

Instructions for Tuning a Bosch-  
Rexroth Servo Drive using IndraWorks  
DS – HCS01.1E Servo Drives (Analog)

# Indraworks DS Tuning Procedure (Analog)



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# Introduction

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## Summary

This document is designed to serve as a guideline to assist technical personnel in the tuning of a Bosch-Rexroth servo drive. The setup document applies only to servo drives that are used in conjunction with an AMS Controls XL200 Series Controller.

Bosch-Rexroth drives can be tuned in-house or in the field. The following procedures are written for a technician tuning a drive, in-house. Where an asterisk (\*) appears, field-tuning procedures deviate from what is written. **Customers attempting to tune a drive unit on-site should use the information following the asterisk.**

## Prerequisites

The document is designed using Indraworks DS version 15v16. Some earlier versions of Indraworks DS will not work with Gen 2 control sections, so it is best to download this version from the Bosch-Rexroth website before moving forward. Otherwise, your screens may not match this documentation.

In addition, for this documentation the HCS01 IE-W00XX-A-02-B-ET-EC-EM-NN-NN-FW loaded with Firmware FWA-INDRV\*-MPB-20VRS-D5-I-NNN-NN. If your drive has a different part number or is loaded with a different firmware this documentation may not match and you may be required to adjust additional settings that are not called out specifically in this documentation, however, this will get the basics accomplished.

# Pre-Tuning Checks

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## Safety Precautions

**DANGER: Safety precautions must be followed at all times! Bosch-Rexroth drives have large capacitors inside them that can deliver a high amperage shock to anyone touching the terminals on the drive. These capacitors can remain charged for up to 10 minutes after having power removed. Remove power and lock out incoming line power before touching any of the terminals on the drive. Eye protection should also be worn while working with these units.**

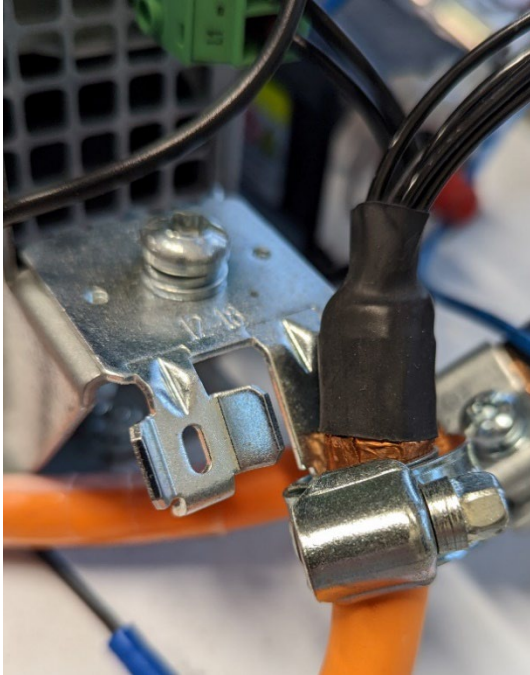
## Power Cable Connections

The power cable that connects the drive to the motor **must not** be “spliced,” terminated, or otherwise modified. There are important grounding and shielding connections between the motor and the drive that **must** be maintained for proper operation. Improper connection of this cable **will** cause catastrophic failures in the motor and the drive. The motor cable must be connected directly from the motor to the drive. Failure to do so **will** result in damaged equipment.

## Power and Resolver Cable Connections

Various motors from Bosch come with either 2 separate connectors for Power and Resolver or the two are built into a single cable for this reason we will refer to the motor connection side as Power/Resolver Cables. With power removed and locked out, connect the motor power/resolver cable to the drive and motor. It is important to attach the three main power wires to the appropriate terminals. These wires are labeled 1, 2, and 3, respectively, and **must** be connected to the corresponding terminals, A1, A2, and A3. These drives are self-phasing and cannot correctly phase themselves if the power leads are not properly connected.

The drive comes with “hose clamps” that can be used to clamp the motor cable to the drive. At the end of the motor cable the cable’s internal shields emerge and are wrapped under copper foil. The motor cable must be clamped to the case of the drive with the copper foil shield making contact to the case of the drive (see the Functional Description section of the drive manual for more details.)



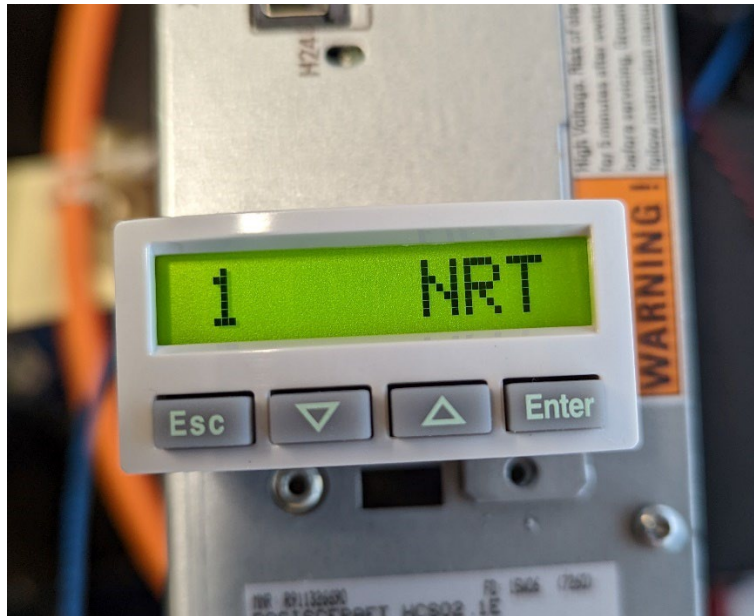
Looking at the motor side of the cable, there is a shield wire terminated with a ring connector. This connector must be connected to the case of the motor via the terminals inside the head of the connector plug. There are two terminals in the head, one for the motor cable, and one for the resolver feedback cable. Some motor/cable combinations have screw on connections at the motor. No additional shield terminations need to be made in these cases.

The motor cable has four wires for the thermal switch and motor brake that must be connected to the drive and motor. See the Functional Description section of the drive manual for terminal connections.

The resolver feedback cable must be connected to the drive and motor. On the drive side, the connector is a DB15 connector. On the motor side, there is a screw-on connector. Note: MS2N Series Motors will be a single cable.

## Apply Power

Once all the terminal connections have been made and verified, apply 24VDC power to the drive. The screen on the drive will most likely power up to the following display. This is OK and will be cleared as we progress.



# Getting Connected

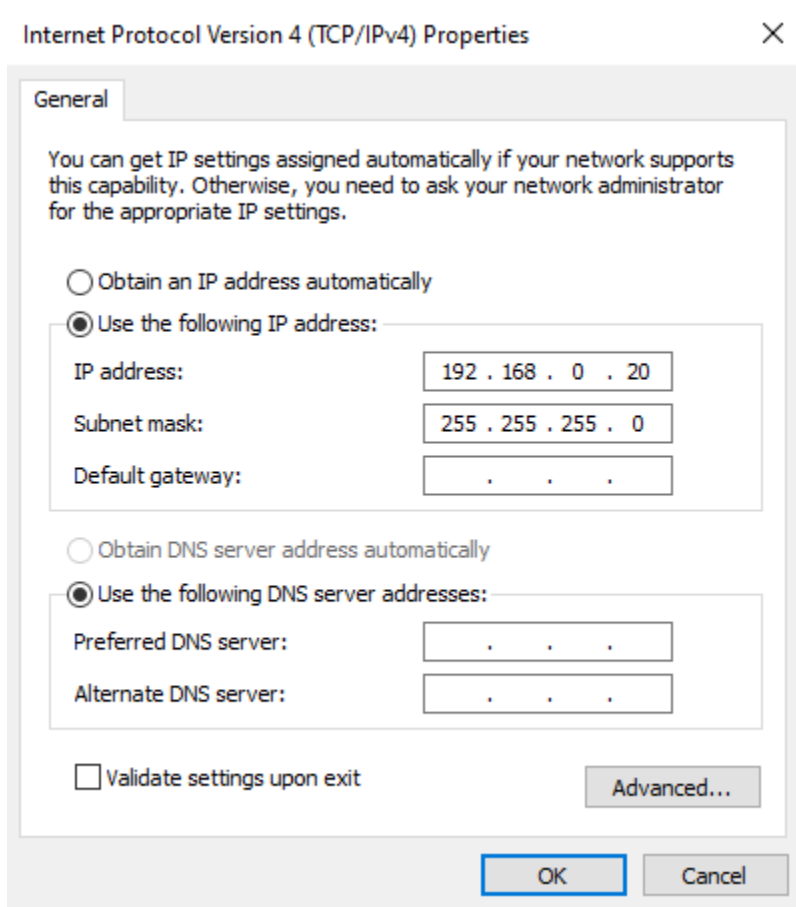
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## Connecting your PC to the Servo Drive

### Connect the Ethernet Cable

To connect the PC to the Servo Drive, a standard patch or crossover ethernet cable can be used. You will need an empty ethernet port on your PC or an ethernet adapter can be used.

Note: To communicate with the drive your PC's Internet Protocol Version 4 (TCP/IPv4) Settings must be set to the same IP scheme as the drive's current settings. If this is a new Drive out of the box the IP address of the drive will be 192.168.0.1, however, if the drive has been previously configured you will need to look for documentation from the previous Engineer on how the IP was configured. See below for an example of IP Settings that may work:



Internet Protocol Version 4 (TCP/IPv4) Properties

General

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

☐ Obtain an IP address automatically

☒ Use the following IP address:

IP address: 192 . 168 . 0 . 20

Subnet mask: 255 . 255 . 255 . 0

Default gateway: . . . .

☐ Obtain DNS server address automatically

☒ Use the following DNS server addresses:

Preferred DNS server: . . . .

Alternate DNS server: . . . .

☐ Validate settings upon exit

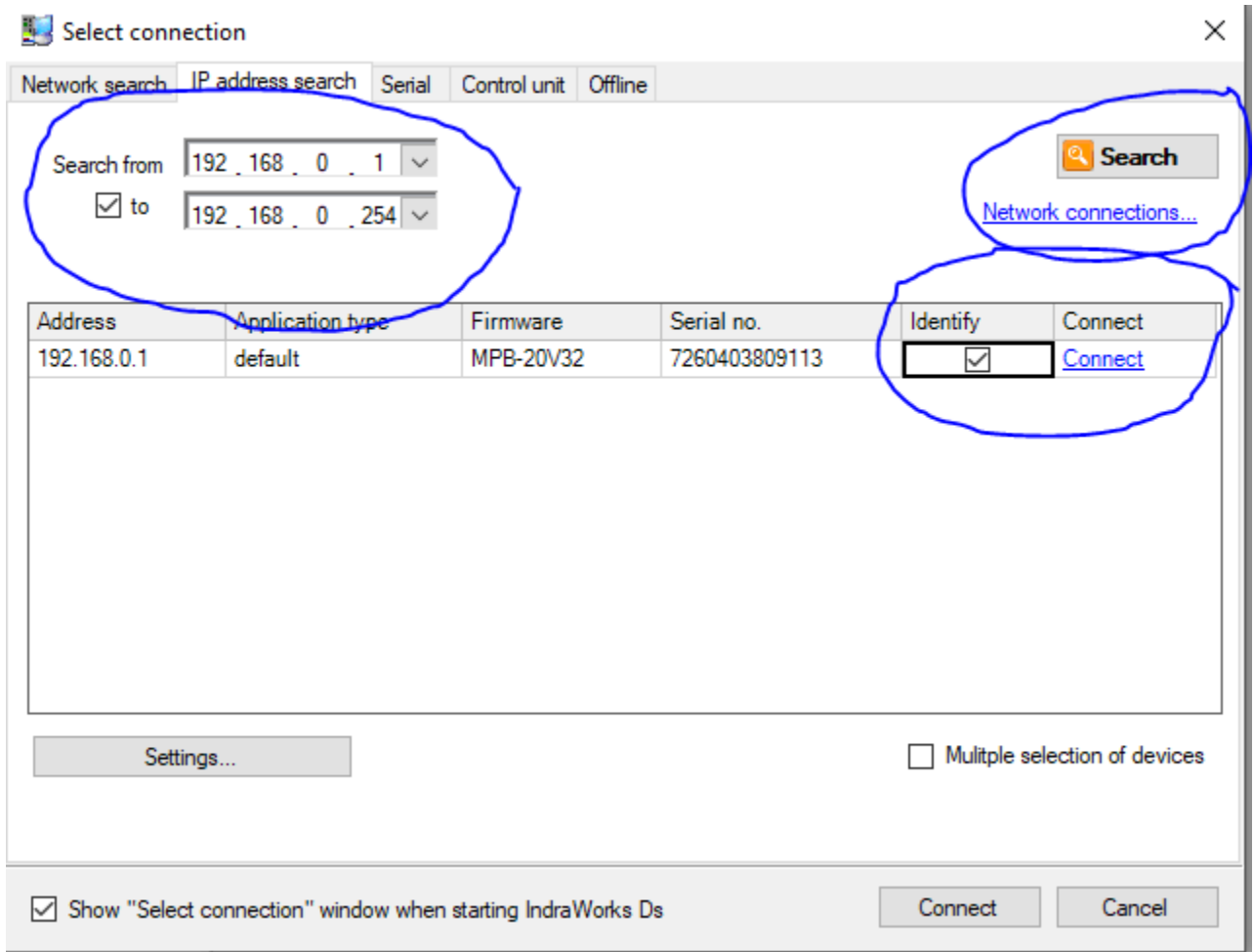
Advanced...

OK Cancel



### Initializing Communication from IndraWorks

Start up the IndraWorks Ds software and select Tools/Start New Indraworks DS Instance. The box below will appear. Make sure the IP address shown starts with the IP address of the drive and then click “Search”. If you are properly connected to the drive the drive will appear in the window and you can click “Connect”.



Select connection

Network search IP address search Serial Control unit Offline

Search from 192 . 168 . 0 . 1

☒ to 192 . 168 . 0 . 254

Search

[Network connections...](#)

Address	Application type	Firmware	Serial no.	Identify	Connect
192.168.0.1	default	MPB-20V32	7260403809113	<input checked="" type="checkbox"/>	<a href="#">Connect</a>

Settings...

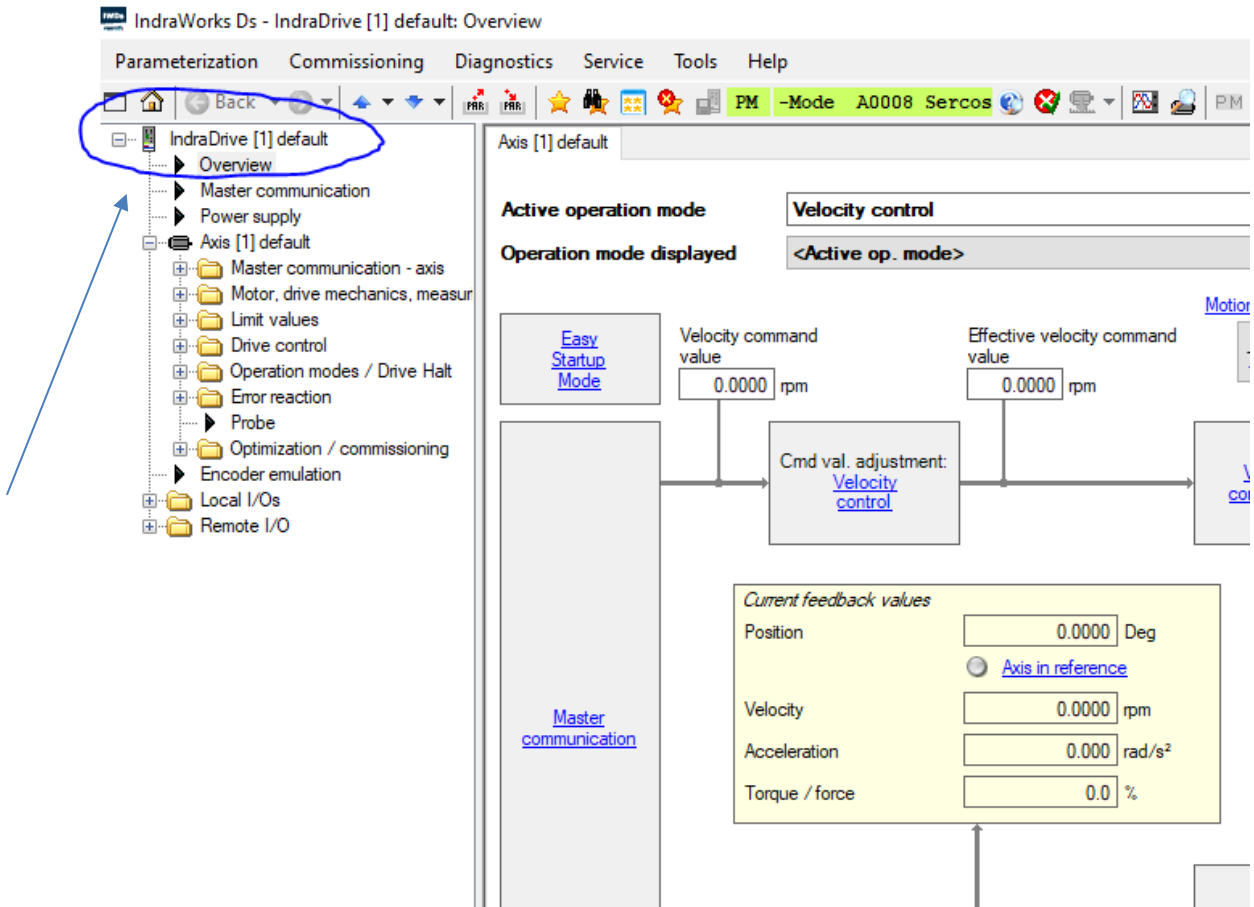
☐ Multiple selection of devices

☒ Show "Select connection" window when starting IndraWorks Ds

Connect Cancel

## Verifying Communication from IndraWorks

Verify that you now see your project in the “project tree” located in the upper left-hand side of the screen. You are now on-line with the drive. We are now able to configure the drive.



The screenshot displays the IndraWorks software interface for configuring an IndraDrive. The title bar indicates the project is "IndraWorks Ds - IndraDrive [1] default: Overview". The menu bar includes "Parameterization", "Commissioning", "Diagnostics", "Service", "Tools", and "Help". The toolbar shows various icons for navigation and configuration.

**Project Tree (Left Panel):** The "IndraDrive [1] default" folder is selected and circled in blue. It contains the following sub-items:

- Overview
- Master communication
- Power supply
- Axis [1] default
- Master communication - axis
- Motor, drive mechanics, measur
- Limit values
- Drive control
- Operation modes / Drive Halt
- Error reaction
- Probe
- Optimization / commissioning
- Encoder emulation
- Local I/Os
- Remote I/O

**Main Configuration Area (Right Panel):**

- Axis [1] default:** The active operation mode is set to "Velocity control". The operation mode displayed is "<Active op. mode>".
- Velocity command value:** Set to 0.0000 rpm.
- Effective velocity command value:** Set to 0.0000 rpm.
- Cmd val. adjustment:** Set to "Velocity control".
- Current feedback values:**
  - Position: 0.0000 Deg
  - Velocity: 0.0000 rpm
  - Acceleration: 0.000 rad/s<sup>2</sup>
  - Torque / force: 0.0 %

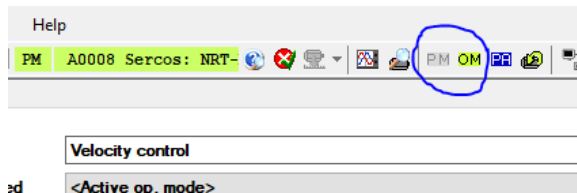
A blue arrow points from the "Overview" item in the project tree to the main configuration area. The "Master communication" section is also visible in the main area.

# Commissioning the Servo Drive

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## Set Parameterization Mode

Before adjusting drive parameters, we must put the drive into a parameterization mode (PM). If this is a new drive it will start up in this mode, however, if not you can easily do this by clicking the PM Button at the top of the screen.



## Parameter Adjustment

Various levels of parameters will now be adjusted. These are shown below:

### Load Basic Parameters

To start the process of setting the parameters, it is important to start from a default set of parameters. To do this we will “Load Basic Parameters” from the Indraworks software. To do this:

- Click “Commissioning”
- Click “Load Basic Parameters”
- Click “Set saved parameters to default values”
- Click “Without serial interface/Engineering Port”
- Click “Load Basic Parameters”

Axis [1]: Load basic parameters...

Load the following basic parameters:

- ☐ Motor-specific control loop parameter values
- ☒ Set saved parameters to default values
  - ☒ Without master communication parameters / master communication Engineering
  - ☐ Without MLD parameters
- ☐ Set parameters depending on field bus profile to default values
- ☐ Set entire drive PLC (MLD) to default value (RE6) incl. deletion of boot project

Load basic parameters

### Set Drive Language

By default, the drive will use German as the language in which it displays errors. This makes it difficult to determine the cause of problems from Indraworks. This is not to be confused with the language setting on the Indraworks software. They are completely different. To set the language do the following:


- Click “Parameterization”
- Click “Parameters”
- Click “Parameter Editor”
- Click the “IDN” box and enter S-0-0265
- Under “Value”, enter “I” as shown below:

Parameter editor

IDN S-0-0265

Axis [?] Training Center Roll F

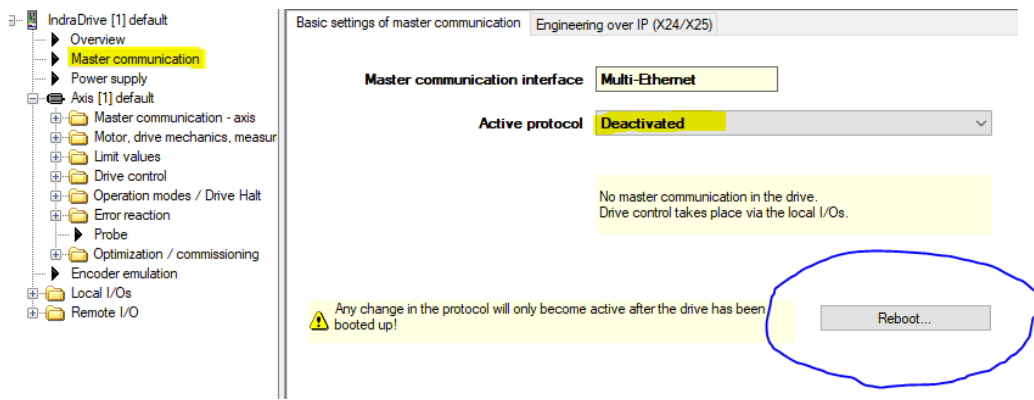
Name	Language selection
Status	OK
Min	0
Max	4
Value	1



## Set Master Communication

The Master Communication of the drive sets the protocol used in the drive for control and we can set a new IP address if we choose.

- Click “Master Communication” in the project tree
- Click the tab in the settings screen to “Basic settings of master communication”
- In the Active protocol window set “Deactivated” as the option and choose yes for any pop-up windows.
- Click “Reboot”

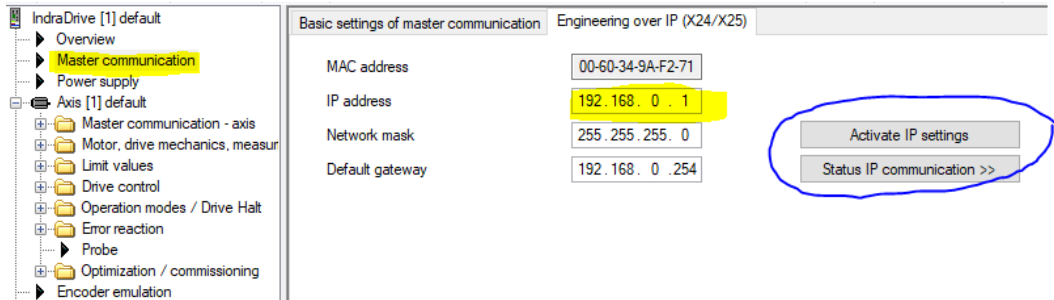


## Set Drive IP address

If we want to set the drive up with an alternate IP address, we can do this by changing the setting as follows:

- Click “Master Communication” in the project tree
- Click the tab in the settings screen to “Engineering over IP (X24/X25)”
- In the IP address window, you can assign a different setting
- Click “Activate IP Setting” when completed

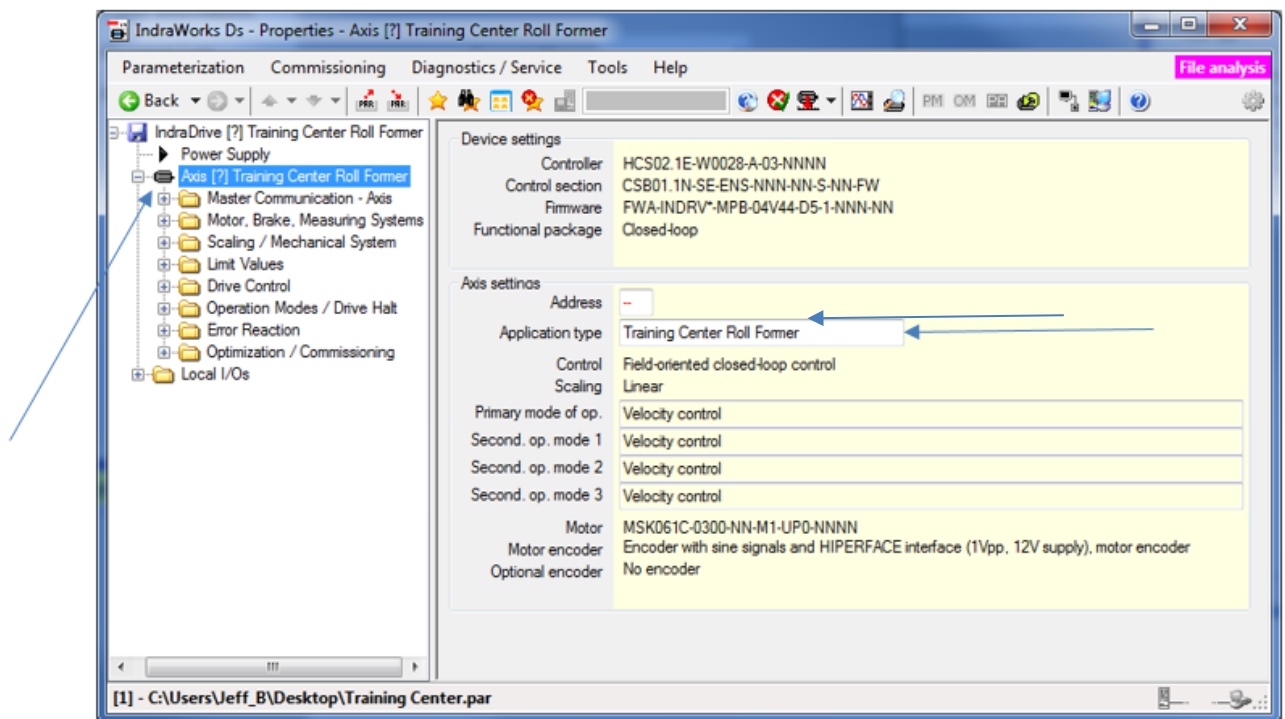
Important: Once you change this setting in the drive you will need to go back to your PC Internet Protocol settings from earlier in this document to re-establish communications.



## Name the Axis

We want to give each Axis a name. This helps us identify the Axis. To name the Axis do the following:

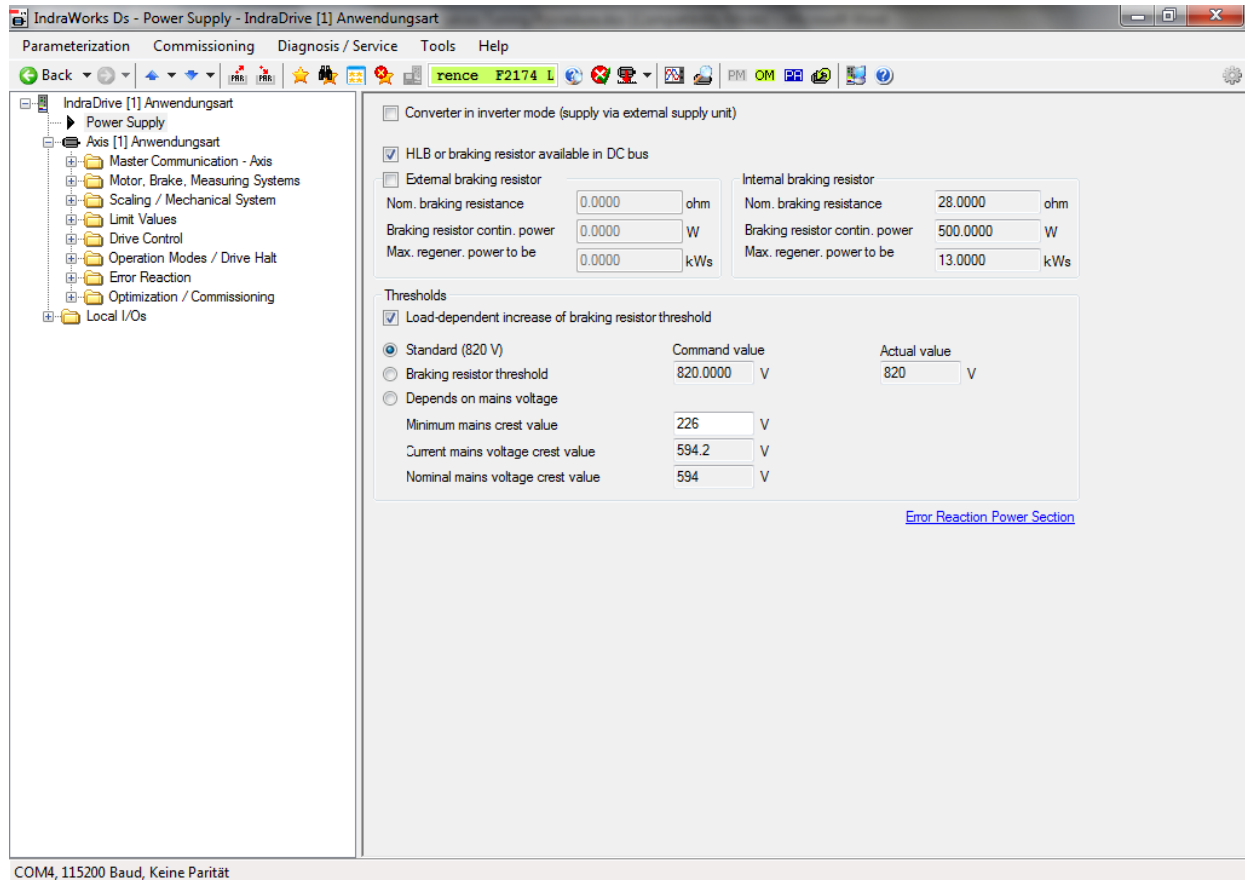
- Right Click the “Axis” in the Project Tree.
- Choose “Properties.”
- Name the Axis under “Application Type.”



## Braking Resistor

Inform the system if there is a Braking Resistor available. Double click the “Power Supply” text on the left-hand side of the screen. The window below will appear. If there is a braking resistor on the system check the box marked “HLB or Braking resistor available on the DC Bus.”

**Note: Some drives do not support the addition of a Braking Resistor. For these drives you will not see the option to add an HLB or Braking Resistor.**



The screenshot shows the IndraWorks software interface for configuring a Power Supply. The left-hand side displays a tree view with the following structure:

- IndraDrive [1] Anwendungsart
  - Power Supply
  - Axis [1] Anwendungsart
    - Master Communication - Axis
    - Motor, Brake, Measuring Systems
    - Scaling / Mechanical System
    - Limit Values
    - Drive Control
    - Operation Modes / Drive Halt
    - Error Reaction
    - Optimization / Commissioning
    - Local I/Os

The right-hand side of the window displays the configuration options for the Braking Resistor:

- ☐ Converter in inverter mode (supply via external supply unit)
- ☒ HLB or braking resistor available in DC bus
- ☐ External braking resistor
 

Nom. braking resistance	0.0000	ohm
Braking resistor contin. power	0.0000	W
Max. regener. power to be	0.0000	kWs
- Internal braking resistor
 

Nom. braking resistance	28.0000	ohm
Braking resistor contin. power	500.0000	W
Max. regener. power to be	13.0000	kWs
- Thresholds
  - ☒ Load-dependent increase of braking resistor threshold
 

	Command value	Actual value
Standard (820 V)	820.0000 V	820 V
Braking resistor threshold		
Depends on mains voltage		
Minimum mains crest value	226 V	
Current mains voltage crest value	594.2 V	
Nominal mains voltage crest value	594 V	

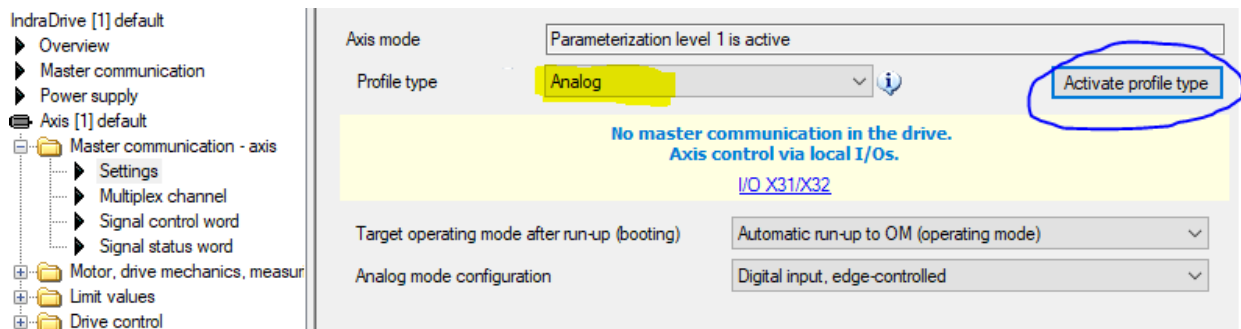
At the bottom of the window, the status bar indicates: COM4, 115200 Baud, Keine Parität.



## Set Analog Profile

We need to ensure the drive is setup with the profile type of “Analog”. We can do this by:

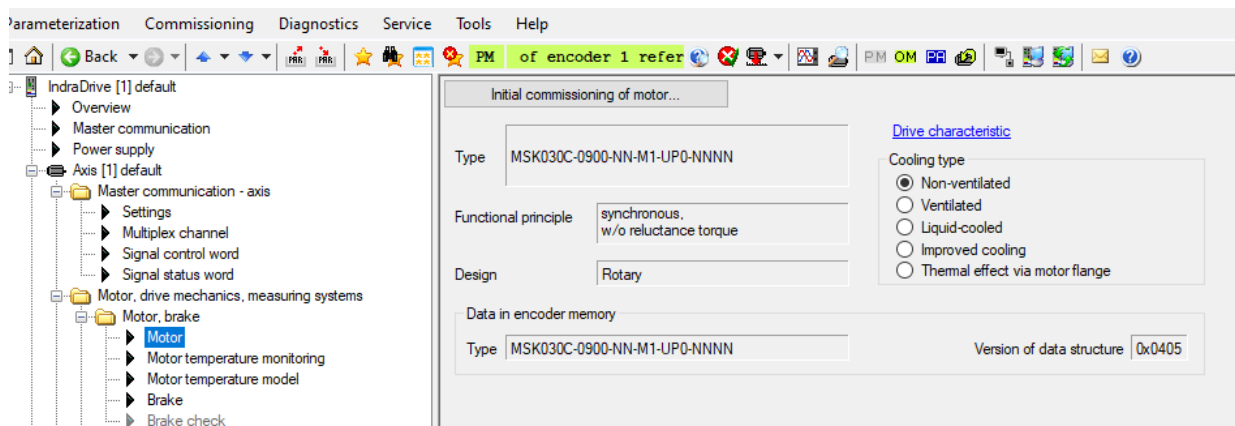
- Click “Master communication – axis”
- Click “Settings”
- Verify the Profile type is set to Analog. If not, set it as such and then click “Activate Profile Type”



## Set Cooling Type

If the servo motor has a cooling fan attached, we must inform the drive. To do this:

- Click “Motor, drive mechanics, measuring systems.”
- Expand “Motor, brake”
- Click “Motor.”
- Set “Ventilated” if there is a fan – or “Non-Ventilated” if there is not a fan.

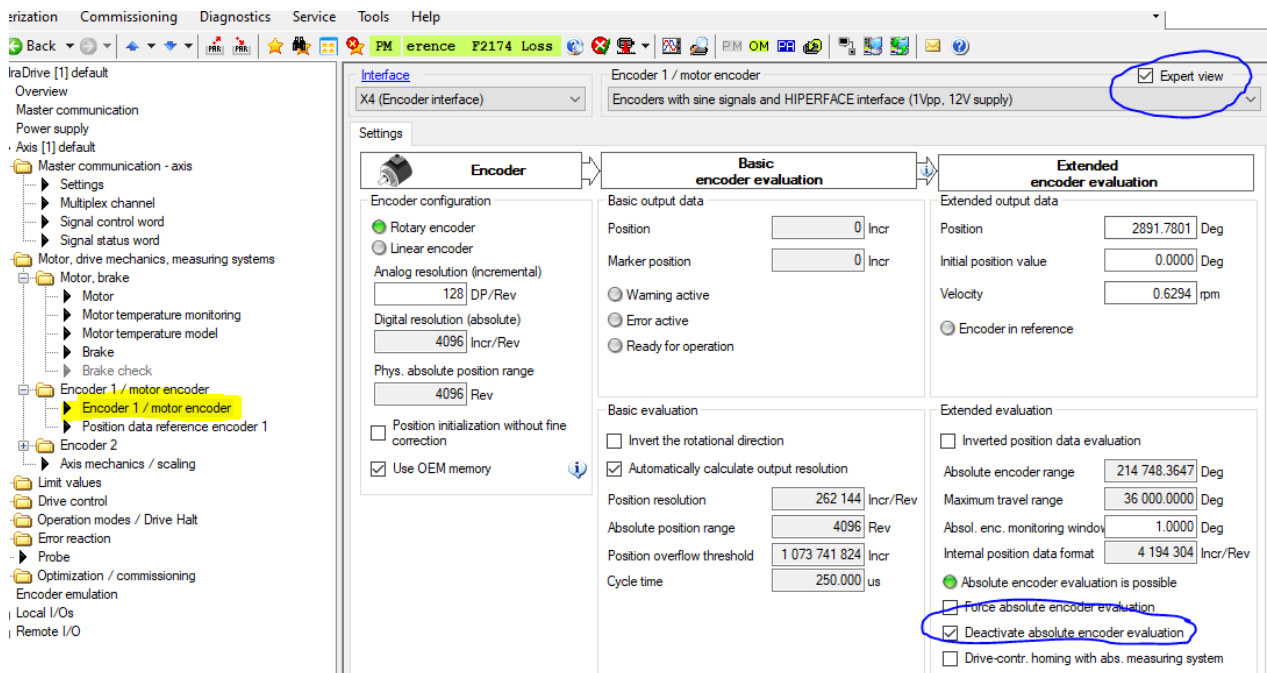


## Disable Absolute Positioning

Most servo motors provided by AMS Controls will have an absolute encoder on them.

However, absolute positioning is not used for a Die Accelerator or Roll Feed application. This feature needs to be turned off. To do this:

- Click “Motor, drive mechanics, measuring systems.”
- Expand “Encoder I/ motor encoder”
- Click “Encoder I/ motor encoder”
- In the settings window, Click “Expert View”
- Click “Deactivate absolute encoder evaluation”



The screenshot shows the AMS Controls software interface with the 'Encoder' settings window open. The 'Expert view' checkbox is checked. The 'Basic encoder evaluation' section shows 'Position' and 'Marker position' set to 0. The 'Extended encoder evaluation' section shows 'Position' set to 2891.7801 Deg, 'Initial position value' set to 0.0000 Deg, and 'Velocity' set to 0.6294 rpm. The 'Basic evaluation' section shows 'Automatically calculate output resolution' checked. The 'Extended evaluation' section shows 'Absolute encoder evaluation is possible' checked, and 'Deactivate absolute encoder evaluation' checked.

## Set the Axis Mechanics of the system

The setting of the axis mechanics and mechanical gearing of the system is extremely important! It is important that we set these to actual values of the attached load. The drive uses these settings to properly determine speed, gains, and feedback values. Incorrectly setting these values WILL result in unexpected faults and drive tuning.

### Set the scaling:

- Click “Motor, drive mechanics, measuring systems”
- Click “Axis mechanics / scaling”
- On the settings page, click the “Scaling Extended” tab
- Set the scaling Units as shown below

Axis mechanics & scaling		Scaling extended	
<b>Position scaling</b>			
<input type="radio"/> Rotary <input checked="" type="radio"/> Linear  <input checked="" type="radio"/> Absolute <input type="radio"/> Modulo	<input type="radio"/> Load reference <input checked="" type="radio"/> Motor shaft <input type="checkbox"/> Negation <input type="text" value="3.600000"/> in	<input checked="" type="radio"/> Preferred scaling <input type="radio"/> User-defined  <input type="text" value="0.000001"/> Resolution	Factor <input type="text" value="1"/> Exponent <input type="text" value="-6"/> Unit <input type="text" value="in"/>
<b>Velocity scaling</b>			
<input type="radio"/> Rotary <input checked="" type="radio"/> Linear	<input type="radio"/> Load reference <input checked="" type="radio"/> Motor shaft <input type="checkbox"/> Negation	<input type="radio"/> Preferred scaling <input checked="" type="radio"/> User-defined <input type="text" value="0.0001"/> Resolution	Factor <input type="text" value="1"/> Exponent <input type="text" value="-4"/> Unit <input type="text" value="in/s"/>
<b>Acceleration scaling</b>			
<input type="radio"/> Rotary <input checked="" type="radio"/> Linear <input type="radio"/> Ramp time	<input type="radio"/> Load reference <input checked="" type="radio"/> Motor shaft	<input checked="" type="radio"/> Preferred scaling <input type="radio"/> User-defined <input type="text" value="0.00001"/> Resolution <input type="text" value="3000.0000"/> in/s Ramp reference velocity	Factor <input type="text" value="1"/> Exponent <input type="text" value="-5"/> Unit <input type="text" value="in/s²"/>
<b>Torque/force data scaling</b>			
<input checked="" type="radio"/> In percent <input type="radio"/> Torque <input type="radio"/> Force	<input type="radio"/> Load reference <input checked="" type="radio"/> Motor shaft <input type="checkbox"/> Negation	<input checked="" type="radio"/> Preferred scaling <input type="radio"/> User-defined <input type="text" value="0.1"/> Resolution	Factor <input type="text" value="1"/> Exponent <input type="text" value="-1"/> Unit <input type="text" value="%"/>
<b>Temperature scaling</b>			
<input type="radio"/> °C <input checked="" type="radio"/> °F			

### Set the Axis Mechanics & Scaling

This is the location in which we tell the controller what the system is connected to. The screen should look like the following picture, however; the actual gearing and feed constant settings will be determined by attached mechanics. The most common applications used for these are Roll Feeds and Die Accelerators. A couple of examples for how these settings are determined are on following pages of this document.

- Click “Motor, drive mechanics, measuring systems”
- Click “Axis mechanics / scaling”
- On the settings page, click the “Axis mechanics & scaling” tab
- Set the scaling type to “Linear”
- Set the Data reference to “Load”

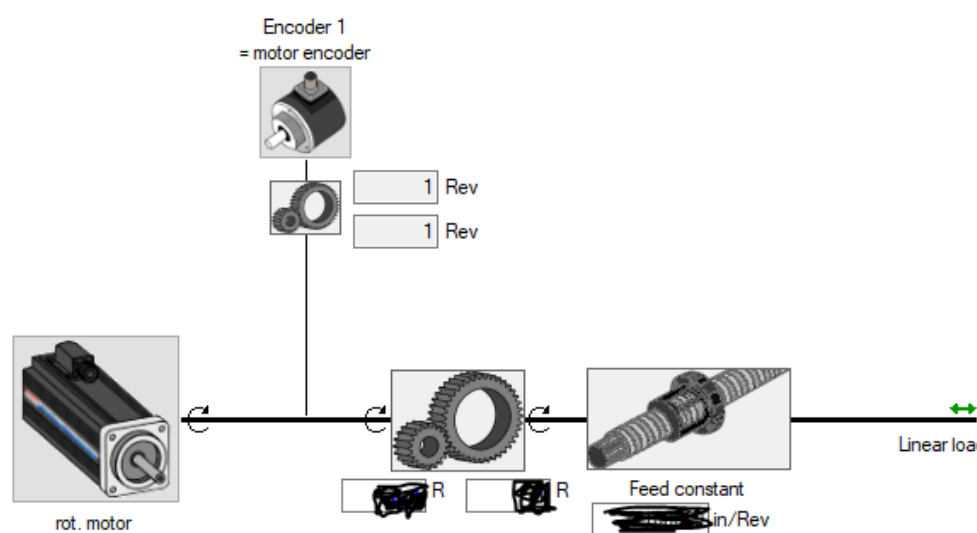
**Note: DO NOT adjust the “Maximum Travel Range” parameter. This can drastically affect other parameters in the system. It is meaningless in our application.**

Axis mechanics & scaling **Scaling extended**

Scaling type <input type="radio"/> Rotary <input checked="" type="radio"/> <b>Linear</b> <input type="radio"/> Scaling not uniform	Negation <input type="radio"/> Yes <input checked="" type="radio"/> <b>No</b> <input type="radio"/> Negation not uniform	Data reference <input checked="" type="radio"/> <b>Load</b> <input type="radio"/> Motor shaft <input type="radio"/> Data reference not uniform
Position data format <input checked="" type="radio"/> <b>Absolute</b> <input type="radio"/> Modulo	Max. travel range ± <input type="text" value="360.000000"/> in Modulo value <input type="text" value="3.600000"/> in	Velocity data Time unit <input type="text" value="s"/>

Encoder 1  
= motor encoder

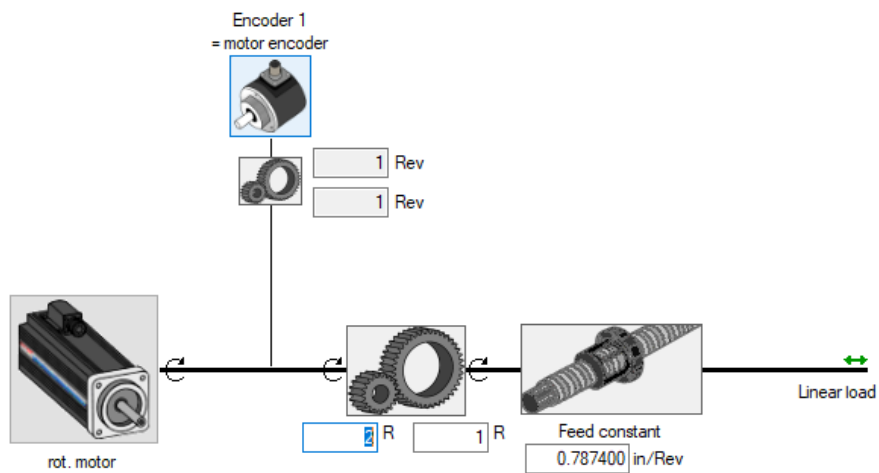
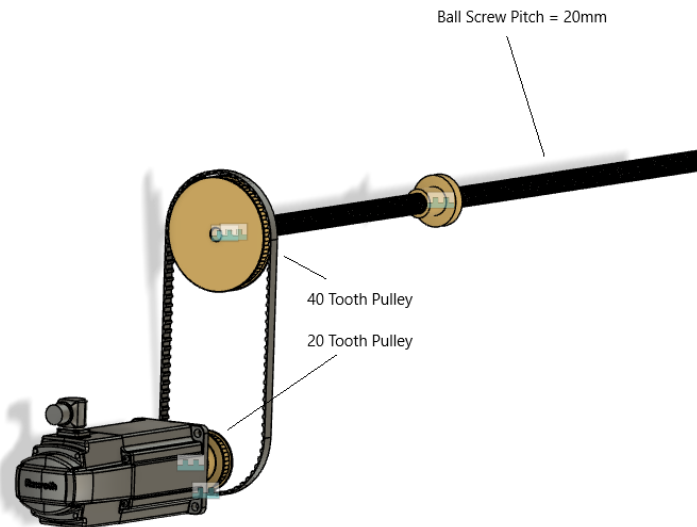


The diagram illustrates the mechanical setup. A motor (rot. motor) is connected to a motor encoder (Encoder 1). The encoder is connected to a gear system consisting of two gears, each labeled '1 Rev'. The gear system is connected to a linear load (Linear load) via a feed constant. The feed constant is labeled 'Feed constant' and has a value of  in/Rev.

## Example Axis Mechanics Settings (Die Accelerator)

Below is an example of the mechanics of a Die Accelerator system using a ball screw and gear reduction. For the examples below the settings would be as follows:

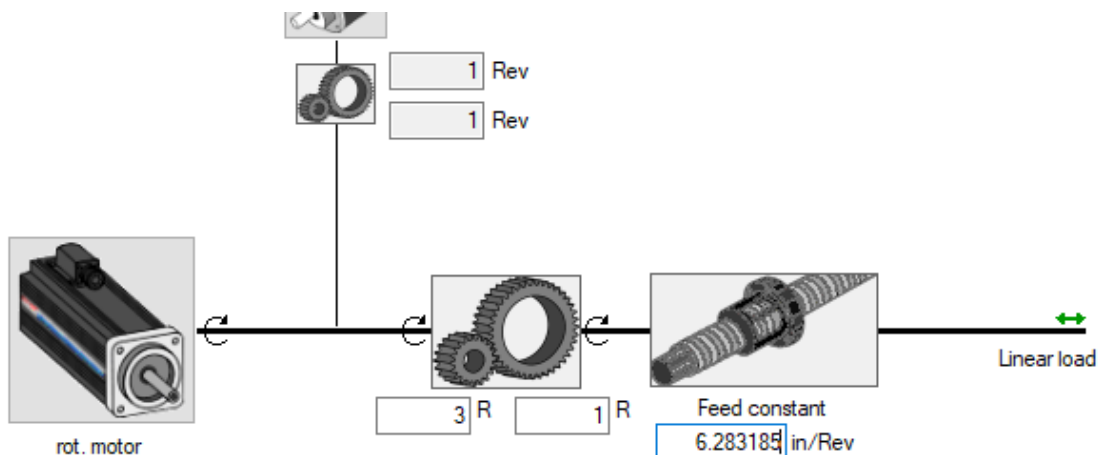
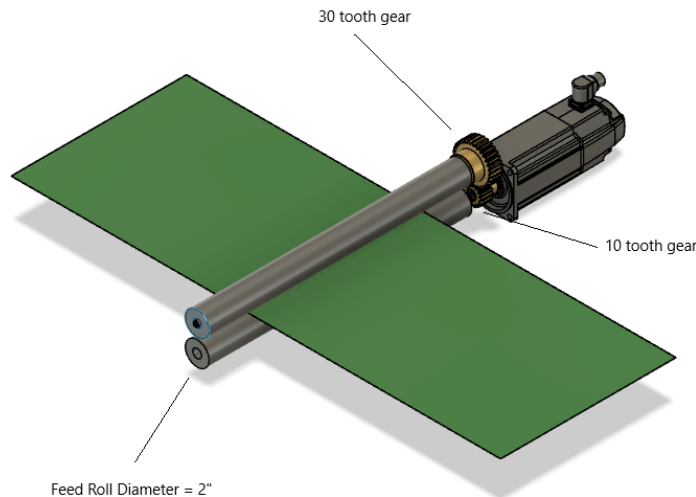
- Feed Constant = 0.7874" (20mm/25.4)
  - The feed constant is the amount of movement of the load per rotation of that device. In this instance the screw pitch or lead is 20mm. We convert that to inches by taking mm and dividing by 25.4.
- Gear Ratio is 2:1 or 40:20



## Example Axis Mechanics Settings (Feed Rolls)

Below is an example of the mechanics of a Feed Roll or Servo Feeder system using a set of feed rolls and gear reduction. For the examples below the settings would be as follows:

- Feed Constant = 6.283185" (2" x 3.14159)
  - The feed constant is the amount of movement of the material per rotation of the rolls. In this instance the feed roll diameter is 2". To get the amount of movement per rev of the rolls, we need to know the circumference. We get the circumference by taking the feed roll diameter x pi.
- Gear Ratio is 3:1 or 30:10



## Set Motion Limit Values

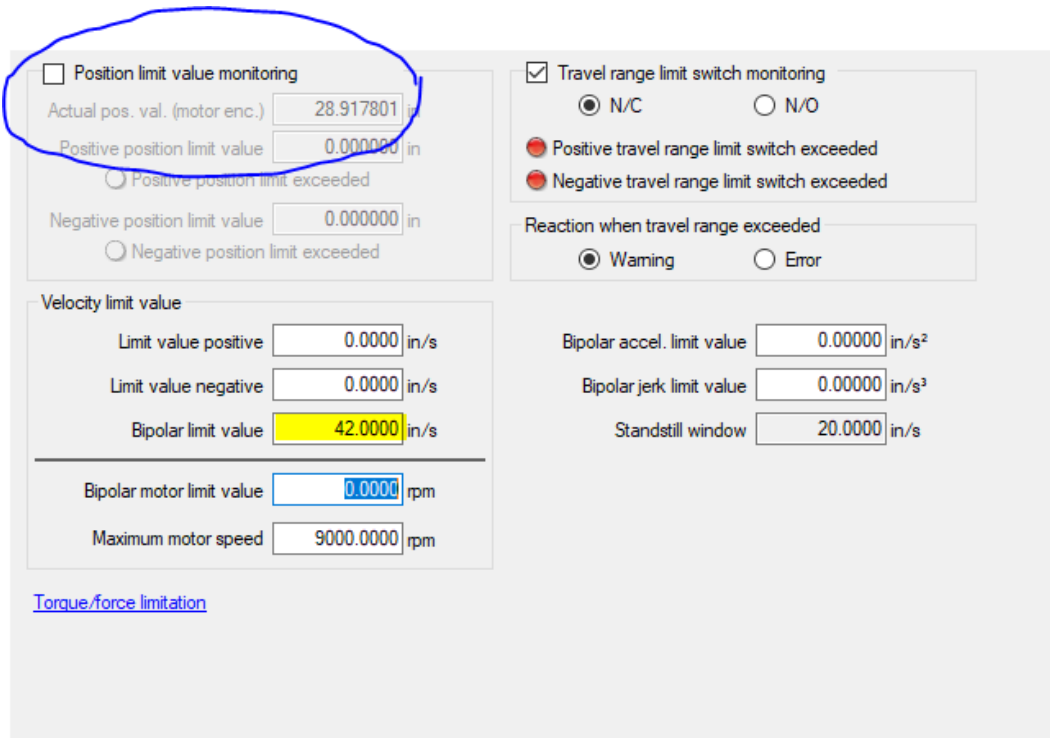
Set the Motion Limits of the system. Go there by doing the following:

- Click “Limit Values.”
- Click “Motion Limit Values.”
- DO NOT set position limit value monitoring as active. This is only used where the drive is handling the positioning of the motor.

We want to set this value to a speed we never intend to reach; therefore, we need to know the maximum FPM of the Axis. We will need to convert this value to in/sec and add 40% to properly scale the system. For Example, we have a Die Accelerator System that we want to run at a max speed of 150FPM. The following formula would be used:

$$\frac{150FPM}{5} = 30 \text{ in/s} * 1.4 = 42 \text{ in/s}$$

Therefore 42 in /s would be entered as shown below:



☐ Position limit value monitoring

Actual pos. val. (motor enc.) 28.917801 in

Positive position limit value 0.000000 in

☐ Positive position limit exceeded

Negative position limit value 0.000000 in

☐ Negative position limit exceeded

Velocity limit value

Limit value positive 0.0000 in/s

Limit value negative 0.0000 in/s

Bipolar limit value 42.0000 in/s

Bipolar motor limit value 0.0000 rpm

Maximum motor speed 9000.0000 rpm

[Torque/force limitation](#)

☒ Travel range limit switch monitoring

☒ N/C ☐ N/O

☒ Positive travel range limit switch exceeded

☒ Negative travel range limit switch exceeded

Reaction when travel range exceeded

☒ Warning ☐ Error

Bipolar accel. limit value 0.00000 in/s²

Bipolar jerk limit value 0.00000 in/s³

Standstill window 20.0000 in/s

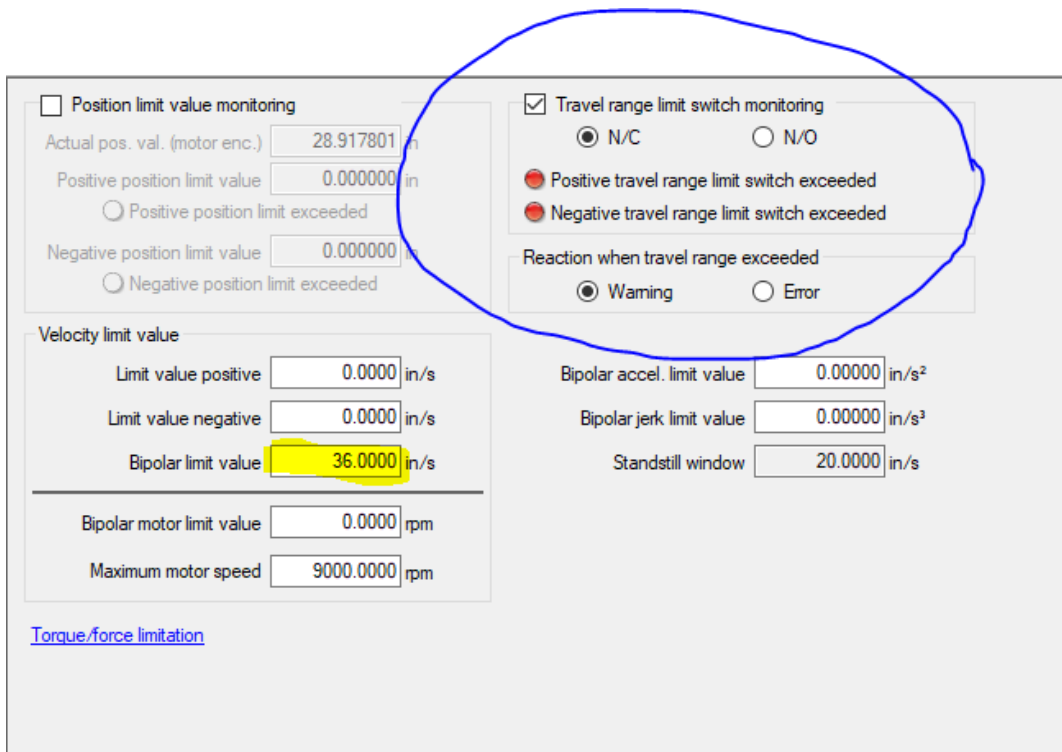
## Set Travel Range Limit Switch Monitoring

Set the Travel Range Limit Switch Monitoring of the system. Go there by doing the following:

- Click “Limit Values.”
- Click “Motion Limit Values.”

At this time we will tell the drive if we have over-travel switches connected and if they are N/O or N/C. The drive should be set to react as a warning as shown.

Important! - If you are setting up a Roll Feed System do NOT check the travel range box above.



☐ Position limit value monitoring

Actual pos. val. (motor enc.)  in

Positive position limit value  in

☐ Positive position limit exceeded

Negative position limit value  in

☐ Negative position limit exceeded

☒ Travel range limit switch monitoring

☒ N/C ☐ N/O

☒ Positive travel range limit switch exceeded

☒ Negative travel range limit switch exceeded

Reaction when travel range exceeded

☒ Warning ☐ Error

Velocity limit value

Limit value positive  in/s

Limit value negative  in/s

Bipolar limit value  in/s

Bipolar motor limit value  rpm

Maximum motor speed  rpm

Bipolar accel. limit value  in/s<sup>2</sup>

Bipolar jerk limit value  in/s<sup>3</sup>

Standstill window  in/s

[Torque/force limitation](#)

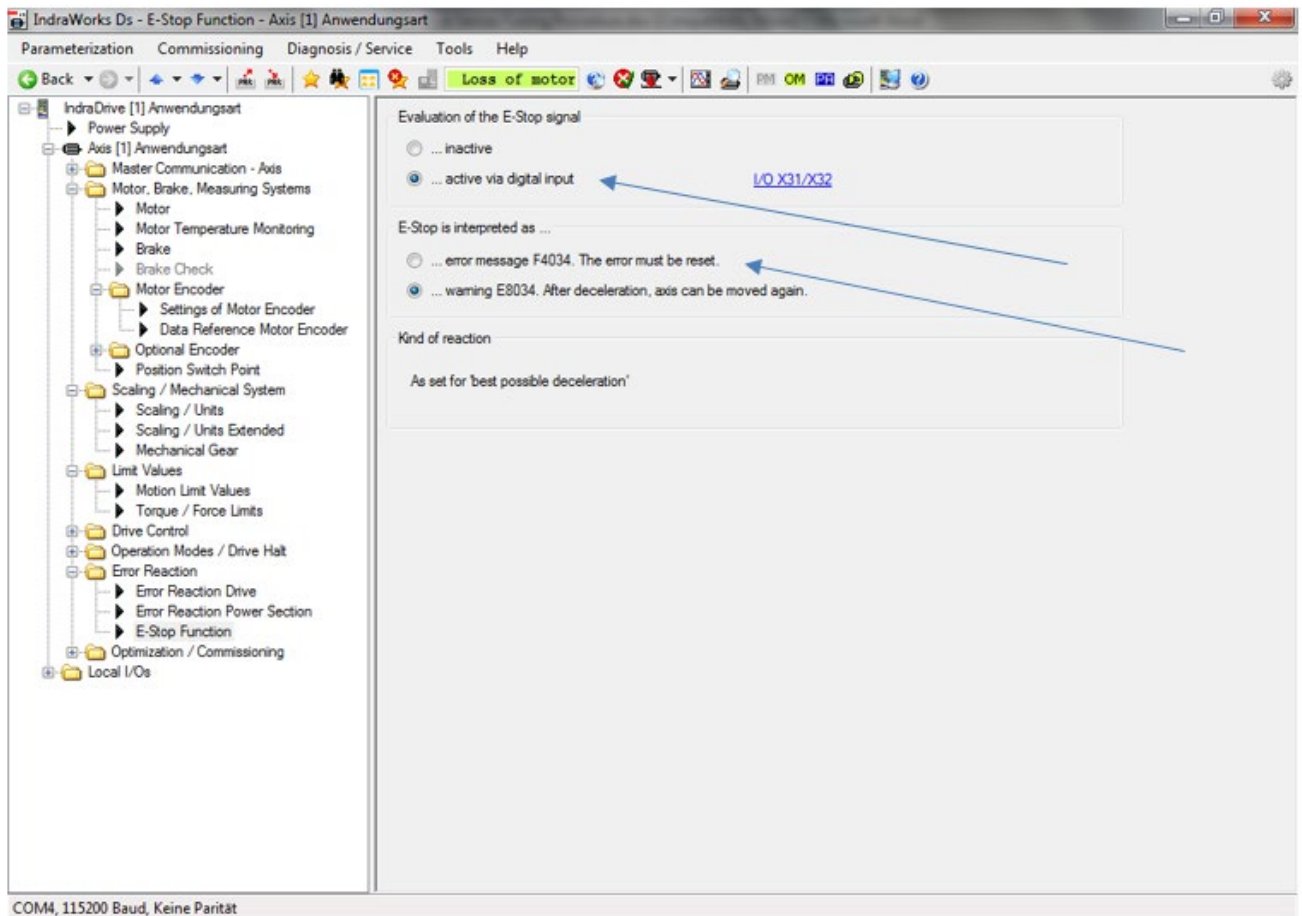


## Set E-stop Function

Set the E-stop function. Assuming the E-stop signal is being used and is physically wired the below selections can be made. Go there by doing the following:

- Click “Error Reaction.”
- Click “E-stop Function.”
- Set the “Evaluation of the E-stop Signal” to Active
- Set “E-stop is interpreted as...” to Warning E8034

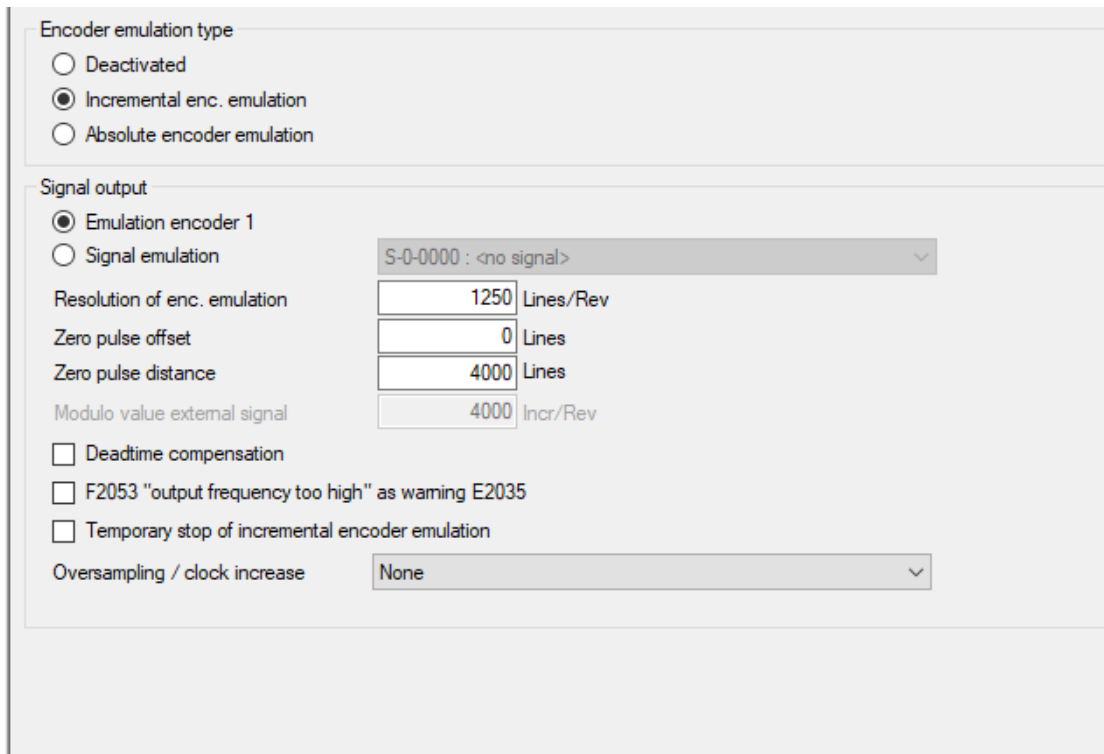
**Note: If the E-stop signal is not being utilized simply check “inactive.”**



## Set the Encoder Emulation

The drive sends encoder pulses to the AMS Controller, this is referred to as encoder emulation. The number of pulses per rev can be adjusted in the drive. As a standard, AMS Controls uses 1250 ( $1250 \times 4 = 5000$ ) for this on most applications except for a rotary. Go there by doing the following:

- Click “Encoder Emulation”
- Set the Encoder Emulation type to “Incremental enc. Emulation”
- Set Signal output to “Emulation encoder 1”
- Set Resolution of enc. Emulation to “1250”



The screenshot shows a configuration window for encoder emulation. It is divided into two main sections: "Encoder emulation type" and "Signal output".

**Encoder emulation type**

- ☐ Deactivated
- ☒ Incremental enc. emulation
- ☐ Absolute encoder emulation

**Signal output**

- ☒ Emulation encoder 1
- ☐ Signal emulation

Below the radio buttons, there are four input fields with their respective units:

- Resolution of enc. emulation: 1250 Lines/Rev
- Zero pulse offset: 0 Lines
- Zero pulse distance: 4000 Lines
- Modulo value external signal: 4000 Incr/Rev

Below these fields, there are three checkboxes:

- ☐ Deadtime compensation
- ☐ F2053 "output frequency too high" as warning E2035
- ☐ Temporary stop of incremental encoder emulation

At the bottom, there is a dropdown menu for "Oversampling / clock increase" set to "None".

## Set Inputs and Outputs (I/O)

The Input and Output assignments are dictated by the electrical design. The Inputs and Outputs are assignable in the software. Go there by:

- Clicking “Local I/Os.”
- Click “I/O X31/X32.”

In the example below the following I/O were assigned:

- Input 1 (X31:1) = Drive Enable
- Input 2 (X31:2) = Drive Reset
- Input 3 (X31:3) = E-stop
- Input 4 (X31:4) = Forward Overtravel
- Input 5 (X31:5) = Reverse Overtravel
- Output 8 (X31:8) = Drive Fault

Digital inputs

Status

	PIN	Signal	Bit	
<input type="radio"/>	X31:1	P-0-4028 : Device control word	15	
<input type="radio"/>	X31:2	S-0-0099 : C0500 Reset class 1 diagnostics	0	
<input type="radio"/>	X31:3	P-0-0223 : E-Stop input	0	
<input type="radio"/>	X31:4	P-0-0222 : Travel range limit switch inputs	0	
<input type="radio"/>	X31:5	P-0-0222 : Travel range limit switch inputs	1	
<input type="radio"/>	--	S-0-0000 : Not assigned	0	
<input type="radio"/>	--	S-0-0000 : Not assigned	0	
<input type="radio"/>	--	S-0-0000 : Not assigned	0	
<input type="radio"/>	--	S-0-0000 : Not assigned	0	
<input type="radio"/>	--	S-0-0000 : Not assigned	0	
<input type="radio"/>	--	S-0-0000 : Not assigned	0	

Digital outputs

	PIN	Signal	Bit	
<input type="radio"/>	X31:8	<input checked="" type="checkbox"/> P-0-0115 : Device control: Status word	13	

## Set the Analog Scaling (Tuning)

The AMS Controller sends a +/- 10V Analog signal to the drive that is used as a speed reference. We want to utilize as much of the 10V as we can for the application. Many motor/drive systems are capable of spinning much faster than we need them to for the application, therefore, we want to scale the analog to use most of our 10V signal for our application. This is done very much like the motion limit setting.

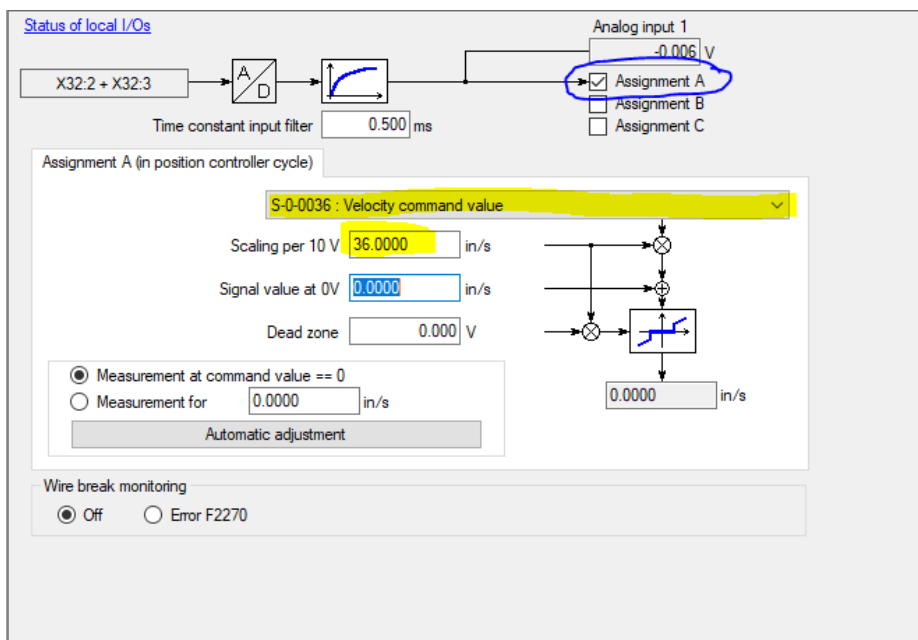
Set the Analog Input of the system. Go there by doing the following:

- Click “Local I/O’s”
- Click “Analog input 1 X32”
- Set Assignment A as checked
- Set the assignment A (in position controller cycle) to “S-0-0036: Velocity command value”

We want to set this value to a speed above our max required speed, therefore, we need to know the maximum FPM of the Axis. We will need to convert this value to in/sec and add 20% to properly scale the system. For Example, we have a Die Accelerator System that we want to run at a max speed of 150FPM. The following formula would be used:

$$\frac{150\text{FPM}}{5} = 30 \text{ in/s} * 1.2 = 36 \text{ in/s}$$

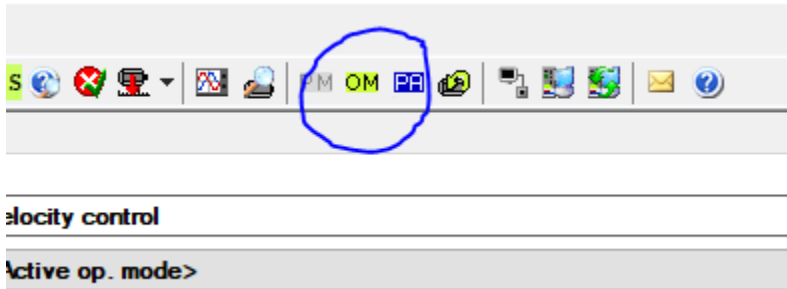
Therefore 36 in /s would be entered as shown below:



**IMPORTANT!!! – Once the drive is enabled for the first time, this value has been known to change drastically and will cause issues. Make sure you go back and check these settings after the first enabling of the drive.**

## Set Operating Mode

Once all of the steps above are completed, you can place the drive back into “Operating Mode”. This is done by clicking the “OM” button at the top of the screen



**IMPORTANT!!! – Once the drive is enabled for the first time, this value has been known to change drastically and will cause issues. Make sure you go back and check these settings after the first enabling of the drive.**

# Spinning the Motor

---

## Controller Setup

Now that the initial drive parameters are set, the system is ready for motion.

**DANGER: De-couple the motor from all mechanical connections to die. Should the command signal be out of phase on start-up, the motor will quickly spin out of control in one direction, causing physical harm to equipment and personnel.**

1. The motor should be disconnected from any mechanical structures, gearing, or couplings before continuing. Place the motor on the floor and secure the motor so it can't roll. Most servo motors have enough torque to roll over or even flip in the air, causing damage to the motor or those standing near.
2. The closed-loop AMS Controls controller must now be programmed with the information required to begin testing the servo system. Explanations of these parameters follow.
3. Begin by setting the following parameters to their corresponding “start-up” settings:

Jog Select	Die
Loop Gain	5
Maximum Die Return Velocity	Max. Line Speed + 15fpm
Minimum Die Return Velocity	1*
Acceleration	Line Speed in fpm + 10-15
Return Acceleration	Same as Acceleration
Minimum Die Distance	See Below
Maximum Die Distance	Max. Travel Allowed**
Line Resolution	See Below

## Jog Select

The Jog Select parameter allows the operator to switch from jogging the line through the controller to jogging the die. If “Line” is selected, the controller turns on its Forward and Reverse outputs when the corresponding inputs are activated.

When “Die” is selected, the controller does not turn on its directional outputs when the jog buttons are pushed. When the controller is configured to jog the die, and a jog input is received, the controller turns on its Drive Enable output and tries to command the drive with the analog signal.



## **Loop Gain**

In simple terms, Loop Gain reflects the responsiveness of the motor. If this number is too low, the motor will be slow and sluggish to respond. If the Loop Gain is set too high, the motor will become “over-stable” and begin to oscillate.

AMS Controls sets the Loop Gain as high as possible without pushing the motor into an “over-stable” state. This is accomplished by increasing the Loop Gain until the motor begins to oscillate, then backing the number down until oscillation goes away.

For most applications, the Loop Gain for a Bosch-Rexroth motor/drive combination should be set around 10-15.

## **Maximum Die Return Velocity/Minimum Die Return Velocity**

When running parts, the AMS Controls controller can calculate the speed at which it needs to bring the die back to the home position in order to achieve the next part. It is programmed to always try to come back as slowly as possible to save wear and tear on the servo/actuator system\*.

The Maximum Return Velocity of the motor should be set high enough so that the controller can bring the die back to the home position before the next cut point is reached. For most applications, adding 10 to 15 feet per minute to the maximum line speed is sufficient.

If the controller is able to achieve the first target, but displays a “Missed Shear” error afterward, increase the Maximum Die Return Velocity to overcome this problem.

Minimum Die Return Velocity should be set as low as possible to extend the life of the mechanical parts on the servo/actuator system. However, should the need arise to bring the die back to the home position faster, the Minimum Die Return Velocity parameter can be set as high as is necessary.

*\*On Hole Detect models, the controller is not programmed with the part length, so it cannot calculate a return speed. In these cases, the controller will always bring the die back to home at the Maximum Die Return Velocity. Careful consideration should therefore be given when setting the drive “Bipolar Velocity Limit Value” on controller models with the Hole Detect option. See the section “Velocity Scaling”*



### **Acceleration/Return Acceleration**

Acceleration is the rate at which the controller brings the die up to line velocity. Enter the value calculated for the sizing of the application.

Return Acceleration should be set high enough for the controller to bring the die up to speed to get back to the home position, but Return Acceleration can usually be set lower to increase the life of the mechanical equipment in the servo/actuator system.

### **Minimum Die Distance**

Minimum Die Distance is the minimum amount of distance the die must travel at the controller's programmed Acceleration to reach line velocity. This distance can be calculated by using the following formula:

$S_0$  = Line Speed in Feet per Minute

$S_1$  = Line Speed in Inches per Second

D = Total Dwell Time of Press

A = Acceleration

$$S_0 / 5 = S_1$$

$$(S_1)^2 / (2 * A) = \text{Minimum Die Distance}$$

Every time the controller accelerates the die to line speed to achieve a cut, the die typically overshoots the actual target, initially, and spends a little time trying to compensate for the overshoot. This results in something of a dampening curve. The higher the Acceleration, the longer it takes for the controller to position the die accurately. Increasing the Minimum Die Distance can decrease tolerance problems caused by this overshoot.

### **Maximum Die Distance**

Depending on the setting of the On Tolerance Error parameter in the controller, this parameter may or may not be critical. If the On Tolerance Error parameter is set to "Stop No Cut," the controller will begin calculating its tolerance when the die reaches the Minimum Die Distance, and will not fire the die until it's in tolerance. If the controller cannot achieve tolerance by the programmed Maximum Die Distance, it will not make the cut, but instead will stop the line, bring the die back to the home position, and give the operator an "Out Of Tolerance" error.





If the On Tolerance Error parameter is set to “Cut and Stop,” the controller will fire the die at the Minimum Die Distance and calculate tolerance error at the end of the Shear Dwell Down Time. In this instance, Maximum Die Distance is ignored.

In any case, the controller updates the Lag time of the servo system whenever the die is traveling between the Minimum and Maximum Die Distances.

### **Line Resolution**

The Line Resolution parameter is the amount of material represented by one pulse from the line encoder. Line Resolution is calculated using the following formula:

P = Model of AMS Controls Encoder or the Pre-Quadrature Pulses per Rev. of a Non-AMS Controls Encoder

D = Diameter of the Measuring Wheel

C = Circumference of the Measuring Wheel

$\pi$  = Pi, a Mathematical Constant Approximately Equal to 3.14

$$C = \pi * D$$

$$\text{Line Resolution} = C / (P * 4)$$

## Die/Motor Resolution

Depending on your application, you may need to set a Die Resolution (Die Accelerator System) or Motor Resolution (Roll Feed System). Each is calculated in the same way using the same formula. The actual value of the parameter represents the amount of Die Movement (Die Accelerator) or Material Movement (Roll Feed) per pulse from the encoder. Formulas for each would be as follows:

### Die Accelerator

FC = Feed Constant of the Mechanics

Gear = Gear Ratio of the attached Mechanics

PPR = Emulated Encoder Pulses Per Rev

EFC = Effective Feed Constant

Res = Die or Motor Resolution

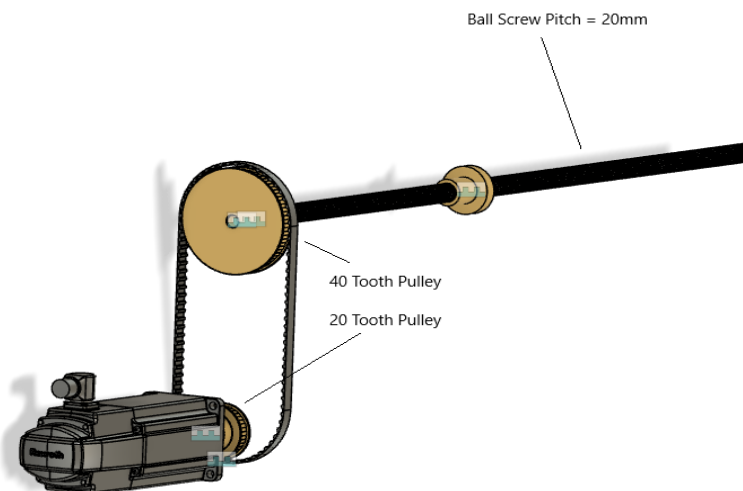
We start by figuring out the Effective Feed Constant

$$EFC = \frac{FC}{Gear}$$

**Using the example below we calculate the effective feed constants  $\frac{.7874}{2} = .3937$**

We can now calculate our Die Resolution using the formula  $Res = \frac{EFC}{PPR * 4}$

**Using the example below we calculate this as  $\frac{.3937}{1250 * 4} = .00007874$**



## Roll Feed

FC = Feed Constant of the Mechanics

Gear = Gear Ratio of the attached Mechanics

PPR = Emulated Encoder Pulses Per Rev

EFC = Effective Feed Constant

Res = Die or Motor Resolution

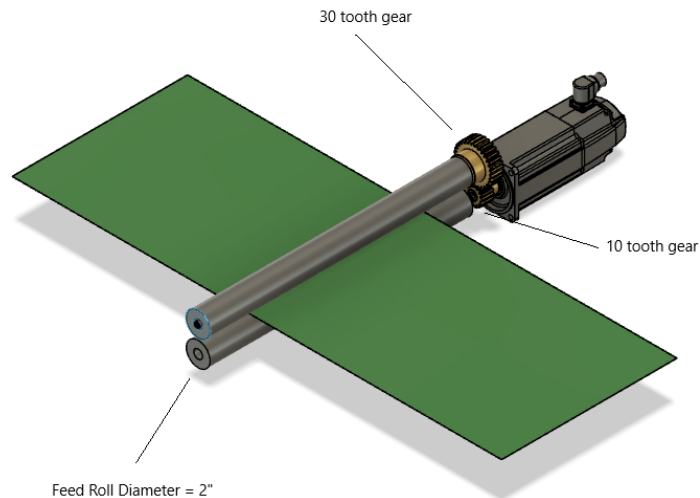
We start by figuring out the Effective Feed Constant

$$EFC = \frac{FC}{Gear}$$

**Using the example below we calculate the effective feed constant  $\frac{6.283185}{3} = 2.094395$**

We can now calculate our Motor Resolution using the formula  $Res = \frac{EFC}{PPR * 4}$

**Using the example below we calculate this as  $\frac{2.094395}{1250 * 4} = .000418879$**





4. Reset the line/console. The drive should display “Ab” on the digital read out on the firmware module. This indicates the drive is powered up and ready for motion. If the module displays any other code, check the Bosch-Rexroth Functional Description manual for the appropriate firmware version. Call AMS Controls if questions arise. AMS Controls technicians are experts in the use of these drive systems with AMS Controls XL Series controllers. Bosch-Rexroth technicians may not be able to assist in start-ups because they do not know how our controller interfaces with the drive.
5. Enter the controller setup screen “Closed Loop Data” and select “Jog Die Accelerator” from the menu. The screen will display a position of 0.000”. Press the “Jog Forward” button. The motor should begin turning. Check the motor rotation. If the motor is turning in the wrong direction, see the section “**Reversing the Motor Direction**”.
6. Now that the motor is turning in control and in the proper direction, reconnect the motor to the actuator or roll feed mechanism. This should be done with the power removed from the drive and motor.

**\*Before moving the die, over-travel limit-switches and the home switch must be in place. Over-travel switches should be part of the E-Stop chain for the machine. Shock absorbers should be mounted at both ends of the travel to maintain the AMS Controls warranty on the actuator and to protect the mechanical equipment from damage. Additional hard, or physical, stops should be added to prevent damage to equipment and personnel.**

7. Press the “Manual Shear” button to home the die and zero the position reading on the controller. This will move the die to the home switch, bring the die off the switch, then back onto the switch and fire the press. If any **Shear Die Distance** has been programmed, the die will move to the programmed position before the press fires.

The manual shear button must remain depressed until the controller fires the press, or the process will be aborted. This is a safety feature of the controller.

8. Enter the “Setup” menu and go to the “Closed Loop Data” submenu in the controller. Select “Die Test” from the “Closed Loop Data” submenu. Enter a test length and a line speed to simulate and press enter to begin the test. The die will begin to simulate production.

It's usually a good idea to start off at a low speed (10-50 fpm) and work up to a test that will simulate the line at maximum production speed. This will require that the Die Test be halted and restarted for each change in simulated line speed.

9. The AMS Controls Closed-Loop controller performs its main function by accelerating a cutting tool to line speed, matching position and speed of the target, and firing a press to actuate the cutting tool. The controller accomplishes this by using the **Acceleration** and **Minimum Die Distance** programmed by the user.



One way to improve tolerance is to increase **Minimum Die Distance**. This gives the controller more distance to match speed and position of the target. Lowering **Acceleration** can accomplish the same thing by decreasing the amount of “overshoot” of the die once it has reached line velocity.

Try increasing **Minimum Die Distance** until it no longer seems to have an effect on the tolerance. At this point, begin increasing **Loop Gain**. **Loop Gain** is the final tool in fine-tuning the servo system.

**Loop Gain should be increased until the tolerance begins to become more erratic. At this point, the closed-loop is over-stable. Set the gain to a lower, more stable number.**

# Troubleshooting

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## **Motor Spins Out of Control (Drive Not Responding Error)**

Once you have commissioned your drive, you may experience the drive spinning uncontrollably when attempting to jog. This is most likely due to the analog command or encoder feedback being out of phase. Try the following, in most cases the first action item resolves the issue.

1. E-stop the system and Swap the Analog Command Wires
2. Check the analog command at the Controller and the Drive for voltage
3. Check the AMS Diagnostics/Closed Loop Data screen for Encoder Feedback

## **Reversing the Motor Direction**

Once you have commissioned your drive, and you find that the motor is spinning in the opposite direction that is required, it is possible to invert this direction.

1. E-stop the system
2. Swap the Analog Command Wires with each other AND Swap the A+ and A- wires of the encoder feedback

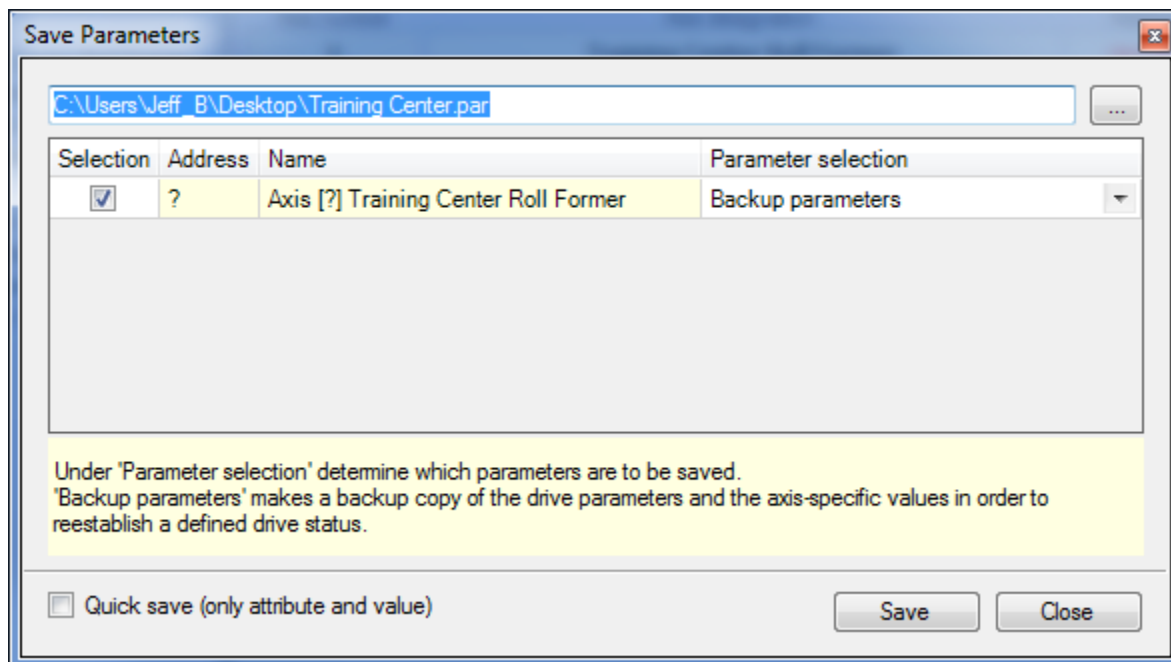
# Backup and Restore Parameters

## Back Up Parameters

It is recommended to back up or “Save” the parameters once the drive is commissioned in case parameters are lost. Prior to backing up parameters, you must first place the drive into a “Parameterization mode” or “Phase 2”. See the section for **Set Parameterization Mode** on page 10 for assistance. To back up the parameters do the following:

- Click “Parameterization.”
- Click “Save...”
- Click the address bar at the top and choose a location to save the file.
- Click “Save.”

Once the process is complete, click “Close”. At this time you must place the drive back into “Operation Mode” or “Phase 4”. See the section **Set Operating Mode** on page **Error! Bookmark not defined.** for assistance.



## Restore Parameters

In case of a problem, you may want to restore parameters from a known good state. In this case you may want to restore or “Load” parameters. Prior to loading parameters, you must first place the drive into a “Parameterization mode” or “Phase 2”. See the section Set Parameterization Mode on page 10 for assistance. To restore the parameters do the following:

- Click “Parameterization.”
- Click “Load...”
- Click the address bar at the top and choose a location to load the file.
- Click “Loading.”

Once the process is complete, click “Close”. At this time you must place the drive back into “Operation Mode” or “Phase 4”. See the section Set Operating Mode on page **Error! Bookmark not defined.** for assistance.

