TS3000 series Robot Controller

INSTRUCTION MANUAL

"VISION SENSOR + CONVEYOR" SYNCHRONIZATION FUNCTION

Notice

- Make sure that this instruction manual is delivered to the final   of Toshiba Machine's industrial robot.

- Before operating the industrial robot, read through and completely understand this manual.

- After reading through this manual, keep it nearby for future reference.

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STE80866

Introduction

This manual describes the "vision sensor + conveyor synchronization function used for Toshiba Machine's Industrial Robot Controller TS3000 (TS3100).

Section 1   General Descriptions
The outline and features of this function is described.

Section 2   Interface
The connecting method between the TS3000 (TS3100) controller and the conveyor encoder, vision sensor is described.

Section 3   Parameter Setting and Preparations
The setting procedures for the parameters exclusively used for the Ethernet function (ETHERNET. PAR) and the parameters used for the "Vision sensor + conveyor" synchronization function (CONVEYOR. PAR) are described.

Section 4   Setting Vision Sensor
Various vision sensor setting procedures for communication between the vision sensor and robot controller TS3000 (TS3100) are described.

Section 5   Programming and Teaching
The programming procedures for using the "vision sensor + conveyor" synchronization function are described.

Section 6   Operation
The utility function used for the "vision sensor + conveyor" synchronization function, and the procedures for stopping, resetting and restarting operations are described.

Section 7   Troubleshooting
The self-diagnosis function and troubleshooting of the "vision sensor + conveyor" synchronization function are described.

The contents of this manual are subject to change without prior notice to effect improvements. Various instruction manuals are available, including the Introductory, Startup, Operation, Robot Language, Interface, Communications, Transportation and Installation, and Maintenance manuals.   Refer to these manuals as necessary.

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Section 1
General Descriptions

1.1   Main Features of "Vision Sensor + Conveyor" Synchronization Function

(1)   What is the "vision sensor + conveyor" tracking?
The vision sensor recognizes workpieces running continuously over the conveyor, and the robot performs handling in line with the workpiece travel speed.

(2)   Features of "vision sensor + conveyor" synchronization function of TS3000 (TS3100)
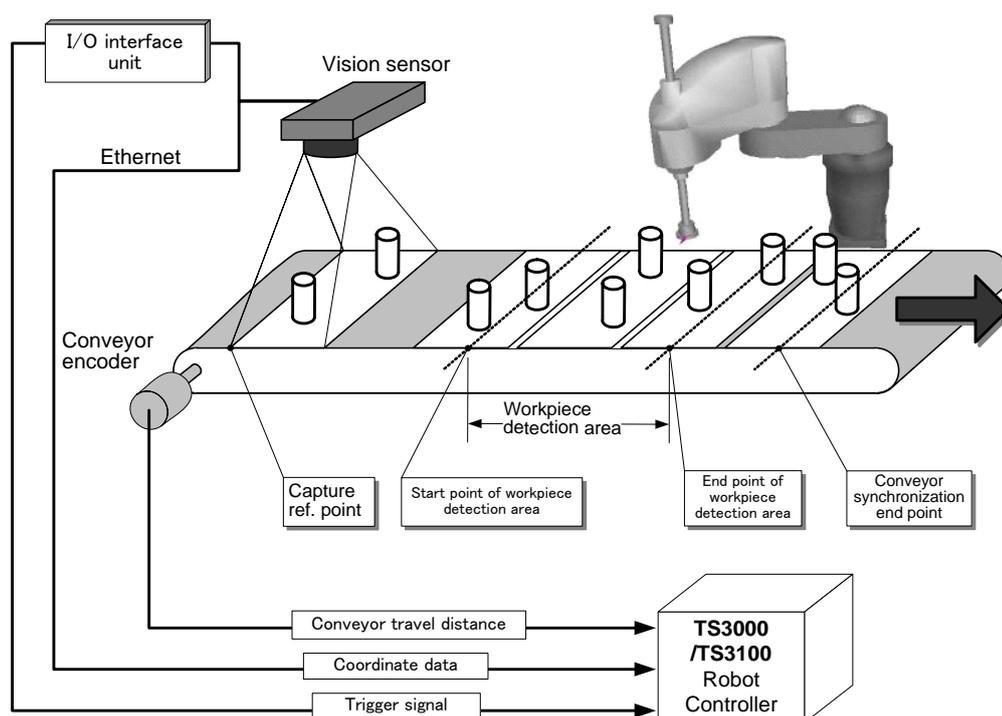
- It is possible to construct <u>a low-priced system using an existing vision sensor (designed for Ethernet)</u>.

- The robot can perform handling in line with conveyor (workpiece) speed, <u>without stopping the conveyor</u>.

- The robot performs handling of workpieces in turn, which are located in the workpiece detection area, from the downstream direction of the conveyor.

- The system automatically identifies each workpiece position on the conveyor.   (The user need not create a special program at all.)

- The robot can also perform discriminative handling in which it performs handling of only workpieces of specified type among workpieces of multiple types running on the conveyor.

- The robot is capable of performing sorting handling in which it randomly picks up workpieces of multiple types running on the conveyor to group them according to the type.

- Simple and plain programming is possible, using the exclusive language.

- Designed for multiple conveyors.   (For instance, the "vision sensor + conveyor" synchronization can be executed on conveyor 1, and the previous conveyor synchronization on conveyor 2.)

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1.2　　Differences from Previous System

1.2.1　Previous Conveyor Synchronization Function

<Processing flow>
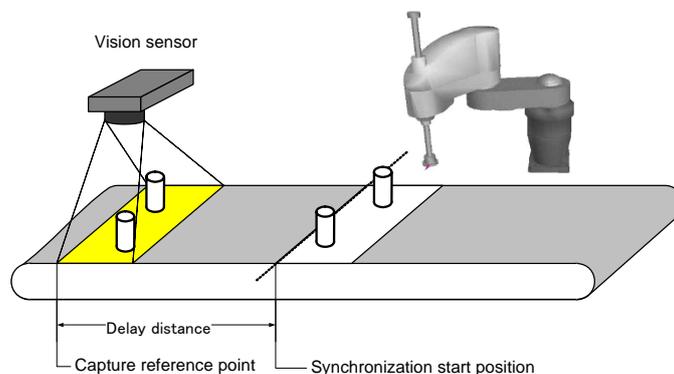
[1]　A workpiece is running on the conveyor.

[2]　The vision sensor detects it and presses the shutter release button.

[3]　The vision sensor sends the workpiece coordinates to the TS3000 (TS3100) controller.

[4]　The robot stands by until the workpiece reaches the start position of conveyor synchronization with the robot.

[5]　When the workpiece has arrived at the synchronization start position, the robot starts synchronizing with the conveyor.　　($\rightarrow$ SYNC)

[6]　The robot picks up the workpiece according to the coordinate data transmitted.

[7]　The synchronization finishes.　　($\rightarrow$ UNSYNC)
　　Hereafter, the above steps ([1] through [7]) are repeated.

<Points at issue>

(1) Communication time
 As workpiece coordinates X, Y and C (real number data) are sent to the controller via RS232C, communication processing speed and data size to be handled are limited.

(2) Waiting time
 The processing of conveyor synchronization starts the moment the vision sensor system has captured a workpiece.   Once the processing of synchronization has started, however, the system enters a standby state until the synchronization finishes, and the processing of next capture is not possible.

(3) Re-synchronization is not possible once synchronization has finished.
 Once the UNSYNC (synchronization finish) has been processed, all workpiece position data on the conveyor synchronized up till now are lost, and the SYNC (synchronization) processing cannot be performed repeatedly.

1.2.2   "Vision Sensor + Conveyor" Synchronization Function

<Processing flow>
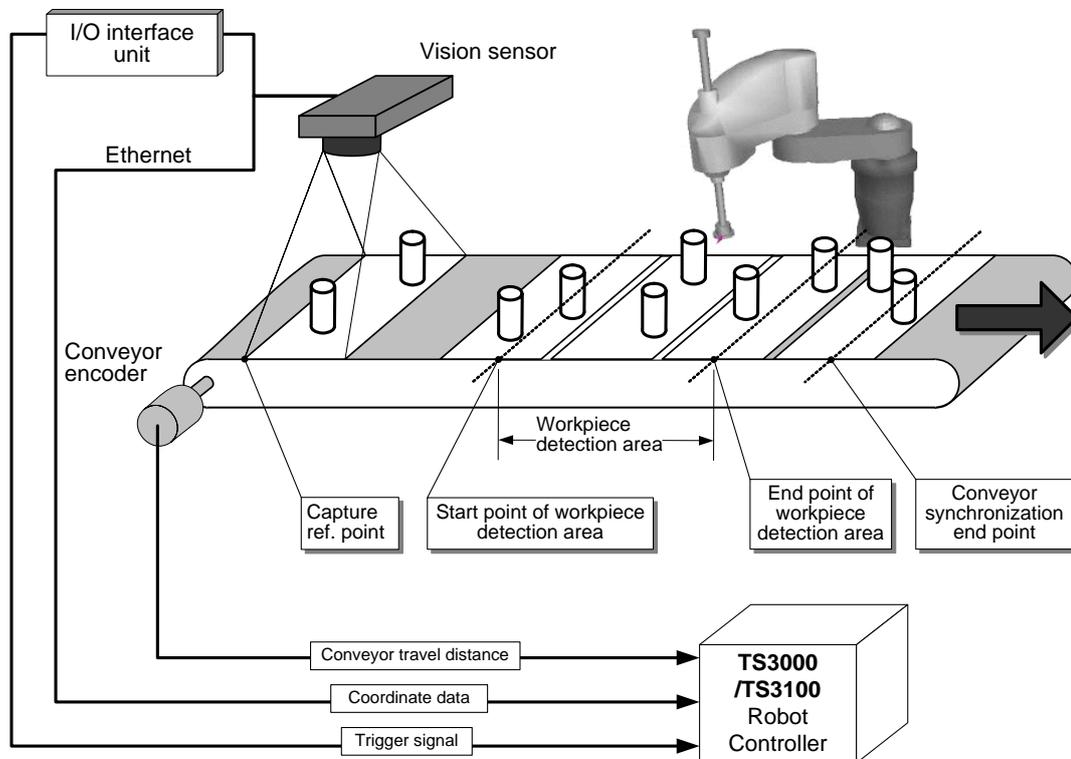
[1]   Workpieces are running on the conveyor.

[2]   Irrespective of workpiece presence or absence, the vision sensor presses the shutter release button on a regular basis.

[3]   The vision sensor sends the workpiece coordinates to the TS3000 (TS3100) controller each time it has captured a workpiece.

[4]   The TS3000 (TS3100) controller monitors each workpiece travel distance based on the conveyor encoder signal.

[5]   At the same time that each workpiece has entered the workpiece detection area (or when each workpiece is already present in the workpiece detection area), the robot starts synchronization with the conveyor.   Otherwise, the robot enters a standby state.

[6]   The TS3000 (TS3100) controller automatically calculates each workpiece coordinate position.   It is also possible to discriminate and sort out

workpieces by designating the detecting conditions (such as information on workpiece type).

[7]   The synchronization finishes.
       Hereafter, the above steps ([1] through [7]) are repeated.

<Improvements from previous specifications>

(1)   Communication time
       Due to processing of exclusive communication, using the Ethernet, the
       communication time can be shortened significantly.

(2)   Reduction in waiting time
       With each capture timing, tracking data (i.e., workpiece information sent
       from the vision sensor) is created internally, and it is possible to trace it.
       Thus, the vision sensor can capture workpieces successively without waiting
       synchronization finish.

(3)   Repeated synchronization is possible after synchronization has finished.
       Even after the UNSYNC (synchronization finish) has been processed,
       capture data on the conveyor remains saved, and the SYNC
       (synchronization) processing can be performed repeatedly for workpieces in
       the conveyor synchronization permit area.

(4)   Target position values during synchronization can be calculated
       automatically, using the exclusive language.
       In the past, the user had to create a SCOL program for setting target motion
       positions, based on the data sent through RS232C communication.
       When the exclusive target motion position command (VCPOS) is used,
       however, the target motion positions are calculated and set internally and
       automatically.

       Additionally, when VCVSEL1 ~ 3 and VCWSTAT1 ~ 3 (exclusive language)
       are used jointly, the robot can pick up workpieces while discriminating and
       sorting them out based on the workpiece type information, etc.

1.3   System Structure

1.3.1   System Structure 1

When using the software for vision sensor adjustment, connect in the following manner.
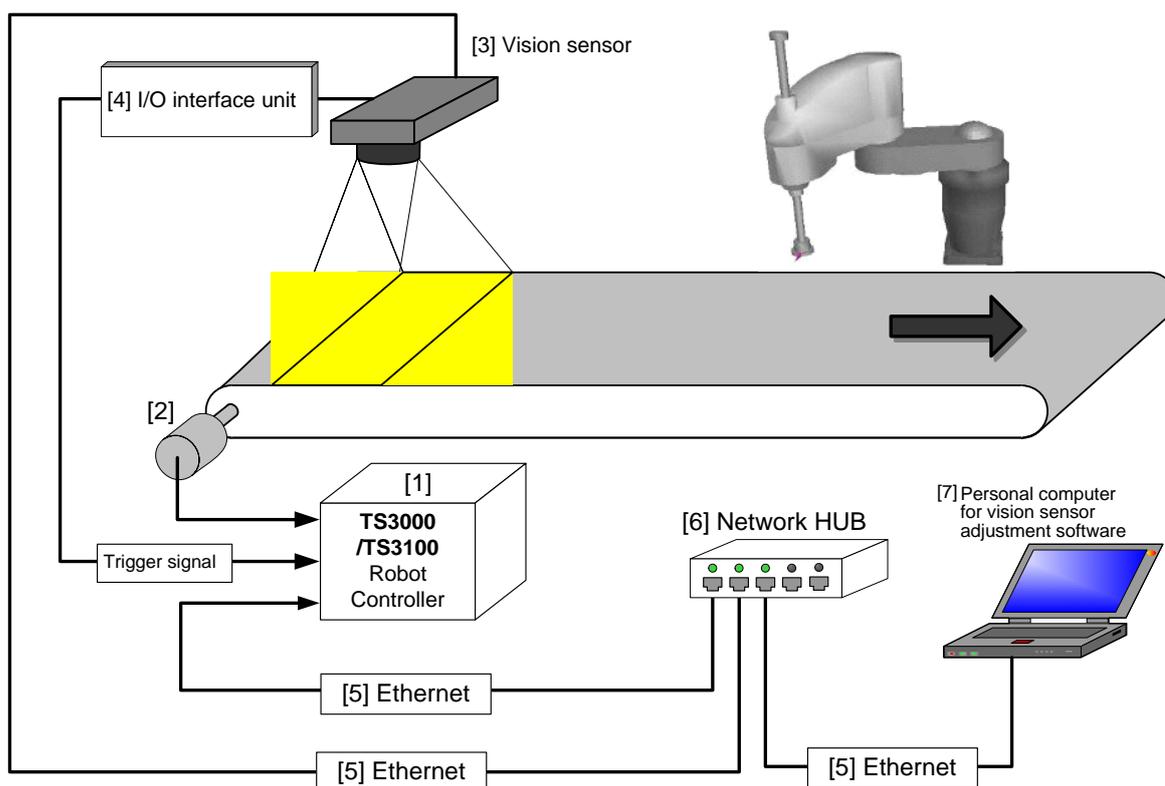
[1]	"Conveyor synchronization + Ethernet " for TS3000 (TS3100)
[2]	Conveyor encoder
[3]	Vision sensor designed for Ethernet.
[4]	Trigger signal output unit for vision sensor
[5]	Ethernet cable (straight cable)
[6]	Ethernet HUB
[7]	Personal computer for vision sensor adjustment software

1.3.2 System Structure 2

When connecting the vision sensor directly with the controller, connect in the following manner.
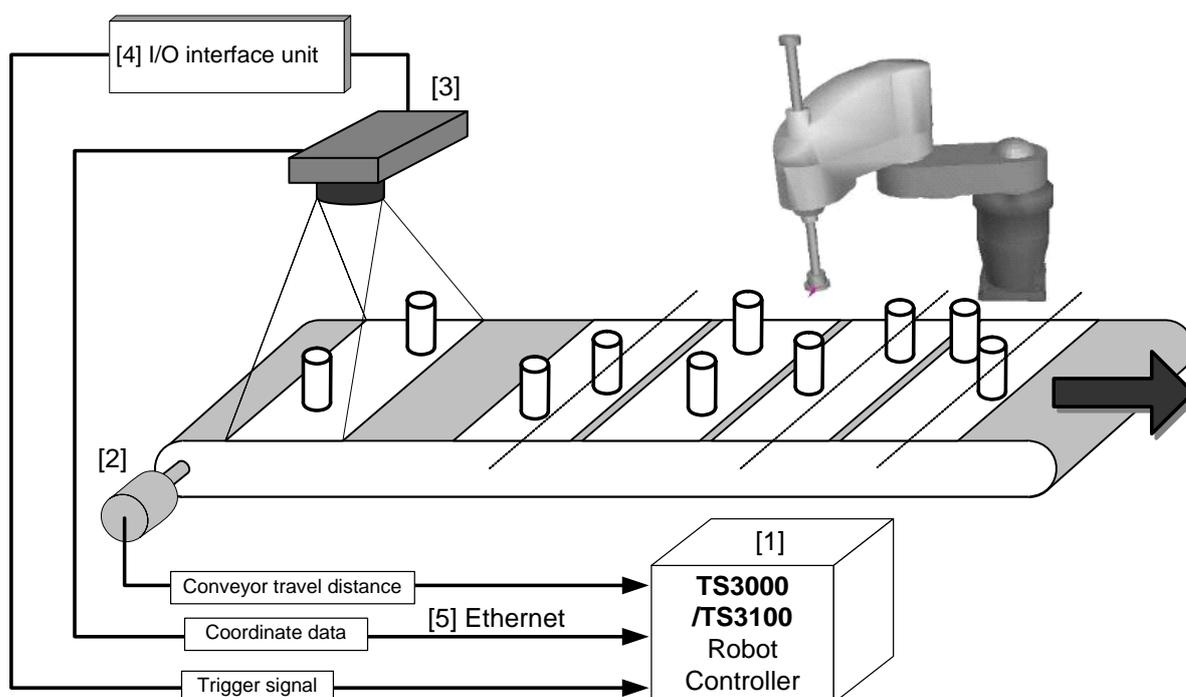
[1]	"Conveyor synchronization + Ethernet " for TS3000 (TS3100)
[2]	Conveyor encoder
[3]	Vision sensor designed for Ethernet.
[4]	Trigger signal output unit for vision sensor
[5]	Ethernet cable (straight cable)

1.3.3   System Structure 3

Pick up the work- piece from the conveyor(1CH), and place them to the tray on the conveyor(2CH).
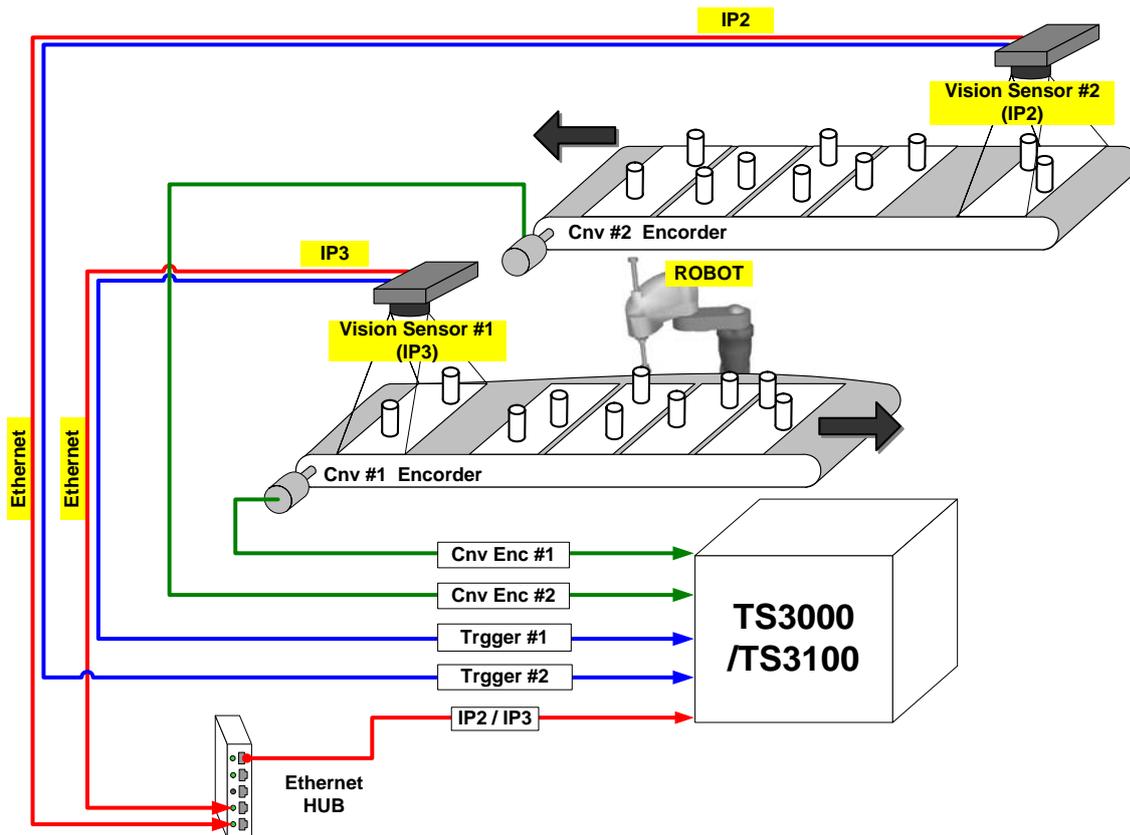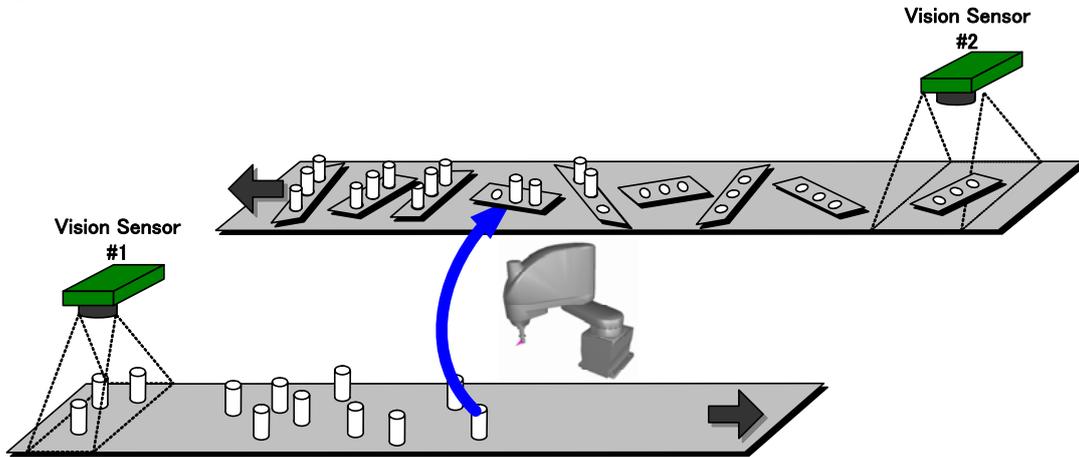
1.3.4   System Structure 4

Pick up the multi-typed work piece from the conveyor(1CH), and place them to the tray on the conveyor(Ch2).
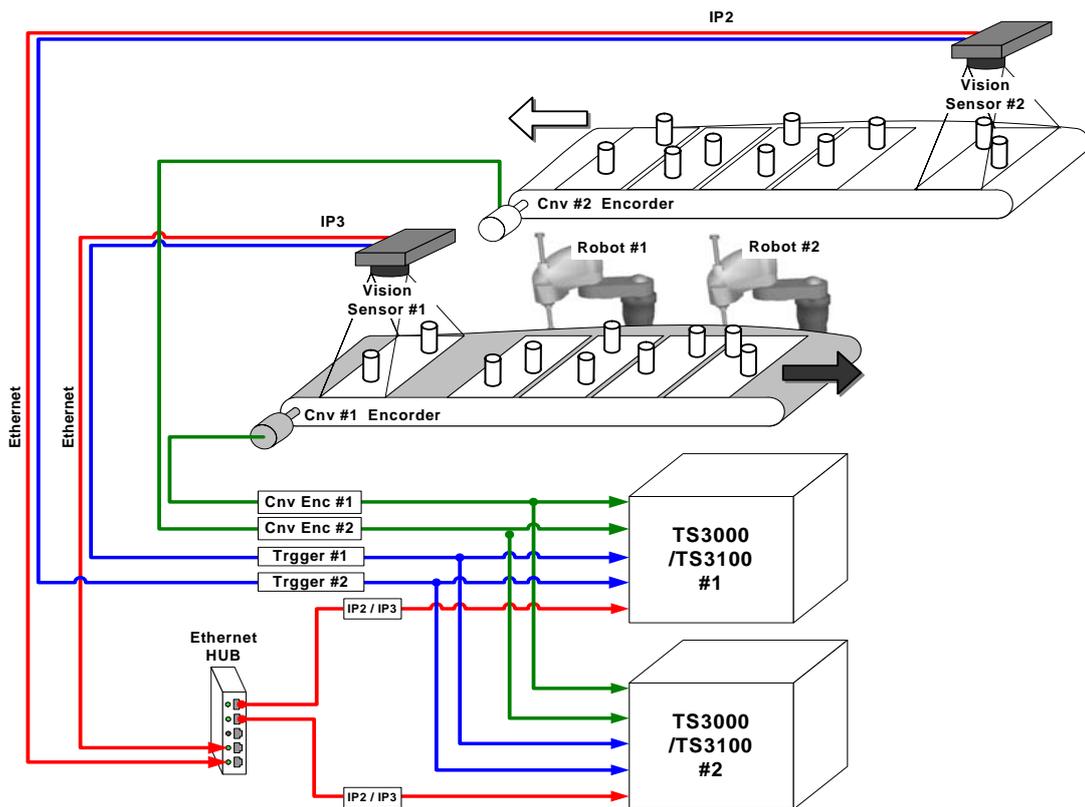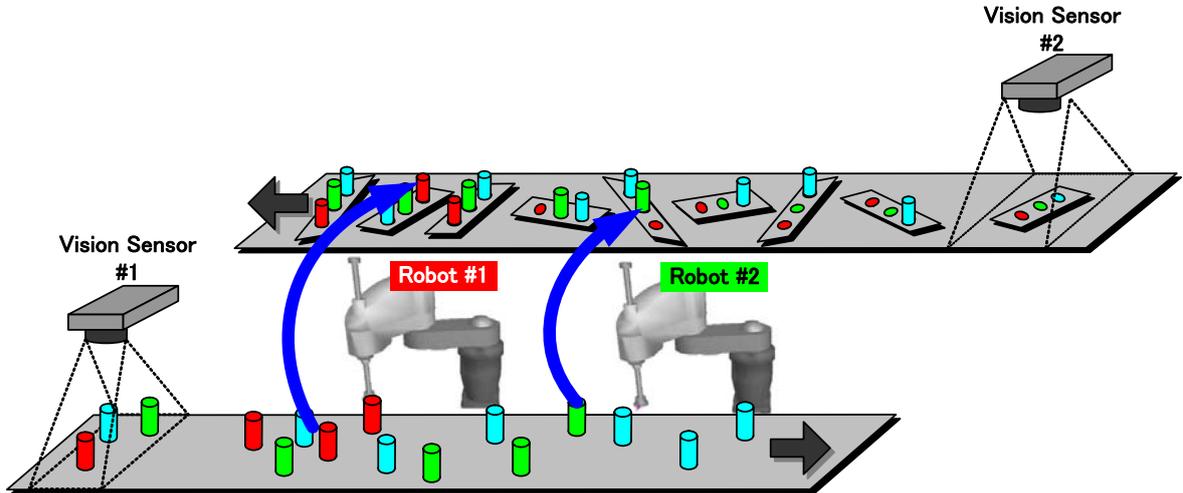
1.4   Programming Language

It is possible to automatically calculate the target motion values during conveyor synchronization, using the exclusive language.

All target motion values during conveyor synchronization are calculated internally and automatically, which are set in system variable VCPOS then.   (In the past, the user had to create the target positions during synchronization in the SCOL program, based on the data sent through RS232C communication.)

When VCVSEL1 ~ 3 and VCWSTAT1 ~ 3 (exclusive language) are used jointly, the robot can pick up workpieces while discriminating and sorting them out based on the workpiece type information, etc.

Language	Example of statement	Description
VCFUNC	VCFUNC=ON	Data receiving start switch ON: Receiving of data from the vision sensor starts. OFF: Receiving of data from the vision sensor finishes.
VCPOS	MOVES VCPOS MOVES VCPOS+POINT(,,100)	Target motion position during "vision sensor + conveyor" synchronization. All target motion positions during conveyor synchronization are calculated internally and automatically, which are then set in this system variable.
VCSEEK	IF VCSEEK==ON THEN ~	(A) Replies the presence or absence of next workpiece satisfying the detecting conditions (VCSEL1 ~ 3) in the workpiece detection area. ON: The next workpiece is present. OFF: The next workpiece is absent.

Language	Example of statement	Description
VCSEEK	IF VCSEEK==ON THEN ~	(B) If the next workpiece exists, its target motion position is set in VCPOS.
VCSEL1 ~ 3	VCSEL1=1 VCSEL2=0	Designates the detecting conditions when the next workpiece is to be detected by the VCSEEK or SYNC command.
VCWSTAT1 ~ 3	IF VCWSTAT1==1 THEN GOTO LP	Refers to the workpiece additional information of currently detected workpiece.
SYNC(N) N: Channel number	SYNC(1)	Conveyor synchronization start command. Starts conveyor synchronization when the workpiece has entered (or already exists in) the conveyor synchronization permit area. (In the previous system, at the same time that the synchronization start trigger signal has turned on, conveyor synchronization starts.)

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1.5   Setup Procedures

Set up the "vision sensor + conveyor" synchronization system according to the following flow chart.

```
                    ┌───────────┐
                   (   Start     )
                    └─────┬─────┘
                          │
             ┌────────────────────────┐
             │ Connection of          │      Connect the TS3000 (TS3100) with      → Section 2
             │ peripheral equipment   │      peripheral equipment (conveyor
             └────────────────────────┘      encoder, vision sensor, etc.).
                          │
             ┌────────────────────────┐
             │ TS3000/TS3100          │      Perform setting of Ethernet           → Section 3
             │ parameter setting      │      parameters (ETHERNET.PAR) and
             └────────────────────────┘      conveyor parameters
                          │                  (CONVEYOR.PAR).
             ┌────────────────────────┐
             │ Setting of             │
             │ vision sensor          │      Set the transmit data format, shutter → Section 4
             └────────────────────────┘      timing, data transmit protocol, trigger
                          │                  signal output, data output timing, etc.
             ┌────────────────────────┐
             │ Calibration            │
             └────────────────────────┘      Execute calibration (i.e., the work for → Section 4
                          │                  registering the robot coordinate
            NO       ◇ Communicate ◇        system in the vision sensor).
           ◄─────────◇ data normally? ◇
                          │
                        YES              Make sure of normal data receiving,
                          │              using the test program.
             ┌────────────────────────┐
             │ Programming            │
             │ and teaching           │
             └────────────────────────┘
                          │
             ┌────────────────────────┐      Create a program, using the "vision +  → Section 5
             │ Start and stop,        │      conveyor" exclusive language.
             │ Reset and restart      │
             └────────────────────────┘
                          │
            YES      ◇ Error         ◇      Operate the robot, using a created     → Section 6
           ◄─────────◇ generated?    ◇      program.
                          │
                         NO
                          │
                    ┌───────────┐            Stop the program.   When restarting    → Section 7
                   (   End       )           the program, reset the conveyor as
                    └───────────┘            necessary.
```

Section 2
Interface

2.1   Connecting Vision Sensor (Ethernet)

- The Ethernet function of the TS3000 (TS3100) controller supports the connection pursuant to the "10base–T".

- Communication with a personal computer and vision sensor on the Ethernet is possible in the same local area, using the "TCP/IP" protocol.

- The vision sensor is connected with the controller via Ethernet.

- The cable is connected to connector "Ethernet" provided on the rear side of the controller.

Ethernet interface connector

- When connecting the TS3000 (TS3100) controller with the vision sensor through the Ethernet HUB, use a straight cable.

- When connecting the TS3000 (TS3100) controller directly with the vision sensor, use a cross cable.

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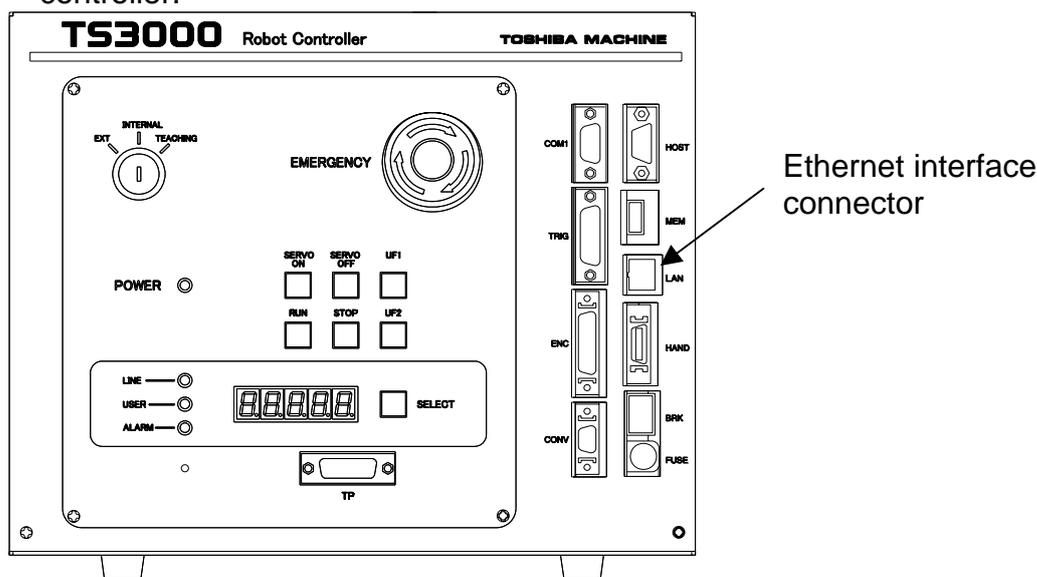
- The Ethernet function of the TS3000 (TS3100) controller can use four (4) ports (IP0 ~ 3). IP3 and IP2 are used for the communication processing of "Vision + conveyer synchronous function" among these.
- IP3 is used as the exclusive port for processing of "vision sensor + conveyor" synchronization protocol.   though "IP2" can be switched to "Non-Procedual processing port ". When setting the Ethernet IP address and each port, see Section 3.

<1CH Vision CV System>
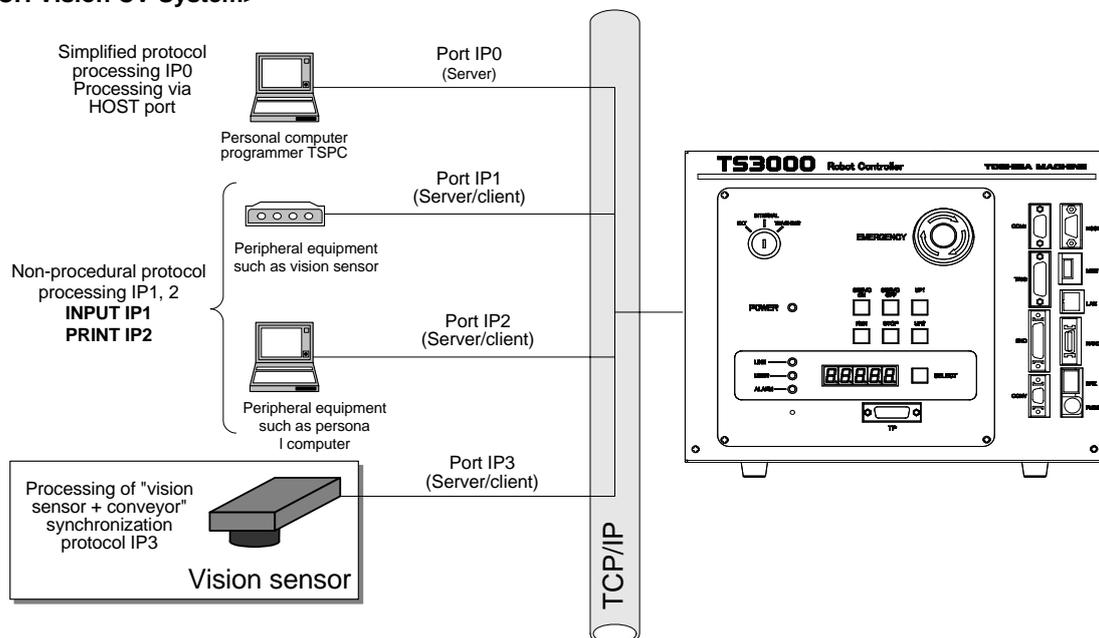
< 2CH VISION CV SYSTEM >
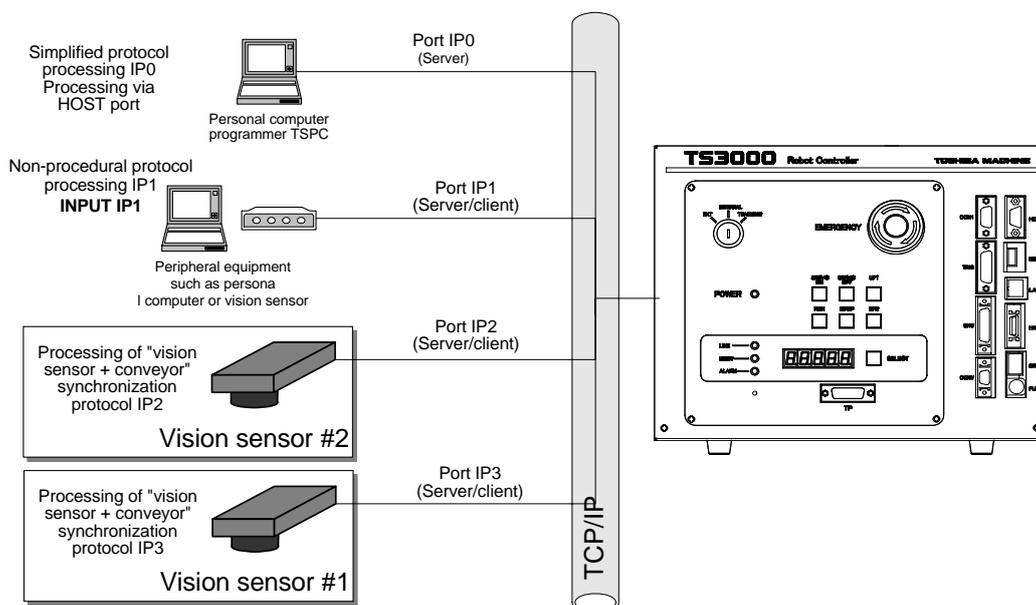
2.2   Connecting Trigger Input Signal

- The conveyor synchronization function detects the trigger signal by using this high-speed signal input to assure more accurate detection of the conveyor encoder position while the trigger signal is ON.

- The conveyor synchronization start trigger uses two (2) of the eight (8) high-speed inputs.   Connect the CH1 conveyor trigger to high-speed signal input INP0 and the CH2 conveyor trigger to high-speed signal input INP1.   (For details, see Fig. 2.1 ~ 2.3.)

- Also, when the high-speed input function is used for the conveyor synchronization start trigger switch, the remaining six (6) input switches other than the two (2) input switches become inoperative.   (When using eight (8) high-speed inputs, the position data latch function cannot be used together with the conveyor synchronization function.)

The high-speed signal input specifications of the TS3000 are shown below.

Table 2.1   High-speed signal input specifications

Item	Specifications
No. of inputs	Two (2) inputs (Of total eight (8) inputs, only two (2) inputs are used for the conveyor synchronization.)
Input specification	Transistor open collector input or non-voltage contact input
Input signal (See Fig. 2.1.)	CH1: INP0 CH2: INP1
Delay time	2.2 µsec (calculated value)

2.3 Circuit Structure

The circuit structures are shown below. As a bi-directional photocoupler is used in the input circuit, the source type (plus common) or the sink type (minus common) can be changed over.
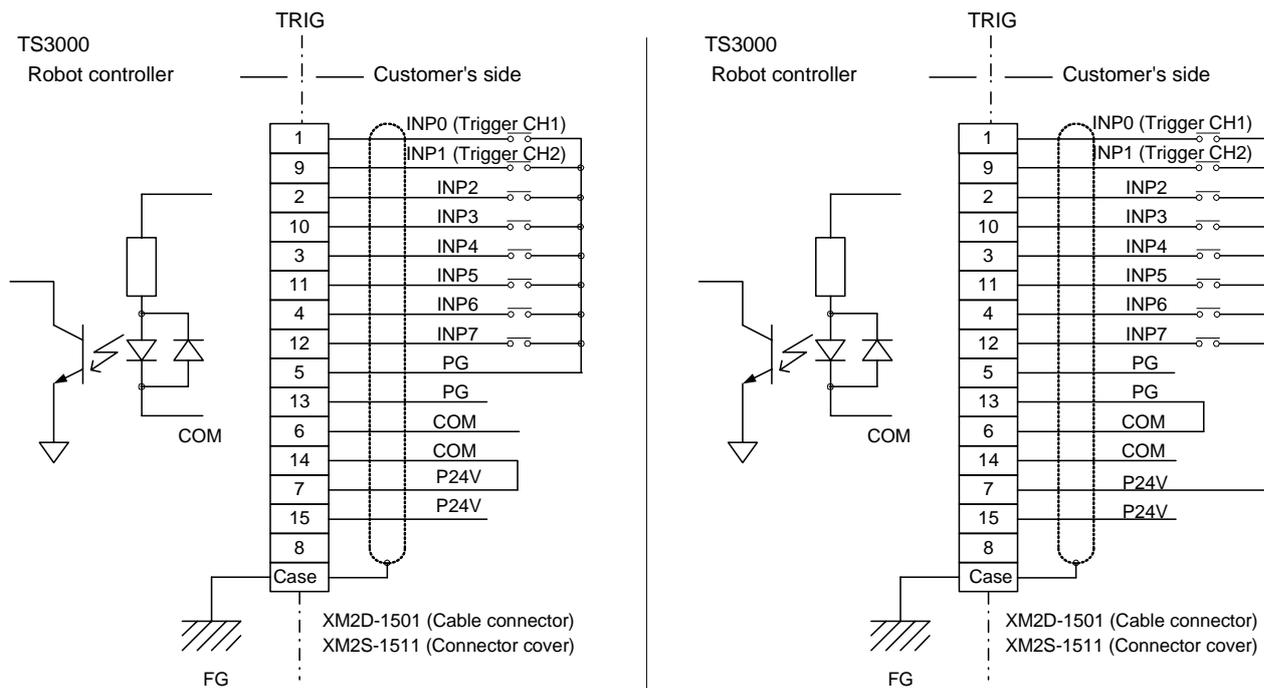
(a) Source type (plus common)   (b) Sink type (minus common)

Fig. 2.1 Connection of high-speed input circuit
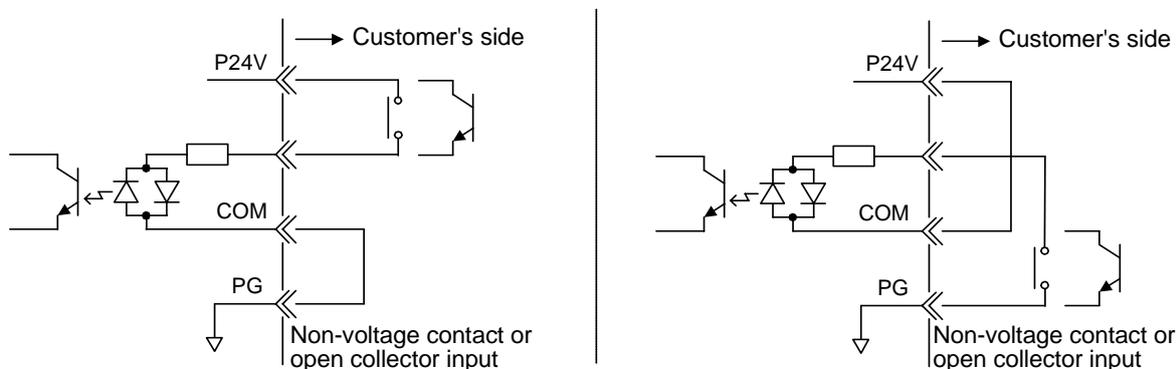
Fig. 2.2 Example of input signal circuit (when internal power supply is used)

2.3.1   Contact/Transistor Specifications

The contact/transistor connected with external device should satisfy the following specifications.

Table 2.2   Non-voltage contact/transistor specifications

Non-voltage contact specifications	Transistor specifications
Contact rating: DC24 V, 10 mA or over Circuit current: Approx. 7 mA Minimum current: DC24 V, 10 mA Connected impedance: 100 Ω or less	Voltage between collector and emitter: 30 V or over Current between collector and emitter: 10 mA Circuit current: Approx. 7 mA Leak current between collector and emitter: 100 μA

2.3.2   Example Connection of Conveyor Trigger Input Signals

Connect the conveyor synchronization start trigger switch to either of the high-speed input conveyor synchronization trigger switch 1 or 2.   The connection is shown in Fig. 2.3 and Fig. 2.4.
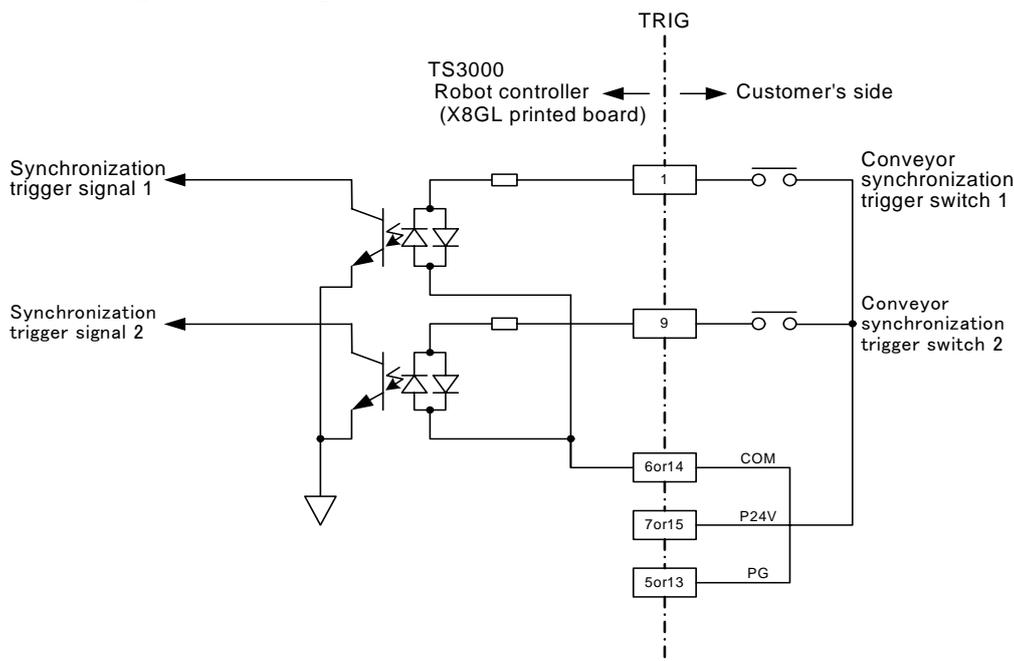
Fig. 2.3   Connection of conveyor synchronization start trigger switch
(internal power supply; minus (−) common)
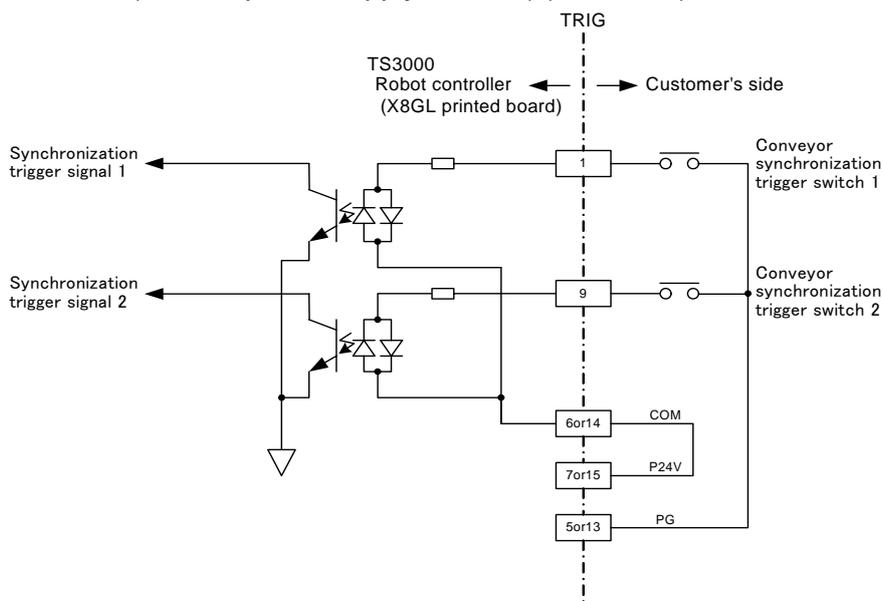
Fig. 2.4   Connection of conveyor synchronization start trigger switch
(internal power supply; plus (+) common)

2.3.3   Specifications of Conveyor Trigger Input Signal Cable

The specifications of the conveyor trigger input signal cable are shown below.

- Cable core   : $0.2\ mm^2 \sim 0.52\ mm^2$ twisted cable
- Cable outer diameter   :   Max. 9 mm
- Shield   :   Shield cluster
- Cable length   :   30 m or less

2.4   Connecting Conveyor Encoder

When the conveyor synchronization function of the TS3000 is used, the signal from the incremental encoder and input signal from the conveyor synchronization start trigger switch are required.

2.4.1   Incremental Encoder Specifications

Use such an encoder having phase A and B signals with 90° phase difference, whose output circuit is of an RS–422 differential output (line driver) type.

Table 2.3   Encoder specifications

Phases A/B maximum response frequency	250 kHz
Receiver IC	HD26LS32FP
Cable breakage detection	Provided

2.4.2   Incremental Encoder Connector Specifications

Connect the incremental encoder with CONV (*1) of TS3000.

*1:   Connector CONV on controller side: Type 52986–1479 made by Molex

Table 2.4   Connector and maker

Connector part name	Type and maker
Connector	54306–1419 (Molex)
Connector cover	54331–0141 (Molex)

For the connector signal array, see Para. 2.6.3.

2.4.3   Connection between Incremental Encoders

Use and connect a shield twisted pair cable as shown in Fig. 2.5 and Fig. 2.6.   If it is connected incorrectly, noise resistance deteriorates, causing a malfunction. When the robot controller external power supply is used, connect according to Fig. 2.5.   When the internal power supply is used, see Fig. 2.6.   (The encoder input comes in two (2) channels.   Use them when necessary.)
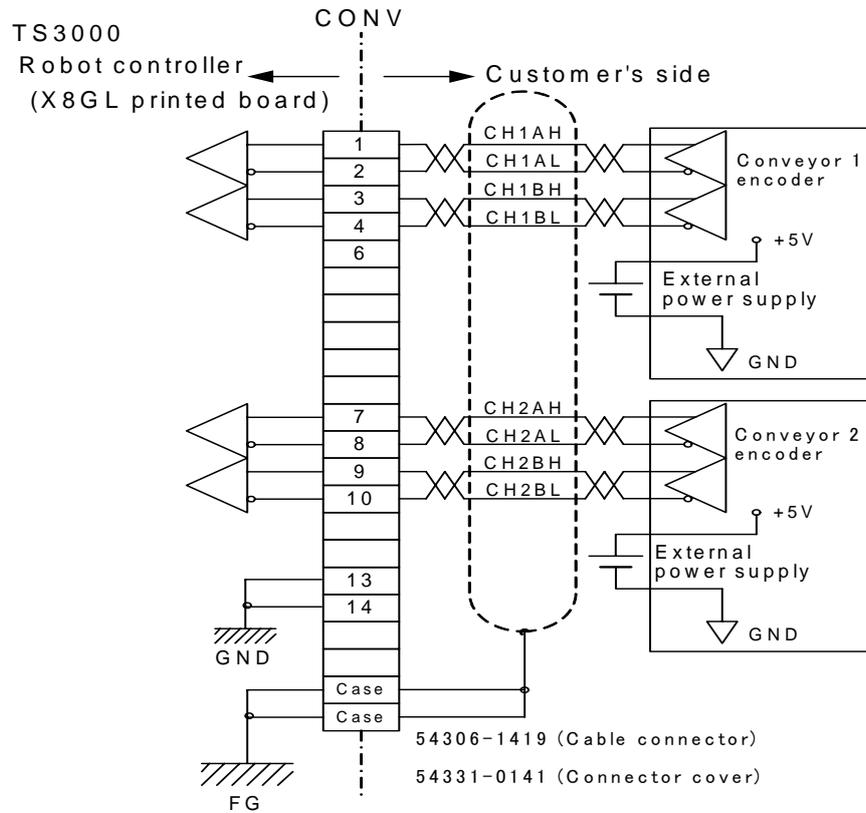
Fig. 2.5   Connection between incremental encoders (when external power supply is used)
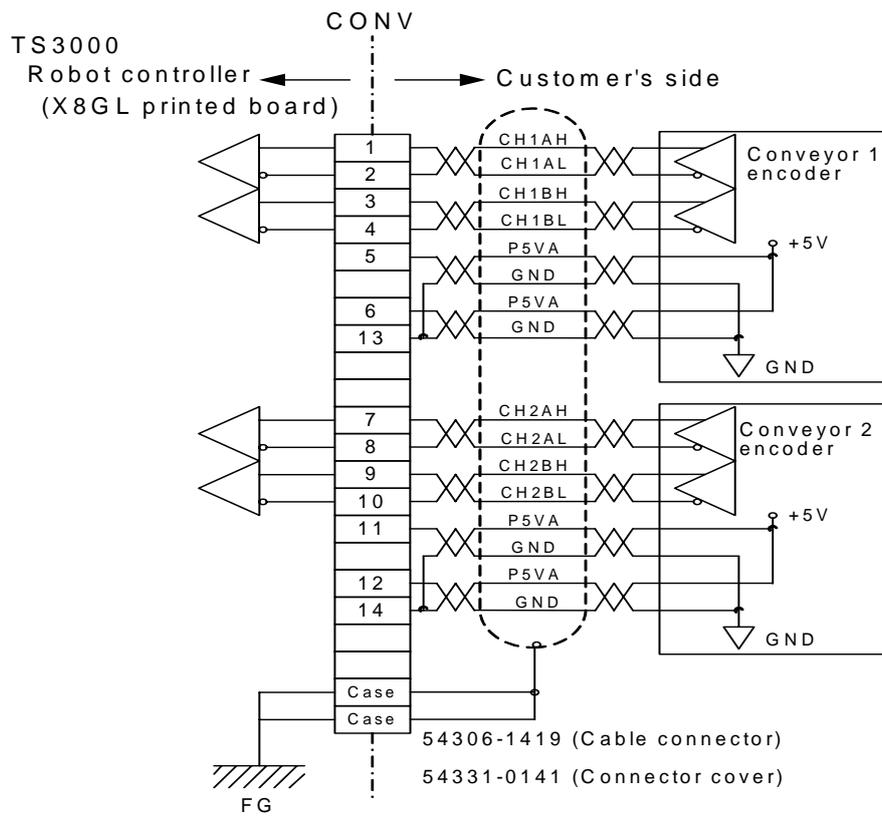
Fig. 2.6   Connection between incremental encoders (when internal power supply is used)

2.4.4 Relationship between Encoder Cable Length and Number of Power Supply Twisted Pairs

When +5 V supplied from the robot controller (i.e., printed board) is used for the encoder power supply, connect the cable, considering voltage drop in the cable.

[Example of calculating cable voltage drop]

When the allowable encoder voltage is taken as 4.5 V, relationship between the cable length and number of power supply twisted pairs is as shown below. (Assume that cable resistance is 110 Ω/km, encoder current consumption 150 mA and controller supply voltage 5 V.)

$$Ve = 5 - \frac{110}{1000} \times l \ \times 2 \times \frac{150}{1000} \times \frac{1}{p}$$

"Ve" indicates the encoder voltage, "l" the cable length, "2" the counts of reciprocations and "p" the number of twisted pairs.

From the above expression, it can be known that the allowable encoder voltage of 4.5 V can be assured under the following conditions.

No. of power supply twisted pairs	Cable length
1	15 m or less
2	30 m or less
3	45 m or less

When the cable of more than 45 m is required, therefore, the external power supply should be used.

The example of the above calculation is valid under the above conditions only. Figure out, referring to the example of the above calculation.   Especially, note that the current consumption differs with an encoder to be used.
If the external power supply is used, the cable length can be longer.   The maximum cable length should be 100 m, however, in terns of the signal.

2.4.5 Fabricating Cable

Fabricate a cable in the following manner.

a)   Incremental encoder cable specifications

- Core cable: $0.2 \text{ mm}^2 \sim 0.52 \text{ mm}^2$, twisted wires
- Cable outer diameter: Max. 8.5 mm
- Shield: Shield cluster
- Cable length: See Para. 2.6.4.

Use such a cable which satisfies the above specifications.   Otherwise, the robot may malfunction due to noise entry, in addition to fusing caused by short-circuit or overheating of the core cable.

b)   Fabricating a cable
The connector is of a solder cup type which solders wires.
To fabricate a cable, take careful precautions on soldering of the wires to the connector and shield processing, and refer to Fig. 2.7.

Housing

Soldering

10 mm

Bare wire length 2 mm

Shield

Cable clamp
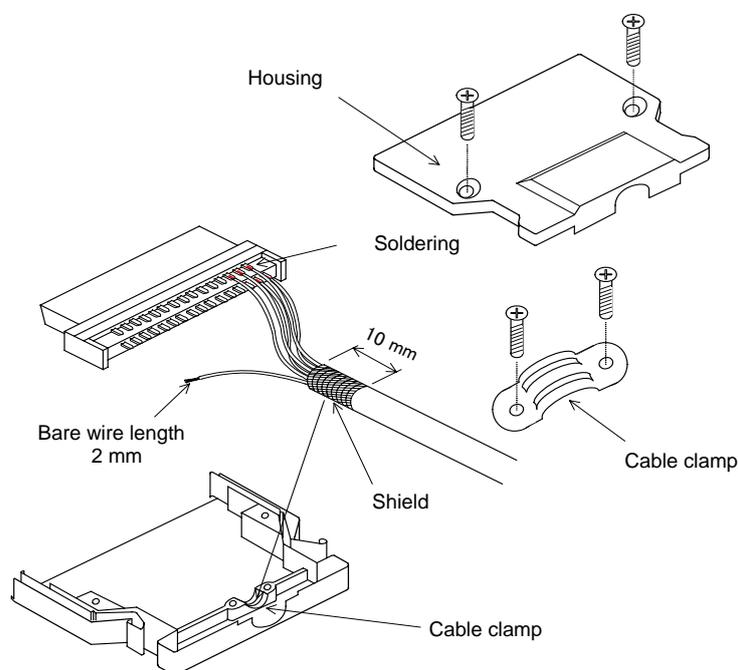
Cable clamp

Fig. 2.7   Fabricating a cable

Note: The shield of the cable is connected with the grounding terminal of the TS3000 (TS3100) robot controller through the housing.   <u>The shield should be connected with the housing completely in the cable clamping part.</u>

2.4.6   Defining Optimal Resolution of Encoder

The minimum processing period of conveyor synchronization is 3 msec.   If the number of pulses of the conveyor encoder, that can be sampled every this period is too small, the tracking accuracy to the conveyor will deteriorate.
Select the encoder so that [V_{pulse}: Number of sampling pulses per 3 msec] as calculated from the following equation is about <u>10 ~ 100 pulses</u>.

[V_{pulse}: Number of sampling pulses per 3 msec] can be figured out from the following equation.

$$V_{pulse} = \frac{3}{1000} \cdot Re \left(\frac{V_{CNV}}{\pi \cdot D} \cdot \frac{1}{G_m} \right) \qquad\qquad (1)$$

where,

<u>R_e: Encoder resolution (ppr)</u>
When the 2000 (ppr) resolution encoder is used, for instance, it is processed as 8000 (ppr) (i.e., 2000 multiplied by 4) in the TS3000 (TS3100) controller.

V_{CNV}: Conveyor speed (mm/sec)

Customer's desired conveyor speed

V_{CNV} = 50 (mm/sec)

D: Conveyor roller diameter (mm)

Customer's conveyor roller diameter

D = 100 (mm)
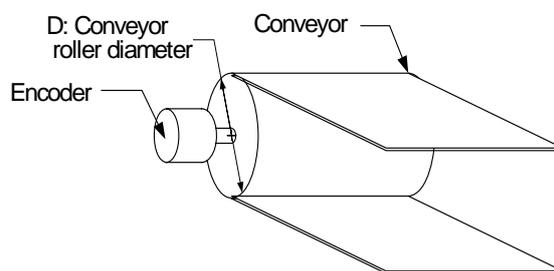
G_m: Reduction ratio (Conveyor roller speed / Encoder speed)

This value differs with the customer's encoder set conditions.

[Example]   When the encoder revolves 25 turns while the conveyor roller
revolves by one (1) turn:

G_m* = 1/25 = 0.04

*   The value of G_m (reduction ratio) should be exactly divisible.

From Expression (1) above, Expression (2) can be obtained.

$$R_e = V_{pulse} \cdot \frac{1000}{3} \cdot \frac{\pi \cdot D \cdot G_m}{V_{CNV}} \qquad (2)$$

When the values are substituted for V_{CNV}, G_m, D and V_{pulse} in Expression (2),
the optimal encoder resolution (R_e) is about 840 ~ 8400 (ppr).

Section 3
Parameter Setting and Preparations

3.1   Ethernet Parameter (ETHERNET.PAR)

Tabled below are the parameters used in the Ethernet function of the controller.

No.	Data	Description	Initial value (CH1/CH2)
1	[E00] OPEN MODE IP0–3: 0:NON 1:SERVER 2:CLIENT	Designates the open mode of the Ethernet port.	1000
2	[E01] ROBOT CONTROLLER IP ADDRESS	Specifies the robot controller's own IP address.	192.168.0.124
3	[E02] ROBOT CONTROLLER NAME	(Unused)	NO1-TS2K
4	[E03] SUBNET MASK	Specifies the subnet mask of the connected network.	255.255.255.0
5	[E04] DEFAULT GATEWAY	Default gateway address	192.168.0.1
6	[E05] OWN PORT NO	Specifies the controller side port number of each port.	
	IP0		1000
	IP1		1001
	IP2 : Vision CV (2CH)		1002
	IP3 : Vision CV (1CH)		1003
7	[E06] PORT NUMBER OF	Specifies the destination (i.e., server side) port number of each port. (To be specified only when the client mode is selected.)	
	IP0		1000
	IP1		1001
	IP2 : Vision CV (2CH)		1002
	IP3 : Vision CV (1CH)		1003
8	[E07] IP ADDRESS OF DESTINATION	Specifies the destination IP address of each port. (To be specified only when the client mode is selected.)	
	IP0		192.168.0.150
	IP1		192.168.0.151
	IP2 : Vision CV (2CH)		192.168.0.152
	IP3 : Vision CV (1CH)		192.168.0.153
9	[E08] ROBOT COMMUNITY NAME	Community name of the network.	NO1–TS2K
10	[E09] DHCP	Unused	0
11	[E10] HOST MODE FULL CONTROL PORT: 0:RS232C 1:ETHERNET	Unused	0

3.1.1　Ethernet Port Open Mode
　　　[E00] Open mode　IP0 IP1 IP2 IP3

Specify the open mode for the Ethernet port.

Data format	:	Integer type
Data unit	:	None
Data setting range	:	0 ~ 2
Data format	:	= (IP0)　　(IP1)　　(IP2)　　(IP3)
Example of value	:	= 1 0 0 0

```
        ┌──────┐      ┌──────┐
        │ 2CH  │      │ 1CH  │
        └──────┘      └──────┘
```
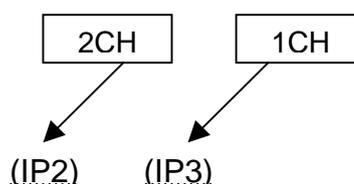
　0　:　Unused (not open)
　1　:　Server
　2　:　Client

As the IP0 is exclusively used for the simplified protocol, however, only the server mode ("1") can be specified for it.　If the external equipment is used as the server, specify "client" for the robot controller.　If it serves as the client, specify "server" for the controller.

3.1.2　Robot Controller IP Address
　　　[E01] Robot controller IP address

Specify the robot controller's own IP address.

Data format	:	Integer type
Data unit	:	None
Data setting range	:	0 ~ 255
Example of value	:	= 192.168.0.124

- The IP address is an address for identifying the controller.

- The IP address consists of four (4) numeric numbers between 0 and 255 and periods flanked by the numbers.　When directly connecting a single controller with a single personal computer connected to the network, the IP address can be the initial value (any value).　When connecting them via the existing LAN, however, specify the IP address according to the instructions given by the customer's LAN system manager.

- If the same IP address is used repeatedly, the Ethernet function will not work properly.

- The personal computer communicating with the robot controller should be connected on the same network.

3.1.3   Name of Robot Controller
[E02] Robot controller name

This parameter is not used currently.

3.1.4   Setting of Subnet Mask
[E03] Subnet mask

Specify the subnet mask of the network to be connected.

Data format   :   Integer type
Data unit   :   None
Data setting range   :   0 ~ 255
Example of value   :   = 255.255.255.0

When connecting via the existing LAN, specify the subnet mask according to the instructions given by the customer's LAN system manager.

3.1.5   Setting of Default Gateway Address
[E05] Default gateway

Specify the default gateway address.

Data format   :   Integer type
Data unit   :   None
Data setting range   :   0 ~ 255
Example of value   :   = 192.168.0.1

When connecting via the existing LAN, specify the default gateway address according to the instructions given by the customer's LAN system manager.

3.1.6 Setting of Controller Communication Port Number
[E06] Own port no

Specify the port number of each port used by the robot controller.

Data format   :   Integer type
Data unit   :   None
Data setting range :
Example of value   :   = 1000

The port number is something like the frequency of a radio.   Specify the port number for each of IP0 ~ IP3.   Take careful precautions not to use the same port number repeatedly.

Example:
{IP0}
= 1000
{IP1}
= 1001
{IP2}   ◀─── for Vision+CV (2CH)
= 1002
{IP3}   ◀─── for Vision+CV (1CH)
= 1003

3.1.7 Setting of Communication Port Number of Connected Equipment
[E07] Port number of destination

Specify the port number of each port used by the destination.   (This mode is valid only in the client mode.)

Data format   :   Integer type
Data unit   :   None
Data setting range :
Example of value   :   = 1000

• These port numbers should be made identical with the port numbers used by the destination server.

- The port number is something like the frequency of a radio.   Specify the port number for each of IP0 ~ IP3.   Take careful precautions not to use the same port number repeatedly.

Example:
{IP0}
= 1000
{IP1}
= 1001
{IP2}   ←——   for Vision+CV (2CH)
= 1002
{IP3}   ←——   for Vision+CV (1CH)
= 1003

3.1.8   Setting of IP Address of Connected Equipment
[E08] IP address of destination

Specify the IP address of each port connecting the destination.   (This mode is valid only in the client mode.)

Data format   :   Integer type
Data unit   :   None
Data setting range   :   0 ~ 255
Example of value   :   = 192.168.0.150

Example:
{IP0}
= 192.168.0.150
{IP1}
= 192.168.0.151
{IP2}   ←——   for Vision+CV (2CH)
= 192.168.0.152
{IP3}   ←——   for Vision+CV (1CH)
= 192.168.0.153

3.1.9 Community Name of Network
[E09] Robot community name

This parameter is not used currently.

3.1.10 [E10] DHCP

This parameter is not used currently.

3.1.11 Host Mode Full Control Port
[E11] Host mode FULL control port

Specify whether the RUN (program execution) command should be controlled via
RS232C communication or TCP/IP communication while the controller is in the
host mode.

Data format   :   Integer type
Data unit   :   None
Data setting range   :   0 or 1
Example of value   :   = 0

0: RS232C
1: Ethernet

3.1.12 Confirming Connection on Ethernet Utility Display

Before using the Ethernet function, confirm the following matters.

(1)   Make sure that the Ethernet cable between the robot controller and external equipment (personal computer, for instance) is connected properly.

(2)   Make sure that the Ethernet cable used is correct.

• When directly connecting the external equipment and robot controller, a cross cable should be used.

• When the HUB is used, a straight cable should be used.

(3)   Make sure that the parameters of the controller are set legally.

(4)   Make sure that the controller power was turned off once after the parameter setting.

Press the <UTILITY> key, and the system calls the following display

```
ROBOT  UTILITY




AUX      I/O      POS      TRANS   WK-TM   >
```
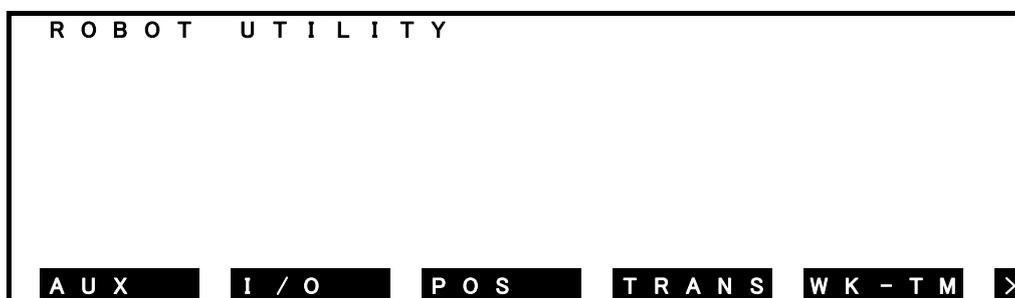
Press the <NEXT> key three (3) times, and the [ETHER] menu appears.

```
REORG   J-LIM   DATE    MOTOR   ENC           >

PLC-M   MEMOR   ZEROP   VER     CONV          >

ETHER                                         >
```
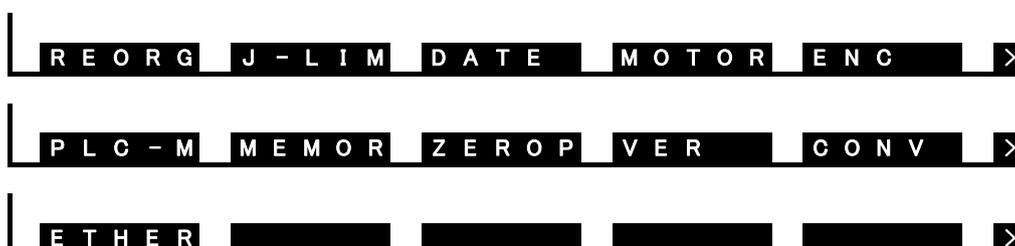
Press the [ETHER] key, and the system calls the following display.

```
E T H E R N E T   S T A T U S                          [ 1 / 3 ]


  I P   A D D R E S S              1 9 2 . 1 6 8 .     0 . 1 2 4
  S U B N E T   M A S K            2 5 5 . 2 5 5 . 2 5 5 .     0
  M A C   A D D R E S S                0 0 0 0 4 8 : 1 4 0 2 0 6
  F I R M W A R E       S 1 S 6 0 0 0 0 ╱ 0 0 0 1 : 0 0 : 2 0
```

IP ADDRESS   :   Controller's own Ethernet address as described in
                      Ethernet parameter [E01].
SUBNET MASK   :   Subnet mask as described in Ethernet parameter [E03].
MAC ADDRESS   :   Mac address.
FIRMWARE   :   Firmware version of Ethernet unit.

Press the <NEXT> key, and the following display appears.   Make sure that the
controller's own Ethernet address and subnet mask as specified by the
parameters beforehand are set.

```
E T H E R N E T   S T A T U S                          [ 2 / 3 ]
      O w n P o r t   C o n n e c t   I P             P o r t
I P 0     1 0 0 0     0 0 0 . 0 0 0 . 0 0 0 . 0 0 0   0 0 0 0 0
I P 1     0 0 0 0     0 0 0 . 0 0 0 . 0 0 0 . 0 0 0   0 0 0 0 0
I P 2     0 0 0 0     0 0 0 . 0 0 0 . 0 0 0 . 0 0 0   0 0 0 0 0
I P 3     0 0 0 0     0 0 0 . 0 0 0 . 0 0 0 . 0 0 0   0 0 0 0 0
```

2CH
1CH
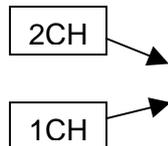
IP0 ~ IP3   :   Ethernet channel number.
OwnPort   :   Port number on the robot side.
Connect IP :   IP address of the destination.
Port   :   Port number of the destination.

On this display, status information on connection when the controller is
connected with external equipment is shown.

```
E T H E R N E T   S T A T U S                          [ 3 / 3 ]
        A p p .           M o d e           S t a t u s
I P 0   H O S T           T C P / S         L I S E N
I P 1   S C O L           T C P / C         C L O S E D
I P 2   S C O L           T C P / S         C L O S E D
I P 3   S Y S T E M       T C P / S         C L O S E D
```

2CH →
1CH →

IP0 ~ IP3	:	Ethernet channel number.
App.	:	Application name using each channel.
Mode	:	Type of protocol, open status.
Status	:	Change in Ethernet port status.

- App. (The application name using each channel is displayed.)
    HOST : Connection pursuant to the simplified protocol.
    SCOL : Connection pursuant to the non-procedural protocol.

- Mode (The open mode of each port is displayed.)
    TCP/S : Server connection as per the TCP protocol.
    TCP/C : Client connection as per the TCP protocol.

- Status (Change in Ethernet status is displayed.)
  For details on each status, refer to the TCP/IP manual, etc., commercially available.

    1 : Closed
    2 : Listen
    3 : Syn-Sent
    4 : Syn-Received
    5 : Established
    6 : Fin-Wait1
    7 : Fin-Wait2
    8 : Close wait
    9 : Closing
    10 : Last ACK
    11 : Time Wait

3.2   Conveyor Parameter 1
CONVEYOR.PAR: [C00] Conveyor Parameter

The conveyor parameters (CONVEYOR.PAR.: [C00] Conveyor Parameter) are exclusively used for the conveyor synchronization function.

No.	Data	Description	Initial value (CH1/CH2)	
	Conveyor Parameter 1 (CH1, CH2)			
1	Encoder rotating direction	Encoder rotating direction	0	0
2	Encoder sampling period [ms]	Encoder sampling period	3	3
3	Conveyor stop judgment time [ms]	Time for judging conveyor stop.	0	0
4	Type of conveyor synchronization	Type of conveyor synchronization 0 : Linear 1 : Circular (CW) 2 : Circular (CCW) 3 : Vision+Conveyor	0	0
5 ~ 7	Dummy data	Dummy data	0	0
	Conveyor Parameter 2 (CH1, CH2)			
8	Travel value per pulse of encoder [μm/pulse]	Travel distance per one (1) pulse of encoder	0.0	0.0
9	Rotation center position X of arc conveyor [mm]	X coordinate of arc conveyor rotation center position	0.0	0.0
10	Rotation center position Y of arc conveyor [mm]	Y coordinate of arc conveyor rotation center position	0.0	0.0
11 ~ 15	Dummy data	Dummy data	0.0	0.0

[U20] Conveyor Parameter

{Conveyor Parameter1(CH1,CH2)}

{Encoder rotating direction}

= 0   **0**

{Encoder sampling period [ms]}

= 3   **3**

{Conveyor stop judgment time [ms]}

= 0   **0**

{Type of conveyor synchronization}

= 0   **0**

　:   :

{Conveyor Parameter2(CH1,CH2)}

{Travel value per pulse of encoder [um/pulse] [mdeg/pulse]}

= 0.0   **0.0**

{Rotation center position X of arc conveyor [mm]}

= 0.0   **0.0**

{Rotation center position Y of arc conveyor [mm]}

= 0.0   **0.0**

{Limitation width of synchronization(inner)}

= 0.0   **0.0**

{Limitation width of synchronization(outer)}

= 0.0   **0.0**

　:   :

If " 3 " is set to 2CH side of parameter **{ Type of conveyor synchronization }**, 2CH's vision + conveyer synchronous function is enabled.

3.2.1 Encoder Rotating Direction

Data format   :   Integer type
Data setting range :   0 or 1
Example of value   :   0

The value of this parameter is decided according to the encoder specifications used and the rotating direction of the encoder set to the conveyor.
Press the <UTILITY> key, then select the [CONV] menu.   The following menu display appears.

```
( C O N V _ M O N )                 < C H 1 >           < C H 2 > 1 / 7
  C o n v   F o r m     : V I S I O N _ C V     L I N E A R
  C o n v   V e l o c   : - * * * * . * * *   - * * * . * * * *
  C o n v   S t a t u s :               0                 0
  E n c     P u l s e   :         3 2 7 6 7         3 2 7 6 7
  M e s     P u l s e   :         6 3 4 1 7               0
  M e s     T r i p     : - * *        * *   - * * * . * * * *
  M E S 1       M E S 2
```
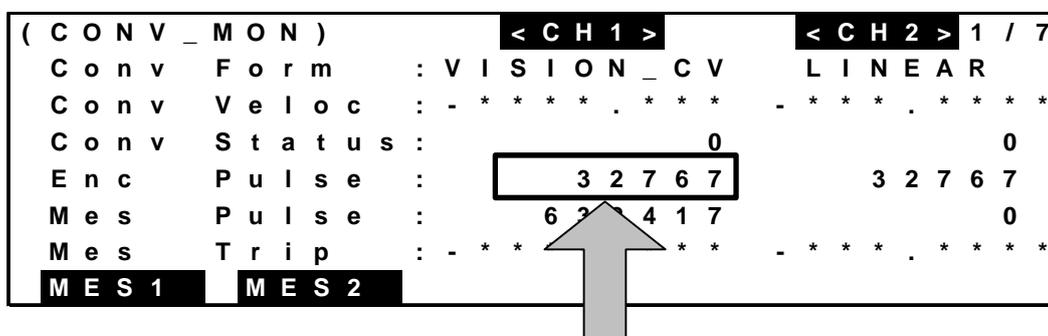
Run the conveyor and specify the value in the direction in which the value of [Pulse] increases.

When the value of [Pulse] increases while "0" is specified for the encoder rotating direction → Specify zero (0).

When the value of [Pulse] decreases while "0" is specified for the encoder rotating direction → Specify number 1.

3.2.2 Encoder Sampling Period

Data format   : Integer type

Data unit   : msec

Data setting range : 3 ~ 30000

Example of value : 3

This parameter specifies the period (*) during which the counter value from the encoder attached to the conveyor is obtained.

* As the arithmetic operation period of the conveyor synchronization function is 3 ms, the actual parameter value is a multiple of this arithmetic operation period (3 ms) whose fractions are ignored.

[Cautions]

The conveyor synchronization function calculates the synchronization travel distance at minimum periods of 3 msec (default).   It is also possible to specify a larger value, however.   Determine the value, taking note of the following.

When the value is decreased (minimum value 3 msec):
- The trackability for the conveyor speed improves.
- If this value is too small, however, the synchronization speed changes even with conveyor pulsation, which may result in vibration of the robot.

When the value is increased:
- The synchronization speed is less affected by conveyor pulsation.
- The conveyor rotating angle and arithmetic operation error can be absorbed.
- The trackability for the conveyor speed deteriorates.

Unless the pulsation is caused, specify the default value (3 msec).

Example:

When the conveyor sampling period is set to 15 msec, the synchronization travel distance is figured out based on the previous conveyor sampling period average speed (Vave).
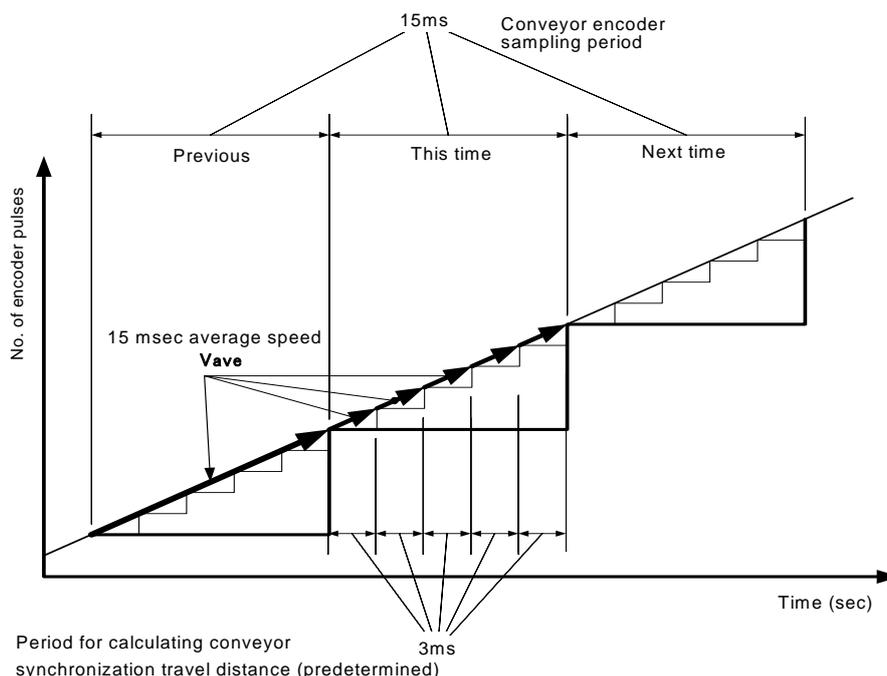
3.2.3   Conveyor Stop Judgment Time

This parameter specifies the conveyor stop judgment time.   Unless the encoder counter value changes during the time set by this parameter value, the system interprets that the conveyor is stopped, and outputs the error of "001−048: Conveyor Stop".   As this is the error of level 1, programmed operation continues.

Data format   :   Integer type
Data unit   :   msec
Data setting range :   0 ~ 30000
Example of value   :   3000

- Normally, the conveyor stop time is specified by the 2nd argument of the SYNC command.   Unless the 2nd argument is specified, the conveyor stop is judged with this parameter value.

- When the 2nd argument of the SYNC command is not specified and this parameter value is zero (0), the system will not judge the conveyor stop.

3.2.4   Type of Conveyor Synchronization

Data format   :   Integer type
Data setting range :   0 ~ 2
Example of value   :   0

This parameter specifies the type of the conveyor synchronization function.
Select a desired type from the following four (4) types.

0   :   Linear conveyor (Can be set for CH1 and CH2.)
1   :   Arc conveyor (CW) (Can be set for CH1 and CH2.)
2   :   Arc conveyor (CCW) (Can be set for CH1 and CH2.)
3   :   "Vision+ conveyor" synchronization function
                                       (Can be set for CH1 and CH2.)

For the "vision + conveyor" synchronization function, specify "3" for channel 1
(CH1) of this parameter.

Example)   = 3   1

3.2.5   Dummy Data

Data format   :   Integer type

Area reserved for the system.

3.2.6 Travel Distance per Pulse of Encoder

This parameter specifies the conveyor travel distance (µm) per one (1) pulse of the encoder set to the conveyor.

Data format   :   Real number type
Data unit   :   µm
Example of value   :   0

If the total number of encoder pulses is ∆P (pulse) when the conveyor moves by ∆L (µm), the conveyor travel distance per one (1) pulse of the encoder α (µm) can be calculated from the following equation.

$$\alpha = (\Delta L / \Delta P) * 1000$$

The total number of encoder pulses (∆P) can be obtained in the following manner.

(1)   Press the <MES1> (F1) or <MES2> (F2) function key corresponding to the channel (CH1 or CH2) through which you wish to measure, using the cursor.

```
( C O N V _ M O N )          < C H 1 >           < C H 2 > 1 / 7
  C o n v   F o r m     : V I S I O N _ C V      L I N E A R
  C o n v   V e l o c   : - * * * * . * * *    - * * * . * * * *
  C o n v   S t a t u s :              0                     0
  E n c     P u l s e   :        3 2 7 6 7           3 2 7 6 7
  M e s     P u l s e   :        6 3 2 4 1 7               0
  M e s     T r i p     : - * * * * . * * *    - * * * . * * * *
  M E S 1        M E S 2
```

To count the number of pulses of CH1, press [MES1].

(2) To count the number of pulses of CH1 or CH2, select [MES1] or [MES2], respectively.   After moving the conveyor by ∆L, press the <SET> key.

```
( C O N V _ M O N )              < C H 1 >        < C H 2 > 1 / 7
  C o n v   F o r m    : V I S I O N _ C V     L I N E A R
  C o n v   V e l o c  : - * * * * . * * *   - * * * . * * * *
  C o n v   S t a t u s :                0              0
  E n c     P u l s e  :          3 2 7 6 7        3 2 7 6 7
  M e s     P u l s e  :        6 3 2 4 1 7              0
  M e s     T r i p    : - * * * * . * * *   - * * * . * * * *
  M E S 1        M E S 2
```
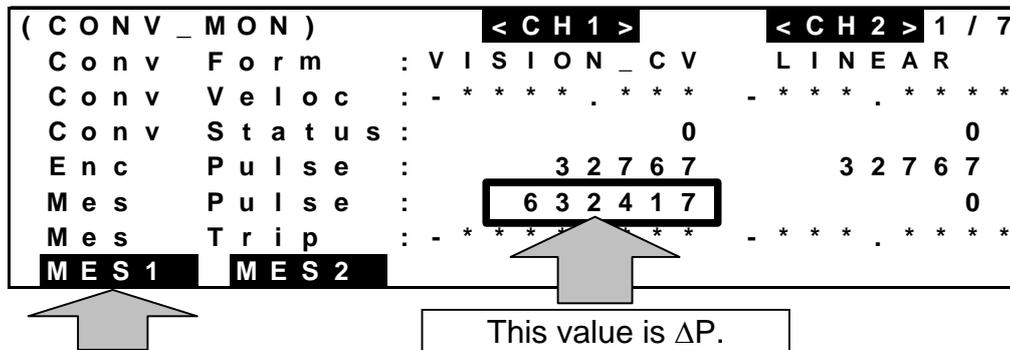
This value is ∆P.

(3) When you press the <SET> key, the present total number of pulses (Mes Pulse) is shown on the display.   Then figure out the travel distance per one (1) pulse (α μm) by substituting this value for "∆P" in the above equation. (To measure the value again, press the [MES1] or [MES2] key.)

3.2.7 Rotation Center Position X, Y of Arc Conveyor

This function does not use these parameters.

3.2.8 Dummy Data

Data format   :   Real number type

Area reserved for the system.

3.3   Conveyor Parameter 2
CONVEYOR.PAR: [C01] Vision + Conveyor Tracking Parameter

These parameters are exclusively used for the "vision sensor + conveyor" synchronization function.   This function is operative only when [3: "Vision sensor + conveyor" synchronization function] is specified for the type of conveyor synchronization of conveyor parameter [C00] described above.

"[C01] Vision + Conveyor Tracking Parameter" table

No.	Data	Description	Initial value (CH1/CH2)	
1	Delimiter Character	Delimiter of communication data 0 : Comma	0	0
2	Work sort function enable SW	Work data sorting function enable SW	0	0
3	Dummy data	Dummy data (integer)	0	0
4	Data reception timeout [ms]	Capture data receive timeup [ms]	0.0	0.0
5	Calibration Offset [mm]	Calibration offset [mm]	0.0	0.0
6	Detection area start point [mm]	Start point of workpiece detection area [mm]	0.0	0.0
7	Detection area end point [mm]	End point of workpiece detection area [mm]	0.0	0.0
8	Conveyor Sync limit point [mm]	Limit point of conveyor synchronization [mm]	0.0	0.0
9	Overlap allowance [mm]	Allowance for workpiece overlap [mm]	0.0	0.0
10	Capture width [mm]	Capture width [mm]	0.0	0.0
11	Calibration reference position (X)	Calibration reference point X coordinate [mm]	0.0	0.0
12	Calibration reference position (Y)	Calibration reference point Y coordinate [mm]	0.0	0.0
13 ~ 14	Dummy data	Dummy data (real number)	0.0	0.0

[U28] Vision + Conveyor Tracking Parameter(CH1,CH2)

{Delimiter Character (0:','   1:' ')}

= 0   0

{Work sort function enable SW (0:Disable, 1:Enable)}

= 0   **0**

　　:   :

{Data reception timeout [ms]}

= 0.0   **0.0**

{Calibration offset [mm]}

= 0.0   **0.0**

{Detection area start position [mm]}

= 0.0   **0.0**

{Detection area end position [mm]}

= 0.0   **0.0**

{Conveyor Sync limit position [mm]}

= 0.0   **0.0**

{Overlap allowance [mm]}

= 0.0   **0.0**

{Capture width [mm]}

= 0.0   **0.0**

{Calibration reference point (X)}

= 0.0   **0.0**

{Calibration reference point (Y)}

= 0.0   **0.0**

　　:   :

3.3.1   Delimiter Character

As only comma is used as the delimiter of communication data, this parameter is not used.

Data format   :   Real number type
Data setting range   :   None
Example of value   :   0 : Comma

3.3.2   Work data sorting function enable SW

"Workpiece data sorting function" is a function to rearrange the order of the received data from downstream to upstream of the conveyor. So the robot can process sequentially from the downstream of the conveyor, that As the robot can process an optimal picking without wasted motion.
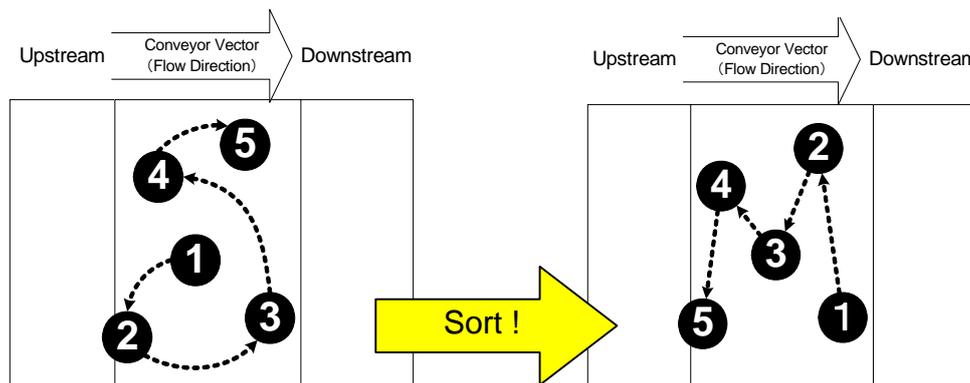
Data format   :   Integer type
Data setting range   :   0:Disable, 1:Enable
Example of value   :   0:Disable

3.3.3   Data Reception Timeout

.Conveyor parameter [C01] The "1-180: VCV Comm Process Timeout" error occurs when the data receive cannot be completed in Data reception time out (data receive time-out) setting time or less.   Conveyor parameter C01 of this function This function becomes disabled for "0.0" { Data reception timeout ms }

3.3.4   Calibration Offset [*1] [mm]

Calibration Offset is the parameter for specifying the length from the **capture area reference line** to **calibration reference line** in mm.
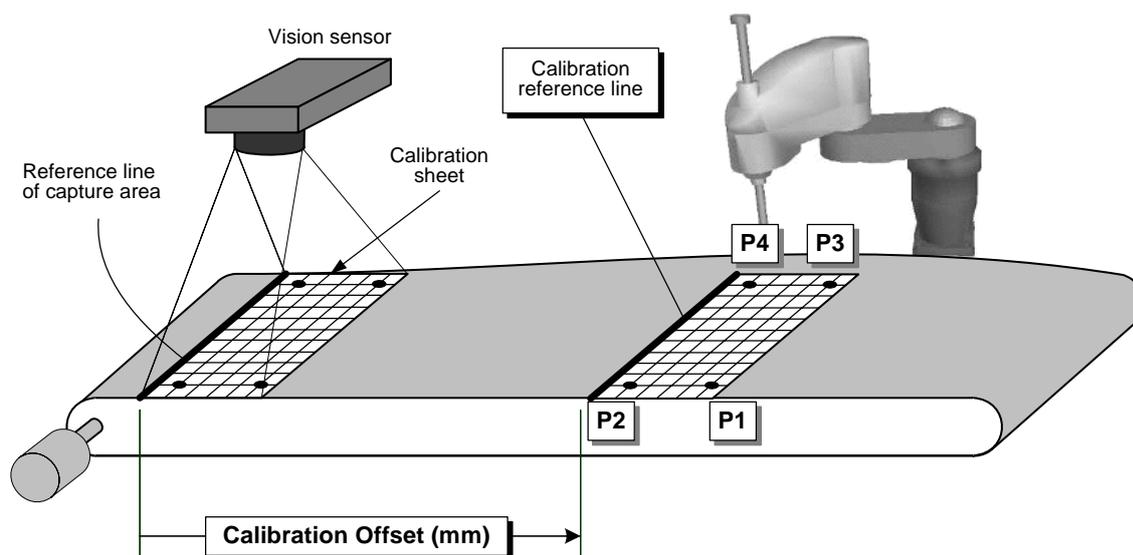
"Calibration" is the work for registering the robot's coordinate system in the vision sensor. Once the calibration is executed, using the vision sensor, all coordinates sent from the vision sensor are based on the world coordinate system of the robot.

> ## Outline of calibration
>
> (1)   Capture the calibration sheet by the vision sensor.
>
> (2)   Register Four (4) calibration points (P1 ~ P4) on the calibration sheet to the vision sensor.
>
> (3)   Move the conveyor to a position where the robot can reach the calibration sheet.
>   ⇒ This position is called the "calibration position".
>
> (4)   Move the end effector of robot to each calibration point (P1 ~ P4) in order to measure the point (P1 ~ P4) in the world coordinate system.
>
> (5)   These four (4) calibration points (P1 to P4) are taught the vision sensor.
>
> *:   For details on the calibration procedures, see Section 4.3.

[*1] It can also be set by directly editing parameter USER.PAR.   When using the UTILITY function, however, parameter setting is very easy.   For details, see Para. 6.1.

3.3.5 Detection Area Start Point (*) [mm]

3.3.6 Detection Area End Point (*) [mm]

3.3.7 Conveyor Sync Limit Point (*) [mm]

* It can also be set by directly editing parameter CONVEYOR.PAR. When using the UTILITY function, however, parameter setting is very easy. For details, see Para. 6.1.

| Capture area | Start point of workpiece detection area | Workpiece detection area | End point of workpiece detection area | Conveyor synchronization limit point |
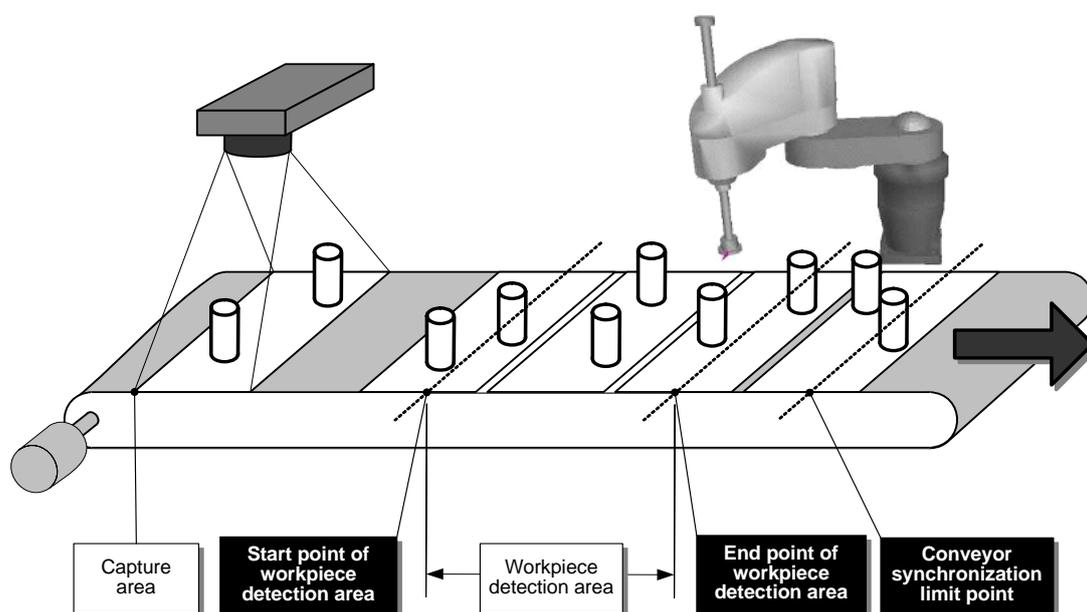
Start point of workpiece detection area	:	Specify the distance from the capture reference point to the start point of workpiece detection area in mm.
End point of workpiece detection area	:	Specify the distance from the capture reference point to the end point of workpiece detection area in mm.
Conveyor synchronization limit point	:	Specify the distance from the capture reference point to the conveyor synchronization limit point in mm.

♦　About the workpiece detection area:

- When workpieces running on the conveyor have entered the <u>workpiece detection area</u>, the robot starts tracking the conveyor.
- At the same time that the robot starts tracking the conveyor, it moves to the position of a workpiece which is located most downstream.

- Unless a workpiece exists in the <u>workpiece detection area</u>, the robot will not start synchronizing with the conveyor.　The next workpiece stands by in the workpiece area.

♦　About conveyor synchronization limit point:

- When the robot apex position has passed the <u>conveyor synchronization limit point</u> after the robot started synchronizing with the conveyor, it finishes the synchronization.

3.3.8   Overlap Allowance [mm]

If the distance "Δw" between the workpieces detected next and previously is smaller than the overlap allowance (mm), the system interprets that the next and previous workpieces are the same workpiece, and ignores the next workpiece.

Δw

Next workpiece   Previous workpiece

3.3.9   Capture Width [mm]

Specify the width of an image captured by the vision sensor.

Vision sensor

Capture area
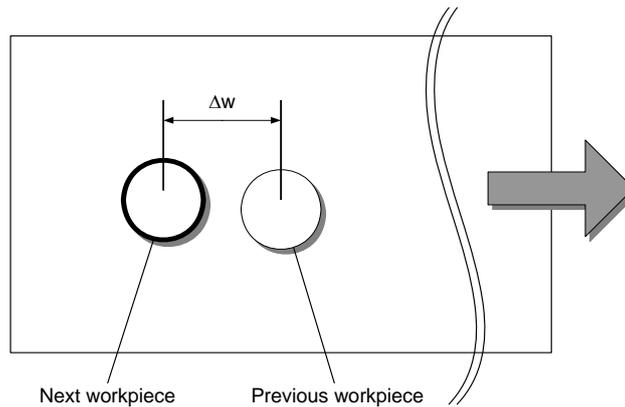
Width of capture (mm)
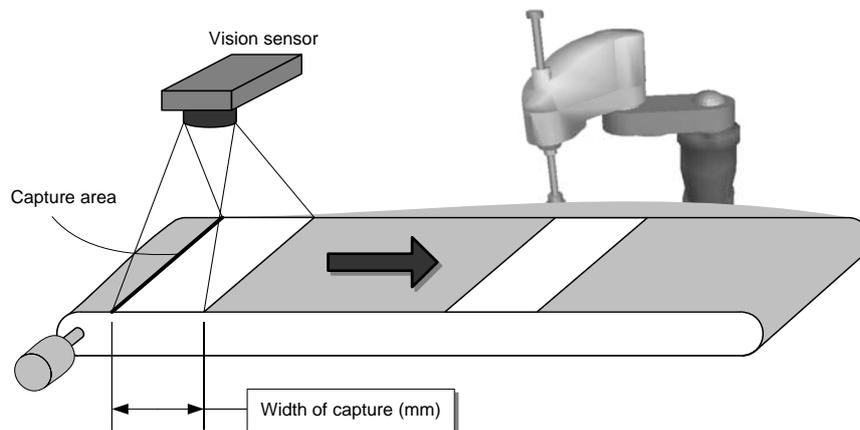
3.3.10 Calibration Reference Position (X)

3.3.11 Calibration Reference Position (Y)

The calibration reference position (X, Y) is <u>any position in the world coordinate system, which is located on the calibration reference line</u>. By registering this reference position, it is possible to make the robot controller recognize the relationship between the capture area reference line of vision sensor and the calibration position.

For the calibration reference position (X, Y), specify the position (X, Y) in mm in the world coordinate system of the robot. (For the setting procedures, see Para. 4.3.)
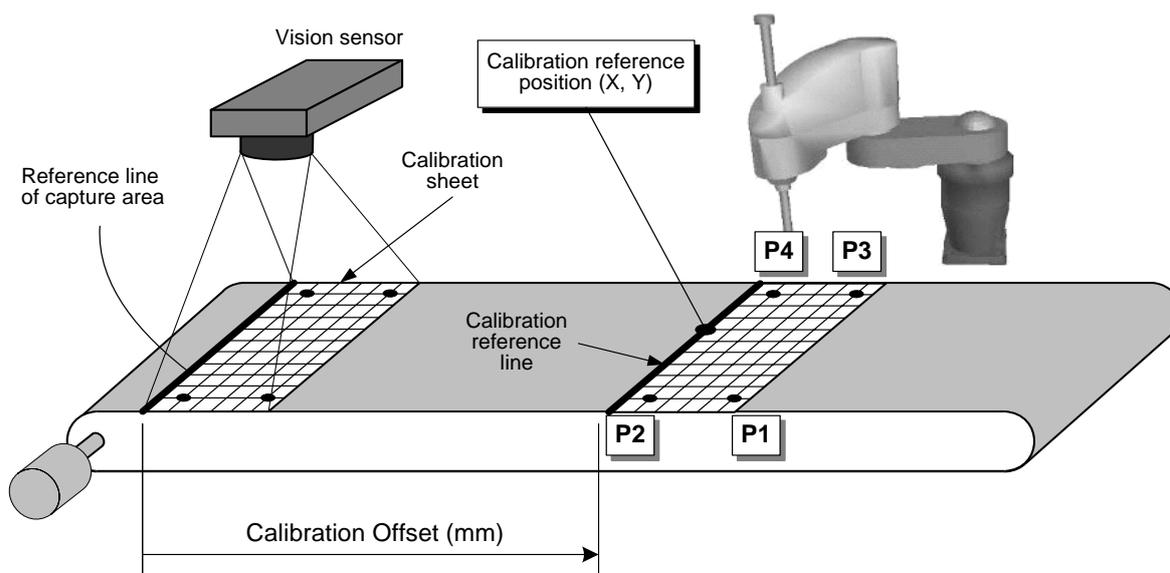
3.3.12 Dummy Data

Data format   :   Real number type

Area reserved for the system.

Section 4
Setting Vision Sensor

This section describes the various setting procedures on the vision sensor side to perform communication between the vision sensor and robot controller TS3000 (TS3100).

4.1   Trigger Signal and Data Transmission Process

Set the vision sensor so that the trigger signal and data can be transmitted to the TS3000 (TS3100) according to the following process.

Data type	Description
short	No. of data
float	X coordinate data of w orkpiece 1
float	Y coordinate data of w orkpiece 1
float	C coordinate data of w orkpiece 1
short	Additional data 1 of w orkpiece 1
short	Additional data 2 of w orkpiece 1
short	Additional data 3 of w orkpiece 1
:	:
float	X coordinate data of w orkpiece 10
float	Y coordinate data of w orkpiece 10
float	C coordinate data of w orkpiece 10
short	Additional data 1 of w orkpiece 10
short	Additional data 2 of w orkpiece 10
short	Additional data 3 of w orkpiece 10
Char	"CR" (End code)

[1]   The vision sensor captures a workpiece.

[2]   <u>The trigger signals is output to the robot controller.</u>
(It is ideal that the trigger signal is output with the timing that the vision sensor
has obtained coordinate data.)

[3]   Coordinate data are sent to the controller via Ethernet.
(<u>Send the data more than 10 msec after</u> the trigger signal is sent.)

4.2   Transmit Data Format

The data format is predetermined as shown below.

Data type	Name	Description	
Integer	Num	No. of data	
Real number	x	X coordinate data of workpiece 1	Workpiece coordinate data (X, Y, C)
Real number	y	Y coordinate data of workpiece 1	
Real number	c	C coordinate data of workpiece 1	
Integer	Opt1	Additional data 1 of workpiece 1	Workpiece additional data (workpiece type, etc.)
Integer	Opt2	Additional data 2 of workpiece 1	
Integer	Opt3	Additional data 3 of workpiece 1	
:	:	:	
Real number	x	X coordinate data of workpiece 10	
Real number	y	Y coordinate data of workpiece 10	
Real number	c	C coordinate data of workpiece 10	
Integer	Opt1	Additional data 1 of workpiece 10	
Integer	Opt2	Additional data 2 of workpiece 10	
Integer	Opt3	Additional data 3 of workpiece 10	
Char	"CR"	"CR" (End code)	

Max. 10 (per each capture)

[1]   Data format   : ASCII code
[2]   Delimiter   : Separation by comma (,)
[3]   End code   : CR (End code)

<Example format>

10 , **400.0** , **-50.0** , **0.0** , **1** , **2** , **3** , **…..** , **CR**

No. of data   Workpiece 1   Workpiece 1 additional   End code
               coordinates (X, Y, C) data (1 ~ 3)
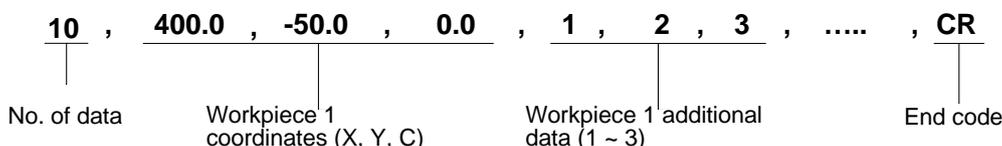
< MAXISMUM Number of reception data >

10 workpiece data can be sent by one transmission. The error "001-178: VCV Comm data format error" occurs when over 10 data is sent,   and the sent data is canceled automatically. Robot doesn't stop even if this error occurs.

< Work Data sorting function >

Robot picks workpieces romdamly if the order of the reception of data is random. The workpiece data sorting function is effective to process the workpiece from the downstream of the conveyer sequentially.
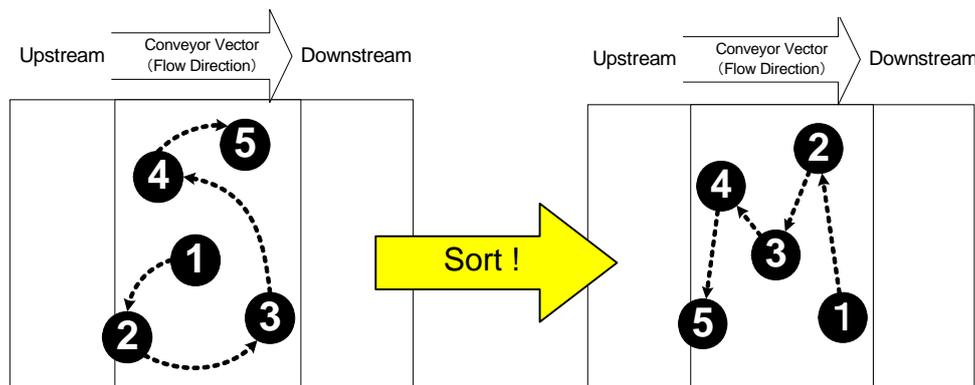
"Workpiece data sorting function" is a function to rearrange the order of the received data from downstream to upstream of the conveyor. So the robot can process sequentially from the downstream of the conveyor, that As the robot can process an optimal picking without wasted motion.

Please enable this function referring to the paragraph of "3.3.2. data sorting (rearrange) function".

4.3   Calibration Procedures

"Calibration" is the work for registering the robot's coordinate system in the vision sensor. When the calibration is executed, using the vision sensor, all coordinates sent from the vision sensor are based on the world coordinate system of the robot.

4.3.1   Determining vision sensor capture position
Determine the capture position of the vision sensor.
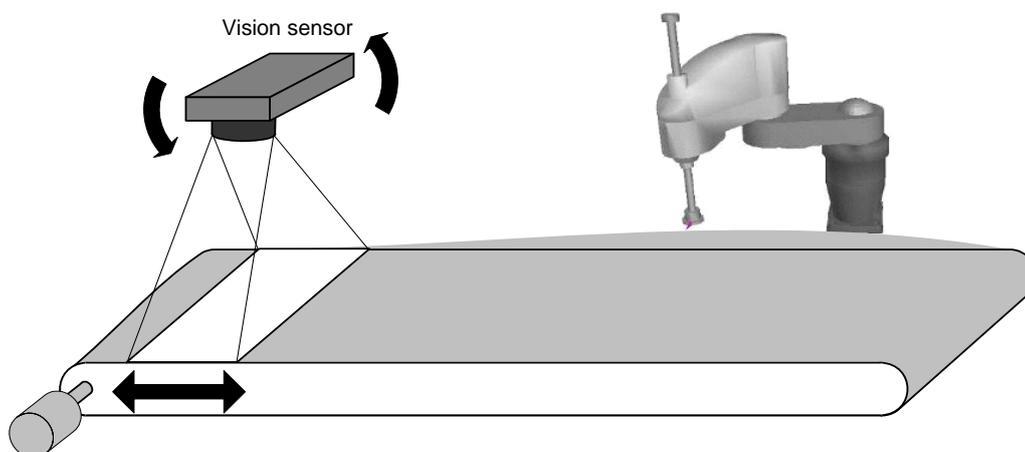
4.3.2   Preparing calibration sheet

Cut off the calibration sheet [*](*) according to the size and width of the conveyor and place it on the capture position.

---
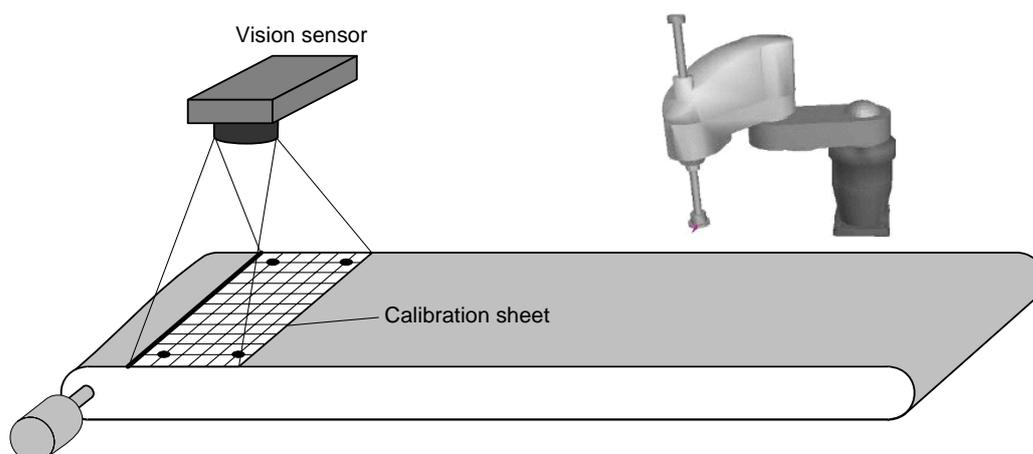
[*] For the calibration sheet, copy and use the sheet in Para. 4.5.

4.3.3   Setting capture area

Set the capture area to a desired size on the vision sensor setting display.
At this time, <u>fine-adjust the capture area so that it can align with the reference lines of the calibration sheet</u>.
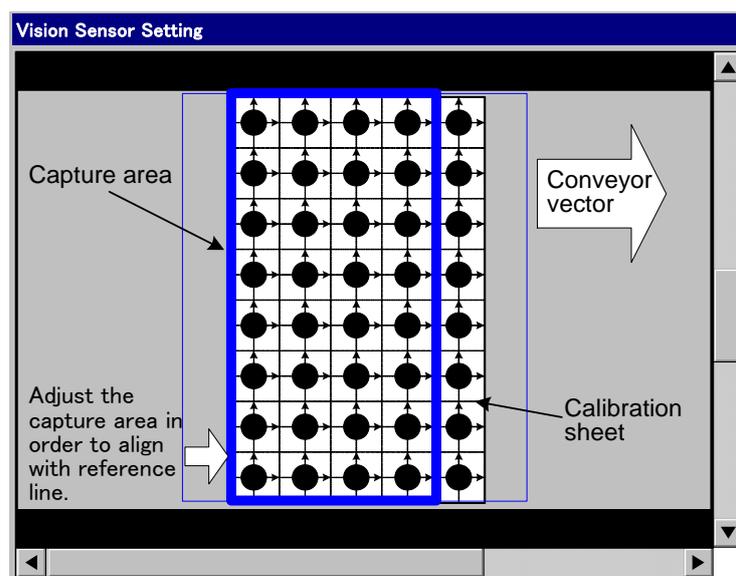
(Caution)

The capture area of the vision sensor should be set to an appropriate width based on the workpiece size, conveyor speed, vision sensor specifications and performance.   (If many workpieces have been captured at once, using the vision sensor with low processing ability, the analysis time of the vision sensor becomes long and data transmission to the robot controller may be delayed.)

4.3.4   Register of vision sensor calibration points

Select and determine four (4) reference points (P1 ~ P4) from a group of points on the calibration sheet, then register them in the vision sensor.
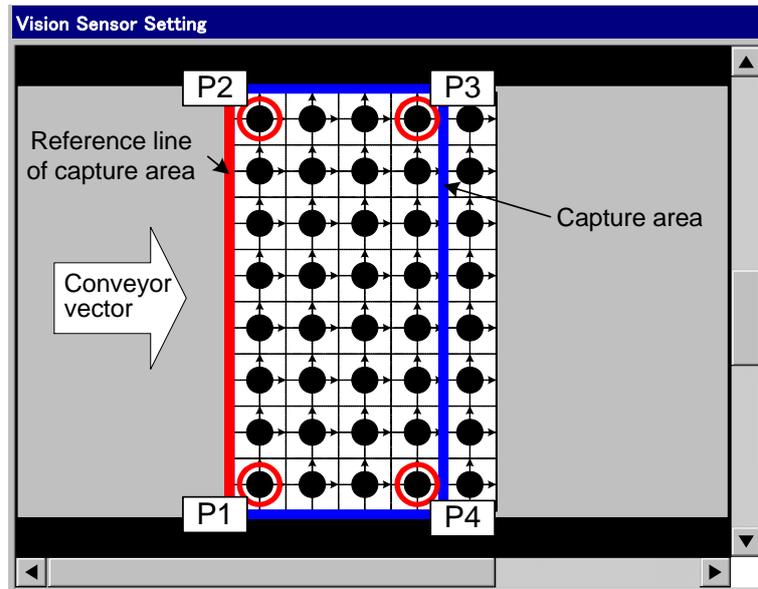
4.3.5   Register of calibration offset (mm)

Register the calibration offset (mm) of conveyor parameter "[C01] Vision + Conveyor Tracking Parameter" in the following manner.

(Caution)

Before registering the calibration offset, be sure to stop the operation.   (If it is executed during programmed operation, target motion positions of the robot will change.)

- Press the <UTILITY> key followed by the [CONV] (F4) key to start up the conveyor utility.

- Open the conveyor synchronization utility (VISION+CV_PAR1) display on page 2, and the following display is called.

```
( V C V _ P A R 1 )      < C H 1 >           < C H 2 >   2 / 7
 C u r _ P o s      : * * * * * . * * *     * * * * * . * * *
 C a l i b _ O f s t : * * * * * . * * *    * * * * * . * * *
 D e t e c t _ S t r : * * * * * . * * *    * * * * * . * * *
 D e t e c t _ E n d : * * * * * . * * *    * * * * * . * * *
 S y n c _ L i m i t : * * * * * . * * *    * * * * * . * * *

 R E S E T    H E R E
```
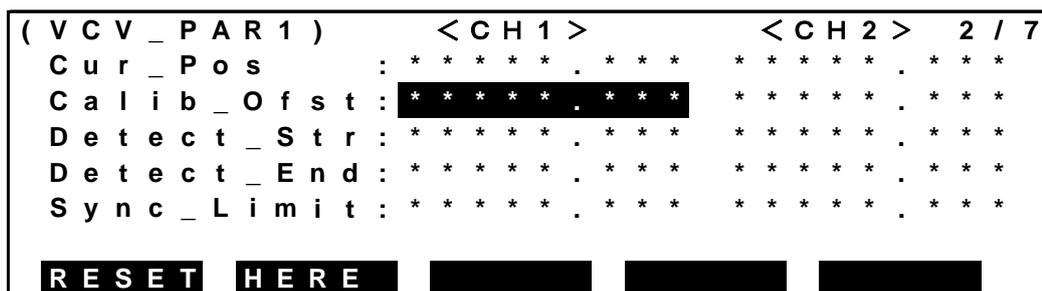
- Move the conveyor to a position where the robot can reach the calibration sheet.
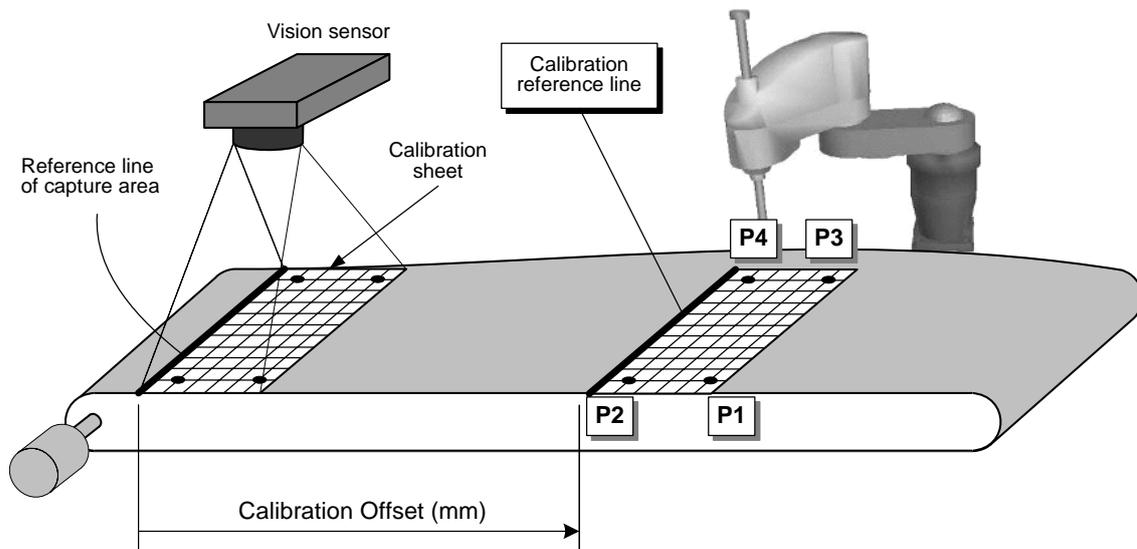
- After the conveyor has moved to the position where calibration is to be done, stop the conveyor and press the [HERE] (F2) key.   Now, the calibration offset (mm) has been registered. (<u>To make the set value valid, reset the program, then run the program again.)</u>

- To change the value directly, press the <EXE> key. Then the numerical input mode takes effect.   Enter a desired numerical value directly through the teach pendant, press the <EXE> key again.

```
( V C V _ P A R 1 )      < C H 1 >          < C H 2 >   2 / 7
C u r _ P o s     : * * * * * . * * *    * * * * * . * * *
C a l i b _ O f s t : * * * * * . * * *    * * * * * . * * *
D e t e c t _ S t r : * * * * * . * * *    * * * * * . * * *
D e t e c t _ E n d : * * * * * . * * *    * * * * * . * * *
S y n c _ L i m i t : * * * * * . * * *    * * * * * . * * *

R E S E T   H E R E
```

- Align the end effector of the robot with P1 ~ P4, measure the X and Y coordinates of P1 to P4 based on the world coordinate system, then **register these values in the vision sensor**.

4.3.6 Register of calibration reference position

Register the calibration reference position (X, Y) of conveyor parameter "[C01] Vision + Conveyor Tracking Parameter".

- The calibration reference position (X, Y) is <u>any position in the world coordinate system, which is located on the calibration reference line</u>.

- By registering this **"reference position"** and **"calibration offset"**, it is possible to make the robot controller recognize the relationship between the **position of vision sensor** and **the world coordinate system of the robot**.
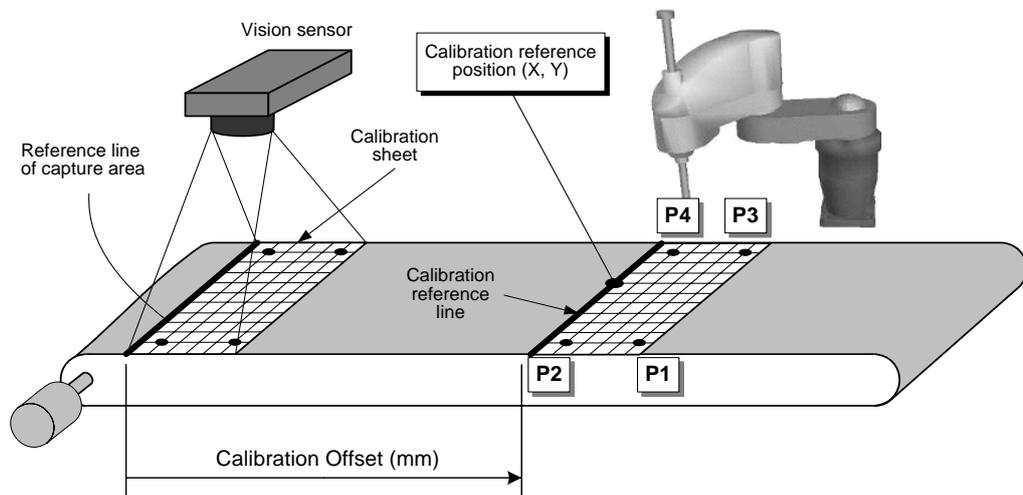
- As in the measurement of coordinate values of P1 to P4 made in Para. 4.3.5 above, move the robot tip to any position on the calibration reference line and set the coordinate value (X, Y) of this position in the parameter.

- Set the master mode key switch to "MANU", press the [EDIT] (F1) key, select "CONVEYOR.PAR", open the conveyor parameter display and edit the following parameters.

[C01] Vision + Conveyor Tracking Parameter

{Calibration reference position X}
= **0.0**   0.0

{Calibration reference position Y}
= **0.0**   0.0

4.3.7   Setting capture interval (sec) of vision sensor

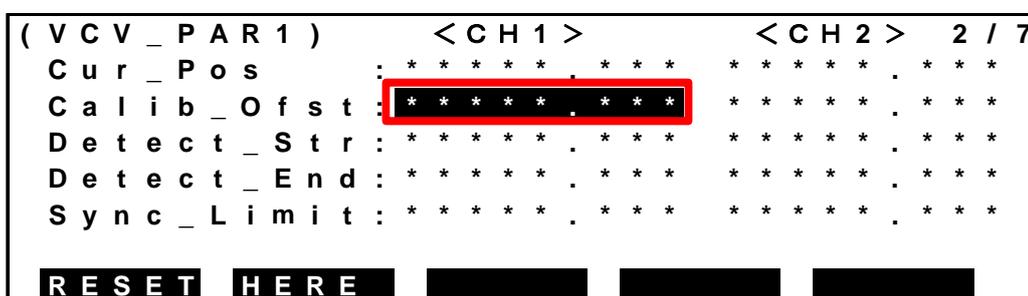Specify the time intervals (sec) at which the vision sensor captures data.

● Press the <UTILITY> key followed by the [CONV] (F4) key to start up the conveyor utility.

● Open the conveyor synchronization utility (VISION+CV_MON1) display on page 4, and the following display is called.

```
( V C V _ M O N 1 )                                    4 / 7
 T r k _ C n t / N u m     :              * * * /   * * *
 T o p / H e a d / T a i l :   * * * /   * * * /   * * *
 C u r _ W r k / T r k     :              * * * /   * * *
 T r g _ I n t e r v a l   :   * * * * * . * * * ( m m )
```

Trg_Interval   : Trigger interval (mm)

The conveyor travel distance until the current trigger signal is accepted after the previous trigger signal is displayed in mm.   Adjust the capture interval (sec) of the vision sensor so that this trigger interval (mm) can be identical with the value of "Capture width (mm)" of "[C01] Vision + Conveyor Tracking Parameter".
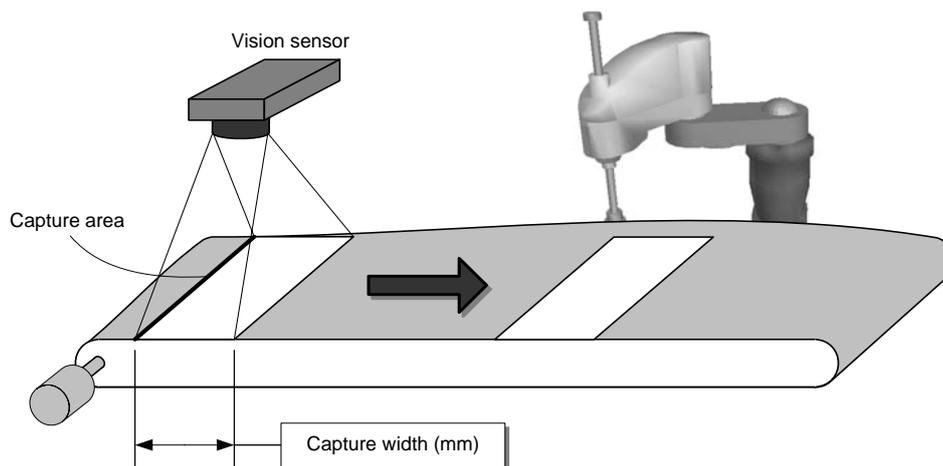
(Caution) Unless the capture interval (sec) is set properly, the following phenomenon will occur.

● The capture interval is too long. → Missing of workpiece.
● The capture interval is too short. → Duplicated detection of workpiece.

4.4   Tracking Data

When the robot controller has detected the trigger signal sent from the vision sensor, it creates the tacking data internally and automatically.   Up to 100 tracking data can be saved.   (The number of capture data that can be saved varies with the capture width and conveyor length.   Design the system so that the number of capture data will not exceed the maximum number.)
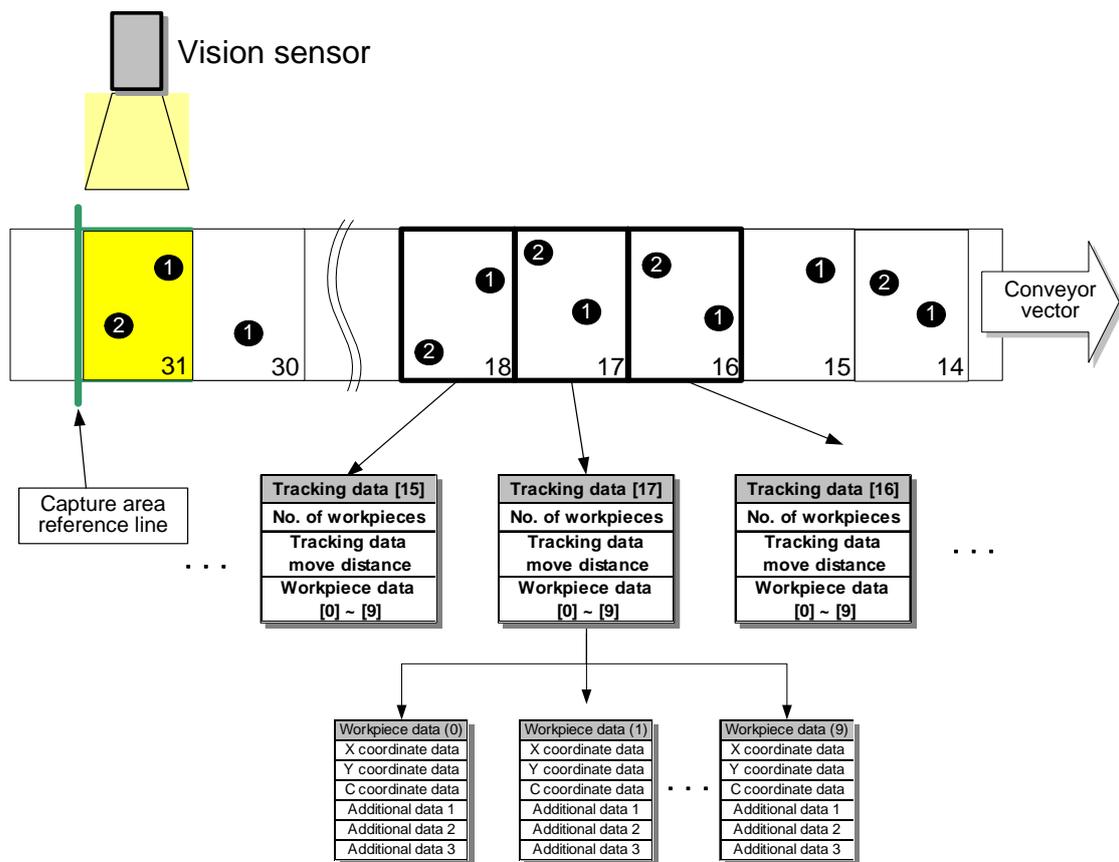
Each of these tracking data is assigned with an index number, as shown above. The robot controller tracks the workpiece position on the conveyor by using such tracking data.

\<Contents of tracking data\>

[1]   No. of workpieces

No. of workpieces collected during one (1) count of capture.

[2]   Tracking data move distance

The move distance of tracking data as viewed from the capture area reference line is saved.

[3]   Workpiece data 0 ~ 9

Workpiece coordinates and other information sent from the vision sensor are saved here.   (They are created for each collected workpiece.)

4.5   Calibration Sheet

Copy this sheet, cut it off to a desired size and use it for the calibration purpose.
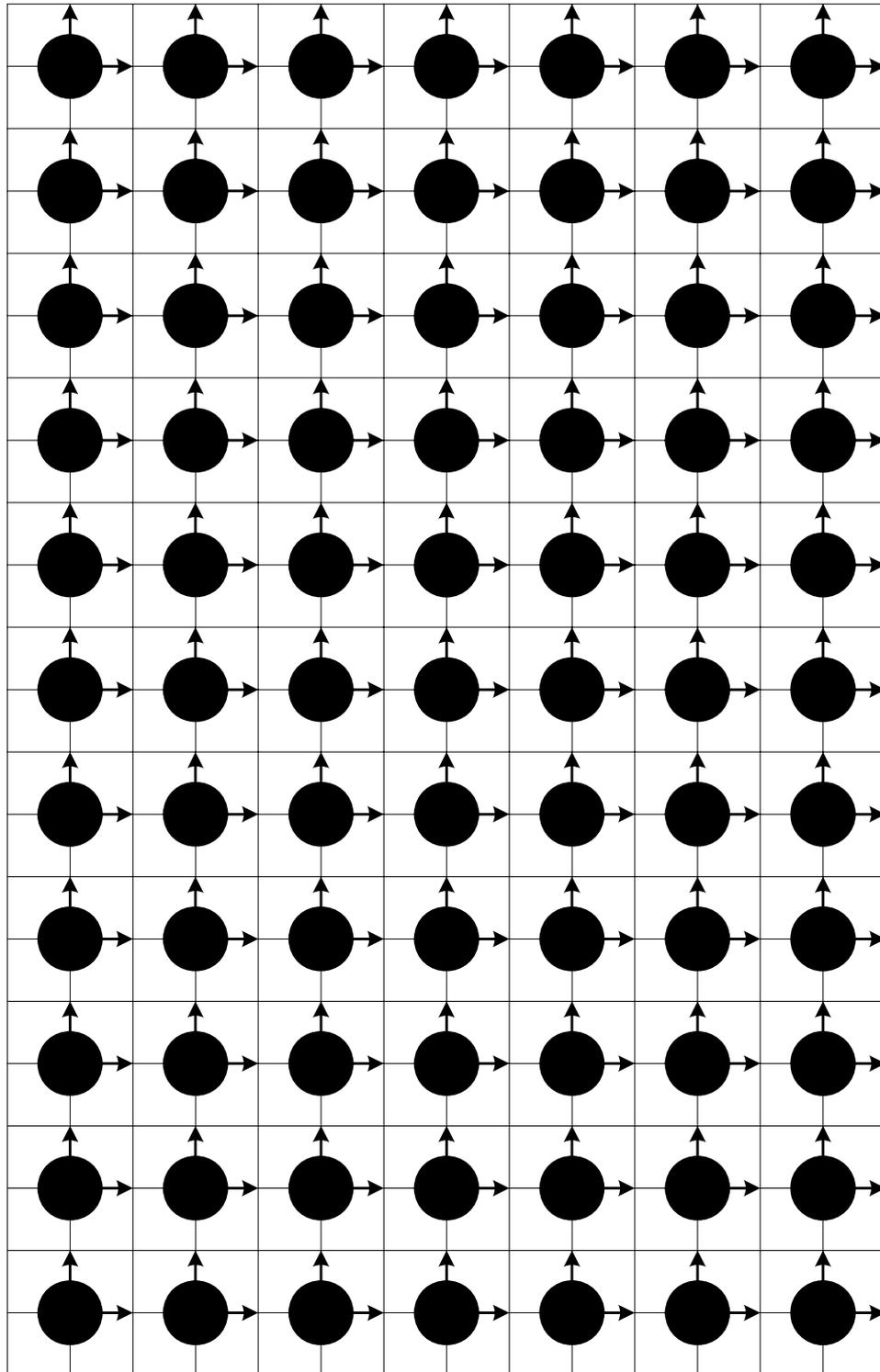
Section 5
Programming and Teaching

This section describes the programming method when executing the "vision sensor + conveyor" synchronization function.

5.1 Exclusive Language for Previous Conveyor Synchronization

The commands used for the previous conveyor synchronization function are tabled below.

Command	Function
CONV	Defines the conveyor synchronization parameters.
SYNC	Starts the conveyor synchronization.
UNSYNC	Finishes the conveyor synchronization.
XIN	Monitors the encoder cable breakage.
CNVSTAT	Accesses the information on conveyor synchronization status.

CONV

| Function | : Defines the conveyor synchronization parameters. |

| Format | : CONV (<Number>, <Position 1>, <Position 2>, <Real number 1>, <Real number 2>, <Real number 3>) |

| Example | : CONV (N, A, B, C, D, E) |

| Explanation & caution | : Defines the parameters required for conveyor synchronization. |
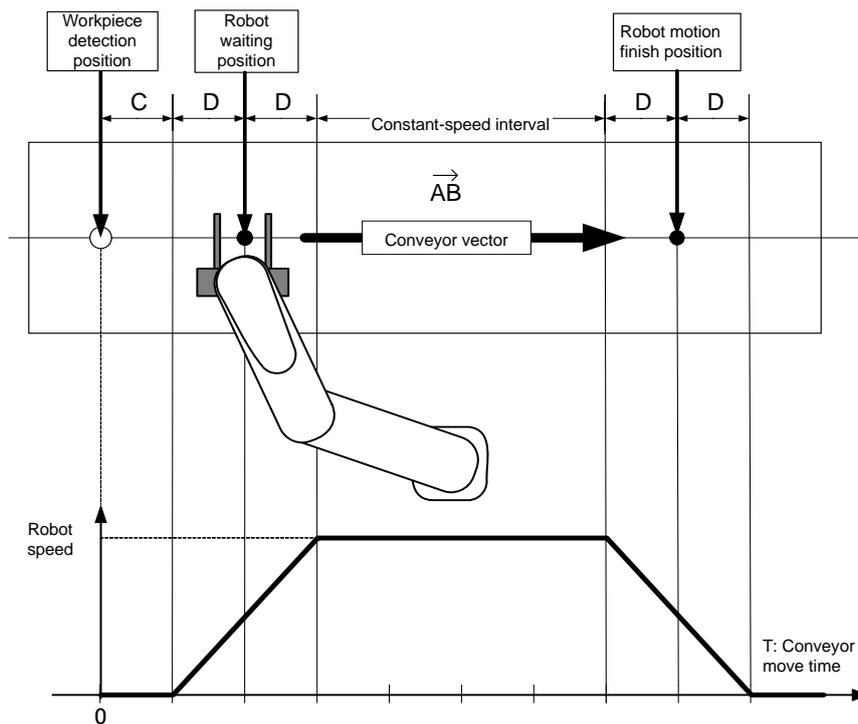
<Number; N>   conveyor channel number

This controller allows synchronization of conveyors on a total of two (2) lines.   Specify the channel number for desired conveyor synchronization.

<Position 1; A>   Conveyor vector start position (position type data)
Specify the start position of conveyor vector.
(Only vector type position data can be specified.)

<Position 2; B>   Conveyor vector end position (position type data)
Specify the end position of conveyor vector.
(Only vector type position data can be specified.)

(Caution)

The parameters given above (i.e., <Position 1; A> and <Position 2; B>) are handled in a different manner between the previous conveyor synchronization function and "vision sensor + conveyor" synchronization function, as shown below.

Previous conveyor synchronization	When the conveyor has moved by $\left|\overrightarrow{AB}\right|$ after synchronization, the conveyor synchronization finishes.
"Vision sensor + conveyor" synchronization	When the robot apex position has passed the conveyor synchronization limit point in the figure below, the conveyor synchronization finishes.

Capture area

Start point of workpiece detection area

Workpiece detection area

End point of workpiece detection area

Conveyor synchronization limit point
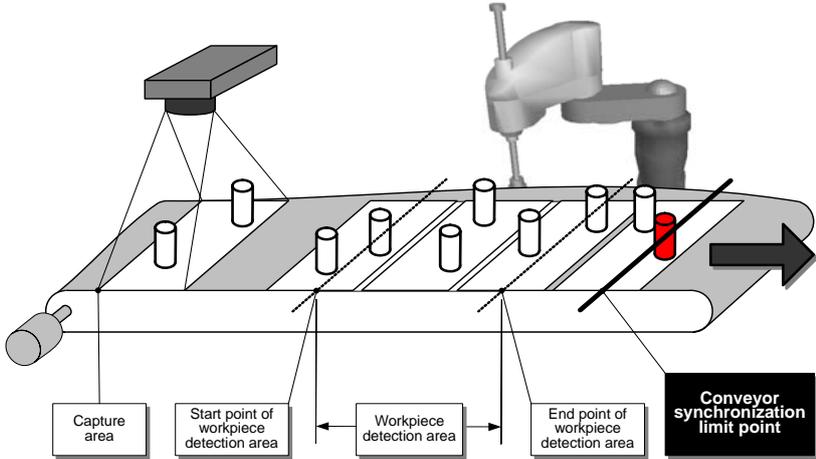
*   When program language "UNSYNC" has been executed, or program reset has been effected during program stop, the conveyor synchronization finishes.

<Real number 1; C>   <u>Conveyor synchronization delay distance (mm)</u>

This parameter should be specified to compensate for the physical synchronization delay. If this value is too large, however, an error will occur. To avoid this, this value should be used for fine adjustment and the system should be configured so as to minimize this distance, where possible.

<Real number 2; D>   <u>Conveyor synchronization acceleration/deceleration distance (mm)</u>

Specify the acceleration/deceleration distance (unit: mm) required for conveyor synchronization.

<Real number 3; E>   <u>Travel distance per pulse of encoder (μm)</u>

This parameter is the same as conveyor parameter "[C00] Conveyor Parameter (Travel value per pulse of encoder)". For how to figure out the value, see Para. 3.2.6.

This parameter can be omitted.
- When it is omitted (or E = 0), the conveyor parameter value is used instead.
- When the value of the conveyor parameter is zero (0), the value of "CONV (....E) is used.

(Caution)
When the value of the conveyor parameter is 0.0 with the E parameter omitted (or E = 0), the error saying "002–033 Conveyor Parameter Error" occurs at the time of program execution and the robot stops.

(Cautions)
- Once defined, the conveyor synchronization parameter data are stored in the internal memory until the controller power is turned off. To change the conveyor synchronization parameter value, be sure to describe the new CONV command and reset.

- Zero (0) can be specified for each of parameters C and D. When D (acceleration/deceleration distance) = 0, however, the synchronization speed of the robot is sharply increased to the conveyor speed, as shown below, which results in an excessively large load exerted on the robot.
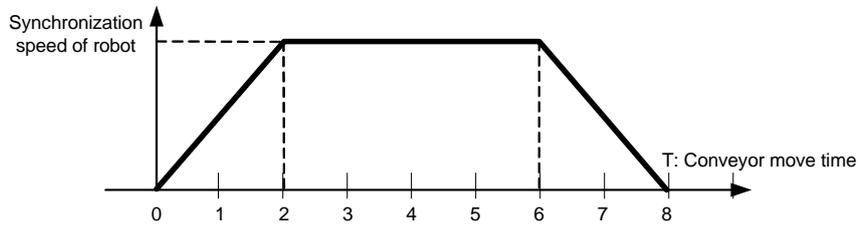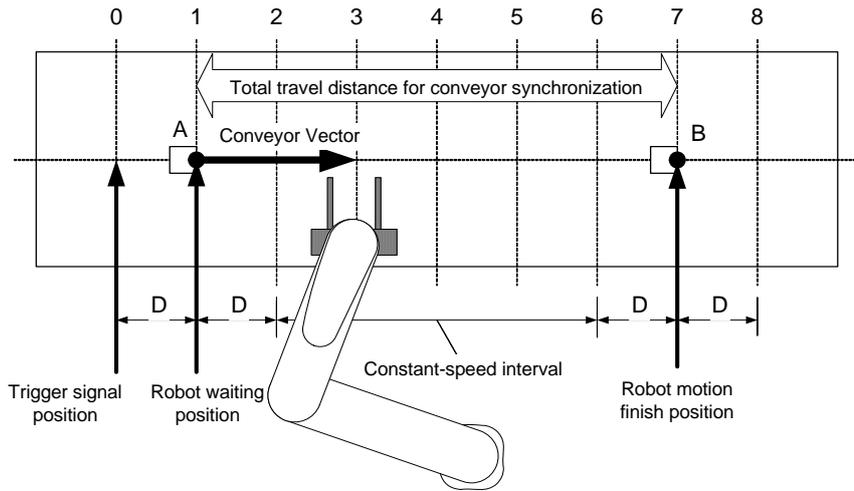
When C = 0
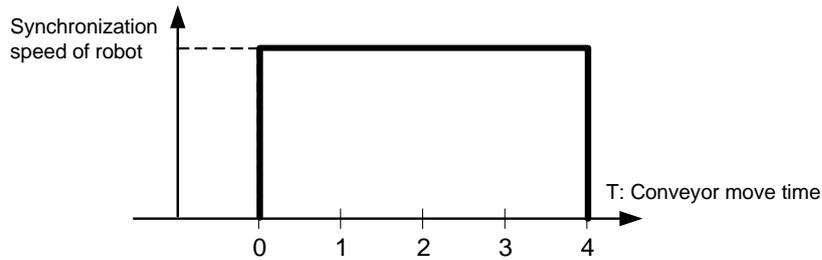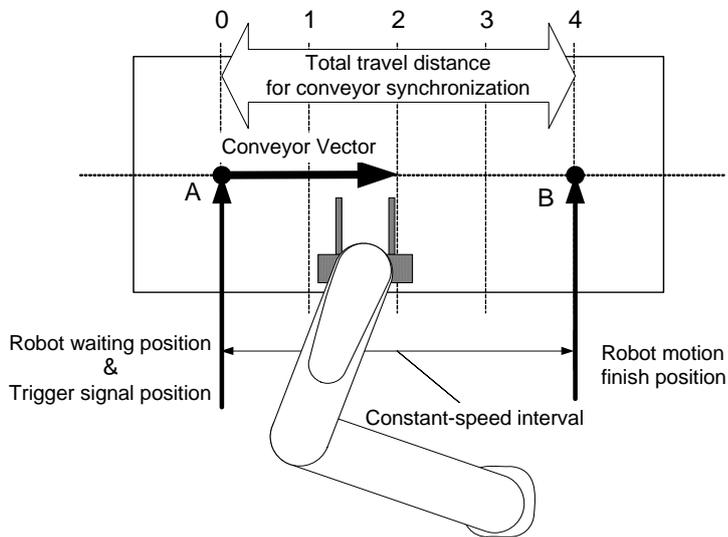
When C = D = 0

SYNC

Function	: Starts the conveyor synchronization.

Format	: SYNC (<Number>, [<Stop judgment time>])

Example	: SYNC (N, T)

Explanation & caution	: This command is handled in a different manner between the previous conveyor synchronization function and "vision sensor + conveyor" synchronization function, as shown below.

Previous conveyor synchronization	At the same time that the trigger signal has turned on, conveyor synchronization starts.
"Vision sensor + conveyor" synchronization	 Capture area Start point of workpiece detection area Workpiece detection area End point of workpiece detection area Conveyor synchronization limit point • When a workpiece is present in the workpiece detection area, conveyor synchronization starts. • When VCSEEK1 ~ 3 ("vision sensor + conveyor" synchronization detecting conditions (data on type of workpiece and workpiece status) is used, it is possible to start synchronization by detecting only workpieces of specified type. (For details, see the descriptions on VCSEL1 ~ 3 given later.)

<Number; N>　　Specify the channell number of the conveyor to be synchronized. Either 1 or 2 can be designated.

A constant or variable of scalar type data can be used.

<Stop judgment time; T>

Specify the conveyor stop judgment time.　Unless this value is specified, the stop judgment is executed according to the value of conveyor parameter "[C00] Conveyor Stop Judgment Time".

- Unless the conveyor synchronization parameters are defined by the CONV command, an error occurs when this command is executed.

- When starting the "vision sensor + conveyor" synchronization, be sure to describe the SYNC command at the beginning and the UNSYNC command at the end of the synchronization.　Otherwise, an error occurs when this command is executed.

- Nesting is not possible for the SYNC command or UNSYNC command.

- If the stop operation is executed during waiting for workpiece detection, the conveyor synchronization will not start and the program stops.　To restart the program, be sure to perform the reset operation, irrespective of the execution state (reset, retry or continue), then execute the program.　For details, see Section 6.

⚠ CAUTION

Motion Commands during the conveyer synchronization

Following 4 motion commands are available during the conveyer synchronization

MOVES	:Straight line interpolation
MOVEC	:Circular interpolation
MOVE	:PTP(point to point) motion command
MOVEJ	:Arch motion command

MOVE or **MOVEJ** motion commands make more high-speed handling possible even during the conveyer synchronization. Please be careful for following point.

- CONFIG (the posture of the robot-arm) can't be changed during the conveyer synchronization.

- A "002-069 : CONFIG Error" occurs when the value other than FREE , or the value which was different from CONFIG of the previous movement is specified with CONFIG.

- When MOVE or MOVEJ movement is executed, the trajectory is formed so that the joint with the longest time of the movement time moves at the maximum speed (if speed=100).
  And, **the conveyer speed is added to the movement speed during the conveyer synchronization.** Therefore, movement direction of the axis aligns with the conveyer movement direction, "8-041〜5 Axis1 - 5 Exceed Speed" or "8-071〜5:Axis1- 5 Motor speed over" occur. In this case, lower the movement speed of the robot by using the SPEED command.

UNSYNC

| Function | : Finishes the conveyor synchronization. |

| Format | : UNSYNC (<Number>) |

| Example | : UNSYNC (N) |

| Explanation & caution | : The conveyor synchronization finishes. |

<Number; N>   Specify the channel number of the conveyor for which synchronization is to be finished.

• When a value other than zero (0) is specified for the acceleration/deceleration distance for conveyor synchronization [<Relative distance 2; D], the robot decelerates and stops while the conveyor moves by "D" from the timing of this command execution.

• When the robot hand tip has reached the conveyor synchronization limit point during conveyor synchronization, the conveyor synchronization finishes automatically, irrespective of description of the UNSYNC command.   (This does not mean that the UNSYNC command is unnecessary.   Rather, the robot movement synchronized with the conveyor speed is stopped to assure the safety.)

• Unless this command is used together with the SYNC command described on the preceding pages, an error occurs.

XIN

Function	: Monitors the encoder cable breakage.

Format	: XIN (<Signal name>)

Example	: ON XIN (1) DO GOTO L100

Explanation & caution	: Breakage of the encoder cable is monitored. If a fault is detected, it is informed.

<Number; N>   Specify the logical number of the conveyor for which encoder cable breakage is to be monitored.

- This command is used to instantly detect a cable breakage.   Use this command together with the ON command so that cable breakage can be detected at any time.

- When the ON–DO command is used together with this command, the number of counts that can be simultaneously monitored should not exceed ten (10).   If the value exceeds ten (10), an error occurs and the robot program stops accordingly.

- To cancel the monitoring of encoder cable breakage, use the IGNORE command.
  This command can be used together with the IF command and WAIT command.

- If the encoder cable has broken, the error saying "001–047 Conveyor Line Breakage" occurs.   The robot will not stop, however, and continuously move, synchronized with the conveyor (encoder) speed effective just before the detection of cable breakage.

- The error of "001–047 Conveyor Line Breakage" is not reset as long as the power is turned off.   When this error has occurred, turn the power off, identify and remedy the broken cable, then turn the power on again.

(Cautions)

- Even if an encoder cable breakage has been detected during conveyor synchronization, the robot continues tracking the conveyor at the same speed because it memorizes the speed just after the cable breakage.

- If the above error (001–047) has occurred, however, be sure to recess the robot to the safe place.   If the operation is continued without taking any necessary steps, the robot and workpiece, or conveyor may collide.   Recess the robot to the safe place by referring to the retraction program listed below.

> Sample
> program

```
PROGRAM XINSAMPLE
    CONV (1, A, B, 40.0, 10.0)
    .........
L000:
    ON   XIN (1)   DO   GOTO   L100
    .........

    IGNORE   XIN (1)

    .........
    SYNC (1)
    ON   XIN (2)   DO   GOTO   L200

    .........
    IGNORE   XIN (2)
    UNSYNC (1)

    .........
    GOTO   L000
L100:
    PRINT   "C/V ERROR (1)", CR
    STOP
L200:
    MOVES   P1

    UNSYNC (N)
    PRINT   "C/V ERROR (2)", CR
    STOP
END
```

Code	Description
`ON   XIN (1)   DO   GOTO   L100`	Monitoring of encoder cable breakage before the start of synchronization.
`.........`	(The monitoring should be cancelled just after the XIN command. Breakage detection check cannot be executed.)
`IGNORE   XIN (1)`	Cancel of monitoring before the start of synchronization.
`ON   XIN (2)   DO   GOTO   L200`	Monitoring of encoder cable breakage during synchronization.
`IGNORE   XIN (2)`	Cancel of monitoring during synchronization.
`MOVES   P1`	After the robot is recessed to the safe position with the linear interpolation control command, program execution stops.

CNVSTAT

| Function | : | Accesses the information on conveyor synchronization status. |

| Format | : | CNVSTAT |

| Example | : | WAIT   CNVSTAT > = 4
 ON   COVSTAT   < >4   BREAK   DO   GOTO   L1 |

| Explanation & caution | : | The information on conveyor synchronization status is accessed. |
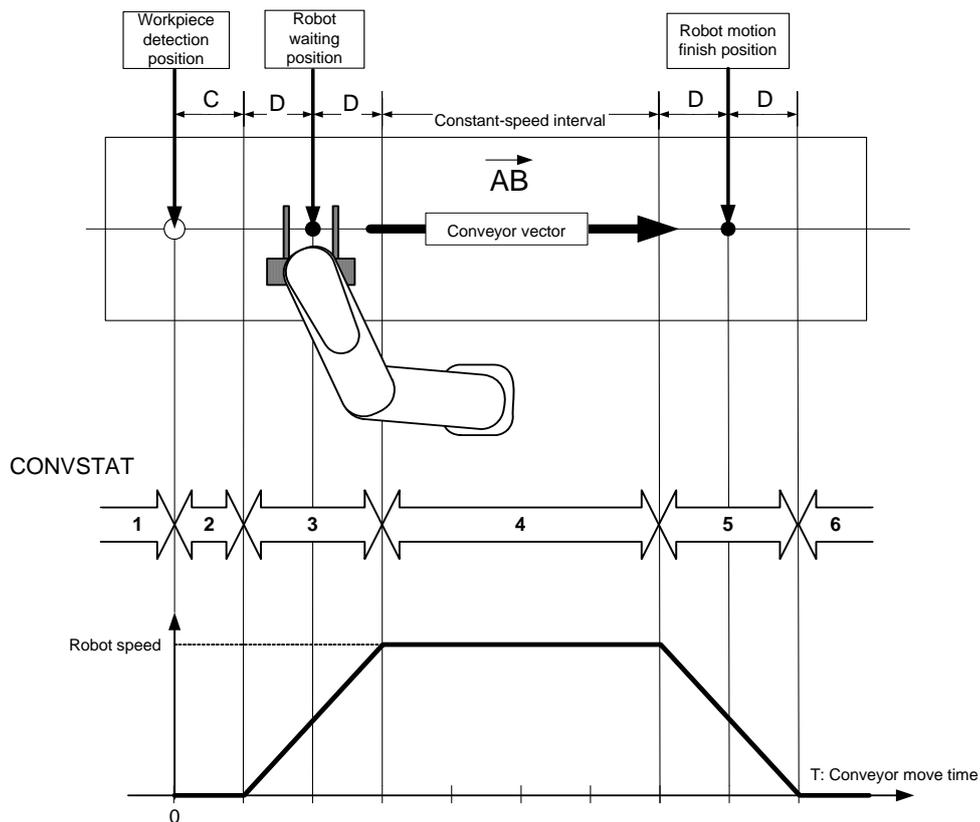
Conveyor status table

0	Conveyor asynchronization	Signifies that the conveyor is not synchronized. (As this command can be used only after execution of the SYNC command, "1" is not set actually in the program.
1	Waiting for trigger signal	The conveyor is waiting until the trigger signal is turned on.
2	Conveyor moving in delay interval	The conveyor is moving in the delay interval.
3	Conveyor moving in acceleration interval	The conveyor is moving in the acceleration interval. During this time, the robot catches up with the conveyor speed.
4	Conveyor moving in constant-speed interval	The conveyor is moving in the constant-speed interval. The robot is moving by tracking the conveyor. Handling of a workpiece on the conveyor should be performed while CNVSTAT = 4.
5	Conveyor moving in deceleration interval	The conveyor is moving in the deceleration interval. During this time, the robot catches up with the conveyor speed.
6	Finish of conveyor synchronization	The conveyor synchronization has finished, and the conveyor is waiting for the UNSYNC command.

Cautions:

- This command can be used during conveyor synchronization (i.e, after the SYNC command is executed).

- A value cannot be substituted for CNVSTAT.

- Only when the CNVSTAT conditional statement is used as the ON condition, the BREAK and PAUSE commands can be used.

Sample
program

```
PROGRAM MAIN
    CONV (1, A, B, 100.0, 200.0)
    MOVE   P1
    SYNC (1)
    WAIT   CNVSTAT >=4
    MOVES   P2
    MOVES   P3
    WAIT   CNVSTAT >=6
    UNSYNC (1)
END
```

5.2   "Vision Sensor + Conveyor" Exclusive Language

For the "vision sensor + conveyor" synchronization function, five (5) exclusive commands are newly added.   By using these commands, it is possible to easily create any complicated "vision sensor + conveyor" application program.

Command	Example of statement	Description
VCFUNC	VCFUNC=0N	Data receiving start switch ON: Receiving of data from the vision sensor starts. OFF: Receiving of data from the vision sensor finishes.
VCPOS	MOVES VCPOS MOVES VCPOS+POINT(,,100)	Target motion position during "vision sensor + conveyor" synchronization. All target positions during "vision sensor + conveyor" synchronization are calculated internally and automatically, which are set then in this system variable.
VCSEL1 ~ 3	VCSEL1=1 VCSEL2=0	Used to specify the next workpiece detecting conditions by means of VCSEEK or SYNC command.
VCWSTAT1 ~ 3	IF VCWSTAT1==1 THEN GOTO LP	Used to refer to additional information of currently detected workpiece.
VCSEEK	IF VCSEEK==ON THEN ~	(A) Used to reply the presence or absence of next workpiece satisfying the detecting conditions (VCSEL1 ~ 3) in the workpiece detection area. (ON: Next workpiece present. OFF: Next workpiece absent.) (B) If the next workpiece exists, its target motion position is set in VCPOS.

Command	Example of statement	Description
SYNC(N) N: Channel number	SYNC(1)	Conveyor synchronization start command. When the workpiece has entered (or already entered) the conveyor synchronization permit area, conveyor synchronization starts. (Previous system: At the same time that the synchronization start trigger signal has turned on, conveyor synchronization starts.)

VCFUNC

Function	: Data receiving start switch for "vision sensor + conveyor" synchronization function

Format	: VFUNC = <Value>

Example	: VFUNC = ON

Explanation & caution	: ON: Receiving of data from the vision sensor starts.
	OFF: Receiving of data from the vision sensor ends.

- When VCFUNC = ON, receiving of data sent from the vision sensor starts.

- After input of trigger signal has been detected, analysis of received data starts. For details, see Para. 4.1.

- When VCFUNC = OFF, receiving of data sent from the vision sensor ends.

(Caution)

- Even when VFUNC = OFF, conveyor synchronization will not finish.

- As long as the work received at "VCFUNC=ON" remains on the conveyer, the conveyer synchronization is continued.

- To cancel the data of a workpiece now on the conveyor, stop the program, then reset it.

Sample
program

PROGRAM VCPROG1
                    :

VCFUNC = ON   Receiving of data starts.

CONV(N, A, B, C, D)

LP:

    SYNC(1)   If a workpiece exists in the workpiece detection area,
                                     synchronization starts.
    :

    UNSYNC(1)   Synchronization ends.

    :

GOTO LP

VCFUNC = OFF   Receiving of data finishes.

END

VCPOS

Function	:	Target motion position (system variable) exclusively used for "vision sensor + conveyor" synchronization function

Format	:	MOVES VCPOS

Example	:	MOVES VCPOS MOVES VCPOS + POINT (, , 100) P0 = VCPOS

Explanation & caution	:	Specifies the target motion position during "vision sensor + conveyor" synchronization. The workpiece in the optimal position is automatically selected from the on the conveyer, and its position data set to VCPOS.

Caution 1:   VCPOS signifies the target motion position which is exclusively used in the "vision sensor + conveyor" synchronization function.   NEVER use it in other than the "vision sensor + conveyor" synchronization (i.e., between the SYNC and UNSYNC commands).   Otherwise, the robot may move to an unexpected position, or the alarm saying "002–079: PointOutOfRange" occurs.

Caution 2:   VCPOS is the position data which is selected from the current conveyer channel.

Caution 3:   Only reading of this system variable is possible.   Writing is not allowed.

- Data structure:
  VCPOS is the position type variable.   The format is the same as that of the position type variable (X, Y, C, Z, T, Configuration).

- Initial value:
  The initial value of VCPOS target motion position is "0.0" for all of X, Y, C, Z, T and configuration.

- Detection timing and set value of VCPOS:
  If a workpiece has entered or already entered the workpiece detection area after execution of SYNC command or VCSEEK command, a workpiece located most downstream in the area is detected and this coordinate position is set in VCPOS.
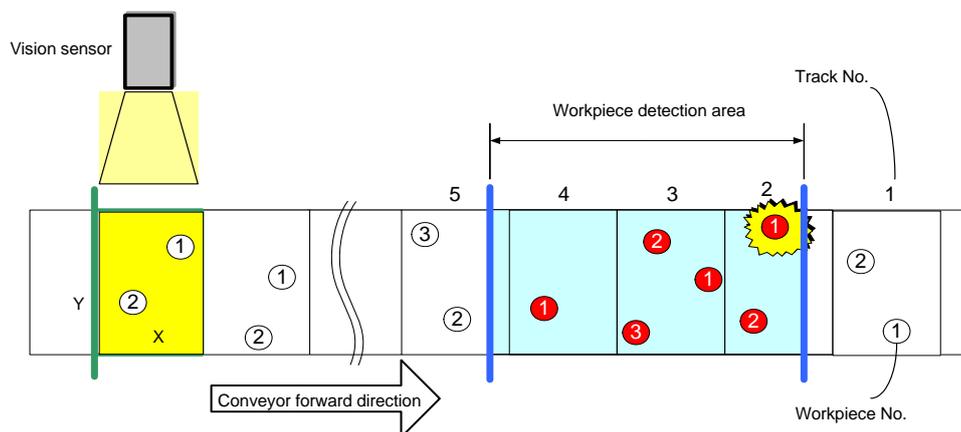
- Calculation using VCPOS:
  It is possible to specify the target position which is offset from this target position, using the POINT command.

  Example)   MOVES VCPOS+POINT(, , 25)

Sample program	Random pick-and-place program

```
PROGRAM VISCONV2
     CONV(1, A, B, 0, 0)
     VCFUNC=ON
     MOVE A                            Moves to waiting position.
     SYNC(1)                           If a workpiece exists in the workpiece detection area,
                                       synchronization starts.
     MOVES VCPOS+POINT( , , 100)       Moves to the position above the workpiece position as
                                       detected by SYNC command.
     MOVES VCPOS                       Moves to the workpiece position detected by SYNC
                                       command.
         :                             Picks up the workpiece.
     MOVES VCPOS+POINT( , , 100)       Moves to the position above the workpiece position as
                                       detected by SYNC command.
     UNSYNC(1)                         Conveyor synchronization end.
     MOVE HOME+POINT( , , 50)
     MOVE HOME
         :                             Places the workpiece.
     MOVE HOME+POINT( , , 50)
     WAIT MOTION >=100
     PRINT 10.0–TIMER, CR
END
```

⚠ CAUTION

Motion Commands during the conveyer synchronization

Following 4 motion commands are available during the conveyer synchronization

|	
MOVES	:Straight line interpolation
MOVEC	:Circular interpolation
MOVE	:PTP(point to point) motion command
MOVEJ	:Arch motion command

MOVE or **MOVEJ** motion commands make more high-speed handling possible even during the conveyer synchronization. Please be careful for following point.

- CONFIG (the posture of the robot-arm) can't be changed during the conveyer synchronization.

- A "002-069 : CONFIG Error" occurs when the value other than FREE , or the value which was different from CONFIG of the previous movement is specified with CONFIG.

- When MOVE or MOVEJ movement is executed, the trajectory is formed so that the joint with the longest time of the movement time moves at the maximum speed (if speed=100).
  And, **the conveyer speed is added to the movement speed during the conveyer synchronization.** Therefore, movement direction of the axis aligns with the conveyer movement direction, "8-041～5 Axis1 - 5 Exceed Speed" or "8-071～5:Axis1- 5 Motor speed over" occur. In this case, lower the movement speed of the robot by using the SPEED command.

VCSEEK

| Function | : Command for confirming next workpiece presence or absence and detecting next workpiece. |

| Format | : VCSEEK == <ON> or <OFF> |

| Example | : IF VCSEEK == OFF THEN GOTO LP1 |

| Explanation & caution | : |

- The VCSEEK command is used to detect the next workpiece which is located furthermore downstream from the currently detected workpiece during the operation from workpiece detection to conveyor synchronization.
- When VCSEEK is executed, the system retrieve whether the next workpiece is exist in the detection area. The position data of next workpiece is set to VCPOS.
- <u>This function is effective when the robot picks up two (2) or more workpieces while it is tracking the conveyor.</u>

Currently detected workpiece

Next workpiece

Conveyor vector
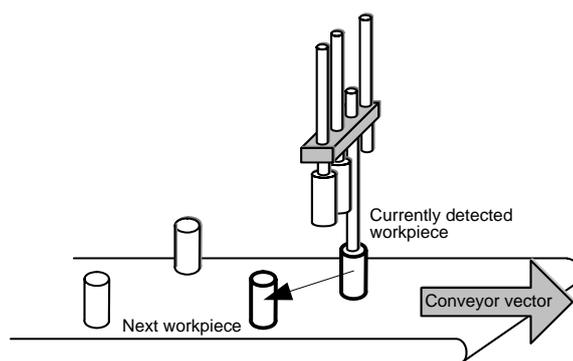
- When VCSEL 1 ~ 3 (conditions for detecting "vision sensor + conveyor" synchronization, such as workpiece type and workpiece status) is used, <u>it is possible to discriminate and group the workpieces of specified type alone</u>. For details, see the descriptions on VCSEL1 ~ 3 given later.

- The role of VCSEEK:

    A) <u>Judgment of next workpiece presence or absence</u>
        Replies the presence or absence of the next workpiece in the workpiece detection area during conveyor synchronization.

        Next workpiece is present. ⇒ VCSEEK == ON
        Next workpiece is absent. ⇒ VCSEEK == OFF

    B) <u>Updating target motion position "VCPOS"</u>
        When the next workpiece is present, its target motion position is set in VCPOS.

Caution 1:   As shown in the table below, this function can be used together with IF statement (condition judgment command).   It cannot be used jointly with WAIT command or ON command, however.

Condition judgment command	Use
IF VCSEEK == ON THEN GOTO LP	Permitted
WAIT VCSEEK == ON	Prohibited
ON VCSEEK == ON DO ⋯	Prohibited

Caution 2:   The VCSEEK command functions normally only during the "vision sensor + conveyor" synchronization mode (SYNC ~ UNSYNC).

Caution 3:   This command can be used during conveyor synchronization after processing of SYNC command.

Caution 4:   Only reading of this system variable is possible.   Writing is not allowed.

Caution 5:   After execution of VCSEEK command, only reading of this system variable is possible.   Writing is not allowed.

Caution 6:   VCSEEK is executed against the current channel of conveyor.

| Sample program | Multiple-workpiece (four (4) pcs.) pick-and-place program |

```
PROGRAM VISCONV2B
ENABLE NOWAIT
        PASS = 60
        VCFUNC = ON
        CONV(1,A,B,0,0)
        MOVE HOME + POINT(,,OFST)
        SYNC(1)
        I = 0
LP:
        I = I + 1
        ENABLE PASS
        MOVES VCPOS + POINT(,,OFST)
        DISABLE PASS
        MOVES VCPOS
'***** PICK-UP WORK PIECE *****
        DELAY 0.1
        ENABLE PASS
        MOVES VCPOS + POINT(,,OFST)
        WAIT MOTION >= 100
        IF I >= 4 THEN GOTO USNC
        IF VCSEEK == ON THEN GOTO LP
USNC:
        UNSYNC(1)
        MOVE P0 + POINT(,,OFST)
        DISABLE PASS
        MOVE P0
        DELAY 0.1
'***** PLACE WORK PIECE *****
        ENABLE PASS
        MOVE P0 + POINT(,,OFST)
        DISABLE PASS
        MOVE HOME + POINT(,,OFST)
END
```
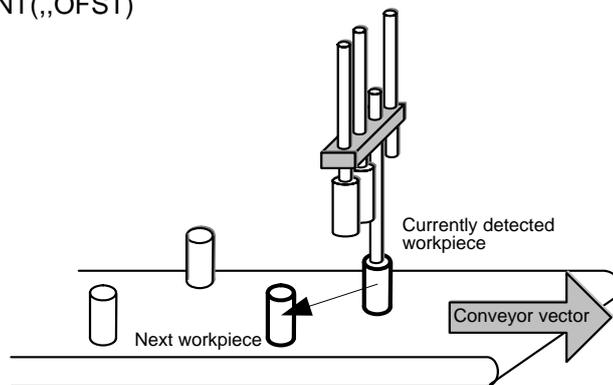
If next workpiece exists, the robot moves to the next workpiece position. If no, conveyor synchronization finishes.

If the number of workpieces exceeds the maximum value, conveyor synchronization finishes.

'Conveyor synchronization end

Currently detected workpiece

Next workpiece

Conveyor vector

VCSEL1 ~ 3

Function	: Designation of conditions for detecting "vision sensor + conveyor" synchronization (workpiece type and workpiece status).

Format	: VCSEL1 = \<Integer\>

Example	: VCSEL1 = 10

Explanation & caution	: The TS3000 (TS3100) controller can receive three (3) different workpiece additional information from the vision sensor. It is possible to identify only desired workpieces by applying the detecting conditions of VCSEL1 ~ 3 to this additional information. (This function is useful when sorting and detecting workpieces.)

Caution 1:   Only reading of this system variable is possible.   Access is not allowed.

Caution 2:   Joint use of this command with motion command by using WITH statement is not allowed.

Caution 3:   VCSEL1-3 set the detecting condition to the current conveyor channel.

- Workpiece data format:

    The format of workpiece data that can be received from the vision sensor is predetermined, as shown below.   (For details, see Para. 4.2.)

Name	Description
x	X coordinate data of workpiece
y	Y coordinate data of workpiece
c	C coordinate data of workpiece
Opt1	**Additional data 1 of workpiece**
Opt2	**Additional data 2 of workpiece**
Opt3	**Additional data 3 of workpiece**

Among the above six (6) elements, <u>Opt1 to Opt3 are the additional information which can be specified for each workpiece</u> by the user at his or her discretion.

Example)   Opt1:   Workpiece type data 1 (Workpiece profile)
            Opt2:   Workpiece type data 2 (Color information)
            Opt3:   Workpiece quality data 3 (Workpiece accepted, rejected, etc.)

- How to set VCSEL1 ~ 3:

Name	Description
x	X coordinate data of workpiece
y	Y coordinate data of workpiece
c	C coordinate data of workpiece
Opt1	**Additional data 1 of workpiece**
Opt2	**Additional data 2 of workpiece**
Opt3	**Additional data 3 of workpiece**

Opt1 → VCSEL1
Opt2 → VCSEL2
Opt3 → VCSEL3

As shown above, Opt1 to 3 are linked with VCSEL1 to 3, respectively.
<u>If the number identical with the workpiece additional data number as shown above is programmed beforehand</u>, only workpieces belonging to specific type or satisfying specific conditions can be detected when detecting workpieces, using the SYNC or VCSEEK command.
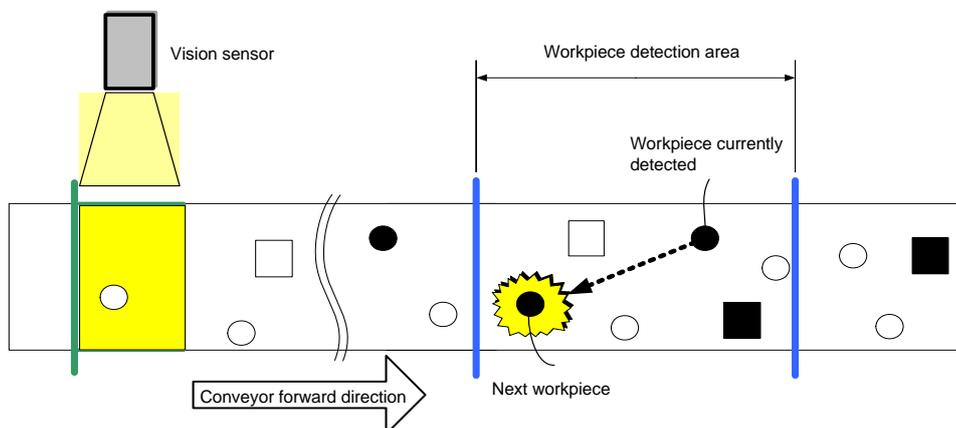
For instance, assume that the following data are set in workpiece additional data 1 ~ 3.
   Opt1   :   Type of workpiece (1: Round, 2: Square)
   Opt2   :   Color of workpiece (1: White, 2: Black)
   Opt3   :   Workpiece status (1: OK, 2: NG)

Now, when the following three (3) conditions are programmed,
   VCSEL1=1   Round workpiece
   VCSEL2=2   Black workpiece
   VCSEL3=1   NG workpiece

in the detection command (SYNC command or VCSEEK command) to be executed after this, only workpieces satisfying all conditions of VCSEL1 to 3 are collected.

- How to set "free status" for VCSEL1 to 3:

  When zero (0) is specified for VCSEL1 ~ 3, the free status mode takes effect and conditional detection is not executed.
  For instance, assume that the following data are specified for workpiece additional data 1 ~ 3.

  Opt1   :   Workpiece type data 1 (Workpiece profile $\Rightarrow$ 1: Round, 2: Square)
  Opt2   :   Workpiece type data 2 (Color information   1: White, 2: Black)
  Opt3   :   Workpiece quality data 3 (Workpiece accepted, rejected, etc. $\Rightarrow$ 1: OK, 2: NG)

  Example 1)   When detecting only black NG workpieces, neglecting workpiece type data 1:

  VCSEL1=0   Workpiece type data 1 (Workpiece profile) $\rightarrow$ Free
  VCSEL2=2   Workpiece type data 2 (Color information) $\rightarrow$ Black workpiece
  VCSEL3=1   Workpiece quality data 3 (Workpiece accepted, rejected, etc.) $\rightarrow$ NG workpiece

Example 2)　When detecting all workpieces, neglecting workpiece type data 1 to 3:

VCSEL1=0　Workpiece type data 1 (Workpiece profile) → Free
VCSEL2=0　Workpiece type data 2 (Color information) → Free
VCSEL3=0　Workpiece quality data 3 (Workpiece accepted, rejected, etc.) → Free

Sample program	Program for discriminating and detecting specified workpieces

PROGRAM VISCONV2

CONV(1, A, B, 0, 0)	
VCSEL1=1	"1: Round" is set for detecting condition 1 (workpiece profile).
VCFUNC=ON	
MOVE A	Moves to waiting position.
SYNC(1)	If a round workpiece exists in the workpiece detection area, synchronization starts.
MOVES VCPOS+POINT(, , 100)	Moves to the position above the workpiece position as detected by SYNC command.
MOVES VCPOS	Moves to the workpiece position detected by SYNC command.
:	Picks up the workpiece.
MOVES VCPOS+POINT(, , 100)	Moves to the position above the workpiece position as detected by SYNC command.
UNSYNC(1)	Conveyor synchronization end.
MOVE HOME+POINT(, , 50)	
MOVE HOME	
:	Places the workpiece.
MOVE HOME+POINT(, , 50)	
END	

VCWSTAT1 ~ 3

Function	:	Refers to workpiece additional information (workpiece type and status) of workpiece currently detected.

Format	:	VCWSTAT1

Example	:	IF VCWSTAT1 == 1 THEN GOTO LP PRINT VCWSTAT3, CR A=VCWSTAT1

Explanation & caution	:	Each workpiece data has three (3) additional information (workpiece type and status). Additional information of currently detected workpiece can be output to VCWSTAT1 ~ 3 by means of SYNC command or VCSEEK command. When VCWSTAT1 ~ 3 is used, <u>workpiece of many kinds running on the conveyor can be randomly picked up and sorted out by type.</u>

Caution 1:　　Only access of this system variable is possible.   Writing is not allowed.

Caution 2:　　Joint use of this command with motion command by using WITH statement is not allowed.

Caution 3:　　VCWSTAT1-3　can refer the additional information from current conveyor channel.

```
PROGRAM VISCONV2
    CONV(1, A, B, 0, 0)
    VCFUNC=ON
    VCSEL1=0
    MOVE A
    SYNC(1)
    CONFIG=LEFTY
    MOVES VCPOS+POINT( , , 100)
    MOVES VCPOS
    DELAY 0.2
'***** PICK-UP WORK PIECE *****
    MOVES VCPOS+POINT( , , 100)
    UNSYNC(1)

    TYPE=VCWSTAT1
    MOVE P(TYPE)+POINT( , , 50)
    MOVE P(TYPE)
    DELAY 0.2
'***** PLACE WORK PIECE *****
    MOVE P(TYPE)+POINT( , , 50)
    WAIT MOTION >=100
    PRINT 10.0–TIMER, CR
END
```

UNSYNC(1) — Workpiece additional data 1 of detected workpiece is saved in variable "TYPE".

Workpiece set position changes with the workpiece additional data number of detected workpiece.

※ **2CH vision + conveyer SCOL language programming notes**

Please make SCOL program taking care of following points.

1. The language that can be used for 1/2CH individual conveyer is as follows.
   CONV(N), SYNC(N), and USYNC(N) (N: Channel number)

2. The common language for 1/2CH conveyer is as follows.
   VCSEL1～3、VCFUNC、VCWSTAT1～3、VCSEEK、CNVSTAT

3. the language used together" becomes effective for the channel of synchronized with now.

```
PROGRAM VCV2CH

    :

'***** CH1 *****

VCSEL1 = 1
VCSEL2 = 1                              Setting of calculation condition 1-3
VCSEL3 = 1
CONV( 1,A,B,C,D )                       CONV parameter setting for CH1 conveyer

SYNC(1)                                 CH1 conveyer work detection waiting
LP1:

    :

   MOVE VCPOS                           Move to target position detected from the CH1 conveyer.
   PRINT VCWSTAT1,                      Display of work addition information 1-3
       VCWSTAT2, VCWSTAT3, CR
   IF VCSEEK == ON THEN GOTO LP1        Retrive next work pice from CH1 conveyer
    :
UNSYNC(1)                               Stop CH1 conveyer synchronization

    :

'***** CH2 *****

VCSEL1 = 2
VCSEL2 = 2                              Setting of calculation condition 1-3
VCSEL3 = 2
CONV(2,A,B,C,D )                        CONV parameter setting for CH2 conveyer

SYNC(2)                                 CH2 conveyer work detection waiting
LP1:

    :

   MOVE VCPOS                           Move to target position detected from the CH2 conveyer.
   PRINT VCWSTAT1,                      Display of work addition information 1-3
       VCWSTAT2, VCWSTAT3, CR
   IF VCSEEK == ON THEN GOTO LP1        Retrive next work piece from CH2 conveyer
    :
UNSYNC(2)                               Stop CH2 conveyer synchronization

    :
END
```

Section 6
Operation

6.1   Conveyor Synchronization Utility

This paragraph describes the conveyor synchronization utility function used in the "vision sensor + conveyor" synchronization mode.
(A total of four (4) displays are available.)

6.1.1   Conveyor Synchronization Utility (CONV_MON)

This paragraph deals with the utility function for performing various monitoring operations of the conveyor synchronization function.

```
[1]->( C O N V _ M O N )          < C H 1 >          < C H 2 > 1 / 7
[2]->  C o n v   F o r m   : V I S I O N _ C V       L I N E A R
[3]->  C o n v   V e l o c   : - * * * . * * *   - * * * . * * * *
[4]->  C o n v   S t a t u s :            0              0
[5]->  E n c     P u l s e   :        3 2 7 6 7        3 2 7 6 7
[6]->  M e s     P u l s e   :        6 3 2 4 1 7            0
[7]->  M e s     T r i p   : - * * * . * * *   - * * * . * * * *
      M E S 1       M E S 2
```

[1]   Trigger signal monitor:
When the conveyor trigger signal has turned on, <CH1> and <CH2> are inversely displayed.

    <CH1>   :   Trigger signal OFF

    <CH1>   :   Trigger signal ON

[2]   Conv Form: Type of conveyor synchronization

LINEAR	$\rightarrow$	Linear
ARC (+)	$\rightarrow$	Arc (CW)
ARC (−)	$\rightarrow$	Arc (CCW)
VISION_CV	$\rightarrow$	Vision sensor + conveyor

[3]   Conv Veloc: Conveyor speed

[4]   Conv Status: Conveyor status

    0 :   During asynchronization

    1 :   Waiting for synchronization signal

    2 :   During synchronization delay

    3 :   During acceleration for synchronization

    4 :   During constant-speed for synchronization

    5 :   During deceleration for synchronization

    6 :   During processing of synchronization end

    −1 :   Conveyor breakage

[5]   Enc Pulse: Pulse counter value of the conveyor encoder

[6]   Mes Pulse: Total number of pulses of the conveyor encoder
      When you press the [MES1] (F1) or [MES2] (F2) function key, measurement
      of total encoder pulses starts.

[7]   Mes Trip: Measured travel distance of the conveyor
      Real travel distance of the conveyor is indicated in mm.   When you press
      the [MES1] (F1) or [MES2] (F2) function key, measurement of conveyor
      travel distance starts.

● How to measure the total number of pulses of conveyor encoder and conveyor travel distance:

(1)   Press the [MES1] (F1) or [MES2] (F2) function key corresponding to the channel (CH1 or CH2) through which you wish to measure, using the cursor.

```
( C O N V _ M O N )              < C H 1 >           < C H 2 > 1 / 7
  C o n v   F o r m      : V I S I O N _ C V      L I N E A R
  C o n v   V e l o c    : - * * * * . * * *    - * * * . * * * *
  C o n v   S t a t u s  :                0               0
  E n c     P u l s e    :         3 2 7 6 7         3 2 7 6 7
  M e s     P u l s e    :         6 3 2 4 1 7             0
  M e s     T r i p      : - * * * * . * * *    - * * * . * * * *
  M E S 1       M E S 2
```

When you wish to count the number of pulses of CH1, press the [MES1] (F1) function key.

(2)   When you wish to count the number of pulses of CH1, press the [MES1] (F1) function key.   Likewise, when you wish to count the number of pulses of CH2, press the [MES2] (F2) function key. After moving the conveyor by "ΔL", press the [SET] function key.

```
( C O N V _ M O N )              < C H 1 >           < C H 2 > 1 / 7
  C o n v   F o r m      : V I S I O N _ C V      L I N E A R
  C o n v   V e l o c    : - * * * * . * * *    - * * * . * * * *
  C o n v   S t a t u s  :                0               0
  E n c     P u l s e    :         3 2 7 6 7         3 2 7 6 7
  M e s     P u l s e    :         6 3 2 4 1 7             0
  M e s     T r i p      : - * * * * . * * *    - * * * . * * * *
  S E T
```

(3)   Press the [SET] key, and the number of pulses measured "Mes Pulse" and the value converted from the number of pulses measured to the travel distance in mm "Mes Trip" are displayed.   To measure again, press the [MES1] (F1) or [MES2] (F2) key and repeat Steps (1) and (2) above.

```
( C O N V _ M O N )              < C H 1 >          < C H 2 > 1 / 7
  C o n v   F o r m     : V I S I O N _ C V        L I N E A R
  C o n v   V e l o c   : - * * * * . * * *    - * * * . * * * *
  C o n v   S t a t u s :                 0                    0
  E n c     P u l s e   :           3 2 7 6 7          3 2 7 6 7
  M e s     P u l s e   :         6 3 2 4 1 7                  0
  M e s     T r i p     : - * * * * . * * *    - * * * . * * * *
  M E S 1         M E S 2
```

(Caution)

The value of "Mes Trip" is not displayed correctly unless the conveyor parameter is specified.   For this purpose, figure out the travel distance per one (1) pulse from the measured value of "Mes Pulse" and conveyor travel distance (actually measured value), then set the value in "[C00] Conveyor Parameter". For the parameter setting procedures, see Para. 3.2.6.

6.1.2 Conveyor Synchronization Utility (VCV_PAR1)

Press the <NEXT> key, and the system calls the utility display where you can
edit various parameter values used for the "vision sensor + conveyor"
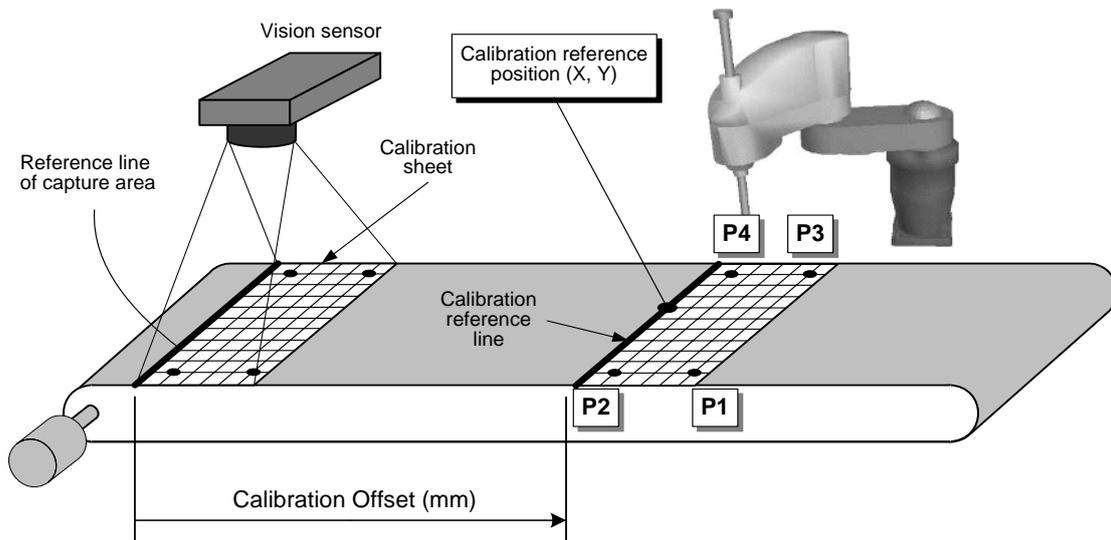synchronization function.

```
        ( V C V _ P A R 1 )      < C H 1 >        < C H 2 >   2 / 7
[1]->    C u r _ P o s     : * * * * * . * * *   * * * * * . * * *
[2]->    C a l i b _ O f s t : * * * * * . * * *   * * * * * . * * *
         D e t e c t _ S t r : * * * * * . * * *   * * * * * . * * *
         D e t e c t _ E n d : * * * * * . * * *   * * * * * . * * *
         S y n c _ L i m i t : * * * * * . * * *   * * * * * . * * *

          R E S E T    H E R E
```

[1] Cur_Position: Present conveyor position (mm)

[2] Calib_Offset: Calibration offset (mm)

It is possible to set the calibration offset (mm) of conveyor parameter "[C01]
Vision + Conveyor Tracking Parameter."　For details on the setting
procedures, see Para. 4.3.5

[3]   Detect_Str: Start point of workpiece detection (mm)

[4]   Detect_End: End point of workpiece detection (mm)

[5]   Sync_Limit: Conveyor synchronization limit point (mm)

```
( V C V _ P A R )          < C H 1 >          < C H 2 >    2 / 7
 C u r _ P o s      : * * * * * . * * *    * * * * * . * * *
 C a l i b _ O f s t : * * * * * . * * *    * * * * * . * * *
 D e t e c t _ S t r : * * * * * . * * *    * * * * * . * * *
 D e t e c t _ E n d : * * * * * . * * *    * * * * * . * * *
 S y n c _ L i m i t : * * * * * . * * *    * * * * * . * * *

 R E S E T    H E R E
```

[3]->
[4]->
[5]->

Data [3] through [5] above correspond to the workpiece detection start point, workpiece detection end point and conveyor synchronization limit point of conveyor parameter "[C01] Vision + Conveyor Tracking Parameter", respectively.   You can edit the parameter value on this display.

• Move the inversely displayed area above to a desired parameter position you wish to change, using the cursor keys on the teach pendant.

| Capture area | **Start point of workpiece detection area** | Workpiece detection area | **End point of workpiece detection area** | **Conveyor synchronization limit point** |
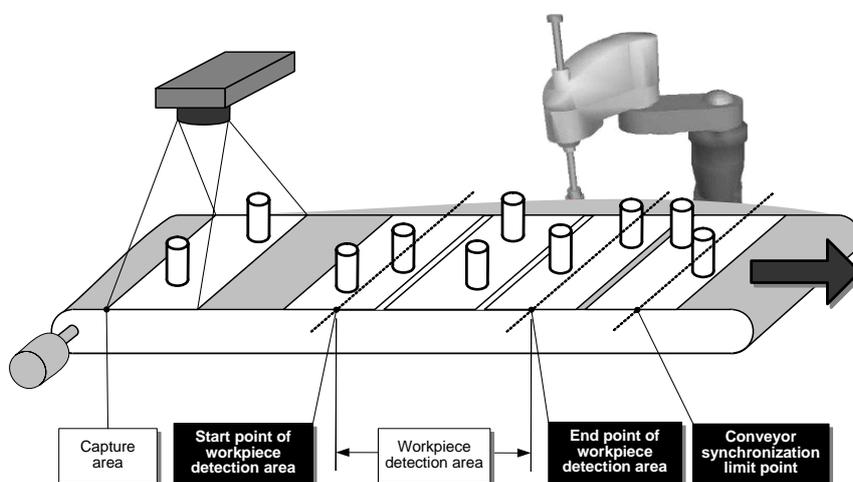
• Stop the conveyor once at the vision frame reference point.   Press the [RESET] (F1) key.   Then the present conveyor position [1] is reset.

• Continuously move the conveyor as it is.

- Stop the conveyor at the workpiece detection area start point, workpiece detection area end point and conveyor synchronization limit point and press the [HERE] (F2) key each time.

- To change the value, press the <EXE> key.   Then the numerical input mode takes effect.   Enter a desired numerical value directly through the teach pendant, press the <EXE> key again.

6.1.3   Conveyor Synchronization Utility (VCV_PAR2)

This paragraph describes the utility function for editing various parameter values used for the "vision sensor + conveyor" synchronization function.

```
( V C V _ P A R 2 )      < C H 1 >        < C H 2 >   3 / 7
[1]->  O v l a p _ A d j  : * * * * * . * * *    * * * * * . * * *
[2]->  C a p t _ W I d t h : * * * * * . * * *    * * * * * . * * *
```

- To edit, move the inversely displayed area above to a desired parameter position you wish to change, using the cursor keys on the teach pendant. Press the <EXE> key, and the numerical input mode takes effect.   Enter a desired numerical value directly through the teach pendant, press the <EXE> key again.

[1] Overlap_Adj: Overlap allowance at workpiece detection area start point (mm)
     If the distance "Δw" between the workpieces detected next and previously is smaller than the overlap allowance (mm), the system interprets that the next and previous workpieces are the same workpiece, and ignores the next workpiece.

Δw

Next workpiece   Previous workpiece
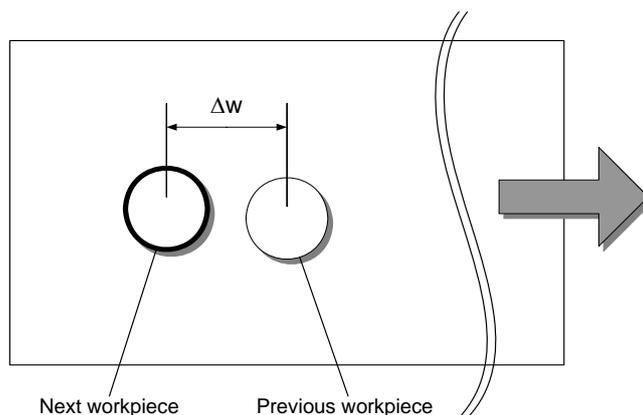
[2]   Capture_Width: Capture width (mm)
Specify the width of an image captured by the vision sensor in mm.
The width of capture is the distance measured in the conveyor travel
direction, taking the vision frame reference point as the start point.
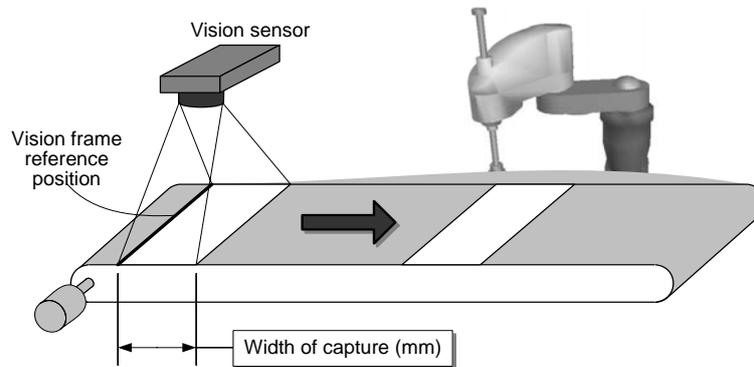
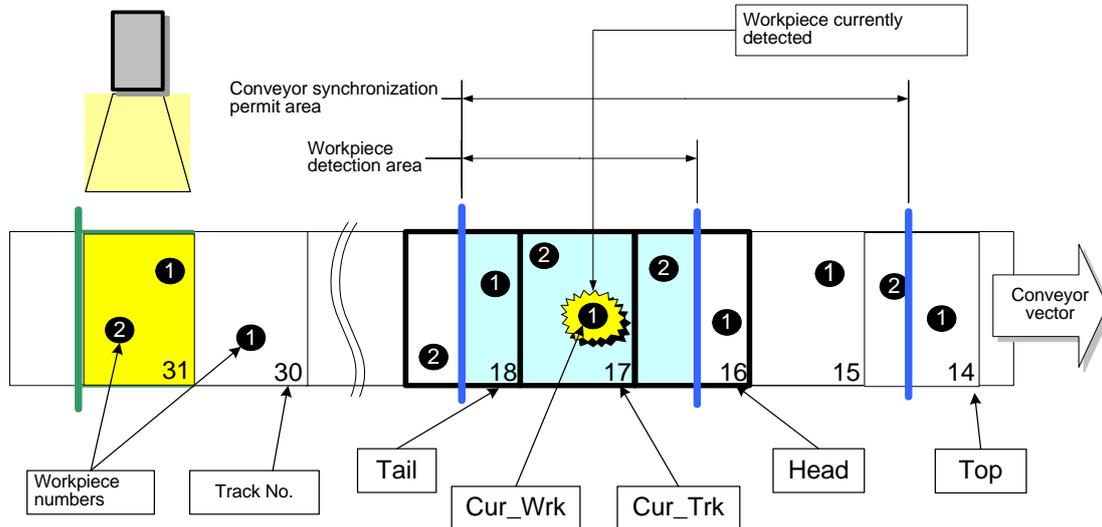### 6.1.4 Conveyor Synchronization Utility (VCV_MON1 -1, VCV_MON1-2)

This paragraph refers to the internal counter monitor function during the "vision sensor + conveyor" synchronization mode.

< for CH1 Conveyor >

```
( V C V _ M O N 1 - 1 )                 < C H 1 >        4 / 7
[1]->  T r k _ C n t / N u m    :            * * * /    * * *
[2]->  T o p / H e a d / T a i l :  * * * /    * * * /    * * *
[3]->  C u r _ W r k / T r k    :            * * * /    * * *
[4]->  T r g _ I n t e r v a l  :  * * * * * . * * * ( m m )
```

< for CH2 Conveyor >

```
( V C V _ M O N 1 - 1 )                 < C H 1 >        4 / 7
[1]->  T r k _ C n t / N u m    :            * * * /    * * *
[2]->  T o p / H e a d / T a i l :  * * * /    * * * /    * * *
[3]->  C u r _ W r k / T r k    :            * * * /    * * *
[4]->  T r g _ I n t e r v a l  :  * * * * * . * * * ( m m )
```


[1]   Trk_Cnt/Num
      The newest track number (*1) and total number of tracking data existent on
      the conveyor are displayed.

      *1:   Index number of tracking data.

[2]   Top/Head/Tail
Top   :   The leading track number of the conveyor synchronization
            permit area is displayed.
Head   :   The leading track number of the workpiece detection area is
            displayed.
Tail   :   The last track number of the workpiece detection area is
            displayed.

[3]   Cur_Wrk/Trk
Cur_Wrk   :   The workpiece number (*2) of the workpiece currently
               detected is displayed.
Cur_Trk   :   The track number of the workpiece currently detected is
               displayed.

*2:   Workpiece index number existent in tracking data.

[4]   Trg_Interval
The conveyor travel distance until the current trigger signal is accepted after
the previous trigger signal is displayed.

6.1.5 Conveyor Synchronization Utility (VCV_MON2)

```
( V C V _ M O N 2                                  6 / 7
[1]->  V C P O S . X : * * * * * . *    V C W S T A T 1 : * * * * *
[2]->  V C P O S . Y : * * * * * . *    V C W S T A T 2 : * * * * *
[3]->  V C P O S . Z : * * * * * . *    V C W S T A T 3 : * * * * *
[4]->  V C P O S . C : * * * * * . *
```

[1] VCPOS. X/VCPOS. Y/VCPOS. Z/VCPOS. C
The target motion positions of the workpiece detected currently are displayed. (The same values as in SCOL language "VCPOS" are displayed.)

[2] VCWSTAT1 ~ 3
Workpiece additional information (workpiece type and status) for the workpiece currently detected can be referred to. (The same values as in SCOL language "VCWSTAT1 ~ 3" are displayed.)

6.1.6 Addition of conveyer utility (VCV_MON3)

System reservation

6.2 Stop Operation

The following stop operations are available for the TS3000 (TS3100) controller.

- STOP command and external stop signal input
- BREAK command
- Master mode switch
- STOP command of SCOL language
- MODE selection (STEP/MOTION)
- FIELD HOLD command

A. Stop with servo ON

- Emergency stop
- Servo OFF (external servo OFF input signal)

B. Stop with servo OFF

When the stop operation is executed during conveyor synchronization (i.e., while the robot is moving by tracking the conveyor speed), the results are as follows:

A: Stop with servo ON

If the stop operation is executed during conveyor synchronization, the program stops, but <u>the robot will not stop and continues tracking the conveyor to the conveyor synchronization limit point</u>.

Stop operation

The robot continues tracking to the synchronization end point.
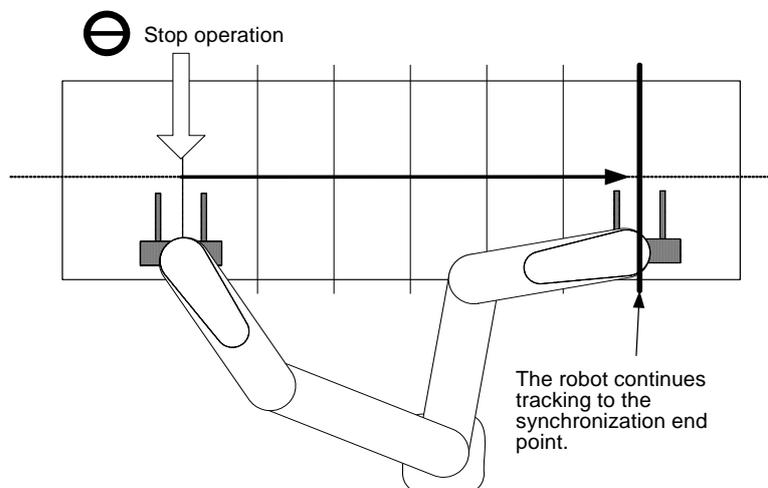
If the robot is kept intact under this condition, the robot stops at the conveyor synchronization limit point.   As a result, the robot hand may collide with a workpiece on the synchronized conveyor.   To prevent this, the system should be constructed, fully considering the following matters.

[1]   If the conveyor or other external equipment has entered an emergency stop state, the robot should also enter an emergency stop state.

[2]   If the robot has entered an emergency stop state, the conveyor or other external equipment should also enter an emergency stop state.

[3]   If the robot program has stopped due to some reason (error stop/stop operation by operator), the conveyor should be stopped also.

B: Stop with servo OFF

The robot stops instantaneously to stop the synchronization processing instantly.

When performing the stop operation during conveyor synchronization, strictly observe the following precautions, fully taking notice of the above.

<div style="border: 1px solid black; padding: 10px;">

⚠ **CAUTION**

- Even if the program stopped during conveyor synchronization, continuous operation is possible by using the restart function just after the program stop.   In principle, however, after the stop operation, <u>be sure to reset the operation, move the robot to the safe place by manual guidance, reset the program, then resume the operation</u>.   (For details, see Para. 6.3.)

- Unless an error is caused, <u>DO NOT effect the servo OFF or emergency stop during conveyor synchronization</u>.   Otherwise, the robot hand will collide with a workpiece on the synchronized conveyor.

- To avoid the above accident, construct the system, taking notice of the following matters.

    [1]   If the conveyor or other external equipment has entered an emergency stop state, the robot should also enter an emergency stop state.

    [2]   If the robot has entered an emergency stop state, the conveyor or other external equipment should also enter an emergency stop state.

    [3]   If the robot program has stopped due to some reason (error stop/stop operation by operator), the conveyor should be stopped also.
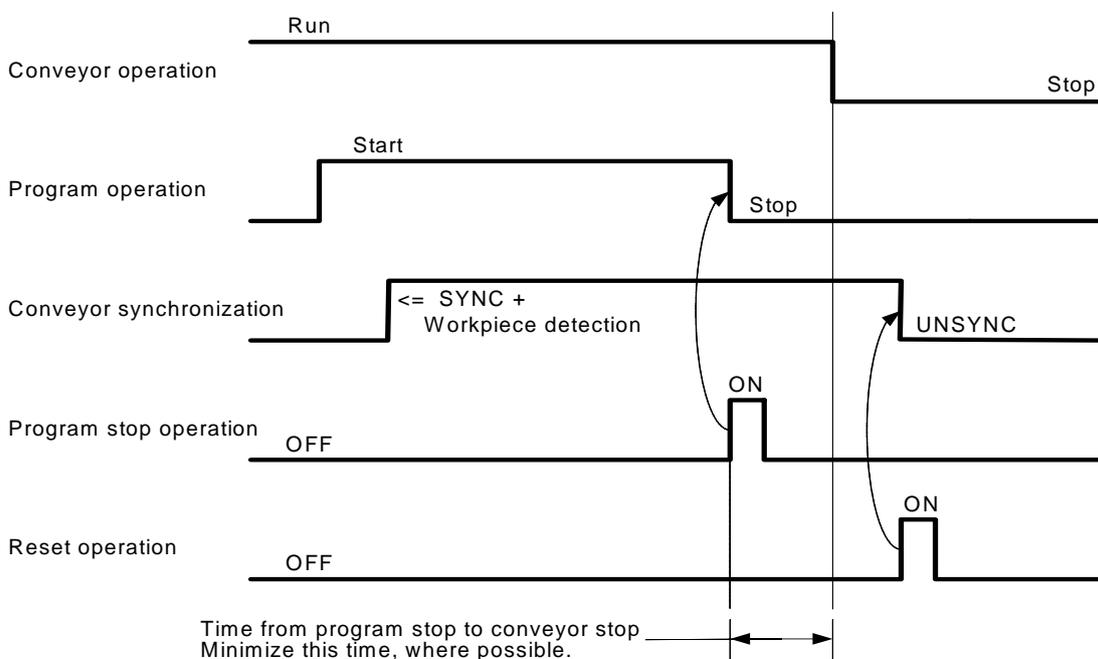
</div>

6.3   Procedures for Reset to Restart

When the reset operation is executed after the stop operation done during conveyor synchronization, the internal processing as shown below is executed.

[1]   The processing of conveyor synchronization finishes.   (The UNSYNC command (i.e., synchronization end command) is executed internally.)   [2]   All tracking data saved (i.e., track number, workpiece number, workpiece coordinate, etc.) are cleared.

The reset operation comes in the three (3) types; program reset, step reset and cycle reset.

After the stop operation as described in the preceding paragraph is executed during conveyor synchronization, be sure to perform the reset operation before restarting the program.   When executing the reset operation, however, be sure to strictly observe the following procedures.   Otherwise, the robot hand may collide with a workpiece on the synchronized conveyor.

Run

Conveyor operation

Stop

Start

Program operation

Stop

<= SYNC +
Workpiece detection

Conveyor synchronization

UNSYNC

ON

Program stop operation   OFF

ON

Reset operation   OFF

Time from program stop to conveyor stop
Minimize this time, where possible.

Cautions:

- After the stop operation and before the reset operation, be sure to stop the conveyor.   The time covering from the program stop to the conveyor stop as indicated in the above figure should be as short as possible.

- If the stop operation in Para. 6.3–B has been effected, the time covering from the program stop to the conveyor stop as indicated in the above figure should be almost zero (0).

6.4   **Conveyor Stop**

If the number of encoder pulses counted is zero (0) during the time designated by the construct parameter after the start of conveyor synchronization following the synchronization trigger signal ON, the error saying "001–048: Conveyor Stop" generates.   This is the error of level 1, and the program is executed continuously without being stopped.
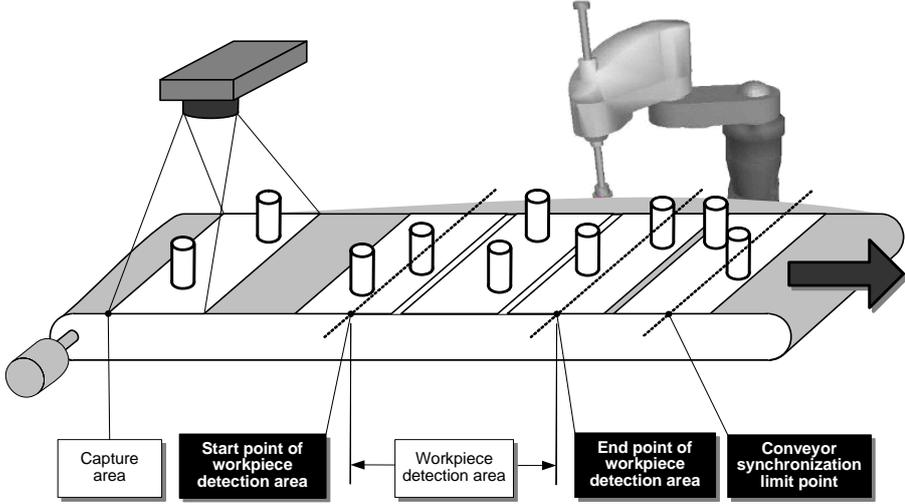
The conveyor (encoder) speed fluctuation should be within ±7.5 % to the average constant speed of the conveyor being used.   Otherwise, precise synchronization accuracy cannot be assured, and the workpiece or hand, etc., may be damaged accordingly.

Section 7
Operation

7.1 Error Message Table

If an error has been detected by the self-diagnosis function, appropriate error message is displayed on the teach pendant, as shown below. Identify the cause and take appropriate measures according to the following table.

Error code	Error message, possible causes and remedies
001–047	Conveyor Line Breakage
	• The encoder cable of the specified conveyor number is broken or the encoder is defective. Check for the wiring.
	• Even after this error occurred, the robot continuously tracks the conveyor based on the conveyor (encoder) speed just before the error generation, without being stopped.
	• If the encoder cable breakage has been detected during conveyor synchronization, be sure to recess the robot to the safe place. Otherwise, the robot may collide with the workpiece or conveyor.
	This error will not be reset unless the power is turned off. Locate and remedy the broken part, then turn the power on again.
001–048	Conveyor Stop
	The conveyor stop time has reached the judgment time as specified by the parameter.
	• The conveyor was stopped when the UNSYNC command has been executed.
002–033	Conveyor Parameter Error
	• The parameter value exceeds the permissible range.
001–177	VCV Comm Process Abnormal
	Communication data has been sent from the vision sensor more than twice before the trigger signal turned on.
	→ Confirm again the data transmit timing from the vision sensor and the trigger signal transmission timing. (For details, see Para. 4.1.)

Error code	Error message, possible causes and remedies
001−178	VCV Comm data format error
	The format of the data reached from the vision sensor is illegal. (Data other than the numerical value has reached. The format of the numerical data is illegal. The number of data is illegal.)
	→ Confirm again the data format sent from the vision sensor. (For details, see Para. 4.2.)
001−179	VCV Too many triggers
	The number of tracking data that can be saved exceeds the maximum value.
	→ Increase the capture width of the vision sensor and reduce the number of capture counts.
	→ Or reduce the distance from the capture reference point to the conveyor synchronization limit point.
001−179	VCV Comm Process Timeout
	Conveyor parameter C01 The "1-180: VCV Comm Process Timeout" error occurs when the data receive cannot be completed in Data reception time out (data receive time-out) setting time or less.
	Conveyor parameter C01 of this function This function becomes disabled for "0.0" { Data reception timeout ms }

Error code	Error message, possible causes and remedies
004-051	Conveyor sync limit area

	The robot goes into the "conveyer synchronous limitation area" whilst the conveyor synchronization. Execute program reset and error reset after moving the robot outside the limitation area. Review the program and the conveyer parameter setting when occurring again.
	
	   Specify the "conveyer synchronous limitation area" parameter on "CONVEYOR.PAR: C00 Conveyor parameter -> { Limitation width of synchronization }" by the unit (mm).
	
	   This error can be reset. After the error occurs, execute "PROGRAM RESET" by all means before resumes operations .

004-052	VCV Comm data format error
	The communication port of Ethernet (IP2 or IP3) closed while the vision conveyer was synchronizing. Please confirm whether wiring and the vision device of Ethernet work normally.

APPROVED BY:

CHECKED BY:

PREPARED BY: