

# Bourns® Advanced Network Transformer

## WHITE PAPER



SRF2012A-801Y  
Common Mode Choke



SM453229-381N7Y  
Chip-LAN Transformer

### INTRODUCTION

The growth in the use of Ethernet for a diverse range of Information Technology (IT) systems is well known. Ethernet allows companies to leverage increased bandwidth capabilities to support future networking and real-time data sharing needs. This has led to the increasing integration of Ethernet-based transformers in connected communication applications primarily for isolation and signal conditioning. The high reliability mandated in communication systems can be threatened by coupling signals from devices that work with different power specifications. If there is a fault operation in one device, it can potentially spread to other connected devices compromising the overall performance and reliability of the network.

Component suppliers are also tasked with meeting ongoing IT equipment manufacturability trends that include miniaturization, higher manufacturing yield rates, and strict product quality metrics. Therefore, it is important that all components within a system contribute to facilitating greater levels of automated production.

This white paper will present a new type of Chip-LAN transformer solution for Ethernet-based IT equipment. Details of the component's discrete, center-tapped construction, drum core winding and ferrite plate cap will be explained along with the benefits from its toroid core magnetic path design. This paper will also outline the technology advancements that make smaller form factor solutions with consistent feature sets possible while also delivering high-quality signal conditioning performance in a device designed for fully-automated production.

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## LAN TRANSFORMER BACKGROUND

A LAN (Local Area Network) transformer is a magnetics module designed to link the interface between the PHY (Physical Layer) transceiver and the RJ45 connector. A typical LAN circuit with the physical layer transceiver is shown in Figure 1.

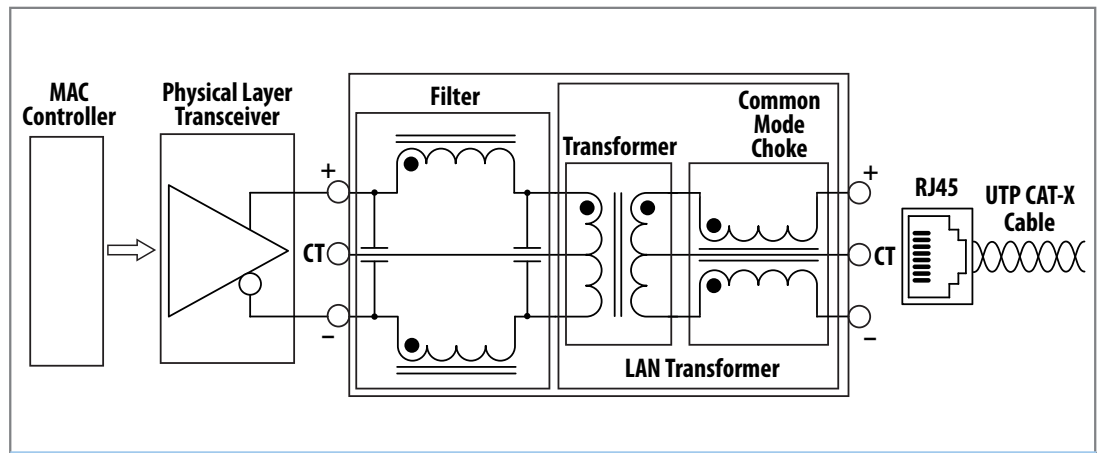


Figure 1

The purpose of a LAN transformer is to convey pulse signals at high speed and at the same time provide other functionality such as isolation between the input and output. Theoretically, the circuit will include a pulse transformer and common mode choke coils that will allow it to transmit and receive signals, providing the essential functions of coupling, matching, isolation and filtering. These capabilities all contribute to transmission quality.

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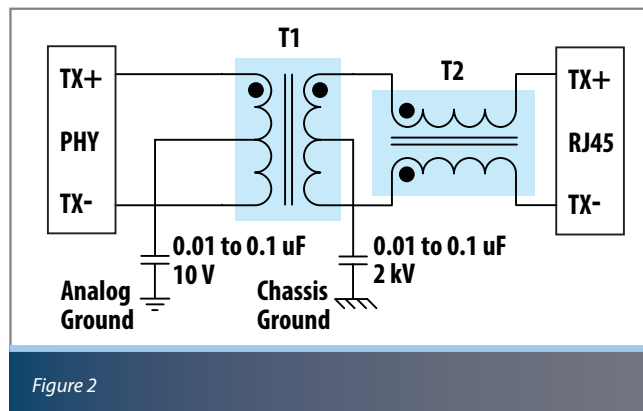
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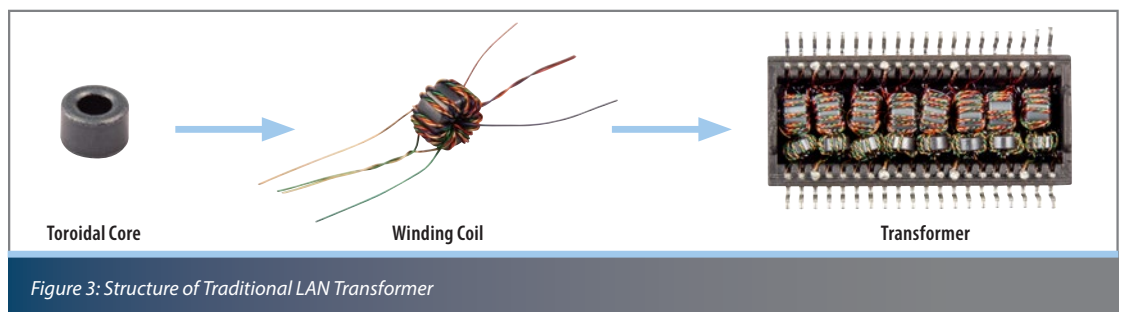
## THE BENEFITS AND DISADVANTAGES OF TRADITIONAL LAN TRANSFORMERS

Traditional LAN transformers are commonly a combination of at least two parts: a pulse transformer (T1) and common mode choke (T2), shown below in Figure 2. These combined parts deliver a 1:1 turn ratio on both the transmit and receive paths.



Traditional LAN transformers typically have a toroidal shape core (T-core) and are used on T1 and T2 lines because of their superior electrical performance. The advantage of the T-core is that due to its symmetrical closed-loop core, the amount of magnetic flux that escapes outside the core, known as leakage flux, is low. Therefore, the T-core is more efficient and provides the advantage of radiating less electromagnetic interference (EMI).

Further benefits are achieved by the LAN transformer's structure (Figure 3) consisting of a plastic case with terminal pins, a toroidal ferrite core, enamel copper wiring and special adhesive materials.



Traditional manufacturing of a LAN transformer typically utilizes a great deal of manual labor in the winding process, which can result in higher production costs and less consistent quality. The T-core structure is difficult to automate and manufacturers cannot easily control its electrical consistency from expected variations due to the manual process of winding. Therefore, traditionally manufactured LAN transformers can exhibit unevenness in transmission quality and have long lead times.

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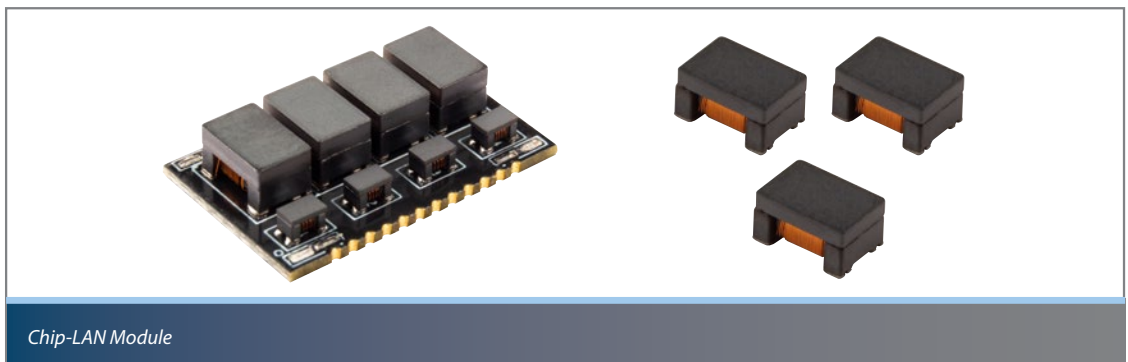
## ADVANTAGES GAINED FROM NEW CHIP-LAN TRANSFORMERS

Production automation and feature consistency are becoming more important requirements in light of the growing trend of transferring ever-larger amounts of data at ultra-fast transmission rates. Based on their ability to be produced using fully-automatic manufacturing that contributes to higher device uniformity and improved reliability, newly available Chip-LAN transformers (T1, T2) can be an optimal solution.

Table 1 - Evaluation of Typical Features

REQUIREMENT	TRADITIONAL TRANSFORMER	CHIP-LAN MODULE	CHIP-LAN (DISCRETE)
IEE Features	Good but inconsistent	Good	Good
Manufacture	Manual	Automatic	Automatic
EMI debug	Spend time; Inflexible	Save time; Flexible	Save time; Flexible
Cost	Higher	Medium	Lower
Quality	Can be inconsistent	Consistent	Consistent
Delivery Period	Long delivery cycle common	Short delivery cycle	Short delivery cycle

Unlike traditional LAN magnetics built with multiple toroidal core transformers and common mode chokes in a single module, the Chip-LAN transformer is a discrete, center-tapped component wound on a drum core and capped with a ferrite plate to emulate the result of the close magnetic path of a toroid core. A common mode chip inductor pairs with a Chip-LAN transformer to provide EMI suppression.



Chip-LAN Module



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## ADVANTAGES GAINED FROM NEW CHIP-LAN TRANSFORMERS (CONTINUED)

The innovative design of a Chip-LAN transformer allows the magnetic flux to travel through the interior of both cores, providing the functional equivalent of a toroidal core, which is illustrated in Figure 4.

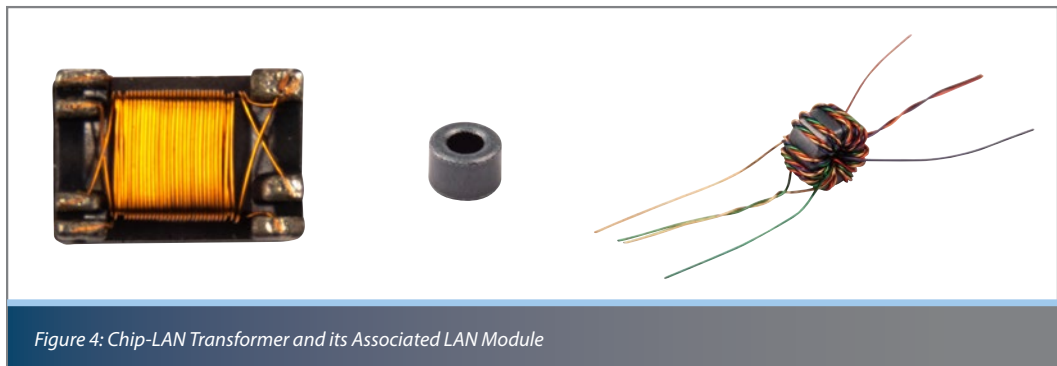


Figure 4: Chip-LAN Transformer and its Associated LAN Module

In addition, the Chip-LAN transformer design employs advanced circuit technology with precision automated winding technology to produce surface mount magnetic components, and uses mature surface mount technology making it a fully-automated production product. Chip-LAN transformers largely eliminate the drawbacks experienced with traditional network transformers with lower product stability and requiring extensive manpower to manufacture. Furthermore, the new design structure of a Chip-LAN transformer is compliant with a customer's SMT process, enabling enhanced product quality and consistency. Time-to-market is also streamlined by decreasing lead times.

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## ADVANTAGES OF CHIP-LAN ARCHITECTURE

- Optimized for design and debug development
- Reduces EMI and IEEE debug time and resources
- Three PCB options provide additional manufacturing flexibility:
  - Pulse transformer only
  - Common mode choke only
  - Pulse transformer + common mode choke
- Saves PCB space
- Drop-in replacement for traditional LAN transformers
  - 100 % pin-for-pin replacement (mechanical)
  - 10/100/1000 Mbps, 2.5 Gbps available (electrical)
- Allows production to be fully automated

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## SUMMARY

The added manufacturability and reliability delivered with the Bourns® Chip-LAN transformers make them ideal solutions for many applications in the communications market. Bourns developed its new Chip-LAN transformer family to be fully compliant with IEEE 802.3/802.3u and 802.3ab, which optimizes it for the Ethernet market. The integrated features in Chip-LAN transformers create options that make it easier for engineers to design a system solution.

[www.bourns.com](http://www.bourns.com)

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