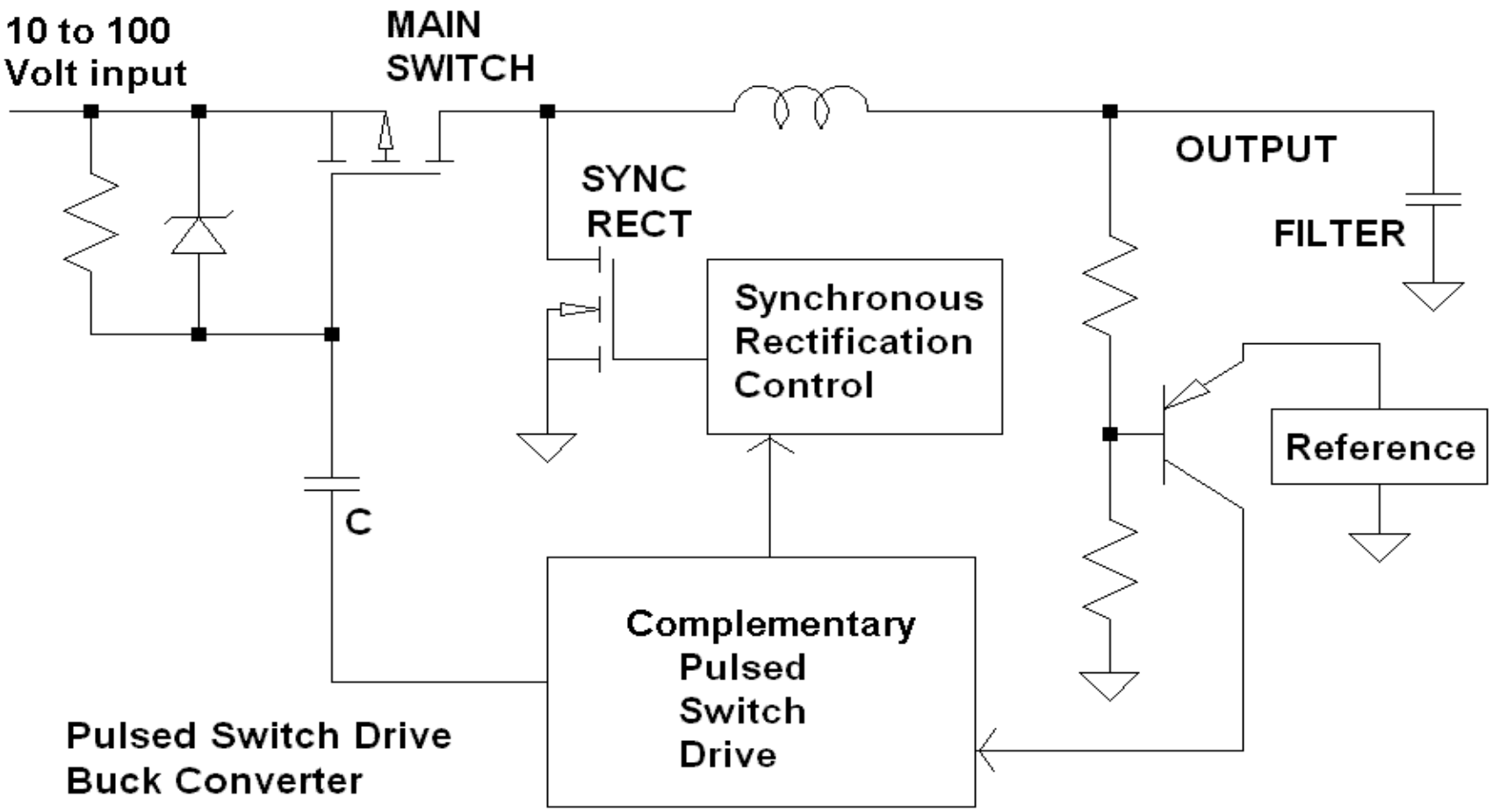
The buffer output can slew rapidly up or down due to the fast, controllable current pulses

Power consumption is minuscule, even with a very slowly changing input signal

Such a buffer with enhanced drive current can directly drive a power FET to achieve minimal switching losses

A pulsed switch drive buck converter illustrates the technique

# *Ultra-low Vampire Power Buck Converter*




Main switch ON time can be constant or modulated

# *Complementary Pulsed Switch Drive, Detail*

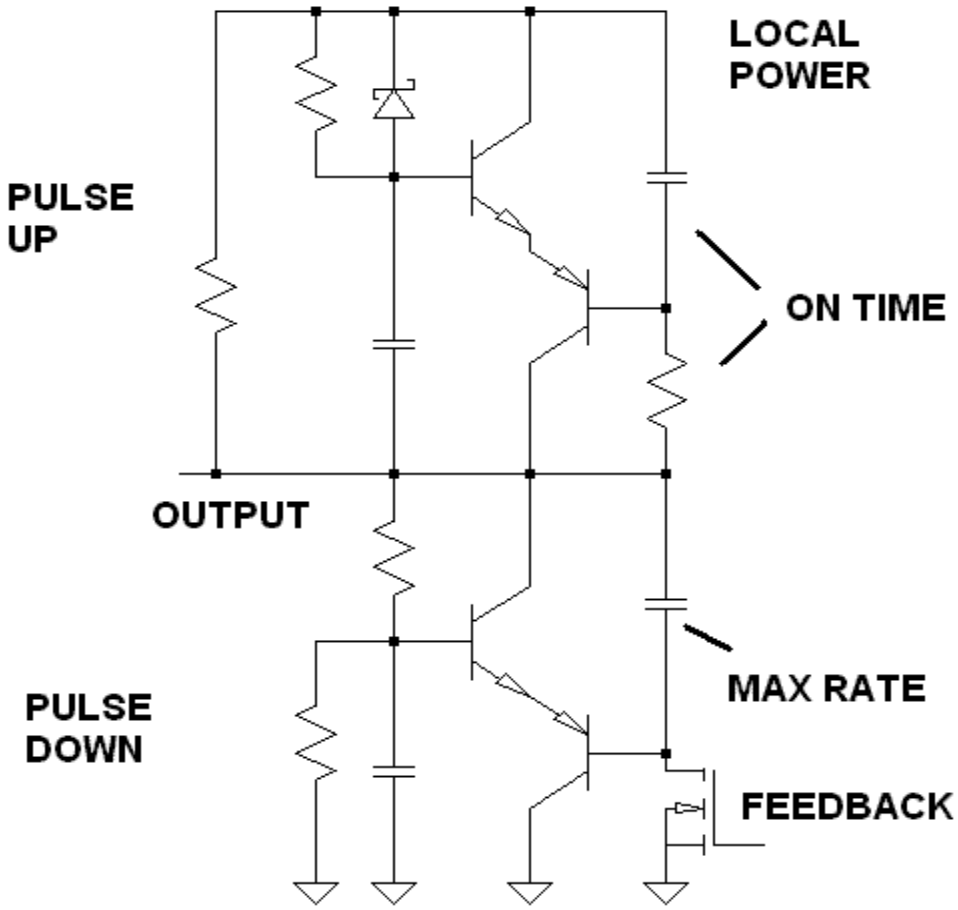
Fast, tunable edges

No need for well-regulated local power

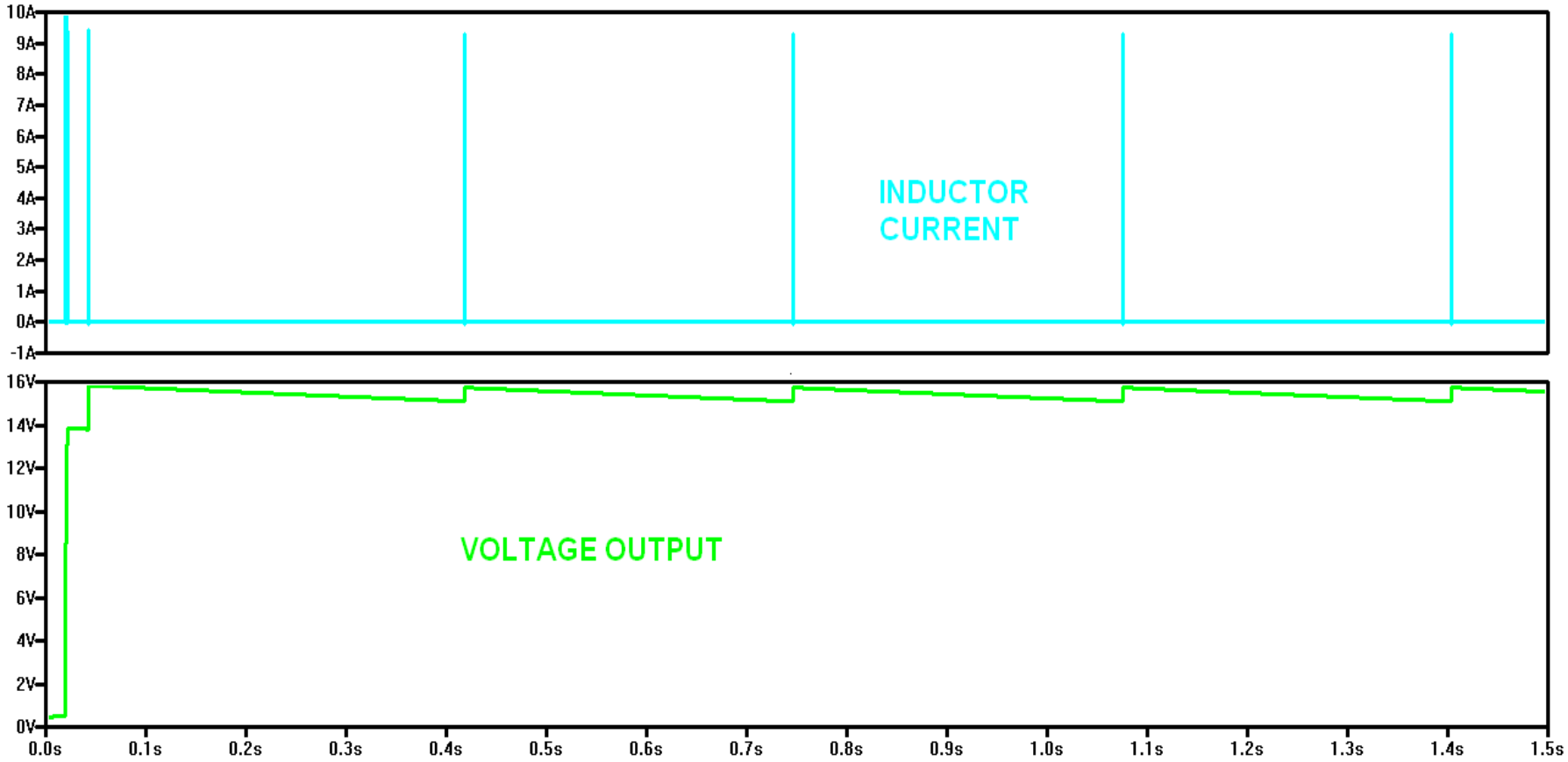
Intrinsic max rate control

Minuscule standby power

Newly patented technology



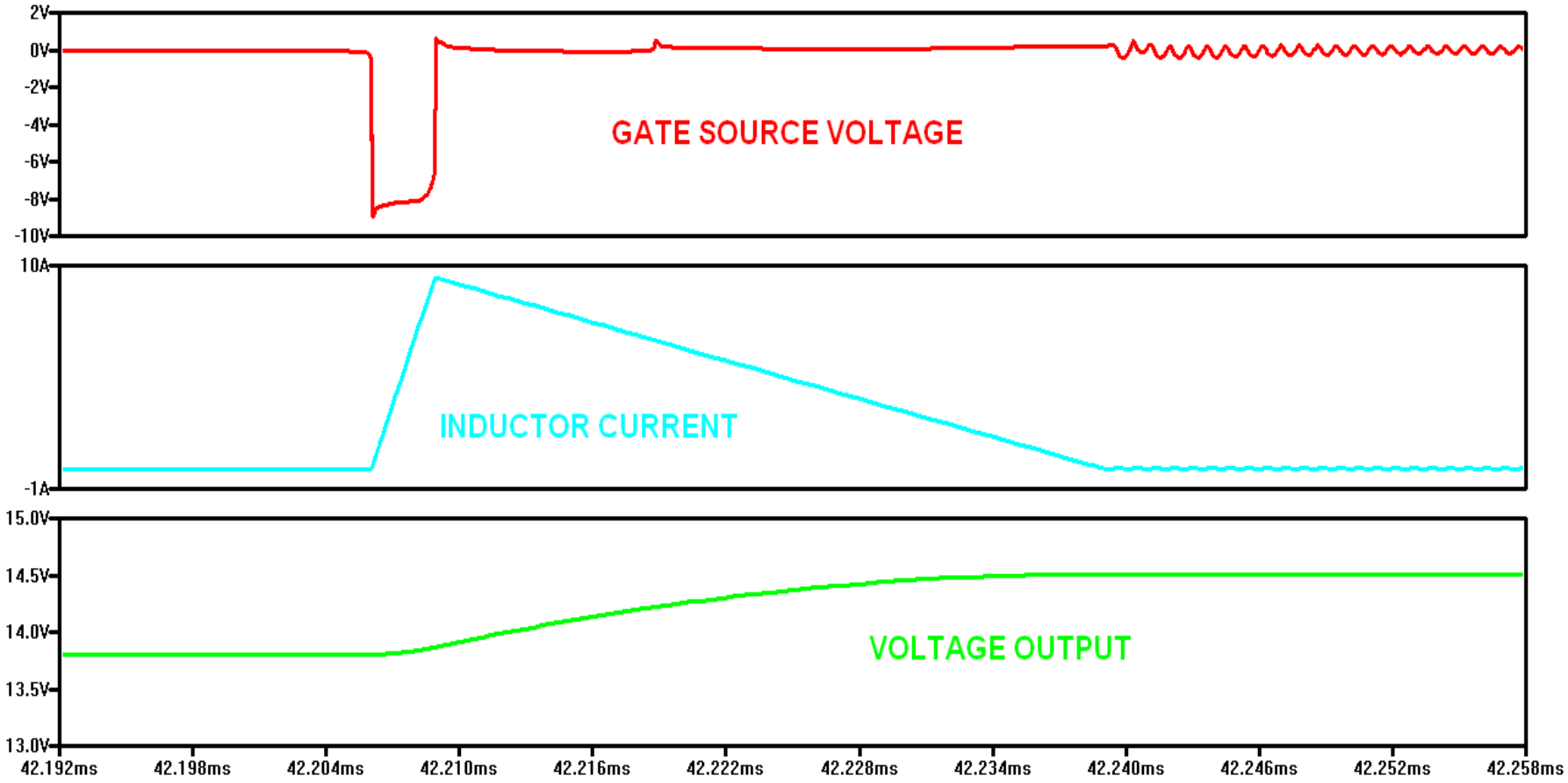
# *Low-Load Buck Converter Waveforms*




Running at 0.01% of full load, efficiency is 90%

The frequency, once in regulation, is about 3 Hz

# Buck Converter Waveforms - Detail




Here is one cycle expanded - the ON time is 3us

# *Pulsed Switch Drive Buck Advantages*

Vampire power measured in 100s of microwatts

Operates efficiently at extreme duty cycles for wide input voltage and load ranges

Simulations indicate an efficiency over 96% at 1% of full load

Very low parts count, even without integration

Scalable power level

DCM, CCM, or Critical Mode operation

Low cost

# *More Triggered Pulse Circuit Applications*

When the input to a typical logic circuit hovers between a logic 1 and a logic 0, extra power is drawn

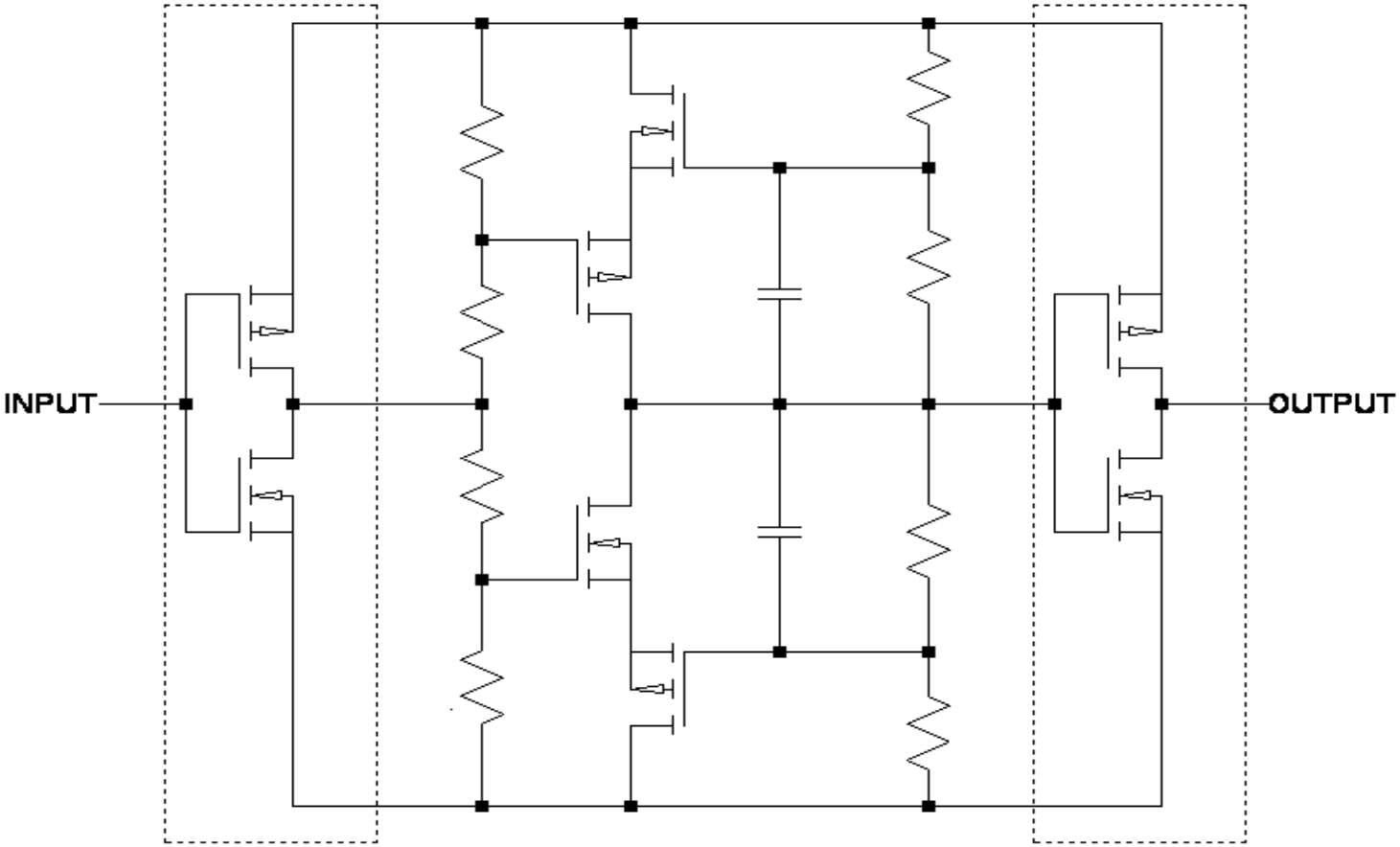
That extra power can swamp the power required for normal operation

Conditions change only very slowly in unloaded SMPCs

A single indeterminate logic input will consume vampire power and can destroy low-load efficiency

A variation of the switch drive buffer circuit will form a logic buffer or comparator with both vanishingly small standby current and fast output transitions

# *Generalized Hysteretic Buffer Circuit*




Buffer multiplies edge rate by 10,000 or more

# *Other CogniPower Intellectual Property*

Predictive Energy Balancing for superior control of all types of power converters

Compound Converter for near-ideal Power Factor Correction without requiring a separate power stage

Techniques for more efficient switch drivers

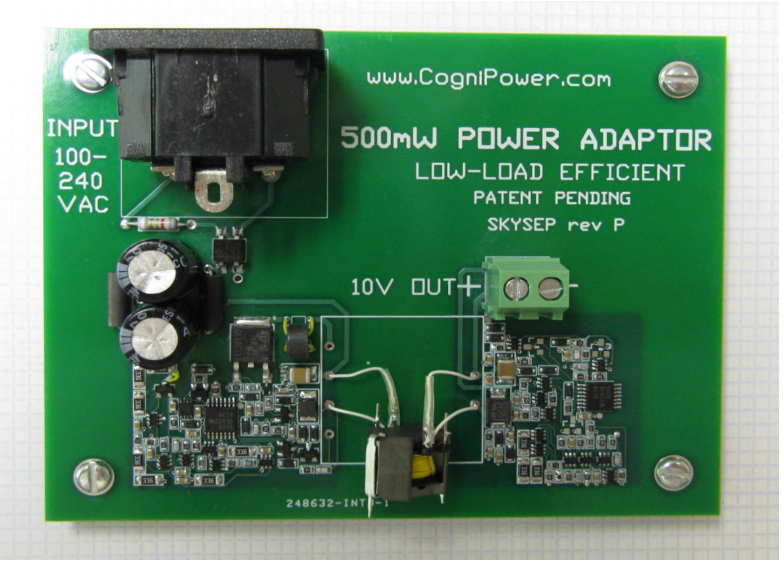
Bidirectional power converters and amplifiers

Full-duplex digital isolation

Energy-based techniques for faster-settling circuits

# *Come See Us in Booth 1338*

2012 DPR
Prototype




CogniPower technology is covered by 27 issued patents in the US and abroad, with more pending

We welcome licensing and technology transfer opportunities

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