# Engineering Test Report

## Industrial Ethernet Torsion Test

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## 1. Overview:

Continuous movement applications that force a cable to flex repeatedly will subject the cable to various types of stress that can degrade performance and cause failure in the field. The most commonly recognized type of flex stress is the act of repeatedly bending a cable back and forth. This back and forth flexing is detailed under separate cover in the *Quabbin, Rolling Bend Flex test report*. However, a rolling bend isn't the only type of flex stress. A second lesser known stress called torsional stress can also be at work in a continuous movement application. The focus of this report is torsional stress and the impact on the Quabbin Industrial Ethernet products.

As previously explained in the *Quabbin, Rolling Bend Flex test report*, the testing has been designed to simulate the movement of a robotic arm. If we can use an analogy, the rolling bend flex cycle represents the bending and reaching of the robotic arm as it emulates a human arm bending at the elbow and possibly straightening to extend and grasp something. The scenario covers two of the three types of flex stress yet still leaves us to account for the third, torsional stress. Using the same analogy as above, we would see torsional (or rotational) stress come into play as wrist rotation. Just as a human arm includes a wrist capable of rotation, a robotic arm also needs to accommodate wrist like motion for positioning tools and/or to grasp objects. As the "wrist" rotates through the full field of motion, it can twist a control cable up to 360 degrees, similar to the visual picture of wringing out a wet towel. Obviously these torsional forces must be considered during cable development in order to have a design robust enough to survive the intended purpose. Hence we arrive at the Quabbin Industrial Ethernet Torsion Test.

### Summary

Torsion tests were performed on Quabbin 5772 2 pair industrial Ethernet cable and Quabbin 5077 4 pair double shielded cable. The test was a 360 degree twist total per cycle (180° in each direction) over 34" of cable. Three Million cycles on each cable have been completed with no apparent degradation to the cable.

## 2. Equipment Required:

Quabbin torsion tester

2 meter assembly of Quabbin 5772 2 pair cable

- (24 AWG, Unshielded, Flame Retardant TPE Jacket)

2 meter assembly of Quabbin 5077 2 pair cable

- (26 AWG, Shield/Braid, Zero Halogen Flame Retardant Jacket)

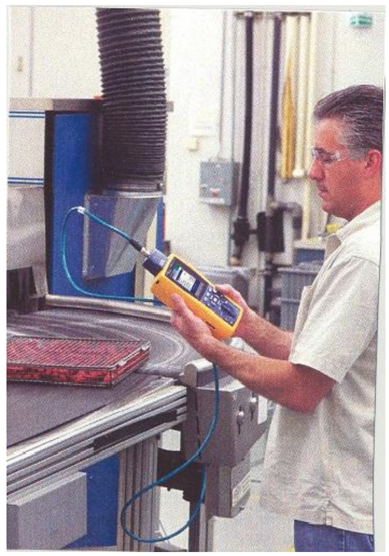
1 lb. weight

Fluke® DTX 1800 Cable Analyzer™ or equivalent with patch cord adapters

# 3. Procedure and Results

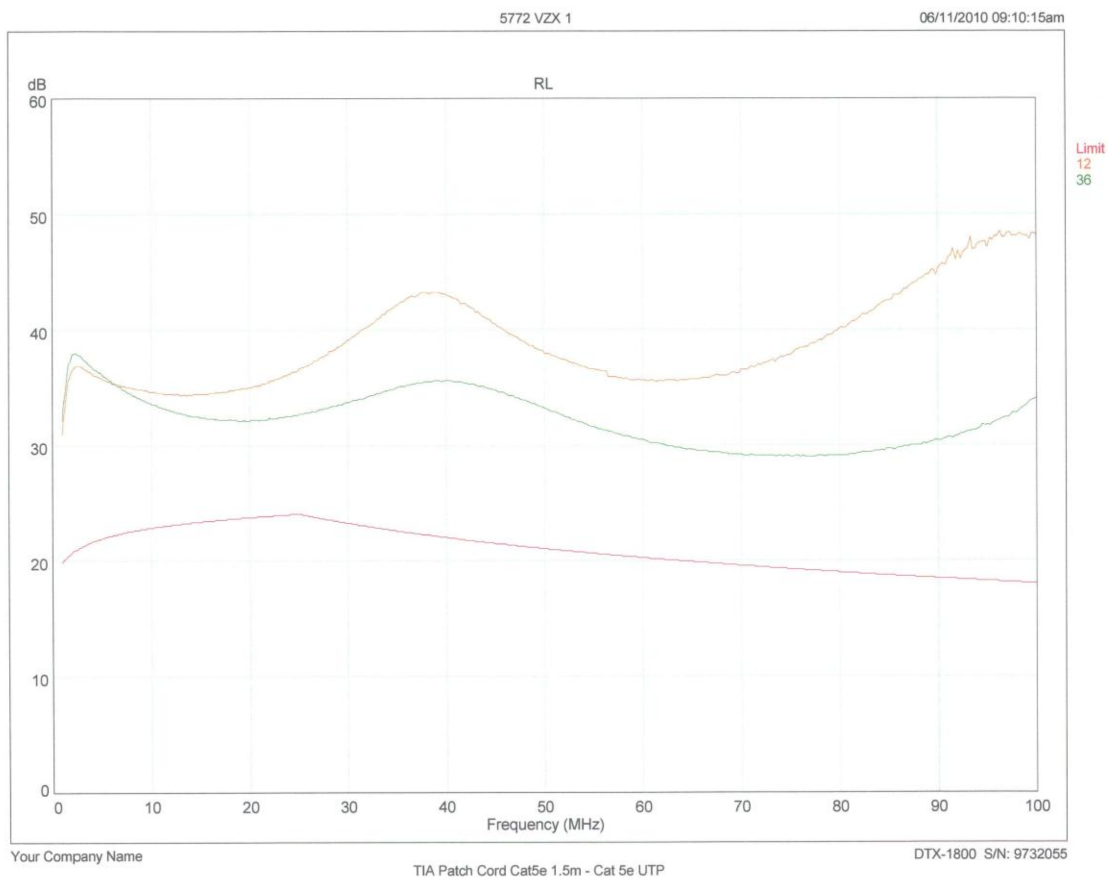
## 3.1. 5772

Assembly was made using Cat 5e modular plugs using industry standard practices. Cord was tested using the handheld tester.

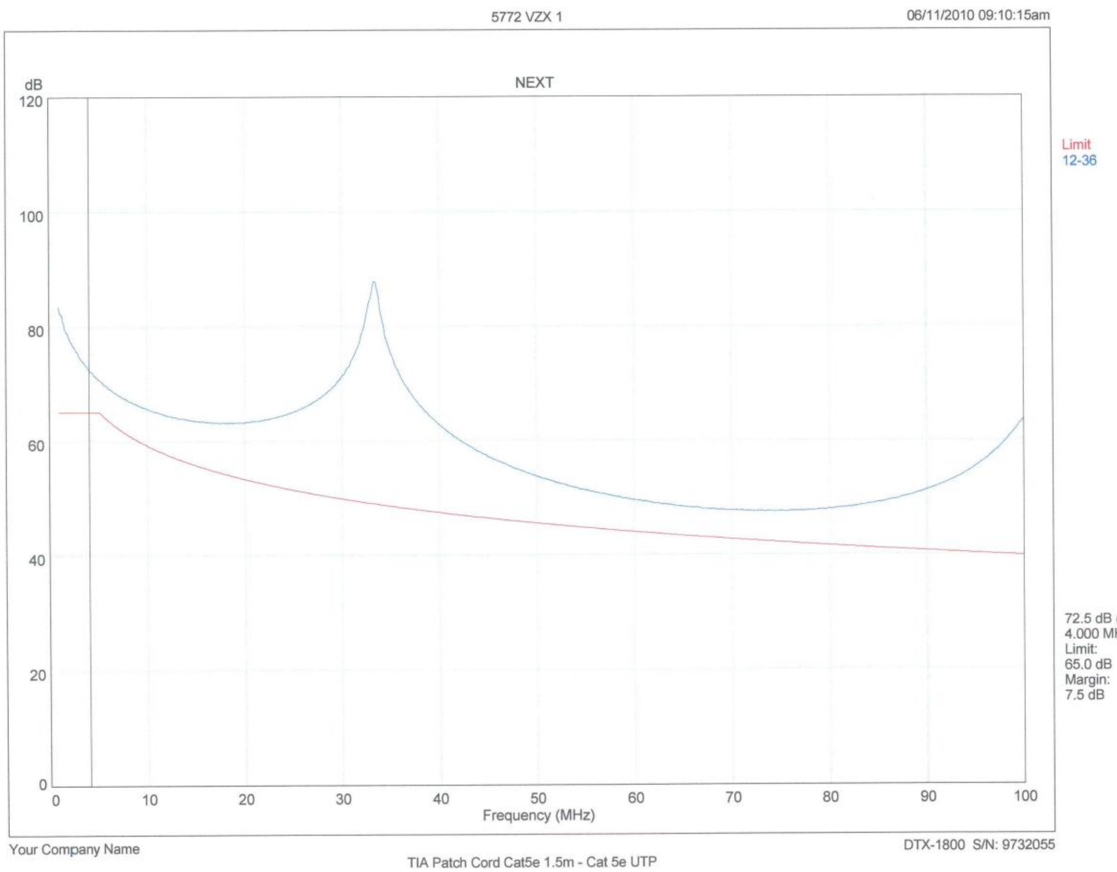


Return loss and NEXT plots are shown below. Assembly passed on pins 12 and 36.

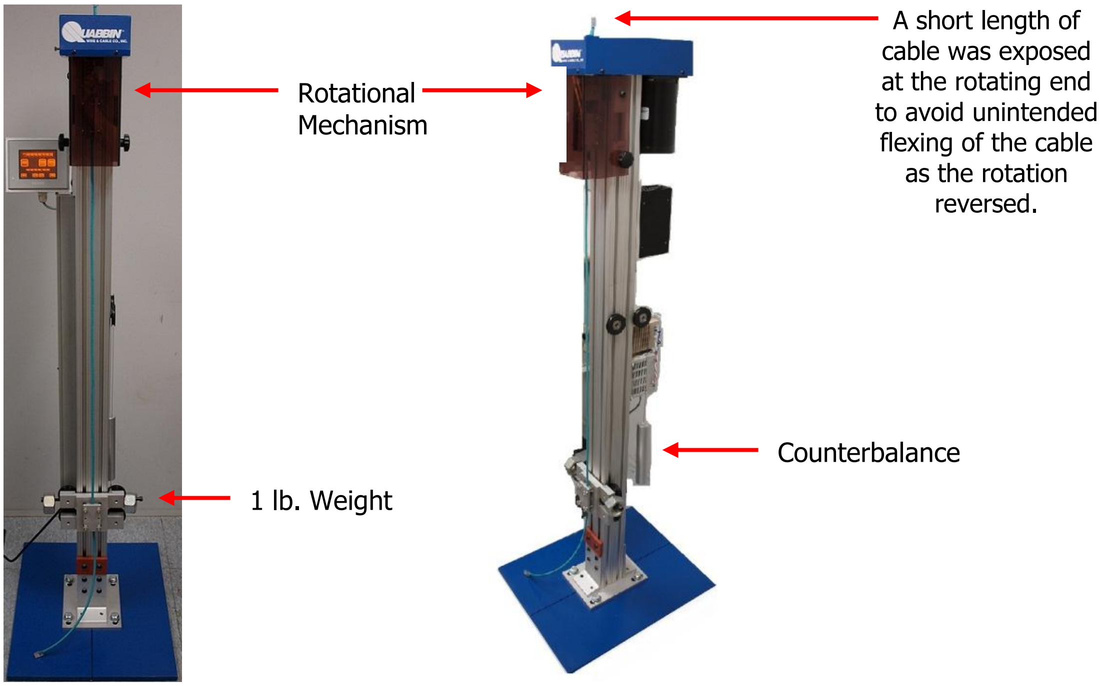
# 5772 Return Loss - Prior to Testing



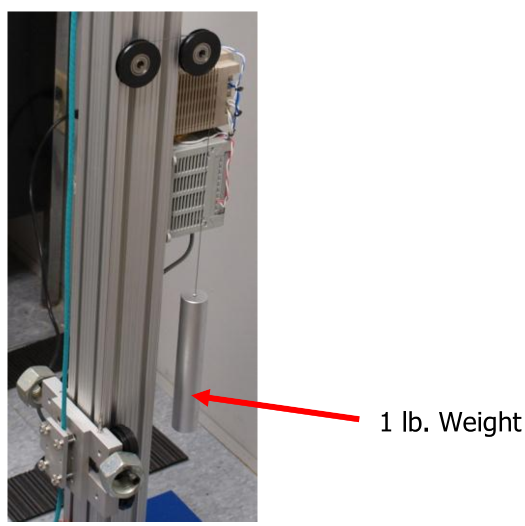
# 5772 NEXT - Prior To Testing



Next the cord was clamped in the test fixture using care not to crush the cable.

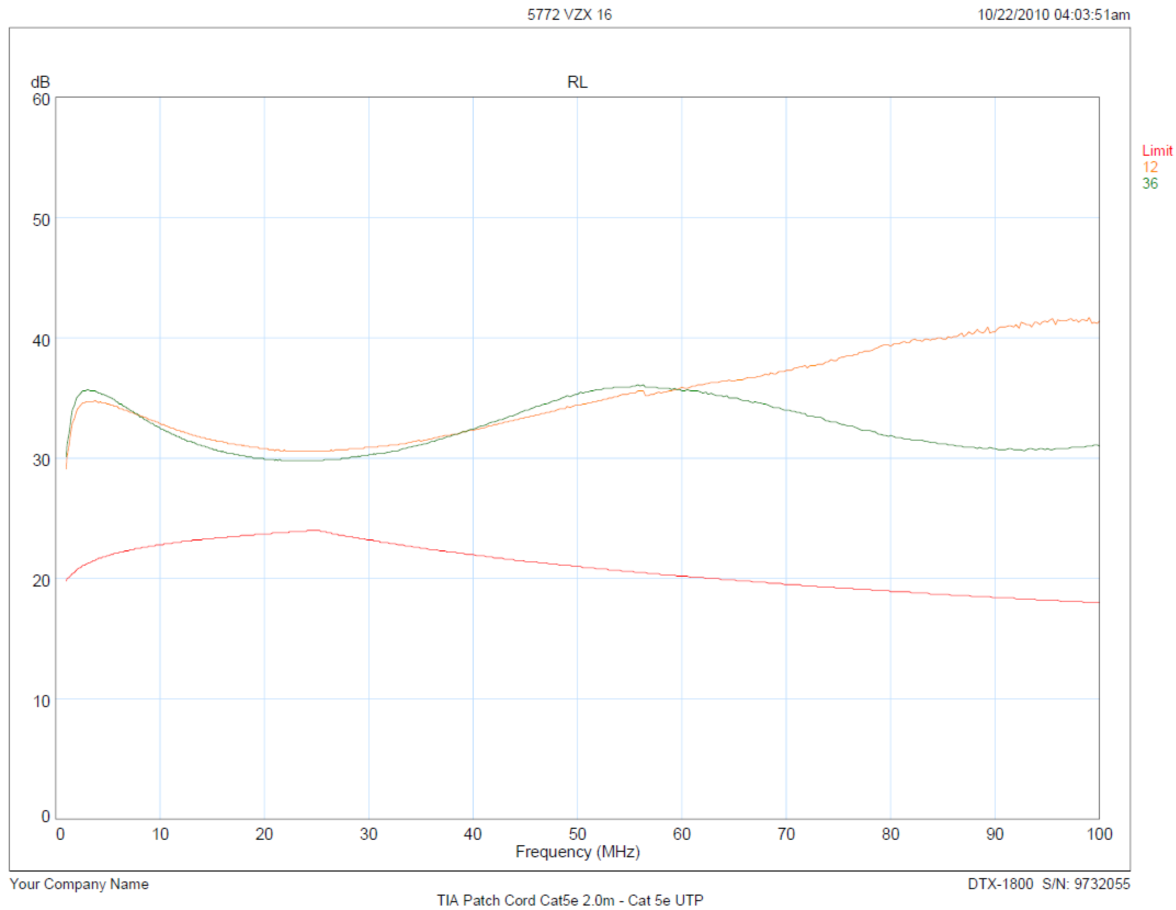



Weight was added to the lower carriage to keep the cable taut. The lower carriage can move as the cable is twisted and becomes shorted to avoid breaking the cable. The test was set to a 360 degree twist total per cycle (180 in each direction).

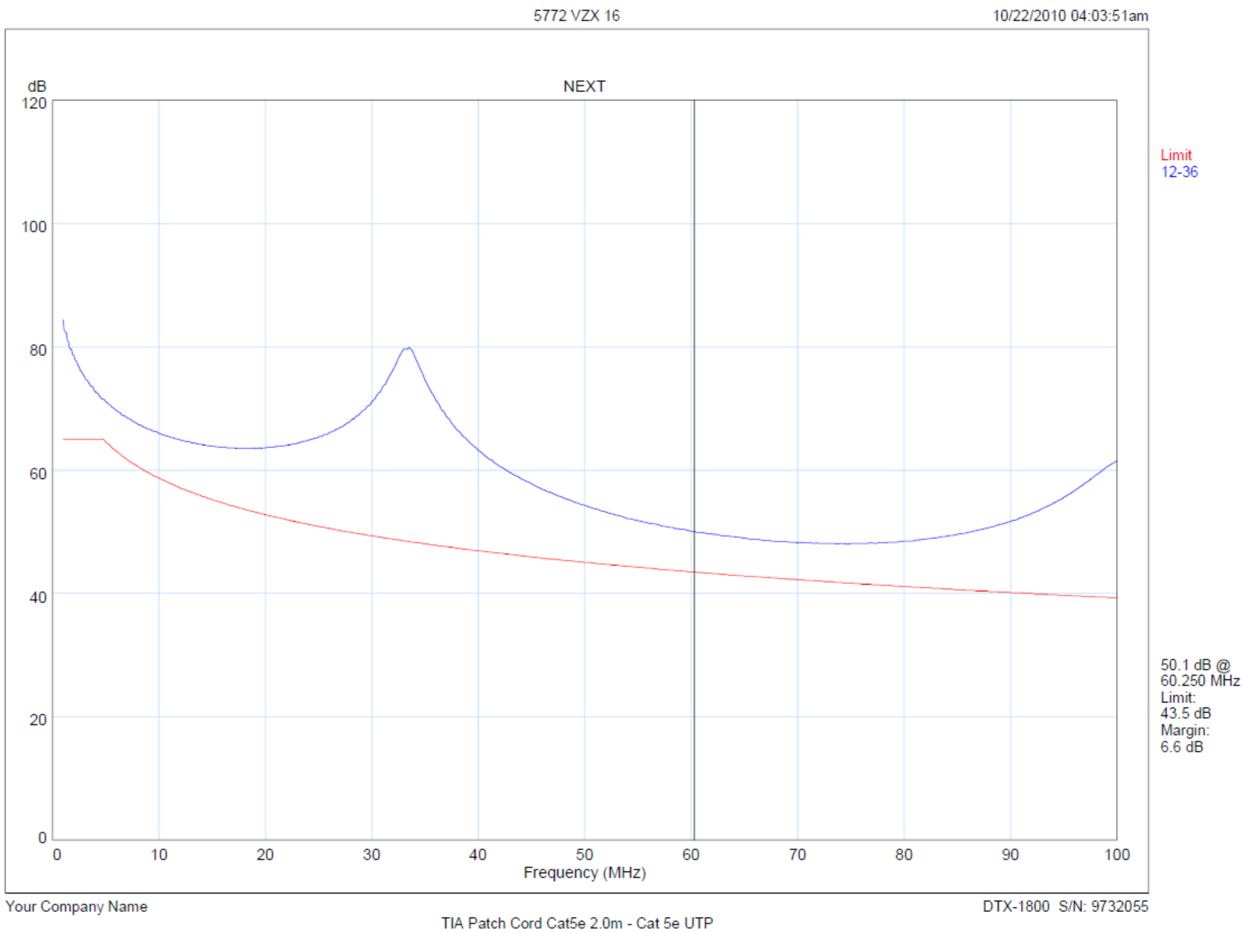



After 3 million cycles the patch cord assembly test was redone. Results are shown below.

# 5772 Return Loss – After Testing



# 5772 NEXT – After Testing



### 3.1.1. Conclusions

#### 3.1.1.1. Electrical performance

The 5772 cable assembly passed Cat 5e requirements after 3 million cycles. There was some change in the return loss performance however there was no reduction in margin. There was no significant change in NEXT performance.

#### 3.1.1.2. Physical Inspection

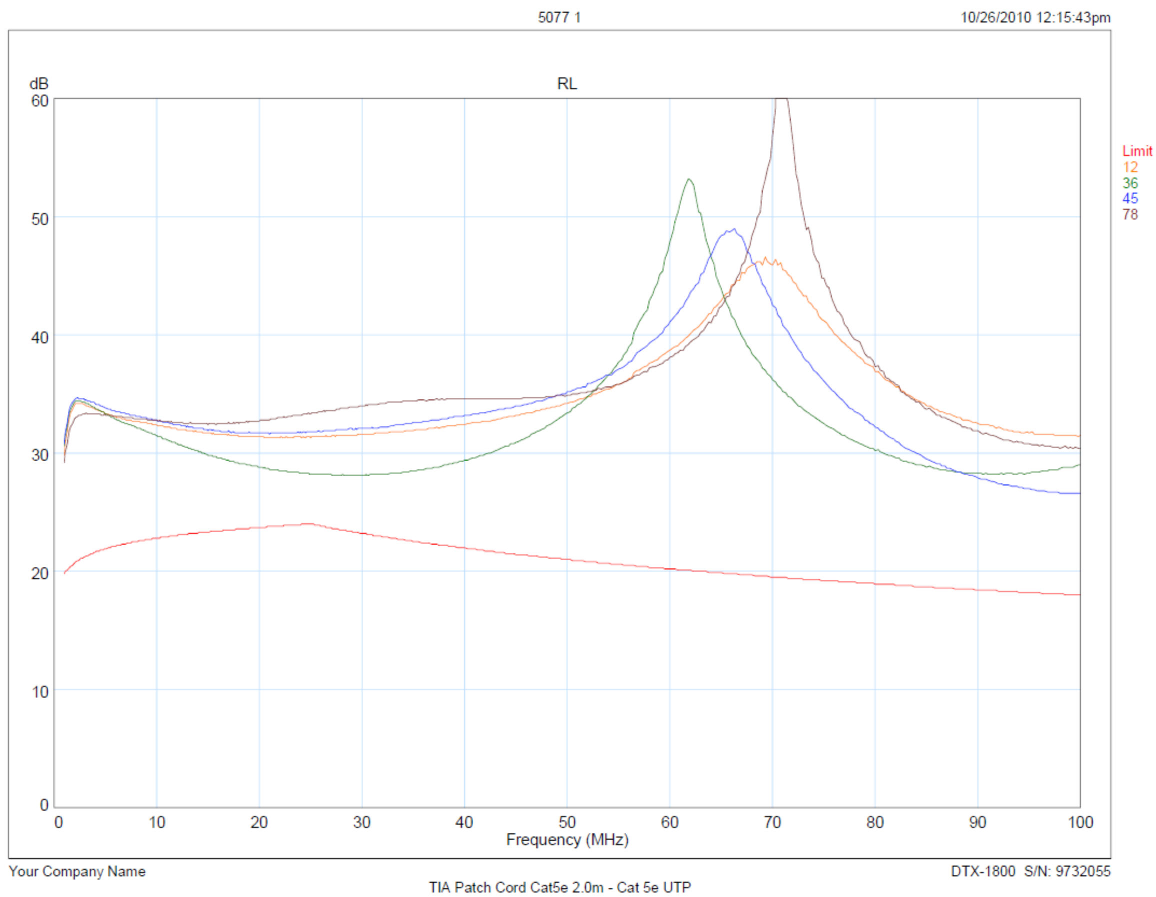
Dissecting the cable revealed no physical damage to the polyester tape or insulation. The jacket did not appear to harden or degrade in any way. Pair lays were consistent and the fillers remained in the proper location.

## 3.2. 5077 Testing

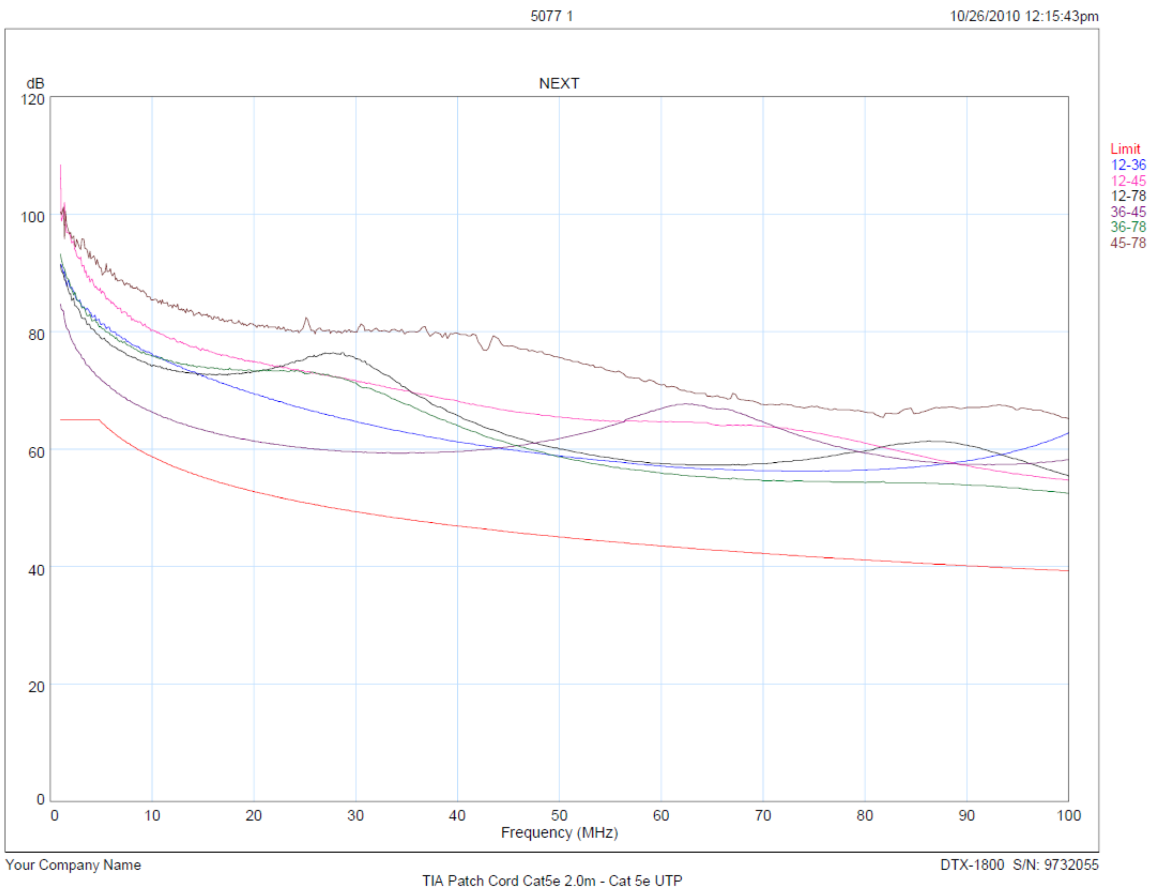
### 3.2.1. Testing

Assembly was made using Cat 5e modular plugs using industry standard practices. Cord was tested using the handheld tester. Results prior to flexing are below. After testing the cable assembly was attached to the tester using the same method as the 5772 illustrated above. After 3 million torsion cycles the patch test was repeated. The results are below.

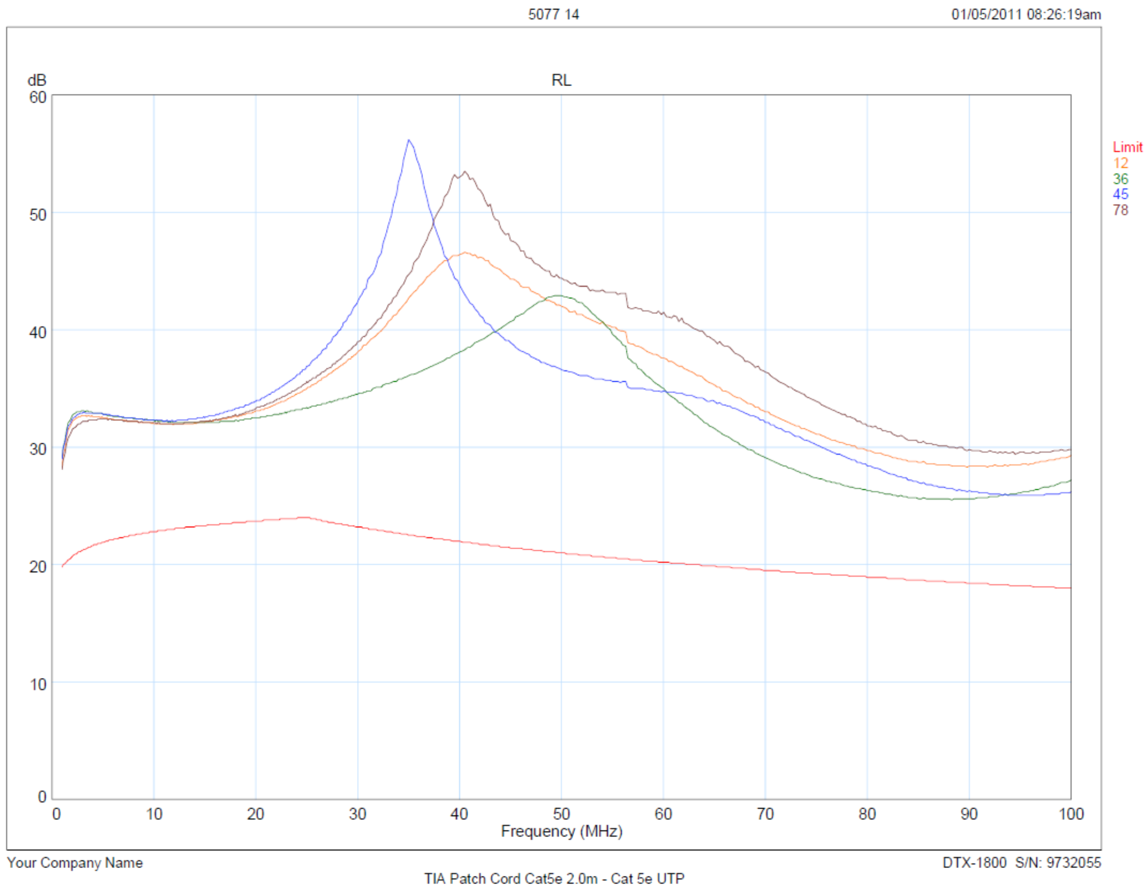
# 5077 Return Loss - Prior to Testing



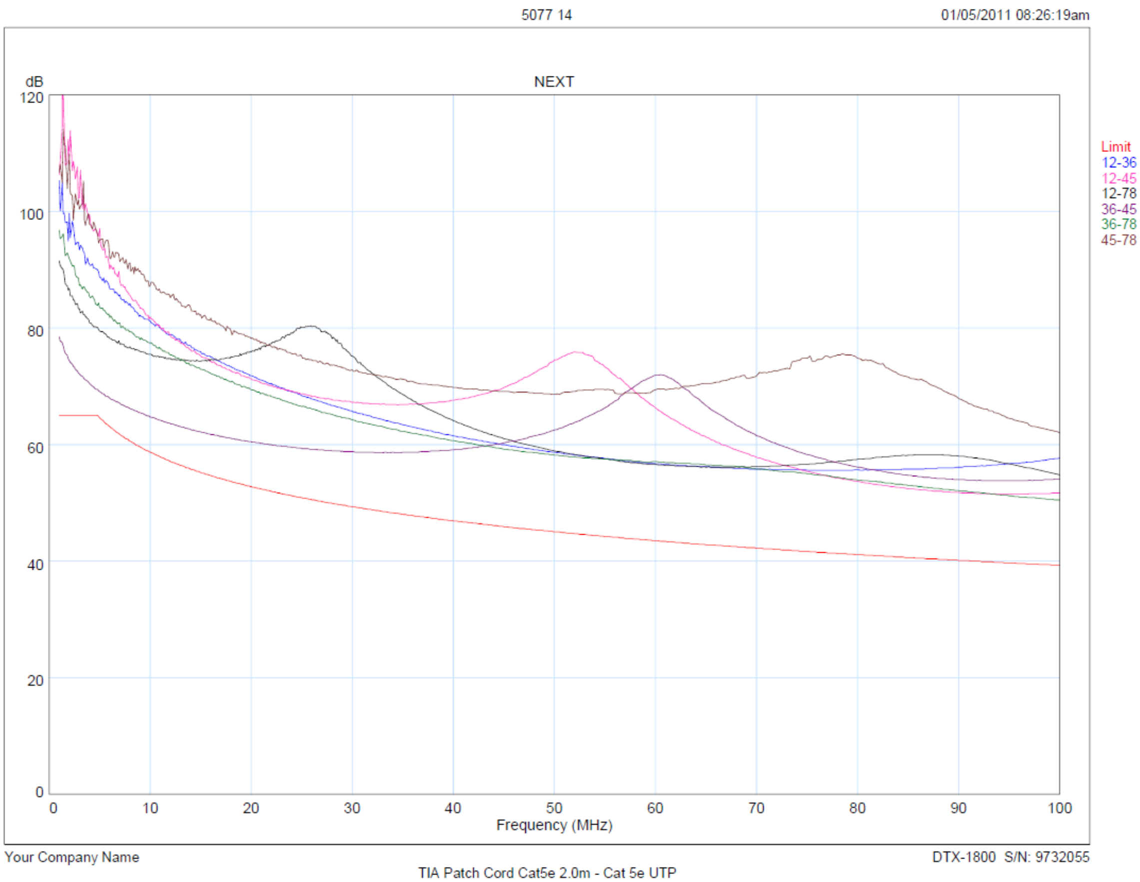
# 5077 NEXT - Prior To Testing



# 5077 Return Loss – After Testing



# 5077 NEXT – After Testing




## 3.2.2. Conclusions

### 3.2.2.1. Electrical performance

The return loss margin appears to improve after 3 million cycles however this is probably normal variation. NEXT performance is unchanged after 3 million torsion cycles

### 3.2.2.2. Physical inspection

Dissecting the cable revealed no physical damage to the shields or insulation. The jacket did not appear to harden or degrade in any way. Pair lays were consistent.

### 3.2.2.3. Application

Both the 5772 and 5077 cable constructions are suitable for continuous flex applications that encompass torsional stress.