KEYENCE

96M0366

User's Manual

Visual KV Series

3

Programming

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.

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.

Visual KV (Series) KV-10xx, 16xx, 24xx, 40xx	KV-10AR/AT/DR/DT KV-24AR/AT/DR/DT	KV-16AR/AT/DR/DT KV-40AR/AT/DR/DT
Conventional KV (Series) KV-300 (Series) KV-10/80 (Series)	KV-10R(W)/T(W) KV-24R(W)/T(W) KV-80R(W)/T(W) KV-300	KV-16R(W)/T(W) KV-40R(W)/T(W)

General Precautions

- At startup and during operation, be sure to monitor the functions and performance of the KV Sereis 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 IncrediWare (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.

⚠ CAUTION

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*

Chapter 1 **Configuration and Specifications [Visual KV Series Only]**

Describes the system configuration of the Visual KV Series, the names and functions of each part, and the specifications.

Chapter 2 **System Installation [Visual KV Series Only]**

Describes the installation and connection of each Visual KV Series unit as well as system maintenance.

Chapter 3 **Access Window [Visual KV Series Only]**

Describes the Access Window used for changing and monitoring data.

Chapter 4 **KV-D20 Operator Interface Panel [Visual KV Series Only]**

Describes the KV-D20 Operator Interface Panel used for changing, monitoring, and displaying the status of inside relays, timers, counters and data memories.

Chapter 5 **KV-300, KV-10/80 Hardware [KV-300, KV-10/80 Series Only]**

Describes the hardware specifications and wirings for KV-300 and KV-10/80 Series.

Chapter 6 **Handheld Programmer**

Describes how to use the handheld programmer and memory card.

Chapter 7 **KV-L2 Serial Interface Module [KV-300 Series Only]**

Describes the serial interface modules for KV-300 Series.

Chapter 8 **KV-AN6 Analog I/O Module [KV-300 Series Only]**

Describes the optional Analog I/O module for KV-300 Series

Chapter 9 **KV-AD4/DA4 Analog I/O Unit [KV-10/80 Series Only]**

Describes the optional Analog I/O unit for KV-10/80 Series.

Chapter 10 **Troubleshooting**

This chapter describes the error code list, countermeasures against problems, and error indications for each unit.

Appendices

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

2 *Support Software*

Chapter 1 **Introduction**

Describes the items included in the package, the product outline, the method to connect a personal computer, the installation method, etc.

Chapter 2 **Editor**

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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WARRANTIES AND DISCLAIMERS

See 3-367.

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Chapter 1

Programming

This chapter 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.

➪ *For a detailed description of instructions, refer to "2.4. Instruction Details" (p.3-56).*

1.1 Before Creating Programs

This section describes what you should know before creating programs and operations for the Visual KV Series.

1.1.1 Flow from Introduction to Operation

This section describes an overview of program creation procedures, functions used, and setting items.
In the example described below, a latch circuit is created as a program for the Visual KV Series.

Introduction

Examining contents of operations

Figure 1 shows a latch circuit which operates as follows.

Pushbutton switch PB1: ON
Pushbutton switch PB2: OFF
→Pilot lamp (PL) turns on.

Pushbutton switch PB1: OFF
Pushbutton switch PB2: OFF
→Pilot lamp (PL) remains lit even if PB1 turns OFF.

Pushbutton switch PB1: OFF
Pushbutton switch PB2: ON
→Pilot lamp (PL) goes out when PB2 is set to ON.

Time chart

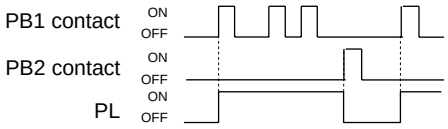
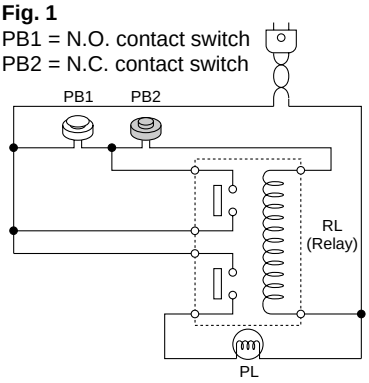


Fig. 1
PB1 = N.O. contact switch
PB2 = N.C. contact switch



Next, a program is created that will use the same operation as this circuit to control a PLC.

Program examination

Circuit 1 shows relay symbols for the latch circuit.
Examine which contact in the Visual KV Series is used for each pushbutton switch and pilot lamp (Table 1). When many I/O devices are required for control, expansion units should also be considered.

Circuit 1

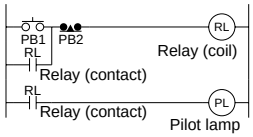


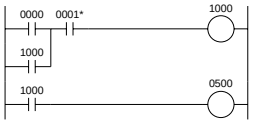
Table 1

I/O device	Contact No.
Pushbutton switch PB1 (N.O. contact)	Input relay (0000)
Pushbutton switch PB2 (N.C. contact)	Input relay (0001)
Relay RL	Internal relay (1000)
Pilot lamp PL	Output coil (0500)

Program creation

Edit a program using the "LADDER BUILDER for KV" programming support software creation tool.

Ladder diagram



Coding list

```
LD    0000
OR    1000
AND   0001
OUT   1000
LD    1000
OUT   0500
END
```

* Enter "N.O. (AND X001)" to 0001 to use N.C. contact.

Transferring and confirming the program

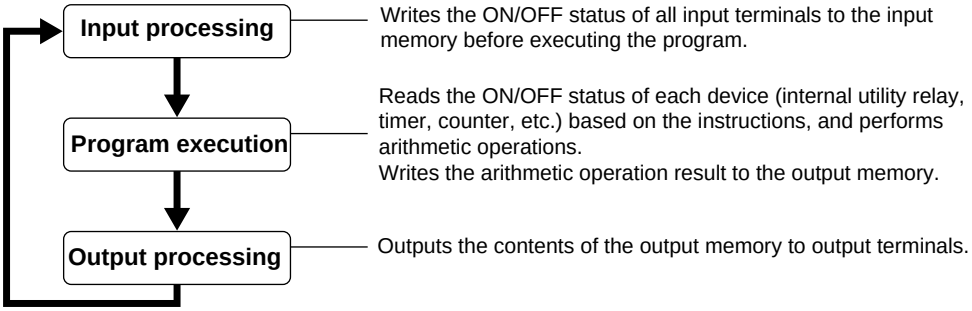
Transfer the created program to the Visual KV Series, perform a test run, and then confirm operations with the actual devices.

Operation

1.1.2 Scan Time

Scan time

The Visual KV Series repeatedly executes a ladder based on the sequence circuit as follows.

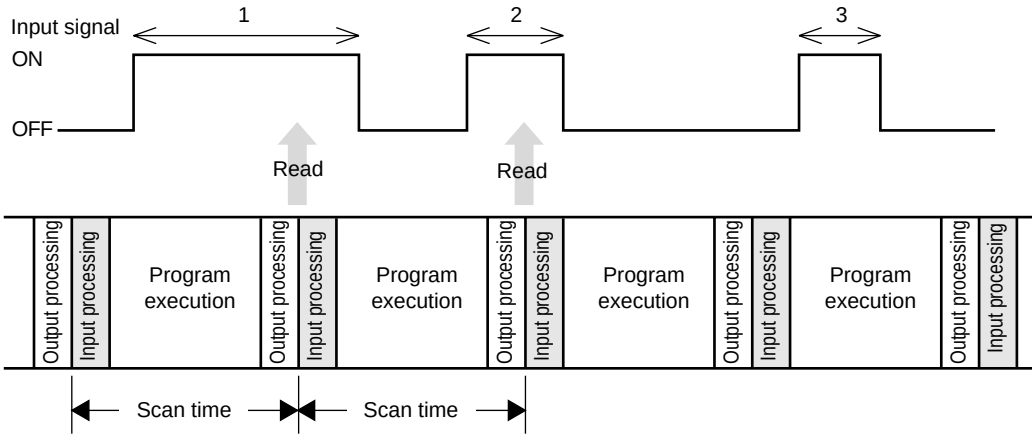


The duration of time required to perform one cycle is called the scan time (or cycle time). The scan time varies based on program size and the instructions used in the program.

Input response time delay

In addition to the I/O processing time, there is also an input time delay in the Visual KV Series caused by the scan time. The input time delay is generated because the input status can only be read during the input processing time. If the input status is changed after input processing, the changed contents can only be read during the next scan time.

In the figure below, 1 and 2 can be read but 3 cannot be read.



Reference: The maximum and minimum values of the input response time are as follows.

Maximum value: Input time constant + Scan time x 2 + Output response delay time

Minimum value: Input time constant + Scan time + Output response delay time

Note 1: When the input time constant is made small by setting the HSP instruction, special utility relay 2813, and data memory DM1940, a signal may not be received if its ON time is shorter than the scan time.

Note 2: The INT instruction is independent of the scan time.

Note 3: The minimum scan time is 140 μs (with the basic unit).

1.2 User Memory

This section describes the allowable size (capacity) of a program which can be created in the Visual KV Series.

1.2.1 Program Capacity

When a user program is created for the Visual KV Series, the maximum number of steps a program can contain using the mnemonic diagram varies based on the byte count of the instructions used. The instruction byte count is determined individually for each instruction.

➪ *For more about byte counts for each instruction, refer to "2.1 Instruction List" (p.3-34).*

Maximum number of lines in a program

In the KV-10xx/16xx, a program with approximately 2,000 steps can be written. In the KV-24xx/40xx, a program with approximately 4,000 steps can be written.

- **Total byte count of the memory used by instructions ≤ 6,000 bytes / 12,000 bytes**
- **Total byte count of the memory used by objects of instructions ≤ 12,000 bytes / 24,000 bytes**

  * In the description above, a value on the left side indicates the byte count for the KV-10xx/16xx, while a value on the right side indicates the byte count for the KV-24xx/40xx.

  * The memory occupied by objects indicates the memory required to execute a program when operation is started.

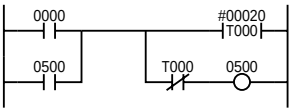
For example, the allowable number of steps to be written can be calculated from the memory occupied by the instructions as follows.

12,000 bytes / 3 bytes (average byte count of an instruction) = 4,000 steps

Note: If either the memory occupied by the instructions or the memory occupied by objects of a program exceeds the specified memory capacity, the program cannot be written or executed.

Calculating the byte count used

The byte count used in this program can be calculated as shown in the table below.



Line No.	Instruction	Operand	Byte count	Number of objects
00000	LD	0000	3	5
00001	OR	0500	3	4
00002	TMR	000#00020	2	7
00003	ANB	T000	3	8
00004	OUT	0500	3	8
Total			14 bytes	32 bytes

1.3 Device Configuration

"Device" is a general name for relays, registers, etc. processed by instructions. This section describes the available devices in the Visual KV Series and their general use.

1.3.1 Device List

Relay list

Relay No.	Normal use	High-speed use (1)	High-speed use (2)		Remarks
0000	Input relays (Direct input allowed area)	Interrupt inputs INT0 to INT3	(Polarity inversion allowed) Input captures		They function as B phase of high-speed counters through specification of utility relays in KV-10.
0001					
0002					–
0003					–
0004	Input relays	High-speed counter 0 input	High-speed counter 0	A phase input	–
0005		High-speed counter 1 input	High-speed counter 1		–
0006		–	High-speed counter 0	B phase input	–
0007			High-speed counter 1		–
0008			High-speed counter 0	Preset input	–
0009			High-speed counter 1		–
0010 to 0415	Input relays				–
0500	Output relays (Direct output allowed area)	High-speed counter 0 output			70 points
0501		High-speed counter 1 output	Specified frequency pulse output		–
0502		Ramp-up/down control output			–
0503		–			–
0504 to 0915	Output relays				76 points
1000 to 1915	Internal utility relays				160 points
2000 to 2815	Special utility relays				144 points
2900 to 2915	Special utility relays				HKEY information storage area
3000 to 17915	Internal utility relays				2,144 points

Note 1: The ON/OFF status of the set functions is always cleared when the operation mode is changed from PROGRAM to RUN. However, special utility relays 2700 to 2715 are held even when the operation mode is changed from PROGRAM to RUN or when the power is turned off.

Note 2: Internal utility relays can be held by setting the MEMSW instruction

List of I/O relays in basic units

Model	KV-10xx	KV-16xx	KV-24xx	KV-40xx
Basic input relays	0000 to 0005	0000 to 0009	0000 to 0015	0000 to 0107
Basic output relays	0500 to 0503	0500 to 0505	0500 to 0507	0500 to 0515

List of relays in expansion units

■ Input units

Connection order	KV-E4X		KV-E8X		KV-E16X	
	KV-10/16/24	KV-40	KV-10/16/24	KV-40	KV-10/16/24	KV-40
1st input module	100 to 103	200 to 203	100 to 107	200 to 207	100 to 115	200 to 215
2nd input module	200 to 203	300 to 303	200 to 207	300 to 307	200 to 215	300 to 315
3rd input module	300 to 303	400 to 403	300 to 307	400 to 407	300 to 315	400 to 415
4th input module	400 to 403		400 to 407		400 to 415	

■ Output units

Connection order	KV-E4T(P)/R	KV-E8T(P)/R	KV-E16T(P)/R
1st output module	600 to 603	600 to 607	600 to 615
2nd output module	700 to 703	700 to 707	700 to 715
3rd output module	800 to 803	800 to 807	800 to 815
4th output module	900 to 903	900 to 907	900 to 915

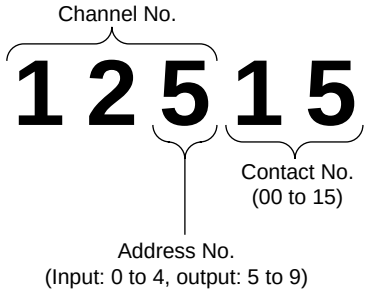
■ I/O units

Connection order	KV-E4XR/T(P)			
	Input relays		Output relays	
	KV-10/16/24	KV-40	KV-10/16/24	KV-40
1st input module	100 to 103	200 to 203		
2nd input module	200 to 203	300 to 303		
3rd input module	300 to 303	400 to 403		
4th input module	400 to 403			
1st output module			603 to 606	603 to 606
2nd output module			703 to 703	703 to 703
3rd output module			803 to 803	803 to 803
4th output module			903 to 903	903 to 903

* Relay Nos. of expansion units are automatically assigned in the order of connection.
* The connection order is counted only for input and output units. When I/O units are connected, they are counted as input units and output units separately.

1.3.2 Relay No.

The relay No. configuration is shown below.



Address No.

Address Nos. are assigned to basic units, input expansion units, output expansion units, and I/O expansion units. Zero to 4 are assigned to input units, while 5 to 9 are assigned to output units. Address Nos. assigned in a unit vary based on the number of I/O terminals and the connection position of the unit.

Model		Address Nos.
Basic units	KV-10xx	0, 5
	KV-16xx	0, 5
	KV-24xx	0, 5
	KV-40xx	0, 1, 5
Input expansion units	kV-E4X	1 to 4*
	KV-E8X	1 to 4*
	KV-E16X	1 to 4*
Output expansion units	KV-E4R/E4T(P)	6 to 9
	KV-E8R/E8T(P)	6 to 9
	KV-E16R/E16T(P)	6 to 9
I/O expansion units	KV-E4XR/E4XT(P)	1 to 4*, 6 to 9

* 2 to 4 in KV-40xx

■ Address No. assignment procedure

- The address No. is represented as a number 0 to 9.
- Address Nos. 0 to 4 are provided for inputs, while address Nos. 5 to 9 are provided for outputs.

Contact No.

- Contact Nos. are input/output terminal Nos. of basic units, input expansion units, output expansion units, and I/O expansion units.
- The contact No. is represented as a number 0 to 15.

  Example

  In the KV-E4X, with 4 input terminals, the contact Nos. are 0 to 3. In the KV-E16T(P), with 16 input terminals, the contact Nos. are 0 to 15.
- In a unit with 16 or more terminals, the contact No. of the 17th terminal returns to 0 and its address No. is increased by 1.

  Example

  In the KV-40AR, with 40 terminals (24 input and 16 output terminals), address No. 0 is assigned to input terminal Nos. 1 to 16 and address No. 1 is assigned to input terminal Nos. 17 to 24

Channel No.

The channel No. is the higher order digit in the contact No.

1

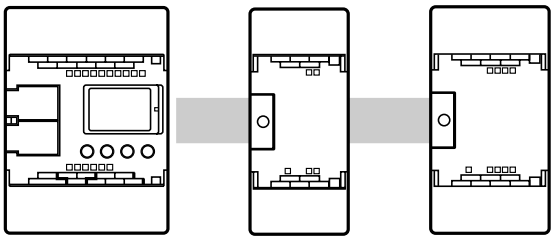
1.3.3 Assigning Relay Nos.

When assigning relay Nos., the unit No. is based on the connection position of the unit, and the address No. is determined based on the unit type and I/O contacts.

a) KV-16AR Basic unit
Input: 10 points
Output: 6 points

b) KV-E4X Input expansion unit
Input: 4 points

c) KV-E8R Output expansion unit
Output: 8 points



With the connections above, the relay Nos. for each unit are assigned as shown in the table below.

Unit	Assigned relay Nos.
a) KV-16AR	0000 to 0009 (input) and 0500 to 0505 (output)
b) KV-E4X	0100 to 0103 (input)
c) KV-E8R	01600 to 0607 (output)

1.3.4 Input Relays

Input relays receive ON/OFF signals sent from external input equipment.

Note 1: Input relays function as contacts in programs. They cannot be used as relay coils (outputs).

Note 2: There is no restriction of the contact type (N.O. or N.C.) used, the order the relay Nos. are used, or the number of relays used.

Basic unit

■ **Input relay time constant**

Though the time constant is usually 10 ms ±20%, it can be changed using the following settings.

- When the HSP instruction is used: 10 μs ±20%
- While special utility relay 2813 remains ON, the time constant can be changed in 7 steps by setting data memory DM1940 as follows.

When DM1940 is set to 0: 10μs ±20%
1: 20 μs ±20%
2: 500 μs ±20%
3: 1 ms ±20%
4: 2.5 ms ±20%
5: 5 ms ±20%
6: 10 ms ±20%
Never set a numeric value of 7 or larger.

➪ *For more about changing the input time constant, refer to "1.4.1 Input Time Constant Change Function" (p.3-23).*

■ **Hardware input (independent of scan time)**

- High-speed counter
  When the time constant is set to 10 μs using the HSP instruction or data memory DM1940 (only while special utility relay 2813 remains ON), the maximum input response of input relays 0004 and 0005 of CTH0 and CTH1 becomes 30 kHz.
- INT instruction: 0000 to 0003
  This instruction can receive any signal without regard to the scan time as far as the signal ON time is longer than the input time constant.

➪ *"HSP instruction" (p.3-86), "INT instruction" (p.3-192), "4.1 High-speed Counter Instructions" (p.3-204)*

Note 1: While special utility relay 2813 remains ON, the input time constant can be specified for all input relays in a basic unit.

Note 2: Never enter a number of 7 or larger to data memory DM1940.

Note 3: The input time constant specified by data memory DM1940 becomes effective at the rising edge of special utility relay 2813. To change the input time constant, first change data memory DM1940, then set special utility relay 2813 to OFF and ON again. Or change the operation mode of a KV basic unit from PROGRAM to RUN.

Note 4: If the HSP instruction and special utility relay 2813 are used at the same time, priority is given to the HSP instruction.

Note 5: Only when a high-speed counter input or INT instruction is given, available input signals do not depend on the scan time.

Expansion unit

■ **Input relay time constant**

By setting special utility relays 2609 to 2612 to ON, the time constant in input expansion units can be set to 10 μs.

Special utility relay No.	Function	
2609*	Input time constant of input expansion unit with relay Nos. 0100 to 0115	OFF: 10 ms, ON: 10 μs
2610	Input time constant of input expansion unit with relay Nos. 0200 to 0215	OFF: 10 ms, ON: 10 μs
2611	Input time constant of input expansion unit with relay Nos. 0300 to 0315	OFF: 10 ms, ON: 10 μs
2612	Input time constant of input expansion unit with relay Nos. 0400 to 0415	OFF: 10 ms, ON: 10 μs

* Not available with the KV-40xx

1.3.5 Output Relays

Output relays output the program execution results to the outside. There are two types of outputs, relay and transistor.

Note 1: Output relays function as contacts and relay coils in programs.

Note 2: There is no restriction of the contact type (N.O. or N.C.) used, the order the relay Nos. are used, or the number of relays used.

Output operation time

- Transistor output
  OFF → ON: 50 μs or less (10 μs or less in 500 to 502)
  ON → OFF: 250 μs or less (10 μs or less in 500 to 502, 100 μs or less for other outputs in the basic unit)

- Relay output
  OFF → ON: 10 ms or less
  ON → OFF: 10 ms or less

Transistor output type		Relay output type	
KV-10AT(P)/DT(P)	KV-16AT(P)/DT(P)	KV-10AR/DR	KV-16AR/DR
KV-24AT(P)/DT(P)	KV-40AT(P)/DT(P)	KV-24AR/DR	KV-40AR/DR
KV-E4T	KV-E8T(P)	KV-E4R	KV-E8R
KV-E16T(P)	KV-E4XT(P)	KV-E16R	KV-E4XR

Note 1: When programming direct clock pulses, output relays 0500 and 0501 are used to output pulses in a transistor-type output unit.

Note 2: When the ramp-up/down control function is used, output relay 0502 outputs positioning pulses in a transistor-type output unit.

➪ *"Chapter 5. Positioning Control" (p.3-253)*

Note 3: When the specified frequency pulse output function is used, output relay 0501 outputs pulses in a transistor-type output unit.

➪ *"4.5.1 Specified Frequency Pulse Output Function" (p.3-228)*

1.3.6 Internal Utility Relays

In a relay circuit, when one relay contact is used twice or more inside the circuit, a multi-pole relay with the same number of poles as the number used may be needed. Internal utility relays function only in programs, and eliminate the complexity of relay circuits to facilitate circuit design.

Note 1: Internal utility relays function as contacts and relay coils in programs.

Note 2: There is no restriction of the contact type (N.O. or N.C.) used, the order the relay Nos. are used, or the number of relays used.

Retentive function of internal utility relays

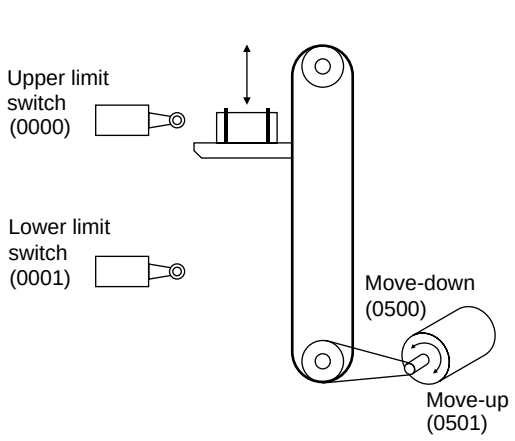
Except for internal utility relays, all relays turn OFF when the operation mode is changed or when operation is stopped via a power shutdown. When operation is restarted, all relays remain OFF except relays whose input condition is ON. However, internal utility relays can be set using the MEMSW (memory switch) whether or not they are to be retained. (Internal utility relays 2700 to 2715, however, are always retained.)

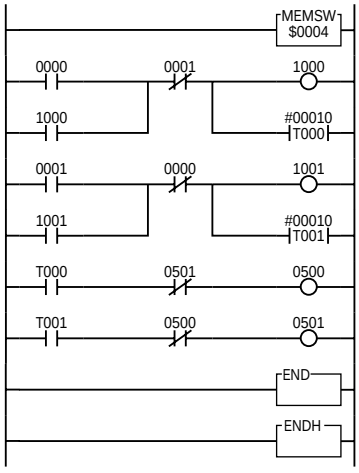
When an internal utility relay is set to be retained, its ON/OFF status is stored even if the power is turned off. By using the retained relay all clear function (FUN65), all relays which are set to be retained can be set to OFF.

➪ *For more about setting the memory switch, refer to "MEMSW instruction" (p.3-92).*

Application example of a retentive function: Lift vertical movement control

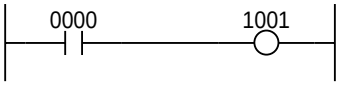
Internal utility relays 1000 and 1001 are set to be retained.
When the upper/lower limit switch turns ON, the direction of lift movement is inverted. Even if the power is turned off while the lift is moving up (or down), the lift continues to move up (or down) when the power is turned on again.





Note: The retentive function is effective only when internal utility relays retained by the self-retentive circuit or the SET/SFT/KEEP instruction are also retained by the memory switch.

Internal utility relays are not retained in the program shown below.



1.3.7 Special Utility Relays

Each special utility relay has a unique function. By using special utility relays effectively, programs can be simplified and program control improved.

Note 1: A special utility relay can be used as many times as desired in one program.

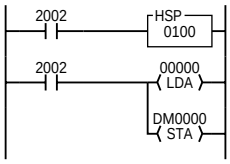
Note 2: Special utility relays dedicated for reading can be used as contacts, but cannot be used as outputs.

For more about relays dedicated for reading, refer to "1.3.8 Special Utility Relay List" (p.3-14).

Description

Relay 2002: Always ON

By setting an output relay to ON using relay 2002, the output relay can be used as a "running indicator output".



Set the input time constant of relay 0100 to 10 μs.
Transfer the ON/OFF status data of channel 0000 to DM0000.

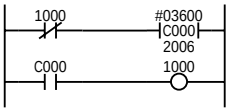
Relay 2003: Always OFF.

Opposite that of relay 2002, use relay 2003 where it is not required to be turned on. For example, when using only the up function of an up/down counter, use relay 2003 in the DW (down) input.

Relays 2004, 2005 and 2006: Clock pulse

For each relay, the time ratio is "ON:OFF = 1:1". (Accordingly, the ON time of relay 2005 is 0.05 sec/pulse.)
However, because these relays depend on the scan time, error as much as the scan time is generated.

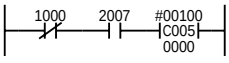
- By combining an output relay, an "intermittent output" can be made.
- By using relay 2006 as input for a counter, the counter can be used as a long-term timer.



1000 turns ON at every hour.

Relay 2007: Remains OFF during only one scan when operation is started.

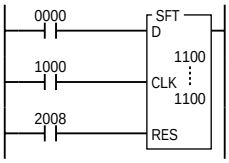
This relay can be used when a signal needs to be sent after a specific period (equivalent to one scan) after operation is started. This relay can also be used for an initial reset at the start of operation.
After one scan, this relay remains ON.



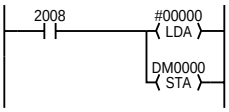
When operation is started, this relay returns the current value of C005 to 0.

Relay 2008: Remains ON during only one scan when operation is started.

This relay can be used for an initial reset at the start of operation.
After one scan, this relay remains OFF.



When operation is started, this relay sets all internal utility relays used by the SFT instruction to OFF.



When operation is started, this relay returns the current value of DM0000 to 0.

Relay 2813: Sets the input time constant of the CPU.

While relay 2813 remains ON, the input time constant of a basic unit can be set using the value of DM1940.

1.3.8 Special Utility Relay List

Special relays and arithmetic operation flags

"1.3.7 Special Utility Relays" (p.3-12)

Relay No.	Function
2002*	Always ON.
2003*	Always OFF.
2004*	0.01-s clock pulse (duty cycle: 50%)
2005*	0.1-s clock pulse (duty cycle: 50%)
2006*	1.0-s clock pulse (duty cycle: 50%)
2007*	Remains OFF during first scan after startup.
2008*	Remains ON during first scan after startup.
2009*	Turns ON when result of arithmetic operation is negative or when an overflow is generated.
2010*	Turns ON when result of arithmetic operation is 0.
2011*	Turns ON when result of arithmetic operation is positive.
2012*	Turns ON when an arithmetic operation generates an error.

* Read-only relay.

Special utility relays for high-speed counter(0)

"Chapter 4. High-Speed Counters" (p.3-203)

Relay No.	Function	
2100*	Internal clock used only for CTH0 (1 μs)	
2101*	Internal clock used only for CTH0 (10 μs)	
2102*	Internal clock used only for CTH0 (100 μs)	
2103	Automatic clear of CTH0 when comparator CTC0 turns ON.	ON: Cleared OFF: Not cleared
2104	Prohibits/permits direct output to 0500 when comparator CTC0 turns ON.	ON: Prohibited OFF: Permitted
2105	Direct output to 0500 is set to OFF when comparator CTC0 turns ON.	ON: Set to OFF OFF: Not set to OFF
2106	Direct output to 0500 is set to ON when comparator CTC0 turns ON.	ON: Set to ON OFF: Not set to ON
2107	ON/OFF status of output to 0500 is reversed each time comparator CTC0 turns ON.	ON: Reversed OFF: Not reversed
2108	Prohibits/permits direct output to 0500 when comparator CTC1 turns ON.	ON: Prohibited OFF: Permitted
2109	Direct output to 0500 is set to OFF when comparator CTC1 turns ON.	ON: Set to OFF OFF: Not set to OFF
2110	Direct output to 0500 is set to ON when comparator CTC1 turns ON.	ON: Set to ON FF: Not set to ON
2111	ON/OFF status of output to 0500 is reversed each time comparator CTC1 turns ON.	ON: Reversed OFF: Not reversed
2112	Automatic clear of CTH0 when comparator CTC1 turns ON.	ON: Cleared OFF: Not cleared
2113	Selects multiplication mode for comparator CTH0. OFF ON OFF ON	
2114	OFF: 1 pulse OFF: x2 ON: x4 ON: 2 pulses	

* Read-only relay.

Multiplication mode	1 pulse	x2	x4	2 pulses
2113	OFF	ON	OFF	ON
2114	OFF	OFF	ON	ON

Note: Never use special utility relays that are not shown above.

Special utility relays for high-speed counter(1)

➪ *"Chapter 4. High-Speed Counters" (p.3-203)*

Relay No.	Function	
2200*	Internal clock used only for CTH1 (1 μs)	
2201*	Internal clock used only for CTH1 (10 μs)	
2202*	Internal clock used only for CTH1 (100 μs)	
2203	Automatic clear of CTH1 when comparator CTC2 turns ON.	ON: Cleared OFF: Not cleared
2204	Prohibits/permits direct output to 0501 when comparator CTC2 turns ON.	ON: Prohibited OFF: Permitted
2205	Direct output to 0501 is set to OFF when comparator CTC2 turns ON.	ON: Set to OFF OFF: Not set to OFF
2206	Direct output to 0501 is set to ON when comparator CTC2 turns ON.	ON: Set to ON OFF: Not set to ON
2207	ON/OFF status of output to 0501 is reversed each time comparator CTC2 turns ON.	ON: Reversed OFF: Not reversed
2208	Prohibits/permits direct output to 0501 when comparator CTC3 turns ON.	ON: Prohibited OFF: Permitted
2209	Direct output to 0501 is set to OFF when comparator CTC3 turns ON.	ON: Set to OFF OFF: Not set to OFF
2210	Direct output to 0501 is set to ON when comparator CTC3 turns ON.	ON: Set to ON OFF: Not set to ON
2211	ON/OFF status of output to 0501 is reversed each time comparator CTC3 turns ON.	ON: Reversed OFF: Not reversed
2212	Automatic clear of CTH1 when comparator CTC3 turns ON.	ON: Cleared OFF: Not cleared
2213 **2214**	Selects multiplication mode for comparator CTH1. OFF ON OFF ON OFF: 1 pulse OFF: x2 ON: x4 ON: 2 pulses	

* Read-only relay.

Multiplication mode	1 pulse	x2	x4	2 pulses
2213	OFF	ON	OFF	ON
2214	OFF	OFF	ON	ON

Note: Never use special utility relays that are not shown above.

Other special utility relays

Relay No.	Function	
2300	External outputs disabled (outputs 0500 to 0915)	ON: Disabled OFF: Not disabled
2301	External refresh inputs disabled (inputs 0000 to 0415)	ON: Disabled OFF: Not disabled
2303	Constant scan time mode (write preset value in TM29)	ON: Enabled OFF: Disabled
2304	Remains ON for one scan when scan time exceeds preset constant scan time.	
2305	Start flag for frequency counter operation.	
2306	Specified frequency pulse output	ON: Enabled OFF: Disabled
2307	Error flag for specified frequency pulse output	
2308	Stops motor driver when turned ON.	
2309	Turns ON when motor driver is in operation. Stops motor driver in emergencies when turned OFF by interrupt instruction.	
2310	Starts motor driver when turned ON (detection at rising edge).	
2314	Start flag for cam switch operation.	
2315	Turns ON when an error occurs in cam switch operation.	

* Read-only relay.

Relay No.	Function
2400	Timing of CTH0 external signal OFF External preset OFF At falling edge ON At rising edge ON Level OFF not used ON OFF ON
2401	
2402	Interrupt polarity of INT OFF At rising edge OFF At falling edge ON At rising edge ON At both edges OFF ON OFF ON
2403	
2404	Interrupt polarity of INT1 OFF At rising edge OFF At falling edge ON At rising edge ON At both edges OFF ON OFF ON
2405	
2406	CTH0 set as ring counter ON: Set OFF: Not set
2407	Ignore phase B input when CTH0 is set to no multiplication mode. ON: Ignore phase B input and always count up. OFF: Use phase B input as usual.
2408	Timing of CTH1 external preset OFF External preset OFF At falling edge ON At rising edge ON Level OFF not used ON OFF ON
2409	
2410	Interrupt polarity of INT2 OFF At rising edge OFF At falling edge ON At rising edge ON At both edges OFF ON OFF ON
2411	
2412	Interrupt polarity of INT3 OFF At rising edge OFF At falling edge ON At rising edge ON At both edges OFF ON OFF ON
2413	
2414	CTH1 set as ring counter ON: Set OFF: Not set
2415	Ignore phase B input when CTH1 is set to no multiplication mode. ON: Ignore phase B input and always count up. OFF: Use phase B as usual.

2500	Customized switch [F1] on KV-D20 operator interface panel is assigned.		
2501	Customized switch [F2] on KV-D20 operator interface panel is assigned.		
2502	Customized switch [F3] on KV-D20 operator interface panel is assigned.		
2503	Customized switch [F4] on KV-D20 operator interface panel is assigned.		
2504	Customized indicator lamp 1 on KV-D20 operator interface panel is assigned.		
2505	Customized indicator lamp 2 on KV-D20 operator interface panel is assigned.		
2506	Customized indicator lamp 3 on KV-D20 operator interface panel is assigned.		
2507	Customized indicator lamp 4 on KV-D20 operator interface panel is assigned.		
2508	Permits change between operator mode and device mode of KV-D20 operator interface panel .	ON: Permitted	OFF: Not permitted
2509	Permits the KV-D20 operator interface panel to be shifted between operator mode and system mode.	ON: Permitted	OFF: Not permitted
2510	Specifies the display language for the KV-D20 operator interface panel	ON: Japanese	OFF: English
2511	Sets the beep for the KV-D20 operator interface panel	ON: Use beep	OFF: No beep
2512	Reserved for system		
2513	Reserved for system		
2515	Displays a user message (contents of DM1950) in the Access Window	ON: Display message	OFF: Do not display message

Relay No.	Function	
2609	Input time constant of input expansion unit with relay Nos. 0100 to 0115	OFF: 10 ms ON: 10 μs
2610	Input time constant of input expansion unit with relay Nos. 0200 to 0215	OFF: 10 ms ON: 10 μs
2611	Input time constant of input expansion unit with relay Nos. 0300 to 0315	OFF: 10 ms ON: 10 μs
2612	Input time constant of input expansion unit with relay Nos. 0400 to 0415	OFF: 10 ms ON: 10 μs
2613	Clearing of input at expansion disconnect	OFF: Cleared ON: Not cleared

2712	Disconnect error OFF: Normal ON: Disconnection in connected unit	This area is stored even when the operation mode is changed from PROGRAM to RUN, or when the power is turned off (without being affected by the MEMSW instruction). This area is not cleared even if the utility relay All Clear function is activated. However, this area is cleared when an All Clear is executed without registering a program.
2714	Use of high-speed input correction circuit ON: Used OFF: Not used	
2715	ON while cam switch is in operation.	

2800	Break signal send to communication port A (remains ON while sending).
2801	Receives text data from communication port A, and remains ON during only 1 scan while receiving text data.
2802	Communication port A text data acceptance error. Remains ON during only 1 scan ON when text data is received while either relay 2801 or relay 2803 is ON.
2803	Communication port A text data receive error Remains ON during only 1 scan when a text data receive error occurs.
2804	Communication port A text data send start (remains ON during sending.)
2805	Break signal send to communication port B (remains ON while sending).
2806	Receives communication port B text data, and remains ON during only 1 scan while receiving text data.
2807	Communication port B text data acceptance error. Remains ON during only 1 scan ON when text data is being received while relay 2806 or relay 2808 is ON.
2808	Communication port B text data receive error Remains ON during only 1 scan when a text data receive error occurs.
2809	Communication port B text data send start (remains ON during sending.)
2812	Turns ON when an abnormality occurs with backup battery.
2813	Sets input time constant to all inputs in basic module (except inputs used by HSP instruction). OFF: Sets input time constant to 10 ms. ON: Refers to value stored in DM1940, then determines input time constant.
2814	HKEY instruction: Multiple keys are prohibited.
2815	HKEY instruction: Scan is finished.
2900 to 2915	HKEY information storage area.

Note: Never use special utility relays that are not shown above.

1.3.9 Timers and Counters

Timers and counters can be set in a program, and their outputs can be used as contacts elsewhere in the program. [There is no restriction on the contact type (N.O. or N.C.) and the order of use.]
A same number can be assigned to only one timer or counter. For example, T005 and C005 cannot be used in the same program.

Timer/Counter list

Name		Contact	Coil (instruction)	Number
Timer	Timer (0.1-s timer)	T000 to T249	TMR000 to 249	250 in total
	High-speed timer (0.01-s timer)		TMH000 to 249	
	High-speed 1-ms timer (0.001-s timer)		TMS000 to 249	
Counter	Counter	C000 to C249	C000 to 249	
	Up/down counter		UDC000 to 249	

Description

■ **Timers**

- When 0.1-s timers (TMR) and high-speed 0.001-s timers (TMS) are used as contacts, the "Tnnn" No. is used for both types. However, the form for setting is different. "TMRnnn#ddddd" is used for 0.1-s timers, "TMHnnn#ddddd" is used for high-speed 0.01-s timers, and "TMSnnn#ddddd" is used for high-speed 1-ms timers (nnn = timer No, ddddd = timer set value).
- In a single program, different timer Nos. must be assigned to each of TMRnnn, TMHnnn, and TMSnnn.
- When the PLC is stopped, all timers are reset and their current values become equivalent to set values.

■ **Counters**

- When counters (C) and up/down counters (UDC) are used as contacts, the "Cnnn" No. is used for both types. However, the form for setting is different. "Cnnn#ddddd" is used for counters, while "UDCnnn#ddddd" is used for up/down counters.
- In one program, different numbers must be assigned to each of the counters and up/down counters.
- Even when operation is stopped, each counter stores whatever value it has at that time.

➪ *"TMR instruction" (p.3-67), "TMH instruction" (p.3-68), "TMS instruction" (p.3-69), "C instruction" (p.3-72), "UDC instruction" (p.3-76).*

■ **High-speed counters and high-speed counter comparators**

The Visual KV Se ries is equipped with two high-speed counters (CTH0 and CTH1) and four high-speed counter comparators (CTC0, CTC1, CTC2, and CTC3) with a 30-kHz input response speed (frequency), two phases, and size of 16 or 24 bits.

Note: When a high-speed counter or high-speed counter comparator will be used as a 24-bit device, a set value is required to be stored in a data memory using the MEMSW instruction.

➪ *For details about high-speed counters and high-speed counter comparators, refer to "Chapter 4 High-speed Counters" (p.3-203).*

1.3.10 Data Memories

Data memories store various types of data.
Data memories are not usually used in a program that consists of contacts, coils, timers, and counters. When arithmetic instructions are used, however, data memories can be used to store data for arithmetic operations as well as the results of arithmetic operations.

DM No.	Description
DM0 to DM999	Not specified (can be used by user)
DM1000 to DM1099	Text receive port A
DM1100 to DM1199	Text send port A
DM1200 to DM1299	Text receive port B
DM1300 to DM1399	Text send port B
DM1400	Cam switch function: The first output relay No.
DM1401	Cam switch function: Comparison value in multi-step comparator mode
DM1402	Cam switch function: Pulse count of one cycle of equipment input to CTH0
DM1403	Not specified (can be used by user)
DM1404	Measurement cycle (ms)
DM1405	Result of frequency count (Hz)
DM1406/DM1407	Cam switch function: Set value of angle at which output relay turns ON/OFF
DM1408/DM1409 **:** **DM1468/DM1469**	Cam switch function: Set value of angle at which output relay +1 turns ON/OFF : Cam switch function: Set value of angle at which output relay +31 turns ON/OFF
DM1470	Reserved by system (cannot be used by user)
DM1471 to DM1479	Not specified (can be used by user)
DM1480	Ramp-up/down control function: Startup frequency (Hz) (200 to 50,000)
DM1481	Ramp-up/down control function: Operating frequency (Hz) (200 to 50,000)
DM1482	Ramp-up/down control function: Acceleration time (ms) (0 to 4,000)
DM1483	Not specified (can be used by user)
DM1484	Ramp-up/down control function: Output pulse count (lower digit) (0 to 65,535)
DM1485	Ramp-up/down control function: Output pulse count (upper digit) (0 to 65,535)
DM1486	Ramp-up/down control function: Error code (11 to 17)
DM1487 to DM1499	Not specified (can be used by user)
DM1565 to DM1569	Not specified (can be used by user)
DM1578 and DM1579	Not specified (can be used by user)
DM1580 to DM1599	KV-D20 Operator interface panel: Display device No.
DM1664 to DM1699	Not specified (can be used by user)
DM1670 to DM1675	Reserved by system (cannot be used by user)
DM1676	KV-D20 Operator interface panel: Screen shift permission setting in operator mode

DM No.	Description
DM1677 to DM1679	Area for direct access mode for the KV-D20 operator interface panel
DM1680 to DM1699	KV-D20 Operator interface panel: Display device attributes
DM1764 to DM1799	Not specified (can be used by user)
DM1806 to DM1809	Not specified (can be used by user)
DM1826 to DM1899	Not specified (can be used by user)
DM1900/DM1901*	24-bit value read from CTH0 (lower digit/upper digit)
DM1902/DM1903*	24-bit value read from CTH1 (lower digit/upper digit)
DM1904/DM1905*	24-bit value read from CTC0 (lower digit/upper digit)
DM1906/DM1907*	24-bit value read from CTC1 (lower digit/upper digit)
DM1908/DM1909*	24-bit value read from CTC2 (lower digit/upper digit)
DM1910/DM1911*	24-bit value read from CTC3 (lower digit/upper digit)
DM1912/DM1913	24-bit current value written to CTH0 (lower digit/upper digit)
DM1914/DM1915	24-bit current value written to CTH1 (lower digit/upper digit)
DM1916/DM1917	24-bit current value written to CTC0 (lower digit/upper digit)
DM1918/DM1919	24-bit current value written to CTC1 (lower digit/upper digit)
DM1920/DM1921	24-bit current value written to CTC2 (lower digit/upper digit)
DM1922/DM1923	24-bit current value written to CTC3 (lower digit/upper digit)
DM1924/DM1925	CTH0 preset input (lower digit/upper digit)
DM1926/DM1927	CTH1 preset input (lower digit/upper digit)
DM1928/DM1929*	Input capture when INT0 is generated (lower digit/upper digit)
DM1930/DM1931*	Input capture when INT1 is generated (lower digit/upper digit)
DM1932/DM1933*	Input capture when INT2 is generated (lower digit/upper digit)
DM1934/DM1935*	Input capture when INT3 is generated (lower digit/upper digit)
DM1936	Specified frequency pulse output function: Set frequency (Hz)
DM1937	I/O expansion unit connection information
DM1938	Digital trimmer No. 0: Upper limit value
DM1939	Digital trimmer No. 1: Upper limit value
DM1940	Input time constant setting 0: 10 µs 1: 20 µs 2: 500 µs 3: 1 ms 4: 2.5 ms 5: 5 ms 6: 10 ms Any other value cannot be set.
DM1941 to DM1943	Reserved by system (cannot be used by user)
DM1944	Number of instructions converted into 1 scan when division conversion is performed
DM1945 to DM1949	Not specified (can be used by user)
DM1950	Access window error display (0 to 255)
DM1951 to DM1999	Not specified (can be used by user)

* Read-only relay.

Note 1: 16-bit binary data is stored in each of the data memories as for internal registers.

Note 2: The data stored in data memories is held even when the power is turned off or when the All Clear function is executed. The backup time is 20 days or more in the KV-10xx, and 2 months or more in other models.

Note 3: DM1000 to DM1999 are assigned as special data memories.

1.3.11 Temporary Data Memory

These data memories are used for temporary storage. When arithmetic instructions are used, temporary data memories can be used to temporarily store the data for arithmetic operations as well as the results of arithmetic operations.

TM No.	Usage	Attribute
TM00	Used for arithmetic operations (DIV/MUL)	R/W
TM01	Used for arithmetic operations (DIV)	R/W
TM02 to TM27	Not specified (can be used by user)	R/W
TM28	Stores scan time (module: 1 ms) beyond set value while constant scan time operation is performed.	R*
TM29	Stores set value (module: 1 ms) of constant scan time operation	R/W
TM30	Stores CTC0 value when INT3 interruption is given.	R*
TM31	Stores measured scan time (mean value of every 10 scans) (module: 0.1 ms).	R

Attribute	R: Read	W: Write

* Both R and W are enabled when special functions are not used.

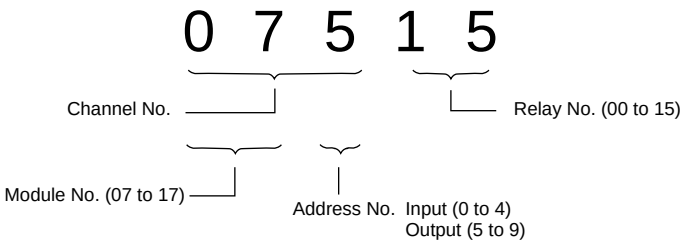
Note 1: Temporary data memories are initialized when the power is turned on.

Note 2: TM20, TM30, and TM31 are read-only, so cannot be used for writing. However, TM28 can be used for both reading and writing if special functions are not used.

Note 3: TM00 and TM01 are used by the MUL and DIV instructions. Never use them for any other purpose.

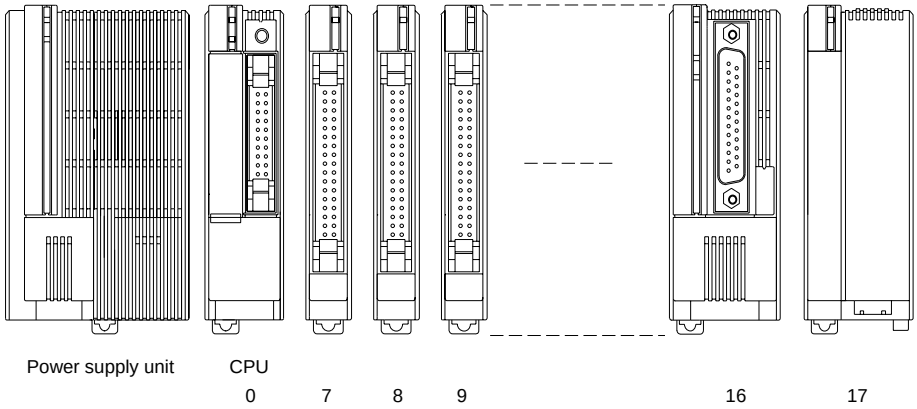
1.3.12 Relay Nos. and Functions

Assignment of Relay Nos.
The components of a relay no. are shown below.



■ Unit Nos.

Unit nos. are assigned to units within the KV-300 system, with the unit connected to the right of the KV-300 CPU (see the figure below) assigned as no. 7. The CPU is assigned as unit no. 0.



■ Address Nos.

Address nos. are assigned to the input units, output units, and I/O terminal units. The following table shows the assignment of address nos. to units.

Unit		Address No.
KV-300 CPU	CPU	0, 5
KV-C16X	16-input unit	0
KV-C32X	32-input unit	0. 1
KV-B16R	16-output unit	5
KV-B16S	16-output unit	5
KV-C32T	32-output unit	5, 6
KV-R8X	8-input terminal unit	0 to 4 *
KV-R16X	16-input terminal unit	
KV-R8R	8-output terminal unit	5 to 9 *
KV-R16R	16-output terminal unit	
KV-R8T	8-output terminal unit	
KV-R16T	16-output terminal unit	

* The KV-R1A I/O Distribution Unit accommodates 5 input units and 5 output units. Addresses are set with address switches.

1.4 Special Functions

This section describes special functions to set and confirm operations on the Visual KV Series, and useful functions for program debugging and adjustment of external equipment.

1.4.1 Input Time Constant Change Function

The input time constant can be changed when a signal is read from an input contact. When connecting external equipment which has no contact in which chattering such as transistor outputs does not occur, and inputting pulses of short width, the input time constant change function can be used to decrease the input time constant.

Setting the input time constant for basic units using special utility relays

The input time constant for a basic unit can be changed using data memory DM1940 and special utility relay 2813.
Though the input time constant is usually 10 ms, it can be changed to a value that corresponds to the number stored in DM1940 by setting special utility relay 2813 to ON.
If the HSP instruction and special utility relay 2813 are used at the same time, priority is given to the HSP instruction and the number stored in DM1940 is ignored.

■ **Special utility relay 2813**

OFF: Sets the input time constant to 10 ms.
ON: Refers to the number stored in DM1940, then determines the input time constant.

Number stored in DM1940	Input time constant
0	10 μs
1	20 μs
2	500 μs
3	1 ms
4	2.5 ms
5	5 ms
6	10 ms
7 or more	Not allowed

Note 1: Be sure to set the input time constant to 10 μs when using the 30-kHz high-speed counter input.

Note 2: Never enter a number that is 7 or larger to data memory DM1940.

Note 3: The input time constant specified by data memory DM1940 becomes effective at the rising edge of special utility relay 2813.

To change the input time constant, first change data memory DM1940, then set special utility relay to OFF and ON again. Or change the operation mode of the KV basic unit from PROGRAM to RUN.

Note 4: The input time constant for input relays set by the HSP instruction is 10 μs.

➪ *For more about the HSP instruction, refer to "HSP instruction" (p.3-86).*

➪ *For more about setting the input time constant for expansion units, refer to "Input time constant for expansion units" (p.1-76).*

Note 5: Set the special utility relay using the SET/RES instructions.

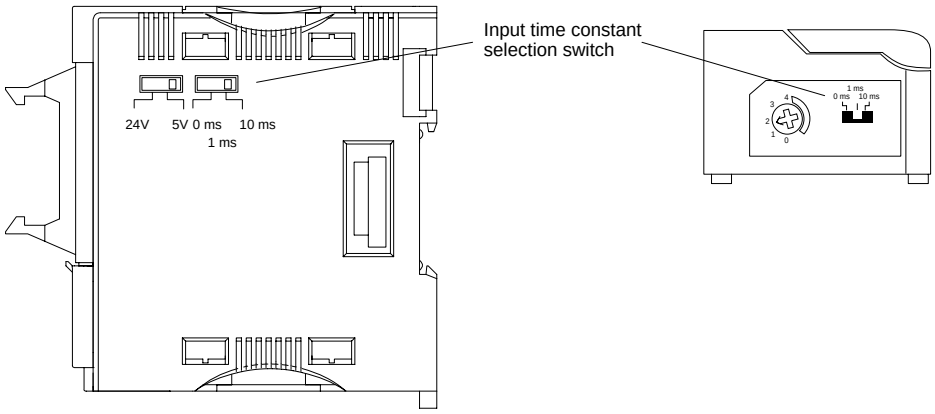
Note 6: When the input time constant is set to 1 ms or less, connect the output equipment without contacts. If connecting output equipment with contacts, contact bounds may enter.

Note 7: Except for interrupts and high-speed counters, signals whose ON time is shorter than the scan time may not be received even if the input time constant is set to a small value.

1.4.2 Modifying the Input Relay Time Constant KV-300 PLC Only

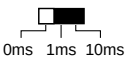
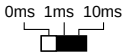
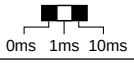
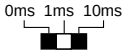
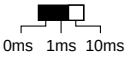
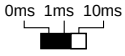
■ **Modifying with External Switches**

KV-C32X/C16X KV-R16X/R8X



As shown in above figures, an external switch can be used to select the input time constant only on the KV-C32X/C16X Connector Input Units and KV-R16X/R8X I/O Terminal Units.

In the following table, white represents the switch position.

Input time constant	KV-C32X/C16X	KV-R16X/R8X
25 µs ±20%		
1 ms ±20%		
10 ms ±20%		

Note: Connect a solid-state contact output device when the input time constant is set to 1 ms for 25 µs. Connection of a contact output device may result in contact bounce.

Modification within the CPU

The input time constant for KV-300 CPU input relay nos. 0000 to 0009 can be modified in the program.

Input time constant	Setting
10 µs ±20%	Turn ON special utility relay 2813 (0000 to 0009).
25 µs ±20%	Use the HSP instruction.
10 ms ±20%	Default

Note 1: When using the 30 kHz high-speed counter input, turn ON special utility relay 2813.

Note 2: When special utility relay 2813 is ON, the input time constant of input relays 0000 to 0009 is set to 10 µs ±20%.

Note 3: The input time constant remains 10 ms ±20% if the HSP instruction is used when special utility relay 2813 is ON.

Note 4: When the input time constant is set to 10 µs or 25 µs, a solid-state output device must be connected. Connection of a contact output device may result in contact bounce.

1.4.3 Constant Scan Time Mode

This function executes a program while keeping the scan time at a constant value which usually changes based on the processing contents. This section describes how to set this function.

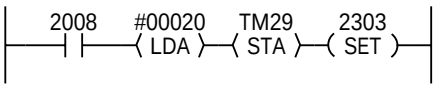
Though the scan time changes usually depending on the processing contents, it can be kept at a constant value by using this function. This function can be used to acquire data from external equipment at a constant time interval.
The set value should be longer than the maximum scan time because the scan time is kept at a constant value until the end of processing.

■ Setting procedure

Set the desired scan time to temporary data memory TM29.
Set special utility relay 2303 to ON.
The scan time is written to TM31.
The scan time can be set in 1-ms increments.
Enter the desired scan time (ms) to the temporary data memory.

■ Setting example

In this example, the scan time is kept at 20 ms.



Note 1: Be sure to set the constant scan time value so it is larger than the actual scan time.

Note 2: If the actual scan time exceeds the set scan time, special utility relay 2304 turns ON (during the next 1 scan) while the actual scan time is written to TM28 (unit: 1 ms).

Note 3: The scan time can be set up to 200 ms in temporary data memory TM29. If a value larger than 200 ms is input, it will be treated as 200 ms.

1.4.4 Output Disabled Function

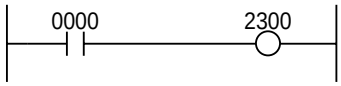
This function disables outputs from each unit in RUN mode without regard to the program used. By disabling external outputs, the program can be debugged while external equipment is connected, even when output of signals to the external equipment is not desired.

■ Setting procedure

When special utility relay 2300 turns ON, all outputs from all output relays (0500 to 0915) to the outside are cleared after 1 scan is finished.
However, the display in the Access Window and the output indicator lamps are not cleared.

■ Setting example

By setting/resetting special utility relay 2300 using the Access Window, the "KV IncrediWare (DOS)" or "LADDER BUILDER for KV" programming support software, or the KV-P3E(01) handheld programmer, the external output prohibition function can be used.
External outputs are prohibited while input 0000 is ON. External outputs are permitted, though, while input 0000 is OFF.



➪ *For more about operating procedures, refer to the "Chapter 6. Handheld Programmer" (p.1-195).*

1.4.5 Input Refresh Disabled Function

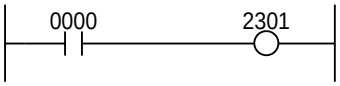
This function disables the update of inputs from each unit triggered by input signals from external equipment.
By disabling external input refresh, inputs from each unit can be set to ON/OFF in monitor status without mechanical operations to enable a program check.

■ Setting procedure

When special utility relay 2301 turns ON, input refresh (read of input relays) for all input relays (0000 to 0415 used by the QL Series) is skipped.
In this status, inputs can be set to ON/OFF from the Access Window, the "KV IncrediWare (DOS)" or "LADDER BUILDER for KV" programming support software, or the KV-P3E(01) handheld programmer.

■ Setting example

By setting/resetting special utility relay 2301 using the Access Window, the "KV IncrediWare (DOS)" or "LADDER BUILDER for KV" programming support software, or the KV-P3E(01) handheld programmer, the external input refresh prohibition function can be used.
External input refresh is prohibited while input 0000 is ON. External input refresh is permitted, though, while input 0000 is OFF.



➪ *For more about operating procedures, refer to the "Chapter 6. Handheld Programmer" (p.1-195).*

Note: Once external input refresh is prohibited, it can be permitted only by setting special utility relay 2301 to OFF from the Access Window, the "KV IncrediWare (DOS)" or "LADDER BUILDER for KV" programming support software, or the KV-P3E(01) handheld programmer.

1.4.6 Contact Comment Save Function

- This function transfers contact comments to the Visual KV Series using the "KV IncrediWare (DOS)" or "LADDER BUILDER for KV" programming support software.
- The Visual KV Series can store not only programs but also comments registered to each contact using the "KV IncrediWare (DOS)" or "LADDER BUILDER for KV" programming support software.
  A program may not be easy to understand if only device Nos. are used. By registering comments to the contacts, the program can be easily debugged and more efficiently maintained.
- The number of contact comments that can be transferred is up to 1,000 for both normal transfer and compression transfer.
- The KV-D20 operator interface panel includes the contact comment display function.

➪ *For more about operating procedures, refer to "2.5 Entering Comments/Labels" (p.1-46) and "4.2.2 Setting the comment transfer" (p.2-138).*

Note 1: Line comments cannot be stored.

Note 2: The KV-P3E(01) handheld programmer cannot read or write contact comments.

Note 3: The KV-D20 operator interface panel cannot display contact comments which have been compressed and transferred.

1.4.7 Special Functions KV-300 PLC only

Constant Scan Time Mode

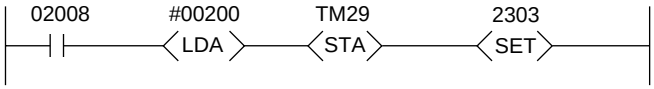
In this mode, operation can take place according to a preset scan time (in ms).

■ Setting

Write the desired scan time into TM29 (temporary data memory), then turn on special utility relay No. 2303. The scan time can also be written into TM31. Specify a scan time in increments of 10 ms (a value of less than 10 ms is invalid).
Here, write a value into TM equivalent to 10 times the scan time.

Example

Set the constant scan time to 20 ms.



Note 1: The set value for the constant scan time must be greater than the actual scan time. Otherwise, special utility relay 2304 turns on during every scan to disable constant scan time mode.

Note 2: If the scan time exceeds the set value, special utility relay no. 2304 turns on during the next scan.

1

Output Disabled Function

During checking of a program, this function clears output from output relays regardless of the program currently running.

■ Setting

Turn on special utility relay No. 2300. After one scan is completed, all output relays (00500 to 00503, 07500 to 17915) are cleared.

Example

Use the output disabled function by executing FORCED RESET/RESET to special utility relay No. 2300 from the monitor display.

☞ *To execute FORCED RESET or RESET, refer to "Chapter 6 Handheld Programmer" (p.1-195).*

Input Refresh Disabled Function

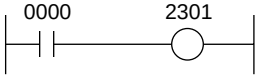
Set this function if it is desired to turn ON/OFF input relays from the monitor display without activating the machine when checking a program.

■ Setting

Turn ON special utility relay No. 2301 to skip input refresh (reading from input relays). Input relays can then be turned ON/OFF with the KV-P3E(01) or with KV IncrediWare (DOS) on the monitor display.

Example

Set input relay No. 0000 to ON to disable input refresh; set to OFF to enable input refresh.



Note: If input refresh is disabled, it is not enabled until input relay No. 0000 is turned on from the handheld programmer.

1.5 Extended Ladder Diagrams

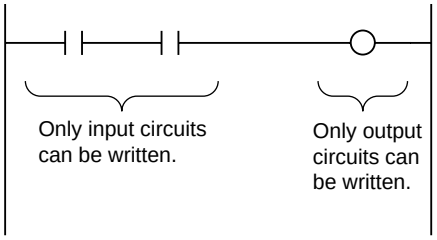
This section describes KEYENCE's unique extended ladder diagram.

1.5.1 Features of Extended Ladder Diagrams

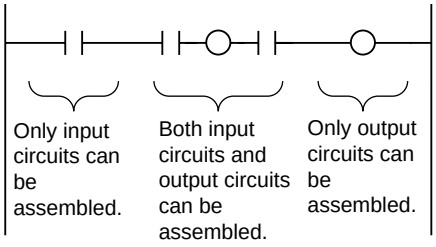
The extended ladder diagram is a programming method developed to reduce problems related to design, testing, operation, and maintenance of programs.
In a conventional ladder diagram, output instructions can be written only on the right side of a ladder diagram. On the other hand, in an extended ladder diagram, output instructions can be written anywhere except on the left. As the result, the programs shown below can be written.

Mixture of input and output circuits

Conventional ladder diagram

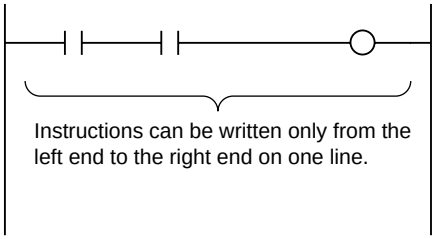


Extended ladder diagram

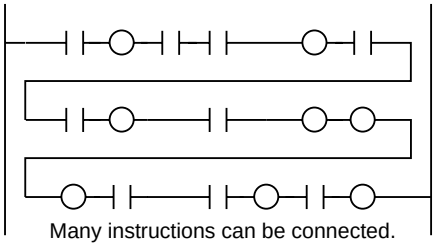


Connection of two or more instructions on one line

Conventional ladder diagram

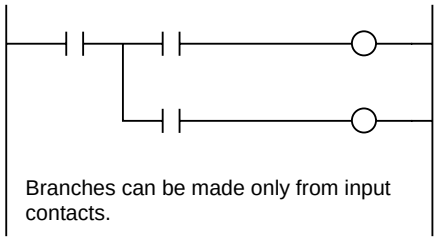


Extended ladder diagram

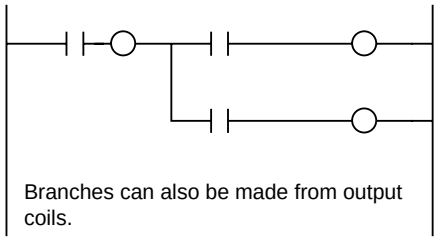


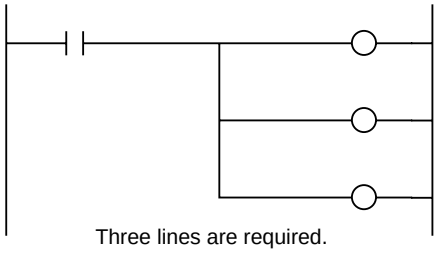
Branch from output coil

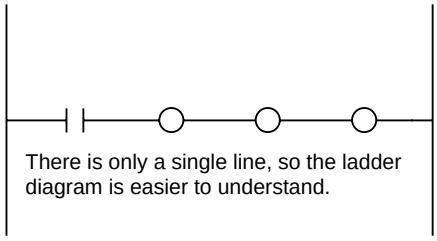
Conventional ladder diagram



Extended ladder diagram







1.5.2 Advantages of Extended Ladder Diagrams

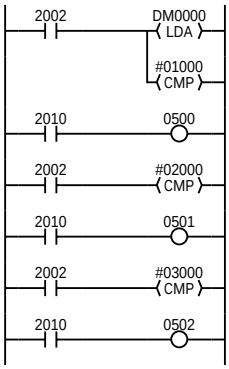
The number of lines in a ladder diagram can be reduced.

Because both output instructions and input instructions can be written side by side, the number of program lines can be reduced.
As the result, the contents of the program can be seen at a glance.

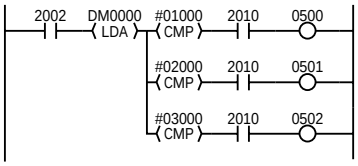
Example

When DM0000 stores 1000, 0500 turns ON.
2000, 0501 turns ON.
3000, 0502 turns ON.

Conventional ladder diagram



Extended ladder diagram



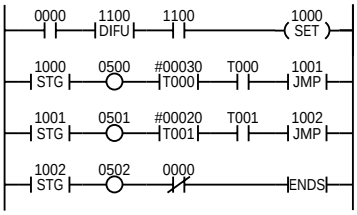
In a conventional ladder diagram, operations performed by the program cannot be easily understood. In an extended ladder diagram, operations performed by the program can be understood at a glance.

Processing sequence is clear.

Ladder symbols can be laid out in processing sequence, so the program flow is easier to understand. In addition, maintainability is considerably improved.

Example

When the start switch is set to ON, a lamp is lit for three seconds, a buzzer is sounded for two seconds, and then the motor starts to rotate.



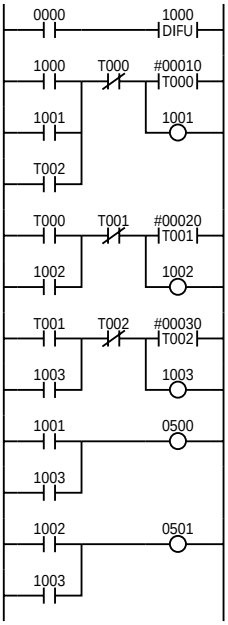
When the start switch (0000) is set to ON, a lamp (0500) is lit and timer 0 is activated.

When timer 0 turns ON three seconds later, the lamp goes out, a buzzer (0501) is sounded, and timer 1 is activated.

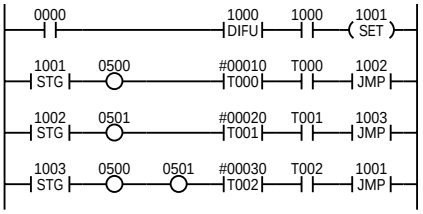
When timer 1 turns ON two seconds later, the buzzer is stopped and the motor (0502) starts to rotate.

When the start switch (0000) is set to OFF, the motor is stopped and all operations are reset.

Conventional ladder diagram



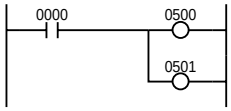
Extended ladder diagram



By using an extended ladder diagram as shown above, the program can be executed in the sequence of the processing to be performed. So even a person who uses a relay sequence for the first time can understand the processing contents. By combining the STG instruction, double coils can also be used.

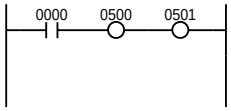
Note: When an extended ladder diagram is used, the number of lines in ladder diagram may be reduced. However, this may not necessarily reduce the number of mnemonics in the program.

Conventional ladder diagram



LD 0000
OUT 0500
OUT 0501

Extended ladder diagram



LD 0000
OUT 0500
CON
OUT 0501

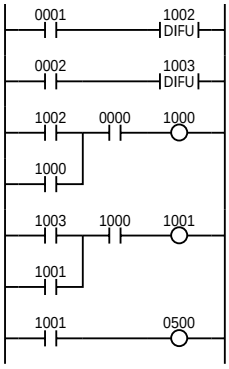
The CON instruction for connection is added.
(The scan time is not affected.)

1.5.3 Example of an Extended Ladder Diagram

■ **Using W-UE**

Only when inputs are given in the order "0000 → 0001 → 0002", output 0500 turns ON.

Conventional ladder diagram



At the rising edge of input 0001, 1002 turns ON.

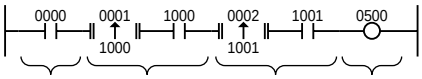
At the rising edge of input 1003, 1002 turns ON.

If input 0000 is ON, 1000 turns ON.

If 1000 is ON, 1001 turns ON.

When 1001 turns ON, output 0500 turns ON.

Extended ladder diagram



Input 0000 turns ON. Input 0001 turns ON. Input 0002 turns ON. Output 0500 turns ON.

Because the program can be written in only one line when an extended adder diagram is used, it is easier to look at and understand compared with a program written using a conventional ladder diagram.

Chapter 2

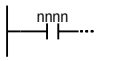
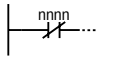
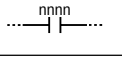
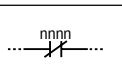
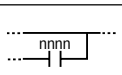
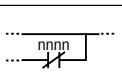
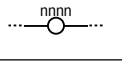
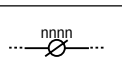
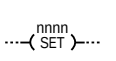
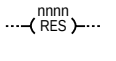
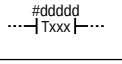
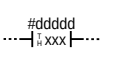
Instructions

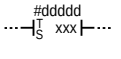
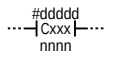
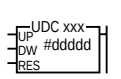
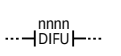
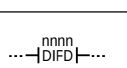
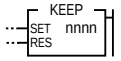
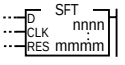
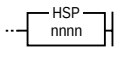
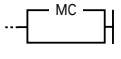
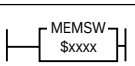
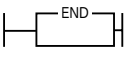
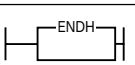
Describes the concrete usage of instructions in the KV Series.
Refer to "Chapter 3 Interrupts" on page 3-191 for details of interrupt instructions.
Refer to "Chapter 4 High-speed counters" on page 3-203 for details of the high-speed counters used in the application instruction.

2.1 Instruction List Visual KV Series

The KV Series uses 80 instructions.
The instructions are divided into four categories according to their functions: basic instructions, application instructions, arithmetic instructions, and interrupt instructions.
The following is an overview of applications and functions. For details, refer to the respective description pages for each instruction.

2.1.1 Basic Instructions

Instruction	Symbol	Mnemonic	Operand	Operand value	Function	Exec.time (μs)	Bytes	Page
LOAD		LD	R No. T/C No.	0000 to 17915 T000 to T249 C000 to C249 CTC0 to CTC3	Connects N.O. contact to bus.	0.7 to 1.6	3 (12)	3-57
LOAD BAR		LDB			Connects N.C. contact to bus.	0.7 to 1.6	3 (12)	3-57
AND		AND			Connects N.O. contact in series with previous contact.	0.7 to 0.9	3 (8)	3-58
AND BAR		ANB			Connects N.C. contact in series with previous contact.	0.7 to 0.9	3 (8)	3-58
OR		OR			Connects N.O. contact in parallel with previous contact.	0.7 to 0.9	3 (8)	3-60
OR BAR		ORB			Connects N.C. contact in parallel with previous contact.	0.7 to 0.9	3 (8)	3-60
AND LOAD	———	ANL	———	———	Connects in series blocks made of one or more contacts.	0.8	1 (4)	3-61
OR LOAD	———	ORL			Connects in parallel blocks made of one or more contacts.	0.8	1 (4)	3-63
OUT		OUT	R No.	0500 to 1915 2009 2300 to 17915	Outputs input ON/OFF status to R coil.	1.5	3 (12)	3-65
OUT BAR		OUB			Outputs inverted input ON/ OFF status to R coil.	1.5	3 (12)	3-65
SET		SET	R No. T/C No.	0500 to 1915 2009 2300 to 17915 T000 to T249 C000 to C249	Forces relay ON and holds this status when input is ON.	1.9 to 12.8	3 (14)	3-66
RESET		RES		0500 to 1915 2009 2100 to 17915 T000 to T249 C000 to C249 CTH0 to CTH1 CTC0 to CTC3	Forces R/T/C OFF when input is ON.	1.9 to 20.5	3 (14)	3-66
0.1-s TIMER		TMR	T No., # preset value	000 to 249 #00000 to #65535	16-bit on-delay T that counts down in 0.1-s decrements.	12.0 to 17.8	2 (6)	3-67
0.01-s TIMER		TMH (FUN49)			16-bit on-delay T that counts down in 0.01-s decrements.	12.0 to 17.8	2 (6)	3-68

Instruction	Symbol	Mnemonic	Operand	Operand value	Function	Exec.time (μs)	Bytes	Page
1-ms TIMER		TMS (FUN51)	T No., # preset value	000 to 249 #0000 to #65535	16-bit on-delay T that counts down in 1-ms decrements.	12.0 to 17.8	2 (7)	3-69
COUNTER		C	# preset value, C No., counter input R	#00000 to #65535 000 to 249 0000 to 17915	Sets 16-bit up-counter.	12.0 to 17.8	4 (7)	3-72
UP-DOWN COUNTER		UDC (FUN52)	C No., # preset value	000 to 249 #00000 to #65535	Sets a 16-bit up-down counter.	13.0 to 24.0	2 (10)	3-76
DIFFEREN-TIATE UP		DIFU (FUN10)	R No.	1000 to 1915 3000 to 9915	Turns ON R for 1 scan time at rising edge of input.	11.2 to 13.2	3 (10)	3-78
DIFFEREN-TIATE DOWN		DIFD (FUN09)			Turns ON R for 1 scan time at falling edge of input.	10.0 to 12.8	3 (10)	3-78
KEEP		KEEP (FUN22)	R No.	0500 to 1915 2009 2100 to 17915	Turns ON R and holds this status when SET input is ON. Turns OFF R when RESET input is ON.	8.2 to 19.8	3 (11)	3-80
SHIFT		SFT (FUN39)	nnnn: 1st R No. mmmm: Last R No.	1000 to 1915 3000 to 9915	Sets shift register.	(*)	5 (15)	3-82
HIGH SPEED		HSP (FUN18)	R No.	(KV-10) 0000 to 0005 (KV-16) 0000 to 0009 (KV-24) 0000 to 0015 (KV-40) 0000 to 0107	Reduces input relay time constant to 10 μs for higher input response.	3.8 to 9.4	3 (8)	3-86
MASTER CONTROL		MC (FUN24)	———	———	Selects ON/OFF status of R coils, Ts, or Cs.	0.2	1 (4)	3-89
MASTER CONTROL RESET		MCR (FUN25)	———	———	Represents end of MC.	0.2	1 (0)	3-89
MEMORY SWITCH		MEMSW (FUN26)	$ constant	$ 0000 to $ FFFF	Sets memory switches.	—	3 (0)	3-92
NOP	———	NOP (FUN30)	———	———	Performs no operation.	—	1 (0)	3-94
END		END	———	———	Indicates end of each routine of program.	—	1 (1)	3-94
END HI		ENDH	———	———	Indicates end of entire program.	—	1 (0)	3-94

- Number of bytes represents the memory capacity required for each instruction.
- Number in ( ) represents the memory capacity required for object code of each instruction.
- *1 34 + 0.25 + n x 0.25 (n: No. of shift steps)
- All operand values are shown in normal notation. The corresponding relay numbers in X-Y-M notation are shown below:

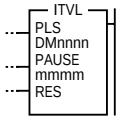
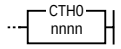
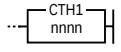
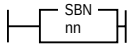
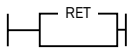
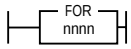
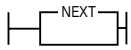
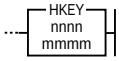
Normal notation	**X-Y-M notation**
0000 to 0415	X000 to X04F
0500 to 0915	Y050 to Y09F
1000 to 6915	M1000 to M6915
7000 to 17915	X700 to X174F or Y750 to Y179F

2.1.2 Application Instructions

Instruction	Symbol	Mnemonic	Operand	Operand value	Function	Exec.time (μs)	Bytes	Page
WAIT ON	nnnn ON mmmm	W-ON	nnnn: R, T, C Nos. mmmm: R No. R No.	17915 T000 to T249 C000 to C249 CTC0 to CTC3 mmmm: 1000 to 1915 3000 to 9915 1000 to 1915	R (output operand [mmmm]) when R, T, or C (input operand [nnnn]) is ON.	10.4 to 12.6	5 (12)	3-96
WAIT OFF	nnnn OFF mmmm	W-OFF			Turns ON R (output operand [mmmm]) when R, T, or C (input operand [nnnn]) is OFF.	13.6 to 18.5	5 (12)	3-96
WAIT UP EDGE	nnnn ↑ mmmm	W-UE			Turns ON R (output operand [mmmm]) at rising edge of R, T, or C (input operand [nnnn]).	13.6 to 18.5	5 (12)	3-98
WAIT DOWN EDGE	nnnn ↓ mmmm	W-DE			Turns ON R (output operand [mmmm]) at falling edge of R, T, or C (input operand [nnnn]).	6.8 to 5.3	1 (0)	3-98
CONNECT	———	CON (FUN 06)	———	———	Represents series connection of output instruction together with another instruction.	———	1 (4)	3-102
PUSH		MPS			Stores input status and arithmetic flag.	3.2	1 (4)	3-103
READ		MRD			Reads input status and arithmetic flag stored with PUSH.	6.8	1 (4)	3-103
POP		MPP			Reads & clears input status and arithmetic flag stored with PUSH.	10.5 to 13.0	3 (10)	3-103
STAGE	nnnn STG	STG (FUN 44)	R, T, C Nos.	3000 to 9915 0000 to 0009	Executes instructions in STG block when R (operand) is ON.	4.5 to 12.5	3 (8)	3-106
JUMP	nnnn JMP	JMP (FUN 21)			When input is ON, turns R of current stage OFF and moves to stage specified by operand.	4.3 to 7.5	1 (4)	3-106
END STAGE	ENDS	ENDS (FUN 14)	———	———	Turns current stage OFF and next stage ON when input is ON.	2.5	3 (10)	3-106
STEP	STP nnnn	STP (FUN 45)	R No. nnnn: 0000 to	0500 to 9915 T000 to T249 C000 to C249 CTC0 to CTC3 11.2 to 13.4	Executes program between STP & STE when R (operand) is ON.	5 (12)	1 (0)	3-114
STEP END	STE	STE (FUN 43)	———	———	Is used with STEP to make program step.	———	Turns ON	3-114

- Number of bytes represents the memory capacity required for each instruction.
- Number in ( ) represents the memory capacity required for object code of each instruction.
- All operand values are shown in normal notation. The corresponding relay numbers in X-Y-M notation are shown below:

Normal notation	X-Y-M notation
0000 to 0415	X000 to X04F
0500 to 0915	Y050 to Y09F
1000 to 6915	M1000 to M6915
7000 to 17915	X700 to X174F or Y750 to Y179F

Instruction	Symbol	Mnemonic	Operand	Operand value	Function	Exec.time (μs)	Bytes	Page
INTERVAL TIMER		ITVL	DMnnnn: DM No. mmmm: R No.	DMnnnn: DM0000 to DM1985 mmmm: 1000 to 1912 3000 to 9912	Measures pulse-to-pulse interval & pulse width in specified mode.	20.0 to 80.0	5 (10)	3-117
16-BIT COUNTER		CTH	Count input R	0004 2100 2101 2102	16-bit (0 to 65535) up-down counter for clock pulses with input response frequency of 30 kHz.	14.4	4 (6)	3-204
16-BIT COUNTER COMPARA-TOR		CTC	n: Comparator No. ddddd: # preset value	n: 0,1 ddddd: #00001 to #65535	Hardware-based comparator between preset & current values of high-speed counter (CTH0). This comparator is turned ON when these values are equal.	2.3 to 3.5	2 (6)	3-204
16-BIT COUNTER		CTH	Count input R	0005 0500 2200 2201 2202	16-bit (0 to 65535) up-down counter for clock pulses with input response frequency of 30 kHz.	14.4	4 (6)	3-204
16-BIT COUNTER COMPARA-TOR		CTC	n: Comparator No. ddddd: # preset value	n: 2,3 ddddd: #00001 to #65535	Hardware-based comparator between preset & current values of high-speed counter (CTH1). This comparator is turned ON when these values are equal.	2.3 to 3.5	2 (6)	3-204
SUBROUTINE CALL		CALL (FUN 03)	Subroutine No.	00 to 99	Executes subroutine specified by operand.	5.4 to 6.5	2 (8)	3-122
SUBROUTINE ENTRY		SBN (FUN 38)	Subroutine No.	00 to 99	Represents beginning of subroutine specified by operand.	———	2 (4)	3-122
SUBROUTINE RETURN		RET (FUN 33)	———	———	Represents end of subroutine.	4.3	1 (4)	3-122
REPEAT START		FOR (FUN 16)	# constant, DM No. TMxx	#00000 to #65535 DM0000 to DM1999 TM00 to TM29	Executes program between FOR & NEXT for number of times specified by operand.	12.0 to 18.0	3 (20)	3-125
REPEAT END		NEXT (FUN 29)	———	———	Represents end of repetition.	0.5	1 (4)	3-125
16-KEY INPUT		HKEY (FUN 17)	nnnn: Input R mmmm: Output R	nnnn: 0000 to 415 mmmm: 0500 to 915	Reads 16-key data by time-sharing and outputs these data into special utility Rs 2900 to 2915.	22.1 to 180.0	5 (10)	3-131

- Number of bytes represents the memory capacity required for each instruction.
- Number in ( ) represents the memory capacity required for object code of each instruction.
- All operand values are shown in normal notation. The corresponding relay numbers in X-Y-M notation are shown below:

Normal notation	**X-Y-M notation**
0000 to 0415	X000 to X04F
0500 to 0915	Y050 to Y09F
1000 to 6915	M1000 to M6915
7000 to 17915	X700 to X174F or Y750 to Y179F

2.1.3 Arithmetic Instructions

Instruction	Symbol	Mnemonic	Operand	Operand value	Function	Exec.time (μs)	Bytes	Page
DATA MEMORY WRITE	nnnn DW DMmmmm	DW	nnnn: #/$ constant DMmmmm: DM No.	nnnn: #0000 to #65535 $0000 to $FFFF DMmmmm: DM0000 to DM1999	Writes constant into data memory.	8.0	5 (8)	3-136
TRIMMER SETTING	n TMIN	TMIN (FUN 50)	Trimmer No.	0 to 1	Inputs value set by access window's digital trimmer (0 to 65535) to internal register.	8.9	1 (6)	3-138
	n TMIN	@TMIN @(FUN 50)				20.9	1 (16)	
LOAD A	nnnn LDA	LDA (FUN 23)	R No., C/T No., DM No, TM xx, #/$ constant, #TMxx	0000 to 17915 T000 to T249 C000 to C249 CTH0 to CTH1 DM0000 to DM1999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	Inputs value specified by operand into internal register or inputs current value when T/C is specified as operand.	6.4 to 14.0	3 (8)	3-140
	nnnn LDA	@LDA @(FUN 23)				18.4 to 26.0	3 (18)	
STORE A	nnnn STA	STA (FUN 42)	R No., C/T No., DM No., TM xx, #TMxx	0500 to 1915 2100 to 17915 T000 to T249 C000 to C249 CTH0 to CTC3 DM0000 to DM1999 TM00 to TM29 #TM00 to #TM29	Transfers content of internal register to location specified by operand, or changes preset value when T/C is specified as operand.	6.6 to 28.5	3 (8)	3-140
	nnnn STA	@STA @(FUN 42)				18.0 to 40.5	3 (18)	
COMPARE	nnnn CMP	CMP (FUN 04)	DM/TM No. TMxx, #/$ constant, #TMxx	DM0000 to DM1999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	Compares content of internal register and value specified by operand.	10.8 to 35.6	3 (6)	3-146
	nnnn CMP	@CMP @(FUN 04)				22.8 to 47.6	3 (16)	
ADD	nnnn ADD	ADD (FUN00)			Adds content of internal register and value specified by operand and inputs result back to same register.	9.4 to 34.2	3 (6)	3-150
	nnnn ADD	@ADD @(FUN 00)				21.4 to 46.2	3 (16)	
SUBTRACT	nnnn SUB	SUB (FUN 46)			Subtracts value specified by operand from content of register and inputs result back to same register.	10.8 to 35.6	3 (6)	3-150
	nnnn SUB	@SUB @(FUN 46)				22.8 to 47.6	3 (16)	
MULTIPLY	nnnn MUL	MUL (FUN 28)			Multiplies content of internal register by value specified by operand and inputs result back to same register.	14.4 to 38.1	3 (6)	3-150
	nnnn MUL	@MUL @(FUN28)				26.4 to 50.1	3 (16)	

- Number of bytes represents the memory capacity required for each instruction.
- Number in ( ) represents the memory capacity required for object code of each instruction.

Instruction	Symbol	Mnemonic	Operand	Operand value	Function	Exec.time (μs)	Bytes	Page
DIVIDE	nnnn DIV	DIV (FUN 11)	R No., DM No., TM xx, #/$ constant, #TMxx	DM0000 to DM1999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	Divides content of internal register by value specified by operand and inputs result back to same register.	17.4 to 43.3	3 (6)	3-150
	↑ nnnn DIV	@DIV @(FUN 11)				29.4 to 55.3	3 (16)	
AND A	nnnn ANDA	ANDA (FUN 01)	R No., DM No., TM xx, #/$ constant, #TMxx	0000 to 17915 DM0000 to DM1999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	ANDs each of 16 bits of internal register and that of value specified by operand, and inputs result back to same register.	8.2 to 33.1	3 (8)	3-159
	↑ nnnn ANDA	@ANDA @(FUN 01)				20.2 to 45.1	3 (18)	
OR A	nnnn ORA	ORA (FNC 31)			ORs each of 16 bits of internal register and that of value specified by operand, and inputs result back to same register.	8.2 to 33.1	3 (8)	3-161
	↑ nnnn ORA	@ORA @(FUN 31)				20.2 to 45.1	3 (18)	
EXCLUSIVE OR A	nnnn EORA	EORA (FUN 15)	R No., DM No., TM xx, #/$ constant, #TMxx	0000 to 17915 DM0000 to DM1999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	EXCLUSIVE-ORs each of 16 bits of internal register and that of value specified by operand, and inputs result back to same register.	8.2 to 33.1	3 (8)	3-164
	↑ nnnn EORA	@EORA @(FUN 15)				20.2 to 45.1	3 (18)	
SHIFT RIGHT A	#dd SRA	SRA (FNC 41)	# constant	#01 to #16	Moves content of internal register serially right by value specified by operand.	9.3 to 27.6	2 (6)	3-166
	↑ #dd SRA	@SRA @(FUN 41)				21.3 to 39.6	2 (16)	
SHIFT LEFT A	#dd SLA	SLA (FNC 40)			Moves content of internal register serially left by value specified by operand.	9.2 to 27.6	2 (6)	3-166
	↑ #dd SLA	@SLA @(FUN 40)				21.2 to 39.6	2 (16)	
ROTATE RIGHT A	#dd RRA	RRA (FUN 37)			Rotates contents of internal register and carry bit (2009) clockwise by operand value.	10.3 to 28.6	2 (6)	3-169
	↑ #dd RRA	@RRA @(FUN 37)				22.3 to 40.6	2 (16)	
ROTATE LEFT A	#dd RLA	RLA (FUN 35)			Rotates contents of internal register and carry bit (2009) counterclock-wise by operand value.	10.3 to 28.6	2 (6)	3-169
	↑ #dd RLA	@RLA @(FUN 35)				22.3 to 40.6	2 (16)	

- Number of bytes represents the memory capacity required for each instruction.
- Number in ( ) represents the memory capacity required for object code of each instruction.
- All operand values are shown in normal notation. The corresponding relay numbers in X-Y-M notation are shown below:

Normal notation	**X-Y-M notation**
0000 to 0415	X000 to X04F
0500 to 0915	Y050 to Y09F
1000 to 6915	M1000 to M6915
7000 to 17915	X700 to X174F or Y750 to Y179F

Instruction	Symbol	Mnemonic	Operand	Operand value	Function	Exec.time (μs)	Bytes	Page
COMPLEMENT	COM	COM (FUN 05)	———	———	Inverts content of each bit in internal register.	5.6	1 (4)	3-171
	COM	@COM @(FUN 05)				17.6	1 (14)	
INCREMENT MEMORY	nnnn INC	INC (FNC 19)	DM/TM No.	DM0000 to DM1999 TM00 to TM29	Adds 1 to content of data memory specified by operand.	9.8	3 (6)	3-172
	nnnn INC	@INC @(FUN 19)				21.8	3 (16)	
DECREMENT MEMORY	nnnn DEC	DEC (FNC 07)	DM/TM No.	DM0000 to DM1999 TM00 to TM29	Subtracts 1 from content of data memory specified by operand.	10.4	3 (6)	3-172
	nnnn DEC	@DEC @(FUN 07)				22.4	3 (16)	
MULTIPLEXER	#n MPX	MPX (FUN 27)	# constant	#0 to #3	Converts 4-bit data (specified by operand) of internal register into 16-bit data.	10.1	1 (6)	3-176
	#n MPX	@MPX @(FUN 27)				22.1	1 (16)	
DEMULTIPLEXER	DMX	DMX (FUN 12)	———	———	Converts position of highest order bit with 1 in internal register into 4-bit data.	22.6	1 (4)	3-176
	DMX	@DMX @(FUN 12)				34.6	1 (14)	
TRANSFER BCD	TBCD	TBCD (FUN 47)	———	———	Converts content of internal register (16-bit binary) into 4-digit BCD data.	5.6	1 (4)	3-180
	TBCD	@TBCD @(FUN 47)				17.6	1 (14)	
TRANSFER BIN	TBIN	TBIN (FUN 48)	———	———	Converts content of internal register (4-digit BCD) into 16-bit binary data.	9.6	1 (4)	3-180
	TBIN	@TBIN @(FUN 48)				21.6	1 (14)	
ASCII CONVERT	ASC	ASC (FUN 02)			Converts content of lower order 8 bytes of internal register into 2-digit ASCII code.	9.7	1 (4)	3-183
	ASC	@ASC @(FUN 02)				21.7	1 (14)	
REVERSE ASCII CONVERT	RASC	RASC (FUN 32)			Converts 2-digit ASCII code of internal register into 2-digit numerical value.	9.3	1 (4)	3-183
	RASC	@RASC @(FUN 32)				21.3	1 (14)	
SQUARE ROOT	ROOT	ROOT (FUN 36)			Takes square root of 32-bit data (TM00: higher order byte, internal register: lower order byte) and inputs result back to same register.	95.7	1 (4)	3-185
	ROOT	@ROOT @(FUN 36)				107.7	1 (14)	

- Number of bytes represents the memory capacity required for each instruction.
- Number in ( ) represents the memory capacity required for object code of each instruction.
- All operand values are shown in normal notation. The corresponding relay numbers in X-Y-M notation are shown below:

Normal notation	X-Y-M notation
0000 to 0415	X000 to X04F
0500 to 0915	Y050 to Y09F
1000 to 6915	M1000 to M6915
7000 to 17915	X700 to X174F or Y750 to Y179F (OUTPUT)

2.1.4 Interrupt Instructions

Instruction	Symbol	Mnemonic	Operand	Operand value	Function	Exec.time (μs)	Bytes	Page
INTERRUPT DISABLED	···(DI)···	DI (FUN 08)	———	———	Disables execution of interrupt.	2.2	1 (12)	3-193
INTERRUPT ENABLED	···(EI)···	EI (FUN 13)	———	———	Enables execution of interrupt.	4.0	1 (10)	3-193
INTERRUPT	INT nnnn	INT (FUN 20)	R No.	000 to 003	Executes interrupt instructions between INT and RETI at rising/falling edge of input relays 0000 through 0003.	60.0 to 90.0	1 (8)	3-192
	INT CTCn		Comparator No.	CTC0 to CTC3	Used with comparators CTC0 to CTC3 and executes instructions between INT and RETI.	60.0 to 90.0	1 (8)	3-192
RETURN INTERRUPT	RETI	RETI (FUN 34)	———	———	Represents end of interrupt.	18.0 to 22.0	1 (4)	3-192

- Number of bytes represents the memory capacity required for each instruction.
- Number in ( ) represents the memory capacity required for object code of each instruction.
- All operand values are shown in normal notation. The corresponding relay numbers in X-Y-M notation are shown below:

Normal notation	X-Y-M notation
0000 to 0415	X000 to X04F
0500 to 0915	Y050 to Y09F
1000 to 6915	M1000 to M6915
7000 to 17915	X700 to X174F or Y750 to Y179F

2.1.5 Function No. List (Alphabetical order)

The following list shows the function Nos. used to enter instructions with the KV-P3E(01) handheld programmer.

☞ *Refer to "Chapter 6 Handheld Programmer" on page 1-195 for details.*

Function No.	Instruction
00	ADD
01	ANDA
02	ASC
03	CALL
04	CMP
05	COM
06	CON
07	DEC
08	DI
09	DIFD
10	DIFU
11	DIV
12	DMX

Function No.	Instruction
13	EI
14	ENDS
15	EORA
16	FOR
17	HKEY
18	HSP
19	INC
20	INT
21	JMP
22	KEEP
23	LDA
24	MC
25	MCR

Function No.	Instruction
26	MEMSW
27	MPX
28	MUL
29	NEXT
30	NOP
31	ORA
32	RASC
33	RET
34	RET1
35	RLA
36	ROOT
37	RRA
38	SBN

Function No.	Instruction
39	SFT
40	SLA
41	SRA
42	STA
43	STE
44	STG
45	STP
46	SUB
47	TBCD
48	TBIN
49	TMH
50	TMIN
51	TMS
52	UDC

Reference: To find function No. assigned to desired function:

1. Press the **[FUN]** key.
2. When the cursor appears at the position where the function No. is to be entered, press the [↑ ON] or [↓ OFF] key and scroll the functions and assigned Nos. to find the desired function.

2.2 Instruction List KV-300 Series, KV-10/80

- Number of bytes represents the memory capacity required for each instruction.
- Number in ( ) represents the memory capacity required for object code of each instruction.
- Abbreviations: R: Relay, T: Timer, C: Counter, #: Decimal, $: Hex.

2.2.1 Basic Instructions

KV-10/16/24/40/80

Instruction	Symbol	Mnemonic	Operand	KV-10/16/24/40/80				Function	Page
				Operand value KV-10/16	Operand value KV-24/40/80	Exec.time (μs)	Bytes		
LOAD	nnnn	LD	R No. T/C No.	0000 to 2915 T000 to T063 C000 to C063 CTC0 to CTC3	0000 to 6915 T000 to T119 C000 to C119 CTC0 to CTC3	1.5 to 2.5	3 (4)	Connects N.O. contact to bus.	3-57
LOAD BAR	nnnn	LDB				2.1 to 3.5	3 (6)	Connects N.C. contact to bus.	3-57
AND	nnnn	AND				1.5 to 2.5	3 (4)	Connects N.O. contact in series with previous contact.	3-58
AND BAR	nnnn	ANB				2.7 to 4.5	3 (8)	Connects N.C. contact in series with previous contact.	3-58
OR	nnnn	OR				1.5 to 2.5	3 (4)	Connects N.O. contact in parallel with previous contact.	3-60
OR BAR	nnnn	ORB				2.7 to 4.5	3 (8)	Connects N.C. contact in parallel with previous contact.	3-60
AND LOAD		ANL				1.0 to 1.4	1 (2)	Connects in series blocks made of one or more contacts.	3-61
OR LOAD		ORL				1.0 to 1.4	1 (2)	Connects in parallel blocks made of one or more contacts.	3-63
OUT	nnnn	OUT	R No.	0500 to 1915 2009 2300 to 2915	0500 to 1915 2009 2300 to 6915	5.2 to 8.4	3 (13)	Outputs input ON/OFF status to R coil. Outputs inverted input	3-65
OUT BAR	nnnn	OUB				6.4 to 10.4	3 (17)	ON/OFF status to R coil.	3-65
SET	nnnn (SET)	SET		0500 to 1915 2009 2100 to 2915 T000 to T063 C000 to C063	0500 to 1915 2009 2100 to 6915 T000 to T119 C000 to C119	3.1 to 23.0	3 (8)	Forces R ON and holds this status when input is ON.	3-66
RESET	nnnn (RES)	RES		0500 to 1915 2009 2100 to 2915 T000 to T063 C000 to C063 CTH0 to CTH1 CTC0 to CTC3	0500 to 1915 2009 2100 to 6915 T000 to T119 C000 to C119 CTH0 to CTH1 CTC0 to CTC3	3.1 to 24.0	3 (8)	Forces R/T/C OFF when input is ON.	3-66
0.1-s TIMER	#ddddd T xxx	TMR	T No., # preset value	000 to 063 #00000 to #65535	000 to 119 #00000 to #65535	17.0 to 22.0	2 (5)	16-bit on-delay T that counts down in 0.1-s decrements.	3-67
0.01-s TIMER	#ddddd H xxx	TMH (FNC49)				17.0 to 22.0	2 (5)	16-bit on-delay T that counts down in 0.01-s decrements.	3-68
1-ms TIMER	#ddddd S xxx	TMS (FNC51)				17.0 to 22.0	2 (5)	16-bit on-delay T that counts down in 1-ms decrements.	3-69
COUNTER	#ddddd C xxx nnnn	C	# preset value, C No., clock source R	#00000 to 65535 000 to 063 0000 to 6915	#00000 to #65535 000 to 119 0000 to 6915	19.0 to 21.0	4 (7)	Sets 16-bit up-counter.	3-72
UP-DOWN COUNTER	UDC xxx UP DW RES #ddddd	UDC (FNC52)	C No., # preset value	000 to 063 #00000 to #65535	000 to 119 #00000 to #65535	21.0 to 26.0	2 (5)	Sets a 16-bit up-down counter.	3-76

Instruction	Symbol	Mnemonic	Operand	KV-10/16/24/40/80				Function	Page
				Operand value KV-10/16	Operand value KV-24/40/80	Exec.time (μs)	Bytes		
DIFFERENTIATE UP	nnnn DIFU	DIFU (FNC10)	R No.	1000 to 1915	1000 to 1915 3000 to 6915	11.0 to 13.0	3 (5)	Turns ON R for 1 scan time at rising edge of input.	3-78
DIFFERENTIATE DOWN	nnnn DIFD	DIFD (FNC09)				11.0 to 13.0	3 (5)	Turns ON R for 1 scan time at falling edge of input.	3-78
KEEP	KEEP SET RES nnnn	KEEP (FNC22)	R No.	0500 to 1915 2009 2100 to 2915	0500 to 1915 2009 2100 to 6915	9.0 to 26.0	3 (5)	Turns ON R and holds this status when SET input is ON.	3-80
SHIFT	SFT D CLK RES nnnn : mmmm	SFT (FNC39)	R No.1st & last R Nos.	1000 to 1915	1000 to 19153000 to 6915	(*)	5 (7)	Turns OFF R when RESET input is ON.	3-82
HIGH SPEED	HSP nnnn	HSP (FNC18)	R No.	(KV-10) 0000 to 0005 (KV-16) 0000 to 0009	(KV-24) 0000 to 0015 (KV-40) 0000 to 0107	8.0 to 9.0	3 (4)	Sets shift register.	3-86
MASTER CONTROL	MC	MC (FNC24)	——	——		1.8 to 3.2	1 (7)	Reduces input relay time constant to 25 ms for higher input response.	3-89
MASTER CONTROL RESET	MCR	MCR (FNC25)	——	——		0.6 to 1.0	1 (2)	Selects ON/OFF status of R coils, Ts, or Cs.	3-89
MEMORY SWITCH	MEMSW $xxxx	MEMSW (FNC26)	$ constant	$ 0000 to $ FFFF		—	3 (0)	Represents end of MC. Sets memory switches.	3-92
NOP	——	NOP (FNC30)	——	——		—	1 (0)	Performs no operation.	3-94
END	END	END	——	——		—	1 (3)	Indicates end of each routine of program.	3-94
END HI	ENDH	ENDH	——	——		—	1 (0)	Indicates end of entire program.	3-94

KV-300

Instruction	Symbol	Mnemonic	Operand	KV-300			Function	Page
				Operand value	Exec.time (μs)	Bytes		
LOAD	nnnn	LD	R No. T/C No.	0000 to 0009 0500 to 17915 T000 to T249 C000 to C249 CTC0 to CTC3	0.15 to 0.70	3 (5)	Connects N.O. contact to bus.	3-57
LOAD BAR	nnnn	LDB			0.15 to 0.90	3 (7)	Connects N.C. contact to bus.	3-57
AND	nnnn	AND			0.15 to 0.50	3 (4)	Connects N.O. contact in series with previous contact.	3-58
AND BAR	nnnn	ANB			0.15 to 0.80	3 (8)	Connects N.C. contact in series with previous contact.	3-58
OR	nnnn	OR			0.15 to 0.50	3 (4)	Connects N.O. contact in parallel with previous contact.	3-60
OR BAR	nnnn	ORB			0.15 to 0.80	3 (8)	Connects N.C. contact in parallel with previous contact.	3-60
AND LOAD	——	ANL	——	——	0.55	1 (3)	Connects in series blocks made of one or more contacts.	3-61
OR LOAD		ORL			0.55	1 (3)	Connects in parallel blocks made of one or more contacts.	3-63

Instruction	Symbol	Mnemonic	Operand	KV-300			Function	Page
				Operand value	Exec.time (μs)	Bytes		
OUT	nnnn —◯—	OUT	R No.	0500 to 1915 2009 2300 to 17915	0.20 to 0.56	3 (8)	Outputs input ON/OFF status to R coil.	3-65
OUT BAR	nnnn —⊘—	OUB			0.50 to 1.20	3 (11)	Outputs inverted input ON/OFF status to R coil.	3-65
SET	nnnn —(SET)—	SET		0500 to 1915 2009 2100 to 17915 T000 to T249 C000 to C249	0.20 to 5.70	3 (12)	Forces R ON and holds this status when input is ON.	3-66
RESET	nnnn —(RES)—	RES		0500 to 1915 2009 2100 to 17915 T000 to T249 C000 to C249 CTH0 to CTH1 CTC0 to CTC3	0.50 to 4.40	3 (12)	Forces R/T/C OFF when input is ON.	3-66
0.1-s TIMER	#ddddd T xxx	TMR	T No., # preset value	000 to 249 #00000 to 65535	5.60 to 10.40	2 (7)	16-bit on-delay T that counts down in 0.1-s decrements.	3-67
0.01-s TIMER	#ddddd H xxx	TMH (FNC49)			5.60 to 10.40	2 (7)	16-bit on-delay T that counts down in 0.01-s decrements.	3-68
1-ms TIMER	#ddddd S xxx	TMS (FNC51)			5.60 to 10.40	2 (7)	16-bit on-delay T that counts down in 1-ms decrements.	3-69
COUNTER	#ddddd C xxx nnnn	C	# preset value, C No., clock source R	#00000 to #65535 000 to 249 0000 to 0009 0500 to 17915	7.60 to 9.45	4 (7)	Sets 16-bit up-counter.	3-72
UP-DOWN COUNTER	UDC xxx UP #ddddd DW RES	UDC (FNC52)	C No., # preset value	000 to 249 #00000 to #65535	8.00 to 11.60	2 (10)	Sets a 16-bit up-down counter.	3-76
DIFFEREN-TIATE UP	nnnn DIFU	DIFU FNC10)	R No.	1000 to 1915 3000 to 6915 (*) 7000 to 9915	6.70	3 (10)	Turns ON R for 1 scan time at rising edge of input.	3-78
DIFFEREN-TIATE DOWN	nnnn DIFD	DIFD (FNC09)			6.70	3 (10)	Turns ON R for 1 scan time at falling edge of input.	3-78
KEEP	KEEP SET RES nnnn	KEEP (FNC22)	R No.	0500 to 1915 2009 2100 to 17915	6.10 to 7.90	3 (11)	Turns ON R and holds this status when SET input is ON.	3-80
SHIFT	SFT D CLK RES nnnn mmmm	SFT (FNC39)	1st & last R Nos.	1000 to 1915 3000 to 6915 (*) 7000 to 9915	6.40 to 8.20	5 (15)	Turns OFF R when RESET input is ON.	3-82
HIGH SPEED	HSP nnnn	HSP (FNC18)	R No.	0000 to 0009	4.66 to 4.92	3 (8)	Sets shift register.	3-86
MASTER CONTROL	MC	MC (FNC24)	——	——	0.20	1 (4)	Reduces input relay time constant to 25 ms for higher input response.	3-89
MASTER CONTROL RESET	MCR	MCR (FNC25)	——		—	1 (0)	Selects ON/OFF status of R coils, Ts, or Cs.	3-89
MEMORY SWITCH	MEMSW $xxxx	MEMSW (FNC26)	$ constant	$0000 to $FFFF	—	3 (0)	Represents end of MC. Sets memory switches.	3-92
NOP	——	NOP (FNC30)	——	——	—	1 (0)	Performs no operation.	3-94
END	END	END	——	——	0.95	1 (1)	Indicates end of each routine of program.	3-94
END HI	ENDH	ENDH	——	——	—	1 (0)	Indicates end of entire program.	3-94

Note: 14.0 + 3.0 x (n) to 17.0 + 3.0 x (n) (n represents number of times the original data is generated.)

2.2.2 Application Instructions

KV-10/16/24/40/80

Instruction	Symbol	Mnemonic	Operand	KV-10/16/24/40/80				Function	Page
				Operand value KV-10/16	Operand value KV-24/40/80	Exec.time (μs)	Bytes		
WAIT ON	nnnn ON mmmm	W-ON	nnnn: R,T, or C No.	nnnn: 0000 to 2915 T000 to T063 C000 to C063 CTC0 to CTC3 mmmm: 1000 to 1915	nnnn: 0000 to 6915 T000 to T119 C000 to C119 CTC0 to CTC3 mmmm: 1000 to 1915 3000 to 6915	11.0 to 13.0	5 (7)	Turns ON R (2nd operand [mmmm]) when R, T, or C (1st operand [nnnn]) turns ON.	3-96
WAIT OFF	nnnn OFF mmmm	W-OFF				11.0 to 13.0	5 (7)	When R, T, or C (1st operand [nnnn]) turns OFF, R (2nd operand [mmmm]) turns ON.	3-96
WAIT UP EDGE	nnnn ↑ mmmm	W-UE				14.0 to 18.0	5 (7)	R (2nd operand [mmmm]) turns ON at rising edge of R, T, or C (1st operand [nnnn]).	3-98
WAIT DOWN EDGE	nnnn ↓ mmmm	W-D				14.0 to 18.0	5 (7)	R (2nd operand [mmmm]) turns ON at falling edge of R, T, or C (1st operand [nnnn]).	3-98
CONNECT		CON [FNC 06]				0.4 to 0.6	301	Represents series connection of output instruction together with another instruction.	3-102
PUSH		MPS				11.0 to 14.0	1 (3)	Stores input status and arithmetic flag.	3-103
READ		MRD				8.0 to 10.0	1 (3)	Reads input status and arithmetic flag stored with PUSH.	3-103
POP		MPP				10.0 to 12.0	1 (3)	Reads & clears input status and arithmetic flag stored with PUSH.	3-103
STAGE	nnnn STG	STG [FNC 44]	R No.	1000 to 1915	1000 to 1915 3000 to 6915	11.0 to 14.0	3 (7)	Executes instructions between STG & JMP when R (operand) is ON.	3-106
JUMP	nnnn JMP	JMP [FNC 21]				10.0 to 13.0	3 (5)	Turns current stage OFF and next stage ON when input is ON.	3-106
END STAGE	ENDS	ENDS [FNC 14]				7.0 to 9.0	1 (3)	Turns current stage OFF when input is ON.	3-106
STEP	STP nnnn	STP [FNC 45]	R, T, C Nos.	0000 to 2915 T000 to T063 C000 to C063 CTC0 to CTC3	0000 to 6915 T000 to T119 C000 to C119 CTC0 to CTC3	3.7 to 5.3	3 (7)	Executes program between STP & STE when R (operand) is ON.	3-114
STEP END	STE	STE [FNC 43]				0.00	1 (0)	Is used with STEP to make program step.	3-114
INTERVAL TIMER	ITVL PLS DM nnnn PAUSE mmmm RES	ITVL	DM & R No.	DM0000 to DM0985 1000 to 1912	DM0000 to DM1985 1000 to 1912 3000 to 6912	29.0 to 79.0	5 (7)	Measures pulse-to-pulse interval & pulse width in specified mode.	3-117
8-BIT COUNTER	CTH0 nnnn	CTH	Clock source Rs	0004 2100 to 2102		9.0 to 39.0	4 (4)	8-bit (0 to255) up-counter for clock pulses with input response frequency of 10 kHz.	3-277
8-BIT COUNTER COMPARA-TOR	#ddddd CTCn	CTC	n: Comparator No. ddddd: # preset value	n: 0,1 ddddd: #00000 to #00255		3.0 to 4.0	2 (5)	Hardware-based comparator between preset & current values of high speed counter. This comparator is turned ON when these values are equal.	3-277
16-BIT COUNTER	CTH1 nnnn	CTH	Clock source Rs	0005 2200 to 2202		8.0 to 48.0	4 (4)	16-bit (0 to 65535) up-counter for clock pulses with input response frequency of 10 kHz.	3-204
16-BIT COUNTER COMPARA-TOR	#ddddd CTCn	CTC	n: Compara-tor No. ddddd: # preset value	n: 2,3 ddddd: #00000 to #65535		3.0 to 4.0	2 (5)	Hardware-based comparator between preset & current values of high speed counter. This comparator is turned ON when these values are equal.	3-204
SUBROU-TINE CALL	nn CALL	CALL [FNC 03]	Subrou-tine No.	00 to 99		8.0 to 10.0	2 (6)	Executes subroutine specified by operand.	3-122
SUBROU-TINE ENTRY	SBN nn	SBN [FNC 38]	Subrou-tine No.	00 to 99		0.00	2 (0)	Represents beginning of subroutine specified by operand.	3-122
SUBROU-TINE RETURN	RET	RET [FNC 33]				4.6 to 6.2	1 (5)	Represents end of subroutine.	3-122

Instruction	Symbol	Mnemonic	Operand	KV-10/16/24/40/80				Function	Page
				Operand value KV-10/16	Operand value KV-24/40/80	Exec.time (μs)	Bytes		
REPEAT START	FOR nnnn	FOR [FNC 16]	# constant, DM No.	#00000 to #65535 DM0000 to DM0999 TM00 to TM29	#00000 to #65535 DM0000 to DM1999 TM00 to TM29	5.0 to 20.0	3 (15)	Executes program between FOR & NEXT for number of times specified by operand.	3-125
REPEAT END	NEXT	NEXT [FNC 29]	———	———		1.7 to 2.3	1 (3)	Represents end of repetition.	3-125
16-KEY INPUT	HKEY nnnn mmmm	HKEY [FNC 17]	I/O R	nnnn:0000 to 0009 10000 to 10415 : 17000 to 17415 mmmm:10500 to 10915 : 17500 to 17915		71 to 370	5 (7)	Reads 16-key data by time-sharing and outputs these data into special utility Rs 2900 to 2915.	3-131

KV-300

Instruction	Symbol	Mnemonic	Operand	KV-300			Function	Page
				Operand value	Exec.time (μs)	Bytes		
WAIT ON	nnnn ON mmmm	W-ON	nnnn: R,T, or C No.	nnnn: 0000 to 0009 0500 to 17915 T000 to T249 C000 to C249 CTC0 to CTC3 mmmm: 1000 to 1915 3000 to 6915 (*)7000 to 9915	5.00 to 6.10	5 (9)	Turns ON R (2nd operand [mmmm]) when R, T, or C (1st operand [nnnn]) turns ON.	3-96
WAIT OFF	nnnn OFF mmmm	W-OFF			5.00 to 6.10	5 (9)	When R, T, or C (1st operand [nnnn]) turns OFF, R (2nd operand [mmmm]) turns ON.	3-96
WAIT UP EDGE	nnnn ↑ mmmm	W-UE			6.10 to 7.50	5 (10)	R (2nd operand [mmmm]) turns ON at rising edge of R, T, or C (1st operand [nnnn]).	3-98
WAIT DOWN EDGE	nnnn ↓ mmmm	W-DE			6.10 to 7.50	5 (10)	R (2nd operand [mmmm]) turns ON at falling edge of R, T, or C (1st operand [nnnn]).	3-98
CONNECT	———	CON [FNC 06]	———	———	—	1 (0)	Represents series connection of output instruction together with another instruction.	3-102
PUSH		MPS			1.30	1 (9)	Stores input status and arithmetic flag.	3-103
READ		MRD			2.70	1 (18)	Reads input status and arithmetic flag stored with PUSH.	3-103
POP		MPP			1.40	1 (9)	Reads & clears input status and arithmetic flag stored with PUSH.	3-103
STAGE	nnnn STG	STG [FNC 44]	R No.	1000 to 1915 3000 to 6915 (*)7000 to 9915	5.60 to 6.50	3 (10)	Executes instructions between STG & JMP when R (operand) is ON.	3-106
JUMP	nnnn JMP	JMP [FNC 21]			3.80 to 6.00	3 (7)	Turns current stage OFF and next stage ON when input is ON.	3-106
END STAGE	ENDS	ENDS [FNC 14]	———	———	—	1 (0)	Turns current stage OFF when input is ON.	3-106
STEP	STP nnnn	STP [FNC 45]	R, T, C Nos.	0000 to 0009 0500 to 6915 (*)7000 to 9915 T000 to T249 C000 to C249 CTC0 to CTC3	1.30	3 (9)	Executes program between STP & STE when R (operand) is ON.	3-114
STEP END	STE	STE [FNC 43]	———	———	—	1 (0)	Is used with STEP to make program step.	3-114
INTERVAL TIMER	ITVL PLS DM nnnn PAUSE mmmm RES	ITVL	DM & R No.	DMnnnn: DM0000 to DM9985 mmmm: 1000 to 1912 3000 to 6912 (*)7000 to 9912	13.80 to 17.30	5 (11)	Measures pulse-to-pulse interval & pulse width in specified mode.	3-117
16-BIT COUNTER	CTH0 nnnn	CTH	Clock source Rs	0004 2100 2101 2102	3.85	4 (7)	16-bit (0 to 65535) up-counter for clock pulses with input response frequency of 30 kHz.	3-204

Instruction	Symbol	Mnemonic	Operand	KV-300			Function	Page
				Operand value	Exec.time (μs)	Bytes		
16-BIT COUNTER COMPARA-TOR	#ddddd CTCn	CTC	n: Comparator No. ddddd: # preset value	n: 0, 1 ddddd: #00000 to #65535	—	2 (0)	Hardware-based comparator between preset & current values of high speed counter. This comparator is turned ON when these values are equal.	3-204
16-BIT COUNTER	CTH1 nnnn	CTH	Clock source Rs	0005 2200 2201 2202	3.85	4 (7)	16-bit (0 to 65535) up-counter for clock pulses with input response frequency of 30 kHz.	3-204
16-BIT COUNTER COMPARA-TOR	#ddddd CTCn	CTC	n: Comparator No. ddddd: # preset value	n: 2, 3 ddddd: #00000 to #65535	—	2 (0)	Hardware-based comparator between preset & current values of high speed counter. This comparator is turned ON when these values are equal.	3-204
SUBROU-TINE CALL	nn CALL	CALL [FNC 03]	Subroutine No.	00 to 99	3.16	2 (17)	Executes subroutine specified by operand.	3-122
SUBROU-TINE ENTRY	SBN nn	SBN [FNC 38]	Subroutine No.	00 to 99	—	2 (0)	Represents beginning of subroutine specified by operand.	3-122
SUBROU-TINE RETURN	RET	RET [FNC 33]	———	———	1.15 to 1.45	1 (6)	Represents end of subroutine.	3-122
REPEAT START	FOR nnnn	FOR [FNC 16]	# constant, DM No.	#00000 to #65535 DM0000 to DM9999 TM00 to TM29	1.55	3 (19)	Executes program between FOR & NEXT for number of times specified by operand.	3-125
REPEAT END	NEXT	NEXT [FNC 29]	———	———	—	1 (0)	Represents end of repetition.	3-125
16-KEY INPUT	HKEY nnnn mmmm	HKEY [FNC 17]	I/O R	nnnn:0000 to 0009 10000 to 10415 : 17000 to 17415 mmmm:0500 to 0503 10500 to 10915 : 17500 to 17915	16.50	5 (9)	Reads 16-key data by time-sharing and outputs these data into special utility Rs 2900 to 2915.	3-131

2.2.3 Arithmetic Instructions

KV-10/16/24/40/80

Instruction	Symbol	Mnemonic	Operand	KV-10/16/24/40/80				Function	Page
				Operand value KV-10/16	Operand value KV-24/40/80	Exec.time (μs)	Bytes		
DATA MEMORY WRITE	nnnn –< DW >– DMmmmm	DW	#/$ constant, DM No.	#00000 to #65535 $0000 to $FFFF DM0000 to DM0999	#0000 to #65535 $0000 to $FFFF DM0000 to DM1999	3.6 to 6.0	5 (6)	Writes constant into data memory.	3-136
TRIMMER SETTING	n –< TMIN >–	TMIN [FNC 50]	Trimmer No.	0	0 to 1	13.0 to 15.0	1 (4)	Converts trimmer rotation angle into 0 to 249 and inputs it into internal register.	3-138
	n –↑ TMIN >–	@TMIN @[FNC 50]				25.0 to 29.0	1 (11)		
LOAD A	nnnn –< LDA >–	LDA [FNC 23]	R No., C/T No., DM/TM No., #/$ constant, #TMxx	0000 to 2915 T000 to T063 C000 to C063 CTH0 to CTH1 DM0000 to DM0999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	0000 to 6915 T000 to T119 C000 to C119 CTH0 to CTH1 DM0000 to DM1999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	10.0 to 46.0	3 (5)	Inputs value specified by operand into internal register or inputs current value when T/C is specified as operand.	3-140
	nnnn –↑ LDA >–	@LDA @[FNC 23]				22.0 to 60.0	3 (12)		
STORE A	nnnn –< STA >–	STA [FNC 42]	R No., C/T No., DM/TM No., #/$ constant, #TMxx	0500 to 1915 2100 to 2915 T000 to T063 C000 to C063 DM0000 to DM0999 TM00 to TM29 #TM00 to #TM29	0500 to 1915 2100 to 6915 T000 to T119 C000 to C119 DM0000 to DM1999 TM00 to TM29 #TM00 to #TM29	9.0 to 99.0	3 (5)	Transfers content of internal register to location specified by operand, or changes preset value when T/C is specified as operand.	3-140
	nnnn –↑ STA >–	@STA @[FNC 42]				21.0 to 113.0	3 (12)		
COMPARE	nnnn –< CMP >–	CMP [FNC 04]	DM/TM No., #/$ constant, #TMxx	DM0000 to DM0999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	DM0000 to DM1999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	14.0 to 68.0	3 (5)	Compares content of internal register and value specified by operand.	3-146
	nnnn –↑ CMP >–	@CMP @[FNC 04]				26.0 to 82.0	3 (12)		
ADD	nnnn –< ADD >–	ADD [FNC 00]				13.0 to 65.0	3 (5)	Adds content of internal register and value specified by operand and inputs result back to same register.	3-150
	nnnn –↑ ADD >–	@ADD @[FNC 00]				25.0 to 79.0	3 (12)		
SUBTRACT	nnnn –< SUB >–	SUB [FNC 46]	DM/TM No., #/$ No., #TMxx	DM0000 to DM0999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	DM0000 to DM1999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	15.0 to 68.0	3 (5)	Subtracts value specified by operand from content of register and inputs result back to same register.	3-150
	nnnn –↑ SUB >–	@SUB @[FNC 46]				27.0 to 82.0	3 (12)		
MULTIPLY	nnnn –< MUL >–	MUL [FNC 28]				17.0 to 71.0	3 (5)	Multiplies content of internal register by value specified by operand and inputs result back to same register.	3-150
	nnnn –↑ MUL >–	@MUL @[FNC 28]				29.0 to 85.0	3 (12)		
DIVIDE	nnnn –< DIV >–	DIV [FNC 11]				22.0 to 79.0	3 (5)	Divides content of internal register by value specified by operand and inputs result back to same register.	3-150
	nnnn –↑ DIV >–	@DIV @[FNC 11]				34.0 to 93.0	3 (12)		

Instruction	Symbol	Mnemonic	Operand	KV-10/16/24/40/80				Function	Page
				Operand value KV-10/16	Operand value KV-24/40/80	Exec.time (μs)	Bytes		
AND A	nnnn –<ANDA>–	ANDA [FNC 01]	R No., DM/TM No., #/$ No., #TMxx	0000 to 2915 DM0000 to DM0999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	0000 to 6915 DM0000 to DM1999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	11.0 to 64.0	3 (5)	ANDs each of 16 bits of internal register and that of value specified by operand, and inputs result back to same register.	3-159
	nnnn –↑ANDA>–	@ANDA @[FNC 01]				23.0 to 78.0	3 (12)		
OR A	nnnn –< ORA >–	ORA [FNC 31]				11.0 to 63.0	3 (5)	ORs each of 16 bits of internal register and that of value specified by operand, and inputs result back to same register.	3-161
	nnnn –↑ ORA >–	@ORA @[FNC 31]				23.0 to 77.0	3 (12)		
EXCLU-SIVE OR A	nnnn –<EORA>–	EORA [FNC 15]	R No., DM/TM No., #/$ No., #TMxx	0000 to 2915 DM0000 to DM0999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	0000 to 6915 DM0000 to DM1999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	10.0 to 63.0	3 (5)	EXCLUSIVE-ORs each of 16 bits of internal register and that of value specified by operand, and inputs result back to same register.	3-164
	nnnn –↑EORA>–	@EORA @[FNC 15]				22.0 to 77.0	3 (12)		
SHIFT RIGHT A	#dd –< SRA >–	SRA [FNC 41]	# constant	#01 to #16		11.0 to 28.0	2 (4)	Moves content of internal register serially right by value specified by operand.	3-166
	#dd –↑ SRA >–	@SRA @[FNC 41]				23.0 to 42.0	2 (11)		
SHIFT LEFT A	#dd –< SLA >–	SLA [FNC 40]				10.0 to 28.0	2 (4)	Moves content of internal register serially left by value specified by operand.	3-166
	#dd –↑ SLA >–	@SLA @[FNC 40]				22.0 to 42.0	2 (11)		
ROTATE RIGHT A	#dd –< RRA >–	RRA [FNC 37]				12.0 to 30.0	2 (4)	Moves content of internal register serially right, allowing each bit that leaves right end to enter carry bit and then leftmost bit.	3-169
	#dd –↑ RRA >–	@RRA @[FNC 37]				24.0 to 44.0	2 (11)		
ROTATE LEFT A	#dd –< RLA >–	RLA [FNC 35]				12.0 to 29.0	2 (4)	Moves content of internal register serially left, allowing each bit that leaves left end to enter carry bit and then rightmost bit.	3-169
	#dd –↑ RLA >–	@RLA @[FNC 35]				24.0 to 43.0	2 (11)		
COMPLE-MENT	–< COM >–	COM [FNC 05]	———	———		5.0 to 6.0	1 (3)	Inverts content of each bit in internal register.	3-171
	-↑ COM >–	@COM @[FNC 05]				17.0 to 20.0	1 (10)		
INCRE-MENT MEMORY	nnnn –< INC >–	INC [FNC 19]	DM/TM No.	DM0000 to DM0999 TM00 to TM29	DM0000 to DM1999TM00 to TM29	12.0 to 15.0	3 (5)	Adds 1 to content of data memory specified by operand.	3-172
	nnnn –↑ INC >–	@INC @[FNC 19]				24.0 to 29.0	3 (12)		
DECRE-MENT MEMORY	nnnn –< DEC >–	DEC [FNC 07]				14.0 to 17.0	3 (5)	Subtracts 1 from content of data memory specified by operand.	3-172
	nnnn –↑ DEC >–	@DEC @[FNC 07]				26.0 to 31.0	3 (12)		
MULTI-PLEXER	#n –< MPX >–	MPX [FNC 27]	# constant	#0 to #3		24.0 to 25.0	1 (4)	Converts 4-bit data (specified by operand) of internal register into 16bit data.	3-176
	#n –↑ MPX >–	@MPX @[FNC 27]				36.0 to 39.0	1 (11)		

Instruction	Symbol	Mnemonic	Operand	KV-10/16/24/40/80				Function	Page
				Operand value KV-10/16	Operand value KV-24/40/80	Exec.time (µs)	Bytes		
DEMULTI-PLEXER	–< DMX >–	DMX [FNC 12]	———	———	———	28.0 to 30.0	1 (3)	Converts position of highest order bit with 1 in internal register into 4-bit data.	3-176
	–↑ DMX >–	@DMX @[FNC 12]				40.0 to 44.0	1 (10)		
TRANSFER BCD	–<TBCD>–	TBCD [FNC 47]	———	———	———	19.0 to 21.0	1 (3)	Converts content of internal register (16-bit binary) into 4-digit BCD data.	3-180
	–↑ TBCD>–	@TBCD @[FNC 47]				31.0 to 35.0	1 (10)		
TRANSFER BIN	–< TBIN >–	TBIN [FNC 48]	———	———	———	18.0 to 20.0	1 (3)	Converts content of internal register (4-digit BCD) into 16-bit binary data.	3-180
	–↑ TBIN>–	@TBIN @[FNC 48]				30.0 to 34.0	1 (10)		
ASCII CONVERT	–< ASC >–	ASC [FNC 02]				8.0	1 (3)	Converts content of lower order byte of internal register into 2-digit ASCII code.	3-183
	–↑ ASC >–	@ASC @[FNC 02]				20.0 to 22.0	1 (10)		
REVERSE ASCII CONVERT	–<RASC>–	RASC [FNC 32]				12.0 to 14.0	1 (3)	Converts 2-digit ASCII code into one byte data.	3-183
	–↑ RASC>–	@RASC @[FNC 32]				24.0 to 28.0	1 (10)		
SQUARE ROOT	–<ROOT>–	ROOT [FNC 36]				102.0 to 103.0	1 (3)	Takes square root of 32-bit data (TM00: higher order byte, internal register: lower order byte) and inputs result back to same register.	3-185
	–↑ ROOT>–	@ROOT @[FNC 36]				114.0 to 117.0	1 (10)		

KV-300

Instruction	Symbol	Mnemonic	Operand	KV-300			Function	Page
				Operand value	Exec.time (µs)	Bytes		
DATA MEMORY WRITE	nnnn –< DW >– DMmmmm	DW	#/$ constant, DM No.	nnnn: #0000 to #65535 $0000 to $FFFF DMmmmm: DM0000 to DM9999	0.60 to 1.40	5 (11)	Writes constant into data memory.	3-136
TRIMMER SETTING	n –< TMIN >–	TMIN [FNC 50]	Trimmer No.	0, 1	5.10 to 5.60	1 (11)	Converts trimmer rotation angle into 0 to 249 and inputs it into internal register.	3-138
	n –↑ TMIN >–	@TMIN @[FNC 50]			2.00 to 5.70	1 (25)		
LOAD A	nnnn –< LDA >–	LDA [FNC 23]	R No., C/T No., DM/TM No., #/$ constant, #TMxx	0000 to 0009 0500 to 17915 T000 to T249 C000 to C249 CTH0 to CTH1 DM0000 to DM9999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	0.30 to 28.00	3 (12)	Inputs value specified by operand into internal register or inputs current value when T/C is specified as operand.	3-140
	nnnn –↑ LDA >–	@LDA @[FNC 23]			2.30 to 30.00	3 (26)		
STORE A	nnnn –< STA >–	STA [FNC 42]	R No., C/T No., DM/TM No., #/$ constant, #TMxx	0500 to 1915 2100 to 17915 T000 to T249 C000 to C249 CTC0 to CTC3 DM0000 to DM9999 TM00 to TM29 #TM00 to #TM29	0.20 to 30.00	3 (12)	Transfers content of internal register to location specified by operand, or changes preset value when T/C is specified as operand.	3-140
	nnnn –↑ STA >–	@STA @[FNC 42]			2.20 to 32.00	3 (26)		

Instruction	Symbol	Mnemonic	Operand	KV-300			Function	Page
				Operand value	Exec.time (μs)	Bytes		
COMPARE	nnnn –< CMP >–	CMP [FNC 04]	DM/TM No., #/$ constant, #TMxx	DM0000 to DM9999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	9.20 to 36.00	3 (12)	Compares content of internal register and value specified by operand.	3-146
	nnnn –↑ CMP >–	@CMP @[FNC 04]			11.20 to 38.00	3 (26)		
ADD	nnnn –< ADD >–	ADD [FNC 00]			7.70 to 35.00	3 (12)	Adds content of internal register and value specified by operand and inputs result back to same register.	3-150
	nnnn –↑ ADD >–	@ADD @[FNC 00]			9.70 to 37.00	3 (26)		
SUBTRACT	nnnn –< SUB >–	SUB [FNC 46]	DM/TM No., #/$ No., #TMxx	DM0000 to DM9999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	8.40 to 35.00	3 (12)	Subtracts value specified by operand from content of register and inputs result back to same register.	3-150
	nnnn –↑ SUB >–	@SUB @[FNC 46]			10.40 to 37.00	3 (26)		
MULTIPLY	nnnn –< MUL >–	MUL [FNC 28]			9.80 to 37.00	3 (12)	Multiplies content of internal register by value specified by operand and inputs result back to same register.	3-150
	nnnn –↑ MUL >–	@MUL @[FNC 28]			11.80 to 39.00	3 (26)		
DIVIDE	nnnn –< DIV >–	DIV [FNC 11]			13.70 to 41.00	3 (12)	Divides content of internal register by value specified by operand and inputs result back to same register.	3-150
	nnnn –↑ DIV >–	@DIV @[FNC 11]			15.70 to 42.00	3 (26)		
AND A	nnnn –<ANDA>–	ANDA [FNC 01]	R No., DM/TM No., #/$ No., #TMxx	0000 to 0009 0500 to 17915 DM0000 to DM9999 TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	6.90 to 33.00	3 (12)	ANDs each of 16 bits of internal register and that of value specified by operand, and inputs result back to same register.	3-159
	nnnn –↑ANDA>–	@ANDA @[FNC 01]			8.90 to 35.00	3 (26)		
OR A	nnnn –< ORA >–	ORA [FNC 31]			6.90 to 33.00	3 (12)	ORs each of 16 bits of internal register and that of value specified by operand, and inputs result back to same register.	3-161
	nnnn –↑ ORA >–	@ORA @[FNC 31]			8.90 to 35.00	3 (26)		
EXCLUSIVE OR A	nnnn –<EORA>–	EORA [FNC 15]	R No., DM/TM No., #/$ No., #TMxx	0000 to 0009 0500 to 17915 DM0000 to DM9999TM00 to TM31 #00000 to #65535 $0000 to $FFFF #TM00 to #TM29	6.90 to 33.00	3 (12)	EXCLUSIVE-ORs each of 16 bits of internal register and that of value specified by operand, and inputs result back to same register.	3-164
	nnnn –↑EORA>–	@EORA @[FNC 15]			8.9 to 35.00	3 (26)		

Instruction	Symbol	Mnemonic	Operand	KV-300			Function	Page
				Operand value	Exec.time (μs)	Bytes		
SHIFT RIGHT A	#dd –< SRA >–	SRA [FNC 41]	# constant	#01 to #16	10.80	2 (22)	Moves content of internal register serially right by value specified by operand.	3-166
	#dd –↑ SRA >–	@SRA @[FNC 41]			12.80	2 (25)		
SHIFT LEFT A	#dd –< SLA >–	SLA [FNC 40]			10.80	2 (11)	Moves content of internal register serially left by value specified by operand.	3-166
	#dd –↑ SLA >–	@SLA @[FNC 40]			12.80	2 (25)		
ROTATE RIGHT A	#dd –< RRA >–	RRA [FNC 37]			12.00	2 (11)	Moves content of internal register serially right, allowing each bit that leaves right end to enter carry bit and then leftmost bit.	3-169
	#dd –↑ RRA >–	@RRA @[FNC 37]			14.00	2 (25)		
ROTATE LEFT A	#dd –< RLA >–	RLA [FNC 35]			12.00	2 (11)	Moves content of internal register serially left, allowing each bit that leaves left end to enter carry bit and then rightmost bit.	3-169
	#dd –↑ RLA >–	@RLA @[FNC 35]			14.00	2 (25)		
COMPLE-MENT	–< COM >–	COM [FNC 05]	——	——	6.10	1 (9)	Inverts content of each bit in internal register.	3-171
	–↑ COM >–	@COM @[FNC 05]			8.10	1 (23)		
INCREMENT MEMORY	nnnn –< INC >–	INC [FNC 19]	DM/TM No.	DM0000 to DM9999 TM00 to TM29	7.70	3 (12)	Adds 1 to content of data memory specified by operand.	3-172
	nnnn –↑ INC >–	@INC @[FNC 19]			9.70	3 (26)		
DECREMENT MEMORY	nnnn –< DEC >–	DEC [FNC 07]			7.70	3 (12)	Subtracts 1 from content of data memory specified by operand.	3-172
	nnnn –↑ DEC >–	@DEC @[FNC 07]			9.70	3 (26)		
MULTI-PLEXER	#n –< MPX >–	MPX [FNC 27]	# constant	#0 to #3	7.30	1 (11)	Converts 4-bit data (specified by operand) of internal register into 16- bit data.	3-176
	#n –↑ MPX >–	@MPX @[FNC 27]			9.30	1 (25)		
DEMULTI-PLEXER	–< DMX >–	DMX [FNC 12]	——	——	6.70	1 (9)	Converts position of highest order bit with 1 in internal register into 4-bit data.	3-176
	–↑ DMX >–	@DMX @[FNC 12]			8.70	1 (23)		

Instruction	Symbol	Mnemonic	Operand	KV-300			Function	Page
				Operand value	Exec.time (μs)	Bytes		
TRANSFER BCD	–<TBCD>–	TBCD [FNC 47]	———	———	13.20	1 (9)	Converts content of internal register (16-bit binary) into 4-digit BCD data.	3-180
	-↑ TBCD>–	@TBCD @[FNC 47]			15.20	1 (23)		
TRANSFER BIN	–< TBIN >–	TBIN [FNC 48]			14.00	1 (9)	Converts content of internal register (4-digit BCD) into 16-bit binary data.	3-180
	- ↑ TBIN>–	@TBIN @[FNC 48]			16.00	1 (23)		
ASCII CONVERT	–< ASC >–	ASC [FNC 02]			8.50	1 (9)	Converts content of lower order byte of internal register into 2-digit ASCII code.	3-183
	–↑ ASC >–	@ASC @[FNC 02]			10.50	1 (23)		
REVERSE ASCII CONVERT	–<RASC>–	RASC [FNC 32]			6.80	1 (9)	Converts 2-digit ASCII code into one byte data.	3-183
	-↑ RASC>–	@RASC @[FNC 32]			8.80	1 (23)		
SQUARE ROOT	–<ROOT>–	ROOT [FNC 36]			77.70	1 (9)	Takes square root of 32-bit data (TM00: higher order byte, internal register: lower order byte) and inputs result back to same register.	3-185
	-↑ ROOT>–	@ROOT @[FNC 36]			79.70	1 (23)		

2.2.4 Interrupt Instructions

KV-10/16/24/40/80

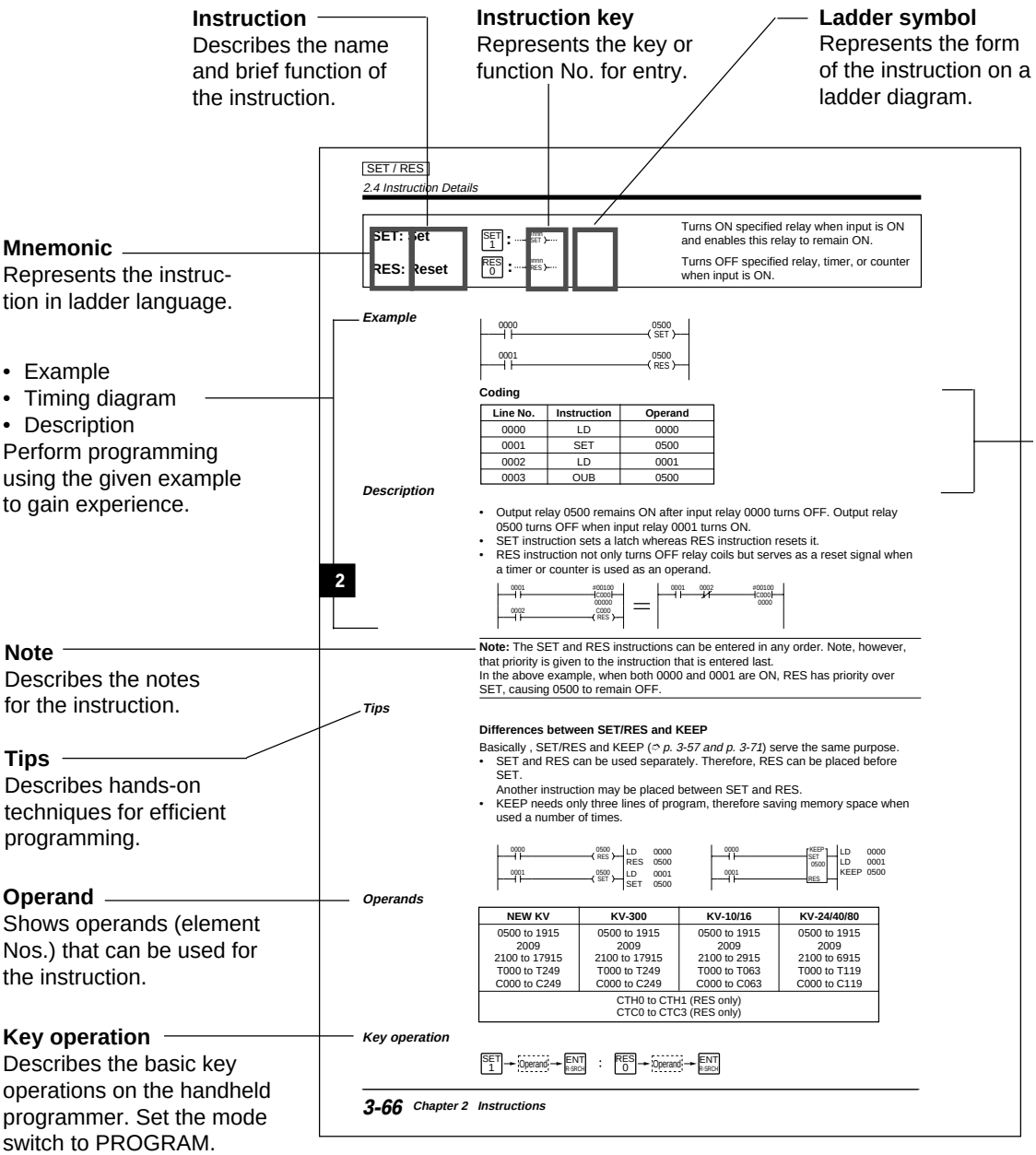
Instruction	Symbol	Mnemonic	Operand	KV-10/16/24/40/80				Function	Page
				Operand value KV-10/16	Operand value KV-24/40/80	Exec.time (μs)	Bytes		
INTERRUPT DISABLED	–< DI >–	DI [FNC 08]	———	———		3.0 to 4.6	1 (4)	Disables execution of interrupt.	3-193
INTERRUPT ENABLED	–< EI >–	EI [FNC 13]	———	———		3.0 to 4.6	1 (4)	Enables execution of interrupt.	3-193
INTERRUPT	INT nnn	INT [FNC 20]	R No.	000 to 003		35.0 to 48.0	1 (8)	Executes instructions between INT and RETI at rising edge of any of input 000 to 003 or at falling edge of 003.	3-192
	INT CTCn		Comparator No.	CTC0 to CTC3		35.0 to 48.8		Used with comparators CTC0 to CTC3 and executes instructions between INT and RETI.	3-192
RETURN INTERRUPT	RETI	RETI [FNC 34]	———	———		20.0 to 23.0	1 (3)	Represents end of interrupt.	3-192

KV-300

Instruction	Symbol	Mnemonic	Operand	KV-300			Function	Page
				Operand value	Exec.time (μs)	Bytes		
INTERRUPT DISABLED	–< DI >–	DI [FNC 08]	———	———	3.20	1 (9)	Disables execution of interrupt.	3-193
INTERRUPT ENABLED	–< EI >–	EI [FNC 13]	———		5.80	1 (0)	Enables execution of interrupt.	3-193
INTERRUPT	INT nnn	INT [FNC 20]	R No.	000 to 003	40.00 to 80.00	1 (0)	Executes instructions between INT and RETI at rising edge of any of input 000 to 003 or at falling edge of 003.	3-192
	INT CTCn		Comparator No.	CTC0 to CTC3	40.00 to 80.00	1 (0)	Used with comparators CTC0 to CTC3 and executes instructions between INT and RETI.	3-192
RETURN INTERRUPT	RETI	RETI [FNC 34]	———	———	60 to 100	1 (0)	Represents end of interrupt.	3-192

2.3 Convention Details

In this chapter, each instruction is described as follows:



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