Motoman® NX100 Controller

Integrated Vision Function Manual

Part Number: 153139-1CD
Revision: 1

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Chapter 1

Introduction

1.1 Vision Function Overview

The Motoman® NX100 Integrated Vision Function is an optional feature that enables the NX100 controller to communicate with a vendor-supplied sensor device (Vision System) through an RS-232C serial port. The Vision System provides the NX100 controller with robot position offset data. The NX100 controller uses the position offset data for robot motion compensation.

Note: Postition offset data must be specifically formatted for the NX100 controller. See Appendix C for data formatting specifications.

A simplified integration / communication diagram for the NX100 Vision Function is shown in Figure 1.

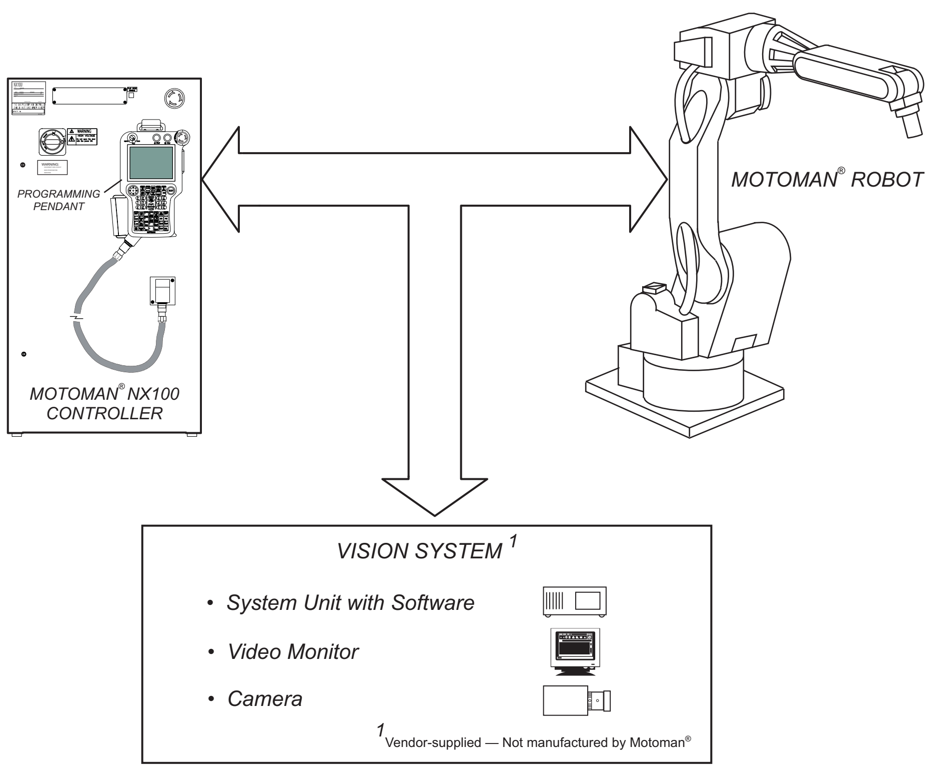

Figure 1 Simplified Integration / Communication Diagram — NX100 Vision Function

The major steps associated with NX100 Vision Function/Vision System operation and JOB programming are represented by the flow chart shown in Figure 2.

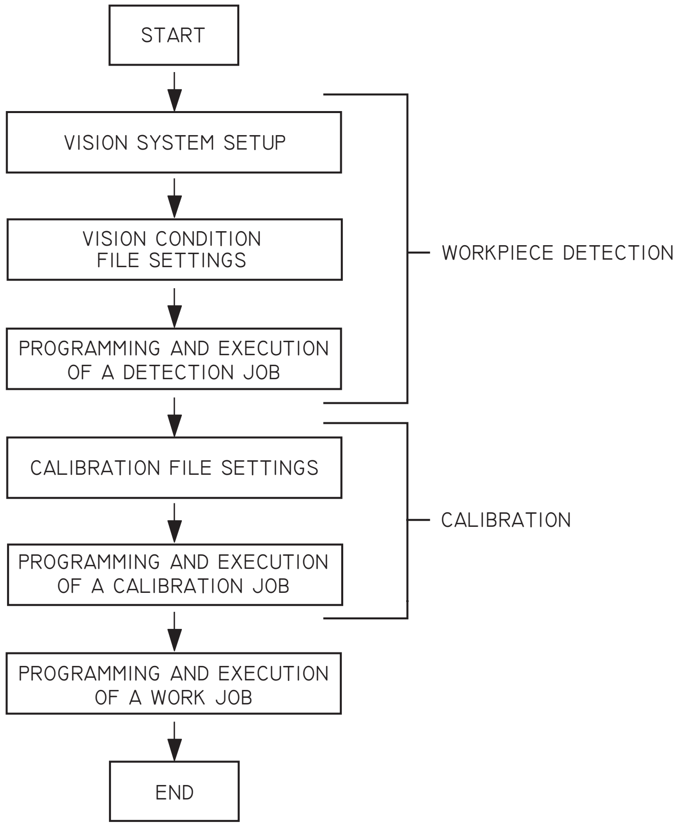

Figure 2 Flow Chart — NX100 Vision Function/Vendor-Supplied Vision System

1.2 Equipment Designation

In this manual, components and assemblies of the NX100 Vision Function and vendor-supplied Vision System are designated as follows –

EQUIPMENT TYPE	DESIGNATION USED IN THE MANUAL
NX100 Controller	NX100
NX100 Programming Pendant	Programming Pendant
NX100 Vision Function	Vision Function
Vision System (Vendor-supplied — not manufactured by Motoman®)	Vision System

1.3 NX100 Programming Pendant

The Programming Pendant (see Figure 3) provides icon-driven system programming, and is the primary means of programmer/operator interaction with the NX100 Vision Function. It also features a menu-driven interface to simplify operator interaction with the NX100 Vision Function. All programming functions are available through the Programming Pendant. The pendant features the Windows® CE operating system and displays information on a 6½ -inch, color LCD, touch screen display (640 X 480 VGA). The pendant also incorporates a CompactFlash® card slot for program (JOB) backups. Most operator controls are located on the Programming Pendant. For detailed information on the pendant programming keys, programming functions, file backup functions, and display functions, please refer to the Motoman *NX100 Operator's Manual for General Purpose* (refer to Section 1.5).

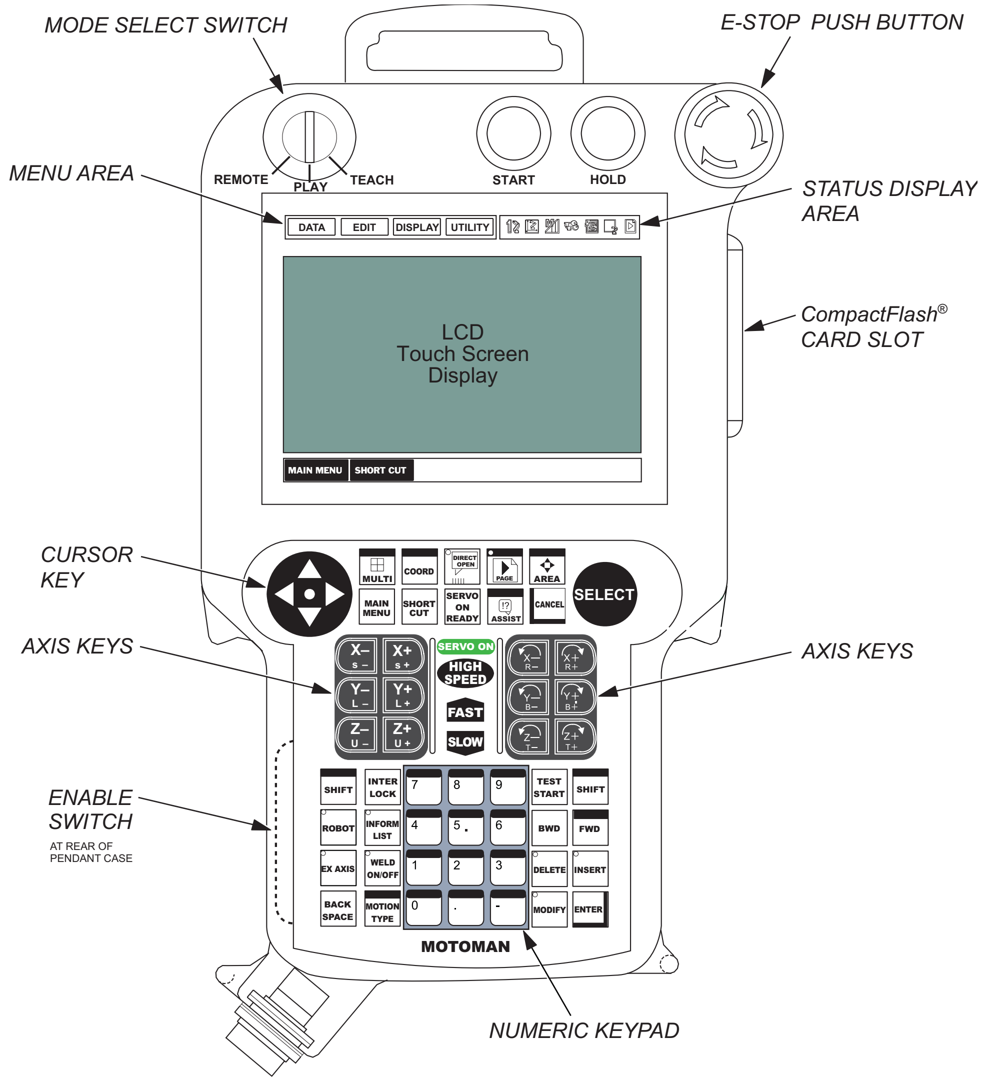

Figure 3 NX100 Programming Pendant

Note: The Programming Pendant LCD touch screen display goes dark after a few minutes of inactivity. Press any key to restore the screen.

1.4 Representation of Pendant Keys and Menu Items in the Manual

PENDANT KEYS AND MENU ITEMS	REPRESENTATION USED IN THE MANUAL
CHARACTER KEYS	The pendant keys that have characters printed on them are indicated by [ ] in the manual. Example: [ENTER]
SYMBOL KEYS	The keys that are marked with an iconic graphic are represented by a reproduction of the iconic graphic in the manual. Example:  Note: The CURSOR KEY is an exception, as it is NOT marked with an iconic graphic.
Keys that must be pressed simultaneously	Two keys that must be pressed simultaneously are indicated by a "+" sign between the two keys. Example: [SHIFT] + [COORD] Press and hold the [SHIFT] key, then press the [COORD] key.
menu items shown on the LCD touch screen display	Menu items shown on the Programming Pendant LCD touch screen display are represented by { }. Example: { JOB }

Note: The NX100 OPERATOR'S MANUAL FOR GENERAL PURPOSE (P/N 150077-1) contains a detailed description of the Programming Pendant and associated keys, push buttons, and menu selections (refer to Section 1.5).

Note: Throughout this manual, the expression "Select – – –" means that the Programming Pendant CURSOR is moved to the desired object item, then the Programming Pendant SELECT key is pressed.

1.5 Reference Documentation

- Motoman *NX100 Controller Manual* (P/N 149201-1)
- Motoman *NX100 Operator's Manual for General Purpose* (P/N 150077-1)
- Motoman *INFORM III User's Manual* (P/N 150078-1)
- Motoman *Manipulator (Robot) Manual* (P/N depends on robot model)
- Manuals for vendor-supplied Vision System

1.6 Customer Support Contact Information

If you need assistance with any aspect of the NX100 Integrated Vision, please contact Motoman Customer Support at the following 24-hour telephone number –

937. 847. 3200

For routine technical inquiries, you can also contact Motoman Customer Support at the following e-mail address –

techsupport@motoman.com

When using e-mail to contact Motoman Customer Support, please provide a detailed description of your issue, along with complete contact information. Please allow approximately 24 to 36 hours for a response to your inquiry.

Note: Please use e-mail for routine inquiries, only. If you have an urgent or emergency need for service, replacement parts, or information, you must contact Motoman Customer Support at the telephone number shown above.

NOTES

Chapter 2
Safety

2.1 Introduction

It is the purchaser's responsibility to ensure that all local, county, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions for each installation are met and followed.

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems. This information can be obtained from the Robotic Industries Association (RIA) by requesting ANSI/RIA R15.06-1999.

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www.roboticsonline.com

Ultimately, the best safeguard is trained personnel. The user is responsible for providing personnel who are adequately trained to operate, program, and maintain the robot cell. **THE ROBOTIC SYSTEM MUST NOT BE OPERATED BY PERSONNEL WHO HAVE NOT BEEN TRAINED!**

We recommend that all personnel who intend to operate, program, repair, or use the robot system be trained in an approved Motoman training course and become familiar with the proper operation of the system.

This safety chapter addresses the following –

- Standard Conventions (Section 2.2)
- General Safeguarding Tips (Section 2.3)
- Mechanical Safety Devices (Section 2.4)
- Installation Safety (Section 2.5)
- Programming, Operation, and Maintenance Safety (Section 2.6)

2.2 Standard Conventions

This manual includes the following alerts – in descending order of severity – that are essential to the safety of personnel and equipment. As you read this manual, pay close attention to these alerts to insure safety when installing, operating, programming, and maintaining this equipment.

DANGER!
Information appearing in a DANGER concerns the protection of personnel from the immediate and imminent hazards that, if not avoided, will result in immediate, serious personal injury or loss of life in addition to equipment damage.

WARNING!
Information appearing in a WARNING concerns the protection of personnel and equipment from potential hazards that can result in personal injury or loss of life in addition to equipment damage.

CAUTION!
Information appearing in a CAUTION concerns the protection of personnel and equipment, software, and data from hazards that can result in minor personal injury or equipment damage.

Note: Information appearing in a Note provides additional information which is helpful in understanding the item being explained.

2.3 General Safeguarding Tips

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. General safeguarding tips are as follows –

- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this robot system.
- Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the robot cell.

- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
- The robot must be placed in Emergency Stop (E-Stop) mode whenever it is not in use.
- In accordance with ANSI/RIA R15.06-1999, section 4.2.5, Sources of Energy, use lockout/tagout procedures during equipment maintenance. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).

2.4 Mechanical Safety Devices

The safe operation of the robot, transporter, auxiliary equipment, and system is ultimately the user's responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, ANSI/RIA R15.06-1999 safety standards, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location.

The following safety equipment is provided as standard –

- Safety fences and barriers
- Light curtains and/or safety mats
- Door interlocks
- Emergency stop palm buttons located on operator station, robot controller, and programming pendant

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.

2.5 Installation Safety

Safe installation is essential for protection of people and equipment. The following suggestions are intended to supplement, but not replace, existing federal, local, and state laws and regulations. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location.

- Be sure that only qualified personnel familiar with national codes, local codes, and the ANSI/RIA R15.06-1999 Robot Safety standard are permitted to install the equipment.
- Identify the work envelope of each robot with floor markings, signs, and barriers.
- Position all controllers outside the robot work envelope.
- Whenever possible, install safety fences to protect against unauthorized entry into the work envelope.
- Eliminate areas where personnel might get trapped between a moving robot and other equipment (pinch points).
- Provide sufficient room inside the workcell to permit safe teaching and maintenance procedures.

2.6 Programming, Operation, and Maintenance Safety

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to program, operate, and maintain the system. All personnel involved with the operation of the equipment must understand potential dangers of operation.

- Inspect the robot and work envelope to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Be sure that all safeguards are in place. Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Do not enter the robot cell while it is in automatic operation. Be sure that only the person holding the programming pendant enters the workcell.
- Check the E-Stop button on the programming pendant for proper operation before programming. The robot must be placed in Emergency Stop (E-Stop) mode whenever it is not in use.
- Back up all programs and jobs onto suitable media before program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.
- Any modifications to PART 1, System Section, of the robot controller concurrent I/O program can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1, System Section. Making any changes without the written permission of Motoman will VOID YOUR WARRANTY!
- Some operations require standard passwords and some require special passwords. Special passwords are for Motoman use only. YOUR WARRANTY WILL BE VOID if you use these special passwords.
- The robot controller allows modifications of PART 2, User Section, of the concurrent I/O program and modifications to controller parameters for maximum robot performance. Great care must be taken when making these modifications. All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot and other parts of the system. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations.
- Check and test any new or modified program at low speed for at least one full cycle.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.
- Use proper replacement parts.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).

Chapter 3

Workpiece Detection

3.1 Vision System Setup

This section of the chapter describes setup of the Vision System to detect a specified part or workpiece.

Select {OPTION} from the main menu ➡ Select {VISION COND.}*1 ➡ Press the page key [page key] to select a condition number ➡ Move the cursor to an item to be set and press [SELECT] ➡ Enter a value by pressing the number keys, and press [ENTER]

*1 The vision condition display appears. Pressing [SELECT] with the cursor on COORDINATE switches between ROBOT and PIXEL.

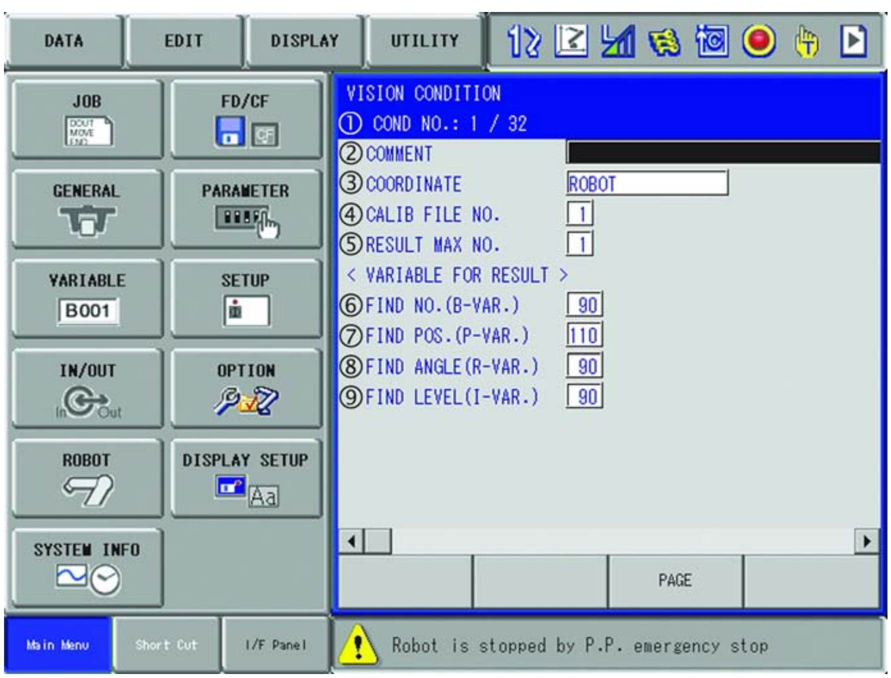


Figure 4 VISION CONDITION Screen — Programming Pendant LCD Touch Screen Display

① **COND NO**
Displays the vision condition file number. Select the number by pressing the page key or by entering a number using the number keys under the page key.

② **COMMENT**
Enter a comment. Comment is limited to a maximum of 32 characters.

③ **COORDINATE**
Displays the resulting coordinates for the position of the detected workpiece.
ROBOT: The detection result is stored in the robot coordinates (three dimensions).
PIXEL: The detection result is stored in the pixel coordinates (two dimensions)

④ **CALIB FILE NO**
Displays the calibration file number used to convert the detection result into robot coordinates.
When PIXEL is set as the COORDINATE, the calibration files are invalid.
The setting range is from 1 to 16.

⑤ **RESULT MAX NO**
Displays the number of workpieces whose detection results are stored as user variables in the job when a multiple number of workpieces are detected.
The setting range is from 1 to 20.

⑥ **FIND NO (B-VAR)**
Displays the byte variable (B-variable) number. This variable stores the number of detected workpieces.

⑦ **FIND POS (P-VAR)**
Displays the position variable (P-variable) number. This variable stores the position of a detected workpiece. When a multiple number of workpieces are detected, the results for the number specified in RESULT MAX NO are stored in sequential order, starting with the P-variable that is defined.

When ROBOT is set as the COORDINATE, the positions (three-dimensions; X, Y, and Z) on a robot coordinate system are stored.

When PIXEL is set as the COORDINATE, the positions (two-dimensions; X and Y) on a pixel coordinate system are stored.

Note: If CALIBRATION (refer to Chapter 4) has not been performed at this point, set PIXEL as the COORDINATE of the vision file. The detection results are stored in two-dimensional (2-D) pixel coordinates.

⑧ **FIND ANGLE (R-VAR)**
Displays the real-number variable (R-VAR) number. This variable stores the detected workpiece angle. When a multiple number of workpieces are detected, the results for the number specified in RESULT MAX NO are stored.

⑨ **FIND LEVEL (I-VAR)**
Displays the integer variable (I-variable) number. This variable stores the correlation value of a detected workpiece. When a multiple number of workpieces are detected, the results for the number specified in RESULT MAX NO are stored.

3.2 Programming the Workpiece Detection JOB

3.2.1 VSTART (Vision Detection Instruction)

The VSTART command (see Job Example below) instructs the NX100 Vision Function to initiate the VSTART function for workpiece detection.

Note: For information regarding definition of a JOB, preparation of a JOB, and registration of an instruction, refer to Chapter 5 of this manual.

JOB EXAMPLE

```
NOP
VSTART    FIND    FT=0    MD=0    VF#(1)
           ①       ②       ③        ④
VWAIT
END
```

① DETECTION METHOD

Specifies the detection method from the vision system.

② DETECTION TYPE NUMBER

Specifies the scenes to be detected in the vision system. It is necessary that the specified detection type has been registered in the vision system.

The setting range is from 0 to 255.

③ DETECTION MODEL NUMBER

Specifies the model of the workpiece to be detected in the vision system. It is necessary that the specified detection model has been registered in the vision system.

The setting range is from 0 to 7.

④ VISION CONDITION FILE NUMBER

Specifies a vision condition file No. It is necessary that the contents of the specified vision condition file have been set in the vision system.

The setting range is from 1 to 32.

3.2.2 VWAIT (Vision Wait Instruction)

Pauses execution of the current JOB ("waits") until completion of the VSTART instruction.

Note: When a VWAIT instruction does not immediately follow a VSTART instruction in the JOB, the NX100 processes all instructions that are placed between the VSTART and VWAIT instructions.

3.3 Execution (Playback) of Workpiece Detection Job

1. Perform the CALIBRATION process (refer to Chapter 4 of this manual).
2. Playback the prepared workpiece detection JOB, and confirm that the detection results are stored in correct and specified variables.

✍ *Note: Refer to the NX100 OPERATOR'S MANUAL should you have any questions or a need for additional information regarding the JOB playback process (refer to Section 1.5).*

Chapter 4

Calibration

Typically, a sensor (such as the Vision System) has a coordinate system that differs from the coordinate system used by the robot. Because of this difference, the offset data must be transformed so the result reflects a valid offset for the coordinate system of the robot.

The coordinate values detected by the Vision System are two-dimensional (2-D) values . The NX100 Vision Function converts the detected 2-D coordinate values into three-dimensional robot coordinate values.

CALIBRATION is the operation that enables an accurate conversion between the two different coordinate systems.

4.1 Setting the Calibration File

Select {OPTION} from the main menu ➡ Select {VISION CALIB} ➡ Press the page key [▶] to select a condition No. ➡ Move the cursor to an item to be set and press [SELECT] ➡ Enter a value by pressing the number keys, then press [ENTER].

Note: Pressing [SELECT] with the cursor on TYPE, switches between STANDARD and LASER light modes.

Note: Pressing [SELECT] with the cursor on MODE, switches between MOBILE CAMERA (attached to robot) and FIXED CAMERA (attached to stationary stand).

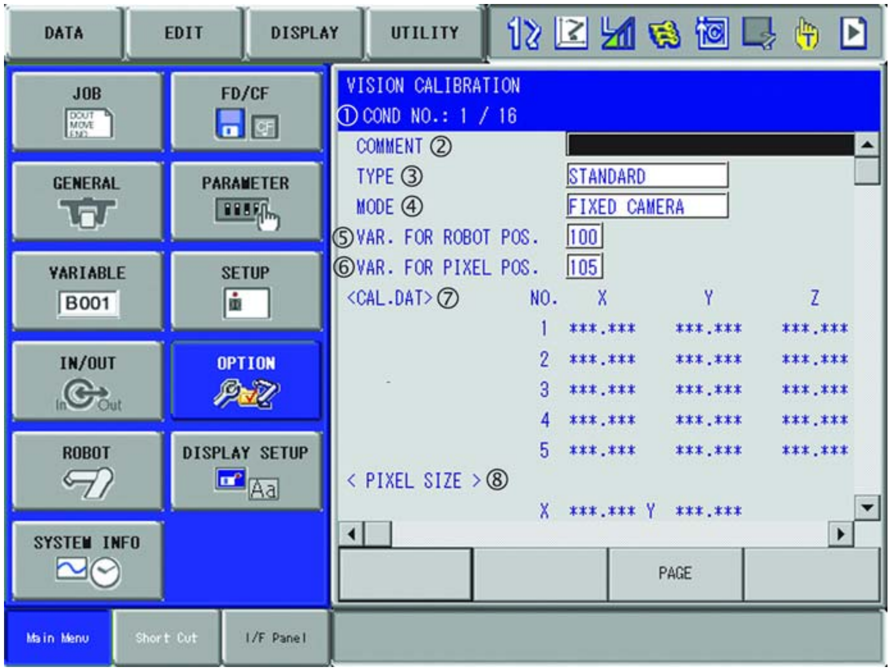


Figure 5 VISION CALIBRATION Screen — Programming Pendant TouchScreen Display

① COND NO

Displays the calibration file number. Select the number by pressing the page key  or by entering a number using the number keys.

The setting range is from 1 to 16.

② COMMENT

Enter a comment. Comment is limited to a maximum of 32 characters.

③ TYPE

Displays the calibration types —

- STANDARD – Calibration using normal (noncoherent) light source.
- LASER – Calibration using LASER (coherent) light source.

④ MODE

Displays camera installation mode information —

- MOBILE – The camera is attached to the manipulator (robot), so that it moves as the robot moves.
- FIXED – The camera is attached to stand or fixture and does not move as the robot moves.

⑤ VAR FOR ROBOT POS

Displays the starting variable to be used to store the robot coordinates for calibration.

⑥ `VAR FOR PIXEL POS`

Displays the starting variable to be used to store the pixel coordinates for calibration.

⑦ `CAL DAT`

Displays the differences between the taught robot coordinate values and the calculated robot coordinate values.

✍ *Note: The coordinate values shown on the Programming Pendant display should always be less than 1 mm.*

If CALIBRATION has not yet been completed, or the contents of the CALIBRATION file has been changed, the coordinate values will appear as empty fields (indicated by *.***).

✍ *Note: These fields cannot be edited manually.*

⑧ `PIXEL SIZE`

✍ *Note: Displayed only when TYPE = STANDARD.*

Displays the minimum unit (PIXEL) of the image in millimetres (mm).

If CALIBRATION has not yet been completed, or the contents of the CALIBRATION file has been changed, the coordinate values will appear as empty fields (indicated by *.***).

✍ *Note: These fields cannot be edited manually.*

4.2 Preparation of Calibration Job

This section describes the programming of the Calibration Job for both "fixed" camera and "mobile" camera configurations.

Also described is the actual execution (playback) of the Calibration Job to confirm correct calibration data and pixel size information.

4.2.1 Standard Calibration with a Fixed Camera

In the following Standard Calibration JOB example, calibration TYPE = STANDARD, and calibration MODE = FIXED CAMERA —

```
NOP
'=====================================================================================
'THIS CALIBRATION JOB IS USED TO CALIBRATE 'THE VISION FUNCTION WITH A FIXED CAMERA
'
'TOOL FILE 23 SHOULD BE SET TO THE FOCAL LENGTH OF THE CAMERA
'
'REF POINTS SHOULD BE 'TAUGHT USING THE TOOL FILE IN WHICH THE WORK TOOL IS DEFINED
'
'TARGET LOCATIONS ARE DESCRIBED FROM THE PERSPECTIVE OF THE VISION SYSTEM
'
'TARGET LOCATIONS ARE ASSUMED TO BE DEFINED IN SCENES 21 THROUGH 25
'
'=====================================================================================
'REFP1 SHOULD BE TAUGHT OVER THE TOP LEFT TARGET
'=====================================================================================
REFP 1 C00000
TIMER T=0.10
GETS PX100 $PX011
CNVRT PX100 PX100 BF
SUB P110 P110
VSTART FIND FT=21 MD=0 VF#(32)
VWAIT
JUMP *ERR1 IF B090=0
SET P105 P110
'=====================================================================================
'REFP2 SHOULD BE TAUGHT OVER THE TOP RIGHT TARGET
'=====================================================================================
REFP 2 C00001
TIMER T=0.10
GETS PX101 $PX012
CNVRT PX101 PX101 BF
SUB P110 P110
VSTART FIND FT=22 MD=0 VF#(32)
VWAIT
JUMP *ERR2 IF B090=0
SET P106 P110
'=====================================================================================
'REFP3 SHOULD BE TAUGHT OVER THE CENTER TARGET
'=====================================================================================
REFP 3 C00002
TIMER T=0.10
GETS PX102 $PX013
CNVRT PX102 PX102 BF
SUB P110 P110
VSTART FIND FT=23 MD=0 VF#(32)
VWAIT
JUMP *ERR3 IF B090=0
SET P107 P110
```

Sample JOB continued on next page

Sample JOB continued from previous page

```
'=========================================================================================
'REFP4 SHOULD BE TAUGHT OVER THE LOWER LEFT TARGET
'=========================================================================================
REFP 4 C00003
TIMER T=0.10
GETS PX103 $PX014
CNVRT PX103 PX103 BF
SUB P110 P110
VSTART FIND FT=24 MD=0 VF#(32)
VWAIT
JUMP *ERR4 IF B090=0
SET P108 P110
'=========================================================================================
'REFP5 SHOULD BE TAUGHT OVER THE LOWER RIGHT TARGET
'=========================================================================================
REFP 5 C00004
TIMER T=0.10
GETS PX104 $PX015
CNVRT PX104 PX104 BF
SUB P110 P110
VSTART FIND FT=25 MD=0 VF#(32)
VWAIT
JUMP *ERR5 IF B090=0
SET P109 P110
'
VSTART CALIB CALF#(1)
VWAIT
JUMP *END
*ERR1
'REF PT 1 NOT DETECTED
PAUSE
*ERR2
'REF PT 2 NOT DETECTED
PAUSE
*ERR3
'REF PT 3 NOT DETECTED
PAUSE
*ERR4
'REF PT 4 NOT DETECTED
PAUSE
*ERR5
'REF PT 5 NOT DETECTED
PAUSE
*END
END
```

4.3 Execution (Playback) of Calibration Job

Execute (playback) the calibration JOB to confirm correct calibration data and pixel size.

Note: For JOB execution (playback) methods, refer to the NX100 OPERATOR'S MANUAL (refer to Section 1.5).

Chapter 5

Preparation and Execution of Work Job

5.1 Preparation of Work Job

This section of the chapter describes preparation of a JOB to shift a work piece position to match reference points according to results of the detection process.

Note: For information on JOB preparation and registration of an instruction, refer to the NX100 Operator's Manual.

Job example –

NOP	← Start of new program
VSTART FIND FT=0 MD=0 VF#(1)	← Detects the position of a workpiece
VWAIT	← Waits for completion of detection
SUB P001 P000	← Calculates difference values from the reference points
SFTON P001	← Starts shift for the calculated difference values
MOVL	← Shift
MOVL	← Shift
SFTOF	← Ends shift
END	← End of program

Note: To shift a work piece position according to detection results, you must calculate the difference between work piece position and reference positions. Detect the work piece position at teaching, and register that position value in a P-variable as the reference position.

5.2 Execution (Playback) of Work Job

Procedure –

1. In the JOB example shown above, add a PAUSE instruction before the SFTON instruction.
2. Execute (playback) the JOB in a test run.
3. Stop the job with the PAUSE instruction, then confirm that the values for X, Y, and Z of position variable P001 correspond to the calculated differences.
4. Restart the test run and confirm the shifted position of the robot.

Note: If each value of position variable P001 differs greatly with the reference points, check the following –

- *Confirm that the positions to be detected are correct in the Vision System.*
- *Confirm that the values in the CAL.DAT files are 1 mm or less.*

Chapter 6
Other Functions

6.1 Detecting Scene Number Specification

Executing a VSTART instruction switches the detecting scene (measurement condition) in the Vision System.

JOB EXAMPLE

```
NOP
VSTART    SELCND    CND=0
            ①         ②

NWAIT
END
```

① EXECUTION METHOD

Specifies the switching of the detecting scene.

② DETECTING SCENE NUMBER

Specifies the detecting scene number. Setting range is from 0 to 15.

6.2 Loading and Saving Vision Files

Vision Function files can be saved to or loaded from the Programming Pendant CompactFlash® card slot (refer to Section 1.3).

DATA TO BE SAVED	ASSOCIATED FILE NAME
Vision Condition Data	VISION.DAT
Vision Calibration Data	VISCALIB.DAT

6.2.1 Loading Vision Files

Select {FD/CF} from the main menu ➔ Select {LOAD} ➔ Select FILE/GENERAL DATA ➔ Select a file to be loaded ➔ Press [ENTER] ➔ Select YES

6.2.2 Saving Vision Files

Select {FD/CF} from the main menu ➔ Select {SAVE} ➔ Select FILE/GENERAL DATA ➔ Select a file to be saved ➔ Press [ENTER] ➔ Select YES

Chapter 7

Instruction List.

INSTRUCTION LIST		
VSTART Starts NX100 Vision Function	INSTRUCTION ITEMS	FIND FT = Detection Type Number Range (0 – 255) MD = <Detection Model Number> Range (0 – 7) VF# = <Vision Condition File Number> Range (1 – 32)
		SELCND CND = <Detection Scene Number> Range (0 – 255)
		CALIB CALF# = (<Calibration File Number>) Range (1 – 16)
	EXAMPLE	`VSTART FIND FT=0 MD=0 VF#(1)`
VWAIT Waits for completion of NX100 Vision Function	INSTRUCTION ITEMS	None
	EXAMPLE	`VWAIT`

NOTES

Chapter 8

Alarm List

ALARM NUMBER	MESSAGE	CAUSE	REMEDY
4124	WRONG EXECUTION OF VISION INST [1]	An incorrect file number is specified	Specify correct file number
	WRONG EXECUTION OF VISION INST [2]	An incorrect value is set in the specified file	Set correct value
	WRONG EXECUTION OF VISION INST [3]	CALIBRATION could not be performed	• Set robot coordinate values and pixel coordinate values (used for CALIBRATION) as user variables. • Set correct user variable numbers in the CALIBRATION file.
	WRONG EXECUTION OF VISION INST [4]	The Vision System COMM port could not be initialized	Set correct parameters for the COMM port
	WRONG EXECUTION OF VISION INST [5]	A "time-out" error occurred during transmission of serial COMM data	• Reconnect the cable between the Vision System and the NX100. • Make sure that the serial COMM settings for the VISION SYSTEM match the settings for the NX100.

ALARM NUMBER	MESSAGE	CAUSE	REMEDY
4124	WRONG EXECUTION OF VISION INST [6]	A "time-out" error occurred during reception of serial COMM data	• Reconnect the cable between the Vision System and the NX100. • Make sure that the serial COMM settings for the VISION SYSTEM match the settings for the NX100.
	WRONG EXECUTION OF VISION INST [7]	The data received from the Vision System is corrupt	• Reconnect the cable between the Vision System and the NX100. • Make sure that the serial COMM settings for the VISION SYSTEM match the settings for the NX100. • Set the Vision System for detection.
	WRONG EXECUTION OF VISION INST [8]	The PIXEL coordinate values could not be converted to the robot coordinate values	• Set the VISION SYSTEM to detect a correct position. • Use a valid CALIBRATION file (.clb)
	WRONG EXECUTION OF VISION INST [8]	Position (P) variables could not be read from or written to.	• Do not use the specified position (P) variable for the other job, simultaneously.

Chapter 9

Parameter List

PARAMETER	CONTENTS	INITIAL VALUE
RS000	Standard Port Protocol Specification	6 (protocol for vision system)
RS100	Data Bit Length	8
RS101	Stop Bit Length	2
RS102	Parity Specification	0 (none)
RS103	Transmission Speed Specification	8 (19200 baud)
RS104	Time 1 for WAITING Response (SELCND, in units of 0.1 second)	100
RS105	Time 2 for WAITING Response (for specifying items to be measured in FIND, in units of 0.1 second)	20
RS106	Time 3 for WAITING Response (for measurement in FIND, in units of 0.1 second)	100
RS107	Number of Retries for Data Transmission	3
RS109	Vision Command Protocol	5
S2C333	Multiple Tool Enable	1

NOTES

Appendix A

Installation and Setup Procedures

A.1 Installation of NX100 Integrated Vision

Note: In addition to this manual, please have manuals available for the vendor-supplied Vision System (refer to Section 1.5).

Note: These procedures assume that the Vision System is connected to the same power disconnect as the NX100 controller.

Procedure –

1. Mount the camera in the desired location.
2. Place the monitor in the desired location.
3. Mount the Vision CPU in the NX100 on provided din rail if applicable.
4. Make any necessary cable or electrical connections to the Vision CPU.
5. Connect the Vision CPU to the NX100 NCP01 serial port located on the bottom of the NCP01 board.

Note: The NCP01 board is located in the CPU rack inside the NX100 controller.

6. Turn on power to the NX100.
7. Confirm NX100 communication (RS) parameter settings (refer to Chapter 9 in this manual).
8. Confirm communication parameter settings in the Vision System CPU (refer to vendor-supplied Vision System documentation)

A.2 Setup of NX100 Integrated Vision

1. Create the Vision Program shown in chapter 4 of this manual.
2. Place and secure the Calibration Target (refer to Appendix B) within the camera's field of vision.
3. Measure the distance from the camera lens to the work surface (this is the working distance of the camera) and enter this into Tool File 23.
4. Set the Calibration Tool to Tool File 22.
5. Select Tool File 22 and teach REFP1 through REFP5 as described by the comments in the CALIBF job.
6. Setup Vision Calibration File 1.

✍ *Note: Set camera TYPE to FIXED. Leave all other settings as default.*

7. Setup Vision Condition File 32.

✍ *Note: Set coordinate value to PIXEL. Leave all other settings as default.*

8. Define scenes 21 through 25 in the Vision System.

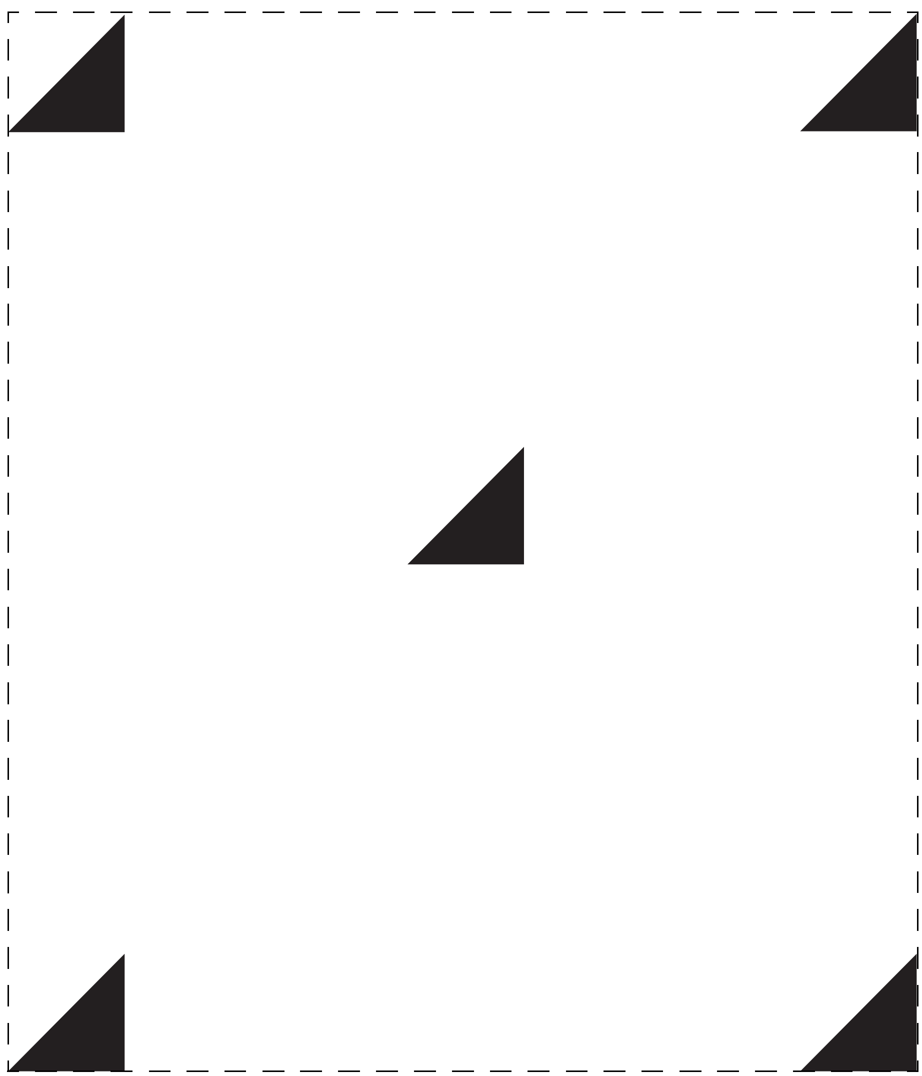
✍ *Note: Scene 21 should be the same location as REFP1, Scene 22 REFP2, Scene 23 REFP3, Scene 24 REFP4, and Scene 25 REFP5.*

9. Execute the CALIBF job. When complete, check the results in Vision Calibration File 1.

✍ *Note: If the CAL.DAT file displays errors greater than 1 mm, touch-up the appropriate REFP position and execute the CALIBF job again.*

Appendix B

Sample Calibration Target



NOTES

Appendix C

Vision Data Syntax Requirements

The output data from the vision system must be structured in a very specific way to be understood by the robot controller. The following sections describe the specific syntax requirements for the data output from the vision system. Please refer to your specific *vendor-supplied* vision system manuals for specific instructions on how to meet these requirements.

The following is a sample exchange between the robot controller and a vision system.

Sample Exchange					
	NX100 Command Line		**Command String**	**Hex Syntax**	**Explanation**
1	VSTART FIND FT=0 MD=0 VF#(1)		Scene <#> <CR>		The NX100 controller sends out a Scene <#> command with a carriage return. This initiates the capture sequence. The Scene <#> command along with the carriage return are sent as ASCII code.
2	VWAIT		OK <CR>	4F4B 0D	The controller waits for an OK string and carriage return to be sent from the vision system as ASCII code.
3	MEASURE		M <CR>	4D 0D	Upon receipt of the OK string from the vision system, the controller sends the "M" command to take a measurement.
4			32 bit, 32 bit, 32 bit, 32 bit, OK <CR>		The vision system returns the measurement values along with the OK string and carriage return.
5	VWAIT				

C.1 Data Syntax

The communication syntax between the controller and the vision system is very specific and must be structured very carefully. All communications between the controller and the vision system is structured as serial and must be received as such. For example, each letter of the OK command sent from the vision system in Step 2 of the example above, must be sent as ASCII code. In Hexidecimal, this would be: 4F4B 0D - Capital O = 4F, Capital K = 4B, Carriage Return = 0D.

However, the measurement values returned by the vision system; X, Y, Rotation, and Correlation, must be sent as 32 bit binary integers, while the OK command and the carriage return are sent as ASCII equivalent code. For example, in Hexidecimal, a typical measurement string might look like this:

0004 E3F4 0007 54E0 0002 BF20 0001 5F90 4F4B 0D
X Y Rotate Correlation OK <CR>

C.1.1 Decimal Values

Because the X, Y, and Rotation values are recorded as decimal fractions, We must find an easy way to transfer the fractional decimal values as binary. To accomplish this, the output decimal values from the vision system must be multiplied by 1000 before transferring to the robot controller. The robot controller then performs an internal operation on the transferred decimal number that shifts the final decimal place to the left 3 places, effectively dividing the number by 1000. It is therefore very important that the output decimal values from the vision system be multiplied by 1000 before transferring to the robot controller.

Table 1 Sample Communication Syntax

	X (Pixels)	**Y (Pixels)**	**Rotate**	**Correlation**	**ASCII Code**	**Termination Character ASCII Code**
Measurement Results	320.5	480.48	180	90	OK	<CR>
Transfer Value	320500	480480	180000	90000	OK	<CR>
Hexidecimal	0004 E3F4	0007 54E0	0002 BF20	0001 5F90	4F4B	0D
Binary	0000 0000 0000 0100 1110 0011 1111 0100	0000 0000 0000 0111 0101 0100 1110 0000	0000 0000 0000 0010 1011 1111 0010 0000	0000 0000 0000 0001 0101 1111 1001 0000	0100 1111 0100 0011	1101