Cable Type Twin 0.65

CAI Certification Specification

Ref: CAI-011-C / T065 / 12-2016

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1 General

This specification defines the pass/fail criteria for the testing of cable type 0.65 twin, and references the relevant sections of BS EN 50117-1: 2002 where appropriate. The methods of BS EN 50117-6:1997 are used as appropriate.

All details, where applicable, will be recorded on CAI-010-C: Cable Testing Result Sheet. When a cable fails any section, the details of the failure will be fully recorded.

High quality connectors are to be used to test the cable as required throughout this procedure, referencing the correct method of connection in the VHF/UHF Handbook.

2 Mechanical Specification

The mechanical specifications for the cable are as follows:

Inner Conductor	: To be copper
Diameter of Inner Conductor	: 0.65 +/- 0.02 mm
Outer Braid / Tape	: No dissimilar metals except the foil may be aluminium and the braid copper and where the foil is aluminium the copper braid must be tin plated 0.75 microns +/- 0.25
Diameter of outer Conductor	: Not less than 3.5 mm
External Diameter of each Sheath	: 4.70 +/- 0.2 mm
Separating Web	: To be minimal such that on separation of the two cores an equal amount of outer sheath is left on both cores. Note the overall diameter of each core should be within the above limit.
Bending Radius	: 35 mm
Flexing Radius	: 75 mm

Note: On separating the cable into two for termination, the cables should peel without exposing the braid of either core.

3 Cable Measuring

Physically measure and cut 100 m (+/- 25 cm), 30 m (+/- 6 cm) and 3 m (+/- 3 cm) from the cable to be tested using a tape measure, when required. Once measured, put onto reels as necessary for the tests to be carried out.

4 Testing (Electrical)

<u>Carry out the following test with 100 m of cable on the drum</u>

4.1 Conductor Resistance

(Reference BS EN 50117-1: 2002 Section 4.1)

Measure the DC resistance of each core of the cable under test, and using the formula in section 5.2 normalise the result to 20°C, of both the inner and outer conductors.

Using the formula in section 5.1 convert the reading to Ω/km.

The DC resistance of each inner conductor should be <55 Ω/km.

The DC resistance of each outer conductor should be <16 Ω/km.

4.2 Regularity of Impedance

(Reference BS EN 50117-1: 2002 Section 5.1.2.5)
In the absence of any content in the above clause the interim procedure is detailed in appendix A

Using a TDR, enter the velocity ratio of the cable under test as specified by the manufacturer into the TDR, and observe the cable regularity of impedance.

Regularity of Impedance should be < 1% throughout the test specimen.

4.3 Longitudinal Loss (Attenuation)

Reference BS EN 50117-1: 2002 Section 5.1.2.2)

The attenuation of the cable under test at 20° C should meet the following:

5 MHz	:	<2.7 dB/100 m
50 MHz	:	<7.5 dB/100 m
100 MHz	:	<10.0 dB/100 m
200 MHz	:	<13.8 dB/100 m
460 MHz	:	<21.4 dB/100 m
860 MHz	:	<30.0 dB/100 m
1000 MHz	:	<32.5 dB/100 m
1750 MHz	:	<42.2 dB/100 m
2150 MHz	:	<47.0 dB/100 m

4.4 Return Loss

(Reference BS EN 50117-1: 2002 Section 5.1.2.4)

The return loss of the cable under test at 20° C should meet the following:

5 - 30 MHz	:	>23 dB
30 - 470 MHz	:	>23 dB
470 - 862 MHz	:	>20 dB
862 - 2150 MHz	:	>15 dB

In each frequency band, 3 peak return loss values up to 4 dB lower than the stated specified limit are permissible.

<u>Carry out the following tests with 30 m of cable cut from the drum</u>

4.5 Capacitance

Measure the capacitance of each of the cores of the cable under test using a capacitance meter and convert the reading to give pF/m.

The values between cores should not vary by more than 2.5%.

4.6 Relative Propagation Velocity

(Reference BS EN 50117-1: 2002 Section 5.1.2.1)

Calculate the required values at 20° C using BS EN 50117-1: 2002 Section 5.1.2.1.

Express the final value using BS EN 50117-1: 2002 Section 5.1.2.1.

The values between cores should not vary by more than 2.5%.

4.7 Characteristic Impedance

Reference BS EN 50117-1: 2002 Section 5.1.2.3)

Using the values obtained in section 4.6 above, and capacitance value obtained in section 4.5 above. Apply the values using BS EN 50117-1: 2002 section 5.1.2.3 to calculate the mean characteristic impedance of the cable under test The Characteristic Impedance of each core should be 75 Ω +/- 3 Ω.

Carry out the following tests using new cable from the drum

4.8 Single Bend Test

(Reference BS EN 50117-1: 2002 Section 5.2.9)

Using a 20 m (minimum) length of the cable under test, wrap a section 180^{o} around a 70 mm diameter mandrel - ensuring the cable touches all the required parts of the mandrel.

Using a TDR, ensure that the regularity of impedance is <1% for each core.

After testing, there should be no cracks, or breaks in the dielectric, metallic elements or sheath.

4.9 Repeated Bending Test

(Reference BS EN 50117-1: 2002 Section 5.2.10)

Using a 10 m (minimum) piece of the cable under test, bend a section 90^{o} around the 70 mm diameter mandrel, then straighten and bend again 3 times. Wind the same section of cable three turns around the same mandrel. Ensure the cable touches all the required parts of the mandrel for these tests.

Using a TDR, ensure that the regularity of impedance is <1%.
After testing, there should be no cracks, or breaks in the dielectric, metallic elements or sheath.

Carry out the following test using a new 3 m section of cable

4.10 Screening Attenuation

(Reference BS EN 50117-1: 2002 Section 5.1.2.7)

Using the formula specified in BS EN 50289-1-6: 2002 section 9.3.1equation, the result +6 dB of the cable under test should meet the following attenuation levels:

30 - 300 MHz	:	> 85 dB
300-470 MHz	:	> 80 dB
470 - 1000 MHz	:	> 75 dB
1000 - 2150 MHz	:	> 65 dB

Carry out the following tests using 15 m section of new cable

4.11 Flexing Test

(Reference BS EN 50117-1: 2002 Section 5.2.10)
Mark the middle 10 m (minimum) of the cable under test as the test area, and pull the cable through the 150 mm diameter pulleys backwards and forwards 5 times, with a force of 10 to 20 N, at a rate of not less than 1 m/minute.

Using a TDR, ensure that the regularity of impedance of each core is <1%.

For each core.
Re-check the screening attenuation on a 3m length of the 10m of cable tested using the set up in Section 4.10, and the formula specified in BS EN 50117-1: 2002 section 11.10.6 equation (31), the result +6dB of the cable under test should meet the following attenuation levels:

30 - 300 MHz	:	> 85 dB
300-470 MHz	:	> 80 dB
470 - 1000 MHz	:	> 75 dB
1000 - 2150 MHz	:	> 65 dB

After testing, there should be no cracks, or breaks in the dielectric, metallic elements or sheath.

4.12 Crush Resistance

(Reference BS EN 50117-1: 2002 Section 5.2.3)

Using a TDR and a torque wrench set to 13.6 Nm, ensure the cable has no lateral movement and apply a crush load to the cable for 2 minutes.

Ensure that the regularity of impedance is <1% and record any magnitude variations.

Appendix A
Regularity of Impedance Test Procedure

A.1 Method A: Pulse return loss

A.1.1 Principle

The test determines in the time domain the return loss of coaxial cables using a pulse signal.
NOTE. The pulse return loss is displayed against time to show the local irregularities of the characteristic impedance at the ends of the cable to be determined. The procedure normally is used with long cable lengths relative to the pulse width

A.1.2 Definitions

Pulse return loss a_p is defined as

$$a_p = 20 \log (u_s / u_{r.x}) \quad \text{in dB}$$

Where

u_s is the voltage of the pulse at the input end.

$u_{r.x}$ is the voltage of the pulse reflected by an irregularity at a distance x from the cable input end and measured at the input end of the cable

The corrected pulse return loss, $a_{p.c}$ is the return loss measured at the input end minus the pulse attenuation by travelling 2x. It is defined by

$$a_{p.c} = a_p - (2ax / 100) \quad \text{in dB}$$

Where

a is the attenuation constant in dB/100 m at the frequency f_e around which the main part of the pulse energy is concentrated and x is the measured distance in m. For a sensitive determination of $a_{p.c}$ it should be noted that the pulse attenuation may not vary linearly with length due to the pulse distortion

The resolution, dl is the minimum distance between two faults which can be distinguished on a return loss curve
The pulse width t_p, is characterised by the value of the pulse width at half height.

A.1.3 Test equipment

The test equipment shall be assembled generally in accordance with the figure below.

A.1.4 Procedure

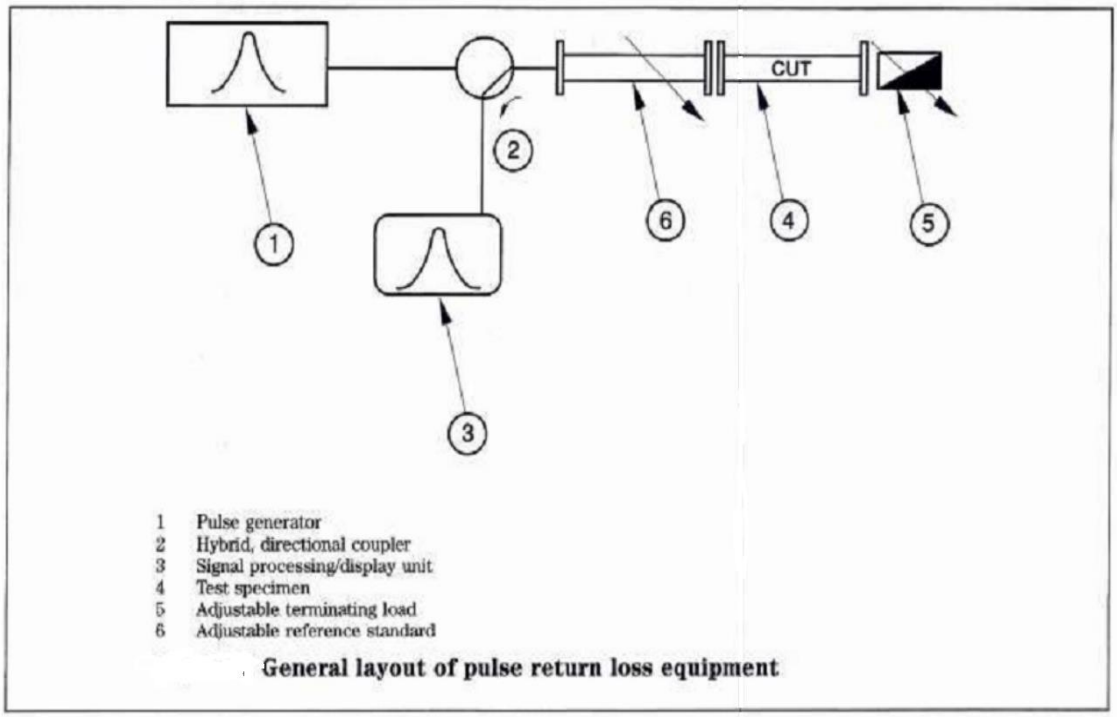
The pulse is an approximately sine square pulse. Unless otherwise specified in the relevant cable specification, the width of the pulse shall be =< 10ns.
The resolution dl is determined by

$$dl = 0.15\ t_p\ v_r \quad \text{in m}$$

Where

t_p is the pulse width in ns,
v_r is the velocity ratio of the test sample
The frequency fe = 250 / tp in MHz
Items 5 and 6 in figure 8 shall be adjusted for minimum reflection and the return loss shall be displayed and recorded

A. 1.5 Requirements
The regularity of impedance shall not exceed the value stated in the relevant cable specification



1 Pulse generator
2 Hybrid, directional coupler
3 Signal processing/display unit
4 Test specimen
5 Adjustable terminating load
6 Adjustable reference standard

General layout of pulse return loss equipment

A. 2. Method B : Step function return loss

A. 2.1 Principle
The test determines in the time domain the return loss of cables using a step function signal

Note the step function return loss is displayed against time to show the local distribution of magnitude and phase of irregularities of the characteristic impedance near the input end of the test specimen.

A. 2.2 Definitions
The step reflection coefficient is defined as
rs = ur.x / us * 100 in %
Where

ur.x is the step voltage reflected by an irregularity at a distance x from the input end of the cable

Us is the step voltage applied to the test specimen.

For a step function the rise time tr, is defined as the difference between the 10% and 90% value of step amplitude. The rise time affects the resolution.

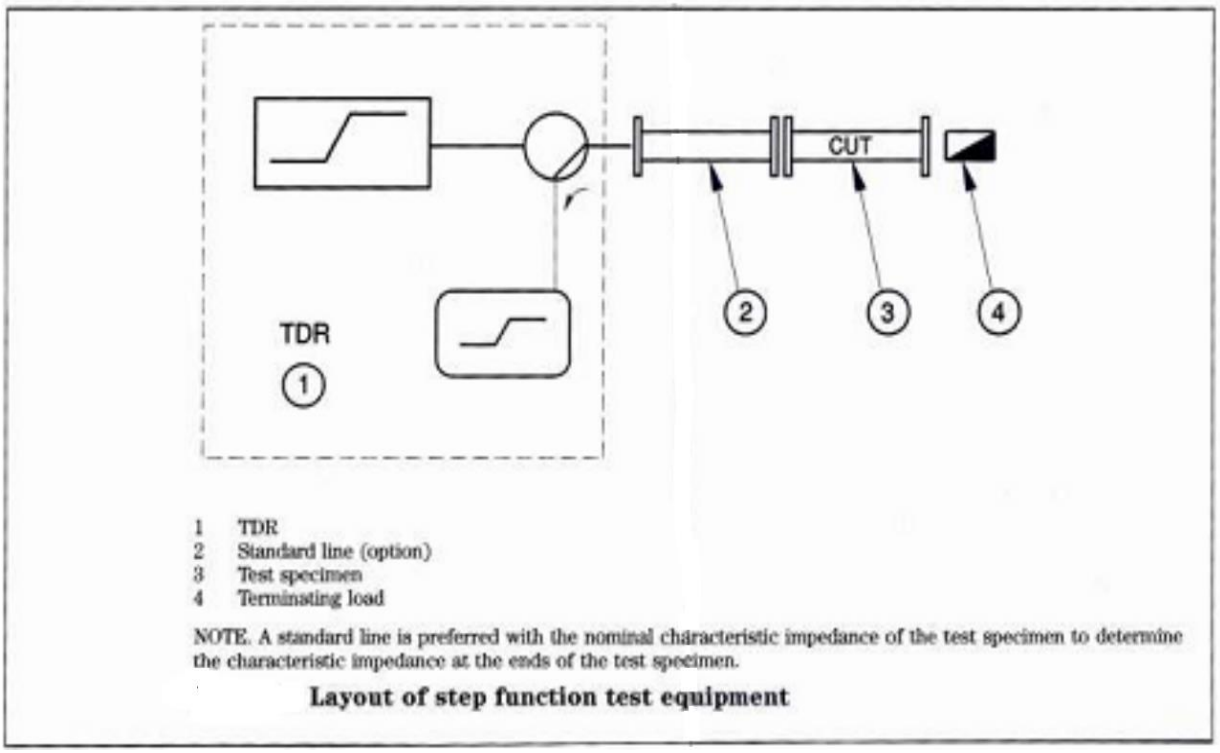
The resolution dl can be determined by:

dl = 150 * 10-6 * tr * vr in m

where

tr is the rise time in ps;

vr is the velocity ratio of the test specimen



1 TDR
2 Standard line (option)
3 Test specimen
4 Terminating load

NOTE. A standard line is preferred with the nominal characteristic impedance of the test specimen to determine the characteristic impedance at the ends of the test specimen.

Layout of step function test equipment

A.2.3 Test procedure
The test equipment shall be assembled generally in accordance with the figure

A.2.4 Procedure
The step function used to test the test specimen shall have a rise time of =< 5 ns.

A.2.5 Requirements
The step reflection coefficient shall comply with the value indicated in the relevant specification

Appendix B

Certification Summary: CAI-007-C / 100 / 05-2013
Cable Type 100

Standard : BS EN50117-1: 2002
Coaxial Cables Generic Specification

MECHANICAL SPECIFICATION

Inner Conductor	: copper
Diameter of Inner Conductor	: 0.65 +/- 0.02 mm
Diameter of Outer Conductor	: Not less than 3.5 mm
Outer Braid / Tape	: No contact between dissimilar metals
External Diameter of Sheath	: 4.70 +/- 0.2 mm
Separating Web	: To be minimal such that on separation of the two cores an equal amount of outer sheath is left on both cores. Note the overall diameter of each core should be within the above limit.
Bending Radius	: 35 mm
Flexing Radius	: 75 mm

ELECTRICAL SPECIFICATION

Nominal Impedance	: 75 Ω +/- 3 Ω
DC Resistance (20°C)	: Inner <55 Ω/km Outer <16 Ω/km

Attenuation:

5 MHz	: <2.7 dB/100 m
50 MHz	: <7.5 dB/100 m
100 MHz	: <10.0 dB/100 m
200 MHz	: <13.8 dB/100 m
460 MHz	: <21.4 dB/100 m
860 MHz	: <30.0 dB/100 m
1000 MHz	: <32.5 dB/100 m
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2150 MHz	: <47.0 dB/100 m

Return Loss:

5 - 30 MHz	:	>23 dB
30 - 470 MHz	:	>23 dB
470 - 862 MHz	:	>20 dB
862 - 2150 MHz	:	>15 dB

Screening Attenuation:

30 - 300 MHz	:	> 85 dB
300-470 MHz	:	> 80 dB
470 - 1000 MHz	:	> 75 dB
1000 - 2150 MHz	:	> 65 dB

Screening Attenuation following Flexing Test:

30 - 300 MHz	:	> 85 dB
300-470 MHz	:	> 80 dB
470 - 1000 MHz	:	> 75 dB
1000 - 2150 MHz	:	> 65 dB

Flexing:

Maintain minimum impedance regularity <1%, and screening performance.

Static Bend Test:

Maintain minimum impedance regularity <1%.

Crush Resistance:

Maintain impedance regularity <1%.