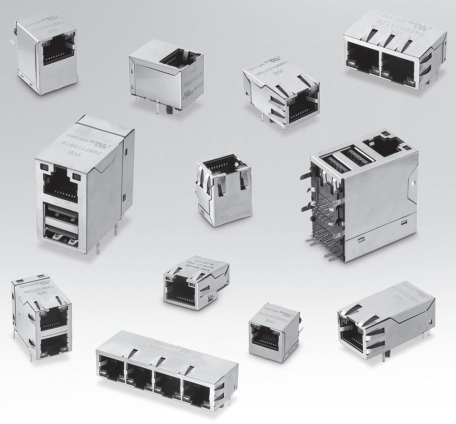
WE-RJ45
RJ45 LAN Transformer



Characteristics

- RJ45 Connector with integrated transformer/ common mode choke
- Power over Ethernet up to 50 Watt and speed up to 10 Gbit/s
- Available in SMD, THT and THT with USB
- Compliant with standards: IEEE 802.3u, IEEE 802.3an, IEEE 802.3af, IEEE 802.3at and upcoming IEE 802.3bt

Applications

- Suitable for industrial temperatures from –40 °C up to +85 °C
- Compatible to Industrial Ethernet systems like EtherCAT or Profinet
- Compliant with most IC's for Ethernet applications such as Microchip, Texas Instruments, Broadcom, Linear Technology
- Hub, Router, Switches, IPcameras, IoT applications

Connecting LAN Transformers

The schematic of a LAN Transformer can differ from application to application. This can quickly cause confusion when searching for the right product, especially as the schematics have some similarities: All LAN Transformer products in the catalogue have at least got one transformer and one Common Mode Choke (CMC) in each channel. For 10/100 BaseT applications there is one in the transmit- and one in the receive channel. So, as a minimum there are two transformers and two CMCs in a 10/100 BaseT. In addition to these well-known components, there is a resistor-network on the inner circuit of an RJ45-Transformer. This resistor network (known as a 'Bob Smith' termination) is built up with a 75 Ω resistor for each twisted pair and is connected to GND with a 1000 pF capacitor. The result is an additional reduction of EMI-Noise.

Further elements which can be placed onto the inner board are triple winded CMCs and two CMCs on one core or so called Auto-Transformers. The reason that those elements are part of some circuits and sometimes not, lies on the inner wiring from plug to customer's application. Where there are too many lines crossed, there is a loss of performance. To compensate the losses additional elements have to be built in (further information you will find into the Trilogy of Magnetics, page 108 ff.).

In most cases, the inner circuit can be seen as a "black box".

Example 1 shows how a discrete LAN Transformer can be connected with the chip, the so called PHY (Physical Logical Unit). Needed is a LAN-Connector without magnetics (i.e. Würth Elektronik 615 006 143 421), a discrete LAN Transformer (i.e. 749 010 012A) and a PHY-Chip to turn the analog signals into data. In most cases the wiring looks like the picture below. With a discrete LAN-Transformer, there is no 75 Ω termination. However, it is highly recommended to include this into the design.

The complete solution is also known as an integrated transformer (example 2). Not only does it combine connector with a discrete transformer, it also has an integrated 75 Ω termination. The pin out of the cable-side in the RJ45, marked with "J" is always in the same sequence. Discrete Transformers have an "X" to mark the recommended cable side.

Fig. 1: 100 Base-T discrete

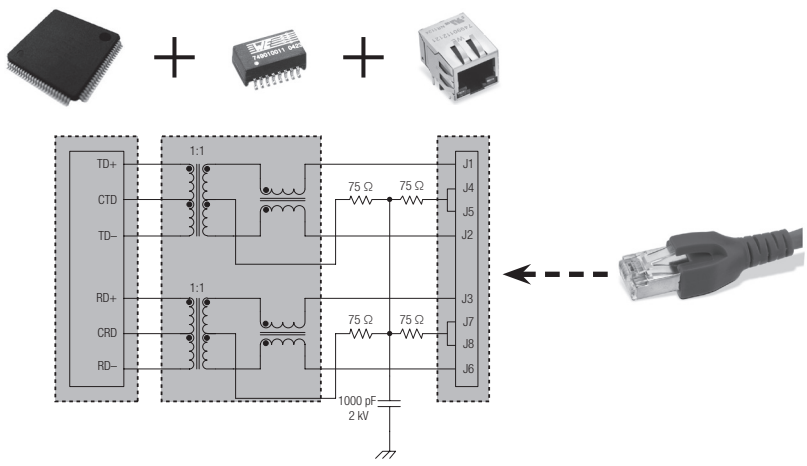
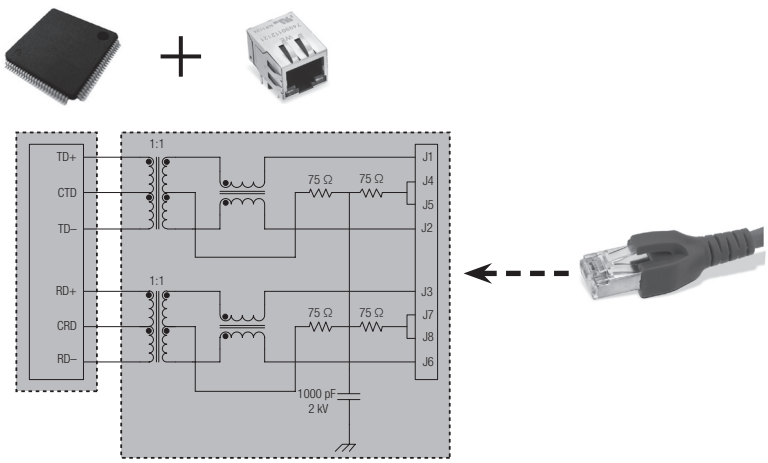


Fig. 2: 100 Base-T integrated



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With 1000 BaseT all four possible signal channels are in use. Example 3 again shows an integrated RJ45 connector. Conspicuous here are termination resistors of 50 Ω from data line to ground, which are located between LAN Transformer and PHY. The reason is a high impedance amplifier on the entrance of the PHY. The termination resistors are avoiding a reflection of data signals on the signal lines.

For current driven PHYs there often is a voltage source (3.3 V) connected on the Transformer middle pin and between the termination resistors. It depends on the inner circuit of the PHY if you need the termination resistors and/or voltage sources. So it`s important to look at the application example in the PHY datasheet. Generally, the distance between PHY and LAN Transformer has to be tracked as short as possible.

For protection against a transient Voltage overload condition use a TVS Diode placed between the LAN Transformer and PHY. Some examples of this application can be found in the Trilogy of Magnetics page 161.

With Power over Ethernet (PoE) it is possible to supply external periphery devices with energy. In example 4 a voltage source is shown. Here it is called PSE (Power Source Equipment). First the supply voltage will be combined with the data signals. At the transformer, the supply Voltage and data signals are separated out. The data signals will be transmitted on the other transformer side; the supply voltage will flow through the middle pin. In addition to the 75 Ω termination there are capacitors in its circuit (1000 BaseT), because otherwise the wires carrying the voltage will have a short to ground

A diode-bridge is an inverse-polarity protection for the Power Device (PD). In the Schematic it is drawn right beside the Power Device. Some integrated LAN Transformers the diode bridge is already integrated into the RJ45 housing (see page 411 Schematic 3). Because of a noise-reducing Auto Transformer, a Bob Smith Termination is not needed. However an additional Common Mode Choke put in the PoE lines (e.g. 744 230 251) is recommended if the risk to common mode noise is high. More detailed information about Power over Ethernet can be found in the Trilogy of Magnetics page 125 ff.

Fig. 3: Current driven 1000 Base-T

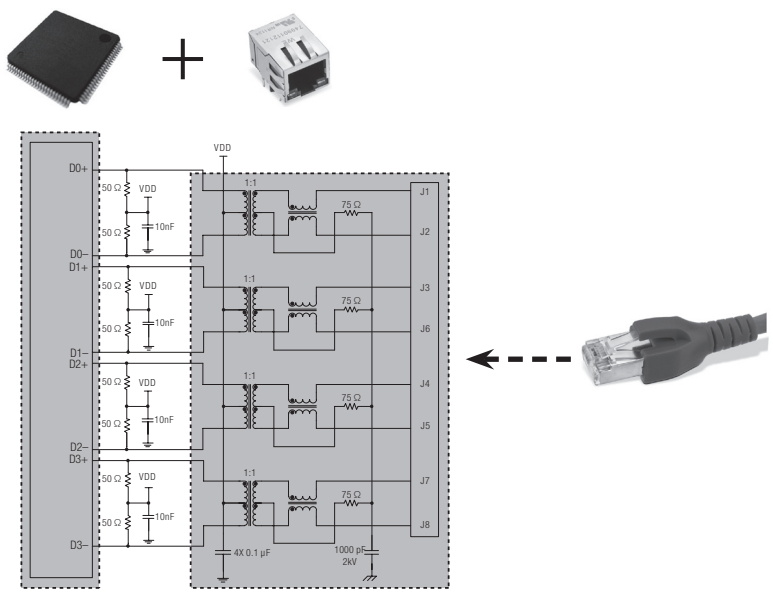

Fig. 4: Power over Ethernet Base-T