Quartzdyne, Inc.
Galvanic Isolation of Quartzdyne Digital Pressure Transducers

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Many systems require galvanic isolation between electronic circuits and the metalwork of the system. Unfortunately, Quartzdyne Pressure Transducers are intimately coupled to chassis ground, particularly through the high-pressure electrical feed-through pins and the pressure housing. If this coupling were to be broken, any difference in potential between the oscillator ground and the chassis would be amplified by the oscillator resulting in increased jitter (lower usable resolution), counting errors, and possible damage to the sensitive oscillator circuit.

Mechanical Isolation

It is possible to provide electrical isolation using mechanical means by inserting a shield, or guard between the pressure crystal, its leads, and the pressure housing as shown in Figure 1. This is not trivial, however, and it could add as much as $1500 to the cost of building a transducer. Additionally, there would be an increase in the size of the pressure housing (1" OD min) and the transducer pressure performance would be degraded, particularly during temperature transients or where large temperature gradients exist such as a subsea wellhead. While mechanical isolation is possible, it is not the preferred solution from a cost or performance point of view.

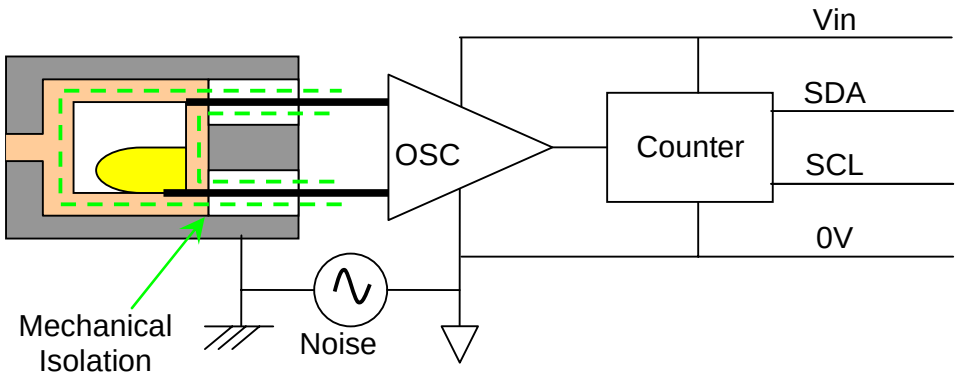

Figure 1. Mechanical isolation. A shield at circuit ground potential is required between the crystal and its leads and the pressure housing.

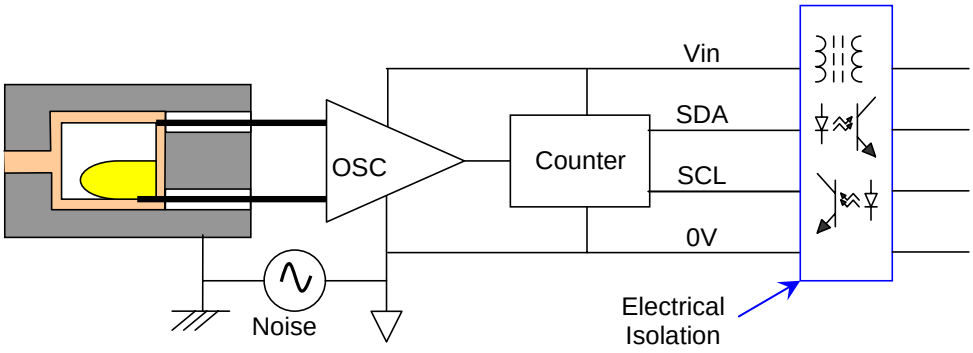

Figure 2. Electrical isolation uses an isolated DC-DC converter on the supply lines and optocouplers on the communication lines.

Electrical Isolation

Electrical isolation is fairly straight-forward and does not degrade the performance of the transducer. The power supply is isolated using transformer-coupled DC-DC converters, and the signal lines are isolated using optocouplers as shown in Figure 2. Isolated DC-DC converters are readily available for applications with temperatures not exceeding 85°C. Devices such as C&D Technologies LME0503 and RECOM RM5.03.3 are typical of many that would be adequate for most surface or subsea applications.

Isolation of the digital interface signals SCL and SDA is done using optocouplers. There is a good application note from Phillips Semiconductor which describes in detail the trade-offs of various solutions to isolating I^2C signals [1]. In this application note the P82B96 bi-directional bus buffer [2] is used to split the incoming and outgoing signals on the data line to allow coupling through separate optocouplers as shown in Figure 3. Optocouplers such as PS2501 [3] are then used to isolate the signals in the various directions. The isolator is repeated for the SCL line. The transmission rate is limited to about 10kHz in this version by the optocoupler. High-speed optocouplers such as the 6N137 [4] are available which can isolate the signals at the full 100kHz clock rate, but these consume as much as 7-10mA each (times 4 optocouplers).

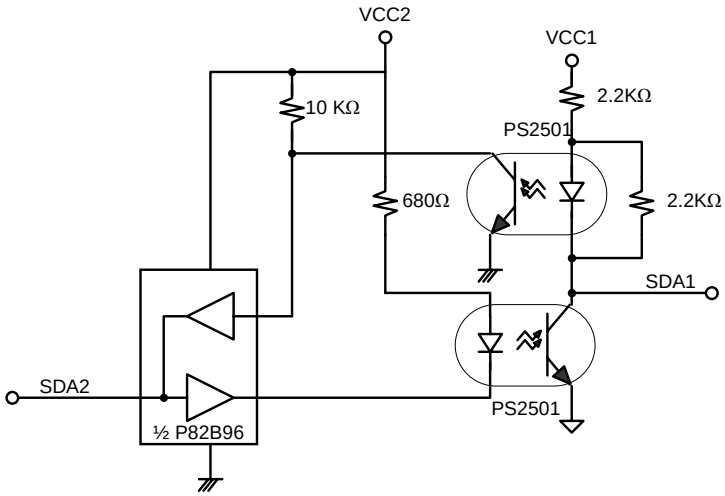

Figure 3. Isolated I^2C buffer. Circuit is repeated for SCL.

In systems with multiple transducers, it may be possible to use one isolation unit for multiple transducers. This could significantly reduce both the cost and power consumption. Another place to consider putting the isolation is at the host's communication and power interface. Depending on the interface, this may be easier than isolating the I^2C bus. The down-side to a shared isolation system is the potential of ground loops if the transducers and support electronics are not physically close to each other. Also, some safety regulations do not allow multiple ground connections even within a single chassis.

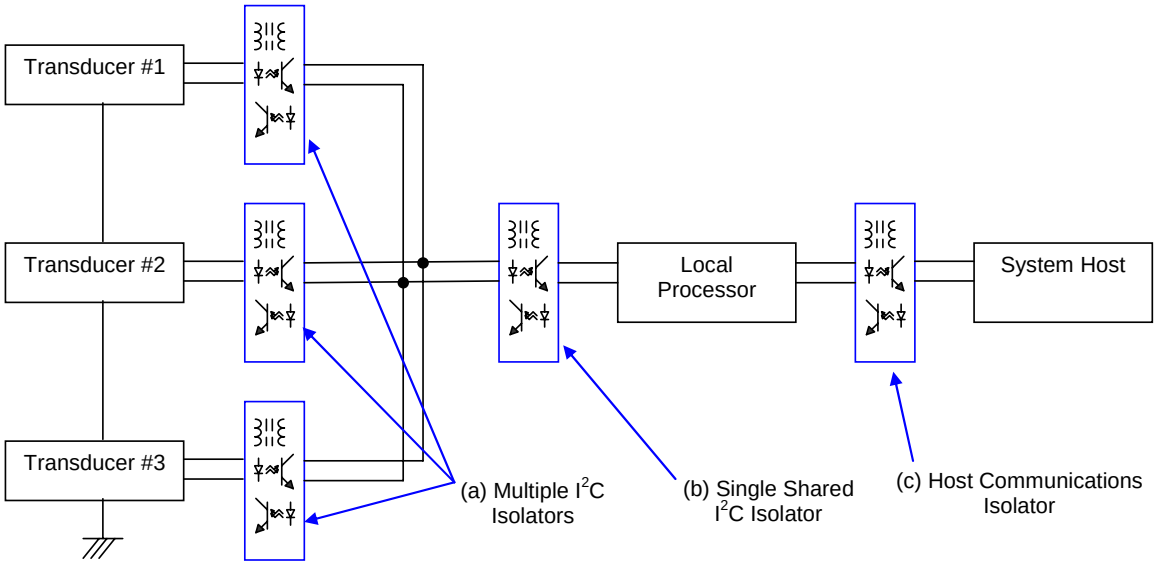

Figure 4. Three options for electrical isolation within a system: (a) Multiple isolation units at or near each transducer, (b) a single isolation unit at the local host, shared by all transducers, or (c) a single isolation unit between the local processor and the system host.

References

[1] Phillips AN460: Using the P82B96 for Bus Interface
http://www.semiconductors.philips.com/acrobat_download/applicationnotes/AN460_1.pdf

[2] Phillips P82B96: Dual Bi-directional Bus Buffer
http://www.semiconductors.philips.com/pip/P82B96.html

[3] NEC PS2501-1,-2,-4: Single Transistor Photocoupler
http://www.cel.com/pdf/datasheets/ps2501.pdf

[4] Fairchild 6N137: Very High Speed Optocoupler. See HCPL-2630 for dual version.
http://www.fairchildsemi.com/pf/6N/6N137.html