

Annex 113A

(informative)

Description of cable clamp and test setup

113A.1 Overview

This annex describes an example of a cable clamp and a representative methodology that should be used in common-mode noise rejection, rejection of external EM fields, or similar MultiGBASE-T receiver tests using EM clamp injection techniques, which are used to determine the sensitivity of the PMA receiver to external EM fields introduced by the cabling and interconnect system. Variations of this methodology may also be useful for other testing as applicable for design and development purposes. Refer to the receiver specifications of the PHY under test for specific impairments, impairment source power levels, and relevant frequency ranges.

113A.2 Description of cable clamp

(Note – The larger inner diameter clamp is described here; see Annex 40B for the description of an alternate clamp for use with smaller diameter cable types)

As shown in Figure 113A-1 and 113A-2, the clamp is 300 mm long, 75 mm wide, 78 mm high with a center opening of 9.525 mm (0.375 in). The clamp consists of two halves that permit the insertion of a cable into the clamp.

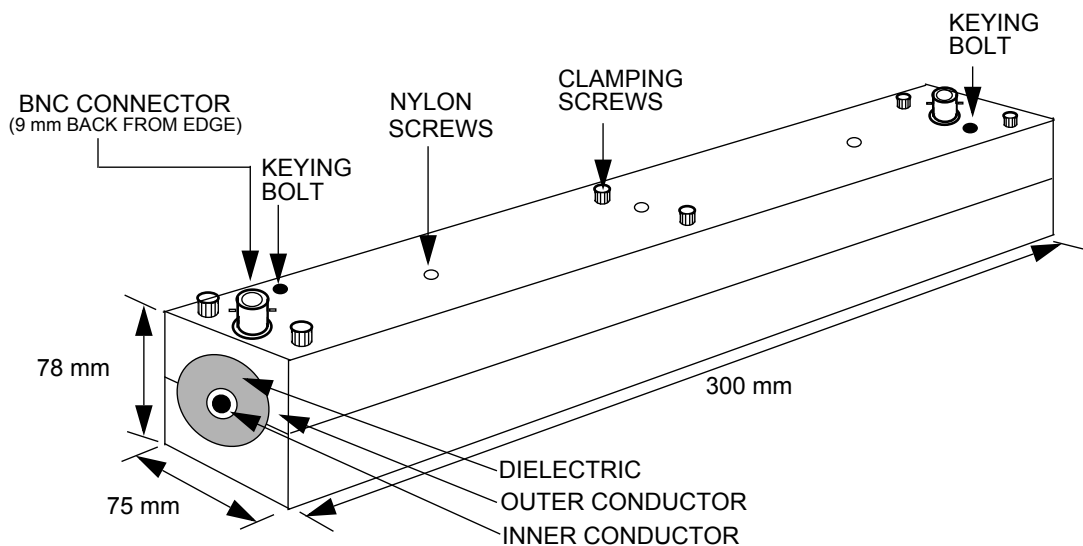


Figure 113A-1—Cable clamp

The clamp has a copper center conductor and an aluminum outer conductor with a high density polyethylene dielectric. The following is a review of the construction and materials of the clamp:

- a) *Inner conductor*—Copper tubing with an inner diameter of 9.53 mm (0.375 in) and an outer diameter of 12.7 mm (0.50 in).
- b) *Outer conductor*—Aluminum bar that is 300 mm long and approximately 78 mm by 75 mm. The bar is milled to accept the outer diameter of the dielectric material.
- c) *Dielectric*—High Density Polyethylene (Residual, TypeF) with dielectric constant of 2.32. The hollow cylinder has an outside diameter of 45 mm and an inner diameter that accepts the outside diameter of the copper inner conductor.
- d) *Connectors*—BNC connectors are located 9 mm (0.39 in) from each end of the clamp and are recessed into the outer conductor. The center conductor of the connector is connected to the inner conductor as shown in Figure 113A–2.
- e) *Clamping screws*—Six screws are used to connect the two halves of the clamp together after the cable has been inserted. Although clamping screws are shown in Figure 113A–1, any clamping method may be used that ensures the two halves are connected electrically and permits quick assembly and disassembly.
- f) *Nylon screws*—Used to align and secure the inner conductor and dielectric to the outer conductor. The use and location of the screws is left to the manufacturer.
- g) *Keying bolts*—Two studs used to align the two halves of the clamp

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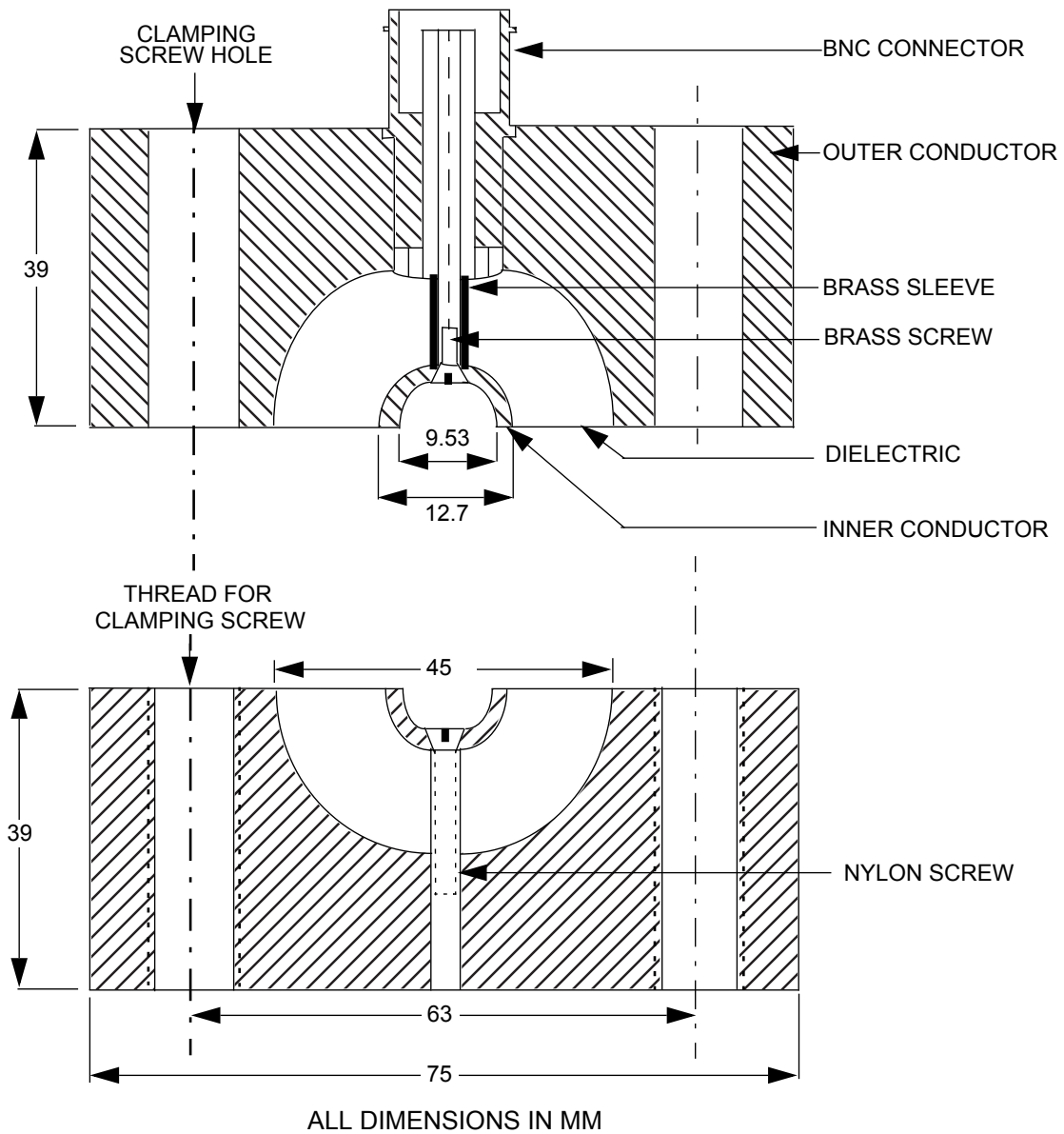


Figure 113A-2—Cross-section of cable clamp

As shown in Figure 113A-2 the inner conductor on the bottom half of the clamp extends slightly (~ 0.1mm) above the dielectric to ensure there is good electrical connection with the inner conductor of the top half of the clamp along the full length of the conductor when the two halves are clamped together.

The electrical parameters of the clamp between 1 MHz and 2 000 MHz are summarized in Table 113A-1—

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Table 113A-1—Cable clamp electrical parameters (1 MHz – 2 000 MHz)

Frequency Range	Insertion Loss	Return Loss
1 MHz - 250 MHz	< 0.2dB	> 20.0 dB
250 MHz - 500 MHz	< 1.0 dB	> 7.0 dB
500 MHz - 1 000 MHz	< 3.5 dB	> 3.5 dB
1 000 MHz - 2 000 MHz	< 15.0 dB	> 1.0 dB

113A.3 Cable clamp validation

In order to ensure the cable clamp is operating correctly, the following measurement and validation procedures are provided and should be completed prior to conducting the test described in 113A.4 and illustrated in Figure 113A-4.

Cable clamp electrical measurement - The clamp should be measured to ensure the insertion loss and return loss are as specified in 113A.2. Electrical parameters of the clamp are measured between the source connections and without cabling (that is, no cabling inserted in the clamp inner conductor).

Cable clamp validation – This validation procedure is provided to verify proper operation of the test setup before performing any tests. In contrast to the clamp electrical measurement, the cable clamp validation test procedure uses the clamp with cabling that meets the PHY link segment specifications inserted into the clamp.

The validation test hardware consists of the following:

- a) Transmitter/Receiver – A link partner system, configured for the data rate being evaluated, with the transmitter disabled.
- b) Breakout Fixture – A passive fixture with an MDI connector jack input and individual outputs for each of the 8 signal wires. Wires of pairs not being measured should be terminated to the ground plane with a 50 Ω resistor.
- c) Balun – 4 ports, laboratory quality with a 100 Ω differential input and a 50 Ω single-ended, unbalanced output:

Insertion Loss (100 Ω balanced <-> 50 Ω unbalanced): < 4dB (1 MHz-2 000 MHz)

Return Loss: > 8dB (1 MHz- 3 MHz), > 15dB (3 MHz-2 000 MHz)

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Common-Mode Rejection: > 50dB (1 MHz-1 000 MHz), > 40dB at 2 000 MHz

Common-Mode Return Loss > 8 dB (1 MHz-2 000 MHz)

d) 50 Ω resistors – Used to terminate unmeasured conductors.

e) Test cable – A 30m, 4-pair 100 Ω plug terminated cable that meets the PHY link segment specifications.

f) Chokes (5) - Wideband Ferrite Material:

Inner diameter: Selected to minimize the gap between the ferrite and the cable used for the test.

Impedance: 175 Ω @ 100 MHz, 275 Ω @ 250 MHz, 375 Ω @ 500 MHz, 400 Ω @ 1 000 MHz

g) Ground plane - Copper sheet or equivalent large enough to span the equipment interface under test and the clamp, including the portion of the cable between the equipment and the chokes.

h) Signal generator capable of providing a sine wave signal of 1 MHz to 2 000 MHz.

i) Signal Sensor & Measurement System - Oscilloscope, power meter or spectrum analyzer with at least 4 000 MHz bandwidth

j) Receiver

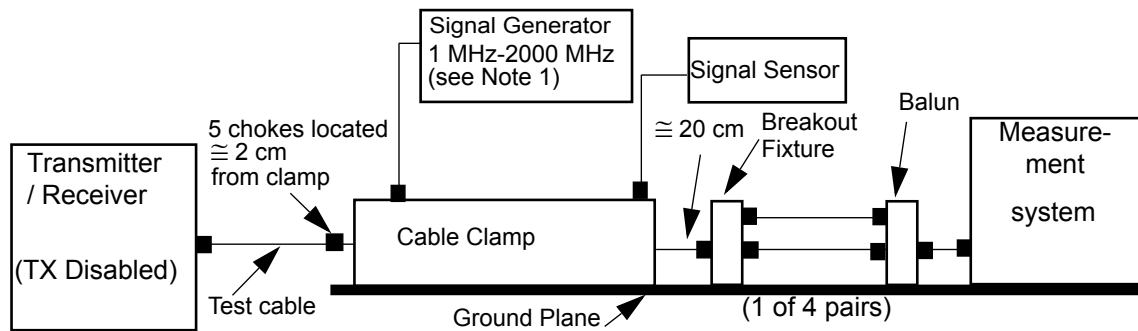


Figure 113A-3—Cable clamp validation test configuration

With the test cable inserted in the cable clamp, a signal generator with a 50 Ω output impedance is connected to one end of the cable clamp and a signal sensor with a 50 Ω input impedance is connected to the other end.

The signal generator shall be capable of providing a sine wave signal of 1 MHz to 2 000 MHz. The output of the signal generator is adjusted for the specified signal power at 20 MHz on the signal sensor. The remainder of the test is conducted without changing the signal generator voltage. The cable pairs not connected to the balun are terminated in a resistor network. The cable clamp, breakout fixture and balun must be in direct contact with the ground plane in a manner consistent with good RF measurement practices. The chokes are placed on the cable, located next to each other and approximately 2.0 cm from the clamp.

The cable between the clamp and the breakout fixture should be positioned straight from the clamp to the breakout port and not contact the ground plane. Any plug shield contacts should mate with the breakout jack shield. The cable between the transmitter and the cable clamp should be installed either in a linear run or wrapped randomly on a cable rack. The cable rack should be at least 3 m from the cable clamp.

The differential-mode and common-mode voltage outputs of the balun and breakout fixture should meet the limits shown in Table 113A-2 over the frequency range 1 MHz to 2 000 MHz for each cable pair.

Table 113A-2—Common- and differential-mode output voltages

Frequency (f)	Common-mode voltage	Differential-mode voltage
1 MHz - 30 MHz	$<0.1+0.97(f/30)$ Vpp	$<2.4 + 19.68 (f/30)$ mVpp
30 MHz - 80 MHz	<1.07 Vpp	<22 mVpp
80 MHz - 250 MHz	$<1.07 - 0.6 (f-80)/170$ Vpp	<22 mVpp
250 MHz - 2 000 MHz	<470 mVpp (-2.6dBm)	<22 mVpp (-29 dBm)

After the setup has been validated, the clamp, cabling, and choke positions should remain unchanged when performing any receiver tests.

NOTE 1 - Prior to making validation measurements or performing the test described in 113A.4, the cable clamp should be tested without the cable inserted to determine the variation of the signal generator voltage with frequency at the output of the clamp. The signal generator output should be adjusted to the specified signal power (for example, 6 dBm for 40GBASE-T) at 20 MHz on the signal sensor. When the frequency is varied from 1 MHz to 2 000 MHz, the measured power should not vary more than $\pm 10\%$. If the power varies more than $\pm 10\%$, then a correction factor must be applied at each measurement frequency.

113A.4 Test Setup

Cabling up to the maximum specified length that meets the link segment specification for the PHY under test (for example, Clause 113.7 for 40GBASE-T), is connected between two such PHYs and inserted into the cable clamp. The cable should be terminated on each end with an MDI

connector plug specified for the MDI of the PHY under test (for example, Clause 113.8.1 for 40GBASE-T).

The breakout fixture and balun are replaced by the transmitter/receiver under test, with the system port positioned at the original location of the breakout. The clamp should be located a distance of ≈ 20 cm from the receiver port.

As described in the validation setup, the cable clamp and transmitter/receiver under test should be placed on a common ground plane and the system ground should be in direct contact with the ground plane. The chassis grounds of all test equipment used should be connected to the ground plane. A signal generator with a 50Ω impedance is connected to one end of the clamp and measurement equipment with a 50Ω input is connected to the other end of the clamp. The signal generator shall be capable of providing a sine wave signal of 1 MHz to 2 000 MHz or other cable-clamp-coupled impairment as specified. The output of the signal generator (as adjusted in 113A.3 Note 1) is applied to the clamp input to simulate the specified impairment (for example, an external electromagnetic field of approximately 3 V/m).

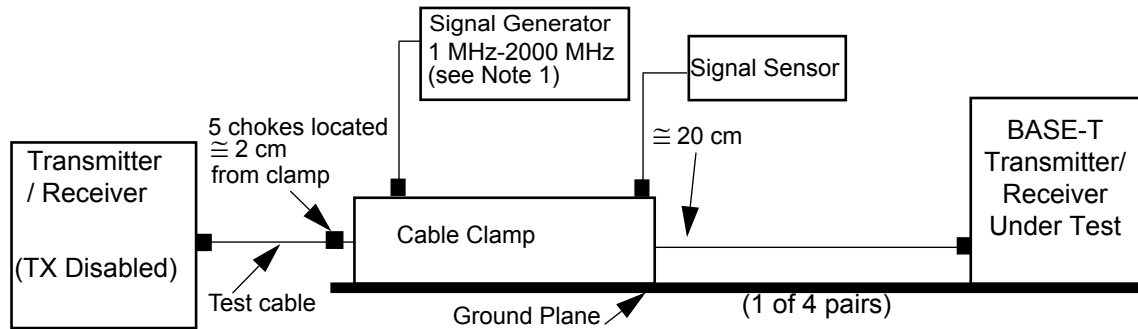


Figure 113A-4—Cable clamp test configuration

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