



AutoCal<sup>®</sup>  
36581NNF, 36581KKF,  
36582KKF  
Automatic VNA Calibrator

***User's Guide***



**Automatic Calibrator for Anritsu 360B and  
37000 Series Vector Network Analyzers or  
MS462XX Series Vector Network Measurement Systems**


MARCH 2007  
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部件名称	有毒有害物质或元素					
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**Manufacturer's Name:** ANRITSU COMPANY

**Manufacturer's Address:** Microwave Measurements Division  
490 Jarvis Drive  
Morgan Hill, CA 95037-2809  
USA

declares that the product specified below:

**Product Name:** AutoCal

**Product Description:** Automatic VNA Calibrator

**Model Number:** 36581KKF, 36581NNF, 36582KKF

conforms to the requirement of:

EMC Directive 89/336/EEC as amended by Council Directive 92/31/EEC & 93/68/EEC  
Low Voltage Directive 73/23/EEC as amended by Council directive 93/68/EEC

### **Electromagnetic Interference:**

Emissions: CISPR 11:1990/EN55011:1991 Group 1 Class A

Immunity: IEC 1000-4-2:1995/prEN50082-1:1995 - 4kV CD, 8kV AD  
IEC 1000-4-3:1993/ENV50140:1994 - 3V/m  
IEC 1000-4-4:1995/prEN50082-1:1995 - 0.5kV SL, 1kV PL

### **Electrical Safety Requirement:**

Product Safety: The Product Complies when used with Company supplied Power  
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Morgan Hill, CA

  
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5-SEPT-97

Date

European Contact: For Anritsu product EMC & LVD information, contact Anritsu LTD, Rutherford Close,  
Stevenage Herts, SG1 2EF UK, (FAX 44-1438-740202)



## How to Use this Manual

This manual describes how to setup the **AutoCal**® calibrator and how to access the on line HELP documentation. After setup, nearly all operation is guided by the associated software, running on a standard Personal Computer. Most of the documentation necessary to understand and use the **AutoCal** calibrator is provided on line, following the standard form for HELP used with the Windows operating system.

This manual describes (1) the physical requirements, including test hardware, software, and computer resources necessary to setup a measurement and (2) how to start and use the software to control the calibration.

First-time users and maintenance supervisors should read the general material in Chapter 1. This chapter describes the basic operation of the instruments, and the performance specifications.

### Important Usage Note

Refer to the MS462XX Operation Manual when using **AutoCal** with the MS462XX Vector Network Measurement System. The serial enabled 37000 series VNA with firmware version 3.37 or later offers an internal serial **AutoCal** control interface, therefore a separate PC is not required. Consult the 37000 VNA Operation Manual for more details.

# ***Chapter 1***

## ***General Information***

### **Introduction**

This chapter provides a general description of the **AutoCal** calibrators, including specifications, setup, and the use of the associated software and online documentation. This series has five models, as shown below. Throughout this manual, the term **AutoCal** will refer to the series. Individual models will be referred to by model number. The 36581NNF/1 and KKF/1 are for use with the MS462XX Vector Network Measurement System (VNMS).

<b><u>Model</u></b>	<b><u>Switch</u></b>	<b><u>Freq. Range</u></b>	<b><u>Connector.</u></b>
36581NNF	Electronic	40 MHz-18 GHz	N (Male)-N (Female)
36581KKF	Electronic	40 MHz-20 GHz	K (Male)-K (Female)
36582KKF	Mechanical	40 MHz-40 GHz	K (Male)-K (Female)
36581NNF/2	Electronic	10 MHz-9 GHz	N (Male)-N (Female)
36581KKF/2	Electronic	10 MHz-9 GHz	K (Male)-K (Female)

### **Description**

The **AutoCal** module is controlled by a Personal Computer and appropriate software, a 37000 series Vector Network Analyzer (VNA) equipped with a serial interface and firmware version 3.23 or later, or any MS462XX VNMS. The **AutoCal** module provides an automatic system for fast, repeatable high-quality calibrations of a VNA.

## ***Chapter 1 General Information***

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The **AutoCal** module is inserted between the VNA test ports to perform the calibration.

The *electronic* **AutoCal** modules use solid state electronic switches to exchange the internal calibration standards. Note that these units have a lower frequency limit (18 and 20 GHz). The *mechanical* modules use electro-mechanical actuators to exchange the standards and have the highest frequency limit, but have a small non-repeatability error. The *mechanical* modules contain internal standards used to measure port isolation; the *electronic* modules do not contain isolation standards and require a manual operation to perform this measurement.

A standard serial RS-232 interface extender is used to connect the **AutoCal** module to the PC host controller, VNA, or VNMS. The GPIB interface (IEEE488.2) is used to control the VNA. The VNA must be either an Anritsu model 360B or a member of the Anritsu 37000 series. Power is supplied by a connecting cable from a universal power supply (+5 Vdc, +15 Vdc, -15 Vdc for the electronic modules; +5 Vdc, +24 Vdc for the mechanical modules). A power on-off switch is not provided.

Test Port Cable Converters (Anritsu series 36583) are used during and after the calibration process to establish the desired test port connector type and sex.

The host PC controller runs under the Microsoft Windows operating system and requires an internal National Instruments GPIB interface card.

Refer to the MS462XX Operation Manual when using AutoCal with a MS462XX VNMS.



## Calibrations

Four types of calibrations can be performed using **AutoCal**:

**One-Port:**  $S_{11}$  1-Port and  $S_{22}$  1-Port are 1-port calibrations performed on the indicated port of the VNA and are equivalent to the traditional Open-Short-Load calibrations. Note that an  $S_{22}$  1-Port calibration is not available with the 360B.

**Full 2-Port:** This type is equivalent to the traditional Open-Short-Load-Thru (OSLT) calibration.

**Thru Update:** This type is a new form of calibration which is used to update an existing 12-term calibration in the VNA. This calibration could have been performed using any method of calibration which yields 12 terms (LRL, LRM, **AutoCal**, or OSLT). Due to cable movement and aging, the calibration may have degraded over time. The Thru Update refreshes the calibration by measuring a Thru connection and updating the Transmission Tracking and Load Match calibration constants.

**Adapter Removal:** This calibration measures the characteristics of male-male or female-female test port cables for subsequent measurement of non-insertable devices. An adapter is required for this calibration. Adapter Removal requires two calibration procedures in order to calculate the parameters and electrical length of the adapter.

**NOTE:** If a full frequency range calibration is not required, modify the VNA Setup Menu to reflect only the needed range. This will be useful when calibrating a 40 GHz VNA below 20 GHz with a 20 GHz **AutoCal** module.

## **System Requirements**

### **Computer (if used as the controller):**

- Standard PC with a 386 or higher processor and a math coprocessor
- Windows 3.1 or later operating system
- 1.5 MB of RAM in addition to memory required by any other operating programs
- National Instruments GPIB card and extension cable (available from Anritsu) with Windows software drivers installed.
- Serial communications port (COM port)

### **Network Analyzer:**

- Anritsu 360B, with system software version 4.04 or newer
- Anritsu 37000, system software version 1.04 or newer or 3.23 or newer for internal control
- MS462XX Vector Network Measurement System, system software version 1.01 or newer

### **Calibrator:**

- Anritsu **AutoCal** module  
Electronic modules for 10 MHz to 20 GHz, no isolation standards  
Mechanical module for 40 MHz to 40 GHz, with isolation standards
- Power supply with attached cable  
(Different power supplies are used for the two types of modules and the power connectors are of different types to avoid errors in connection.)
- Serial interface cable
- **AutoCal** program disk

## Definitions

The following terms are used in explaining the calibration procedures using the **AutoCal** module:

### Thru

A *thru* is a connection of the two test ports where the transmission path is of modest or low loss when used during calibration. Two kinds of thru connections are defined for the **AutoCal** calibration: (1) a *Calibrator thru* is an internal path through the calibrator. (2) a *True thru* is a direct cable connection between the test ports, with no intervening connectors. The calibrator thru is not as accurate as a true thru, so you have the option of using the more accurate method, if necessary. The 4-port **AutoCal** module contains internal thru paths that are normally used during a calibration. True thrus can be used in lieu of the internal thrus in some calibrations for small improvements in transmission tracking accuracy. This is available only in some firmware versions; contact Anritsu for more information.

### Isolation

For certain measurements that require accurate  $S_{21}$  or  $S_{12}$  readings for very small values of those parameters, an *isolation* step is required to characterize the leakage of the VNA and test setup. Isolation is sometimes used to improve the dynamic range by mathematically reducing the effects of leakage. This calibration step is optional and can be performed by using the external calibration standards (see the MS462XX Operation Manual). Since the MS462XX's internal leakage is very small, the step does not usually help very much. However, if the cable setup from the VNA is leaking, there are cases when the isolation step can be helpful.

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### **VNA Measurement Averaging Factor**

This is the averaging factor used within the VNA to determine the number of samples taken during a calibration. Default values are provided for the various standards with the general rule being higher averaging for measurements with lower signal-to-noise ratios (for example, match measurements on loads or thru). This factor is set by the VNA menu:

**Avg/Smooth Menu**

### **VNA Video IF Bandwidth**

The video IF bandwidth is the measurement bandwidth of the VNA that can be changed both during a calibration and during a measurement. The default value is 1 kHz, but it can be increased for faster measurements (and slightly higher trace noise and noise floor) or decreased for better dynamic range. In conjunction with VNA averaging above, this determines the calibration or measurement time and usually does not have to be changed for the calibration. This setting is the same as the value set by using the VNA menu:

**Video IF BW**

### **Characterization File**

Each calibrator module has a file containing data which characterizes each standard in the calibrator. This file also contains information (identification number, start and stop frequencies) concerning the capabilities of the calibrator. Each characterization file has the extension “.acd.” When modules are changed, you must open the appropriate new characterization file using the menus (see Chapter 2):

**File | Open Characterization File...**

## Performance Specifications

<b>Temperature Range:</b>	23 °C ± 3 °C ambient
<b>Frequency Range:</b>	40 MHz to 18 GHz (36581NNF) 10 MHz to 9 GHz (36581NNF/2) 40 MHz to 20 GHz (36581KKF) 10 MHz to 9 GHz (36581KKF/2) 40 MHz to 40 GHz (36582KKF)
<b>Module Connectors:</b>	N Male, N Female (36581NNF) K Male, K Female (36581KKF, 36582KKF)
<b>Test Port Cable:</b>	K Male (2 ea), K Female (2 ea) (3658K)
<b>Converter Set:</b>	3.5 mm Male (2 ea) 3.5 mm Female (2 ea) (36583L) SMA Male (2 ea) SMA Female (2 ea) (36583S)

	<i>without 36583 Converter Set</i>	<i>with 36583 Converter Set</i>	<i>36581/2 Models</i>
<b>Directivity:</b>			
0.01 to 0.04 GHz	——	——	38 dB
0.04 to 0.2 GHz	38 dB	36 dB	38 dB
0.2 to 2 GHz	38 dB	36 dB	38 dB
2 to 9 GHz	38 dB	36 dB	36 dB
9 to 20 GHz	38 dB	36 dB	——
20 to 40 GHz	34 dB	32 dB	——
<b>Load Match:</b>			
0.01 to 0.04 GHz	——	——	38 dB
0.04 to 0.2 GHz	38 dB	36 dB	38 dB
0.2 to 2 GHz	38 dB	36 dB	38 dB
2 to 9 GHz	38 dB	36 dB	36 dB
9 to 20 GHz	38 dB	36 dB	——
20 to 40 GHz	34 dB	32 dB	——

## Chapter 1 General Information

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	without 36583 Converter Set	with 36583 Converter Set	36581/2 Models
<b>Source Match:</b>			
0.01 to 0.04 GHz	—	—	36 dB
0.04 to 0.2 GHz	34 dB	32 dB	36 dB
0.2 to 2 GHz	34 dB	32 dB	36 dB
0.2 to 9 GHz	34 dB	32 dB	34 dB
9 to 20 GHz	34 dB	32 dB	—
20.0 to 40.0 GHz	26 dB	24 dB	—
<b>Reflection Tracking:</b>			
0.01 to 0.04 GHz	—	—	±0.15 dB
0.04 to 0.2 GHz	±0.15 dB	±0.20 dB	±0.15 dB
0.2 to 2 GHz	±0.20 dB	±0.25 dB	±0.15 dB
2 to 9 GHz	±0.20 dB	±0.25 dB	±0.20 dB
9 to 20 GHz	±0.20 dB	±0.25 dB	—
20.0 to 40.0 GHz	±0.25 dB	±0.30 dB	—
<b>Transmission Tracking (Module Thru Mode):</b>			
0.01 to 0.04 GHz	—	—	±0.15 dB
0.04 to 0.2 GHz	±0.15 dB	±0.20 dB	±0.15 dB
0.2 to 2 GHz	±0.20 dB	±0.25 dB	±0.15 dB
2 to 9 GHz	±0.20 dB	±0.25 dB	±0.20 dB
9 to 20 GHz	±0.20 dB	±0.25 dB	—
20.0 to 40.0 GHz	±0.25dB	±0.30 dB	—
<b>Transmission Tracking (True Thru Mode):</b>			
0.01 to 0.04 GHz	—	—	±0.15 dB
0.04 to 0.2 GHz	±0.10 dB	±0.15 dB	±0.15 dB
0.2 to 2 GHz	±0.10 dB	±0.15 dB	±0.15 dB
2 to 9 GHz	±0.10 dB	±0.15 dB	±0.20 dB
9 to 20 GHz	±0.10 dB	±0.15 dB	—
20.0 to 40.0 GHz	±0.20dB	±0.25 dB	—
Operating Temperature:	0 °C to +50 °C		
Storage Temperature:	-20 °C to +70 °C		
Re-characterization Period:	6 months		

# ***Chapter 2***

## ***Operation***

### **Introduction**

This chapter describes the setup and operation of the **AutoCal** calibration module, the host PC controller, and how to make use of the extensive on-line documentation.

Refer to the MS462XX Operation Manual when using **AutoCal** with the MS462XX Vector Network Measurement System. Refer to the 37000 series Operation Manual when using the internal **AutoCal** control.

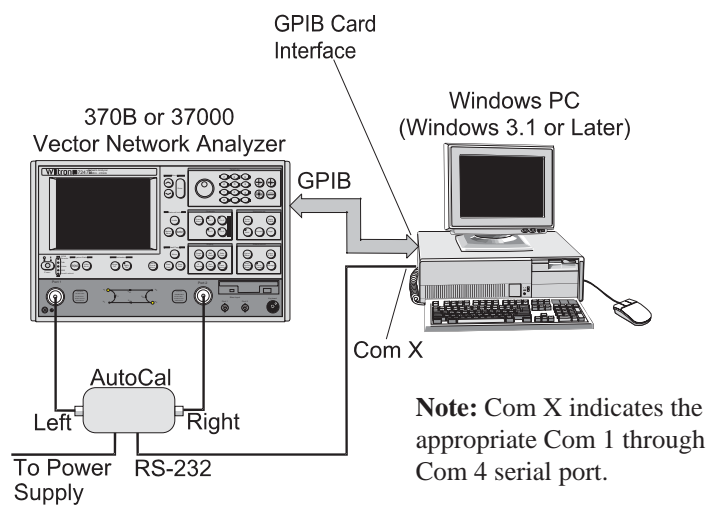
### **Physical Setup**

See Figure 2-1 (next page) for an illustration of the connections necessary to perform an automatic calibration using the **AutoCal** module. Different power cable connectors are used with the mechanical modules and the electronic modules to prevent connecting the wrong power supply in error.

There is no on-off switch. When power is connected to the **AutoCal** module, the LED labeled POWER should come on immediately. The second LED, labeled OPERATE, should come on in about five minutes, after the internal temperature control oven has stabilized. Internal temperature is held within a 5 °C window.

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**Figure 2-1.** *AutoCal Measurement Setup*



## Controller Setup

### Loading Software

The **AutoCal** software is furnished on a standard 3.5 inch floppy disk. The **AutoCal** host computer must be running the Windows 3.1 or later operating system. Software installation follows standard Windows practice.

With Windows running, place the **AutoCal** software floppy disk in a convenient floppy disk drive (usually **a:**). In the Windows 3.1 Program Manager or File Manager, click FILE and choose Run. In later Windows versions, click Start and choose Run. In the Run dialog window, type:

**drivename:\setup**

in the Command Line and press ENTER or click OK.

You will be prompted to choose a drive partition and directory for installation of the **AutoCal** software. Unless there is some unusual reason, choose a drive letter and accept the default directory \AutoCal\.

The software will be installed.

**Note:** *The calibration standards internal to each **AutoCal** module have been characterized by the factory and this characterization is recorded in the software disk unique to each particular **AutoCal** module. Each **AutoCal** module must be used with its corresponding characterization file.*

## Software Operation

### Software Interface

The **AutoCal** software follows the standard Windows interface conventions. As with other Windows-based applications, **dialog boxes** are used to display available choices or alternatives and for the user to indicate choices or to enter data. If you are not familiar with the Windows interface conventions, study of the Windows documentation will be helpful. A brief review will be given below.

The typical Windows dialog box has a **title bar**, which displays the name or subject of the dialog box. Where appropriate, there may be a brief instruction or explanation in the space below the title bar.

**List boxes** are used to display lists of choices, usually data sets or alternative actions. If there are too many choices to fit in the list box, **slide bars** are provided at the borders of the list box to permit viewing of all items in the list. Where appropriate, a list box may be presented as the name of a single item (the currently active item) with a **down-arrow** in a little box at the right (a **combo** box). Selection of the down-arrow brings the entire list into view. Click on an item in the list to select it.

**Option buttons** are used to choose between mutually exclusive options. Option buttons appear as a round selection area labeled with the name of the associated option. The selected option has a large black dot in the selection area. To change to another option, click on the corresponding selection area.

The dialog window may contain a **display box**, which shows the current values of variables or settings with descriptive labels.

Finally, a dialog window will contain one or more labeled **command buttons**. Clicking a command button will choose and execute the

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## ***Chapter 2 Operation***

command as labeled. Nearly always, there will be a command button labeled **HELP**, which gives access to the **HELP** text (see below). Often, a dialog window will be used only to transmit information to the user. The command button labeled **OK** serves to close the dialog window.

A command button labeled **CANCEL** is always provided to allow a return to the previous status without taking an action.

### **Starting AutoCal**

The **AutoCal** software is started by executing the program **auto\_cal.exe** in the directory where the software is installed (as chosen on page 2-3). Alternatively, the software can be started by clicking the **AutoCal** icon in the Program Manager (if one has been created).

If there is no **AutoCal** Program Manager icon, click **File** in the Program Manager or File Manager, choose **Run**, and type:

disk partition:\AutoCal directory\auto\_cal  
Press **OK**.

For example: e:\autocal\auto\_cal                      [OK]

The **AutoCal** program will appear and will display the **Characterization Files** dialog window.

### **Using AutoCal HELP**

Most of the information necessary to use the **AutoCal** software is contained in the extensive associated **HELP** files.

All **AutoCal** dialog windows contain a command button labeled **HELP**. Clicking **HELP** brings up descriptive material appropriate to that dialog box. Frequently, terms and references used in any **HELP** screen are displayed in light green with an underline. When the cursor

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is moved over a light green area, the cursor turns into a pointing hand. Clicking the cursor brings up a screen with additional material. The user can then continue to bring up related material in the same manner, or can use command buttons to return to the main **HELP** menu or to return to the main **AutoCal** program.

Note that the command button labeled **HISTORY** gives convenient access to a list of previously chosen items. Clicking on an item name in **HISTORY** gives immediate access to that item without returning to the original context.

### **Characterization Files**

The **AutoCal** program begins by displaying the **Characterization Files** dialog window. **AutoCal** looks for all files in the current directory with the extension “**.acd**” and displays them in a list box in the **Characterization Files** dialog window. One characterization file must be chosen to correspond to the specific **AutoCal** module to be used.

The unique Module ID number for the currently selected file will be displayed, together with the maximum and minimum frequency that can be used in the calibration.

To accept the configuration displayed and to proceed with the calibration procedure, click Command Button **ACCEPT**.

If you wish to allow files from other directories or files with extensions *other* than “**.acd**” to be included in the list, click Command Button **BROWSE** to bring up the standard Windows Open File dialog box.

Click **HELP** to access detailed instructions and explanations.

Click **CANCEL** to return without taking an action.

## **Setup Dialog**

The **Setup** dialog box follows **Characterization**.

Setup allows choice of the calibration to be performed. The five possible test configurations are presented in a pull-down window, with the current selection highlighted. Parameters which do not apply to the selected configuration are shown in gray and do not respond to selection.

Note that you are required to choose the connection port configuration. A valid calibration may be performed with either VNA port connected to either **AutoCal** port. Terminals **LEFT** and **RIGHT** on the **AutoCal** module may be connected to **P2** and **P1** on the VNA, though the usual connection is to **P1** and **P2**, respectively.

Similarly, you are required to choose the type of Thru connection to be used, either the internal Thru built into the **Calibrator** or a manually connected True Thru.

If appropriate, you will be offered a choice for an **Isolation Averaging** calibration. If you choose to enable this test, you may take the default value or choose an averaging factor from the list.

Click the command button **CALIBRATE** to proceed with the automatic calibration.

The associated **HELP** shows a complete description of the Setup requirements and related topics.

## **Automatic Calibration Procedure**

After completion of the **setup** procedure (above), the VNA begins the automatic calibration run, measuring the standards and pulling the data over the GPIB interface. The user does not need to intervene.

When the entire calibration is complete, including all exchanges of standards required by the test, the PC controller will display **CALIBRATION COMPLETE**. The button on the VNA labeled **APPLY CAL** will be illuminated.

The user must press the **SAVE/RECALL** button on the VNA to save the results of the calibration.

The calibration data set should be named for reference. The name can be entered by means of the rotary knob on the VNA panel or by means of an accessory keyboard (37000 only).

For use and application of the calibration data, see the Operation Manual for the appropriate VNA.

## **Manual Control**

Full manual control of the **AutoCal** module is provided by choosing **MANUAL** from the dialog options. Under **MANUAL** control, the user has the option of connecting any of the calibration standards to the VNA ports. This is useful for manually checking the calibration.

## Pin Depth Specifications

The depth of the center pin on connectors is a critical specification, which if not met can cause damage to mating connectors. Table 2-1 provides pin-depth specifications for associated **AutoCal** connectors.

**Table 2-1.** *Pin Depth Specifications*

Device	Connector	Pin Depth (inches)
3658XXX	K-Female	+0.0000 to -0.005
3658XXX	K-Male	+0.0000 to -0.005
3658XXX	N-Female	[0.207] (+0.000, -0.005)*
3658XXX	K-Female	[0.207] (+0.000, -0.005)*
32K50 32KF50	K-Male (cable side)	Negative Indication
	K-Female	+0.0000 to -0.0005
	K-Male (DUT side)	+0.0000 to -0.0005
32L50 32LF50	K-Male (cable side)	Negative Indication
	3.5mm-Female (DUT side)	+0.006 to -0.008
	3.5mm-Male (DUT side)	+0.006 to -0.008
32S50 32SF50	K-Male (cable side)	Negative Indication
	SMA-Female (DUT side)	+0.0005 to -0.0015
	SMA-Male (DUT side)	+0.0005 to -0.0015

\*Gauging Type N Connectors: The actual value of a Type N master gauge block will always vary to some degree from the desired nominal value. The recorded measured value of the master gauge must be observed when calibrating the Pin Depth Gauge to the desired nominal value. Although the **AutoCal** Module Pin Depths are not critical, this information may be helpful in the measurement of Type N mating components. Examples are shown on the following page.

## ***Chapter 2 Operation***

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### **Pin Depth Examples**

#### ***Example 1:***

##### **FEMALE MASTER GAUGE BLOCK (protrusion)**

Desired nominal value: 0.2070

**Case 1** Actual value of master gauge: 0.2071  
Protrusion is 0.0001 more than desired.  
The gauge should be set to indicate +0.0001.

**Case 2** Actual value of master gauge: 0.2069  
Protrusion is 0.0001 less than desired  
The gauge should be set to indicate -0.0001.

#### ***Example 2:***

##### **MALE MASTER GAUGE BLOCK (cavity)**

Desired nominal value: 0.2070

**Case 1** Actual value of master gauge: 0.2071  
The cavity is 0.0001 deeper than desired.  
The gauge should be set to indicate -0.0001.



## NOTES





**Anritsu**