Designing-in an industrial Ethernet connection

In a world in which Ethernet is being embraced in automotive and other critical systems, it isn't surprising that factories and industrial facilities are keen to adopt a common network infrastructure that unites their administration, control systems and device-level functions. In many ways, the automotive industry's acceptance of Ethernet has provided opportunities in the industrial domain, as the sheer economies of scale created by automotive Ethernet applications render it more economical for lower volume, yet equally demanding alternative applications.

Industrial environments certainly share many of the characteristics of automotive applications, including harsh operating conditions, with potential for dust and water ingress; extreme temperatures and vibration. But they also share similar mission critical real-time traffic requirements that, historically, Ethernet wasn't designed for.

Recognising both the need for higher bandwidths and speeds that Ethernet provides, plus the particular requirements of industrial customers, multiple organisations and vendors are facilitating the adoption of industrial Ethernet, among them the Industrial Ethernet Association (IEA), the Open DeviceNet Vendor Association (ODVA), Modbus.org, the Fieldbus Foundation, Profinet and Profibus International (PI). Several extensions to the original IEEE 802.3 protocol have been ratified by the IEEE, enabling Ethernet to support the deterministic requirements of industrial processes. These extensions have since become open standards.

***PART NUMBERS**

Bel ICMs:	L829-1J1T-43
L834-1C1T-S7	SI-46001-F
S811-1X1T-36-F	SI-52008-F
0826-1X4T-43-F	SI-60082-F
0845-2D1T-H5	
0879-2C2R-54	**TRP ICMs:**
0821-1X1T-43-F	1840029-1
08B0-1X1T-36-F	1840417-1

* Samples are representative of the configurations available

With transmission speeds up to 100 Megabits per second (Mbps), 100 BASE-T (IEEE 802.3u) has become the most commonly installed Ethernet system within the industrial environment. Gigabit Ethernet (IEEE 802.3z), with speeds to 1000 Mbps, and 10-Gigabit Ethernet/10Gbe (IEEE 802.3ae), providing up to 10 Gbps, can also be found. Higher transmission speeds and new functional requirements, such as Power over Ethernet (catered for by IEEE 802.3af), mean that Ethernet standardisation continues to evolve.

So, when designing Ethernet into industrial end applications, the baseline requirement is compatibility with the IEEE 802.3 Ethernet standard, which defines the physical layer (PHY) and the media access control (MAC) of the data link layer for all wired Ethernet networks. PHY functionality is usually implemented in a chip which interfaces between the analogue domain of Ethernet's line modulation and the digital domain of link-layer packet signalling. Two other important components that make up the Ethernet PHY functionality are the 'magnetics', analogue circuitry that handles the key electrical interfacing requirements (electrical isolation, signal balancing, common-mode rejection, impedance matching and EMC improvement), and the RJ45 connector, found on all Ethernet cables in current use.

Nowadays, the magnetics circuitry is commonly built into the RJ45-type connector block. While slightly more expensive than discrete solutions, these integrated connector modules (ICMs) offer numerous advantages when used in the design of a PHY board, including lower component count, potentially better EMC and a smaller PCB footprint. From a design work perspective, they are quicker and easier to incorporate than discretes, and provide the necessary assurance that the connection complies with Ethernet standards. This last point becomes particularly important as the industry moves to higher speeds, with the magnetics becoming more challenging to 'tune' with the PHY chip for 10Gbe.

There are myriad ICMs to choose from. Among them are different mechanical arrangement options e.g. side by side, stacked, tab up etc.; SMT and USB-combination products; higher isolation (shielded) versions; and ICMs with different operating temperature ranges. Some of these cater specifically to the industrial market, where reliable, low cost connections are required in hostile environments, with operating temperatures between -40°C and +85°C. Examples are Bel Magnetic Solution's TRP ICMs, which are compatible with all major 10/100Base-T and 1GBase-T PHYs, including Power over Ethernet (PoE). As with the move to higher speeds, PoE places additional demand on the magnetics' performance because of the need for higher currents.

Among the applications listed by Bel as suitable for its industrially-targeted ICMs are industrial Ethernet controllers, machine control boards, Ethernet lighting controls, industrial wireless access points and industrial video display units. Notably, these are all control system and device-level functions that confirm Industrial Ethernet's migration throughout the factory floor. However, as the PHYs' electrical performance goes a large way to determining the effectiveness – particularly when it comes to meeting real-time traffic requirements – of the network in a hostile and noisy factory environment, it is worth spending extra time on careful Ethernet component choice. More information and samples of Bel Magnetic Solution's TRP ICM range can be found here.

To discuss your industrial Ethernet requirements and order pilot samples, request a visit from your regional product specialist at **avnet-abacus.eu/bel-magnetic-solutions-magjack**