

# Adventures in 4K Video

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# Choices for 4K 12 GHz Infrastructure

- Fiber Optic Cable
  - Single mode
- Premise/data cable
  - Category 6a (10GbaseT)
    - Tico compression: 4:1
    - Four 4K signals on one cable, with bandwidth left over.
  - Category 8 –coming soon
    - 40Gb/s
    - 30m maximum
- Coaxial Cable

# Fiber Optic Cable

- Single mode
  - Unlimited bandwidth
  - Unlimited distance
  - Multimode
    - Single mode price approaching multimode
- Conversion: electrons to photons
  - Fiber is cheap, conversion is not
- Fiber will win when....
  - Fiber amplifiers, splitters, optical circuitry



## Video and IP

- Grass Valley is pushing this.
- In installations of 16 cameras or more.
- TICO compression....a gentle 4:1
- Takes 12 GHz down to 3 GHz
- On a 10GbaseT data cable
  - Three 12 GHz TICO signals
  - 1 GHz left over – audio, control, metadata

# Data Cable

- Category 6a, “augmented” Category 6
  - 10GbaseT
  - 10 gigahertz bandwidth, 10 gigabits data rate
  - 100Ω 100m (328 ft.)
    - Coming soon: Category 8
      - 25GbaseT, 25 GHz bandwidth
      - 40GbaseT, 40 GHz bandwidth
    - 30m (100 ft.) maximum

# A New Kind of Category 6a – 10GXS

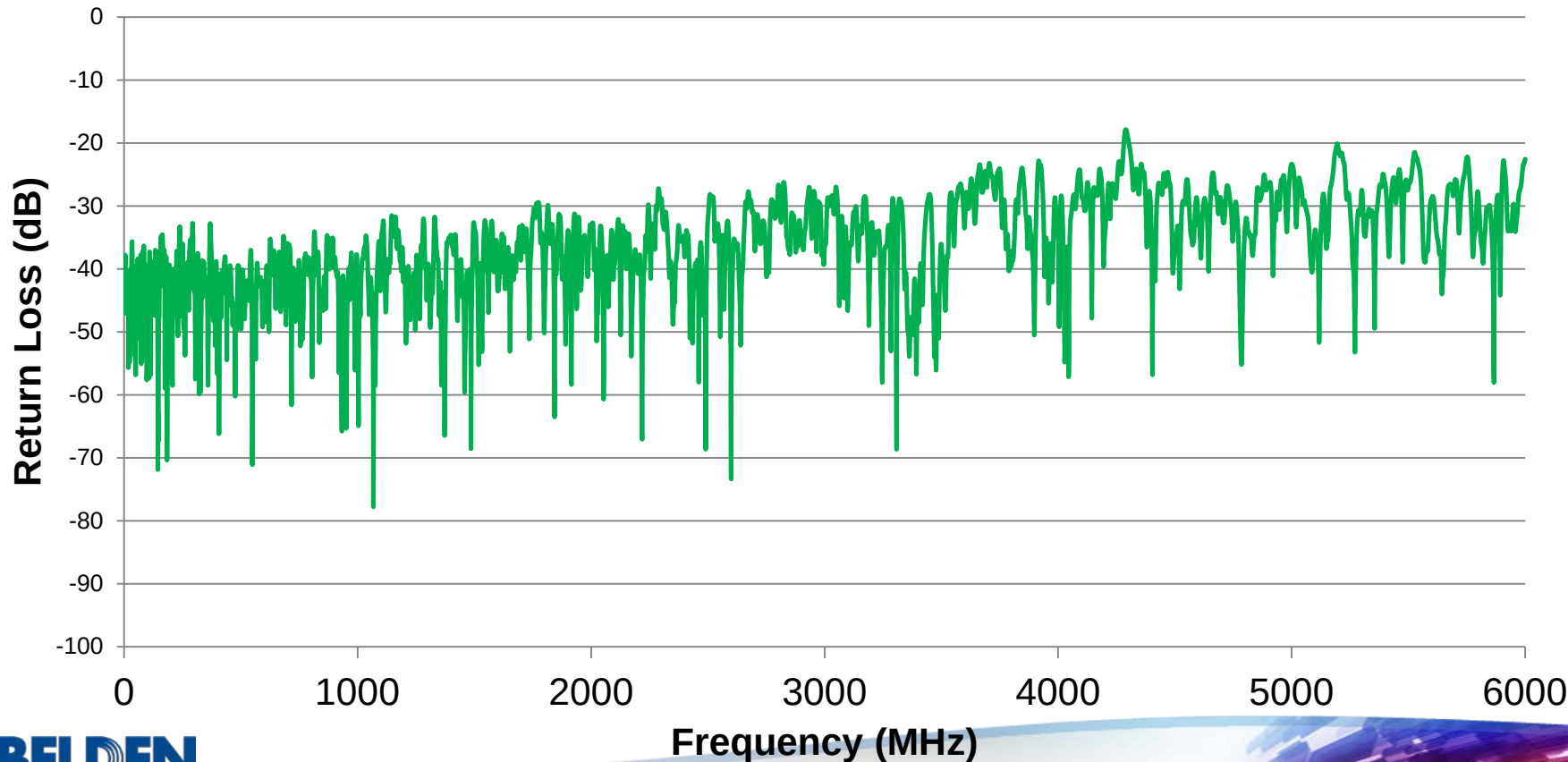




# Coaxial Cable

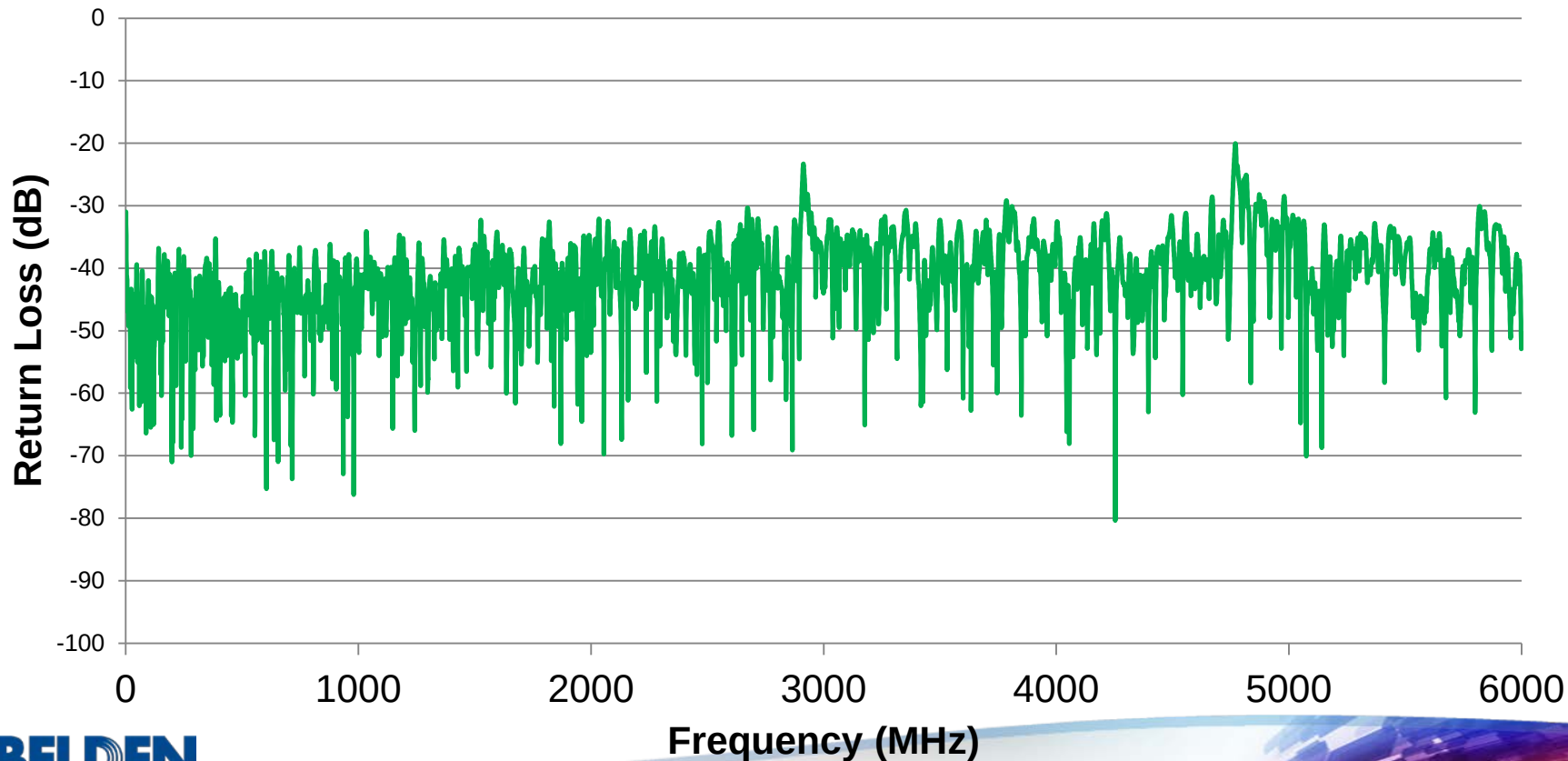
- **Digital video (SDI) – 75  $\Omega$** 
  - SD-SDI (Standard Definition) 270 MHz
  - HD-SDI (High Definition) 1.5 GHz
  - 3G-SDI (1080p/60) 3 GHz
  - 4K (SMPTE 2081-1) 6 GHz
  - 4K (SMPTE 2082-1) 12 GHz
- **Part numbers**
  - 179DT Tiny 2.54mm, 1/10<sup>th</sup> of an inch
  - 1855A Miniature – second most popular
  - 1505A Our original digital video cable
  - 1694A World's most popular!
  - 1794A Best shielding
  - 7731A Largest, longest distance

# Testing Existing Coax Cables to 6 GHz – Belden 179DT

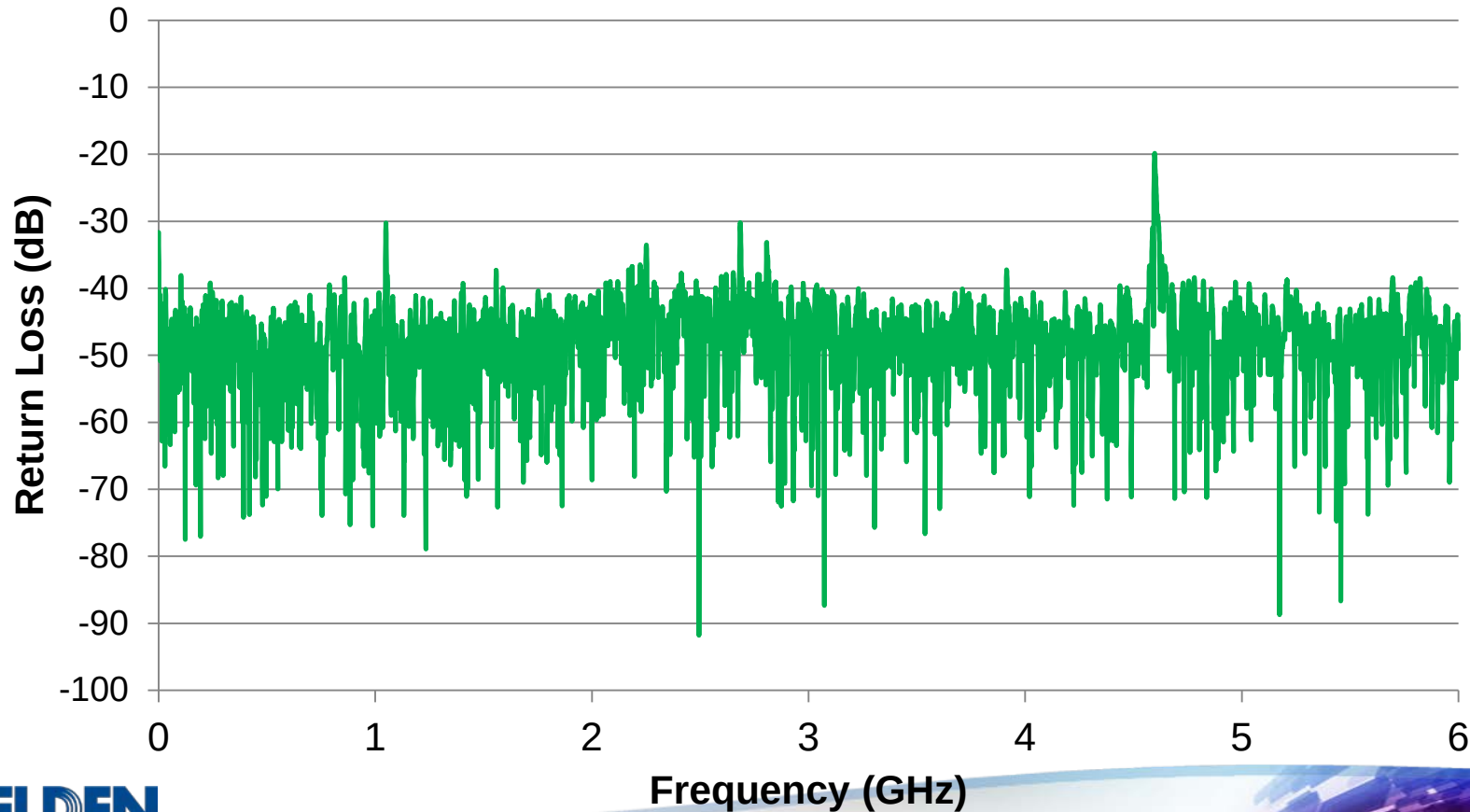




# Testing Existing Coax Cables to 6 GHz – Belden 1855A



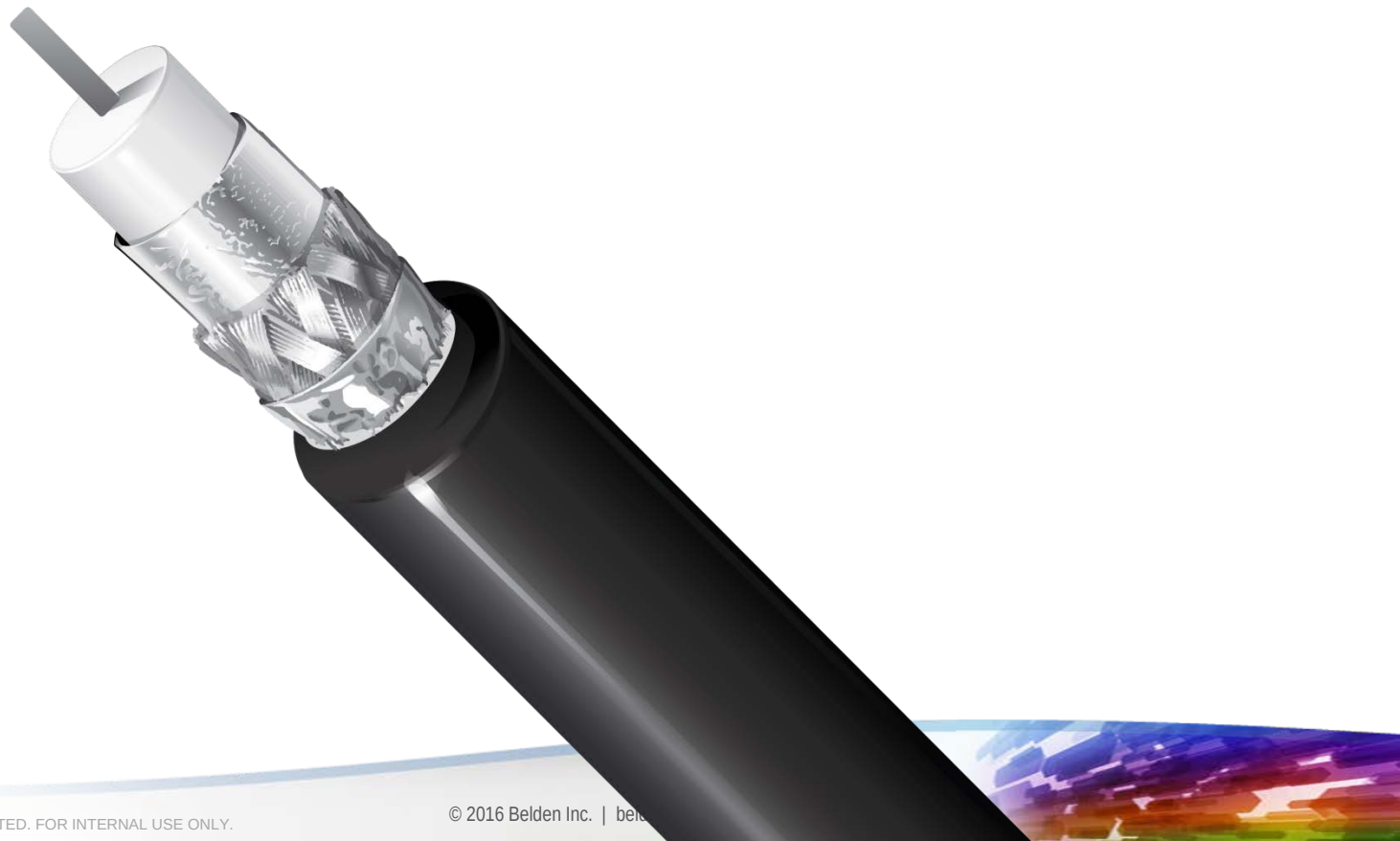
# Testing Existing Coax Cables to 6 GHz – Belden 1694A



# High-Density Nitrogen Gas Injected Foam

| Velocity of Propagation | % Nitrogen |
|-------------------------|------------|
| 78%                     | 43.75%     |
| 80%                     | 49.8%      |
| 83%                     | 58.93%     |
| 86%                     | 66.51%     |

# Belden 4794R – our first 12 GHz 4K single-link coax



# Belden 4794R – 20 Years of Improvements

- Center conductor
  - Silver-coated copper
- Dielectric
  - New high performance polyethylene
- Shield
  - Foil-Braid-Foil
  - Foil bonded to core, foil bonded to jacket
  - Highest shield effectiveness we have ever made
  - Special braiding machines – 95% coverage tinned copper

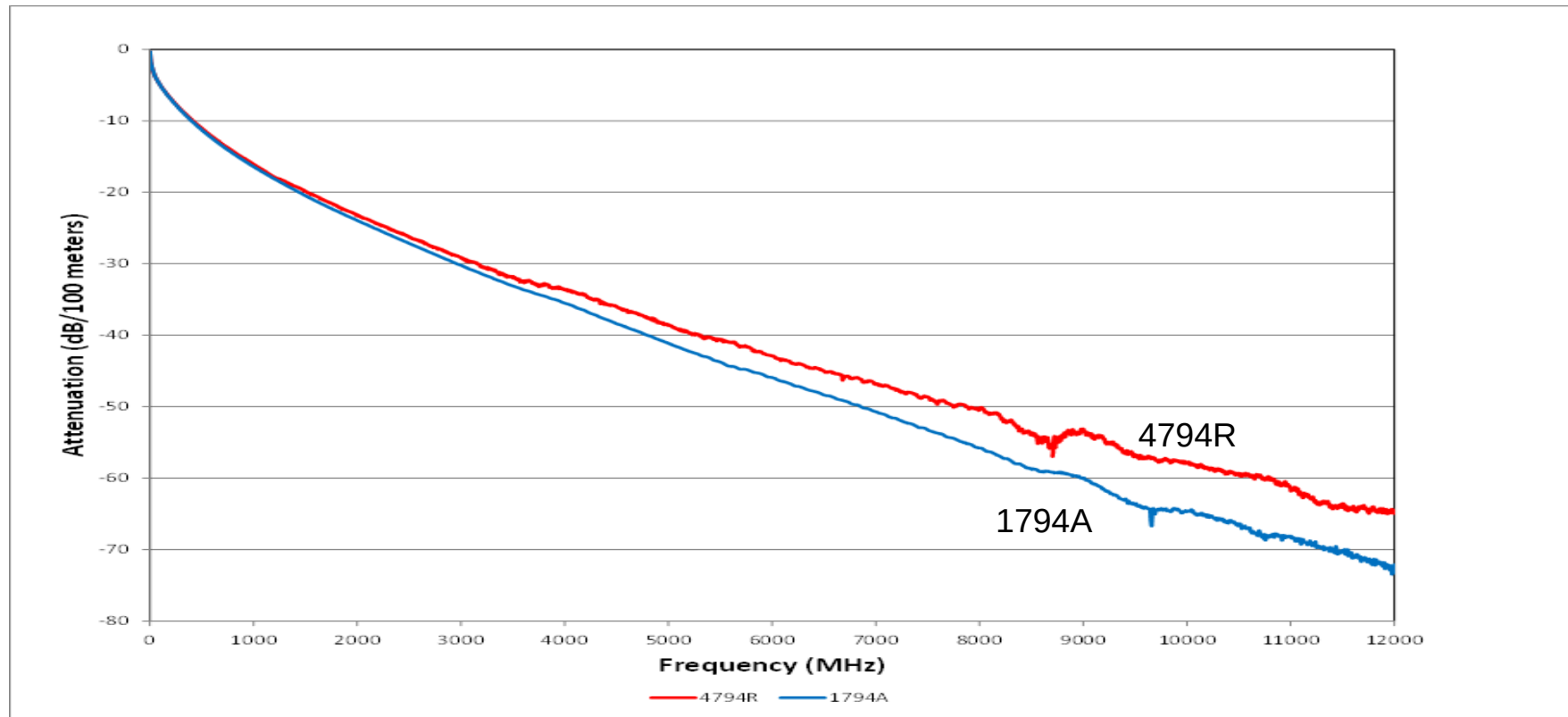
| Formula      | -30 dB at ½ clock |            | -20 dB at ½ clock |            | -20 dB at ½ clock |            | -40 dB at ½ clock |            | -40 dB at ½ clock |            | -40 dB at ½ clock |           |
|--------------|-------------------|------------|-------------------|------------|-------------------|------------|-------------------|------------|-------------------|------------|-------------------|-----------|
| Data Rate:   | 270 Mb/s          |            | 1.5 Gb/s          |            | 3.0 Gb/s          |            | 3.0 Gbps          |            | 6 Gb/s            |            | 12 Gb/s           |           |
| SMPTE Std:   | ST-259M           |            | ST-292M           |            | ST-424M           |            | ST-425            |            | 2081-1            |            | 2082-1            |           |
| Application: | SD-SDI            |            | HD-SDI            |            | 3G-SDI            |            | 3G-SDI            |            | 6GHz 4K           |            | 12 GHz 4K         |           |
| Cable Part # | Ft.               | m          | Ft.               | m          | Ft.               | m          | Ft.               | m          | Ft.               | m          | Ft.               | m         |
| <b>179DT</b> | 410               | <b>125</b> | 115               | <b>35</b>  | 81                | <b>25</b>  | 161               | <b>49</b>  |                   |            |                   |           |
| <b>1865A</b> | 508               | <b>155</b> | 134               | <b>41</b>  | 90                | <b>27</b>  | 179               | <b>55</b>  |                   |            |                   |           |
| <b>1855P</b> | 733               | <b>223</b> | 190               | <b>58</b>  | 125               | <b>38</b>  | 249               | <b>76</b>  |                   |            |                   |           |
| <b>1855A</b> | 766               | <b>233</b> | 214               | <b>65</b>  | 149               | <b>45</b>  | 298               | <b>91</b>  | 203               | <b>62</b>  |                   |           |
| <b>1505F</b> | 839               | <b>256</b> | 220               | <b>67</b>  | 147               | <b>45</b>  | 294               | <b>90</b>  |                   |            |                   |           |
| <b>1506A</b> | 1014              | <b>309</b> | 265               | <b>81</b>  | 177               | <b>54</b>  | 353               | <b>108</b> |                   |            |                   |           |
| <b>1694F</b> | 1046              | <b>319</b> | 279               | <b>85</b>  | 188               | <b>57</b>  | 376               | <b>115</b> |                   |            |                   |           |
| <b>1505A</b> | 1082              | <b>330</b> | 301               | <b>92</b>  | 209               | <b>64</b>  | 418               | <b>127</b> | 285               | <b>87</b>  |                   |           |
| <b>1695A</b> | 1258              | <b>383</b> | 321               | <b>98</b>  | 210               | <b>64</b>  | 420               | <b>128</b> |                   |            |                   |           |
| <b>1694A</b> | 1338              | <b>408</b> | 370               | <b>113</b> | 255               | <b>78</b>  | 510               | <b>155</b> | 346               | <b>106</b> |                   |           |
| <b>1794A</b> | 1702              | <b>519</b> | 469               | <b>143</b> | 319               | <b>97</b>  | 637               | <b>194</b> | 432               | <b>132</b> |                   |           |
| <b>4794R</b> | 1716              | <b>523</b> | 480               | <b>146</b> | 329               | <b>100</b> | 659               | <b>201</b> | 449               | <b>137</b> | 306               | <b>93</b> |
| <b>7732A</b> | 1877              | <b>572</b> | 451               | <b>137</b> | 283               | <b>86</b>  | 565               | <b>172</b> |                   |            |                   |           |
| <b>7731A</b> | 2091              | <b>637</b> | 582               | <b>177</b> | 390               | <b>119</b> | 780               | <b>238</b> | 529               | <b>161</b> |                   |           |

# Dimensions and Tolerances – Belden 4794R

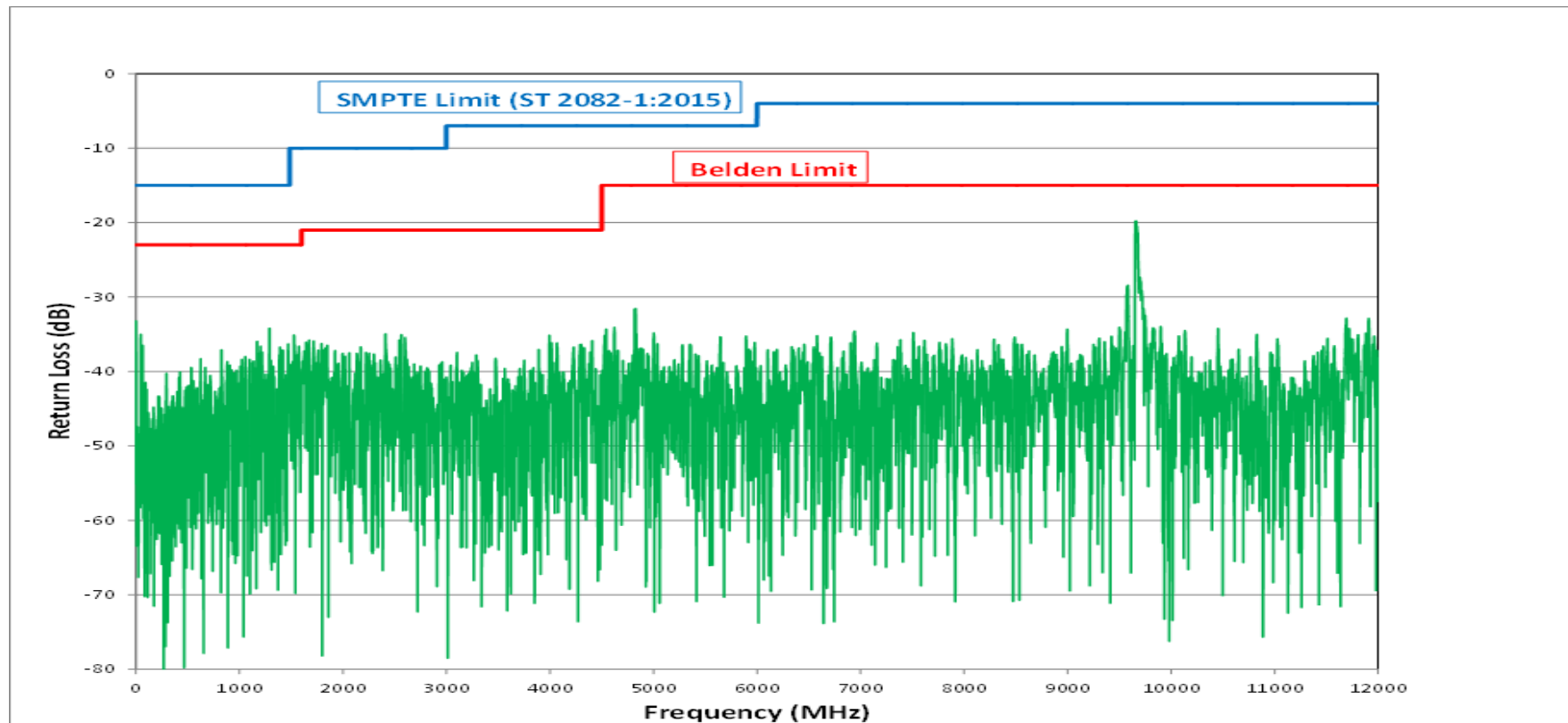
|                            | mm   | Tolerance +/- | Inches | Tolerance +/- |
|----------------------------|------|---------------|--------|---------------|
| Conductor Diameter 16AWG   | 1.29 | 0.00508       | .051   | .0002         |
| Dielectric Diameter        | 5.72 | 0.127         | .225   | .005          |
| Inner Shield Tape Diameter | 5.87 |               | .231   |               |
| Braid Diameter             | 6.66 | 0.635         | .262   | .0025         |
| Jacket Diameter            | 8.13 | 0.127         | .320   | .005          |



# Belden 4794R – Attenuation (Compared to 1794A)



# Belden 4794R – Return Loss



# Connectors

- 75  $\Omega$  BNC for digital video
  - 4.5 GHz: Existing cable & connectors
  - 6 GHz: Existing cable & connectors !!
  - 12 GHz New cable, one connector



# What is Next

- Colors
  - Currently black only
  - Brown, Red, Orange, Yellow, Green, Blue, Violet, Gray, White
- Other sizes
  - 1855A = 4855R
  - 1694A = 4694R
  - 7731A = 4731R
- Other applications
  - Outdoor
  - Direct Burial
  - Fire Ratings (Plenum)



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