Going the Distance with Serial Digital Coax

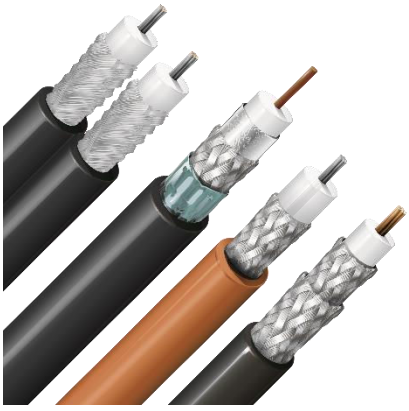
By Rose Lockwood, Global Account Director, Broadcast

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 liste
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 2083[1].

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 distance.

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	3 Gb/s
1	1855A		7787A 7788A 7789A 7790A 7791A 7792A 2178A	1855S3 1855S5 1855S6
2	4855R	4855RX5 4855R10 4855R16		
3	1505A		7794A 7795A 7796A 7798A	1505S3 1505S5 1505S6
4	1506A			1283S3 1283S5 1283S6
5	4505R	4505RX5		
6	1694A		7710A 7711A 7712A 7713A	1694D 1694WB 1694S3 1694S5 1694S6
7	1695A			1695S3 1695S5 1695S6
8	4694R	4694RX5		
9	1794A		2177A	
10	4794R	4794RX5		