HAAS SERVICE AND OPERATOR MANUAL ARCHIVE

Rotary Operators Manual 96-0315D RevD English June 2008

- This content is for illustrative purposes.
- Historic machine Service Manuals are posted here to provide information for Haas machine owners.
- Publications are intended for use only with machines built at the time of original publication.
- As machine designs change the content of these publications can become obsolete.
- You should not do mechanical or electrical machine repairs or service procedures unless you are qualified and knowledgeable about the processes.
- Only authorized personnel with the proper training and certification should do many repair procedures.

WARNING: Some mechanical and electrical service procedures can be extremely dangerous or life-threatening. Know your skill level and abilities.

All information herein is provided as a courtesy for Haas machine owners for reference and illustrative purposes only. Haas Automation cannot be held responsible for repairs you perform. Only those services and repairs that are provided by authorized Haas Factory Outlet distributors are guaranteed.

Only an authorized Haas Factory Outlet distributor should service or repair a Haas machine that is protected by the original factory warranty. Servicing by any other party automatically voids the factory warranty.

Introduction

The Haas rotary tables and indexers are fully automatic, programmable, positioning devices. The units are made up of two parts: The mechanical head, that holds the workpiece, and the control.

The unit was specifically designed for rapid positioning of parts in secondary operations such as milling, drilling, and tapping. The device is especially suited to automatic machines such as NC mills and automatic production machines. The control can be remotely activated by your equipment and does not require human assistance, resulting in fully automatic operation. Furthermore, one unit can be used on several different machines, thereby eliminating the need for multiple units.

Positioning of the workpiece is accomplished by programming the angular movements, these positions are stored in the control. Up to seven programs can be stored, and the battery powered memory will retain the program when the power is turned off.

The control is programmed in steps (angle) sizes from .001 to 999.999°. There can be 99 steps, for each program, and each step can be repeated (looped) 999 times. The optional RS-232 interface can be used to upload, download, enter data, read position, start, and stop motor operation.

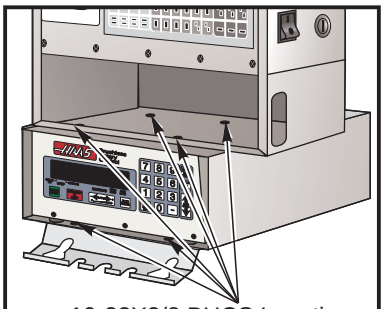
This system of the rotary control and unit is defined as a “semi-fourth axis”. This means that the table cannot do simultaneous interpolation with other axes. Linear moves or spirals can be generated by having an axis of the mill move at the same time the rotary table moves; the “Programming” section describes this in detail.

HRTs, TRTs, and TRs are equipped with a pneumatic brake; compressed air (approx. 100 psi) is needed to activate the brake.

Unpacking and Setup

Optional Servo Control Bracket

Designed to work specifically with the Haas line of CNC mills. This bracket keeps the Servo Control in easy reach of the operator, allowing for easy programming between the Haas mill and Rotary table. Contact your Haas dealer to order. (Haas part number: SCPB)


10-32X3/8 BHCS Locations

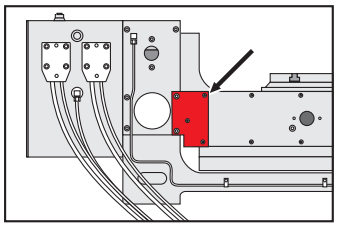
TR-Series Shipping Bracket Removal

Remove the shipping bracket before using

TR160(160-2)/TR210: The shipping bracket is located on the right rear of the unit.
Replace the (2) 10-32 and (2) 1/4-20 screws, do not replace the 1/2-13 bolt. The TR160 does not have a 1/2-13 bolt.

TR310: Remove the (4) 1/2-13 bolts and washers. Remove the (2) T-nuts from the rotary platter.

Keep all hardware and shipping brackets.


TR-210

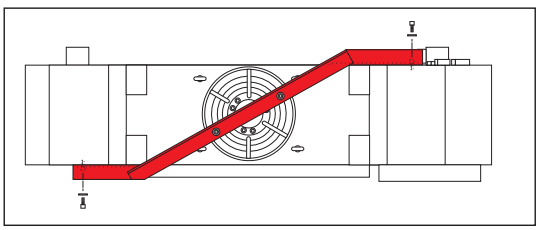
Haas Tailstocks

Tailstocks with live centers are recommended.

!Warning! Tailstocks cannot be used with the HRT320FB table.

Clean bottom surface of tailstock casting before mounting to mill table. If there are any noticeable burrs or nicks on the mounting surface, clean them with a deburring stone.

Tailstocks must be properly aligned to the rotary table before using. See the Haas tailstock manual (96-5000) for more information and the operating pressure of pneumatic tailstocks.


TR-310

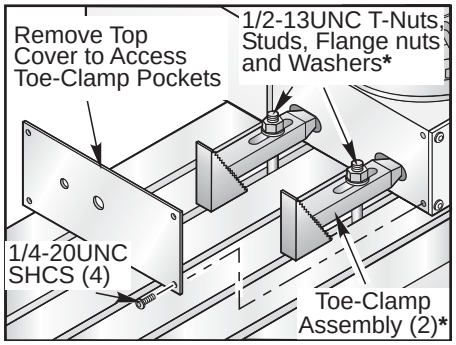
General Setup

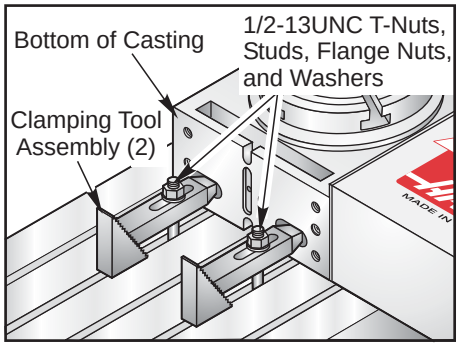
There are a number of ways the rotary products can be installed. Use the following pictures as a guide.

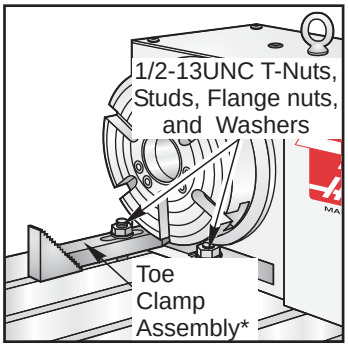
Route the cable from the table such that it avoids tool changers and table edges. Cable slack must be provided for your machine's movements. If the cable is cut, the motor will fail prematurely.

Rotary Table Mounting

NOTE: The HRT 160, 210, 450, and 600 Rotary Tables can be secured as shown:

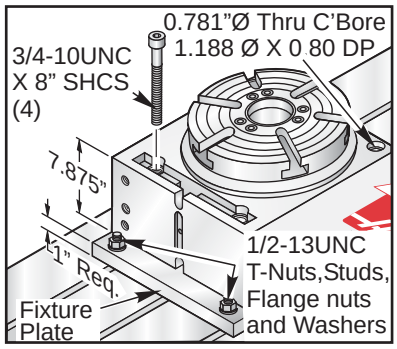


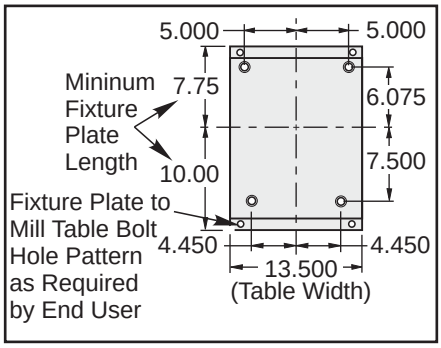




*Standard stud mounting, front and rear For extra rigidity, use additional Toe-Clamps (*not supplied)*

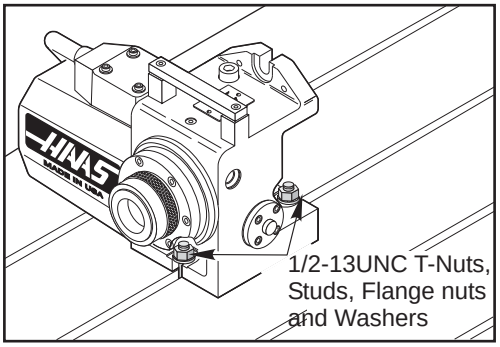
The HRT 310 can be secured as shown (Dimensions are in inches)

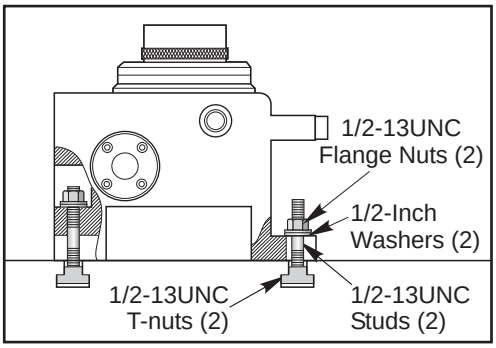




HRT 310 Table-to-Fixture Bolt Hole Pattern

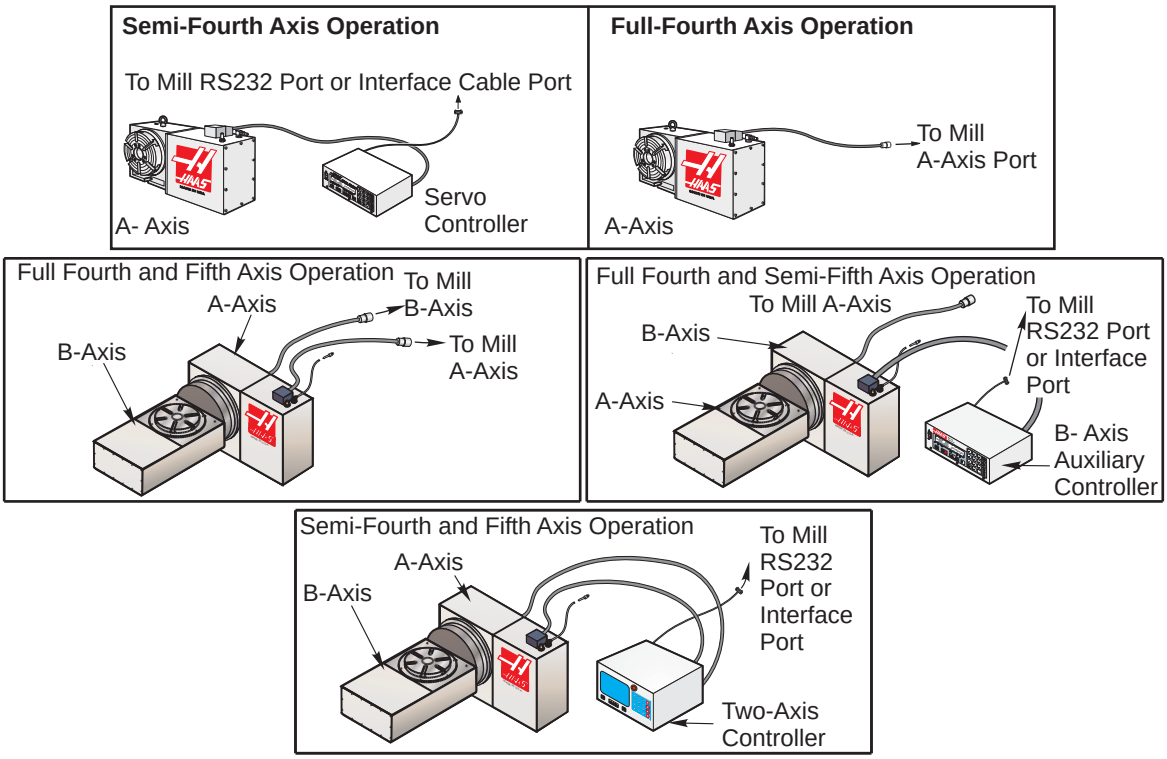
HA5C Mounting





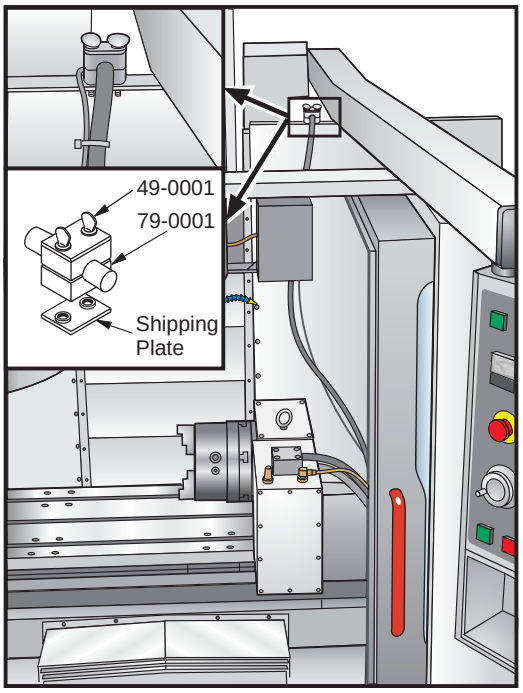
1. Secure the unit to the mill table.

2. Connect the cables from the rotary unit to the control, with the power off. **Never connect or disconnect the cables with the power on**. It can be connected as either a full-fourth or semi-fourth axis. See the following figure. For full-fourth axis, the indexer is connected directly to the HAAS mill control at the connector labeled “A axis”. The mill must have the 4th (and 5th) axis option(s) to run full-4th (and full-5th) axis.



3. Route the cables over the back of the mill sheetmetal and install the cable clamp. The bottom plate of the clamp assembly must be removed and discarded before installing the clamp to the mill. Assemble the clamp to the mill as shown.

4. If adding a full forth, or full fifth rotary product to a Haas mill, the settings must be set for the specific unit. Refer to the instructions in the mill manual (mill settings 30 and 78) or call the Haas service department.



5. **Semi-Fourth Axis:** Secure the servo control in the servo pendant bracket (Haas part number SCPB). Do not cover any surface of the control, as it will overheat. Do not place the unit on top of other hot electronic controls.

6. **Semi-Fourth Axis:** Connect the AC line cord to a power supply. The cord is a three-wire ground type, and the ground must be connected. The power service must supply a minimum of 15 amps continuously. Conduit wire must be 12 gauge or larger and fused for at least 20 amps. If an extension cord is used, use a three-wire ground type, the ground line must be connected. Avoid outlets that have large electric motors connected to them. Use only heavy duty 12 gauge extension cords capable of 20 amp load. Do not exceed a length of 30 feet.

7. **Semi-Fourth Axis:** Connect the remote interface lines. See “Interfacing to Other equipment” section.

8. **HRT, TR and TRT** - Connect the table to an air supply (120 psi max). The line pressure to the brake is not regulated. The air pressure must remain between 80 and 120 psi.

NOTE: Haas recommends the use of an in-line air filter/regulator for all tables. The air filter will keep contaminates from entering the air solenoid valve.

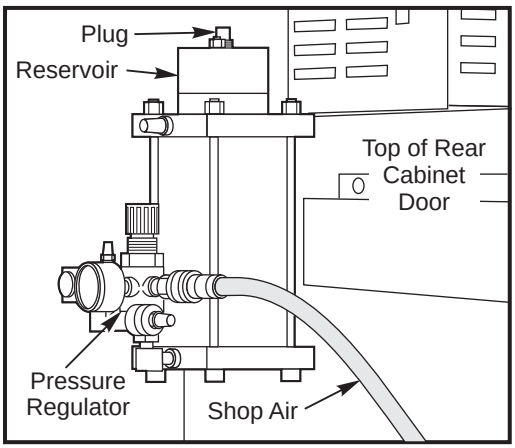
9. Check the oil level. If it is low, add oil. Use MOBIL SHC-634 synthetic gear oil (Viscosity Grade ISO 220). For the HRT210SHS use Mobil SHC-626 synthetic gear oil (Viscosity Grade ISO 68).

10. Turn on the mill (and servo control, if applicable) and home the table/indexer by pressing the Zero Return button. All Haas indexers home in the clockwise direction as viewed from the platter/spindle. If the table(s) home counter-clockwise, press E-stop and call your dealer.

HRT/TRT 110 Brake Booster Installation

Warning: The brake booster is shipped empty. It must be filled with oil and the air purged from the system before operating.

The brake booster(s) are installed on the back of the rear cabinet door as shown. Mount the brake booster(s) by opening the rear cabinet door, clipping them to the top of the door, then shutting the rear cabinet door.



Set-up

Fill the reservoir by removing the plug (square bolt) and adding either, Mobil DTE 25, Shell Tellus 23, or Chevron EP 22. The oil should be added until it is 1/4” to 1/2” below the reservoir cap.

Turn the pressure regulator down (turn adjusting knob counter clock-wise) so no air pressure enters the system. Install an air supply to the input side of the regulator. Loosen the hex-head bolt on top of the HRT/TRT unit. Slowly turn the pressure up on the regulator until the gauge shows 5 psi. Hydraulic fluid will flow through the system and exit through the loose bolt on the HRT/TRT body. Tighten the hex-head bolt once a steady flow of oil flows by the bolt.

Refill the oil reservoir, it should be 1/4” to 1/2” below the reservoir cap.

Pressure Adjustment

Set the air pressure for the HRT/TRT brake booster between 35 and 40psi. Turning the knob clockwise increases the pressure, turning it counter-clock wise decreases the pressure. It may be necessary to pull up on the knob, before adjusting, to unlock it. Press the adjusting knob down once the pressure is set to lock the adjusting knob. **Warning**: Setting a pressure above the recommendation may damage the brake.

Oil Level

Check the brake booster oil level before using. The oil level should be 1/4” to 1/2” below the reservoir cap. If necessary, add oil by removing the plug (square bolt), at the top of the reservoir and filling with Mobil DTE25, Shell Tellus 23, or Chevron EP22 oil. Only use these types of oil.

Interfacing to Other Equipment

The Haas control has two signals, one input and one output. The mill tells the rotary control to index (an input), it indexes, and then sends a signal back, to the mill, that the index (an output) has been completed. This interface requires four wires; two for each signal, and are from the rotary control remote input and from the mill.

The control can be installed to communicate with your mill two different ways: RS-232 Interface or CNC Interface Cable. These connections are detailed in the following sections.

The Relay In the Haas Control

The relay inside the control has a maximum rating of 2 amps (1 amp for HA5C) at 30 volts DC. It is programmed as either a normally closed (closed during cycle) or a normally open relay (after cycle). See the "Parameters" section. It is intended to drive other logic or small relays, it will not drive other motors, magnetic starters, or loads exceeding 100 watts. If the feedback relay is used to drive another DC relay (or any inductive load), a snubber diode must be installed across the relay's coil in the opposite direction of coil current flow. Failure to use this diode or other arc suppression circuitry on inductive loads, will damage the contacts of the relay.

Use an ohmmeter to measure the resistance across pins 1 and 2, to test the relay. The reading should be infinite, with the control off. If a lower resistance is measured, the contact points have failed and the relay must be replaced.

The Remote Input

The CNC Interface Cable provides communication between the mill and Haas rotary control. Since most CNC machine tools are equipped with spare M-codes, semi-fourth axis machining is achieved by connecting one end of the CNC Interface Cable to any of these spare relays (switches), and the other to the Haas rotary control. Commands for the rotary unit are stored in rotary control memory, and each pulse of the mill relay, triggers the rotary control to move the unit to its next programmed position. Once the move is complete, the rotary control signals that it has finished and is ready for the next pulse.

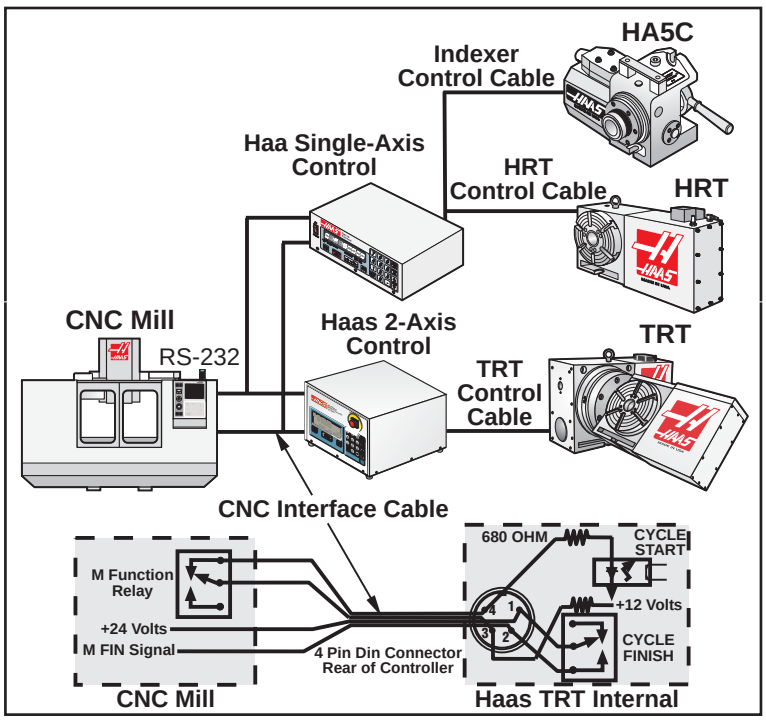
A remote socket is provided on the back panel of the control unit. The remote input consists of a **cycle start** signal and a **cycle finish** signal. To connect to the remote, you will need a connector (contact your dealer) that can be used to trigger the controller from any one of several sources. The cable connector used is a male four-pin DIN connector. The Haas Automation part number is 74-1510 (Amphenol part number is 703-91-T-3300-1). The Haas Automation part number is 74-1509 for the panel receptacle in the control box (Amphenol part number 703-91-T-3303-9).

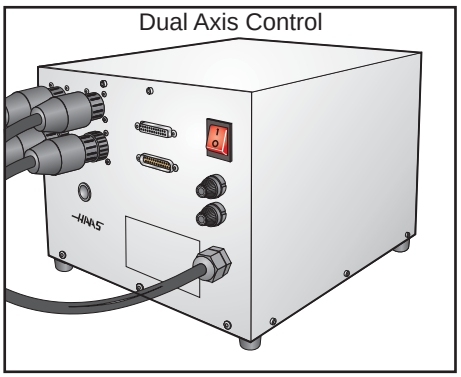
Cycle Start

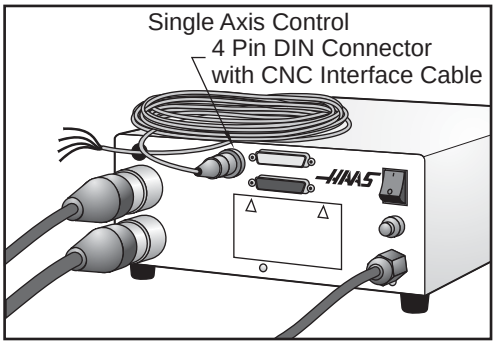
When pins 3 and 4 are connected to each other for a minimum of 0.1 seconds, the control will move the unit one cycle or step. To move again, pins 3 and 4 must open for a minimum of 0.1 seconds. Under no circumstances apply power to pins 3 and 4; a relay closure is the safest way to interface the control.

When **cycle start** is used, pin 3 supplies a positive 12 volts at 20 milliamps and pin 4 is connected to the diode of an opto-isolator that grounds to chassis. Connecting pin 3 to pin 4 causes a current to flow through the diode of the opto-isolator, triggering the control.

If the control is used around high frequency equipment such as electric welders or induction heaters, shielded wire must be used to prevent false triggering by radiated EMI (electromagnetic interference). The shield should be attached to earth ground. A typical CNC interface follows:







Cycle Finish

If your application is in an automatic machine (CNC mill) the feedback lines (pins 1 and 2) are used. Pins 1 and 2 are connected to the contacts of a relay inside the control and have no polarity or power on them. They are used to synchronize the automatic equipment with the controller.

The feedback cables tell the mill that the rotary unit has finished. The relay can be used to “Feed Hold” NC machine movements or can be used to cancel an **M** function. If the machine is not equipped with this option, an alternative may be to dwell (pause) longer than it takes to move the rotary unit. The relay will trigger for all cycle start closures except G97.

Remote Operation with Manual Equipment

The remote connection is used to index the unit other than by the Start switch. For example, using the optional **Haas remote quill switch** (Haas P/N RQS), every time the quill handle is retracted it touches a clamped micro switch, automatically indexing the unit. Or use the switch to index the unit automatically during milling. For example, every time the table comes back to a specific position, a bolt on the table can press the switch, indexing the unit.

In order to index the unit, pins 3 and 4 need to be connected (Do not apply power to these wires). A connection, at pins 1 and 2 are not needed for the control to operate. However pins 1 and 2 could be used to signal another option, such as an automatic drilling head.

A color-coded cable is available to help with the installation (M-Function control), the cable colors and pin designations are:

1 = red, 2 = green, 3 = black, 4 = white

HA5C Remote Input Example: A common application for the HA5C is dedicated drilling operations. The cycle start wires are connected to a switch that closes when the drill head retracts and the “Finish” wires are connected to the “Start” wires of the drill head. When the operator pushes Cycle Start**,** the HA5C indexes to position, and triggers the drill head to drill the hole. The switch mounted to the top of the drill head will index the HA5C when the drill retracts. This results in an endless loop of indexing and drilling. To stop the cycle, enter a G97 as the last step of the control. The G97 is a **No Op** code that tells the control not to send the feedback so the cycle can be stopped.

Remote Operation with CNC Equipment

NOTE: All of the Haas controls come standard with 1 CNC interface cable. Additional CNC interface cables can be ordered (Haas P/N CNC).

CNC mills have Miscellaneous functions called “M-functions”. These control external switches (relays) that turn other mill functions on or off (i.e., spindle, coolant, etc.). The Haas remote cycle start cable is hooked into the normally open contacts of a spare M-function relay. Our remote feedback cables are then connected to the M-function-finished cable (MFIN), an input to the mill control, that tells the mill to continue to the next block of information. The interface cable is Haas P/N: CNC

The RS-232 Interface

There are two connectors used for the RS-232 interface; one male and one female DB-25 connectors. Multiple rotary controlls are connected by daisy-chaining the boxes. The cable from the computer connects to the female connector. Another cable can connect the first control to the second by connecting the male connector of the first box to the female connector of the second; this can be repeated for up to nine controlls. The RS-232 connector on the control used to up and down load programs.

• **HRT & HA5C** - The RS-232 connector on the back of most PCs is a male DB-9, so only one type of cable is required for connection to the control, or between controls. This cable must be a DB-25 male on one end and a DB-9 female on the other. Pins 1, 2, 3, 4, 5, 6, 7, 8, and 9 must be wired one-to-one. It cannot be a Null Modem cable, which inverts pins 2 and 3. To check cable type, use a cable tester to check that communication lines are correct. The control is DCE (Data Communication Equipment), which means that it transmits on the RXD line (pin 3) and receives on the TXD line (pin 2). The RS-232 connector on most PCs is wired for DTE (Data Terminal Equipment), so no special jumpers should be required. The down line (RS-232 OUT) DB-25 connector is used when multiple controls are used. The first control’s down (RS-232 OUT) line connector goes to the second controller’s up (RS-232 IN) line connector, etc.

• **TRT** - On most PCs today, the RS-232 connector is a DB-9. To connect the two, a null modem cable with a female DB-9 on one end and a male DB-25 on the other end is required. Both the PC and the Dual axis controller are DTE’s, so a null modem cable is required. use the following connections to build or test a cable:

PC female DB-9		**Haas dual control Male DB-25**
Pin 2, Receive Data	connects to	Pin 2, Transmit Data*
Pin 3, Transmit Data	connects to	Pin 3, Receive Data*
Pin 5, Logic Ground	connects to	Pin 7, Logic Ground*
Pin 4, DTR	connects to	Pin 6, DSR
Pin 6, DSR	connects to	Pin 20, DTR
Pin 7, RQS	connects to	Pin 5, CTS
Pin 8, CTS	connects to	Pin 4, RQS

*The Haas controller requires the marked signals as a minimum. Connect the remaining signals if required.

Pin 1 on the DB-9 is data carrier detect and is not commonly used. Pin 1 on the DB-25 is used for the cable shield/earth ground and should be connected at one end to minimize noise.

The Haas dual controller has 2 serial ports, both up and down load ports, (as previously described, except it is a DCE). The down load, or Down Line, connector is only used when one or more control is used. The first control’s down line or “RS-232 OUT” connector connects to the second control’s up line or “RS-232 IN” connector, etc. The CNC control is connected to the first control’s up line or “RS-232 IN” connector.

The RS-232 interface sends and receives **seven data bits, even parity, and two stop bits**. The data rate can be between 110 and 19200 bits per second. When using RS-232, it is important to make sure that Parameters 26 (RS-232 Speed) and 33 (X-on/X-off Enable) are set to the same value in the rotary control as the PC. Parameter 12 must be set to 3 in order to coordinate mill and control motion. This will prevent Aux. axis position mismatch alarm (355) when in handle jog mode. If Parameter 33 is set to **on**, the control uses X-on and X-off codes to control reception; be sure the computer is able to process these. It also drops CTS (pin 5) at the same time it sends X-off and restores CTS when it sends X-on. The RTS line (pin 4) can be used to start/stop transmission by the controller or the X-on/X-off codes can be used. The DSR line (pin 6) is activated at power-on of the controller and the DTR line (pin 20 from the PC) is not used. If Parameter 33 is 0, the CTS line can still be used to synchronize output. When more than one Haas rotary control is daisy-chained, data sent from the PC goes to all of the controls at the same time. That is why an axis selection code (Parameter 21) is required. Data sent back to the PC from the controls is OR'ed together so that, if more than one box is transmitting, the data will be garbled. Therefore, the axis selection code must be unique for each controller. The serial interface may be used in either a remote command mode or as an Upload/Download path.

RS-232 Remote Command Mode

Parameter 21 cannot be zero for the remote command mode to operate; the control looks for an axis select code defined by this parameter. The controller must also be in RUN mode to respond to the interface. Since the control powers-on in RUN mode, unattended remote operation is possible.

Commands are sent to the controller in ASCII code and terminated by a carriage return (CR). All commands, except for the B command, must be preceded by the axis select code (U, V, W, X, Y, Z). The B command does not require the select code, since it is used to activate all axes simultaneously. The ASCII codes used to command the control follow:

RS-232 Single Axis Commands

The following are the RS-232 commands, where **X** is the selected axis:

xSnn.nn	Specify step size or absolute position.
xFnn.nn	Specify feed rate in units/second.
xGnn	Specify G code.
xLnnn	Specify loop count.
xP	Specify servo status or position. (This command causes addressed controller to respond with servo position if normal operation is possible, or otherwise with the servo status.)
xB	Begin programmed step on X-axis.
B	Begin programmed step on all axes at once.
xH	Return to Home position or use home offset.
xC	Clear servo position to zero and establish zero.
xO	Turn servo on.
xE	Turn servo off.

RS-232 Dual Axis Commands (TRT)

A-Axis- Same as above.

B-Axis

xSBnn.nn	Specify step
xGBnn.nn	Specify feed rate
xGBnn	Specify G code
xLBnnn	Specify loop count
xPB	Specify servo statusor position
xHB	Return to HOME position or use home offset
xCB	Clear servo position to zero and establish zero

For both A&B:

xB	Begin programmed step on X-axis
B	Begin programmed step on all axes at once
xO	Turn servo on
xE	Turn servo off

RS-232 Responses

The **xP** command is presently the only command that responds with data. It returns a single line consisting of:

xnnn.nnn	(servo at standstill at position **nnn.nnn**) or
xnnn.nnnR	**(**servo in motion past position **nnn.nnn**) or
xOn	(servo is off with reason **n**) or
xLn	(servo Home position lost with reason **n**)

Remote Operation with a FANUC CNC Control (HRT & HA5C)

FANUC control set-up requirements

There are several requirements that must be met before a Haas Servo Control can be interfaced with a FANUC controlled mill. These are as follows:

1. FANUC control with custom macro enabled and Parameter 6001, bits 1 and 4 set to “1”.

2. A serial port on the FANUC control must be available for use by the Haas rotary control while DPRNT program is running.

3. 25’ RS-232 shielded cable (DB25M/DB25M), null modem not required. Radio Shack part number RSU10524114.

4. Shielded M-code relay cable Haas Automation Part Number: CNC

DB25 pinout: 1-1 2-2
3-3 4-4
5-5 6-6
7-7 8-8
20-20

Haas Parameters

Once the previous requirements have been met, revise the parameters of the Haas control. The following are the parameters that will need to be changed. (Initial settings. Change these only after the interface is functioning.)

Parameter 1 = 1
Parameter 2 = 0
Parameter 5 = 0
Parameter 8 = 0
Parameter 10 = 0
Parameter 12 = 3
Parameter 13 = 65535
Parameter 14 = 65535
Parameter 21 = 6 (see table 1)
Parameter 26 = 3 (see table 2)
Parameter 31 = 0
Parameter 33 = 1

Table 1

0 = RS 232 upload/download programs
1 = U
2 = V
3 = W
4 = X
5 = Y
6 = Z
7,8,9 Reserved

Table 2

0 = 110
1 = 300
2 = 600
3 = 1200
4 = 2400
5 = 4800
6 = 7200
7 = 9600
8 = 19200

Fanuc Parameters

The following Fanuc control parameters must be set to successfully communicate with the Haas rotary control.

Baud Rate	1200 (Initial setting. Change this only after interface is functioning.)
Parity	Even (Required setting)
Data Bits	7 or ISO (If CNC control defines Data bits as word length + parity bit, set to 8)
Stop bits	2
Flow control	XON / XOFF
Character Coding (EIA/ISO)	ISO (Required setting, EIA will not work)
DPRNT EOB	LF CR CR (“CR” is required, “LF” is always ignored by the servo control)
DPRNT	Leading zeroes as blanks - OFF

Be certain to set FANUC parameters related to the actual serial port connected to Haas rotary control. The parameters have been set for remote operation. A program can now be entered, or run an existing program. There are several key items to consider to ensure your program will run successfully.

DPRNT must proceed every command sent to the Haas Control.

The commands are sent to the controller in ASCII code and terminated by a carriage return (CR).

All commands must be proceeded by an axis select code (U, V, W, X, Y, Z). For example, setting parameter 21 = 6, means Z will represent the axis code.

RS 232 Command Blocks

DPRNT[ ]	Clear/Reset receive buffer
DPRNT [ZGnn]	Loads G-code nn into step no. 00, “0”is a place holder
DPRNT[ZSnn.nnn]	Loads Step Size nnn.nnn into Step no. 00
DPRNT[ZFnn.nnn]	Loads Feed Rate nnn.nnn into Step no. 00
DPRNT[ZLnnn]	Loads Loop Count into Step no. 00
DPRNT[ZH]	Return home immediately without M-FIN
DPRNT [ZB]	Activates Remote Cycle Start without M-FIN
DPRNT [B]	Activates Remote Cycle Start without M-FIN regardless of Haas Servo Control Parameter 21 setting (*Not for general use in this application.)

Notes:

1. Use of “Z“ above assumes Haas Servo Control Parameter 21 = 6.
2. Leading and trailing “0” must be included (correct: S045.000, wrong: S45).
3. When writing your program in the FANUC format it is important to **not** to have blank spaces or carriage returns (CR) in your DPRNT statement.

DPRNT Program Example

The following is an example of one way to program using the FANUC style.

```
O0001
G00 G17 G40 G49 G80 G90 G98
T101 M06
G54 X0 Y0 S1000 M03
POPEN                       (Open FANUC serial port)
DPRNT [ ]                   (Clear/Reset Haas)
G04 P64
DPRNT [ZG090]               (Servo Control Step should now read “00” )
G04 P64
DPRNT [ZS000.000]           (Loads Step Size 000.000 into Step 00)
G04 P64
DPRNT [ZF050.000]           (Loads Feed Rate 50 units/sec into Step 00)
G04 P64
Mnn                         (Remote Cycle Start, moves to P000.0000, sends M-FIN)
G04 P250                    (Dwells to avoid DPRNT while M-FIN is still high)
G43 Z1. H01 M08
G81 Z-.5 F3. R.1            (Drills at: X0 Y0 P000.000)
DPRNT [ ]                   (Make certain Haas Input Buffer is Clear )
G04 P64
#100 = 90.                  (Example of correct Macro substitution)
DPRNT [ZS#100[33] ]         (Loads Step Size 090.000 into Step 00)
                            (Leading Zero converted to Space Param. must be off)

G04 P64
Mnn                         (Remote Cycle Start moves to P090.000, sends M-FIN)
G04 P250
X0                          (Drills at: X0 Y0 P090.000)
G80                         (Cancels drill cycle)
PCLOS                       (Close FANUC serial port)
G00 Z0 H0
M05
M30
```

Upload / Download

The serial interface may be used to upload or download a program. All data is sent and received in ASCII code. Lines sent by the controller are terminated by a carriage return (CR) and line feed (LF). Lines sent to the controller may contain a LF, but it is ignored and the lines are terminated by a CR.

An upload or download is started from the Program mode with the G code displayed. To start an upload or download, press the minus (-) key while the G code is displayed and blinking. **Prog n** is displayed, where **n** is the currently selected program number. You can select a different program by pressing a number key and then Start to return to Program mode or Mode to return to Run mode. Or you can press the minus (-) key again and the display will show: **SEnd n** ,where **n** is the currently selected program number. You can select a different program by pressing a number key and then Start to begin sending that selected program. Or you can press the minus (-) key again and the display will show: **rEcE n** ,where **n** is the currently selected program number. You can select a different program by pressing a number key and then Start to begin receiving that selected program. Or you can press the minus (-) key again and the display will return to Program mode. Both uploading and downloading can be terminated by pressing the CLR button.

Programs sent or received by the controller have the following format:

Single Axis

%
N01 G91 X045.000 F080.000 L002
N02 G90 X000.000 Y045.000 F080.000
N03 G98 F050.000 L013
N04 G96 P02
N05 G99
%

Dual Axis Programs (Sent to Control)

%
N01 G91 S000.000 F065.000 G91 S999.999 F060.000
N02 G91 S-30.000 F025.001 G91 S-30.000 F050.000
N03 G97 L020
N04 G99
%

Dual Axis Programs (Received by Control) Mode dependant (M:A or M:B):

%
N01 G91 S045.000 F080.000 L002
N02 G90 S000.000 F080.000
N03 G98 F050.000 L013
N04 G96 P02
N05 G99
%

The controller will insert steps and re-number all required data. The P code is the destination of a subroutine jump for G code 96.

The % must be found before the controller will process any input and it will always begin output with a %. The N code and G code are found on all lines and the remaining codes are present as required by the G code. The N code is the same as the step number display in the controller. All N codes must be continuous starting from 1. The controller will always end output with a % and input to it is terminated by a %, N99 or G99. Spaces are only allowed where shown.

The controller will display “SEnding” as a program is sent. The controller will display “LoAding” as a program is received. In each case the line number will change as the information is sent or received. An error message will be displayed if bad information was sent, and the display will indicate the last line received. If an error occurs, make sure that the letter O was not inadvertently used in the program instead of a zero. Also see the “Troubleshooting” section.

When an RS-232 interface is used, it is recommended that the programs be written in Windows “Notepad”, or another ASCII program. Word processing programs, such as Word, are not recommended, as they will insert extra, unnecessary information.

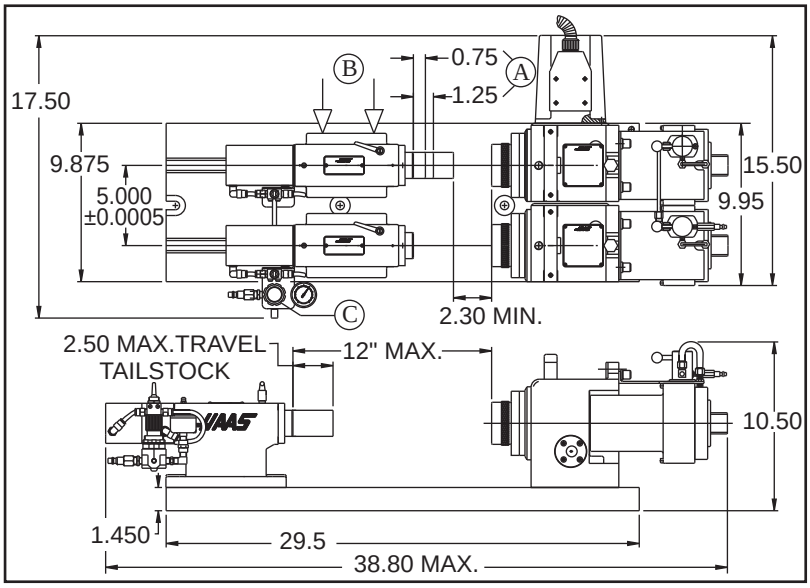
Upload/Download functions do not need an axis select code as they are manually initiated by an operator at the front panel. However, if the select code (Parameter 21) is not zero, an attempt to send a program to the control will fail, as the lines do not begin with the correct axis select code.

HA2TS Setup and Operation (HA5C)

1. Position the tailstock so that the tailstock quill is extended between 3/4” to 1-1/4”. This will optimize spindle rigidity (item A).

2. Tailstock to HA5C head alignment can be accomplished by simply pushing the tailstock (item B) to one side of the T-slots prior to tightening the flange nuts to 50 ft-lbs. Precision locating pins mounted on the bottom of the tailstock allow for quick alignment, since the pins are parallel within 0.001” of the spindle bore. However, make sure both tailstock units are positioned to the same side of the T-slot. This alignment is all that is needed for the recommended use of live centers.

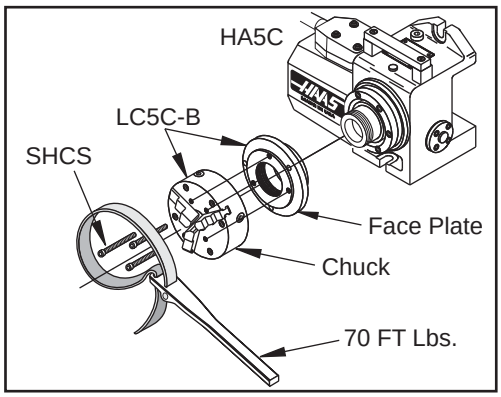
3. Set the air regulator (item C) between, 5-40 psi., with a maximum 60 psi. It is recommended is to use the lowest air pressure setting that provides the required rigidity for the part.



Use of Collets, Chucks, and Face Plates

HA5C – The unit accepts standard 5C collets and step collets. When inserting the collets, align the keyway on the collet with the pin inside the spindle. Push the collet in and turn the collet drawbar clockwise until proper collet tightness is obtained.

Chucks and face plates use the 2 3/16-10 threaded nose on the spindle. Chucks that are have no more than a 5” diameter and weigh less than 20 pounds are recommended. Pay special attention when installing chucks, always make sure that the thread and the outside diameter of the spindle are free of dirt and chips. Apply a thin coating of oil to the spindle, and screw the chuck on gently until it seats against the rear of the spindle. Tighten the chuck to approximately 70 ft.-lb with a strap wrench. Always use a firm, steady pressure to remove or install chucks or face plates, otherwise damage to the indexing head may result.



HA5C Chuck Installation

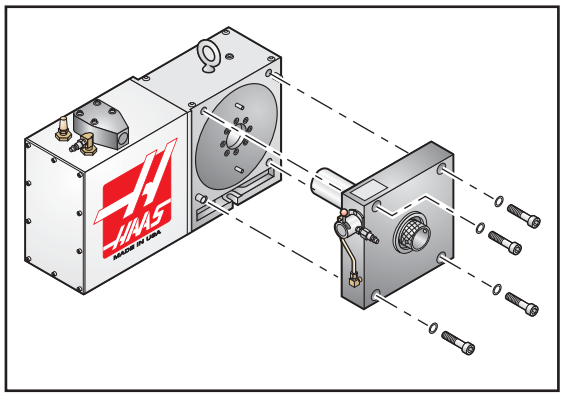
WARNING !

Never use a hammer or pry bar to tighten the chuck, this will damage the precision bearings inside your unit.

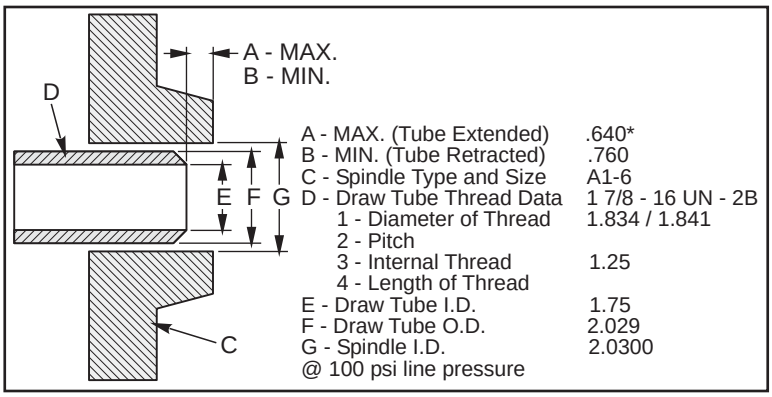
A6AC Air Collet Closer (HRT)

The A6AC collet closer bolts to the back of the HRT A6 (See the following illustration). The drawbar and collet adapters are designed to mate with the Haas A6/5C spindle nose. The optional A6/3J and A6/16C can be obtained from a local tooling distributor. Failure to follow the A6AC installation instructions may result in thrust bearing failure.

NOTE: A special drawtube adapter is required for the 16C and 3J. Make sure to supply the tooling distributor with spindle/drawbar details as shown.



A6AC collet closer shown mounted to an HRT A6



Drawtube to spindle dimensions (extended/retracted)

Clamping Force and Air Supply

The A6AC is a 1-3/4” diameter thru-hole type closer, adjustable from the rear. It holds parts using spring force to provide up to 0.125” of longitudinal movement and up to 5000 lbs. of draw force at 120 psi.

Adjustment

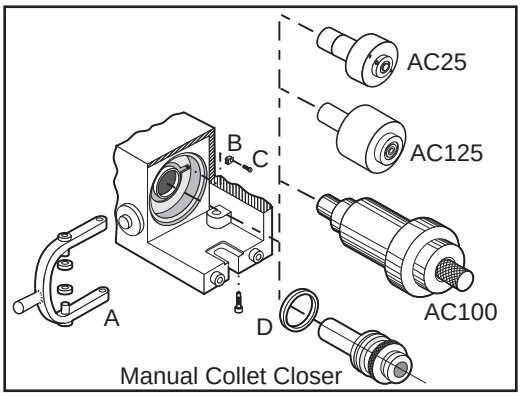
To adjust the collet closer, align a collet with the keyway, push the collet into the spindle, and turn the draw bar clockwise to pull the collet in. To make the final adjustment, place a part in the collet, turn the air valve to the Unclamped position to charge the cylinder and compress the spring mechanism. Tighten the draw bar until it stops, then loosen it 1/4-1/2 turn and turn the air valve to the “Clamped” position (adjusted for maximum clamping force). To reduce clamping force, back off on the draw bar or reduce the air pressure before adjusting.

Air Collet Closers

Model AC25 / AC100 / AC125 for the HA5C, and T5C

The **AC25** is a non thru-hole type closer that holds parts using air pressure, which provide up to 3000 pounds of draw force, depending on air pressure supplied. The unit provides .03” of longitudinal movement so diameter variations of up to .007” can be clamped securely without readjustment.

The **AC100** is a thru-hole type closer that holds parts using spring force, which provides up to 10,000 pounds of draw force. The unit provides .025” of longitudinal movement so diameter variations of up to .006” can be clamped securely without readjustment. Set air pressure between 85 and 120 psi.



Replacing the manual collet closer with a model AC25, AC100, or AC125 Air Collet Closer

The **AC125** air collet closer has a 5/16” thru-hole that will allow small diameter stock to extend out the back of the unit. The **AC125** also has a large diameter counterbore in the drawtube that allows stock to pass through a standard 5C collet up to approximately 1.6” out the rear of the collet. This also allows the use of most standard collet stops. The **AC125** uses air pressure to provide up to 10,000 lb. of draw force (adjustable through a customer supplied air pressure regulator). The drawtube travel of 0.060” allows the unit to securely clamp parts with up to .015” variation in diameter without readjustment.

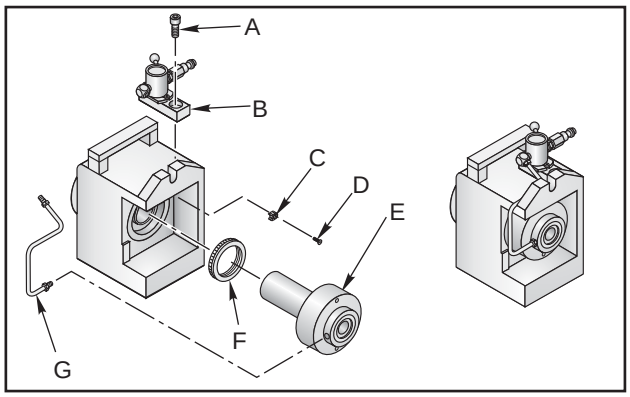
Manual Collet Closer Removal (Model AC25 / AC100 / AC125)

Before installing the an air collet closer on the unit, you must first remove the manual collet closer assembly (Item B). Remove the top and bottom mounting bolts for the handle (Item A) and slide the handle off the collet closer assembly. Remove the collet closer, slide the collet closer assembly out the back of the spindle. Remove the flathead screw (Item C) and locking pawl (Item B) and unscrew the spindle nut (Item D). (It may be necessary to use two 1/8" pins and a screwdriver to break the spindle nut loose.)

AC25 Collet Closer Installation

To install the AC25, install new spindle nut (Item F), locking pawl (Item C) and FHCS (Item D). Insert drawtube of assembled AC25 (Item E) into back of HA5C spindle and screw the main body onto the back of the spindle. Tighten with strap wrench to approximately 30 ft-lb. Mount valve assembly (Item B) to top of HA5C as shown using ½-13 SHCS (Item A). Assemble fittings of copper tube (Item G) between valve and fitting on back of collet closure and tighten.

CAUTION! The Model AC25 Collet Closer relies on air pressure to maintain clamping force and will release if the air supply is accidentally removed. If this presents a fail-safe problem, an air switch should be installed in-line to stop machining operations if the air supply should fail.



AC25 Air Collet Closer

AC25 Collet Installation

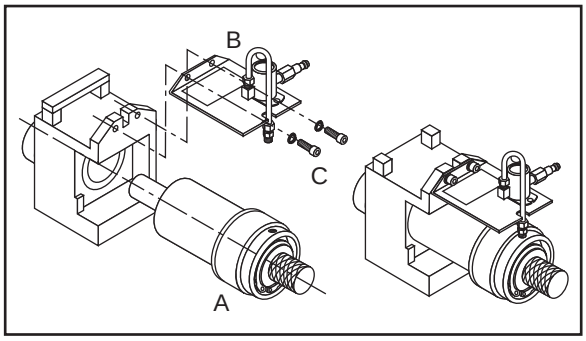
To install a collet, line the collet keyway up with the spindle key and insert the collet. There are two ways to turn the draw tube to adjust the collet:

1. A collet with a 11/64" or larger opening can be adjusted using a 9/64" hex wrench.

2. Collets smaller than 11/64" are adjusted by turning the drawtube with a pin through the slot. Look between the back face of the worm gear and collet closer to see the holes in the draw tube. It may be necessary to jog the spindle until they are visible. Use a 9/64 diameter pin to rotate the draw tube and tighten the collet. There are 15 adjustment holes, so it will take 15 steps to turn the draw tube one full revolution. Put a part in the collet and tighten until it grips the part then back the draw tube off ¼ to ½ turn. Not for multi-head HA5C units.

AC100 Collet Closer (HA5C only) Installation

To install the **AC100**, assemble the brass air fittings with the valve and slip ring as shown in the figure below. When assembling the fittings, ensure they are all tight and square with the valve. Mount the valve to the bracket with the 10-32 x 3/8" BHCS. Bolt the bracket to the back of the indexing head with the ¼-20 x ½" SHCS and ¼" split lock washers. Ensure the slip ring and bracket are square so that the unit can rotate freely before tightening down the bracket. Connect the valve and slip ring with the copper tubing and tighten down these fittings.



AC100 Air Collet Closer

CAUTION! The **AC100** Collet Closer is designed to clamp parts when the air pressure is Off. Do not index while air pressure is applied to the unit; this causes excessive loading on the slip ring and will damage the motor.

AC100 Collet Installation

NOTE: The air pressure for the AC100 should be set between 85 and 120 psi.

Align the collet keyway with the spindle key and insert the collet. Hold the collet in place and tighten down the drawbar by hand. With the air pressure valve **on**, place your part in the collet and tighten the drawbar until it stops. Back off ¼-½ turn then turn the air **off**. The collet will clamp your part with maximum holding power.

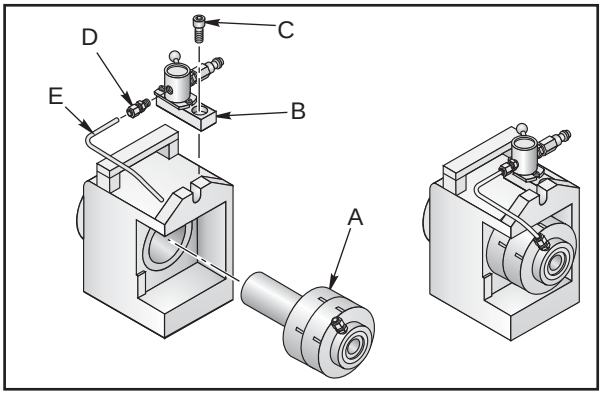
For thin-walled or fragile parts, turn the air pressure off, place your part in the collet, and tighten the drawbar until it stops. This is your starting point for adjustment at the loose end. Turn the air pressure valve on and tighten the drawbar ¼-½ turn. Turn the air off and the collet will begin to clamp your part. Repeat until you achieve the desired amount of clamping force.

AC125 Collet Closer

Carefully insert the drawtube of the assembled AC125 (Item A), into the back of the HA5C spindle and screw the main body onto the back of the spindle.

CAUTION: Hitting the collet assembly against the spindle can cause damage to the threads on the end of the draw bar.

Tighten with a strap wrench to approximately 30 ft./lbs. Mount the valve assembly (Item B) to the top of the HA5C as shown using 1/2-13 SHCS (Item C). Assemble the fitting (Item D) part number 58-16755 and copper tube (Item E) part number 58-4059 between the valve and fitting on the back of the collet closure and tighten.



AC125 Air Collet Closer.

Never use a hammer to remove or install these items. The shock will damage the precision bearings and gears inside the unit.

Collet Installation (Model AC125)

All collets used with the **AC125** must be clean and in good condition. To install a collet in the **AC125**, align the collet keyway with the spindle key and insert the collet. Insert a 5/16” hex wrench into the hex in the back of the drawtube, and turn the drawtube to engage the collet. Tighten the drawtube until it grips the part, and then back off approximately 1/4 turn. This will be a good starting point for fine-tuning the grip range.

Collet Closer Removal (Model AC25 / AC100 / AC125)

Air collet closers fitted at the factory are not intended to be removed. However, if servicing is required, use a woven strap wrench to remove the collet assembly. Do not use a hammer or impact wrench to remove the closer bodies; damage may occur to the gear and bearing sets. When re-installing the collet closer, use a strap wrench and tighten to approximately 30 ft-lb.

Collet Sticking

NOTE: To prevent excessive wear and collet sticking, make sure collets are in good condition and free from burrs. A light coat of Molybdenum grease on the collet wear surfaces will extend the life of the spindle/collet and help prevent sticking.

When using the **AC25**, releasing a collet is accomplished by removing the air supply. The collet is then pushed out by a heavy spring inside the air collet.

The **AC100** uses shop air to move the drawbar forward and release the collet. Increasing the air pressure can help free the collet when it sticks; however, do not exceed 150 psi.

The **AC125** uses shop air to pull the drawtube in, and a heavy internal spring to push the drawtube out and release the collet. If, after repeated use, the spring will not push the collet out, use one of the following methods to remove the collet and lubricate the outside of the collet with a light grease before re-inserting:

1. If the three-way air valve provided with the unit becomes clogged, the exhaust airflow may be restricted, which may cause the collet to stick in the taper. If this situation arises, leave the valve in the clamped position, and connect and disconnect the air supply several times in rapid succession.
2. If the above procedure does not free the collet, switch the valve to the unclamped position, then gently tap the back end of the drawtube with a plastic-faced mallet.

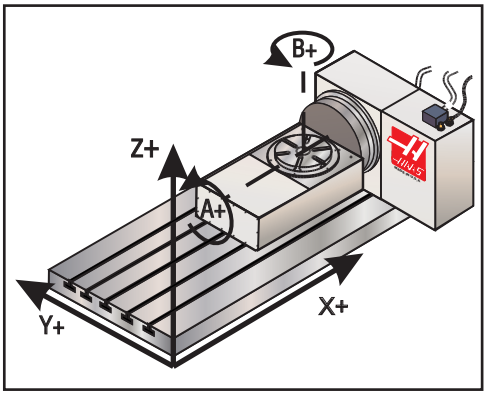
HA5C Tooling Locations

The HA5C is equipped with tooling points in order to speed setups. One of the most time-consuming procedures in setup is aligning the head with the table. On the mounting surfaces are two 0.500” bored holes on 3.000” centers. The holes on the bottom surface are parallel to the spindle within 0.0005” per 6 inches and on center within ±0.001”. By boring matching holes in the tooling plate, setups become routine. Using tooling holes will also prevent the head from shifting on the mill table when the part is subjected to heavy cutting forces.

On CNC mills, a machined stepped plug of 0.500” diameter one side and 0.625” on the other comes with the Haas head. The 0.625” diameter fits into the T-slot of the mill table. This will give quick parallel alignment.

Dual Axes Coordinate System

The layout of the **A** and **B** axes of the Haas five-axis control are shown in the following figures. The **A**-axis is rotary motion about the **X**-axis, while the **B**-axis determines rotary motion about the **Y**-axis. The right hand rule can be used to determine axis rotation for the **A** and **B** axes. When placing the thumb of the right hand along the positive **X**-axis, the fingers of the right hand will point in the direction of tool movement for a positive A-axis command. Likewise, when placing the thumb of the right hand along the positive **Y**-axis, the fingers of the right hand will point in the direction of tool movement for a positive **B**-axis command. It is important to remember that the right hand rule determines direction of tool movement and not the table movement direction. For the right hand rule, the fingers will point opposite of the positive rotary table movement. Refer to the following figures.



Work coordinates (Positive direction).

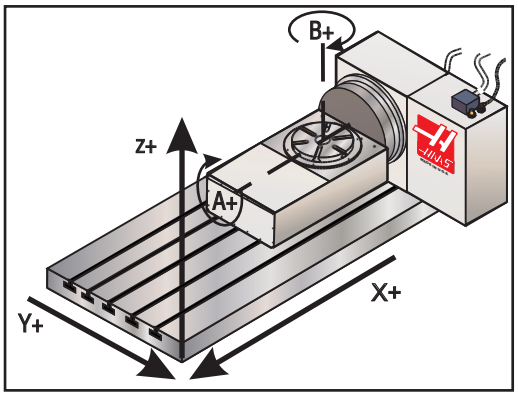


Table movement (Positive command).

NOTE: The previous figures represent one of many possible machine tool and table configurations. Different table movements are possible, for positive directions, depending on the equipment, parameter settings, or five-axis programming software being used.

THE FRONT PANEL DISPLAY

The front panel displays the program and mode for the rotary unit. The display consists of 4 lines with up to 80 characters per line. The first line displays current spindle position (POS), followed by the G code display (G) then the loop count display (L).

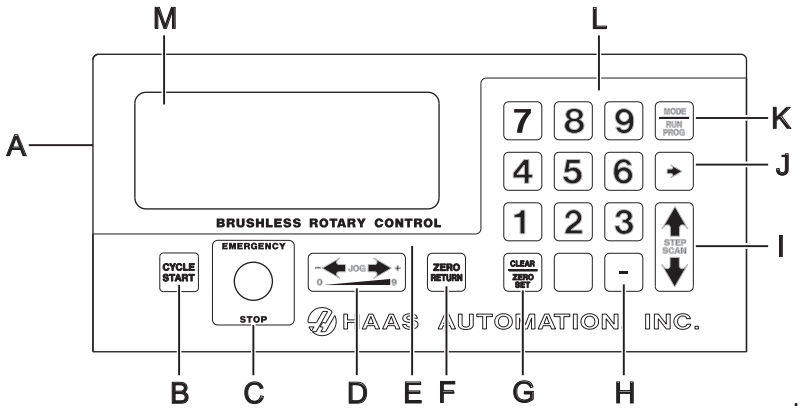
The second and third lines display the step number (N) followed by the step size, then the feed rate (F).The left three characters,on the second or third line, are the step number and go from 1 to 99. They cannot be changed with the numeric keys and are selected by using the Step Scan arrow buttons.

The fourth line is the control statud line. It provides three control operations: RUN, STOP, ALARM. These operations are followed by the percentage of load, and the last status of the air brake.

Every step (or block) contains several pieces of information that are necessary for the program, and they are displayed simultaneously. The data is preceded by a letter(s) to indicate what type of information is displayed.

Successive pushes of the right arrow button will cause the display to cycle to the next register, that is, Position - Step Size - Feed Rate - Loop Count - G Code - Position - etc. In Run mode, the right arrow button selects among any of these five displays. In Program mode, all of these but the position may be displayed.

Think of the display as a window that shows only one command of the program at a time. The Display Scan button allows you to scan sideways and see all the information for a single step. Pushing the Display Scan button shifts the window one place to the right, looping from left to right at the end of the row. Pushing the up arrow displays the previous step, the down arrow displays the next step. Using these three keys, it is possible to scan to anywhere in the program. If a new number is entered in that position, the number is stored when scanned to another position or returned to Run mode.



A) Main Power switch to turn the unit on (back panel).

B) Cycle Start – Begins a step, stops a continued operation, inserts a step, or turns the servo on.

C) Emergency Stop – Turns off the servo when on and aborts the step in progress.

D) Jog – Causes the servo to move in either the forward or backward direction at a rate defined by the last numeric key pressed.

E) Load meter – Indicates (%) of spindle load. A high load indicates excessive load or workpiece support misalignment. Hi-LoAd or Hi Curr alarms may occur if not corrected. Damage to the motor or table may result if excessive loads continue (See “Troubleshooting” section)

F) Zero Return – Causes the servo to return to the Home position, search for mechanical Home, delete a step, or move forward to the mechanical offset.

G) Zero Set – Clears the entered data, resets program to 0, or defines the present servo position as Home.

H) Minus Key – Selects negative step values or Prog/Upload/Download functions.

I) Step Scan – Scans step numbers from 1 through 99 in RUN mode. It scans up/down in Program mode.

J) Display Scan – Scans the display to show either the screen with Position, Step Angle, Feed Rate, Loop Counts, G Code, and the status line, or position and status line in RUN mode. It scans left/right in Program mode.

K) Mode/Run Prog – Switches from Run mode to Program mode (with blinking display).

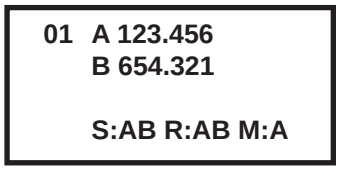
L) Data entry keys and jog speed selection.

M) 4-line display – Show current data, i.e. spindle position, Feedrates, Loop Count, Step Angle, G Code and Present step number (Step numbers 1 to 99 are available). Also displays errors when powered up.

There are twenty characters that can be displayed on each line of the four lines in the display. The left two characters are the step numbers, from 1 to 99. They cannot be changed with the numeric keys and are selected by using the Step Scan arrow buttons. Every step (or block) contains several pieces of information that are necessary for your program, but they cannot be displayed simultaneously. Use the Display Scan button to view the data for each step. The data is preceded by a letter to indicate what type of information is being displayed. For example, if an **F** precedes the number, the displayed data is for feed rates. The “Display Scan” key is used to move from one display to the next.

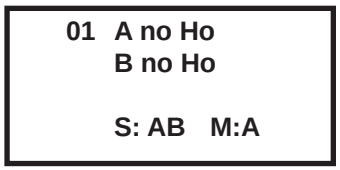
Dual Axis Rotary Products

Three variables at the bottom of the display represent the operation the dual control is in. The “S:” means servo on. The “R:” means running, and the “M:” means the axis mode. Each is followed by an axis letter A or B. When the servo is on and both axes are enabled, the control displays “S:AB R: M:A”. When both axes are running the control displays “S:AB R:AB M:A”.

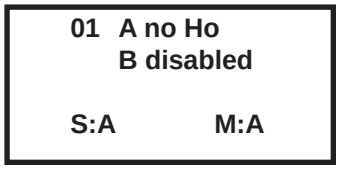


Display Examples

The graphic to the right show what is displayed when the control is powered up and “Cycle Start” is pressed.



The display shows that the A and B axes have not been homed and that both are enabled (Parameter 47 = 0). The “S:” is short for “Servo On”, and “AB” represents the axis that has its servo on. The “M:” represents the axis mode the control is in and the following letter(s) represent the axis available for operation.



Both A and B axes are enabled when Parameter 47 is set to 0. The A-axis is disabled when it is set to 1 and the B-axis is disabled when it is set to 2. The example to the right show what is displayed when Parameter 47 set to 2.

In Program mode, the blinking numbers can be edited. Use the Display Scan button to move sideways, to view all the information for that step. Pushing the Display Scan button shifts the window one place to the right, looping from left to right at the end of the row. Push the up arrow to view the previous step, and the down arrow to view the next step. If a new value is entered, it is saved once a new step is selected, or when the rotary control is returned to Run mode.

Turning the Servo On

There is a single 115V AC (220V AC - TRT units) supply required by the controller. Ensure that the front panel power switch is turned off and connect the motor cable(s) from the table/indexer and the power cord. Turn the controller on. The unit will go through a self-test and then display.

If any other message is displayed, refer to the “Error Codes” section of this manual. The numbers only remain in the display for about one second.

The “Por On” message indicates that the servos (motors) are turned off (this is normal).

Pressing any key will allow you to continue operation but the low battery may have caused loss of your program parameters. Press the front panel Start switch once. The panel now indicates: **01 no Ho**

This indicates the motor(s) are now powered but the zero position is not defined (there is no home position).

Finding the Zero Position

Press the Zero Return button to start the automatic homing operation. When the table/indexer stops, the display indicates: **01 Pnnn.nnn**

Zero Return function will depend on the selected axis for 2-axis rotary tables i.e. M:A or M:B (use the **right** arrow key to select the desired axis).

If the display shows a non-zero number, press the Clear button for three seconds.

Manually Finding The Zero Position

Use the left/right Jog switch to position the table to the position that you want to use as zero and then press and hold the Clear button for three seconds. The display should now indicate: **01 P 000.000**

This indicates that the zero position is established and the controller is ready to begin normal operations. If a different position is used as zero, jog the table to the new position and press the Clear button for three seconds. The display will again indicate: **01 P 000.000**

If the new Home position is cleared, the display will show a non-zero position. In this case, press the Zero Return button and the table will move to the pre-defined zero position.

Offsetting the Zero Position

Use the left/right Jog switch to position the rotary unit to the position to use as zero and press the Clear button for 3 seconds. The following is displayed: **01 P000.000**

Dual-axis units – Press the right arrow button to select the B-axis and repeat.

This indicates that the zero position is established and the controller is ready to begin normal operations. If a different position is used as zero, jog the indexer to the new position and press the Clear button for 3 seconds. The following is displayed: **01 P000.000**

If there is a zero offset defined, a non-zero number is displayed. In this case, press the Zero Return button once and the unit will move forward to the predefined zero position. For 2-axis units, press the right arrow key, to select the B (rotary) axis, and repeat.

NOTE: 2-axis units using a dual axis control will zero-return at a slower speed. To save time, jog the unit to a position close to zero, before turning the unit off.

Jogging

The rotary unit is jogged using the number buttons (0-9). Each number is a percent of the maximum speed. Jog speed is selected with the front panel number keys and is a fraction of the maximum feed rate.

Select the axis to jog using the right arrow button on 2-axis units.

If the control is set up for linear motion, there are both positive and negative travel limits possible. If a step is started which would have caused the control to exceed the travel limits, the following message is shown: **2 FAr**

The control will not execute the step. See Parameter 13 and 14 for the A-axis travel range, and Parameter 59 and 60 for the B-axis travel range.

Error Codes

A set of self tests are run when the control is turned on and the results may indicate a control fault. Intermittent low voltage errors or power failures may be the result of inadequate power to the controller. Use short heavy duty extension cords. Make sure that the supplied power is a minimum of 15 amps at the plug.

Blank front panel - Program CRC failure (bad RAM, or cycle power if bad ROM to RAM program transfer.)

E0 EProm - EPROM CRC error

Frt Pnel Short - Front panel switch closed or shorted

Remote Short - Remote Start switch closed and enabled, or remote CNC input shorted (remove cable to test)

RAM Fault - Memory fault

Stored Prg Flt - Stored program fault (low battery)

Power Failure - Power failure interrupt (low line voltage)

Enc Chip Bad - Encoder chip bad

Interrupt Flt - Timer/interrupt fault

1kHZ Missing - Clock generation logic failure (1 kHz signal missing)

Scal Cmp Lrge - Exceeding maximum allowed rotary scales compensation. HRT210SC only

0 Margin Small - (Zero margin too small) Distance between the home switch and the final motor position, after seeking home, is either less than 1/8 or greater than 7/8 of a motor revolution. This alarm occurs while homing the rotary table. Parameter 45, for the A-axis or Parameter 91 for the B-axis must be set properly. Use the default value (0) for the axis parameter (45 or 91) and add 1/2 of a motor revolution. 1/2 motor revolution is calculated by taking the value in Parameter 28 for the A-axis, or Parameter 74 for the B-axis and dividing by 2. Enter this value for parameter 45 or 91 and re-home the rotary table.

Servo Off Codes

At any time the servo (motor) is turned off,a reason code is displayed along with the following codes. An “A” or “B” may precede the code for TRT units. This is the reference to the axis that caused the fault.

Por On - Power just applied (or failed previously)

Servo Err Lrge - Servo following error too large (see Parameter 22 or 68)

E-Stop - Emergency stop

Software Fuse - Software fuse; Unit turned off due to overload condition (see Parameter 23 or 69)

RS-232 Problem - Remote RS-232 commanded off

Encoder Fault - Z channel fault (bad encoder or cable)

Scale Z Fault - Rotary scale Z channel fault (bad rotary scale encoder or cable) HRT210SC only

Z Encod Missing - Z channel missing (bad encoder or cable)

Scale Z Missing - Rotary scale Z channel missing (bad rotary scale encoder or cable) HRT210SC only

Regen Overheat - High line voltage

Cable Fault - Break detected in encoder cable wiring

Scale Cable - Break detected in rotary scale cable wiring (HRT210SC only)

Pwr Up Phase Er - Power up phase error

Drive Fault - An overcurrent or drive fault.

Enc Trans Flt - Encoder transition fault had been detected.

Indr Not Up - Platter not fully up (HRT320FB only). Can be caused by low air pressure.

Emergency Stop

Pressing the Emergency Stop button will turn the servo off, cause the spindle to decelerate and stop, and display, "**E-StoP**". If the last step was not completed, the control will remain on that step, rotary position has not been lost. To restart push Cycle Start twice (once to turn the servo on, and again to restart the step). The remote cycle start/finish will not function until the Emergency Stop is removed by pushing the Start button.

Programming the Controller

Introduction

Programming is done through the keypad on the front panel. The other buttons, on the right column of the keypad, are used for program control.

The Mode button selects between the "Run" mode and "Program" mode. The display is steady when in "Run" mode, and flashing on and off, when in "Program" mode.

"Run" mode is used to execute pre-programmed commands and "Program" mode is used to enter commands into memory. The servo loop can be turned on in either mode and will hold the motor to a commanded position when idle.

When the controller is first turned on, it is in "Run" mode but the servo is turned off. This is indicated by: **Por On**. Pressing the Start key will allow you to continue operation.

Always press and immediately release a button. Pushing and holding a button down will cause the button to repeat, however, this is useful when scrolling through a program. Some buttons have more than one function depending on the mode.

How Data is Stored in the Controller's Memory (TRT and TRs)

Step Number		Step Size	Feed Rate	Loop Count	G code
1	(A-axis)	90.000	80	01	91
	(B-axis)				
2	(A-axis)	-30.000	05	01	91
	(B-axis)				
3	(A-axis)	0	80	01	99
	(B-axis)				
through					
99	(A-axis)	0	80	01	99
	(B-axis)				

- your program data -

window — Pushing the **right** arrow key moves the window to the right.
Pushing the **up** arrow or **down** arrow keys moves the window up or down.

Entering a Step

Single axis

To enter a step into the controller's memory, press the Mode button, which puts the control in "Program" mode. The display will begin blinking and show a step size. Clear the last program by pressing and holding the Clear button for 3 seconds, if necessary.

To enter a 45º step, type ”45000”. The display will show, “N01 S45.000 G91” and on a line below, “F60.272 L001” (the F value is the max speed for the rotary table). Press the down arrow button. This will store the 45º step. Enter a feed rate of 20º per second, by type, “20000”. The display will show “01 F 20.000”. Return the controller to “Run” mode by, pressing the Mode button.

Start the 45º step by pressing the Cycle Start button, the table should move to the new position.

2-Axis

To enter a B-axis 45º step and a simultaneous rotary 90º step, press the right arrow and enter, “45000”. The display will show: **01 A 45.000** (with the M:A display).

Press the right arrow button. This will cause the 45º step to be stored and the feed rate to be displayed.

Start the 45º step by pressing the Cycle Start button. The indexer should move to the new position and, at the end of the step, the display should indicate:

01 P045.000
P090.000

To enter a feed rate of 80º per second, for the A-axis, press right arrow again and enter, “80000”. The display should now indicate: 01 A F 80.000.

Then press the right key twice and enter, “90000”. The display should now indicate: 01 B 90.000. Enter a feed rate of 80º per second for the B-axis, by pressing the right arrow again and enter, “80000”. The display should now indicate: 01 B F 80.000. To return the controller to the “Run” mode, press the Mode button. The display should now indicate:

01 A P000.000
B P000.000

Start the program by pressing the Cycle Start button. The indexer should move to the new position and, at the end of the step, the display should indicate:

01 A P045.000
B P090.000

Putting a Program Into Memory

Note: All data is automatically stored in memory when a control button is pressed.

Programming begins with ensuring that the controller is in Program mode and at step number 01. To do this, press the Mode button while the unit is not in motion. **The displays must be blinking**. Next, push and hold the Clear key for five seconds. You have now cleared the memory and are at step one and ready to begin programming, “01 000.000” is displayed. Please note that the memory does not have to be cleared each time data is entered or changed. Data in the program can be changed simply by writing new data over old.

Seven programs can be stored in a single-axis control (numbered 0-6) and 4 can be stored in a dual-axis (0-3). To access a program, press the minus key while showing a G code. The display will change to: Prog n. Press a number key to select a new program and then press the Mode key to return to Run mode or the start key to continue with the Program mode. Each one of the possible 99 steps in a program must contain a G code (G) and one of the following:

a) Step size or position command shown as a number with possible minus sign,
b) Feed rate shown with a preceding **F**
c) Loop count shown with a preceding **L**
d) Subroutine destination with a preceding **Loc**

To display the additional codes associated with a step, press the **right** arrow key.

Some of these entries are not allowed for particular G codes and either cannot be entered or are ignored. Most steps are incremental position commands and this is the default G code (91). The G codes 86, 87, 89, 92, and 93 should be used with the CNC relay function disabled (Parameter 1 = 2).

Enter your step size, in degrees, to three decimal places. The decimal places must always be entered, even if they are zero. Enter a minus sign (-) for opposite rotation. To edit a feed rate or loop count, push the **right** arrow key to view the entry and input the data.

S135.000 G91
F040.000 L001

Example lines of code

If you are programming for a part that does not use feed rates or loop counts, simply push the **down** arrow to go to the next step. Insert the G code and step size and move on to the next step. The step will automatically be set to the fastest feed rate and a loop count of one.

If you enter a wrong number, or one that is out of limits, the control will display: **Error**. To correct this, push the Clear button and enter the correct number. If you are entering a valid number and an error still appears, check Parameter 7 (Memory Protect).

When the last step is entered, an end code must be in the following step. Note: Steps 2 through 99 are set to the end code when the memory is cleared. This means that it is not necessary to enter G99. If you are removing steps from an existing program, make sure that you have entered a G99 after the last step.

NOTE: The HRT320FB does not use a feedrate; it indexes at maximum speed.

G Codes

G28 Return to home position (same as G90 with step 0)
G33 Continuous motion
G73 Peck cycle (linear operation only)
G85 Fractional circle division
G86 Turn CNC relay on
G87 Turn CNC relay off
G88 Return to Home position (same as G90 with step 0)
G89 Wait for remote input
G90 Absolute position command
G91 Incremental command
G92 Pulse CNC relay and wait for remote input
G93 Pulse CNC relay
G94 Pulse CNC relay and run next L steps automatically
G95 End of program/return but more steps follow
G96 Subroutine call/jump (destination is a step number)
G97 Delay by L count/10 seconds (down to 0.1 second)
G98 Circle division (circular operation only)
G99 End of program/return and end of steps

2-Axis Note: An axis with G95, G96, or G99 will be run regardless of the other axis' G-code commands. If both axes contain one of these G-codes, only the A-axis G-code will run. Each step will wait for the slower axis to finish all its loops before going to the next step. When G97 is programmed for both axes, the amount of delay is the sum of both delays.

Continuous Motion

G33 uses the Cycle Start button to start continuous motion. When the button is held, G33 motion continues until the button is released. An M-Fin signal from the CNC control is connected to the "Remote Cycle Start", and an arbitrary feed rate is entered in the feed rate field. The direction of G33 motion is clockwise when the step size is set to 1.000 and counter-clockwise when it is set to –1.000. The loop count is set to 1.

Absolute / Incremental Motion

G90 and **G91** can be used for absolute (**G90**) or incremental (**G91**) positioning. G90 is the only command allowing absolute positioning. Note that G91 is the default value and provides incremental motion.

G28 and G88 both provide for a programmed home command. The entered feed rate is used to return to the zero position.

Feed Rates

The feed rate display ranges between 00.001 and the maximum for the rotary unit (see table). The feedrate value is preceded by an **F** and displays the feed rate that will be used for the selected step. The feed rate corresponds to degrees rotated per second. For example: A feed rate of 80.000 means the platter will rotate 80° in one second.

Maximum Feed Rates

270.000 for HA5C
80.000 for HRT 160,
60.000 for HRT 210
50.000 for HRT 310
50.000 for HRT 450
270.000 for TRT

Loop Counts

Loop Counts allows a step, to repeat, up to 999 times, before going on to the next step. The loop count is an “L” followed by a value between 1 and 999. In “Run” mode, it displays the remaining loop counts for the selected step. It is also used in conjunction with the Circle Division function to enter the number of divisions in the circle from 2 to 999. The Loop Count specifies the number of times to repeat a subroutine, when used with G96.

Subroutines (G96)

Subroutines allow repetition of a sequence up to 999 times. To “call” a subroutine, enter G96. After entering 96 move the blinking display 00 preceded by Step# registered to enter the step to jump to. The control will jump to the step called out in the Step# register, when the program reaches the G96 step. The control will execute that step and the ones following until it until a G95 or G99 is found. The program then jumps back to the step following the G96.

A subroutine can be repeated by using a the loop count of a G96. To end the subroutine, insert either a G95 or G99 after the last step. A subroutine call is not considered a step by itself since it executes itself and the first step of the subroutine. Note: Nesting is not permitted.

Delay Code (G97)

G-code 97 is used to program a pause (dwell) in a program. For example, programming a G97 and setting L = 10 will produce a 1 second dwell. G97 does not pulse the CNC relay at step completion.

Circle Division

Circle division is selected with a **G98** (or **G85** for TRT units). The **L** defines how many equal parts a circle is divided into. After the **L** count steps, the unit will be in the same position it started from. Circle division is only available in the circular modes (i.e., Parameter 12 = 0, 5, or 6). **G85** selects division of an angle other than 360° for dual-axis units. Dual axis units must have one of the axis in non-zero stop mode to move, and the other axis must have a zero stop.

Auto Continue Control

If Parameter 10 is set to 2, the control will execute the entire program, and stop when the G99 is reached. The program can be stopped by pressing and holding Cycle Start until the current step is finished. To restart the program press Cycle Start again.

Inserting a Line

A new step is inserted into a program by pressing and holding Cycle Start for three seconds while in Program mode. This will move the current step, and all following step, down and a new step inserted with default values. **Note:** Subroutine jumps must be renumbered.

Deleting a Line

A step is deleted from a program by pressing and holding the Zero Return button for three seconds while in Program mode. It will cause all the following steps to move up by one. **Note**: Subroutine jumps must be renumbered.

Default Values

For all rotary units the default values are:

000.000	(step size zero – **Single axis**)
A 000.000	(step size zero – **Dual axis**)
B 000.000	
F	(maximum feed rate defined by Parameters)
L	001
G	91 (incremental)

If an entry is cleared or set to 0 by the operator, the value will be changed, by the control, to the default value. All entries are stored when selecting the next display function, step number, or returning to Run mode.

Selecting a Stored Program

The program is selected by pressing the minus (-) button while a G code is displayed in Program mode. This changes the display to: Prog n. Press a number to select a new program, and then press the Mode button to return to Run mode, or the Cycle Start button to continuze with Program mode.

Clearing a Program

To clear a program (not including parameters), go to Program mode (press the Mode button if display is not blinking) and press and hold the Clear button for three seconds. The display will cycle through all 99 steps and set all but the first to G99. The first step is set to G91, step size 0, maximum feed rate, and a loop count of 1.

Operating Hints

1. To select another display, while in the Run mode, press the Display Scan button.
2. The program can be started at any step using the Up/Down scan keys.
3. Make sure the mill has the same number of M functions programmed as you have steps in the rotary control.
4. Do not program two M functions, one directly after another, in the mill to index the rotary control. This may cause a timing fault in the mill. Use a dwell of 1/4 second between them.

Simultaneous Rotation and Milling

G94 is used to perform simultaneous milling. The relay is pulsed at the beginning of the step so that the NC mill will go to the next block. The rotary control then executes the L steps without waiting for start commands. Normally the L count on the G94 is set to 1 and that step is followed by a step which is run simultaneous with an NC mill.

Spiral Milling (HRT & HA5C)

Spiral milling is the coordinated movement of the rotary unit and the mill axis. The simultaneous rotation and milling allows machining of cams, spiral, and angular cuts. Use a G94 in the control and add the rotation and feed rate. The control will execute G94 (signals the mill to proceed) and the following step(s) as one. If more than one step is required, use an L command. In order to spiral mill, the mill feedrate must be calculated so that the rotary unit and the mills axis will stop at the same time.

In order to calculate the mill feed rate, the following information needs to be addressed:

1. The angular rotation of the spindle (this is described in the part drawing).
2. A feed rate for the spindle (arbitrarily select a reasonable one, for example, five degrees (5°) per second).
3. The distance you wish to travel on X-axis (see part drawing).

For example, to mill a spiral that is 72° of rotation and move 1.500" on the X-axis at the same time:

1. Compute the amount of time it will take the rotary unit to rotate through the angle
   # of degrees / (feed rate of spindle) = time to index
   72 degrees / 5° per sec = 14.40 seconds for unit to rotate.

2. Compute the mill feed rate that will move the X distance in 14.40 seconds.
   (length to travel in inches/# of seconds of rotation) x 60 seconds = mill feed rate in inches per minute.
   1.500 inches/14.4 seconds = 0.1042 inches per second x 60 = 6.25 inches per minute.

Therefore, if the indexer is set to move 72° at a feed rate of 5° per second you will have to program the mill to travel 1.500 inches with a feed rate of 6.25 inches per minute for the spiral to be generated.

The program for the Haas control would be as follows:

STEP	STEP SIZE	FEED RATE (see previous feed rate table)	LOOP COUNT	G CODE
01	0	080.000 (HRT)	1	[94]
02	[72000]	[5.000]	1	[91]
03	0	080.000 (HRT)	1	[88]
04	0	080.000 (HRT)	1	[99]

The mill program would look like this:

```
N1  G00 G91              (rapid in incremental mode)
N2  G01 F10. Z-1.0       (feed down in Z-axis)
N3  M21                  (to start indexing program above at step one)
N4  X-1.5 F6.25          (index head and mill move at same time here)
N5  G00 Z1.0             (rapid back in Z-axis)
N6  M21                  (return indexer Home at step three)
N7  M30
```

Possible Timing Issues

When the unit executes a G94, a 250 millisecond delay is required before starting the next step. This may cause the mill axis to move before the table rotates, leaving a flat spot in the cut. If this is a problem, add a 0 to 250 milliseconds dwell (G04) in the mill, after the M function, to prevent mill axis movement. By adding a dwell, the rotary unit and the mill should start moving at the same time. It may be necessary to alter the feedrate on the mill to avoid timing issues at the end of the spiral. Do not adjust the feed rate on the rotary ontrol; the mill has a finer feed rate adjustment. If the undercut appears to be in the X-axis direction, increase (0.1) the mill feed rate. If the undercut appears in the radial direction, decrease the mill feed rate.

If the timing is off by several seconds such that the mill completes its movement before the indexer, and there are several spiral moves one right after another (as in retracing a spiral cut) may cause the mill to stop. The reason is the mill sends a cycle start signal (for next cut) to the rotary control before it has completed its first move; the rotary control will not accept another start command until it finishes the first. It is important to check the timing calculations when doing multiple moves. A way to verify this is to Single Block the control, allowing five seconds between steps. If the program runs successfully in Single Block and not in the continuous mode, the timing is off.

SINGLE AXIS PROGRAMMING

Example #1

Index the platter 90°.

1. Turn Power switch on (located on the rear panel).
2. Push the Cycle Start button.
3. Push the Zero Return button.
4. Push the Mode button and release. Displays will blink.
5. Push and hold the Clear button for five seconds. “01 000.000” displayed.
6. Enter 90000
7. Push Mode button. Steady displays.
8. Push Cycle Start to index.

Example #2

Index the platter 90° (Example #1, Steps 1-8), rotate at five degrees/sec (F5) in the opposite direction for 10.25 degrees, and then return home.

9. Push the Mode button. Displays blinking.
10. Push the Down Arrow once. You should be on Step 2.
11. Enter 91 on the key pad. Use Clear to erase mistakes.
12. Push the Display Scan button once.
13. Enter -10250 on the keypad.
14. Push the Down arrow once. The control is now on the feed display.
15. Enter 5000.
16. Push the down arrow once. The control is now on step 3.
17. Enter 88.
18. Push the up arrow four times. The control is now on step 1.
19. Push the Mode button. The display will become steady (not flashing).
20. Push the Cycle Start button three times. The unit should index 90 degrees (90°), slow feed in the opposite direction for 10.25 degrees (10.25°), then return home.

The following examples show the program as you would enter it into the control. We will assume each time that you have cleared out the memory. The bold-face type indicates data that to be entered into the controller.

Example #3

Drill a four-hole pattern, and then a five-hole pattern on the same part.

Step	Step Size	Feed Rate (see previous feed rate table)	Loop Count	G Code
01	90.000	270.000 (HA5C)	4	91
02	72.000	270.000 (HA5C)	5	91
03	0	270.000 (HA5C)	1	99

Example #3 could have also been done using Circle Division.

Step	Feed Rate (see previous feed rate table)	Loop Count	G Code
01	270.000 (HA5C)	4	98
02	270.000 (HA5C)	5	98
03	270.000 (HA5C)	1	99

Example #4

Index 90.12°, start a seven-hole bolt pattern, and then return to the zero position.

Step	Step Size	Feed Rate	Loop Count	G Code
01	90.120	270.000	1	91
02	0	270.000	7	98
03	0	270.000	1	88
04	0	270.000	1	99

Example #5

Index 90°, slow feed for 15°, repeat this pattern three times, and return home.

Step	Step Size	Feed Rate	Loop Count	G Code
01	90.000	270.000	1	91
02	15.000	25.000	1	91
03	90.000	270.000	1	91
04	15.000	25.000	1	91
05	90.000	270.000	1	91
06	15.000	25.000	1	91
07	0	270.000	1	88
08	0	270.000	1	99

This is the same program (Example #5) using subroutines.

Step	Step Size	Feed Rate	Loop Count	G Code
01	0	Step # [4]	3	96
02	0	270.000	1	88
03	0	270.000	1	95
04	90.00	270.000	1	91
05	15.00	25.000	1	91
06	0	270.000	1	99

Example #5, with subroutines, explanation:

Step #1 tells the control to jump to Step #4. The control does steps #4 and #5 three times (loop count “3” in step 1), Step #6 marks the end of the subroutine. After finishing the subroutine, the control jumps back to the step following the “G 96” call (in this case, Step #2). Since Step #3 is not part of a subroutine, it marks the end of the program and will return the control to Step #1.

Using subroutines in Example #5 saves two program lines. However, to repeat the pattern eight times, a subroutine would save twelve lines, and only the loop count in Step #1 would change to increase the number of times to repeat the pattern.

As an aid in programming subroutines, think of the subroutine as a separate program. Program the control using “G96” when you want to “call” the subroutine. Complete the program with an End 95 code. Enter the subroutine program and note the step it begins with. Enter that step in the LOC area of the G96 line.

Example #6

Index 15, 20, 25, 30 degrees, in sequence, four times and then drill a five-hole bolt pattern.

Step	Step Size	Feed Rate	Loop Count	G Code
01	0	Loc 4	4	96
02	0	270.000 (HA5C)	5	98
03	0	270.000 (HA5C)	1	95

Main program above Steps 01-03 - Subbroutine steps 04-08

04	15.000	270.000 (HA5C)	1	91
05	20.000	270.000 (HA5C)	1	91
06	25.000	270.000 (HA5C)	1	91
07	30.000	270.000 (HA5C)	1	91
08	0	270.000 (HA5C)	1	99

Dual-Axis Programming

Example #1

Index the rotary table, not the tilt-axis, 90°.

1. Turn Power switch on.
2. Push the Cycle Start switch.
3. Push the Zero Return switch.
4. Push the Mode button and release. Display will blink.
5. Push and hold Clear button for five seconds. “G 91” displayed.
6. Push the Display Scan button until M:A is displayed (the “Steps” display).
7. Enter 90000. Use the Clear button to fix a mistake
8. Push Mode button. Steady displays.
9. Push Cycle Start to index.

Example #2

Index the rotary axis 90° (previous steps 1-9) and then index the tilt axis 45°.

10. Push the Mode button. Display will blink.
11. Push the Down Arrow once. This will move the control to step 2.
12. Enter 91 on the key pad.
13. Push the Display Scan button until M:B is displayed.
14. Enter 45000 on the key pad.
15. Push the Up Arrow button once. Move the control to step 1.
16. Push the Mode button. Steady displays.
17. Push the Cycle Start switch; the table moves to 90°. Push Cycle Start again and the tilt-axis moves to 45°.

The following examples show the program as it is entered into the control. It is assumed that the memory is cleared.

Example #3

Tilt the rotary table 30°, then drill a four-hole pattern, and then drill a five-hole pattern on the same part.

Step	Mode (M:)	G Code	Step Size	Feed Rate	Loop Count
01	A	91	000.000	080.000	1
	B	91	30.000	080.000	1
02	A	91	90.000	080.000	4
	B	91	000.000	000.00	4
03	A	91	72.000	080.00	5
	B	91	000.000	080.000	5
04	A	99	000.000	080.000	1
	B	99	000.000	080.000	1

Step	Mode (M:)	G Code	Step Size	Feed Rate	Loop Count
01	A	91	000.000	080.000	1
	B	91	30.000	080.000	1
02	A	98	000.000	080.000	4
	B	98	000.000	080.000	4
03	A	98	000.000	080.000	5
	B	98	000.000	080.000	5
04	A	99	000.000	080.000	1
	B	99	000.000	080.000	1

Example #4

Tilt the table 37.9°, index the rotary table 90.12°, start a seven-hole bolt pattern, and then return to the zero position.

Step	Mode (M:)	G Code	Step Size	Feed Rate	Loop Count
01	A	91	000.000	080.000	1
	B	91	37.900	080.000	1
02	A	91	90.120	080.000	1
	B	91	000.000	080.000	1
03	A	98	000.000	080.000	7
	B	98	000.000	080.000	7
04	A	88	000.000	080.000	1
	B	88	000.000	080.000	1
05	A	99	000.000	080.000	1
	B	99	000.000	080.000	1

Example #5

Tilt the table 22°, index it 90°, and slow feed 15°, repeating the pattern three times and then return home.

Step	Mode (M:)	G Code	Step Size	Feed Rate	Loop Count
01	A	91	000.000	080.000	1
	B	91	22.000	080.000	1
02	A	91	90.00	080.000	1
	B	91	000.000	080.000	1
03	A	91	15.00	25.000	1
	B	91	000.000	080.000	1
04	A	91	90.00	080.000	1
	B	91	000.000	080.000	1
05	A	91	15.00	25.000	1
	B	91	000.000	080.000	1
06	A	91	90.00	080.000	1
	B	91	000.000	080.000	1
07	A	91	15.00	25.000	1
	B	91	000.000	080.000	1
08	A	88	000.000	080.000	1
	B	88	000.000	080.000	1
09	A	99	END 99	080.000	1
	B	99	000.000	080.000	1

This is the same program (Example #5) using subroutines.

Step	Mode (M:)	G Code	Step Size	Feed Rate	Loop Count
01	A	91	000.000	080.000	1
	B	91	22.000	080.000	1
02	A	91	90.00	080.000	1
	B	91	000.000	080.000	1
03	A	98	15.00	25.000	1
	B	98	000.000	080.000	1
04	A	88	90.00	080.000	1
	B	88	000.000	080.000	1
05	A	99	15.00	25.000	1
	B	99	000.000	080.000	1
06	A	91	90.00	080.000	1
	B	91	000.000	080.000	1
07	A	98	15.00	25.000	1
	B	98	000.000	080.000	1

Example #5, with Subroutines, Explanation:

Step #2 tells the control to jump to step #5. The control does steps #5 and #6 three times, step #7 marks the end of the subroutine. After finishing the subroutine the control jumps back to the step following the “G 96” call or step #3. Since step #4 is not part of a subroutine, it marks the end of program and will return the control to step #3

The difference in using subroutines in example #5 saves two program lines. However, to repeat the pattern eight times would save twelve program lines, and only the loop count in step #2 would change to increase the number of times to repeat the pattern.

As an aid in programming subroutines, think of the subroutine as a separate program. Program the control using “G 96” when you want to invoke the previously written subroutine. When finished, complete the program with an End 95 code. Now enter your subroutine and note the step it begins with; enter that step in the “Loc” register of the “G 96” call.

Example #6

Tilt the table -10°, then index 15, 20, 25, 30 degrees in sequence four times and then drill a five-hole bolt pattern.

Step	Mode (M:)	G Code	Step Size	Feed Rate	Loop Count
01	A	91	000.000	080.000	1
	B	91	-10.000	080.000	1
01	A	96	000.000	Loc 4	4
	B	96	000.000	080.000	1
02	A	98	000.000	080.000	5
	B	98	000.000	080.000	1
03	A	95	000.000	080.000	1
	B	95	000.000	080.000	1
Main Program Seps 01-03 – Subroutine Steps 04-08					
04	A	91	15.000	080.000	1
	B	91	000.000	080.000	1
05	A	91	20.000	080.000	1
	B	91	000.000	080.000	1
06	A	91	25.000	080.000	1
	B	91	000.000	080.000	1
07	A	91	30.000	080.000	1
	B	91	000.000	080.000	1
08	A	99	000.000	080.000	1
	B	99	000.000	080.000	1

Programmable Parameters

There are parameters associated with each axis. These parameters are used to change the way the control and rotary unit operates. A battery, in the control, keeps the parameters (and the stored program) saved for up to eight years. To change a parameter, go to the Program mode by pressing the Mode button. Then press the up arrow and hold it at step 1 for three seconds. After three seconds, the display will change to the parameter entry mode.

Use the up and down arrow keys to scroll through the parameters. The right arrow key is used to alternate between parameters for the A and B axes for TRT units. Pressing the up/down arrow, right arrow, or Mode button will cause an entered parameter to be stored.

Some of the parameters are protected from being changed by the user, to avoid unstable or unsafe operation. If one of these parameters needs to be changed, call your dealer. The Emergency Stop button, must be pressed in before a parameter value can be changed.

To exit from parameter entry mode, press the Mode button to go to Run mode or push the down arrow key to return to Step 1.

Gear Compensation

The control has the ability to store a compensation table to correct for small errors in the worm gear. The gear compensation tables are part of the parameters. While parameters are displayed, press the right arrow button to select the gear compensation tables; there is both a plus (+) direction table and a minus (-) direction table. Use the right arrow button to display the + or - table. The gear compensation data is displayed as:

gP Pnnn cc **for plus table**
G- Pnnn cc **for minus table**

The nnn value is the machine position in degrees and the cc is the compensation value in encoder steps. There is a table entry every two degrees starting at 001 and going to 359. If your control has non-zero values in the gear compensation tables, it is recommended that you do not change them.

When the gear compensation tables are displayed, the up and down arrow button will select the next three consecutive 2° entry. Use the minus (-) and numeric buttons to enter a new value. The right button will select the six compensation values to edit. **Warning:** If the Emergency button is not pressed, when changes are made, the unit will move by the adjustment amount.

Clearing of parameters will set all of the gear compensation tables to zero. To exit the gear compensation display, press the Mode button; this returns the control to RUN mode.

When a table/indexer is using gear compensation, the values in Parameter 11, and/or Parameter 57, must be set to “0”.

Dual-Axis Travel Limits

Travel limits are defined by Parameters 13 and 14, for the A-axis and Parameters 59 and 60 for the B-axis. Changing these parameters will allow the tilt axis to rotate beyond the normal limits and may twist and damage the cables and air supply line.

Tangled cables should be resolved by turning off the control, disconnecting the cables and untwisting them manually.

Call your dealer before adjusting these parameters.

Parameter List

The B-axis of a dual axis unit is shown in parenthesis ( )

Parameter 1: CNC Interface Relay Control, range 0 to 2
- 0 : relay active during indexer motion
- 1 : relay pulsed for ¼ second at end of motion
- 2 : no relay action

Parameter 2: CNC Interface Relay Polarity & Aux. Relay Enable, range 0 to 3
- 0: normally open
- +1: normally closed cycle finish relay
- +2: to pulse optional second relay at end of program.

Parameter 3 (49): Servo Loop Proportional Gain, range 0 to 255 Protected!

Servo loop proportional gain increases current in proportion to the proximity to the target position. The farther from the target, the greater the current up to the maximum value in Parameter 40. A mechanical analogy is a spring that will oscillate past the target unless dampened by the Derivative gain.

Parameter 4 (50): Servo Loop Derivative Gain, range 0 to 99999 Protected!

Servo loop derivative gain resists motion effectively braking oscillations. This parameter is increased in proportion to the p gain.

Parameter 5: Double Remote Trigger Option, range 0 to 1

When this parameter is set to 1, the remote start must be triggered twice to activate the control. When it is zero, each activation of the remote input will trigger a step.

Parameter 6: Disable Front Panel Start, range 0 to 1

When set to 1, the front panel Start and Home buttons will not work.

Parameter 7: Memory Protection, range 0 to 1

When set to 1, no changes can be made to the stored program. Does not prevent changing parameters.

Parameter 8: Disable Remote Start range 0 to 1

The remote start input will not work

Parameter 9 (55): Encoder Steps Per Programmed Unit, range 0 to 99999

Defines the number of encoder steps required to complete one full unit (degree, inch, millimeter, etc.)

Example 1: An HA5C with a 2000 pulse per revolution encoder (with four pulses per line, or quadrature) and a 60:1 gear ratio would produce: (8000 x 60)/360 degrees = 1333.333 encoder steps. Since 1333.333 is not a whole integer, it must be multiplied by some number to clear the decimal point. Use Parameter 20 to accomplish this in the above case. Set Parameter 20 to 3, therefore: 1333.333 x 3 = 4000 (entered in Parameter 9)

Example 2: A HRT with 8192 line encoder (with quadrature), a 90:1 gear ratio and a final drive of 3:1 would produce: [32768 x (90 x 3)]/360 = 24576 steps for 1 degree of motion.

Parameter 10: Auto Continue Control, range 0 to 3
- 0 : Stop after each step
- 1 : Continue all looped steps and stop before next step
- 2 : Continue all programs until end code 99 or 95
- 3 : Repeat all steps until stopped manually

Parameter 11 (57): Reverse Direction Option, range 0 to 3 Protected!

This parameter consists of two flags used to reverse the direction of the motor drive and encoder. Start with a zero and add the number shown for each of the following selected options:
- +1 Reverse the direction of positive motor motion.
- +2 Reverse the polarity of motor power.

Changing both flags to the opposite state will reverse the direction of motor motion. Parameter 11 Cannot be changed on TR or TRT units.

Parameter 12 (58): Display Units and Precision (decimal location), range 0 to 6. Must be set to 1, 2, 3, and 4 if travel limits are to be used (including circular motion with travel limits).

0 : degrees and minutes (circular) Use this setting to program four digits of degrees up to 9999 and two digits of minutes.

1 : inches to 1/10 (linear)

2 : inches to 1/100 (linear)

3 : inches to 1/1000 (linear)

4 : inches to 1/10000 (linear)

5 : degrees to 1/100 (circular) Use this setting to program four digits of degrees up to 9999 and two digits of fractional degrees to 1/100

6 : degrees to 1/1000 (circular) Use this setting to program three digits of degrees up to 999 and three digits of fractional degrees to 1/1000

Parameter 13 (59): Maximum Positive Travel, range 0 to 99999

This is the positive travel limit in units*10 (entered value loses last digit). It applies only to linear motion (i.e., Parameter 12 = 1, 2, 3, or 4). If it is set to 1000, positive travel will be limited to 100 inches. The entered value is also affected by the gear ratio divider (parameter 20).

Parameter 14 (60): Maximum Negative Travel, range 0 to 99999

This is the negative travel limit in units*10 (entered value loses last digit). It applies only to linear motion (i.e., Parameter 12 = 1, 2, 3, or 4). For examples see Parameter 13.

Parameter 15 (61): Backlash Amount, range 0 to 99

This parameter is used to compensate electronically for mechanical gear backlash. It is in units of encoder steps. Note that this parameter cannot correct mechanical backlash.

Parameter 16: Auto Continue Dwell, range 0 to 99

This parameter causes a pause at the end of a step when the automatic continuation option is used. The delay is in multiples of 1/10 second. Thus, a value of 13 will give 1.3 seconds of delay. Used primarily for continuous duty, allowing for motor cool down time and longer motor life.

Parameter 17 (63): Servo Loop Integral Gain, range 0 to 255 Protected!

If the integral is to be disabled during deceleration (for less overshoot), set Parameter 24 accordingly. Integral gain provides larger increases of current to achieve target. This parameter, set too high, will often cause a hum.

Parameter 18 (64): Acceleration, range 0 to 999999 x 10 Protected!

Defines how fast the motor is accelerated up to the desired speed. The value used is (Par 18)*10 in encoder steps/second/second. The highest acceleration is thus 655350 steps per second per second for TRT units. It must be greater than or equal to twice Parameter 19, usually 2X. The entered value = the desired value/Parameter 20 if a gear ratio divider is used. a lower value results in gentler acceleration.

Parameter 19 (65): Maximum Speed, range 0 to 999999 x 10

Defines the maximum speed (RPM of motor). The value used is (Par 19)*10 in encoder steps/second. The highest speed is thus 250000 steps per second for TRT units. It must be less than or equal to Parameter 18. If this parameter exceeds Parameter 36, only the smaller number is used. See Parameter 36 also. The entered value = the desired value/Parameter 20 if a gear ratio divider is used. Lowering this value results in reduced maximum speed (maximum motor RPM).

Standard Formula: degrees (inches) per sec X ratio (Parameter 9)/100 = entered value in Parameter 19.

Formula with Gear Ratio Divider: (Parameter 20): degrees (inches) per second X ratio (Parameter 9)/[ratio divider (Parameter 20) x 100] = entered value in Parameter 19.

Parameter 20 (66): Gear Ratio Divider, range 0 to 100 Protected!

Selects non-integer gear ratios for Parameter 9. If Parameter 20 is set to 2 or more, Parameter 9 is divided by Parameter 20 before it is used. If this parameter is set to 0 or 1, no change is made to Parameter 9.

Example 1: Parameter 9 = 2000 and Parameter 20 = 3, the number of steps per unit will be 2000/3 = 666.667, thus compensating for fractional gear ratios.

Example 2 (with a gear ratio divider Parameter 20 needed): 32768 encoder pulses per revolution X 72:1 gear ratio X 2:1 belt ratio/360 degrees per revolution = 13107.2. Since 13107.2 is non-integer we require a ratio divider (Parameter 20) set to 5 then: 13107.2 ratio = 65536 (Parameter 9) encoder steps/5 (Parameter 20) ratio divider.

Parameter 21: RS-232 Interface Axis Select, range 0 to 9

When zero, no remote RS-232 functions are available. When it is 1 to 9, that number is used to define the axis code for this controller. U is 1, V is 2, W is 3, X is 4, Y is 5, and Z is 6. 7 through 9 are other ASCII character codes.

Parameter 22 (68): Maximum Allowed Servo Loop Error, range 0 to 99999 Protected!

When zero, no maximum error limit test is applied to the servo. When it is non-zero, that number is the maximum allowed error before the servo loop is turned off and an alarm generated. This auto shut-off results in a display of: **Ser Err**

Parameter 23 (69): Fuse Level in %, range 0 to 100 Protected!

Defines a fuse level for the servo control loop. The value is a percentage of maximum power level available to the controller. It has an exponential time constant of about 30 seconds. If exactly the set level is output by the driver continuously, the servo will shut off after 30 seconds. Twice the set level will shut the servo off in about 15 seconds. This parameter is factory set and is usually set from 25% to 35% depending on the product. This auto shut-off results in a display of: **Hi LoAd.**

Warning!

Changes from Haas recommended values <u>will</u> damage the motor.

Parameter 24 (70): General Purpose Flags, range 0 to 4095 Protected!

Consists of five individual flags for controlling servo functions Start with a zero and add the number shown for each of the following selected options:

+1: Interpret Parameter 9 as twice entered value.
+2: Disable integral while decelerating (see Parameter 17)
+4: Disable integral when brake is engaged (see Parameter 17)
+8: Protection of parameters enabled (see Parameter 30)
+16: Serial interface disabled
+32: Start-up “Haas” message disabled
+64: Lower lag in compensation
+64: Elapsed time display allowed
+128: Disable Z channel encoder test
+256: Normally closed overtemp sensor
+512: Disable cable test
+1024: Disable rotary scale encoder cable test (HRT210SC only)
+2048: Disable rotary scale encoder Z test (HRT210SC only)

Parameter 25 (71): Brake Release Time, range 0 to 19 Protected!

If zero, the brake is not activated (i.e., always engaged); otherwise this is the delay time to release the air before the motor is started in motion. It is in units of 1/10 second. A 5 will thus delay for 5/10 second. (Not used in HA5C, and defaulted to 0.)

Parameter 26: RS-232 Speed, range 0 to 8

Selects data rates on the RS-232 interface. The HRT & HA5C parameter values and rates are:

0: 110	1: 300	2: 600	3: 1200	4: 2400
5: 4800	6: 7200	7: 9600	8: 19200	

The TRT always has this parameter set to 5, at a data rate of 4800.

Parameter 27 (73): Automatic Home Control, range 0 to 512 Protected!

All Haas Indexers use a home switch used in conjunction with the Z pulse on the motor encoder (one for each revolution of the motor) for repeatability. The home switch consists of a magnet (Haas P/N 69-18101) and proximity switch (Haas P/N 36-3002), which is of the magnetically sensitive transistor type. When the control is shut down and restarted, it will require the user to press the “Zero Return” button. The motor then operates slowly in a clockwise direction (as viewed from the platter of a rotary table) until the proximity switch is magnetically tripped, then backs up to the first Z pulse. (See parameter code options in parameter section for actual options.) Note that to reverse direction when seeking a home switch (if it currently moves away from the home switch during the home sequence), add 256 to the value in Parameter 27.

This parameter is used to customize the home control function of servo.

0: no automatic home functions available (no home switch)
1: only table zero position switch available
2: only Z channel home available
3: home on both Z channel and table zero switch
+4: home if inverted Z (determined by encoder used)
+8: home to zero position in negative direction
+16: home to zero position in positive direction
+24: home to zero position in shortest direction
+32: auto servo on at power on
+64: auto search for home at power on (have “auto servo on at power up” selected)
+128: for inverted Home switch (determined by home switch used)
+256: search for home in positive direction

Parameter 28 (74): Encoder Steps Per Motor Revolution, range 0 to 99999 Protected!

Used with the Z channel option to check the encoder accuracy. If Parameter 27 is 2 or 3, it is used to check that the correct number of encoder steps are received per revolution.

Parameter 29 (75) UNUSED

Parameter 30: Protection, range 0 to 65535

Protects some of the other parameters. Every time the controller is turned on, this parameter will have a new, random, value. If protection is selected (Parameter 24), the protected parameters cannot be changed until this parameter is set to a different value that is a function of the initial random value.

Parameter 31: CNC Relay Hold Time, range 0 to 9

Specifies the amount of time the CNC interface relay is held active at the end of a step. If zero, the relay time is ¼ second. All other values give the time in multiples of 0.1 second.

Parameter 32 (78): Delay Time for Engaging Brake, range 0 to 19 Protected!

Sets the amount of time delay between the end of a motion and engaging the air brake. It is a unit of 1/10 seconds. A “4” will thus delay for 4/10 second.

Parameter 33: X-on/X-off Enable, range 0 or 1

Enables the sending of the X-on and X-off codes via the RS-232 interface. If your computer needs these, this parameter should be set to 1. Otherwise, only the RTS and CTS lines can be used to synchronize communication. (See section on RS-232 Interface.)

Parameter 34 (80): Belt Stretch Adjustment, range 0 to 399 Protected!

Corrects for stretching in a belt if one is used to couple the motor to the load being moved. It is a count of the number of steps of motion that are added to the motor position while it is moving. It is always applied in the same direction as the motion. Thus, when motion stops, the motor will snap backward to take the load off the belt. This parameter is not used in an HA5C and is defaulted to 0.

Parameter 35 (81): Dead Zone Compensation, range 0 to 19 Protected!

Compensates for the dead zone in the driver electronics. It is normally set to 0 or 1.

Parameter 36 (82): Maximum Speed, range 0 to 999999 x 100 Protected!

Defines the maximum feed rate. The value used is (Par 36)*10 in encoder steps/second. The highest speed is thus 250000 steps per second for TRT units and 1,000,000 steps per second for HRT & HA5C units. It must be less than or equal to Parameter 18. If this parameter exceeds Parameter 19, only the smaller number is used. See Parameter 19 also.

Parameter 37 (83): Encoder Test Window Size, range 0 to 999

Defines the tolerance window for the Z channel encoder test. This much error is allowed in the difference between the actual encoder position and the ideal value when the Z channel is encountered.

Parameter 38 (84): Loop Second Dif Gain, range 0 to 9999

Servo loop second differential gain.

Parameter 39 (85): Phase Offset, range 0 to 9

Offset of encoder Z-pulse to zero degree of phasing.

Parameter 40 (86): Max Current, range 0 to 2047

Maximum peak current output to the motor. Units DAC bits. **Warning!** Changes to this parameter from Haas recommended values will damage the motor.

Parameter 41: Unit Selection

0 is no unit shown
1 Degrees (shown as “deg)
2 Inches (“in”)
3 Centimeters (cm)
4 Millimeters (mm)

Parameter 42 (88): Mtr Current Coefficnt, range 0 to 3

Filter coefficient for the output current.

0 is 0% of 65536
1 is 50% of 65536 or 0x8000
2 is 75% of 65536 or 0xC000
3 is 7/8 of 65536 or 0xE000

Parameter 43 (89): Elct Rev Per Mec Rev, range 1 to 9

Number of electrical revolutions of the motor per one mechanical revolution.

Parameter 44 (90): Exp Accel Time Const, range 0 to 999

Exponential acceleration time constant. Units are 1/10000 seconds.

Parameter 45 (91): Grid Offset, range 0 to 99999

The distance between the home switch and the final stopped motor position after homing, is added by this grid offset amount. It is modulus of Parameter 28, which means that if Parameter 45 = 32769 and Parameter 28 = 32768, then it is interpreted as 1.

Parameter 46: Beeper Duration, range 0 to 999

Length of beeper tone in milliseconds. 0-35 no tone. Default 150 milliseconds.

Parameter 47: HRT320FB Zero Offset, range 0 to 9999 For HRT320FB.

Angular value to offset zero position. Units are 1/1000 of a degree.

Parameter 48: HRT320FB Increment, range 0 to 1000 HRT320FB only

Angular value to control indexer increments. Units are 1/1000 of a degree

Parameter 49: Scale Steps Per Deg, range 0 to 99999 x 100 HRT210SC only

Converts the rotary scale steps into degrees to access values in the rotary compensation table.

Parameter 50: UNUSED

Parameter 51: Rotary Scale General Purpose Flags, range 0 to 63 HRT210SC only.
Consists of six individual flags for controlling the rotary encoder functions.

+1 - enable the use of the rotary scale

+2 - invert the direction of the rotary scale

+4 - negate the direction of the rotary scale compensation

+8 - use motor Z pulse when zeroing

+16 - display the rotary scale in steps and in HEX format

+32 - disable rotary scale compensation during brake.

Parameter 52: Dead Zone (Not used) HRT210SC only

Parameter 53: Rotary Multiplier, range 0 to 9999 HRT210SC only
Increases current in proportion to the proximity to the absolute rotary scale position. The farther from the absolute rotary scale target, the greater the current up to the maximum compensation value in Parameter 56. Alarm will be generated if exceeded, see Parameter 56.

Parameter 54: Scale Range, range 0 to 99 HRT210SC only
Selects non-integer ratios for Parameter 49. If Parameter 5 is set to 2 or more, Parameter 49 is divided by Parameter 54 before it is used. If this parameter is set to 0 or 1, no change is made to Parameter 49.

Parameter 55: Scale Steps Per Rev, range 0 to 999999 x 100 HRT210SC only
Converts the rotary scale steps into encoder steps. It is also used with the Z option to check the rotary scale encoder accuracy.

Parameter 56: Scale max Compensation, range 0 to 999999 HRT210SC only
The maximum number of encoder steps that the scale could compensate before alarm “rLS Err” occurs.

Troubleshooting

Troubleshooting a Working Interface on a CNC

If there are problems, try to isolate the problem by checking the Haas rotary control and the mill separately. There are only two signals and each one can be checked separately from the other. If the rotary unit stops indexing because of an interface problem, follow these simple checks:

1. Check The HAAS Control Remote Input Alone
Disconnect the remote cable from the back of the controller. Set the control to index a single step of 90º. Connect a continuity tester or a voltmeter (a digital meter may not be fast enough to sample the brief pulse) set for low ohms across pins 1 and 2; they are marked on the rear of the control as Finish Signal. It must show an open circuit, otherwise check relay Parameters #1 (should be 1) and #2 (should be 0). The relay must show an open circuit, with the control turned off, otherwise the relay is defective. Use a jumper wire to short pins 3 and 4 together, (They are marked on the rear of the control as “Cycle Start”). The unit must index, and at the end of the index, the voltmeter should deflect briefly toward low ohms or continuity. If this works as described, the problem is NOT in the rotary control but may be the interface cable or mill.

2. Check The CNC Cable Interface Alone
Check the signals from the CNC using your voltmeter. Note that the pin orientation is reversed. Execute an **M** function from the mill to rotate. The mill Cycle Start light should come on and stay on. Use the meter and check continuity across the Cycle Start pins (pins 3 and 4). Try not to short the test leads and pins against the shield of the male plug.

NOTE: Some mills may have a +12 to +24 volt signal on pin 4 to activate a rotary unit. Check if there is voltage between pin 4 and the ground, if the continuity test fails, this is also a valid Cycle Start signal. If there is voltage present on Pin 4, a Haas interface box must be used (Part # IB). Contact your dealer if there are questions on how to use the interface box.

To check the cycle finish signal, use a voltmeter test probe to short together pins 1 and 2 on the mill cable. The Cycle Start light on the mill should turn off.

If the tests (1 and 2) pass, there is a valid signals coming from the mill.

3. Check The HAAS Control And The Mill Together
Reset the mill by pressing the Reset button or turning it off. Connect the remote cable, then turn both the rotary unit and mill on. Once connected the rotary unit should remain idle. If the rotary unit moves, the Cycle Start signal from the mill is shorted. If it remains idle, execute or MDI an M function from the mill to index. Do not index from the program unless using single-block. If the rotary unit does not move, the mill is not outputting a signal or there is a break in the cable.

If the rotary unit indexes properly, ensure that the mill Cycle Start light goes out at the end of index. If the light does not go out, the Cycle Finish signal is not returning to the mill. This could be and open wire in the remote cable or a problem in cables that connect to the CNC.

If the unit works only in single block, but not in the Run mode, there may be a timing problem involving two M functions, or a simultaneous milling problem. Review the section on simultaneous milling. If there are two M functions, separate them with a dwell of ¼ second.

Symptom	Probable Causes	Remedy
Unit is turned on but the power switch is not illuminated.	Control is not receiving power.	Check power cord, fuse, and AC supply.
Front panel Start and Zero Return buttons do not work.	In PROGRAM mode, or Parameter 6 is set to 1.	Change Parameter 6 to 0. Set to RUN mode.
Error displays when trying to program.	Parameter 7 is set to 1.	Change Parameter 7 to 0.
Lo Volt or Por On appears while running, or erratic operation.	Power supply to control is inadequate.	Power source must be capable of 15 amps at 120V AC. Use shorter and/or heavier gauge cord.
Indexer runs through entire program without stopping.	Parameter 10 is set to 3.	Change Parameter 10 to 0.
Ser-Err (Servo Error) during first home find initiation, or upon indexing.	1. Faulty main cable or cable connector. 2. Driving a heavy load, or unit is jammed. 3. Check Parameter 25.	1. Check cable and motor fuse, replace if damaged. 2. Reduce workload weight and/or feed rates, and/or eliminate obstruction. 3. Parameter 25 must be set to 8 for HRT 160, 210, 450 (19 for HRT 310).
High load (HI LoAd) High Current (Hi Curr)	1. Fixture or workpiece is distorted, or rotary unit is jammed 2. Tailstock or workpiece support not properly aligned. 3. Heavy workload. 4. Brake does not release 5. Coolant-damaged conduit box 6. Shorted motor	1. Ensure fixture workpiece mounting surface is flat within .001”, and/or eliminate obstruction. 2. Align tailstock or support to table within .003 TIR . 3. Reduce feed. 4. Examine Brake solenoid valve, and replace if necessary. Air line kinked or exhaust muffler restricted. Clean muffler with solvent or replace. 5. Examine conduit box - replace if necessary. 6. Consult Haas Service Department.
Workpiece chatter during index or continuous cutting operations.	1. Brake not operative (HRT & TRT). 2. Excessive backlash. 3. Excessive wormshaft play.	Consult Haas Service department.
HA5C and A6 dead length collets sticking, and/or insufficient clamping force.	Excessive spindle/collet friction.	Lubricate spindle and collet with a Molybdenum disulfide grease.
Air leaking around brake disc-HRT&TRT.	Chips blown in between O-ring and brake disc.	Consult Haas Service department. (Do not use air gun around brake disc).
Oil leaking out exhaust muffler (TRT).	Brake air line pressure set too low (TRT).	Set air pressure to between 85 and 120 psi (TRT).
HRT320FB only – Display reads “Indr dn” and platter does not lift.	Insufficient air pressure, or platter face is prevented from lifting.	Check air pressure (60 psi min). Check for platter clearance or excessive weight of workpiece.
HRT (A6) – Dead length collets sticking, and/or insufficient clamping force.	Excessive spindle/collet friction.	Lubricate spindle and collet with a Molybdenum disulfide grease.
Air leaking around rear brake disk.	Chips blown in between O-ring and brake disk.	Contact Haas Service Department. Do Not use air gun around brake seal disk.

Routine Maintenance

The Haas rotary units require very little in the line of routine servicing. However, it is very important to perform these services to ensure reliability and long operating life.

Inspection of the Table (HRT & TRT)

To ensure that the table will perform accurately, a few points of inspection that should be performed occasionally. 1. The platter face runout 2. Platter I.D. runout 3. Worm play 4. Backlash between worm and gear 5. Backlash in the system 6. Popout (Face Gear units).

Platter Face Runout: To check the platter runout, mount an indicator to the body of the table. Position the stylus on the face of the platter and index the table 360°. The runout should be 0.0005” or less.

Platter I.D. Runout: To check the platter I.D. runout, mount the indicator to the table body. Position the stylus on the platter through-hole and index the table 360°. Runout should be 0.0005” or less.

Worm Play: Worm play will show up as backlash at the platter; therefore, worm play must be measured before meaningful backlash measurements can be made. Remove the air supply to the table. First drain the oil, then remove the worm housing cover from the side of the table. Mount an indicator to the table body with the sensing arm on the exposed end of the worm. Use an aluminum bar to rock the platter back and forth. There should be no detectable reading. Not applicable for the HRT210SHS.

Backlash Between Worm And Gear: To check the backlash between the worm and gear, the air supply must first be disconnected. Place a magnet on the face of the platter at a radius of 4”. Mount an indicator on the body of the table and position the stylus on the magnet. Use an aluminum bar to rock the platter back and forth (apply approximately 10 ft-lb while testing). Backlash should be between 0.0001” (0.0002” for HRT) and 0.0006”. Not applicable for the HRT210SHS.

Backlash In The System: Connect the air to the table. Index the table in the negative direction 360°. Place the indicator at the edge of the platter. Program a .001° move into the controller. Cycle the rotary table at this .001° move until you detect movement with the indicator. Read the amount of backlash in the system from the readout. Not applicable for the HRT210SHS.

Popout (Face Gear only): To check popout, disconnect the air supply from the unit and index the table 360°. Mount an indicator to the table body. Position the stylus on the platter face and zero the dial. Connect the air supply and read the popout from the indicator dial. Popout should be between 0.0001” and 0.0005”

Adjustments

The face runout, face I.D. runout, worm play, backlash between worm and gear, and the popout are set at the factory and are not field serviceable. If any of these specifications are out of tolerance, contact your dealer.

Backlash In The System: The backlash in the system can be compensated for by the use of Parameter 15. Contact Haas service department for details.

Coolants

Machine coolant must be water-soluble, synthetic oil based or synthetic based coolant/lubricant. **Using mineral cutting oils will damage rubber components and void the warranty**.

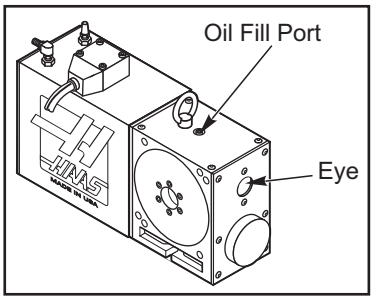
Do not use pure water as a coolant; components will rust. Do not use flammable liquids as coolant.

Do not submerge the unit in coolant. Keep the coolant lines on the work piece spraying away from the rotary unit. Tool spraying and spatter is acceptable. Some mills provide flood coolant such that the rotary unit is practically submerged. Try to cut the flow down to match the job.

Inspect the cables and gaskets for cuts or swelling. Damage must be repaired immediately.

Lubrication

Replace Rotary unit oil every 2 years.



Fill Port location for Rotary Table

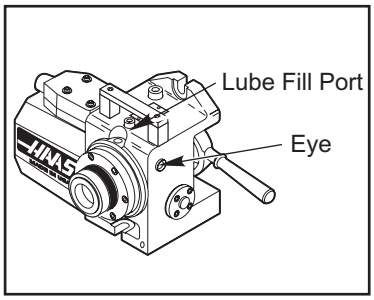
HRT Lubrication

Use the sight-glass to check the oil level. The unit must be stopped and upright to accurately read the oil level. The lube level should reach the middle of the sight glass. **HRT210SHS** - The oil level should show no more than 1/3 on the sight glass.

To add oil to the Rotary Indexer, remove the pipe plug from the oil fill port. This is located on the top plate. Add Mobil SHC-634 **(HRT210SHS uses mobil SHC-626)** oil until the proper level is reached. Replace the fill port bolt and tighten.

HA5C Lubrication

Use the sight-glass to check the oil level. The unit must be stopped and upright to accurately read the oil level. The sight-glass is located on the side of the unit. The lube level should reach the middle of the eye. If necessary, add lube until the level reaches the mid-point of the eye.



Fill Port Location for Rotary Indexer

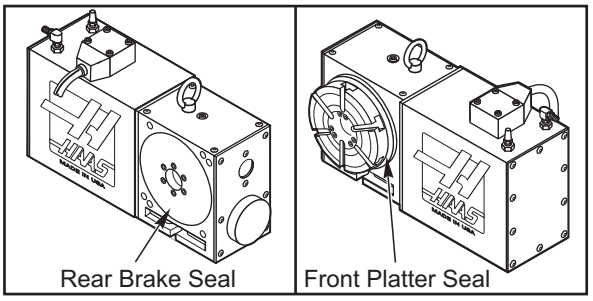
To add lube to the Rotary Indexer, locate and remove the Pipe-plug from the lube fill port. This is located under the handle in the casting (see Figure below). Add Mobil SHC-634 oil until the proper level is reached. Replace the fill port bolt and tighten.

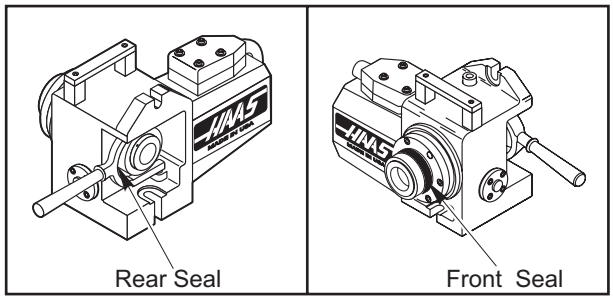
TRT Lubrication

The table is lubricated with MOBIL SHC 634. The oil level must not drop below the sight glass level. If the level is low, fill the table through the pipe plug in the body. Fill to the top of the sight glass. Do not over fill. If the oil is dirty, drain and refill with fresh oil (Mobil SHC-634).

Clean Up

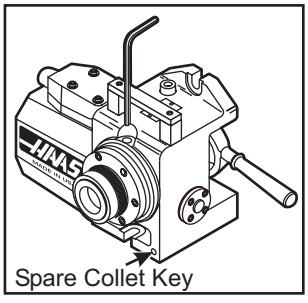
After use, it is important to clean the rotary table. Remove all metal chips from the unit. The surfaces of the unit are precisely ground for accurate positioning and metal chips could damage those surfaces. Apply a coat of rust preventative to the collet taper or platter. **Do not use air gun around front or rear seals**. Chips may damage seal if blown in with an air gun.

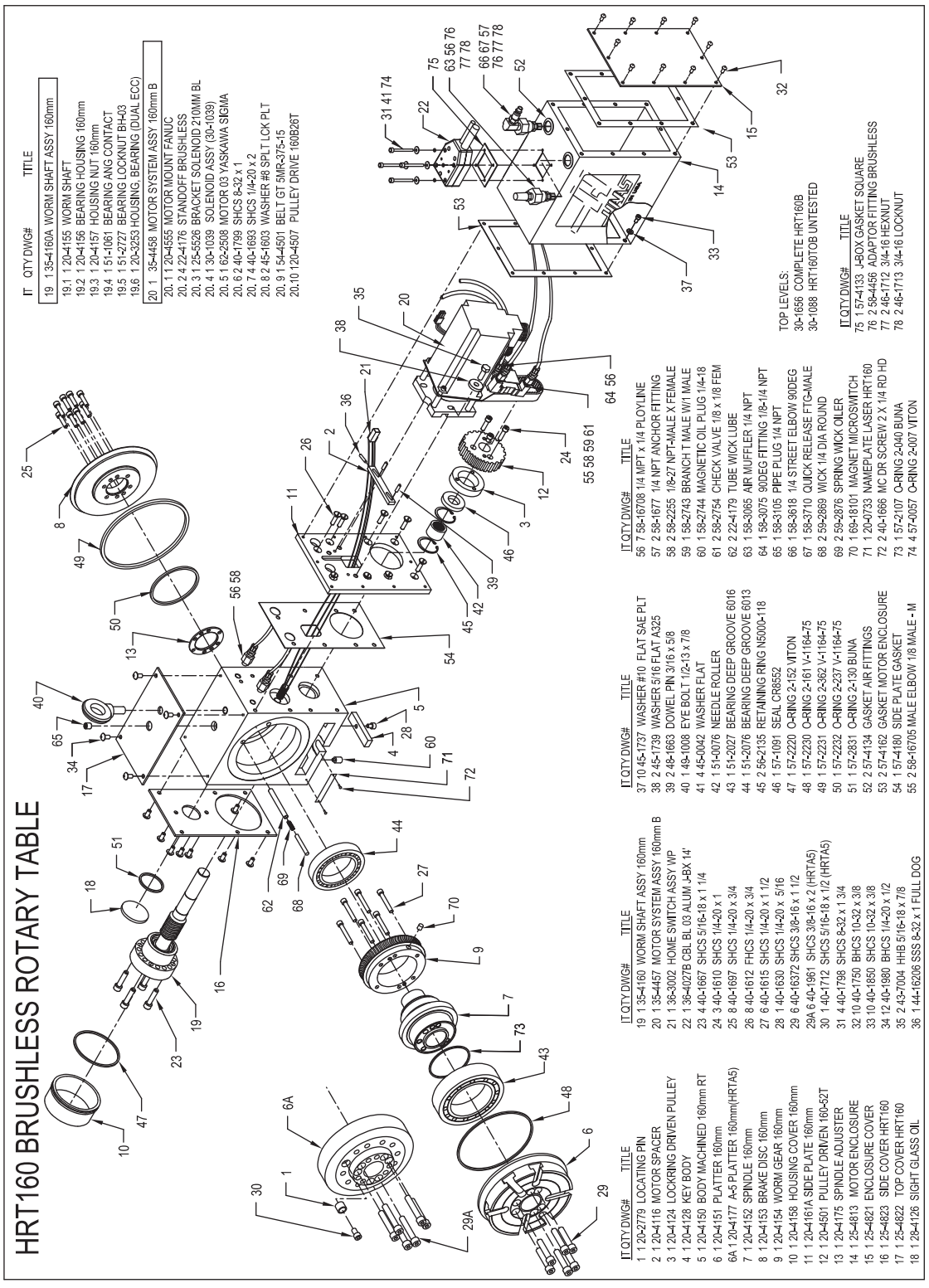




HA5C Collet Key Replacement

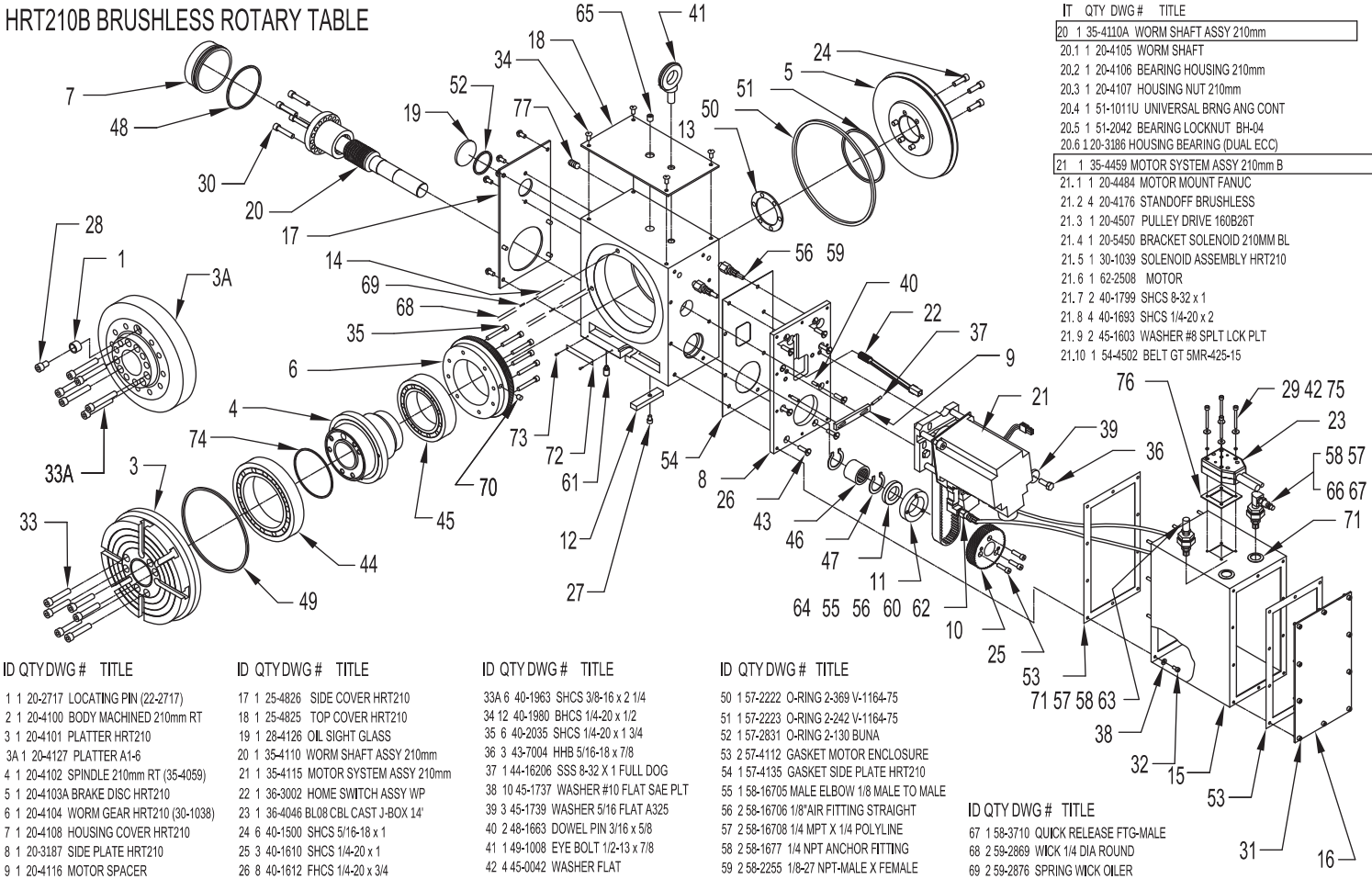
Remove the pipe plug from the access hole with a 3/16 allen wrench. Align the collet key with the access hole by jogging the spindle. Remove the collet key with a 3/32 allen wrench. Replace the collet key with Haas P/N 22-4052 only. A spare collet key is located on the front casting face. Screw the collet into the spindle until it begins to protrude into the inside diameter. Place a new collet into the spindle while aligning the keyway with the key. Tighten the key until it hits the bottom of the keyway, then back off 1/4 turn. Pull the collet out to make sure it slides freely. Replace the pipe plug in the access hole. **NOTE: Never run the indexer with the collet key backed out; this will damage the spindle and gall the spindle bore.**





Note: All rotary tables use Polyurethane tubing for all air lines. Specifications are: 1/4 O.D. x .160 I.D. 95A Durometer.

HRT210B BRUSHLESS ROTARY TABLE



IT	QTY	DWG #	TITLE
20	1	35-4110A	WORM SHAFT ASSY 210mm
20.1	1	20-4105	WORM SHAFT
20.2	1	20-4106	BEARING HOUSING 210mm
20.3	1	20-4107	HOUSING NUT 210mm
20.4	1	51-1011U	UNIVERSAL BRNG ANG CONT
20.5	1	51-2042	BEARING LOCKNUT BH-04
20.6	1	20-3186	HOUSING BEARING (DUAL ECC)
21	1	35-4459	MOTOR SYSTEM ASSY 210mm B
21.1	1	20-4484	MOTOR MOUNT FANUC
21.2	4	20-4176	STANDOFF BRUSHLESS
21.3	1	20-4507	PULLEY DRIVE 160B26T
21.4	1	20-5450	BRACKET SOLENOID 210MM BL
21.5	1	30-1039	SOLENOID ASSEMBLY HRT210
21.6	1	62-2508	MOTOR
21.7	2	40-1799	SHCS 8-32 x 1
21.8	4	40-1693	SHCS 1/4-20 x 2
21.9	2	45-1603	WASHER #8 SPLT LCK PLT
21.10	1	54-4502	BELT GT 5MR-425-15

ID	QTY	DWG #	TITLE
1	1	20-2717	LOCATING PIN (22-2717)
2	1	20-4100	BODY MACHINED 210mm RT
3	1	20-4101	PLATTER HRT210
3A	1	20-4127	PLATTER A1-6
4	1	20-4102	SPINDLE 210mm RT (35-4059)
5	1	20-4103A	BRAKE DISC HRT210
6	1	20-4104	WORM GEAR HRT210 (30-1038)
7	1	20-4108	HOUSING COVER HRT210
8	1	20-3187	SIDE PLATE HRT210
9	1	20-4116	MOTOR SPACER
10	1	20-4502	PULLEY DRIVEN 210-52T
11	1	20-4124	LOCKRING DRIVEN PULLEY
12	1	20-4128	KEY BODY
13	1	20-4130	SPINDLE SPACER HRT210
14	2	22-4140	TUBE WICK OILER 210
15	1	25-4816	MOTOR ENCLOSURE
16	1	25-4824	ENCLOSURE COVER

ID	QTY	DWG #	TITLE
17	1	25-4826	SIDE COVER HRT210
18	1	25-4825	TOP COVER HRT210
19	1	28-4126	OIL SIGHT GLASS
20	1	35-4110	WORM SHAFT ASSY 210mm
21	1	35-4115	MOTOR SYSTEM ASSY 210mm
22	1	36-3002	HOME SWITCH ASSY WP
23	1	36-4046	BL08 CBL CAST J-BOX 14'
24	6	40-1500	SHCS 5/16-18 x 1
25	3	40-1610	SHCS 1/4-20 x 1
26	8	40-1612	FHCS 1/4-20 x 3/4
27	1	40-1630	SHCS 1/4-20 x 5/16
28	1	40-16391	SHCS 3/8-16 X 1/2
29	4	40-1798	SHCS 8-32 x 1 3/4
30	4	40-1715	SHCS 5/16-18 x 1 1/2
31	10	40-1750	BHCS 10-32 x 3/8
32	10	40-1645	SHCS 10-32 x 5/8
33	6	40-1960	SHCS 3/8-16 x 1 3/4

ID	QTY	DWG #	TITLE
33A	6	40-1963	SHCS 3/8-16 x 2 1/4
34	12	40-1980	BHCS 1/4-20 x 1/2
35	6	40-2035	SHCS 1/4-20 x 1 3/4
36	3	43-7004	HHB 5/16-18 x 7/8
37	1	44-16206	SSS 8-32 X 1 FULL DOG
38	10	45-1737	WASHER #10 FLAT SAE PLT
39	3	45-1739	WASHER 5/16 FLAT A325
40	2	48-1663	DOWEL PIN 3/16 x 5/8
41	1	49-1008	EYE BOLT 1/2-13 x 7/8
42	4	45-0042	WASHER FLAT
43	1	51-0026	NEEDLE ROLLER 28x37x30mm
44	1	51-2026	BEARING DEEP GROOVE, #6021
45	1	51-2027	BEARING DEEP GROOVE, #6016
46	2	56-2085	SNAP RING N5000-145
47	1	57-1041	SEAL CR10957
48	1	57-2220	O-RING 2-152 BUNA
49	1	57-2221	O-RING 2-260 V-1164-75

ID	QTY	DWG #	TITLE
50	1	57-2222	O-RING 2-369 V-1164-75
51	1	57-2223	O-RING 2-242 V-1164-75
52	1	57-2831	O-RING 2-130 BUNA
53	2	57-4112	GASKET MOTOR ENCLOSURE
54	1	57-4135	GASKET SIDE PLATE HRT210
55	1	58-16705	MALE ELBOW 1/8 MALE TO MALE
56	2	58-16706	1/8"AIR FITTING STRAIGHT
57	2	58-16708	1/4 MPT X 1/4 POLYLINE
58	2	58-1677	1/4 NPT ANCHOR FITTING
59	2	58-2255	1/8-27 NPT-MALE X FEMALE
60	1	58-2743	MALE BRANCH 'T', 1/8"
61	1	58-2744	MAGNETIC OIL PLUG 1/4-18 NPT
62	2	58-2754	1/8 x 1/8 FEMALE CHECK VALVE
63	1	58-3065	AIR MUFFLER 1/4 NPT
64	3	58-3075	'L'FITTING 1/8 TO 1/4 NPT
65	1	58-3105	PIPE PLUG 1/4 NPT
66	1	58-3618	1/4 STREET ELBOW 90DEG.

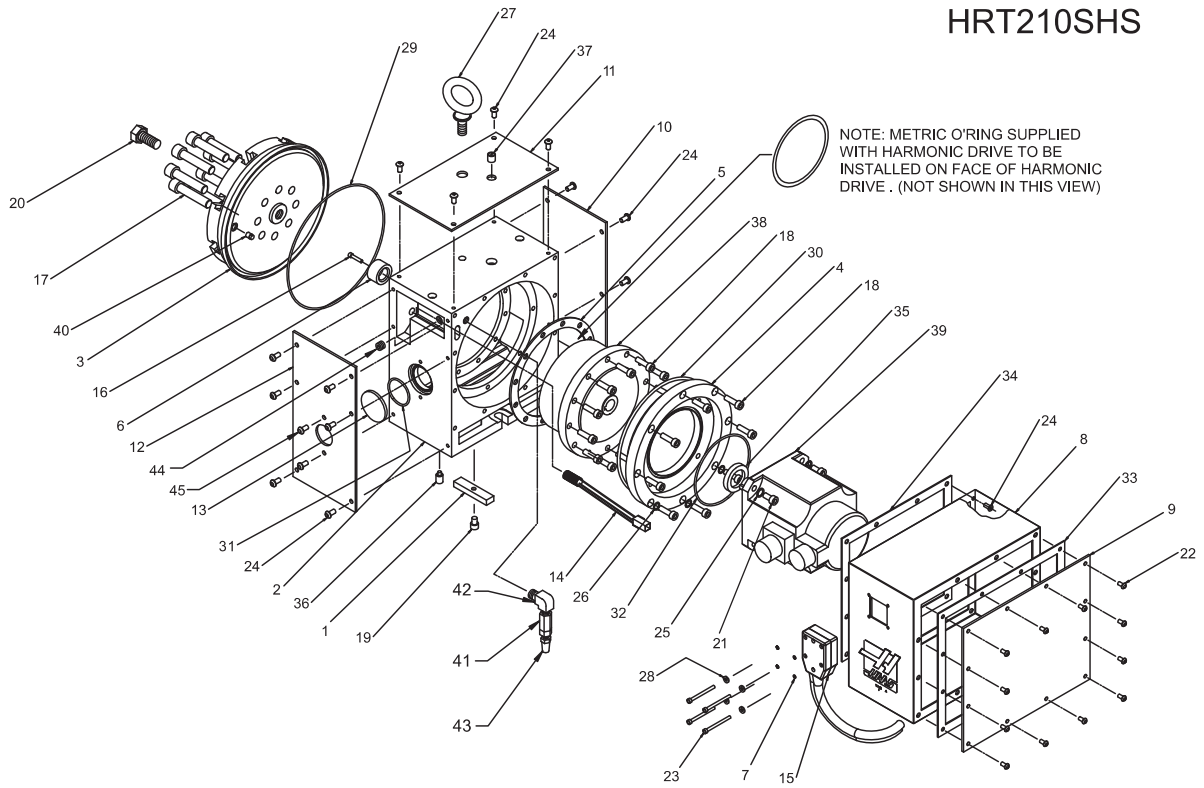
ID	QTY	DWG #	TITLE
67	1	58-3710	QUICK RELEASE FTG-MALE
68	2	59-2869	WICK 1/4 DIA ROUND
69	2	59-2876	SPRING WICK OILER
70	1	69-18101	MAGNET MICROSWITCH
71	2	57-4134	GASKET AIR FITTING
72	1	20-0606	NAMEPLATE LASER HRT210
73	2	40-1666	MC DR SCREW 2 X 1/4 RD HD
74	1	57-0054	ORING 2-044 BUNA
75	4	57-0057	O-RING 2-007 VITON
76	1	57-4133	J-BOX GASKET SQUARE
77	1	58-1627	FITG NPT-1/8-M PLUG

TOP LEVELS:
30-1688 COMPLETE HRT210B
30-1063 HRT210-TOB UNTESTED

EX-0020D
REV.D/MT/11-21-01

Note: All rotary tables use Polyurethane tubing for all air lines. Specifications are: 1/4 O.D. x .160 I.D. 95A Durometer.

HRT210SHS



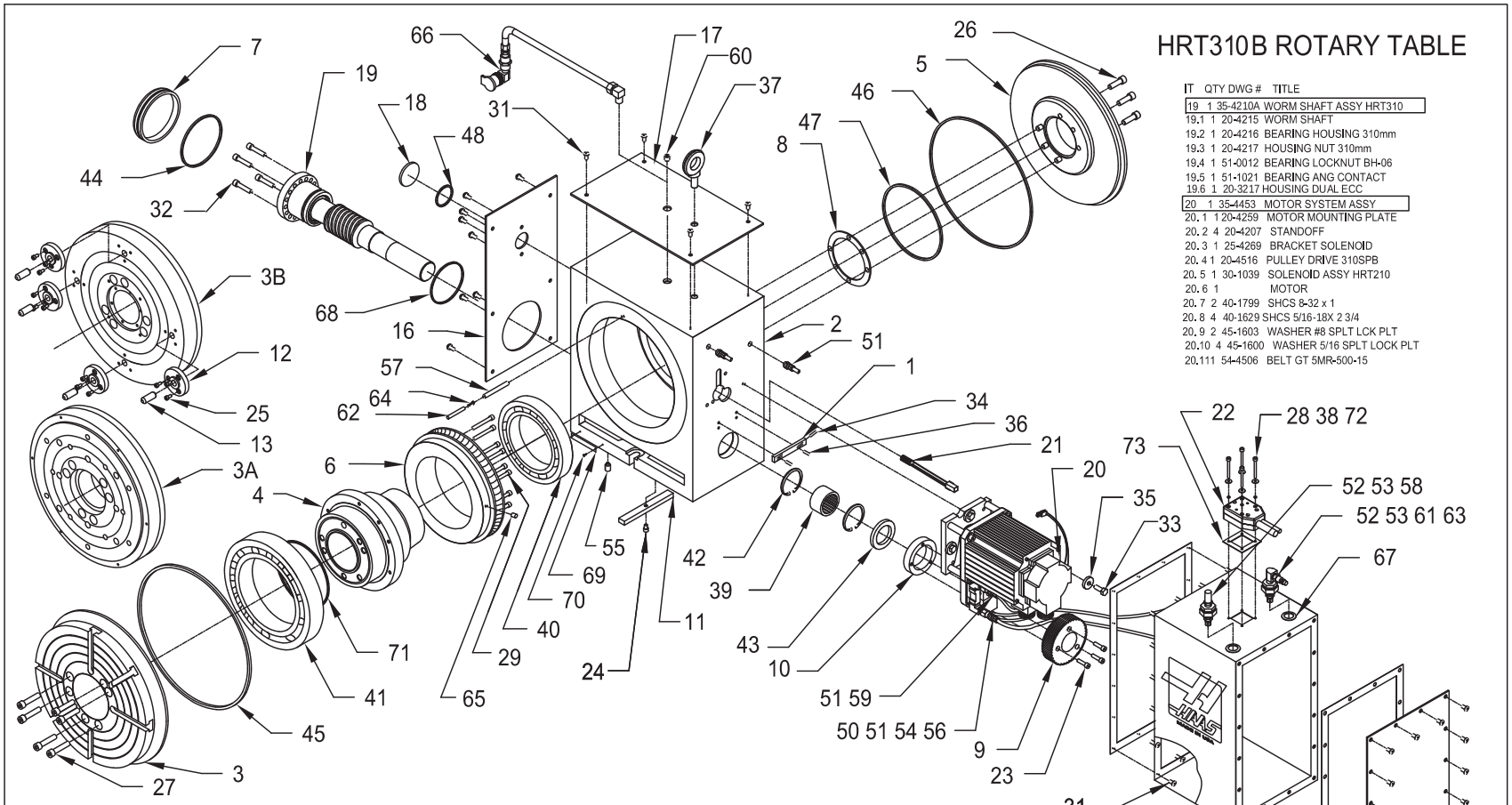
ID	QTY	DWG#	TITLE
1	1	20-4128	KEY, BODY
2	1	20-4520	BODY MACHINING
3	1	20-4521	PLATTER, HRT210SHS
4	1	20-4522	MOTOR MOUNT, HRT210SHS
5	1	20-4523	DRIVE SPACER
6	1	20-4531	RETENTION CAP
7	4	57-0057	O-RING 2-007 VITON
8	1	25-4819	MOTOR ENCLOSURE
9	1	25-4848	ENCLOSURE COVER
10	1	25-4847	SIDE COVER-A
11	1	25-4849	TOP COVER
12	1	25-4850	SIDE COVER-B
13	1	28-4126	OIL SIGHT GLASS
14	1	36-3002	MICRO SWITCH ASSY
15	1	36-4029B	BL 05 CABLE WP 14'

ID	QTY	DWG#	TITLE
16	1	43-1651	MSHCS, M5 X 16
17	8	40-0010	MSHCS, M12 X 45
18	4	40-1667	SHCS, 5/16-18 X 1¼
19	1	40-1630	SHCS, ¼-20 X 5/16
20	1	43-0015	HHB 1/2-13 X 1 SELF SEALING
21	4	40-1500	SHCS, 5/16-18 X1
22	12	40-1750	BHCS,10-32 X 3/8
23	4	40-1798	SHCS, 8-32 X 1 3/4
24	28	40-1980	BHCS, ¼-20 X 1/2
25	4	45-0039	WASHER BRASS Ø.328 I.D.X Ø.562 O.D.
26	3	45-0047	WASHER BRASS Ø0.314 I.D. X Ø0.420 O.D.
27	1	49-1008	EYE BOLT, ½-13 X 7/8
28	4	45-0042	WASHER, #8 SEALING S.S.
29	1	57-2221	O-RING, 2-260 VITON
30	1	57-2127	O-RING, 2-166

ID	QTY	DWG#	TITLE
31	1	57-2831	O-RING, 2-130 BUNA
32	1	57-2875	O-RING, 2-157 BUNA
33	1	57-4529	GASKET, ENCLOSURE COVER
34	1	57-4530	GASKET, MOTOR ENCLOSURE
35	1	57-4533	SEAL CR11615
36	1	58-2744	MAGNETIC OIL PLUG ¼-18
37	1	58-3105	PIPE PLUG ¼ NPT
38	1	59-4532	HARMONIC DRIVE, 50:1
39	1	62-0014	YASKAWA SIGMA MOTOR 09
40	1	69-18101	MAGNET, MICRO SWITCH
41	1	58-2754	1/8 X 1/8 FEMALE CHECK VALVE
42	1	58-16705	MALE ELBOW, 1/8
43	1	58-2262	AIR MUFFLER, CENTERED
44	1	58-1627	1/8-27 PIPE PLUG
45	2	40-1633	BHCS 1/4 X 3/8 ZINC

Note: All rotary tables use Polyurethane tubing for all air lines. Specifications are: 1/4 O.D. x .160 I.D. 95A Durometer.

HRT310B ROTARY TABLE



IT	QTY	DWG #	TITLE
19	1	35-4210A	WORM SHAFT ASSY HRT310
19.1	1	20-4215	WORM SHAFT
19.2	1	20-4216	BEARING HOUSING 310mm
19.3	1	20-4217	HOUSING NUT 310mm
19.4	1	51-0012	BEARING LOCKNUT BH-06
19.5	1	51-1021	BEARING ANG CONTACT
19.6	1	20-3217	HOUSING DUAL ECC
20	1	35-4453	MOTOR SYSTEM ASSY
20.1	1	20-4259	MOTOR MOUNTING PLATE
20.2	4	20-4207	STANDOFF
20.3	1	25-4269	BRACKET SOLENOID
20.4	1	20-4516	PULLEY DRIVE 310SPB
20.5	1	30-1039	SOLENOID ASSY HRT210
20.6	1		MOTOR
20.7	2	40-1799	SHCS 8-32 x 1
20.8	4	40-1629	SHCS 5/16-18X 2 3/4
20.9	2	45-1603	WASHER #8 SPLT LCK PLT
20.10	4	45-1600	WASHER 5/16 SPLT LOCK PLT
20.11	1	54-4506	BELT GT 5MR-500-15

IT	QTY	DWG#	TITLE
1	1	20-4116	MOTOR SPACER
2	1	20-4210	BODY MACHINED310mm RT
3	1	20-4211	PLATTER
3A	1	20-4231	PLATTER HORIZONTAL
3B	1	20-4246	PLATTER HORIZ. PALLET CHANGER
4	1	20-4212	SPINDLE (30-1065)
5	1	20-4213	BRAKE DISC
6	1	20-4214	WORM GEAR 310mm RT (35-4056)
7	1	20-4218	HOUSING COVER 310mm
8	1	20-4236	SPINDLE SPACER HRT310
9	1	20-4506	PULLEY DRIVEN 310-64T
10	1	20-4229	LOCKRING DRIVEN PULLEY
11	1	20-4230	KEY BODY 310MM/450MM
12	4	20-9766	BUSHING PALLET INDEX
13	4	20-9792	LOCATING PIN HORIZ. PC
14	1	25-4817	MOTOR ENCLOSURE BRUSHLESS
15	1	25-4827	ENCLOSURE COVER
16	1	25-4829	SIDE COVER HRT310

IT	QTY	DWG#	TITLE
17	1	25-4848	TOP COVER HRT310
18	1	28-4126	SIGHT GLASS OIL
19	1	35-4210	WORM SHAFT ASSY 310mm
20	1	35-4215A	MOTOR SYSTEM ASSY 310mm
21	1	36-3002	HOME SWITCH ASSY WP
22	1	36-4029C	CONDUIT ASSY ROTARY WP
23	3	40-1610	SHCS 1/4-20 x 1
24	1	40-1630	SHCS 1/4-20 x 5/16
25	16	40-1632	SHCS 1/4-20 x 1/2 (HZ ONLY)
26	6	40-1636	SHCS 3/8-16 x 1 1/4
27	6	40-1661	SHCS 1/2-13 x 2
28	4	40-1798	SHCS 8-32 x 1 3/4
29	8	40-1693	SHCS 1/4-20 x 2
30	16	40-1750	BHCS 10-32 x 3/8
31	28	40-1980	BHCS 1/4-20 x 1/2
32	4	40-1716	SHCS 5/16-18 x 1 3/4
33	2	43-7004	HHB 5/16-18 x 7/8
34	1	44-16206	SSS 8-32 x 1 FULL DOG

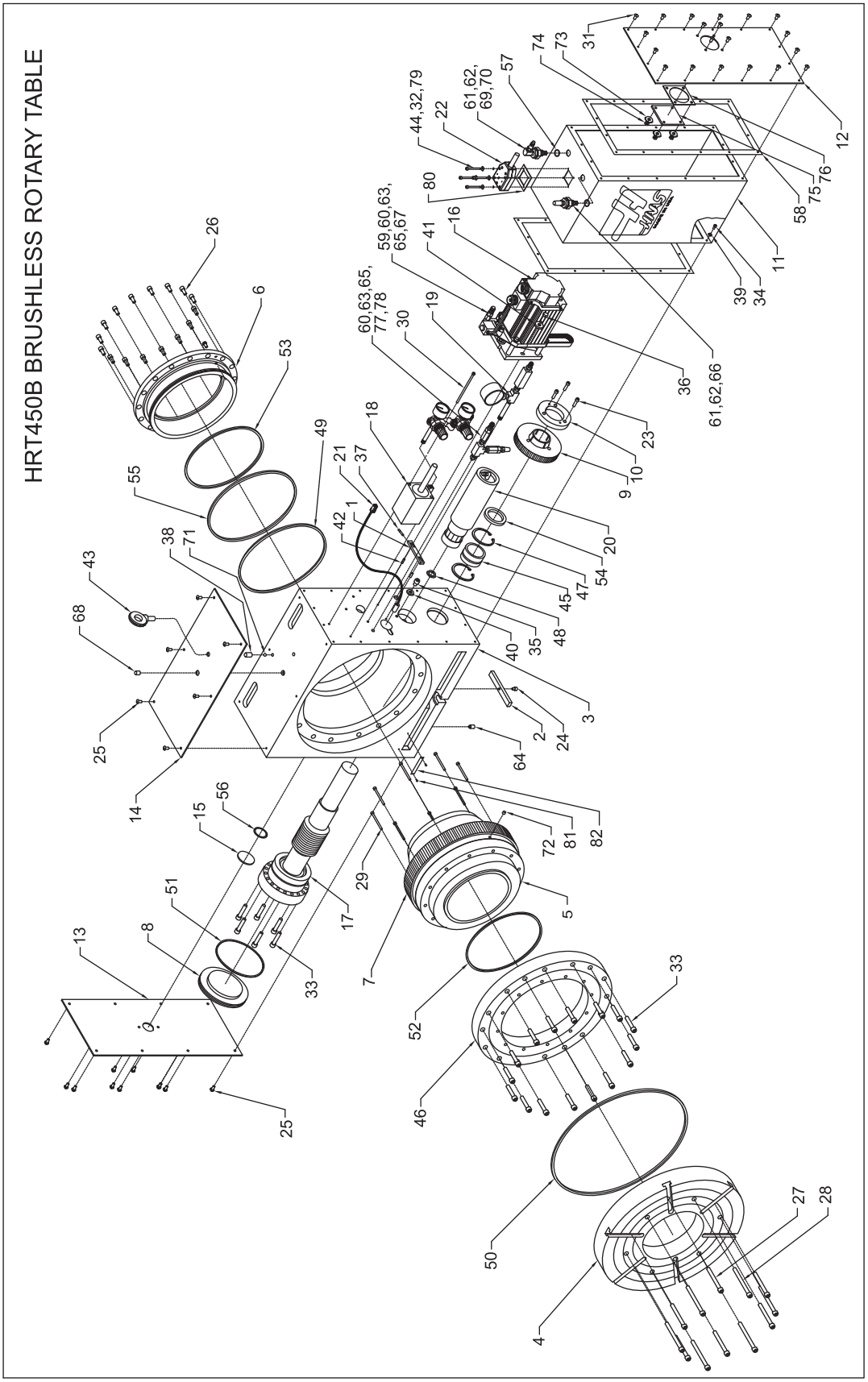
IT	QTY	DWG#	TITLE
35	2	45-1739	WASHER 5/16 FLAT A325
36	2	48-1663	DOWEL PIN 3/16 x 5/8
37	1	49-1008	EYE BOLT 1/2-13 x 7/8
38	4	45-0042	WASHER FLAT
39	1	51-0036	NEEDLE ROLLER 42x52x30mm
40	1	51-2036	BEARING DEEP GROOVE #6024
41	1	51-2037	BEARING DEEP GROOVE #6032
42	2	56-2087	SNAP RING N5000-206
43	1	57-1051	SEAL CR16504
44	1	57-2250	O-RING 2-156 VITON
45	1	57-0025	O-RING 2-275 V-1164-75
46	1	57-2252	O-RING 2-381 V-1164-75
47	1	57-2144	O-RING, 2-256 V-1164-75
48	1	57-2831	O-RING 2-130 BUNA
49	2	57-4223	GASKET MOTOR ENCLOSURE
50	2	58-16705	MALE ELBOW 1/8 MALE TO MALE
51	5	58-16706	1/8 AIR FITTING STRAIGHT
52	1	58-16708	1/4 MPT x 1/4 POLYLINE

IT	QTY	DWG#	TITLE
53	2	58-1677	1/4 NPT ANCHOR FITTING
54	1	58-2743	BRANCH T MALE W/1 MALE
55	1	58-2744	MAGNETIC OIL PLUG 1/4-18 NPT
56	2	58-2754	CHECK VALVE 1/8 X 1/8 FEM
57	2	22-4248	TUBE WICK OILER 310
58	1	58-3065	AIR MUFFLER 1/4 NPT
59	3	58-3075	90DEG FITTING 1/8-1/4 NPT
60	1	58-3105	PIPE PLUG 1/4 NPT
61	1	58-3618	1/4 STREET ELBOW 90DEG
62	2	59-2869	WICK 1/4 DIA ROUND
63	1	58-3710	QUICK RELEASE FITTING MALE
64	2	59-2876	TITAN SPRING #T-7078
65	1	69-18101	MAGNET MICROSWITCH
66	1	35-4220	REMOTE OIL FILL ASSY(HS-1R/1RP ONLY)
67	2	57-4134	GASKET AIR FITTING
68	1	57-4105	O-RING 2-039 VITON
69	1	20-0582	NAMEPLATE LASER HRT310
70	2	40-1666	MC DR SCREW 2 X 1/4 RD HD

TOP LEVELS:
30-1703 COMPLETE HRT310
30-1075 HRT310TO UNTESTED

IT	QTY	DWG#	TITLE
71	1	57-2121	O-RING 2-161 BUNA
72	4	57-0057	O-RING 2-007 VITON
73	1	57-4133	J-BOX GASKET SQUARE

Note: All rotary tables use Polyurethane tubing for all air lines. Specifications are: 1/4 O.D. x .160 I.D. 95A Durometer.



Note: All rotary tables use Polyurethane tubing for all air lines. Specifications are: 1/4 O.D. x .160 I.D. 95A Durometer.

I D	QTY	DWG #	DESCRIPTION
1	1	20-4116	MOTOR SPACER
2	1	20-4230	KEY BODY 310MM/450MM
3	1	20-4250	BODY MACHINED 450mm RT
4	1	20-4251	PLATTER
5	1	20-4252	SPINDLE
6	1	20-4253A	FLEX BRAKE
7	1	20-4254	WORM GEAR
8	1	20-4258	HOUSING COVER
9	1	20-4508	PULLEY DIVEN 450-78T
10	1	20-4264	LOCKRING
11	1	25-4814	MOTOR ENCLOSURE
12	1	25-4830	ENCLOSURE COVER
13	1	25-4832	SIDE COVER
14	1	25-4831	TOP COVER
15	1	28-4126	OIL SIGHT GLASS
16	1	35-4454	MOTOR SYSTEM ASSY 450MM B
17	1	35-4245	WORM SHAFT ASSY
18	1	35-4250	ACCUMULATOR ASSY
19	1	35-4255	CHECK VALVE ASSY
20	1	35-4260	HYDRAULIC CYLINDER ASSY
21	1	36-3002	HOME SWITCH ASSY WP
22	1	36-4030B	CBL BL ALUM J-BOX 18.5’
23	3	40-1610	SHCS 1/4-20 X 1
24	1	40-1630	SHCS 1/4-20 X 5/16
25	16	40-1980	BHCS 1/4-20 X 1/2
26	16	40-16385	SHCS 5/16-18 X 3/4
27	6	40-16437	SHCS 3/8-16 X 3 1/4
28	6	40-16438	SHCS 3/8-16 X 4
29	8	40-1679	SHCS 1/4-20 X 2 1/2
30	2	40-1696	SHCS 1/4-20 X 4 1/2
31	16	40-1750	BHCS 10-32 X 3/8
32	4	40-1804	SHCS 8-32 X 2
33	20	40-1960	SHCS 3/8-16 X 1 ¾
34	16	40-1632	SHCS 1/4-20 X ½
35	1	40-16391	SHCS 3/8-16 X 1/2
36	3	43-7004	HHB 5/16-18 X 7/8
37	1	44-16205	SSS 8-32 X 1 FULL DOG
38	1	44-1696	SSS 1/2-13 X 3/4 FULL DOG
39	16	45-16390	WASHER 1/4 FLAT SAE PLT
40	1	45-1730	WASHER 3/8 HARD
41	3	45-1739	WASHER 5/16 FLAT A325
42	2	48-1663	DOWEL PIN 3/16 X 5/8
43	1	49-1008	EYE BOLT 1/2-13 X 7/8
44	4	45-0042	WASHER FLAT
45	1	51-0077	NEEDLE ROLLER
46	1	51-2038	BRNG CROSS ROLLER
47	2	56-2083	RETAINING RING N5000-244
48	1	57-0020	O-RING 2-210 VITON
49	1	57-0025	O-RING 2-275 V-1164-75
50	1	57-0094	O-RING 2-384 V-1164-75
51	1	57-0097	O-RING 2-162 VITON
52	1	57-0098	O-RING 2-270 VITON
53	1	57-0101	O-RING 2-373 V-1164-75
54	1	57-2086	SEAL CR19606
55	1	57-2251	O-RING 2-276 V-1164-75
56	1	57-2831	O-RING 2-130 BUNA
57	2	57-4134	GASKET AIR FITTINGS
58	2	57-4261	GASKET ENCLOSURE COVER
59	2	58-16705	MALE ELBOW 1/8 MALE TO MALE
60	4	58-16706	1/8 AIR FITTING STRAIGHT
61	2	58-16708	1/4 MPT X 1/4 POLYLINE
62	2	58-1677	¼ NPT ANCHOR FITTING
63	2	58-2743	BRANCH T MALE W/1 MALE
64	1	58-2744	MAGNETIC OIL PLUG 1/4-18
65	4	58-2754	CHECK VALVE 1/8 X 1/8 FEM
66	1	58-3065	AIR MUFFLER 1/4 NPT
67	1	58-3075	90DEG FITTING 1/8-1/4 NPT
68	1	58-3105	PIPE PLUG 1/4 NPT
69	1	58-3618	1/4 STREET ELBOW 90DEG
70	1	58-3710	QUICK RELEASE FTG-MALE
71	1	59-2055	3/8” STEEL BALLS
72	1	69-18101	MAGNET MICROSWITCH
73	4	45-1850	WASHER ¼ FENDER PLT
74	4	46-1625	NUT ¼-20 HEX BLK
75	1	28-4278	SIGHT GLASS PRESS GUAGE
76	1	57-4279	GASKET, SIGHT GLASS
77	1	58-2262	AIR MUFFLER CENTERED BRO
78	2	58-16732	1/8X1/8 MALE HEX JOINT
79	4	57-0057	O-RING 2-007 VITON
80	1	57-4133	J-BOX GASKET SQUARE
81	2	40-1666	MC DR SCREW 2 X 1/4 RD HD
82	1	20-0733	NAMEPLATE LASER HRT160

35-4245A WORM SHAFT ASSY

I D	QTY	DWG #	DESCRIPTION
17.1	1	20-4255	WORM SHAFT
17.2	1	20-4256	BEARING HOUSING
17.3	1	20-4257	HOUSING NUT
17.4	1	51-1013	BEARING ANG CONTACT
17.5	1	51-2043	BEARHUG LOCKNUT BH-09
17.6	1	20-3401	HOUSING, DUAL ECC

35-4245 CHECK VALVE ASSY

I D	QTY	DWG #	DESCRIPTION
19.1	1	58-16708	1/4 NPT X 1/4 POLYLINE
19.2	1	58-1734	HYD HEX NIPPLE 1/4 NPT
19.3	1	58-27396	DRY GUAGE 2000PSI 1/4NPT
19.4	1	58-2753	HYDRAULIC CHECK VALVE
19.5	1	58-3695	¼ NPT FEMALE T
19.6	1	58-1682	NIPPLE ¼ NPT X 2 SST

35-4250 ACCUMULATOR ASSY

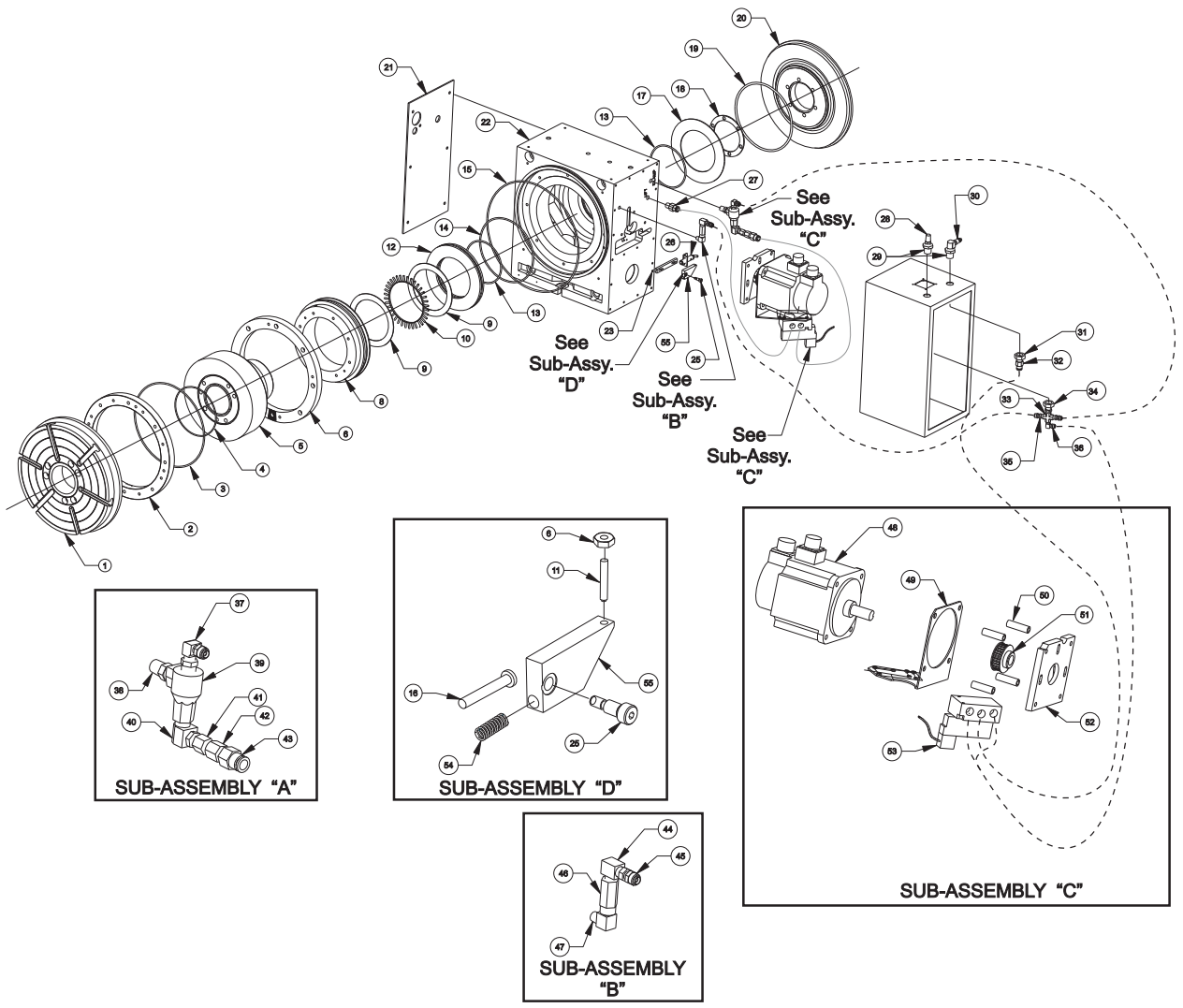
I D	QTY	DWG #	DESCRIPTION
18.1	2	58-1627	1/8-27 PIPE PLUG
18.2	2	58-16732	1/8X1/8 MALE HEX JOINT
18.3	1	58-16700	STREET ELBOW 1/8 INCH
18.4	1	58-1683	LONG NIPPLE 1/8-27 X 3 BRASS
18.5	2	58-27395	AIR PRESSURE GUAGE
18.6	2	58-2740	AIR REGULATOR
18.7	3	58-3075	90DEG FITTING 1/8-1/4 NPT
18.8	1	58-3100	FEMALE BRANCH T 1/8NPT
18.9	1	59-2736	AIR CYLINDER QJ92-1673

35-4454 MTR SYSTEM ASSY 450MMB

I D	QTY	DWG #	DESCRIPTION
16.1	4	22-4207	STANDOFF
16.2	1	20-4259	MOTOR MOUNTING PLATE
16.3	1	20-4519	PULLEY DRIVE 45600B
16.4	1	25-4269	BRACKET SOLENOID
16.5	1	30-1103	SOLENOID ASSY WP
16.6	1	62-0014	MOTOR 09 YASKAWA SIGMA
16.7	4	40-1629	SHCS 5/16-18 X 2 3/4
16.8	2	40-1799	SHCS 8-32 X 1
16.9	4	45-1600	WASHER 5/16 SPLT LCK PLT
16.10	2	45-1603	WASHER #8 SPLT LCK PLT
16.11	1	54-4508	BELT GT 5MR-800-15
16.12	1	57-0149	Seal 1.188 CR400301

35-4260 HYDRAULIC CYLINDER ASSY

I D	QTY	DWG #	DESCRIPTION
20.1	1	20-4270	PRIMARY CYLINDER
20.2	1	20-4271	PRIMARY PISTON 450MM
20.3	1	20-4272	CAP PRIMARY CYLINDER
20.4	1	20-4273A	SECONDARY CYLINDER
20.5	1	20-4274	SECONDARY PISTON
20.6	1	56-2084	RETAINING RING N5000-200
20.7	1	57-1036	POLYSEAL 1870-16250
20.8	1	57-1037	WEARBAND W2-2000-375
20.9	2	58-3075	90 DEG FITTING 1/8-1/4 NPT
20.10	1	59-2058	BALL 1/4 STEEL
20.11	1	59-2083	SPRING 31/64 X 4 7/16
20.12	1	58-0058	O-RING 2-014 V-1164-75
20.13	1	57-0096	O-RING 2-133 VITON
20.14	1	57-1038	POLYSEAL 12500250

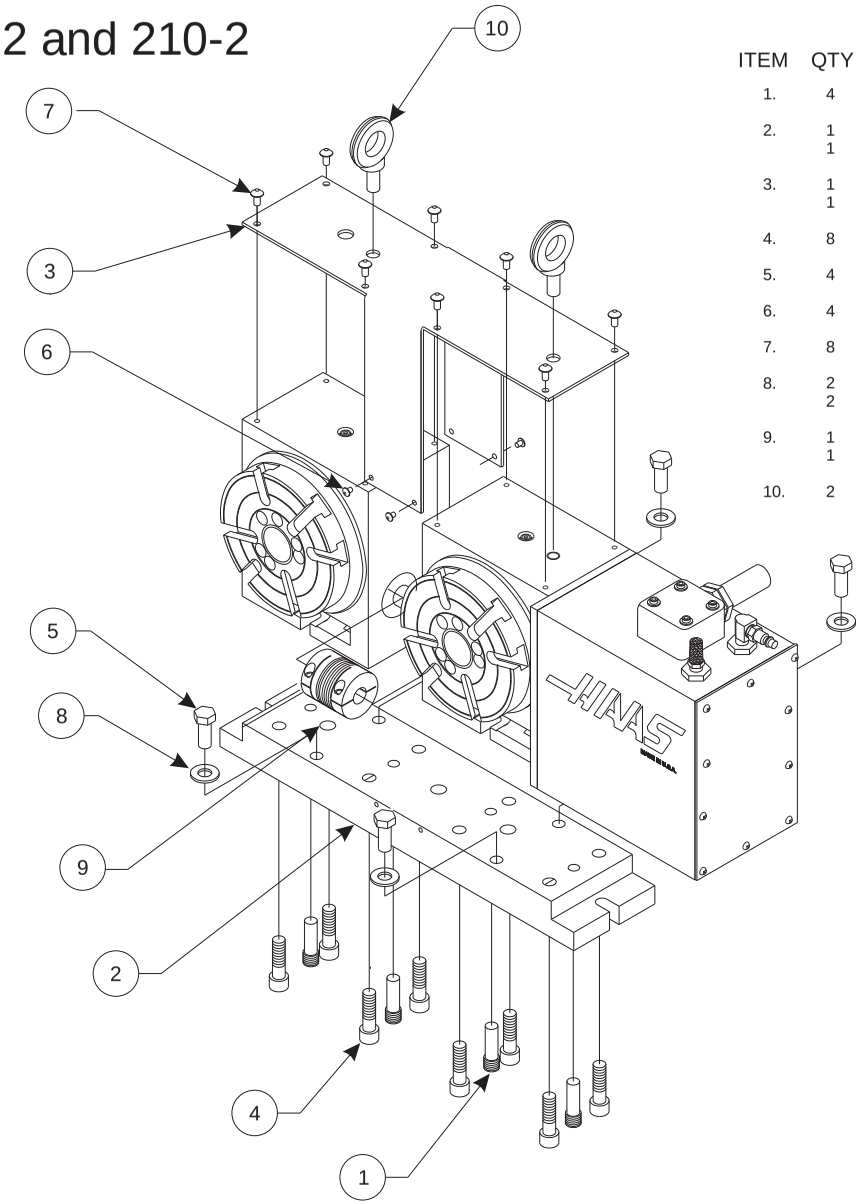


HRT320FB

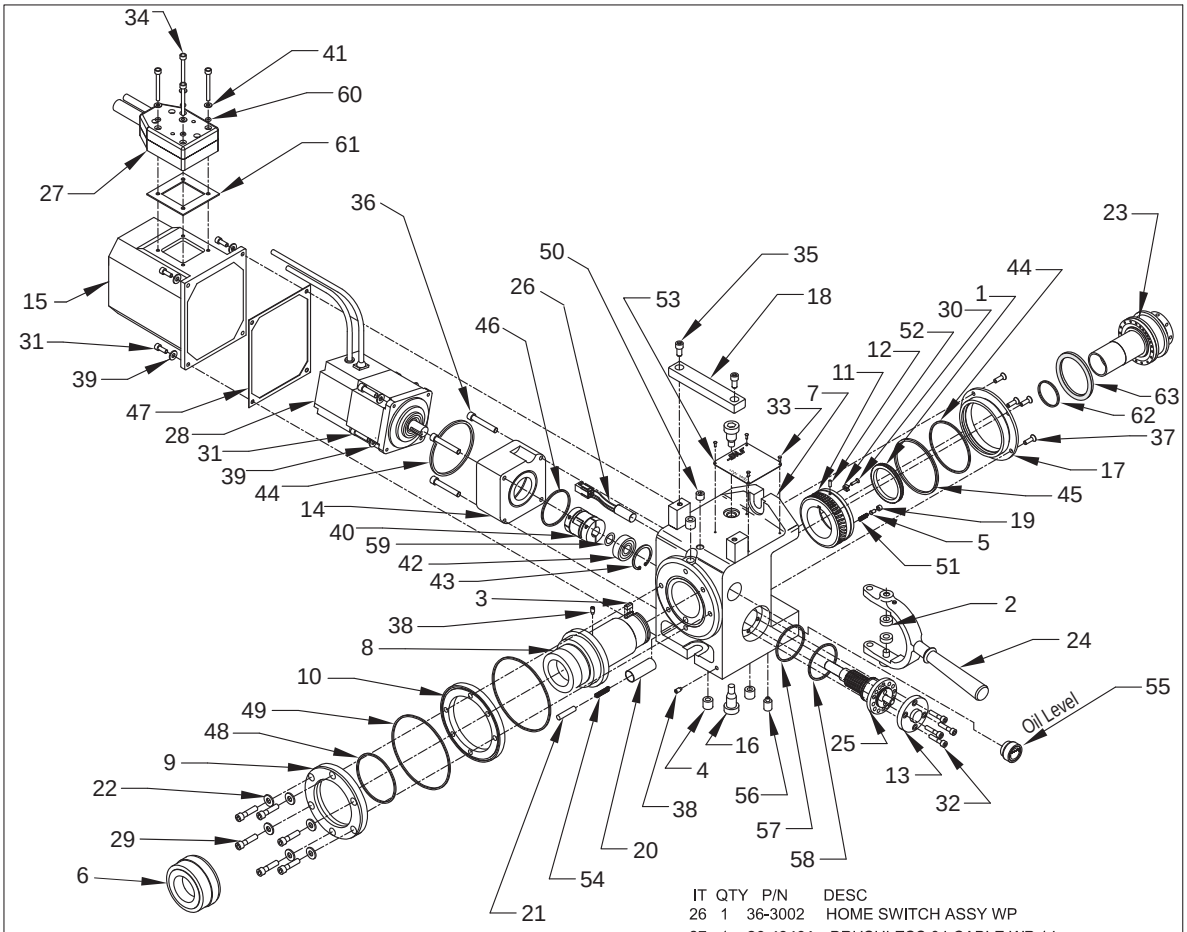
I.D.	QTY.	DWG. NO.	DESCRIPTION
1	1	20-1912	PLATTER
2	1 SET	20-4285	FACE GEAR
3	1	57-4283	O-RING
4	1	57-2121	O-RING
5	1	20-4283	SPINDLE INDEXER
6	1	46-1617	8-32 HEX NUT
7	1	20-1913	SPINDLE SLEEVE
8	1	20-4287	WORM GEAR
9	2	51-4285	THRUST WASHER
10	1	51-4286	THRUST BEARING
11	1	44-16206	SET SCREW, 8-32 X 1 FULL DOG
12	1	20-4286	LIFT PISTON
13	2	57-4282	O-RING
14	1	57-0139	O-RING
15	1	57-2980	O-RING
16	1	48-0101	CLEVIS PIN 3/16 X 1.25
17	1	57-4288	THRUST BEARING (NYLON)
18	1	20-4236	SPINDLE SPACER
19	1	57-0381	O-RING 2-365
20	1	20-4213	BRAKE DISC
21	1	25-7812	SIDE COVER
22	1	20-1914	BODY
23	1	20-4116	MOTOR ADJUSTMENT PLATE + SSS
24	1	20-2457	CAM LIFT TRIP
25	1	49-0048	SHOULDER BOLT 1/4-20 X .375
26	1	69-1601	PROX. SWITCH
27	1	58-3680	STR 6 TUBE-4 MP
28	1	58-3065	1/4 MUFFLER
29	2	58-1677	ANCHOR 4FP BODY
30	1	58-3710	QUICK RELEASE FITTING, MALE RN
31	1	58-1677	ANCHOR 4FP NUT
32	1	58-3680	STR 6 TUBE-4 MP
33	1	58-1676	CROSS 1/8
34	1	58-1676	ANCHOR 4FP NUT
35	1	58-1677	ANCHOR FP NUT
36	1	58-3075	1/4 TUBE X 1/8 NPT ELBOW
37	1	58-3075	1/4 TUBE X 1/8 NPT ELBOW
38	1	58-3691	1/4 NPT MALE HX JOINT
39	1	59-2832	QUICK EXHAUST 1/4
40	1	58-3618	1/4 STREET ELBOW, 90 DEG.
41	1	58-0297	ORFICE FITTING .020
42	1	58-3657	FM ADAPTER
43	1	58-5680	STR 6 TUBE-4 MP
44	1	58-16700	1/4 STREET ELBOW, 90 DEG.
45	1	58-16706	1/4 TUBE X 1/8 NPT
46	1	58-2754	CHECK VALVE
47	1	58-16705	MM ELBOW
48	1	62-0012	YASKAWA SGMG-09A2 AB
49	1	25-4291	MOTOR BRACKET
50	4	20-4207	MOTOR, STAND OFF
51	1	20-4516	32 TOOTH PULLEY, SIGMA 09
52	1	20-4259	MOTOR MOUNTING PLATE
53	1	32-0039	SOLENOID VALVE, 5 WAY
54	1	59-0668	SPRING, ¼ X 1 X .029
55	1	20-2457A	CAM LIFT TRIP

Note: All rotary tables use Polyurethane tubing for all air lines. Specifications are: 1/4 O.D. x .160 I.D. 95A Durometer.

HRT 160-2 and 210-2



ITEM	QTY	PART/NO	DESCRIPTION
1.	4	20-2312	GUIDE PIN
2.	1	20-4467	160-2 HEAD BASEPLATE
	1	20-4136	210-2 HEAD BASE PLATE
3.	1	25-4468	160-2 TOP COVER
	1	25-4137	210-2 TOP COVER
4.	8	40-1663	SHCS, 1/2-13 X 1 3/4"
5.	4	40-1678	HHB, 1/2-13 X 1 1/4"
6.	4	40-1750	BHCS, 10-32 X 3/8"
7.	8	40-1980	BHCS, 1/4-20 X 1/2"
8.	2	45-1740	WASHER, BLCK HARD 1/2" (FRONT SIDE)
	2	20-2360	WASHER MODIFICATION (BACK SIDE)
9.	1	52-4469	COUPLING, 22mm X 15mm
	1	49-4131	COUPLING, 28mm X 18mm
10.	2	49-1008	EYE BOLT 1/2-13 X 7/8



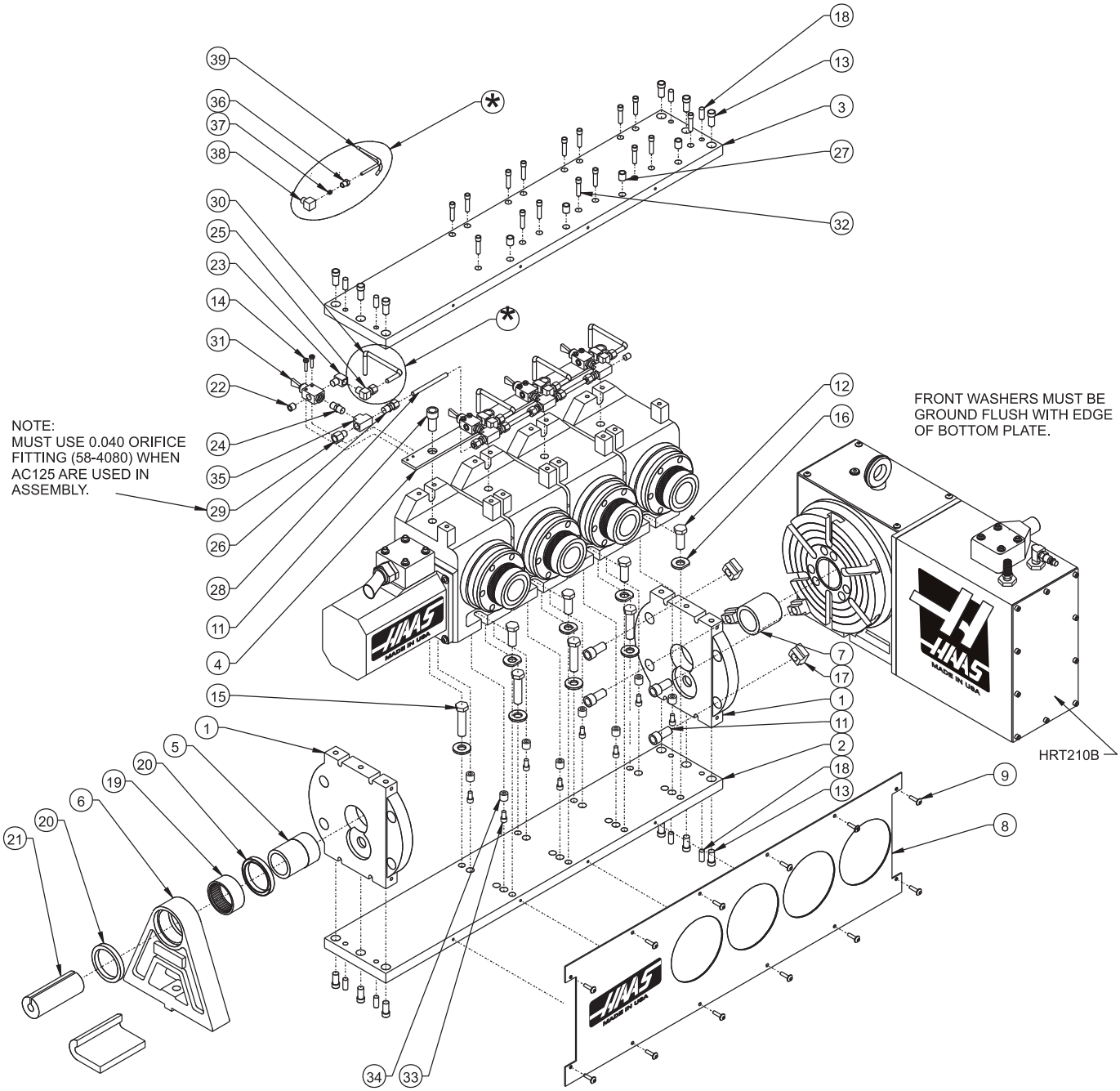
IT	QTY	P/N	DESC
1	1	20-2052	SPINDLE NUT (MANCCA)
2	2	22-2060	BUSHING HANDLE (MANCCA)
3	1	22-4019	KEY SPINDLE
4	2	22-5017	LOCATING PIN
5	1	22-2069	DETENT PIN S5C (30-1122)
6	1	20-2072	SPINDLE COVER S5C
7	1	20-4000B	BODY MACHINED INDEX
	1	35-4057	SPINDLE/SPACER ASSY HA5C
8	1	20-4001A	SPINDLE 5CV
9	1	20-4002A	SPINDLE LOCK
10	1	20-4003	SPINDLE SPACER
11	1	20-4004	WORM GEAR (30-1122)
12	1	69-18103	MAGNET #89 F 1405 (30-1122)
13	1	20-4008	BEARING END CAP
14	1	20-4451	MOTOR MOUNT
15	1	20-4810	BL MOTOR ENCLOSURE
16	2	22-4012	HANDLE BOLT (MANCCA)
17	1	20-4013A	REAR OIL SHIELD 5CV
18	1	20-4014	REMOVABLE HANDLE
19	1	22-4018	DETENT PLUG (30-1122)
20	1	20-4020	TUBE WICK OILER
21	1	59-2869	WICK 1/4 DIA ROUND
22	6	49-4101	WASHER 1/4 COPPER
23	1	35-3050	COLLET HOLDER ASSEMBLY (MANCCA)
	1	57-2057	FIBER WASHER
24	1	35-3073	INDEXER HANDLE ASSY (MANCCA)
	1	20-2059	HANDLE COLLET CLOSER
	1	48-1664	PIN ROLL 3/16 X 5/8
	2	48-1665	PIN DOWEL 5/16 X 3/4
25	1	35-4000	WORM SHAFT ASSY HA5C
	1	20-4005	WORM SHAFT HA5C
	1	20-4007A	BEARING HOUSING WORM HA5C
	1	20-4015	BEARING NUT
	1	51-4010	BEARING ANGULAR CONTACT 10X26X6MM
	1	51-4115	BEARING LOCKNUT BH-00
	1	57-4100	O-RING 2-024 VITON

IT	QTY	P/N	DESC
26	1	36-3002	HOME SWITCH ASSY WP
27	1	36-4046A	BRUSHLESS 04 CABLE WP 14
28	1	62-2495	MOTOR AC SERVO YASKAWA 04
29	6	40-1610	SHCS 1/4-20 X 1
30	1	40-1613	FHCS 4-40 X 3/8
31	8	40-1645	SHCS 10-32 X 5/8
32	8	40-16455	SHCS 10-32 X 7/8
33	4	40-1666	MC DR SCRW 2 X 1/4 RD HD
34	4	40-1798	SHCS 8-32 X 1 3/4
35	2	40-1632	SHCS 1/4-20 X 1/2
36	4	40-16205	SHCS 10-32 X 1 3/4
37	4	40-1703	FHCS 10-32 X 1/2
38	1	22-4052	COLLET KEY HA5C
39	8	45-1735	WASHER #10 FLAT SAE T18-8
40	1	52-4478	14mm X 12mm CURVED JAW COUPLING
41	4	45-0042	WASHER FLAT .60 TAK
42	1	51-4000	BEARING RADIAL 12X32X10MM
43	1	56-0010	SNAP RING N5000-125
44	2	57-2022	O-RING 2-150 V- 1164-75
45	1	57-2105	O-RING 2-143 V- 1164-75
46	1	57-2235	O-RING 2-032 VITON
47	1	57-4011	MOTOR ENCLOSURE GASKET
48	1	57-4102	O-RING 2-035 V- 1164-75
49	2	57-4110	O-RING 2-045 V- 1164-75
50	2	58-1627	1/8-27 PIPE PLUG
51	1	59-2070	SPRING DETENT (30-1122)
52	1	59-2071	LOCKING PAWL
53	1	20-0732	NAMEPLATE LASER HA5C
54	1	59-2876	SPRING WICK OILER
55	1	59-4110	SIGHT GLASS LSP501-O8RGL
56	2	58-2745	MAGNETIC OIL PLUG
57	1	57-4100	O-RING 2-024 VITON
58	1	57-4130	O-RING 2-138 VITON
59	1	55-4478	WAVE WASHER C06
60	4	57-0057	O-RING 2-007 VITON
61	1	57-4133	J-BOX GASKET SQUARE
62	1	57-4114	O-RING 2-127 V-1164-75
63	1	57-2057	FIBER WASHER

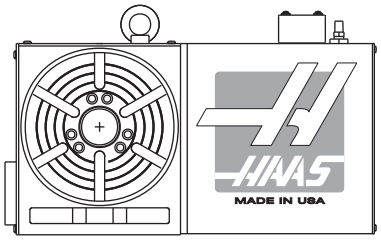
Note: All rotary tables use Polyurethane tubing for all air lines. Specifications are: 1/4 O.D. x .160 I.D. 95A Durometer.

HA5C Assembly Drawing

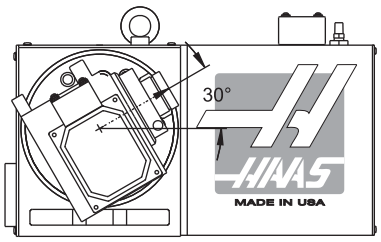
HA5C2.3.4



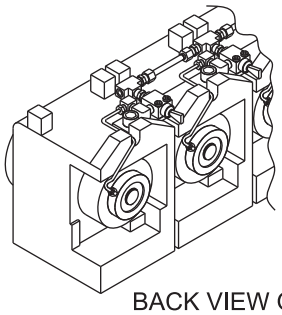
Note: All rotary tables use Polyurethane tubing for all air lines. Specifications are: 1/4 O.D. x .160 I.D. 95A Durometer.



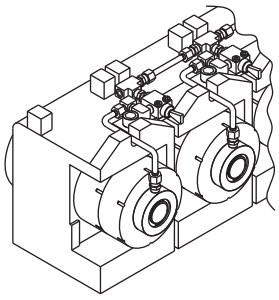
NOTE:
MUST USE AN HRT210
WITH SHORT T-SLOT
UP WHEN PLATTER
IS IN HOME POSITION.



POSITION OF SPINDLES
WHEN ASSEMBLED T5C2,3,4
IS IN HOME POSITION.



BACK VIEW OF AC25

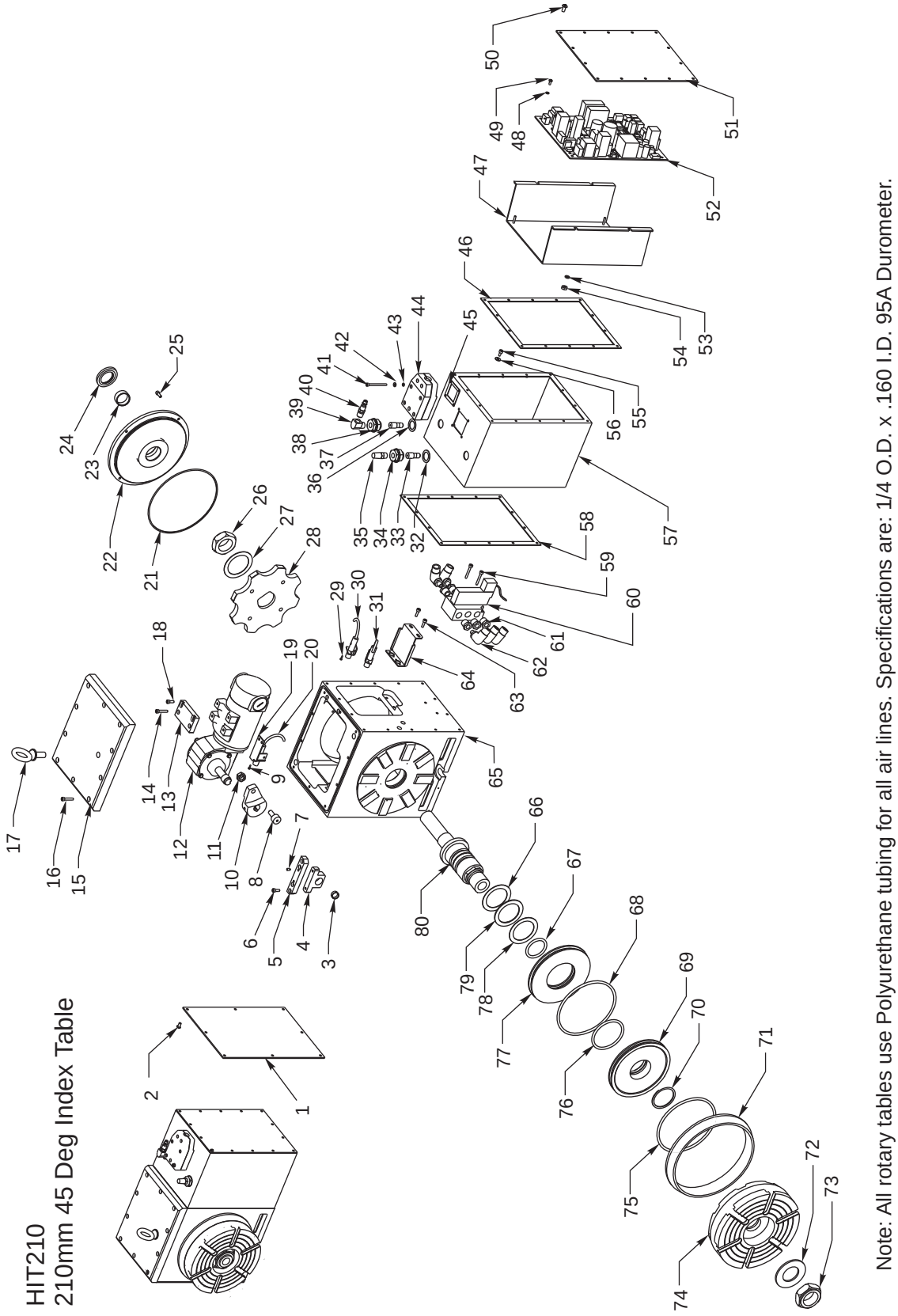


BACK VIEW OF AC125

ID	PART/NO	DESCRIPTION
1.	20-4072A	SIDE PLATE
2.	20-4073	BOTTOM PLATE (T5C3)
	20-4082	BOTTOM PLATE (T5C4)
	20-4085	BOTTOM PLATE (T5C2)
3.	20-4074	TOP PLATE (T5C3)
	20-4083	TOP PLATE (T5C4)
	20-4086	TOP PLATE (T5C2)
4.	20-4088	VALVE MOUNT STRIP (T5C2)
	20-4089	VALVE MOUNT STRIP (T5C4)
	20-4090	VALVE MOUNT STRIP (T5C3)
5.	20-4093	BEARING SUPPORT
6.	20-4340	A-FRAME SUPPORT
7.	22-4183	PILOTING PLUG
8.	25-4812	CHIP GUARD (T5C2)
	25-4803	CHIP GUARD (T5C3)
	25-4811	CHIP GUARD (T5C4)
9.	40-16093	BHCS, 10-32 X 3/4"
10.	40-1610	SHCS, 1/4-20 X 1"
11.	40-1654	SHCS, 1/2-13 X 1"
12.	40-1678	HHB, 1/2-13 X 1 1/4"
13.	40-2030	SHCS, 3/8-16 X 3/4"
14.	41-1604	PPHS, 8-32 X 3/4"
15.	43-16012	HHB, 1/2-13 X 2"
16.	45-1740	WASHER, BLACK HARD 1/2"
17.	46-3000	NUT "T" 1/2-13
18.	48-1665	PIN, DOWEL 5/16 X 3/4"
19.	51-0006	NEEDLE ROLLER, 50 X 58 X 25mm
20.	57-2086	OIL SEAL, CRW1 19606
21.	57-4094	CONDUIT SRAIN RELIEF GASKET
22.	58-1627	1/8-27 PIPE PLUG
23.	58-16700	STEET ELBOW, 1/8"
24.	58-16732	1/8 X 1/8 MALE HEX JOINT
25.	58-16752	90 COMPRESSION TILT
26.	58-16755	MALE AIR FITTING, 1/8"
27.	58-3105	PIPE PLUG, 1/4 NPT
28.	58-4055	COPPER TUBE, BET. VALVES
29.	58-4080	.040 ORIFICE FITTING 1/8"
30.	58-4091	COPPER TUBE (T5CN)
31.	59-2746	REVERSE ACTING, TV-4DMP
32.	40-1697	SHCS 1/4-20 X 3/4
33.	22-2065	LOCATING PIN
34.	40-1632	SHCS, 1/4-20 X 1/2
35.	58-3100	FEMALE BRANCH T 1/8 NPT

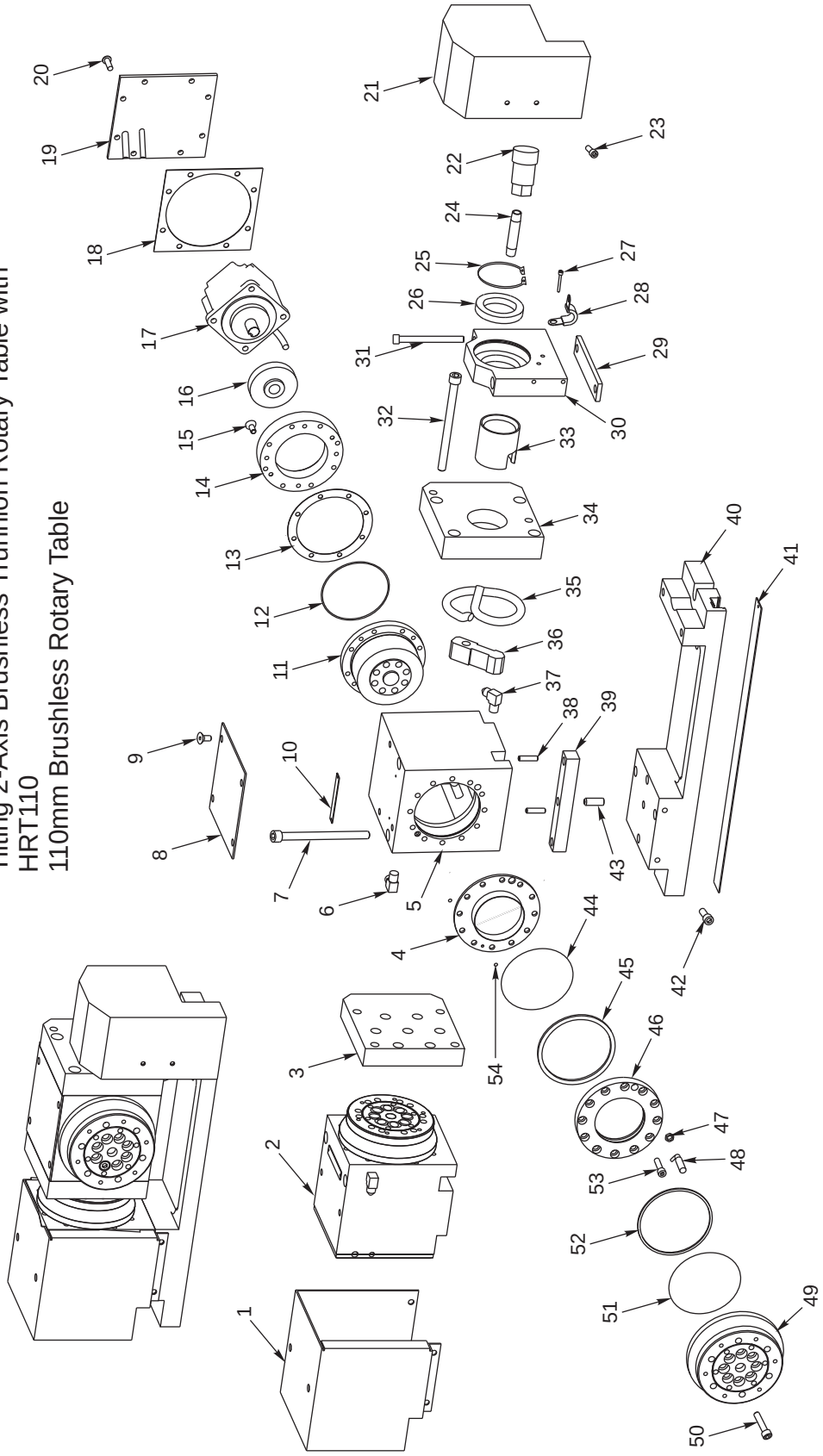
(*) FOR USE WITH AC25

36.	58-2110	SLEEVE NUT
37.	58-2130	SLEEVE COMP NYLON TUBING
38.	59-3058	5/32 TUBE ELBOW
39.	58-4096	COPPER TUBE (T5CN AC25)


HIT210
210mm 45 Deg Index Table
Note: All rotary tables use Polyurethane tubing for all air lines. Specifications are: 1/4 O.D. x .160 I.D. 95A Durometer.

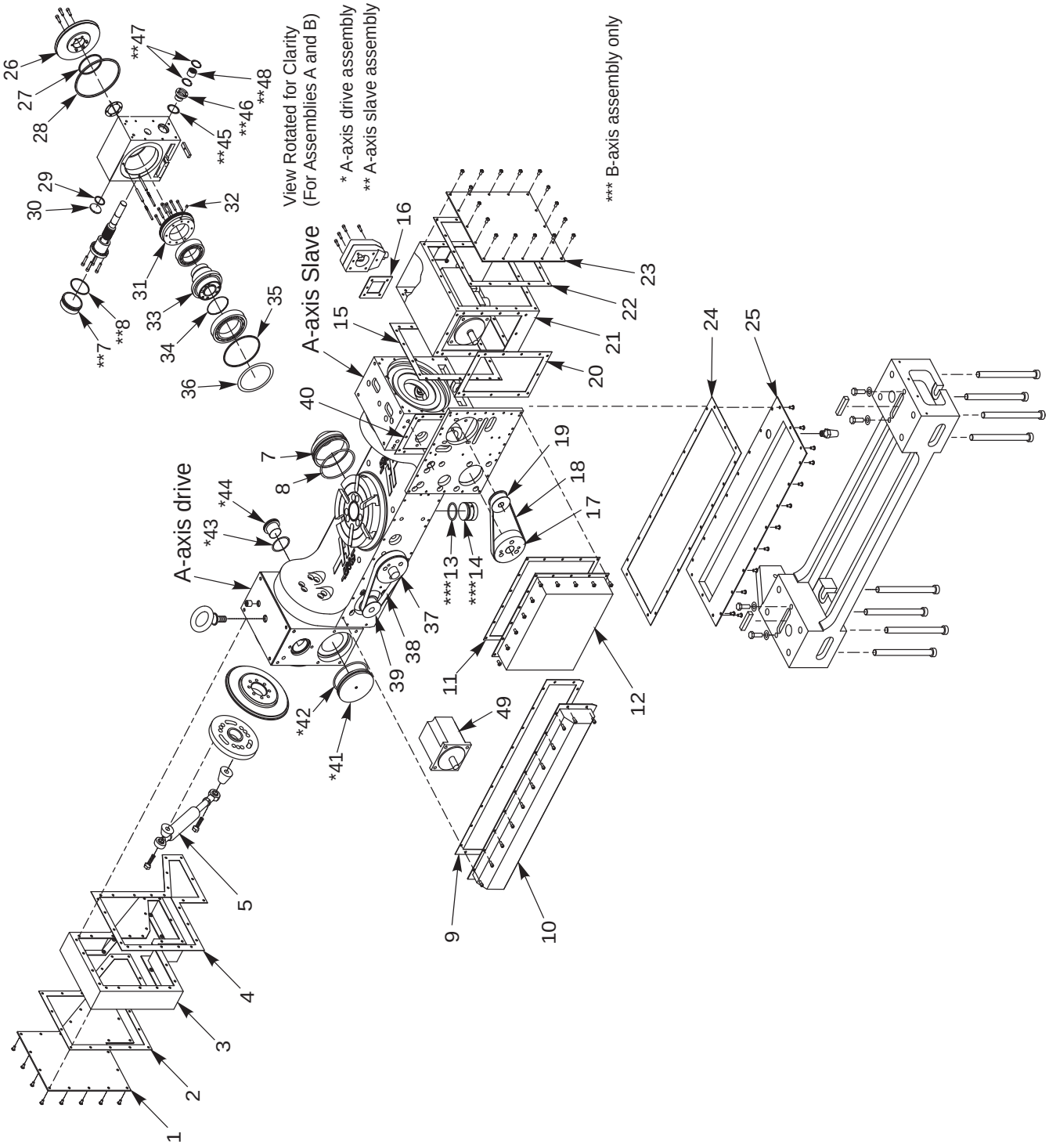
ID	QTY	DWG#	DESCRIPTION
1.	1	25-9057	SIDE COVER HIT210
2.	8	40-1750	BHCS 10-32 X 3/8
3.	1	51-0196	BEARING, SLEEVE BRONZE
4.	1	20-4076	SHAFT SUPPORT HIT210
5.	1	20-4299	SHAFT SUPPORT, ADJUSTER
6.	4	40-1640	SHCS 10-32 X 1/2 ZINC PLATE
7.	2	44-1634	SSS 10-32 X 3/8 FULL DOG
8.	1	51-0051	CAM FOLLOWER 3/4 HEX
9.	2	40-16413	SHCS M3 X 5
10.	1	20-4061	DRIVER GENEVA 1 PIN
11.	1	46-16551	NUT 3/8-24 HEX
12.	1	33A-5R & 33A-5L	DC RIGHT ANGLE GEARMOTOR
13.	1	20-4077	MOTOR MOUNT PLATE HIT210
14.	2	40-2026	SHCS 10-32 X 1
15.	1	20-4048	TOP PLATE, HIT210
16.	10	40-2026	SHCS 10-32 X 1
17.	1	49-1008	EYE BOLT 1/2-13 X 7/8
18.	2	40-1640	SHCS 10-32 X 1/2 ZINC PLATED
19.	1	25-9072	PROX BRACKET INDEX MRK
20.	1	69-1700	PROX SW NC 2WR 1.0M
21.	1	57-0016	O-RING 2-167 BUNA
22.	1	20-4078	COVER PLATE, REAR HIT210
23.	1	51-10059	S BRG 1.25 SLV BRONZE 1.25 X 1.5 X .5
24.	1	57-0476	SEAL 1.25 CR12340 1.756ODCR12340
25.	4	40-1640	SHCS 10-32 X 1/2 ZINC PLATED
26.	1	40-0114	NUT 1 3/8-12 JAM
27.	1	51-2984	THRUST WASHER TRB-3446
28.	1	20-4062	GENEVA STAR, 8 STN HIT210
29.	4	40-16413	SHCS M3 X 5
30.	1	69-1700	PROX SW NC 2WR 1.0M
31.	1	69-1700	PROX SW NC 2WR 1.0M
32.	1	57-4134	GASKET AIR FITTING
33.	1	58-16708	FITG POLY-1/4 X NPT-1/4 M
34.	1	58-1677	FITG BKHD NPT-1/4 X .750 DIA
35.	1	58-3065	AIR MUFFLER NPT-1/4-M
36.	1	57-4134	GASKET AIR FITTING
37.	1	58-16708	FITG POLY-1/4 X NPT-1/4 M
38.	1	58-1677	FITG BKHD NPT-1/4 X .750 DIA
39.	1	58-3618	FITG NPT-1/4-F X NPT-1/4-M 90 BR
40.	1	58-3710	FITG QUIK CONN-1/4-M X NPT-1/4-M STR
41.	4	40-1798	SHCS 8-32 X 1 3/4 ZINC PLATED
42.	4	45-0042	WASHER FLAT 0.170ID X 0.400OD
43.	4	57-0057	O-RING 2-007 VITON
44.	1	20-3071/3072	J-BOX, ENCODER
45.	1	57-4133	GASKET SQUARE J-BOX
46.	1	57-0459	GASKET, MOTOR ENCL HIT210
47.	1	25-9076	BRACKET, BOARD MNT HIT210
48.	4	45-16982	WASHER #4 INT LOCK PLT
49.	4	41-1005	PPHS 4-40 X 1/4 ZINC
50.	14	40-1750	BHCS 10-32 X 3/8
51.	1	25-9056	ENCLOSURE COVER HIT210
52.	1	32-5064	HAAS INDEX TABLE CCA
53.	4	45-1603	WASHER #8 SPLT LCK PLT MED
54.	4	46-1617	NUT 8-32 HEX
55.	14	40-1850	SHCS 10-32 X 3/8 W/LOC
56.	14	45-1737	WASHER #10 FLAT SAE PLT
57.	1	25-9055	MOTOR ENCLOSURE HIT210
58.	1	57-0459	GASKET, MOTOR ENCL HIT210
59.	2	40-2028	SHCS 10-32 X 1 1/4
60.	1	32-5631	TT AIR SOLENOID ASSY
61.	5	58-3664	FITG REDUCER NPT-3/8-M X NPT-1/8-F
62.	5	58-3658	FITG LBO-3/8 X NPT-1/8-M 90
63.	2	40-1632	SHCS 1/4-20 X 1/2 ZINC PLATED
64.	1	25-9059	PROX BRACKET, HOME
65.	1	20-4056	BODY - MACHINED, HIT210
66.	1	51-2984	THRUST WASHER TRB-3446
67.	1	57-0095	O RING 2-327 VITON
68.	1	57-2146	O RING 2-358 VITON
69.	1	20-3405	GT-20 T/C UPPER PISTON
70.	1	56-0055	RTNG RING 2.125 SH
71.	1	20-4060	PLATTER RING, HIT210
72.	1	45-0124	WASHER 1 1/2 STEEL
73.	1	44-0113	NUT 1 1/2 JAM NYLOCK
74.	1	20-4059	PLATTER, HIT210
75.	1	57-2146	O RING 2-358 VITON
76.	1	57-2983	O-RING 2-336 VITON
77.	1	20-3409	GT-20 T/C LOWER PISTON
78.	1	51-2984	THRUST WASHER TRB-3446
79.	1	51-0200	THRUST 2.125-2.875-0.0781
80.	1	20-4057	SHAFT HIT210

TR110
Tilting 2-Axis Brushless Trunnion Rotary Table with
HRT110
110mm Brushless Rotary Table



Note: All rotary tables use Polyurethane tubing for all air lines. Specifications are: 1/4 O.D. x .160 I.D. 95A Durometer.

ID	QTY	DWG#	DESCRIPTION
1.	1	25-7809	SPLASH SHIELD TR110
2.	1		HRT110
3.	1	20-3023	DRIVE PLATE TR110
4.	1	20-3235	BRAKE FLEX CYLINDER HRT110 TR110
5.	1	20-2947	MACHINED BODY, HRT110
6.	1	58-16700	FITG NPT-1/8-F X NPT-1/8-M 90 BR
7.	2	40-16439	SHCS 3/8-16 X 5
8.	1	25-6771	B-Axis Cover TR110
9.	4	40-1605	FHCS 6-32 X 3/8 ZINC PLATED
10.	1	29-0606	NAMEPLATE
11.	1	59-2930	HARMONIC DRIVE 50:1 CSF-45-50-5HV
12.	1	57-0378	O-RING 85 X 1.5mm
13.	1	20-3030	PLATTER SPACER
14.	1	20-2949	MOTOR ADAPTER, HRT110
15.	8	40-1920A	FHCS ¼-20 X 5/8
16.	1	Part of 59-2930	HARMONIC DRIVE COUPLER (packaged w/Harmonic Drive)
17.	1	59-0787	GEARBOX RGH-25-80SP HARMONIC DRIVE
18.	1	57-0368	GASKET, MOTOR COVER HRT110
19.	1	20-2952	MOTOR COVER PLATE
20.	8	40-1976	BHCS ¼-20 X ¾ ZINC PLATED
21.	1	25-7766	COVER, SUPPORT FRAME
22.	1	58-0959	FITG SWIVEL 90 DEG ¼-18NPTF X1/
23.	3	40-1639	SHCS 3/8-16 X 1 DOMESTIC ONLY
24.	1	58-1671	NIPPLE 1/8 NPT X 2 BRASS LOCTITE V
25.	1	56-0111	RTNG RING N5000-281 TRUARC 2.812 IN
26.	1	51-0183	BEARING DEEP GROOVE 50 ID X 72 OD X
27.	2	40-2028	SHCS 10-32 X 1 1/4
28.	1	59-2044	CABLE CLAMP 3/4 RICHCO SPN-12
29.	1	20-3026	SHIM PLATE TR110
30.	1	20-3029	SUPPORT FRAME TR110
31.	2	40-16438	SHCS 3/8-16 X 4
32.	2	40-16439	SHCS 3/8-16 X 5
33.	1	20-3025	SUPPORT SLEEVE TR110
34.	1	20-3024	SUPPORT PLATE TR110
35.	1	58-2458	TEFLON HOSE
36.	1	20-3571	HYDRAULIC FITTING TR110
37.	1	58-16700	FITG NPT-1/8-F X NPT-1/8-M 90 BR
38.	2	48-0105	PULL PIN 7/16 X 1 MCMASTER 97175A
39.	1	20-2951	T BAR CLAMP
40.	1	20-3022	BASE PLATE TR110
41.	1	25-6770	CABLE COVER CHANNEL TR110
42.	4	40-1632	SHCS 1/4-20 X 1/2 ZINC PLATED
43.	1	44-1640	SSS 3/8-16 X 1 CUP PT
44.	1	57-0399	O-RING 2-042 BUNA
45.	1	57-0398	QUAD RING Q4-334
46.	1	20-3234	BRAKE CAP HRT110 TR110
47.	1	20-2994	NUT, HOME SWITCH M8X1
48.	1	32-0053	ROTARY HOME SENSOR SW 16HRT110/TR110
49.	1	20-2948	PLATTER BRAKE HRT110
50.	8	40-0089	SHCS M8 X 35 DOMESTIC ONLY
51.	1	57-0400	O-RING 2-245 BUNA
52.	1	57-0397	HRT110 TEFLON SEAL PLATTER SEAL
53.	12	40-1610	SHCS 1/4-20 X 1 DOMESTIC ONLY
54.	2	57-0057	O-RING 2-007 VITON



Note: All rotary tables use Polyurethane tubing for all air lines. Specifications are: 1/4 O.D. x .160 I.D. 95A Durometer.

TR160

1. 25-4859
2. 57-4726
3. 25-4858
4. 57-4725
5. 59-4700
6. N/A
7. 20-4158

**8. 57-2220
**9. 57-4724

10. 25-4857
11. 57-4730
12. 25-4809
13. 57-2125
14. 20-4710
15. 57-4728
16. 57-4133
17. 20-4501
18. 54-4505
19. 20-4507
20. 57-4727
21. 25-4860
22. 57-4729
23. 25-4861
24. 57-4723
25. 25-4855
26. 25-4712
27. 57-2232
28. 57-2231
29. 57-2831
30. 28-4126
31. 20-4154
32. 69-18101
33. 20-4152
34. 57-2107
35. 57-2144(A-Axis)
    57-2230(B-Axis)
36. 20-4151
37. 20-4501
38. 54-4700
39. 20-4511
40. 57-4180

*41. 20-4709
*42. 57-2220
*43. 57-0194
*44. 20-4708

**45. 57-0194
**46. 20-3253
**47. 56-2135
**48. 51-0076

	Tilt	Rotary
49. Cable	36-4122A	36-4122A
Motor	62-2508	62-2495A

TR210

1. 25-4872
2. 57-4657
3. 25-4871
4. 57-4656
5. 59-4367
6. N/A

**7. 20-4108
**8. 57-2220

9. 57-4664
10. 25-4876
11. 57-4660
12. 25-4808
13. 57-0015
14. 20-4670
15. 57-4658
16. 57-4133
17. 20-4502
18. 54-4653
19. 20-4511
20. 57-4653
21. 25-4869
22. 57-4652
23. 25-4870
24. 57-4662
25. 25-4874
26. 20-4103A
27. 57-2223
28. 57-2222
29. 57-2831
30. 28-4126
31. 20-4104
32. 59-18101
33. 20-4102
34. 57-0054
35. 57-0139(A-Axis)
    57-2221 (B-Axis)
36. 20-4101
37. 20-4502
38. 54-4654
39. 20-4507
40. 57-4135

*41. 20-4108
*42. 57-2220
*43. 57-4115
*44. 20-4668

**45. 57-2234
**46. 20-3186
**47. 56-2085
**48. 51-0026

	Tilt	Rotary
49. Cable	36-4030C	36-4122A
Motor	62-0014	62-2508

TR310

1. 25-4889
2. 57-4644
3. 25-4888
4. 57-4643
5. 59-4602
6. N/A

**7. 20-4382
**8. 57-2250

9. 57-4619
10. 25-4882
11. 57-4425
12. 25-4807
13. 57-4604
14. 20-4604
15. 57-4641
16. 57-4133
17. 20-4505
18. 54-4510
19. 20-4515
20. 57-4624
21. 25-4886
22. 57-4641
23. 25-4887
24. 57-4625
25. 25-4884
26. 20-4213
27. 57-2144
28. 57-2252
29. 57-2831
30. 28-4126
31. 20-4214
32. 69-18101
33. 20-4212
34. 57-2121
35. 57-2251 (A-AXIS)
    57-0025 (B-AXIS)
36. 20-4211
37. 20-4505
38. 54-0218
39. 20-4519
40. N/A

*41. 20-4382
*42. 57-2250
*43. 57-4120
*44. 20-4388

**45. 57-0052
**46. 20-3217
**47. 56-2087
**48. 51-0036

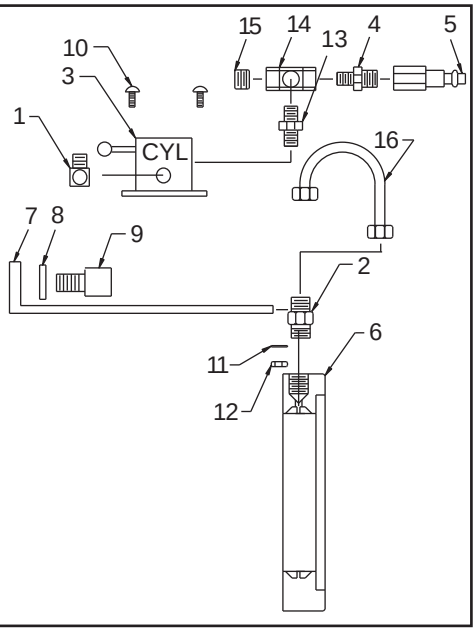
	Tilt	Rotary
41. Cable	36-4030C	36-4030C
Motor	62-0016	62-0014

* A-axis drive assembly only ** A-axis slave assembly only *** B-axis assembly only

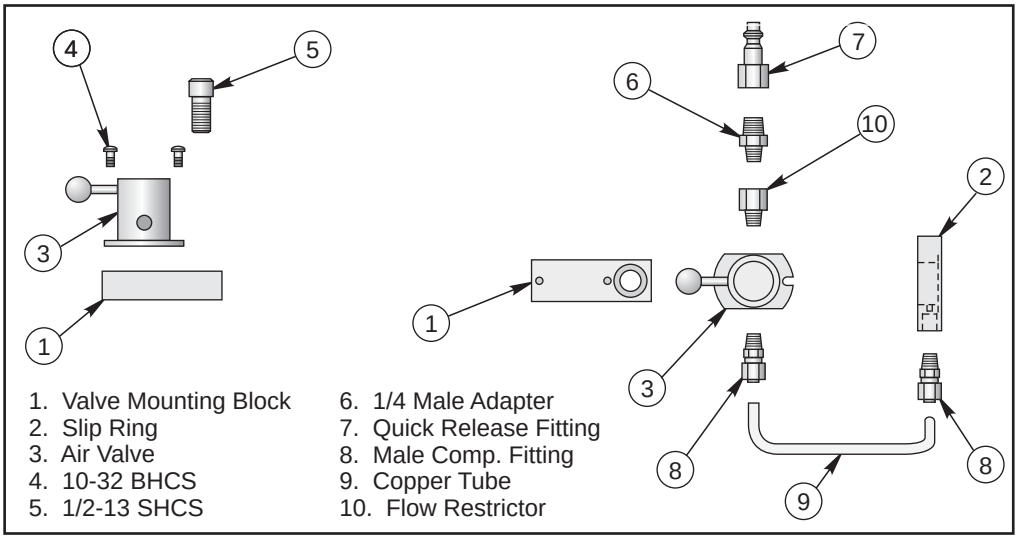
AC100 Valve Assembly and slip ring (AC100)

MATERIALS

1. 90 Comp. Fitting
2. Male Comp. Fitting
3. Valve
4. 1/4 Male Adaptor
5. Quick Release
6. Slip Ring
7. Bracket
8. Washer 1/4 Split
9. SHCS, 1/4-20 x 1/2
10. BHCS, 10-32 x 3/8
11. Washer, #10 Star
12. Hex Nut, 10-32
13. Male Hex JCT.
14. 1/8 NPT Female Tee
15. 1/8-27 Pipe Plug
16. Copper Tube (4026)



Assembly of valve and slip ring (AC 25/ 125)



1. Valve Mounting Block
2. Slip Ring
3. Air Valve
4. 10-32 BHCS
5. 1/2-13 SHCS
6. 1/4 Male Adapter
7. Quick Release Fitting
8. Male Comp. Fitting
9. Copper Tube
10. Flow Restrictor

***** The flow restrictor does not exist on the AC25.