CogniPOWER
power smarter

Simplifying Efficient Low Power AC/DC Converters

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Founder and President

Requirements for Low-Power AC/DC

- Low cost
- High efficiency
- Minimum no-load power
- Ease of digital control
- Small size
- Good transient response
- High reliability
- Low cost

Demand Pulse Regulation (DPR) Fits the Bill

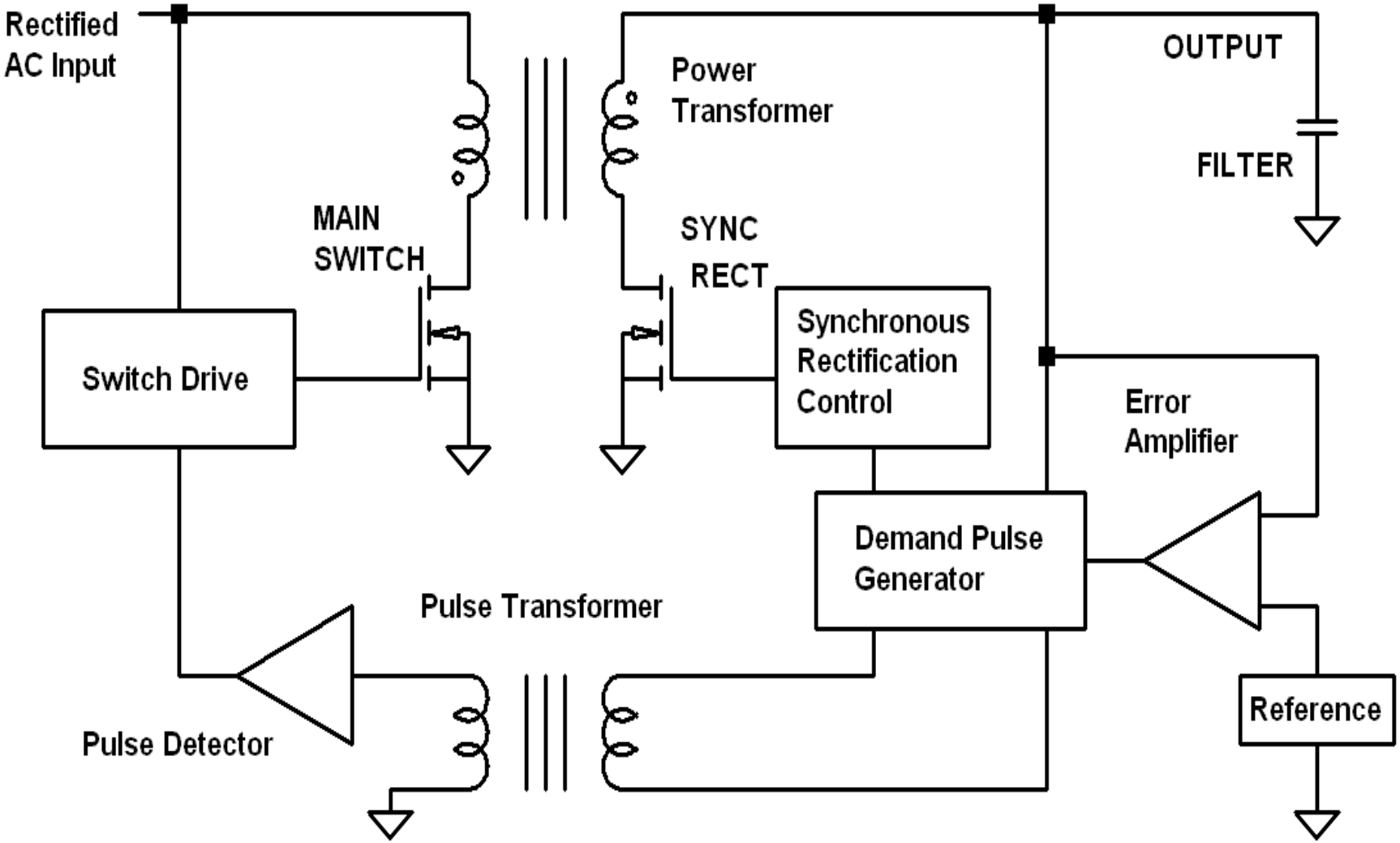
Demand Pulse Regulation is a new approach to low-power AC/DC supplies

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

Block Diagram of DPR Power Converter



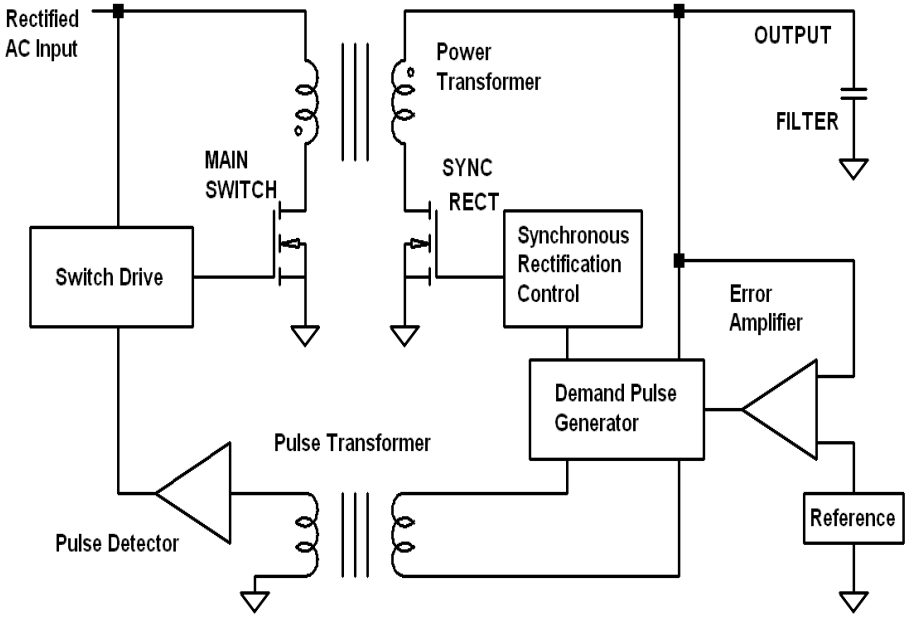
How Does it Work?

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

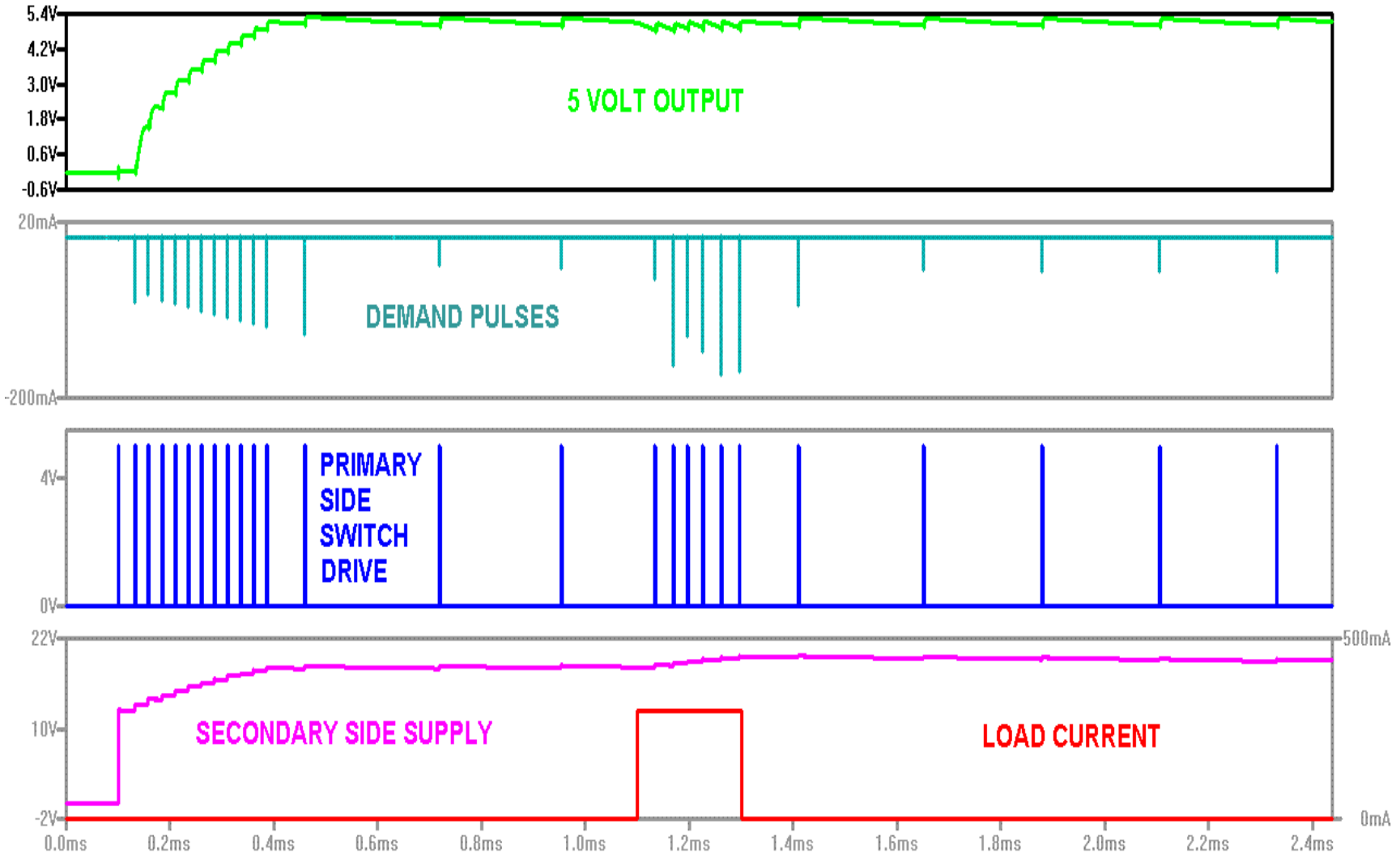
The primary side switch is turned off by the switch drive control on the basis of the primary current or time

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 Waveforms



DPR Waveforms Explained

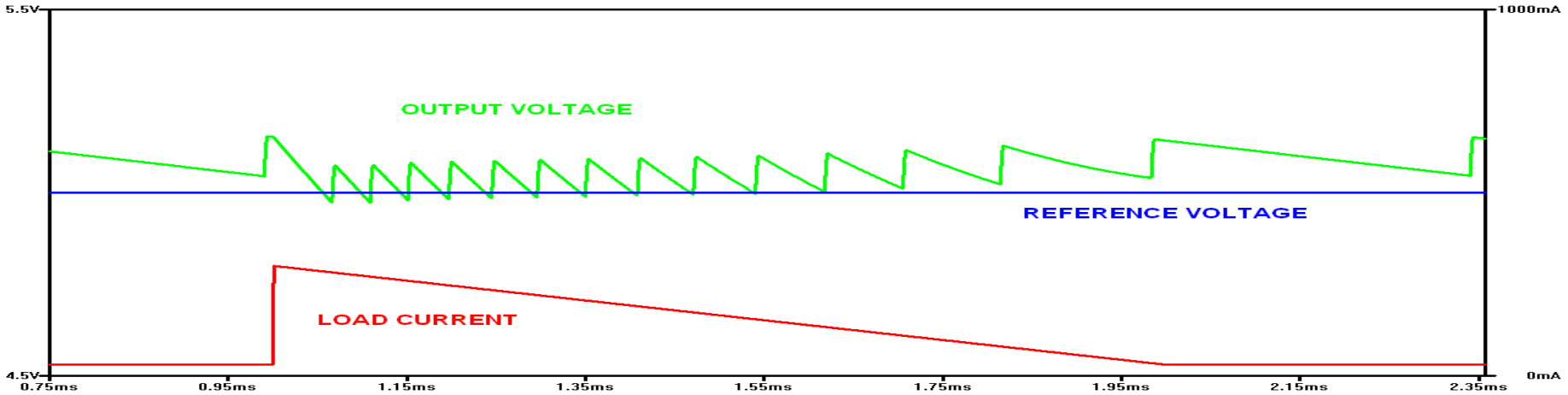
Whenever the instantaneous output falls below the regulation point, a demand pulse is generated

At the left, during start-up, the demand pulses are sent at the maximum frequency allowed

Demand pulses are seen to spread out at low load

The 1st primary side switch pulse is the start-up pulse, which brings up the secondary side supply

DPR Performance



A simple 2-transistor error amplifier running on next-to-no power supply current produces good results

A 30 to 300 mA load step is shown here

The output voltage stays within a 200 mV envelope

Tighter regulation requires only a little more supply current for the error amplifier

DPR Efficiency

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 excellent no-load power consumption, which can be reduced to under 400 micro Watts

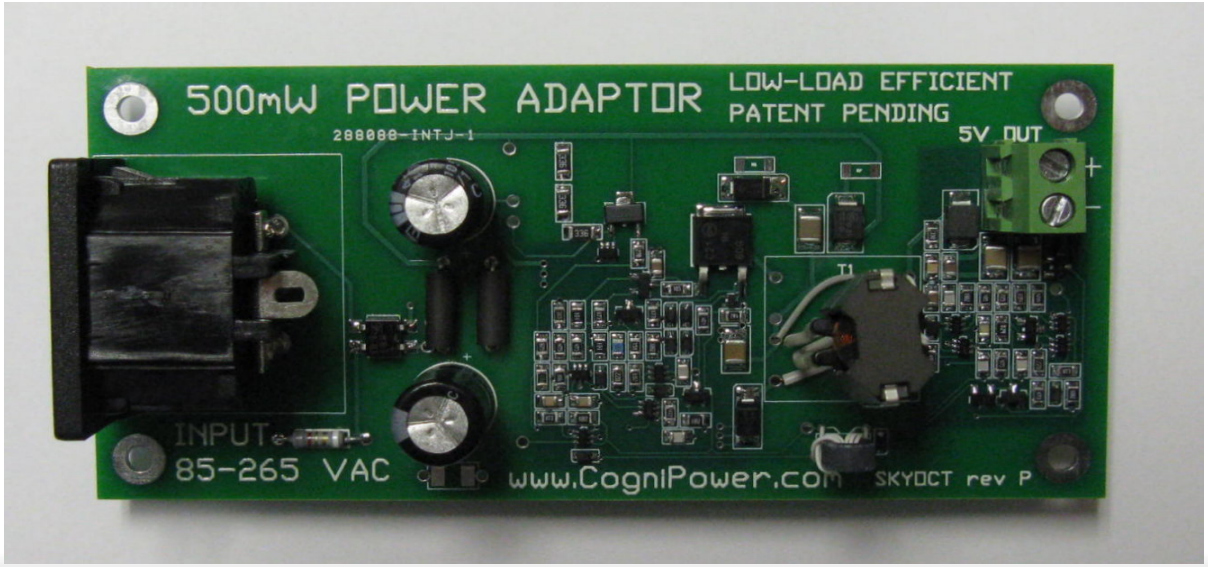
Secondary side control enables simpler, more efficient, synchronous rectification as an added bonus

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 additional protocols

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



Practicalities, Let's Get Real

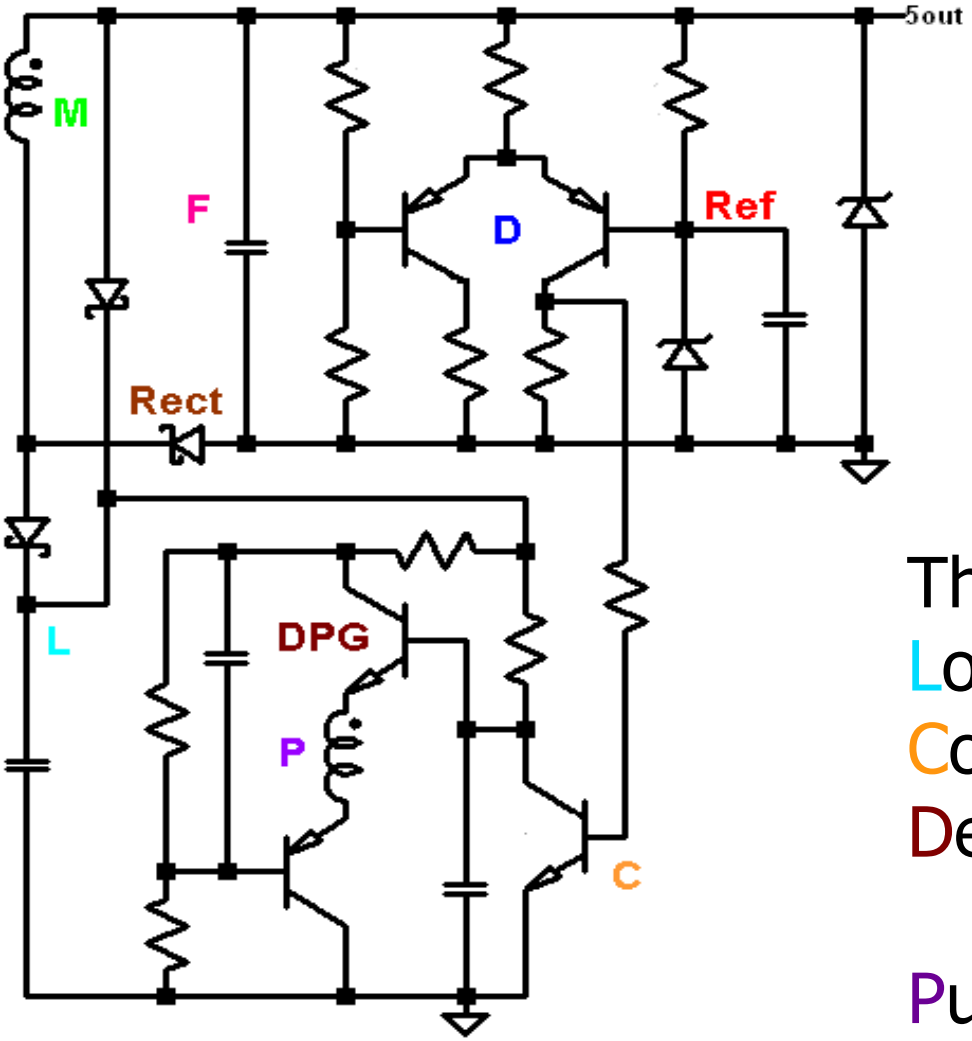
Switching in and out of continuous mode does not upset DPR control

The signal transformer can be tiny, with a single stitch of wire each, for primary and secondary

The primary side control chip can be a simplified version of an ordinary primary side control chip which needs only to generate one start-up pulse, to turn on the switch when a demand pulse is detected, and to shut off the switch at a preset current

The key to building a practical DPR power converter is the secondary side circuitry

An Actualized Secondary Side DPR Circuit



The upper block:
Reference
Differential error amp
Main transformer
Rectifier and Filter

The lower block, DPG:
Local power supply
Control from error amp
Demand Pulse Generator
trigger circuit
Pulse transformer

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

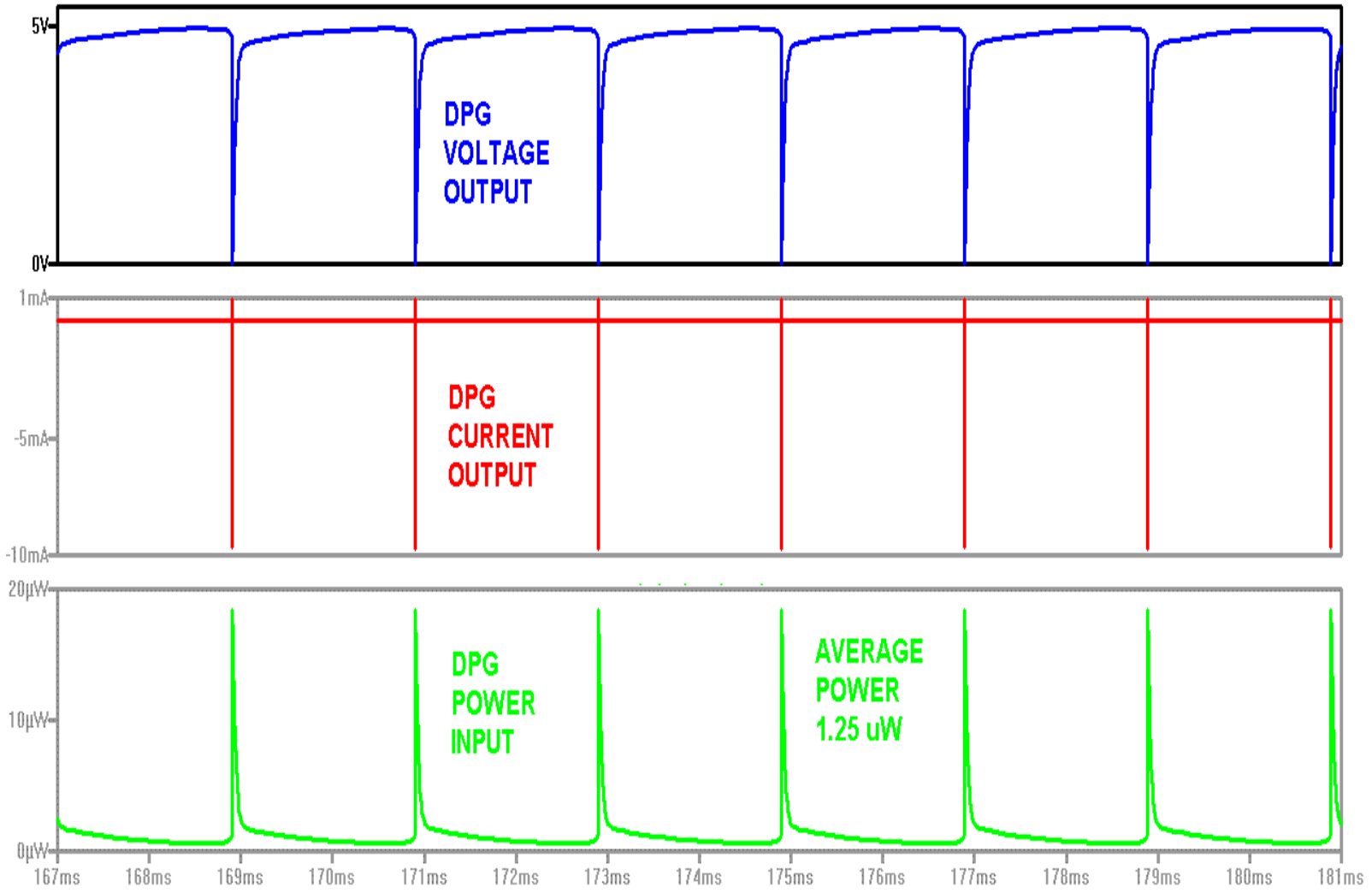
That very fast edge propagates easily through a minimal, inexpensive, non-critical pulse transformer

The DPG sets the maximum frequency of operation

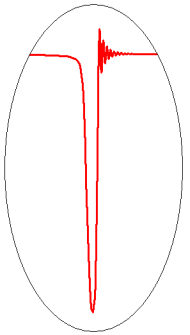
The DPG output frequency is in proportion to the magnitude of the error signal, allowing smooth operation, even into and out of continuous conduction

And, the DPG itself does not require regulated power

Demand Pulse Generator Waveforms



10mA pulse



40ns wide

DPR Advantages Compared to Alternatives

The Demand Pulse Generator provides all the feedback needed for a DPR power converter simply and efficiently

The alternatives have these well known disadvantages:

Optocouplers are slow, power-hungry and they age

Reflected voltages generally require extra transformer windings, they are imperfect representations of the output voltage, and inherent delay falls inside the control loop, requiring compensation and slowing transient response

Use of reflected voltages places demands on transformer construction that conflict with maximizing efficiency

Summary of DPR Efficiency Gains

Ultra-low standby power enables unmatched low load efficiency

Advance notice from secondary side control for when the primary side switch is about to turn on enables simpler, more efficient synchronous rectification

Uncompromised power transformer design enables better coupling, and therefore less need for dissipative snubbing

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

Other Uses for DPG

Ultra-low standby power is important for more than just USB chargers

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

- IoT
- Smart appliances
- Computer standby supplies
- LED lighting
- TVs, or any equipment turned on by a remote
- Communications infrastructure

Other Uses for DPG Trigger Circuit

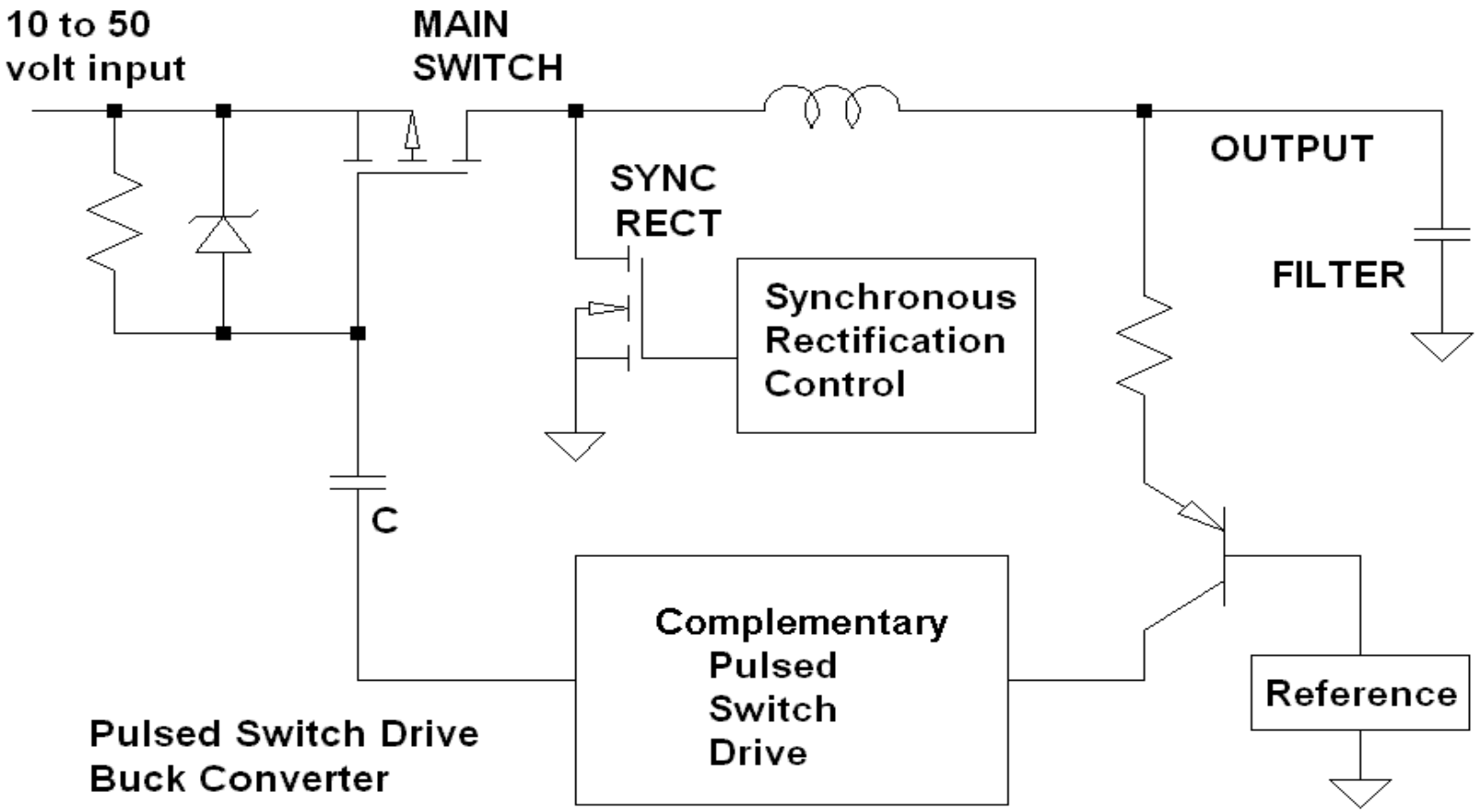
Slowly changing signals fed to digital logic draw extra current when they are in the indeterminate region, and that extra current can be many times the power otherwise required for operation

A buffer circuit can be made from two complementary DPG trigger circuits to produce a crisp logic level output from a very slowly changing voltage input signal

A pulsed complementary buffer with enhanced drive current can directly drive a power FET to achieve minimal switching losses

A pulsed switch drive buck converter illustrates the point

Ultra-low Vampire Power Buck Converter



Main switch On time can be constant, or modulated

Complementary Pulsed Switch Drive, Detail

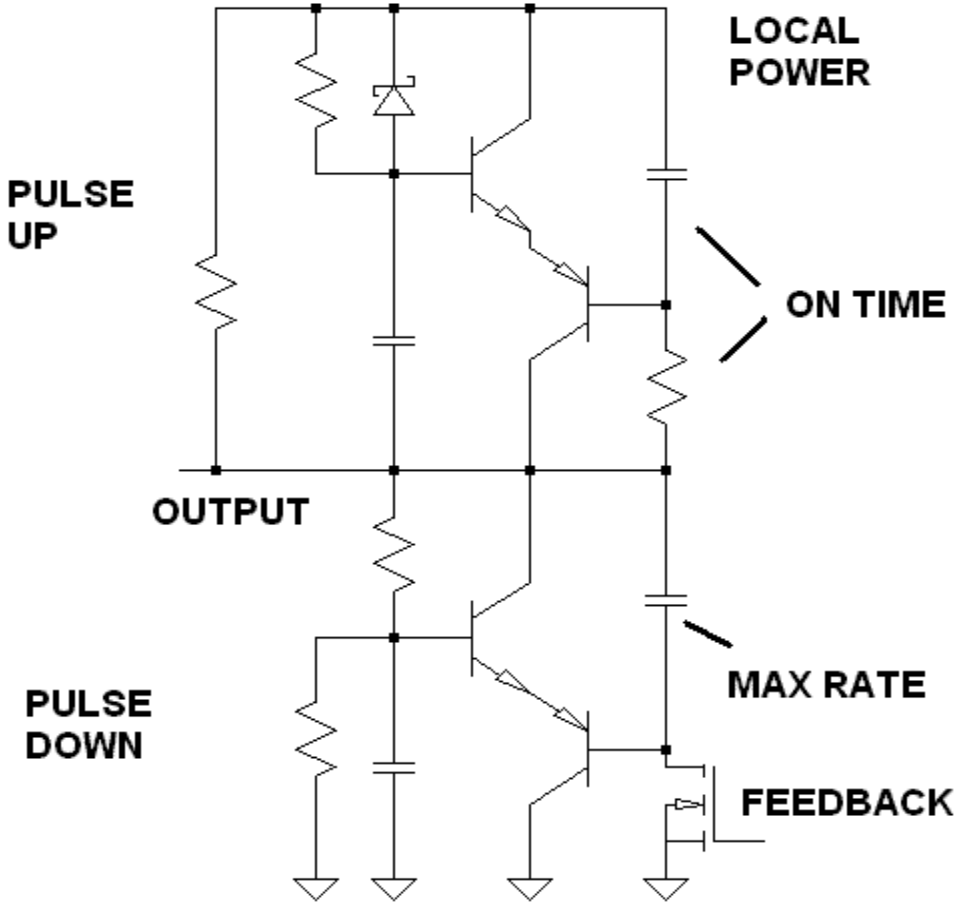
Fast, tunable edges

No need for well-regulated local power

Intrinsic max rate control

Minuscule standby power

Newly patented technology



Pulsed Switch Drive Buck Performance

Vampire power measured in 100s of micro Watts

Operates over wide voltage ranges

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

Very low parts count, even without integration

Scalable power level, DCM or CCM operation, or both

Applications include AC side switch drive, local power for power converter controls, automotive DC to DC, and extend to generalized ultra-efficient switch drive

Other 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

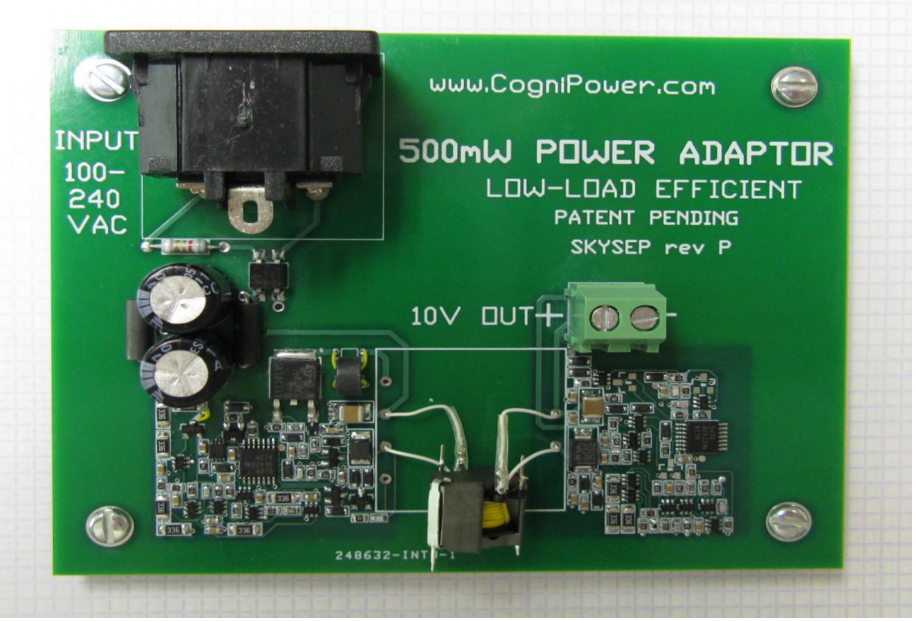
Bidirectional power converters and amplifiers

Full-duplex digital isolation

Energy-based techniques for faster-settling circuits

Multiplexed inductor and inductorless power converters

Thank You



CogniPower technology is covered by 24 issued patents in the US and abroad, with more pending

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