(almost) everything you ever wanted to know about...

connectors for video, HF and test equipment

Replies from
Rémy Mallard (France)

We ask less of audio connectors than we do of those for video, RF and test equipment input/output. There are certainly good reasons for this. We asked Remy Mallard to tell us more.

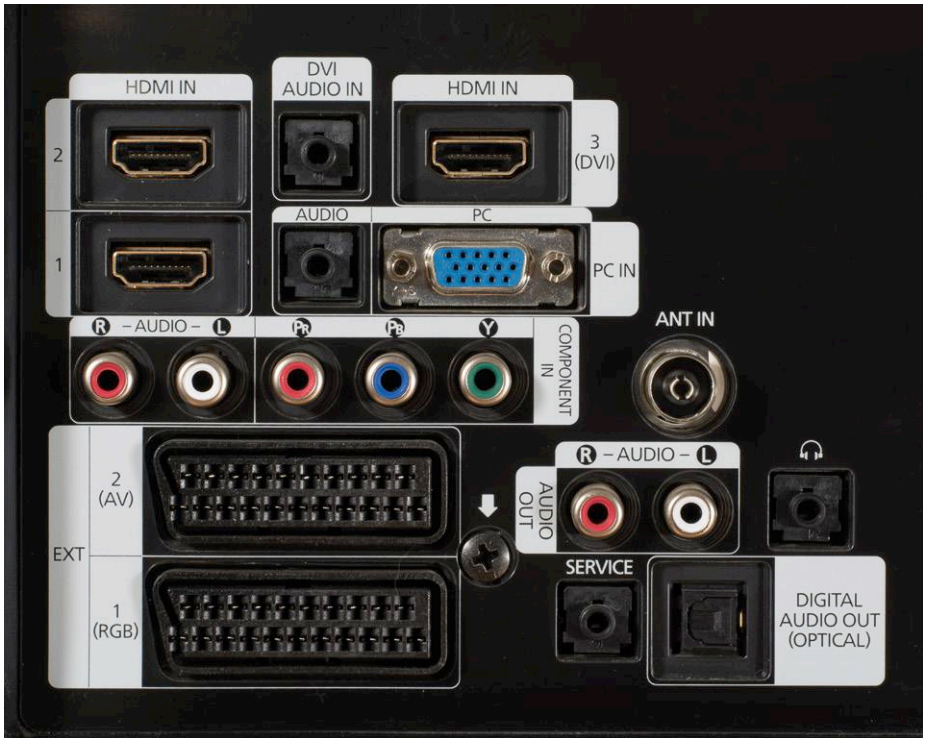

photo : Shutterstock

Q *In general terms, what can you say about video connectors?*

A Video has passed from black and white to color, then from analog to digital. Video connectors have also evolved, and the manufacturers will always offer rugged connectors to the pros, and 'bargain' (but quite solid all the same) connectors to the general public. In the professional world, analog video is transported over one or more coaxial cables terminated with robust 75-Ω BNC plugs: one conductor for composite (CVBS) video signals (PAL, SECAM or NTSC, luminance Y and chrominance C over the same wire), two distinct conductors for S-Video or Y/C (separate luminance and chrominance), or three conductors for separate components **R**ed **G**reen **B**lue or YUV [1] or YP_BP_R. Digital video may also be carried as SDI over coaxial cable with BNC plugs. For long distances correctors / equalizers are needed to compensate for high-frequency losses caused by the cables, and Ethernet links (twisted pairs and RJ45 connectors) or optical fiber may also be used (**Figure 1**).

For analog video for general consumer use, the very costly BNC connectors have been replaced by cheaper ones: RCA/Cinch (composite video on the yellow plug), SCART (French Péritel) with 21 pins, imposed on television manu-

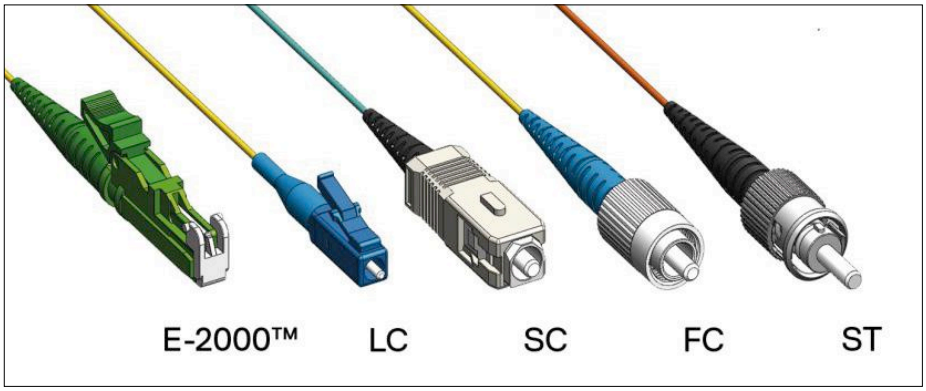

Figure 1. Fiber optic connectors. (Source: www.insys-ch.com)

Figure 2. HDMI Connector.
(Source: kabeldirekt-store.de)

Figure 3. DisplayPort Connector for digital screen interface, from VESA.
(Source: kabeldirekt-store.de)

Figure 4. Type 7/16 (7-16) female connector.

facturers from 1980 to 2015 and well known for its bad connections (composite video, Y/C and/or RGB), or even Ushiden with four pins (S-Video). Digital Video made its entry with DV cameras and their famous IEEE 1394 connector (FireWire at Apple; i.link at Sony) which allowed lossless transfer of picture and sound. Very practical…even if it only worked one way (to prohibit making digital copies, maybe? Today, DVI, HDMI (**Figure 2**) or DisplayPort (**Figure 3**) connectors are in common use, and transport digital video signals… with cables sometimes very costly, where an Ethernet cable would do as well. 'All-digital' eliminates the A/D and D/A conversion steps (**A**nalog, **D**igital) which contributes to a better image quality and a reduction of cost and complexity of equipment.

If digital video is now part of our daily lives, compatibility with legacy equipment is often desirable. That's why you still find on some equipment (TVs, game consoles, home cinema systems, camcorders and digital cameras) analog inputs and outputs on RCA plugs, 3- or 4-way jacks, or even some proprietary connector that makes users complain… but makes sellers of adapters very happy.

Acronym	Meaning
BNC	Bayonet Neill–Concelman
CVBS	Chroma Video Blanking Synchro
DV	Digital Video
DVI	Digital Visual Interface -A *(analog only, equivalent to VGA)* -D *(digital only)* -I *(analog and digital)*
FC	Ferrule Connector
LC	Lucent Connector *or* Local Connector
HDMI	High Definition Multimedia Interface
NTSC	National Television System Committee
PAL	Phase Alternating Line
RCA	Radio Corporation of America
SC	Subscriber Connector, Standard Connector *or* Siemon Connector
SCART	Syndicat des Constructeurs d'Appareils Radiorécepteurs et Téléviseurs (European TV manufacturers consortium)
SDI	Serial Digital Interface
SECAM	SÉquentiel Couleur À Mémoire (French TV standard)
SMA	SubMiniature version A
ST	Straight Tip
VESA	Video Electronics Standards Association

Q *Why do RF (radio frequency) connectors differ from video connectors?*

A You will find BNC connectors (75 Ω) used for video and also in low-power RF (BNC 50 Ω). But where RF connectors really come into their own is working with higher frequency or high power signals.

RF connectors are generally coaxial, with a central conductor surrounded by grounded metallic screening. They allow the various parts of a radio frequency system to be interconnected (antenna, receiver, cable, transmitter, filter, etc.). Some of them are lockable (screwing for SMA or TNC, bayonet for BNC) and others are not (TV 'PAL' antenna connector, 9.52 mm diameter, which only holds by friction, like an RCA/Cinch).

BNC connectors are fine for a few watts, even a few tens of watts, but are no good for high powers. There, one would use the robust "7/16" connectors (max 3 kW/5 GHz) (**Figure 4**), N connectors (max 1 kW/10 GHz) (**Figure 5**), or even, for more modest needs, SO-239 female (**Figure 6**) and PL-259 male connectors (strangely, these last two are often just called 'UHF connectors' although they do not work well above 100 MHz). Mini-UHF, F and SMA (**Figure 7**) connectors are suitable for signals in the GHz range, but are not good for high powers. Their small size makes them ideal for compact HF couplers or distributors (distribution of TV or satellite signals in buildings, for example). For very high powers, specific large connectors are used, which will not be known in your local components shop. At hyper-frequencies (several GHz) connectors and coaxial cables give way to

Figure 5. Type N male connector.

Figure 6. Type SO-239 connector.

Figure 7. Type SMA connector.

waveguides. That's where you discover what 'deluxe plumbing' means.
It must be recognized that the world of RF is very particular, and demands a good knowledge of the laws of physics and electromagnetism. It takes very little for an HF equipment or link to work badly or not at all. My first FM transmitter, put together as if it was an audio mixer (I had no knowledge of the rules governing RF) was sadly lacking in efficiency!

Q *Do RF connectors need special materials?*

A Yes. Because at RF, any connector is a source of loss of signal transmission. Their choice, which depends on the frequency and the power of the signals being carried, is often very critical. Various types of conductor may be used for the different parts of the connector (center pin, body, intermediate rings): stainless steel, brass, gold plated brass, bronze plated brass, nickel plated brass, gold beryllium bronze, copper-beryllium, nickel, gold or silver. The insulator (the dielectric) which keeps the pin separate from the body is often made of Teflon® (PTFE), which shows very low losses at high frequencies (it is usable up to around 10 GHz). The thickness of the plating (gold for example) on the moving parts depends mainly on the number of connections foreseen by the manufacturer.

Q *Can you use adaptors (gender changers) at RF?*

A Yes, but be careful! That causes yet more losses, often considerable even for high priced connectors. In an RF link, always avoid gender changers and extensions (always use one 6-m cable rather than three 2-m cables in series). And if you're looking at an RF link of several tens of meters, it's worth looking at the losses from the coaxial cable itself, which may be appreciable!

Q *And what of the connectors used on test equipment?*

A Test equipment needs to be accurate, reliable and robust. On lab equipment, connected cables are often used. But there are different requirements for portable equipment: their connectors must withstand multiple connections and disconnections, but also small accidents like being dropped (yes, I know you're always careful!). The BNC connector is without doubt the most common connector on oscilloscopes, connecting probes with 'high impedance' screened cable or 50 Ω cables (my first oscilloscope used banana plugs, but its bandwidth was severely limited — so let's forget that). Equipment such as vector analyzers, spectrum analyzers and wattmeters often use N connectors, made for 50 Ω, and usable up to several GHz. ⏮

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Web Link

[1] YUV color space: https://en.wikipedia.org/wiki/YUV

Figure 8. Connectors for very high frequency, but these don't handle high power.