

Indra Works DS Tuning Procedure

Rexroth Indramat 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.**

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Items Required for Setup

CUSTOMERS PLEASE READ THIS PAGE. CRITICAL INFORMATION REGARDING YOUR EQUIPMENT IS CONTAINED IN THIS FIRST PAGE

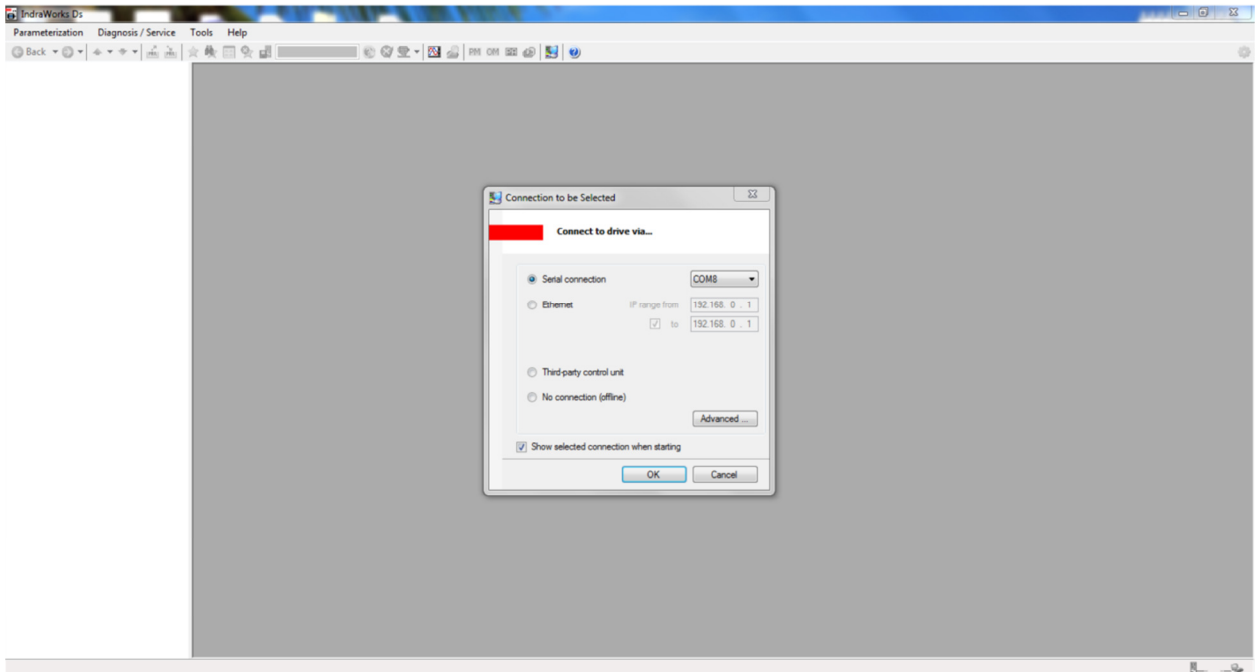
1. Safety precautions must be followed at all times! Indramat drives have large capacitors inside them that can deliver a high amperage shock to anyone touching the terminals on the drive. These capacitors can remain charged for up to 10 minutes after having power removed. Remove power and lock out incoming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

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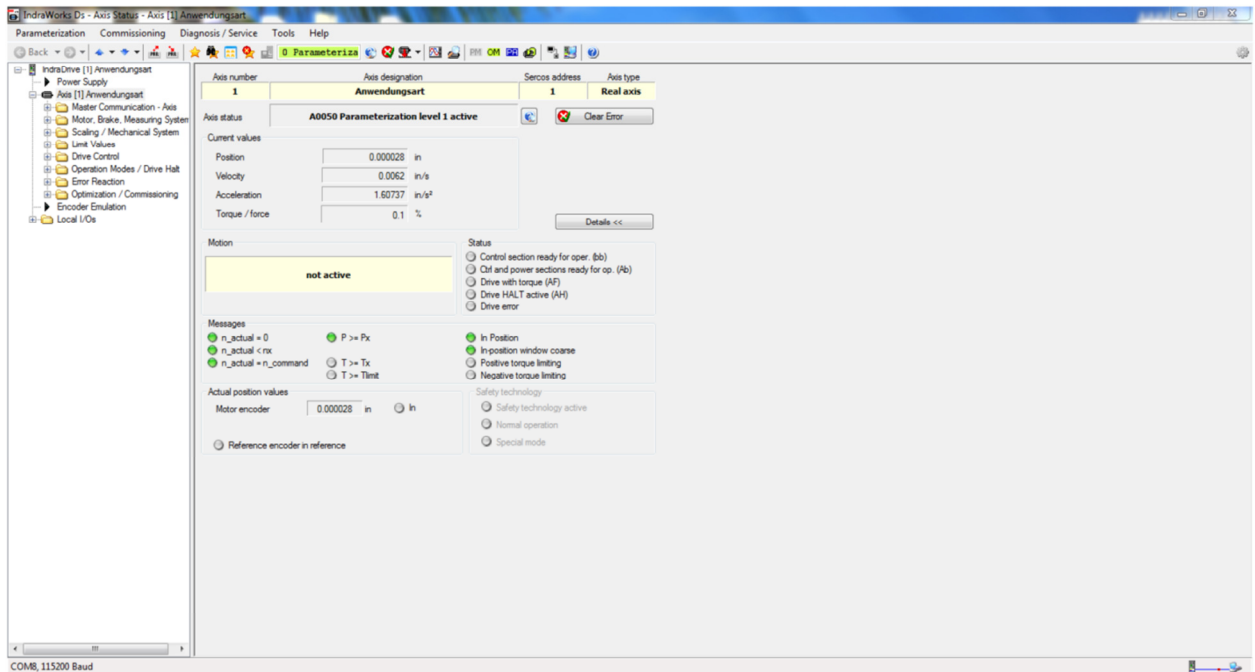
2. The power cable that connects the drive to the motor **must not** be “spliced”, terminated, or otherwise modified. There are important grounding and shielding connections between the motor and the drive that **must** be maintained for proper operation. Improper connection of this cable **will** cause 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.
3. With power removed and locked out, connect the motor power 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.
4. 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.
5. 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.
6. 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 .
7. Once all the terminal connections have been made and verified, reapply power and turn the console on. The drive should power up to a “bb” or “Ab” state, depending on the way the console was wired (this is discussed further, later.)
8. Using the interface cable IKB0041, connect the drive to a laptop computer.
9. Start up the IndraWorks DS software.

Tuning the Drive

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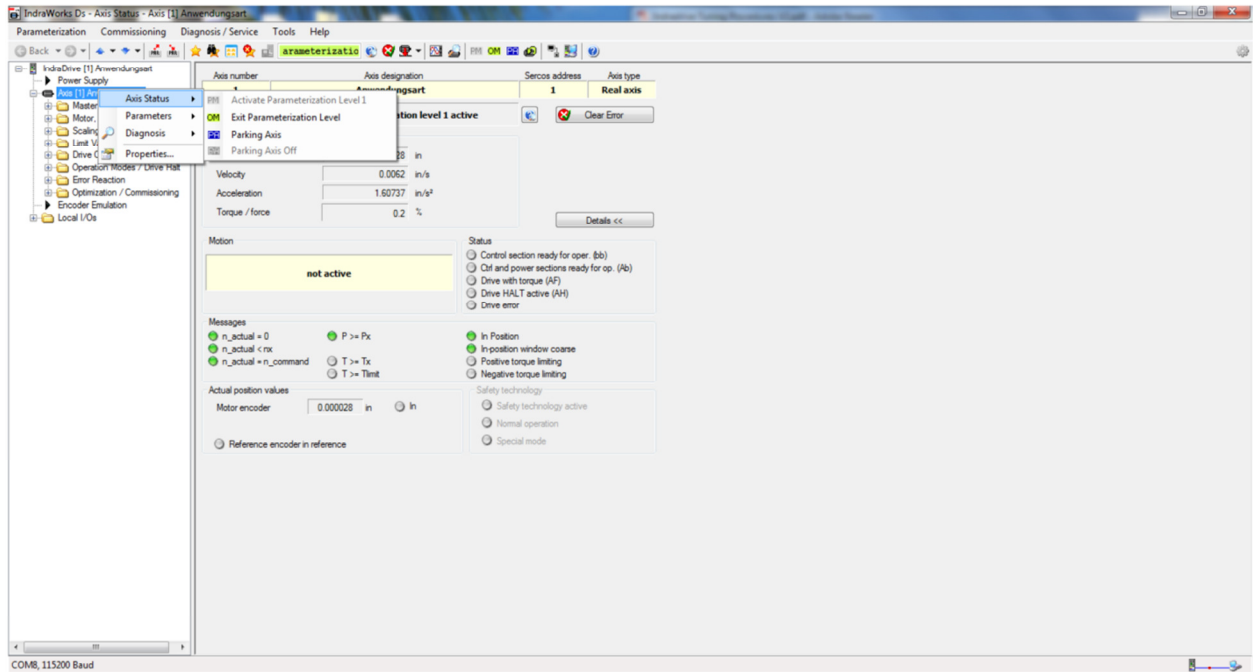


Use the drop down next to Serial connection and select the COM port that your cable is plugged into.

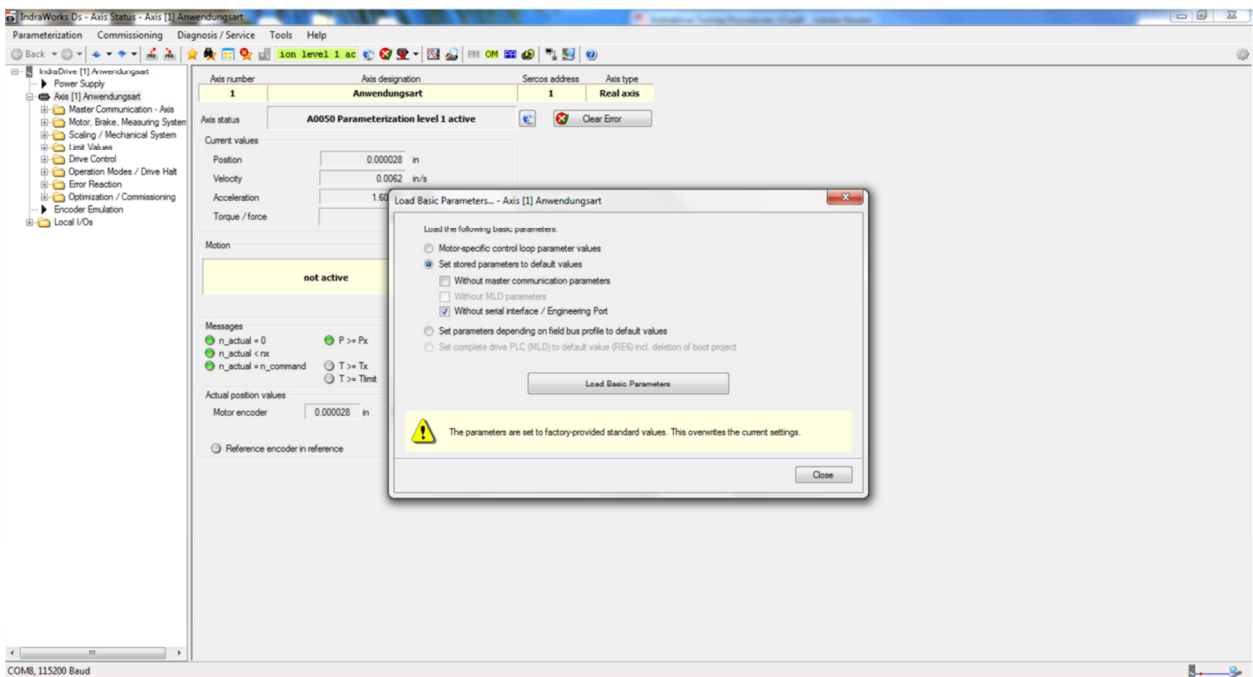


If connected properly you should now be at the main screen.

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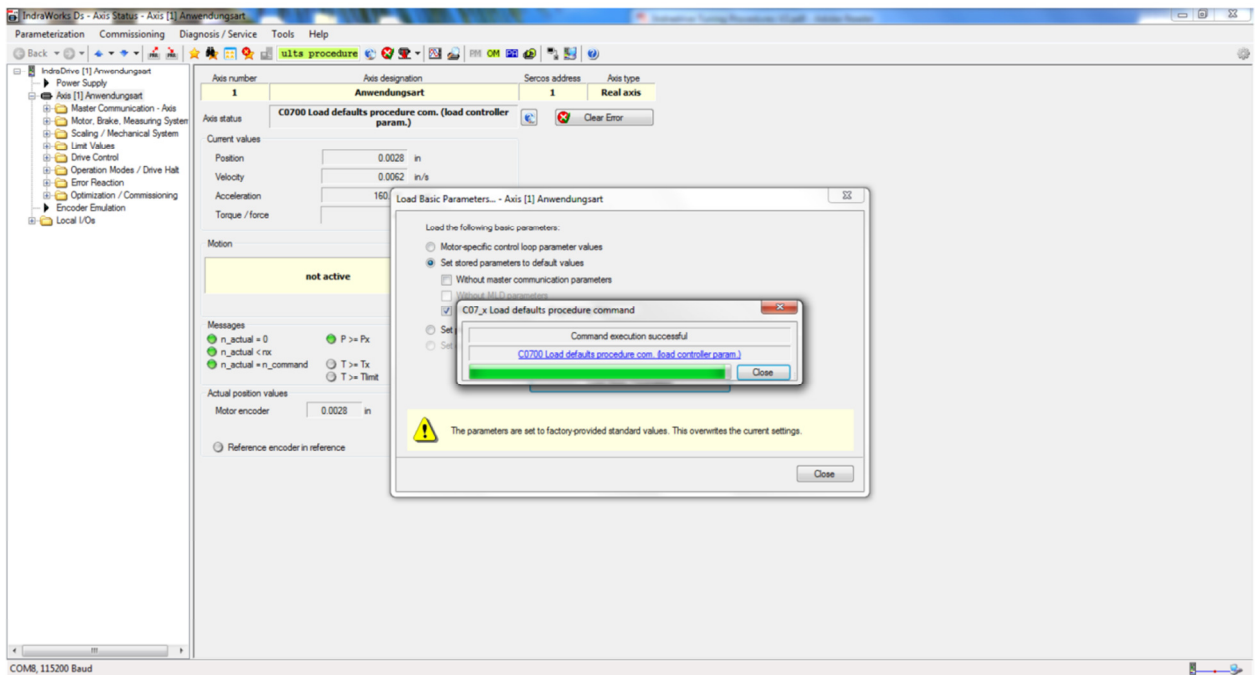


Right-click on Axis (1), highlight Parameters, and choose Load Basic Parameters.

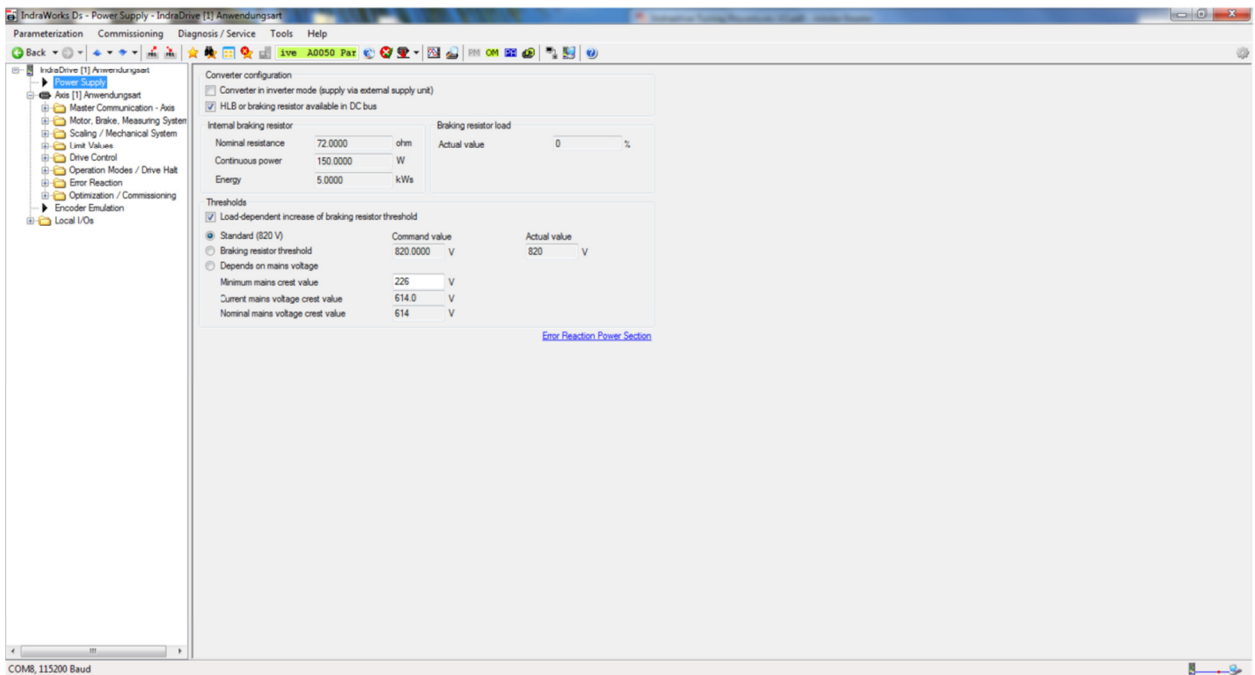


Click Load Basic Parameters

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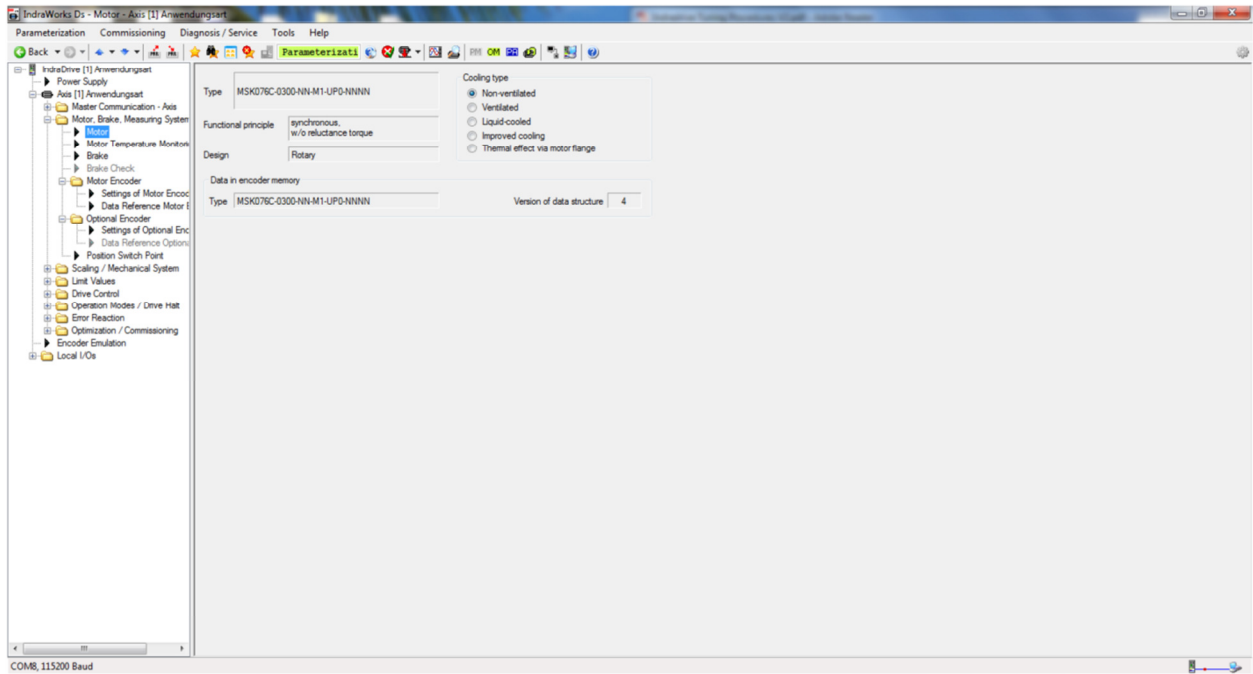


When finished, close the two windows so they we are on the main page again.



On the left side of the screen, double click on Power Supply to see this window. If a braking resistor is connected, make sure to check mark it like shown above.

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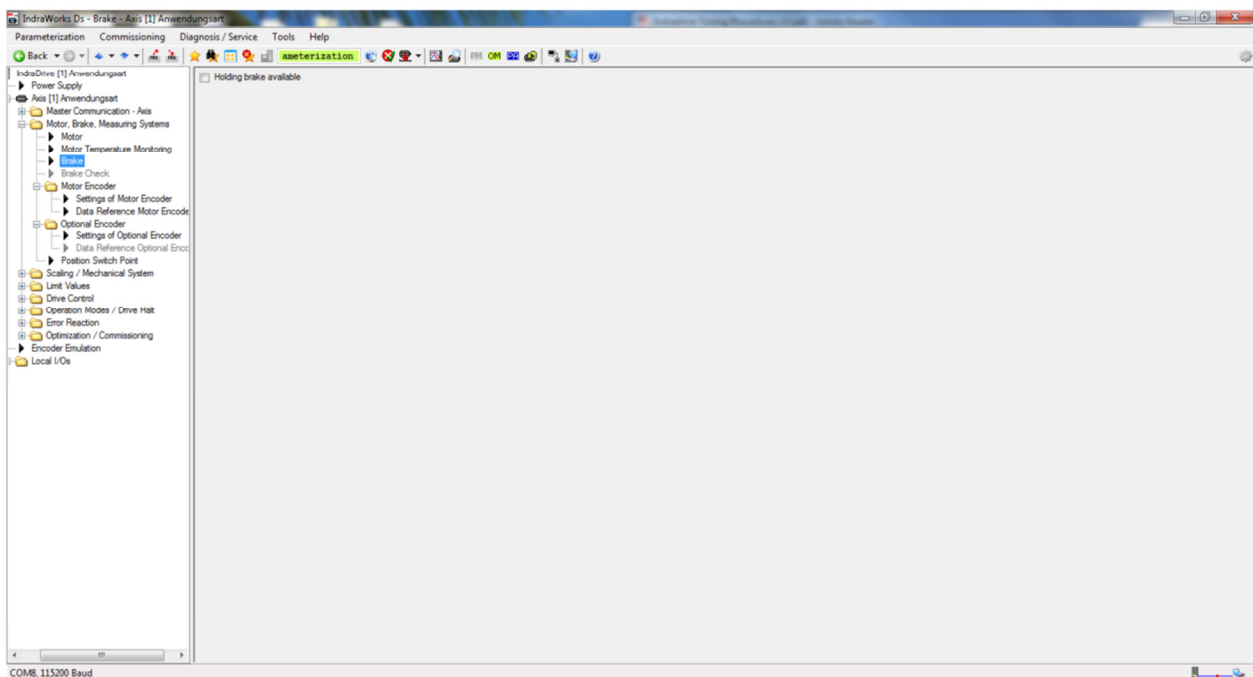


Next expand the Motor, Brake, Measuring System folder and double click on Motor.

Choose the type of cooling required for the motor. Most of the systems provided by AMS will be Non-Ventilated or Ventilated depending on whether there is a cooling fan or not. The following applies:

No Motor mounted cooling Fan = Non-Ventilated

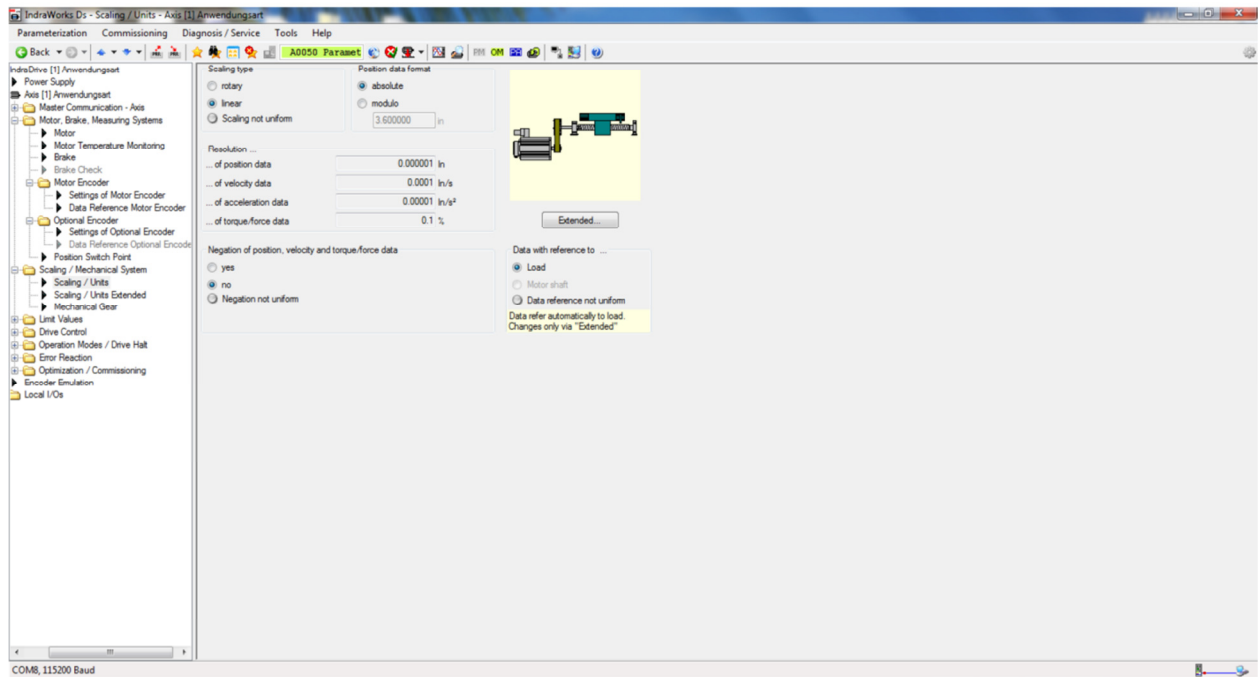
Motor mounted cooling fan = Ventilated



Click the Blue arrow pointing down so that we are now on this screen.

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If the motor has a brake, make sure the “Holding brake available” is checked.



Click the Blue arrow pointing down so that we are now on this screen.

Set the following:

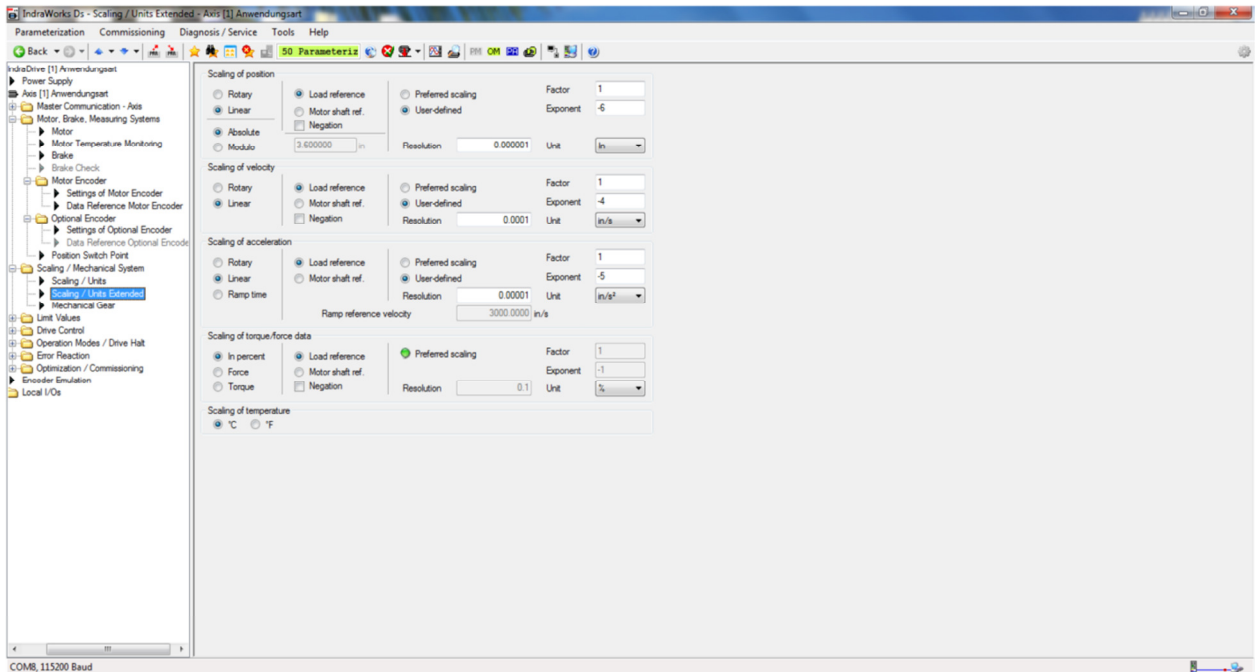
Scaling Type = Linear

Position Data Format = Absolute

Data with reference to = Load

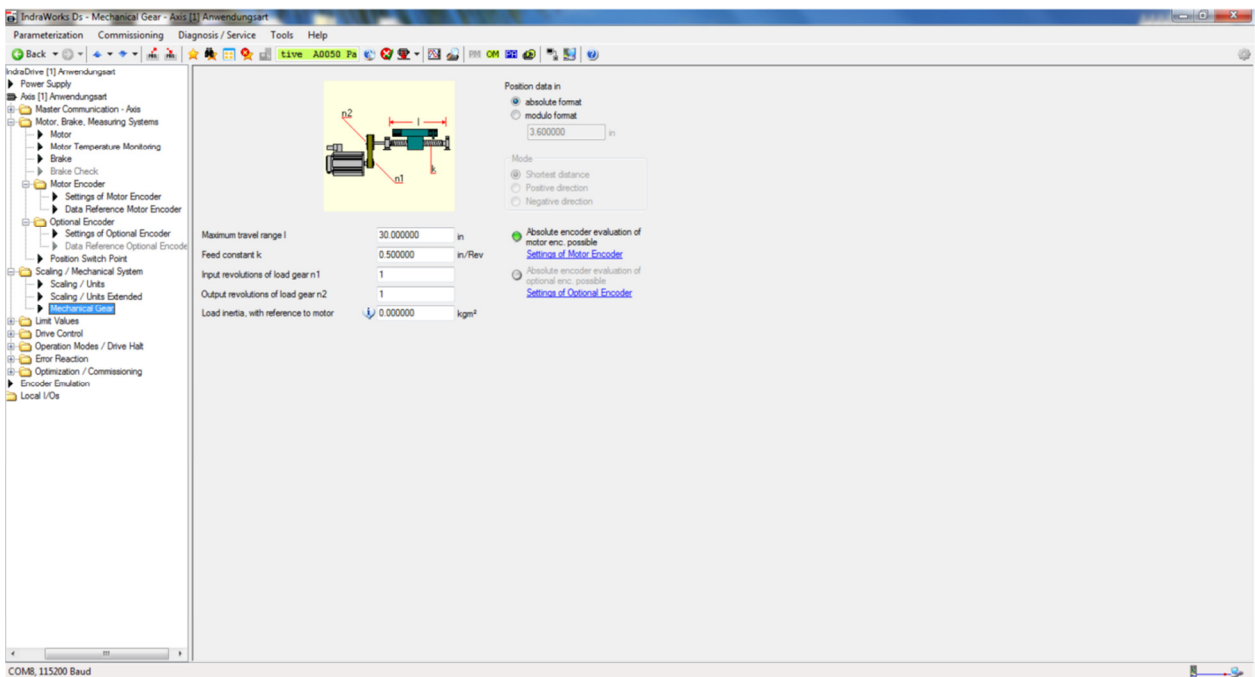
You'll notice the resolution data is in mm. To change units to English click “Extended”

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Set all of the scalings to “User Defined” and select the units as shown above

Click Close



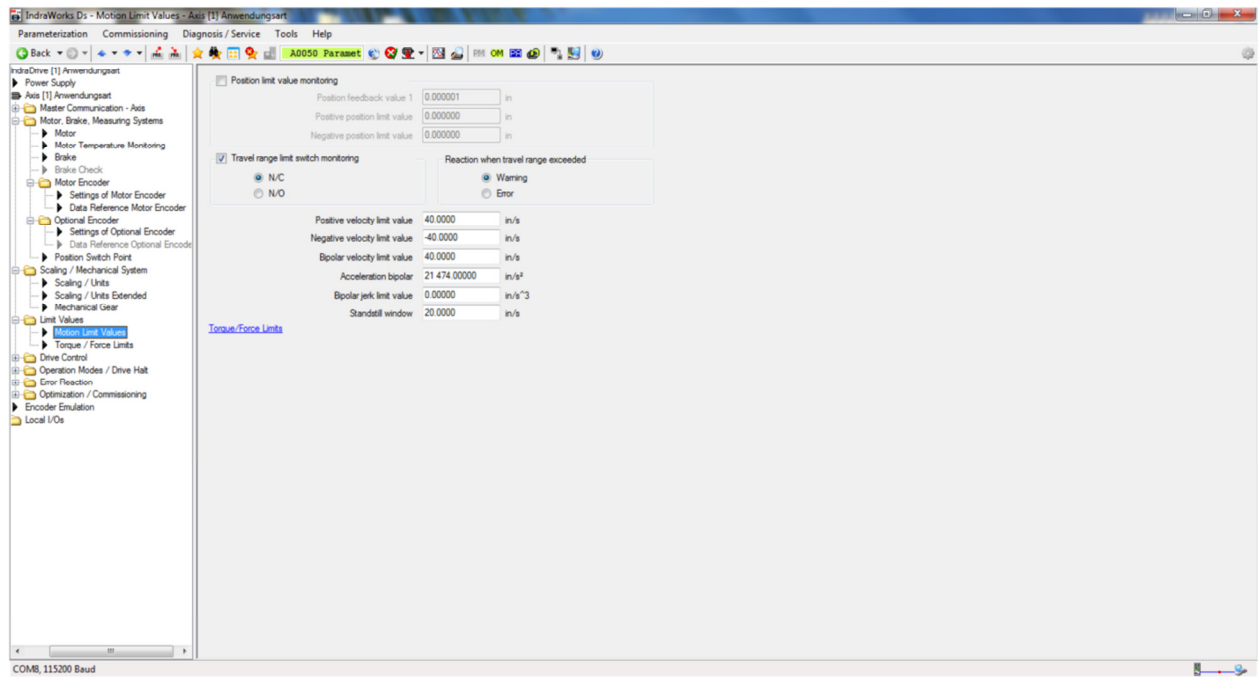
Click the Blue arrow pointing down so that we are now on this screen.

The above screen is where we tell the drive what our motor is attached to. For the above example I chose to use a ballscrew with a .5” pitch, no gear box, and 30” of travel. The following applies:

Maximum Travel Range = Ballscrew available travel
Feed Constant K = Ballscrew Pitch

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Input Revolutions of Load gear N1 and N2 = gear ratio

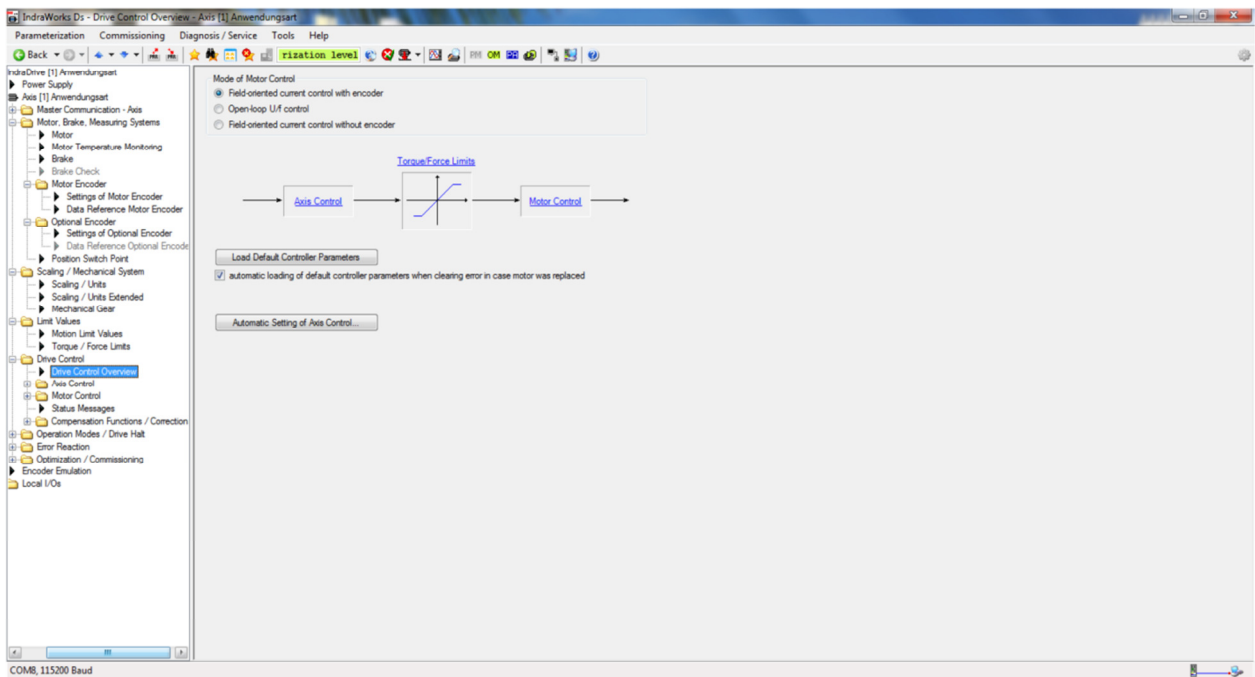


Click the Blue arrow pointing down so that we are now on this screen.

If this is a **Die Accelerator**, and the design calls for the travel range inputs to be used, make the above selections. For the limit values - we want to "Open them up" by making them the largest possible number. Do this by Right Clicking the field and selecting "Parameter info". Whatever the Max value is enter into this field.

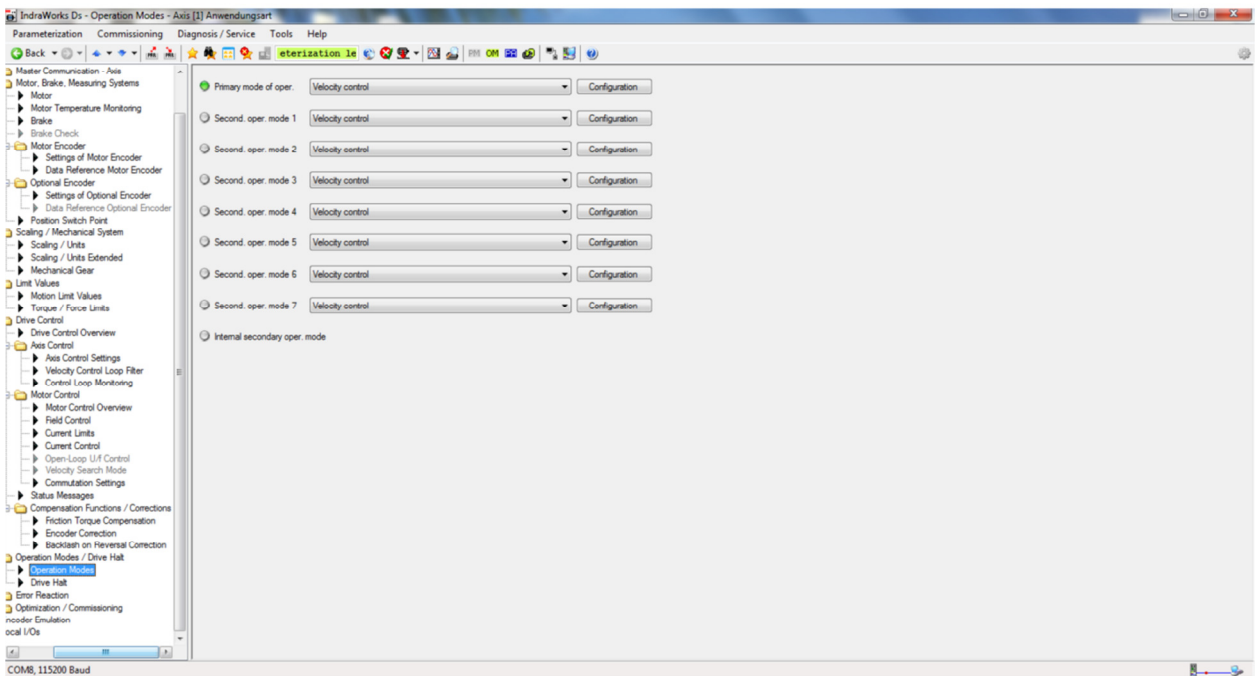
If the application is a **Feed-to-Stop or Roll Feed** travel range switches should **not** be used and should not be checked.

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Click the Blue arrow pointing down so that we are now on this screen.

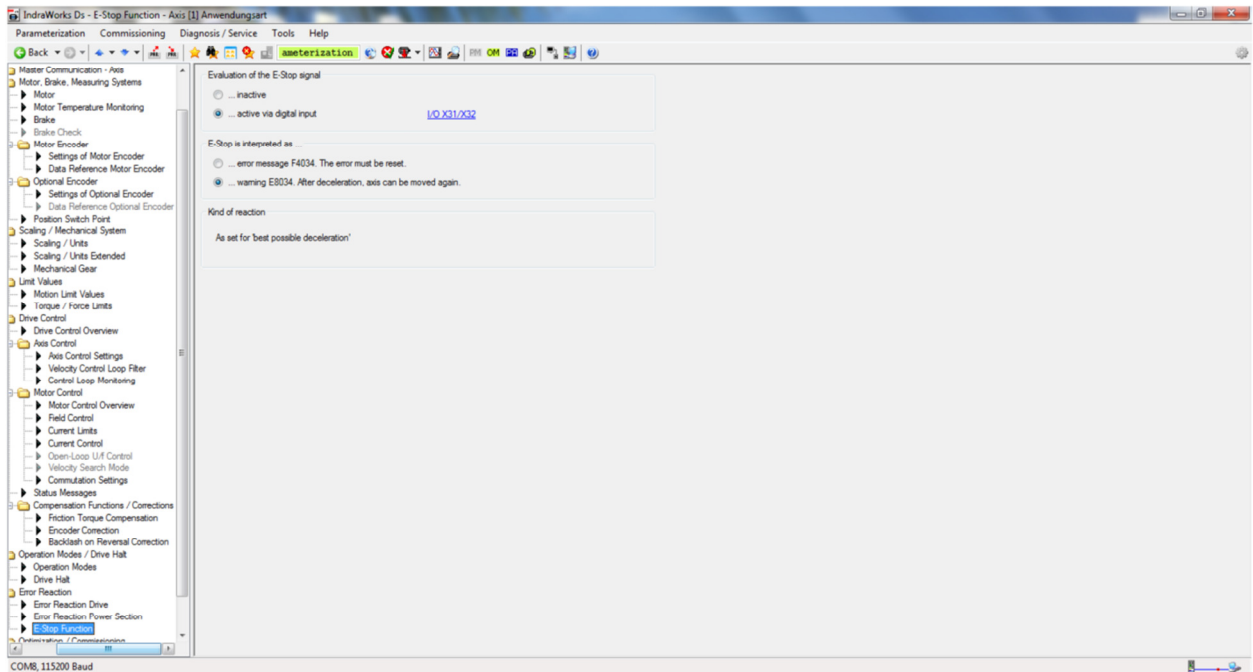
Make sure "Field-oriented closed-loop control" is checked.



Click the Blue arrow pointing down so that we are now on this screen.

Make sure Velocity control is selected for all items.

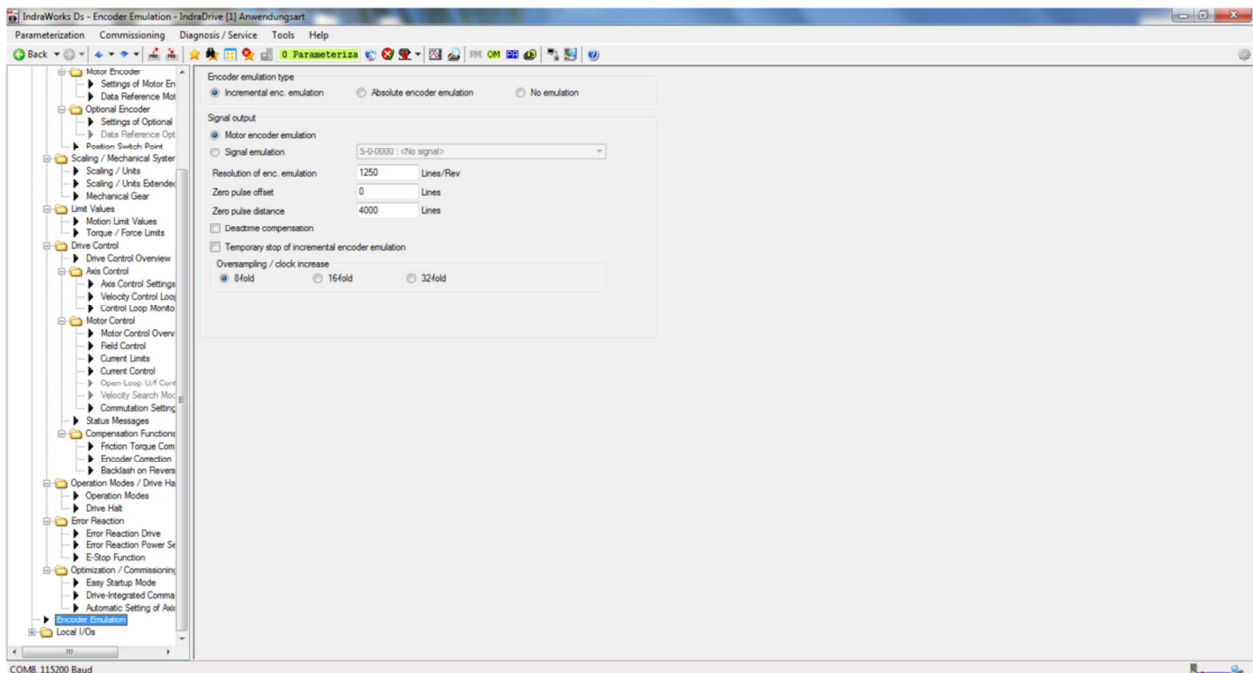
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Click the Blue arrow pointing down so that we are now on this screen.

Assuming the E-stop signal is being used and is physically wired the above selections can be made.

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



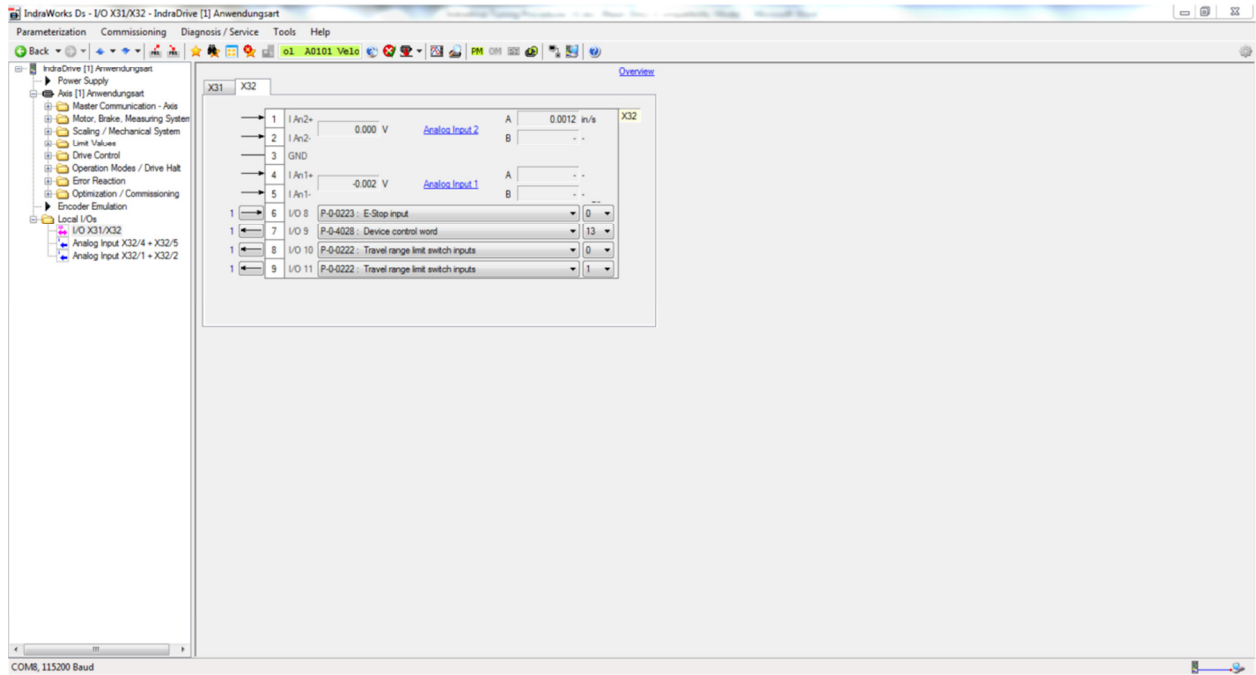
Double Click on Encoder Emulation to see this screen.

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Click “Incremental encoder emulation”.

Click “Motor encoder emulation”.

Change the “Resolution of enc. emulation” to 1250 Lines/rev.

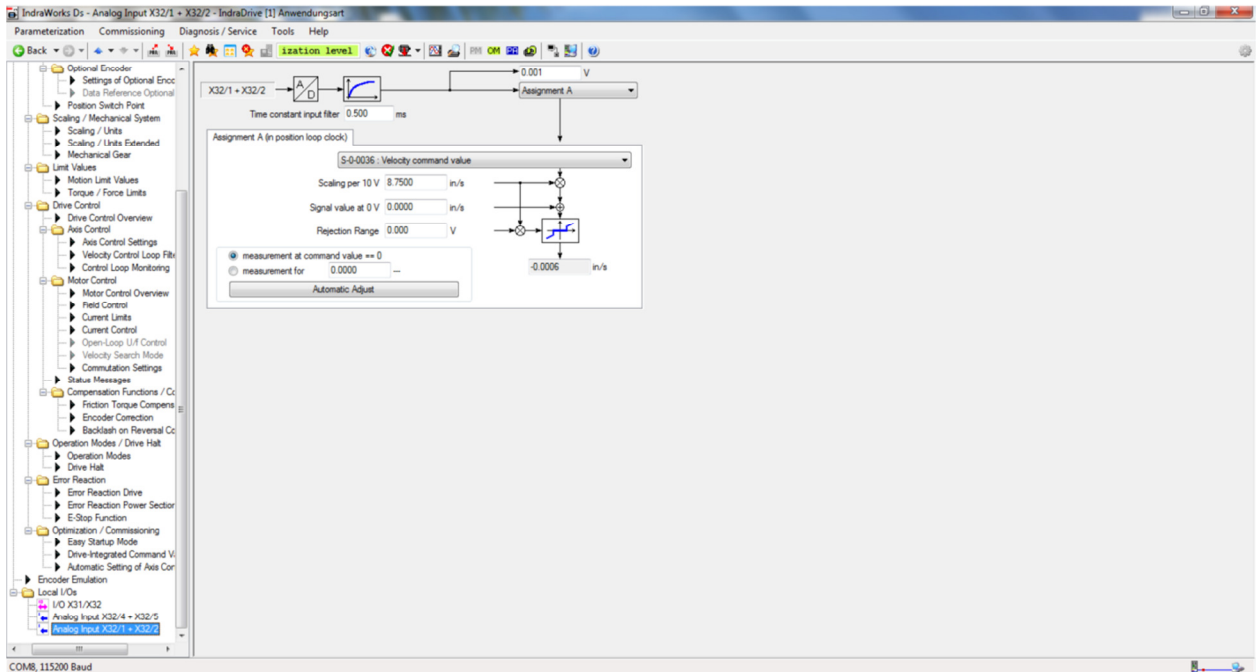


Double click Local I/Os, and click on I/O X31/X32. Now click on the X32 tab so your screen matches the one above.

Change the necessary I/O points to match what is shown above. The only points that should change are the last three points.

Important!! Notice that the arrow for E32 point 7 above is pointing left. This designates this point as an output. This point comes default pointing right or as an Input. To change this, simply click on the arrow and then make your selection.

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Click the Blue arrow pointing down so that we are now on this screen.

Use the drop down menus to select the items shown above. They are:

Choose “Assignment A”

Choose “S-0-0036: Velocity Command Value”

To set the scaling us the following formula:

$(\text{Max Line Speed in FPM} / 5) / .8 = \text{Scaling per 10V}$

Example for a system with a max line speed of 150FPM the following applies:

$(150/5) / .8 = 37.5$

At this point you are finished parameterizing the drive. Click the OM icon in the Task Bar at the top of the window to put the drive in Operating Mode.

The drive should now show an AB on the front panel. If it does not, try and hit the esc button on the front of the drive. If you still see an error, check the drive status by right clicking on the axis folder and choosing diagnosis/status. Use your manual to troubleshoot any errors that are shown in the status window.

Controller Setup

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

De-couple 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.

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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 servomotors 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 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	See Parameter Description Below
Acceleration	Line Speed in fpm + 10-15
Return Acceleration	Same as Acceleration
Minimum Die Distance	See Below
Maximum Die Distance	Max. Travel Allowed (See Below)
Line Resolution	See Below
Die Resolution	See Below

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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 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 an Indramat motor/drive combination should be set around 10-15.

Maximum Die Return Velocity/Minimum Die Return Velocity:

When running parts, the AMS 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 Analog Input scaling of Volts per RPM on controller models with the Hole Detect option.**

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.

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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 AMS 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 Encoder or the Pre-Quadrature Pulses per Rev. of a Non-AMS Encoder

D = Diameter of the Measuring Wheel

C = Circumference of the Measuring Wheel

Pi = Pi, a Mathematical Constant Approximately Equal to 3.14

$$C = \text{Pi} * D$$

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

Die Resolution:

The Die Resolution parameter is the amount of die travel represented by one pulse from the drive or motor encoder signal. Die resolution is critical to tight tolerance applications. If the die appears to be

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moving at a different rate of speed than the line, it's because the programmed Die Resolution value is incorrect.

Die Resolution is calculated by dividing the amount of linear die travel acquired through one turn of the shaft of the servo motor, divided by the number of pulses output from the servo drive for one revolution of the motor. Ballscrew pitch, pulley and pinion gear circumference, and gear box ratios are all important variables in the equation to calculate Die Resolution. The formula used depends on the specific application.

Regardless of what type of system is used, or how the Die Resolution is calculated, it is important to check the calculated resolution by actually moving the die with the AMS controller, measuring the move, and comparing the measured distance to how far the controller reported moving the die. A large amount of error can be introduced in the original calculation if even one number is off by a small amount. This is especially important on machines capable of high line speeds. Call AMS (800-334-5213) for details.

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 Indramat Functional Description manual for the appropriate firmware version. Call AMS if questions arise. AMS technicians are experts in the use of these drive systems with AMS controllers. Indramat technicians may not be able to assist in start-ups because they do not know how the AMS controller interfaces with the drive.
5. **For XL Model Controllers-** 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.

For MP Model Controllers- Press the Setup key until the screen displays the option, "Jog Die". The screen should display a position of 0.000".

The motor should begin turning. If the motor turns in a controlled manner and in the proper direction, proceed to step 50.

When any of the DIP-switches on the controller are changed, the power on the controller must be cycled for the change to take effect. Once power has been cycled, the controller will clear its memory, so be sure to record all of the settings from the parameter list, first.

If the analog command signal is inverted, the motor will "run away", or spin out of control, in the same direction regardless of which jog button is pushed. In this case, switch the Analog Polarity DIP-switch on the back (or side) of the controller.

If the encoder signals are inverted, the motor will run away, but it will change direction depending on which jog button is pressed. Switch the Encoder Direction DIP-switch on the back (or side) of the controller.

If both the analog command signal and the encoder signals are reversed, the motor will run in control, but move opposite the direction of the jog button pressed. Switch both the Analog Polarity and the Encoder Direction DIP-switches on the back (or side) of the controller.

6. Now that the motor is turning in control and in the proper direction, reconnect the motor to the actuator. 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 warranty on the actuator and to protect the mechanical**

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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 AMS controller fires the press, or the process will be aborted. This is a safety feature of the AMS controller.

8. **For XL Model Controllers-** Enter the Setup menu and go to the Closed Loop Data submenu in the AMS 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.

For MP Model Controllers- Press the Setup key until the option, "Die Test" appears. Enter a test length and a line speed to simulate, and press the enter key 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. Once the controller is running Die Test at the line's maximum speed, open the Analog Input X32/1 – X32/2 window of the Indra Works Ds software. Connect the leads of a VOM to the analog command cable. The VOM must measure between the two wires in the cable, not to ground.

To gain maximum control over the motor speed, the AMS controller should put out about 8.5 VDC from its analog command signal at the top line speed.

If this is not the case, adjust the Scaling per 10V _ in/s until this is achieved.

10. Once the analog command signal is at the target voltage for maximum line speed, the tolerance of the cuts should be checked. In XL model controllers, tolerance for each cycle is displayed in the Die Test window. In MP model controllers, the setup key must be pressed to find the Error Display option, and that option must be chosen.

If the controller reports tolerance as a large error, watch the screen for a few cycles to see if the controller is still improving tolerance. This is usually the case after changing the scaling parameters of the drive.

Once the tolerance has stabilized (the tolerance should not change by more than a few thousandths of an inch from one cycle to the next), some other fine-tuning adjustments may be necessary. If the tolerance reported by the controller is sufficient, no further tuning is required, otherwise, proceed to step 55.

11. The AMS 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 AMS 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.

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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.