Harmonas-FLeX

Harmonas-FLeX™ Distributed Controller

1. Introduction

The Harmonas-FLeX Distributed controller (FLC) is a compact controller designed to be installed in a local control panel. The functions and features of the FLC are described briefly below.

■ Control

- The FLC has the functionality of process controllers like those in Yamatake's DCS series. It can handle both PID and sequence control and is equipped with a rich set of functions.
- The user generates control programs and carries out maintenance in the RTC integrated engineering environment. By means of virtual simulation software that runs on a personal computer, debugging can be done efficiently.
- Control programs can be represented with logic diagrams using function blocks for easy understanding and debugging. Generated programs can be displayed in the form of drawings.

■ Installation

- The FLC is compact enough to be installed in a small box (400 × 400 mm). It can be mounted in an existing control cabinet or wall-mounted box.
  Mountable on an existing control cabinet or wall-mounted box.
- Power supply and wiring for field device signals, with a short protection circuit, are built in. Since the FLC can be connected directly to field wiring, installation is complete simply by installing the FLC and connecting the power supply to the field wiring.
- There are up to 368 input/output points (or approximately 256 points with a typical configuration). Various input/output types can be combined to suit the application.
- The FLC was designed to resist environmental factors, and can be operated in a sealed box.

■ System Compatibility

- Redundant Ethernet ports are a standard feature.
- Can be connected to an EST555Z programmable smart terminal for graphic operations and data collection and storage. This system can be used as a digital recorder.
- By simple connection of an Ethernet cable, the FLC can be integrated into systems such as the Harmonas-DEO™ automation system. FLC units can be individually installed in local control panels, making incremental networking and systemization possible.

Note: Refer to CP-SS-1800E for EST555Z programmable smart terminal specifications.

Figure 1. Example of Installation in a Box

Figure 2. EST555Z

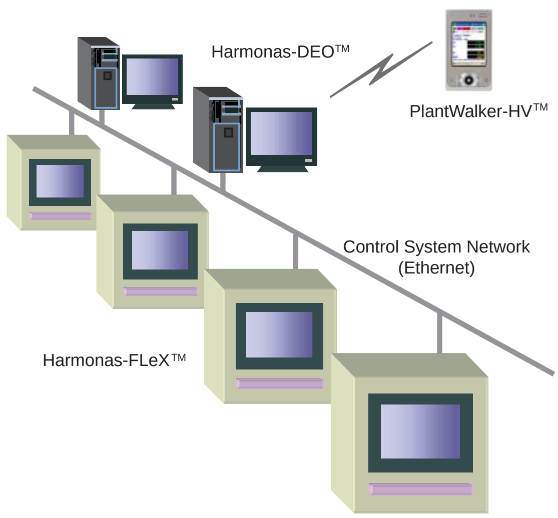


Figure 3. System Architecture

2. Functional Overview

The FLC consists of a main unit and up to three expansion units, each unit equipped with 6 I/O card slots. When using an expansion unit, insert an interface card for the expansion unit into an I/O slot in the main unit, and similarly insert a card for interfacing with the main unit into each expansion unit, and then connect the cards with a dedicated cable.* The remaining I/O cards can be selected as needed from among the following types.

- AI (4 to 20 mA/1 to 5V DC) : 8 per/card
- Thermocouple with mV input (-100 to 100 mV) : 4 per/card
- AO (4 to 20 mA) : 8 per/card
- AO (4 to 20 mA) : 4 per/card
- RTD (8 I/O points for air-conditioning, or 4 for free use)
- Pulse input : 8 per/card
- DI : 16 per/card
- DI (relay input) : 16 per/card
- DO (semiconductor output) : 16 per/card
- DO (relay output) : 16 per/card
- Serial communications : 1 port/card
- EST I/F (mounted on the main unit) : 1 port/card

Ethernet is used for the control network and for connection to other systems such as the Harmonas-DEO automation system or an information system. Redundant Ethernet for the control network is a standard feature.

* The interface card in each expansion unit does not use an I/O slot, but instead uses a control card slot, since the I/O expansion units do not require a control card.

■ Specifications

Table 1. Hardware Specifications

Item	Specifications
CPU	32-bit
Number of I/O points	• Largest configuration when three expansion units are connected - 23 I/O cards max. (if the EST is connected, 22 cards max.) - HLAI: 184 pts. (max.), 8 pts./card - Thermocouple mV input: 92 pts. (max.), 4 pts./card - RTD AI for room temperature: 184 pts. (max.), 8 pts./card, fixed range of -20 to 80 °C - RTD Al: 92 pts. (max.), 4 pts./card, free use - AO: 184 pts. (max.), 8 pts./card, max. load resistance 300 Ω - AO: 92 pts. (max.), 4 pts./card, max. load resistance 700 Ω - DI: 368 pts. (max.), 16 pts./card - DO: 368 pts. (max.), 16 pts./card - Pulse input: 184 pts. (max.), 8 pts./card Note: The maximum numbers for I/O points given above assume that the number of available mounting slots is restricted by the connection of three expansion units. Also, in practice there is some restriction on the number of cards from a control functional performance point of view. • Configuration with only the main unit - 6 I/O cards (5 if the EST is connected)
Weight	Approximately 4 kg
Power	85 to 264V AC, 47 to 63 Hz
Grounding	D-type grounding (resistance of 100 Ω or less)
Power consumption	Main unit and expansion unit, 150 VA each
Instantaneous power interruption	20 ms (if FLC 3.4V internal power supply is interrupted for a longer period and automatic data backup mode is selected, FLC power supply unit keeps power at least 20 seconds for data saving).
Inrush current	45A max. (at cold start)

Table 2. Specifications for Communications

<table>
<tr><th>Type of Communications</th><th colspan="4">Specifications</th></tr>
<tr><td>Through external network (Harmonas-DEO, etc.)</td><td colspan="4">10 Mbps Ethernet, 400 parameters/second (PPS) max. (total of 400 PPS between controllers)</td></tr>
<tr><td>Between controllers</td><td colspan="4">Using Ethernet, up to 400 PPS (total with external communication)</td></tr>
<tr><td rowspan="6">With PLC</td><td colspan="4">1:1 communication with the PLC through Ethernet. Up to 256 word data elements and up to 1024 bit data elements can be read/written.</td></tr>
<tr><td rowspan="5">Supported model</td><td>Manufacturer</td><td>PLC</td><td>Supported Ethernet module</td></tr>
<tr><td rowspan="3">Mitsubishi Electric Corp.</td><td>MELSEC A series</td><td>AJ71E71-S3, A1SJ71E71-S3</td></tr>
<tr><td>MELSEC QnA series</td><td>AJ71QE71, A1SJ71QE71</td></tr>
<tr><td>MELSEC Q series (Q mode)</td><td>QJ71E71</td></tr>
<tr><td>JTEKT Corporation</td><td>TOYOPUC 3JG</td><td>FL/ET-T-V2</td></tr>
<tr><td>Serial</td><td colspan="4">• 1:1 communication with a serial communication device using RS232 or RS485. (RS485 multidrop is not supported.)
• 1 port/card (1 FLC can take up to 4 serial communication cards)
• Up to 256 word data elements/card and up to 512 bit data elements/card can be read/written.</td></tr>
<tr><td>I/O</td><td colspan="4">• Dedicated parallel bus
(An I/O slot on the main unit is used to interface with the expansion units. No I/O slots are used on the expansion units.)</td></tr>
<tr><td rowspan="3">To flat-panel display (EST)</td><td colspan="4">• 1:1 communications with the controller using RS232 or RS485
• The EST555Z and EST240Z are compatible.
(An I/O slot on the main unit is used for the interface.)</td></tr>
<tr><td rowspan="2">Transmission distance</td><td>RS232</td><td colspan="2">15 m</td></tr>
<tr><td>RS485</td><td colspan="2">1000 m**</td></tr>
</table>

** This controller should not be installed in an environment strongly affected by noise: near electromagnetic switches or high-voltage facilities, for example. The use of fiber-optic cables (converters) is recommended.

Table 3. Software Specifications

Item	Specifications
Control point	32 Regulatory control points 32 Regulatory PV points
Control algorithm	19 types (48 formulas)
Control cycle	• Basic cycle is selectable from 0.1, 0.2, 0.5 and 1 second. (CL is fixed at 1 second.) • In part, 0.1 second execution processing is possible (also for CL).
Sequence program	• 128 CL (control language) programs (max.) • 6080 MU: 18240–24480 CL statements (The CL memory has no relation to other functions and can be used as dedicated memory.)
Logic program	• 64 points • 1024 blocks max., 16 blocks max. for each logic point • 25 algorithms
SAMA function block	• 128 points max. • 2048 blocks max. • 91 algorithms (When monitoring from the Harmonas-DEO Supervisory Station and/or EST is necessary, values and/or status of block calculations are allocated to numeric variables or flag variables.)
Digital composite	256 points max.
Numeric value variable	8192* + (80 × the number of sequences used) points
Flag variable	8192** + (128 × the number of sequences used) points
Timer variable	32 points

* 3,000 points are for use by the user, and the rest are reserved for the system.
**3,000 points (including 512 for alarms are for use by the user, and the rest are reserved for the system.

■ Environmental conditions

Suitable conditions for FLC installation, use, storage and transport are shown in the following table. Be sure to leave clearance in the specified amount around the main unit. In addition to the following conditions, give due consideration to external magnetic fields, electrostatic discharge, radio interference, and the like.

Table 4. Environmental Conditions

Item		Standard operating conditions	Normal operating conditions	Restricted operating conditions	Conditions for storage and transport
Ambient temperature [1]	Range (°C)	23 ± 2	0 to 50	0 to 60	-40 to 70
	Rate of change (°C/h)	±5	±20	±20	—
Relative humidity	(%)	50 ± 10	5 to 95 (0.020 kg/kg')[2]	5 to 95 (0.020 kg/kg')	5 to 95 (0.020 kg/kg')
Vibration [3]	Amplitude	0	0.35 mm or less (2 to 9 Hz)	0.35 mm or less (2 to 9 Hz)	1.5 mm or less (2 to 9 Hz)
	Acceleration	0	$1 m/s^2$ or less (9 to 150 Hz)	$1 m/s^2$ or less (9 to 150 Hz)	$5 m/s^2$ or less (9 to 150 Hz)

Notes:
1. The atmosphere should not contain corrosive gas. Installation in a control panel where the temperature is 45 °C or less is recommended.
2. In humid air, the ratio of kilograms of water vapor to kilograms of dry air.
3. Do not install where there is continuous strong vibration.

Definitions
1) Standard operating conditions: range of operating conditions under which external influences on performance can be ignored.

2) Normal operating conditions: range of operating conditions under which equipment or devices are designed to operate within the specified error rate and range of operating conditions recommended by the manufacturer from all viewpoints such as functions, performance, and reliability.

3) Restricted operating conditions: operating conditions which are outside the normal operating range, and under which the absence of fluctuations in product performance cannot be guaranteed, but under which the equipment can be used without receiving permanent damage; a range of conditions, under which only temporary use is permitted.

4) Transport and storage conditions: range of conditions required for preventing permanent damage during transport, during storage in a warehouse, or while unused. (Equipment requires appropriate protective packing to prevent damage.)

Note 1: Equipment requires appropriate protecting packing to prevent irrecoverable damage.

Note 2: that in some cases, equipment must be adjusted to recover normal performance.

■ Input and output specifications

Table 5. Input and Output Specifications

Item		Specifications
Analog input	Number of I/O points	8 per card
	Supply voltage and current consumption	24V DC ± 10%, 70 mA (when the transmitter* power supply is not used)
	Input signal	1 to 5V DC (0 to 100%)
	Input range (FS)	0.726 to 5.276V DC (-6.9 to 106.9%)
	Accuracy	0.2% F.S.
	Effect of ambient temperature change	±0.02% F.S. /°C
	Input type	Differential input for use on different channels (allowable operating voltage ± 3V)
	Input impedance	1 MΩ or higher
	Transmitter power supply	18.6 to 26.4V DC, max. 200 mA (total for 8 points, for all cards)
Thermocouple (mV) input	Number of I/O points	4 per card
	Supply voltage and current consumption	24V DC ± 10%, 50 mA
	Input circuit	Isolation per point
	Input signal	-100 to 100 mV. For input temperatures, see Table 6 below.
	Cold junction compensation accuracy	±0.5°C (at 25°C)
	Conversion standard accuracy	For µV input, ±20 µV. For thermocouple input, see Table 6 below.
	Effect of temperature change	For thermocouple input: Based on an FLC ambient temperature of 25°C, for additional accuracy add the result of the following formula to the conversion standard accuracy. *Conversion accuracy =* *Conversion standard accuracy (T2) ± T2 ×(T1 - 25)/15* Where: T1 = FLC ambient temperature (°C) T2 = conversion standard accuracy (= the relevant value in Table 6)
	Withstand voltage	500V AC (between input channels, and between input and field power supply)
	Common mode rejection ratio (CMRR)	120 dB or more (DC to 60 Hz)
	Normal mode rejection ratio (NMRR)	40 dB or more (50 Hz/60 Hz)
	Scan cycle	1 s
	Open circuit detection (OTD)	Upscale or downscale, selectable per point
	Input impedance	1 MΩ or more
RTD (resistance temperature detector) input: free range	Number of I/O points	4 per card
	Supply voltage and current consumption	24V DC ± 10%, 50 mA
	Input circuit	Isolation per point
	Input signal	Pt 100 Ω, variable range
	Conversion standard accuracy	±0.8°C
	Effect of temperature change	Based on an FLC ambient temperature of 25°C, for additional accuracy add the result of the following formula to the conversion standard accuracy. *Conversion accuracy =* *Conversion standard accuracy (±0.8 °C) ± 0.8°C ×(T - 25)/15* Where: T = FLC ambient temperature (°C)
	Allowable wiring resistance	Max. 20 Ω
	Difference in resistance values of wiring	Since this creates temperature measurement error, make the difference as small as possible.
	Withstand voltage	500V AC (between the input and SG)
	Common mode rejection ratio (CMRR)	110 dB or more (DC to 60 Hz)
	Normal mode rejection ratio (NMRR)	40 dB or more (50 Hz/60 Hz)
	Scan cycle	1 s
	Input impedance	1 MΩ or more
Temperature input (room temperature, outside air temperature, etc.)	Number of I/O points	8
	Supply voltage and current consumption	24 V DC ± 10%, 70 mA
	Input signal	PT 100 Ω, -20 to 80°C, fixed range
	Accuracy	1% F.S. (at 25°C ± 2°C)
	Isolation	Common isolation with the input power supply and system power supply
	Allowable wiring resistance	5 Ω or less

* The transmitter power supply is not insulated from the input power supply.
When the transmitter power supply is used, the minus input becomes common and differential input is not possible.
When connecting a two-wire transmitter or 4 to 20 mA input, add a 250 Ω resistor to the external terminal.

Table 5. Input and Output Specifications (continued)

Item		Specifications
Analog output (8 points/card)	Number of I/O points	8 per card
	Supply voltage and current consumption	24V DC ± 10%, 140 mA (at 100% output on all points)
	Output range	4 to 20 mA (0 to 100%)
	Output scope	2.9 to 21.1 mA (-6.9% to 106.9%)
	Accuracy	0.5% F.S. (as adjusted at the factory, and at 25°C ± 2°C)
	Repeatability	0.5% F.S.
	Isolation	Common isolation with the input power supply and system power supply
	Maximum load resistance	300 Ω*
Analog output (4 points/card)	Number of I/O points	4 per card
	Supply voltage and current consumption	24V DC ± 10%, 140 mA (at 100% output on all points)
	Output range	4 to 20 mA (0 to 100%)
	Output scope	2.9 to 21.1 mA (-6.9% to 106.9%)
	Accuracy	0.35% F.S.
	Isolation	Isolated from the system power supply
	Maximum load resistance	700 Ω
Pulse input	Number of I/O points	8 per card
	Input circuit	Photocoupler input (source/sink is selectable by card)
	Common points	8
	Supply voltage and current consumption	24V DC ± 10%, 50 mA (when all points are ON)
	Input signal	On: 13V or more (12 mA or more) Off: 4V or less (1.2 mA or less)
	Input impedance	1.5 kΩ
	Input range	High: 0 to 5 kHz Low: 0 to 20 Hz
	Minimum pulse width	High input range: 0 to 5 kHz, ON 0.1 ms, OFF 0.1 ms. Low input range: 0 to 20 Hz, ON 25 ms, OFF 25 ms.
	Isolation	Isolated from the system power supply but not isolated from the input power supply
Digital input	Number of I/O points	16 per card
	Input circuit	Photocoupler input (source/sink is selectable by card)
	Common points	16
	Supply voltage and current consumption	24V DC ± 10%, 100 mA (when all points are ON)
	Input signal	On: 18V or more (2.4 mA or more) Off: 6V or less (0.8 mA or less)
	Input impedance	6.8 kΩ
	Input filter time constant	10 ms
	Isolation	Isolated from the system power supply but not isolated from the input power supply
	Input type	Status-type, latch-type (push button), or counter-type, specifiable for each point (by software).
	Latch type DI input detection width	100 ms or more
	Countable pulse width	100 ms or more (200 ms or more for on + off cycle)
Digital input (connected to the Omron G7TC)	Number of I/O points	16 per card
	Input circuit	Depends on relays used for the Omron G7TC
	Common	
	Supply voltage and current consumption	24V DC ± 10%, 100 mA. Do not feed power to the Omron G7TC from the FLC power supply. Not isolated.
	Input signal	Depends on relays used for the Omron G7TC
	Input impedance	
	Input filter time constant	
	Isolation	The I/O card is isolated from the system power supply. For the Omron G7TC, isolation depends on the relays used.
	Input type	Status-type, latch-type (push button), or counter-type, specifiable for each point (by software).
	Latch-type DI input detector	100 ms or more
	Countable pulse width	100 ms or more (200 ms or more for on + off cycle)

Notes:

- If the Omron G7TC-ID16 24V DC type is used, specifications are as follows:
  - — Coil: rated coil current 21 mA, resistance 1150 Ω.
  - — Contacts: rated load 1A (resistive load), 0.5A (inductive load). Electrical life is 10 million operations (10 mA resistive load), 2.5 million operations (10 mA inductive load), 0.05 million operations (1A resistive load), or 0.02 million operations (1A inductive load).

* Generally, the input resistance of a HART protocol-compliant positioner is approximately 600 Ω. To connect an analog output (8-point output type) and HART protocol-compliant positioner, use an isolator or other appropriate device.

Table 5. Input and Output Specifications (continued)

Item		Specifications	
Digital output	Number of I/O points	16 per card	
	Output circuit	Open collector	
	Common points	16	
	Output supply voltage and current consumption	24V DC ± 10%, 10 mA (when all points are OFF)	
	Maximum switching current (load current)	0.5A (for one point)	
		2A (for one card)	
	Output transistor ON voltage	1.5V or less (with 0.5A load current)	
	Isolation	Isolated from the system power supply but not isolated from the output power supply	
	Output type	Latch-type, status-type, or pulse-type output, specifiable for each point (by means of software)	
	Pulse-type DO pulse width	100 ms to 120 s, 100 ms resolution	
Digital output (connected to the Omron G7TC)	Number of I/O points	16 per card	
	Output circuit	Depends on the relays used for the Omron G7TC	
	Output supply voltage and current consumption	24V DC ± 10%, 400 mA (powering the Omron G7TC, with 16 relays energized)*	
	Contact rating	Depends on the relays used for the Omron G7TC	
	Operation time		
	Reset		
	Isolation	The I/O card is isolated from the system power supply. For the Omron G7TC, isolation depends on the relays used.	
	Output type, pulse width	Same as open collector input	
Serial communications	Number of ports	1	
	Max. number of cards	4 per FLC	
	Number of communication points	Word data	256 points/card
		Bit data	512 points/card
	Interface**	RS232	D-sub 9 pin
		RS485	6-pole terminal strip
	Transmission rate	2400, 4800, 9600, 19200 bps	
	Circuit configuration	RS232	1:1
		RS485	1:1

* Limit the number of digital output cards (connected to the Omron G7TC) when power is supplied from the FLC power supply to the Omron G7TC to a maximum of 4 cards/unit.

** RS-232C or RS485 is selected by the DIP switches on the card. The RS-232C and RS485 interfaces cannot be used at the same time by a single card. RS485 multidrop is not supported.

Note: If the Omron G7TC-OC16 24V DC type is used, specifications are as follows:

— Coil: rated coil current 21 mA, resistance 1150 Ω.
— Contacts: rated load 5A (resistive load), 2A (inductive load). Electrical life is 1 million operations (at rated load).

Table 6. Thermocouple Type and Conversion Standard Accuracy

Thermocouple Type	Input Temperature	Accuracy*
T	−200 to 0°C	± (1.0 − 0.005 × input temperature)°C
	0 to 350°C	± 0.5°C
J	−100 to 0°C	± (1.0 − 0.005 × input temperature)°C
	0 to 1100°C	± 0.5°C
E	−200 to 0°C	± (1.0 − 0.005 × input temperature)°C
	0 to 900°C	± 0.5°C
K	−200 to 0°C	± (1.0 − 0.005 × input temperature)°C
	0 to 1300°C	± 0.5°C
R	0 to 400°C	± 3.0°C
	400 to 1600°C	± 2.0°C
S	0 to 300°C	± 3.0°C
	300 to 1700°C	± 2.0°C
R	0 to 100°C	± 3.0°C
	100 to 1770°C	± 2.0°C

The above precisions do not include cold junction compensation precision (±0.5˚C).

* These figures for accuracy do not include cold junction compensation accuracy.

■ Models

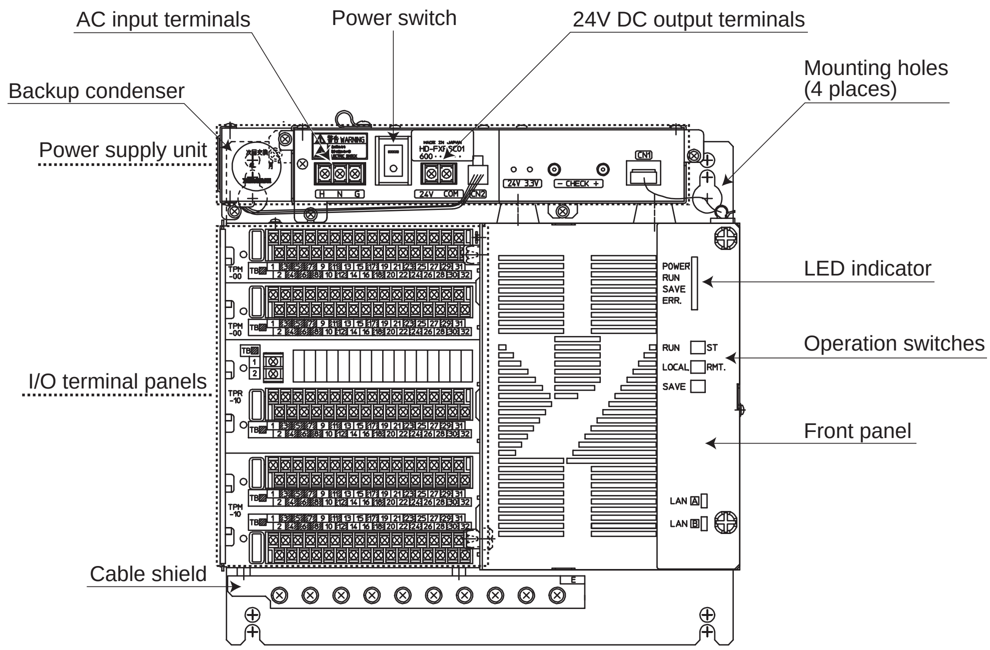
Table 7. List of Models

Varnish	Model	Description	Remarks
**	HD-FXFLC13P	Main unit with field power supply	Controller main unit. Select either one.
**	HD-FXFLC13PE	Main unit with field power supply + expansion unit I/F board	
	HD-FXSWFLC20	FLC license	Necessary for each main unit
**	HD-FXFLE10P	Expansion unit with field power supply	Controller expansion unit
**	HD-FXDCBX00	Expansion unit I/F board (3 ports on the main unit side)	Necessary when connecting an expansion unit to the main unit without an expansion unit I/F
	HD-FXEXPNL	Front panel for connecting the expansion unit (a part for the main unit)	
	HD-FXCBL01	Expansion unit connection cable: 1 m	Necessary when using an expansion unit
	HD-FXCBL02	Expansion unit connection cable: 2 m	
	HD-FXCBL03	Expansion unit connection cable: 3 m	
**	HD-FXAIPS10	Analog input card (with terminals)	Input/output card
**	HD-FXLIPS00	Thermocouple mV input card (with terminals)	
**	HD-FXRTDPS0	RTD input card (air conditioning specifications: -20 to 80°C, with terminals)	
**	HD-FXRTDPS1	RTD input card (free use, with terminals)	
**	HD-FXPIPS00	Pulse input card (with terminals)	
**	HD-FXAOPS00	Analog output card (8 I/O points/card with terminals)	
**	HD-FXAOPS10	Analog output card (4 I/O points/card with terminals)	
**	HD-FXDIPS00	Digital input card (with terminals)	
**	HD-FXG7IS00	Digital input card (with terminal panel for connecting to the Omron G7TC)	
**	HD-FXDOPS00	Digital output card (SS output, with terminals)	
**	HD-FXG7OS00	Digital output card (with terminal panel for connecting to the Omron G7TC)	
**	HD-FXDYPS00	Digital output card (with relay terminals)	
**	HD-FXSIPS00ME	Serial communication card (1 port/card, RS232C or RS485)	For communications with a serial communication device
	HD-FXG7C10	G7TC connection cable: 1m	Necessary when using terminal panel for connecting to the Omron G7TC
	HD-FXG7C15	G7TC connection cable: 1.5m	
	HD-FXG7C20	G7TC connection cable: 2m	
	HD-FXG7C30	G7TC connection cable: 3m	
	HD-FXG7C50	G7TC connection cable: 5m	
**	HD-FXESTS00	EST smart terminal I/F card	Necessary when connecting to the EST
	HD-FXSWRTC1E1	RTC_FLeX, English version for Windows XP, 1 license	

**For varnish finished products, affix "C" to the end of the model number.

■ **Component names and functions**

The names of each component are given in Figure 4.



Note: Connect the field 24V power supply (2.2A) to the feeder terminal on the specified terminal panel for each I/O module.

Figure 4. FLC Component Names

Functions of the LED indicators are as follows:

- POWER: Lit while the power supply of the communication control unit is working normally.
- RUN: Lit while control is being executed.
- SAVE: Lit if the control database is in flash memory. Blinks while saving.
- ERR.: Blinks when an error occurs.

Functions of the operation switches are as follows:

- RUN/STOP: Starts/stops control and puts the system on idle.
- LOCAL/RMT.: Switches to LOCAL control for starting and stopping control with the RUN/STOP switch, and switches to RMT. control when operating through the RTC.
- SAVE: To save, move the switch to the left and hold it there until the SAVE LED starts to blink. When the switch is released, it returns to the right.

3. Control Functions (Control Points)

Control functions are classified into the following types of control point:

■ Regulatory PV Point (RegPV)

Standard I/O processing functions, like industrial unit conversion and alarms, are directly carried out by the above-mentioned I/O monitoring functions. The regulatory PV point performs process variable (PV) calculations and compensation functions. PV processing is accomplished using algorithms such as flow compensation, integration and variable dead time compensation. Detailed configuration possibilities include alarm suppression, signal filtering, and algorithm and calculation formula options. For available algorithms and other supported functions, see Table 8.

Table 8. Regulatory PV Point Features

Available algorithms	Support functions
Data acquisition Flow compensation Middle of three High/low/average selector Summer Totalizer Variable dead time with lead/lag General linearization Calculator algorithm	PV source selection (automatic, manual, substitution) PV clamping Engineering unit conversion and PV extention range check (sensor failure) PV status PV filtering PV alarming - Bad PV (sensor failure) - PVHI, PVLO - PVHIHI, PVLOLO - PV rate of change alarm

■ Regulatory Control Point (Reg Ctl)

Regulatory control points are used to carry out the control functions of the FLC. Configuration of the algorithms listed in Table 9 determines the regulatory control point functions. Each algorithm has configurable options, allowing complicated control to be achieved by simple menu selection. Standard functions include initialization and windup protection. Set point lamping (by operator entry of target values and lamp time) is also available.

Table 9. Regulatory Control Point Features

Available algorithms	Support functions
PID PID with feed forward PID with external feedback Position proportional Ratio control Ramp/soak Auto/manual station Incremental summing Switch Override selector	Mode/mode attribute Red tag Initialization Anti-reset windup External mode switching Safety shutdown Output limit PV source selection PV alarming - Bad PV (sensor failure) - PVHI, PVLO - PVHIHI, PVLOLO - PV rate of change alarm

■ Digital Composite Point (Dig Comp)

Digital Composite points are multi-input and multi-output points that provide an interface to discrete equipment, like motors, pumps and solenoid valves. Digital Composite points provide interlock processing functions as a standard feature. Dig Comp points can also display interlock states on the screen of a Harmonas-DEO supervisory station. The displayed states have information effective for tracking the cause of the interlock. The local “hand/off/auto” switches generally used for motor driving equipment can also be handled. Figure 5 shows the major parameters related to this type of control point.

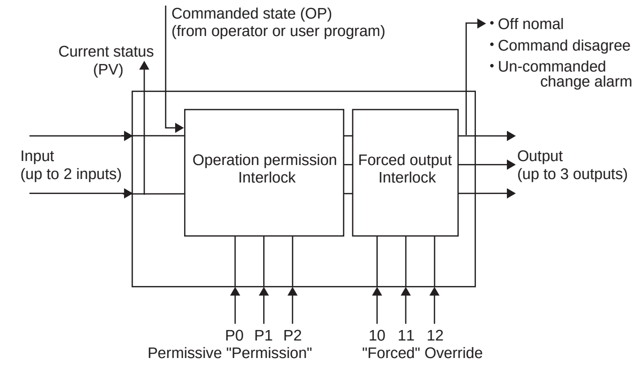


Figure 5. Structure of Digital Composite Points

■ Logic Point (Logic)

Logic points are used with digital composite points to provide interlock logic functions. A logic point has the processing equivalent of up to two pages of relay ladder logic. A logic point consists of a logic block, flag, numeric value variable, input connection and output connection. There are three possible configurations of logic point inputs, outputs, and logic blocks (see Table 10). In addition to offering logic block functions, logic points can also be used for data transfer. In this role they read data from input connections and transfer it via output connections to the parameters of other defined databases.

Table 10. Configuration Options for Logic Points

Type \ Configuration	Input	Output	Logic block
Option 1	12	4	16
Option 2	12	8	8
Option 3	12	12	0

Note: Each logic point provides six status flags, six user flags and four numeric value variables.

Table 11. Logic-Block Algorithms

Logic	AND OR NOT NAND NOR XOR QUALIFIED-OR 2 (2-input majority decision) QUALIFIED-OR 3 (3-input majority decision)
Comparison	EQ (= dead band) NE (≠ dead band) GT (> dead band) GE (≥ dead band) LT (≤ dead band) LE (< dead band)
Delay	DELAY ON DELAY OFF DELAY
Pulse	FIXPLS (fixed length pulse) MAXPLS (maximum time limit pulse) MINPLS (minimum time limit pulse)
Watch dog timer	WATCHDOG
Flip flop	FLIPFLOP
Input error check	CHECKBAD
Switch	SWITCH
State change detection	CHDETECT

■ Function Block Point (FB)

A function block point offers 91 different types of function blocks (see Table 12) and up to 8191 function blocks can be used in a single point. Function blocks conform to the SAMA (Scientific Apparatus Makers Association) block notation system. The user arranges function blocks in a logic diagram to construct control functions.

Table 12. Function Block Algorithms

Arithmetic operation (8 types)	ADD (addition)	SUB (subtraction)	MUL (multiplication)	DIV (division)
	MOD (modulo)	EXPT (exponent x^y)	SUM (4-point addition)	DADD (digital addition)
Single number value variable (13 types)	ABS (absolute value)	SQR (square)	SQRT (square root)	LN (logarithm natural)
	LOG (customary logarithm)	EXP (exponent e^x)	SIN (sine)	COS (cosine)
	TAN (tangent)	ATAN (arc tangent)	TRUNC (truncation)	ROUND (rounding)
	PSQRT (percent square root)			
Selection (9 types)	MAX (maximum value)	MIN (minimum value)	AVG (average value)	
	HSE (high selector)	LSE (low selector)	MID3 (middle of three)	
	SW (switch)	SFT (softening switch)	ALSW (alternate switch)	
Detection (12 types)	HLM (high limiter)	LLM (low limiter)	DRL (rate-of-change limiter)	HMS (high monitor)
	LMS (low monitor)	DRM (rate-of-change monitor)	DMS (deviation monitor)	NUMCHK (normality check)
	BADCHK (badness check)	INFCHK (infinity check)	QLTCHK (change check 1)	CHGCHK (change check 2)
Conversion (4 types)	PTE (EU value conversion)	ETP (% conversion)	FUNC (function conversion)	CONV (data type conversion)
Logical operation (11 types)	AND (logical product)	OR (logical sum)	NOT (inversion)	NAND (inverted logical product)
	NOR (inverted logical sum)	XOR (exclusive logical sum)	QOR2 (2-input majority decision)	SR (set)
	RS (reset)	ORIN4 (4-input logical sum)	ANDIN4 (4-input logical product)	
Comparison (6 types)	EQ (= dead band)	NE (dead band)	GT (> dead band)	
	GE (dead band)	LT (< dead band)	LE (dead band)	
Pulse (3 types)	FIXPLS (fixed length pulse)	MAXPLS (max. time limit pulse)	MINPLS (min. time limit pulse)	
Timer (5 types)	CYCPLS (timer)	WDT (watchdog timer)	DELAY (delay)	ONDLY (on delay)
	OFFDLY (off delay)			
Counter (4 types)	UCNT (up counter)	DCNT (down counter)	AAV (analog totalizer)	PAV (pulse totalizer)
Control operation (8 types)	PID (PID operation)	PRO (proportion)	INT (integration)	DIF (differentiation)
	LDLG (lead/lag)	DED (dead time)	TF (filtering time)	DLTPV (speed type PV)
Others (8 types)	RMP (ramp)	MAV (moving average)	ANMA (analog memory)	GW (gate way)
	SG (single)	FL (flag)	TIMFL (one shot FL)	REDTAG

■ Process Module Data Point (Proc Mod)

Process control often requires flexible control programs that can be used for continuous, batch, or hybrid applications. A process module data point is a user-created program (CL program) written in a special-purpose control language. This language provides powerful sequence control and calculation functions. CL programs can access analog input and output, digital input and output, logic block status, alarm status, failure status, numeric value variables, and flags. Process module data points provide phase, step and statement structures suitable for implementing batch process control functions. They can also activate a sequence for hold, shutdown, or emergency shutdown, making use of the powerful functionality of multilevel error processing.

■ Flag Point

Flag points indicate two states, such as on and off, and accept input of Boolean algebra values. Flag points can be changed by operators or user programs. The FLC allows up to 8192 flags, 512 of which support off-normal alarms (a change from steady state generates the alarm).

■ Numeric Value Variable Point

Numeric value variable points are variables that save numeric values, which is especially useful for batch (recipe) operations. The FLC has up to 8192 numeric value variable points.

■ Timer Point

Timer points are used by both operators and user programs to supervise process events. Timer points are processed once every second. The FLC has 32 available timer points.

4. Alarm System Functions

FLC supports a variety of alarm functions. When an alarm occurs, notifications appear at the open supervisory station on various types of screens. Alarms are generally classified as PV alarms or digital alarms.

■ PV Alarms

The types of configurable alarm for process variables are listed below. Alarms can be set in both I/O points and control points. In general, if a control point uses an I/O point, the alarm is set in the control point. Otherwise, it is set in the I/O point.

- High
- High high
- Low
- Low low
- Change rate high
- Change rate low
- Significant change

A dead band can be set in all PV alarms mentioned above.

■ Digital Alarms

There are three types of digital alarm:

- Off-normal alarm
- Uncommanded change alarm
- Command disagree alarm

Off-normal alarms are activated when the status changes to ON. Both uncommanded change alarms and command disagree alarms are set within digital composite points and detect a disagreement between input and output. A command disagree alarm detects a disagreement between input and output just after an output change, while an uncommanded change alarm detects a disagreement between input and output when no output change has been made. Both alarms can set dead band time.

■ Alarm Priority

Alarm priority can be configured for individual alarm types for each point. A choice of seven alarm priorities can be assigned:

- Emergent (emergency)
- Important (high)
- Ordinary (low)
- Journal only
- Only journal printer output (not used when the EST is connected)
- Journal recording + printer output (not used when the EST is connected)
- None (no action)

■ Contact Cutout

The contact cutout function allows a program to temporarily stop an alarm for any point (or all points) having alarm functions. The “CONTCUT” parameter, which is available for points having alarm functions, can be turned on to put points in the alarm stop status.

5. Processing Performance

By combining adjustment control loops, logic functions, and sequence and I/O processes, the FLC tailors control functions to fit the needs of specific applications. Configuration needs to take into account restrictions on the maximum number of points per FLC, the processing unit (PU) value, which is a unit of processing capability, and the memory unit (MU) value, which is the permitted memory size for a CL program.

■ Maximum Number of Points

Limits on the number of points settable per FLC are as follows.

Table 13. Maximum Number of Points Per FLC

Point type	Maximum number of points
Regulatory control	32
Regulatory PV	32
Process module	128
Logic	64
Digital composite	256
Function block	128
Numeric value variable (NN)	8,192* + 80 × (number of sequences used)
Flag variable (FL)	8,192** + 128 × (number of sequences used)
Timer variable (TM)	32
I/O point	(Number of points per I/O card)×23

* 3,000 points are for use by the user, and the rest are reserved for the system.
** 3,000 points (including 512 for alarms) are for use by the user, and the rest are reserved for the system.

■ Maximum Number of Blocks

The following restrictions apply to function blocks, which are components of function block points.

Table 14. Maximum Number of Function Blocks

Per function block point	2048 blocks
Per FLC	2048 blocks

■ Processing Unit (PU Value)

This unit represents the processing capability of the FLC, based on factors such as the point types and control cycles. The following tables list the maximum PU values per FLC and PU values for various types of points.

Table 15. Maximum PU Value (Per FLC)

Point Type	PU value
Total of control points and function blocks and of I/O points	700

Table 16. PU Values for I/O Points

Device	PU Value				
		I/O Monitoring Cycle			
		1 s	0.5 s	0.2 s	0.1 s
Main unit	2.0	--			
Expansion unit (per unit)	4.0	--			
Status input per card (DI)	--	0.7	1.1	2.3	4.3
Latch input per card (DI)	--	4.0	4.0	4.0	4.0
Integrating input per card (DI)	--	4.0	4.0	4.0	4.0
Status output per card (DO)	--	0.2	0.4	1.0	2.0
Pulse output per card (DO)	--	2.0	2.0	2.0	2.0
Analog input per card (AI)	--	1.5	2.2	4.3	7.8
Thermocouple mV input per card	--	0.9	--	--	--
RTD input (room temperature) per card	--	1.5	2.2	4.3	7.8
RTD input (free range) per card	--	0.9	--	--	--
Analog output per card (AO)	--	0.3	0.6	1.5	3.0
Pulse input per card (PI)	--	1.0	1.4	2.6	4.6
Serial communications per card (SI)	--	7.6	--	--	--

Note: For AI, the table assumes that two alarms (occurrence or reset) occur once every second in the 4 slots. For DI, it is assumed that one off-normal alarm occurs once every second in the 8 slots.

Table 17. Control Point and Function Block PU Values

Control Point	PU Value (control cycle = 1 s)
RegPV	0.8
RegCtl	1.1
Logic	0.7
DigComp	0.1
ProcMod (short)	1.0
ProcMod (long)	2.0

Function Block	1 s PU Value	Function Block	1 s PU Value	Function Block	1 s PU Value
ADD	0.024	LLM	0.016	LE	0.024
SUB	0.024	DRL	0.040	FIXPLS	0.024
MUL	0.024	HMS	0.016	MAXPLS	0.024
DIV	0.024	LMS	0.016	MINPLS	0.024
MOD	0.020	DRM	0.040	CYCPLS	0.028
EXPT	0.024	DMS	0.024	WDT	0.024
SUM	0.028	NUMCHK	0.016	DELAY	0.016
DADD	0.028	BADCHK	0.016	ONDLY	0.028
ABS	0.016	INFCHK	0.016	OFFDLY	0.028
SQR	0.016	QLTCHK	0.016	UCNT	0.020
SQRT	0.016	CHGCHK	0.024	DCNT	0.020
LN	0.024	PTE	0.020	AAV	0.028
LOG	0.024	ETP	0.020	PAV	0.028
EXP	0.024	FUNC	0.028	PID	0.076
SIN	0.024	CONV	0.032	PRO	0.024
COS	0.024	AND	0.020	INT	0.048
TAN	0.024	OR	0.020	DIF	0.064
ATAN	0.024	NOT	0.020	LDLG	0.040
TRUNC	0.024	NAND	0.020	DED	0.036
ROUND	0.024	NOR	0.020	TF	0.048
PSQRT	0.016	XOR	0.020	DLTPV	0.024
MAX	0.028	QOR2	0.024	RMP	0.032
MIN	0.028	SR	0.020	MAV	0.044
AVG	0.028	RS	0.020	ANMA	0.028
HSE	0.024	ORIN4	0.028	GW	0.020
LSE	0.024	ANDIN4	0.028	SG	0.016
MID3	0.028	EQ	0.024	FL	0.016
SW	0.024	NE	0.024	TIMFL	0.028
SFT	0.040	GT	0.024	REDTAG	0.008
ALSW	0.020	GE	0.024		
HLM	0.016	LT	0.024		

■ Memory Unit (MU) Value

The MU value is determined by the total size of the CL programs. It indicates to the user how much FLC memory is available. The MU value tells only the amount of memory used to store the CL programs themselves.

For MU value calculation, a CL program is divided into units of about three statements each. The MU value is then found by the number of units. Each unit is called a CL block, with 1 CL block = 1 MU. The maximum MU value per FLC is 6080.

In contrast to PU values, MU values are not affected by control cycles or the number of I/O points.

■ Control Cycles

Control cycles are selectable per FLC from among 1 s, 500 ms, 200 ms and 100 ms (for combinations, see Table 18). Not only the control cycles, but also some of the data points can be processed at high speed (100 ms) by means of the fast scan function.

Table 18. Combination of Control Cycles

SCANRATE Parameter	Point Type			
	RegcTl, RegPV	Logic, DigComp	PromMod	FB
Reg1 Log1	1 s	1 s	1 s	Selection of the following control cycles per point ・1 s ・500 ms ・200 ms ・100 ms
Reg1 Log2	1 s	500 ms	1 s	
Reg1 Log5	1 s	200 ms	1 s	
Reg1 Log10	1 s	100 ms	1 s	
Reg2 Log2	500 ms	500 ms	1 s	
Reg2 Log5	500 ms	200 ms	1 s	
Reg2 Log10	500 ms	100 ms	1 s	
Reg5 Log5	200 ms	200 ms	1 s	
Reg5 Log10	200 ms	100 ms	1 s	
Reg10 Log10	100 ms	100 ms	1 s	
Fast scan	100 ms	100 ms	100 ms	

6. Smart Debugging

The smart debug function can check operations of various control functions and I/O processing functions provided by the FLC without using I/O modules.

This function can be carried out for individual FLCs. After the transition to the debug mode, the function neither receives input from I/O modules nor transmits output to I/O modules, except for performing controlling operations within FLC and I/O processing operations.

Users can set any desired values on the FLC as virtual process data, making the debugging of CL programs, etc., easy. Users can also operate and supervise the status of the debug mode on the Harmonas-DEO supervisory station.

7. Software Simulation

The software simulation function (optional) allows stand-alone PCs to carry out FLC functions virtually. The function allows the user to create and debug applications in an environment without actual connected devices. One PC can carry out virtual operations for four FLCs.

8. Restart

8.1 Warm Restart

The FLC restarts operation based on data from the flash memory on the control card (CTC) at the time of normal restart. It is designed so that, at restart, the necessary startup operations are minimized, while the status of the process is maintained. The control loop sending output to the field is switched to manual mode, and user program sequence can be selected from among automatic start from the beginning, stop at the first step, or stop at the last execution position.

Saving data to flash memory can be done manually with switches on the front panel of the controller or on the EST.

8.2 Hot Restart

This type of restart is intended for automatic recovery from momentary interruption and resumes control with the database contents immediately before the momentary interruption kept intact. For hot restart to be executed, the automatic data save function must be configured in advance.

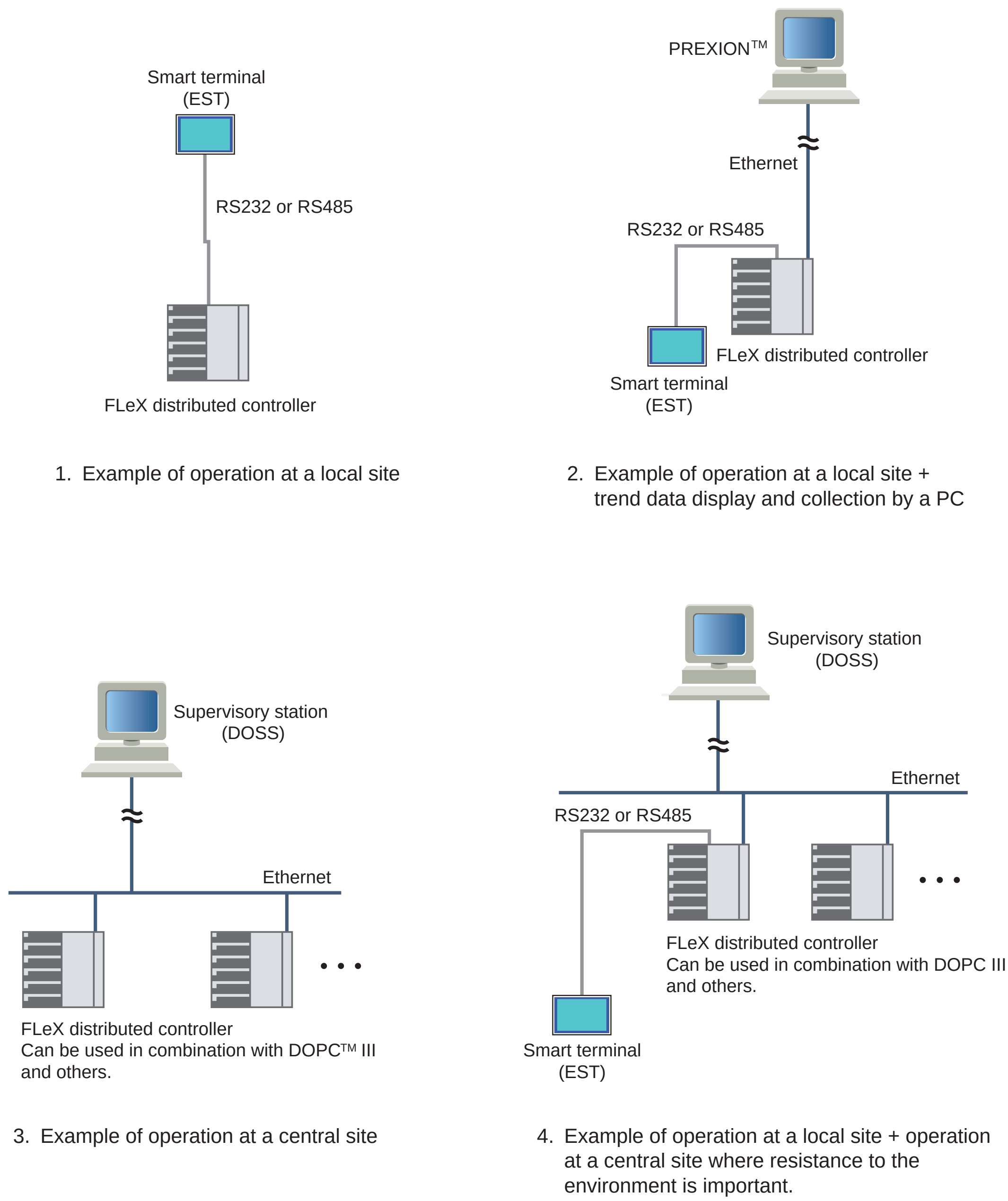


Figure 6. System Architecture

9. Connection of Expansion Units

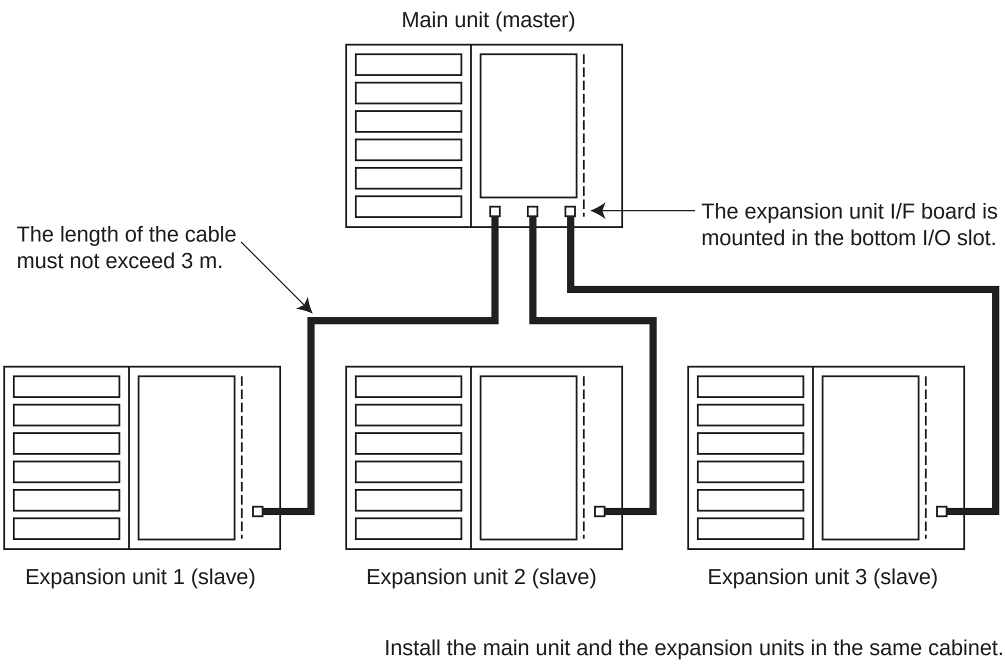


Figure 7. Diagram for Connection of Expansion Units

10. Dimensions

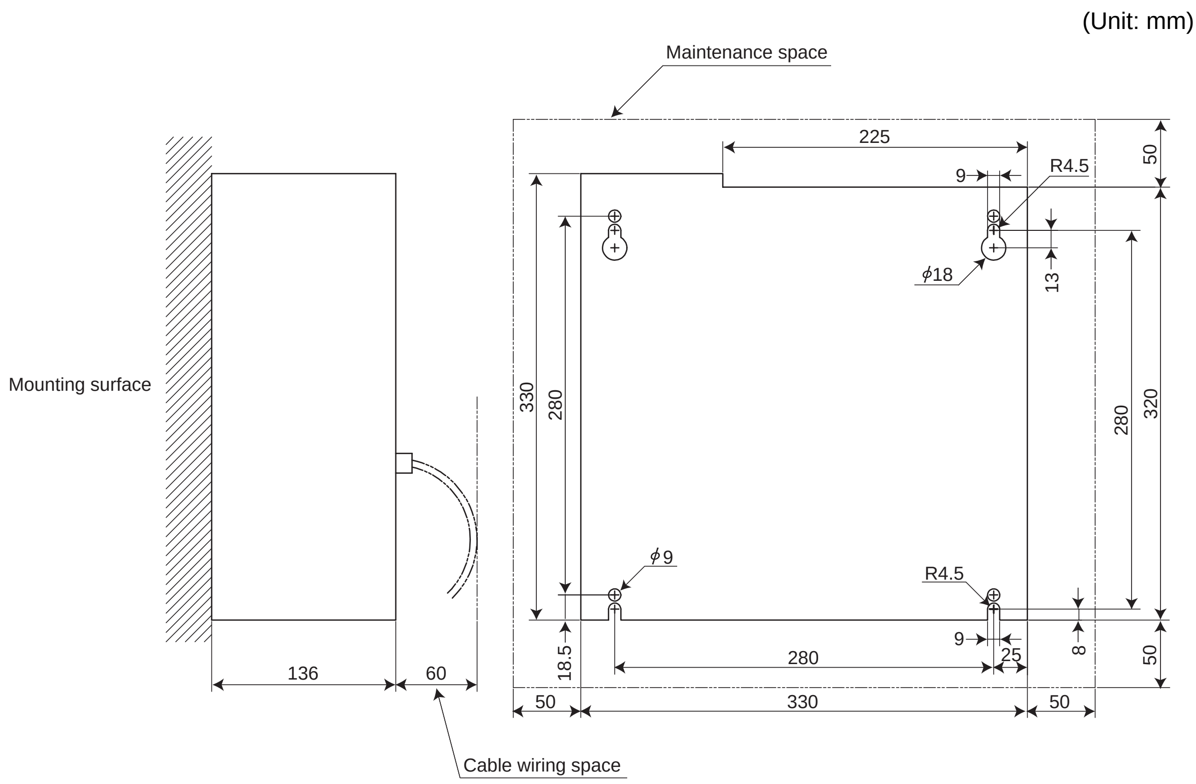


Figure 8. FLC Outer Dimensions

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