How this manual is organized:
Please read each manual relevant to your purpose.
Safety Precautions

This instruction manual describes the operation and function of the KV Series PLC. Read this manual carefully to ensure safe use and maximum performance from your KV Series PLC.

Symbols

The following symbols alert you to important messages. Be sure to read these messages carefully.

⚠️ WARNING
Failure to follow instructions may lead to injury. (electric shock, burn, etc.)

⚠️ CAUTION
Failure to follow instructions may lead to product damage.

Note:
Provides additional information on proper operation.

Conventions

This manual describes the operation/function of all Keyence KV Series PLC. Note following conventions when you use.

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General Precautions

- At startup and during operation, be sure to monitor the functions and performance of the KV Series PLC.
- We recommend that you take substantial safety measures to avoid any damage in the event a problem occurs.
- Do not open or modify the KV Series PLC or use it in any way other than described in the specifications.
- When the KV Series PLC is used in combination with other instruments, functions and performance may be degraded, depending on operating conditions and the surrounding environment.
- Do not use the KV Series PLC for the purpose of protecting the human body.

Note: The built-in display may show the error message "Error 40" blinking the very first time you turn on the power supply to the Visual KV Series. Press any key around the display to cancel this message. The Visual KV Series shows this message when no program is loaded.
Note to User

When using the Visual KV Series in the following conditions or environments, be sure to use the Visual KV Series with sufficient margin regarding the rating and functions, take appropriate safety precautions such as fail-safe, and contact our sales personnel if any questions arise.

- Use in conditions or environments not described in this manual
- Use for nuclear power control, railway facilities, air service facilities, vehicles, combustion devices, medical equipment, amusement machines, safety equipment, etc.
- Use for applications where large effects are predicted to be given on human lives and properties and safety is especially requested.

Restriction on Acquiring the CE Marking

- **Restriction to be compatible with EMC directives**
  - When using a relay output type unit (whose model name ends with "R"), connect spark killers having the appropriate withstand voltage against the load to the output terminals in parallel to contacts (because the unit discharges when a relay contact becomes open and noise is generated). In our experiments, we use the following models of spark killers.
    - XEB0101 0.1 µF-10 Ω manufactured by OKAYA DENKI SANGYO
  - The following 1-turn ferrite core is added to the AC power input circuit of the KV-40AR/T, the KV-24AR/T and to the DC power input circuit of the KV-40DR/T.
    - ZCAT3035-1330 manufactured by TDK

**Note:** The contents above do not by themselves ensure that the entire machine manufactured in accordance with the above contents is compatible with EMC directives. You must judge by yourself whether or not the entire machine is compatible with EMC directives because compatibility may change depending on the component configuration, wiring and location inside of the machine.

- **Restriction on compatibility with low-voltage directives (IEC-1010-1)**
  - Use insulated type crimp-style terminals.
  - For wiring materials, use lead wires whose sheath is 0.4 mm or more.
  - The Visual KV Series is allowed to be installed in a vertical position only. (Spacers for expansion units are not available.)
  - Be sure to use the Visual KV Series inside the control panel.
Features of the Visual KV Series

- **Extremely small**
  The Visual KV Series is the smallest in the world among AC type PLCs equipped with screw terminal blocks, and saves installation space.

- **Extremely fast**
  The minimum scan time is 140 µs and minimum instruction execution time is 0.7 µs, which is the fastest control in its class.

- **AC power built-in type newly added**
  AC power built-in type units are newly added. This type can be used in small spaces where a switching power supply unit cannot be installed.

- **Excellent Access Window**
  An Access Window with two-color backlight is adopted in all models to facilitate changing and monitoring of device data. Changing between RUN mode and PROGRAM mode, checking the error code when an error has occurred, etc. can be performed in a Visual KV Series unit without the need for any handheld programmer.
  The analog trimmer, which has been popular in the conventional KV Series, is digitized to enable more detail settings. [Digital trimmers]

- **User message setting function**
  In the Access Window, 256 different user messages can be displayed. This function can be used to give instructions on works on the production line, indicate abnormalities in the units, etc.

- **Program write in RUN mode**
  Ladder programs can be changed even while the system is running.

- **Equipped with two serial ports**
  Visual KV Series basic units are equipped with two serial ports to connect peripheral units, improving the debug environment.
  (The KV-10xx is equipped with only one serial port.)

- **Easy Ramp-up/down control function**
  The one-axis motor control function is offered separately from high-speed counters so that feedback control is enabled.

- **Equipped with two 24-bit high-speed 30 kHz, two-phase counters**
  The Visual KV Series is equipped with two high-speed counters each with a two-point comparator output function that enables high-speed encoder input.

- **Specified frequency pulse output function**
  High-speed counters can function as pulse oscillators of 50 kHz maximum with easy setting, without creating a complicated ladder program.

- **Frequency counter function**
  High-speed counters can function as frequency counters with easy setting, without creating complicated ladder programs.

- **Cam switch function**
  High-speed counters can function as cam switches with easy setting, without creating complicated ladder programs.
• **Interrupt function**
  The Visual KV Series is equipped with four high-speed interrupt inputs of 10 µs maximum.

• **Input time constant change function**
  The time constant can be set in 7 steps from 10 µs to 10 ms.

• **Double memory backup functions**
  In addition to a conventional SRAM battery backup function, the Visual KV Series is also equipped with an EEPROM backup function.

### Compatibility with Conventional KV Series Peripheral Units

The Visual KV Series functions as a high-end compatible model of the conventional KV Series. Peripheral units of the conventional KV Series such as the ladder support software "KV IncredWare (DOS)" and "LADDER BUILDER for KV" and the handheld programmer KV-P3E(01) can be used since they are part of the Visual KV Series.

However, it should be noted that the contents have changed as follows.

- The internal clock cycle of high-speed counters consists of three types: 1 µs, 10 µs, and 100 µs.
- The time constant for an input relay specified by the HSP instruction is 10 µs.
- The analog trimmer function is set with the Access Window built into the basic unit.
- The available device setting range of the TMIN instruction is from 0 to 65535. [Handheld programmer KV-P3E(01) can display 0 to 9999.]
- The RUN/PROGRAM LED is displayed in the Access Window provided on the front face of the basic unit.
- Transistor output is not independent, but is common.
- With the transistor type, the output terminal layout is different.
- The specifications for output current of transistor outputs Nos. 500 to 502 is 100 mA.
- Conventional KV Series expansion units are not available as expansion units for the Visual KV Series.
- The channel setting switch is not provided for expansion units. Channels are determined in connection order.
- Scans in expansion I/O units are not synchronous with the scan time in Visual KV Series basic units.
- Assignment of special utility relays has partially changed.
- Data memory device Nos. DM1000 to DM1999 are assigned as special data memories.
Cautions when using the previous version of ladder support software

Pay strict attention to the following items when using the ladder support software.

• When using the ladder support software “KV IncrediWare (DOS)” or “LADDER BUILDER for KV Ver. 1.0x”, set the model to “KV-300”.
• DM0 to DM1999 are only available.

When the ladder support software “LADDER BUILDER for KV Ver. 1.0x” is used, do not use the monitor’s Change All function. If the Change All function is used, the basic unit may be damaged. Never use the Change All function.

Peripheral units and other units incompatible with the Visual KV Series

Peripheral units in the conventional KV Series and other units shown below are not compatible with the Visual KV Series.

• Expansion I/O units for the conventional KV Series: KV-8ER/8ET/8EX/16EX/8EYR/8EYT/16EYR/16EYT
• Analog I/O units for the conventional KV Series: KV-AD4/DA4

Cautions when Using the Serial Port

The KV-16xx/24xx/40xx units are equipped with two RJ-11 modular connectors for serial communication.

When using them, pay strict attention to the following contents:

• Programs can be transferred and monitored using either communication port A or B. However, never connect the ladder software and a handheld programmer to the two ports at the same time.
• The KV-D20 operator interface panel can be connected to either communication port A or B. However, only one KV-D20 unit can be connected to a single basic unit.
• Never leave both the KV-D20 operator interface panel and KV-P3E(01) handheld programmer on simultaneously for a long period of time.
# How this manual is organized

The Visual KV Series User’s Manual is composed of 3 separate manuals; 1-Installation, 2-Support Software, 3-Programming. Please read each manual relevant to your purpose.

## 1 Installation

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## Appendices

The appendix includes a list of ladder program applications and the index.

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Describes the operating procedures in Editor mode.

Chapter 3 Simulator
Describes the operating procedures in Simulator mode.

Chapter 4 Monitor
Describes the operating procedures in Monitor mode.

Appendices
Includes instructions list, devices list, sample program list and quick reference for key operation and shortcuts.

3 Programming

Chapter 1 Programming
Describes basic knowledge including program creation procedures, device configuration, relay assignments, special functions to set and confirm Visual KV Series operations, as well as the extended ladder diagrams. Understand the contents described here completely at first before creating programs.

Chapter 2 Instructions
Describes the concrete usage of instructions in the KV Series.
Refer to "Chapter 3 Interrupts" on page 3-183 for details of interrupt instructions.
Refer to "Chapter 4 High-speed counters" on page 3-195 for details of the high-speed counters used in the application instruction.

Chapter 3 Interrupts [Visual KV Series Only]
The interrupt processing function executes an interrupt program when an external input or request from the high-speed counter comparator (interrupt factor) is encountered during KV operation.
This chapter describes the types of interrupt factors as well as inputs and outputs encountered during interrupt processing.

Chapter 4 High-speed Counters [Visual KV Series Only]
Describes high-speed counters and high-speed counter comparators, which allow high-speed pulse measurement and pulse output, independent of the scan time.

Chapter 5 Positioning Control [Visual KV Series Only]
Describes ramp-up/down control of stepping motors and servo motors.

Chapter 6 Interrupts, High-speed Counters, Positioning Control [KV-300, KV-10/80 Series Only]
Describes ramp-up/down control of stepping motors and servo motors.

Chapter 7 Serial Communication
The KV Series can be connected to an external device with an RS-232C interface to establish communication.
This chapter describes communications specifications, how to connect the KV Series to external devices, and how to perform communication.

Chapter 8 Programming Examples
Describes the typical programming examples for KV-10/80 Series. These programs can be used for Visual KV Series. However, pay attention to the I/O addressing compatibility before use.
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1.1 System Configuration

This section describes the Visual KV Series system configuration and each unit type.

1.1.1 System Configuration

The Visual KV Series system has the following configuration.

- **Basic units: 16 types**

- **Expansion units: 11 types**

- **Conventional KV Series peripheral units**

---

**For more about expanding the system by connecting expansion units, refer to "Connecting Visual KV Series Expansion Units" (p.1-71).**
When the ladder support software "KV IncrediWare (DOS)" or "LADDER BUILDER for KV Ver. 1.0x" is used, the Change All function on the monitor is not available. Using the Change All function may damage the basic unit. Never use the Change All function.

### 1.1 System Configuration

- **Extension cable for expansion unit (300 mm)**
  - For all expansion units
  - OP-35361

- **Expansion unit spacer**
  - For 4-I/O expansion unit
  - OP-35342
  - For 8-I/O expansion unit
  - OP-35343
  - For 16-I/O expansion unit
  - OP-35344

- **Metal fixture for screw tightening**
  - For 10-I/O basic unit OP-35345
  - For 16-I/O basic unit OP-35346
  - For 24-I/O basic unit OP-35347
  - For 40-I/O basic unit OP-35348
  - For 4- to 16-I/O expansion units
  - OP-35349
1.2 Specifications

This section describes the general specifications and performance specifications for the Visual KV Series units.

1.2.1 General Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>AC power type</th>
<th>Specifications</th>
<th>DC power type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>KV-16AR/AT(P)</td>
<td>KV-16AR/AT(P)</td>
<td>KV-10DR/DT(P)</td>
</tr>
<tr>
<td>Input supply voltage</td>
<td>100 to 240 VAC (±10%)</td>
<td>24 VDC (+10%, -20%)</td>
<td></td>
</tr>
<tr>
<td>Allowable instantaneous time</td>
<td>KV-10AR/DR: 100 mA or less</td>
<td>KV-24AR/AT(P)</td>
<td>KV-24DR/DT(P)</td>
</tr>
<tr>
<td>Internal current consumption (converted into 24 VDC value)</td>
<td>Basic units</td>
<td>KV-10DR: 745 mA</td>
<td>KV-24DR: 785 mA</td>
</tr>
<tr>
<td>Expansion units</td>
<td>KV-10DT: 725 mA</td>
<td>KV-24DT: 745 mA</td>
<td>KV-16AR/AT(P): 0.5 A</td>
</tr>
<tr>
<td>Maximum load current consumption</td>
<td>KV-10DR: 730 mA</td>
<td>KV-24DR: 765 mA</td>
<td>KV-16AR/AT(P): 0.6 A</td>
</tr>
<tr>
<td>Ambient temperature (No freezing)</td>
<td>KV-16DR: 765 mA</td>
<td>KV-40DR: 790 mA</td>
<td>KV-40AR/AT(P): 0.7 A</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>0 to +50°C (32 to 122°F), 0 to +45°C (32 to 113°F)</td>
<td>KV-P3E(01) Handheld programmer: 65 mA or less</td>
<td></td>
</tr>
<tr>
<td>Operating atmosphere</td>
<td>No excessive dust or corrosive gases allowed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>KV-10AR: Approx. 250 g</td>
<td>KV-10DR: Approx. 150 g</td>
<td>KV-16AR: Approx. 300 g</td>
</tr>
<tr>
<td></td>
<td>KV-16DR: Approx. 190 g</td>
<td>KV-24AR: Approx. 350 g</td>
<td>KV-24DR: Approx. 240 g</td>
</tr>
<tr>
<td></td>
<td>KV-40AR: Approx. 450 g</td>
<td>KV-40DR: Approx. 330 g</td>
<td>KV-10AT(P): Approx. 240 g</td>
</tr>
<tr>
<td></td>
<td>KV-10DT(P): Approx. 140 g</td>
<td>KV-16AT(P): Approx. 280 g</td>
<td>KV-16DT(P): Approx. 180 g</td>
</tr>
<tr>
<td></td>
<td>KV-24AT(P): Approx. 330 g</td>
<td>KV-24DT(P): Approx. 210 g</td>
<td>KV-40AT(P): Approx. 410 g</td>
</tr>
<tr>
<td></td>
<td>KV-40DT(P): Approx. 280 g</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>KV-E4X: Approx. 80 g</td>
<td>KV-E8X: Approx. 100 g</td>
<td>KV-E16X: Approx. 130 g</td>
</tr>
<tr>
<td></td>
<td>KV-E4T: Approx. 80 g</td>
<td>KV-E8T(P): Approx. 100 g</td>
<td>KV-E16T(P): Approx. 130 g</td>
</tr>
<tr>
<td></td>
<td>KV-E4R: Approx. 100 g</td>
<td>KV-E8R: Approx. 130 g</td>
<td>KV-E16R: Approx. 130 g</td>
</tr>
<tr>
<td></td>
<td>KV-E4XT(P): Approx. 100 g</td>
<td>KV-E4XR: Approx. 120 g</td>
<td></td>
</tr>
<tr>
<td></td>
<td>KV-P3E(01): Approx. 230 g</td>
<td>KV-D20: Approx. 160 g</td>
<td></td>
</tr>
</tbody>
</table>

*1. Configured with KV-E16R (x4), KV-E16X (x4) and KV-P3E(01).

*2. Configured with KV-E16R (x4), KV-E16X (x3) and KV-P3E(01).
1.2.2 AC Power Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>Switching method</td>
</tr>
<tr>
<td>Ripple noise</td>
<td>240 mVp-p or less</td>
</tr>
<tr>
<td>AC power current</td>
<td>KV-10Ax: 0.4 A, KV-16Ax: 0.5 A</td>
</tr>
<tr>
<td>consumption</td>
<td>KV-24Ax: 0.6 A, KV-40Ax: 0.7 A</td>
</tr>
<tr>
<td>AC power input voltage</td>
<td>100 to 240 VAC (±10%)</td>
</tr>
<tr>
<td>AC power factor</td>
<td>60%</td>
</tr>
<tr>
<td>Output voltage 1.</td>
<td>24 VDC±10%</td>
</tr>
<tr>
<td>Output capacity</td>
<td>KV-10Ax: 0.4 A, KV-16Ax: 0.6 A</td>
</tr>
<tr>
<td></td>
<td>KV-24Ax: 0.6 A, KV-40Ax: 0.7 A</td>
</tr>
<tr>
<td>Power consumption</td>
<td>KV-10Ax: 14 W, KV-16Ax: 21 W</td>
</tr>
<tr>
<td></td>
<td>KV-24Ax: 21 W, KV-40Ax: 24 W</td>
</tr>
<tr>
<td>Used fuse</td>
<td>Rated voltage: 240 VAC, rated current: 3.15 A, Characteristics: Fast-melting type</td>
</tr>
</tbody>
</table>

1. Includes the internal current consumption and current consumption of expansion units.

Note: The maximum output capacity available with the AC type service power output is the output capacity of each basic unit subtracted by the internal current consumption of the basic unit, connected expansion units, and connected peripheral units.

Visual KV Series operation at power interruption

- Drop in supply voltage
  When the supply voltage drops, the Visual KV Series stops operating and the output turns off.

- Detection of instantaneous power interruption
  - An AC type basic unit continues operating against instantaneous power interruption of less than 40 ms. A DC type basic unit continues operating against instantaneous power interruption of less than 2 ms.
  - An AC type basic unit may or may not accept instantaneous power interruption of 40 ms or more. A DC type basic unit may or may not accept instantaneous power interruption of 2 ms or more.
  - When accepting instantaneous power interruption, a basic unit stops operating and the output turns off.

- Automatic recovery
  - Once the supply voltage recovers, the Visual KV Series restarts operation automatically.

![Diagram](Rated voltage: Less than 40 ms → Rated voltage: 40 ms or more → Rated voltage)

Note: If the supply voltage increases gradually or drops, the Visual KV Series may repeat operation and then stop. If problems continue to occur with equipment and other operations from repetitive starts and stops, provide a protection circuit so that the output shuts down until the voltage reaches the rated value.

- Time until start of operation
  - The time period from when the power is turned on until operation starts varies depending on the conditions, including the supply voltage, system configuration, and operating environment. The minimum time is approximately 1.2 ms.
  - When a user program is changed, it will be saved in the EEPROM when the power is next turned on. Therefore, in such a case, the time period from when the power is turned on until operation starts is longer than usual.
## 1.2.3 Performance Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arithmetic operation control method</strong></td>
<td>Stored program method</td>
</tr>
<tr>
<td><strong>I/O control method</strong></td>
<td>Refresh method</td>
</tr>
<tr>
<td><strong>Program language</strong></td>
<td>Ladder chart method + Expanded ladder method</td>
</tr>
<tr>
<td><strong>Instruction types</strong></td>
<td>Basic instruction: 28 types</td>
</tr>
<tr>
<td></td>
<td>Application instruction: 22 types</td>
</tr>
<tr>
<td></td>
<td>Arithmetic instruction: 26 types</td>
</tr>
<tr>
<td></td>
<td>Interrupt instruction: 4 types</td>
</tr>
<tr>
<td><strong>Minimum scan time</strong></td>
<td>140 µs</td>
</tr>
<tr>
<td><strong>Instruction processing speed</strong></td>
<td>Basic instruction: 0.7 µs</td>
</tr>
<tr>
<td></td>
<td>Application instruction: 6.4 µs</td>
</tr>
<tr>
<td><strong>Program capacity</strong></td>
<td>2,000 steps (KV-10xx, KV-16xx)</td>
</tr>
<tr>
<td></td>
<td>4,000 steps (KV-24xx, KV-40xx)</td>
</tr>
<tr>
<td><strong>Maximum number of connected expansion units</strong></td>
<td>8 (7 for KV-40xx)</td>
</tr>
<tr>
<td><strong>Number of I/O points</strong></td>
<td>10 to 152 (when maximum number of expansion units are connected)</td>
</tr>
<tr>
<td><strong>Internal utility relay</strong></td>
<td>2,304: 1000 to 1915 and 3000 to 17915</td>
</tr>
<tr>
<td><strong>Special utility relay</strong></td>
<td>160: 2000 to 2915</td>
</tr>
<tr>
<td><strong>Data memory (16 bits)</strong></td>
<td>2,000 words: DM 0000 to DM1999</td>
</tr>
<tr>
<td><strong>Temporary data memory (16 bits)</strong></td>
<td>32 words: TM00 to TM31</td>
</tr>
<tr>
<td><strong>Timer/counter</strong></td>
<td>250 in all:</td>
</tr>
<tr>
<td></td>
<td>0.1-sec timer: TMR (0 to 6553.5 secs)</td>
</tr>
<tr>
<td></td>
<td>0.01-sec timer: TMH (0 to 655.35 secs)</td>
</tr>
<tr>
<td></td>
<td>0.001-sec timer: TMS (0 to 65.535 secs)</td>
</tr>
<tr>
<td></td>
<td>UP counter: C</td>
</tr>
<tr>
<td></td>
<td>Up/down counter: UDC</td>
</tr>
<tr>
<td><strong>Digital trimmer</strong></td>
<td>2 (set in Access Window)</td>
</tr>
<tr>
<td><strong>High-speed counter</strong></td>
<td>2 of 30 kHz, 2-phase high-speed counter (0 to 65535 count)</td>
</tr>
<tr>
<td><strong>High-speed counter comparator</strong></td>
<td>4 (2 for each high-speed counter)</td>
</tr>
<tr>
<td></td>
<td>Direct output is enabled.</td>
</tr>
<tr>
<td><strong>Positioning control function</strong></td>
<td>Independent 1 axis, 50 kHz maximum</td>
</tr>
<tr>
<td><strong>Memory switches</strong></td>
<td>16</td>
</tr>
<tr>
<td><strong>Data Backup function against instantaneous power interruption</strong></td>
<td>EEPROM which can be overwritten 100,000 times or more</td>
</tr>
<tr>
<td><strong>Program memory</strong></td>
<td>Can be backed up with electrical double-layer capacitor for 20 days or more at 25°C: KV-10AR/AT(P)/DR/DT(P) for 2 months or more at 25°C (77°F): Any other model can be backed up with EEPROM in all models.</td>
</tr>
<tr>
<td><strong>Data memory, counter, internal utility relay, and contact comment (Held devices are set by the MEMSW instruction.)</strong></td>
<td>CPU and RAM errors</td>
</tr>
<tr>
<td><strong>Self-diagnosis</strong></td>
<td>Handheld programmer KV-P3E(01) ²</td>
</tr>
<tr>
<td></td>
<td>Memory card M-2/M-3</td>
</tr>
<tr>
<td></td>
<td>Card reader/writer Z-1 ³</td>
</tr>
<tr>
<td></td>
<td>Programming support software LADDER BUILDER for KV (Windows version) ⁴ (KV-H6WE2) KV IncrediWare (DOS) (KV-H6E)</td>
</tr>
<tr>
<td><strong>Number of contact comments stroable</strong></td>
<td>1,000 max.</td>
</tr>
</tbody>
</table>

1. When high-speed counters are set using the MEMSW instruction, 24-bit data can be counted.
2. Comments cannot be handled in the handheld programmer KV-P3E(01).
3. The card reader/writer Z-1 can be used with the programming support software "KV IncrediWare (DOS)".
4. When the programming support software "LADDER BUILDER for KV Ver. 1.0x" is used, the Change All function on the monitor is not available. Using the Change All function may damage the basic unit. Never use the Change All function.
Data backup function against instantaneous power interruption

- **Electrical double-layer capacitor built into the basic unit**

  Contents of data memories, current values of counters, and the contents of internal utility relays in a Visual KV Series basic unit are saved in RAM backed up with an electrical double-layer capacitor built into the Visual KV Series basic unit by the Data backup function against instantaneous power interruption.

  The backup time varies depending on the ambient temperature.

  If power to the Visual KV Series basic unit remains OFF for more than the holding time by the RAM, the data may be cleared or become corrupted.

  To avoid the data being cleared, save the data in the EEPROM using the backup function to the EEPROM.

    - For writing to and reading from the EEPROM, refer to "LOAD mode and SAVE mode" (p.1-96).

  When a user program is written, it is saved in RAM. The next time the power is turned on, the user program is automatically transferred from RAM to the EEPROM and is also saved in the EEPROM. If power to the Visual KV Series basic unit will remain OFF for more than the backup time by the RAM, turn the power off immediately after writing a user program, and then turn the power on again so that the user program is transferred to the EEPROM.

  - **Data backup function by electrical double-layer capacitor built into the basic unit**

    Visual KV Series: 2 months or more at 25°C (77°F)
    (20 days or more at 25°C (77°F) in KV-10xx)

  - **EEPROM**

    The Visual KV Series basic unit is equipped with a backup function to save programs, contents of data memories, current values of counters, etc. in the EEPROM.

    Even if the power is interrupted or power to the Visual KV Series basic unit remains OFF, the data is still saved. When the power turns ON again, the contents of the EEPROM is automatically read. (The contents of data memories and current values of counters should be read by manipulating the Access Window.)

    When data is changed and the power is turned off without saving the changed data, the changes are saved only in the built-in electrical double-layer capacitor and are not saved in the EEPROM.

    If the Visual KV Series basic unit remains OFF for 2 months or more at 25°C (77°F) (20 days or more at 25°C (77°F) in KV-10xx) while the data is backed up only with the built-in electrical double-layer capacitor, the saved contents may be cleared or become corrupted.

    If the Visual KV Series basic unit will remain OFF for a long period of time, save the data in the EEPROM.

    - Refer to "LOAD mode and SAVE mode" (p.1-96).

  - **Data backup function with the EEPROM**

    Visual KV Series: 10 years or more at 25°C (77°F)
    (available number of overwrites: 100,000 times or more)
1.3 Common I/O Specifications of Basic Units

This section describes the common I/O specifications of Visual KV Series basic units. There are two types of basic units, AC power type and DC power type. Two types of output types are offered: relay output and transistor output.

1.3.1 Model of a Basic Unit

■ Basic unit model designation

The model of a Visual KV Series basic unit is indicated as follows:

KV-10AR

Output type: R = relay output, T = transistor output
Power supply type: A = AC power type, D = DC power type
Number of I/O points: 10 = 10 points, 16 = 16 points,
24 = 24 points, 40 = 40 points

■ Unit type

The following four types of Visual KV Series basic units are offered:

- AC power/relay output type: KV-10AR/16AR/24AR/40AR
- AC power/transistor output type: KV-10AT(P)/16AT(P)/24AT(P)/40AT(P)
- DC power/relay output type: KV-10DR/16DR/24DR/40DR
- DC power/transistor output type: KV-10DT(P)/16DT(P)/24DT(P)/40DT(P)

1.3.2 Common I/O Specifications

■ Input specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>24 V mode</th>
<th>5 V mode (Inputs 000 to 007 can be changed to 5 V input.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum input rating</td>
<td>26.4 VDC</td>
<td></td>
</tr>
<tr>
<td>Input voltage</td>
<td>24 VDC, 5.3 mA</td>
<td>5 VDC, 1.0 mA</td>
</tr>
<tr>
<td>Minimum ON voltage</td>
<td>19V</td>
<td>4.5V</td>
</tr>
<tr>
<td>Minimum OFF current (voltage)</td>
<td>2mA</td>
<td>2.5V</td>
</tr>
<tr>
<td>Common method</td>
<td>COM is shared inside.</td>
<td></td>
</tr>
<tr>
<td>Input time constant</td>
<td>10 ms typical</td>
<td>10 µs when HSP instruction is used</td>
</tr>
<tr>
<td>Interrupt input response</td>
<td>10 µs (representative)</td>
<td></td>
</tr>
<tr>
<td>High-speed counter input response</td>
<td>30 kHz (24V±10%) (duty: 50%)</td>
<td></td>
</tr>
</tbody>
</table>

* For 5V±10%, refer to the 5 V mode response frequency characteristic chart (representative example).

1.3 Common I/O Specifications of Basic Units
### 1.3 Common I/O Specifications of Basic Units

#### Output specifications (relay output):
KV-10AR/DR, KV-16AR/DR, KV-24AR/DR, and KV-40AR/DR

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rated load</strong></td>
<td>250 VAC/30 VDC</td>
</tr>
<tr>
<td></td>
<td>2 A (inductive load)</td>
</tr>
<tr>
<td></td>
<td>4 A (resistive load)</td>
</tr>
<tr>
<td><strong>Peak load current</strong></td>
<td>5A</td>
</tr>
<tr>
<td><strong>Rising operating time</strong></td>
<td>10 ms or less</td>
</tr>
<tr>
<td>(OFF → ON)</td>
<td></td>
</tr>
<tr>
<td><strong>Falling operating time</strong></td>
<td>10 ms or less</td>
</tr>
<tr>
<td>(ON → OFF)</td>
<td></td>
</tr>
<tr>
<td><strong>Common method</strong></td>
<td>Each common terminal is independent.</td>
</tr>
<tr>
<td><strong>Relay service life</strong></td>
<td>Electrical service life: 100,000 times or more (20 times/min)</td>
</tr>
<tr>
<td></td>
<td>Mechanical service life: 20,000,000 times or more</td>
</tr>
<tr>
<td><strong>Relay replacement</strong></td>
<td>Not allowed</td>
</tr>
</tbody>
</table>

#### Output specifications (transistor output):
KV-10AT(P)/DT(P), KV-16AT(P)/DT(P), KV-24AT(P)/DT(P), and KV-40AT(P)/DT(P)

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rated load</strong></td>
<td>30 VDC</td>
</tr>
<tr>
<td></td>
<td>0.1 A (500 to 502)</td>
</tr>
<tr>
<td></td>
<td>0.3 A (others)</td>
</tr>
<tr>
<td><strong>Peak load current</strong></td>
<td>0.2 A (500 to 502)</td>
</tr>
<tr>
<td></td>
<td>1 A (others)</td>
</tr>
<tr>
<td><strong>Maximum voltage at OFF</strong></td>
<td>30 VDC</td>
</tr>
<tr>
<td><strong>Leak current in OFF</strong></td>
<td>100 μA or less</td>
</tr>
<tr>
<td><strong>status</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Residual voltage in ON</strong></td>
<td>0.8 V or less</td>
</tr>
<tr>
<td><strong>status</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Rising operation time</strong></td>
<td>10 μs or less (500 to 502) (at 5 to 100 mA)</td>
</tr>
<tr>
<td>(OFF → ON)</td>
<td>20 μs or less (others) (at 10 to 300 mA)</td>
</tr>
<tr>
<td><strong>Falling operation time</strong></td>
<td>10 μs or less (500 to 502) (at 5 to 100 mA)</td>
</tr>
<tr>
<td>(ON → OFF)</td>
<td>100 μs or less (others) (at 10 to 300 mA)</td>
</tr>
<tr>
<td><strong>Common method</strong></td>
<td>1 common</td>
</tr>
<tr>
<td><strong>Output frequency</strong></td>
<td>50 kHz (500 to 502)</td>
</tr>
<tr>
<td><strong>Built-in serial resistance</strong></td>
<td>1.6 KΩ 1/2W (R500 to R502)</td>
</tr>
</tbody>
</table>
1.4 KV-10AR/AT(P)/DR/DT(P) (10-I/O Basic Unit)

This section describes the name and function of each part, the I/O specifications, the terminal layout, circuit diagrams, and dimensions of the KV-10 xx.

1.4.1 Part Names and Functions

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Input terminal block</td>
<td>24 VDC input terminal block (000 to 005 can be changed to 5 V input).</td>
</tr>
<tr>
<td>2</td>
<td>Output terminal block</td>
<td>Output terminal block. Pulse output function is built in 500 to 502 (in transistor output type only). A 1.6 kΩ current limiting resistor is built in R502 (to connect a motor driver).</td>
</tr>
<tr>
<td>3</td>
<td>Power input terminal (KV-10DR/DT(P))</td>
<td>Supplies 24 VDC.</td>
</tr>
<tr>
<td></td>
<td>Power output terminal (KV-10AR/AT(P))</td>
<td>Supplies 100 to 240 VAC to the power input terminals on the lower side of the unit, and allows the service power supply to be taken from the 24 VDC terminal.</td>
</tr>
<tr>
<td>4</td>
<td>Input indicator lamps</td>
<td>Indicate input status. Each lamp lights up at ON.</td>
</tr>
<tr>
<td>5</td>
<td>Output indicator lamps</td>
<td>Indicate output status. Each lamp lights up at ON.</td>
</tr>
<tr>
<td>6</td>
<td>Connector (provided on side)</td>
<td>Used to connect an expansion unit</td>
</tr>
<tr>
<td>7</td>
<td>Access Window</td>
<td>Used to refer to and change the current and set values of timers and counters as well as the contents of data memories. The backlight color indicates the operation status. Lit in green: RUN mode Lit in red: PROGRAM mode Flashing red: Error status</td>
</tr>
<tr>
<td>8</td>
<td>Setting keys</td>
<td>Used to refer to and change current values, etc. while referring to the Access Window.</td>
</tr>
<tr>
<td>9</td>
<td>Input voltage selector switch</td>
<td>Changes the input voltage of the basic unit.  ■ ■: 24 V input ■ ■: 5 V input</td>
</tr>
<tr>
<td>10</td>
<td>Communication port A</td>
<td>RJ-11 Modular connector for connecting a personal computer, handheld programmer, or operator interface panel.</td>
</tr>
</tbody>
</table>

For more about the Access Window, refer to "Chapter 3. Access Window" (p.1-79).
1.4.2 Terminal Layout Drawings and I/O Circuit Diagrams

KV-10AR/DR (Relay output type)

- Terminal layout drawing

- Input circuit diagram
Output circuit diagram

• C3 and C4 are each independent.
KV-10AT(P)/DT(P) (Transistor output type)

- Terminal layout drawing

- Input circuit diagram
1.4.3 AC Power Input (KV-10AR/AT(P))

- 1.6 kΩ current limiting resistor is built in R502 (to connect a motor driver).

* For KV-10ATP/DTP
1.4.4 Relationship between Continuous Simultaneous ON Ratio and Ambient Temperature

**CAUTION**

*If the number of I/O points which turn ON at the same time exceeds the specifications range, the unit may be damaged.*

The graphs below show the relationship between the ambient temperature and the continuous simultaneous ON ratio.

Load current L:

\[
\text{AC power output capacity at 400 mA} - \frac{\text{Individual current consumption when KV-D20 is connected}}{\text{(Service power output current) + (Expansion unit current consumption)}}
\]

**Derating when KV-10AR is mounted upward**

**Derating when KV-10AT(P) is mounted upward**

**Derating when KV-10DR is mounted upward**

**Derating when KV-10DT(P) is mounted upward**

**Derating when KV-10AR is mounted in front**

**Derating when KV-10AT(P) is mounted in front**

**Derating when KV-10DR is mounted in front**

**Derating when KV-10DT(P) is mounted in front**
1.4.5 Dimensions

- **Main unit**

  ![Main unit diagram](image)

  - Front view
  - Side view (KV-10AR/AT(P))
  - Side view (KV-10DR/DT(P))
  - Bottom view (KV-10AR/AT(P))

- **Metal fixture for screw tightening**

  ![Metal fixture diagram](image)

  - 4Ø5.0 (Mounting hole)
  - Main unit mounting hole* (2 positions)

  * Two M3.5 countersunk-head screws are included for mounting the main unit.
1.5 KV-16AR/AT(P)/DR/DT(P) (16-I/O Basic Unit)

This section describes the name and function of each part, the I/O specifications, the terminal layout, circuit diagrams, and dimensions of the KV-16xx.

1.5.1 Part Names and Functions

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Input terminal block</td>
<td>24 VDC input terminal block (000 to 007 can be changed to 5 V input).</td>
</tr>
<tr>
<td>2</td>
<td>Output terminal block</td>
<td>Output terminal block. Pulse output function is built in 500 to 502 (in transistor output type only). A 1.6 kΩ current limiting resistor is built in R502 (to connect a motor driver).</td>
</tr>
<tr>
<td>3</td>
<td>Power input terminal (KV-24DR/DT(P))</td>
<td>Supplies 24 VDC.</td>
</tr>
<tr>
<td></td>
<td>Power output terminal (KV-24AR/AT(P))</td>
<td>Supplies 100 to 240 VAC to the power input terminals on the lower side of the unit, and allows the service power supply to be taken from the 24 VDC terminal.</td>
</tr>
<tr>
<td>4</td>
<td>Input indicator lamps</td>
<td>Indicate input status. Each lamp lights up at ON.</td>
</tr>
<tr>
<td>5</td>
<td>Output indicator lamps</td>
<td>Indicate output status. Each lamp lights up at ON.</td>
</tr>
<tr>
<td>6</td>
<td>Connector (provided on side)</td>
<td>Used to connect an expansion unit</td>
</tr>
<tr>
<td>7</td>
<td>Access Window</td>
<td>Used to refer to and change the current and set values of timers and counters as well as the contents of data memories. The backlight color indicates the operation status. Lit in green: RUN mode Lit in red: PROGRAM mode Flashing red: Error status</td>
</tr>
<tr>
<td>8</td>
<td>Setting keys</td>
<td>Used to refer to and change current values, etc. while referring to the Access Window.</td>
</tr>
<tr>
<td>9</td>
<td>Input voltage selector switch</td>
<td>Changes the input voltage of the basic unit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>: 24 V input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>: 5 V input</td>
</tr>
<tr>
<td>10</td>
<td>Communication port A</td>
<td>RJ-11 Modular connector for connecting a personal computer, handheld programmer, or operator interface panel.</td>
</tr>
<tr>
<td>11</td>
<td>Communication port B</td>
<td>RJ-11 Modular connector for connecting a personal computer, handheld programmer, or operator interface panel.</td>
</tr>
</tbody>
</table>

* For more about the Access Window, refer to "Chapter 3. Access Window" (p.1-79).
1.5.2 Terminal Layout Drawings and I/O Circuit Diagrams

KV-16AR/DR (Relay output type)

- Terminal layout drawing

- Input circuit diagram

Circuit configuration of inputs 000 to 007

- Photocoupler insulation
- 4.3kΩ

Circuit configuration of inputs 008 to 009

- Photocoupler insulation
- 4.3kΩ
- 510Ω
**Output circuit diagram**

- C3 and C4 are each independent.
KV-16AT(P)/DT(P) (Transistor output type)

- Terminal layout drawing

- Input circuit diagram

Circuit configuration of inputs 000 to 007
- Photocoupler insulation
- Internal circuit

Circuit configuration of inputs 008 to 009
- Photocoupler insulation
- Internal circuit
1.5.3 AC Power Input (KV-16AR/AT(P))
1.5.4 Relationship between Continuous Simultaneous ON Ratio and Ambient Temperature

If the number of I/O points which turn ON at the same time exceeds the specifications range, the unit may be damaged.

The graphs below show the relationship between the ambient temperature and the continuous simultaneous ON ratio.

Load current L:

\[
\text{Load current } L = (\text{AC power output capacity at 600 mA}) - (\text{Individual current consumption when KV-D20 is connected}) + (\text{Service power output current}) + (\text{Expansion unit current consumption})
\]

Derating when KV-16AR is mounted upward

Supply voltage: 100 to 240 V

Derating when KV-16AT(P) is mounted upward

Supply voltage: 100 to 240 V

Derating when KV-16AR is mounted in front

Supply voltage: 100 to 240 V

Derating when KV-16AT(P) is mounted in front

Supply voltage: 100 to 240 V

Derating when KV-16DR is mounted upward

Supply voltage: 100 to 240 V

Derating when KV-16DR is mounted in front

Supply voltage: 100 to 240 V

Derating when KV-16DT(P) is mounted upward

Supply voltage: 100 to 240 V

Derating when KV-16DT(P) is mounted in front

Supply voltage: 100 to 240 V
1.5.5 Dimensions

- **Main unit**

  ![Main unit diagram]

- **Metal fixture for screw tightening**

  ![Metal fixture diagram]

* Two M3.5 countersunk-head screws are included for mounting the main unit.
1.6 KV-24AR/AT(P)/DR/DT(P) (24-I/O Basic Unit)

This section describes the name and function of each part, the I/O specifications, the terminal layout, circuit diagrams, and dimensions of the KV-24xx.

1.6.1 Part Names and Functions

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Input terminal block</td>
<td>24 VDC input terminal block (000 to 007 can be changed to 5 V input).</td>
</tr>
<tr>
<td>2</td>
<td>Output terminal block</td>
<td>Output terminal block. Pulse output function is built in 500 to 502 (in transistor output type only). A 1.6 kΩ current limiting resistor is built in R502 (to connect a motor driver).</td>
</tr>
<tr>
<td>3</td>
<td>Power input terminal (KV-24DR/DT(P))</td>
<td>Supplies 24 VDC.</td>
</tr>
<tr>
<td>4</td>
<td>Power output terminal (KV-24AR/AT(P))</td>
<td>Supplies 100 to 240 VAC to the power input terminals on the lower side of the unit, and allows the service power supply to be taken from the 24 VDC terminal.</td>
</tr>
<tr>
<td>5</td>
<td>Input indicator lamps</td>
<td>Indicate input status. Each lamp lights up at ON.</td>
</tr>
<tr>
<td>6</td>
<td>Output indicator lamps</td>
<td>Indicate output status. Each lamp lights up at ON.</td>
</tr>
<tr>
<td>7</td>
<td>Connector (provided on side)</td>
<td>Used to connect an expansion unit.</td>
</tr>
<tr>
<td>8</td>
<td>Access Window</td>
<td>Used to refer to and change the current and set values of timers and counters as well as the contents of data memories. The backlight color indicates the operation status.Lit in green: RUN mode  Lit in red: PROGRAM mode  Flashing red: Error status</td>
</tr>
</tbody>
</table>
| 9   | Input voltage selector switch             | Changes the input voltage of the basic unit.  

For more about the Access Window, refer to “Chapter 3. Access Window” (p.1-79).
1.6.2 Terminal Layout Drawings and I/O Circuit Diagrams

KV-24AR/DR (Relay output type)

- Terminal layout drawing

- Input circuit diagram
Output circuit diagram

- C3 to C6 are each independent.
KV-24AT(P)/DT(P) (Transistor output type)

■ Terminal layout drawing

■ Input circuit diagram
1.6 KV-24AR/AT(P)/DR/DT(P) (24-I/O Basic Unit)

## Output circuit diagram

### Internal circuit

![Diagram showing internal circuit connections]

- For KV-24ATP/DTP

## 1.6.3 AC Power Input (KV-24AR/AT(P))

![Diagram showing AC power input connections]

- A 1.6 kΩ current limiting resistor is built in each of R500 to R502 (to connect a motor driver).
- V1 to V3 are short-circuited inside (so they can be used as a relay terminal block).
1.6.4 Relationship between Continuous Simultaneous ON Ratio and Ambient Temperature

**CAUTION**

*If the number of I/O points which turn ON at the same time exceeds the specifications range, the unit may be damaged.*

The graphs below show the relationship between the ambient temperature and the continuous simultaneous ON ratio.

Load current \(L\):

\[
(\text{AC power output capacity at 600 mA}) - (\text{Individual current consumption when KV-D20 is connected}) = (\text{Service power output current}) + (\text{Expansion unit current consumption})
\]

- **Derating when KV-24AR is mounted upward**
- **Derating when KV-24AR is mounted in front**
- **Derating when KV-24AT(P) is mounted upward**
- **Derating when KV-24AT(P) is mounted in front**
- **Derating when KV-24DR is mounted upward**
- **Derating when KV-24DR is mounted in front**
- **Derating when KV-24DT(P) is mounted upward**
- **Derating when KV-24DT(P) is mounted in front**
1.6.5 Dimensions

- **Main unit**

  Front view
  ![Front view diagram]

  Side view (KV-24AR/AT(P))
  ![Side view (KV-24AR/AT(P))]

  Side view (KV-24DR/DT(P))
  ![Side view (KV-24DR/DT(P))]

  Bottom view (KV-24AR/AT(P))
  ![Bottom view (KV-24AR/AT(P))]

- **Metal fixture for screw tightening**

  ![Metal fixture diagram]

  * Two M3.5 countersunk-head screws are included for mounting the main unit.
1.7 KV-40AR/AT(P)/DR/DT(P) (40-I/O Basic Unit)

This section describes the name and function of each part, the I/O specifications, the terminal layout, circuit diagrams, and dimensions of the KV-40xx.

1.7.1 Part Names and Functions

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Input terminal block</td>
<td>24 VDC input terminal block (000 to 007 can be changed to 5 V input).</td>
</tr>
<tr>
<td>2</td>
<td>Output terminal block</td>
<td>Output terminal block. Pulse output function is built in 500 to 502 (in transistor output type only). 1.6 kΩ current limiting resistor is built in R502 (to connect a motor driver).</td>
</tr>
<tr>
<td>3</td>
<td>Power input terminal (KV-40DR/DT(P))</td>
<td>Supplies 24 VDC.</td>
</tr>
<tr>
<td>4</td>
<td>Power output terminal (KV-40AR/AT(P))</td>
<td>Supplies 100 to 240 VAC to the power input terminals on the lower side of the unit, and allows the service power supply to be taken from the 24 VDC terminal.</td>
</tr>
<tr>
<td>5</td>
<td>Input indicator lamps</td>
<td>Indicate input status. Each lamp lights up at ON.</td>
</tr>
<tr>
<td>6</td>
<td>Output indicator lamps</td>
<td>Indicate output status. Each lamp lights up at ON.</td>
</tr>
<tr>
<td>7</td>
<td>Connector (provided on side)</td>
<td>Used to connect an expansion unit.</td>
</tr>
<tr>
<td>8</td>
<td>Access Window</td>
<td>Used to refer to and change the current and set values of timers and counters as well as the contents of data memories. The backlight color indicates the operation status. Lit in green: RUN mode Lit in red: PROGRAM mode Flashing red: Error status</td>
</tr>
</tbody>
</table>
| 9   | Input voltage selector switch            | Changes the input voltage of the basic unit.  

- [ ] : 24 V input  
- [ ] : 5 V input |
| 10  | Communication port A                     | RJ-11 Modular connector for connecting a personal computer, handheld programmer, or operator interface panel. |
| 11  | Communication port B                     | RJ-11 Modular connector for connecting a personal computer, handheld programmer, or operator interface panel. |

For more about the Access Window, refer to "Chapter 3. Access Window" (p.1-79).
1.7.2 Terminal Layout Drawings and I/O Circuit Diagrams

KV-40AR/DR (Relay output type)

- **Terminal layout drawing**

- **Input circuit diagram**

  **Circuit configuration of inputs 000 to 007**
  - 000 to 007: 4.3KΩ, Photocoupler insulation
  - 000 to 007: Relay selector circuit

  **Circuit configuration of inputs 008 to 107**
  - 008 to 107: 4.3KΩ, Photocoupler insulation
  - 008 to 107: 510Ω, Relay selector circuit
• C3 to C8 are each independent.
KV-40AT(P)/DT(P) (Transistor output type)

- **Terminal layout drawing**

![Terminal layout drawing](image)

- **Input circuit diagram**

![Input circuit diagram](image)

Circuit configuration of inputs 000 to 007

- Photocoupler insulation
- 24V/5V selector circuit
- 4.3kΩ

Circuit configuration of inputs 008 to 107

- Photocoupler insulation
- 510Ω
1.7.3 AC Power Input (KV-40AR/AT(P))
1.7.4 Relationship between Continuous Simultaneous ON Ratio and Ambient Temperature

If the number of I/O points which turn ON at the same time exceeds the specifications range, the unit may be damaged.

The graphs below show the relationship between the ambient temperature and the continuous simultaneous ON ratio.

Load current L:

\[
\text{Load current } L = \frac{\text{(AC power output capacity at 700 mA) - (Individual current consumption when KV-D20 is connected)}}{\text{(Service power output current) + (Expansion unit current consumption)}}
\]

Derating when KV-40AR is mounted upward
Supply voltage: 100 to 240 V

Derating when KV-40AT(P) is mounted upward
Supply voltage: 100 to 240 V

Derating when KV-40AR is mounted in front

Derating when KV-40AT(P) is mounted in front

Derating when KV-40DR is mounted upward

Derating when KV-40DR is mounted in front

Derating when KV-40DT(P) is mounted upward

Derating when KV-40DT(P) is mounted in front
1.7.5 Dimensions

- **Main unit**

  ![](image1.png)

- **Metal fixture for screw tightening**

  ![](image2.png)

* Two M3.5 countersunk-head screws are included for mounting the main unit.
1.8 KV-E4X/E8X/E16X (Expansion Input Unit)

This section describes the name and function of each part, the input specifications, the terminal layout, circuit diagrams, and dimensions of three types of expansion input units.

1.8.1 Part Names and Functions

![Diagram of KV-E4X/E8X/E16X]

1. Input terminal block
2. Input indicator lamps
3. READY/ERROR indicator lamp
4. Expansion cable
5. Connector (provided on side)

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Input terminal block</td>
<td>24 VDC input terminal block</td>
</tr>
<tr>
<td>2</td>
<td>Input indicator lamps</td>
<td>Indicate input status. Each lamp lights up at ON.</td>
</tr>
<tr>
<td>3</td>
<td>READY/ERROR indicator lamp</td>
<td>Indicates operation status of expansion input unit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lit: Normal operation Flashing: Communication error</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not lit: Power not connected</td>
</tr>
<tr>
<td>4</td>
<td>Expansion cable</td>
<td>Used to connect a basic unit or another expansion unit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A standard expansion cable approximately 60 mm in length is provided.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For extensions, use the optional 300 mm expansion cable (OP-35361).</td>
</tr>
<tr>
<td>5</td>
<td>Connector</td>
<td>Used to connect an expansion unit.</td>
</tr>
</tbody>
</table>

1.8.2 Input Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>KV-E4X</th>
<th>KV-E8X</th>
<th>KV-E16X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit type</td>
<td>4-I/O input</td>
<td>8-I/O input</td>
<td>16-I/O input</td>
</tr>
<tr>
<td>Number of inputs</td>
<td>4</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>External connection method</td>
<td>Terminal block</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum input rating</td>
<td>26.4 VDC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input voltage</td>
<td>24 VDC, 5.3 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum ON voltage</td>
<td>19 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum OFF current</td>
<td>2 mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input impedance</td>
<td>4.3 kΩ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common method</td>
<td>4 points/common</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input time constant (Changed in two steps by special utility relays 2609 to 2612)</td>
<td>For both rising (OFF → ON) and falling (ON → OFF) operations, 10 ms: 10 ms ±20%, 10 μs: 10 μs ±20%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For more about the general specifications, refer to “General Specifications” (p.1-4).
1.8.3 Terminal Layout Drawings and Input Circuit Diagrams

KV-E4X (4-I/O expansion input unit)

- Terminal layout drawing

- Input circuit diagram

• V1 to V5 are short-circuited inside (so they can be used as a relay terminal block).
KV-E8X (8-I/O expansion input unit)

- Terminal layout drawing

- Input circuit diagram

- C1 and C2 are each independent.
- V1 to V2 and V3 to V4 are short-circuited inside respectively (so they can be used as relay terminal blocks).
KV-E16X (16-I/O expansion input unit)

- Terminal layout drawing

```
Input circuit diagram
```

- Input circuit diagram

```
• C1 to C4 are each independent.
```

---

**C1**

**C2**

**C3**

**C4**

---

**Sensor**

**Internal circuit**

**Photocoupler insulation**

4.3kΩ

510Ω
1.8.4 Dimensions

- Main unit

![Diagram of Main unit dimensions](image1)

- Metal fixture for screw tightening

![Diagram of Metal fixture dimensions](image2)

* Two M3.5 countersunk-head screws are included for mounting the main unit.
1.9 KV-E4R/E4T/E8R/E8T(P)/E16R/E16T(P) (Expansion Output Unit)

This section describes the name and function of each part, the output specifications, the terminal layout, circuit diagrams, and dimensions of three types of expansion input units.

1.9.1 Part Names and Functions

1. Output terminal block
2. Output indicator lamps
3. READY/ERROR indicator lamp
4. Expansion cable
5. Connector (provided on side)

1.9.2 Output Specifications

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
</table>
| 1   | Output terminal block | Output terminal block.  
Transistor output: 30 VDC  
Relay output: 250 VAC, 30 VDC |
| 2   | Output indicator lamps| Indicate output status. Each lamp lights up at ON.                        |
| 3   | READY/ERROR indicator lamp | Indicates operation status of expansion output unit.  
Lit: Normal operation  
Flashing: Communication error  
Not lit: Power not connected |
| 4   | Expansion cable       | Used to connect a basic unit or another expansion unit.  
A standard expansion cable approximately 60 mm in length is provided.  
For extensions, use the optional 300 mm expansion cable (OP-35361). |
| 5   | Connector             | Allows to connect an expansion unit.                                      |
#### KV-E4R/E8R/E16R (Relay output type)

<table>
<thead>
<tr>
<th>Model</th>
<th>KV-E4R</th>
<th>KV-E8R</th>
<th>KV-E16R</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4-I/O relay output</td>
<td>8-I/O relay output</td>
<td>16-I/O relay output</td>
</tr>
<tr>
<td>Number of outputs</td>
<td>4</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Output type</td>
<td>Relay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External connection method</td>
<td>Terminal block</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated load voltage</td>
<td>250 VAC/30 VDC</td>
<td>2 A (inductive load)</td>
<td>4 A (resistive load)</td>
</tr>
<tr>
<td>Rated output current</td>
<td>2 A/point (inductive load)</td>
<td>4 A/point (resistive load)</td>
<td>4A/common</td>
</tr>
<tr>
<td>ON resistance</td>
<td>50 mΩ or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common method</td>
<td>4 points/common</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rising operation time (OFF → ON)</td>
<td>10 ms or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falling operation time (ON → OFF)</td>
<td>Electrical: 100,000 times or more (20 times/min) Mechanical: 20,000,000 times or more</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relay service life</td>
<td>Not allowed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For more about the general specifications, refer to "General Specifications" (p. 1-4).

#### KV-E4T/E8T(P)/E16T(P) [Transistor output type (NPN/PNP)]

<table>
<thead>
<tr>
<th>Model</th>
<th>KV-E4T</th>
<th>KV-E8T(P)</th>
<th>KV-E16T(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4-I/O transistor output</td>
<td>8-I/O transistor output</td>
<td>16-I/O transistor output</td>
</tr>
<tr>
<td>Number of outputs</td>
<td>4</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Output type</td>
<td>Transistor (NPN/PNP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External connection method</td>
<td>Terminal block</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated load voltage</td>
<td>30 VDC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated output current</td>
<td>0.5A/point (NPN), 0.3A/point (PNP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leak current in OFF status</td>
<td>100 μA or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual voltage in ON status</td>
<td>0.8 V or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common method</td>
<td>Shared inside</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rising operation time (OFF → ON)</td>
<td>50 μs or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falling operation time (ON → OFF)</td>
<td>250 μs or less</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For more about the general specifications, refer to "General Specifications" (p. 1-4).
1.9.3 Terminal Layout Drawings and Input Circuit Diagrams

KV-E4R [4-I/O expansion output unit (relay output type)]

■ Terminal layout drawing

■ Output circuit diagram

• V1 to V5 are short-circuited inside (so they can be used as a relay terminal block).
KV-E4T [4-I/O expansion output unit (transistor output type)]

- Terminal layout drawing

- Output circuit diagram

• V1 to V5 are short-circuited inside (so they can be used as a relay terminal block).
KV-E8R [8-I/O expansion output unit (relay output type)]

- Terminal layout drawing

- Output circuit diagram

- C1 and C2 are each independent.
- V1 to V2 and V3 to V4 are short-circuited inside (so they can be used as relay terminal blocks).
KV-E8T(P) [8-I/O expansion output unit (transistor output type)]

- Terminal layout drawing

- Output circuit diagram

* For KV-E8TP

• V1 to V2 and V3 to V4 are short-circuited inside (so they can be used as relay terminal blocks).

NPN
PNP

Internal circuit
KV-E16R [16-I/O expansion output unit (relay output type)]

- Terminal layout drawing

- Output circuit diagram

• C1 and C4 are each independent.
KV-E16T(P) [16-I/O expansion input unit (transistor output)]

- Terminal layout drawing

- Output circuit diagram

* For KV-E16TP

**NPN**

**PNP**
1.9.4 Dimensions

- Main unit

- Metal fixture for screw tightening

* Two M3.5 countersunk-head screws are included for mounting the main unit.
1.10 KV-E4XR/E4XT(P) (Expansion I/O Unit)

This section describes the name and function of each part, the I/O specifications, the terminal layout, circuit diagrams, and dimensions of two types of expansion I/O units.

1.10.1 Part Names and Functions

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Input terminal block</td>
<td>24 VDC input terminal block</td>
</tr>
<tr>
<td>2</td>
<td>Output terminal block</td>
<td>Output terminal block. Transistor output: 30 VDC. Relay output: 250 VAC, 30 VDC</td>
</tr>
<tr>
<td>3</td>
<td>Input indicator lamps</td>
<td>Indicate input status. Each lamp lights up at ON.</td>
</tr>
<tr>
<td>4</td>
<td>READY/ERROR indicator lamp</td>
<td>Indicates operation status of expansion I/O unit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lit: Normal operation. Flashing: Communication error.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extinguished: Power not connected.</td>
</tr>
<tr>
<td>5</td>
<td>Output indicator lamps</td>
<td>Indicate output status. Each lamp lights up at ON.</td>
</tr>
<tr>
<td>6</td>
<td>Expansion cable</td>
<td>Used to connect a basic unit or another expansion unit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A standard expansion cable approximately 60 mm in length is provided.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For extensions, use the optional 300 mm expansion cable (OP-35361).</td>
</tr>
<tr>
<td>7</td>
<td>Connector</td>
<td>Allows to connect an expansion unit.</td>
</tr>
</tbody>
</table>
1.10.2 Input Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>External connection method</td>
<td>Terminal block</td>
</tr>
<tr>
<td>Maximum input rating</td>
<td>26.4 VDC</td>
</tr>
<tr>
<td>Input voltage</td>
<td>24 VDC, 5.3 mA</td>
</tr>
<tr>
<td>Minimum ON voltage</td>
<td>19 V</td>
</tr>
<tr>
<td>Maximum OFF current</td>
<td>2 mA</td>
</tr>
<tr>
<td>Input impedance</td>
<td>4.3 kΩ</td>
</tr>
<tr>
<td>Common method</td>
<td>4 points/common</td>
</tr>
<tr>
<td>Input time constant (changed in two steps</td>
<td>For both rising (OFF → ON) and falling (ON → OFF)</td>
</tr>
<tr>
<td>by special utility relays 2609 to 2612)</td>
<td>operations, 10 ms: 10 ms ±20%</td>
</tr>
<tr>
<td></td>
<td>10 μs: 10 μs ±20%</td>
</tr>
</tbody>
</table>

*For more about the general specifications, refer to “General Specifications” (p.1-4).*

1.10.3 Output Specifications

KV-E4XR (Relay output type)

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output type</td>
<td>Relay</td>
</tr>
<tr>
<td>External connection method</td>
<td>Terminal block</td>
</tr>
<tr>
<td>Rated load voltage</td>
<td>250 VAC/30 VDC</td>
</tr>
<tr>
<td></td>
<td>2 A (inductive load)</td>
</tr>
<tr>
<td></td>
<td>4 A (resistive load)</td>
</tr>
<tr>
<td>Rated output current</td>
<td>2A/point (inductive load)</td>
</tr>
<tr>
<td></td>
<td>4A/point (resistive load)</td>
</tr>
<tr>
<td></td>
<td>4A/common</td>
</tr>
<tr>
<td>ON resistance</td>
<td>50 mΩ or less</td>
</tr>
<tr>
<td>Common method</td>
<td>4 points/common</td>
</tr>
<tr>
<td>Rising operation time (OFF → ON)</td>
<td>10 ms or less</td>
</tr>
<tr>
<td>Falling operation time (ON → OFF)</td>
<td>10 ms or less</td>
</tr>
<tr>
<td>Relay service life</td>
<td>Electrical: 100,000 times or more (20 times/min)</td>
</tr>
<tr>
<td></td>
<td>Mechanical: 20,000,000 times or more</td>
</tr>
<tr>
<td>Relay replacement</td>
<td>Not allowed</td>
</tr>
</tbody>
</table>

KV-E4XT(P) (Transistor output type)

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output type</td>
<td>Transistor (NPN/PNP)</td>
</tr>
<tr>
<td>External connection method</td>
<td>Terminal block</td>
</tr>
<tr>
<td>Rated load voltage</td>
<td>30 VDC</td>
</tr>
<tr>
<td>Rated output current</td>
<td>0.5A/point (NPN), 0.3A/point (PNP)</td>
</tr>
<tr>
<td>Leak current in OFF status</td>
<td>100 μA or less</td>
</tr>
<tr>
<td>Residual voltage in ON status</td>
<td>0.8 V or less</td>
</tr>
<tr>
<td>Common method</td>
<td>4 points/common</td>
</tr>
<tr>
<td>Rising operation time (OFF → ON)</td>
<td>50 μs or less</td>
</tr>
<tr>
<td>Falling operation time (ON → OFF)</td>
<td>250 μs or less</td>
</tr>
</tbody>
</table>

*For more about the general specifications, refer to “General Specifications” (p.1-4).*
1.10.4 Terminal Layout Drawings and Input Circuit Diagrams

KV-E4XR (Relay output type)

- Terminal layout drawing

- Input circuit diagram

V1 to V2 and V3 to V4 are short-circuited inside (so they can be used as relay terminal blocks).
• V1 to V2 and V3 to V4 are short-circuited inside (so they can be used as relay terminal blocks).
KV-E4XP(P) (Transistor output type)

- Terminal layout drawing

- Input circuit diagram

- V1 to V2 and V3 to V4 are short-circuited inside (so they can be used as relay terminal blocks).
Output circuit diagram

- V1 to V2 and V3 to V4 are short-circuited inside (so they can be used as relay terminal blocks).
1.10.5 Dimensions

- **Main unit**

  Front view

  Side view

  - 4-ø5.0 (Mounting hole)
  - Main unit mounting hole (2 positions)
  - t = 2

- **Metal fixture for screw tightening**

  Main unit mounting hole

  - 25
  - 38
  - 4-ø5.0 (Mounting hole)

* Two M3.5 countersunk-head screws are included for mounting the main unit.
1.11 KV-D20 (Operator Interface Panel)

This section describes the name and function of each part, the general specifications, the functional specifications, and dimensions of the operator interface panel.

1.11.1 Part Names and Functions

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Customized indicator lamps</td>
<td>Assigned to special utility relays as follows. Lamp 1: 2504  Lamp 2: 2505  Lamp 3: 2506  Lamp 4: 2507 When a relay turns ON, the corresponding LED becomes lit.</td>
</tr>
<tr>
<td>2</td>
<td>Liquid crystal display screen</td>
<td>Displays ladder comments (up to 20 characters) and all devices in KV Series.</td>
</tr>
<tr>
<td>3</td>
<td>Customized switch</td>
<td>Assigned to special utility relays as follows. F 1: 2500  F 2: 2501  F 3: 2502  F 4: 2503 When a switch is turned on, the corresponding relay turns ON.</td>
</tr>
<tr>
<td>4</td>
<td>Setting operation switches</td>
<td>Changes screen display.</td>
</tr>
<tr>
<td>5</td>
<td>Communication port</td>
<td>RJ-11 Modular connector. Used for communication between KV basic units while connected to the basic unit’s communication port with an accessory cable (OP-26487). This port also supplies driving power for the KV-D20.</td>
</tr>
<tr>
<td>6</td>
<td>Bit guide</td>
<td>Shows the corresponding number of each bit on the KV-I/O monitor screen, the operator screen, or the 8-bit ON/OFF indication in the device mode.</td>
</tr>
</tbody>
</table>
1.11 KV-D20 (Operator interface panel)

### 1.11.2 General Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>Supplied from the communication port of the KV (5 VDC)</td>
</tr>
<tr>
<td>Current consumption</td>
<td>5 VDC, 180 mA max. (60 mA max. when converted for 24 V)</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>0 to +50°C (32 to 122°F), No freezing</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>35 to 85%, No condensation</td>
</tr>
<tr>
<td>Ambient storage temperature</td>
<td>-20 to +70°C (-4 to 158°F), No freezing</td>
</tr>
<tr>
<td>Withstand voltage</td>
<td>1,500 VAC for 1 minute (Between power terminal and I/O terminal as well as between entire external terminals and case)</td>
</tr>
<tr>
<td>Noise immunity</td>
<td>1,500 Vp-p or more, pulse width: 1 μs, 50 ns (by noise simulator) Conforms to EN standard (EN61000-4-2/-3/-4/-6)</td>
</tr>
<tr>
<td>Vibration</td>
<td>10 to 55 Hz, double amplitude: 1.5 mm, 2 hours in each of X, Y and Z axis directions</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>50 MΩ or more (Between power terminal and I/O terminal as well as between entire external terminals and case by 500 VDC megohmmeter)</td>
</tr>
<tr>
<td>Operating atmosphere</td>
<td>No excessive dust or corrosive gases.</td>
</tr>
<tr>
<td>Weight</td>
<td>Main unit: Approx. 160 g Communication cable: Approx. 60 g Mounting fixture: 30 g (2 pieces)</td>
</tr>
<tr>
<td>Enclosure rating</td>
<td>Built-in panel, IP-65F only for the front operation panel</td>
</tr>
</tbody>
</table>

### 1.11.3 Functional Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of connectable units</td>
<td>1 per basic unit</td>
</tr>
<tr>
<td>Display screen</td>
<td>Blue-negative type backlighted LCD, 20 digits x 4 lines</td>
</tr>
<tr>
<td>Character size</td>
<td>2.95 x 4.75 mm (5 x 7 dots)</td>
</tr>
<tr>
<td>Customized switches</td>
<td>4 switches assigned to special utility relays F1: 2500 F2: 2501 F3: 2502 F4: 2503</td>
</tr>
<tr>
<td>Setting operation switch</td>
<td>✈ ✇ ✆ ✇</td>
</tr>
<tr>
<td>Customized indicator lamps</td>
<td>Four red LEDs assigned to special utility relays Lamp 1: 2504 Lamp 2: 2505 Lamp 3: 2506 Lamp 4: 2507</td>
</tr>
</tbody>
</table>
1.11.4 Dimensions

- Main unit

Panel thickness: 1.0 to 3.0 mm

- Panel cut size
Chapter 2

System Installation

This chapter describes the installation and connection of each Visual KV Series unit as well as system maintenance.

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2.1 Installation Environment

This section describes cautions with the environment in which each unit is installed and the installation position inside the panel.

2.1.1 Installation Environment

Never install a unit in the following locations:

- Locations exposed to direct sunlight
- Locations whose ambient temperature is outside the allowable range of 0 to +50°C
- Locations whose ambient humidity is outside the allowable range of 35 to 85% RH
- Locations subject to drastic temperature change where condensation may occur
- Locations with corrosive or flammable gases
- Locations with excessive dust, salt, iron powder, or soot
- Locations subject to direct vibrations and impacts
- Locations subject to splashes of water, oil, chemicals, etc.
- Locations where a strong magnetic or electrical field is generated

*Units are made of synthetic resin. If the unit surface touches a solvent with a strong dissolving force, it could melt. Keep such solvents away from the units.*
2.1.2 Installation Position

- **Installation direction**
  When attaching a unit inside a panel, install the unit so that the front face (equipped with the Access Window, communication ports, etc.) faces front or upwards.

- **Distance between adjacent panels/equipment**
  When installing a unit, keep the distances shown below between the panel or equipment so that the power supply can release heat.

* Upward installation does not comply with CE marking.

**Note 1:** If the temperature inside the panel exceeds 50°C, which is specified as the maximum ambient operating temperature, then install heat exchangers, etc. to reduce the temperature.

**Note 2:** Ensure sufficient ventilation space so that the power supply can release heat.

**Note 3:** Never install a unit just above any equipment which generates a lot of heat.
2.1.3 Installation Procedure

This section describes how to attach a connected unit directly to a panel, to a DIN rail, or to a DIN rail with an expansion unit spacer.

- Attaching a unit directly to a panel
  Attach the metal fixture for screw tightening to each KV Series unit using the countersunk-head screws through the countersunk holes. Mount the fixture directly to the panel.

- Attaching a unit to a DIN rail
  Hang an upper claw of a Visual KV Series basic unit to the upper side of the DIN rail, and press the basic unit onto the DIN rail until a click sound is heard.

- Removing a unit from a DIN rail
  Pull a lower claw of a Visual KV Series basic unit downward from the front direction using a screwdriver, and then remove the basic unit from the DIN rail.

Expansion unit spacer

When an expansion unit spacer is attached to a Visual KV Series expansion unit, its height becomes flush with an AC power type Visual KV Series basic unit. The procedure to attach a Visual KV Series expansion unit to an expansion unit spacer is the same as the procedure to attach a Visual KV Series unit to a DIN rail. Refer to the instruction manual supplied with the Visual KV Series for DIN rail mounting.

- Dimensions for expansion unit spacers

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OP-35342</td>
<td>Spacer for 4-I/O expansion unit</td>
</tr>
<tr>
<td>OP-35343</td>
<td>Spacer for 8-I/O expansion unit</td>
</tr>
<tr>
<td>OP-35344</td>
<td>Spacer for 16-I/O expansion unit</td>
</tr>
</tbody>
</table>
2.1.4 Cautions on Wiring for Each Unit

This section describes cautions to keep in mind when wiring is performed for I/O units. Be sure to read this section before starting wiring.

Wiring procedures for basic units

The wiring procedures for basic units are described below.

- **Turn off the power before starting wiring.**
- **For the installation position, select a location whose ambient temperature is 0 to +50°C, whose ambient humidity is 35 to 85% RH, and one which is not subject to drastic temperature changes.**
- **If the 24 VDC + output terminal and the 24 VDC - output terminal are switched, the power supply unit and connected units may be damaged. Never switch them.**
- **Be sure that the sum of the current consumption of all connected units does not exceed the output capacity of the service power supply. If the system is operating in an overload status, the internal circuits may generate heat or be damaged. To recover from an overload status, disconnect some of the connected units.**
- **Never connect the DC output of any other power supply, either in serial or parallel, to the 24 VDC output terminals. If the DC output is connected, the power supply unit may be damaged.**

- **Wiring for an AC type basic unit**

  For an AC type basic unit, perform the wiring as shown in the figure below.

  ![Wiring Diagram](image.png)

  **Note 1:** Connect an insulating transformer (1:1) or noise filter to reduce line noise.

  **Note 2:** Use twisted cables to reduce induction effects.

  **Note 3:** When using a basic unit in a location with a lot of noise, the noise may be reduced by completely grounding the basic unit.
Wiring for a DC type basic unit
For a DC type basic unit, perform the wiring as shown in the figure below.

**Note:** Connect the power supply to the power supply input terminals with 24 VDC output, which offers a sufficient margin of power capacity. Usually, the sum of the current consumption of all connected units multiplied by 1.5 or more is required for the power capacity.

Cautions on wiring for I/O units
When performing wiring for an I/O unit, pay strict attention to the following contents.

- Separate input lines from output lines in wiring.
- If the wiring for power is located near I/O signal lines, a malfunction may occur caused by the effects of a high voltage and large current.
- Keep I/O signal lines away from the power wiring by at least 100 mm.
- Separate 24 VDC I/O lines from 100 VAC and 200 VAC lines.
- When using pipes for wiring, make sure that the pipes are securely grounded.

When I/O signal lines cannot be separated from the wiring for power
In such a case, perform grounding on the KV side using batch-shielded cables. (In some environments, grounding should be performed on the reverse side of the KV.)

Terminal
The terminal screws used are M3. When performing wiring with crimp-style terminals, use the following ones.
Cautions on grounding

Because the Visual KV Series is constructed to be sufficiently resistant to noise, it can usually be used without being grounded. However, when the Visual KV Series is used in an environment with a lot of noise, grounding is required. In such a case, pay strict attention to the following contents.

- Perform complete grounding for each individual unit. In this case, the ground resistance should be 100 Ω or less.
- If individual grounding is not possible, perform common grounding. In this case, the length of each grounding cable should be equal.

### 2.1.5 Contact Protection

If inductive loads such as clutches, motors, and solenoids are used, a rush current may flow when the load power supply is turned on, or a counter electromotive voltage may be generated when the load power supply is shut down. The rush current and the counter electromotive voltage can contribute considerably to shortening the service life of the contacts. To prevent this from happening, provide a contact protection circuit.

#### Contact protection circuit examples

- **For AC load 1**
  - Contact
  - Load
  - CR circuit

- **For AC load 2**
  - Contact
  - Varistor

- **For DC load 1**
  - Contact
  - Load
  - Diode

- **For DC load 2**
  - Contact
  - Zener diode

When the supply voltage is 24 to 48 V, provide a protection circuit in position “b”. When the supply voltage is 100 to 200 V, provide a protection circuit in position “a”.

**Note 1**: Use a load coil whose rating is less than the contact capacity.

**Note 2**: Use a diode whose peak inverse voltage is 10 times or more the circuit voltage and whose forward current is not less than the load current.

**Note 3**: Individually attach diodes, varistors, and CR circuits directly to the relay coil terminal.
2.2 Connecting Visual KV Series Expansion Units

This section describes the method to connect Visual KV Series expansion units to a Visual KV Series basic unit and the various functions of expansion units.

2.2.1 Visual KV Series Expansion Units

Visual KV Series expansion input units

- KV-E4X
- KV-E8X
- KV-E16X

Visual KV Series expansion output units

- KV-E4R
- KV-E4T
- KV-E8R
- KV-E8T(P)
- KV-E16R
- KV-E16T(P)

Visual KV Series expansion I/O units

- KV-E4XR
- KV-E4XT(P)
2.2.2 Connecting Visual KV Series Expansion Units

- Connect a basic unit and an expansion unit with an expansion cable.
- An expansion cable approximately 60 mm long is provided as standard.
- When extending the expansion cable, use long expansion cables (300 mm) (OP-35361).
- Up to two expansion cables (300 mm) can be connected to one basic unit.
- The READY/ERROR LED is lit during normal communication, flashes when an abnormality occurs, and is not lit when the power is not supplied correctly. If this LED is not lit, check whether the expansion cables are correctly connected.

**Standard cable (approx. 60 mm)**

![Diagram of Standard cable (approx. 60 mm)]

**Long cable (approx. 300 mm)**

![Diagram of Long cable (approx. 300 mm)]

**Standard cable (approx. 60) + Long cable (approx. 300 mm)**

![Diagram of Standard cable (approx. 60) + Long cable (approx. 300 mm)]

**CAUTION**

Be sure to turn off the power before connecting or disconnecting expansion cables. If they are connected or disconnected while the power is on, the units may be damaged or fail.

**Note:** Keep noise sources such as power cables and electromagnetic switches away from expansion cables (300 mm) as much as possible.
Connection methods

1. Peel off the tape stuck to the right side of the basic unit.

2. Connect an expansion cable to the connector.

When extending a cable
Replace a standard expansion cable (60 mm) with an optional expansion cable (300 mm) (OP-35361).

1. Disconnect the standard expansion cable from the expansion unit connector.

2. Connect an optional expansion cable (300 mm) to the expansion unit connector.

3. Connect the optional expansion cable (300 mm) to the basic unit connector.
Number of connectable units

- **When the basic unit is a KV-10xx/16xx/24xx**
  
  Up to four input units and four output units (that is, up to 8 total expansion units) can be connected to one basic unit.

- **When the basic unit is a KV-40xx**
  
  Up to three input units and four output units (that is, up to 7 total expansion units) can be connected to one basic unit.

- **When KV-E4XT/KV-E4XR expansion I/O units are connected**
  
  One I/O unit is regarded as two units (that is, one input and one output unit). For example, when only expansion I/O units are connected to one basic unit, up to four expansion I/O units can be connected. Up to three expansion I/O units can be connected to a KV-40xx basic unit.

---

**Note 1:** There are no restrictions about the order of connected expansion units.

**Note 2:** When connecting expansion units to an AC power type basic unit, be sure that the total current consumption of all connected units does not exceed the output capacity of the Visual KV Series basic unit. Otherwise, consider to use a DC power type basic unit in combination with an external DC power supply having enough capacity.
2.2.3 Confiming the Connection Settings of Expansion Units

Relay No. (unit No., address No., contact No.)
The relay No. of each expansion unit is automatically assigned in the order of connection.

Expansion unit relay list

### Input units

<table>
<thead>
<tr>
<th>Connection order</th>
<th>KV-E4X</th>
<th>KV-E8X</th>
<th>KV-E16X</th>
</tr>
</thead>
<tbody>
<tr>
<td>KV-10/16/24</td>
<td>KV-40</td>
<td>KV-40</td>
<td>KV-40</td>
</tr>
<tr>
<td>1st input unit</td>
<td>100 to 103</td>
<td>100 to 107</td>
<td>100 to 115</td>
</tr>
<tr>
<td>2nd input unit</td>
<td>200 to 207</td>
<td>200 to 207</td>
<td>200 to 215</td>
</tr>
<tr>
<td>3rd input unit</td>
<td>300 to 307</td>
<td>300 to 307</td>
<td>300 to 315</td>
</tr>
<tr>
<td>4th input unit</td>
<td>400 to 407</td>
<td>400 to 407</td>
<td>400 to 415</td>
</tr>
</tbody>
</table>

### Output units

<table>
<thead>
<tr>
<th>Connection order</th>
<th>KV-E4T/R</th>
<th>KV-E8T(P)/R</th>
<th>KV-E16T(P)/R</th>
</tr>
</thead>
<tbody>
<tr>
<td>KV-10/16/24</td>
<td>KV-40</td>
<td>KV-40</td>
<td>KV-40</td>
</tr>
<tr>
<td>1st output unit</td>
<td>600 to 603</td>
<td>600 to 607</td>
<td>600 to 615</td>
</tr>
<tr>
<td>2nd output unit</td>
<td>700 to 703</td>
<td>700 to 707</td>
<td>700 to 715</td>
</tr>
<tr>
<td>3rd output unit</td>
<td>800 to 807</td>
<td>800 to 807</td>
<td>800 to 815</td>
</tr>
<tr>
<td>4th output unit</td>
<td>900 to 907</td>
<td>900 to 907</td>
<td>900 to 915</td>
</tr>
</tbody>
</table>

### I/O units

<table>
<thead>
<tr>
<th>Connection order</th>
<th>KV-E4XR/T(P)</th>
<th>Input relay</th>
<th>Output relay</th>
</tr>
</thead>
<tbody>
<tr>
<td>KV-10/16/24</td>
<td>KV-40</td>
<td>KV-10/16/24</td>
<td>KV-40</td>
</tr>
<tr>
<td>1st input unit</td>
<td>100 to 103</td>
<td>200 to 203</td>
<td>—</td>
</tr>
<tr>
<td>2nd input unit</td>
<td>200 to 203</td>
<td>300 to 303</td>
<td>—</td>
</tr>
<tr>
<td>3rd input unit</td>
<td>300 to 303</td>
<td>400 to 403</td>
<td>—</td>
</tr>
<tr>
<td>4th input unit</td>
<td>400 to 403</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1st output unit</td>
<td>—</td>
<td>—</td>
<td>600 to 603</td>
</tr>
<tr>
<td>2nd output unit</td>
<td>—</td>
<td>—</td>
<td>700 to 703</td>
</tr>
<tr>
<td>3rd output unit</td>
<td>—</td>
<td>—</td>
<td>800 to 803</td>
</tr>
<tr>
<td>4th output unit</td>
<td>—</td>
<td>—</td>
<td>900 to 903</td>
</tr>
</tbody>
</table>
Connection information for expansion units

The connection status (connected or unconnected) of a connected expansion unit can be confirmed using the Access Window, the ladder support software "KV IncrediWare (DOS)" and "LADDER BUILDER for KV", or the KV-P3E(01) handheld programmer.

- Refer to "Chapter 3. Access Window" (p.1-79), "Chapter 6. Handheld Programmer" (p.1-195), and the "6.2.9. Displaying the Use Status" (p. 2-70).

The connection information is written to data memory DM1937 as shown in the table below.

<table>
<thead>
<tr>
<th>DM1937 display digit</th>
<th>Indication contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit 0*</td>
<td>Connection of expansion input unit with relay Nos. 0100 to 0115</td>
</tr>
<tr>
<td></td>
<td>0: Unconnected or disconnected 1: Connected</td>
</tr>
<tr>
<td>Bit 1</td>
<td>Connection of expansion input unit with relay Nos. 0200 to 0215</td>
</tr>
<tr>
<td></td>
<td>0: Unconnected or disconnected 1: Connected</td>
</tr>
<tr>
<td>Bit 2</td>
<td>Connection of expansion input unit with relay Nos. 0300 to 0315</td>
</tr>
<tr>
<td></td>
<td>0: Unconnected or disconnected 1: Connected</td>
</tr>
<tr>
<td>Bit 3</td>
<td>Connection of expansion input unit with relay Nos. 0400 to 0415</td>
</tr>
<tr>
<td></td>
<td>0: Unconnected or disconnected 1: Connected</td>
</tr>
<tr>
<td>Bit 4</td>
<td>Connection of expansion output unit with relay Nos. 0600 to 0615</td>
</tr>
<tr>
<td></td>
<td>0: Unconnected or disconnected 1: Connected</td>
</tr>
<tr>
<td>Bit 5</td>
<td>Connection of expansion output unit with relay Nos. 0700 to 0715</td>
</tr>
<tr>
<td></td>
<td>0: Unconnected or disconnected 1: Connected</td>
</tr>
<tr>
<td>Bit 6</td>
<td>Connection of expansion output unit with relay Nos. 0800 to 0815</td>
</tr>
<tr>
<td></td>
<td>0: Unconnected or disconnected 1: Connected</td>
</tr>
<tr>
<td>Bit 7</td>
<td>Connection of expansion output unit with relay Nos. 0900 to 0915</td>
</tr>
<tr>
<td></td>
<td>0: Unconnected or disconnected 1: Connected</td>
</tr>
</tbody>
</table>

* Always set to “0” when the KV-40xx is used.

In the case of connection above, DM1937 is set as follows.

<table>
<thead>
<tr>
<th>DM1937 (binary)</th>
<th>Decimal (Hexadecimal)</th>
<th>KV-E8X</th>
<th>KV-E4XT(P)</th>
<th>KV-E8R</th>
<th>KV-E16T(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#118($0076)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal status:</td>
<td>#116($0074)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM1937 (binary)</td>
<td>Dec *</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When KV-E8X has failed:</td>
<td>11100000</td>
<td>#118($0076)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM1937 (binary)</td>
<td>Dec *</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When KV-E4XT has failed:</td>
<td>11100000</td>
<td>#118($0076)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Always set to "0" when the KV-40xx is used.
Input time constant for expansion units

The initial setting of the time constant is "10 ms" for each expansion unit. The input time constant can be set to "10 µs" using the Access Window, the ladder support software "KV IncrediWare (DOS)" and "LADDER BUILDER for KV", or the KV-P3E(01) handheld programmer.

Change the value of special utility relays 2609 to 2612.

<table>
<thead>
<tr>
<th>Special utility relay No.</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>2609*</td>
<td>Input time constant of expansion input unit with relay Nos. 0100 to 0115 OFF: 10 ms; ON: 10 µs</td>
</tr>
<tr>
<td>2610</td>
<td>Input time constant of expansion input unit with relay Nos. 0200 to 0215 OFF: 10 ms; ON: 10 µs</td>
</tr>
<tr>
<td>2611</td>
<td>Input time constant of expansion input unit with relay Nos. 0300 to 0315 OFF: 10 ms; ON: 10 µs</td>
</tr>
<tr>
<td>2612</td>
<td>Input time constant of expansion input unit with relay Nos. 0400 to 0415 OFF: 10 ms; ON: 10 µs</td>
</tr>
</tbody>
</table>

* Not used for the KV-40xx.

Clearing the input value when disconnecting

The system can be set so that the input value is cleared when disconnection has occurred for some reason.

This setting can be performed using the Access Window, the ladder support software "KV IncrediWare (DOS)" and "LADDER BUILDER for KV", or the KV-P3E(01) handheld programmer.

Change the value of special utility relay 2613. Enter "0" or "1".

<table>
<thead>
<tr>
<th>Special utility relay No.</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>2613</td>
<td>Clears input when expansion is disconnected. OFF: Holds previous value. ON: Clears input.</td>
</tr>
</tbody>
</table>
2.2.4 Transferring I/O Information between Expansion Units and the Basic Unit

An expansion unit operates at a cycle of 800 µs without depending on the scan time. When performing input while setting the input time constant of an expansion unit to 10 µs, or when synchronizing the output of a basic unit with the output of an expansion unit, pay strict attention to the following contents.

When inputting

- **When the scan time is longer than 800 µs (communication cycle) plus 10 µs (input time constant)**
  Set the input signal ON time equal to or longer than the scan time.

<table>
<thead>
<tr>
<th>Scan time</th>
<th>Communication cycle in expansion unit</th>
<th>Input signal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ON</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OFF</td>
</tr>
</tbody>
</table>

- **When the scan time is equal to or shorter than 800 µs (communication cycle) plus 10 µs (input time constant)**
  Set the input signal ON time to 810 µs or longer.

<table>
<thead>
<tr>
<th>Scan time</th>
<th>Communication cycle in expansion unit</th>
<th>Input signal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ON</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OFF</td>
</tr>
</tbody>
</table>

In the case of output

The output of an expansion unit is delayed by a maximum of 800 µs from the output of a basic unit.

When synchronizing the output of an expansion unit with the output of a basic unit, pay strict attention to the communication cycle.

- **Note:** When the output ON time is 800 µs or shorter, the output may be aborted.
2.3 Inspection and Maintenance

This section describes the inspection and maintenance procedures for units.

2.3.1 Inspection

While basic units and other units have been used for a long period of time, the connector connection area may become loose, the battery may wear out, or another nonconformity may occur in operation.

To avoid any nonconformities, inspect the basic units, other units, and the wiring periodically.

The major inspection items are as follows.

• Check to ensure that the connector connection area is not disconnected or loose.
• Check to ensure that terminals on terminal blocks are not loose.
• Check to ensure that the wiring cables among units and each equipment are not damaged.

2.3.2 Maintenance

While basic units and other units have been used for a long period of time, dirt will adhered. Wipe off any collected dirt with a clean, dry cloth.

Wipe off any dust and dirt that has collected on small and narrow portions with cotton swabs.

Be sure to turn off the power before starting any inspection or maintenance of the units.