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SCSI-2 CABLE CONSIDERATIONS - A SUMMARY

In summarizing all of the known considerations for SCSI-2 cable design optimization, from both the system/electronic as well as connectorization viewpoints, the following criteria need to be factored into the final configuration:

1 - Impedance values want/need to be significantly higher than those found in 'standard' 28 AWG paired cables (in excess of 90 ohms, when properly evaluated), with the exception of the Term-Power lead(s) which want to be lower.

2 - In the 25/pair configuration, the REQ, ACK and data pairs are particularly 'impedance-critical'.

3 - The term-power lead(s) should be no higher in DC resistance than 65 ohms/kft.

4 - Most connectors designed for SCSI-2 can tolerate no more than a .032" maximum insulation diameter.

5 - Overall cable diameters have also been essentially pre-determined by connector back-shell design. (For a 25/pair configuration, this is .410" maximum.)

6 - To minimize reflections, and hence optimize overall system performance, there should be minimum impedance mismatch at all interfaces.

7 - Cellular insulation systems are effectively incompatible with current moulding technology, producing very poor production yields. Crosslinked foams may work, but will be incompatible with (8) below.

8 - The cables need to be as cost-effective as possible, since widespread usage is anticipated.

IMPEDANCE:
There are many methods of evaluating impedance of multi-pair cables. The following are some of the most common ones, all using a TDR (Time-Domain Reflectometer) for measurement:

Single-Ended	- Single-measurement, floating pairs
Differential	- 3-measurement method
G-S-G	- All grounds in common
G-G-S-G-G	- One conductor vs. all others

Each of the last 2 methods may be done with shield connected or floating.

Normally, cables to be used for SCSI-2 applications are evaluated using a modified G-S-G termination, with all ground leads connected in common and to the overall shield at both ends of the cable under test.

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Since most published data on multi-paired cables represents values derived differentially (if, indeed, the test protocol is identified at all...), it becomes a task to attempt to relate these values to the impedance preferred by the system.

Considering a typical 25-pair shielded cable (3 layers), each of these methods produces not only different values for characteristic impedance, but different layer-to-layer typical variances. Note that the highest-impedance pairs are always found on the inside (core) of the cable. In the case of a normal 25-pair cable, the core contains 2 pairs (Fig. 1).

When an un-shielded (internal) cable is considered, not only is the average value higher for a given construction, but the "variance curve" is reversed and the higher-impedance pairs are found on the outside layer (Fig. 2). Core pairs will be essentially the same impedance as for the shielded construction ....food for thought, isn't it... This fact alone may encourage some designers to more actively evaluate the use of identical (shielded) internal and external cables to minimize this effect.

Differential measurement will always produce the highest readings, and the least variance for any construction tested by the methods outlined (Fig. 3); however this method of evaluation may not be meaningful when the actual usage of the cable in a given system application is considered.

Therefore: It is important to define the most pertinent test protocol for a given application before attempting to evaluate the suitability of a cable for that application. In other words, <u>when specifying a desired value for characteristic impedance, it is incumbent on the system designer to also specify by what method this value is to be determined.</u>

Looking at the 'variance curves' previously mentioned, it is obvious that the 'reasonableness' of a given impedance tolerance is directly related to the test protocol to be used in the evaluation.

It should also be obvious that if there are particular signals which are most 'performance critical' in a given interface, it would be wise to select from the cable the pair-locations which will yield both:

A - The optimal performance in the longest-run (external) cable, and

B - The least internal/external impedance mismatch!

In every case, these will be found to be the pairs nearest the center of the cable. Note that we are considering here that similar wire-sizes and similarly cost-effective (i.e., non-exotic) insulation systems will be utilized.

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While the 'variance curve' on an external (shielded) cable can not easily be reversed (without radically altering the relative velocities and/or insulation diameters of conductors in each layer), it can be 'normalized' to a very meaningful extent of use of an electro/mechanical 'buffering' layer between the peripheral (outer) layer of pairs, and the overall shield. The amount of improvement can be seen from the data presented. (Fig. 4)

Given the foregoing design restrictions and considerations, it is reasonable to conclude that an optimized design will contain:

> Solid dielectric for cost effective processing & connectorization.

> Uniform dielectric O.D. (not exceeding .032" maximum) for consistent Vp and ease of connectorization.

> Optimized D/d for signal pairs, and 28 AWG for term-power lead(s).

> Buffering to optimize average impedance & flatten the "variance curve".

> Finished cable O.D. meeting backshell restrictions.

Furthermore, it is prudent to pre-assign cable locations for the performance-critical (highest impedance/lowest capacitance) pairs, as well as term-power (lowest DCR, lowest impedance/highest capacitance) pairs to assure the most consistent system performance and minimal interconnection mismatch with <u>any</u> cable.

Finally, it should be noted that while a cable which has been designed to perform in an <u>unbalanced</u> (single-ended) system will always work well in a <u>differential</u> application, <u>the converse does not apply!</u>

ASTRO has designed and built cables which meet the foregoing criteria, and should meet or exceed all known system performance considerations which have been investigated to date. (Fig. 5)

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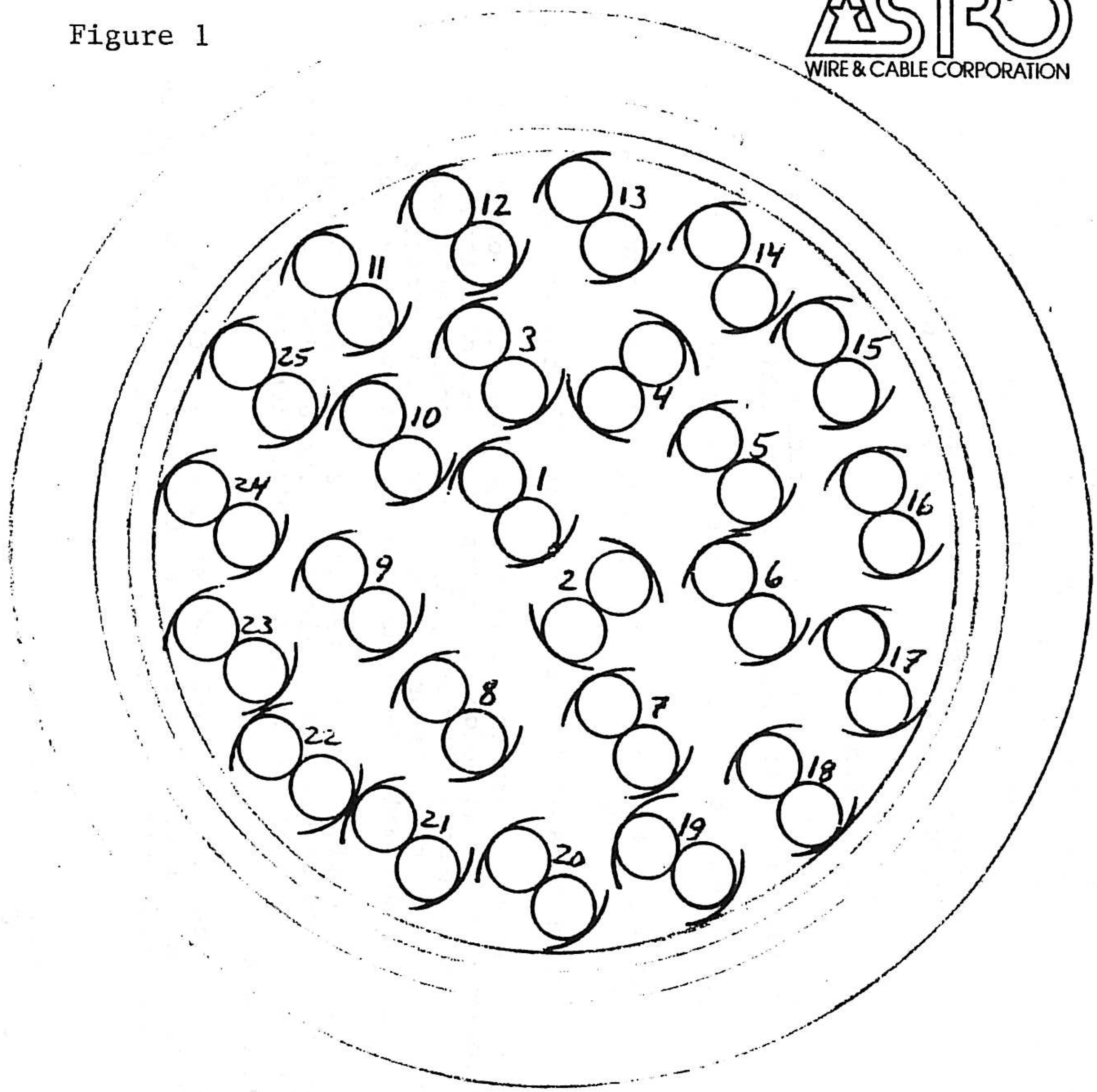
Figure 1



Typical 25/pr cable cross-section

186

Figure 2

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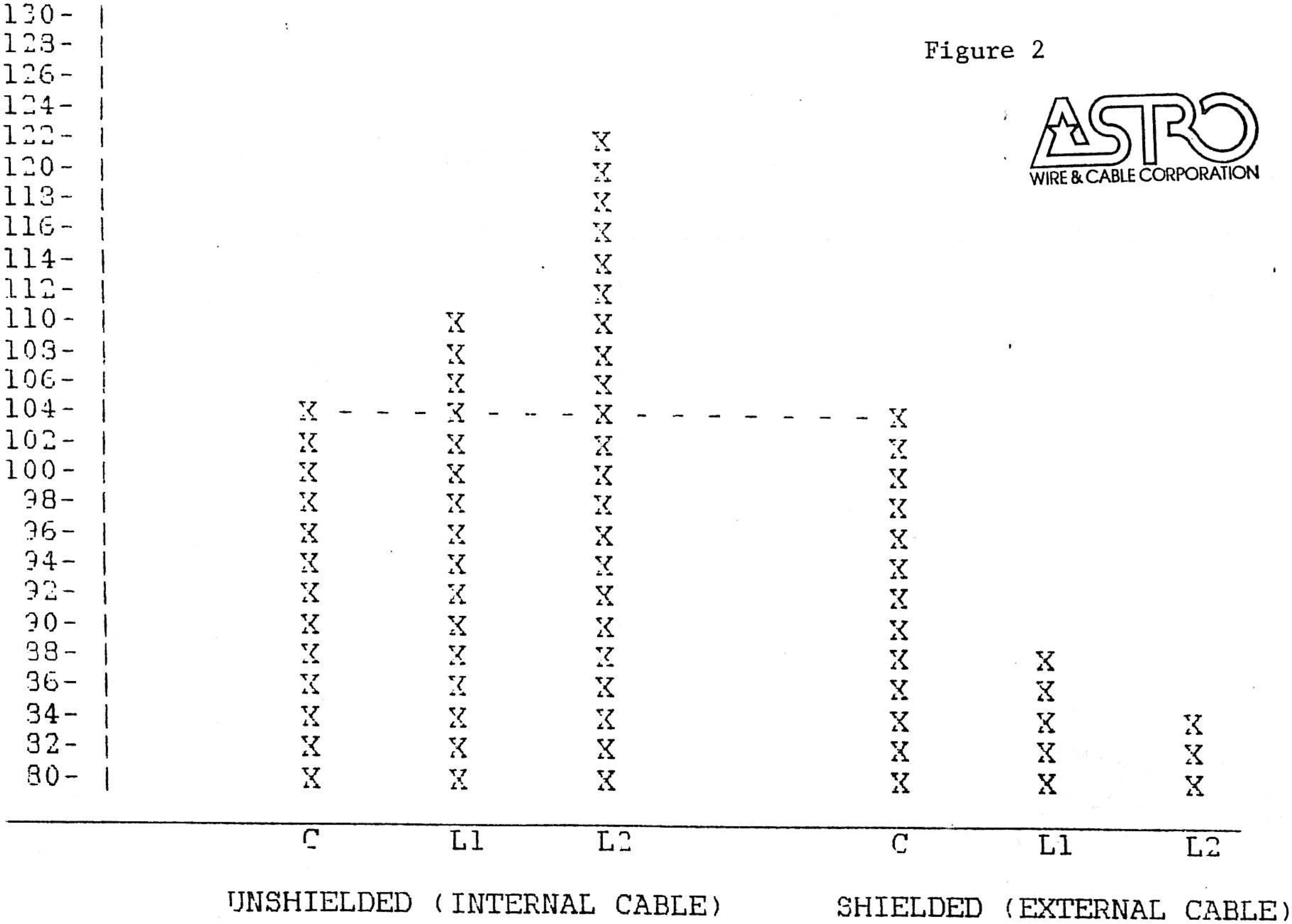

187

Figure 3

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	Z DIFFERENTIAL			Z G-S-G		
	C	L1	L2	C	L1	L2
120-						
118-						
116-	X					
114-	X					
112-	X					
110-	X					
108-	X	X				
106-	X	X				
104-	X	X	X	X		
102-	X	X	X	X		
100-	X	X	X	X		
98-	X	X	X	X		
96-	X	X	X	X		
94-	X	X	X	X		
92-	X	X	X	X		
90-	X	X	X	X	X	
88-	X	X	X	X	X	
86-	X	X	X	X	X	
84-	X	X	X	X	X	X
82-	X	X	X	X	X	X
80-	X	X	X	X	X	X

188

Figure 4

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	STANDARD CABLE C	STANDARD CABLE L1	STANDARD CABLE L2	WITH BUFFERED SHIELD C	WITH BUFFERED SHIELD L1	WITH BUFFERED SHIELD L2
110-						
108-						
106-						
104-						
102-	X			X		
100-	X			X		
98-	X			X		
96-	X			X	X	
94-	X			X	X	
92-	X			X	X	X
90-	X			X	X	X
88-	X	X		X	X	X
86-	X	X		X	X	X
84-	X	X	X	X	X	X
82-	X	X	X	X	X	X
80-	X	X	X	X	X	X

Figure 5

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