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**This specification was developed by the SFF Committee prior to it becoming the SFF TA (Technology Affiliate) TWG (Technical Working Group) of SNIA (Storage Networking Industry Association).**

The information below should be used instead of the equivalent herein.

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<http://www.snia.org/sff/join>

The complete list of SFF Specifications which have been completed or are currently being worked on can be found at:

<http://www.snia.org/sff/specifications/SFF-8000.TXT>

The operations which complement the SNIA's TWG Policies & Procedures to guide the SFF TWG can be found at:

<http://www.snia.org/sff/specifications/SFF-8032.PDF>

Suggestions for improvement of this specification will be welcome, they should be submitted to:

<http://www.snia.org/feedback>

SFF Committee documentation may be purchased in electronic form.  
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SFF Committee  
**SFF-8417**  
Specification for  
**Multi Conductor Cable Flex Cycle Test Procedure**  
Rev 4.5 January 28, 2014

Secretariat: SFF Committee

**Abstract:** This specification defines a test procedure to determine a flex cycle performance of bulk cable and cable assemblies that are utilized in gigabit environments.

This specification provides a common reference for systems manufacturers, system integrators, and suppliers. This is an internal working specification of the SFF Committee, an industry ad hoc group.

This specification is made available for public review, and written comments are solicited from readers. Comments received by the members will be considered for inclusion in future revisions of this specification.

**Support:** This specification is supported by the identified member companies of the SFF Committee.

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**EXPRESSION OF SUPPORT BY MANUFACTURERS**

The following member companies of the SFF Committee voted in favor of this industry specification.

Amphenol  
Broadcom  
EMC  
Emulex  
FCI  
Foxconn  
Hewlett Packard  
HGST  
NetApp  
Seagate  
Sun Microsystems  
TE Connectivity  
Volex

The following member companies of the SFF Committee voted to abstain on this industry specification.

Cinch  
Finisar  
Fujitsu CPA  
JDS Uniphase  
Luxtera  
Molex  
Sandisk  
Sumitomo  
Xyratex

**Update History:**

Revision 4.3

- Adopted current template.

Revision 4.5

- Corrected spelling error in Figure 4-1.

- Expanded Section 6 to include an alternate test method for Type C cable assemblies that are active and/or contain DC blocking capacitors.

## Foreword

The development work on this specification was done by the SFF Committee, an industry group. The membership of the committee since its formation in August 1990 has included a mix of companies which are leaders across the industry.

When 2 1/2" diameter disk drives were introduced, there was no commonality on external dimensions e.g. physical size, mounting locations, connector type, connector location, between vendors. The first use of these disk drives was in specific applications such as laptop portable computers and system integrators worked individually with vendors to develop the packaging. The result was wide diversity, and incompatibility.

The problems faced by integrators, device suppliers, and component suppliers led to the formation of the SFF Committee as an industry ad hoc group to address the marketing and engineering considerations of the emerging new technology.

During the development of the form factor definitions, other activities were suggested because participants in the SFF Committee faced more problems than the physical form factors of disk drives. In November 1992, the charter was expanded to address any issues of general interest and concern to the storage industry. The SFF Committee became a forum for resolving industry issues that are either not addressed by the standards process or need an immediate solution.

Those companies which have agreed to support a specification are identified in the first pages of each SFF Specification. Industry consensus is not an essential requirement to publish an SFF Specification because it is recognized that in an emerging product area, there is room for more than one approach. By making the documentation on competing proposals available, an integrator can examine the alternatives available and select the product that is felt to be most suitable.

SFF Committee meetings are held during T10 weeks (see [www.t10.org](http://www.t10.org)), and Specific Subject Working Groups are held at the convenience of the participants. Material presented at SFF Committee meetings becomes public domain, and there are no restrictions on the open mailing of material presented at committee meetings.

Most of the specifications developed by the SFF Committee have either been incorporated into standards or adopted as standards by EIA (Electronic Industries Association), ANSI (American National Standards Institute) and JEDEC (Joint Electron Device Engineering Council).

If you are interested in participating or wish to follow the activities of the SFF Committee, the sign up for membership and/or documentation can be found at:  
[www.sffcommittee.com/ie/join.html](http://www.sffcommittee.com/ie/join.html)

The complete list of SFF Specifications which have been completed or are currently being worked on by the SFF Committee can be found at:  
<ftp://ftp.seagate.com/sff/SFF-8000.TXT>

If you wish to know more about the SFF Committee, the principles which guide the activities can be found at:  
<ftp://ftp.seagate.com/sff/SFF-8032.TXT>

Suggestions for improvement of this specification will be welcome. They should be sent to the SFF Committee, 14426 Black Walnut Ct, Saratoga, CA 95070.

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SFF Committee --

## Multi Conductor Cable Flex Cycle Test Procedure

### 1. Scope

This specification defines the flex cycle testing procedure for round bulk cable and cable assemblies which are used in gigabit applications. These cables include parallel pairs or twisted pairs, both shielded and unshielded. This procedure can also be used as a guideline for cycle testing of ribbonized cable assemblies.

This specification provides a method for determining the flex cycle performance of round bulk cable and cable assemblies. These constructions are being utilized in Fibre Channel, Infiniband, PCIexpress, SAS, 10GbE and other I/O architectures.

### 2. References

#### 2.1 Industry Documents

The following interface standards are relevant to many SFF Specifications.

- EIA-364-41D Cable Flexing Test Procedure for Electrical Connectors
- SFF-8410 HSS Copper Testing and Performance Requirements
- SFF-8414 HPEI Passive Cable Assembly S-Param Measurements
- SFF-8415 Attributes of HSS Interconnects
- SFF-8416 HPEI Bulk Cable Measurement/Performance Requirements

#### 2.2 SFF Specifications

There are several projects active within the SFF Committee. The complete list of specifications which have been completed or are still being worked on are listed in the specification at <ftp://ftp.seagate.com/sff/SFF-8000.TXT>

#### 2.3 Sources

Those who join the SFF Committee as an Observer or Member receive electronic copies of the minutes and SFF specifications (<http://www.sffcommittee.com/ie/join.html>).

Copies of ANSI standards may be purchased from the InterNational Committee for Information Technology Standards (<http://www.techstreet.com/incitsgate.tmp1>).

#### 2.4 Conventions

The ISO convention of numbering is used i.e., the thousands and higher multiples are separated by a space and a period is used as the decimal point. This is equivalent to the English/American convention of a comma and a period.

American	French	ISO
0.6	0,6	0.6
1,000	1 000	1 000
1,323,462.9	1 323 462,9	1 323 462.9

#### 2.5 Definitions

For the purpose of SFF Specifications, the following definitions apply:

**Bulk Cable:** Insulated bundled or ribbonized metallic wires without connector termination.

**Cable Termination:** The attachment of wires to the termination side of a connector. Schemes commonly used in the industry are IDC (Insulation Displacement Contact), IDT (Insulation Displacement Termination), wire slots, solder, weld, crimp, braze, etc.

**Connector housing:** Mechanical enclosure encompassing the plug, contacts and bulk cable termination of the device under test.

**Jacket:** Materials that provide a protection in mechanical and chemical properties applied as a direct covering over cable components.

**Kellems Grip:** A wire mesh device used to secure a weight to a cable specimen by gripping the cable specimen 360 degrees.

**Mandrel:** A cylindrical arbor that serves as a core around which specimen shall be flexed.

**OD:** This term describes the Outside Diameter of the cable under test. This term could also describe the thickness of a ribbonized configuration.

**Shield:** A conductive envelope which encloses a wire or group of wires.

### 3. General Description

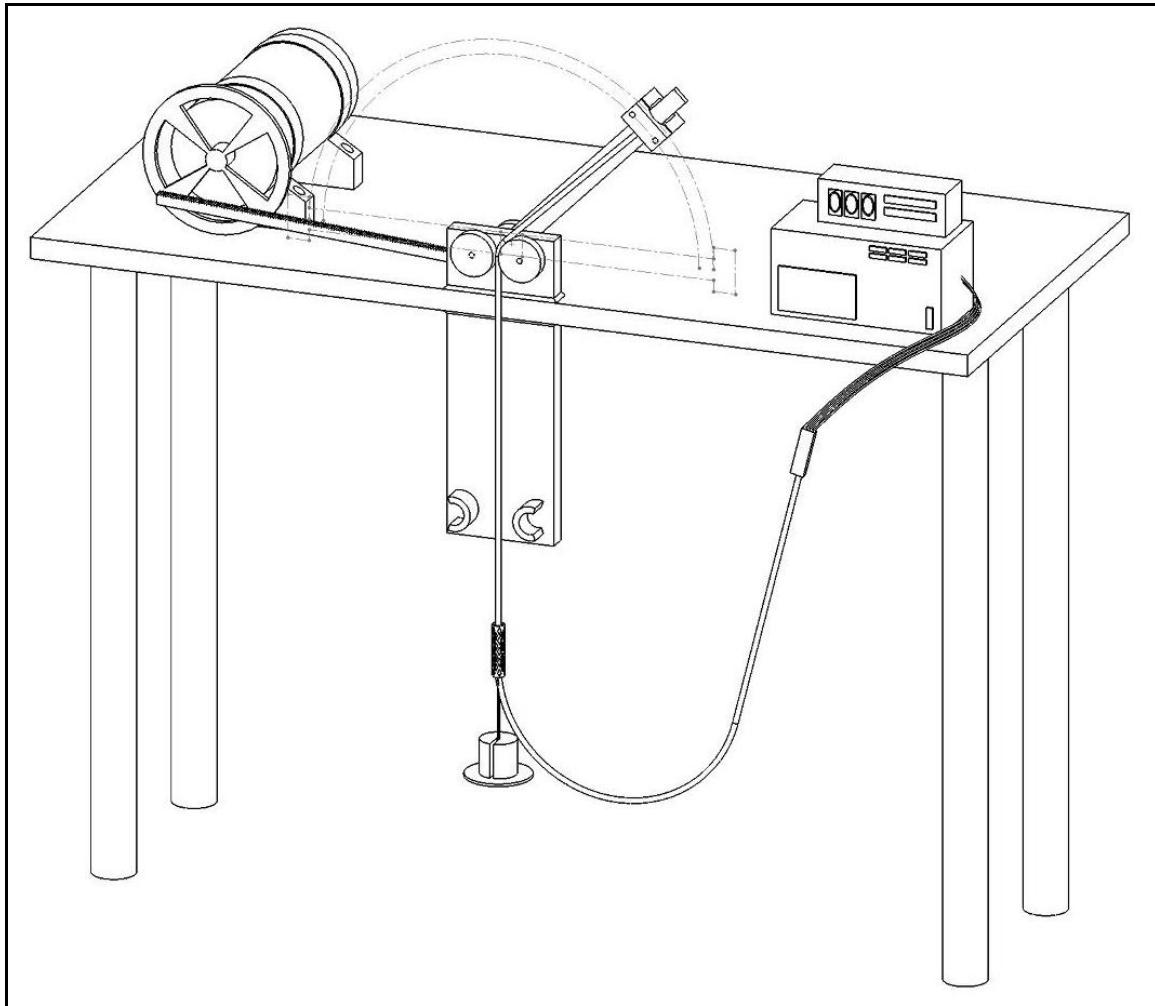


FIGURE 3-1 DRAWING OF SETUP

The bulk cable or cable assemblies shall be flexed in a plane on an apparatus. The apparatus swings through a 180 degree arc, around two fixed horizontal centerline mandrels. A cushioned clamp holds the position of the terminated area to the movable arm of the flex cycle tester. A weight is hung from the specimen. The samples are flexed alternately from a position 90 degrees from the vertical on one side to a position 90 degrees from vertical on the other side, at a frequency of 13 +/- 1 cycles per minute. One cycle is a traverse of the mechanically driven arm 180 degrees clockwise plus 180 degrees counterclockwise.

### 4. Test Specimen

This procedure considers the following 3 test specimen types.

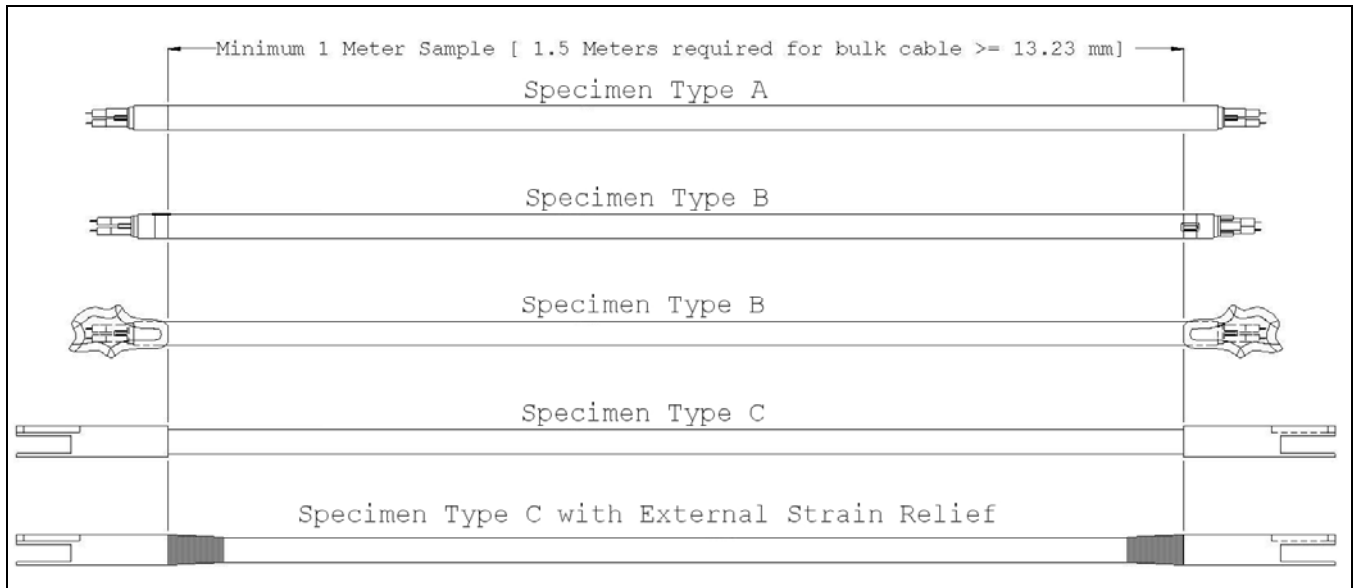
- Specimen type A is for evaluating the flex cycle life of raw bulk cable.
- Specimen type B is for evaluating the flex cycle life of bulk cable in a simulated cable assembly.
- Specimen type C is for evaluating the flex cycle life of a finished cable assembly.

The test specimen shall be a minimum raw bulk cable length of 1000 mm +/- 50 mm (See Figure 4-1) for all raw bulk cable outside diameters less than or equal to 13.23 mm.



For all test specimens with bulk cable outside diameter greater than 13.23 mm the minimum length shall be 1500 mm +/- 50 mm. (See Table 1)

The test specimen shall have all signal carrying conductors electrically connected in series to form a continuous circuit with the continuity monitor.



**FIGURE 4-1 LENGTH SAMPLE**

#### 4.1 Test Specimen Type A, Bulk Cable

Test specimen type A shall not have any material or device affixed to either end of the specimen except for purposes of monitoring continuity.

#### 4.2 Test Specimen Type B, Fixed Bulk Cable

Test specimen type B requires all cable ends to be secured such that movement of the cable components is eliminated within the terminated area. (See Figures 4-2 and 4-3)

##### 4.2.1 Fixed Bulk Cable using Band-It®

Test specimen Type B can be prepared using a trademarked device called a Band-it®. A Band-It® functions similar to a nylon cable tie but is metal. Band-it® products can be found at: <http://www.band-it-idex.com/>

##### 4.2.2 Fixed Bulk Cable using Epoxy

Test specimen Type B can be prepared using two part epoxy. Take note to apply epoxy to allow for proper clamping to apparatus (See Figure 5-5). It is recommended that a fast setting epoxy is chosen to reduce test preparation time.

#### 4.3 Test Specimen Type C, Cable Assembly

Test specimen type C is a finished cable assembly.

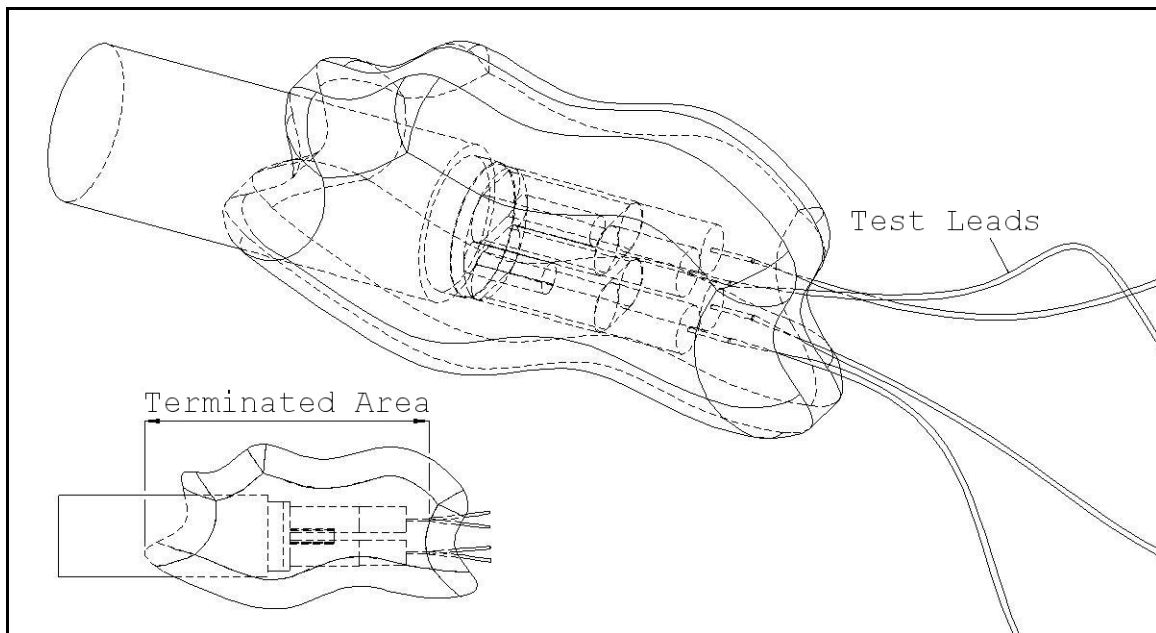


FIGURE 4-2 EPOXIED BULK CABLE

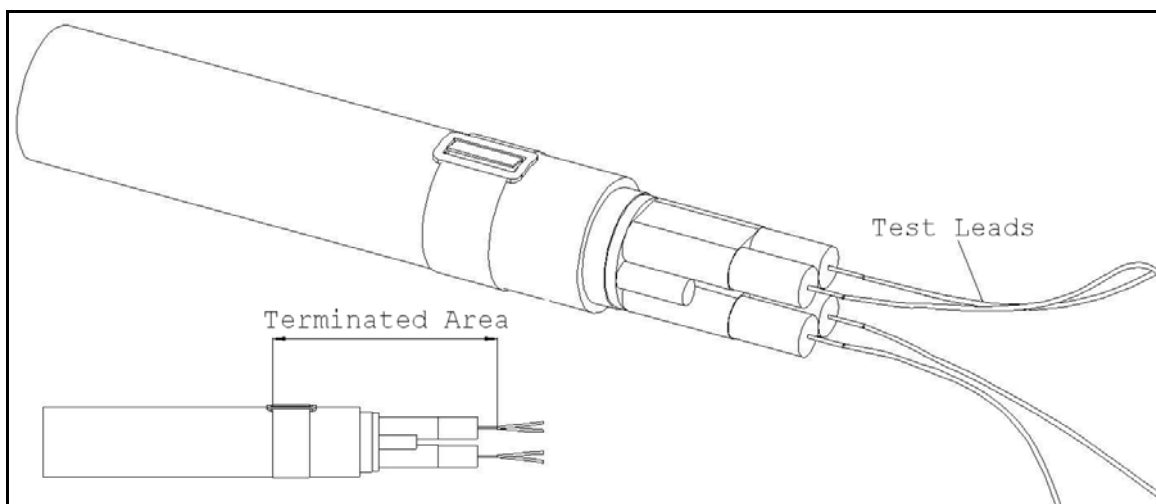
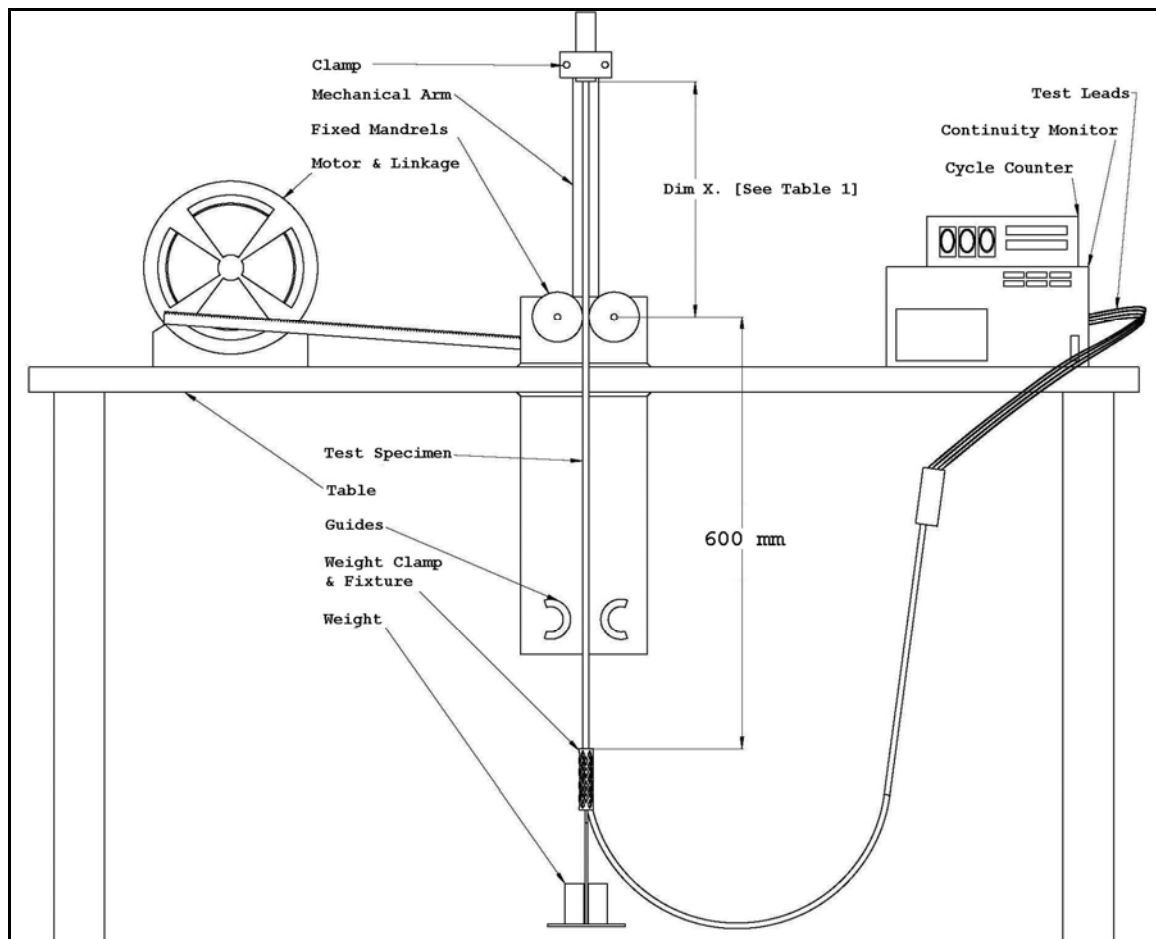


FIGURE 4-3 CLAMPED BULK CABLE (BAND-IT®)

## 5. Test Setup & Calibration

(Figures are not to scale)

### 5.1 Test Setup



**FIGURE 5-1 TEST APPARATUS**

Dimension X is measured from centerline of the mandrels to the maximum flexible portion of the specimen. (See Figure 5-1)

The dimension measured from the center of the mechanical pivot point to the top of the weight clamping location is 600 mm +/- 50 mm. (See Figure 5-1)

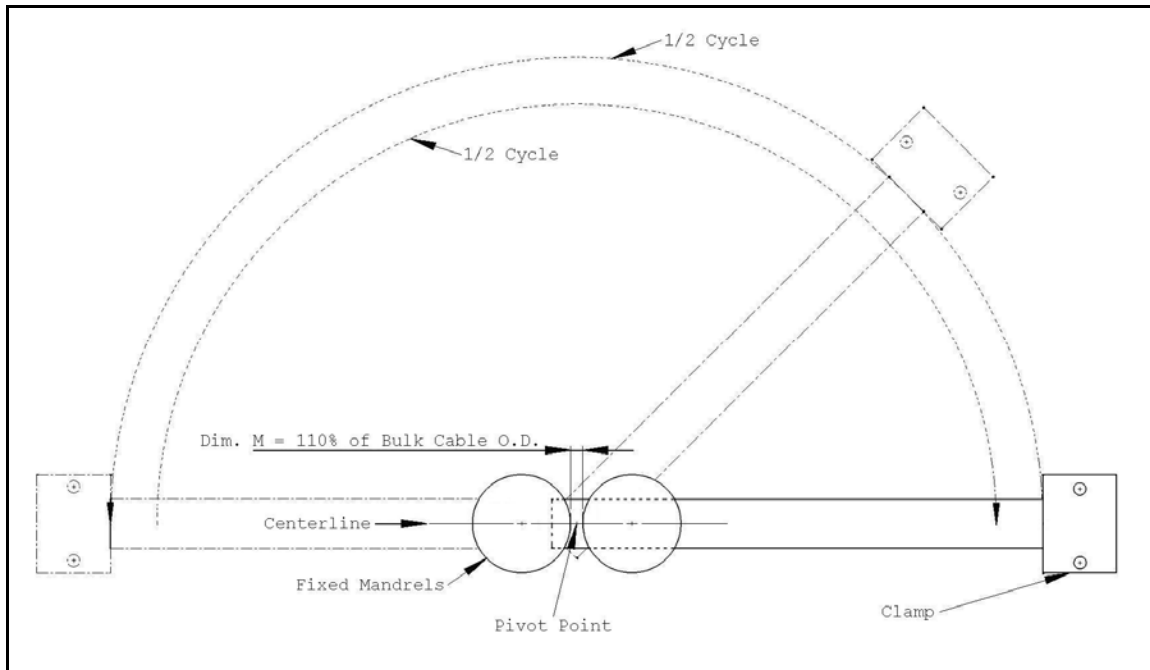
The horizontal centerline of the two mandrels intersects with the mechanical pivot point. (See figure 5-2)

**TABLE 5-1 MANDREL SIZE VS CABLE OD**

Dimension R (mm) Mandrel Radius	Dimension X (mm)	Cable OD Min (mm)	Cable OD Max (mm)	Cable OD Min (in)	Cable OD Max (in)
13	250	1.77	3.05	0.070	0.120
19	250	3.05	4.33	0.120	0.170
25	250	4.33	5.61	0.170	0.220
31	250	5.61	6.88	0.221	0.270
37	250	6.88	8.15	0.271	0.320
43	250	8.15	9.42	0.321	0.370
49	250	9.42	10.69	0.371	0.420
55	250	10.69	11.96	0.421	0.470
61	250	11.96	13.23	0.471	0.520
69	450	13.23	14.50	0.521	0.570
76	450	14.50	15.77	0.571	0.620
82	450	15.77	17.04	0.621	0.670
88	450	17.04	18.31	0.671	0.720
101	450	18.31	19.58	0.721	0.770
107	450	19.58	20.84	0.771	0.820

Mechanical Arm shall be motorized or pneumatic actuated and capable of rotating 90 degrees from vertical in both directions (see Figure 5-2).

Dimension M (See Figure 5-2) is defined as 110% of the maximum specified OD of the specimen. If specimen specification is not available, 110% of the measured specimen OD shall be used.

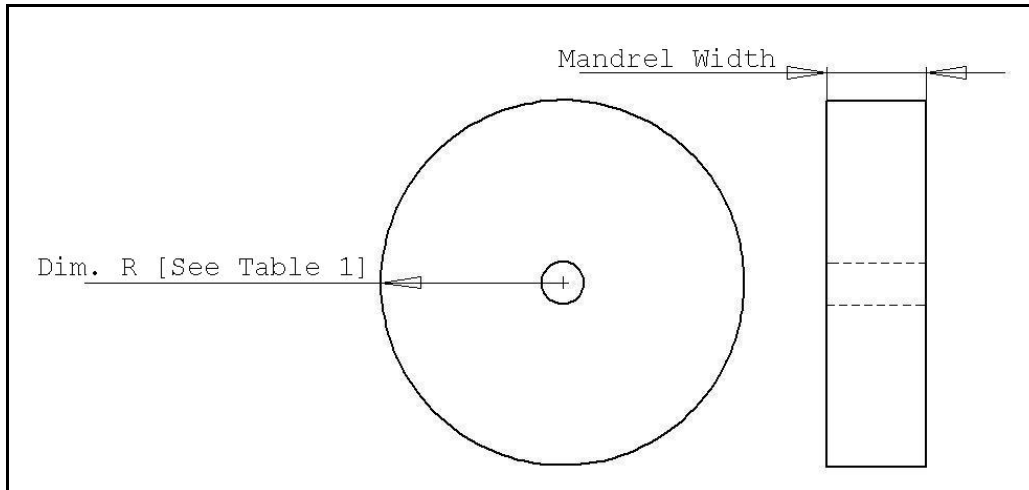


**FIGURE 5-2 TEST APPARATUS TRAVERSE OF ONE COMPLETE FLEX CYCLE**

Mandrels shall be fixed and non-rotating.

The width of the fixed mandrels needs to be wide enough to ensure the test specimen maintains proper contact with the surface of the fixed mandrels during flex

cycling.



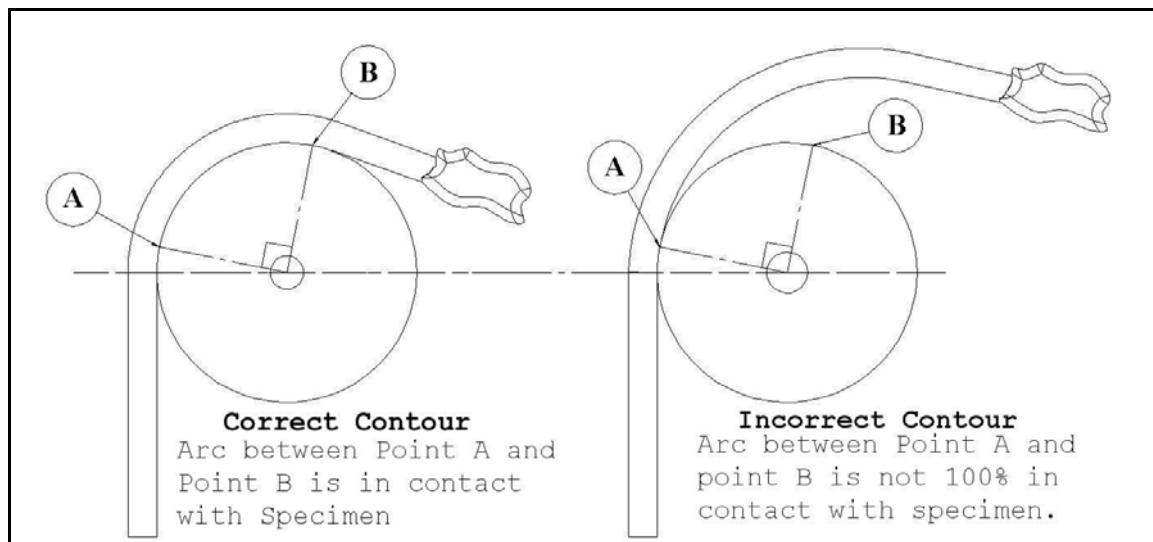
**FIGURE 5-3 MANDREL PROFILE**

Weight shall be secured to cable jacket using a Kellems Grip, friction clasp or equivalent to the specimen to ensure minimal disturbance is applied to the internal construction of the specimen.

Weight and device securing the weight shall not interact with any object or surface at any point during the test.

Weight shall be sufficient to ensure that the specimen follows the contour of the mandrels from Point A to Point B as shown in Figure 5-4. The arc created by Point A and Point B shall be no less than 90 degrees.

Due to the difference in raw materials, differing weights would be necessary to achieve the appropriate contour to the fixed mandrels i.e. PVC jacketing versus PVDF jacketing.



**FIGURE 5-4 SPECIMEN FOLLOWING CONTOUR OF MANDRELS**

The guides are required and located between the centerline of the mandrels and the most vertical point of the weight clamp to ensure correct contour of specimen shown in Figure 5-4. The guides cannot interfere with the fixed mandrels or the weight.

Clamp shall fix connector or bulk cable to the mechanical arm. Clamp shall not pivot with respect to the mechanical arm. The clamping point shall be near as possible to Dimension X without interfering with any flexible portion of the specimen. (Figure 5-5 represents orientation of clamp to specimen)

Apparatus shall be capable of indicating a discontinuity of 1 microsecond or longer of current flow within all signal conductors.

Apparatus shall include a cycle counter. The cycle counter shall have communication with the continuity monitor.

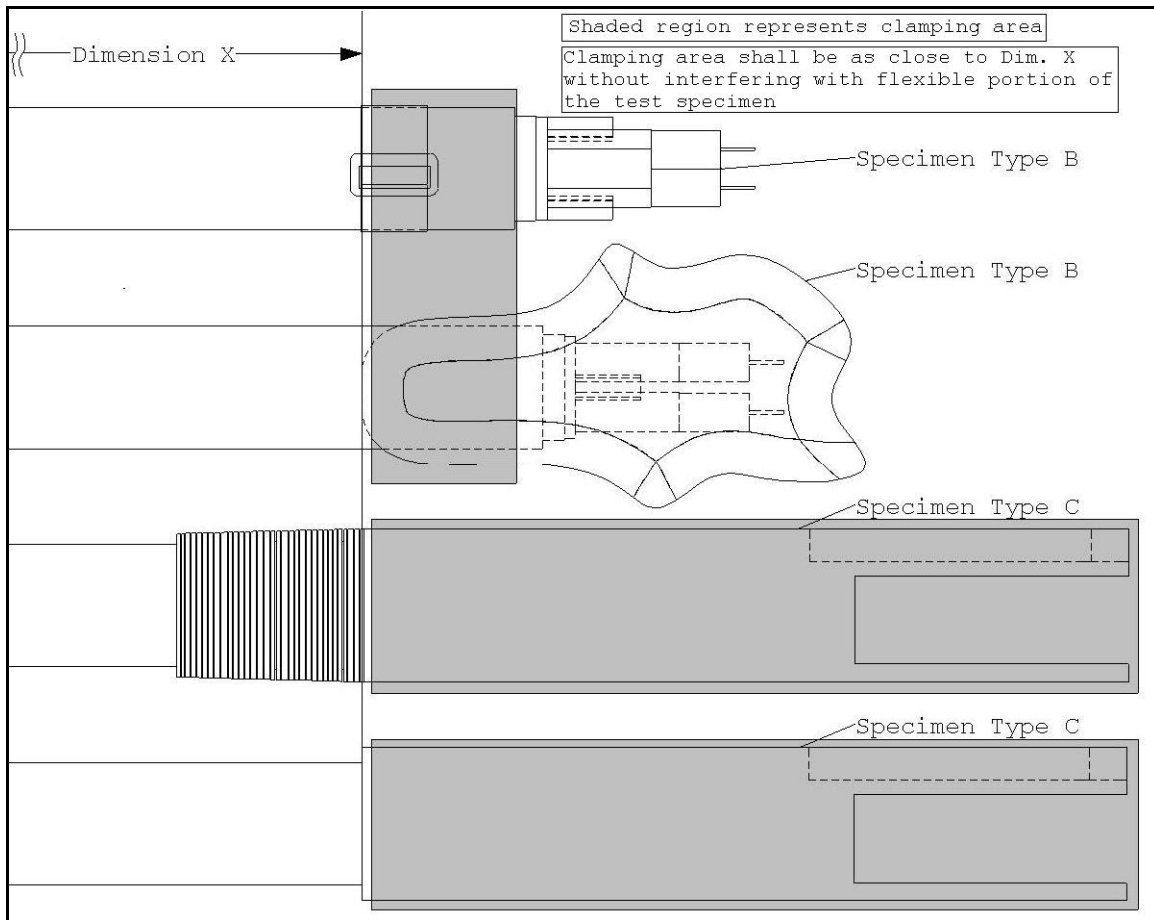


FIGURE 5-5 CLAMPING POSITION

## 5.2 Calibration

All monitoring and test apparatus shall be calibrated to national standards to the extent needed.

## 6. Test Procedure

### 6.1 Pretest

- a) Environment shall be 24 degrees Celsius +/- 8 degrees Celsius.
- b) The specimen is placed in the flex tester.
- c) Weight is added progressively until the conditions in Figure 5-4 are achieved.
- d) It is confirmed that the flex tester will not start without continuity; as well it will stop if the specimen exhibits a discontinuity. However, Type C cable assemblies that are active cables and/or cables containing DC blocking capacitors may be tested per the alternate method described in 6.2.2.

### 6.2 Test & Measurement

#### 6.2.1 Test Method for All Specimen Types

The apparatus travels alternately from a position 90 degrees minimum from the vertical on one side to a position 90 degrees minimum from vertical on the other side, at a frequency of 13 +/- 1 cycles per minute. One cycle is a traverse of the mechanically driven arm 180 degrees clockwise plus 180 degrees counterclockwise.

#### 6.2.2 Measurement Method for Active Type C

Active Type C specimens are active cable assemblies and/or cable assemblies containing DC blocking capacitors, and continuous monitoring for continuity of these cable assembly types is difficult.

The SI performance data (s4p data, Insertion Loss, Return Loss, and/or Eye & Jitter measurements, depending on the cable's particular performance criteria) shall be measured prior to flexing the cable. Then, the cable shall be flexed as described in 6.2.1 for the specified number of cycles without continuously monitoring continuity.

If specified by the customer, additional SI performance measurements may be recorded at periodic intervals during the total flex cycles in order to narrow the window of discovering any failure conditions.

#### 6.2.3 Measurement Method for All Other Types

The specimen is continuously monitored for continuity during the test method in 6.2.1.

### 6.3 Post Test

- a) Upon the completion of the customer requirement of total flex cycles, continuity is confirmed. Additional electrical characteristics may be measured based on specific applications.
- b) The specimen shall be visually inspected for damage to the cable and connector housing including strain relief. Damage includes signs of deterioration to the jacket, ultimately impairing its effectiveness.
- c) Active Type C cables tested using the method in 6.2.2 shall have the SI performance data measured again and compared to the original data collected to detect any change in performance caused by the flexing of the cable.

## 7. Test Results & Documentation

Documentation may contain the following details, including any exceptions.

- Test procedure, condition and method, as applicable
- Name of operator and date of test
- Scope of test
- Specimen used
- Test conditions and environments
- Test equipment used and calibration due date
- Specimen description including fixturing
- Dimension X in Figure 5-1 and Table 1.
- Mandrel diameter
- Weight
- Test procedure
- Cycling rate, if other than specified herein
- Electrical continuity checks
- Values and observations
- Total cycles