

# MegaStir

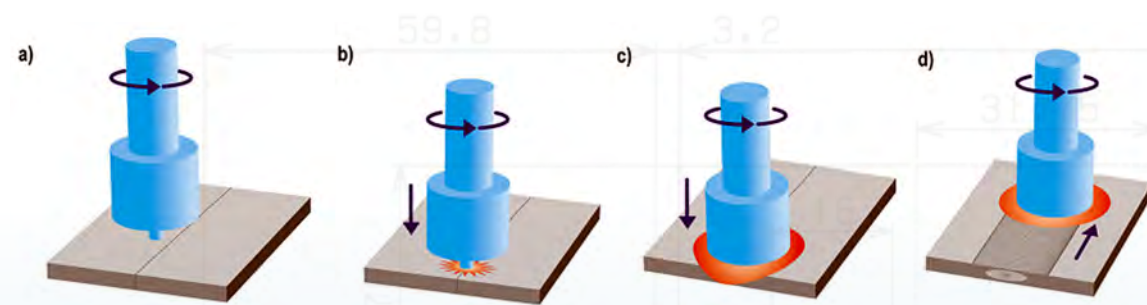
A Joint Venture of Schlumberger  
and Advanced Metal Products



**PRODUCTS  
& SERVICES**

A BETTER  
WELD

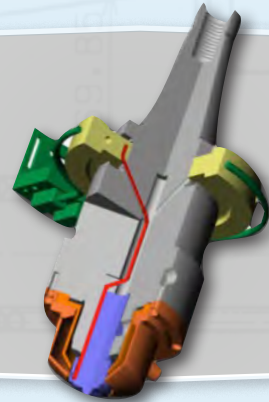
F R I C T I O N   S T I R   W E L D I N G



## FRICITION STIR WELDING

In the friction stir welding process, two solid metal surfaces are joined by “stirring” the metals together using a spinning tool. The tool is inserted into the location where the two metals are to be joined. The rotation of the tool creates enough friction to heat the material to a plastic or doughy state. As the tool moves down the weld joint, the metals flow together and become forged. No outside material is used and the resulting weld is made solely of the parent materials.

**MegaStir** has made significant innovations in the friction stir welding process by creating and patenting tool tips made from PCBN to allow friction stir welding of harder metals such as steel and nickel-based alloys.



**MegaStir** has also created a unique tool holder that keeps the tips and tool at a steady temperature, thus assuring that the metals are not melted and that the tool itself is not consumed in the process.

A weld that has been made through friction stirring offers numerous advantages:

### HIGH STRENGTH & TOUGHNESS

Because heat is kept low during the process, the resulting joined metals have a fine grain structure that resists fatigue stress; therefore, porosity and cracking do not occur.

### LITTLE DISTORTION

Due to the low heat and small heat-affected zone, there is minimal distortion of the joined parts, reducing the costs associated with preparing the part for subsequent use.

### DEFECT-FREE

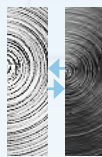
Variables such as force, rotational speed, traverse speed and heat are completely monitored and controllable, allowing for an optimum weld. Pin length and geometry are custom-made for the specific application assuring an extremely high quality weld.

Friction stir welding offers several other advantages over traditional welding:



### ENVIRONMENTALLY SOUND

Friction stir welding requires less energy and does not produce the fumes and gases of traditional welding.



### JOINING DISSIMILAR ALLOYS

Because the metals are stirred, normally “unweldable” alloys such as aluminum and stainless steel can be friction stir welded.



### GEOMETRIC CHALLENGES

Friction stir welding is a great solution when welding parts with complex geometries, contoured parts, cylinders and long-length panels.

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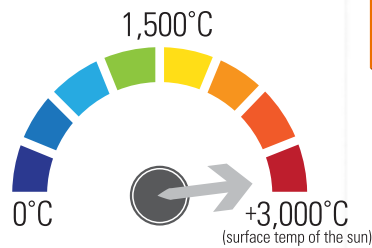
## A BETTER WELD.

### MEGASTIR IS A PREMIERE TOOL DESIGN & FABRICATION COMPANY SPECIALIZING IN FRICTION STIR WELDING

**MegaStir** has top-notch, innovative engineers with extensive expertise in tool materials and tool engineering who can create solutions for your toughest welding challenges. With a state-of-the-art, ISO 9001 certified R&D, prototyping and production facility, **MegaStir** can meet all of your friction stir welding needs.

Established in 2002, with a world-wide customer base, **MegaStir** is a joint venture between Schlumberger Ltd. and Advanced Metal Products, Inc.

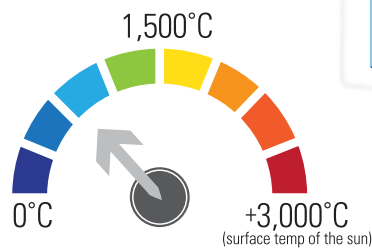
# MELTING POINTS



## HIGH-TEMPERATURE FRICTION STIR WELDING

Because metals such as steel, stainless steel, and nickel-based alloys have high melting points, they have posed many challenges for friction stir welding. Tools made

from refractory alloys containing tungsten, hafnium, rhenium, molybdenum, niobium, and zirconium have high-temperature properties, but during friction stir welding, these elements either alloy with the material being friction stir welded or abrade and deposit tool material in the weld region after welding only a few centimeters. The MegaStir proprietary solid-state joining process combines cutting and friction to join high-temperature alloys quickly and consistently, resulting in a superior weld. Using its own patented PCBN formulas, MegaStir tools offer unique high friction and durable tool wear. Designed for applications ranging from elastomeric products rated for extreme temperatures to pressures in oil and gas wells and aerospace engines to recreational products, MegaStir tools can handle your high temperature friction stir welding needs.



## LOW-TEMPERATURE FRICTION STIR WELDING

Friction stir welding for low-melting-point metals, such as aluminum and aluminum alloys, has been used in the aerospace, marine, and transportation industries for many years. Benefits include low distortion, greater weld

strength, little or no porosity, no filler metals, little or no post-weld repair, no solidification cracking, no welding fumes or gases, improved corrosion resistance, and lower cost in production applications. The process uses tools made from hardened tool steels that are inexpensive to fabricate. Tool steels provide sufficient hardness and abrasion resistance at these temperatures.

### POLYCRYSTALLINE CUBIC BORON NITRIDE (PCBN)

PCBN is a synthetic super abrasive material (second in hardness only to diamond) that MegaStir creates in its high temperature, ultra-high pressure presses. PCBN is an ideal material for high temperature friction stir welding as it possesses excellent toughness plus an exceptionally high value of thermal conductivity and boasts THE BEST thermal stability & hardness.

# TOOL MATERIAL

Selecting the correct tool material requires knowing which material characteristics are important for each friction stir welding application. When choosing your tool material, consider the material of the work piece, the expected life of the tool, and your own experiences and preferences. Use this chart to help you determine what tool material may be best for your friction stir welding application.

TOOL MATERIAL	PROPERTIES	WELDABLE METALS
PCBN	high temperature high hardness ~3600hv	steel, stainless steel, Ni, Cu metal matrix composite
PCBN/W-Re	high temperature excellent toughness good hardness ~2000hv	steel, stainless steel, Ni, Cu metal matrix composite
H13 Steel	good toughness good strength	Al alloys, Mg alloys
MP159 Cobalt	highest toughness highest strength highest thickness	Al alloys, Mg alloys
Tungsten Carbide	good toughness at low temps	Cu, metal matrix composite, testing of steel and Ti alloys
Polycrystalline Diamond	high wear, high toughness	Al alloys, metal matrix composite

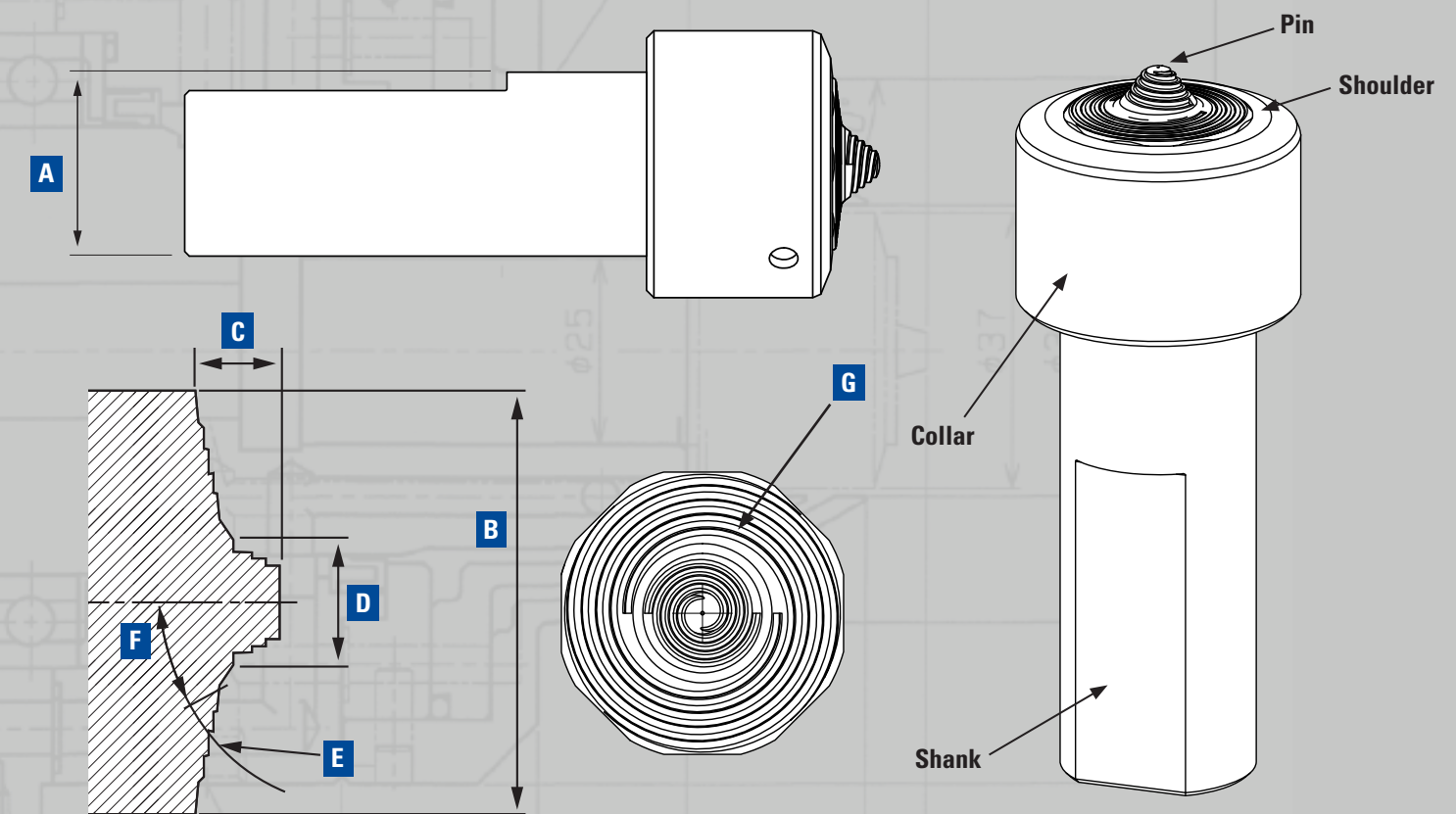
PCBN is an ideal material for high temperature friction stir welding as it possesses excellent toughness plus an exceptionally high value of thermal conductivity and boasts THE BEST thermal stability & hardness.

These qualities, especially when combined with ceramics and metals, make it a premiere material for friction stir welding of high melting point metals. MegaStir has further optimized the abilities of PCBN in its MS-Series and Q-Series tools for the best durability and quality high temperature friction stir welds.

# TOOL DESIGN

MegaStir tools consist of a protruding "pin" which is plunged into the work pieces and the larger concentric "shoulder" which is maintained on the surface of the joint. The shoulder has a concave surface, which produces a combination of frictional heating and forging pressure. To create an optimal friction stir weld, you must combine optimal rotational speed of the tool with forging pressure applied by the tool and the travel speed of the tool with respect to the base material. These parameters are governed by the tool

geometry (i.e. shoulder and pin diameter), mechanical properties of material to be joined (i.e. flow stress), and material thickness. When the shoulder and pin rotate in contact with the base material, it creates frictional heat, producing a local plasticized region around the tool. As the tool traverses along the weld joint, plasticized material is displaced around the tool. The high degree of deformation and the large forging pressures applied by the tool shoulder, produce a full metallurgical bond.



**A** Shank Diameter

**B** Shoulder Diameter

**C** Pin Length

**D** Pin Base Diameter

**E** Convex Radius

**F** Pin Angle

**G** Shoulder & Pin Features

- Threads
- Step Spirals
- Flats
- Other



25mm M Series Tool

50mm M Series Tool

## M SERIES TOOL

Longest-wearing polycrystalline cubic boron nitride (PCBN) tip for steel friction stir welding. This tool works great for most steel welds at higher temperatures.

### FEATURES

**Tip Material:** PCBN with ceramic binder (highest percentage of PCBN)  
**Shank Material:** Tungsten carbide  
**Wear:** Longer

**Use:** Most steel and stainless steel applications  
**Temperature Monitoring Port:** Yes  
**Hardness:** ~3600 Vickers

### SPECIFICATIONS

**Tool Tip:** PCBN  
**Pin Length:** Up to 25mm  
**Custom Pin Sizes:** Contact MegaStir

**Shank Size:** 1 inch, 25mm, 38mm, 50mm or custom  
**Shoulder Diameters:** 25mm, 38mm, 50mm or custom  
**Threading:** C4 or MM

Part Number	Pin Length	Part Number	Pin Length	Part Number	Pin Length
MS-M-001	1mm	MS-M-006	6mm	MS-M-011	11mm
MS-M-002	2mm	MS-M-007	7mm	MS-M-012	12mm
MS-M-003	3mm	MS-M-008	8mm	MS-M-019	19mm
MS-M-004	4mm	MS-M-009	9mm	MS-M-020	20mm
MS-M-005	5mm	MS-M-010	10mm		



Q Series Tool with 50MM shank

Q Series Tool with 25mm shank

## Q SERIES TOOL

Made from PCBN with tungsten rhenium binder, the Q Series Tool has the toughest, most crack-resistant PCBN tip available. This premium tool welds the toughest and thickest metals at higher temperatures.

### FEATURES

**Tip Material:** PCBN tungsten rhenium binder  
**Shank Material:** Tungsten carbide  
**Wear:** Use when toughness and torque are critical  
**Use:** Nickel-based alloys and higher-strength stainless steels

**Temperature Monitoring Port:** Yes  
**Hardness:** ~2000 Vickers

### SPECIFICATIONS

**Tool Tip:** Q Series PCBN  
**Pin Length:** Up to 25mm  
**Custom Pin Sizes:** Contact MegaStir

**Shank Size:** 1 inch, 25mm, 38mm, 50mm or custom  
**Shoulder Diameters:** 25mm, 38mm, 50mm or custom  
**Threading:** C4 or MM

Part Number	Pin Length	Part Number	Pin Length	Part Number	Pin Length
MS-Q-001	1mm	MS-Q-006	6mm	MS-Q-011	11mm
MS-Q-002	2mm	MS-Q-007	7mm	MS-Q-012	12mm
MS-Q-003	3mm	MS-Q-008	8mm	MS-Q-019	19mm
MS-Q-004	4mm	MS-Q-009	9mm	MS-Q-020	20mm
MS-Q-005	5mm	MS-Q-010	10mm		



D Series Debur Tool

## D SERIES TOOL

This time-saving tool provides deburring, burnishing and milling during the welding process. Attached directly to the MegaStir tool, it finishes the weld without any extra processing time.

### FEATURES

- Tip Material:** Q or M Series PCBN
- Shank Material:** Tungsten carbide
- Operation System:** Pivotol or fixed cutter
- Use:** High temperature applications

- Purpose:** Cleans flash without interfering in weld process
- Compatibility:** MegaStir liquid-cooled tool holder
- Temperature Monitoring Port:** N/A
- Hardness:** Same as Q or M Series

### SPECIFICATIONS

- Tool Tip:** Q or M Series PCBN
- Pin Length:** Up to 25mm
- Custom Pin Sizes:** contact MegaStir
- Shank Size:** 1 inch, 25mm, 38mm, 50mm or custom
- Shoulder Diameters:** 25mm, 38mm, 50mm or custom
- Threading:** C4 or MM

Part Number	Pin Length	Part Number	Pin Length	Part Number	Pin Length
MS-M-001	1mm	MS-M-006	6mm	MS-M-011	11mm
MS-M-002	2mm	MS-M-007	7mm	MS-M-012	12mm
MS-M-003	3mm	MS-M-008	8mm	MS-M-019	19mm
MS-M-004	4mm	MS-M-009	9mm	MS-M-020	20mm
MS-M-005	5mm	MS-M-010	10mm		



H13 1-inch tool

H13 20mm tool

## H SERIES TOOL

Solid, one-piece tool made from H13 offers all-around good wear.

### FEATURES

- Tool Material:** Standard H13 tool steel (combined shank/tip)
- Wear:** Economical, good wear
- Use:** Aluminum and magnesium welding
- Temperature Monitoring Port:** No

### SPECIFICATIONS

- Shank/Tip:** H13 tool steel
- Shank Size:** 1 inch, 25mm, 38mm, 50mm or custom
- Shoulder Diameters:** 25mm, 38mm, 50mm or custom
- Threading:** C4 or MM
- Custom Pin Sizes:** contact MegaStir

Part Number	Pin Length	Part Number	Pin Length	Part Number	Pin Length
MS-H-001	1mm	MS-H-006	6mm	MS-H-011	11mm
MS-H-002	2mm	MS-H-007	7mm	MS-H-012	12mm
MS-H-003	3mm	MS-H-008	8mm	MS-H-019	19mm
MS-H-004	4mm	MS-H-009	9mm	MS-H-020	20mm
MS-H-005	5mm	MS-H-010	10mm		





Liquid Cooled Tool Holder

Tool Holder Collet

## LIQUID-COOLED TOOL HOLDER

The MegaStir Tool Holder uses a patented liquid cooling system which pulls the heat from the tool, keeping it at a steady temperature, allowing for better quality welds and improved tool life.

### FEATURES

- Offers exclusive steady-state temperature system with argon shielding ports and gas shroud. Does not build up heat like other tool holders.
- Accepts all MegaStir tools as well as the proprietary telemetry system and deburr tool. Also fits other-party tools of standard size.
- Fits standard CAT #50 tapered spindles.
- Available in 25 mm, 50 mm and 1 inch shanks. Drawbar connections available in English and metric threaded connections.

### SPECIFICATIONS

Compatible with all MegaStir friction stir welding tools.

Part Number	Description
MS6001	MDM50-2500 liquid-cooled tool holder for metric sized tools
MS6002	IDM50-2500 liquid-cooled tool holder for English sized tools

## TOOL HOLDER COLLET

Adapter for MegaStir liquid-cooled tool holder.

Part Number	Description
MS60010	50mm - 38mm collet
MS60011	50mm - 25mm collet



Telemetry System

## TELEMETRY SYSTEMS

Provides real-time temperature and load monitoring of the friction stir welding tool.

### FEATURES

- Fits onto the MegaStir Tool Holder and monitors the K-type thermocouple which is inserted into the friction stir welding tool.
- Allows you to make adjustments to the welding process to maintain proper temperature of the metals.
- Offers a second channel load cell (optional) for monitoring and control of downward force during welding.

### SPECIFICATIONS

Compatibility: MegaStir liquid-cooled tool holder

Part Number	Description
MS60101	Single channel temperature monitoring telemetry system
MS60102	Double channel temperature and load monitoring telemetry system

## FRICTION STIR SPOT WELDING TOOL

Designed for small, spot welds, the friction stir spot welding tool is smaller than the full-size friction stir welding tools and is available for both low and high temperature welding. Friction stir spot welding tools are available in 10mm and 12mm shoulder sizes.



### SOLID UNIT

- Low temperature applications
- Available as a single solid tungsten carbide unit



### TOOL HOLDER & TIPS

- Higher temperature steel applications
- Comes with a smaller steel tool holder and separate tips from M Series or Q Series material



### SPOT WELDING TIPS

- M Series or Q Series material

PART NUMBER	PIN LENGTH	DESCRIPTION
MS45014	.5mm	Solid friction stir spot welding unit made from tungsten carbide with 16 mm shank and PCBN tip. Specify 10 or 12 mm shoulder size. Specify M Series or Q Series tip. Custom pin lengths and shank sizes also available. Tool holder not required.

PART NUMBER	DESCRIPTION
MS60201	Tungsten carbide friction stir spot welding tip holder with custom tip. Specify shoulder size, M Series or Q Series tip material and pin size. Custom pin lengths available. 16 mm shank standard (custom sizes on request).

# MegaStir

A Joint Venture of Schlumberger  
and Advanced Metal Products

**MegaStir offers the latest in friction stir welding tools and technology. Designed for endurance and quality welding, MegaStir tools consistently produce top quality, high strength welds in a single pass. With its proprietary cooling design, the MegaStir tool holder draws heat away from the tool and keeps the tool at a steady temperature, even when welding at higher temperatures.**

MegaStir tools come in a wide variety of sizes, hardness and tip material so you can get the perfect tool for the job. Since PCBN is the second-hardest material on earth and is thermally stable at elevated temperatures, the MegaStir patented PCBN tips let you friction stir weld the hardest steel, stainless steel and nickel-based alloys. MegaStir uniquely offers a friction stir spot welding tool for high temperature applications as well. More economical tools are available for aluminum and lower temperature welding.

MegaStir tools let you manage your welds through position, force, and temperature control. Controlling the temperature of both the tool and the weld is critical in order to maintain tool integrity and weld strength. With a thermocouple in the tool holder, all MegaStir tools have a receptive port for the thermocouple near the tool tip, allowing for a highly accurate reading of both tool and material temperature. The thermocouple wire from the tool holder slides into the tool itself, so you can monitor and maintain temperature while the tool is rotating. Because concentricity and run-out are key elements in friction stir welding, all MegaStir tools have a precision tungsten carbide shank which transmits the torque from the shank through the tool tip.

## MEGASTIR PRODUCTION SERVICES

MegaStir offers a variety of friction stir welding production services, from R&D through prototyping, alloy development, and full production. MegaStir has a full metallurgical lab and testing services.

### FULL PRODUCTION FRICTION STIR WELDING

MegaStir's expertise in friction stir welding, combined with high end machinery allows for a wide range of capabilities—from simple plate welding for mechanical and metallurgical samples to long welds and complex geometries. MegaStir also specializes in circumferential welds, which are produced around the outer surface of a cylindrical piece and are used to fabricate structural pipes. MegaStir can provide full-penetration and partial-penetration, single-pass friction stir welds up to 25 mm in thickness, and are continuously

extending current limits. Friction stir welding services are offered for all alloys, including aluminum, steel, stainless steel, and nickel-based alloys.

### FRICTION BIT JOINING

Used primarily in the automotive industry, friction bit joining is a proprietary friction spot welding technique developed by MegaStir. This method is used to join steels and dissimilar metals, including aluminum to steel. It uses a consumable bit, resembling a welded rivet, that first cuts through a specific material then joins the parts together. MegaStir designs and builds friction bit joining machines and consumable bits for custom tasks based on its patented technology.

### CUSTOM MACHINES

MegaStir can design and build oil pipeline friction stir welding machines, friction bit joining machines or any other friction stir welding machine for your specific job.

### PROTOTYPING

MegaStir has full prototyping facilities with engineers on staff to develop and prototype parts and components.

### ENGINEERING AND R&D

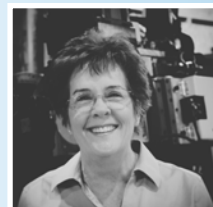
MegaStir engineers are highly skilled and constantly engaging in new research and development of tools, tool materials and the friction stir welding process. They are also available for custom R&D and engineering projects.

**Contact MegaStir for your production and custom machinery needs.**

## THE MEGASTIR CORE TEAM



**Russell Steel**  
Director of Business  
Development



**Annette Jenkins**  
Product Manager



**Dale Fleck**  
General Manager

## TOP INDUSTRIES SERVED BY FRICTION STIR WELDING

AEROSPACE

GROUND TRANSPORTATION

OIL & GAS

OCEAN TRANSPORT

TECHNOLOGY MANUFACTURING



# MegaStir

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