



100 Things You Forgot About Audio and Video Cable to Help you Choose and Install It

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So You're...

- ◆ Designing an HD facility.
- ◆ Installing an HD station.
- ◆ Have you remembered everything?
 - Wire & cable: the "forgotten" component
 - Here's a list
 - 100 things you might have forgotten
 - ◆ Or maybe didn't know!



100, 99, 98, 97, 96, 95

- ◆ Analog audio cables can be compared by their capacitance.
 - “Budget” cables are PVC inside and out
 - Better cables are polypropylene
 - Better still are polyethylene
 - Teflon is even better
 - Foamed polyethylene is the best



94, 93, 92,

- ◆ With audio cable...
 - Some cables will go farther than other cables.
 - One reason is the capacitance.
 - ◆ The lower, the better
 - Another reason is the SOURCE IMPEDANCE of the driving device.



Source Impedance

Source Impedance	15 pF/ft. (49 pF/m)	20 pF/ft. (66 pF/m)	30 pF/ft. (98 pF/m)	50 pF/ft. (164 pF/m)
50 Ω	5406 ft. 1648m	4055 ft. 1236m	2703 ft. 824m	1622 ft. 495m
100 Ω	2707 ft. 825m	2030 ft. 619m	1353 ft. 413m	812 ft. 248m
150 Ω	1873 ft. 571m	1352 ft. 412m	901 ft. 275m	541 ft. 165m
600 Ω	451 ft. 138m	338 ft. 103m	225 ft. 68.6m	135 ft. 41.2m
1 k Ω	271 ft. 82.6m	203 ft. 61.9m	135 ft. 41.2m	81 ft. 24.7m
10 k Ω	27 ft. 8.2m	20 ft. 6.1m	14 ft. 4.3m	8 ft. 2.4m
50 k Ω	5.4 ft. 165cm	4 ft. 122cm	2.7 ft. 82cm	1.6 ft. 49cm

-1 dB at 20 kHz



91, 90, 89

- ◆ Twisted pairs reject noise.
- ◆ But only when they are run as a balanced lines.
- ◆ Balance is measured by "common mode rejection ratio" CMRR.



88, 87, 86, 85, 84

- ◆ Digital audio cables
 - Twisted pairs or coax.
- ◆ Each pair or coax
 - Can carry one or two channels.
- ◆ Digital audio twisted pairs are 110Ω
 - Compromise between size and performance
- ◆ You can run digital audio on analog pairs
 - But not very far ~ 50 ft.
- ◆ Digital pairs are the BEST analog pairs.
 - Low capacitance 13 pF/ft.



83, 82, 81, 80, 79, 78

- ◆ Digital audio can also run on 75Ω coax.
- ◆ Coax runs MUCH farther than pairs.
- ◆ Same coax for audio and video
 - Maybe a different color?
- ◆ One connector for the entire install
- ◆ One stripping tool
- ◆ One crimp tool



Digital Audio Distance

	6 MHz (48 kHz Sampling)	25 MHz (192 kHz Sampling)
26 AWG pairs	813 ft.	474 ft.
24 AWG pairs	1105 ft.	649 ft.
22 AWG pairs	1538 ft.	1015 ft.
Belden 1855A	1992 ft.	1111 ft.
Belden 1505A	2911 ft.	1538 ft.
Belden 1694A	3467 ft.	2000 ft.

200mV Distance



77, 76, 75, 74

- ◆ 48kHz audio is (48 x 128) 6.144 MHz
- ◆ Digital audio on coax (6 MHz) is the same as analog video (6 MHz channel)
- ◆ Analog video patch panels work *perfectly* for digital audio (recycle!)
- ◆ Video distribution amps also work.
 - Have to check their square wave response to handle 48kHz AES data



73, 72, 71

- ◆ You can also use Category 5e or Category 6 to carry analog or digital audio.
- ◆ The same cable can carry 10baseT, 100baseT or 1000baseT Ethernet®
- ◆ Same cable can carry RGB or VGA for monitors and displays.
 - More on RGB/VGA later!



70, 69, 68, 67, 66

- ◆ You can also use multipair snake.
- ◆ Digital snake is the ultimate analog.
 - 13 pF/ft.
- ◆ Install snake
 - Stiff and shiny.
- ◆ Field snakes
 - Rugged and flexible.
- ◆ There are plenum snake cables.



65, 64, 63, 62, 61

- ◆ Where's plenum ground wire?
 - Not a cable.
 - NEC only rates *cables*.
 - ◆ See NEC Article 300 and 310
- ◆ NEC is a voluntary code
 - But most areas now use it.
 - Exceptions: Chicago, Las Vegas, LA



60, 59, 58, 57, 56, 55, 54, 53

- ◆ Speaker cables are current-delivery.
- ◆ Key parameter is AWG, resistance.
 - Capacitance...hmmm
 - Inductance...forget it
- ◆ Speaker cables are unbalanced
 - Unless you have a bridged output
- ◆ Don't need shielding.
 - Hard to interfere with
 - Foil shields are for RF



52, 51, 50, 49, 48

- ◆ 70-volt systems more efficient
 - Long speaker cable runs
 - Lower gage size (\$\$\$)
- ◆ Requires special amp output
- ◆ Transformers on speakers
 - Can select output power for each
 - "Zone" volume



47, 46, 45, 44, 43, 42

- ◆ Or use powered speakers
 - Line level input
 - No speaker cable
- ◆ Networked audio
 - CobraNet and many others
 - Multichannel delivery
- ◆ Control audio in software
 - EQ, delay etc.



41, 40, 39, 38

- ◆ Analog video is 4.2 MHz bandwidth.
- ◆ Quarter-wave is 61 ft.
 - A flaw must be 61 ft. long to show up.
- ◆ Connector impedance doesn't matter
 - Not long enough to show up.
- ◆ Patch panels, bulkhead/feedthrough
 - Not long enough to show up.



37, 36, 35, 34

- ◆ RGB is component analog
 - Splits video into component parts
 - Top analog performance
- ◆ Usually delivered on multiple coaxes
 - Delivery "timing" is critical.
- ◆ Bundled coaxes **MUST** have 'timing'
 - Ask the manufacturer



33, 32, 31, 30, 29, 28

- ◆ RGB can run on coaxes or UTP
 - Timing (delay skew) is critical.
- ◆ UTP delay skew per 100m (328 ft.)
 - EIA/TIA 568B standard: 45 nsec
 - Belden 1872A MediaTwist: 25 nsec
 - Belden 7989R/7989P, Cat 6: 10 nsec
 - Belden 7988R/7988P, Cat 5e: 9 nsec
 - Belden 7987R/7987P, Cat Ø:2.2 nsec



27, 26, 25

- ◆ Timing in RGB coaxes: 5 nsec/100 ft.
 - That's 16 nsec/100m
 - Twisted pairs have passed RGB coax!
- ◆ Coax can still go farther
 - Gage size
 - Impedance stability
- ◆ Jacketless coaxes "Banana Peel[®]"
 - Lighter, smaller, cheaper, easier install.
 - Plenum and Riser



24, 23, 22

- ◆ SDI is 270 Mbps/135 MHz.
- ◆ Usually tested to 400 MHz
 - Third harmonic is $135 \times 3 = 405$ MHz
 - Square waves need harmonics.
- ◆ Quarter wave at 400 MHz is 7 inches



21, 20, 19, 18

- ◆ HD-SDI is 1.485Gbps/750MHz clock.
- ◆ Third harmonic is 2.25 GHz.
- ◆ Quarter-wave is 1.3 inches
 - Most Belden precision digital video cables are tested to 4.5 GHz
- ◆ And then we have 3G-SDI
 - Master format for 1080i AND 720p
 - 1080p/60



17, 16, 15

- ◆ 3G-SDI clock is 1.5 GHz.
- ◆ Third harmonic is 4.5 GHz.
 - Belden 1505A and 1694A now tested to 4.5 GHz with guaranteed return loss numbers:
 - -23 dB 5MHz-1.6GHz,
 - -21 dB 1.6 GHz -4.5 GHz
- ◆ Quarter-wave distance 0.656 inches
 - EVERYTHING is critical!



14, 13, 12

- ◆ 75Ω coaxes up to RG-11, .405"
 - Belden 7731A
 - HD distance: 546 ft. (3G = 364 ft.)
 - ◆ Real-world distance ~ 1000 ft.
- ◆ Down to .100"
 - Belden 179DT
 - HD distance: 109 ft. (3G = 76 ft.)
- ◆ SMPTE formula in 292M, 424M
 - -20 dB down at 1/2 clock.



11, 10, 9

- ◆ SMPTE distance is ~ half way to cliff.
- ◆ You can go up to twice as far:
 - Look at eye patterns
 - Look at bit errors (BERT)
- ◆ Max theoretical distance: 1000 ft.
 - After that – fiber
 - Single mode fiber
 - SMPTE 311M
 - Tactical fiber



8, 7

- ◆ Maximum distance chip dependent.
- ◆ Preserve cable performance.
 - Don't deform cable
 - ◆ Don't step on it
 - ◆ Don't run over it
 - ◆ Don't put heavy items on it



6, 5

- ◆ Avoid “periodic” cable losses
 - Don't put wire ties at the same distance
 - Tighten them by hand, not a gun.
 - Wider ties are better than thinner.
 - Velcro ties are best.
 - J-hooks and ladder rungs can also show
- ◆ Cable made with high-density hard-cell nitrogen gas-injected foam will resist deformation.



4, 3

- ◆ Everything in the chain is critical
- ◆ SMPTE minimum RL is -15 dB for all.
 - Cable
 - Connectors
 - Patch cords
 - Patch panels
 - Bulkheads and feedthroughs
 - Connectors on equipment



2, 1

- ◆ You can test HD signals
 - H-P/Agilent network analyzer
- ◆ Cheap way to test
 - Bundle of cable
 - Faraday cable clone
 - ◆ www.faradaytech.co.uk
 - Vindicom HRM-1500 HD tester
 - ◆ www.vindicom.com



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