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## HYPERTHERM SENSOR<sup>™</sup> PHC PLASMA HEIGHT CONTROL

**OPERATION & SET UP GUIDE** 



Making people and machines more productive through process Automation

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## Safety

## **Read this Manual**

Read and understand this manual, the cutting machine manuals, and your employer's safety practices. **Note:** This product is not designed to be field serviceable. Return this product to an authorized repair center for service.

## Sensor PHC Safety Listing

Note: This product has been designed and manufactured in accordance with CE and UL Safety Standards.

UL has successfully tested and listed this product in accordance with the applicable U.S. and Canadian Safety Standards. File number E307226.

Additional markings:

- 1) Use minimum 75<sup>°</sup>C copper wire only.
- 2) Use copper conductors only.
- Suitable for use on a circuit capable of delivering not more than 5000rms symmetrical amperes, 230 volts maximum.
- 4) Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection provided by integral LISTED branch circuit protection fuse.
- 5) "Solid state motor overload protection is provided at 145% of full load current", or the equivalent.

## **Section 1: Overview**

Hypertherm's Sensor<sup>™</sup> PHC (228214) is a plasma torch height control/initial height sensing (THC/IHS) system designed for conventional plasma cutting applications on an X-Y cutting table. The system uses the plasma arc voltage to control the physical stand-off (distance) between the torch and work piece during plasma arc cutting. Initial Height Sense (IHS) is accomplished by ohmic contact sensing or by a limited force stall detection method. The Sensor<sup>™</sup> PHC has been optimized for conventional plasma at or below 200 amps.

**Note:** Sensor<sup>™</sup> PHC is not recommended for HyDefinition<sup>®</sup> or HyPerformance<sup>™</sup> cutting or for higher power applications. The system is not recommended for use on a water table.

A complete Sensor<sup>™</sup> PHC system includes the following components:

## **PHC Control Module**

The PHC control module (228116) houses a microcontroller, an operator control panel, and a Lifter motor drive. This unit provides initial height sensing, arc voltage control. The PHC control module interfaces with the torch lifter, the CNC machine, and the plasma power supply through standard discrete I/O interfaces. The operator interface includes an LED display for set and actual arc voltage as well as error codes. The control unit main functions are: arc voltage control/manual position mode, end of cut retract, IHS test, pierce height, voltage controlled cut height, pierce delay; and access to setup and calibration adjustments. See Figure 2 on page 15.

## **Plasma Interface Assembly**

The plasma interface (228256) provides a clean, standardized connection between the PHC control module and the plasma power supply. The assembly can be mounted either to the back of or inside the plasma power supply. The voltage divider provides a filtered low voltage signal which is derived from the cutting arc voltage. The interface also provides an enclosed terminal block for easy connection to the interface signals. See Figure 3 on page 16.

## Lifter Assembly

The torch lifter station (228117) positions a torch head vertically above the work piece and is controlled by the PHC control module. Its maximum standard stroke is 6 inches (152 mm) between home and the lower limit. It is driven by a DC motor attached to a lead screw. The control module interfaces with an optional lower limit switch to detect maximum travel downward. The control also interfaces with an optional home switch to detect when the lifter is in the highest position. The standard lifter does not use limit switches but has been designed to allow for hard stop limit detection. A power-off brake disables power off motion of the torch. A torch breakaway is an integral part of the lifter and provides a level of protection for the torch, lifter and X-Y table. Upon impact, the breakaway releases from the locked position and allows the torch to float. A breakaway switch detects when this protection has tripped and signals both the PHC control and the CNC machine. See Figure 4 on page 17.

## **Sensor PHC Models**

Description
Sensor PHC with control module, lifter, and 50-foot cables
Sensor PHC (with 123896) for Powermax bundle
Sensor PHC without lifter station
Sensor PHC without lifter or 123895
Sensor PHC without control module
Sensor HPC without plasma interface

## Features

Sensor<sup>™</sup> PHC Plasma Height Control is an automated height control system for plasma shape cutting applications. This product uses microprocessor technology to automatically detect the plate and adjust torch position to an arc voltage set point during plasma cutting operations. This reduces operator input, improves accuracy and increases productivity. The design of the Sensor<sup>™</sup> PHC has been optimized for lower power conventional plasma operation.

## Features

- > Sensor<sup>™</sup> PHC can be used with any CNC
- Easy setup & operation
- > Both manual & automatic operation modes
- Microprocessor control for increased sensitivity and control
- High positioning speeds possible with up to 6 amps continuous current and linear adjustment over full range
- Built-in torch breakaway protection
- > Built-in diagnostic and fault detection features
- > Auto retract on plate contact
- > 7 Segment LED display for set/actual arc voltage & error displays
- Power on indicator
- > Upper and lower limit indicators
- In Position Indicator
- > Attention / error indicator
- > Torch position hold indicator
- Plate contact indicator

## Options

- Interface cables
- > Torch mounting clamps -1 3/8", 1 3/4" and 2" diameters available.

## System Specifications\*

Compatible motors:	DC PM 24Vdc, 2 Amps to 6 Amps
Max power output:	150W
Standard lifter range:	Linear 6" (152mm)
Motor output:	Full "H" bridge PWM with current & voltage sensing
Accuracy:	0.01" (.25mm ) or 0.5 Volt **
Voltage control range:	50 Vdc to 210 Vdc
IHS range:	0.05 inches (1.2 mm) to 0.5 inches (12 mm) **
Operator controls:	Arc voltage, IHS height, & pierce delay control knobs
Operator switches:	IHS test, auto / manual, & manual up / down
Operator display:	3 digit 7 segment display for set volts, actual volts, & error
Calibration adjustments:	Arc voltage, stall force, auto kerf detect level
Setup DIP switches:	Max motor current, arc voltage response, IHS speed, auto delay, int/ext pierce delay, end of cut retract height, auto kerf detect, preflow during IHS, limit switches, breakaway switch, arc voltage calibration
Measuring technology:	Arc voltage feedback & ohmic contact sensing
Interface inputs/ outputs:	8 outputs and 6 inputs optically isolated on "D" connectors
Control dimensions:	6.2"(157mm)W x 4.3"(1.9mm)D x 10.4"(264mm)H
Control weight:	9 lbs
Control power:	115VAC 0r 230VAC +/- 10% 50/60 Hz -selectable
Standard lifter dimensions:	6"(152mm)W x 3.15"(80mm)D x 21.5"(546mm) **
Standard lifter weight:	19 lbs **
Operating environment:	0 to 50C; 95% relative humidity (non-condensing)

\*Information subject to change without notice. \*\* With Standard supplied lifter mechanics

## Connections

All connections to the Sensor<sup>™</sup> PHC are made through four connectors on the bottom of the control unit. See Figure 1.



WARNING! For safety and proper operation this unit must be connected to the star ground on the work table.

#### PHC to CNC Signals

All signals to the CNC are connected through the 25-pin D subconnector on the control unit. For detailed interfacing information, see PHC Interface Signals on page 29 and CNC Interface Signals on page 30.

Outputs to CNC: Digital IHS complete output Digital motion output Digital retract complete output Digital error output/torch collision

Inputs from CNC:

Digital cycle start input Digital corner hold input Digital IHS sync input Interlock

#### PHC to Plasma Signals

All signals to the plasma interface are connected through the 15-pin D subconnector on the control unit. These signals are easily connected through the plasma interface unit or directly to a Powermax<sup>®</sup> G3 supply using a G3 interface cable. For more detailed information, see Plasma Interface Assembly on page 16.

Outputs to plasma: Digital plasma start output Digital hold ignition output

Inputs from plasma: Digital transfer input Analog attenuated arc voltage

#### **PHC to Lifter Signals**

All signals to the lifter are connected through the 9-pin D subconnector on the control unit. For more detailed information, see Standard Lifter Assembly on page 17.

Inputs from lifter:

Digital upper limit switch Digital lower limit switch Digital breakaway switch Analog tip touch sense

#### **PHC to Lifter Power Connections**

All power connections to the lifter are coupled through the 7-pin circular connector on the control unit. For more detailed information, see Standard Lifter Assembly on page 17.

Outputs to Lifter: Motor drive 24V PWM Power off brake 24Vdc

### Sensor<sup>™</sup> PHC Front Panel Indicators

Green	Power
Yellow	Upper Limit
Green	In Position
Yellow	Lower Limit
Red	Attention / Error Code
Yellow	Corner / Kerf Hold
Red	Plate Contact
Red 3 digit	Set / Actual Arc Voltage – Error Number – Set Pierce Height & Delay

## Sensor<sup>™</sup> PHC Front Panel Controls

Multiturn Rotary Pot	Set Arc Voltage
Rotary Pot	Pierce Height Retract
Rotary Pot	Pierce Delay Time
Momentary Toggle Switch	IHS Test
Toggle Switch	Auto / Manual
Momentary 3 pos Toggle	Manual Up / Down

## **Control Module**

## Electrical

Input power (switch selected dual range)	115 VAC or 230 VAC, 1 Phase, 50/60 Hz
Parallel digital I/O	. + 12 Vdc
Motor drive output voltage	.24 Vdc
Motor drive output current	2,3,4,6 Amps max DIP switch selectable
Motor brake output	.+24 Vdc ½ Amp

The features of the control module are highlighted in Figure 2.



Figure 2: Control Module

## **Plasma Interface Assembly**

The plasma interface module is shown in Figure 3.

### Electrical

Parallel digital I/O	.+12 Vdc to +24 Vdc
Interface signals	Plasma start, hold ignition, transfer
Voltage divider function	.Arc voltage (attenuated and filtered)



Figure 3: Plasma Interface (Cover Removed)

If you are using a Sensor PHC 228245 with an HSD 130, select plasma interface assembly 228247 (25-foot cable) or 228248 (50-foot cable). Refer to Field Service Bulletin 805740 for installation information.

## **Standard Lifter Assembly**

## Electrical

Motor	+ 24 Vdc, 3 Amps
Motor brake	+ 24 Vdc ½ Amp
Limit switches	not used – hard stop limit detection
Breakaway switch	+ 12 Vdc proximity

### **Lifter Control Function**

Motordrive	DC full bridge, PWM chopped current source
Lifter speed feedback	.Motor voltage
Maximum lifter speed	200 inches (508 cm) per minute
Maximum lifter stroke	6- inches (152 mm)
Maximum lifter load	10 pounds



Figure 4: Lifter Assembly

## **Section 2: Installation and Setup**

The standard PHC system includes the following components:

## **Standard components**

### **PHC Control Module**

Power cord - 6.5 ft. (2 m) Lifter assembly with torch breakaway Plasma interface assembly Interface cables

- Lifter motor drive cable
- Lifter interface cable
- Plasma interface cable
- Ohmic contact wire
- CNC interface cable

Sensor™ PHC system instruction manual

In addition, the following optional components can be ordered:

## **Optional components**

Interface cables Torch mounting clamps -1 3/8 ", 1 3/4" and 2" diameters available.

## Claims

### Claims for damage during shipment

If your unit is damaged during shipment, you must file a claim with the carrier. Hypertherm will furnish you with a copy of the bill of lading upon request. If you need additional assistance, please contact your Hypertherm Customer Service agent.

### Claims for defective or missing merchandise

If any of the merchandise is defective or missing, call your authorized Hypertherm distributor. If you need additional assistance, please contact your Hypertherm Customer Service agent.

## **Power Requirements**

The PHC can be connected to either 115 Vac or 230 Vac 50/60 Hz. Depending on the input voltage, Slow Blow fuses of the correct size should be installed. For 115 Vac, install a 2 Amp fuse and for 230 Vac, a 1 Amp fuse should be used. The power input voltage is selected by installing the fuse block into the power input module so that the correct voltage is displayed through the power input module window. See Figure 5 for input voltage selection.

If the line cord plug is removed and the unit is directly wired then the connections should be made as follows.

- Blue wire AC neutral
- Brown wire AC hot
- Green wire ground-chassis







Figure 5: Power Connection and Fuse

## **Control Unit Mounting**

Before interconnecting the PHC system, mount the units as required, using customer-supplied hardware. Do not allow the units to lie unsecured on top of cabinets or on the floor. The control units can be mounted from either the rear or the front as shown in Figure 6 and Figure 7.

#### **Control Unit Mounting from Rear**

Mount the PHC control unit close to the machine operator console for easy access to the operator panel. The unit should be mounted to provide easy access and visibility to the PHC controls and display. There are four mounting holes for #10-32 inch or M4 mm fasteners.





Figure 6: Control Unit Rear Mounting

#### **Control Unit Mounting from Front**

Mount the PHC control unit close to the machine operator console for easy access to the operator panel. The unit should be mounted to provide easy access and visibility to the PHC controls and display. There are six mounting holes available. See Figure 7





Figure 7: Control Unit Front Mounting

## **Plasma Interface Assembly Mounting**

Mount the plasma interface assembly close to the plasma power supply for easy connection of arc voltage and signal wires between the units. The unit can be mounted in any position and can be mounted directly to the back or inside of the power supply. The mounting holes are sized for #6 or M3 fasteners. See Figure 8.

NOTE: The plasma interface ground terminals must be connected to the plasma power supply positive ground to provide measurement feedback for arc voltage. This feedback is essential for optimal cutting performance.



Figure 8: Plasma Interface Mounting

## Lifter Assembly Mounting

Mount the lifter assembly on the cutting table to take maximum advantage of the vertical travel range. Typically the bottom of the lifter should be between 6 and 8 inches above the cutting table.

NOTE: The lifter ground terminal must be connected to the cutting table ground to provide measurement feedback for tip touch sensing. This feedback is essential for optimal cutting performance. See Figure 9.



Figure 9: Lifter Mounting

## Torch Breakaway Assembly

The torch breakaway (229164) should be mounted to the lifter as shown in Figure 10.

# **CAUTION**: The breakaway uses extremely strong magnets to clamp the two halves of the breakaway unit together. Use extra care when you mate the two halves of the breakaway.

Hold the breakaway at a 45 degree angle to the mounting plate and carefully place the lower alignment pin into the mating depression on the breakaway back plate. Slowly angle the breakaway toward the back plate. Use care to avoid pinching your fingers between the two halves. After installation, it is almost impossible to separate the two halves without the leverage of the mounting block and torch.



Figure 10: Torch Breakaway

## **Torch Mounting Block Kit**

Mount the torch mounting block kit to the lifter torch breakaway assembly. See Figure 11.

The mounting blocks are available in three sizes as listed.

- 128277 Torch mounting block 1 3/8" diameter
- 128278 Torch mounting block 1 3/4" diameter
- 128279 Torch mounting block 2" diameter



Figure 11: Torch Mounting Clamp

## **System Cables**

Install system cables as shown in Figure 12. All cables should be properly shielded with shield connections at both ends of the cables. If possible, route all PHC cables away from high power plasma cables. If both the plasma high power and PHC cables must share a cable track, it is recommended that they are separated as much as possible in the cable track. For reliable operation, all grounds must be connected to machine grounds as directly as possible.



## Figure 12: System Cables

Note: If you are using a Powermax with a built-in voltage divider, use the Powermax interface cable 123896.

## **Grounding Requirements**

## 

To ensure personal safety and reduce electromagnetic interference (EMI), the PHC system must be properly grounded.

NOTE: For reliable operation, the lifter ground terminals must be connected to the ground on the cutting table ground to provide measurement feedback for tip touch sensing. The plasma interface ground terminals must be connected to the plasma power supply positive ground to provide measurement feedback for arc voltage. Both types of feedback are essential for optimal cutting performance.

## Power cord grounding

The PHC control module must be properly grounded through the power cord according to national or local electrical codes.

## Protective earth ground

Install protective earth (PE) grounding cables to the three PHC components (control unit, lifter, and plasma interface,) as shown in Figure 13. Grounding must comply with national or local electrical requirements.

Note: The PE (Ground) cables must be supplied by the customer.



Figure 13: System Grounding

## **PHC Interface Signals**

Most of the PHC interface signals are through optoisolators. Figure 14 shows the details of connecting the IO to external switches, relays, transistors, and other circuitry. The figure shows examples using both the internally available isolated +12V source and using an external voltage source. Do not use an external voltage higher than +24V with inputs without adding some additional series resistance.

Note: The "Plasma Start" output to the plasma power supply is a relay dry contact closure.

## 

Do not exceed 24V or 30mA in or out of any optoisolator. Observe correct signal polarity to prevent damage.



Figure 14: General Interfacing Examples

## **CNC Interface Signals**

See Figure 14 on page 29 for an illustration.

CNC Interface Signals 25-pin D Subconnector		
Name	Pair ~ Pin #s (wire color)	Signal Type
Cycle Start	In + 11 (red) ~ In - 23 (blue)	Isolator input
Auto Disable / Corner Hold	In + 10 (red) ~ In - 22 (green)	Isolator input
IHS Sync	In + 9 (red) ~ In - 21 (white)	Isolator input
IHS Complete	Out + 18 (black) ~ Out - 5 (yellow)	Isolator output
Motion	Out + 17 (black) ~ Out - 4 (blue)	Isolator output
Retract Complete	Out + 16 (black) ~ Out - 3 (green)	Isolator output
Error or Breakaway (DIP switch selectable)	Out + 15 (black) ~ Out - 2 (white)	Isolator output
Interlock	14 (black) ~ 1 (red) contact closure required	Isolator & relay coil
Field +12V	12 (red), 24 (yellow), 13 (yellow), 25(brown)	Field power output
Field Common	6 (brown), 19 (black), 8 (black), 20 (orange)	Field power common

**Note: All required signals are shown in bold.** All other signals are optional for multiple torch operation, improved performance, or reduction in cycle times.

# 

Observe optoisolator signal polarities to prevent damage to the control unit.

## **CNC Signal Descriptions**

Use a customer supplied mating 25-pin D subconnector or cut off the unused connector and wire directly to the appropriate signals.

## **Cycle Start**

This signal is an output from the CNC and an input to the PHC. The CNC activates this signal to begin the Initial Height Sensing and start a plasma cut.

## Auto Disable / Corner Hold

This output from the CNC is activated to turn off the automatic voltage control and freeze the position of the torch. This signal is optional but improves performance and is usually used to prevent diving in corners. This signal is required if PHC pierce delay has been disabled and the CNC is controlling the pierce delay time. In this case, the "Auto Disable" is activated during the "Pierce Delay Time" as well as the subsequent "Accel Delay" to allow machine motion to reach a steady cutting speed.

#### **IHS Sync**

This optional CNC output is used to synchronize torches in a multiple torch installation. The CNC issues this signal to delay plasma torch ignition until all torches in a multiple torch configuration have completed their IHS sequence and are in position and ready to fire. When the CNC releases (de-activates) this signal, the torch ignites and the plasma torch begins piercing.

For single torch installations, this signal is not required and can be left unconnected.

#### **IHS Complete**

This optional signal is an output from the PHC and an input to the CNC. This signal is used to indicate that initial height sensing is complete and that a torch is in position and ready to fire. For multiple torch installations, the CNC waits for all active torches to indicate IHS COMPLETE before simultaneously releasing all IHS SYNC signals to allow the torches to ignite.

For single torch installations, this signal is not required.

#### Motion

This signal is an output from the PHC and an input to the CNC. The signal is issued after plasma ignition and the PHC set pierce delay time. It indicates to the CNC that the pierce delay is complete and the cut motion should begin. If the CNC performs all pierce delay timing, the EXT\_PIERCE\_DELAY - DIP switch on the PHC should be turned ON which forces the PHC pierce delay to be zero and disables the front panel pierce delay control. If the CNC is controlling the pierce delay, the CNC uses the AUTO\_DISABLE / HOLD signal to delay the arc voltage control until the pierce and accel times have elapsed.

#### **Retract Complete**

This signal is an output from the PHC that is active when a cut has been completed and the torch has been retracted to the selected retract height. The CNC can use this signal to delay rapid transit to the next cut until the torch has been raised and cleared any tip-ups. The use of this signal is optional.

### Error

This signal is output by the PHC for errors. The actual error number displays on the PHC front panel LED display.

#### Interlock

This is a normally closed contact closure provided by the CNC to allow PHC motion. If this contact is opened, the PHC motor drive does not receive power.

**NOTE:** This signal is required for operation of the PHC. If this signal is not used as an external interlock, use a jumper to satisfy the input.



Figure 15: Basic CNC Interface

## **Plasma Interface Signals**



WARNING: HAZARDOUS VOLTAGE & ENERGY The plasma interface signals from plasma cutting equipment without an internal voltage divider are directly connected to the plasma cutting circuit output. To prevent electrical shock and energy hazards, wiring from the plasma cutting circuit of the power supply to the plasma interface (228256) must be enclosed or protected.

Hypertherm Powermax systems are equipped with a factory-installed internal voltage divider which is designed to be safely connected without tools to the Sensor<sup>™</sup> PHC plasma interface using the standard PHC to Powermax cable provided by Hypertherm.

The plasma interface (228256) includes the arc voltage divider for connection to Hypertherm Powermax plasma supplies not equipped with a factory installed internal voltage divider and other plasma supplies. However, the wiring from the plasma cutting circuit to the 228256 must be enclosed or protected for safe operation and use. The plasma cutting circuit output ratings are printed on the data plate and vary by manufacturer and model up to 500 VDC and 400 ADC, such that contact with metal live parts of this connection under normal operating and fault conditions can result in death or burns.

To make connections between the plasma cutting circuit and 228256:

- · Use qualified service personnel only.
- Turn OFF and disconnect all power.
- Mount the 228256 as close as is practical to the entry point to the power supply. Permanent connection is recommended.
- If cord connected, use jacketed cables suitable for the environment.
  - Verify that the outer jacket of each interconnecting cable is protected from damage at the entry point to the power supply. A strain relief is recommended.
  - Verify that the outer diameter of the interconnecting cable fits the strain relief with provided 228256:
    - Plasma start, transfer grip: .114" .250" diameter
    - Plasma interface grip: .064" -.210" diameter
  - Strip back the outer jacket and individual conductor insulation as needed.
  - Insert the outer jacket cable through the strain relief and make connections as shown in Figure 16 on page 34.
  - Verify the outer jacket is a min. of 1 inch (2.54 cm) inside the 228256 and tighten the strain relief(s).
- Before operating the equipment, verify that the connections are correct and that all live parts are enclosed and that all jacket/conductor insulation is protected against damage.

Plasma Interface Signals			
Name	15-pin D Subconnector Pin #s	Plasma Interface	Signal Type
Plasma start	2, 10	J1-1, J1-2 (dry contact)	Relay contact output
Hold ilgnition	Pos 3 Neg 11	J1-4 (+), J1-5 (-)	Isolator output
Transfer	Out + 4 Out - 12	J3-1 (+), J3-2 (-)	Isolator input
Arc voltage	Out + 8 Out - 15	Ground stud (+), Term (-)	Attenuated filtered analog
Field +12V	1, 9	J1-3	Field power output
Field common	5, 6, 7, 13, 14	J3-3	Field power common





For a diagram of circuits on the plasma interface, see Figure 18 on page 36.



Figure 17: Plasma Interface





Figure 18: Plasma Interface Connections



Observe signal polarities when connecting to optocouplers. Do not exceed 24Vdc on any signal lines. Do not exceed 30mA current from any input or output. Do not exceed 50mA total current drawn from Sensor<sup>™</sup> internal +12V field supply. Failure to observe these warnings could damage the unit.

#### **Plasma Start**

This signal is a relay contact output from the PHC and an input the plasma power supply. The PHC activates this signal by closing the contact to start the plasma power supply.

WARNING: An interface to older plasma systems, such as the MAX100 or MAX200 must be implemented with a customer-supplied relay (see Figure 19). Older plasma systems draw large current levels through the PLASMA START input that are far in excess of the capability of the Sensor PHC START output.



Customer Supplied Relay: 12VDC Coil, 30ma Maximum Coil Rating, 10-amp contact rating.



Figure 19: Interfacing to Older Plasma Systems (MAX100 or MAX200)

#### **Hold Ignition**

This output from the PHC and input to the plasma power supply should be activated to delay the high frequency ignition of mechanized torches. This signal is usually issued to synchronize the ignition of multiple plasma torches. This signal can also be used to save cycle time by performing preflow during IHS. The use of this signal is optional but improves performance on plasma systems that can use it. This signal is not used for contact start torches installed on Powermax<sup>®</sup> plasma units.

### Transfer

This signal is an output from the plasma power supply and an input the PHC. The plasma power supply activates this output to signal that arc transfer has occurred.

## Lifter Interface Signals

These signals can be directly connected to a Sensor<sup>™</sup> PHC standard lifter using the supplied cable.

Lifter Interface Signals 9-Pin D Subconnector		
Name	Pin #s	Signal Type
Lower limit switch *	6 - Switch to common	Isolator input
Upper limit switch *	2 - Switch to common	Isolator input
Torch breakaway switch	7 - Switch to common	Isolator input
Torch tip touch sense	4, 5, 9	Attenuated filtered analog
Field +12V	1	Field power output
Field common	3, 8	Field power common

\* The PHC standard lifter does not include limit switches and the PHC detects the hard stop limits by monitoring motor speed.

## Lower Limit Switch

This signal is an output from the lifter and an input to the PHC. The lifter can activate this signal to indicate that the lifter has reached the lower range of motion. The normally open/closed sense of this signal can be changed through setup DIP switch #14. The use of a limit switch is optional.

## **Upper Limit Switch**

This signal is an output from the lifter and an input to the PHC. The lifter can activate this signal to indicate that the lifter has reached the upper range of motion. The normally open/closed sense of this signal can be changed through setup DIP switch #14. The use of a limit switch is optional.

## **Breakaway Switch**

This signal is an output from the lifter and an input to the PHC. The lifter can activate this signal to indicate that the mechanical torch breakaway has tripped. The normally open/closed sense of this signal can be changed through setup DIP switch #15. The use of a torch breakaway switch is optional.

## **Lifter Power Connections**

These connections can be made directly to a Sensor<sup>™</sup> PHC standard lifter using the supplied cable.

Lifter Power Connections 7-Pin Circular Connector		
Name	Pin #s	Signal Type
Motor power – up direction	Positive 1 Negative 2	PWM H bridge output
Lifter brake	Positive 4 Negative 5	+24Vdc output
Chassis ground	6	

#### **Motor Power**

This signal is an output from the PHC. It is output from a PWM controlled "H" bridge motor drive. The maximum current level can be set using DIP switches #1 and #2. This output is intended to drive a 24Vdc permanent magnet motor.

### Lifter Brake

This output from the PHC is a 24Vdc signal to an electromagnetic brake. When this signal is energized, the brake is released to allow lifter motion.



## **DIP Switch Setup**

### **Switch Settings**

Switch settings for control module operation and setup outlined below. **Note\*:** Default switch settings (as shipped) are indicated in **BOLD** text.

As shown in the figure above, the setup DIP switches are divided into two groups of eight switches. The top set of switches is numbered SW1 through SW8 and the bottom set of switches is numbered SW9 through SW16.

<u>SW1</u>	<u>SW2</u>	Maximum Motor Current / Power
on	on	Max Current = 2 Amps, 50 Watts
on	off	Max Current = 3 Amps, 75 Watts *
off	on	Max Current = 4 Amps, 100 Watts
off	off	Max Current = 6 Amps, 150 Watts

Set DIP switches SW1 and SW2 to the rating for the current of the lifter motor. This is the maximum current that is applied and is directly related to the motor power rating. This setting is also used to determine the minimum applied current for stall sensing and to calculate the motor speed based on the measured motor voltage.

**NOTE:** For optimum performance it is important that these switches are set correctly. For the standard lifter, these switches should be set for 3 Amps

<u>SW3</u>	<u>SW4</u>	Voltage Control Response / Gain
on	on	Gain = Low = +/- 4V In Position Range
on	off	Gain = Med Low = +/- 2V In Position Range *
off	on	Gain = Med High = +/- 1V In Position Range
off	off	Gain = High = $+/-0.5V$ In Position Range

Set DIP switches SW3 and SW4 to select the closed loop voltage control response. The DIP switches should be set for the highest gain possible that yields an acceptable control response. An acceptable response should be stable and should have a minimum overshoot. These settings are a function of the lifter and motor combination. For faster lifters use a lower gain setting. Faster settings can require the use of the "Corner Hold" signal from the CNC to prevent diving in the corners. This setting affects control.

SW5	IHS Slow Approach / Retract Speed	
on	Speed = Low = 15% of Max Speed *	
off	Speed = High = 30% of Max Speed	

The setting of SW5 affects the speed of the torch when it approaches the plate during an IHS cycle. This speed is also used when the torch retracts from plate contact to the pierce height and during the first seconds of low speed manual motion. This setting is a compromise between positioning accuracy and cycle time. Set a speed that is as fast as possible and still provides the required IHS range and fine manual motion accuracy.

SW6	CNC Error Select
on	Normal – Error output on all errors *
off	Error output on Torch Breakaway only

The SW6 allows the user to select logic for error conditions. Select On to provide an output for all errors. Select Off to provide an output only when the torch breakaway input is active.

SW7	Auto Voltage Control Acceleration Delay	
on	Low – Enable Voltage Control 0.5 Second after Pierce delay *	
off	High – Enable Voltage Control 2.5 Second after Pierce delay	

The SW7 delay setting is used to allow the cutting machine to accelerate to steady state speed before starting the closed loop voltage control of torch height. The shorter delay should be used for most machines. For very large cutting machines, use the longer delay to avoid diving into the plate during machine acceleration.

SW8	External Pierce Delay
on	CNC controls pierce delay – Front panel Pierce delay is disabled
off	Normal – Internal Pierce Delay *

SW8 should be turned ON if the CNC controls the time for the pierce delay. When this switch is ON, the front panel control for pierce time is disabled and the PHC uses a pierce time of zero. The CNC issues the AUTO / CORNER HOLD command, waits for the MOTION signal, and begins timing the pierce delay. After the Pierce Time has elapsed, the CNC can begin the actual cutting machine motion and start to time the acceleration delay. After the acceleration delay time has elapsed, the CNC can remove the AUTO / CORNER HOLD and allow the PHC to control the torch height.

<u>SW9</u>	<u>SW10</u>	End of Cut Retract Time	
on	on	Retract = Low = 0.25 Sec @ Max Speed	(0.8" std lifter)
on	off	Retract = Med Low = 0.5 Sec @ Max Speed	(1.6" std lifter)*
off	on	Retract = Med High = 1.0 Sec @ Max Speed	(3.3" std lifter)
off	off	Retract = High = 1.5 Sec @ Max Speed	(5.0" std lifter)

SW9 and SW10 control the end of cut retract. This setting should be set as low as possible to achieve optimum cycle times and still clear worst case tip-ups. The end of cut retract moves at the maximum lifter speed.

## SW11 Automatic Kerf Detect

 on
 Normal – PHC the detects Kerf crossings and auto HOLD

 off
 Automatic Kerf Detection is disabled\*

For the automatic kerf detection to operate properly, the kerf threshold pot must be adjusted to the correct level. The correct level is low enough to trip the kerf detection when crossing a kerf, but high enough that nuisance trips are avoided during normal cutting. This pot should be adjusted by viewing the yellow "corner / kerf hold LED" during a test cut.

### SW12 Preflow During IHS

 on
 Plasma Start and Preflow during IHS with capable plasma systems

 off
 Normal – Plasma Start and Preflow after IHS – Contact Start Torch \*

Note: This function must be disabled for Powermax<sup>®</sup> contact start torches.

This function is only used with high frequency start mechanized torches. With mechanized torches, this function can save cycle time by performing IHS and torch preflow during the same period of time. When "Preflow During IHS" is active, the "Start" and "Ignition Hold" output signals are applied to the plasma system during the IHS process. This allows the plasma system to begin the gas preflow requirement during the same period of time when the PHC lifter is positioning the torch at the correct pierce height. After the PHC lifter has been positioned at the correct pierce height, the Ignition Hold output is removed to allow the torch to start and the cutting process to begin.

SW13ReservedonNormaloffSpecial operation

### SW14 Lifter Limit Switches

on (Sw NC) Open on Limit – Use normally closed lifter inputs

off (Sw NO) Close on Limit – or switches not used, lifter hard stops \*

For the standard lifter, limit switches are not used. The PHC senses the lifter upper and lower limits by sensing when the lifter hard stops at the travel limits.

## SW15 Torch Breakaway Switch

on (Sw NO) Open on Breakaway – Use normally open switch input \*

off (Sw NC) Close on Breakaway – or switch not used

For the standard lifter, the torch breakaway uses a normally open proximity switch. When the breakaway is installed, the switch closes. When the breakaway is tripped, the switch opens again.

<u>SW16</u>	Arc Voltage Calibration Mode
on	Display actual arc voltage during idle state for calibration
off	Normal – Display set arc voltage during Idle state *

For normal operation, this switch should be set to OFF.

This switch is used to display the actual arc voltage on the PHC display. This allows the arc voltage to be calibrated by adjusting the Arc Voltage adjustment pot. When the calibration mode is active, the PHC displays "X.X.X." with the X's indicating the measured arc voltage and all the decimal points on to indicate calibration mode.

When calibration mode is active the display can be temporarily overridden by adjusting either the kerf detect level or the stall force. If you adjust either the kerf detect or stall force, a 0 to 10 reference level displays temporarily. After one second of inactivity the display reverts to the measured arc voltage.

NOTE: The arc voltage calibration procedure should be performed on all new installations because the actual measured arc voltage accuracy is a combination of the individual plasma interface and control units.

## **Calibration Pot Setup**

#### **ARC - Arc Voltage Calibration**

This trim pot is used to calibrate the actual arc voltage used for arc voltage control feedback. To calibrate the arc voltage, place the PHC into the arc voltage calibration mode by turning ON DIP switch #16. This causes the actual arc voltage to display on the 3 digit LED display. The user can either perform a test cut with a meter connected to the plasma supply output or connect a known voltage (250 Vdc max.) to the plasma interface arc voltage terminals (negative electrode and positive ground). Adjust the arc voltage pot until the display is equal to the applied voltage on the meter.

**NOTE:** For accurate operation, this procedure should be done for all new installations since the measured arc voltage accuracy is combination of the specific plasma interface and control units.

#### **KERF - Auto Kerf Detection Level**

This adjustment pot sets the auto kerf detection level. The auto kerf function must be enabled by turning ON the automatic kerf detect DIP switch #11. When this pot is adjusted with the PHC in calibration mode, the display temporarily shows a 0 to 10 reference level display. The auto kerf detection works by looking for a rapid change in the arc voltage. When the pot is adjusted toward the lower settings, the PHC looks for smaller voltage changes and the kerf detection is more sensitive. At higher settings, the kerf detection is less sensitive. The pot should be set sensitive enough to reliably detect kerf crossings but not so sensitive that false nuisance trips occur and degrade the height control performance. The operation of auto kerf detect can be checked by monitoring the yellow Hold LED on the PHC front panel during a plasma cut. If the threshold is properly set, the yellow Hold LED lights whenever a Kerf is crossed. Note that this LED also lights when an active Auto/Corner input is present on the CNC Interface or when the unit is set for Manual operation.

#### **STALL - IHS Stall Sensing Level**

This adjustment is used to set the Stall force sensing level during Initial Height Sense (IHS). When this pot is adjusted with the PHC in calibration mode, the display temporarily shows a 0 to 10 reference level display. The stall force is always used as a backup to the ohmic contact sensing in automatic mode. When it is set to the lower settings (turn counter-clockwise), the maximum applied force is lower during IHS. Higher settings (turn clockwise) increase the maximum applied force. If this setting is too high, the torch or consumables can be damaged or can deflect the work piece or trip the torch breakaway. Set this adjustment as low as possible but high enough so that false stalled plate detects do not occur in mid air. The adjustment can be checked by executing an IHS Test with the nozzle ohmic wire disconnected.

## **Section 3: Operation**

Automated torch height control (THC) systems used in mechanized plasma cutting are used to provide the optimum height for the desired metal cutting process. The appropriate cut height is crucial to the plasma process to provide the ability to transfer the Arc to the work piece for piercing / cutting and for optimum cut quality (bevel angle, etc).



With the plasma process there is a direct relationship between the cut voltage and the torch height (gap between the metal work surface and the torch electrode). By using the automated control to monitor the working arc (cut) voltage, it can then control the THC to maintain a specific voltage set point.

## **Automatic Operation**

Automatic voltage control operation is selected by placing the lower center toggle switch in the upper auto position. In this mode, the unit automatically performs IHS to the set pierce height, ignite the plasma torch, wait for the torch to pierce the plate, and begin the cutting machine motion.

The basic Sensor<sup>™</sup> PHC auto operation setup consists of three steps:

#### 1. Set arc voltage

Use the larger multi-turn adjustment, to set the arc voltage on the display. The starting point for this voltage should be included in the cut charts supplied with your plasma system. It is important to remember that this voltage is just a starting point since the actual arc voltage depends on consumable wear, torch lead lengths, gas flow rates, and machine motion. For optimal cut quality you must make small adjustments to the nominal arc voltage that is specified in the cut charts. The important item to control is the torch-tip to work height during a cut. The arc voltage is just an indirect method to control this height.

#### 2. Set IHS retract or pierce height

Use the lower left rotary control to set the IHS retract height. As this control is adjusted, the display is temporarily overridden with a 0 to 10 reference level. This represents the desired pierce height. The actual height should be available in the cut charts supplied with the plasma system. This setting is approximate because it depends on whether the unit can sense the plate using ohmic contact or must rely on the backup limited force stall sensing.

Check this setting by performing an IHS test and check for the correct pierce height. Each time the lower left IHS test switch is pressed, the torch alternates between the set IHS height and the end of cut retract height. Continue testing and fine tuning this adjustment until the desired IHS height is achieved.

If the IHS speed (DIP SW #5) has been set to the normal low speed setting, then the IHS retract adjustment range should be between about 50 thousandths and 1/2 inch. If the IHS speed was set to the high speed setting, then the IHS retract adjustment range should be between about 1/10<sup>th</sup> inch and 1 inch.

### 3. Set pierce delay time

Use the lower right rotary control to set the pierce time delay. As this control is adjusted, the display is temporarily overridden with a 0 to 4.0 second delay time. This is the time delay between igniting the torch and beginning the cut motion. The pierce delay is the time required for the plasma torch to initially cut through the plate. This time delay should be included in the cut charts provided with your plasma system. To provide more accuracy for the short delay settings, this rotary control is divided into two ranges. The first range covers the first ½ rotation of the control and provides a linear delay between 0 and 1 second. The second ½ rotation provides a linear delay of between 1 and 4 seconds.

## **Manual Operation**

Manual lifter operation is selected by placing the lower center toggle switch in the lower manual position. In this mode, the unit manually jogs or slews slow or fast in the desired direction. If a cut is started while in the manual mode, the torch moves only in response to the front panel manual move commands. The IHS, voltage control, and end-of-cut retract functions are all disabled during manual mode.

Use your cut chart and the following steps to set up operations in manual mode:

- 1. Select manual mode with the toggle switch.
- 2. Set cut height with the up/down toggle switch.

The three types of manual motion are jog, slow and fast. Note that slow and fast types of manual motion are time-based.

#### Manual Jog

Manual jog motion is useful for fine-tuning the torch height in manual mode. When the lower right manual motion switch is momentarily switched into either the up or down position, the torch jogs approximately 20 thousandths in the desired direction. Repeat the momentary depression of the switch up or down to create a series of discrete jog motions in the desired direction. This is useful for fine-tuning the torch height in manual mode.

#### **Slow Manual Motion**

Continue to hold the manual motion switch for about ½ second after the jog has completed to create slow manual motion in the desired direction. This motion should be at the IHS speed as determined by DIP SW #5.

#### **Fast Manual Motion**

Hold the manual motion switch for about one second after the start of slow manual motion to create fast manual motion. The fast manual motion continues for as long as the manual motion switch is depressed.

## Section 4: Troubleshooting

## **Error Codes**



Figure 21: Error Indications

The red ERROR LED indicates abnormal conditions. The error code is displayed in the PHC 3 digit LED display as E.XX where XX represents the error number. The meanings are listed below. Most errors are cleared by either removing the abnormal condition or with the application of the next "Cycle Start" from the CNC.

## E.01 CYCLE\_START at power up Error

**Reason:** The CNC CYCLE\_START input was active when the PHC was powered up. **Solution:** Deactivate the CYCLE\_START input on the CNC interface to clear the error.

### E.02 Plate Contact at Home Error

**Reason:** Ohmic contact sensed the work piece when the torch was at the maximum retract position. Possible causes:

• A short circuit in either the nozzle connection wire or the torch consumables.

• A coolant leak on a liquid cooled torch.

**Solution:** This error is reset on the next CYCLE\_START.

## E.03 Lifter Timeout Error

**Reason:** Lifter motion was commanded but the lifter destination was not sensed within the timeout period. Possible causes:

- A mechanical problem in the lifter such as the motor coupling to the lifter mechanics has loosened.
- The torch lead set is binding and limiting the lifter motion.
- A problem with the motor wiring, motor drive, or with the motor itself.

**Solution:** The error is reset on the next CYCLE\_START.

## E.04 Limit Reached during Auto Operation

**Reason:** The lifter reaches a travel limit during arc voltage controlled operation. Possible causes:

- The lifter does not have the range of travel to accommodate the thickness of the material being cut.
- Improper operation of either the limit switches or the limit switch wiring.

**Solution:** Adjust the lifter or torch mounting to make more effective use of the lifter travel range. This error is reset on the next CYCLE\_START.

### E.05 IHS SYNC Timeout

**Reason:** The torch reaches the IHS pierce position and is waiting for the IHS\_SYNC input from the CNC to be released.

**Solution:** Check the wiring of the IHS\_SYNC input and the CNC programming for this signal. This error is reset on the next CYCLE\_START.

The HIS\_SYNC signal is usually only used for multiple torch installations.

## E.06 Transfer Timeout Error

**Reason:** The Plasma torch was fired but that the TRANSFER signal was not received within 5 seconds Possible causes:

- A faulty IHS sequence that resulted in an improperly high pierce height.
- Failure to transfer due to bad consumables.
- Improper plasma gas settings.
- Bad work piece grounding.
- The TRANSFER signal on the power supply interface is missing or improperly connected to the PHC Plasma Interface

Solution: The next CYCLE\_START resets this error.

### E.07 Lost Plasma Arc Error

**Reason:** The plasma torch lost transfer during operation before CYCLE\_START was removed Possible causes:

- Cutting off the edge of the plate.
- Bad consumables.
- Improper height control settings.

Solution: The next CYCLE\_START resets this error.

### E.08 Torch Breakaway Error

**Reason:** The torch breakaway has tripped. Possible causes:

• The torch crashed into the work piece because of tip-ups or improper height control setup.

**Solution:** If a torch breakaway is not installed, turn the setup DIP switch #15 on the PHC to OFF (down) to ignore this input.

If a torch breakaway is installed, see Torch breakaway error on page 53 for a troubleshooting procedure.

#### E.09 Low Input Power Error

**Reason:** The PHC input power is 20% below the nominal voltage. **Solution:** increase the input voltage to within the nominal operating range.

#### E.10 High Input Voltage Error

**Reason:** The PHC input power is 15% above the nominal voltage. **Solution:** Decrease the input voltage to within the nominal operating range.

#### E.11 Over-Temperature Error

**Reason:** The motor drive circuitry has experienced an over-temperature shutdown. **Solution:** Allow the unit to cool down.

#### E.12 Interlock Tripped Error

Reason: The External Interlock has been tripped.

**Solution:** Verify that there is a contact closure across the External Interlock input on the CNC Interface connector.

#### E.13 Excess Plate Contact Error

Reason: The torch tip made excess contact with the plate during a short period of time.

- The voltage set point is too low.
- The consumables are worn and the voltage set point needs to be increased.

**Solution:** The next CYCLE\_START resets this error.

#### E.99 Internal Software Error

**Reason:** An abnormal, unexpected condition occurred in the software. **Solution:** Perform a power up reset of the PHC.

## **Troubleshooting Guide**

Problem	Solution
The Error LED and Error code are displayed.	Note the error code number and refer to the detailed list of error indications on page 49.
No response to CYCLE START Input	<ul> <li>Check the power switch on the PHC.</li> <li>Check power connections.</li> <li>Check the fuse in the power entry module.</li> <li>Check the cycle start connection.</li> </ul>
Torch Ignites before IHS is complete	<ul> <li>Check that preflow during IHS is disabled – DIP SW #12 Off.</li> <li>Check plasma Corner Hold Input if it is used.</li> </ul>
No IHS motion	<ul> <li>Check that the PHC is in auto mode.</li> <li>Check that the torch lead set is not binding.</li> <li>Check that the stall force is not set too low – increase stall force setup adjustment.</li> </ul>
Inaccurate IHS using ohmic contact	<ul> <li>Check that the PHC is in auto mode.</li> <li>Check that the ohmic contact wire is connected.</li> <li>Check that the torch retaining cap is tight.</li> <li>Check for water on the plate. If there is water present, disconnect the ohmic wire and use stall force only.</li> <li>Check for oil or paint coating on the plate. If they are present, use stall force only.</li> <li>Check the nozzle, shield, or both and clean or replace them.</li> <li>Check the work plate connection.</li> </ul>
Inaccurate IHS using stall force	<ul> <li>To disable ohmic sensing, disconnect the wire from the torch tip.</li> <li>Check that the stall force is set correctly.</li> <li>Check for excessive plate deflection.</li> <li>Check plate support.</li> <li>Increase the IHS setting to compensate for plate deflection.</li> </ul>
Torch fails to ignite	<ul> <li>Check that plasma is powered and operational.</li> <li>Check for proper IHS height.</li> <li>Check that the IHS SYNC input from the CNC is not active.</li> <li>Check the torch consumables.</li> </ul>
Torch fails to Transfer	<ul> <li>Check that the pierce height is not too high.</li> <li>Check the work plate connection.</li> <li>Check the torch consumables.</li> <li>Check the preflow gas flow rate.</li> </ul>

Problem	Solution
Arc extinguishes after Transfer with large pierce hole	<ul> <li>Check that the pierce delay is not too long.</li> <li>Check that the machine motion output is active and connected to the CNC.</li> <li>Check that the CNC is active and the set machine speed is appropriate.</li> </ul>
Torch begins cutting before the pierce is complete	Check that the pierce delay is not set too short.
Torch dives toward plate immediately after voltage control begins	<ul> <li>Increase the Set Arc Voltage value.</li> <li>Increase Machine Accel Delay – DIP SW#7 Off.</li> <li>Check the arc voltage calibration.</li> </ul>
Torch retracts from plate immediately after voltage control begins	<ul> <li>Decrease the Set Arc Voltage value.</li> <li>Increase the Set Pierce Height value.</li> <li>Check the arc voltage calibration.</li> </ul>
Erratic voltage control	<ul> <li>Check all system ground connections.</li> <li>Check the torch for cooling water leaks.</li> </ul>
Failure to retract at end of cut	<ul> <li>Check End of Cut Retract settings – DIP SW #9 &amp; #10.</li> <li>Check for torch and lead set binding or obstruction.</li> </ul>
Torch breakaway error	

If the torch breakaway has not tripped, check the connections from the lifter to the PHC:

1. To test the switch, touch a piece of metal to the target on the magnetic sensor at the top of the breakaway. The LED in the middle of the sensor lights up if the switch is working.



- 2. Verify that the ground is seamless from the lifter interface board to the start ground on the work table. See Figure 13 on page 12.
- 3. Verify that the magnetic sensor cable is connected to the lifter interface board. This connector is third from the top of the board.



4. Test the connection by attaching a jumper between pins 7 and 8 on the 9pin D subconnector.



If the E08 error disappears, repair the connection between the magnetic sensor and the lifter interface board.

- 5. If the error message remains, test the cable and the lifter interface connector on the PHC:
  - a. To test the cable, verify the continuity of each wire that connects the lifter to the PHC.
  - b. To test the connector on the PHC, place a jumper between pins 7 and 8 of the 9-pin D subconnector.



If the E08 error disappears from the console, the fault is in the cable. If the error persists, the fault is in the PHC. Contact Technical Support.

## **Parts and Kits**

Kit Number	Description	
Configured PHC Kits		
228214	Sensor PHC with control module, lifter, and 50-foot cable	
228242	Sensor PHC without lifter station	
228243	Sensor PHC without lifter or 123895	
228244	Sensor PHC without control module	
228245	Sensor PHC without plasma interface	
	PHC Replacement Parts	
228199	PHC control module assembly, complete	
228200	PCB assembly, PHC processor	
228201	PCB assembly, PHC motor drive	
228202	Cable kit, Sensor PHC enclosure (line filter, CPC harness, wired pot)	
228203	Bezel with Red Lens, for PHC control module	
228204	Fuse, 1.6A Slo Blo, 1/4 x 1 1/4" (2 required)	
	PHC Lifter Replacement Parts	
228205	Torch lifter station, 6" stroke, breakaway, PHC, complete	
228206	Motor, PHC lifter (24v, w/brake, terminated)	
228207	Coupling, PHC lifter	
228191	Wire, ohmic contact, Ti or PHC lifter	
228192	PCB assembly, Ti or PHC lifter interface	
228193	Magnetic breakaway assembly, PHC/Edge Ti	
228194	Breakaway Sensor/cable with fastener, terminated	
228195	Ti or PHC upper sheet metal cover with fasteners	
228196	Ti or PHC lower sheet metal cover with fasteners	
228197	Ti or PHC lifter silicone end stop and fastener	
228208	Ball screw, 2mm pitch, with nut and bearing	

## **Recommended THC Slide Maintenance**

Servicing a ball screw generally means cleaning and re-lubrication. The ball screw should be cleaned carefully by wiping away all used grease, dust and dirt with a clean, dry cloth. If possible, move the nut several times over the full travel to ensure that as much old grease as possible comes out of the nut. Do not use any detergents or other cleaning fluids, such as trichloroethylene, alcohol or acetone.

**NOTE:** Do not remove or disassemble the ball screw or ball screw nut. After cleaning, apply a thin layer of fresh grease over the entire surface of the screw. After re-lubrication, the assembly should be operated through its stroke several times at low speeds and low loads to ensure that all contact surfaces of nut, balls and screw are covered with a grease film.

Interval Every six months

## Lubricant

For the linear bearing carriage and ball screw, the bearing manufacturer suggests grease with the following characteristics:

- 1. Lithium soap-based grease
- 2. NLGI Grade 2
- 3. No metallic particles in the grease.

Examples of compatible lubricants:

- Mobil-1 Synthetic grease and is available at most Auto Parts Stores.
- Mobilith SHC220 is another example that should be available at an industrial supply such as McMaster-Carr.

The linear bearing carriage uses a grease fitting and the ball screw lubricant is applied to the screw itself:



Cover Removed

To lubricate the THC slide:

- 1. Position the lifter approximately at the top of stroke.
- 2. Press the E-stop on the Ti (or power off the PHC).
- 3. Remove the lifter lower cover.
- 4. Clean the visible portion of the ball screw and bearing rails with a clean dry cloth.
- 5. Enable the Ti (or PHC).
- 6. Slew to the bottom of the stroke.
- 7. Press the E-stop on the Ti (or power off the PHC).
- 8. Clean the visible portion of the ball screw and bearing rails with a clean dry cloth.
- 9. Repeat several times (slewing back and forth to distribute and remove grease/debris).
- 10. Grease the bearing grease port with a needle-type grease gun.
- 11. Apply a thin coat of grease to the ball screw threads.
- 12. Slew back and forth do distribute grease, while checking for binding or erratic movement.
- 13. Replace cover.

## Appendix A: Interfacing to a Custom Lifter

The performance of the Sensor<sup>™</sup> PHC is tightly coupled to the lifter and motor characteristics. The Sensor<sup>™</sup> PHC was designed as a conventional plasma height control and the lifter does not include any position feedback. All lifter moves are timed moves at regulated speeds. The Sensor<sup>™</sup> PHC microprocessor uses both the DC motor's back generated voltage and the DC motor's ohmic component to calculate the motor feedback speed. The lifter screw pitch affects the lifter linear speed and the control loop gain when operating with arc voltage. The screw pitch also affects the limited stall force sensing. The lifter friction and maximum torch weight affect the point at which the lifter requires a brake to maintain position. For these reasons, the motor and lifter characteristics are critical and must be tightly controlled.

## Requirements

The following is a partial list of lifter and motor characteristics that are compatible with this controller.

- Lifter Ball screw pitch = 2mm/rev
- · Lifter with limit switches or lifter with soft mechanical end stops
- Lifter capable of 200 in/min.
- Lifter should have low backlash and little mechanical play
- If the functions are required the lifter should provide for the electrical interface to limit switches, breakaway switches, and torch tip sensing. Contact Hypertherm Automation Engineering for information concerning the lifter signal interface.
- Motor should be a 24Vdc permanent magnet type
- Motor should turn 2500 RPM at 24Vdc. Alternatively, the motor RPM at 24Vdc should be matched with the lifter ball screw pitch/ gear reduction/ pulley reduction so that the combination results in 200 in / min of lifter linear speed.
- Motor should have 2A, 3A, 4A, or 6A max current rating.
- Motor resistance should be about 20% of full-scale rating. For example, a 3A rated motor should have an ohmic resistance of approximately = 24 / 3 \* 20% = 1.6 Ohms
- Depending on the torch weight load and lifter friction, you may need a brake to hold position.

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The performance of the Sensor<sup>™</sup> PHC is tightly coupled to the lifter and motor characteristics. To ensure proper operation, a non-standard customer designed lifter should be fully tested with this controller under all anticipated operating conditions.

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