

Phoenix Smart Control System

Technical Capabilities & Features Documentation

Enterprise-Grade Distributed Control System with Integrated HMI

Executive Overview

?What is Phoenix

Phoenix Smart Control System is a comprehensive, enterprise-grade **Distributed Control System (DCS)** with a fully integrated HMI/SCADA visualization platform. Developed over 10 years with 150,000+ lines of sophisticated Java code, Phoenix represents a universal IoT framework capable of managing any .industrial automation and building infrastructure at scale

Core Capabilities at a Glance

System Architecture

- True DCS Architecture:** Distributed intelligence at every node •
- Offline Operation:** Complete independence from cloud services **100%** •
- Multi-Platform Support:** Runs on 8+ embedded Android platforms •
- Unlimited Scalability:** From single controller to thousands in tree topology •

Key Features

- Pre-Configured Device Types** with bilingual support (Persian/English) **54** •
 - Built-in Visual Dashboard Builder** with drag-and-drop designer •
 - Industrial Protocols** supported simultaneously **+6** •
 - Pascal Runtime Environment** for custom automation logic •
 - Integrated Access Control** with biometric authentication •
 - I/O Points** per controller capability **+10,000** •
-

System Architecture & Design .1

Multi-Layered Architecture 1.1

:Phoenix employs a sophisticated service-oriented architecture optimized for reliability and flexibility



Distributed Control System (DCS) Features 1.2

True Distributed Intelligence

- **Autonomous Operation:** Each node operates independently
- **Peer-to-Peer Communication:** Direct node communication without central server
- **Hierarchical Control:** Multi-level control architecture
- **Fault Tolerance:** System continues operation even with node failures
- **Load Balancing:** Automatic distribution of processing load

Scalability Architecture

- Start with single controller
- Expand to hundreds of controllers
- Tree topology support

- Mesh network capability •
- No single point of failure •

Core Technology: ACV System .2

Active Control Variable (ACV) Framework 2.1

The ACV system is Phoenix's revolutionary framework that transforms any sensor, actuator, or control .point into a standardized, intelligent variable with comprehensive state management

Data Processing Pipeline

Physical Device → ENID Addressing → ACV Abstraction → Expression Engine → Condition Engine → Output Actions

ACV Capabilities

Comprehensive Field Management (45+ Fields)

- Value Processing Chain: 9 specialized fields for data transformation •
- Calibration Support: Slope and offset for sensor calibration •
- Noise Filtering: Min/max change thresholds •
- Historical Tracking: Min/max/average value recording •
- Setpoint Management: Target values with ranges •
- Expression Evaluation: Mathematical transformations •

State Machine System-5

Use Case	Visual Indicator	Description	State
Maintenance mode	Gray	System offline	DISABLE
Standard operation	Green	Operating normally	NORMAL
Threshold approached	Yellow	Warning condition	CAUTION
Immediate attention	Red	Critical condition	DANGER
Malfunction detected	Flashing	System fault	ERROR

Supported Device Types (54 Categories) 2.2

Environmental Monitoring

Temperature Sensors: Multiple ranges and types •

Humidity Sensors: Relative and absolute •

Pressure Sensors: Atmospheric and industrial •

Air Quality: CO₂, CO, SO₂, CH₄, HC, Dust •

Weather Stations: Wind speed/direction, rainfall •

Electrical Systems

Voltage Monitoring: AC/DC measurement •

Current Monitoring: Ampere measurement •

Power Monitoring: kW, kWh tracking •

Power Quality: Harmonics, power factor •

UPS Systems: Battery status, runtime •

Mechanical Systems

Load Cells: Weight measurement •

Level Meters: Tank and reservoir monitoring •

Flow Meters: Liquid and gas flow •

Vibration Sensors: Equipment health monitoring •

Safety & Security

Smoke Detectors: Fire detection •

Gas Leak Detectors: Multiple gas types •

Water Leak Detectors: Flood prevention •

Motion Sensors: Occupancy and intrusion •

Door/Window Sensors: Access monitoring •

Glass Break Detectors: Security breach •

HVAC Control

AC Units: Full control and monitoring •

Heating Systems: Boilers, heaters •

Ventilation: Fans, dampers •

Chillers: Temperature control •

Heat Pumps: Efficiency optimization •

Lighting Control

- Dimming Control: 0-100% adjustment •
- RGB Control: Color management •
- Schedule-Based: Time-based automation •
- Occupancy-Based: Motion-triggered •
- Daylight Harvesting: Natural light integration •

Access Control

- RFID Readers: Card access •
- Biometric Devices: Fingerprint, face •
- Keypads: PIN entry •
- Intercoms: Two-way communication •
- Electric Locks: Strike, magnetic, motor •

Industrial I/O

- Digital Inputs: Contact closures •
- Digital Outputs: Relay control •
- Analog Inputs: 0-10V, 4-20mA •
- Analog Outputs: Control signals •
- PWM Outputs: Motor speed control •
- Counter Inputs: Pulse counting •

ENID Universal Addressing System .3

Revolutionary Addressing Architecture 3.1

ENID (Equipment Node Identifier) provides globally unique identification for every I/O point in the .system

ENID Structure

[BASE_CODE].[DEVICE_NO].[CATEGORY].[IO_TYPE].[DATA_TYPE].[PIN]

Example: 1000.0.1.1.2.1

- BASE_CODE: 1000 (Controller ID)
- DEVICE_NO: 0 (Main device)
- CATEGORY: 1 (Temperature)
- IO_TYPE: 1 (Input)
- DATA_TYPE: 2 (Float)
- PIN: 1 (Physical pin)

Key Features

- **64-bit Encoding Space:** Virtually unlimited addresses
- **Zero Collision Guarantee:** Mathematically proven uniqueness
- **Hierarchical Organization:** Logical grouping of devices
- **Direct SNMP Mapping:** Enterprise OID integration
- **Human Readable:** Easy troubleshooting

Built-in Visual Dashboard Builder & HMI .4

Complete Human-Machine Interface 4.1

Phoenix includes a revolutionary Visual Dashboard Builder that eliminates the need for expensive .separate HMI software

Dashboard Designer Features

Drag-and-Drop Interface

- **Visual Design Mode:** Real-time preview
- **Grid Snapping:** Precise alignment
- **Multi-Select:** Group operations
- **Copy/Paste:** Rapid development
- **Undo/Redo:** Safe experimentation

Component Library (9 Types)

Features	Purpose	Component
PNG/JPG support	Backgrounds, logos	Static Image
state visualization-5	Status display	Input Image
Touch actions	Control buttons	Output Image
Real-time updates	Value display	Dynamic Text
Access control	Commands	Button
Custom labels	Boolean control	Switch
Visual feedback	State control	Toggle
Min/max/step	Analog control	SeekBar
Validation	Value entry	EditText

Industrial Font Library

- DigitGraphics: Digital LCD style 01 •
- Digital Display TFB: 7-segment display •
- Digital-7: Classic digital •
- Digital-7 Mono: Fixed-width •
- DS-Digital: Modern LCD •
- Liquid Crystal: Matrix display •
- Open 24 Display: Bold digital •
- BankGothic MD BT: Industrial headers •

State Visualization System-5

:Each component can display different appearances based on system state

- State-based Images: Different image per state •
- State-based Colors: Automatic color changes •
- State-based Text: Dynamic text updates •
- State-based Visibility: Show/hide based on conditions •
- State-based Actions: Different behaviors per state •

Value Mapping System

:Transform raw data into meaningful displays

Text Mapping: "0:Off;1:On;2:Auto;3:Manual"
Image Mapping: "0:pump_off.png;1:pump_on.png;2:pump_fault.png"
Output Mapping: "0:0;50:500;100:1000"

Expression Engine .5

Advanced Mathematical Processing 5.1

Phoenix includes an enterprise-grade expression evaluator with BigDecimal precision for financial and industrial accuracy

Supported Operations

Arithmetic Operations

- % , / , * , - , + :Basic
- Power: ^ (with decimal exponents)
- ()Absolute: ABS
- ()Rounding: ROUND(), FLOOR(), CEIL

Trigonometric Functions

- ()SIN(), COS(), TAN
- ()ASIN(), ACOS(), ATAN
- Degrees/Radians conversion

Logical Operations

- =! , == , => , =< , > , < :Comparisons
- Boolean: AND, OR, NOT
- Conditional: IF(condition, true_value, false_value)

Statistical Functions

- AVG(): Average of values
- MIN(): Minimum value
- MAX(): Maximum value
- SUM(): Total sum

COUNT(): Number of items •

Special Variables

self: Current value reference •

me: Alias for current value •

set: Setpoint value •

x: Input variable •

Custom variables from any ACV •

Condition Engine & Automation .6

Rule-Based Automation System 6.1

.Advanced automation through cascading condition evaluation with real-time variable mapping

Condition Capabilities

Complex Logic Evaluation

Multiple conditions per ACV •

Nested IF/THEN/ELSE logic •

Time-based restrictions •

State-based triggers •

Multi-variable expressions •

Action Types

Set output values •

Send notifications •

Log events •

Trigger alarms •

Execute scenarios •

Start/stop equipment •

Time Scheduling

Daily schedules •

- Weekly patterns •
- Holiday calendars •
- Exception dates •
- Astronomical clock (sunrise/sunset) •

Automation Examples

```
IF temperature > 28 AND time > "09:00" THEN
  AC = ON
  FAN_SPEED = 75%
  SEND_SMS("AC activated due to high temperature")
END IF
```

```
IF motion_detected AND security_armed THEN
  ALARM = ON
  LIGHTS = ON
  CAMERA_RECORD = TRUE
  NOTIFY_SECURITY()
END IF
```

Pascal Runtime Environment .7

Embedded Programming Capability 7.1

Phoenix includes a complete Pascal compiler and runtime, enabling custom automation programs
without external PLC programming tools

Pascal Features

Language Support

- Full Pascal syntax •
- Variables: Integer, Real, String, Boolean, Arrays •
- Control structures: IF/THEN/ELSE, FOR, WHILE, REPEAT, CASE •
- Procedures and functions •
- Real-time execution •

Multi-Threading

- Unlimited concurrent programs
- Independent thread execution
- Inter-thread communication
- Shared variable access
- Event-driven triggers

Sample Pascal Program

pascal

```
Program BuildingAutomation;
var
    temp, humidity, co2: real;
    occupancy: boolean;
    ventilation, lighting: integer;
Begin
    // Read sensors
    temp := temperature_sensor;
    humidity := humidity_sensor;
    co2 := co2_sensor;
    occupancy := motion_detected;

    // Ventilation control
    if (co2 > 1000) or (humidity > 70) then
        ventilation := 100 // Maximum
    else if occupancy then
        ventilation := 50 // Normal
    else
        ventilation := 10; // Minimum

    // Lighting control
    if occupancy and (ambient_light < 300) then
        lighting := 80 // 80% brightness
    else
        lighting := 0; // Off

    // Write outputs
    vent_output := ventilation;
    light_output := lighting;
End.
```

Industrial PID Control .8

Professional Process Control 8.1

.Phoenix includes unlimited concurrent PID control loops for precise industrial process control

PID Features

Advanced Capabilities

- Unlimited Loops: No artificial limits •
- Anti-Windup Protection: Prevents integral saturation •
- Continuous Mode: For rotating equipment (0-360°) •
- Auto-Tuning: Self-optimization •
- Cascade Control: Multi-loop configurations •

Control Applications

- Temperature control ($\pm 0.1^{\circ}\text{C}$ precision) •
- Pressure regulation •
- Flow control •
- Level management •
- Motor speed control •
- pH control •

Configuration Options

- Proportional gain (K_p) •
 - Integral time (K_i) •
 - Derivative time (K_d) •
 - Output limits •
 - Dead band •
 - Sample time •
-

Multi-Protocol Communication .9

Industrial Protocol Support 9.1

Phoenix seamlessly integrates with existing industrial systems through comprehensive protocol
.support

Supported Protocols

Modbus (TCP/RTU)

Master/Slave modes •

Function codes: 1, 2, 3, 4, 5, 6, 15, 16 •

Data types: Coils, Discrete Inputs, Holding Registers, Input Registers •

Speed: Up to 115200 baud (RTU) •

Addressing: 1-247 devices •

SNMP (v1/v2c/v3)

Enterprise OID: 1.3.6.1.4.1.39850 •

MIB support: Custom MIB generation •

Traps: Automatic alarm notification •

Polling: Configurable intervals •

Security: v3 authentication and encryption •

BACnet (IP/MSTP)

Device profiles: B-BC, B-AAC •

Object types: All standard objects •

Services: Read, Write, Subscribe •

Discovery: Automatic device finding •

Scheduling: Time schedules, calendars •

KNX/EIB

Physical layers: TP, IP •

Group addresses: 3-level addressing •

Datatypes: All standard DPTs •

Scenes: 64 scenes per device •

Visualization: Integrated •

Additional Protocols

OPC UA: Client/Server •

MQTT: IoT integration •

REST API: Web services •

WebSocket: Real-time streaming •

Custom: User-defined protocols •

Universal Message Format

:All protocols translate to Phoenix's universal format for seamless integration

DeviceNo, Category, Address, Value, Status

Data Management & Recording .10

Intelligent Data Storage 10.1

Level Recording System-14

:Optimize storage while maintaining data integrity

Use Case	Interval	Level
No recording	Disabled	0
Critical values	On change	1
Fast processes	seconds 10	2
Active monitoring	seconds 30	3
Standard monitoring	minute 1	4
Normal operation	minutes 5	5
Slow changes	minutes 10	6
Environmental	minutes 30	7
Trending	hour 1	8
Long-term analysis	hours 2-24	9-14

Storage Optimization

- **Change-based recording:** Only store when value changes
- **Threshold filtering:** Ignore minor fluctuations
- **Compression:** Automatic data compression
- **Circular buffers:** Automatic old data management
- **storage reduction** compared to continuous recording **80%**

Database Architecture

Three-Database Strategy

- .1 **Configuration Database:** System setup and real-time values
 - .2 **Historical Database:** Time-series data storage
 - .3 **Event Database:** Alarms, logs, audit trail
-

Security & Access Control .11

Multi-Layer Security Architecture 11.1

Authentication Methods

Biometric Authentication

- **Face Recognition:** 99.7% accuracy with liveness detection
- **Fingerprint:** Capacitive and optical sensor support
- **Multi-factor:** Combine biometric with card/PIN

Card-Based Access

- **RFID Support:** 125KHz and 13.56MHz
- **NFC Integration:** Smartphone access
- **QR Codes:** Temporary access
- **Barcode:** Legacy system support

Advanced Features

- **Time Zones:** Schedule-based access
- **Holiday Calendars:** Special day handling

- **Anti-passback:** Prevent credential sharing
- **Visitor Management:** Temporary credentials
- **Audit Trail:** Complete access history

Encryption & Security

- **TLS 1.3:** Secure communications
 - **AES-256:** Data encryption
 - **Role-based access:** Granular permissions
 - **Session management:** Automatic timeout
 - **Intrusion detection:** Anomaly monitoring
-

Notification & Alerting System .12

Multi-Channel Notifications 12.1

Communication Channels

SMS Notifications

- **GSM Module Integration:** Direct hardware control
- **Message Templates:** Pre-defined formats
- **Group Messaging:** Broadcast to teams
- **Delivery Confirmation:** Receipt tracking
- **Priority Levels:** Emergency bypass

Email Alerts

- **SMTP Support:** Any email server
- **HTML Templates:** Rich formatting
- **Attachments:** Reports and logs
- **Scheduling:** Digest emails
- **Escalation:** Multi-tier alerting

Modern Channels

- **Telegram Bot:** Instant messaging
- **Push Notifications:** Mobile apps

- **Voice Calls:** Critical alarms

- **WhatsApp:** Business API

- **Teams/Slack:** Enterprise integration

Alert Configuration

- **Threshold-based:** High/low limits

- **Rate-of-change:** Rapid variations

- **Deviation:** From setpoint

- **State-change:** Status transitions

- **Compound:** Multiple conditions

Hardware Platform Support .13

Supported Embedded Platforms 13.1

:Phoenix runs on various Android-compatible embedded systems

Primary Platforms

ASUS Tinker Board

- **Best for:** Production deployments

- **Performance:** Optimal

- **I/O Options:** Complete

- **Industrial:** Temperature range

Raspberry Pi 4

- **Best for:** Development

- **Performance:** Excellent

- **Community:** Large support

- **Cost:** Moderate

Additional Platforms

- **ODROID Series:** High performance

- **Orange Pi:** Budget option

- NanoPi: Compact size
- Rock Pi: Alternative ecosystem
- Jetson Nano: AI capabilities
- Custom Boards: OEM solutions

Hardware Interfaces

- GPIO: Digital I/O control
- I2C: Sensor communication
- SPI: High-speed devices
- UART: Serial devices
- USB: Peripherals
- Ethernet: Network connectivity
- Wi-Fi/Bluetooth: Wireless options

Performance Specifications .14

System Performance Metrics 14.1

Processing Capability

Notes	Specification	Metric
Cold start to operational	seconds 30>	Boot Time
points simultaneously 10,000	Hz 10	I/O Scan Rate
Database writes	second/10,000	Update Rate
Input to output	100ms>	Response Time
Local network	10ms>	Network Latency

Capacity Specifications

Notes	Capacity	Component
Tree topology	Unlimited	Controllers per System
Mixed types	+10,000	I/O Points per Controller
Role-based	Unlimited	Users
Multi-screen	Unlimited	Dashboards
Compressed storage	Years	Historical Data

Notes	Capacity	Component
Web/mobile clients	+1000	Concurrent Connections

Reliability Metrics

- **MTBF:** >50,000 hours
- **Availability:** 99.9%
- **Recovery Time:** <5 minutes
- **Data Integrity:** Checksums and validation
- **Redundancy:** Automatic failover

Integration Capabilities .15

Third-Party Integration 15.1

Enterprise Systems

- **ERP Integration:** SAP, Oracle, Microsoft
- **MES Systems:** Production management
- **CMMS:** Maintenance management
- **Energy Management:** ISO 50001 compliance
- **BIM Integration:** Revit, AutoCAD

Cloud Platforms

- **AWS IoT:** Device management
- **Azure IoT Hub:** Microsoft ecosystem
- **Google Cloud IoT:** Analytics
- **Private Cloud:** OpenStack, VMware
- **Hybrid Solutions:** Edge-to-cloud

Analytics & Reporting

- **Business Intelligence:** Power BI, Tableau
- **Time-Series Databases:** InfluxDB, TimescaleDB
- **Machine Learning:** TensorFlow integration
- **Custom Reports:** Crystal Reports, Jasper

Application Domains .16

Building Automation 16.1

Commercial Buildings

- Office complexes •
- Shopping centers •
- Hotels and resorts •
- Hospitals •
- Educational institutions •
- Airports •
- Convention centers •

Residential

- Smart homes •
- Apartment complexes •
- Gated communities •
- Senior living facilities •

Industrial Automation 16.2

Manufacturing

- Production lines •
- Quality control •
- Inventory management •
- Energy monitoring •
- Predictive maintenance •

Process Control

- Water treatment plants •
- Chemical processing •
- Food & beverage •

- Pharmaceutical •

- Oil & gas •

Infrastructure 16.3

Utilities

- Power distribution •

- Water networks •

- Gas distribution •

- Renewable energy •

- Smart grid •

Transportation

- Traffic management •

- Parking systems •

- Tunnel ventilation •

- Railway stations •

- Port facilities •

Specialized Applications 16.4

Data Centers

- Environmental monitoring •

- Power management •

- Security systems •

- Cooling optimization •

Agriculture

- Greenhouse control •

- Irrigation systems •

- Climate control •

- Livestock monitoring •

Healthcare

- Operating room control •
 - Clean room management •
 - Medical gas systems •
 - Laboratory automation •
-

Unique Advantages .17

Technical Differentiators 17.1

Complete Solution

- All-in-One Platform:** No need for multiple systems •
- Built-in HMI:** No separate visualization software •
- Integrated Programming:** Pascal runtime included •
- Universal Compatibility:** Any hardware, any protocol •

Operational Benefits

- Offline Capable:** No internet dependency **100%** •
- Zero License Fees:** One-time purchase •
- No Vendor Lock-in:** Open architecture •
- Local Support:** Regional language support •

Performance Advantages

- Real-time Response:** <100ms guaranteed •
- Unlimited Scaling:** No artificial limits •
- High Reliability:** Proven 24/7 operation •
- Low Hardware Cost:** Runs on \$200 hardware •

Business Benefits 17.2

Cost Savings

- Lower TCO:** Compared to traditional DCS **90%** •
- No Annual Fees:** Perpetual license •

- **Reduced Training:** Intuitive interface
- **Lower Maintenance:** Self-diagnostic features

Flexibility

- **Modular Expansion:** Grow as needed
 - **Custom Development:** Pascal programming
 - **Protocol Freedom:** Connect anything
 - **Future-Proof:** Regular updates
-

Support & Training .18

Technical Support Services 18.1

Support Levels

- **Installation Support:** Initial setup assistance
- **Configuration Help:** System optimization
- **Troubleshooting:** Problem resolution
- **Remote Assistance:** Online support
- **On-site Service:** Critical issues

Documentation

- **User Manuals:** Complete operation guides
- **Technical Reference:** API documentation
- **Video Tutorials:** Step-by-step training
- **Sample Projects:** Ready-to-use templates
- **Knowledge Base:** Common solutions

Training Programs 18.2

Available Courses

- **Basic Operation:** 2-day fundamentals
- **Advanced Configuration:** 3-day deep dive
- **Pascal Programming:** Custom logic development
- **System Integration:** Protocol configuration

Maintenance: Troubleshooting and optimization •

Training Delivery

On-site Training: At customer location •

Training Center: Hands-on labs •

Online Courses: Self-paced learning •

Certification: Professional credentials •

Conclusion

Phoenix Smart Control System represents a decade of innovation in distributed control systems. With its comprehensive feature set, proven reliability, and unmatched cost-effectiveness, Phoenix provides a .complete solution for any automation challenge

Key Takeaways

Enterprise-Grade DCS with distributed intelligence ✓

Complete HMI Solution included at no extra cost ✓

Universal Compatibility with any hardware or protocol ✓

Proven Reliability with 700+ successful installations ✓

Future-Ready Platform with continuous updates ✓

:For more information

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