Chapter 6
Cable, connectors, and performance testing

6.1 General comments

When choosing cables and connectors for LVDS it is important to remember:

1. Use controlled impedance media. The cables and connectors you use should have a differential impedance of about 100Ω. They should not introduce major impedance discontinuities that cause signal reflections.

2. Balanced cables (twisted pair) are usually better than unbalanced cables (ribbon cable, multi-conductor) for noise reduction and signal quality. Balanced cables tend to generate less EMI due to field canceling effects and also tend to pick up electromagnetic radiation as common-mode (not differential-mode) noise, which is rejected by the receiver.

3. For cable distances <0.5m, most cables can be made to work effectively. For distances 0.5m < d < 10m, CAT3 twisted pair cable works well and is readily available and relatively inexpensive. Other types of cables may also be used as required by a specific application. This includes twin-ax cables built from separate pairs and ribbon style constructions, which are then coiled.

6.2 Cabling suggestions

As described above, try to use balanced cables (twisted pair, twin-ax, or flex circuit with closely coupled differential traces). The creators of LVDS intended it to be used over a wide variety of media. The exact media is not specified in the LVDS Standard. The intention was to leave that aspect to the referencing standard that specifies the complete interface. This includes the media, data rate, length, connector, function, and pin assignments. In some applications that are very short (<0.3m), ribbon cable or flex circuit may be acceptable. In box-to-box applications, a twisted pair or twin-ax cable would be a better option due to robustness, shielding and balance. Whatever cable you do choose, following the suggestions below will help you achieve optimal results.

6.2.1 Twisted pair

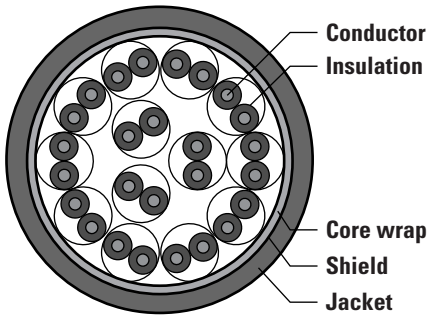

Figure 6.1. Drawing of twisted pair cable – cross-section

Twisted pair cables provide a good, low-cost solution with good balance, are flexible, and capable of medium to long runs depending upon the application skew budget. A variety of shielding options are available. Twisted pair cables are offered unshielded, with an overall shield or with shields around each pair in conjunction with overall shield. Installing connectors on twisted pair cables is difficult.

1. Twisted pair is a good choice for LVDS. CAT3 cable is good for runs up to about 10m, while CAT5 has been used for longer runs.
2. For the lowest skew, group skew-dependent pairs together (in the same ring to minimize skew between pairs).
3. Ground and/or terminate unused conductors (do not float).

6.2.2 Twin-ax cables

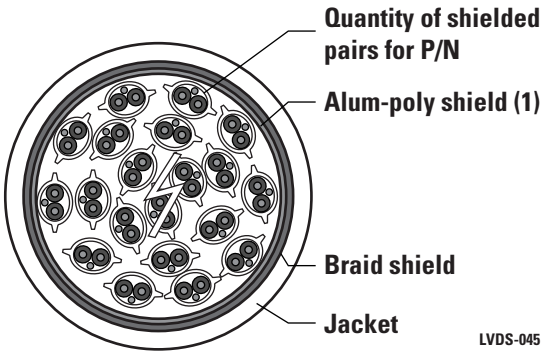

Figure 6.2. Drawing of individually shielded parallel pair twin-ax cable – cross section

Twin-ax cables are flexible, have low skew and shields around each pair for isolation. Since they are not twisted, they tend to have very low skew within a pair and between pairs. These cables are for long runs and have been commonly deployed in Channel Link and FPD-Link applications.

1. Drain wires per pair may be connected together in the connector header to reduce pin count.
2. Ground and/or terminate unused conductors.

6.2.3 Flex circuit

Flex circuit is a good choice for very short runs, but it is difficult to shield. It can be used as an interconnect between boards within a system.

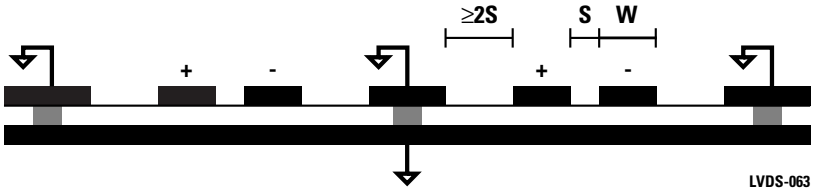

Figure 6.3. Flex circuit – cross-section

1. Closely couple the members of differential pairs (S < W). Do not run signal pairs near the edges of the cable, as these are not balanced.
2. Use a ground plane to establish the impedance.
3. Use ground shield traces between the pairs if there is room. Connect these ground traces to the ground plane through vias at frequent intervals.

6.2.4 Ribbon cable

Ribbon cable is cheap and is easy to use and shield. Ribbon cable is not well suited for high-speed differential signaling (good coupling is difficult to achieve), but it is OK for very short runs.

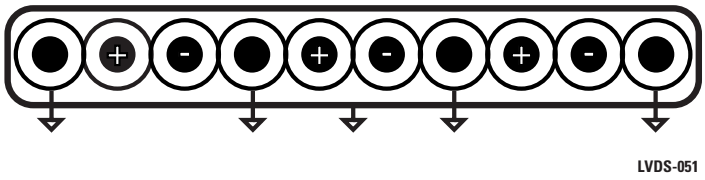

Figure 6.4. Flat cable – cross-section

1. If ribbon cable must be used, separate the pairs with ground wires. Do not run signal pairs at the edges of the ribbon cable.
2. Use shielded cable if possible. Shielded flat cable is available.

6.2.5 Additional cable information

Additional information on cable construction may be found in National Application Note AN-916. Also, many cable, connector and interconnect system companies provide detailed information on their respective websites about different cable options. A non-inclusive list of a few different options is provided below:

- 3M www.3M.com/interconnects/
- Spectra-strip cable products www.spectra-strip.amphenol.com/default.CFM
- AMP http://connect.amp.com/

6.2.6 Connectors

Connectors are also application dependent and depend upon the cable system being used, the number of pins, the need for shielding and other mechanical footprint concerns. Standard connectors have been used at low to medium data rates, and optimized low skew connectors have been developed for medium- to high-speed applications.

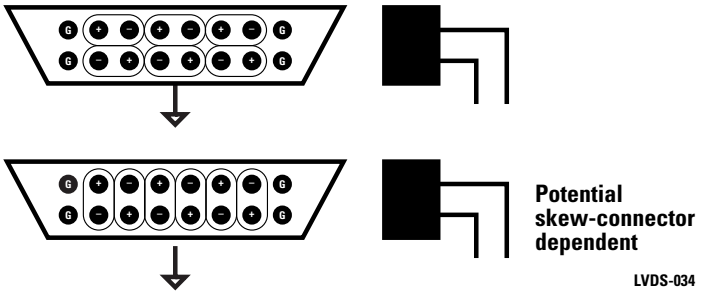

Figure 6.5. Typical connector pinouts

1. Choose low-skew, impedance-matching connectors if possible.
2. Group members of each pair together. Pins of a pair should be close together (adjacent) not separated from each other. This is done to maintain balance, and to help ensure that external noise, if picked up, will be common-mode and not differential in nature.

3. Some connectors have different length leads for different pins. Group pairs on same length leads. Consult the connector manufacturer for the orientation of pins that yield the lowest skew and crosstalk for your particular connector. Shorter pin lengths tend to be better than long ones, minimize this distance if possible.
4. Place ground pins between pairs where possible and convenient. Especially use ground pins to separate TTL/CMOS signals from LVDS signals.
5. Ground end pins. Do not use end pins for high-speed signals, if possible, as they offer less balance.
6. Ground and/or terminate unused pins.

Many different connector options exist. One such cable-connector system that has been used for LVDS with great results is the 3M "High-speed MDR Digital Data Transmission System." This cable system is featured on the National channel-link (48-bit) and LDI evaluation kits. The connector is offered in a surface mount option that has very small skew between all the pins. Different cable types are also supported.

6.3 Cable ground and shield connections

In many systems, cable shielding is required for EMC compliance. Although LVDS provides benefits of low EMI when used properly, shielding is still usually a good idea especially for box-to-box applications. Together, cable shielding and ground return wires help reduce EMI. The shielding contains the EMI and the ground return wire (the pair shield or drain wire in some cables) and provides a small loop area return path for common-mode currents. Typically one or more pairs are assigned to ground (circuit common). Using one or more pair reduces the DC resistance (DCR) of the path by the parallel connection of the conductors. This provides a known, very low impedance return path for common-mode currents.

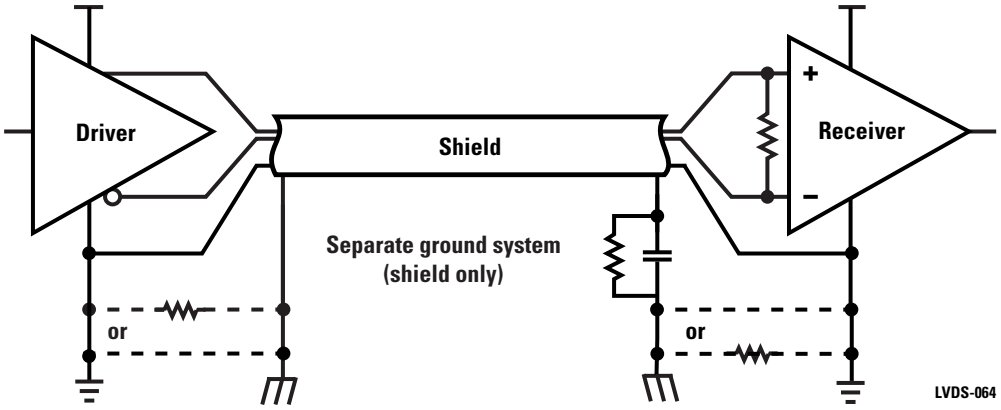

Figure 6.6. Typical grounding scheme

In most applications, the grounding system will be common to both the receiver and the driver. The cable shield is connected at one end with a DC connection to the common ground (frame ground). Avoid "pig-tail" (high-inductance) ground wiring from the cable. The other end of the shield is typically connected with a capacitor or network of a capacitor and a resistor as shown in the Figure 6.6. This prevents DC current flow in the shield. In the case where connectors are involved that penetrate the system's enclosure, the cable shield must have a circumferential contact to the connector's conductive backshell to provide an effective shield and must make good contact.

Note: It is beyond the scope of this book to effectively deal with cabling and grounding systems in detail. Please consult other texts on this subject and be sure to follow applicable safety and legal requirements for cabling, shielding, and grounding.