QUALITY INSPECTION TECHNICAL MANUAL
TRAPEZOIDAL & MOTION THREAD

ISO Tr, ASME Acme, Buttress — Lead Screws & Power Transmission

Document No.:	KFP-QIM-THD-007
Revision:	F
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Classification:	Internal Technical Document
Scope:	Trapezoidal (Tr, 30° metric), Acme (29° inch), Stub Acme, and Buttress (45°/7°) threads for power transmission and linear motion. Does NOT cover fastening threads (see THD-001/002).

IATF 16949 | ISO 9001 | ISO 14001 Certified Facility

Revision History

Rev.	Date	Description & Triggering Standards	Author	Approved
A	2005-06	Initial release based on ISO 2901:1993, ISO 2903:1993, ASME B1.5-1997. Three-wire method for 30° and 29° trapezoidal threads.	Quality Eng.	Quality Dir.
B	2009-03	Added Buttress thread provisions per ASME B1.9-1973 (R2007). Added lead accuracy measurement for precision leadscrews.	Quality Eng.	Quality Dir.
C	2013-09	Added CMM helical scan for lead/pitch error. Enhanced backlash measurement method. Added Stub Acme per ASME B1.8-1988 (R2006).	Quality Eng.	Quality Dir.
D	2016-11	Added SPC for lead accuracy. Enhanced surface finish requirements for wear surfaces.	Quality Eng.	Quality Dir.
E	2019-08	Added ball screw thread inspection provisions (reference to JIS B1192 / ISO 3408). Added preload and backlash test methods.	Quality Eng.	Quality Dir.
F	2026-03	Verified all normative refs current. Added: CMM multi-start thread scanning, lead accuracy over full travel, wear measurement protocol, lubrication compatibility test reference.	Quality Eng.	Quality Dir.

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1. Scope and Normative References

1.1 Scope

Motion/power threads transmit force and convert rotary motion to linear motion. They differ fundamentally from fastening threads: the primary quality parameter is lead accuracy, not assembly fit.

1.2 Normative References

Standard	Title / Scope
ISO 2901:2016	ISO metric trapezoidal screw threads — Basic profile and maximum material profiles
ISO 2902:2016	ISO metric trapezoidal screw threads — General plan
ISO 2903:2016	ISO metric trapezoidal screw threads — Tolerances
ISO 2904:2016	ISO metric trapezoidal screw threads — Basic and design dimensions
ASME B1.5-1997 (R2014)	Acme screw threads (29°)
ASME B1.8-1988 (R2006)	Stub Acme screw threads
ASME B1.9-1973 (R2007)	Buttress screw threads (7°/45°)
ISO 3408-3:2006	Ball screws — Acceptance conditions (reference)

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2. Thread Geometry

Feature	Metric Tr (ISO 2901)	Acme (ASME B1.5)	Stub Acme	Buttress (B1.9)
Thread angle	30° (symmetric)	29° (symmetric)	29° (shallow depth)	45° load / 7° clearance
Application	Leadscrews, valves, jacks	Leadscrews, vises, presses	Heavy-load; shallow thread	Unidirectional high load (vises, artillery)
Pitch range	1.5–44 mm	0.1″–0.5″ (2–10 TPI)	Same as Acme	Same as Acme
Multi-start	Common (2, 4, 6 starts)	Common	Rare	Rare
Critical param	Lead accuracy	Lead accuracy	Load capacity	Load flank angle

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3. Inspection Methods

3.1 Three-Wire Method for Trapezoidal Threads

For 30° ISO trapezoidal: $d_2 = M - 2dw \times (1 + 1/\sin 15°) + P/2$

For 29° Acme: $d_2 = M - 2dw \times (1 + 1/\sin 14.5°) + P/2$

Best-size wire: dw = P / (2 × cosα) where α = half-angle (15° for Tr, 14.5° for Acme).

3.2 Lead Accuracy

Lead accuracy is the most critical parameter for motion threads. It determines positioning accuracy and backlash.

(a) CMM measurement: scan thread helix over full travel length. Report cumulative lead error and periodic lead error.

(b) Cumulative lead error: total deviation from nominal lead over the full screw length. Typical tolerance: ±0.02 mm per 300 mm for precision leadscrews.

(c) Periodic lead error: deviation repeating once per revolution (from machine spindle error). Typical: ≤0.005 mm.

(d) Multi-start threads: measure lead of EACH start independently, then verify angular spacing between starts (nominal 360°/N ± tolerance).

3.3 Backlash Measurement

Assemble screw with mating nut. Apply axial load in one direction, record position. Reverse load, record new position. Backlash = position difference. Compare to drawing specification.

3.4 Surface Finish

Thread flanks on motion threads are wear surfaces. Ra ≤1.6 µm for standard; Ra ≤0.8 µm for precision leadscrews. Verify with profilometer on load flank.

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4. Inspection Equipment

Equipment	Specification	Parameters Measured	Application
CMM (helical scan)	Acc. ±0.001 mm; helical interpolation	Lead error, pitch dia., thread profile, start spacing	FAI, PPAP, audit
Three-wire sets	Calibrated for 30° and 29° thread angles	Pitch diameter	Production verification
Profile projector	10×–50×; trapezoidal overlays	Thread angle, flank straightness, root form	Form verification
Lead measuring machine	Dedicated or CMM-based; full-travel scan	Cumulative and periodic lead error	Precision leadscrew qualification
Backlash test fixture	Axial load cell + position indicator	Assembly backlash	Per customer spec
Surface tester	Profilometer Ra/Rz	Flank surface finish	Per spec; Ra ≤1.6 µm
Micrometer	0.001 mm	Major/minor diameter	SPC checks
AMETEK OES	Multi-element	Material verification	Incoming

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5. Inspection Procedures

(a) FAI: thread profile (projector) + pitch diameter (3-wire or CMM) + lead accuracy (CMM full-travel scan) + surface finish + backlash (with mating nut).

(b) In-process: pitch diameter every 10 pcs (low-volume CNC production); lead accuracy every 25 pcs or 1×/hour.

(c) Final: dimensional package + lead accuracy certificate + backlash measurement + surface finish record.

(d) Multi-start: verify each start independently; label starts (1, 2, 3...) at the entry end.

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Non-Conformance Handling and Disposition

Standard NC Procedure

Step	Action
1. Containment	STOP production. Segregate with RED tag. Quarantine. NCR Form KFP-NCR-001.
2. Scope	Trace to last good inspection. Re-inspect 100% of suspect window.
3. Root cause	8D/5-Why analysis. Common: tool wear, wrong setup, gauge error, material variation.
4. Disposition (MRB)	REWORK / USE-AS-IS (customer concession) / SCRAP.
5. Corrective action	Permanent fix; verify effectiveness over ≥3 production lots.
6. Customer notification	If NC product shipped: 24-hr notice + 8D per IATF 16949 §8.7.1.6.

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Records, Traceability & Documentation

Record	Doc ID	Retention	Storage
Material cert (EN 10204 3.1)	Per lot	15 yr (auto) / 10 yr	QMS + archive
OES report	KFP-MAT-OES-[lot]	= material cert	QMS
FAI report	KFP-FAI-[part]-[date]	Part life + 1 yr	QMS
SPC charts	Auto-generated	Current + 2 yr	SPC database
Gauge log	KFP-GAG-LOG-[line]	Current + 1 yr	QMS
CMM thread report	KFP-CMM-THD-[part]	Part life + 1 yr	QMS + PDF
Final inspection	KFP-FIN-[lot]-[date]	15 yr (auto)	QMS
NCR / 8D	KFP-NCR-[seq]	Part life + 3 yr	QMS
Gauge cal cert	KFP-CAL-[gauge ID]	+ 2 cal cycles	QMS
PPAP package	Per customer	Part life + 1 yr EOL	QMS + portal

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Document Approval

Reviewed and approved by:

Role	Name	Signature	Date
Prepared by:	Quality Engineer		
Reviewed by:	Production Manager		
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END OF DOCUMENT

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