Productivity in Motion

SAC-RDE

Reference Manual

SAC-RDE01a

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Terms and Conditions

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Introduction

ORMEC's SAC-RDE series of servodrives are designed to be a drop in replacement for a SAC-DE servodrive. Both drives are torque mode servodrives with analog command inputs. The SAC-RDE is a modern, fully digital servodrive with an analog command input.

Documentation for the SAC-RDE drive can be found in this Reference Manual, in the SAC-RDE Installation Instructions and in the on-line Help of MotionSet™, the GUI (Graphical User Interface), the most powerful commissioning and configuration tool available.

This Reference manual is intended for qualified persons who understand installation and operation principles of servodrives and are looking for specific information regarding this product.

The Help system distributed with the MotionSet™ setup and commissioning tool primarily documents how the software operates, how to define motion and interactions with the drive.

Using this Reference Guide

This reference is designed to provide quick access to the vital information you need. The best way to find the information is to use the Table of Contents or Index. In addition, there are many links throughout the manual. Clicking on them will quickly move you to the referenced item.

The reference is ordered to take you through the process needed to get your motor turning. Each section uses color coded headings to provide a visual aid to the various sections. This manual is organized as:

- Safety First – Safety precautions
- SAC-RDE Features - Overview of the features available
- Implementation Guidelines - good practices for successful installations
- Quickstart – a simplified list of steps for setup and motion
- Connecting to the SAC-RDE - describes physical connections to the drive, in the normal order encountered in the field,
- Defining Projects - describes setting up the drive using the MotionSet™ commissioning tool including how to define motions
- Indicators - explains the lights and indicators on the drive
- Feature Details - describes and explains features not found in other sections
- Solving Problems - is a troubleshooting guide, just in case there are questions
- Specifications - detailed specifications

Finally, everyone wants to get up, running and moving a motor as fast as possible. To that end, section "Quickstart" provides a fast overview. It is written for professionals with experience commissioning servodrives and other automation equipment. It provides little explanation. If you want more explanation please follow the other sections.

Safety First

This section includes precautions you should take for the safety of you, other personnel and your equipment. These and all local and national standards and requirements should be considered and followed when installing and operating electronic equipment.

Safety Precautions

ORMEC's SAC-RDE and associated equipment are intended for installation into a complete system by qualified persons. If the product is installed incorrectly it may produce a safety hazard or cause damage to equipment.

The product and system use high voltages, high currents and high levels of stored energy, any of which may cause injury or death.

The complete system is used to control mechanical systems which may also use and contain high voltage and high currents as well as moving mechanical equipment. These may also cause injury, including death.

You must give close attention to the electrical installation and system design to avoid hazards in both normal operation or in the event of equipment malfunction. System design, installation, commissioning and maintenance must be carried out by qualified personnel who have the necessary training and experience.

Qualified Personnel

Qualified personnel are persons who by way of training or experience and instruction of automation equipment and electronics are authorized to install, commission and service industrial electronic equipment. Qualified personnel are aware of pertinent standards and safety precautions and follow them.

Mount in an Enclosure

This product is intended to be mounted in an enclosure that prevents access except by qualified persons and that prevents the ingress of contamination. This product is designed for use in an environment classified as pollution degree 2 in accordance with IEC664-1. This means that only dry, non-conducting contamination is acceptable.

Drive Settings

It is essential that you correctly set and maintain proper drive settings. Depending on the application incorrect settings can cause incorrect or unstable operation resulting in unsafe operation or severe mechanical damage.

You must take appropriate precautions against inadvertent changes or tampering. Restoring default parameters in certain applications may cause unpredictable or hazardous operation.

Grounding

This drive must be grounded by a conductor sufficient to carry all possible fault current in the event of a fault.

This equipment has high earth leakage current. You must comply with local safety regulations with respect to minimum size and special installation requirements on the protective earth conductor for high leakage current equipment.

The safety ground connections must be made at all times.

Hot surfaces present

Servodrives may have hot surfaces during operation. Temperatures may rise to above 80ºC (176ºF) and may take a few minutes to cool down after operations cease. Care should be exercised to allow sufficient airflow along hot surfaces, avoid contact by other materials including wiring and do not touch during or shortly after operation.

Don't disconnect while live

Never connect or disconnect electrical connections to the servodrive while it is live. In unfavorable circumstances this may cause electrical arcing with damage to contacts and danger to persons.

Residual Voltages

The servodrive contains capacitors designed to store energy. These capacitors may retain a dangerous voltage for 5 to 10 minutes after power is removed. Therefore, wait at least 5 minutes after switching off the supply voltages before disconnecting or touching the servodrive.

Keep Covers on

Do not open the servodrive. Keep all covers and control cabinet doors closed during operation. Otherwise there are deadly hazards, with the risk of death, severe danger to health or material damage.

SAC-RDE Features

ORMEC's SAC-RDE series of servodrives are designed to be a drop in replacement for a SAC-DE servodrive. Both drives are torque mode servodrives with analog command inputs. The SAC-RDE is a modern, fully digital servodrive with an analog command input.

The drive comes configured and ready to operate with a specific motor as a torque mode drive. In most replacement applications no further configuration will be needed. If needed configuration and commissioning are a snap using MotionSet software, a modern, intuitive tool which can reduce commissioning to just minutes. A familiar menu driven programming environment make it easy to configure.

Communication

- USB and Ethernet Connectivity standard in all SAC-RDE drives for fast and reliable commissioning.

Motor Feedback

- Software configurable to support popular feedback devices
  - Standard Quadrature Encoders (A quad B) up to 12 MHz. Differential or single-ended (page 23).
  - Yaskawa Sigma 1 quadrature
- Fault detection for safe operation.
- Power to operate feedback device provided.
- Details found at Step C 5: Connect motor feedback (page 23).

Power connections

- Separate logic and main power allows independent control of main power for safety
- Logic power can be 115/230 AC or 120-325 VDC.
  - When using AC or high voltage DC input then 24 VDC output is available to drive I/O
  - Maximum wire size AWG #12, stranded.
- Pluggable terminal blocks for all power connections, up to 15A.
- Main power single phase
- See Step C 2: Provide control power or Step C 3: Provide motor power – input for details (page 21).

Displays and Troubleshooting made simple

- A two digit status display shows current operation as well as fault indications at a glance

- 10 LEDs to provide detailed information
- Complete details can be found at Indicators (page 36)
- Troubleshooting support coordinated with MotionSet
  - MotionSet scope with built in advanced data-logging and triggering capabilities to monitor and optimize any system. For details see Scope - Advanced Troubleshooting (page 50)
  - Event log

Advanced Features

- Regenerative control standard on many models. They are provided with a small, internal resistor. A larger, external resistor can be added. See Regen: (page 42)
- Electronic Braking: for emergency stop situations (page 42).

System Definition and Start up Simplified

- MotionSet advanced commissioning tool (page 47).
- Project Definition Simplified with drag and drop and pull down lists (page 47).
- Real time monitoring tools to see what is going on.
- I/O status and forcing simplify machine start up (page 50).
- Real time capture of motion and machine parameters – 27 to choose from. Not just a few plots of the motion. Displayed in a scope view with triggering and analysis capabilities. Details at Scope - Advanced Troubleshooting (page 50).

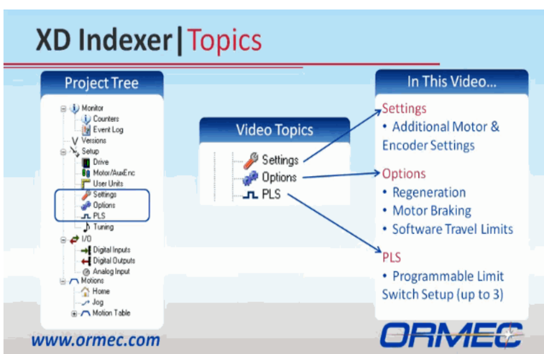
Overview and Training Videos

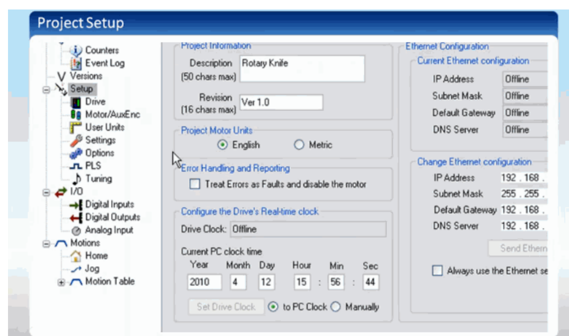
Video training modules are available that show the features and benefits of the drive. Below is a comprehensive list. Individual videos are referenced in the appropriate sections of the manual. The Indexer Video Library is also featured on the Ormec website. To view a video below, click on the text. (Internet connection required to view.)

General overview videos.

MotionSet Overview

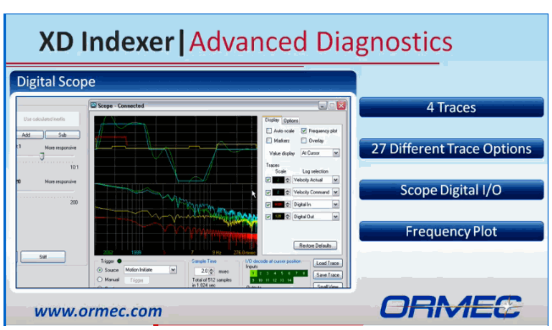
Specific training videos.

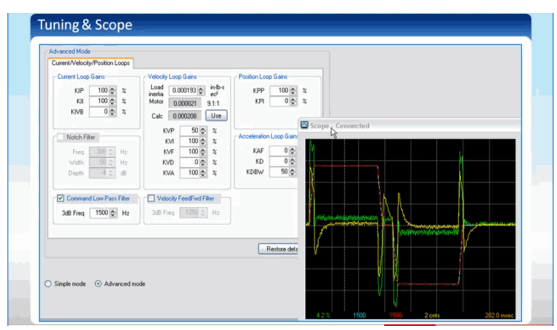




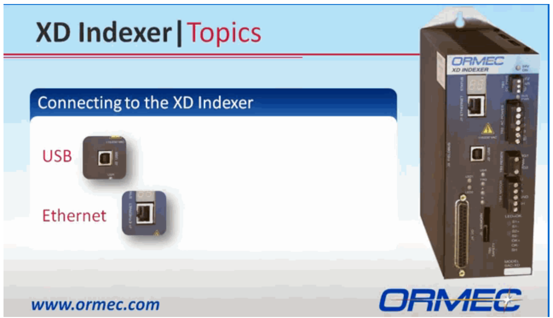
System Settings Hardware Setup

Specific MotionSet training videos.

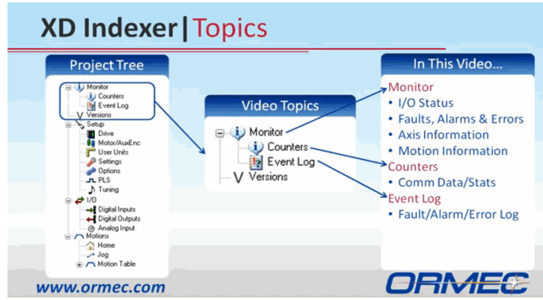




MotionSet Diagnostics Tuning and Digital Scope



Connecting via USB & Ethernet



Monitor, Counters and Event Log

Implementation Guidelines

This section includes basic guidelines for installation and use of SAC-RDE servodrives. Following these guidelines can significantly improve the performance of the complete system. While failure to follow these guidelines does not insure problems, poor practices lead to poor performance.

This checklist provides an overview, details follow.

- Attach safety grounds
- Mount to a grounded metal panel
- Separate motor and feedback cables
- Use shielded feedback and motor cables
- Use fuses or circuit breakers and line filters on inputs
- Keep the drive cool for extended life
- Use sufficient wire gauge for input power

Read the safety precautions

Be sure to read, understand and follow all of the precautions listed under “Safety Precautions”.

Read the manual

This installation manual contains detailed information for correctly connecting and using this equipment. Be sure to read and understand the equipment and features you use..

Grounding for return currents

This drive must be grounded using one of the safety ground connections, found on TB1 and TB2. It is also highly recommended that the drive be mounted on a grounded metal panel, with paint scrapped at the mounting points. Bolt threads alone are not a sufficient conductor.

Current from the drive to the motor will induce return currents into surrounding conductors and enclosures. Proper grounding controls the return path, improving operation.

Separate motor cables

Separate motor power cables and encoder feedback cables.

Motor power conductors (connected to terminal U, V and W) can contain high voltages and currents and radiate noise. Feedback cables are low voltage signals. Do not run them in the same wire channel. Separation by at least 6 inches is recommended.

Use shielded motor cables

Cables for motor power and encoder feedback should be shielded and the shields grounded.

Use of shielding significantly reduces the electrical emissions out of cables and coupling into cables. Shields must be grounded to be effective.

Fuses and line filters

Input power, both control and main power should be protected by fuses or circuit breakers.

Careful consideration should be given to the use of input filters on both control and main power supplies. These devices serve to protect the servodrive from external noise and also to limit the noise injected back onto the line.

Mount for cooling

The temperature ratings of the servodrive are for the ambient temperature at the drive. Typical enclosures trap heat and can have a higher internal temperature than the outside ambient. This may require cooling the enclosure or circulating or venting air inside the enclosure so that the drive ambient temperature remains within specifications.

Use sufficient wires

Use wiring which is of sufficient gauge, temperature and insulation rating. Temperature ratings of at least 80º C and insulation ratings at least double the input voltage are recommended.

Typical installations are in environments with elevated temperature. In addition, operation of controls which move large amounts of energy give off heat.

Switching characteristics and starting and stopping of motors will produce voltages which are higher than the line voltage. Additional insulation rating is required for protection.

Decoding Model Numbers

There are 7 models of SAC-RDE servodrives. They are a drop in replacement for a corresponding SAC-DE model and are configured for a specific motor.

Current Equipment		Replacement Servodrive
Servodrive	**Motor**	
SAC-DE01A2/I	MAC-DE003A2/I	SAC-RDE01A2-I
SAC-DE02A1/I	MAC-DE003A1/I	SAC-RDE02A1-I
SAC-DE02B2/I	MAC-DE006B2/I	SAC-RDE02B2-I
SAC-DE03B1/I	MAC-DE006B1/I	SAC-RDE03B1-I
SAC-DE03C2/I	MAC-DE011C2/I	SAC-RDE03C2-I
SAC-DE04C1/I	MAC-DE008C1/I	SAC-RDE04C1-I
SAC-DE04D2/I	MAC-DE021D2/I	SAC-RDE04D2-I

Quickstart

If using a SAC-RDE to replace an existing SAC-DE servodrive document SAC-RDE02 Installation Instructions provides detailed, step by step guidance to install the drive. It is recommended that you consult that document.

Connecting to the SAC-RDE

This section provides the information needed to connect the servodrive to your machine and application.

Step C 1: Mounting the SAC-RDE

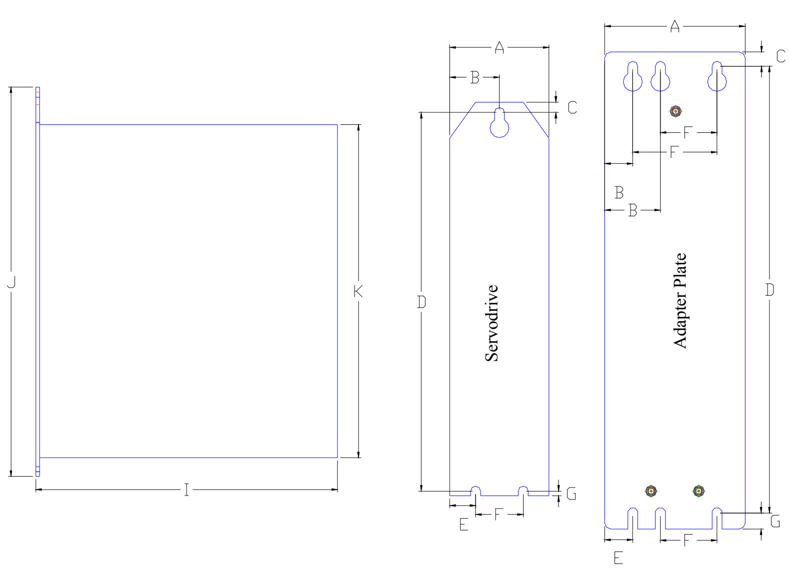
Location: The drive generates heat during operation. It must be mounted in a location and orientation to allow that heat to dissipate. The better the dissipation the longer the life of the unit. Heat is one of the major factors in the life expectancy of electronics.

The best location is on a metal panel, vertically with space around to allow airflow.

Protection: Protect from contamination and contact with other objects. Contaminates such as dirt, oil, corrosive gases, metal filings and other conductive materials must be avoided.

Size: All models are mounted using 3 or 4 #10-32 machine screws.

Additional details can be found in mounting drawings on the ORMEC website, http://www.ormec.com/Products/Drives/XDSeriesIndexerServoDrive.aspx



	Model			
	With adapter plate		Without adapter plate	
Dimen -sion	RDE01 RDE02 RDE03	RDE04	RDE01 RDE02 RDE03	RDE04
A	3.05		3.05	
B	.59 or 1.17		1.49	
C	.3		.22	
D	9.42		7.985	
E	.59		.97	
F	1.19 or 1.77		1.0	
G	0.34		0.1	
I	6.56		6.46	
J	10.1		8.3	
K	7.2			
All dimensions inches and nominal values.				

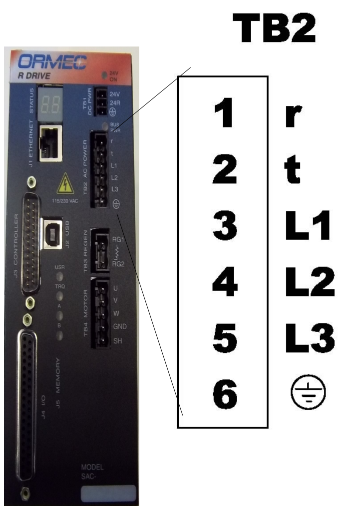
Table 1: Physical Dimensions

Step C 2: Provide control power

AC control power

Applies to version: This section applies to all models.

Connections: Supply AC power to run the SAC-RDE control circuitry on connector TB2. With AC input 24 VDC is output on TB1 and is available for machine I/O. This is limited to non-inductive loads. It should not be used on inductive loads, such as solenoids or motor brakes.



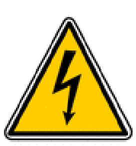
For models SAC-RDExx					
TB1 – DC power			TB2 – AC power		
Pin	Signal	Typical	Pin	Signal	Typical
1 24V	24 VDC **output**	24 VDC, 1.0 A	1	r	85 – 264 VAC input 0.8 A – 0.4 A Note: 264 VAC is maximum control power input.
2 24R	return		2	t	
3	FG	Not used	3-5	See Step C 3: Provide motor power – input for definition	
			6	FG	Required safety connection
Maximum wire size solid AWG #14, stranded AWG #12					

Table 2: Control Power - AC Input power, SAC-RDE

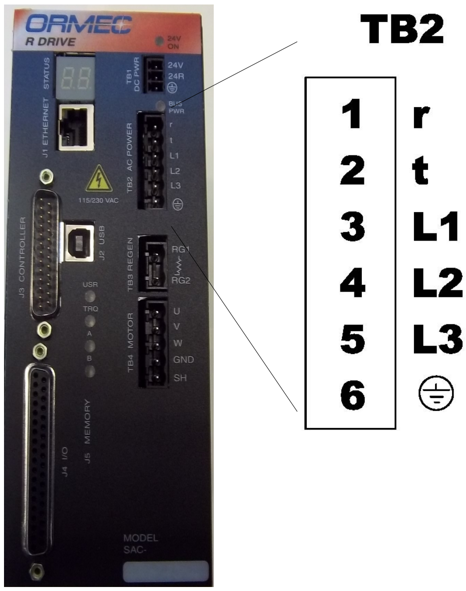
Step C 3: Provide motor power – input

Applies to version: This section applies to all SAC-RDE.

Connections: Supply AC power to run the motor on connector TB2. All models use single phase power, however, you may connect 3-phase input. The 3rd phase will be ignored.



Warning: The voltage applied must not exceed the voltage rating of the motor. Doing so will endanger personnel and personal safety and cause premature failure of the motor.



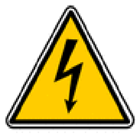
Models SAC-RDExx		
TB2 – AC input power		
Pin	Signal	Typical
1-2	See Step C 2: Provide control power for definition	
3	L1	***Warning***: Do not exceed motor voltage rating. Rating: 120 VAC or 230 VAC 3A to 12 A capable depending on motor and application
4	L2	
5	L3	
6	FG	Required safety connection
Maximum wire size solid AWG #14, stranded AWG #12		

Table 3: Motor input power connections

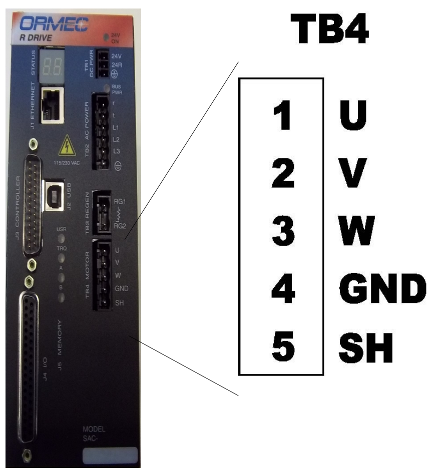
Step C 4: Connect motor power – output

Applies to version: This section applies to all models of SAC-RDE.

Connections: Connect motor power to motor on terminal block TB4. Using ORMEC motors and motor cables simplifies connections and insures color code is as defined. Select a wire gauge sufficient to meet the current requirements of the motor.



Warning: Dangerous voltages are present on this terminal block. Qualified personnel only.



Models SAC-RDExx			
TB4 – Motor power			
Pin	Signal	Typical	Comment
1	U	RED - Motor phase U	***Warning***: High voltage present. Can be present even when disabled.
2	V	WHITE – Motor phase V	
3	W	BLACK – Motor phase W	
4	GND	GRN – Ground from motor	
5	SH	SHIELD – connect cable shield. ***Warning***: dangerous induced voltages can be present on ungrounded shields.	
Maximum wire size solid AWG #14, stranded AWG #12			

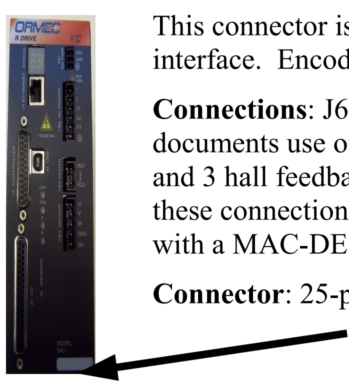
Table 4: Motor Power Connections SAC-RDExx

Step C 5: Connect motor feedback

Quadrature Encoders

Applies to version: This section applies to all SAC-RDE models.

Compatibility: This connector is not the same as the SAC-DE drives. An adapter cable is available to convert from a SAC-DE feedback cable to the SAC-RDE connector. Part number CBL-XRDEMAC. In addition a complete feedback cable, from the motor to the drive is available. Part number CBL-RDEMAC/xx.



This connector is fully compatible with ORMEC's SW, SM and SD drives' quadrature encoder interface. Encoder cables used in those systems can be attached to the drive.

Connections: J6 This connection supplies the feedback device for the motor axis. This section documents use of a quadrature encoder – providing 2 position signals, 90 degrees out of phase and 3 hall feedback signals and one reference mark. Using ORMEC encoder cables simplifies these connections. Note that the hall feedback signals are defined in the connector but not used with a MAC-DE motor.

Connector: 25-pin female D-Sub on drive. Mate (on cable) is a 25-pin male D-Sub.

J6 – Motor feedback Quadrature Encoder			
Pin	Signal	Typical	Comments
1	ENCA	RS485 diff. pair	A quad B input. A leads B for CCW rotation
2	ENCA'		
3	ENCB	RS485 diff. pair	
4	ENCB'		
5	ENCZ	RS485 diff. pair	Encoder Reference - Once / rev pulse
6	ENCZ'		
7	ENCU	RS485 diff. pair	Hall input U- Phase matches motor U-V phase
8	ENCU'		
9	ENCV	RS485 diff. pair	Hall input V - Phase matches motor V-W phase
10	ENCV'		
11	ENCW	RS485 diff. pair	Hall input W - Phase matches motor W-U phase
12	ENCW'		
13	Enc Pwr 3 pins	5.25 VDC 400 mA max	
24			
25			
16	Gnd 3 pins		
17			
18			
19	Overtem p	Contact closure – conduct current from Overtemp to Gnd. 12V signal.	
20	Gnd		

Table 5: Quadrature Encoder Connections

Step C 6: Enable the SAC-RDE

In order to execute any defined motion, or to energize the motor outputs the drive must be enabled. There are two ways to enable the drive, hardware enable or software enable.

Warning*: Correct configuration settings are required in the drive before enabling. If you have not already set those values go to section* *Defining Projects* *first, then return here before proceeding.*

Warning*: Disconnect the motor from the load before proceeding. Mount the motor firmly to a structure to prevent injury. Initial testing of any servodrive should be done with the load disconnected from the motor to prevent damage to the motor or mechanical system.*

Hardware enable

When the drive is running without the MotionSet User Interface connected then IN1 must be conducting current to enable the drive. If no current is flowing in IN1 then the drive will not be enabled and will not run motions. IN1 is available on the controller connector, J3, and also available on the I/O connector J4. The same internal signal is connected in parallel to each connector. Normally the J3 controller interface connector is used.

To configure IN1 for use with a sinking current device (e.g. switch or NPN output) connect the positive side of your I/O power supply (e.g. 24v) to pin 14 of J3 or to pin 5 of J4. Connect the high side of your enable switch or device to pin 16 of connector J3 or to pin 1 of connector J4. Connect the other side of your enable switch to ground of your I/O power supply.

To configure IN1 for use with a sourcing current device (e.g. switch or PNP output) connect the negative side of your I/O power supply (e.g. ground) to pin 14 of J3 to pin 5 of J4. Connect the high side of your enable switch or device to the positive side of your I/O power supply (e.g. 24v). Connect the other side of your enable switch to pin 16 of connector J3 or to pin 1 of connector J4.

MotionSet - Software enable

When the MotionSet User interface is connected to the SAC-RDE then the hardware enable on IN1 can be overridden. Open the I/O exerciser by clicking on the  ICON.

Once open the left column of indicators can control the inputs. By default the hardware remains in control of the input, which is the safest mode of operation. The hardware input can be overridden by the I/O exerciser. This can be selected on a point by point basis. A check box to the left of each input selects and indicates which are overridden. At the top of the column is a quick select to override all inputs.

Using the mouse to control I/O points:

> Left mouse button – momentary enable – while you press and hold the I/O point is forced on. When you let go it goes off.
>
> Right mouse button– latches I/O point on. Stays on until you click on it again (left or right click).

To Enable the drive for motion use IN1 – Enable. Enable is fixed to IN1 and is the only fixed I/O point. Right mouse click on IN1 to latch the drive enabled.

Step C 7: Connecting the controller interface

Applies to version: This section applies to all SAC-RDE. All normal signals used in a controller interface are available on one connector, J3.

Connector: 25-pin male D-Sub on SAC-RDE. Mate (on cable) is a 25-pin female D-Sub.

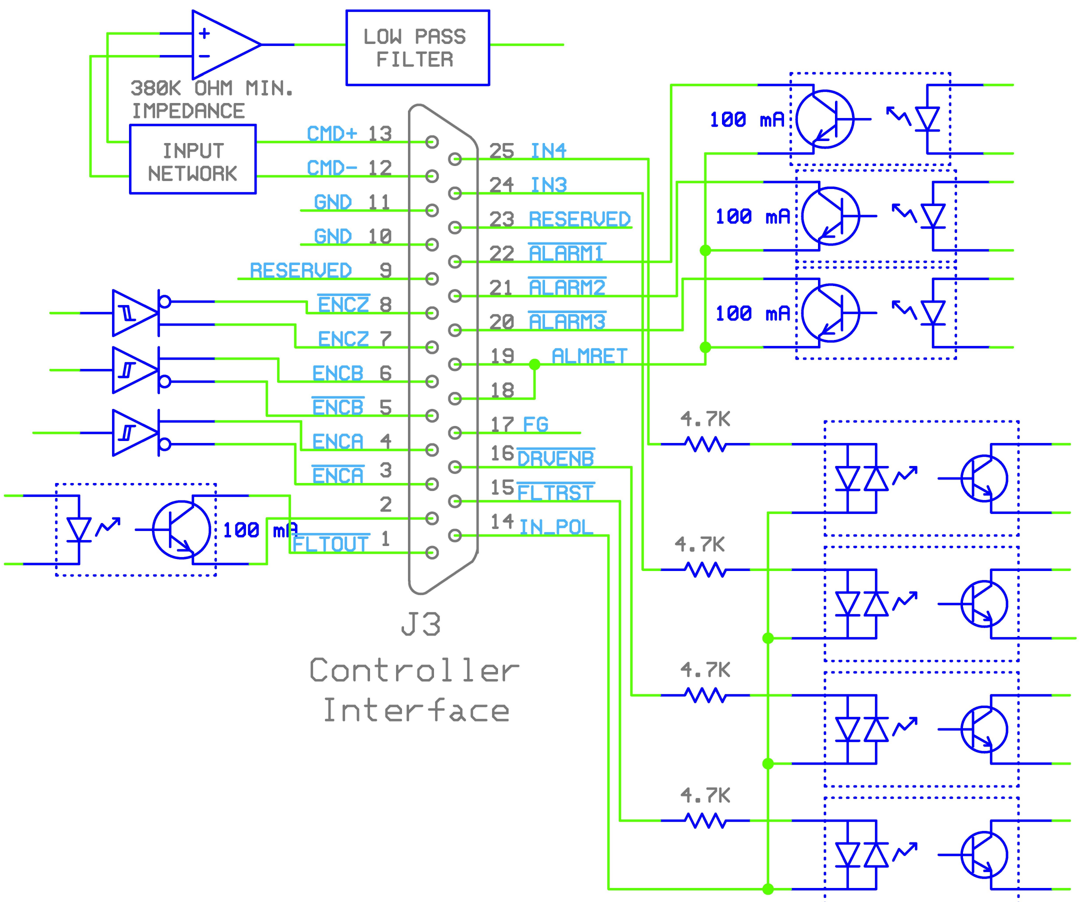
Connections: Controller interface connections are provided at connector J3.

Function:

J3 – RDE Controller Interface			
Pin	Signal	Typical	Comments
4	ENCA	RS485 diff. pair	A quad B output. A leads B for CCW rotation
3	ENCA'		
6	ENCB	RS485 diff. pair	
5	ENCB'		
7	ENCZ	RS485 diff. pair	Encoder Reference - Once / rev pulse
8	ENCZ'		
13	CMD+	Diff. Analog Input	+/- 10v Command input.
12	CMD-		
10	GND	GND	Used for digital and analog ground. Must have a gnd connection between controller and drive.
11	GND		
16	DrvEnb'	Sinking, optocoupler	Drive Enable' and Fault Reset' are active low, optically-coupled inputs
15	FltRst'		
14	In Polarity	+12v or +24v	Normally +12, sets the polarity of DrvEnb' and FltRst' to active low
1	FltOut'		When fault active sinks current to pin 2, optically-coupled
22	Alarm1'		Alarm codes. Active low, sinking to pin 19
21	Alarm2'		
20	Alarm3'		
2	FltOut' return	FltOut' and Alarmx' sink current to these pins. Normally connected to ground of interface power supply.	
19	Alarm' return		
17	FG		

J3 – RDE Controller Interface		
18	OUT3E	Connected to pin 19 internally.
24	IN3	Paralleled connections from J4. Not used.
25	IN4	
9		Reserved. Do not connect.
23		

J3 Controller Interface



Step C 8: Connecting I/O points

Inputs:

The standard inputs are configured in a group of 4. Each group can be hardware configured to interface to sinking or sourcing type inputs. Configuration is accomplished by wiring, no software settings are required.

The inputs operate by conducting current. When input current is 0 the input is off. When input current is above the minimum the input is on. When the software is configured for edge operation a “rising” edge is the transition from Off to On. That is from no current to current on. It does not matter whether the input is configured for sinking or sourcing.

Sinking current devices:

For sinking devices the drive group polarity pin is connected to the positive side of the power supply. The drive input pin is connected to the high side of the input device. The low side is connected to the negative side of the power supply. See Figure 1: Sinking current style input example using switch or NPN device to the right for an example.

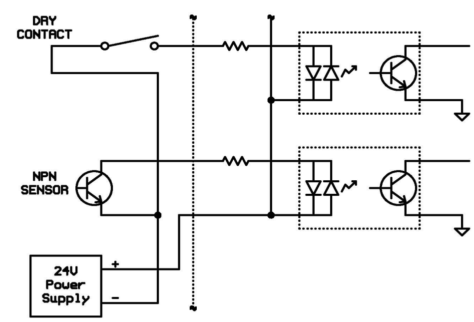


Figure 1: Sinking current style input example using switch or NPN device

Sourcing current devices:

For sourcing devices the drive group polarity pin is connected to the negative side of the power supply. The drive input pin is connected to the low side of the input device. The high side is connected to the positive side of the power supply. See Figure 2: Sourcing current style input example using switch or PNP device to the right for an example

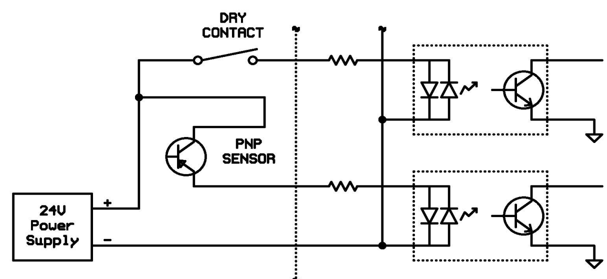


Figure 2: Sourcing current style input example using switch or PNP device

Outputs:

The SAC-RDE comes standard with 8 optically coupled outputs. Six are capable of switching 100 mA (Out 1 – 6) and two are capable of switching 1000 mA (Out 7 and 8).

Outputs 1 – 4 are configured as sinking current outputs and assigned functions, Drive Fault', Alarm1', Alarm2' and Alarm3'.

Outputs 7 and 8 are high current outputs, providing only the collector so are only capable of sinking current. In order to use them the I/O power supply must be connected to OUT PWR pin and the OUT COM pin. Outputs 7 and 8 are capable of sinking up to 1000 mA (1A) of current. These outputs can be used to directly control many 24 VDC brakes on motors and are configured as Brake outputs on the SAC-RDE..

OUT 1-4 outputs

Both the collector and emitter of the output transistor are provided. Examples to the right show use of the outputs with devices requiring a current sinking type output and also a current sourcing type output.

The drive outputs do not have any internal current limiting or protection. Current limiting is the responsibility of the external device. The impedance must be sufficient to limit the current to under 100 mA. If not an additional resistor is required. Failure to do so will cause premature failure of the outputs.

All of these outputs are intended for non-inductive loads.

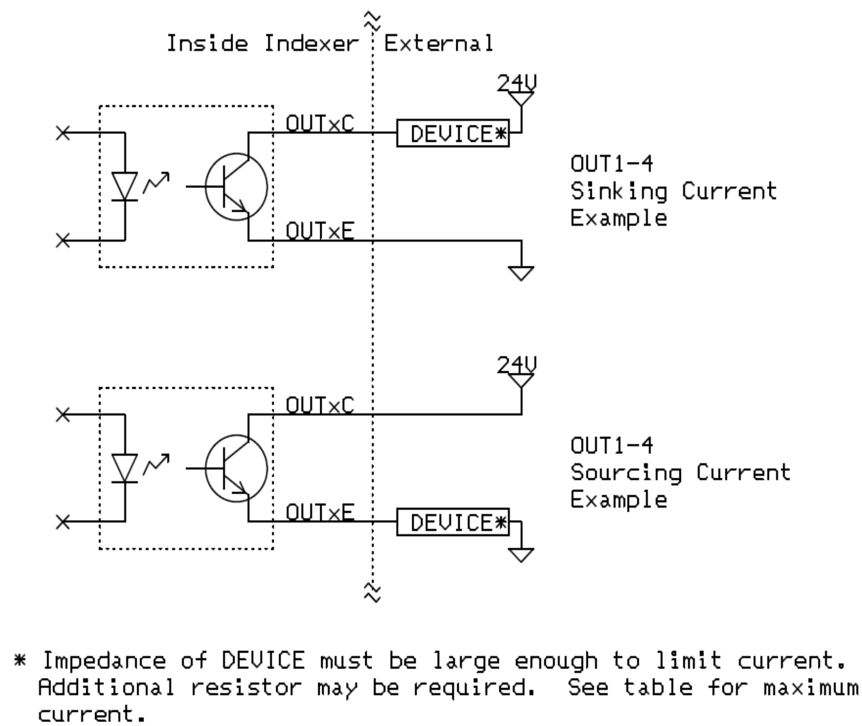


Figure 3: OUT1 - OUT4 circuitry example

OUT 5-8 outputs

Only the collector of the output transistor is provided. Examples to the right show their use.

OUT5 and OUT6 sink current only, sinking to pin OUT COM. They are intended for non-inductive loads.

OUT COM must be connected to the return of the power supply.

OUT7 and OUT8 also sink current only, sinking to pin OUT COM. However, because of the high current device used OUT PWR must be connected to +24VDC for these devices to work. These two outputs have a built in flyback diode allowing them to be used with inductive loads. (The flyback diode requires that OUT PWR be connected.)

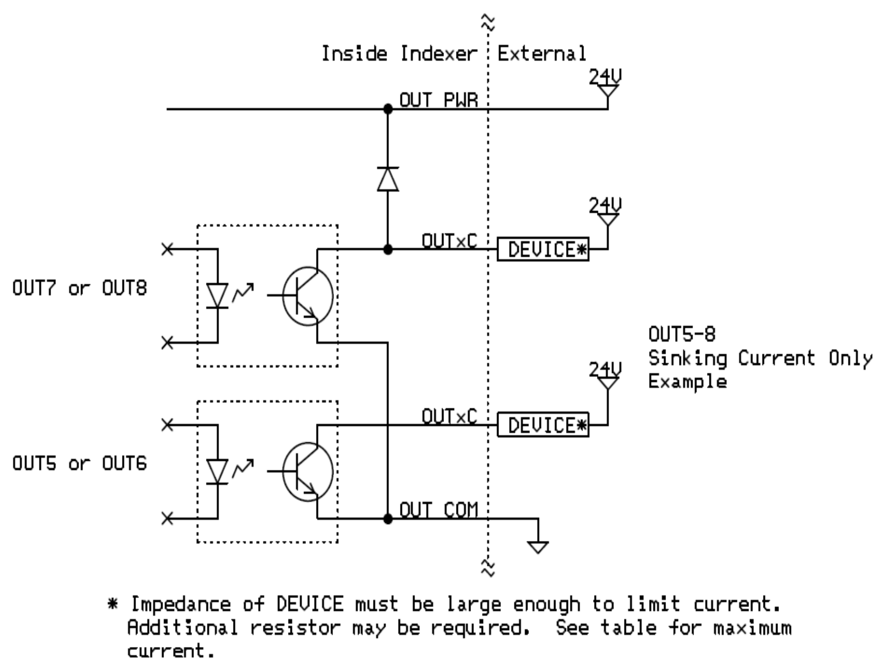
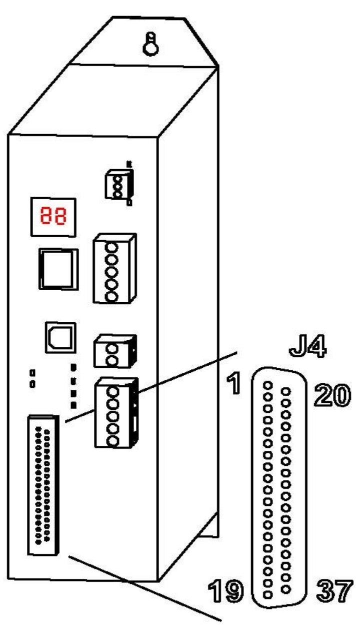


Figure 4: OUT5 - OUT8 circuitry example

The impedance of the DEVICE must be sufficient to limit the current, to 100 mA on OUT 5 and OUT6 and 1000 mA on OUT7 and OUT8. If the impedance is not sufficient then an additional current limiting resistor is required.



J4 – I/O Output Connections			
Pin	Signal	Typical	Comments
11	OUT 5C	24 VDC 100 mA max, sinking only	Outputs 5-8 are open collector outputs, providing collector only. OUT-COM must be connected to provide return.
12	OUT 6C		
14	OUT 7C	24 VDC 1000 mA max, sinking only	
16	OUT 8C		
17	OUT PWR	24 VDC input. Used with OUT 7 and 8.	Only required if OUT7 or 8 is used.
13	OUT COM	Return current path for OUTs 5-8.	Required for OUTPUTs 5-8.
15	Reserved	Do not connect	

Table 6: I/O Output Connections

Defining Projects

Step D 1: Open commissioning tool – MotionSet

ORMEC provides a fully integrated commissioning tool, called MotionSet.

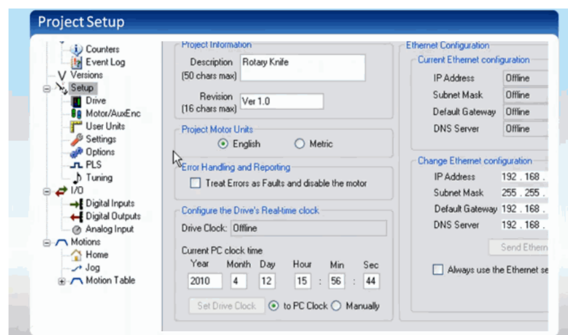
With MotionSet you:

1) define which motor is attached to the drive,
2) send (download) those definitions to the drive,
3) monitor activity on the drive,

MotionSet is a software GUI (Graphical User Interface) which must be installed on your computer to use it. With it you will be able to define projects and communicate with the drive. The software is found on the ORMEC website at http://www.ormec.com/Products/Software/MotionSet.aspx. If you haven't already installed MotionSet please do so at this time.

First – start MotionSet: Find the ICON on your desktop and double click to start. (Or find it in the ORMEC Systems Corp program group.

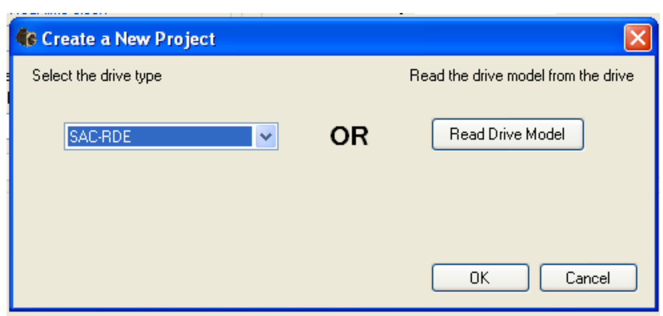
Below is a written, step by step guide to configuring your system. A video of this process is also available at Project Setup.



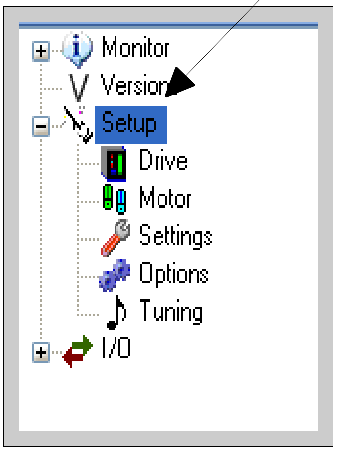
Step D 2: Start your project

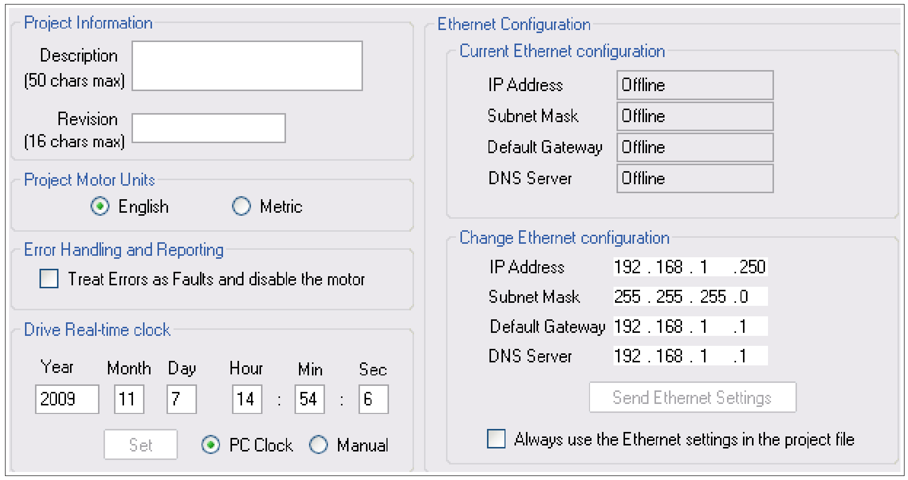
In most cases there is no need to configure the drive. It comes factory set for a motor and is ready to go. However, if you prefer to make changes or view the settings you will need to open a project definition.

Once in MotionSet begin a new project by selecting menu File and New. A Create a New Project box should open. (See figure.) Select drive type SAC-RDE and then OK.



Then expand Setup (click on +). Once open you will need to work down the list, selecting and defining as you go. The project screen will allow you to enter a description and revision to identify the





project, select units and change the Ethernet address if necessary.

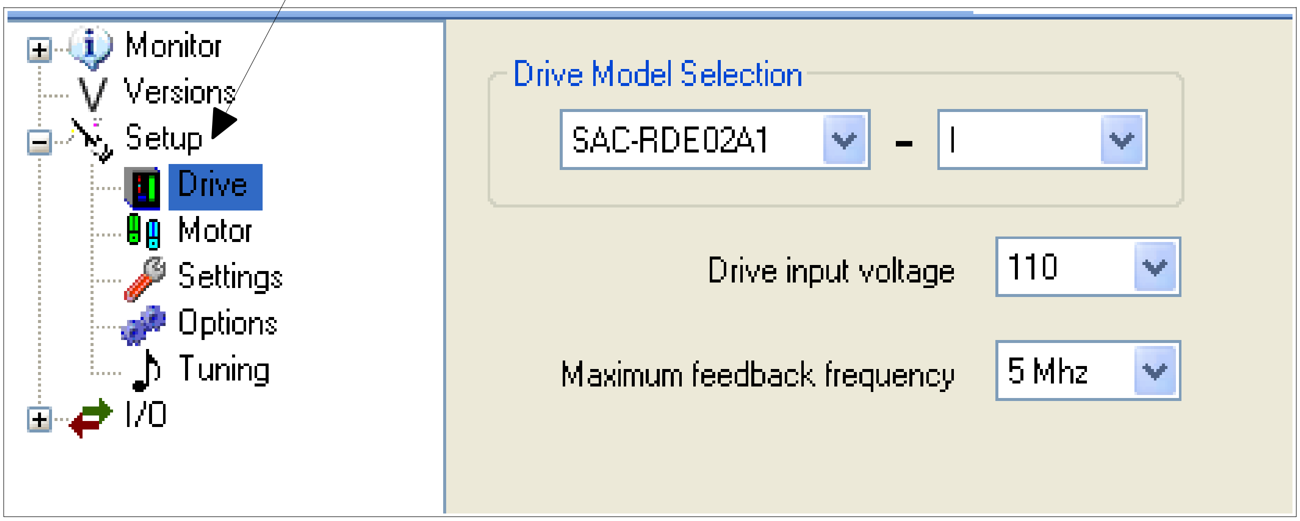
Once open review each item on the right, changing those which are not correct.

Entry	Meaning / Comment
Description	A saved description to aid in keeping track of projects. This item is recommended, but not required.
Revision	Support to aid in tracking revisions and variations. This item is recommended, but not required.
Error Handling and Reporting	Faults are defined as conditions which prevent operation of the drive. Faults are situations or failures which may result in equipment or personnel damage. Because of the safety nature all Faults cause the drive to disable the motor. Error are conditions which are not correct but which are less severe than a Fault. Errors will likely cause an error in the application motion but are not a safety risk. By default errors are reported but do not disable the drive. Checking the box will cause Errors to be handled the same as Faults, that is disabling the drive when they happen.
Drive Real Time Clock	The drive has a built in real time clock. It is used to time stamp entries in the event log and for general information. This box controls the time source for setting the clock on the drive. **Note**, the drive has a built in short term clock backup power. When turned off the Real Time Clock will remain accurate for about 24 hours. After that it will need to be reset if an accurate date and time is desired.

Table 7: Project Setup Item explanation

Step D 3: Select your drive

Under SETUP select Drive. This will allow you to configure for the correct drive. .



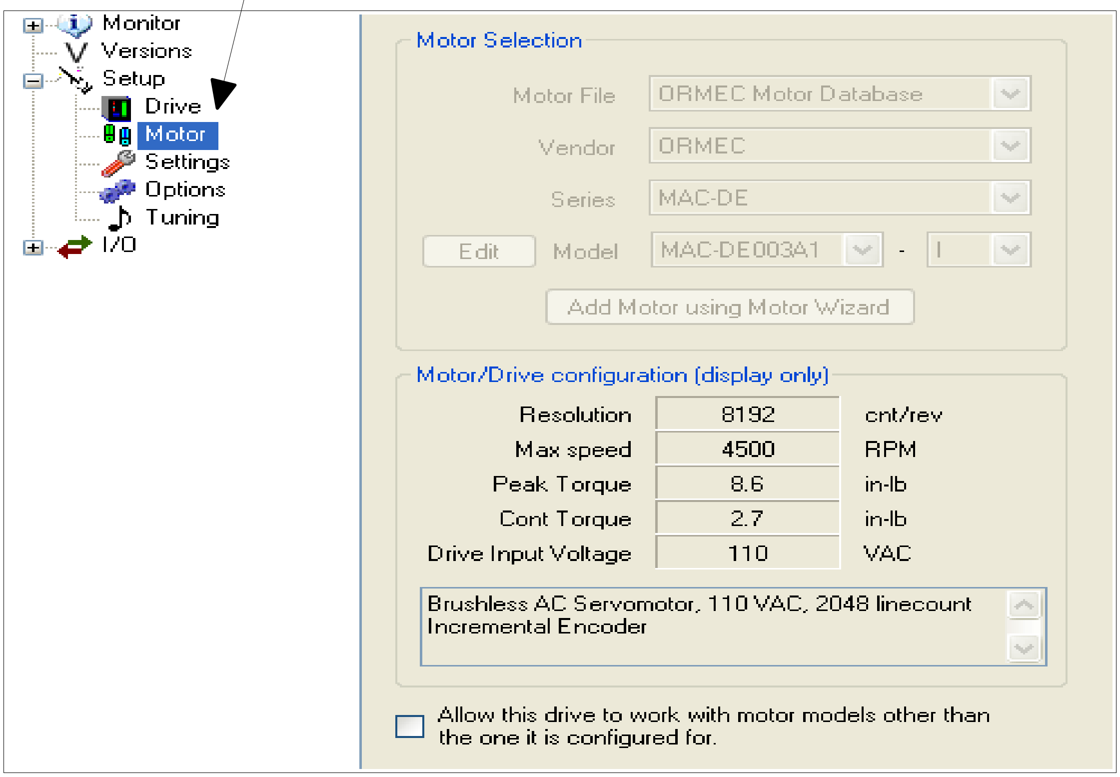
Once open review each item on the right, changing those which are not correct.

Entry	Meaning / Comment
Drive Model Selection	The model number identifies the drive current rating and installed auxiliary feedback options installed. You'll notice that you can't select a model number to match all the options you have. That's fine. MotionSet does not need to know about all the options. Those not needed are not shown. Note: If you were already connected to your SAC-RDE drive the drive selection would be automatically filled to match.
Drive input voltage	Set this to match your actual connection. If this settings differs from the actual voltage then motor tuning will be incorrect.
Maximum feedback frequency	Applies to quadrature encoders. Calculate your maximum feedback speed and select the next higher value. Feedback frequency = (encoder resolution) * (maximum RPM) / 60. Example: (8000 cnts/rev) * (5000 RPM) / (60 sec/min) = 666,666 Hz. The next higher value is 5 MHz.

Table 8: Setup Drive Item explanation

Step D 4: Select your motor

Under SETUP select Motor. This will allow you to select and configure for the correct motor. This is only needed if you are changing from the default motor. In order to select a different motor you must check the box at the bottom of the screen – Allow this drive to work with other motor models.



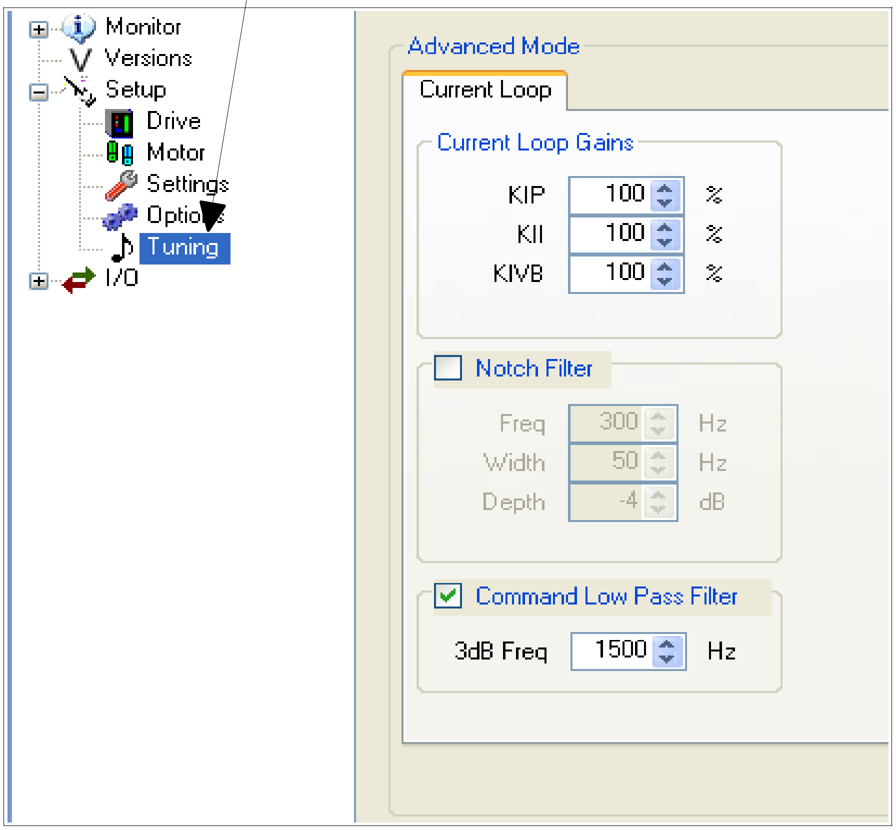
Once open review each item on the right, changing those which are not correct.

Entry	Meaning / Comment
Motor File	Choose between 2 databases of motors. The "ORMEC Motor Database" contains definitions for all standard ORMEC motors. The "Custom Motor Database" allows you to define and save your motor definitions for use in other projects.
Series	An organization tool to place a line of motor or similar motors together. In the ORMEC database we group by motor lines. In your custom database you can choose your preferred organization.
Motor/Drive configuration	This table of information in the middle of the screen cannot be changed. It is a display of information about the motor which you can use to make sure you selected the motor you wanted. The information comes from the motor and drive selections and cannot be changed here. Changes are made in the motor selection or drive selections on the previous step.

Table 9: Setup Motor Item explanations

Step D 6: Set motor tuning

Under SETUP select Tuning. This will allow you to select and adjust motor current loop performance.



"Tuning" is the adjustment of the control loops to achieve the desired control response. Feedback control is the process of measuring a desired output, comparing it to the commanded input and then making changes to correct for errors. Changing too slowly produces sluggish results. Changing too quickly or too aggressively results in overshoot and ringing and in extreme cases unstable performance.

A typical system works to control the load to a specific position. To accomplish that there generally are 3 nested control loops – torque, velocity and position. The torque loop (often referred to as current loop) is configured in the drive. It is how well and fast the drive responds to torque commands. As seen in the screen above you can make some adjustments, though generally they are not needed.

The remaining two loops, velocity and position are in the controller and not in the drive. To adjust them consult the manuals and procedures for the specific controller.

Indicators

Aka Displays and Lights

The drive has built in up to 15 indicators to assist in monitoring operation and getting started. The following table describes these indicators.

Label Name and Meaning	**Color**	**Meaning**	
24V On	Yellow	Indicates that 24v power is present. In DC input drives 24vdc comes from external connector. In AC input version 24v DC indicates that power is present. Not provided on XD4xx indexers.	
Bus Power	Yellow	Indicates that bus (motor power) is powered. Brightness proportional to voltage. Bus takes time to discharge after removing AC power.	
A and B Motor feedback	Yellow and Green	Indicates activity on motor feedback device.	
		Quadrature encoder: Lights reflect state of A and B feedback signals. As the motor moves LEDs will flicker. At higher speeds they will appear to be on continuously.	
TRQ Torque command	Green/Yellow	This LED indicates torque command to motor. Green for forward torque, Yellow for reverse torque. Brightness varies with torque level.	
LED1 and LED2 Configurable	Red/Green and Red/Yellow	When no Fieldbus option is installed these LEDs are available for general use. Use MotionSet to configure functionality.	
LED1 and LED2 Fieldbus activity	Red/Green and Red/Yellow	When a Fieldbus option is installed these LEDs indicates activity on fieldbus interface. Specific display varies by type of fieldbus.	
7-segment display			

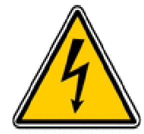
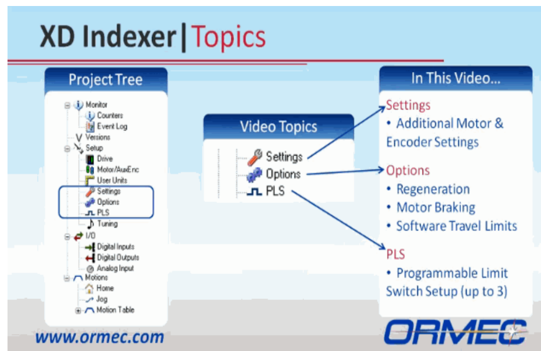
Left decimal point		Indicates drive alive. Flashes at slow rate when drive is powered and running and MotionSet is not connected. Flashes at a faster rate when MotionSet is connected.	
Right decimal point		When lit indicates drive is enabled ~ power block energized and controlling current to motor. ***Warning: when lit the motor may move at any time.*** 	
2 numeric digits		Varies by operation of the drive. J displayed when jogging. Number – indicates that a defined motion is running. Specific value matches the motion executing. When motions are chained the display will change as each motion is entered.	

Table 10: Lights and Indicators

Feature Details

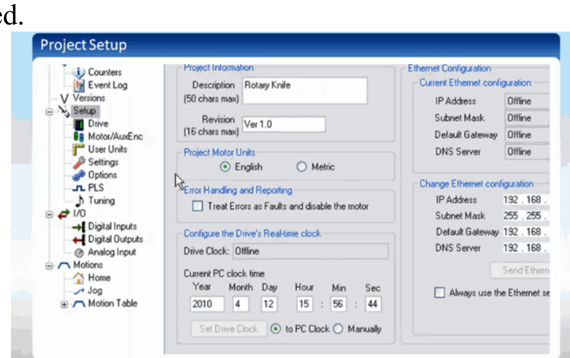
This chapter provides documentation on most of the remaining features found in the drive. Additional documentation can be found in the on line help with MotionSet and in many cases an explanation can be found in one of ORMEC's training videos. Links to those videos are provided in the graphics to the right or in the text below.

The video System Setup covers the following topics at about the time position indicated, for quick viewing and links to the written documentation on a topic are provided.



Motor Settings (0:30)
Enable Timing (3:25), written at Enable Timing:
Overtemp control (3:40)
Regen control (4:00), written at Regen:
Brake control (4:25), written at Brake output and control:
Electronic Brake (4:50), written at Electronic Braking:

The video Hardware Setup covers the following topics at about the time position indicated, for quick viewing and links to the written documentation on a topic are provided.



Project Setup (0:35), written at Step D 2: Start your project
Drive Selection (1:35), written at Step D 3: Select your drive
Motor Selection (2:50), written at Step D 4: Select your motor

Mating Connectors:

Model	Location	Style	Mating Connector
All models	TB1	Term Block, 3.81mm 3 position	PCD, ELVT03600 Phoenix, 1826982
	TB2	Term Block, 5.0mm 6 position	PCD, ELFT06160 Phoenix, 1792566
	TB3	Term Block, 7.62mm 2 position	PCD, ELFT02460 Phoenix, 1832413
	TB4	Term Block, 5.0mm 5 position	PCD, ELFT05160 Phoenix, 1792553
	J3	25-pin D-Sub, female	
	J4	37-pin D-Sub, male	
	J6	25-pin D-Sub, male	
	J7	15-pin D-Sub, male	

Table 11: Mating Connectors

Project Storage:

SAC-RDE execution is defined in the project which is loaded in the drive. The project is loaded using MotionSet, the drive commissioning and configuration tool. Once loaded there are two methods of storage. The active, running project is stored in local RAM. This memory has a super capacitor power reserve so that the memory is retained for approximately 20 hours after drive power is removed. Additionally the drive has on-board EEPROM for long term storage of the project.

Power Up Project Loading

When the SAC-RDE is turned on the local RAM is checked to determine if there is a valid project loaded. If so the project is made active.

If the local RAM does not contain a project then the project saved in the EEPROM memory is loaded into RAM. That project is the last project explicitly saved.

EEPROM Storage

The SAC-RDE has on-board EEPROM storage for a project. The project stored in this memory is completely controlled by you using MotionSet. When you connect to the drive with MotionSet and send a project it is stored in the RAM local memory. It is not automatically stored in the EEPROM. To store it in EEPROM requires execution of the command, Online | Store Nonvol. Doing so will overwrite the project in EEPROM with the current project in RAM.

The project in EEPROM can be explicitly loaded if desired by using the Online | Restore Nonvol menu command in MotionSet.

Note that the EEPROM has a limited guaranteed number of times it can be written, which is 10,000. Therefore you may not want to store nonvol every time you send a project to the drive.

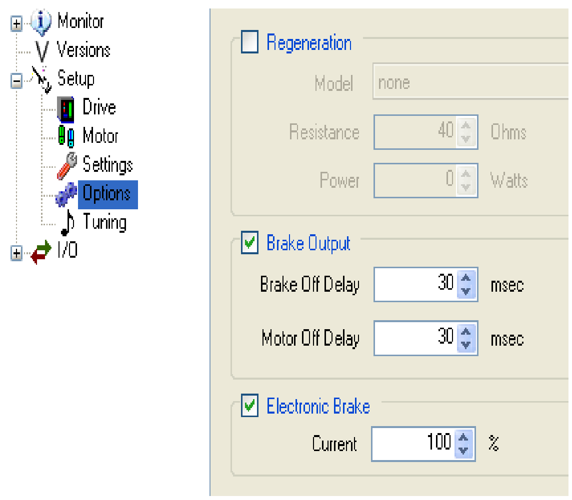
Enable Timing:

Brake output and control:

The drive has built in hardware and software support for motor brakes. The two keys to brake control are circuitry capable of driving the needed current and the software to automatically time the brake control relative to the enable signal.

The drive has high current drivers on Out 7 and Out 8. These outputs are designed to support most 24 VDC motor brakes. They can sink up to 1 A of current and work with 24 VDC supplies. A built in flyback diode is included to damp the inductive kick which can occur when the current is stopped. If this circuitry is not sufficient then an external relay can be used to control the brake. The drive output would then control the relay with the relay controlling the brake. When using an external relay any output can be configured as the brake control output.

For a brake to work well in a vertical application you need to take into consideration the delays between the drive enable signal and the motor holding position as well as the delay in the brake closing or opening after it is commanded.



For example, when the brake is closed and the drive disabled the brake is holding the load in position. The enable signal is applied to the drive from a switch or PLC. It will take time, possible 100's of msec., for the drive to see the input, turn on the power block and have current established in the motor. If the brake were to be controlled by the same signal from the switch or PLC it might let go in less time. If that happened the load could fall. The ideal control method is to use the same signal to enable the drive and then release the brake with a time delay. This can be accomplished in the drive by setting the "Brake Off Delay". Disabling the motor is done in reverse order. When the switch or PLC disables the drive the brake must be engaged first or the load will fall. This is accomplished in the drive by setting the "Motor Off Delay". Both settings can be found in MotionSet on the Setup | Options page.

Refer to the Enable and Brake Timing diagram:

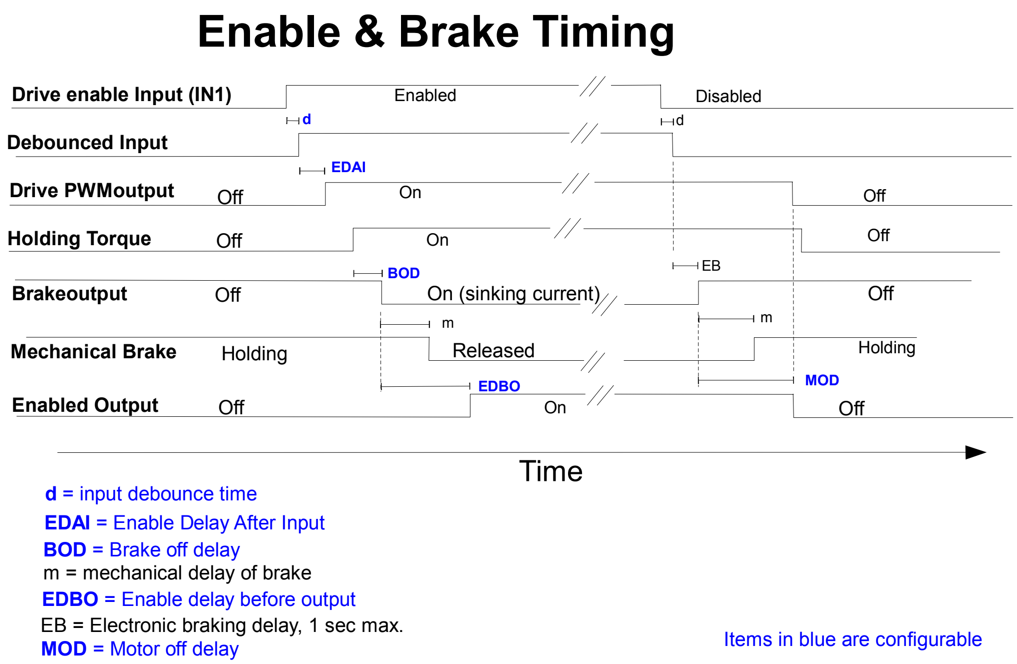


Figure 5: Enable & Brake Timing

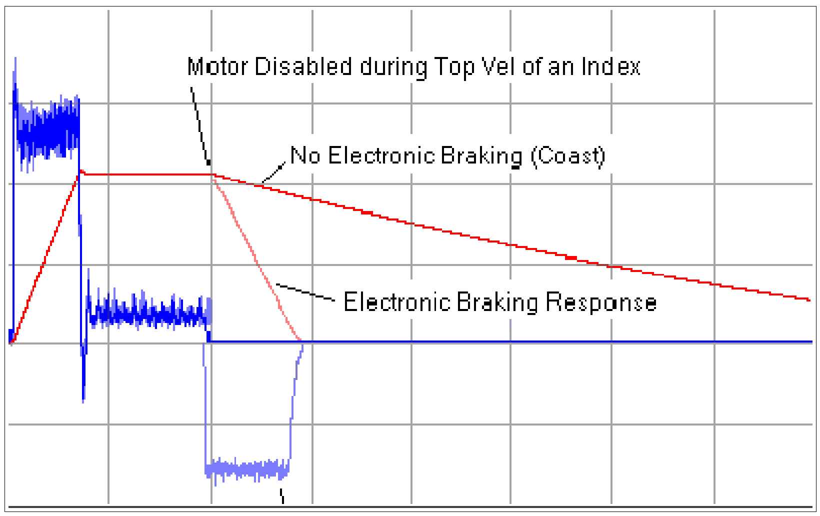
the sequence of events and recommendations:

- **d** - the hardware enable signal is debounced, delaying recognition. The debounce time is configured on the I/O Digital Inputs screen and defaults to 5 msec.
- **EDAI** – Enable Delay After Input delays the drive from applying torque. It is primarily used when the same or similar signals close a contactor for motor power (L1, L2 and L3 inputs) and the enable input. If the motor bus power is not high enough when the drive enables a low bus voltage error will result. This delay supports slow contactor closures or other delays in the system.
- Within milliseconds of drive outputs beginning the motor torque will be applied.
- **BOD** – Brake Off Delay will delay the changing of the brake output to open the brake. This can be used to adjust the brake timing to external devices.
- m – the brake is a mechanical device and will take some time to open, releasing the motor. This time is dependent on the specific brake.
- **EDBO** – Enable Delay Before Output allows adjustment of the output drive enable signal. This signal is often used as a response signal to the PLC or controller to know that the drive is ready to move, that is that motion commands can begin. When using a brake this delay should be set longer than the mechanical delay in the brake.

Electronic Braking:

Electronic Brake is a feature that provides the means to stop the coasting motion that otherwise occurs whenever a drive is suddenly disabled while the motor and load are running along at some velocity. Braking is accomplished by applying an opposing current to the motor which interacts with the motor magnetics to slow motion. It is an uncontrolled deceleration rate which is dependent on the current applied and inertial load on the motor. MotionSet is used to set the current used for electronic braking.

An SAC-RDE defaults to have Electronic Brake enabled and at 100%, which matches the SAC-DE equivalent. This can be changed if desired using MotionSet, on the Setup – Options entry in the tree.



The Tuning Display shown illustrates the effects of electronic braking. During a relatively high speed index motion the motor is suddenly disabled.

- With electronic braking disabled, the drive ceases to produce any current and the motor and load coast from running velocity to an eventual stop.
- With electronic braking enabled, the drive produces an opposing constant current to 'brake' the motor and load. The applied opposing current begins to decay (proportional to speed) once the motor and load slow to 10% of the axis maximum speed setting. Electronic braking therefore prevents coasting on a disabled motor axis.

Regen:

SAC-RDE models RDE03B1-I, RDE03C2-I, RDE04C1-I, RDE04D2-I have built in regen resistors. If a larger resistor needs to be installed externally contact Ormec for instructions on disconnecting the internal resistor.

During active deceleration of a motor and load, kinetic energy in the form of induced voltage & current flows from the motor/load back to the drive. This energy is stored by the DC bus capacitors on the drive, thereby raising its internal bus voltage. If excessive energy is fed back to the drive, the bus voltage rise may trigger a High Bus Voltage Fault. This situation can be avoided by:

- Decelerating the motor/load less aggressively
- Decreasing the effective load at the motor shaft (employ a load reduction gear box)
- Providing a means to remove excess bus energy from the drive

A regeneration transistor, combined with an internal or external regen resistor provides a means to dissipate excess bus voltage, before a fault is generated. The excessive energy is dissipated in the form of heat at the resistor.

Regenerative Loads

Regenerative loading occurs when the direction of power flow is from the machine to the motor: the motor is acting as a generator. Another way of describing this is that the load torque is acting in a direction to 'help' the motor to move in the commanded direction of motion. This can occur for a variety of reasons including:

1. Decelerating the machine faster than it would coast, especially from high speeds and with large inertial loads;

2. Using the motor to act as a brake on an unwind stand for a roll of material, where the tension in the web causes the motor to brake while moving forward; or

3. Using the motor to lower a vertical load that is not counterbalanced.

In many cases, this extra energy is dissipated by machine friction, or stored temporarily in the drive's power capacitors. However, if the amount of regenerative energy is excessive, it must be shunted to an external regenerative resistor, in order to prevent a high bus voltage condition. For assistance determining if your application has a regenerative load component, contact your ORMEC Sales and Applications Engineer.

Shunt Regulator

SAC-RDE models RDE03B1-I, RDE03C2-I, RDE04C1-I, RDE04D2-I have built in shunt regulator circuitry for dissipating excessive regenerative voltage. The shunt regulator consists of a voltage comparator and a switching transistor. When the voltage comparator detects excess bus voltage, it turns on the shunt regulator transistor, dissipating energy from the servodrive capacitors to the external regen resistor. The drive controls the on-time duty cycle, so that the average current is appropriate for the regen resistor specified in the project software setting.

Sizing a Regen Resistor: Application-specific Formulas

Sizing a Regen Resistor: Regeneration Due To Deceleration

Regeneration during a motor's deceleration is due to the decreasing kinetic energy of the rotating inertia. Not all of this energy will make it back to the DC bus; some or all of it may be absorbed by machine friction and motor losses. In the case of sizing regen resistors, neglecting frictional losses is a <u>conservative</u> approach to sizing a regen resistor.

Each deceleration in a cycle results in a loss of kinetic energy at the motor. Depending on frictional losses, some or all of this energy may make it back to the drive as **Regenerative Energy**. Rotational kinetic energy at any velocity can be calculated with the general equation $E = \frac{1}{2} I \omega^2$. Applying the appropriate units conversions:

$$E_{regen} = \frac{1}{2} I \cdot \left(V_i^2 - V_f^2 \right) \cdot 0.00124 \qquad \text{(Equation 1)}$$

where: E_{regen} is the loss of kinetic energy during a deceleration (Joules)

I is the total system inertia (motor + load) (in-lb-sec^2)

V_i is the initial speed of the motor before deceleration (RPM)
V_f is the final speed of the motor after deceleration (RPM)

(0.00124) is a unit conversion: $\frac{(2\pi\, rad/rev)^2 \cdot (4.448\text{N}/lb)(25.4\text{mm/in})}{(60\, sec/min)^2 (1000\text{mm/m})}$

Average Regenerative Power for the total cycle can be calculated as:

$$P_{avg} = \frac{E_1 + E_2 + E_n}{T_{cycle}} \qquad \text{(Equation 2)}$$

where P_{avg} is the average dissipated power over the entire cycle (Watts)
E_1 is the energy dissipated by the 1st decel in the cycle (Joules)
E_2 is the energy dissipated by the 2nd decel in the cycle (Joules) …
E_n is the energy dissipated by the Nth decel in the cycle (Joules)
n is the number of decelerations in the cycle
T_{cycle} is the total repetitive cycle time (seconds)

Sizing a Regen Resistor: Regeneration Due To Web Tension (motor acting as brake)

The regeneration in a tensioned-web application is due to the web tension pulling the braking motor along in the same direction that it is moving.

Average Regenerative Power is calculated with the general formula:
P = Tω. Applying the appropriate units conversions:

$$P_{avg} = (0.0118) * T \cdot V \qquad \text{(Equation 3)}$$

where P_{avg} is the continuous regenerated power (Watts)
T is the torque at the motor due to web tension (in-lb)
V is the velocity of the motor shaft (RPM)
(0.0118) is a conversion: $\frac{(2\pi\, rad/rev) \cdot (25.4\text{mm/in})(4.448\text{N/lb})}{(60\, sec/min)(1000\text{mm/m})}$

Sizing a Regen Resistor: Regeneration Due to Vertical Load

In an application where the motor is supporting the weight of a poorly counterbalanced load, regeneration may occur when the load is being lowered. This is due to gravity ‘helping’ the motor lower the load.

Instantaneous Regenerative Power can be calculated with the formula
P = Tω. Applying the appropriate units conversions:

$P_{instant}$ = (0.0118) * T *V (Equation 4)

where $P_{instant}$ is the instantaneous regenerated power (Watts)
T is the torque at the motor due to load weight (in-lb)
V is the speed of the motor during downward motion (RPM)
(0.0118) is a conversion: $\frac{(2\pi\, rad/rev) \cdot (25.4\text{mm/in})(4.448\text{N/lb})}{(60\, sec/min)(1000\text{mm/m})}$

Average Regenerative Power for the total cycle can be calculated as:

$$P_{avg} = \frac{P_1 \cdot T_1 + P_2 \cdot T_2 + P_n \cdot T_n}{T_{cycle}} \qquad \text{(Equation 5)}$$

where P_{avg} is the average dissipated power over the entire cycle (Watts)

P_1 is the power dissipated by the cycle's 1st downward move (Watts)

T_1 is the time spent in the cycle's 1st downward move (seconds)

P_2 is the power dissipated by the cycle's 2nd downward move (Watts)

T_2 is the time spent in the cycle's 2nd downward move (seconds)

…

P_n is the power dissipated by the cycle's Nth downward move(Watts)

T_n is the time spent in the cycles Nth downward move (seconds)

n is the total number of downward moves in the cycle

T_{cycle} is the total repetitive cycle time (seconds)

Sizing a Regen Resistor: Use Average Regenerative Power

Once Average Regenerative Power has been determined using one of the methods presented, the sizing of the resistor is nearly complete.

The wattage of the regenerative resistor should be greater than or equal to the application's calculated Average Regenerative Power.

The next section shows the minimum resistance requirements, as well as additional limitations on the regen power that can be shunted, based on the ServoWire SD Drive's shunt transistor.

Sizing a Regen Resistor: Regen Transistor and Resistor Limitations

The amount of energy that can be dissipated by an external regen resistor may be limited by the current capability of the switching transistor.

Table 24 below shows 1) the minimum regen resistance allowed, 2) the resulting current at that resistance and 3) the maximum average regen power capability of the drive.

NOTE: Do not use a lower resistance than shown in the table below! Too low a resistance may result in peak currents that are too high for the regen transistor, and could result in damage to the transistor.

	Regen Resistor	Drive Regen Power Output	Regen Transistor
SAC-RDE	**Minimum Resistance**[(1)]	Maximum Average Power [(3)]	Peak Current [(2)]
Internal resistor	50 Ω	55 W	8.5 A
External resistor	50 Ω	700 W	8.5 A

1 Minimum resistance – limited by drive transistor
2 Calculated using minimum resistance at maximum voltage
3 Average Regen output Power which the drive can sustain over time without failure.

Table 12: Regen Resistor Selection Requirements

The actual resistance of the regen resistor determines the current in the resistor. Using Ohms law the current when the regen transistor turns on will be I = V/R. V will be 200V or 395 V or 775 V depending on the drive bus voltage setting and motor voltage setting. The table shows the calculated current for the minimum resistance allowed.

When using the minimum resistance value the power output (dissipated in the resistor) will be much higher than the drive and the resistor can sustain. Having this peak capability allows the drive to remove a large amount of energy quickly. For example, using the SAC-XD215 values: $P = V^2 /R$. With V = 395 V and R = 40 ohms the instantaneous power is $395^2/40$ = 3,900 W. For a short time the drive and resistor (properly sized) can tolerate this power. The column "Maximum Average Power" shows how much average regen power the drive can sustain without damage. Verifying that the Average Power requirements are met is accomplished by analysis of the application.

The resistors current and power ratings may also limit the amount of energy that can be dissipated by a regen resistor. The peak current that will be seen by the resistor is shown in **Table 12**. This current is limited by the regen resistor's resistance value, so if a higher resistance is used, the peak current will be lower.

The SAC-RDE drive uses an on-off duty cycle limits the average current that will be seen by the resistor. This limits the average current so that neither the wattage of the resistor (configuration software setting) nor the continuous current of the regen transistor is exceeded on a continuous basis.

Regen Resistor	Resistance	Wattage	Peak Current on 230 V drive (425 VDC max)	Peak Current on 460 V drive (800 VDC max)
SAC-SMRR/0055	50 Ω	55 W	8.5 A	16 A
SAC-SMRR/0700	54 Ω	700 W	7.9 A	14.8 A

Table 13: Standard Regen Resistor Specifications

The regen resistors are voltage rated for up to 1000 VDC allowing them to be used on both the 230 VAC and 460 VAC drives. When applying the resistor the minimum resistance supported by the drive must not be exceeded.

MotionSet Introduction

Configuration of the drive and system start up are greatly simplified when you use Ormec's MotionSet commissioning and exercising software. With MotionSet you can define your project, download them to the drive, monitor and test I/O points, capture real time data and display it, and debug the application.

This section of the manual provides an overview of the capabilities of the MotionSet software, it is not complete documentation. The on line help found with MotionSet provides all of the details. Clicking the image to the right will run a video introduction to MotionSet

MotionSet can be downloaded and installed from Ormec's website at MotionSet download

Project Definition

MotionSet provides a simple, graphical, drag and drop interface to define your project. With it you

- name your project,
- select the communication method and address,
- select the drive and motor,
- configure the remaining features.

The details necessary to accomplish this can be found in other sections of this manual, see Defining Projects.

Monitoring general drive information

A common practice is to monitor the state of the drive and motor, especially during machine design and start up. The MotionSet project tree has 3 entries for general information, Monitor, Counters and Event Log.

A sample Monitor screen is shown in Figure 6. There are four areas on the screen. The Axis block shows information about the motor. The top of the block shows fault and error conditions and provides a simple ability to clear those states so that operation can continue. Below that are common numeric values useful as a visual indication of what is going on. At the bottom of the block are status of 4 dedicated motor inputs, overtemperature and 3 hall commutation signals.

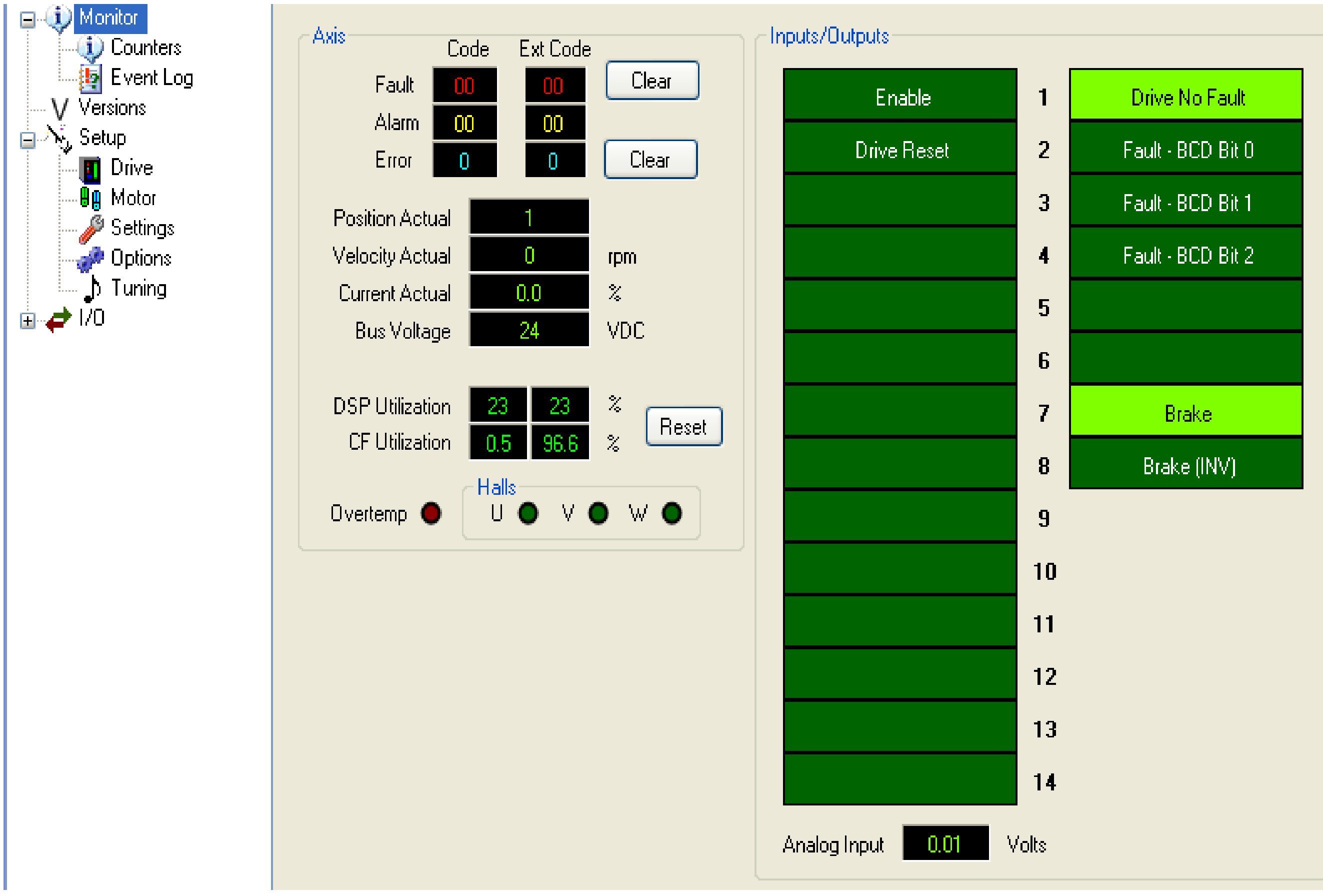


Figure 6: MotionSet general Monitor screen

The column on the right displays the status of the drive I/O points. Active points will change color. Note that function names appear on the points used to make understanding easier. With this display it is not possible to change the I/O point status. To accomplish that requires running the I/O Exerciser, which is described at I/O status and forcing.

The next entry in the Project Tree will bring up the Counter monitor display. This provides detailed packet information for both Ethernet and USB communications. It is most useful in verifying communication and debugging problems. An example is shown in Figure 7.

The final monitoring entry is Event Log. The Event Log provides a history of error and fault messages and other significant actions occurring on the drive. The log stays intact until manually cleared. An example event log is shown in Figure 8.

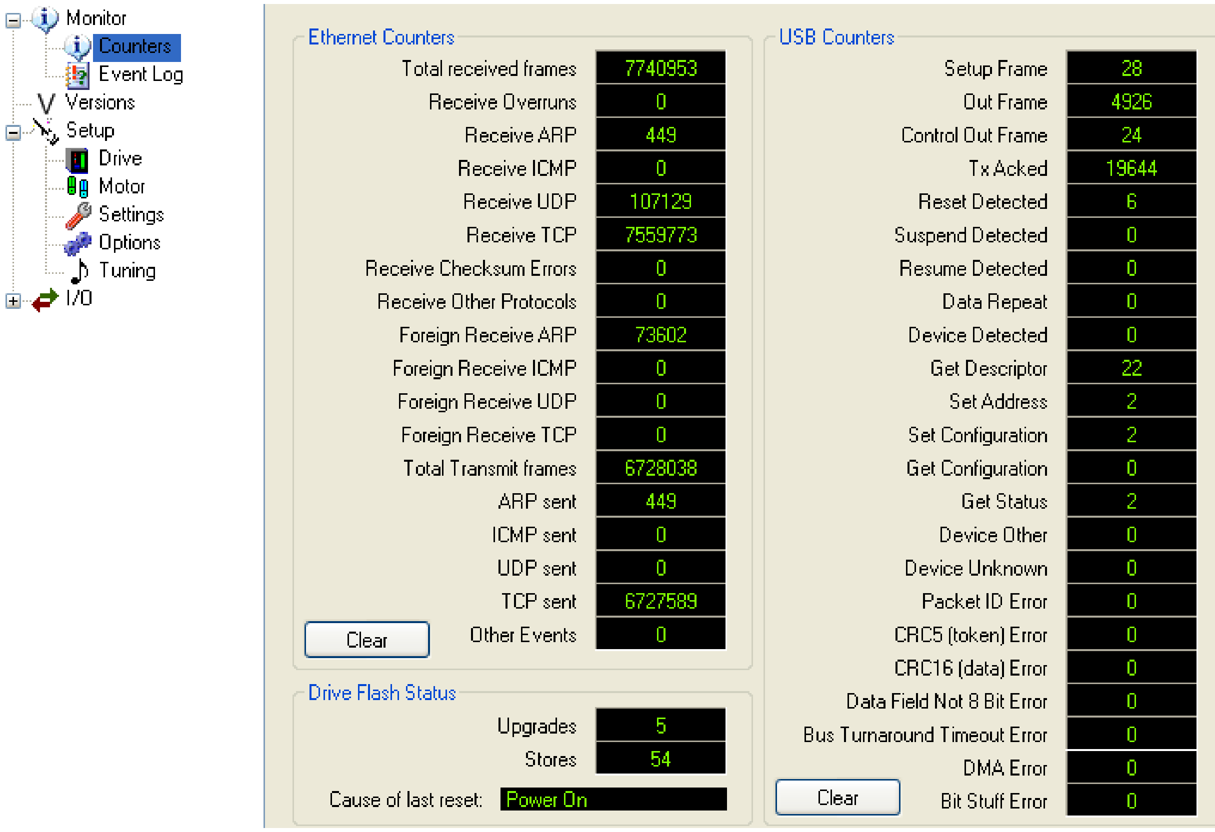


Figure 7: Communication Packet Information

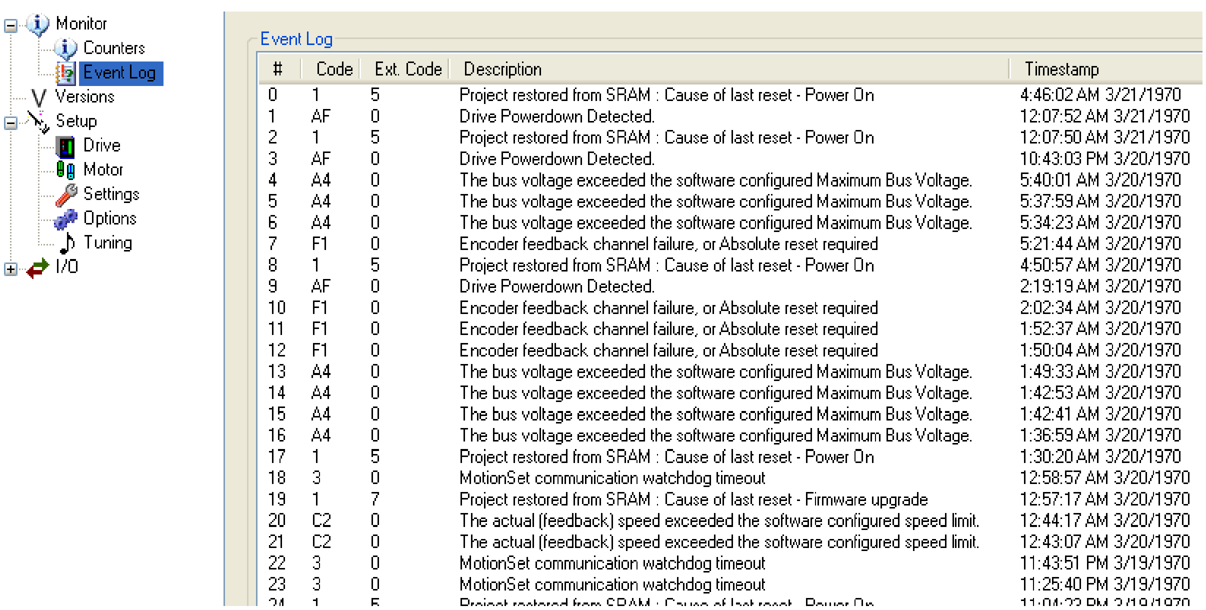
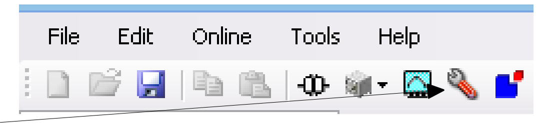


Figure 8: Event Log Example

I/O status and forcing

In the previous section you saw how to display the current state of the drive I/O points. That works well when all that is needed is to monitor the operation. However, during machine commissioning it is often desirable to exercise the I/O, and to do so by forcing it rather than actuating the physical I/O, which may not be practical. The I/O Exerciser provides this needed capability.

The I/O Exerciser is a tool which not only displays the current state of each I/O point but also allows selective forcing, or overriding, of the physical I/O point. The I/O Exerciser is started by clicking on the I/O Exerciser ICON 



Once started the Exerciser will open in a new window and look like Figure 9. This view should look similar to the monitor view, Inputs and Outputs labeled with functions. Notice the check boxes to the left or right of the columns. When checked control of that point is taken by the Exerciser from the drive. The color of the block changes to indicate the control change. When forcing you may choose a momentary assert via a left-click or a toggle via a right-click. Points which are not forced will display the actual value.

With this feature it is easy to force each output and verify the resulting action on the machine is correct. Forcing inputs makes it possible to test drive functions without needing actual input hardware.

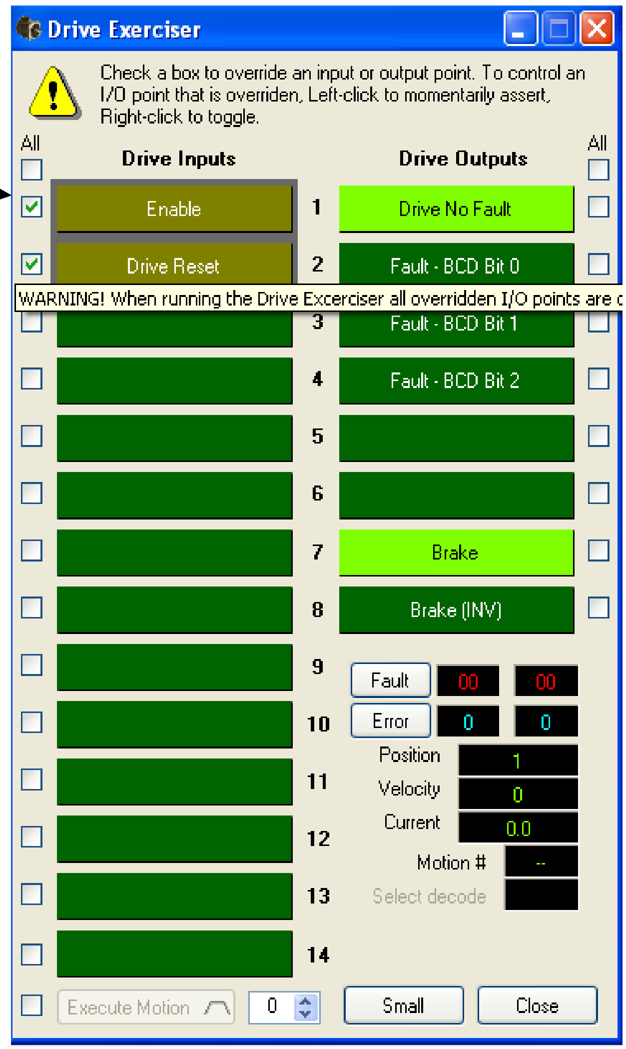


Figure 9: I/O Exerciser Example

Scope - Advanced Troubleshooting

Exercising the I/O will go a long way to verifying initial machine operation, however, it isn't always enough. Sometimes a machine problem occurs during the motion or it is timing dependent. To identify and fix those problems you need real time capture of everything about the motion and the machine. That's where the MotionSet Scope comes in. The Scope provides real time capture of up to four channels at once and then displays them for analysis. The trace can be saved to a file for further analysis or recalled later for review. The data-logging is done in the drive, buffered and then uploaded to the Scope for display to eliminate communication lag issues.

The Scope features

- Multiple triggering sources and options,
- Capture up to 4 channels,
- Variable time base,
- Ability to save and load previous traces,
- Frequency plots to find machine resonances,
- multiple cursor measurements, zoom, pan, marker and overlay display capabilities.

To understand the machine operation you need to see more than just the motor velocity. Scope supports capturing 4 channels simultaneously, from 27 choices which include:

Motion Signals	Hardware signals	Other information
Velocity actual	Analog input 1 and 2	Bus current
	Motor Zref	Bus voltage
	Phase U current	Current actual
	Phase V current	Current commanded
	Phase W current	Digital In & Out

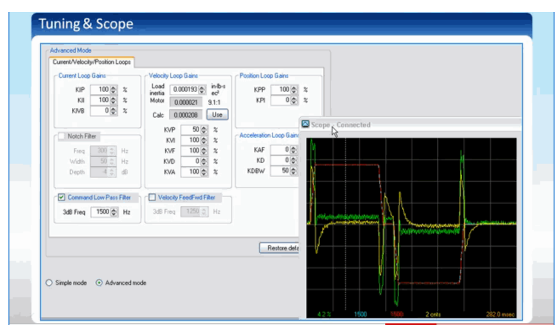
Table 14: MotionSet Scope Signal Selections

Triggering options include continuous capture, manual trigger or source triggered. Source triggering provides the ability to trigger on hardware signals as well as many motion status points so you can zoom in around a specific event. The choices include:

Hard signals	Motion Status	Other items
Any Input, IN1 – IN4	In Motion	Drive Fault
Any Output, OUT1 – OUT8		Drive Alarm
Motor Zref		Drive Error

Table 15: MotionSet Scope Trigger sources

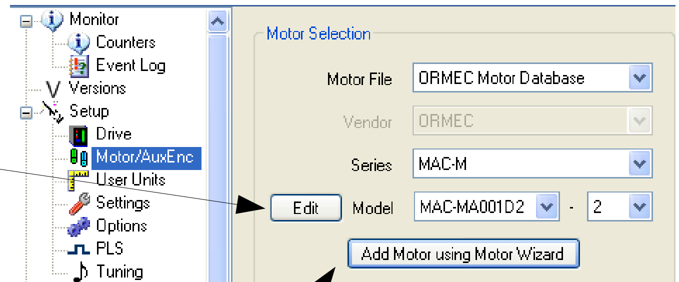
A Scope and Tuning video, found on the Ormec website, shows the scope in operation during a tuning example. It can be easily accessed by clicking the image to the right.



Custom Motor Definition

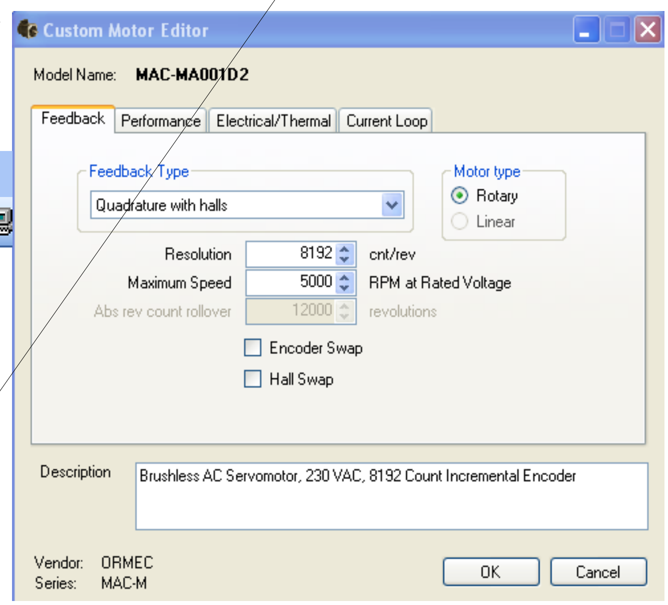
Motion set comes with an extensive library of defined motors, however, you may still need to add your specific motor before using it. Adding a motor definition to the motor database is simple, with two approaches available. You may start with an existing motor definition, making the appropriate changes or you can begin with a clean slate and enter or learn the motor.

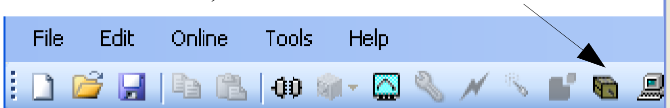
MotionSet stores motor definitions in two databases, ORMEC Motor Database and Custom Motor Database. All motors you define are stored in the Custom Motor Database. All motors defined by Ormec are stored in the ORMEC Motor Database. The primary difference between the two is that the ORMEC Motor Database may be replaced with newer versions when MotionSet is enhanced but Custom Motor Database will never be replaced in a MotionSet upgrade. This protects any definition work you do.



Editing an existing motor begins on the Motor/AuxEnc branch of the Project Tree. Select the closest motor (or some motor) from either database and then click the Edit button.

This will bring up the Custom Motor Editor window which looks like this. Note that you must be disconnected from the drive to edit a motor. (Changing Motor or Drive selections must always be done off-line for safety reasons, preventing inadvertent motions.) When done, click OK and the new motor is saved in the Custom Motor Database. If you want to rename the motor use the Custom Motor Database, started from the toolbar.





Using the motor wizard begins with a new definition and the wizard can measure most of the needed parameters. Starting the motor wizard is accomplished by either clicking on the “Add Motor using Motor Wizard” or using the ICON on the toolbar.

The toolbar ICON is available only when you are connected to the drive.

When the Motor Wizard starts it will look like the screen shot in figure 10. The steps to learn your motor are:

1. Enter the top five values as they are required.
   a) The Feedback type is read from the drive and is based on the encoder found at power up. If incorrect change it.
   b) Rated voltage is the motor's rated voltage, not what you have connected.

c) Peak current is motor peak, as read from the datasheet in RMS amps/phase

d) Continuous current for the motor, as read from the datasheet, also in RMS amp/phase.

e) Maximum speed of the motor, as read from the datasheet, in RPM. This should be the speed when run at the Rated Voltage entered above. This should be the voltage based speed, not bearing speed if different. (Some vendors list two maximum speeds, one is speed based on back EMF, which is the driven speed and a second speed which is a bearing rating.)

2. If desired, enter the datasheet motor construction data. These values will be measured when the wizard is run. If you don't know the values, they don't need to be entered.

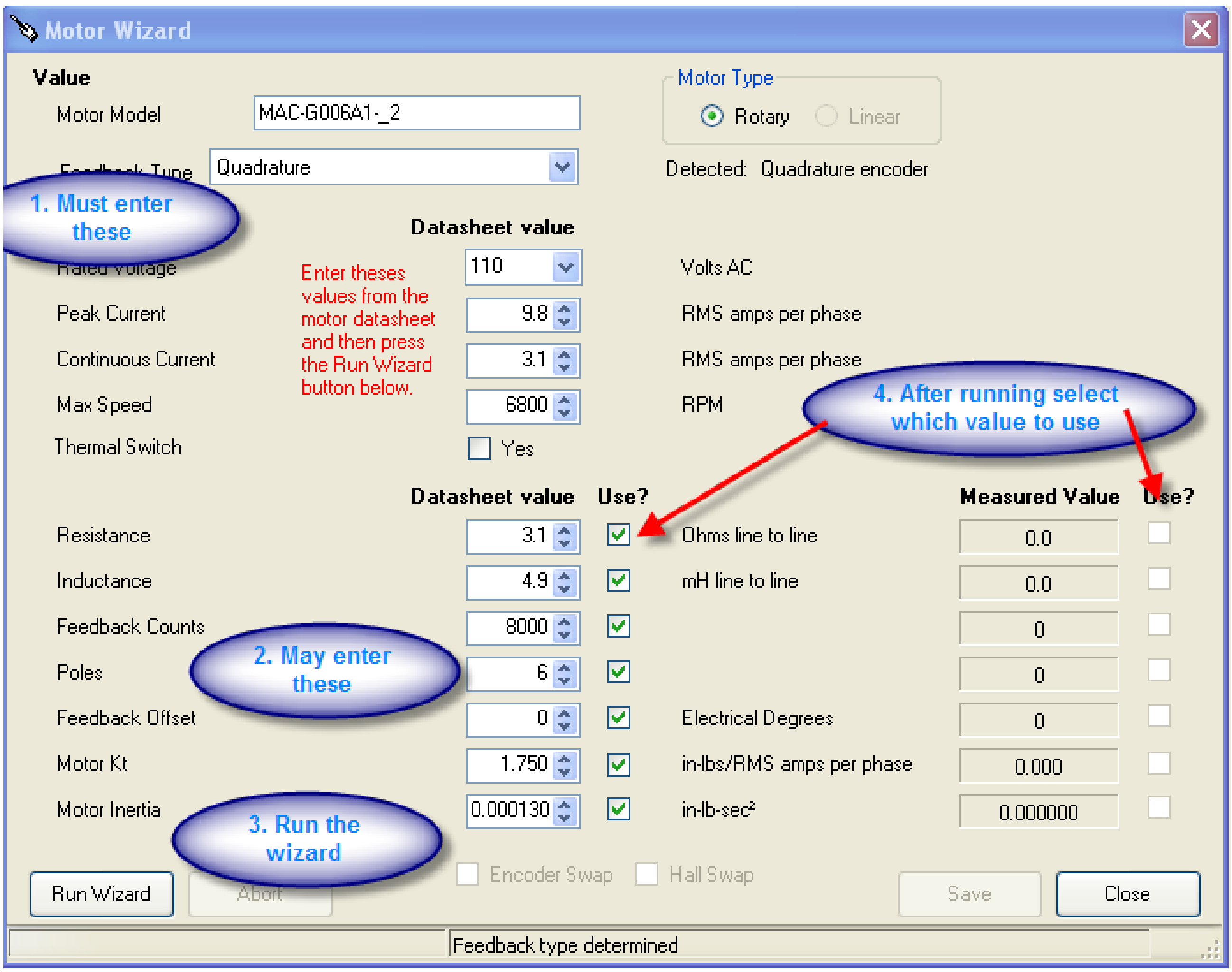


Figure 10: Motor Wizard

WARNING: Verify that the motor is disconnected from any loads and that it is safe to move. When the wizard runs the motor will move. You should be prepared.

3. Run the Wizard – click on the “Run Wizard” button in the lower left corner. This will start the motor analysis. You should see entries in the Measured Value column being filled in as the tests progress.

4. Make a choice of values – There are now two columns of values, datasheet and measured. Click on the boxes in the 'Use?' Columns to select which values to use. How do you pick? Datasheet values are usually design parameters and may or may not be tested. They are set to cover all copies of the motor, allowing for inevitable production variations. The measured values apply to this specific

motor. If it is on the fringe of the manufacturers range then it may not be completely representative of all copies of the motor. The selection depends on how much the values differ, if you plan on using more of these motors or if this is a single application.

Solving Problems

Aka Troubleshooting

The first table in Solving Problems is organized around general problems.

The second table is a list of Error codes and what to do when they happen.

What went wrong	When did it happen	What to do or how to fix it
Applied power and nothing happened. No lights or activity.	When power applied.	**DC Input**: 1) Verify the voltage on TB1. 2) check model number for -*A****. This is an AC input drive. The DC connections on TB1 are now an output and are diode protected. Applying power will be blocked by the diode. Switch to AC input on TB2.
		AC Input: 1) Verify control power connections are on pins r & t of TB2 and that the voltage is above 85 VAC. 2) check model number for -*A*****. If the A is missing (then a D) this is a DC input drive. No AC control power circuitry exists. Switch to DC input on TB1.
Closed input and motion didn't happen		Verify that the drive is enabled. This is indicated by the right decimal point in the status display. No motion can be executed while disabled. If working from the I/O exerciser 1) make sure that you have turned on override by checking the box next to the input, 2) make sure to hold the mouse click long enough. If using physical I/O 1) use MotionSet or the I/O exerciser to monitor the inputs and verify that the drive is seeing the input, 2) if the input is working check that the input is mapped to Initiate the motion and 3) verify that a motion is defined at the motion number which is initiated. If a motion is already running then another motion cannot be started while the motion is in process. This includes the dwell time at the end of the motion previous motion. Check the dwell time on all motions.
Ethernet won't connect	After changing connections	When configuring more than one drive you will likely move your Ethernet cable from one unit to another. Microsoft windows will sometimes have a problem when you try to connect a second device with a different MAC address using the same IP address. (Each drive has a different hardware physical address, called a MAC address.) You can clear the Windows table by executing the following command in a command window. arp -d 192.168.1.250 (Use Start – Run and then cmd or command to open a command window.)

Table 16: Troubleshooting Guide

The Fault Code table provides an understanding of the Fault Codes which may be displayed on the drive. A Fault is defined as a problem which is severe enough or has a safety risk such that motion cannot be initiated or continued. This differs from a warning where operation may safely continue.

All Faults will disable the drive. Energizing the output power and control of the motor cannot happen due to the severity of the problem.

Faults are displayed on the 2-digit display near the upper left corner of the drive. In addition many faults are coded and provided to the controller via J3. The interface is a 3 bit, BCD coding.

All faults are 2 digit numbers and begin at a value of 70. The value 70 is larger than an valid motion number. During normal operation the drive will display the running motion, which is a number from 0 to 32. This is normal and does not indicate an error.

Some of the Faults have an extended code which provides additional detail about the problem. Faults displayed on the drive show a main fault code followed by an underscore and extended code number.

J3 Alarm bit codes		
Alarm Code	**Fault displayed on drive**	**Meaning**
1	A1	Drive peak current
4	A4 or A9 or AA	Phase loss or power problem
5	C2 or CE or F1	Encoder problem
7	A0 or F0 or F4	RMS current limit
For additional explanation see corresponding error in table below.		

Table 17: J3 Alarm bit codes

Main Fault Code	Extended code	What it means	What to do.
0 to 32			This is normal operation. The number indicates the motion table entry which is running.
70		Offline	
75		Tension too high	The actual tension has exceeded its maximum limit
76		Tension too low	The actual tension has exceeded its minimum limit
77		Forward software travel limit exceeded	The actual position is more positive than the forward software travel limit
78		Reverse software travel limit exceeded	The actual position is more negative than the reverse software travel limit
All 90s		Internal error	Contact ORMEC Service
A0		Drive RMS current limit	Indicates that the drive's RMS current limit has been exceeded. (An F0 indicates that the motor's RMS limit has been exceeded.) The RMS limit is basically an average current. The limit is equal to the Indexers current rating. Current above the limit can be applied for a short time without error. The amount of time varies and is dependent on how much above the current rating and how high the average is when the short term excursion occurs. a) RMS current limit problems are usually application related. High average currents usually mean more current (power) was needed than anticipated. b) If the machine has been running for some time then look for load changes. Check machine binding, increased friction, higher loads, off center loads. Check for faster speeds, which require more power. c) If this is start up then additionally check inertia and loads. Verify that the machine parameters are as expected. A larger drive may be needed if additional loading is found and can't be reduced.
A1		Drive Peak current limit	Indicates the drive's Peak current limit has been exceeded. XD models XD203 – XD215 allow a peak current of 3x rated current. This fault indicates a very high current. a) Look for external short circuits. b) Check motor selection. If the motor resistance and inductance defined are significantly different from the actual motor high peak currents are possible. Such a mismatch can happen if the wrong motor is selected, or if a custom motor has incorrect values entered. It can also happen if the motor windings have been damaged and therefore differ from specifications.

Main Fault Code	Extended code	What it means	What to do.
A2		Hardware Protection Fault - Current limit	The drive hardware fault has occurred. Normally this is caused by a motor short circuit or short circuit on the motor outputs. It can also indicate a Regen overcurrent, IGBT overtemperature, low internal control voltage. a) Check for external short circuits. Disconnect the motor power cable (TB4) or the regen output (TB3) and try again. If the condition does not repeat it is most likely external. b) Allow to cool down to check for overtemperature. c) A low internal control voltage is rare. This cause requires return of the drive for repair.
A3		Bus voltage too low	The measured bus voltage is less than half the selected value. a) Check the bus voltage setting in the project. Running at 115 VAC with a setting of 230 VAC will often result in this error. b) Check wiring. If MotionSet reports a good voltage under no load then look for issues which will cause voltage sags during operation.
A4		Bus voltage too high	The bus voltage has risen above the safe limit for the hardware. On 230 VAC series drives the threshold is about 400 VDC. a) The usual cause is decel rates. If the fault primarily occurs during deceleration then adjustments are needed. Decelerating slower or less load can help. If necessary the regen option may needed. When decelerating the rotation energy in the load must be removed. If friction is not sufficient then the excess energy will raise the bus voltage. b) Check voltage on incoming power at L1, L2 and L3. If too high correct.
A6		Motor configuration missing	The drive was enabled but no project definition has been loaded. Connect with MotionSet and load a project.
A7		Function not allowed while enabled	It is illegal to perform certain operations while a motor on the drive is enabled, such as changing the configuration of the drive. An attempt was made to write parameters for the 'Number of Poles ' or Resolution to the drive while the drive was enabled. The drive must be disabled before changing these parameters.
A8		Invalid commutation position	A Drive configured for a motor with an absolute encoder was commanded to enable when the absolute encoder was discharged, or while the commutation position was invalid, or the Absolute battery power output was toggled on a Drive configured for an incremental encoder. The commutation position is invalid on a drive configured for an absolute encoder motor when: ❍ The Drive is powered up, prior to drive configuration. ❍ An open encoder line is detected. ❍ During trapezoidal commutation. ❍ "Number Of Poles" is written. ❍ "Resolution" is written. The commutation position becomes valid when the absolute encoder's position is read.

Main Fault Code	Extended code	What it means	What to do.
A9		Motor power phase loss	Indicates that one phase of motor input power is missing. Check L1, L2 and L3. Input phases are only checked when the drive is enabled. This error usually occurs when there is insufficient delay between the application of motor input power (usually closing a contactor) and enabling the drive.
AA		Softstart SCR error	Some models use an SCR in the inrush control. The SCR must be turned on before the drive can be enabled. This error indicates that the SCR has not been turned on and is only generated on the transition from disabled to enabled. The usual cause is insufficient delay between applying motor input power (bus power) and enabling the drive. An extended error code may be included to help in troubleshooting this error.
	1		Bus voltage not high enough. Either the AC input is too low or not enough time has elapsed to charge the bus capacitors.
	2		Indicates that one phase of motor input power is missing. Check L1, L2 and L3. This could be a missing signal or it could be caused by enabling too quickly after applying power.
	3		Inrush current not complete. The current needed to charge the internal capacitors must be complete before turning on the SCR. It takes a few cycles of the AC input to complete the charging. Enabling too quickly after turning on motor input power can generate this error. Another possibility is that there is a connection to the RG1 or Bus+ connection. A short circuit or incorrectly mounted regen resistor will cause current which will prevent the SCR from being turned on.
	4		After the first three conditions are met the drive waits up to 50 msec to turn on the SCR.
AB		Safe Torque Off not energized	The Safe Torque Off option is installed and one or both STO inputs are not energized. Both inputs require current before the drive can be enabled. This error indicates an attempt was made to enable the drive before that happened.
AC		Overtemp or Inrush problem	This error occurs during drive operation. It indicates that either the IGBT has overheated and needs to cool or that there is a failure of the softstart SCR.
AD		Estop input active	
AE		Drive upgrade required	A requested feature is not available in this version of software. Update the drive software.
AF		Low control voltage	Indicates that the on-board self diagnostic has detected that the 5vdc power supply is too low.
B0		Drive upgrade failed	An attempt to upgrade the software in the drive has failed. An extended code may be displayed.

Main Fault Code	Extended code	What it means	What to do.
	1		A checksum error occurred when verifying the downloaded copy of the new software. Retry the download. If the problem persists contact ORMEC service.
	2		The downloaded software is not compatible with this hardware. An identifier in the software indicates that it will not work on this hardware. Check any compatibility information included with the software. Reinstall the software to be downloaded.
	3		After programming the on board FLASH memory a checksum was calculated and the value was incorrect. Safe operation of the drive is not possible. Contact ORMEC service.
	4		An internal flash error occurred while programming the on board FLASH memory.
B1		Nonvolatile memory failure	
	1		A failure occurred loading the nonvolatile memory.
	2		A failure occurred saving the nonvolatile memory.
	3		Power up restore from nonvolatile memory failed, resetting to factory defaults. This error may occur each time the drive is powered off for more than 20 hours. Connect MotionSet and restore the project.
	4		
	5		
	6		Low battery fault
C0		Exceeded maximum position error	Actual position error exceeds the limit set in the project. The limit is set on the Setup |Settings page. Note if the error repeats and in what portion of the motion the error occurs. a) During acceleration – position error increases during acceleration and deceleration. Check for position error limit too small. Check tuning – too soft increases errors. Check acceleration rate – too fast may be physically impossible. b) during constant velocity – Check for position error limit too small. Check for binding producing a perturbation.
C1		Overspeed commanded	The commanded speed exceeded the software configured speed limit. The application-specified Max Speed is set on the Settings page in MotionSet
C2		Motor overspeed	The actual (feedback) speed exceeded the software configured speed limit. The application-specified limit for Max Speed is set on the Settings page in MotionSet
C3		Overtravel limit asserted	Motion was commanded further into a travel limit, while still active. Once an overtravel limit is reached further motion cannot be commanded into the limit. Motion off of the limit is possible, but not further into the limit.
C7		Motion Segment Overflow	

Main Fault Code	Extended code	What it means	What to do.
C8		Missing Motion Table	
CB		EBC overflow	Pacer backup compensation overflow.
CD		Home timeout	The motor traveled a distance greater then the specified homing timeout without achieving the home condition. Possible causes include a missing home sensor.
CE		Auxiliary feedback overspeed	The auxiliary encoder's actual speed exceeded the specified limit.
D0		Unassigned Motion	Commanded an undefined/unassigned motion
D1		Error as Fault	Errors are configured to generate faults. The extended fault code contains the error number.
D2		Too many motions	Too many simultaneous motions have been commanded.
F0		Motor RMS current limit	Indicates that the Motor's RMS current limit has been exceeded. (An A0 indicates that the drive's RMS limit has been exceeded.) The RMS limit is basically an average current. The limit is equal to the Motor's current rating. Current above the limit can be applied for a short time without error. The amount of time varies and is dependent on how much above the current rating and how high the average is when the short term excursion occurs. a) RMS current limit problems are usually application related. High average currents usually mean more current (power) was needed than anticipated. b) If the machine has been running for some time then look for load changes. Check machine binding, increased friction, higher loads, off center loads. Check for faster speeds, which require more power. c) If this is start up then additionally check inertia and loads. Verify that the machine parameters are as expected. A larger motor may be needed if additional loading is found and can't be reduced.
F1		Encoder wire open	The drive has detected a problem with one of the feedback wires on connector J6, motor feedback.
	1		Indicates that the drive is configured for quadrature feedback and that one of the wires ENCA, ENCA', ENCB, ENCB' is open or shorted. Could also be caused by a failure of one channel of the encoder.
	2		Indicates that the drive is configured for a Yaskawa serial encoder and that communication to the encoder has failed.
F2		Auxiliary encoder wire open	The drive has detected a problem with one of the feedback wires on connector J7, Auxiliary feedback. One of the wires ENCA, ENCA', ENCB, ENCB' is open or shorted. Could also be caused by a failure of one channel of the encoder.

Main Fault Code	Extended code	What it means	What to do.
F3	0	Invalid Hall state	The drive has detected a problem with Hall feedback. Valid hall states are 1 – 6. This error indicates a Hall value of 0 or 7 was detected. Usually caused by a wiring error on J6. Check wires ENCU, ENCU', ENCV, ENCV', ENCW and ENCW'. Can be caused by selecting the wrong type of feedback, causing the drive to look on the wrong interface for Hall information. The extended codes indicate which interface was tested.
	1		Invalid Hall on quadrature/incremental encoder interface.
	2		Invalid Hall on Yaskawa encoder interface.
	3		Invalid Hall on Sigma II encoder interface. This usually indicates that serial communications with the encoder have failed.
	4		Invalid Hall on other interface.
F4		Motor Overtemp signal error	Indicates that the Motor Overtemp input on J6 is not conducting current. When used the input must be sinking current to be OK. a) Check motor temperature. If high then cool and restart. If repeated failures review application. b) Check wiring. A broken wire can cause this fault.
F5		Feedback option not recognized	The drive firmware does not recognize an installed feedback option board. The drive has detected an installed option module, but does not recognize and/or support the module type. To correct the problem try, a) Verify that the drive firmware supports the option module. Update the drive firmware if not. b) Check the installation of the module to verify it was installed correctly or hasn't come loose. c) Return the unit to ORMEC for repair/replacement of the module.
F6		Motor overtemp mode error	Indicates that the drive is configured for no Overtemp input but the input is conducting current. This is a possible safety error because temperature protection is not in place when it might be expected. a) If protection is desired change the project setting. Edit the motor type and set thermal switch present. b) If no thermal switch is present on the motor then find the cause of the short on J6.
F7	0	Serial Encoder error	An error bit has been returned by the serial encoder. An extended code may provide additional information. Some errors can be cleared using an encoder reset command. Others require a power cycle to clear.
	1		The general error bit has been set.
	2		The encoder has reported an over speed error.
	3		The encoder has reported an absolute position error.
	4		The encoder has reported a battery low error.

Main Fault Code	Extended code	What it means	What to do.
	6		The encoder has reported an overtemp error.
	7		The encoder has reported a back up battery warning.
F8		Feedback type not recognized	A motor feedback type was requested in the project or motor definition and that type is not supported on this drive. a) Verify that feedback type should be supported. b) Verify feedback type listed in motor definition. c) Drive version or firmware version may not support this feedback device. Upgrade if possible.
	1		An attached Tamagawa encoder returned an ID which is not supported.
	2		The attached Sigma II encoder returned an ID which is not supported.

Table 18: Fault Codes

Specifications

Environmental Specifications

Operating Temperature	0 to 50°C
Storage Temperature	-20 to +70°C
Operating and Storage Humidity	10 to 90%, non-condensing

Table 19: Environmental Specifications

General Electrical Specifications for 115/230 VAC Drives

Incoming main power line voltage – TB2 pins L1, L2, L3		
	<u>Warning</u>: Use the servomotor's voltage rating to determine the maximum input voltage for the servodrive. Connecting 230 VAC when using a 115 VAC motor will destroy the motor and may cause other injury.	
	SAC-RDE (pins L1 and L2)	Single Phase, 50/60 Hz 85 – 265 VAC 115 or 230 VAC typical

Control Power – AC input control power – TB2 pins r, t, FG		
Vin	SAC-RDE	Single Phase, 50/60 Hz 85 – 265 VAC 115 or 230 VAC typical 1A maximum
Vout	With AC control power 24VDC output available TB1 pins 24V, 24R	24 V, +/- 7% 1A maximum

Table 20: Incoming Power Specifications – 115/230 VAC Drives

Mechanical Specifications

Drive Model	Weight lbs (nominal)
SAC-RDE	2.6

Table 21: Drive Weight

Output Specifications

Drive Model	Rated Output Power (kva)	Cont. Current (Amps RMS/phase)	Peak Current 3 sec (Amps RMS/phase)
SAC-RDE01A2 SAC-RDE02A1 SAC-RDE02B2 SAC-RDE03B1 SAC-RDE03C2	0.7	3	9
SAC-RDE04C1 SAC-RDE04D2	1.2	5	15
Notes: Rated output power requires 230 VAC input.			

Table 22: Motor Output Specifications – 115/230 VAC Drives

I/O Specifications

J3 Controller Interface connector DrvEnB', FltRst', IN3, IN4	Optically-coupled Digital Inputs
Internal resistance	4.7 k ohms
Current to turn on	1.8 mA minimum
Voltage to turn on	10 VDC minimum
Voltage maximum	27 VDC
Turn on time (electrical)	10 usec maximum
Turn off time (electrical)	10 usec maximum
Note: These inputs can have an additional software debounce which adds to turn on and turn off times above.	

Table 23: Digital Inputs Specifications, Controller Interface

J3 Controller Interface connector Cmd+, Cmd-	**Analog Input**
Differential input, CMD+ to CMD-	+/- 10V typical
Single ended input, CMD+ (CMD- grounded)	+/- 10 V input range
Operating voltage Range Common mode voltage	+/- 120 V
Absolute max, common mode or differential	+/- 200 V max

Table 24: Analog Input Specifications

	J3 Controller Interface connector DrvFlt', Alarm1', Alarm2', Alarm3'	**Optically-coupled Digital Outputs**
	Note: current must be limited by external device.	
	Current	100 mA maximum
Vce	On state Voltage, maximum	1.5 VDC at 100 mA
	Off state Voltage	30 VDC maximum

Table 25: Digital Outputs Specifications, Controller Interface

J3 Controller Interface connector ENCA, ENCA', ENCB, ENCB', ENCZ, ENCZ'	**Quadrature Encoder Signals**
Standards	RS485, RS422
Voltage at any pin	-7 VDC to +12 VDC typ.
Absolute Max. Input Voltage	-7 VDC to +15 VDC max.
Differential Output Voltage	
No load	Vod > 2.7 V
Rload = 54 ohms	1 V > Vod < 2.5 V
Where Vod = ENCx - ENCx'	

Table 26: Position Feedback Outputs Specifications

	J4 I/O connector OUT5, OUT6	Optically-coupled Digital Outputs
	Note: current must be limited by external device.	
	Current	100 mA maximum
Vce	On state Voltage, maximum	1.5 VDC at 100 mA
	Off state Voltage	30 VDC maximum

Table 27: Digital Outputs Specifications

	J4 I/O connector OUT7, OUT8	Optically-coupled High Current Digital Outputs
	Note: current must be limited by external device.	
	Current	1000 mA maximum
Vce	On state Voltage, maximum	0.9 VDC at 1000 mA
	Off state Voltage	30 VDC maximum
	Load Inductance	300 uH maximum
	OUT COM current limit, this is the combined conducting limit. The total On current from OUT5 – OUT8 cannot exceed this amount.	2000 mA maximum

Table 28: High Current Digital Outputs Specifications

Encoder Specifications

J6 Motor Feedback Connector J7 Pacer Feedback Connector ENCA, ENCA', ENCB, ENCB'	Quadrature Encoder Signals
Common Mode Input	-15 VDC to +15 VDC max.
Absolute Max. Input Voltage	+/- 25 VDC
Maximum Encoder Data Rate: (after x4 multiplication)	12 MHz
Quadrature Specification	90° +/- 45°
Differential Turn On Voltage	Receiver Output
Vid > 0.7 V	H
-0.7 V > Vid < 0.7 V	In determinant
Vid < -0.7 V	L
Where Vid = ENCx - ENCx'	

ENCZ, ENCZ'	Encoder Reference Signals

ENCU, ENCU', ENCV, ENCV', ENCW, ENCW'	Hall State Inputs
Common Mode Input	-12 VDC to +12 VDC max.
Absolute Max. Input Voltage	+/- 25 VDC
Differential Turn On Voltage	Receiver Output
Vid > 0.2 V	H
-0.2V > Vid < 0.2 V	In determinant
Vid < -0.2 V	L
Where Vid = ENCx - ENCx'	
Single-ended Turn On Voltage	Receiver Output
ENCx > 3.0 V	H
2 V > ENCx < 3 V	In determinant
ENCx < 2 V	L
ENCx' open	

ENC PWR	Encoder Power
Voltage	5.25 VDC +/- 5%
Current	450 mA max., each connector

TEMP', TEMP RET	Overtemp Inputs
Should be normally sinking current to prevent on over-temperature condition.	
Current to turn on	2.5 mA
Voltage max.	+12 VDC maximum

Table 29: Quadrature Encoder Specifications

REGEN Specifications

Minimum resistance of REGEN resistor	Drive	Value
Rrg	SAC-RDE03B1 SAC-RDE03C2 SAC-RDE04C1 SAC-RDE04D2	50 ohms
Turn on voltage		
Von	All	395 VDC typ

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