ELECTRICAL WIRE PROCESSING TECHNOLOGY EXPO 2024

HARNESS THE FUTURE

CONFERENCE: MAY 14-16 | EXHIBITION: MAY 15-16

BAIRD CENTER | MILWAUKEE, WI

The Essential Guide to Crimp Force Monitoring

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President

WireProcess Specialties

Produced by:

WHMA Wiring Harness Manufacturer's Association

IPC BUILD ELECTRONICS BETTER

BAIRD CENTER

Contents

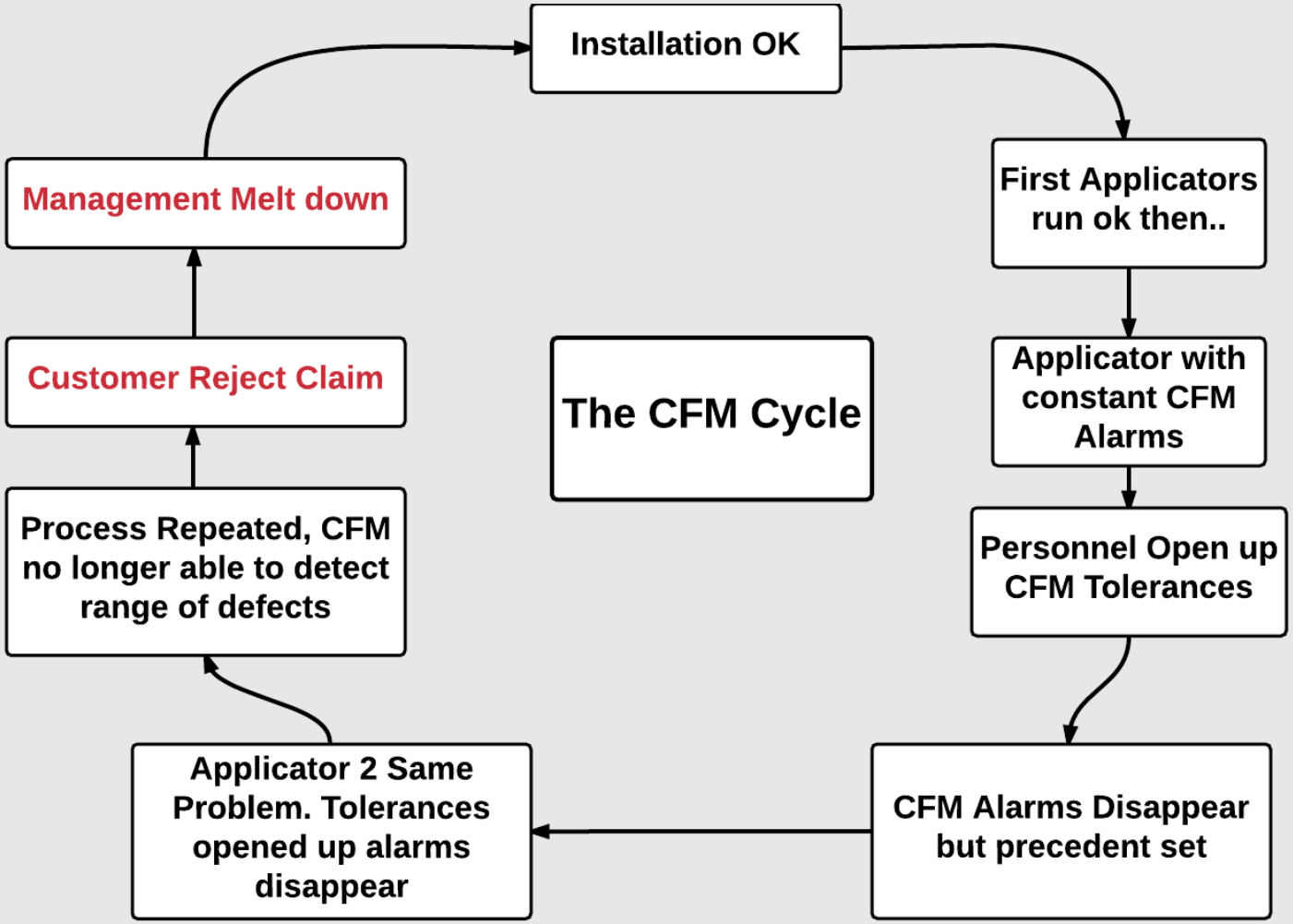
- Crimp Basics
- CFM Operation
- CFM Defects
- Troubleshooting Crimps
- Network Integration

HARNESS THE FUTURE

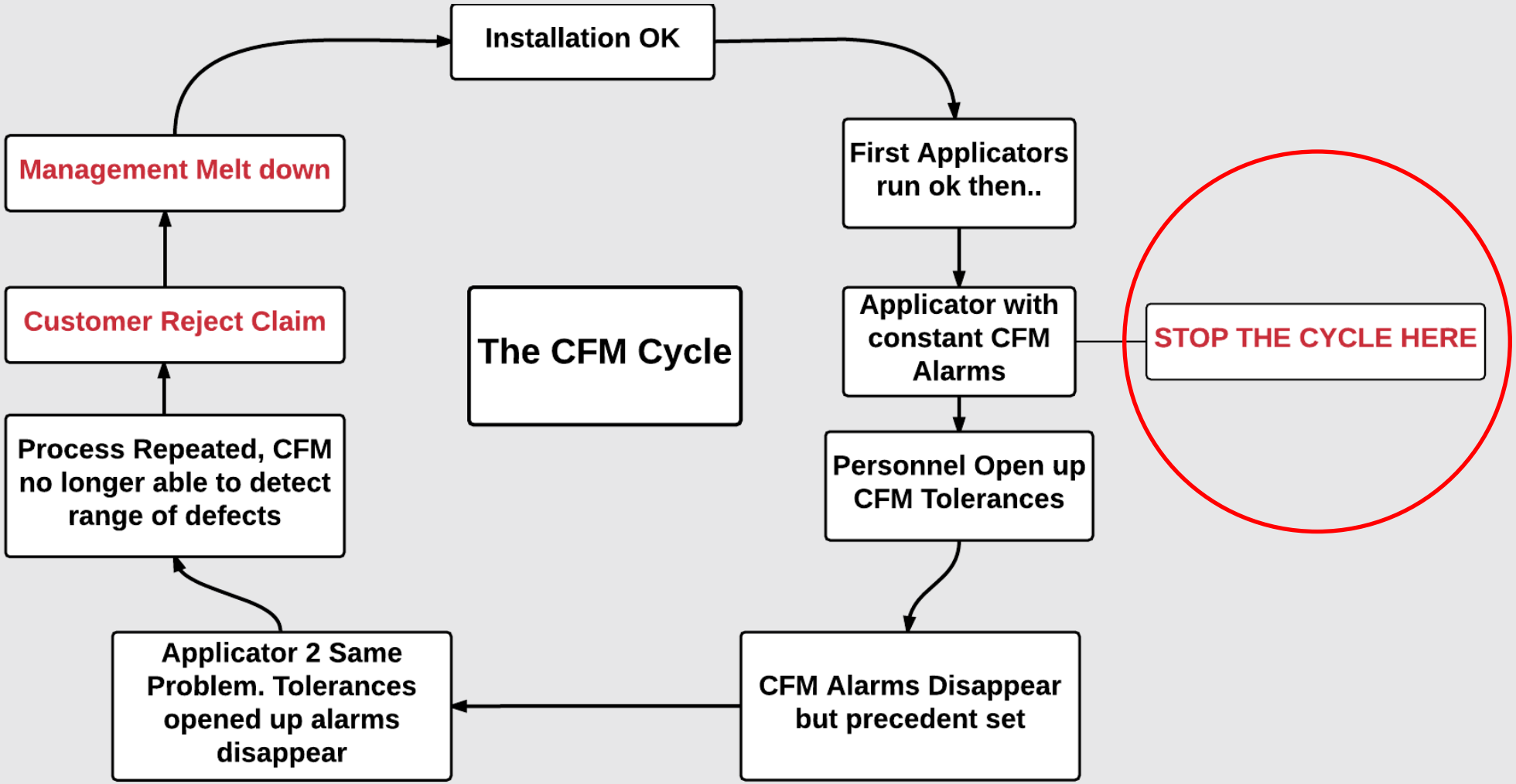
Crimp Force Monitors Expose,
But Do Not Solve your Quality Problems

That is your job

The CFM Cycle

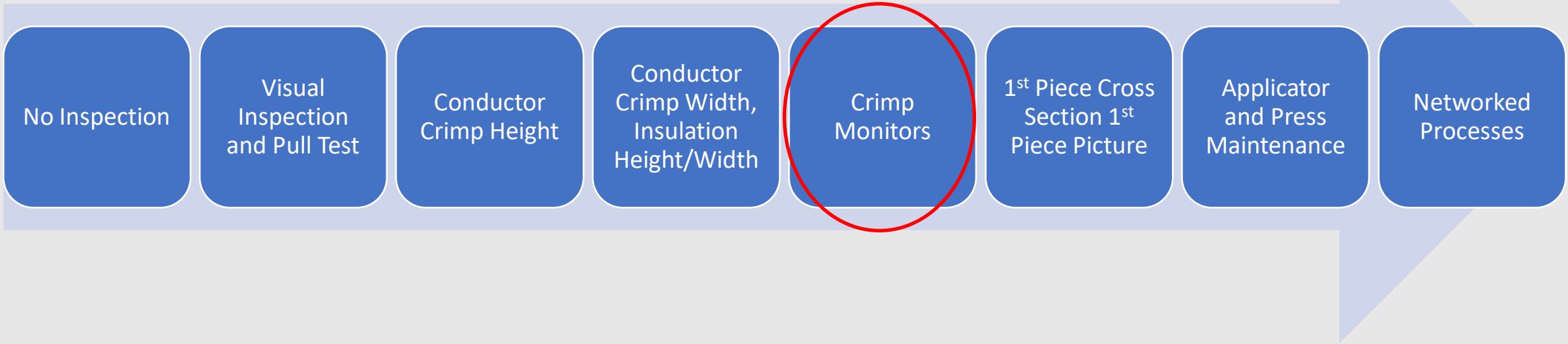


The CFM Cycle



Where is Your Company?

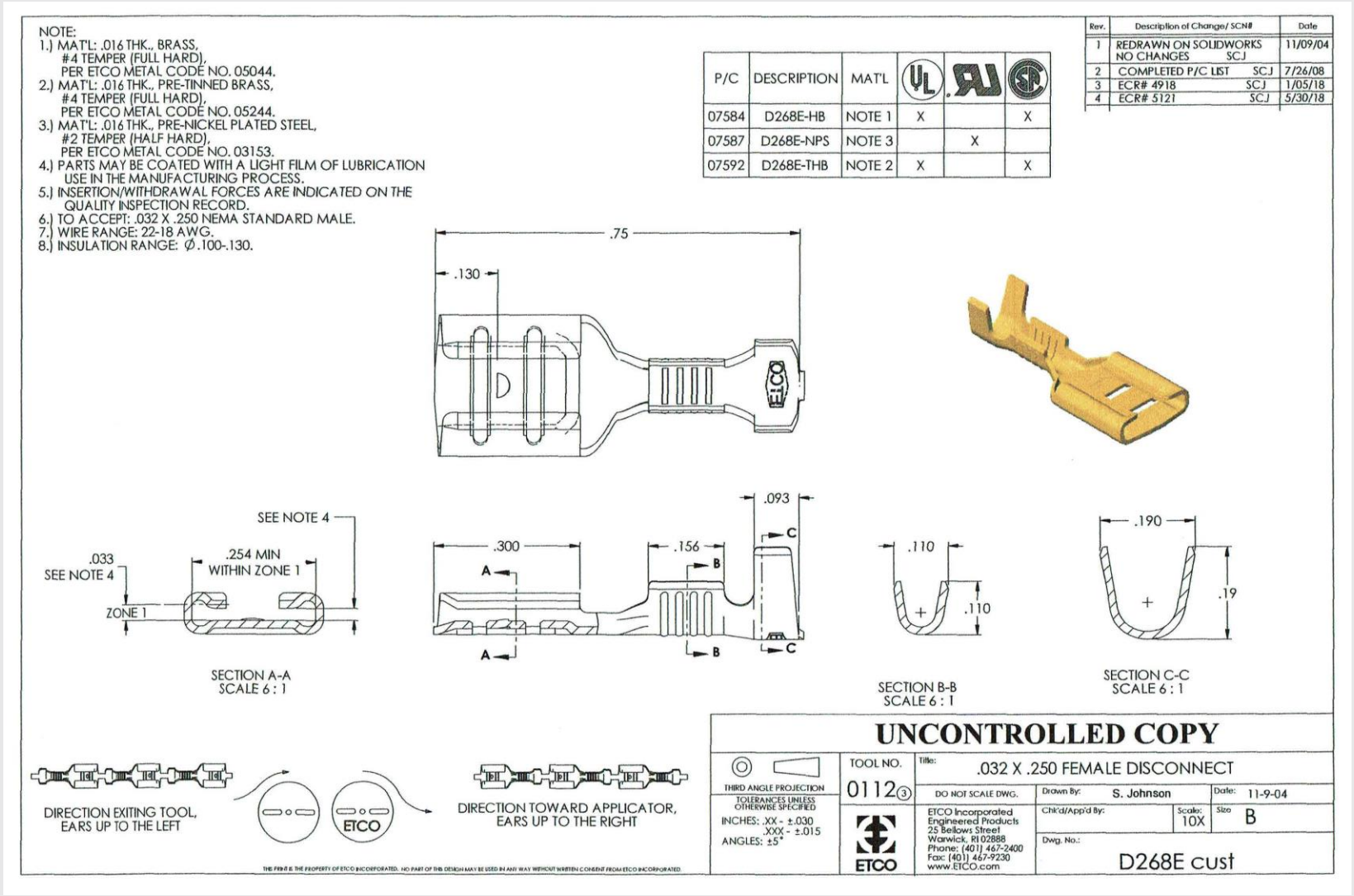
Low Level → **Average** → **High Level**



The Tale of a Terminal Crimp

Terminal
ETCO D268E-HB
22-18 Awg

Wire
18 Awg



Crimp Basics

Crimp Basics

- Core Crimp Elements
- Fundamental Crimp Specs

Crimp Basics

Defining an Electrical Connection

A terminal crimp is an acceptable electrical connection when a wire and terminal are compressed together with tooling designed specifically for the wire and terminal combination.

An acceptable electrical connection has a balance between low electrical resistance and high tensile test.

Crimp Basics

Aspects of an Acceptable Terminal Crimp

To assure a crimp exhibits low electrical resistance and high tensile strength you need to pay close attention to:

- The Repeatability of the crimp by assuring all Core Crimp Elements are in full control.

- Fundamental Crimp Specs and that they are carefully followed in the validation and production of crimped wires.

Core Crimp Elements

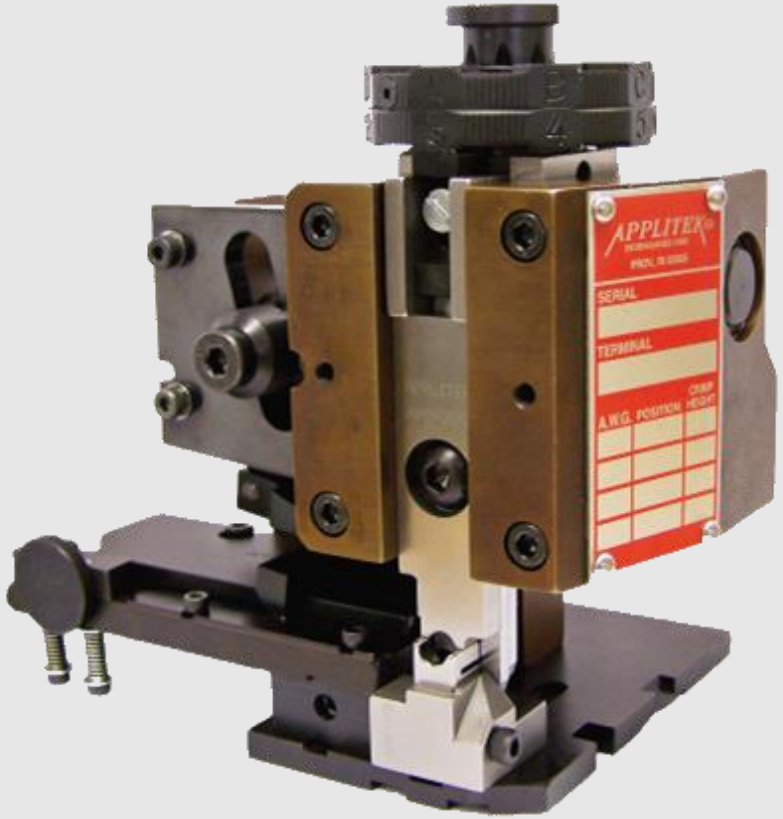
Terminals and Wire

- Terminal crimp barrel matches the wire being crimped.

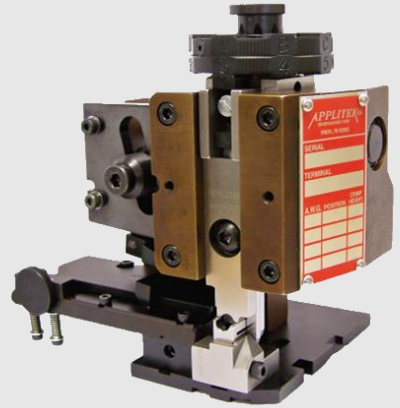
- Strip Length and Strip Quality
- Oxidized and/or Contaminated Strands

Core Crimp Elements

Crimp Tooling

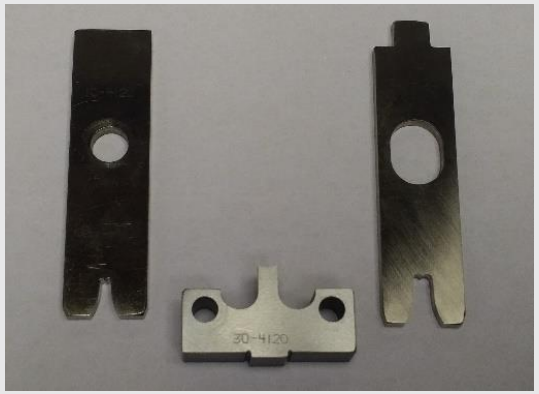


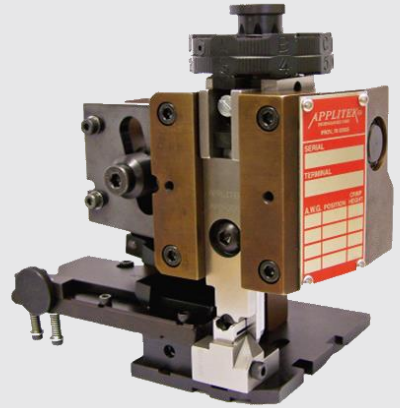
Core Crimp Elements



Crimp Tooling

- Check Wear on:
  - Conductor Crimp Tools
  - Insulation Crimp Tools
  - Cut Off Tools
  - Springs

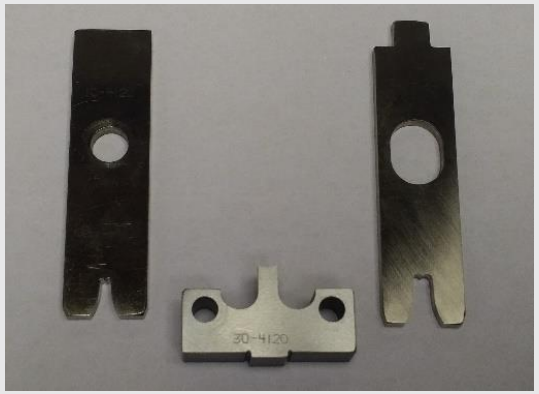


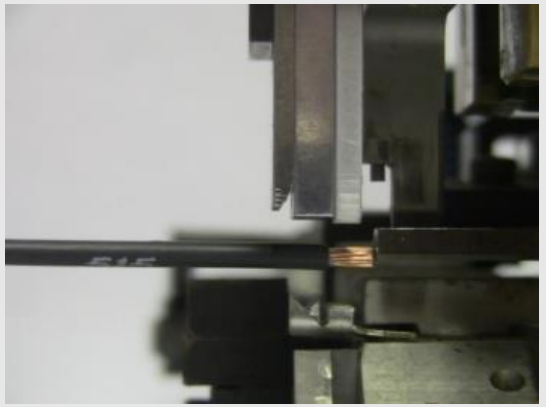


Core Crimp Elements

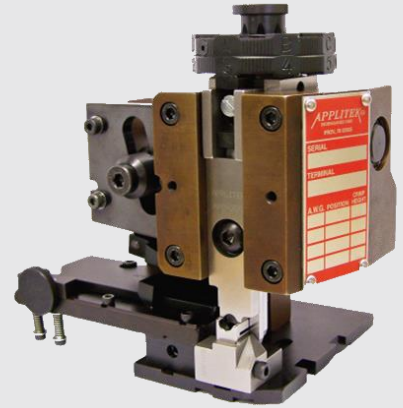
Crimp Tooling

- Check Wear on:
  - Conductor Crimp Tools
  - Insulation Crimp Tools
  - Cut Off Tools
  - Springs
- Wire Stop



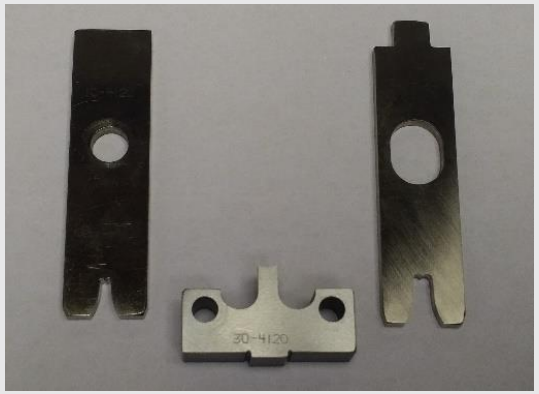


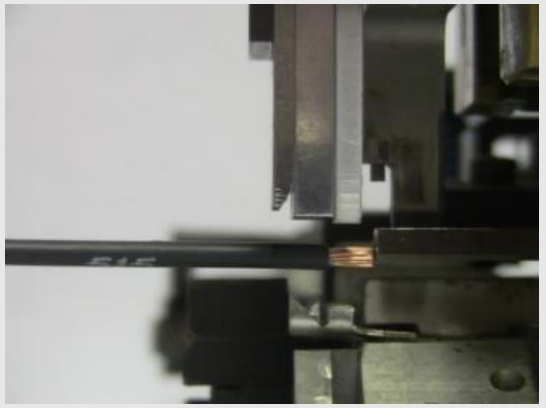
Core Crimp Elements

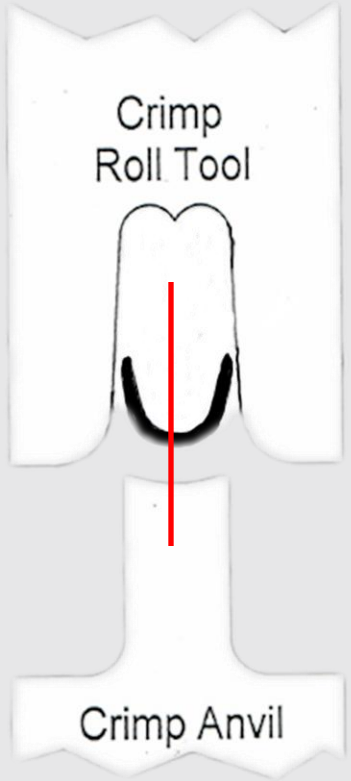


Crimp Tooling

- Check Wear on:
  - Conductor Crimp Tools
  - Insulation Crimp Tools
  - Cut Off Tools
  - Springs
- Wire Stop
- Terminal Centered on Anvil
- Ram Lubricated



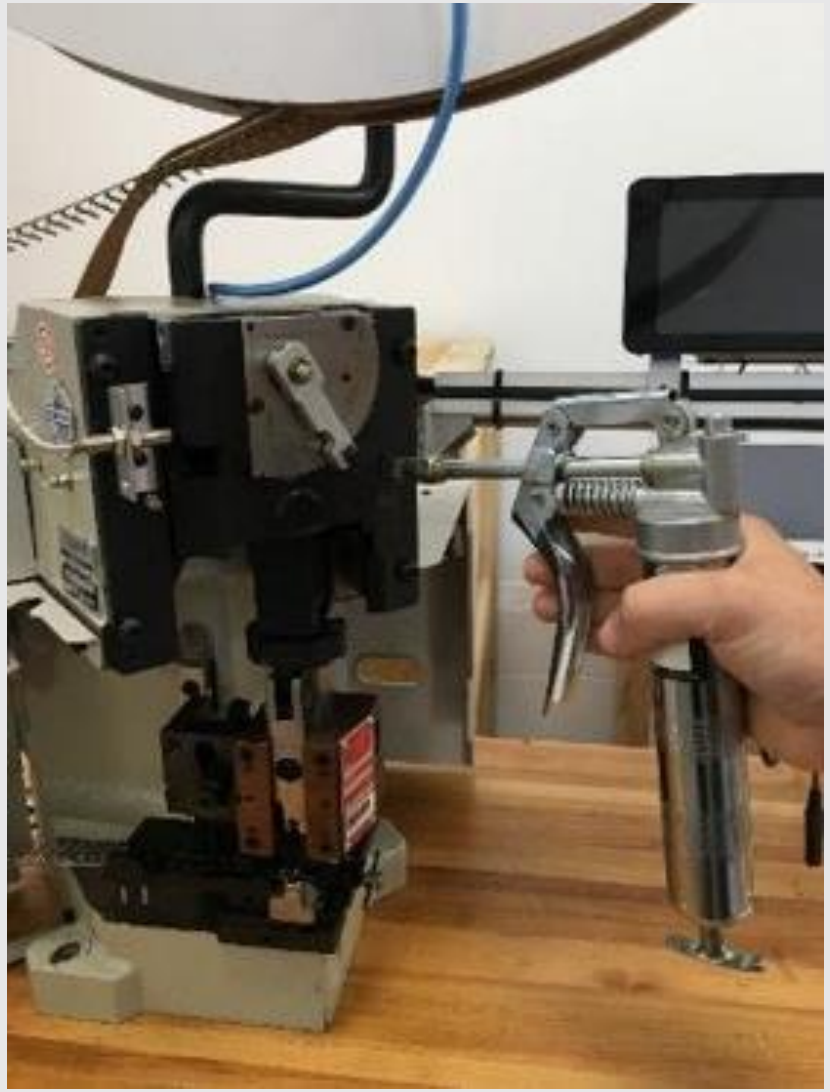




Core Crimp Elements

Crimp Press

- Ram is tight
  - No play front to back, side to side, up and down)
- No Excess Wear in Base Plate/Ram Adapter.
- Grease Points



Core Crimp Elements

Crimp Press

- Press Calibrated and capability study on statistical Force and Shut Height

Core Crimp Elements

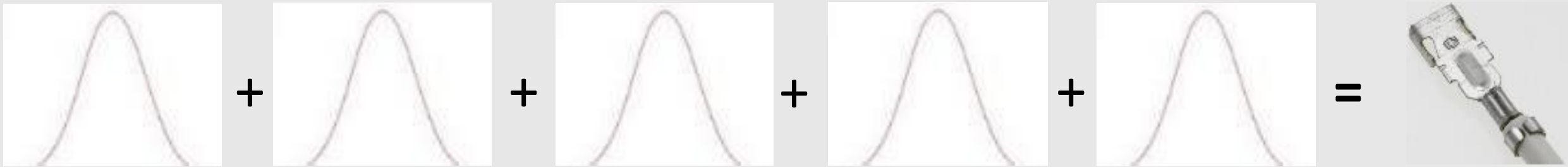
Crimp Operator

Trained Operators

- Wire and Terminal
- Crimp Procedures
- Visual Specs
- Measured Specs

Core Crimp Elements

Any single element that is out of control affects overall crimp quality.



Wire + **Terminal** + **Applicator** + **Crimp Press** + **Operator** =

Core Crimp Elements

Repeatable Crimp Process = **Smaller CFM Tolerances** = **CFM Detects Smaller Defects**

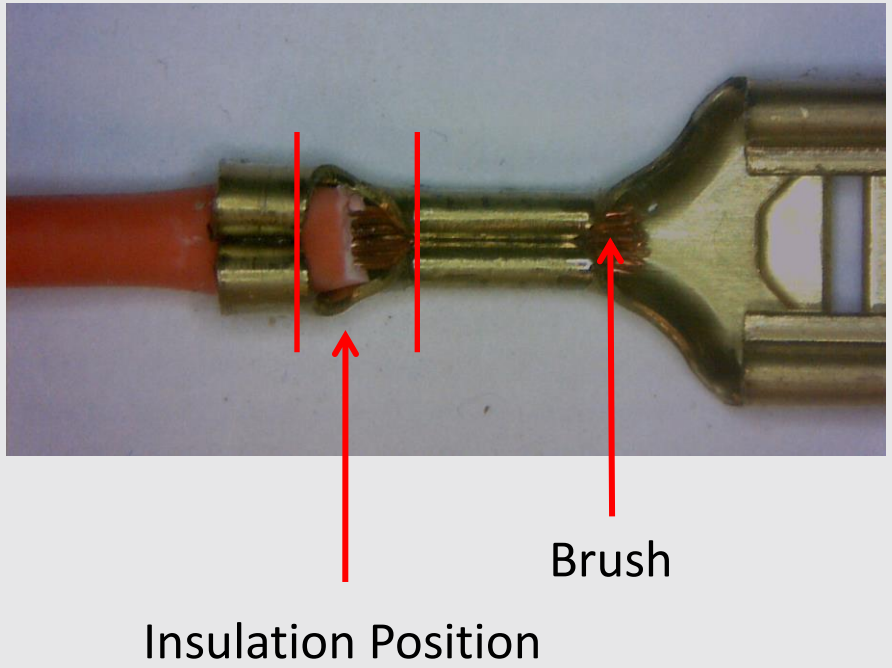
Core Crimp Elements

The Inverse is Also True

Non-Repeatable Crimp Process	=	**Larger CFM Tolerances**	=	**CFM Cannot Detect Smaller Defects**

Fundamental Crimp Specs

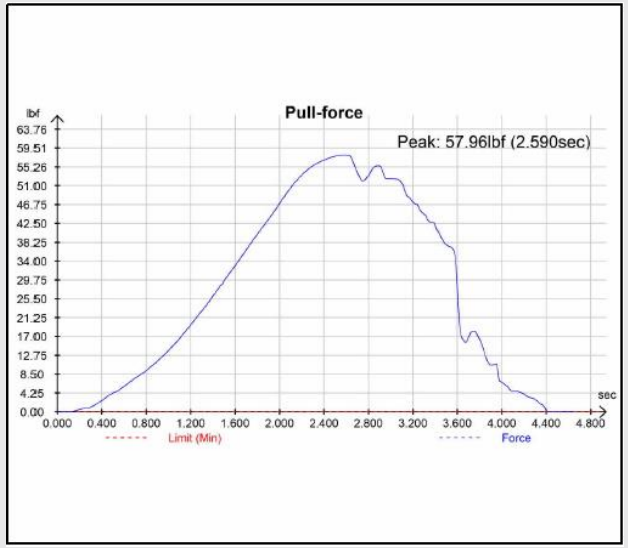
Visual Specs

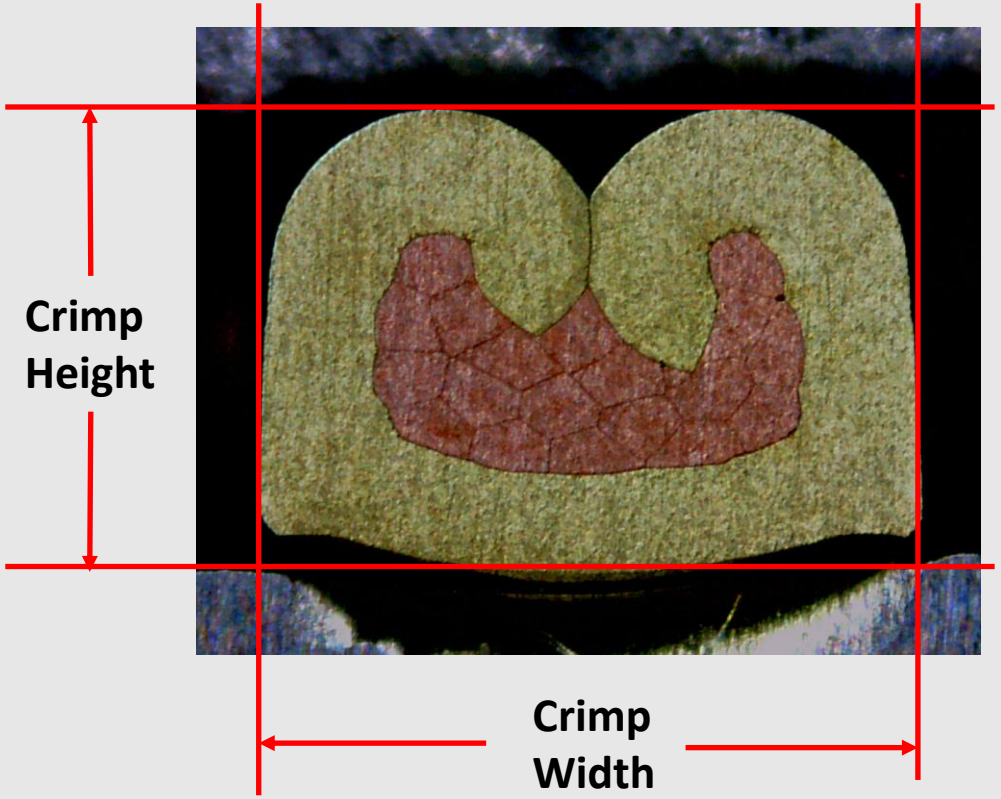


Fundamental Crimp Specs

Measured Specs

- Conductor Crimp Height and Width
- Insulation Crimp Height and Width
- Pull/Tensile Test

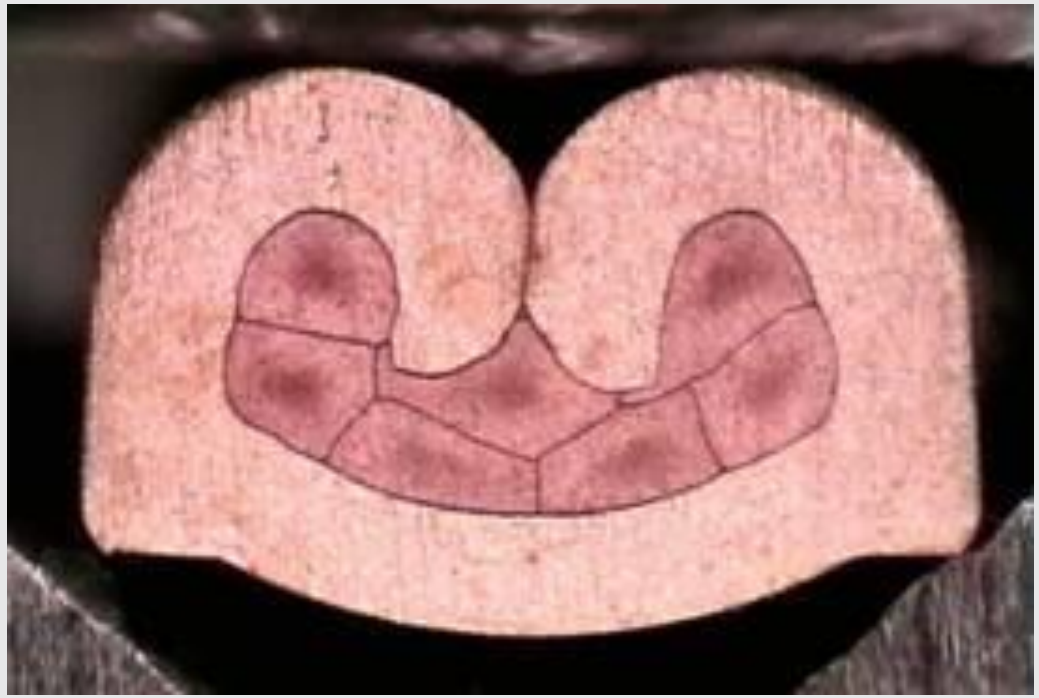




Fundamental Crimp Specs

Cross Section

- Crimp Wings Locked (No Gap).
- Full Strand Compaction (no round strands).
- Crimp Wings Symmetric.
- Crimp Wings Only Touch Conductor.
- Terminal Free of Cracks or Breaks.

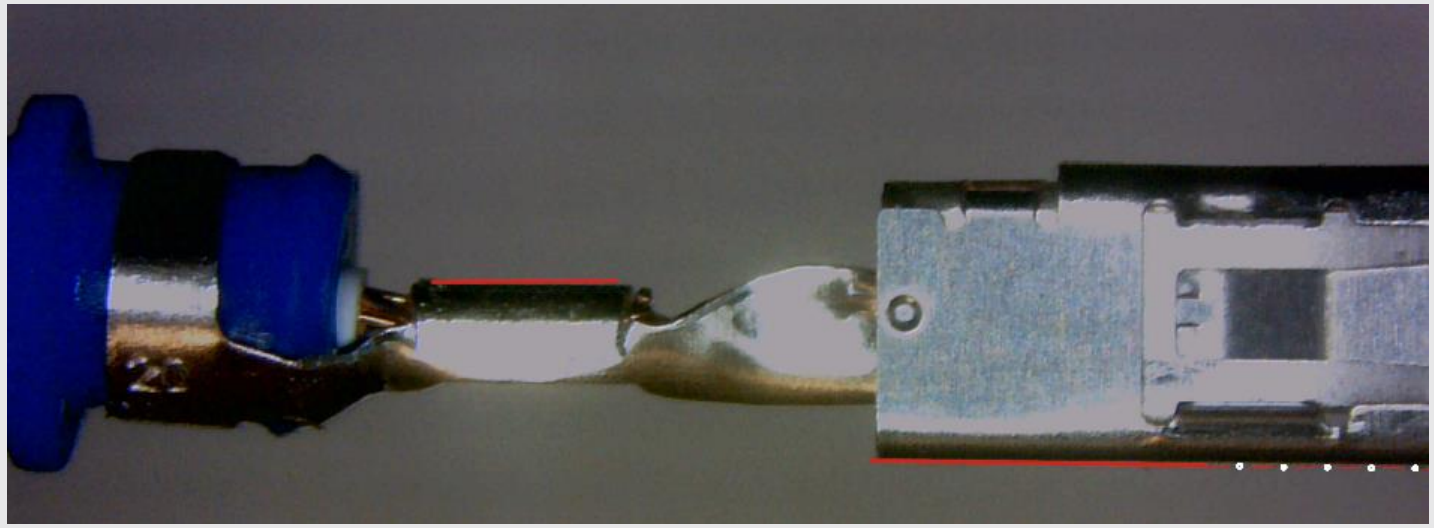


Fundamental Crimp Specs

Bend Angle

Extrusion during crimp process can cause the terminal to conform to a “banana” shape.

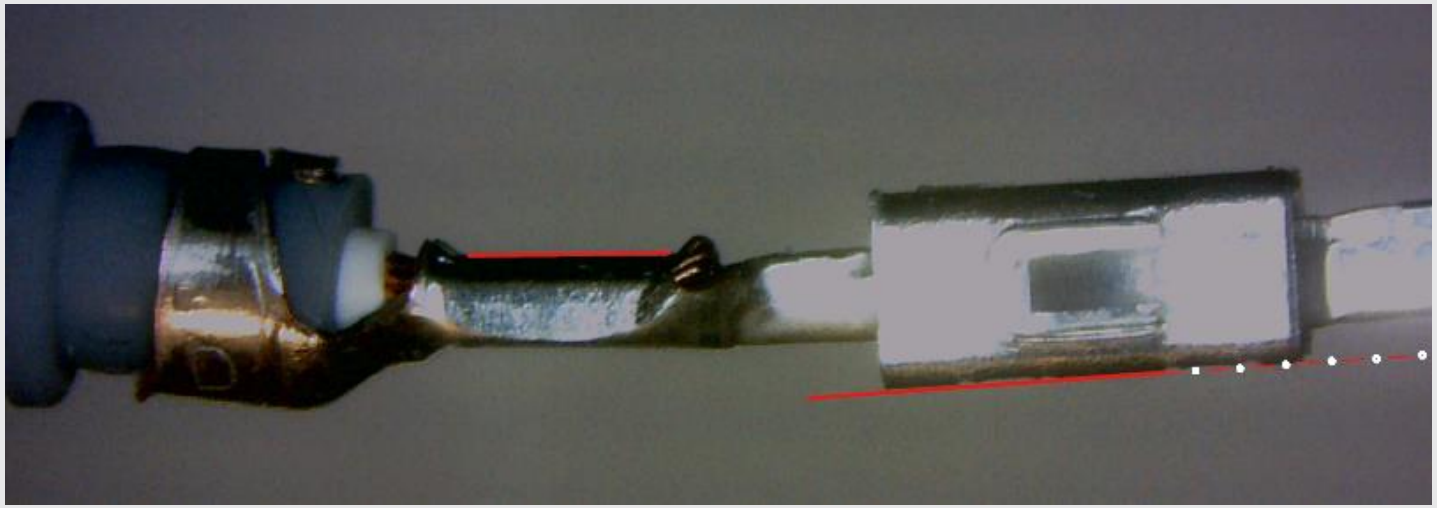
- Mis-matched mating terminals in a connector housing.



Fundamental Crimp Specs

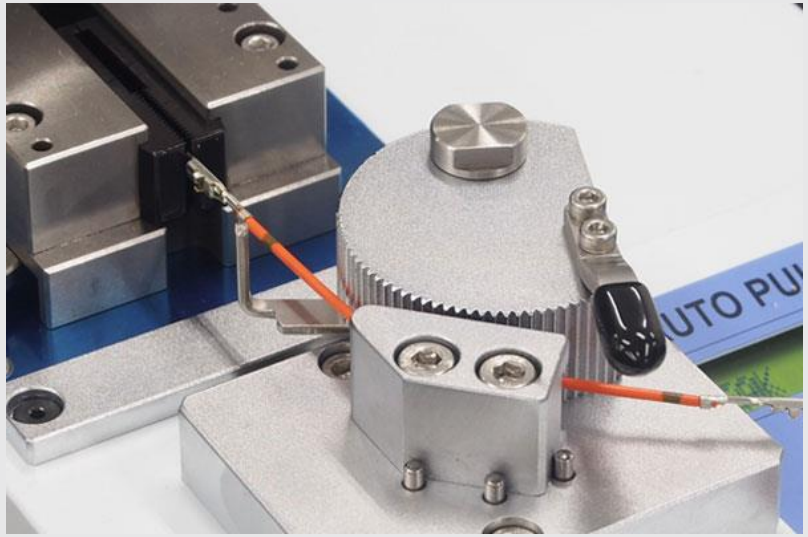
Bend Angle

Excess Bend Angle



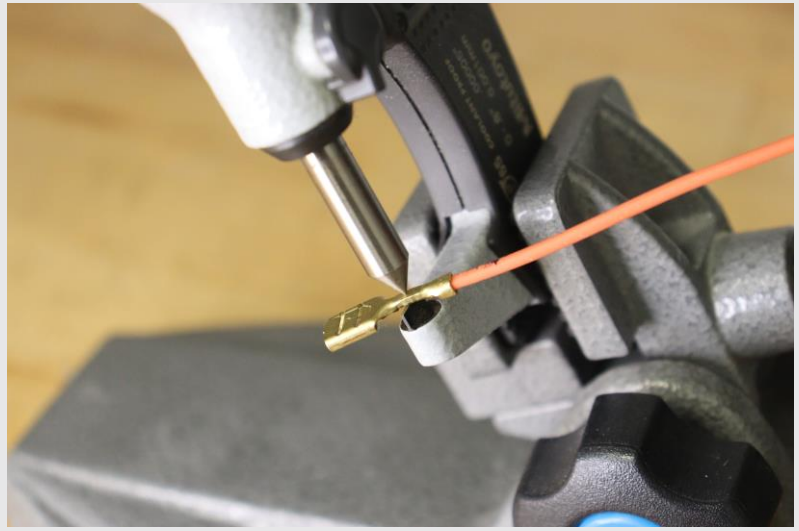
Fundamental Crimp Specs

Measurement Tools



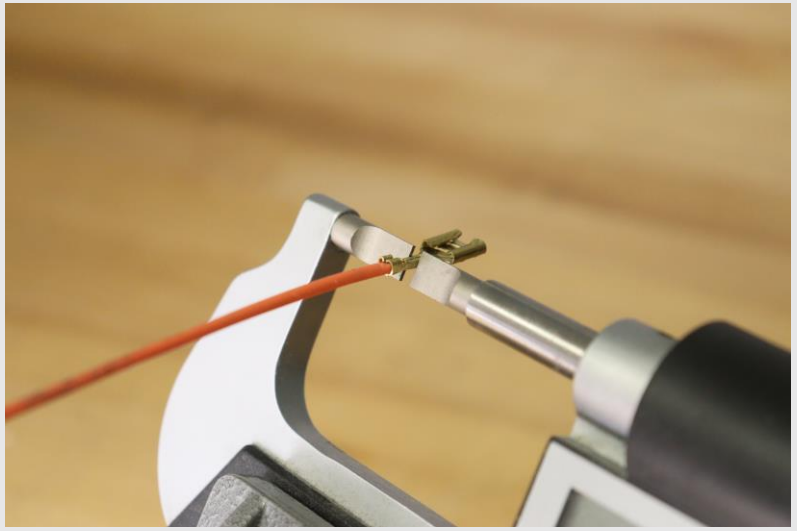
Pull/Tensile Test

- Motorized with 50-250 mm axial motion



Point-Blade Micrometers

- Conductor Crimp Height



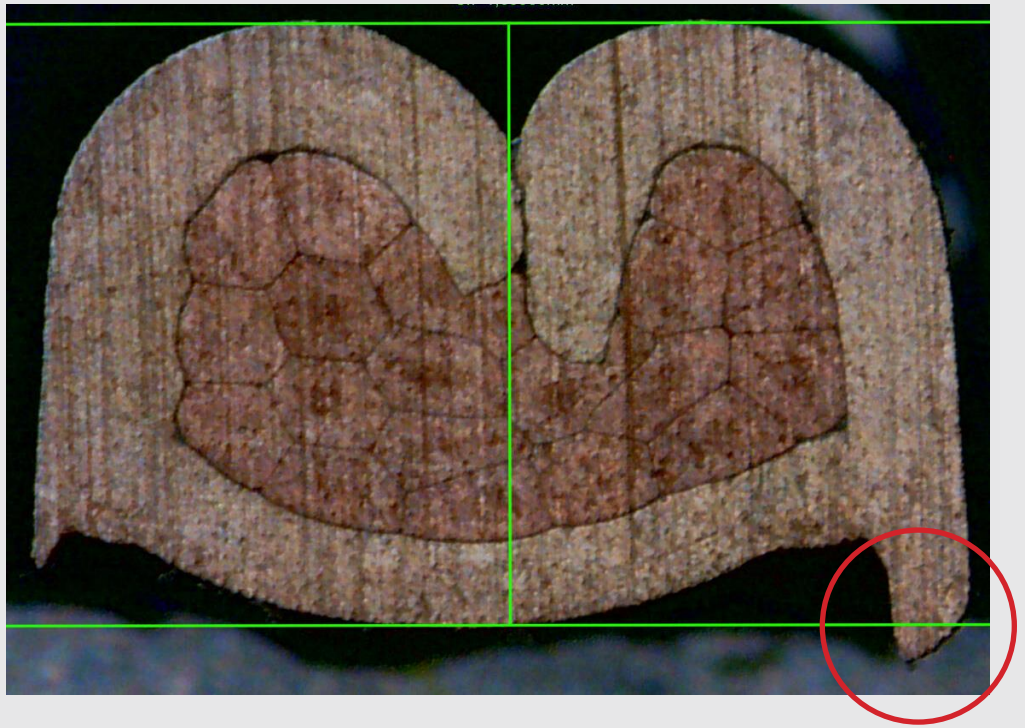
Blade-Blade Micrometers

- Conductor Crimp Width
- Insulation Crimp Height/Width

Fundamental Crimp Specs

Measurement Tools

Calipers are not used for Conductor Crimp Height

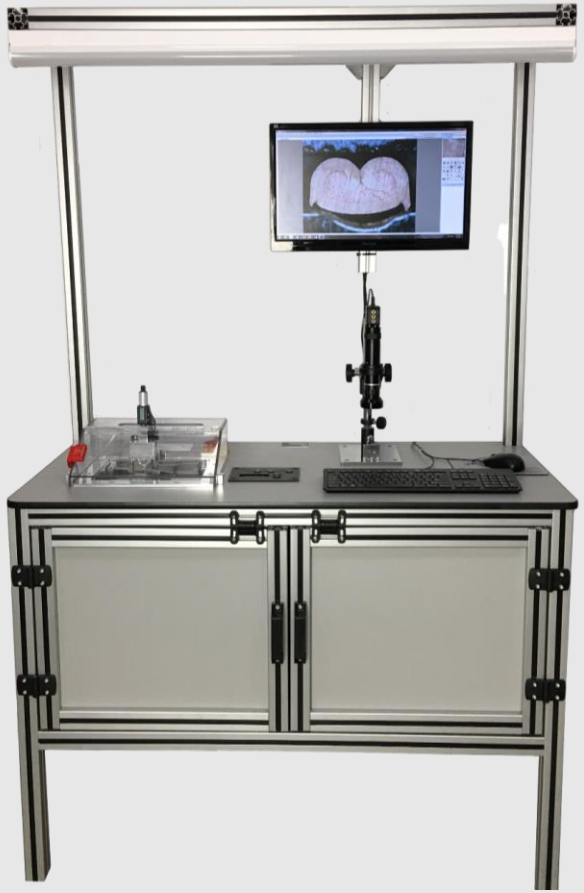


Fundamental Crimp Specs

Measurement Tools

USB Microscope

Bend Angle



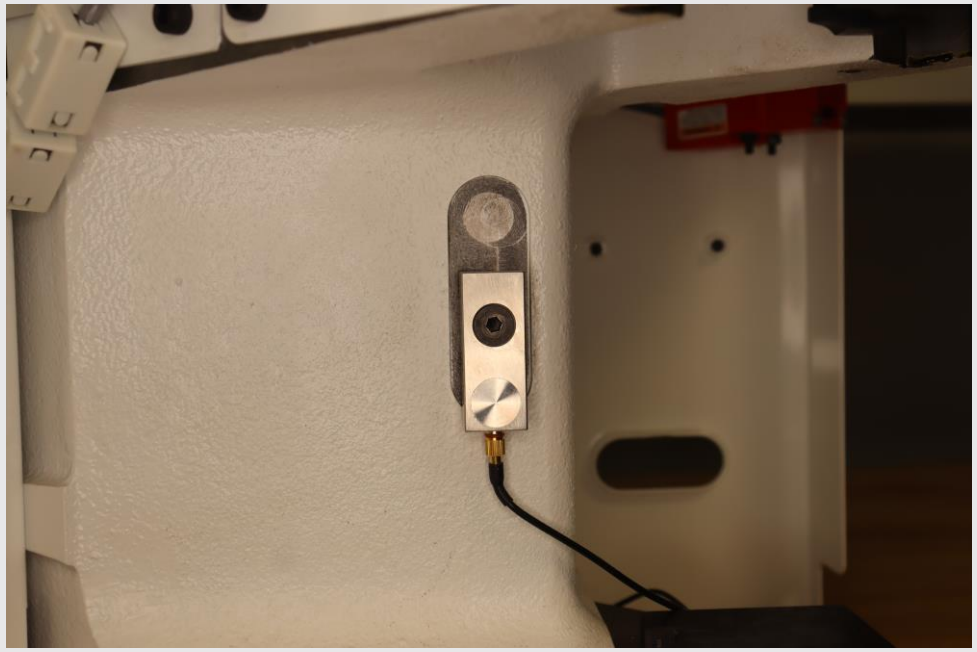
Cross Section

CFM Operation

CFM Operation

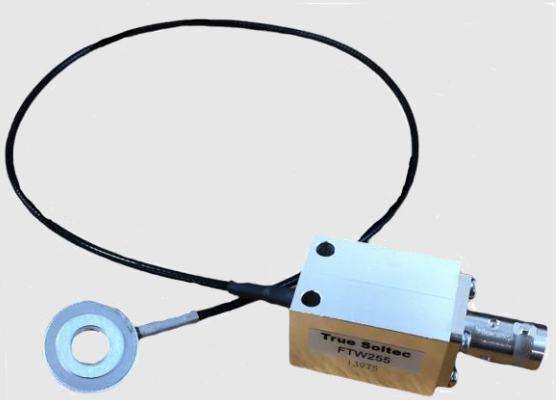
- CFM Components
- Pre-Production Validation
- Teach In
- Real Time Monitoring

CFM Components



Frame Sensor Mount

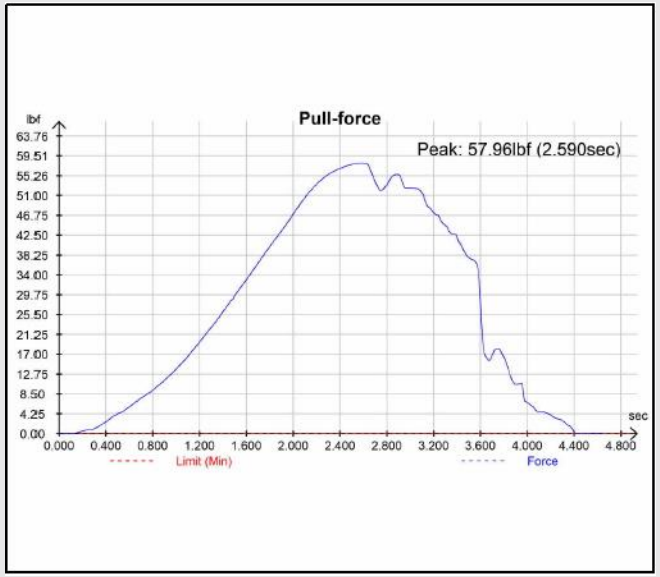
CFM Components

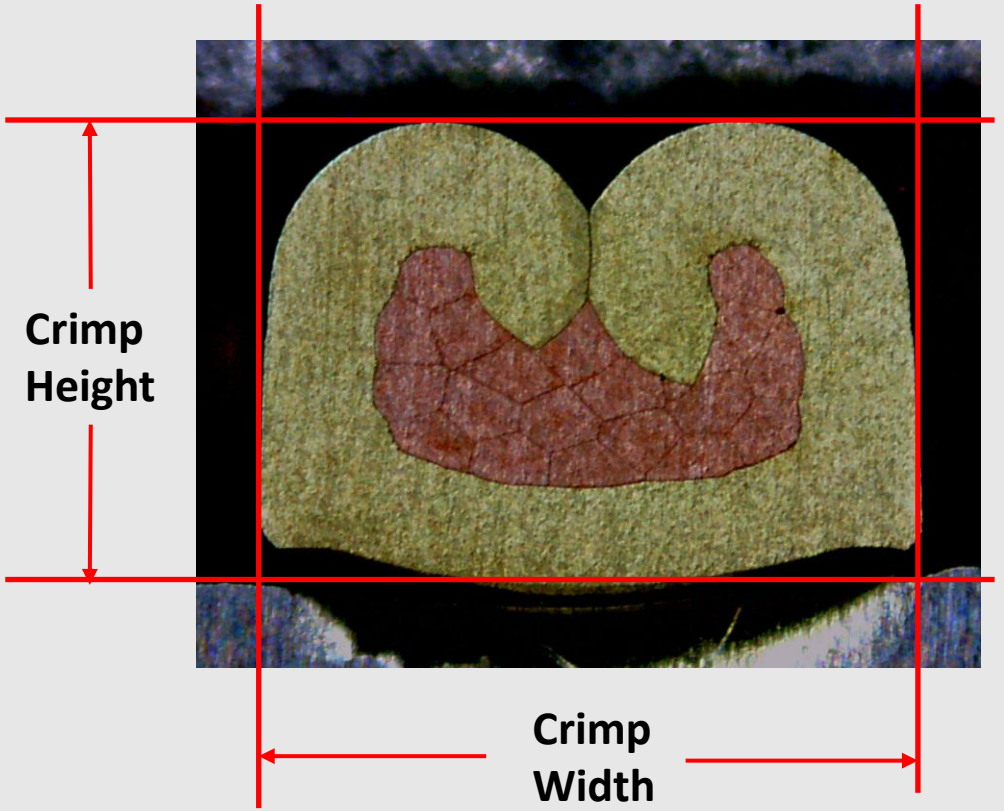


Base Plate Sensor Mount

Pre-Production Validation

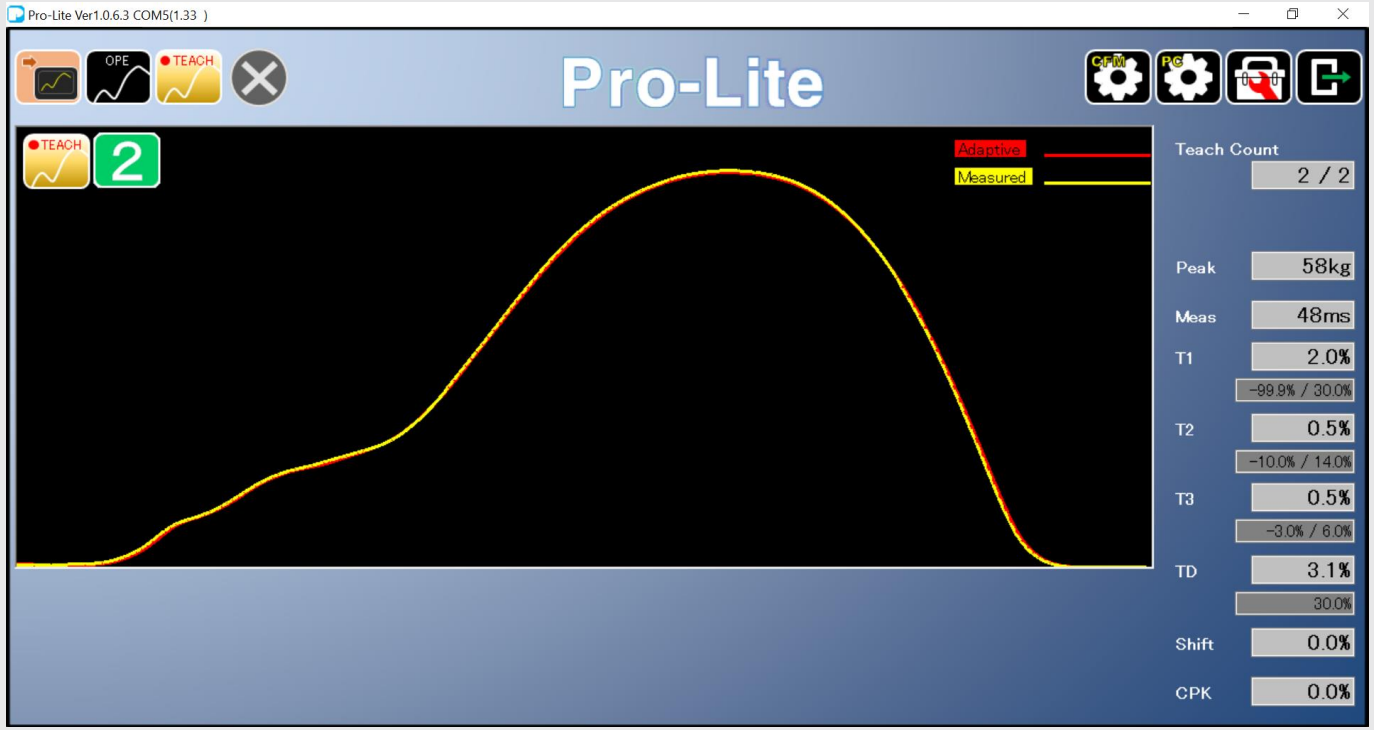
- Conductor Crimp Height and Width
- Insulation Crimp Height and Width
- Pull/Tensile Test





HARNESS THE FUTURE

Teach In



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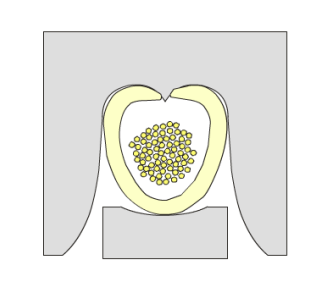
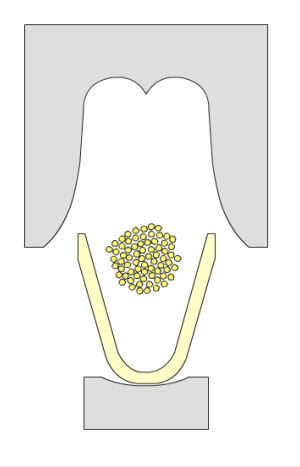
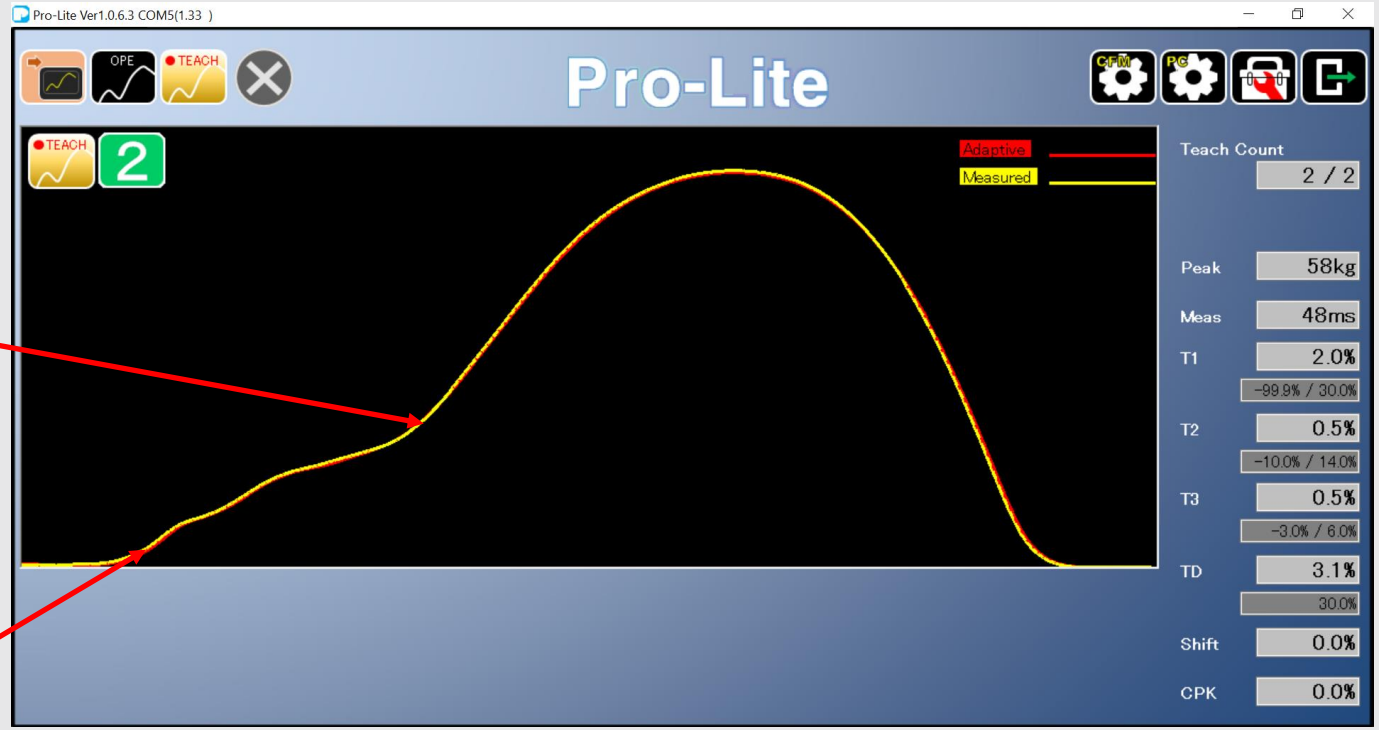
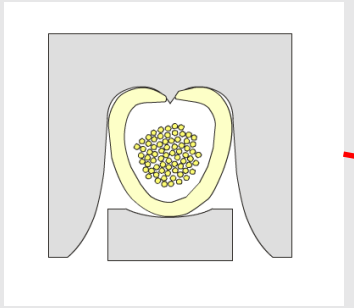
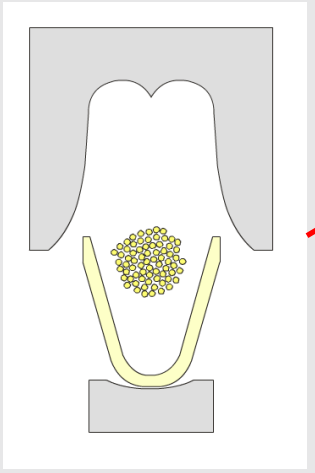


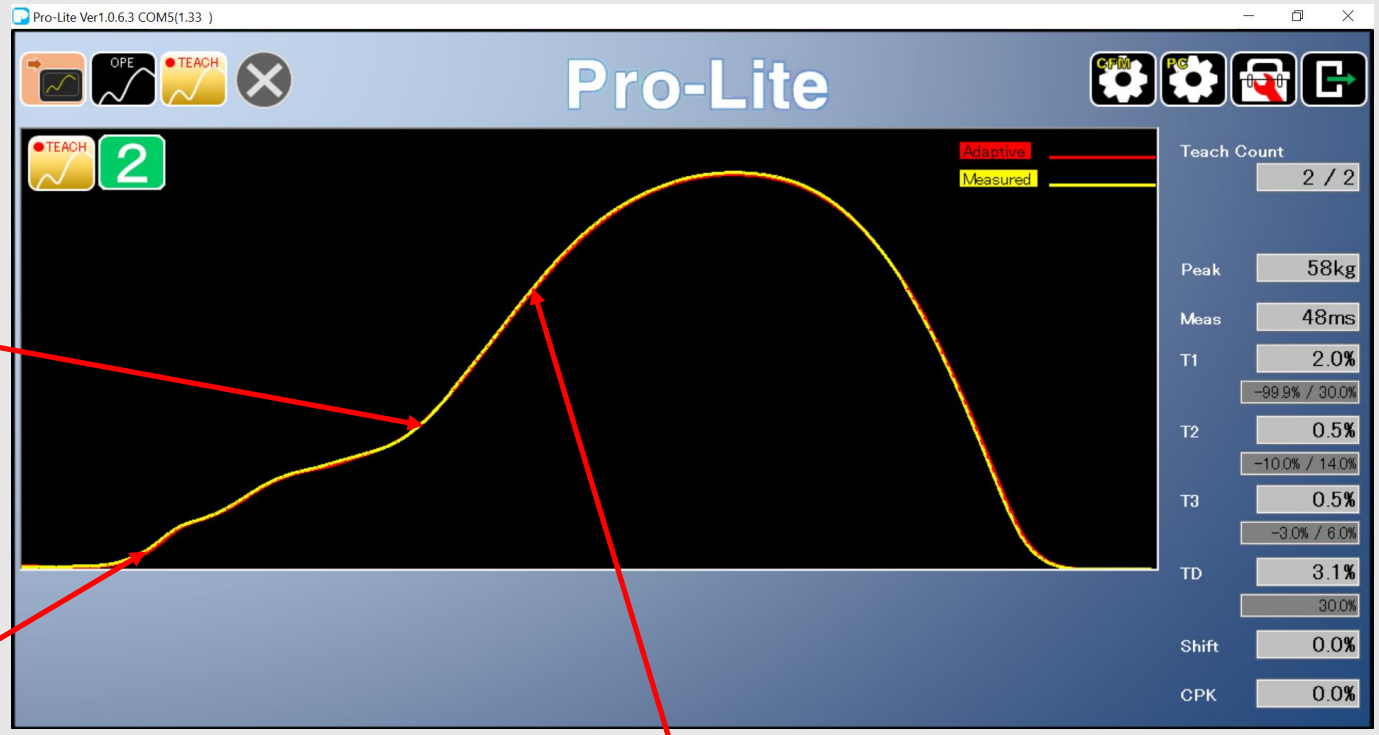



Pro-Lite Ver1.0.6.3 COM5(1.33)
OPE
TEACH
Pro-Lite
CFM
PG
TEACH
2
Adaptive
Measured
Teach Count
2 / 2
Peak
58kg
Meas
48ms
T1
2.0%
-99.9% / 30.0%
T2
0.5%
-10.0% / 14.0%
T3
0.5%
-3.0% / 6.0%
TD
3.1%
30.0%
Shift
0.0%
CPK
0.0%

Teach In






Pro-Lite Ver1.0.6.3 COM5(1.33)
OPE
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2
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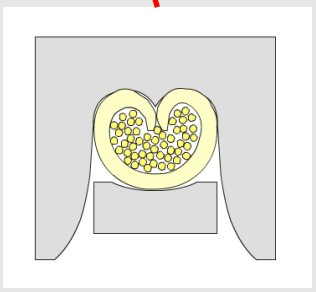
2 / 2
Peak
58kg
Meas
48ms
T1
2.0%
-99.9% / 30.0%
T2
0.5%
-10.0% / 14.0%
T3
0.5%
-3.0% / 6.0%
TD
3.1%
30.0%
Shift
0.0%
CPK
0.0%



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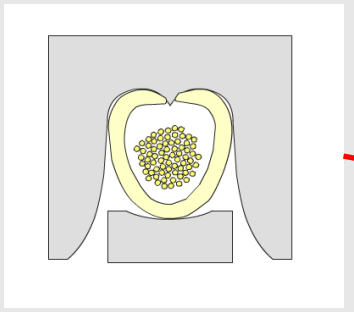
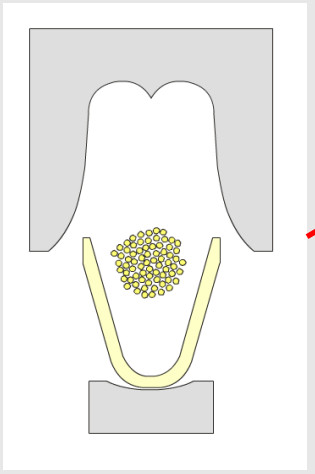
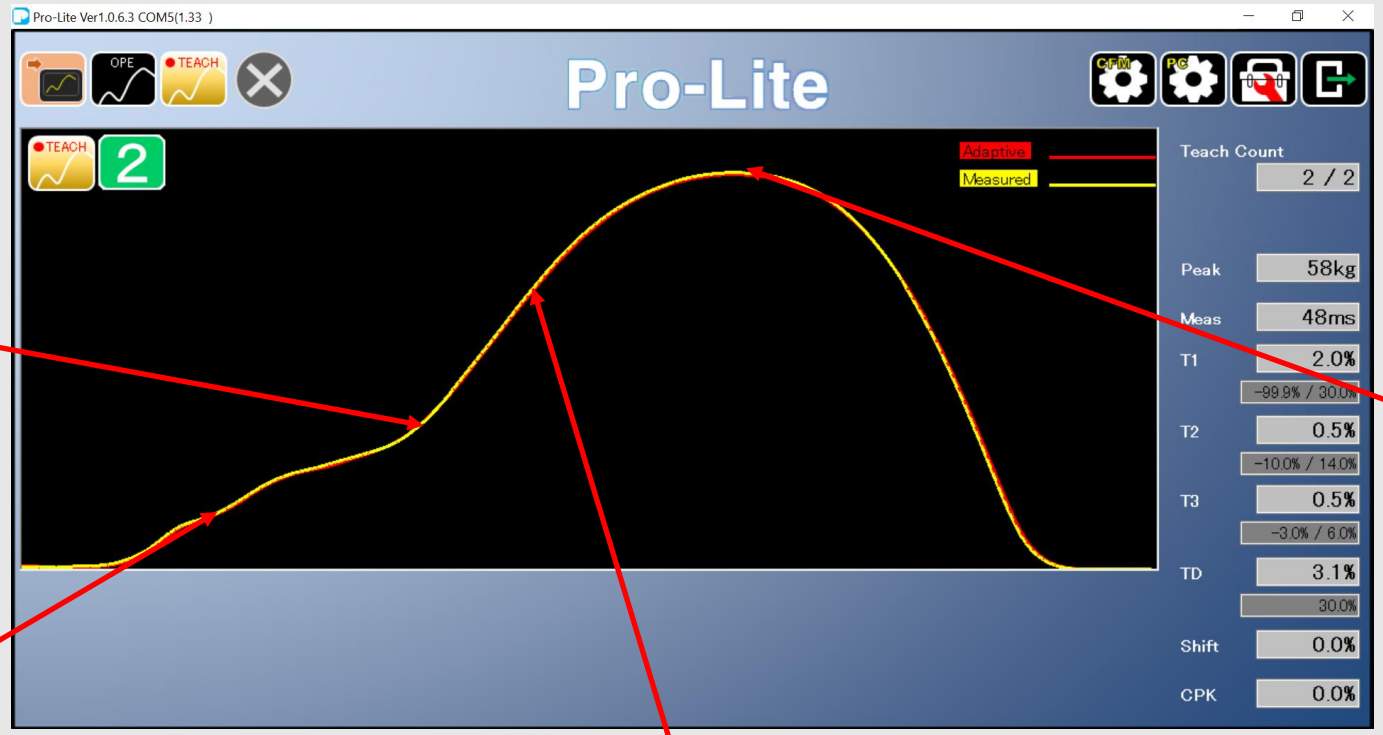
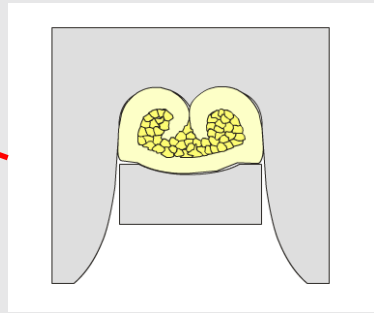
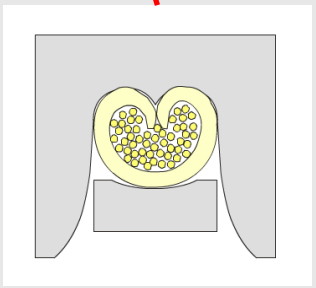
Teach In



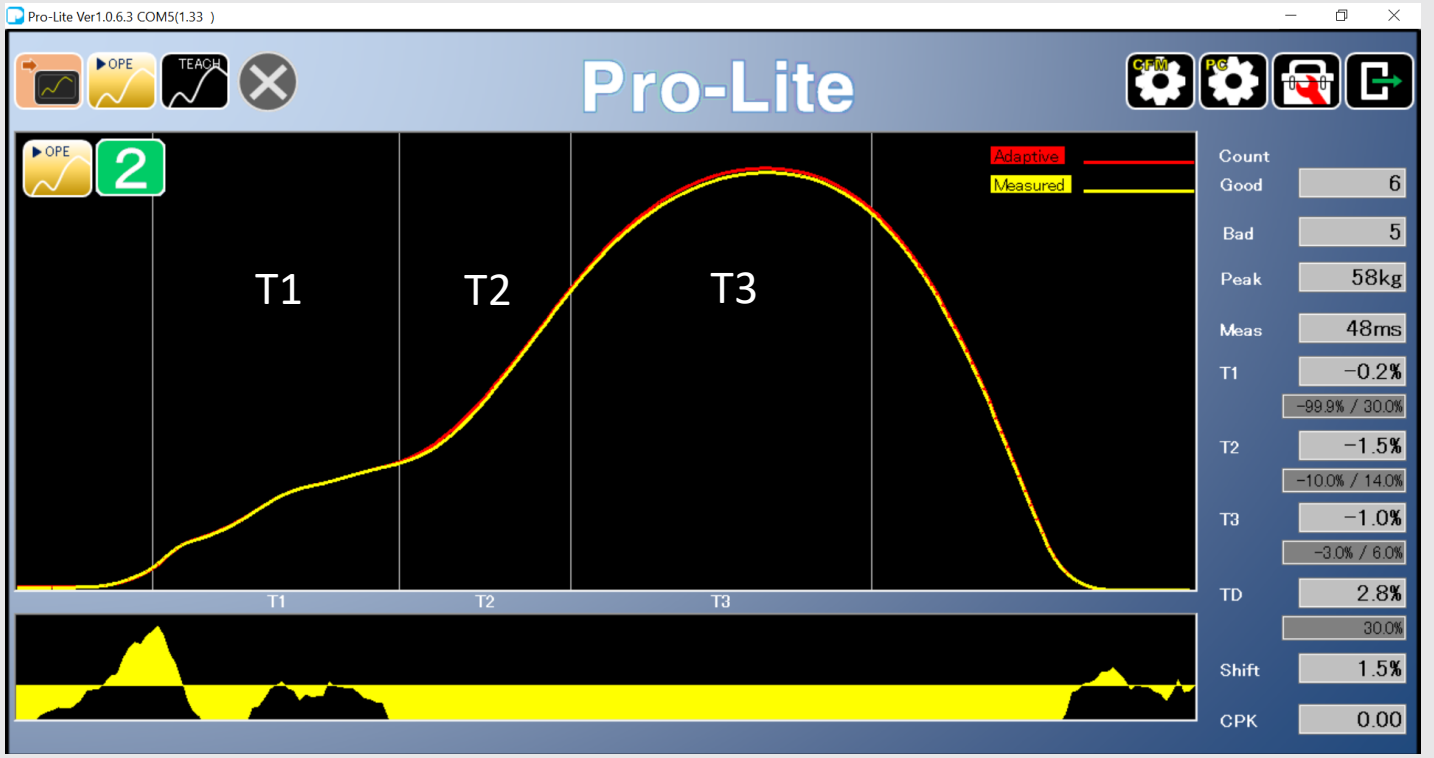








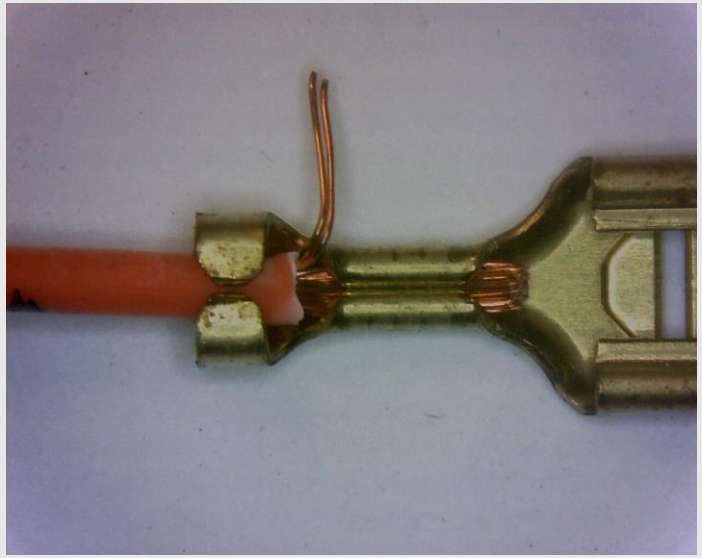
Real Time Monitoring

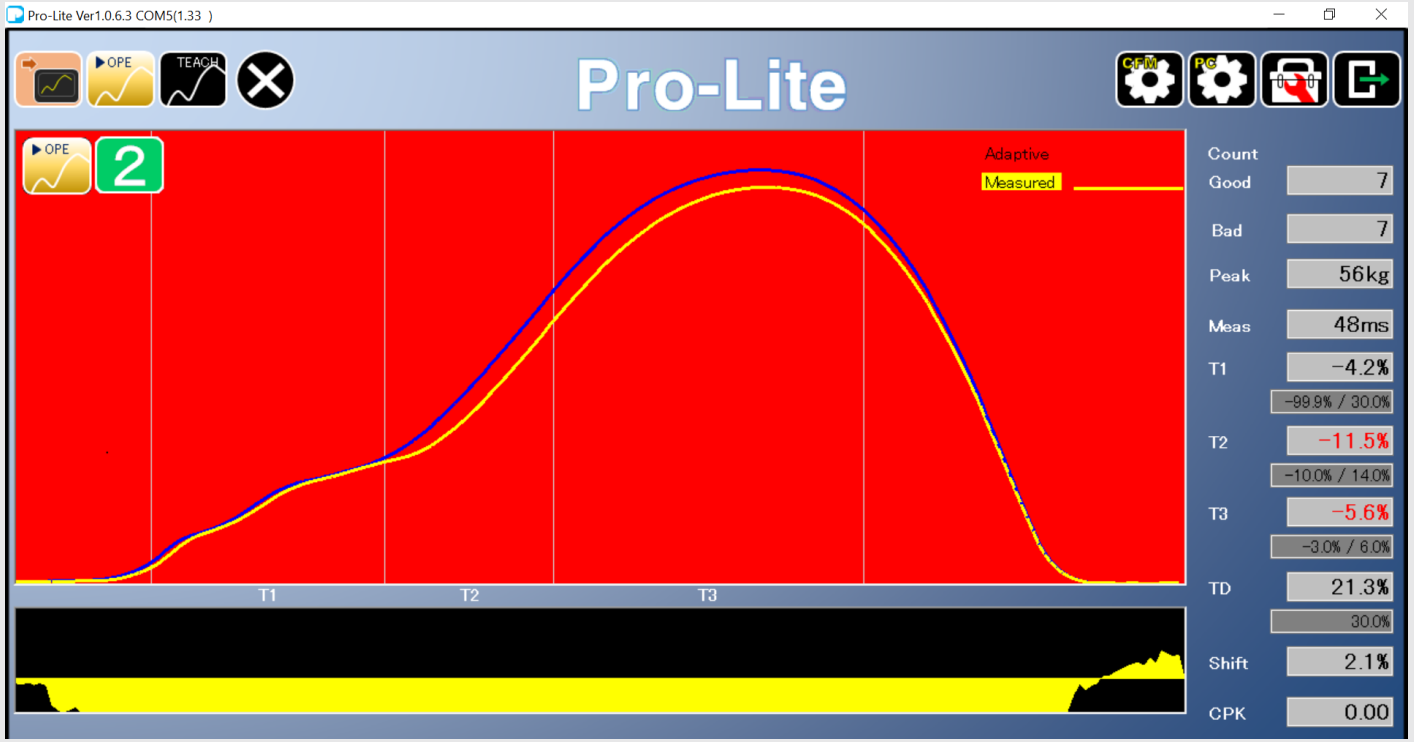


Crimp Defects

Crimp Defects and CFM Alarms

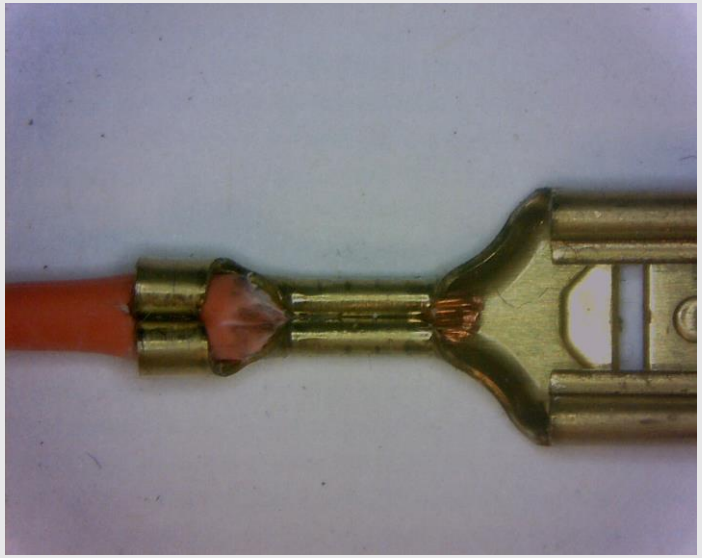
- Strands Missing

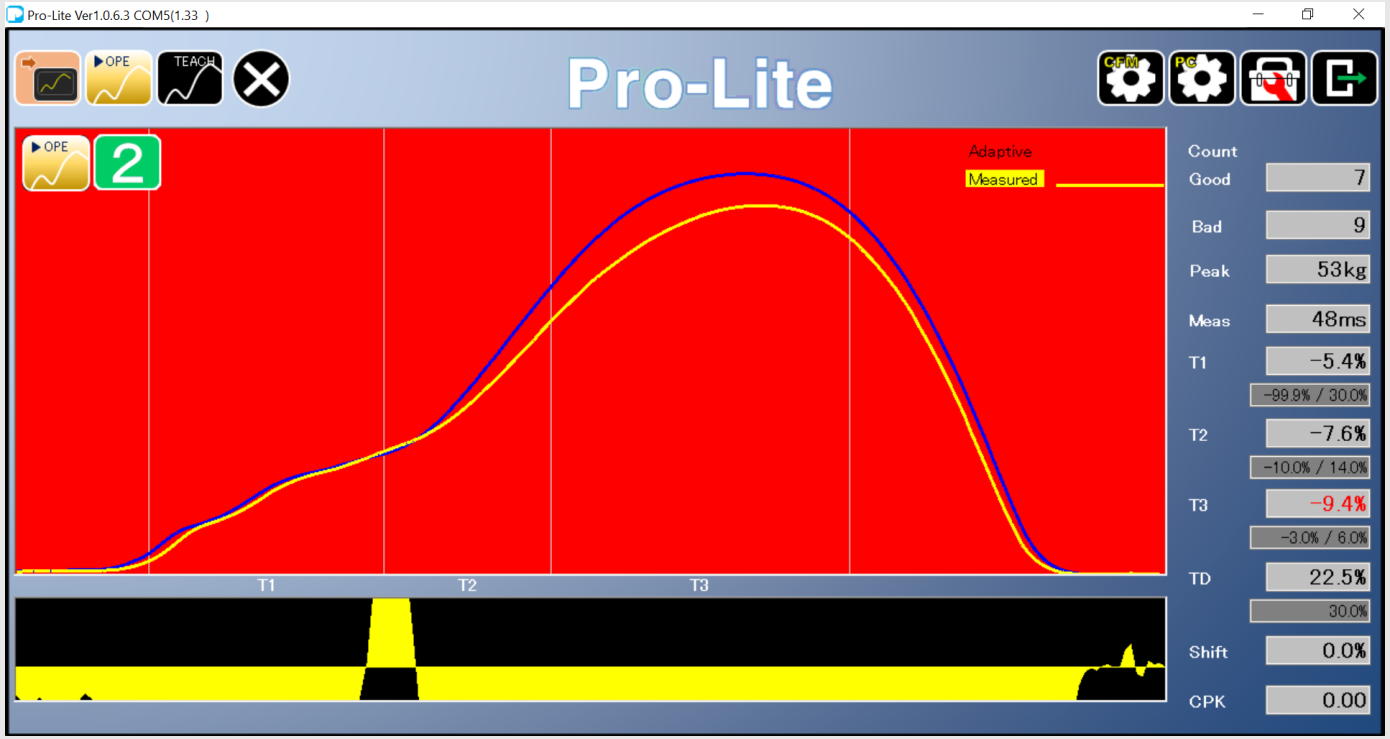




Crimp Defects and CFM Alarms

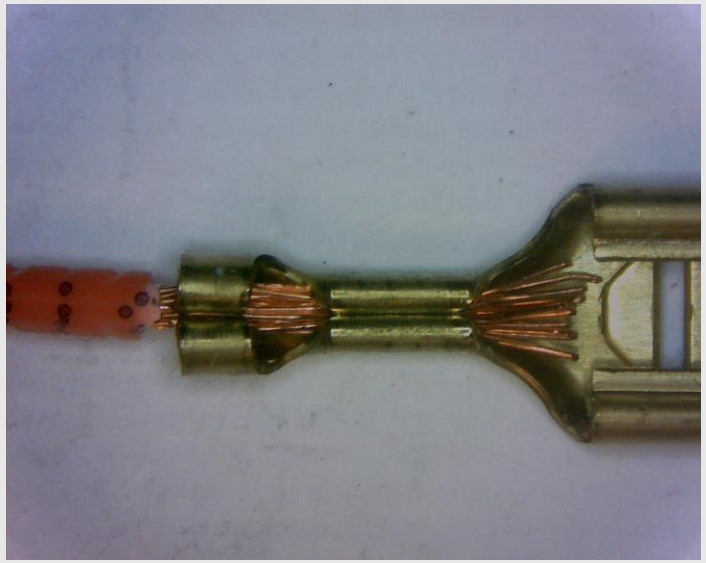
- Insulation in Wire Crimp

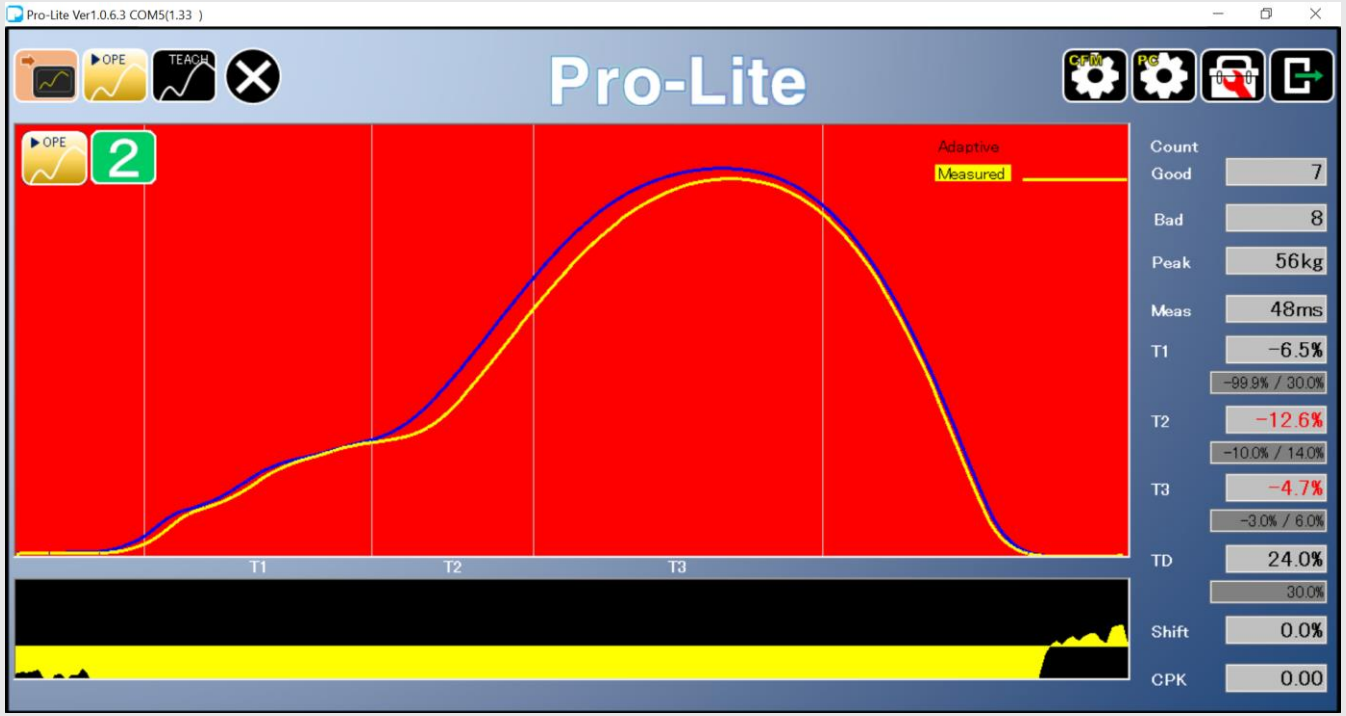




Crimp Defects and CFM Alarms

- Insulation Outside Insulation Crimp.





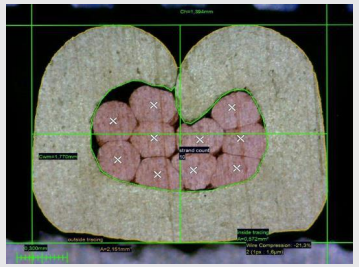
Troubleshooting Crimps

Troubleshooting Crimps

- Conductor Compression
- Internal Crimp Shape Causing CFM Alarms
- Headroom
- Other Considerations

Conductor Compression

-20%



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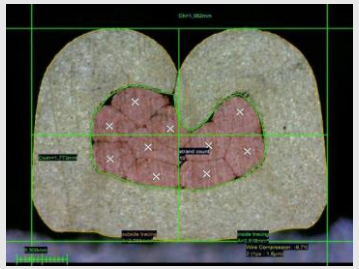

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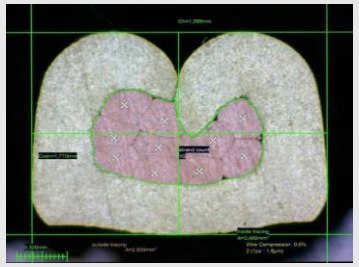

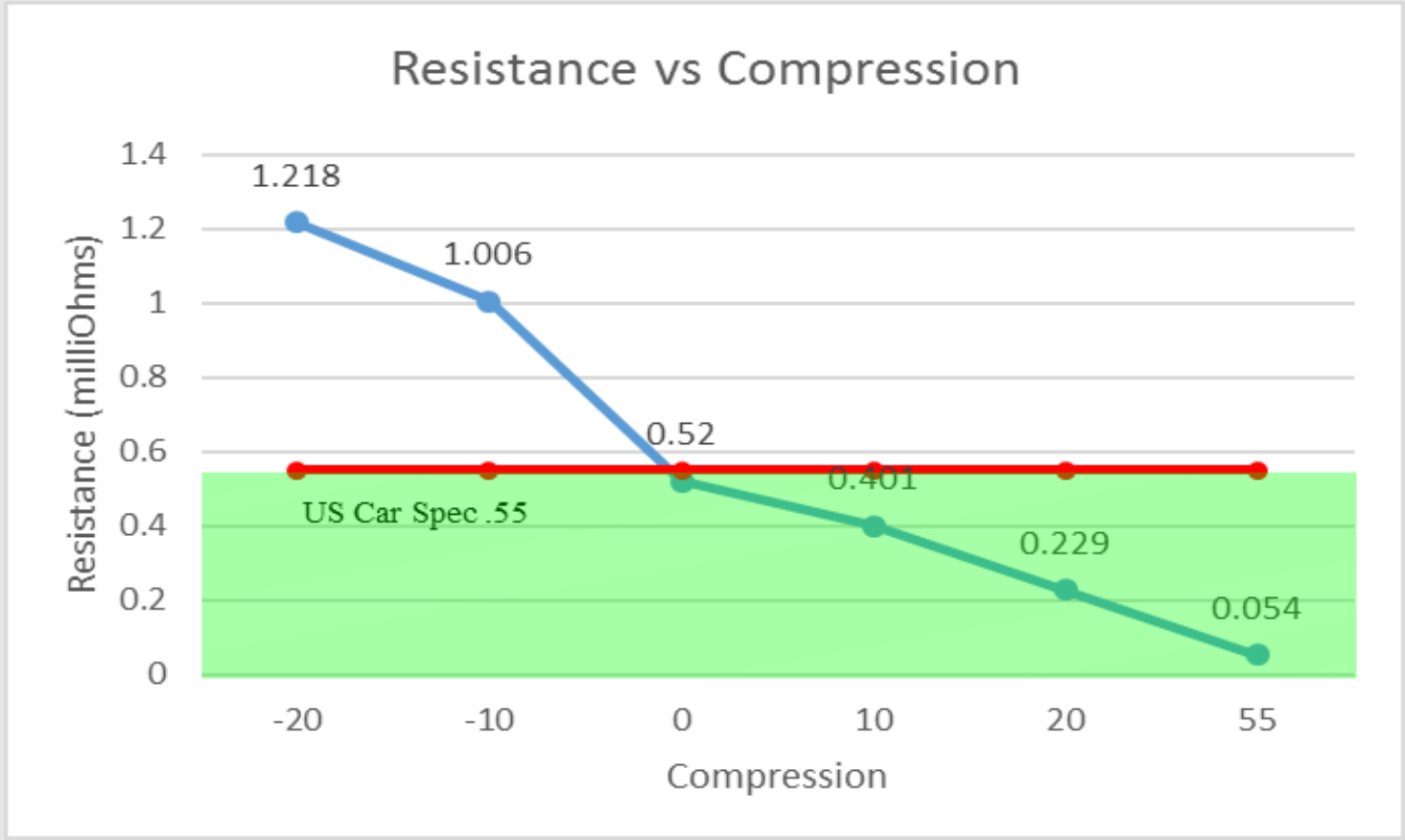

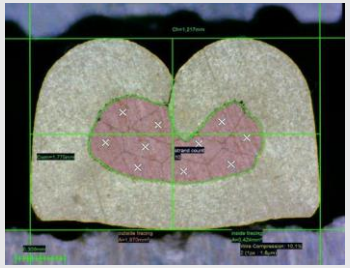

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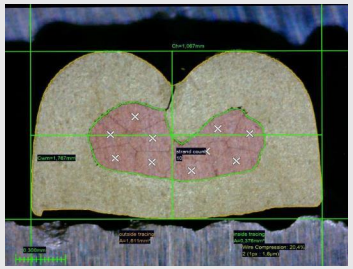

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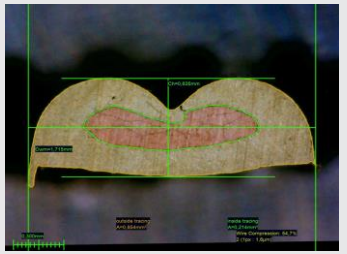

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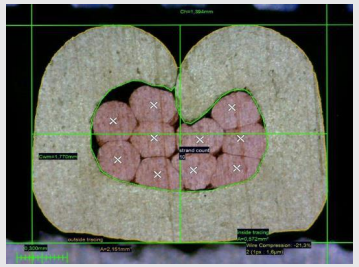
Conductor Compression

-20%



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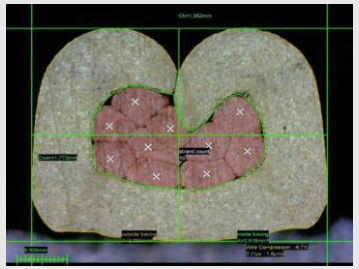

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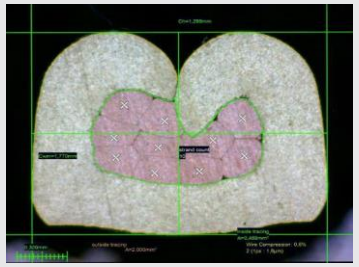

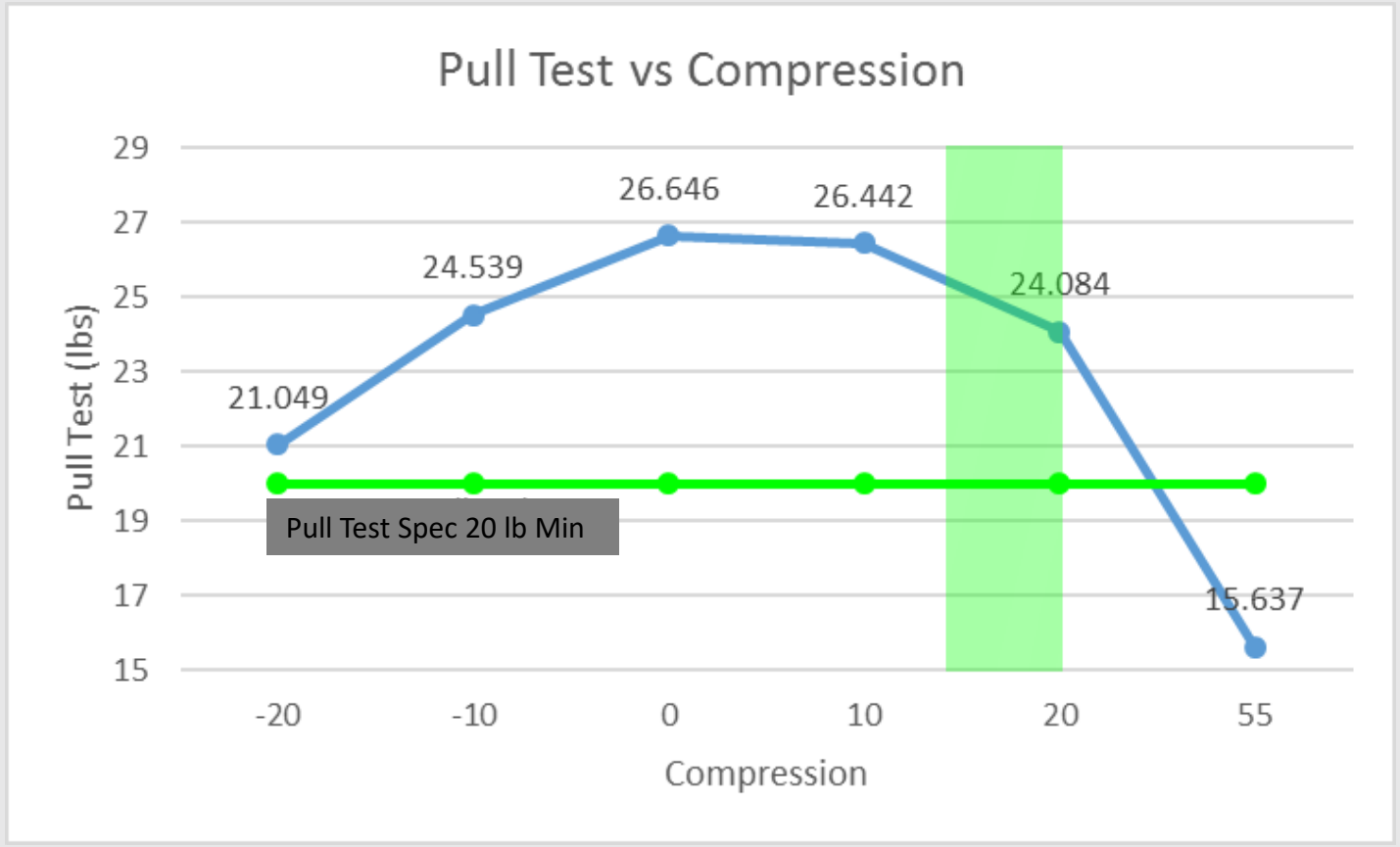

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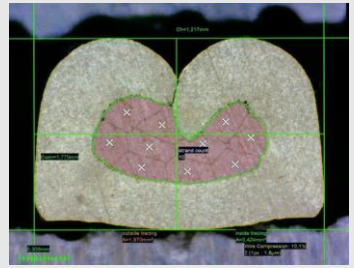

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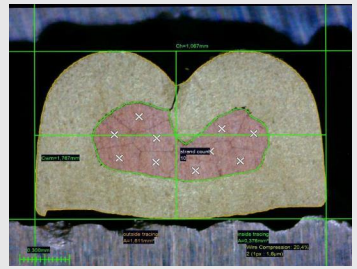

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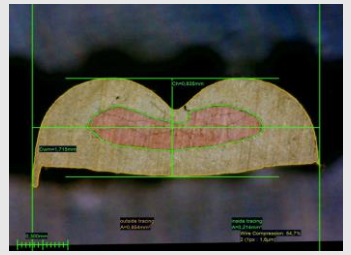
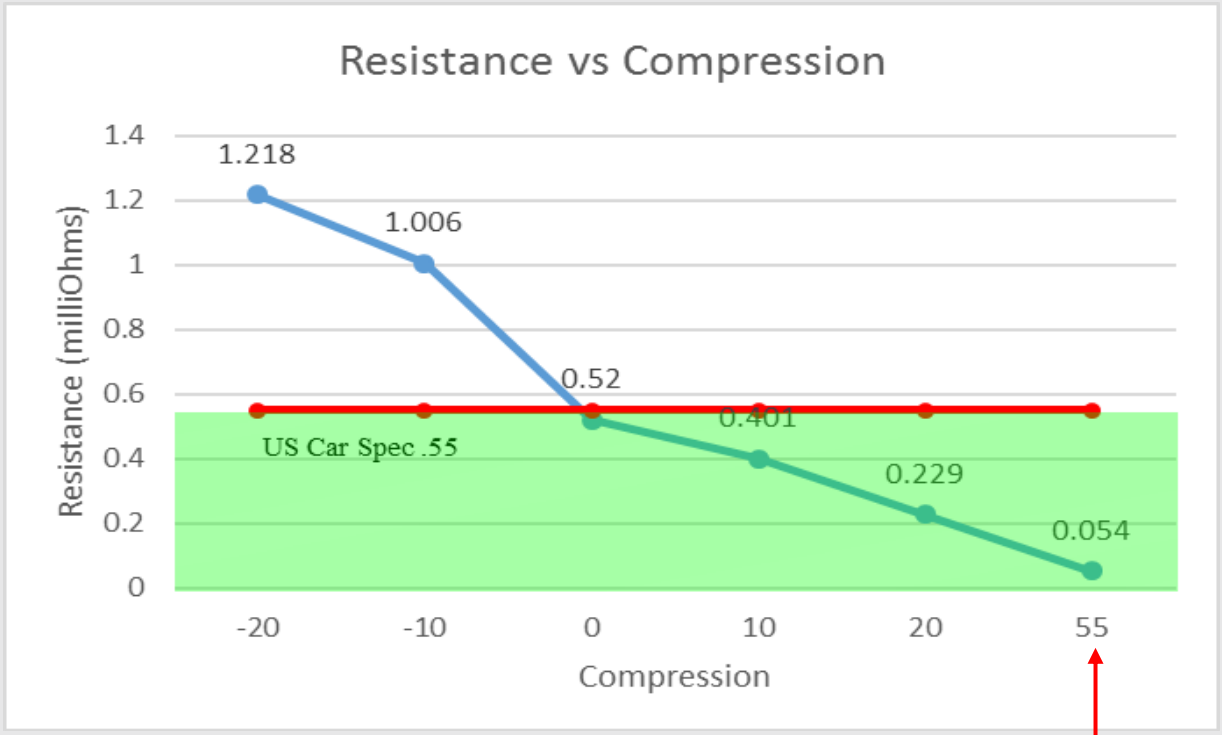
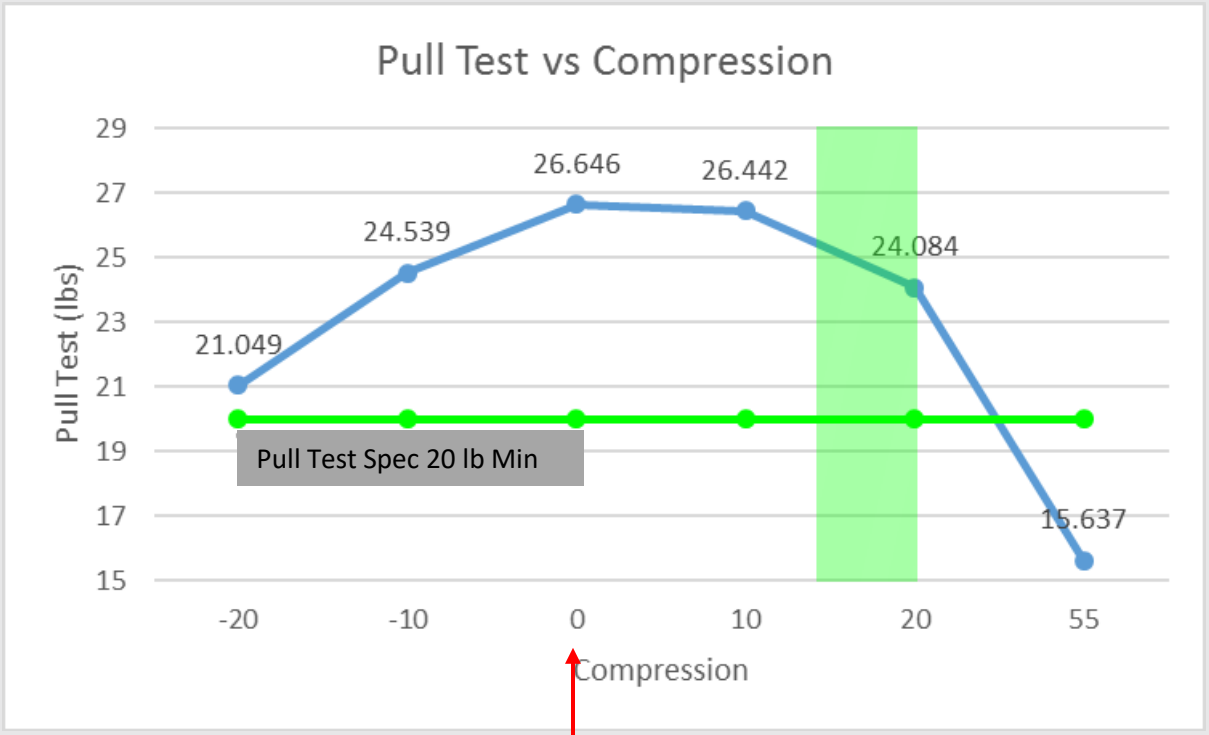
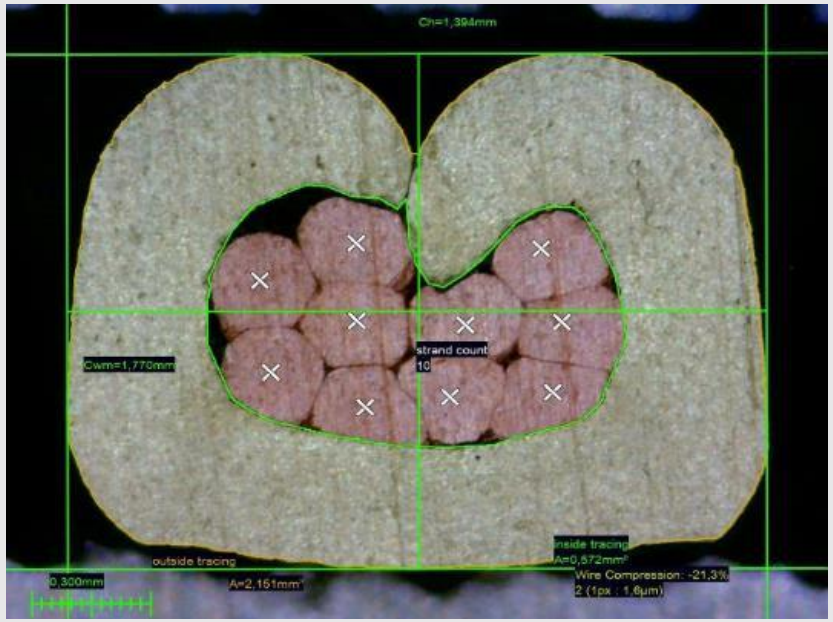


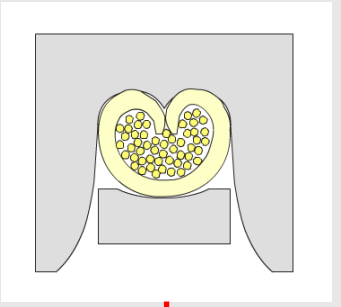
Conductor Compression

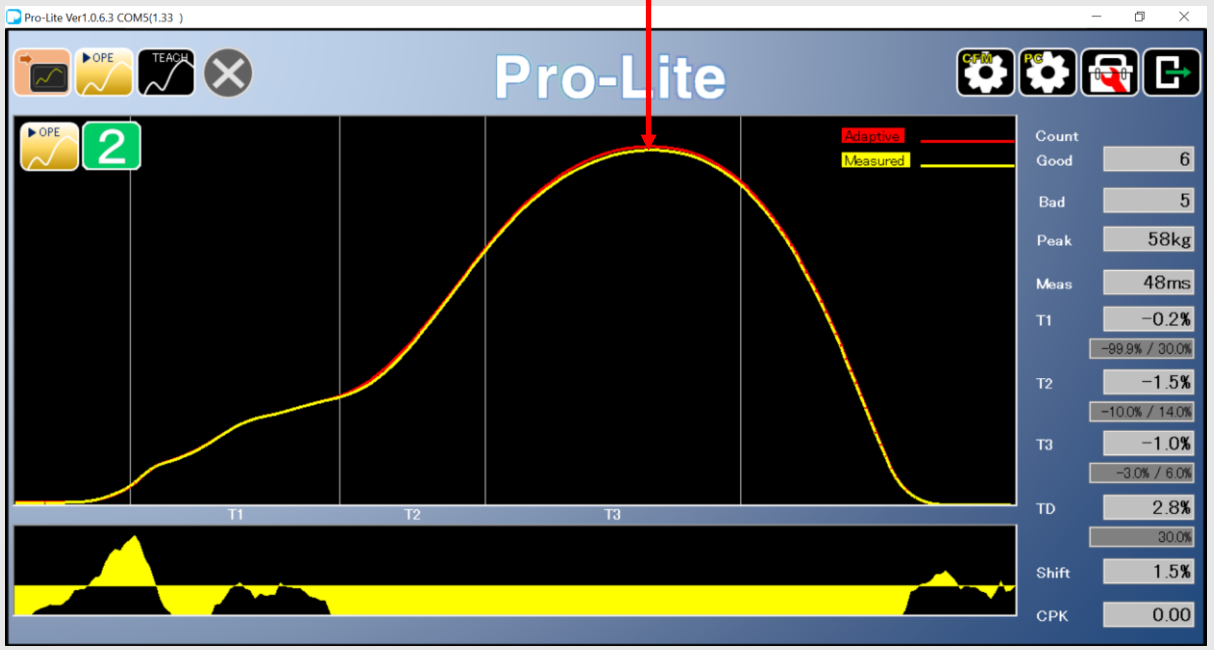




Conductor Compression



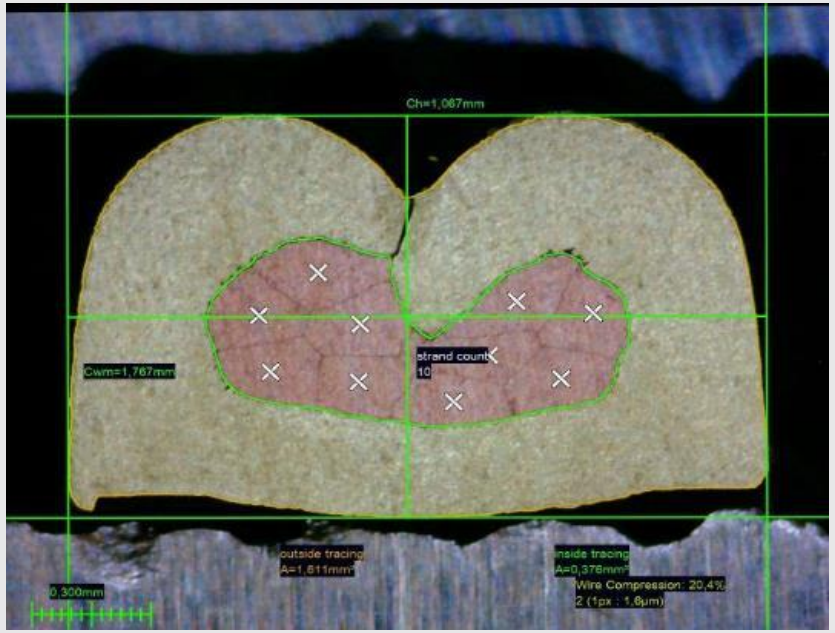


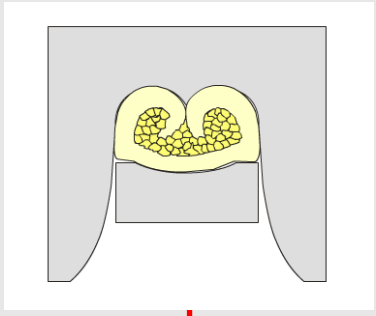


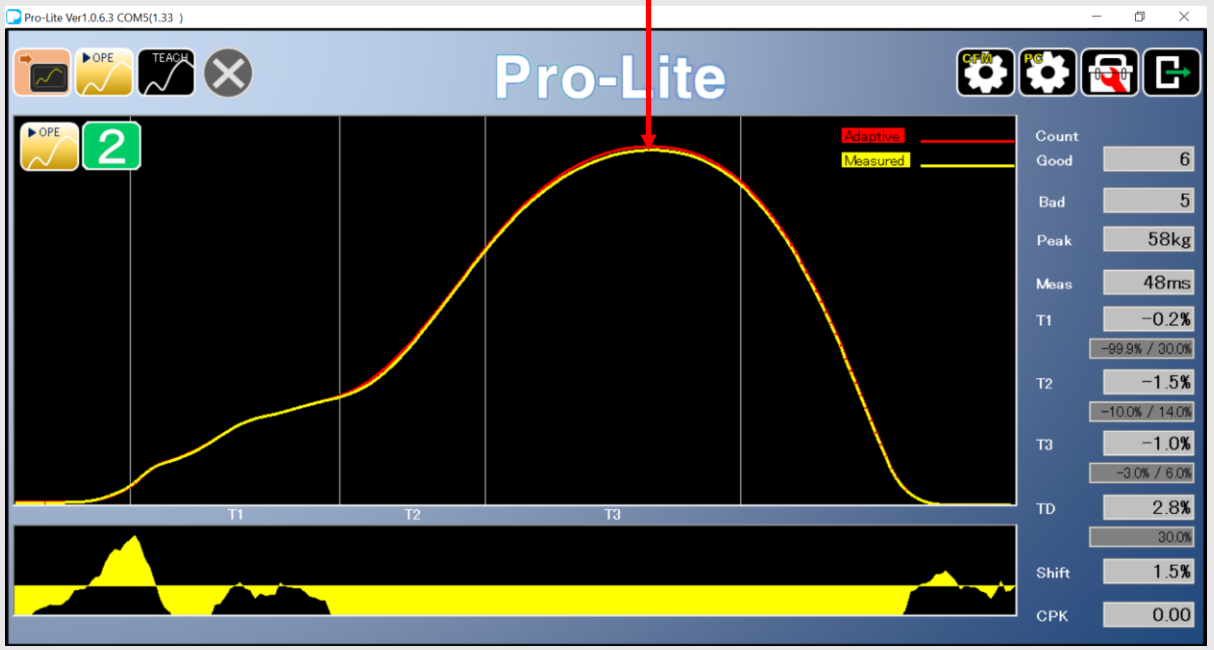
Crimp With Un-Compressed Strands

- High Electrical Resistance
- Low Pull Force
- CFM Detection less sensitive.

Conductor Compression



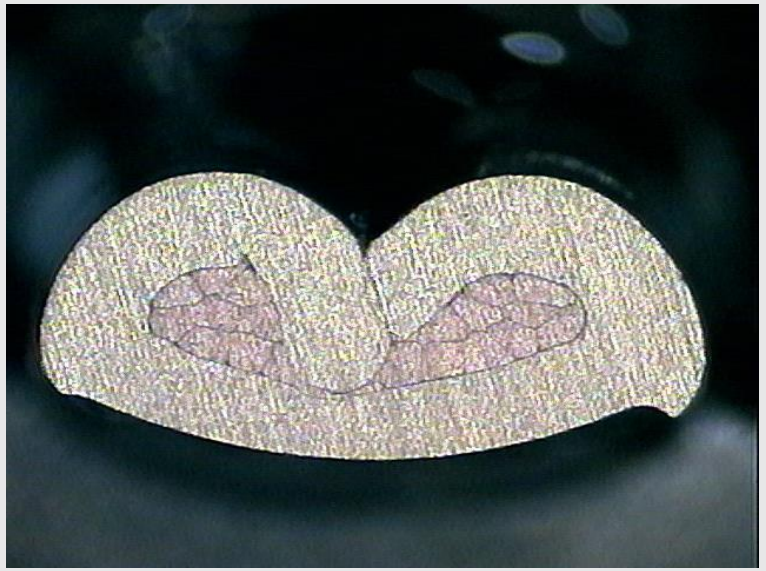




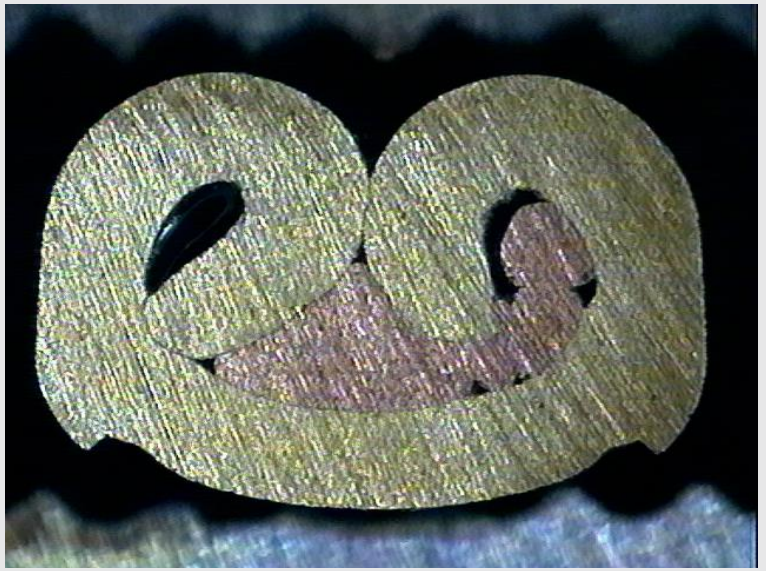
Crimp with Compressed Strands

- Lower Electrical Resistance
- Higher Pull Force
- CFM Detection more sensitive

Cross Section

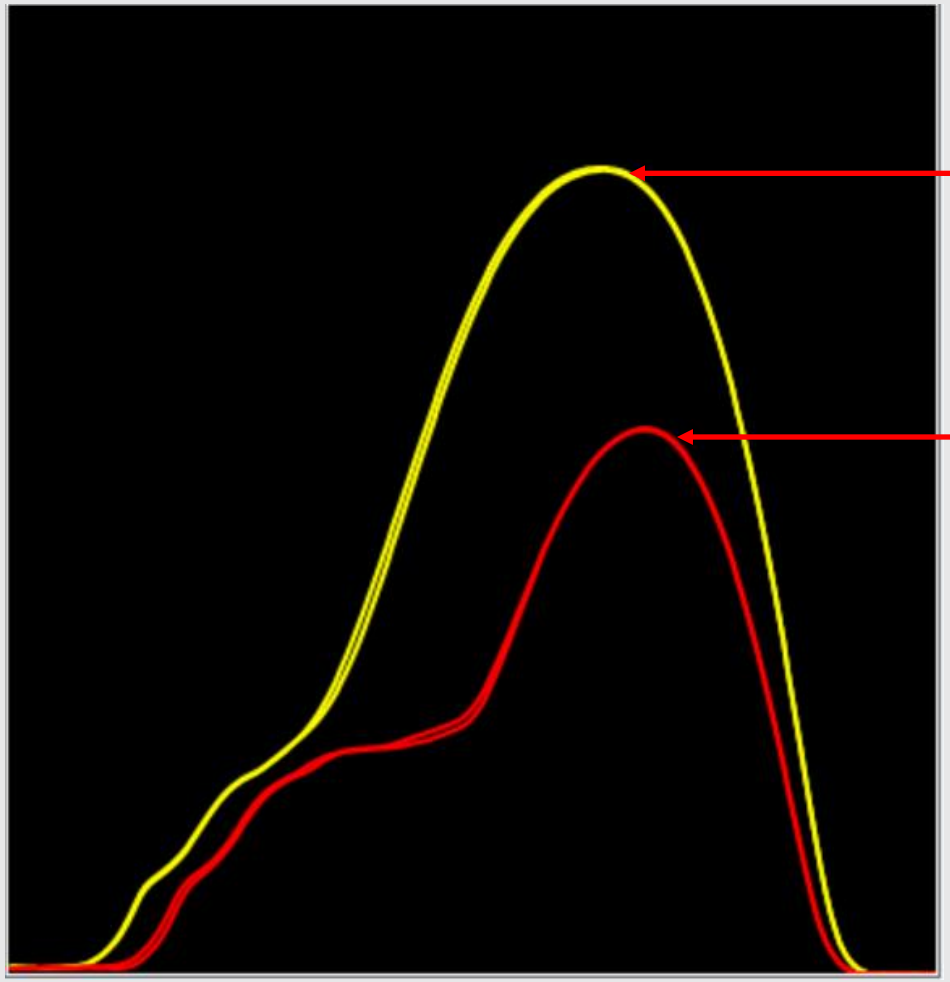


Crimp Legs Crashing to the terminal floor



Crimp Legs Curling over and contacting the wall with (or without) strands encapsulated.

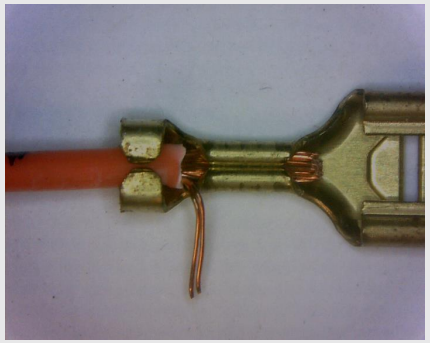
Headroom



Headroom

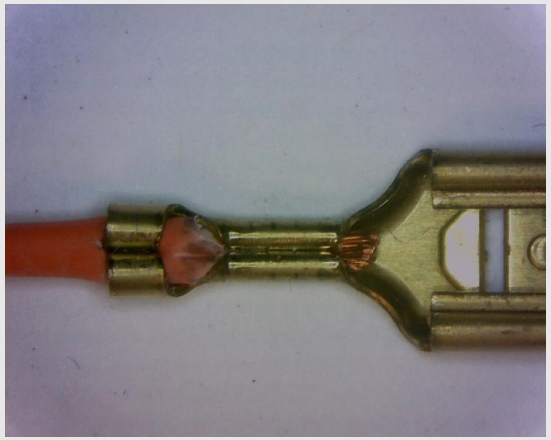
Additional Considerations

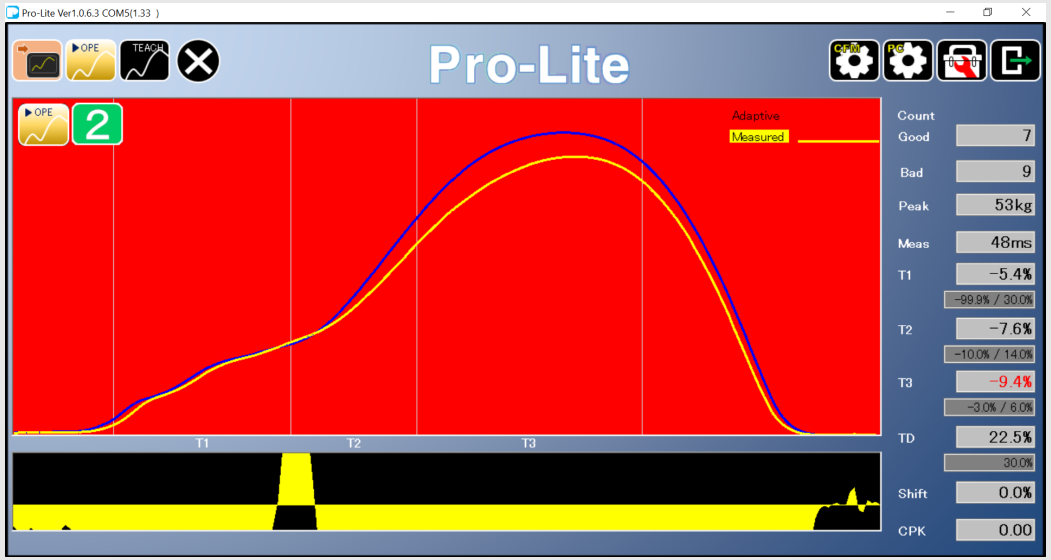
- Do Crimp Operators have control over tolerance setting?
  - Sufficient Training and Control Over Setting Tolerances.
- How are crimp defects handled to prevent introduction into downstream processing?
  - Is there a method to document defective crimp, segregate from production stream and destroy?



Additional Considerations

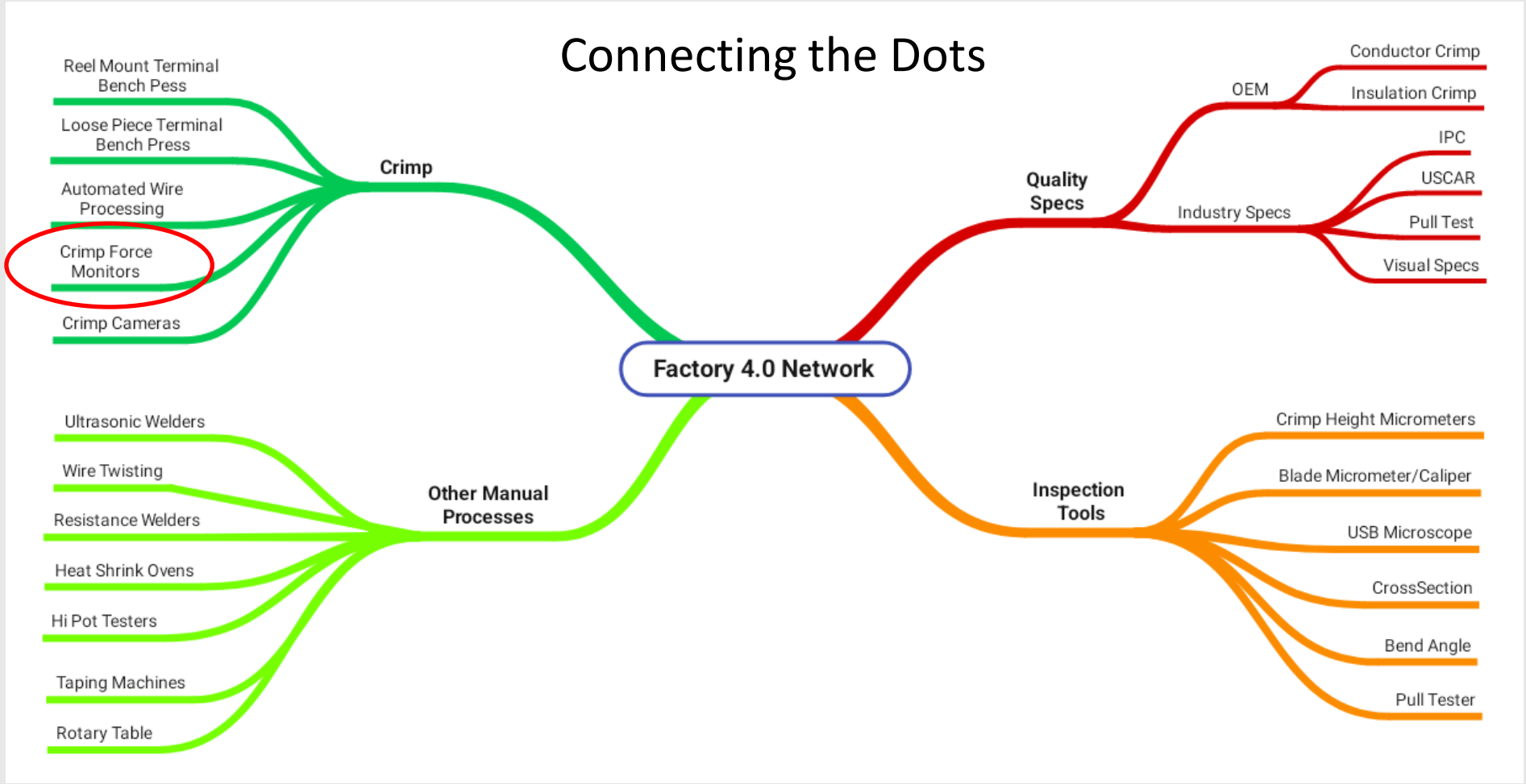
- Is there a process in place to test effectiveness of crimp force monitors.
  - Crimp a defective wire to see if the CFM detects it.





Network Integration

Network Integration



Industry 4.0 Network Deployment

- How Does a Crimp Force Monitor fit into an Industry 4.0 Network?
  - Tolerance Setting associated with a Terminal Crimp Setup.
  - Tolerance Settings enforced by Network.
    - Additional level of security.
    - Reduces Plant Floor Subjectivity.
    - Manual tolerance change will trigger a full crimp validation.

Industry 4.0 Network Deployment

- Crimp Alarms
  - Will require taking a picture of the defect
  - Enforce destruction of the defective circuit
- Crimp Force Results (good and defect) recorded and archived by Network.

Summary

Summary

- Elements of a Crimp: Wire, Terminal, Crimp Tooling, Crimp Press, Crimp Press Operator
  - Ensuring Each Element is Repeatable
- Fundamental Crimp Specs
  - Visual and Measured Specs, Cross Section, Bend Angle
- Conductor Compression
- Headroom

Summary

- Other Considerations
  - Defect Destruction
  - Replicating Crimp Defect to confirm CFM Detection
- CFM in an Industry 4.0 Factory Network
  - Enhanced Functionality vs Standalone CFM
  - Helps to Reduce Subjectivity on CFM Tolerance Setting

Thank You for Attending

Thanks to Chris LaRue and C&S Technologies
for assisting in this seminar.

Please Visit www.cs-technologies.com/
Crimp Force Monitors, Cross Section, Pull Test
Industry 4.0 Factory Network.

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Questions.