

# Edmunds Gages

## ADAMM Manual Ver 2.0



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# EDMUNDS ADAMM READOUT

Version 2.0

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# **1 GENERAL DESCRIPTION**

## **Shop Floor Construction**

Housed in a compact aluminum enclosure, ADAMM uses no rotating drives or media to operate or store data, so it is perfect for the shop floor. The commercial 15 inch flat panel display can be used mounted aboard the main enclosure or remotely mounted using the monitor's standard VESA mount, making it a more compact and, therefore, more versatile system.

## **Programmable, User-Friendly Software**

Menu-driven, user-friendly software lets you easily program ADAMM to measure several dimensions simultaneously on a variety of part applications - for manual sorting and classification. ADAMM's 65,000-part buffer provides continuous SPC monitoring. And ADAMM can accommodate up to 8 electronic or air/electric inputs. ADAMM software is completely tamper-proof and password protected.

## **Menus Let You Accumulate, Display and Analyze Part Data**

ADAMM lets you call up a full complement of menus to put you in command of SPC data or gaging variables in a variety of formats and outputs. A simple 16-position keypad that corresponds to menu-driven displays provides on-screen prompts to walk operators through tasks to be performed. ADAMM requires no extensive training to operate.

## **STANDARD ADAMM FEATURES**

### **Standard Hardware Features:**

- ✓ Real-time battery-backed clock
- ✓ 15-inch flat panel display
- ✓ Four RS 232-C ports
- ✓ One Ethernet port
- ✓ One LPT1 parallel printer port
- ✓ Two USB Ports (For memory Stick use only)
- ✓ 16-position keypad/pushbutton for entering operating parameters

### **Standard Software Features:**

- ✓ Inch or millimeter units of measurement
- ✓ Actual size or deviation from nominal readout
- ✓ Part classification from 2 to 10 classes
- ✓ Programmable internal system alarm display
- ✓ 8 Gage Capability
- ✓ 65,000 part memory buffer
- ✓ SPC charts, including statistical data, histogram,  $\bar{x}$  & R, and scatter charts.
- ✓ Selectable time frame window for analyzing data stored in part reading buffer.
- ✓ Long term histogram and statistical charts
- ✓ Part Counters display
- ✓ Process stability tests
- ✓ Annotation logging
- ✓ Password protected set-up
- ✓ Automatic Mastering
- ✓ R&R study
- ✓ Event log
- ✓ Static or dynamic gaging
- ✓ Real-time software
- ✓ Remote Copy capability for setup and data storage



ADAMM



8 CHANNEL SIGNAL CONDITIONING



I/O



KEYPAD/PUSHBUTTON PACK

## 2 GLOSSARY

### **A/D**

A term that refers to the Analog to Digital signal conversion process. Analog voltages are received by the system, converted to digital numbers, then stored or analyzed by the computer.

### **ANNOTATION**

The ability to assign an explanatory note to a measured part stored in the ADAMM Part Buffer.

### **AT (Available Tolerance)**

The distance between the mean of a process and the nearest end of the specification or between the mean and the specified limit of a zero based tolerance.

### **BALANCING**

A procedure for adjusting the software Mag for 1 to 7 transducers.

### **CHANNEL**

Transducer Input.

### **CHECK**

A feature, characteristic, or location on a part being measured.

### **CHARACTERISTIC**

A check, feature, or location on a part being measured.

### **C<sub>p</sub> (Process Capability)**

The ratio of the total tolerance to six standard deviations. C<sub>p</sub> may range in value from 0 to infinity, with a larger value indicating a more capable process. A value near 1.33 is normally considered acceptable.

### **C<sub>pk</sub> (Capability Index)**

The ratio of the available tolerance (AT) to three standard deviations. An Index combining C<sub>p</sub> and K to indicate whether the process will produce units within the tolerance limits. C<sub>pk</sub> has a value equal to C<sub>p</sub> if the process is centered on the mean specification; if C<sub>pk</sub> is negative, the process mean is outside the specification limits; if the C<sub>pk</sub> is between 0 and 1 then some of the 6  $\sigma$  spread falls outside the tolerance limits. If C<sub>pk</sub> is larger than 1, the 6  $\sigma$  spread is completely within the tolerance limits.

### **CR (Capability Ratio)**

The ratio of variability to tolerance.

### **HISTOGRAM**

A bar graph that displays the frequency of occurrence of values within a group of observations.

**INPUT**

A device that provides a usable output in response to a specified measurement.

**K**

Comparison of mean to midpoint and how the data is centered in the specification limits.

**KEYPAD**

The tactile device that permits the inputting of data or commands into the ADAMM.

**LCL** (Lower Control Limit)

The lower limit for means or ranges on a control chart.

**MAG** (Magnification)

Electrical or software gain adjustment applied to transducer inputs for calibration.

**MASTER**

A calibrated standard reproducing the part features.

**MENU**

A screen display from which programs or functions may be selected. Menus are used whenever you have to choose from a limited set of responses.

**MULTIPLIER**

The numerical value applied to an input in a gaging formula.

**NOMINAL DIMENSION**

The desired mean value for the particular dimension for a product whose size is of concern.

**OFFSET** - Electrical (Voltage) or Software (Numeric)

The valued adjustment that gets applied to transducer inputs for calibration.

**PARALLEL**

The transmission mode that sends a number of bits simultaneously over separate lines.

**PARAMETER**

A variable term in a function that determines the specific form of the function, but not its general nature.

**POLARITY**

The signed (+ or -) value of the input's magnification that determines the direction of change in an input's reading.

**PROTOCOL**

A formal set of conventions governing the formatting and relative timing of message exchange between two communicating devices.

**R (Range)**

The difference between the largest and smallest values observed in a sample or subgroup.

 **$\bar{R}$  (Average Range)**

The average of all the ranges (R) from the samples or subgroups.

**REAL TIME**

Data acted upon immediately instead of being accumulated and processed at a later time.

**REPEATABILITY**

Measurement variation of a gage or test equipment when used by one operator or under one set of environmental conditions.

**REPRODUCIBILITY**

The variation in measurement averages when more than one operator or environmental variable is imposed on a given gage or piece of test equipment.

**RESOLUTION**

The smallest significant number that a measurement is displayed.

**R&R STUDY**

Repeatability & Reproducibility Study

**SERIAL**

A transmission mode where information bits are sent sequentially on a single data channel.

**SPC**

Statistical Process Control.

**STANDARD DEVIATION**

A measure of the spread of individuals about the mean, taken from a sample.

**START GAGE**

A signal to the ADAMM to initiate a measurement cycle.

**TRANSDUCER**

A device which provides a usable output in response to a specified measurement.

**UCL**

The upper limit for means or ranges on a control chart.

**VARIABLE**

A quantity or function that may assume any given value or set of values.

**X**

The mean of a subgroup or sample.

 **$\bar{X}$**  (x bar)

The mean of all of the subgroups.

**ZERO**

The Electrical (Voltage) or Software (Numeric) adjustment that gets applied to transducer inputs` for calibration.

## 3 CONVENTIONS

### KEYPAD

- [INDEX]** Performs 2 functions:
- 1) Aborts the current keypad entry procedure.
  - 2) Returns to the previous menu level.
- [ENTER]** Signifies the end of the keypad entry procedure. It is also used to clear the alarm window that can be displayed on all menus.
- [YES]** Check Change Key:  
Updates any Check dependent screen with the next Checks data.
- [SHIFT][C]** Check Selection Key:  
Activates a check selection window in any Check dependent screen.
- [SHIFT][PRINT]** Initiates a Screen Dump to a Printer.
- [SHIFT][E]** Performs 2 distinct functions depending on the menu it is initiated from:
- 1) Gage Readings:  
Deletes the last part gaged data (for the Displayed Gage) from the SPC Data Base.
  - 2) Gage R&R Study:  
Allows a selected R&R Sample to be re-gaged.

## **MENU**

### **LINE 1 (GRAY):**

- 1) Menu Name
- 2a) Gage Name - Gage dependent displays
- 2b) Check Name - Check dependent displays
- 3) Units of Measure - Numeric displays

### **LINE 23:**

- 1) Right Justified Main Menu with Sub-menus level indicator (number).
- 2) The text is always displayed in yellow.

### **LINE 24 (RED):**

- 1) Prompt Line

### **LINE 25 (BLACK):**

- 1) Alarm Line

## External Keyboard

An external keyboard emulates the keys available on the Edmund keypad. The table below shows a cross-reference of PC keyboard keys to Edmunds keypad keys.

PC Keyboard	Edmunds Keypad		PC Keyboard	Edmunds Keypad
1	1		N or n	NO
2	2		Y or y	YES
3	3		S or s	SHIFT
4	4		Back Space	ERASE
5	5		Enter	ENTER
6	6		Esc	INDEX
7	7		Print Screen Sys Rq	PRINT
8	8		-	-
9	9		+	+
0	0		.	.

When editing text on the ADAMM, such as check names, the alphabetic keys can be used to speed up data entry. Pressing the 'k' key puts the ADAMM in keyboard entry mode, and allows text to be typed in directly. All alphabetic characters must be entered in lower case, so make sure the CAPS LOCK feature is off. For example, the check name DIAMETER would be typed in as diameter, instead of selecting each character from the character list. To exit keyboard mode, press the '=' key.

#### 4. EDMUNDS GAGES ADAMM MENU DIAGRAM

- |                             |   |
|-----------------------------|---|
| <b>1 SYSTEM DESCRIPTION</b> | 1. SYSTEM SETUP SUMMARY<br>2. GAGE SETUP SUMMARY<br>3. CHECK SETUP SUMMARY<br>4. SYSTEM FEATURES SUMMARY  |
| <b>2 GAGE MASTERING</b>     | 1. MASTER THE GAGE<br>2. MASTERING RESULTS<br>3. MASTER SIZES   |
| <b>3 LIMITS</b>             | 1. NOMINAL SIZES<br>2. PART TOLERANCES<br>3. REASONABLE LIMITS<br>4. SORT CLASSES   |
| <b>4 SPC SETUP</b>          | 1. ENABLE DATA ACCUMULATION-----<br>2. DEFINE $\bar{x}$ & R CHART PARAMETERS<br>3. ENABLE SPC ALARMS  |
| <b>5 DATA RESET</b>         | 1. PART COUNTERS<br>2. GAGE DATA FILES & CHARTS<br>3. LONG TERM SPC CHARTS  |
| <b>6 INPUT SETUP</b>        | 1. DISPLAY ALL INPUTS<br>2. DISPLAY PART DIMENSIONS<br>3. DISPLAY INPUT BARGRAPH<br>4. BALANCE INPUTS-----<br>5. MONITOR A CHECK<br>6. GAGE CYCLE HISTORY<br>7. CHECK SETUP DISPLAY |
| <b>7 GAGE READINGS</b>      | 1. DIGITAL READINGS DISPLAY<br>2. BARGRAPH DISPLAY<br>3. GAGE DATA FILE<br>4. GRAPHICAL PART DISPLAY  |
| <b>8 COUNTERS</b>           | 1. PART COUNTERS  |
| <b>9 SPC CHARTS</b>         | 1. HISTOGRAMS<br>2. STATISTICS<br>3. $\bar{x}$ & R CHARTS<br>4. SCATTER CHARTS<br>5. GAGE DATA FILES<br>6. HISTOGRAMS (LONG TERM)<br>7. STATISTICS (LONG TERM)                      |
| <b>10 SYSTEM ALARMS</b>     | 1. DISPLAY ALARMS   |
| <b>11 CLOCK MENU</b>        | 1. SHOW TIMES   |

## 12 UTILITIES

1. SYSTEM CONFIGURATION-----
  1. DEFINE ACCESS PASSWORDS
  2. UNITS OF MEASUREMENT
  3. NUMBER OF GAGES
  4. SINGLE GAGE MONITORING
  5. GAGE RECOGNITION MODE
  6. ALLOCATE DATA FILE MEMORY
  7. WORK SHIFT START TIMES
  
2. GAGE SETUP-----
  1. GAGE NAMES
  2. GAGE TYPE/TIMER
  3. GAGE RESOLUTION
  4. NUMBER OF PART CHECKS
  5. GAGE ENABLE/DISABLE
  6. GAGE CYCLE SETUP
  7. DATA OFFLOAD
  
3. PART CHECK SETUP-----
  1. CHECK NAMES
  2. CHECK FUNCTIONS
  3. CHECK FORMULAS
  4. MULTIPLE CHECKS
  5. INPUT CHANNEL MAG & POLARITY
  6. CHECK ENABLE/DISABLE
  7. CHECK RESOLUTION SETUP
  
4. GAGE R&R STUDY-----
  1. GAGE R&R STUDY
  2. # TRIALS & SAMPLES
  3. RESET R&R STUDY DATA
  4. START/STOP STUDY
  5. UCLr TEST
  6. PRINT R&R STUDY
  7. WRITE R&R TO FILE
  
5. ALARM SETUP-----
  1. ENABLE ALARMS
  
6. SYSTEM HARDWARE UTILITIES---
  1. SET SYSTEM CLOCK
  2. CRT SAVER
  3. SERIAL COMMUNICATIONS---
    1. COMMUNICATION SETUP
    2. DIAGNOSTICS
    3. TEST SERIAL PORTS
  4. ANALOG CONFIGURATION
  5. NETWORK SETUP-----
    1. IP ADDRESS SETUP
    2. NETWORK NAMES
    3. NETWORK PRINTER
    4. NETWORK PART DATA STORAGE
  6. SELECT SYSTEM PRINTER---
    1. SYSTEM PRINTER TYPE
    2. TEST PRINTER PORT
  
7. ADAMM FILE UTILITIES-----
  1. ADAMM SETUP FILE UTILITY
  2. REMOTE COPY UTILITY
  3. PART GRAPHICS FILE UTILITY
  
8. HIDDEN MENUS-----
  1. INITIALIZE SETUP DATA
  2. SOFTWARE CONVERSION
  3. MASTERING LIMITS
  4. SET AD SAMPLING
  5. SET WATCHDOG TIMER
  6. INSTALL OPERATING SOFTWARE
  7. DIAGNOSTIC DATA

# 5 MENU DESCRIPTIONS

## 1 SYSTEM DESCRIPTION

ADAMM summary setup screens are accessed through this menu.

The summary screens, 1.1, 1.2, and 1.3, are for display only, no ADAMM setup information can be changed on these screen. If the operator needs to change setup information that is displayed on the summary screens then the operator can jump to the desired menu by entering the complete menu number and pressing **[Enter]**.

For Example:

If the formula for a check being displayed on menu 1.3, Check Summary, needs to be changed the operator can enter "12.3.3" and jump to the check formula screen for that check to make the desired changes.

### 1.1 SYSTEM SETUP SUMMARY

Single screen display that shows the following setup information:

Menu 12.1.3	Gage Recognition Mode
Menu 12.6.4	Analog Configuration
Menu 12.6.5.1	IP Address
Menu 12.6.5.2	Network User Name
	Network Workgroup Name
	Network Domain Name
	Network Logon To Domain
Menu 12.6.5.3	Network Print Server
	Network Printer
Menu 12.6.6	System Printer Type
Menu 12.8.6	Watchdog Timer

### 1.2 GAGE SETUP SUMMARY

Single screen display for each Gage that displays the following gage dependent setup information:

Menu 3.4	Classify
Menu 4.1	Data Accumulation
Menu 12.1.4	GDF Allocation
Menu 12.2.2	Type/Timer
Menu 12.2.3	Resolution
Menu 12.2.4	Number of Checks

### 1.3 CHECK SETUP SUMMARY

Single screen display for each Check. The following screens depict the information displayed for 2 different check functions; Average and Multiple Check.

Check Setup Summary:		GAGE #1		CHECK#01		CHECK 01		UNITS: in	
Menu #									
2.3	Max Master	0	No.	0	Min Master	0	No.	0	
3.1	Nominal	0							
3.2	Limits:	USL	0	REJ	LSL	0	REJ		
3.3		URL	0		LRL	0			
12.2.5	Cycle:	Queue 20	Filter	5	Min Reads	40	Min Samples	+0.00000	
12.3.2	Function	AVERAGE							
12.3.6	Status	ENABLED							
12.3.7	Display Resolution	0.00001							
12.3.3	Formula:	A1 x +1.00000	+ A2 x +1.00000	+ A3 x +1.00000					
		+ A4 x +1.00000	+ B1 x +1.00000	+ B2 x +1.00000					
		+ B3 x +1.00000	+ B4 x +1.00000						
12.3.5	Input	Mag/Pol	Offset	(+)Limit	(-)Limit	Bal Mag (6.4.3)			
	A1	+1.00000	-0.00090	+0.02045	-0.02045	+1.00000			
	A2	+1.00000	+0.00042	+0.02045	-0.02045	+1.00000			
	A3	+1.00000	+0.00000	+0.02045	-0.02045	+1.00000			
	A4	+1.00000	+0.00000	+0.02045	-0.02045	+1.00000			
	B1	+1.00000	+0.00000	+0.02045	-0.02045	+1.00000			
	B2	+1.00000	+0.00000	+0.02045	-0.02045	+1.00000			
	B3	+1.00000	+0.00000	+0.02045	-0.02045	+1.00000			
	B4	+1.00000	+0.00000	+0.02045	-0.02045	+1.00000			
Enter Menu Number or [INDEX] Key to Exit: [YES]/[C] for Next Check									

Check Setup Summary:		GAGE #1		CHECK#03		CHECK 03		UNITS: in	
Menu #									
2.3	Max Master	0	No.	0	Min Master	0	No.	0	
3.1	Nominal	0							
3.2	Limits:	USL	0	REJ	LSL	0	REJ		
3.3		URL	0		LRL	0			
12.2.5	Cycle:	Queue 20	Filter	5	Min Reads	40	Min Samples	+0.00000	
12.3.2	Function	AVERAGE							
12.3.6	Status	ENABLED							
12.3.7	Display Resolution	0.00001							
12.3.3	Formula:	A3 x +1.00000							
12.3.5	Input	Mag/Pol	Offset	(+)Limit	(-)Limit	Bal Mag (6.4.3)			
	A3	+1.00000	+0.00000	+0.02045	-0.02045	+1.00000			
Enter Menu Number or [INDEX] Key to Exit: [YES]/[C] for Next Check									

#### 1.4 SYSTEM FEATURES SUMMARY

ADAMM's software serial number, version number and release date are displayed on this screen.

## 2 GAGE MASTERING

The analog signal from the gage inputs is an uncalibrated signal. ADAMM's software scales this signal to convert the voltage to an actual dimension, and then applies the necessary corrections. The correction process allows for compensation for both input positioning and the calibration of the electronics. This process is accomplished by invoking Gage Mastering on ADAMM.

### 2.1 MASTER THE GAGE

The "*MASTER THE GAGE*" sub-menu initiates the calibration procedure in order to calculate a gain multiplier "*MAG*" and an offset "*ZERO*" for each part characteristic. This is accomplished by taking readings of a Max Master and a Min Master of known dimensions. These known dimensions are then used to compute a calibration line, which ties voltage to dimension.

Example:      Kmax : Max master of known size  
                  Kmin : Min master of known size  
                  Gmax : Gaged Max master  
                  Gmin : Gaged Min master

$$\mathbf{MAG} = \frac{K_{\max} - K_{\min}}{G_{\max} - G_{\min}}$$

$$\mathbf{ZERO} = K_{\max} - [MAG \times G_{\max}]$$

$$\text{Corrected Reading} = (\text{Raw Reading} * \text{MAG}) + \text{ZERO}$$

If a part characteristic consists of more than one Input, then the Mag and Zero values for that characteristic will reflect the Inputs in combination.

The Mastering procedure will fail if any of the following conditions occurs:

- 1) MAG ADJUSTMENT TOO LARGE
- 2) ZERO ADJUSTMENT TOO LARGE
- 3) SATURATED READING
- 4) MIN MASTER > MAX MASTER
- 5) MIN MASTER = MAX MASTER
- 6) INSUFFICIENT USABLE READINGS

If a Mastering procedure was unsuccessful the calibration values obtained from the last successful mastering session will be used.

### 2.2 MASTERING RESULTS

A multi-page report listing the latest mastering results. Page 1 displays the keypad entered master sizes along with its associated gaged measurement readings taken during the Mastering Sequence. The remaining pages display the calculated Mag and Zero that will be applied to each check in order to calibrate the readings. An error window will be displayed if any of the Checks were not mastered successfully.

## **2.3 MASTER SIZES**

Before the gage can be Mastered, the actual size of the masters being used need to be entered into ADAMM. The operator can enter the (known) calibrated dimensions of each Master, and define the sequence that each dimension will be calibrated. "MASTER NO." is a means for ADAMM to associate the entered size with the appropriate Master, up to 8 masters may be programmed.

The Master Sizes may be entered as actual part sizes, or as deviations from nominal. See 3.1 "Nominal Sizes" for an explanation.

## **3 LIMITS**

Part Tolerances and Reasonable Limits are used to determine the overall status of a part and the subsequent message that is sent to the machine control. The overall status of a part is either "Accept", "Rework" or "Reject". The status of an individual check can be good, under, over, over reasonable limit, under reasonable limit, or saturated. If all of the gaged dimensions are within their respective tolerance limits (a limit is violated when the gaged value EXCEEDS the pre-defined limit value), then the part is considered acceptable, otherwise it is classified reject or rework.

A Reasonable Limit is used to determine the maximum and minimum size a gaged dimension can be before it is considered an "extreme error". If a reading exceeds a reasonable limit, then it is not included in the SPC charts, and the part status will be "REJECT" (It is included in the counters and Part Buffer sections). This limit protects ADAMM from using "invalid" data in the statistical calculations.

Each "ACCEPT" gaged part can also be broken down into different classifications. See 3.4 "Sort Classes" for an explanation.

### **3.1 NOMINAL SIZES**

The Nominal Sizes are operator entered values that represent the mean size of the part. If the displayed results are to be expressed as a deviation from nominal, then these values should be set to zero. If the displayed results are to be expressed as an actual size, then the nominal should be programmed as the mean size. All programmable sizes in ADAMM must be defined in an equivalent manner to that of the displayed results (absolute or deviation).

### **3.2 PART TOLERANCES**

The Part Tolerances are operator-entered values that specify the Upper and Lower Tolerance Limit for each of the predefined Part Checks. The Part tolerances determine the status of a measured part. If all of the measured Part Checks are within their respective Tolerance Limits, then the part will be classified as "Accept". Each Limit has a selectable Reject Class associated with it. If a Part Check measurement exceeds a Tolerance Limit then the part can be classified as either a Reject or a Rework depending on the preprogrammed reject class.

### 3.3 REASONABLE LIMITS

The Reasonable Limits are operator entered values for each of the defined part Checks. The Reasonable Limits are used to protect the data accumulation feature of ADAMM from accepting invalid data. If a measurement for a part check exceeds its Upper or Lower Reasonable Limit, then the data for all of the measured part checks on that part will not be included in the accumulated data. The part will be classified as a "Reject". To disable this function, set the reasonable limits to "0".

### 3.4 SORT CLASSES

Sort Classes gives ADAMM the ability to classify a part as a numeric number (1-10). There are 5 Major parameters that need to be programmed:

- 1) **Classifying Dimension** - Defines the Part Check is to be used for classifying the part. Only One part Check can be used.
- 2) **# Sort Classes** - Defines the number of numeric classes that the part will be categorized into for the classifying dimension.
- 3) **Classifying Dim. MAG** - Classifying Dimension is multiplied by this value to determine part class. The default value is +1.000
- 4) **Classifying Dim. Zero** - This value will be added to the Classifying Dimension to determine the part class. The default value is +0.0000
- 5) **Sort Classes** - Upper and Lower Boundaries for each sort class. Note: The sort class boundaries must not overlap.

The following is a brief description of the Sort Classification Algorithm:

Class Result = Classifying Dim. x Classifying Dim. Mag + Classifying Dim. Zero

Class 1 = (Result  $\leq$  Class 1 Upper Boundary)  
and  
(Result  $\geq$  Class 1 Lower Boundary)

Class 2 = (Result  $\leq$  Class 2 Upper Boundary)  
and  
(Result  $\geq$  Class 2 Lower Boundary)

## 4 SPC SET UP

### 4.1 ENABLE DATA ACCUMULATION

There are 3 separate areas of data accumulation in ADAMM:

- 1) **Part Counters** – A running total of all parts gaged.
- 2) **Gage Data File & Charts** - Actual measurement data.
- 3) **Long Term SPC Charts** – A running total used in generating Long Term Statistics and Histograms.

Data accumulation can be enabled or disabled independently for each of the 3 areas.

### 4.2 DEFINE $\bar{x}$ & R CHART PARAMETERS

$\bar{x}$  & R Chart Parameters are operator entered values that are used in constructing the  $\bar{x}$  & R Chart. There are 3 groups of parameters that need to be defined for each Part Check:

- 1) **Subgroup Size** - Number of Consecutively Gaged Parts in the Sample (Plot).
- 2) **Sample Frequency** - Number of Consecutively Gaged Parts "skipped" between Sample plots.
- 3) **Control Limits** - (UCL<sub>x</sub>, LCL<sub>x</sub>, UCL<sub>r</sub>) - The Scale for the  $\bar{x}$  & R chart is determined by these values. As an option, the Control Limits can be calculated by ADAMM.

### 4.3 ENABLE SPC ALARMS

ADAMM can be configured to monitor alarm conditions using the  $\bar{x}$  & R data. Each new sample (plot) that is accumulated for the  $\bar{x}$  & R chart will be evaluated against all enabled SPC Alarms. If a sample violates an Enabled Alarm then ADAMM will display a message on the display. There are four types of SPC Alarms:

- 1) **Point Outside of Control Limit** - Any point (plot) falling outside of its defined Control Limits will generate this alarm.
- 2) **Upward/Downward Trend of 7 or More** - Seven consecutive points that continue to increase or decrease will generate this alarm.
- 3) **Hugging the Control Line** - Two out of three Points that lie within the outer one-third zones will generate this alarm.
- 4) **Runs Above/Below The centerline** - A predefined number of successive points on the Control Chart that fall on one side of the centerline will generate this alarm.

## 5 DATA RESET

The three separate areas of data accumulation: Part Counters, Gage Data File & Charts and Long Term SPC Charts can be reset Independently. If an operator access password is programmed in menu 12.1.1, "Define Access Passwords" then it must be entered before the operator is allowed to reset the data. The supervisor or master password will also allow the operator to reset the data.

## 6 INPUT SET UP

### 6.1 DISPLAY ALL INPUTS

Displays the individual raw inputs in Real Time. Only inputs defined in the Check Formulas will be displayed. This display is a convenient tool for positioning and adjusting inputs during setup. This menu contains a Zoom feature, which allows the displayed readings for any individual inputs to be magnified. This feature is selected by pressing the corresponding numeric key.

### 6.2 DISPLAY PART DIMENSIONS

Displays up to 16 of the defined Part Check measurements in Real Time in both Raw and Corrected form. The Part Check measurements are the result of combining the inputs defined in the check formula.

This menu also contains a Zoom feature, which allows the displayed readings for a selected check to be magnified. This feature is selected by pressing the **[1]** key.

### 6.3 DISPLAY INPUT BARGRAPH

The Input Bargraph display uses a Real Time color-coded bargraph to display input values. The input name and the actual value of the input are displayed to the left of the bargraph. A Yellow box outlining the range of acceptable values for the input is drawn around the bargraph. If the input value is within the range of acceptable values, the bargraph is displayed in Green. If the input value is outside the range of acceptable values, the bargraph is displayed in Red. Input saturation is displayed in Pink.

Pressing the **[1]** key selects the next active input. Only defined active inputs can be displayed.

Pressing the **[2]** key changes the scale for the bar graph. Each line on the bargraph can represent .001, .0001 or .00001 units. The labels to the right of the bargraph indicate the current scale selected.

Pressing the **[3]** key allows a new target, or middle value to be entered. For example, if the range of the acceptable values for a particular input is between +0.00040 and +0.00080, then the target value would be +0.00060.

Pressing the **[+]** key increases the range of acceptable values by enlarging the acceptable values window size.

Pressing the **[-]** key decreases the range of acceptable values by shrinking the acceptable values window size.

## **6.4 BALANCE INPUTS**

This menu allows an operator to balance several inputs in relation to one "reference" input. The balancing algorithm calculates a "Balancing Mag" for each of the inputs by reading the inputs concurrently and comparing the readings to the reference input reading.

### **6.4.1 SELECT INPUTS TO BALANCE**

Before performing the balancing procedure it is necessary to define the inputs to be balanced. This menu allows entry of the Reference Input and from 1 to 7 Inputs for balancing.

### **6.4.2 PERFORM BALANCING PROCEDURE**

The balancing procedure is initiated from this menu. ADAMM will display the necessary prompts in order to step the operator through the balancing procedure. ADAMM will display an error message if the balancing Mag for any of the inputs is greater than 25%.

### **6.4.3 DISPLAY BALANCING RESULTS**

The results of the balancing procedure can be viewed in this menu at any time. The balancing Mag for all Inputs are displayed as well as its Mag/Polarity as set in Menu 12.3.5 Input Channel Mag & Polarity.

## **6.5 MONITOR A CHECK**

This display contains specific information on the readings used to calculate a check. It includes information on the total number of readings taken, the number of readings passing cutout and rotation tests, and the number of saturated readings. The High and Low readings are displayed as well as the Max and Min queue entries. The results are for the last part gaged. Only one check may be monitored at a time.

## **6.6 GAGE CYCLE HISTORY**

Displays information on the last part gaged, including the total number of readings taken, the cycle type, the number of readings passing cut-out and rotation tests for each check, and if there were any saturated inputs, reasonable limits exceeded, or insufficient number of readings taken.

## **6.7 CHECK SETUP DISPLAY**

Displays a summary of information and live readings for the selected check. The information displayed includes:

**Max/Min Master Sizes and Numbers:** Displays the master information entered in menu 2.3. The information in this menu is for display only. The values can only be changed from Menu 2.3.

**Calibration Results:** Displays the results of the last successful mastering cycle including the mag, zero offset, and verification offset. The calibration results are also displayed in menu 2.2. The information in this menu is for display only. The values can only be changed by running another master cycle successfully.

**Check Formula:** Displays a list of all of the input channels used in the selected check, (A1, A2, etc) and the multiplier applied to the input. The live reading from each input and the live reading times the multiplier is also displayed. The information is for display only the check formula inputs and multipliers can be changed in menu 12.3.

**Check Results:** The raw reading is the final result of the check formula before the calibration is applied. The corrected reading is the final result of the check with the calibration applied.

Pressing the [YES] key cycles through all the checks.

## 7 GAGE READINGS

### 7.1 DIGITAL READINGS DISPLAY

This menu displays the following information:

**RESULT** - The gaged results of all of the predefined Part Checks.

**STATUS** - Individual status for all predefined Part Checks.

**PART STATUS** - The overall status of the part: Accept, Rework or Reject.

The information displayed is from the last part gaged.

**NOTE: Only those checks which are defined as "Enabled" in menu 12.3.6, "Check Enable/Disable" will be displayed in this menu.**

### 7.2 BARGRAPH DISPLAY

This menu displays a graphical representation of all Part check measurements with respect to each check's Max and Min tolerance limits. The tolerance limits are represented by two horizontal lines: one upper line corresponding to the Upper Tolerance limit, and one lower line corresponding to the Lower Tolerance limit. The check results are represented by the vertical bars and are scaled according to each check's individual tolerance limits. The overall part status is also displayed at the bottom of the screen.

**NOTE: Only those checks which are defined as "Enabled" in menu 12.3.6, "Check Enable/Disable" will be displayed in this menu.**

### 7.3 GAGE DATA FILE

The Gage Data File on ADAMM contains all of the information stored for each part gaged. There is one file for each gage programmed on ADAMM, and these files are accessible through the NetBEUI or TCP/IP network interface. The gage data file name is the same as the part setup file. Below is an example of a gage data file containing five records. The individual fields of the comma-delimited file are also described below.

**NOTE: Only those checks which are defined as "Enabled" in menu 12.3.6, "Check Enable/Disable" will be recorded in the gage data file.**

```
~FILEHEADER
02
001000
YW
IN
~GAGEFILEDATA
000001,02/20/01-09:12:34,REJ,00,0000,02, -0.000192,UN, -0.000192,UN
000002,02/20/01-09:12:48,REJ,00,0000,02, +0.000451,OV, +0.000451,OV
000003,02/20/01-09:12:50,REJ,00,0000,02, +0.000733,OV, +0.000733,OV
000004,02/20/01-09:13:09,ACP,00,0000,02, +0.000281, , +0.000281,
000005,02/20/01-09:13:13,ACP,00,0000,02, +0.000251, , +0.000251,
```

#### **Header Information**

The first section of the file contains the header information and is identified by the line ~FILEHEADER.

The next line contains the number of checks defined for the gage. In this case, there are two checks.

Next, the maximum number of parts to store in the data section is given. This example shows that a maximum of 1000 parts will be stored in the gage data file.

The next line indicates whether the gage data file will wrap around when full, and overwrite the oldest data. The letters YW indicate wrapping is enabled, while NW indicates that wrapping is disabled.

The last line in the header section contains the units of measurement used to store the check results in the data section. IN is for inches and MM is for millimeters.

## **Gage Data Records**

The next section contains the gaged part results data and is identified by the line ~GAGEFILEDATA. Each line contains results for a single part, with commas separating the individual fields, which are described below.

The first field is a 6-digit record number.

The next field is the date-time stamp. The format of the date-time stamp is MM/DD/YY-HH:MM:SS

Where MM is the month,  
DD is the day of the month,  
YY is the last two digits of the year,  
HH is the hour, in 24-hour format,  
MM is the minute,  
SS is the second

The next field is the overall part status. The possible statuses are ACP for an accept part, REJ for a reject part, and REW for a rework part.

The next field is the two-digit annotation number entered in menu 7.3. If no annotation was entered, this field will be 00.

The next field is a four-digit number reserved for future use.

The next field is a two-digit number representing the number of check results and statuses stored for the current part. Using this number will tell you how many more fields to expect. (2 per check)

The check result field is a 10-character field, containing the signed numeric checks result value. It will be padded with spaces to the left, if necessary, to maintain the 10-character width.

The check status field is a 2-character field containing the status of the check. The possible statuses are UN for under tolerance, OV for over tolerance, and two blank spaces for within tolerance.

## **Wrapping**

If the gage data file has wrapped, the oldest record will be overwritten with new data the next time a part is gaged. When this happens, the newer data will come *before* the older data in the file. Therefore, always refer to the date-time stamp to determine when the part was gaged.

When the gage data file has wrapped, deleting the last part gaged presents a new problem. Since the record cannot be removed from the file without corrupting the order of the index numbers, the date-time stamp is changed to 00/00/00-00:00:00 to show that the part was

deleted. ADAMM then knows to overwrite this record with the new data the next time a part is gaged. Any record with a date-time stamp of 00/00/00-00:00:00 should be ignored.

The screen can only display fifteen parts per page. To display the next fifteen parts, scroll through the gage data file, displaying successive pages of fifteen parts. The search function allows the user to automatically find the first or last part in the gage data file, as well as the next reject and next part with an annotation.

## **Annotation**

Annotations may be logged with each part in the gage data file. There are 32 different user definable annotations to select from. An asterisk (\*) next to the part status denotes an annotation logged for that part. Annotations are useful for identifying special points in the gage data file, such as new operator, excessive tooling wear, or a change of material.

### To manually annotate a particular record:

- 1) Use the **[1]** or **[2]** keys to display the page containing the record to be annotated.
- 2) Press **[4]** to select Annotate.
- 3) Use the **[1]** or **[2]** keys to select the desired record.
- 4) Press [enter] to select Log Annotation and display the Annotation Selection Window.
- 5) Using the keypad enter an annotation code from 00 to 31.
- 6) ADAMM will prompt "Edit Text (yes/no)". Select **[yes]** to enter a new text description for the current annotation number. Select **[no]** leave the annotation description as is and mark the record with the current annotation.

## **Deleting Records**

### Deleting the last gage Reading

The Shift **[E]** key is used to delete the last gage reading from the Part Counters, Gage Data File and SPC charts. This feature is available from the "**DIGITAL READINGS**" Menu 7.1, "**BARGRAPH MENU**" 7.2 and the "**GAGE DATA FILE**" Menu 7.3.

If there was no data accumulated during the last gage cycle or it had already been deleted, the message *"No Data Accumulated Last gage Cycle"* will be displayed. If there was data accumulated during the last gage cycle, the following messages are displayed as the data is deleted:

"Deleting Record from Part Counters", "Deleting Record from Gage Data File and Charts" and "Deleting Record from Long Term SPC".

### Deleting Selected Gage Readings

The operator may select 1 or more gage readings to delete from the gage data file by selecting option **[5]**, Delete. ADAMM will highlight the currently selected record number and a status bar near the bottom of the screen will indicate the "Flagged Status:" either "Keep Part" or "Flagged for deletion". A list of options will also be displayed at the bottom of the screen including:

[1] - Move Up - Highlights the next record up on the screen.  
[2] - Move Down - Highlights the next record down on the screen.  
[3] - Page Up - Displays the next screen of records.  
[4] - Page Down - Displays the next screen of records.  
[5] - Toggle Flag - Marks the currently highlighted record for deletion. An "X" will be displayed next to the record number and the "Flagged Status:" will change to "Flagged for Deletion." Pressing [5] again will remove the flagged status and the part will be marked "Keep Part".

[Enter] - After all the desired parts have been flagged press [enter] to actually delete the records from the gage data file. A progress window will be displayed shown percentage complete. NOTE: If the gage data file contains a large number of parts the deletion progress may take some time.

#### **7.4 GRAPHICAL PART DISPLAY**

This menu will be display the part graphic selected in Menu 12.7.3 "Part Graphics File Utility".

## **8 COUNTERS**

This menu displays part count totals for the gage since the last counter reset. The following part count totals are displayed:

**OVER COUNT** – The Number of Gaged readings that have exceeded the Upper Tolerance Limit.

**UNDER COUNT** – The Number of Gaged readings that have exceeded the Lower Tolerance Limit.

**ACCEPT PARTS** – The Total number of parts gaged with all check dimensions within their specified Tolerance Limits since the last counters reset.

**REJECT PARTS** – The Total number of parts gaged which had one or more check dimensions outside the specified tolerance limits since the last counters reset designated as “REJECT”.

**REWORK PARTS** – The Total number of parts gaged which had one or more check dimensions outside the specified tolerance limits since the last counters reset designated as “REWORK”.

**TOTAL PARTS** – The Total Number of Parts gaged since the last counter reset.

## 9 SPC CHARTS

### 9.1 HISTOGRAMS

A Histogram is a bargraph that displays the relative frequency of occurrence of values within a group of observations. A separate histogram display is generated for each part check. The Histogram is generated from the stored gaged data. Before the Histogram can be drawn a time frame for analysis must be entered. This allows the gaged data stored in ADAMM to be analyzed independently per shift, day, week or month.

There are 5 floating vertical lines displayed on the Histogram:

- 1)  $\bar{x}$  - Mean of the Sample
- 2) USL - Upper Specification Limit
- 3) LSL - Lower Specification Limit
- 4)  $\bar{x} + 3\sigma$
- 5)  $\bar{x} - 3\sigma$

The Histogram also displays additional count information:

- 1) **# SAMPLES** – The Total number of Samples
- 2) **# W/IN SPEC** – The Total number of Samples within Tolerance
- 3) **# ABOVE USL**- The Total number of Samples above Upper Specification Limit.
- 4) **# BELOW LSL**- The Total number of Samples below Lower Specification Limit.

All bars displayed above the USL will be displayed in Red, all bars displayed below the LSL will be displayed in Yellow and bars within the LSL and the USL will be displayed in Green.

### 9.2 STATISTICS

The Statistics Menu displays the results of the statistical data on parts that have been gaged. A separate statistical display is generated for each part check. Statistics are calculated from the stored gage data file. Before the Statistics can be calculated, a time frame for analysis must be entered. This allows the gaged data stored in ADAMM™ to be analyzed independently per shift, day, week or month. The following statistical data is displayed:

- High Sample
- Low Sample
- Range
- Mean
- STD. DEV. ( $\sigma$ )
- Mean + 3  $\sigma$
- Mean - 3  $\sigma$
- Process Capability (Pp)
- Capability Index (Ppk)
- Capability Ratio (Pr)
- Counters: # samples
  - # within Spec.
  - # Above USL.
  - # Below LSL.

### **9.3 $\bar{x}$ & R CHART**

The  $\bar{x}$  & R Chart is generated from the stored gaged data. The maximum number of plots on the chart is a function of the defined sample size and frequency. See Menu 4.0 "SPC SETUP" for setup of plots sizes and frequency.

The  $\bar{x}$  chart is a control chart where the average of the sub-group is the statistical measure that is being calculated and plotted. The R chart is a control chart where the range of a sub-group is the statistical measure that is being calculated and plotted.

Example:

Number of Parts Gaged = 100

Subgroup Size = 5

Sample frequency = 50

Total Plots = 2

Plot #1 = 1,2,3,4,5

Plot #2 = 56,57,58,59,60

Trend alarms can be monitored in this display.

### **9.4 SCATTER CHART**

The Scatter Chart generates a plot of two variables, one against the other to display trends. The two variables (Part Checks) are entered in this menu along with the Data Time Frame.

The Scatter Chart is generated from the stored gage data file. Before the Scatter Chart can be drawn a time frame for analysis must be entered. The two variables (Part Checks) must also be entered.

### **9.5 GAGE DATA FILE**

ADAMM has the capability to store up to 65,000 part readings. Additional information is stored with each individual part:

1. Time and Date Stamp
2. Individual Check Status
3. Part Status
4. Check Result
5. Annotation

### **9.6 HISTOGRAMS (Long Term)**

The Long Term Histograms is similar to the 9.1 Histograms except for the ability to define a time frame for analysis.

### **9.7 STATISTICS (Long Term)**

The Long Term Statistics is similar to the 9.2 Statistics except for the ability to define a time frame for analysis.

## **10 SYSTEM ALARMS**

### **10.1 DISPLAY ALARMS**

One to sixteen ADAMM alarms will be displayed with a Date/Time Stamp of when it occurred. The alarms can be enabled or disabled from menu 12.5.1 "**ENABLE ADAMM ALARMS**".

## **11 CLOCK MENU**

The Clock Menu displays ADAMM's event log for each active gage. The current Date and Time are also displayed real time. The Event Log displays the time, date and shift that the event last occurred. The following events are logged in this menu:

- 1) MASTERED
- 2) SETUP ITEM CHANGED
- 3) MASTER SIZES CHANGED
- 4) SPEC. LIMIT CHANGED
- 5) COUNTERS RESET
- 6) GAGE DATA FILE RESET
- 7) LONG TERM SPC RESET
- 8) R & R STUDY PERFORMED
- 9) LAST ADAMM ALARM

## 12 UTILITIES

### 12.1 SYSTEM CONFIGURATION

#### 12.1.1 DEFINE ACCESS PASSWORDS

Data security for ADAMM is enforced by a double password system. The double password system consists of an Operator Access password and a Supervisor Access password.

The Master Password is needed in order to define the Operator or Supervisor password. The operator and supervisor passwords can be defined as any combination of alphanumeric digits from 1 to 4 characters in length. It is possible to disable either of the passwords by defining the password to be the **[YES]** key.

The supervisor access password needs to be entered before any keypad programmable setup parameter, such as the check limits, can be altered.

The operator access password needs to be entered before ADAMM will allow the SPC data to be reset in menu 5.0.

#### 12.1.2 UNITS OF MEASUREMENT

Two units of measure are available for displaying numeric values: inches or millimeters. Operator programmable values will automatically convert to reflect the selected unit of measure.

#### 12.1.3 NUMBER OF GAGES

ADAMM can be configured to simultaneously control 1 to 8 unique gages.

#### 12.1.4 SINGLE GAGE MONITORING

All Gage dependent menus can be configured to default to a single Gage. This eliminates the need to answer the "Select A Gage" prompt that is common to all Gage Dependent menus.

#### 12.1.5 GAGE RECOGNITION MODE

This menu controls how ADAMM selects which gage to measure when a start gage interrupt is received. There are five options available:

- 1) **Default** – When this mode is selected ADAMM will measure whatever gage is selected in the "Single Gage Monitoring" menu 12.1.4 if single gage monitoring is enabled. If Single Gage Monitoring is disabled, ADAMM will measure the first gage that is enabled. See "Gage Enable/Disable" menu 12.2.5.
- 2) **Manual** – When this mode is selected ADAMM will display a pop up window prompting the operator to select which gage measure. Use the keyboard to select the gage number to be gaged.
- 3) **Automatic** - When this mode is selected ADAMM will select the first enabled gage in which all of the checks are reading on scale. For example, consider when ADAMM has three gages programmed and enabled for three different air plugs. If one of the air plugs is place in a part to be gaged and the other two are left venting only the gage corresponding that is in the part will be measured.

- 4) **Default Auto Check** – When this mode is selected ADAMM will select the gage to measure in the same manner as in the “Default” option above. However, only checks in which all the input associated with the check are **not** saturated will be stored. Additional start gage signals are allowed until all checks in the gage have been stored. For example, if there are 8 checks in a gage and when the start gage signal is received only 4 of the checks are not saturated, ADAMM will store only those 4 results. When a second start gage signal is received, if the remaining four checks are not saturated, they will be stored and the gaging cycle will be complete. The same 8 checks could also be done with 8 start gage signals so long as each check was measured without being saturated at least once. Menu 7.1 “Digital Display” will show checks that have **not** been stored in as blank and checks that have been stored as the actual value stored. If the same check is re-gaged before completing all checks, the old value will be overwritten.
- 5) **Manual Auto Check** – When this mode is selected ADAMM will display a pop up window prompting the operator to select which gage to measure. Use the keyboard to select the gage number to be gaged. However, only checks in which all the input associated with the check are **not** saturated will be stored. Additional start gage signals are allowed until all checks in the gage have been stored. For example, if there are 8 checks in a gage and when the start gage signal is received only 4 of the checks are not saturated, ADAMM will store only those 4 results. When a second start gage signal is received, if the remaining four checks are not saturated, they will be stored and the gaging cycle will be complete. The same 8 checks could also be done with 8 start gage signals so long as each check was measured without being saturated at least once. Menu 7.1 “Digital Display” will show checks that have not been stored as blank and checks that have been stored as the actual value stored. If the same check is re-gaged before completing all checks, the old values will be overwritten.

#### **12.1.6 ALLOCATE DATA FILE MEMORY**

The number of parts it can store is dependent on the number of gages and part checks defined in ADAMM. If ADAMM is configured for more than 1 gage, the memory allocation for ADAMM needs to be defined. The amount of memory to be allocated per gage is programmable.

#### **12.1.7 WORK SHIFT START TIMES**

Starting times for the first, second and third shifts can be entered in this menu. The shifts must be programmed using the 24-hour military format. Shifts should not overlap each other.

## 12.2 GAGE SETUP

### 12.2.1 GAGE NAMES

This menu allows a Name to be defined for each gage. This name will be used in subsequent displays to associate data with a particular gage. The maximum number of characters permitted in a gage name is 12.

### 12.2.2 GAGE TYPE / TIMER

A gage can be either defined as "*Static*" or "*Dynamic*". A Static gage requires the part to be stationary in order for measurement data to be collected from the parts surface. In contrast a part placed in a dynamic gage must be moved (e.g. rotated) in order for data to be dynamically accumulated from its surface.

- 1) External End Gage Signal
- 2) Cycle Timer

The Keyboard/Push Button Pack must generate the External End Gage signal.

The Cycle Timer allows ADAMM to gage a part for a determined length of time and then stop if it does not receive an "End of Gage" signal. The length of time is a keypad entered variable.

Each gage has a programmable "*Settle Time*". The Settle Time specifies the time duration between the "*Start Gage*" signal and the initiation of reading of the Inputs.

### 12.2.3 GAGE RESOLUTION

The Gage Resolution defines the number of significant digits that will be displayed to the right of the decimal point as well as the increment value of the least significant digit. The resolution for each gage is set independently. Gage resolution is defined by system units of measurement (Inch or Metric) and is determined by two factors:

- 1) The smallest range selected out of all the inputs used for the gage. Note: input range is set using the jumpers on the signal conditioning boards.
- 2) The selected units of measurement.

There are 7 resolution options in Inch Mode:

- 1) 0.001"
- 2) 0.0001"
- 3) 0.00005"
- 4) 0.00001"
- 5) 0.000005"
- 6) 0.000002"
- 7) 0.000001"

If the gage resolution chosen is beyond the system resolution, gage head readings observed will appear erratic.

## 12.2.4 NUMBER OF PART CHECKS

The number of part checks for each gage needs to be defined. A single gage can be defined to have from 1 to 12 checks.

## 12.2.5 GAGE ENABLE/DISABLE

The Gage Enable/Disable feature informs ADAMM which of the defined gages are currently being used: "Enabled", and which ones are not being used "Disabled" .

## 12.2.6 GAGE CYCLE SETUP

### 12.2.6.1 GAGE CYCLE SETUP

There are 4 keypad-entered parameters that are check and gage dependent that need to be defined in this menu. The parameters affect the algorithm used in accumulating measurement readings during a measurement cycle.

**QUEUE SIZE** - Number of Maximum and Minimum readings stored during a gage cycle.

**FILTER** - Number of stored Maximum and Minimum Readings that are discarded.

**MINIMUM # READINGS** - Minimum number of required stored readings for a gage cycle.

**MINIMUM SAMPLING  $\Delta$**  - Minimum amount of expected change from one valid reading to the next. This value is used in a dynamic gage to detect when the part is stationary.

### 12.2.6 SERIAL DATA OFFLOAD

Each check for a gage can be configured to have its result automatically downloaded to the COM1 port. The offload format would be:

Check1Result, Check2 Result, ...etc followed by a <CR><LF>

## 12.3 PART CHECK SETUP

### 12.3.1 CHECK NAMES

Names should be created for all part checks. The part check names will be used in subsequent displays to associate data with a specific part check for a particular gage. The maximum length of a part check name is 11 characters including blanks. The set of selectable characters for part check names is the same set as for gage names: {'A' through 'Z', '0' through '9', (-), (.), (/), (,) and a space.

After selecting a check name for editing, pressing the **[D]** key displays a dictionary of commonly used check names and their abbreviations. First, enter the number of the desired check name or abbreviation. Then, select either the full string, by pressing the **[F]** key, or the abbreviation, by pressing the **[A]** key.

If the full string is selected, the current check name is replaced by the selected full description check name from the dictionary. If the abbreviation is selected, the next four character positions, beginning at the current character position, of the current check name are replaced with the selected abbreviation from the dictionary. For example, if the current check name was "ABCDEFGHIIJK", the current character position was 3, and the selected abbreviation was "cdef", then the new check name would be "ABcdefGHIJK".

Press the **[INDEX]** key to exit the dictionary at any time.

### 12.3.2 CHECK FUNCTIONS

Defining a check's function involves assigning a check type to a part check. ADAMM™ recognizes eight check types:

- 1) MULTIPLE CHECK
- 2) AVERAGE
- 3) MAX
- 4) MIN
- 5) TIR (Total Indicator Reading)
- 6) TOL. CHECK
- 7) TIR-ALT MAG
- 8) INTEG. AVG

They are defined as follows:

**MULTIPLE CHECK:** A multiple check is a check that is defined as a function of two or more previously defined checks.

Example: Chk #4 = Chk #1 + Chk #2 - Chk #3

**AVERAGE:** If a check's type is declared to be an average check, the maximum and minimum readings are added together and this sum is divided by 2.

**MAX:** Declaring a check's type to be a maximum check results in the largest reading being displayed for the part check.

**MIN:** Declaring a check's type to be a minimum check results in the smallest reading being displayed for the part check.

**TIR:** (Total Indicator Reading) represents the difference between the maximum reading and the minimum reading.

**TOL CHK:** If a check is declared to be a tolerance check, the maximum reading is compared against the maximum tolerance limit and the minimum reading is compared against the minimum tolerance limit. If either the max or min reading is greater than their respective tolerance limits, then that reading is displayed. If neither reading is outside of its respective tolerance limit, then the average of the maximum and minimum reading is displayed.

**TIR-ALT MAG:** A check using the TIR-ALT MAG function is a dynamic feature who's MAG is applied from another check. Often inputs are used to measure an average size and a dynamic feature such as parallelism, runout, etc. **NOTE:** A specialized master is not provided for the calibration of this feature. TIR-ALT MAG will allow the MAG and Zero from some other feature to be applied to a dynamic function without the use of a master.

**INTEG. AVG:** A check defined as an INTEG. AVG sums all of the gage readings and divides it by the number of gage readings.

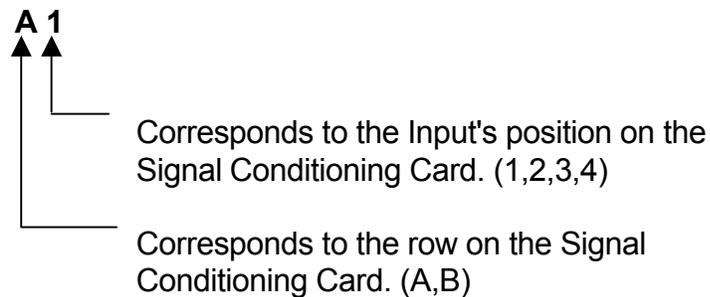
### 12.3.3 CHECK FORMULAS

There are three elements required to develop a Check Formula.

These include:

- 1) Input Definition
- 2) Indicator
- 3) Multiplier

Input Definition is simply identifying the inputs ADAMM™ will use to measure the particular characteristic of the part. Input identification numbers will be applied as follows:

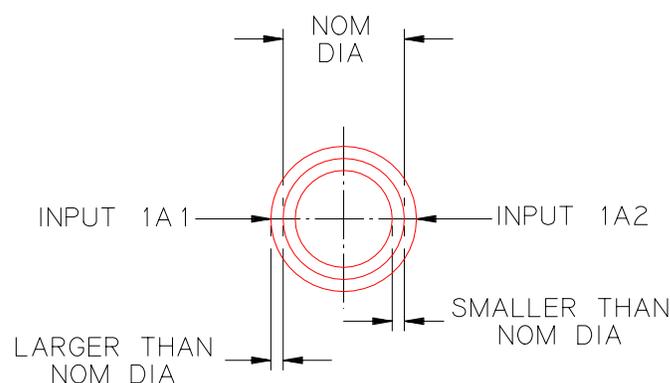


The Indicator is the signed value given to the multiplier. This permits addition or subtraction of inputs in the formula.

The Multiplier is determined by the number of probes used to measure the particular part characteristic or to correct any ratio that may be introduced by a contact arm or tooling.

The Check Function is applied to the resultant value of the algebraic equation. ADAMM™ takes numerous readings during a gaging cycle. How these readings are displayed as a final numeric display of the part characteristic is determined by the Gaging Function. See menu 12.3.2 "**CHECK FUNCTIONS**" for the options available.

An example of a formula for a dual input electronic application measuring an outer diameter is as follows:



One can witness from the figure above that when the diameter grows larger in size, each of the probes sees ½ the total diameter change. If the diameter changed by .100", then each probe was displaced by .050". Knowing the displacement of each probe's spindle and the total change of size, we can then apply a constant multiplier value to each of the inputs for this application as follows:

$$(A1 \times +1.0000) \text{ and } (A2 \times +1.0000)$$

The multiplier factor of 1.0000 is used because we want to use the entire value of the displacement viewed by each input. A positive indicator is used to add the two values together. The corresponding table entries would look like this:

ROW #	INPUT CHANNEL	MULTIPLIER	ALT MAG CHK #
1	A1	+1.0000	
2	A2	+1.0000	

The completed formula would be displayed as:

$$\text{CHK \#1} = A1 \times +1.0000 + A2 \times +1.0000$$

(NOTE: The ALT MAG CHK# column will only appear if the check function is defined as ALT MAG.)

Part checks defined as "MULTIPLE CHECKS" will NOT appear in this display.

### 12.3.4 MULTIPLE CHECKS

Multiple checks provide a more advanced level of part check definition by allowing a check to be defined in terms of other checks. Complicated check formulas are simplified by defining regular checks to represent intermediate steps of the formula, then using a Multiple Check to calculate the final result from the intermediate steps.

Each line in the multiple checks table is given a case number and represents an operation on two previously defined checks. Each gage can define up to sixteen multiple checks, one on each line.

Each line consists of four sections of information: the first operand, second operand, operation, and resultant. The operands are previously defined checks, specified by a gage number, check number, position number and multiplier.

The operation defines the type of action to perform on the two operands, such as addition. The resultant specifies which check number to store the result of the operation in.

The individual fields in the multiple check table are below:

**CASE** - The case number labels the entries in the multiple check table. A maximum of sixteen entries is allowed for each gage, in ascending order.

**1ST CHK** - The first check number field specifies which check number to use as the first operand in the operation.

**2ND CHK** - The second check number field specifies which check number to use as the second operand in the operation.

**POS** - The position field is used when the same check is made in multiple positions on the same part. For example, if two measurements of the inner diameter of a cylinder are made, one at the top of the cylinder and one at the bottom of the cylinder, the same tooling can be used to take both measurements. First, the tooling would be moved to position one, where the top measurement is taken. Then, the tooling is moved to position two, where the bottom measurement is taken. The first position field on the multiple check table specifies at which tooling position to measure the first check. The second position field on the multiple checks table specifies at which tooling position to measure the second check. Up to 12 positions may be programmed.

**MULTIPLIER** - The first multiplier field is used to scale the first check value. Likewise, the second multiplier field is used to scale the second check value. The multipliers are applied to the check values before the operation takes place.

**COND** - The condition field contains the operation to apply to the two checks, or operands. There are seven selections to choose from.

**NULL** - Specifies no operation and clears the current case line.

**ADD** - Returns the sum of the first and second checks.

**MAX** - Returns the maximum reading of a set of checks.

**MIN** - Returns the minimum reading of a set of checks.

**TIR** - Returns the difference between the maximum and minimum reading checks.

**VEC** - Returns the vector addition of the two checks, or the square root of the sum of the squares of the first and second checks.

**MULT** - Returns the product of the first and second checks.

**RESULTANT** - The resultant field contains the check number in which the result of the operation is stored. This check number must be defined as a multiple check in the check functions menu, 12.3.2. Entering a "0" in the resultant field continues the operation on to the next line. The intermediate result is not assigned to a check, thereby reducing the number of checks used. For example, if four checks are to be added together, add the first two on one line and enter "0" in the resultant field. Then, add the second two on the next line, and enter the resultant check number in the resultant field. The sum of all four checks will then reside in the resultant check number.

Example: The following example illustrates the use of a Multiple Check to evaluate the following expression:

$$(\text{Check 5}) = (\text{Check 1}) + (\text{Check 2}) + (\text{Check 3}) - (\text{Check 4})$$

This expression will start with Check 1, add Check 2, add Check 3 and subtract Check 4, placing the result in Check 5. The Multiple Check menu to depict the expression is shown below.

**MULTIPLE CHECKS:**

**GAGE #1**

CASE	1 <sup>ST</sup>			2 <sup>ND</sup>			COND	RESULT
	CHK	POS	MULTIPLIER	CHK	POS	MULTIPLIER		
1	1	1	+1.00000	2	1	+1.00000	ADD	CONT
2	3	1	+1.00000	4	1	-1.00000	ADD	5

The first line of the table adds together Check 1, multiplied by (+)1.000 and Check 2, multiplied by (+)1.000. By entering "0" in the resultant field, the calculation is continued to the next line.

The second line of the table continues the calculation adding Case 1 to Check 3, multiplied by (+)1.000, and Check 4, multiplied by (-)1.000. The result is Check 5.

A multiplier is a signed (+ or -) quantity. The multiplier quantity is designated positive or negative relative to the algebraic formula. To remove a channel from a part check algorithm, enter a channel # of "0".

**12.3.5 INPUT CHANNEL MAG & POLARITY**

The Type, Range, Polarity/MAG, Offset and Limits for each Input in the gaging fixture(s) must be defined. The Type is defined as either "Air" or "LVDT" depending on the input used. The range of an LVDT input will default to +/- 0.040 which is the range of a standard LVDT transducer. The Range of an air input will default to a null value.

The Polarity/MAG variable is a signed number that assigns direction to the linear movement of the Input and is also a conversion factor providing compatibility between ADAMM software and Inputs with different linear ranges. In most cases using an LVDT input, the Polarity/MAG is set equal to +1.0000. The Polarity/MAG for an air input is determined by the full scale value and Magnification of the air tool. This value has been calculated and can be found under the Air/Electronic Signal Conditioning section in Calculations.

The **OFFSET** variable is an additional signed number, which can be added to the individual Input Reading to allow for tooling inconsistencies.

The (+) and (-) saturation limits are used in probe check calculations to determine whether an input is functioning correctly.

INPUT							
#	CHANNEL	TYPE	RANGE	POL/MAG	OFFSET	(+) LIMIT	(-) LIMIT
1	A1	LVDT	+/-0.040	+1.0000	+0.0000	+0.2045	- 0.2045
2	A2	AIR	-----	.180	+0.0010	+0.002	- 0.002

### 12.3.6 CHECK ENABLE / DISABLE

This option will allow the operator to disable any of the predefined checks. If disabled, a checks gaged value will not be included in the part's overall status.

### 12.3.7 CHECK RESOLUTION SETUP

The operator can use this menu to define the display resolution for individual checks. For example, if the gage resolution is set to .000001 in menu 12.2.3 then all the checks will display to that resolution. However, the operator can use menu 12.8 to program check #1 to a resolution of .001 and then whenever check #1 is displayed on other ADAMM menus the display resolution will be .001, all other checks will still display at the gage resolution of .000001.

## 12.4 GAGE R & R STUDY

### 12.4.1 GAGE R & R STUDY

Gage Repeatability is the variation in measurements obtained when one operator uses the same gage for measuring the identical characteristics (part checks) of the same parts.

Gage Reproducibility is the variation in the average of measurements made by DIFFERENT operators using the same gage when measuring identical characteristics of the same parts.

*"Equipment Variation"* is synonymous with Gage Repeatability and this value is displayed as "EV". Similarly, *"Appraiser Variation"* is synonymous with Gage Reproducibility and is displayed as "AV".

A complete R & R study is conducted on a sample size of 1 to 10 parts, in two or three trials and is performed by three different operators: A, B, and C. A partial or "simulated" R & R study can be conducted by a single operator to quickly verify gage Repeatability exclusively, as an aid in detecting any tooling problems that may be present.

When an R & R study is enabled, regular gaging is disabled, the SPC charts are not updated, and no feedback is sent to the machine control. If the operator exits from the R & R display menu, and then gages a part, the R & R study is stopped and regular gaging is resumed. The operator will have to manually restart the R & R to finish the study.

### 12.4.2 #TRIALS / SAMPLE SIZE

Number of trials available: 2 or 3

Number of samples available: 1 - 10

### 12.4.3 RESET R & R STUDY DATA

Resets R & R data for all checks in gage selected.

#### **12.4.4 START/STOP STUDY**

Select Start or Stop R & R study.

#### **12.4.5 UCLr TEST**

This test compares the upper control limit range (UCLr) to the data accumulated in the R&R test and discards any reading which exceeds the upper control limit range. This feature can be enabled or disabled in this menu.

#### **12.4.6 PRINT R & R STUDY**

Selecting Item 6 from the R & R Study menu (12.4.0) will automatically print the Gage R & R Study screens (12.4.1). If no R & R data has been stored, the message *"No R & R Data Accumulated."* is displayed, and nothing is printed.

If R & R Data has been stored, the R & R Study screens are printed in order by operator for each check. In other words, the R & R Study screen for Operator A, Check #1 is printed first, then Operator B, Check #1, then Operator C, Check #1, then Operator A, Check #2, then Operator B, Check #2, and so on for all checks. Only operators with R & R Data are printed.

ADAMM simulates the keystrokes necessary to enter each screen and then prints them. Pressing any key during the print cycle will halt printing where it is and leave ADAMM in the current screen. When all of the screens have been printed, ADAMM returns to the R & R Study menu (12.4.0).

#### **12.4.7 WRITE R & R STUDY TO FILE**

Selecting this option causes ADAMM to write the results of the last, or currently being run, R & R to a text file in the CYCLDATA directory of ADAMM memory. The text file will be named "RRSTUDY.DAT". The file can be copied to a zip disk using menu 12.7.3 option (7) or directly from ADAMM if it is connected to a network, see Section 8, Communication, Network connection for more information.

### **12.5 ALARM SETUP**

#### **12.5.1 DEFINE MACHINE ALARMS**

ADAMM has internal alarms available to alert the operator to specific internal conditions. These alarms are defined by the system and cannot be changed. They can, however, be enabled and disabled by the operator. The first six alarms are defined as:

**SPC ALARM** - This alarm is activated when an SPC alarm condition is encountered. Some examples are trends, hugging the control line, and runs.

**REASONABLE LIMIT EXCEEDED** - This alarm is activated when a reasonable limit is exceeded.

**DYNAMIC GAGE CYCLE ERROR** - This alarm is activated when an error occurs in the dynamic gage cycle. This alarm only applies for dynamic gages.

**SATURATED INPUT(S)** – This alarm is activated when an input consistently reads the same value during the gage cycle.

**GAGE DATA FILE DISABLED (FULL)** – This alarm is activated when the number of readings stored in the gage data File has exceeded the storage limits.

**NETWORK WRITE FAILED** - If Network Data Storage is enabled, this alarm would activate when the system is unable to write gage results to the set up network location. Select the ADAMM alarm to modify and press **[ENTER]**. Since ADAMM's alarms are for preset internal alarm conditions, the Alarm Descriptors cannot be modified. The Alarm Destination defines where the alarm will be displayed when triggered. The three options are:

**ANY MENU** - Displays ADAMM alarms in a pop up window in the middle of the screen, regardless of the current ADAMM screen. Multiple alarms can be displayed.

**STATUS LINE 25** - Displays ADAMM alarms on the bottom line of the screen, regardless of the current ADAMM screen.

**ALARM MENU ONLY** - Displays ADAMM alarms in the Menu 10.2 Display ADAMM Alarms only.

The Status determines whether or not ADAMM alarm is displayed when the alarm is triggered. Follow the prompt to enable/disable ADAMM alarm display.

The **[YES]** key is used to display the next page of ADAMM alarms.

## **12.6 SYSTEM HARDWARE UTILITIES**

### **12.6.1 SET SYSTEM CLOCK**

ADAMM's battery backed clock time and date can be changed in this menu. The time must be entered in a military format.

### **12.6.2 CRT SAVER**

The CRT SAVER will help prevent permanent etching of the display screen if the same menu is displayed for extended periods of time. There are 2 programmable parameters that can be defined:

**CRT SAVER TIMER PRESET** - The CRT Saver Timer Preset will blank out the CRT display after an operator definable length of time since the last key was pressed.

### **12.6.3 SERIAL COMMUNICATIONS**

The serial communication parameters for the two serial ports are programmed in this menu. There are also three diagnostic menus available for serial communication testing.

#### **12.6.3.1 SERIAL COMMUNICATION SETUP**

There are five parameters that need to be defined for each port:

- 1) Baud Rate
- 2) Parity
- 3) Stop Bits
- 4) Data Bits
- 5) Tx Delay

### **12.6.3.2 SERIAL COMMUNICATIIONS DIAGNOSTICS**

The Diagnostics menu is a diagnostic display used for debugging serial communication protocols. The display provides the following information:

- 1) Displays Serial Input Buffer Real Time
- 2) Duart Status
- 3) Last Error Duart Error condition
- 4) **[YES]** Key to reset

### **12.6.3.3 TEST SERIAL PORT**

This diagnostic menu is utilized to test any serial port configured in ADAMM for its ability to transmit or receive data.

### **12.6.4 ANALOG CONFIGURATION**

The configuration of the number of inputs available (4 or 8) is programmed in this menu.

### **12.6.5 NETWORK SETUP**

#### **12.6.5.1 IP ADDRESS SETUP**

If ADAMM is configured for TCP/IP ADAMM's IP address, subnet mask, and gateway is defined in this menu.

#### **12.6.5.2 NETWORK NAMES**

ADAMM network User & Computer Name, Workgroup Name, Domain Name and domain logon is defined in this menu.

#### **12.6.5.3 NETWORK PRINTER**

ADAMM network printer is defined in this menu.

#### **12.6.5.4 NETWORK PART DATA STORAGE**

This menu is used to define the network storage path, and the file names for the gage data, part counter, alarm, and feedback files for each gage that is to transfer data to the network.

### **12.6.6 SELECT SYSTEM PRINTER**

ADAMM allows the operator the option of choosing the type of printer to be utilized and the protocol for that printer.

#### **12.6.6.1 SYSTEM PRINTER TYPE**

The types of printers are:

- 1) EPSON FX-850/1050
- 1) EPSON LQ-870/1170
- 2) HP PCL 5 PRINTER
- 4) GENERIC PRINTER

**NOTE:** No graphics screens are printed when the System Printer Type is set to "GENERIC PRINTER". Only text screens are printed. Also, no special characters, such as the  $\bar{x}$  character, are printed either. The  $\bar{x}$  character is replaced with 'x', r-bar is replaced with 'r', and sigma is replaced with 's'.

#### **12.6.9.2 TEST PRINTER PORT**

ADAMM will perform a test of the printer port by enabling this option.

### **12.7 ADAMM FILE UTILITIES**

ADAMM provides two methods of saving ADAMM setup File and Gage Data Files (GDF). These files can be stored on the on-board flash memory or to a remote Iomega Zip Drive. The on-board flash memory provides direct access to file storage while the remote Iomega Zip Drive allows for offloading of the files for archiving or SPC analysis.

#### **12.7.1 ADAMM SETUP FILE UTILITY**

This menu allows the operator to save, load or delete setup files to/from the flash memory. The currently loaded setup file is displayed. Select option and follow prompt commands. In order to delete a setup from flash memory the delete password, 335, must be entered.

**NOTE:** When a setup is loaded, the associated gage data file is also loaded. The gage data file has the same name as the gage setup file except the file extension is ".dg1"

#### **12.7.2 REMOTE COPY UTILITY**

This menu allows the operator to store, retrieve or delete setup files, gage data files or R&R result files from an Iomega Zip Drive, an Edmunds qualified compact flash drive, or an Edmunds qualified compact flash reader. ADAMM's operating software can also be loaded from an external drive, which provides for easy installation of enhancements and upgrades to the operating software. The following steps outline the use of the remote copy utilities.

#### **Remote Device:**

1. Connect the compact flash drive or compact flash reader/writer to the USB port on ADAMM enclosure.
2. Select desired remote utility for Menu 12.7.3 and follow command prompt.
3. Setup files will be copied to and from the following directory on the drive:  
:\REMOTE\PARM  
Gage Data Files will be copied to the following directory on the drive:  
:\REMOTE\GDF

#### **12.7.3 PART GRAPHICS FILE UTILITY**

If configured, the Part Graphical files used in displaying gaging results graphically would be selected here. The results would be displayed in Menu 7.4 "Graphical Part Display".

## **12.8 HIDDEN MENUS (ACCESS BY MASTER PASSWORD ONLY)**

### **12.8.1 INITIALIZE SETUP DATA**

Initializes Setup Data. (Programmable Parameters) Clears all programmable data and reset ADAMM to default settings.

### **12.8.2 SOFTWARE CONVERSION**

Re-initializes the Memory to Accommodate installation of Software Updates.

### **12.8.3 MASTERING LIMITS**

The maximum allowable percentage of "MAG" adjustment and the maximum "ZERO" shift allowed during the mastering sequence for each check can be programmed depending on the gage's application. The default setting for the "MAG" adjustment is 25%. For checks using air inputs, the recommended maximum allowable "MAG" adjustment is 10%. The default setting for the maximum allowable "ZERO" shift is .002" or .0508 MM.

### **12.8.4 SET AD SAMPLING**

The number of times ADAMM will solicit the AD signals to obtain the average reading can be programmed here.

### **12.8.5 SET WATCHDOG TIMER**

The watchdog timer can be enabled or disabled here.

### **12.8.6 INSTALL OPERATING SOFTWARE**

ADAMM operating software can be loaded from the USB port. This allows for easy installation of enhancements and upgrades to the operating software.

### **12.8.7 DIAGNOSTIC DATA**

This menu can be used to create a text file containing all of the gage readings, either per input or per check, recorded during a dynamic gaging cycle.

- 1) Diagnostic Mode allows the operator to select either [1], "Checks" or [2], "Inputs". If Checks is selected the text file will contain the readings of each enabled check after applying all inputs and multipliers. If Inputs is selected the text file will record the readings from each individual probe.
- 2) Select Checks/Inputs allows the operator to select the checks or inputs for which data will be collected. Entering a check number will toggle between "Disabled", no data collected, and "Store Data", data for that check is recorded.

**Note:** The text file created only stores data for one cycle at a time. If a second cycle is run the data file will be overwritten.

## 6 SETUP GUIDE

ADAMM is designed to satisfy a diverse range of applications. To provide this flexibility however, a somewhat comprehensive set of parameters exists. Although the minimum configuration is straight forward, a setup guide may prove useful until the user is more familiar with the system. This guide will not include feedback variables or any special features provided exclusively for a particular application.

It is assumed that the reader is accustomed to the keypad conventions and menu numbering system. To avoid redundancy, this guide will not make mention to keystrokes. Menu reference numbers will be supplemented to assist the operator where appropriate. Refer to Keypad and Menu Conventions if necessary.

An ADAMM PROGRAM SET-UP document typically accompanies ADAMM if tooling is provided. This document will contain check definitions and corresponding formulas as well as input MAG factors and polarities. See Example below.

### \*SAMPLE\*

#### ADAMM PROGRAM SET UP

CUSTOMER: Edmunds Gages                      S.O. #200000                      SKG-12345

Gage Name: Input Shaft      No. of Cks: 4                      Units: IN                      Res: .0001

CHK	DESCRIPTION	FUNCTION	FORMULAS & MULTIPLIER(S)
1	DIAMETER	AVG	A1 x (+)1.000 + A2 x (+)1.000
2	DIAMETER	AVG	A2 x (+)1.000 + A3 x (+)1.000
3	LENGTH	AVG	A4 x (+)1.000
4	TAPER	MPL CHK	CHK1 x (+)1.000 + CHK 2 x (-)1.000

INPUT							
#	CHANNEL	TYPE	RANGE	POL/MAG	OFFSET	(+) LIMIT	(-) LIMIT
1	A1	LVDT	+/-0.040	+1.0000	+0.0000	+0.2045	- 0.2045
2	A2	LVDT	+/-0.040	+1.0000	+0.0000	+0.2045	- 0.2045
3	A3	LVDT	+/-0.040	+1.0000	+0.0000	+0.2045	- 0.2045
4	A4	AIR	-----	.180	+0.0010	+0.002	- 0.002

## PRELIMINARY SET UP

From ADAMM's INDEX menu, enter the **"UTILITIES"** Menu 12.0.

- A. Select **"SYSTEM CONFIGURATION"** Menu 12.1. 1.
  1. Select Menu 12.1.2 **"UNIT OF MEASUREMENT"** and select which units pertain to the gage (Millimeter or Inch)
  2. Select Menu 12.1.3 **"NUMBER OF GAGES"** and enter the number of gages. A prompt will indicate the range available for this selection.
  3. Select Menu 12.1.4 **"SINGLE GAGE MONITORING"** and select whether a single gage is to be monitored.
  4. Select Menu 12.1.4 **"GAGE RECOGNITION MODE"** and select from the choices which method will be used
  5. Select Menu 12.1.6 **"WORK SHIFT START TIMES"** and enter the shift parameters relative to you work schedule. The time will be in 24-hour military format and the times cannot overlap.
  6. Return to **"UTILITIES"** Menu 12.0

B. Select **"GAGE SETUP"** Menu 12.2.

1. Select Menu 12.2.1 **"GAGE NAME"**. It may be convenient, to name the gage. If you wish to name a gage, select the gage for editing. The name of the gage can be up to 12 characters long, including spaces.

ADAMM will display an alphabetic selection bar for naming. There will be a triangular cursor under the first character in the gage name. This corresponds to the highlighted character in the alphabetic bar. By using the **[1]** or **[2]** key, the operator can move the highlighted character in the alphabetic bar to select the letter needed.

After selecting the correct letter, press the **[3]** key to select the next character position in the name. Repeat the above process until the complete gage name is entered. Press the **[8]** key to exit the name editor.

2. Return to **"GAGE SETUP"** Menu 12.2.
3. Select Menu 12.2.2 **"GAGE TYPE/TIMER"**. The gage type may be either static or dynamic. If the input readings are gathered with respect to a stationary object, the gage type is considered to be static; otherwise the process is dynamic. With a static gage all the

input readings should be the same, making it possible to gather inputs during a constant interval. This is not the case for dynamic gaging since the time required to gage is not a constant from application to application. Therefore, a programmable cycle timer from 0.0 seconds to 99.9 seconds is available. Set the cycle timer to a time, which allows completion of the gaging cycle. If 0.0 is entered, the timer function is disabled. If appropriate, a "*SETTLE TIME*" may be programmed into the gaging process. This will add a dwell period between receiving the start gage indication and the actual start of the gaging process.

4. Return to "**GAGE SETUP**" Menu 12.2.
5. Select "**GAGE RESOLUTION**" Menu 12.2.3. Select the appropriate resolution.
6. Return to "**GAGE SETUP**" Menu 12.2.
7. Select "**NUMBER OF PART CHECKS**" Menu 12.2.4. For each gage enter the appropriate number of part checks.
8. Return to "**GAGE SETUP**" Menu 12.2.
9. Select "**GAE ENABLE/DISABLE**" Menu 12.2.5. For each gage select whether it is enabled or disabled.
10. Select "**GAGE CYCLE SETUP**" Menu 12.2.6. The 4 parameters listed (Queue Size, Filter, Minimum # of Readings and Minimum Sampling  $\Delta$ ) apply to input sampling during the gage cycle. Refer to Menu Descriptions for a more detailed discussion about the gage cycle parameters. The default settings (Queue = 20, Filter = 5, Min. # of Readings = 40 and Min. Delta = 0) will allow the user to gage parts in a static mode. However, for dynamic or special applications additional considerations may be necessary.
11. Return to "**UTILITIES**" Menu 12.0.

C. Select "**PART CHECK SETUP**" Menu 12.3.

1. Select "**CHECK NAMES**" Menu 12.3.1. It may be convenient, although not necessary, to name the part checks. This will provide a noticeable identification of each. If you wish to name a part check, select that check for editing. The name of each check can be up to 11 characters long, including spaces. The ADAMM™ will display an alphabetic selection bar for naming. There will be a triangular cursor under the first character in the part check name. This corresponds to the highlighted character in the alphabetic bar. By using the **[1]** or **[2]** key, the operator can move the highlighted character in the alphabetic bar to select the letter needed.

2. After selecting the correct letter, press the **[3]** key to select the next character position in the name. Repeat the above process until the complete check name is entered. Press the **[7]** key if you wish to edit another check name, or press **[8]** to exit the name editor.
3. Return to **"PART CHECKS"** Menu 12.3.
4. Select **"CHECK FUNCTIONS"** Menu 12.3.2. Select the appropriate gage to edit if prompted. When editing the current check function, a list of available functions will appear. Refer to Menu Descriptions for a more detailed description of the check functions.
5. Return to **"PART CHECKS"** Menu 12.3.
6. Select **"CHECK FORMULAS"** Menu 12.3.3. For the checks not defined as multiple checks, a formula in terms of input readings must be created for each check. A complete description of the elements required to develop a Check Formula is outlined in the Menu Descriptions section.

A typical diameter check may be represented as:  
 $CHECK\#01 = A1 \times 1.00000 + A2 \times 1.00000$

This formula can be entered as follow:

- a. Select Row 1
  - b. Select the first input, in this case A1, which is input channel 1.
  - c. Enter the multiplier value 1.00000.
  - d. Select the second input, in this case A2, which is input channel 2.
  - e. Enter the multiplier value 1.00000.
  - f. Enter **[SHIFT] [NO]** to end editing procedure.
  - g. Notice the updated formula displayed below the table - it should agree with the desired formula.
  - h. Press the **[YES]** key to display the next check.
7. Return to **"PART CHECKS"** Menu 12.3.
  8. Select **"MULTIPLE CHECKS"** Menu 12.3.4. A complete description of the elements required to develop a Multiple Check Formula is outlined in the Menu Descriptions section. For the checks defined as multiple checks, a formula in terms of previously defined checks must be created.

A typical taper check may be represented as:  
 $CHECK\#03 = CHECK\#01 - CHECK\#02$

This formula can be entered as follows:

- a) Select Case 1

- b) Select Gage 1 since all checks in this example exists in Gage 1.
- c) Enter the number 1 as the 1st check.
- d) Enter the position, value "1".
- e) Enter the multiplier value 1.00000.
- f) Enter Gage 1.
- g) Enter the number 2 as the 2nd check.
- h) Enter the 2nd position, value "1".
- i) Enter the multiplier value -1.00000.
- j) Enter the condition, ADD.
- k) Enter the resultant as Check 3.

9. Return to **"PART CHECKS"** Menu 12.3.

10. Select **"MAG/POLARITY"** Menu 12.3.5. Select the appropriate channel, and then enter the Input Type. Press the **(Y)** key to advance to the next field. In order, enter the Range and Polarity/Mag factor. Note this value is entirely different from the multiplier value entered in the check formula menu. If an offset entry is appropriate, enter a value to be added to the input value; otherwise, enter **[YES]** to edit the next input channel. Also enter a value for gage head saturation (+ & -).

11. Return to **"PART CHECKS"** Menu 12.3.

12. Select **"CHECK ENABLE/DISABLE"** Menu 12.3.6. Ensure each check is **"ENABLED"**.

13. Return to ADAMM's **"INDEX"** Main Menu.

D. Select **"LIMITS"** Menu 3.0.

1. Select **"NOMINAL SIZES"** Menu 3.1. There are two ways ADAMM can display its readings. The first is to display an actual number. The second is to display a deviation (-0.0001) from a nominal size (2.0000). If you wish to display an actual number, a nominal size will need to be entered for each part check. Enter the nominal part size for each check. Note the final reading is displayed as a deviation from nominal. Therefore, if all readings should be displayed as deviations from zero, simply enter zero for each check.

**NOTE: THE MANNER OF ENTRY OF ALL REMAINING VARIABLES IN THE LIMITS MENU MUST BE CONSISTENT WITH THE PROGRAMMED NOMINAL SIZE. IF YOU ARE DISPLAYING ACTUAL NUMBERS, ALL OTHER VARIABLES MUST BE ENTERED AS ACTUAL NUMBERS. IF YOU ARE DISPLAYING DEVIATIONS FROM NOMINAL, ALL OTHER VARIABLES MUST BE ENTERED AS DEVIATIONS FROM ZERO.**

2. Return to **"LIMITS"** Menu 3.0.

3. Select "**PART TOLERANCES**" Menu 3.2. Enter the upper and lower specification limits as well as the sort classes for each check. Typically the sort classes are "*REJECT*", meaning if the part check is not within the programmed tolerances, the part is rejected. However, a "*REWORK*" class is also available. A "*REWORK*" designation is defined as a condition of a part check that can be corrected by altering the part.

An example of this would be an I.D. that is undersized. The I.D. could be enlarged to the correct size by reworking it. The "*REWORK*" sort class would be applied to the specification limit that deems it correctable. In the case of the undersized I.D., the lower specification limit would be the "*REWORK*" sort class.

4. Return to "**LIMITS**" Menu 3.0.
5. Select "**REASONABLE LIMITS**" Menu 3.3. Enter the upper and lower reasonable limits for each check. The Reasonable Limits are established to protect the SPC data accumulation of ADAMM from accepting readings from parts that are grossly out of tolerance. This condition could be the result of broken tooling, un-machined parts introduced to the gage, etc. The reasonable limits are dependent upon the machining process. The closer the process can be controlled, the smaller the Reasonable Limit range. The Reasonable Limits should always be set outside of the part tolerances. To disable this feature, set the reasonable limit to "0".
6. Return to "**LIMITS**" Menu 3.0.
7. Select "**SORT CLASSES**" Menu 3.4. This feature allows the operator to classify a part with a numeric number (1-10) in reference to one particular part check. Five parameters must be entered to enable this feature. Select Item 1 "*CLASSIFYING DIMENSION*" and select the part check being utilized to classify the part. Select Item 2 "*# OF SORT CLASSES*" and enter the number of classes you wish to classify the part into. Select Item 3 "*CLASSIFYING DIM. MAG*" and enter 1.0000. Select Item 4 "*CLASSIFYING DIM. OFFSET*" and enter 0. Select Item 5 "*SORT CLASS*". Select Class 1. Define the range of the class. Select Class 2. Define the range of this class.

The upper limit of one of the classes must not be equal to the lower limit of the next class. Also, the class limits will run from highest to lowest and they must not overlap. Define the ranges of the remaining classes.

8. Return to "**LIMITS**" Menu 3.0.
9. Return to ADAMM's "**INDEX**" Menu.

E. Select "**GAGE MASTERING**" Menu 2.0.

1. Select "**MASTER SIZES**" Menu 2.3. Enter the part check master sizes and the number of the master the part check characteristic is calibrated to as per the calibration report. Typically the Max Master is designated Master 1 and the Min Master as Master 2, however, up to 8 masters may be defined.

For example, if check number 1 is calibrated with a max and min master enter the max master size for check 1 from the master calibration report in "Max Master Size" and enter "1" in the max "Master No." Enter the min master size for check 1 from the master calibration report in "Min Master Size" and enter "2" in the max "Master No."

If a check uses only one master for calibration, for example to calibrate a TIR check, enter the master size from the calibration report in "Max Master Size" and enter "1" in max "Master No." then enter "0" as the min "Master No."

**REMEMBER: The Master Sizes MUST be defined in the same format (Actual Numbers or Deviation from Nominal) as the variables in the "LIMITS" menu.**

2. Return to ADAMM's "**INDEX**" Menu.

The Preliminary ADAMM setup is now complete. ADAMM can be mastered at this time.

## **$\bar{x}$ & R CHART PARAMETERS**

1. Select "**DEFINE  $\bar{x}$  & R CHART PARAMETERS**" Menu 4.2.
2. Enter Check #1. Enter the Subgroup Size for the check. Enter the Sample Frequency for the check.
3. If you want the ADAMM to calculate the UCL<sub>x</sub>, LCL<sub>x</sub> and UCL<sub>r</sub> values, enter "**C**" for the check.
4. If you have values calculated for these parameters, enter each one.
5. Repeat the above for all of the checks.

## **BALANCE INPUTS**

ADAMM allows the operator to balance the outputs of dissimilar inputs (A/E and Electronic) when they are utilized together in a part check formula. Typically a reference LVDT input is utilized to balance air inputs or another LVDT. Up to seven inputs may be balanced to a reference input for each balance group. A reference input may be utilized more than once if there are more than seven inputs that require balancing to that reference input.

If a balancing routine is required for a gage set up, a balance master may be supplied for the balancing routine. If no balance master is supplied, a master or a part with the

maximum clearance for the balance inputs may be utilized.

By performing the balancing routine, ADAMM calculates and assigns a Mag factor for the inputs being balanced relative to reference input. After a successful balancing procedure is completed, the gage can be mastered.

The operator first must determine which input will serve as the reference input and which inputs are to be balanced. If Edmunds supplies the gage and a balancing procedure is required, the balance groups will have already been established and the balancing procedure will only have to be performed. If not, the balance group(s) will have to be set up prior to the balancing procedure.

### **BALANCE GROUP SET UP**

1. Select **"INPUT SETUP"** Menu 6.0.
2. Select **"BALANCE INPUT"** Menu 6.4.
3. Select **"INPUTS TO BALANCE"** Menu 6.4.1.
4. Select Group #1. Select Row #1 and enter the reference input for the balance group.
5. Select Row #2. Enter the first input that requires balancing.
6. Repeat selecting rows and entering inputs until all of the inputs that require balancing are entered.
7. If another balance group is required, press the **[YES]** key to advance to Balance Group 2 and perform the set up procedure for Group 2.
8. When all of the groups are completed, return to **"BALANCE INPUTS"** Menu 6.4.

### **PERFORM BALANCE ROUTINE**

1. Select **"PERFORM BALANCE ROUTINE"** Menu 6.4.2.
2. Select the Balance Group you wish to perform the balancing routine on.
3. At the prompt *"Perform Balancing Routine"* press the **[YES]** key.
4. Utilizing either the balance master, MAX master or part in the gage, bias the part in the direction of the reference input. While holding the part in position, press the **[YES]** key to record the first position reading.
5. Now bias the part in the opposite direction. While holding the part in position, press the **[YES]** key to record the second position reading.
6. ADAMM will now display the spread and balancing Mag for the reference

and balanced inputs. If the Mag correction is below 25%, the inputs will balance. LVDT inputs should always balance to a reference LVDT input. If not, there is a mechanical problem with either the LVDT or the contact arm utilized in the gage. A/E inputs may not balance on the first attempt. If they do not, the Mag will have to be adjusted for the input that is out of balance.

7. To adjust the Mag perform steps 1-3 above. With the part on the gage, bias it in the direction of the reference input. Observe the reading for the reference input. Using the "ZERO" knob of the A/E block for the corresponding input, adjust the display for the input to match that of the reference input.

8. Do not press the **[YES]** key. This allows the operator to see live readings in the First Reading column on the display. Bias the part in the opposite direction. Observe the reading for the reference input in relation to the input being balanced. If the value for the balance input is less than that of the reference input, the Mag needs to be increased. If the value for the balance input is more than that of the reference input, the Mag needs to be decreased.

9. To increase the Mag, turn the "MAG" knob of the A/E block for the corresponding input clockwise until the display reads approximately 5 times the noted difference, regardless of the direction the display changes. After adjusting the Mag, turn the "ZERO" knob in the same direction as the "MAG" knob to correct the display to match the reading of the reference input.

10. Bias the part in the opposite direction. Observe the reading for the reference input in relation to the input being balanced. If the value for the balance input still does not match that of the reference input, the Mag will have to be adjusted again according to the procedure above. When the values for the balancing inputs matches those of the reference input, perform the balancing routine.

11. Once Balance Group #1 has been successfully balanced, proceed to the next balance group if required. After all balance groups have been balanced, the gage can be calibrated.

## **GAGE DATA FILE ANNOTATIONS**

ADAMM allows the operator to annotate individual part readings in the Gage Data File to identify changes in the process that could affect the SPC data being collected.

The annotations are indicated by asterisks (\*) in the "STATUS" column of the gage reading. There are 32 annotation definitions available. Each annotation definition can be up to 32 characters in length.

If an annotation is indicated for a gaged reading, the annotation number and definition is automatically displayed at the bottom of the gage data file when the reading is selected.

Set up and definition of annotations is as follows:

1. Select "**GAGE READINGS**" Menu 7.0 in ADAMM. Select "**GAGE DATA FILE**" Menu 7.3.
2. Press the **[4]** key to select "**ANNOTATIONS**".
3. Using either the **[1]** or **[2]** key, select the gage reading you wish to annotate. A highlighted reading number in the Index column indicates the reading selected.
4. Press the **[ENTER]** key. The ADAMM will display the annotation selections available. Use the **[YES]** key to scroll through the annotations. If the annotation you wish to utilize has been previously defined, enter the number of the annotation and press **[ENTER]**. Press the **[NO]** key in response to the question "**Edit Annotation?**" The ADAMM will place an asterisk (\*) next to the part reading status and display the annotation number and definition at the bottom of the Gage Data File.
5. If the annotation you wish to utilize has **not** been previously defined, enter the number of the first unused annotation and press **[ENTER]**. Press the **[YES]** key in response to the question "**EDIT ANNOTATION?**". The ADAMM will display the alphabetic selection bar used to name the definition. Enter the annotation definition and press **[ENTER]** when completed. ADAMM will place an asterisk (\*) next to the part reading status and display the annotation number and definition at the bottom of the Gage Data File.

# 7 CALCULATIONS

## CALIBRATE THE GAGE

The analog signal received from the gaging fixture is an uncalibrated signal that must be scaled before converting it to an actual dimension. The ADAMM software calculates a gain multiplier (MAG) and a zero offset (ZERO) for each part characteristic by taking readings from a max and a min master of known dimensions. This MAG and ZERO are then used to convert the input voltage to an actual dimension. The formulas used to calculate MAG and ZERO are:

$$\text{MAG} = \frac{K_{\text{max}} - K_{\text{min}}}{G_{\text{max}} - G_{\text{min}}}$$

$$\text{ZERO} = K_{\text{max}} - [\text{MAG} \times G_{\text{max}}]$$

Where:

- Kmax is the known size of Max Master.
- Kmin is the known size of Min Master.
- Gmax is the gaged size of Max Master.
- Gmin is the gaged size of Min Master.

If any of the following conditions occur, the gage will not successfully master and the calibration values obtained from the last successful mastering session will be used.

1. MAG correction greater than programmed limit.
2. ZERO correction greater than programmed limit.
3. Gage head saturated.
4. Masters gaged out of sequence. (MIN>MAX)
5. Insufficient Usable Readings

### AIR/ELECTRIC SIGNAL CONDITIONING

The Mag values that are input into the ADAMM for Air/Electronic signals are dependent upon the applicable full scale value that the particular air tooling was designed for. Boxed values are preferred.

<u>Full Scale Value</u>	<u>Low MAG</u>	<u>Medium MAG</u>	<u>High MAG</u>
.010	.600		
.008	.460		
.006	.350		
.005	.290		
.004	.240		
.003	.200		
.002	<span style="border: 1px solid black; padding: 2px;">.120</span>	.360	
.001		<span style="border: 1px solid black; padding: 2px;">.180</span>	.360
.0005			.180
.0002			.072

## SPC VARIABLES

### X-bar, or Mean (average):

$$\bar{X} = \frac{\text{sum of measurements}}{\text{\# of measurements taken}}$$

### Range:

R = largest value - smallest value

### Standard deviation, or sigma:

$$\sigma = \sqrt{\frac{n * (\sum x^2) - (\sum x)^2}{n(n - 1)}}$$

where n is the number of samples taken

### Process Performance:

**Pp** – Relationship of process distribution to spec limits. If PP is >1.33, process is considered capable.

$$Pp = \frac{USL - LSL}{6\sigma}$$

Where  $\sigma$  is the standard deviation  
USL is the upper spec. limit  
LSL is the lower spec. limit

### Process Ratio:

**Pr** – The inverse of Pp.

$$Pr = \frac{6\sigma}{USL - LSL}$$

**Process Index:**

**Ppk** – How centered the process distribution is. If Ppk is >1.33 the process is considered capable.

$$Ppk = \frac{USL - \text{Mean}}{3\sigma} \quad \text{or} \quad \frac{\text{Mean} - LSL}{3\sigma} \quad (\text{whichever is Less})$$

**Lower specification limit:**

**LSL** = User defined

**Upper specification limit:**

**USL** = User defined

**X-double-bar, or average X:**

$$\bar{\bar{X}} = \frac{\text{sum of } \bar{X} \text{'s}}{\# \text{ of } \bar{X} \text{'s}}$$

**Average range:**

$$\bar{R} = \frac{\text{sum of ranges}}{\# \text{ of ranges}}$$

**Upper control limit for X:**

**UCLx** = User defined or ADAMM calculated as below:

$$UCLx = \bar{\bar{X}} + (A2 * R) \quad \text{See control chart constants below for A2 value}$$

**Lower control limit for X:**

**LCLx** = User defined or ADAMM calculated as below:

–

**LCLx** =  $\bar{X} - (A2 * R)$  See control chart constants below for A2 value

**Upper control limit for R:**

**UCLr** = User defined or ADAMM calculated as below:

**UCL $\bar{r}$**  =  $D4 * R$  See control chart constants below for D4 value

**Correlation:**

$$r = \frac{(n * s1) - (x1 * y1)}{\sqrt{(n * x2) - (x1)^2} * \sqrt{(n * y2) - (y1)^2}}$$

- where n = number of samples taken
- s1 = summation of ( X \* Y )
- x1 = summation of X
- x2 = summation of X-squared
- y1 = summation of Y
- y2 = summation of Y-squared

**CONTROL CHART CONSTANTS**

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Number of observations in subgroup

	<b>A2</b>	<b>D4</b>
2	1.880	3.267
3	1.023	2.575
4	0.729	2.282
5	0.577	2.115
6	0.483	2.004
7	0.419	1.924
8	0.373	1.864
9	0.337	1.816
10	0.308	1.777

## GAGE REPEATABILITY AND REPRODUCIBILITY CALCULATIONS

### Measurement Unit Analysis

Repeatability - Equipment Variation (E.V.)

$$E.V. = (\bar{R}) \times (K_1)$$

TRIALS	2	3
K <sub>1</sub>	4.56	3.05

Reproducibility - Appraiser Variation (A.V.)

$$A.V. = \sqrt{[(X_{diff}) \times (K_2)]^2 - [(E.V.)^2 / (n \times r)]}$$

OPERATORS	2	3
K <sub>2</sub>	3.65	2.70

n = Number of Parts

r = Number of Trials

Repeatability and Reproducibility - (R & R)

$$R \& R = \sqrt{(E.V.)^2 + (A.V.)^2}$$

% Tolerance Analysis

$$\% E.V. = 100 * \{ (E.V. / (\text{Tolerance})) \}$$

$$\% A.V. = 100 * \{ (A.V. / (\text{Tolerance})) \}$$

$$\% R \& R = \sqrt{(\% E.V.)^2 + (\% A.V.)^2}$$

NOTE:

Calculations are based upon predicting 5.15 sigma (99% of the area under the normal curve)