Hypertherm®

Phoenix™ Software Version 9 Series

Programmer Reference

806420 | Revision 9.1 | English

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RECOGNIZE SAFETY INFORMATION

The symbols shown in this section are used to identify potential hazards. When you see a safety symbol in this manual or on your machine, understand the potential for personal injury, and follow the related instructions to avoid the hazard.

FOLLOW SAFETY INSTRUCTIONS

Read carefully all safety messages in this manual and safety labels on your machine.

- Keep the safety labels on your machine in good condition. Replace missing or damaged labels immediately.
- Learn how to operate the machine and how to use the controls properly. Do not let anyone operate it without instruction.
- Keep your machine in proper working condition. Unauthorized modifications to the machine may affect safety and machine service life.

DANGER WARNING CAUTION

Hypertherm uses American National Standards Institute guidelines for safety signal words and symbols. A signal word DANGER or WARNING is used with a safety symbol. DANGER identifies the most serious hazards.

- DANGER and WARNING safety labels are located on your machine near specific hazards.
- DANGER safety messages precede related instructions in the manual that will result in serious injury or death if not followed correctly.
- WARNING safety messages precede related instructions in this manual that may result in injury or death if not followed correctly.
- CAUTION safety messages precede related instructions in this manual that may result in minor injury or damage to equipment if not followed correctly.

ELECTRICAL HAZARDS

- Only trained and authorized personnel may open this equipment.
- If the equipment is permanently connected, turn it off, and lock out/tag out power before the enclosure is opened.
- If power is supplied to the equipment with a cord, unplug the unit before the enclosure is opened.
- Lockable disconnects or lockable plug covers must be provided by others.
- Wait 5 minutes after removal of power before entering the enclosure to allow stored energy to discharge.
- If the equipment must have power when the enclosure is open for servicing, arc flash explosion hazards may exist. Follow ALL local requirements (NFPA 70E in the USA) for safe work practices and for Personal Protective Equipment when servicing energized equipment.
- The enclosure shall be closed and the proper earth ground continuity to the enclosure verified prior to operating the equipment after moving, opening, or servicing.
- Always follow these instructions for disconnecting power before inspecting or changing torch consumable parts.

ELECTRIC SHOCK CAN KILL

Touching live electrical parts can cause a fatal shock or severe burn.

- Operating the plasma system completes an electrical circuit between the torch and the workpiece. The workpiece and anything touching the workpiece are part of the electrical circuit.
- Never touch the torch body, workpiece or the water in a water table when the plasma system is operating.

Electric shock prevention

All Hypertherm plasma systems use high voltage in the cutting process (200 to 400 VDC are common). Take the following precautions when operating this system:

- Wear insulated gloves and boots, and keep your body and clothing dry.
- Do not stand, sit or lie on – or touch – any wet surface when using the plasma system.
- Insulate yourself from work and ground using dry insulating mats or covers big enough to prevent any physical contact with the work or ground. If you must work in or near a damp area, use extreme caution.
- Provide a disconnect switch close to the power supply with properly sized fuses. This switch allows the operator to turn off the power supply quickly in an emergency situation.
- When using a water table, be sure that it is correctly connected to earth ground.
- Install and ground this equipment according to the instruction manual and in accordance with national and local codes.
- Inspect the input power cord frequently for damage or cracking of the cover. Replace a damaged power cord immediately. **Bare wiring can kill.**
- Inspect and replace any worn or damaged torch leads.
- Do not pick up the workpiece, including the waste cutoff, while you cut. Leave the workpiece in place or on the workbench with the work cable attached during the cutting process.
- Before checking, cleaning or changing torch parts, disconnect the main power or unplug the power supply.
- Never bypass or shortcut the safety interlocks.
- Before removing any power supply or system enclosure cover, disconnect electrical input power. Wait 5 minutes after disconnecting the main power to allow capacitors to discharge.
- Never operate the plasma system unless the power supply covers are in place. Exposed power supply connections present a severe electrical hazard.
- When making input connections, attach proper grounding conductor first.
- Each Hypertherm plasma system is designed to be used only with specific Hypertherm torches. Do not substitute other torches which could overheat and present a safety hazard.

CUTTING CAN CAUSE FIRE OR EXPLOSION

Fire prevention

- Be sure the area is safe before doing any cutting. Keep a fire extinguisher nearby.
- Remove all flammables within 35 feet (10 m) of the cutting area.
- Quench hot metal or allow it to cool before handling or before letting it touch combustible materials.
- Never cut containers with potentially flammable materials inside – they must be emptied and properly cleaned first.
- Ventilate potentially flammable atmospheres before cutting.
- When cutting with oxygen as the plasma gas, an exhaust ventilation system is required.

Explosion prevention

- Do not use the plasma system if explosive dust or vapors may be present.
- Do not cut pressurized cylinders, pipes, or any closed container.
- Do not cut containers that have held combustible materials.

WARNING
Explosion Hazard
Argon-Hydrogen and Methane

Hydrogen and methane are flammable gases that present an explosion hazard. Keep flames away from cylinders and hoses that contain methane or hydrogen mixtures. Keep flames and sparks away from the torch when using methane or argon-hydrogen plasma.

WARNING
Hydrogen Detonation with
Aluminum Cutting

- Do not cut aluminum underwater or with water touching the underside of the aluminum.
- Cutting aluminum underwater or with the water touching the underside of the aluminum can result in an explosive condition that can detonate during plasma cutting operations.

WARNING
Explosion Hazard
Underwater Cutting with Fuel Gases

- Do not cut under water with fuel gases containing hydrogen.
- Cutting under water with fuel gases containing hydrogen can result in an explosive condition that can detonate during plasma cutting operations.

TOXIC FUMES CAN CAUSE INJURY OR DEATH

The plasma arc by itself is the heat source used for cutting. Accordingly, although the plasma arc has not been identified as a source of toxic fumes, the material being cut can be a source of toxic fumes or gases that deplete oxygen.

Fumes produced vary depending on the metal that is cut. Metals that may release toxic fumes include, but are not limited to, stainless steel, carbon steel, zinc (galvanized), and copper.

In some cases, the metal may be coated with a substance that could release toxic fumes. Toxic coatings include, but are not limited to, lead (in some paints), cadmium (in some paints and fillers), and beryllium.

Gases produced by plasma cutting vary based on the material to be cut and the method of cutting, but may include ozone, oxides of nitrogen, hexavalent chromium, hydrogen, and other substances if such are contained in or released by the material being cut.

Caution should be taken to minimize exposure to fumes produced by any industrial process. Depending upon the chemical composition and concentration of the fumes (as well as other factors, such as ventilation), there may be a risk of physical illness, such as birth defects or cancer.

It is the responsibility of the equipment and site owner to test the air quality in the area where the equipment is used and to ensure that the air quality in the workplace meets all local and national standards and regulations.

The air quality level in any relevant workplace depends on site-specific variables such as:

- Table design (wet, dry, underwater).
- Material composition, surface finish, and composition of coatings.
- Volume of material removed.
- Duration of cutting or gouging.
- Size, air volume, ventilation and filtration of the work area.
- Personal protective equipment.
- Number of welding and cutting systems in operation.
- Other site processes that may produce fumes.

If the workplace must conform to national or local regulations, only monitoring or testing done at the site can determine whether the site is above or below allowable levels.

To reduce the risk of exposure to fumes:

- Remove all coatings and solvents from the metal before cutting.
- Use local exhaust ventilation to remove fumes from the air.
- Do not inhale fumes. Wear an air-supplied respirator when cutting any metal coated with, containing, or suspected to contain toxic elements.
- Assure that those using welding or cutting equipment, as well as air-supplied respiration devices, are qualified and trained in the proper use of such equipment.
- Never cut containers with potentially toxic materials inside. Empty and properly clean the container first.
- Monitor or test the air quality at the site as needed.
- Consult with a local expert to implement a site plan to ensure safe air quality.

GROUNDING SAFETY

Work cable Attach the work cable securely to the workpiece or the work table with good metal-to-metal contact. Do not connect it to the piece that will fall away when the cut is complete.

Work table Connect the work table to an earth ground, in accordance with appropriate national and local electrical codes.

Input power

- Be sure to connect the power cord ground wire to the ground in the disconnect box.
- If installation of the plasma system involves connecting the power cord to the power supply, be sure to connect the power cord ground wire properly.
- Place the power cord's ground wire on the stud first, then place any other ground wires on top of the power cord ground. Fasten the retaining nut tightly.
- Tighten all electrical connections to avoid excessive heating.

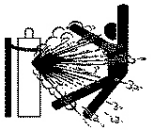
STATIC ELECTRICITY CAN DAMAGE CIRCUIT BOARDS

Use proper precautions when handling printed circuit boards:

- Store PC boards in anti-static containers.
- Wear a grounded wrist strap when handling PC boards.

COMPRESSED GAS EQUIPMENT SAFETY

- Never lubricate cylinder valves or regulators with oil or grease.
- Use only correct gas cylinders, regulators, hoses and fittings designed for the specific application.
- Maintain all compressed gas equipment and associated parts in good condition.
- Label and color-code all gas hoses to identify the type of gas in each hose. Consult applicable national and local codes.



GAS CYLINDERS CAN EXPLODE IF DAMAGED

Gas cylinders contain gas under high pressure.
If damaged, a cylinder can explode.

- Handle and use compressed gas cylinders in accordance with applicable national and local codes.
- Never use a cylinder that is not upright and secured in place.
- Keep the protective cap in place over valve except when the cylinder is in use or connected for use.
- Never allow electrical contact between the plasma arc and a cylinder.
- Never expose cylinders to excessive heat, sparks, slag or open flame.
- Never use a hammer, wrench or other tool to open a stuck cylinder valve.

A PLASMA ARC CAN CAUSE INJURY AND BURNS

Instant-on torches

Plasma arc comes on immediately when the torch switch is activated.

The plasma arc will cut quickly through gloves and skin.

- Keep away from the torch tip.
- Do not hold metal near the cutting path.
- Never point the torch toward yourself or others.

ARC RAYS CAN BURN EYES AND SKIN

Eye protection Plasma arc rays produce intense visible and invisible (ultraviolet and infrared) rays that can burn eyes and skin.

- Use eye protection in accordance with applicable national and local codes.
- Wear eye protection (safety glasses or goggles with side shields, and a welding helmet) with appropriate lens shading to protect your eyes from the arc's ultraviolet and infrared rays.

Skin protection Wear protective clothing to protect against burns caused by ultraviolet light, sparks, and hot metal.

- Gauntlet gloves, safety shoes and hat.
- Flame-retardant clothing to cover all exposed areas.
- Cuffless trousers to prevent entry of sparks and slag.
- Remove any combustibles, such as a butane lighter or matches, from your pockets before cutting.

Cutting area Prepare the cutting area to reduce reflection and transmission of ultraviolet light:

- Paint walls and other surfaces with dark colors to reduce reflection.
- Use protective screens or barriers to protect others from flash and glare.
- Warn others not to watch the arc. Use placards or signs.

Arc current (amps)	Minimum protective shade number (ANSI Z49.1:2005)	Suggested shade number for comfort (ANSI Z49.1:2005)	OSHA 29CFR 1910.133(a)(5)	Europe EN168:2002
Less than 40 A	5	5	8	9
41 to 60 A	6	6	8	9
61 to 80 A	8	8	8	9
81 to 125 A	8	9	8	9
126 to 150 A	8	9	8	10
151 to 175 A	8	9	8	11
176 to 250 A	8	9	8	12
251 to 300 A	8	9	8	13
301 to 400 A	9	12	9	13
401 to 800 A	10	14	10	N/A

PACEMAKER AND HEARING AID OPERATION

Pacemaker and hearing aid operation can be affected by magnetic fields from high currents.

Pacemaker and hearing aid wearers should consult a doctor before going near any plasma arc cutting and gouging operations.

To reduce magnetic field hazards:

- Keep both the work cable and the torch lead to one side, away from your body.
- Route the torch leads as close as possible to the work cable.
- Do not wrap or drape the torch lead or work cable around your body.
- Keep as far away from the power supply as possible.

NOISE CAN DAMAGE HEARING

Cutting with a plasma arc can exceed acceptable noise levels as defined by local codes in many applications. Prolonged exposure to excessive noise can damage hearing. Always wear proper ear protection when cutting or gouging, unless sound pressure level measurements taken at the installed site have verified personal hearing protection is not necessary per relevant international, regional, and local codes.

Significant noise reduction can be obtained by adding simple engineering controls to cutting tables such as barriers or curtains positioned between the plasma arc and the workstation; and/or locating the workstation away from the plasma arc. Implement administrative controls in the workplace to restrict access, limit operator exposure time, screen off noisy working areas and/or take measures to reduce reverberation in working areas by putting up noise absorbers.

Use ear protectors if the noise is disruptive or if there is a risk of hearing damage after all other engineering and administrative controls have been implemented. If hearing protection is required, wear only approved personal protective devices such as ear muffs or ear plugs with a noise reduction rating appropriate for the situation. Warn others in the area of possible noise hazards. In addition, ear protection can prevent hot splatter from entering the ear.

A PLASMA ARC CAN DAMAGE FROZEN PIPES

Frozen pipes may be damaged or can burst if you attempt to thaw them with a plasma torch.

DRY DUST COLLECTION INFORMATION

At some sites, dry dust can represent a potential explosion hazard.

The U.S. National Fire Protection Association's 2007 edition of NFPA standard 68, "Explosion Protection by Deflagration Venting," provides requirements for the design, location, installation, maintenance, and use of devices and systems to vent combustion gases and pressures after any deflagration event. Consult with the manufacturer or installer of any dry dust collection system for applicable requirements before you install a new dry dust collection system or make significant changes in the process or materials used with an existing dry dust collection system.

Consult your local "Authority Having Jurisdiction" (AHJ) to determine whether any edition of NFPA 68 has been "adopted by reference" in your local building codes.

Refer to NFPA68 for definitions and explanations of regulatory terms such as deflagration, AHJ, adopted by reference, the Kst value, deflagration index, and other terms.

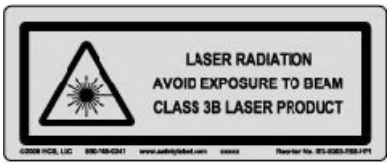
Note 1 – Hypertherm's interpretation of these new requirements is that unless a site-specific evaluation has been completed to determine that all dust generated is not combustible, the 2007 edition of NFPA 68 requires the use of explosion vents designed to the worst-case Kst value (see annex F) that could be generated from dust so that the explosion vent size and type can be designed. NFPA 68 does not specifically identify plasma cutting or other thermal cutting processes as requiring deflagration venting systems, but it does apply these new requirements to all dry dust collection systems.

Note 2 – Users of Hypertherm manuals should consult and comply with all applicable federal, state, and local laws and regulations. Hypertherm does not, by the publication of any Hypertherm manual, intend to urge action that is not in compliance with all applicable regulations and standards, and this manual may never be construed as doing so.

LASER RADIATION

Exposure to the laser output can result in serious eye injury. Avoid direct eye exposure.

For your convenience and safety, on Hypertherm products that use a laser, one of the following laser radiation labels has been applied on the product near where the laser beam exits the enclosure. The maximum output (mV), wavelength emitted (nM) and, if appropriate, the pulse duration is also provided.



Additional laser safety instructions:

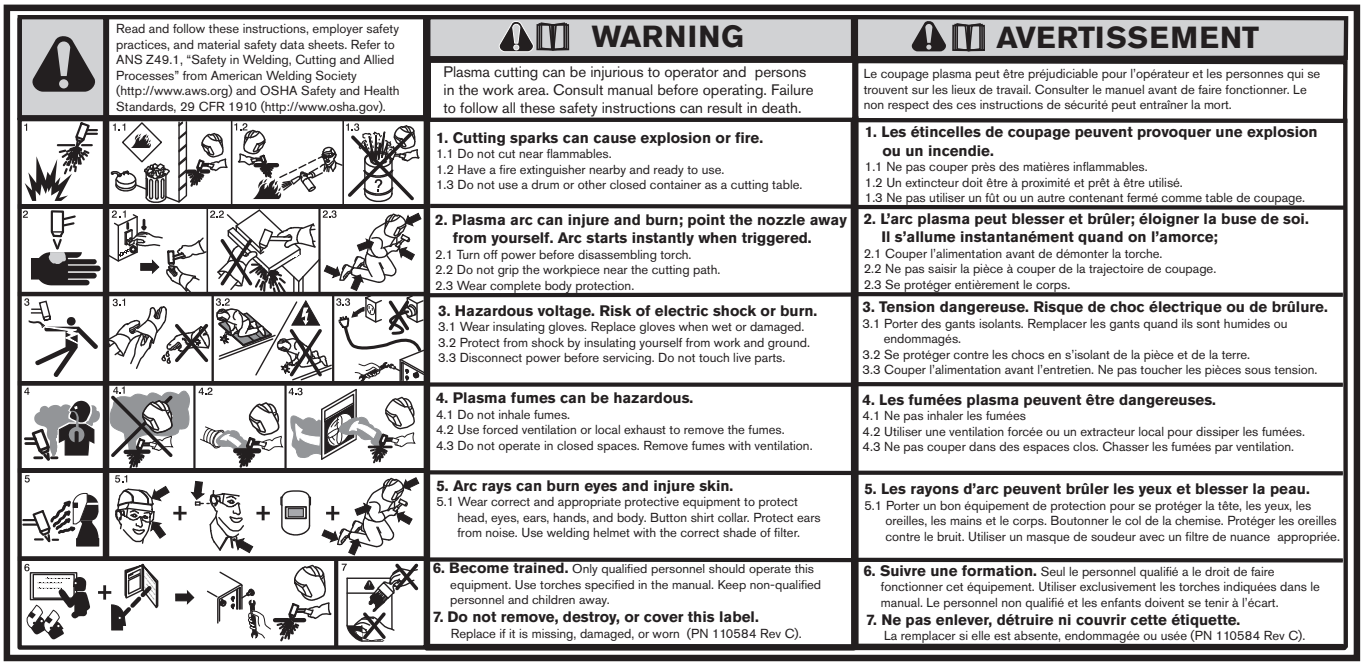
- Consult with an expert on local laser regulations. Laser safety training may be required.
- Do not allow untrained persons to operate the laser. Lasers can be dangerous in the hands of untrained users.
- Do not look into the laser aperture or beam at any time.
- Position the laser as instructed to avoid unintentional eye contact.
- Do not use the laser on reflective workpieces.
- Do not use optical tools to view or reflect the laser beam.
- Do not disassemble or remove the laser or aperture cover.
- Modifying the laser or product in any way can increase the risk of laser radiation.
- Use of adjustments or performance of procedures other than those specified in this manual may result in hazardous laser radiation exposure.
- Do not operate in explosive atmospheres, such as in the presence of flammable liquids, gases, or dust.
- Use only laser parts and accessories that are recommended or provided by the manufacturer for your model.
- Repairs and servicing MUST be performed by qualified personnel.
- Do not remove or deface the laser safety label.

ADDITIONAL SAFETY INFORMATION

1. ANSI Standard Z49.1, Safety in Welding and Cutting, American Welding Society, 550 LeJeune Road P.O. Box 351020, Miami, FL 33135
2. ANSI Standard Z49.2, Fire Prevention in the Use of Cutting and Welding Processes, American National Standards Institute 1430 Broadway, New York, NY 10018
3. ANSI Standard Z87.1, Safe Practices for Occupation and Educational Eye and Face Protection, American National Standards Institute, 1430 Broadway, New York, NY 10018
4. AWS F4.1, Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping That Have Held Hazardous Substances, American Welding Society 550 LeJeune Road, P.O. Box 351040, Miami, FL 33135
5. AWS F5.2, Recommended Safe Practices for Plasma Arc Cutting, American Welding Society 550 LeJeune Road, P.O. Box 351040, Miami, FL 33135
6. CGA Pamphlet P-1, Safe Handling of Compressed Gases in Cylinders, Compressed Gas Association 1235 Jefferson Davis Highway, Arlington, VA 22202
7. CSA Standard W117.2, Code for Safety in Welding and Cutting, Canadian Standards Association Standard Sales 178 Rexdale Boulevard, Rexdale, Ontario M9W 1R3, Canada
8. NFPA Standard 51B, Cutting and Welding Processes, National Fire Protection Association 470 Atlantic Avenue, Boston, MA 02210
9. NFPA Standard 70–1978, National Electrical Code, National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210
10. OSHA, Safety and Health Standards, 29FR 1910 U.S. Government Printing Office, Washington, D.C. 20402
11. AWS Safety and Health Fact Sheets, American Welding Society 550 LeJeune Road, P.O. Box 351040, Miami, FL 33135 www.aws.org/technical/facts/

WARNING LABELS

This warning label is affixed to some power supplies. It is important that the operator and maintenance technician understand the intent of these warning symbols as described.



Read and follow these instructions, employer safety practices, and material safety data sheets. Refer to ANS Z49.1, "Safety in Welding, Cutting and Allied Processes" from American Welding Society (http://www.aws.org) and OSHA Safety and Health Standards, 29 CFR 1910 (http://www.osha.gov).

WARNING

Plasma cutting can be injurious to operator and persons in the work area. Consult manual before operating. Failure to follow all these safety instructions can result in death.

1. Cutting sparks can cause explosion or fire.
1.1 Do not cut near flammables.
1.2 Have a fire extinguisher nearby and ready to use.
1.3 Do not use a drum or other closed container as a cutting table.

2. Plasma arc can injure and burn; point the nozzle away from yourself. Arc starts instantly when triggered.
2.1 Turn off power before disassembling torch.
2.2 Do not grip the workpiece near the cutting path.
2.3 Wear complete body protection.

3. Hazardous voltage. Risk of electric shock or burn.
3.1 Wear insulating gloves. Replace gloves when wet or damaged.
3.2 Protect from shock by insulating yourself from work and ground.
3.3 Disconnect power before servicing. Do not touch live parts.

4. Plasma fumes can be hazardous.
4.1 Do not inhale fumes.
4.2 Use forced ventilation or local exhaust to remove the fumes.
4.3 Do not operate in closed spaces. Remove fumes with ventilation.

5. Arc rays can burn eyes and injure skin.
5.1 Wear correct and appropriate protective equipment to protect head, eyes, ears, hands, and body. Button shirt collar. Protect ears from noise. Use welding helmet with the correct shade of filter.

6. Become trained. Only qualified personnel should operate this equipment. Use torches specified in the manual. Keep non-qualified personnel and children away.

7. Do not remove, destroy, or cover this label.
Replace if it is missing, damaged, or worn (PN 110584 Rev C).

AVERTISSEMENT

Le coupage plasma peut être préjudiciable pour l'opérateur et les personnes qui se trouvent sur les lieux de travail. Consulter le manuel avant de faire fonctionner. Le non respect des ces instructions de sécurité peut entraîner la mort.

1. Les étincelles de coupage peuvent provoquer une explosion ou un incendie.
1.1 Ne pas couper près des matières inflammables.
1.2 Un extincteur doit être à proximité et prêt à être utilisé.
1.3 Ne pas utiliser un fût ou un autre contenant fermé comme table de coupage.

2. L'arc plasma peut blesser et brûler; éloigner la buse de soi. Il s'allume instantanément quand on l'amorce;
2.1 Couper l'alimentation avant de démonter la torche.
2.2 Ne pas saisir la pièce à couper de la trajectoire de coupage.
2.3 Se protéger entièrement le corps.

3. Tension dangereuse. Risque de choc électrique ou de brûlure.
3.1 Porter des gants isolants. Remplacer les gants quand ils sont humides ou endommagés.
3.2 Se protéger contre les chocs en s'isolant de la pièce et de la terre.
3.3 Couper l'alimentation avant l'entretien. Ne pas toucher les pièces sous tension.

4. Les fumées plasma peuvent être dangereuses.
4.1 Ne pas inhaler les fumées
4.2 Utiliser une ventilation forcée ou un extracteur local pour dissiper les fumées.
4.3 Ne pas couper dans des espaces clos. Chasser les fumées par ventilation.

5. Les rayons d'arc peuvent brûler les yeux et blesser la peau.
5.1 Porter un bon équipement de protection pour se protéger la tête, les yeux, les oreilles, les mains et le corps. Boutonner le col de la chemise. Protéger les oreilles contre le bruit. Utiliser un masque de soudeur avec un filtre de nuance appropriée.

6. Suivre une formation. Seul le personnel qualifié a le droit de faire fonctionner cet équipement. Utiliser exclusivement les torches indiquées dans le manual. Le personnel non qualifié et les enfants doivent se tenir à l'écart.

7. Ne pas enlever, détruire ni couvrir cette étiquette.
La remplacer si elle est absente, endommagée ou usée (PN 110584 Rev C).

Warning labels

This warning label is affixed to some power supplies. It is important that the operator and maintenance technician understand the intent of these warning symbols as described. The numbered text corresponds to the numbered boxes on the label.

1. Cutting sparks can cause explosion or fire.

1.1 Do not cut near flammables.

1.2 Have a fire extinguisher nearby and ready to use.

1.3 Do not use a drum or other closed container as a cutting table.

2. Plasma arc can injure and burn; point the nozzle away from yourself. Arc starts instantly when triggered.

2.1 Turn off power before disassembling torch.

2.2 Do not grip the workpiece near the cutting path.

2.3 Wear complete body protection.

3. Hazardous voltage. Risk of electric shock or burn.

3.1 Wear insulating gloves. Replace gloves when wet or damaged.

3.2 Protect from shock by insulating yourself from work and ground.

3.3 Disconnect power before servicing. Do not touch live parts.

4. Plasma fumes can be hazardous.

4.1 Do not inhale fumes.

4.2 Use forced ventilation or local exhaust to remove the fumes.

4.3 Do not operate in closed spaces. Remove fumes with ventilation.

5. Arc rays can burn eyes and injure skin.

5.1 Wear correct and appropriate protective equipment to protect head, eyes, ears, hands, and body. Button shirt collar. Protect ears from noise. Use welding helmet with the correct shade of filter.

6. Become trained. Only qualified personnel should operate this equipment. Use torches specified in the manual. Keep non-qualified personnel and children away.

7. Do not remove, destroy, or cover this label. Replace if it is missing, damaged, or worn.

Symbols and marks

Your product may have one or more of the following markings on or near the data plate. Due to differences and conflicts in national regulations, not all marks are applied to every version of a product.

S mark

The S mark indicates that the power supply and torch are suitable for operations carried out in environments with increased hazard of electrical shock according to IEC 60974-1.

CSA mark

Products with a CSA mark meet the United States and Canadian regulations for product safety. The products were evaluated, tested, and certified by CSA-International. Alternatively, the product may have a mark by one of the other Nationally Recognized Testing Laboratories (NRTL) accredited in both the United States and Canada, such as UL or TÜV.

CE mark

The CE marking signifies the manufacturer's declaration of conformity to applicable European directives and standards. Only those versions of products with a CE marking located on or near the data plate have been tested for compliance with the European Low Voltage Directive and the European Electromagnetic Compatibility (EMC) Directive. EMC filters needed to comply with the European EMC Directive are incorporated within versions of the product with a CE marking.

Eurasian Customs Union (CU) mark

CE versions of products that include an EAC mark of conformity meet the product safety and EMC requirements for export to Russia, Belarus, and Kazakhstan.

GOST-TR mark

CE versions of products that include a GOST-TR mark of conformity meet the product safety and EMC requirements for export to the Russian Federation.

C-Tick mark

CE versions of products with a C-Tick mark comply with the EMC regulations required for sale in Australia and New Zealand.

CCC mark

The China Compulsory Certification (CCC) mark indicates that the product has been tested and found compliant with product safety regulations required for sale in China.

UkrSEPRO mark

The CE versions of products that include a UkrSEPRO mark of conformity meet the product safety and EMC requirements for export to the Ukraine.

Serbian AAA mark

CE versions of products that include a AAA Serbian mark meet the product safety and EMC requirements for export to Serbia.

Introduction

Hypertherm maintains a global Regulatory Management System to ensure that products comply with regulatory and environmental requirements.

National and local safety regulations

National and Local safety regulations shall take precedence over any instructions provided with the product. The product shall be imported, installed, operated and disposed of in accordance with national and local regulations applicable to the installed site.

Certification test marks

Certified products are identified by one or more certification test marks from accredited testing laboratories. The certification test marks are located on or near the data plate.

Each certification test mark means that the product and its safety-critical components conform to the relevant national safety standards as reviewed and determined by that testing laboratory. Hypertherm places a certification test mark on its products only after that product is manufactured with safety-critical components that have been authorized by the accredited testing laboratory.

Once the product has left the Hypertherm factory, the certification test marks are invalidated if any of the following occurs:

- The product is modified in a manner that creates a hazard or non-conformance with the applicable standards.
- Safety-critical components are replaced with unauthorized spare parts.
- Any unauthorized assembly, or accessory that uses or generates a hazardous voltage is added.
- There is any tampering with a safety circuit or other feature that is designed into the product as part of the certification, or otherwise.

CE marking constitutes a manufacturer's declaration of conformity to applicable European directives and standards. Only those versions of Hypertherm products with a CE Marking located on or near the data plate have been tested for compliance with the European Low Voltage Directive and the European EMC Directive. EMC filters needed to comply with the European EMC Directive are incorporated within versions of the power supply with a CE Marking.

Certificates of compliance for Hypertherm products are available from the Downloads Library on the Hypertherm web site at https://www.hypertherm.com.

Differences in national standards

Nations may apply different performance, safety or other standards. National differences in standards include, but are not limited to:

- Voltages
- Plug and cord ratings
- Language requirements
- Electromagnetic compatibility requirements

These differences in national or other standards may make it impossible or impractical for all certification test marks to be placed on the same version of a product. For example, the CSA versions of Hypertherm's products do not comply with European EMC requirements, and therefore do not have a CE marking on the data plate.

Countries that require CE marking or have compulsory EMC regulations must use CE versions of Hypertherm products with the CE marking on the data plate. These include, but are not limited to:

- Australia
- New Zealand
- Countries in the European Union
- Russia

It is important that the product and its certification test mark be suitable for the end-use installation site. When Hypertherm products are shipped to one country for export to another country; the product must be configured and certified properly for the end-use site.

Safe installation and use of shape cutting equipment

IEC 60974-9, titled Arc Welding Equipment – Installation and use, provides guidance in the safe installation and use of shape cutting equipment and the safe performance of cutting operations. The requirements of national and local regulations shall be taken into consideration during installation, including, but not limited to, grounding or protective earth connections, fuses, supply disconnecting device, and type of supply circuit. Read these instructions before installing the equipment. The first and most important step is the safety assessment of the installation.

The safety assessment must be performed by an expert, and determines what steps are necessary to create a safe environment, and what precautions should be adopted during the actual installation and operation.

Procedures for periodic inspection and testing

Where required by local national regulations, IEC 60974-4 specifies test procedures for periodic inspection and after repair or maintenance, to ensure electrical safety for plasma cutting power sources built in conformity with IEC 60974-1. Hypertherm performs the continuity of the protective circuit and insulation resistance tests in the factory as non-operating tests. The tests are performed with the power and ground connections removed.

Hypertherm also removes some protective devices that would cause false test results. Where required by local national regulations, a label shall be attached to the equipment to indicate that it has passed the tests prescribed by IEC 60974-4. The repair report shall indicate the results of all tests unless an indication is made that a particular test has not been performed.

Qualification of test personnel

Electrical safety tests for shape cutting equipment can be hazardous and shall be carried out by an expert in the field of electrical repair, preferably someone also familiar with welding, cutting, and allied processes. The safety risks to personnel and equipment, when unqualified personnel are performing these tests, may be much greater than the benefit of periodic inspection and testing.

Hypertherm recommends that only visual inspection be performed unless the electrical safety tests are specifically required by local national regulations in the country where the equipment is installed.

Residual current devices (RCDs)

In Australia and some other countries, local codes may require the use of a Residual Current Devices (RCD) when portable electrical equipment is used in the workplace or at construction sites to protect operators from electrical faults in the equipment. RCDs are designed to safely disconnect the mains electrical supply when an imbalance is detected between the supply and return current (there is a leakage current to earth). RCDs are available with both fixed and adjustable trip currents between 6 to 40 milliamperes and a range of trip times up to 300 milliseconds selected for the equipment installation, application and intended use. Where RCDs are used, the trip current and trip time on RCDs should be selected or adjusted high enough to avoid nuisance tripping during normal operation of the plasma cutting equipment and low enough in the extremely unlikely event of an electrical fault in the equipment to disconnect the supply before the leakage current under a fault condition can pose a life threatening electrical hazard to operators.

To verify that the RCDs continue to function properly over time, both the trip current and the trip time should be tested periodically. Portable electrical equipment and RCDs used in commercial and industrial areas in Australia and New Zealand are tested to the Australian standard AS/NZS 3760. When you test the insulation of plasma cutting equipment to AS/NZS 3760, measure the insulation resistance according to Appendix B of the standard, at 250 VDC with the power switch in the ON position to verify proper testing and to avoid the false failure of the leakage current test. False failures are possible because the metal oxide varistors (MOVs) and electromagnetic compatibility (EMC) filters, used to reduce emissions and protect the equipment from power surges, may conduct up to 10 milliamperes leakage current to earth under normal conditions.

If you have any questions regarding the application or interpretation of any IEC standards described here, you are required to consult with an appropriate legal or other advisor familiar with the International Electrotechnical standards, and shall not rely on Hypertherm in any respect regarding the interpretation or application of such standards.

Higher-level systems

When a system integrator adds additional equipment; such as cutting tables, motor drives, motion controllers or robots; to a Hypertherm plasma cutting system, the combined system may be considered a higher-level system. A higher-level system with hazardous moving parts may constitute industrial machinery or robotic equipment, in which case the OEM or end-use customer may be subject to additional regulations and standards than those relevant to the plasma cutting system as manufactured by Hypertherm.

It is the responsibility of the end-use customer and the OEM to perform a risk assessment for the higher-level system, and to provide protection against hazardous moving parts. Unless the higher-level system is certified when the OEM incorporates Hypertherm products into it, the installation also may be subject to approval by local authorities. Seek advice from legal counsel and local regulatory experts if you are uncertain about compliance.

External interconnecting cables between component parts of the higher level system must be suitable for contaminants and movement as required by the final end use installation site. When the external interconnecting cables are subject to oil, dust, water, or other contaminants, hard usage ratings may be required.

When external interconnecting cables are subject to continuous movement, constant flexing ratings may be required. It is the responsibility of the end-use customer or the OEM to ensure the cables are suitable for the application. Since there are differences in the ratings and costs that can be required by local regulations for higher level systems, it is necessary to verify that any external interconnecting cables are suitable for the end-use installation site.

Introduction

The Hypertherm Environmental Specification requires RoHS, WEEE and REACH substance information to be provided by Hypertherm's suppliers.

Product environmental compliance does not address the indoor air quality or environmental release of fumes by the end user. Any materials that are cut by the end user are not provided by Hypertherm with the product. The end user is responsible for the materials being cut as well as for safety and air quality in the workplace. The end user must be aware of the potential health risks of the fumes released from the materials being cut and comply with all local regulations.

National and local environmental regulations

National and local environmental regulations shall take precedence over any instructions contained in this manual.

The product shall be imported, installed, operated and disposed of in accordance with all national and local environmental regulations applicable to the installed site.

The European Environmental regulations are discussed later in *The WEEE Directive*.

The RoHS directive

Hypertherm is committed to complying with all applicable laws and regulations, including the European Union Restriction of Hazardous Substances (RoHS) Directive that restricts the use of hazardous materials in electronics products. Hypertherm exceeds RoHS Directive compliance obligations on a global basis.

Hypertherm continues to work toward the reduction of RoHS materials in our products, which are subject to the RoHS Directive, except where it is widely recognized that there is no feasible alternative.

Declarations of RoHS Conformity have been prepared for the current CE versions of Powermax plasma cutting systems manufactured by Hypertherm. There is also a "RoHS mark" on the Powermax CE versions below the "CE Marking" on the data plate of CE versions of Powermax series units shipped since 2006. Parts used in CSA versions of Powermax and other products manufactured by Hypertherm that are either out of scope or exempt from RoHS are continuously being converted to RoHS compliance in anticipation of future requirements.

Proper disposal of Hypertherm products

Hypertherm plasma cutting systems, like all electronic products, may contain materials or components, such as printed circuit boards, that cannot be discarded with ordinary waste. It is your responsibility to dispose of any Hypertherm product or component part in an environmentally acceptable manner according to national and local codes.

- In the United States, check all federal, state, and local laws.
- In the European Union, check the EU directives, national, and local laws. For more information, visit www.hypertherm.com/weee.
- In other countries, check national and local laws.
- Consult with legal or other compliance experts when appropriate.

The WEEE directive

On January 27, 2003, the European Parliament and the Council of the European Union authorized Directive 2002/96/EC or WEEE (Waste Electrical and Electronic Equipment).

As required by the legislation, any Hypertherm product covered by the directive and sold in the EU after August 13, 2005 is marked with the WEEE symbol. This directive encourages and sets specific criteria for the collection, handling, and recycling of EEE waste. Consumer and business-to-business wastes are treated differently (all Hypertherm products are considered business-to-business). Disposal instructions for the CE versions of Powermax plasma systems can be found at www.hypertherm.com/weee.

The URL is printed on the symbol-only warning label for each of these CE version Powermax series units shipped since 2006. The CSA versions of Powermax and other products manufactured by Hypertherm are either out of scope or exempt from WEEE.

The REACH regulation

The REACH regulation (1907/2006), in force since June 1, 2007, has an impact on chemicals available to the European market. The REACH regulation requirements for component manufacturers states that the component shall not contain more than 0.1% by weight of the Substances of Very High Concern (SVHC).

Component manufacturers and other downstream users, such as Hypertherm, are obligated to obtain assurances from its suppliers that all chemicals used in or on Hypertherm products will have a European Chemical Agency (ECHA) registration number. To provide chemical information as required by the REACH regulation, Hypertherm requires suppliers to provide REACH declarations and identify any known use of REACH SVHC. Any use of SVHC in amounts exceeding 0.1% w/w of the parts has been eliminated. The MSDS contains a full disclosure of all substances in the chemical and can be used to verify REACH SVHC compliance.

The lubricants, sealants, coolants, adhesives, solvents, coatings and other preparations or mixtures used by Hypertherm in, on, for, or with its shape cutting equipment are used in very small quantities (except the coolant) and are commercially available with multiple sources that can and will be replaced in the event of a supplier problem associated with REACH Registration or REACH Authorization (SVHCs).

Proper handling and safe use of chemicals

Chemical Regulations in the USA, Europe, and other locations require that Material Safety Data Sheets (MSDS) be made available for all chemicals. The list of chemicals is provided by Hypertherm. The MSDS are for chemicals provided with the product and other chemicals used in or on the product. MSDS can be downloaded from the Downloads Library on the Hypertherm web site at https://www.hypertherm.com. On the Search screen, insert MSDS in the document title and click on Search.

In the USA, OSHA does not require Material Safety Data Sheets for articles such as electrodes, swirl rings, retaining caps, nozzles, shields, deflectors and other solid parts of the torch.

Hypertherm does not manufacture or provide the materials that are cut and has no knowledge whether the fumes released from materials that are cut will pose a physical hazard or health risk. Please consult with your supplier or other technical advisor if you need guidance concerning the properties of the material you will cut using a Hypertherm product.

Fumes emission and air quality

Note: The following information on air quality is intended for general information only and should not be used as a substitute for reviewing and implementing applicable government regulations or legal standards in the country where the cutting equipment will be installed and operated.

In the USA, the National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM) is a collection of methods for sampling and analyzing contaminants in workplace air. Methods published by others, such as OSHA, MSHA, EPA, ASTM, ISO or commercial suppliers of sampling and analytical equipment, may have advantages over NIOSH methods.

For example, ASTM Practice D 4185 is a standard practice for the collection, dissolution, and determination of trace metals in workplace atmospheres. The sensitivity, detection limit, and optimum working concentrations for 23 metals are listed in ASTM D 4185. An industrial hygienist should be used to determine the optimum sampling protocol, considering analytical accuracy, cost, and optimum sample number. Hypertherm uses a third party industrial hygienist to perform and interpret air quality testing results taken by air sampling equipment positioned at operator stations in Hypertherm buildings where plasma cutting tables are installed and operated.

Where applicable, Hypertherm also uses a third party industrial hygienist to obtain air and water permits.

If you are not fully aware and up to date on all applicable government regulations and legal standards for the installation site, you should consult a local expert prior to purchasing, installing, and operating the equipment.

ENTERING INTO THE LICENSE AGREEMENT SET FORTH BELOW (THE "LICENSE AGREEMENT") GIVES YOU THE RIGHT TO USE THE HYPERTHERM TECHNOLOGY AND RELATED SOFTWARE AND EMBODIED THEREIN WITH HYPERTHERM HPR XD PLASMA SYSTEMS.

PLEASE READ THE LICENSE AGREEMENT CAREFULLY BEFORE USING THE SOFTWARE.

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1. Certain definitions: "Designated Hypertherm Patents" shall mean United States Patent Application Nos. 12/341,731, 12/466,786, and 12/557,920, including foreign equivalents, and any patents issuing therefrom; "Hypertherm Plasma Systems" shall mean Hypertherm HPR XD plasma systems, including 130, 260 and 400 amp systems; "Hypertherm Technology" shall mean Hypertherm's proprietary hole cutting technology, including know-how, specifications, inventions, methods, procedures, algorithms, software, programs, works of authorship and other information, documentation and materials for use in programming and operating an automated high temperature thermal cutting system; "Controller Platform" shall mean Hypertherm computer numerical controller and/or MTC software platform supplied with this license; and "End User Customer(s)" shall mean an entity licensed to use the Hypertherm Technology for such entity's own internal business purposes and not for distribution to others.
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3. The End User Customer shall be granted a non-exclusive, non-transferable, personal, royalty-free license, without the right to sublicense, under the Designated Hypertherm Patents solely to the extent necessary to enable the End User Customer to exercise the rights granted under Paragraph 2, above. The License Agreement shall provide that, except for the rights expressly granted to the End User Customer in the License Agreement, the license under the Designated Hypertherm Patents shall not be deemed to grant any license or immunity for combining the Hypertherm Technology with other items or for the use of such combination.
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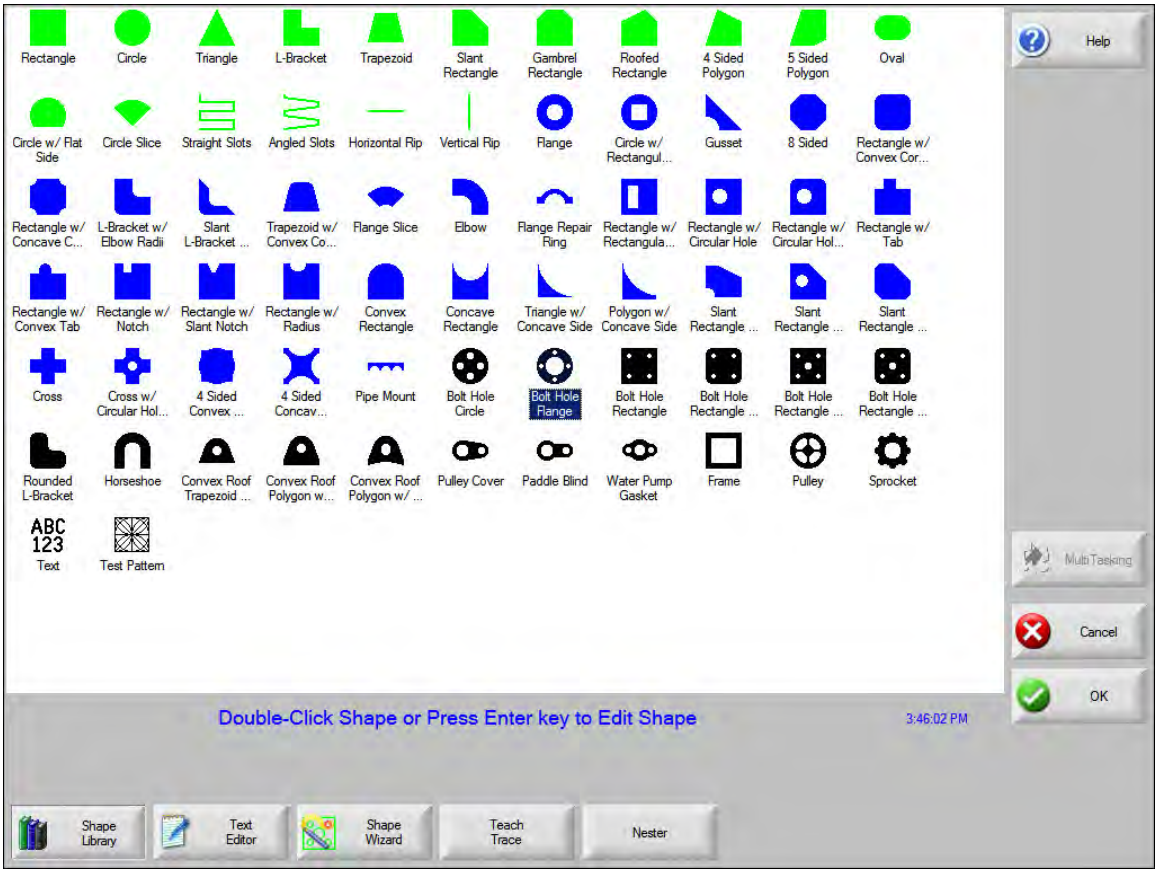
9. TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO EVENT SHALL HYPERTHERM, ITS LICENSORS OR SUPPLIERS BE LIABLE FOR ANY INDIRECT, EXEMPLARY, PUNITIVE, CONSEQUENTIAL, INCIDENTAL OR SPECIAL DAMAGES, INCLUDING LOST PROFITS, ARISING OUT OF OR IN CONNECTION WITH THE USE OF THE HYPERTHERM TECHNOLOGY OR RELATED SOFTWARE EMBODIED THEREIN, EVEN IF SUCH PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THE LIMITATION STATED IN THIS SECTION SHALL APPLY REGARDLESS OF THE FORM OF ACTION, WHETHER THE ASSERTED LIABILITY OR DAMAGES ARE BASED ON CONTRACT (INCLUDING, BUT NOT LIMITED TO, BREACH OF WARRANTY), TORT (INCLUDING, BUT NOT LIMITED TO, NEGLIGENCE), STATUTE, OR ANY OTHER LEGAL OR EQUITABLE THEORY.

Section 1
Shape Library

The CNC contains a built-in Shape Library with more than 68 commonly used shapes. These shapes are *parametric.* Parametric shapes are shapes whose size or geometry you can edit. The shapes in the library are color-coded from easy (green) to difficult (black).



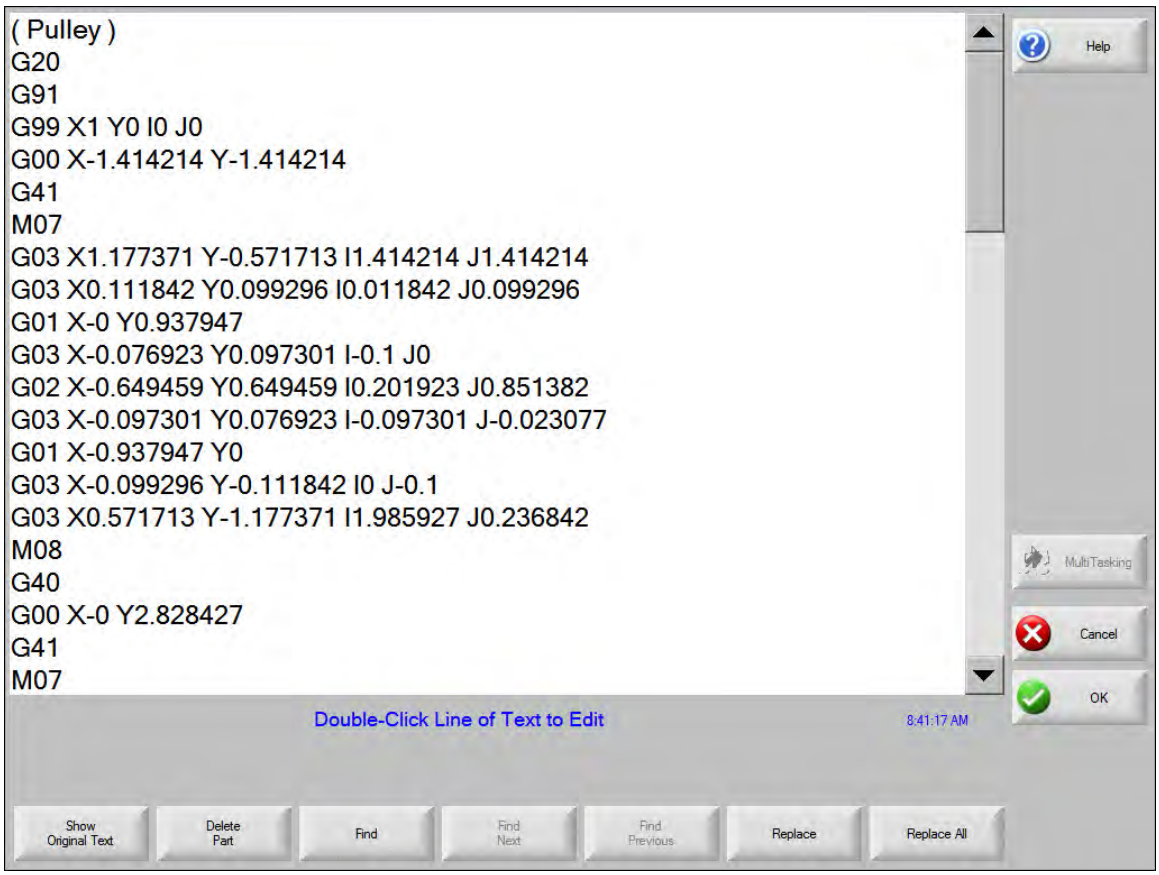
To select a simple shape:

1. On the Main screen, press Shape Manager.
2. Choose a shape, then OK.

The shape is displayed with the default parameters or the parameters from the last time this shape was edited. For more information on the available shapes, see *Loading a part from the Shape Library* in the *Phoenix 9.72.0 Operator's Manual*.

Text Editor

The text editor screen allows you to write or edit a part program in either ESSI or EIA format. The current part that is in memory is displayed when this screen opens.



To edit code:

1. Choose a line of code. On the CNC, the alphanumeric keypad displays.
2. Enter changes to existing lines of code or add new lines.
3. Press OK to save your changes. If you want to save the changes to the hard drive, select Files > Save to Disk.

The text editor screen contains the following soft keys:

Show Original Text: Allows you to view and edit the part program in its original format.

Delete Part: Deletes the current part from the Text Editor so that a new part can be constructed.

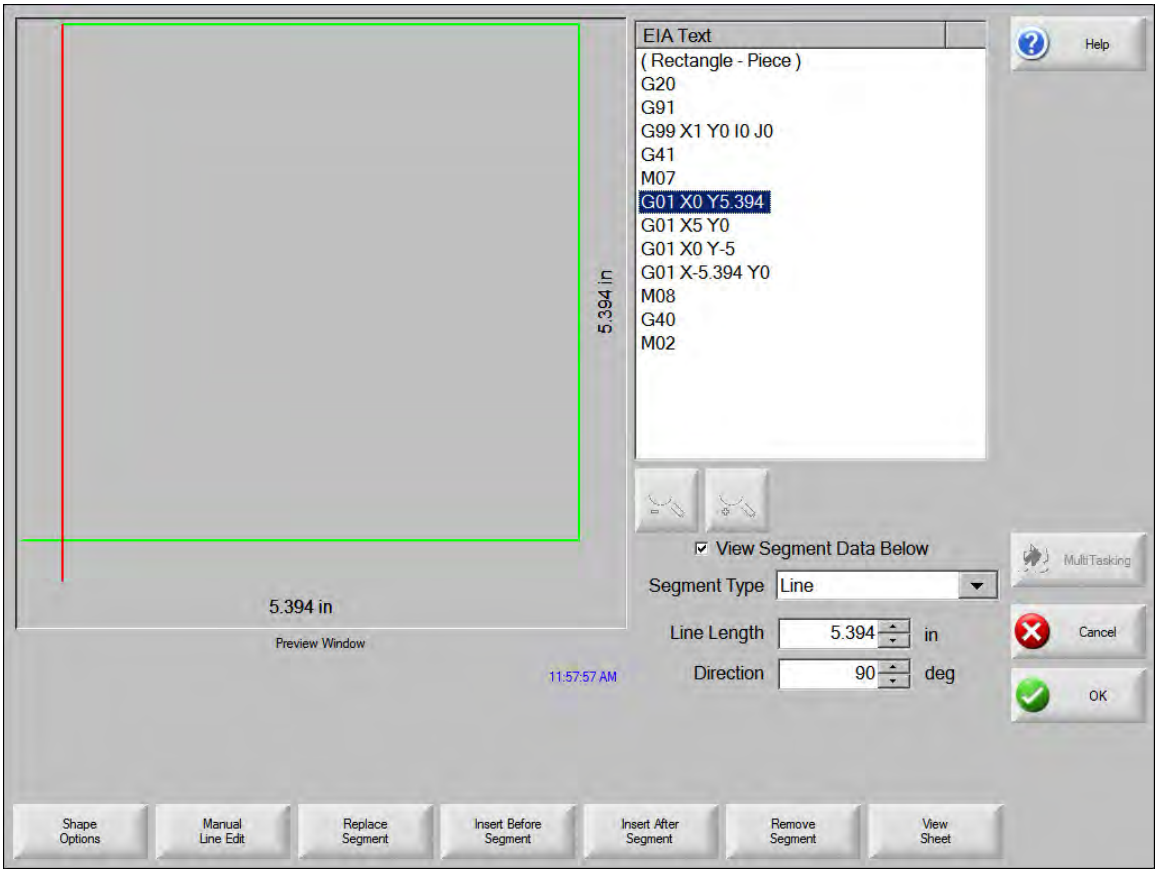
Shape Wizard

ShapeWizard® is a proprietary graphical part editor that provides a user-friendly, graphical interface for editing part programs.

You can view the segment that you edit and other changes that you make, as well.

There are a number of features on the Shape Wizard screen to facilitate editing part programs:

- The shape you select is displayed in the Preview Window and the corresponding code is displayed in the EIA Text window.
- As you edit lines of code, the changes are visible in the Preview Window.
- You can add or modify EIA RS-274D codes in a part program in the EIA Text window.
- If you don't know EIA RS-274D codes, you can edit or create segments by making entries and selections in the Segment Data fields below the EIA Text window.
- Zoom keys decrease or increase the size of the part in the Preview Window.



To edit a part program in the EIA Text window:

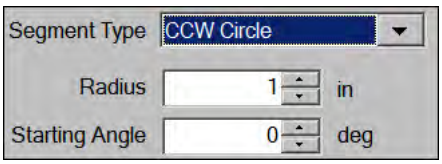
1. Choose on a line of code to highlight it.

2. Choose Manual Line Edit. The alphanumeric keypad is displayed for line edits.

3. Type over a line to replace the text.
   The ASCII text that you enter must be a valid EIA RS-274D code or an error message will display.

4. To view data about the segment of the part that you have highlighted, select the View Segment Data Below check box.

5. You can use the Segment Type field and related fields to change the highlighted segment type and add it to the program.



6. While a line is highlighted in blue, use soft keys to add or replace a segment:

   Replace Segment: Replaces the segment highlighted in gray in the Text Editor window with the segment selected from the Segment Type window.

   Insert Before Segment: Inserts the segment selected from the Segment Type window to be inserted before the segment highlighted in. gray in the Text Editor window.

   Insert After Segment: Inserts the segment selected from the Segment Type window after the segment highlighted in gray in the Text Editor window.

   Remove Segment: Deletes the segment that is highlighted in gray or blue in the EIA Text window from the part program.

7. As you edit a line of code, the picture of the part in the Preview window is updated. The corresponding segment is highlighted in red if it is a cut segment or in blue if it is a traverse.

Teach Trace

The Teach Trace function of the CNC allows parts and remnants to be traced rather than programmed. The position information from the traced part remains as a part program that can be saved to disk.

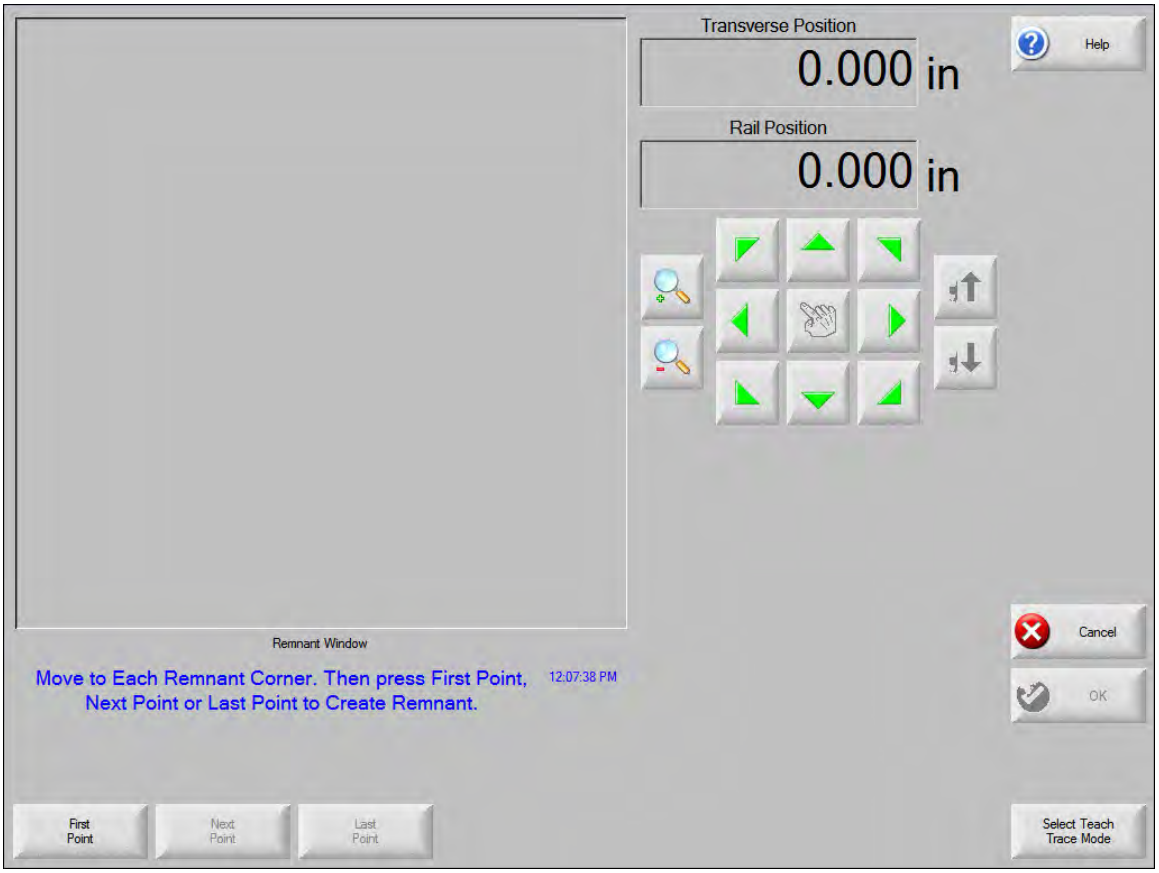
The Teach Trace algorithms in the CNC can recognize both arcs and lines. This reduces the overall memory required to store these parts and improves the smoothness of the cut.

The traced part in memory is in EIA format and can be cut, saved or edited using any of the part options.

Teach Trace has two modes, Remnant Trace and Teach Trace. The screen opens in Remnant Trace mode. Press the Select Teach Trace Mode soft key to use Teach Trace.

Remnant Trace Mode

In Remnant Trace mode, you can trace the outline of a plate remnant and save it as a file so that it can be used later and nests of parts can be cut from the remnant.



To trace a remnant:

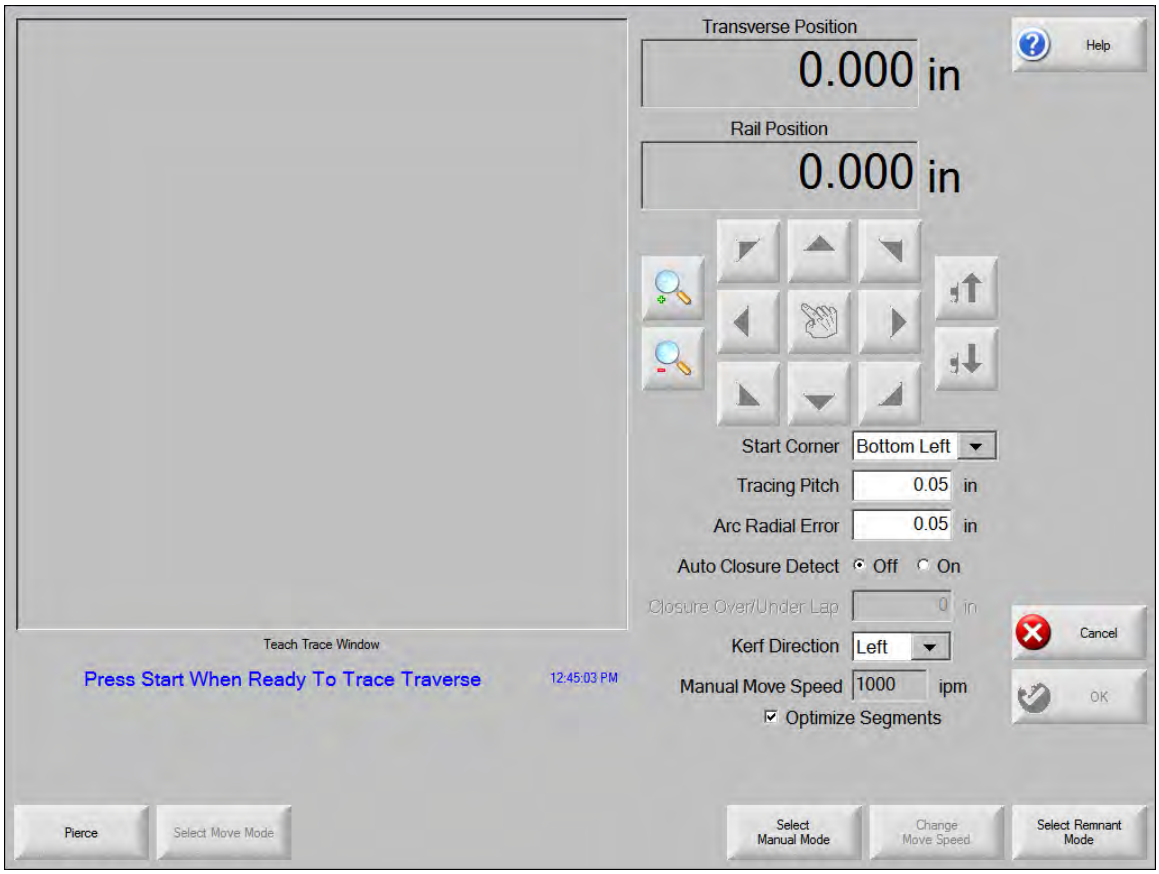
1. On the TeachTrace screen, press the Select Remnant Mode soft key.
2. Jog to the point on the Remnant window where you want the trace to begin. Use the joystick or jog keys to move the torch over the plate.
3. Choose First Point.
4. Jog to the next point and choose Next Point. Repeat this step until you have traced all but the final point.
5. When the pointer is over the last point you need to trace, choose Last Point. Trace Remnant draws a line between this point and the first point to close the remnant.
6. Choose OK to let TeachTrace create the remnant. TeachTrace connects the last point to the first point automatically and returns to the Preview Window.
7. Choose Files > Save to Disk.

8. Select a folder for the new remnant file from the Save to drop-down list. It is helpful to have a folder named Remnant to hold your remnant files.

9. Enter a file name in the File Name field.

10. Choose OK.

Teach Trace Mode



The Teach Trace function must be used with an optional stand-alone optical tracing system.

To trace a part:

1. Press Select Auto Mode to trace the part automatically.

2. Press Select Manual Mode to trace the part manually. This also enables the Change Move Speed button so you can change the speed at which the sensor moves.

3. Select traverse or pierce. You can switch between traverse and pierce during the tracing procedure.

4. Position the optical sensor near the part drawing.

5. Press Start. Use the sensor positioning controls to direct the sensor towards the part.

6. After the sensor has located the part, the tracing system will follow the part outline until completion.

7. If you are using manual mode, you can press the Change Move Speed button repeatedly to select a speed for the optical sensor.

8. When the tracing system is finished tracing, press OK. You can cut, save or edit the part.

The Teach Trace function contains the following parameters:

Start Corner: Allows you to select where the part you trace will begin for proper viewing on the screen.

Tracing Pitch: Determines how precisely to learn a part. The Tracing Pitch can be adjusted to favor the resolution or size of the taught part. This value does not affect the actual position resolution of the part.

A good starting point for most tracing systems is 0.01".

Arc Radial Error: Specifies the arc error tolerance to be used when checking the current segment for dimensional accuracy. All ESSI or EIA programs are comprised of lines, arcs, and circles. Arc Radial Error is used to ensure that the starting and ending radial vectors are within tolerance to describe a valid geometry.

Auto Closure Detect: Allows the CNC to detect that it has returned to the starting point. With this feature on, the CNC stops the motion of the tracer when the part is complete and programs a lead-out.

Closure Over/Under Lap: By specifying a positive value for this parameter, the CNC does not stop the tracer until it has gone past the start point by the value of this parameter.

Specify a negative value to stop the tracer as soon as the tracing head position is within this parameter's distance of the starting point. This is only available if the Auto Closure Detect is On.

Kerf Direction: Selects the kerf for cut segments.

Traverse/Pierce: Switches between the traverse and cut segments of the part as it is taught.

Select Auto/Manual Mode: Use this button to change trace modes.

If you select manual mode, you can also use the Change Move Speed button to change the trace speed.

Change Move Speed: Press this button to change the trace speed in manual mode.

Select Remnant Mode: Press this button to use remnant mode to create remnants.

Section 2
ASCII Codes

This section provides the 128 ASCII codes (American Standard Code for Information Interchange) as defined by ANSI (American National Standards Institute) Standard X3.4-1977.

Control Codes

Hex	Dec	Character	Name	Description
00	0	^ @	NUL	Null
01	1	^A	SOH	Start of Header
02	2	^B	STX	Start of Text
03	3	^C	ETX	End of Text
04	4	^D	EOT	End of Transmission
05	5	^E	ENQ	Enquiry
06	6	^F	ACK	Acknowledge
07	7	^G	BEL	Bell
08	8	^H	BS	Backspace
09	9	^I	HT	Horizontal Tab
0A	10	^J	LF	Line Feed
0B	11	^K	VT	Vertical Tab
0C	12	^L	FF	Form Feed
0D	13	^M	CR	Carriage Return
0E	14	^N	SO	Shift Out
0F	15	^O	SI	Shift In
10	16	^P	DLE	Data Link Escape
11	17	^Q	DCI	Device Control 1
12	18	^R	DC2	Device Control 2
13	19	^S	DC3	Device Control 3
14	20	^T	DC4	Device Control 4
15	21	^U	NAK	Negative Acknowledge
16	22	^V	SYN	Synchronous Idle
17	23	^W	ETB	End Transmission Block
18	24	^X	CAN	Cancel
19	25	^Y	EM	End of Medium

Hex	Dec	Character	Name	Description
1A	26	^Z	Sub	Substitute
1B	27	^[	ESC	Escape
1C	28	^\	FS	File Separator
1D	29	^]	GS	Group Separator
1E	30	^^	RS	Record Separator
1F	31	^_	US	Unit Separator
20	32		SP	Space

All Codes

Hex	Dec	Symbol	Hex	Dec	Symbol	Hex	Dec	Symbol
00	0	^ @	2B	43	+	56	86	V
01	1	^A	2C	44	,	57	87	W
02	2	^B	2D	45	-	58	88	X
03	3	^C	2E	46	.	59	89	Y
04	4	^D	2F	47	/	5A	90	Z
05	5	^E	30	48	0	5B	91	[
06	6	^F	31	49	1	5C	92	\
07	7	^G	32	50	2	5D	93	]
08	8	^H	33	51	3	5E	94	^
09	9	^I	34	52	4	5F	95	_
0A	10	^J	35	53	5	60	96	`
0B	11	^K	36	54	6	61	97	a
0C	12	^L	37	55	7	62	98	b
0D	13	^M	38	56	8	63	99	c
0E	14	^N	39	57	9	64	100	d
0F	15	^O	3A	58	:	65	101	e
10	16	^P	3B	59	;	66	102	f
11	17	^Q	3C	60	<	67	103	g
12	18	^R	3D	61	=	68	104	h
13	19	^S	3E	62	>	69	105	i
14	20	^T	3F	63	?	6A	106	j
15	21	^U	40	64	@	6B	107	k
16	22	^V	41	65	A	6C	108	l
17	23	^W	42	66	B	6D	109	m
18	24	^X	43	67	C	6E	110	n
19	25	^Y	44	68	D	6D	111	o

Hex	Dec	Symbol	Hex	Dec	Symbol	Hex	Dec	Symbol
1A	26	^Z	45	69	E	70	112	p
1B	27	^[	46	70	F	71	113	q
1C	28	^\	47	71	G	72	114	r
1D	29	^]	48	72	H	73	115	s
1E	30	^^	49	73	I	74	116	t
1F	31	^_	4A	74	J	75	117	u
20	32		4B	75	K	76	118	v
21	33	!	4C	76	L	77	119	w
22	34	“	4D	77	M	78	120	x
23	35	#	4E	78	N	79	121	y
24	36	$	4F	79	O	7A	122	z
25	37	%	50	80	P	7B	123	{
26	38	&	51	81	Q	7C	124	|
27	39	‘	52	82	R	7D	125	}
28	40	(	53	83	S	7E	126	~
29	41	)	54	84	T	7F	127	¬
2A	42	‘	55	85	U			

Section 3

EIA RS-274D Program Support

The CNC supports EIA RS-274D part programs. An EIA RS-274D program lists the codes that are used to create a part. The Phoenix software provides the ShapeWizard® graphical programming environment to help you edit your programs.

The following list defines the EIA codes that are directly supported, mapped, or currently unsupported by the CNC. Mapped EIA codes are automatically converted into directly supported EIA codes when the program is loaded. Unsupported EIA codes are ignored. All other EIA codes generate an error.

Directly Supported EIA Codes

EIA Code	Description
Fx	Machine Speed (if Speed Override enabled)
Nx	Line Number
(text)	Comments
Xxx	X Axis Endpoint or other Data
Yxx	Y Axis Endpoint or other Data
Ixx	I Axis Integrand or Part Option Data
Jxx	J Axis Integrand or Part Option Data
Oxx Sxx	Output (1-64), State (0-Off or 1-On)
Wxx Sxx	Wait for Input (1-64), State (0-Off or 1-On)
G00 Xx Yx	Rapid traverse (linear interpolation)
G00 Ax	Sets Tilt angle – A is the angle value in degrees
G00 XYxx Axx	Performs Linear Interpolation of Tilt angle along line segment.
G00 Xx Yx	Traverse command where x = value to move the desired axes a distance.
G00 Zx.xx Tx	Index THC height Z distance for torch T. Manual mode only.
G00 Cxx	Move to rotate “C” position
G00 C180-	Rotate Axis offset 180 degrees will continue to rotate in the proper direction
G00 C-180-	Rotate Axis offset -180 degrees will continue to rotate in the proper direction
G00 Px Tx Sx Rx	Rapid traverse: Rotate Transverse 2 axis for square or rectangular tube positioning. P = +/- 180 degrees T = Top measurement of tube S = Side measurement of tube R = Corner radius, +/- 90 degrees X or Y = Optional: Rail axis position
G01 Xx Yx	Linear interpolation (cut) at program cut speed
G01 Ax Fx	Sets Tilt angle, A-axis position in degrees with a speed command (F) in RPM. F is required.
G01 Cx Fx	Sets Rotate angle, C-axis position in degrees with a speed command (F) in RPM. F is required.
G01 C180- Fx	Rotate Axis offset 180 degrees with speed command in RPM. F is required.
G01 C-180- Fx	Rotate Axis offset -180 degrees with speed command in RPM. F is required.

EIA Code	Description
G01 Px Fx Tx Sx Rx	Rotate Transverse 2 axis for square or rectangular tube cutting. P = +/- 180 degrees F = Optional: Rotational speed in RPM T = Top measurement of tube S = Side measurement of tube R = Corner radius, +/- 90 degrees X or Y = Optional: Rail axis position
G02 Xx Yx Ix Jx	Clockwise Circle or Arc Xx Yx = Arc end point Ix Jx = Arc center point (radius value)
G03 Xx Yx Ix Jx	Counterclockwise Circle or Arc Xx Yx = Arc end point Ix Jx = Arc center point (radius value)
G04	Preset Dwell (uses Setup Dwell Time)
G04 xx	Program Dwell in Seconds
G08 X x	Repeat Subroutine X Times
G20	Select English Units (inches)
G21	Select Metric Units (mm)
G40	Disable Kerf Compensation
G41	Enable Left Kerf Compensation
G42	Enable Right Kerf Compensation
G43 Xx	Kerf Value
G41 D1-200	Enables Left Kerf using a Kerf Table variable
G42 D1-200	Enables Right Kerf using a Kerf Table variable
G43 D1-200	Sets the current Kerf value via the Kerf Table using prior set Left / Right Kerf
G59 D1-200Xx	Sets Kerf table variable from 1-200
G59 Vxx Fxx	Changes Hypertherm CNC parameters from within the part programs. This use of the G59 code is unique to Hypertherm part programs that run on a Hypertherm CNC. See *G59 Process Variables* on page 89 for more information.
G66 Dx Bx Cx	Auto Align 3 Point Method with Long Offset Distance, Fast Speed, Slow Speed values respectively
G82	Oxyfuel Cut Mode
G83	Oxyfuel Cut Mode Contour Bevel Head
G84	Plasma Cut Mode
G85	Plasma Cut Mode Contour Bevel Head

EIA Code	Description
G90	Absolute Programming Mode
G91	Incremental Programming Mode
G92	Set Axis Presets
G93 Xx.xxx	Bevel consumable correction. Adds or subtracts a value from the Bevel Pivot Length parameter used only with ABXYZ bevel heads. The Bevel Pivot Length baseline value uses 130A O_2/Air consumables. When using a different consumable set, issue the G93 code at the beginning of the part program (after setting the part program units) to change the Bevel Pivot Length. For example, G93 X0.035 adds 0.035 inches (0.89 mm) to the Bevel Pivot Length to correct for HPR260XD consumables. 80 A O_2/Air = 0.000 inches or mm 130 A O_2/Air = 0.000 inches or mm 200 A O_2/Air = 0.011 inches or 0.28 mm 260 A O_2/Air = 0.035 inches or 0.89 mm 400 A O_2/Air = -0.019 inches or -0.48 mm (The 400 A values are subtracted from the Bevel Pivot Length.)
G96 X xx	Sets the rotational speed of a rotating Transverse 2 axis used in pipe cutting (use Y if Y is the Transverse axis). The xx value equals the diameter of the pipe.
G97	Program Repeat Pointer
G97 Tx	Program Repeat Pointer. Executes the repeat T times
G98	Repeat at G97, or start of program if no G97
G99	Part Options
M00	Program Stop
M01	Optional Program Stop (uses Setup Parameter)
M02	End of Program
M07	Cut On
M07 HS	Forces an IHS for cutting, regardless of the distance between cuts or any previous M08 command.
M08 RF	Retracts to Full Retract height. Works only with Sensor THC.
M08 RT –x.xx	Retracts to the Transfer Height and skips IHS, if the skip IHS distance is >0, instead of the Retract Height at the end of a cut. The –x.xx variable represents the amount of time before the end of a cut that the Cut Off command is issued.
M08 Txx.xx	Cut Off T = Temporary Optional Time Delay from –1 to 99.99 seconds
M09	Enable Marker 1
M09 HS	Forces an IHS for marking, regardless of the distance between marks or any previous M10 RT command.
M10	Disable Marker 1

EIA Code	Description
M10 RF	Retracts to Retract Height. Works only with Sensor THC.
M10 RT	Retracts to the Transfer Height and skips IHS, if the skip IHS distance is >0, instead of the Retract Height at the end of a mark.
M11	Marker Offset 1 On
M12	Marker Offset 1 Off
M13	Enable Marker 2
M14	Disable Marker 2
M14 RF	Retracts to Retract Height. Works only with Sensor THC.
M15	Cut On
M16	Cut Off
M17	Oxy Gas On
M18	Oxy Gas Off
M19	Cancel All Stations
M26	Station Select On
M27	Station Select Off
M28	Follower Disabled / CBH rotator disable or disable automatic control of C axis
M29	Follower Enable / CBH rotator disable/ enable automatic control of C axis.
M30	End of Program (same as M02)
M31	Reset Functions (Cut Off, Marker Off, Kerf Off)
M32	Unclamp / Unlock All Stations
M32 Txx	Unclamp / Unlock T Station, where T = 1 through 19
M33	Unclamp / Lock All Stations
M34	Clamp / Unlock All Stations
M34 Txx	Clamp / Unlock T Station, where T = 1 through 19
M35	Clamp / Unlock All Stations Mirror
M35 Txx	Clamp / Unlock Mirror T Station, where T = 1 through 19
M36 Tx	Process Select T where x selects the process 1 = Plasma 1 2 = Plasma 2 3 = Marker 1 4 = Marker 2 5 = Laser 6 = Waterjet
M37 Txx (1-20)	Select Station T where T = 1 through 20
M38 Txx (1-20)	Deselect Station T where T = 1 through 20

EIA Code	Description
M40	Start of Subroutine
M40 x	Start of Subroutine. Executes the repeat X times
M41	End of Subroutine
M48	Speed Override Enable
M49	Speed Override Disable
M50	Disable torch height control
M51 Txx.xx	Enable torch height control (Optional Time Delay in seconds before enable)
M52	Disable Sensor THC and raise torch (for oxyfuel parts only)
M53	Enable Sensor THC and lower torch (for oxyfuel parts only)
M63	User Defined 1 On
M64	User Defined 1 Off
M54	User Defined 2 On
M55	User Defined 2 Off
M56	User Defined 3 On
M57	User Defined 3 Off
M58	User Defined 4 On
M59	User Defined 4 Off
M65	End of Program (same as M02) or Auto Reload
M72	Marker Offset 2 Off
M73	Marker Offset 2 On
M75	A Axis/Tilt Go to Home Command - Rapid Index
M76	C Axis/Rotate Go to Home Command - Rapid Index
M77	Go to Home position Y Axis
M78	Go to Home position X Axis
M79 Tx (1-4)	Go To Home Position (1-4)
M84	Disable Mirror Head 2
M85	Enable Mirror Head 2
M86	Unpark Head 1
M87	Park Head 1
M88	Unpark Head 2
M89	Park Head 2
M90	Aligns CBH / Rotator to Tangent angle of next cut segment
M90-	Align rotator negative, when not using shortest path motion

EIA Code	Description
M91	Space Head 2. Includes a *spacingvalue* that is an absolute position on the specified axis.
M92	Space Head 1. Includes a *spacingvalue* that is an absolute position on the specified axis.
M93	Drill Cycle output
M94	Peck Drill Cycle output
M95	Tap Cycle output
M96	Tool Change output
M274	Marker Offset 3 Off
M275	Marker Offset 3 On
M276	Marker Offset 4 Off
M277	Marker Offset 4 On
M278	Marker Offset 5 Off
M279	Marker Offset 5 On
M280	Marker Offset 6 Off
M281	Marker Offset 6 On
M282	Marker Offset 7 Off
M283	Marker Offset 7 On
M284	Marker Offset 8 Off
M285	Marker Offset 8 On
M286	Marker Offset 9 Off
M287	Marker Offset 9 On
M288	Marker Offset 10 Off
M289	Marker Offset 10 On
M290	Marker Offset 11 Off
M291	Marker Offset 11 On
M292	Marker Offset 12 On
M293	Marker Offset 12 On
M301	Assigns the current X/Y position to Home Position 1
M302	Assigns the current X/Y position to Home Position 2
M303	Assigns the current X/Y position to Home Position 3
M304	Assigns the current X/Y position to Home Position 4
M305	Assigns the current X/Y position to Home Position 5
M306	Assigns the current X/Y position to Home Position 6
M307	Assigns the current X/Y position to Home Position 7

EIA Code	Description
M308	Assigns the current X/Y position to Home Position 8
M309	Assigns the current X/Y position to Home Position 9
M310	Assigns the current X/Y position to Home Position 10
M311	Assigns the current X/Y position to Home Position 11
M312	Assigns the current X/Y position to Home Position 12

Mapped EIA Codes

Phoenix supports part programs that contain mapped EIA codes. However, *all* of the EIA codes in the program must be mapped. Phoenix supports code-mapping of the entire part program, but not a part program that has a mix of mapped and un-mapped codes.

EIA Code	Description	Mapped to
G04 Fx	Program Dwell	G04 x
G05	Set Axis Presets	G92
G21	Linear Interpolation	G01 (at cut speed)
G22	CW Circular Interpolation	G02
G23	CCW Circular Interpolation	G03
G41 Kx	Left Kerf with value	G41 with kerf value
G42 Kx	Right Kerf with value	G42 with kerf Value
G97 Tx	Subroutine Loop	G08 X*value* and M40
G45	Lead In to Kerfed Part	G01, G02, or G03
G70	Select English Units	G20
G71	Select Metric Units	G21
G98	End of Subroutine Loop	M41
M03	Cutting Device On/Off	M07 (Oxyfuel) or M08 as appropriate
M04	Cutting Device On	M07
M05	Cutting Device Off	M08 (Oxyfuel)
M06	Cutting Device Off	M08
M06	Enable Marker 2	M13
M07	Disable Marker 1 or 2	M10 or M14 as appropriate
M08	Enable Marker 1	M09
M09	Disable Marker 1 or 2	M10 or M14 as appropriate
M10	Enable Marker 2	M13

EIA Code	Description	Mapped to
M14	Height Sensor Disable	M50
M15	Height Sensor Enable	M51
M20	Cutting Device On/Off	M07 or M08 as appropriate (Plasma)
M21	Cutting Device On/Off	M07 or M08 as appropriate (Plasma)
M20	Output 9 On	O9 S1
M21	Output 9 Off	O9 S0
M22	Output 12 On	O12 S1
M23	Output 12 Off	O12 S0
M24	Wait for Input 7 On	W7 S1
M25	Wait for Input 8 On	W8 S1
M25	CBH Enable	M29
M26	Wait for Input 7 Off	W7 S0
M26	CBH Disable	M28
M27	Wait for Input 8 Off	W8 S0
M67, M02	Kerf Left	G41
M68, M03	Kerf Right	G42
M69, M04	Kerf Off	G40
M65, M70	Cutting Device On	M07
M66, M71, M73	Cutting Device Off	M08
M70	Marker Offset 1 Off	M12
M71	Marker Offset 1 On	M11
M70T01	Marker Offset 1 Off	M12
M71T01	Marker Offset 1 On	M11
M70T02	Marker Offset 2 Off	M72
M71T02	Marker Offset 2 On	M73
M70T03	Marker Offset 3 Off	M274
M71T03	Marker Offset 3 On	M275
M70T04	Marker Offset 4 Off	M276
M71T04	Marker Offset 4 On	M277
M70T05	Marker Offset 5 Off	M278
M71T05	Marker Offset 5 On	M279
M70T06	Marker Offset 6 Off	M280

EIA Code	Description	Mapped to
M71T06	Marker Offset 6 On	M281
M70T07	Marker Offset 7 Off	M282
M71T07	Marker Offset 7 On	M283
M70T08	Marker Offset 8 Off	M284
M71T08	Marker Offset 8 On	M285
M98	End Comment	)
M99	Start Comment	(
M221	No Mirror, No Rotate	G99 X1 Y0 I0 J0
M222	Mirror Y, No Rotate	G99 X1 Y0 I0 J1
M223	Mirror X and Y	G99 X1 Y0 I1 J1
M224	Mirror X, No Rotate	G99 X1 Y0 I1 J0
M225	Mirror X/Y on -45 Deg	G99 X1 Y270 I1 J0
M226	Rotate 90 Deg CCW	G99 X1 Y90 I0 J0
M227	Mirror X/Y on +45 Deg	G99 X1 Y270 I0 J1
M228	Rotate 90 Deg CW	G99 X1 Y270 I0 J0
M245	Output 1 On	O1 S1
M246	Output 1 Off	O1 S0
M247	Output 2 On	O2 S1
M248	Output 2 Off	O2 S0
M249	Output 3 On	O3 S1
M250	Output 3 Off	O3 S0
M251	Output 4 On	O4 S1
M252	Output 4 Off	O4 S0
M253	Wait for Input 1 On	W1 S1
M254	Wait for Input 1 Off	W1 S0
M255	Wait for Input 2 On	W2 S1
M256	Wait for Input 2 Off	W2 S0
M257	Wait for Input 3 On	W3 S1
M258	Wait for Input 3 Off	W3 S0
M259	Wait for Input 4 On	W4 S1
M260	Wait for Input 4 Off	W4 S0

Unsupported EIA Codes

EIA Code	Description
G30	Mirror Off
G46	Table 0 Select
G94	Feed per minute
G95	Feed per rev
G99	Freestanding G99
G103 Q*name*	Stop Current Program/ Load New Program
G201	Incremental Line In2
G202	Incremental CW Arc In2
G203	Incremental CCW Arc In2
G211	Incremental Line In3
G212	Incremental CW Arc In3
G213	Incremental CCW Arc In3
G221	Absolute Line In2
G222	Absolute CW Arc In2
G223	Absolute CCW Arc In2
G231	Absolute Line In3
G232	Absolute CW Arc In3
G233	Absolute CCW Arc In3
G240	Programmable Kerf
G247	Table 1 Select
G248	Table 2 Select
G249	Table 3 Select
G250	Table 4 Select
G276	Internal Variable Load
G277	External Variable Load
G278	X Axis Home
G279	Y Axis Home
G280	X Home Return
G281	Y Home Return
M66	PLC Control Code
M75	Ignored if not using CBH, Tilt Rotator(s)
M76	Ignored if not using CBH, Tilt Rotator(s)

EIA Code	Description
M210	X Sign Toggle
M211	Y Sign Toggle
M212	X and Y Swap and Toggle
M231	Aux. State Reset
M261	Aux. Torch Master On
M262	Aux. Torch Master Off

The unsupported EIA codes previously noted are ignored when read. Some of these codes may be supported in the future. Any EIA codes that are not listed above will result in a translator error upon loading the EIA program. Known EIA codes that will not be accepted include, but are not limited to:

- Pxx: Program number
- Dxx: Indexed Kerf operations
- Vxx: Internal variable load

EIA Comments

Comments may be placed into the part program to be displayed on screen and viewed by the operator. The comment line must first be preceded by a program stop command (EIA M00 code or ESSI 0 code). For example:

- M00 – Pauses Program
- (Comment) – Text to be displayed

Section 4
ESSI Code Support

The CNC supports ESSI part programs as defined by the International Standards Organization in ISO 6582. An ESSI program lists the sequence of lines, arcs, speeds, kerf and I/O functions used to create a part. While the user is free to program in ESSI using a standard text editor, it is recommended that the ShapeWizard® Graphical Programming environment be used instead.

While the user is free to download ESSI programs to the control, it is important to note that all Part Programs will be internally converted to EIA for execution in the control. Following is a list of the ESSI codes that are mapped into the control, or currently unsupported by the control. Mapped ESSI codes are automatically converted upon program load into directly supported EIA codes. Unsupported ESSI codes are ignored. All other ESSI codes will generate an error.

Mapped ESSI Codes

ESSI Code	Description	Mapped to EIA
%	Start of Program	Not Used-Automatic
+/-*value*…	Line or Arc	G00, G01, G02 or G03 as appropriate
0	End Program or Stop	M02 or M00 (if 64 is End Program)
3	Start Comment	(
4	End Comment	)
5	Enable Rapid Traverse	Not Used-Automatic
6	Disable Rapid Traverse	Not Used-Automatic
7	Cutting Device On	M07
8	Cutting Device Off	M08
9	Enable Marker 1	M09
10	Disable Marker 1	M10
11	Marker Offset 1 On	M11
12	Marker Offset 1 Off	M12
11+1	Marker Offset 1 On	M11
12+1	Marker Offset 1 Off	M12
11+2	Marker Offset 2 On	M73
12+2	Marker Offset 2 Off	M72
11+3	Marker Offset 3 On	M275
12+3	Marker Offset 3 Off	M274
11+4	Marker Offset 4 On	M277
12+4	Marker Offset 4 Off	M276
11+5	Marker Offset 5 On	M279
12+5	Marker Offset 5 Off	M278
11+6	Marker Offset 6 On	M281
12+6	Marker Offset 6 Off	M280
11+7	Marker Offset 7 On	M283

ESSI Code	Description	Mapped to EIA
12+7	Marker Offset 7 Off	M282
11+8	Marker Offset 8 On	M285
12+8	Marker Offset 8 Off	M284
13	Enable Marker 2	M13
14	Disable Marker 2	M14
15	Marker Offset 2 On	M73
16	Marker Offset 2 Off	M72
21	No Mirror, No Rotate	G99 X1 Y0 I0 J0
22	Mirror Y, No Rotate	G99 X1 Y0 I0 J1
23	Mirror X and Y	G99 X1 Y0 I1 J1
24	Mirror X, No Rotate	G99 X1 Y0 I1 J0
25	Mirror X/Y on -45 Deg	G99 X1 Y270 I1 J0
26	Rotate 90 Deg CCW	G99 X1 Y90 I0 J0
27	Mirror X/Y on +45 Deg	G99 X1 Y270 I0 J1
28	Rotate 90 Deg CW	G99 X1 Y270 I0 J0
29	Enable Left Kerf Comp	G41
30	Enable Right Kerf Comp	G42
38	Disable Kerf	G40
39+*value*	Machine Speed	F*value*
40+*value*	Programmable Kerf	G43 X*value*
41	Preset Dwell	G04
41+*value*	Program Dwell in mSec	G04 X*value*
45	Ht Sensor Enable/Lower	M53
46	Ht Sensor Disable/Raise	M52
47	Ht Sensor Enable	M51
48	Ht Sensor Disable	M50
51	CBH Enable	M29

ESSI Code	Description	Mapped to EIA
52	CBH Disable	M28
53	Cutting Device On	M07
54	Cutting Device Off	M08
63	Reset Functions	M31
64	End Program	M02
65	End of Program/ Reload	M65
67	Ht Sensor Disable	M50
68	Ht Sensor Enable	M51
70	Select English Units (in)	G20
71	Select Metric Units (mm)	G21
79+1	Go To Home Position 1	M79 T1
79+2	Go To Home Position 2	M79 T2
79+3	Go To Home Position 3	M79 T3
79+4	Go To Home Position 4	M79 T4
81	Incremental Mode	G91
82	Absolute Mode	G90
83	Set Axis Presets	G92
90	End of Program	M02
97	Program Repeat Pointer	G97
97+*value*	Subroutine Loop	M40 X*value*
98	Repeat at 97, Subroutine loop	G97, G98 or M41 as appropriate or start of program if no 97
99	End of Program	M02
245	Output 1 On	O1 S1
246	Output 1 Off	O1 S0
247	Output 2 On	O2 S1
248	Output 2 Off	O2 S0

ESSI Code	Description	Mapped to EIA
249	Output 3 On	O3 S1
250	Output 3 Off	O3 S0
251	Output 4 On	O4 S1
252	Output 4 Off	O4 S0
253	Wait for Input 1 On	W1 S1
254	Wait for Input 1 Off	W1 S0
255	Wait for Input 2 On	W2 S1
256	Wait for Input 2 Off	W2 S0
257	Wait for Input 3 On	W3 S1
258	Wait for Input 3 Off	W3 S0
259	Wait for Input 4 On	W4 S1
260	Wait for Input 4 Off	W4 S0
282	Marker Offset 3 On	M275
283	Marker Offset 3 Off	M274
284	Marker Offset 4 On	M277
285	Marker Offset 4 Off	M276
286	Marker Offset 5 On	M279
287	Marker Offset 5 Off	M278
288	Marker Offset 6 On	M281
289	Marker Offset 6 Off	M280
290	Marker Offset 7 On	M283
291	Marker Offset 7 Off	M282
292	Marker Offset 8 On	M285
293	Marker Offset 8 Off	M284

Unsupported ESSI Codes

ESSI Code	Description
103+Name	Stop Current Program/ Load New Program
237	X Sign Toggle
238	Y Sign Toggle
239	X and Y Swap and Toggle
266	Table 1 Select
267	Table 2 Select
268	Table 3 Select
269	Table 4 Select
276	Internal Variable Load
277	External Variable Load
278	X Axis Home
279	Y Axis Home
280	X Home Return
281	Y Home Return

The unsupported ESSI codes above are ignored when read. Some of these codes may be supported in the future. Any ESSI codes that are not listed above will result in a translator error upon loading the ESSI program.

ESSI Comments

Comments may be placed in to the part program to be displayed on screen and viewed by the operator. The comment line must first be preceded by a program stop command (EIA M00 code or ESSI 0 code).

- ESSI example:
  - 0 – Pauses Program
  - 3 – Start Comment
  - Comment – Text to be displayed
  - 4 – End Comment

Section 5
Advanced Feature Codes

Kerf Table Codes

Code	Description
G59 D1-200Xxx	Sets kerf table variable from 1 – 200
G41 D1-200	Enables Left Kerf using a Kerf Table variable
G42 D1-200	Enables Right Kerf using a Kerf Table variable
G43 D1-200	Changes current kerf value via Kerf Table using previously set left or right kerf

Special Kerf and G59 Code Settings

Kerf Override

By default, this option is enabled. If the parameter is disabled, all kerf value codes (G41 X, G42 X, G43 X, etc.) are ignored. The Load Kerf Table variable is also ignored. This parameter cannot be changed while the part program is paused.

G59 Code Override

By default, this option is enabled. If the parameter is disabled, all G59 codes are ignored. The parameter cannot be changed while the part program is paused.

Parallel Kerf Enable for Hole Center Piercing

This parameter allows the kerf to be enabled in parallel with the first segment of cut motion that follows the Enable Kerf command. Kerf location is interpolated in parallel with the first cut segment so that the kerf offset is reached by the end of the first cut segment. The overall effect on a radial lead-in is to turn it into a spiral lead-in. This parameter allows all current part programs and nests to take advantage of parallel kerf enable without being reposted by the host.

Users of Hypertherm CNCs now have an option to enable or disable this feature in the Cut Setup screen.

Tilt / Rotator Part Codes

Code	Description
G00 A*value*	Sets tilt angle as a preparatory command – A is the angle value in degrees
G00 XY*value* A*value*	Performs Linear Interpolation of Tilt angle along line segment.
G00 A*value* F*value*	Sets tilt angle – Angle value in degrees with a speed command in RPM
M28	Disables Follower
M29	Enables Follower
M90	Preparatory Cmd - Aligns Rotator to Tangent angle of next cut segment
M90-	Align rotator when not using shortest path motion
M75	A axis/Tilt Goto Home Cmd - Rapid Index
G00 Cxx	Move to rotate C position
G01 Cxx Fxx	Move to rotate C position with Speed “F” command
G00 C180-	Rotate Axis align 180 degrees will continue to rotate in the proper direction
G00 C-180-	Rotate Axis align -180 degrees will continue to rotate in the proper direction
G01 C180- Fxx	Rotate Axis align 180 degrees with speed
G01 C-180- Fxx	Rotate Axis align -180 degrees with speed

Station Select Codes

Stations (Lifter / THCs) can be selected and de-selected using the following EIA-274D program codes.

Code	Description
M19 T*value*	Cancel All Station Selections
M37 T*value*	Select Station 1-20 (Tvalue)
M38 T*value*	De-select Station 1-20 (Tvalue)

Additionally, these Station Select program codes can be overridden using the user selected THC inputs to the CNC. The feature to override the part program must be enabled at the Cutting Setup screen.

Process Select Codes

Process selections can be made using a EIA-274D program code in the following format.

Example: M36 Tx

- M36 = Select Process
- Tx = Process name, where:
  - T1 = Plasma Process 1
  - T2 = Plasma Process 2
  - T3 = Marker Process 1
  - T4 = Marker Process 2
  - T5 = Laser Process
  - T6 = Waterjet

Automatic Plate Alignment Codes

Three point alignment distance and speeds can be defined with the following EIA format program code:

G66D100B300C30

Where:

- G66 = 3-point alignment command
- Dxx= Distance between two plate edge reference points
- Bxx = Rapid feed rate for distance (D) motion
- Cxx = Slow feed rate for the distance to the edge

Automatic Torch Spacing

The automatic torch spacing feature uses part program codes and CNC outputs to position cutting stations for multiple torch cutting processes.

To enable Automatic Torch Spacing:

1. Choose Setups > Password > Machine Setups and choose ON for Automatic Torch Spacing. Save the values.
2. In the Cutting screen, under Status and Program Code, set Auto Torch Spacing Override to Enabled.

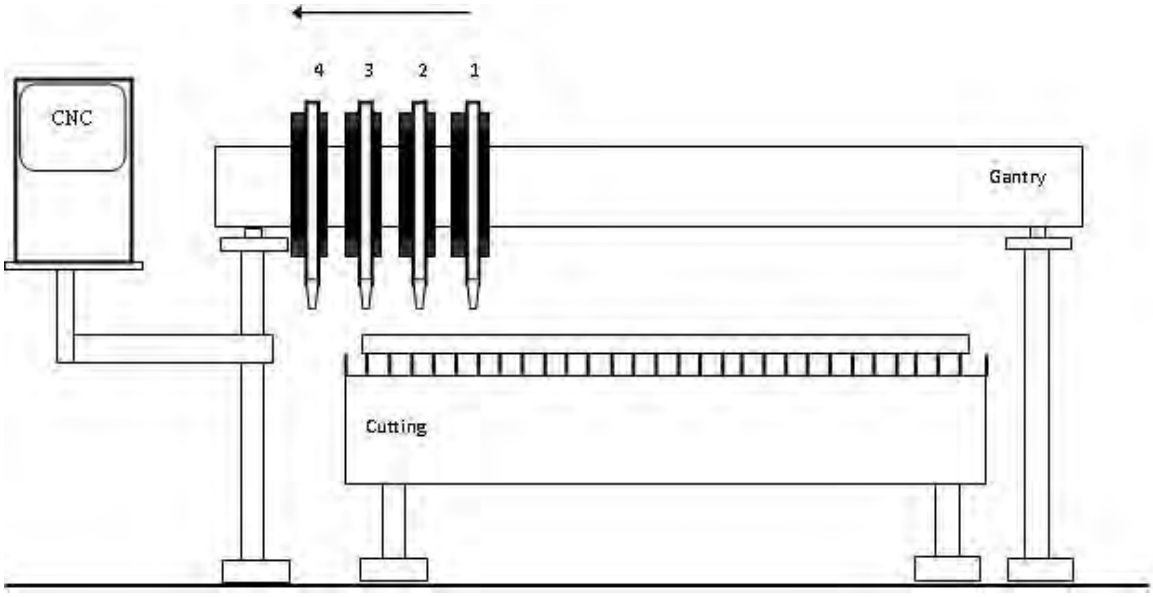
In this process, the primary torch station has a fixed mount to the transverse axis and the other secondary torch stations have the ability to clamp to the mechanics of the transverse axis during use or lock to the gantry or beam when not in use.

For the example, in the following illustration, Torch 1 is the primary station and Torch 2-4 are the secondary stations.

Typical use is as follows:

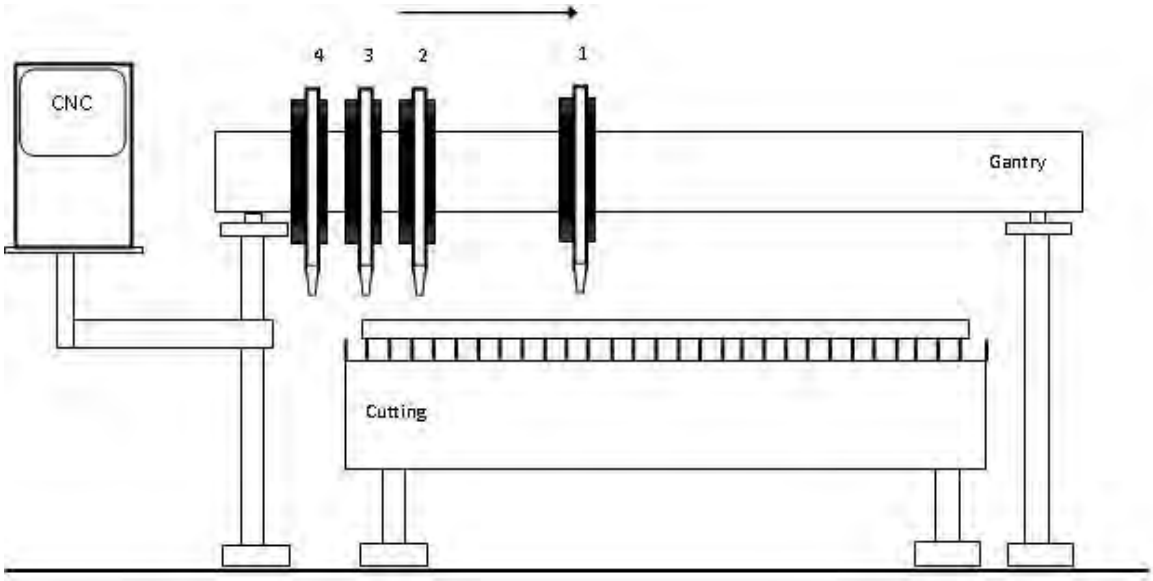
1. Unclamp and unlock all stations (except the first which is fixed and slides the others).

2. Go to Home Command on Transverse Axis (M77 or M78 depending on orientation).

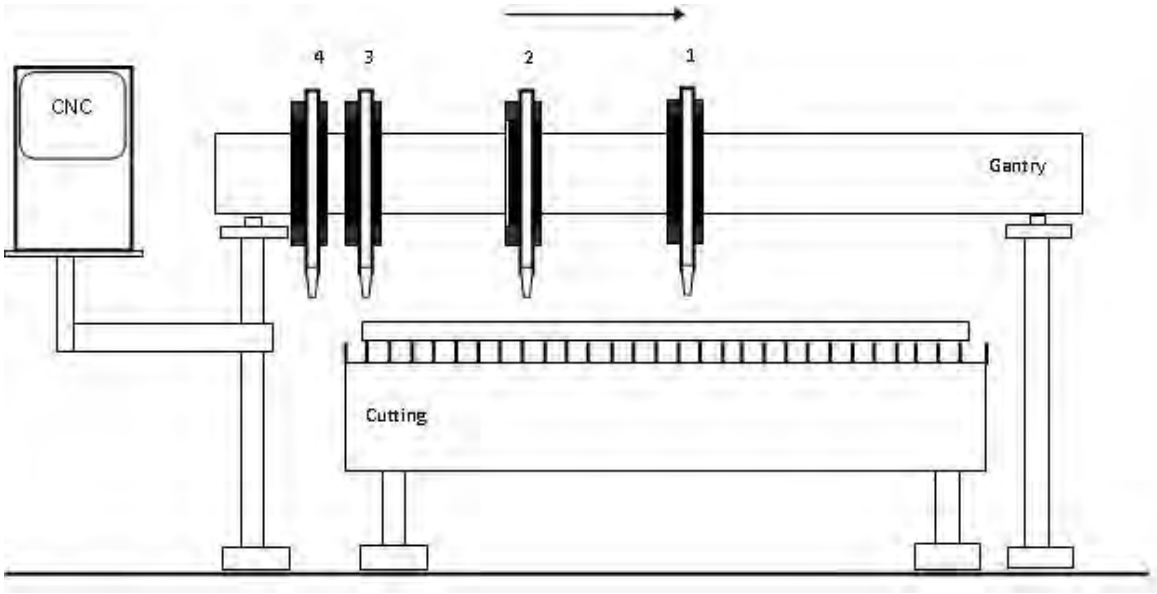


3. Clamp and Unlock all carriages and G00 index inward on transverse (optional command - may used to space all stations away from edge / OT switch of machine).

4. Lock and Unclamp all and G00 index to space first station (remember-first station has no clamping/locking on board).



5. Unlock and Clamp next station and G00 index to space the next station.



6. Repeat Step 5 until as many stations as needed are spaced.

Homing also automatically includes the commands necessary to push the stations to the side and lock or clamp them whenever the transverse is homed, if Auto Torch Spacing is enabled. Unclamp/ Clamp and Unlock / Lock commands execute a one second delay before moving.

Automatic Torch Spacing Program Codes

Code	Description
M32	Unclamp / Unlock All Stations
M33	Unclamp / Lock All Stations
M34	Clamp / Unlock All Stations
M34Txx	Clamp / Unlock T Station, where T = 1 through 19
M35	Clamp / Unlock All Stations Mirror
M35Txx	Clamp / Unlock Mirror T Station, where T = 1 through 19
M77	Go to Home position Y Axis
M78	Go to Home position X Axis
G00 Xxx Yx	Traverse command where x = value to move the desired axes a distance.

Automatic Torch Spacing I/O

Station Lock 1-19: Locks the unused torch station to the gantry or beam when not in use.

Station Clamp 1-19: Clamps the selected torch station to the transverse axis for standard cutting.

Station Mirror 1-19: Clamps the selected torch station to the transverse axis for mirrored cutting.

Example Part Program

The transverse axis is configured as the X axis.

Three station cut of 20 inch vertical rip.

Code	Description
G70	English Units
G91	Incremental Mode
G99 X1 Y0 I0 J0	Axes Preset zero Scaling
M32	Unclamp / Unlock All Stations
M78	Home X Axis (move all stations to Home position)
M34	Clamp All / Unlock All
G00X2Y0	Traverse X axis 2 inches (to move off edge/switch)
M33	Unclamp All / Lock All
G00X10Y0	Traverse X axis 10 inches (to set 10 inch space – station 1)
M34 T1	Clamp Station 1 / Unlock Station 1
G00X10Y0	Traverse X axis 10 inches (to set 10 inch space – station 2)
M34 T2	Clamp Station 2 / Unlock Station 2
G41	Left Kerf
M07	Cut On
G01 X0 Y20	Line segment (Y axis 20 inches)
M08	Cut Off
G40	Kerf Off
M02	End of Program

Dual Transverse without Beveling

Hypertherm supports dual transverse without beveling for cutting machines that have only SERCOS drives.

To set up this type of table:

1. A CNC must be enabled with 10 axes.
2. SERCOS drives should be set up with the following addresses (on the physical drives):
   - Address 1: Rail
   - Address 2: Transverse
   - Address 3: Dual Gantry
   - Address 4: Sensor THC1
   - Address 5: Dual Transverse
   - Address 6: Sensor THC2 (if a second THC is used)
3. After these addresses are set, enable dual transverse. From the Main screen, select Setups > Password and enter the NRT password (no rotate and tilt).

The NRT password allows the use of dual transverse axis without dual bevel axes systems. The RT password reverses this setup.

4. The measurement units (English or metric) that are used in the drives must match the units that are used in the CNC.
5. Park Dual Head 1 and Park Dual Head 2 are both required I/O points that must be assigned for either Park Dual Head 1 or Park Dual Head 2 to function.

Beveling

Hypertherm supports several software beveling options. The following sections describe the software beveling options available. Hypertherm does not support the mechanical design of bevel heads.

Contour Bevel Head for Oxyfuel Cutting (CBH)

The CBH axis supports a rotational motion bevel for oxyfuel cutting process. There is no tilting axis with CBH. The CBH axis is either set up on Axis 3 or Axis 4, depending on whether dual gantry or Sensor THC axes are enabled and assigned to Axis 3. The beveling codes M28, M29, M90, and M76 (described in the M and G Codes Used for Beveling section), can be used with CBH. A CBH axis cannot be defined when tilt rotator or dual tilt rotator axes are defined on the Machine Setups screen.

The program code M90 is typically used at the beginning of a part program to align the rotational axis before cutting begins. The M76 code is used at the end of the part program to bring the CBH back to its rotational home position.

Tilt Rotator Plasma Bevel

The tilt rotator is assigned to Axes 5 and 6 and supports plasma beveling. The preferred tilt rotator settings include No Scaled Rotator, No Dual Tilting Rotator and No Transformation. These are the simplest settings and work well for bevel mechanical designs in which the torch center point is directly in line with the tilt and rotate axes.

Some plasma bevel designs require that the rotator motion be scaled. The Scaled Rotator setting allows the rotational axis motion to be scaled directly by this parameter. It is the responsibility of the machine/bevel designer to determine the value for this setting, if it is required.

Some plasma bevel designs require dual tilting axes. Dual Tilting Mode 1 is used for most standard dual tilting systems where both tilt axes move through +/- 45 degrees to achieve the desired tilt and rotation motions. Mode 2 is a special form of dual tilting axis in which special equations control the motion. If Dual Tilting mode is needed, and special equations are needed, the machine/bevel designer must calculate and provide them. Hypertherm determines the amount of time that is required to add these equations to a new Dual Tilting mode for the customer.

Note that BACF, described in the Bevel Angle Change on the Fly (BACF) section, is not supported for dual tilting bevel designs. In addition, even though both axes are dual tilting, they are still referred to as rotate and tilt axes on all screens, as the effective motions are still rotation and tilt.

Some plasma bevel designs require a transformation of the rotate and tilt axes motion to achieve the proper motion. The transformation allows the torch to be at the correct bevel angle and orientation to the cut for the given bevel mechanical design. The machine/bevel designer must provide these equations if they are needed. Hypertherm determines the amount of time that is required to add these equations to a new Transformation mode for the customer. BACF, described in the Bevel Angle Change on the Fly (BACF) section, is supported for transformed bevel designs.

The beveling codes M28, M29, M90, M75, and M76, described in M and G Codes Used for Beveling, can be used with tilt rotator.

M90 is typically used at the beginning of the part to align the rotational axis before cutting begins. M75 and M76 are used at the end of the part to bring the tilt rotator back to its vertical home position.

Dual Tilt Rotator Plasma Bevel

The dual tilt rotator is assigned to Axes 8 and 9 and supports a second plasma beveling system. All of the settings described in the Tilt Rotator Plasma Bevel section also apply to the dual tilt rotator.

In addition, the dual tilt rotator can also have its own dual transverse axis assigned to Axis 7. When there is a dual transverse axis assigned, the two plasma bevel systems are homed to opposite sides of the machine. The dual transverse axis allows the two transverse axes to be independently parked and unparked, spaced, and mirrored to each other using the M84 through M92 commands described in M and G Codes Used for Beveling.

Include the following code sequences in your torch spacing part programs:

- M91Yxx – Moves Head 2 Yxx inches from Bevel Head 1
- M92Yxx – Moves Head 1 Yxx inches from Bevel Head 2

These spacing commands establish a relative spacing between the heads regardless of where the heads are actually located. Only one of these commands should be used at one time. If Head 1 needs to be at a specific position before head 2 is positioned in relation to Head 1, then the command sequence is:

- M89 – Park Head 2
- G01 Yxx – Move Head 1 to actual coordinate
- M88 – Unpark Head 2
- M91Yxx – Space Head 2 in relation to Head 1 by Yxx inches
- M02 – End Program – Used if this is a standalone Torch Spacing program

Likewise, if Head 2 needs to be at a specific position before Head 1 is positioned in relation to Head 2, then the command sequence is:

- M87 – Park Head 1
- G01 Yxx – Move Head 2 to actual coordinate
- M86 – Unpark Head 1
- M92Yxx – Space Head 1 from Head 2 by Yxx inches
- M02 – End Program – if this is a standalone torch spacing program

Bevel Angle Change on the Fly (BACF)

BACF allows the tilt axis to change position in parallel with X and Y motion, instead of only in a preparatory G00 'Axx' command. 'G01,02,03 X Y I J Axx' is supported for true rotate and tilt bevel mechanical designs. BACF is not supported for dual tilting bevel mechanical designs.

The 'Axx' command (where xx = the bevel angle) executes in parallel with X and Y motion. The A angle is reached at the end of the segment.

All BACF motions are only performed if the maximum speed of the appropriate axis is not exceeded by excess X and Y speed, or by Max Tilt or Rotator Max speeds that are too low.

M and G Codes Used for Beveling

The following lists of the M and G codes can be used for beveling.

Kerf Table Commands to Change Kerf During Multi-pass, Multi-bevel Cuts

G59 D(1-200) Xvalue: Sets the kerf table variable from 1-200

G41 D(1-200): Enables the left kerf using a kerf table variable

G42 D(1-200): Enables the right kerf using a kerf table variable

G43 D(1-200): Changes the current kerf value via kerf table using previously set left or right kerf

Tilt/Rotator Commands

G00 Aangle in degrees: Sets Tilt angle as a preparatory command

G01 X Y Aangle in degrees: Performs Tilt BACF

M28: Disables follower

M29: Enables follower

M90: Aligns rotator to tangent angle of next cut segment

M75: A axis/tilt go to home command - rapid index

M76: C axis/rotate go to home command - rapid index

Dual Tilt/Rotator Commands Used with Dual Plasma Bevel Systems

M84: Disable mirror Head 2

M85: Enable mirror Head 2

M86: Unpark Head 1

M87: Park Head 1

M88: Unpark Head 2

M89: Park Head 2

M91 Yxxxx: Space Head 2 xxxx millimeters

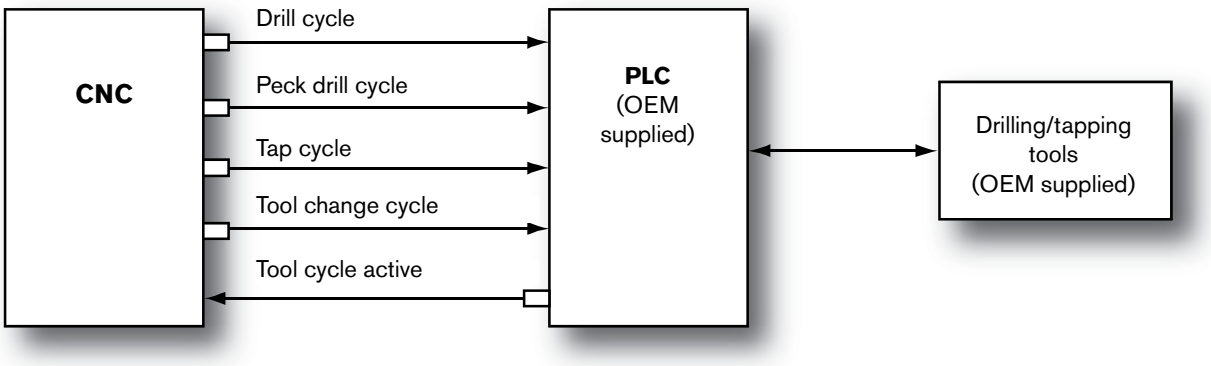
M92 Yxxxx: Space Head 1 xxxx millimeters

Tube cutting with bevel command

G00 or **G01 Px Ax Tx Sx Rx Xx or Yx** Rotate Transverse 2 axis for square or rectangular tube cutting.
P = +/- 180 degrees
A = Tilt angle
F = Rotational speed in RPM (optional *only* for G01. Not used for G00)
T = Top measurement of tube
S = Side measurement of tube
R = Corner radius, +/- 90 degrees
X or Y = Optional: Rail axis position

Drilling and Tapping using a PLC

Phoenix supports new program codes that turn on and off outputs to allow drilling and tapping with an external programmable logic control (PLC). The drill cycles can be included in a part program to be run on a multi-tool table.



After wiring is complete between the CNC and the PLC, assign the outputs and input in the Machine Setups > I/O screen. When the CNC reads one of the following codes in a part program, it activates the corresponding output.

Code	Output
M93	Drill cycle
M94	Peck drill cycle
M95	Tap cycle
M96	Tool change

Operation

- The CNC runs a part program and reads one of the tool cycle program codes.
- The CNC brings the gantry to a controlled stop and inhibits motion and then turns on the corresponding output.
- The PLC receives the input signal for one of the tool cycles and activates the Tool Cycle Active signal to the CNC.
- The CNC receives the Tool Cycle Active input from the PLC and waits.
- The PLC controls the operation of the drill during the tool cycle.
- The PLC turns off the Tool Cycle Active input when the tool cycle completes.
- The CNC turns off the tool cycle output and continues with the part program.

  Notes:

  - The CNC inhibits motion while the Tool Cycle Active input is on. When the input shuts off, motion immediately starts. You can use the Program Inhibit input if a pause is required or if motion restarts too abruptly. Turn on the Program Inhibit input with the Tool Cycle Active input. Turn off the Program Inhibit input after a short time delay after shutting off the Tool Cycle Active input. Using the Program Inhibit input creates a smoother motion transition than relying on the Tool Cycle Active input alone.
  - **Pausing or stopping with Tool Cycle Active input on:** When you press F10 to pause or stop the part program, the Pause screen appears. The CNC turns off the drill or tool change cycle output. When the part program resumes, the CNC re-executes the drill cycle M code *if* the machine hasn't been moved forward or backward on path. The CNC does not execute any X/Y motion until the drill cycle completes.
  - **Tool Cycle Active Input** must be off to move the machine or resume part program motion.
  - **Drill and Tool Change cycles** are not run in trial mode or when using Forward/Backup on Path on the Pause screen.
  - **Serial messaging** can be used can be used to issue tool change commands to a PLC before running the M codes. See the *Serial Messaging* section of the *Programmer's Reference Manual* for more information.

Sample code and description

The following sample code demonstrates the sequence of commands to drill a hole, then cut a 5 in (127 mm) square.

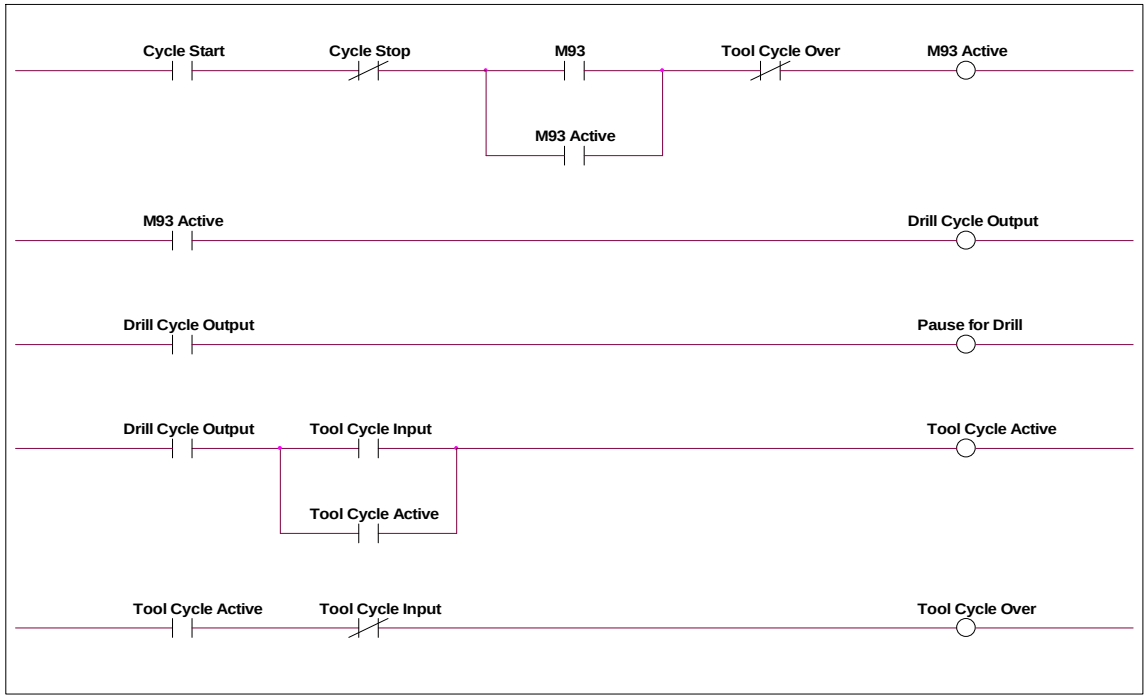
Note: The Marker Offset XY position is set in the Cutting screen (Choose Setups from the Main Screen). Marker Offset Off reverses the polarity of the position. For example, if Marker Offset is X+5 Y+5, then Marker Offset Off position would be X-5 Y-5.

Code	Description
G20	*English units*
G91	*Incremental mode*
M11	*Marker Offset On to reposition the torch and drill*
M93	*Drill Cycle*
M12	*Marker Offset Off to return torch and drill to original position.*
G00 X-2.5 Y-2.5	*Rapid Traverse to square*
G41	*Left kerf*
M07	*Cut control on*
G01 X0 Y5 G01 X5 Y0 G01 X0 Y-5 G01 X-5 Y0	*Cut out a square, 5 inches on each side*
M08	*Cut control off*
G40	*Kerf off*
M02	*End of part program*

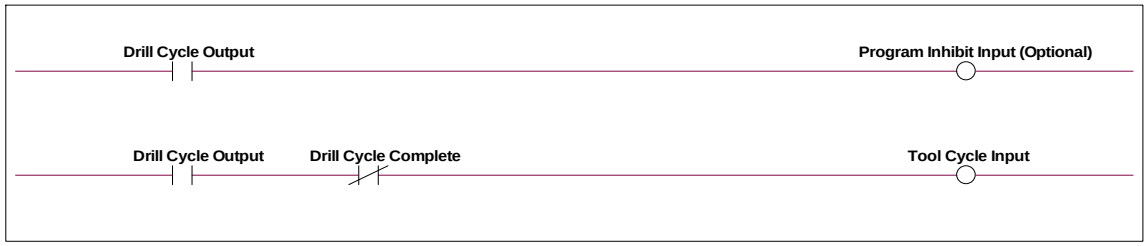
Ladder Logic Diagram of Drill Cycle

Ladder Logic Representation of the Drill Cycle

EDGE Pro



Extertnal PLC Logic



RACF – Rotate Angle Change on the Fly

RACF allows rotate angle change on the fly interpolated along with X, Y motion so that cuts can be made on more than one side of a square tube when it is rotated during the cut. The THC must be able to respond to the arc voltage fast enough during the tube rotation.

'G01,02,03 X Y I J Cxx' is the command that is used.

The transverse backs up or moves ahead to account for the change in part location due to the CBH or rotary axis tube rotation.

All Possible Axis Assignments

- Axis 1 – Transverse or Rail
- Axis 2 – Rail or Transverse
- Axis 3 – Dual Gantry, CBH or Sensor THC
- Axis 4 – CBH or Sensor THC
- Axis 5 – Rotate or Sensor THC
- Axis 6 – Tilt or Sensor THC
- Axis 7 – Dual Transverse or Sensor THC
- Axis 8 – Dual Rotate or Sensor THC
- Axis 9 – Dual Tilt or Sensor THC
- Axis 10 – Sensor THC
- Axis 11 – Sensor THC
- Axis 12 – Sensor THC

Special Passwords

NRT – No Rotate Tilt

The NRT password allows you to use a dual transverse axis without physically having the tilt rotator and dual tilt rotator drives and motors. The Tilt Rotator Axes screens are still visible, but are not used. They are typically used when non-bevel 2-torch servo spacing with vertical cutting is needed with a dual transverse. This password remains in effect after the CNC is powered off.

RT – Rotate Tilt

The RT password re-enables the use of the tilt rotator and dual tilt rotator drives and motors with a dual transverse system. This password is needed only if the NRT password has previously been used. This password remains in effect after the CNC is powered off.

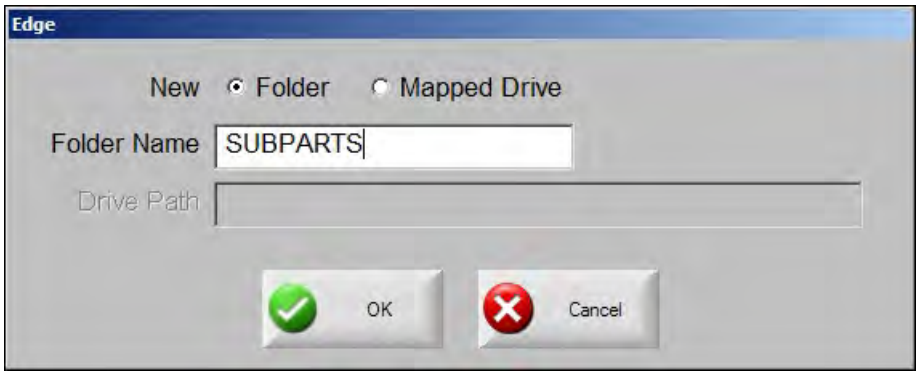
NSA – No SERCOS Axes

The NSA password allows a SERCOS ring to be phased up but does not phase up any SERCOS axes that are configured. This allows SERCOS I/O nodes or modules, such as Hypertherm I/O, Beckhoff, or Reco I/O modules to be tested without requiring the SERCOS drives to phase up. The password is temporary until the power on the CNC is cycled.

Section 6
Subparts

Subparts allow you to call and execute a separate part file within a part program using a simple line of text.

To configure a subroutine part for use, the user must first create a folder on the CNC hard drive named “SUBPARTS”. To create a folder on the hard drive, select Load From Disk. With the folder location highlighted, press the + key to create a new folder.



Save the part program in the SUBPARTS folder.

To execute the part, insert a line of code within the part program with the following format.

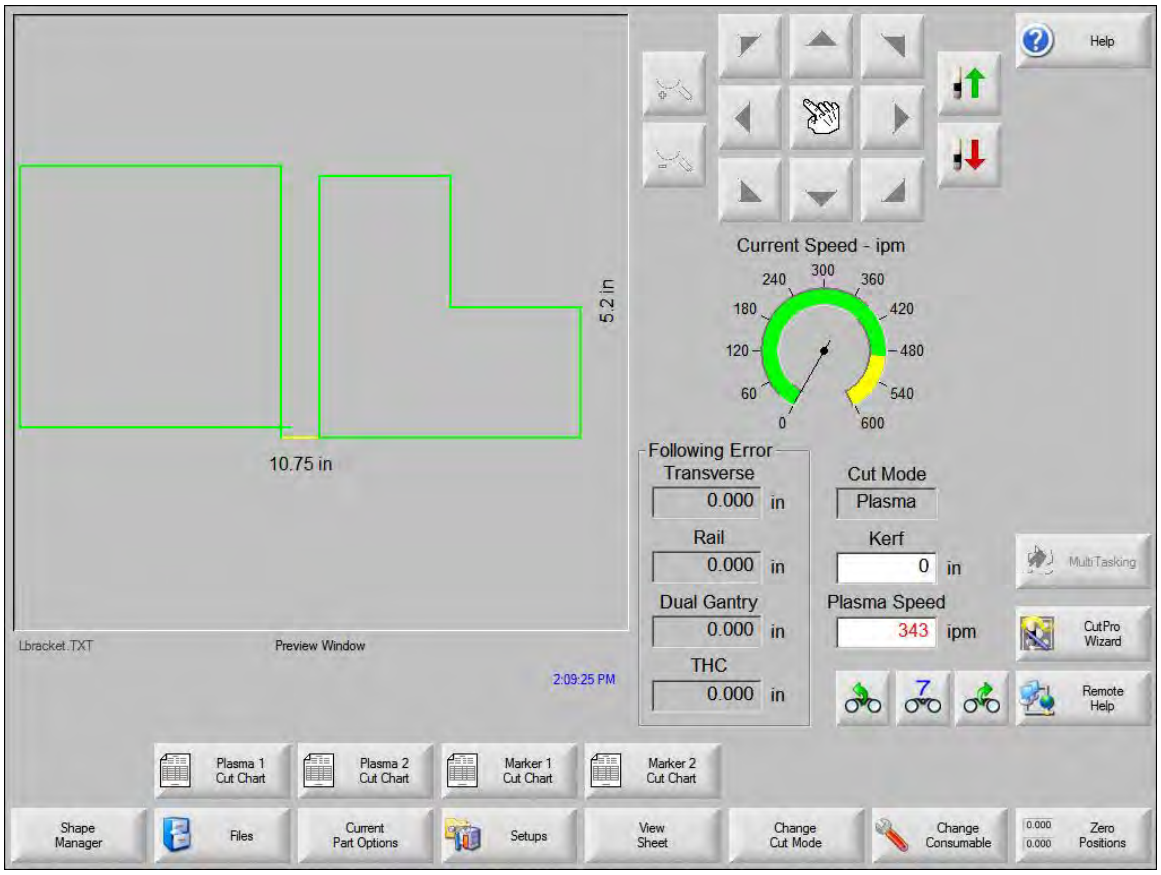
PFILENAME

Start the line of code with the letter P to indicate that a Sub Part is to be executed, followed by the filename for the desired part program.

For example, to execute subpart L-Bracket after completing a simple 5" x 5" square with a programmed traverse, the part program would look something like the following example:

```
(Rectangle - Piece)

G20

G91

G99 X1 Y0 I0 J0

G41

M07

G01 X-5.2 Y0

G01 X0 Y5

G01 X5 Y0

G01 X0 Y-5.2

M08

G00 X.75 Y0

PL-BRACKET

G40

M02
```

When it is executed, this program will be represented as the original part plus the additional subpart and will include the programmed traverse.



Note: Subparts can also contain subparts. After being translated by the CNC, the final text of the part will contain the complete text of the original part and subpart.

Section 7
Marker Font Generator

The Marker Font Generator feature can be used to label or identify parts with a marking device before cutting. This is accomplished by use of a simple command string within the part program code to call existing text characters (fonts) and execute marking of the selected text.

The program code uses a specific format and is structured to provide information to be used when marking. Information on the font source location, scale factor, angle, marker tool, tool offset and text are entered as information blocks in the command string. Each section or information block in the command string is separated by a space. The format of this command code is outlined as follows.

Note: If a value is not present for a specific information block, the default values will be used. The default values are:

Font (F): Internal

Angle (A): 0

Offset (O): #1

Scale (S): One

Marker (M): #1

Example of a simple command string:

<F2 S2 A45 M2 O2 <TEST 123>

Where:

<: The program command must begin with the "<" symbol to indicate that the Marker Font Generator feature is being used.

F: The first block of information is the Font Source location. The "F" is followed by a digit to indicate the location where the font is stored:

- 1 = an internal font in the control software
- 2 = a font located on the CNC hard drive

- 3 = a font from diskette or USB memory

  If no font is found at the selected location, the default internal font will be used. For the example given, the font location would be from the hard drive.

S: The second information block determines the scale of the text. The “S” is followed by a number that indicates the scale factor. For the example given, the scale factor is twice the original font dimensions.

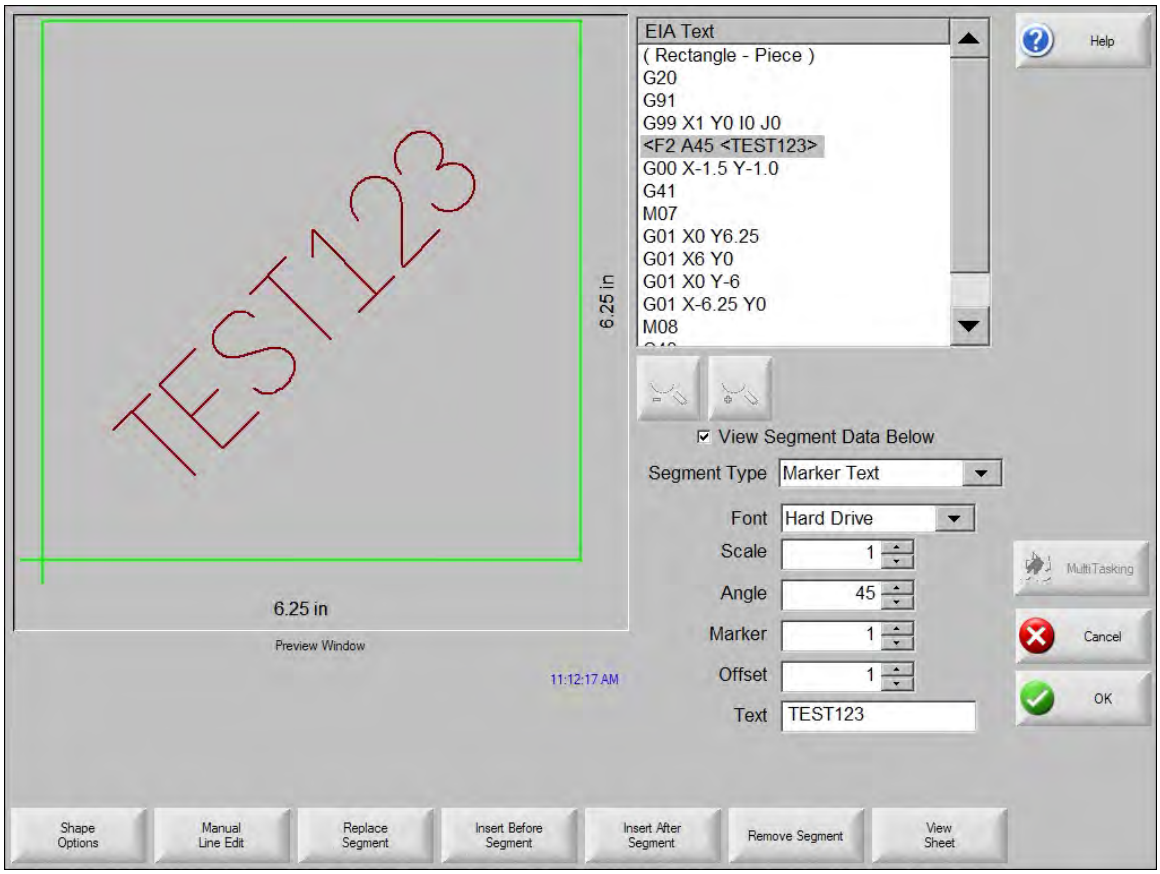
A: The third information block determines the angle of the text. The “A” is followed by a number that indicates the degree of angle. For the example given, the degree of the angle is 45.

M: The fourth information block determines the Marker Tool to be used. The “M” is followed by the number of the marker tool (Marker Enable Output) to be used. Up to two marker enables are supported.

O: The fifth information block determines which tool Offset to be used. The “O” is followed by a number indicates that one of the nine different tool offsets previously configured in control setups is to be used. The example shown indicates that tool offset number two should be used.

< >: The final information block is used to specify the marker text to be executed. The text must be enclosed in the “<” and “>” marks to be valid and understood as the selected text. For the example given, the marker text executed would be “TEST 123”

When the previous code example is translated by the CNC, it generates the Marker Text “TEST 123” onto the plate as shown here in ShapeWizard.



To improve the ease of use for the part program designer and control operator, the marker font generator always inserts a traverse segment to return to the original start point at the beginning of the marking text.

Internal Fonts

The internal fonts located within the control software are 1" high and are limited to characters available on the control keypad. Alphabetical characters are limited to upper case letters only.

External Fonts

External fonts can be loaded from a floppy disk or from the control hard drive. When the CNC generates the text, the CNC searches for part files to correspond to the selected character. The part file names must be based on their ASCII numeric equivalent and have a .txt file extension.

For example, for the marker text “Ab 12”, the control searches for the following files to generate the text:

Text	**ASCII No.**	**File Name**
Capital A	65	ASCII65.txt
Lower case b	98	ASCII98.txt
Space	32	ASCII32.txt
No 1	49	ASCII49.txt
No 2	50	ASCII50.txt

For more information on ASCII codes, refer to the “ASCII Codes” chapter.

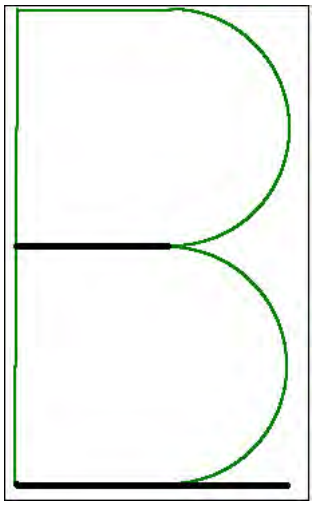
Font programs may be saved on the control hard drive by creating a folder labeled “Fonts” using the “Save to Disk” feature and saving the font programs within this folder. Remember, if a corresponding part file to text requested is not found at the selected source location, the internal font file will be used.

Custom Fonts

Custom fonts can be used when using the marker font generator. To construct these font files, certain guidelines should be adhered to.

- Programming format must be EIA.
- Only M09 and M10 can be used to enable and disable the marker.
- Only G00, G01, G02 and G03 codes can be used.
- The program must end in an M02.
- The proper file name must be assigned to the font program.
- The font program must begin in the lower left and end in the lower right.
- Font programs should have the consistent dimensional limits (i.e. 1' high, etc.).

Example: The letter “B” – File Name Ascii66.txt



M09

G01 X0 Y1

G01 X0.321429 Y0

G02 X0 Y-0.5 I0 J-0.25

G01 X-0.321429 Y0

M10

G00 X0.321429 Y0

M09

G02 X0 Y-0.5 I0 J-0.25

G01 X-0.321429 Y0

M10

G00 X0.571 Y0

M02

The darker lines in the drawing represent the Traverse segment, and the lighter lines represent the Marking lines. You can see by this illustration that at the end of the font program, a traverse is used to continue motion to the bottom right corner.

Note: The Burny 3/5 style of programming for the Marker Font Generator feature is also supported for the default internal font source.

Section 8
G59 Process Variables

Hypertherm CNCs provide cut charts for a variety of cutting processes: plasma, marker, laser, and waterjet. An operator can select a cut chart manually on the CNC, or the part program can issue codes that select the cut chart automatically.

Computer aided manufacturing (CAM) software places process variables, called *G59 codes*, in the part program to select the cut chart for a process. Using the process variables in the part program automates cut chart selection on the CNC. This section lists the G59 code and its variables and values supported by Hypertherm CNCs.

To use G59 codes in your part program, you must enable EIA G59 Code Override on the Cutting screen on the CNC.

G59 codes use the following format:

G59 Vxxx **F**xx

Where:

- G59 = Load a variable
- Vxxx = The variable type
- Fxx = The variable value
- xx or xxx = the number of digits for the F value. When the F value has a decimal, the value is represented as xx.x

Example: G59 V507 F33

Where:

V507 = Plasma 1 Material Thickness

F33 = 0.5 inch

Variable Types

The G59 code supports several variable types:

- V5xx selects the process and makes selections within the cut chart.
- V6xx selects plasma process parameters.
- V800 – V824 selects laser process parameters.
- V825 and up selects waterjet process parameters.

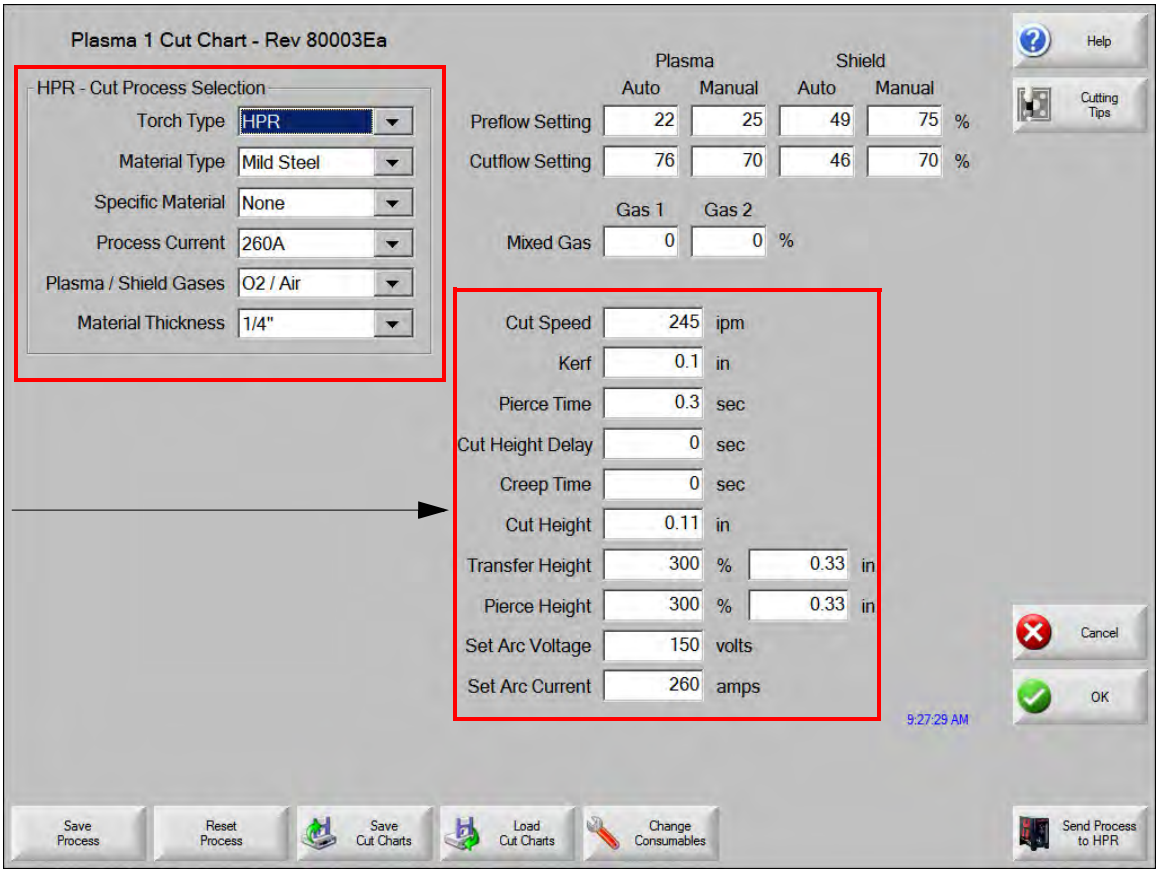
The value for each variable must be present in the cut chart on the CNC. For example, if the part program includes a G59 code with the material thickness variable with a value of ½ inch (G59 V507 F33) but the cut chart for that process does not include a material thickness of ½ inch, an "Invalid Process" error will display when the CNC loads the program. To clear the error, you must remove the unsupported code from the part program. For more information on resolving an "Invalid Process" or "Conflicting Process" errors, see the *Conflicting process* section of the *Phoenix V9Series Installation and Setup* manual.

In addition, V5xx variables must be issued in the part program in the same order that they are listed in the cut chart:

1. Torch Type
2. Material Type
3. Specific Material (optional)
4. Process Current
5. Plasma/Shield Gases
6. Material Thickness
7. Cutting Surface
8. Water Muffler (for some older plasma supplies)

V5xx codes select the cut chart

V6xx codes overwrite these settings after the cut chart has loaded



The V6xx variables override other parameters that are part of the cut chart, such as Arc Voltage, Cut Height, Pierce Time, and Marker Amperage. The V6xx variables are not required when using process variables to select a cut chart; they are only needed when overriding the values in the cut chart. For example, to change the value of Set Arc Voltage in the Plasma 1 process from 120 VDC in the cut chart, to 125 VDC, issue a G59 V600 F125 code in the part program.

Part program format

Hypertherm CNCs require that the G59 codes be in specific positions in the part program. Each cut in the part starts with an M07 (Cut On) and ends with the M08 (Cut Off). The M07 and M08 turn on the Cut Control output which activates the cutting tool.

- The G41 (Enable Left Kerf Compensation) or G42 (Enable Right Kerf Compensation) must immediately precede the M07.
- The G59 V5xx codes select the cut chart and must precede the G41 or G42 code. Once the program selects the cut chart, the V5xx codes do not need to be re-issued *unless* the program requires a change in process (a new cut chart).
- V6xx and V8xx codes are needed only when overriding a cut chart value.

Code	Description
G20	English units
G91	Incremental mode
G99 X1 Y0 I0 J0	Set part options
G59 V503 F1.00	Plasma 1 material type mild steel
G59 V504 F130	Plasma 1 current 130 A
G59 V505 F2	Plasma 1 plasma/shield gas O2/air
G59 V507 F33	Plasma 1 material thickness 1/2 inch
G59 V525 F27	Marker 1 plasma/shield gas air/air
G59 V658 F10	Override Marker 1 current, set to 10 A
M36 T3	Select Marker 1 process
M50	Disable torch height control
M09	Marker on
G03 X0 Y0 I0.5 J0	Counterclockwise arc
M10	Marker Off
M51	Enable torch height control
G00 X-0.75 Y-1.299	Rapid traverse
M36 T1	Select Plasma 1 process
G59 V600 F125	Override Plasma 1 arc voltage setting, set to 125 V
G41	Enable left kerf
M07	Cut on

Code	Description
G01 X0.176777 Y0.176777	Line
G02 X0 Y0 I1.06066 J1.06066	Clockwise arc
G01 X-0.1 Y0	Line
M08	Cut off
G40	Disable kerf
M02	End program

V5xx Variables

The following table lists the V5xx variable types. The G59 codes that contain these variables must be entered in the part program in the order they appear in the cut chart. Each variable type has a set of Fx values. The following sections list the values for each variable type.

Variable	Plasma 1	Plasma 2	Marker 1	Marker 2	Laser	Waterjet	Oxyfuel
Torch Type	V502	V512	V522	V532			V561
Material Type	V503	V513	V523	V533	V543	V553	V562
Process Current	V504	V514	V524	V534			
Plasma/Shield Gases	V505	V515	V525	V535			
Cutting Surface	V506	V516	V526	V536			
Material Thickness	V507	V517	V527	V537	V547	V557	V564
Water Muffler	V508	V518	V528	V538			
Power Setting					V544		
Assist Gas					V545		
Focal Length					V549		
Laser nozzle size					V550		
Orifice Size						V554	
Nozzle Size						V556	
Cut Pressure (waterjet)						V558	
Fuel Gas							V563
Tip Size							V565

Contact Hypertherm Technical Service for information about G59 codes for obsolete plasma supplies.

Torch type

Add the torch type values to the these variables:

V502 Plasma 1 torch type	V512 Plasma 2 torch type
V522 Marker 1 torch type	V532 Marker 2 torch type
V561 Oxyfuel torch type	

Example: G59 V512 F34 – Plasma 2, HPRXD torch.

F1 = MAX200	F2 = SE200	F3 = HT4400
F4 = FineLine200	F5 = FineLine100	F6 = LH2100S
F7 = LH2100T	F8 = LH2125S	F9 = LH2125T
F10 = PAC186	F11 = T80M	F12 = MAX100
F13 = MAX100D	F14 = ArcWriter	F15 = PAC620
F16 = PAC123	F17 = PAC125	F18 = T60M
F19 = T100M	F20 = HySpeed	F21 = HPR
F22 = LH1510S	F23 = LH1510T	F24 = LH1575S
F25 = LH1575T	F26 = FineLine260	F27 = FineCut
F28 = Spirit275	F29 = HSD	F30 = Spirit400
F31 = HPR Bevel	F32 = TDC_XT300	F33 = TDC_XT301
F34 = HPRXD	F35 = HPRXD Bevel	F36 = T45M
F37 = HPRXD Thick Pierce	F38 = LF150	F39 = HyPro2000
F40 = TDC_XT300 Bevel	F42 = M45 (Powermax45)	F43 = M65 (Powermax65)
F44 = M85 (Powermax85)	F45 = HyPro2000(Silver)	F46 = Duramax
F47 = Harris Model 80	F48 = Harris Model 98	F49 = Victor MT 200
F50 = Victor MT 300	F52 = M105 (Powermax105)	F53 = Low Speed FineCut
F54 = MAXPRO200	F55 = Duramax Hyamp	F56 = Dialine 281
F57 = Dialine 300	F58 = FineCut Hyamp	

Material type

Add one of the following material type values to these variables:

V503 Plasma 1 material type	V513 Plasma 2 material type
V523 Marker 1 material type	V533 Marker 2 material type
V543 Laser material type	V553 Waterjet material type
V562 Oxyfuel	

Add .xx for Specific Material. Some specific material values are used for specialized cut charts, such as True Hole®. Example: G59 V503 F1.01 – Plasma 1, mild steel, specific material 1.

F1 = Mild Steel	F1.99 = Mild Steel, True Hole (English or metric)	F1.97 Mild Steel, Fine Feature
F2 = Stainless Steel	F2.99 = Stainless Steel, HDi (inox)	F3 = Aluminum
F4 = Other	F5 = Brass	F6 = Copper

Plasma current

Add one of the following process current values to these variables:

V504 Plasma 1 current	V514 Plasma 2 current
V524 Marker 1 power current	V534 Marker 2 current

Example: G59 V514 F100 – Plasma 2, 100 A process current.

F5 = 5 A	F7 = 7 A	F8 = 8 A
F9 = 9 A	F10 = 10 A	F15 = 15 A
F18 = 18 A	F20 = 20 A	F22 = 22 A
F25 = 25 A	F30 = 30 A	F35 = 35 A
F40 = 40 A	F45 = 45 A	F50 = 50 A
F55 = 55 A	F60 = 60 A	F65 = 65 A
F70 = 70 A	F80 = 80 A	F85 = 85 A
F100 = 100 A	F105 = 105 A	F125 = 125 A
F130 = 130 A	F150 = 150 A	F200 = 200 A
F260 = 260 A	F275 = 275 A0	F300 = 300 A

F340 = 340 A	F400 = 400 A	F500 = 500 A
F600 = 600 A	F760 = 760 A	F800 = 800 A
F1000 = 1000 A	F1500 = 1500 A	F2000 = 2000 A
F2500 = 2500 A	F3000 = 3000 A	F3500 = 3500 A
F4000 = 4000 A	F4500 = 4500 A	F5000 = 5000 A
F5500 = 5500 A	F6000 = 6000 A	

Plasma/shield gas or Laser assist gas

Add one of the following gas selection values to these variables:

V505 Plasma 1 plasma/shield gas	V515 Plasma 2 plasma/shield gas
V525 Marker 1 plasma/shield gas	V535 Marker 2 plasma/shield gas
V545 Laser assist gas	

Example: G59 V505 F2 – Plasma 1, O2 plasma gas and air shield gas

F1 = Air/Air	F2 = O2/Air	F3 = O2/O2
F4 = N2/Air	F5 = N2/CO2	F6 = None/N2
F7 = O2/N2	F8 = CH4 / N2	F9 = H35/N2
F10 = H5/N2	F11 = Air/N2	F12 = N2/N2
F13 = CO2/N2	F14 = None/Air	F15 = CH4/Air
F16 = O2-N2/Air	F17 = O2-N2/O2	F18 = O2
F19 = N2	F20 = N2/None	F21 = Air
F22 = F5/N2	F23 = H35&N2/N2	F24 = H17/N2
F25 = Ar/Ar	F26 = Air/Ar	F27 = Ar/Air

Cutting surface

Add one of the following cutting surface values to these variables:

V506 Plasma 1 cutting surface	V516 Plasma 2 cutting surface
V526 Marker 1 cutting surface	V536 Marker 2 cutting surface

Example: G59 V536 F2 – Marker 2, cutting 3 inches below water.

- 1 = Above water
- 2 = 3 inches below water

Material Thickness

Add one of the following material thickness values to these variables:

V507 Plasma 1 material thickness	V517 Plasma 2 material thickness
V527 Marker 1 material thickness	V537 Marker 2 material thickness
V547 Laser material thickness	V557 Waterjet material thicknesse
V564 Oxyfuel material thickness	

Example: G59 V507 F14 – Plasma 1, 1 mm thick.

The following table shows material thickness values sorted by the metric (decimal) thickness. To look up a material thickness by the Fxx value, see the table beginning on page 102.

Metric (Decimal)	Gauge and Fraction	Fx
None	None	1
0.35 mm (0.015 in.)	28 GA	2 or 3
0.40 mm (0.016 in.)	27 GA	4 or 5
0.50 mm (0.018 in.)	26 GA	6 or 7
0.55 mm (Metric only)	25 GA	100
0.60 mm (0.024 in.)	24 GA	8 or 9
0.70 mm (Metric only)	23 GA	101
0.80 mm (0.030 in.)	22 GA	10 or 11
0.90 mm (0.036 in.)	20 GA	12 or 13
1 mm (0.040 in.)	19 GA	14

Metric (Decimal)	Gauge and Fraction	Fx
1.2 mm (0.048 in.)	18 GA	15 or 16
1.5 mm (0.060 in.)	16 GA	17 or 18
1.6 mm (0.063 in.)	1/16 in.	19
2 mm (0.075 in.)	14 GA	20 or 21
2.2 mm (0.090 in.)	13 GA	47
2.4 mm (Metric only)	3/32 in.	22
2.5 mm (0.105 in.)	12 GA	23 or 24
3 mm (0.120 in.)	11 GA	48
3.2 mm (0.125 in.)	1/8 in.	25
3.5 mm (0.135 in.)	10 GA	26 or 27
3.8 mm (0.150 in.)	9 GA	49
4 mm (0.164 in.)	8 GA	52
4.5 mm (0.180 in.)	7 GA	50
4.8 mm (0.188 in.)	3/16 in.	28
5 mm (0.194 in.)	6 GA	53
5.5 mm (0.210 in.)	5 GA	51
6 mm (0.25 in.)	1/4 in.	29
7 mm (Metric only)	9/32 in.	102
8 mm (0.313 in.)	5/16 in.	30
9 mm (Metric only)	11/32 in.	92
10 mm (0.375 in.)	3/8 in.	31
11 mm (0.438 in.)	7/16 in.	32
12 mm (0.5 in.)	1/2 in.	33
13 mm (Metric only)	17/32 in.	103
14 mm (0.563 in.)	9/16 in.	34
15 mm (Metric only)	19/32 in.	93
16 mm (0.625 in.)	5/8 in.	35
17 mm (Metric only)	11/16 in.	104

Metric (Decimal)	Gauge and Fraction	Fx
18 mm (Metric only)	23/32 in.	105
19 mm (0.75 in.)	3/4 in.	36
20 mm (Metric only)	25/32 in.	106
21 mm (Metric only)	13/16 in.	107
22 mm (0.875 in.)	7/8 in.	37
23 mm (Metric only)	29/32 in.	98
24 mm (Metric only)	15/16 in.	108
25 mm (1 in.)	1 in.	38
26 mm (Metric only)	1-1/32 in.	109
27 mm (Metric only)	1-1/16 in.	110
28 mm (Metric only)	1-3/32 in.	94
29 mm (1.125 in.)	1-1/8 in.	39
30 mm (Metric only)	1-3/16 in.	111
31 mm (Metric only)	1-7/32 in.	112
32 mm (1.25 in.)	1-1/4 in.	40
33 mm (Metric only)	1-5/16 in.	113
34 mm (Metric only)	1-11/32 in.	114
35 mm (Metric only)	1-3/8 in.	41
36 mm (Metric only)	1-7/16 in.	99
37 mm (Metric only)	1-15/32 in.	115
38 mm (1.5 in.)	1-1/2 in.	42
40 mm (Metric only)	1-5/8 in.	54
44 mm (Metric only)	1-23/32 in.	95
45 mm (1.75 in.)	1-3/4 in.	43
48 mm (Metric only)	1-7/8 in.	55
50 mm (2 in.)	2 in.	44
55 mm (Metric only)	2-1/8 in.	56
58 mm (Metric only)	2-9/32 in.	96

Metric (Decimal)	Gauge and Fraction	Fx
60 mm (2.25 in.)	2-1/4 in.	45
64 mm (2.5 in.)	2-1/2 in.	46
65 mm (Metric only)	2-9/16 in.	97
70 mm (2.75 in.)	2-3/4 in.	57
75 mm (3 in.)	3 in.	58
80 mm (Metric only)	3-1/8 in.	59
85 mm (3.25 in.)	3-1/4 in.	60
90 mm (3.5 in.)	3-1/2 in.	61
95 mm (3.75 in.)	3-3/4 in.	62
100 mm (4 in.)	4 in.	63
105 mm (Metric only)	4-1/8 in.	64
110 mm (4.25 in.)	4-1/4 in.	65
115 mm (4.5 in.)	4-1/2 in.	66
120 mm (4.75 in.)	4-3/4 in.	67
125 mm (5 in.)	5 in.	68
130 mm (Metric only)	5-1/8 in.	69
135 mm (5.25 in.)	5-1/4 in.	70
140 mm (5.5 in.)	5-1/2 in.	71
145 mm (5.75 in.)	5-3/4 in.	72
150 mm (6 in.)	6 in.	73
155 mm (Metric only)	6-1/8 in.	74
160 mm (6.25 in.)	6-1/4 in.	75
165 mm (6.5 in.)	6-1/2 in.	76
170.0 mm (6.75 in.)	6-3/4 in.	77
180 mm (Metric only)	7-1/8 in.	79
185 mm (7.25 in.)	7-1/4 in.	80
190.0 mm (7.5 in.)	7-1/2 in.	81
195 mm (7.75 in.)	7-3/4 in.	82

Metric (Decimal)	Gauge and Fraction	Fx
200 mm (8 in.)	8 in.	83
215 mm (8.5 in.)	8-1/2 in.	84
230 mm (9 in.)	9-in.	85
240 mm (9.5 in.)	9-1/2 in.	86
255 mm (10 in.)	10 in.	87
265 mm (10.5 in.)	10-1/2 in.	88
280 mm (11 in.)	11 in.	89
290 mm (11.5 in.)	11-1/2 in.	90
305 mm (12 in.)	12 in.	91
7 in. (English only)	7 in.	78

The following table shows material thicknesses by Fx value.

Fx	Metric (Decimal)	Gauge and Fraction
1	None	None
2 or 3	0.35 mm (0.015 in.)	28 GA
4 or 5	0.40 mm (0.016 in.)	27 GA
6 or 7	0.50 mm (0.018 in.)	26 GA
8 or 9	0.60 mm (0.024 in.)	24 GA
10 or 11	0.80 mm (0.030 in.)	22 GA
12 or 13	0.90 mm (0.036 in.)	20 GA
14	1 mm (0.040 in.)	19 GA
15 or 16	1.2 mm (0.048 in.)	18 GA
17 or 18	1.5 mm (0.060 in.)	16 GA
19	1.6 mm (0.063 in.)	1/16 in.
20 or 21	2 mm (0.075 in.)	14 GA
22	2.4 mm (Metric only)	3/32 in.
23 or 24	2.5 mm (0.105 in.)	12 GA
25	3.2 mm (0.125 in.)	1/8 in.

Fx	Metric (Decimal)	Gauge and Fraction
26 or 27	3.5 mm (0.135 in.)	10 GA
28	4.8 mm (0.188 in.)	3/16 in.
29	6 mm (0.25 in.)	1/4 in.
30	8 mm (0.313 in.)	5/16 in.
31	10 mm (0.375 in.)	3/8 in.
32	11 mm (0.438 in.)	7/16 in.
33	12 mm (0.5 in.)	1/2 in.
34	14 mm (0.563 in.)	9/16 in.
35	16 mm (0.625 in.)	5/8 in.
36	19 mm (0.75 in.)	3/4 in.
37	22 mm (0.875 in.)	7/8 in.
38	25 mm (1 in.)	1 in.
39	29 mm (1.125 in.)	1-1/8 in.
40	32 mm (1.25 in.)	1-1/4 in.
41	35 mm (Metric only)	1-3/8 in.
42	38 mm (1.5 in.)	1-1/2 in.
43	45 mm (1.75 in.)	1-3/4 in.
44	50 mm (2 in.)	2 in.
45	60 mm (2.25 in.)	2-1/4 in.
46	64 mm (2.5 in.)	2-1/2 in.
47	2.2 mm (0.090 in.)	13 GA
48	3 mm (0.120 in.)	11 GA
49	3.8 mm (0.150 in.)	9 GA
50	4.5 mm (0.180 in.)	7 GA
51	5.5 mm (0.210 in.)	5 GA
52	4 mm (0.164 in.)	8 GA
53	5 mm (0.194 in.)	6 GA
54	40 mm (Metric only)	1-5/8 in.

Fx	Metric (Decimal)	Gauge and Fraction
55	48 mm (Metric only)	1-7/8 in.
56	55 mm (Metric only)	2-1/8 in.
57	70 mm (2.75 in.)	2-3/4 in.
58	75 mm (3 in.)	3 in.
59	80 mm (Metric only)	3-1/8 in.
60	85 mm (3.25 in.)	3-1/4 in.
61	90 mm (3.5 in.)	3-1/2 in.
62	95 mm (3.75 in.)	3-3/4 in.
63	100 mm (4 in.)	4 in.
64	105 mm (Metric only)	4-1/8 in.
65	110 mm (4.25 in.)	4-1/4 in.
66	115 mm (4.5 in.)	4-1/2 in.
67	120 mm (4.75 in.)	4-3/4 in.
68	125 mm (5 in.)	5 in.
69	130 mm (Metric only)	5-1/8 in.
70	135 mm (5.25 in.)	5-1/4 in.
71	140 mm (5.5 in.)	5-1/2 in.
72	145 mm (5.75 in.)	5-3/4 in.
73	150 mm (6 in.)	6 in.
74	155 mm (Metric only)	6-1/8 in.
75	160 mm (6.25 in.)	6-1/4 in.
76	165 mm (6.5 in.)	6-1/2 in.
77	170.0 mm (6.75 in.)	6-3/4 in.
78	7 in. (English only)	7 in.
79	180 mm (Metric only)	7-1/8 in.
80	185 mm (7.25 in.)	7-1/4 in.
81	190.0 mm (7.5 in.)	7-1/2 in.
82	195 mm (7.75 in.)	7-3/4 in.

Fx	Metric (Decimal)	Gauge and Fraction
83	200 mm (8 in.)	8 in.
84	215 mm (8.5 in.)	8-1/2 in.
85	230 mm (9 in.)	9-in.
86	240 mm (9.5 in.)	9-1/2 in.
87	255 mm (10 in.)	10 in.
88	265 mm (10.5 in.)	10-1/2 in.
89	280 mm (11 in.)	11 in.
90	290 mm (11.5 in.)	11-1/2 in.
91	305 mm (12 in.)	12 in.
92	9 mm (Metric only)	11/32 in.
93	15 mm (Metric only)	19/32 in.
94	28 mm (Metric only)	1-3/32 in.
95	44 mm (Metric only)	1-23/32 in.
96	58 mm (Metric only)	2-9/32 in.
97	65 mm (Metric only)	2-9/16 in.
98	23 mm (Metric only)	29/32 in.
99	36 mm (Metric only)	1-7/16 in.
100	0.55 mm (Metric only)	25 GA
101	0.70 mm (Metric only)	23 GA
102	7 mm (Metric only)	9/32 in.
103	13 mm (Metric only)	17/32 in.
104	17 mm (Metric only)	11/16 in.
105	18 mm (Metric only)	23/32 in.
106	20 mm (Metric only)	25/32 in.
107	21 mm (Metric only)	13/16 in.
108	24 mm (Metric only)	15/16 in.
109	26 mm (Metric only)	1-1/32 in.
110	27 mm (Metric only)	1-1/16 in.

Fx	Metric (Decimal)	Gauge and Fraction
111	30 mm (Metric only)	1-3/16 in.
112	31 mm (Metric only)	1-7/32 in.
113	33 mm (Metric only)	1-5/16 in.
114	34 mm (Metric only)	1-11/32 in.
115	37 mm (Metric only)	1-15/32 in.

Water Muffler

Add one of the following water muffler values to these variables:

V508 Plasma 1 water muffler	V518 Plasma 2 water muffler
V528 Marker 1 water muffler	V538 Marker 2 water muffler

Example: G59 V508 F1 – Plasma 1, water muffler installed.

- F1 = Installed
- F2 = Not installed

Laser power setting

Add one of the following power values to the variable V544, Laser power setting.

Example: G59 V544 F2500 – Laser, 2500 W power setting.

F500 = 500 W	F1000 = 1000 W	F1500 = 1500 W
F2000 = 2000 W	F2500 = 2500 W	F3000 = 3000 W
F3500 = 3500 W	F4000 = 4000 W	F4500 = 4500 W
F5000 = 5000 W	F5500 = 5500 W	F6000 = 6000 W

Laser focal length

Add one of the following torch type values to the variable V549, Laser focal length.

Example: G59 V549 F6 – Laser, 12.5-inch focal length.

F1 = 2.5 in.	F2 = 5 in.	F3 = 5.9 in.
F4 = 7.5 in.	F5 = 10 in.	F6 = 12.5 in.
F7 = 15 in.		

Laser nozzle size

Add one of the following nozzle size values to the variable V550.

Example: G59V550 F2 – Laser, 1.0 mm FAST nozzle size.

F1 = 1.0mm	F2 = 1.0 mm FAST	F19 = 1.2 mm
F20 = 1.2 mm FAST	F3 = 1.5 mm	F4 = 1.5 mm FAST
F5 = 2.0 mm	F6 = 2.0 mm FAST	F7 = 2.5 mm
F8 = 2.5 mm FAST	F9 = 3.0 mm FAST	F10 = 3.0mm FAST
F11 = 3.5mm	F12 = 3.5mm FAST	F13 = 4.0mm
F14 = 4.0mm FAST	F15 = 4.5mm	F16 = 4.5mm FAST
F17 = 5.0mm	F18 = 5.0mm FAST	

Waterjet nozzle size

Add one of the following orifice size values to the variable V556.

Example: G59 V556 F30 – Waterjet, 0.030 inch nozzle

F30 = 0.03 in.	F40 = 0.04 in.

Waterjet orifice size

Add one of the following orifice size values to the variable V554.

Example: G59 V554 F10 – Waterjet, 0.010 inch orifice.

F10 = 0.010 inch	F11 = 0.011 inch	F12 = 0.012 inch
F14 = 0.014 inch	F16 = 0.016 inch	

Waterjet cut pressure

For waterjet cut pressure add F60000 to the variable V558.

Example: G59 V558 F60000 – Waterjet, cut pressure 60000 psi

Fuel gas for Oxyfuel

Add one of the following torch type values to the variable V563.

Example: G59 V512 F2 – Oxyfuel, Propane fuel

F1 = Acetylene	F2 = Propane	F3 = Natural Gas
F4 = Propylene	F5 = Mapp	

Oxyfuel tip size

Add one of the following torch type values to the variable V565.

Example: G59 V565 F3 – Oxyfuel, 4/0 tip size.

F1 = 5/0	F2 = 5/0 ½	F3 = 4/0
F4 = 4/0 ½	F5 = 000	F6 = 000 ½
F7 = 00	F8 = 00 ½	F9 = 0
F10 = 0 ½	F11 = 1	F12 = 1 ½
F13 = 2	F14 = 2 ½	F15 = 3
F16 = 3 ½	F17 = 4	F18 = 4 ½
F19 = 5	F20 = 5 ½	F21 = 6
F22 = 6 ½	F23 = 7	F24 = 7 ½
F25 = 8	F26 = 8 ½	F27 = 9
F28 = 9 ½	F29 = 10	F30 = 10 ½
F31 = 11	F32 = 11 ½	F33 = 12

V6xx plasma variables

Use the following G59 V6xx variables to select process parameters that govern torch height control.

Plasma 1 Variables

Variable	Name	Range for Fx	Example
V600	Plasma 1 Set Arc Voltage	10 to 300 volts	F132
V601	Plasma 1 Pierce Time	0 to 9 seconds	F0.5
V602	Plasma 1 Pierce Height Factor	50 to 400 %	F200
V603	Plasma 1 Cut Height	0 to 1 in. (0 to 25.4 mm)	F0.13 (inch)
V604	Plasma 1 Transfer Height Factor	50 to 400%	F200
V605	Plasma 1 Cut Height Delay	0 to 5 seconds	F2.00
V606	Plasma 1 Kerf Detect Reacquire Time (Sensor THC only)	0 to 10 seconds	F3.00
V607	Plasma 1 Mode Select	F1 = Manual F2 = Auto	F2
V608	Plasma 1 Arc Current	Amperage depends on plasma system	
V613	Plasma 1 AVC Delay	0 to 10 seconds	F2.25

Plasma 2 Variables

Variable	Name	Range for Fx	Example
V625	Plasma 2 Set Arc Voltage	10 to 300 volts	F250.00
V626	Plasma 2 Pierce Time	0 to 9 seconds	F8.50
V627	Plasma 2 Pierce Height Factor	50 to 400 %	F200.00
V628	Plasma 2 Cut Height	0 to 1 in. (0 to 25.4 mm)	F0.75
V629	Plasma 2 Transfer Height Factor	50 to 400 %	F200.50
V630	Plasma 2 Cut Height Delay	0 to 5 seconds	F2.00
V631	Plasma 2 Kerf Detect Reacquire Time (Sensor THC only)	0 to 10 seconds	F5.25
V632	Plasma 2 Mode Select	F1 = Manual F2 = Auto	F2
V633	Plasma 2 Arc Current	Depends on plasma system	
V638	Plasma 2 AVC Delay	0 to 10 seconds	F2.25

Marker 1 Variables

Variable	Name	Range for Fx	Example
V650	Marker 1 Set Arc Voltage	10 to 300 volts	F250.00
V652	Marker 1 Start Height Factor	50 to 400 %	F200.00
V653	Marker 1 Mark Height	0 to 1 in. (0 to 25.4mm)	F0.75
V657	Marker 1 Mode Select	F1 = Manual F2 = Auto	F2
V658	Marker 1 Arc Current	Amperage depends on plasma system	
V663	Marker 1 AVC Delay	0 to 10 seconds	F2.25

Marker 2 Variables

Variable	Name	Range for Fx	Example
V675	Marker 2 Set Arc Voltage	10 to 300 volts	F250.00
V677	Marker 2 Start Height Factor	50 to 400 %	F200.00
V678	Marker 2 Mark Height	0 to 1 in. (0 to 25.4 mm)	F0.75
V682	Marker 2 Mode Select	F1 = Manual F2 = Auto	F2
V683	Marker 2 Arc Current	Amperage depends on plasma system	
V688	Marker 2 AVC Delay	0 to 10 seconds	F2.25

V8xx laser variables

Use the following G59 V8xx variables to select process parameters for the HyIntensity Fiber Laser.

Note: The value of the V810 variable enables or disables the use of these V8xx variables in laser part programs.

Variable	Name	Range for Fxx	Example
V800	Pierce mode	0 = Blast 1 = Pulse	F0
V803	Cut power	To the maximum wattage of the laser supply	F1000
V804	Creep time	0 – 9.999 seconds	F7.5
V805	Cut height	0 – 50.8 mm (0 – 2 in.)	F1.5
V806	Cut pressure	0 – 6.9 bar (0 – 100 psig)	F5
V807	Pierce pressure	0 – 6.9 bar (0 – 100 psig)	F5
V808	Cut duty cycle	1 – 100%	F80
V809	Modulation rate	1 to 500 Hz	F250.00
V810	CAM control	F1 enables V8xx codes F0 disables V808 and V809 codes	F1
V811	Start corner power percentage	0 - 100%	F50
V812	Minimum corner power percentage	0 - 100%	F25
V813	Laser purge timer override	0 - 10 seconds	F5
V814	Laser mode	1 = Cutting 2 = Marking 3 = Vaporization 4 = Fine Feature	G59 V814 F0 Select laser cut mode.

V8xx waterjet variables

Use these variables to select process parameters for Hypertherm's HyPrecision™ waterjet systems.

Variable	Name	Range for Fx	Example
V825	Pierce Type	G59 V825 Fx Dx.x Tx.x Sx.x F1 = Dynamic F2 = Circular F3 = Wiggle F4 = Stationary Dx.xxx = Displacement, 0.254 – 25.4 mm (0.001 – 1.0 inch) ❑ Circle diameter for Circular pierce ❑ Segment length for Wiggle pierce Tx.x = Pierce time in seconds, 0 - 9999.99 Sxxx = Pierce speed 2.54 – 2540 mm/min (0.1 – 100 in/min)	G59 V825 F2 D0.1 T10 S10 Select Circular Pierce Type with a circle diameter of 0.1 inch for 10 seconds at 10 in/min.
V827	Low Pressure Pierce	G59 V827 Fx Tx.x Pxxxx F0 = OFF F1 = ON F2 = Maintain until next G59 V827, or a new cut chart is selected, or a new part program is loaded. Tx.x = Low pressure pierce time in seconds 0 - 9999.99 Pxxxxx = Pump pressure 10,000 psi to the cut pressure. All other G59 variables in the part program must come before G59 V827 F2 and the G04. Use G04 Xx Dwell for x seconds to allow the waterjet pump to transition to low pressure setting. Low pressure pierce time cannot exceed the time set for normal piercing. Low pressure cannot be set below 10,000 psi.	G59 V827 F1 T5 P30000 Low pressure pierce ON for 5 seconds at 30000 psi.

Variable	Name	Range for Fx	Example
V828	Cut Pressure	G59 V828 Fxxxxxx Fxxxxxx = pump pressure in psi At this time 60000 is the only valid cut pressure.	G59 V828 F60000 Cut pressure set to 60000 psi
V829	Pierce Motion Delay	G59 V829 Fx.x Fx.x = 0 - 9.99 seconds	G59 V829 F3 Delay pierce motion for 3 seconds after M07 Cut On.
V830	Abrasive On Delay	G59 V830 Fx.x or F-x.x Fx.x = -1.0 – 5.0 seconds	G59 V830 F3 Delay starting the abrasive flow for 3 seconds after M07 Cut On. G59 V830 F-1 Start the abrasive flow 1 second *before* the M07 Cut On.
V831	Abrasive Off Delay	G59 V831 Fx.x or F-x.x Fx.x = -1 - 9.99 seconds Abrasive Off Delay and Water Off Delay run concurrently.	G59 V831 F3 Delay turning off the abrasive flow for 3 seconds after M08 Cut Off. G59 V831 F-1 Turn off the abrasive flow 1 second *before* the M08 Cut Off.
V832	Water Off Delay	G59 V832 Fx.x or F-x.x Fx.x = - 1 – 9.99 seconds Abrasive Off Delay and Water Off Delay run concurrently.	G59 V832 F3 Delay turning off the water flow for 3 seconds after M08 Cut Off. G59 V832 F-1 Turn off the water flow 1 second *before* the M08 Cut Off.
V837	Cut Height	G59 V837 Fx.x Fx.x = 0.254 - 25.4 mm (0.01 - 1.0 inch)	G59 V837 F0.3 Set Cut Height to 0.3 inch.
V838	Waterjet Mode	G59 V838 Fx Fx = F1 – Q1 Rough F2 – Q2 Coarse F3 – Q3 Medium F4 – Q4 Smooth F5 – Q5 Fine F6 – Q6 Wet Run - No abrasive	G59 V838 F3 Set Waterjet Mode to Q3 Medium.

Section 9
Serial Messaging

The Serial Messaging feature may be used to pass commands embedded within a part program through a selected serial port to an external device. Both RS-232 and RS-422 are supported. TCP/ IP protocol is not supported at this time. There are 2 Serial Messaging ports available.

Overview

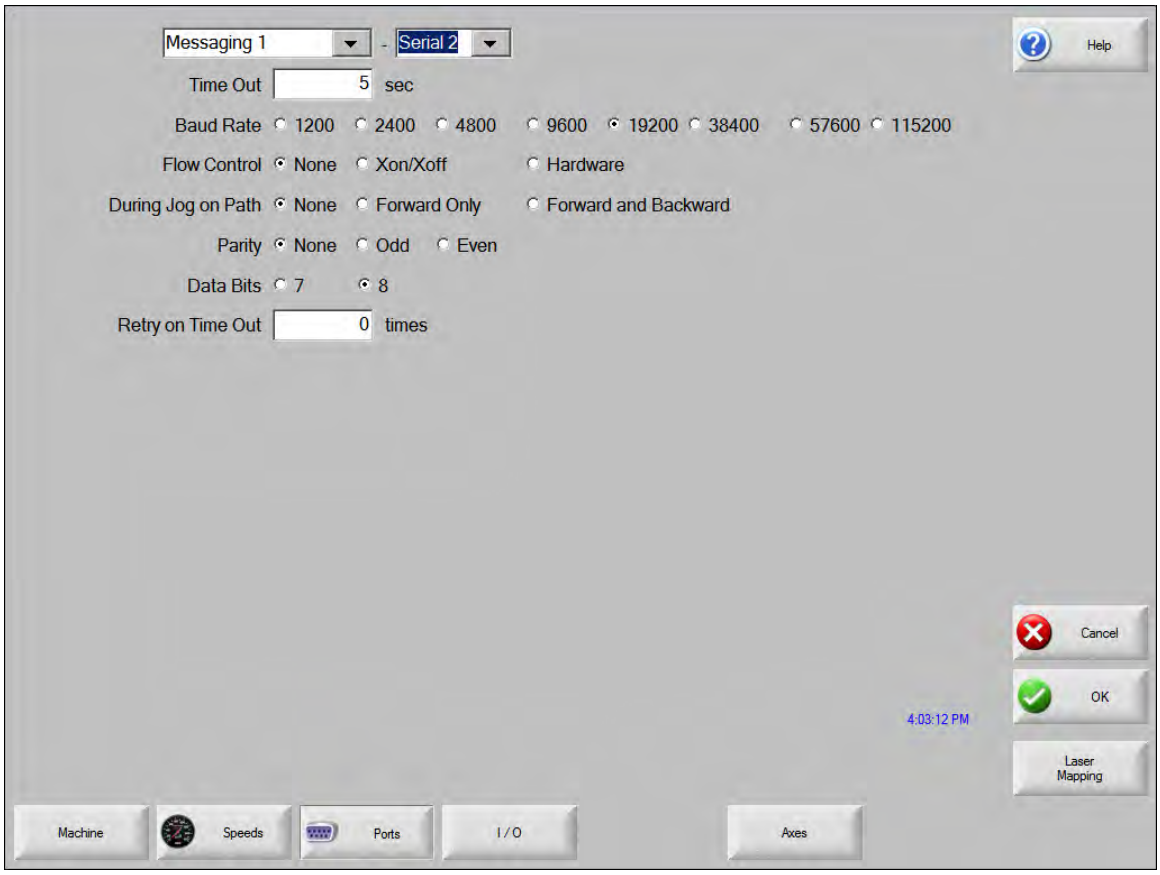
Serial Messaging has a fairly basic communication protocol that has three simple formats to send ASCII codes as command strings. During the messaging function, a status indicator for “Message Transmit”, “Message Delay” or “Message Verify” will be displayed in the Watch window.

Options

- While the selected message is sent to the external device, the part program will be temporarily suspended. After completion of the transmission, the part program will then automatically resume. No acknowledgement from the external device is required. An additional Time Delay may also be added.
- A message is sent concurrent to execution of the part program and no delay is encountered. No acknowledge is required. No Delay Time is allowed.
- The message is sent with a suspension of the program during transmission as in the first option, but an Acknowledge from the external device (ACK) is required before the part program can continue. A Non-Acknowledge (NAK) response from the external device will prompt a retransmit of the message from the control. An optional Time Out value may be added to the program code. If no Time Out code is used in the program code the Default time out value at the Ports setup screen will be used. Additionally, an optional automatic retry feature may be enabled at the Ports setup screen.

To enable use of this feature, assign Messaging to the selected port(s) at the Ports setup screen.

After you enable serial messaging, the flow control parameters that communicate with the external device must be selected.



The following parameters must be configured. Hardware and flow control configuration information must match the external device.

Time Out: The Time Out value may be used for the Message Type 22 (which requires an acknowledgement from the external device after the message) if there is no Time Out value used in the command string of the program code.

Baud Rate: Select a communication speed from 1200 to 115200 Baud.

Flow Control: Select to use None, Xon/Xoff or Hardware.

During Jog on Path: Select whether messages will be sent when jogging Forward or Backward on Path while at the Pause screen.

Note:

- All messaging will stop when the Stop Key has been pressed or the Remote Pause input becomes active.
- The Message Type 21 will transmit the message concurrent to the associated motion segment during Backup on Path.

Parity: Select None, Odd or Even.

Data Bits: Select 7 or 8 Data Bits.

Retry on Time Out: For the Message Type 22 (which requires an acknowledgement from the external device after the message) an automatic retransmit of the message may be sent. The user may select the number of retries allowed before faulting from a lack of response from the external device. The fault prompt “Message Error” will be displayed when in a Time Out condition.

Programming Code

The ASCII message string follows a unique program message format. Each command begins with a “>” character and ends with a “<” character. These characters are used as delimiters to frame the command (Message Type, Optional Format and Optional Delay Time/Time Out) instructions for the message.

Message Information

The format of this command code is outlined as follows:

>20+Format+Delay Time/Time Out+Port<Message

Where:

>2x*:* Message Command type (see Message Command Type section):

>20 = Direct message with Delay

>21 = Direct message without Delay

>22 = Message that requires Acknowledge

Format: Optional format value that allows the user to add:

Line Feed and Carriage Return commands, etc., message string.

0,1,16,17,32,33,48,49,64,65,80,81,96,97,112,113 are supported (see Format Value section).

Delay Time/Time Out: Optional delay time/time out value

Time in seconds (see Time Out Value section.)

Port: Optional serial port number:

0 = Default port 1

1 = Port 2

Message: The message content (see the message text section.)

Note: Serial message format is always written within comment characters and the command portion of the program code is between the “>” character and the “<” character.

ESSI Example:

- 3
- >20,1,1,0<Message
- 4

EIA Example:

- (>20,1,1,0<Message)

Note: You can use the plus sign (+), hyphen (-), comma (,) or space as a delimiter between fields for the command instruction.

Message Command Type

>20<: This command delays the part program until all bytes have been transmitted, then optionally waits the Delay Time, if specified.

>21<: A message is sent concurrent to execution of the part program and no delay is encountered. No acknowledge is required.

>22<: The message is sent with a suspension of the program during transmission as in option one, but an Acknowledge from the external device (ACK = Hexadecimal 06) is required before the part program can continue. A nonacknowledge (NAK = Hexadecimal 15) response from the external device will prompt a retransmit of the message from the control.

An optional Time Out value may be added to the program code. If no Time Out code is used in the program code the Default time out value at the Ports setup screen will be used. Additionally, an optional automatic retry feature may be enabled at the Ports setup screen.

With the automatic retry feature the message will automatically be retransmitted if no response is detected. The retry is executed after the Time Out value has elapsed. The number of retries can be defined on the Ports configuration screen.

Optional Format Value

The following specialty characters for the format can be sent, in addition to a command string.

Specialty Characters Supported

HEX	Name	Description
01	SOH	Start of Header
02	STX	Start of Text
03	ETX	End of Text
04	EOT	End of Transmission
0A	LF	Line Feed
0D	CR	Carriage Return
	BCC	“Exclusive Or” Check Byte

Note: Checksum is always an “Exclusive OR” of the Data because it does not include any of the “Format” characters, including the CR/LF option.

Optional Format Character Assignments

Value	Assignment
0	No special assignment (must be used in the format location if a Delay or Port is required but no Format options are required). Append a Carriage Return (<CR> = Hex value OD) and a Line Feed (<LF> = Hex Value0A).
16	Append an “Exclusive OR” (<BCC>) to the end of the message.
17	Appends a combination of 16 and 1.
32	Encloses the message with Start of Text (<STX> = Hex Value 02) and End of Text (<ETX> = Hex Value 03). The <ETX> follows the message and the optional <CR><LF>> append codes but precedes the Check Byte <BCC>.
33	Appends a combination of 1 and 32.
48	Appends a combination of 16 and 32.
49	Appends a combination of 1, 16 and 32.
64	Append a Start of Header (<SOH> = Hex value 01) and an End of Transmission (<EOT> = Hex Value04) to the message.
65	Appends a combination of 1and 64.
80	Appends a combination of 16 and 64.
81	Appends a combination of 1, 16 and 64.
96	Appends a combination of 32 and 64.
97	Appends a combination of 1, 32, and 64.
112	Appends a combination of 16, 32 and 64.
113	Appends a combination of 1, 16, 32 and 64.

Optional Delay Time/Time Out Value

The Delay Value issues a delay in seconds at the end of the message for Message Type 20.

No delay is supported for Message Type 21.

This value also works as a Time Out value for Message Type 22. An error will be displayed if the message is not acknowledged (ACK Hexadecimal 06) within the specified time. If no Time Out Delay is defined in the command, the Time Out parameter on the Ports screen will be used.

The value is in a 3.2 format where a value of 5 is equal to 5.00 seconds. Accepted limits for the value is range of 0.00 to 999.99 seconds.

If there is no delay, but the optional port below is being selected, then 0 is required to be entered in the optional delay location.

Optional Port

The Optional Port setting selects which Messaging Port to use. The default messaging port to use is Port 1 if this parameter is omitted. If the optional port is used, 0 = Messaging Port 1 and 1 = Messaging Port 2.

Message Text Content

Up to 300 data characters in each command string may be sent. The Command characters (information between and including the “>” and “<” signs) are included in this maximum.

Printable and Non- Printing ASCII codes can be used in the message string. For more information on ASCII codes and the Hexadecimal value, refer to the ASCII Code chapter.

Non-printing characters are supported by use of a two-character command and can send a Binary Code in the Range from 0-255. Double byte character to support combinations will affect the maximum length count with each pair reducing the maximum data characters by 1. For more information on these values, refer to the Non-printing Character section.

Non-Printing Characters

Non Printing Characters are supported through use of a pair of two printing codes to equal the non-printing code. This pair of characters is retained in the program code but sent as single 8-bit code when transmitted.

There are three types of character pairs and each performs a different operation based on the first character of the pair. This produces a single modified character for transmission.

Character Options

- The “&” two-character pair clears the 0x40 bit from the 2nd character code value.
- The “!” two-character pair clears the 0x40 bit and sets the 0x80 bit set in the 2nd character code.
- The “$” two-character pair clears the 0xC0 bit in the 2nd character.

To transmit the single character with a value 0x01, use the two-character sequence “&A”. This converts the “A” value of 0x41 to 0x01 by clearing the 0x40 bit.

To transmit 0x81, use “!A” or to transmit 0xC1, use “$A”.

Exceptions / Additions

As the “&”, “!” and “$” are used as key indicators for the non-print characters, there is a special format used when these characters are used as a print character in the message text. Simply use the character twice. “&&” = “&”

The ESSI style part program uses several unique characters which requires special two character codes to be used. For example, the message code “&K” in the part program will transmit the code value of 0x2B which is the ASCII code for the plus sign (+). In order to send the + character the code “&K” must be used.

The following are unique codes used in WORD ADDRESS and ESSI programs.

Code	Code Value	Description
&’	0x20 = space	At end of ESSI program
&h	0x28 = “(“	To transmit “(” from WORD ADDRESS program
&i	0x29 = “)“	To transmit “)” from WORD ADDRESS program
&?	0x7F = DEL	Non-printable DELETE code
&K	0x2B = “+”	To transmit “+” from ESSI program

Non-Printing Character Table

ASCII Codes Less Than Hexadecimal 20

Code	Hex	Code	Hex	Code	Hex	Code	Hex
&@	00	&H	08	&P	10	&X	18
&A	01	&I	09	&Q	11	&Y	19
&B	02	&J	0A	&R	12	&Z	1A
&C	03	&K	0B	&S	13	&[	1B
&D	04	&L	0C	&T	14	&\	1C
&E	05	&M	0D	&U	15	&]	1D
&F	06	&N	0E	&V	16	&^	1E
&G	07	&O	0F	&W	17	&_	1F

8 bit Character Codes Greater Than Hexadecimal 80

Code	Hex	Code	Hex	Code	Hex	Code	Hex
!@	80	!H	88	!P	90	!X	98
!A	81	!I	89	!Q	91	!Y	99
!B	82	!J	8A	!R	92	!Z	9A
!C	83	!K	8B	!S	93	![	9B
!D	84	!L	8C	!T	94	!\	9C
!E	85	!M	8D	!U	95	!]	9D

Code	Hex	Code	Hex	Code	Hex	Code	Hex
!F	86	!N	8E	!V	96	!^	9E
!G	87	!O	8F	!W	97	!_	9D
!`	A0	!h	A8	!p	B0	!x	B8
!a	A1	!I	A9	!q	B1	!y	B9
!b	A2	!j	AA	!r	B2	!z	BA
!c	A3	!k	AB	!s	B3	!;	BB
!d	A4	!l	AC	!t	B4	!<	BC
!e	A5	!m	AD	!u	B5	!=	BD
!f	A6	!n	AE	!v	B6	!>	BE
!g	A7	!o	AF	!w	B7	!?	BF
$@	C0	$H	C8	$P	D0	$X	D8
$A	C1	$I	C9	$Q	D1	$Y	DD
$B	C2	$J	CA	$R	D2	$Z	DA
$C	C3	$K	CB	$S	D3	$[	DB
$D	C4	$L	CC	$T	D4	$\	DC
$E	C5	$M	CD	$U	D5	$]	DD
$F	C6	$N	CE	$V	D6	$^	DE
$G	C7	$O	CF	$W	D7	$_	DF
$`	E0	$h	E8	$p	F0	$x	F8
$a	E1	$I	E9	$q	F1	$y	F9
$b	E2	$j	EA	$r	F2	$z	FA
$c	E3	$k	EB	$s	F3	$;	FB

Code	Hex	Code	Hex	Code	Hex	Code	Hex
$d	E4	$l	EC	$t	F4	$<	FC
$e	E5	$m	ED	$u	F5	$=	FD
$f	E6	$n	EE	$v	F6	$>	FE
$g	E7	$o	EF	$w	F7	$?	FF

Section 10
Importing Prepared DXF Files

The DXF Translator software allows the control to load and translate a DXF style drawing created in Autocad® or Autocad LT® into an EIA part program. Certain guidelines must be observed when creating the CAD drawing to allow the CNC to load and understand the file. The optional DXF translation utility is enabled through a password provided by your control supplier.

Drawing Format

There should be nothing on the cut layer except lines, arcs, circles and text commands. Do not put dimensions or notes on the same layer as cut data.

Elliptical segments, squares and polylines are not supported. Divide these elements into short arcs or line segments. You can use the ACAD EXPLODE command to convert POLYLINES into segments.

The end angles of two arcs from any intersection point cannot be within the same quadrant.

Text commands determine cut sequence, and determine the path through multi-segment intersections. Text commands are placed on the drawing with the text feature of your CAD program. The size of the text is not important. However, the location of the text is extremely important. Text must be left-justified and text commands must be snapped to the appropriate intersection or pierce points.

Text commands indicate pierce points and cut direction. Note that the directional commands should only be used to determine the direction of the next line segment when more than one exit path exists at an intersection of segments.

Text Commands

1: Indicates the first pierce point (subsequent pierce points follow in numerical order)

+: Indicates a Counter-Clockwise circle

-: Indicates a Clockwise circle

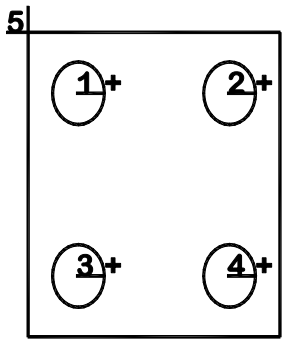
Directional Commands

The following commands indicate the next segment's direction, if it is a line, or the ending angle, if it is an arc, if the angle is:

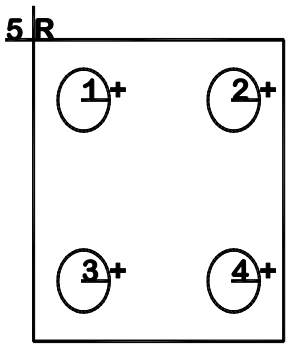
R	350° to 10°
RU	0° to 45°
UR	45° to 90°
U	80° to 100°
UL	90° to 135°
LU	135° to 180°
L	170° to 190°
LD	180° to 225°
D	225° to 170°
DR	270° to 315°
RD	315° to 360°

Traverses are automatically determined between pierce points and do not need to be entered on the CAD drawing.

The following example is a basic bolt hole rectangle with the lead-in and lead-out for the rectangle as part of the top and side line segments. The numbers indicate the order of the pierces and the "+" sign indicates a counter-clockwise rotation for the circles.



If the lead-in and lead-out are created as additional line segments added to the top and side line segments, additional text is required to indicate which direction the next line segment should take as part of the part program, as shown in the following diagram:



In this example, the letter “R” has been snapped to the intersection of the four line segments to indicate that the next line segment after lead-in (pierce 5) would be the segment which is located at 350 to 10 degrees and then to the other connected segments on the square. After the left side (vertical) segment has been cut, no additional text is required to indicate which line should be cut. The Lead-out segment is the only segment left to cut because the lead-in and the first segment have already been cut.

Notes:

- There should be nothing on the cut layer except lines, arcs, circles and text or directional commands.
- Line segments must be connected to complete the cut path.
- If multiple line segments or arcs need to be repeated, each line segment should be drawn, rather than copied and pasted.
- Features for marking are not available.
- No traverse lines are required. All lines in the CAD drawing are assumed to be cut lines.
- Left kerf is assumed.