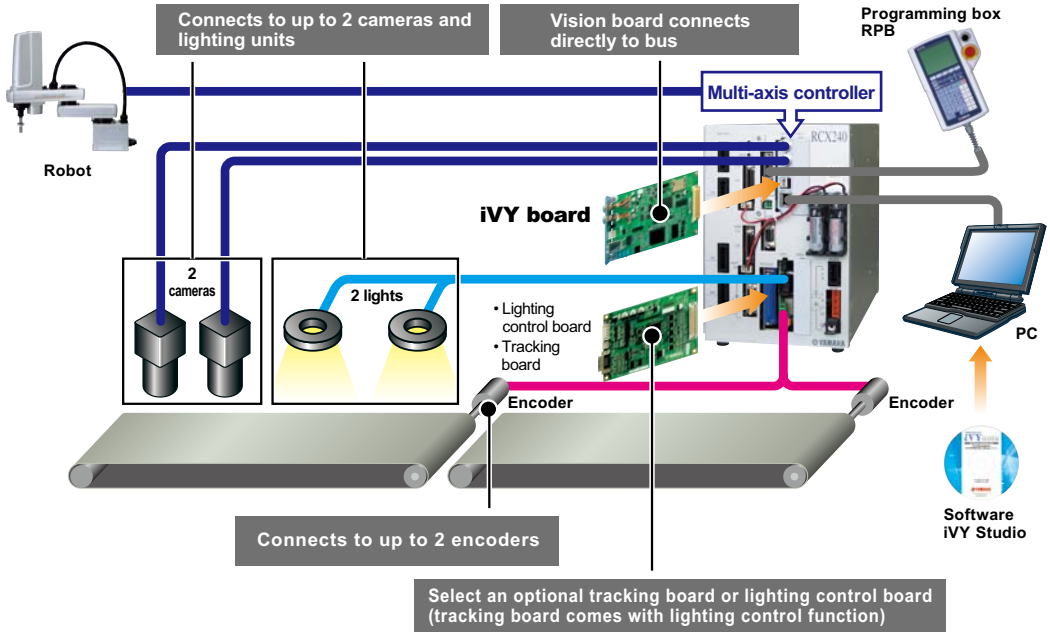
ROBOT VISION

Simple to use and cuts the number of job steps!
“Finds and Takes” without teaching tasks

Many robot users might think, “We tried vision recognition but it seems to take a lot of work” or “we tried it before and making adjustments was a tough job”. But the YAMAHA iVY System eliminates those problems. Anyone can make setups on the YAMAHA iVY System and it also cuts down on the number of job steps!

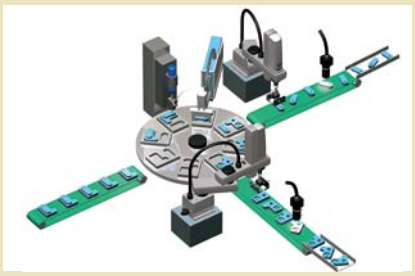
iVY system layout

Gives you a ready-to-go robot controller equipped with an image processing function by just setting an iVY board in your 4-axis robot controller RCX240 or RCX240S. Putting “eyes” in your robot allows you to search and take workpieces, find deviations in workpiece position and make corrections even in the case of large errors, expanding the range of applications.



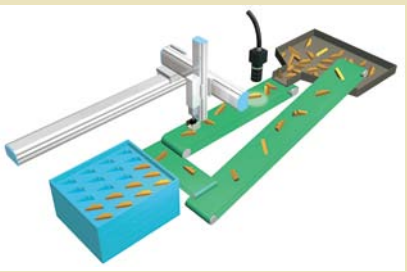
■ Options

- Lighting control board
- Tracking board
- CCD camera
- LAN cable (Shield crossing)
- Camera cable
- Lens
- Close-up ring



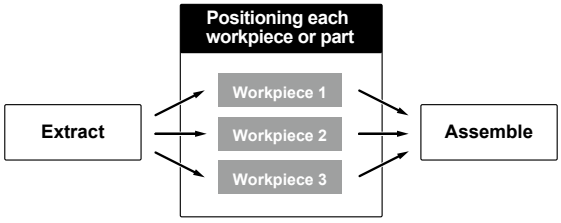
■ Finds workpieces and positions them

■ Makes corrections automatically even if camera moves



■ Performs tracking on conveyors

Ordinary system: No robot vision



Positioning jig replacement and other tasks are needed whenever the workpiece is changed. Costs for setups/changeover and jig fabrication/storage are especially high when dealing with a small lot of workpieces.

System with robot vision

Setups are easy to handle by just loading new model data even if changing the workpiece or part. No mechanical positioning is needed so costs are cut by equipment downsizing and lower jig tool expenses.

Point 1

Easy for anyone to use – supports wide spectrum of applications

Attempting to make system upgrades with robots combined with commercial image processing equipment took a great deal of time and trouble due to tasks such as aligning the conventional robot controller with the image processing equipment, exchanging data and messages, and offset processing, etc.

In the YAMAHA “iVY System” however the vision board is integrated into the robot controller, and operation is drastically simplified by limiting the functions to positioning and position correction. This makes the system incredibly easy to use compared to other vision systems used up until now. YAMAHA aimed for “a vision system anyone can easily use right from the start” and this is what they achieved so be sure to check out the YAMAHA robot vision for yourself!

Ordinary robot vision

- Difficult to handle and work with
- Troublesome to actually use
- Expensive to install and startup
- Knowing where to ask for help is a problem

Requires getting expert knowledge which is a hassle

If using the iVY system

- Everything is easy and simple!
- Lower cost with fewer man-hours needed
- Simple to use so effective for diverse applications
- YAMAHA gives you total support

Easy for anyone to use and has an expanding range of applications!

Point 2

Register workpiece data in 3 easy steps!

YAMAHA wanted “A vision system that anyone can easily use”. But image recognition itself has been around for a long time. However, up to now image recognition required complex tasks such as coordinate matching (calibration) or setting coordinate offsets for shifting cameras and so image recognition never became very popular with robot users. YAMAHA machine vision called the iVY System, however, can be operated by anyone including machine designers or the actual machine operators.

STEP. 1

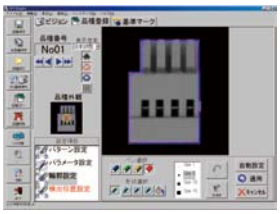
Capture the image

Place the workpiece within the camera field-of-view and set the image capture range.

STEP. 2

Set the contour

The iVY System automatically finds the contour, so a pen tool can then fill in the required contour section.



STEP. 3

Register the detection position

Use the mouse to specify the detection position.
Set the position wherever needed.

Search results

Point 3

Includes dedicated “iVY Studio” software

The iVY system also includes dedicated “iVY Studio” software. This single software registers the work (sets edges, sets all types of parameters, set data loading range) and reference marks used for calibration, and also performs all tasks involving vision including backup and restore, operation monitor control, etc.

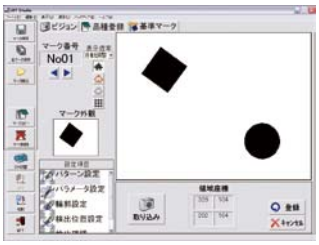
Support software iVY Studio

- Makes searches, registers part types
- Registers reference marks (for calibration)
- Registers up to 40 workpieces
- Easily adds workpieces
- Detects up to 40 workpieces at the same time
- Data backup
- Functions as a monitor during program operation

Point 4

Super simple calibration (Coordinate matching alignment tasks)

Conventional equipment combining “image processing equipment + robot” requires an extreme amount of time and trouble due to the task of “calibration” that aligns the camera coordinates with the robot coordinates. On the iVY system however the operator only has to follow conversation-type instructions from the programming box so operation is simple and finishes in a short time.
The iVY system also automatically corrects these coordinates even if the robot installation position has changed during tasks such as clamping upward, clamping downward, clamping robot Z axis, and clamping the Scara robot Y arm.



Just follow instructions on the Wizard!

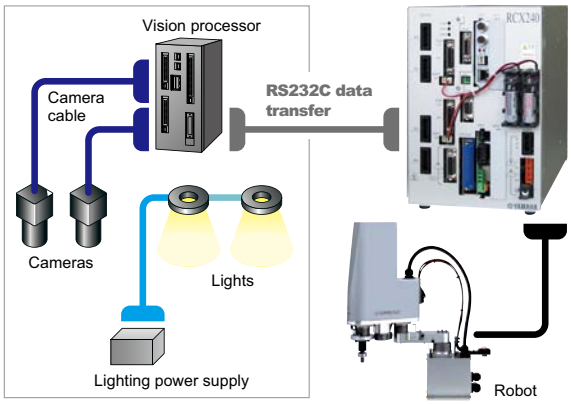
Point 5

Unified operation with integrated controller

Other machine vision products on the market use different formats so a coordinate conversion program had to be written into the controller.
The iVY system however has an integrated controller so robot point data is stored in one extremely and easy step. Camera control and lighting control are handled by integrated operation within the robot controller in an easy to understand operation that reduces the man-hours needed for equipment startup.

Ordinary robot vision

① **Aligning with the robot coordinates is a tough job**
② **Offset calculation is needed if the camera is moved**
③ **Operating delays occur between the camera and robot due to the communication time lag**
④ **Communication formats must be made to match each other**

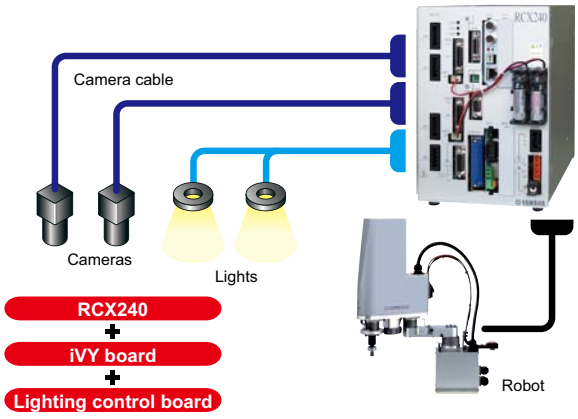


Connecting an external camera to the robot controller requires tasks such as coordinate matching (calibration) and running a correction program so equipment startup can be difficult.
Ordinary equipment requires a lot of time and trouble even when using simple applications so the possible applications are limited.

If using the iVY system

Point

① **Contains a simple calibration function**
② **Coordinates are automatically adjusted even if camera is moved**
③ **High-speed connections over a dedicated bus line**
④ **Integrated operation within controller**
⑤ **Supports all models of YAMAHA robot lineup**



Calibration on the YAMAHA iVY system is simple! Moreover all coordinates are adjusted automatically when a camera is installed on the robot. Being easy to use also makes it ideal for a diverse range of applications.

Point 6

Select freely from the YAMAHA robot lineup

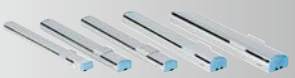
All YAMAHA robots are controllable on the RCX controller. Select from among the single-axis robot FLIP-X series, the linear single-axis robot PHASER series, the Cartesian robot XY-X, or the SCARA robot YK-XG according to your application needs.
A low-cost and light-weight robot vision system can be easily built up at a low cost with an optimal model selected to match the user's application.

■ Cartesian robots XY-X

■ SCARA robots YK-XG

■ Linear motor single-axis robots PHASER

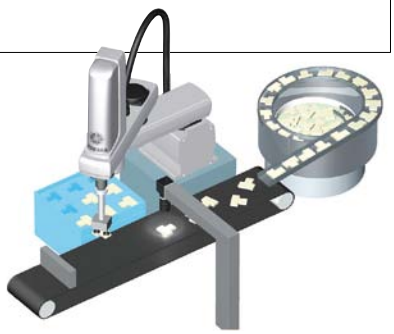
■ Single-axis robots FLIP-X



Point 7

Handles workpice without teaching

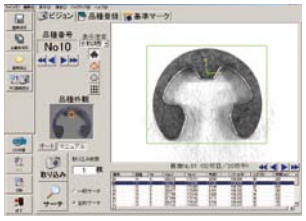
Teaching an accurate position to the robot is essential when attempting to handle work by robot and if an offset or deviation occurs in the work position then correctly handling the work is impossible. In the iVY system however after rough positioning, image recognition is used to make an accurate position adjustment. The work can be moved without teaching so the man-hours needed for startup are reduced and flexible adjustments such as work piece changes or additions can be made.



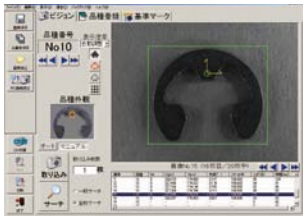
Point 8

Stable edge search for great results

Ordinary machine vision equipment uses gray search (normalized correlative search) which is easily affected by dirt, notches on the workpiece and lighting conditions which limit its usable applications and work environment. The iVY system however contains an edge search engine that makes searches using the contour shape of the part. This contour (edge) search is strongly resistant to outside effects and so instantly opens up a whole range of applications.



Search made with good lighting

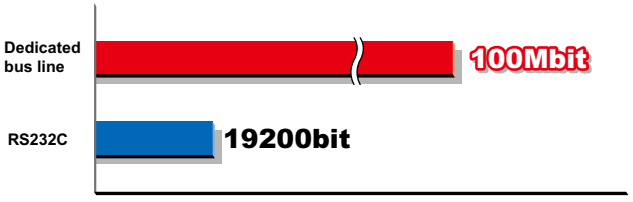


Search is accurate even with poor lighting

Point 9

High-speed connections over a dedicated bus line

Connecting a bus line directly to the CPU board in the robot controller yields data transfer speeds some 5,000 times higher than serial data transfer on ordinary machine vision equipment!
Programming is also easy because the time lag occurring during communications or data transfer does not have to be considered. It also easily handles conveyor tracking tasks that require high-speed processing.

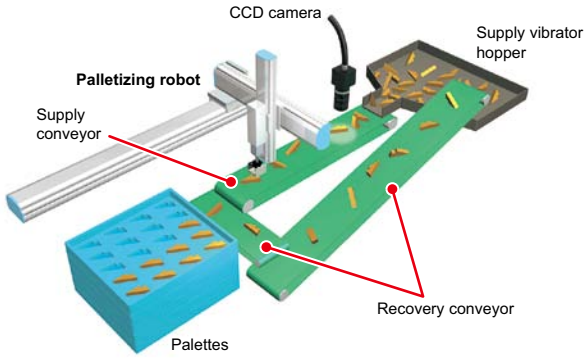


Data transfer per second

Point 10

Conveyor tracking available

Just adding a conveyor tracking board allows handling of conveyor tracking tasks.
Pulse (AB phase) signals from an encoder installed on the conveyor are input to a tracking board to continuously recognize work positions and allow pick up of work without having to stop the conveyor.
Up to 2 cameras or lightings or conveyor encoder units can be connected to support movement between conveyors.



Point 11

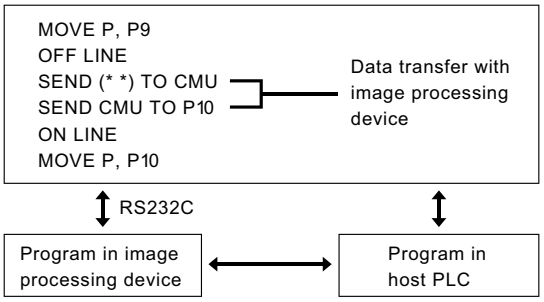
Vision is also easily controllable on the robot program

The robot program executes all vision control tasks including camera switching, image loading, and work piece search. Writing programs is simple compared to ordinary vision systems because control is all-inclusive from robot movement to camera control. Moreover, debugging is also efficient so the total number of required man-hours can be drastically reduced.

■ **Examples of Robot vision language**

Command names	Functions
VCAPTURE	Load image from camera
VSEARCH	Search for the specified part type
VMONITOR	Switch the monitor mode ON or OFF
VGETCNT	Acquire the number of parts that were found
VGETPOS	Acquire the position data
VGETTIME	Acquire the time required by the executed search command
VGETSCR	Acquire judgment values for the detected work
VSAVEIMG	Store images in BMP format

Ordinary robot vision



Controls using different programs

If using the iVY system

```
MOVE P, P9
VSEARCH 1,2,0   ——  make a work search
P10=VGETPOS(0)  ——  load the points
MOVE P, P10     ——  move to that point
```

MERITS

- **No data communication time lag**
- **Controllable with just the robot program**
- **Needs only a few lines of commands**
- **Simple and easy to understand**

Controls with just one robot program

The iVY SYSTEM can eliminate these problems!

Must cut down on teaching man-hours

Robot teaching tasks require a lot of time and effort. The iVY system however acts as the “Eyes of the Robot” to drastically shorten the time usually required for teaching by automating the final fine adjustment step in during positioning.

Must simplify the positioning mechanism

Changing the setup such as for positioning tasks takes a lot of time when there are a large number of parts types and more and more work tends to involve small lot production with different parts. The iVY system can help to drastically lower costs for fabricating positioning jigs, monitoring and replacement tasks, etc.

Need to handle random work tasks

The iVY system can also assist in operations such as “placing the work directly after moving from the parts feeder” or “grip the work on the pallet and transport it”. Using the position correction function on the iVY system can make performing these tasks simple.

Need to pickup work flowing on the conveyor

The iVY system also handles conveyor tracking tasks. Signals from an encoder installed on the conveyor are input to allow continuously recognize work positions in the process flow. So that work can be picked up without having to stop the conveyor.

Don’t know where to find help when trouble occurs

Problems such as being unable to load images, or unable to write data, position errors tend to occur often in commercial image processing equipment used in combination with the robot. Those are the times when the YAMAHA iVY system will keep working well. The iVY system delivers total support for tasks ranging from loading of images from the camera to operating the robot.

iVY System

Robot with image processing functions

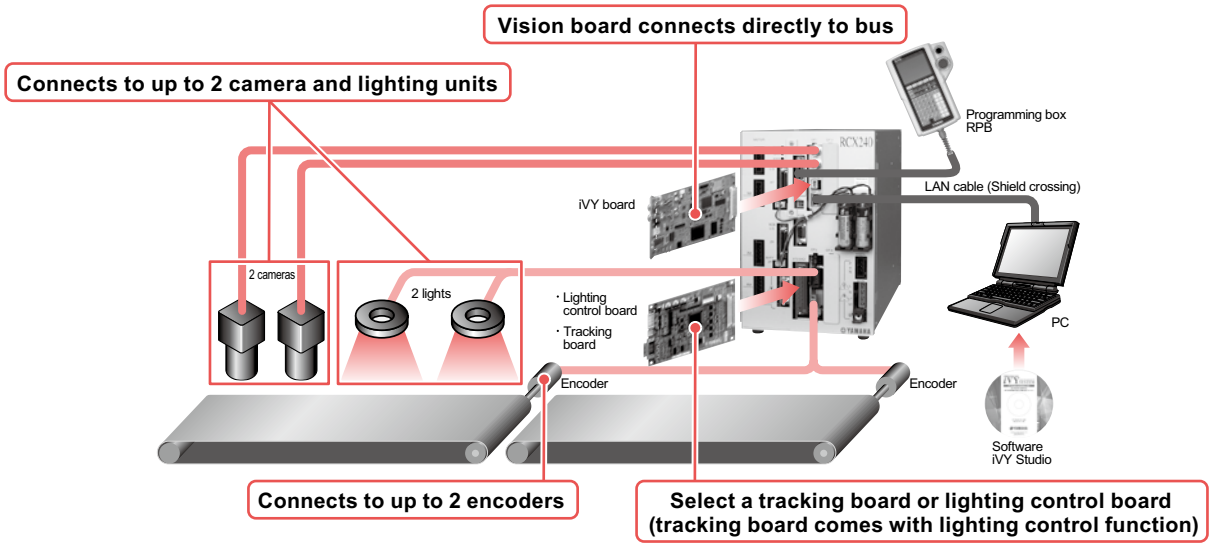
"SEARCH and TAKE" "CHECK POSITION and ASSEMBLE"
YAMAHA offers a whole new production line concept that eliminates time-consuming teaching and positioning tasks with "iVY-system"!

Main functions ▶ P.40

iVY system layout

Basic system contents

- RCX240 controller
- iVY system (Plug-in Board)
- iVY Studio (Support software)



Features

1 Amazingly easy to use!

Ordinary robot vision requires a great deal of time and trouble due to tasks such as setting up data transfer. However the Yamaha "iVY System" is super easy to operate because it utilizes a unique work positioning function.

2 Super-easy one-step calibration

Calibration (coordinate matching alignment task) is an easy job on the iVY system and finished in a short time because all the operator does is comply with the conversation type commands from the programming box.

3 Uses edge search for great stability

Machine vision on most current equipment uses gray search which is easily affected by the work piece surface state and lighting conditions. The iVY system however includes a "search engine" using edge search that is strongly resistant to outside effects and so opens up a whole new range of machine vision applications.

4 High-speed bus connection is resistant to noise and fast!

Connecting a bus line directly to the CPU board in the robot controller yields data transfer speeds some 5,000 times higher than serial data transfer on commercial vision equipment.

5 Robot program provides easy control of vision tasks

Vision tasks such as camera switching, image capture, and work search can now be easily controlled from the robot program. Tasks ranging from moving the robot to camera control are all carried out in one unified sequence so writing a program is easy.

6 Yamaha delivers total support!

The controller, robot and vision are all manufactured by Yamaha. This means that Yamaha can provide total support for everything from loading images on the camera to robot operation.

iVY System

iVY System basic specifications

iVY board

- **Edge (contour) searches**
  The edge search format of the iVY system is relatively unaffected by missing and soiled workpieces.
- **Generous number of registered models**
  Up to 40 models can be registered and used in searches. This permits easy setup changes simply by changing the model number.
- **Supports 2 cameras**
  Up to 2 cameras can be connected (both cameras must be the same type).
- **iVY Studio permits search conditions to be monitored during automatic robot operation**
  iVY Studio permits monitoring of work search conditions during automatic robot operation, and monitoring of fiducial mark search conditions during calibration setting operations.

Basic specifications

Item		iVY board
Basic specifications	Applicable controllers	RCX240 / RCX240S
	Pixels	640 (H) × 480 (V) (300,000 pixels, VGA)
	Settable part types	40 part types
	Connectable cameras	Maximum 2 units Note. If connecting 2 units, then must be the same model
	Camera types	Double speed compatible analog camera
	Memory	128MB SDRAM, 256MB miniSD card
	External I/F	Ethernet (100BASE-TX)
Search method		Edge search (Correlative edge filter, Sobel filter)
Image input	Trigger	S/W trigger, H/W trigger, Camera internal synch
	External trigger input	2 points
Functions	Search function	Position offset, Auto registry of point data
	ID recognition (usage planned)	QR-Code [Model2], DataMatrix
Setup support functions		Calibration, image storage function Note1 (all images / specified image)

Note. 1. Requires Windows PC.

Lighting control board (Options)

- **Digitally modulated light format used for PWM**
  A digitally modulated light format is used for pulse width modulation (PWM), resulting in stable light modulation.
- **Light emission format (continuous light / strobe light) is selectable according to the application**
  The light emission format can be selected according to the application in question.
  Continuous light : 100-step light modulation (0 to 100%)
  Strobe light : 10µs to 33ms light emission time setting
- **Supports 12V and 24V lighting specifications (constant voltage type)**
  Either a 12V or 24V lighting specification can be used to supply power which matches the LED lighting specification in question. LED lighting colors (red, white, green, blue) are also supported.
- **2Ch lighting output, with max. output capacity of 60W**
  2 lighting channels can be used simultaneously, provided that the total power consumption for both channels does not exceed 60W (for 24VDC. For 12VDC, the maximum is 30W). The modulated light and lighting control mode settings can be specified individually.

Basic specifications

Item		Lighting control board (option)
Basic specifications	Applicable controllers	RCX240 / RCX240S
	Number of lighting connected units	Up to 2 units
	Light adjusting system	PWM control (0 to 100%) (Cycle 60kHz) Stroboscopic light (10 to 33000us)
	Trigger	S/W trigger, H/W trigger
	External trigger input	2 points
	Lighting power input	12VDC or 24VDC (Supplied from outside commonly to 2 channels)
	Lighting output	When DC12V is supplied: Less than 30W with 2 channels totaled When DC24V is supplied: Less than 60W with 2 channels totaled

Tracking board (Options)

- **Conveyor tracking support**
  The tracking board receives pulse signals (AB phase) from conveyor encoders in order to continuously check the positions of conveyed workpieces. This allows workpieces to be picked up without stopping the conveyor.
- **Equipped with 2 pulse counters**
  The tracking board has 2 pulse counters, allowing workpieces to be checked on 2 lines simultaneously. Each of the pulse counters supports pulse inputs of up to 2Mpps.
- **Equipped with lighting control function**
  The tracking board is equipped with the lighting control board functions, allowing it to perform all the iVY system functions with only an iVY board and a tracking board.

Basic specifications

Item			Tracking board (option)
Basic specifications	Applicable controllers		RCX240 / RCX240S
	Lighting control section	Light adjusting system	Up to 2 units
		Light adjusting system	PWM control (0 to 100%) (Cycle 60kHz) Stroboscopic light (10 to 33000us)
		Trigger	S/W trigger, H/W trigger
		External trigger input	2 points
		Lighting power input	12VDC or 24VDC (Supplied from outside commonly to 2 channels)
		Lighting output	When DC12V is supplied: Less than 30W with 2 channels totaled When DC24V is supplied: Less than 60W with 2 channels totaled
	Pulse input section	Number of encoder connected units	Up to 2 units
		Encoder power source	DC5V (Less than 500mA with 2 channels totaled) (Supplied from controller)
		Applicable encoder	Line driver equivalent to 26LS31 / 26C31 (Conforming to RS422)
		Input phase	A, $\bar{A}$, B, $\bar{B}$, Z, $\bar{Z}$
		Maximum response frequency	2MHz
		Counter / Step-up multiplication	0 to 65535 / Double, quadruple
		Other	Provided with broken wire detect function

Note. The tracking board is required when using the tracking function.

Accessories and part options

Standard accessories

iVY board

Model	With power supply harness	KX0-M4402-00
	Without power supply harness	KX0-M4402-10

iVY board accessories

Name	Single unit model	Set Model
Camera trigger input cable connector	KX0-M657L-00	KX0-M657K-00
Custom tool	KX0-M657M-00	

Support software for PC iVY Studio

iVY Studio is support software for the iVY system that allows registering part types and reference marks as well as monitoring the work search status during automatic robot operation by connecting to the robot controller.

Environment

Software model	KX0-M4988-00
OS	Microsoft Windows 2000/XP/Windows Vista Note The 64 bit version is not subject to the operation warranty.
CPU	Exceeding the environment recommended by the OS being used
Memory	64MB or more (Recommend)
Hard disk	Vacant capacity of more than 40MB in the installation destination drive Note. Besides the above, also requires memory space for storing images and data.
Display	800 × 600 dots or more, 32768 colors (16bit High Color) or more (recommended)
Network	TCP/IP Ethernet port × 1

Options

Lighting control board

Model	KX0-M4400-G0

Lighting control board accessories

Name	Single unit model	Set Model
Lighting power cable connector	KX0-M657L-10	KX0-M657K-10
Wiring lever	KX0-M657M-10	
Lighting input trigger cable connector	KX0-M657L-00	KX0-M657K-00
Custom tool	KX0-M657M-00	

Tracking board

Model	KX0-M4400-E0

Tracking board accessories

Name	Single unit model	Set Model
Lighting power cable connector	KX0-M657L-10	KX0-M657K-10
Wiring lever	KX0-M657M-10	
Lighting input trigger cable connector	KX0-M657L-00	KX0-M657K-00
Custom tool	KX0-M657M-00	
AB phase input cable connector	KX0-M657L-20	KX0-M657K-20
AB phase input cable connector case	KX0-M657M-20	

Camera cable

Cable for connecting the camera to the iVY board.

Model	3.5m	KX0-M66F3-00
	6m	KX0-M66F3-10
	9.5m (relay 3.5m+6m)	KX0-M66F0-20
	Relay cable 3.5m	KX0-M66F4-00
	7m (relay 1m+6m)	KX0-M66F0-30
	Relay cable 1m	KX0-M66F4-10

Note. When installing a camera cable in a moving section, use a relay cable so that it can be easily replaced if needed.

CCD camera

Model	KX0-M7913-00

Lens

Model	8mm	KM7-M7214-60 (ML-0813)
	12mm	KM7-M7214-40 (ML-1214)
	16mm	KM7-M7214-30 (ML-1614)
	25mm	KM7-M7214-20 (ML-2514)

Close-up ring

Model	0.3mm	KX0-M7215-00
	1.0mm	KX0-M7215-10
	2.0mm	KX0-M7215-20
	5.0mm	KX0-M7215-30

LAN cable with shield cloth (5m)

Model	KX0-M55G0-00

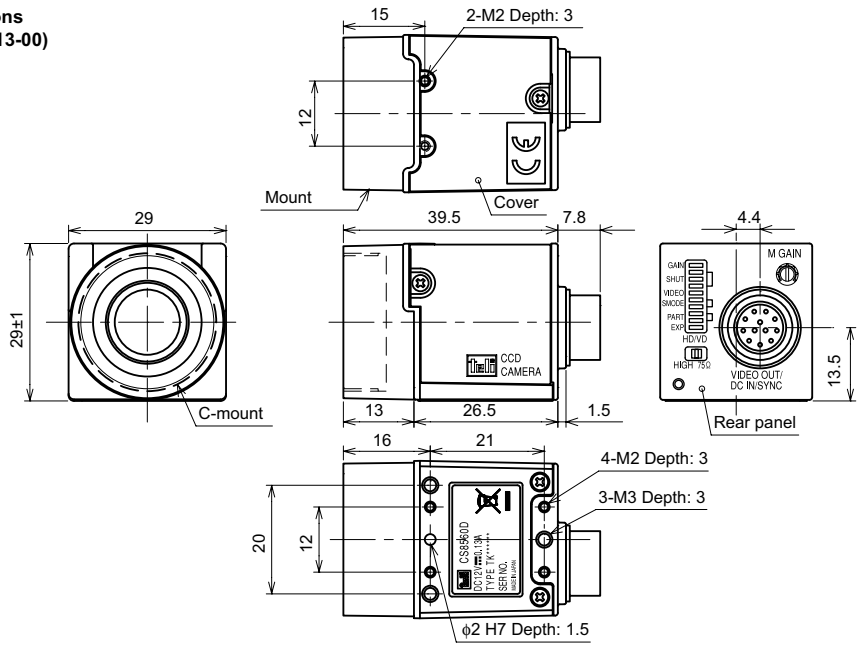
Tracking encoder cable (10m)

Model	KX0-M66AF-00

Dimensional outlines

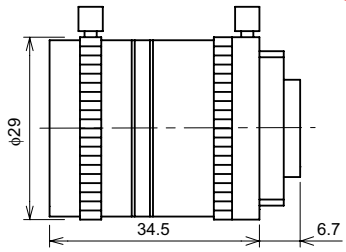
CCD camera

● **CCD camera dimensions**
(Model No. : KX0-M7913-00)

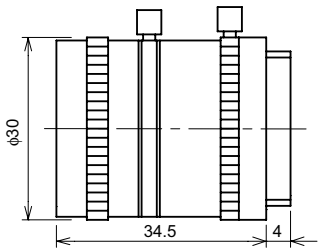


Lenses

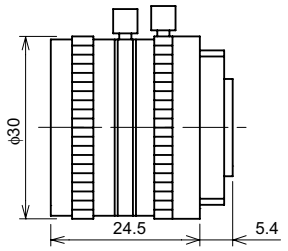
● **8mm lens [ML-0813]**
(Model No. : KM7-M7214-60)



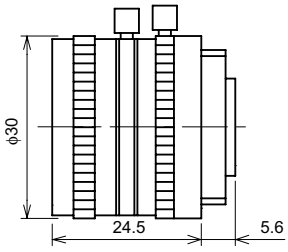
● **12mm lens [ML-1214]**
(Model No. : KM7-M7214-40)



● **16mm lens [ML-1614]**
(Model No. : KM7-M7214-30)



● **25mm lens [ML-2514]**
(Model No. : KM7-M7214-20)



Standard lens angle-of-view table

	Focal length (mm)	Aperture value (F No.)	Angle-of-view (degrees)		Closest approach distance (m)
			Vertical	Horizontal	
8mm lens [ML-0813]	8	F1.3-CLOSE	45.0	57.8	0.2
12mm lens [ML-1214]	12	F1.4-CLOSE	21.9	29.0	0.3
16mm lens [ML-1614]	16	F1.4-CLOSE	23.0	30.4	0.4
25mm lens [ML-2514]	25	F1.4-CLOSE	21.6	28.5	0.5

Note. Field-of-view table for our standard lenses. As the field-of-view widens, distortion on image edges may increase.

Viewing angle, WD, and magnification when using close-up ring

Close-up ring (mm)	8mm lens [ML-0813]				12mm lens [ML-1214]			
	Viewing angle (mm×mm)		WD (mm)	Magnification	Viewing angle (mm×mm)		WD (mm)	Magnification
	Vertical	Horizontal			Vertical	Horizontal		
None	72	96	148	0.05	77	103	248	0.05
0.5	32	43	59	0.11	41	55	125	0.09
	57	77	115	0.06	89	119	289	0.04
1	21	27	34	0.18	28	38	80	0.13
	29	38	52	0.13	45	59	136	0.08
1.5	26	34	22	0.24	21	29	57	0.17
	19	26	31	0.19	30	40	85	0.12
2	–	–	–	–	17	23	42	0.21
	–	–	–	–	22	30	59	0.16
5	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–

Close-up ring (mm)	16mm lens [ML-1614]				25mm lens [ML-2514]			
	Viewing angle (mm×mm)		WD (mm)	Magnification	Viewing angle (mm×mm)		WD (mm)	Magnification
	Vertical	Horizontal			Vertical	Horizontal		
None	82	109	358	0.04	65	87	458	0.06
0.5	48	64	206	0.07	48	64	338	0.08
	117	156	515	0.03	181	242	1270	0.02
1	34	45	143	0.11	38	50	269	0.10
	58	78	252	0.06	91	121	637	0.12
1.5	26	35	108	0.14	31	42	223	0.12
	39	52	164	0.09	60	81	425	0.06
2	22	29	86	0.17	27	36	191	0.13
	29	39	120	0.12	45	60	320	0.08
5	10	14	35	0.35	14	19	103	0.25
	12	16	42	0.31	18	24	130	0.20

Notes
- This table shows viewing angles when using the standard lens and close-up ring. (If no close-up ring this is closest approach.)
- If not using a close-up ring, then a WD smaller than the value in this table cannot be used.
- If using a close-up ring, then only a WD close to this value can be used.
- The values in this table are at most only a reference and do not signify an absolute index.
- To find viewing angle and WD other than for our standard lens, visit our website at: http://www.moritex.co.jp/products/.