SP1.4.4
On-Chip Transformers Facilitate Integration For Isolated Power Supplies

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Outline

◆ Isolated Power Supply Integration Needs
  ● Isolation Integration Is the Key
◆ Integrated Isolation Technology Using On-Chip Transformers
  ● Multi-Channel Signal Isolation
  ● Fully Integrated DC-DC Converter Up to Half Watt
  ● Integrated Transformer Driver and Power Controller Up to 2W
◆ Isolated Gate Driver
  ● Integrated Isolated Gate Driver Up to 4A
  ● Integrated Isolated Gate Driver With Integral High Side Supply
◆ Future Integration Possibilities
A Typical Isolated AC-DC Power Supply

What Prevents the Integration? Isolation!

APEC2010
On-Chip Transformer Signal Isolation

- **Integration**
- **Performance**
- **Power Consumption**
- **Ease-of-Use**
- **Reliability**

- **Magnetic Rather Than Optical Transmission**
- High-Fidelity Signal Transfer
- 90% Lower Power Consumption
- No Wearout and Low Variation Over Time and Temperature
- Robust Isolation and High Common Mode Transient Immunity
Transformer and Package Provide Up To 5 kV rms Isolation

Transformer Chip

Direction of Isolation Barrier

Output Pins

Input Pins

10μm PI
4μm Au

IC PASS

IC top metal 1μm

Transformer Chip

[Diagram of transformer chip and isolation barrier]
Signal Transmission Operational Diagram

- Detect Data Edges
- Encode as Pulses
- Transfer Through Transformer
- Decode Pulses
- Reconstruct Data

Rising Edge
Falling Edge

CMOS Top Metal
Insulation

ANALOG DEVICES
On-Chip Transformer Provides Up to 0.5W Isolated Power

- Miniaturized, isolated DC/DC converter
- High-freq energy conversion with low-freq energy regulation
- Energy conversion optimized while regulation maintained through wide input and load ranges
Integration Saves Space and Power Compared to Discrete Solution

**Est. Total Power:** 220 mW
- Supply @ 20mA Load: 205 mW
- Optocoupler Data: 15 mW

**2W Discrete**

**Est. Total Power:** 490 mW
- Supply @ 20mA Load: 275 mW
- Optocoupler Data: 220 mW
Power Transformer Radiation Minimized Through Anti-Phase Center Tape

PCB Radiation Dominant-PCB Techniques Available
Digital Power Supply Isolated Power Needs-Secondary Start-up

Example: ADuM5404  Example: ADP1043
Integrated Transformer Driver and Secondary Controller: 2W with Greater than 70% Efficiency

Converter Block Diagram

20L SSOP

Converter Block Diagram

ANALOG DEVICES
Pulse Transformer Gate Driver Limitations

- Duty Cycle Limitation
- Poor Efficiency
- Bulky
- Many Discrete Components
- Transformer Driver Needed
Level Shifter with Bootstrap Gate Drive Limitations

- No Galvanic Isolation
- Shifting One Direction Only
- Reverse Junction Turn On at Switching
- Finite Turn-on Time; Not Good For Long Off Period
- Limited Switching Speed
Use of Half-Bridge Gate Drivers with Integral High Side Supply

Size Reduction, Ease of Use and Elimination of Duty-Cycle Limitation

ANALOG DEVICES
Half-Bridge Gate Driver with Integral High Side Supply
4A Gate Driver For Push-Pull with Primary Controller With Synchronous Rectification

ADuM3210: Standard 5V Outputs ADuM3220: 4A 5-15 Outputs
4A Isolated Gate Driver For Push-Pull with Secondary Controller

ADuM3210: Standard 5V Outputs
ADuM3220: 4A 5-15 Outputs
ADuM125x/225x: A Single-Component Solution for Isolated I²C Communication

**Primary-Secondary Communication**

- **Power Supply**
  - Primary
  - Secondary

- **ADuM2250**

- 5.0 kV isolation rating
- 8.0 mm creepage/clearance

**PMBus/SMBus Communication**

- **Power Supply**
  - ADuM1250

- 2.5 kV isolation rating
- 4.0 mm creepage/clearance
>300 Million iCoupler Channels in Use Today

- In production since 2001
- Thousands of customers
- Wide range of applications
  - Plasma Display Panels
  - Industrial Process Controls
  - Power Supplies
  - Medical Devices
  - Motor Drives
  - Instrumentation Devices
  - Automotive Systems
  - Networking Equipment

Cumulative Channel Shipments

- Millions of Channels
- '03 - '09
Advancing Beyond Standard Isolation

Multi-Channel Digital Isolators
- Standard Multi-Channel
- ESD Enhanced
- 125 °C Automotive AEC-Q100
- 50 & 500 mW isoPower
- 5 kV Medical IEC 60601-1
- 1 kV Isolation
- Small Package
- PWM Controller – 2W Power

Gate Drivers
- Half Bridge with isoPower
- 0.1 A Full Bridge
- 0.1 A Half Bridge
- 4A Half Bridge

RS-485
- Integrated Transformer Driver
- Full & Half Duplex

Converter
- ΣΔ Modulator

RS-
- isoPower

I²C
- 2.5 kV rms
- 5 kV rms IEC 60601-1

US
- USB 2.0 12 Mbps
Future Integration Possibilities

Thank you!