

# **Enhance Design Performance using Integrated Power and Digital Isolation Design**

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## **Abstract**

Modern isolated systems in industrial automation, motor drives, and communication interfaces face significant design challenges when implementing traditional transformer-based DC-DC conversion for isolation barriers. Conventional approaches require complex component selection, challenging PCB layouts, extensive safety certifications, and careful EMI management, leading to increased costs, larger board space, and extended development cycles. Engineers must navigate multiple discrete components including isolation transformers, driver circuits, rectification stages, and feedback networks to achieve a successful design.

Texas Instruments' ISOW64xx series addresses these challenges through revolutionary integration, combining isolated DC-DC conversion and digital isolation in single-package designs optimized for superior EMC performance at competitive costs. The integrated architecture eliminates external transformers and supporting circuits, reducing component count by up to 70% while delivering 140mA output current (in 5V input, 3.3V output mode) capability for powering precision ADCs and communication interfaces.

This document presents three key application areas where integrated isolation designs provide substantial advantages:

- PLC analog input modules requiring high-redesign ADC power and data isolation.
- Long-distance industrial communication systems using RS485/PROFIBUS and CAN protocols.
- Sensor front-end interfaces handling diverse signal types.

The integrated approach delivers measurable improvements in design simplification, faster time-to-market, reduced system costs, and industry-leading EMC performance that surpasses competitive designs. For engineers developing isolated systems, these integrated designs represent a paradigm shift from complex discrete designs toward optimized, cost-effective architectures that accelerate product development while verifying robust performance in demanding industrial environments.

## **Introduction**

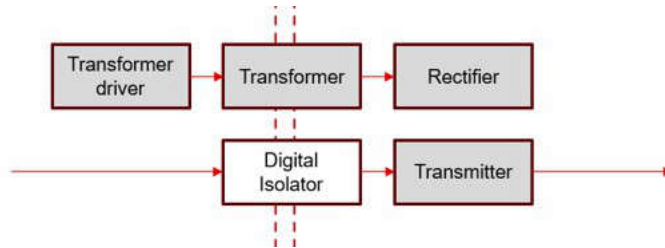
Every isolated device requires an isolated DC-DC converter to power the circuits on the floating ground side. This isolation is essential for safety, noise immunity, and ground loop elimination in applications such as industrial automation, motor drives, and communication interfaces. Traditional designs use transformers to generate isolated DC supply, requiring additional transformer drivers, rectification circuits, feedback networks, and control logic. The transformer operates at switching frequencies typically between 100kHz to 1MHz, requiring careful magnetic design to achieve proper turns ratios, minimize leakage inductance, and maintain isolation voltage ratings up to 5kVRMS or higher. These designs also need precision feedback circuits using optocouplers or magnetic coupling to maintain output voltage regulation across load and line variations. The combination of these requirements creates several design challenges that increase complexity, cost, and time-to-market for engineers developing isolated systems.

## Why Traditional Isolated DC-DC Designs Are Complex

- **Multiple Component Selection:**

Traditional isolated power requires many discrete components:

- Isolation transformer with specific turns ratio.
- Transformer driver ICs.
- Rectifier diodes and filter capacitors.
- Feedback circuits with optocouplers.
- Protection and control circuits.



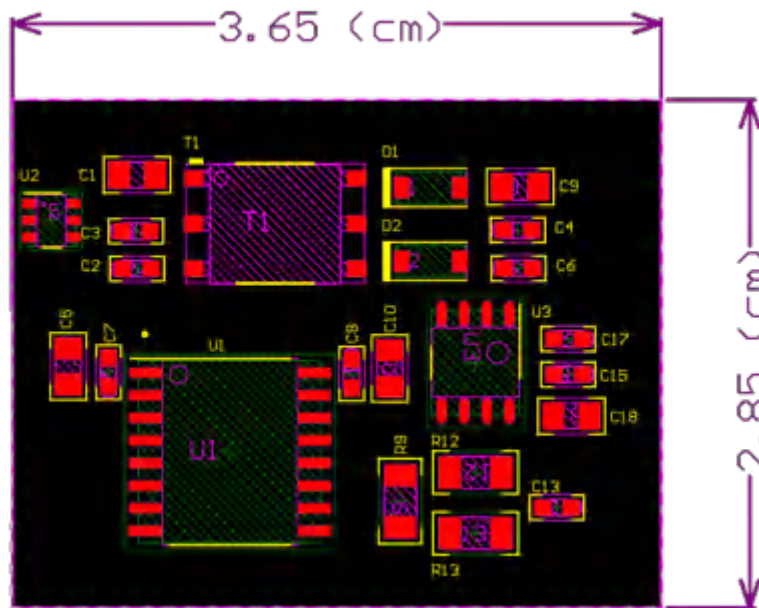
**Figure 1. Components Required for Discrete Design**

- **Challenging PCB Layout:**

Isolated converters create layout difficulties:

- High-frequency switching generates noise that requires careful routing.
- Isolation barriers need specific spacing between primary and secondary sides.
- Thermal management becomes critical with multiple power components.
- EMI control requires additional filtering and shielding.

See [ISOW6441DWEEVM](#), [ISOW3080DWEEVM](#), [ISOW1050DWEEVM](#) for layout guidance.



**Figure 2. Complex Layout with Discrete implementation**

- **Safety Certification Complexity:**

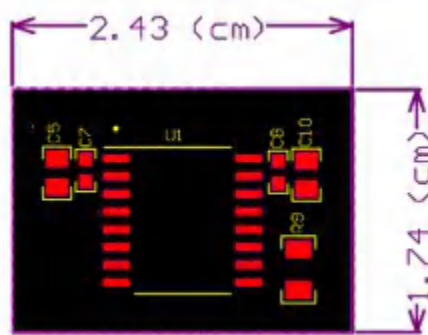
External isolation transformers add certification burden:

- Transformers require separate safety agency approvals.
- Additional high-voltage testing is required.
- More documentation and compliance testing.
- Longer certification timelines.

- **Higher System Cost and Board Space:**

Traditional approaches increase overall costs:

- More components mean higher BOM costs.
- Larger PCB area needed for transformer and supporting circuits.
- Additional assembly and testing time.
- Higher inventory management complexity.



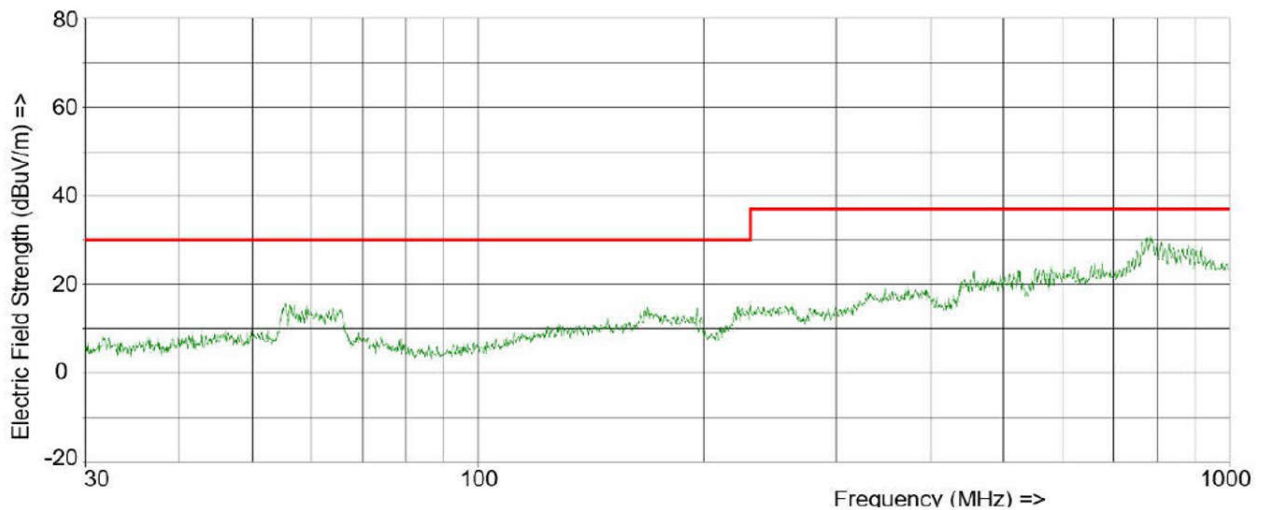
**Figure 3. Simple Layout implementation (60% Area Reduction)**

- **EMI and Performance Issues:**

Switching transformers create electromagnetic challenges:

- Transformer ringing generates high-frequency noise.
- Parasitic capacitance between windings causes common-mode currents.
- Leakage inductance affects efficiency and regulation.
- Additional filtering circuits are needed for EMC compliance.

See [Radiated Emissions Application Note](#) for CISPR 32 emissions data.



**Figure 4. Best EMI Performance Using ISOW Devices**

**TI's Integrated Design: ISOW64xx Series** solves these problems by integrating both the DC-DC converter and digital isolator in a single package, specifically designed to deliver the best EMC performance at the most affordable cost. Unlike competitive designs, these devices use optimized internal switching topologies and advanced EMI mitigation techniques that eliminate the noise issues common with external transformers. The integrated design provides superior electromagnetic compatibility that no other competing designs can match, while maintaining cost-effectiveness for high-volume production.

The ISOW3080 takes integration further by combining isolated DC-DC power, digital isolation, and RS485 transceiver functionality in one device, delivering unmatched EMC performance for RS485 applications. Similarly, the ISOW1050 integrates CAN transceiver capability along with power and digital isolation, providing the industry's best EMC performance for CAN interface designs.

### Key Benefits

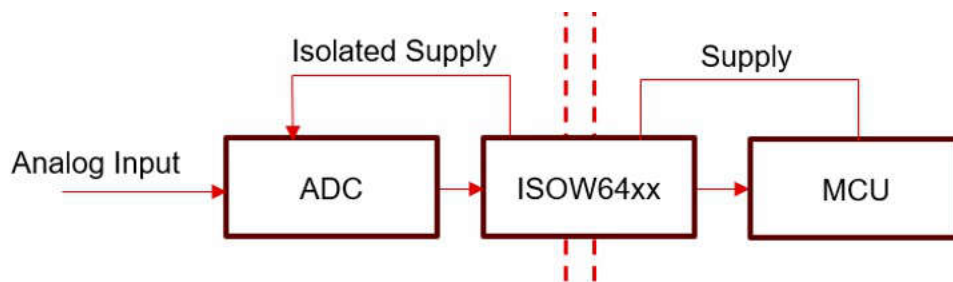
- **Simplified Design:** No external transformer design required - just connect power and signals.
- **Reduced Components:** Up to 70% fewer parts compared to discrete designs.
- **Better Performance:** Optimized internal design provides better efficiency and lower EMI.
- **Faster Time-to-Market:** Pre-certified isolation reduces design and testing time.
- **Lower Cost:** Integrated design reduces total system cost.

### Applications

#### • PLC Analog Input Modules:

In programmable logic controller (PLC) analog input systems, conditioned analog signals must be digitized and safely transmitted across isolation barriers to protect the control system from ground loops and electrical faults. The typical architecture includes:

- **Analog-to-Digital Conversion:** High-resolution ADCs (typically 16-24 bits) convert conditioned analog signals to digital format. Popular choices include delta-sigma ADCs such as ADS131M series or successive approximation ADCs for faster conversion times. These ADCs require stable power supplies with low noise characteristics to maintain conversion accuracy.
- **Isolated Digital Communication:** Digital isolators transfer the converted data across the isolation barrier while maintaining galvanic isolation ratings up to 5kVRMS for industrial safety requirements.
- **Isolated Power Requirements:** The ADC and isolated side of digital isolators require clean, regulated power supplies. Traditional designs need separate isolated DC-DC converters adding complexity and cost.
- **ISOW64xx Design:** The ISOW64xx provides 140mA minimum output current in 5V input to 3.3V output configuration, sufficient to power precision ADCs (typically 10-50mA) and digital isolator circuits (10-20mA). This integrated approach eliminates external DC-DC converter design, reduces PCB area by up to 60%, and simplifies power supply sequencing and regulation.



**Figure 5. Use of ISOW in Analog Input Modules**

- **Isolated Long-Distance Industrial Communication:**

Industrial environments require robust communication over distances up to 1200 meters with high noise immunity and multi-drop capability. Two dominant protocols address these requirements:

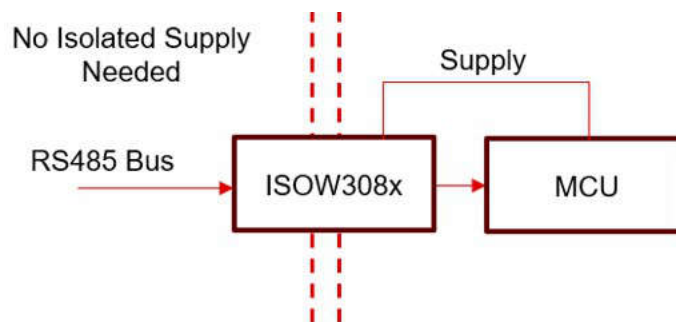
- **RS485 Communication Networks:** Half-duplex differential signaling supports up to 32 nodes per network segment with data rates optimized for different applications. RS485 is widely used for general industrial automation with standard data rates of 500kbps for reliable long-distance communication and 1Mbps for higher speed applications where distance is shorter. PROFIBUS-DP (Decentralized Peripherals) uses RS485 physical layer but with specific timing and protocol requirements, supporting deterministic communication for factory automation. PROFIBUS typically operates at 500kbps for standard installations and 1Mbps for high-performance applications.
- **CAN Bus Networks:** Controller Area Network protocol provides deterministic, error-robust communication for real-time control applications. CAN supports up to 1Mbps data rates with automatic arbitration and error detection/correction. Industrial CAN implementations require isolated transceivers to prevent ground loops between nodes.
- **Traditional Design Challenges:** Separate selection of isolation barriers, DC-DC converters, and communication transceivers creates component matching issues, increases BOM complexity, and requires careful EMC design to meet industrial emission and immunity standards.
- **ISOW3080 Integrated RS485 Design:** TI offers four optimized variants to meet specific application requirements:
  - **ISOW3080:** 500kbps RS485 transceiver for standard industrial automation applications.
  - **ISOW3086:** 1Mbps RS485 transceiver for high-speed communication requirements.
  - **ISOW3080P:** 500kbps PROFIBUS-optimized transceiver meeting PROFIBUS-DP timing specifications.
  - **ISOW3086P:** 1Mbps PROFIBUS-optimized transceiver for high-performance PROFIBUS networks.

All variants combine isolated power, digital isolation, and protocol-optimized transceivers in a single package, eliminating the need for external transceiver ICs and associated protection circuits while delivering superior EMC performance.

- **ISOW1050 Integrated CAN Design:** TI provides two CAN interface options to meet different system power requirements:
  - **ISOW1050:** CAN transceiver with single power supply operation
  - **ISOW1050V:** CAN transceiver with flexible dual power supply operation

Both variants integrate isolated power, digital isolation, and CAN transceiver meeting ISO 11898-2 physical layer specifications in a single package.

- **Alternative Protocol Support:** For protocols beyond RS485 and CAN (such as PROFINET, EtherCAT, or custom UART), ISOW64xx provides the isolated power and digital isolation foundation, allowing designers to add appropriate communication transceivers while maintaining the integrated power advantage.



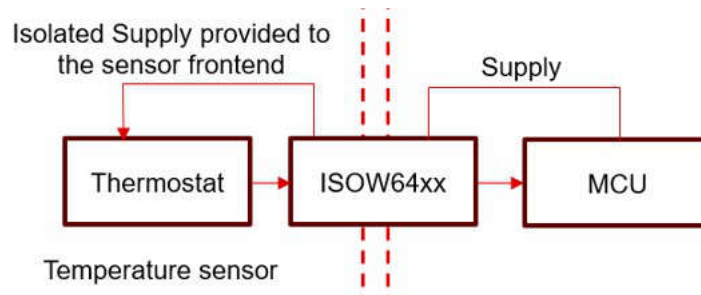
**Figure 6. Isolated Long-Distance Industrial Communication**

- **Sensor Front-End Interface Modules:**

Industrial sensor interfaces require precise signal conditioning, isolation for safety and noise immunity, and reliable power delivery in harsh electromagnetic environments:

- **Sensor Signal Types:** Industrial sensors generate various signal formats: 4-20mA current loops for long-distance noise immunity, 0-10V voltage signals from pressure/temperature sensors, thermocouples requiring microvolt amplification with cold junction compensation, and RTDs needing precision excitation currents for accurate temperature measurement.
- **Sensor Power Requirements:** Various sensors have different power needs:
  - Temperature sensors (thermocouples, RTDs): 1-10mA excitation currents.
  - Pressure/strain gauge sensors: 5-20mA bridge excitation.
  - Proximity sensors: 10-50mA depending on sensing technology.
  - Smart sensors with digital outputs: 20-100mA including communication circuits.
- **Signal Conditioning Circuits:** Precision instrumentation amplifiers, programmable gain amplifiers, cold junction compensation for thermocouples, and linearization circuits require stable power supplies with low noise and good regulation.
- **ISOW64xx Sensor Interface Design:** The 140mA minimum output current capacity handles multiple sensor types and associated signal conditioning circuits. The integrated approach provides:
  - Clean, regulated power for sensitive analog circuits
  - Digital isolation for sensor data transmission
  - Reduced component count and simplified PCB layout
  - Pre-certified isolation meeting international safety standards
  - Superior EMC performance for industrial noise environments

This integrated design enables faster sensor interface development while ensuring robust performance in demanding industrial applications.



**Figure 7. Sensor Front-End Interface Modules**

## Conclusion

For engineers designing isolated systems, the choice is clear: traditional discrete DC-DC converter designs with external transformers increase complexity, cost, and EMI challenges, while TI's integrated ISOW64xx series delivers the industry's best EMC performance at the lowest system cost. With up to 70% fewer components, superior electromagnetic compatibility that no competitor can match, and proven reliability in demanding industrial applications, ISOW designs provide the optimal path forward for PLC modules, communication interfaces, and sensor systems.

## References

- Texas Instruments, [ISOW644x Robust-EMC, Reinforced, Quad-Channel Digital Isolator With Integrated DC-DC Converter](#), datasheet.
- Texas Instruments, [ISOW308x Robust-EMC, Isolated RS-485/RS-422 Transceiver With Integrated DC-DC Converter](#), datasheet.
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- Texas Instruments, [ISOW1050 EVM Datasheet for Layout Guidance](#), evaluation module.
- Texas Instruments, [Passing CISPR 32 Class-B Radiated Emissions With Ease Using ISOW6441](#), application note.
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