What Makes a Good Coupler?

BETA TRANSFORMER TECHNOLOGY CORPORATION
A subsidiary of Data Device Corporation

Application Note

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As with so many things, the design and manufacture of couplers involves many trade-offs, most having to do with cost. The minimum requirements for data bus couplers (MIL-STD-1553) are quite open and easily met. It is possible to make a pulse transformer that meets the requirement but unless it is designed and manufactured specifically with an application in mind it will probably not deliver optimal performance, particularly in marginal situations of long buses with many remote terminals and long stub cables. Also, it may not stand up to certain environmental conditions. MIL-STD-1553 is a standard not a specification. It does not define the environmental conditions that must be met.

What do you look for in selecting a data bus coupler?

First, it must meet the requirements of MIL-STD-1553 and the environment it will be exposed to.

Other subtle parameters that should be considered are:

The data bus is a balanced transmission line. To maintain this balance, its common mode rejection ability, minimum return energy loss and low reflections, the way a transformer is manufactured, is important. The transformer is essentially a pulse transformer that is generally wound on a torriodal core. Since this is a balanced line the primary and secondary should not be wound separately. Separate windings, although giving low inter winding capacitance, will be asymmetrical with increased leakage inductance. This will result in higher droop, poor waveform integrity, and higher reflected energy (return energy loss). For optimum line balance the windings should be wound together using bifilar wire. This results in somewhat higher inter winding capacitance but lower leakage inductance with lower droop and better waveform integrity. For lab environments, most transformers will perform adequately but in marginal situations (large buses, many remote terminals, long stubs and/or high EMI environments) performance will suffer and become marginal. This will be manifested in high bit error and word error rate or complete no response in extreme situations.

Another area of concern is physical construction. Couplers are generally manufactured with tin plated steel or aluminum cases. Tin plated steel gives better protection against magnetic fields while aluminum is lighter. Also, most aluminum cases are not solder sealed and have the mounting base held on with screws. Steel cases are soldered on all seams.

Sealing of in-line couplers should be carefully examined both for EMI and environmental integrity. On small units like in-line couplers, solder sealed steel cases are superior to screwed

together aluminum cases. The seal at the cable entry point on in-lines is very important. The cable enters the case through a ferrule which is crimped and soldered to the case. Some manufacturers then solder the shield to the ferrule outside of the coupler and use a molded boot with a snug fitting over the wire/ferrule interface. This is not adequate for long term sealing against humidity and other contaminants. Once contaminants or moisture penetrate to the shield they will wick up into the braid or foil and start corrosion.

Remember "corrosion never sleeps." North Hills brings the cable, including the outer jacket and shield into the ferrule, crimps the ferrule onto the outer jacket and solders the shield to the inner end of the ferrule. The ferrule and cable assembly are then soldered to the inside of the case (the ferrule has a lip to seat to the inside surface of the can). The outer jacket /ferrule interface is then sealed with internally adhesived shrink tubing.

Upon entering the coupler case the signal conductors must have a strain relief loop before being soldered to the printed circuit terminal. This is necessary to prevent tension on the individual conductors pulling on the solder joint and creating an open or intermittent.

Once fully assembled the circuitry is encapsulated and the case solder sealed. The overall coupler assembly then receives an outer, internally adhesived, shrink tube boot, the ends of which are filled with an appropriate RTV adhesive. Viton is the preferred shrink tubing.

One final consideration is transformer consistency. Some coupler manufacturers do not wind their own transformers. But they buy them from various other manufacturers. This can lead to differences in coupler performance due to different transformer characteristics. In extreme cases or in marginal conditions the couplers can become position sensitive. That is, they may work in some positions in the bus, but not in others. This can be avoided by buying your couplers only from a manufacturer who makes their own transformers, preferably from one well-versed in hi-frequency transformer technology and technique, like North Hills.

Remember "Caveat Emptor"— let the buyer beware.

North Hills™

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E-Mail: service@BTTC-Beta.com

Visit: BTTC-Beta.com Data Device Corporation

Call:

HQ, N.Y., U.S.A	(631) 224-7393
UK	+44-(0)1635-811140
France	+33-(0)1-41-16-3424
Germany	+49-(0)89-1500-12-11
Japan	+81-(0)3-3814-7688
Asia	+65-6489-4801
India	+91 80 46797 0368