Application Note 384
T1/E1/J1 Dual Connector Interface

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INTRODUCTION

Many designs in the telecommunications market are designed for operation throughout the world. These designs must be capable of handling the T1 standard used in the United States, the J1 standard used in Japan, and the E1 standard used throughout the rest of the world. To enable manufacturers to produce a single design of this nature, Dallas Semiconductor has introduced a line of T1/E1/J1 combination line interface units (LIUs) and single-chip transceivers (SCTs). Both the DS21348 combination LIU and the DS2155/56 SCT can be used to provide a single hardware platform for T1/E1/J1 communications.

Although these devices provide the electrical interface for the different transmission systems, there is still a physical difference in both the cable and the connectors that are used in each systems. The following is a list of the transmission system, the cable, and the connector.

SYSTEM TYPE	CABLE TYPE	CONNECTOR TYPE
T1	100Ω Balanced Twisted-Pair Cable	RJ-48 or Bantam Connector
J1	110Ω Balanced Twisted-Pair Cable	RJ-48 or Bantam Connector
E1	120Ω Balanced Twisted-Pair Cable	RJ-48 or Siemens 3-Pin Connector
E1	75Ω Single-Ended Coaxial Cable	BNC Connector

For each of the transmission systems, the physical connections are usually made through balanced twisted-pair cables and a RJ-48 type connector. However, it is not uncommon to find an E1 system that operates over a 75Ω single-ended coaxial cable with a BNC type connector. The interface circuit for both the balanced and single-ended connections requires either two transformers in series or a single transformer with a split secondary winding. This application note focuses on the single transformer solution, which is cost effective and requires less space.

Circuit Description

This interface in Figure 1 is built using the Pulse Engineering TX1099 transformer. This transformer is a dual surface-mount transformer that contains a split secondary winding. The transformer is a 1CT:1:0.8 and can be thought of as having two sections for the interface. The 1CT:1 section is used in the balanced twisted-pair cable connections and the 1:0.8 section is used in the single-ended coaxial-cable connections.

Receive Side Interface

Dallas Semiconductor's 3.3V devices normally require the use of a 1:1 transformer on the receive side of the device. With the 1:1 transformer, the matching resistance between the TIP and RING pins is simply the line impedance (i.e., for a 100Ω balanced twisted-pair cable the resistance between TIP and RING is exactly 100Ω). To ease board design and layout, Dallas Semiconductor created an internal impedance matching circuit to terminate the cable at either 75Ω, 100Ω, or 120Ω[1] through the use of software. To take advantage of this feature, the network interface must be terminated externally with 120Ω between TIP and RING. More details on this feature can be found in the device's data sheet.

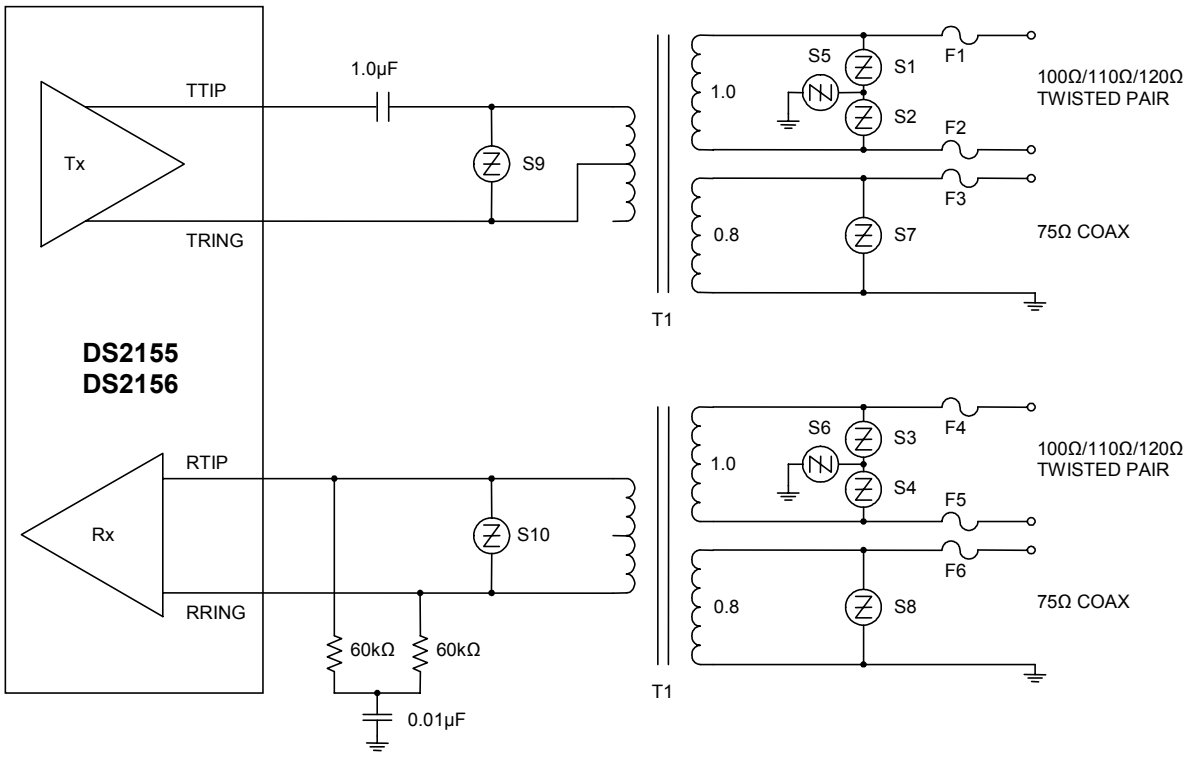
[1]The DS21348, DS2155, and DS2156 do not have a receive termination or line-build-out setting specifically for the 110Ω balanced twisted-pair cable used in Japan. The selection of 100Ω for receive termination or line build-out is within 10% and should work adequately.

In Figure 1, the balanced twisted-pair interface uses the 1CT:1 section of the transformer and requires no design changes. However, the single-ended coaxial cable interface uses the 1CT:0.8 section and requires modification. To properly match the line impedance, the resistance between RTIP and RRING is set for 120Ω. The resulting resistance seen by the line is 76.8Ω.

$$120\Omega \times (0.8)^2 = 76.8\Omega$$

This value is close enough to the ideal 75Ω to properly terminate the line. The software should configure the device for a receive termination of 120Ω whenever E1 communication is enabled.

Figure 1. DUAL CONNECTOR INTERFACE



Transmit Side Interface

The 3.3V devices normally require the use of a 1:2 transformer on the transmit side of the device. To achieve the necessary primary-to-secondary winding ratio, the center tap of the TX1099 primary side is connected to one of the inputs. In effect, the transformer is now a 1:2:1.6 with the 1:2 section for the balanced twisted-pair cable connections and the 1:1.6 section for the single-ended coaxial cable connections. As with the receive side, the balanced twisted-pair interface requires no design changes because it meets the required transformer specifications. Since the single-ended coaxial cable interface uses the 1:1.6 section, the pulse amplitude is lower if line build-out in the device is set for 75Ω E1 transmission. Normally, the pulse amplitude out of the device is doubled by the 1:2 transformer, but in this case it is only multiplied by 1.6. To create the necessary pulse amplitude into the cable, the line build-out is set for 120Ω. The 120Ω line-build-out setting creates a nominal 1.5V pulse into the primary winding of the transformer. This produces a 2.4V pulse at the cable.

$$1.5\text{Vop} \times 1.6 = 2.4\text{Vop}$$

This value is within the 2.37 ±10% peak voltage for E1 75Ω transmission. When using either of the E1 connections, the software should configure the device for a transmit line build-out of 120Ω.

Recommendations

The unused connector port in this design should be shorted between TIP and RING. In the case of the twisted pair connectors, there are special RJ-48 and bantam jacks that short TIP to RING if no connector is present. For the BNC connectors, jumpers could be used to short the pins. Optionally, external shorting plugs could be used in either case.