VFD and Servo Drive Systems Root Cause Analysis Workbook - Loss of Output or Performance

VFD and Servo Drive Systems | Loss of Output or Performance | Asset ID FIX-08-06-03

Safety gate: Stop, isolate and verify before exposure to hazardous energy. Lockout/Tagout and live testing require the applicable site procedure, authorised controls and a qualified person. Never bypass a guard, interlock or protective device to complete this workbook.

How to use this field resource

This is an equipment-agnostic documentation workbook for vfd and servo drive systems. It helps a trained team preserve alarm history and operating context before resets, parameter edits or replacement. It does not identify a fault by itself and does not replace the equipment-specific OEM manual, drawings, limits, permits or a qualified technician's judgement.

Intake field	Record
Asset or equipment ID	_____
Site and location	_____
Reported by / time	_____
Fault situation	Loss of Output or Performance
Operating state	Stopped / standby / starting / running / loaded
Safety owner	_____
OEM reference used	Document number and revision: _____

Evidence areas for this system

For a loss of output or performance, focus on evidence that can be dated, repeated and handed to another technician. Capture the as-found state before clearing alarms, changing settings or disturbing connections.

#	Evidence area	First record
1	Alarm and event history	As-found note: _____
2	Incoming supply state	As-found note: _____
3	Drive status and command source	As-found note: _____
4	Motor and feedback connection	As-found note: _____
5	Load and motion condition	As-found note: _____
6	Parameter-change record	As-found note: _____

Root Cause Analysis Workbook

Use this section to compare expected capacity with the actual result under a recorded load. Record baseline, demand, output and limiting indication before choosing the next action.

Branch	Confirmed fact	Cause hypothesis	Discriminating evidence
0	Observed fact: _____	Possible link to alarm and event history	Evidence needed: _____
1	Observed fact: _____	Possible link to incoming supply state	Evidence needed: _____
2	Observed fact: _____	Possible link to drive status and command source	Evidence needed: _____
3	Observed fact: _____	Possible link to motor and feedback connection	Evidence needed: _____
4	Observed fact: _____	Possible link to load and motion condition	Evidence needed: _____
5	Observed fact: _____	Possible link to parameter-change record	Evidence needed: _____

Root-cause standard

- A replaced part is not automatically the root cause.
- Name the physical or process mechanism that produced the failure.
- Explain why the evidence rules out the closest alternative.
- Identify the condition that allowed the cause to persist.
- Define a verification that would fail if the diagnosis were wrong.

VFD and Servo Drive Systems Evidence Map

Evidence first: Preserve alarms, event history, settings, trends and the as-found physical state before reset, disconnection or adjustment. If safe access is uncertain, stop and refer the task to the authorised person.

#	System area	Evidence action	Trace	Record
1	Alarm and event history	Observe and identify	Evidence ID: _____	Finding: _____
2	Incoming supply state	Record source and time	Evidence ID: _____	Finding: _____
3	Drive status and command source	Compare with reference	Evidence ID: _____	Finding: _____
4	Motor and feedback connection	State what it supports	Evidence ID: _____	Finding: _____
5	Load and motion condition	State what it rules out	Evidence ID: _____	Finding: _____
6	Parameter-change record	Choose the least invasive next check	Evidence ID: _____	Finding: _____

Scenario boundary

For this loss of output or performance, confirm the complaint with comparable conditions before escalating the repair. Write the boundary before testing so urgency does not quietly change the rules.

Boundary	Definition
Known good condition	_____
Known failed condition	_____
Difference between them	_____
First missing evidence	_____
Stop-work threshold	_____
Escalation owner	_____

Evidence labels

- FACT - directly observed and traceable.
- REPORT - supplied by another person; source recorded.
- INFERENCE - reasonable explanation that still needs a test.
- UNKNOWN - important gap that must not be filled by assumption.
- LIMIT - OEM, engineering or site acceptance value.

Loss of Output or Performance Condition Workbook

The goal is to compare expected capacity with the actual result under a recorded load. Describe the failed state narrowly enough that another trained person could look for the same thing without being told your suspected cause.

Question	Boundary prompt	Record
What changed?	Function, output, indication or behaviour	_____
Where?	Asset, side, circuit, zone or process stage	_____
When?	Sequence step, runtime, load or environment	_____
How often?	Every cycle, random, once, or after delay	_____
What restores it?	Nothing, time, reset, cooling or load change	_____
What stays normal?	Unaffected systems or functions	_____
What changed recently?	Work, software, settings, parts or operating duty	_____

Controlled reproduction plan

Plan field	Record
Safe starting state	_____
One condition to vary	_____
Conditions held constant	_____
Evidence captured	Baseline, demand, output and limiting indication
Maximum attempts	_____
Immediate stop signal	_____
Authorising person	_____

Attempt notes

Attempt	Starting condition	Result	Decision
1	State: _____	Observed: _____	Next decision: _____
2	State: _____	Observed: _____	Next decision: _____
3	State: _____	Observed: _____	Next decision: _____
4	State: _____	Observed: _____	Next decision: _____

Measurement and Evidence Register

Measurement boundary: This page records an approved test; it does not authorise one. A qualified person must choose the method, instrument category, connection points, isolation state and protective controls from the applicable procedure.

ID	Evidence area	Traceable source	Result	When
1	Alarm and event history	Method / source: _____	Value / state: _____	Time: _____
2	Incoming supply state	Method / source: _____	Value / state: _____	Time: _____
3	Drive status and command source	Method / source: _____	Value / state: _____	Time: _____
4	Motor and feedback connection	Method / source: _____	Value / state: _____	Time: _____
5	Load and motion condition	Method / source: _____	Value / state: _____	Time: _____
6	Parameter-change record	Method / source: _____	Value / state: _____	Time: _____

Instrument and reference record

Control	Record
Instrument or data source	_____
Identifier and range	_____
Calibration / validation status	_____
OEM or engineering reference	Document and revision: _____
Equipment operating state	_____
Uncertainty or limitation	_____

Before using a value

- Check units, scale, timestamp and source identity.
- Keep raw evidence where practical; do not retain only a conclusion.
- Record values that disagree with the current theory.
- Compare only like operating conditions.
- Treat a single normal reading as one data point, not proof that an intermittent fault is absent.

Cause and Evidence Matrix

List competing explanations before the team settles on one. A good next check separates hypotheses; a poor check produces the same answer no matter which cause is true.

#	Hypothesis	Supporting	Contradicting	Discriminating check
1	Alarm and event history hypothesis	For: _____	Against: _____	Next evidence: _____
2	Incoming supply state hypothesis	For: _____	Against: _____	Next evidence: _____
3	Drive status and command source hypothesis	For: _____	Against: _____	Next evidence: _____
4	Motor and feedback connection hypothesis	For: _____	Against: _____	Next evidence: _____
5	Load and motion condition hypothesis	For: _____	Against: _____	Next evidence: _____
6	Parameter-change record hypothesis	For: _____	Against: _____	Next evidence: _____

Five-why chain with evidence

Level	Explanation	Proof or gap
Problem	Loss of Output or Performance	Evidence ID: _____
Why 1	_____	Evidence: _____
Why 2	_____	Evidence: _____
Why 3	_____	Evidence: _____
Why 4	_____	Evidence: _____
Why 5	_____	Evidence: _____

Cause confidence

- Confirmed - reproduced or directly measured against a valid reference.
- Probable - best fit, but one meaningful alternative remains.
- Possible - plausible and worth a safe test.
- Unrelated - contradicted by the evidence.
- Unknown - evidence is missing or unreliable.

Repair Decision and Return-to-Service Gate

Release authority: Completion of a repair is not permission to energise or operate. Restore energy and return equipment to service only through the site's authorised process, with guards and protective functions reinstated.

Decision field	Record
Confirmed problem	_____
Evidence-supported cause	_____
Approved repair reference	Document and revision: _____
Work completed	_____
Parts / settings changed	_____
Residual defect or restriction	_____
Person completing / checking	_____

Controlled verification

Verification	Acceptance basis	Status
As-found symptom	Loss of Output or Performance	Absent / present / not tested
Primary function	Alarm and event history	Pass / fail / not tested
Related function	Incoming supply state	Pass / fail / not tested
Protection and alarms	Normal protective state retained	Pass / fail / not tested
Leak, heat, noise or damage	No new adverse condition	Pass / fail / not tested
Recorded operating condition	Load / mode / duration: _____	Accepted / restricted

Release signatures

- Technical check by: _____ Date/time: _____
- Operations acceptance by: _____ Date/time: _____
- Safety or permit close-out by: _____ Date/time: _____
- Follow-up owner and due date: _____

Handover, Follow-Up and Prevention Plan

Close the record so the next shift can understand the loss of output or performance, the evidence, the repair decision and any remaining restriction without relying on memory.

Handover field	Record
Current equipment state	_____
What was confirmed	_____
What remains unknown	_____
Operating restriction	_____
Evidence location	Log / work order / folder: _____
Next owner and action	_____
Escalation trigger	_____

Follow-up schedule

When	Review	Record
Next shift	Confirm state and restriction	Owner: _____ Result: _____
24 hours	Review alarm and event history	Owner: _____ Result: _____
7 days	Check for repeat events under comparable duty	Owner: _____ Result: _____
30 days	Review effectiveness and maintenance action	Owner: _____ Result: _____

Prevention decision

- Update the task, limit, drawing or training only when the cause supports it.
- Remove any temporary control by its approved expiry point.
- Share the lesson without exposing private, security-sensitive or proprietary data.
- Record whether the action reduced repeat faults, downtime or diagnostic effort.
- Reopen the analysis if the symptom returns under the same conditions.

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