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Power and Data Isolation Made Easy

Si86Px Design Examples for EV Chargers, PLC Data Interfaces, and Robotics/Encoders

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Abstract

Modern industrial and automotive systems increasingly rely on galvanic isolation to protect low-voltage control electronics while maintaining robust operation in environments dominated by fast switching edges, ground potential differences, and severe electromagnetic interference. At the same time, designers repeatedly encounter a practical bottleneck: isolating high-speed signals is rarely the hardest problem: delivering clean, well-regulated isolated power to the secondary side often drives the largest penalty in PCB area, BOM cost, and debug time.

This whitepaper presents three real world application examples that demonstrate how Skyworks Si86Px digital isolators integrate signal isolation and isolated power transfer in a single package to simplify system architecture and improve design repeatability:

1. EV fast charger high side current/voltage sensing
2. Industry 4.0 PLC modules with isolated RS-485 connectivity
3. Robotics/servo drives implementing isolated encoder interfaces

For each application, we describe the system context, outline the dominant design challenges (power availability, noise immunity, timing determinism, EMC robustness, and thermal/fault behavior), and provide implementation guidance including block diagrams, recommended signal-channel allocation, power tree integration, and layout/EMI best practices.

Introduction

Design teams keep running into the same bottleneck: isolating high-speed signals is straightforward, but generating clean isolated power on the far side often consumes the most PCB area, BOM, and debug time. Si86Px directly targets that pain point by integrating both signal and power isolation into a single package - including the dc-dc controller and transformer - so many designs need only decoupling capacitors instead of external magnetics or a separate isolated module.

What makes Si86Px particularly compelling versus similar integrated power isolators is the quality of the isolated power rail. Industry-leading load regulation (0.1% typical) aimed at powering sensitive downstream components like ADCs and sensors means less measurement drift and fewer workarounds (extra LDOs, filtering, etc.).

On the signal side, Si86Px keeps pace with modern industrial links: up to 150 Mbps with 15 ns max propagation delay, plus 100 kV/µs minimum CMTI for robust operation in noisy environments such as motor drives and power conversion. The –40 to +125 °C operating temperature range, 3.75 kVrms isolation, and integrated thermal protection (including bidirectional shutdown) also makes it ready to work in harsh conditions.

From a system perspective, Si86Px helps you ship faster because it shrinks the isolation island (wide-body SOIC-16/SOIC-20, dual/quad channel options) and reduces design complexity - fewer parts, fewer magnetics/layout iterations, all with controlled EMI at the same time using hysteretic control and frequency dithering.

When Si86Px Fits: Application Decision Guide

Si86Px is a strong fit when a system requires both isolated digital communication and low power isolated supply in a compact implementation. By combining high-speed signal isolation with integrated isolated power transfer, Si86Px can simplify architectures that would otherwise require a digital isolator, isolated dc-dc converter, transformer, and associated support components.

The following table provides a quick first stage assessment.

Design requirement or condition	Si86Px fit	Design guidance
Data and power isolation both required	Strong fit	Si86Px integrates both functions, reducing the need for a separate isolated dc-dc converter and transformer.
Isolated side load can operate within 0.5 W output power budget	Strong fit	Suitable candidates include ADCs, sensor interfaces, encoder transceivers, and low power RS-485 transceivers. Verify worst case load, startup current, temperature, and output voltage.
PCB area, component count, or external magnetics must be minimized	Strong fit	Integration can reduce the isolation subsystem footprint and eliminate magnetics selection and placement effort.

Design requirement or condition	Si86Px fit	Design guidance
Two or four isolated digital channels are required	Strong fit	Select the OPN according to channel count, channel direction, input supply, isolated output voltage, and default output state.
High data rate and low propagation delay required	Strong fit	Appropriate for SPI, UART, encoder communication, control, status, and other time sensitive digital interfaces.
The isolation barrier is exposed to high common-mode transients	Strong fit	Particularly relevant to EV power conversion and isolation applications in high EMI environments. PCB partitioning and routing remain important.
A stable isolated rail is needed for measurement circuitry	Strong fit	Tight load regulation can simplify the supply architecture for ADCs and sensor interfaces, although the complete analog error budget must still be evaluated.
Isolated side load requires more power than what Si86Px can provide	Alternative preferred	Compare a traditional digital isolator combined with a higher power isolated converter.
A suitable isolated supply already exists	Compare architectures	A traditional digital isolator may provide a simpler or more economical solution.
More than four isolation channels needed for the same domain	Compare architectures	Consider devices with more isolation channels or complementing Si86Px with a traditional digital isolator, comparing the resulting area, cost, and power needs.
Required channel direction combination unavailable	Compare architectures	Consider complementing Si86Px with a traditional digital isolator or convert the interface to a supported arrangement, such as SPI or I^2C.
Specific output rails, multiple isolated rails, or bipolar supplies are required	Alternative preferred	A dedicated isolated power supply will generally provide greater rail flexibility.
Specific isolation rating, working voltage, automotive, or regulatory requirements apply	Verify selected OPN	Confirm package, isolation, working voltage, qualification, and certification against final system requirements.

Application Level Fit

- **EV fast charger sensing:** Si86Px is particularly effective when an isolated ADC or sensor front end needs a compact, well-regulated local supply and a high-speed digital connection to the controller.
- **PLC and remote I/O:** Si86Px is well suited to powering an isolated field side transceiver while isolating logic level transmit, receive, and control signals.
- **Robotics and servo drives:** Si86Px is a strong fit for isolated absolute encoder transceivers and sensor hubs working close to the EMI field of motors. The required channel directions should be verified early, especially for encoder interfaces.

1. Application: EV Fast Charger: Isolated Current/Voltage Sensing Front-End

1.1 The Challenge

System Context

The rapid growth of dc fast charging is being driven by the need to reduce charge time, which typically implies higher power levels and increasingly modular power architectures. In these systems, high-wattage power electronics (rectification/PFC stages and isolated dc-dc conversion) must be monitored and controlled by low-voltage digital controllers, creating a persistent requirement for galvanic isolation between the high-voltage power domain and the low-voltage control domain.

Core Challenge: Accurate Measurement Across a Noisy Isolation Boundary

Modern power stages introduce aggressive switching edges and fast commutation events that can generate large common-mode transients, coupling noise into measurement paths and digital interfaces. As a result, the sensing subsystem must deliver accurate current/voltage feedback without spurious toggling, data corruption, or control loop instability when the system experiences fast transients or electrical noise.

Key Design Challenges

1. **No convenient power on the isolated side**
   Sensing often lives on a "floating" or high-voltage referenced domain (current shunts, dividers, isolated amplifiers/modulators, ADCs). This domain frequently does not have an easy local bias source, forcing designers to add an isolated supply rail just to run the measurement front end. The additional isolated supply can drive up PCB area, BOM, and qualification effort, especially in space constrained fast charger modules.

2. **Clean rail requirements for precision data conversion**
   Accurate sensing depends on power quality: rail ripple, load regulation, and transient response can directly translate into ADC reference/offset variation and measurement drift. In fast chargers, the isolated sensing rail must remain stable while the surrounding system sees sharp load steps and switching noise.

3. **High-speed, deterministic data transport**
   Sensing chains frequently use SPI/GPIO (and sometimes time-sensitive sampling/interrupt signaling) to communicate between controller and measurement island. These links must

maintain deterministic timing across temperature and line variation while remaining immune to noise coupling from the power stage.

4. **Safety isolation + system partitioning pressures**
   Fast chargers must protect users and meet isolation expectations that separate high voltage from low voltage electronics, which affects PCB creepage/clearance, partitioning, and mechanical constraints, often under intense packaging pressure to raise power density.

5. **Thermal and fault behavior of the isolated island**
   The sensing island and its isolated supply must behave predictably during abnormal conditions (e.g., shorts, overloads, hot environments) to avoid cascading failures or undefined measurement outputs during fault events.

Implication for Architecture

An EV fast charger sensing design is frequently limited not by the ADC or the MCU, but by the complexity of building a small, low-noise isolated power island and maintaining robust data integrity in an environment with large transients, while still meeting packaging and safety constraints.

1.2 Si86Px Delivers

Fast EV chargers increasingly rely on high power conversion stages where the control electronics must remain galvanically isolated from the high-voltage domain for safety and robust operation. In this context, the sensing subsystem (current/voltage measurement, ADCs, and protection signaling) is often positioned close to the power stage, where switching noise and large common-mode transients are most severe. Si86Px is designed to simplify the creation of a compact, isolated sensing island by combining signal isolation and isolated power generation in one device, directly targeting the common bottleneck of having to build and qualify a separate isolated bias supply.

Collapsing the Isolated Island: Signal and Power in a Single Package

A recurring EV charger design penalty is the isolated side power rail: without an available bias on the high-voltage referenced side, designers often add an isolated module or transformer-based supply just to run the sensing circuitry. Si86Px integrates an isolated dc-dc converter and matched miniature transformer alongside the digital isolation channels, enabling the isolated sensing domain to be powered directly from the device rather than from external magnetics. This integration reduces PCB area and BOM cost and removes a major source of layout iteration (transformer placement, switching loops, and EMI surprises related to magnetics).

Power Integrity for Precision Sensing and Why Regulation Matters

Sensing accuracy is frequently limited by rail quality, especially when ADCs and analog front ends share supply noise with switching activity. Si86Px is aimed specifically to provide a well-regulated

isolated rail for sensitive loads, highlighting 0.1% typical load regulation as a key benefit for powering ADCs and sensors in high performance systems. The converter architecture features hysteretic control with frequency dithering to reduce EMI, supporting the need for clean sensing rails in noise-dense power electronics layouts. The device is also specified to deliver up to 0.5 W of isolated power, which is typically sufficient for an ADC, signal conditioning, and digital interface island in an EV charger measurement chain.

Data Integrity Under High dV/dt Stress

EV fast charger power stages create large and fast common-mode events that can corrupt isolated interfaces if transient immunity is insufficient. Si86Px addresses this by specifying 100 kV/µs minimum CMTI and high-speed channel capability up to 150 Mbps, enabling robust transfer of telemetry and time sensitive status signals in electrically noisy environments. For control loops and synchronized sampling, 15 ns maximum propagation delay helps minimize timing uncertainty added by the isolation barrier.

Predictable Behavior in Fault and Thermal Stress Conditions

Isolated power islands must behave safely under overloads and abnormal conditions; otherwise, the sensing island can become a hidden reliability risk. Si86Px includes power transfer protection features such as overtemperature detection and thermal shutdown in the power circuitry, including a bidirectional mechanism where the output side overtemperature condition can disable power transfer on the input side. There are other safeguards for fault scenarios (e.g., timeout monitoring of feedback activity and output overvoltage clamping), improving robustness when the isolated domain experiences shorts or feedback disruption.

Resulting system impact: In EV chargers, Si86Px enables a smaller, more repeatable sensing subsystem by eliminating the separate isolated bias supply, while simultaneously supporting fast telemetry and high transient immunity needed near high-power switching nodes.

1.3 Technical Details

Block Diagram

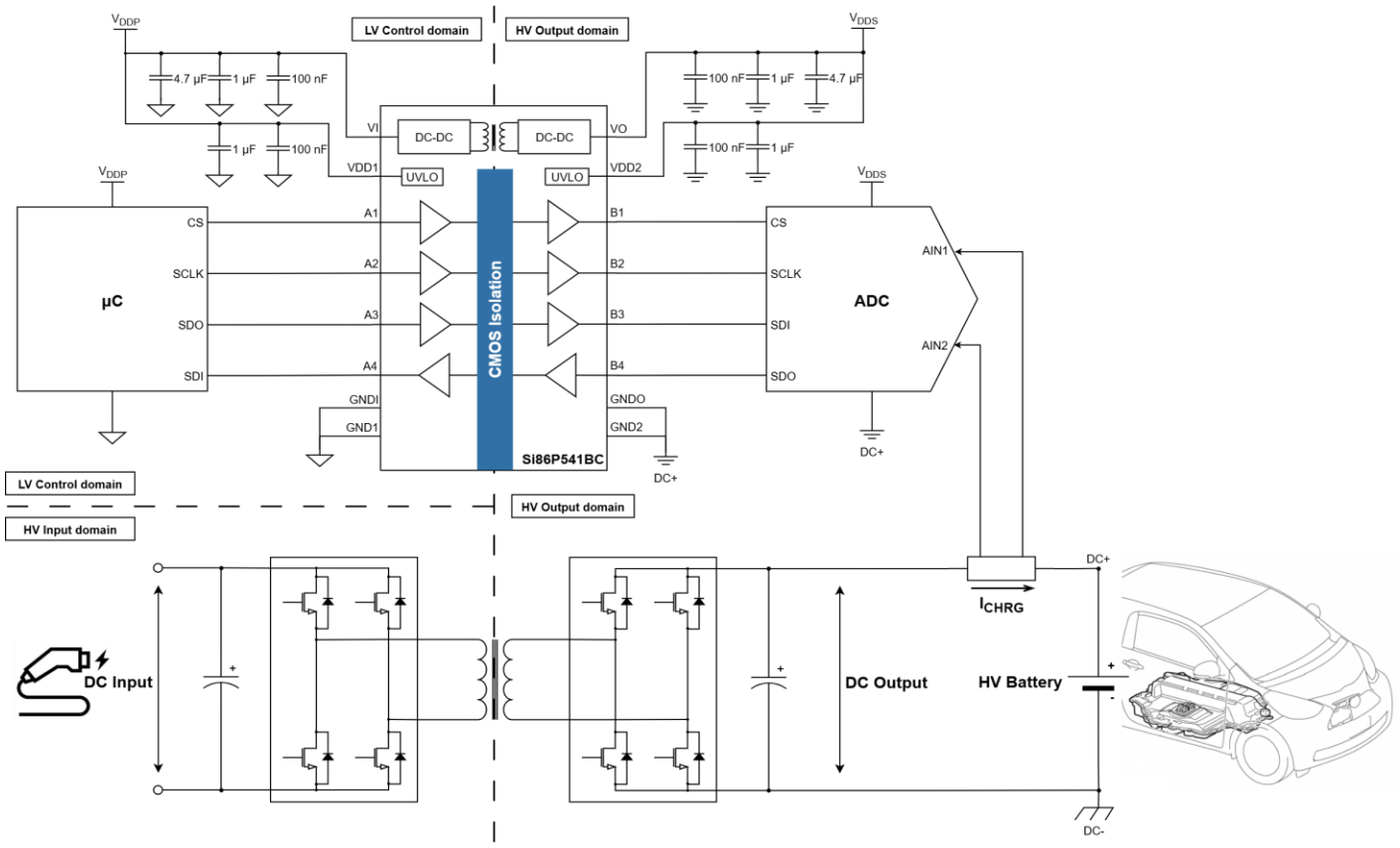


Figure 1. Example: High side charge current sensing in a DC fast charger

Recommended Signal-Channel Allocation

Typical Sensing Interfaces

- **4-wire SPI**: SCLK, MOSI, MISO, CS
- **3-wire SPI + IRQ/DRDY**: SCLK, MOSI, MISO + data ready / interrupt as the fourth channel
- **I²C**: SCL, SDA - dual-channel variants of Si86Px can be used to reduce pin count and footprint

Power tree implementation

- Treat Si86Px as two coupled subsystems:
    - Converter input supply: VI (primary side power for integrated dc-dc) with GNDI.
    - Signal isolator power supplies: VDD1 (controller side) and VDD2 (isolated side).

- Use VO (isolated converter output) and GNDO as the isolated rail/return and derive VDD2 from VO on the isolated side.
- Do not drive VDD2 from an external supply independent of the device
    - VDD2 is intended to be powered exclusively by VO.
- Select a VI/VO combination appropriate to your island rail needs
    - Options include fixed 3.3 V input to 3.3 V output, flexible 3.3–5.0 V input to 3.3 V output, and fixed 5.0 V input to 5.0 V output depending on variant.
- Budget isolated power with realistic expectations: Si86Px is positioned for up to 0.5 W isolated output and emphasizes tight regulation (e.g., 0.1% typical load regulation) for sensitive loads like ADCs and sensors.

Layout and EMI Guidance

- Partition the PCB into domains: keep the controller ground physically separated from the isolated ground, and route signals into/out of the package without crossing the barrier region.
- Place decoupling capacitors tight to pins (short loops) on:
    - VI–GNDI, VO–GNDO, VDD1–GND1, VDD2–GND2 to control transient currents and limit emissions. (Si86Px is designed to require minimal external components beyond decoupling in typical use.)
- Route isolated digital lines away from switching nodes and high dV/dt copper. Si86Px has a high, 100 kV/µs minimum CMTI, but layout still determines how much common-mode energy couples into I/O structures.
- If you are chasing emissions margin, note the converter offers hysteretic control with frequency dithering for reduced EMI – still, placement/loop control remains the dominant lever at board level.

Protection and Fault Behavior Notes

- Leverage the integrated safety mechanisms in the power transfer path: Si86Px includes thermal detection and a bidirectional shutdown mechanism for the power circuitry (input side shutdown locally; output side can signal across the barrier).
- The data sheet also describes overvoltage clamping behavior on VO and a timeout behavior if feedback activity is lost – both relevant to charger fault cases where the island might be shorted or disturbed.

2. Application: Industry 4.0 PLC Module: Isolated RS-485

2.1 The Challenge

System Context

PLC and remote I/O modules connect controllers to the factory floor through long cables, field wiring, and distributed power domains. RS-485 remains widely used in industrial and instrumentation communications because it supports long links and differential signaling, and it tolerates some ground potential differences. However, those same long cables and field connections act as antennas and conduits for disturbances, placing the I/O interface in the highest-risk zone for EMC events and transient stress.

Core Challenge: Survive and Communicate Through Real-World EMC Stress

Industrial RS-485 links must operate in harsh electromagnetic environments where lightning, ESD, electrical fast transients (EFT), and surge events can damage ports or cause repeated communication faults. Meeting EMC requirements is not just about protection components; it requires architectural choices that consider transient immunity early, because leaving EMC to the end of the design cycle can cause schedule and budget overruns.

Key design challenges

1. **Conducted transients on signal/control ports**
   EFTs are high-frequency electrical disturbances caused mainly by the arcing that occurs when inductive loads (like relays, motors, or circuit breakers) are switched off. They consist of repetitive, fast-rising voltage spikes (bursts) that can disrupt or damage sensitive electronic devices. In practice, these bursts can manifest as unexplained resets, dropped packets, or intermittent faults - failure modes that are very difficult to reproduce in the lab.

2. **Port protection complexity vs. performance**
   Protecting RS-485 for ESD/EFT/surge often requires a coordinated stack of TVS diodes, series resistors, MOVs, or other protection elements. This increases component count, and layout sensitivity, and can degrade signal integrity if not carefully engineered.

3. **Ground potential differences and isolation strategy**
   While RS-485 tolerates a defined common-mode range, real installations can exceed assumptions due to grounding practices and long runs, motivating isolation between the controller logic ground and the field/cable domain. Isolation breaks ground loops and

improves robustness, but it introduces the next challenge: how to power the isolated field side reliably and compactly.

4. **Field side power**
   Many PLC/remote I/O designs isolate the transceiver side for robustness; then they discover the transceiver and termination/bias network still need a stable supply referenced to the isolated ground. If that supply requires a separate isolated module, the design can bloat in size and complexity - undesirable in high channel-density I/O.

5. **Reliability expectations in harsh industrial environments**
   Industrial equipment must operate for long lifetimes amid strong electromagnetic fields and frequent transients, requiring isolation circuits that deliver error-free behavior under surges and noise.

Implication for Architecture

PLC and remote I/O interfaces are ultimately constrained by the combined burden of EMC robustness, isolation strategy, and providing a clean isolated rail for the field side interface, while keeping the solution compact and manufacturable at scale.

2.2 Si86Px Delivers

PLC and remote I/O modules operate at the boundary between sensitive controller electronics and the harsh factory environment, where long cables and field wiring carry both intended signals and unwanted transients. RS-485 networks must survive EMC stresses such as ESD, EFT (burst), and surge events, and designers are advised to treat EMC as an architectural requirement early to avoid cost and schedule overruns. In this setting, galvanic isolation helps break ground loops and improve robustness, but it immediately creates the companion problem of powering the isolated transceiver and field side circuitry. Si86Px is purpose-built for exactly this combined requirement: isolated data channels plus an integrated isolated supply rail in a compact package.

Solving the Field side Power Problem Cleanly

Many PLC fieldbus architectures isolate the transceiver side to manage ground shifts and noise coupling but then require an isolated dc-dc module or discrete transformer solution to power the field side transceiver and bias network. Si86Px integrates the isolated converter and transformer and can deliver up to 0.5 W of isolated power, enabling the transceiver side supply to be derived directly from the same device providing signal isolation. The product positioning explicitly targets space-constrained designs by removing the need for external power components and magnetics.

Enabling Robust Control/Data Signaling to the Transceiver

A practical RS-485 node needs more than just TX/RX; it also needs direction and enable control (DE, /RE) and sometimes fault or status lines. Si86Px provides dual and quad channel variants to isolate these signals in common PLC use cases while maintaining high speed headroom (up to 150 Mbps) and low latency (15 ns max). This helps preserve protocol timing margins and reduces the risk that isolation becomes the limiting factor in communication robustness.

Resilience in High-Noise Industrial Environments

Industrial RS-485 ports are exposed to fast transients and other disturbances that can cause data errors, resets, or intermittent failures. While system-level surge/ESD protection remains necessary, the isolation device must maintain data integrity during large common-mode events and rapid ground shifts across the isolation barrier. Si86Px specifies 100 kV/µs minimum CMTI, supporting robust isolation channel behavior in electrically noisy installations such as motor control cabinets and switching panels.

Simplifying EMC and Thermal Integration for Manufacturable I/O Density

PLC modules frequently compete on channel density and footprint, which magnifies the cost of additional isolated supplies and their EMI containment. Si86Px uses a converter approach using hysteretic control and frequency dithering for reduced EMI and integrates thermal protection mechanisms in the power transfer path, reducing system-level "unknowns" that typically appear late in validation. Its wide body SOIC options also support straightforward assembly and consistent isolation spacing for industrial production.

Resulting system impact: In PLC or remote I/O fieldbus designs, Si86Px reduces the isolation subsystem to a compact integrated solution that addresses both data and power needs, supporting higher density, fewer components, and more predictable EMC performance.

2.3 Technical details

Block Diagram

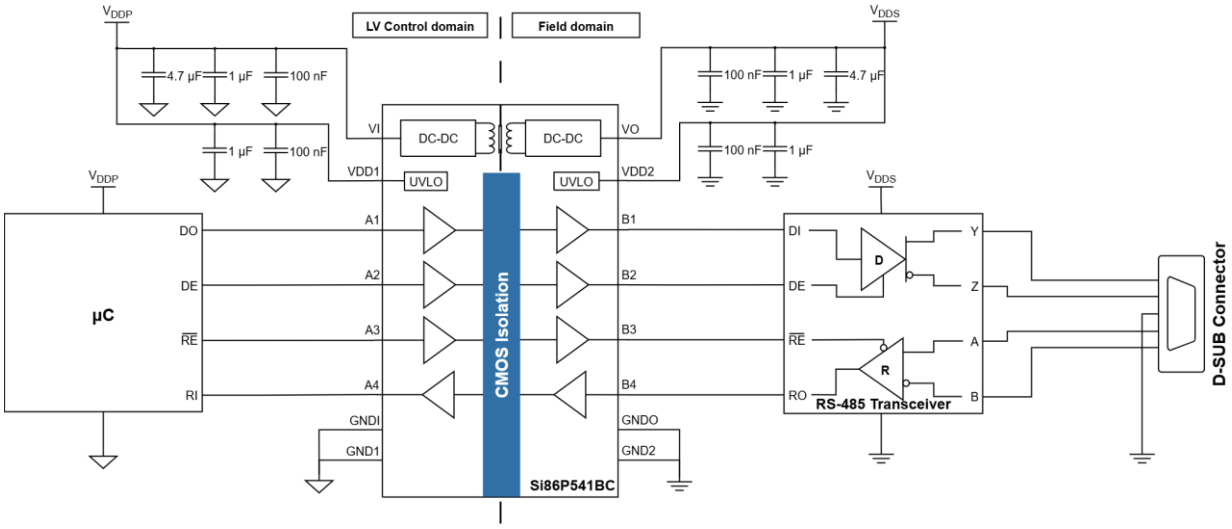


Figure 2. Example: Isolated RS-485 communication interface

Recommended Signal-Channel Allocation

A typical RS-485 transceiver control interface usually requires:

- **DI (TXD)** from MCU to transceiver
- **RO (RXD)** from transceiver to MCU
- **DE** (driver enable) and
- **RE** (receiver enable)

This maps naturally onto four isolated channels.

Power Tree Implementation

- Use VI-GNDI from the PLC logic rail (3.3 V or 5 V depending on variant) to feed the integrated converter and generate VO-GNDO on the isolated side.
- Power the field side logic supply VDD2 from VO, per datasheet guidance.
- Do not drive VDD2 from an external supply independent of the device
    - VDD2 is intended to be powered exclusively by VO.

- Feed the RS-485 transceiver VDD from VO as well, keeping all field side components referenced to GNDO.
    - For local decoupling needs at the transceiver, follow transceiver manufacturer recommendations.

Layout and EMI Guidance

- Treat the connector/cable interface as an EMI source: keep TVS/protection parts close to the connector and route differential signals A-B and Y-Z as a controlled pair where possible.
- Maintain a clean domain split around the isolator: controller side copper/pours should not "creep" into the field side region; avoid stitching grounds across the isolation barrier.
- Place decoupling close to VI/VO and VDD1/VDD2 pins. PLC layouts often fail EFT immunity due to long return loops and poorly controlled high-frequency currents.
- 100 kV/µs minimum CMTI of Si86Px makes it robust but remember: cable-induced events are often system-level and still require proper port protection and grounding strategy.

Thermal and Fault-Behavior

- Field wiring mistakes can overload the isolated rail or transceiver supply. Si86Px includes thermal shutdown for the power path and additional fault-handling mechanisms described in the data sheet (e.g. timeout monitoring and overvoltage clamp behavior).

3. Application: Robotics/Servo Drives: Isolated Encoder Interface

3.1 The Challenge

System Context

Industrial automation and robotics platforms increasingly rely on distributed motion subsystems - servo drives, motor modules, and remote feedback devices - where control electronics must operate reliably alongside high-current switching hardware and inductive loads. In these environments, it is common for low-voltage controllers (MCU/FPGA/SoC) to interface with feedback and I/O elements that may be physically close to motor phases, power converters, relays, and solenoids, creating persistent requirements for robust signal integrity and safe domain separation.

Core Challenge: Deterministic Feedback/Control in the Presence of Strong Electrical Disturbances

Motion systems depend on timely, correct feedback to maintain stability and precision. At the same time, industrial environments are characterized by strong electromagnetic fields, surges, fast transients, and elevated noise floors, all of which can challenge the reliability of interface circuits that bridge between "quiet" control logic and "noisy" motor/power domains. When disturbances couple into feedback lines or reference grounds, the result is often not a clean failure but intermittent symptoms: missed edges, spurious transitions, corrupted packets, or sudden fault trips that are difficult to reproduce and debug.

Key Design Challenges

1. **Encoder and sensor lines are timing-sensitive and noise-susceptible**
   Servo loops and robotics feedback can involve high edge rates and tight timing margins, whether the interface is a set of digital lines (incremental feedback, index/strobe, enable/fault) or a digital bus feeding a sensor/ADC hub. The difficulty is that motor drives and associated power hardware can generate large dv/dt events and broadband EMI that couples capacitively and inductively into signal routing. Even when shielding and cabling are well executed, the interface must tolerate common-mode disturbances without false switching or timing distortion that can destabilize the loop or degrade motion quality.

2. **Ground potential differences and ground loops across distributed mechanics**
   Robotics platforms are physically distributed: motors, sensors, and controllers may be separated by cabling and machine structures. That distribution makes grounding a major practical constraint - ground potential differences and unintended current return paths can

inject error into feedback and I/O signals. Engineers frequently find that logic-level signaling is not sufficient when reference grounds move relative to each other during switching events or load changes, resulting in unpredictable behavior.

3. **Protection and robustness must coexist with compact integration**
   Robotics and servo drives are trending toward higher channel density and smaller form factors, pushing interface circuitry into tight PCB areas near noisy power sections. In this regime, achieving robust immunity often requires more than adding protection components; it becomes a system level exercise in partitioning, routing discipline, and minimizing the susceptibility of high-impedance nodes and timing critical nets. As channel density increases, the cost of each additional component (and each additional layout constraint) compounds quickly - especially in multi-axis motion systems implemented across many boards.

4. **Isolated side power can be a hidden complexity for remote sensing islands**
   In many servo architectures, a portion of the interface circuitry is placed near the motor or sensor head for signal conditioning and noise control. That circuitry needs a stable local supply, but it may not share the same ground as the main controller and may not have an easily available power source referenced to its local domain. Providing this power can lead to added converters, magnetics, or modules - each introducing EMI, thermal considerations, and additional validation effort.

5. **Long-term reliability expectations under harsh operating conditions**
   Industrial automation equipment is expected to run for long service lifetimes in harsh electrical environments. Guidance around industrial isolation emphasizes that strong fields, surges, and fast transients are usual, meaning that the interface solution must deliver robust, error free behavior not only in the lab but across years of field operation. Traditional approaches can suffer from parameter variation with temperature and age (particularly in legacy isolation solutions), which makes timing and noise margins difficult to guarantee without overdesign.

Implication for Architecture

In robotics and servo drive systems, the engineering burden is often dominated by the boundary between the control domain and the motor/sensor domain: maintaining deterministic timing, avoiding noise-triggered faults, managing grounding realities, and supplying any remote sensing/interface circuitry without expanding the BOM or the EMI footprint. The most successful architectures treat these requirements as first-order constraints early in the design cycle as late stage fixes (extra filtering, reroutes, bolt-on protection) tend to increase size, cost, and schedule risk, especially in multi-axis platforms.

3.2 Si86Px Delivers

Servo drives and robotics systems increasingly demand compact, high performance control electronics operating adjacent to motor phases, inverters, and switching power supplies - an environment defined by strong EMI and frequent transient events. In many architectures, the encoder interface or sensor head is physically near the motor, and isolation is used to protect the controller, break ground loops, and maintain signal integrity despite ground potential differences and switching noise. Si86Px aligns with this "sensor/encoder island" problem by integrating isolated power generation with multi-channel high-speed isolation in a compact wide body package.

Enabling a Powered Isolated Interface Close to the Motor

A persistent integration problem in servo systems is that isolating the interface is only half the job; the isolated side still needs a stable supply referenced to the isolated ground. Si86Px provides the isolated power path on-chip with a matched miniature transformer, delivering a reliable isolated rail without external magnetics, which is especially valuable in dense servo control enclosures. With up to 0.5 W isolated output capability, a typical encoder/sensor interface (line receivers, level translation, small logic, ADC) can be powered directly from the isolated output.

Deterministic High-Speed Isolation for Motion Control Signaling

Robotics and servo control benefit from predictable timing and low latency in feedback paths, even when the physical signaling is relatively simple (GPIO, encoder status, SPI for sensor hubs). Si86Px supports high-speed data transfer up to 150 Mbps with 15 ns maximum propagation delay, limiting the isolation device's contribution to timing uncertainty in closed-loop systems. The family offers dual and quad channel options, enabling practical mapping for common servo I/O groupings (e.g., multiple encoder lines plus an enable/status line).

Immunity to Common-Mode Transients near Inverters

Inverter switching and motor cabling can generate fast common-mode disturbances that stress any interface crossing between grounds. Si86Px specifies 100 kV/µs minimum CMTI, a key enabler for maintaining data integrity when the encoder/sensor domain experiences rapid voltage shifts relative to the controller domain. The device family is also positioned for strong EMI immunity and reliable isolation, reflecting the design intent for noisy industrial environments such as motor control.

Power Rail Quality and EMI Behavior in Compact Servo Electronics

In servo drives, the isolated rail frequently powers components that are sensitive to supply variation (line receivers, sensor hubs, ADC references). Si86Px emphasizes fast and accurate regulation and uses a converter scheme with hysteretic control and frequency dithering to reduce EMI, improving the odds of first-pass EMC success in tightly packed motor-control assemblies. The package options

(16 or 20 pin WB SOIC) also support simplified manufacturing and robust isolation spacing for industrial designs.

Robustness Under Thermal Stress and Fault Conditions

Servo drives can experience elevated operating temperatures and localized heating near power components. Si86Px incorporates thermal detection and shutdown functionality for the power transfer circuitry (including bidirectional signaling of overtemperature conditions), supporting safer behavior when the isolated island or its load is stressed. Its operating range of –40 °C to +125 °C further aligns with industrial motion control environments.

Resulting system impact: In servo/robotics designs, Si86Px enables the creation of a compact, powered isolated interface close to the motor, with high transient immunity and predictable timing, reducing both the component overhead and the integration risk traditionally associated with encoder interface implementations.

3.3 Technical Details

Block Diagram

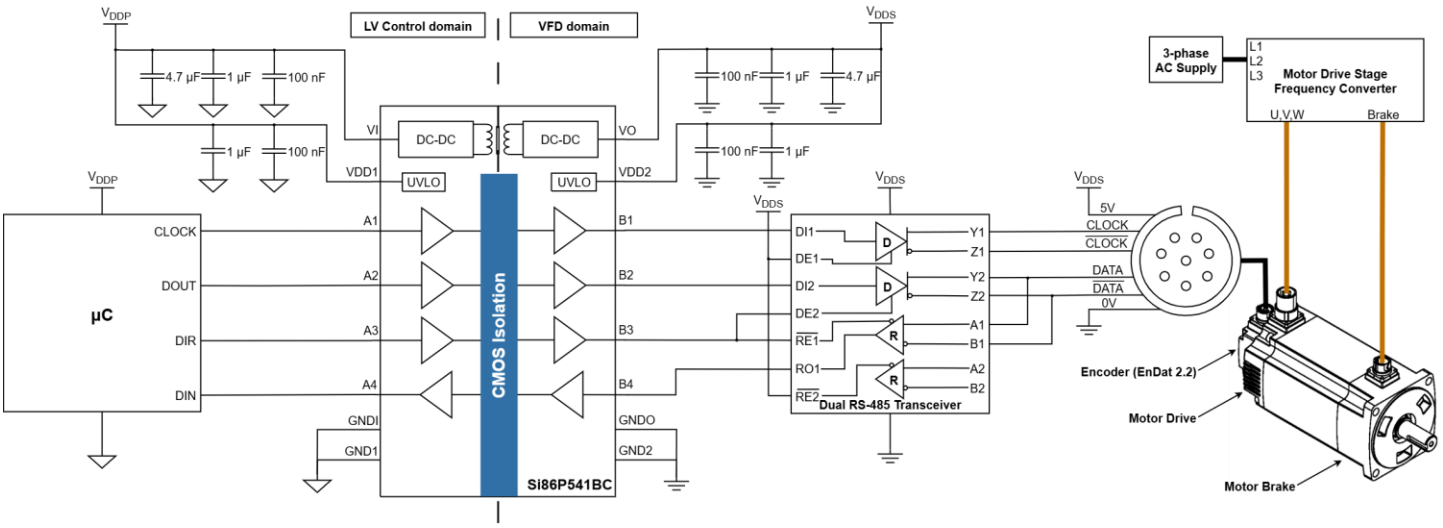


Figure 3. Example: Isolated EnDat 2.2 interface for absolute encoders (differential clock, half-duplex data)

Recommended Channel Allocation

Typical servo interfaces requiring isolation:

- **Absolute encoder interfaces:**
    - EnDat 2.2: CLOCK, DIN, DOUT, DIR
    - BiSS: MA, SL - dual-channel variants of Si86Px can be used to reduce footprint
- **Sensor hub:** SPI (SCLK/MOSI/MISO/CS) to a motor-adjacent sensor/ADC hub (similar to the remote sensing implementation described at the EV fast charger application)

Power tree implementation

- Use VI-GNDI from the controller domain (5 V required) and generate VO-GNDO to power the encoder/sensor interface circuitry.
- Power VDD2 from VO and keep the isolated side referenced to GNDO throughout the encoder/sensor island.

Layout and EMI Guidance

- Servo drive boards are often space constrained, so apply a strict "two islands" layout: controller domain and motor/encoder domain separated by the isolation barrier region; route each side's return currents only within its domain.
- Keep the isolated rail's high-frequency current loops small with tight VO–GNDO decoupling near the device and near the remote interface ICs (transceivers, sensor hub, etc.).
- In motor control environments, fast inverter edges create common-mode transients. Si86Px specifies 100 kV/µs minimum CMTI, which is directly relevant for encoder/sensor signal integrity in noisy installations.
- Enforce clean return paths and avoid routing sensitive signals parallel to switching nodes or gate drive traces. The power converter in Si86Px offers hysteretic control with frequency dithering to aid in reducing the overall EMI.

Thermal and Reliability Notes

- Si86Px targets harsh environments with –40 °C to +125 °C operation and includes integrated thermal detection and bidirectional thermal shutdown in the power transfer circuitry, supporting more predictable behavior in hot servo enclosures.

Conclusion

The examples in this whitepaper demonstrate that the most scalable approach is to treat isolation as a complete subsystem, addressing power transfer, signal channels, protection behavior, and EMI/thermal integration together. Si86Px embodies this approach by combining high-speed digital isolation with integrated isolated power transfer in a single compact device, enabling designers to reduce external magnetics, simplify the isolated power tree, and minimize layout iterations tied to transformer placement, switching loop containment, and secondary rail stability. Equally important, a consistent implementation model (clear power tree rules, disciplined domain separation, and validation focused on transients and load steps) helps convert isolation from a late stage risk into a repeatable design element.

Ultimately, Si86Px enables more than just galvanic isolation. It helps reduce size and BOM while improving time-to-market and first pass robustness: cleaner isolated sensing rails for precision measurement in EV chargers, simpler and denser industrial communications modules in PLC systems, and more reliable motion control interfaces. By integrating both signal and power isolation into one subsystem, Si86Px gives designers a practical path to building smaller, more robust, and more repeatable isolated architectures in some of today's most demanding applications.

Key Takeaways

- **Isolation is a system problem, not a single component choice:** Robust designs require signal isolation, isolated side power delivery, EMC behavior, and thermal/fault response to be addressed together.
- **The isolated side power rail is often the true bottleneck:** Supplying a stable isolated rail for ADC/sensor islands or field side transceivers frequently dominates PCB area, BOM, and debug effort more than the data barrier itself.
- **High-noise environments demand both immunity and disciplined layout:** Fast transients from power stages, motor drives, and long cables require careful domain partitioning, short decoupling loops, and controlled routing, especially near high dV/dt copper.
- **First-pass success improves when validation mirrors real stress:** Verify isolated rail behavior under load steps and temperature and validate data integrity under switching noise and field disturbances instead of only in nominal bench conditions.
- **Si86Px delivers value beyond component consolidation:** By reducing external magnetics, simplifying isolated-domain power delivery, and supporting robust high-speed communication, Si86Px helps designers build smaller, cleaner, and more reliable isolated systems across demanding end applications.

More Info

For more information about Si86Px, check out our webpage at Skyworks | Si86Px Digital Isolators.

Evaluation kit for the isolator featured in the application examples is available at the distributors. Technical details on the evaluation kit are also available on our webpage: Skyworks | Product Details - Si86P541BC-IS / Si86P541BC-ISR.



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