# REVISION LOG

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| VERSION | EFFECTIVE DATE | DESCRIPTION OF REVISION(S) |
|---|---|---|
| 001 | 2018.08 | Module creation and release. |
| 001.1 | 2023.04 | Inclusion of Measurement Standards for clarification, page iv. Minor appearance and format updates. |
| 002 | 2024.07 | Regulatory update for EASA 2023-989 compliance. |
| 003 | 2025.10 | Rewrite of Submodule 11, with other corrections and clarifications. |


Figure 11-25. Hand operated hydraulic crimping tool.

| Wire Size | Test Current | Voltage Drop (Max) Millivolts | (Min.) Pull-Apart Load (lbs.) |
|---|---|---|---|
| 26 | 3 | 8 | 7 |
| 24 | 4.5 | 8 | 10 |
| 22 | 9 | 7 | 15 |
| 20 | 11 | 6 | 19 |
| 18 | 16 | 5 | 38 |
| 16 | 22 | 7 | 50 |
| 14 | 32 | 6 | 70 |
| 12 | 41 | 5 | 110 |
| 10 | 55 | 5 | 150 |
| 8 | 73 | 5 | 225 |
| 6 | 101 | 5 | 300 |
| 4 | 135 | 5 | 400 |

Figure 11-26. Crimped joint test table.

normal resistance of the wire. The correct combination of wire, terminal end and proper crimping with the depth mark in the correct location should all be evident.

Both the conductor and insulator must be correctly inserted in the terminal end fitting. Only conductor material should be in the crimp barrel. Neither the conductor or the insulator should appear damaged in any way with insulator material gripped by the insulation crimp so the conductor is not visible.

Actual testing of crimps is not usually performed on an installation made with the proper crimping tool. Crimping tools should be inspected annually and/or if excessive play is detected. Crimps made with the tool can be checked using go/no-go gauges supplied by the tool manufacturer. Tensile strength and voltage carrying capability of crimps made with a specific crimping tool can be tested in the shop. Example voltage and tensile strength values for testing of crimped connections on a range of wire sizes are given in **Figure 11-26**.

## CONNECTORS

Connectors (plugs and receptacles) facilitate maintenance when frequent disconnection is required. Electrical connectors are designed in many sizes and shapes to facilitate the installation and maintenance of electric circuits and equipment in all types of flying vehicles.

For example, it may be necessary to replace a damaged section of electric harness. If the section of harness is connected to other sections by means of connectors, it is a simple matter to unplug the damaged section at both ends and remove it.

A completely new section may then be quickly installed. If the damaged section was instead connected to other sections by terminal strips, it would be necessary to disconnect each wire from the terminal studs separately; this operation would consume considerable time, especially if the harness contained many wires.

Connectors are also used to connect electric and electronic assemblies, or line replaceable units (LRUs), such as voltage regulators, flight computers, inverters, and radio equipment. When it is necessary to replace such an assembly, the connector makes it possible to disconnect the unit quickly and to reconnect the new unit with no danger of connecting any of the leads incorrectly. [**Figure 11-27**]

Figure 11-27. Electrical connectors.

The proper choice and application of connectors is a significant part of the aircraft wiring system. Connectors must be kept to a minimum, selected, and installed to provide the maximum degree of safety and reliability to the aircraft. For the installation of any particular connector assembly, the specification of the manufacturer or the appropriate governing agency must be followed.

## TYPES OF CONNECTORS

There is a multitude of types of connectors. The connector types that use crimped contacts are generally used on aircraft. Some common types are the round cannon type, the rectangular, and the module blocks. Environmentally resistant connectors should be used in applications subject to fluids, vibration, heat, mechanical shock, and/or corrosive elements.

When HIRF/lightning protection is required, special attention should be given to the terminations of individual or overall shields. The number and complexity of wiring systems have resulted in an increased use of electrical connectors. Environment resistant connectors are used in applications where they are probably subjected to fluids, vibration, heat, mechanical shock, corrosive elements, etc. Firewall class connectors incorporating these same features should, in addition, be able to prevent the penetration of the fire through the aircraft firewall connector opening and continue to function without failure for a specified period of time when exposed to fire. Hermetic connectors provide a pressure seal

for maintaining pressurized areas. When EMI/RFI protection is required, special attention should be given to the termination of individual and overall shields. Backshell adapters designed for shield termination, connectors with conductive finishes, and EMI grounding fingers are available for this purpose. [**Figure 11-28**]

Rectangular connectors are typically used in applications where a very large number of circuits are accommodated in a single mated pair . They are available with a great variety of contacts, which can include a mix of standard, coaxial, and large power types. Coupling is accomplished by various means. Smaller types are secured with screws which hold their flanges together.[**Figure 11-29**]

Larger ones have integral guide pins that ensure correct alignment, or jack screws that both align and lock the connectors. Rack and panel connectors use integral or rack mounted pins for alignment and box mounting hardware for couplings.

Module blocks are types of junctions that accept crimped contacts similar to those on connectors. Some use internal busing to provide a variety of circuit arrangements. They are useful where a number of wires are connected for power or signal distribution. When used as grounding modules, they save and reduce hardware installation on the aircraft.

Standardized modules are available with wire end grommet seals for environmental applications and are track mounted. Function module blocks are used to provide an easily wired package for environment resistant mounting of small resistors, diodes, filters, and suppression networks. Various types of MS standard connectors are shown in **Figure 11-30**.

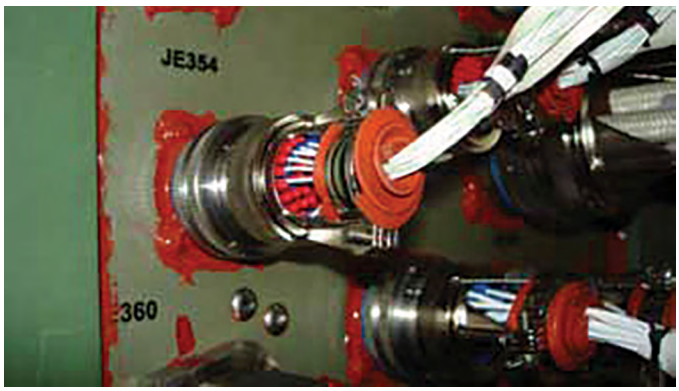

Figure 11-28. Backshells with strain relief.


Figure 11-29. Rectangular connectors.

### INLINE JUNCTIONS

Inline terminal junctions are used in lieu of a connector when only a few wires are terminated and when the ability to disconnect the wires is desired. The inline terminal junction is environment resistant. The terminal junction splice is small and may be tied to the surface of a wire bundle when approved by the OEM.

## CURRENT AND VOLTAGE RATING

Selected connectors must be rated for continuous operation under the maximum combination of ambient temperature and circuit current load. Hermetic connectors and connectors used in circuit applications involving high inrush currents should be derated. It is good engineering practice to conduct preliminary testing in any situation where the connector is to operate with most or all of its contacts at maximum rated current load.

When wiring is operating with a high conductor temperature near its rated temperature, connector contact sizes should be suitably rated for the circuit load. This may require an increase in wire size. Voltage derating is required when connectors are used at high altitude in non pressurized areas.

## COUPLING AND INSTALLATION

### CONNECTOR WIRING

Pins and sockets are identified by numbers or letters. It's usual in many types of connectors to signify a wiring sequence by a spiraling guideline embossed on the face of the inserts. [**Figure 11-31**]

To accommodate future wiring additions, spare contacts are normally provided. Locating the unwired contacts along the outer part of the connector facilitates future access. A good practice is to provide two spares on connectors with 25 or fewer contacts; 4 spares on connectors with 26 to 100 contacts; and 6 spares on connectors with more than 100 contacts.


Figure 11-30. Various types of MS standard connectors.

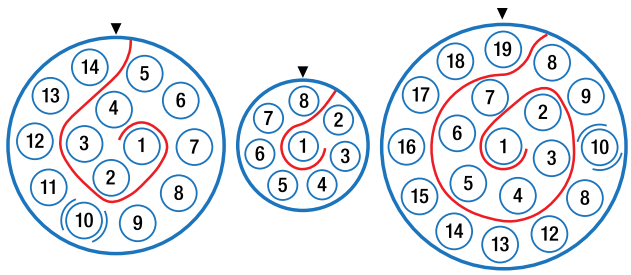

Figure 11-31. Inline terminal junction pin patterns.

Spare contacts are not normally provided on receptacles of components that are unlikely to have added wiring. Connectors must have all available contact cavities filled with wired or unwired contacts. Unwired contacts should be provided with a plastic grommet sealing plug.

### WIRE INSTALLATION INTO THE CONNECTOR

Wires that perform the same function in redundant systems must be routed through separate connectors. On systems critical to flight safety, system operation wiring should be routed through separate connectors from the wiring used for system failure warning. It is also good practice to route a system's indication wiring in separate connectors from its failure warning circuits to the extent practicable. These steps can reduce an aircraft's susceptibility to incidents that might result from connector failures.

### ADJACENT LOCATIONS

Mating of adjacent connectors should not be possible. In order to ensure this, adjacent connector pairs must be different in shell size, coupling means, insert arrangement, or keying arrangement. When such means are impractical, wires should be routed and clamped so that incorrectly mated pairs cannot reach each other. Reliance on markings or color stripes is not recommended as they are likely to deteriorate with age. [**Figure 11-32**]

### SEALING

Connectors must be of a type that excludes moisture entry through the use of peripheral and interfacial seal that are compressed when the connector is mated. Moisture entry through the rear of the connector must be avoided by correctly matching the wire's outside diameter with the connector's rear grommet sealing range. It is recommended that no more than one wire be terminated in any crimp style contact. The use of heat shrinkable tubing to build up the wire diameter, or the application of potting to the wire entry area as additional means of providing a rear compatibility with the rear grommet is recommended. These extra means have inherent penalties and should be considered only where other means cannot be used. Unwired spare contacts should have a correctly sized plastic plug installed.

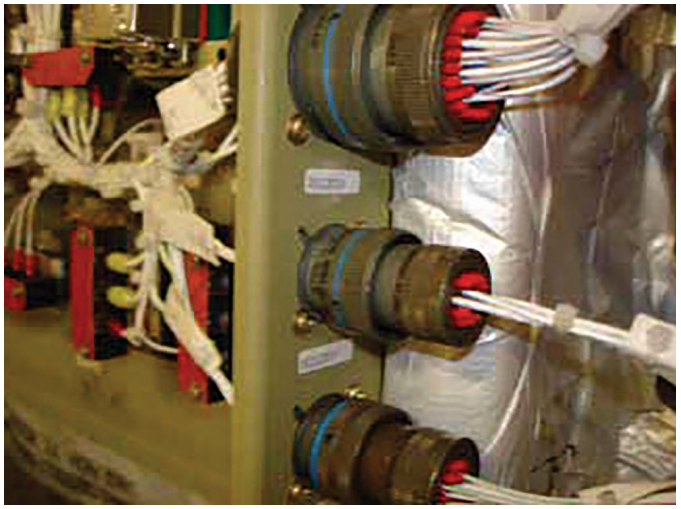

Figure 11-32. Connector arrangement to avoid wrong connection.

### DRAINAGE

Connectors must be installed in a manner that ensures moisture and fluids drain out of and not into the connector when unmated. Wiring must be routed so that moisture accumulated on the bundle drains away from connectors. When connectors must be mounted in a vertical position, as through a shelf or floor, the connectors must be potted or environmentally sealed. In this situation, it is better to have the receptacle faced downward so that it is less susceptible to collecting moisture when unmated.

### WIRE SUPPORT

A rear accessory back shell must be used on connectors that are not enclosed. Connectors with very small size wiring, or subject to frequent maintenance activity, or located in high vibration areas must be provided with a strain relief type back shell. The wire bundle should be protected from mechanical damage with suitable cushion material where it is secured by the clamp. Connectors that are potted or have molded rear adapters do not normally use a separate strain relief accessory. Strain relief clamps should not impart tension on wires between the clamp and contact. Refer back to **Figure 11-28** as an example.

Sufficient wire length must be provided at connectors to ensure a proper drip loop and that there is no strain on termination after a complete replacement of the connector and its contacts.

## CONNECTOR IDENTIFICATION

AN and MS connectors are identified by an identification number which is typically stamped on the connector wall. **Figure 11-33** is an example of such an AN connector type.

**AN 3106 A 10 4 S A**

This identification code is explained in the following sections.

### STANDARD

Whether the connector is of AN or MS standards.

### TYPE

This describes the general configuration of the connector; as common examples:

3100 – Wall receptacle
3101 – Cable receptacle
3106 – Straight plug
3107 – Quick disconnect plug
3108 – Angle plug

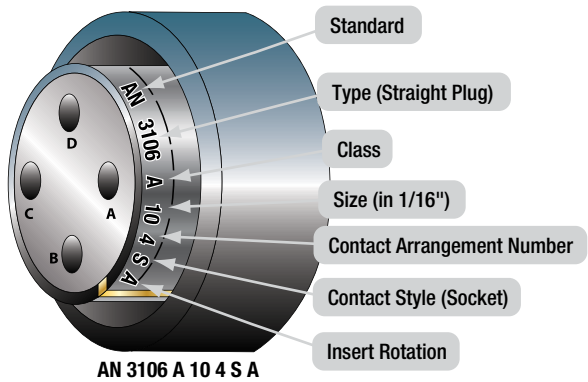


Figure 11-33. AN connector markings.

### CONNECTOR CLASS

The following classes of connectors are most common:

#### CLASS A

Class A is the most common type of connector. They consist of a single piece of material for the rear shell. Class A connectors are considered general purpose connectors supporting a variety of electrical applications.

#### CLASS B

Class B connectors are those with a multi piece rear shell. It features two sections that allow the rear shells to separate. By opening the rear shell, class B connectors allow for access to the soldered electrical contacts.

#### CLASS C

Class C connectors are pressurized connectors. Like class A connectors, they consist of a single rear shell but can be used in applications which require pressurization.

#### CLASS D

Class D connectors are designed with a grommet in the rear shell that protects against the intrusion of moisture. The grommet seals the rear shell so that water, humidity and other forms of moisture can not reach the electrical contacts. Class D connectors are also resistant to mechanical stress such as vibrations. As aircraft produce vibrations naturally, class D connectors are often used.

#### CLASS K

Class K connectors are designed to use in extreme heat. They are essentially fireproof. Even when exposed to flames, electricity will continue to flow through them. Class K connectors are typically used in applications such as engine firewalls where it is essential that electricity remains uninterrupted.

### SHELL SIZE

MS connector shell sizes refer to the outside diameter of the connector in 1/16ths of an inch. For example a #10 connector is 5/8" diameter. This sizing is crucial to ensure that various connectors correctly fit with the connector housing.

### CONTACT ARRANGEMENT

The contact arrangement is identified the number and size of the connectors and there physical arrangement. You must use a chart to identify each arrangement by the code number.

### CONTACT STYLE

The contact style may be either a P or an S to indicate pin or socket (male or female).

### INSERT ROTATION

For applications where similar sized connectors are used, connectors also offer differing rotations to prevent mismatching. This is achieved by varying the keyway's position on the connector face. A and B are standard rotations. In other applications, the keyway can be rotated in various positions or directions.