# calmotion

# 527F CNC

**Retrofit controller for machines made by Fadal Machining Centers**

**Installation and set-up manual**

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# Introduction

This manual is intended to provide a description of the installation steps for the 527F CNC.  The 527F CNC has been designed to fit in a like form factor as the IEEE S100 card edge bus used in machines made by Fadal Machining Centers.

The 527F CNC controller cards primarily use the power and ground connections of the S100 bus. The data bus connections are not connected. The connections to the amplifier control, motor feedback,.. have been placed as closely to the same location as possible to the existing connections in order to minimize the disturbance of the original wiring.

Communication takes place with a daisy chained high speed bus on the front of the cards. Industry standard CAT5 cables are used to connect each card for communication to the CNC master.

The 527F CNC is a multiprocessor embedded control and many of the processors communicate over high speed CAT5 connections. The cables provided with the 527F CNC are color coded by function in order to more easily identify the purpose of the cables.

Main CNC/Axis cards – Blue

Video – Yellow

Ethernet – Orange

Keyboard – White (Used with optional Pendant Panel)

I/O Monitor – Green (Used with optional I/O monitoring board)

The connectors on the CNC are covered with colored plastic covers to identify the functions of each connector.


# Requirements

The installer should have basic skills working with a voltmeter. Please review the instruction manual thoroughly before beginning installation.

The installer should verify that proper space and clearance has been taken into account prior to drilling holes in the CNC pendant. This includes cable bending radius and cable length.

**All work while installing the 527F must be done with the power disconnected to the machine.**

The 527F CNC requires a minimum resolution super VGA (800 x 600) capable monitor in order to view all of the screen data. Many of the original LCD monitors installed in the machines were

preset to standard VGA (640 x 480) specifications. Some of these monitors are not multi-sync capable and require that the setting of the monitor resolution be changed to SVGA. An external button board, p/n PCB-0270 or equivalent, may be required to change the VGA input type to the monitor.

Composite video monitors will need to be replaced. These are identified with a green screen and coaxial cable connection. There are a number of vendors who supply VGA monitors that fit in the same form factor as the composite video monitors and can supply a replacement monitor that will meet the SVGA specification.

The 527F uses either a PC or a stand-alone video board to display the control screens.
The PC with USB video dongle typically is mounted in the pendant, the HDMI goes to the LCD, the USB dongle connects to the yellow CAT5 cable going to rear cabinet to the 527F control card in slot 8.
The stand-alone video board that is typically installed in the control cabinet that contains the S100 card cage. The video board has an HDMI output and is supplied with DIN rail clips and din rail to be secured in the control cabinet at the rear of the machine. The installer should consider the path to route an HDMI cable that must be run from the control cabinet to the front pendant.

## USB

A panel mount USB connector is typically installed at the pendant for ease of use for the operator. A 14 foot USB cable is provided with the 527F and should be routed at the same time as the video Ethernet CAT5 cable.

## Ethernet

The 527F has powerful Ethernet capability and the installer should consider connection to a local network prior to installation. A panel mount CAT5 plug is provided with the 527F kit. When installed, a wired or wireless access point can be added in order for the 527F to be added to a network.

Although not required, the Ethernet connection provides the fastest was to transfer programs to the CNC memory and allows an operator to pull files from server locations on the network. Optional email capability of the 527F requires an Ethernet connection to the facility network. Updates to the CNC are done with the Ethernet connection.

## Installation steps

Prior to removing any of the original control cards

1. Record all SETP parameters.
2. Record all BL settings.
3. For AC machines, record the ZERO offset for each axis. Record surveys.

4. A photo of the controller cards in card cage can be helpful should the need arise to replace them back into the S100 card cage.

Make a temporary setup of an external LCD and power strip on a work table. This will allow the pendant to be unmodified while getting the 527F control cards installed and setup. Once the control is functioning with this temporary setup. Then any modifications that will be made to the pendant can be made knowing that the 527F control is functioning properly.

## Removal of existing controller cards

1. Power off the machine. Push the emergency stop button in.

2. Remove all of the cards in the 1060 card cage, except for the 1550 chiller and the 1040 mill interface. Place tape on the cards as they are removed and record which slot in which they were previously located. In the case of DC machines, the clock card located in slot 15, must be left in place.

## Installation of 527F controller cards

1. Video card installation depending on type provided in the installation kit. Currently the kits include only the PC video style not the former stand-alone video card.
   1. PC video with USB dongle will be installed later in the instruction below.
   2. For the previous style stand-alone Video card: Secure the DIN rail provided inside the control cabinet for the video card. It may be easiest to remove the machine screw for the upper latch of the control cabinet and use it to secure the DIN rail. The video card is supplied with power wires that must be connected to the 5 volt connection of the CNC power supply. The yellow CAT5 cable used for video must be connected from the video board to the 527F S100 interface card that resides in slot 8. The connections have yellow covers to identify the video connections.

2. Run the black USB cable from the control cabinet to the front pendant. Install the panel mount USB connector in the front pendant. This should preferably be on the bottom so that the USB flash drive is not sticking out the side where it can be more easily broken off. Connect the USB cable to the panel mount plug.

3. Install the panel mount Ethernet connector in the rear electrical cabinet. Be sure to check orientation of the connector. Plug the orange CAT5 cable into the Ethernet connector on inside of cabinet.

4. The facility network cable plugs into the external side.

5. Insert the S100 interface card into slot 8

6. Insert the axis cards into the appropriate slots as indicated below. Ensure that the dip switch settings match the location of the slot.
   X Axis slot 9 is directly above J1

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Y Axis slot 10 is directly above J2
Z Axis slot 11 is directly above J3
B Axis slot 12 is directly above J4
A Axis slot 13 is directly above J5
C Axis slot 14 is directly above J6

Note: A direction jumper located on each of the axis cards is typically not used. But, if the original axis cards removed have the direction jumper installed, then possibly the new axis cards will also need this direction jumper installed. The direction jumper is used to change the rotation of the motor when going in the positive direction. This is used in linear axis applications if the motor is mounted on the opposite side of the ball screw than is typical.

If an axis motor does not run away, but turns in the opposite direction than desired, place a jumper on the axis card and reverse the analog signal wires (AC only )

7.  Connect the blue CAT5 cables across the front of the axis cards and the S100 interface board ending with the spindle card. These connections are daisy chained and end with the spindle card. The spindle card must be the last connection.

8.  The orange CAT5 cable plugs into the S100 interface daughter board

9.  Connect the USB cable into the S100 interface daughter board

10. Connect the feed rate pot cable into S100 interface board. If the 1020 card is being used for a DC machine, the feed rate pot cable must be connected to the S100 interface board. Do not leave the 3 pin Feed Pot cable attached to the 1020 card it must be moved to the 527F card in slot 8.

# 527F PC Video Installation Options

There are two options of delivering 527F Video to the display. One is the standard video option and the other is the PC option. The standard video option displays only CNC screens and is installed in the rear electrical cabinet. The PC option is installed in the pendant and can be used for other purposes if a mouse and keyboard are added.

## Standard Video Option

The video card is mounted on a DIN rail. Mount this in the rear electrical cabinet and power the video card
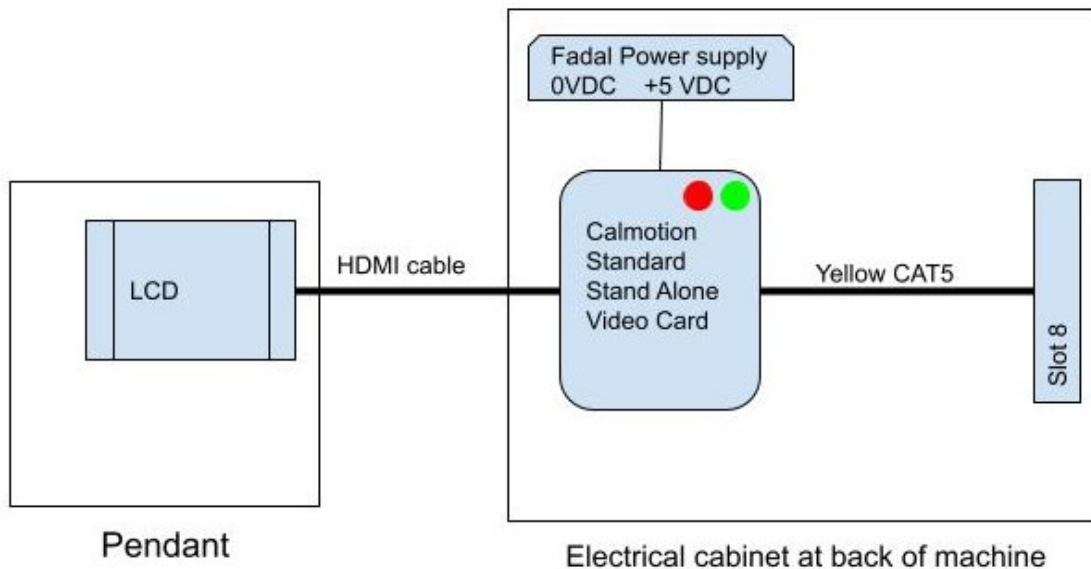


On the Calmotion Standard Stand Alone Video Card on DIN rail:

- A solid red LED means power is good.
- If the red LED is off, flickering, or flashing, it could mean the power supply or connect are weak or unstable.
- Intermittent flashing green LED is good.
- Solid green LED can indicate a power up issue or SD card not inserted.

## PC Video Option

The NUC PC is installed in the pendant and a yellow CAT cable should be brought from the rear cabinet and plugged into the USB port on the PC. Secure the DIN rail provided inside the pendant cabinet for the electrical outlet. The NUC PC will automatically power when the machine is powered. See the PC connections diagram below.

Note, the USB cable with panel mount USB plug is not for this PC, the USB cable and panel mounted plug plugs into the USB plug on the 527F CNC card that is slot 8 of the motherboard.

Pendant | Electrical cabinet at back of machine
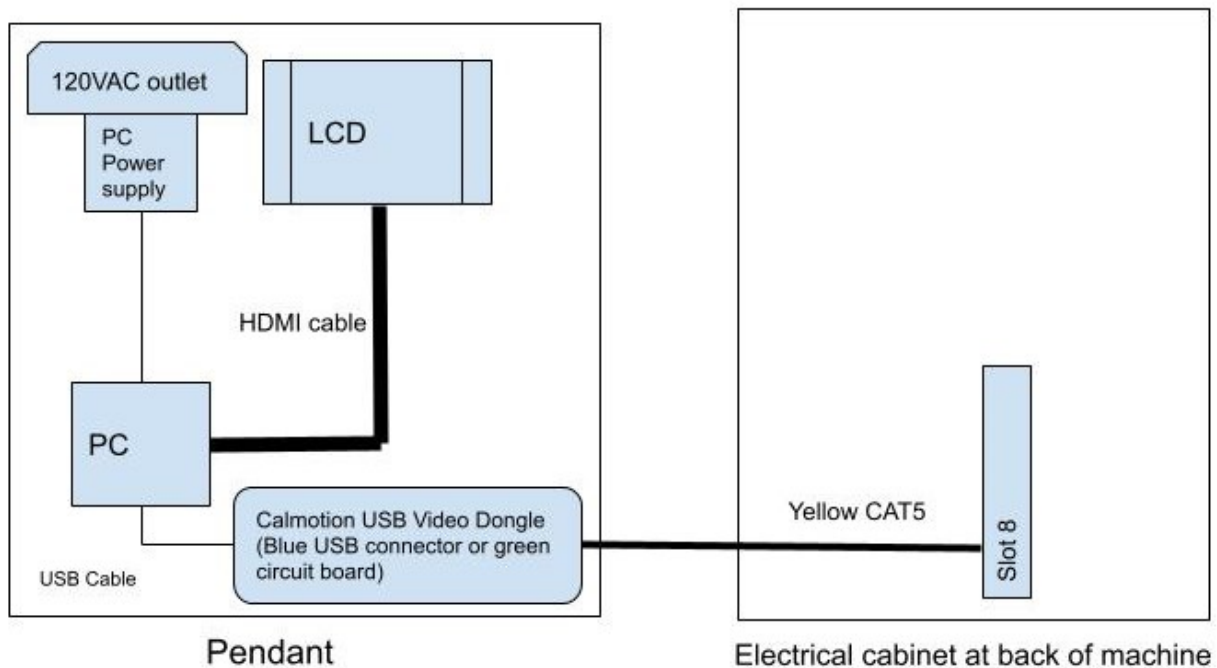
1. Disconnect power from the machine tool.

2. Mount the support tray for the keyboard and mouse to the bottom of the pendant and secure with the provided hardware.

3. Some models have a tray used to support the weight of the CRT. If installed in the pendant, it can act as a shelf for the customer supplied NUC computer. Not all pendants will have the tray.
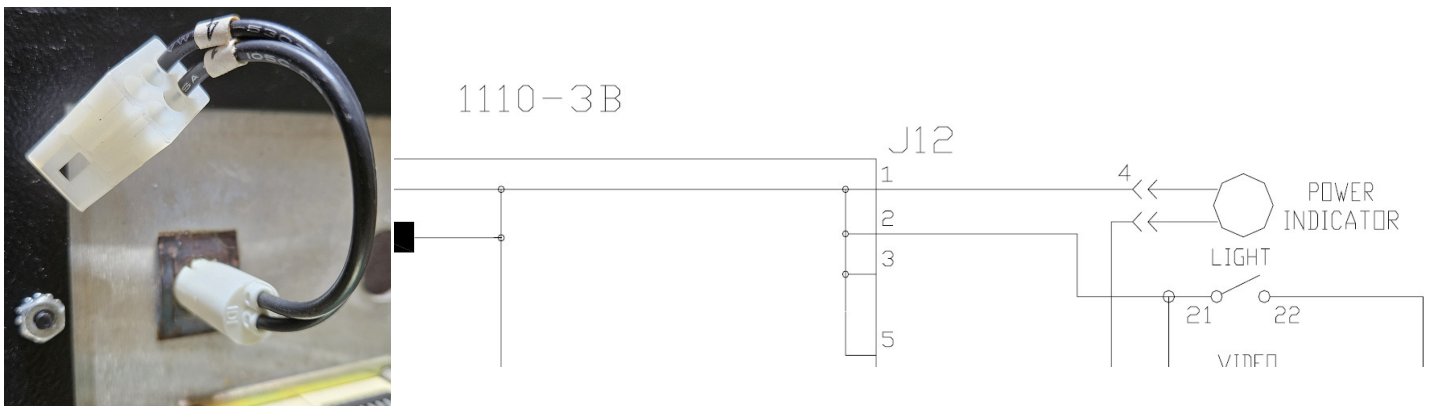


4. Locate the harness assembly used to power the green power indicator lamp on the pendant. A typical assembly is shown above. Refer to the Fadal wiring diagrams, shown above is when the 1110 distribution board is in the pendant. If the pendant does not have a green power indicator lamp, then refer to the Fadal wiring diagrams to find another 120VAC source for power.

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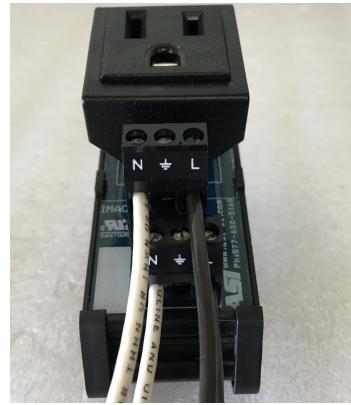
5. The din rail receptacle should now be mounted. Remove one of the nuts securing the pendant handle. Slide the din rail over the exposed screw and secure with the nut.

6. Ensure that there is enough length to reach the receptacle AND for the Molex plug to reach the monitor prior to cutting the wire. Snap the receptacle into the DIN rail and find an appropriate place in the power cable to cut. The black wires should be connected to the L terminal block of the receptacle and the white wires should be connected to the N terminal block as shown above. Snap the receptacle into the DIN rail. The power supply for the NUC computer may have a ground plug. If so, connect a ground wire on the DIN outlet to the sheet metal of the pendant box. It is good practice to connect a ground in either case in the event the power plug is used in some other way.

7. Connect the Calmotion USB video dongle to the PC and secure. Connect the yellow CAT5 cable to the video communication port of the 527F CNC in the control cabinet to the USB dongle. The connection will have a yellow tab around the connector for identification purposes. An HDMI or VGA cable should then be connected to the monitor as appropriate. Plug the PC power supply into the power outlet installed in the previous step.

8. With the E-Stop switch pressed in, apply power to the machine. The PC is configured to auto run upon application of machine power. The 527F viewing software will auto boot if the computer has been supplied from Calmotion.

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Proper connection of CAT5 cables

# SETP Parameters

After the cards have been installed. Set all the parameters back to what were previously used. Note that some parameters are new and how to set them are below. Note that some of the parameters will not exactly transfer into the 527F from the previous control. Parameters like ORIENTATION FACTOR, TURRET FACTOR, RIGID TAPPING GAIN, etc will all require some adjustments.
Use the test programs that are located in SERVICE PROGRAMS to test out different aspects of the control. Like orientation, tool changes, rigid tapping, etc. When a test fails adjust the appropriate associated parameters till the test passes for the new control values.

## Restore settings

Press the emergency stop button in prior to applying power to machine.

At the ENTER NEXT COMMAND prompt, type SETP to enter the machine parameters. Restore the settings from legacy CNC. Most of the settings are the same as the legacy CNC, however, there are a few additions to the 527F CNC that require special attention:

# SETP, Page 1

### VIDEO STYLE

Use PC USB DONGLE when using a PC running the 527F video application with the 527F USB video card.
All other 527F video cards must be set to STANDARD DISPLAY SCREENS.

### EXTRA TOOL #S

Set to NO to have the tool changer tool numbering work just like the Fadal controls.
Set to YES to allow any tool number (T1 to T200) to be put into any tool changer pocket. With this option, each tool # needs to be added/deleted to the tool changer.

### T#

Set to NO to not send anything out RS232 in regards to a tool change.
Set to YES to have the tool number sent, T###, out the RS232 when a tool change occurs. This is typically used in conjunction with an aftermarket servo coolant attachment.

### ORIENTATION FACTOR

Two orientation factors can now be used for each spindle gear range. This allows for better orientation control in different gear ranges. Also there are two other parameters that can be

adjusted, the TIMEOUT sets how many seconds before the orientation has to complete before an error occurs.

The INCREMENTS allows for finer control of the factor. The default is 10, but if the INCREMENTS is set to 1, then the orientation factor is 10x finer, so a previous FACTOR=10 & INCREMENTS=10 can now be entered FACTOR=100 & INCREMENTS=1.

# SETP, Page 2

### MISC

This new setting has 2 options to keep the ATC slide motor ON or OFF during the tool change. Keeping the slide on is typically only used on older machines that do not have a spring installed to keep the ATC at the spindle. Start with set this to NO, to not keep the slide motor on during tool change.

# SETP, Page 3

### IPM (and DPM)

There are additional IPM settings to choose from. The CUSTOM IPM allows each axis to have a different max IPM or DPM. When there is a rotary table installed, make sure that the max DPM is set for that rotary and tilt table in DPM.

### VECTOR

If the spindle turns the wrong way when an M4 is commanded. Then change the VECTOR setting. This parameter changes the state of the K3 K4 relays to go to the Spindle drive. Some spindle drives use the relays to control direction, while other drives use the analog command signal.

### AXIS DISPLAY

Set either Reference Offset or Following Error in the position display window. The position display readout has a column for the Following Error an axis amplifier has been set to. This column can also show a Reference Offset. This reference offset can be set with the REF command.

### JERK (change in acceleration per millisecond)

The rate of change of the acceleration is called the jerk amount. Enter the number of milliseconds to get to full acceleration amount. The acceleration for each axis is set with the ramp parameters on page 4.

Use a suggested value of 5 to control the initial ramp of the acceleration. Rapid changes in acceleration can lead to unwanted performance, machine bumping, uneven cuts. A JERK parameter has been added to change the rate of acceleration that will be allowed. A larger value will create longer acceleration ramps while smaller values will allow the machine to reach its acceleration more quickly. This value establishes the number of milliseconds it takes to reach the require acceleration from one acceleration value to another.

## FEED RATE 100%

Use a starting suggested value is 160. Feed pot calibration is performed by using this setting to adjust the analog value input to the CNC to match the desired position of the potentiometer. Set the potentiometer to 100% and observe the % value of the feed rate potentiometer under the Spindle / Feedrate menu. If the value shown is not 100%, raise or lower the value in this setting until 100% is shown.

Note, that the knob can be loosened and physically moved to achieve the best position on the potentiometer shaft.

## MOTOR FEEDBACK

The 527F control will allow a mix of axis motor feedback types for each axis. The choices for encoder feedback are 5000 and 8192 encoders. If a resolver is used for feedback, set this parameter to 4096. If scales are used enter the letter 'S'. Note that Calmotion axis cards are different depending on whether encoder or resolver feedback is used.

# SETP, Page 4

## XYZAB RAMPS

XYZ AB RAMP is an individual adjustment of a ramp (acceleration) for each axis. 100 is normal . Smaller is shorter. Larger than 100 will be a longer ramp for that axis.

## XYZ DELTAS

DELTA is the inches per minute when to start ramping for that axis. Typically just leave X and Y at 40 and Z at 30. Feed rates that are less than that axis setting #, will not ramp that axis.

## XYZAB GAINS

The default gain of zero is to use normal gain.
Do not change from the value of 0 as this is not available on all axis cards.
A value of 10 should be equivalent to 0. Larger than 10 should be higher gain.

## Spindle RPM Offsets

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The original SPINDLE RPM OFFSET parameter has been replaced with 4 new parameters. The problem with the former parameter SPINDLE RPM OFFSET was that it was difficult to select a number that worked well for both high and low ranges. When the spindle drive does not have a high low range, then only setting just the low range values would be required.  If it is a Wye/Delta drive, then both the low and high range settings will be needed.

These are four new parameters, available on page 4 of the SETP command.

| Parameter | 10K Hi/Low Spindle | 7.5K Spindle | 15K Spindle |
|---|---|---|---|
| LOW RANGE 0 RPM OFFSET | 40 | 40 | 40 |
| LOW RANGE MAX RPM OFFSET | 340 | 340 | 340 |
| HIGH RANGE 0 RPM OFFSET | 40 | 40 | 40 |
| HIGH RANGE MAX RPM OFFSET | 800 | 340 | 340 |

NOTE, Three things to be aware of when setting these values:

1. make sure the spindle % pot is not enabled (M49)

2. make the range desired is maintained. With the S# use the .1 or the .2 to force the range desired.

3. Do not use the RPM extremes for minimum and maximum RPMs. Keep RPM in a reasonable range to avoid clipping at high RPMs and lack of power at low RPMs. See the steps below for a 10,000 RPM mechanical high/low gear machine. The maximum spindle speed is 2500 RPM in low range, note do not use the maximum RPM in either range to avoid clipping of the maximum RPM.

1. Start with all 4 of the parameters set to 0.  The offset value is in RPMs
2. In MDI:

**S300.1 M3 M49**

(note the number of RPMs that are short and add this number to the LOW RANGE 0 OFFSET)

2. In MDI:

**S2400.1 M3 M49**

(note the number of RPMs that are short and add this number to the LOW RANGE HIGH OFFSET)

2. In MDI:

**S300.2 M3 M49**

(note the number of RPMs that are short and add this number to the HIGH RANGE 0 OFFSET)

2. In MDI:

**S9000.2 M3 M49**

(note the number of RPMs that are short and add this number to the HIGH RANGE HIGH OFFSET)

# Ethernet Network Parameters



| AXES | PROGRAM | DISTANCE TO GO | REFERENCE | MACHINE |
|------|---------|----------------|-----------|---------|
| X | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Y | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Z | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| A | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| B | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| C | 0  RPM | | | |

```
                                        SPINDLE / FEEDRATE
                                    S   300 T  1   POCKET  1
                                    F  3.00 / F       0.00    150%
                                    COOLANT1  OFF      COOLANT2  OFF


                                             TOOLS

                                    H0 = 0
ENTER NEXT COMMAND IP               D0 = 0
EXAMPLE TO CHANGE NETWORK SETTINGS:   IPA,192.168.1.123    E0X0Y0Z0

CURRENT NETWORK SETTINGS:                  Active G / M Codes
IP ADDRESS 192.168.1.99  (USE THE IPA COMMAND TO CHANGE)
IP MASK 255.255.255.0  (USE THE IPM COMMAND TO CHANGE)    G0   G2   G17  G20/G70  G90
IP GATEWAY 192.168.1.1  (USE THE IPG COMMAND TO CHANGE)   G9   G40  G80  G98
IP DNS 0.0.0.0  (USE THE IPD COMMAND TO CHANGE)             M9      M0    OPT STP
IP NTP  (USE THE IPN COMMAND TO CHANGE)                   FORMAT 1
                                                          LAST 00:00:00  RUN 00:00:00
ENTER NEXT COMMAND
```

**Illustration 1: Reference screen and IP command**

## Setting the static IP address of the 527F

The IP address of the CNC is stored on an SD card that is contained on a daughter board mounted on top of the S100 interface board. The current IP address of the CNC can be viewed by typing the IP command at the ENTER NEXT COMMAND prompt. These values can be changed at the CNC or the SD card can be removed with power off and modified on a PC offline. The values are stored in the root directory within a file labeled 527F.INI .

Quick IP setup:
1. On a PC on the network, use the IPCONFIG Windows program to determine the Ipv4 range of the network.
2. Enter a new IP address for the 527F by using the first three numbers of the address the network, but pick a larger number for the fourth number. For example if the PC Ipv4 showed IP:192.168.1.56, enter the command IPA,192,168,1,230 to set the static IP address of the 527F to be 192.168.1.230.
3. The mask should typically be set to IPM,255,255,255,0

4. The gateway and NTP IP addresses are **not** required. And they will allow the 527F connection to the internet. Leave set to 0.0.0.0 to skip the following steps.
5. The gateway and the DNS should be set if you would like to use NTP to set the time and date on the 527F
6. Use IPN to set the address of a Network Time Protocol computer that is on the internet. Search for public NTP IP addresses on the internet, there are a lot of free public NTP computers provided by the government or other agencies.

See separate manual on 527F Network Setup for more detailed information for setting up a connection to the facilities Ethernet or WiFi network.

# Machine Initialization

1. Push emergency stop button in.
2. Power on machine.
3. Cautiously release the emergency stop button and watch for a run away. If an axis runs away, the direction on the axis card is backwards. Power off the machine and set a jumper on the axis card. The jumper is labeled with silkscreen "Direction". Restart at step 1
4. Type ZERO at the enter next command prompt. The value of Zero for each should initially be set to a value of 0. The SV command with also show each axis offset amount, but note the SV shows a whole number, for example, in SV an offset of -150 is equivalent to -.0150 inches in the ZERO command. Enter the survey values.

**Note: The 527F survey values have the opposite polarity as those used by the CNC88, CNC88HS,... The survey values entered are also 10x greater. CNC88 values should be multiplied by -10 and entered into the 527F.**

5. Type BL at the Enter Next Command prompt to enter the backlash values. A value of 0 should initially be used. Note that BL values must be multiplied by 10. The 527F allows finer adjustment than the legacy control and uses units of
   .00001 inches.
6. Power off machine. Wait for 30 seconds and re-apply power to the machine.
7. Jog each axis to the cold start mark
8. Cold start the machine using the CS command.
9. Jog each axis to the cold start marks.
10. Using the position values on the screen, enter them using the ZERO command for each axis. Example: If the X axis display indicates a value of 0.0012, type ZERO,1,.0012 and press <Enter>.  (or use the SV command to enter the zero offset).

Note: If new values are entered using the above steps, use the SETP command and exit from it to re-load these values to the axis card. Repeat the above steps until the cold start marks are lined up with the machine.

## Balance Program

The signal gain values of the amplifiers must be tuned higher than those used with the legacy control in order to obtain the best performance from the 527F. Run the 5811 program and  adjust the amplifier signal gain value until the suggested value of 150 is reached for DC machines. The AC machine suggested value is 250.

The values for all axis should be the same if the ball screw pitch is equal for all three axis. Some machines have a Z axis pitch different than X and Y which require a different ratio of following error. The following error for Z should be greater than X and Y by 25% in the following cases.

6030 machines

8030 machines
Machines with a metric ball screw of X, Y 10 mm and Z ball screw of 8 mm


## Setting up Rigid tapping Procedure on 527F

The GAIN and RAMP parameters determine the performance of rigid tapping. The the XYZ balance program must be completed prior to rigid tap calibration.

Note: XYZ RAMP, JERK, and Z GAIN have no effect on rigid tapping . The Z GAIN is not used by the 527F. In the table below are good starting points for the GAIN and RAMP parameter for rigid tapping.

| | 7500 Wye/Delta | 10,000 High/low | | |
|---|---|---|---|---|
| GAIN | 30 | 60 | | |
| RAMP | 40 | 100 | | |
| O5811 balance | DC motors 200FE AC motors 300FE | DC motors 200FE AC motors 300FE | | |

BEFORE running rigid tapping calibration:

1.  Set the XYZ signal gain and amplifier balance with the service program 5811 first.

2.  Run the auto tuning on the spindle drive or make sure the RPM for M3 & M4 RPM is the same for each direction by balancing the signal on the spindle drive.

3.  In MDI:
    (a) M49 S1000. M3.
    (b) Measure the true RPM of the spindle.
    (c) M49 S1000. M4.
    (d) Measure the true RPM of the spindle. It must match the M3 RPM.

4.  Use the rigid tap gauge SVT-0077, it has 14 threads per inch (0.0714")

5.  Use an indicator with a small diameter ball to fit between grooves on the SVT-0077.

6.  Establish which direction the pointer rotates when pressing the indicator needle up. The following steps will assume the pointer rotates CW when the needle is pressed up. Pressing the indicator needle down should cause the pointer to rotate CCW.

# Rigid Tapping Calibration:

1. Use the service program 6000 to set up the rigid tapping GAIN and RAMP parameters.

2. Use the SETP command to set a default value of 100 for RAMP. The ramp will be fined tuned after the tapping gain is established.

3. Use the SETP command to enter a tapping gain factor.

4. Set the Feed Pot at 100%.

5. Ensure that the indicator needle is not touching the tapping gauge.

6. Start program 6000. Allow the spindle to calibrate. When Z moves down for first cycle, press Single Step. Move the indicator into the tapping gauge. Ensure the indicator needle ball is small enough to fit into the thread of the gauge and the ball of the needle is not touching the wall of gauge.

7. If the tapping gauge is going down (Z-) and indicator pointer is CW (to right of 0), the GAIN is too low. In this case, increase the current GAIN value. Alternatively, if the indicator pointer is CCW (to left of 0), the GAIN is too high. Decrease the current GAIN value to correct.

Note: The GAIN values should be changed between 5-10.

8. Adjust the RAMP parameter for ideal results across all spindle speeds when the pointer indicates a zero value. ~ +/- .001