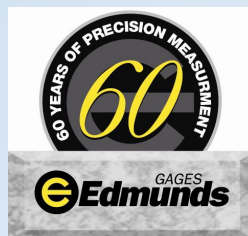
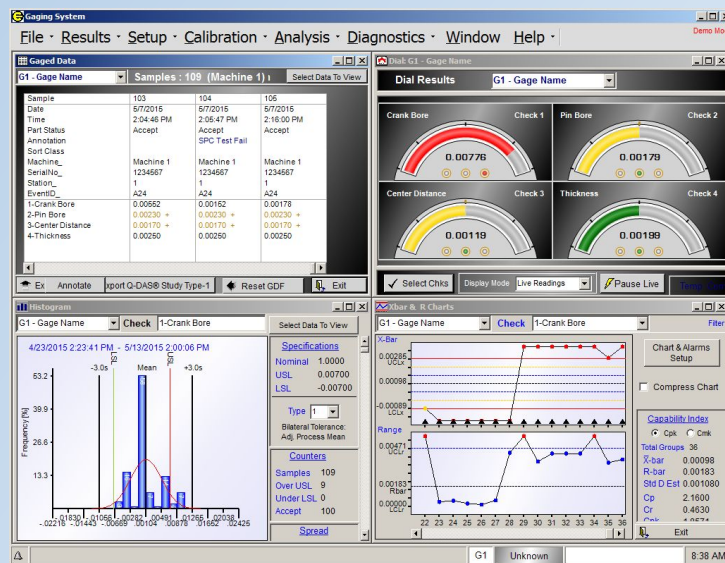


Edmunds Gages

EPIC-CAG™ User Guide

Revision 2.0 8/07/15



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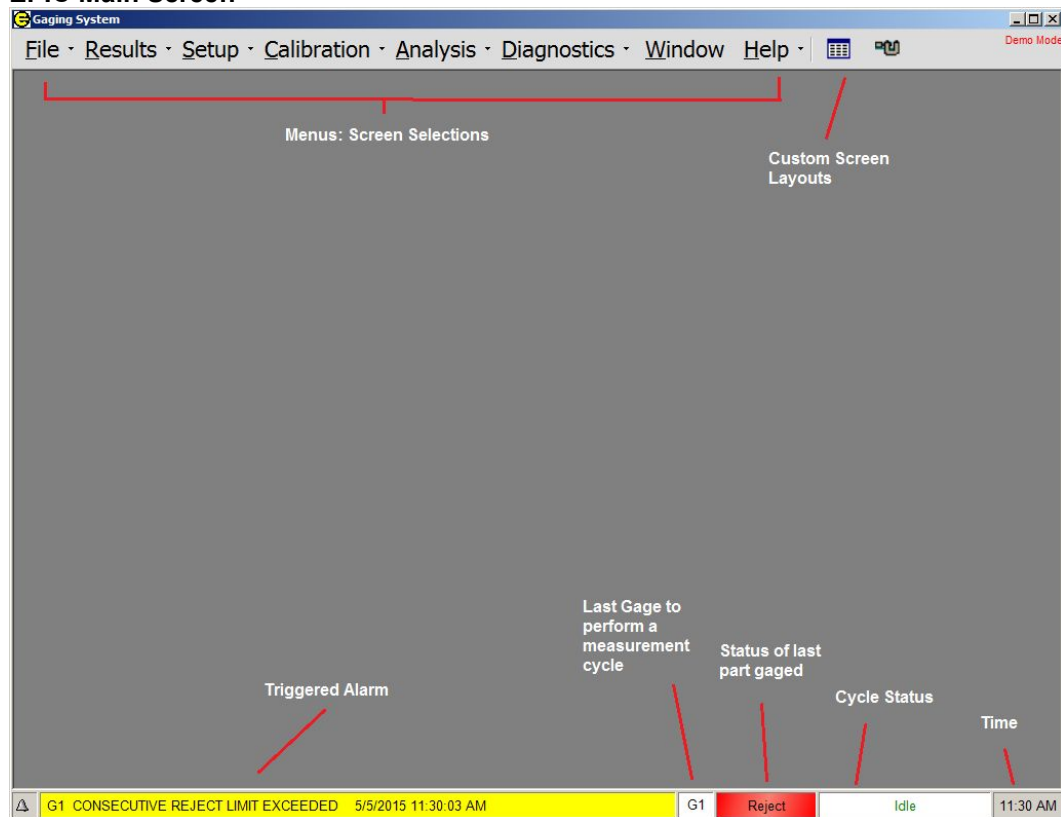
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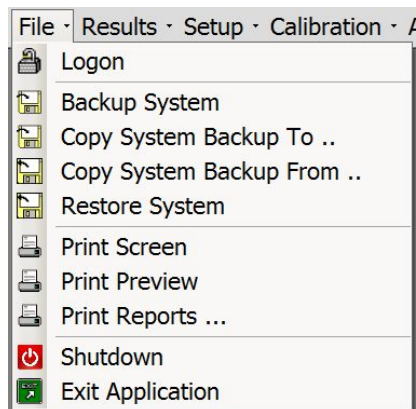
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1. SECTION : Menus - Screen Descriptions

EPIC Main Screen



1.1. File



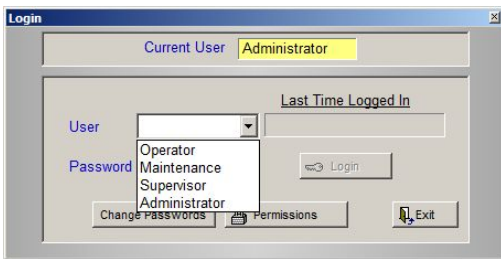
1.1.1. Logon

The “Logon” screen lets the operator login as one or four users (Operator, Maintenance, Supervisor, or Administrator) . The user password and permissions can be change when logged-in as Administrator. When the system is first started the “Operator” user is automatically logged-in and does not require a password.



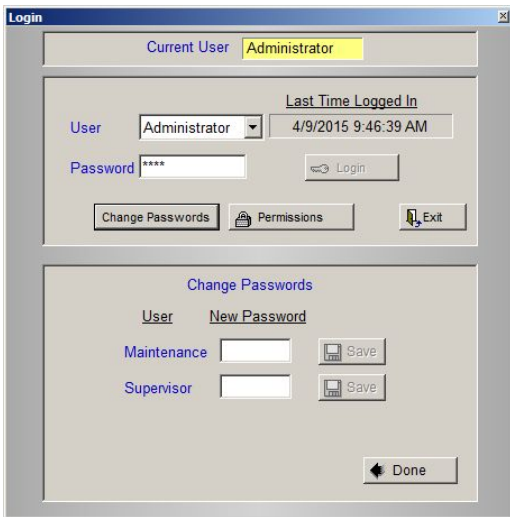
1.1.1.1. User

Use the pull down menu to login as Operator, Maintenance, Supervisor, or Administrator. The administrator can program the different users to have different permissions regarding what can be accessed or changed.



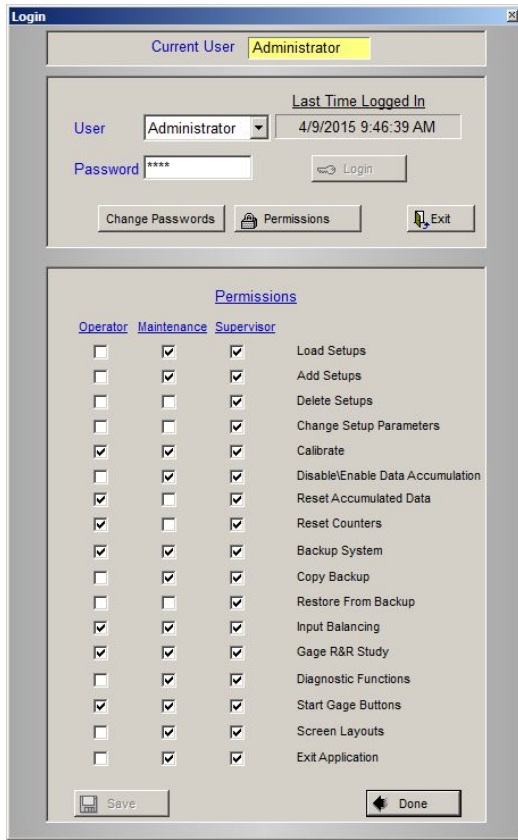
1.1.1.2. Change Password

Only the administrator is allowed to change user passwords. There is no password required to login as “Operator”. The passwords must be 4 character long (numbers and/or alpha characters).

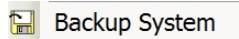


1.1.1.3. Permissions

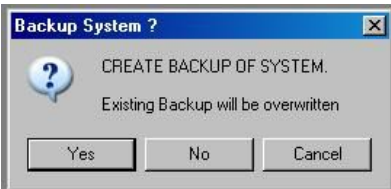
The administrator is allowed to program various permissions for the operator, maintenance, and supervisor.



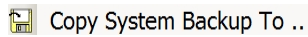
1.1.2. Backup System



Backup System creates a system backup, including all programmed setup parameters and stored results. The backup is stored on the system locally in a predefined location. The current backup will be overwritten.



1.1.3. Copy System Backup To ..



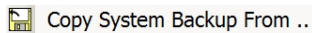
Copies the existing system backup to a user-defined location (example: USB memory stick).



NOTE: The system backup that is copied to the user-defined location is not the current running setup files. To get the current setup files, first need to “Backup System” as explained in section 3.1.2



1.1.4. Copy System From ..




Copies the system backup from a user-defined location to the predefined location on the system. The current backup will be overwritten.

1.1.5. Restore System ..

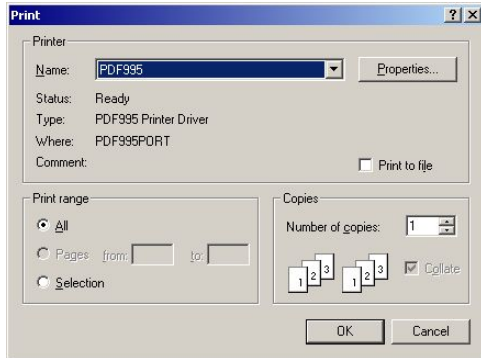


Restores the complete system from the current backup that is stored locally in the predefined location. The current setup will be overwritten including all stored results.


1.1.6. Print Screen

 Print Screen

Allows the operator to print the current screen to a PDF file or an installed printer. If the screen is to be printed to a PDF file select “PDF995” and printer.




1.1.6.1. Print Preview

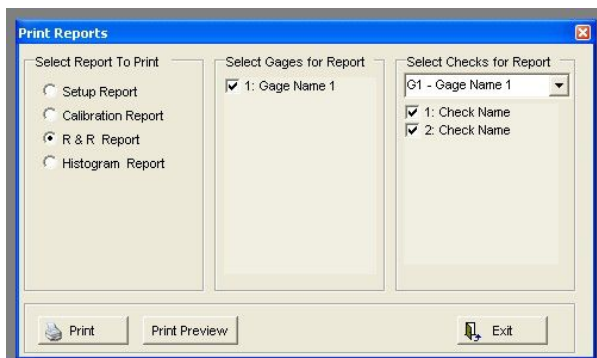
 Print Preview

Displays the print screen in preview mode.

1.1.7. Print Reports ...

 Print Reports ...

Allows the operator to print the following reports to the system default printer:



1.1.7.1. Setup Report

Prints a complete list of setup parameters for the currently loaded setup.

1.1.7.2. Calibration Report

Prints the calibration and verification (optional) results for the selected Gages.

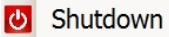
1.1.7.3. R&R Report

Prints the R&R results for the selected Gages and Checks.


1.1.7.4. Histogram Report

Prints the Histogram charts for the selected Gages and Checks.

1.1.8. Shutdown



Shutdown (power-down) the system. The EPIC application will be closed and the operating system will be shutdown.

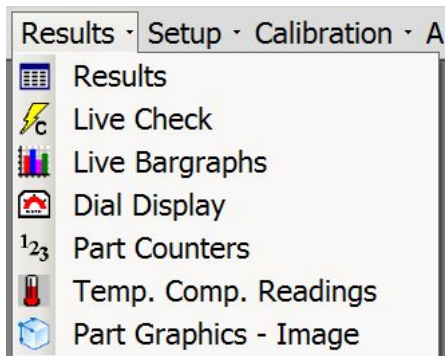
 **NOTE:** The system should be “Shutdown” before power is removed from the system to prevent possible corruption of system software.

1.1.9. Exit Application

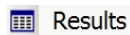


Closes the EPIC software application.

1.2. Results



1.2.1. Results



The Results screen displays the measured results and status for each Check (feature) along with specification limits, part counters and overall part status. This screen will update at the completion of a gaging cycle with the new results data.

Gaging Results | G1 - Gage Name | Units: inch

No.	Check Name	LSL	Nominal	USL	Actual	Deviation	Status
01	Crank Bore	-0.00120	1.00000	0.00120	1.00200	0.00200	Over USL
02	Pin Bore	-0.00150	0.97000	0.00150	0.97200	0.00200	Over USL
03	Center Distance	-0.00200	0.50000	0.00200	0.50200	0.00200	Accept
04	Thickness	-0.00100	1.00000	0.00100	1.00200	0.00200	Over USL

Reject

Gage Cycle Info.

Cycle Status: Idle
 Next Position: Pos-1 1 of 1
 Num. Readings: 37218
 Acquisition Time: 0.064

Part Counts

Accept: 1
 Reject: 4
 Rework: 0
 Total: 5

From: 4/9/2015 9:24:00 AM
 To: 4/10/2015 10:59:39 AM

Sort Class

Classifying Check: 1 - Crank Bore
 Part Class: 10 - Class 10
 Class Value: 0.00200

Temp. Comp. Type: Disabled

G1 | Reject | 10 - Class 10 | 10:59 AM

1.2.1.1. Check Data

For each Check the following information is displayed:

Check Number

Check Name

LSL (Lower Specification Limit)

Nominal (Nominal part size) – Displayed if nominal size entered.

USL (Upper Specification Limit)

Actual (Actual size of the last part gaged) – Displayed if nominal size entered.

Deviation (Deviation from nominal part size) – Displayed if nominal size entered.

Results (Deviation from nominal size) - Displayed if nominal size not entered.

Status (Status of the Check for the last part gaged)

Accept	within limits
Over USL	over upper specification limit
Under LSL	under lower specification limit
Over UAL	over upper approach limit (optional)
Under LAL	under upper approach limit (optional)
Unknown	status not known

1.2.1.2. Gage Cycle Info:

Cycle Status - Current status of the gage cycle.

Next Position - The next position to be gaged in a multiple position gage.

Num. Of Readings - Number of readings taken during the last gaging cycle.

Acquisition Time - Amount of time during which readings were taken.

1.2.1.3. Part Counts

Accept - Total number of accepted parts since the last part counters reset.

Reject- Total number of rejected parts since the last part counters reset.

Rework- Total number of rework parts since the last part counters reset.

Total- Total number of parts gaged since the last part counters reset.



NOTE: The part counters can be reset by selecting menu Results : Part Counters : Reset Counters

1.2.1.4. Sort Class


Classifying Check - The results of this Check are used to sort the part into classes.


Part Class - The class that the last gaged part was sorted into.

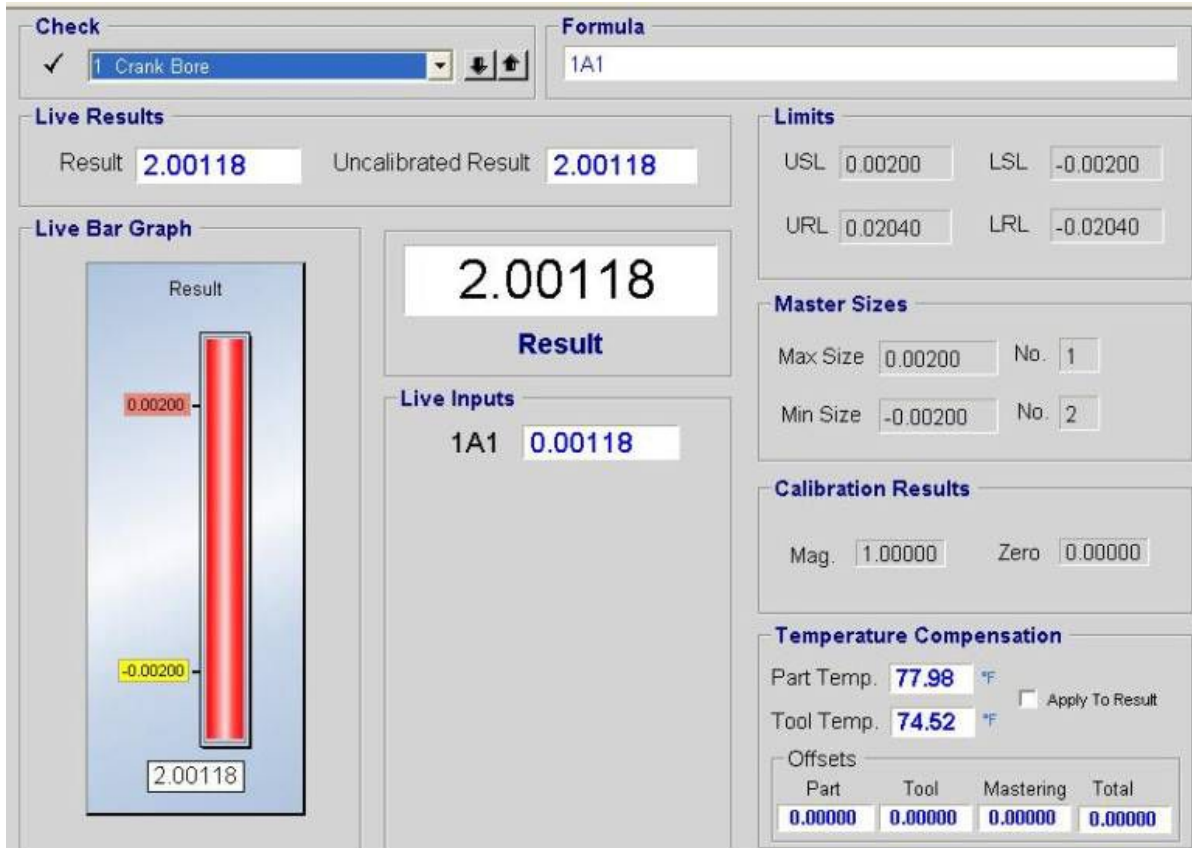
Class Value- The size used to sort the last part gaged.

Class Value = Classifying Check Result x Classifying Mag + Classifying Offset

1.2.2. Live Check

 Live Check

 **NOTE:** Checks that have function defined as Multiple Checks will not be active as live results.



The screenshot displays the 'Live Check' interface for a 'Crank Bore' check. The 'Check' dropdown is set to '1 Crank Bore' and the 'Formula' is '1A1'. The 'Live Results' section shows a 'Result' of 2.00118 and an 'Uncalibrated Result' of 2.00118. The 'Live Bar Graph' shows a red bar at the 2.00118 mark on a scale from -0.00200 to 0.00200. The 'Live Inputs' section shows '1A1' with a value of 0.00118. The 'Limits' section shows USL (0.00200), LSL (-0.00200), URL (0.02040), and LRL (-0.02040). The 'Master Sizes' section shows Max Size (0.00200, No. 1) and Min Size (-0.00200, No. 2). The 'Calibration Results' section shows Mag (1.00000) and Zero (0.00000). The 'Temperature Compensation' section shows Part Temp (77.98 °F) and Tool Temp (74.52 °F) with an 'Apply To Result' checkbox. The 'Offsets' table shows values for Part, Tool, Mastering, and Total, all set to 0.00000.

Part	Tool	Mastering	Total
0.00000	0.00000	0.00000	0.00000

Check

Use the pull down menu to select the Check to be displayed.

Formula

The gage formula for the selected Check. Listed for display only.

Menu: Select Setup → Check Setup to modify the check formula.

Result

A live reading of the check result with the calibrated Mag value and zero offset applied.

$$\text{Result} = (\text{Uncalibrated Result} * \text{MAG}) + \text{ZERO}$$

Uncalibrated Result

A live reading of the check result before the calibrated Mag value and Zero offset is applied.

Live Inputs

A live reading of all inputs used to calculate the Check.

Live Bar Graph

A live reading of the selected parameter. Click on the Results, Uncalibrated Results, or a Live Input and that live reading will be displayed in the live bar graph and the zoomed up display window. If Results or Uncalibrated Results are selected the USL and LSL are displayed to the left of the bar graph. If the Check is within the specified limits the bar will be green. If the Check is below the Lower Specification Limit the bar will be yellow. If the Check is above the Upper Specification Limit the bar will be red.



NOTE: Click on the Results, Uncalibrated Results, or a Live Input to display reading in the live bar graph and the zoomed display window.

Limits

The USL, LSL, URL, and LRL are listed for display only.
Menu: Setup → Check Setup to modify the Check limits.

Master Sizes

The Max and Min master sizes are listed for display only.
Menu: Setup → Check Setup to modify the master sizes.

Calibration Results

The Mag value and Zero offset are listed for display only. These values are from the last successful calibration cycle.

Temperature Compensation (Optional)

Apply to Results

Check this box to include the Total temperature Offset in the live results.

Part Temp

A live reading of the part temperature from the probe set for the current check.

Tool Temp

A live reading of the tooling temperature from the probe set for the current check.

Offsets

Part - The offset based on the current part temperature.

Coeff part \times (temp part – 68°)

Tool- The offset based on the current tool temperature.

Coeff tool \times (temp tool – 68°)

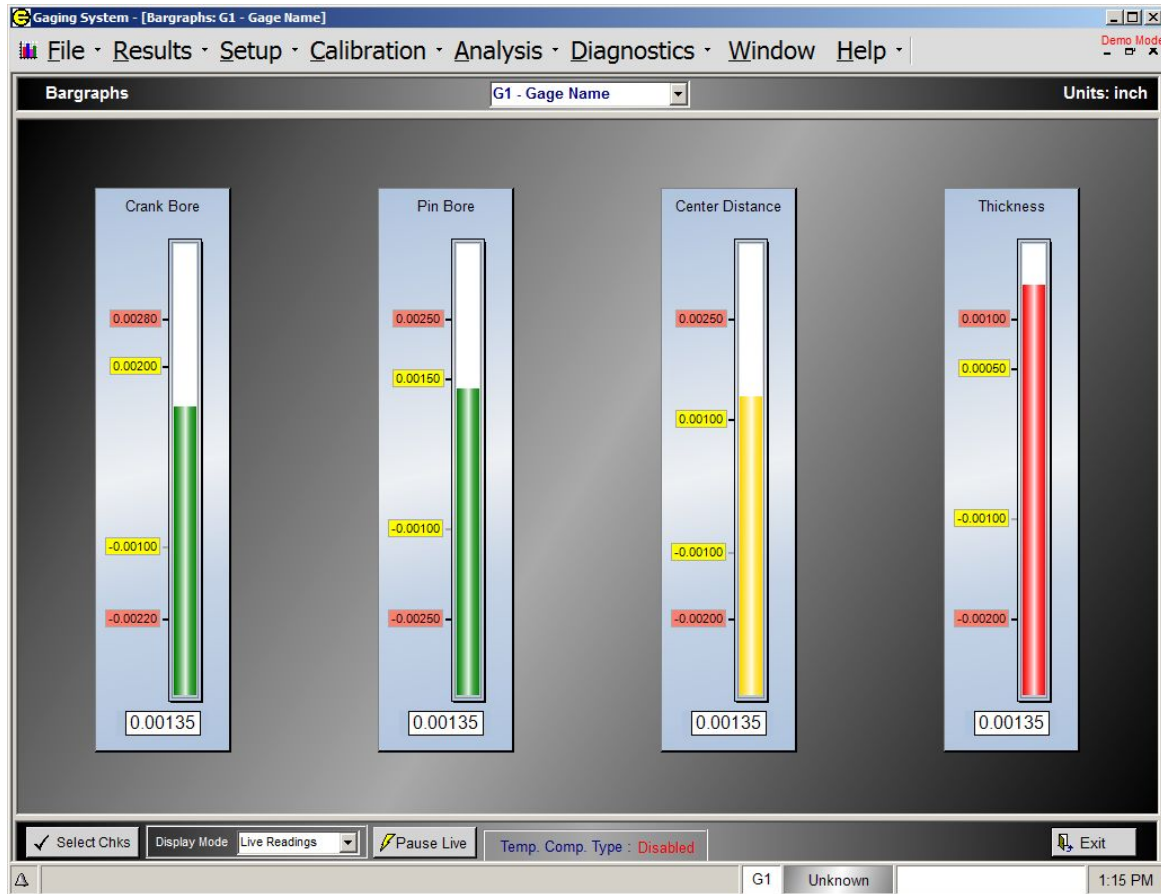
Master - The offset based on the current tool temperature.

Coeff master \times (temp master – 68°)

Total - The offset applied to the Check results.

1.2.3. Live Bar Graphs

Live Bargraphs



Bar Graph

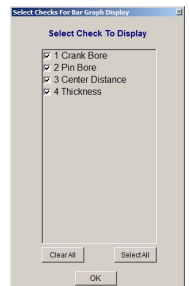
The Check name is displayed above the bar graph. The specification limits and approach limits are displayed to the left of the bar graph.

Bar Color:

- Green - Result within approach limits (if used) and within specification limits.
- Yellow - Result within specification limits and outside approach limits.
- Red - Result outside specification limits.

Select Checks

Selecting this button opens a dialog box with a list of all the Checks in the current gage. To display a Check select the check box to the left of the check name on the list.




Display Mode

Use the pull down menu to select either "Last Part Gaged" or "Live Readings". If "Last Part Gaged" is selected, the bargraphs will display the results of the last part gaged. If Live Readings is selected then the bargraphs will display a live

reading of the checks. If Live Readings is selected then a button will be displayed to allow the operator to "Start" or "Pause" the live readings.

1.2.4. Dial Display

 Dial Display



Dial

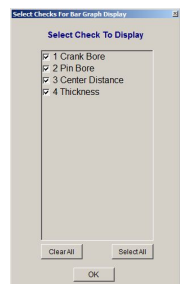
The Check name is displayed in top left corner. The specification limits and approach limits (optional) are indicated on the dial display with hash mark.

Dial Color:

- Green** - Result within approach limits (if used) and within specification limits.
- Yellow** - Result within specification limits and outside approach limits.
- Red** - Result outside specification limits.

Select Check

Selecting this button opens a dialog box with a list of all the checks in the current gage. To display a Check select the check box to the left of the check name on the list.



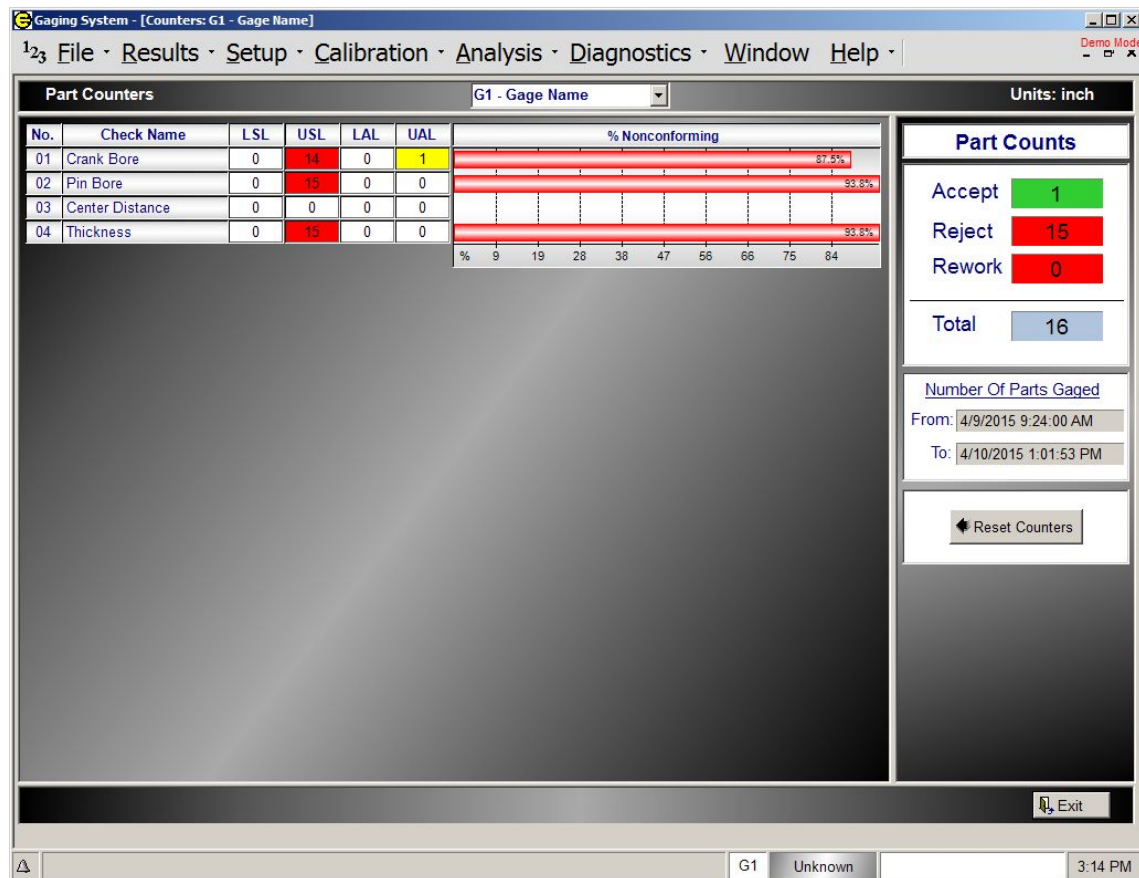
Display Mode

Use the pull down menu to select either "Last Part Gaged" or "Live Readings".

If "Last Part Gaged" is selected the Dial will display the results of the last part gaged. If Live Readings is selected then the Dials will display a live reading of the Checks. If Live Readings is selected then a button will be displayed to allow the operator to "Start" or "Pause" the live readings.

1.2.5. Part Counters

1.2.3 Part Counters



NOTE: If the Check is not enabled or set to display in the **Check Setup** screen the Check will not be displayed on the Part Counters screen.

For each Check the following information is displayed:

Check Number

Check Name

LSL – The number of parts gaged under the Lower Specification Limit.

USL – The number of parts gaged over the Upper Specification Limit.

LAL – The number of parts gaged under the Lower Approach Limit (Optional).

UAL – The number of parts gaged over the Upper Approach Limit (Optional).

%Nonconforming - displays graphically the percentage of parts gaged that are outside specification limits for the given Check.

Reset Counters

Selecting this button will reset all counters to zero for the current gage.

1.2.6. Temperature Compensation Readings (Optional)

 Temp. Comp. Readings

Displays the temperature compensation reading for the last part gaged.



No.	Check Name	Probe Set	Part Temperature	Part Offset	Tool Temperature	Tool Offset	Calibration Offset	Total Offset
01	Crank Bore	Probe Set 1	78.86°	0.00022	74.75°	-0.00007	0.00000	0.00015
02	Pin Bore	Probe Set 1	78.86°	0.00022	74.75°	-0.00007	0.00000	0.00015
03	Center Distance	Probe Set 1	78.86°	0.00022	74.75°	-0.00007	0.00000	0.00015
04	Thickness	Probe Set 1	78.86°	0.00022	74.75°	-0.00007	0.00000	0.00015

Temperature Compensation Readings

No. - The Check number associated with the temperature compensation option. For display only.

Check Name - The Check name associated with the temperature compensation option. For display only.

Probe Set - The probe set used to measure the temperature of the part and tooling. For display only.

Part Temperature - Reading in degrees Fahrenheit of the part temperature from the designated probe set for the current Check during the last gaging cycle.

Part Offset - The calculated part offset based on the part temperature during the last gage cycle.
Coeff part x (temp part – 68°)

Tool Temperature - Reading in degrees Fahrenheit of the tooling temperature from the designated probe set for the current Check during the last gaging cycle.

Tool Offset - The calculated tool offset based on the tool temperature during the last gaging cycle.
Coeff tool x (temp tool – 68°)

Mastering Offset - The calculated mastering offset based on the master temperature during the last calibration cycle. Coeff master x (temp master – 68°)

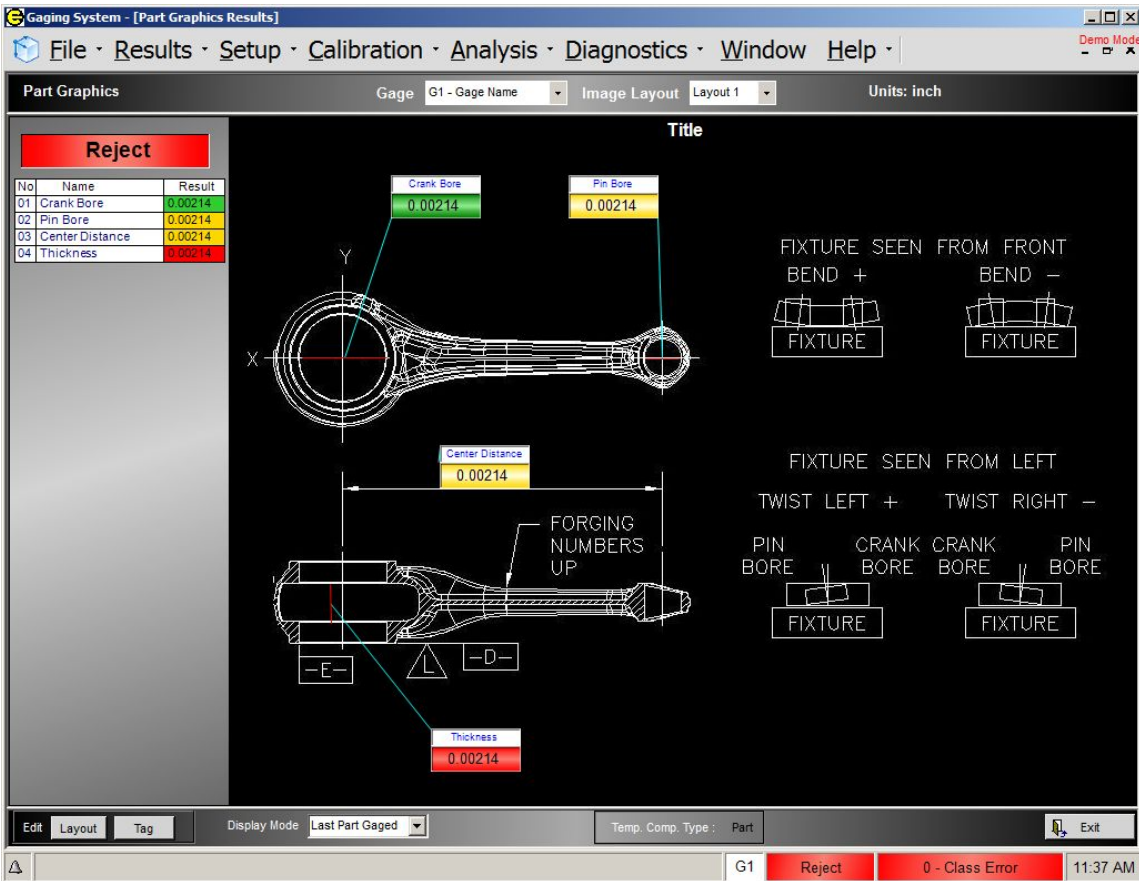
Total Offset - The offset applied to the Check results during the last gage cycle.
(Part Offset + Tool Offset + Mastering Offset)

1.2.7. Part Graphics - Image (Optional)

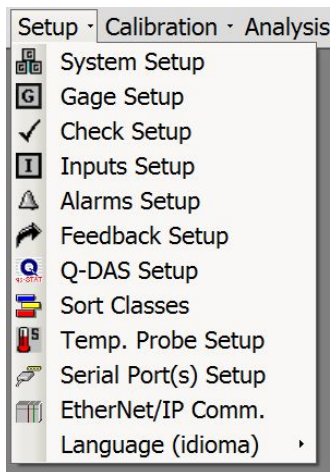
 Part Graphics - Image

The Part Graphics screen is a results screen that can be customized to display part graphics with live measurement results. A graphical image of the part and the features (Checks) being measured can be displayed.

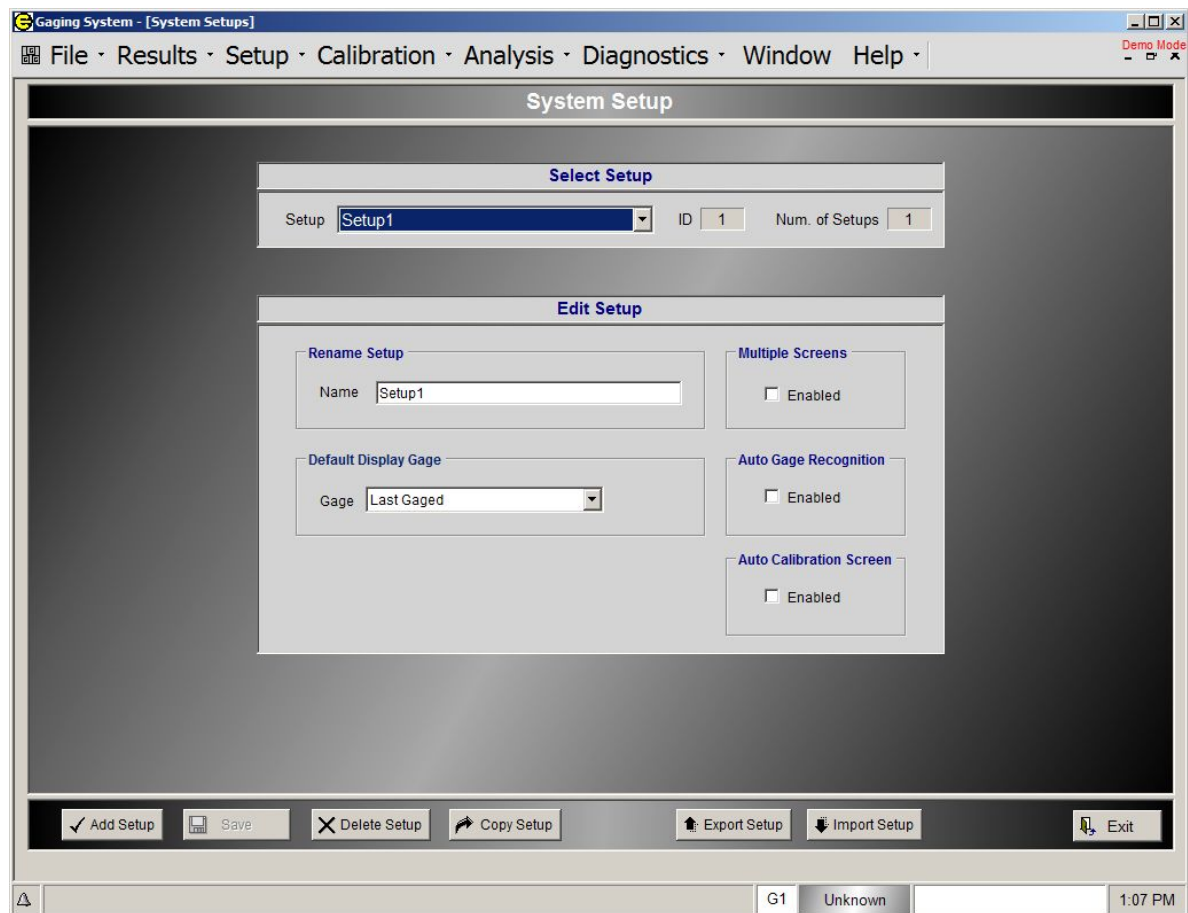
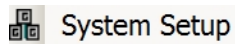
See [SECTION 8 Part Graphics](#) for more details on setting up a Part Graphics results screen.



1.3. Setup



1.3.1. System Setup



Select Setup

Setup - Indicates name of the currently selected setup. Use the pull down menu to select another setup. A setup consists of all programmed parameters needed to run the system. Multiple setups can be programmed but only one can be loaded at a time. Note that one setup may contain one or more gages.

ID- Unique number assigned to the setup.

Num. of Setups - Indicates the number of setups currently programmed.

Edit Setup

Rename Setup - The name of the current setup can be changed by entering a new name in this field.

Default Display Gage - If more than one Gage is programmed in the current setup use the pull down menu to select the Gage that will be the default display Gage in the setup, results, and mastering screens.

Multiple Screens - If the Enable box is checked a new window will open every time a new menu is selected from a pull down menus or the short cut key. This will allow for multiple screens to be viewed at one time. If the Enable box is not checked only one window will be open at a time. When a new screen is selected from a pull down menus or short cut key the old window will close automatically.

Auto Gage Recognition - When a start gage signal is received, a gage cycle will be performed for the first Gage found that has all it's Checks within reasonable limits.

Auto Calibration Screen - If an auto calibration signal is received, the Calibration screen will automatically be displayed.



Add Setup - Adds a new setup. The new setup contains default values and must be programmed by operator as required.

Save - If a change is made on this screen then this field will be highlighted in red indicating that the setup must be saved before exiting the screen or the changes will be lost. If the operator leaves the screen without saving the change will not be saved.

Delete Setup - Deletes the currently selected setup.

Copy Setup - Copies the currently selected setup.

Export Setup - Exports the current setup to a .txt file. This file contains all the programmable parameters of the current setup.

Import Setup - Imports an existing setup from a .txt file. The imported setup will be added as an additional system setup and can be accessed from the Setup ID pull down.

1.3.2. Gage Setup

G Gage Setup

1.3.2.1. Select Gage

Gage - Indicates the number and name of the currently selected Gage. Use the pull down menu to select another Gage.

Enabled - If Enabled is not checked then the Gage will not respond to a start Gage command and therefore will not Gage.

Number of Gages - Indicates the number of Gages in the current setup.

1.3.2.2. Nominal

If the “Apply Nominal” button is checked then the nominal size programmed on the Check Setup screen will be applied to the Check results. **Limits and master sizes must be programmed in absolute sizes.**

If the “Apply Nominal” button is not checked then the nominal size programmed on the Check Setup screen will not be applied to the check results. The programmed nominal will be used for reference only.

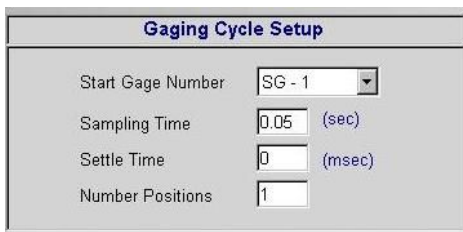
Limits and master sizes must be programmed as deviation from nominal size.

1.3.2.3. Units



Results can be calculated in inches or millimeters. Limits and master sizes must be programmed in the corresponding units.

1.3.2.4. Gaging Cycle Setup



Start Gage Number

The system is capable of receiving a total of four (12) individual start gage commands from an external device (See Section 3 EPIC CAG Communications). The start gage commands are numbered 1-12. The start gage command can be assigned to a gage by selecting the start gage number for the pull down menu. When the start gage command is received, it will initiate a gaging cycle for the assigned Gage.

Gage Linking -

Multiple Gages can be assigned the same Start Gage Number. In this case, a gage cycle will be initiated for each Gage assigned to the received start gage number (Gage Linking). The gage cycles will be initiated one after the other starting with the Gage with the lowest Gage Number.

Example:

The CAG™ is configured as 3 Gages for 1 tooling fixture. There is one Push Button Pack connected to the system providing a Start Gage Number 1 (SG-1) command. It would be desirable to initiate Gage #1, Gage #2 and Gage #3 measurement cycles at the same time. By assigning SG-1 to Gage #1, Gage #2 and Gage #3 all three Gages will perform a measurement cycle on after the other.

Sampling Time

The amount of time in seconds during which the Gage will take readings. If the Gage is programmed with multiple positions then the sample can be programmed individually for each gaging position (see *Number of Positions* below). NOTE: A minimum number of readings (40) will be taken regardless of the sampling time.

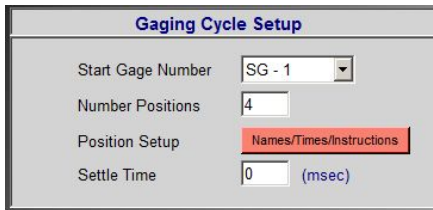
Settle Time

The amount of time in seconds after a start Gage command before readings are taken. If the Gage is programmed with multiple positions then the settle time programmed will be the same at all Gage positions.

Number of Positions

Number of positions making up a gage cycle. If the number of positions is greater than one then a start Gage command must be issued for each position. All Checks defined at position one will be recorded at the first start Gage command, all Checks defined at position two will be recorded at the second start gage command, etc.

If the Number of Positions is greater than one, a selection button is present that will display a screen for setting the names, sample times and instructions for each position (see below).



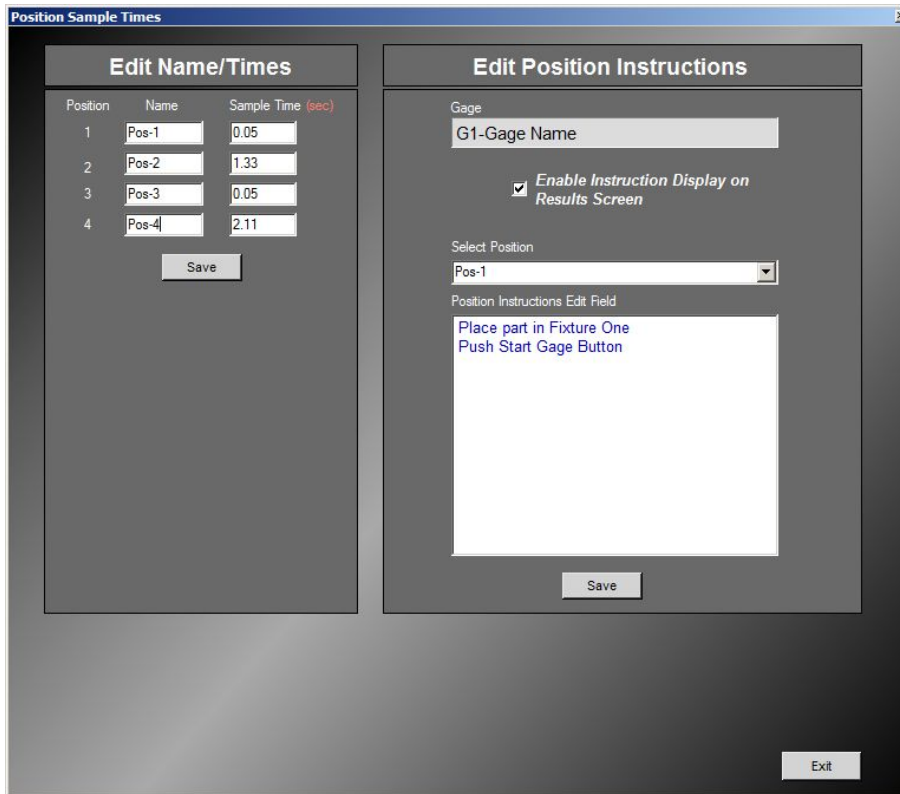
Gaging Cycle Setup

Start Gage Number: SG - 1

Number Positions: 4

Position Setup: **Names/Times/Instructions**

Settle Time: 0 (msec)



Position Sample Times

Position	Name	Sample Time (sec)
1	Pos-1	0.05
2	Pos-2	1.33
3	Pos-3	0.05
4	Pos-4	2.11

Edit Name/Times

Edit Position Instructions

Gage: G1-Gage Name

Enable Instruction Display on Results Screen

Select Position: Pos-1

Position Instructions Edit Field

Place part in Fixture One
Push Start Gage Button

Save

Exit

Edit Names/Times

Name - Name assigned to a gaging position used for easy identification.

Sample Time - The amount of time in seconds during which the Gage will take readings for the given gaging position.

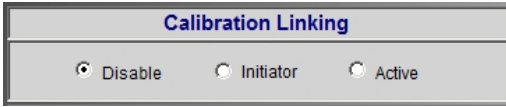
Edit Position Instruction

Enable Instruction Display on Results Screen - When checked the programmed position instructions will be displayed on the Results Screen.

Select Position - Drop down box that allows the selection of a position in which instructions can be entered.

Position Instruction Edit Field - Edit field that allows the user to enter custom instruction and or information pertaining to the selected Gage position. The text entered in this field will be displayed on the Results Screen when the Gage is in the gaging position.

1.3.2.5. Calibration Linking



Calibration linking provides the ability to link Calibration cycles together for 2 or more defined Gages.

Initiator - assigns the current Gage as the initiator of the Calibration Cycles. When the Gage that is assigned as initiator is calibrated all other Gages assigned as active will also be calibrated.

Active - assigns the current Gage as calibration linking active. When the initiator Gage is calibrated the Gages assigned as active will also be calibrated.

Disabled - assigns the current Gage as calibration linking disabled. The Gage will not be calibrated when the initiator Gage is calibrated.

Example:

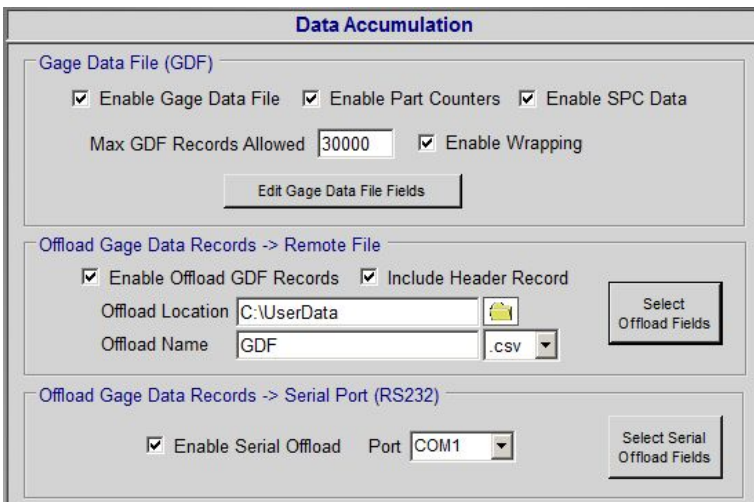
The CAG™ is configured as 3 Gages with all having the same Checks and using the same Mastering artifacts to calibrate. It would be desirable to initiate Gage #2 and Gage #3 calibration cycles at the same time as Gage #1. By programming Gage #1 as the Initiator and Gage #2 and Gage #3 as active, a Gage #1 calibration cycle will also initiate Gage #2 and Gage #3 calibration cycles as well.

1.3.2.6. EtherNet/IP - Write Status To Controller TAG (Optional)

If the EtherNet/IP option is installed the part status can be written to “TAG” on connected PLC controller at the completion of a measurement cycle.



1.3.2.7. Data Accumulation



Gage Data File (GDF)

Enable Gage Data File - If this box is checked the results of the currently selected Checks will be recorded in the gage data file. All charts and statistics are computed from the data stored in the Gage Data File (GDF).

Enable Part Counters - If checked, part counters will be enabled.

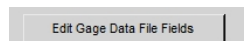
Enable SPC Data - If checked, calculated SPC data will be stored for use in SPC charts and SPC alarms.

Max GDF Records Allowed - Maximum number of records allowed to be stored in the GDF. Once this limit is reached, additional reading will not be stored in the GDF.

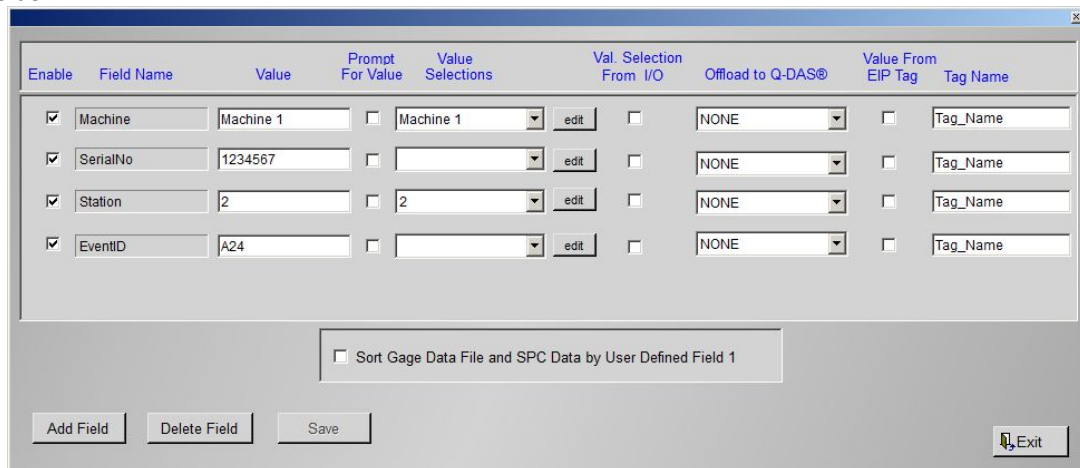
Enable Wrapping - if wrapping enabled, the oldest sample record will be removed from the GDF and the new sample record will be added. Wrapping will start when the "Max GDF Records Allowed" limit is reached.

User Defined Gage Data File Fields

Edit Gage Data File Fields - When this button is selected a screen is displayed that allows the user to enter/edit User Defined Fields.



The user can add up to five user-defined fields to the gage data file. For example, the user can program a field to record the part serial number or the machine or spindle that the part was machined on. If there is any data currently in the gage data file the user cannot add or alter the existing user defined gage data file fields.



The screenshot shows a dialog box titled "Edit Gage Data File Fields". It contains a table with the following columns: Enable, Field Name, Value, Prompt For Value, Value Selections, Val. Selection From I/O, Offload to Q-DAS®, Value From EIP Tag, and Tag Name. There are four rows of data:

Enable	Field Name	Value	Prompt For Value	Value Selections	Val. Selection From I/O	Offload to Q-DAS®	Value From EIP Tag	Tag Name	
<input checked="" type="checkbox"/>	Machine	Machine 1	<input type="checkbox"/>	Machine 1	edit	<input type="checkbox"/>	NONE	<input type="checkbox"/>	Tag_Name
<input checked="" type="checkbox"/>	SerialNo	1234567	<input type="checkbox"/>		edit	<input type="checkbox"/>	NONE	<input type="checkbox"/>	Tag_Name
<input checked="" type="checkbox"/>	Station	2	<input type="checkbox"/>	2	edit	<input type="checkbox"/>	NONE	<input type="checkbox"/>	Tag_Name
<input checked="" type="checkbox"/>	EventID	A24	<input type="checkbox"/>		edit	<input type="checkbox"/>	NONE	<input type="checkbox"/>	Tag_Name

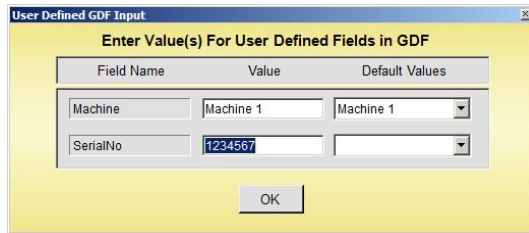
Below the table is a checkbox labeled "Sort Gage Data File and SPC Data by User Defined Field 1". At the bottom of the dialog are buttons for "Add Field", "Delete Field", "Save", and "Exit".

Enable - If Enable is checked then the field will be recorded in the Gage Data File.

Field Name - User defined name of the field in the Gage Data File.

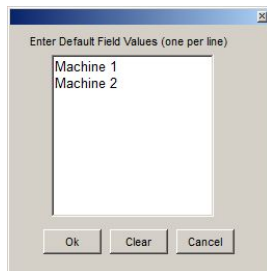
Value - This value that will be recorded in the Gage Data File.

Prompt - If "Prompt" is selected, the CAG will display a dialog box at the end of each gage cycle requesting the operator to enter the value for all enabled user defined fields.



Value Selections - A list of predefined values. When a value is selected from the list it will be written to the “Value” field and will be recorded in the Gage Data File at the end of the next gaging cycle.

Value Selections (Edit) - By clicking “Edit” a pull down list of values can be created.



Value Selection From I/O - Input message from external machine control (PLC) used to select value from list of value selections.

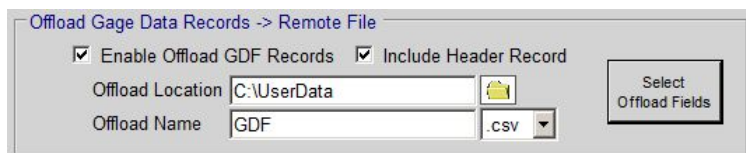
Offload to Q-DAS (Optional) - The user defined field value can be offloaded to a specified Q-DAS key by selecting the key from the pull down menu (only available if Q-DAS option installed).

Value From EIP Tag (Optional) - if checked, it will read value from an EtherNet/IP TAG on a connected PLC controller at store in the user defined field value.

Tag Name (Optional) - Name of EtherNet/IP TAG located on the connected PLC controller.

Offload Gage Data Records -> Remote File

The EPIC system can be setup to offload measured results to a specified file after each measurement cycle. The offload file will be comma delimited text file format with either a .txt or .csv extension. The offload file can reside on the EPIC system or externally on USB memory drive or mapped Network drive. The offloaded results record will be appended to an existing file or a new file will be created if it does not exist. The offload can be enabled and setup in the EPIC Gage Setup screen.



Enable Offload GDF Records - When checked the GDF records will be written to the specified file.

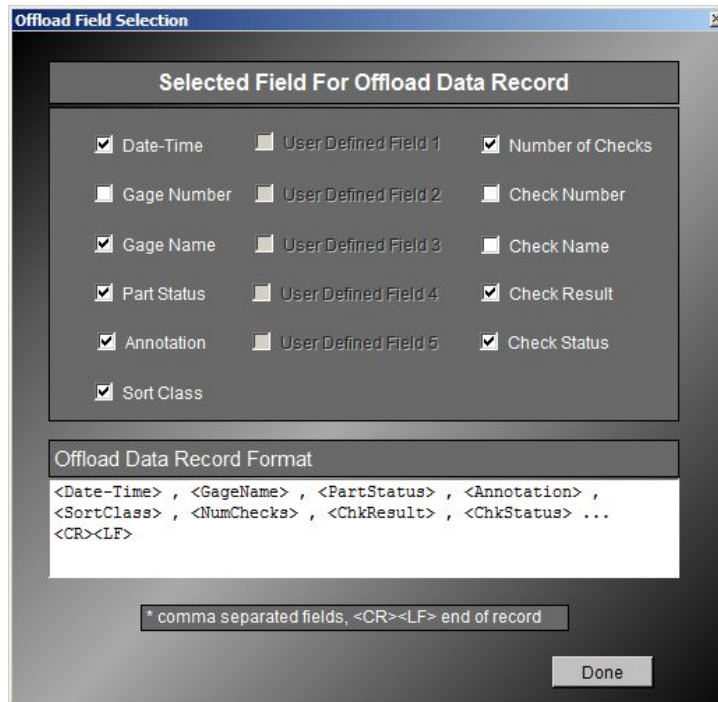
Include Header Record - If the “Include Header Record” is selected, a single header record will be written as the first line the offload file. The header record will contain descriptions of each field in data records that follow.

Offload Location - Location of the offload file, this can be a shared network drive/folder, USB memory drive or locally on EPIC system (C:\UserData).

Offload Name - Programmable name of the offload file.

File Extension (.CSV or .Txt) - Offload file extension, used by external application to open the file.

Select Offload Fields - When this button is selected a screen is displayed that allows selection of the fields to be offloaded.



File Format Example:

The example below is the contents of an offload file for a EPIC system setup with two Checks (ID Bottom and OD Top) and sort class option enabled. The fields selected for offload are show in the figure above. The "Include Header Record" was also enabled.

```
Date-Time,Gage Name,Part Status,Annotation,Sort Class,Number of Chks,ID Bottom,ID
Bottom Status,OD Top,OD Top Status
6/26/2015 1:48:54 PM,Connector Rod,Accept, ,Class 2,2,0.00231,Accept,0.00201,Accept
6/26/2015 1:48:55 PM,Connector Rod,Accept, ,Class 2,2,0.00230,Accept,0.00200,Accept
6/26/2015 1:50:43 PM,Connector Rod,Accept, ,Class 2,2,0.00230,Accept,0.00200,Accept
6/26/2015 1:50:44 PM,Connector Rod,Accept, ,Class 2,2,0.00230,Accept,0.00200,Accept
6/26/2015 1:50:45 PM,Connector Rod,Accept, ,Class 2,2,0.00230,Accept,0.00200,Accept
```

Offload Gage Data Records -> Serial (RS232)

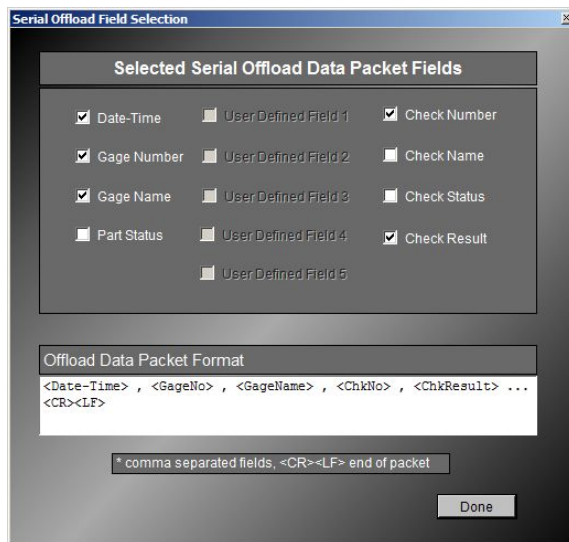


This option allows the offload of GDF record data out the RS232 serial port at the completion of each gaging cycle. The GDF record will be transmitted in ASCII comma-delimited format ending with new line characters (carriage return/line feed). The data packet that makes up the transmitted record is programmable (see Select Serial Offload Fields below)

Enable Serial Offload - When checked the GDF records will be transmitted out the selected serial port.

Port - Serial Communication Port (Com) that will be used to transmit the GDF records. The serial port setup and configuration are done in the Serial Port Setup screen.

Select Serial Offload Fields - When this button is selected a screen is displayed that allows selection of the fields to be offloaded.



Example of offloaded Data Packet:

4/20/2015 8:35:58 AM,1,Gage Name,1,1.00216,2,0.97216,3,0.50216,4,1.00216<CR><LF>

1.3.2.8. Add/Save/Delete Gage



Add Gage - Adds a new Gage with default values programmed. The new Gage must be programmed by operator as required.

Save - If a change is made on this screen then this field will be highlighted in red indicating that the setup must be saved before exiting the screen or the changes will be lost. If the operator leaves the screen without saving the change will not be saved.

Delete Gage - Deletes the currently selected Gage. All Checks, setups and accumulated data will be deleted

1.3.3. Check Setup

✓ Check Setup

1.3.3.1. Select Check

Check- Indicates the number and name of the currently selected Check. Use the pull down menu or Up/Down arrows to select another Check.

Number of Checks- Indicates the number of Checks in the current setup.

1.3.3.2. Enable/Display/Resolution

Enable- if enabled the Check will be evaluated during the measurement cycle and compared against limits to determine Check and Part Status

Display- if the Display box is selected, the Check will be displayed on all results screen. If the Display box is not selected the Check will not appear on the any of the results screens but will still be evaluated during the measurement cycle and compared against limits and used to determine Part Status.

1.3.3.3. Function - Formula

Each check is defined by a function, a formula, and for multi-position gages a position. Refer to the CAG program guide supplied with the Gage for specific information on the programmed checks in a given application.

Function - Defining a Check's function involves assigning one of the following functions to the Check:

Average: A Check that is defined as “Average” will sum all of the gage readings and divide it by the number of gage readings.

Max: Defining a Check's function as “Max” results in the largest gage reading being displayed for the part check. The largest gage reading is defined by the Queue size and filter (See Sampling)

Min: Defining a Check's function as “Min” results in the smallest gage reading being displayed for the part check. The smallest gage reading is defined by the Queue size and filter (See Sampling)

TIR: (Total Indicator Reading) represents the difference between the maximum reading and the minimum reading. Max and Min gage readings are defined by the Queue size and filter (See Sampling)

Alt TIR: Total Indicator Reading using an alternate Check's Mag in the formula.

Multi Chk: A Multiple Check is a Check that is defined as a function of two or more defined Checks.

Multi2 Chk: A Multiple2 Check is a Check that is defined as a function of two or more Checks that are defined as Multiple Checks.

Gage Chk: Check results is the copy of a Check result from another Gage.

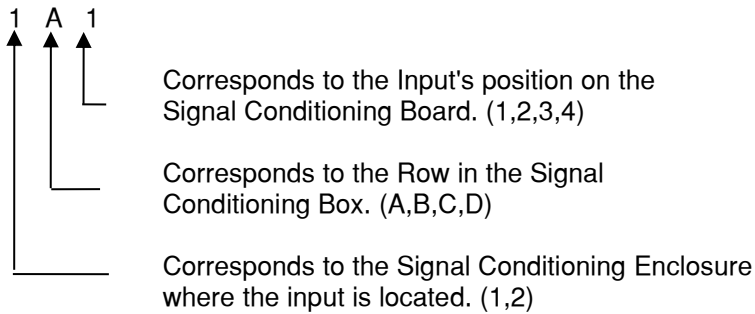
Ethernet/IP : (Optional) Check results is obtained from an EtherNet/IP Tag located on an external connected PLC controller.

Formula

The formula is a mathematical expression that is used to compute the results of the Check. The formula can contain more than one Input, Check, Operator, Function or combination there of. The Formula Generator lists the available Inputs, Operators and Functions the system can use to calculate a result.

Formula Generator

Inputs - Input identification numbers are defined as follows:



Numeric - Whole numbers from "0" to "9". Decimal points can be used with the numbers.

Operator - Standard arithmetic operators (+, -, *, /, Div, ^, mod, >, <)

Function - A variety of mathematic functions can be applied to any individual Check or Input to generate a Check formula.

Sqrt - Square Root Example: Sqrt(C1) would yield the square root of Check #1.

^ - Raised to the Power Of Example: 1A1^(2) would yield the square of 1A1.

Max - Maximum Value Example: Max(1A1, 1A2, 1A3) – Returns the Max value of the 3 inputs

Min – Minimum Value Example: Min(1A1, 1A2, 1A3,) – Returns the Min value of the 3 inputs

Abs – Absolute Value Example: Abs(1A1)

Sin - Sine

Cos - Cosine

Tan - Tangent

Cot - Cotangent

Arcsin - Arc Sine

Arcos - Arc Cosine

Arctan – Arc Tangent

Arccot - Cotangent

Exp – e to the Power Of

Exp2 – 2 to the Power of

Log – Natural Log

Log2 - Log Base 2

Log10 – Log base 10

Multiple Checks in a Gage with only one gage position

The system can combine the results of two or more Checks. For example if Check #1 and Check #2 measure a shaft diameter at two different points the taper can be calculated by a multiple check using the formula as follows:

$C1 - C2$ (Check #1 minus Check #2)

Multiple Checks in a Gage with two or more gage positions

If a Gage is programmed with multiple positions then the formula for the multiple check must define both the Check number and the position at which the Check readings are taken. Write the Check formula in the manner shown below.

$C1_1 + C2_1 + C3_2$

(Check #1 at position 1 plus Check #2 at position 1 plus Check #3 at position 2)

Calc. Result- For Gages programmed with multiple positions only. This is the position at which the Check results will be calculated.

1.3.3.4. Specification Limits

Specification Limits						
Nominal	Approach		Specification		Reasonable	
0	UAL	1.00000	USL	1.00300	URL	1.02040
	LAL	1.00000	LSL	0.99720	LRL	0.97960

Nominal - The nominal size of the current Check. See also the Gage Setup screen. If “Apply Nominal” is selected then the results will use this nominal value to display in absolute size.

UAL - (optional) The upper approach limit for the current Check. If the gaged reading violates this limit it will be indicated on results screens and in the gage data file. A value of zero “0” will disable this limit from being used.

LAL - (optional) The lower approach limit for the current Check. If the gaged reading violates this limit it will be indicated on results screens and in the gage data file. A value of zero “0” will disable this limit from being used.

USL - The upper specification limit for the current Check. If a gaged reading is above this value the part will be rejected.

LSL - The lower specification limit for the current Check. If a gaged reading is below this value the part will be rejected.

URL - The upper reasonable limit for the current Check. If a gaged reading is above this value the part data will not be stored in the gage data file and an alarm will be triggered if enabled.

LRL - The lower reasonable limit for the current Check. If a gaged reading is below this value the part data will not be stored in the gage data file and an alarm will be triggered if enabled.

1.3.3.5. Sampling

Sampling is only selectable if the check function is defined as MAX, MIN, or TIR.

Sampling	
Queue Size	20
Filter	5
Min. Delta	0.000000
Min. Samples	40

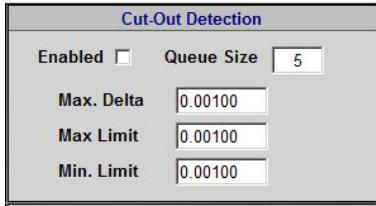
Queue Size - The number of Maximum and Minimum readings stored during a gage cycle. In this setting the 20 maximum and 20 minimum readings would be used.

Filter - The number of Maximum and Minimum Readings that are discarded. In this setting the 5 largest and 5 smallest readings would be discarded.

Min Delta - The minimum amount of expected change from one valid reading to the next. This value is used in a dynamic gaging cycle to determine when a part is stationary. Readings will be discarded that do not meet the minimum amount of change.

Min. Samples - The minimum number of valid samples needed to calculate the check result. If the Min number of samples is not met the Check result will display an “UNKNOWN” status and an alarm will be triggered if enabled.

1.3.3.6. Cut-Out Detection



Cut-Out Detection	
Enabled	<input type="checkbox"/>
Queue Size	5
Max. Delta	0.00100
Max Limit	0.00100
Min. Limit	0.00100

Cut-Out Detection allows for measurement of interrupted gaging surfaces in a dynamic gaging cycle by eliminating the readings, which are taken on non-functional surfaces. By establishing discriminate parameters, each check can be tailored to record only those readings, which are applicable to the characteristic being checked.

Cut-Out Detection is based upon the readings of the gage cycle. These readings are best observed in Diagnostic Menu "Monitor Check". Once the reading meets the set-up parameters, it is stored in the Queue.

The Queue is a buffer for acceptable readings taken during the gage cycle. Once the Queue is full, that is, the number of readings stored equals the Queue Size programmed, the next acceptable reading causes the first reading stored to be used by the CAG in the gaging algorithm.

The set-up parameters for Cut-Out Detection are:

Queue Size – The number of acceptable raw readings that the CAG will store in the Queue. The default value for the Queue Size is 4.

Max. Delta - The maximum allowable difference between progressive readings during a dynamic gage cycle. This allows the operator to establish the point during the gaging cycle when the input (LVDT or Air Nozzle) has begun to enter or exit the unusable area of the part (cutout). As long as the readings do not violate the Max Delta, the readings will be stored in the Queue.

Once the Max Delta has been violated, the CAG will purge the Queue and discontinue storing readings in the Queue until the readings fall within the Max and Min Limits and do not violate the Max Delta criteria.

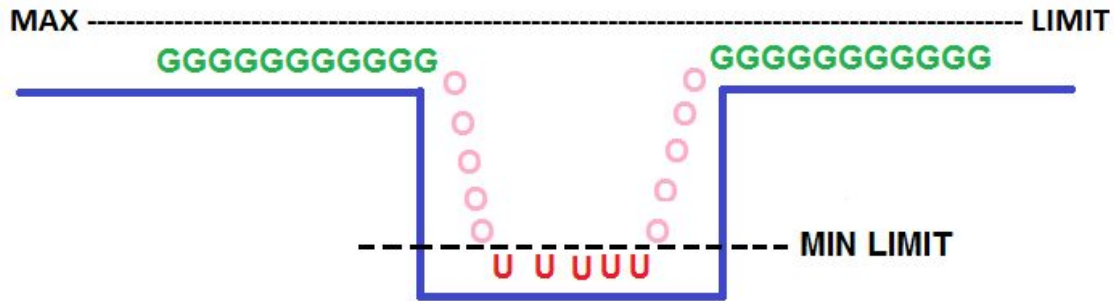
Max Limit - The programmed upper limit of raw readings the CAG will enter into the Queue. Any raw reading above the Max Limit will not be entered in the Queue.

Min Limit - The programmed lower limit of raw readings the CAG™ will enter into the Queue. Any raw reading below the Min Limit will not be entered in the Queue.

EXAMPLE Cut-Out Detection:

In a dynamic electronic fixture gage, the required measurement is the outside diameter of a shaft. The O.D. surface of a shaft has a keyway interrupting the gaging surface. The Cut-Out Detection feature will be used to eliminate any readings taken when the gage probe falls into the keyway area. A diagram of what the readings might look like is depicted in Figure I.

Figure 1.



- G - Progressive readings on gaging surface, within MAX and MIN LIMITS and not exceeding the MAX DELTA.
- O - Readings exceeding MAX DELTA
- U - Readings below the MIN LIMIT

The first step would be to select the “**Live Check Setup**” menu in the EPIC and while manually rotating the part, observe the “*Raw Readings*” associated with the O.D. check. The observed readings will help determine our set-up parameters.

Max Delta: By observing the change between readings when the probe is on the gaging surface as the part is rotated, the operator can establish the approximate difference between the readings, or delta. In Figure I, this would be the difference between the “G” readings. The surface finish of the part and the speed at which the part is rotated will affect the delta.

Once the approximate delta has been determined, the Max Delta should be programmed as a slightly greater value. This value will allow the system to differentiate between acceptable progressive readings and when the probe starts to fall into or exit the keyway.

For instance, the observed maximum delta between the “G” readings has been determined to be .0005”. By programming the Max Delta to .0007”, the CAG will accept the readings on the gaging surface because the difference between them is less than .0007”. When the probe begins to fall into or exit the keyway (“O” readings in Figure I), the delta will exceed .0007”. The CAG will then recognize that the Max Delta has been exceeded and will stop accepting readings and purge the Queue.

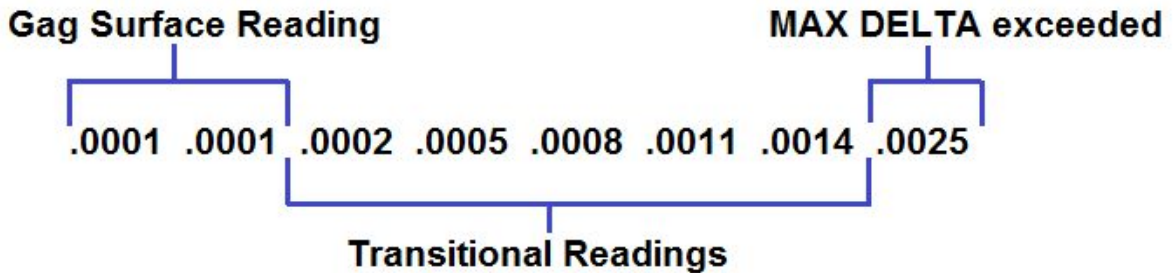
Max Limit: The value for the Max Limit should be programmed to be greater than the highest reading obtained when rotating the part manually. The keyway feature, which we are eliminating, generates readings less than the readings obtained on the gaging surface, therefore, the Max Limit is set above the highest reading obtained on the gaging surface.

Min Limit: The lowest reading obtained while the probe is in the keyway will determine the Min Limit. This would be the “U” reading in Figure I. The Min Limit should be set slightly above the lowest readings obtained. Once the probe reaches the bottom of the keyway, progressive readings may not exceed the programmed Max Delta because the bottom of the keyway is flat and the change between readings will not exceed the Max Delta. By programming the Min Limit to a value slightly above the readings obtained at the bottom of the keyway, these readings will be under the Min Limit and will not be entered into the Queue.

Queue Size: The size of the Queue will be determined by how many readings are involved with the transition between the gaging surface and the cutout. As with any interrupted feature, the transition edge between the gaging surface and the edge is not an abrupt change, but gradual. The readings taken closest to the transition edges (entrance and exit) will taper off gradually, but may not exceed the Max Delta. Establishing a Queue size,

which will encompass these transition readings, the operator will eliminate readings that do not exceed the Max Delta but are not representative of the gaging surface.

For example, as the gage probe either approaches the cutout or exits it, the readings begin to change at a rate of .0003". These readings do not reflect the gaging surface, but rather the transitional surface between the gaging surface and the cutout. The system would store the readings on the transitional surface in the Queue because they do not violate the Max Delta or Max/Min Limits. However, once the probe falls far enough into the cutout, the Max Delta will be violated, the system will stop accepting readings and the Queue will be cleared. If the Queue size was set correctly, the transitional readings would be purged from the Queue. In the example below the Queue size should be set at 6. At the point the Max Delta is exceeded (.0025) the Queue would contain the previous 6 readings. The Queue would be cleared, eliminating the transitional readings.



1.3.3.7. Calibration

Calibration			
Master Sizes		Sequence No.	
Max	<input type="text" value="1.00100"/>	No.	<input type="text" value="1"/>
Min	<input type="text" value="0.99900"/>	No.	<input type="text" value="2"/>
<input type="checkbox"/> Alt. Cal.	Alt. Gage <input type="text" value="1"/>	Alt. Check	<input type="text" value="1"/>
Calibration Results			
Mag.	<input type="text" value="1.00000"/>	Zero	<input type="text" value="0.00000"/>

Master Sizes - Enter the calibrated Max and Min master sizes from the master certification report for the current check.

Sequence Number - Enter the sequence in which the MAX and MIN masters for the current Check feature will be presented to the gage. For instance, if the Max Master for the gage includes the max size for the current Check and will be presented to the gage first during the master cycle enter "1" as the sequence number for the Max Master size. If the Min Master for the gage includes the min size for the current Check and will be presented to the gage second during the master cycle enter "2" as the sequence number for the Min Master size.

Special Cases:

Max No. = 0, Min No. = 0

Check is not calibrated. Mag defaults to 1.00, Zero = 0

Max No. = 0, Min No. = User designation

Zero Calculation only from Min Master, Mag = 1.0

Min No. = 0, Max No. = User designation

Zero Calculation only from Max Master, Mag = 1.0

Alt. Cal. - Enables Alternate Calibration. If enabled, calibration (Mag & Zero) will be assigned from another Check.

Alt. Gage - Alternate Calibration Gage. During calibration the Mag. & Zero from Alt. Cal. Check will be assigned to the current Check. The Alt. Cal. Check is contained in the Alt. Gage setup..

Alt. Check- Alternate Calibration Check. During calibration the Mag. & Zero from Alt. Cal. Check will be assigned to the current Check. The Alt. Cal. Check is contained in the Alt. Gage setup..

Calibration Results - The MAG and Zero from the last successful master cycle are shown for reference only.

1.3.3.8. Auto Air Shutoff (Optional)



Enabled - Enable Auto Air Shutoff. Air supply for air gaging will be turn OFF and ON as needed.

Output Bit - Auto Air Shutoff requires special hardware (shutoff valve) to turn air off and on. The shutoff valve is controlled with digital output form the CAG system. The "Output Bit" will need to be set to the digital output that is controlling the air shutoff valve (See also I/O Diagnostics screen).

Port A - Bits 1-8
Port B - Bits 17-24
Port C - Bits 9-16

1.3.3.9. Verification (Optional)

If the EPIC software includes the optional Verification module the Verification box will appear on the Check setup screen.

Once the Gage has been calibrated, the means to verify the stability of the process is provided by the "Verification" screen.

The difference between the verification actual part size and the measured verification part size will be used to verify the system and provide a zero adjustment to correct the system.

Verification		
Verification Part Size	<input type="text" value="1.00000"/>	<input checked="" type="checkbox"/> Enabled
Max Zero Adjust Lim	<input type="text" value="0.00000"/>	<input type="checkbox"/>
Min Zero Adjust Lim	<input type="text" value="0.00000"/>	

Verification Part Size - Enter the calibrated size of the verification master for the current Check from the master certification report.

Max Zero Adj. Limit - Maximum accumulated verification zero correction allowed. If the accumulated zero offset exceeds this limit the verification will fail.

Min Zero Adj. Limit - Minimum amount of zero offset applied during verification. If the verification zero offset is less than this value then no zero offset will be applied.

Enabled - If this box is selected then the current Check will be included in the verification cycle.

If the zero adjustment exceeds the min zero adjust limit and the accumulated zero adjustment does not exceed the max zero adjust limit a zero adjustment will be applied and the verification will pass.

1.3.3.10. EtherNet/IP (Optional)

If the EtherNet/IP option is installed the Check result can be written to “TAG” on connected PLC controller at the completion of a measurement cycle.

EtherNet/IP - Write Results To Controller TAG	
Enabled	<input type="checkbox"/> TAG Name <input type="text" value="TAG_NAME"/>

1.3.3.11. Temperature Compensation (Optional)

If the EPIC software includes the optional Temperature Compensation module the setup will appear on the Check setup screen. For full description and setup procedures see Section 6.

Temperature Compensation	
Enabled	<input checked="" type="checkbox"/>
Probe Set	<input type="text" value="Probe Set 1"/>
Part Coefficient	<input type="text" value="0.000020"/>
Tooling Coefficient	<input type="text" value="-0.000010"/>
Master Coefficient	<input type="text" value="0.000001"/>

Probe Set - The Probe Set utilized for the Check is selected in this field.

Part Coefficient - The coefficient of expansion for the part material would be entered here.

Tooling Coefficient - The coefficient of expansion for the tooling material would be entered here.

Master Coefficient - The coefficient of expansion for the master material would be entered here.

1.3.3.12. Add/Save/Delete Check

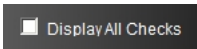


Add Check- Adds a new Check with default values programmed. The new Check must be programmed by operator as required. **Note:** the gage data file (GDF) must be rest (contain no reading) in order to Add a Check.

Save - If a change is made on this screen then this field will be highlighted in red indicating that the setup must be saved before exiting the screen or the changes will be lost. If the operator leaves the screen without saving the change will not be saved.

Delete Check- Deletes the currently selected Check. All Checks, setups and accumulated data will be deleted. **Note:** the gage data file (GDF) must be rest (contain no reading) in order to Add a Check.

1.3.3.13. Display All Checks



Display All Checks - when selected, all Checks setup parameter will be displayed in spread-sheet format. This display provides an easy way to view multiple Checks at one time and change setup parameter for multiple Checks.

No	Check Name	Enable	Display	Function	Tag Name	Formula	Nominal	UAL	LAL	USL	LSL	URL	LRL	Max Mast
1	Crank Bore	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	0	TAG_NAME	1A1	1.00000	1.00000	1.00000	1.00300	0.99720	1.02040	0.97960	1.00100
2	Pin Bore	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	0	TAG_NAME	1A1	0.97000	0.97150	0.96900	0.97250	0.96750	0.99040	0.94960	0.97100
3	Center Distance	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	0	TAG_NAME	1A1	1.00000	1.00050	0.99900	1.00100	0.99800	1.02040	0.97960	1.00100
4	Thickness	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	0	TAG_NAME	1A1	0.00000	0.00000	0.00000	0.01000	-0.01000	0.02040	-0.02040	0.00100

1.3.4. Inputs Setup

I Inputs Setup



Type - There are two types of inputs available to be utilized with the EPIC CAG. Electronic inputs use an Edmunds LVDT to translate linear motion into gage readings. Air/Electronic (A/E) inputs use an Edmunds A/E transducer to translate air pressure differentials into gage readings utilizing Edmunds air tooling.

Polarity/Mag - The Polarity/Mag variable is a two part signed number that assigns direction and a conversion factor to provide compatibility between the EPIC software and the Inputs.

Polarity - The Polarity is either Plus (+) or Minus (-) depending on the type of input.

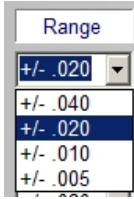
An Electronic Input programmed with a positive polarity will read larger when the LVDT probe tip is depressed. An Electronic Input programmed with a negative polarity will read smaller when the LVDT probe tip is depressed.

An A/E input measuring an external diameter is programmed with a positive polarity. An A/E input measuring an internal diameter is programmed with a negative polarity.

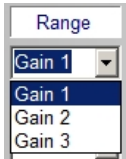
Mag - The Mag is a numerical factor that is multiplied times the raw input value. The default value is 1.0000.

Range: Depending on the Input Type (LVDT or AIR) the Range setting has a different function.

LVDT: The Range is used to to set the total measurement distance of the LVDT. Typically the smaller the range setting the greater the resolution providing for more accuracy. There are four Range options to choose from for input type LVDT (+-.040, +-.020, +-.010, +-.005). NOTE: the maximum range of the Edmunds Standard LVDT is +-.020.



AIR: The Range is used to set the gain of Edmunds A/E block. The gain should be set according to the A/E block installed (see below).



AIR Block Types:

Gain 1, A/E Blocks:

- 3101700
- 3101710
- 3101720
- 3101800
- 3101801
- 3101802

Gain 2, A/E Blocks:

- 310122X

Gain 3, A/E Blocks:

- 3101800A
- 3101801A
- 3101802A

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

(+)Limit (-)Limit - The (+) and (-) limits are used in Check calculations to determine whether an input has reached its saturation limit. The saturation point for an input is considered to be the point at which it is no longer returning accurate readings because it has reached its physical or electronic limit. For an LVDT input this is usually when the probe reaches its physical end of travel or hits a mechanical stop. The default value is .02045 inches or .5194 MM.

Balancing Mag - This value will be 1.0000 unless a balancing procedure has been performed for the input. See Input Balancing.

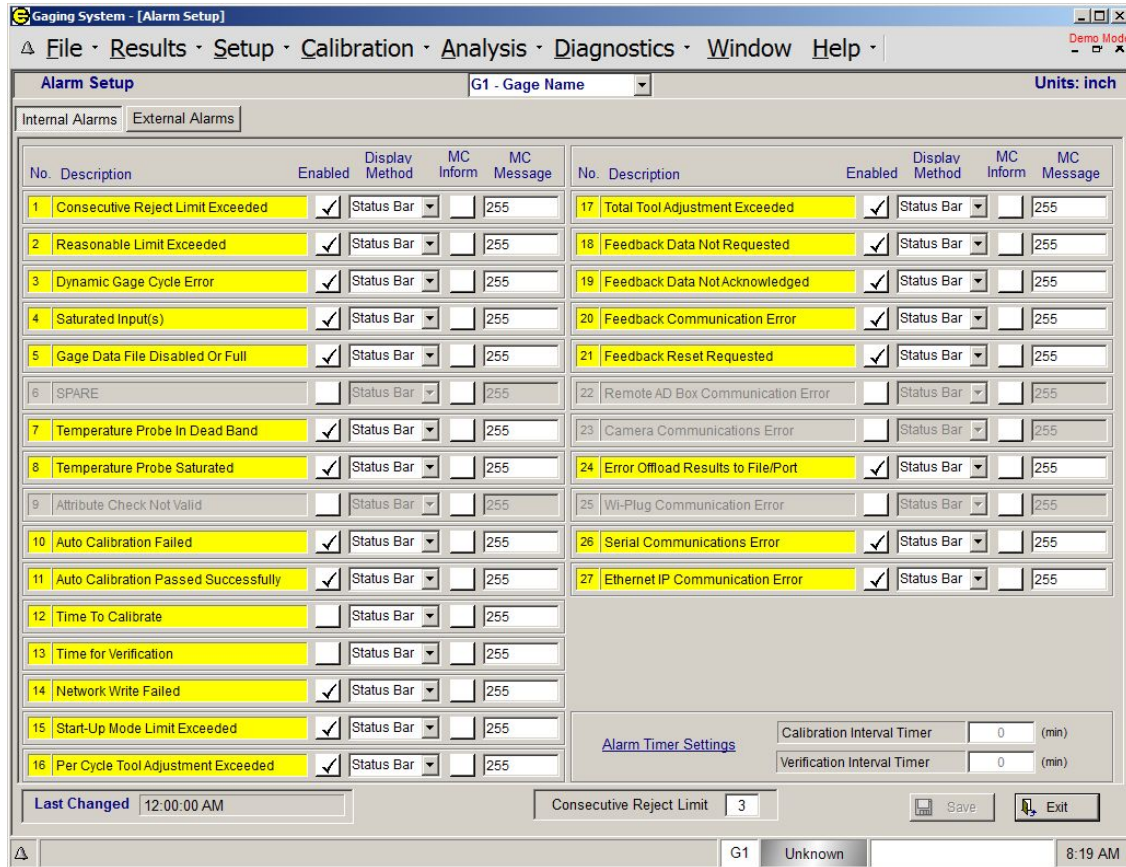
Status - If an input is currently used in an active Check it will be listed as "Active" otherwise it will be listed as "Not Active".

1.3.5. Alarms Setup

Alarms Setup

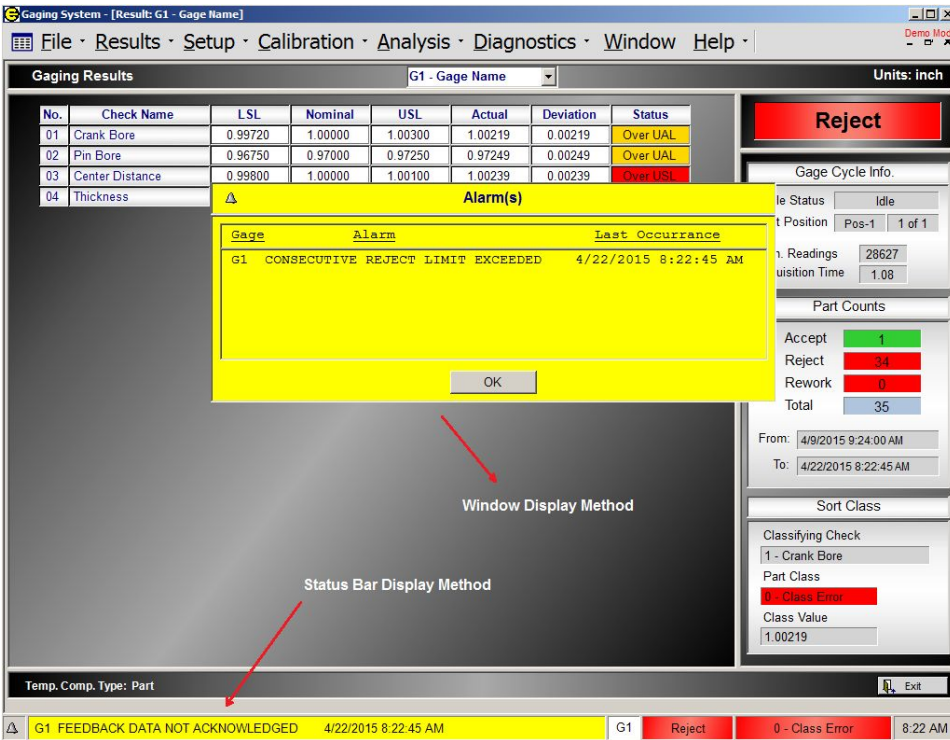
Internal Alarms

The CAG can inform the operator of process problems via pre-programmed internal alarms.



Enable - If this box is checked then the selected alarm is active. Only those alarms that are highlighted in yellow can be enabled. Alarms that are not highlight in yellow are not used in the current setup. For instance if no temperature compensation software is loaded then the alarms pertaining to the temperature probes will not be highlighted in yellow and can not be selected.

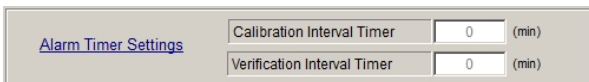
Display Method - Select from the display method (Status Bar, Window, or None) for the alarm. If Status Bar is selected then the alarm will be displayed on the bottom line of the EPIC application. If Window is selected the alarm will be displayed in a pop up window (see figure below).



MC Inform - Inform Machine Control. If MC Inform is selected then the system will send a message to the machine control PLC when the selected alarm occurs (see External Communications - Appendix XX).

MC Message - The number of the message sent to the PLC. 255 is the default (Shutdown)

Alarm Timer Settings - There are two user programmable alarms that have timers associated with their function.



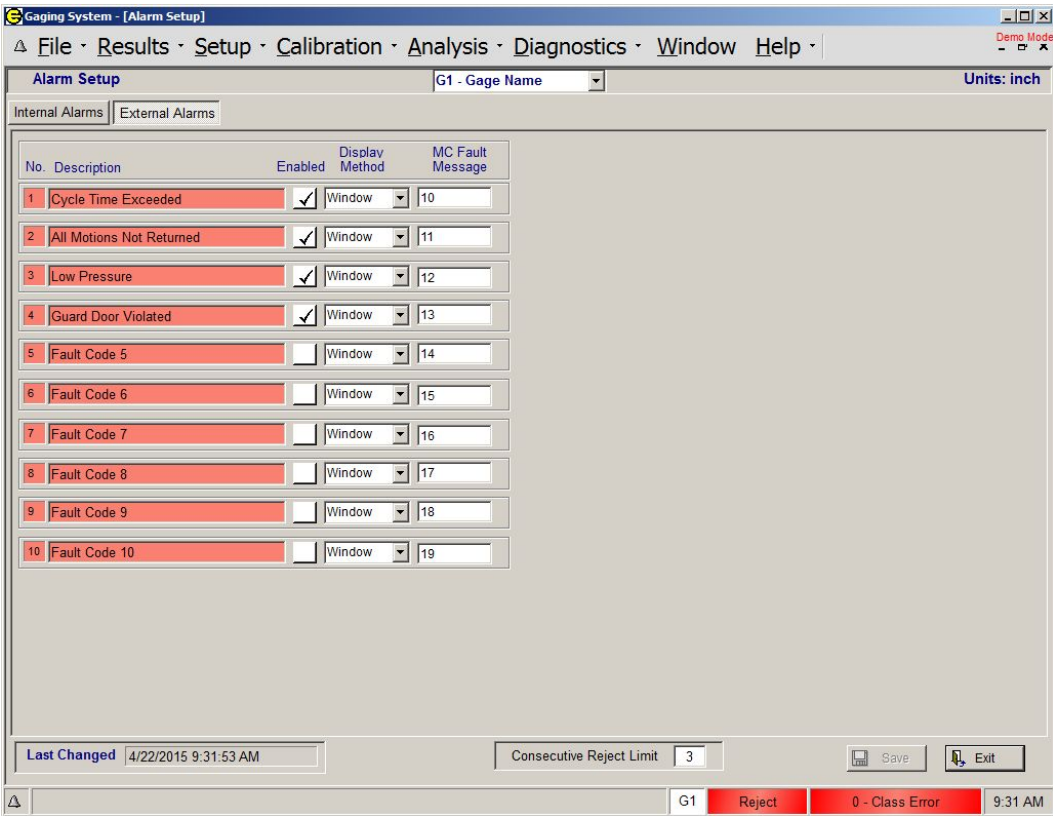
No.12 -Time To Calibrate – The time between calibration cycles can be set to prompt the operator to calibrate the gage. The preferred display method for this alarm is “Window”. Once the alarm has been triggered it will continue to appear after every gage cycle until the Gage is calibrated. This alarm can also be setup to inform the machine control when the “Time To Calibrate” alarm is triggered.

No.13 -Time For Verification – The time between verification cycles can be set to prompt the operator to verify the gage. The preferred display method for this alarm is “Window”. Once the alarm has been triggered it will continue to appear after every gage cycle until the Gage is verified. This alarm can also be setup to inform the machine control when the “Time For Verification” alarm is triggered.

Consecutive Reject Limit - The number of consecutive rejects for alarm No.1 can be programmed depending on the process and SPC requirements. Once this number has been set, Alarm No.1 will display once the number of consecutive rejects exceeds the programmed value.

External Alarms (Optional)

The EPIC system can receive fault code messages from external machine control (PLC) and inform the operator of process problems via pre-programmed external alarms.



Description - Text that can be entered by the operator to describe the fault. The description will be displayed when the alarm is triggered.

Enable - If this box is checked then the selected alarm is active.

Display Method - Select from the display method (Status Bar, Window, or None) for the alarm. If Status Bar is selected then the alarm will be displayed on the bottom line of the EPIC application. If Window is selected the alarm will be displayed in a pop up window.

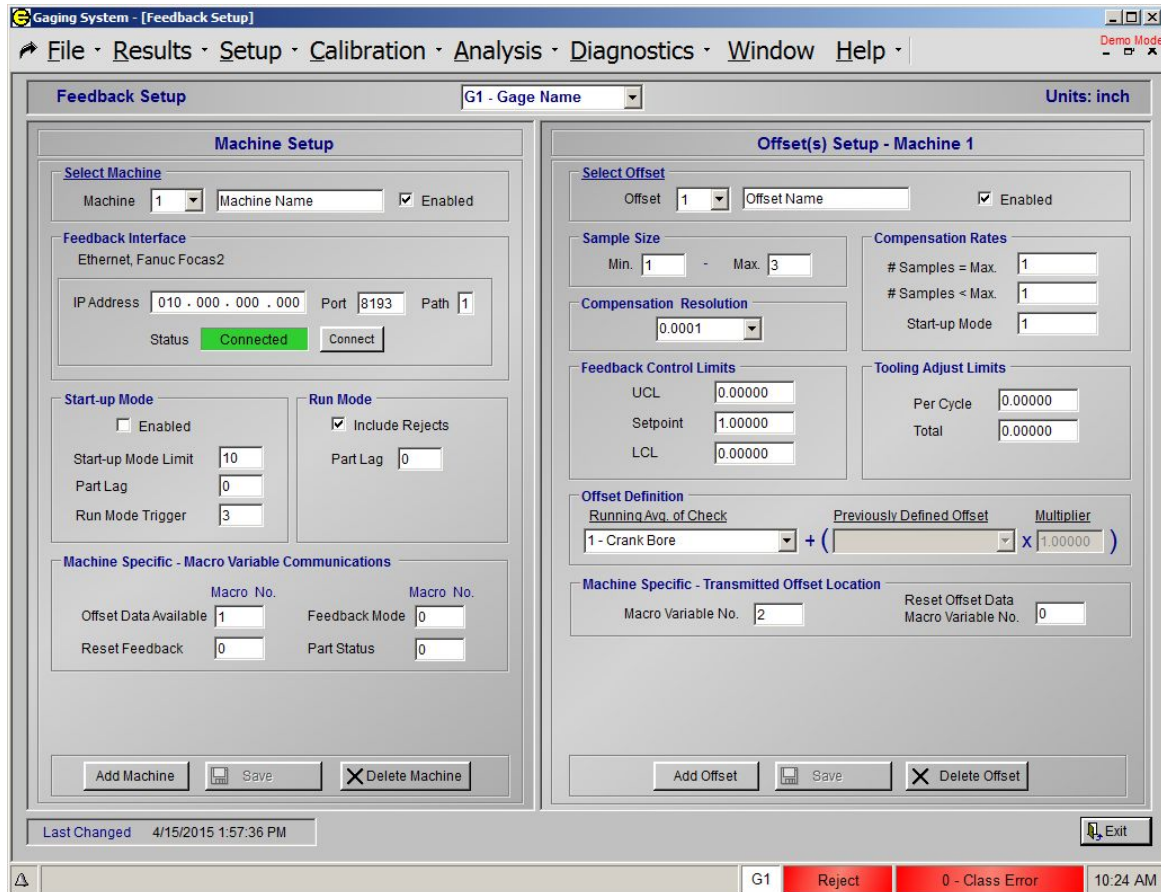
MC Fault Message - message from the machine control (MC) that will trigger the alarm.

1.3.6. Feedback Setup (Optional)

Feedback Setup

The EPIC CAG™ system can be configured to compute machine tool offsets and transmit the offsets to the machine for tool adjustments. One Gage setup can provide feedback to multiple machines and multiple offsets can be programmed for each machine.

See [Section 4 Feedback Setup and Operations](#)



1.3.7. Q-DAS Setup (Optional)

Q-DAS Setup

The optional Q-DAS module provide for setup and offload of specification/process parameter as well as measurement results to Q-DAS capable file(s). See Q-DAS documentation for a full description of fields and file format.

Q-DAS@ Part Data

Gage: G1 - Gage Name

File Location: C:\UserData

File Name: QDASDATA (.DFD)

Batch Reading Count: 50

Enable Part Offload:

Q-DAS@ Value Data

Key	Enable	Value	Description
K0100	<input checked="" type="checkbox"/>	1	Number of Characteristics
K1001	<input checked="" type="checkbox"/>	0	Part Number
K1002	<input checked="" type="checkbox"/>	0	Part Description
K1004	<input checked="" type="checkbox"/>	0	Amendment Status (Eng Change)
K1007	<input checked="" type="checkbox"/>	0	Part Number Short Description
K1021	<input checked="" type="checkbox"/>	0	Manufacturer Number Text
K1022	<input checked="" type="checkbox"/>	0	Manufacturer description
K1053	<input checked="" type="checkbox"/>	0	Plants Level Operation Number
K1101	<input checked="" type="checkbox"/>	0	Department
K1203	<input checked="" type="checkbox"/>	0	Reason for Test
K1303	<input checked="" type="checkbox"/>	0	Plant
K1900	<input checked="" type="checkbox"/>	0	Part Remarks

Q-DAS@ Value Data

Key	Enable	Value	Description
K0001	<input checked="" type="checkbox"/>		Value (Measured)
K0002	<input checked="" type="checkbox"/>	0	Value Attribute
K0004	<input checked="" type="checkbox"/>		Date/Time
K0005	<input type="checkbox"/>	0	Events (Catalog)
K0006	<input type="checkbox"/>	0	Part Serial Num/Batch Num
K0007	<input type="checkbox"/>	0	Position/Cavity (Catalog)
K0008	<input type="checkbox"/>	0	Station/Line/Operator (Catalog)
K0009	<input type="checkbox"/>	0	Text
K0010	<input type="checkbox"/>	0	Machine (Catalog)
K0012	<input type="checkbox"/>	0	Gage (Catalog)
K0014	<input type="checkbox"/>	0	Part Ident (Serial Num)
K0053	<input type="checkbox"/>	0	Operation/Order Number

Q-DAS@ Characteristics Data

Characteristic Number: 1

Assigned Check: 1

Crank Bore: []

Key	Enable	Value	Description
K2001	<input checked="" type="checkbox"/>	1	Characteristic Number
K2002	<input checked="" type="checkbox"/>		Characteristic Description
K2003	<input type="checkbox"/>		Characteristic Abbreviation
K2005	<input checked="" type="checkbox"/>	2	Characteristic Class
K2008	<input type="checkbox"/>	0	Characteristic Group Type
K2015	<input type="checkbox"/>	0	Tool Wear Trend (1 = + 2 = -)
K2030	<input type="checkbox"/>	0	Group Number
K2031	<input type="checkbox"/>	0	Group Element Number
K2022	<input checked="" type="checkbox"/>	4	Decimal Places
K2080	<input type="checkbox"/>	0	Use Catalog
K2101	<input checked="" type="checkbox"/>	0.00000	Nominal Value
K2110	<input checked="" type="checkbox"/>	-0.00100	Lower Specification Limit

Key	Enable	Value	Description
K2111	<input checked="" type="checkbox"/>	0.00100	Upper Specification Limit
K2112	<input type="checkbox"/>	0.00000	Lower Allowance
K2113	<input type="checkbox"/>	0.00000	Upper Allowance
K2120	<input checked="" type="checkbox"/>	1	Lwr Lim Type: 0: no lim, 1:
K2121	<input checked="" type="checkbox"/>	1	Up Lim Type: 0: no lim, 1: spec
K2142	<input checked="" type="checkbox"/>	Inches	Unit Description Inches/mm
K2401	<input type="checkbox"/>	0	Gage Number Text
K2402	<input type="checkbox"/>		Edmunds Gages
K2406	<input type="checkbox"/>		Edmunds Gages
K2404	<input type="checkbox"/>	1E-05	Gage Resolution
K2900	<input type="checkbox"/>		Edmunds Gages Check Data
			Characteristic Remarks

Buttons: Delete, Delete Stored Results (.DFX file), Exit

Status Bar: G1, Reject, 0 - Class Error, 10:55 AM

Gage - Selection of the Gage

File Location - Sets the location the Q-DAS description file (.DFD) and value file (.DFX) will be written to. The location can be manually entered or clicking the file folder icon can perform a search.

File Name - name of the description data file (.DFD) and value data file (.DFX).

Enable Part Offload - enabled the offload of part data to the Q-DAS files. Measured results data will be offloaded at the completion of gaging cycle.

Batch Reading Count - number of data records that will be stored before writing to the value file (.DFX). The data records are written to a temporary file. When the number for records in the temporary file equals the Batch Reading Count, the records in the temporary file are written to the Q-DAS value file (.DFX). The Q-DAS system will then read the records from the value file.

Characteristic Number - Selection of the Characteristic

Assign Check- Drop down selection box containing all the Checks programmed in the system. When a Check number is selected it automatically assigned that Check data to the selected Q-DAS Characteristic. By default,

Check data such as name, specification limits, units etc... are assigned to the appropriate Characteristic K values. These values can be changed if necessary.

Add - Adds a new Characteristic. The new Characteristic must be assigned a Check and programmed by operator as required.

Save - Saves the current Characteristic.

Delete - Deletes the currently selected Characteristic.

1.3.8. Sort Classes

Sort Classes

Sort Classes gives the EPIC system the ability to classify a part based on the measured size of a Check.

No	Class Description	Upper Class Boundary	Lower Class Boundary
1	Class 1	0.00110	0.00100
2	Class 2	0.00120	0.00110
3	Class 3	0.00130	0.00120
4	Class 4	0.00140	0.00130
5	Class 5	0.00150	0.00140
6	Class 6	0.00160	0.00150
7	Class 7	0.00170	0.00160
8	Class 8	0.00180	0.00170
9	Class 9	0.00190	0.00180
10	Class 10	0.00200	0.00190

Classifying Check - Defines which part Check is to be used for classifying the part.

Number of Sort Classes - Defines the number of classes that the part will be categorized into for the classifying Check.

Classifying Mag. - Classifying check result is multiplied by this value to determine part class. Default value = 1.000.

Classifying Offset - This value will be added to the classifying Check result to determine the part class.

Default value = 0.000.

Class Description - Each class can be given a name in this field. The maximum number of characters is 12.

Upper & Lower Class Boundary - For each sort class an Upper and Lower Class Boundary must be defined.

Note: Sort Class Boundaries must not overlap

Sort Class Algorithm

Class Result = Classifying Check Result x Classifying Mag + Classifying Offset

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)

Auto Generate Class Boundaries

Class 1 Lower Boundary - The Class 1 Lower Boundary value is used as the starting point for Auto-Generate Class Boundaries. This value will be assigned to Class 1 lower boundary and all proceeding Class boundaries will be generated from this using the Class Spread.

Class Spread - Class Spread is the range between upper and lower boundaries of each Sort Class. The Class Spread is used during Auto Generate process.

Example:


Class1 Upper Boundary = Class 1 Lwr Boundary + Class Spread

Class 2 Lwr Boundary = Class 1 Upper Boundary

Class2 Upper Boundary = Class 2 Lwr Boundary + Class Spread

etc....

1.3.9. Temp. Probe Setup (Optional)

 Temp. Probe Setup

HARDWARE REQUIRED

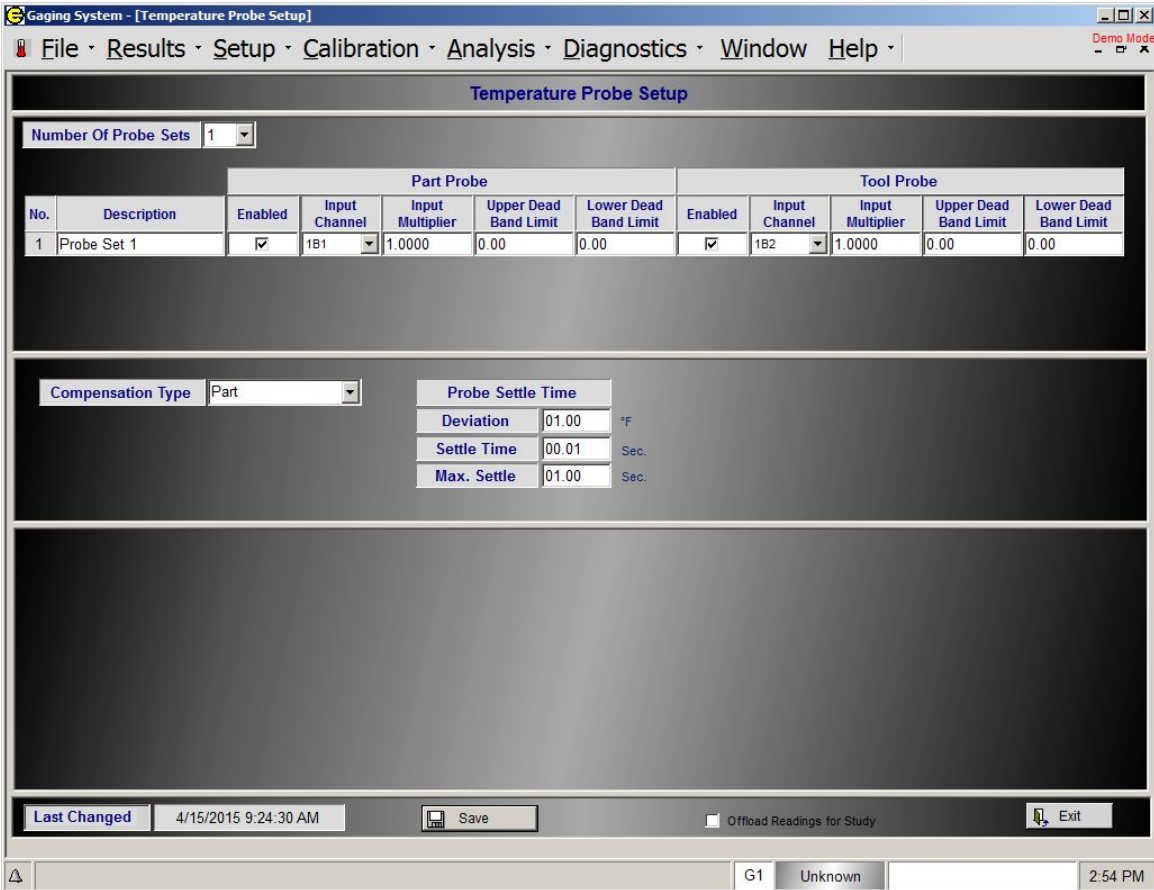
Temperature compensation is accomplished via optional EPIC software and external hardware. The additional hardware required for temperature compensation is as follows:

- ✓ Edmunds (4) Channel Temperature Amplifier Card # 7200020
- ✓ Edmunds supplied temperature probes.

The amplifier card can be installed in any position in the CAG signal conditioning rack. Once installed, the displayed readings on the Live Inputs screen will be in degrees Fahrenheit with .01 degree resolution.

Example: +78.04°

The temperature probes are strategically mounted in the gage fixture to provide temperature measurement of the fixture tooling and the part or master in the gaging position.



Number of Probe Sets - The total number of probe sets (0-4) utilized in the gage. A probe set consists of (1) Part probe and (1) Tool Probe.

Probe Set Number - The probe set identifying number.

Description - Each probe set can be named here. The maximum number of characters is 12.

Part Probe - The probe that measures the part temperature

Enabled - If checked the part probe is enabled

Input Channel - The input channel on the temperature amplifier card that the part probe is connected to.

Input Multiplier - The factor the input's values will be multiplied by to provide the temperature reading. The value should be set to +1.00 for 0F.

Upper/Lower Dead Band Limit - The dead band limits allow the CAG to determine if the temperature probe is functioning correctly. The Dead Band is commonly set to 99.5 to 100.5 degrees F. If your measuring environment is in this temperature range you will want to set the Dead band to 0.00 Degrees.

Tool Probe - The probe that measures the tooling temperature

Enabled - If checked the tooling probe is enabled

Input Channel - The input channel on the temperature amplifier card that the tooling probe is connected to.

Input Multiplier - The factor the input's values will be multiplied by to provide the temperature reading. The value should be set to +1.00 for 0F.

Upper/Lower Dead Band Limit - The dead band limits allow the CAG to determine if the temperature probe is functioning correctly. The Dead Band is commonly set to 99.5 to 100.5 degrees F. If your measuring environment is in this temperature range you will want to set the Dead band to 0.00 Degrees.

Compensation Type:

The manner in which the Gage is to operated is designated in this field. There are (3) types of temperature compensation. Gage Calibration automatically selects the proper compensation type during the mastering cycle.

Disabled - This selection disables temperature compensation.

Part - This option utilizes the part coefficient to compute the temperature compensation. This option should be used whenever temperature compensation is desired during the gaging cycle or when performing an R&R study on parts.

Master As Part - This selection should be utilized whenever an R&R study is performed on masters only or to add the correct compensation when measuring a master as a part.

Probe Settle Time

There are (3) probe settle time variables that can be programmed for the probe sets. The variables are used to ensure that the temperature probes have settled and the correct temperature readings are taken.

Deviation - This value, in degrees F, is the maximum deviation in degrees F that the probe can read between readings before it is considered in a settled state.

Settle Time - This value, in seconds, is the time waited between readings when the probe is in an unsettled state.

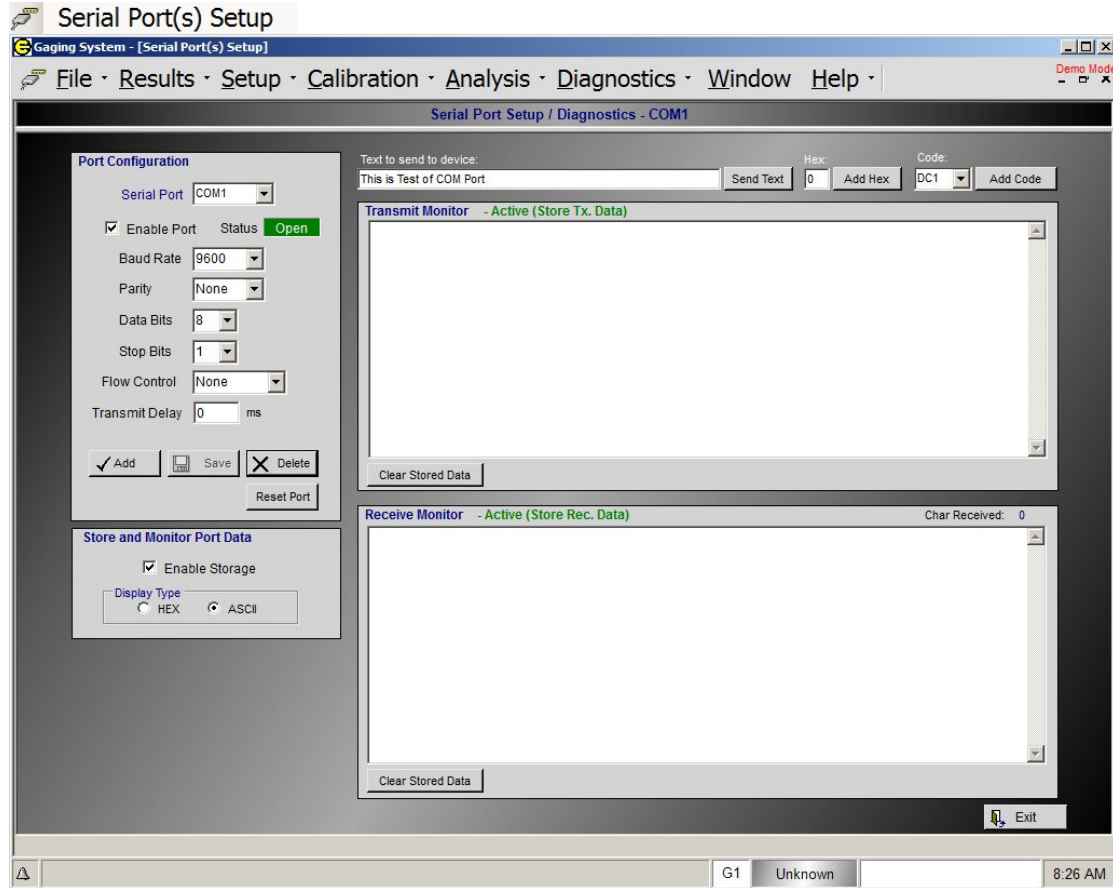
Max Settle - This value, in seconds, is the maximum time allowed to record a temperature reading. If the probe is not in an unsettled state when the Max settle time is reached, the last temperature reading will be used.

Example: Deviation = +.020°F , Settle Time = .20 sec, Max Settle = 25 seconds

The gage will take a temperature reading. The Gage will then wait the settle time (.20 sec) then take another reading. If the second reading exceeds the first by more than the deviation amount (.02°F - unsettled), the gage will wait the settle time, then take another reading. This cycle will continue until a) the reading

difference is less than the programmed deviation or the Max Settle time (25 seconds) has been exceeded. Once either a or b is satisfied the temperature will be recorded and the compensation will be applied.

1.3.10. Serial Port(s) Setup



Port Configuration

The RS-232 Serial Port(s) of the CAG can be configured to match any device connected to it.

Serial Port - Select the serial port to setup and/or monitor

Enable Port - Enable/Disable port. This will also open or close the port.

Status - Status of the port either "Open" or "Closed"

Baud Rate - Select the Baud Rate, must match the connected device.

Parity - None, Odd, Even, Mark, Space

Data Bits - 8, 7, 6

Stop Bits - 0, 1, 2, 1.5

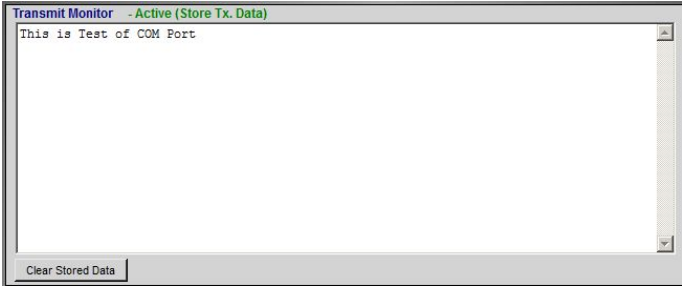
Flow Control - None, Xon/Xoff, RTS/CTS, RTS Xon/Xoff

Transmit Delay - delay in millisecond between each character byte of data sent. Needed in some case to slow transmission.

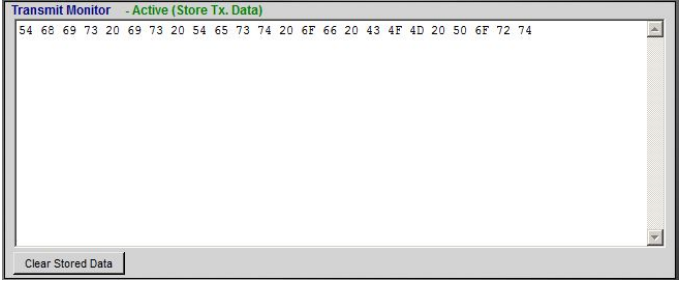
Enable Storage - If enabled data sent and received from the serial port will be stored and displayed.

Display Type

ASCII - Display data sent and received in ASCII format



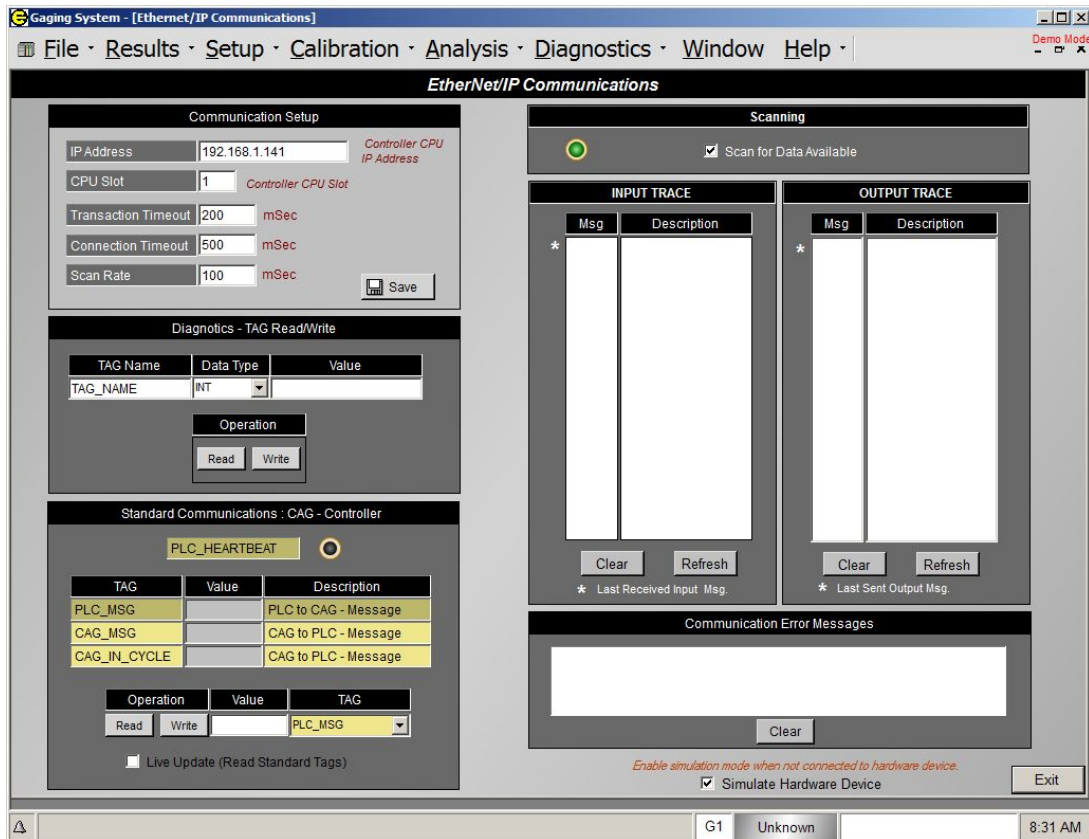
Hex - Display data sent and received in Hexidecimal format



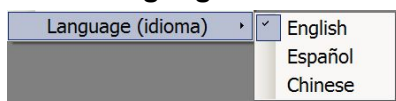
1.3.11. EtherNet/IP Comm.

 EtherNet/IP Comm.

See [Section 3.2 - EPIC Standard EtherNet/IP Communication](#)

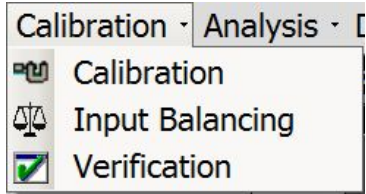


1.3.12. Language



Language Selection - English, Spanish, Chinese

1.4. Calibration



1.4.1. Calibration

Calibration

The analog signal received from the gaging fixture is an uncalibrated signal that must be scaled before converting it to an actual dimension. The EPIC software calculates a gain multiplier (MAG) and a zero offset (ZERO) for each part characteristic (Check) 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 OFFSET are:

$$\text{MAG} = \frac{\text{ActualMax} - \text{ActualMin}}{\text{MeasuredMax} - \text{MeasuredMin}}$$

$$\text{Zero} = \text{ActualMax} - [\text{MAG} * \text{MeasuredMax}]$$

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

Where:

- Actual Max is the known size of Max Master from the master certification report.
- Actual Min is the known size of Min Master from the master certification report.
- Measured Max is the gaged size of Max Master.
- Measured Min is the gaged size of Min Master.



For each Check the following information is displayed:

Check Number - The programmed Check number.

Check Name - The programmed name of the Check .

Actual Size Max – The actual max master size from the master certification report.

Actual Size Min – The actual min master size from the master certification report.

Measured Max – The size measured by the gage in the last calibration cycle.

Measured Min – The size measured by the gage in the last calibration cycle.

% Mag Adjust - The percentage of adjustment applied to the measured difference in master readings to obtain a Mag value of 1.00.

$$\% \text{Mag Adjust} = \text{Absolute Value} (1 - \text{Mag}) * 100$$

Mag Value – The numeric value multiplied times the measured difference in master reading to obtain the actual max/min difference.

Zero Offset – The numeric value added to any gaged reading to correct for the zero offset.

Status – The status of the Check from the last calibration cycle.

Unknown Default values loaded, Gage has not be calibrated.

Pass Check passed calibration

Max=Min Max measured reading equals Min measured reading

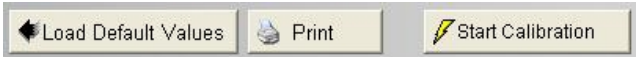
Min>Max Min measured reading is greater than Max measured reading

Mag Adj %Mag Adjust is greater than %Mag Adj Limit. The default limit is 25% (see Limits)

Zero Adj Zero Adjust is greater than Zero Adj Limit. The default limit is .002 (see Limits)

Sat Input One or more of the Inputs used in the Check formula contain Saturated readings.

NOTE: If on the Check Setup screen the Enabled box is not selected for a Check then the check will NOT be displayed on the Calibration screen.



Start Calibration

Select this button to begin the gage calibration cycle. The CAG will prompt the operator to load the first master and begin the calibration cycle. Refer to the individual gage documentation for specific calibration procedures. **All Checks must “Pass” during a calibration cycle for the gage to be successfully calibrated.**

Load Default Values

Resets all Mag Values to 1.000 and all Zero Offsets to 0.0000.

Master Sizes and Sequence Number

Select Setup → Check Setup to enter the master sizes and sequence numbers.

Calibration Fail Conditions

Max = Min

The measured Max and Min sizes are equal. This indicates the same master or no masters were introduced to the Gage during the calibration sequence.

Min > Max

The measured Min size was greater than the Max Size. This indicates the masters were introduced in the wrong sequence.

Mag Adj Error (% Mag Adjustment > 25%)

The percentage of Mag adjustment required to calibrate the Check exceeds the default value of 25% (see Limits). This indicates the input requires adjustment.

- ✓ With an electronic input, the LVDT needs to be repositioned so that the raw reading is closer to the master reading from the calibration report.
- ✓ With an Air input the Mag of the air input needs to be adjusted.

Zero Error (Zero Adj > .002 inch)

The amount of zero correction required to calibrate the Check exceeds the default value of .002 in (see Limits).

With an electronic input the LVDT needs to be re-positioned so that the raw reading is closer to the master reading from the calibration report.

With an Air input the Zero of the air input needs to be adjusted.

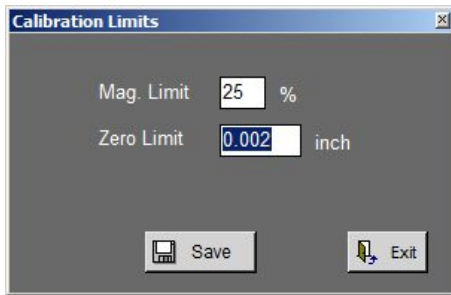
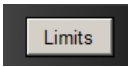
Saturated Inputs

One or more of the Inputs used in the Check formula contain Saturated readings. The raw Input value exceeds the saturation limits during the calibration cycle (see Inputs Setup Screen).

Calibration Limits (%Mag Adj Limit / Zero Adj)

In most cases in is not recommended to change the default calibration limits. The causes of failed calibration should be investigated first.

To access the Calibration Limits the user must be logged in as **ADMINISTRATOR**. When logged in as administrator the “Limits” button will be visible on the bottom of the screen.



Zero Limit:

Enter limit in Inch, it will be converted to mm if needed when it is used.

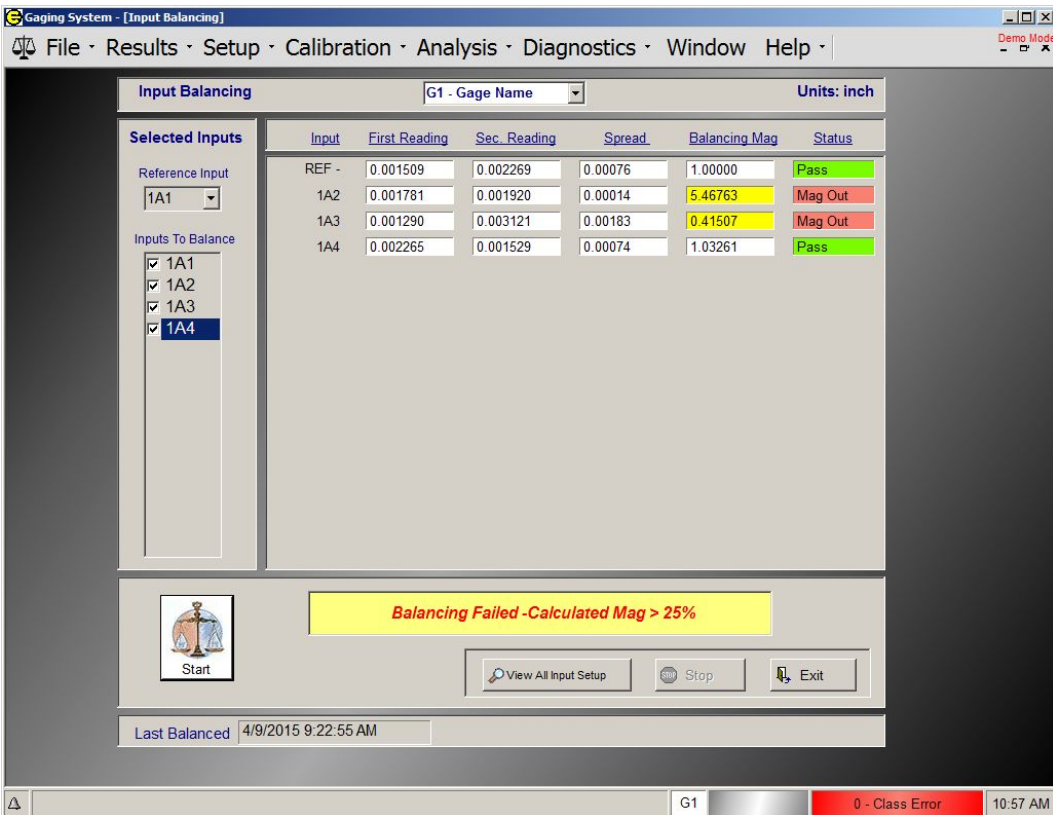
If '0' is entered, the limit will automatically be set based on Check Resolution as follows:

- .2 = 3 decimal places
- .02 = 4 decimal places
- .002 = 5 decimal places
- .0002 = 6 decimal places

1.4.2. Input Balancing

Input Balancing

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. 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.



Input	First Reading	Sec. Reading	Spread	Balancing Mag	Status
REF -	0.001509	0.002269	0.00076	1.00000	Pass
1A2	0.001781	0.001920	0.00014	5.46763	Mag Out
1A3	0.001290	0.003121	0.00183	0.41507	Mag Out
1A4	0.002265	0.001529	0.00074	1.03261	Pass

Reference Input

Selected inputs can be balanced relative to a 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 readings.

Input Bal. Mag = (Ref. Reading 1 - Ref. Reading 2) / (Input Reading 1 - Input Reading 2)

Inputs to Balance

Select the inputs to be balanced from the list. **The referenced input must be selected.**

Balancing Procedure

- 1) Load the appropriate part or master onto the gage.
- 2) Press the "Start" button on the Input Balancing screen.
- 3) The system will prompt the operator to shift the part to one side.
- 4) With the part or master shifted toward the reference input press "Continue".
- 5) The system will prompt the operator to shift the part to the opposite side.
- 6) With the part or master shifted away from the reference input press "Finish".

- 7) The results of the balancing procedure will be displayed on the system. If the balance procedure is successful the Balance Mag value will be applied to the input, see the Input Setup screen.

Balancing A/E Inputs

If an A/E input does not balance on the first attempt perform the following procedure:

- 1) With the part or master on the gage, bias it in the direction of the reference input and press "Start" on the Input Balancing screen. Observe the "First Reading" for the reference input. Using the "ZERO" knob of the A/E block for the input to be balanced, adjust the display for the "First Reading" of the input to match that of the reference input.
- 2) Do not press "Continue". 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.
- 3) 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.
- 4) 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 press "Stop" on the Input Balancing screen and then perform the balancing routine.

1.4.3. Verification (Optional)

Verification

Once the Gage has been calibrated, the means to verify the stability of the process is provided by the Verification menu. The checks that will utilize verification are set up in the menu “Check Setup”. Once verification is enabled, the Gage will be verified from the Verification menu.

Check Setup Screen - Verification

Verification		
Verification Part Size	0.002000	Enabled
Max Zero Adjust Lim	0.000800	<input checked="" type="checkbox"/>
Min Zero Adjust Lim	0.000010	

This menu initiates the verification process and displays the results. Each mastered Check, for which verification has been defined, is displayed with the following information:

The screenshot shows the 'Verification' window for Gage G1. The status is 'Pass' and the last verified time is 4/23/2015 11:15:17 AM. The table below summarizes the data shown in the screenshot:

No.	Check Name	Actual Size	Meas. Size	Zero Adj	Acc Zero Adj	Status	Min Lim	Max Lim
01	Crank Bore	0.002000	0.002176	-0.000176	-0.000176	Adjust	0.000010	0.000800
02	Pin Bore	0.00200	0.00228	-0.00028	-0.00028	Adjust	0.00001	0.00080
03	Center Distance	0.00200	0.00237	-0.00037	-0.00037	Adjust	0.00001	0.00080
04	Thickness	0.00200	0.00230	-0.00030	-0.00030	Adjust	0.00001	0.00080

At the bottom of the window, a status bar displays: G1 AUTO CALIBRATION PASSED SUCCESSFULLY 4/23/2015 11:15:17 AM. Below this, there are buttons for 'Reset', 'Start Verification', and 'Exit'. A red bar at the very bottom shows 'G1 Reject 0 - Class Error 11:15 AM'.

No. - The number of the Check being verified.

Check Name - The name of the Check being verified.

Actual Size - The actual size of the verification master for the Check selected. This value is programmed as the “Verification Part Size” on the Check Setup screen from the Master Calibration report.

Measured Size - The check size of the verification master as measured in the last verification cycle.

Zero Adjustment - The difference between the actual size and the measured size of the verification master.

Acc Zero Adjustment - The accumulated zero adjustment of all verification cycles. In order for the gage to pass Verification the accumulated value cannot exceed the programmed Max Zero Adjust limit.

Status – The status of the Check from the last Verification cycle.

Unknown	Default values loaded, Gage has not be verified.
Pass	Check passed verification - no zero adjustment made, zero adjustment below min zero adj limit.
Adjust	Check passed verification - zero adjustment made.
Max Zero Adj	Accumulated zero adjustment exceeds max zero adjustment limit.
Sat Input	One or more of the Inputs used in the Check formula contain Saturated readings.

Min Limit - Minimum amount of zero offset applied during verification.

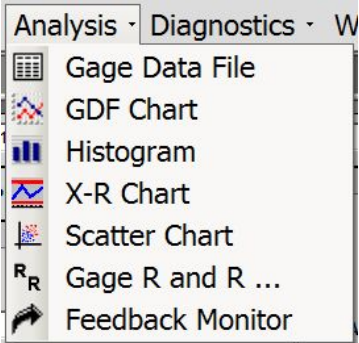
If the verification zero offset is less than this value then no zero offset adjustment will be applied.

Max Limit - Maximum accumulated verification zero correction allowed.

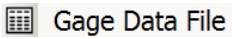
If the accumulated zero offset exceeds this limit the verification will fail.

Start Verification - Initiates the gage verification cycle. The system will prompt the operator on the steps required.

1.5. Analysis



1.5.1. Gage Data File (GDF)



The Gage Data File on the EPIC system contains all of the information stored for each part gaged. There is one file for each Gage programmed on the EPIC system.

NOTE: Checks that are not "Enabled" in the "Check Setup" will be displayed as "Disabled" in the GDF.

Sample	1	2	3	4	5	6	7	8	9
Date	4/22/2015	4/22/2015	4/22/2015	4/22/2015	4/22/2015	4/22/2015	4/22/2015	4/22/2015	4/22/2015
Time	1:02:07 PM	1:02:27 PM	1:02:41 PM	1:02:53 PM	1:02:58 PM	1:03:02 PM	1:03:08 PM	1:03:13 PM	1:03:17 PM
Part Status	Reject	Accept	Accept	Accept	Accept	Accept	Reject	Reject	Reject
Annotation									
Sort Class	Class 12	Class 11	Class 11	Class 11	Class 11	Class 9	Class 8	Class 8	Class 9
Machine_	Machine 1	Machine 2	Machine 2	Machine 2	Machine 2	Machine 2	Machine 2	Machine 2	Machine 2
SerialNo_	1234568	1234569	1234570	1234570	1234570	1234570	1234570	1234570	1234570
Station_	1	1	1	1	1	1	1	1	1
EventID_	A24	A24	A24	A24	A24	A24	A24	A24	A24
1-Crank Bore	0.00159	0.00076	0.00076	0.00059	0.00010	-0.00158	-0.00239	-0.00239	-0.00185
2-Pin Bore	0.00189 +	0.00106	0.00106	0.00089	0.00040	-0.00128 -	-0.00209 -	-0.00209 -	-0.00155 -
3-Center Distance	0.00129 *	0.00046	0.00046	0.00029	-0.00020	-0.00188 -	-0.00269 *	-0.00269 *	-0.00215 *
4-Thickness	0.00177	0.00094	0.00094	0.00077	0.00028	-0.00140	-0.00221	-0.00221	-0.00167

For each gage cycle the following information is recorded:

Sample – The sample number since the last data reset.

Date – The date the samples was taken

Time – The time the sample was taken

Part Status – The status (Accept or Reject) of the part. If any part Check results are out side of the USL and LSL then the part will be rejected.

Sort Class (Optional) – If sort classes are defined for a part Check then the sort class into which the part falls will be displayed.

User Defined Fields (Optional) - The user can define additional information to be stored for each sample. For example, a field may be defined to specify the sample as coming from one of four different machines. In the GDF screen displayed above, Machine, SerialNo, Station, EventID are user defined fields. User defined fields are setup in Gage Setup screen.

Check Results - The results of all enabled Checks are displayed.

If a Check status is "Reject", that is outside of the USL (upper specification limit) or LSL (lower specification limit), then an asterisk will be placed next to the results to denote a reject on that Check feature and the value will be RED. (Optional) If the Check results are outside of the UAL (upper approach limit) or the LAL (lower approach limit) then a "+" or "-" will be placed next to the results and value will be YELLOW.

NOTE: If the Check results are outside of the URL (upper reasonable limit) or the LRL (lower reasonable limit) then data **will not be recorded** for that part.

Select Data to View

Allows the operator to select what data to display. The display options are:

The screenshot shows a dialog box titled "Select Data to View". It has several sections: "Time Frame For Displayed Data" with "From" and "To" date-time pickers (both set to 5/29/2007 08:48:03 AM) and a "To Current Time" checkbox; "View Data Method" with radio buttons for "Display All" and "By Time Frame" (selected); "Filter By GDF Field" with a dropdown menu and a "Machine" checkbox; and a bottom section with "Total Parts Stored : 0", "Ok", and "Cancel" buttons.

Display All – Displays all accumulated data for the current Gage.

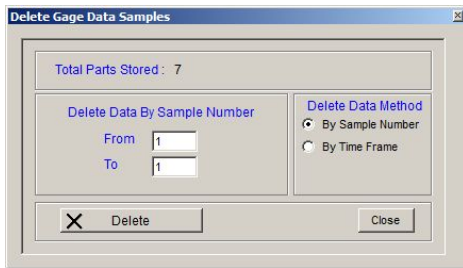
By Time Frame - The operator can select to display only samples taken in a given time frame. The operator can select to display data from a given date and time to another date and time or from a given date and time up to the current time by selecting "To Current Time"

Filter By GDF Field - If User Defined Field is used and setup for sorting (See UDF Setup in Gage Setup Screen).

Delete Sample

The screenshot shows a button with a red 'X' icon and the text "Delete Sample(s)".

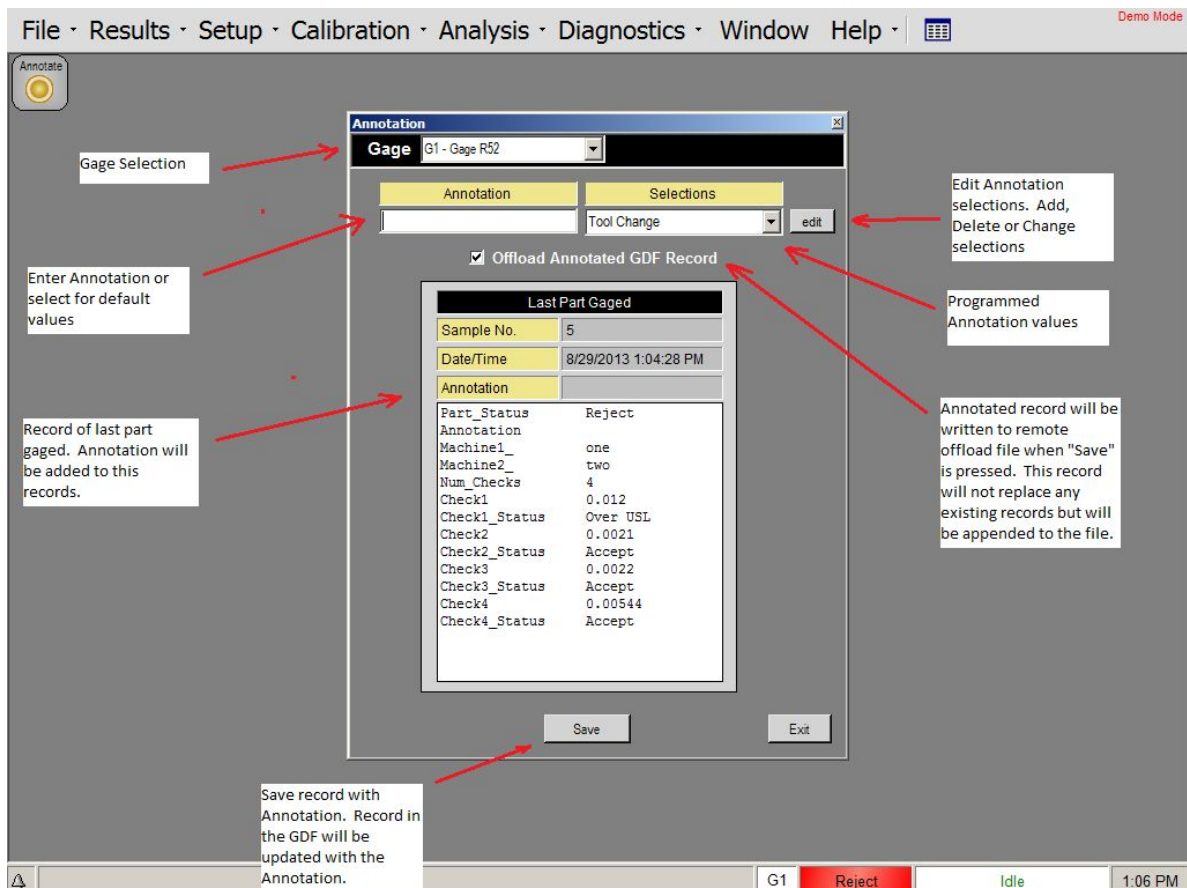
Allows the operator to delete a sample or range of samples by sample number or time frame. Enter a sample number(s) in the From and To boxes and press “Delete”. The system will prompt “Sample (#) will be deleted from the Gage Data File. Do you want to delete the sample.” Press “Yes” to delete the sample.



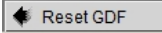
Annotate

Annotate

The Annotation Option of the EPIC software provides the ability for the user to assign an explanatory note to a measurement part record stored in the Gage Data File (GDF). Annotations are useful for identifying special point in the GDF, such as new operator, excessive tooling wear, or a change of material. The user has the ability to enter predefined annotation notes that can be selected at time of annotation or enter the annotation directly. (See [Section 2 Annotation](#), for full description)



Reset GDF



Clears all data from the GDF for the current Gage.

Export Data



The measured results stored in the Gage Data File can be exported to comma delimited text file (GageName.csv). The export location can reside locally on the EPIC system or externally on USB memory drive or mapped Network drive.

File Record Format :

The individual fields of the comma-delimited file are described below.

Header Information

The first section of the file contains the header information.

- The first line contains the **date** the file was created.
- The second line contains the **time** the file was created.
- The third line contains the **name** of the Gage the data is from.
- The fourth line contains the **number of Checks** for which data was recorded.
- The fifth line contains the **number of samples** in the file

Gage Data Records Format

Sample Number, Date-Time, Part Status, Sort Class*, UDF1*, UDF2*, UDF3*, UDF4*, UDF5*, Result1, Status1, Result2, Status2,.....

* Optional fields

Each line contains results for a single part, with commas separating the individual fields, which are described below.

- The first field is the **sample number**
- The second field is the **date and time** the sample was taken.
- The third field is the overall **status** of the part (Accept or Reject)
- The next field lists the **sort class** result for the part. This is an **optional** field and will not be included if sort classes are not defined for the gage.
- The next fields contain any **user-defined-field** data, such as defining what machine or spindle the part was machined on. These fields are **optional** and only included if user defined fields have been created in the Gage Setup screen. A maximum of five user-defined-field can be defined.
- The next two fields contain the actual gage **reading** of Check #1 and the Check **status** (Accept, Over USL, Under LSL, Over UAL, Under LAL) of Check #1.
- The data fields then continue with the gage reading and check status for all the other checks in the same manner as Check #1.

File Example:

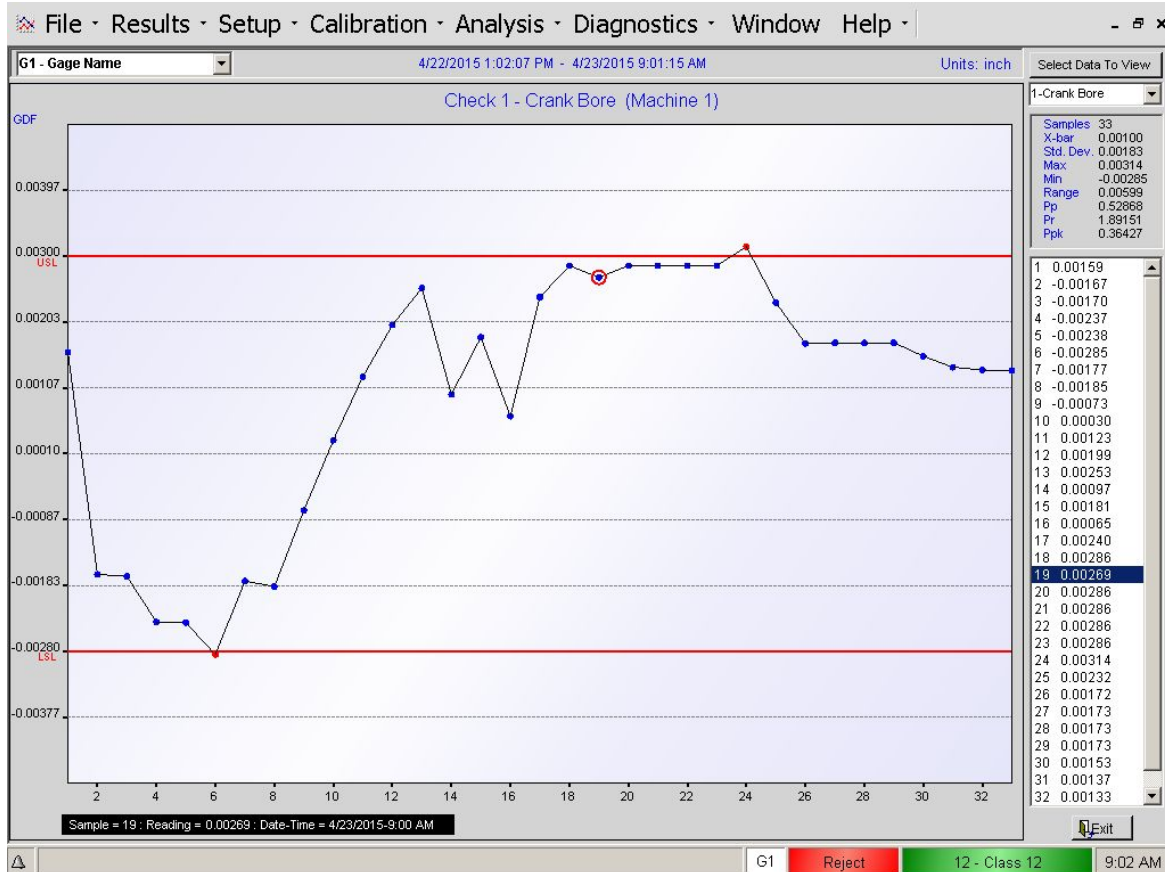
Date, 3/24/2011
Time, 12:46 PM
Gage, G1-G-51547
Number Checks, 3
Number Samples, 6

1, 3/17/2011 12:22:08 PM, Accept, 0.0033, Accept, 0.0018, Accept, 0.0025,
Accept,
2, 3/17/2011 12:22:08 PM, Accept, 0.0034, Accept, 0.0017, Accept, 0.0025,
Accept,
3, 3/17/2011 12:22:08 PM, Accept, 0.0037, Accept, 0.0018, Accept, 0.0025,
Accept,
4, 3/17/2011 12:22:08 PM, Accept, 0.0031, Accept, 0.0018, Accept, 0.0025,
Accept,
5, 3/17/2011 12:22:08 PM, Reject, 0.0033, Reject, 0.0012, Accept, 0.0025,
Accept,
6, 3/17/2011 12:22:08 PM, Accept, 0.0032, Accept, 0.0018, Accept, 0.0025,
Accept,

1.5.2. GDF Chart

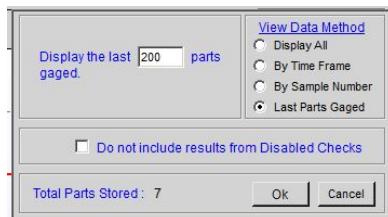


The Gage Data File Chart is generated from the stored gaged data. The display is a chart of all gage readings for the selected Check and selected data range.



Select Data to View

Allows the operator to select what data from the gage data file to display.



Display All – Displays all accumulated data from the gage data file for the selected check.

By Time Frame - The operator can select to display only samples taken in a given time frame.

By Sample Range - The operator can select to display a range of samples.

Last Parts Gaged- The operator can select to display only the results from a selected number of the last parts gaged.

For each Check the following is displayed:

Samples – Total number of samples viewed.

X-bar – Average of the samples viewed

Max – The maximum reading of all samples viewed

Min – The minimum reading of all samples viewed

Range – The difference between the max and min samples

Std. Dev. - The standard deviation of the sample viewed.

Pp - Process Performance

Pr – Performance Ratio

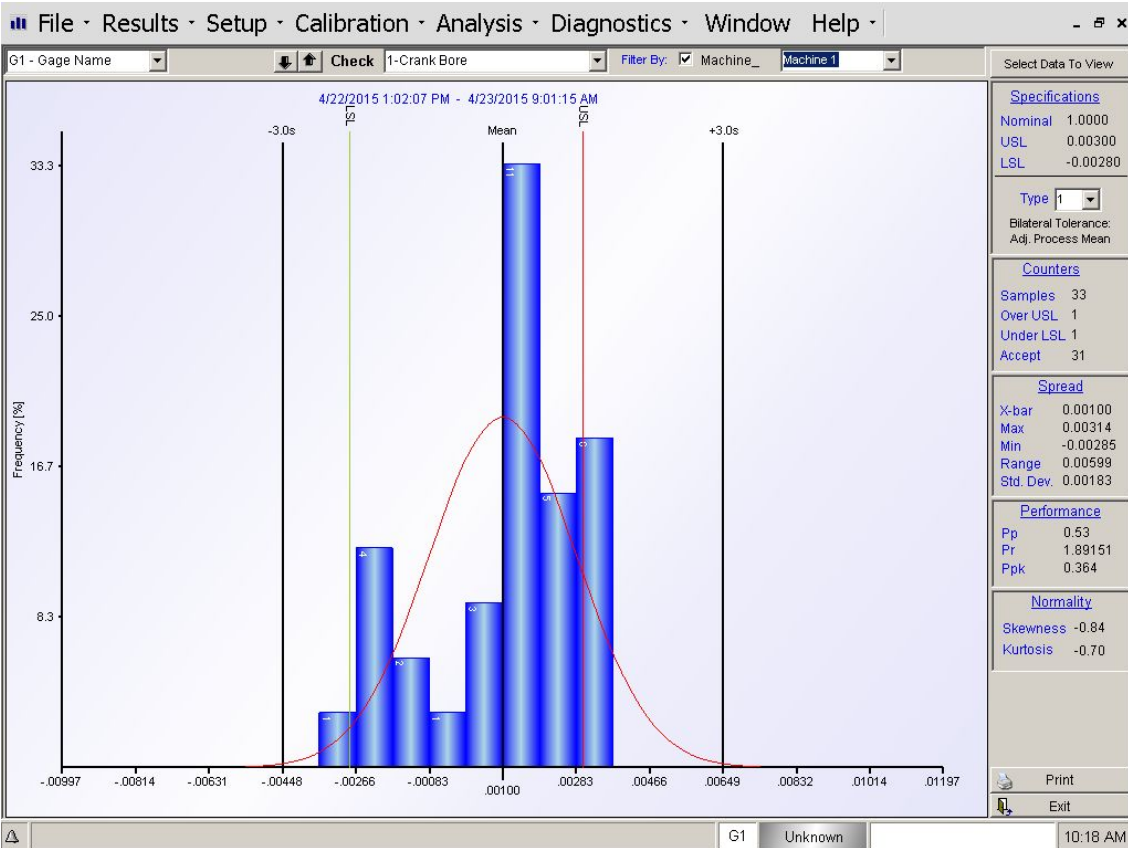
Ppk - Performance Index

* see [APPENDIX A - Performance/Process Capability Calculations](#)

1.5.3. Histogram

Histogram

A Histogram is a bar graph, which displays the relative frequency of occurrence of values within a group of observations. A separate histogram display is generated for each part Check. The pull down menu at the top the screen can be used to select which check's data will be displayed. The histogram is generated from the stored gaged data.



Select Data to View

Allows the operator to select what data from the gage data file to display.

Display All – Displays all accumulated data from the gage data file.

View Data Method

Display All

By Time Frame

By Sample Number

Last Parts Gaged

Do not include results from Disabled Checks

Display Probability Density Curve

Total Parts Stored : 7

Ok Cancel

By Time Frame - Displays only samples taken within a given time frame.

Time Frame For Displayed Data

From 4/22/2015 08:22:01 AM

To 4/23/2015 01:08:39 PM

To Current Time

View Data Method

Display All

By Time Frame

By Sample Number

Last Parts Gaged

Do not include results from Disabled Checks

Display Probability Density Curve

Total Parts Stored : 7

Ok Cancel

By Sample Range - Displays a range of samples.

Display Data By Sample Number

From 1

To 1

View Data Method

Display All

By Time Frame

By Sample Number

Last Parts Gaged

Do not include results from Disabled Checks

Display Probability Density Curve

Total Parts Stored : 7

Ok Cancel

Last Parts Gaged- Displays only a selected number of the last parts gaged.

Display the last 500 parts gaged.

View Data Method

Display All

By Time Frame

By Sample Number

Last Parts Gaged

Do not include results from Disabled Checks

Display Probability Density Curve

Total Parts Stored : 7

Ok Cancel

Histogram Display

There are 5 floating vertical lines displayed on the Histogram:

- 1) Mean of the Sample
- 2) USL - Upper Specification Limit

- 3) LSL - Lower Specification Limit
 - 4) $\bar{x} + 3\sigma$
 - 5) $\bar{x} - 3\sigma$
- σ = standard deviation

The Histogram also displays additional information for each check:

Specifications

Nominal Size – The nominal size programmed for the check.

USL - The Upper Specification Limit programmed for the check.

LSL - The Lower Specification Limit programmed for the check.

Tol. Type

Specification Type Selection

Type 1: Bilateral Tolerances, Adjustable Process Mean

Type 2: Bilateral Tolerances, Non-Adjustable Process Mean

Type 3: One-Sided Tolerance, or Zero-Based Tolerance

Counters

Samples – Total number of samples included in the histogram.

Over USL - Number of samples above the USL.

Under LSL - Number of samples below the LSL.

Accept - Number of samples acceptable parts in the sample.

Spread

X-Bar – The average of all the readings in the sample.

Max - The maximum reading in the sample.

Min - The minimum reading in the sample.

Range - The difference between the maximum and minimum readings in the sample.

Std. Dev. - The standard deviation of the sample.

Performance (see **Appendix A** for Performance Capability Description and Calculations)

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

Pr – Inverse of Pp.

Ppk- How centered the process distribution is. If Ppk is ≥ 1.33 , process is considered capable.

Normality

Skewness- The Measure of Symmetry.

For a Histogram with normal distribution, Skewness = 0.

Skewness >0 , distribution extending to the right.

Skewness <0 , distribution extending to the left.

Kurtosis

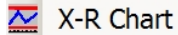
The Measure of whether the data is peaked or flat relative to Normal Distribution.

For a Histogram with normal distribution, Kurtosis = 0.

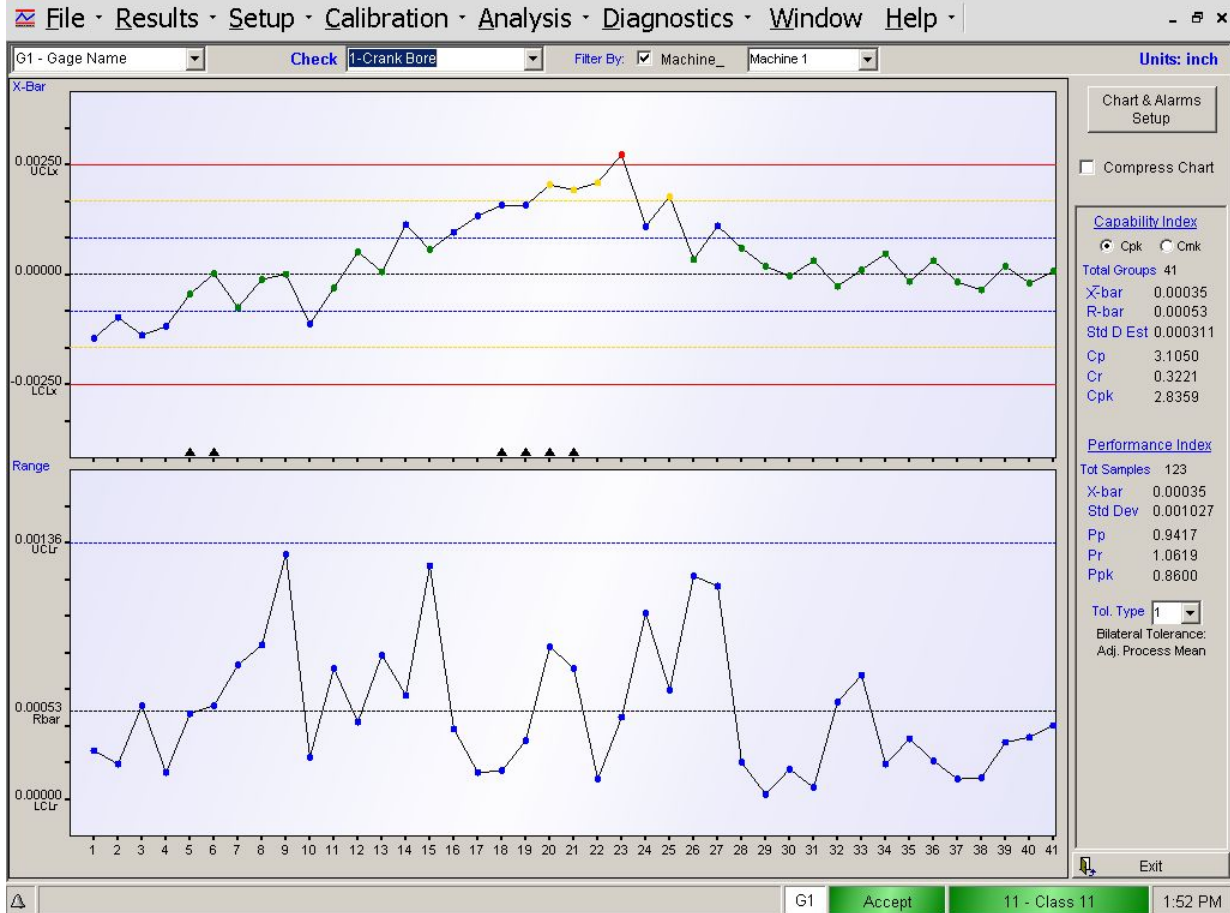
Kurtosis >0 , distribution sharp peak.

Kurtosis <0 , distribution relatively flat.

1.5.4. Xbar-R Chart



The Xbar-R chart plots the process mean (Xbar chart) and process range (R chart) over time for measured data in subgroups. This combination control chart is widely used to examine the stability of processes in many industries.



1.5.4.1. Chart & Alarm Setup



When you select to “Chart & Alarms Setup” the SPC Setup screen is displayed. Each Gage setup can have a different set of control charts setup parameter defined and each Check setup can have different control limits and alarming defined.

SPC Setup GAGE G1 - Gage Name

Sampling Setup Subgroup Size: 3 Frequency: 0 Max Samples: 300	SPC Alarm - Automatic Annotation Enable: <input checked="" type="checkbox"/> Annotation Msg: SPC Test Fail	Chart Display Settings <input checked="" type="checkbox"/> Color Limit Lines <input checked="" type="checkbox"/> Color Chart Points <input type="checkbox"/> Spec. Limit Lines +- 4 sigma(σ) (y axis range)
SPC Alarm - Inform MC Enable: <input type="checkbox"/> MC Message: 255		<input type="button" value="Save"/>

SELECT CHECK: 1-Crank Bore (setup per Check)

Control Limits X Chart: UCLx: 0.0025000, LCLx: -0.0025000 R Chart: UCLr: 0.0013572, LCLr: 0.0000000		Calculate Control Limits <input type="button" value="Calculate Selected Check"/> <input type="button" value="Calculate All Check"/>
--	--	--

Process Stability Alarms

No.	Process Stability Test	Enable	Display Method
1	1 point beyond 3σ control limit	<input checked="" type="checkbox"/>	Window
2	2 out of 3 consecutive pnts outside 2σ control limit	<input checked="" type="checkbox"/>	Window
3	4 out of 5 consecutive pnts outside 1σ control limit	<input checked="" type="checkbox"/>	Window
4	9 consecutive points on same side of centerline	<input type="checkbox"/>	Window
5	6 consecutive points increasing or decreasing	<input type="checkbox"/>	Window
6	14 consecutive points oscillate up & down	<input type="checkbox"/>	Window
7	15 consecutive pnts inside of the 1σ control limit	<input type="checkbox"/>	Window

σ = standard deviation

1.5.4.2. Sampling Setup

This value defines the number of samples in a subgroup for a Check. Subgroup size can be value 1 to 15. Each Check have the same subgroup size. A subgroup is represented on the chart as a point.

Frequency - Number of Consecutively Gaged parts skipped between Sample plots (subgroup).

Max Samples - Maximum number of samples used (display and analysis).

Example: if Max Samples is set to "300" then the last 300 measured readings will be used, if subgroup size is set to 3 then 100 chart points will be displayed.

1.5.4.3. SPC Alarm - Automatic Annotation

Enable - If enabled, annotation will automatically be logged in the Gage Data File when any of the "Process Stability Alarms" are triggered for any Check. The annotation can be viewed in the Gage Data File screen or on the chart (see Viewing Chart below).

Annotation Msg - Message that will be written to Gage Data File if a Process Stability Alarm is triggered and Automatic Annotation enabled. Message can be a maximum of 15 characters.

1.5.4.4. SPC Alarm - Inform MC

Enable - Enable- Inform Machine Control of Process Stability Alarm . If an Process Stability Alarm is triggered, this programmed message will be transmitted to Machine Control (PLC etc..). This is primarily used to shutdown the machine control when an out of process condition occurs.

MC Message - Message that will be transmitted to Machine Control (PLC etc..) if a Process Stability Alarm is triggered and Inform MC enabled.

1.5.4.5. Chart Display Setting

Color Limit Lines - Uses colored lines to show the boundaries for the control chart zones.

Within control charts, there are four zones:

Green	From the center-line to ± 1 standard deviation.
Blue	From ± 1 standard deviations to ± 2 standard deviations.
Yellow	From ± 2 standard deviations to ± 3 standard deviations.
Red	Outside ± 3 standard deviations

Color Chart Points - Plots the subgroup data points using a colored dot to show which zone contains the point.

Spec. Limit Lines - Plots the specification limits for displayed Check on the control chart. If the specification limits do not plot on your control charts after activating this feature, this indicates that your process is in such control that the spec limits would chart outside the control chart.

Y axis range - Used to specify the range of the Y-axis (the vertical axis) of your control charts. The range value is + number of standard deviation from median center line.

1.5.4.6. Control Limits

There are a set of control limit for each feature being measured (Check).

UCLx - Xbar chart upper control limit

LCLx - Xbar chart lower control limit

UCLr - Range chart upper control limit

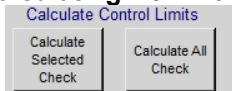
LCLr - Range chart lower control limit

New control limits can be either be entered manually or have the software calculate new limits from the active data in the gage data file. Your control charts are the indicator of when you may need to modify or recalculate your control limits. For example, let's say you make an improvement to your process—you replace an old, unreliable piece of equipment with a new machine. After replacing the machine and beginning to make your product again, let's say your control charts begin to show that you have a great deal less variation in your product. At this time, you may want to recalculate your control limits to reflect the improved process.

Manually Entering New Control Limits

Control limits can be manually enter for the current data file at any time. For example, perhaps you've been performing your SPC analysis by hand in the past and have already established your control limits for a process. To enter new limits, select the Check you want to modify and enter the new limit in the text boxes provided and select "Save" when done.

Calculating New Control Limits from Existing Data



Select the “Calculate Selected Check” button to calculate new control limits for the currently select "Check". The calculated control limits will be base on the currently accumulated readings.

Select “Calculate All Check” button to calculate new control limits for all "Checks". The calculated control limits will be base on the currently accumulated readings

EPIC calculations for control limits:

$$UCLx = \bar{x} + (3 * (\text{StdDev} / \text{Subgroup Size}))$$

$$LCLx = \bar{x} - (3 * (\text{StdDev} / \text{Subgroup Size}))$$

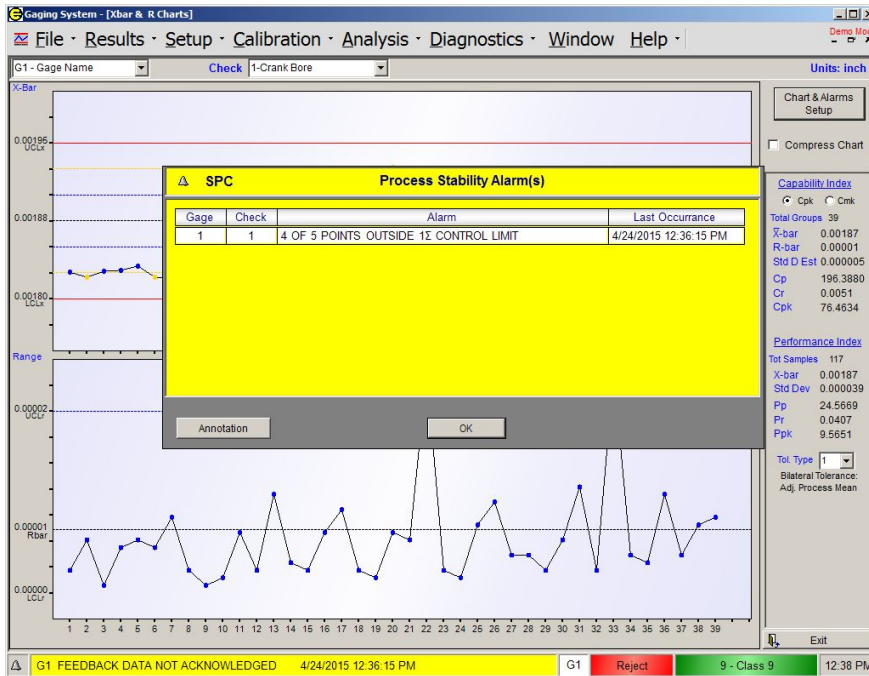
1.5.4.7. Process Stability Alarms

Process Stability Alarms			
No.	Process Stability Test	Enable	Display Method
1	1 point beyond 3σ control limit	<input type="checkbox"/>	Window
2	2 out of 3 consecutive prnts outside 2σ control limit	<input type="checkbox"/>	Window
3	4 out of 5 consecutive prnts outside 1σ control limit	<input type="checkbox"/>	Window
4	9 consecutive points on same side of centerline	<input type="checkbox"/>	Window
5	6 consecutive points increasing or decreasing	<input type="checkbox"/>	Window
6	14 consecutive points oscillate up & down	<input type="checkbox"/>	Window
7	15 consecutive prnts inside of the 1σ control limit	<input type="checkbox"/>	Window

σ = standard deviation

There are seven process stability alarms that can be activated for each Check independently. The alarms are generated from sample data charted the Xbar chart. The alarm process stability test is performed when new data is added to the gage data file at the completion of a measurement cycle when the Enable checkbox is selected. If a process stability test fails the alarm will be activated and displayed according to the “Display Method”. The alarm will also be logged in the SPC Alarm Log (see Alarm Display).

Display Method - Select the display method (Status Bar, Window, or None) for the alarm. If Status Bar is selected then the alarm will be displayed on the bottom line of the EPIC application. If Window is selected the alarm will be displayed in a pop up window (see figure below).



Annotation from Alarm Window Display

When a process stability alarm is triggered and displayed (Window) there is an option to annotate the gage data file with cause of alarm. Select the "Annotation" button to bring up the following screen that allows an annotation message to be entered.

The 'Annotation' dialog box is shown with the following fields and data:

Gage: G1 - Gage Name

Annotation: SPC Test Fail

Selections: [Dropdown Menu]

edit

Last Part Gaged	
Sample No.	117
Date/Time	4/24/2015 12:36:15 PM
Annotation	SPC Test Fail
Part_Status	Reject
Annotation	SPC Test Fail
Sort_Class	Class 9
Machine_	Machine 1
SerialNo_	1234567
Station_	1
EventID_	A24
Num_Checks	4
Check1	0.0019
Check1_Status	Accept
Check2	0.00183
Check2_Status	Over UAL
Check3	0.00182
Check3_Status	Over USL
Check4	0.00199
Check4_Status	Accept

Save Exit

1.5.4.8. Viewing Chart

The control chart shows the upper and lower control limits (UCL and LCL) and the individual subgroup data. There is also the option to display color limit lines and specification limits. When a large amount of subgroup data has been collected that will not fit on the display a scroll-bar will be displayed to allow scroll back and forth through the chart data.

Viewing Subgroup Data

When viewing a control chart, click on any subgroup point displayed on the chart to receive a small data table which displays information about that particular subgroup, including subgroup number, sample that makeup the subgroup, date and time, subgroup data readings, and annotation.



Viewing Annotation

The control charts also shows if Annotation has been attached to any subgroup by displaying a black triangle flag on the axis below the subgroup. To view the Annotation click on the triangle flag (see figure below).



Compress Chart - The control chart window also contains a Compress Chart checkbox. Use this option when you have collected more subgroup data than fits in the control chart window at one time. The Compress Chart option compresses your control chart so that all subgroups are visible in the control chart window.

Process Capability

 See [Appendix A](#) for Performance / Process Capability Description and Calculations

Cpk - Process Capability Indices Cp and Cpk are normally used when determining the capability of a continuous production process and where the sampling of parts is made continuously during the production.

Cmk - Machine Capability Indices Cm and Cmk are used when determining the ability of a production machine to produce, for example as acceptance test of new equipment. The sampling of parts is made in a short period of time without changes in machine settings. All efforts are made to try to isolate the

influence on the machine from other factors.

Total Groups- Total number of subgroups used in generating the chart.

X-bar - Average (Mean) of the average of each subgroup values

R-bar - Average range of all the range values (Xmax-Xmin) for each subgroup

Std D Est - Estimated Standard Deviation (Std Dev Est). Std Dev Est = Rbar / d2

Cp - Process Capability.

Cr - Capability ratio.

Cpk - Process Capability index.

Performance Capability



See [Appendix A](#) for Performance / Process Capability Description and Calculations

Performance Capability Indices Pp and Ppk are normally used when determining the possibilities of a process to produce within specified requirements and where the sampling of parts is made in the form of a large sample taken on one occasion.

Total Sample - total number of samples.

Xbar - Average (mean) of all readings.

Std Dev - Standard Deviation

Pp - Performance index.

Pr - Performance ratio.

Ppk - Performance index.

Tol. Type - Specification Type Selection

Type 1: Bilateral Tolerances, Adjustable Process Mean

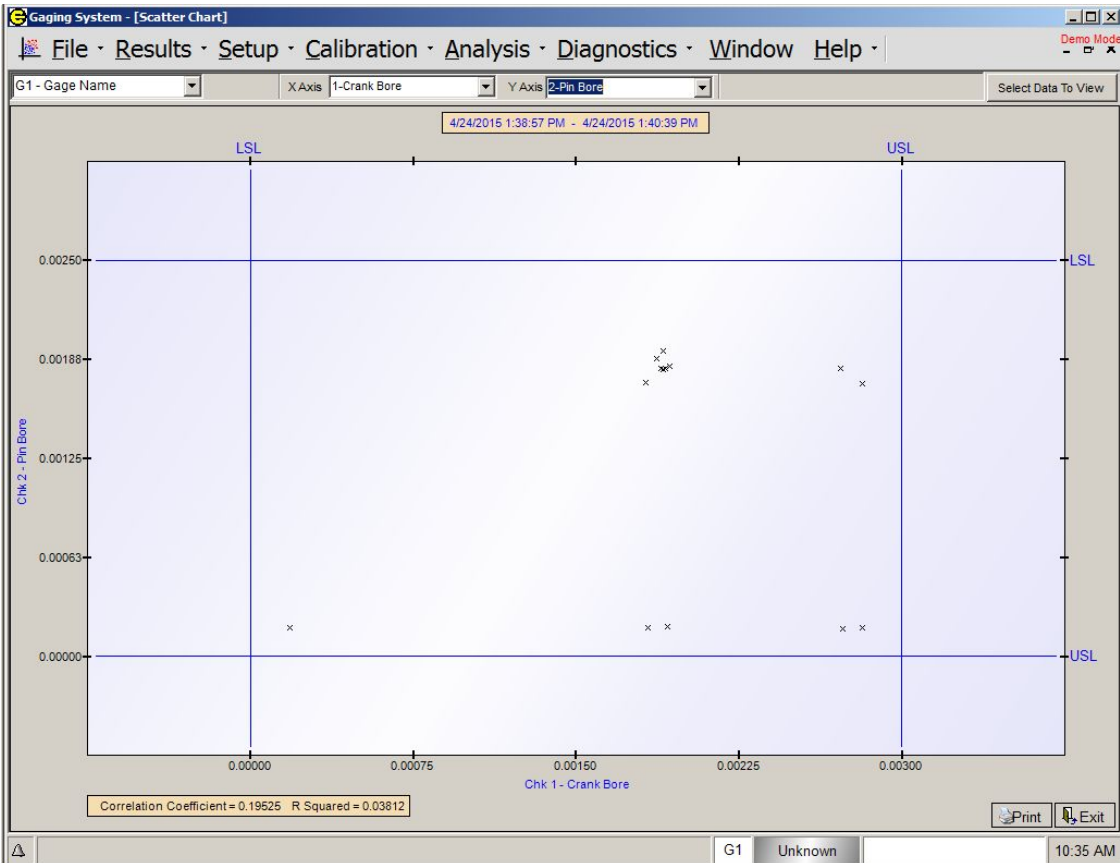
Type 2: Bilateral Tolerances, Non-Adjustable Process Mean

Type 3: One-Sided Tolerance, or Zero-Based Tolerance

1.5.5. Scatter Chart

Scatter Chart

The Scatter Chart generates a plot of two variables (Part Checks), one against the other to display trends. The Gage, Part Checks and Data Viewing Method are selected in this menu.



Gage - By using the pull down menu, the operator selects the gage in which the part checks to be monitored are programmed.

X Axis - By using the pull down menu, the operator selects the X Axis Part Check to be displayed.

Y Axis - By using the pull down menu, the operator selects the Y Axis Part Check to be displayed.

Select Data to View

Allows the operator to select what data from the gage data file to display.

Display All – Displays all accumulated data from the gage data file.

All Parts Displayed	View Data Method <input checked="" type="radio"/> Display All <input type="radio"/> By Time Frame <input type="radio"/> By Sample Number <input type="radio"/> Last Parts Gaged
<input type="checkbox"/> Do not include results from Disabled Checks <input checked="" type="checkbox"/> Display Probability Density Curve	
Total Parts Stored : 7 <input type="button" value="Ok"/> <input type="button" value="Cancel"/>	

By Time Frame - Displays only samples taken within a given time frame.

Time Frame For Displayed Data From: 4/22/2015 08:22:01 AM To: 4/23/2015 01:08:39 PM <input type="checkbox"/> To Current Time	View Data Method <input type="radio"/> Display All <input checked="" type="radio"/> By Time Frame <input type="radio"/> By Sample Number <input type="radio"/> Last Parts Gaged
<input type="checkbox"/> Do not include results from Disabled Checks <input checked="" type="checkbox"/> Display Probability Density Curve	
Total Parts Stored : 7 <input type="button" value="Ok"/> <input type="button" value="Cancel"/>	

By Sample Range - Displays a range of samples.

Display Data By Sample Number From: 1 To: 1	View Data Method <input type="radio"/> Display All <input type="radio"/> By Time Frame <input checked="" type="radio"/> By Sample Number <input type="radio"/> Last Parts Gaged
<input type="checkbox"/> Do not include results from Disabled Checks <input checked="" type="checkbox"/> Display Probability Density Curve	
Total Parts Stored : 7 <input type="button" value="Ok"/> <input type="button" value="Cancel"/>	

Last Parts Gaged- Displays only a selected number of the last parts gaged.

Display the last 500 parts gaged.	View Data Method <input type="radio"/> Display All <input type="radio"/> By Time Frame <input type="radio"/> By Sample Number <input checked="" type="radio"/> Last Parts Gaged
<input type="checkbox"/> Do not include results from Disabled Checks <input checked="" type="checkbox"/> Display Probability Density Curve	
Total Parts Stored : 7 <input type="button" value="Ok"/> <input type="button" value="Cancel"/>	

1.5.6. Gage R and R

R_R Gage R and R ...

The screenshot displays the 'Gaging System - [Gage Repeatability and Reproducibility Report]' window. The main data area is a table with columns for 'Appraiser / Trial #' and 'PART' (1-10), and rows for 'Average' and 'Range' for each appraiser (A, B, C). Below the table, the 'Average and Range Method (ARM)' section shows calculated values for EV, AV, GRR, PV, TV, and ndc. The 'R&R Study Status' is 'Complete'. The bottom status bar shows 'G1 Reject 0 - Class Error 10:53 AM'.

Appraiser / Trial #	PART										Average
	1	2	3	4	5	6	7	8	9	10	
A 1	0.00503	0.00502	0.00502	0.00502	0.00502	0.00502	0.00503	0.00503	0.00502	0.00502	0.00502
A 2	0.00502	0.00502	0.00503	0.00503	0.00502	0.00503	0.00502	0.00503	0.00502	0.00502	0.00502
A 3	0.00502	0.00503	0.00503	0.00503	0.00503	0.00502	0.00503	0.00503	0.00502	0.00502	0.00503
Average	0.00502	0.00502	0.00503	0.00503	0.00502	0.00502	0.00503	0.00503	0.00502	0.00502	0.00502
Range	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00000	0.00000	0.00000	0.00001
B 1	0.00507	0.00507	0.00507	0.00507	0.00507	0.00507	0.00507	0.00508	0.00507	0.00508	0.00507
B 2	0.00507	0.00507	0.00508	0.00507	0.00507	0.00507	0.00507	0.00508	0.00508	0.00507	0.00507
B 3	0.00508	0.00508	0.00507	0.00508	0.00507	0.00508	0.00507	0.00508	0.00508	0.00507	0.00507
Average	0.00507	0.00507	0.00507	0.00507	0.00507	0.00507	0.00507	0.00508	0.00508	0.00507	0.00507
Range	0.00001	0.00001	0.00001	0.00001	0.00000	0.00001	0.00000	0.00001	0.00001	0.00001	0.00001
C 1	0.00506	0.00507	0.00506	0.00507	0.00507	0.00506	0.00507	0.00507	0.00507	0.00506	0.00507
C 2	0.00507	0.00506	0.00506	0.00507	0.00507	0.00506	0.00506	0.00507	0.00506	0.00507	0.00507
C 3	0.00506	0.00507	0.00506	0.00506	0.00506	0.00506	0.00506	0.00506	0.00506	0.00507	0.00506
Average	0.00506	0.00507	0.00506	0.00507	0.00507	0.00506	0.00506	0.00507	0.00506	0.00506	0.00506
Range	0.00001	0.00001	0.00000	0.00001	0.00001	0.00000	0.00001	0.00001	0.00001	0.00002	0.00001
Part Avg.	0.00505	0.00505	0.00505	0.00506	0.00505	0.00505	0.00505	0.00506	0.00505	0.00505	0.00505

Average and Range Method (ARM)

\bar{x}_a 0.00502	Max \bar{x} 0.00507	\bar{r}_a 0.00001	EV 0.00002	%EV 00.78%
\bar{x}_b 0.00507	Min \bar{x} 0.00502	\bar{r}_b 0.00001	AV 0.00013	%AV 04.38%
\bar{x}_c 0.00506	\bar{x}_{DIFF} 0.00005	\bar{r}_c 0.00001	GRR 0.00013	%GRR 04.45%
\bar{x} 0.00505	UCL _R 0.00002	\bar{r} 0.00001	PV 0.00001	%PV 00.36%
		R_p 0.00001	TV 0.00013	ndc 0

R&R Study Status Complete Not Active

Study Setup
 # of Appraisers 3
 # of Trials 3
 # of Parts 10

Analysis Method
 % Total Variation (TV)
 % Tolerance (0.00300)
 UCL_R Test

Last Study 4/28/2015 10:53:45 AM | Print RR Study | Export Q-DAS® Study Type-2 | Export Readings | View Summary | Exit

G1 Reject 0 - Class Error 10:53 AM

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

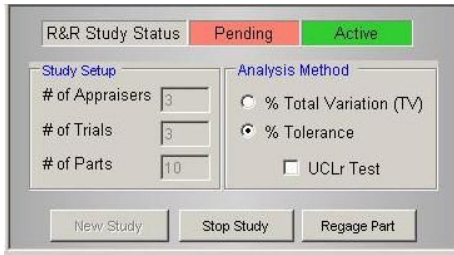
Gage Reproducibility - Appraiser Variation (AV) - is the variation in the average of measurements made by DIFFERENT appraisers using the same gage when measuring identical characteristics of the same parts.

Average and Range Method (ARM) is used to compute the gage R&R.

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 different appraisers: A, B, and C. A partial or "simulated" R & R study can be conducted by a single appraiser 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, SPC charts are not updated, and no feedback is sent to the machine control.

1.5.6.1. Gage R&R Setup



Study Setup

of Appraisers - Number of appraisers to be used in the study. Must be from 1 to 3.

of Trials - Number of trials for each part. Must be either 2 or 3.

of Parts - Number of parts to be used in the study. Must be between 1 and 10.

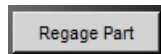
Analysis Method

% Total Variation - %EV, %AV, %GRR, %PV are computed as a percentage of the Total Variation (TV)

% Tolerance - %EV, %AV, %GRR, %PV are computed as a percentage of the part tolerance

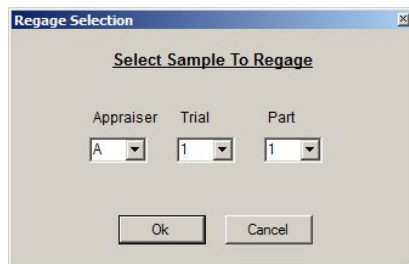
UCLr Test - This test compares the upper control limit range (UCLr) to the data accumulated in the R&R test and discards any reading which exceeds the upper control limit range. If this box is checked then any reading which exceeds the upper control limit will be discarded.

Regage Part



If an error occurs when measuring a part during a gage R&R, an individual part may be re-gaged rather than repeating the entire study. For example, if a part is not properly seated in the Gage when the start gage command is issued the gage will record incorrect readings. These readings can be over written using Regage Part.

When the “Regage Part” button is pressed a dialog box will open allowing the operator to select the Appraiser number, Trial number, and Part number to be regaged (see figure below).



1.5.6.2. Performing a Gage R&R Study

1. Use the pull down menu in the upper left corner of the screen to select the gage on which the gage R&R study
2. Under “Study Setup” enter the number of appraisers (1-3), the number of trials (2-3) and the number of parts (1-10) to be used in the study.
3. Select “New Study”. The system will alert the operator that any existing gage R&R data for the current Gage will be deleted. Select “Yes” to continue.

4. The system will prompt with next part to be gaged. Appraiser 1, Trial1, Part 1.
5. Have the first appraiser load part number 1 on the gage and initiate a gage cycle.
6. The system will prompt for the next appraiser, trial, and part to be gaged.
7. Continue to gage parts as prompted by the system until the study is completed. To pause in the middle of the study select "Stop Study". The study can be continued by selecting "Continue Study".

1.5.6.3. Gage R&R Calculations

The calculations used for the GR&R are presented in the following sections. All calculations are based on predicting 5.15 sigma (99.0% of the area under the normal distribution curve).

Repeatability - Equipment Variation (EV)

$$EV = \bar{R} \times K_1$$

K_1 is $5.15/d_2$ where d_2 is dependent on the number of trials (m) and the number of parts times the number of operators (g) which is assumed to be greater than 15.

$$\%EV = 100(EV/Tolerance)$$

OR

$$\%EV = 100(EV/TV)$$

TRIALS	2	3
K_1	4.56	3.05

Reproducibility - Appraiser Variation (AV)

$$AV = \sqrt{(\bar{X}_{DIFF} \times K_2)^2 - (EV^2/nr)}$$

where:

$$\bar{X}_{DIFF} = \text{Max}\bar{X}_i - \text{Min}\bar{X}_i$$

(\bar{X}_i is the average of all readings for a single operator.)

K_2 is $5.15/d_2^*$ where d_2^* is dependent on the number of operators (m) and (g) is 1, since there is only one range calculation.

n = number of parts

r = number of trials

If a negative value is calculated under the square root sign, the appraiser variation (AV) defaults to zero (0).

$$\%AV = 100(AV/Tolerance)$$

OR

$$\%AV = 100(AV/TV)$$

Operators	2	3
K_2	3.65	2.70

Repeatability and Reproducibility (R&R)

$$R\&R = \sqrt{EV^2 + AV^2}$$

$$\%R\&R = 100(R\&R/Tolerance)$$

OR

$$\%R\&R = 100(R\&R/TV)$$

Part Variation (PV)

$$PV = R_p \times K_3$$

where:

$$R_p = \text{Max}\bar{X}_p - \text{Min}\bar{X}_p$$

R_p is defined as the range of \bar{X}_p values where \bar{X}_p is average across all trials and operators of a single part tested.

K_3 is $5.15/d_2^*$ where d_2^* is dependent on the number of operators (m) and (g) is 1, since there is only one range calculation.

$$\%PV = 100(PV/\text{Tolerance})$$

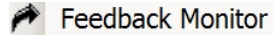
Or

$$\%PV = 100(PV/TV)$$

Total Variation (TV)

$$TV = \sqrt{(R\&R^2 + PV^2)}$$

1.5.7. Feedback Monitor



The Feedback monitor menu allows the operator to view the compensation amounts and rates for the process.

See also [Section 4 Feedback Setup and Operation](#)

Offset	Sample Count	Running Average	Status	Feedback Offset
1 - Offset ONE	1	0.00506	Over UCL	0.00506
2 - Offset TWO	1	0.00506	Over UCL	0.00506

Running Avg.	Calculated Offset	Transmitted Offset	Tool Adj. Total	Transmitted Counts
0.00506	0.00506	0.00506	0.00506	0

1.5.7.1. Offset Data

Offset – The name of the current offsets.

Sample Count – The number of samples used to calculate the offset.

Running Average – The running average of the offsets.

Status – The status

Feedback Offset – Amount of offset applied to the last part.

Feedback Mode – The current mode of feedback (Run or Start-Up)

Part Status – The status of the last part gaged.

Total Parts – Total number of parts gaged since last reset of feedback data

Accept Parts -Total number of Accept parts gaged since last reset of feedback data

Reject Parts -Total number of Reject parts gaged since last reset of feedback data

Consecutive Accept - The number of consecutive Accept parts gaged since last reset of feedback data

Start-Up Count – The number of parts used in the Start-Up mode.

Time Stamp – The From and To time of the current feedback data

Reset – Resets Feedback data for either Gage or Machine

1.5.7.2. Individual Offset Details

The Feedback control set-up and data for each individual offset can be viewed here. The offsets can be selected using the pull-down menu.

1.5.7.3. Feedback Control Setup

The Feedback Control Setup is taken from the Feedback Setup menu and is for display only.

1.5.7.4. Feedback Data

Check Result – The last measured result for the Check associated with the offset

Sample Count – The current number of samples.

Lag Count – The current number of lag parts.

Running Average – The running average of the sample data.

Calculated Offset – $(\text{Running Average} - \text{Set Point}) * (\text{Comp Rate})$ This is calculated when the Running Average violates the Control Limits for the check.

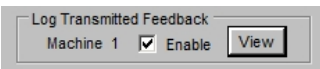
Transmitted Offset – The calculated Feedback Offset to be transmitted if the Tooling Adjust Limits are not exceeded.

Tool Adjustment Total – The total of the tooling adjustments since the last feedback reset.

Transmitted Counts – The number of counts transmitted thru the binary coded messages via the parallel I/O.

Sample Data - The values used to compute the Running Average.

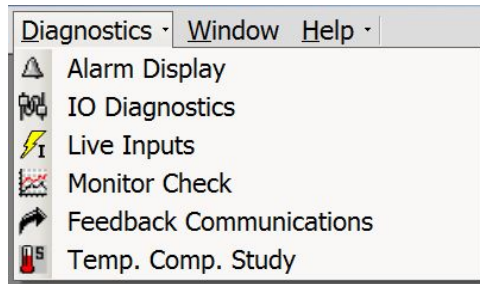
1.5.7.5. Log Transmitted Feedback



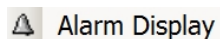
If enabled, Transmitted Offset Data will be logged. The offset data will be written to a comma delimited text file that can be viewed or copied (see figure below).

Date	Time	Offset Val	Tot Adj	Tot Prt Cnt	Avg. Adj
4/28/2015	1:14 PM	0.0051	0.015204	5	0.003041
4/28/2015	1:14 PM	0.0051	0.020271	6	0.003379
4/28/2015	1:14 PM	0.0051	0.025338	7	0.003620
4/28/2015	1:14 PM	0.0051	0.030399	8	0.003800
4/28/2015	1:14 PM	0.0051	0.035461	9	0.003940
4/28/2015	1:14 PM	0.0051	0.040529	10	0.004053
4/28/2015	1:14 PM	0.0051	0.045588	11	0.004144
4/28/2015	1:14 PM	0.0051	0.050642	12	0.004220
4/28/2015	1:14 PM	0.0051	0.055710	13	0.004285
4/28/2015	1:14 PM	0.0051	0.060767	14	0.004340
4/28/2015	1:15 PM	0.0051	0.065833	15	0.004389

1.6. Diagnostics



1.6.1. Alarm Display



Alarm Display screen displays a log of system alarms with the date and time the alarm occurred.

Active Alarm(s)

Description	Last Occurrence
Consecutive Reject Limit Exceeded	4/28/2015 1:54:12 PM
Feedback Data Not Acknowledged	4/28/2015 1:54:12 PM

Internal Alarm Log

Date-Time	Description
4/28/2015 10:49:47 AM	Feedback Data Not Acknowledged
4/28/2015 12:59:42 PM	Feedback Data Not Acknowledged
4/28/2015 1:13:20 PM	Feedback Data Not Acknowledged
4/28/2015 1:13:22 PM	Feedback Data Not Acknowledged
4/28/2015 1:53:46 PM	Feedback Data Not Acknowledged
4/28/2015 1:53:48 PM	Feedback Data Not Acknowledged
4/28/2015 1:54:12 PM	Consecutive Reject Limit Exceeded
4/28/2015 1:54:12 PM	Feedback Data Not Acknowledged

SPC Alarm Log

Chk	Date-Time	Description
1	4/24/2015 1:40:12 PM	2 of 3 Points Outside 2 σ control limit
1	4/24/2015 1:40:25 PM	1 Point Beyond 3 σ Control Limit
1	4/24/2015 1:40:25 PM	2 of 3 Points Outside 2 σ control limit
1	4/24/2015 1:40:25 PM	4 of 5 Points Outside 1 σ Control Limit
1	4/24/2015 1:40:25 PM	6 Consecutive Points increasing or decreasing
1	4/28/2015 10:48:58 AM	1 Point Beyond 3 σ Control Limit
1	4/28/2015 10:48:58 AM	2 of 3 Points Outside 2 σ control limit
1	4/28/2015 10:48:58 AM	4 of 5 Points Outside 1 σ Control Limit

External Alarm Log

Buttons: Reset Alarms, Reset Alarm Log, Print, Exit

Status Bar: G1 FEEDBACK DATA NOT ACKNOWLEDGED 4/28/2015 1:54:12 PM | G1 Reject 0 - Class Error 1:54 PM

Active Alarm(s) - alarms that are currently active and have not been acknowledged.

Internal Alarm Log - a log of the last 25 internal alarms that were triggered. Internal alarms are alarms triggered from the EPIC CAG system as opposed to alarm triggered from an external connected controller (PLC).

SPC Alarm Log - a log of the last 25 SPC Alarms (Process Stability Alarms) that were triggered.

External Alarm Log - a log of the last 25 external alarms that were triggered. External alarms are received from external machine control such as controlling PLC.

1.6.2. IO Diagnostics

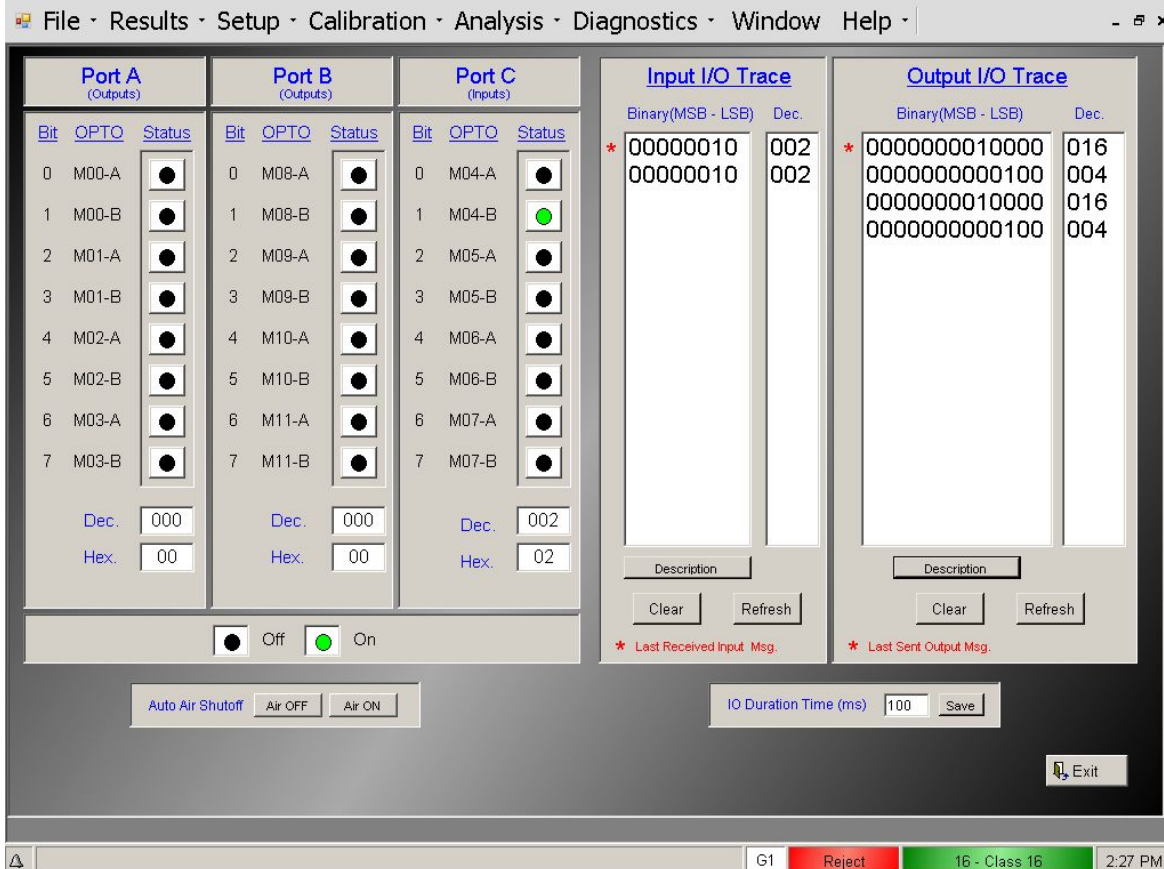
IO Diagnostics

The IO Diagnostics screen is used to view the communication between the EPIC CAG system and the external controller (PLC). The IO Diagnostics screen that will be displayed will depend on the type of communication configured for the system. There are two standard interfaces for communication between external controller and the EPIC CAG system, Parallel IO and EtherNet/IP. The two types of interfaces are explained in detail in [Section 3.1](#) and [Section 3.2](#).

1.6.2.1. Parallel IO Communications

 See [Section 3.1 Parallel IO Communications](#) for more details.

The IO Diagnostic screen used for Parallel IO Communication is display below. It pictorially displays the three ports of digital IO (Port A, Port B, Port C).



Outputs – Ports A & B

Bit - the bit number on the output port.

OPTO - the location/label of the output on the opto board.

Status - a green dot indicates that the output is ON and a black dot indicates that the output is OFF. Click on the status button to force the output ON.

Inputs – Port C

Bit - the bit number on the output port.

OPTO - the location/label of the output on the opto board.

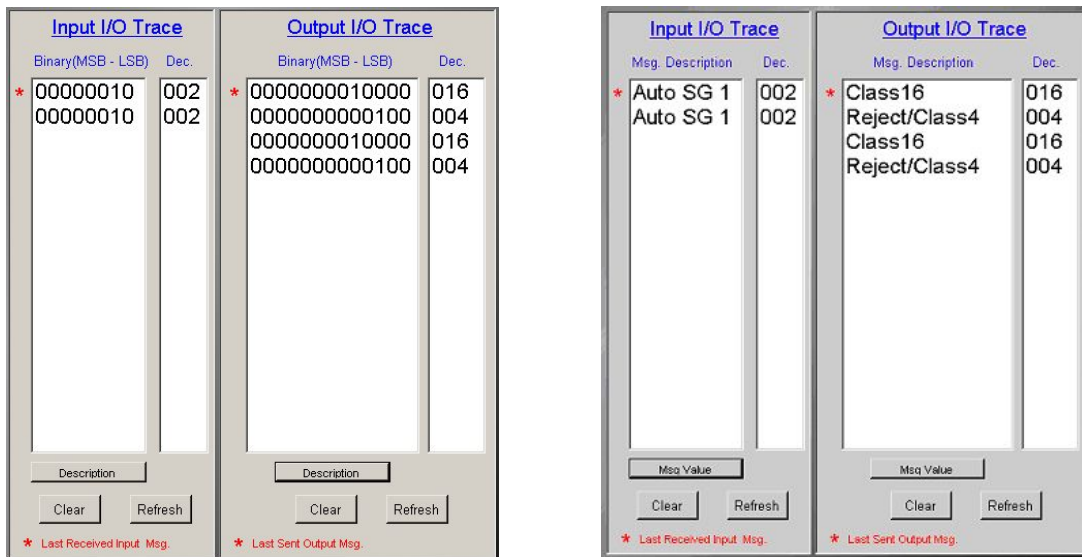
Status - a green dot indicates that the input is ON and a black dot indicates that the input is OFF.

Input I/O Trace

The Input I/O Trace displays the last 15 messages received in the Input buffer. The display shows the message in binary that can be used to see what individual input is on/off easily. It also shows the message in decimal. If the *Description* button is pressed, a brief description of the message will be displayed.

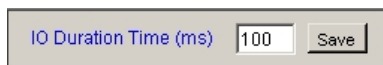
Output I/O Trace

The Output I/O Trace displays the last 15 messages transmitted in the output buffer. The display shows the message in binary that can be used to see what individual input is on/off easily. It also shows the message in decimal. If the *Description* button is pressed, a brief description of the message will be displayed.



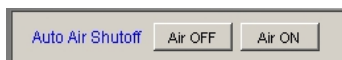
IO Duration Time

Allows the operator to program the length, in milliseconds, of the I/O message as sent by the EPIC system to the PLC. For example, if the IO Duration Time is set for 100, the output lines used for the message will be held ON for a duration of 100 milliseconds then turned OFF.



Auto Air Shutoff (Optional)

The Air Off and Air ON buttons provide means of testing the Auto Air function. When the Air ON button is pressed the output used for controlling the air will be turned ON. The output(s) used to controlling the auto air shutoff are programmed in the Check Setup screen.



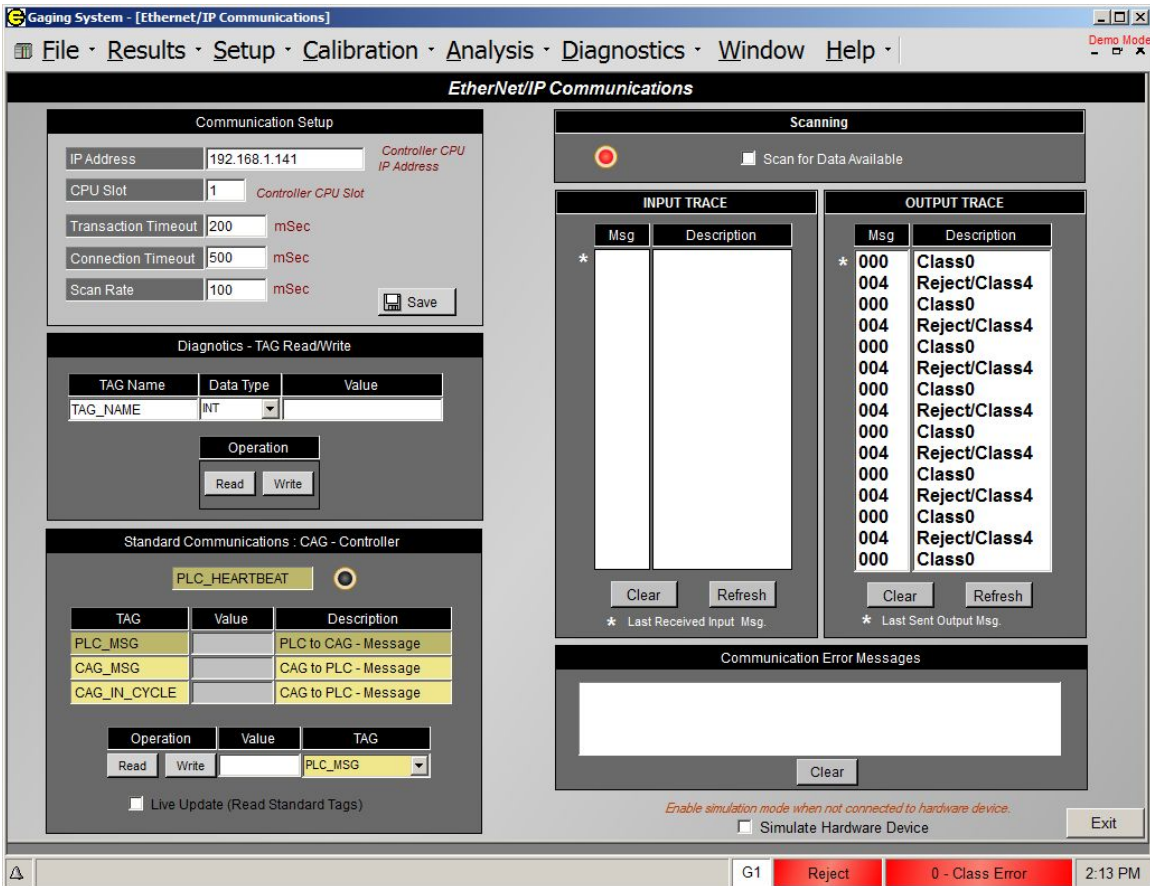
1.6.2.2. EtherNet/IP Communications

Communication between EPIC CAG system and Allen Bradley ControlLogix Controllers is achieved using EtherNet/IP (Industrial Protocol). Control commands and status are passed between the EPIC CAG and AB Controller (PLC) by means of reading and writing messages to predefined memory locations (TAGS) residing on the AB Controller.

 See [Section 3.2 EtherNet/IP Communications](#).

The IO Diagnostic screen used for EtherNet/IP Communication is display below.

EtherNet/IP Communications



The screenshot shows the 'EtherNet/IP Communications' software interface. It features a 'Communication Setup' section with fields for IP Address (192.168.1.141), CPU Slot (1), Transaction Timeout (200 mSec), Connection Timeout (500 mSec), and Scan Rate (100 mSec). Below this is a 'Diagnostics - TAG Read/Write' section with a table for TAG Name, Data Type, and Value. The 'Standard Communications : CAG - Controller' section includes a table for TAG, Value, and Description. The 'Scanning' section has a 'Scan for Data Available' button and two trace tables: 'INPUT TRACE' and 'OUTPUT TRACE'. The 'OUTPUT TRACE' table shows a list of messages with descriptions like 'Class0' and 'Reject/Class4'. At the bottom, there is a 'Communication Error Messages' section and a status bar displaying 'G1', 'Reject', '0 - Class Error', and '2:13 PM'.

Communication Setup

IP Address - address of the controller CPU.

CPU Slot - controller CPU slot

Transaction Timeout - Transaction Timeout occur when a query is sent but no reply is received within the number of milliseconds specified by the Timeout Transaction setting.

Connection Timeout - Connection Timeout occur when system tries to connect to the controller but can not within the number of milliseconds specified by the Connection Timeout setting.

Scan Rate - the amount of time in milliseconds between each query for new data.

Diagnostics - TAG Read/Write

Read - To read a TAG value from the controller, enter TAG name and Data Type and select Read button. The value will be displayed in the Value textbox. A value returned of "9999" indicates an error has occurred and the TAG could not be read.

Write- To write to a TAG on the controller, enter TAG name,Data Type and the value to write then elect the Write button. If the value can not be written a error message will appear.

Standard Communications: CAG - Controller

PLC_HEARTBEAT - The PLC Heartbeat is used to verify communication between CAG and PLC. The LED will switch between GREEN and RED when communication is working correctly.

Display the value of communication Tags

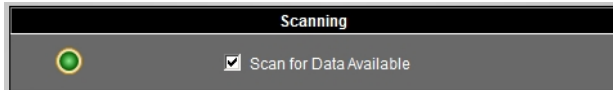
TAG	Value	Description
PLC_MSG		PLC to CAG - Message
CAG_MSG		CAG to PLC - Message
CAG_IN_CYCLE		CAG to PLC - Message

Read/Write to the predefined communication Tags

Operation	Value	TAG
Read	Write	PLC_MSG

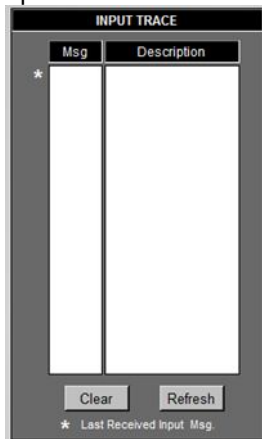
Scanning

Scanning must be enabled to receive new data (messages) from the controller. If the LED is Green the system is Scanning and operating correctly. If the LED is Red the system is not scanning.



INPUT TRACE

The Input Trace displays the last 15 messages received. The display shows the message number and description.



OUTPUT TRACE

The Output Trace displays the last 15 messages transmitted. The display shows the message number and description.

OUTPUT TRACE	
Msg	Description
* 000	Class0
004	Reject/Class4
000	Class0
004	Reject/Class4
000	Class0
004	Reject/Class4
000	Class0
004	Reject/Class4
000	Class0
004	Reject/Class4
000	Class0
004	Reject/Class4
000	Class0
004	Reject/Class4
000	Class0

Clear Refresh

* Last Sent Output Msg

1.6.3. Live Inputs

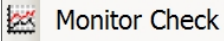
Live Inputs

This screen displays live readings of all active Inputs. An active Input is an input that is used in a defined Check formula or assigned to a temperature compensation probe set.

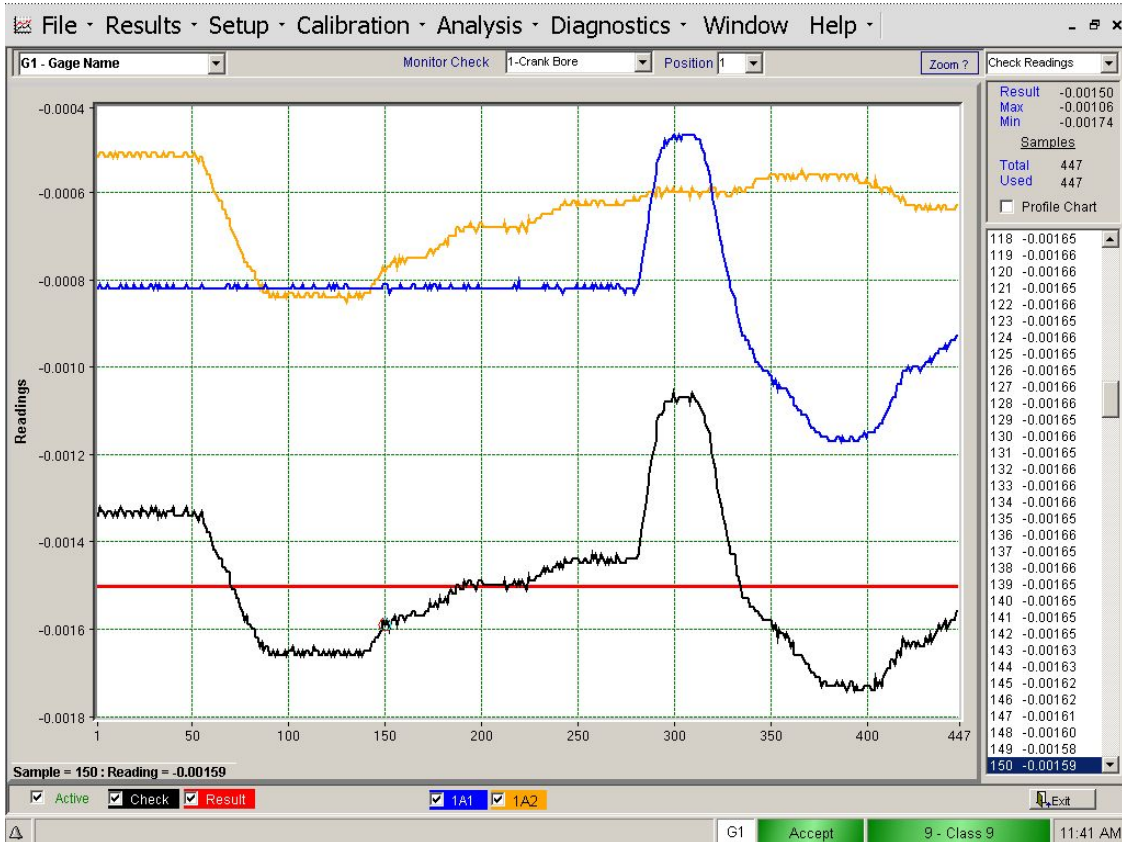
Gage Selection - Use the pull down menu at the top center of the screen to select the gage. All inputs programmed in the Checks for the selected gage will be displayed.

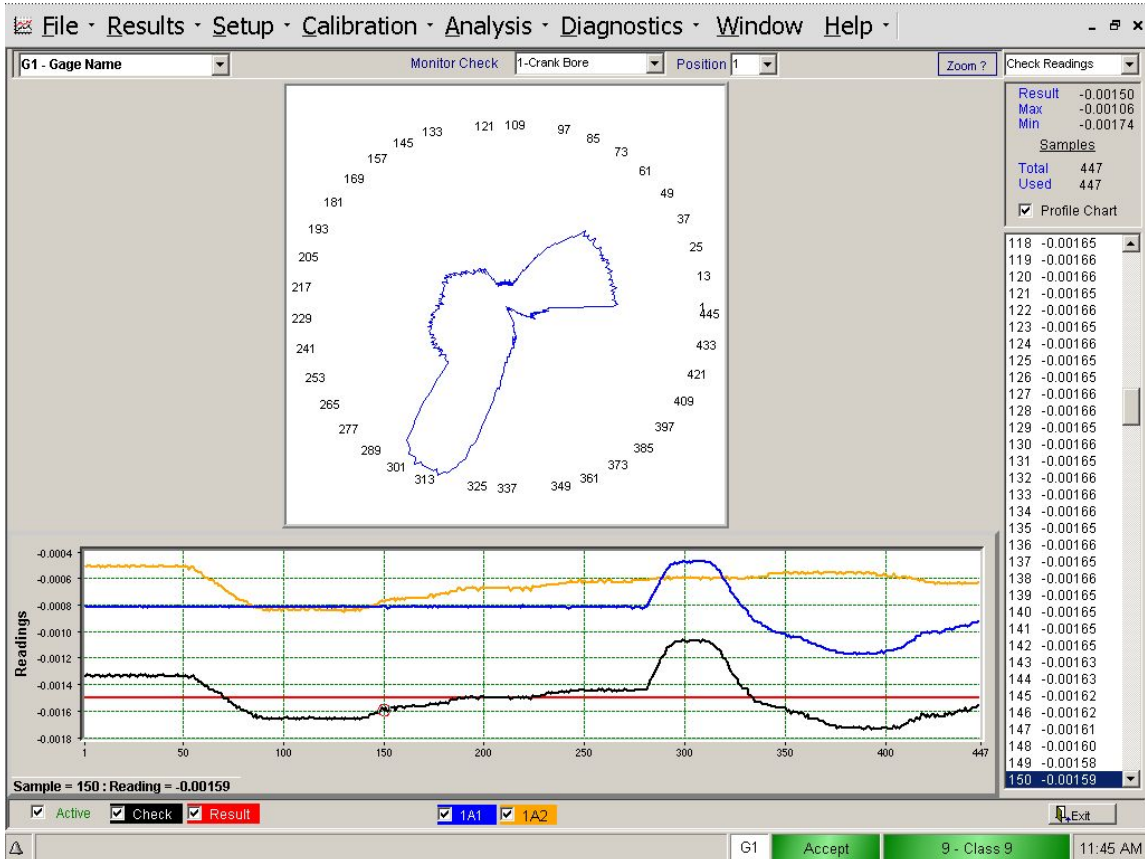


1.6.4. Monitor Check



This display contains specific information on the readings used to calculate a Check. It includes a chart of all readings taken for the individual inputs that make up the Check as well as the Check result. It also 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. Only one Check may be monitored at a time.





Gage Selection - Use the pull down menu in the upper left corner of the screen to select a gage.
Monitor Check - Use the pull down menus in the upper center section of the screen to select a Check from the current gage and a position of the selected Check to monitor.



Active - Select this box to activate Check monitoring for the selected Check. If the Active box is selected and any or all of the Check, Result, or Input boxes are checked then data will be recorded for the selected items when the current Check is gaged.

Check - All readings associated with the selected Check will be listed. To record the readings from a Check activate the "Check" box and select "Active". The next time a start gage command is initiated the readings from the Check will be displayed in the corresponding color.

Result- The result of the Check selected will be shown as a horizontal red line on the chart.

Inputs- All readings associated with the selected input will be listed. To record the readings from an input activate the input box and select "Active. The next time a start gage command is initiated the raw readings from the input will be displayed in the corresponding color.

Profile Chart - The Profile Chart option can be displayed by checking the Profile Chart box. This chart is useful in setting up a type of roundness check or cut-out detection.

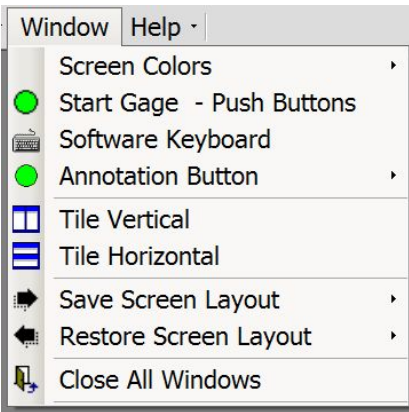
The number of readings taken is shown on the outside of the chart and the shape of the chart gives an indication of part geometry.

1.6.5. Feedback Communications (Optional)

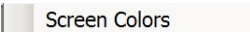
 Feedback Communications

 See [Section 5.1 Focus2 Feedback](#)

1.7. Window

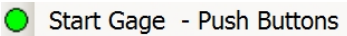


1.7.1. Screen Colors



Choose background screen color. There is a choice between black or blue background color.

1.7.2. Start Gage - Push Buttons



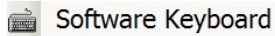
Selecting the “Start Gage – Push Buttons” option will create a “Start Gage” button that will display on all screens. A “Start Gage” signal is sent to the system if this button is pushed. This enables the operator to initiate a gage cycle from any displayed screen. To remove the “Start Gage” icon, click the “X” in the lower right hand corner of the icon. The Start Gage button can be moved to desired location on the screen by click-hold and drag with a mouse.



Multiple Start Gage Buttons - a Start Gage button will be displayed for each Gage that is setup in the system. The Start Gage buttons will be labeled with the Gage number in the center of the button. To change the orientation of the buttons from vertical to horizontal select the <--> symbol. To display only one Start Gage button with the option to select the Gage from a drop-down box, select the [-] symbol. Selecting the [+] will display all the Start Gage buttons.



1.7.3. Software Keyboard



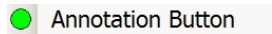
Selecting this option will bring up Windows Software Keyboard. To enter data, place cursor in the field to be edited and select the keys on Software Keyboard.



NOTE: An embedded Keypad can be activated and used to enter data in any field in the EPIC application by simply double clicking the field that needs editing.



1.7.4. Annotation Button (Optional)



When the Annotation Option is installed as part of the EPIC system an “Annotation Button” can be displayed on the screen by selecting “Enable” under this menu option. See [Section 2](#) for more information on Annotation.



1.7.5. Tile Vertical

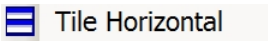


The Tile feature for displaying multiple screens is available **only** when the “Multiple Screens” option is selected in the System Setup Menu.

Tile Vertical

The multiple screens selected will be displayed top to bottom.

1.7.6. Tile Horizontal

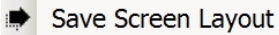


The Tile feature for displaying multiple screens is available **only** when the “Multiple Screens” option is selected in the System Setup Menu.

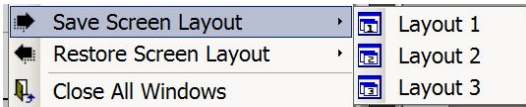
Tile Horizontal

The multiple screens selected will be displayed left to right.

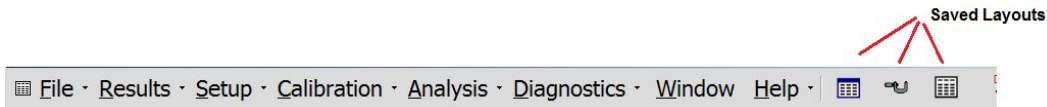
1.7.7. Save Screen Layout



The system allows the operator the ability to save 3 screen layouts for fast retrieving. To save a screen layout open the screen(s) to be saved. Click on “Window” in the Menu bar and select “Save Screen Layout”. Click on one of the 3 options listed and that screen will be saved under that Layout number.



When a screen layout is saved, an icon will be displayed on the Main screen menu bar. This icon can be selected to display (restore) the saved screen layout.

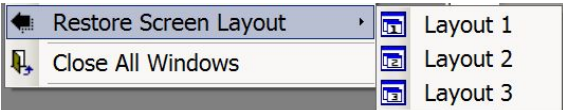


To remove (clear) a saved Screen Layout close all screens and “Save Screen Layout” to the Layout number to be removed.

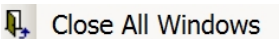
1.7.8. Restore Screen Layout



The selected Layout (1,2,3) will be restored (displayed).



1.7.9. Close All Windows



All open Windows (screens) will be closed

2. SECTION: Annotation - Gage Data Records

The Annotation Option of the EPIC software provides the ability for the user to assign an explanatory note to a measurement part record stored in the Gage Data File (GDF). Annotations are useful for identifying special point in the GDF, such as new operator, excessive tooling wear, or a change of material. The user has the ability to enter predefined annotation notes that can be selected at time of annotation or enter the annotation directly.

2.1. Annotation Button (Figure 1, Figure 2)

When the Annotation Option is installed as part of the EPIC CAG system an “Annotation Button” will be displayed on the screen. This button can be moved around the screen giving the user the ability to place it at a convenient location. The Annotation Button can be disabled (not displayed) in the “Window – Annotate Button” menu (see Figure 2). Pressing the Annotation Button will bring up the Annotation Screen. The Annotation Screen allows the user to assign annotation to the last part record stored in the gage data file.

FIGURE 1.

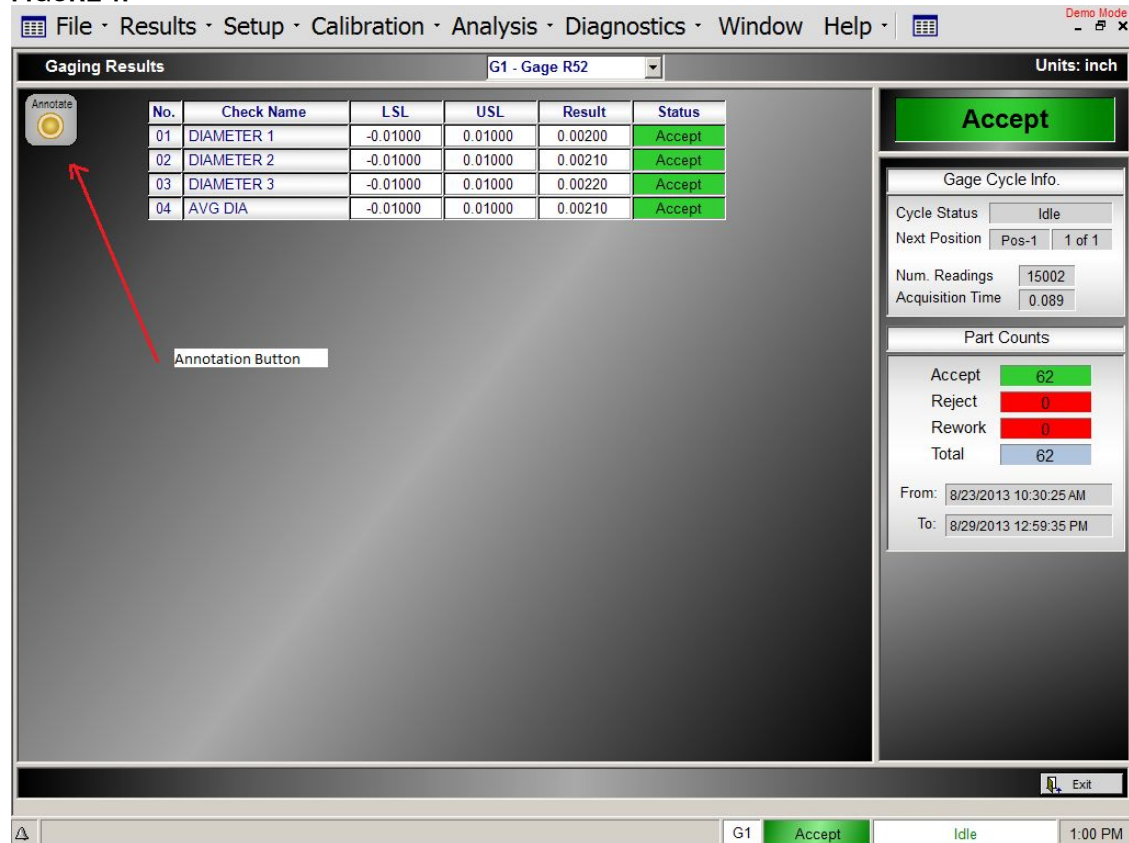


FIGURE 2.

The screenshot displays the 'Gaging System' software interface. The main window title is 'Gaging System - [Result: G1 - Gage Name]'. The menu bar includes 'File', 'Results', 'Setup', 'Calibration', 'Analysis', 'Diagnostics', 'Window', and 'Help'. The 'Window' menu is open, showing options like 'Screen Colors', 'Start Gage - Push Buttons', 'Software Keyboard', 'Annotation Button', 'Tile Vertical', 'Tile Horizontal', 'Save Screen Layout', 'Restore Screen Layout', 'Close All Windows', and '1 Result: G1 - Gage Name'. The 'Gaging Results' table is visible with the following data:

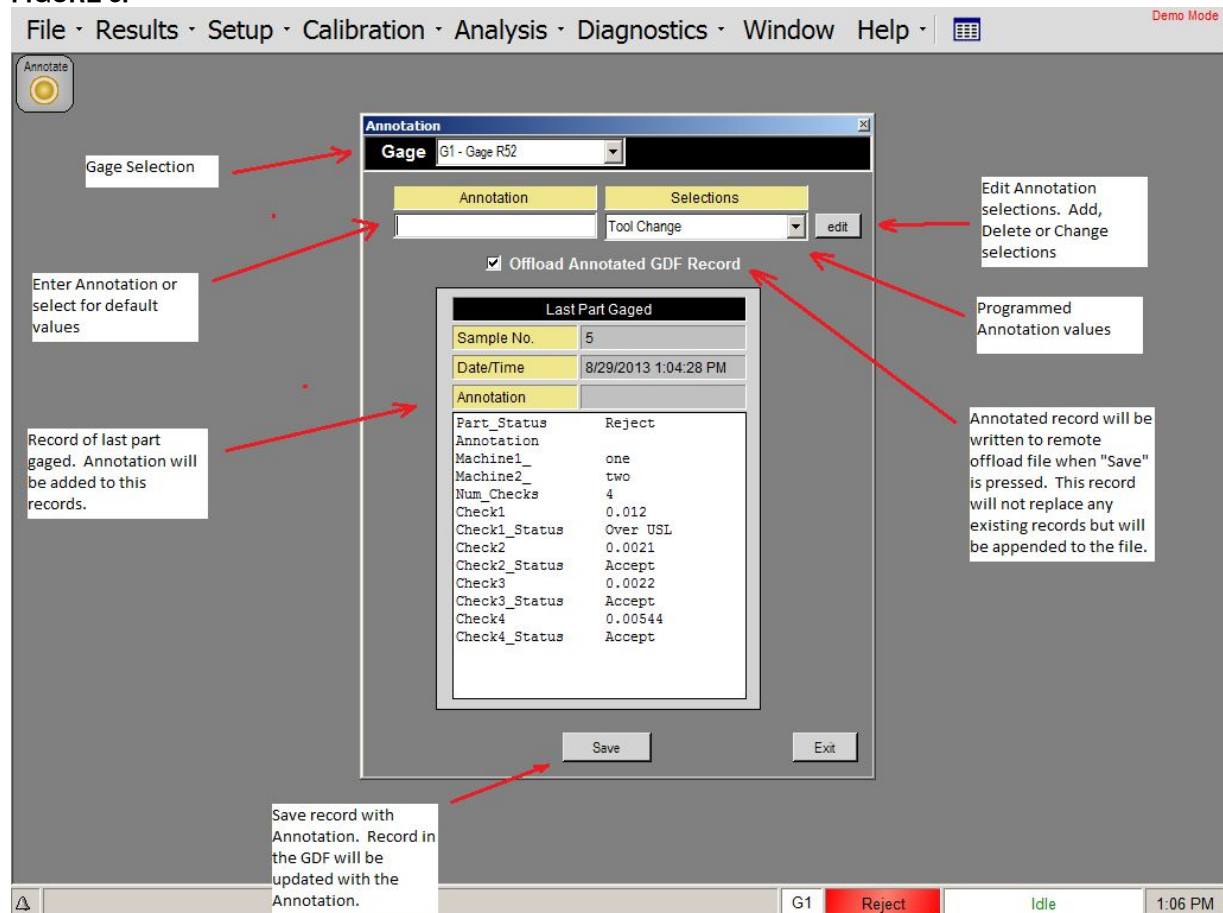
No.	Check Name	LSL	Nominal	USL	Actual	Deviation
01	Crank Bore	-0.00280	1.00000	0.00300	1.00190	0.00190
02	Pin Bore	-0.00250	0.97000	0.00250		
03	Center Distance	-0.00200	1.00000	0.00100		
04	Thickness	-0.01000	0.00000	0.01000	0.00199	0.00199

The 'Sort Class' panel on the right shows 'Classifying Check' as '1 - Crank Bore', 'Part Class' as '9 - Class 9', and 'Class Value' as '0.00190'. The status bar at the bottom indicates 'Temp. Comp. Type: Disabled' and 'G1 Reject 9 - Class 9 12:47 PM'.

2.2. Annotation Screen (Figure 3)

The Annotation Screen is displayed when the Annotation Button is pressed. The screen will display the last part gauged (last record stored in the gage data file). The “Gage” drop down box can be used to select the last part gauged for a different Gage. The user can enter the annotation note by typing in the Annotation input box or by double clicking on the input box and using the on screen keyboard. The annotation note can be a maximum of 15 characters. The user also has the option to select the annotation note from the Selections drop down box containing preprogrammed annotation notes. Once the annotation note is entered, the SAVE button must be pressed for the annotation to be written to the gage data file. If the EPIC system is setup to offload the part measurement record to a network file or remove device file, the “Offload Annotated GDF Record” checkbox will be displayed on the Annotation Screen. If the “Offload Annotated GDF Record” checkbox is selected (checked), the annotated record will be offloaded (re-transmitted) when the SAVE button is pressed. Note: this may result in the offload file containing duplicate measurement records, one with annotation and one without. The duplicate records will contain the same date-time stamp.

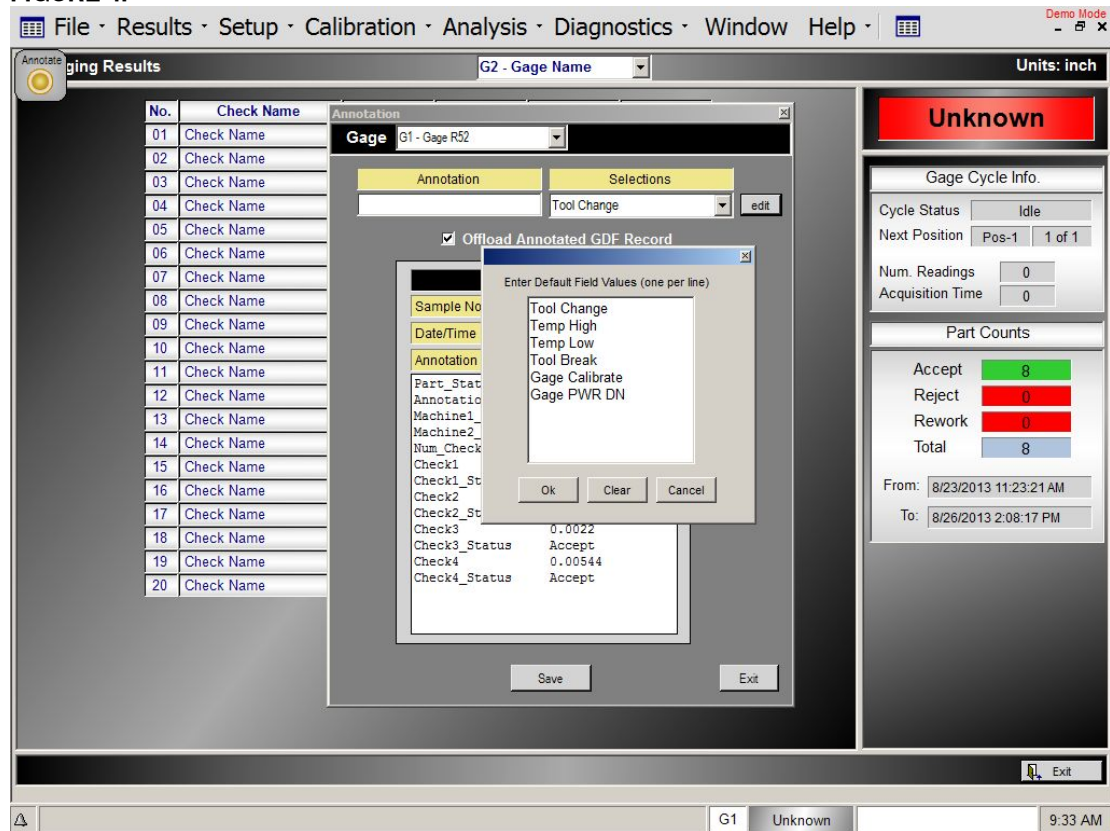
FIGURE 3.



Entering Predefined Annotation Notes (Figure 4)

To enter predefined Annotation notes the user would select the “edit” button on the Annotation Screen. An input box screen will appear and user would proceed to enter the Annotation notes. The Annotation notes can be a maximum of 15 characters.

FIGURE 4.



2.3. Viewing Annotation in the Gage Data File (Figure 5)

FIGURE 5.

The screenshot shows a software window titled 'Annotate' with a menu bar (File, Results, Setup, Calibration, Analysis, Diagnostics, Window, Help) and a 'Demo Mode' indicator. The window displays a table with 10 columns representing samples. The data is as follows:

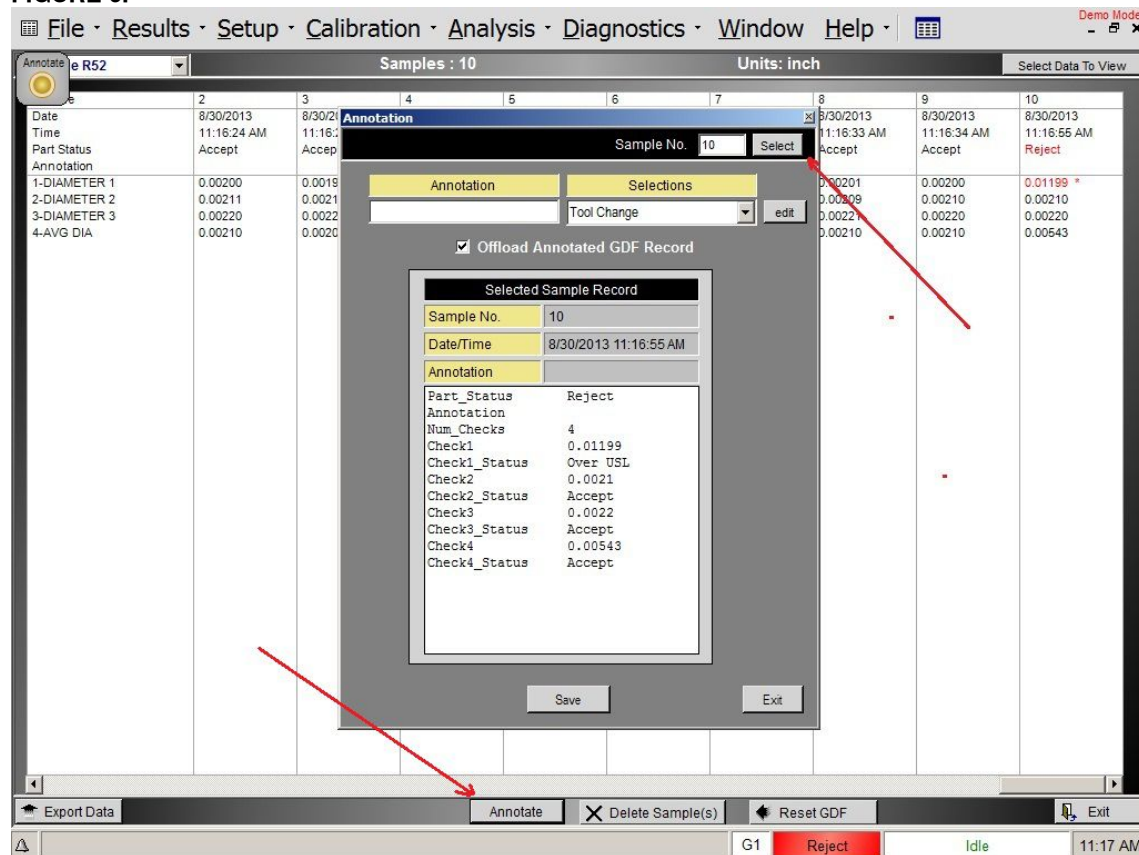
	2	3	4	5	6	7	8	9	10
Date	8/30/2013	8/30/2013	8/30/2013	8/30/2013	8/30/2013	8/30/2013	8/30/2013	8/30/2013	8/30/2013
Time	11:16:24 AM	11:16:28 AM	11:16:29 AM	11:16:30 AM	11:16:30 AM	11:16:31 AM	11:16:33 AM	11:16:34 AM	11:16:55 AM
Part Status	Accept	Accept	Accept	Accept	Accept	Accept	Accept	Accept	Reject
Annotation				Tool Change					Tool Wear
1-DIAMETER 1	0.00200	0.00199	0.00200	0.00200	0.00201	0.00201	0.00201	0.00200	0.01199 *
2-DIAMETER 2	0.00211	0.00210	0.00210	0.00210	0.00210	0.00211	0.00209	0.00210	0.00210
3-DIAMETER 3	0.00220	0.00220	0.00220	0.00220	0.00220	0.00220	0.00221	0.00220	0.00220
4-AVG DIA	0.00210	0.00209	0.00210	0.00210	0.00210	0.00210	0.00210	0.00210	0.00543

At the bottom of the window, there are buttons for 'Export Data', 'Annotate', 'Delete Sample(s)', 'Reset GDF', and 'Exit'. The status bar at the very bottom shows 'G1 Unknown' and the time '11:21 AM'.

2.4. Adding Annotation to Previous Measurement Records (Figure 6)

The user can Annotate previous measurement records in the Gage Data File by selecting the “Annotate” button on the bottom of the Gage Data File Screen. When this button is selected, the Annotation screen will be displayed with an option to enter a “Sample No.”. The user can enter a record sample number and hit the “Select” button to load that sample record in the Annotation screen. Annotation can then be entered and saved.

FIGURE 6.



2.5. Viewing Annotation in the Gage Data File Chart (Figure 7)

Measurement records containing a previously entered Annotation Note can be identified in the list of readings on the right side of the screen. Readings will be followed by the letter “A”, indicating that an Annotation Note has been entered for that record. To view the Annotation Note, the user can select the reading containing the Annotation (“A”) and the Annotation Note will be displayed on the bottom of the screen and the sample will be highlighted on the chart. Sample points on the chart can also be selected and the reading will be highlighted in the list of readings and if there is an Annotation Note associated with that record it will be displayed on the bottom of the screen.

FIGURE 7.



3. SECTION : EPIC CAG Communications

3.1. EPIC CAG Standard Parallel I/O Communications

Communications with the Edmunds EPIC CAG™ is accomplished via a discrete parallel interface. All parallel communication lines are optically isolated providing a versatile interface between a sensitive microprocessor system and a factory environment. Most applications dictate the use of 120 VAC opto I/O modules, but "DC" requirements are easily satisfied by direct replacement.

EPIC CAG communication is distinctly different depending on the CAG™ type, auto or manual. A manual CAG™ typically provides a 37-pin connection to be used in conjunction with the Edmunds external control push-button pack. The automatic CAG configuration implements an asynchronous protocol. The remainder of this section will exclusively discuss attributes of the automatic CAG™ protocol.



Note that information in this section only exemplifies the standard configuration and is subject to change where applicable. The protocol depicted here, however, will most likely be modeled. Refer to the Application Specific Setup section for inclusive details of all modifications.

As with any asynchronous communications, a protocol, or set of conventions governing the format and timing of the data transfer must apply. EPIC CAG™ utilizes a simple handshaking type protocol to enhance its interface compatibility. Communication is bi-directional, meaning both the EPIC CAG™ and the external device may initiate communication. For the most part, however, the EPIC CAG™ only responds to or acknowledges external requests.

First, a discussion of how a message or command is transferred between the CAG and an external device may be appropriate. An illustration that represents a standard configuration is given below:

EPIC CAG OUTPUTS	EPIC CAG INPUTS
5 data lines, bits 0-4	7 data lines, bits 0-6
1 data available line	1 interrupt line

In the event the direction of communication is not clear, the EPIC CAG™ inputs correspond with the external device's outputs. Note that 7 data lines for both the CAG™ and the external device only exemplifies a typical configuration and is subject to change where applicable.

The CAG™ input data lines provide the means to transfer information from an external device to the CAG™. The CAG™ input interrupt line will initiate a hardware interrupt. The CAG™ will handle this interrupt by reading the data lines and responding appropriately. In effect, the interrupt indicates to the CAG that a valid message or command is present on the data lines.

The CAG™ output data lines provide the means to transfer information from the CAG™ to an external device. The CAG™ output line, data available, will ensure the receiving device that the information on the data line is valid on a low to high transition.

The information transferred by the data lines is encoded as a binary representation. To state simply, each message has a unique code, or bit pattern.

Communication with the CAG may be initiated by writing the appropriate bit pattern on the data lines and asserting the interrupt. It is important to ensure that the data lines are electrically stable when the interrupt is asserted. The maximum pulse length of the interrupt is not a consideration since the CAG is triggered on the

rising edge of the pulse. The user must only ensure the turn on and off time for the opto isolators are satisfied (typically 5 to 15 ms).

Similarly, the CAG™ communicates to an external device by writing the appropriate bit pattern on the data lines and asserting the data available line. The I/O Duration Time is programmable. If the CAG™ is required to send a series of messages, 1ms is the minimum time between data available pulses.

3.1.1. EPIC CAG™ Input Messages

Start Gage

The CAG performs the task of translating an electronic signal to a useful numeric representation. In doing so the CAG must sample the inputs (i.e. LVDTs) an appropriate number of times and execute an algorithm(s) to acquire a numeric result. This function is termed "GAGE" or "GAGING". For obvious reasons, the CAG must be informed when to initiate this function. Through parallel communication, the CAG can be instructed to begin this process. This command is termed "Start Gage". Two types of start gage messages are available, auto and manual. They both prompt the CAG to initiate the algorithms discussed above; however, distinct differences apply. A manual start gage requests the CAG to gage and that's all. With the manual start gage command, the CAG will acquire a numeric result for the sampled inputs and update the current part status, however the CAG will NOT update the SPC charts, counters, feedback, and so on.

The auto start gage message requests the CAG to gage and update all appropriate SPC charts, counters, feedback variables, and any or all other functions the CAG provides.

Since the CAG has the ability to access any gage setup on request, it is only appropriate that a start gage message, for both auto and manual, exist for each gage setup. Simply, for each gage setup there is a corresponding auto and manual start gage message. In response to a start gage message, the CAG will acknowledge with a part status message.

End Gage

It was defined in the discussion for the start gage command that the CAG samples the inputs an appropriate number of times, and then executes an algorithm(s) to attain a numeric result. This definition holds for many applications; however, it may be desirable to acquire input readings while the part is in motion. This dynamic process adds the flexibility of externally controlling at what time the CAG starts and stops collecting input readings. Until now, the discussion has focused on static gaging which only required a start gage indication. With dynamic gaging, an "End Gage" command is needed to instruct the CAG to end the current input sampling. The CAG can also be configured to end this process after a programmed time interval, in which case the end gage command is not necessary.

Auto Mastering (Calibration)

When a CAG is used in a full automation environment it can be instructed to initiate a mastering sequence by the PLC. The "Auto Mastering" command will put the CAG into Calibration Mode. When in Calibration Mode a start gage message will begin the mastering process as programmed in the "Check Setup" menu. The masters must be introduced to the gage in the correct sequence by the PLC controlled process.

Abort Mastering (Calibration)

If a situation arises where the PLC detects an unfavorable condition an "Abort Mastering" message can be sent to the CAG to stop the mastering process.

Auto Verification (Optional)

When a CAG is used in a full automation environment it can be instructed to initiate a verification cycle by the PLC. The "Auto Verification" command will put the CAG into Verification Mode. When in Verification Mode a start gage message perform a Verification cycle as programmed in the "Check Setup" menu. The verification master must be introduced to the gage by the PLC controlled process.

Reset Feedback

The CAG feedback data used to transmit offsets to the machine can be reset by the PLC. This is usually done when a tooling change has been made.

Machine ID

The identity of the machine that is supplying offset data to the CAG is supplied with this command. The Machine ID can be used in Feedback application where the identity of the machine supplying the part is required.

Reset Position


If the multi-position gage cycle is interrupted the PLC can issue a "Reset Position" message to the CAG reset the gaging position to the start position.

Load Setup

The load setup message(s) is used to automatically load the EPIC system with a different Setup.

External Device (PLC) ---> EPIC CAG Messages

The table below references each available message with the appropriate bit pattern.

 **Note:** The interrupt input (opto M7 C7 - bit 7) will need to be turned ON for the message to be acted on by the CAG.

	Interrupt	MESSAGE					
	opto M7 C7 - bit 7	opto M6 C5 - bit 5	opto M6 C4 - bit 4	opto M5 C3 - bit 3	opto M5 C2 - bit 2	opto M4 C1 - bit 1	opto M4 C0 - bit 0
Manual Start Gage 1	1	0	0	0	0	0	1
Automatic Start Gage 1	1	0	0	0	0	1	0
Manual Start Gage 2	1	0	0	0	0	1	1
Automatic Start Gage 2	1	0	0	0	1	0	0
Manual Start Gage 3	1	0	0	0	1	0	1
Automatic Start Gage 3	1	0	0	0	1	1	0
Manual Start Gage 4	1	0	0	0	1	1	1
Automatic Start Gage 4	1	0	0	1	0	0	0
End Gage	1	0	0	1	0	0	1
Auto Mastering Gage 1	1	0	0	1	0	1	0
Auto Mastering Gage 2	1	0	0	1	0	1	1
Auto Mastering Gage 3	1	0	0	1	1	0	0
Auto Mastering Gage 4	1	0	0	1	1	0	1
Abort Mastering	1	0	0	1	1	1	0
Reset Feedback Gage 1	1	0	1	0	0	1	0

Reset Feedback Gage 2	1	0	1	0	0	1	1
Reset Feedback Gage 3	1	0	1	0	1	0	0
Reset Feedback Gage 4	1	0	1	0	1	0	1
Machine ID 1	1	0	1	0	1	1	0
Machine ID 2	1	0	1	0	1	1	1
Machine ID 3	1	0	1	1	0	0	0
Machine ID 4	1	0	1	1	0	0	1
Machine ID 5	1	0	1	1	0	1	0
Machine ID 6	1	0	1	1	0	1	1
Machine ID 7	1	0	1	1	1	0	0
Machine ID 8	1	0	1	1	1	0	1
Reset Position Gage 1	1	0	1	1	1	1	0
Reset Position Gage 2	1	0	1	1	1	1	1
Reset Position Gage 3	1	1	0	0	0	0	0
Reset Position Gage 4	1	1	0	0	0	0	1
Auto Verification Gage 1	1	1	0	0	0	1	0
Auto Verification Gage 2	1	1	0	0	0	1	1
Auto Verification Gage 3	1	1	0	0	1	0	0
Auto Verification Gage 4	1	1	0	0	0	0	1
Load Setup ID 1	1	1	1	0	1	0	0
Load Setup ID 2	1	1	0	0	1	0	1
Load Setup ID 3	1	1	0	0	1	1	0
Load Setup ID 4	1	1	0	0	1	1	1
Load Setup ID 5	1	1	0	1	0	0	0
Load Setup ID 6	1	1	0	1	0	0	1
Load Setup ID 7	1	1	0	1	0	1	0
Load Setup ID 9	1	1	0	1	0	1	1
Load Setup ID10	1	1	0	1	1	0	0
Load Setup ID11	1	1	0	1	1	0	1

3.1.2. CAG Output Messages

Acknowledge

The CAG transmits an "Acknowledge" message in response to a fault code message.

End Gage

The CAG transmits an "End Gage" message in response to a manual start gage or to an auto start gage during a mastering sequence

Good, Reject or Rework Part Status

The CAG transmits a part status message as an acknowledgment to an auto start gage.

R & R Sort

The CAG transmits an "R&R Sort" message to acknowledge an auto start gage during the R&R study.

Class

The CAG can classify a part into 20 programmable categories. If the CAG is setup to classify then the class data will always be present on the **second** data available strobe during an auto start gage.

Shutdown

The CAG can be configured to notify an external device of an undesirable event or sequence of events, such as a consecutive reject error for example. When necessary the CAG will transmit a "Shutdown" message. This message is initiated by the CAG and requires no response.

EPIC CAG Messages ---> External Device

The table below references each available message with the appropriate bit pattern.



Note: The data available output (opto M10 B5 - bit 5) will be turned ON when the message is ready to be acted on by the external device.

	Data Available	MESSAGE				
	opto M10 B5 Bit 13	opto M2 A4 Bit 4	opto M1 A3 Bit 3	opto M1 A2 Bit 2	opto M0 A1 Bit 1	opto M0 A0 Bit 0
ACK	1	0	0	0	0	1
End Gage	1	0	0	0	1	0
Accept Status	1	0	0	0	1	1
Reject Status	1	0	0	1	0	0
Rework Status	1	0	0	1	0	1
R&R Sort 1	1	0	0	1	1	0
Shutdown	1	1	1	1	1	1
Class Error	1	0	0	0	0	0
Class #1	1	0	0	0	0	1
Class #2	1	0	0	0	1	0
...						
Class #20	1	1	0	1	0	0

3.1.3. Examples: Parallel IO Communications

Example #1

Application: Typical Automatic Gage Cycle:

A. Single Gage

B. No Classifying

1. PLC Sends Start Gage Message to initiate the measurement cycle.

The PLC will set the binary coded message on data bit 0 thru data bit 4 and wait for a short duration for the lines to setup before activating the Interrupt. The message and Interrupt will remain on until a response is received from the CAG.

PLC -> CAG - Sends Start Gage Message

	Interrupt	MESSAGE					
	opto M7 C7 - bit 7	opto M6 C5 - bit 5	opto M6 C4 - bit 4	opto M5 C3 - bit 3	opto M5 C2 - bit 2	opto M4 C1 - bit 1	opto M4 C0 - bit 0
Automatic Start Gage 1	1	0	0	0	0	1	0

2. CAG responds with Status message at the completion of the measurement cycle.

The CAG will set the binary coded message for status on data bit 0 through data bit 12 and wait for a short duration for the lines to setup before activating the data available line. The data available line will remain on for the programmed message duration in IO Diagnostics screen.

CAG -> PLC - Sends Status Message (Accept Part)

	Data Available	MESSAGE				
	opto M10 B5 Bit 13	opto M2 A4 Bit 4	opto M1 A3 Bit 3	opto M1 A2 Bit 2	opto M0 A1 Bit 1	opto M0 A0 Bit 0
Accept Status	1	0	0	0	1	1

Example #2

Application: Typical Automatic Gage Cycle:

A. Single Gage

B. Classifying

1. PLC Sends Start Gage Message to initiate the measurement cycle.

The PLC will set the binary coded message on data bit 0 thru data bit 4 and wait for a short duration for the lines to setup before activating the Interrupt. The message and Interrupt will remain on until a response is received from the CAG.

PLC -> CAG - Sends Start Gage Message

	Interrupt	MESSAGE					
	opto M7 C7 - bit 7	opto M6 C5 - bit 5	opto M6 C4 - bit 4	opto M5 C3 - bit 3	opto M5 C2 - bit 2	opto M4 C1 - bit 1	opto M4 C0 - bit 0
Automatic Start Gage 1	1	0	0	0	0	1	0

2. CAG responds with Status message followed by the Class message at the completion of the measurement cycle.

The CAG will set the binary coded message for Status on data bit 0 through data bit 12 and wait for a short duration for the lines to setup before activating the data available line. The data available line will remain on for the programmed message duration in IO Diagnostics screen.
The CAG will then set the binary coded message for the Class number on data bit 0 through data bit 12 and wait for a short duration for the lines to setup before activating the data available line. The data available line will remain on for the programmed message duration in IO Diagnostics screen.

CAG -> PLC

CAG Sends Status Message (Accept Part)

CAG Sends Class Message (Class #2)

	Data Available	MESSAGE				
	opto M10 B5 Bit 13	opto M2 A4 Bit 4	opto M1 A3 Bit 3	opto M1 A2 Bit 2	opto M0 A1 Bit 1	opto M0 A0 Bit 0
Accept Status	1	0	0	0	1	1
Class #3	1	0	0	1	0	0

3.2. EPIC CAG Standard EtherNet/IP Communications

CAG (EPIC) ← → Allen Bradley ControlLogix Controller (PLC)

Communication between Edmunds EPIC CAG units and Allen Bradley ControlLogix Controllers is achieved using EtherNet/IP (Industrial Protocol). Control commands and status are passed between the CAG and AB Controller (PLC) by means of reading and writing messages to predefined memory locations (Tags) residing on the AB Controller.

TAGS that must be defined on Allen Bradley Controller (PLC)

Tag Name	Scope	Data Type	Description
PLC_MSG	Controller	Integer	PLC --> CAG message
CAG_MSG	Controller	Integer	CAG --> PLC message
CAG_IN_CYCLE	Controller	Boolean	CAG --> PLC message
PLC_HEARTBEAT	Controller	Integer	PLC --> CAG message

PLC → CAG

Messages from the PLC Controller to the CAG unit (Start Gage, End Gage, Reset etc...) will be written to "PLC_MSG" tag by the PLC. The CAG will scan the "PLC_MSG" Tag for any change if value. If the Tag value changes and the value is greater than zero "0", the message will be acted upon. The CAG will clear the Tag value (set to 0) right after it is read.

CAG → PLC

Messages from the CAG™ unit to the PLC Controller (Part Status, End Gage, Class etc...) will be written to the "CAG_MSG" tag by the CAG™. The PLC will scan the "CAG_MSG" tag for a valid message. The PLC will clear the tag (set to 0) after it has acted upon the message.

CAG IN CYCLE

The CAG will set the "CAG_IN_CYCLE" Boolean tag to "1" when the CAG is in cycle (gauging). The "CAG_IN_CYCLE" tag will be cleared ("0") when the gaging cycle is complete. The PLC can monitor this tag to insure a gaging cycle is not initiated when the CAG is currently in a gage cycle.

PLC HEARTBEAT

The PLC Heartbeat can be used to verify communication between CAG and PLC.

If the PLC sets the "PLC_HEARTBEAT" Integer tag to "1", the CAG will then set it to zero "0". The PLC can use this as a way to insure communications exists.

3.2.1. PLC Messages (PLC → CAG)

TAG: PLC_MSG

Start Gage

The CAG™ performs the task of translating an electronic signal to a useful numeric representation. In doing so the CAG™ must sample the inputs (i.e. LVDTs) an appropriate number of times and execute an algorithm(s) to acquire a numeric result. This function is termed "GAGE" or "GAGING". For obvious reasons, the CAG™ must be informed when to initiate this function. Through Ethernet/IP communication, the CAG™ can be instructed to begin this process. This command is termed "Start Gage". Two types of start gage messages are available, auto and manual. They both prompt the CAG™ to initiate the algorithms discussed above; however, distinct differences apply. A manual start gage requests the CAG™ to gage and that's all. With the manual start gage command, the CAG™ will acquire a numeric result for the sampled inputs and

update the current part status, however the CAG™ will NOT update the SPC charts, counters, feedback, and so on.

The auto start gage message requests the CAG™ to gage and update all appropriate SPC charts, counters, feedback variables, and any or all other functions the CAG provides.

Since the CAG™ has the ability to access any gage setup on request, it is only appropriate that a start gage message, for both auto and manual, exist for each gage setup. Simply, for each gage setup there is a corresponding auto and manual start gage message. In response to a start gage message, the CAG™ will acknowledge with a part status message.

End Gage

It was defined in the discussion for the start gage command that the CAG samples (reads) the inputs an appropriate number of times, and then executes an algorithm(s) to attain a numeric result. This definition holds for many applications; however, it may be desirable to acquire input readings while the part is in motion. This dynamic process adds the flexibility of externally controlling at what time the CAG starts and stops collecting input readings. Until now, the discussion has focused on static gaging which only required a start gage indication. With dynamic gaging, an "End Gage" command is needed to instruct the CAG to end the current input sampling. The CAG can also be configured to end this process after a programmed time interval, in which case the end gage command is not necessary.

Auto Calibration

When a CAG is used in a full automation environment it can be instructed to perform a calibration (mastering) sequence by the PLC. The "Auto Calibration" command will instruct the CAG™ to begin the calibration process as programmed in the Calibration menu. The masters must be introduced to the gage in the correct sequence by the PLC controlled process.

Abort Mastering

If a situation arises where the PLC detects an unfavorable condition an "Abort Mastering" message can be sent to the CAG™ to stop the mastering process.

Reset Position

If the multi-position gage cycle is interrupted the PLC can issue a "Reset Position" message to the CAG™ reset the gaging position to the start position.

PLC Messages

ACTION	PLC_MSG Tag (Integer)
Manual Start Gage 1	1
Auto Start Gage 1	2
Manual Start Gage 2	3
Auto Start Gage 2	4
Manual Start Gage 3	5
Auto Start Gage 3	6
Manual Start Gage 4	7
Auto Start Gage 4	8
EndGage	9
Auto Calibration Gage 1	10
Auto Calibration Gage 2	11
Auto Calibration Gage 3	12
Auto Calibration Gage 4	13
Abort Calibration	14
Reset Positions Gage 1	30
Reset Positions Gage 2	31
Reset Positions Gage 3	32
Reset Positions Gage 4	33

3.2.2. CAG Messages (CAG → PLC)

TAG: CAG_MSG

Acknowledge

The CAG™ transmits an "Acknowledge" message in response PLC command.

End Gage

The CAG™ transmits an "End Gage" message in response to a manual start gage or to an auto start gage during a mastering sequence

Good, Reject or Rework Part Status

The CAG transmits a part status message as an acknowledgment to an auto start gage during static gaging and to an end gage message during dynamic gaging.

CAG Messages

Description	CAG_MSG Tag (Integer)
Acknowledge (ACK)	1
EndGage	2
Accept Status	3
Reject Status	4
Rework Status	5
R&R	6

3.2.3. Example of a Typical Gaging Cycle:

TAG	VALUE	DESCRIPTION
PLC_MSG	0	Initial state, PLC_MSG tag clear with a value of "0"
PLC_MSG	2	PLC Initiates the gaging cycle by writing a "2" in PLC_MSG tag. In this case "2" is the "Auto Start Gage 1" message.
PLC_MSG	0	CAG reads the PLC_MSG tag, and then clears the message by writing "0" to PLC_MSG tag
		CAG acts on the message and starts a gaging cycle
CAG_MSG	3	At the completion of the gaging cycle, the CAG writes the part status (3, 4, or 5) to the CAG_MSG tag
CAG_MSG	0	PLC reads the part status for the "CAG_MSG" tag and then clears the message by writing "0" to "CAG_MSG" tag.

4. SECTION : Feedback Setup and Operations

The EPIC CAG system can be configured to compute machine tool offsets and transmit the offsets to the machine for tool adjustments. One Gage setup can provide feed back for multiple machines and multiple offsets can be programmed for each machine.

The final offset that goes to the machine for a given tool will be made up of components from two sources. The first source is the running average of a measured feature minus a set point. The second source is a combination of the other offsets generated for this cycle.

This will handle cases where some variables affect others in the machine. It becomes apparent that if this second source is utilized, the order of offset calculation becomes critical and must be taken into account by the user when defining the offset algorithm.

The offset calculation is a function of one running average multiplied by a compensation factor and up to three other offsets, each with a multiplier.

The compensation algorithm operates in two modes. The first mode is called "START UP" mode. The second is called "RUN" mode.

The Start Up mode is entered on demand by the machine or manually by the operator. Upon entering this mode, all running averages are reset. The CAG provides a separate set of running averages compensation factors that will be used while in this mode.

When the system is in the Start Up mode it will include rejected parts in the feedback calculations. When in the run mode the rejected parts are not included in the calculations.

The CAG will stop the process if the system stays in start up mode for more than an adjustable number of pieces.

The CAG will stop the process in Run Mode if an adjustable number of consecutive rejects are measured.

4.1. Feedback Setup Settings

The screenshot displays the 'Gaging System - [Feedback Setup]' software interface. The window title is 'Gaging System - [Feedback Setup]' and it shows a menu bar with 'File', 'Results', 'Setup', 'Calibration', 'Analysis', 'Diagnostics', 'Window', and 'Help'. The main area is divided into two panels: 'Machine Setup' and 'Offset(s) Setup - Machine 1'. The 'Machine Setup' panel includes sections for 'Select Machine' (Machine 1, Machine Name, Enabled), 'Feedback Interface' (Ethernet, Fanuc Focas2, IP Address 010.000.000.000, Port 8193, Path 1, Status Connected), 'Start-up Mode' (Enabled, Start-up Mode Limit 10, Part Lag 0, Run Mode Trigger 3), and 'Machine Specific - Macro Variable Communications' (Offset Data Available 1, Feedback Mode 0, Reset Feedback 0, Part Status 0). The 'Offset(s) Setup - Machine 1' panel includes 'Select Offset' (Offset 1, Offset Name, Enabled), 'Sample Size' (Min 1, Max 3), 'Compensation Rates' (# Samples = Max 1, # Samples < Max 1, Start-up Mode 1), 'Compensation Resolution' (0.0001), 'Feedback Control Limits' (UCL 0.00000, Setpoint 1.00000, LCL 0.00000), 'Tooling Adjust Limits' (Per Cycle 0.00000, Total 0.00000), 'Offset Definition' (Running Avg. of Check: 1 - Crank Bore, Multiplier 1.00000), and 'Machine Specific - Transmitted Offset Location' (Macro Variable No. 2, Reset Offset Data Macro Variable No. 0). At the bottom, there are buttons for 'Add Machine', 'Save', and 'Delete Machine' on the left, and 'Add Offset', 'Save', and 'Delete Offset' on the right. The status bar at the bottom shows 'Last Changed 4/15/2015 1:57:36 PM', 'G1', 'Reject', '0 - Class Error', and '10:24 AM'.

4.1.1. Machine Setup

Machine Selection

Machine - Selection for Machine and programmable machine name.

Enabled - Enables feedback for the selected machine.

Feedback Interface

The EPIC system is capable of interfacing with many types of machine controls. The EPIC system will be configured at the factory with the feedback interface required to communicate to the specified machine control. This section of the machine setup will include setup required to interface with the specific machine being configured. The following is a list of the current standard feedback interfaces (see also [Section 5 Feedback Interfaces](#)):

Standard Interfaces

Parallel I/O
Edmunds Serial (RS232)
Okuma Serial (RS232)
Okuma Thinc (Ethernet)
GE Focus2 (Ethernet)
Allen Bradley EtherNet/IP
Ethernet File Transfer

Plus - Minus Comp (dedicated IO)

Start-up Mode

Enable - Enables a machine to use a Start-up mode

Start-up Mode Limit - Maximum number of consecutive parts allowed to be gaged in Start-up mode. If this limit is exceeded an alarm is triggered and feedback will not be calculated. The alarm can be programmed to send a shutdown.

Part Lag (Start-up) - Number of parts following a compensation that will not be included in the new running average.

Run Mode Trigger - Number of consecutive gaged good parts that must be measured in the Start-up Mode before advancing to Run Mode.

Run Mode

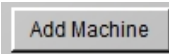
Include Rejects - Enabled allows feedback to be calculated on rejected parts in Run Mode.

Part Lag (Run Mode) - Number of parts following a compensation that will not be included in the new running average.

Machine Specific

This section of the machine setup will include specific setup required to interface with the specific machine being configured for (see [Section 5 Feedback Interfaces](#))

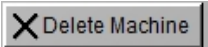
Add Machine - Add additional feedback Machine to the current select Gage setup.



Save - Save the current Machine setup. The Save button will be red when changes have been made but not yet saved.



Delete Machine - Delete the current Machine setup and all Offset setup associated with the Machine.



4.1.2. Offset Setup

Select Offset

Offset - Selection for offset and programmable offset name.

Enabled - Enables feedback for the selected offset.

Sample Size

Min - Minimum number of parts that must be gaged before feedback data can be computed for an offset.

Max - Maximum number of parts that can be used to compute feedback data.

Compensation Rates

Samples = Max - Compensation rate applied to the running average when the following conditions exist:

- The Gage is in Run Mode.
- The running average exceeds 1 of the Feedback Control Limits.
- The number of Samples accumulated for the offset is equal the Max Sample Size.

Samples < Max - Compensation rate applied to the running average when the following conditions exist:

- The Gage is in Run Mode.
- The running average exceeds 1 of the Feedback Control Limits.
- The number of Samples accumulated for the offset is equal or greater than the Min Sample Size.

Start-up Mode - Compensation rate applied to the running average when the following conditions exist:

- The Gage is in Start-up Mode.
- The running average exceeds 1 of the Feedback Control Limits.
- The number of Samples accumulated for the offset is equal or greater than the Min Sample Size.

Feedback Control Limits

UCL - The Upper Control Limit is a trigger point for computing compensation data for a given offset. If the Running Average minus the set point is greater than the Upper Control Limit and the accumulated # of samples is equal to or greater than the Min Sample Size then Feedback data will be computed for that offset and transmitted back to the Machine.

Setpoint - The Setpoint is a value that is subtracted from the running average before the running average is evaluated against the UCL and LCL Limits. This feature allows the offset to correct to a value other than nominal.

Example: A dimension that is measured right after being machined may be larger, do to heat expansion, than when the part is cooled. In this case, it may be desirable to control the dimension to a Setpoint greater than nominal to compensate for the heat expansion.

LCL - The Lower Control Limit is a trigger point for computing compensation data for a given offset. If the Running Average minus the Setpoint is less than the Lower Control Limit and the accumulated # of samples is equal to or greater than the Min Sample Size then Feedback data will be computed for that offset and transmitted back to the Machine.

Compensation Rate - The resolution of the machine tool being compensated is entered here.

Feedback Control Limits

Per Cycle - The Per Cycle Tooling Adjust Limit is the maximum allowed adjustment on any given measurement cycle. This protects the Machine from over compensation. If the limit is exceeded an alarm is triggered which can be programmed to send a shutdown command.

Per Cycle - The Total Tooling Adjust Limit is the maximum allowed adjustment since the last tool change (feedback reset). The computed compensation data for an offset is totaled and compared against this limit. If the Limit is exceeded an alarm is triggered which can be programmed to send a shutdown command.

Offset Definition

Running Avg. of Check - The measured part feature (Check) that the running average will be performed on for an offset.

Previously Defined Offset - An offset can be a function of another offset. This is useful when the other offset computed for the same measurement cycle will affect the amount of compensation this is to be applied for this offset (this is not common).

Multiplier - The percentage of the previously defined offset that will be added or subtracted to the running average during the measurement cycle.

Machine Specific

This section of the offset setup will include specific setup required to interface with the specific machine being configured for (see [Section 5 Feedback Interfaces](#))

4.2. Feedback Operation

In this section the operation of the Edmunds Feedback will be demonstrated through several examples. Note that many of the screens shown in the examples are of the “Feedback Monitor” screen. The “Feedback Monitor” screen allows the operator to view the compensation amounts and rates for the process (see [Section 1.5.7 Feedback Monitor](#)).

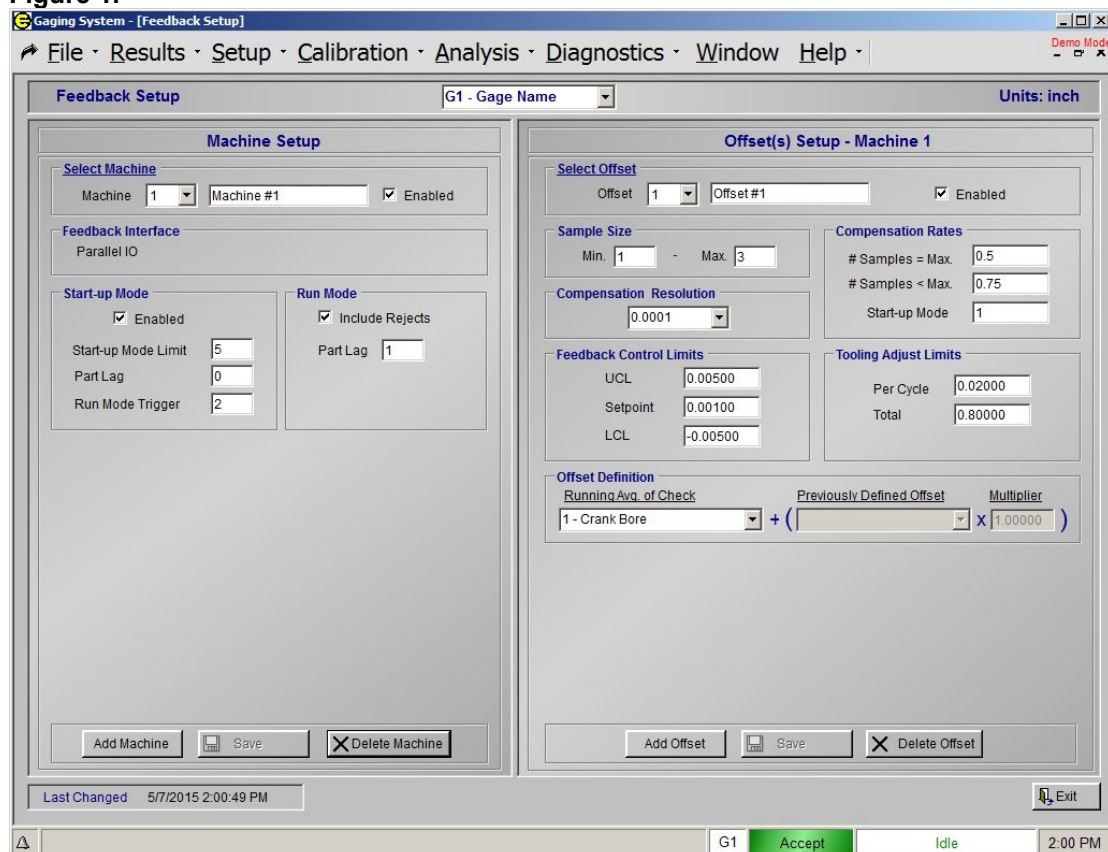
4.2.1. START-UP MODE:

Start-up mode is used to quickly bring the production process under control and produce acceptable parts. Start-up mode differs from run mode in two important ways:

- 1) A separate, start-up mode compensation rate is used to allow for a different rate of feedback than during run mode.
- 2) Because reject parts are likely to be produced during start-up mode, they are also included in the running average used to calculate feedback.

If start-up mode is utilized and enabled, and feedback is reset, start-up mode is entered and all accumulated data, such as tooling adjustments and part counters, are cleared. The following example uses one offset defined as Offset #01 to illustrate start-up mode operation (see Figure 1).

Figure 1.



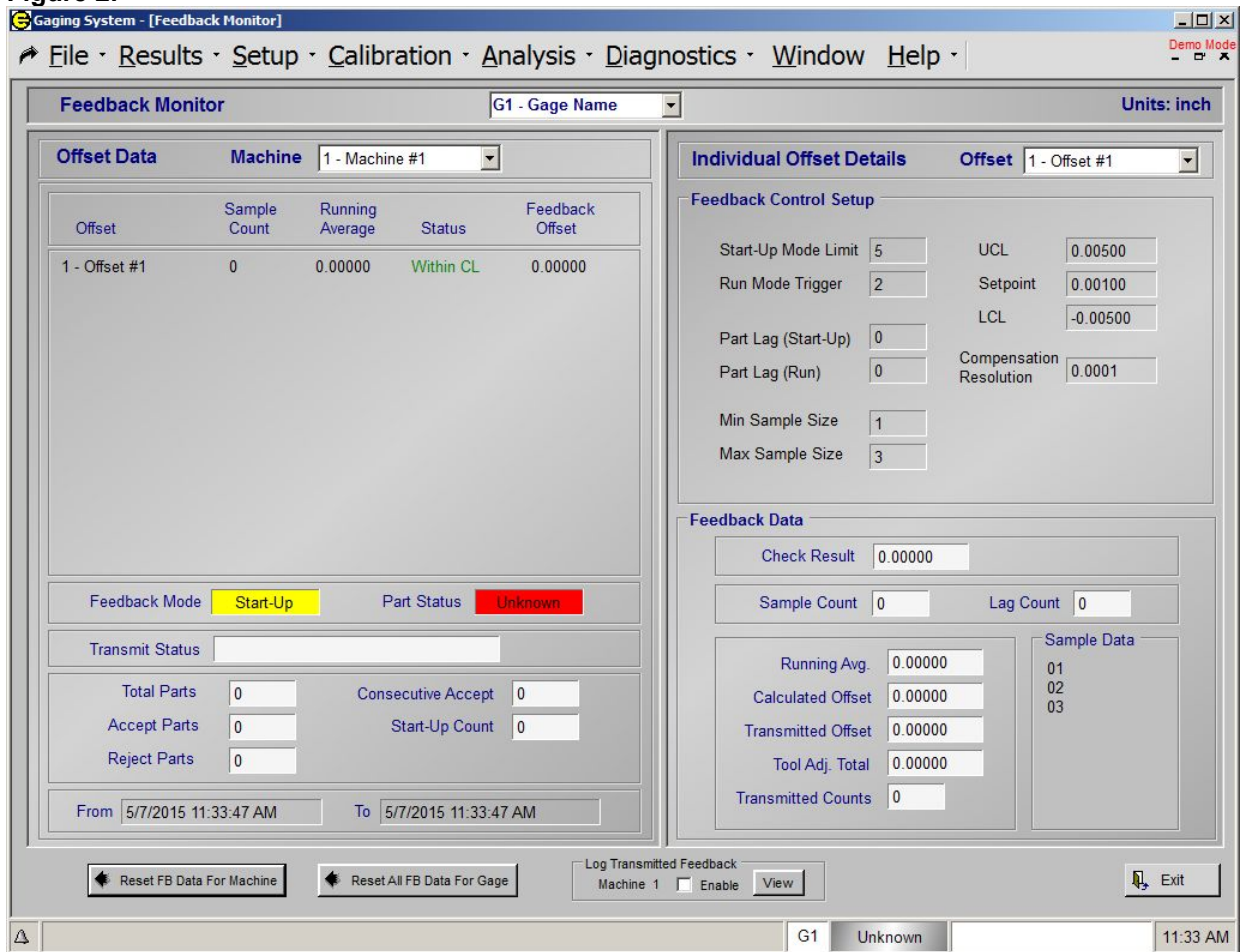
1. Start-up Mode - initialized

On power-up, or when resetting the feedback data in *Feedback Monitor* screen, the feedback data is initialized to the values shown in Figure 2. The part status is “Unknown” and Check result values is 0.000.

The part counters and sample count are set to 0. The lag count is set to the user defined start-up mode part lag, 0, because after reset, it is assumed that there are no parts waiting to be gaged between the machine and the CAG and, therefore, there is no lag. Initializing the part lag in this manner allows the CAG to include the first part gaged in the feedback algorithm.

The feedback mode is set to **Start-Up** mode, and the running average, calculated and transmitted offsets, tool adjustment total, and sample data are all set to 0.

Figure 2.



2. Start-up - First Part (Reject)

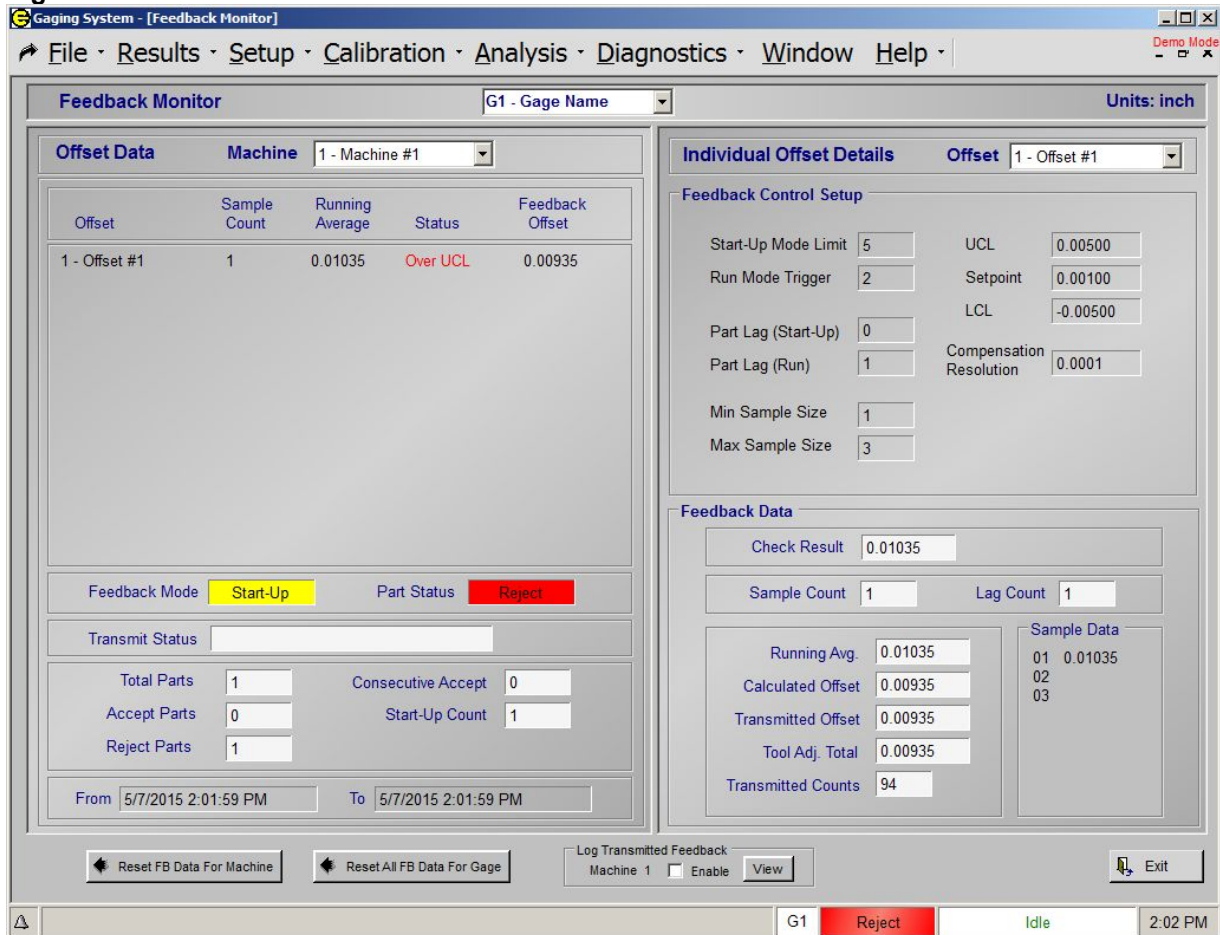
The first part is gaged, the part status is *Reject*, and the Check result is +0.01035. The feedback data is updated as shown in Figure 3.

The part counters were updated as follows: **Total Parts** was incremented from 0 to 1 because a part was gaged, **Consecutive Accept** remained unchanged because the part status was not Accept, and **Start-Up Count** was incremented from 0 to 1 because the part was gaged in START-UP mode.

The sample counters were updated as follows: **Sample Count** was incremented from 0 to 1 because the Check result was included in the sample data (Reject parts are used in START-UP mode only), and **Lag Count** was incremented from 0 to 1 because the Lag Count was less than or equal to the user defined start-up mode lag count.

The feedback mode is Start-Up because the **Consecutive Accept** counter, 0, is less than the run mode trigger, 2. The running average, +0.01035, is the average of the sample data. The calculated offset, +0.00935, is the running average minus the setpoint value, +0.00100, multiplied by the start-up mode compensation rate, +1.00000. Feedback is transmitted because the running average exceeds the upper feedback control limit UCL, +0.00500, and the sample count, 1, is greater than or equal to the min sample size, 1.

Figure 3.



3. Start-up - Second Part (Accept)

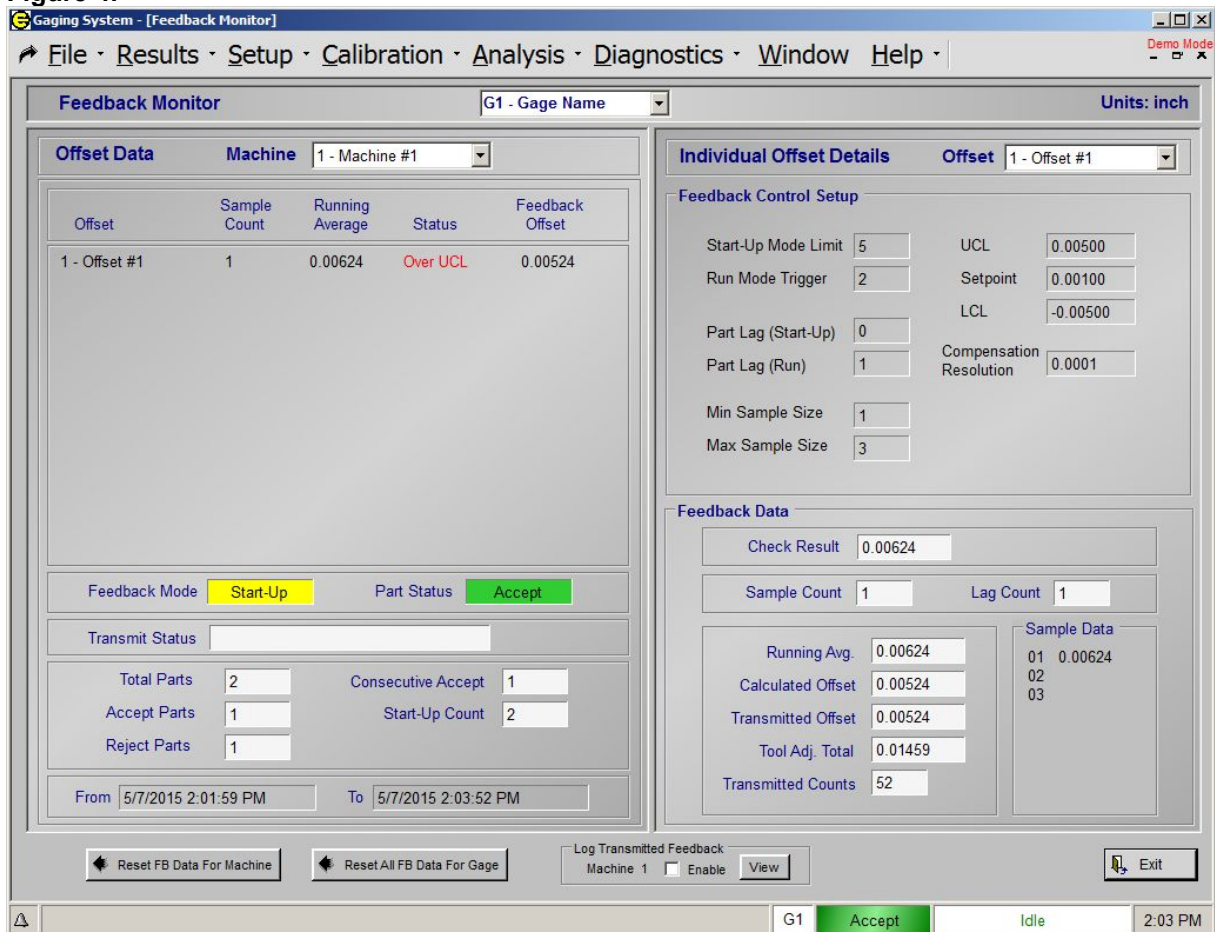
The sample count, lag count, and sample data are reset to 0 when the next part is gaged, because feedback was transmitted on the last gage cycle.

The next part is gaged, the part status is *Accept*, and the Check result is +0.00624. The feedback data is updated as shown in Figure 4.

The part counters were updated as follows: **Total Parts** was incremented from 1 to 2 because a part was gaged, **Consecutive Accept** was incremented from 0 to 1 because the part status was Accept, and **Start-Up Count** was incremented from 1 to 2 because the part was gaged in Start-Up mode.

The sample counters were updated as follows: **Sample Count** was unchanged because the lag count, 0, was less than the start-up mode part lag, 1, and then **Lag Count** was incremented from 0 to 1.

Figure 4.



4. Start-up Mode - Third Part (Accept)

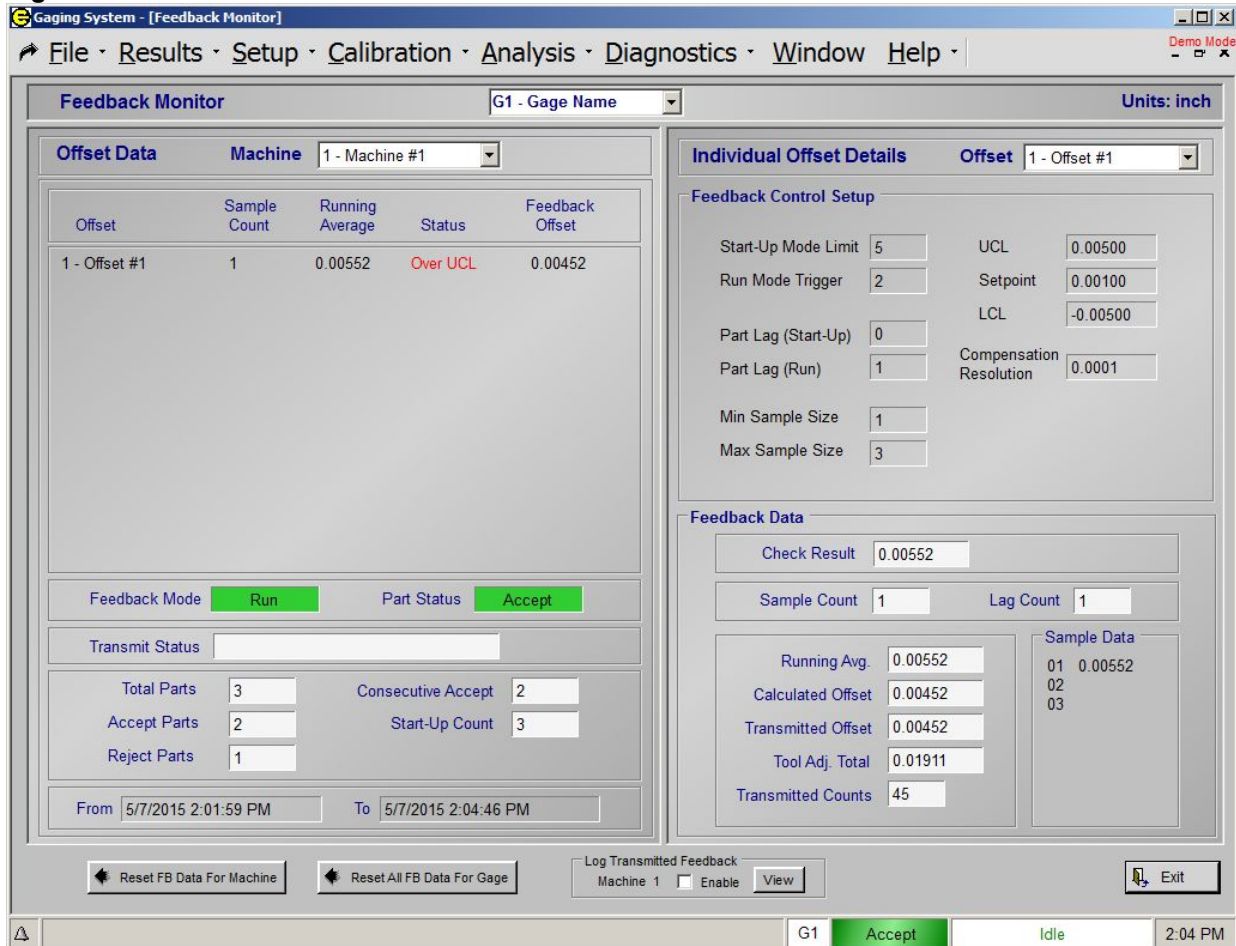
The third part gaged is Accept, and the Check result is +0.00552. The feedback data is updated as shown in Figure 5.

The part counters were updated as follows: **Total Parts** was incremented from 2 to 3 because a part was gaged, **Consecutive Accept** was incremented from 1 to 2 because the part status was Accept, and **Start-Up Count** was incremented to 3 because the part was gaged in **Run** mode.

The sample counters were updated as follows: **Sample Count** was incremented from 0 to 1 because the Check result was included in the sample data, and the **Lag Count** was incremented from 1 to 2 because the Lag Count, 1, was not greater than the user defined start-up mode lag count, 1.

The feedback mode displays **RUN** because the **Consecutive Accept** counter (2) was greater than or equal to the run mode trigger and it will be in Run mode for the next cycle. The running average, +0.00552, is the average of the sample data. The calculated offset, +0.00452, is the running average minus the setpoint value, +0.00100, multiplied by the start-up mode compensation rate, +1.00000. Feedback is transmitted because the running average exceeds the upper feedback control limit UCL, +0.00500, and the sample count, 1, is greater than or equal to the min sample size, 1.

Figure 5.



4.2.2. RUN MODE:

Run mode is used to continuously control the production process to produce acceptable parts as close to the set point as possible. Run mode is entered when the consecutive good counter equals the run mode trigger, and can only return to Start-up mode in three ways:

- 1) Turn power off and on again.
- 2) Reset the feedback data through “Reset FB Data” on “Feedback Monitor” screen.
- 3) Special software to communicate with an external source that instructs the EPIC CAG to reset the feedback data.

EXAMPLE:

This is a continuation of the previous example, with the same feedback setup as in the Start-Up mode section. It will continue from the last gage cycle described in START-UP mode step 5. above, and the feedback data from Figure 5.

1. Run Mode - First Part (Accept)

The sample count, lag count, and sample data are reset to 0 when the next part is gaged, because feedback was transmitted on the last gage cycle. The next part is gaged, the part status is Accept, and the Check result is +0.00152. The feedback data is updated as shown in Figure 6.

The part counters were updated as follows: **Total Parts** was incremented from 3 to 4 because a part was gaged, **Consecutive Accept** was incremented from 2 to 3 because the part status was Accept, and Start-Up Count was unchanged.

The sample counters were updated as follows: **Sample Count** was unchanged because the **Lag Count**, 0, was less than the run mode part lag, 1, and then **Lag Count** was incremented from 0 to 1.



NOTE: No Feedback was Calculated/Transmitted because the 1 part Lag (Lag Count set to 1).

Figure 6

Gaging System - [Feedback Monitor] Demo Mode

File · Results · Setup · Calibration · Analysis · Diagnostics · Window Help

Feedback Monitor G1 - Gage Name Units: inch

Offset Data Machine 1 - Machine #1

Offset	Sample Count	Running Average	Status	Feedback Offset
1 - Offset #1	0	0.00000	Within CL	0.00000

Feedback Mode Run Part Status Accept

Transmit Status

Total Parts	<input type="text" value="4"/>	Consecutive Accept	<input type="text" value="3"/>
Accept Parts	<input type="text" value="3"/>	Start-Up Count	<input type="text" value="3"/>
Reject Parts	<input type="text" value="1"/>		

From To

Individual Offset Details Offset 1 - Offset #1

Feedback Control Setup

Start-Up Mode Limit	<input type="text" value="5"/>	UCL	<input type="text" value="0.00500"/>
Run Mode Trigger	<input type="text" value="2"/>	Setpoint	<input type="text" value="0.00100"/>
		LCL	<input type="text" value="-0.00500"/>
Part Lag (Start-Up)	<input type="text" value="0"/>	Compensation Resolution	<input type="text" value="0.0001"/>
Part Lag (Run)	<input type="text" value="1"/>		
Min Sample Size	<input type="text" value="1"/>		
Max Sample Size	<input type="text" value="3"/>		

Feedback Data

Check Result

Sample Count Lag Count

Running Avg.	<input type="text" value="0.00000"/>	Sample Data 01 02 03
Calculated Offset	<input type="text" value="0.00000"/>	
Transmitted Offset	<input type="text" value="0.00000"/>	
Tool Adj. Total	<input type="text" value="0.01911"/>	
Transmitted Counts	<input type="text" value="0"/>	

Log Transmitted Feedback Machine 1 Enable

G1 Accept Idle 2:05 PM

2. Run Mode - Second Part (Accept)

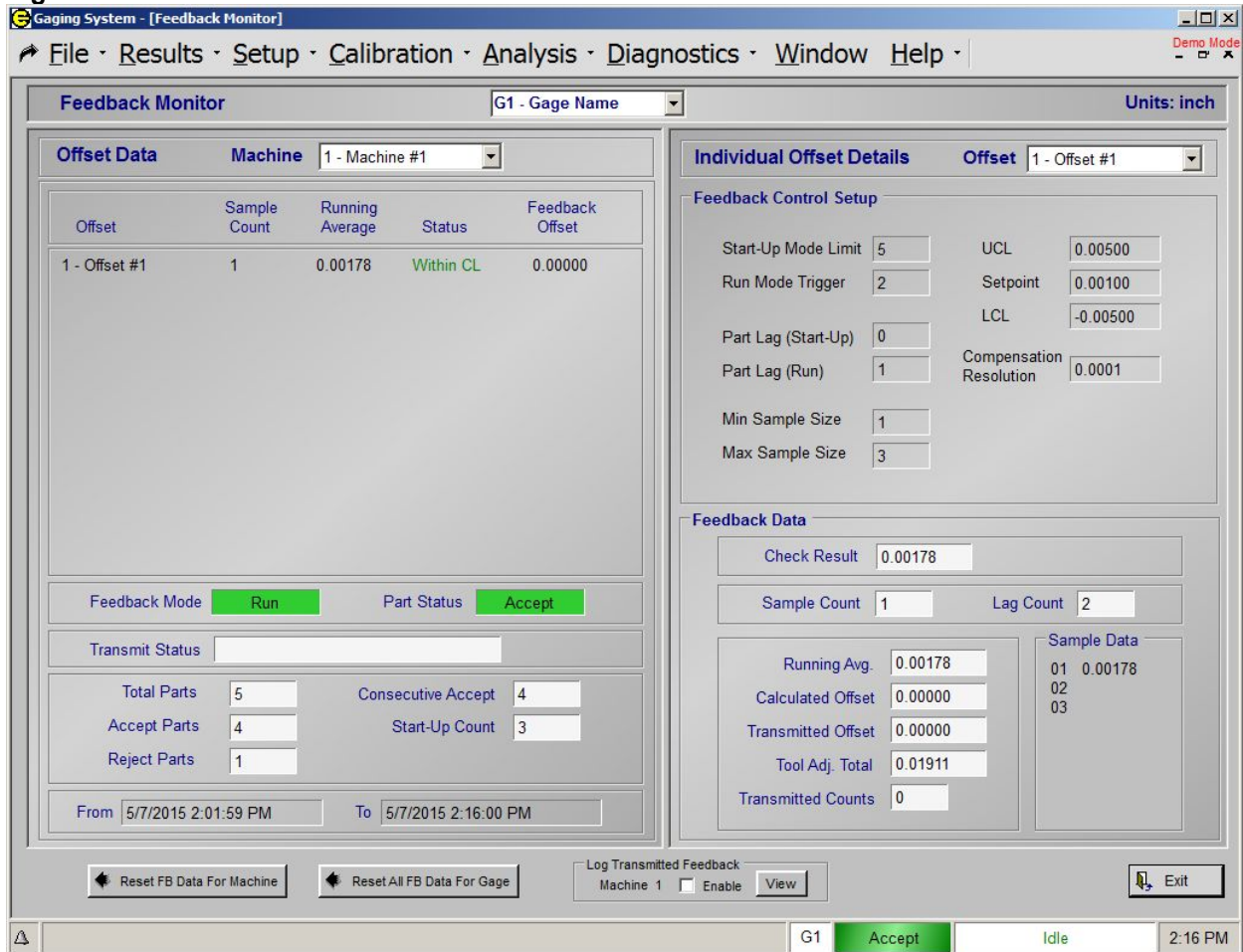
The next part is gaged, the part status is Accept, and the Check result is +0.00178. The feedback data is updated as shown in Figure 7.

The part counters were updated as follows: **Total Parts** was incremented from 4 to 5 because a part was gaged, **Consecutive Accept** was incremented from 3 to 4 because the part status was Accept, and Start-Up Count was unchanged.

The sample counters were updated as follows: **Sample Count** was incremented from 0 to 1 because the Check result was included in sample data, and LAG COUNT was incremented from 1 to 2 because the **Lag Count**, 1, was not greater than the user defined run mode lag count, 1.

The running average, +0.00178, is the average of the sample data. **Feedback is not transmitted because the running average does not violate the feedback control limits**, -0.00500 and +0.00500, and therefore, the calculated offset and transmitted offset are zero.

Figure 7



3. Run Mode - Third Part (Accept)

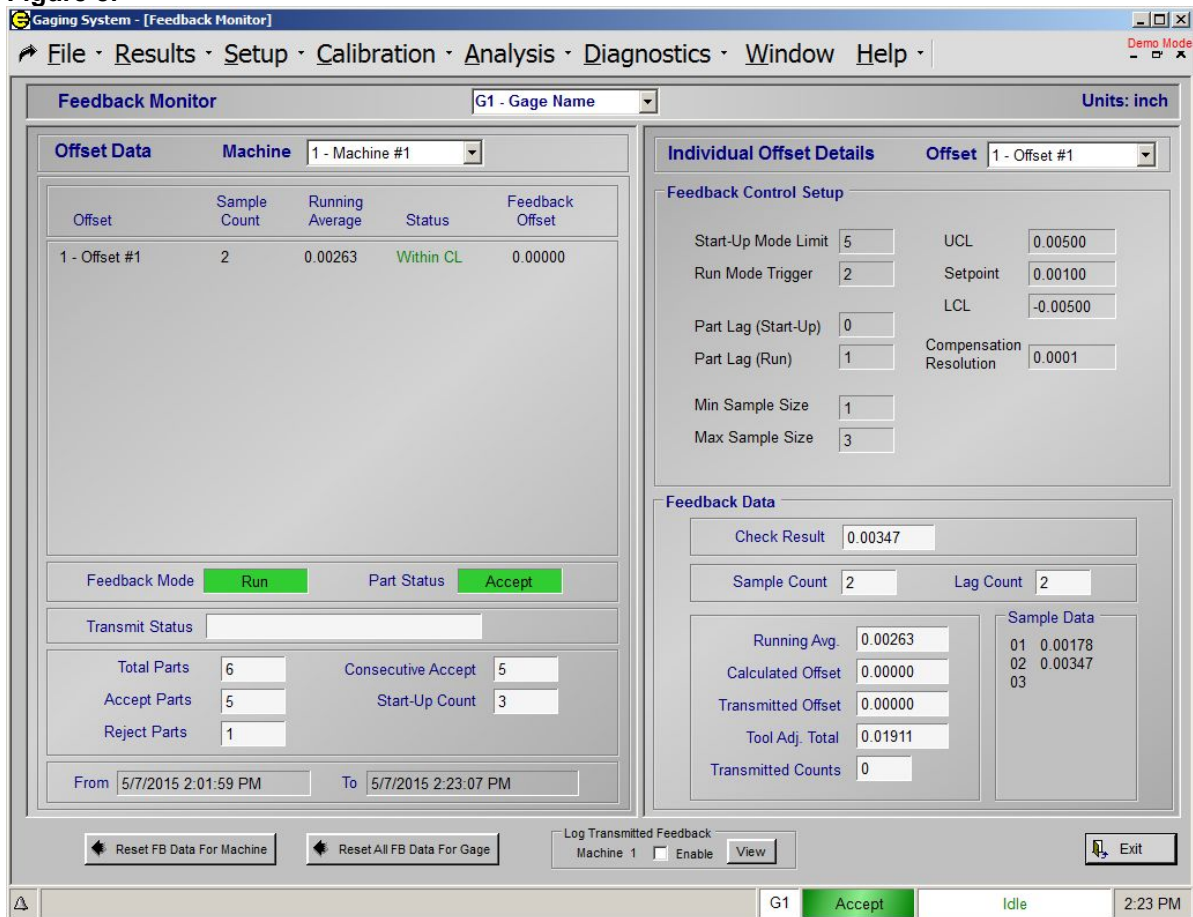
The next part is gaged, the part status is Accept, and the Check result is +0.00347. The feedback data is updated as shown in Figure 8.

The part counters were updated as follows: **Total Parts** was incremented from 5 to 6 because a part was gaged, **Consecutive Accept** was incremented from 4 to 5 because the part status was Accept, and Start-Up Count was unchanged.

The sample counters were updated as follows: **Sample Count** was incremented from 1 to 2 because the Check result was included in the sample data, and Lag Count remained unchanged.

The running average, +0.00263, is the average of the sample data. **Feedback is not transmitted because the running average does not violate the feedback control limits**, -0.00500 and +0.00500, and therefore, the calculated offset and transmitted offset are zero.

Figure 8.



4. Run Mode - Fourth Part (Accept)

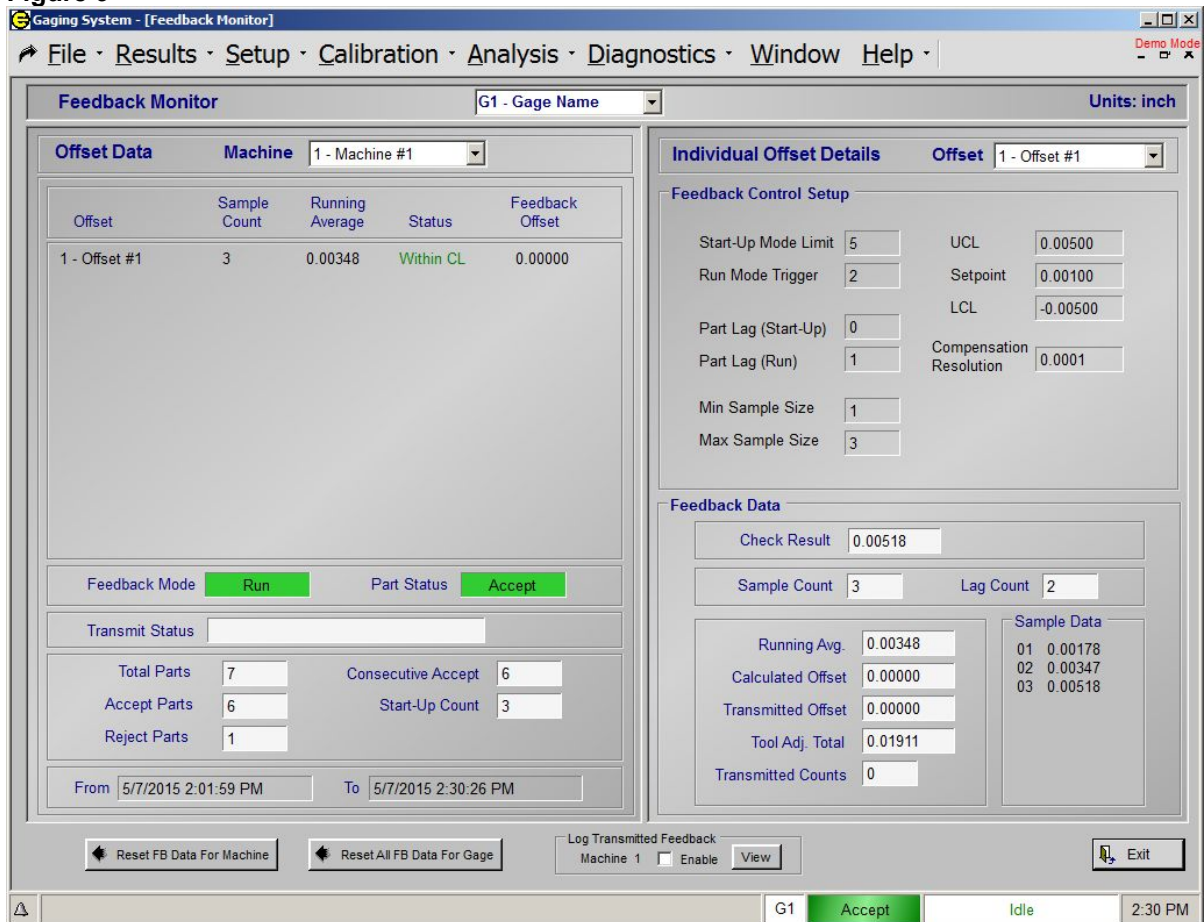
The next part is gaged, the part status is Accept, and the Check result is +0.00518. The feedback data is updated as shown in Figure 9.

The part counters were updated as follows: **Total Parts** was incremented from 6 to 7 because a part was gaged, **Consecutive Accept** was incremented from 5 to 6 because the part status was Accept, and Start-Up Count was unchanged.

The sample counters were updated as follows: **Sample Count** was incremented from 2 to 3 because the Check result was included in the sample data, and Lag Count remained unchanged.

The running average, +0.00348, is the average of the sample data. **Feedback is not transmitted because the running average does not violate the feedback control limits**, -0.00500 and +0.00500, and therefore, the calculated offset and transmitted offset are zero.

Figure 9



5. Run Mode - Fifth Part (Accept)

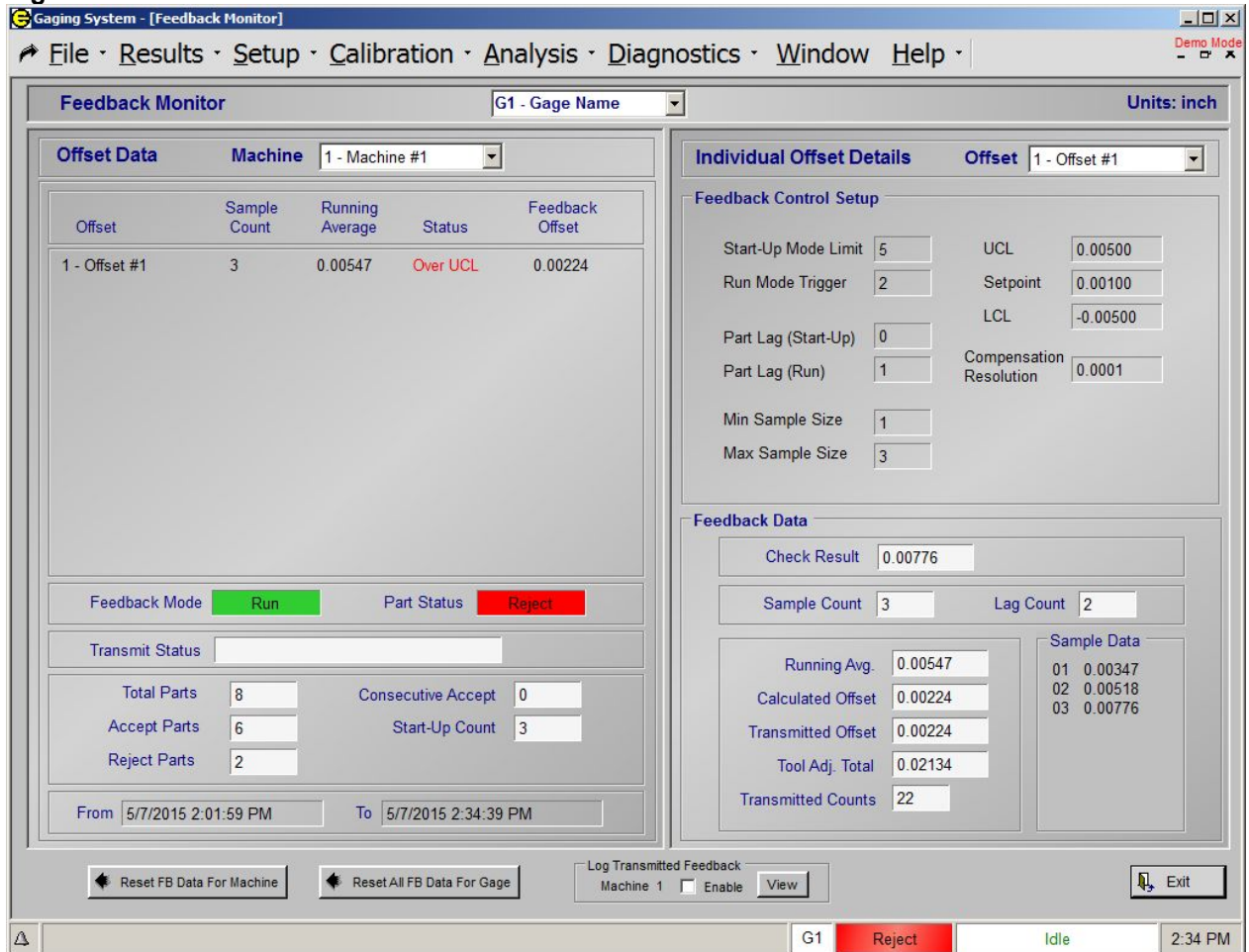
The next part is gaged, the part status is Accept, and the Check result is +0.00776. The feedback data is updated as shown in Figure 10.

The part counters were updated as follows: **Total Parts** was incremented from 7 to 8 because a part was gaged, **Consecutive Accept** was incremented from 6 to 7 because the part status was Accept, and Start-Up Count was unchanged.

The sample counters were updated as follows: **Sample Count** was unchanged because it already equals the max sample size of 3, and Lag Count remained unchanged.

The running average, +0.00547, is the average of the sample data. The calculated offset, +0.00224, is the running average minus the setpoint value, multiplied by the #SAMPLES = MAX compensation rate of +0.50000. $((0.00547 - 0.00100) * 0.50000) = 0.00223$. Feedback is transmitted because the running average exceeds the upper feedback control limit UCL, +0.00500, and the sample count, 3, is greater than or equal to the min sample size, 1.

Figure 10



5. SECTION : Feedback Interfaces

5.1. G.E. Fanuc FOCAS2 Interface

5.1.1. Introduction and Interface Protocol:

The Focas2 interface between the EPIC CAG™ and the G.E. Fanuc control will require an Ethernet connection and the G.E. Fanuc control's "Custom Macro" option. Either the embedded Ethernet or the Fast Ethernet option (J909) can be used on the G.E. Fanuc control. The IP address, Port number and Path of the Fanuc Control are programmable values within the EPIC software running on the CAG. The EPIC CAG can be programmed to read and write to macro variable addresses located in the G.E. Fanuc control.

Feedback compensation parameters defined on the CAG™ can have an associated macro variable address assigned as part of the setup.

In practice, the EPIC CAG™ will complete a measurement cycle and use the new data to determine if Tool Compensation is required.

The EPIC CAG™ will solicit the Fanuc Control macro variable "Data Available" to determine if the previous Tool Compensation data has been read. A value of 1.0 indicates that the previous data has not been read by the Machine Tool Macro. The Machine Tool is responsible to reset this variable to 0.0 after reading the Tool compensation offset macro variables. The EPIC CAG™ will solicit this variable once per measurement cycle. If the previous data has not been read by the Machine Tool then the EPIC CAG™ will not solicit this variable again until the completion of the next measurement cycle. The running average will not be reset.

If the "Data Available" variable equals 0.0 then the previous data has been read by the Machine Tool Macro. The EPIC CAG™ will update the Tool Compensation Offset Macro variables with the new compensation values. If compensation is not required for any given offset, then a value of 0.0 will be written. The EPIC CAG™ will update the "Data Available" macro variable to a value of 1.0 after the new compensation data has been written.

A "Machine Feedback Reset" macro variable can be assigned in the EPIC CAG™ to indicate a Tool change. The Machine Tool will set this variable to 1.0 whenever a tool change occurs. The CAG™ will solicit this macro variable at the beginning of a measurement cycle to determine if the accumulated feedback data for all offsets should be reset. The CAG™ will set the "Feedback Reset" variable to 0.0 at the completion of the reset.

An "Offset Feedback Reset" macro variable can be assigned in the EPIC CAG™ to indicate an individual Offset Date reset is required. The Machine Tool will set this variable to 1.0 whenever the Offset data is required to be reset. The CAG™ will solicit this macro variable at the beginning of a measurement cycle to determine if the accumulated feedback data should be reset. The CAG™ will set the "Offset Feedback Reset" variable to 0.0 at the completion of the reset.

This interface can accommodate up to 16 Machine Tool Offsets. A maximum of 34 macro variables will be required: Data Available, Machine Data Reset, Offset #1 thru Offset #16, Offset Data Reset #1 thru #16.

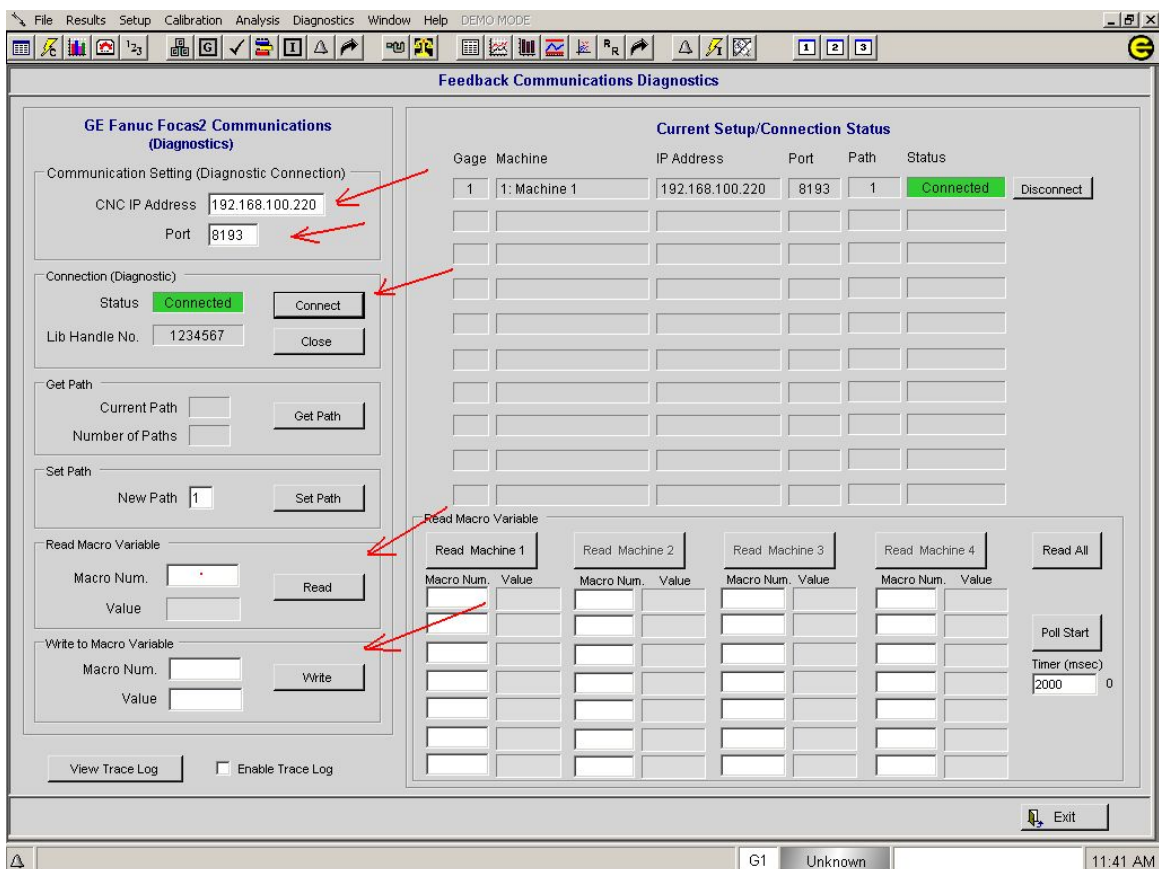
5.1.2. Initial Setup and Establishing Communications:

System Requirements:

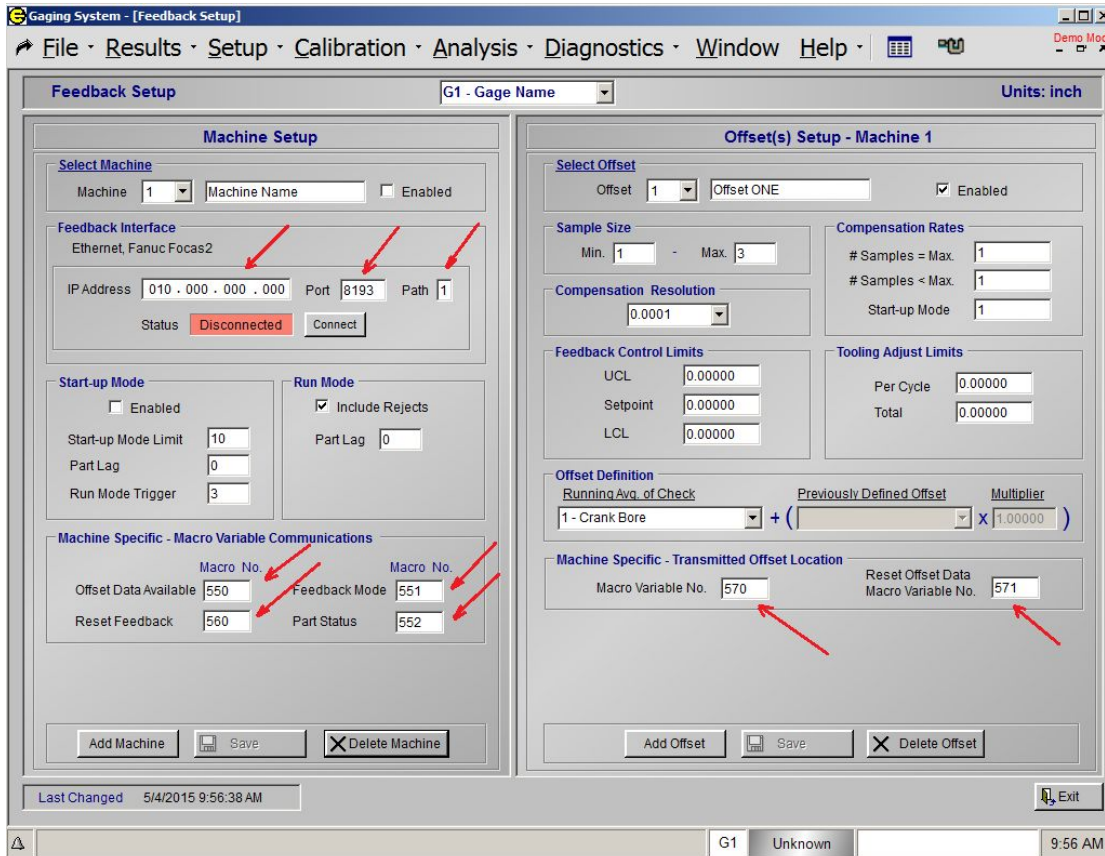
-Edmunds EPIC CAG™: Optional Focas2 Feedback module installed.

-G.E. Fanuc controller with Fanuc control's "Custom Macro" option and either the embedded Ethernet or the Fast Ethernet option (J909).

1. Determine/Report the IP Address, Port and Path of the Fanuc controller.
2. Set the IP Address of the EPIC CAG™ unit. The IP Address of the CAG unit will need to be compatible with the Fanuc controller (first three sets of numbers in the addresses need to match) Example: Fanuc controller IP Address: 192.168.100.220, CAG™ unit IP Address: 192.168.100.221. See (**APPENDIX B**) for instructions on setting the CAG IP Address.
3. Test the communications using EPIC Feedback Communications Diagnostics screen:
 - a. Enter menu "Diagnostics" – "Feedback Communications" in the EPIC software.
 - b. Enter the CNC IP Address (address of the Fanuc Controller) and Port number.
 - c. Click on the "Connect" button. Status should display "Connected" if communication was established. If connection fails, verify IP Addresses and Port number of both the Fanuc controller and the EPIC CAG™ and also verify the Ethernet cable is connected correctly.
 - d. Test Write/Read of data to the controller macro variables. In the "Write Macro Variable" box, enter macro number and value to write. Click on "Write" button. Read back that value by entering the macro number in the "Read Macro Variable" box and click on the "Read" button.



5.1.3. Focas2 Feedback Setup In EPIC Software:



5.1.3.1. Machine Specific - Macro Variable Communications

Offset Data Available - Macro variable number on host Fanuc Controller (Machine). A non-zero value will be written to this macro variable when offset data is available. The host machine will read this variable, if the value is non-zero, the offset data will be read and applied. The macro variable value will then be set to zero by the host machine.

Reset Feedback - Macro variable number on host Fanuc Controller (Machine). A non-zero value will be written to this macro variable when offset data is available. The host machine will read this variable, if the value is non-zero, the offset data will be read and applied. The macro variable value will then be set to zero by the host machine.

Feedback Mode - Macro variable number on host Fanuc Controller (Machine). The Feedback Mode (Startup or Run) will be written to this macro variable when feedback data is available.

Run Mode = 1

Start-up Mode = 2

If Macro variable number is zero '0', Mode will not be written (disabled)

Part Status - Macro variable number on host Fanuc Controller (Machine). The Part Status will be written to this macro variable when feedback data is available.

Unknown = 0

Accept = 1

Reject = 2

Flyer = 3

If Macro variable number is zero '0', Status will not be written (disabled)

5.1.3.2. Machine Specific - Transmitted Offset Locations

Macro Variable No. - Macro variable number on host Fanuc Controller (Machine). The Feedback Offset value will be written to this macro variable. The value in the macro variable will be used to adjust the tooling offset in the machine.

Reset Offset Data Macro Variable No. - Macro variable number on host Fanuc Controller (Machine). The value of this macro variable will be read, if it is non-zero offset sample data will be reset. If macro variable number is set to zero, variable will not be read (reset function disabled).

5.1.4. Example Macro Program for Reading Feedback Offsets.

Note: this program should be used for reference only, actual variable number will differ.

Macro Variable numbers used in the following example program:

Data Available: 550

Offset #1: 501

Offset #2: 502

Offset #3: 503

Offset #4: 504

Offset #5: 505

Reset Feedback: 560

Tool Wear Offset Variables:

Tool Offset #1: 2001

Tool Offset #2: 2002

Tool Offset #3: 2003

Tool Offset #4: 2004

Tool Offset #5: 2005

:9500 (EDMUNDS GAGE - FB MACRO)

(REV.A, 09/29/11)

(TEST FOR FEEDBACK)

(LOOK AT DATA AVAL)

```
IF[#550EQ1.0]GOTO210
GOTO220
```

```
N210
```

```
(SET FEEDBACK OFFSET'S)
(ADD NEW OFFSET TO TOOL OFFSET)
(OFFSET #1)
#2001=[#2001+ #501]
(OFFSET #2)
#2001=[#2002+ #502]
(OFFSET #3)
#2001=[#2003+ #503]
(OFFSET #4)
#2001=[#2004+ #504]
(OFFSET #5)
#2001=[#2005+ #505]
```

```
(RESET - DATA AVAIL.)
#550=0
```

```
(RESET EDMUNDS OFFSET VARIABLE)
#501=0
#502=0
#503=0
#504=0
#505=0
GOTO999
```

```
N220
```

```
(TEST FOR TOOL CHANGE)
(CODE HERE TO DETERMINE IF TOOL CHANGE AND RESET FEEDBACK NEEDED)
```

```
*
*
*
*
```

```
(IF RESET NEEDED - RESET FEEDBACK ALL TOOLS)
#560=1.0
```

```
#501=0
#502=0
#503=0
#504=0
#505=0
```

```
GOTO 999
```

N999
M99

5.2. Edmunds AB EtherNet/IP Feedback Interface

CAG (EPIC) <-- --> Allen Bradley ControlLogix Controller (PLC)

5.2.1. Introduction and Interface Protocol:

The EtherNet/IP interface between the Edmunds CAG and the ControlLogix control will require an Ethernet connection. The IP address and CPU slot of the ControlLogix control are programmable values within the EPIC software running on the CAG. The Edmunds CAG can be programmed to read and write to Tag variables located in the ControlLogix control.

Feedback compensation parameters defined on the CAG can have an associated Tag names assigned as part of the setup.

In practice, the Edmunds CAG will complete a measurement cycle and use the new data to determine if Tool Compensation is required.

The Edmunds CAG will solicit the ControlLogix control Tag “Data Available” to determine if the previous Tool Compensation data has been read. A value of 1.0 indicates that the previous data has not been read by the Machine Tool Macro. The Machine Tool is responsible to reset this Tag to 0.0 after reading the Tool compensation offset Tag variables. The Edmunds CAG will solicit this variable once per measurement cycle. If the previous data has not been read by the Machine Tool then the Edmunds CAG will not solicit this variable again until the completion of the next measurement cycle. The running average will not be reset.

If the “Data Available” Tag equals 0.0, then the previous data has been read by the Machine Tool.

The Edmunds CAG will update the Tool Compensation Offset Tag variables with the new compensation values. If compensation is not required for any given offset, then a value of 0.0 will be written. The Edmunds CAG will update the “Data Available” Tag to a value of 1.0 after the new compensation data has been written.

A “Machine Feedback Reset” Tag can be assigned in the Edmunds CAG to indicate a Tool change. The Machine Tool will set this Tag to 1.0 whenever a tool change occurs. The CAG will solicit this Tag at the beginning of a measurement cycle to determine if the accumulated feedback data for all offsets should be reset. The CAG will set the “Feedback Reset” Tag to 0.0 at the completion of the reset.

An “Offset Feedback Reset” Tag variable can be assigned in the Edmunds CAG to indicate an individual Offset Date reset is required. The Machine Tool will set this Tag to 1.0 whenever the Offset data is required to be reset. The CAG will solicit this Tag at the beginning of a measurement cycle to determine if the accumulated feedback data should be reset. The CAG will set the “Offset Feedback Reset” Tag to 0.0 at the completion of the reset.

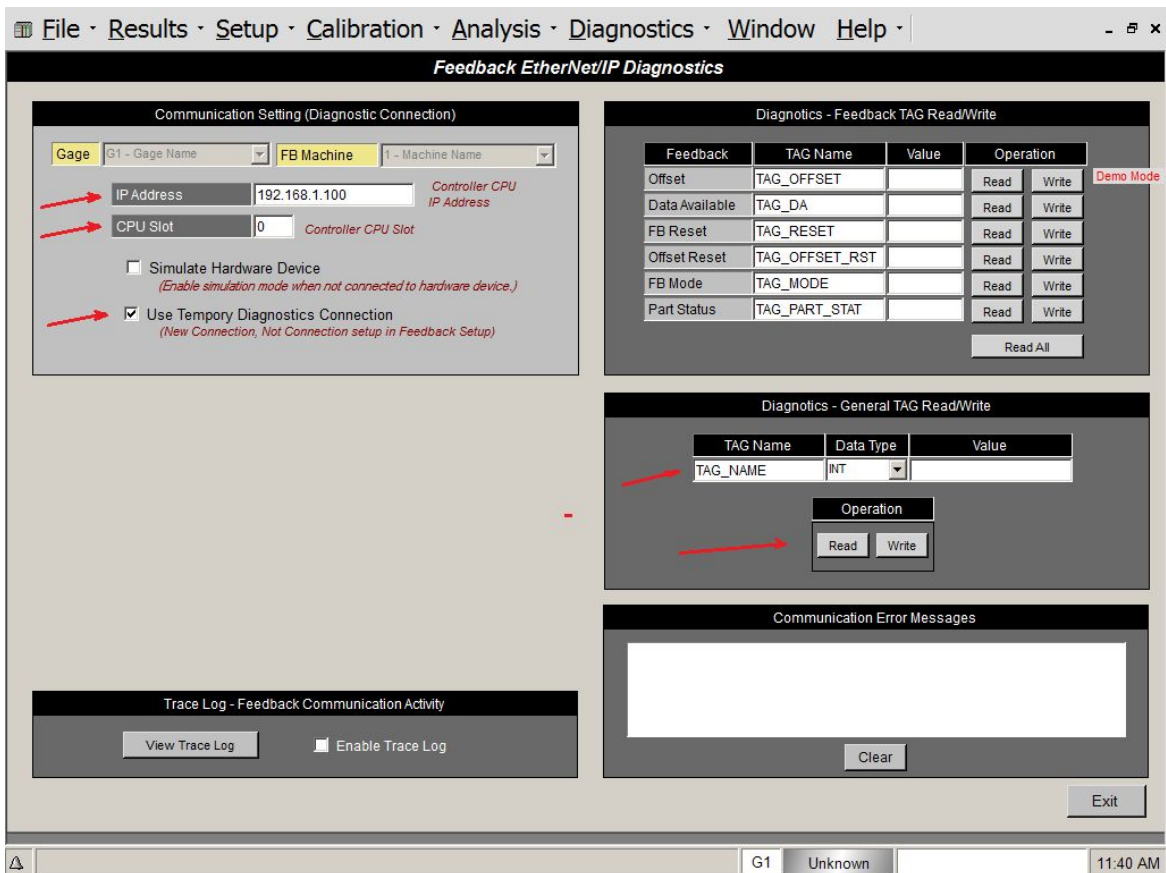
This interface can accommodate up to 16 Machine Tool Offsets. A maximum of 34 Tag variables will be required: Data Available, Machine Data Reset, Offset #1 thru Offset #16, Offset Data Reset #1 thru #16.

5.2.2. Initial Setup and Establishing Communications:

System Requirements:

- Edmunds EPIC CAG: Optional AB EtherNet/IP Feedback module installed.
- AB ControlLogix Controller

- Determine/Report the IP Address and CPU slot of the ControlLogix controller.
- Set the IP Address of the EPIC CAG unit. The IP Address of the CAG unit will need to be compatible with the ControlLogix controller (first three sets of numbers in the addresses need to match) Example: ControlLogix controller IP Address: 192.168.100.220, CAG unit IP Address: 192.168.100.221. See **(APPENDIX B)** for instructions on setting the CAG IP Address.
- Test the communications using EPIC Feedback EtherNet/IP Diagnostics screen:
 - Enter menu “Diagnostics” – “Feedback AB EtherNet/IP Diag” in the EPIC software.
 - Enter the CNC IP Address (address of the AB ControlLogix Controller) and CPU Slot number.
 - Select “Use Temporary Diagnostics Connection”
 - Test Write/Read of data to the controller Tag variables. In the “Diagnostics – General TAG Read/Write” box, enter Tag name and value to write. The Tag variable must exist on the controller. Click on “Write” button. Read back that value by entering the “Read” button.



5.2.3. AB EtherNet/IP Feedback Setup In EPIC Software:

TAG Usage:

Offset Data Avail: TAG Name associated with TAG on Machine Control PLC Controller.
A non-zero value will be written to this Tag when offset data is available.
The host machine will read this Tag, if the value is non-zero, the offset data will be read and applied.
The Tag value will then be set to zero by the host machine.

Reset Feedback: TAG Name associated with TAG on Machine Control PLC Controller.
A non-zero value will be written to this Tag when offset data is available.
The host machine will read this Tag, if the value is non-zero, the offset data will be read and applied.
The Tag value will then be set to zero by the host machine.

FB Mode: TAG Name associated with TAG on Machine Control PLC Controller.
The Feedback Mode (Startup or Run) will be written to this Tag when feedback data is available.
Run Mode = 1
Start-up Mode = 2
If the Tag Name is set to "None", the mode will not be written.

Part Status: TAG Name associated with TAG on Machine Control PLC Controller.
The Part Status will be written to this Tag when feedback data is available.
Unknown = 0
Accept = 1
Reject = 2
Flyer = 3
If the Tag Name is set to "None", the Status will not be written.

Offset Tag: TAG Name associated with TAG on Machine Control PLC Controller.
The calculated feedback offset value will be written to this Tag. The value in the Tag will be used to adjust the tooling offset in the machine.

Reset Offset Data: TAG Name associated with TAG on Machine Control PLC Controller.
The value of this Tag will be read, if it is non-zero offset sample data will be reset.
If the Tag Name is set to "None", the Tag will not be read (reset function disabled).

Feedback Setup Screen

File · Results · Setup · Calibration · Analysis · Diagnostics · Window Help ·

G1 - Gage Name Units: inch

Machine Setup

Select Machine
Machine: 1 Machine Name: Enabled

Feedback Interface
AB EtherNet/IP
IP Address: 192.168.1.100 CPU Slot: 0

Start-up Mode
 Enabled
Start-up Mode Limit: 10
Part Lag: 0
Run Mode Trigger: 3

Run Mode
 Include Rejects
Part Lag: 0

Machine Specific - EtherNet/IP Tag Communications

Offset Data Avail. Tag	TAG_DA	FB Mode Tag	TAG_MODE
Reset Feedback Tag	TAG_RESET	Part Status Tag	TAG_PART_STAT

Add Machine Save Delete Machine

Offset(s) Setup - Machine 1

Select Offset
Offset: 1 Offset Name: Enabled Demo Mode

Sample Size
Min: 1 Max: 3

Compensation Rates
Samples = Max: 1
Samples < Max: 1
Start-up Mode: 1

Compensation Resolution
0.0001

Feedback Control Limits
UCL: 0.00000
Setpoint: 0.00000
LCL: 0.00000

Tooling Adjust Limits
Per Cycle: 0.00000
Total: 0.00000

Offset Definition
Running Avg. of Check: 1 - Check Name + (Previously Defined Offset) x Multiplier: 1.00000

Machine Specific - Transmitted Offset AB Tag

Offset Tag: TAG_OFFSET Reset Offset Data Reset Tag: TAG_OFFSET_RST

Add Offset Save Delete Offset

Last Changed 2/3/2014 10:57:34 AM Exit

G1 Unknown 11:55 AM

5.3. Edmunds - Okuma Thinc Feedback Interface

5.3.1. Introduction and Interface Protocol:

The Okuma Thinc interface between the Edmunds CAG™ and the Okuma P200/P300 control will require an Ethernet connection and the Okuma control running the Okuma Thinc API drivers and Edmund-Okuma Server application. The IP address and Port number of the Okuma control are programmable values within the EPIC software running on the CAG.™ The Edmunds CAG™ can be programmed to read and write to common variables located in the Okuma control.

Feedback compensation parameters defined on the CAG can have an associated common variable number assigned as part of the setup.

In practice, the Edmunds CAG™ will complete a measurement cycle and use the new data to determine if Tool Compensation is required.

The Edmunds CAG™ will solicit the Okuma control common variable “Data Available” to determine if the previous Tool Compensation data has been read. A value of “1” indicates that the previous data has not been read by the Okuma Macro. The Okuma is responsible to reset this variable to “0” after reading the Tool compensation offset common variables. The Edmunds CAG™ will solicit this variable once per measurement cycle. If the previous data has not been read by the Okuma then the Edmunds CAG™ will not solicit this variable again until the completion of the next measurement cycle. The running average will not be reset.

If the “Data Available” common variable equals “0” then the previous data has been read by the Okuma Macro.

The Edmunds CAG™ will update the Tool Compensation Offset common variable with the new compensation values. If compensation is not required for any given offset, then a value of “0” will be written. The Edmunds CAG will update the “Data Available” common variable to a value of “1” after the new compensation data has been written.

A “Machine Feedback Reset” common variable can be assigned in the Edmunds CAG™ to indicate a Tool change. The Machine Tool will set this variable to “1” whenever a tool change occurs. The CAG™ will solicit this common variable at the beginning of a measurement cycle to determine if the accumulated feedback data for all offsets should be reset. The CAG™ will set the “Feedback Reset” variable to “0” at the completion of the reset.

An “Offset Feedback Reset” common variable can be assigned in the Edmunds CAG™ to indicate an individual Offset Data reset is required. The Machine Tool will set this variable to 1.0 whenever the Offset data is required to be reset. The CAG™ will solicit this common variable at the beginning of a measurement cycle to determine if the accumulated feedback data should be reset. The CAG™ will set the “Offset Feedback Reset” variable to 0.0 at the completion of the reset.

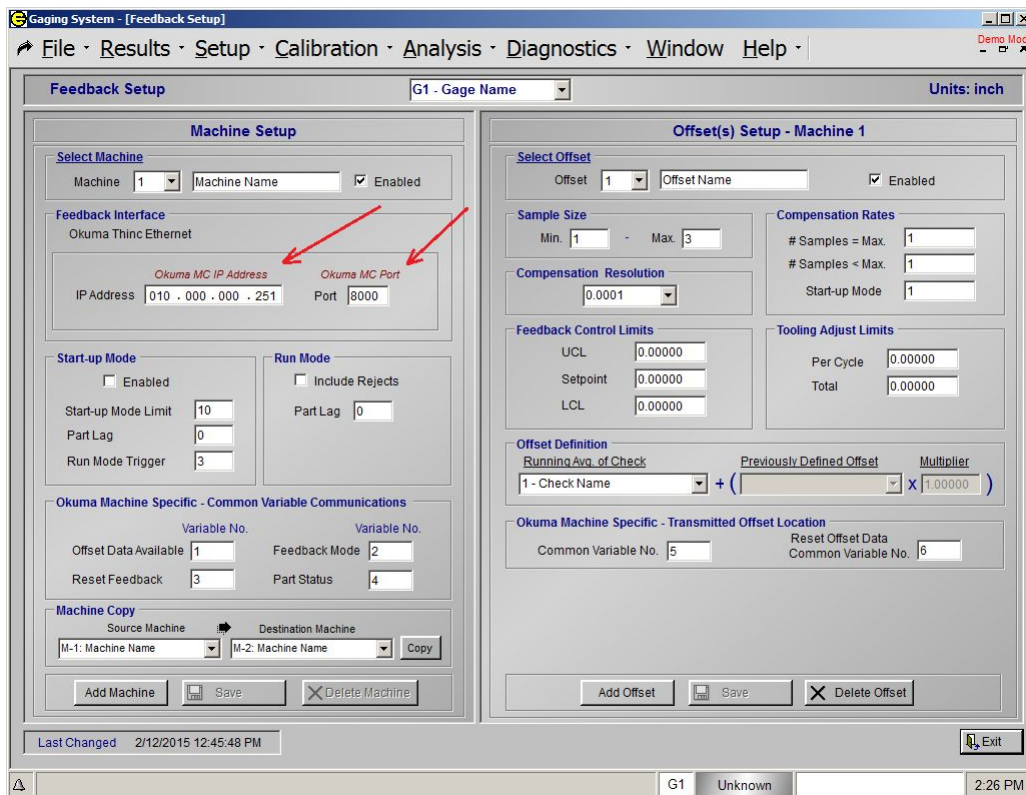
This interface can accommodate up to 16 Machine Tool Offsets. A maximum of 34 common variable will be required: Data Available, Machine Data Reset, Offset #1 thru Offset #16, Offset Data Reset #1 thru #16.

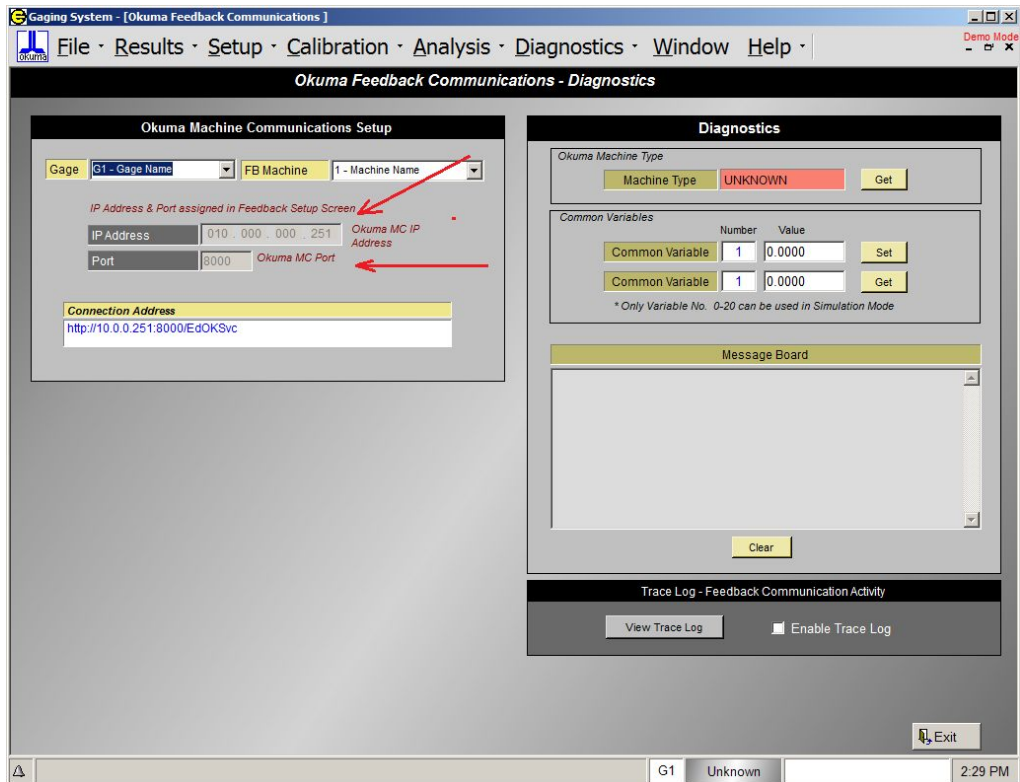
5.3.2. Initial Setup and Establishing Communications:

System/Software Requirements:

- Edmunds EPIC CAG™ with Okuma Thinc feedback option.
- Okuma P200/P300 control
- Okuma Thinc API drivers installed on Okuma controller
- Edmunds-Okuma Server application installed on Okuma controller.

1. Install the Edmunds-Okuma Server application on the Okuma controller. See **(Section 3.3.4 below)** for the Edmunds-Okuma Server setup instructions.
2. Determine/Report the IP Address, Port of the Okuma controller.
3. Set the IP Address of the EPIC CAG unit. The IP Address of the CAG™ unit will need to be compatible with the Okuma controller (first three sets of numbers in the addresses need to match) Example: Okuma controller IP Address: 192.168.100.220, CAG unit IP Address: 192.168.100.221. See **(APPENDIX B)** for instructions on setting the CAG IP Address.
4. Test the communications:
 - a) Enter menu “Setup” – “Feedback Setup” in the EPIC software.
 - b) Enter the Okuma IP Address and Port number. Select SAVE.
 - c) Enter menu “Diagnostics” – “Okuma Feedback Diagnostics” in the EPIC Software.
 - d) Click on the “Get” button in the “Okuma Machine Type” box. Machine Type should display “Lathe” or “Machine Center”.
 - e) Test Set/Get of data to the controller common variables. In the “Common Variables” box, enter common variable number and value to write. Click on “Set” button. Read back that value by entering the common variable number and click on the “Get” button.





5.3.3. Okuma Thinc Feedback Setup In EPIC Software:

Okuma Common Variable Usage:

Offset Data Avail: Common variable number associated with common variable on Okuma controller. A non-zero value will be written to this common variable when offset data is available. The Okuma control will read this common variable, if the value is non-zero, the offset data will be read and applied. The common variable value will then be set to zero by the Okuma control.

Reset Feedback: Common variable number associated with common variable on Okuma controller. A non-zero value will be written to this common variable when offset data is available. Okuma control will read this common variable, if the value is non-zero, the offset data will be read and applied. The common variable value will then be set to zero by the Okuma control.

FB Mode: Common variable number associated with common variable on Okuma controller. The Feedback Mode (Startup or Run) will be written to this common variable when feedback data is available.

Run Mode = 1
 Start-up Mode = 2
 If the common variable is set to "0", the mode will not be written.

Part Status: Common variable number associated with common variable on Okuma controller. The Part Status will be written to this common variable when feedback data is available.
 Unknown = 0

Accept = 1
Reject = 2
Flyer = 3

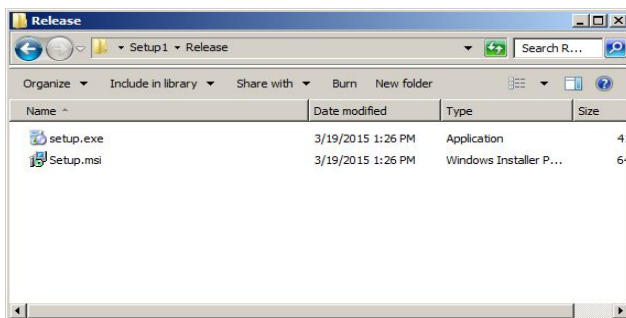
If the common variable is set to "0", the Status will not be written.

Offset Tag: Common variable number associated with common variable on Okuma controller. The calculated feedback offset value will be written to this common variable. The value in the common variable will be used to adjust the tooling offset in the machine.

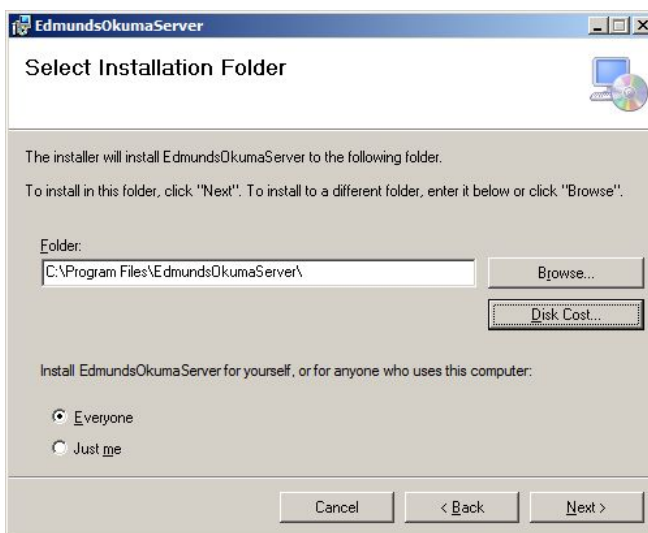
Reset Offset Data: Common variable number associated with common variable on Okuma controller. The value of this common variable will be read, if it is non-zero offset sample data will be reset. If the common variable number is set to "0", the common variable will not be read (reset function disabled).

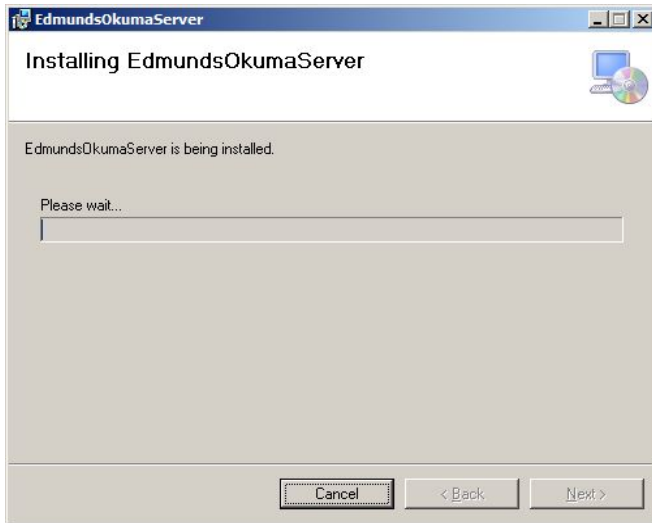
5.3.4. Edmunds-Okuma Server setup Instructions .

1. Installation of the Edmunds-Okuma Server application on the Okuma Controller (P200/P300).
 - a. Run the Setup.exe

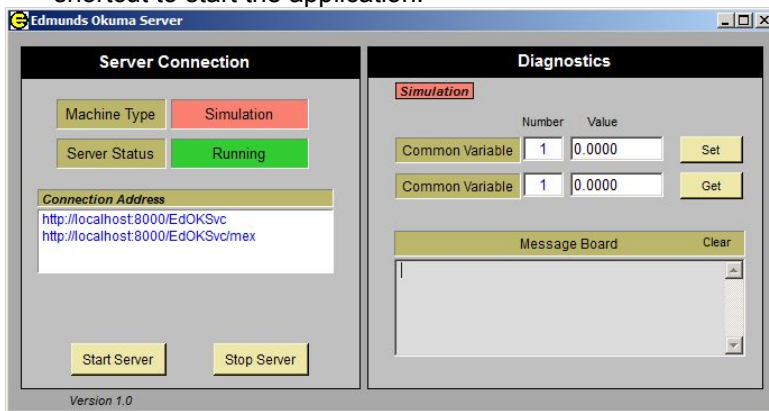


- b. Follow install prompted instructions





- c. After setup is complete an icon will be located on desktop, “Edmund-Okuma Server”. Click on shortcut to start the application.



- d. Insure the “Server Status” is “Running”. The application can be minimized to the status bar.



The server application will need to remain open and server “Running” to allow feedback communication from the Edmunds EPIC CAG.

5.3.5. Example Macro Program for Reading Feedback Offsets.

Note: this program should be used for reference only, actual variable number will differ.

Common Variable numbers used in the following example program:

Data Available: V100

Offset #1: V1

Offset #2: V2

Offset #3: V3

Offset #4: V4

Offset #5: V5

Offset #6: V6

Reset Feedback: V101

```
-----
OGAGE (OKUMA EDMUNDS GAGE VARIABLE ADJUSTMENT)
(*** VARIABLES ***)
(V100 = NEW DATA AVAILABLE 0/1)
(V101 = RESET FEEDBACK 0/1)
(VTWOX[**] = TOOL WEAR OFFSET X)
(VTWOZ[**] = TOOL WEAR OFFSET Z)
(V1 = EDMUNDS GAGE FEED BACK X TOOL 1)
(V2 = EDMUNDS GAGE FEED BACK Z TOOL 1)
(V3 = EDMUNDS GAGE FEED BACK X TOOL 2)
(V4 = EDMUNDS GAGE FEED BACK Z TOOL 2)
(V5 = EDMUNDS GAGE FEED BACK X TOOL 3)
(V6 = EDMUNDS GAGE FEED BACK Z TOOL 3)

(*** SYSTEM CHECKS ***)
IF [VMLCK EQ 1] NRTS      (CHECK IF MACHINE LOCK IS ACTIVE)
IF [VRSTT EQ 128] NRTS   (CHECK IF SEQUENCE RESTART IS ACTIVE)
IF [V100 EQ 0] NCK1      (CHECK FOR NEW DATA)
GOTO NSET

NSET (*** PERFORM ADJUSTMENTS ***)

(*** TOOL OFFSET 1 ***)
VTWOX[1]=VTWOX[1]+V1 (X AXIS ADJUSTMENT)
VTWOZ[1]=VTWOZ[1]+V2 (Z AXIS ADJUSTMENT)
()
(*** TOOL OFFSET 2 ***)
VTWOX[2]=VTWOX[2]+V3 (X AXIS ADJUSTMENT)
VTWOZ[2]=VTWOZ[2]+V4 (Z AXIS ADJUSTMENT)
()
(*** TOOL OFFSET 3 ***)
VTWOX[3]=VTWOX[3]+V5 (X AXIS ADJUSTMENT)
VTWOZ[3]=VTWOZ[3]+V6 (Z AXIS ADJUSTMENT)
()
V100=0 (RESET DATA FLAG)
(*** RESET GAGE VARIABLES ***)
```

```

V1=0
V2=0
V3=0
V4=0
V5=0
V6=0
GOTO NRTS (GOTO END OF ROUTINE)

NCK1 (CHECK FOR NEW TOOL FLAG)
V101=1 (SET RESET DATA FLAG)

CNT=20 (NUMBER OF TOOL GROUPS)
CTR=1 (COUNTER FOR FIRST TOOL GROUP)

NLOOP (PARSE THROUGH TOOL GROUPS)
IF [VTLCN[CTR] EQ 0] NRST (CHECK NUMBER OF MACHINED WORK PIECES)
M331 (BUFFER PROHIBIT)
IF [[CTR+1] GT CNT] NRTS (CHECK FOR LOOP OVERSHOOT)
(ELSE)
CTR=CTR+1 (INCREMENT THE COUNTER)
GOTO NLOOP (GOTO LOOP)

NRST (RESET TOOL GAGE DATA)
V101=1 (SET RESET DATA FLAG)
(*** RESET GAGE VARIABLES ***)
V1=0
V2=0
V3=0
V4=0
V5=0
V6=0

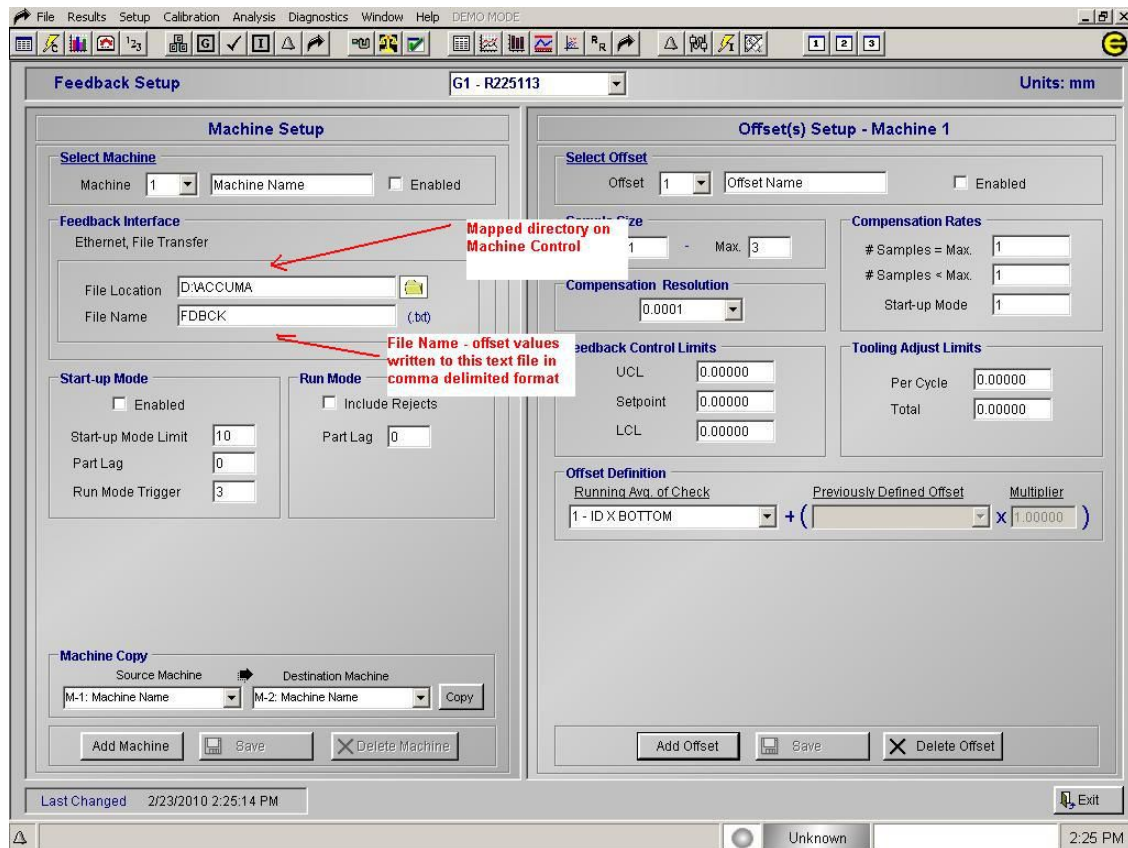
NRTS RTS (END OF SUB ROUTINE)

```


5.4. EPIC Feedback – Ethernet File Transfer (EFT)

EPIC Software Feedback Setup Screen:

Feedback offsets are written to a file in a mapped directory on the machine control or network computer. If the file does not exist, the file will be created and the offset record will be written to the file. If the file exists the offset record will be appended to the file.



File Format

Ethernet File Transfer format

Feedback offset records will be offloaded to a comma delimited text file on a mapped network drive. If the file does not exist, the file will be created and the offset record will be written to the file. If the file exists the offset record will be appended to the file.

Record Format:

Offset1,Offset2,Offset3,... <CR><LF>

Example:

0.00012,-0.00015,0.00038

5.5. EPIC Standard Serial Feedback (RS232)

Overview:

The following is a description of the serial data offload protocol between an Edmunds EPIC CAG system and a Machine Tool.

The data offload will be a solicited serial data transfer from the CAG to the Machine Tool over an RS-232 serial port. RS-232 control lines are not used in this protocol. The only lines that will be utilized are: TXD, RXD, Signal Ground and the Shield. Baud, parity, stop bits and bits per character are all programmable values in the EPIC system in the Serial Port Setup screen.

The calculated compensation data are referred to as part offsets, is sent to the Machine Tool by request. The Machine Tool will request the data from the CAG by transmitting a DC1 (11H) character to the CAG. The CAG will respond with the data.

The Machine Tool will respond with a DC3 (13H) character if the data was received successfully. If the data was not received successfully the cell controller will re-transmit the DC1 (11H) character. If the CAG does not receive the DC3 (13H) character within 5 seconds of receiving the DC1 (11H) character, a communication error message will be displayed on the CAG screen.

The CAG will reset the offset data when it receives the DC3 (13H) character.

Data Packet:

The data packet offloaded will contain the packet length, part status, number of offsets, and offset results. A detailed description of the packet follows:

Field #	Description	Length
1	STX	1
2	packet length	3
3	part status	1
4	# of offsets	2
5	offset #1 result	10
6	offset #2 result	10
7	ETX	1
8	bcc	1

STX – The start of text character, 02 Hex, or simply 02H, signifies the beginning of the packet.

Packet Length – The length is a three byte ASCII field representing the number of bytes in the packet from the first byte, the STX, to the last byte, the bcc, inclusive. For example, if there are 50 bytes from STX to the bcc, then the packet length is 30H, 35H, 30H.

Part status – A single byte representing the status of the part measured. There are three possible values for the part status:

Hex Value	ASCII	Status
47H	“G”	Good, Accept
42H	“B”	Bad, Reject
52H	“R”	Rework

of offsets – A two byte field representing the number of check results to be offloaded. The valid range for this field is 1 (30H, 31H) to 16 (31H, 36H)

Offset #1 data – The actual check result, in ASCII, for Check number 1. The offset result is a ten byte field containing the sign, Check value with decimal point, and padded with spaces, if necessary, to the right to fill the ten byte field.

For example, if the offset result is –0.12345, then the ten byte field would contain the following bytes:

Byte #	Hex Value	ASCII
1	2DH	"_"
2	30H	"0"
3	2EH	"."
4	31H	"1"
5	32H	"2"
6	33H	"3"
7	34H	"4"
8	35H	"5"
9	20H	" "
10	20H	" "

Offset #n data – Check number n's result, in the same ten byte field format as described under "offset #1 data" above. Each offset result is sent in this same format.

ETX – End of text character, 03H, signifies the end of the packet, with only the bcc to follow.

bcc – Exclusive OR of all bytes in packet from the packet length to ETX, inclusive.

Example:

The following is an example of a typical automatic measurement cycle and data transmission. Assume the data transmission is from the CAG with the following data:

Part Status = REJECT
 # of Offsets = 2
 Offset #1 = +0.011
 Offset #2 = -0.005

The offsets are calculated by the CAG with the following conditions:

Offset #	Units	Comp Resolution
1	mm.	0.001
2	mm.	0.001

The packet length is calculated with the following formula:

$$\begin{aligned}
 \text{Packet length} &= (\text{\#offsets} \times 10) + 9 \\
 &= (2 \times 10) + 9 \\
 &= 29 \text{ decimal}
 \end{aligned}$$

The Machine Tool solicits the measurement data from the CAG by sending the following byte:

Byte #	Hex value	ACSII	Description
1	10H	DC1	

The response sent by the CAG to the Machine Tool consists of the following packet:

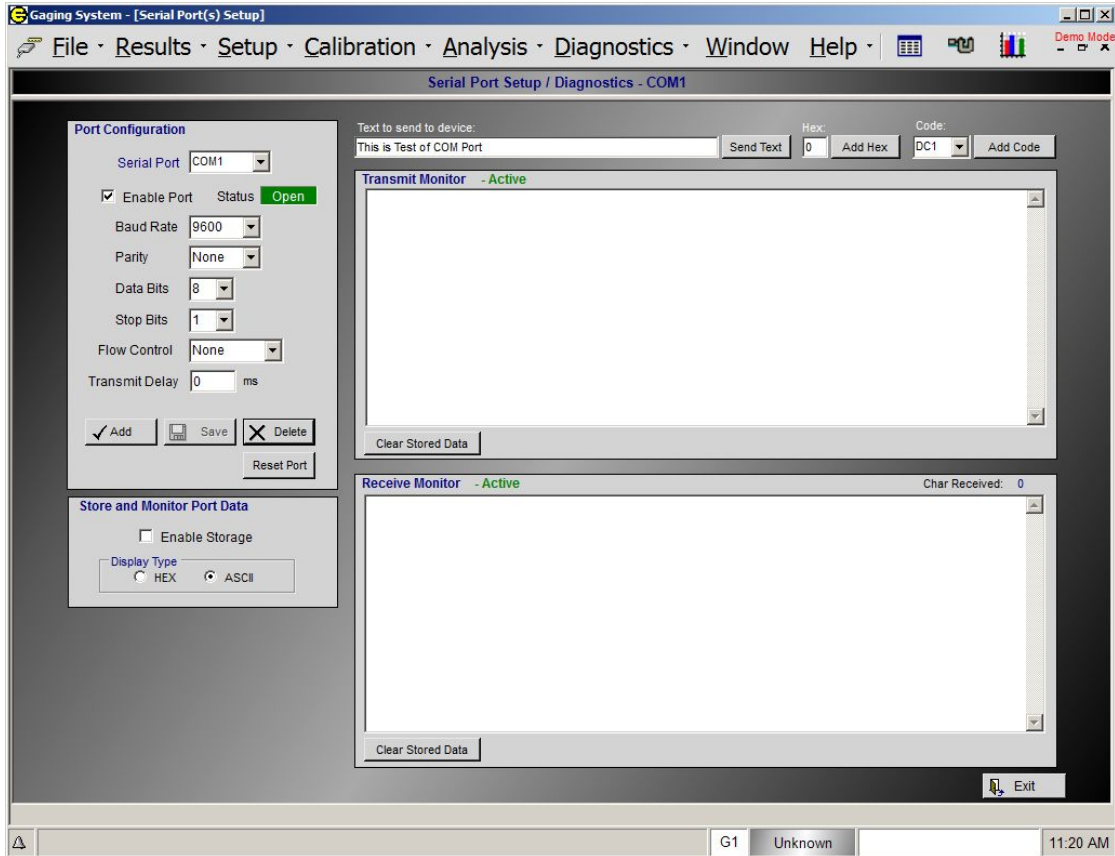
Byte #	Hex value	ACSII	Description
1	02H		STX, Start of Text
2	30H	"0"	Packet length (100)
3	32H	"2"	Packet length (10)
4	39H	"9"	Packet length (1)
5	42H	"B"	Bad, Reject part
6	30H	"0"	Number of offsets (10)
7	32H	"2"	Number of offsets (1)
8	2BH	"+"	--+
9	30H	"0"	
10	2EH	"."	
11	30H	"0"	
12	31H	"1"	+-(
13	31H	"1"	
14	20H	" "	
15	20H	" "	
16	20H	" "	
17	20H	" "	--+
18	2DH	"_"	--+
19	30H	"0"	
20	2EH	"."	
21	30H	"0"	
22	30H	"0"	+-(
23	35H	"5"	
24	20H	" "	
25	20H	" "	
26	20H	" "	
27	20H	" "	--+
28	03H		EXT, End of Text
29	7Eh		bcc

Assuming the packet was received successfully by the Machine Tool, the response by the Machine Tool to the Edmunds CAG consists of the following byte:

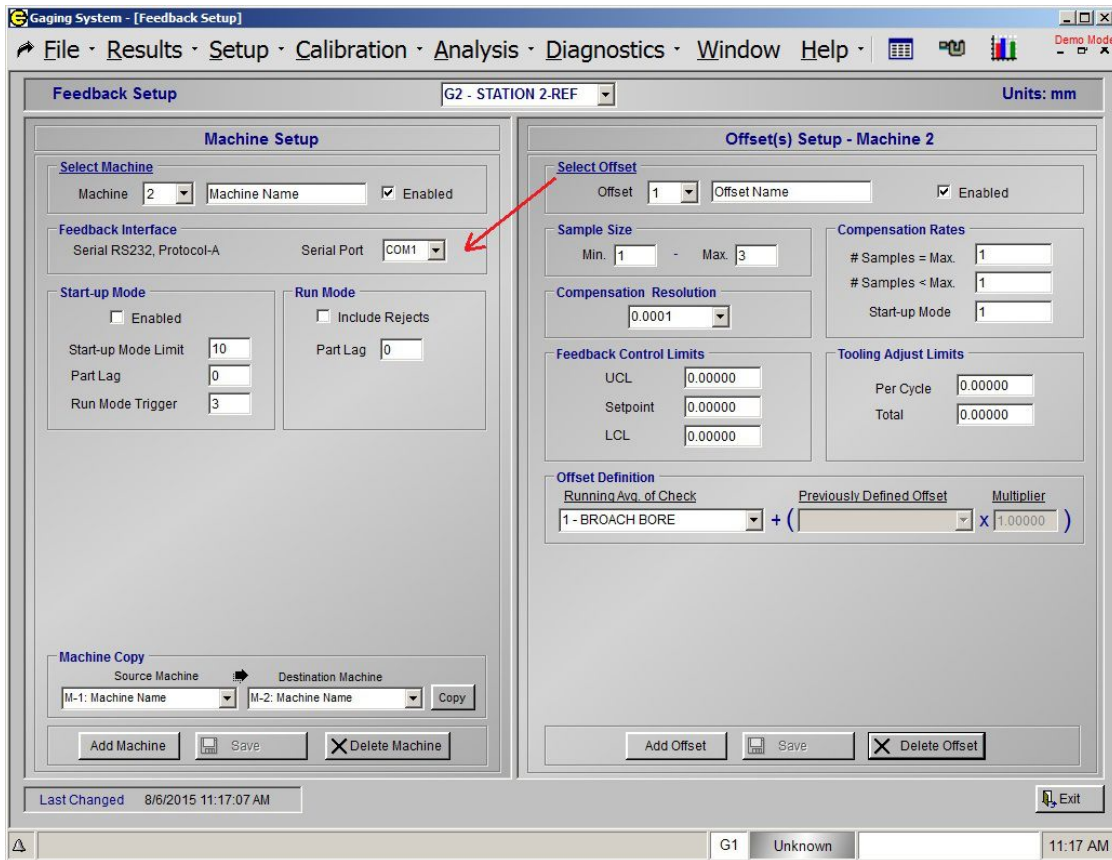
Byte #	Hex value	ACSII	Description
1	13H	DC3	

EPIC Software Setup for Serial Feedback:

The EPIC CAG serial port needs to be enabled and configured to interface with the Machine Tool. The serial port baud rate, parity, stop bits and bits per character are all programmable values in the EPIC system in the Serial Port Setup screen.



The serial port used to communicate with the Machine Tool is selected in the Feedback Setup screen (see below).



6. SECTION: Temperature Compensation

6.1. Temperature Compensation Overview

The calibration of a gage and the measurement of parts have many factors that affect system accuracy. One of the most important factors to be considered is temperature. Under optimum conditions, the Gage would be calibrated and parts measured at 68° Fahrenheit. Reality dictates that gages operate under “shop floor” conditions and parts are measured during various stages of the manufacturing cycle.

The EPIC CAG™ has the capability to provide temperature compensation for gage calibration and part measurement. This permits gage mastering and measurement of parts when they exit a machine tool or other external process, regardless of the process temperature. An offset is computed by the EPIC CAG™ based upon the part temperature, master temperature, tooling temperature and predefined coefficients of expansion for each component. This offset is then added to the parts gaged readings and the corrected part size is displayed.

The amount of offset is dependent upon a range of factors – part material, master material, part thickness etc. In order to provide the proper coefficient of expansion for each, a temperature compensation study is performed on each component: part, master and tooling. Once the study is completed, the coefficients of expansion for each component are stored in the EPIC CAG™ and retrieved as needed.

The actual formula for temperature compensation is:

(Initial gaged readings) + (tooling compensation) + (part compensation) + (master compensation) = Compensated gaged readings.

The part checks that require compensation are selectable in the EPIC software program. Each part Check that is to receive temperature compensation is associated with a temperature probe set. A probe set consists of two (2) input channels. One input channel is utilized to measure the part temperature while the other measures the tooling temperature.

In operation, the operator would master the gage utilizing the calibrated masters. A correction offset for each applicable Check is computed by the EPIC to compensate for any variations in the master’s size due to temperature. The offset is based upon the master temperature, tooling temperature and the predefined coefficients of expansion for the master and tooling.

Master Offset = [Coeff_{master} x (temp_{master} – 68°)] + [Coeff_{tool} x (temp_{tool} – 68°)]

The temperature compensation master offsets will be applied during normal gaging in the same manner as the Mag and Zero offsets are applied.

During gage operation, the part would be measured in the normal gage cycle. . A correction offset for each applicable Check is computed by the EPIC for temperature compensation. The offsets are based upon the part temperature, tooling temperature and the predefined coefficients of expansion for the part and tooling.

Part Offset = [Coeff_{part} x (temp_{part} – 68°)] + [Coeff_{tool} x (temp_{tool} – 68°)]

The temperature compensation part offsets will be applied during normal gaging in the same manner as the Mag and Zero offsets are applied.

The corrected final gage readings would be displayed and part status would be determined based on the corrected readings.

6.2. Steps to Setting up the EPIC CAG™ Temperature Compensation .

1. Setup the means of acquiring part and tooling temperatures (Temperature Probe Setup screen)
 - a. Select number of probe sets. A typical probe set will be (1) probe for part and (1) probe for tooling.
 - b. Name probe sets as desired menu (see Section 1.3.9 Temp. Probe Setup)
 - c. The probe sets will have to be assigned input channels. The input channel is the input on the temperature amplifier card that the temperature probe will be plugged into (see Section 1.3.9 Temp. Probe Setup).
 - d. The probe sensors allow for entering input channel dead band. The dead band allows the CAG™ to determine if the temperature probe has failed. The dead band is 99.5 – 100.5 degrees Fahrenheit. If your measuring environment is in this area you will want to set the dead band to 0.0 degrees (see Section 1.3.9 Temp. Probe Setup).
 - e. The probe sensors allow for entering temperature settle time (see Section 1.3.9 Temp. Probe Setup)
2. Enable the type of temperature compensation. The manner in which the gage is to be operated is designated in this menu. There are (3) types of temperature compensation. Gage mastering automatically selects the proper compensation type during the master cycle (see Section 1.3.9 Temp. Probe Setup).
 - a. Part – This selection should be utilized whenever temperature compensation is desired during gage operation or when performing an R & R study on parts.
 - b. Master As Part - This selection should be utilized whenever an R & R study is performed on masters only or need to add the correct compensation to the master when measuring it as a part.
 - c. Disabled - This selection disables temperature compensation.
3. Assign the probe sets to Checks. For a part Check to receive temperature compensation a probe set has to be assigned (see Section 1.3.9) .

At this point the system will be setup for temperature compensation given that a temperature compensation study has been performed and the coefficients of expansion have been determined and entered in the system (see following for temperature compensation study).

6.3. Manual Temperature Composition Study

Use the following procedure to calculate the values of the master, part, and tooling coefficients that can be entered in menu “Check Setup -Temperature Compensation”

Begin by determining the coefficient for the Max Master.



NOTE: While performing the temperature study for the master or part the tooling must be maintained at a constant temperature.

Use the following procedure to determine the coefficient for the Max master and then repeat the procedure for a sample part.

- 1) Disable all temperature compensation in menu: Setup - Temp. Probe Setup.
- 2) Measure the Max master in the gage, with the master and tooling at ambient, and record gaged size readings for all temperature compensated checks as well as master and tooling temperatures.
- 3) Heat the Max master to a temperature of approximately 100 – 105 °F.
- 4) Record the master temperature outside of the gage. Put the master into the gage and run a measurement cycle. Remove the master from the gage. Select menu: “Results” and record gaged size readings for all temperature compensated Checks as well as master and tooling temperatures.
- 5) Perform the procedure a few times as the temperature of the master decreases in approximately 5 degree increments.
- 6) Calculate the individual Master coefficient by dividing the change in size by the change in temperature of the master from the ambient readings to the reading of the heated part. $(\text{Ambient Size} - \text{Heated Size}) / (\text{Ambient Temp} - \text{Heated Temp})$ for each check.
- 7) Calculate the Average Master Coefficient for each Check.
- 8) Enter the Average Master Coefficient for each compensated check in the appropriate location in menu “Check Setup -Temperature Compensation”.

Use the following procedure to determine the coefficient for the tooling.



NOTE: While performing the temperature study for the tooling the master must be maintained at a constant temperature.

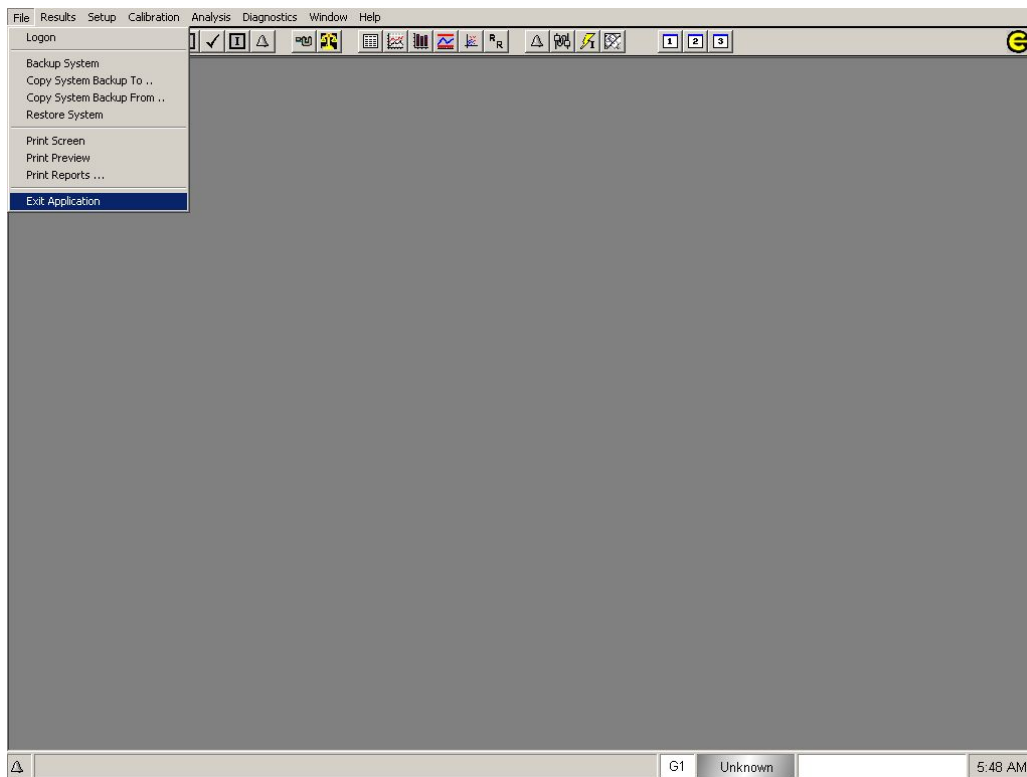
- 3) Enable all temperature compensation in menu Setup - Temp. Probe Setup. Select “Master As Part”.
- 2) Measure the Max master in the gage, with the master and tooling at ambient, and record gaged size readings as well as master and tooling temperatures.
- 3) Heat the tooling to a temperature of approximately 90 – 95 °F.
- 4) Record the master temperature outside of the gage. Put the master into the gage and run a measurement cycle. Remove the master from the gage. Select menu “Results” and record gaged size readings for all temperature compensated checks as well as master and tooling temperatures.
- 5) Perform the procedure a few times as the temperature of the tooling decreases in approximately 5 degree increments.
- 9) Calculate the Tooling coefficient by dividing the change in size by the change in temperature of the tooling from the ambient readings to the reading of the heated tooling $(\text{Ambient Size} - \text{Heated Size}) / (\text{Ambient Temp} - \text{Heated Temp})$ for each check.
- 10) Enter the coefficient in the appropriate location in menu “Check Setup -Temperature Compensation”.
- 11) Master the gage with all components at ambient.

- 12) Heat the Max Master and do a gage R&R as the master cools down. This will show how the gage repeats with varying temperatures. If the gage R & R is acceptable then the Master coefficient is good.
- 13) Repeat the process but heating the tooling and keeping the master the same temperature. Do a Gage R&R and if the R%R is acceptable then the tooling coefficient is good.
- 14) Enable the temperature compensation in menu Setup - Temp. Probe Setup and select "Part".
- 15) Heat the part up and do a Gage R & R as the part cools down. If the R & R is acceptable than the part coefficient is good.

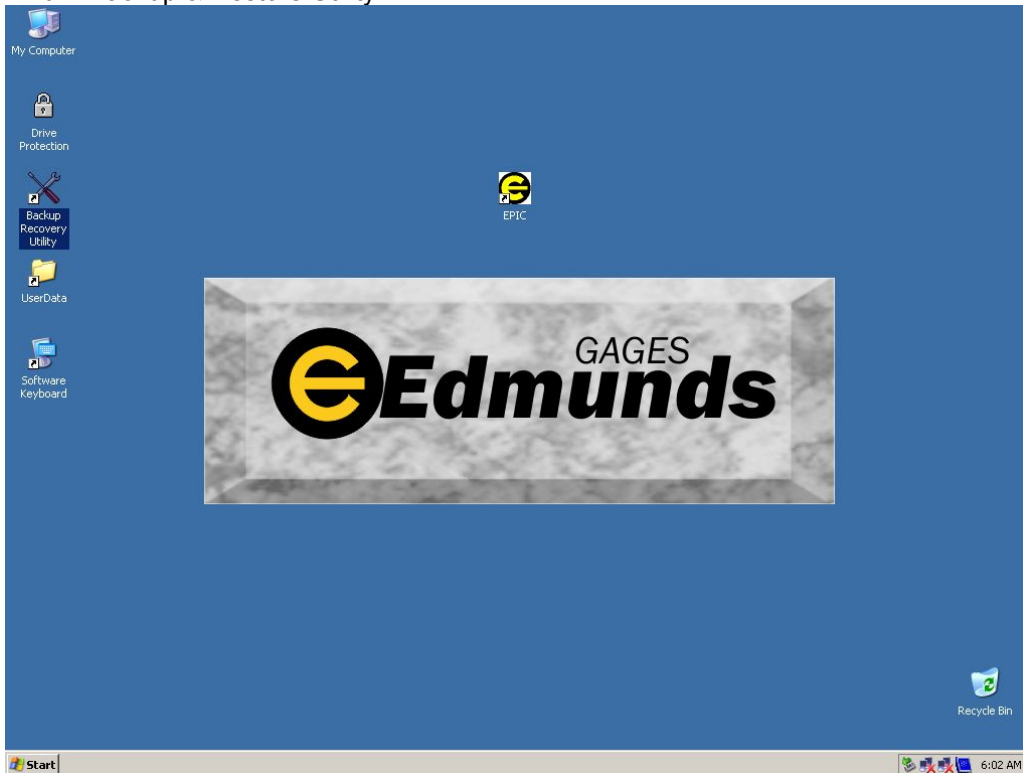
7. SECTION : Backup/Restore EPIC System

7.1. Backup EPIC System to USB Compact Flash Drive

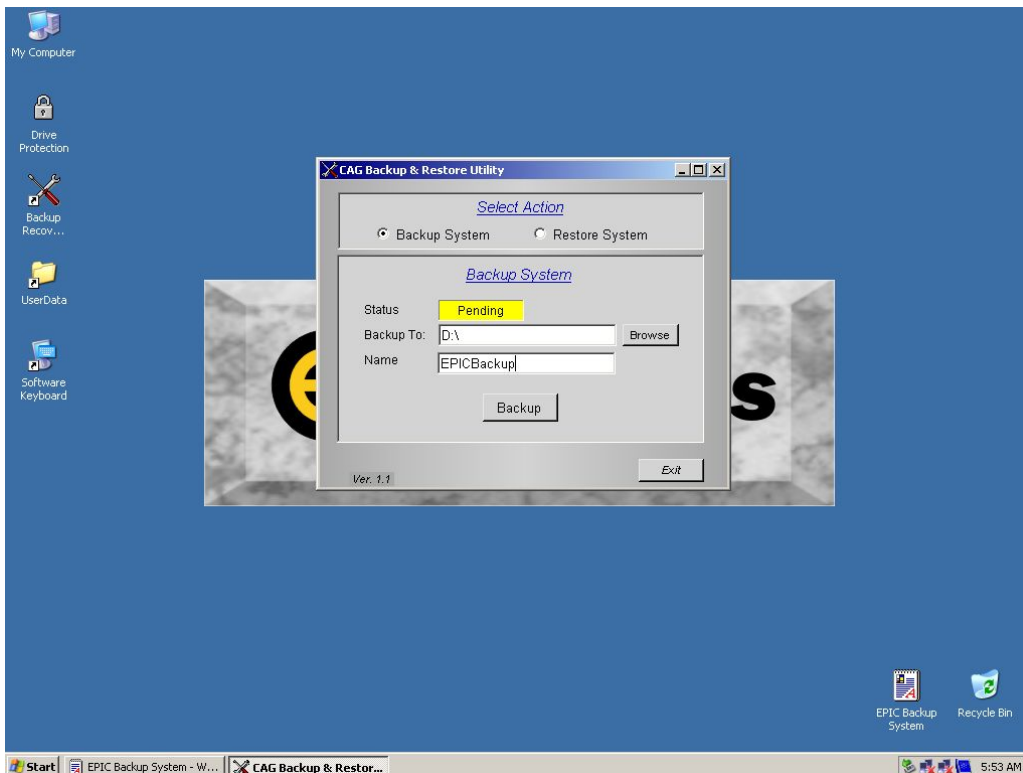
1. Insert USB Memory Stick into USB port on the side of CAG™ unit.
2. Exit EPIC application, menu “File” – “Exit Application”



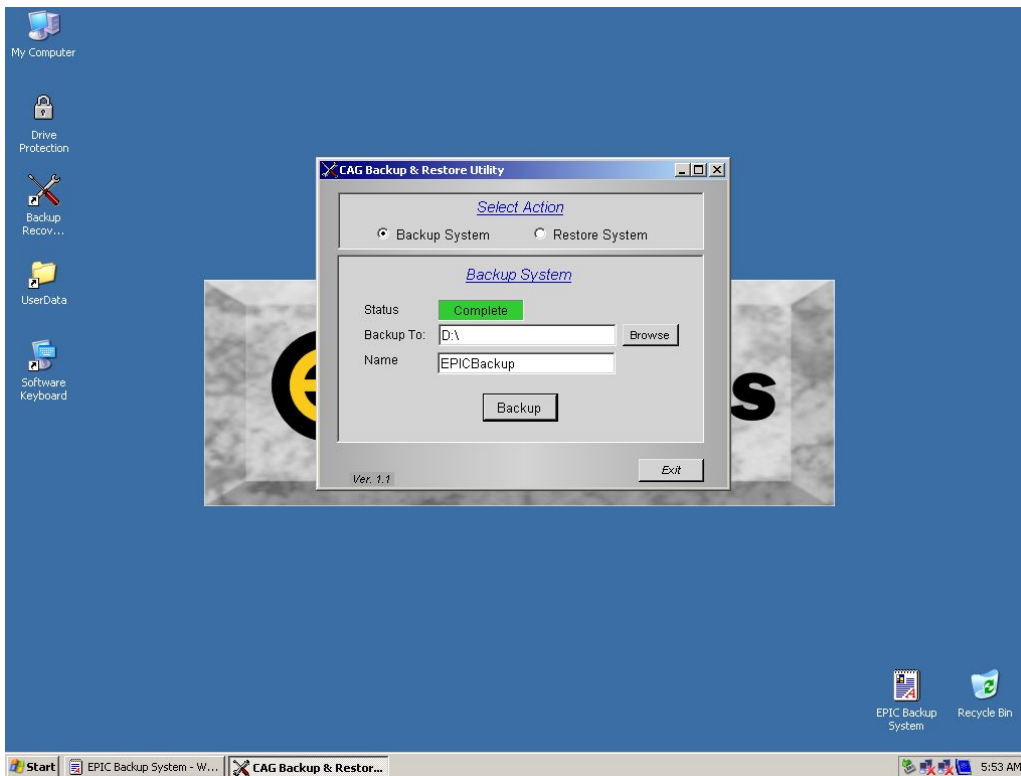
3. Run "Backup & Restore Utility".



4. Browse for or enter the drive letter of the USB memory stick in the "Backup To:" location.
5. Enter a name in the "Name" location. The EPIC system files will be copied to a folder with this name on the USB memory stick.

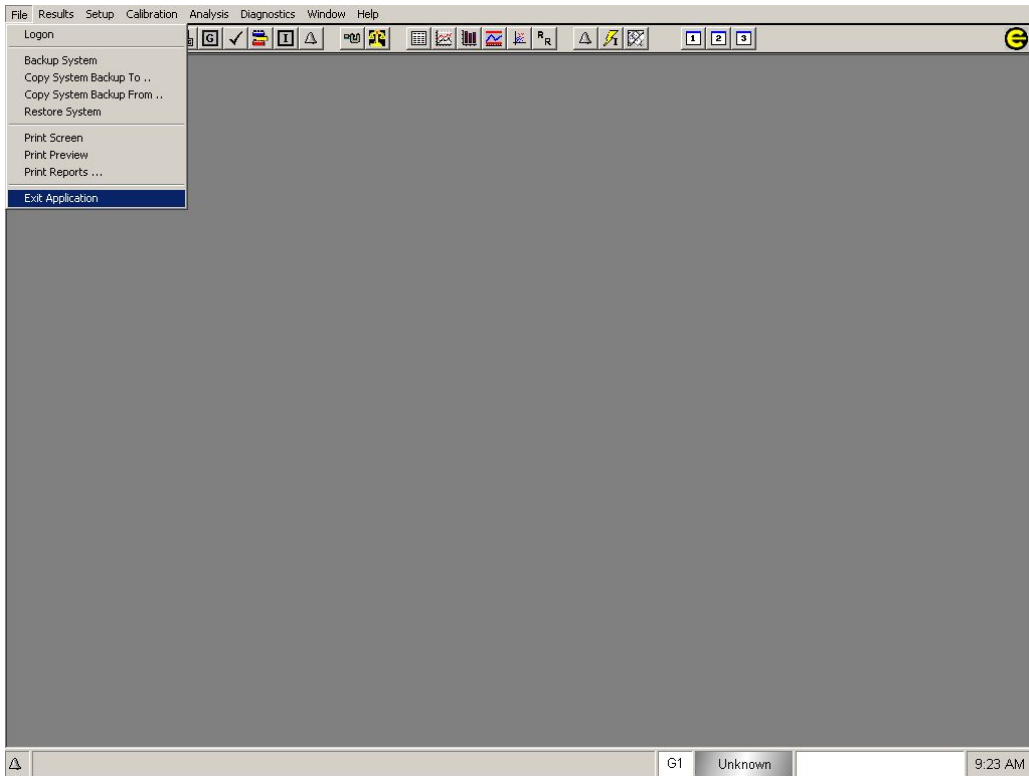


6. Select "Backup" and the EPIC system will be copied to USB memory stick.

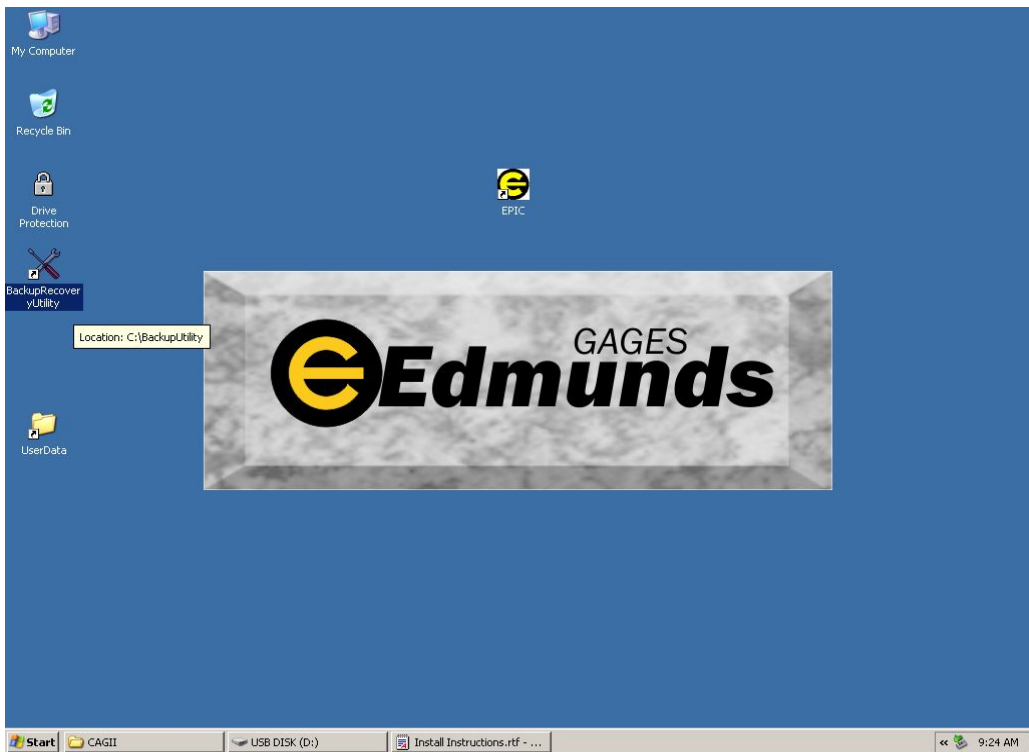


7.2. Restore EPIC system From USB Compact Flash Drive

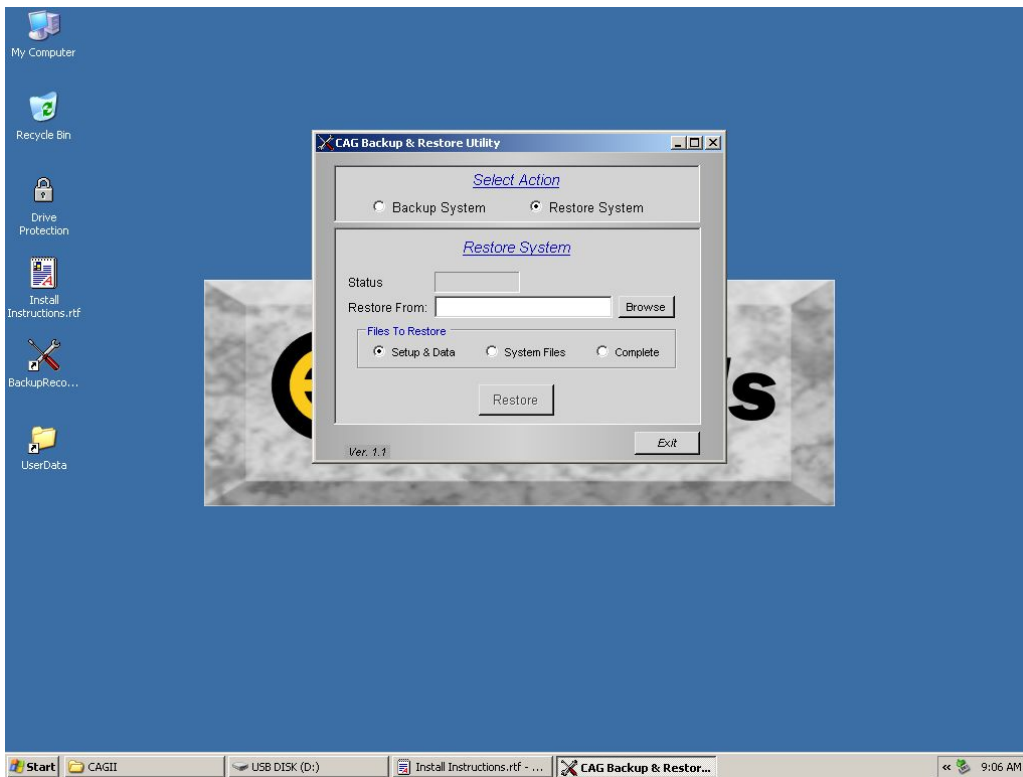
1. Exit EPIC application: menu "File" - "Exit Application"



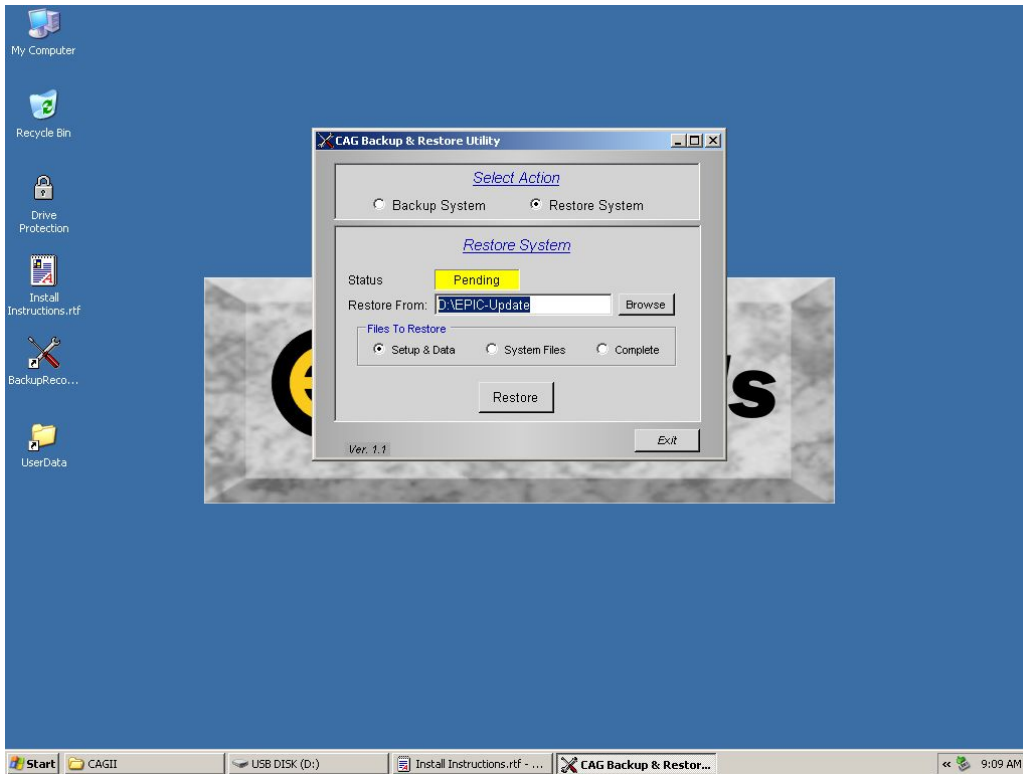
2. Insert USB flash drive into USB port.
3. Run "BackupRecoverUtility" - click on icon located on desktop.



4. Select "Restore System" under "Select Action"

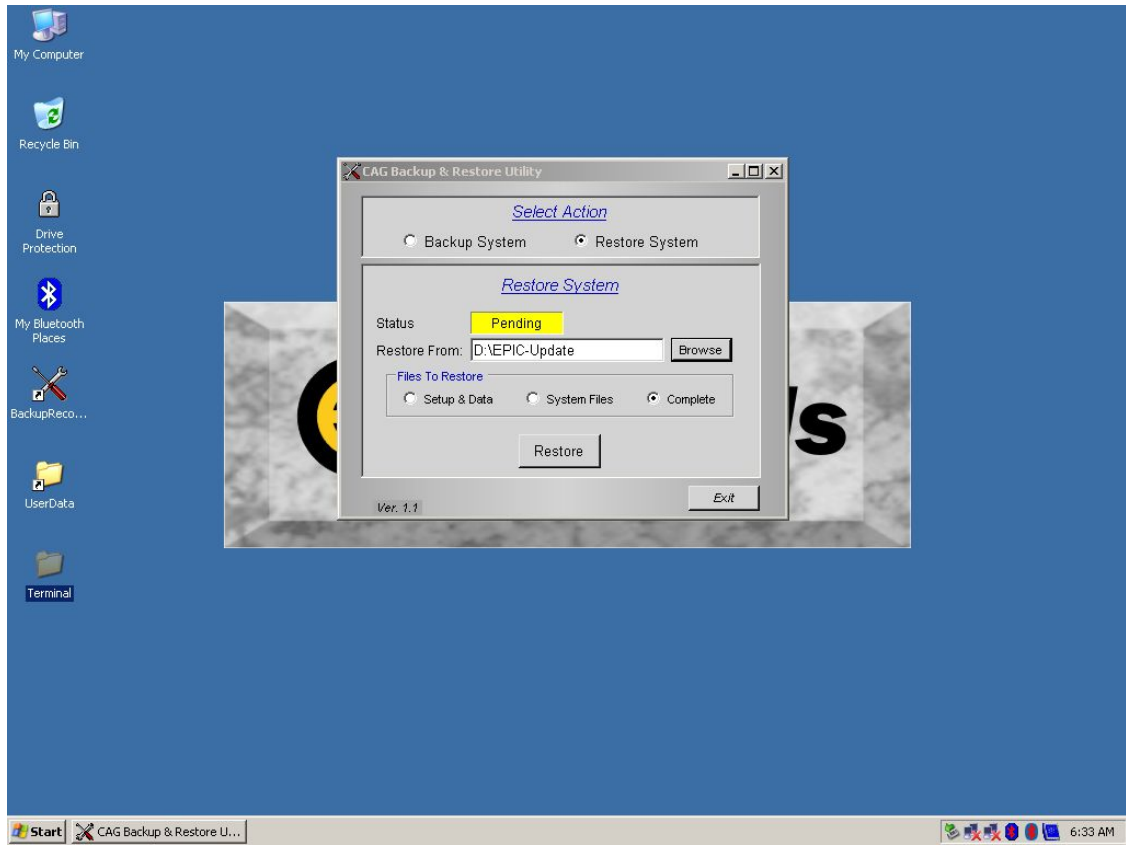


5. Enter the "Restore From" path by selecting "Browse" button and locate directory containing the backup on the USB flash drive. The path should be look something like this, "D:\EPIC-Backup"

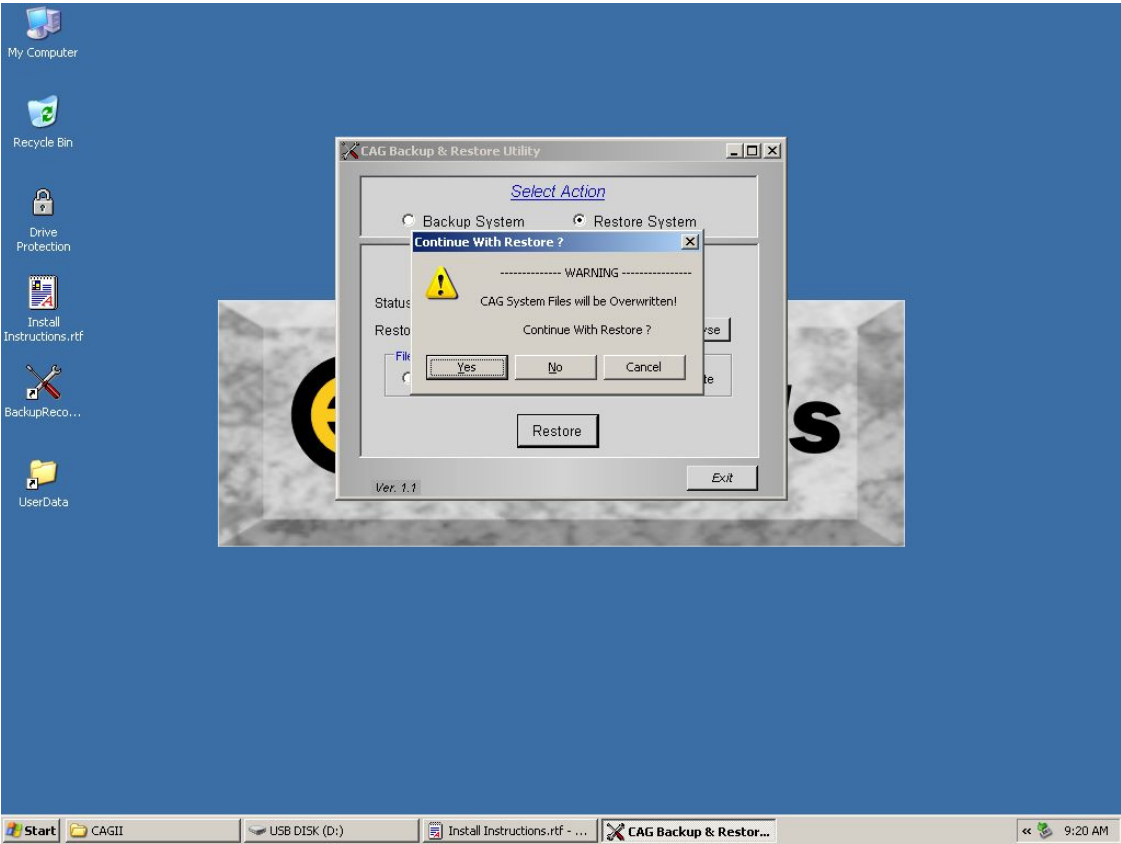


6. Select “Files To Restore”

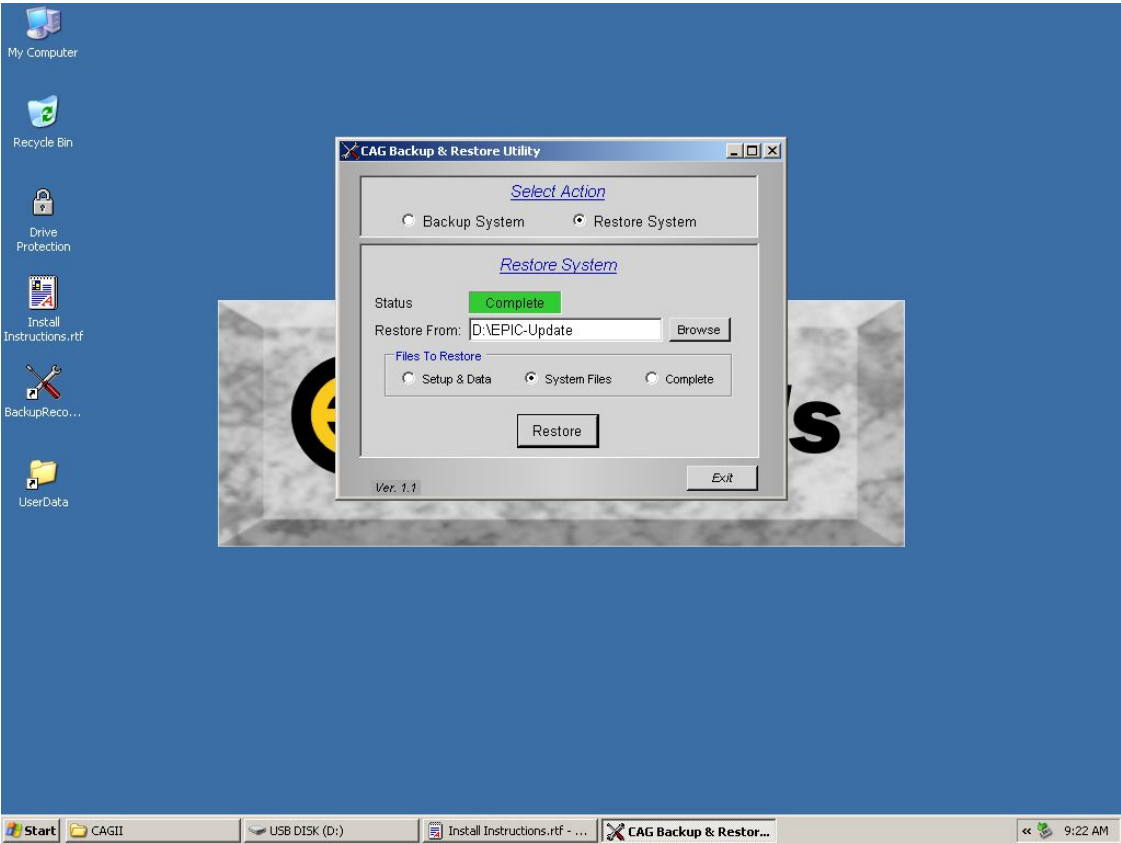
- a) Setup & Data - this will restore the Setup(s) and the measured data.
- b) System File - this will restore the system file only that run the applicaton, not the user entered Setup and measured data.
- c) Complete - this will restore the complete EPIC system including System File, Setup(s) and measured data.



7. Select the "Restore" button and select "Yes" to overwrite system files.

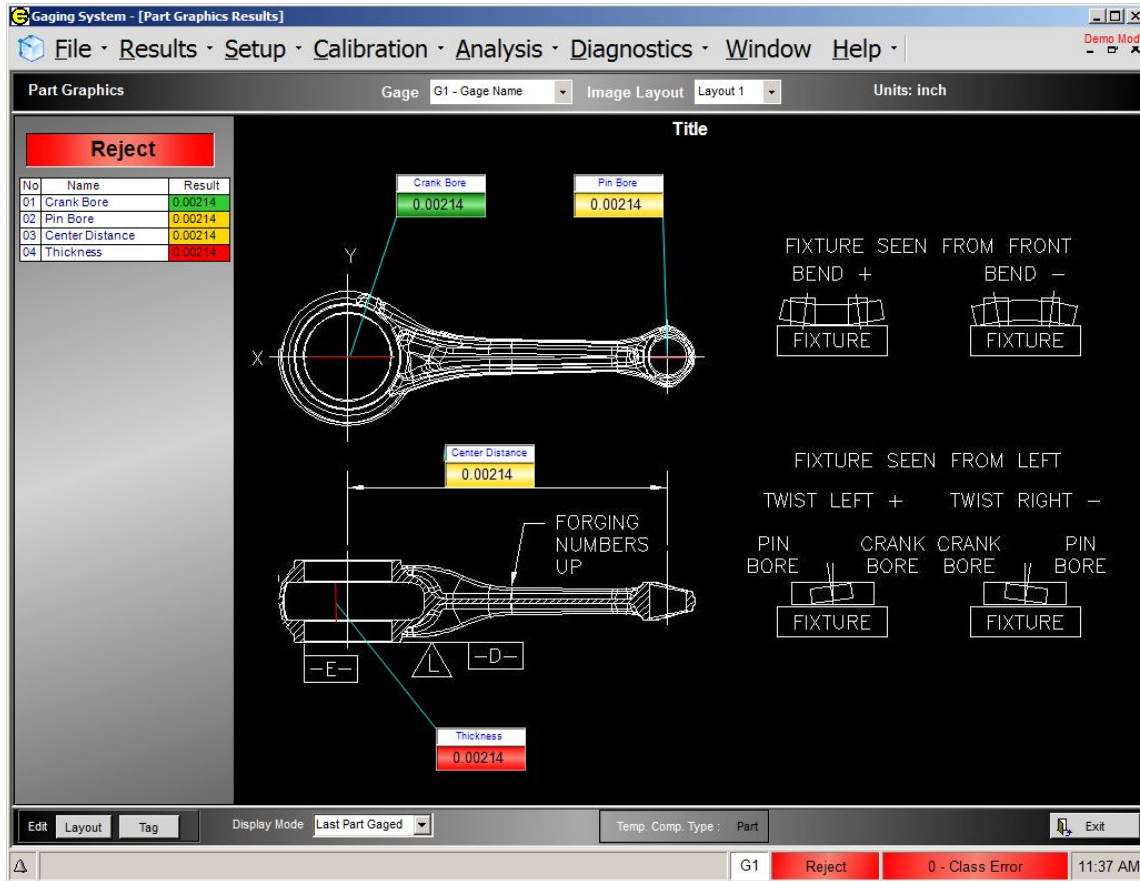


8. After restore "Complete", exit BackupRestoreUtility and start EPIC application.



8. SECTION: Part Graphics

The Part Graphics screen is a results screen that can be customized to display part graphics with live measurement results. A graphical image of the part and the features (Checks) being measured can be displayed.



Setting Up a Graphics Screen

1. Creating Image file.

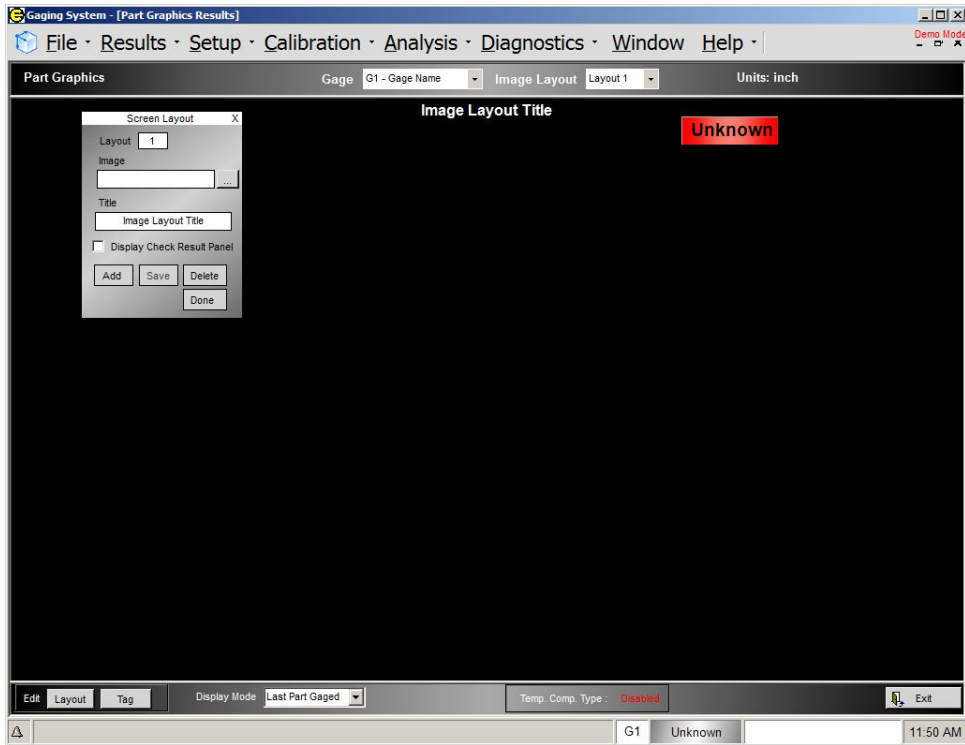
- Image Format - JPG image format.
- Size -
 - 1000 pixels x 620 pixels (if Result panel NOT displayed) .
 - 900 pixels x 620 (if Results panel displayed)
- Location on EPIC-CAG - The image file must reside in the following directory on EPIC system:
C:\Edmunds Gages\CAGSU\DataBases\PartGraphics

2. Create a Layout - The Layout contains everything used to display the custom graphics screen including the part graphics image, Check results Tags, Titles and Results panel options. Multiple layouts can be created for a give Gage Setup.

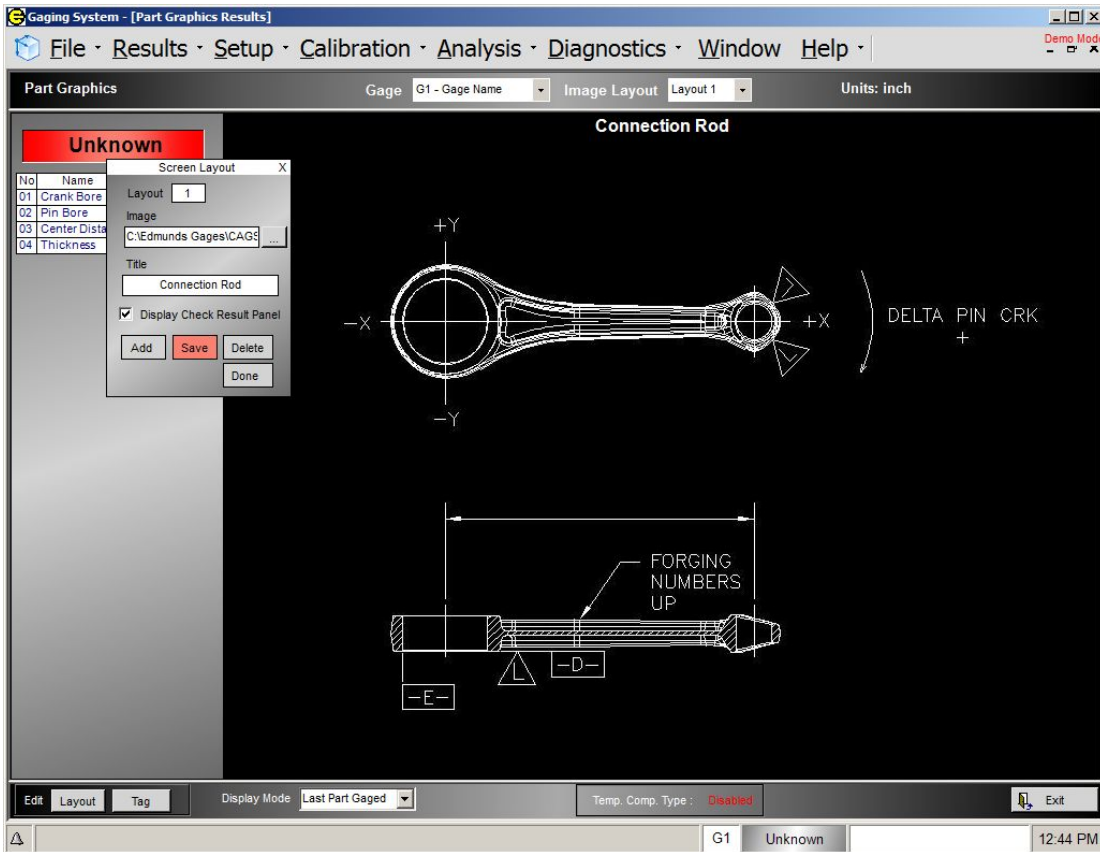
- Select the Layout button in bottom left corner.

- b) A “Screen Layout” edit box will appear. Using the edit box, an existing Layout can be modified or a new Layout can be added. Select the “Add” button to add a new Layout (see Figure 1). Note that each Layout is given a number.

Figure 1

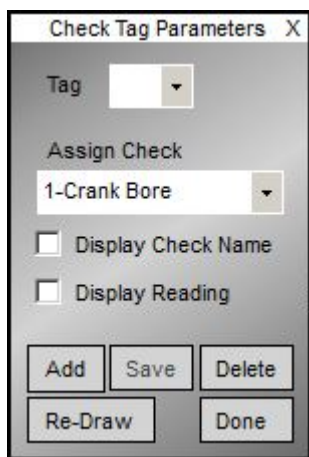


- c) Select the Image to be displayed by selecting the browse button next to the Image text box.
d) Enter a title for the Layout in the Title text box.
e) Select “Display Check Results Panel”. This will display all the features (Checks) setup in the system along with part status. The results will be updated at the completion of a measurement cycle.
f) Select Save and Done.



3. **Add Tags** - Tags are used to display Check results. Multiple Tag can be created for a Layout. Tag can be place anywhere on the image.

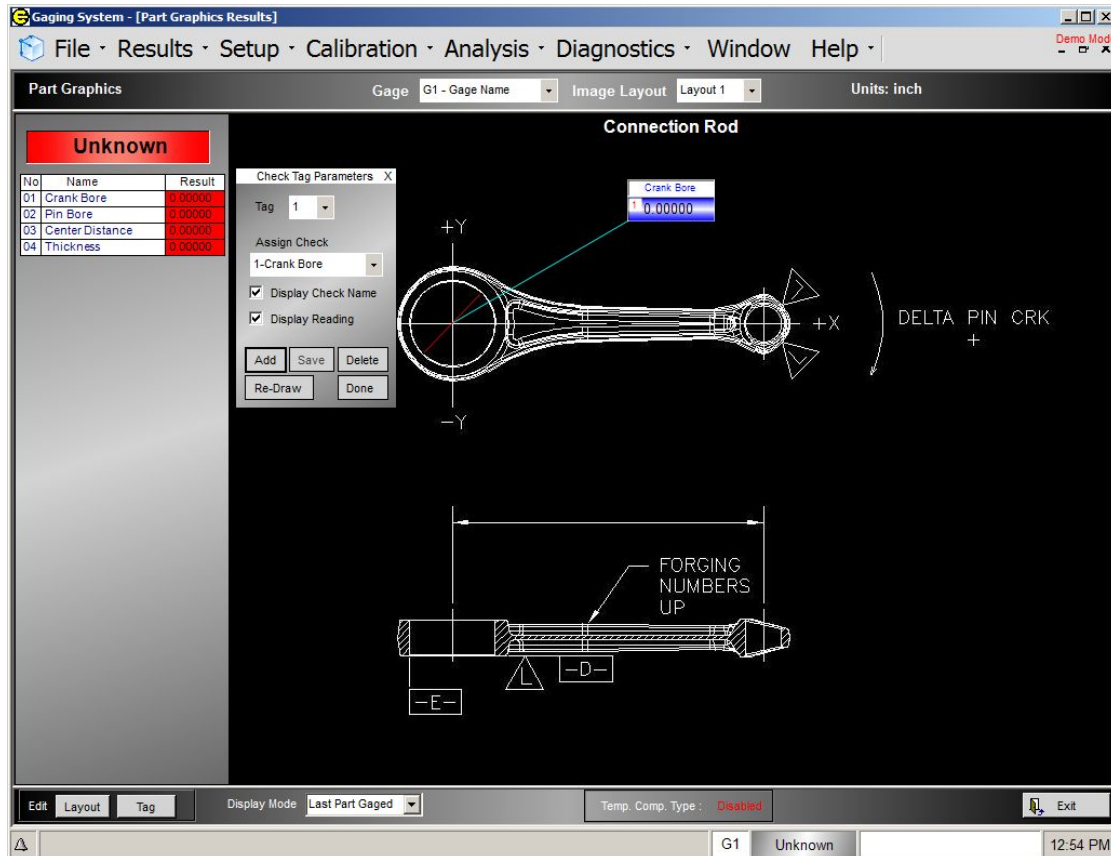
- a) Select the Tag button on the bottom left of the screen. A “Check Tag Parameters” edit box will appear. Using the edit box, an existing Tag can be modified or a new Tag can be added.



- b) Add Tag: Select the “Add” button to add a new Tag. When the “Add” button is selected a new Tag is added and the system is then in draw mode. In draw mode, the first thing that will be draw in a Red line used to indicate the dimension or location of measurement. To start drawing the Red dimension line,

position cursor at the start of the desired location and press and hold down the right mouse button. Then drag the mouse to the end location. When the mouse button is release, a Tag will automatically be displayed with a leader line to the middle of Red dimension line. Move the Tag by moving the mouse, click the right mouse button when the Tag is in the desired location.

- c) Assign Check: Select the "Assign Check" drop-down box to assign a Check to the added Tag.
- d) Display Check Name: To display the Check name as part of the Tag select the "Display Check Name" check-box.
- e) Display Reading: To display the Check result reading as part of the Tag select the "Display Check Name" check-box.
- f) Select "Save"
- g) Select "Done" to finish or "Add" to add another Tag.



9. SECTION: Air Check Setup (Mag & Zero)

Use the following procedure to set mag and zero for all air circuits. This procedure must be followed before the gage is calibrated.

1. On the EPIC readout select the **“Results”** menu and then select **“Live Check”**.
2. Select the Check associated with the air circuit from the drop-down menu.
3. Monitoring of the **“Uncalibrated Result”** should be used in the setup procedure. Click on the **“Uncalibrated Result”** reading in the Live Results box. This will display the **“Uncalibrated Result”** in the zoomed reading window and on the bar graph (see Figure 1 below).
4. Load the **MAX** master onto the tooling. Utilizing the master calibration sheet, determine the deviation of the **MAX** master for the Check being set up.
5. Adjust the **ZERO** knob of the input being set up until the **“Uncalibrated Result”** display reads the total deviation of the **MAX** master on the calibration sheet.
6. Remove the **MAX** master.
7. Load the **MIN** master onto the tooling.
8.
 - a.) If the difference between the **“Uncalibrated Result”** displayed reading with the MIN master loaded and the display reading with the MAX master from step 5 is less than difference between the calibrated max and min sizes from the master calibration sheets, the magnification needs to be increased. This is done by turning the **MAG** knob for the input clockwise.
 - b.) If the difference between the **“Uncalibrated Result”** displayed reading with the MIN master loaded and the display reading with the MAX master from step 5 is greater than difference between the calibrated max and min sizes from the master calibration sheets, the magnification needs to be decreased. This is done by turning the **MAG** knob for the input counter clockwise.



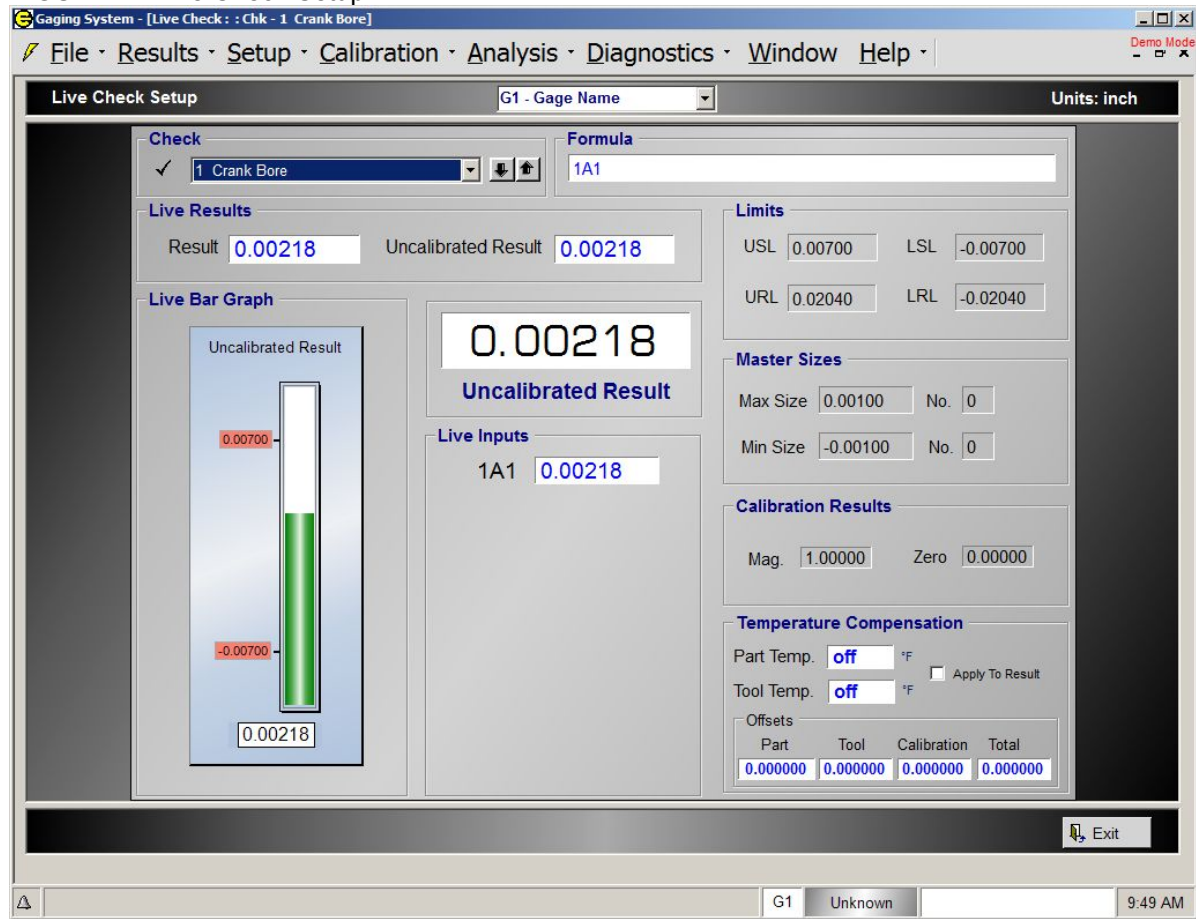
NOTE: Use a factor of 3X for adjusting the display readings. For example: If the displayed reading is +.0005 and the calibrated value is +.0001 the difference is .0004 greater. Therefore, you turn the **“MAG”** knob counter clockwise so that the reading changes by .0012.

IMPORTANT: THE DIRECTION YOU TURN THE MAG KNOB DETERMINES WHETHER YOU ARE INCREASING OR DECREASING THE MAGNIFICATION. YOU SHOULD BE CONCERNED WITH HOW MUCH THE DISPLAY CHANGES, NOT THE DIRECTION THE NUMBERS CHANGE!

From the above example The displayed reading may be $(+.0005) + (.0012) = +.0017$ or it could read $(+.0005) - (.0012) = -.0007$. This depends on the polarity of the check.

9. After adjusting the **MAG** knob, turn the **ZERO** knob in the same direction as the **MAG** knob to adjust the displayed reading to equal the deviation of the **MIN** master value on the calibration sheet.
10. Remove the **MIN** master from the tooling and install the **MAX** master.
11. Repeat steps 5 through 10 until the displayed readings for the each master corresponds to the master values on the calibration sheet.

FIGURE 1 - Live Check Setup



APPENDIX A - Performance/Process Capability Calculations

Performance Capability

Performance Capability indices Pp and Ppk are normally used when determining the possibilities of a process to produce within specified requirements and where the sampling of parts is made in the form of a large sample taken on one occasion

Pp

Pp is a Performance index. It is the relationship of the process distribution to the established spec limits. Typically a process is considered capable when the Pp is 1.33 or greater. Pp uses the actual standard deviation calculation from all samples in the active data set to determine performance

$$Pp = (USL - LSL) / (6 * StdDev)$$

Pr

Pr is the Performance ratio. Pp uses the actual standard deviation calculation from all samples in the active data set to determine performance.

$$Pr = (6 * StdDev) / (USL - LSL)$$

Ppk

Ppk is the Performance index. It is a measure of how centered the process distribution is. Pp uses the actual standard deviation calculation from all samples in active data set to determine performance.

$$Ppk = \text{Min}[(USL - \bar{X}), (\bar{X} - LSL)] / (3 * StdDev)$$

Process Capability

Process Capability indices Cp and Cpk are normally used when determining the capability of a continuous production process and where the sampling of parts is made continuously during the production

Cp

Cp is Process Capability. Capability is the relationship of the process distribution to the established spec. limits. Typically a process is considered capable when the Cp is 1.33 or greater. Cp uses the estimated standard deviation calculation base on subgroup size and samples in the XR chart subgroups.

$$Cp = (USL - LSL) / (6 * StdDevEst)$$

Cr

Cr is the Capability ratio.

$$Cr = (6 * StdDevEst) / (USL - LSL)$$

Cpk

Cpk is the Process Capability index. It is a measure of how centered the process distribution is. A process is considered capable when the Cpk is 1.33 or greater.

$$Cpk = \text{Min}[(USL - \bar{X}), (\bar{X} - LSL)] / (3 * StdDevEst)$$

Machine Capability

Machine Capability indices C_m and C_{mk} are used when determining the ability of a production machine to produce, for example as acceptance test of new equipment. The sampling of parts is made in a short period of time without changes in machine settings. All efforts are made to try to isolate the influence on the machine from other factors

C_m

C_m is Machine Capability. Machine Capability is the relationship of the process distribution to the established spec. limits. Typically a process is considered capable when the C_m is 1.33 or greater. C_m uses the estimated standard deviation calculation based on subgroup size and samples in the XR chart subgroups.

$$C_m = (USL - LSL) / (6 * StdDevEst)$$

C_r

C_r is the Machine Capability ratio.

$$C_r = (6 * StdDevEst) / (USL - LSL)$$

C_{mk}

C_{mk} is the Machine Capability index. It is a measure of how centered the process distribution is. A process is considered capable when the C_{mk} is 1.33 or greater.

$$C_{mk} = \text{Min}[(USL - \bar{X}), (\bar{X} - LSL)] / (3 * StdDevEst)$$

Standard Deviation

$$\text{Std Dev} = \text{Sqrt}[(\sum(X_i - \bar{X})^2) / (n-1)]$$

Standard Deviation Estimate

Estimated Standard Deviation (Std Dev Est). The estimate of the standard deviation of a stable process using the dispersion statistics associated with the sub-grouped samples taken from the XR Chart Data.

$$\text{Std Dev Est} = \bar{R} / d_2$$

d_2 Constants

Subgroup Size (N)

N d_2

1 1.128 (Rbar moving range average)

2 1.128

3 1.693

4 2.059

5 2.326

6 2.534

7 2.704

8 2.847

9 2.97

\bar{X}

\bar{X} : Average (Mean) of the average of each subgroup

$$\bar{X} = (X_1 + X_2 + X_3 + \dots + X_n) / n$$

\bar{X}

\bar{X} : Average (Mean) of all readings

$$\bar{X} = (X_1 + X_2 + X_3 + \dots + X_n) / n$$

RBar

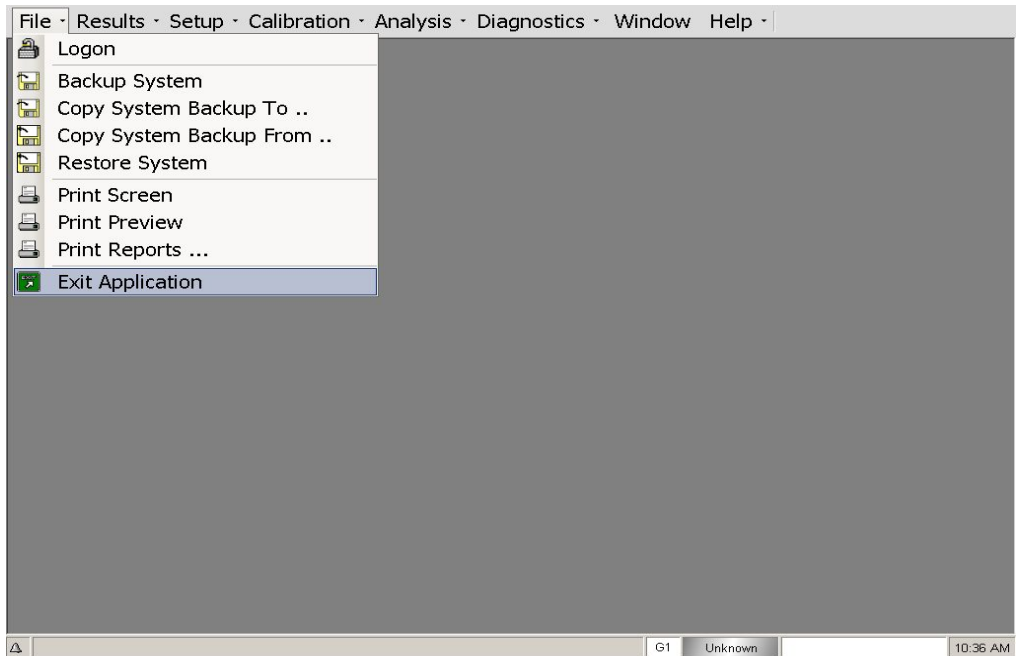
R-bar: Average range of all the range values (Xmax-Xmin) for each subgroup

$$R\text{-bar} = (R1 + R2 + R3 + \dots Rn)/n$$

R = (Xmax - Xmin) from subgroup values

APPENDIX B - Setting Ethernet IP Address of EPIC CAG unit

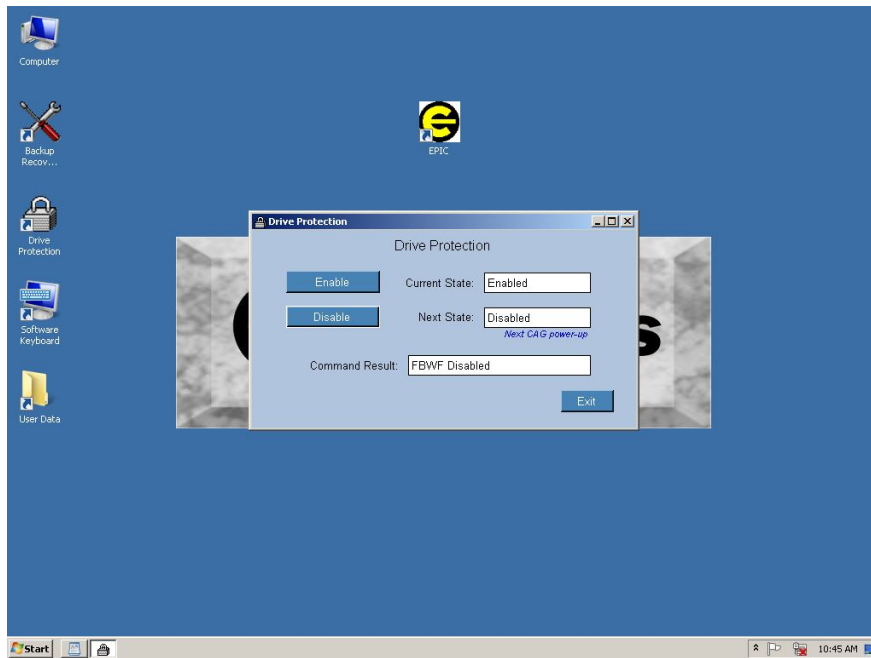
1. Exit the EPIC application



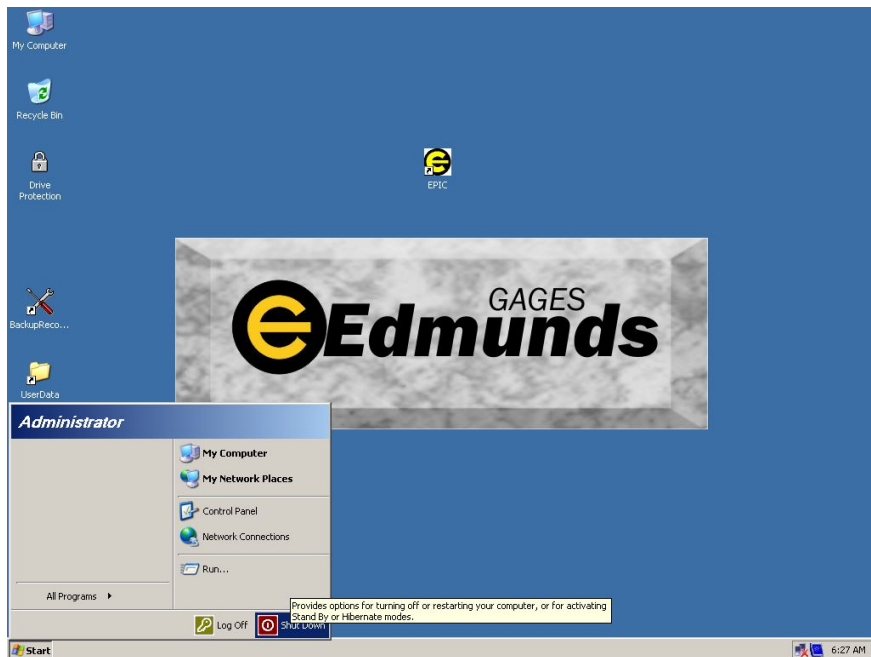
2. Click on "Drive Protection"



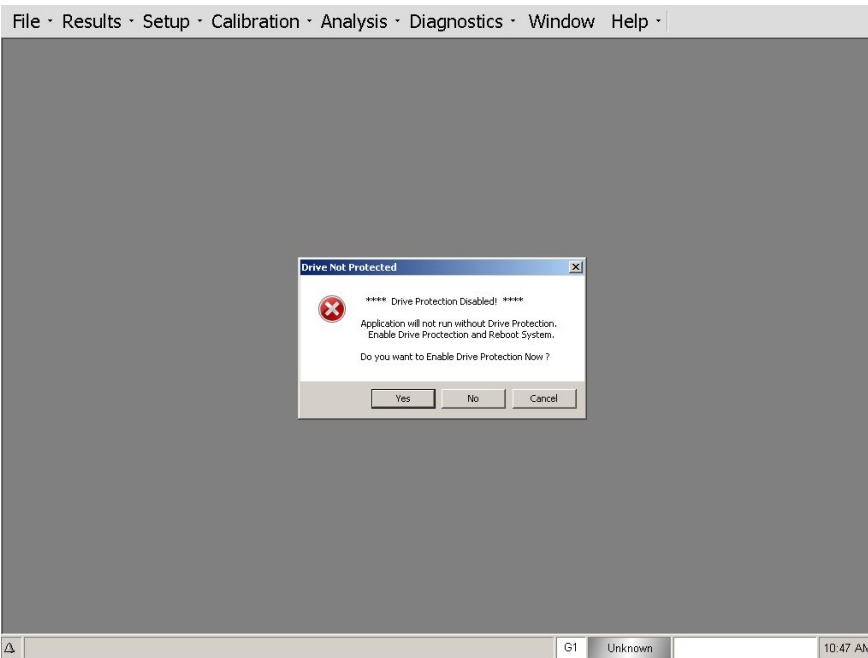
3. Click on "Disable". Need to reboot system.



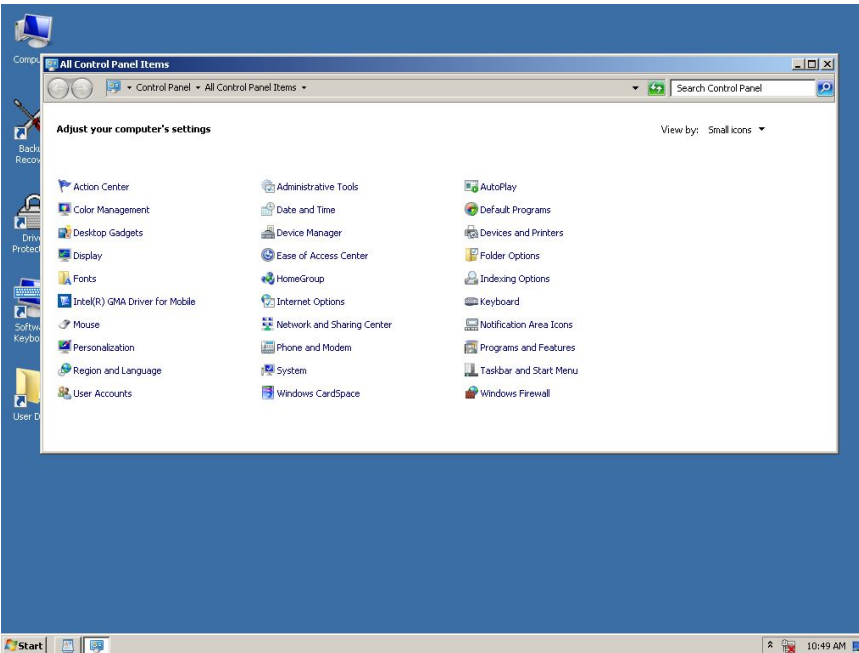
4. Shutdown system (reboot)



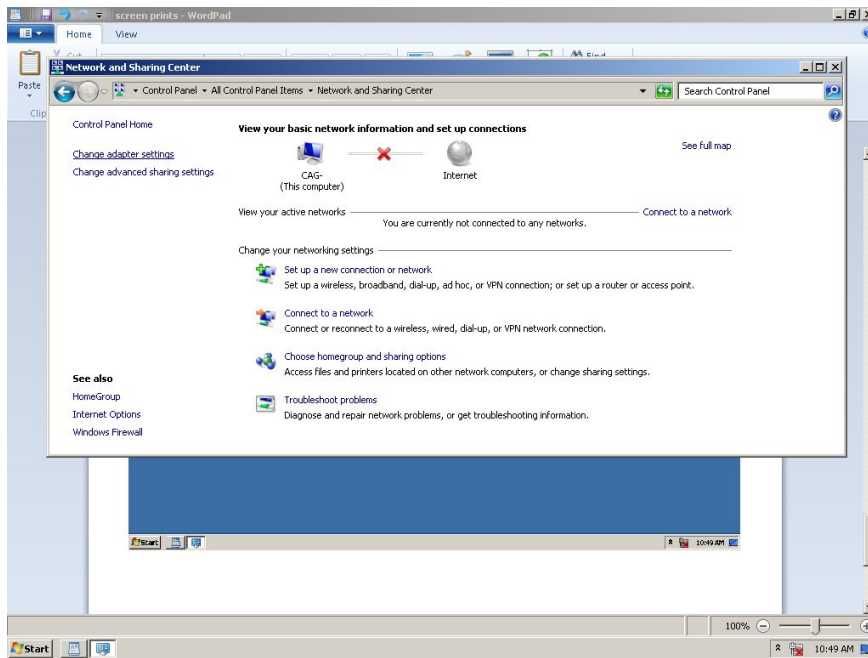
5. When system powers up the EPIC application will display error message. The EPIC application will not run if drive protection is disabled. Select "NO", the system will then exit to Windows Desktop.



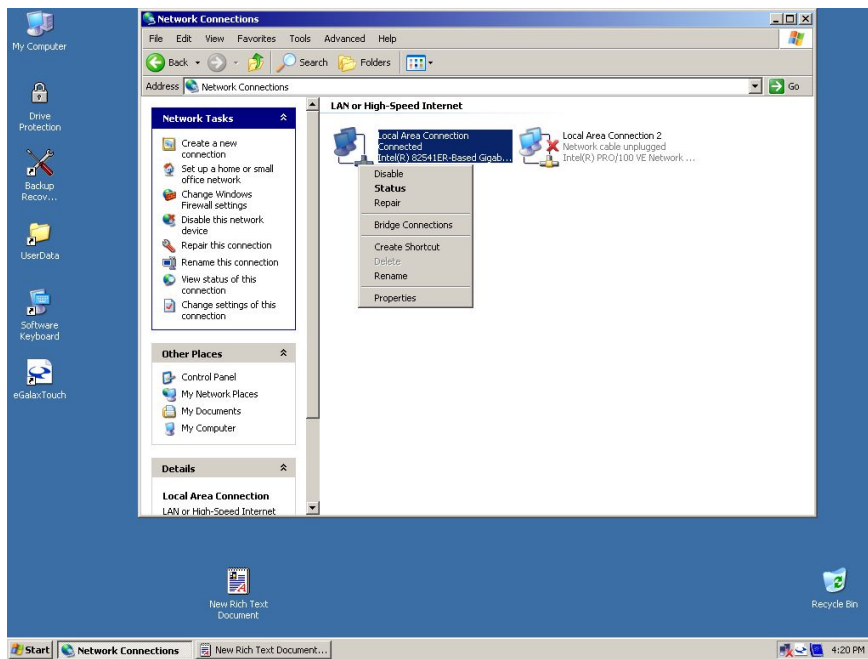
6. From the Desktop, click on the "Start" button then select "Settings" then "Control Panel". Once in the "Control Panel" select "Network and Sharing Center".



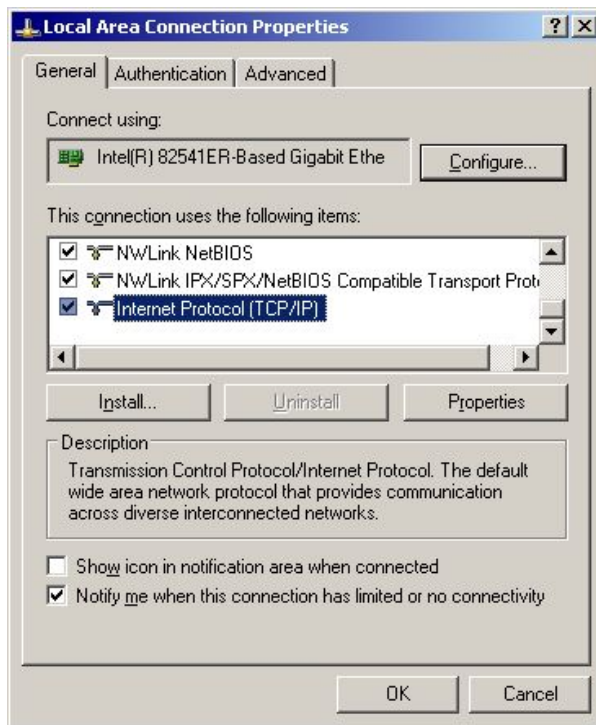
7. Select “Change adapter settings”.



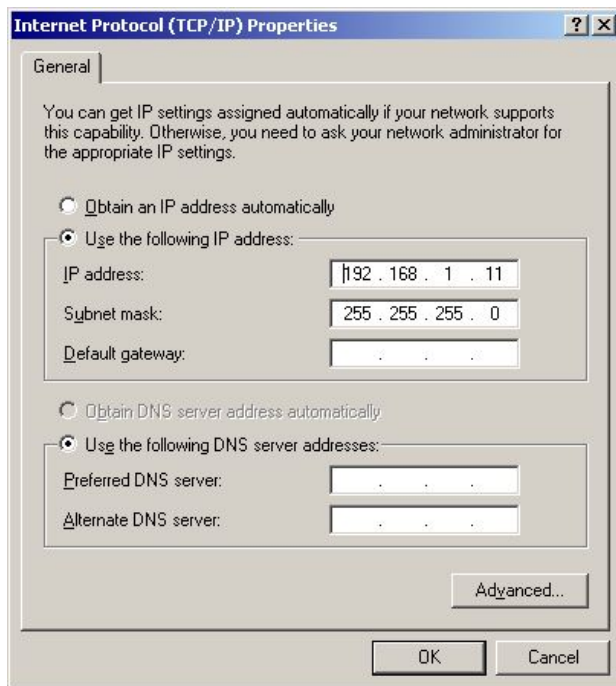
8. Right click mouse button on “Local Area Connection” and select “Properties”.



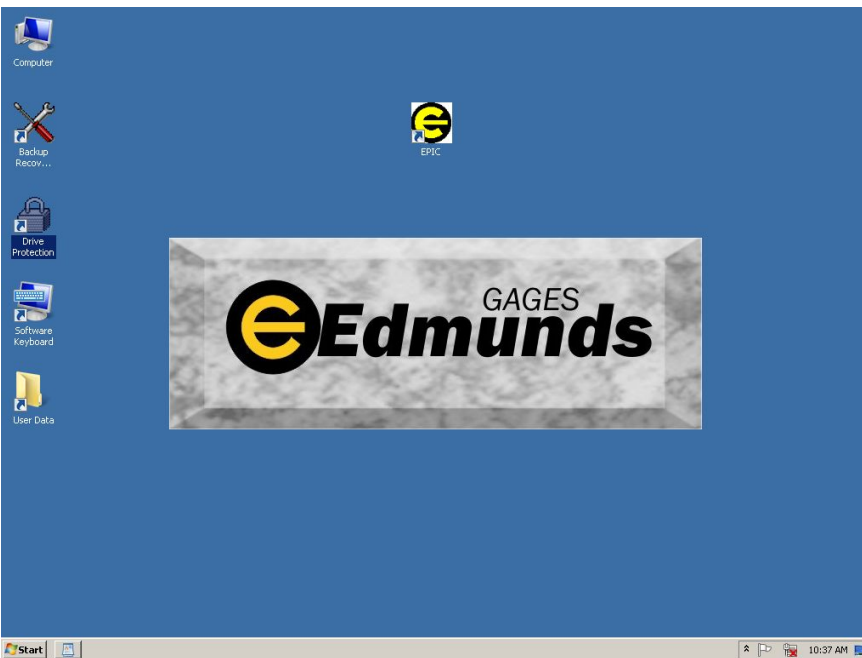
9. Select “Internet Protocol (TCP/IP)”.



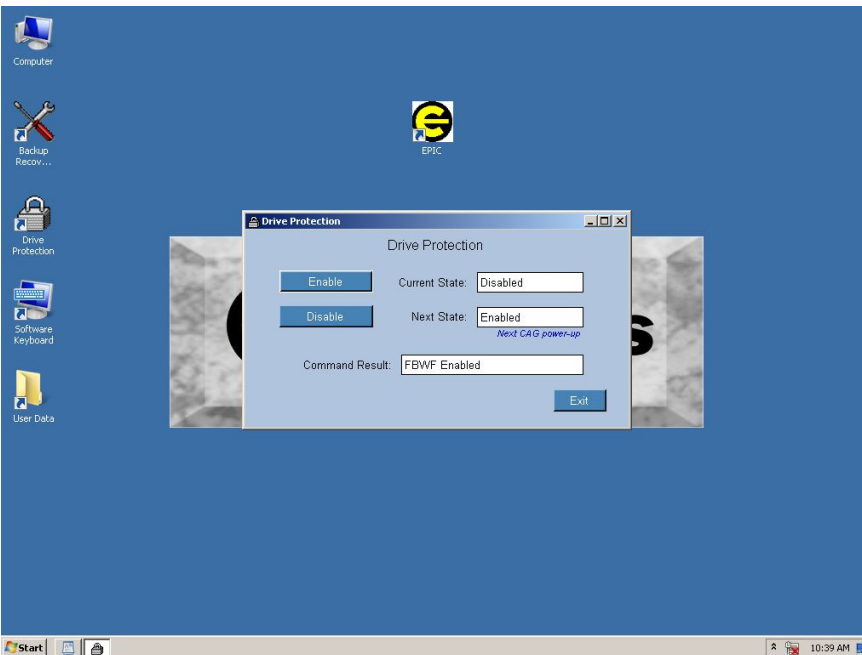
10. Set the “IP address” and “Subnet mask” as needed. Select OK when done.



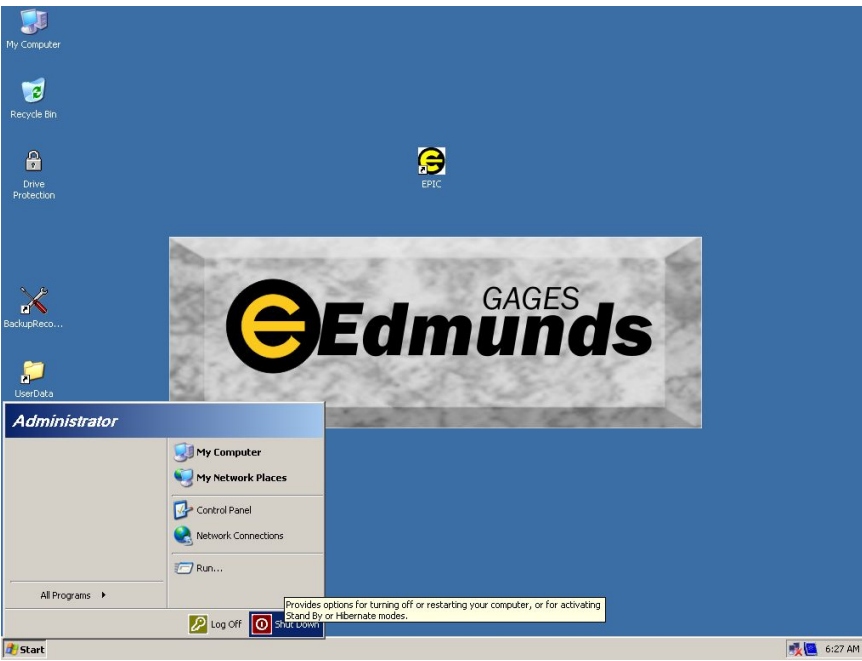
11. Click on “Drive Protection”



Click on “Enable.” Need to reboot system.



13. Shutdown system (reboot). Complete



APPENDIX C - EPIC Software Activation

The EPIC Software requires an Activation Code to prevent a software shutdown from occurring. Each system is preset with a number of days the system will run until shutdown. The number of days until system shutdown can be viewed in the "About" screen (see Figure 1). When the system is within seven (7) days of shutdown a red warning alarm will display every hour stating the system is not activated and will shutdown in a number of hours (see Figure 2). If the system has is shutdown, the user can still navigate to all the screens but the system will not perform a measurement cycle or calibration cycle and live input readings will be disabled. When the system is shutdown, a warning alarm will be displayed every hours stating the system is is not activated (see Figure 3).

Figure 1. Help - About Screen - System Not Activated

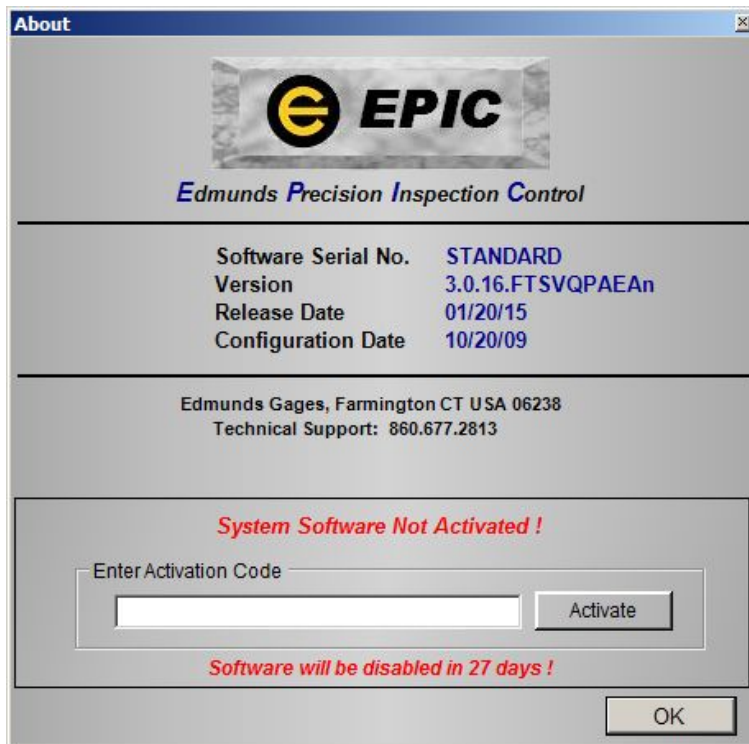


Figure 2. System Not Activated - Alarm

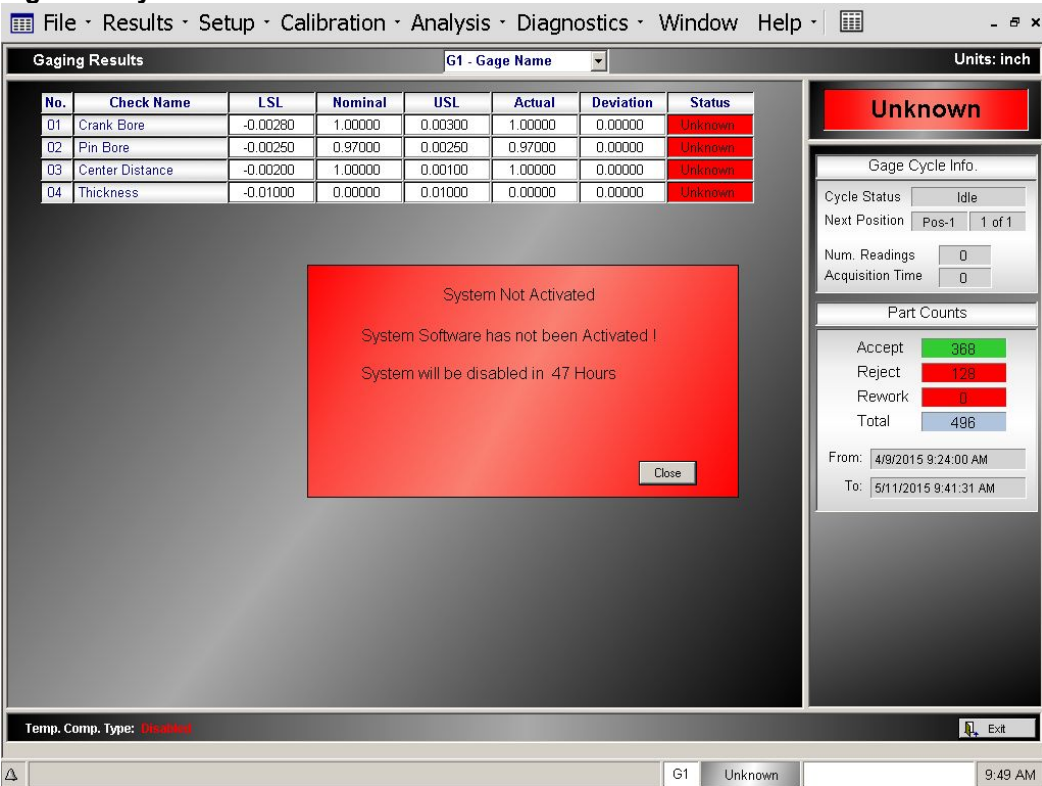
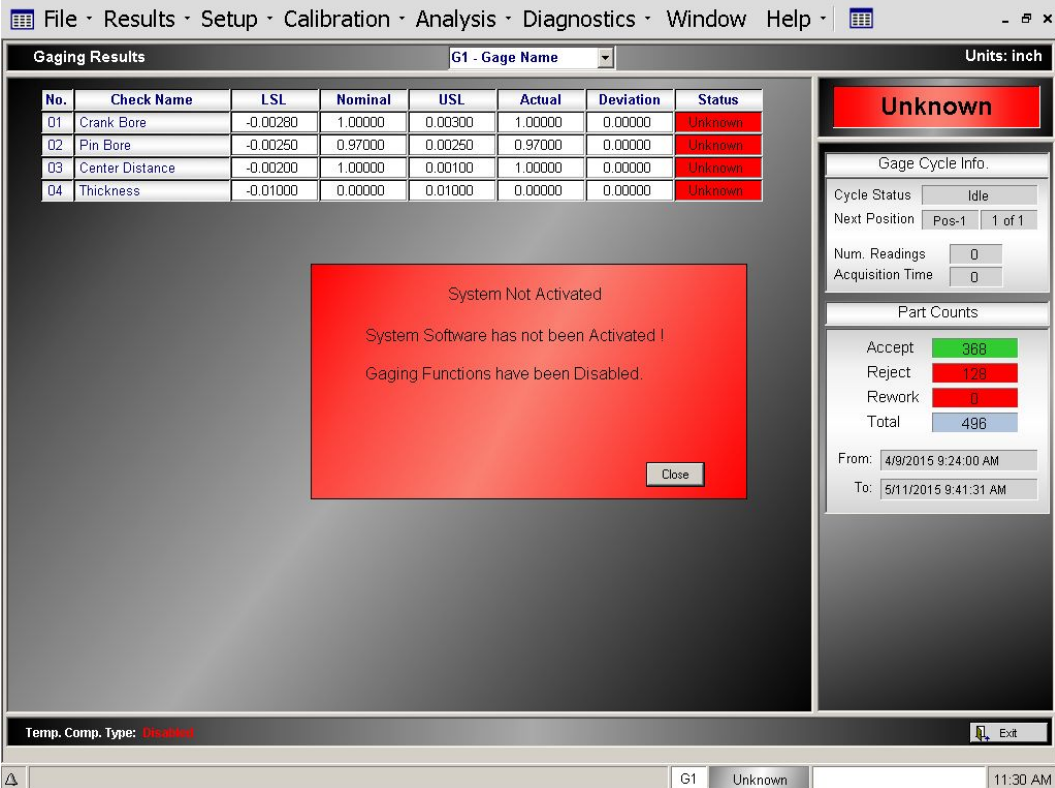


Figure3. System Shutdown



Activating EPIC System:

1. Open the About screen (menu: Help - About)
2. Enter Activation code supplied by Edmunds Gages.
3. Select the "Activation" button (see Figure 4)
4. A message box will be displayed stating Software Activated.
5. When the system is Activated the About screen will no longer display activation box (see Figure 5).

Figure 4

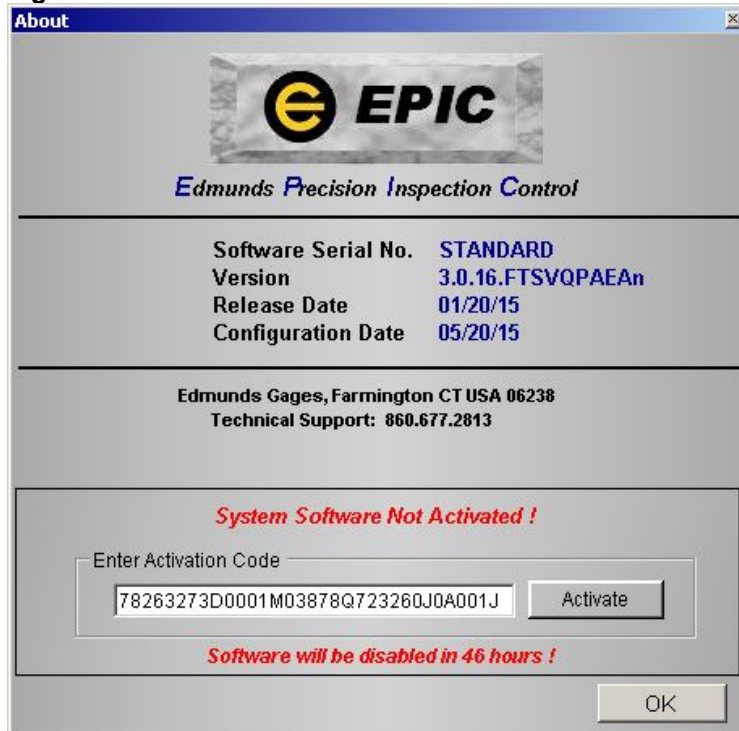


Figure 5

