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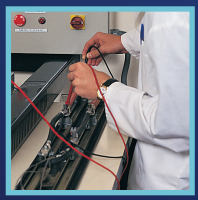
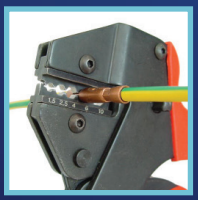
creative wiring solutions

CTT



A Comprehensive Guide To Good Crimping Practice

www.cablecraft.co.uk

This guide has been produced to help you achieve a perfectly crimped terminal or splice every time. The following pages illustrate the 'Do's' and 'Dont's' of using matched terminals and tooling from the extensive Cablecraft-CTT product ranges, coupled with advice on correct wire preparation and sizing.

Although many of the illustrations shown in this guide show crimping with smaller wires and terminals, all the techniques discussed apply to all wires of all sizes, all types of conductor, and all insulation materials. These techniques also apply to all types of crimp terminals including Open barrel, Closed barrel, and Copper Tube type terminals. These techniques are not brand specific, and apply to all types of these products from all manufacturers.

CONTENTS

CORRECT SIZING & PREPARATION OF CABLES & WIRE

Good Wire Preparation and Crimping Techniques, Eliminates Waste of Poor Quality Crimped Terminations

The Correct Method For Cable Sizing

What is CMA?

CMA is used to calculate the actual size of the conductor whether it be round, square or rectangular. AWG is used to size wire in the USA, and mm^2, although used throughout Europe and the far east, it is a typical wire size system rather than an actual measurement. Although many wire and cables are sized in mm^2, when measured the actual amount of copper used in the construction of the conductor is often less than the stated mm^2 would define.

This is allowable under the specifications in force for the construction of wires and cables, but can cause problems when crimping to an expected pull off and millivolt drop or resistance standard. So it is best to convert all sizes to CMA, which can also combine conductors of a differing size and shape together to arrive at a size reference that a terminal can be selected from.

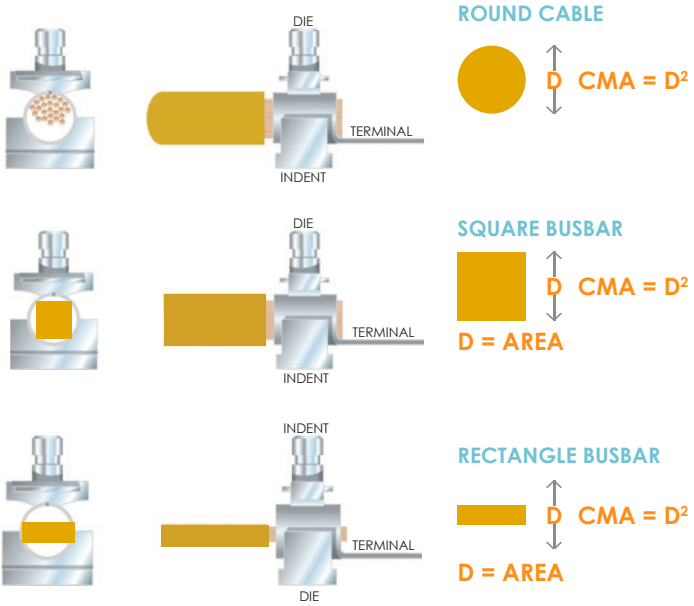
CMA = Circular Mil Area

C **Circular** mil area defines the cross-sectional area of the circular object.

M **Mil** is one thousandth of an inch. (1 mil = 0.001")

A Used extensively for calculating **Area** of electrical conductors.

Pictured below are 3 examples of where CMA could be applied.

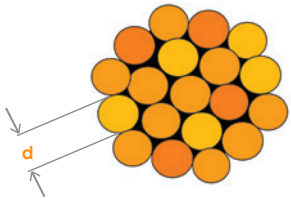


For Solid Wire - Multiply the diameter of the wire (in mils) by itself.
Solid Wire CMA Formula = D^2 = Area D^2
Square millimetre to CMA calculators can be easily found on the internet.

Calculating Circular Mil Area (CMA) For Stranded Wire

Multi-conductor wire (stranded). Square the diameter of one conductor* of wire and multiply times the number of strands.

Stranded wire CMA formula = $D^2 \times N$



$CMA = d^2 \times N$

N = Number of Strands

* NOTE: To obtain an accurate CMA calculation of a multi-conductor wire, the CMA for each individual wire strand must be calculated and added together.

CMA Chart

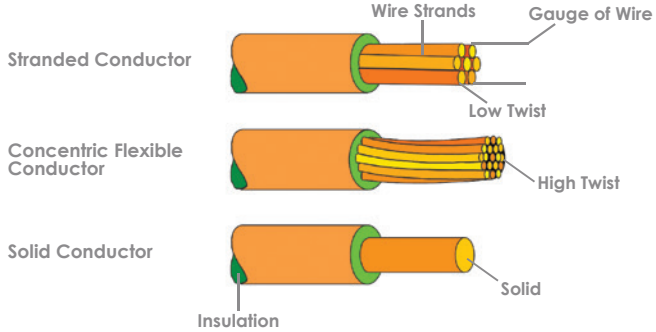
NOMINAL WIRE SIZE		N = NUMBER OF STRANDS	STRANDS	DIAMETER
CMA	AWG	MM²	INCH	MM
1504	18.5	0.75	30	.0071	0.180
1600	18	0.8	16	.0100	0.254
1624	18	0.8	1	.0403	1.024
2537	16	1.25	16	.0125	0.320
2581	16	1.3	1	.0508	1.290
2800	16	1.4	7	.0200	0.508
3260	15	1.6	1	.0571	1.450
4123	14	2	26	.0126	0.320
4167	14	2	105	.0063	0.160
4234	14	2	84	.0071	0.180

Our experience has revealed that cable diameters and tolerances can vary not only from manufacturer to manufacturer, but it can also vary on the same grade of cable produced by one manufacturer on different machines. Imported cables have additional variations in hardness/softness of copper. Variations in dimensions of cross section is dependant on cable and flexible cable make up. Flexible cables may be straight lay or bunch weaved.

It should also be noted that the British Standard BS 6360 only stipulates maximum O.D. of the cable and defined resistivity over a measured length of cable conductor. Unless the cable is carefully selected for its make up type and the O.D. is directly related to the terminal I.D, problems may result.

Elements Of Wire & Types Of Conductors

Copper wire is manufactured in three different types to cover different applications. The examples below show stranded, flexible and solid conductors.



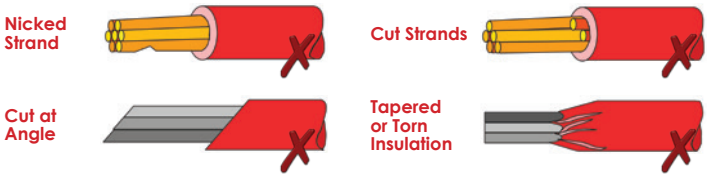
Wire Preparation

To make a good electrical connection you first have to strip the cable correctly. The following diagrams show the correct and incorrect method of stripping cable and the results of a poorly stripped cable.

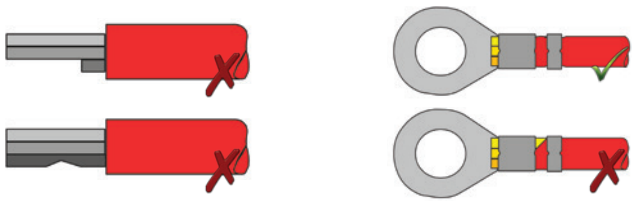
Stripping Wire; Good Strips

Stripping Wire; Bad Strips

Remove proper length of insulation cleanly: no nicking, cutting or breaking of wire strands.



Results of Bad Strips = Loss of Electrical Characteristics

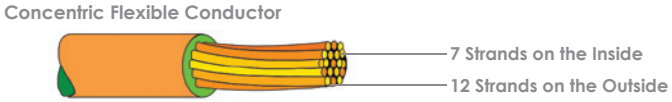


Nicked and cut strands = Decreased electrical and mechanical strength.

Uneven or tapered strip = Insulation in wire crimp or ineffective insulation support.

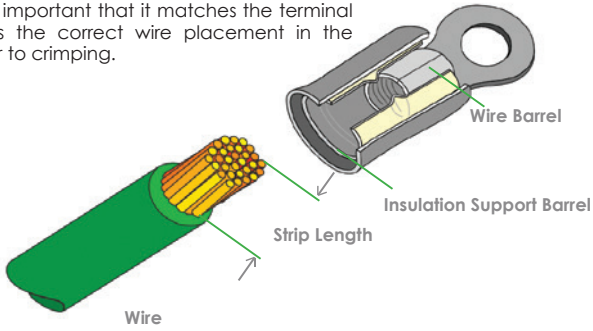
Damage to Conductor

Extra care needs to be taken when stripping concentric flexible cable as 63% of the outer wire can be damaged during the stripping process.



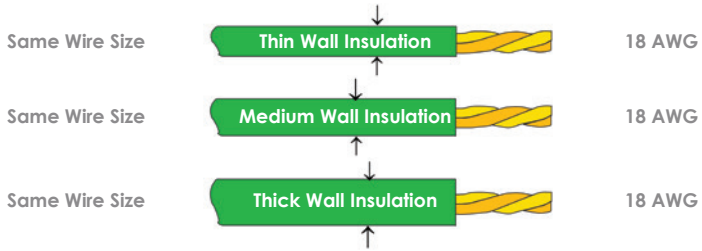
Strip Length

Strip Length is key to correct wire placement in the terminal. It is important that it matches the terminal and enables the correct wire placement in the terminal prior to crimping.



Wire Insulation Variations

1. Wire insulation diameters vary among wire of the same mm^2 and AWG wire size.
2. Terminal insulation barrel must be designed to accommodate insulation O.D. of wire being used.
3. Tooling with correct insulation crimp range must be used to ensure good insulation support crimp.



AMP CTT Terminal Selection Guide

When selecting a terminal for your application consider the insulation material specification e.g. Halogen-free, high temperature etc, and consider the technical capabilities of the terminal.

INSULATION MATERIALS	PRODUCT	APPLICATION
PVC	AMP PLASTI-GRIP, CTT EASY ENTRY	GENERAL INSTALLATION
NYLON	AMP PIDG, CTT NYLON EASY ENTRY, CTT VIBRATION RESISTANT.	OPERATING TEMP UP TO 105˚C
PVF	AMP PIDG	RADIATION RESISTANT
TEFLON	AMP PIDG	ACID RESISTANT, HIGH TEMPERATURE TO 288˚C
POLYOLEFIN	AMP SEALED TERMINALS	MOISTURE RESISTANT

AMP CTT Cable Cross Reference Chart

WIRE SIZE MM²	TYPICAL CABLES (METRIC)	AMP CODE
0.5	16/0.20	22 - 16
0.75	24/0.20	22 - 16
1.0	32/0.20 1/1.13	22 - 16
1.5	30/0.25 1/1.38	22 - 16 16 - 14
2.5	50/0.25 1/1.78	16 - 14
4	56/0.30 7/0.85	12 - 10
6	84/0.30 7/1.04	12 - 10
10	80/0.40 7/1.35	8
16	126/0.40 7/1.70	6
25	196/0.40 7/2.13	4
35	276/0.40 19/1.53	2
50	396/0.40 19/1.78	1/0
70	360/0.50 19/2.14	2/0
95	475/0.50 19/2.52	3/0
120	608/0.50 37/2.93	231 - 300 MCM
150	756/0.50 37/2.25	231 - 300 MCM
185	925/0.50 37/2.52	300 - 380 MCM
240	1221/0.50 61/2.25	380 - 478 MCM

CRIMP TERMINAL TYPES

Types of Terminals

Terminal specifications can vary greatly, so it is important to check the type of material and thickness specified by the terminal manufacturer. Most crimping standards are written around pre-insulated copper ring terminals and do NOT include open barrel terminals.

Closed Barrel FASTON Receptacle manufactured from 20 thou brass, phosphor bronze or nickel steel.

Open Barrel, End Feed Ring Tongue manufactured from 20 thou brass, phosphor bronze or nickel steel.

Open Barrel FASTON manufactured from 20 thou brass, phosphor bronze or nickel steel.

Closed Barrel Slotted Ring Tongue manufactured from 32 thou copper.

Copper Sheet Terminals manufactured from flat copper sheet and brazed seams.

Copper Tube Terminals manufactured from seamless copper tube.

Terminal Base Metals

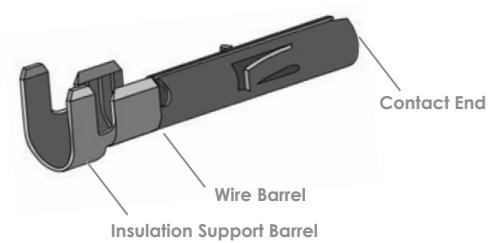
MATERIALS	USED FOR	REASON
COPPER	Common Terminations	Conductivity
BRASS	Pins, Sockets	Hard Material
ALUMINIUM	Al Conductor	Light Weight
NICKEL	NI Conductors	High Temp
BRONZE	Termi Point Clips	High Pressure

Tin Commandments

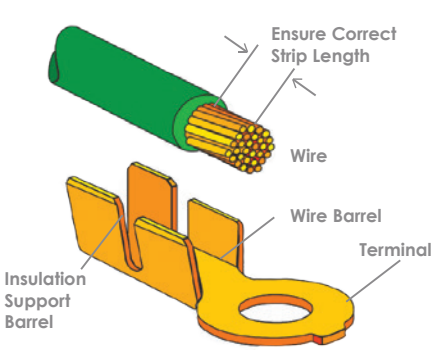
Tin or Tin alloy coatings are cost effective and reliable alternatives to gold if used according to the following guidelines:

1. Tin coated contacts should be mechanically stable in the mated condition.
2. Tin coated contacts need at least 100 grams contact normal force.
3. Tin coated contacts need lubrication.
4. Tin coating is not recommended for continuous service at high temperatures.
5. The choice of plated, reflowed, hot air leveled, or hot tin dipped coatings does not strongly affect the electrical performance of tin or tin alloy coated contacts.
6. Electroplated tin coatings should be at least 100 microinches thick.
7. Mating tin coated contacts to gold coated contacts is not recommended.
8. Sliding or wiping action contact engagement is recommended with tin coated contacts.
9. Tin coated contacts should not be used to make or break current.
10. Tin coated contacts can be used under dry circuit or low level conditions.

Parts of a Terminal - Open Barrel (F-Crimp)



Functions of Wire & Insulation Support Barrels in Open Barrel Terminals



Wire Barrel

Provides electrical and mechanical connection to wire conductor(s).

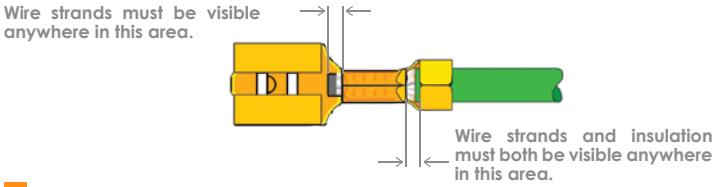
Insulation Support Barrel

- Provides strain relief for wire insulation.
- Requires a more relaxed crimp than wire barrel crimp.
- Provides no electrical connection or appreciable mechanical strength.

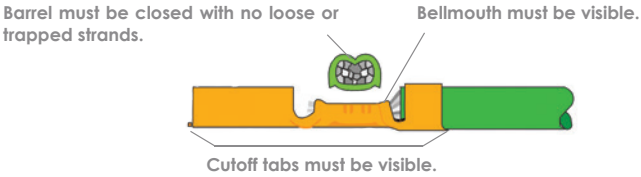
Insulation Crimp Adjustment

'F' Crimp - Insulation support barrel forms in the same configuration as wire barrel crimp, but more relaxed.

Crimp Inspection For Open Barrel Terminals

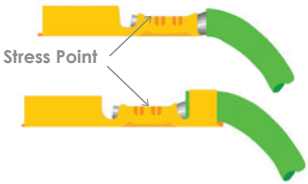


1. Wire strands must be visible between wire stop and end of wire barrel.
2. Bellmouth must be visible at window end of wire barrel.
3. Wire insulation must be inside insulation support sleeve.

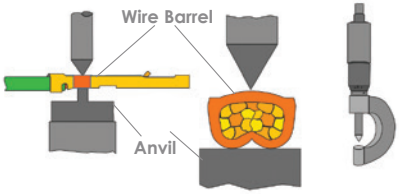


1. Cutoff tabs must be visible at insulation barrel and mating end of terminal.
2. Wire strands must be visible at contact end of wire barrel but must not extend past area indicated.
3. Wire strands and insulation must both be visible anywhere between wire barrel and insulation barrel.
4. Bellmouth must be visible at wire end of wire barrel.

Advantages of Insulation Support

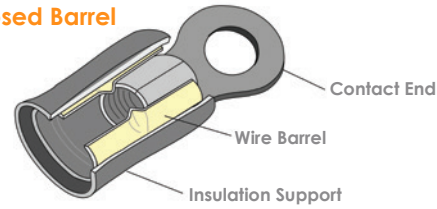


Checking Crimp Height



1. Check crimp height of finished termination using crimp height comparator.
2. Crimp height data is found in instruction sheet (hand tools) or on data plate (applicators).

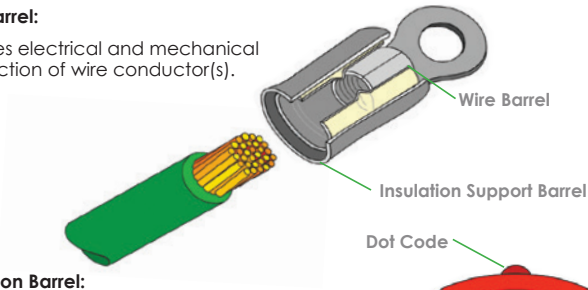
Parts of a Terminal - Closed Barrel



Functions of Closed Wire Barrel & Insulation Support Barrel

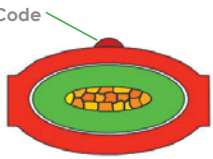
Wire Barrel:

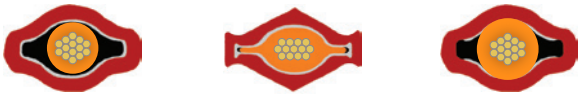
Provides electrical and mechanical connection of wire conductor(s).



Insulation Barrel:

- Provides strain relief for wire insulation.
- Requires a more relaxed crimp than wire barrel crimp.
- Provides no electrical connection or appreciable mechanical strength.



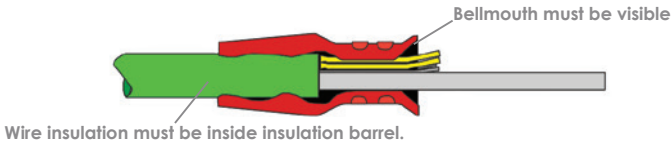


'O' Crimp - Insulation support barrel wraps around wire insulation.

Examples of insulation support crimp adjustments:

1. Too Loose: No mechanical support or strain relief for wire.
2. Too Tight: Barrel digs into wire strands - can actually break wire strands.
3. Optimum: Wire insulation held firmly. Slight indenting of insulation. Good mechanical support and strain relief.

Proper Strip Length & Placement of Wire

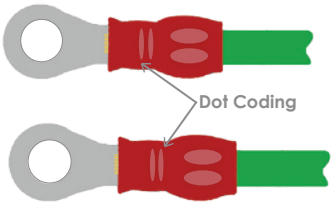


Dot Code

The Purpose of Dot Coding

- Identifies tool with terminal.
- Will show wrong combination of tool and terminal.

WIRE RANGE	COLOUR	AMP DOT CODE	CTT DOT CODE
26-22	Yellow	One	●
24-20	White	Two	●●
22-18	Red	One	●
16-14	Blue	Two	●●
16-14HD	Black (BR)*	One	●
12-10	Yellow	One	●



* BR Network Rail Standard

Crimping Procedure

A Cut wire to length, cleanly.

B Strip wire ends, ensuring the insulation is removed cleanly and square with axis, with no breaking or nicking of wire ends visible.

C Use the recommended stripped length appropriate to the connector being used, ensuring all strands are inserted into the crimp barrel.

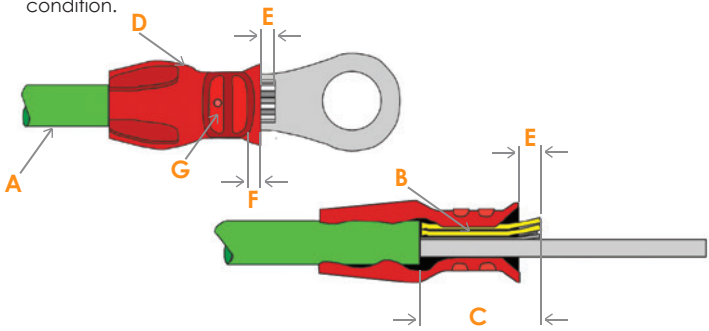
D Ensure the selected crimp die form is suitable for the correct combination of wire size and connector being used.

E Insert conductor, stripped, to a length which leaves approximately 1mm visible at front of barrel.

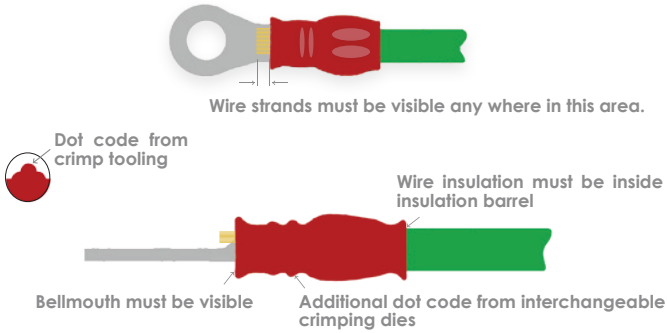
F Position in die such as to leave approximately 1mm of barrel to form a bellmouth at the front of the barrel.

G Check the correct Dot Code is being used.

H Ensure the tool and dies are calibrated and maintained in a serviceable condition.



Crimp Inspection Procedure

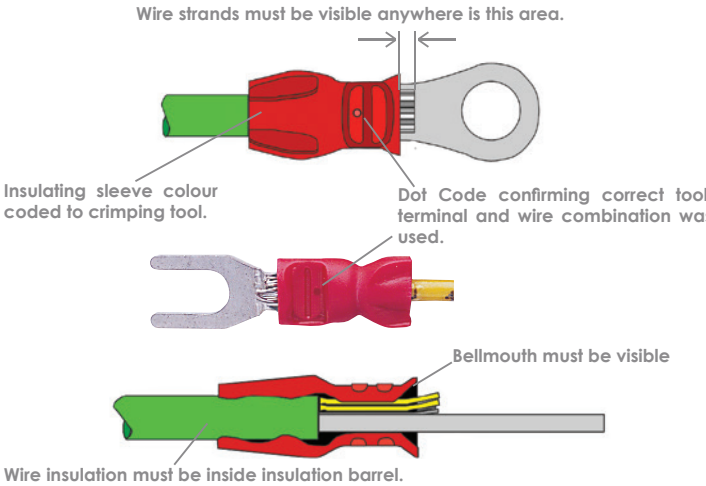


Crimp Inspection Checklist

Examples of insulation support crimp adjustments:

1. Wire strands must be visible at tongue end of wire barrel, but must not extend past area indicated.
2. Bellmouth must be visible at tongue end of wire barrel.
3. Wire insulation must be inside - and supported by - insulation barrel.
4. Dot code should be in accord with instructional material packaged with crimp, tooling and dies. An additional dot code appears on terminals crimped with interchangeable crimping dies.

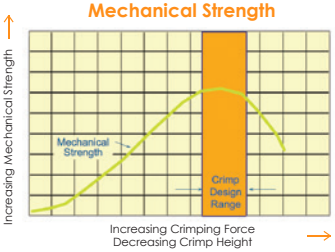
The Finished Crimp Terminal



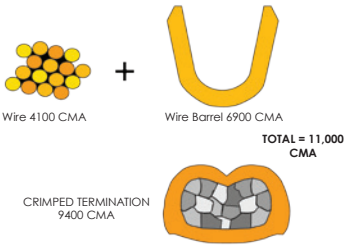
Mechanical & Electrical Characteristics of Crimp Terminals

Additional force applied beyond the crimp design range results in a rapid degeneration of performance both electrically and mechanically.

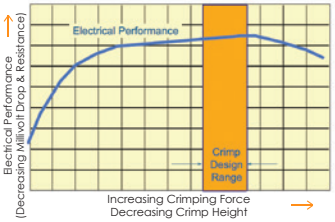
Mechanical Strength

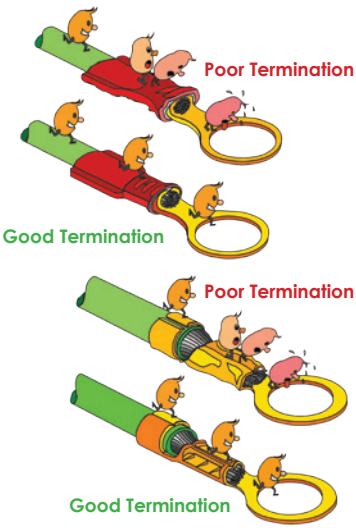


Area Reduction

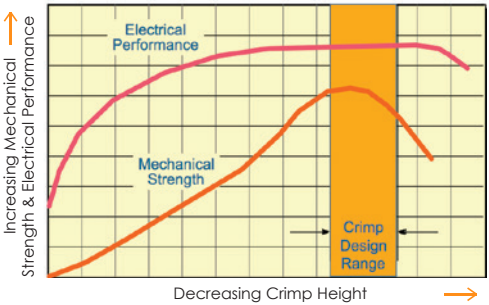


Electrical Performance





Crimp Design Parameters



Copper Tube Power Terminals

The technique of crimping a terminal onto an electrical conductor has been used for over 60 years and is the dominant connecting technique for power cables.

The most important reasons for the success of this system are **simplicity** and **safety**. Cold compression is the optimum technique which provides both.

This system contains from the smallest conductor, 1.5mm², to the largest 1000mm² cross section, a tested combination of terminal size and tool geometry related to the actual size of the conductor.

Manufacturers choose to apply this combination in different ways, for example; a terminal with little material wall thickness in the barrel can be crimped with a press die designed for this situation. The same terminal crimped with another die from a different system, where the die is designed for a terminal with a thicker wall thickness (larger barrel), would result in massive under-crimping which in turn could cause overheating, due to poor electrical contact.

It is of the utmost importance to always check that the tools and terminals are tested together and are purchased from the same manufacturer.

Cablecraft-CTT can offer a fully matched system and advise on suitable terminals for all applications.

Different conductor materials are often crimped with completely different die geometry. For copper, the most common and effective method is the hexagonal crimp. This shape gives a smooth and mechanically strong crimp with little or no risk of the conductor strands being broken.

When crimping aluminium it is important to break the layers of insulating oxide as efficiently as possible, and the indent crimp is the most effective method.

The most important system component is the **operator**. This person must be provided with the necessary information and training to enable them to make a perfect crimp. A high quality product, tooling, clear instructions and comprehensive training course will help ensure this can be achieved every time.

Cablecraft CTT offers full in-house training to all crimping standards.
For more information see page 35.

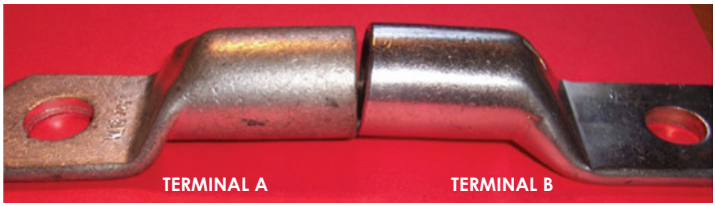
Hexagonal Crimp Double Pass 'Collar' Effect

Indent Type Crimp

Hexagonal Crimp Single Pass

Copper Tube Power Terminals...Are They All The Same?

Terminals A and B are from different manufacturers which appear to be virtually identical in O.D. (outside diameter), I.D. (inside diameter) and wall thickness of the crimp barrel.



They are stamp marked completely differently, terminal A marked for use with 240mm^2 cable and the other marked for use with 185mm^2 cable.

It is clearly critical that if crimping terminal B and using a die marked 185mm^2 that it must be the one made by Manufacturer B as Manufacturer A's 185mm^2 die will be much smaller and would result in massive over crimping of terminal B, if the dies from Manufacturer A were used.

Similarly mixing the dies and tooling for Terminal A would result in massive under crimping. **Never** mix tooling and terminals from different manufacturers.

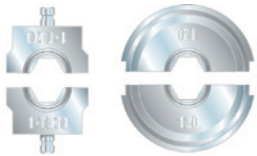
'Spot the difference' - the three terminals above are all marked as 240mm^2

Barrel and palm lengths can also vary.

Good Practice Crimping Guide: Uninsulated Copper Tube Terminals

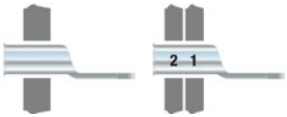
First select the correct crimping tool from the comprehensive Cablecraft-CTT range of tooling. The range includes heavy duty, ratchet and hydraulic options. Then select the correct die:

Use only matched die marked with terminal wire size. Fit die to tool ensuring that both die have the same size crimp cavities.



ASSEMBLY

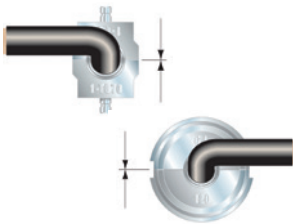
Insert wire into terminal - with hand tools it may be convenient to grip the terminal lightly while doing so. Check tool instructions for whether one or two crimps are required and position the terminal between die as show. For double crimps - crimp in order 1, 2, etc.



CRIMP

Operate the tool until full crimp pressure is achieved. This will be shown by operation of the pressure relief valve and closure of the die faces. Refer to the tool manual for more details.

Operate the pressure relief valve and remove the crimped terminal. Repeat the process if two or more crimps are required.



INSPECT

The completed crimp should look like the first two examples. Following these are examples of bad practice.

A - wire seen in correct position through site hole.

B - correct die reference embossed upon crimp area relates to terminal reference and wire size.

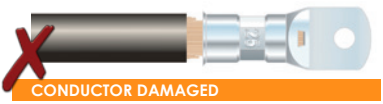
CRIMPED CORRECTLY

CRIMPED TOO NEAR THE PALM

CRIMPED TOO FAR FROM THE PALM

CONDUCTOR NOT FULLY INSERTED

TWO CRIMPS OVERLAPPING



CONDUCTOR DAMAGED

LOOSE STRANDS NOT CRIMPED

CABLECRAFT-CTT & AMP TOOLING

Cablecraft-CTT RTB 510 System

This precision made hand ratchet tool is used in conjunction with a wide selection of dies which cover all types of compression connectors. The tools system offers crimping facilities for:

- Pre-insulated and uninsulated terminals 0.75 to 16mm²
- Copper tube terminals 0.75 to 6.0mm² (indent type) and 0.75 to 6.0mm² (hexagon type).
- Cord end terminals 0.5 to 50mm²

Crimp performance to comply with BS, LUL, Rail Industry and international standards. Its design enables the necessary force to be produced with the minimum effort. Specially designed locating faces and just two retaining screws make changing the die an easy operation.

RTB 510

PCCR-10RT

✓ Adjustment, spares and repair service

✓ On site calibration gauges available

PART NO.	DESCRIPTION	SIZE (mm²)
RTB 510	RTB 510 Tool	0.5 - 50.0
PCCR-10RT	Empty Carry Case for Tool and 10 Die Pairs	- -

CABLECRAFT-CTT RAIL KIT

This kit comes complete in a carry case and contains the following:
1 x RTB-510 tool
1 x Q Relay Connector (FTD63-Q-10RT)
3 x Dies (PVRD15S-10RT, PVRD25S-10RT, PVRD6S-10RT)

PART NO.

RTB-510-BRK

RTB-510 TOOL BODY TEST BLOCK

Tool body test block enables correct setting of tool body to be established. This allows for a fast calibration tool setting check.

PART NO.

TB-10RT

RTB 510 System - Die for Pre-Insulated & Uninsulated Terminals

Made with quality hardened ground steel, each die has ground location faces and two retaining screws to retain die in tool body.

PART NO.	WIRE CSA (mm²)	RECOMMENDED TERMINAL TYPE
PD56-10RT	0.75 - 6.00	Red, Blue, Yellow Pre-Insulated Terminals
PVRD15S-10RT	0.75 - 1.50	Vibration Resistant Terminals
PVRD25S-10RT	1.50 - 2.50	Vibration Resistant Terminals
PVRD6S-10RT	4.00 - 6.00	Vibration Resistant Terminals
PVRD15CP-10RT	0.75 - 1.50	R63CPFPO-VR-N
PETD2560-10RT	0.50 - 6.00	Insulated and Uninsulated End Terminals
PETD616-10RT	6.00 - 16.00	Insulated and Uninsulated End Terminals
PETD2535-10RT	25 and 35	Insulated and Uninsulated End Terminals
PETD2550-10RT	25 and 50	Insulated and Uninsulated End Terminals
UHD56-10RT	0.75 - 6.00	BST Terminals
UID56-10RT	0.75 - 6.00	UR Terminals
FTD1475-10RT	0.14 - 0.75	UFPO Flat Tabs 2.8 and 4.8
FTD56-10RT	0.50 - 6.00	UFPO Flat Tabs 6.3
FTD63-Q-10RT	0.63 (9/0.30)	Q Relay Connector

RTB 510 System - Go-No-Go Gauges

Periodic verification of the indenter aperture, or the across flats of an hexagon die set is most important. The prescribed method is via the Go/No-Go gauging method. A double ended gauge will quickly and accurately check that the dimensions complies with the specification limits. Put simply, the Go end should pass through the opening. The No-Go end should NOT.

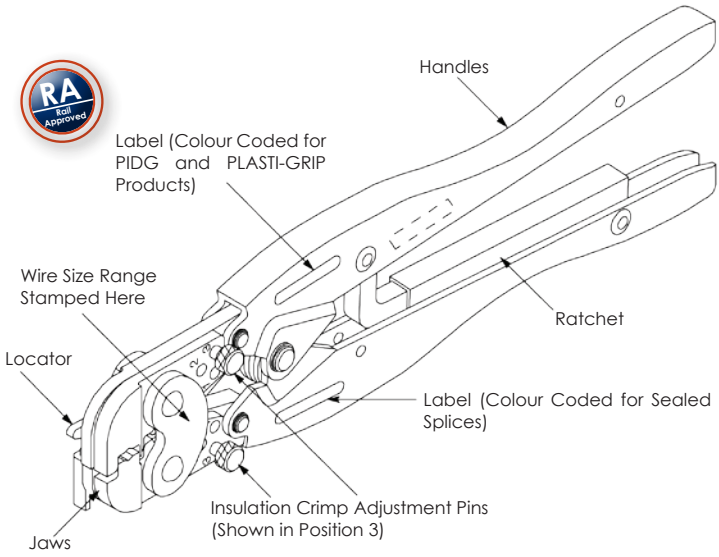
Go/No-Go gauges for connector tooling applications are manufactured to extremely close tolerances.

The gauges are usually manufactured in two types: the first type are round gauges for verifying the dimension between opposing indenters. It is important not to crimp the gauge as this will adversely affect the indenters.

The second type of Go/No-Go gauge is for verifying the opposing flats of a hexagon die set. Two of the opposing sides of the gauge usually have machined flat surfaces for clearance purposes- again, it is important not to crimp the gauge.

Cablecraft will be pleased to advise on the correct gauges for your applications.

DIE PART NO.	GAUGE PART NO.
PD56-10RT	GPD5615-10RT
PD56-10RT	GPD5625-10RT
PD56-10RT	GPD566-10RT
PVRD15S-10RT	GPVRD15-10RT
PVRD25S-10RT	GPVRD25-10RT
PVRD65-10RT	GPVRD6-10RT
PVRD15CP-10RT	GPVRD15CP-10RT
UHD56-10RT All 4 Required	GUHD5615-10RT
	GUHD5625-10RT
	GUHD564-10RT
	GUHD566-10RT
UID56-10RT All 3 Required	GUID5615-10RT
	GUID5625-10RT
	GUID566-10RT



The handles and label of each tool are colour-coded to match the colour coding of the product to be crimped. The tools may show more than one colour code.

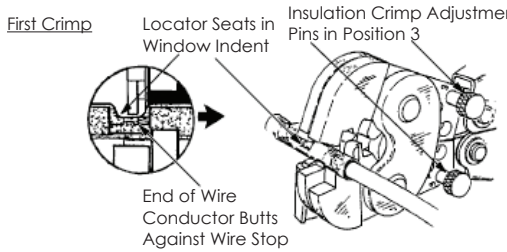
These tools are members of the AMP CERTI-CRIMP hand crimping tool family. The ratchet ensures full crimping of the product.

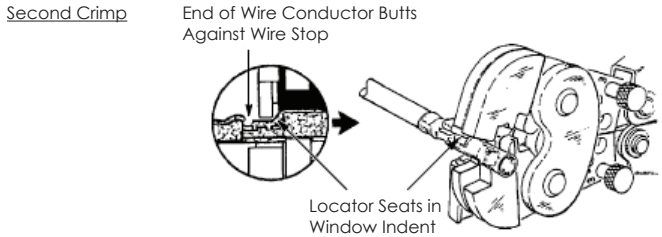
Once engaged, the ratchet will not release until the handles have been fully closed. The crimping jaws bottom before the ratchet releases.

This design feature assures maximum tensile performance of the crimp. DO NOT re-adjust the ratchet.

Always ensure that the correct tool and product combination is being used.

AMP CERTI-CRIMP Ratchet Hand Tool Locating & Crimping Instructions & Adjustment





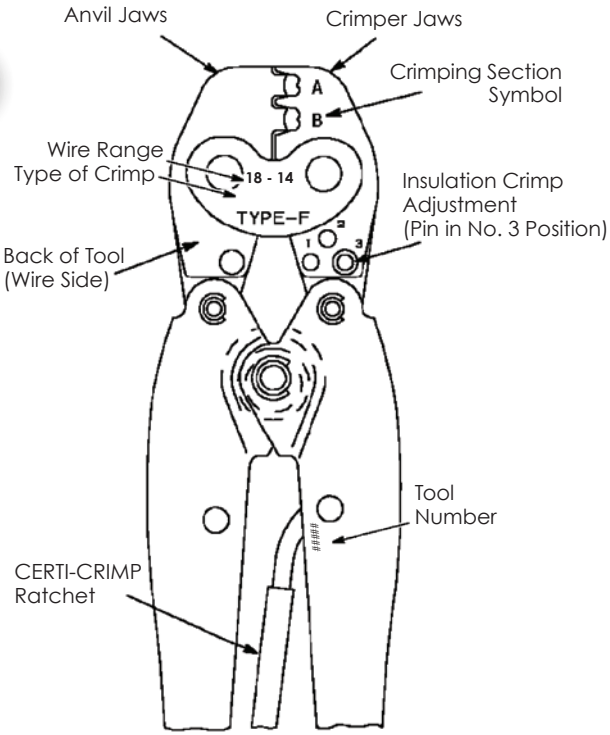
Strip the wire to the dimension required being careful to avoid nicking or cutting the conductor(s). DO NOT use wire with nicked or missing conductor(s).

Open the tool jaws by closing the tool handles until the ratchet releases, then allow the handles to open fully. Place the product in the jaws as shown above.

Close the tool handles until the product is held firmly in place. DO NOT deform the wire barrel. Insert properly striped wire(s) into the wire barrel as shown above. DO NOT allow wire insulation to enter the wire barrel.

Complete the crimp by closing the tool handles until the ratchet releases. Release the tool handles, allow the handles to open fully, and remove the crimped product.

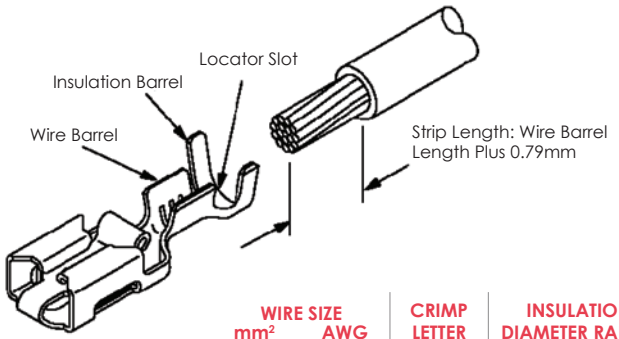
To crimp the other wire barrel of a splice, re-position the uncrimped wire barrel in the tool. Repeat these steps.



This double action hand crimping tool is designed to crimp 'F Type' positive lock terminals. It features two crimping jaws, each consisting of an anvil and a crimper. When closed, the jaws form two crimping chambers, each marked on the back side of the tool with the letters A and B.

The CERTI-CRIMP ratchet ensures full crimping of the terminal. Once engaged, the ratchet will not release until the tool handles have been fully closed.

AMP Double Action Hand Tool - Crimping Procedure



WIRE SIZE mm²	WIRE SIZE AWG	CRIMP LETTER	INSULATION DIAMETER RANGE
0.7 - 2.0	18 - 14	A	2.4 - 3.2
2.1 - 4.0	14 - 11	B	3.6 - 4.3

Select the appropriate terminal and wire size, making sure they are compatible. The wire size and insulation diameter must be within the specified range for the terminal. Strip the wire to the length shown below. Do not nick or cut the wire strands.

Then, proceed as follows:

1. Hold tool so that the back side is facing you.

2. Make certain that the ratchet is released by squeezing the tool handles and allowing them to open fully.

3. Looking straight into the back of appropriate crimp section, insert terminal (insulation barrel first) into the front of the crimp section. Position terminal in crimpers so the centre of the terminal wire barrel is in-line with the centre of the wire barrel crimping jaw.

4. Hold terminal in this position and squeeze tool handles together until jaws close just enough to retain terminal. Do not deform wire barrel or insulation barrel.

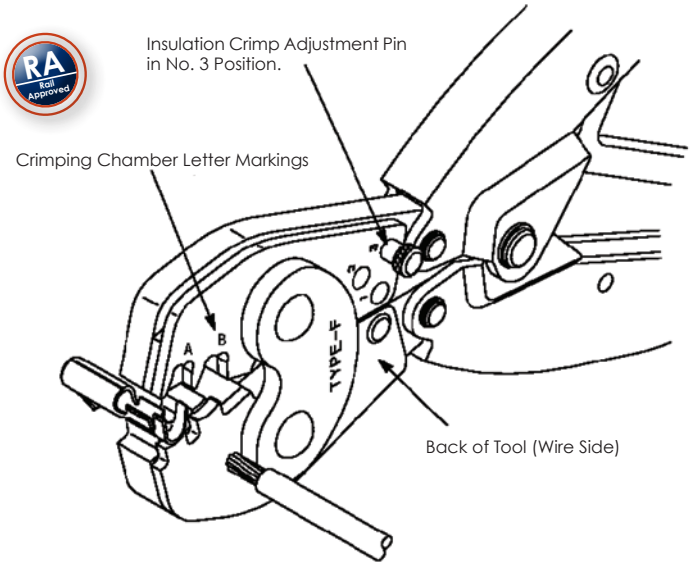
5. Insert a properly stripped wire through wire slot in locator and into wire barrel.

6. Hold the wire in place and squeeze the tool handles until the ratchet releases.

CAUTION: Squeezing the handles together too much will deform the wire barrel.

7. Allow the tool handles to open fully and remove the crimped terminal.

AMP Double Action Hand Tool Insulation Crimp Adjustment



This ratchet hand tool has three insulation crimping adjustment positions to adjust the wire insulation grip: 1-Tight, 2-Medium and 3-Loose. To obtain the desired insulation grip, proceed as follows:

1. Insert pins into the No.3 position, as shown above.

2. Position terminal into crimping jaws.

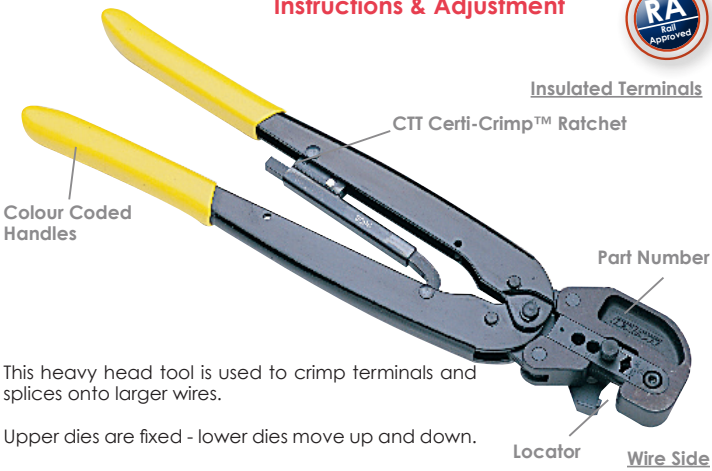
3. Insert an un-stripped wire just into the insulation barrel sleeve.

4. Crimp the terminal. Then remove the crimped terminal from the crimping jaws and check the insulation support by bending the wire back and forth once.

5. The insulation barrel sleeve should retain grip on the wire insulation. If the wire pulls out, move the insulation adjustment pins to the next tighter position (No. 2) and proceed. If the wire does not pull out, the pins are properly adjusted and the tool is ready for crimping.

6. Perform another test crimp. Adjust pins as necessary, until the desired insulation grip is obtained. Do not use a tighter setting than is required.

CTT AMP Heavy Head Tool Instructions & Adjustment



This heavy head tool is used to crimp terminals and splices onto larger wires.

Upper dies are fixed - lower dies move up and down.

Crimp Tools for Pre-Insulated Products. Illustration of:

A. Locator
B. CTT Certi-Crimp™ ratchet
C. Colour Coded Handle
D. Insulation Crimp Adjustment

Instructions For Setting The Insulation Crimp Tightness

To check and set the insulation support first set the pins on the insulation support crimp dies to the loosest setting (position 3) and insert and crimp an un-stripped wire. Hold the terminal in one hand and the wire in the other. Bend the wire up 90˚ and then down 90˚. The wire should remain held in the insulation support and not show any signs of pinching of the insulation. If the wire comes out during this test then the next tightest setting should be selected and the test repeated until a suitable setting is found. It may be that a terminal with a smaller insulation range may need to be selected. The wire should not be pulled laterally.

CTT AMP Heavy Head Tool - Locating Procedure

Caution: Make certain that the insulation crimping adjustment is correct before making production crimps.

1. With tool handles in the open position:

A. For terminal - place in tool so tongue goes over locator.
B. For splice - centre the window indent over locator.

2. Close handles until terminal or splice is held in place without deforming wire barrel.

3. Insert stripped wire until it bottoms and close handles until CTT Certi-Crimp™ ratchet releases.

4. To crimp other half of splice, remove splice from tool, rotate splice 180˚, reposition splice in tool and complete crimp 23 instructed in steps 2 and 3.

CABLECRAFT-CTT TOOL CALIBRATION & REPAIR CENTRE

Tool Maintenance & Repair Centre

All Cablecraft-CTT tools are made to the very highest specifications. To ensure their performance throughout their life they should be properly maintained, including daily spot checks for wear.

Daily Tool Checks

- Remove dust, moisture and other contaminants from the tool with a clean brush or a soft, lint-free cloth. Do NOT use objects that could damage the tool.
- Lubricate with general purpose machine oil.
- Check for excessive wear on pins.
- Carefully inspect all parts including die for any wear, damage or breakage.
- Check that the ratchet mechanism is releasing only on completion of the crimp cycle and is, consequently, not too tight for normal use.
- Carry out tensile tests with the most frequently used terminal types including the largest and smallest sizes.
- If any faults are found, the tool should be returned to the Cablecraft-CTT service department for attention.

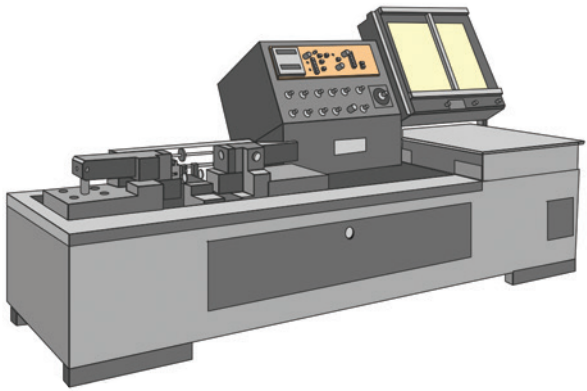
Cablecraft-CTT Tool Calibration

Cablecraft-CTT offers a fast turnaround tool calibration service. It is important to have your tools calibrated on a yearly basis or every 10,000 crimps, which ever is sooner, to ensure you are getting the best crimp possible. After we have performed a number of tests on the tool to make sure it is up to the standards, we will provide you with a calibration certificate that will be matched to your tools asset number.

If any faults are found, the tool should be returned to the Cablecraft-CTT service department for immediate attention.

Pull Testing - Tensile Strength Tester

Cablecraft-CTT can offer a complete crimp pull test service. For details of current standards, please see page 48 or contact technical@cablecraft.co.uk.



CABLECRAFT-CTT TRAINING COURSE

Cablecraft-CTT CERT-N-CRIMP Training Course

A full product and crimp training programme is now available at Cablecraft-CTT. Below is an outline of what is covered in the course. If you are interested in more information about our training programme, please contact us or email: technical@cablecraft.co.uk, where we will be happy to assist in your requirements.

What's Covered In The CERT-N-CRIMP Course

The training course includes information on Wire Preparation, Crimping, Inspection and Test, which enables work to be carried out which meets and exceeds the requirements of BS 5G178, 5057, 4579, British Rail WOSS 560-4, LUL Standards RSE024 & E6487A2.

- Crimping Systems
- Appreciation of Crimping Equipment
- Operation & Maintenance of Crimping Tools
- Practical Application of Crimping Tools
- Gauging & Calibration
- Evaluation of Crimp Joint Standards
- Health & Safety

Certificate of Completion of CERT-N-CRIMP Training Course

CABLECRAFT
creative wiring solutions

Certificate of Completion

Name

of

Company Name

HAS COMPLETED A TRAINING COURSE IN

WIRE PREPARATION, CRIMPING, INSPECTION AND TEST,
WHICH ENABLES THEM TO CARRY OUT WORK WHICH MEETS AND EXCEEDS THE
REQUIREMENTS OF BS 5G178, 5057, 4579, BRITISH RAIL WOSS 560-4, LUL STANDARDS RSE024 & E6487A2.

THIS COURSE COVERED THE FOLLOWING DISCIPLINES:

CRIMPING SYSTEMS
APPRECIATION OF CRIMPING EQUIPMENT
OPERATION & MAINTENANCE OF CRIMPING TOOLS
PRACTICAL APPLICATION OF CRIMPING TOOLS
GAUGING & CALIBRATION
EVALUATION OF CRIMP JOINT STANDARDS
HEALTH & SAFETY

TRAINING OF THE ABOVE MENTIONED DISCIPLINES MADE BY: _____

DATE: _____

SIGNED: _____ **DATE:** _____

CHRIS JENART - DIRECTOR

CTT CABLECRAFT COMPANY · CABLECRAFT creative wiring solutions · AMP TE TYCO CONNECTIVITY COMPANY

Cablecraft House, Circle Business Centre, Blackburn Road, Houghton-Regis, Bedfordshire LU5 5DD
Tel: 01582 606 033 · Fax: 01582 606 063 · Email: sales@cablecraft.co.uk · Web: www.cablecraft.co.uk

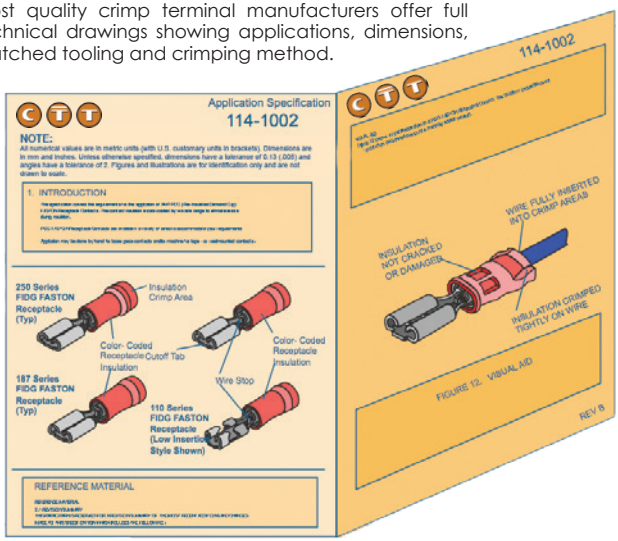
CERTIFICATE NO. 00140

RAIL INDUSTRY DOCUMENTATION

Components of a Quality Termination

Application Specification

Most quality crimp terminal manufacturers offer full technical drawings showing applications, dimensions, matched tooling and crimping method.



Cablecraft-CTT Rail Log Sheet Data: Crimp Range & Insulation Diameter

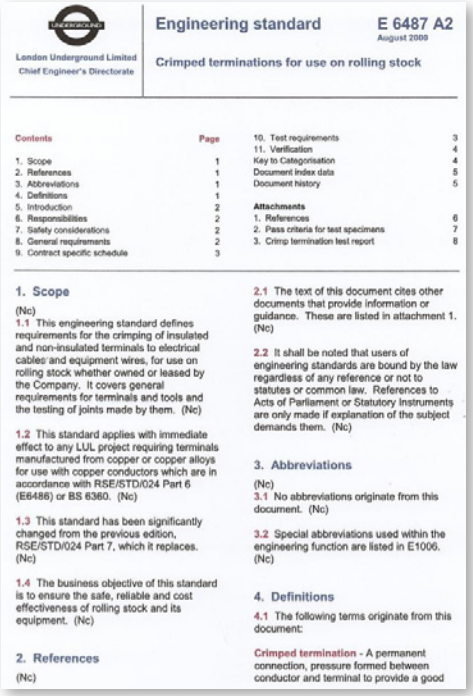
A crimping log sheet is required for railway signalling and rolling stock applications. This data can be stored and referred to in the event of a crimped joint failure.

TERMINAL NAME, RECEPTACLE

		286561	**CRIMPING DATA**					
			PAD LTR	**CRIMP HEIGHT**			**WIRE SIZE**	
			A	0.73 ± .002 (1.85 ± 0.05mm)			14	
			B	.058 ± .002 (1.47 ± 0.05mm)			16	
			C	NOT			USED	
			D	NOT			USED	
			CRIMP	**SIZE**		**TYPE**	**RANGE**	
			WIRE	.110 (2.79mm)		F	16 - 14	
			INSUL	.150 (3.81mm)		F	.145 MAX.	

WIRE STRIP LENGTH	TERM APPL SPEC	FEED	APPL INSTRUCTION	SET UP GAGE	LAYOUT
.203 - .234	NONE	.602	408 - 8040	458637-1	L1889

							129
							128
2	2	2	-	C	1-354779-8	PIN, WIRE DISC (.3080) B	127



London Underground Limited
Chief Engineer's Directorate

Engineering standard **E 6487 A2**
August 2000

Crimped terminations for use on rolling stock

Contents

1. Scope

(Nc)

1.1 This engineering standard defines requirements for the crimping of insulated and non-insulated terminals to electrical cables and equipment wires, for use on rolling stock whether owned or leased by the Company. It covers general requirements for terminals and tools and the testing of joints made by them. (Nc)

1.2 This standard applies with immediate effect to any LUL project requiring terminals manufactured from copper or copper alloys for use with copper conductors which are in accordance with RSE/STD/024 Part 6 (E6486) or BS 6360. (Nc)

1.3 This standard has been significantly changed from the previous edition, RSE/STD/024 Part 7, which it replaces. (Nc)

1.4 The business objective of this standard is to ensure the safe, reliable and cost effectiveness of rolling stock and its equipment. (Nc)

2. References

(Nc)

2.1 The text of this document cites other documents that provide information or guidance. These are listed in attachment 1. (Nc)

2.2 It shall be noted that users of engineering standards are bound by the law regardless of any reference or not to statutes or common law. References to Acts of Parliament or Statutory Instruments are only made if explanation of the subject demands them. (Nc)

3. Abbreviations

(Nc)

3.1 No abbreviations originate from this document. (Nc)

3.2 Special abbreviations used within the engineering function are listed in E1006. (Nc)

4. Definitions

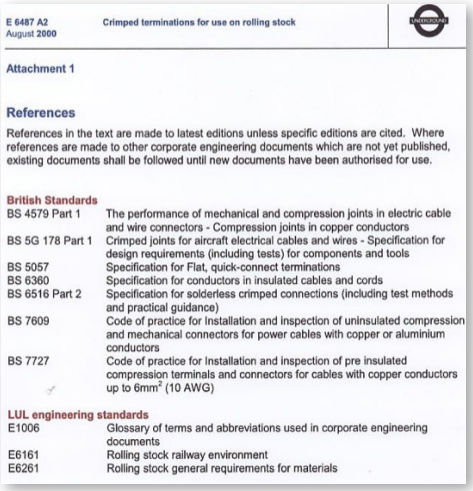
4.1 The following terms originate from this document:

Crimped termination - A permanent connection, pressure formed between conductor and terminal to provide a good

London Underground Standards

The London Underground has the highest crimping standards in the Rail Industry (E6487.A2) to include:

- RSE/STD 024 Part 6
- BS 5G 178 Part 1
- BS 5057
- BS 6360
- BS 6516 Part 2
- BS 7609
- BS 7727



E 6487 A2
August 2000

Crimped terminations for use on rolling stock

Attachment 1

References

References in the text are made to latest editions unless specific editions are cited. Where references are made to other corporate engineering documents which are not yet published, existing documents shall be followed until new documents have been authorised for use.

British Standards

BS 4579 Part 1	The performance of mechanical and compression joints in electric cable and wire connectors - Compression joints in copper conductors
BS 5G 178 Part 1	Crimped joints for aircraft electrical cables and wires - Specification for design requirements (including tests) for components and tools
BS 5057	Specification for Flat, quick-connect terminations
BS 6360	Specification for conductors in insulated cables and cords
BS 6516 Part 2	Specification for solderless crimped connections (including test methods and practical guidance)
BS 7609	Code of practice for Installation and inspection of uninsulated compression and mechanical connectors for power cables with copper or aluminium conductors
BS 7727	Code of practice for Installation and inspection of pre insulated compression terminals and connectors for cables with copper conductors up to 6mm^2 (10 AWG)

LUL engineering standards

E1006	Glossary of terms and abbreviations used in corporate engineering documents
E6161	Rolling stock railway environment
E6261	Rolling stock general requirements for materials

LUL Engineering Standards

- E1006
- E6161
- E6261

London Underground Standards

A crimped terminal test report is required on rolling stock. Six crimped samples are tested for visual inspection, resistance and pull off load, which is documented and signed off.

E 6487 A2
August 2000

Crimped terminations for use on rolling stock

Attachment 3

Crimp termination test report

(Cat 3)

Combination

Terminal make, type	
Tool make, type, serial/asset no	
Die type, serial/asset no	
Cable make, type, CSA, stranding	

Test results

Specimen no	1	2	3	4	5	6	Acceptance limit
Resistance (micro ohms)							
Pull off load (N)							

Visual appearance and other remarks :

Contract details

Rolling stock type	
Main Contractor, Contract No.	
Contractor (crimping)	
Equipment type	
Test authority	

Signed ..... Date .....

For test authority

(Cat 3)

IMAGE © NETWORK RAIL

CABLECRAFT-CTT & AMP RAIL CABLE REFERENCE CHARTS

AMP CTT Terminal Wire Range & Colour Code Chart

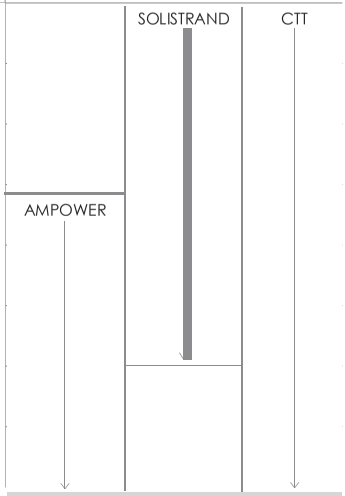
AMP & CTT INSULATED (PIDG & PLASTI-GRIP)

TERMINAL SIZE	AMP PRODUCT COLOUR CODE	CTT PRODUCT COLOUR CODE	CMA RANGE	EMBOSSED CRIMP CODE
26 - 22	Yellow		202 - 810	●
24 - 20	White		320 - 1290	●
20 - 16	Red	Red	509 - 3260	●
16 - 14	Blue	Blue	2050 - 5180	●●
12 - 10	Yellow	Yellow	5180 - 13,100	●●●
8	Red		13,100 - 20,800	**8**
6	Blue		20,800 - 33,100	**6**
4	Yellow		33,100 - 52,600	**4**

UNINSULATED

TERMINAL SIZE	CMA RANGE
26 - 22	202 - 810
22 - 16	509 - 3260
16 - 14	2050 - 5180
14 - 12	3260 - 8230
12 - 10	5180 - 13100
8	13100 - 20800
6	20800 - 33100
4	33100 - 52600
2	52600 - 83700
1/0	83700 - 119500
2/0	119500 - 150500
3/0	150500 - 190000
4/0	190000 - 231000
250 - 300 MCM	231000 - 300000
300 - 350 MCM	300000 - 380000
400 MCM	380000 - 478000
900 MCM	850000 - 950000
1000 MCM 1250 MCM 1500 MCM	950000 - 112500

EMBOSSED CRIMP CODE AMP & CTT



DIE SIZING REFERENCE STAMPED ON TERMINAL AFTER CORRECT CRIMPING: AMPOWER, SOLISTRAND & CTT

CTT Vibration Resistant Pre-Insulated Nylon Easy Entry Terminals Performance Standards

[A] RME 646A
[B] BS4G 178 PT1 1984
[C] Electrical Contact Resistance, Insertion/ Withdrawal Forces

TEST	MILLIVOLT	THERMAL CYCLING	TENSILE PULL OFF	FLUID TESTS	INSULATION SUPPORT	DIELECTRIC TEST	SALT SPRAY	HEAT AGEING	LOW TEMP CRIMP
BS4579 PT 1 1970	YES	YES	NO	NO	NO	NO	NO	NO	NO
BS5G178 PT 1 1993	YES	YES	YES	YES	YES	YES	YES	YES	YES
BS4G178 PT 2 1986[B]	YES	NO	NO	NO	NO	NO	NO	NO	NO
RSE/STD/024 PT 7[A]	YES	YES	NO	NO	NO	NO	NO	NO	NO
MOD 59.71 PT 1 ISSUE 2	YES	YES	YES	YES	YES	YES	YES	YES	YES
ST 363C	YES	YES	YES	--	--	--	--	--	YES
BS5057[C]	NO	NO	YES	NO	NO	--	NO	NO	NO

BS4579 PT 1 1970
General industry specification (and test parameters) for the control and performance of compression joints.

BS5G178 PT 1 1993
Aerospace specification for control of crimping, including operator control tests.

BS4G178 PT 2 1986 (B)
Aerospace specification for manufacturers of crimps to meet design/test requirements for components and tools.

RSE/STD/024 PT 7 (A)
LUL Equipment standard (replaced by E6487 AI) including vibration applications and defined tests.

MOD 59.71 Issue 1
Standards for warships, tanks and other MOD applications.

ST 363C
European standard giving technical standard for special conductors for transportation applications - channel tunnel.

BS5057 (C)
Specification for brass and phosphur bronze push-on terminals - extraction, tensile and contact resistance instructions.

UL/CSA
Underwriters Laboratories approvals/Canadian Standards Authority for North America & Canada.

Vibration Resistant Terminals, Tools Gauges & Strip Lengths
Matched to Fit Non-Concentric Rail Industry Cables Reference LUL RSE STD 024 Part 6.

CABLE TYPE	CSA MM²	INS MAX DIA.	TERMINAL COLOUR AWG	M3.5	M4	M5	M6	M8	M10	M12	HAND TOOL	STRIP LENGTH	WIRE CRIMP GAUGE
V	0.5	2.4	RED	R37PR-VR-N	R43PR-VR-N	R53PR-VR-N	R65PR-VR-N	R85PR-RVR-N			CTT-RTB510	5 - 6	GPVRD15S-10RT
II	0.75	3.1	RED	R37PR-VR-N	R43PR-VR-N	R53PR-VR-N	R65PR-VR-N	R85PR-RVR-N			CTT-RTB510	5 - 6	GPVRD15S-10RT
V	0.75	2.62	RED	R37PR-VR-N	R43PR-VR-N	R53PR-VR-N	R65PR-VR-N	R85PR-RVR-N			CTT-RTB510	5 - 6	GPVRD15S-10RT
II	1	3.5	RED	R37PR-VR-N	R43PR-VR-N	R53PR-VR-N	R65PR-VR-N	R85PR-RVR-N			CTT-RTB510	5 - 6	GPVRD15S-10RT
V	1	2.8	RED	R37PR-VR-N	R43PR-VR-N	R53PR-VR-N	R65PR-VR-N	R85PR-RVR-N			CTT-RTB510	5 - 6	GPVRD15S-10RT
II+V	1.5	3.82	BLUE	B37PR-VR-N	B43PR-VR-N	B53PR-VR-N	B63PR-VR-N	B85PR-RVR-N	B10PR-RVR-N	B10PR-RVR-N	CTT-RTB510	5 - 6	GPVRD25S-10RT
II+V	2.5	4.3	BLUE	B37PR-VR-N	B43PR-VR-N	B53PR-VR-N	B63PR-VR-N	B85PR-RVR-N	B10PR-RVR-N	B10PR-RVR-N	CTT-RTB510	5 - 6	GPVRD25S-10RT
II+V	4	5.12	YELLOW	Y37PR-VR-N	Y43PR-VR-N	Y53PR-VR-N	Y63PR-VR-N	Y85PR-RVR-N	Y10PR-RVR-N	Y12PR-RVR-N	CTT-RTB510	6 - 7	GPVRD6S-10RT
II+V	6	5.7	YELLOW	Y37PR-VR-N	Y43PR-VR-N	Y53PR-VR-N	Y63PR-VR-N	Y85PR-RVR-N	Y10PR-RVR-N	Y12PR-RVR-N	CTT-RTB510	6 - 7	GPVRD6S-10RT

Vibration Resostand & Restricted Neck (where available) Terminals, Tools, Gauges & Strip Lengths Matched to Fit Thin Wall Rail Industry Cables • Reference LUL RSE STD 024 Part 6

CABLE TYPE	CSA MM²	INS MAX DIA.	TERMINAL COLOUR AWG	M3.5	M4	M5	M6	M8	M10	M12	HAND TOOL	DIE	STRIP LENGTH	WIRE CRIMP GAUGE
1+1V	0.5	1.68	RED/RED	R37PR-RVR-N	R43PR-RVR-N	R53PR-RVR-N	R65PR-RVR-N	R85PR-RVR-N			CTT-RTB510	PVRD15S-10RT	6.4 - 7.1	GPVRD15S-10RT
1+1V	0.75	1.87	RED	R37PR-VR-N	R43PR-VR-N	R53PR-VR-N	R65PR-VR-N	R85PR-RVR-N			CTT-RTB510	PVRD15S-10RT	5 - 6	GPVRD15S-10RT
1+1V	1	1.99	BLUE/BLUE	B37PR-VR-N	B43PR-RVR-N	B53PR-RVR-N	B63PR-RVR-N	B85PR-RVR-N	B10PR-RVR-N		CTT-RTB510	PVRD25S-10RT	6.4 - 7.1	GPVRD25S-10RT
1+1V	1.5	2.35	BLUE/BLUE	B37PR-VR-N	B43PR-RVR-N	B53PR-RVR-N	B63PR-RVR-N	B85PR-RVR-N	B10PR-RVR-N		CTT-RTB510	PVRD25S-10RT	6.4 - 7.1	GPVRD25S-10RT
1+1V	2.5	2.93	BLUE	B37PR-VR-N	B43PR-VR-N	B53PR-VR-N	B63PR-VR-N	B85PR-RVR-N	B10PR-RVR-N		CTT-RTB510	PVRD25S-10RT	5 - 6	GPVRD25S-10RT
1+1V	4	3.65	YELLOW	Y37PR-VR-N	Y43PR-VR-N	Y53PR-VR-N	Y63PR-VR-N	Y85PR-RVR-N	Y10PR-RVR-N	Y12PR-RVR-N	CTT-RTB510	PVRD6S-10RT	6 - 7	GPVRD6S-10RT

CTT Power Terminals
HDT Type For London Underground Rail Industry Cables

CABLE TYPE	CSA MM²	TERMINAL TYPE	STRIP LENGTH	RATCHET HAND TOOL	DIE NUMBER	HYDRAULIC HAND TOOL	DIE NUMBER
ALL CABLE TYPES	0.5 - 1.6mm²	CTT	5 - 6	RTB-510	UID 56-10RT		
ALL CABLE TYPES	1.0 - 2.6mm²	CTT		RTB-510	UID 56-10RT		
ALL CABLE TYPES	2.7 - 6.6mm²	CTT	6 - 7	RTB-510	UID 56-10RT		
ALL CABLE TYPES	4mm²	CTT HDT TUBE TYPE	6.5	RTB510	UHD 56-10RT		
ALL CABLE TYPES	6mm²	CTT HDT TUBE TYPE	6.5	RTB510	UHD 56-10RT		
ALL CABLE TYPES	6mm²	CTT HDT TUBE TYPE	6.5	CRT6-150	CRT6-150D-1	CHT185	CHT185D-6
ALL CABLE TYPES	10mm²	CTT HDT TUBE TYPE	11.5	CRT6-150	CRT6-150D-1	CHT185	CHT185D-10
ALL CABLE TYPES	16mm²	CTT HDT TUBE TYPE	13	CRT6-150	CRT6-150D-2	CHT185	CHT185D-16
ALL CABLE TYPES	25mm²	CTT HDT TUBE TYPE	13	CRT6-150	CRT6-150D-2	CHT185	CHT185D-25
ALL CABLE TYPES	35mm²	CTT HDT TUBE TYPE	15	CRT6-150	CRT6-150D-2	CHT185	CHT185D-35
ALL CABLE TYPES	50mm²	CTT HDT TUBE TYPE	17	CRT6-150	CRT6-150D-2	CHT185	CHT185D-50
ALL CABLE TYPES	70mm²	CTT HDT TUBE TYPE	20	CRT6-150	CRT6-150D-1	CHT185	CHT1850-70
ALL CABLE TYPES	95mm²	CTT HDT TUBE TYPE	27	CRT6-150	CRT6-150D-1	CHT185	CHT185D-95
ALL CABLE TYPES	120mm²	CTT HDT TUBE TYPE	32	CRT6-150	CRT6-150D-3	CHT185	CHT185D-120
ALL CABLE TYPES	150mm²	CTT HDT TUBE TYPE	32	CRT6-150	CRT6-150D-3	CHT185	CHT185D-150

AMP Crimp Terminal Sizes for Rail Cables

TERMINAL BARREL COLOUR	MM² RANGE	CMA	WIRE BARREL DIAMETER	INSULATION SUPPORT RANGE STANDARD MIN	STANDARD MAX	EXPANDED MIN	EXPANDED MAX	EXP/EXPANDED MIN	EXP/EXPANDED MAX		
YELLOW	0.1 - 0.4	202 - 810			2.08					PIDG	
RED/GREEN	0.2 - 0.4	754	0.84	0.97	2.79					PIDG	RESTRICTED ENTRY
RED/RED	0.4 - 0.6	1186	1.04	1.17	2.79					PIDG	RESTRICTED ENTRY
RED/WHITE	0.6 - 0.95	1900	1.3	1.42	2.79					PIDG	RESTRICTED ENTRY
RED STANDARD	0.35 - 1.5	509 - 3260	1.55	2.03	3.18					PIDG	
RED EXPANDED	0.35 - 1.5	509 - 3260	1.55			2.67	3.56			PIDG	
ORANGE	0.95 - 1.4	2750	1.73	1.4	2.7					PIDG	
BLUE/BLUE	0.95 - 1.35	2426	1.47	1.6	3.3					PIDG	RESTRICTED ENTRY
BLUE/GREEN	1.35 - 2.0	3831	1.85	1.98	3.3					PIDG	RESTRICTED ENTRY
BLUE/STANDARD	1.0 - 2.6	2050 - 5180	2.16	2.67	3.81					PIDG	
BLUE EXPANDED	1.0 - 2.6	2050 - 5180	2.16			2.92	4.32			PIDG	
YELLOW/BLACK	1.0 - 2.6	2050 - 5180	2.67	3.81	5.85	4.3	6.35	5.6	7.62	PIDG	
BLACK	1.0 - 2.6	2050 - 5180	2.16			4.3	6.35			PIDG	
YELLOW/YELLOW	2.0 - 3.0	6088	2.29	2.41	5.08					PIDG	RESTRICTED ENTRY
YELLOW/BROWN	3.0 - 5.0	10319	2.9	3.02	5.08					PIDG	RESTRICTED ENTRY
YELLOW STANDARD	2.6 - 6.6	5180 - 13100	3.28	3.81	5.85					PIDG	
YELLOW EXPANDED	2.6 - 6.6	5180 - 13100	3.28			4.3	6.35			PIDG	
YELLOW EXP/EXPANDED	2.6 - 66	5180 - 13100	3.28					5.6	7.62	PIDG	
RED	6.64 - 10.5	13100 - 20800			7.57					AMPLIBOND	
BLUE	10.5 - 16.8	20800 - 33100			9.58					AMPLIBOND	
YELLOW	16.8 - 26.7	33100 - 52600			11.07					AMPLIBOND	
RED	26.7 - 42.4	52600 - 83700			12.82					AMPLIBOND	
BLUE	42.4 - 60.6	83700 - 119500			16.05					AMPLIBOND	
YELLOW	60.6 - 76.3	119500 - 150500			17.37					AMPLIBOND	
RED	76.3 - 96.3	150500 - 190000			18.72					AMPLIBOND	
BLUE	96.3 - 117	190000 - 231000			20.23					AMPLIBOND	

AMP PIDG Restricted Entry Nylon Terminals, Tools, Gauges and Strip Lengths Matched to Fit Tyco Rail Cable Reference Raychem 99 600 Volt

CABLE TYPE	AWG	INS MAX DIA.	TERMINAL COLOUR AWG	M3.5	M4	M5	M6	M8	HAND TOOL	STRIP LENGTH	PIN SETTING	WIRE CRIMP GAUGE
99MO11X(600V)	26	0.88	YELLOW	323915	323619	324075			46121	5 to 6	1	574918
99MO11X(600V)	24	0.98	YELLOW	323915	323619	324075			46121	5 to 6	1	574918
99MO11X(600V)	22	1.13	YELLOW	323915	323619	324075			46121	5 to 6	2	574918
99MO11X(600V)	20	1.4	RED/RED 20	51863-3	1-320551-3	2-36153-4	2-320571-4	2-320572-3	47386/525690	6.4 to 7.1	1	574917
99MO11X(600V)	18	1.65	RED/WHITE 20	2-31649-5	1-320551-4	2-36153-5	2-320571-5	2-320572-4	47386/525690	6.4 to 7.1	1	574917
99MO11X(600V)	16	1.9	BLUE/BLUE 16	2-320561-3	1-51864-0	51864-7	2-320563-3	2-320572-2	47387/525691	6.4 to 7.1	1	574916
99MO11X(600V)	14	2.25	BLUE/GREEN 14	51864-8	1-51864-1	51864-9	2-320563-4	2-320575-3	47387/525691	6.4 to 7.1	1	574916
99MO11X(600V)	12	2.6	YELLOW/YELLOW 12	2-36161-5	2-320568-2	2-36161-3	2-320569-5	2-320576-2	59239-4/525692	9.5 to 10.3	1	574915

Crimp Terminal Pull Off Force Table

CABLE SIZE MM²	ELECTRICAL INSTALLATION STANDARD BS-EN 60352-2-2006 MINIMUM PULL OFF FORCE (N)	RSE STD 024 PART 6 RAIL STANDARD MINIMUM PULL-OFF FORCE (N)
0.5	60N	75N
0.75	85N	115N
1.00	108N	150N
1.50	150N	220N
2.50	240N	370N
4.00	310N	590N
6.00	360N	700N
10.00	380N	1160N
16.00	960N	1850N
25.00	1500N	2900N
35.00	2100N	4100N
50.00	3000N	5800N
70.00	4200N	6700N
95.00	5700N	8800N
120.00	7200N	9700N
150.00	9000N	12000N
185.00	11100N	14800N
240.00	14400N	19200N
300.00	18000N	24000N
400.00	24000N	--
630.00	37800N	--
800.00	48000N	--
1000.00	60000N	--

AMP PIDG Wire Colour & Crimping Tool & Dot Code Guide

AMP PIDG terminals for thin wall wire insulation. The insulation sleeve is striped 3 times and colour coded to match PIDG tooling handles.

AWG WIRE SIZE	WIRE SIZE COLOUR STRIPES	TOOL HANDLE AND INSULATING SLEEVE COLOUR	CRIMPING DOT CODE
26	Black	Yellow	1 Dot
24	Blue	Yellow	1 Dot
22	Green	Red	1 Dot
20	Red	Red	1 Dot
18	White	Red	1 Dot
16	Blue	Blue	2 Dots
14	Green	Blue	2 Dots
12	Yellow	Yellow	1 Dot
10	Brown	Yellow	1 Dot

Tool Calibration Record

OPERATORS NAME	TOOL PART NO.	TOOL ASSET NO.	DATE PURCHASED	DATE CALIBRATED

Notes

Notes