MOTOCALV EG
OPERATOR’S MANUAL

Upon receipt of the product and prior to initial operation, read these instructions thoroughly, and retain for future reference.

Please have the following information available when contacting Yaskawa Customer Support:

- System
- Primary Application
- Software Version (Located on Programming Pendant by selecting: {Main Menu} - {System Info} - {Version})
- Robot Serial Number (Located on robot data plate)
- Robot Sales Order Number (Located on controller data plate)

Part Number: 152646-1CD
Revision: 2
This manual explains the MOTOCALV EG. Read this manual carefully and be sure to understand its contents before operation.

General items related to safety are listed in the Chapter 1: Safety of Controller Instructions. To ensure correct and safe operation, carefully read Controller Instructions before reading this manual.

Some drawings in this manual are shown with the protective covers or shields removed for clarity. Be sure all covers and shields are replaced before operating this product.

The drawings and photos in this manual are representative examples and differences may exist between them and the delivered product.

YASKAWA may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications. If such modification is made, the manual number will also be revised.

If your copy of the manual is damaged or lost, contact a YASKAWA representative to order a new copy. The representatives are listed on the back cover. Be sure to tell the representative the manual number listed on the front cover.

YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids your product's warranty.

Software described in this manual is supplied against licensee only, with permission to use or copy under the conditions stated in the license. No part of this manual may be copied or reproduced in any form without written consent of YASKAWA.
Notes for Safe Operation

Before using this product, read this manual and all the other related documents carefully to ensure knowledge about the product and safety, including all the cautions.

In this manual, the Notes for Safe Operation are classified as “DANGER”, “WARNING”, “CAUTION”, or “NOTICE”.

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Safety Signs identified by the signal word DANGER should be used sparingly and only for those situations presenting the most serious hazards.

Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.

Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to “NOTICE”.

NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to “NOTICE”, the word “CAUTION” without the safety alert symbol may be used to indicate a message not related to personal injury.

Even items described as “CAUTION” may result in a serious accident in some situations. At any rate, be sure to follow these important items.

To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “DANGER”, “WARNING” and “CAUTION”.
**Notation for Menus and Buttons**

Descriptions of the programming pendant, buttons, and displays are shown as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menu</td>
<td>The menus displayed on screen are denoted with { }. ex. {TOOL}.</td>
</tr>
<tr>
<td>Button</td>
<td>The buttons, check boxes, radio buttons displayed on screen are denoted with [ ]. ex. [Close]; [Sync] check box; [Fast] radio button.</td>
</tr>
</tbody>
</table>

**Description of the Operation Procedure**

In the explanation of the operation procedure, the expression "Select • • • " means the following operations:

- To move the cursor to the object item and left-click on it with the mouse.
- To pick out the object item by the tab key and press the Enter key.
  
  (In case of selecting a menu, use arrow keys instead of the tab key to pick out the object item, then press the Enter key.)

**Registered Trademark**

In this manual, names of companies, corporations, or products are trademarks, registered trademarks, or bland names for each company or corporation. The indications of (R) and TM are omitted.
1  PREFACE

1.1 Outline of MOTOCALV EG .......................... 7
1.2 Requirements for MOTOCALV EG Execution ...... 7
1.3 Hardware Lock Key .................................. 8
1.4 MOTOCALV EG Setup ............................... 9

2  TYPES OF CALIBRATION

2.1 Robot Calibration ................................. 10
2.2 Tool Calibration .................................. 10
2.3 Tool Posture Calibration .......................... 10
2.4 Workpiece Calibration ............................. 10
2.5 Layout Correction ................................. 10

3  OPERATION

3.1 Robot Calibration ................................. 11
   Operation with Actual Robot ...................... 11
   Operation on Personal Computer ................. 14
3.2 Tool Calibration .................................. 21
   Operation with Actual Robot ...................... 21
   Operation on Personal Computer ................. 22
3.3 Tool Posture Calibration ........................ 25
   Operation with Actual Robot ...................... 25
   Operation on Personal Computer ................. 26
3.4 Workpiece Calibration ............................ 29
   Workpiece Calibration .............................. 29
      ■ Teaching of personal computer reference point teaching job . 29
      ■ Teaching of robot controller reference point teaching job
        (Operation with actual robot) .......................... 29
      ■ Calibration operation ............................. 30
      ■ Calibration operation for multi stations .......... 33
   Job Conversion ..................................... 34
      ■ Job conversion for multi stations ................. 36
3.5 Layout Correction ................................. 39
   Robot Layout Correction ............................ 39
      ■ Teaching of personal computer reference point teaching job . 39
      ■ Teaching of robot controller reference point teaching job
        (Operation with actual robot) .......................... 39
4        APPENDIX

4.1    Examples of Robot Calibration .. 51
4.2    Examples of Tool Calibration .. 57
4.3    Frequently-asked questions .. 65

When the driver has been installed with USB type key connected to
personal computer. .......................................................... 65
When a older version key driver has been installed over a newer key driver
version. ................................................................. 65
## 1 PREFACE

### 1.1 Outline of MOTOCALV EG

The MOTOCALV EG has been developed to improve positioning accuracy of YASKAWA’s industrial robot MOTOMAN. The MOTOCALV EG is an application software for MS-Windows, which offers excellent operability on various types of personal computers.

### 1.2 Requirements for MOTOCALV EG Execution

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OS</strong></td>
<td>Microsoft Windows 10 (64bit)</td>
</tr>
<tr>
<td></td>
<td>Microsoft Windows 7 (32bit / 64bit)</td>
</tr>
<tr>
<td></td>
<td>JAPANESE and ENGLISH Windows version are supported only. *1</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>1 Gbyte or more</td>
</tr>
<tr>
<td><strong>Hardware Disk</strong></td>
<td>100 Mbyte or more</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>Supported by MS-Windows (256 colors or more)</td>
</tr>
<tr>
<td><strong>Hardware Key</strong></td>
<td>Used under single user environment. For details, refer to the following section &quot;1.3 Hardware Lock Key.&quot;</td>
</tr>
</tbody>
</table>

*1 MS-Windows 10/7 are registered trademark of Microsoft Corporation, USA.
1.3 Hardware Lock Key

For proper operation, connect provided hardware lock key (USB type) to personal computer before using this software.

Check and execute <Check the computing environment> <Installation of driver> before connecting the key to USB port.

<Check the computing environment>
Multi-connection of USB type key is not available for one USB port because of hardware structure. Therefore, only one key should be connected to one USB port. When installing multiple offline software into one personal computer and multi-connectiong USB keys, use the personal computer which is provided same numbers of USB ports as the number of software to be installed.

<Installation of driver>

Please install the driver after detaching the all sentinel hardware key from the personal computer.

Execute "\SentinelDriver\Sentinel System Driver Installer 7.5.9.exe" of installation CD-ROM. Refer to"\SentinelDriver\Manual\Sentinel System Driver ReadMe.pdf" for the details of installation.

• Be sure to install the driver.
• When installing the driver, be sure to login in administrator mode in order to add files to system folder and input information in registry.
  • If a key is connected to personal computer before installing the driver, the message concerning the driver is displayed. In this case, and detach the key from personal computer and then install the driver.
  If a key is connected to personal computer before installing the driver under Windows 95/98/NT4.0/2000/XP environment, Windows wizard ([Add New Hardware] Wizard) starts up. In this case, push [cancel], and detach the key from personal computer and then install the driver.
  • When installing the driver under Windows NT4.0 environment, please install the driver located in the folder "\SentinelDriver\SSD5411\SSD5411-32bit.EXE" of installation CD-ROM.
    For the driver installation procedure, please consult the installation manuarl "\SentinelDriver\SSD5411\Manual\us\Readme.pdf".

Refer to "4.3 Frequently-asked questions " for other countermeasures concerning hardware lock key.
1.4 MOTOCALV EG Setup

1. It is strongly recommended that you exit all applications before running the setup program.

   Be sure to login in administrator mode when installing the MOTOCALV EG in Windows 7/10, or else the system related DLL files in Windows might not be updated.

2. Insert the install CD-ROM to the CD-ROM drive.
3. Browse to the CD-ROM drive in the Windows Explorer, and run the "MOTOCALV-EG\setup.exe" program. Then, the "MOTOCALV EG InstallShield Wizard" window appears automatically.
   If you are using Windows 7/10, the [User Account Control] dialog appears, so click [OK] in the dialog.
4. Follow the on-screen instructions.

   If the following message appears during the installation, press [Yes] to continue installation.
   This message is displayed when the installation of redistribution package of Visual C++ 2012 has been executed but installation is required.
   If this message is displayed, run manually \ISetupPrerequisites\BF2F04CD-3D1F-444e-8960-D08EBD285C3F\vcredist_x86.exe after installing MOTOCALV EG, and install or repair the redistribution package of Visual C++ 2012.

5. When the setup is completed, MOTOCALV EG is registered under the {MOTOCALV EG} folder that appears by clicking the [Start] button in the task bar and selecting {Program} and then {Motoman}. (In the case of Windows 10, all menu appears directly under [Motoman].)
6. Connect the hardware key to the printer port or USB port.
   For details, refer to "1.3 Hardware Lock Key" in this chapter.
2 TYPES OF CALIBRATION

The following types of calibrations are available for MOTOCALV EG.

2.1 Robot Calibration

Adjusts the absolute data and tool data, by teaching 5 postures each of 5 points (total 25 points) with robot. This calibration improves the absolute value accuracy of robot.

2.2 Tool Calibration

Adjusts tool data by teaching 7 postures at 1 point (total 7 points) with robot. This calibration calculates the exact tool data (robot control point).

2.3 Tool Posture Calibration

Adjusts tool data by teaching 1 posture at 1 point (total 1 point) with robot. This calibration calculates the exact tool positions (Rx, Ry, and Rz).

2.4 Workpiece Calibration

Recognizes the positional difference between each robot and workpiece, by comparing the job created by offline system and the job created with the actual robot. Then converts the position data by offline system into the data for the actual robot, using the difference above.

2.5 Layout Correction

The layout correction is composed of "Robot Layout Correction" and "Travel Axis Tilt Correction." "Robot Layout Correction" corrects the robot layout in the cell constructed by MotoSim EG for actual robot layout, by comparing the job created by offline system and the job created with the actual robot. "Travel Axis Tilt Correction" corrects the robot layout in the cell constructed by MotoSim EG for the actual robot layout, by calculating the positional difference between the travel axis and the robot positioned on the travel axis.
3 OPERATION

This chapter explains the operation method of each calibration by MOTOCALV EG.

3.1 Robot Calibration

3.1.1 Operation with Actual Robot

1. To perform robot calibration, prepare the data of tool to be mounted in advance.
   The following three methods are available for tool data.
   1) Performs the tool calibration with the actual robot controller.
   2) Performs the tool calibration by MOTOCALV EG.
      (Refer to "3.2 Tool Calibration")
   3) Uses the values of mechanical dimensions if specified in the drawing, etc.

2. Mount an end-pointed tool on the robot flange.
   Use a tool with pointed-end part offset to the direction of X- or Y-axis on the tool coordinate. (Offset amount of approx. 200 mm is recommended.)

3. Using this tool, perform teaching of the job (job name: ROBOT) for 5 postures each of 5 points (total 25 points). The calibration job "ROBOT" is used for actual calculation by the calibration software.
   The teaching method is explained below.

   a) Using the same tool, perform teaching of 5 postures at each 5 point.
      (Use MOVJ or MOVL for interpolation type. On base of the taught positions, X, Y, and Z will be calculated internally.)

   • For teaching of large-size robots of K60 and more, perform teaching with the wrist angle 45 or less, since the flexure by the robot arm weight may affect calibration, with the wrist posture largely inclined. For robot sizes below K60, incline the wrist 45 or more.
   • When the actual playback operation requires movement changing robot form, for example, the robot wrist axis rotating in reverse, perform teaching with the posture of that movement.
b) With operation a), perform teaching of 1 point at 5 different points. The distance between each point should be kept to a minimum of 100 mm. If this condition is not kept, this function doesn't work right. Perform teaching at five points from left upper side to right lower side with 5 postures each, so that the values of X, Y, and Z vary equally in a wide area of the robot front face, for teaching of correct calibration job. For robot postures at job teaching, refer to "4.1 Examples of Robot Calibration".

c) When you teach each point for the robot of seven axis type such as VA1400, please operate E axis in the plus and minus direction.
<Example of Robot Calibration Job>

NOP
*1
MOVJ C0000 VJ=0.78 PL=0
MOVJ C0001 VJ=0.78 PL=0
MOVJ C0002 VJ=0.78 PL=0
MOVJ C0003 VJ=0.78 PL=0
MOVJ C0004 VJ=0.78 PL=0
*2
MOVJ C0005 VJ=0.78 PL=0
MOVJ C0006 VJ=0.78 PL=0
MOVJ C0007 VJ=0.78 PL=0
MOVJ C0008 VJ=0.78 PL=0
MOVJ C0009 VJ=0.78 PL=0
*3
MOVJ C0010 VJ=0.78 PL=0
MOVJ C0011 VJ=0.78 PL=0
MOVJ C0012 VJ=0.78 PL=0
MOVJ C0013 VJ=0.78 PL=0
MOVJ C0014 VJ=0.78 PL=0
*4
MOVJ C0015 VJ=0.78 PL=0
MOVJ C0016 VJ=0.78 PL=0
MOVJ C0017 VJ=0.78 PL=0
MOVJ C0018 VJ=0.78 PL=0
MOVJ C0019 VJ=0.78 PL=0
*5
MOVJ C0020 VJ=0.78 PL=0
MOVJ C0021 VJ=0.78 PL=0
MOVJ C0022 VJ=0.78 PL=0
MOVJ C0023 VJ=0.78 PL=0
MOVJ C0024 VJ=0.78 PL=0
END
4. Save the following robot data from the robot controller to the floppy disk, using a device such as YASNAC FC2, etc.

<table>
<thead>
<tr>
<th>File Name</th>
<th>Contents</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL.PRM</td>
<td>Robot parameter data</td>
<td>For ERC, PARAM.DAT</td>
</tr>
<tr>
<td>ABSO.DAT</td>
<td>Robot absolute data</td>
<td></td>
</tr>
<tr>
<td>TOOL.CND</td>
<td>Tool data</td>
<td>For ERC, TOOL.DAT</td>
</tr>
<tr>
<td>ROBOT.JBI</td>
<td>Job of 5 postures each at 5 points for calibration</td>
<td></td>
</tr>
</tbody>
</table>

3.1.2 Operation on Personal Computer

1. Insert the above floppy disk. Double-click the [MOTOCALV EG] icon in the [Start]-[Program]-[Motoman]-[MOTOCALV EG] (In the case of Windows10, {Motoman} - {MOTOCALV EG}) to start the program. The main screen, "MOTOCALV EG" is displayed for calibration programs.

2. Click the [F1] (ROBOT) button to display the "Robot Calibration" screen.
3. Click the [Select Job] button to display the [Select Job] dialog box. To select the robot calibration job file (Robot.JBI), click the [Open] button or double-click the file. (When the calibration job has been taught under a different job name, select the corresponding file.) Then the screen returns to the "Robot Calibration" screen.

4. Click the [Select Robot] button to display the [Select Robot] dialog box. To select the robot type for robot calibration, click the [OK] button or double-click the corresponding type. If the corresponding type of robot is not on the list, select the "other robot type." Then the screen returns to the "Robot Calibration" screen.

5. Click the [Select Control Group] button to display the [Select Control Group] dialog box. To select the robot number for robot calibration, click the [OK] button to return to the "Robot Calibration" screen.
3.1 Robot Calibration

6. Click the [Check File] button to check the files necessary for calibration. (Verify that the corresponding files for parameter data, absolute data and tool data exist.) When the corresponding files exist, the following message is displayed.

![Check File Screen]

When the corresponding files exist, the following message is displayed.

7. Click the [OK] button to return to the "Robot Calibration" screen. Click the [Execute Calibration] button to display the "Calculation" screen. Then calibration starts and the calculation process is displayed. Clicking the [STOP] button stops the calculation to return to the "Robot Calibration" screen and the calculation result will not be written in the file (ABSO Data, TOOL Data).

![Calculation Screen]

When calculation is completed, the "Calculation finish" screen is displayed. Click the [EXIT] button and the calibration will be judged as "successful" or "failed" based on the average error (theoretical value by calibration calculation). Then 2 types of "Message of Calibration Judgement" are displayed. Click the [OK] button to return to the "Robot Calibration" screen.

![Message of Calibration Judgement Screen]
3.1 Robot Calibration

8. Click the [OK] button to return to the "Robot Calibration" screen. When a successful calibration result is obtained, stop the operation on personal computer once, and load the changed ABSO Data and TOOL Data to the actual robot, by using a device such as YASNAC FC2, etc. (ABSO.DAT, TOOL.CND. For ERC, ABSO.DAT, TOOL.DAT)

9. After verifying that new ABSO Data and TOOL Data have been overwritten in the robot controller, turn OFF power to the robot controller and re-start.

10. Using the same tool as used for the calibration job (5 postures each at 5 points), perform teaching of the control point constant operation job (job name: P7-NEW, 7 postures at 1 point).
    This is called a judgement job.

   For robot postures at job teaching, refer to "4.2 Examples of Tool Calibration".

   • When a message for failed calibration is displayed, perform re-teaching of robot calibration from the step 3) of "3.1.1 Operation with Actual Robot", and re-execute the process.

   • For some failed calibration jobs or robot types after re-teaching and re-executing the process, extend the calculation range for calibration job. For calculation range setting, contact your YASKAWA representative or YASKAWA Robot Service.

   - This operation checks how much robot accuracy is improved by changing the ABSO Data and TOOL Data by calibration job.
11. Save the job (P7-NEW.JBI) of 7 taught postures at 1 point, from the robot controller to the floppy disk.

12. Insert the above floppy disk from the robot controller to the personal computer drive, and execute the continued operation for robot calibration.

13. Click the [Select Judgement-Job] button to display the [Select Judgement-Job] dialog box. To select the created judgement job file (P7-NEW.JBI), click the [Open] button or double-click the file. Then the screen returns to the "Robot Calibration" screen.

14. Click the [Execute Judgement] button to display the "Calculating" screen. The accuracy after calibration of the control point constant operation. The screen shows the X, Y, and Z coordinates and their average coordinates at each point of the judgement job.
When calculation is completed, the “Calculation finish” screen is displayed.

<table>
<thead>
<tr>
<th>STEP</th>
<th>Distance</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Tx</th>
<th>Ty</th>
<th>Tz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td></td>
<td>2172.320</td>
<td>-105.532</td>
<td>1304.128</td>
<td>25.714</td>
<td>0.000</td>
<td>5.357</td>
</tr>
<tr>
<td>C0000</td>
<td>0.456</td>
<td>2172.737</td>
<td>-105.530</td>
<td>1304.250</td>
<td>390.000</td>
<td>0.000</td>
<td>3.745</td>
</tr>
<tr>
<td>C0001</td>
<td>0.505</td>
<td>2172.650</td>
<td>-105.572</td>
<td>1304.312</td>
<td>390.000</td>
<td>0.000</td>
<td>-33.218</td>
</tr>
<tr>
<td>C0002</td>
<td>0.599</td>
<td>2172.410</td>
<td>-105.464</td>
<td>1304.204</td>
<td>390.000</td>
<td>0.000</td>
<td>-94.045</td>
</tr>
<tr>
<td>C0003</td>
<td>0.566</td>
<td>2171.776</td>
<td>-106.044</td>
<td>1304.539</td>
<td>390.000</td>
<td>0.000</td>
<td>147.170</td>
</tr>
<tr>
<td>C0004</td>
<td>0.587</td>
<td>2171.783</td>
<td>-106.044</td>
<td>1304.588</td>
<td>390.000</td>
<td>0.000</td>
<td>157.319</td>
</tr>
<tr>
<td>C0005</td>
<td>0.465</td>
<td>2172.029</td>
<td>-105.359</td>
<td>1304.257</td>
<td>390.000</td>
<td>0.000</td>
<td>191.863</td>
</tr>
<tr>
<td>C0006</td>
<td>0.451</td>
<td>2172.667</td>
<td>-105.252</td>
<td>1304.176</td>
<td>390.000</td>
<td>0.000</td>
<td>48.953</td>
</tr>
</tbody>
</table>

Clicking the [CLOSE] button starts checking the maximum values of distance from the average coordinate to each point, and performs calibration judgement of control point constant operation after the adjustment of ABSO Data and TOOL Data. At completion of calibration process, the calibration will be judged as “successful” or “failed.” Then 2 types of “Message of Calibration Judgement” are displayed. Click the [OK] button to return to the “Robot Calibration” screen.
3.1 Robot Calibration

15. Click the [OK] button to return to the "Robot Calibration" screen. When a successful judgement message is displayed, click the [Print a Report] button to print out the report. The robot calibration operation is completed.

**NOTE** When a failed judgement result message is displayed, perform re-teaching of calibration from step 9).
3.2 Tool Calibration

3.2.1 Operation with Actual Robot

1. To perform tool calibration, prepare the data of tool to be mounted in advance. Mount the tool on the robot flange. The following two methods are available for tool data, in addition to tool calibration method explained in this section.

   1) Performs the tool calibration with the actual robot.
   2) Uses the values of mechanical dimensions of the tool if specified in the drawing, etc.

2. Using this tool, perform teaching of the job (job name: TOOL) of 7 postures and more at 1 point. The calibration job "TOOL" is used for actual calculation by the calibration software.

   The teaching method is explained below.

   a) Using the same tool, perform teaching of 7 postures at one point.
      (Use MOVJ or MOVL for interpolation type. On base of the taught positions, X, Y, and Z will be calculated internally.)

   • For teaching of large-size robots of K60 and more, perform teaching with the wrist angle 45° or less, since the flexure by the robot arm weight may affect calibration, with the wrist posture largely inclined. For robot sizes below K60, incline the wrist 45° or more.
   • When the actual playback operation requires movement as changing robot form, for example, the robot wrist axis rotating in reverse, perform teaching with the posture of that movement. For robot postures at job teaching, refer to "4.2 Examples of Tool Calibration".

---

**NOTE**

- For teaching of large-size robots of K60 and more, perform teaching with the wrist angle 45° or less, since the flexure by the robot arm weight may affect calibration, with the wrist posture largely inclined. For robot sizes below K60, incline the wrist 45° or more.
- When the actual playback operation requires movement as changing robot form, for example, the robot wrist axis rotating in reverse, perform teaching with the posture of that movement. For robot postures at job teaching, refer to "4.2 Examples of Tool Calibration".

---

Diagram:

```
  Robot
     /|
    / |
   /  |
  First posture
 /    |
/     |
Fourth posture
/     |
/      |
Third posture
/       |
/        |
Second posture
/         |
/          |
Sixth posture
/           |
/            |
Fifth posture
/             |
/              |
Seventh posture
/                |
/                 |
Positioning job
```

---

HW0483085 21/66
<Example of Tool Calibration Job>
NOP
MOVJ C000 VJ=0.78 PL=0
MOVJ C001 VJ=0.78 PL=0
MOVJ C002 VJ=0.78 PL=0
MOVJ C003 VJ=0.78 PL=0
MOVJ C004 VJ=0.78 PL=0
MOVJ C005 VJ=0.78 PL=0
MOVJ C006 VJ=0.78 PL=0
END

3. Save the following robot data from the robot controller to the floppy disk, using a device such as YASNAC FC2, etc.

<table>
<thead>
<tr>
<th>File Name</th>
<th>Contents</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL.PRM</td>
<td>Robot parameter data</td>
<td>For ERC, PARAM.DAT</td>
</tr>
<tr>
<td>TOOL.CND</td>
<td>Tool data</td>
<td>For ERC, TOOL.DAT</td>
</tr>
<tr>
<td>TOOL.JBI</td>
<td>Job for tool calibration</td>
<td>7 postures or more at 1 point</td>
</tr>
</tbody>
</table>

### 3.2.2 Operation on Personal Computer

1. Insert the above floppy disk. Double-click the [MOTOCALV EG] icon in the [Start]-[Program]-[Motoman]-[MOTOCALV EG] (In the case of Windows10, {Motoman} - {MOTOCALV EG}) to start the program.
2. Click the [F2] (TOOL) button to display the "Tool Calibration" screen.

3. Click the [Select job] button to display the [Select job] dialog box. To select the tool calibration job file (TOOL.JBI), click the [Open] button or double-click the file. (When the calibration job has been taught under a different name, select the corresponding file.) Then the screen returns to the "Robot Calibration" screen.

4. Click the [Check File] button to check the files necessary for tool calibration. (Verify that the corresponding files for parameter data and tool data exist.) When the corresponding files exist, the following message is displayed.
5. Clicking the [OK] button returns to the "Tool Calibration" screen. Click the [Execute Calibration] button to display the "Calculating" screen. Then calibration starts and the calculation process is displayed. Clicking the [STOP] button stops the calculation to return to the "Tool Calibration" screen and the calculation result will not be written in the file (Tool Data). When calculation is completed, the "Calculation finish" screen is displayed.

![Calculation finish screen]

6. Clicking the [EXIT] button returns to the "Tool Calibration" screen. Click the [Print a Report] button to print out the report.

7. Load the changed tool data to the actual robot, by using a device such as YASNAC FC2, etc. After loading, confirm that the new tool data has been overwritten in the robot controller.

   (TOOL.CND. For ERC, TOOL.DAT)

The tool calibration operation is completed.
3.3 Tool Posture Calibration

3.3.1 Operation with Actual Robot

1. To perform tool posture calibration, prepare the data of tool to be mounted in advance. The following three methods are available for tool data.
   1) Performs the tool calibration with the actual robot.
   2) Performs the tool calibration by MOTOCALV EG. (Refer to "3.2 Tool Calibration ")
   3) Uses the values of mechanical dimensions if specified in the drawing, etc.

2. Mount a tool on the robot flange, and using this tool, perform teaching of the job (job name: TOOLPS) for 1 posture at 1 point. This calibration job "TOOLPS" is used for actual calculation by the calibration software. The teaching method is explained below.

   a) Use a level or other instruments to set the desired posture by moving the robot along the coordinate axis, then teach the point. (Use MOVJ or MOVL for interpolation type. On base of the taught positions, X, Y, and Z will be calculated internally.)

   For example of arc weld torch, when the direction of welding wire is to be the same direction of Z-axis on the tool coordinate, place the tool in such a posture that the weld torch is positioned horizontally, and teach this position.

   

   <Example of Tool Posture Calibration Job>
   NOP
   MOVJ C000 VJ=0.78 PL=0
   END
3.3 Tool Posture Calibration

3. Save the following robot data from the robot controller to the floppy disk, using a device such as YASNAC FC2, etc.

<table>
<thead>
<tr>
<th>File Name</th>
<th>Contents</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL.PRM</td>
<td>Robot parameter data</td>
<td>For ERC, PARAM.DAT</td>
</tr>
<tr>
<td>TOOL.CND</td>
<td>Tool data</td>
<td>For ERC, TOOL.DAT</td>
</tr>
<tr>
<td>TOOLPS.JBI</td>
<td>Job for tool posture calibration</td>
<td>1 posture at 1 point</td>
</tr>
</tbody>
</table>

3.3.2 Operation on Personal Computer

1. Insert the above floppy disk. Double-click the [MOTOCALV EG] icon in the [Start]-[Program]-[Motoman]-[MOTOCALV EG] (In the case of Windows10, {Motoman} - {MOTOCALV EG}) to start the program.

2. Click the [F3] (POSTURE) button to display the "Tool Posture Calibration" screen.

3. Click the [Select job] button to display the [Select job] dialog box. To select the tool posture calibration job file (TOOLPS.JBI), click the [Open] button or double-click the file. (When the calibration job has been taught under a different job name, select the
corresponding file.) Then the screen returns to the "Tool Posture Calibration" screen.

4. Click the [Check File] button to check the files necessary for tool posture calibration. (Verify that the corresponding files for parameter data and tool data exist.) When the corresponding files exist, the following message is displayed.

5. Click the [OK] button to return to the "Tool Posture Calibration" screen. Click the [Define tool posture] button to display the "Tool Posture Settings" screen. Then click the [Rx-], [Rx+], [Ry-], [Ry+], [Rz-], and [Rz+] buttons as many times as needed, to set the taught posture with actual robot. Then click the [OK] button to return to the "Tool Posture Calibration" screen.
6. Click the [Execute Calibration] button to execute the calibration.

7. Click the [Print a Report] button to print out the report.

8. Load the changed tool data to the actual robot, by using a device such as YASNAC FC2, etc. After loading, confirm that the new tool data has been overwritten in the robot controller.
   (TOOL.CND. For ERC, TOOL.DAT)

The tool posture calibration operation is completed.
3.4 Workpiece Calibration

The workpiece calibration is composed of "Workpiece calibration" and "Job conversion." "Workpiece calibration" calculates the positional difference between each robot and workpiece, by comparing the job created by offline system and the job created with the actual robot. Then "Job conversion" converts the position data by offline system into the data for the actual robot, using the difference above.

3.4.1 Workpiece Calibration

- Teaching of personal computer reference point teaching job

Perform teaching of personal computer reference point teaching job by MotoSim EG.

Job name: WORK
Teaching method:
Using the same tool, teach the workpiece reference points. Decide 3 or more reference points. (5 points are recommended. When higher accuracy is required, teach more points.) Teach the first 3 points to form a triangle largely covering the robot working envelope for the workpiece. The order of teaching and number of teaching points should be the same as for the robot controller reference point teaching job explained in "n Teaching of robot controller reference point teaching job (Operation with actual robot)" below. For interpolation type, use MOVJ or MOVL. On base of the taught positions, X, Y, and Z will be calculated internally. (It is recommended that reference point teaching be performed without changing the robot posture, to maintain accuracy of tool data (robot control point)).

<Workpiece calibration: Example of personal computer reference point job>
NOP
MOVL C0000 V=46.0 PL=0
MOVL C0001 V=46.0 PL=0
MOVL C0002 V=46.0 PL=0
MOVL C0003 V=46.0 PL=0
MOVL C0004 V=46.0 PL=0
END

- Teaching of robot controller reference point teaching job (Operation with actual robot)

Perform teaching of robot controller reference point teaching job with actual robot.

Job name: WORKREF
Teaching method:
Using the same tool, teach the workpiece reference points. Decide 3 or more reference points. (5 points are recommended. When higher accuracy is required, teach more points.) Teach the first 3 points to form a triangle largely covering the robot working envelope for the workpiece. The order of teaching and number of teaching points should be the same as for the personal computer reference point teaching job explained in "n Teaching of
personal computer reference point teaching job* in the previous page. Any interpolation type can be used. (For teaching reference points, it is recommended that reference point teaching be performed without changing the robot posture to maintain accuracy of tool data (robot control point)).

<Workpiece calibration: Example of robot controller reference point job>

NOP
MOVL C0000 V=46.0 PL=0
MOVL C0001 V=46.0 PL=0
MOVL C0002 V=46.0 PL=0
MOVL C0003 V=46.0 PL=0
MOVL C0004 V=46.0 PL=0
END

Save the following robot data from the robot controller to the floppy disk, using a device such as YASNAC FC2, etc.

<table>
<thead>
<tr>
<th>File Name</th>
<th>Contents</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL.PRM</td>
<td>Robot parameter data</td>
<td>For ERC, PARAM.DAT</td>
</tr>
<tr>
<td>TOOL.CND</td>
<td>Tool data</td>
<td>For ERC, TOOL.DAT</td>
</tr>
<tr>
<td>WORKREF.JBI</td>
<td>Job for workpiece calibration</td>
<td>3 points or more</td>
</tr>
</tbody>
</table>

Calibration operation

1. Insert the above floppy disk to the personal computer drive. Double-click the [MOTOCALV EG] icon in the [Start]-[Program]-[Motoman]-[MOTOCALV EG] (In the case of Windows10, {Motoman} - {MOTOCALV EG}) to start the program.
2. Click the [F4] (WORKPIECE) button to display the "Workpiece Calibration" screen.

3. Click the [Select PC job] button to display the [Select PC job] dialog box. To select the file of personal computer reference point job for calibration (WORK.JBI), click the [Open] button or double-click the file. (When the reference point job has been taught under a different name, select the corresponding file.) Then the screen returns to the "Workpiece Calibration" screen.

4. Click the [Select a robot controller job] button to display the [Select a robot controller job] dialog box. To select the file of robot controller reference point job saved in the floppy disk for calibration (WORKREF.JBI), click the [Open] button or double-click the file. (When the reference point job has been taught under a different name, select the
corresponding file.) Then the screen returns to the "Workpiece Calibration" screen.

5. Click the [Check File] button to check the files necessary for workpiece calibration. (Verify that the corresponding files for parameter data and tool data exist.) When the corresponding files exist, the following message is displayed.

6. Click the [OK] button to return to the "Workpiece Calibration" screen. If no comment is required, it is not necessary to write in.

7. Click the [Execute Calibration] button to display the "Calculating" screen. Input a comment to be written in the personal computer job (WORK.JBI). Then calibration starts and the calculation process is displayed.

As calculation result, the conversion constant are written in personal computer reference point job (WORK.JBI) and robot controller reference point job (WORKREF.JBI), as a comment statement. The matrix to convert the personal computer job to the robot controller job is written in WORK.JBI, and the matrix to convert the robot controller job to the personal computer job in WORKREF.JBI, respectively. They are written in form of a comment statement, with X, Y, Z, Rx, Ry, Rz values based on the robot wrist motion.

Clicking the [STOP] button stops the calculation to return to the "Workpiece Calibration" screen and the calculation result will not be written in the file (personal computer reference point job, robot controller reference point job). When calculation is com-
3.4 Workpiece Calibration

After completed, the "Calculation finish" screen is displayed.

![Calculation finish screen](image)

**Calibration operation for multi stations**

For multi stations, perform the procedure 3) to 7) indicated in "Calibration operation" to each stations for the number of station times.

---

**NOTE**

- The unit system for X, Y, and Z is distance (mm).
- The unit system for Rx, Ry, and Rz is angle (degree).

---

8. Click the [Print a report] button to print out the report.

---

**Example of personal computer reference point job after calibration**

```
NOP
’WKCOM COMMENT
’WKCAL(0.029)=21.053,-27.353,37.566,1.999,1.999,2.002
MOVL C0000 V=46.0 PL=0
MOVL C0001 V=46.0 PL=0
MOVL C0002 V=46.0 PL=0
MOVL C0003 V=46.0 PL=0
MOVL C0004 V=46.0 PL=0
END
```
3.4.2 Job Conversion

1. Click the [job conversion] button to display the "Workpiece Calibration" screen for job conversion.

Reference job is a job where the positional differences between personal computer and actual robot are written. And the personal computer reference point job (WORK.JBI) selected in the "Workpiece Calibration" screen is taken over to this screen, and displayed.

2. Select the job to convert from the list box on the left. More than one job can be selected.

   The directory should be the same as for the personal computer job (WORK.JBI) (The directory will be fixed and cannot be changed).

3. Click the [Directory…] button to specify the conversion destination directory.

   For the conversion destination directory, the conversion destination directory of the previous conversion is displayed as default.
4. Click the [Convert>>] button to execute the job conversion.

5. If there are jobs to be deleted from conversion source and destination, select the jobs from each list box, then select [Delete Job (D)] from the [File (F)] menu to delete the jobs.

6. When conversion is completed, click the [Close] button to return to the "Workpiece Calibration" screen.
7. Load the converted job to the actual robot, using a device such as YASNAC FC2, etc.

For the converted job, the converted amount is written as default in comment. If this comment exceeds 32 characters, the job cannot be loaded to the robot controller. In this case, remove the check mark on [Output of conversion job comment disabled] of the option menu, to set the mode not to write comment in the job.

The workpiece calibration operation is completed.

■ Job conversion for multi stations

1. Click the [job conversion] button to display the "Workpiece Calibration" screen for job conversion.

Reference job is a job where the positional differences between personal computer and actual robot are written. And the personal computer reference point job (M_L1.JBI) selected in the "Workpiece Calibration" screen is taken over to this screen, and displayed.

Tick the [Multi Station] check box.

2. Select the job to convert from the list box on the left. More than one job cannot be selected.

The directory should be the same as for the personal computer job (M_L1.JBI) selected. (The director will be fixed and cannot be changed.)
3. Click the [Directory…] button to specify the conversion destination directory.

**NOTE** For the conversion destination directory, the conversion destination directory of the previous conversion is displayed as default.

4. Click the [Convert>>] button to execute the job conversion.

Each steps of the job are selected default jobs. The default jobs are the latest correction jobs set before and decide by which correction job the step is to be converted. If necessary, change the correction job of each step by following the procedure indicated below.

1) Click the [Select Reference Job] button to change the correction job.
2) Select the step whose correction job was changed.
3) Click the [Apply Reference] button to change the reference job.
4) Either repeat the procedure to above, or select several steps at a time to convert the reference jobs.
5) For the points of air cut or the steps you do not want to move, click the [Clear Reference] button and confirm that the step does not possess any reference job to prevent the step from being converted.
6) Click the [Convert] button to convert the job.
5. If there are jobs to be deleted from conversion source and destination, select the jobs from each list box, then select [Delete Job (D)] from the [File (F)] menu to delete the jobs.

6. When conversion is completed, click the [Close] button to return to the "Workpiece Calibration" screen.

7. Load the converted job to the actual robot, using a device such as YASNAC FC2, etc.

**NOTE**

For the converted job, the converted amount is written as default in comment. If this comment exceeds 32 characters, the job cannot be loaded to the robot controller. In this case, remove the check mark on [Output of conversion job comment disabled] of the option menu, to set the mode not to write comment in the job.
3.5 Layout Correction

The layout correction is composed of "Robot Layout Correction" and "Travel Axis Correction." "Robot Layout Correction" corrects the robot layout in the cell constructed by ROSTY for actual robot layout, by comparing the job created by offline system and the job created with the actual robot. "Travel Axis Tilt Correction" corrects the robot layout in the cell constructed by ROSTY for the actual robot layout, by calculating the positional difference between the travel axis and the robot positioned on the travel axis.

### 3.5.1 Robot Layout Correction

- **Teaching of personal computer reference point teaching job**

Perform teaching of the personal computer reference point teaching job by using MoToSim EG.

  - **Job name:** RTSJOB
  - **Teaching method:**

    Using the same tool, teach the workpiece reference points. Decide 3 points to form a triangle largely covering the robot working envelope for the workpiece. When the robot is on the travel axis, move the travel axis and teach 3 points to form a triangle as above. The order of teaching and number of teaching points should be the same as for the robot controller reference point teaching job explained in "Teaching of robot controller reference point teaching job (Operation with actual robot)" below. Any type of interpolation can be used.

  ```
  <Robot layout correction: Example of personal computer reference point job>
  NOP
  MOVL C0000 V=46.0 PL=0
  MOVL C0001 V=46.0 PL=0
  MOVL C0002 V=46.0 PL=0
  END
  ```

- **Teaching of robot controller reference point teaching job (Operation with actual robot)**

Perform teaching of robot controller reference point teaching job with actual robot.

  - **Job name:** CTRLJOB
  - **Teaching method:**

    Using the same tool, teach the workpiece reference points. Decide 3 points to form a triangle largely covering the robot working envelope for the workpiece. When the robot is on the travel axis, move the travel axis and teach 3 points to form a triangle as above.

  ```
  NO
  TE
  ```
The order of teaching and number of teaching points should be the same as for the personal computer reference point teaching job explained in "Teaching of personal computer reference point teaching job" above. Any type of interpolation can be used.

<Robot layout correction: Example of robot controller reference point job>

NOP
MOVLC0000 V=46.0 PL=0
MOVLC0001 V=46.0 PL=0
MOVLC0002 V=46.0 PL=0
END

Save the following robot data from the robot controller to the floppy disk, using a device such as YASNAC FC2, etc.

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</tr>
<tr>
<td>TOOL.CND</td>
<td>Tool data</td>
<td>For ERC, TOOL.DAT</td>
</tr>
<tr>
<td>CTRLJOB.JBI</td>
<td>Job for robot layout correction</td>
<td>3 points</td>
</tr>
</tbody>
</table>

### Calibration operation

1. Insert the above floppy disk to the drive of personal computer. Double-click the [MOTOCALV EG] icon in the [Start]-[Program]-[Motoman]-[MOTOCALV EG] (In the case of Windows10, {Motoman} - {MOTOCALV EG}) to start the program.
2. Click the [F5] (LAYOUT) button to display the "Layout Correction" screen.

3. Click the [Select PC job] button to display the [Select PC job] dialog box. To select the file of personal computer reference point job for calibration (RTSJOB.JBI), click the [Open] button or double-click the file. (When the reference point job has been taught under a different job name, select the corresponding file.) Then the screen returns to the "Layout Correction" screen.

4. Click the [Select a robot controller job] button to display the [Select a robot controller job] dialog box. To select the file of robot controller reference point job for calibration (CTRLJOB.JBI), click the [Open] button or double-click the file. (When the reference point job has been taught under a different job name, select the corresponding file.)
3.5 Layout Correction

Then the screen returns to the "Layout Correction" screen.

5. Click the [Select Cell] button to display the "Select Cell" dialog box. To select the corresponding cell file, click the [Open] button or double-click the corresponding file. Then the screen returns to the "Layout Correction" screen.

If two or more robots are registered in the cell, the following message is displayed. Verify the selected robot name.
If no robots are registered in the cell, the following message is displayed.

6. If two or more robots are registered in the cell, click [Robot Name] combo box to select the robot.

7. Click the [Execute Calibration] button to execute the robot layout correction. When calibration is completed, the layout correction amounts are displayed in "Layout Correction" screen.

8. Click the [Correct Robot Layout] button to correct the robot layout on the cell. To create a new cell after correction without overwriting on the cell before, check the mark in the check box "Output Cell Name" of "Correction Option," and input a new cell name to
9. Click the [MoToSim EG Inspection] button to inspect the robot layout correction in the cell of MoToSim EG.

10. Click the [Print a Report] button to print out the report.

The robot layout correction is completed.

### 3.5.2 Travel Axis Correction

- **Operation with actual robot**

  1. Prior to calibration, mount an end-pointed tool on the robot flange and perform tool calibration to obtain tool data.

  2. Using this tool, perform teaching of the job for 3 travel axis movements at 3 points (total 9 points).

    **NOTE** Where the positional angle difference between the robot and the travel axis is considerably large, calibration is not possible.

    a) Teach the same point with 3 postures using the same tool, moving along the
Any type of interpolation can be used. Teach the job at step a) at different 3 points (each point should be separated 100 mm or more).

Example of Travel Axis Tilt Correction Job:

NOP
*1
MOVJ C0000 VJ=0.78 PL=0
MOVJ C0001 VJ=0.78 PL=0
MOVJ C0002 VJ=0.78 PL=0
*2
MOVJ C0003 VJ=0.78 PL=0
MOVJ C0004 VJ=0.78 PL=0
MOVJ C0005 VJ=0.78 PL=0
*3
MOVJ C0006 VJ=0.78 PL=0
MOVJ C0007 VJ=0.78 PL=0
MOVJ C0008 VJ=0.78 PL=0
END
3. Save the following robot data from the robot controller to the floppy disk, using a device such as YASNAC FC2, etc.

<table>
<thead>
<tr>
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<tbody>
<tr>
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</tr>
<tr>
<td>TOOL.CND</td>
<td>Tool data</td>
<td>For ERC, TOOL.DAT</td>
</tr>
<tr>
<td>CTRLJOB.JBI</td>
<td>Travel axis tilt correction job</td>
<td>9 points</td>
</tr>
</tbody>
</table>

### Calibration operation
1. Insert the above floppy disk to the personal computer drive. Double-click the [MOTOCALV EG] icon in the [Start]-[Program]-[Motoman]-[MOTOCALV EG] (In the case of Windows10, {Motoman} - {MOTOCALV EG}) to start the program.

2. Click the [F5] (LAYOUT) button to display the "Layout Correction" screen, then click the [Travel Axis Correction] tab to display the screen for travel axis tilt correction.
3. Click the [Select a robot controller job] button to display the [Select a robot controller job] dialog box. To select the file of robot controller reference point job for calibration (CTRLJOB.JBI), click the [Open] button or double-click the file. (When the reference point job has been taught under a different job name, select the corresponding file.) Then the screen returns to the "Layout Correction" screen.

4. Click the [Select Cell] button to display the [Select Cell] dialog box. To select the corresponding cell file, click the [Open] button or double-click the corresponding file. Then the screen returns to the "Layout Correction" screen.

If two or more robots are registered in the cell, the following message is displayed. Travel axis tilt cannot be corrected for the cell in which two or more robots are registered.
Create a cell in which only one robot is registered, then correct the travel axis tilt.

If the robot registered in the cell is not incorporated with the travel axis, the following message is displayed.

5. Click the [Execute Calibration] button to execute the travel axis tilt correction. When calibration starts, the "Calculating" screen is displayed to show the calculation process.

Clicking the [STOP] button stops the calculation to return to the screen for travel axis tilt correction.

When calibration is completed, the layout correction amounts are displayed in "Layout Correction" screen.
6. Click the [Travel Axis Correction] button to reflect the positional difference between the robot and travel axis with actual robot, to the robot and travel axis in the cell. To create a new cell after correction without overwriting on the cell before, check the mark in the check box "Output Cell Name" of "Correction Option", and input a new cell name to be created.
7. Click the [MoToSim EG Inspection] button to inspect the travel axis tilt correction in the cell of MoToSim EG.

8. Click the [Print a Report] button to print out the report.

The travel axis tilt correction operation is completed.
4.1 Examples of Robot Calibration

5 posture examples at one point are shown below. Perform teaching of these 5 postures each at 5 points (total 25 points).

**For SK and SV**

<First Posture>

![Oblique view](image1)

**Positioning jig**
The distance between each jig should be kept to a minimum of 100 mm horizontally and vertically.

<Second Posture>

![Front view](image2)
4.1 Examples of Robot Calibration

<Third Posture>

<Fourth Posture>

<Fifth Posture>
For SP100

<First Posture>

Positioning jig
The distance between each jig should be kept to a minimum of 100 mm horizontally and vertically.

<Second Posture>

<Third Posture>
4.1 Examples of Robot Calibration

<Fourth Posture>

<Fifth Posture>

For SP70

<First Posture>

Positioning jig
The distance between each jig should be kept to a minimum of 100 mm horizontally and vertically.
4.1 Examples of Robot Calibration

<Second Posture>

<Third Posture>

<Fourth Posture>
4.1 Examples of Robot Calibration

<Fifth Posture>
4.2 Examples of Tool Calibration

For SK and SV

<First Posture>

<Second Posture>
4.2 Examples of Tool Calibration

<Third Posture>

<Fourth Posture>

<Fifth Posture>
4.2 Examples of Tool Calibration

<Sizth Posture>

<Seventh Posture>

For SP100

<First Posture>

Positioning jig
4.2 Examples of Tool Calibration

<Second Posture>

<Third Posture>

<Fourth Posture>
4.2 Examples of Tool Calibration

<Fifth Posture>

<Sixth Posture>

<Seventh Posture>
4.2 Examples of Tool Calibration

For SP70

<First Posture>

<Second Posture>

<Third Posture>
4.2 Examples of Tool Calibration

<Fourth Posture>

<Fifth Posture>

<Sizth Posture>
4.2 Examples of Tool Calibration

<Seventh Posture>
4.3 Frequently-asked questions

4.3.1 When the driver has been installed with USB type key connected to personal computer

1) Under the state that the USB type key is attached to personal computer, delete the item registered as "USB Token" in Device Manager.
2) Uninstalled the driver (Sentinel System Driver 5.41.1(32-bit)) with [Add/Remove Programs].
3) Install the driver with key detached from personal computer.
   With the procedure above, the driver can be performed normally.

4.3.2 When a older version key driver has been installed over a newer key driver version.

In such case, the key driver may not operate properly.
Uninstall the Sentinel System Driver with Windows "Add / Remove Programs" function. Then reinstall the Sentinel key driver. For details, please refer to section " 1.3 Hardware Lock Key " of the manual.
MOTOCALV EG
OPERATOR’S MANUAL

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