



CONNECTING YOUR WORLD: MAKING A LASTING MECHANICAL ELECTRICAL CONNECTION

BURNDY OFFERS A COMPLETE SYSTEM: THE CONNECTORS, TOOLS, AND THE RECOMMENDED TORQUE TO ENSURE A RELIABLE MECHANICAL CONNECTION IS MADE EVERY TIME.

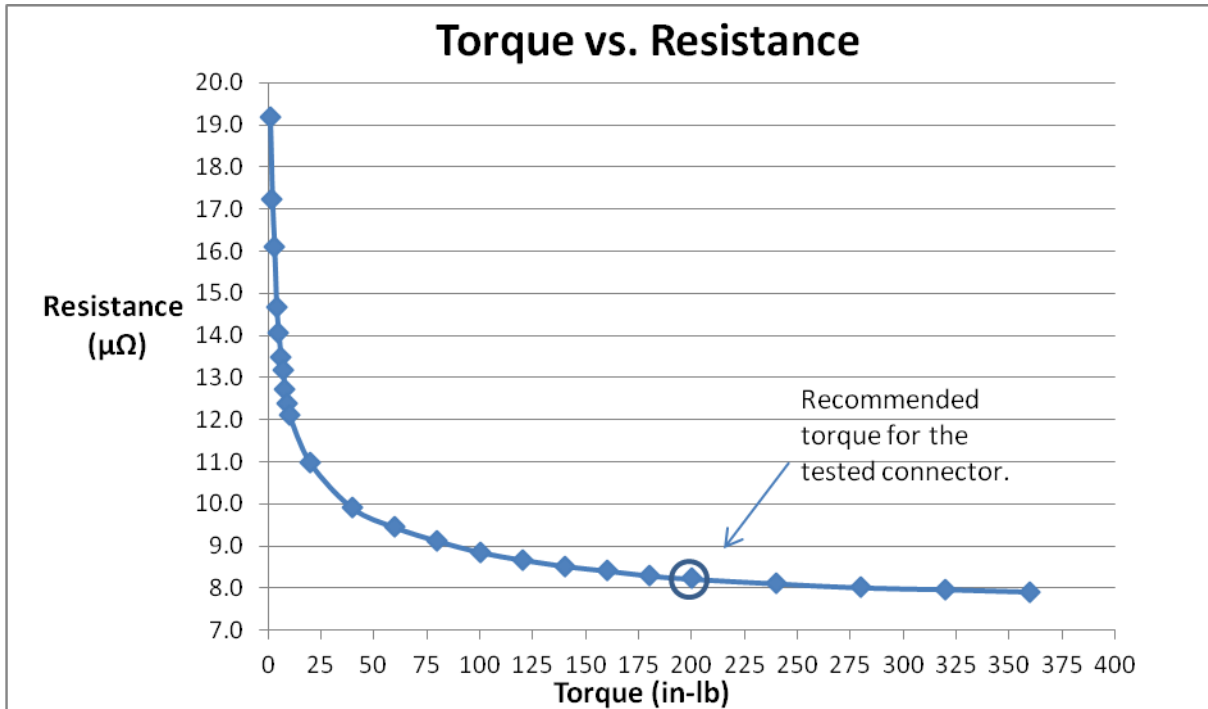
The use of mechanical connections for electrical service to residential and commercial customers is common practice. However, the installation of mechanical wire connectors requires the application of the manufacturer's recommended torque. The use of a torque wrench, torque screwdriver, or device for measuring applied torque is the only way to ensure that the manufacturer's torque is achieved.

Each year there are failures in electrical connections due to improper connections from the misapplied torque. This is not due to poor workmanship; it is rather a lack of understanding of the physical connection between the conductor and the connector. Without using the proper tools, it has been shown that even experienced electricians cannot consistently tighten the connector to the recommended torque value. For electrical connections the old adage hand tight plus a quarter turn is not sufficient to produce a proper mechanical connection. The mechanical interface between the connector and the conductor are an integral part of a safe and reliable electrical connection. The mechanical connection applies a force on the conductor which creates a greater area of contact. The manufacturer of mechanical connectors designs and tests the connectors to establish the correct amount of pressure (torque) to apply to meet the requirements of mechanical reliability and current flow.

A properly installed connector with the recommended torque value creates a low resistance electrical path between the conductor and the connector. A properly torqued

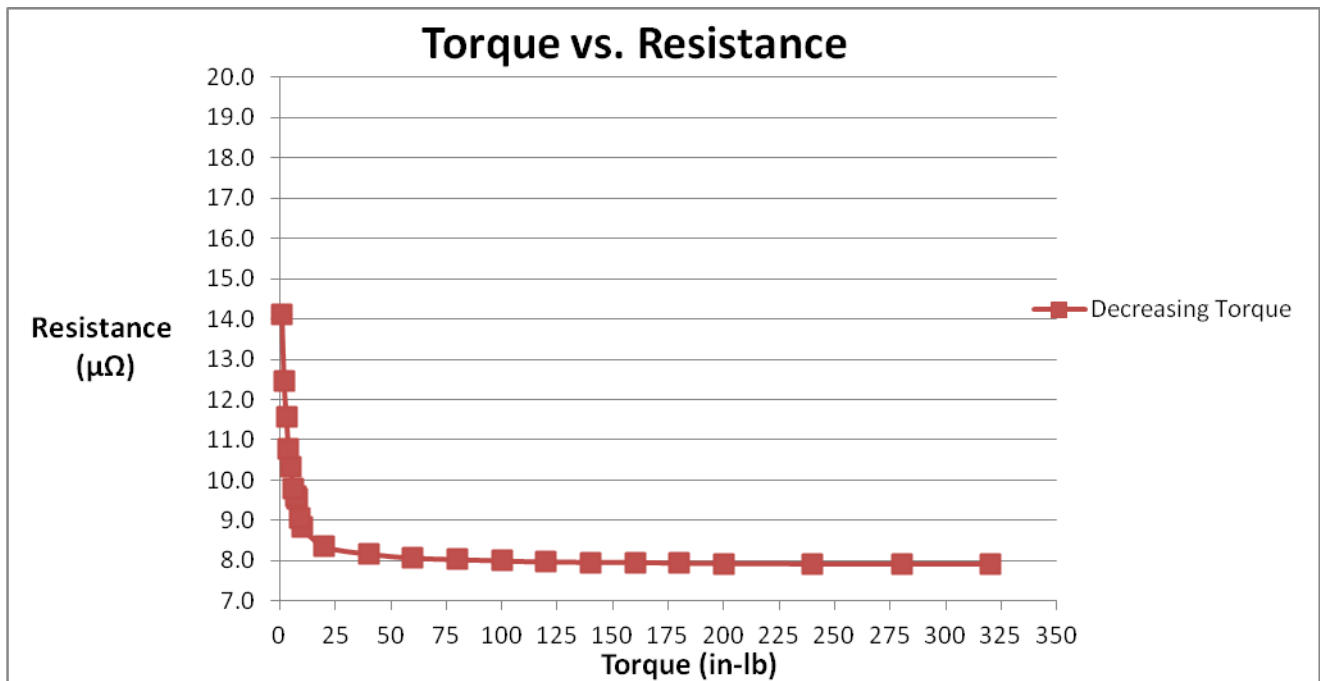
connection will reduce the amount of heat generated during use. When recommended torque is not used the resistance and generated heat is increased, which will lead to a hot running connection that can fail.

In the following graph the resistance to current flow is reduced as the torque is applied to the connection. The resistance between the conductor and the connector falls as the contact area is increased due to the increasing force applied to the clamping device (set screw, pressure bar, and nut). The contact area is increased as the conductor deforms due to the applied pressure.



As shown in the above graph, the resistance continuously decreases as the connection is further tightened. For the tested connector conductor combination, the initial tightening of the connector indicates a large reduction in the measured resistance value. At a torque of about 25 in-lb, the rate of resistance begins to slow. The resistance continues to decrease as the recommended torque is reached. For this connector-conductor combination the recommended torque is 200 in-lb based on the design requirements of the connector. As the clamping force is continued past the recommended torque, the reduction on the resistance between the conductor and the connector becomes stagnant. Achieving the recommended manufacturer's torque is the desired outcome of the installation process. Although the resistance can be decreased additionally by an increase in applied torque, it is

not recommended as damage to the conductor and or the connector could occur. The manufacturer's torque rating is used in accordance with applicable safety standards and performance expectations. Each connector design is tested to the applicable safety standard(s) in which they are covered by and represent the expected forces that could be seen when in use. When a connector is torqued beyond the recommended value there is the potential to damage the connector, conductor, or both, which can cause a failed connection.



As the electrical connections cycle, the thermodynamic properties of the conductor and connector materials will expand and contract at different rates. This dynamic action is common in all electrical connections and will cause the relationship between the conductor and the connector to change. As the connection is affected by the thermodynamic forces, the connectors initial torque value may not be maintained. Dissimilar materials are affected by the heat generated from the conduction of electricity in different ways, which will cause the torque value to change from the initial setting. The above graph shows the effect on the resistance between the connector and the conductor as the torque is removed. This is an indication that under normal electrical load a properly torqued connection will maintain a low resistance value. This is due to the initial force applied to the conductor and connector that increases the surface contact area. Once a connection is made using a properly calibrated torque wrench or screw driver the connection will remain affective and provide low contact resistance.

The design of the connector takes into account the dynamic forces placed on the electrical connection. It should not be inferred from the two graphs that a connection can be tightened to the recommended torque than backed off and still be an effective electrical connection. The torque for the connector provides the mechanical strength to hold the conductor in place while providing a low contact resistance between the conductor and connector.

The use of torque tables from other sources for electrical connections should not be used in place of the manufactures torque; they are only used when the value is not supplied or not readily available. Once a connection is made using the proper tools and torque value the connection should not be retightened. For inspection it is recommended that a click type torque wrench be used to verify the application of the proper torque to prevent an over tightening of the connection. When an electrical connection has more than one clamping mechanism, the torque should be applied evenly among the clamping components. This will prevent an uneven clamping force along the electrical conductor.