Welcome!
Texas Instruments New Product Update

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- Please post questions in the chat or contact your sales person or field applications engineer

New Product Update:
Integrated isolated data and power solutions achieve CISPR 32 Class B emissions compliance

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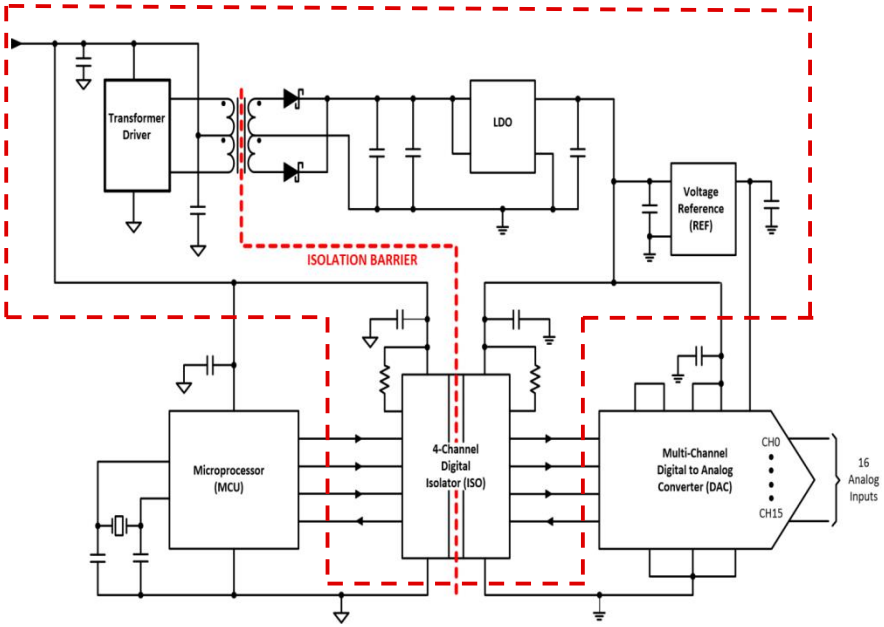
August 12th, 2021

Agenda

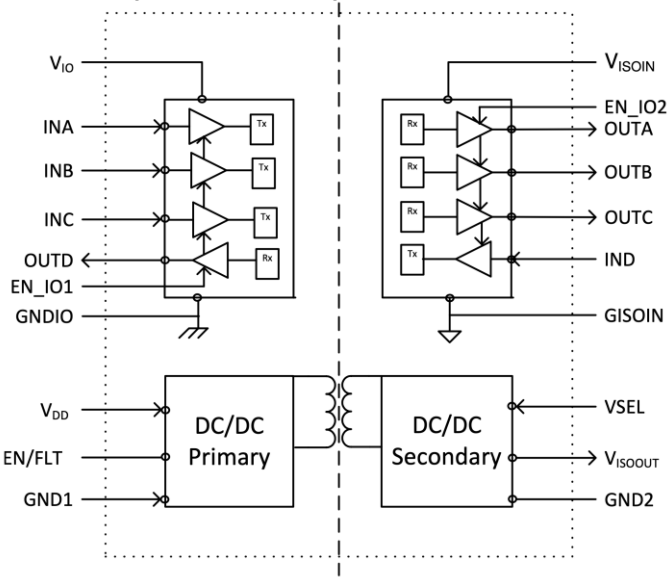
- Isolators with integrated DC-DC converter
- CISPR 32 emissions standard overview
- Common-mode and differential-mode current loops
- PCB layout design guidelines
  - Decoupling capacitors
  - Ferrite beads (FB)
  - Keep-out zones (KOZ)
- Radiated emissions testing guidelines
- Radiated emissions test results
- ISOW adaptor evaluation module

Isolators with integrated DC-DC converter



ISOW7741

Digital isolator with integrated DC-DC converter



Benefits of using integrated solutions

1. Simplicity of design and ease of system certification
2. Reduces product design cycle time
3. Reduces BOM and board space

Challenges of using integrated solutions

1. Higher switching frequency to reduce transformer size
2. Switching frequency falls into regulatory spectrum

ISOW7741

Reinforced digital isolator with low emissions isolated DC-DC converter

Features

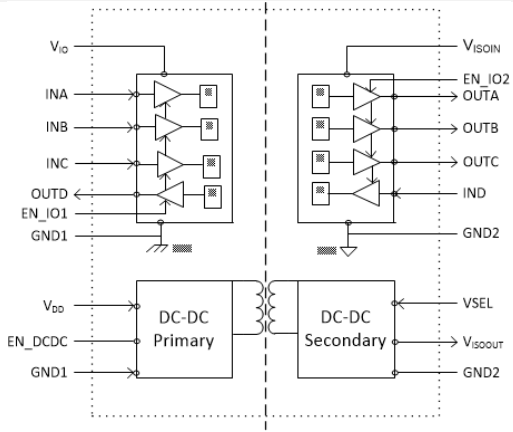
- **Lowest emission integrated isolated data and power**
  - 0.5 W power, high efficiency (45%)
  - Configurable input/output levels
    - 5 V to 5 V; 5 V to 3.3 V => 110 mA output
    - 3.3 V to 3.3 V => 60 mA output
  - Low output ripple: 24 mV
  - Stable line (2 mV/V) and load regulation (1%)
  - Enable DC-DC / fault pin, UVLO, overload, short circuit and thermal shutdown protection
  - Soft start for inrush current prevention
- **4 integrated digital isolation channels**
  - 100 Mbps, 10.7 ns typical prop-delay
- **Immunity and isolation certifications**
  - 5000 V_{RMS} isolation rating (UL 1577)
  - 10000 V_{pk} surge VDE reinforced isolation
  - 1000 V_{RMS} working voltage (DIN V VDE V 0884-11)
  - 100 kV/µs min CMTI
- **Power and package**
  - Input voltage: 3 V to 5 V, isolated output: 3.3 V / 5 V
  - Separate logic supply: 1.71 to 5.5 V
  - 20-pin wide SOIC package (>8.0 mm creepage)

Applications

- **Grid infrastructure**
- **Factory automation**
- **Building automation**
- **HVAC, motor drives**

Benefits

- Meets CISPR 32 Class A/B limits on 2-layer PCB without stitching cap / Y-cap
- Integrated isolated DC-DC converter with on chip transformers helps reduce board space considerably and eases certifications
- CMOS logic level support to interface with 1.8/2.5/3.3/5-V controllers and ASICs
- Integrated fault pin to monitor and safely shutdown DC-DC converter for voltage and temperature outside of operating range

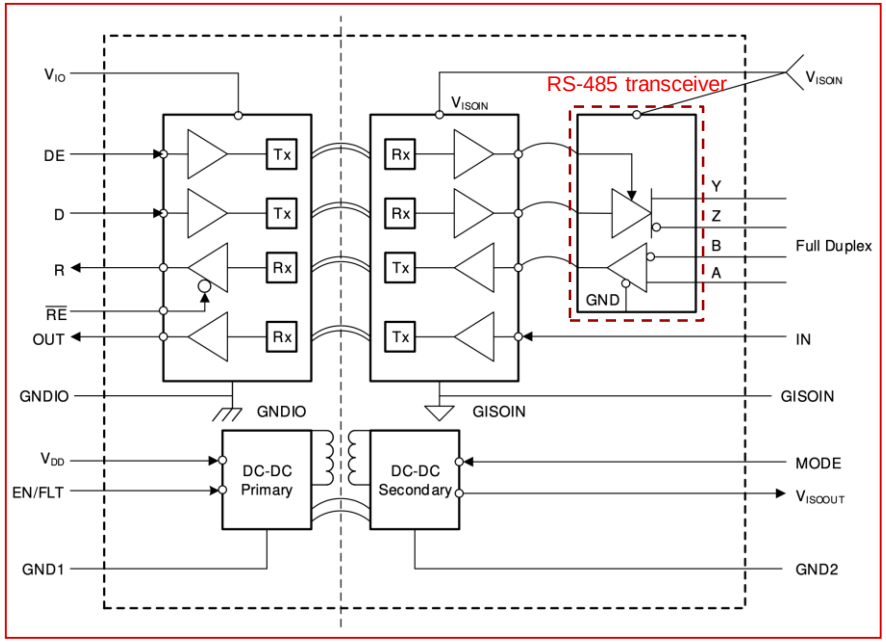


4-ch integrated isolated data and power

Isolators with integrated DC-DC converter

ISOW1412, ISOW1432

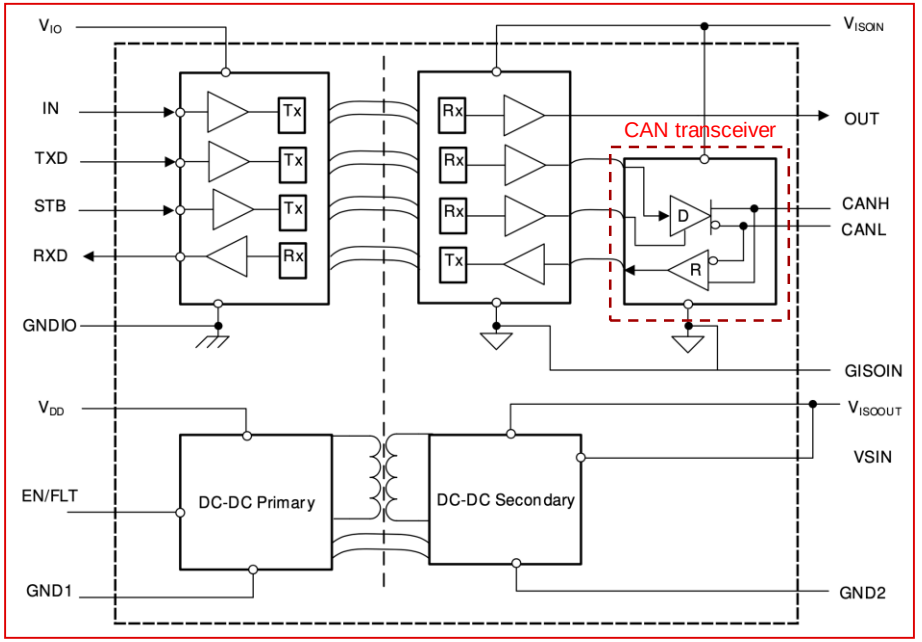
Isolated RS-485 transceiver with integrated DC-DC converter



Data rate: 12 Mbps, 500 kbps (2 speed options)

ISOW1044

Isolated CAN transceiver with integrated DC-DC converter



ISO 11898-2 compliant, support up to 5 Mbps CAN FD

ISOW14x2

Reinforced isolated RS-485 / PROFIBUS transceiver with integrated DC-DC converter

Features

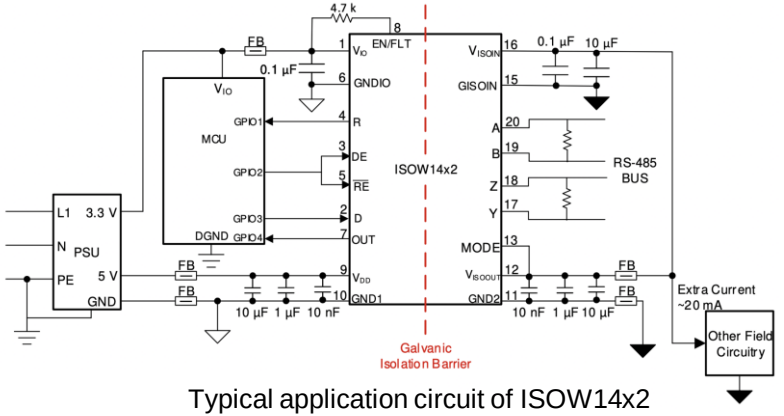
- **Integrated power**
  - 47% efficiency, low emissions, converter enable/disable, soft start for inrush current prevention.
- **Integrated RS-485 transceiver**
  - Data rate: 12 Mbps, 500 kbps (2 speed options)
  - MODE pin to select between RS-485 and PROFIBUS
  - 1/8 Unit-Load - up to 256 nodes on the bus
  - Bus open, short and idle- fail safe receiver
  - UVLO protection, thermal shutdown
  - HBM bus pins 16 kV, IEC ESD bus pins 8 kV (all ratings w.r.t. GND2)
  - 1 Mbps GPIO diagnostic channel
- **Immunity and isolation certifications**
  - 5000 V_{ISO}, 1500 V_{pk} V_{IORM}, 10 kV_{pk} VDE surge
  - CMTI (typ) 100 kV/µs
- **Power and package**
  - Power converter supply: 3 V-5.5 V, logic supply 1.71 V to 5.5V, bus side supply 3.3 V / 5 V selectable by MODE pin.
  - 20-pin wide SOIC package (>8.0 mm creepage)
  - Extended temp: -40 to 125ºC (RS-485), 105ºC (PROFIBUS)

Applications

- **Grid infrastructure**
- **Factory automation**
- **Building automation**
- **HVAC, motor drives**

Benefits

- Meets CISPR 32 Class A/B limits on 2-layer PCB without stitching cap / Y-cap
- Integrated isolated DC-DC converter with on chip transformers helps reduce board space considerably and eases certifications
- Integrated IEC ESD, EFT on bus pins
- Separate logic supply support to interface with 1.8-V / 3.3-V / 5-V controllers and ASICs
- Full duplex device can be used as half duplex on system level by shorting Driver output to Receiver Input



Typical application circuit of ISOW14x2

ISOW1044

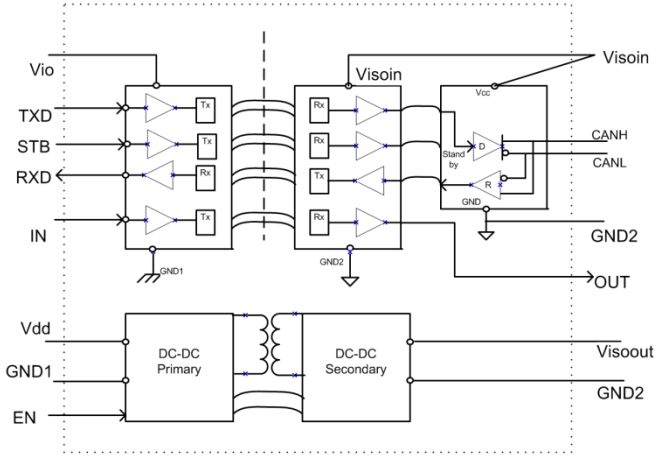
Reinforced isolated CAN transceiver with integrated DC-DC converter

Features

- **Integrated power**
  - 45% efficiency, low emissions, soft start for inrush current prevention.
- **Integrated CAN transceiver**
  - ISO 11898-2 compliant, support up to 5 Mbps CAN FD
  - DC bus-fault protection: ± 58 V, common mode range: ± 12 V
  - High CMTI: 100 kV/µs(typ)
  - Fast loop times: 225 ns(max)
  - ±10 kV HBM ESD and ± 8 kV IEC ESD for bus pins
  - TXD dominant state time out, ideal passive – high impedance I/Os when unpowered
  - UVLO protection, thermal shutdown
- **Immunity and isolation certifications**
  - 5000 V_{ISO}, 1500 V_{pk} V_{IORM}, 10 kV_{pk} VDE surge
- **Power and package**
  - Power converter supply: 4.5 V-5.5 V, logic supply 1.71 V to 5.5 V, bus side supply 5.0 V generated internally.
  - 20-pin wide SOIC package (>8.0 mm creepage)
  - Extended temp: -40 to 105 °C

Benefits

- Meets CISPR 32 Class A/B limits on 2-layer PCB without stitching cap / Y-cap
- Integrated isolated DC-DC converter with on chip transformers helps reduce board space considerably and eases certifications
- IEC ESD, extended bus fault protection integrated.



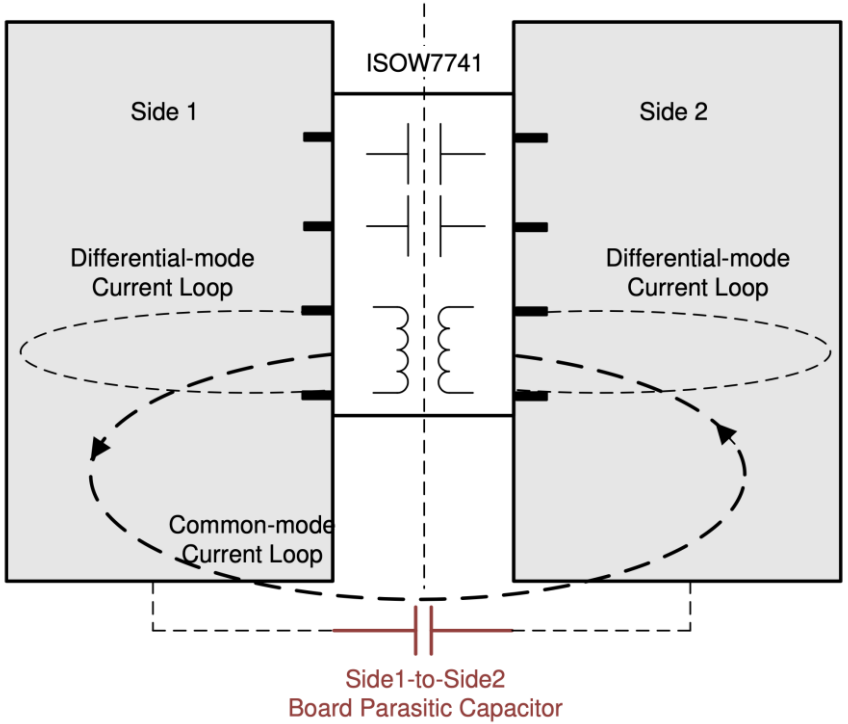
Applications

- **Factory automation**
- **Motor drives**
- **Elevators, escalators**
- **Grid infrastructure**

CISPR 32 emissions standard overview

- CISPR was founded in 1934 to set standards for controlling electromagnetic interference in electrical and electronic device by defining test methods and compliance limits
- CISPR standards for consumer products before 2017
  - CISPR 13 (EN 55013): Broadcast receivers
  - CISPR 22 (EN 55022): Information Technology Equipment
  - (EN 55103-1): AV and professional lighting control
- CISPR 32 replaces CISPR 13, CISPR 22, and EN 55103-1 emissions standards in March 2017
- CISPR 32 is an electromagnetic compatibility standard for Multimedia Equipment (MME)
  - Information Technology Equipment (ITE), audio equipment, video equipment, and broadcast receiving equipment, and entertainment lighting control equipment
- CISPR 32 includes conducted emission and radiated emissions
  - **Class A** - equipment that may not offer adequate protection to broadcast services within a residential environment.
  - **Class B** - equipment that offers adequate protection to broadcast services in residential environment. (more stringent)

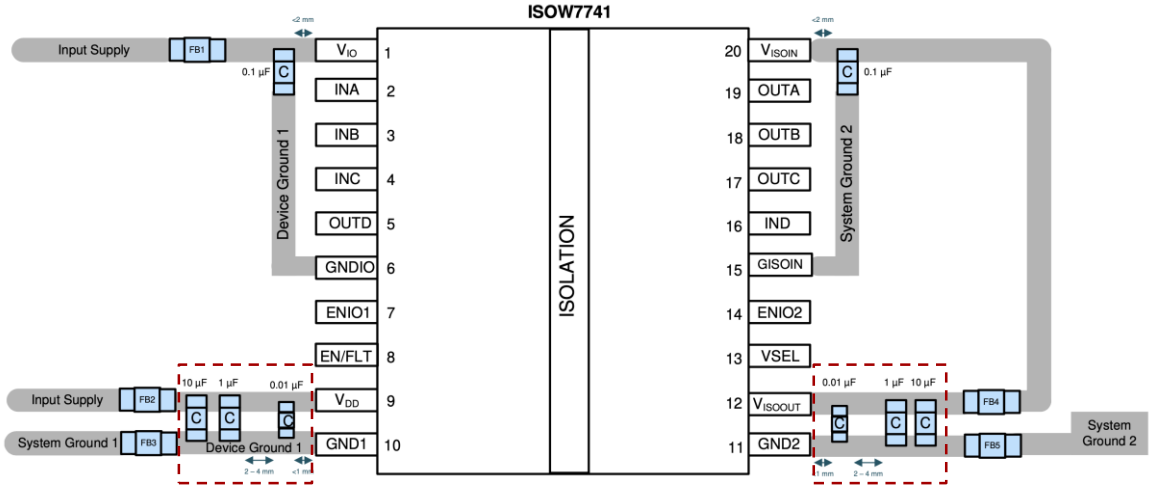
Common-mode and differential-mode current loops



- Differential-mode current loops:
  - High frequency switching currents on supply pins can radiate from their respective sides
  - This can be viewed as a monopole antenna with respect to earth or as dipole with respect to ground

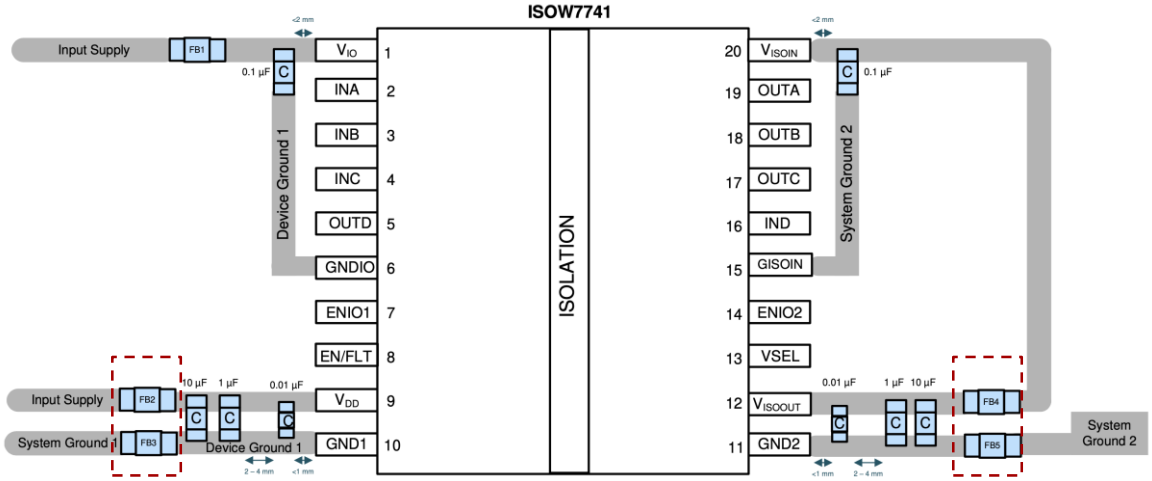
- Common-mode current loop:
  - Switching transients couple through parasitic capacitance across the transformer creating common-mode current
  - Common-mode current forms a large return loop through board-level parasitic capacitance
  - This large current loop can cause radiated emissions in isolated systems
  - This can also be viewed as a dipole antenna formed by the two isolated sides of PCB

PCB layout design guidelines – decoupling capacitors



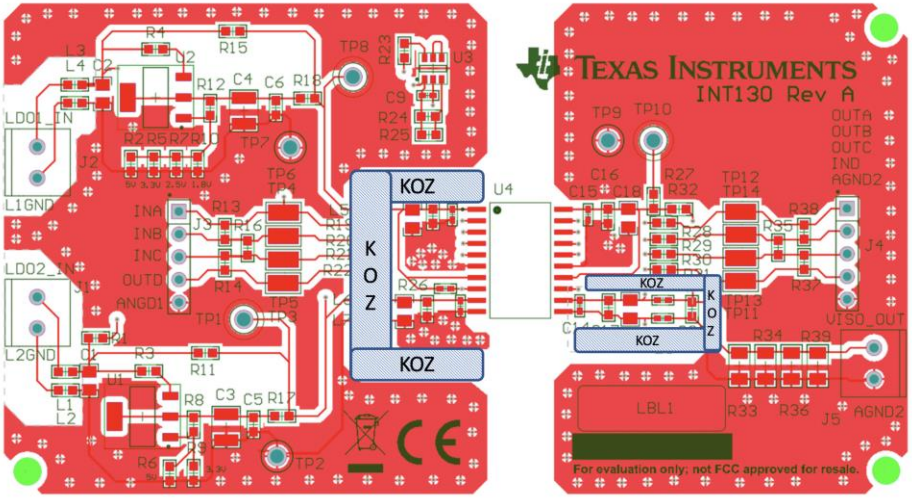
- Decoupling capacitors to shorten differential-mode current loops:
  - Decoupling capacitors provide instantaneous peak current needed by switching circuit
  - Choose right values of capacitors to meet instantaneous peak currents and thereby maintain low voltage ripple
  - ISOW devices require 0.01-µF capacitor placed within 1 mm distance to supply pins
  - A bulk capacitor of at least 10 µF is needed within 2-4 mm distance
  - An optional 1-µF capacitor can be used between these two capacitors for better filtering

PCB layout design guidelines – ferrite beads (FB)



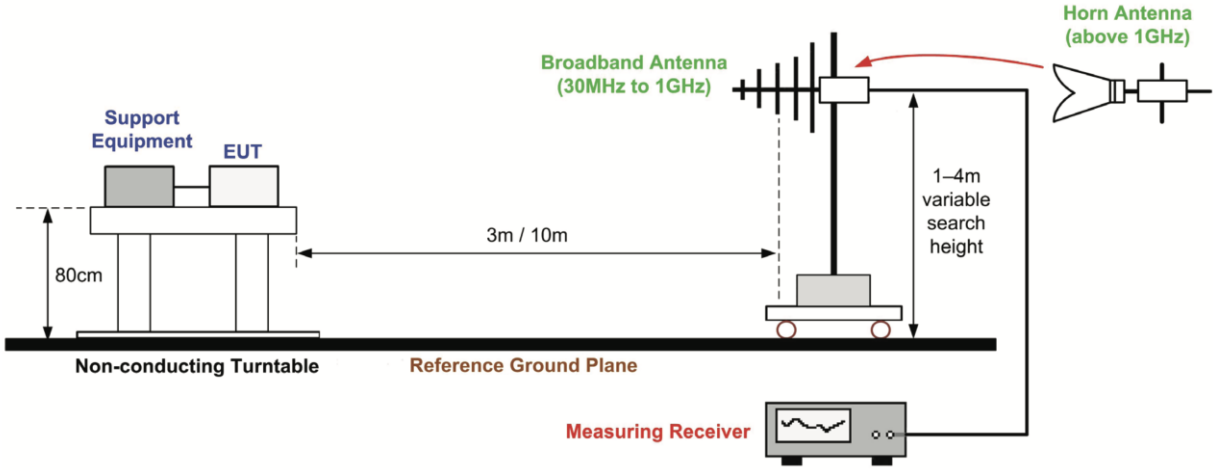
- Ferrite beads to shorten differential-mode and common-mode current loops:
  - Ferrite beads play a vital role in attenuating both differential and common-mode switching noises
  - FB to be inserted between ISOW and rest of the system to break the path that forms large current loops
  - High attenuation offered at select frequencies by FBs limits current loops to a small area allowing only small current loops
  - For effective attenuation, choose FB impedance to be >1 kΩ at the frequencies of interest

PCB layout design guidelines – keep-out zones (KOZ)



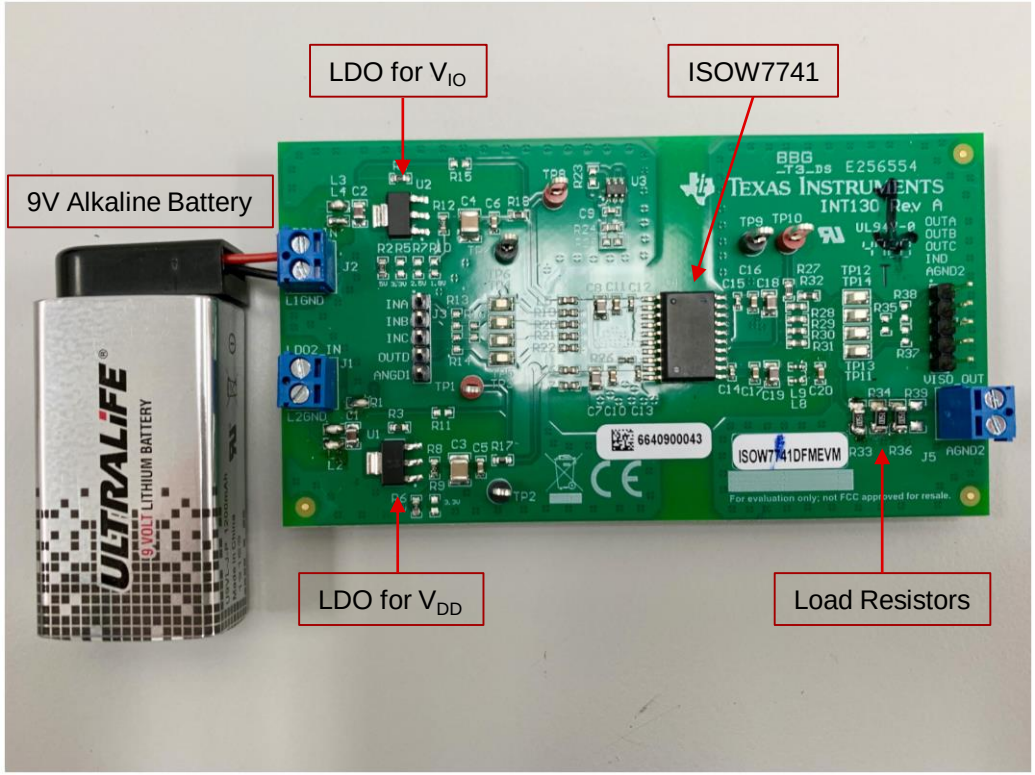
- Keep-out zones to avoid creation of unintentional current loops:
  - Ferrite beads introduce attenuation between device supply pins and rest of the system to block switching noise
  - This separation between device and rest of the system, termed keep-out zone, to be maintained across PCB
  - The width of keep-out zone should be greater than the length of ferrite beads used
  - Failure to maintain keep-out zones will lead to parasitic capacitive coupling of switching noise from device to rest of the system thereby forming differential-mode and common-mode current loops bypassing FBs

Radiated emissions testing guidelines



- Tips for avoiding errors in measuring radiated emissions:
  - If final product has direct or capacitive connection to protected earth (PE), follow the same in EMI test setup
  - If EUT is powered by power supply / mains, keep the length of wires between them short or similar to end use
  - If the wire length can't be kept short, then use common-mode chokes (CMC) or ferrite core clamp filters
  - An alternate approach to avoid lengthy power supply wires is to power EUT using a battery placed close to it
  - Consider testing for quasi-peak emissions when peak emissions margin to the limits is not sufficient

Radiated emissions test results – test setup

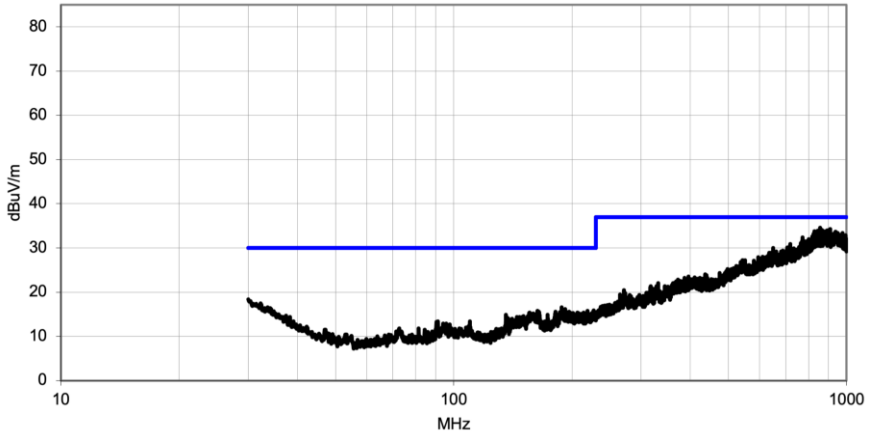


Testing ISOW7741 on EVM powered by a battery for radiated emissions

Radiated emissions test results – CISPR 32 Class B

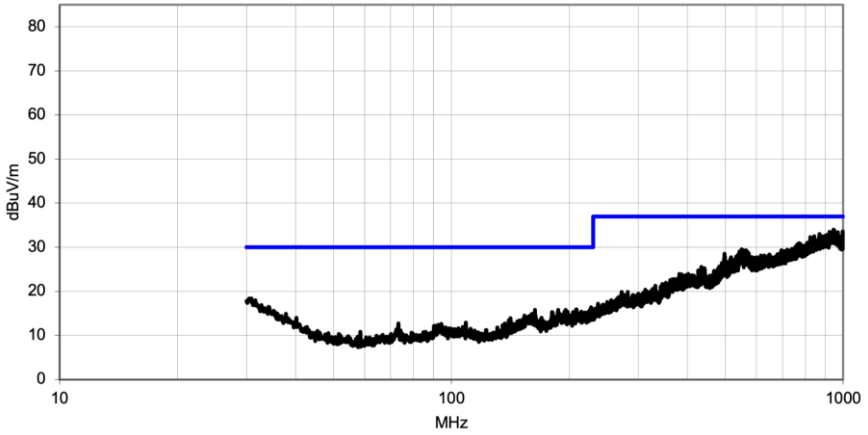
ISOW7741DFMEVM

$V_{DD} = V_{IO} = 5V$, $V_{ISOOUT} = V_{ISOIN} = 5V$, $I_{ISOOUT} = 100mA$

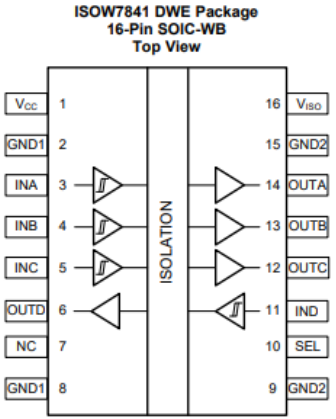


ISOW7741DFMEVM

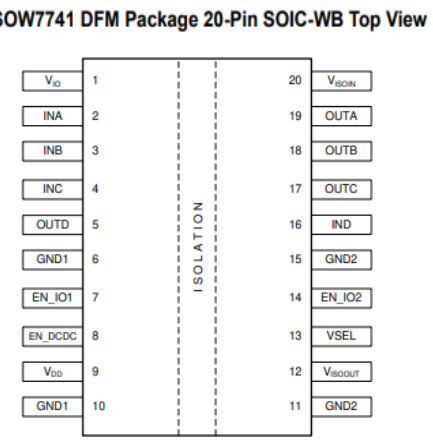
$V_{DD} = V_{IO} = 5V$, $V_{ISOOUT} = V_{ISOIN} = 3.3V$, $I_{ISOOUT} = 50mA$



ISOW adaptor evaluation module (ISOW-ADAPTOR-EVM)

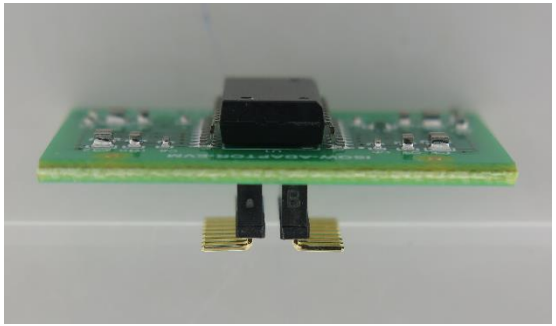


ISOW7841 with 16-pins

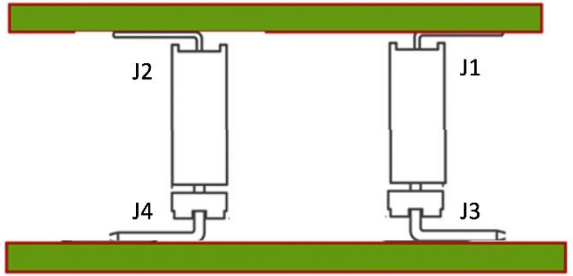


ISOW7741 with 20-pins

https://www.ti.com/tool/ISOW-ADAPTOR-EVM



ISOW-ADAPTOR-EVM

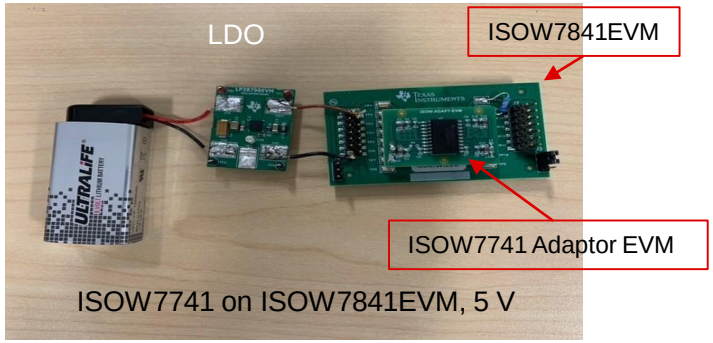


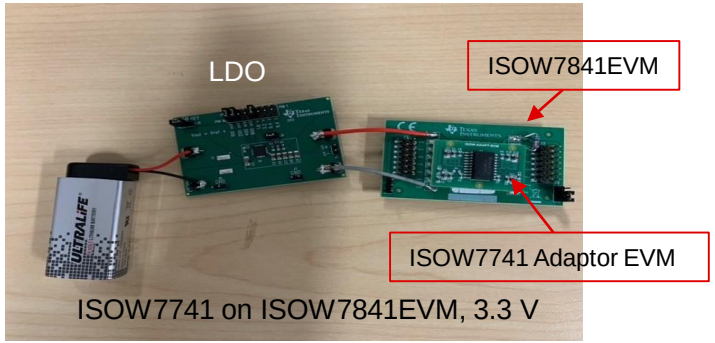
PCB with ISOW784x footprint

ISOW7741 Adaptor EVM *(P2P with ISOW7841)*

- Can be soldered onto any existing ISOW7841 footprint without any changes to PCB
- Customers can perform emissions tests with ISOW7741 on ISOW7841 based boards to confirm reduced emissions

ISOW-ADAPTOR-EVM on ISOW7841EVM test setups

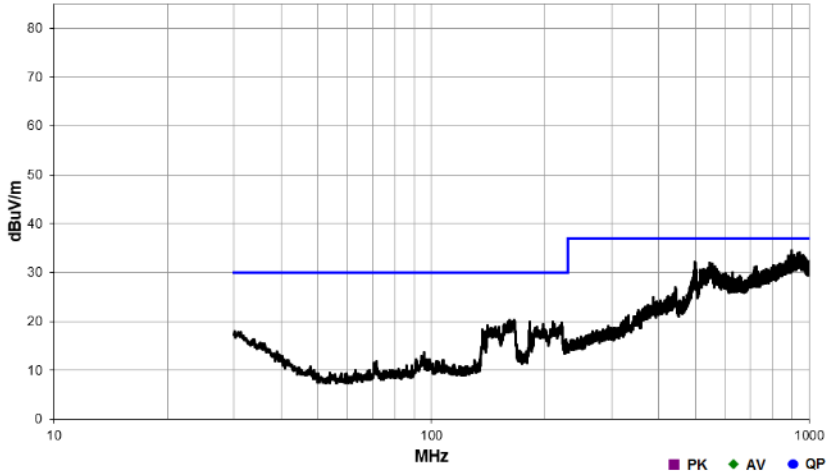




ISOW7741 test results (through adaptor board on ISOW7841EVM)

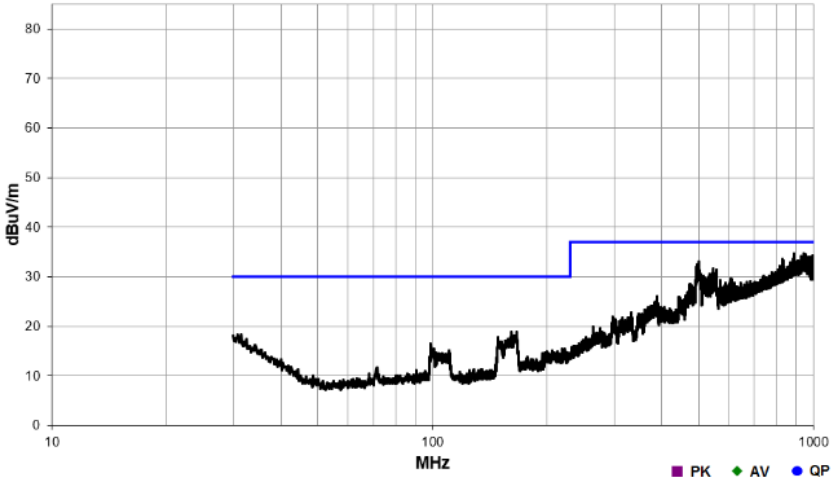
ISOW-ADAPTOR-EVM

$V_{DD} = V_{IO} = 5$ V, $V_{ISOOUT} = V_{ISOIN} = 5$ V, $I_{ISOOUT} = 100$ mA



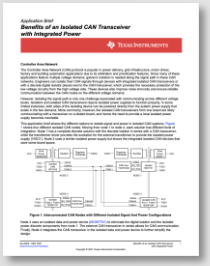
ISOW-ADAPTOR-EVM

$V_{DD} = V_{IO} = 5$ V, $V_{ISOOUT} = V_{ISOIN} = 3.3$ V, $I_{ISOOUT} = 50$ mA

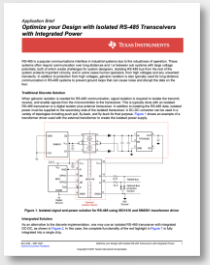


Additional resources

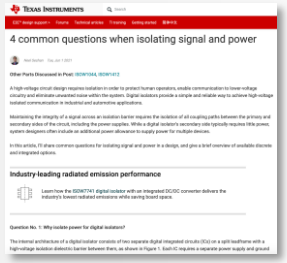
[How to meet CISPR 32 radiated emissions limits with ISOW7741]



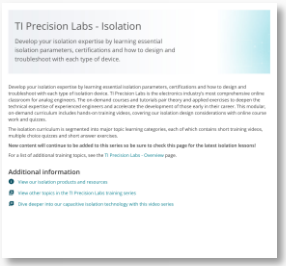
[Integrated signal and power isolation for CAN]



[Integrated signal and power isolation for RS-485 designs]



[4 common questions when isolating signal and power]



[TI Precision Labs – Isolation]

[www.ti.com/isolation]

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