Understanding and Making Crimp Connections That Last

Crimping 101
What are the Basic Process Methods Used to Connect (Terminate) a Wire to Make an Electrical Connection?

- SOLDER
- SOLDERLESS
- WELDED (Ultrasonic Welding)
- CONDUCTIVE ADHESIVE
Solderless Connections

- Everyday You Use Products and Equipment that Have Electrical Connections Using Some Form of Solderless Connections
What are the Common Solderless Methods?

- Crimp
- IDC
  - Insulation Displacement Connection
    - Mass Termination
    - Discrete Wire
- Compression
- Wire Clamping
- Interference Fit or Force Fit
- Wire Wrap
Insulation Displacement Connection

- **Mass Termination**
  - Flat Cables or Ribbon Cables
- **Discrete Wire Termination**
  - Punch Down Blocks
  - Modular Wall Plate Jacks for Phone & Data
  - Nylon Molex Style Connectors
    - MAS-CON Connectors
    - MTA Connectors
Compression

- Industrial Products
- Consumer Appliances
- Consumer Electronics
Wire Clamping

- Industrial Control Systems
- Wiring to Industrial Oil Tight Lights and Switches
- Consumer Large Appliances
Interference Fit or Force Fit

- Computer Backplanes
- Digital Logic Control Systems Backplanes
  - Backplanes on Card Cages
Cables of All Kinds
Wire Harnesses
Aircraft Wiring
Automotive Wiring
Trains
Busses
Consumer Products
Crimp Connections

- Contacts
  - Stamp & Form Contacts
  - Machined Contacts

- Terminals
  - Ring Lugs, Fork Lugs, Splices, Etc
Wire Wrap

- Phone Systems Equipment
- Cross Connect Panels
- Was heavily used for several decades on both prototype and production digital logic based products.
- System Backplanes
- Consumer Electronics
Expectations of a Good Solderless Connection

- Good Electrical Connection
  - Low Resistance
  - Will Not Cause Shorts
- Good Mechanical Connection
  - Wires Will Not Pull Out Easily
  - No Broken Conductor Strands
  - No Mechanical Damage so That Terminals or Contacts Can Properly Mate With Other Devices
- Long Lasting
  - Should Last for Decades
What are the Two Primary Failure Modes of Solderless Connections???
- High Resistance Connection
  - Excess Voltage Drop across connection point
  - Heat Buildup Due to Voltage Drop & High Current Flow

- Mechanical Failure of the Solderless Connection Point or the Conductor (Wire)
Solderless Connections

- What Causes Increased Resistance of a Solderless Connection Over Time???
  - Corrosion (Oxidation) at the Interface Point Between the Conductor and What it is Connected Too (Wire Wrap Post, Contact)
Solderless Connections

- All Solderless Connection Methods Must Achieve One Critical Thing to Assure a Long Lasting Low Resistance Electrical Connection.

- What is This Critical Thing????
  - GAS TIGHT FIT Without Mechanical Damage
Learning About

CRIMP CONNECTIONS
Crimp Design Parameters

- Increasing mechanical strength & electrical performance
- Decreasing cross-sectional area
- Increasing crimping force
- Decreasing crimp height
The 4 Components of a Good Crimp Connection

- **Contact** to Meet the Needed use and Wire Gauge.
- Correctly Stripped **Wire** to fit the Contact.
- Correct **Tooling** for the contact used.
- Trained Assembly **Personnel**.
Solid or Stranded Wire ???

- Crimped Connections are Designed for Stranded Conductors not Solid.

- Solid Conductors Should be Soldered After Crimping.

WHY?
Understanding Conductors and Wire Gauge

- AWG (American Wire Gauge)

- What Does Gauge Mean???
- Do all Wires of the Same Gauge Have the Same Diameter???

- Wire Gauge is the Cross Sectional Area of the Conductor Which is Expressed by the Equivalent Circular Mil Area (CMA)
Understanding Conductors and Wire Gauge

- Why is a 12AWG Wire Larger Than a 24AWG??
- What Does the Following Mean if You Saw it on a Parts List or a Wire Spool Label??
  - 22AWG 7/30
  - 22 Gauge Conductor
  - Stranded Conductor Made up of
  - 7 Solid Strands of 30 Gauge Each
Ring Lug Color Code

- Yellow 4 AWG
- Blue 6 AWG
- Red 8 AWG
- Yellow 10 to 12 AWG
- Blue 14 to 16 AWG
- Red 18 to 22 AWG
- Yellow 24 to 26 AWG
Multiple Conductors

- What if You Have More Than One Conductor That Needs to be Crimped Into a Single Contact or Terminal

- How do You Know What the Equivalent Wire Gauge is?
  - Compute the Total CMA
  - Use the Rule of Threes
Compute the Total CMA

- Add up the CMA of Each Conductor for the Total CMA of the Combined Conductors.

- Take this Total CMA Number to a Wire Chart to Find the Best Wire Gauge Match.

- Compare This Equivalent Wire Gauge to the Contact or Terminal Specifications to See if it Falls Within the Gauge Range.
Rule of Threes

- Used for 2 Wires Into a Single Contact or Terminal
- The Two Conductors Must be the Same Wire Gauge
- This Rule Will Give You the Resulting Combined Equivalent Wire Gauge
Example Using The Rule of Threes

Two 22AWG Wires into a Single Contact

22AWG − 3 = 19AWG
## Stranded vs. Solid Wire

<table>
<thead>
<tr>
<th>Method</th>
<th>Stranded</th>
<th>Solid</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crimp</td>
<td>Yes</td>
<td>No</td>
<td>Solder Solid</td>
</tr>
<tr>
<td>IDC</td>
<td>Yes</td>
<td>Yes</td>
<td>Strand Count</td>
</tr>
<tr>
<td>Wire Wrap</td>
<td>No</td>
<td>Yes</td>
<td>Solder Stranded</td>
</tr>
<tr>
<td>Compression</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Wire Clamping</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
Conductor Strip Length

- The Conductor Strip Length is a Critical Element to Achieving a Good Crimp
- It is Second only to Tooling and Gauge Match in Critical Factors
Hand Crimp Tools

- Pliers Type
  - Very Hard to Get Repeatable Crimp Results Especially with Different Operators.
  - Hand Strength of User Effects Crimp Quality
  - Can Not Predict Longevity of the Crimp
  - Best for Emergency Repairs or When the User Can Tolerate Short Crimp Life and Expense and Downtime of Potential Multiple Repairs Due To Failing Crimps
Hand Crimp Tools

- Ratchet Type Hand Crimp Tools
  - Repeatable Crimp Results Especially with Different Operators.
  - The Crimp Quality is not Effected by the Hand Strength of the Operator.
  - Predictable Long Lasting Crimp Life.
Crimp Validation Methods

- Milivolt Drop Test
  - Used to Measure the Voltage Drop Across the Conductor Crimp Area of a Contact or Terminal
  - Used Mainly as a Validation of the Actual Contact or Terminal Design
  - Normally Not Used in Production Environments
Crimp Validation Methods

- **Crimp Height Measurement** is one of the Most Commonly used Methods in Validating a Crimp
  - Machine Setup
  - Hand Tool Verification
  - Checking Crimp Quality
  - Uses a Special Crimp Height Micrometer to Measure the Actual height of the Crimp
Crimp Validation Methods

- **Pull Testing** is Used to Measure the Actual Pull Out or Conductor Breaking Force.

- Only the Conductor Crimp Area is Actually Crimped, Not the Insulation Crimp.

- This is Typically a Destructive Test.
Visual Crimp Inspection

- Visual Inspection of Key Attributes
- Key Attributes Vary by Type of Part
  - Terminals
  - Stamp & Form Contacts
  - Machined Contacts
Terminals

- Conductor Brush
- Conductor Crimp
- Insulation Crimp
Stamp & Form Contacts

- Insulation Crimp
- Inspection Window
- Conductor Crimp
  - Bell Mouth
  - Crimp Area
  - Conductor Brush
- Locking Tabs
- Cutoff Tab
Machined Contacts

- Insulation Clearance
- Inspection Hole
- Crimp Indent
- Indent Location
Insulation Support Bend Test

- Use Unstripped Insulated Wire
- Only Crimp the Wire in the Insulation Support Crimp Area of the Contact
The End

- THANK
- YOU