Broadcast standards

Suppliers have to contend with high definition broadcast applications pushing operating parameters of interconnection products to the limit. Peter Fayers considers the implications for the BNC connector

The humble BNC connector has been used within the broadcast industry for almost forty years, and has remained a firm favourite within the industry up to the present day. Its advantages are clear; robust construction, ease of use, simple termination method, field installable, low cost and above all, an ability to meet the requirements of ever increasing operating frequencies. Although broadcast connectivity has always been based on 75 ohm transmission lines, often the connectors it employed were not; typically they were 50 ohm devices as originally designed by its inventors back in the 1940s. PAL/NTSC transmission protocols required a sub-carrier frequency of around 4.5 MHz and at this frequency, impedance mis-matches of this kind were not a problem; analogue systems are very tolerant of discontinuities within the transmission path and picture quality expectations, in the past, were not as demanding as they are now.

Circumstances have now changed with the advent of digital transmission systems (SD-SDI; HD-SDI and now 3G-SDI). Such systems dramatically increase the requirement for bandwidth, firstly to approximately 400 MHz then 1.5 GHz and now 3.0 GHz; almost 3 orders of magnitude higher than that required for PAL/NTSC. At these frequencies, discontinuities in the transmission line become considerable sources of return loss (RL) with subsequent loss and degradation of signal transferred to the receiver. Computer simulation comparing the performance of a 75 ohm connector and a 50 ohm connector when used in a 75 ohm transmission line have shown that a 50 ohm connector can be tolerated when used in non HD-SDI broadcast applications, typically 0.2 to 0.7 GHz. However, above this frequency of operation its performance rapidly deteriorates, rendering its ability to meet HD-SDI specifications very uncertain, particularly if you consider the potential for additional RL at the Connector/PCB junction. The true 75 ohm connector shows a significant RL enhancement throughout the frequency range, providing latitude for additional discontinuities at the connector/PCB junction and therefore more readily meeting the requirements of HD-SDI and 3G-SDI applications.

Pseudo 75 ohm BNC connectors

One would be forgiven for assuming that specifying an off the shelf 75 ohm BNC connector would address the needs of digital applications. Unfortunately, this assumption would be wrong. For many years BNC connectors with superficial changes to the front of the insulator (the white plastic material separating the centre conductor from the outer conductor) have been sold as commercial grade 75 ohm connectors. In reality, these have been a sort of half way house, not 50 ohm and not really 75 ohm. Although this modification may enhance their 75 ohm performance, it is totally inadequate to meet demanding applications such as HD/3G-SDI systems.

True 75 ohm connectors

In order to obtain true 75 ohm impedance characteristics, the BNC connector needs to be re-designed from scratch. Extensive use of computer modelling has facilitated this process producing significant changes to the internal geometry and material specifications, whilst at the same time maintaining the BNC physical interface standards. This process, coupled with rigorous testing is the only real way to guarantee genuine 75 ohm performance. As we stand today there are few connector companies offering such product.

Unfortunately it is almost impossible to identify a true 75 ohm BNC connector just by simply looking at it, as much of the important design features are hidden. True 75 ohm BNC connector manufacturers usually produce performance data in the form of max VSWR over a given bandwidth or alternatively RL data in graphical format. This type of information is essential in helping to determine whether or not a connector is suitable for a particular requirement. Ultimately, in-house testing of the connector may be the best course of action to determine its performance within the application.

The connector/PCB junction

It must be borne in mind that the connector is just one element of the transmission line and equal care and attention must be afforded to each and every component/process used within the design of the transmission system.

The PCB layout in particular plays a very significant role in ensuring the overall transmission line RL is minimised. Copper plate thickness and dielectric substrate materials should be carefully chosen to best suit the requirements of the transmission system. Simply changing the substrate material and/or its thickness can change the characteristic impedance dramatically.

The use of multiple layers within PCBs may also provide ways of managing impedance by allowing internal combinations of ground planes and track geometries.

Even the production phase of a design will play a significant role in system performance. High accuracy PCB manufacture is critical, as minor deviation from the original layout dimensions may result in unwanted changes to the controlled impedance tracking. Also the removal of component and Via 'stubs' can positively affect RL by as much as 2 db in HD-SDI type applications.

One approach to minimise transmission line discontinuities is to maintain a straight line path at the junction of the connector and the PCB. Cambridge Connectors achieve this with one version of their true 75 ohm BNC connectors by mounting it on the edge of the PCB.

The future

The future of broadcast technology is unlikely to require lower frequencies, smaller bandwidths or lower packing densities. In which case, some may say that it is beginning to look ever more likely that the reign of the broadcast BNC connector, in its current guise, may well be coming to an end in the next ten years or so. From time to time the industry has toyed with other connector formats like the SMB, 1.0/2.3 and mini BNC but so far it has always returned to the BNC for main stream applications. This is due, to a great extent, to the large legacy of cabling infrastructure, existing tooling investments and user familiarity; all combining to produce a great desire to maintain the status quo. Who knows, with the continual advances in signalling protocols and compression techniques, perhaps the software developers at the forefront of broadcast technology will ensure that the BNC connector will remain connector of choice for many years to come.

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