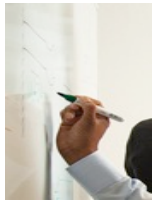
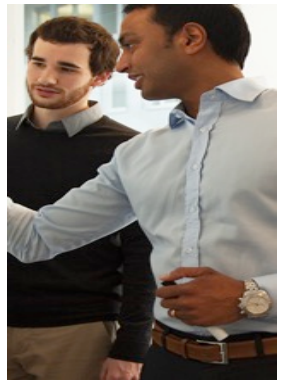




100BaseT1/1000BaseT1 Cable Update

October 2020

Robert Moore

EVERY CONNECTION COUNTS

Cable Requirements Recommendation

Parameter	IEC 61156-12	Open Alliance	Open Alliance	SAE J3117	SAE J3117/2	ARINC Recommended Requirements
	Symmetrical Pairs up to 600 MHz Bulk Cable	1000 Mbs TC9 Shielded Bulk Cable	100 Mbs TC9 Unshielded Bulk Cable	100 Mbs Unshielded 26-20 AWG Bulk Cable	1000 Mbs Unshielded Shielded Bulk Cable	100/1000 Mbs Shielded Bulk Cable
CPUG	1.6 pF/m	-	-			
Zt (mΩ/m max) **1 MHz** **10 MHz** **30 MHz**	Class 1 Class 2 15 50 10 100 30 200	-	-			TBD
Coupling Attenuation (dB min) **30-100 MHz** **1000 MHz** **30-600 MHz**	I Ib II 85 70 55 75 60.5 45.5	Class 1 and 2 70	-		Class 1 and 2 70	TBD
Screening Attenuation (dB min) **30-600 MHz**	-	Class 1 Class 2 35 45	-		Class 1 Class 2 35 45	TBD
Phase Delay (ns/100m max) **4-600 MHz** **2 – 600 MHz (ns/m max)**	$\tau = 534 + \frac{36}{\sqrt{f}}$	10 m 15 m 9 6	-	-	- -	15 m 6

Cable Requirements Recommendation - continued

Attenuation (dB/15 m max)	(from dB/100m) .46				15m 0.60	40m (max) 0.87	
1 MHz	1.31	0.60	0.9	0.9	1.72	2.45	0.60
10 MHz	2.37	1.72	2.4	2.4	3.14	4.46	1.72
33 MHz	3.37	3.14	4.65	4.65	4.47	6.38	3.14
66 MHz	4.17	4.47	6.75	6.75	5.54	7.92	4.47
100 MHz	10.60	5.54	-	-	14.4	20.8	5.54
600 MHz		14.4	-	-			14.4
TCL/LCL (dB max)		Class 1 Class 2			Class 1 Class 2		
1 MHz	50		46	46			
4.64 MHz	40						
10 MHz		50 -			50 -		-
50 MHz		50 -	46	46	50 -		
200 MHz			34	34			
600 MHz	40	30 -			30 -		
TCTL/LCTL (dB max)	-	Class 1 Class 2			Class 1 Class 2		
1 MHz							
10 MHz		46 -	46	46	46 -		-
50 MHz		46 -	46	46	46 -		
200 MHz			34	34			
600 MHz		30 -			30 -		
ELTCL (dB max)							
1 MHz	40	-	-	-	-		-
56.2 MHz	5						
600 MHz	5						
Impedance (ohms)	100 ±5 @ 100 MHz	100 ±5 Differential	100 ±5 Differential	100 ±10 Differential	100 ±5 Differential		100 ±5 Differential

Recommended Cable Requirements - continued

Return Loss (dB min)						
1 MHz	20	22	20	20	22	22
10 MHz	25	22			22	22
20 MHz	25		20	20		
40 MHz		19			19	19
66 MHz			14.8	14.8		
130 MHz		19			19	19
400 MHz		14			14	14
600 MHz	15.6	14			14	14

NOTES:
SAE 3117/2 is a working draft
SAE 3117/2 40m calculations from the working draft don't match the graph provided in the document.
SAE 3117/2 working draft states that they are looking for cable manufacturer data in order to determine if they can change the 130 MHz – 600 MHz requirement to 19 dB min.

Technical Reasoning

The recommendation for the electrical properties is to follow the Open Alliance 1000 Mbs Class 2 requirements for the bulk cable. Class 2 is the shielded construction. IEEE 802.3bp and bw were created before the Open Alliance requirements for shielded constructions for the 1000 Mbs implementation was conceived/issued.

The reasoning to not include LCL/LCTL in the requirements is that in the unshielded construction, these values insured within the automotive world that the systems/cars would be able to meet CISPR 25 Class 5 requirements imposed on automobiles. The reason that automobiles have not used 100BaseT or higher is due to the uncontrolled radiated emissions that unshielded category cables could emit. “!00BaseTX was not able to grow within the automotive ecosystem because it requires two twisted-pair cables and does not meet the strict Comite International Special des Perturbations Radioelectriques (CISPR) 25 Class 5 radiated emissions limits.” [100Base-T1 Ethernet: The Evolution of Automotive Networking, Donovan Porter, Texas Instruments]

Technical Reasoning - continued

Aerospace Ethernet applications have used 100BaseT/BaseTX with the use of shielded quadraxial cables and 1000BaseT/10000BaseT with the use of 4-pair shielded cables while still meeting EMI/EMC needs within the aircraft. Additionally, these cables run through a variety of shielded and unshielded connectors.

The recommended requirements show shielding performance as TBD, either using surface transfer impedance (Zt) or shield design confirmation through coupling attenuation and screening attenuation.

Abrasion Resistance

- Guidance from the August meeting was to evaluate under what conditions proposed 24 and 26 AWG constructions using extruded FEP with jacket wall common to existing small constructions used today at room temperature and elevated temperature.
- Test procedure EN3475-505
- Test temperatures
  - Room Temperature (20-25ºC)
  - Elevated Temperature (55ºC)
    - This temperature was selected as it is the same temperature that was established for the seat-to-seat cable
- Test Variable
  - Force applied to cable during test
- Target
  - Determine under what conditions test results would result in reasonable values
  - Target number: >1000 cycles minimum average based on discussions with Airbus

Abrasion Resistance - Results

Sample	Load	Temperature	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Mean
26 AWG	10N	RT(20°C)	2163	1119	2035	115	2026	1862	1553
	10N	55°C	140	141	94	231	114	186	151
	8N	RT(20°C)	7769	10389	2212	4353			6181
	8N	55°C	1889	660	102	176	610	784	704
	7N	55°C	4245	3816	3871	509	1039	3045	2754

Sample	Load	Temperature	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Mean
26 AWG	10N	RT(20°C)	2373	397	1274	2840	1604	105	1432

- Wall thickness range: 0.007” – 0.012”
- Recommendations:
  - For Room Temperature testing, specify 10N load
  - For 55ºC testing, specify 7N load
  - 1000 cycles minimum average at both test temperatures

Shielding Performance Discussion

- Open Alliance for Class 2 cables calls out IEC 62153-4-7 for Screening Attenuation and Coupling Attenuation
  - TE is having its constructions tested to bulk cable procedures in accordance with IEC 62153-4-4 and IEC 62153-4-9 for screening attenuation and coupling attenuation
- TE has performed surface transfer impedance in accordance with NEMA WC67
- A review of IEC-TR-62153-4-0 shows a correlation between Zt values are screening attenuation
- Based on the graphs provided in IEC-TR-62153-4-0 and the Zt testing preformed on the TE 24 AWG and 26 AWG constructions, this evaluation shows shields appear to meet the Class 2 Screening Attenuation requirements

IEC-TR-62153-4-0 Zt Graph for Various Shield Configurations

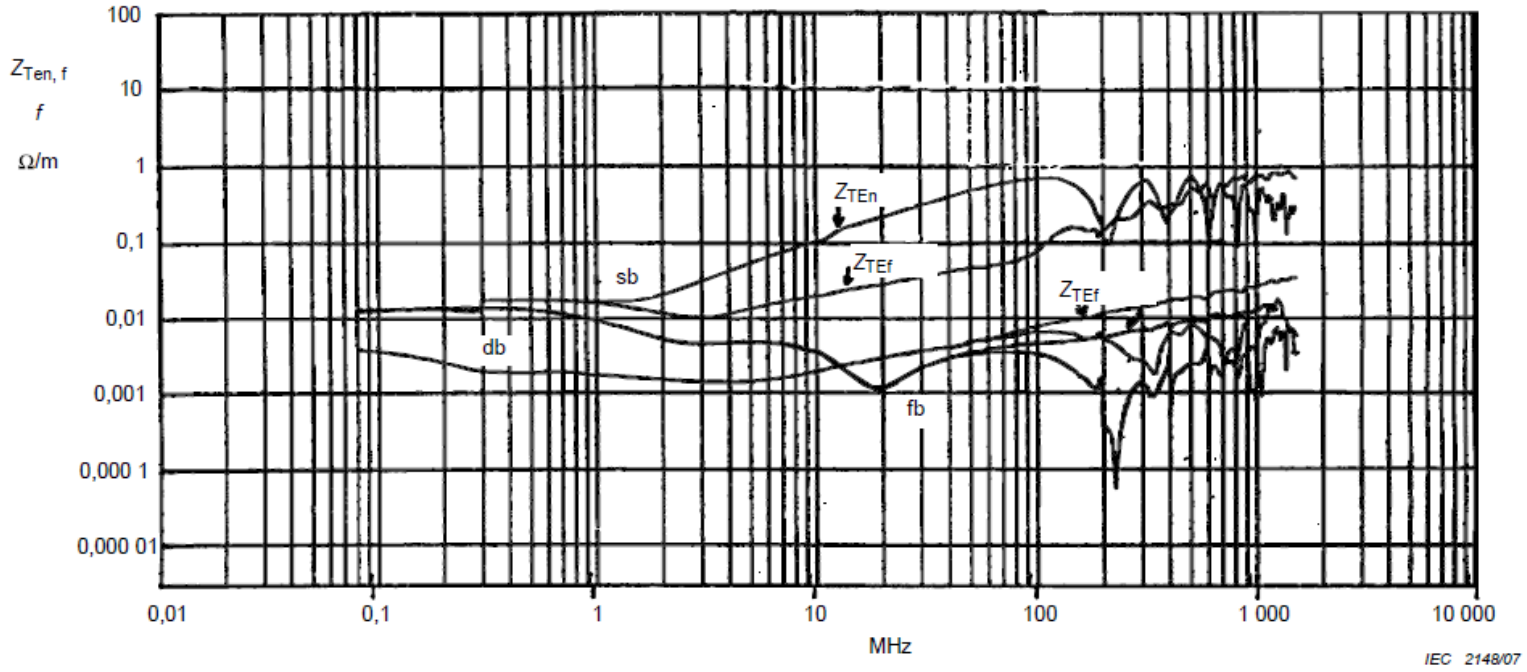
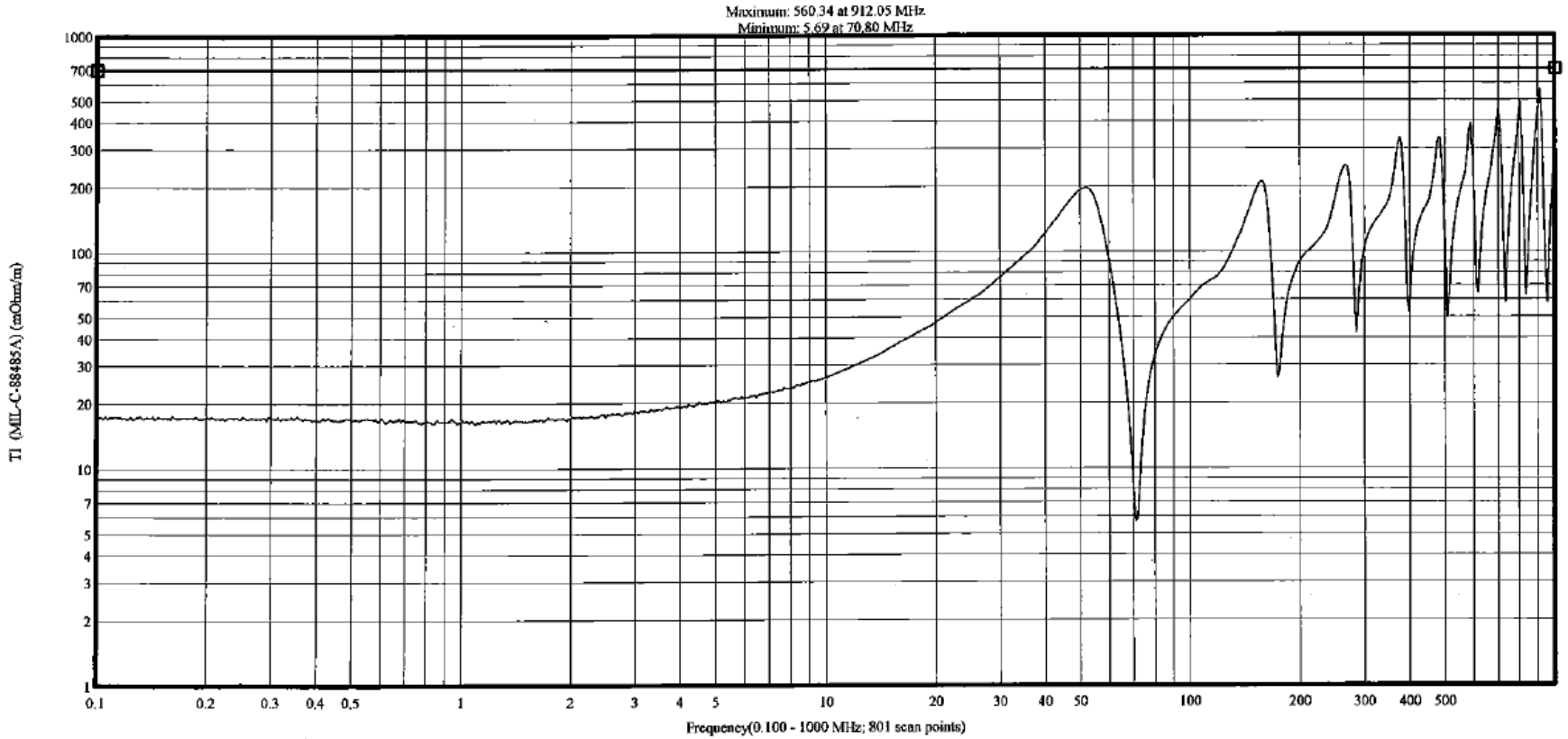


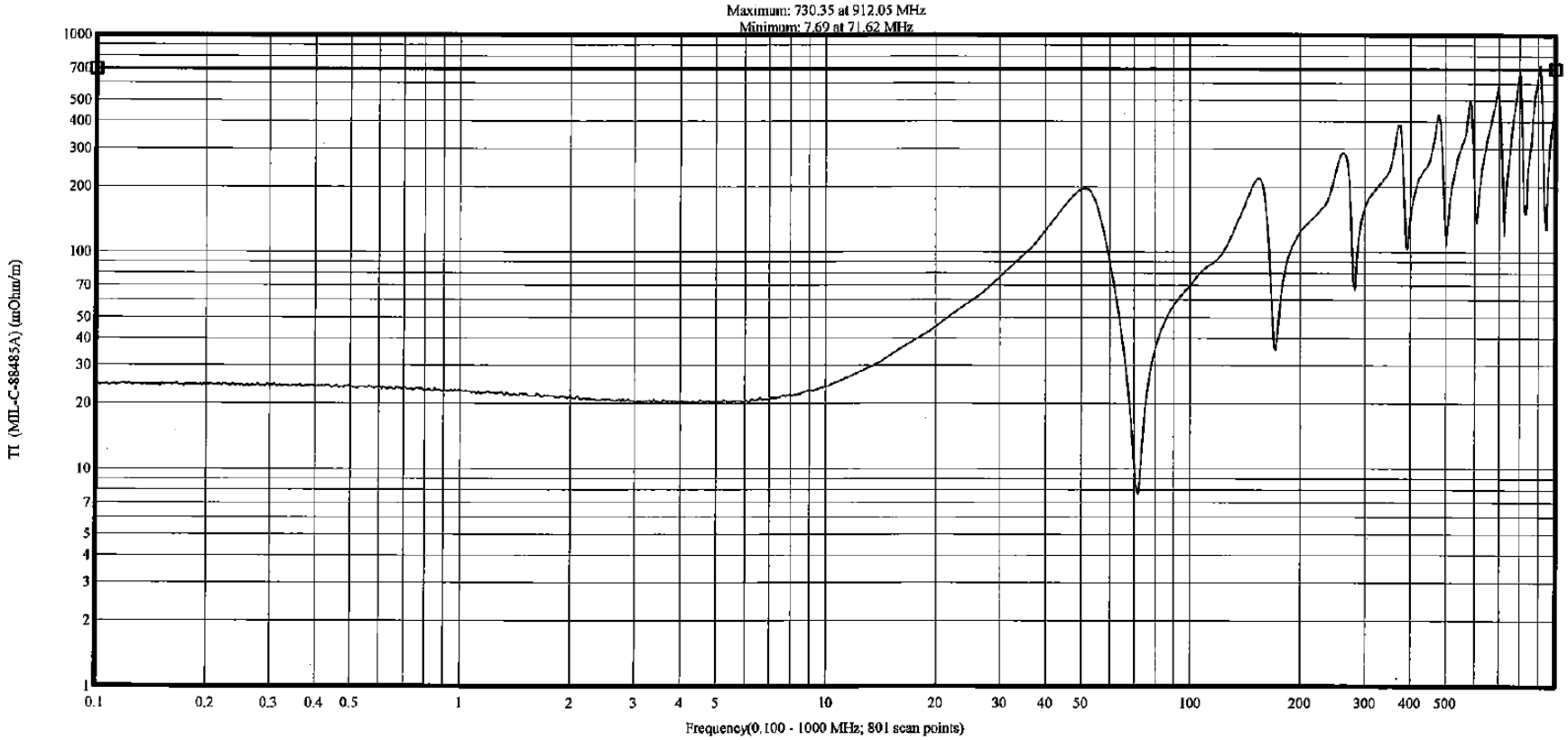
Figure 6 – Typical effective transfer impedance values measured with the line-injection method, (sb = single braid, db = double braid and fb = foil + braid)

26 AWG Zt Measurement



Envelope of values is comparable to sb (single shield) on IEC-TE-61253-4-0 Zt Graphs

24 AWG Zt Measurement



Envelope of values is comparable to sb (single shield) on IEC-TE-61253-4-0 Zt Graphs

IEC-TR-62153-4-7 Single Shield Screening Attenuation

Figure 7a – sb: single braid