

Going the Distance with Serial Digital Coax

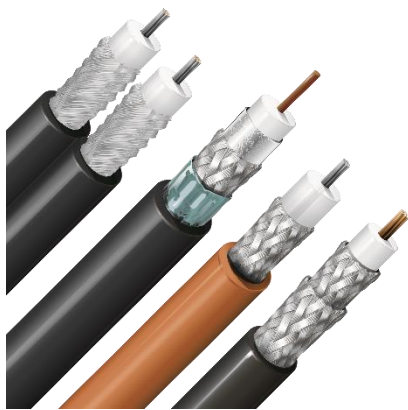
By Rose Lockwood, Global Account Director, Broadcast

In the late '80s, the Society of Motion Picture Television Engineers (SMPTE) developed a standard for transmitting serial digital interface (SDI) video signals. These uncompressed, unencrypted digital signals are still a big part of broadcast signals today.

What type of cabling did SMPTE choose to run this new SDI signal? Although fiber is an option, most SDI signals used a 75 Ohm coax, which has been a staple for broadcasters for years. Coax cable has a proven track record of reliability. It's also easy to terminate and install, and its electrical characteristics offer good performance.

As more and more coax cables for SDI signals hit the market (Belden is proud to have the most complete line of coax cables available), they were offered in multiple variations—riser, plenum, LSZH, high-flex and gel-block outdoor versions—as well as in many sizes ranging from miniature RG-59 up to RG-11. With all these choices, designers needed an easy way to determine how long they could run each of these cables.

To give designers the information they needed, we created a table based on signal loss recommendations for given formats as specified by [SMPTE](#). Just recently, we updated this table to feature a new format and new versions of cables as they become available.

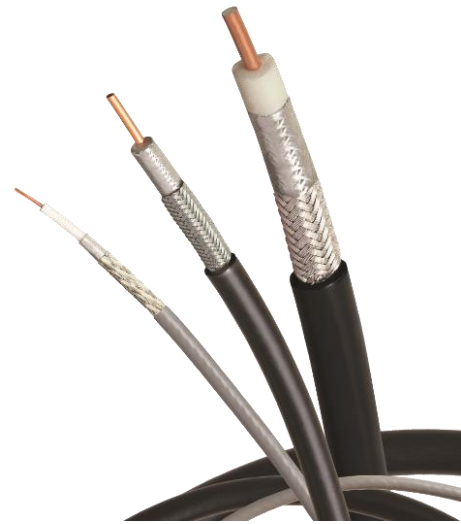


Even though it sometimes goes unnoticed, it's important to note that these tables always have a caveat: *"The bit error rate (BER) can vary dramatically as the calculated distances are approached. BER is dependent on receiver design and the losses of the actual coax used. Distribution and routing equipment manufacturers should be contacted to verify their maximum recommended transmission."*

Because of the scope of work and infrastructure they work with, some designers choose to design right up to the maximum lengths listed on the table; others choose to build a safety margin into the overall distance.

Remember that performance can vary based on the type of active equipment specified. We've heard that reputable manufacturers aren't designing all their 12 GHz receivers to reach the maximum loss level, which could result in distance reductions of up to 50%. This variance is recognized in the SMPTE 2082-1 Standard: *"... however, receivers designed to work with greater or lesser signal attenuation are acceptable."*

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The table we designed is based on attenuation or signal loss at one-half the signal frequency as defined by SMPTE and based on signal type. The distance values are for cables only; they don't include connectors, bulkheads or other items used to connect cables and add loss. Because of variations in equipment, it's impractical to test actual video signal (it would require tests between each variation).

As the industry moves toward 12 Gb/s single-link as part of SMPTE 2082-1, it's now critical for designers to verify distance. To do this, check with your equipment manufacturers to confirm the type of cable needed to reach the distance you want to meet.

Or consider setting up a test system using the equipment and cable to assess the output signal at the required length. This would allow you to mix and match active gear from different manufacturers. Some designers have switched to [fiber optic cabling](#) to achieve greater distances (Belden supports these cables as well), but coax cable certainly isn't dead. In fact, there are quite a few applications where coax is still the best fit.

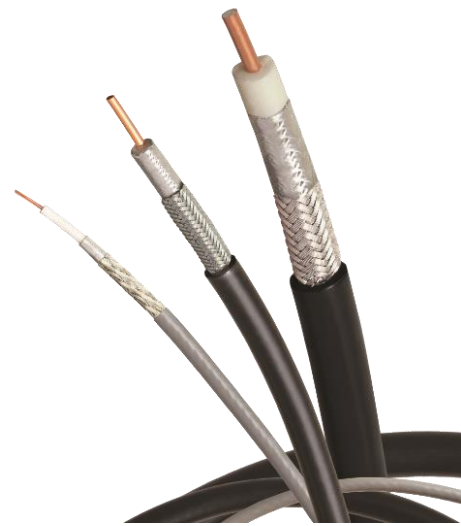
This is why Belden created a new series of coax cables specifically for 12 GHz bandwidth. Belden's [4K UHD Coax Cable for 12G-SDI](#) supports 4K content without a change to fiber. It gives designers access to the best possible performance in a coax cable sweep test to 12 GHz signal.

You want your broadcast performance to stand out—for all the *right* reasons. Downtime, delays and distortion have immediate, far-reaching impact. Reliable audio and video cable solutions help you achieve absolute signal integrity and 100% uptime, no matter the conditions.

Belden's [audio and video cable solutions](#) support fast, easy assembly and maintenance while ensuring long transmission distances in all weather conditions. Drag these cables below roads, above trees, around a stadium and off and on the stage every week—they're ready for anything.

Belden Channel Account Manager for AV Bob Ferguson helped me write this blog, and he is a tremendous resource who can address any of your AV cabling questions. If you want to know more about this topic, email me (rose.lockwood@belden.com) or Bob (bob.ferguson@belden.com). We would be happy to send you the updated table and discuss your choices.

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Estimated Transmission Distance at Serial Data Rates

The distances listed below are estimates based upon the cable loss values (excluding connectors or connectivity) in the SMPTE standards list. Belden cannot guarantee these distance will be obtained due to variations in the equipment used.

The manufacturer of the equipment used should be contacted to determine what distance can be expected with the cable intended to be used.

| Data Rate: | 143 Mb/s | | 177 Mb/s | | 270 Mb/s | | 360 Mb/s | | 1.5 Gb/s | | 3.0 Gb/s | |
|-------------------------------|-------------------------|-----|------------------------|-----|------------------|-----|-------------------|-----|--------------|-----|--------------|-----|
| Spec: | SMPTE ST 259 | | SMPTE ST 259 | | SMPTE ST 259 | | SMPTE ST 259 | | SMPTE ST 292 | | SMPTE ST 424 | |
| Application: | Composite SD-SDI (NTSC) | | Composite SD-SDI (PAL) | | Component SD-SDI | | Widescreen SD-SDI | | HD 1.5G-SDI | | HD 3G-SDI | |
| Cable Part Number | Ft. | m | Ft. | m | Ft. | m | Ft. | m | Ft. | m | Ft. | m |
| 179DT | 551 | 168 | 502 | 153 | 417 | 127 | 364 | 111 | 117 | 36 | 82 | 25 |
| 1865A | 686 | 209 | 627 | 191 | 508 | 155 | 441 | 134 | 134 | 41 | 90 | 27 |
| 1855A ¹ | 1027 | 313 | 941 | 287 | 775 | 236 | 678 | 207 | 215 | 66 | 151 | 46 |
| 1855P | 1004 | 306 | 918 | 280 | 748 | 228 | 649 | 198 | 196 | 60 | 131 | 40 |
| 4855R ² / 4855ANH | 1066 | 325 | 968 | 295 | 800 | 244 | 694 | 212 | 221 | 67 | 155 | 47 |
| 4855P | 976 | 297 | 885 | 270 | 726 | 221 | 631 | 192 | 193 | 59 | 131 | 40 |
| 1505A ³ | 1500 | 457 | 1381 | 421 | 1127 | 344 | 975 | 297 | 304 | 93 | 212 | 65 |
| 1506A ⁴ | 1372 | 418 | 1260 | 384 | 1017 | 310 | 883 | 269 | 262 | 80 | 175 | 53 |
| 1505F | 1211 | 369 | 1092 | 333 | 864 | 263 | 735 | 224 | 223 | 68 | 150 | 46 |
| 4505R ⁵ / 4505ANH | 1474 | 449 | 1321 | 403 | 1079 | 329 | 942 | 287 | 307 | 94 | 217 | 66 |
| 4505P | 1324 | 404 | 1200 | 366 | 986 | 301 | 858 | 262 | 263 | 80 | 177 | 54 |
| 1694A ⁶ | 1846 | 563 | 1681 | 512 | 1376 | 419 | 1203 | 367 | 367 | 112 | 255 | 78 |
| 1695A ⁷ | 1792 | 546 | 1625 | 495 | 1319 | 402 | 1134 | 346 | 327 | 100 | 215 | 66 |
| 1694F | 1490 | 454 | 1340 | 408 | 1043 | 318 | 892 | 272 | 260 | 79 | 174 | 53 |
| 4694R ⁸ / 4694ANH | 1755 | 535 | 1607 | 490 | 1336 | 407 | 1171 | 357 | 383 | 117 | 269 | 82 |
| 4694P | 1704 | 519 | 1535 | 468 | 1259 | 384 | 1095 | 334 | 327 | 100 | 217 | 66 |
| 4694F | 1715 | 523 | 1533 | 467 | 1225 | 373 | 1049 | 320 | 316 | 96 | 213 | 65 |
| 1794A ⁹ | 2427 | 740 | 2224 | 678 | 1799 | 548 | 1559 | 475 | 477 | 145 | 332 | 101 |
| 4794R ¹⁰ / 4794ANH | 2231 | 680 | 2045 | 623 | 1715 | 523 | 1512 | 461 | 494 | 151 | 343 | 105 |
| 4794P | 2146 | 654 | 1935 | 590 | 1570 | 479 | 1352 | 412 | 392 | 119 | 255 | 78 |
| 7731A | 2791 | 851 | 2613 | 796 | 2091 | 637 | 1838 | 560 | 582 | 177 | 390 | 119 |
| 7732A | 2703 | 824 | 2463 | 751 | 1951 | 595 | 1655 | 504 | 461 | 141 | 290 | 88 |
| 4731R / 4731ANH | 2824 | 861 | 2573 | 784 | 2130 | 649 | 1861 | 567 | 598 | 182 | 414 | 126 |
| 4731P | 2605 | 794 | 2342 | 714 | 1913 | 583 | 1646 | 502 | 470 | 143 | 301 | 92 |

| Data Rate per Link: | 3 Gb/s | | 6 Gb/s | | 12 Gb/s | |
|-------------------------------|--|-----|---|-----|---|-----|
| Spec: | SMPTE ST 425-4 (3Gb/s - stereo) ST 2081-1 (6 Gb/s - dual link) ST 2082-1 (12 Gb/s - quad) ST 2083-1 (24 Gb/s - octal link) ¹ | | ST 2081-1 (6 Gb/s - single link) ST 2082-1 (12 Gb/s - dual link) ST 2083-1 (24 Gb/s - quad link) ¹ | | ST 2082-1 (12 Gb/s - single link) ST 2083-1 (24 Gb/s - dual link) ¹ | |
| Application: | UHDTV1, UHDTV2 | | UHDTV1, UHDTV2 | | UHDTV1, UHDTV2 | |
| Cable Part Number | Ft. | m | Ft. | m | Ft. | m |
| 179DT | 164 | 50 | 114 | 35 | | |
| 1865A | 179 | 55 | | | | |
| 1855A ¹ | 302 | 92 | 207 | 63 | | |
| 1855P | 262 | 80 | 174 | 53 | | |
| 4855R ² / 4855ANH | 310 | 94 | 215 | 66 | 149 | 45 |
| 4855P | 262 | 80 | 177 | 54 | 118 | 36 |
| 1505A ³ | 425 | 130 | 287 | 87 | | |
| 1506A ⁴ | 350 | 107 | 230 | 70 | | |
| 1505F | 300 | 91 | 197 | 60 | | |
| 4505R ⁵ / 4505ANH | 433 | 132 | 302 | 92 | 208 | 63 |
| 4505P | 354 | 108 | 235 | 72 | 155 | 47 |
| 1694A ⁶ | 509 | 155 | 340 | 104 | | |
| 1695A ⁷ | 430 | 131 | 280 | 85 | | |
| 1694F | 348 | 106 | 225 | 69 | | |
| 4694R ⁸ / 4694ANH | 538 | 164 | 374 | 114 | 257 | 78 |
| 4694P | 433 | 132 | 285 | 87 | 186 | 57 |
| 4694F | 426 | 130 | 284 | 87 | 184 | 56 |
| 1794A ⁹ | 664 | 202 | 444 | 135 | | |
| 4794R ¹⁰ / 4794ANH | 686 | 209 | 471 | 144 | 321 | 98 |
| 4794P | 510 | 155 | 327 | 100 | 210 | 64 |
| 7731A | 780 | 238 | 529 | 161 | | |
| 7732A | 579 | 176 | 370 | 113 | | |
| 4731R / 4731ANH | 828 | 252 | 566 | 173 | 383 | 117 |
| 4731P | 603 | 184 | 380 | 116 | 243 | 74 |

The serial digital interconnect standards are designed to operate where the signal loss at 1/2 the clock frequency does not exceed the approximate loss values listed below. The recommended length values shown are based on typical attenuation values for the cables listed and the following criteria:
 Maximum length = 30 dB loss at 1/2 the clock frequency: SMPTE ST 259.
 Maximum length = 20 dB loss at 1/2 the clock frequency: SMPTE ST 292 & ST 424.
 Maximum length = 40 dB loss at 1/2 the clock frequency: SMPTE ST 425, ST 2081, ST 2082 & ST 2083¹.

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SMPTE ST 2083-1 is under development.

Bundled coax transmission distances slightly less than single coax due to helix of coax in bundled configuration.

| Footnote | Single | Bundled | |
|----------|--------|-------------------------|---|
| | | 12 Gb/s | 6 Gb/s |
| 1 | 1855A | | 7787A 7788A 7789A 7790A 7791A 7792A 2178A |
| 2 | 4855R | 4855RX5 4855R10 4855R16 | |
| 3 | 1505A | | 7794A 7795A 7796A 7798A |
| 4 | 1506A | | |
| 5 | 4505R | 4505RX5 | |
| 6 | 1694A | | 7710A 7711A 7712A 7713A |
| 7 | 1695A | | 1694D 1694WB |
| 8 | 4694R | 4694RX5 | 1694S3 1694S5 1694S6 |
| 9 | 1794A | | 1695S3 1695S5 1695S6 |
| 10 | 4794R | 4794RX5 | 2177A |