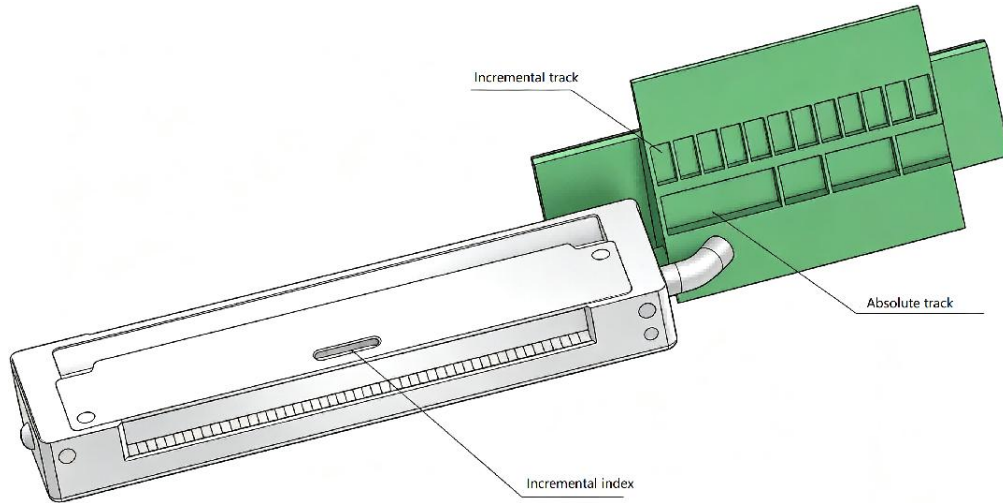




OTV
Precision Sensing



OTV AMG

Absolute Linear Magnetic Encoder System

Product Manual — Linear Displacement Encoder



1. Product Overview

The OTV AMG is a true absolute magnetic linear encoder system engineered for high-performance motion control applications. It delivers non-contact, wear-free absolute position feedback for linear motion axes in demanding industrial environments. The system combines a dual-track encoded magnetic scale with an advanced sensor readhead to provide immediate absolute position data upon power-up — no homing, no batteries, no backup memory required.

Measuring Principle:

The measurement standard is a magnetic scale (MSA50 series) consisting of a stainless steel substrate bonded with an elastomeric ferrite layer. The ferrite layer carries two magnetically encoded tracks:

- **Incremental Track:** A 5 mm pole-pitch track with alternating N/S poles for high-speed incremental interpolation via an AMR (Anisotropic Magnetoresistance) sensor.
- **Absolute Track:** A 14-bit pseudo-random binary sequence (PRBS) track for absolute position decoding via a Hall sensor array.

An internal MCU fuses both data streams using proprietary algorithms to output the final absolute position. The elastomeric ferrite layer is inherently resistant to oils, coolants, and chemicals commonly present on the factory floor.

Key Applications

- **Linear Motors & Direct Drive** — Voice coil actuators, planar motors, iron-core and ironless linear stages
- **Semiconductor Equipment** — Wafer handling, pick-and-place, inspection and metrology stages
- **Lithium Battery Manufacturing** — Electrode winding, stacking, slitting, calendaring, and cell assembly
- **CNC & Precision Machine Tools** — Linear axes on grinding machines, milling centers, and lathes
- **Medical & Laboratory Automation** — Precision positioning stages, scanning systems, liquid handling
- **Large-Format Processing** — Gantry systems, laser cutting, waterjet cutting, large-area inspection (up to 82 m)
- **3C & Electronics Assembly** — Automated assembly, dispensing, testing, and inspection equipment

2. Key Features & Technical Advantages

True Absolute — No Homing, No Batteries

Genuine dual-track absolute encoding delivers valid absolute position within 400 ms of power-up. No battery backup. No reference marks. No homing sequence. The 14-bit PRBS absolute track spans the full 82,000 mm measurement range.

Industry-Leading Measurement Range

Maximum measurement length of 82,000 mm — the longest absolute magnetic linear encoder range available. Single continuous scale with no segment switching or stitching errors.

High-Speed, Low-Latency Operation

Linear velocity up to 5 m/s. Position update time under 6 μ s during active communication. Designed for high-bandwidth servo control loops.

1 μ m Resolution with High Repeatability

Resolution of 1 μ m. Repeatability $\leq \pm 2.5 \mu$ m at 1 μ m resolution with 1.2 mm nominal gap. System accuracy $\leq 50 \mu$ m, module and mounting dependent.

Multi-Protocol Digital Interface

Five digital protocols from a single hardware platform: BiSS-C (RS422, 5 MHz), SSI (RS422, 0.7 MHz), Tamagawa (RS485, 2.5 Mbps, 24-bit), Modbus-RTU (RS485, 256K baud), Panasonic (RS485, 48-bit). Protocol selected at time of order.



Rugged IP67 Construction

Aluminum housing, fully sealed against dust and water immersion. Rated for 100% relative humidity. Operating temperature range -20°C to +80°C.

High-Flex Drag-Chain Cable

TPU-jacketed, dual-shielded, 8-core twisted-pair cable. Rated for 20 million flex cycles at 35 mm bend radius. Available in lengths from 0.5 m to 20 m.

Smart LED Diagnostics

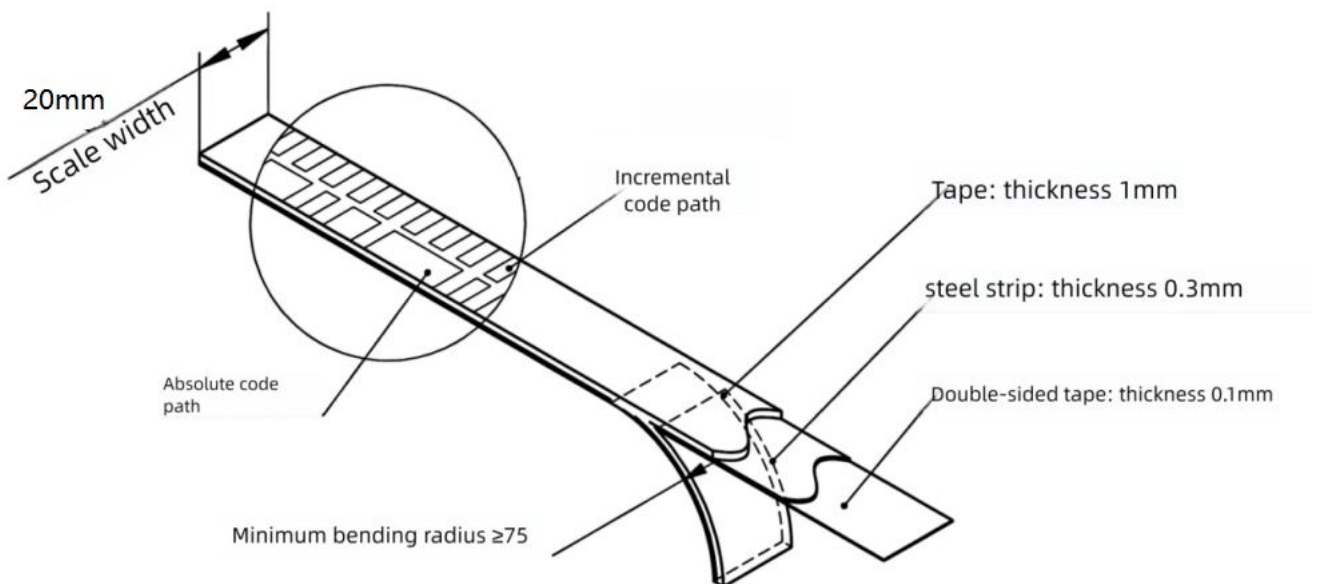
Multi-color LED for real-time status: normal operation (solid blue), over-temperature warning (flashing blue), signal loss (solid red), misalignment (red/purple alternating), and absolute track error requiring power cycle (solid purple).

Robust ESD Protection

RS422 lines: HBM ± 20 kV. RS485 lines: HBM ± 15 kV. All interface lines protected.

3. Magnetic Scale — MSA50 Series

The MSA50 magnetic scale is the measurement standard for the OTV AMG encoder system. It consists of a precision stainless steel carrier with an elastomeric ferrite magnetic layer encoded with two parallel data tracks.



3.1 Scale Construction

Layer	Material	Function
Carrier / Substrate	Stainless Steel	Mechanical base; provides dimensional stability and adhesive bonding surface
Magnetic Layer	Elastomeric Ferrite Compound	Encoded with incremental (5 mm pole pitch) and absolute (14-bit PRBS) tracks
Adhesive Backing	High-Bond Acrylic (with liner)	Pre-applied permanent adhesive for direct mounting to machine surfaces
Cover Liner	Silicone-Coated Release Paper	Protects adhesive until installation; removed during mounting

3.2 Track Encoding

Track	Encoding Type	Pole Pitch / Length	Readout Sensor	Function
Incremental	Alternating N/S Magnetic Poles	5.0 mm	AMR Sensor Array	High-speed interpolation; velocity and commutation signals
Absolute	14-bit Pseudo-Random Binary Sequence (PRBS)	82,000 mm effective range	Hall Sensor Array	Unique absolute position code; no segment switching

NOTE: The encoder readhead must be oriented correctly relative to the dual-track layout. The scale's printed markings indicate the incremental track side. Misorientation triggers a red/purple LED error and invalidates position data.

3.3 Scale Specifications

Parameter	Specification
Scale Series	MSA50
Incremental Pole Pitch	5.0 mm
Absolute Encoding	14-bit PRBS
Effective Measurement Length	Up to 82,000 mm (custom cut to order)
Scale Width	10 mm
Total Thickness	1.4 mm (including adhesive)
Substrate	Stainless steel, non-magnetic
Magnetic Layer	Elastomeric ferrite, chemically resistant
Adhesive	High-bond acrylic, pre-applied
Minimum Handling Bend Radius	> 60 mm
Operating Temperature	-20°C to +80°C
Chemical Resistance	Resistant to common machine tool oils, coolants, and mild solvents
External Field Tolerance	< 0.5 mT for normal operation; > 25 mT causes irreversible damage

4. Encoder Readhead — Technical Specifications

4.1 System Performance

Parameter	Specification
Resolution	1 μ m
Repeatability (Unidirectional)	$\leq \pm 2.5 \mu\text{m}$ @ 1 μ m resolution, 1.2 mm gap
System Accuracy	$\leq 50 \mu\text{m}$ (module and mounting dependent)
Position Update Time	< 6 μ s (during active communication)
Absolute Position Startup Time	< 400 ms after power-up
Maximum Linear Velocity	5 m/s
Sensing Gap (Nominal)	1.2 $\pm$ 0.3 mm
Sensing Gap (Allowable Range)	0.2 – 2.0 mm

4.2 Electrical

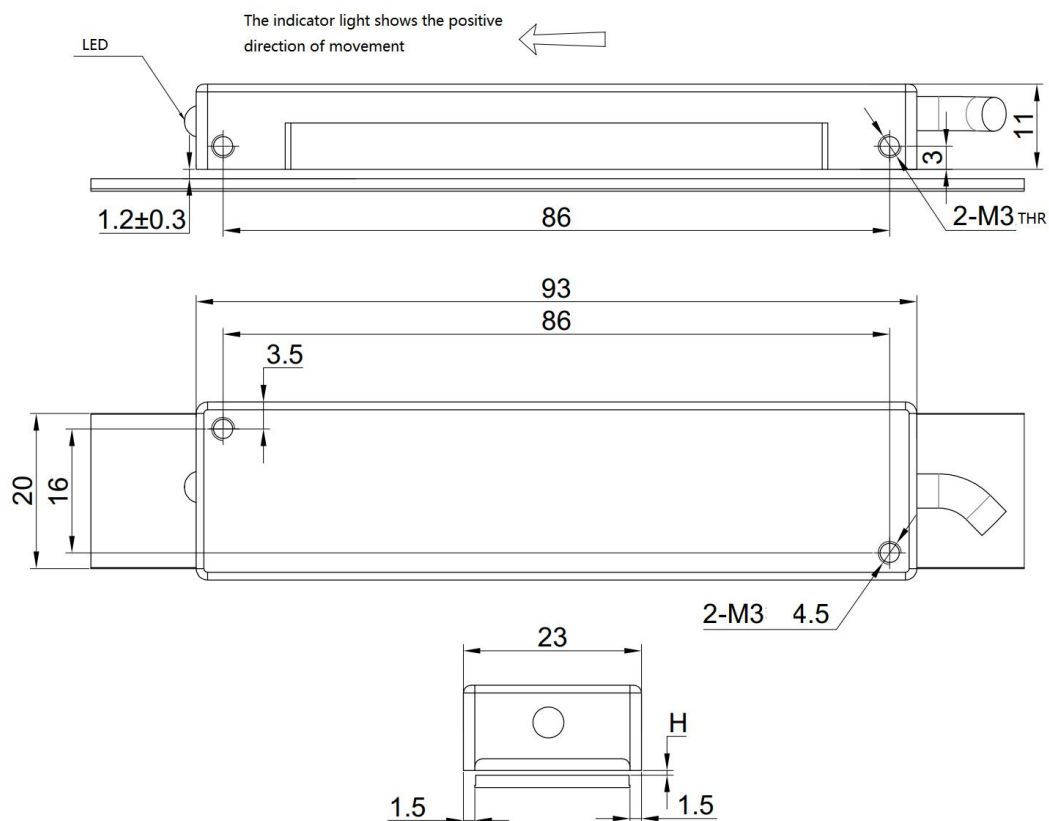
Parameter	Specification
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Supply Voltage	5 VDC $\pm$ 5%
Operating Current (No Load)	< 200 mA @ 25°C ambient
Output Type	Differential RS422 / Serial RS485 (protocol-dependent)
Output Load Current	$\pm$ 40 mA per channel
Interface — BiSS-C (RS422)	Max clock: 5 MHz
Interface — SSI (RS422)	Max clock: 0.7 MHz
Interface — Modbus-RTU (RS485)	Max baud: 256K
Interface — Tamagawa (RS485)	Baud: 2.5 Mbps, 24-bit position
ESD Protection (RS422)	HBM $\pm$ 20 kV
ESD Protection (RS485)	HBM $\pm$ 15 kV

4.3 Mechanical

Parameter	Specification
Dimensions (L $\times$ W $\times$ H)	93 $\times$ 23 $\times$ 11 mm
Mounting Hole Spacing	86 mm (M3 clearance holes)
Housing Material	Anodized Aluminum
Weight	Approx. 30 g (without cable)
Connector Options	DB9 Male / DB15 Male / SCSI-26 Male / SM-6P / Bare Wire (NC)
Cable Type	TPU, high-flex, dual-shielded, 8-core, twisted-pair, drag-chain rated



4.4 Environmental

Parameter	Specification
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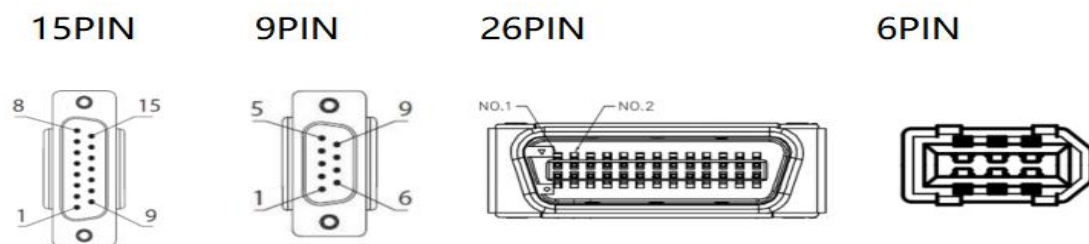
Operating Temperature	–20°C to +80°C
Storage Temperature	–20°C to +105°C
Protection Class	IP67 (IEC 60529)
Relative Humidity	0 – 100% (condensing)
Max External Magnetic Field (Operating)	0.5 mT
Vibration (Operating)	10 – 2000 Hz, 100 m/s ² (IEC 60068-2-6)
Shock (Operating)	300 m/s ² , 11 ms (IEC 60068-2-27)

5. Cable Specifications

Parameter	Specification
Cable Type	TPU (Thermoplastic Polyurethane), high-flex, drag-chain compatible
Conductor Count	8 cores (4 twisted pairs)
Outer Diameter	4.4 ± 0.15 mm
Conductor	0.08 mm ² , 28 AWG, 0.38 Ω/m, tinned copper
Shielding	Dual-layer: aluminum foil + tinned copper braid, 90% coverage
Jacket Material	TPU, halogen-free, oil-resistant
Dynamic Bend Radius	25 mm
Static Bend Radius	10 mm
Flex Life	≥ 20 million cycles @ 35 mm bend radius
Weight	Nominal 34 g/m
Max Cable Length	20 m (longer runs available with signal repeater — contact OTV)
Temperature Range	–40°C to +105°C (cable only; encoder limits apply)

6. Electrical Connections & Pinouts

The following table defines the signal assignments for all supported connector types. Wire colors are consistent across all connector variants.



Function	DB15 Pin	DB9 Pin	SCSI-26 Pin	SM-6P Pin	Wire Color	Signal Name
Power	7, 8	5	11, 13	11, 13	Red	VIN (+5 VDC)
Ground	2, 9	9	24	24	Black	GND (0 V)
Serial Data A	12	2	3	1	Yellow	RS485-A / PS+
Serial Data B	4	6	16	14	Brown	RS485-B / PS–
BiSS/SSI Data –	6	8	14	—	Purple	SLO– / DATA–
BiSS/SSI Data +	14	4	1	—	Green	SLO+ / DATA+



BiSS/SSI Clock –	5	7	15	—	Blue	MA– / CLK–
BiSS/SSI Clock +	13	3	2	—	White	MA+ / CLK+

NOTE: Shield (PE) connects to connector housing. For bare-wire (NC) configuration, a separate shield drain wire is provided. Custom pinouts are available on request. Do not connect unused pins.

7. Installation

7.1 Mechanical Installation

Proper installation is critical to achieving the specified system accuracy. Follow the procedure below and verify with the LED indicator after mounting.

1. Clean the mounting surface. Remove all oil, grease, dust, and debris. The surface must be dry and free of contaminants.
2. Apply the MSA50 magnetic scale. Peel the adhesive liner and press the scale firmly onto the mounting surface. Use the printed directional markings to ensure correct orientation — the incremental track must face the encoder's AMR sensor side.
3. Use the OTV spacer gauge. Insert the 1.2 mm plastic spacer between the encoder sensing face and the scale surface.
4. Position the encoder. Align the encoder body so the sensing window is centered over both magnetic tracks, with the cable exit oriented as required by the machine layout.
5. Secure the encoder. Tighten the M3 mounting screws through the 86 mm-spaced mounting holes. Do not over-torque.
6. Remove the spacer gauge. Gently slide out the spacer after the encoder is secured.
7. Verify LED status. Power on the encoder and move it at least 10 mm along the full travel length. The LED must remain solid BLUE at all positions.

⚠ WARNING: After installation, the encoder LED must be solid BLUE across the entire measurement length. If the LED turns RED or PURPLE at any position, re-check the gap, alignment, and scale orientation before operating the machine.

7.2 Installation Tolerances

Parameter	Tolerance
Operating Gap (Nominal)	1.2 ± 0.3 mm
Operating Gap (Allowable)	0.2 – 2.0 mm
Lateral Offset (Y)	±0.2 mm
Longitudinal Tilt (θ _x)	±0.5°
Yaw Angle (θ _z)	±1°
Roll Angle (θ _y)	±0.5°

7.3 Grounding & EMC Recommendations

Proper grounding is essential for reliable encoder operation in industrial environments.

- Machine ground impedance: ≤ 4 Ω (per applicable machine tool standards).
- Encoder cable shield and controller ground must connect to a single-point machine earth.
- Cable length < 2 m: Metal protective conduit recommended.
- Cable length ≥ 2 m: Metal protective conduit REQUIRED.
- High-EMI environments: Metal protective conduit REQUIRED regardless of cable length.
- When using metal conduit: Bond both ends of the conduit to the machine frame.
- Maximum cable pulling force: 30 N.
- Route signal cables away from high-voltage and motor power cables. Minimum separation: 200 mm.
- Cross power cables at 90° angles when routing cannot be separated.

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7.4 External Magnetic Field Precautions

External Field Strength	Effect on Encoder System
< 0.5 mT	Normal operation — no impact on accuracy or reliability.
0.5 – 1.0 mT	Potential accuracy degradation. Avoid sustained exposure.
1.0 – 25 mT	May cause system malfunction, erroneous position data, or intermittent errors.
> 25 mT	IRREVERSIBLE DAMAGE to the magnetic scale. Scale replacement required.

8. LED Status Diagnostics

The multi-color LED on the encoder body provides real-time diagnostic information for installation verification and in-service troubleshooting.

LED State	Status	Description	Action Required
Solid Blue	NORMAL	Position data valid. Encoder operating within all specifications.	None. Normal operation.
Flashing Blue	WARNING	Encoder internal temperature > 80°C. Position data still valid but approaching thermal limit.	Check machine cooling. Verify ambient temperature. Reduce duty cycle if persistent.
Solid Purple	ERROR	Absolute position data INVALID. Encoder detected magnetic scale demagnetization OR the encoder left and re-entered the scale during powered operation.	Power-cycle the encoder. If error persists after restart, inspect scale for damage or external magnetic field exposure.
Solid Red	ERROR	Position data INVALID. Gap too large, encoder not sensing scale, or internal hardware fault.	Check and adjust encoder-to-scale gap. Verify scale presence. If persistent, contact OTV support.
Red/Purple Alternating	ERROR	Position data INVALID. Encoder orientation incorrect relative to scale track direction.	Verify scale orientation. Rotate encoder or scale 180° to match the dual-track layout.
Off (No Light)	NO POWER	Encoder not receiving supply voltage.	Check power supply and cable connections. Verify +5 VDC at encoder connector.

⚠ WARNING: When the LED is solid PURPLE, position data is invalid and the encoder **MUST** be power-cycled to restore operation. This is a latching error state by design — do not attempt to operate the machine with a purple LED.

Example: MSA 50 – 14 – 2500 = MSA50 scale, 14-bit encoding, 2500 mm length.

9. Accessories & Orderable Items

Item	Part Number	Description
Magnetic Scale	MSA50-14-XXXX	Absolute magnetic scale, 5 mm pole pitch, cut to length (XXXX = mm)
Plastic Spacer Gauge	OTV-SPACER-1.2	1.2 mm installation spacer gauge (pack of 5)
Scale Applicator Tool	OTV-APPLICATOR-MSA50	Guided alignment tool for MSA50 scale installation
Extension Cable, 0.5 m	OTV-CBL-050	TPU high-flex extension cable, 0.5 m, DB9 M-F



Extension Cable, 5 m	OTV-CBL-500	TPU high-flex extension cable, 5 m, DB9 M-F
Extension Cable, 10 m	OTV-CBL-1000	TPU high-flex extension cable, 10 m, DB9 M-F
Signal Repeater	OTV-REPEATER-01	For cable runs > 20 m; contact OTV for configuration
Protective Metal Conduit	OTV-CONDUIT-01	Flexible metal conduit for EMI shielding (per meter)