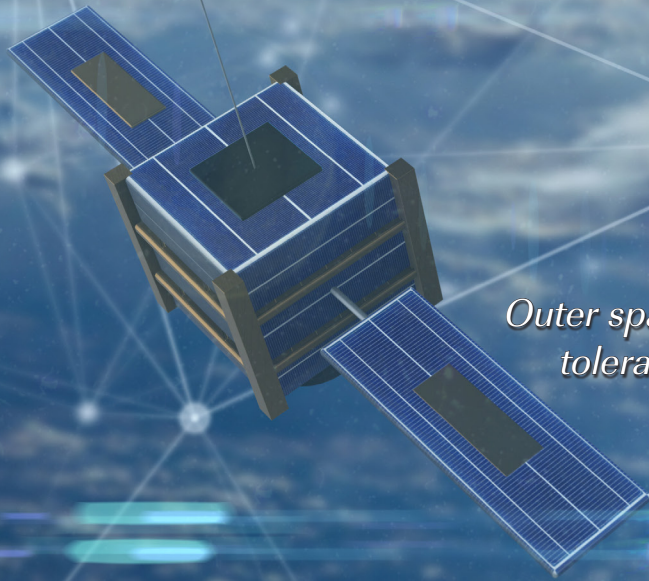


Galvanic isolated CAN nodes in small satellites



Outer space applications require radiation-tolerant CAN transceivers and galvanic-isolated CAN interfaces.

(Source: Adobe Stock)

Small satellites are becoming a more dominant area of the space and satellite market place. In 2019, more than 1000 small satellites were launched. Many satellite companies are starting to design and build what are known as “Mega-Constellations”. These are systems of satellites that are intended to have potentially hundreds of satellites flying in Low Earth Orbit (LEO). The mission length for many of these satellites is longer than 5 years, compared to 15+ years for more traditional satellite missions. These satellites will be used mainly for telecommunications, but have other uses such as scientific exploration and earth observation. In 2022, the global small satellite market size was valued at three billion US-\$ and is expected to reach 13,2 billion US-\$ by 2032, according to a research report published by Spherical Insights & Consulting. As of May 4, 2023, the satellite tracking website “Orbiting Now” lists 7702 active satellites in various Earth orbits.

Small satellites represent some important changes from the traditional satellite market. First, as the name implies, small satellites take up substantially less volume and weigh significantly less than traditional satellites. Small satellites are typically defined as having a mass of less than 500 kg. Another key feature of small satellites is reduced cost. In order to build a constellation of 100 or

more satellites, the aggregate cost of each of these must be far lower than traditional satellites. These size and cost constraints make it challenging to build satellite electronics using standard Class V and QML radiation-tolerant products. The challenge is that many of these small satellites have some quality and radiation-tolerance requirements that cannot be met using commercial-off-the-shelf (COTS) components.

The European Space Agency (ESA) has developed the ECSS-E-ST-50-15C specification. It contains requirements regarding CAN hardware, CAN firmware, and CANopen for on-board spacecraft communications and control systems. It extends the specification of the ISO 11898-1 and ISO 11898-2 standards. Radiation-tolerant CAN transceivers compliant with ISO 11898-2 consist of driver and receiver circuitries. The transmitter circuitry takes a digital serial data stream from the CAN protocol controller and drives the CAN_H and CAN_L bus lines with the appropriate differential signal levels. Galvanic isolation can be used to provide protection against transients induced on the bus, including those caused by Single Event Effects (SEE) from heavy ions in the space environment.

Intersil (now part of Renesas) has developed the ISL71026M radiation-tolerant CAN transceiver and the ISL71710M active digital isolator. Both components come in plastic housings. This saves space on the printed circuit board, which is important for small satellites. Both mentioned components measure 20 mm² each.

The CAN network needs to be terminated on both ends of the bus lines by means of 120-Ω resistors. The recessive

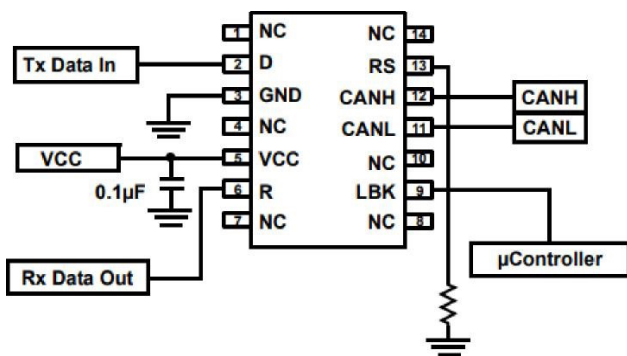


Figure 1: Pin assignments for the ISL71026M transceiver (Source: Renesas)

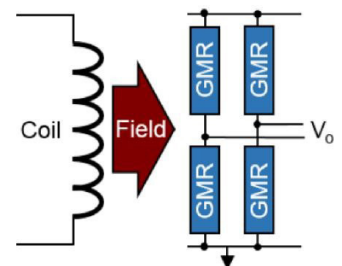


Figure 2: ISL71710M circuitry using GMR technology (Source: Renesas)

Applications

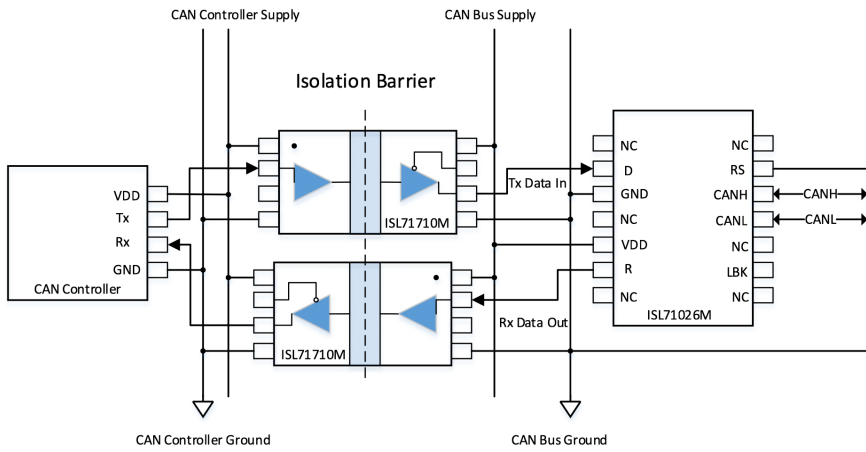


Figure 3: Isolated CAN node using ISL71710M and ISL71026M (Source: Renesas)

state voltage is approximately 2,3 V on both bus lines. In the dominant state, CAN_H goes up to approximately 3 V and CAN_L goes down to approximately 1 V.

The CAN network can be used effectively in a distributed computing application. For example, a satellite payload may have multiple environmental or positioning sensors spread out across the payload board. Using an isolated CAN network to communicate between different CAN nodes is an efficient way to transmit sensor and position data. The isolation ensures protection for the CAN controller.

Renesas has a portfolio of products that are specifically designed for small satellite applications. These products have a higher level of qualification than COTS components that is similar to automotive grade semiconductor products. In addition, the products in this portfolio have been screened for radiation tolerance.

The ISL71026M is a CAN transceiver that follows the radiation-tolerant plastic flow outlined above. It is a 3,3-V CAN transceiver that can operate up to the maximum CAN bit rate of 1 Mbit/s.

The ISL71710M is an active input digital isolator that follows the radiation-tolerant plastic flow. It uses an isolation technology that works on the principles of Giant Magneto Resistive (GMR) effects. This technology allows efficient digital isolation with low-quiescent current, no EMI (electromagnetic intermission) concerns, and no issues with optics greying over time. The GMR technology works using a coil on the input side. This coil is energized and driven by the input buffer, and the polarity depends on the output state of the buffer. This energized coil produces an electric field across the isolation barrier and induces a change in resistance of the GMR elements. As the resistance changes, it causes the output to change the state accordingly.

It is important to note that the ISL71710M digital isolator must be placed in between the CAN protocol controller and the CAN transceiver. This allows the sensitive micro-controller supply to be isolated from the CAN transceiver supply. It is also important to note that while the ISL71710M provides inherently isolation for the data signals, the power supplies for the ISL71710M and the CAN controller must also be isolated. If these are simply tied together, the benefits of using a digital isolator cannot be realized.

Since the ISL71710M and the ISL71026M are packaged in plastic enclosures, much of the cost of typical space products has been removed. In addition, Class V flow for space semiconductors has many production-level tests that add significantly to the cost. These tests include visual inspection, radiography, 100-% burn-in, and 100-% temperature cycling. Removing these in-line production tests allows Renesas to pass the cost savings of those products on to customers. Renesas provides evaluation boards and detailed user guides for customer testing and evaluation.

hz (based on a Renesas whitepaper)



Figure 4: ISL71710M (left) and ISL71026M (right) evaluation boards (Source: Renesas)