

HOW TO INSTALL FUSITE TERMINALS

BACKGROUND

Fusite hermetic terminals for the compressor industry have been substantially improved in recent years for better performance and more efficient operation (Fig. 1). Because of this advancement in technology, a responsibility for the compressor manufacturer has arisen. The manufacturer must exercise greater caution in welding and handling the terminal during assembly. The improved terminals are more sensitive than earlier models to more casual preparation, welding technique, handling and equipment selection.

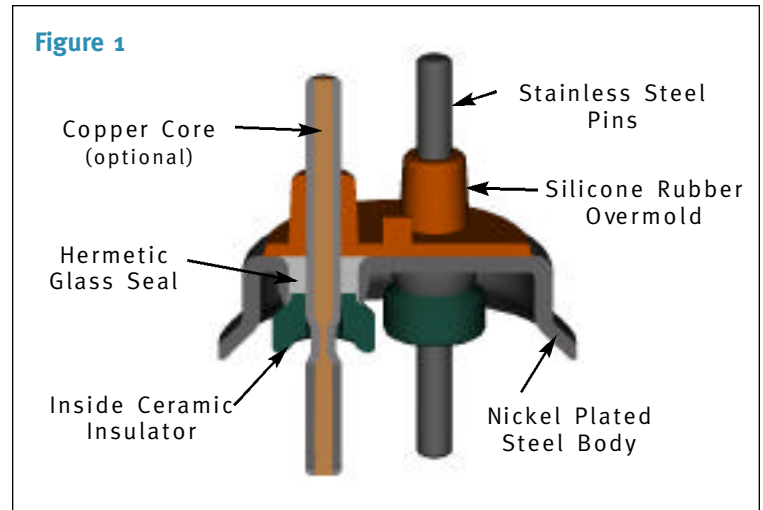
WELDING METHODS

Resistance Welding is the joining of two, or more pieces of metal by applying heat and pressure without the addition of any other material. Welding heat is generated when parts resist the passage of electric current between two electrodes, while pressure refines the grain structure in the parts. This combination of pressure and heat causes the parts to coalesce without actually liquefying.

Projection Welding is a form of resistance welding where the current flow and heating is concentrated at a precise point by design of the parts. Fusite terminals are designed to be projection welded.

WELDER SELECTIONS

Selecting the proper welder is very important for the correct terminal installation. Because selecting a specific welder depends on many different variables, such as plant power supply, compressor shell size, etc., a qualified manufacturer should be consulted.



Several welding consultants have recommended the following type of welders in order of preference:

- 1) **Single phase, low impedance, AC machine:** provides a sharper wave front without gaps between pulses.
- 2) **Multiple transformer versions of above:** when required by plant power or part size.
- 3) **Frequency converter:** converts 3-phase, 60 cycle power to single phase power at low frequency.
- 4) **Rectifier type machine:** transforms 3-phase, 60 cycle power from line voltage to low voltage, then rectifies it to direct current.

On AC machines, a split secondary will provide better current distribution. All machines should be designed to provide the least amount of deflection and a low inertia head to provide better follow-up.

WELDING ELECTRODES

After selecting a welder, it is important to use the proper welding electrodes. Welding electrodes should have high electrical conductivity to reduce generated heat, high thermal conductivity to dissipate heat rapidly, and resistance to deformation under high pressure. The electrodes must have adequate water cooling to provide sufficient life. Also, the electrode force must be in line and uniformly distributed; this can be checked by placing carbon paper between the electrodes.

Included in this section are drawings of the Fusite recommended upper (Fig. 2) and lower (Fig. 3) electrodes which should be of RWMA group A, Class 2 copper, with 85% IACS electrical conductivity and 83 HRB Rockwell hardness, UNS#C81500. The lower electrode is designed to accept a flexible rubber insert (which may be ordered directly from Fusite) to align the terminal and protect the ceramic insulators during welding (Fig 4).

PREPARATION FOR INSTALLATION

The terminal mounting hole should be round and in a flat surface pierced from the outside of the compressor housing. A sharp edge must be provided on the housing where it engages the terminal flange. The out-of-roundness, flatness, and shell thickness should be held within .005" (.127 mm) total indicator run out. Recommended hole diameters are:

Model	Hole Diameter inches (mm)
393	1.130±0.005 (28.70±0.127)
3B3	1.330±0.005 (33.78±0.127)
3K3	1.720±0.005 (43.69±0.127)

CONTROL SETTINGS

As a general rule, welds should be made with the lowest time and the highest current possible. The formula for heat generation in the weld is given by:

$$W = I^2 R t \quad \text{or} \quad W = V I t$$

where:

W = Heat in watt seconds

I = Current in amperes (secondary current)

R = Resistance in Ohms

t = Time in seconds

V = Voltage in volts (secondary voltage)

Here are the primary control settings used in Fusite welding and general guidelines for how they should be set.

Squeeze Time - Set to insure that the electrode force is reached before the weld current begins.

Weld Time - Set as short as possible to obtain acceptable weld. (Minimize cooling between pulses where applicable.)

Tap Setting - Set so that a minimum of about 70% of current will be utilized.

Current - Set to produce an acceptable weld while remaining in the range of about 70-90%.

Hold - Set to provide electrode contact for additional cooling after weld.

Electrode - Set to provide a slight indentation Force in the parts. While controlling expulsion.

The following table gives a recommended starting range for the various models:

Model	Secondary Amps	Electrode Force lb. (Newton)
393	60,000-70,000	3000-3500 (13,350-15,575)
3B3	80,000-90,000	4500-5500 (20,025-24,475)
3K3	100,000-110,000	7000-8000 (31,150-35,600)

Electrode Material: CMW₃ Alloy (R.W.M.A. Group A, Class 2) Copper Alloy (Chromium) 85% I.A.C.S. Electrical Conductivity, Hardness 83 HRB

Figure 2: Upper Weld Electrode

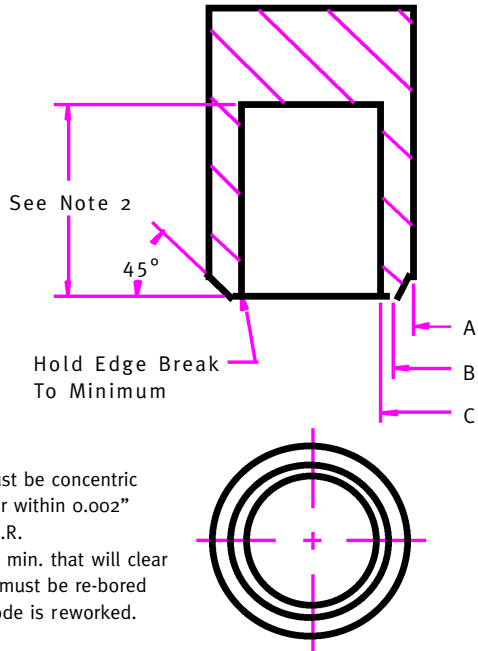
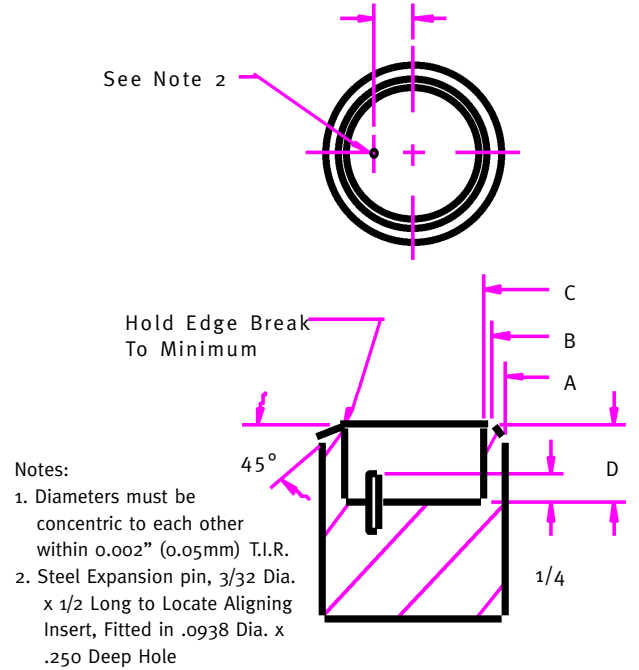


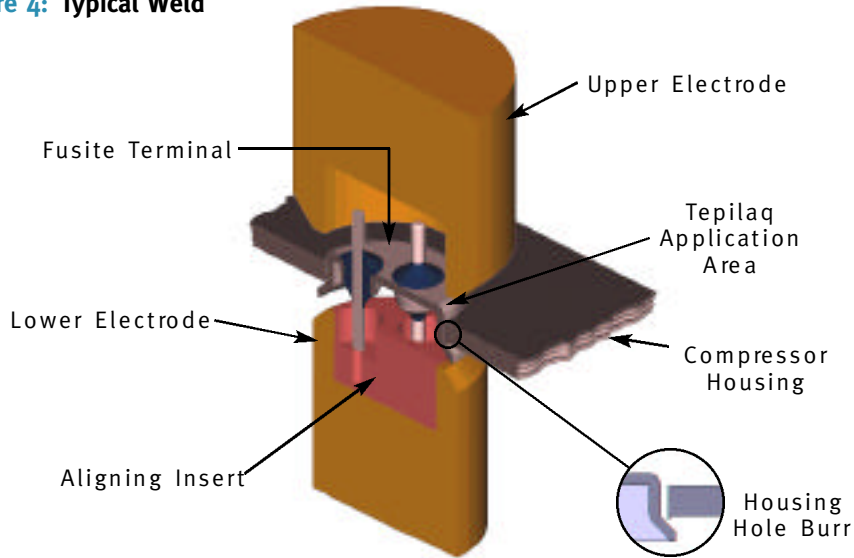
Figure 3: Lower Weld Electrode



	Upper Weld Electrode - inches (mm)		
Terminal Series	Outside A	Outside B	Outside C
393	1.750 (44.45)	1.375 (34.93)	1.156 (29.36)
3B3	2.000 (50.80)	1.600 (40.64)	1.356 (34.44)
3K3	2.500 (63.50)	2.026 (51.46)	1.760 (44.70)

	Lower Weld Electrode - inches (mm)					
Terminal Series	Outside A	Bevel B	Bore C	D	E	Aligning Insert Part Number
393	1.375 (34.93)	1.135 (28.8) 1.140 (28.9)	0.980 (24.9) 0.984 (25.0)	0.650 (16.5) 0.655 (16.6)	0.265 or 0.400 (6.7 or 10.2)	17-61440
3B3	1.624 (41.27)	1.335 (33.9) 1.340 (34.0)	1.181 (29.9) 1.185 (30.1)	0.725 (18.4) 0.730 (18.5)	0.343 (8.71)	17-61448
3K3	2.000 (50.80)	1.725 (43.8) 1.730 (43.9)	1.571 (39.9) 1.575 (40.0)	0.725 (18.4) 0.730 (18.5)	0.4075 (10.35)	17-61444

Figure 4: Typical Weld



Of course, the main guidelines to use in setting the weld parameters are hermeticity, pushout strength and weld temperature, as described in the following section.

QUALITY TESTING

The following procedures are recommended for welding quality assurance.

Hermeticity - The weld must be completely hermetic. There are several different methods of testing, from the standard “bubble tank” to helium mass spectrometers.

Push Out Strength - The weld must withstand a minimum force without coming out of the compressor housing. Fusite recommends a pushout fixture (Fig. 5) which can be used with a hydraulic cylinder to force selected terminals out of the compressor housing. This force can be recorded for future guidelines. Normally, when the terminal is pushed out, some material from the terminal flange will remain on the compressor housing.

Weld Temperature - It is important that the terminal remain below 400 °F (204 °C) during welding. This can be checked by placing 400 °F Tempilaq on the terminal “crown” before welding and assuring that it does not melt.

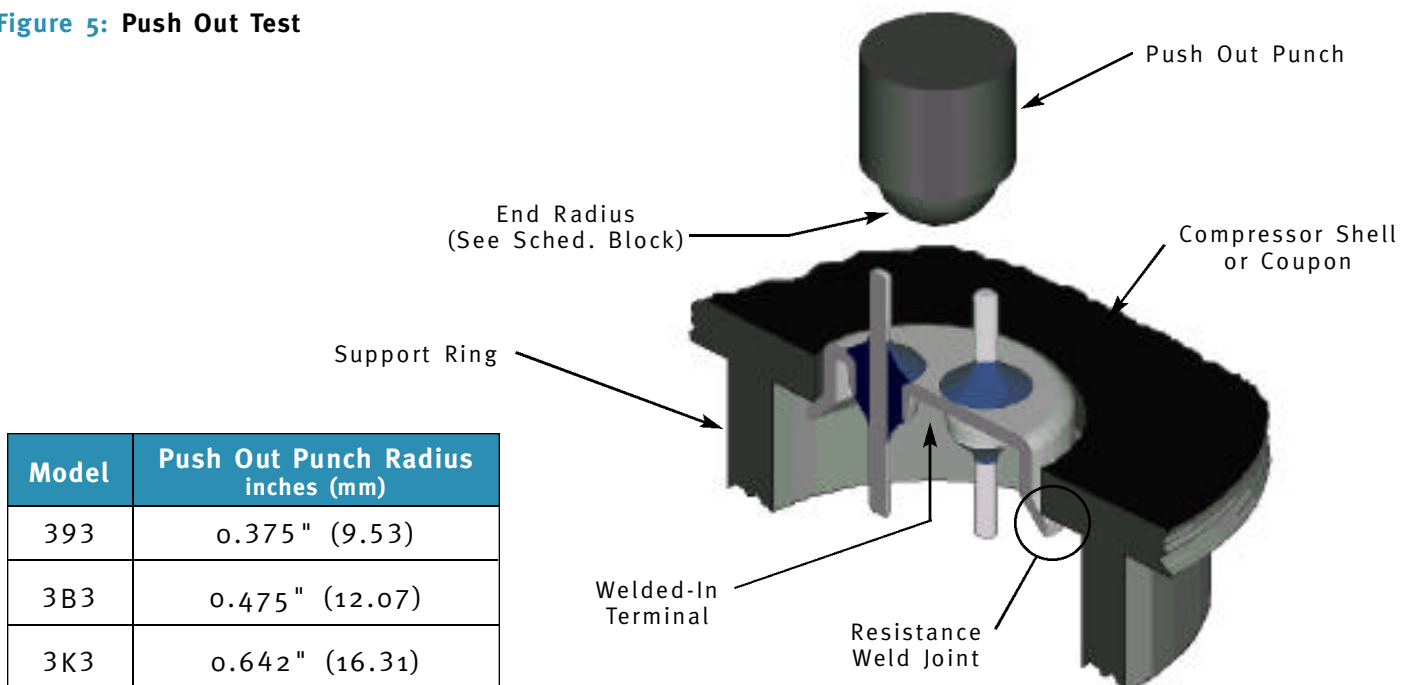
Weld Settings - It is advisable to use a weld monitor to verify the weld conditions.

VISUAL INSPECTION

The compressor housing should be inspected after welding for the following:

- a small, uniform heat-affected zone around the terminal
- a straight, well centered terminal
- light, uniform electrode impression
- uniform metal expulsion, if that is typical in the operation
- no evidence of overheating or electrode arcing on the flat area or sidewalls of the terminal
- no evidence of mechanical damage to the terminal pins, terminal cap or ceramics.

Figure 5: Push Out Test



A guide for common weld defects

PROBLEM	CAUSE	PROBLEM	CAUSE
Expulsion at weld interface	<ul style="list-style-type: none"> • Dirt or oil on part • Improper electrode alignment • Squeeze time too short • Weld force too low • Weld current too high • Weld time too long 	Electrode overheating	<ul style="list-style-type: none"> • Insufficient cooling • Weld time too long • Hold time too short • Weld current too high • Weld pressure too low
Expulsion on surface, electrodes sticking	<ul style="list-style-type: none"> • Squeeze time too short • Weld force too low • Dirt or oil on part • Electrode needs redressing • Weld current too high • Weld time too long • Hold time too short 	Short electrode life	<ul style="list-style-type: none"> • Electrode material too soft • Electrode has insufficient conductivity • Insufficient cooling
Electrode deforming	<ul style="list-style-type: none"> • Weld time too long • Weld force too high • Weld current too high • Insufficient cooling 	Weld leaks	<ul style="list-style-type: none"> • Improper electrode alignment • Weld force too high • Weld force too low
Excessive weld indentation	<ul style="list-style-type: none"> • Weld time too long • Weld force too high • Weld current too high • Improper electrode alignment • Squeeze time too short 	Weld not holding	<ul style="list-style-type: none"> • Weld force too high • Weld current too low • Tap setting too low
		Ceramics chipping	<ul style="list-style-type: none"> • Electrodes not aligned • Improper removal from welder • Improper electrode design • Worn electrodes