

LISTEN.
THINK.
SOLVE.®

Troubleshooting of Motion Systems

Drive Faults, Instruction Errors, Configuration Errors, and Noise

Michael Cardoso
Motion Support Engineer

5/25/2017



PUBLIC

Agenda

Motion Products Overview

Troubleshooting Overview

Axis Faults

Motion Instruction Errors

Configuration Errors

Grounding, Bonding, and Noise

Questions/Answers

Motion Product Family

**Rockwell
Automation**



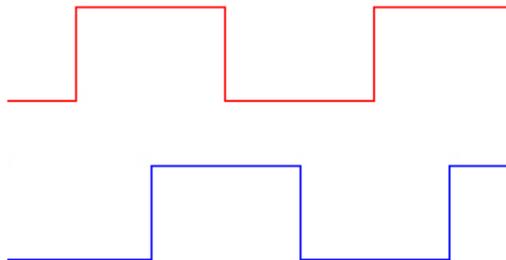
*CIP Motion Drives
Ethernet/IP*



Sercos Drives



Standalone Drives



Agenda

Motion Products Overview

Troubleshooting Overview

Axis Faults

Motion Instruction Errors

Configuration Errors

Grounding, Bonding, and Noise

Questions/Answers

Troubleshooting Overview

What is troubleshooting?

- Troubleshooting is a process
- Start broad and simple
- Gather information
- Utilize available resources
- Don't Panic!



Troubleshooting Overview

Basic Troubleshooting Methodology

- Evaluate symptoms
 - The description of problem is typically a symptom(s) of the problem
- Zero in on an area
 - Isolate devices or sections of the machine where possible
- Build a foundation
 - Test known causes
- Work up to the problem
 - Troubleshooting is a process of trial and error
- Repair / Replace



Troubleshooting Overview

Where do I start?

- Look at the equipment!
- Equipment displays and LED's
- Error codes
- What changed?
- New Install or Running System?



Faults, Errors, and Inhibits

Faults

- Condition preventing operation of the servo drive
- Caused by improper use of the servo drive

Errors

- Motion Instruction could not be completed due to improper state for operation
- Bad Instruction Arguments

Inhibits

- Condition preventing the servo from being enabled
- Safe Torque Off

Agenda

Motion Products Overview

Troubleshooting Overview

Axis Faults

Motion Instruction Errors

Configuration Errors

Grounding, Bonding, and Noise

Questions/Answers

Axis Faults: Fault Codes

Locating Drive Faults

- Look at the drive display, record the error code and LED color pattern
- Open Logix and use the quick view pane to determine type of fault
- View the fault code in Axis.AxisFault
- View the fault log in the axis properties of Logix
- View the online fault log for CIP axis drives

The screenshot shows the Logix Designer interface. In the Controller Organizer, the 'XYZ_Y' axis is selected, and a context menu is open with 'Show Quick View' highlighted. Below the tree view, a table displays the properties for 'Axis 1 - 192.168.1.5'.

2198-H003-ERS2 Kinetix_5500	
Axis 1 - 192.168.1.5	
Type	AXIS_CIP_DRIVE
Description	
Axis State	Faulted
Safety State	Not Configured (Torque Permitted)
Update Period	4.0 ms
Axis Fault	PhysicalAxisFault, FeedbackDataLossFLFault
Module Faults	No Faults
Group Fault	No Faults

Fault Logs

Expand Minimize

- Home
- Diagnostics
- Fault Logs
 - Fault Log

Fault Log

Fault Log (Most Recent on Top) (Real Time)

- CipTime(GMT): Thu Jan 1 01:18:50 1970 FaultId: 15 FLT S15 - CONV OVERCURRENT
- CipTime(GMT): Thu Jan 1 01:18:50 1970 FaultId: 4 FLT S04 - MTR OVERSPEED UL
- CipTime(GMT): Thu Jan 1 01:18:50 1970 FaultId: 3 FLT S03 - MTR OVERSPEED FL
- CipTime(GMT): Thu Jan 1 01:18:43 1970 FaultId: 4 FLT S04 - MTR OVERSPEED UL
- CipTime(GMT): Thu Jan 1 01:18:28 1970 FaultId: 15 FLT S15 - CONV OVERCURRENT

Kinetix 300

Load Faults		Clear Fault History		Clear Faults	
Last Fault Code	E07	Feedback lost: Bad feedback signals/data.			
Fault Code	Device Time				
E07	00:00:04	Feedback lost: Bad feedback signals/data.			
E07	06:47:56	Feedback lost: Bad feedback signals/data.			
E07	02:34:35	Feedback lost: Bad feedback signals/data.			
E09	00:00:05	Under Voltage			
E07	00:38:39	Feedback lost: Bad feedback signals/data.			
E07	00:56:40	Feedback lost: Bad feedback signals/data.			

Ultraware / Ultra 3000

00	E04: 39150:40	Motor Overtemperature Fault
01	E04: 39081:20	Motor Overtemperature Fault
02	E16: 39074:10	Overtravel Fault
03	E16: 39026:20	Overtravel Fault
04	E19: 39023:20	Excess Following Error Fault
05	E19: 38962:40	Excess Following Error Fault
06	E42: 38955:20	Unrecognized Error
07	E06: 38748:00	SERCOS Hardware Overtravel
08	E06: 38747:50	SERCOS Hardware Overtravel
09	E06: 38747:40	SERCOS Hardware Overtravel
10	E04: 38727:20	Motor Overtemperature Fault
11	E42: 38698:20	Unrecognized Error
12	E42: 38698:00	Unrecognized Error
13	E23: 25484:00	IPM Thermal Protection Fault
14	E19: 20253:20	Excess Following Error Fault

CIP Axis Fault Log

Categories:

- General
- Motor
 - Model
 - Analyzer
- Motor Feedback
- Scaling
- Hookup Tests

Faults and Alarms Log

Date/Time	△ Source	Condition	Action	End State
12/31/1969 19:10:...	Faults Cleared	Fault Log Reset	No Action	No Action
12/31/1969 19:10:05	No Alarms	Alarm Log Reset	Alarm Off	
12/31/1969 19:23:08	Faults Cleared	Connection Reset	No Action	No Action
12/31/1969 19:23:30	Faults Cleared	Fault Reset	No Action	No Action

Sercos Event / Fault Log
 Technote 56209

Drive Faults: Troubleshooting

Understanding Drive Faults

- Open the drive manual and read the fault description and solution
- Search for fault code on the knowledgebase
- Call R.A. Technical Support (440)-646-3434
- Motion Group Direct Dial Code 401

User Manual

Table 91 - FLT Sxx Fault Codes

Exception Code on Display	Exception Text	Problem
FLT S02 – MTR COMMUTATION	Motor Commutation Fault	An illegal state transition of hall-commutation feedback been detected.
FLT S03 – MTR OVERSPEED FL - 0	Motor Overspeed Factory Limit Fault	Motor speed has exceeded 1. maximum speed.
FLT S03 – MTR OVERSPEED FL - 1		The output frequency has ex Hz.
FLT S04 – MTR OVERSPEED UL	Motor Overspeed User Limit Fault	Motor speed has exceeded r overspeed user limit.
FLT S05 – MTR OVERTEMP FL nn	Motor Overtemperature Factory Limit Fault	Calculations based on the m thermistor indicate that the factory temperature limit ha exceeded. The nn sub-code is defined a 01: Motor Thermostat or The 02: Encoder Temperature Ser

Knowledgebase

What Do You Need Help With?

Refine search by: Product Error code Answer I

Enter search keywords:

Kinetix 5500 E19

Search Tips

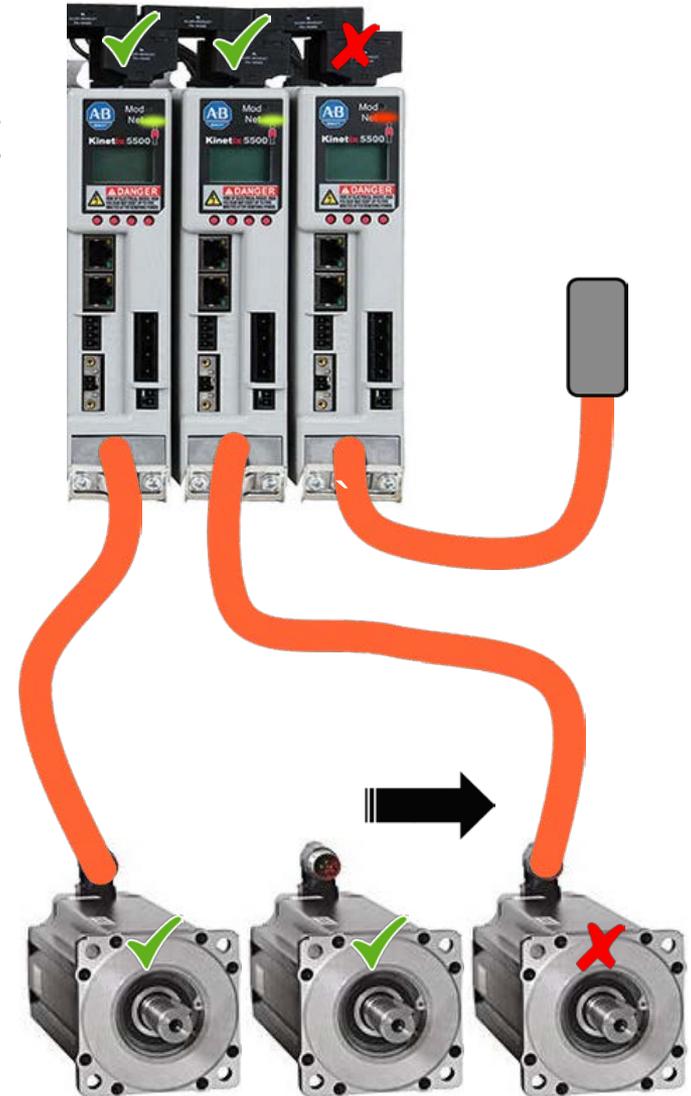
Drive Faults: Hardware

Troubleshooting Hardware

- Verify correct motor catalog against project
- Correct cables + wiring for flying lead
- Verify cable continuity with meter
- Network Connections
- Swap with a working system

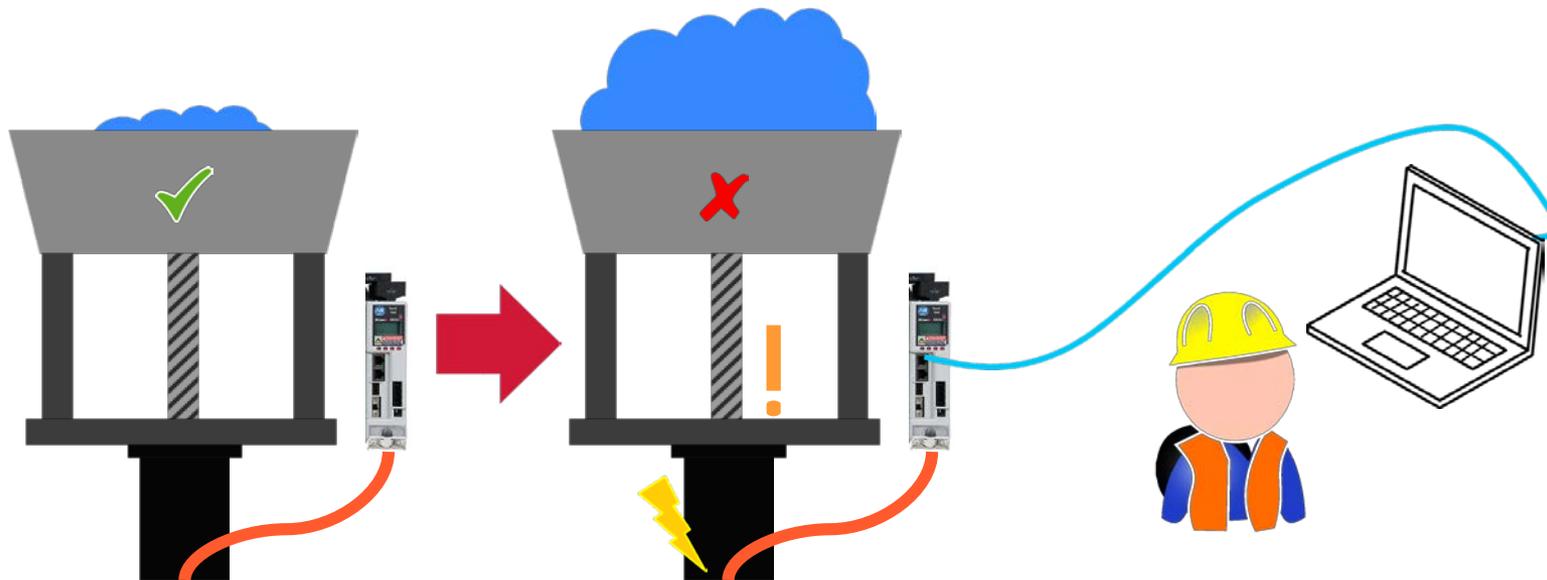
Troubleshooting Load

- Inspect Mechanics
- Verify Lubrication / Binding / Interference
- Trend motor actual current
- Trend position and velocity error

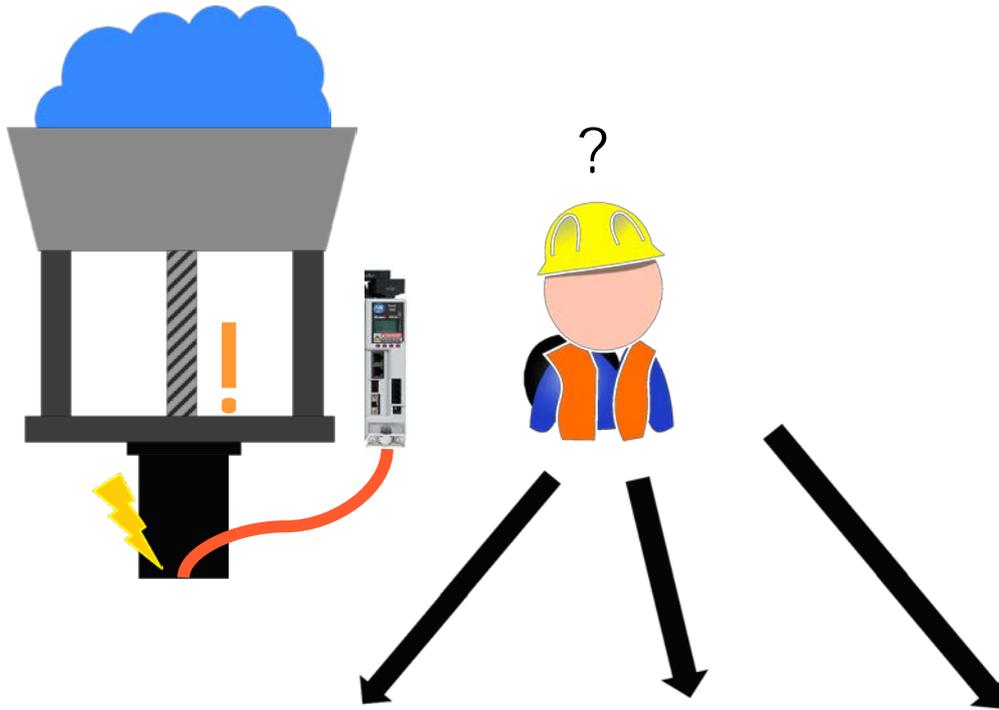


Drive Faults Troubleshooting: Example

Wigets Inc. wishes to run more product on their servo lift every day. Now every so often the machine stops running...



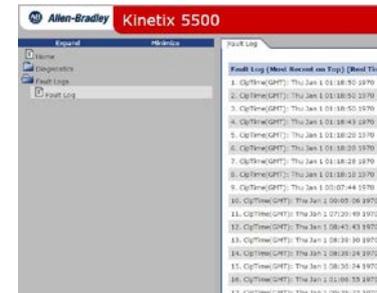
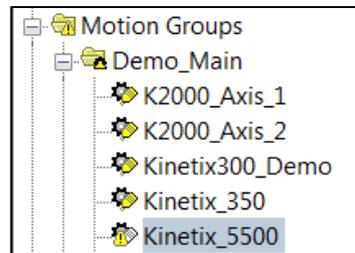
Drive Faults Troubleshooting: Example



Chapter 7 Troubleshoot the Kinetix 5500 Drive System

Table 55 - FLT Sxx Fault Codes (continued)

Exception Code on Display	Exception Text
FLT S10 – INV OVERCURRENT	Inverter Overcurrent Fault
FLT S11 – INV OVERTEMP FL	Inverter Overtemperature Factory Limit Fault
FLT S13 – INV OVERLOAD FL	Inverter Thermal Overload Factory Limit Fault



Drive Faults Troubleshooting: Example



- ✓ Re-Tune Motor
- ✓ Reduce Velocity / Acceleration
- ✓ Decrease Load
- ✓ Upgrade to a larger motor/drive

Clearing Axis Faults

Clearing Faults

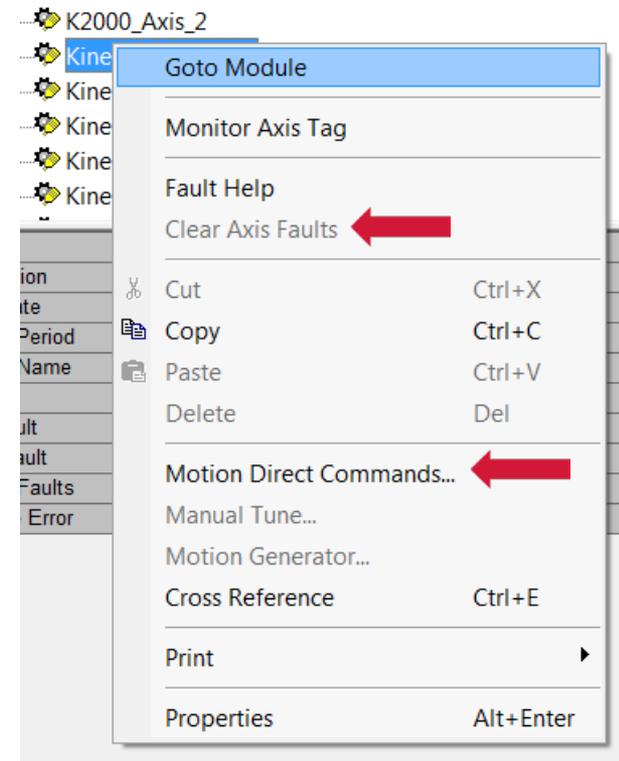
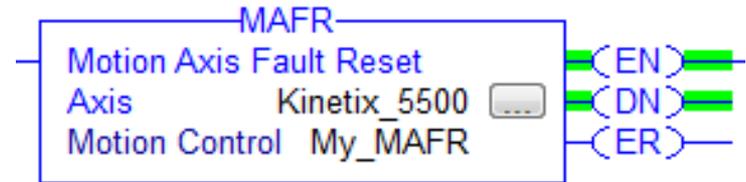
- MAFR / MASR

- Motion Direct

- Right Click -> Clear Axis Faults

- Power Cycle

- Self-Clearing Faults



Agenda

Motion Products Overview

Troubleshooting Overview

Axis Faults

Motion Instruction Errors

Configuration Errors

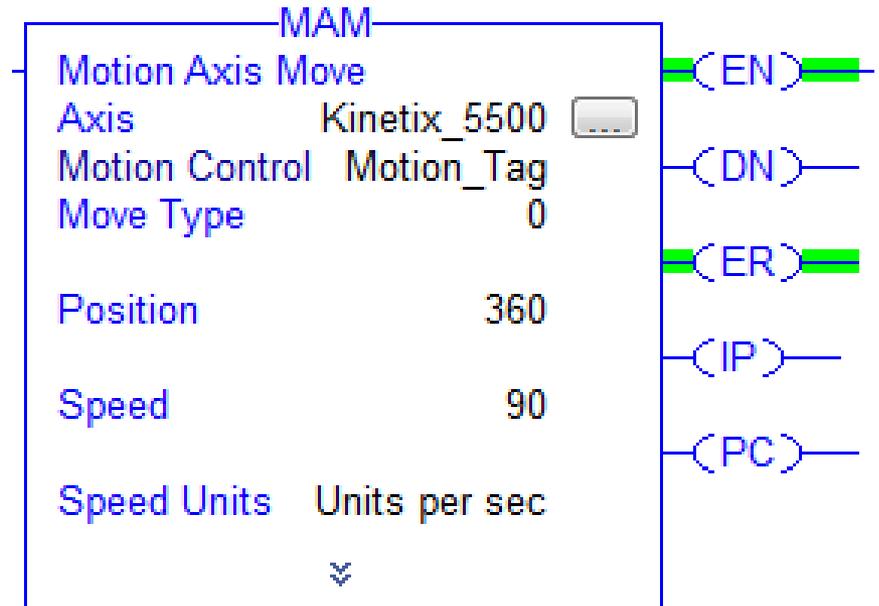
Grounding, Bonding, and Noise

Questions/Answers

Motion Instruction Errors

What is a Motion Instruction Error?

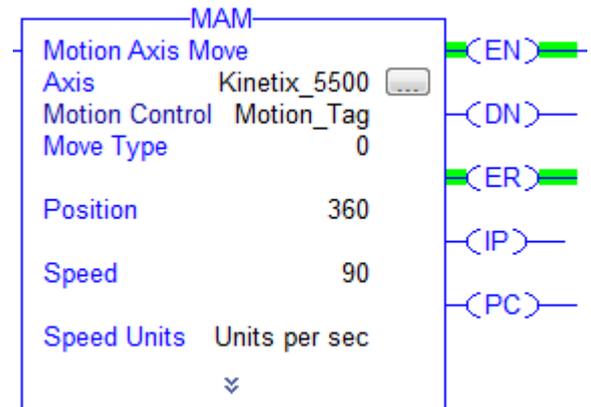
- Instructions that cannot complete
- Axis State Errors
- Syntax Errors
- Bad Programming Practices



Motion Instruction Errors

Locating Motion Instruction Errors

- Go online with your controller and watch the code run
- ERR value
- EXERR value
- Duplicate Motion Control Tag
- Control bit unlatching



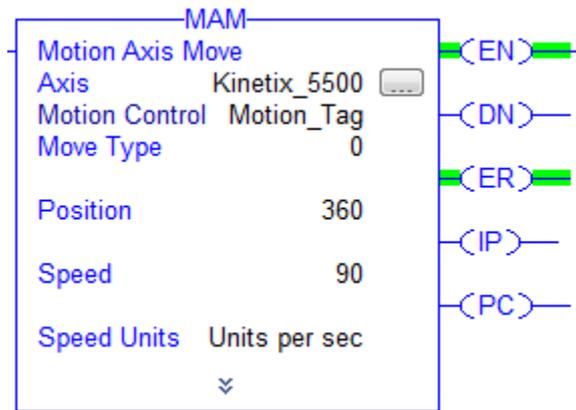
- Motion_Tag.ER	Controller	1
+ Motion_Tag.ERR	Controller	11
+ Motion_Tag.EXERR	Controller	1

Motion Instruction Errors

Understanding Motion Instruction Errors

- Error Code Table (MOTION-RM002 Appendix A)
- F1 – Logix Help
- Knowledgebase
- Don't automatically reset the instructions

Motion Instruction Error Example



Motion_Tag.ER	Controller	1
+ Motion_Tag.ERR	Controller	78

Error	Corrective Action or Cause	Notes
78	New check for a secondary Instruction overlap on top of an active Stop instruction.	Not Allowed While Stopping You cannot overlap certain Motion instructions while stopping. Wait for the first instruction to complete before starting the second instruction.

We notice that the MAM is issuing before the previous MAS is completed

Adding a condition that the MAS.PC bit must be active before issuing the MAM instruction prevents this error from happening again!

Agenda

Motion Products Overview

Troubleshooting Overview

Axis Faults

Motion Instruction Errors

Configuration Errors

Grounding, Bonding, and Noise

Questions/Answers

Motion Axis Configuration Errors

What is a Configuration Error?

- Incorrect data preventing the drives from operating
 - Firmware Mismatch
 - Product Mismatch
 - Motor Mismatch
 - IP or Node addresses
- Bad axis configuration values (Attribute Error)

SERCOS

- "RaceTrack" – Not configured
- 0 - Looking for ring
- 1 - Looking for active nodes
- 2 - Configuring communication
- 3 - Configuring nodes
- 4 - Configured and active

CIP

- 0 - Initializing
- 1 - Pre-Charge
- 2 - Stopped
- 3 - Starting
- 4 - Running
- 5 - Testing
- 6 - Stopping
- 7 - Aborting
- 8 - Faulted
- 9 - Start Inhibited
- 10 - Shutdown...

Motion Group Synchronization

What is Motion Group Synchronization?

- Logix processor verifies all axes are ready to perform motion

Why do I care about it?

- No axes can be used until all are “happy” and ready to be used.

What causes failed synchronization?

- Missing or unconnected drives
- Incorrect motor in axis configuration
- Bad network health
- Incorrect axis configuration parameters



Axis Configuration Error Example

Example...

Troubleshooting Group Synchronization

Troubleshooting

- Look for yellow triangles on axes
 - Quick view pane
 - Attribute errors
- Look for yellow triangles on modules
 - Module errors
 - Missing Hardware

Type	MOTION_GROUP Periodic
Description	
Coarse Update Period	4.0 ms
Timing Model	One Cycle
Group Status	Not Synchronized
Group Fault	No Faults
Axis Fault	PhysicalAxisFault, ModuleFault

The screenshot shows a tree view under 'Motion Groups' with a sub-folder 'Demo_Main'. Inside 'Demo_Main', there are several axes: K2000_Axis_1, K2000_Axis_2, Kinetix300_Demo, Kinetix_350, and Kinetix_5500. The Kinetix_5500 module has a yellow triangle with an exclamation mark next to it. A red arrow points from this icon to a detailed property window for the module.

Type	AXIS_CIP_DRIVE
Description	
Axis State	Faulted
Safety State	Unknown (No Motion Connection)
Update Period	4.0 ms
Axis Fault	ModuleFault
Module Faults	ControlSyncFault, ModuleConnFault
Group Fault	No Faults

The screenshot shows a tree view under 'Ethernet' with two modules: 1756-EN2T EN2T and 2198-H003-ERS2 Kinetix_5500. The 2198-H003-ERS2 Kinetix_5500 module is highlighted. Below it is a detailed property window for the module.

Associated Axes	
Kinetix_5500	
Description	
Power Structure	2198-H003-ERS2
Status	Connecting
Module Fault	(Code 16#0204) Connection Request Error: Connection request timed out.

Agenda

Motion Products Overview

Troubleshooting Overview

Axis Faults

Motion Instruction Errors

Configuration Errors

Grounding, Bonding, and Noise

Questions/Answers

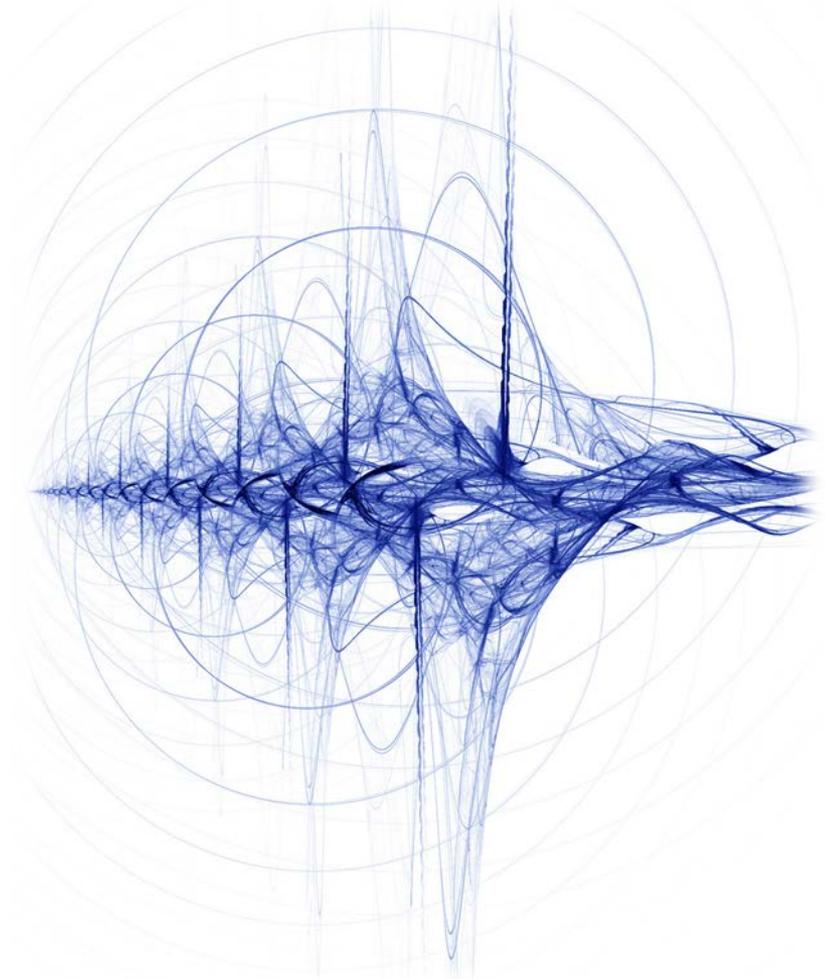
Troubleshooting Noise

What is Electrical Noise?

- Electromagnetic Radiation
- Unwanted signal fluctuations

What causes Electrical Noise?

- Contactors / Transformers
- Cabinet Chillers / Air Conditioners
- **VFDs / Servo Drives!**



What is Electrical Noise important with servo drives?

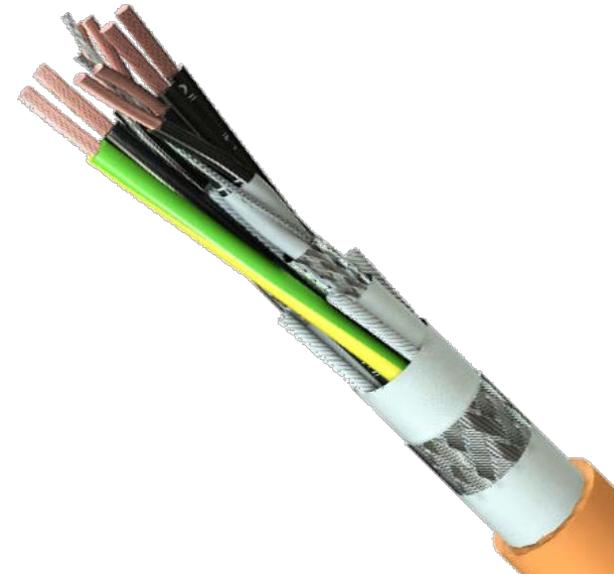
- Drives Generate Noise
- Sensitive Signals
- Faults
- Failed Network Communications
- Poor Motion Performance
- Unintended Motion / Audible Noise



Troubleshooting Noise

How to I minimize noise issues with my drives?

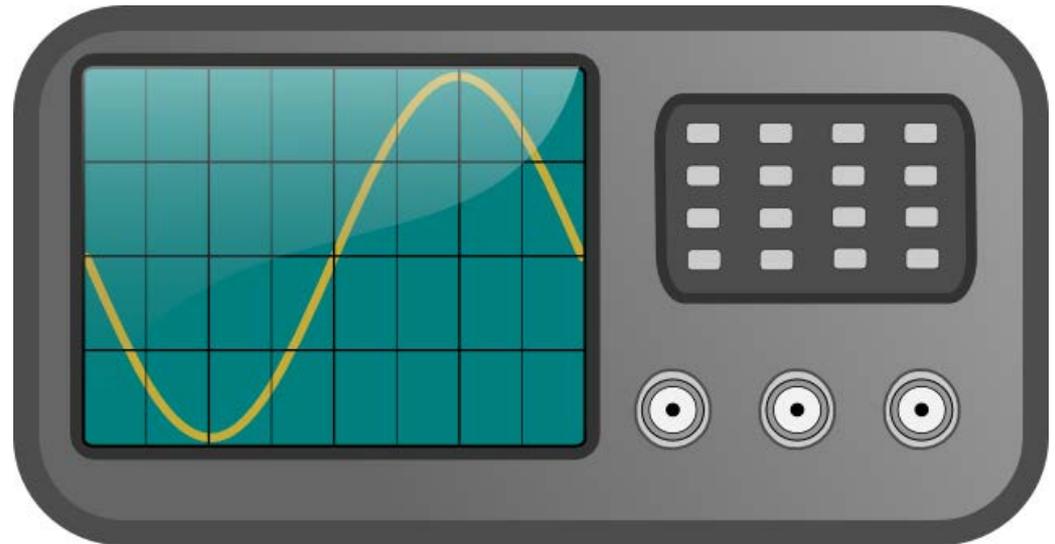
- Clamp Motor Power Cables
- Trim Motor Power and Feedback Cables to Length
- Separate Motor Power and Feedback Cables
- Drive Mounting
- Line Power Filtering
- GMC-RM001



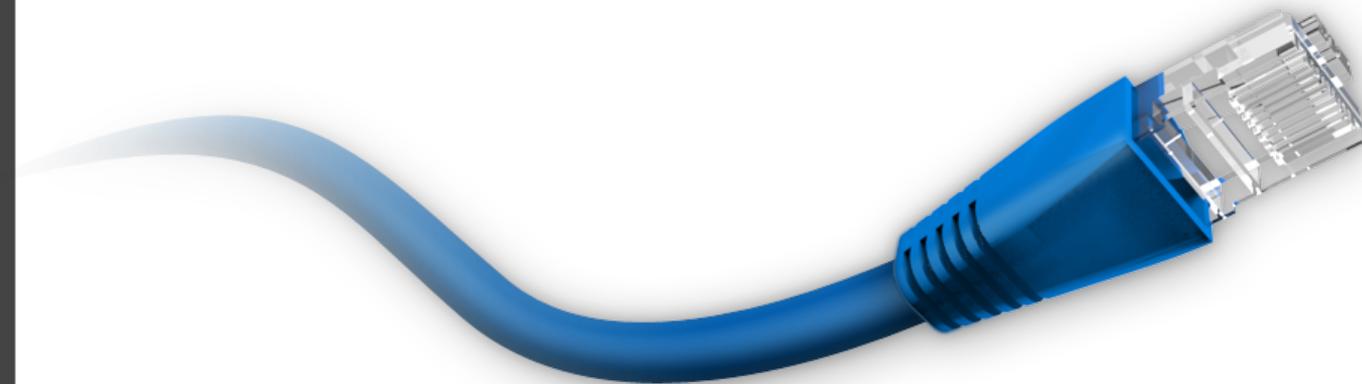
Diagnosing Noise

How can I measure if I have electrical noise?

- Oscilloscope
- Encoder Signal Lines
- Shield Jackets
- Incoming AC Line
- E-field Sniffing



*Join us for the upcoming
Genius Webinar on Motion Networks!*



- General Troubleshooting
- Drive Faults
- Motion Instruction Errors
- Configuration Errors
- Noise Mitigation and Troubleshooting

Reference Materials

Manuals

Motion Instruction Manual: [Publication: MOTION-RM002](#)

SERCOS / Analog Startup: [Publication: MOTION-UM001](#)

CIP Configuration & Startup: [Publication: MOTION-UM003](#)

Control of Electrical Noise: [Publication GMC-RM001](#)

Knowledgebase & Sample Code

Sercos Drive Fault Log AOI: [Sample Code Library](#)

Sercos Ring Event / Error Logging: [56209](#)

Recommended Wiring Practices: [49795](#)

LISTEN.
THINK.
SOLVE.®

Thank You & Questions

Rockwell Automation Technical Support: (440)-646-3434

Direct Dial Code 401



PUBLIC



Connect with us.

www.rockwellautomation.com

 Allen-Bradley • Rockwell Software

**Rockwell
Automation**