Product: Yaskawa CANopen over EtherCAT	**Doc#:** SRV-S0L2U9
Title: Solving Yaskawa EtherCAT drive runs motor with poor motion, A.A12, A.A11	

Question:

How do I solve the problem where the Yaskawa EtherCAT drive runs a motor that has poor motion (jumps, hiccups, shudders, stutters, spontaneous vibrations, jerks, grinding, noisy, etc.) or sometimes I get A.A12 or A.A11?

Answer:

Possible situations:

1. Developing an EtherCAT master (see item 1 below)
2. Using a commercially available EtherCAT master (see item 2 below)

1. If Developing an EtherCAT master:

- Refer to Yaskawa.com document number AN.MTN.01 “Architecture for EtherCAT Master”:
- To prove out the Yaskawa EtherCAT drive system environment under test, refer to Yaskawa.com document number AN.MTN.03 “EtherCAT Servo Drive Quick Start Guide”.
- Note: The SGDV EtherCAT drive has been proven to operate at 125us EtherCAT cycle time with a TwinCAT master with Distributed Clocks enabled.
- Proceed with item 2 below “If using a commercially available EtherCAT master”.

2. If using a commercially available EtherCAT master:

- Refer to Yaskawa.com document number SIEPC72082904, section 9.3 “Troubleshooting”, Problem “Servomotor Moves Instantaneously, and then Stops”.
- Also refer to Problem “Servomotor Speed Unstable”.
- See either flowchart “Analyze Existing System” or “Proving Out The System”.

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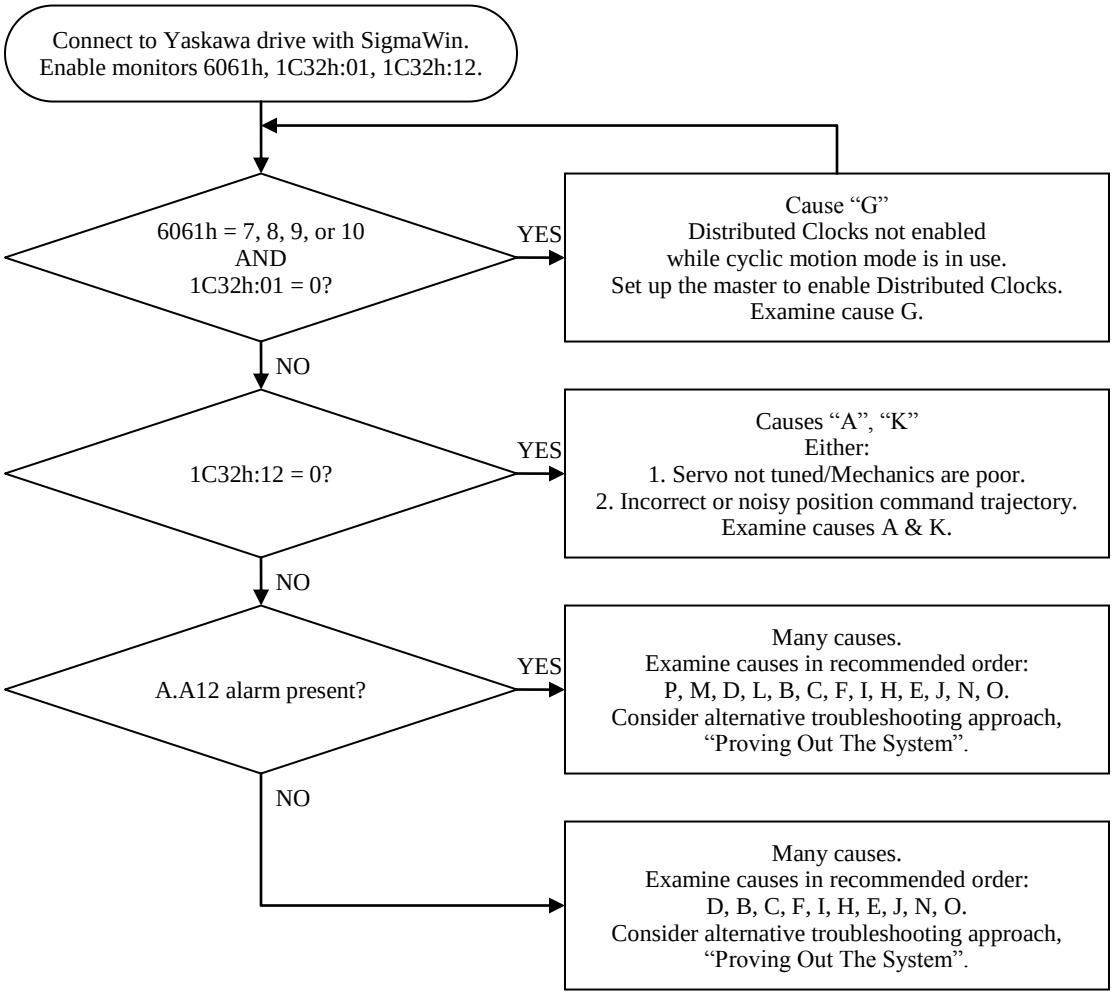
Analyze Existing System:

- By analyzing the existing system, troubleshooting steps may be minimized.
- Follow the flowchart below to troubleshoot using this method of analyzing the system:



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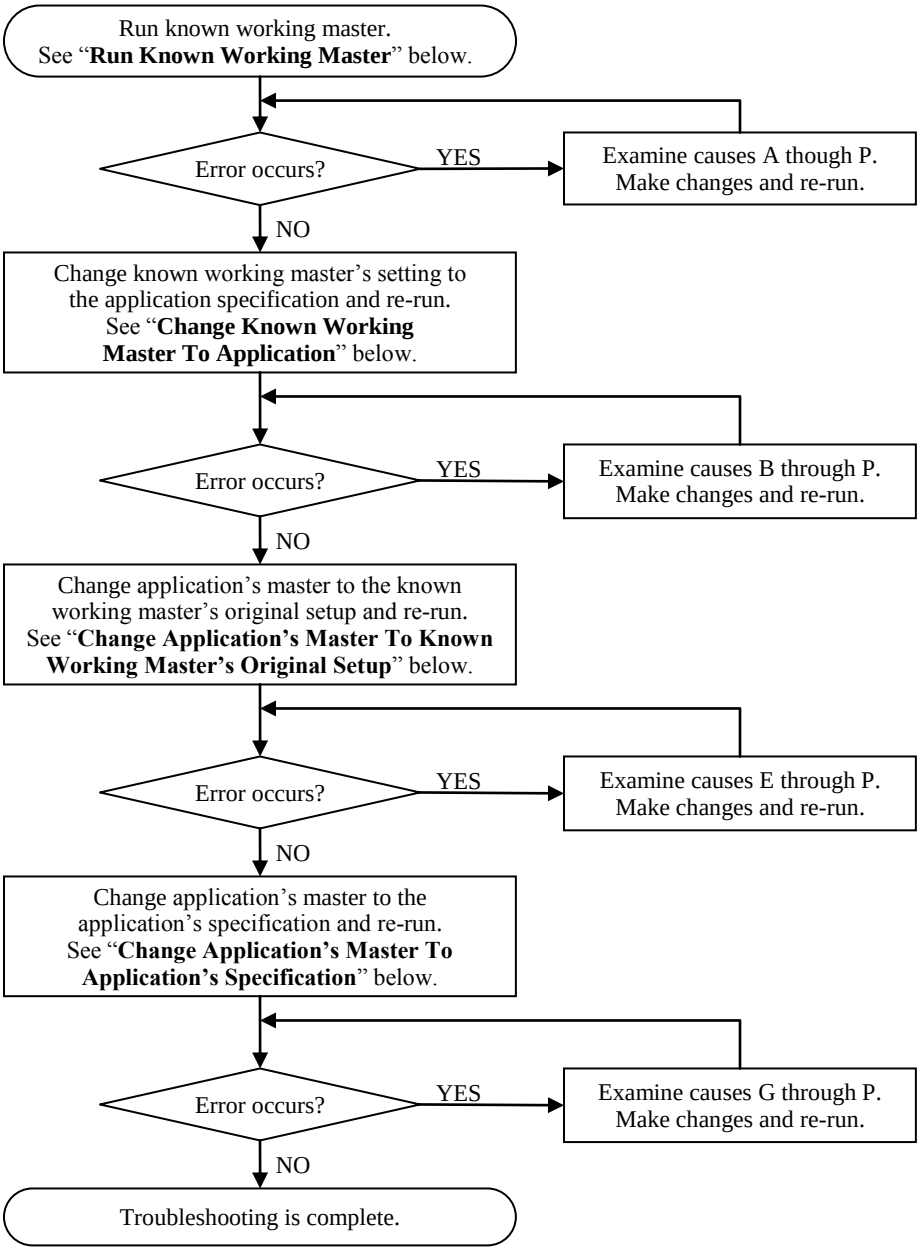
Proving Out The System:

- By running the machine with a known working EtherCAT master successfully, the machine is proven to be OK and the issue resides in the application's EtherCAT master implementation or settings.
- Troubleshooting steps may be minimized using this approach.
- Follow the flowchart below to troubleshoot using this method of proving out the system:



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Run Known Working Master:

1. Create a known working EtherCAT master by following AN.MTN.03 “EtherCAT Servo Drive Quick Start Guide”.
2. Run the system for the amount of time that would prove out the system (Example: 10 minutes, or possibly 24 hours).

Change Known Working Master To Application:

1. Change the known working EtherCAT master’s setting to the application specification:
    a. DC Clock enable/disable
    b. Cycle time
    c. Topology
    d. DC clock reference
    e. Etc.
2. Run the system for the amount of time that would prove out the system (Example: 10 minutes, or possibly 24 hours).

Change Application’s Master To Known Working Master’s Original Setup:

1. Change the application’s EtherCAT master to the known working master’s original setup in AN.MTN.03 “EtherCAT Servo Drive Quick Start Guide” (1 Ethernet cable with no network switches, no motor load, 2ms cycle time, 1st slave DC reference, etc.)
2. Run the system longer than the amount of time that resulted in errors in the original situation.

Change Application’s Master To Application’s Specification:

1. Change the application’s EtherCAT master to the application’s specification (topology, load, cycle time, DC reference, etc.)
2. Run the system longer than the amount of time that resulted in errors in the original situation.

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The following table lists the possible causes, investigative actions, and corrective actions for the drive running a motor with poor motion, or A.A12/A.A11 occurs.

Probable Cause	Investigative Actions	Corrective Actions
Cause A: Servo is not tuned. Machine mechanics are poor.	Verify with SigmaWin that the motor jogs without the poor motion. Trace the Feedback Speed using SigmaWin Trace function. Run a Program Jog profile that matches the profile where the abnormal motion was evidenced. Trace the Feedback Speed using SigmaWin Trace function. If poor motion occurs in SigmaWin Jog or SigmaWin Program jog, check the wiring of the power and encoder cables and check the mounting of the motor to the machine. Check the machine design.	Correct the power and encoder cable wiring. Adjust the machine mechanics. Modify the machine design. If poor motion does not occur in SigmaWin Jog or SigmaWin Program Jog, tune the servomotor.
Cause B: Devices in topology are not compatible with EtherCAT.	Check all devices in the topology. Non-EtherCAT-certified Ethernet switches must not be present on the EtherCAT network. Acquire SigmaWin Trace and check SigmaWin plot for discontinuities (see “SigmaWin Trace” in the section below this table).	Change topology to Line topology and test only the Yaskawa Drive without any 3rd party devices on the network. Verify 3rd party device compatibility for EtherCAT usage.
Cause C: Communication cables do not meet specifications, such as poor quality Ethernet cables.	Check that high-quality shielded Ethernet cables that conform to the 100Base-T Ethernet standard are installed. Check that the cable meets the requirements for the Ethernet cables in the Yaskawa drive’s manual (50m max for SGDV, Shielded). Check that the bend radius of the communication cable does not exceed the cable manufacturer’s specification. Acquire SigmaWin Trace and check SigmaWin plot for discontinuities (see “SigmaWin Trace” in the section below this table).	Change the communication cable to a high-quality shielded Ethernet cable designed for industrial 100Base-T Ethernet. (Example: Omron EtherCAT cable XS5W-T421-BMD-K). Change the communication cable to a cable that meets the Yaskawa drive’s specifications. Change the cable bend radius to be equal to or greater than the cable manufacturer’s specified bend radius.

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Probable Cause	Investigative Actions	Corrective Actions
Cause D: EtherCAT cable plugged into incorrect port.	Check that the EtherCAT cable is plugged into the correct port (“IN” or “OUT”) on the Yaskawa drive.	Correct the EtherCAT cable connections.
Cause E: Insufficient signal strength from the EtherCAT master.	Check the EtherCAT master hardware specifications that the EtherCAT ports conform to the 100-BaseT Ethernet standard. Acquire SigmaWin Trace and check SigmaWin plot for discontinuities (see “SigmaWin Trace” in the section below this table).	Change the hardware, or use an industrial Ethernet switch to amplify the signal.
Cause F: Network Interface Controller (NIC) is incompatible with PC-based EtherCAT master software.	Check the EtherCAT master NIC requirements. For Beckhoff TwinCAT, a specific NIC is required (published list from Beckhoff). For Acontis, a specific NIC is required (contact Acontis). Acquire SigmaWin Trace and check SigmaWin plot for discontinuities (see “SigmaWin Trace” in the section below this table).	Change the NIC to meet the requirements by the EtherCAT master.
Cause G: Distributed Clocks not enabled while Cyclic motion mode is in use.	Check SigmaWin Motion Monitor “6061h:Modes of Operation Display”. Check SigmaWin Motion Monitor “1C32h:01:Synchronization type”.	Set up the master to enable Distributed Clocks if using Mode of Operation 7, 8, 9, or 10, and verify SigmaWin Motion Monitor “1C32h:01:Synchronization type” is 2. Note: “1C32h:01:Synchronization type” may be 0 or 2 if using Mode of Operation other than 7, 8, 9, or 10.

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Probable Cause	Investigative Actions	Corrective Actions
Cause H: Insufficient EtherCAT master performance for the chosen EtherCAT network cycle time.	Check that the EtherCAT master performance is sufficient to operate the chosen EtherCAT network cycle time. For Beckhoff TwinCAT, check that the “RTime %” or “Real Time Usage” in the Real-Time Settings. Acquire SigmaWin Trace and check SigmaWin plot for discontinuities (see “SigmaWin Trace” in the section below this table).	Change the EtherCAT cycle time in the master (maximum 4ms for SGDV), or check EtherCAT master documentation and contact EtherCAT master’s vendor for recommended hardware for the application (specify desired EtherCAT cycle time). Stop execution of programs in the software running on the hardware that are not essential during machine operation. For Beckhoff TwinCAT 2, a 64-bit OS cannot be used for realtime operations.

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Probable Cause	Investigative Actions	Corrective Actions
Cause I: EtherCAT system not set up properly	Check the EtherCAT configuration. Compare the EtherCAT communication cycle to the drive's communication cycle (SigmaWin Motion Monitor 1C32:02:Cycle time). For Beckhoff TwinCAT, check the "I/O at Task Begin" option. For Beckhoff TwinCAT, check SYNC Shift Time in Master>EtherCAT>Advanced Settings>Distributed Clocks. For Beckhoff TwinCAT, if using NC, check the SAF Cycle Ticks. For Beckhoff TwinCAT, check SM Watchdog (register 420h) in Drive>EtherCAT>Advanced Settings>General>Behavior>Watchdog. For Beckhoff TwinCAT, check the task priorities. Acquire SigmaWin Trace and check SigmaWin plot for discontinuities (see "SigmaWin Trace" in the section below this table).	Contact the EtherCAT master's vendor for proper EtherCAT system setup. For Beckhoff TwinCAT, set the "I/O at Task Begin" option. For Beckhoff TwinCAT, increase SYNC Shift Time. For Beckhoff TwinCAT, if using NC, set the SAF Cycle Ticks to a multiple of 125 us. For Beckhoff TwinCAT, enable "Set SM Watchdog" and set value. (Example: ECAT cycle time is 1ms. Setting 1.2ms to Watchdog, the SGDV will not produce A.A11. When setting to 1.1ms to Watchdog, SGDV does produce A.A11.) For Beckhoff TwinCAT, increase the priority of the EtherCAT task.

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Probable Cause	Investigative Actions	Corrective Actions
Cause J: Communications affected by EMI	Check that cables are shielded and not routed near power lines or other sources of noise. Check that the equipment installation (machine's power & ground connections, cable routing, etc.) adheres to the installation instructions described in the Yaskawa drive's user's manual, including the "EMC Install Conditions" section. Check Yaskawa.com document number eng02.016 and check that the machine adheres to the installation described in the document. Check the panel rating for CE. Check the rate of increase of SigmaWin Motion Monitor "1C32h:12:SM2 event miss count" during operation. Check communication cable specifications. Acquire SigmaWin Trace and check SigmaWin plot for discontinuities (see "SigmaWin Trace" in the section below this table).	Change the cable to a shielded cable and change the routing to avoid sources of noise. Use communication cables specified for industrial use (Example: Omron EtherCAT cable XS5W-T421-BMD-K). Change the equipment installation to adhere to the Yaskawa drive's user's manual, EMC Install Conditions, and document eng02.016. Change the panel to a panel that meets CE. Re-check the rate of increase of SigmaWin Motion Monitor "1C32h:12:SM2 event miss count" during operation to verify that SM2 events are not missed.
Cause K: Incorrect or noisy position command trajectory.	Check SigmaWin monitor "1C32h:12:SM2 event miss count" is 0. Acquire SigmaWin Trace and check SigmaWin plot for discontinuities (see "SigmaWin Trace" in the section below this table). Acquire Wireshark Trace and check position commands from master.	Correct the commanded position from the EtherCAT master.
Cause L: A.A12 alarm threshold set to lower than application requirement.	Check CoE object 10F1:2h.	Set CoE object 10F1:2h according to application requirements.

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Probable Cause	Investigative Actions	Corrective Actions
Cause M: EtherCAT communications stopped abruptly.	If A.A12 occurs when stopping EtherCAT communications, this is normal.	Perform fault reset after re-establishing communications though EtherCAT.
Cause N: Distributed Clocks not implemented properly on 3rd party device that is used as reference clock.	Check the DC method on the device that is the DC reference clock for the system (which may be the master or a slave). Acquire SigmaWin Trace and check SigmaWin plot for discontinuities (see "SigmaWin Trace" in the section below this table).	Contact the manufacturer of the device, change the DC method in the master, or use the Yaskawa drive as the DC reference clock.
Cause O: Master's EtherCAT specification and Yaskawa drive's EtherCAT specification are not compatible.	Prove out the system by using an EtherCAT master that has compatibility with Yaskawa EtherCAT drives (see "Proving Out The System" in the section below this table).	Contact the EtherCAT master's vendor and request compatibility testing with Yaskawa drives. Contact Yaskawa sales representative to request compatibility testing with Yaskawa drives.
Cause P: Electrical contact for communications hardware is insufficient.	Visually inspect the RJ-45 connector on the devices and the communication cables. Refer to section "Electrical Contact Inspection" for examples of visual inspection.	If the communication hardware contacts on the Yaskawa device appear unclean, contact Yaskawa for support. Yaskawa can check the contacts and clean them with isopropyl alcohol and a cleanroom rated polyester applicator.

SigmaWin Trace:

Using Yaskawa's configuration software "SigmaWin", acquiring a trace as described may be useful in diagnosing the cause of the issue.

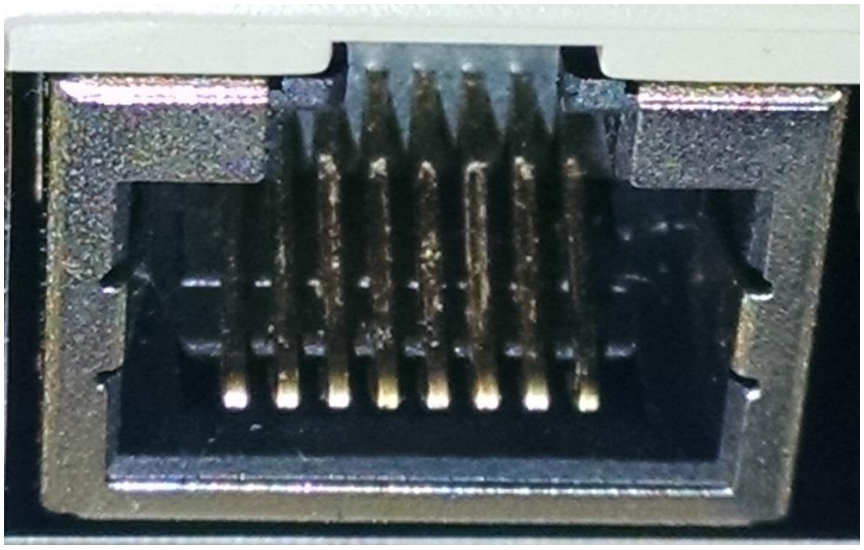
Set up the SigmaWin Trace to include at least the following points:

- Set the sampling time to the EtherCAT cycle time or faster.
- Select the data trace "Position Reference Speed".
- Set the trigger condition such that the trace will acquire data during a move.

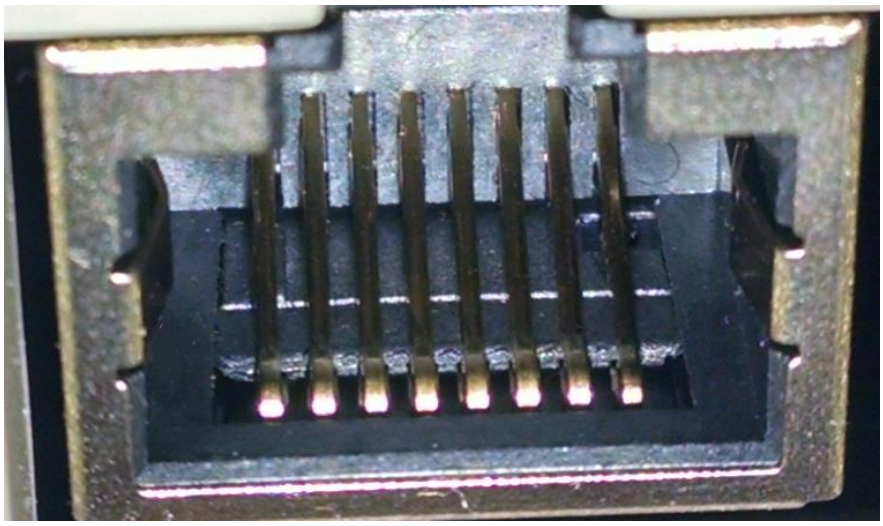
Acquire a trace.

Refer to the SigmaWin user's manual (installed with SigmaWin) for usage details of SigmaWin.

Electrical Contact Inspection:



Above: The communications hardware (RJ-45 connector) has unclean contacts (notice the white residue on the contacts), resulting in insufficient electrical contact for communications.



Above: The communications hardware (RJ-45 connector) has clean contacts, resulting in sufficient electrical contact for communications.