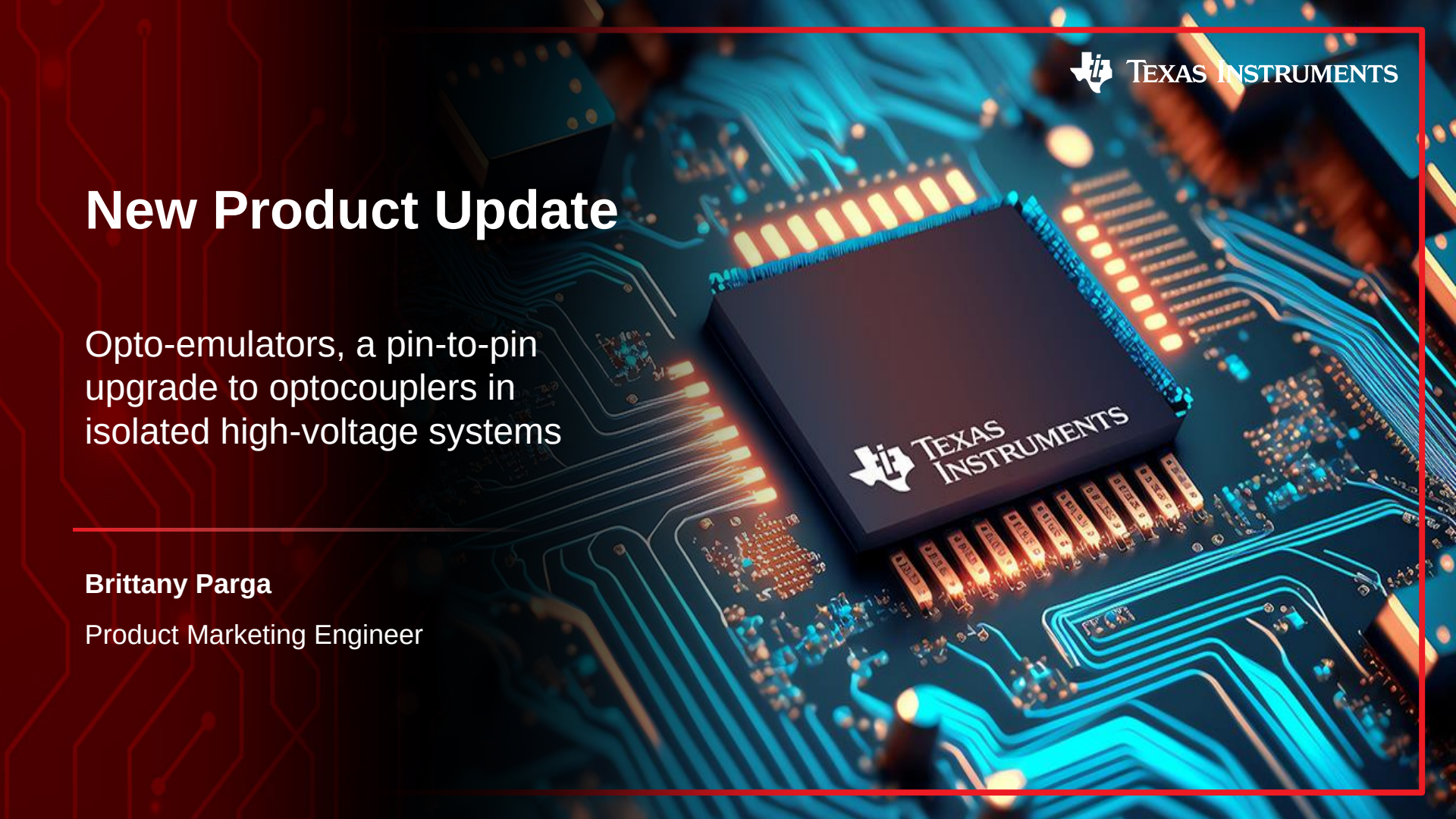
New Product Update

Opto-emulators, a pin-to-pin upgrade to optocouplers in isolated high-voltage systems



Brittany Parga

Product Marketing Engineer

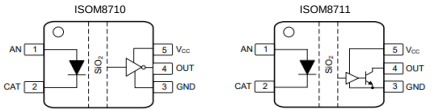
Agenda

- What are opto-emulators?
- System-level benefits of opto-emulators
- TI's opto-emulator family overview

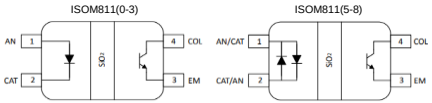
INT- ISO | Opto-emulators to replace optocouplers

Opto-emulators to replace traditional optos

- **Cost competitive to optocouplers**
- ISOM87xx: High speed digital



- ISOM81xx: Open collector analog

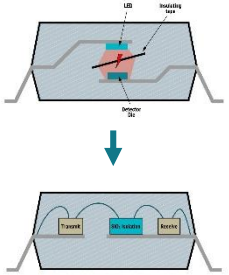


New package development

- **New SO4/SO5** packaging options to be pin-to-pin with existing optocouplers
- Allows for seamless adoption into existing designs

New circuit and process technology

- **Proven analog behavior to look and feel like an optocoupler**
- Current-input diode emulation
- SiO_2 Isolation barrier with strong life-time and HV performance
- Higher CMTI and reliability



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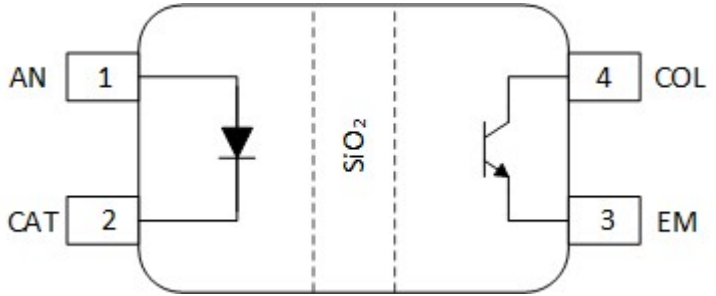
TI's SiO2 Isolation technology

TI's opto-emulator isolators use a diode-input and transistor-output structure separated by a **SiO_2 insulation barrier**



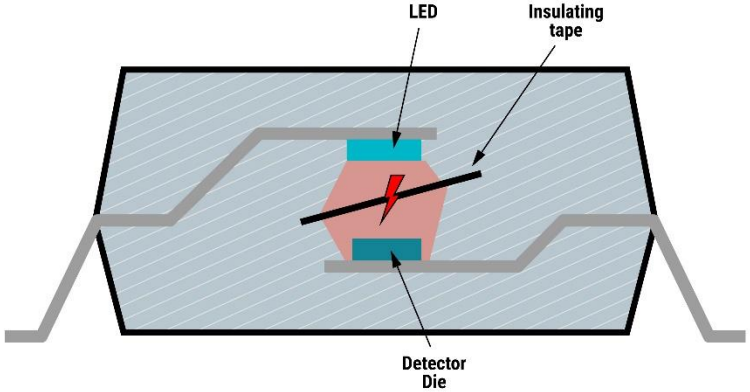
Manufactured and thoroughly tested in a controlled environment to ensure highest quality of isolation products

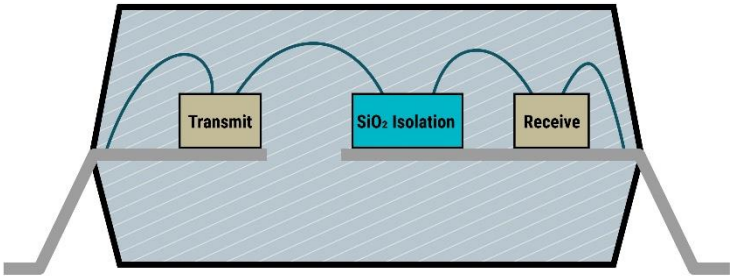
Silicon dioxide (SiO_2) offers the **highest** dielectric strength in the industry

Insulator Materials	Dielectric Strength
Air	~1 Vrms/µm
Epoxies	~20 Vrms/µm
Silica filled Mold Compounds	~100 Vrms/µm
Polyimide	~300 Vrms/µm
SiO_2	~500 Vrms/µm

Unlike polyimide and other polymer based insulators, the reliability of an SiO_2-insulated capacitor does not degrade with exposure to ambient moisture.

Transforming optocoupler designs with TI's SiO_2-based isolation technology





FROM

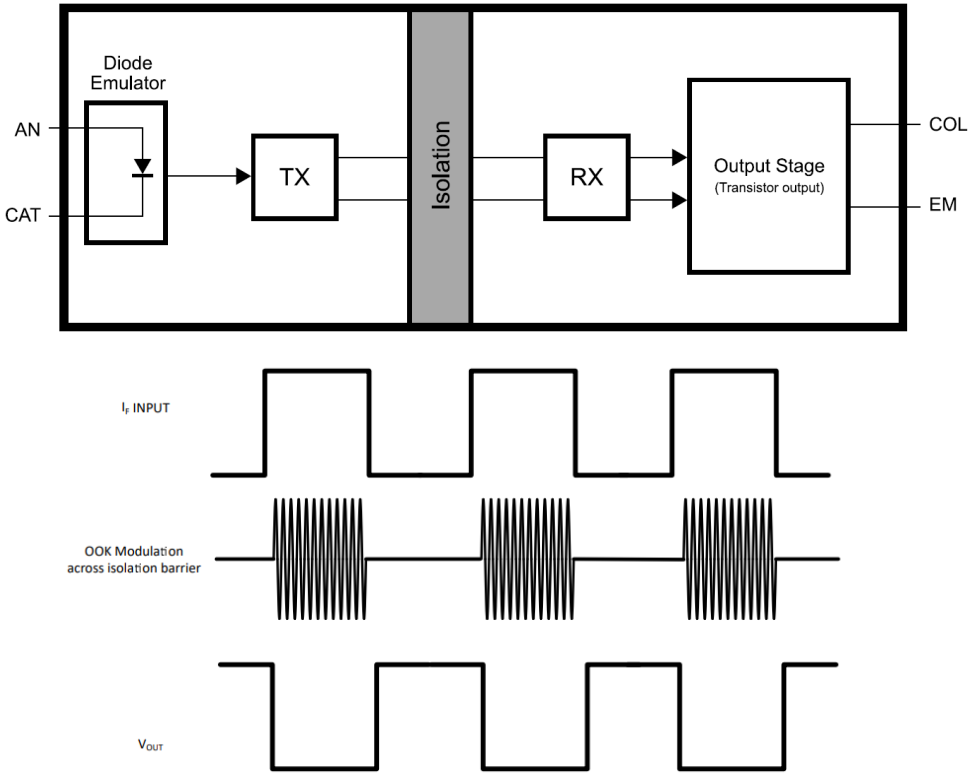
- LED signal transmission, affected by aging
- Dielectrics based on air, epoxies, or mold compounds
  - Air: 1 V_{RMS}/µm
  - Epoxies: 20 V_{RMS}/µm
  - Mold compounds: 100 V_{RMS}/µm
- Certified to IEC 60747-5-5, lifetime testing not required

TO

- Diode emulated, no LED required
- Dielectric based on silicon dioxide
  - SiO_2: 500 V_{RMS}/µm
- Certified to IEC 60747-17 with lifetime testing
  - Production high-voltage testing up to >2x higher

Opto-emulator signal chain

- The input signal is transmitted across the isolation barrier using an on-off keying (OOK) modulation scheme
- The transmitter sends a high frequency carrier across the barrier to represent one digital state and sends no signal to represent the other digital state
- The receiver demodulates the signal after advanced signal conditioning and produces the signal through the output stage
- These devices maximize CMTI performance and minimize radiated emissions



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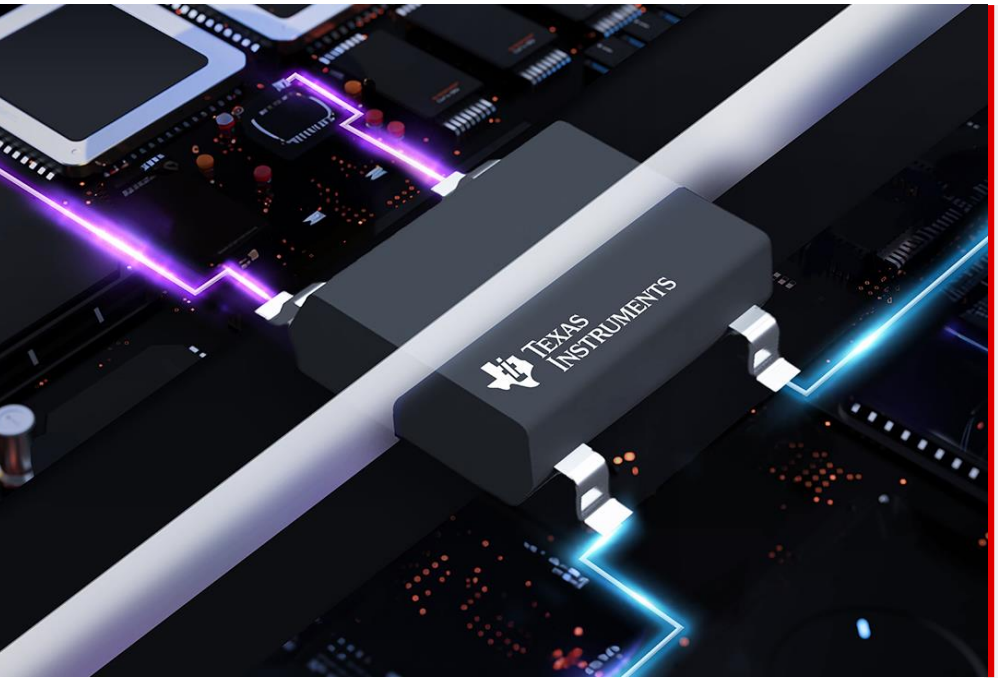
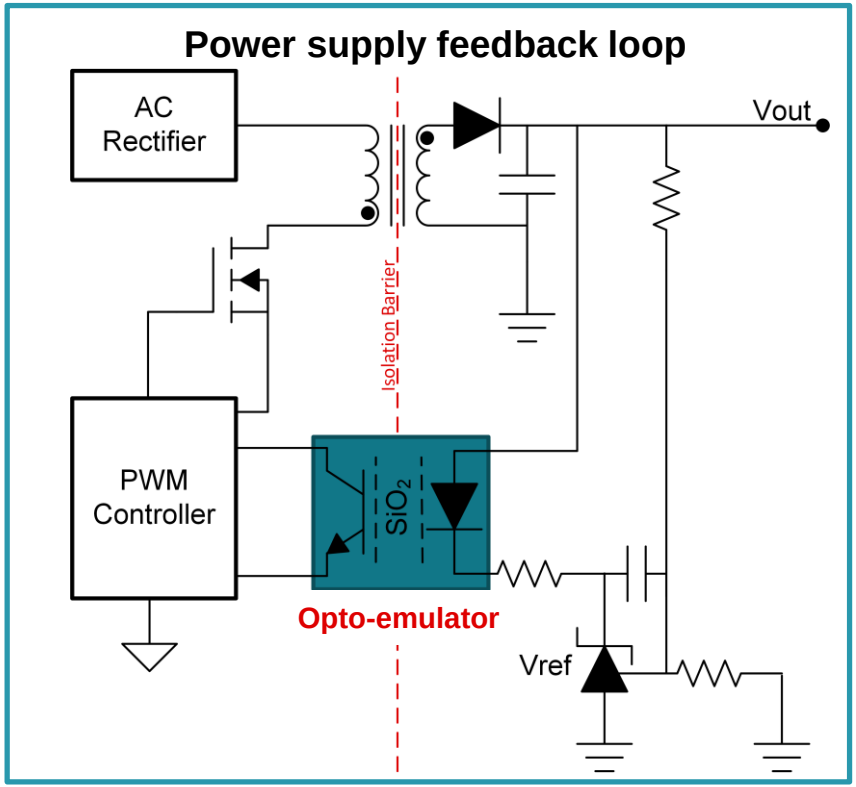
ISOM8xxx: Upgrade optocouplers with TI's new portfolio of opto-emulators



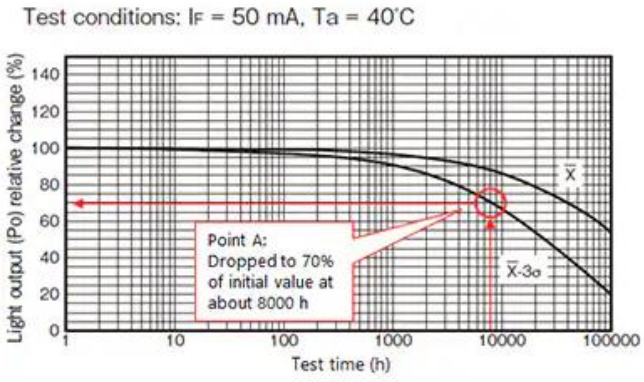
- **Pin-to-pin alternative to optocouplers**
- **Reduces power consumption up to 80%** utilizing a lower I_F threshold and supply current
- **Improved common mode transient immunity (CMTI)** – ISOM8710 features a typical CMTI of 150kV/µs
- **High data throughput** with up to 25 Mbps data rates for digital signals (ISOM8710). And high bandwidth of 680 kHz for analog signals (ISOM8110).
- **Stable and tight current transfer ratio (CTR)** over both temperature and lifetime
- **Temperature range** as wide as –55°C to +125°C

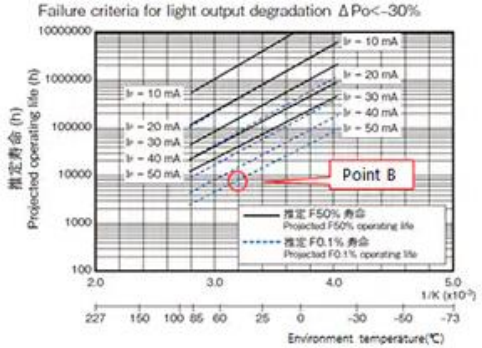
Reach new levels of system performance over lifetime

- **Flat CTR over temperature** ensures consistent output regulation in changing environments
- **Reduced part-to-part variation** enables improved designs for optimized efficiency
- **Wide bandwidth** enables improved load transient response and improves system cost by reducing requirements of output capacitor
- **Improved barrier lifetime** with SiO_2 insulation

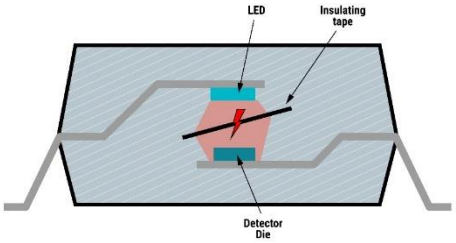


Optocoupler CTR vs. ISOM8xxx opto-emulator over time





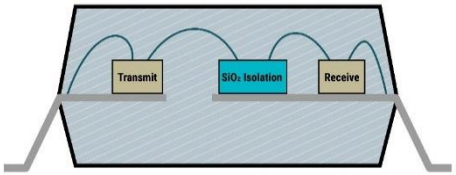
Example of aging variation of optical output of GaAs



LED optocoupler

- The LED in optocouplers dims over time, requiring a higher initial forward current to compensate for long-term aging performance
  - As shown above, optocoupler LED degradation can be 30% after **just 1 year** → requiring at least 30% increased current at time 0

Opto-emulators are based on electrical signals, so there is no LED aging
  - Forward current can be set to **minimum current at time 0 for reduced power consumption**



SiO2 opto-emulator

ISOM811x

3.75 kV_{RMS} opto-emulator with analog behavior in standard SO4 package

Product Folder

Features

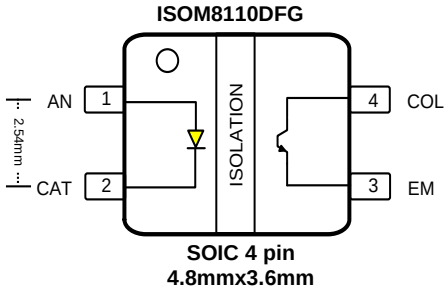
- **Isolation, immunity and certifications**
  - Isolation voltage: 3750 V_{RMS}
  - Working voltage: 707 V_{PK}
  - Creepage: ≥ 5 mm
- **Electrical characteristics**
  - Supports unidirectional and bidirectional DC input types
  - Propagation delay (TON/TOFF): 5 µs (typ)
  - Bandwidth: 680 kHz (max)
  - VCE voltage: 80 V (max)
  - Input current (I_F): 0.5 mA to 20 mA recommended
  - CTR: 100%-155%, 150%-230%, 255%-380%, and 385-570% at I_F = 5 mA
  - V_F range: 1.2 V (typ)
  - Operating temperature range: -55 ˚C to 125 ˚C
- **Configuration and package**
  - Open collector output
  - 1 Channel: 1/0
  - Small SO-4 package (4.8 mm width, 2.54 mm & 1.27 mm pitch)

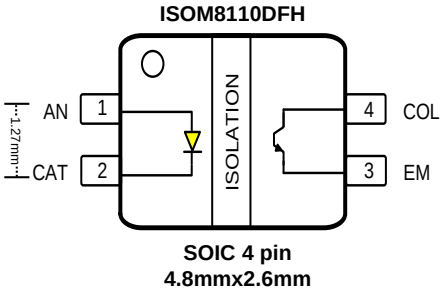
Applications

- PLC and motor drive I/O modules
- Isolated digital inputs
- Switching power supplies
- Building automation
- Automotive audio

Benefits

- Supports low input current (0.5 mA) with CTR 200% (max) for low power applications.
- Eliminate the need to overdesign your system to account for the LED aging effect
- Ease of design for feedback loop compensation with tighter CTR range
- Pin-to-pin drop-in upgrade to traditional optocoupler phototransistor parts





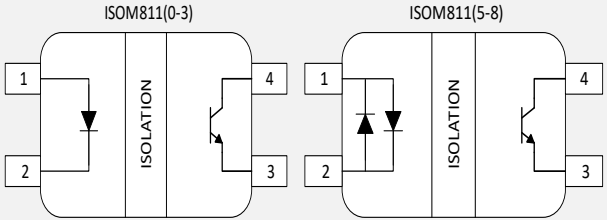
ISOM811x

3.75 kV_{RMS} opto-emulator with analog behavior in standard SO4 package

Product Folder

Features

- **Supports unidirectional and bidirectional DC input types**
- **Supports 4 different CTR variants**
  - Current transfer ratio (CTR) : at I_F = 5 mA, V_{CE} = 5 V
    - ISOM8110, ISOM8115 : 100% to 155%
    - ISOM8111, ISOM8116 : 150% to 230%
    - ISOM8112, ISOM8117 : 255% to 380%
    - ISOM8113, ISOM8118 : 375% to 560%



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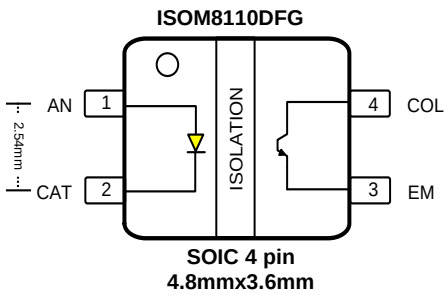
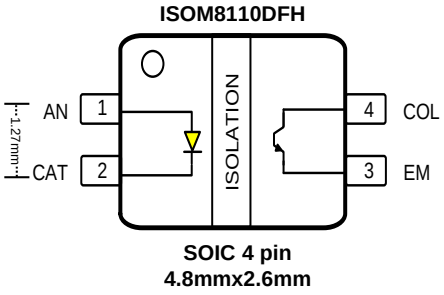




ISOM871x

Single-channel, 25 Mbps, high-speed opto-emulator in SO-5 package

Product folder

Features

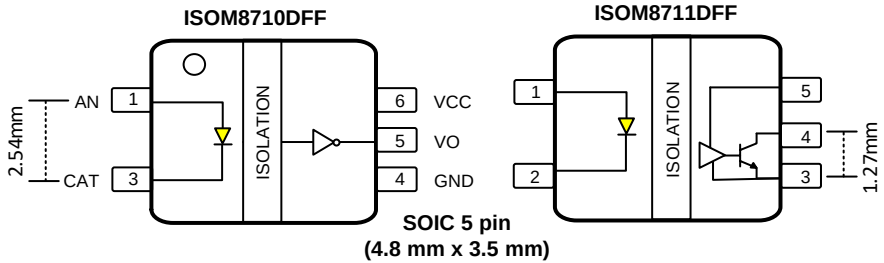
- **Isolation, immunity and certifications**
  - Isolation voltage: 3750 V_{RMS}
  - Working voltage: 707 V_{PK}
  - CMTI: 85 kV/µs (min) 100 kV/µs (typ.)
- **Electrical characteristics**
  - V_{cc} range supports 3.3 V and 5 V
  - Input forward voltage: 1.3 V (min) / 1.8 V (max)
  - Input forward current: 2 mA (min) / 20 mA (max)
  - Reverse input voltage: 5 V (min)
  - 25 Mbps max data rate
  - Prop delay: 47 ns (max)
  - Operating temperature range -40 °C to 125 °C
- **Configuration and package**
  - Two output options:
    - ISOM8710: Inverting, CMOS output
    - ISOM8711: Inverting, open collector output
  - Small SO-5 package (4.8 mm x 3.5 mm)

Applications

- PLC and motor drive I/O modules
- Digital isolation for A/D, D/A conversion
- Microprocessor or FPGA system interface
- Switching power supplies

Benefits

- **Industry-standard packages:** no redesign required
- **Pin-to-pin drop-in upgradable** to existing high-speed optocouplers for superior isolation reliability and lifetime.
- **Consume less system power than optocouplers** since there is no aging effect or temperature variation to compensate for.
- **Achieve enhanced signal integrity in harsh environments** with higher CMTI and wider temperature ratings than optocouplers.



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Getting started

You can start evaluating this device leveraging the following:

Content type	Content title	Link to content or more details
Product folder	TI.com/opto-emulators	ISOM8110 ISOM8710 | ISOM8711
Customer training series or webinar session	[FAQ] [H] Opto-Emulators - Top Questions, Answered	
Technical blog content or white paper	• Introduction to Opto-Emulators • Opto-emulators explained: Why you should upgrade your optocoupler technology • Replacing Optocouplers With Opto-Emulators • Demystifying Isolation Certification Standards: Optocouplers vs Opto-emulator • Isolated Secondary-Side Overvoltage Protection Using Opto-emulators • Isolating Feedback Signals in Power Supplies	
Selection and design tools and models	ISOM8110 PSpice Reference Design Model ISOM8710 IBIS Model | ISOM8710 Unencrypted SPICE Model Package ISOM8711 IBIS Model | ISOM8711 Unencrypted SPICE Model	
Development tool or evaluation kit	ISOM8110DFGEVM ISOM8710DFFEVM	

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