

# IRONLESS LINEAR MOTOR MANUAL

# Simply Better !



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# User Manual Introduction

# Company

At ITG Linear Motors, we design and manufacture high-performance linear motors for a wide range of industrial applications. Our iron core linear motors are known for their power, precision, and efficiency, enabling machines to achieve optimal performance and reliability in fields such as automation, robotics, and high-speed machining.

This manual is intended for technicians, engineers, and system integrators working with linear motor systems. It provides a comprehensive overview of the essential components of an ITG iron core linear motor, along with the key supporting elements needed for a fully functional motion system, including drive electronics, feedback sensors, and cooling mechanisms.

By following the guidelines in this manual, users will gain the knowledge needed to optimize performance, ensure reliability, and seamlessly integrate ITG linear motors into their applications.

# What You'll Find in This Manual

<b></b>	Design & Installation	The design principles and installation guidelines for linear motors.
<b>•</b>	Pre-Startup Settings	The necessary settings before startup.
<b>•</b>	Structural Dimensions	Key dimensions for designing a suitable motor support structure.

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# **O Pre-Installation**

# 1 PRE-INSTALLATION INSTRUCTIONS

Essential Guidelines for Safe Use

Before installing and operating the Linear Motor, please read the following carefully to ensure proper setup and avoid potential hazards.

# **1.1 Key Information**

Before You Begin

- Carefully review this manual before proceeding with installation or operation.
- The manufacturer is not responsible for any damage resulting from improper use, neglect, or failure to follow these instructions.

Handling & Inspection

- Handle all components with care, whether packed or unpacked.
- Magnet plates are fragile avoid dropping or releasing them abruptly.
- Do not expose magnets to temperatures above 70°C to prevent demagnetization.
- Inspect the motor immediately after unboxing; contact the supplier if any irregularities are found.
- Record the serial number for future reference.

# **1.2 Critical Safety Guidelines**

#### **General Safety Considerations**

Confirm that the entire setup complies with CE requirements. Magnet plates generate intense magnetic attraction toward ferromagnetic materials (e.g., iron). Maintain a 25 cm clearance from such objects.

Always secure magnet plates before removing protective covers, and reattach covers prior to disassembly.

Keep sensitive items (e.g., credit cards, medical devices) at least 1 meter away from magnet plates.

#### **Precautionary Measures**

- Grounding: Verify proper grounding of the power supply during installation.
- Power Disconnection: Turn off power during maintenance to prevent accidental activation.
- Cleaning: Use Isopropanol only; other chemicals may damage components.
- UV Protection: Wear protective eyewear and clothing when exposed to UV Blacklight.
- Mechanical Safeguards: Install safety mechanisms to prevent motor damage during power loss.
- Earthing: For non-conductive surfaces (e.g., granite), use grounding wires.

 $\triangleq$  If safety concerns arise, discontinue use and contact ITG immediately.

# **1.3 Certification**

ITG is committed to delivering high-quality, safe, and environmentally responsible products. This section outlines the certifications and compliance standards applicable to ITG iron-less linear motors. For the official Declaration of Conformity, refer to **APPENDIX A**.

**Compliance Overview** 

- 1. CE Certification:
- ITG declares that the IL59, IL91, UX, IL109 and IL109X linear motors comply with European Directive 2006/95/EC.
- ITG confirms that the IL42 and IL44 linear motors described in this manual are designed for integration into other machinery and do not (fully) comply with the Machinery Directive (98/37/EC) as standalone components.
- They meet the following standards:
- EN 60034-1:2010: Rotating Electrical Machines Part 1: Rating and Performance.

- EN 60204-1:2010: Safety of Machinery – Electrical Equipment of Machines: General requirements.

2. UL/CSA Certification:

• All ITG iron-core linear motors are certified to meet UL and CSA standards, ensuring compliance with North American safety regulations.

3. RoHS Compliance:

- ITG products are fully compliant with the Restriction of Hazardous Substances (RoHS) Directive.
- This ensures the absence of hazardous materials such as lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (PBB), and polybrominated diphenyl ethers (PBDE).

#### **Recap of Certifications:**

CE Mark	Compliance with EU safety and environmental standards.
UL/CSA	Certification for North American safety standards.
RoHS	Free from hazardous substances, ensuring environmental and user safety.

#### Next Steps:

For installation, operation, or maintenance guidelines, refer to the relevant chapters in this manual.

For technical support or certification inquiries, contact ITG's customer service team.

# 022 MOTOR COMPONENTS



# **2. MOTOR COMPONENTS**

An ITG ironless linear motor is not a standalone system. It consists of components like a coil unit and magnet yokes, which must be integrated into a complete machine or working unit. The mounting frame size, slide design, bearing type, and damper selection depend on the application. For example, the frame and slide must ensure a proper air gap between the coil unit and magnet yokes.

ITG offers standard and custom components suitable for diverse linear motor applications, enabling easy integration into your system.



Picture 2.1: A complete ironless linear motor system

# 2.1 Components 2.1.1 Coil unit

- The coil unit (available in N and S versions with differing voltage and current requirements)
- The magnet yoke (offered in various lengths and outer dimensions)



Picture 2.2: A coil unit and magnet yoke

## 2.2 Additional Requirements

For complete installation of your linear motor system, the following additional items are required:

- Fastening hardware (bolts and dowel pins)
- Peripheral equipment (servo controller, linear encoder)
- Appropriate installation tools

Note: These items are not included in ITG's standard product delivery.

#### 2.2.1 Fastening Hardware Specifications

The following fastening components are necessary for:

- Precise positioning and secure mounting of the coil unit to the slide assembly
- Proper connection of the magnet yokes to the mounting frame:

Features	IL59	IL91	IL109	IL109X	
Bolts for coil unit (steel)	M3x16,	M4x20,	M5x20,	M5x20,	
	DIN912	DIN912	DIN912	DIN912	
Tightening torque	1.0 - 2.0 Nm	2.0 - 3.0 Nm	3.0 - 5.0 Nm	3.0 - 5.0 Nm	
Bolts for magnet yoke	M4x25,	M5x35,	M6x40,	M6x50,	
(steel)	DIN912	DIN912	DIN912	DIN912	
Dowel pins for magnet yoke (optional)		3h8,	DIN7		

Table 2.3: Bolts for coil unit and yoke IL59, IL91, IL109 and IL109X series

Features	IL42	IL44	
Bolts for coil unit (steel)	M3, DIN912, Class 12.9	M3, DIN912, Class 12.9	
Tightening torque	1.0 - 2.0 Nm	1.0 - 2.0 Nm	
Dept bolt in threat hole	Top: through coil unit	Top: through coil unit	
	Side: 1.5 - 2.8mm	Side: 1.5 - 2.8mm	
Bolts for magnet yoke (steel)	M4x20, DIN912	M4x25, DIN912	
Dowel pins for magnet yoke (optional)	3h8, DIN7		

Table 2.4: Bolts for coil unit and yoke IL42 and IL44 series

# **OB INSTALLATION**



# 3.1 Cleaning

#### Warning: Strong Magnetic Forces

The magnet yokes exert strong attraction forces on all soft magnetic materials (e.g., iron), which cannot be controlled manually. Serious jamming hazards may occur.

- Keep soft magnetic objects (iron) at least 1m away from the magnetic side of the yoke.
- Magnetic-sensitive items (bank cards, pacemakers, data storage devices) must stay 25cm away to avoid damage.

#### **Cleaning Instructions:**

- Use only Isopropanol for cleaning the magnet yoke and coil unit. Other agents may cause damage.
- For non-cleanroom applications, intensive cleaning is not required.
- ITG recommends Isopropanol as the approved cleaning agent.

# **3.2 Installation**

#### Installation in Vacuum Environments

Special procedures apply when installing motors in vacuum conditions.

#### Linear Motor Assembly Guidelines

#### **Pre-Installation Requirements:**

- The mounting frame must be fully installed prior to motor component assembly.
- The sliding mechanism should incorporate:
  - Properly aligned bearings and dampers
  - Correctly installed linear position sensors
  - Organized cable management
  - to ensure smooth, safe, and precise movement throughout the entire stroke length.
- Verify:
  - Accurate ruler positioning and fixation
  - Proper functioning of bearings/dampers
  - Free movement of cables without obstruction

#### **Electrical Installation Sequence (Safety-Critical):**

- 1. Secure magnet yokes to the machine's mounting surface
- 2. Attach the coil assembly to corresponding machine components
- 3. Make all electrical connections to the coil unit
- 4. Note: The mechanical assembly sequence has no magnetic implications as no attractive forces exist between coils and yokes.

#### **Decommissioning Procedure:**

- 1. Disconnect all electrical wiring from the coil unit
- 2. Remove the coil assembly from machine components
- 3. Detach magnet yokes from the mounting surface
- Critical Pre-Installation Check:

Thoroughly inspect and prepare the motor mounting surface according to specifications before beginning installation.

# **3.3 Mounting Surface Requirements**

#### 1. Correct Mounting Side

- Use only the aluminum side of the IL42/IL44 housing for mounting (refer to Figure 3.4).
- Do not use the epoxy/power cable side for alignment — it is not designed for mechanical support.



Picture 3.4: IL42-IL44 coil

#### 2. Surface Flatness

Both magnet yokes and coil units must be mounted on flat surfaces. Warped or uneven surfaces can induce bending forces, leading to potential damage (see Figure 3.3 and Table 3.5 for specifications).



Picture 3.3: Flatness and parallelism of mounting surfaces

Туре	Coil unit flatness	Parallelism	Н	Seperation of mounting faces
	R (mm)	S (mm)	(mm)	V (mm)
IL42	0.02	0.02	51	0.375 +/- 0.05
IL44	0.05	0.02	53	0.625 +/- 0.05
IL59	0.05	0.05	68	5.5 +/- 0.1
IL59X	0.05	0.05	68	6.5 +/- 0.1
IL91	0.1	0.05	105	8.2 +/- 0.1
IL91X	0.1	0.05	105	12.0 +/- 0.1
IL109	0.1	0.05	124.8	11.5 +/- 0.1
IL109X	0.1	0.05	124.8	16.5 +/- 0.1

Table 3.5: Installation tolerances U-series

#### Alignment Requirements

The magnet track (previously referred to as magnet yokes) and coil unit must be precisely aligned relative to each other. This alignment must be ensured by the machine's structural design.



Picture 3.6: Air gaps and axial references, schematically

Magnet Track (MR) Reference Methods (See Figure 3.6)

- Short track: Dowel pins in the middle yoke
- Long track:
  - Dowel pins along the full side
  - Milled reference edge (inner radius < 0.2mm)</li>
- Manual alignment during installation

Coil Unit (CR) Reference Methods (See Figure 3.6)

- Two dowel pins near the first and last mounting bolts
- Milled reference edge (inner radius < 0.2mm)
- Manual alignment during installation

#### **Critical Tolerances**

- Proper air gaps (A1 & A2) can only be achieved when:
  - Correct reference methods are used
  - Dimensions from Table 3.5 are strictly followed
- Detailed component dimensions are provided in Appendix A.

#### **Key Notes:**

- $\checkmark$  Maintain precision in alignment to prevent operational issues.
- $\checkmark$  Verify all tolerances per Table 3.5 before final assembly.
- ✓ Manual alignment requires careful verification.

# **3.4 Magnet Yoke Handling & Installation Guidelines**

#### **Safety & Handling Precautions**

- Handle with extreme care Magnet yokes are highly sensitive to mechanical shock.
  - Never drop or release uncontrolled.
- Clean mounting surfaces Particles >0.1mm can cause misalignment and motor damage.
- Magnetic hazards:
  - Loose iron objects within 5cm will be forcefully attracted, risking damage.
  - Keep magnetic-sensitive items (credit cards, data storage) >1m away.

#### **Installation Best Practices**

1. Start with the middle yoke (preferably the longest):

- Align using 3mm dowel pins or a milled reference edge.
- Secure with bolts at specified torque.
- 2. Subsequent yokes:
  - Use magnetic attraction for alignment (no forced dowel pin fitting).
  - Avoid dowel pin tracks They complicate rotation and may cause tolerance issues.
  - Preferred method: Milled axial reference for precise placement.
- 3. Orientation Note:
  - Standard yokes are "Murphy-safe" A 180° rotation does not affect motor function.



Picture 3.7: Principle of controlled rotational mounting of the magnet yokes

#### **Critical Warnings**

⚠ Prevent magnet-to-magnet collisions – Ensure closing plates do not strike adjacent yokes during installation.

① No guaranteed gap – Yokes are designed for direct contact mounting. (Include referenced figures/tables as applicable.)

#### Key Takeaways:

- ✓ Middle yoke first ensures stable alignment.
- ✓ Milled edges > dowel pins for subsequent yokes.
- ✓ Magnetic forces aid assembly but require caution.

# **3.5 Coil Unit Installation Guidelines**

#### **Surface Preparation**

- Ensure clean mounting surfaces Contaminants >0.1mm may cause misalignment and motor damage.
- Refer to Chapter 3.1 (Page 9) for detailed cleaning procedures.

#### **Installation Steps**

- 1. Manual Placement
  - Handle the coil unit with care; no magnetic attraction forces are present.
  - Align to the axial reference and secure with bolts.
  - Apply specified tightening torque (see Chapter 2.1, Page 7).
- 2. Vibration-Prone Applications
  - Use locking rings or thread-locking compound (e.g., Loctite) to prevent bolt loosening.
- 3. High Continuous Force Applications
  - Apply thermal interface material (heatsink compound) between the coil unit and mounting surface for optimal heat dissipation.

#### **Key Notes:**

- ✓ No magnetic forces simplify coil unit handling.
- ✓ Precision alignment and proper torque are critical for performance.
- ✓ Vibration/heating conditions require additional securing/cooling measures.

# **3.6 Electrical Connections**

#### Safety Precautions

- Always disconnect power before handling wiring.
- Follow the servo controller's installation instructions precisely.
- Ensure full compliance with electrical safety standards (e.g., EN 60204).

#### **3.6.1 General Wiring Guidelines**

- Standard cable configuration:
  - Power cable (1.0m) + temperature sensor cable (1.0m) both shielded (braided metal) for EMI protection.
  - Shields are internally grounded to the coil housing.
  - Cables can be shortened and fitted with custom connectors if needed.
- IL109/UXX3S models: Include a 3m FLEX cable (suitable for cable chains).

Motor-Specific Wiring

- IL59/IL91/IL109/IL109X series: Refer to Figure 3.8.
- IL44 series: Refer to Figure 3.9.
- IL42 series:
  - Refer to Figure 3.10.
  - Uses a 5-wire cable (green/yellow wires are non-functional).

**Critical Notes** 

✓ Verify servo amplifier instructions for proper integration.

Ensure all wiring adheres to EMC and safety regulations.

✓ Maintain shield integrity for noise immunity.



Picture 3.10: Wiring scheme IL42 series ironless, green and yellow wires are unused



Picture 3.9: Wiring scheme IL44 series ironless

Picture 3.8: Wiring scheme IL59, IL91, IL109 and IL109X series

#### 3.6.2 Power Line Connections

#### **Critical Wiring Requirements**

- Phase Alignment:
  - The three-phase power cable must be connected to the servo amplifier such that the motor's positive direction matches the linear encoder's positive direction.
  - Polarity must be verified -- incorrect wiring will cause uncontrolled slide movement.

#### **Installation Notes**

- Custom Cable Termination:
  - The power cable can be modified (shortened/reterminated) to fit the servo drive.
  - Not suitable for cable chains use only fixed or guided routing.

#### **Polarity Verification Procedure**

1. Perform a low-power test run to confirm motor/encoder direction alignment.

2. If motion is reversed, swap any two phase connections and retest.

#### 3.6.3 PTC Sensor Specifications

- Function: Digital-like temperature switch (abrupt resistance rise at critical coil temperature)
- Resistance Characteristics:
  - Normal operation (cool): <100 Ω</li>
  - $\circ~$  Approaching critical temp: Linear rise to  $1k\Omega$
  - Critical temp exceeded: Exponential resistance increase
- Safety Action: Servo amplifier must cut power when resistance exceeds  $1k\Omega$
- Limitation: Provides over-temperature alert only (no continuous temp monitoring)

Critical Requirement: PTC wiring must be properly connected to amplifier.

Temperature	Resistance
Up to 20°C below critical temperature	< 250 Ω
Up to 5°C below critical temperature	< 550 Ω
Nominal switching resistance	1000 Ω
Above critical temperature	> 1330 Ω

Table 3.13: Resistance range of the PTC-1K sensor

## 3.6.4 Maximum Operating Temperature



Series	Maximum operating temperature
IL42	80°C
IL44, IL59, IL91, IL109, IL109X	110°C

Graph 3.14: Temperature dependence of the PTC-1k sensor. The sensor follows the 110°C characteristic

## 3.6.5 NTC Characteristic

The Coil has a NTC temperature sensor for monitoring the temperature.



Graph 3.15: Temperature dependency of the NTC

Sensor specification of NTC-sensor				
Tolerance $\Delta R_{_R} / \Delta R_{_R}$	5%			
Max power	60mW			

T (ºC)	0	10	20	30	40	50	60
Rntc (Ω)	32650	19900	12490	8057	5327	36 03	2488
T (°C)	70	80	90	100	110	120	130
Rntc (Ω)	1752	1258	918	680	511	389	301

Table 3.16: Scheme for obtaining a linear voltage signal from the NTC-sensor

# **3.6.6** Polarization test

#### **Safety Precautions**

- Verify proper electrical and mechanical protection is in place.
- Ensure protective earth is functional.
- Confirm no voltage is present at terminals before connection.

#### **Test Method**

- 1. Use the servo amplifier's instantaneous service mode (if available).
- 2. Manually adjust an external resolver to check motor direction:
  - Correct polarization: Motor movement matches resolver rotation.
  - Incorrect polarization: Swap Phase 1 and 3 of the power cable.

#### Note

- All ironless linear motors share identical internal wiring; one test validates polarization for identical motor-ruler combinations.
- Identical multi-axis setups will exhibit the same polarization.

For further assistance, contact ITG.

# 3.7 Transportation

For transport, additional transport packacking is neccesary.

# 3.8 Storage

#### **Storage Area Requirements**

- Clearly mark storage zones with warning signs.
- Use original packaging only for motors and magnet yokes.
- Max stacking height: 4 cartons.

#### Environmental Conditions



Stacking height	4 cartons
Storage temperature	-25°C to +55°C and a maximum rate of change of 20°C/hour
Storage humidity	5 to 95%, relative humidity with no condensation
Storage duration	No limitation.

# APPENDIX



# APPENDIX A - CERTIFICATE



# APPENDIX A - CERTIFICATE



# APPENDIX B - Digital Hall Module - IL42



Only one ground wire needs to be connected for proper grounding.

# APPENDIX B - Digital Hall Module - IL44



- SINK-TYPE 20mA max.
- PERIOD 24mm (IL44 SERIES)
- SIGNAL DEFINITION ACCORDING TO FIGURE (HIGH=SINK)
- MAXIMUM VOLTAGE DROP 0.4V + 120 \* Isink (in A)
- TYPICAL VOLTAGE DROP 0.1V + 120 \* Isink (in A)
- SHORT CIRCUIT SAFE @SV SUPPLY

#### POWERSUPPLY

- +4.5 .. + 28V DC
- 40mA

#### CABLE CONNECTIONS

WHITE	BROWN	GREEN	YELLOW	GREY	PINK	BLUE	RED	SHIELD
٥V	+4.528V	GND	HALL B	HALL A	GND	GND	HALL C	GND

# APPENDIX B - Digital Hall Module - IL91



# APPENDIX B - Digital Hall Module - IL109/IL109X



















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# ITG

Suzhou ITG Linear Motor Co., Ltd. is a Hi-tech company which has been specialized in R & D, manufacturing, sales and providing relevant technical consultation and aftersales service for direct drive motors such as DDL, DDR, and also for Curve Motor.

Our main products are iron-core linear motors, ironless linear motors, torque motors, curve motors and all the relevant accessories. We also have the availability of providing customized linear motors and OEM service.

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