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NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

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GB/Z 204-2026

Artificial intelligence - System architecture of industrial foundation model

人工智能 工业大模型体系架构

Issued on: July 30, 2026 **Implemented on: July 30, 2026**

Issued by: State Administration for Market Regulation;
Standardization Administration of China

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Foreword

This document was drafted in accordance with the rules given in GB/T 1.1-2020, Directives for standardization - Part 1: Rules for the structure and drafting of standardizing documents.

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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The issuing body of this document is not to be held responsible for identifying any or all such patent rights.

1 Scope

This document establishes the system architecture of industrial large models, comprising the infrastructure layer, the data layer, the key technology layer, the model layer and the application layer, together with security protection.

This document applies to the development, adaptation, deployment and application of industrial large models.

2 Normative references

The following document contains provisions which, through normative reference in this text, constitute indispensable provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document, including any amendments, applies.

GB/T 45288.1-2025, Artificial intelligence - Large models - Part 1: General requirements

3 Terms and definitions

For the purposes of this document, the terms and definitions given in GB/T 45288.1-2025 and the following apply.

3.1 industrial foundation model - a large model applied over the whole life cycle of an industrial product. Note: it includes model systems of different levels and classes, such as industrial base foundation models, industrial domain foundation models and industrial scenario foundation models.

3.2 industrial base foundation model - a large-scale pre-trained model built from large-scale industrial data sets, having a large number of parameters, generally more than one hundred million, and a complex computational structure, and at the same time adapted to different industrial tasks and different industrial fields.

3.3 industrial domain foundation model - an industrial large model possessing specialized domain knowledge, obtained by embedding sector domain knowledge and fine-tuning with an adapter.

3.4 industrial scenario foundation model - an industrial large model adapted to a particular scenario on the basis of an industrial base foundation model or an industrial domain foundation model.

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4 Abbreviated terms

For the purposes of this document the following abbreviated terms apply. AGV: Automated Guided Vehicle. CAD: Computer-Aided-Design. CAE: Computer-Aided-Engineering. CAPP: Computer-Aided-Process-Planning.

6 Infrastructure layer

The infrastructure layer of an industrial large model is the hardware foundation supporting its training, inference and deployment, and comprises: a) cloud, edge and terminal computing resources, including large-scale computing resources in the cloud, low-latency computing resources at the edge and terminal computing resources, covering the central processing unit (CPU), the graphics processing unit (GPU), the field-programmable gate array (FPGA) and dedicated artificial intelligence acceleration chips; b) storage resources, providing large-scale storage capability for the model, including tiered hot and cold data storage, low-latency data reading and large-scale parallel data processing; c) industrial communication network resources, the network resources suited to the training and inference of large models, including switches and routers within the cluster, supporting low-latency, high-throughput data transmission, adapted to general protocols such as 5G/6G, gigabit Ethernet and optical fibre communication as well as industrial protocols, and supporting conversion and adaptation between industrial and general protocols.

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7 Data layer

7.1 Industrial data resources provide high-quality industrial data support for the training, inference and application of the model, and comprise: a) industrial time-series data, the time-series data from industrial equipment, control systems and sensors; b) CAD, CAE and CAPP files, digital design material such as product drawings, three-dimensional models, simulation analysis results and process planning documents; c) machine instructions and control code, the operating programs and control scripts of equipment such as CNC machine tools, robots and AGVs; d) industrial software code, source code or executable files of industrial control software, embedded systems and programmable logic controller (PLC) programs; e) industrial image, audio and video data, the multimedia data of the industrial site from quality inspection and safety monitoring; f) business and management data from the enterprise information systems; g) others.

7.2 Industrial knowledge resources are an important foundation supporting the understanding, reasoning and decision capability of the industrial large model, and comprise: a) general industrial knowledge, including the physical and chemical principles, equipment working principles, control system principles and operating procedures common to several sectors, embodying widely applicable industrial common knowledge; b) sector domain knowledge, including the specialized terminology, sector standards, regulations and

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specifications, process flows, operating mechanisms of key equipment and sector experience needed in a particular sector, such as equipment manufacturing, aviation, automotive, steel, petrochemicals and energy, embodying sector-specific knowledge; c) enterprise private knowledge, including proprietary information such as the particular process schemes, production experience, technical documents, historical project cases and business processes of the enterprise, reflecting its individual knowledge assets.

8 Key technology layer

8.1 Pre-training technology for industrial large models is used, for multi-source and multimodal industrial data, to build by methods such as self-supervised learning a base model having general industrial knowledge understanding and reasoning capability, and comprises mainly: a) industrial self-supervised pre-training, pre-training with unlabelled or weakly labelled industrial data by means of self-supervised learning.

9 Model layer

9.2 Industrial domain foundation models. b) Sector knowledge understanding capability, the capability to understand and handle the terminology and the business particular to the sector; c) efficient fine-tuning capability, supporting methods such as efficient adapter fine-tuning and low-rank fine-tuning, so as to raise the transfer learning capability of the model.

9.3 Industrial scenario foundation models are dedicated models built, on the basis of an industrial base foundation model or an industrial domain model, for a specific business scenario and task type, and comprise: a) the industrial intelligent question-answering large model, having the capability to understand and answer complex questions relating to industrial domain knowledge and to provide immediate specialist knowledge support, for example a metallurgical process question-answering large model or an equipment operation and maintenance question-answering large model; b) the industrial scenario cognition large model, having the capability to understand the intrinsic meaning of the various dynamic scenes and operating conditions in an industrial environment, providing the basis for further analysis and decision, for example a steel defect detection large model; c) the industrial process decision large model, having the capability to give recommendations on the basis of knowledge and reasoning and to help a person make a decision, for example a hot-rolling temperature decision large model for steel.

d) The industrial content generation large model, having the capability to generate automatically specialist content meeting the requirements of the industrial field - technical knowledge documents, process documents, CAD and CAE models, machine instructions and sensor signal samples - so as to meet the needs of research and development, production and maintenance, for example a CAD automatic generation large model or an industrial time-series data generation large model; e) the industrial terminal control large

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