Wire-Wrap®





Wrapping Technique

COOPER Hand Tools

Contents

Please note:
With all Wire-Wrap tools , sleeves and bits need to be ordered seperately.

Wire wrapping is covered by many national and international specifications.

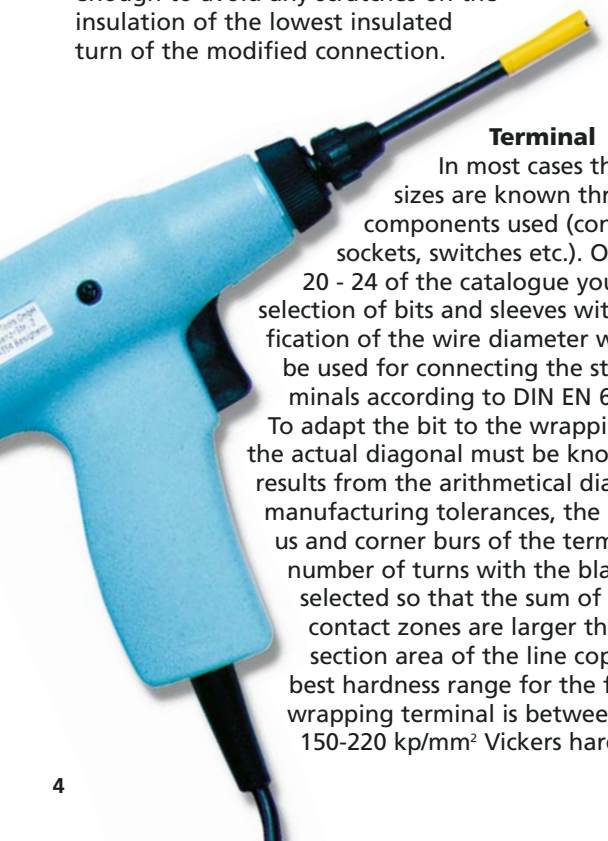
Examples:	
EIA Std. RS. 280-B	USA
Mil. Std. 1130-B	US Army
Navord 10001-WS 6119	US Navy
DIN EN 60352-1	Germany/Europe
N.F.C. 93021	France
I.E.F. Std. 5949	United Kingdom
R.R.E. 33185	British Ministry of Defence

The Wire-Wrap wrapping technique

The Wire-Wrap wrapping technique
The Wire-Wrap system limits the electrical connections to the two necessary mechanical elements: the wire and the terminal. The wire wrapping tools consist of the tool, bit and sleeve. The tool wraps the solid round copper wire under mechanical tension with several turns tightly around the edged terminal. On the edges of the terminal we get a corrosion-safe and gastight connection. There are three different sorts of wrapping bits: Modified, Standard, and C.S.W. bits (see page 6).

Wire
A solid, round wire is used for Wire-Wrap connections. In general wires of 0,25 mm - 1,0 mm diameter (AWG 30 - AWG 18) are connected with hand-held tools. Because of the mechanical tension which appears during the wrapping process the wire material must have a high enough elongation at the breaking point. That means, for a wire diameter up to 0,5 mm (AWG 24), the minimum elongation at breaking point must be 15%. If the wire diameter is larger than 0,5 mm the elongation at breaking point should be 20% minimum. The wire material for C.S.W. bits must also have a minimum elongation of 20%. Customary copper wire, e.g. conductor copper E-CU58F21 according to DIN 40500 or „OFHC copper“, can be used for this wrapping system. Please note the additional information on page 24.

The mostly used insulation materials are: PVC, Kynar, Milene, Teflon and Tefzel. For the C.S.W. Wire-Wrap Technique the wire should have a plastic insulation material which can be notched and torn off with rectilinear knife blades. The insulation itself must have a low bond strength between the wire and the insulation and should not exceed the slip-off values according to the table on page 24. Also the extensibility of the insulation must be large enough to avoid any scratches on the insulation of the lowest insulated turn of the modified connection.



Terminal
In most cases the terminal sizes are known through the components used (connectors, sockets, switches etc.). On pages 20 - 24 of the catalogue you will find a selection of bits and sleeves with a classification of the wire diameter which can be used for connecting the standard terminals according to DIN EN 60 352 - 1. To adapt the bit to the wrapping terminal the actual diagonal must be known. This results from the arithmetical diagonal, the manufacturing tolerances, the corner radius and corner burs of the terminal. The number of turns with the blank wire are selected so that the sum of the single contact zones are larger than the cross section area of the line copper. The best hardness range for the finished wrapping terminal is between HV5 = 150-220 kp/mm² Vickers hardness.

Control
The Wire-Wrap connections are made with a tool, largely eliminating human influence. Frictional forces on the wrapping radius of the bit are wearing and damaging its surface. After many thousands of connections the wrapping radius will become larger and the connections will become less tight. Eventually jagged points or pits may appear on the surface of the wrapping edge. In this case the wrapping tension might be increased to the point of creating brittle connections. A periodic verification of several connections ensures constant quality. The check consists of two simple tests: the „strip force test“ and the „unwrap test“.

Strip force test
For the strip force test the terminals must be tightly clamped. The stripping tool consists of a gauge provided with a dial showing the force by which the connection is stripped off from the terminal. The jaws of the stripping tool hook should be plane, creating a flat surface contact with the wire on either side of the terminal at the lead end of the connection. Also the jaws of the hook must engage along the major dimension (cross selection) of the terminal. The minimum clearance when the terminal and striping tool are properly aligned must be such that there is no binding between jaw and terminal. The stripping force shall be applied slowly and steadily so that any inertial removal force shall be negligible. The maximum rate of stripping should be 250 mm per minute. The connection on square terminals must reach or exceed the minimum strip force before the wrap starts to move on the terminal.

counterforce

Unwrap test
Brittleness of the wire can be checked through the unwrap test. Purpose of the unwrap test is to check whether the wires have been elongated too much during the wrapping process. This test is made with an unwrapping tool which is placed over the terminal and being rotated contrary to the wrapping direction (hand-held wrapping tools normally wrap the wire clockwise). The wire is unwrapped and kept on the tool. During the unwrapping process the wire must not break within the connection area and needs not to be straightened.

It is recommended to record the results of the strip force test and unwrapping test on a test sheet (see page 32). A comparison of the strip force totals shows the condition of the bit. Decreasing strip force indicates a wear of the bit radius. Increasing strip force indicates damages of the bit radius that can lead to brittleness of the wrapped wire.

When visually inspecting the wrap connections make sure that there is no wiring mistake as described on page 8.

Important:
The strip force test and the unwrapping test must be made once a day.

Wire-Wrap®

The Wire-Wrap wrapping technique

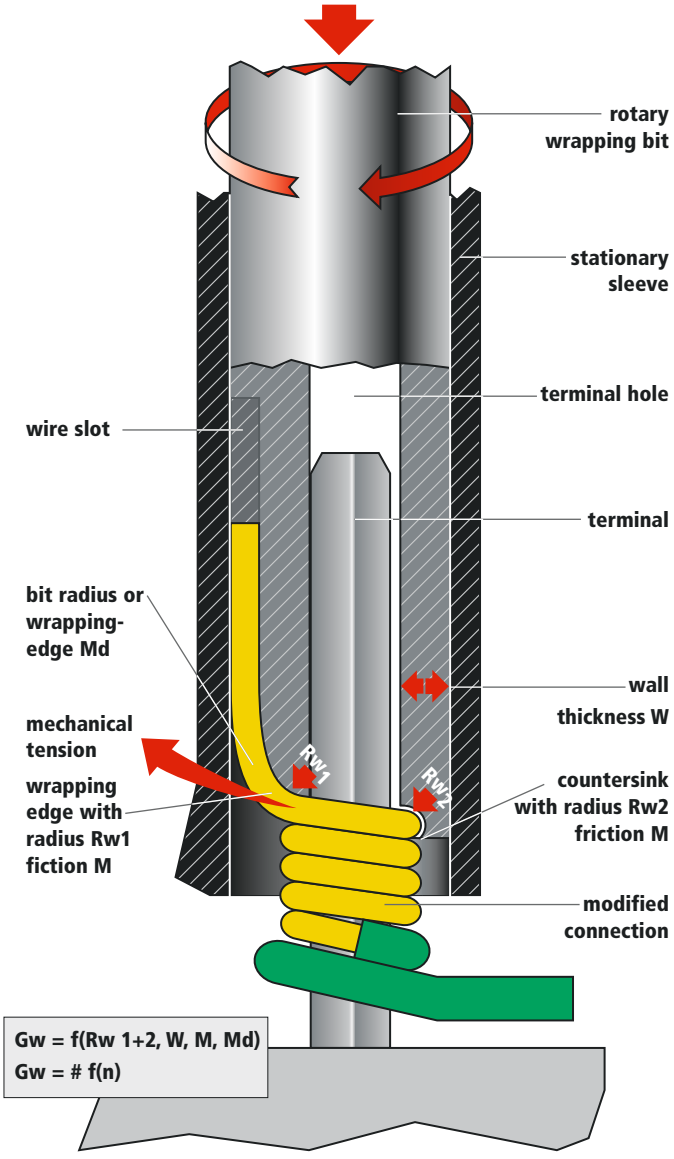
Intimate contact of bare wire and terminal corners
During the wrapping procces, the wire is pulled from the wire slot by the rotation of the bit around the terminal. The wire is drawn over the wrap radius that intersects the bit face and the wire slot, placing tension on the wire in the process. This tension causes stretch of the wire. As the wire is wrapped under mechanical tension, the sharp corners of terminal penetrate into the surface of the wire and an intimate and large surface of contact is established.

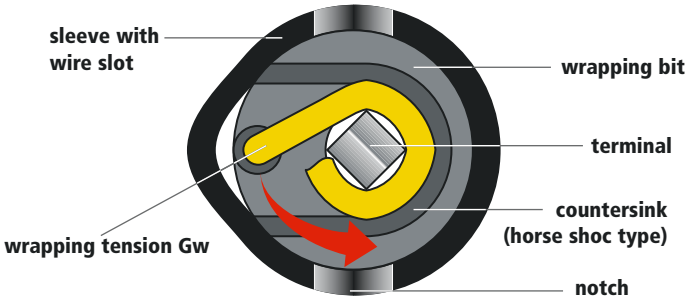
As the turns of wire are hooked at each corner of the terminal, the mechanical tension produced by the wrapping bit remains stored in the wrapped wire and a permanent gas-tight connection is established. After the wrapping operation, the terminal that has been twisted in the direction of wrapping will slightly untwist and some relaxation will occur in the wire material. After some hours, when the connection is stabilized, the compression between wire and terminal corners is from 50.000 psi (35 kg/mm²) to 100.000 psi (70 kg/mm²), depending on the wire diameter and on the wire material. Four turns of wire, i.e. 16 contact points provide a surface of contact equivalent to the cross section of the wire.

The electrical resistance of a wire wrapped connection is in the range of 1 milli ohm, which is less than electrical resistance of one inch of lenght of the wire used to establish the connection. When the connection ages solid state diffusion at the interface corners and wire will often increase the conductivity of the connection.

Example:
Wrapping force during a wrapping tension of 20 kp/mm²:

wire-Ø mm	AWG	wrapping force kp	ca. N
0,25	30	1	10
0,32	28	1,6	16
0,4	26	2,5	25
0,5	24	4,1	41
0,65	22	6,5	65
0,8	20	10,4	104
1,0	18	15,8	158



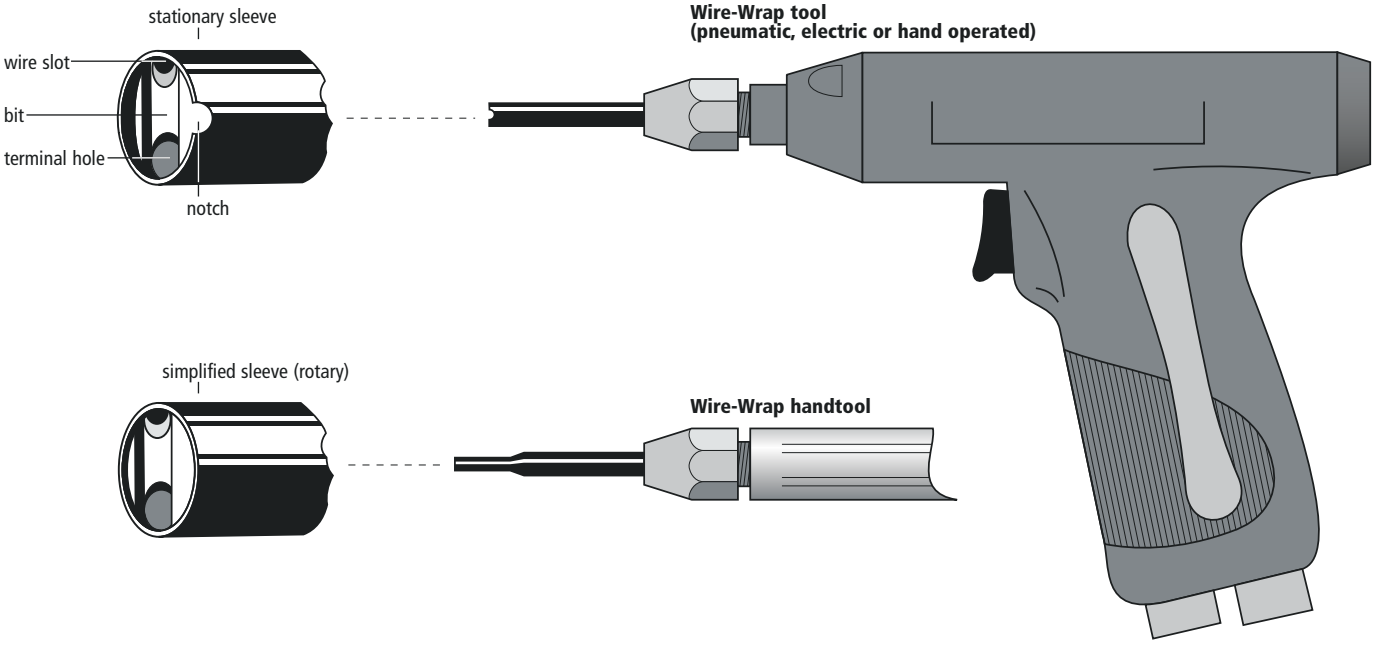


The Wire-Wrap wrapping technique

Wire-Wrap wrapped connections

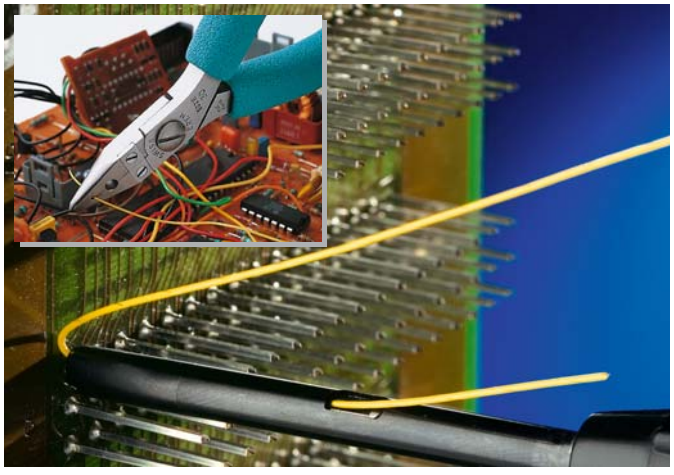
A permanent reliable electrical connection is obtained when a round solid conductor is wrapped around a sharp edged terminal by means of a wrapping bit.

The wire and the terminals have to meet the specifications DIN EN 60 352 - 1 etc. the usual quality available on the market.



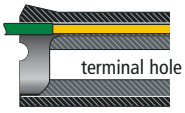
1. Cut and strip the wire.

Depending on the bit style the wire is either stripped durning the wrapping process or before the wrapping process, by means of a stripping tool or machine, to give the correct strip length.

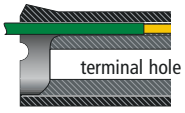


There are three different sorts of wrapping bits:

Standard bit

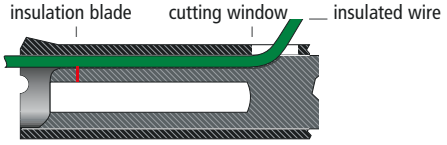


Modified bit



With modified or standard bits the wire insulation has to be stripped before wrapping.

Cut-Strip-Wrap for modified connections



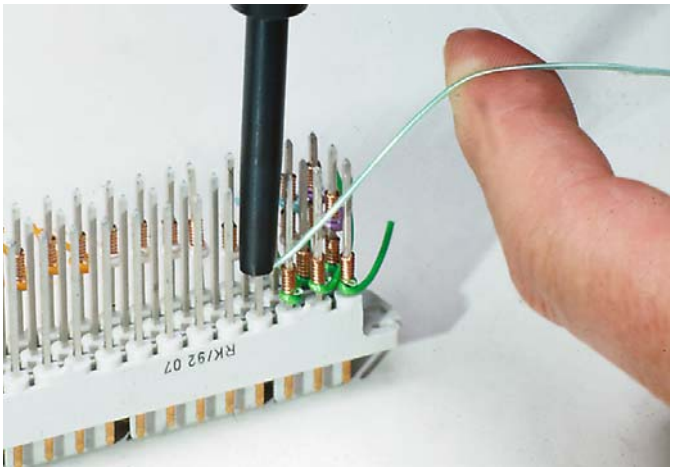
With the C.S.W. bit the wire is cut to lenght and stripped during the wrapping operation.

The Wire-Wrap wrapping technique

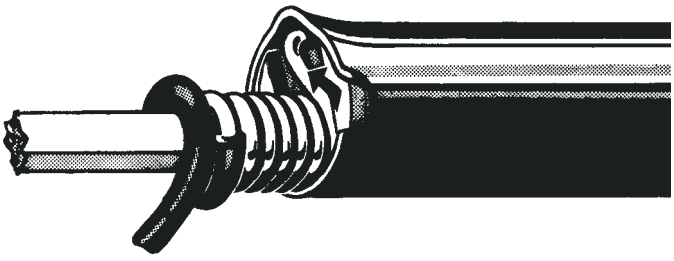
2. Insert the wire in the wire slot.

With modified and standard bits insert the wire in the wire slot as deep as possible.
With C.S.W. bits the wire has to be inserted all the way through the wire slot until it goes out of the cutting window.
The simplified sleeve of the manual tool has no notch. The wire is held by hand.

3. Position the terminal hole of the wrap.



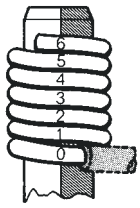
4. Wrap



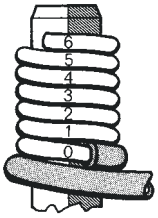
- During the wrapping operation gently press the tool forward.
- The turns of the connection have to be nicely wrapped each against the other.
- Do not push too hard.
- Do not pull backwards.

The Wire-Wrap wrapping technique

Wire-Wrap wrapping process



Reliable standard connection (not modified): The standard wrapping bit wraps only the stripped part of the wire on the terminal.



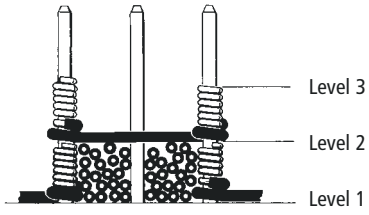
Reliable modified connection: The insulation of a connection made on the second level may overlap the last turn of the connection wrapped on level one. The modified wrapping bit will wrap one turn of insulation at the base of the connection.

The **modified C.S.W. bits** cut the wire, strip the insulation and wrap the wire in one operation.

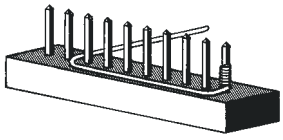
Numbers of turns of conductor	Related to conductor diameter
8	0,25 mm (30 AWG*)
7	0,32 mm (28 AWG)
6	0,4 mm (32 AWG)
5	0,5 mm (24 AWG)
4	0,65 mm (22 AWG)
4	0,8 mm (20 AWG)
4	1,2 mm (18 AWG)

* **AWG** = **A**merican **W**ire **G**auge is nationally accepted for conductor diameter definition.

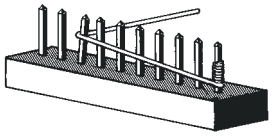
The golden rules of wire wrapping



1. Only two connections on the same terminal (Level 3 is kept as a reserve for change and repair).
2. Wrap both ends of a wire on the same level.
3. Wrap long wires first.
4. Removal of connections: simply unwrap and do not reuse the unwrapped wire.

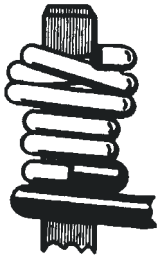


Correct dressing of the wire around a terminal.



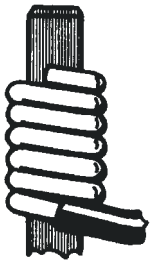
Incorrect dressing of the wire. No clearance between wire and terminal.

Wrong wire wrapping



Overwrap:
Too much backforce or unproperly selected bit.

Spiraled connection:
The tool has been pulled backwards during the wrapping process.



Insufficient insulation for a modified connection:
The wire has not been inserted deep enough in the wire slot, or has slipped out just before wrapping.

Too much „Pig Tail“:
The last turn of connection is not formed against the terminal damaged wrapping bit ratio between terminal width and thickness too large.

Contact pressure

Is contact pressure high when the conductor is wrapped around the corners of a wrap termination post under mechanical tension?

Contact resistance is composed of the sum of the input resistance and the surface contamination resistance. A small contact resistance is reached through reduction of the input resistance by means of high contact pressures by many, large-surface contact zones and the surface contamination resistance by metallically blank contact zones.

The wrap post is usually rectangular or quadratic. It must have well formed corners - if the conductor is wrapped around a round termination post under mechanical tension, it will release itself as soon as the wrapping process is completed and the high contact pressure between the termination post and the wire will no longer exist.

The contact surface will therefore remain very small and not metallically clean. This type of connection must also be soldered after wrapping if it is to permanent or if the electrical conductivity should be increased.

When the conductor is wrapped around the angled post with high tensile stress, the edges of the wrap post press into the soft copper wire. The tensile stress causes the conductor to stretch elastically and plastically and can then be pulled around the edges of the wrap post.

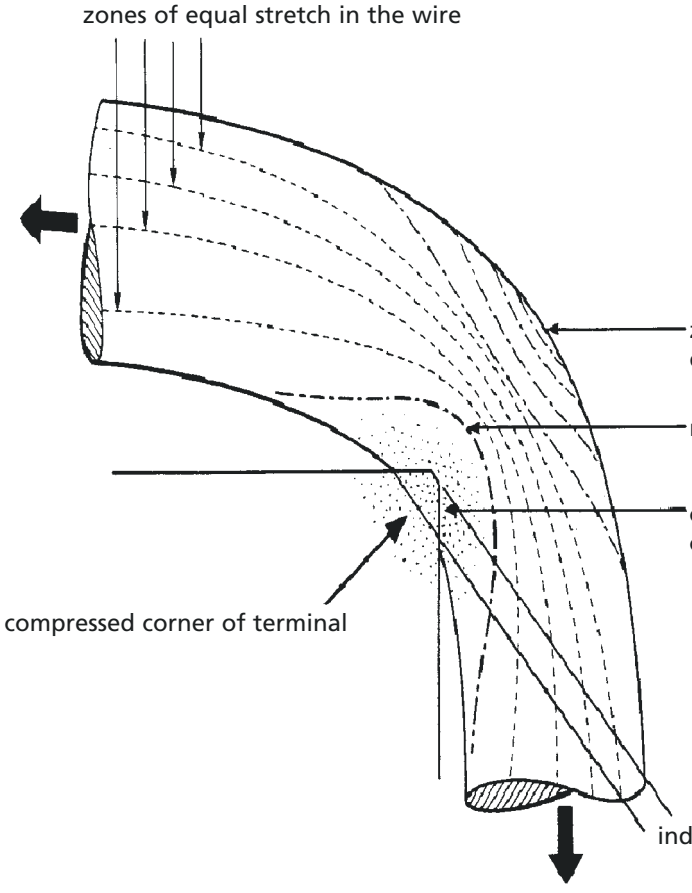
This causes any oxidised layers on the surface - of the conductor as well as the edges of the post - to rupture. These layers are then scraped off and pushed through during the impression of the wrap post edges. A new oxide layer cannot occur during the brief wrapping period since the process takes place at room temperature. Fluxing agent is also not required for this reason.
In this way large-surface, tightly joined, airtight, metallically blank contact zones develop high pressure.

A wrapped wire connection consists of a large number of these contact zones, which results in a very low resistance due to the parallel connection.

A four-corner wrap post and 5 windings of the blank conductor results in 20 paralleled contact zones. This means that the entire contact surface is greater than the cross-section of the wire.

Each individual conductor section (area of winding between two wrap post edges) presses against the edges of the wrap post with both ends. The entire wrapping therefore functions as a wrap spring. The conductor is not overstretched during the winding process and still has extra elasticity. Even the wrap post itself is pressed together somewhat and is subject to elastic torsional stress. This ensures that sufficient elasticity is stored in the wrapping - even after a certain release of stress in the conductor after the winding process - in order to guarantee complete reliability.

Intensive ageing experiments have shown that for the required service life of 40 years, at a temperature of 57°C, the tension in the conductor declines and therefore the contact pressure decreases as well to 50% of the values which were present one week after the winding process.



The contact resistance increases only slightly since the contact surface must remain unchanged for the most part in order to maintain the low value, but not necessarily the contact pressure. If the metallic parts were tightly joined due to initial plastic deformation of the conductor, the metallically blank contact zones (and thereby also the low input and surface contamination resistance) are retained if the contact pressure is reduced in relatively wide junctions. These investigations were confirmed by more extensive measurements made at the U.S. Naval Avionics Facility Indianapolis (NAFI) on conductors with ø 0,25 mm (AWG 30) and ø 0,4 mm (AWG 26).

The Wire-Wrap wrapping technique

Selection criteria for Wire-Wrap tools

Before selecting and using a new tool, check
1) the nose piece you need
2) the position of the index system
3) the service instructions

1) Nose pieces

„A" nose piece:
The wrapping bit is actuated by a coupling that is pressed forward via the tool itself during the wrapping process. This means that the backforce applied on the connection is the same as the force applied by the operator.

Advantages:
- Tool is simpler.
- The operator acquires quickly a good feel of the force to apply to obtain a good wrap.
- The „A" nose piece is used universally in production.

„C" nose piece:
A spring is inserted between the bit coupling and the tool mechanism and handle. This means that the bit will retract in the sleeve during the wrapping process.

Advantage: The backforce applied on the connection is more constant and to a certain extent, independant of the force applied by the operators.

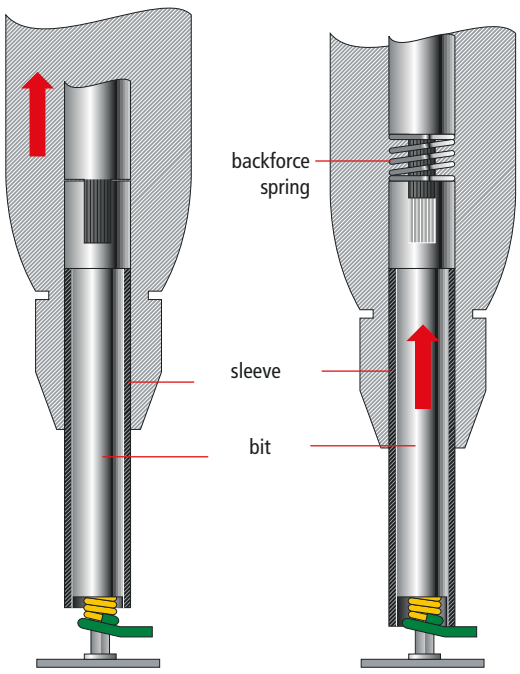
2) Index system
The index system will stop the bit in the same angular position after each wrapping operation: this facilitates the insertion of the next wire in the tool. Index adjustment simpliefies wire insertion.

Tools are supplied adjusted for a 12 o'clock position of the wire slot of the wrapping bit. The production tools of series 14R3G, 14YP1 and 14YB3 offer the possibility of an angular adjustment of the index mechanism. So, the position of the wire slot can be adjusted to suit the operator.

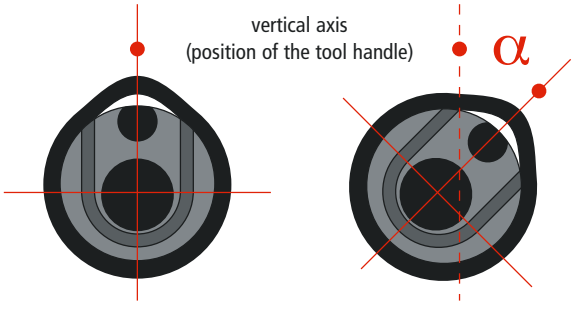
3) Service
Wire-Wrap tools last for years. They can be serviced and repaired by the customer's serviceman or by the authorized distributor.

Spare parts:
We recommend the holding of a certain quantity of spare parts. These are available from your authorized distributor. Service instructions and a spare parts list are issued with wall the tools supplied by the distributor.

„A" nose piece **„C" nose piece**



The index system

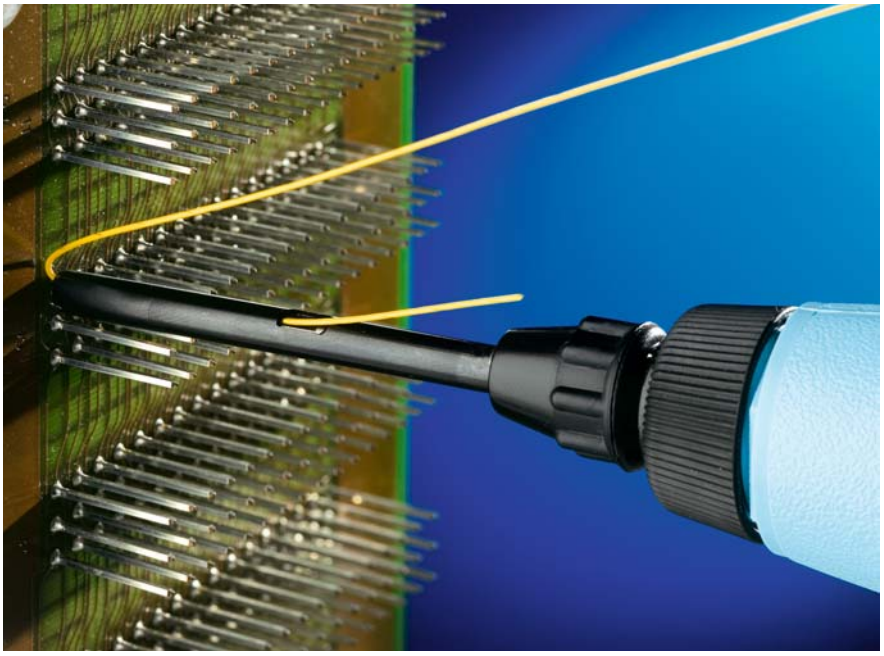


Please make sure the service instructions and parts list are kept in the repair shop!

Wire-Wrap®

Electric powered tools

Electric powered tools are used where no compressed air is available. The rugged construction of these tools limits the service to a minimum. They meet official specifications for safety and for electrical interference protection. These tools are used for volume production, batch production and field service.



14G1 Electric powered tool for micro and mini Wire-Wrap applications

- Low voltage super-light tool (weight 250 g), clockwise rotation
- Specially designed for micro and mini Wire-Wrap applications
- The body consists of rugged plastic material
- Tools feature 230 V, 50/60 Hz
- For selection of wrapping bits and sleeves refer to pages 22-23

Conductor diameter mm	AWG	Weight (tool only) g	Nose piece	Model	Order No.
0,16 - 0,5	34 - 24	250	A	14G1A-230 Volt	0099407625
0,16 - 0,5	34 - 24	250	A	14G1A-12 Volt	0099407661

Electric powered tools

Micro Wire-Wrap technique

- The 14G1 electric powered tool permits the wrapping of AWG 34 wires on a 0,5" (1,27 mm) terminal spacing.
- Specially designed for high density wiring on a grid spacing of 0,5" (1,27 mm).
- Even in the most sophisticated miniaturized electronic devices, it can be advantegeous to connect integrated components by means of wires.
- Any danger of damaging temperature sensitive integrated components is eliminated.
- Ideal to make prototypes, small series, researches specially when circuitry changes are expected.
- Sturdy construction, aluminium and steel housing.
- Low weight.

General Specifications

Conductor size:	AWG 34
Conductor diameter:	0,16 mm, OFHC Copper or of Alloy 134
Insulating diameter:	0,254 mm + 0,012 mm (insulating materials are the same as those used for AWG 30)
Terminals:	0,3 x 0,3 mm
Terminal material:	Phosphor-Bronze or Beryllium-Copper (the same critism as like AWG 30)
Radius of the edge of the terminal:	0,025 mm max.
Terminal length:	Recommended length for 3 connections: 8,12 mm
Connections:	Recommended number of turns: 7-8 with bar wire: 1½ turns with insulation Minimum stripforce: 0,679 kg = 6,7 N

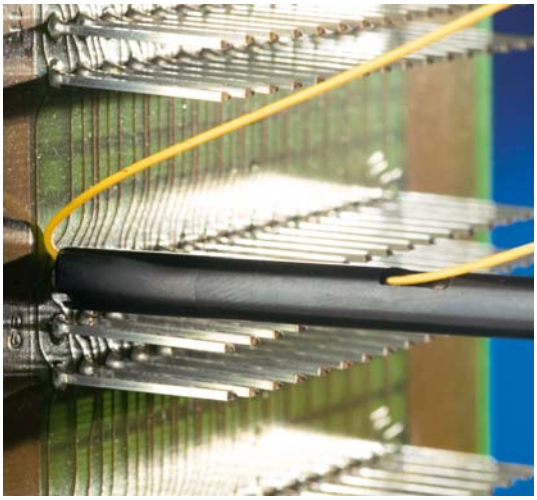
Recommendations

- When the 34 AWG wrapping is performed without the aid of a terminal locator, a large static magnifiying lense with incorporated illumination should be used (Magn: 2 to 3).
- The 34 AWG tool is used like a pencil. Better results are obtained when the operator has the possibility to rest the elbows during the wrapping operation.
- It is adviseable to mount the panel to be wrapped in a fixture. The angle of the fixture should be adjustable according to the comfort of the operator.
- Quantities of wires of various lengths have to be pre-cut and pre-stripped, preferably by means of an automatic stripping machine.

Conductor diameter mm (AWG)	Wire diameter mm	Terminal mm	Grid spacing mm	Terminal hole depth mm	Wrap bit Order no.	Sleeve (stationary) Order no.	Unwrapper Order no.	Average strip length mm	Recommended number of turns (with insulation)
0,16 (34)	0,25	0,6 x 0,6	2,54	10	990967	511274	505084	25	7 - 8 of that
	0,25	0,3 x 0,3	1,25	10	990876	990877	990204	10	1 with insulation

Wire-Wrap®

Electric powered tools



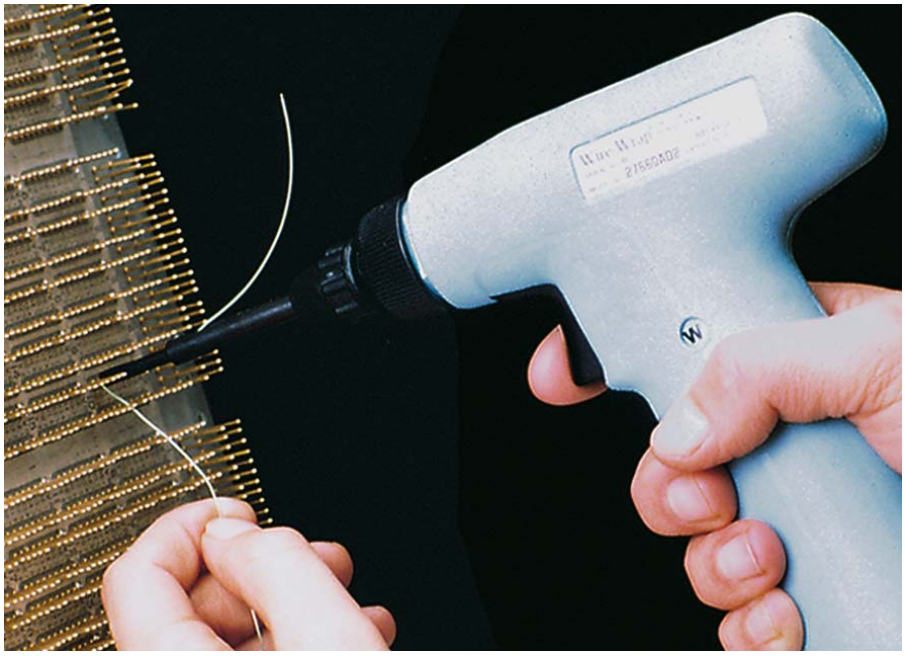
14YB3 Electric powered tool for Wire-Wrap applications

- The 14YB3 heavy duty electrical Wire-Wrap Tool is designed for production, service and installation applications.
- Clockwise rotation
- Powerful and reliable motor A.C.30W
- Planetary gear reduction drive
- Free rotation speed of bit 4500 rpm
- Very low noise level 70 dBA. Bears the official sign for electrical noise interference protection N-12 dB.
- Capacity: 0,20 mm to 1,00 mm i.e. from AWG 32 to AWG 18
- Insulated collet and collet nut
- Double insulated
- Operator adjustable indexing: eight separate positions for operator preference
- Power supply 230 V
- This tool type has been successfully tested according to the harmonized EN specs. 60395-2-45 and EN 55014. Moreover this tool meets the EG specifications 73/23 EWG, 89/336 EWG and bears the CE and CCA approval signs.
- Due to its refined design and construction the 14YB3 can be used on live circuitry and also on devices containing sensitive integrated circuits.
- For selection of wrapping bits and sleeves refer to pages 22-23.

Conductor diameter mm	AWG	Weight (tool only) g	Nose piece	Model	Order No.
0,25 - 1,0	30 - 18	450	A	14YB3-230/A	0090293153
0,25 - 1,0	30 - 18	450	A	14YB3-230/A SEV	0090293154
0,25 - 1,0	30 - 18	450	A	14YB3-230/A UK	0090293155
0,25 - 0,6	30 - 22	450	C	14YB3-230/C	0090293178
0,25 - 0,6	30 - 22	450	C	14YB3-230/C SEV	0090293179

Battery powered tools

This tool can be used away from the bench, they are independent of external source.
The battery powered tools are designed for field repair, service, laboratory applications, and low production. Ideal for research and pre-series.



14R3 Battery powered tool

- The 14R3 can be used for wrapping and unwrapping.
- The rotation of the tool is reverse by changing the position of the handle in the tool head.
- With rechargeable Nickel-Cadmium battery in the handle.
- The Ni-Cd battery cell in the handle can be easily replaced.
- Charger has a recharging indicator light.
- Fast charge: 1 hour.
- A full charge permits the wrapping of 1000 connections or more, depending on the wire diameter.
- In case of necessity, possibility to use dry battery. A safety feature prevents accidental charging of dry batteries.
- Index position can easily be adjusted on 360°.
- For selection of wrapping bits and sleeves refer to pages 22-23.

Conductor diameter mm	AWG	Weight (tool only) g	Nose piece	Model	Order No.
0,25 - 0,65	32 - 22	390	A	14R3G	0090296503
Spare parts					
Charger 230 V, 50 Hz					0090520101
without battery charger					990650WW

Wire-Wrap®

Air powered tools

Pneumatic tools are preferred for volume production.

Advantages:

- Light weight
- Smoother operation
- Long life
- Minimal service

Specially designed for continuous in production and for maximum efficiency of the operators.

For compressed air accessoires please see page 29.

14YP1 Air powered tool

- The 14YP1 is the most used pneumatic tool for production.
- Specially light and perfectly balanced it reduces the fatigue of the operator and allows continuous wrapping on production.
- Clockwise rotation
- The housing is of reinforced strong Lexan plastic.
- The tool is equipped with a 1,80 m hose.
- For selection of wrapping bits and sleeves refer to pages 22-23.

Conductor diameter mm	AWG	Weight (tool only) g	Nose piece	Model	Order No.
0,25 - 0,65	30 - 22	260	A / clockwise rotation	14YP1A	26100AA5
0,25 - 0,65	30 - 22	260	C / clockwise rotation	14YP1C	26110AA4

Hand squeezed tools

These tools are normally used for occasional wrapping. With no external power requirement - operated only by hand - these tools are always ready for use. These light and easily operated tools find their place in any servicemans` tool kit.

14 HP1C Hand squeezed tool

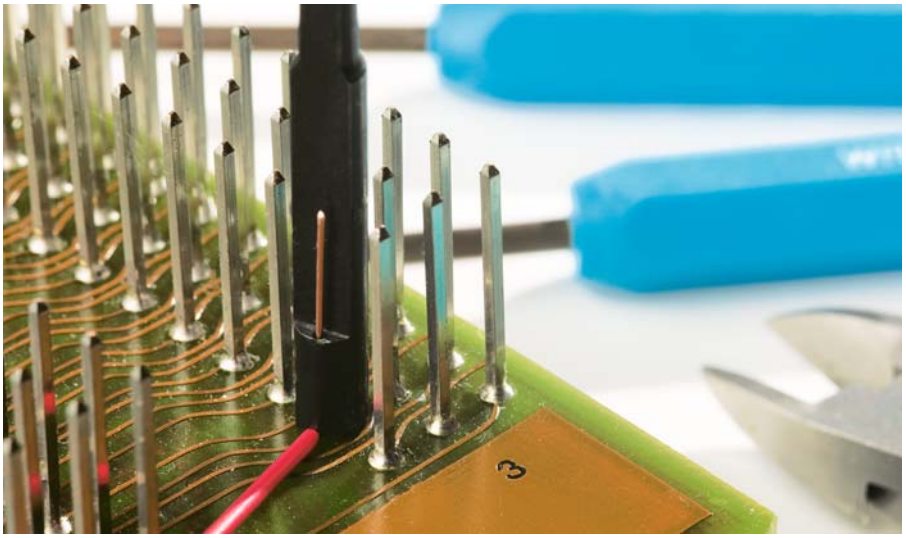
- The 14HP1C consists of a sturdy Lexan plastic frame with a built-in gearing.
- Clockwise rotation
- Squeeze the large trigger and a quality solderless connection is made.
- The universal collet accommodates all wrapping bits and sleeves.
- One squeeze of the trigger provides 10 rotations of the bit.
- The tool is mounted with an „A“ nose piece.
- The model number of the tool does not include the wrapping bit and the sleeve. For selection of bits and sleeves please refer to pages 22-23.

Conductor diameter mm	AWG	Weight (tool only) g	Nose piece	Model	Order No.
0,25 - 0,65	30 - 22	260	A / clockwise rotation	14HP1C	28000AC1

Wire-Wrap®

Manual wrapping tools

Manual wrapping tools are smaller and lighter than many simple screwdrivers. With a manual tool and an unwrapper the serviceman can make changes and repairs rapidly and simply. A manual tool (only 40 grams) consists of a plastic handle, a wrapping bit and a simplified sleeve. The wire is wrapped by manual rotation of the tool and the connection is perfect.



Manual wrapping tools

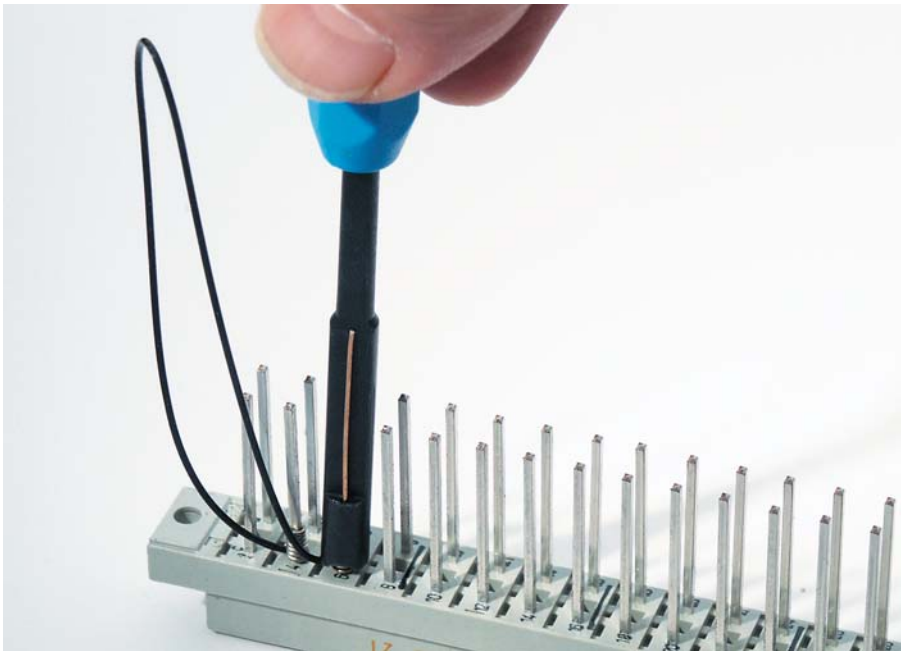
- A manual tool (only 40 grams) consists of a plastic handle, a wrapping bit and a simplified sleeve.
- The wire is wrapped by manual clockwise rotation of the tool and the connection is perfect.
- A listing of tool combinations (handle, bit and sleeve) is presented in the table below. For selection of (stationary) sleeves please refer to page 22. In the table below you see which stationary sleeve is replaced by simplified sleeve.

Breakdown of parts comprising a manual tool

Handle +	Wrapping bit +	Simplified sleeve =	Simplified sleeve replacing stationary sleeve (page 22)
Order No.		Order No.	Order No.
517219	according to the application	517231	18840
	select on page 22	517232	26245
		517229	502129
		517230	506999
		517228	507100
		517230	512056

Example: The manual tool for conductor 0,25 mm (AWG 30) and terminal 0,6 mm sq. on a 2,54 mm grid consists of:
handle 517219 + bit 507063 + simplified sleeve 517228 (corresponds stationary sleeve 507100).

Manual wrapping tools



WRAP 3 F 30 Universal manual wrapping tool

- The tool handles several tasks simultaneously: insulation removal, wrapping and unwrapping of the wire
- Particularly useful for wiring modifications
- Plastic handle

Description	Conductor diameter mm	Conductor diameter AWG	Terminal diagonal mm	Wire diameter mm	Order No.
Universal manual wrapping tool	0,25	30	0,81 - 0,94	1,0	WRAP3F30

Manual wrapping tools

WRAPECO Manual wrapping tool series

- These products are suitable for smaller repair wraps and customer services
- Plastic handle

Description	Conductor diameter mm	AWG	Terminal diagonal mm	Wire diameter mm	Order No.
Manual wrapping tool Maxi	0,8 - 0,9	20 - 19	0,81 - 0,94	1,0	WRAPECOMAXI

Description	Conductor diameter mm	AWG	Terminal diagonal mm	Wire diameter mm	Order No.
Manual wrapping tool Midi	0,4 - 0,6	26 - 22	1,4 - 1,8	1,9	WRAPECOMIDI

Description	Conductor diameter mm	AWG	Terminal diagonal mm	Wire diameter mm	Order No.
Manual wrapping tool Mini	0,25 - 0,4	30 - 24	1,4 - 1,8	1,9	WRAPECOMINI

Wrapping bits and sleeves

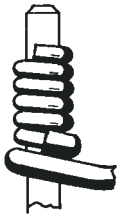
Selection of wrapping bits and sleeves

Application:
Wire diameter, Dimensions of terminal, Grid system, Connection style

Example:
Solid wire with conductor 0,25 mm (AWG 30) and insulation 0,55 mm diameter to be wrapped on a terminal a x b = 0,75 x 0,50 mm, terminal length 13,50 mm on a spacing of 2,54 mm - a modified connection is required.

Solution:
In the table „Technical features of wrapping bits and sleeves" locate column (1): Conductor diameter, and column (2): wrap type.
Example:
Conductor diameter 0,25 mm (AWG 30) and „MOD".

Find:
„Terminal Diagonal" (column 3) in the chart on page 21: Using side „a" = 0,75 mm and side „b" = 0,50 mm calculate the theoretical diagonal = 0,90 mm.
The actual diagonal is 0,90 - 0,04 = 0,86 mm (0,04 mm is the terminal corner radius allowance). For bit 507573 the terminal diagonal is from 0,84 to 0,92 mm.



MOD. = MODIFIED
A connection is called MODIFIED when there is a turn of insulation at the base of the wrap. This turn of insulation will reinforce the connection against shocks and vibrations.

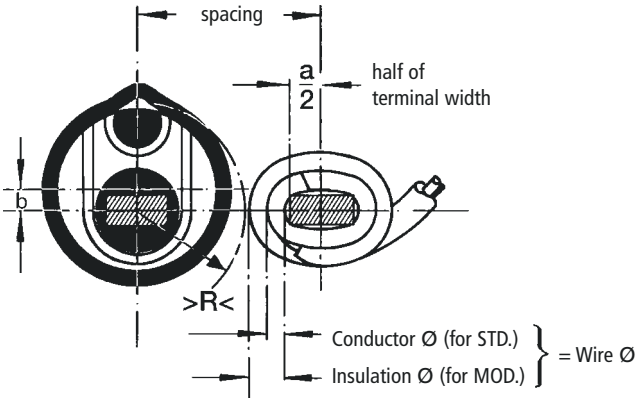
STD. = STANDARD
A connection is called STANDARD when there is no turn of insulation at the base of the wrap. The use of STANDARD connections makes the wrapping of thicker wires in a determined spacing possible (e.g. power supply lines).

Check maximum insulation diameter - column 5 - (applicable only to MODIFIED connections)
The insulation diameter is 0,55 mm. The bit 507573 can accept a maximum insulation diameter of 0,60 mm.

Clearance between sleeve and adjacent wrapped terminal use the formula:
Effective Radius + Wire diameter + $^{a}/_{2}$ Spacing.

The bit 507573 with the sleeve 507100 has an effective radius of 1,55 mm. So: 1,55 + 0,55 + 0,375 < 2,54 mm.

Determine that the Strip Length (column 7) gives the required number of turns (column 8). This relationship depends on the wire diameter and the dimensions of the terminal.
In our example: strip length: 25 mm is correct.

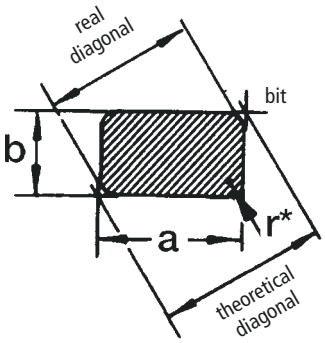


Effective Radius (R) is the radius of the circle covered by the bit + sleeve combination when the tool rotates. As many bits have an excentric terminal hole axis, the (R) is not always half of the sleeve outside diameter.

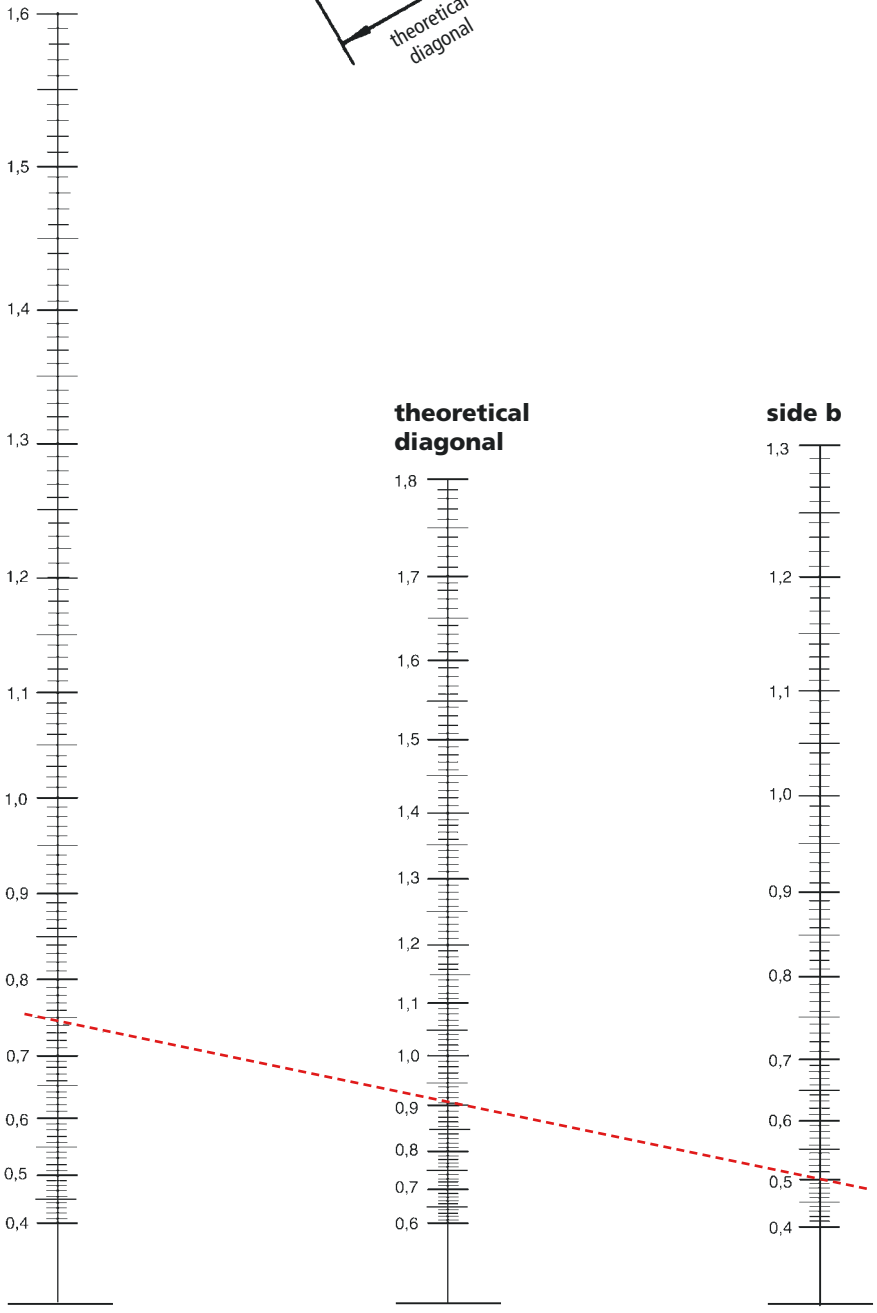
>R< + Wire-Diam.+ $^{a}/_{2}$ Spacing

Wrapping bits and sleeves

Chart for terminal diagonals

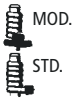


AWG Size	Diameter mm	Cross section mm²
34	0,16	0,021
32	0,202	0,032
31	0,227	0,040
30	0,2555	0,050
29	0,286	0,064
28	0,321	0,080
27	0,361	0,102
26	0,405	0,128
25	0,455	0,163
24	0,511	0,205
23	0,573	0,259
22	0,644	0,325
21	0,723	0,412
20	0,813	0,519
19	0,912	0,652
18	1,024	0,826
17	1,151	1,039
16	1,290	1,309
15	1,450	1,652
14	1,628	2,084
13	1,829	2,627
12	2,053	3,308
11	2,304	4,168
10	2,588	5,262



Wrapping bits and sleeves for clockwise tools

Technical features of wrapping bits and sleeves

(1) Conductor diameter mm / AWG	(2) Wrap type MOD./STD.*	(3) Terminal diagonal mm	Wrap bit Order No.	Sleeve (stationary) Order No.	(4) Terminal hole Ø mm	(5) Max. Insulation Ø mm	(6) Effective radius >R< mm	(7/8) Average strip length for recommended number of turns mm	DIN EN 60352-1	Size of terminals mm
										
0,25 / 30	MOD.	0,59 - 0,64	990891	511274	15	0,49	1,21	20		0,45 x 0,46
	MOD.	0,67 - 0,77	501097	507100	19	0,68	1,67	23 / 8	MINI	0,5 x 0,5
	MOD.	0,78 - 0,87	507063	507100	19	0,60	1,55	25 / 8	MINI	0,6 x 0,6 / 0,635 x 0,635
	MOD.	0,78 - 0,87	990734	507100	28	0,60	1,55	25		0,6 x 0,6 / 0,635 x 0,635
	MOD.	0,79 - 0,95	519936	507100	19	0,70	1,72			0,6 x 0,6
	MOD.	0,84 - 0,92	507573	507100	19	0,60	1,55	25		0,6 x 0,6 / 0,635 x 0,635 / 0,75 x 0,5
	MOD.	1,04 - 1,12	507502	507100	19	0,68	1,8	30 / 8	MINI	0,56 x 0,91
	MOD.	1,35 - 1,45	508105	502129	25	0,68	2,36	38		1,0 x 1,0
	MOD.	1,52 - 1,62	501381	512056	25	0,68	2,72	43		1,14 x 1,14
	STD.	0,69 - 0,77	500352	507100	19	-	1,69	23 / 8		
0,3 / 28	MOD.	0,78 - 0,87	509278	507100	19	0,76	1,7	23 / 7	MINI	0,6 x 0,6 / 0,635 x 0,635
	MOD.	0,84 - 0,92	501389	502129	19	0,91	2,2	25		0,6 x 0,6 / 0,635 x 0,635
0,4 / 26	MOD.	0,59 - 0,98	506445	507100	19	0,79	1,88	23 / 6	MINI	0,6 x 0,6 / 0,635 x 0,635
	MOD.	0,78 - 0,87	507063	507100	19	0,6	1,55	25 / 6		0,6 x 0,6 / 0,635 x 0,635
	MOD.	0,79 - 0,91	511250	507100	19	1,09	1,88	23		0,6 x 0,6 / 0,635 x 0,635
	MOD.	0,87 - 1,28	509405	502129	25	0,86	2,18	25		0,91 x 0,56
	MOD.	1,22 - 1,42	517104	512056	25	1,04	2,54	31 / 6	MIDI	1,0 x 1,0
	MOD.	1,22 - 1,42	511439	502129	25	1,04	2,41	31		1,0 x 1,0
	MOD.	1,35 - 1,76	502118	512056	25	1,04	2,82	35 / 6	MIDI	0,8 x 1,4 / 0,91 x 1,22 / 1,0 x 1,0
	MOD.	1,60 - 1,86	506781	512056	25	1,04	2,84	38		0,8 x 1,6 / 1,14 x 1,14
	MOD.	1,37 - 1,88	519070	18840	28,7	1,17	2,97	38		0,8 x 1,6 / 1,14 x 1,14
	STD.	1,47 - 1,86	504910	512056	25	-	2,66	38		
0,5 / 24	MOD.	0,61 - 1,10	505415	502129	25	1,12	2,49	20 / 5		0,56 x 0,91 / 0,6 x 0,6 / 0,635 x 0,635
	MOD.	1,19 - 1,69	506991	506999	25	1,04	2,54	28		0,8 x 1,4 / 0,91 x 1,22 / 1,0 x 1,0 / 1,14 x 1,14
	MOD.	1,25 - 1,74	504155	18840	28	1,27	3,02	28 / 5	MIDI	0,8 x 1,4 / 0,91 x 1,22 / 1,0 x 1,0 / 1,14 x 1,14
	MOD.	1,37 - 1,86	26263	18840	28	1,17	2,97	38 / 5	MIDI	0,8 x 1,4 / 0,8 x 1,6 / 0,91 x 1,22 / 1,0 x 1,0 / 1,14 x 1,14
	MOD.	1,37 - 1,88	519070	18840	28,7	1,17	2,97	38		
	STD.	0,61 - 1,10	502134	502129	25	-	2,12	20 / 5		
	STD.	1,38 - 1,88	512058	512056	25	-	2,65	30		
0,65 / 22	MOD.	1,25 - 1,86	504939	18840	25	1,32	3,35	28 / 4	MIDI	0,8 x 1,4 / 0,8 x 1,6 / 0,91 x 1,22 / 1,0 x 1,0
	STD.	1,25 - 1,86	505413	18840	25	-	3,0	28 / 4		
	STD.	1,55 - 2,17	18632	18840	25	-	3,16	30		
	STD.	2,49 - 3,11	18635	18640	25	-	3,6	36		
0,8 / 20	MOD.	1,07 - 1,86	26495	26245	25	1,5	3,81	28 / 4	MAXI	0,8 x 1,4 / 0,8 x 1,6 / 0,91 x 1,22 / 1,0 x 1,0 / 1,14 x 1,14
	STD.	1,07 - 1,68	507356	18840	25	-	3,06	28 / 4		
	STD.	1,50 - 2,30	18633	26245	25	-	3,74	32		
	STD.	2,31 - 3,11	18637	18640	25	-	3,81	36		
1,0 / 18	MOD.	1,55 - 1,86	504908	18640	25	1,78	3,83	30 / 4	MAXI	1,14 x 1,14
	STD.	1,55 - 1,86	504222	26245	25	-	3,81	30 / 4		

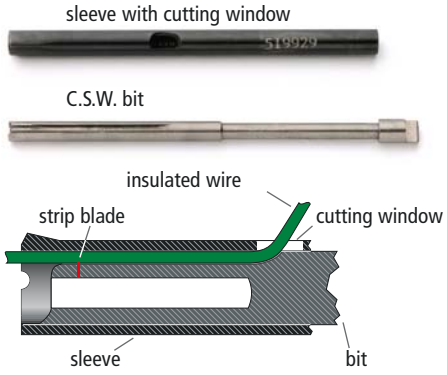
* MOD. = modified / STD. = standard (see page 20).

Wrapping bits and sleeves for clockwise tools

Cut-Strip-Wrap bits and sleeves for modified connections

C.S.W. (Cut – Strip – Wrap)

C.S.W. bits and sleeves can be used with following tools:

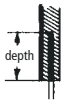
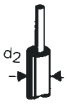


Attention:
For C.S.W. bits use tools with „A" nose piece only.
The C.S.W. bits and sleeves cut the wire to the correct length, strip the insulation and wrap the correct number of turns in one operation.

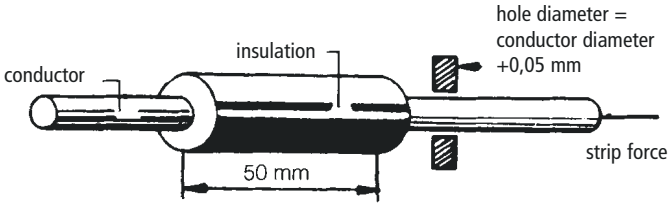
The purpose of the C.S.W. bits and sleeves is not to replace conventional wrapping, but to widen the field of operation of the Wire-Wrap technique.

Selection table C.S.W. for bits and sleeves

For good results its important to keep to the wire specifications on page 20.

(1) Conductor diameter mm	AWG	(3) Terminal diagonal mm	C.S.W. bits Order No.	C.S.W. sleeves Order No.	(4) Terminal hole Ø mm	(5) Wire - Ø mm	(6) effective radius >R< mm	(8) number of turns	Size of terminals mm
									
0,25	30	0,76 - 0,86	990764	990765	25,4	0,48 - 0,55	1,65	7	0,6 x 0,6 / 0,635 x 0,635
		0,76 - 0,86	990841	990765	28,2	0,48 - 0,52	1,65	7	0,6 x 06, / 0,635 x 0,635
		0,76 - 0,86	990063WW	990064WW	25,4	0,51 - 0,56	1,79	7	0,6 x 0,6 / 0,635 x 0,635
0,40	26	0,76 - 0,86	527812	527813	25,4	0,64 - 0,71	2,08	7	0,6 x 0,6 / 0,635 x 0,635
		0,76 - 0,86	990995	527813	25,4	0,70 - 0,79	2,08	7	0,6 x 0,6 / 0,635 x 0,635
		1,65 - 1,75	522205	522204	25,4	0,64 - 0,74	2,95	7	0,8 x 1,6
		1,50 - 1,60	522203	522204	25,4	0,64 - 0,74	2,85	7	1,0 x 1,0 / 1,14 x 1,14
		1,50 - 1,83	522202	522201	25,4	0,79 - 0,89	3,25	7	0,8 x 1,6
		1,37 - 1,47	521105	521116	25,4	0,86 - 0,99	3,25	6	1,0 x 1,0
		1,37 - 1,47	521105	990435	25,4	0,97 - 1,03	3,25	6	1,0 x 1,0
		1,37 - 1,47	519926	519927	25,4	0,66 - 0,74	2,82	6	1,0 x 1,0
		1,37 - 1,47	990681	990435	25,4	0,97 - 1,05	3,35	6	1,0 x 1,0
		1,37 - 1,44	990846	990847	25,4	0,75 - 0,85	2,82	6	1,0 x 1,0 / 1,3 x 0,6
0,40- 0,50	26 - 24	1,37 - 1,47	990996	990997	25,4	0,76 - 0,91	2,78	7	0,6 x 1,3 / 1,0 x 1,0
0,50	24	1,37 - 1,47	990753	519929	25,4	0,74 - 0,85	3,25	6	1,0 x 1,0
		1,50 - 1,83	519066	522201	25,4	0,86 - 0,99	3,38	6	1,0 x 1,0 / 0,8x1,6
		1,68 - 1,78	521198	521199	25,4	1,02 - 1,14	3,48	6	0,8 x 1,6
		1,50 - 1,88	990046	522201	25,4	0,81 - 0,89	3,28	6	0,8 x 1,6
		1,50 - 1,83	518910	518911	25,4	1,02 - 1,14	3,38	6	0,8 x 1,4
		1,50 - 1,83	518910	519929	25,4	0,81 - 0,94	3,25	6	0,8 x 1,4 / 1,0 x 1,0
		1,37 - 1,47	990561	990562	25,4	1,02 - 1,09	3,35	5,5	1,0 x 1,0 / 0,91 x 1,22
		1,37 - 1,47	519928	519929	25,4	0,84 - 0,91	3,23	5,5	1,0 x 1,0 / 0,91 x 1,22
		1,50 - 1,83	519066	519067	25,4	1,02 - 1,14	3,38	6	1,0 x 1,0 / 0,80 x 1,60
		1,37 - 1,47	990579	522212	25,4	1,31 - 1,39	3,28	5	1,0 x 1,0
0,50 - 0,60	24 - 22	1,75 - 1,83	518931	518932	25,4	1,14 - 1,27	3,38	6	0,8 x 1,6
0,60	22	1,37 - 1,47	990646	522212	25,4	1,16 - 1,25	3,38	5	1,0 x 1,0
		1,50 - 1,60	522211	522212	25,4	1,14 - 1,27	3,28	5	1,14 x 1,14 / 0,8 x 1,4
		1,37 - 1,47	990563	990562	25,4	0,94 - 1,02	3,48	5	1,0 x 1,0
		1,37 - 1,47	990779	990780	25,4	1,04 - 1,12	3,38	5	1,0 x 1,0

Wire specifications for C.S.W. connections



Wire specifications for C.S.W. connections:

Conductor:
- Copper wire with 20% minimum elongation at breakpoint.

Wire plating:
- Tinned or silver-plated conductor. The texture of wire plating must be smooth.

Concentricity of insulation:
- Within 80% minimum (ration of thinnest to thickest wall).

Example:
Semi-rigid PVC, FEP Teflon®, Kynar®, Tefzel®, Milene® Elongation at break-point: 125% min., 250% max.

If the adhesion between the conductor and the insulation is excessive, the conductor can be over-elongated by the C.S.W. bit and this will produce a brittle connection.
The strip force of 50 mm of insulation should not exceed the listed values.

Each application has to be checked individually, especially when strip force does not meet the specifications.

Conductor diameter		Strip force
mm	AWG	Newton max.
0,25	30	3,4
0,4	26	4,5
0,5	24	5,5
0,65	22	8,0

Milene® is a registered trademark of the Gore Wire Manufacturing Co.

Wire-Wrap®

Battery tool used as unwrapping tool

14R3 Battery tool used as unwrapping tool

- The 14R3 can be used for wrapping and unwrapping.
- The rotation of the tool is reverse by changing the position of the handle in the tool head.
- With rechargeable Nickel-Cadmium battery in the handle.
- The Ni-Cd battery cell in the handle can be easily replaced.
- Charger has a recharging indicator light.
- Fast charge: 1 hour.
- A full charge permits the wrapping of 1000 connections or more, depending on the wire diameter.
- In case of necessity, possibility to use dry battery. A safety feature prevents accidental charging of dry batteries.
- Index position can easily be adjusted on 360°.
- Unwrapping bit - sleeves assemblies are listed below.

Conductor diameter mm	AWG	Weight (tool only) g	Nose piece	Model	Order No.
0,25 - 0,65	32 - 22	390	A	14R3G	0090296503
Spare parts					
Charger for 230 V, 50 Hz					0090520101
without battery charger					990650WW

Unwrapping bit - sleeve assemblies for unwrapping tools 14R3G and 14HP1CLU

Conductor diameter mm	AWG	Terminal hole diameter and depth mm	Outside diameter of bit mm	Order No.
for unwrapping normal clockwise connections				
0,25 - 0,40	30 - 26	1,02 x 25	2,36	990 420
0,40 - 0,60	26 - 22	1,78 x 25	3,18	990 421
0,40 - 0,60	26 - 22	1,78 x 25	3,96	990 422
for unwrapping counter clockwise connections				
0,25 - 0,40	30 - 36	1,02 x 25	2,36	990 423
0,40 - 0,60	26 - 22	1,78 x 25	3,18	990 424

Hand squeezed tool used as unwrapping tool

14 HP1CLU Hand squeezed tool used as unwrapping tool

- The 14 HP1CLU tool (counter clockwise rotation) can be used to unwrap normal, clockwise connections.
- The 14HP1CLU consists of a sturdy Lexan plastic frame with a built-in gearing.
- Squeeze the large trigger and a quality solderless connection is made.
- The universal collet acommodates all wrapping bits and sleeves.
- Unwrapping bit-sleeve assemblies are listed below.

Conductor diameter mm	AWG	Weight (tool only) g	Nose piece	Model	Order No.
0,25 - 0,65	30 - 22	260	A / counter clockwise	14HP1CLU	28000AB2

Unwrapping bit - sleeve assemblies for unwrapping tools 14R3G and 14HP1CLU

Conductor diameter mm	AWG	Terminal hole diameter and depth mm	Outside diameter of bits mm	Order No.
for unwrapping normal clockwise connections				
0,25 - 0,40	30 - 26	1,02 x 25	2,36	990 420
0,40 - 0,60	26 - 22	1,78 x 25	3,18	990 421
0,40 - 0,60	26 - 22	1,78 x 25	3,96	990 422
for unwrapping normal counter clockwise connections				
0,25 - 0,40	30 - 36	1,02 x 25	2,36	990 423
0,40 - 0,60	26 - 22	1,78 x 25	3,18	990 424

Wire-Wrap®

Manual unwrapping tools

- The manual unwrapping tools are used for quick and easy unwrapping when minor changes are required.
- These tools can also used to perform the unwrapping test for checking possible brittlenes of connections.

L = Left, or counter clockwise tools for clockwise (normal) connections

R = Right, or clockwise tools for counter clockwise connections

Description	Conductor diameter mm	Conductor diameter AWG	Terminal mm	Terminal hole mm	Order No.
Manual unwrapping tool	0,2 - 0,4	32 - 26	0,5 x 0,5	0,9	509436
counter clockwise			0,6 x 0,6	1,0	505084
	0,25 - 0,5	30 - 24	0,56 x 0,91	1,3	509489
	0,4 - 0,8	26 - 20	1,0 x 1,0	1,8	504769
			0,91 x 1,22	1,8	504769
			0,8 x 1,4 / 0,8 x 1,6	1,8	515716
	0,5 - 1,0	24 - 18	1,14 x 1,14	1,8	A31478

Description	Conductor diameter mm	Conductor diameter AWG	Terminal mm	Terminal hole mm	Order No.
Manual unwrapping tool	0,2 - 0,4	32 - 26	0,5 x 0,5	0,9	511203
clockwise and counter clockwise			0,6 x 0,6	1,0	505244
	0,4 - 0,8	26 - 20	1,0 x 1,0 / 0,91 x 1,22 / 0,8 x 1,4 / 0,8 x 1,6	1,8	A26664
	0,5 - 1,0	24 - 18	1,14 x 1,14	1,8	500130

Manual unwrapping tools

420E Universal manual unwrapping tool

- Unwrapping tool, clockwise and counter clockwise
- With isolated, spring loaded sleeve

Description	Conductor diameter mm	Conductor diameter AWG	Terminal mm	Order No.
Universal manual unwrapping tool	0,4 - 0,8	20 - 26	1,0 x 1,0 / 0,8 x 1,6	420E

WRAP 3 F30 Universal manual unwrapping tool

- The tool handles several tasks simultaneously: insulation removal, wrapping and unwrapping of the wire
- Particulary useful for wiring modifications
- Plastic handle

Description	Conductor diameter mm	Conductor diameter AWG	Order No.
Universal manual unwrapping tool	0,25	30	WRAP3F30

Filter regulator lubricator

Filter regulator lubricator

- For a long and trouble-free operation of the pneumatic tools it is recommended to use clean, dry and lubricated air at the correct pressure.
- A good Lubri-Control-Unit is the best friend of your air tool.

Air inlet (threat)	Best range of application m³/min	Model	Order No.
R1/8"	0,03 - 0,4	FRL018	0099404288
Available: fixture elbow			H15024

Tool box for 14YB3 Wire-Wrap tool

Tool box for 14YB3 Wire-Wrap tool

- The small handy tool box is for storing the 14YB3 tool with bits, sleeves and unwrapping tools.

Description	Dimension	Order No.
Tool box - without tools	330 x 240 x 85 mm	0090000013

Strip force gauge

Strip force gauge

- Spring gauge with dial.
- Supplied with two hooks compatible with standardized terminals.
- This gauge allows the regular checking of the quality of the Wire-Wrap connections.

Range		Scale-Division		Weight	
kg	(N*)	g	(N*)	g	Order No.
10	100	100	1	370	0090912968
Spring hook midi					0090914414
Spring hook mini					0090914415

*1N= ~0,1 kg, tolerance +/- 5%

Stripping tools

Stripping tools

- Special stripping tools made of high grade tool steel
- Anti - glare finish
- High precision and EGB-safe
- For strip Wire-Wrap wires

520E

520E Special stripping tool for Wire-Wrap wires

- Strips one or several wires simultaneously.
- Diameter adjustable with screw plus blocking nut.

Wire diameter	AWG	Length mm	Model	Order No.
0,25 - 1,3	30 - 16	120	520 E	520 E

519E Stripping tool

- With adjustable stripping length - on request

502E30

502E30 Combination side stripping tool for Wire-Wrap wires

- This tool combines stripping, cutting and bending/gripping.
- Fine replacable cutting blades.

Wire diameter	AWG	Length mm	Model	Order No.
0,25	30	120	502E30	502E30
0,4	26	120	502E26	502E26
0,5	24	120	502E24	502E24

Test sheet

Name: **Company:**

Department:

Tool model: Order no.:

Wrapping bit: Sleeve:

Only fill results of same bit

Year:
Month:
Day:

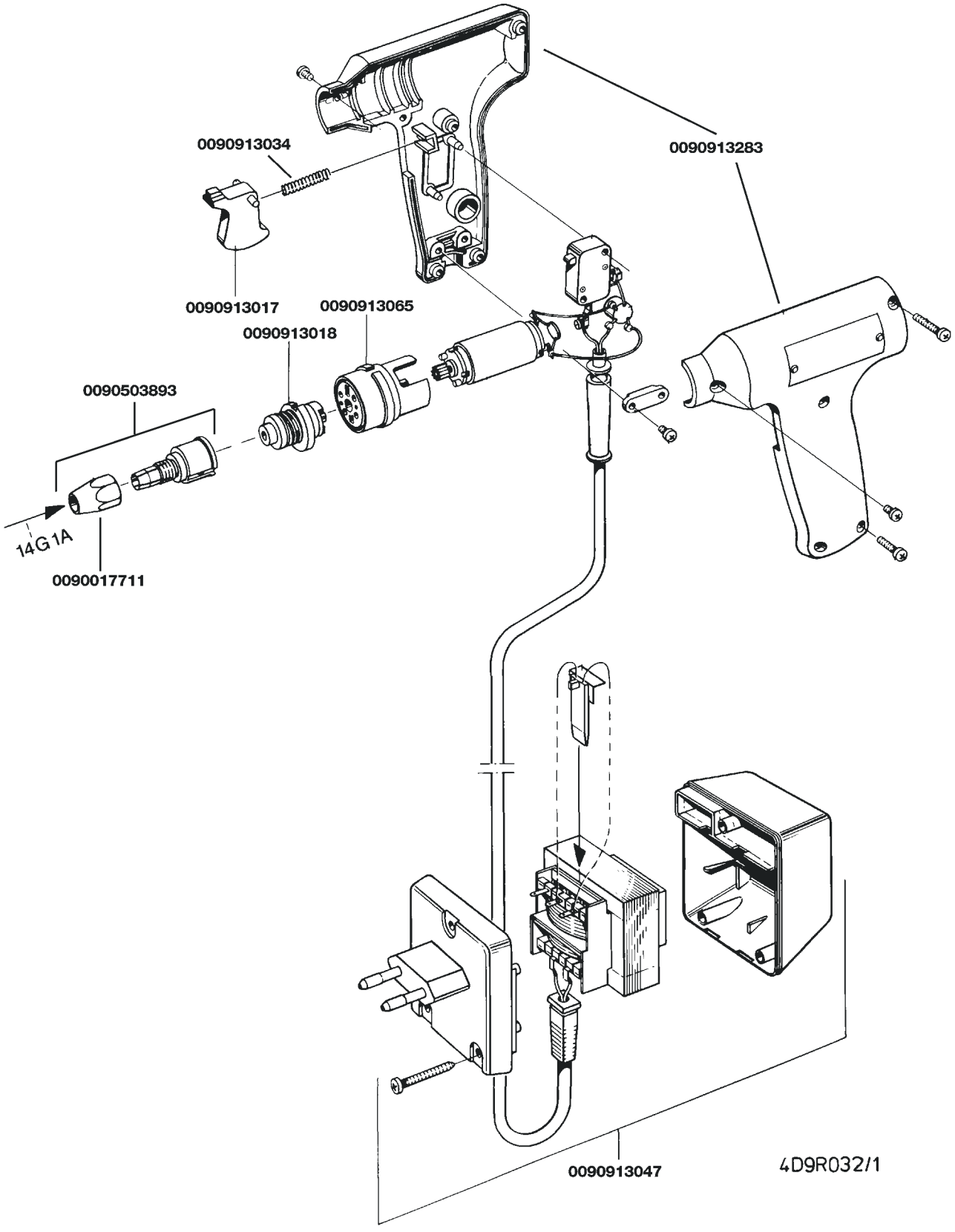
Strip force
(kg or N)
Consecutive no.

Unwrap test
No breakage: V
Breakage: O

Day:	1	2	3	4	5	6	7	8	9	10	total *	1	2	3	4	5

Conductor diameter		Minimum strip force		Number of turns of conductors	Terminals: (make, dimensions, material, plating, hardness)	Wire: (make, dimensions, material elongation, plating L=100)
mm	AWG	kg	N*			
0,25	30	1,5	15	8		
0,32	28	2	20	7		
0,4	26	2,5	25	6		
0,5	24	3	30	5		
0,65	22	3,5	35	4	A comparison of the strip force totals shows the conditions of a bit. Decreasing strip force indicates a wear of the bit radius. Increasing strip force indicates damages of the bit radius that can lead to brittleness of the wrapped wire.	
0,8	20	4	40	4		
1,0	18	5	50	4		

*1N= ~0,1 kg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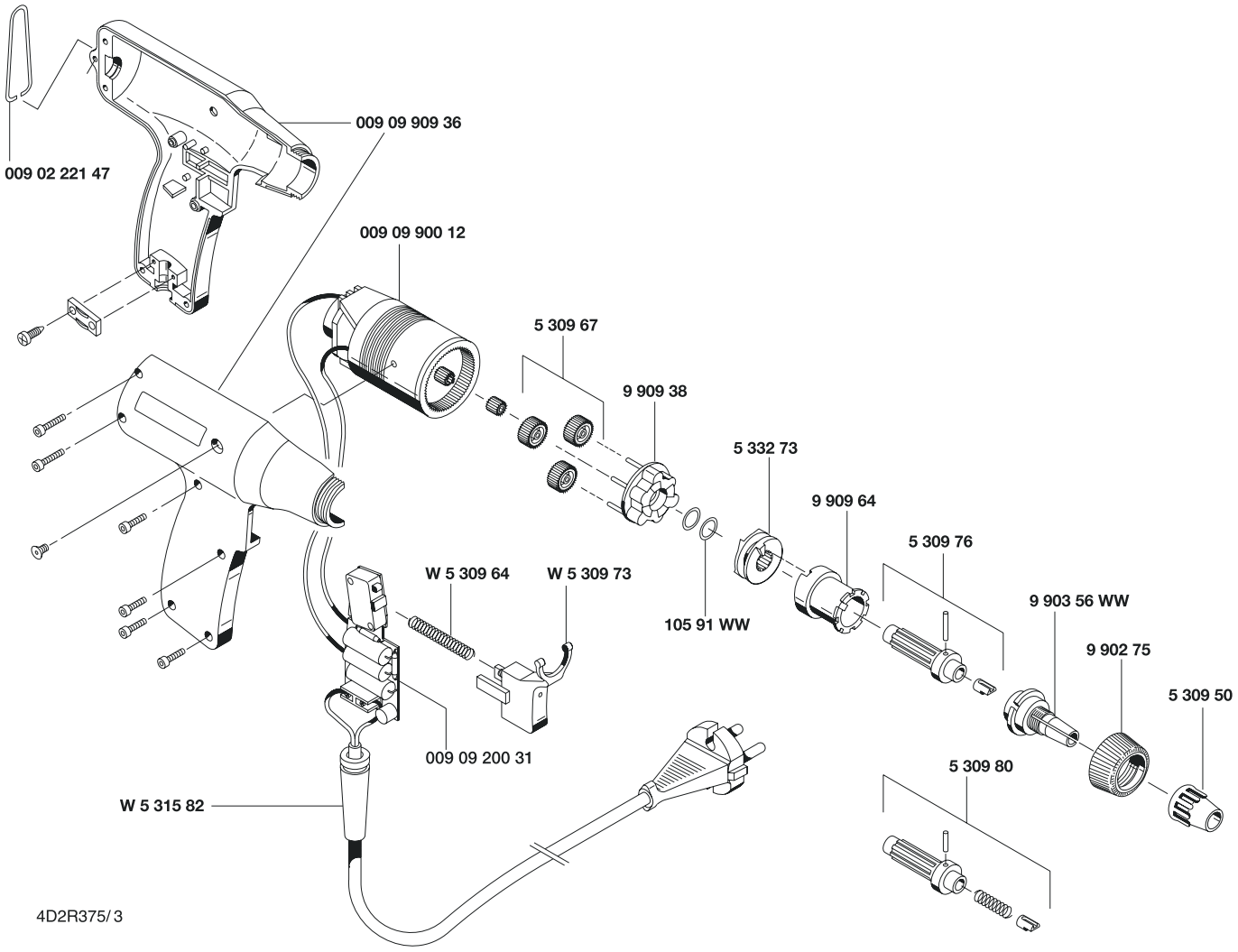
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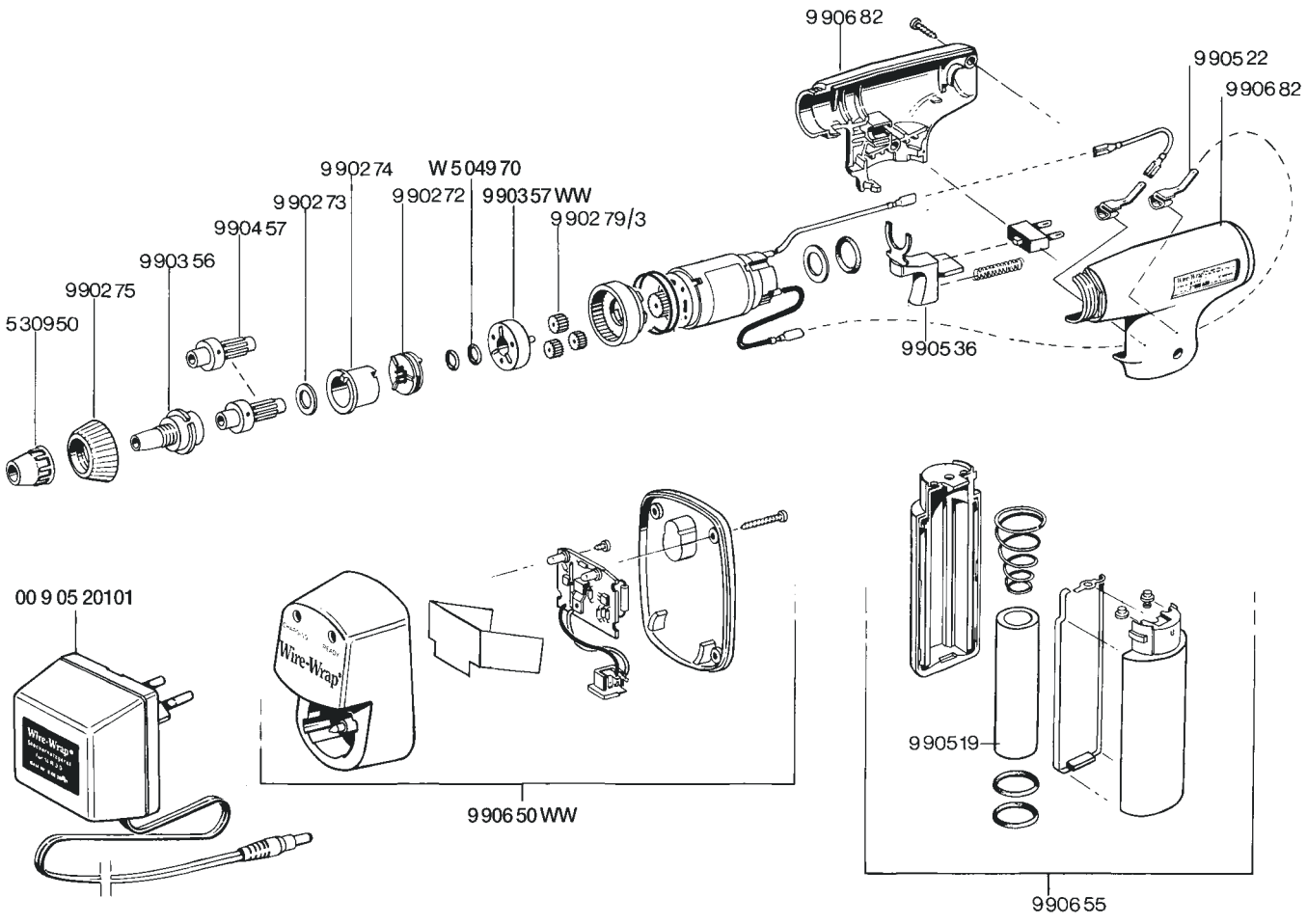
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Wire-Wrap
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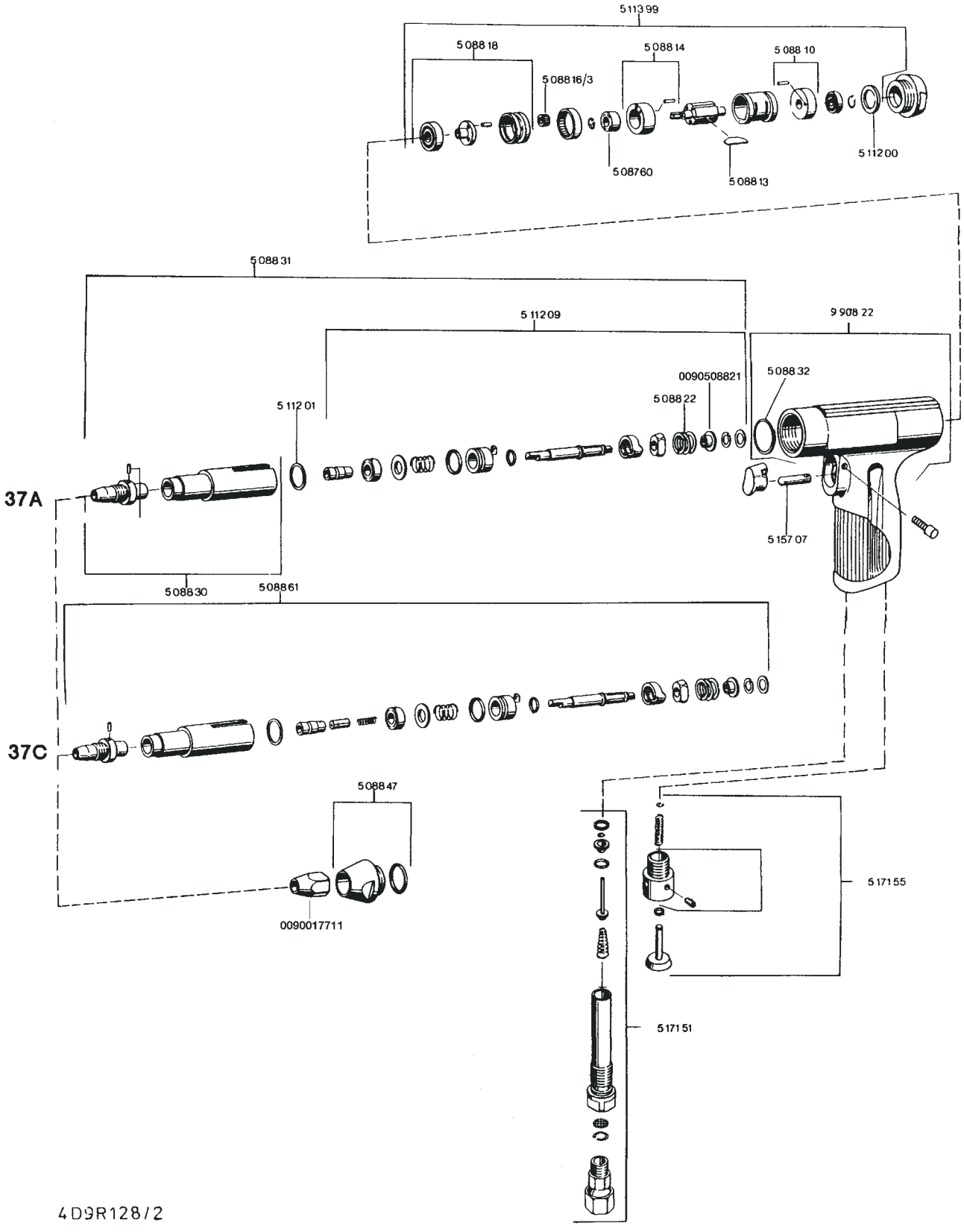
14YP1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5 088 30
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37C
5 088 47
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5 171 51
4D9R128/2

Wire-Wrap®

Index tools

Index bits and sleeves

Bits

Sleeve (stationary)

Sleeve (simplified)

Distributed by:





COOPER Hand Tools

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