How Single Pair Ethernet Streamlines Aircraft Networks

TE Connectivity (TE)

EVERY CONNECTION COUNTS

Agenda & Speakers

01 Intro to TE Connectivity

02 Origin of Single Pair Ethernet

03 Single Pair Ethernet Connectors

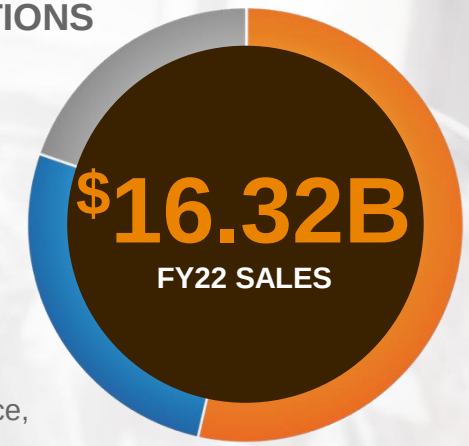
04 Single Pair Ethernet Cables

05 Single Pair Ethernet Cable Assemblies

06 Summary and Audience Q&A

$2.5B

COMMUNICATIONS
Appliances, Data & Devices



$4.5B

INDUSTRIAL
Industrial, Aerospace, Defense & Marine, Medical, Energy

$9.2B

TRANSPORTATION
Automotive, Industrial & Commercial Transportation, Sensors, Application Tooling

CONNECT LIKE THE WORLD DEPENDS ON IT. BECAUSE IT DOES.

236B

PRODUCTS MANUFACTURED ANNUALLY

Sales figures have been rounded for presentation purposes

TE AEROSPACE, DEFENSE & MARINE

PRODUCTS

Wire & Cable
Interconnects
Backshells
Harnessing & Harness Components
Devices
Relays & Contactors
Rugged Optics
Sensors
Value-Add Solutions

BRANDS

AMP
AGASTAT
CII
DEUTSCH
HARTMAN
KILOVAC
MICRODOT
NANONICS
POLAMCO
Raychem
SEACON

History of Single Pair Ethernet

2007

Electrical Wiring Interconnection Systems (EWIS) Standard published

2012

Automotive Driven BroadR-Reach Single Pair Ethernet Standard

2015

IEEE 802.3bw Single Pair Ethernet standard publication

2016

ARINC Cabin Systems Subcommittee Single Pair Ethernet development

2020+

Final Standardization for use in Aircraft environments

Why Single Pair Ethernet in Aerospace?

TE's aerospace grade Mini-ETH single pair ethernet solution is new technology defined in ARINC 854, that offers up to 70% system level weight savings and up to 30% space savings compared to current 8 conductor solutions in use.

Overall complexity is reduced as a result and Customers can expect up to 50% faster termination time compared to existing installation solutions. The system currently qualified on 100Mb/s with future provision for 1 Gb/s to deliver on future need

Mini-ETH products promote faster installation and lower complexity fostering a common ecosystem of ethernet deployment in cabin environments

Mini-ETH Connectors

369 Shielded

EVERY CONNECTION COUNTS

369 Shielded Connector

Mini-ETH Technical Advantages:

- 100Base-T1 standard
- 15m link with four connector breaks
- Reduced termination complexity
  - (369) 2-5 minutes vs. (Quadrax) 6-10 minutes
  - Up to 80% termination time savings
- Provisioned for up to 1,000Mbs
- EWIS compliant

Size Weight and Power (SWaP):

- Up to 37% smaller cross sectional area vs. traditional micro circular connectors
- 5.9g per mated pair (shielded composite)
- 5A power capability at 400VDC

Durable unibody shell

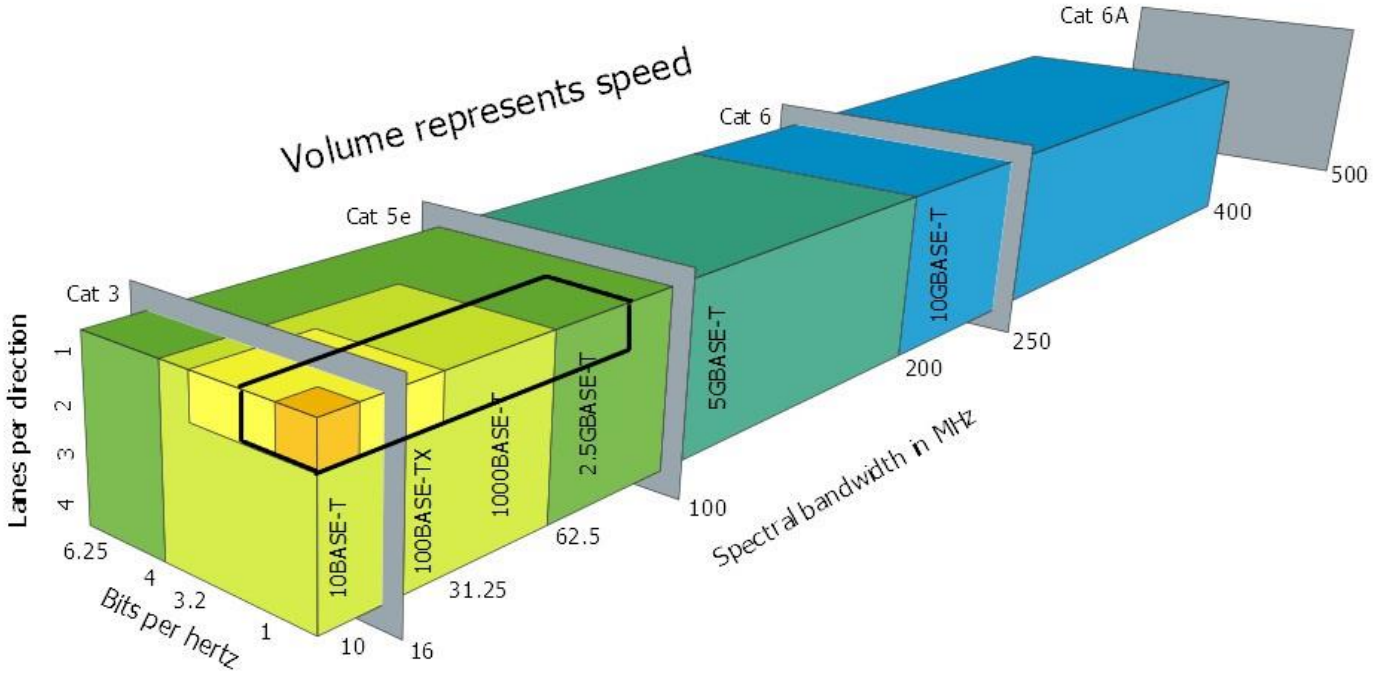
Multiple Keyways

Metal Braid Termination

Boot Sealing

Mini-ETH Connectors – Designing for 100Base-T1

Single Pair Ethernet (SPE) - Standard ethernet protocols transmitted over 2 wires



Key Aspects:

- # Lanes
- Frequency
- Bits per hertz

Image Source

100Base-T1 Requirements

Test parameter		Test standard	Limit (max. value for parameter)
Intra Pair Skew	$t_{intra\_pair\_x}$	IEC 60512-25-4	Only for information)3
CIDM	Z_{RF}	IEC 60512-25-7	100 Ω +/- 10 %, valid for 700 ps rise time evaluation)4
IL	S_{dd21})2	IEC 60512-25-2	1 MHz: 0.025 dB 10 MHz: 0,038 dB 33 MHz: 0.050 dB 66 MHz: 0.075 dB
RL	S_{dd11} , S_{dd22})1	IEC 60512-25-5	1 MHz: 38.0 dB 33 MHz: 38.0 dB 66 MHz: 30.5 dB
LCL LCTL	S_{dc11} , S_{dc22})1 S_{dc21} , S_{dc12})1	IEC 60603-7-7,Annex J	1 MHz: 46.0 dB 50 MHz: 46.0 dB 200 MHz: 34.0 dB

Impedence (Resistance)

Insertion Loss (Attenuation)

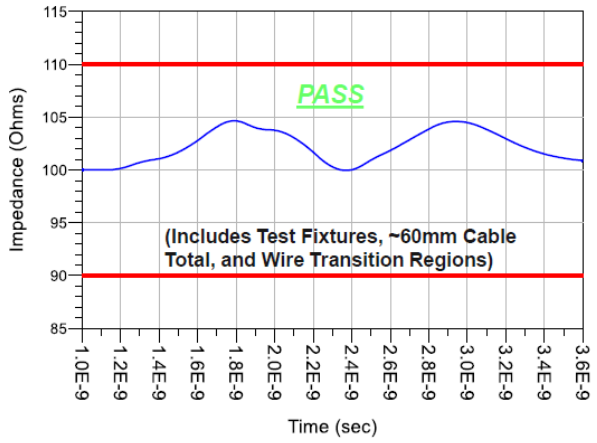
Return Loss (Attenuation)

Longitudinal Conversion Loss (EMI)

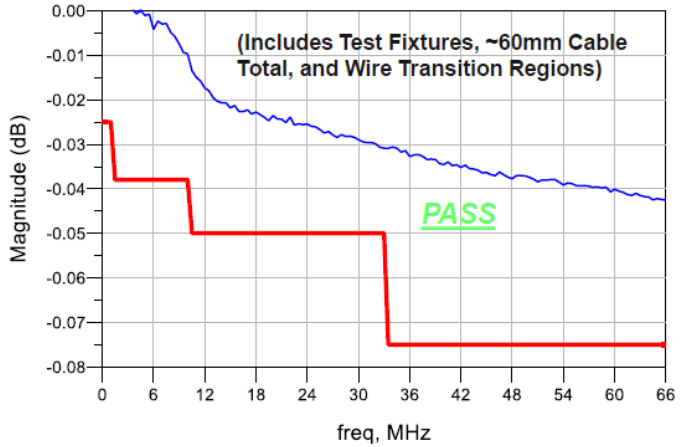
Longitudinal Conversion Total Loss (Balance)

Total Link Length of 15m with up to 4 Connections

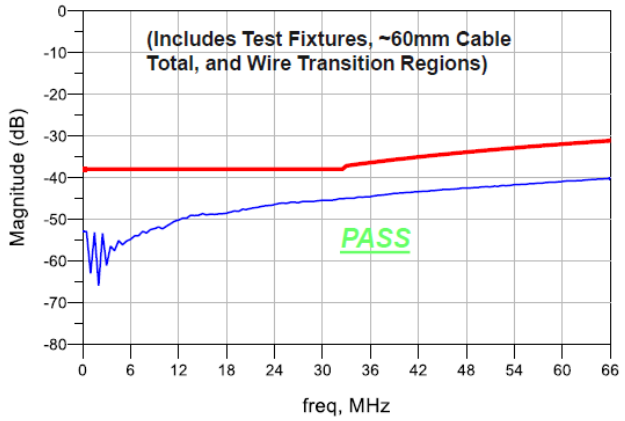
Performance Testing



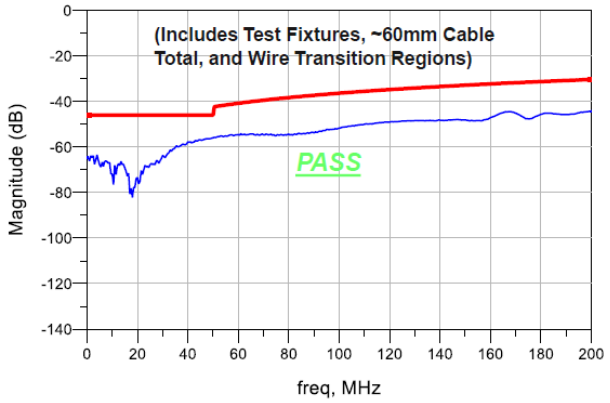
Impedance - **PASS**



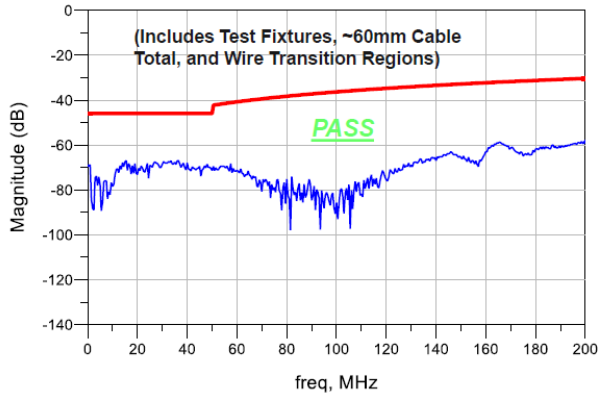
Insertion Loss - **PASS**



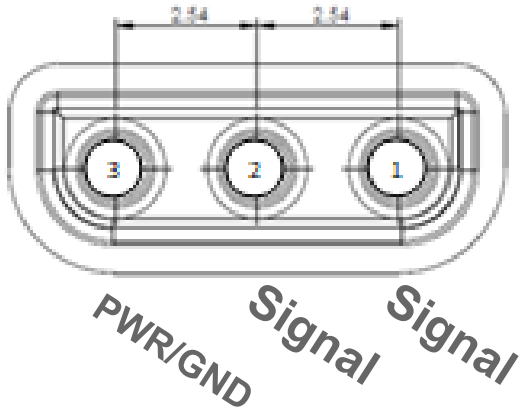
Return Loss- **PASS**



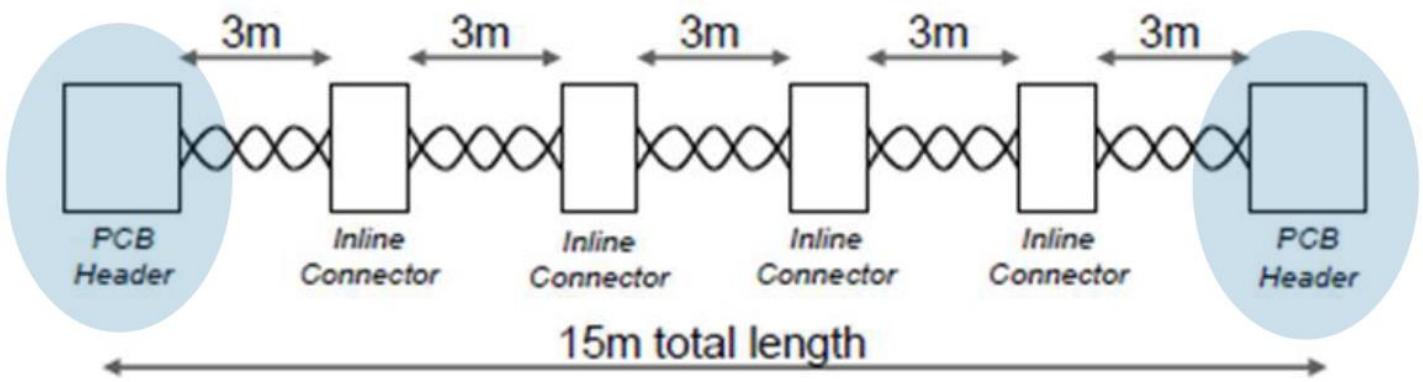
LCL - **PASS**

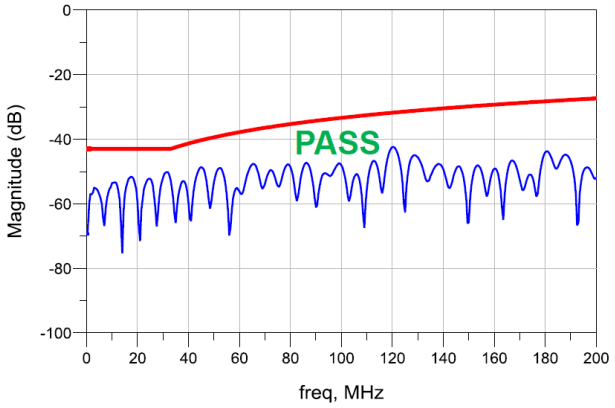


LCTL - **PASS**

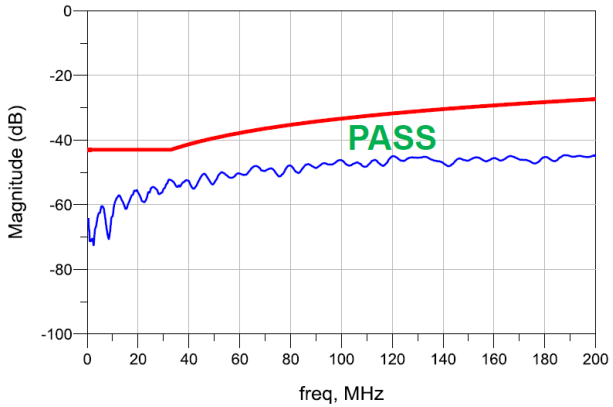


Performance Link Testing

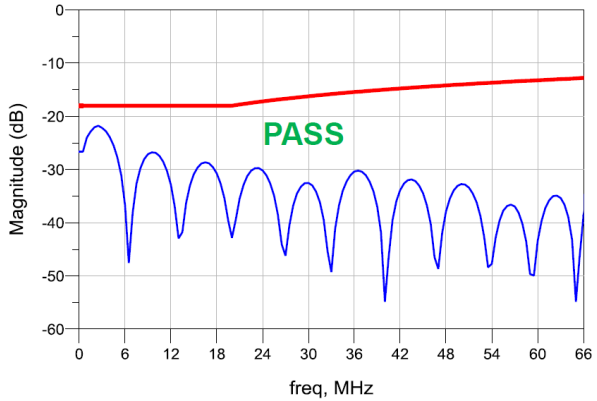




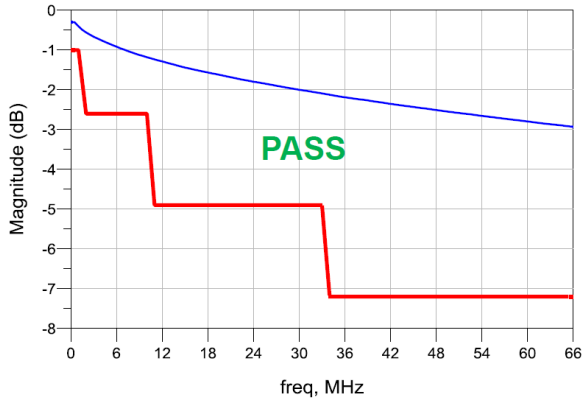
LCL - **PASS**



LCTL - **PASS**



Return Loss - **PASS**

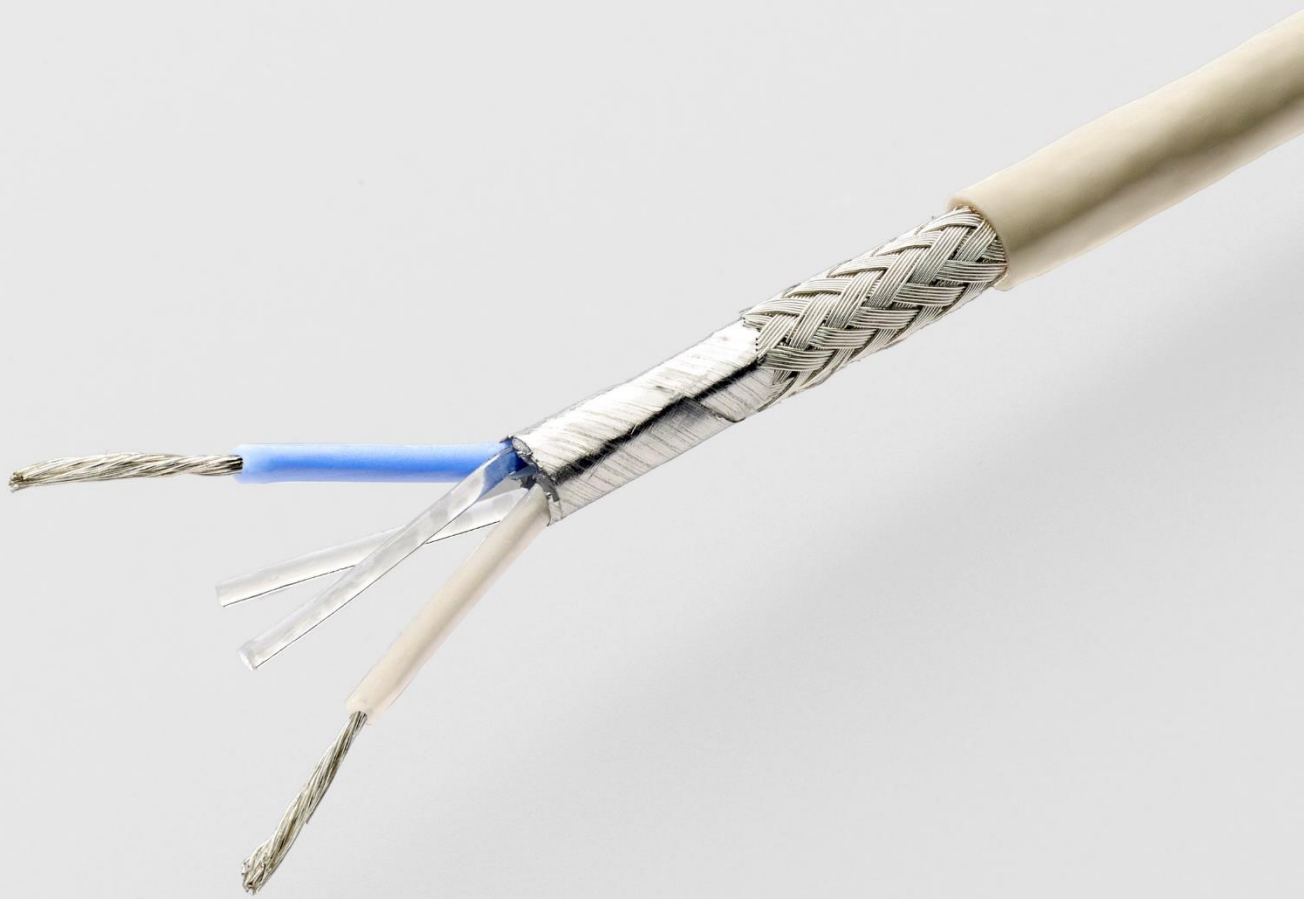


Insertion Loss - **PASS**

Test completed with preliminary cable; production testing delayed due to current global circumstances

Mini-ETH Cabling

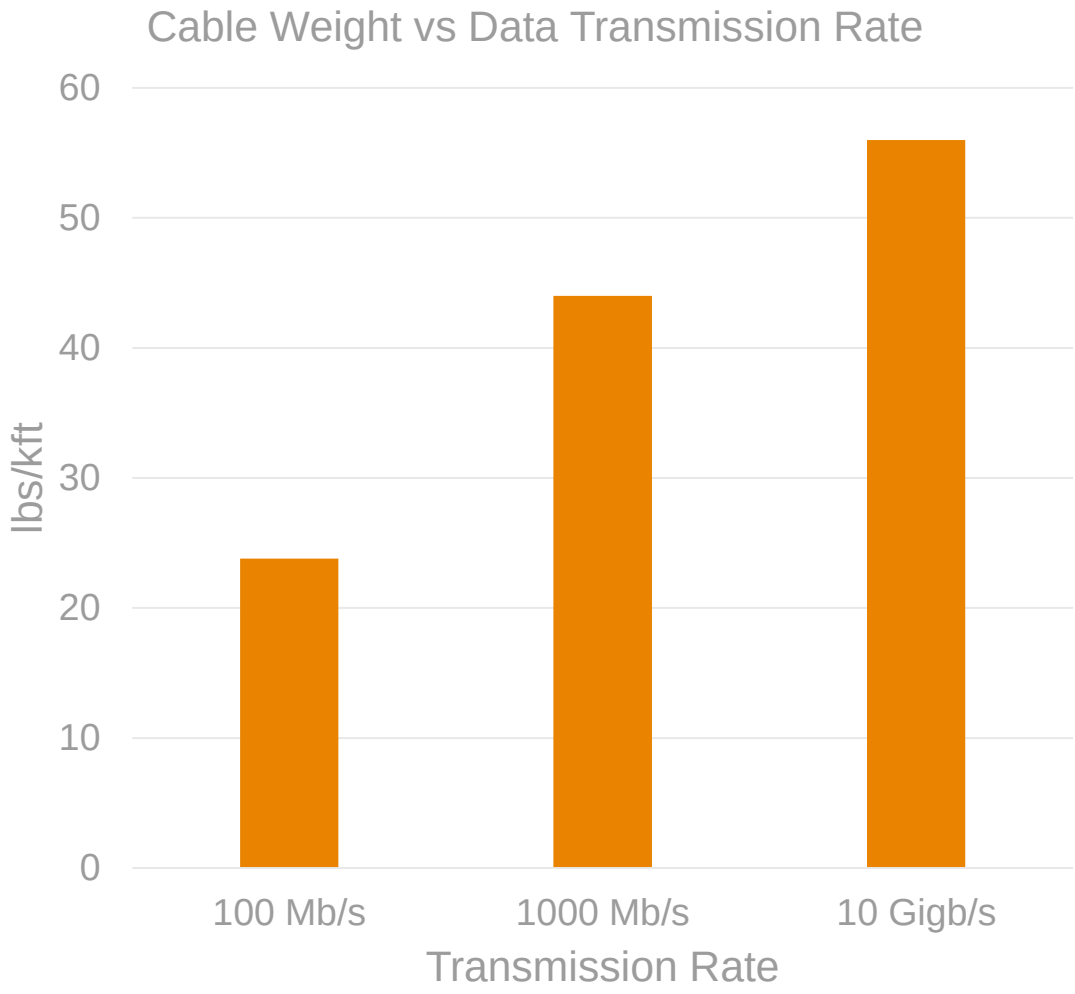
Cable Simplification



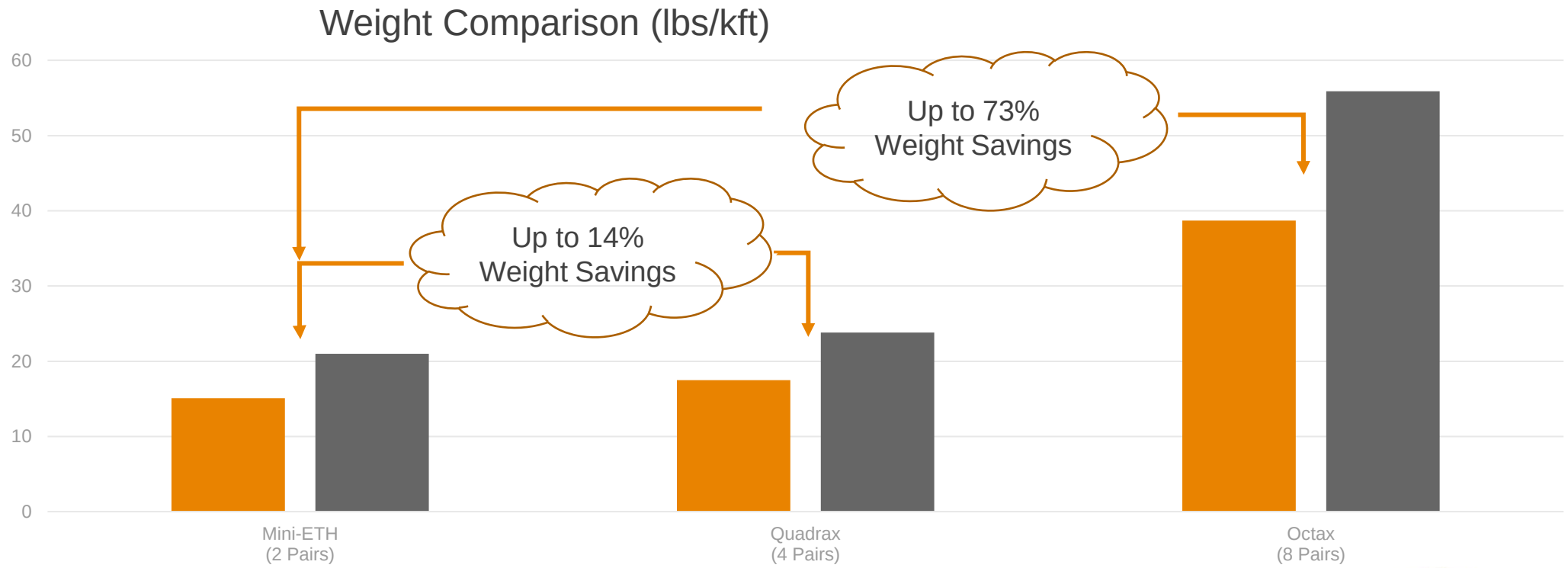
EVERY CONNECTION COUNTS

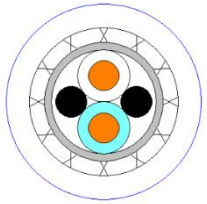
Historical Overview of 100Mb/s + Ethernet Cabling in Aircraft

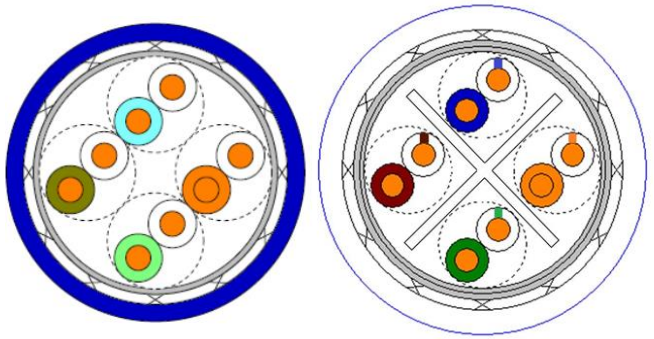
- Late 1990's
  - ARINC Cabin Systems Subcommittee (CSS) includes 100BaseT quadraxial cables into ARINC 800 (4 conductors)
- Early 2010
  - Use of 2 quadraxial cables or more traditional 4 pair cable for 1000BaseT1
  - Use of traditional 4 pair cable for 10000BaseT1 (8 conductors)
- 2016
  - ARINC CSS begins to evaluate introduction of IEEE 802.3bw 100BaseT1 (2 conductors)
  - Work begins to include requirements in ARINC 800



Cable Evolution – Moving to Single Pair Mini-ETH Solution







100/1000BaseT1 Requirements

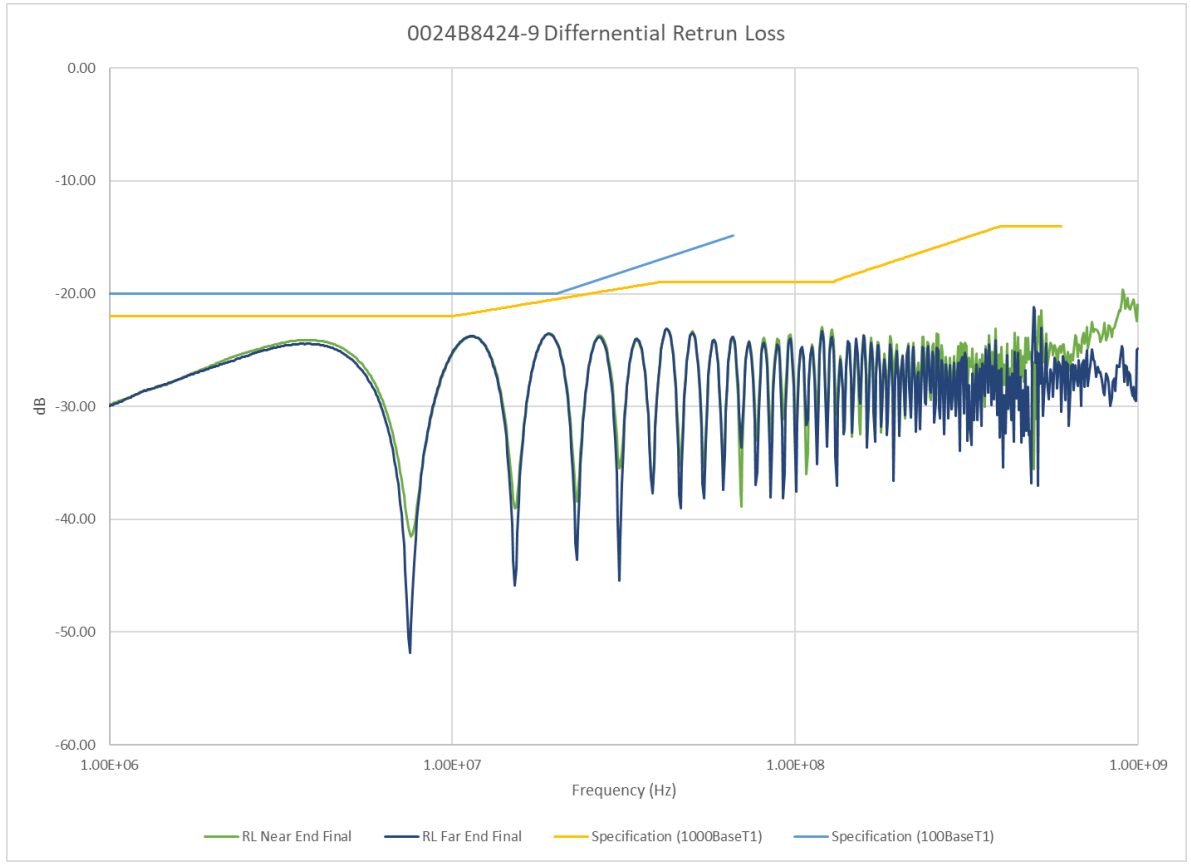
Requirements as proposed in:
ARINC 800 Part 3

Differential Impedance	100 ± 10 Ohms
Differential Insertion Loss	See Table
Differential Return Loss	See Table

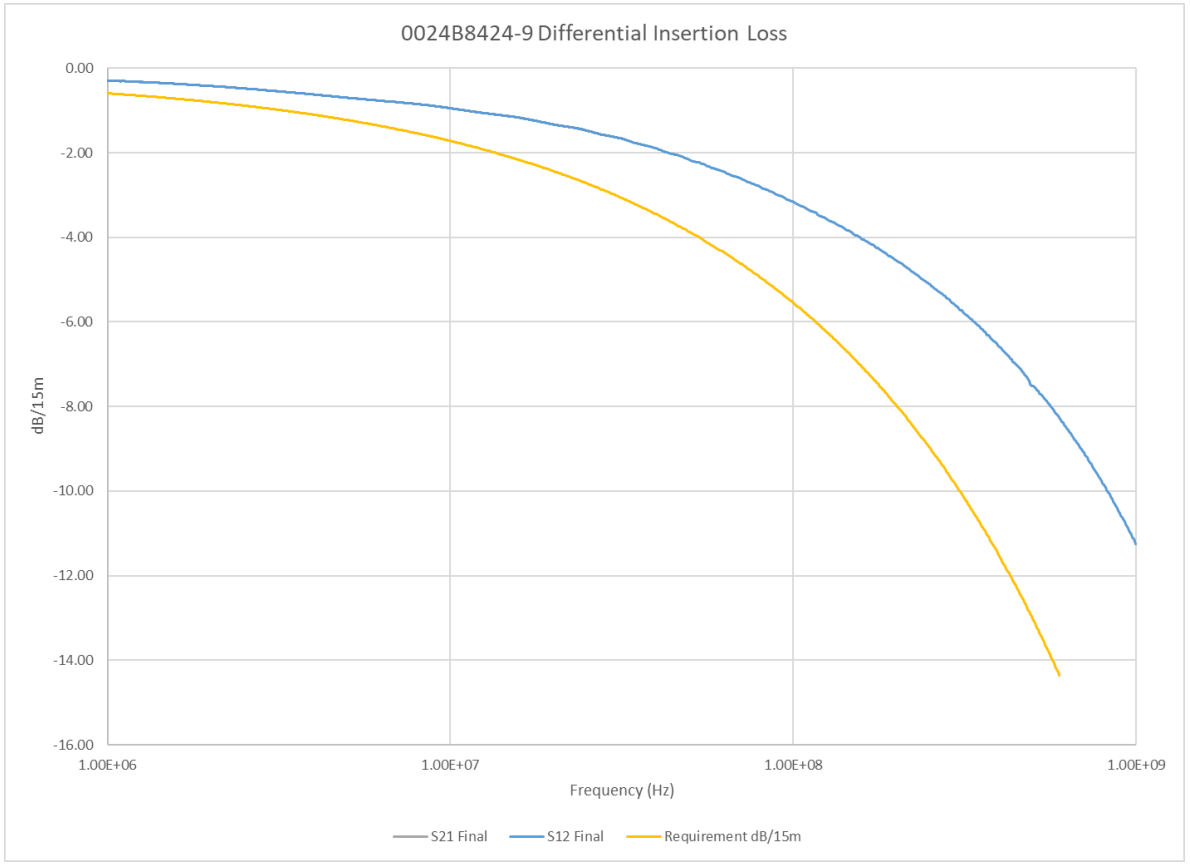
Frequency (MHz)	Differential Insertion Loss dB/15 m max.	Differential Return Loss dB for 15 m min.
1.0	0.597	22
10.0	1.72	22
40.0	3.46	19
100.0	5.54	-
130.0	6.36	19
200.0	7.97	-
400.0	11.5	14
500.0	13.0	-
600.0	14.4	14

Performance Testing – 24 AWG

PASS

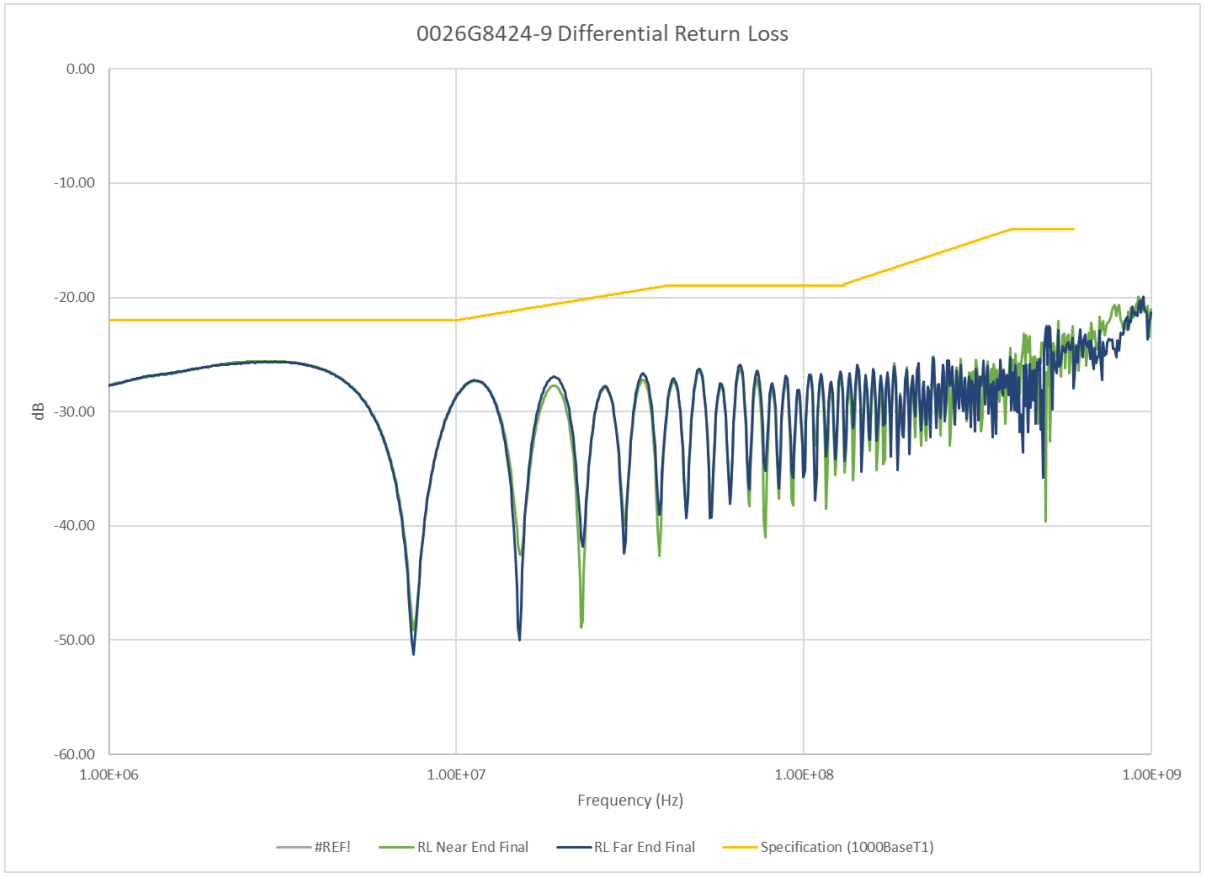


PASS

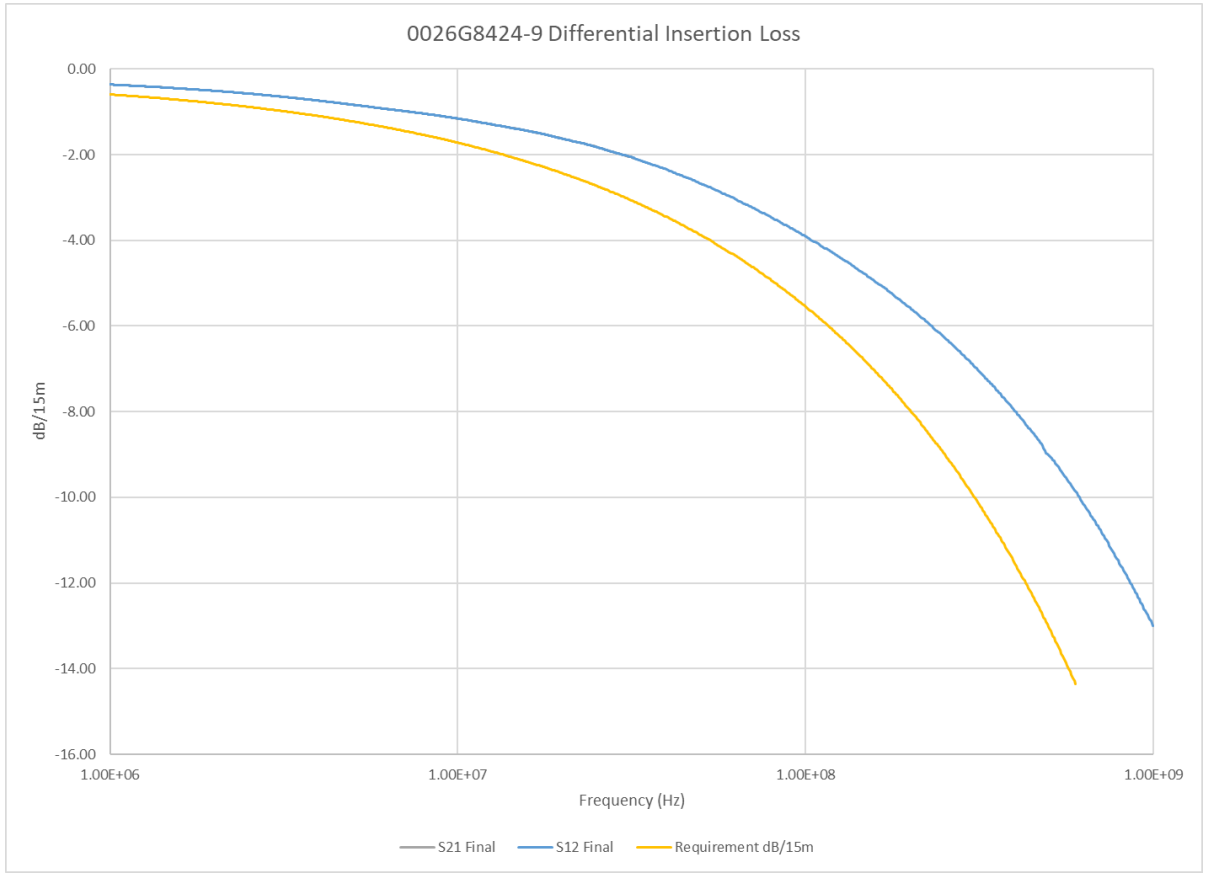


Performance Testing – 26 AWG

PASS



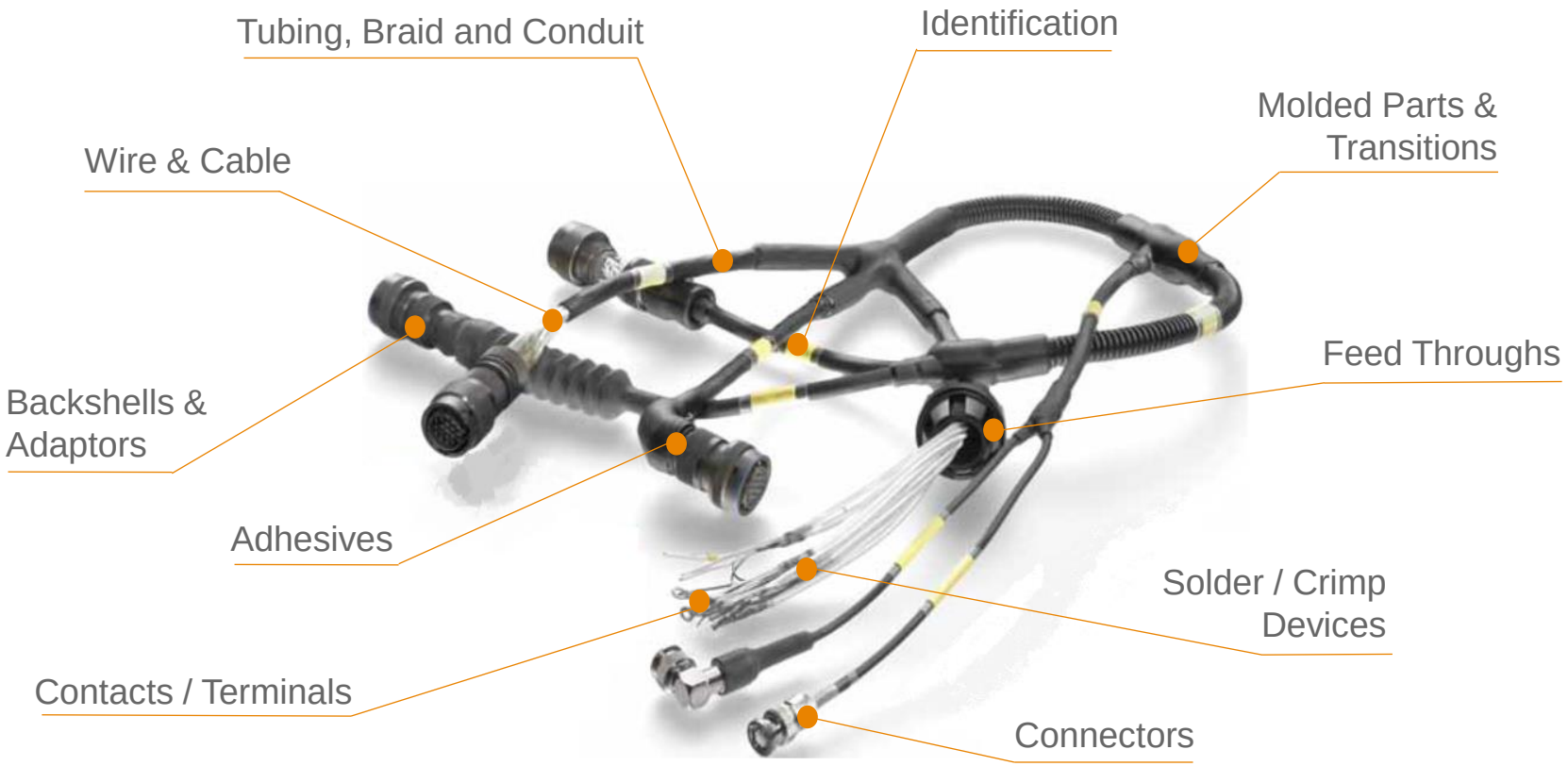
PASS



Mini-ETH Cable Assemblies

EVERY CONNECTION COUNTS

TE Value Add Advantage



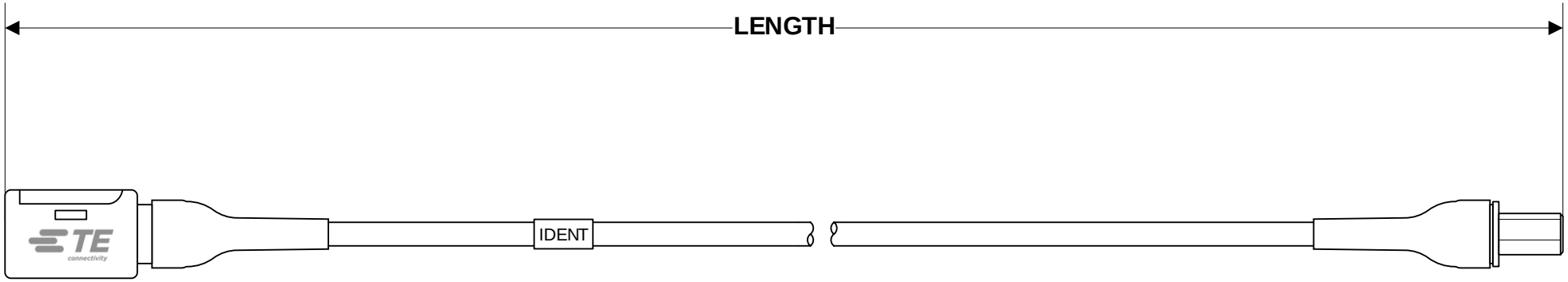
Leading TE Connectivity Aerospace Brands:

Raychem, AMP, DEUTSCH, POLAMCO

- Broad portfolio of products across multiple leading product brands
- Can support fully assembled end-to-end interconnect solutions
- Experts in the design of components and interconnected assemblies, guiding users to the right set of components for their specific applications
- Ability to support various phases of a project, from design to prototype to production
- A “One-stop-shop” delivering in house design, testing, manufacturing and supply chain
- In-house ‘HarnWare’ harness design software
- Global plants certified to Aerospace quality standard AS9100

TE Commercial-Off-The-Shelf (COTS)

- Ready to install Plug & Play assemblies, fully tested to meet ARINC 854 requirements
- Standardized interfaces, pinouts and lengths minimize complexity and simplify product selection
- Enable manufacturers and support networks to hold replacement parts readily available for immediate ‘plug and play’ modular upgrades or repairs
- Designed for cost. More affordable and readily available compared to custom designed assemblies, due to:
  - No or minimal Non-recurring engineering (NRE)
  - Lower unit costs
  - Eliminates complex and custom assembly processes and testing
  - Reduce the development cycle time (Time to Market)
  - Reduced part count
  - Can reduce production lead times
  - Simplifies complex supply chains
- When customization is required, modified COTS (M-COTS) are delivered quicker and more affordably compared to a fully custom assembly



Summary & Conclusion

EVERY CONNECTION COUNTS

Summary & Conclusion

Single Pair Ethernet new in commercial aircraft (ARINC 854 Cabin Equipment Network Bus specification)

Market push towards reconfigurable cabin networks and higher flexibility in retrofit of cabins

TE's Mini-ETH interconnect system

- Faster installation (up to 50% compared to existing installation solutions)
- Weight and Space savings (up to 70% system level and up to 30% space savings vs current 8 conductor solutions)
- Lower complexity (2 wires vs 8 wires)
- Currently qualified on 100Mb/s
- EWIS compliant

Connect with our Speakers: www.designsmarterfaster.com

Learn More on Single Pair Ethernet in Aerospace: www.TE.com/mini-ETH

Get TE's Whitepaper "Advancing Aircraft Connectivity with a Single Pair Ethernet Solution"

Audience Q&A

ANY CONNECTION CAN CHANGE THE WORLD

EVERY CONNECTION COUNTS

TE connectivity