TECHNICAL NOTE:

# HARRIER SERIES: COAXIAL CABLE SELECTION


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## Summary

This Technical Note explains how the characteristics of the data and the physical cable affect the maximum useable cable length.

## Background

The Harrier range of video interface products consists of:

- Interface boards for Tamron, Sony and other block cameras which convert the video data from these cameras to either uncompressed SMPTE HD-SDI / 3G-SDI, or via HD-VLC (visually lossless compression) to a SD-SDI stream (compressed down from either HD-SDI or 3G-SDI).
- Interface boards for Tamron, Sony and other block cameras which convert the video data from these cameras to USB 3.0 and HDMI. (These variants are not the subject of this Technical Note.)
- The Harrier SDI Adapter that can accept any of the SDI formats described above.

The advantage of the compressed HD-VLC system is that the reduced bit-rate allows transmission over three times the cable distance of an uncompressed signal.

Uncompressed SMPTE signals from the camera interface boards may be used in conjunction with any SMPTE compliant receiver.

Actual transmission distances achieved will depend on the properties of the coaxial cable carrying the transmission.

Signal bit rates may be summarized as follows:

| OPERATING MODE | SMPTE | HD-VLC |
|---|---|---|
| HD-SDI (1080p up to 30Hz, 720p and 1080i modes). | 1.485 Gb/s | 270 Mb/s |
| 3G-SDI (1080p 60/59/50 Hz) | 2.97 Gb/s | 540 Mb/s |

It is important to be aware that even when using HD-VLC transmission at 270 Mb/s, the signal frequency is higher than for standard definition analog signals.

Some low-cost, low-bandwidth cables, often used for analog transmission, may not be suitable for use with Harrier interface boards.

## General Features of Cable Construction

The aspects of cable construction which affect signal attenuation (and hence maximum cable length) can be summarized as follows:

1) Solid central conductors perform better than braid or multi-core. For the frequencies at which Harrier operates, solid conductor is the preferred option to minimize attenuation losses but may be less suitable from a mechanical/long-life perspective in high-flex applications. Several different construction methods are commonly used even for solid conductors, depending on the frequency and attenuation requirements.
2) Larger diameter cables perform better than smaller diameter cables.
3) Performance is improved by using higher specification outer ground sheaths. These can be braid or foil, with higher performance cables using up to three layers mixing braid and foil.
4) Performance depends on the characteristics of the insulation material between the inner core and outer sheath. This must have a low dielectric constant, which for high performance cables is achieved not only by choice of the appropriate material, but by using a foaming process which introduces gas filled bubbles to the polymer, exceeding 50vol% of gas.

From the above, it is clear that coaxial cables are available with a wide range of performance characteristics.

## Harrier Coaxial Cable Requirements

Maximum achievable cable lengths depend on the transmitter, the receiver and the characteristics of the coaxial cable connecting the two devices.

As previously discussed, coaxial cable come in a variety of performance characteristics. It is advised to select a “HD” coaxial cable, as these generally perform very well.

It is also the case that SMPTE receivers vary quite widely in performance from one manufacturer to another, which is relevant if the Harrier camera interface board is used to transmit uncompressed SMPTE signals to a third- party receiver.

## Cable Frequency Response Characteristics

A prerequisite of cable performance is that cable attenuation should vary approximately as the square root of frequency from 1MHz to a frequency equal to the bit-rate of the transmitted signal. This requirement is defined SMPTE standards S259, S424 and S292.

In general, receiver equalizers are designed on the assumption that cable attenuation will meet this requirement.

## Cable Attenuation Requirement

As previously described, receiver performance varies considerably from one manufacturer to another.

If the Harrier interface board is to be used to transmit uncompressed SMPTE signals to a third-party receiver, then a safe “rule of thumb” is that the cable attenuation should be less than 20dB at a frequency one half the bit-rate of the signal.

Because attenuation increases with frequency, this of course results in lower cable lengths for 3G-SDI signals than HD-SDI.

Longer cable lengths can be achieved with uncompressed SMPTE signals when using the Harrier receiver, and cable length can be increased by up to three times when using HD-VLC compression.

A good starting point when estimating achievable cable lengths using an end to end Harrier system, is to use the following rules:

| Transmission Standard | Maximum Cable Loss (dB) |
|---|---|
| HD-VLC @ 270 Mb/s | 50dB @ 135MHz |
| HD-SDI @ 1.485 Gb/s | 35dB @ 750MHz |

Harrier will usually exceed the cable lengths obtained from estimates made using these figures.

However, it is important to take into consideration that cable performance may degrade over time due to environmental factors.

Also, it is important to note that as the cable length increases towards the maximum supported length, the Harrier receiver will take a long time (tens of seconds) to lock properly. Depending on the application, it may be appropriate to reduce the maximum cable length slightly to guard against the possibility of this happening.

***Actual performance must be verified experimentally with a given cable system.***

## About Active Silicon

Active Silicon is a leading manufacturer of imaging products and embedded vision systems. We provide camera electronics for image data transmission, frame grabbers for data acquisition and embedded systems for image processing and machine control.

Founded in 1988, Active Silicon has a proven track record in providing reliable, high-quality products for a variety of industries world-wide. Our products have applications in many areas of science and industry including manufacturing, life sciences, medical imaging, security and defense. From space missions to large scale deployment of industrial vision systems, we have provided imaging components and embedded systems that help our customers provide world-class solutions.

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