Edmunds Gages

CAG^{QCM} Manual

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EDMUNDS CAG ^{QCM} READOUT

Version 7.21

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Manual Revision History

Revision	Change	Date
7.19	Original Issue Version 7.19	05/16/02
7.20	• Added menu 4.4, Auto Annotation Logging Setup • Added menu 6.7, Check Setup Display • Added menu 12.4.7, Write R&R to File • Added multiple record deletion from gage data file, menu 7.3 • Added "Last Part Gaged" or "Current Gage Only" modes to Gage Reading, menus 7.1 - 7.3. • Increased maximum allowable gage positions from 4 to 12 in menu 12.3.4. • Gage data file and setup file have the same name.	01/16/03
	• Updated A/E Mag values in section 7, page 2	12/17/03
7.21	Updated manual to new base version 7.21	10/01/04
	Added Technical Notes Section 14	7/25/05
	Added Technical Note #8130401	7/25/05
	Added reference to technical note #8130401 on page 6-13	7/25/05
	Added reference to technical note #8130401 on page 7-2	7/25/05

1 GENERAL DESCRIPTION

Industrial-Hardened Construction

Whether mounted on a fully automatic, post-process gaging system, or used on a bench top for manual gaging, the CAG^{QCM} is perfect for the shop floor. Its rugged, industrial-hardened construction is unaffected by vibration, dirt, oil-laden atmospheres, and wide fluctuations in temperature. The CAG^{QCM}'s cabinet is sealed to protect its components - making it a more compact and, therefore, more versatile system.

Programmable, User-Friendly Software

Menu-driven, user-friendly software lets you easily program CAG^{QCM} to measure several dimensions simultaneously on a variety of part applications - for automatic or manual sorting, classification or machine tool feedback. CAG^{QCM}'s 65,000 part buffer provides continuous SPC monitoring. And CAG^{QCM} can accommodate 16 electronic or air/electric inputs, expandable to 64, that can be arranged as multiple combinations to form as many as four independent gages. CAG^{QCM} software is completely tamper-proof and password protected.

Menus Let You Accumulate, Display and Analyze Part Data

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

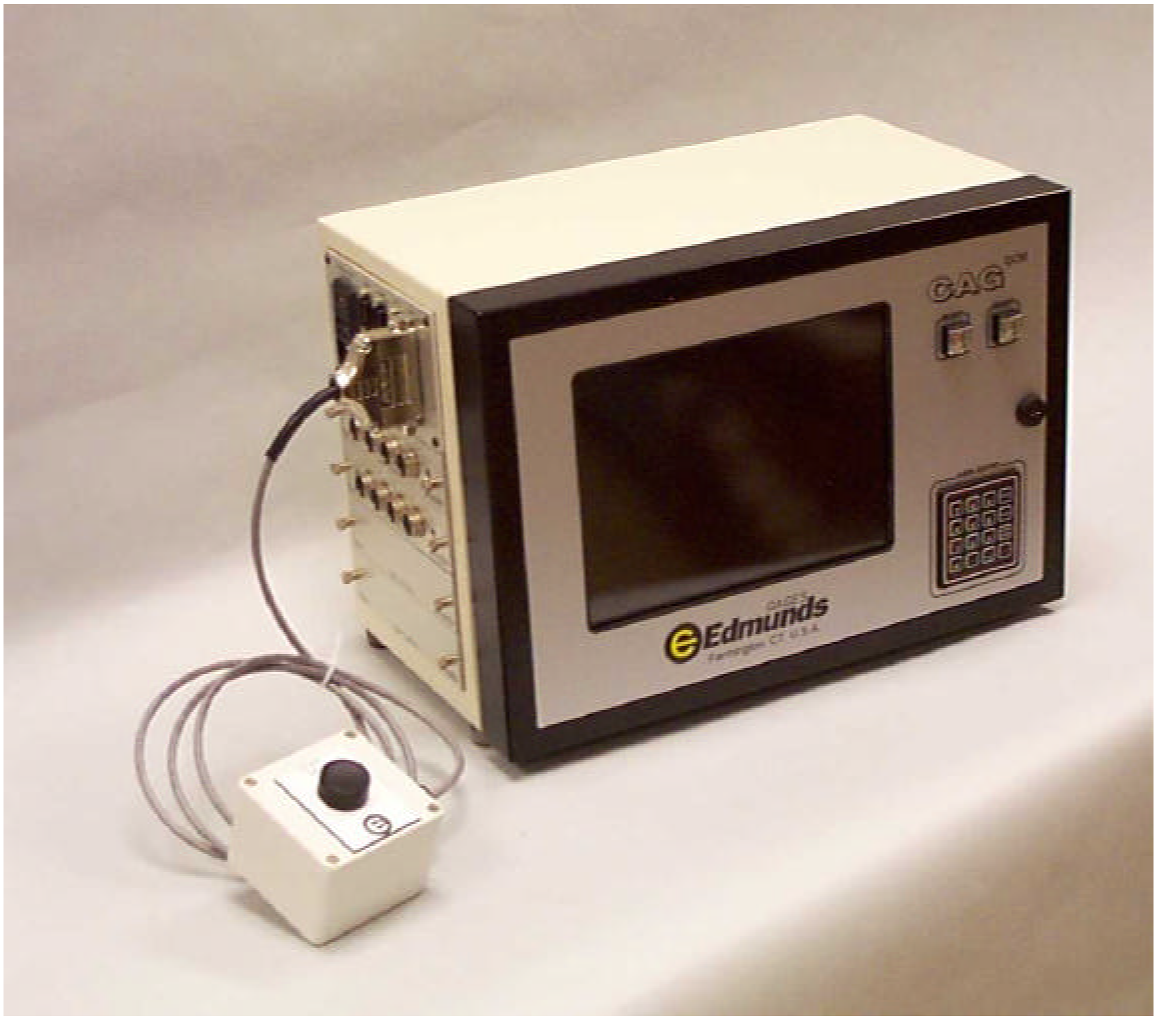
STANDARD CAG^{QCM} FEATURES

Standard Hardware Features:

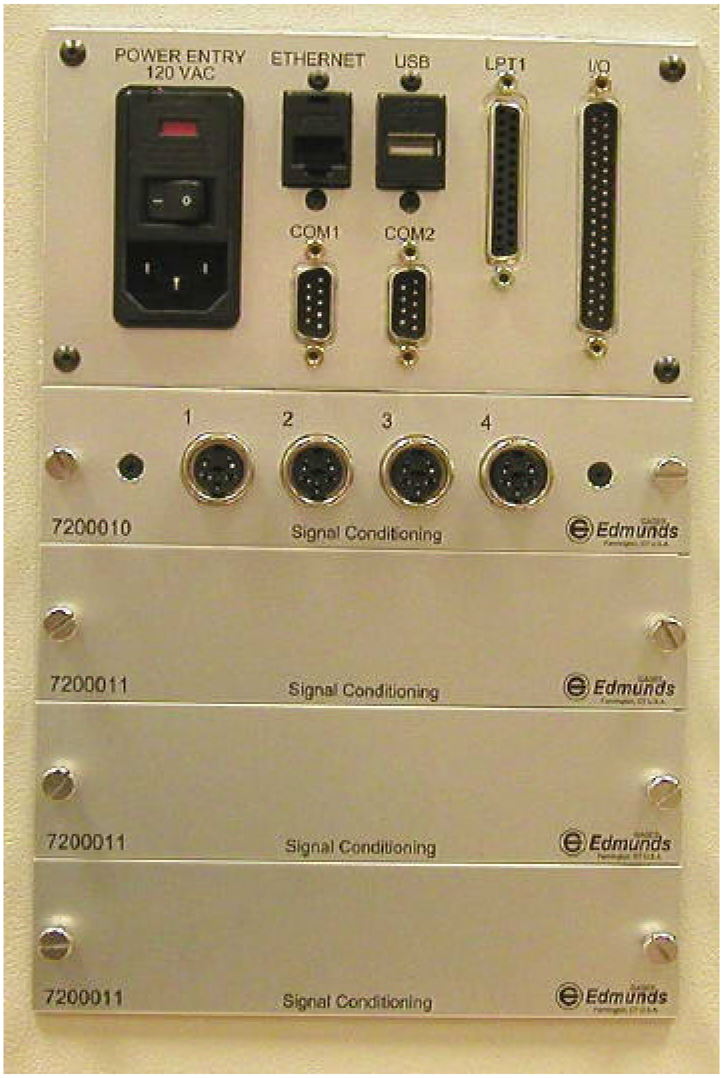
- ✓ Real-time battery-backed clock
- ✓ "Accept" and "Reject" status lights
- ✓ 10-inch active matrix flat panel
- ✓ Two RS 232 ports
- ✓ Ethernet port
- ✓ One 22 parallel I/O lines
- ✓ 16-position keypad for entering operating parameters
- ✓ One LPT1 parallel printer port
- ✓ One USB Port

Standard Software Features:

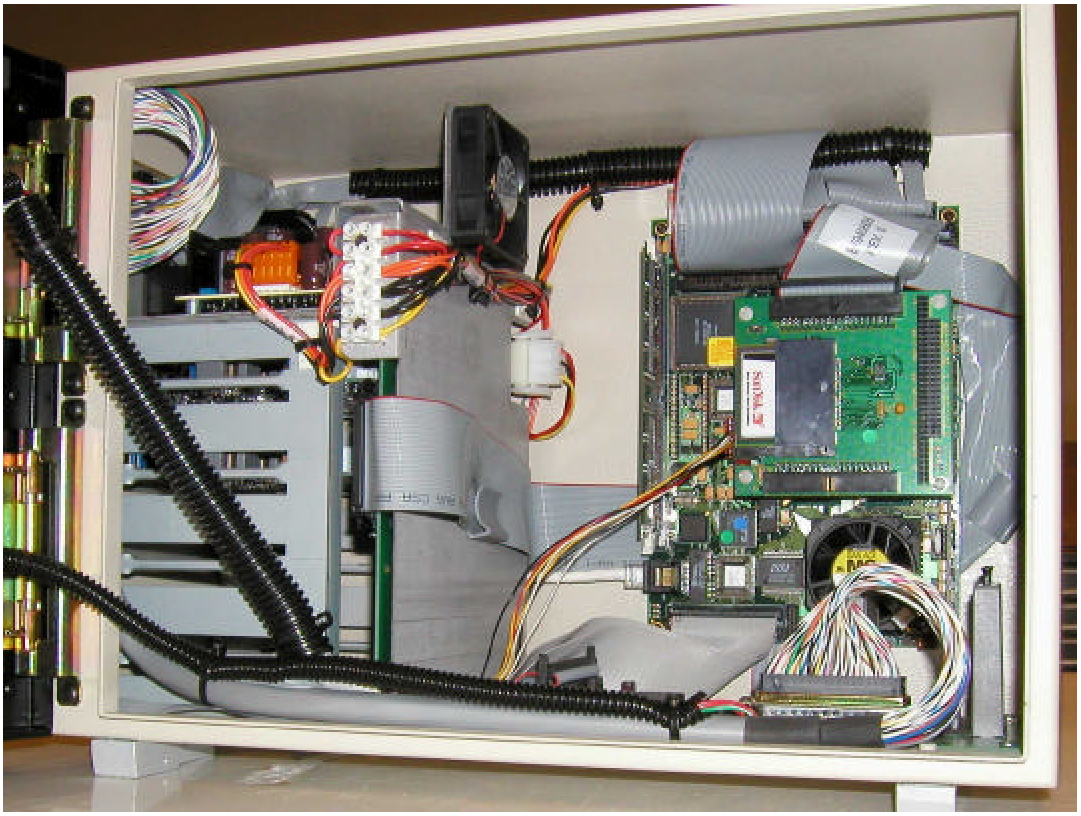
- ✓ Inch or millimeter units of measurement
- ✓ Actual size or deviation from nominal readout
- ✓ Part classification from 2 to 10 classes
- ✓ Programmable internal/external system alarm display
- ✓ 65,000 part memory buffer
- ✓ SPC charts, including statistical data, histogram, x & R, and scatter charts.
- ✓ Selectable time frame window for analyzing data stored in part reading buffer.
- ✓ Long term histogram and statistical charts
- ✓ Part Counters display
- ✓ Process stability tests
- ✓ Annotation logging
- ✓ Password protected set-up
- ✓ Automatic Mastering
- ✓ Gage Verification
- ✓ Programmable to monitor 1 to 4 gages
- ✓ R&R study
- ✓ Event log
- ✓ Static or dynamic gaging
- ✓ Real-time software
- ✓ Remote Copy capability for setup and data storage
- ✓ Up to four "Start Gage" push buttons



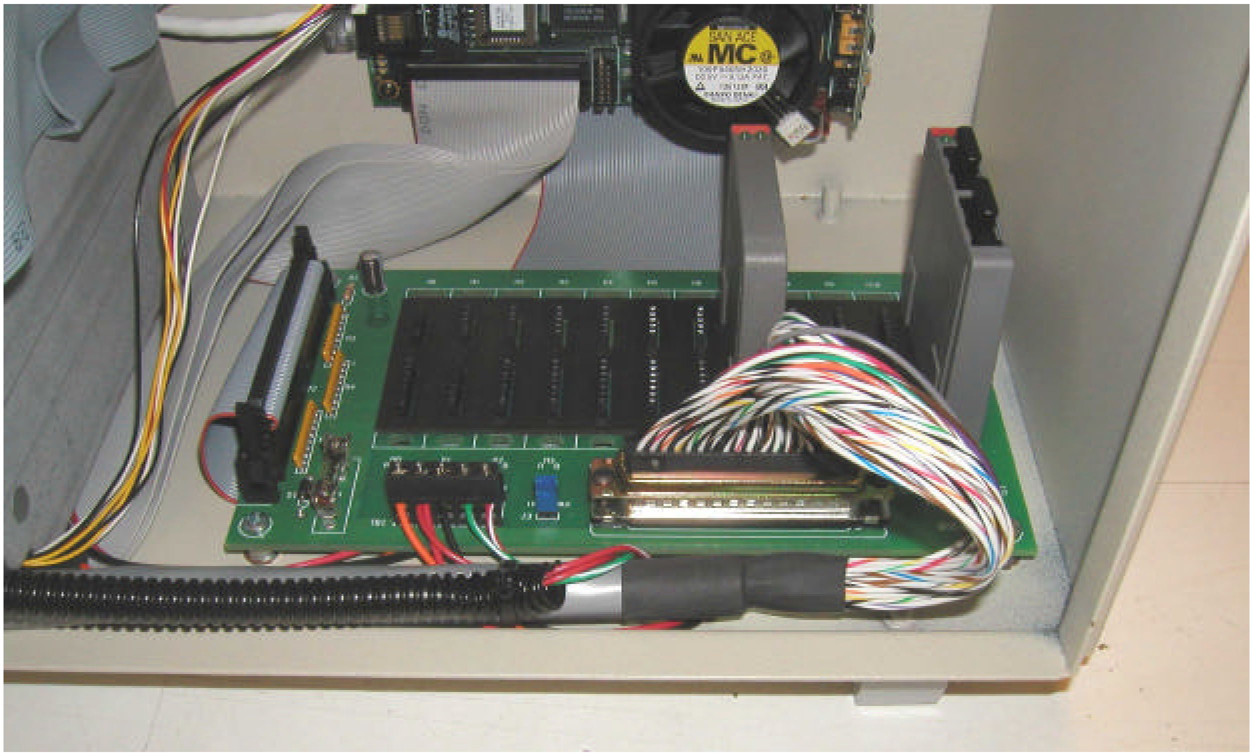
OVERALL



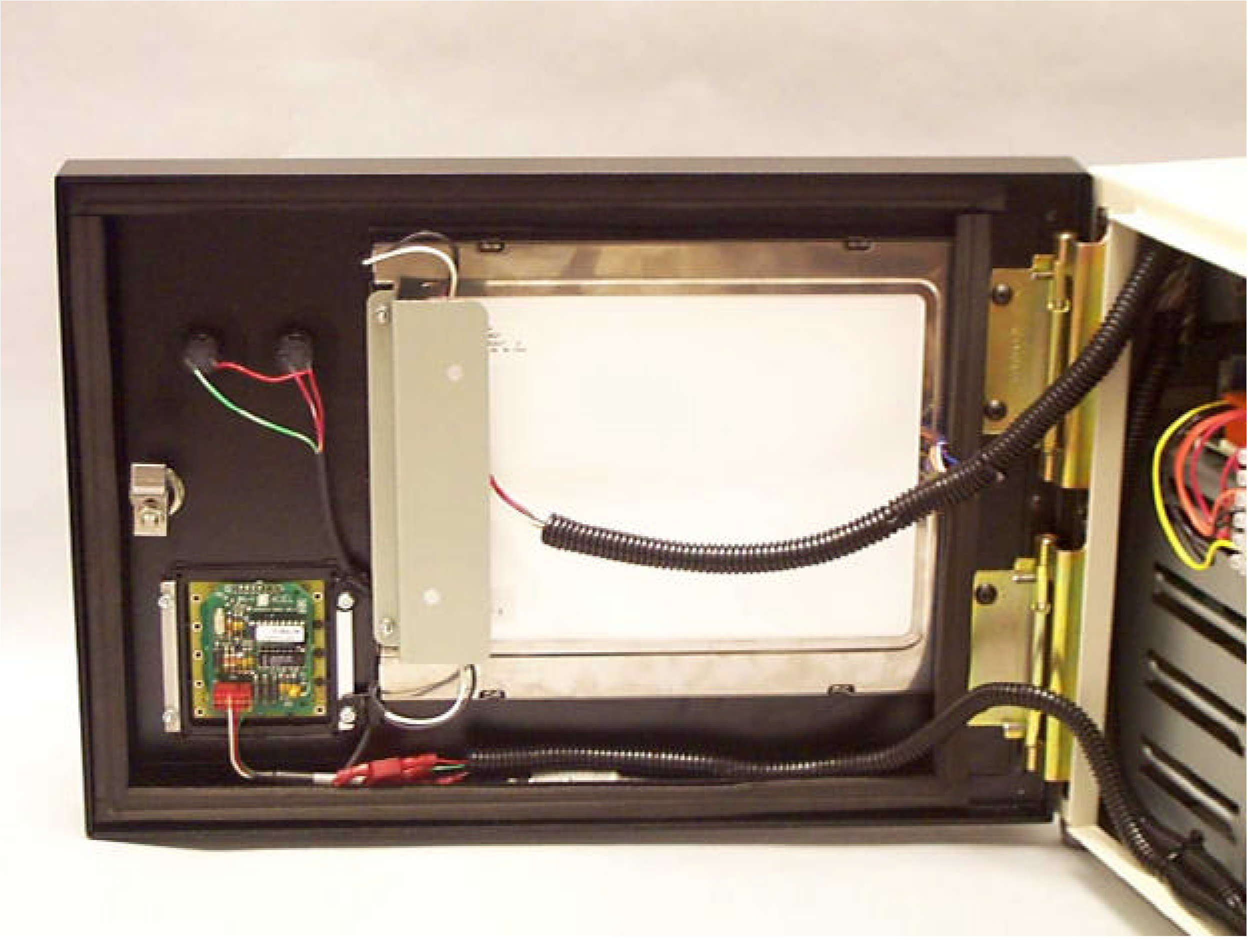
CONNECTIONS



INTERNAL



INTERNAL



INTERNAL

2 GLOSSARY

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

ANNOTATION
The ability to assign an explanatory note to a measured part stored in the CAG's Part Buffer.

AT (Available Tolerance)
The distance between the mean of a process and the nearest end of the specification or between the mean and the specified limit of a zero based tolerance.

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

CAG $^{\mathbf{QCM}}$ (Computer Aided Gaging)
Trade Mark name for the Edmunds Gages Gaging System Computer.

CHANNEL
Transducer Input.

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

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

Cp (Process Capability)
The ratio of the total tolerance to six standard deviations. Cp may range in value from 0 to infinity, with a larger value indicating a more capable process. A value near 1.33 is normally considered acceptable.

Cpk (Capability Index)

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

CR (Capability Ratio)
The ratio of variability to tolerance.

END GAGE
A signal to the CAG to stop taking input readings during a gage cycle.

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

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

INTERRUPT
A computer signal indicating that the CPU should suspend its current task to service a designated activity.

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

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

LED (Light Emitting Diode)
A semiconductor light source that emits visible light.

LCL (Lower Control Limit)
The lower limit for means or ranges on a control chart.

MAG (Magnification)
Electrical or software gain adjustment applied to transducer inputs for calibration.

MASTER
A calibrated standard reproducing the part features.

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

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

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

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

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

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

PLC (Programmable Logic Controller)
A device used to control the mechanical motions on an automatic gage.

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

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

R (Range)
The difference between the largest and smallest values observed in a sample or subgroup.

$\overline{R}$ (Average Range)
The average of all the ranges (R) from the samples or subgroups.

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

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

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

RESOLUTION
The smallest significant number that a measurement is displayed.

R&R STUDY
Repeatability & Reproducibility Study

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

SPC
Statistical Process Control.

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

START GAGE
A signal to the CAG to initiate a measurement cycle.

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

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

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

X
The mean of a subgroup or sample.

$\bar{X}$ (x bar)
The mean of all of the subgroups.

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

3 CONVENTIONS

KEYPAD

[INDEX]	Performs 2 functions: 1) Aborts the current keypad entry procedure. 2) Returns to the previous menu level.
[ENTER]	Signifies the end of the keypad entry procedure. It is also used to clear the alarm window that can be displayed on all menus.
[SHIFT][9]	Gage Change key: Updates any Gage dependent screen with the next Gage's data.
[YES]	Check Change Key: Updates any Check dependent screen with the next Checks data.
[SHIFT][C]	Check Selection Key: Activates a check selection window in any Check dependent screen.
[SHIFT][PRINT]	Initiates a Screen Dump to a Printer.
[SHIFT][E]	Performs 2 distinct functions depending on the menu it is initiated from: 1) Gage Readings: Deletes the last part gaged data (for the Displayed Gage) from the SPC Data Base. 2) Gage R&R Study: Allows a selected R&R Sample to be regaged.

MENU

LINE 1 (GRAY):

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

LINE 23:

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

LINE 24 (RED):

1) Prompt Line

LINE 25 (BLACK):

1) Alarm Line

External Keyboard

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

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

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

4. EDMUNDS GAGES MANUAL CAG MENU DIAGRAM

1 SYSTEM DESCRIPTION

1. SYSTEM SETUP SUMMARY
2. GAGE SETUP SUMMARY
3. CHECK SETUP SUMMARY
4. SYSTEM SETUP SUMMARY

2 GAGE MASTERING

1. MASTER THE GAGE
2. MASTERING RESULTS
3. MASTER SIZES
4. MASTERING TIMER
5. GAGE VERIFICATION-----1. VERIFY THE GAGE
    2. VERIFICATION RESULTS
    3. VERIFICATION MASTER SIZES
    4. VERIFICATION LIMITS
    5. VERIFICATION FREQUENCY TIMER

3 LIMITS

1. NOMINAL SIZES
2. PART TOLERANCE
3. REASONABLE LIMITS
4. SORT CLASSES

4 SPC SETUP

1. ENABLE DATA ACCUMULATION----------------1. PART COUNTERS
    2. GAGE DATA FILES & CHARTS
    3. LONG TERM SPC CHARTS
2. DEFINE x & R CHART PARAMETERS
3. ENABLE SPC ALARMS
4. AUTO ANNOTATION LOGGING SETUP

5 DATA RESET

1. PART COUNTERS
2. GAGE DATA FILES & CHARTS
3. LONG TERM SPC CHARTS

6 INPUT SETUP

1. DISPLAY ALL INPUTS
2. DISPLAY PART DIMENSIONS
3. DISPLAY INPUT BARGRAPH
4. BALANCE INPUTS-----------------------------1. SELECT INPUTS TO BALANCE
    2. PERFORM BALANCING PROCEDURE
    3. DISPLAY BALANCING RESULTS
5. MONITOR A CHECK
6. GAGE CYCLE HISTORY
7. CHECK SETUP DISPLAY

7 GAGE READINGS

1. DIGITAL DISPLAY
2. BARGRAPH DISPLAY
3. GAGE DATA FILE
4. SELECT DISPLAYABLE CHECKS

8 COUNTERS

1. PART COUNTERS

9 SPC CHARTS

1. HISTOGRAMS
2. STATISTICS
3. x & R CHARTS
4. SCATTER CHARTS
5. GAGE DATA FILES
6. HISTOGRAMS (LONG TERM)
7. STATISTICS (LONG TERM)

10 SYSTEM ALARMS

1. DISPLAY CAG ALARMS

11 CLOCK MENU

1. SHOW TIMES

```
12   UTILITIES    1. SYSTEM CONFIGURATION----------1. DEFINE ACCESS PASSWORDS
                                                   2. UNITS OF MEASUREMENT
                                                   3. NUMBER OF GAGES
                                                   4. SINGLE GAGE MONITORING
                                                   5. GAGE RECOGNITION MODE
                                                   6. ALLOCATE DATA FILE MEMORY
                                                   7. WORK SHIFT START TIMES
                                                   8. LINK GAGE CYCLES

                  2. GAGE SETUP----------------------------1. GAGE NAMES
                                                   2. GAGE TYPE/TIMER
                                                   3. GAGE RESOLUTION
                                                   4. NUMBER OF PART CHECKS
                                                   5. GAGE ENABLE/DISABLE
                                                   6. GAGE CYCLE SETUP

                  3. PART CHECKS--------------------------1. CHECK NAMES
                                                   2. CHECK FUNCTIONS
                                                   3. CHECK FORMULAS
                                                   4. MULTIPLE CHECKS
                                                   5. INPUT CHANNEL MAG & POLARITY
                                                   6. CHECK ENABLE/DISABLE
                                                   7. ATTRIBUTE CHECKS-1. ASSIGN ATTRIBUTE CHECK OPTOS
                                                                       2. ASSIGN VALID ATTR DATA OPTO
                                                                       3. VALID ATTR. CHECK DATA TIMER
                                                   8. CHECK RESOLUTION SETUP

                  4. GAGE R&R STUDY ---------------------1. GAGE R&R STUDY
                                                   2. # TRIALS & SAMPLES
                                                   3. RESET R&R STUDY DATA
                                                   4. START/STOP STUDY
                                                   5. UCLr TEST
                                                   6. PRINT R&R STUDY
                                                   7. WRITE R&R TO FILE


                  5. ALARM SETUP--------------------------1. ENABLE CAG ALARMS
                                                   2. PROGRAM CONSECUTIVE REJECT LIMITS

                  6. SYSTEM HARDWARE UTILITIES---1. SET SYSTEM CLOCK
                                                   2. CRT SAVER
                                                   3. SERIAL COMMUNICATIONS--1. SERIAL COMM SETUP
                                                                             2. DIAGNOSTICS
                                                                             3. TEST SERIAL PORTS
                                                   4. ANALOG CONFIGURATION
                                                   5. I/O TEST FUNCTIONS-----1. FORCE OUTPUTS
                                                                         2. MONITOR INPUTS
                                                                         3. I/O TRACE
                                                                         4. I/O MESSAGE DURATION
                                                   6. VIDEO TEST/SETUP SCREEN
                                                   7. NETWORK SETUP --1. IP ADDRESS SETUP
                                                                      2. NETWORK USER NAME
                                                                      3. NETWORK PRINTER
                                                                      4. NETWORK PART DATA STORAGE
                                                   8. ENABLE KEYPAD GAGING
                                                   9. SELECT SYSTEM PRINTER---1. SYSTEM PRINTER TYPE
                                                                              2. TEST PRINTER PORT

                  7. CAG FILE UTILITIES-------------------1. CAG SETUP FILE UTILITY
                                                   2. REMOTE COPY UTILITY
```

8. GAGE/ PART CHECK COPY UTILITY

9. HIDDEN MENUS-------------------------1. INITIALIZE SETUP DATA
    2. SOFTWARE CONVERSION
    3. SPOOL SETUP PARAMETERS
    4. MASTERING LIMITS
    5. SET AD SAMPLING
    6. SET WATCHDOG TIMER
    7. INSTALL OPERATING SOFTWARE
    8. DIAGNOSTIC DATA

NOTE: On CAGs with optional Temperature Compensation Software the Hidden Menus are under **12.10** and the temperature compensation menus are under 12.9.

9. TEMPERATURE COMP---1. TEMPERATURE PROBE SETUP
    1. MANUAL TEMPERATURES
    2. NUMBER OF PROBE SETS
    3. PROBE SET NAMES
    4. ASSIGN INPUT CHANNEL
    5. INPUT CHANNEL DEAD BAND
    6. TEMPERATURE SETTLE TIME
   2. ASSIGN CHECKS
   3. TEMP COMPENSATION TYPE
   4. TEMP COMPENSATION STUDY
    1. AUTO TEMP COMPENSATION STUDY
        1. TC STUDY DISPLAY
        2. START/STOP STUDY
        3. RESET TC STUDY
        4. GAGE SELECTION
        5. STUDY TYPE
        6. PROBE SET SELECTION
        7. SAVE STUDY TO FILE
        8. RESET TC STUDY FILES
    2. DEFINE LINEAR COEFFICIENTS
    3. TEMP COMP DATA OFFLOAD
   5. VIEW COEFFICIENTS

EDMUNDS GAGES AUTOMATIC CAG W/O FEEDBACK MENU DIAGRAM

1 SYSTEM DESCRIPTION
1. SYSTEM SETUP SUMMARY
2. GAGE SETUP SUMMARY
3. CHECK SETUP SUMMARY
4. SYSTEM SETUP SUMMARY

2 GAGE MASTERING
1. MASTER THE GAGE
2. MASTERING RESULTS
3. MASTER SIZES
4. MASTERING TIMER
5. GAGE VERIFICATION
    1. VERIFY THE GAGE
    2. VERIFICATION RESULTS
    3. VERIFICATION MASTER SIZES
    4. VERIFICATION LIMITS
    5. VERIFICATION FREQUENCY TIMER

3 LIMITS
1. NOMINAL SIZES
2. PART TOLERANCE
3. REASONABLE LIMITS
4. SORT CLASSES

4 SPC SETUP
1. ENABLE DATA ACCUMULATION
    1. PART COUNTERS
    2. GAGE DATA FILES & CHARTS
    3. LONG TERM SPC CHARTS
2. DEFINE x & R CHART PARAMETERS
3. ENABLE SPC ALARMS
4. AUTO ANNOTATION LOGGING SETUP

5 DATA RESET
1. PART COUNTERS
2. GAGE DATA FILES & CHARTS
3. LONG TERM SPC CHARTS

6 INPUT SETUP
1. DISPLAY ALL INPUTS
2. DISPLAY PART DIMENSIONS
3. DISPLAY INPUT BARGRAPH
4. BALANCE INPUTS
    1. SELECT INPUTS TO BALANCE
    2. PERFORM BALANCING PROCEDURE
    3. DISPLAY BALANCING RESULTS
5. MONITOR A CHECK
6. GAGE CYCLE HISTORY
7. CHECK SETUP DISPLAY

7 GAGE READINGS
1. DIGITAL DISPLAY
2. BARGRAPH DISPLAY
3. GAGE DATA FILE
4. SELECT DISPLAYABLE CHECKS

8 COUNTERS
1. PART COUNTERS

9 SPC CHARTS
1. HISTOGRAMS
2. STATISTICS
3. x & R CHARTS
4. SCATTER CHARTS
5. GAGE DATA FILES
6. HISTOGRAMS (LONG TERM)
7. STATISTICS (LONG TERM)

10 SYSTEM ALARMS
1. DISPLAY CAG ALARMS
2. DISPLAY MACHINE ALARMS

11 CLOCK MENU
1. SHOW TIMES

12 UTILITIES 1. SYSTEM CONFIGURATION----------1. DEFINE ACCESS PASSWORDS
2. UNITS OF MEASUREMENT
3. NUMBER OF GAGES
4. SINGLE GAGE MONITORING
5. ALLOCATE DATA FILE MEMORY
6. WORK SHIFT START TIMES
7. LINK GAGE CYCLES

2. GAGE SETUP----------------------------1. GAGE NAMES
2. GAGE TYPE/TIMER
3. GAGE RESOLUTION
4. NUMBER OF PART CHECKS
5. GAGE ENABLE/DISABLE
6. GAGE CYCLE SETUP
7. GAGE SETUP COPY UTILITY

3. PART CHECKS---------------------------1. CHECK NAMES
2. CHECK FUNCTIONS
3. CHECK FORMULAS
4. MULTIPLE CHECKS
5. INPUT CHANNEL MAG & POLARITY
6. CHECK ENABLE/DISABLE
7. ATTRIBUTE CHECKS--1. ASSIGN ATTRIBUTE CHECK OPTOS
2. ASSIGN VALID ATTR DATA OPTO
3. VALID ATTR CHECK DATA TIMER
8. CHECK RESOLUTION SETUP

4. GAGE R&R STUDY ---------------------1. GAGE R&R STUDY
2. # TRIALS & SAMPLES
3. RESET R&R STUDY DATA
4. START/STOP STUDY
5. UCLr TEST
6. PRINT R&R STUDY
7. WRITE R&R TO FILE
8. PART SORT SELECTION

5. ALARM SETUP---------------------------1. DEFINE MACHINE ALARMS
2. ENABLE CAG ALARMS
3. PROGRAM CONSECUTIVE REJECT LIMITS

6. SYSTEM HARDWARE UTILITIES---1. SET SYSTEM CLOCK
2. CRT SAVER
3. SERIAL COMMUNICATIONS---1. SERIAL COMM SETUP
2. DIAGNOSTICS
3. TEST SERIAL PORTS
4. ANALOG CONFIGURATION
5. I/O TEST FUNCTIONS-----1. FORCE OUTPUTS
2. MONITOR INPUTS
3. I/O TRACE
4. I/O MESSAGE DURATION
6. VIDEO TEST/SETUP SCREEN
7. NETWORK SETUP ---1. IP ADDRESS SETUP
2. NETWORK USER NAME
3. NETWORK PRINTER
4. NETWORK PART DATA STORAGE
8. ENABLE KEYPAD GAGING
9. SELECT SYSTEM PRINTER---1. SYSTEM PRINTER TYPE
2. TEST PRINTER PORT

7. CAG FILE UTILITIES--------------------1. CAG SETUP FILE UTILITY
    2. REMOTE COPY UTILITY

8. GAGE/PART CHECK COPY UTILITY

9. HIDDEN MENUS--------------------------1. INITIALIZE SETUP DATA
    2. SOFTWARE CONVERSION
    3. SPOOL SETUP PARAMETERS
    4. MASTERING LIMITS
    5. SET AD SAMPLING
    6. SET WATCHDOG TIMER
    7. INSTALL OPERATING SOFTWARE
    8. DIAGNOSTIC DATA

NOTE: On CAGs with optional Temperature Compensation Software the Hidden Menus are under **12.10** and the temperature compensation menus are under 12.9.

9. TEMPERATURE COMP---1. TEMPERATURE PROBE SETUP
    1. MANUAL TEMPERATURES
    2. NUMBER OF PROBE SETS
    3. PROBE SET NAMES
    4. ASSIGN INPUT CHANNEL
    5. INPUT CHANNEL DEAD BAND
    6. TEMPERATURE SETTLE TIME
   2. ASSIGN CHECKS
   3. TEMP COMPENSATION TYPE
   4. TEMP COMPENSATION STUDY
       1. AUTO TEMP COMPENSATION STUDY
           1. TC STUDY DISPLAY
           2. START/STOP STUDY
           3. RESET TC STUDY
           4. GAGE SELECTION
           5. STUDY TYPE
           6. PROBE SET SELECTION
           7. SAVE STUDY TO FILE
           8. RESET TC STUDY FILES
       2. DEFINE LINEAR COEFFICIENTS
       3. TEMP COMP DATA OFFLOAD
   5. VIEW COEFFICIENTS

EDMUNDS GAGES AUTOMATIC CAG W/FEEDBACK MENU DIAGRAM

- **1 SYSTEM DESCRIPTION**
  - 1. SYSTEM SETUP SUMMARY
  - 2. GAGE SETUP SUMMARY
  - 3. CHECK SETUP SUMMARY
  - 4. SYSTEM SETUP SUMMARY

- **2 GAGE MASTERING**
  - 1. MASTER THE GAGE
  - 2. MASTERING RESULTS
  - 3. MASTER SIZES
  - 4. MASTERING TIMER
  - 5. GAGE VERIFICATION
    - 1. VERIFY THE GAGE
    - 2. VERIFICATION RESULTS
    - 3. VERIFICATION MASTER SIZES
    - 4. VERIFICATION LIMITS
    - 5. VERIFICATION FREQUENCY TIMER

- **3 LIMITS**
  - 1. NOMINAL SIZES
  - 2. PART TOLERANCE
  - 3. REASONABLE LIMITS
  - 4. SORT CLASSES

- **4 SPC SETUP**
  - 1. ENABLE DATA ACCUMULATION
    - 1. PART COUNTERS
    - 2. GAGE DATA FILES & CHARTS
    - 3. LONG TERM SPC CHARTS
  - 2. DEFINE x & R CHART PARAMETERS
  - 3. ENABLE SPC ALARMS
  - 4. AUTO ANNOTATION LOGGING SETUP
  - 5. FEEDBACK CONTROL
    - 1. SAMPLE SIZE
    - 2. COMPENSATION RATES
    - 3. FEEDBACK CONTROL LIMITS
    - 4. TOOLING ADJUST LIMITS
  - 6. FEEDBACK CONTROL REPORT

- **5 DATA RESET**
  - 1. PART COUNTERS
  - 2. GAGE DATA FILES & CHARTS
  - 3. LONG TERM SPC CHARTS

- **6 INPUT SETUP**
  - 1. DISPLAY ALL INPUTS
  - 2. DISPLAY PART DIMENSIONS
  - 3. DISPLAY INPUT BARGRAPH
  - 4. BALANCE INPUTS
    - 1. SELECT INPUTS TO BALANCE
    - 2. PERFORM BALANCING PROCEDURE
    - 3. DISPLAY BALANCING RESULTS
  - 5. MONITOR A CHECK
  - 6. GAGE CYCLE HISTORY
  - 7. CHECK SETUP DISPLAY

- **7 GAGE READINGS**
  - 1. DIGITAL DISPLAY
  - 2. BARGRAPH DISPLAY
  - 3. GAGE DATA FILE
  - 4. SELECT DISPLAYABLE CHECKS
  - 5. FEEDBACK DISPLAY

- **8 COUNTERS**
  - 1. PART COUNTERS

- **9 SPC CHARTS**
  - 1. HISTOGRAMS
  - 2. STATISTICS
  - 3. x & R CHARTS
  - 4. SCATTER CHARTS
  - 5. GAGE DATA FILES
  - 6. HISTOGRAMS (LONG TERM)
  - 7. STATISTICS (LONG TERM)

10 SYSTEM ALARMS

1. DISPLAY CAG ALARMS
2. DISPLAY MACHINE ALARMS

11 CLOCK MENU

1. SHOW TIMES

12 UTILITIES

1. SYSTEM CONFIGURATION----------
   1. DEFINE ACCESS PASSWORDS
   2. UNITS OF MEASUREMENT
   3. NUMBER OF GAGES
   4. SINGLE GAGE MONITORING
   5. ALLOCATE DATA FILE
   6. WORK SHIFT START TIMES
   7. LINK GAGE CYCLES
2. GAGE SETUP-----------------------------
   1. GAGE NAMES
   2. GAGE TYPE/TIMER
   3. GAGE RESOLUTION
   4. NUMBER OF PART CHECKS
   5. GAGE ENABLE/DISABLE
   6. GAGE CYCLE SETUP
   7. FEEDBACK SETUP---------------
      1. NUMBER OF OFFSETS
      2. START UP MODE
      3. RUN MODE TRIGGER
      4. PART LAG
      5. OFFSET DEFINITION
3. PART CHECKS---------------------------
   1. CHECK NAMES
   2. CHECK FUNCTIONS
   3. CHECK FORMULAS
   4. MULTIPLE CHECKS
   5. INPUT CHANNEL MAG & POLARITY
   6. CHECK ENABLE/DISABLE
   7. ATTRIBUTE CHECKS--
      1. ASSIGN ATTRIBUTE CHECK OPTOS
      2. ASSIGN VALID ATTR DATA OPTO
      3. VALID ATTR CHECK DATA TIMER
   8. CHECK RESOLUTION SETUP
4. GAGE R&R STUDY ----------------------
   1. GAGE R&R STUDY
   2. # TRIALS & SAMPLES
   3. RESET R&R STUDY DATA
   4. START/STOP STUDY
   5. UCLr TEST
   6. PRINT R&R STUDY
   7. WRITE R&R TO FILE
   8. PART SORT SELECTION
5. ALARM SETUP----------------------------
   1. DEFINE MACHINE ALARMS
   2. ENABLE CAG ALARMS
   3. PROGRAM CONSECUTIVE REJECT LIMITS
6. SYSTEM HARDWARE UTILITIES---
   1. SET SYSTEM CLOCK
   2. CRT SAVER
   3. SERIAL COMMUNICATIONS---
      1. SERIAL COMM SETUP
      2. DIAGNOSTICS
      3. TEST SERIAL PORTS
   4. ANALOG CONFIGURATION
   5. I/O TEST FUNCTIONS-----
      1. FORCE OUTPUTS
      2. MONITOR INPUTS
      3. I/O TRACE
      4. I/O MESSAGE DURATION
   6. VIDEO TEST/SETUP SCREEN

7. NETWORK SETUP ---1. IP ADDRESS SETUP
2. NETWORK USER NAME
3. NETWORK PRINTER
4. NETWORK PART DATA STORAGE
8. ENABLE KEYPAD GAGING

9. SELECT SYSTEM PRINTER---1. SYSTEM PRINTER TYPE
2. TEST PRINTER PORT

7. CAG FILE UTILITIES--------------------1. CAG SETUP FILE UTILITY
2. GAGE DATA FILE UTILITY
3. REMOTE COPY UTILITY

8. GAGE/PART CHECK COPY UTILITY

9 HIDDEN MENUS --------------------------1. INITIALIZE SETUP DATA
2. SOFTWARE CONVERSION
3. SPOOL SETUP PARAMETERS
4. MASTERING LIMITS
5. SET AD SAMPLING
6. SET WATCHDOG TIMER
7. INSTALL OPERATING SOFTWARE
8. DIAGNOSTIC DATA

NOTE: On CAGs with optional Temperature Compensation Software the Hidden Menus are under **12.10**nd the temperature compensation menus are under 12.9

9 TEMPERATURE COMP---1. TEMPERATURE PROBE SETUP
- 1. MANUAL TEMPERATURES
- 2. NUMBER OF PROBE SETS
- 3. PROBE SET NAMES
- 4. ASSIGN INPUT CHANNEL
- 5. INPUT CHANNEL DEAD BAND
- 6. TEMPERATURE SETTLE TIME

2. ASSIGN CHECKS
3. TEMP COMPENSATION TYPE
4. TEMP COMPENSATION STUDY
- 1. AUTO TEMP COMPENSATION STUDY
  - 1. TC STUDY DISPLAY
  - 2. START/STOP STUDY
  - 3. RESET TC STUDY
  - 4. GAGE SELECTION
  - 5. STUDY TYPE
  - 6. PROBE SET SELECTION
  - 7. SAVE STUDY TO FILE
  - 8. RESET TC STUDY FILES
- 2. DEFINE LINEAR COEFFICIENTS
- 3. TEMP COMP DATA OFFLOAD

5. VIEW COEFFICIENTS

5 MENU DESCRIPTIONS

1 SYSTEM DESCRIPTION

The CAG summary screens are accessed through this menu.

The summary screens, 1.1, 1.2, and 1.3, are for display only, no CAG setup information can be changed on these screen. If the operator needs to change setup information that is displayed on the summary screens then the operator can jump to the desired menu by entering the complete menu number and pressing **[enter]**. For example, if the formula for a check being displayed on menu 1.3, Check Summary, needs to be changed the operator can enter "12.3.3" and jump to the check formula screen for that check to make the desired changes.

1.1 SYSTEM SETUP SUMMARY

Single screen display that shows the following setup information:

Menu 12.1	Units
Menu 12.1	Number of Gages
Menu 12.1	Single Gage Monitor
Menu 12.1.7	Gage Linking
Menu 12.6.4	Analog Configuration
Menu 12.7.1	Remote Storage Device
Menu 12.7.2	IP Address
Menu 12.6.7.3	Network User Name
Menu 12.6.8	Keypad Gaging
Menu 12.6.9	System Printer

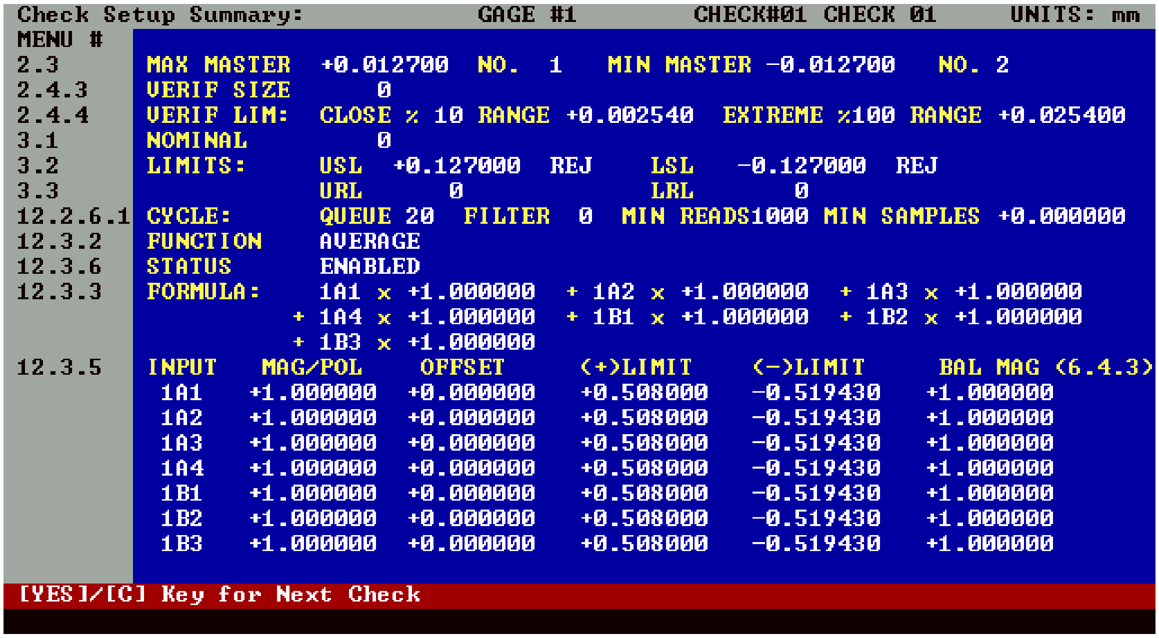
1.2 GAGE SETUP SUMMARY

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

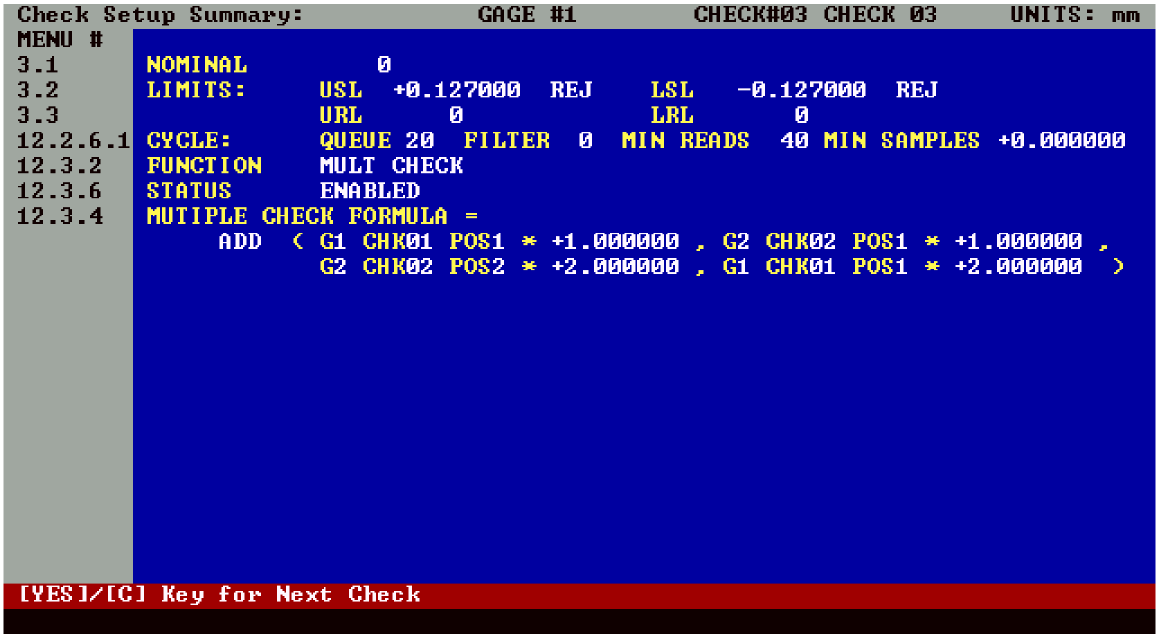
Menu 4.1	Data Accumulation
Menu 12.1.5	GDF Allocation
Menu 12.2.2	Gage Type
Menu 12.2.3	Resolution
Menu 12.2.4	Number of Checks
Menu 12.2.5	Status
Menu 3.4	Classes

1.3 CHECK SETUP SUMMARY

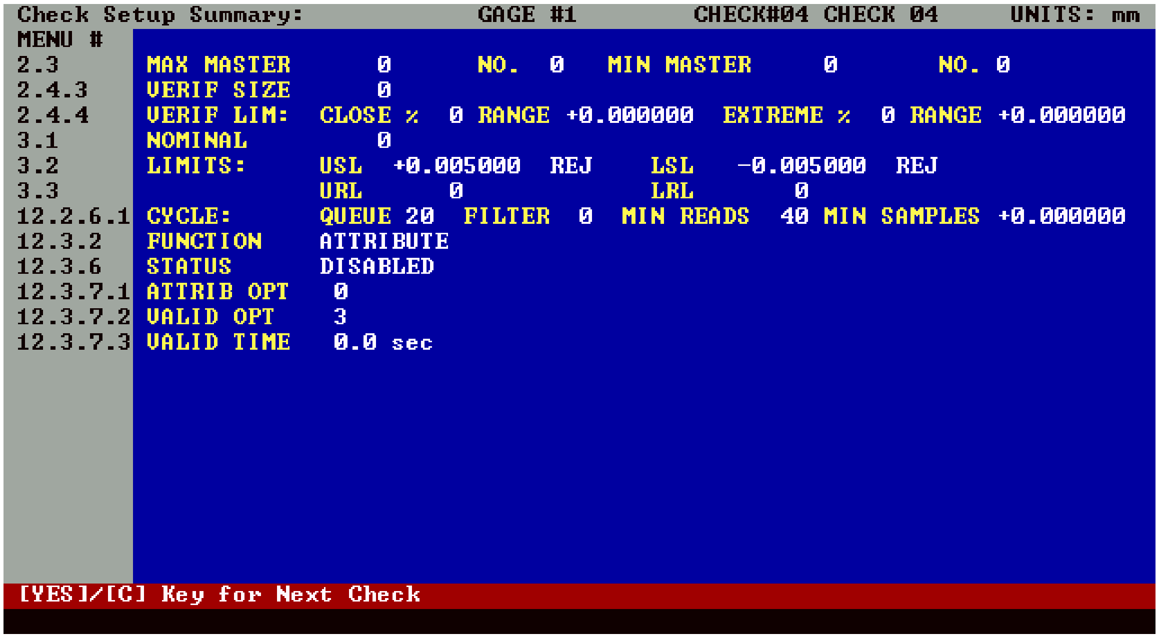
Single screen display for each Check. The following screens depict the information displayed for 3 different check functions; Average, Multiple Check and Attribute.



```
Check Setup Summary:                GAGE #1         CHECK#01 CHECK 01      UNITS: mm
MENU #
2.3         MAX MASTER   +0.012700  NO.  1    MIN MASTER -0.012700    NO. 2
2.4.3       VERIF SIZE       0
2.4.4       VERIF LIM:   CLOSE % 10 RANGE +0.002540  EXTREME %100 RANGE +0.025400
3.1         NOMINAL          0
3.2         LIMITS:      USL  +0.127000  REJ    LSL   -0.127000  REJ
3.3                      URL      0             LRL        0
12.2.6.1    CYCLE:       QUEUE 20  FILTER  0  MIN READS1000 MIN SAMPLES +0.000000
12.3.2      FUNCTION     AVERAGE
12.3.6      STATUS       ENABLED
12.3.3      FORMULA:     1A1 x +1.000000  + 1A2 x +1.000000  + 1A3 x +1.000000
                       + 1A4 x +1.000000  + 1B1 x +1.000000  + 1B2 x +1.000000
                       + 1B3 x +1.000000
12.3.5      INPUT    MAG/POL     OFFSET      (+)LIMIT    (-)LIMIT     BAL MAG (6.4.3)
             1A1    +1.000000  +0.000000   +0.508000   -0.519430    +1.000000
             1A2    +1.000000  +0.000000   +0.508000   -0.519430    +1.000000
             1A3    +1.000000  +0.000000   +0.508000   -0.519430    +1.000000
             1A4    +1.000000  +0.000000   +0.508000   -0.519430    +1.000000
             1B1    +1.000000  +0.000000   +0.508000   -0.519430    +1.000000
             1B2    +1.000000  +0.000000   +0.508000   -0.519430    +1.000000
             1B3    +1.000000  +0.000000   +0.508000   -0.519430    +1.000000

[YES]/[C] Key for Next Check
```



```
Check Setup Summary:                GAGE #1         CHECK#03 CHECK 03      UNITS: mm
MENU #
3.1         NOMINAL          0
3.2         LIMITS:      USL  +0.127000  REJ    LSL   -0.127000  REJ
3.3                      URL      0             LRL        0
12.2.6.1    CYCLE:       QUEUE 20  FILTER  0  MIN READS   40 MIN SAMPLES +0.000000
12.3.2      FUNCTION     MULT CHECK
12.3.6      STATUS       ENABLED
12.3.4      MUTIPLE CHECK FORMULA  =
                 ADD   ( G1 CHK01 POS1 * +1.000000 , G2 CHK02 POS1 * +1.000000 ,
                         G2 CHK02 POS2 * +2.000000 , G1 CHK01 POS1 * +2.000000  )

[YES]/[C] Key for Next Check
```



```
Check Setup Summary:              GAGE #1         CHECK#04 CHECK 04      UNITS: mm
MENU #
2.3        MAX MASTER      0      NO.  0   MIN MASTER     0       NO. 0
2.4.3      VERIF SIZE      0
2.4.4      VERIF LIM:  CLOSE %  0 RANGE +0.000000  EXTREME %  0 RANGE +0.000000
3.1        NOMINAL         0
3.2        LIMITS:     USL  +0.005000  REJ    LSL   -0.005000  REJ
3.3                    URL      0             LRL        0
12.2.6.1   CYCLE:      QUEUE 20  FILTER  0  MIN READS  40 MIN SAMPLES +0.000000
12.3.2     FUNCTION    ATTRIBUTE
12.3.6     STATUS      DISABLED
12.3.7.1   ATTRIB OPT   0
12.3.7.2   VALID OPT    3
12.3.7.3   VALID TIME   0.0 sec

[YES]/[C] Key for Next Check
```

1.4 SYSTEM FEATURES SUMMARY

The CAG software serial number, version number, release date, and feedback type are displayed on this screen.

2 GAGE MASTERING

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

2.1 MASTER THE GAGE

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

<u>Example:</u> Kmax : Max master of known size
Kmin : Min master of known size
Gmax : Gaged Max master
Gmin : Gaged Min master

$$\textbf{MAG} = \frac{\text{Kmax - Kmin}}{\text{Gmax - Gmin}}$$

$$\textbf{ZERO} = \text{Kmax - [MAG x Gmax]}$$

Corrected Reading = (Raw Reading * MAG) + ZERO

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

The Mastering procedure will fail if any of the following conditions occurs:
1) MAG ADJUSTMENT TOO LARGE
2) ZERO ADJUSTMENT TOO LARGE
3) SATURATED READING
4) MIN MASTER > MAX MASTER
5) MIN MASTER = MAX MASTER
6) INSUFFICIENT USABLE READINGS

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

2.2 MASTERING RESULTS

A two-page report listing the latest mastering results. Page 1 displays the keypad entered master sizes along with its associated gaged measurement readings taken during the Mastering Sequence. Page 2 displays the calculated Mag and Zero that will be applied in order to calibrate the readings. An error window will be displayed if any of the Checks

2.3 MASTER SIZES

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

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

2.4 MASTERING TIMER

The automatic prompting of a master cycle can be utilized by programming a timer preset in this menu from 0 to 1440 minutes.

In a manual application, the CAG will prompt the operator with a message on the display *"TIME TO MASTER"*. At this time the operator will enter into menu 2.1 **"MASTER THE GAGE"** and perform a manual verification.

In an automatic application, the CAG can signal the PLC to initiate a master cycle automatically or inform the operator via the display message to perform a gage mastering.

2.5 GAGE VERIFICATION

Once the gage has been calibrated, the means to verify the stability of the process is provided by the *"GAGE VERIFICATION"* menu. The CAG can be programmed to provide a verification procedure with user defined limits in a specified time frame.

2.5.1 VERIFY THE GAGE

This menu allows the operator to manually initiate a gage verification. By selecting this menu, the gage will prompt the operator to insert the verification master and initiate a gage cycle.

2.5.2 VERIFICATION RESULTS

This menu displays the results of the verification cycle. Each masterable check, which has been defined for the gage, is displayed along with the following information:

1) **Calibrated Reading** - The programmed known size of the verification master.

2) **Gaged Reading** - The actual reading of the verification master obtained during the gage cycle.

3) **Zero Shift** - The difference between the Calibrated and the Gaged readings.

4) **Status** - *"Close"* - The close limit has been exceeded but the extreme limit has not been achieved.
"Extreme" - The extreme limit has been achieved.

5) **"Cumulative Zero Shift"** - The accumulated Zero Shift from all of the gage cycles since the last verification cycle.

2.5.3 VERIFICATION MASTER SIZES

The calibrated verification master sizes must be programmed into the CAG to allow calculation of the Zero shift in the verification cycle.

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

2.5.4 VERIFICATION LIMITS

The verification limits are defined as a percentage of the spread between master sizes as programmed in menu 2.3 **"MASTER SIZES"**.

The limit percentages are determined by the operator and programmed in the CAG for each part check. The CAG then calculates the range for each part check based upon the calibrated master sizes. The ranges are utilized to determine the status of the verification results.

The following data is either programmed or calculated:

Close Limit % - The programmed "approach" percentage. This percentage of the calibrated master size difference is used to calculate the close range.

Close Range - The calibrated master size difference times the close limit percentage. The gage will not fail verification if this range is achieved or exceeded. The CAG will display "Close" in the verification results menu if the range has been achieved or exceeded.

Extreme Limit % - The programmed "fail" percentage. This percentage of the calibrated master size difference is used to calculate the extreme range.

Extreme Range - The calibrated master size difference times the extreme limit percentage. The gage will fail verification if this range is achieved or exceeded. The CAG^{TM} will display "Extreme" in the verification results menu if the range has been achieved.

2.5.5 VERIFICATION FREQUENCY TIMER

The automatic prompting of a verification cycle can be utilized by programming a timer preset in this menu from 0 to 1440 minutes.

In a manual application, the CAG will prompt the operator with a message on the display *"TIME TO VERIFY"*. At this time the operator will enter into menu 2.4.1 **"VERIFY THE GAGE"** and perform a manual verification.

In an automatic application, the CAG can signal the PLC to initiate a verification cycle automatically or inform the operator via the display message to perform a gage verification.

3 LIMITS

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

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

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

3.1 NOMINAL SIZES

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

3.2 PART TOLERANCES

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

3.3 REASONABLE LIMITS

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

3.4 SORT CLASSES

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

1) **Classifying Dimension** - Defines which one Part Check is to be used for classifying the part.

2) **# Sort Classes** - Defines the number of numeric classes that the part will be categorized into for the classifying dimension.

3) **Classifying Dim. MAG** - Classifying Dimension is multiplied by this value to determine part class.

4) **Classifying Dim. Zero** - This value will be added to the Classifying Dimension to determine the part class.

5) **Sort Classes** - Upper and Lower Boundaries for each sort class. Note: The sort class boundaries must not overlap.

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

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

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

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

4 SPC SET UP

4.1 ENABLE DATA ACCUMULATION

There are 3 separate areas of data accumulation in the CAG:

1) **Part Counters** - Running Totals of all parts gaged.

2) **Gage Data File & Charts** - Actual measurement data.

3) **Long Term SPC Charts** - Running Totals used in generating Long Term Statistics and Histograms.

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

4.2 DEFINE x & R CHART PARAMETERS

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

1) **Subgroup Size** - Number of Consecutively Gaged Parts in the Sample (Plot).

2) **Sample Frequency** - Number of Consecutively Gaged Parts "skipped" between Sample plots.

3) **Control Limits** - (UCLx, LCLx, UCLr) The Scale for the x & R chart is determined by these values. As an option, the Control Limits can be calculated by the CAG.

4.3 ENABLE SPC ALARMS

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

1) **Point Outside of Control Limit** - A point (plot) falling outside of its defined Control Limits will generate this alarm.

2) **Upward/Downward Trend of 7 or More** - Seven consecutive points that continue to increase or decrease will generate this alarm.

3) **Hugging the Control Line** - Two out of three Points that lie within the outer one-third zones will generate this alarm.

4) **Runs Above/Below The centerline** - A predefined number of successive points on the Control Chart that fall on one side of the centerline will generate this alarm.

4.4 AUTO ANNOTATION LOGGING SETUP

Allows the operator to define annotations made to the parts recorded in the gage data file, menu 7.3, for the following conditions: Gage Mastered, Feedback Adjustment, CAG Alarm Occurred, and Machine Alarm Occurred. If one of the conditions is enable in this menu **and** the condition occurs while the accumulate gage data is also enabled, see menu 4.1 option 2, then a notation will be made in the gage data file, see menu 7.3.

To enable one of the automatic annotation options enter the appropriate number 1 through 4 when the CAG prompts "Select Annotation Logging Condition (1-4)". The "Annot #" field will be highlighted for the selection. Enter an annotation number from 1 to 31. The "Annotation Description" field will change from "Disabled" to " Annotation Text…". The Annotation description text can be edited in menu 7.3.

To disable one of the automatic annotation options enter the appropriate number 1 through 4 when the CAG prompts "Select Annotation Logging Condition (1-4)". The "Annot #" field will be highlighted for the selection. Enter a "0" in the "Annot #" field. The "Annotation Description" field will change to "Disabled".

The annotation may be mark on the current part in the gage data file or the next part gaged depending on which condition is detected.

Gage Mastered: The next part after the master cycle is complete will be annotated.

Feedback Adjustment: The part that triggered the feedback adjustment will be annotated.

CAG Alarm: The part that is being gaged when the CAG alarm occurs will be annotated.

Machine Alarm: The next part to be gaged after the machine alarm occurs will be annotated. Machine alarms are initiated by the PLC controlling the gage. **NOTE:** Machine Alarm is not available in CAGs with manual software.

4.5 FEEDBACK CONTROL (Available only on CAG's with Feedback Software)

The CAG can be configured to compute machine tool offsets and transmit the offsets to the machine control for adjustments. This menu contains the parameters for feedback setup and the variables used for feedback. See CAG Feedback Section 10 for a detailed description of this menu.

4.6 FEEDBACK CONTROL REPORT
(Available only on CAG's with Feedback Software)

See CAG Feedback Section 10 for a description of this menu.

5 DATA RESET

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

6 INPUT SET UP

6.1 DISPLAY ALL INPUTS

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

6.2 DISPLAY PART DIMENSIONS

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

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

6.3 DISPLAY INPUT BARGRAPH

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

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

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

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

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

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

6.4 BALANCE INPUTS

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

6.4.1 SELECT INPUTS TO BALANCE

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

6.4.2 PERFORM BALANCING PROCEDURE

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

6.4.3 DISPLAY BALANCING RESULTS

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

6.5 MONITOR A CHECK

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

6.6 GAGE CYCLE HISTORY

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

6.7 CHECK SETUP DISPLAY

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

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

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

Check Formula: Displays a list of all of the input channels used in the selected check, (1A1, 1A2, etc) and the multiplier applied to the input. The live reading from each input and the live reading times the multiplier is also displayed. The information is for display only the check formula inputs and multipliers can be changed in menu 12.3.

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

Pressing the **[yes]** key cycles through all the checks.

7 GAGE READINGS

7.1 DIGITAL READINGS DISPLAY

This menu displays the following information:

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

STATUS - Individual status for all predefined Part Checks.

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

The information displayed can be from either the last part gaged in any gage or the last part gaged in the gage that is currently selected in menu 12.1, System Configuration, option (4), Single Gage Monitoring. Use the **[7]** key to toggle between "Last Part Gaged" from any gage or "Current Gage Only" modes.

This menu displays a single gage's information if single gage monitoring is activated or if the system is defined for only one gage.
If the system is defined for more than one gage and single gage monitoring is deactivated, the menu is divided into sections to display all of the gage information simultaneously.
NOTE: Only those checks which are defined as "Enabled" in menu 7.4, "Select Displayable Checks" will be displayed in this menu.

7.2 BARGRAPH DISPLAY

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

The information displayed can be from either the last part gaged in any gage or the last part gaged in the gage that is currently selected in menu 12.1, System Configuration, option (4), Single Gage Monitoring. Use the **[7]** key to toggle between "Last Part Gaged" from any gage or "Current Gage Only" modes.

NOTE: Only those checks which are defined as "Enabled" in menu 7.4, "Select Displayable Checks" will be displayed in this menu.

7.3 GAGE DATA FILE

The Gage Data File on the CAG contains all of the information stored for each part gaged. There is one file for each gage programmed on the CAG, and these files are accessible through the NetBEUI or TCP/IP network interface. The gage data file name is the same as the part setup file except with the extension .dg1, .dg2, .dg3 etc. where ".dg1" is gage date from gage number 1, ".dg2" is gage data from gage number 2, etc. Below is an example of a gage data file containing five records. The individual fields of the comma-delimited file are also described below.

NOTE: Only those checks which are defined as "Enabled" in menu 7.4, "Select Displayable Checks" will be recorded in the gage data file.

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

Header Information

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

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

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

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

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

Gage Data Records

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

The first field is a 6-digit record number.

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

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

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

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

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

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

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

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

Wrapping

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

When the gage data file has wrapped, deleting the last part gaged presents a new problem. Since the record can not be removed from the file without corrupting the order of the index numbers, the date-time stamp is changed to 00/00/00-00:00:00 to show that the part was deleted. The CAG then knows to overwrite this record with the new data the next time a part is gaged. Any record with a date-time stamp of 00/00/00-00:00:00 should be ignored.

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

Annotation

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

To manually annotate a particular record:

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

To setup automatic annotation:

Refer to menu 4.4 Auto Annotation Logging Setup for setup procedures.

Note: After enabling the automatic annotation options in menu 4.4 the text descriptions can only be edited from menu 7.3 not from menu 4.4

Deleting Records

Deleting the last gage Reading

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

If there was no data accumulated during the last gage cycle or it had already been deleted, the message *"No Data Accumulated Last gage Cycle"* will be displayed. If there was data accumulated during the last gage cycle, the following messages are displayed as the data is deleted:
"Deleting Record from Part Counters", "Deleting Record from Gage Data File and Charts" and “Deleting Record from Long Term SPC”.

Deleting Selected Gage Readings

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

[1] - Move Up - Highlights the next record up on the screen.
[2] - Move Down - Highlights the next record down on the screen.
[3] - Page Up - Displays the next screen of records.
[4] - Page Down - Displays the next screen of records.
[5] - Toggle Flag - Marks the currently highlighted record for deletion. An "X" will be displayed next to the record number and the "Flagged Status:" will change to "Flagged for Deletion." Pressing [5] again will remove the flagged status and the part will be marked "Keep Part".
[enter] - After all the desired parts have been flagged press [enter] to actually delete the records from the gage data file. A progress window will be displayed shown percentage complete. NOTE: If the gage data file contains a large number of parts the deletion progress may take some time.

7.4 SELECT DISPLAYABLE CHECKS

This menu can be used to select which checks will be displayed in menus 7.1 and 7.2 and recorded in the gage data file in menu 7.3. A list of all the checks is displayed and the operator can select and check to be "Enabled" meaning it will be displayed or "DISABLED" meaning it will not be displayed.

7.5 FEEDBACK DISPLAY (AUTOMATIC CAG W/FEEDBACK ONLY)

See Feedback Section 10 for a detailed description of this menu.

8 COUNTERS

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

OVER COUNT - Number of Gaged readings that exceeded the Upper Tolerance Limit.

UNDER COUNT - Number of Gaged readings that exceed the Lower Tolerance Limit.

TOTAL PARTS - Total Number of Parts gaged since the last counter reset.

TOTAL GOOD - Total number of parts gaged with all check dimensions within their specified Tolerance Limits since the last counters reset.

TOTAL REJECT - Total number of parts gaged which had one or more check dimensions outside the specified tolerance limits since the last counters reset.

9 SPC CHARTS

9.1 HISTOGRAMS

A Histogram is a bargraph, 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 Histogram is generated from the stored gaged data. Before the Histogram can be drawn a time frame for analysis must be entered. This allows the gaged data stored in the CAG to be analyzed independently per shift, day, week or month.

There are 5 floating vertical lines displayed on the Histogram:

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

The Histogram also displays additional count information:

1) **# SAMPLES** - Total no. of Samples

2) **# W/IN SPEC** - Total no. of Samples within Tolerance

3) **# ABOVE USL**- Total no. of Samples above Upper Specification Limit.

4) **# BELOW** LSL- Total no. of Samples below Lower Specification Limit.

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

9.2 STATISTICS

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

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

9.3 x & R CHART

The x & R Chart is generated from the stored gaged data. The maximum number of plots on the chart is a function of the defined sample size and frequency. See menu 4.0 “SPC SETUP” for setup of plots sizes and frequency.

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

Example:
Number of Parts Gaged = 100
Subgroup Size = 5
Sample frequency = 50
Total Plots = 2
Plot #1 = 1,2,3,4,5
Plot #2 = 56,57,58,59,60

Trend alarms can be monitored in this display.

9.4 SCATTER CHART

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

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

9.5 GAGE DATA FILE

The CAG^{TM} has the capability to store up to 65,000 part readings. Additional information is stored with each individual part:

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

9.6 HISTOGRAMS (Long Term)

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

9.7 STATISTICS (Long Term)

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

10 SYSTEM ALARMS

10.1 DISPLAY MACHINE ALARMS

One To eight Programmable Fault Codes will be displayed with a Date/Time Stamp of when it occurred. Machine Alarms are detected externally and are communicated to the CAG via parallel I/O Lines.

10.2 DISPLAY CAG ALARMS

One to sixteen CAG alarms will be displayed with a Date/Time Stamp of when it occurred. The alarms can be enabled or disabled from menu 12.5.2 **"ENABLE CAG ALARMS"**.

11 CLOCK MENU

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

1) MASTERED

2) SETUP ITEM CHANGED

3) MASTER SIZES CHANGED

4) SPEC. LIMIT CHANGED

5) COUNTERS RESET

6) GAGE DATA FILE RESET

7) LONG TERM SPC RESET

8) R & R STUDY PERFORMED

9) LAST CAG ALARM

10) LAST MACHINE ALARM

12 UTILITIES

12.1 SYSTEM CONFIGURATION

12.1.1 LOCAL PASSWORD

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

The Master Password is needed in order to define the Operator or Supervisor password.

The operator and supervisor passwords can be defined as any combination of alpha-numeric digits from 1 to 4 characters in length. It is possible to disable either of the passwords by defining the password to be the **[YES]** key.

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

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

12.1.2 UNITS OF MEASUREMENT

Two units of measure are available for displaying numeric values: inch or millimeter. Keypad programmable values will automatically convert to reflect the selected unit of measure.

12.1.3 NUMBER OF GAGES

The CAG can be configured to simultaneously control 1 to 4 unique gages.

12.1.4 SINGLE GAGE MONITORING

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

12.1.5 GAGE RECOGNITION MODE (Manual CAG Only)

This menu is only present in the manual version of the CAG. This menu controls how the CAG selects which gage to measure when a start gage interrupt is received. There are five options available:

1) **Default** – When this mode is selected the CAG will measure whatever gage is selected in the "Single Gage Monitoring" menu 12.1.4 if single gage monitoring is enabled. If Single Gage Monitoring is disabled, the CAG will measure the first gage that is enabled. See "Gage Enable/Disable" menu 12.2.5.
2) **Manual** – When this mode is selected the CAG will display a pop up window prompting the operator to select which gage measure. Use the keyboard to select the gage number to be gaged.
3) **Automatic** - When this mode is selected the CAG will select the first enabled gage in which all of the checks are reading on scale. For example, consider a CAG that has three gages programmed and enabled for three different air plugs. If one of the air plugs is place in a part to be gaged and the other two are left venting only the gage corresponding that is in the part will be measured.
4) **Default Auto Check** – When this mode is selected the CAG will select the gage to measure in the same manner as in the "Default" option above. However, only checks in which all the input associated with the check are **not** saturated will be stored. Additional start gage signals are allowed until all checks in the gage have been stored. For example, if there are 8 checks in a gage and when the start gage signal is received only 4 of the checks are not saturated, the CAG will store only those 4 results. When a second start gage signal is received, if the remaining four checks are not saturated, they will be stored and the gaging cycle will be complete. The same 8 checks could also be done with 8 start gage signals so long as each check was measured without being saturated at least once. Menu 7.1 "Digital Display" will show checks that have **not** been stored in as blank and checks that have been stored as the actual value stored. If the same check is regaged before completing all checks, the old value will be overwritten.
5) **Manual Auto Check** – When this mode is selected the CAG will display a pop up window prompting the operator to select which gage to measure. Use the keyboard to select the gage number to be gaged. However, only checks in which all the input associated with the check are **not** saturated will be stored. Additional start gage signals are allowed until all checks in the gage have been stored. For example, if there are 8 checks in a gage and when the start gage signal is received only 4 of the checks are not saturated, the CAG will store only those 4 results. When a second start gage signal is received, if the remaining four checks are not saturated, they will be stored and the gaging cycle will be complete. The same 8 checks could also be done with 8 start gage signals so long as each check was measured without being saturated at least once. Menu 7.1 "Digital Display" will show checks that have not been stored as blank and checks that have been stored as the actual value stored. If the same check is regaged before completing all checks, the old values will be overwritten.

12.1.5 ALLOCATE DATA FILE MEMORY (Auto CAG)
12.1.6 ALLOCATE DATA FILE MEMORY (Manual CAG)

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

12.1.6 WORK SHIFT START TIMES (Auto CAG)
12.1.7 WORK SHIFT START TIMES (Manual CAG)

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

12.1.7 LINK GAGE CYCLES (Auto CAG)
12.1.8 LINK GAGE CYCLES (Manual CAG)

The Link Gage Cycles menu provides the ability to link 2 or more defined gages measurement or calibration cycles together.

Example:

The CAG is configured as 3 Gages for 1 tooling fixture. There is 1 Push Button Pack connected to the CAG's Gage #1 connector. It would be desirable to initiate Gage #2 and Gage #3 measurement cycles at the same time as Gage #1. By programming Gage #1 as the Initiator and Gage #2 and Gage #3 as active then a Gage #1 measurement cycle will also initiate Gage #2 and Gage #3 measurement cycles as well.

The Link Gage Cycles menu also provides the ability to specify how the CAG gaged part status lights behave during linked gage cycles through the “Gage Cycle Status Lights” option. This field enables the operator to choose which of the linked gages controls the status lights.

The Link Gage Cycles menu also provides the ability to copy the mag and zero calculated during mastering to another gage. For example, assume gage 1 and gage 2 are setup identically. They measure the same part, but gage 1 measures parts made on lathe 1 and gage 2 measures parts made on lathe 2. The same tooling is used to measure parts for both gages, so the mastering results should be identical also. Therefore, when gage 1 is mastered, the results are copied to gage 2.

12.2 GAGE SETUP

12.2.1 GAGE NAMES

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

12.2.2 GAGE TYPE / TIMER

A gage can be defined as either a *"Static"* or a *"Dynamic"* gage. A static gage requires the part to be stationary in order for measurement data to be collected from the parts surface. In contrast a part placed in a dynamic gage must be moved (e.g. rotated) in order for data to be dynamically accumulated from it's surface. There are 2 methods for ending the gage cycle for a dynamic gage:

1) External End Gage Signal
2) Internal Cycle Timer

The Push Button Pack or a PLC can generate the External End Gage signal.

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

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

12.2.3 GAGE RESOLUTION

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

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

There are 7 resolution options:
1) 0.001”
2) 0.0001”
3) 0.00005”
4) 0.00001”
5) 0.000005”
6) 0.000002”
7) 0.000001”

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

12.2.4 NUMBER OF PART CHECKS

The number of part checks for each gage needs to be defined. A single gage can be defined to have from 1 to 16 checks.

12.2.5 GAGE ENABLE/DISABLE

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

12.2.6 GAGE CYCLE SETUP

12.2.6.1 GAGE CYCLE SETUP

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

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

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

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

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

12.2.6.2 CUT-OUT DETECTION

CutOut 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.

CutOut Detection is based upon the readings of the gage cycle. These readings are best observed in Menu 6.2 **"DISPLAY PART DIMENSIONS"**. 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^{TM} in the gaging algorithm.

The set-up parameters for CutOut Detection are:

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^{TM} 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^{TM} will enter into the Queue. Any raw reading below the Min Limit will not be entered in the Queue.

QUEUE SIZE - The number of acceptable raw readings that the CAG^{TM} will store in the Queue. The default value for the Queue Size is 4.

EXAMPLE:

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 CutOut 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.

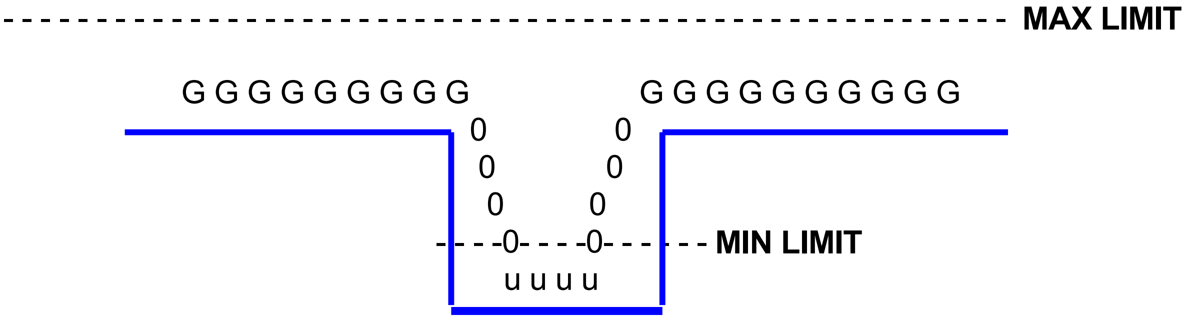


Figure I

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

The first step would be to select Menu 6.2 **"DISPLAY PART DIMENSIONS"** in the CAG^{TM} 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 "X" 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 CAG^{TM} 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 "X" readings has been determined to be .0005". By programming the MAX DELTA to .0007", the CAG^{TM} 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 ("0" readings in Figure I), the delta will exceed .0007". The CAG^{TM} 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 "x" 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 CAG^{TM} 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 CAG will stop accepting readings and the Queue will be cleared.

If the Queue size is correctly set, the transitional readings would be purged from the Queue. In Figure II 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.

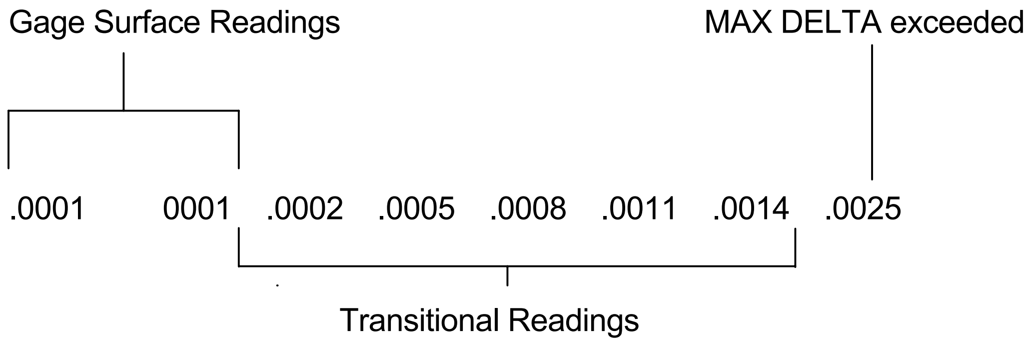


Figure II

12.2.7 FEEDBACK SETUP

See CAG^{TM} Feedback Section 10 for a detailed description of this menu.

12.3 PART CHECKS

12.3.1 CHECK NAMES

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

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

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

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

12.3.2 CHECK FUNCTIONS

Defining a check's function involves assigning a check type to a part check. The CAG^{TM} recognizes eight check types:

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

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

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

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

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

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

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

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

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

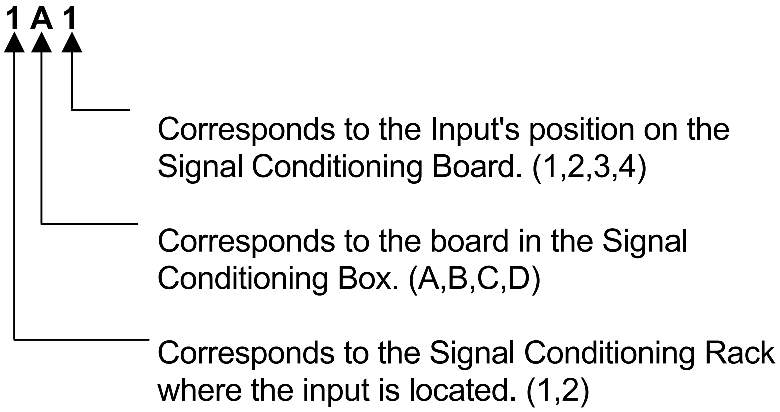
INTEG. AVG: A check defined as an INTEG. AVG sums all of the gage readings and divides it by the number of gage readings.

12.3.3 CHECK FORMULAS

There are three elements required to develop a Check Formula.
These include:

1) Input Definition
2) Indicator
3) Multiplier

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



Corresponds to the Input's position on the Signal Conditioning Board. (1,2,3,4)

Corresponds to the board in the Signal Conditioning Box. (A,B,C,D)

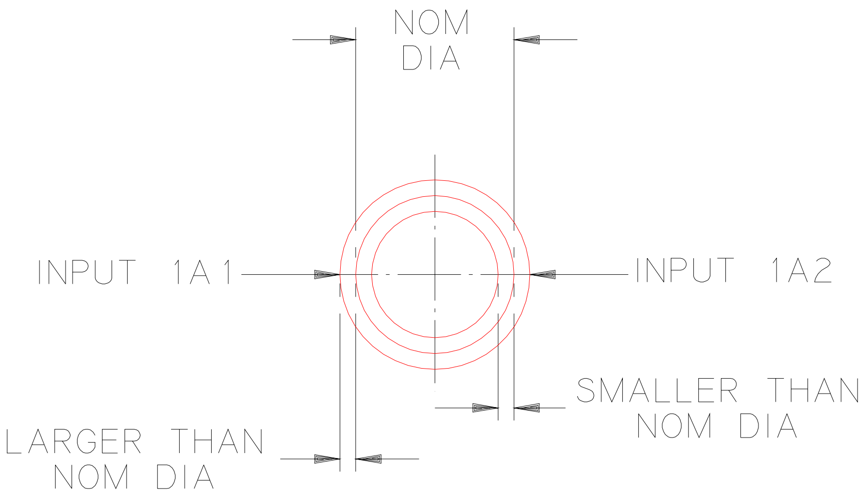
Corresponds to the Signal Conditioning Rack where the input is located. (1,2)

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

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

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

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



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

(1A1 x +1.0000) and (1A2 x +1.0000)

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

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

The completed formula would be displayed as:

CHK #1 = 1A1 x +1.0000 + 1A2 x +1.0000

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

Part checks defined as "MULTIPLE CHECKS" will <u>NOT</u> appear in this display.

12.3.4 MULTIPLE CHECKS

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

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

Each line consists of four sections of information: the first operand, second operand, operation, and resultant. The operands are previously defined checks, specified by a gage number, check number, position number and multiplier. The operation defines the type of action to perform on the two operands, such as addition. The resultant specifies which check number to store the result of the operation in.

The individual fields in the multiple check table are below:

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

GAGE - The first gage number field specifies which gage the first check in the operation will come from. Likewise, the second gage number field specifies which gage the second check in the operation will come from. This allows checks from other gages to be used in defining the current gages multiple checks.

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

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

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

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

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

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

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

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

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

TIR - Returns the difference between the maximum reading and minimum reading of a set of checks.

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

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

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

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

(Gage 1, Check 4) = (Gage 1, Check 1) + (Gage 2, Check 1) +
(Gage 1, Check 2) - (Gage 2, Check 2)

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

MULTIPLE CHECKS: GAGE #1

	1ST				2ND					
CASE	GAGE	CHK	POS	MULTIPLIER	GAGE	CHK	POS	MULTIPLIER	COND	RESULT
1	1	1	1	+1.000	2	1	1	+1.000	ADD	CONT
2	1	2	1	+1.000	2	2	1	-1.000	ADD	4
3										
4										
5										

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

The second line of the table continues the calculation adding Case 1 to Check 2 of Gage 1, multiplied by (+)1.000, and Check 2 of Gage 2, multiplied by (-)1.000. The result is Check 4 of Gage 1.

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

12.3.5 MAG & POLARITY

The Polarity and MAG for each of the Inputs in the gaging fixture(s) must be defined. The Polarity/MAG variable is a signed number that assigns direction to the linear movement of the Input and is also a conversion factor providing compatibility between the CAG software and Inputs with different linear ranges. In most cases, the Polarity/MAG is set equal to +1.0000 . The **OFFSET** variable is an additional signed number, which can be added to the individual Input Reading to allow for tooling inconsistencies. The (+) and (-) saturation limits are used in probe check calculations to determine whether an input is functioning correctly. If the CAG has temperature compensation software this menu will also allow the operator to enter a temperature offset, in degrees Fahrenheit for any temperature probes in the system.

12.3.6 CHECK ENABLE/DISABLE

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

12.3.7 ATTRIBUTE CHECKS

12.3.7.1 ASSIGN ATTRIBUTE CHECK OPTOS

If any checks are defined as attribute checks, this menu is used to define the opto input associated with each check.

12.3.7.2 ASSIGN VALID ATTR DATA OPTO

If any checks are defined as attribute checks, this menu can be used to define an opto input that must be on before the CAG™ checks the status of the optos defined in menu 12.3.7.1. If more than one gage has attribute checks, one opto can be defined for each gage.

12.3.7.3 VALID ATTR CHECK DATA TIMER

If any checks are defined as attribute checks, this menu is used to define the time the CAG waits for the optos defined in menu 12.3.7.2 to go active.

12.3.8 CHECK RESOLUTION SETUP

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

12.4 GAGE R & R STUDY

12.4.1 GAGE R & R STUDY

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

Gage Reproducibility is the variation in the average of measurements made by DIFFERENT operators using the same gage when measuring identical characteristics of the same parts.
"Equipment Variation" is synonymous with Gage Repeatability and this value is displayed as *"EV"*. Similarly, *"Appraiser Variation"* is synonymous with Gage Reproducibility and is displayed as *"AV"*.

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

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

12.4.2 #TRIALS / SAMPLE SIZE

Number of trials available: 2 or 3
Number of samples available: 1 - 10

12.4.3 RESET R & R STUDY DATA

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

12.4.4 START/STOP STUDY

Select Start or Stop R & R study. Select which gage to perform R & R study on. (Inactive if Single Gage Monitor feature is enabled)

12.4.5 UCLr TEST

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

12.4.6 PRINT R & R STUDY

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

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

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

12.4.7 PRINT R & R STUDY

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

12.4.8 PART SORT SELECTION (Not Available on Manual Versions)

This feature is used in automatic gage cycles and allows the operator to select in which exit chute of the gage the parts being sampled in the R&R study will exit. The selections are:

1. Good Chute
2. Reject Chute
3. Rework Chute

12.5 ALARM SETUP

12.5.1 DEFINE MACHINE ALARMS

The CAG has eight programmable machine alarms available to alert the operator to specific external conditions signaled by the machine controller. For example, if the machine controller detects a jam condition, it sends the code corresponding to that condition to the CAG, which displays the defined alarm message.
Select the machine alarm to modify and press **[ENTER]**. To modify the Alarm Descriptor, follow the prompts displayed in the editor window that appears. Press the **[8]** key to exit the editor.

If the CAG^{TM} is configured for one gage, the Source Gage will always be Gage 1, since this is the only gage available. However, if the CAG^{TM} is configured for more than one gage, the Source Gage can be changed to any available gage. Follow the prompt, if it appears, to select the Source Gage from the active gages.

The Alarm Destination defines where the machine alarm will be displayed when triggered. The three options are:

ANY MENU - Displays machine alarms in a pop up window in the middle of the screen, regardless of the current CAG^{TM} screen. Multiple alarms can be displayed.

STATUS LINE 25 - Displays machine alarms on the bottom line of the screen, regardless of the current CAG^{TM} screen.

ALARM MENU ONLY - Displays machine alarms in the Menu 10.1 Display Machine Alarms only.

The Status determines whether or not the machine alarm is displayed when the alarm code is received from the machine control. Follow the prompt to enable/disable the machine alarm display. The **[YES]** key is used to display the next page of machine alarms.

12.5.2 ENABLE CAG^{TM} ALARMS

The CAG^{TM} has internal alarms available to alert the operator to specific internal conditions. These alarms are defined by the system and cannot be changed. They can, however, be enabled and disabled by the operator. The first four alarms are defined below:
CONSECUTIVE REJECT LIMIT EXCEEDED - This alarm is activated when the number of consecutive rejects exceeds the limit defined in the Menu 12.5.2 Program Consecutive Reject Limits.

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

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

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

Select the CAG alarm to modify and press **[ENTER]**. Since the CAG alarms are for preset internal alarm conditions, the Alarm Descriptors can not be modified.

Inform Machine Control is used to enable/disable the shutdown message. If enabled, the CAG sends the shutdown message to the machine controller whenever the CAG alarm is triggered. If disabled, the CAG doesn't send the shutdown message to the machine controller. Follow the prompt to enable/disable the shutdown message.

The Alarm Destination defines where the machine alarm will be displayed when triggered. The three options are:

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

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

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

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

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

12.5.3 PROGRAM CONSECUTIVE REJECT LIMITS

The CAG monitors the number of consecutive rejected parts that have been measured. A consecutive Reject Limit can be programmed in the CAG. On violation of the limit, an error message will be displayed on the display. A shutdown message can also be generated for automatic applications.

12.6 SYSTEM HARDWARE

12.6.1 SET SYSTEM CLOCK

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

12.6.2 CRT SAVER

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

1) CRT SAVER TIMER PRESET
2) RESTORE CRT ON MC INTR

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

The RESTORE CRT ON MC INTR will restore the blanked out screen on the next parallel communication link initiated from a PLC.

12.6.3 SERIAL COMMUNICATIONS

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

12.6.3.1 SERIAL COMMUNICATION SETUP

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

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

12.6.3.2 DIAGNOSTICS

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

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

12.6.3.3 TEST SERIAL PORT

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

12.6.4 ANALOG CONFIGURATION

The configuration of the number of inputs available (16 or 32) is programmed in this menu.

12.6.5 I/O TEST FUNCTIONS

The I/O TEST FUNCTIONS is a diagnostics menu that is used in trouble shooting the Parallel I/O.

12.6.5.1 FORCE OUTPUTS

Force any combination of Outputs ON or OFF.

12.6.5.2 MONITOR INPUTS

Monitor the Inputs Real Time for ON/OFF states.

12.6.5.3 I/O TRACE

Displays the last 15 messages received and transmitted in Input and Output buffer.

12.6.5.4 I/O MESSAGE DURATION

Allows the operator to program the length, in milliseconds, of the I/O message as sent by the CAG to the PLC.

12.6.6 VIDEO TEST/SETUP SCREEN

This menu performs 2 functions for the Video display:

1) Visual Color Test
2) Vertical Sync adjustment

12.6.7 NETWORK SETUP

12.6.7.1 IP ADDRESS SETUP

If the CAG is configured for TCP/IP the CAG IP address, subnet mask, and gateway is defined in this menu.

12.6.7.2 NETWORK USER NAME

The CAG network user name and domain logon is defined in this menu.

12.6.7.3 NETWORK PRINTER

The CAG network printer is defined in this menu.

12.6.7.4 NETWORK PART DATA STORAGE

This menu is used to define the network storage path, and the file names for the gage data, part counter, alarm, and feedback files for each gage that is to transfer data to the network. See "Network File Storage Specifications" in section 8, "Parallel Communication" for additional information.

12.6.8 ENABLE KEYPAD GAGING

Allows Gaging to be initiated from the keypad. When this option is enabled, press **[SHIFT]** and the number of the gage being utilized to gage. This feature allows the operator to initiate the gage cycle to perform any of the following operations:

1) Gage Readings from menu 7.1
2) Gage Mastering from menu 2.1
3) R & R Study from menu 12.4.1

12.6.9 SELECT SYSTEM PRINTER

The CAG allows the operator the option of choosing the type of printer to be utilized and the protocol for that printer. The system printer type options are:

12.6.9.1 SYSTEM PRINTER TYPE

The types of printers are:

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

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

12.6.9.2 TEST PRINTER PORT

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

12.7 CAG FILE UTILITIES

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

12.7.1 CAG SETUP FILE UTILITY

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

NOTE: When a setup is loaded the associated gage data file is also loaded. The gage data file has the same name as the gage setup file except the file extension is ".dg1". If the setup has multiple gages programmed then a gage data file is loaded for each gage. The gage data file name is still the setup name but the extension are ".dg1", ".dg2", etc.

12.7.2 REMOTE COPY UTILITY

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

Remote Device:

1. Connect the IOMEGA ZIP DRIVE to the parallel port (LPT1) or connect the compact flash drive or compact flash reader/writer to the USB port on the CAG enclosure.
2. If using Iomega Zip Drive, make sure a zip disk is installed in Iomega Zip drive.
3. Select desired remote utility for Menu 12.7.3 and follow command prompt.
4. Setup files will be copied to and from the following directory on the zip drive:
   :\REMOTE\PARM
   Gage Data Files will be copied to the following directory on the zip drive:
   :\REMOTE\GDF

12.8 GAGE/PART CHECK COPY UTILITY

The operator can use this menu to copy an entire gage setup from one software gage to another within the CAG or copy an individual check from one gage to another.

12.9 HIDDEN MENUS (ACCESS BY MASTER PASSWORD ONLY)

NOTE: If the CAG has temperature compensation software the hidden menus are moved to menu 12.10.

12.9.1 INITIALIZE SETUP DATA

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

12.9.2 SOFTWARE CONVERSION

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

12.9.3 SPOOL SETUP PARAMETERS

Selecting this menu will automatically print the setup parameters for the CAG. The CAG simulates the keystrokes necessary to enter each screen and then prints them. Pressing any key will halt printing where it is and leave the CAG in the current screen. When all of the screens have been printed, the CAG returns to the Index menu. The screens that are printed are listed below:

MENU #	DESCRIPTION
12.1	System Configuration
12.1.5	Data File Allocation
12.2.1	Gage Names
12.2.2	Gage Type/Timer
12.2.3	Gage Resolution
12.2.4	Number of Part Checks
12.2.5	Gage Enable/Disable
12.2.6	Gage Cycle Setup
12.3.1	Check Names
12.3.2	Check Functions
12.3.3	Check Formulas
12.3.4	Multiple Checks
12.3.5	Mag & Polarity
12.3.6	Check Enable/Disable
12.5.1	Define Machine Alarms - Automatic CAG
12.5.2	Enable CAG Alarms - Automatic CAG
12.5.3	Consec. Reject Limit - Automatic CAG
12.5.1	Enable CAG Alarms - Manual CAG
12.5.2	Consec. Reject Limit - Manual CAG
2.3	Master Sizes
3.1	Nominal Sizes
3.2	Part Tolerances
3.3	Reasonable Limits
3.4	Sort Classes

12.9.4 MASTERING LIMITS

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

12.9.5 SET AD SAMPLING

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

12.9.6 SET WATCHDOG TIMER

The watchdog timer can be enabled or disabled here.

12.9.7 INSTALL OPERATING SOFTWARE

The CAG operating software can be loaded from the remote Iomega Zip Drive. This allows for easy installation of enhancements and upgrades to the operating software.

12.9.8 DIAGNOSTIC DATA

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

Option 1 allows the operator to select either [1], "Checks" or [2], "Inputs". If Checks is selected the text file will contain the readings of each enabled check after applying all inputs and multipliers. If Inputs is selected the text file will record the readings from each individual probe.

Option 2 allows the operator to select the checks or inputs for which data will be collected. Entering a check number toggles between "Disabled", no data collected, and "Store Data", data for that check is recorded.

Option 3 allows the data to be written to a Zip Drive if one is connected to the CAG.

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

12.9 TEMPERATURE COMPENSATION

TEMPERATURE PROBE SETUP

12.9.1.1 Manual Temperatures

Disables all temperature input devices and allows the gage operator to manually enter the temperature of the individual components of the gaging system. (Requires the monitoring of the temperatures involved in the process.

12.9.1.2 NUMBER OF PROBE SETS

The total number of probe sets (0-4) utilized in the gage is programmed in this menu. A typical probe set would be (1) probe for the tooling and (1) probe for the part.

12.9.1.3 PROBE SET NAMES

Once the number of probe sets has been determined, each set can be named in this menu. The maximum number of characters is 12.

12.9.1.4 ASSIGN INPUT CHANNEL

The input channel and multiplier value associated with each probe set is assigned in this menu. There are (2) values that will be assigned to each probe set.

1) Part Input Channel

   This is the input channel on the temperature amplifier card that the temperature probe will be plugged into.

2) Multiplier

This numerical value will be the factor the signal will be multiplied by to provide the temperature reading. This value should be set to +1.00 for F°.

12.9.1.5 INPUT CHANNEL DEAD BAND

The dead band allows the CAG to determine if the temperature probe has failed. The dead band is 99.5 to 100.5 degrees Fahrenheit. If your measuring environment is in this area you will want to set the dead band to 0.0 degrees.

12.9.1.6 TEMPERATURE SETTLE TIME

The temperature probe settle time menu allows fine-tuning of the temperature probe. There are (3) 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.

1) Deviation (degrees F)
   This value is the maximum deviation in degrees F that the probe can read between readings before it is considered in an unsettled state.

2) Settle Time (1/10 sec)
   This value in tenths of a second is the time waited between readings when the probe is in an unsettled state.

3) Max Settle (1/10 sec)
   This value in tenths of a second 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, Settle Time = 20, Max Settle = 250

The gage will take a temperature reading. The gage will wait the settle time (.20 sec) then take another reading. If the second reading exceeds the first by 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.

12.9.2 ASSIGN CHECKS

The temperature compensation software allows individual part checks to be assigned to a probe set and receive temperature compensation. A probe check can be assigned to more than one check. This menu displays all of the part checks associated with the gage. The “Temp Comp” field displays the probe set name that has been assigned to the part check. If the check does not require temperature compensation, the “Temp Comp” should be disabled.

12.9.3 TEMP. COMPENSATION TYPE

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.

1) Part

   This selection should be utilized whenever temperature compensation is desired during gage operation or when performing an R & R study on parts.

2) Master 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.

3) Disabled

   This selection disables temperature compensation.

12.9.4 AUTO TEMP. COMP. STUDY

12.9.4.1 TC Study Display

The temperature compensation study display is viewed in this menu. The sample number, component temperature and expansion coefficient are displayed in a columnar exhibit. The **[1]** and **[2]** keys allow scrolling of the readings. The **[3]** key initiates a "Start Gage" command that is issued for every 1 degree reading that the studied component temp probe changes. The **[YES/C]** keys select displays for other checks.

12.9.4.1.2 Start/Stop Study

The ability to toggle the study "Active" or "Not Active" is provided in this menu.

12.9.4.1.3 Reset TC Study

The ability to reset the current study readings is provided in this menu.

12.9.4.1.4 Gage Selection

The ability to select which of the active gages the study is performed on is provided in this menu.

12.9.4.1.5 Study Type

The ability to select the study type (component) is provided in this menu.

12.9.4.1.6 Probe Set Selection

The ability to select the probe set is provided in this menu.

12.9.4.1.7 Save Study to File

This menu saves the current study to its internal file. If a temperature compensation study had been previously saved, the new study will overwrite the existing study for only the coefficients that were run in the new study.

12.9.4.1.7.3 Fill TC Study Files
Selecting this menu will fill (compute) any missing temperature coefficients in all of the TC studies.

12.9.4.1.8 Reset TC Study Files
This menu resets **ALL** temperature compensation study coefficients associated with the study type selected (menu 12.9.8.5) and the probe set selected (menu 12.9.8.6). **DO NOT** reset these files unless you are absolutely sure this is what you want.

See Section 12, Temperature Compensation, for automatic temperature compensation study procedures.

12.9.4.2 Define Linear Coefficients

Manually enter in coefficients for the Part, Master, and Tooling for each of the characteristics being measured for each gage. These coefficients will be used for all Temp comp lookup files. The coefficients are saved as part of the current part setup and may not directly coincide with the coefficients saved and being used in the TC files. The coefficients have to be saved to TC files before they are used by the system.

12.9.4.3 Temp. Comp. Data Offload

The temperature compensation data will be written to a text file each gage cycle. Check results, part temperature, part offset, tool temperature, tool offset, and master offset will be written. The text file is used for diagnostics and can be accessed through the network connection only.

12.9.5 View Coefficients

In this menu the coefficients of expansion used in temperature compensation can be viewed.

6 SETUP GUIDE

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

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

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

SAMPLE

CAG PROGRAM SET UP

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

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

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

INPUT	POLARITY	MAG FACTOR	OFFSET
1A1	(+)	1.000	0
1A2	(+)	1.000	0
1A3	(+)	1.000	0
1A4	(+)	1.000	0

PRELIMINARY SET UP

From the CAG INDEX menu, enter the **"UTILITIES"** Menu 12.0.

A. Select **"SYSTEM CONFIGURATION"** Menu 12.1.

1. Select Menu 12.1.2 **"UNIT OF MEASUREMENT"** and select which units pertain to the gage (Millimeter or Inch)

2. Return to **"SYSTEM CONFIGURATION"** Menu 12.1.

3. Select Menu 12.1.3 **"NUMBER OF GAGES"** and enter the number of gages. A prompt will indicate the range available for this selection.

4. Return to **"SYSTEM CONFIGURATION"** Menu 12.1.

5. Select Menu 12.1.6 **"WORK SHIFT START TIMES"** and enter the shift parameters relative to you work schedule. The time will be in 24-hour military format and the times cannot overlap.

6. Return to **"UTILITIES"** Menu 12.0.

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

1. Select Menu 12.2.1 **"GAGE NAMES"**. The number of gages selected in Menu 12.1.3 will determine the CAG programmed names of the gages. (Gage 1, Gage 2 etc.) It may be convenient, although not necessary, to name the gages. This will provide a noticeable identification of each. If you wish to name a gage, select that gage for editing. The name of each gage can be up to 12 characters long, including spaces.
The CAG will display an alphabetic selection bar for naming. There will be a triangular cursor under the first character in the gage name. This corresponds to the highlighted character in the alphabetic bar. By using the **[1]** or **[2]** key, the operator can move the highlighted character in the alphabetic bar to select the letter needed.

After selecting the correct letter, press the **[3]** key to select the next character position in the name. Repeat the above process until the complete gage name is entered. Press the **[7]** key if you wish to edit another gage name, or press **[8]** to exit the name editor.

2. Return to **"GAGE SETUP"** Menu 12.2.

3. Select Menu 12.2.2 **"GAGE TYPE/TIMER"**. The gage type may be either static or dynamic. If the input readings are gathered with respect to a stationary object, the gage type is considered to be static; otherwise the process is dynamic. With a static gage all the input readings should be the same, making it possible to gather inputs during a constant interval. This is

not the case for dynamic gaging since the time required to gage is not a constant from application to application. Therefore, a programmable cycle timer from 0.0 seconds to 99.9 seconds is available. Set the cycle timer to a time, which allows completion of the gaging cycle. If 0.0 is entered, the timer function is disabled.

If appropriate, a *"SETTLE TIME"* may be programmed into the gaging process. This will add a dwell period between receiving the start gage indication and the actual start of the gaging process.

4. Return to **"GAGE SETUP"** Menu 12.2.

5. Select **"GAGE RESOLUTION"** Menu 12.2.3. For each gage select the appropriate resolution. Remember that the gage resolution is dependent on the smallest range selected on the signal conditioning cards. It is possible for different gages to have different resolutions.

6. Return to **"GAGE SETUP"** Menu 12.2.

7. Select **"NUMBER OF PART CHECKS"** Menu 12.2.4. For each gage enter the appropriate number of part checks.

8. Return to **"GAGE SETUP"** Menu 12.2.

9. Select **"GAGE ENABLE/DISABLE"** Menu 12.2.5. Ensure each gage to be employed is *ENABLED*. Also remember that the Default State is *DISABLED*. The CAG^{TM} will only collect and process data for gages which are enabled. The set up for disabled gages will remain in the CAG^{TM} memory and can be enabled at any time.

10. Return to **"GAGE SETUP"** Menu 12.2.

11. Select **"GAGE CYCLE SETUP"** Menu 12.2.6. The 4 parameters listed (Queue Size, Filter, Minimum # of Readings and Minimum Sampling Δ) apply to input sampling during the gage cycle. Refer to Menu Descriptions for a more detailed discussion about the gage cycle parameters. The default settings (Queue = 20, Filter = 5, Min. # of Readings = 40 and Min. Delta = 0) will allow the user to gage parts in a static mode. However, for dynamic or special applications additional considerations may be necessary.

12. Return to **"UTILITIES"** Menu 12.0.

C. Select **"PART CHECKS"** Menu 12.3.

1. Select **"CHECK NAMES"** Menu 12.3.1. It may be convenient, although not necessary, to name the part checks. This will provide a noticeable identification of each. If you wish to name a part check, select that check for editing. The name of each check can be up to 11 characters long, including spaces. The CAG^{TM} will display an alphabetic selection bar for naming. There will be a triangular cursor under the first character in the part check name. This corresponds to the highlighted character in the alphabetic bar. By using the **[1]** or **[2]** key, the operator can move the highlighted character in the alphabetic bar to select the letter needed. After selecting the correct letter, press the **[3]** key to select the next character position in the name. Repeat the above process until the complete check name is entered. Press the **[7]** key if you wish to edit another check name, or press **[8]** to exit the name editor.

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

3. Select **"CHECK FUNCTIONS"** Menu 12.3.2. Select the appropriate gage to edit if prompted. When editing the current check function, a list of available functions will appear. Refer to Menu Descriptions for a more detailed description of the check functions. The **[SHIFT] [9]** key sequence displays the next gage setup if required.

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

5. Select **"CHECK FORMULAS"** Menu 12.3.3. For the checks not defined as multiple checks, a formula in terms of input readings must be defined for each check. A complete description of the elements required to develop a Check Formula is outlined in the Menu Descriptions section.

Example:
A typical diameter check may be represented as:

CHECK#01 = 1A1 x +1.00000 + 1A2 x +1.00000

This formula can be entered as follow:

a. Select Row 1
b. Select the first input, in this case 1A1, which is input channel 1.
c. Enter the multiplier value 1.00000.
d. Select the second input, in this case 1A2, which is input channel 2.
e. Enter the multiplier value 1.00000.
f. Enter **[SHIFT] [NO]** to end editing procedure.
g. Notice the updated formula displayed below the table - it should agree with the desired formula.
h. Press the **[YES]** key to display the next check.

The **[SHIFT] [9]** key sequence displays the next gage.

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

7. Select **"MULTIPLE CHECKS"** Menu 12.3.4. A complete description of the elements required to develop a Multiple Check Formula is outlined in the Menu Descriptions section. For the checks defined as multiple checks, a formula in terms of previously defined checks must be defined.

Example:

A typical taper check may be represented as:

CHECK#03 = CHECK#01 - CHECK#02

This formula can be entered as follow:

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

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

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

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

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

12. Return to the CAG **"INDEX"** Main Menu.

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

1. Select **"NOMINAL SIZES"** Menu 3.1. There are two ways the CAG can display its readings. The first is to display actual numbers (1.9999). The second is to display a deviation (-0.0001) from a nominal size (2.0000). If you wish to display actual numbers, a nominal size will need to be entered for each part check. Enter the nominal part size for each check. Note the final reading is displayed as a deviation from nominal. Therefore, if all readings should be displayed as deviations from zero, simply enter zero for each check.

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

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

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

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

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

5. Select **"REASONABLE LIMITS"** Menu 3.3. Enter the upper and lower reasonable limits for each check. The Reasonable Limits are established to protect the SPC data accumulation of the CAG^{TM} from accepting readings from parts which are grossly out of tolerance. This condition could be the result of broken tooling, un-machined parts introduced to the gage, etc. The reasonable limits are dependent upon the machining process. The closer the process can be controlled, the smaller the Reasonable Limit range. The Reasonable Limits should always be set outside of the part tolerances. To disable this feature, set the reasonable limit to “0”.

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

7. Select **"SORT CLASSES"** Menu 3.4. This feature allows the operator to

classify a part with a numeric number (1-10) in reference to one particular part check. Five parameters must be entered to enable this feature. Select Item 1 *"CLASSIFYING DIMENSION"* and select the part check being utilized to classify the part. Select Item 2 *"# OF SORT CLASSES"* and enter the number of classes you wish to classify the part into. Select Item 3 *"CLASSIFYING DIM. MAG"* and enter 1.0000. Select Item 4 *"CLASSIFYING DIM. OFFSET"* and enter 0. Select Item 5 *"SORT CLASS"*. Select Class 1. Define the range of the class. Select Class 2. Define the range of this class.

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

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

9. Return to CAG **"INDEX"** Menu.

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

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

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

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

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

2. Return to the CAG^{TM} **"INDEX"** Menu.

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

x & R CHART PARAMETERS

1. Select "DEFINE x & R CHART PARAMETERS" Menu 4.2.

2. Enter Check #1. Enter the Subgroup Size for the check. Enter the Sample Frequency for the check.

3. If you want the CAG to calculate the UCLx, LCLx and UCLr values, enter **"C"** for the check.

4. If you have values calculated for these parameters, enter each one.

5. Repeat the above for all of the checks.

BALANCE INPUTS

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

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

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

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

BALANCE GROUP SET UP

1. Select **"INPUT SETUP"** Menu 6.0.

2. Select **"BALANCE INPUT"** Menu 6.4.

3. Select **"INPUTS TO BALANCE"** Menu 6.4.1.

4. Select Group #1. Select Row #1 and enter the reference input for the balance group.

5. Select Row #2. Enter the first input that requires balancing.

6. Repeat selecting rows and entering inputs until all of the inputs that require balancing are entered.

7. If another balance group is required, press the **[YES]** key to advance to Balance Group 2 and perform the set up procedure for Group 2.

8. When all of the groups are completed, return to **"BALANCE INPUTS"** Menu 6.4.

PERFORM BALANCE ROUTINE

1. Select **"PERFORM BALANCE ROUTINE"** Menu 6.4.2.

2. Select the Balance Group you wish to perform the balancing routine on.

3. At the prompt *"Perform Balancing Routine"* press the **[YES]** key.

4. Utilizing either the balance master, MAX master or part in the gage, bias the part in the direction of the reference input. While holding the part in position, press the **[YES]** key to record the first position reading.

5. Now bias the part in the opposite direction. While holding the part in position, press the **[YES]** key to record the second position reading.

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

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

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

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

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

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

GAGE DATA FILE ANNOTATIONS

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

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

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

1. Select **"GAGE READINGS"** Menu 7.0 in the CAG. Select **"GAGE DATA FILE"** Menu 7.3.

2. Press the **[4]** key to select **"ANNOTATIONS"**.

3. Using either the **[1]** or **[2]** key, select the gage reading you wish to annotate. A highlighted reading number in the Index column indicates the reading selected.

4. Press the **[ENTER]** key. The CAG will display the annotation selections available. Use the **[YES]** key to scroll through the annotations. If the annotation you wish to utilize has been previously defined, enter the number of the annotation and press **[ENTER]**. Press the **[NO]** key in response to the question **"Edit Annotation?"** The CAG will place an asterisk **(*)** next to the part reading status and display the annotation number and definition at the bottom of the Gage Data File.

5. If the annotation you wish to utilize has **<u>not</u>** been previously defined, enter the number of the first unused annotation and press **[ENTER]**. Press the **[YES]** key in response to the question *"EDIT ANNOTATION?"*. The CAG will display the alphabetic selection bar used to name the definition. Enter the annotation definition and press [ENTER] when completed. The CAG will place an asterisk **(*)** next to the part reading status and display the annotation number and definition at the bottom of the Gage Data File.

The CAG can also be set up to automatically annotate a record in the gage data file when a given condition occurs. The predefined conditions are gage mastered, feedback adjustment, CAG alarm occurred, machine alarm occurred. For more information on automatic annotation see menu 4.4, Auto Annotation Logging Setup.

CONFIGURE SIGNAL CONDITIONING CARDS

Each card can accommodate up to four inputs. The inputs can be from either a LVDT or an Air/Electric signal. Any combination of inputs can be used on the same card. **NOTE:** The signal conditioning card must be properly configured for the type of input used by selecting the correct jumper settings.

NOTE: When using a 7200010 or 7100021 signal conditioning card with a 31017xx series A/E block refer to technical note #8130401 for signal conditioning card setup.

SETTING JUMPERS

1) Determine what type of inputs (LVDT or Air/Electric) are being used with each input (1 - 4) on the card.

2) Remove the signal conditioning card from the CAG by loosening the two screws on the face of the card and pulling it straight out of the CAG. **WARNING: Always disconnect the power supply to the CAG before removing a signal conditioning card.**

3) Each of the four inputs on the card has three jumpers associated with it that must be set. (See figures 6.1 and 6.2 for jumper locations.) For input number one locate the two jumpers,J5 and J15, labeled “L” and “AE”. If the input is being used by an LVDT set **both** the jumpers to “L”. If the input is being used by an A/E input set **both** jumpers to “AE”. The third jumper is used to set input range. For input number one this is jumper J11. **NOTE:** If the input type is “AE” the range jumper **must** be set to “.02/A”. If the input type is set to “L”, any of the four ranges (+/-.005, +/-.010, +/-.02/A, or+/-.040) can be selected.

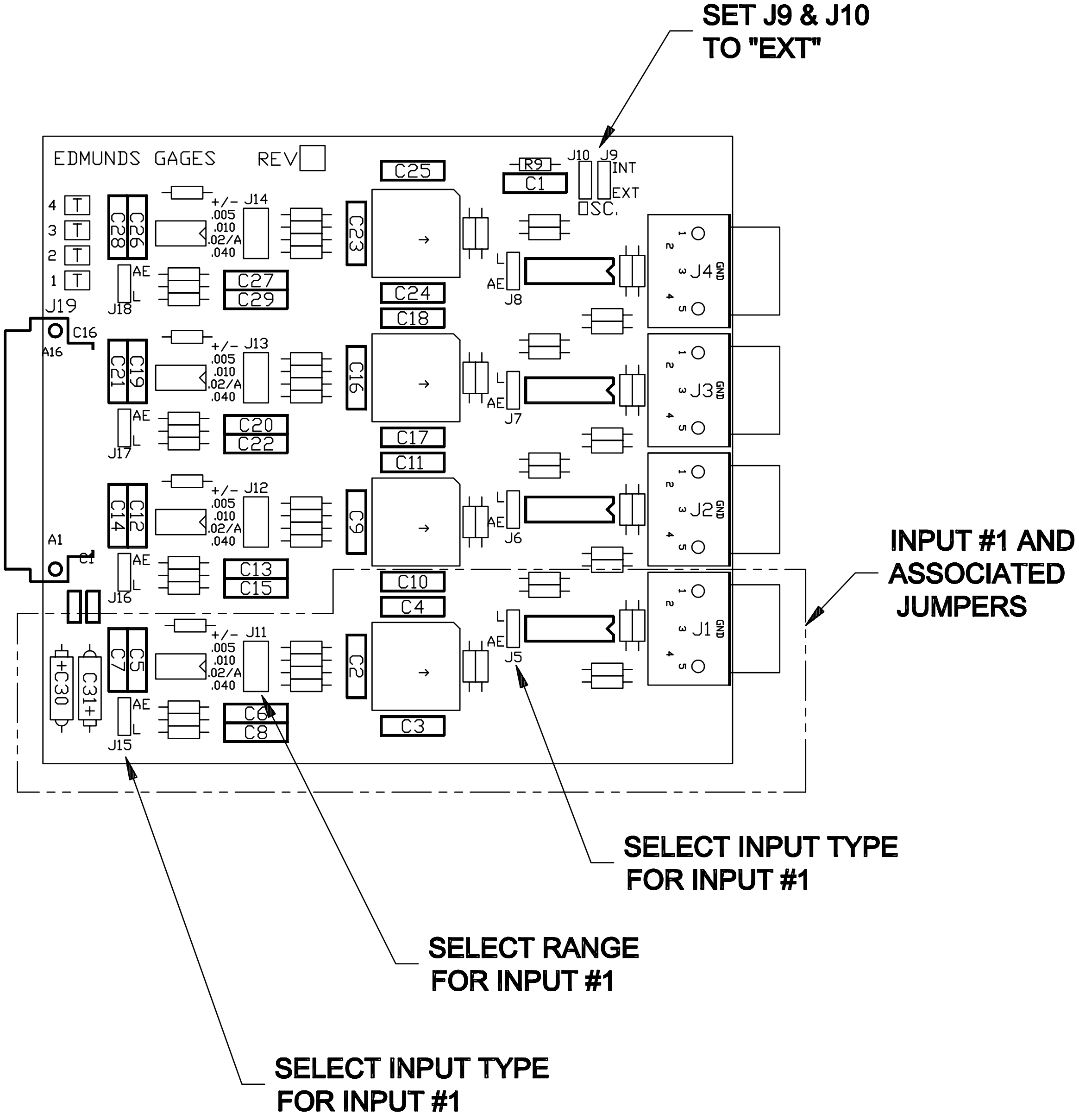
4) Repeat step three for inputs number two, three, and four. See the jumper definition table below for information on which jumpers are associated with which inputs. **NOTE:** If an input on the card is not being used it does not matter what the jumpers are set to.

5) **NOTE:** Jumpers J9 and J10 should **always** be set to “EXT”.

6) Repeat steps 1 – 5 for all the signal conditioning cards being used by the gage.

<u>**Jumper Definition Table**</u>

Input	Select Type	Select Range
1	J5 & J15	J11
2	J6 & J16	J12
3	J7 & J17	J13
4	J8 & J18	J14



SET J9 & J10 TO "EXT"

INPUT #1 AND ASSOCIATED JUMPERS

SELECT INPUT TYPE FOR INPUT #1

SELECT RANGE FOR INPUT #1

SELECT INPUT TYPE FOR INPUT #1

FIGURE 6.1 - SIGNAL CONDITIONING CARD #7200010

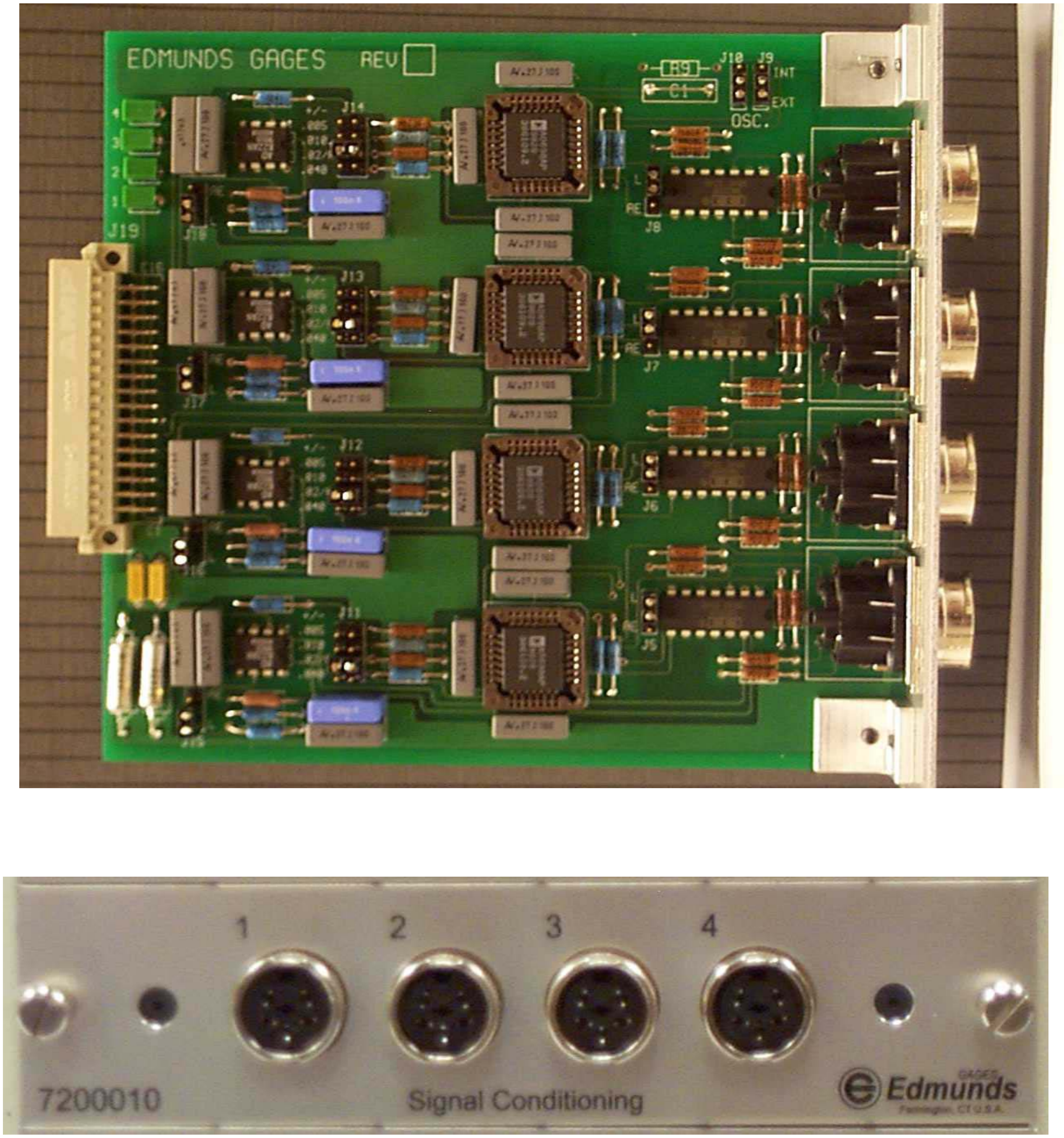


FIGURE 6.2 - SIGNAL CONDITIONING CARD #7200010

7 CALCULATIONS

MASTER THE GAGE

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

$$\textbf{MAG} = \frac{\text{Kmax} - \text{Kmin}}{\text{Gmax} - \text{Gmin}}$$

$$\textbf{ZERO} = \text{Kmax} - [\ \text{MAG} \times \text{Gmax}\ ]$$

Where:

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

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

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

#7200010 SIGNAL CONDITIONING CARD

LVDT SIGNAL CONDITIONING

The Mag values that are input into the CAG for electronic signals are dependent upon the range selected by jumper settings on the signal conditioning card for the input.

Range	MAG
+/-.005	.250
+/-.010	.500
+/-.020	1.000
+/-.040	2.000

LVDT MAG FORMULA = (2 x Travel) or FSV / .040

AIR/ELECTRIC SIGNAL CONDITIONING

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

NOTE: When using a 7200010 signal conditioning card with a 31017xx series A/E block refer to technical note #8130401 for mag factor adjustment.

Full Scale Value	Low MAG	Medium MAG	High MAG
.010	.600		
.008	.460		
.006	.350		
.005	.290		
.004	.240		
.003	.200		
.002	$\boxed{.120}$	.360	
.001		$\boxed{.180}$	.360
.0005			.180
.0002			.072

SPC VARIABLES

X-bar, or Mean (average):

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

Range:

R = largest value - smallest value

Standard deviation, or sigma:

$$\sigma = \left[\frac{n * \left[\text{summation of } X^2\right] - \left[\text{summation of } X\right]^2}{n(n - 1)} \right]^{1/2}$$

where n is the number of samples taken

Process Capability:

$$\mathbf{Cp} = \frac{\text{USL - LSL}}{6 * \sigma}$$

where σ is the standard deviation
USL is the upper spec. limit
LSL is the lower spec. limit

Capability Ratio:

$$\mathbf{CR} = \frac{6 * \sigma}{\text{USL - LSL}}$$

Capability Index:

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

Lower specification limit:

LSL = User defined

Upper specification limit:

USL = User defined

X-double-bar, or average X:

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

Average range:

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

Upper control limit for X:

UCLx = User defined or CAG^{TM} calculated as below:

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

Lower control limit for X:

LCLx = User defined or CAG^{TM} calculated as below:

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

Upper control limit for R:

UCLr = User defined or CAG^{TM} calculated as below:

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

Correlation:

$$\mathbf{r} = \frac{(n * s1) - (x1 * y1)}{\left[(n * x2) - (x1)^{2} \right]^{1/2} * \left[(n * y2) - (y1)^{2} \right]^{1/2}}$$

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

CONTROL CHART CONSTANTS

Number of observations in subgroup	**A2**	**D4**
2	1.880	3.267
3	1.023	2.575
4	0.729	2.282
5	0.577	2.115
6	0.483	2.004
7	0.419	1.924
8	0.373	1.864
9	0.337	1.816
10	0.308	1.777

GAGE REPEATABILITY AND REPRODUCIBILITY CALCULATIONS

Measurement Unit Analysis

Repeatability - Equipment Variation (E.V.)

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

TRIALS	2	3
K_1	4.56	3.05

Reproducibility - Appraiser Variation (A.V.)

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

OPERATORS	2	3
K_2	3.65	2.70

n = Number of Parts
r = Number of Trials

Repeatability and Reproducibility - (R & R)

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

% Tolerance Analysis

% E.V. = 100 { (E.V. / (Tolerance) }

% A.V. = 100 { (A.V. / (Tolerance) }

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

NOTE:
Calculations are based upon predicting 5.15 sigma. 99% of the area under the normal curve.

8 EDMUNDS CAG PARALLEL COMMUNICATIONS

Communications with the Edmunds CAG is accomplished via a discrete parallel interface. All parallel communication lines are signal conditioned with optical isolators 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. All opto connections and voltage requirements are given in the schematic section of this manual.

CAG communications 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. Edmunds utilizes a simple handshaking type protocol to enhance its interface compatibility. Communication is bi-directional, meaning both the Edmunds CAG and the external device may initiate communication. For the most part, however, the 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:

EDMUNDS CAG INPUTS

- 5 data lines, bits 0-4
- 1 interrupt line

EDMUNDS CAG OUTPUTS

- 5 data lines, bits 0-4
- 1 data available line

In the event the direction of communication is not clear, the Edmunds CAG inputs correspond with the external device's outputs. Note that 5 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 data available pulse length is programmable in Menu 12.6.5.5 “I/O Message Duration”. If the CAG is required to send a series of messages, 1ms is the minimum time between data available pulses.

START GAGE COMMAND

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 COMMAND"*. 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.

In other words, the CAG will acquire a numeric result for the sampled inputs and update the current part status; 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 COMMAND

It was defined in the discussion for the start gage command that the CAG samples the inputs (i.e. LVDTs) 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 be configured to end this process after a programmed time interval, in which case the end gage command is not necessary.

FAULT CODE MESSAGE

In order to provide an enhanced operator interface, several programmable messages are available. Via the parallel interface, an external device may request the CAG to display a programmable message. In response to this type of message, the CAG will transmit an acknowledge message to the external device.

ACKNOWLEDGE MESSAGE

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

END GAGE MESSAGE

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 & REWORK PART STATUS MESSAGES

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

R & R SORT MESSAGE

The CAG transmits an *"R&R SORT"* message to acknowledge an auto start gage during the R&R study. The operator may select which R&R sort message the CAG is to transmit. This may be useful in an automatic application where several sorting options are available.

SHUTDOWN MESSAGE

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.

EXTERNAL DEVICE --> EDMUNDS CAG MESSAGES

The table below references each available message with the appropriate bit pattern. The terms bit and line are interchangeable.

	pin 19 M6-A bit 4	pin 17 M5-B bit 3	pin 16 M5-A bit 2	pin 14 M4-B bit 1	pin 13 M4-A bit 0
Manual Start Gage 1	0	0	0	0	1
Auto Start Gage 1	0	0	0	1	0
Manual Start Gage 2	0	0	0	1	1
Auto Start Gage 2	0	0	1	0	0
Manual Start Gage 3	0	0	1	0	1
Auto Start Gage 3	0	0	1	1	0
Manual Start Gage 4	0	0	1	1	1
Auto Start Gage 4	0	1	0	0	0
Endgage	0	1	0	0	1
Fault Code #1	0	1	0	1	0
Fault Code #2	0	1	0	1	1
Fault Code #3	0	1	1	0	0
Fault Code #4	0	1	1	0	1
Fault Code #5	0	1	1	1	0
Fault Code #6	0	1	1	1	1
Fault Code #7	1	0	0	0	0
Fault Code #8	1	0	0	0	1

The CAG input interrupt line is via opto M7-B (Pin 23 on 37 pin connector).

EDMUNDS CAG --> EXTERNAL DEVICE MESSAGES

The table below references each available CAG message with the appropriate bit pattern. The terms bit and line are interchangeable.

	pin 7 M2-A bit 4	pin 5 M1-B bit 3	pin 4 M1-A bit 2	pin 2 M0-B bit 1	pin 1 M0-A bit 0
ACK	0	0	0	0	1
End Gage	0	0	0	1	0
Good Status	0	0	0	1	1
Reject Status	0	0	1	0	0
Rework Status	0	0	1	0	1
R&R Sort #1	0	0	1	1	0
R&R Sort #2	0	0	1	1	1
R&R Sort #3	0	1	0	0	0
Unused	0	1	0	0	1
Unused	0	1	0	1	0
Unused	0	1	0	1	1
Unused	0	1	1	0	0
Unused	0	1	1	0	1
Unused	0	1	1	1	0
Shutdown	1	1	1	1	1

The CAG output data available is via opto M10-B, pin 32 of 37 pin connector.

Network Connection

The CAG is equipped with Ethernet network capability. A RJ45 Ethernet connector is mounted on side of CAG for network connection. NetBEUI (default) and TCP/IP protocols are supported, see network protocol selection below. Network setup is done through menu 12.6.7 Network Setup. Setup for IP address, network names, domain logon and network printer are done in this menu. No changes in the network setup is necessary to communicate to the CAG through the network if default setup is acceptable.

CAG^{QCM} Network Protocol Selection

The CAG^{QCM} can be programmed for either the NetBEUI or TCP/IP network protocols. Which protocol to select depends on which protocols are available on the host PC that will be accessing the CAG^{QCM} data. Many networks run both the NetBEUI and TCP/IP protocols simultaneously, while others run only one protocol. If you don't know which protocols are available on the host PC, your system administrator will be able to help you. If both protocols are available, select NetBEUI on the CAG^{QCM}, since there is less to configure.

The selection is made from the System Maintenance / Network Utilities menu. To access this menu and change the protocol:

1) Turn off the CAG^{QCM} and then turn it back on. As the system is started several screen will be displayed before the main menu is displayed. As these start up screen are loaded wait until the message shown below is displayed and then press the decimal point key three times:

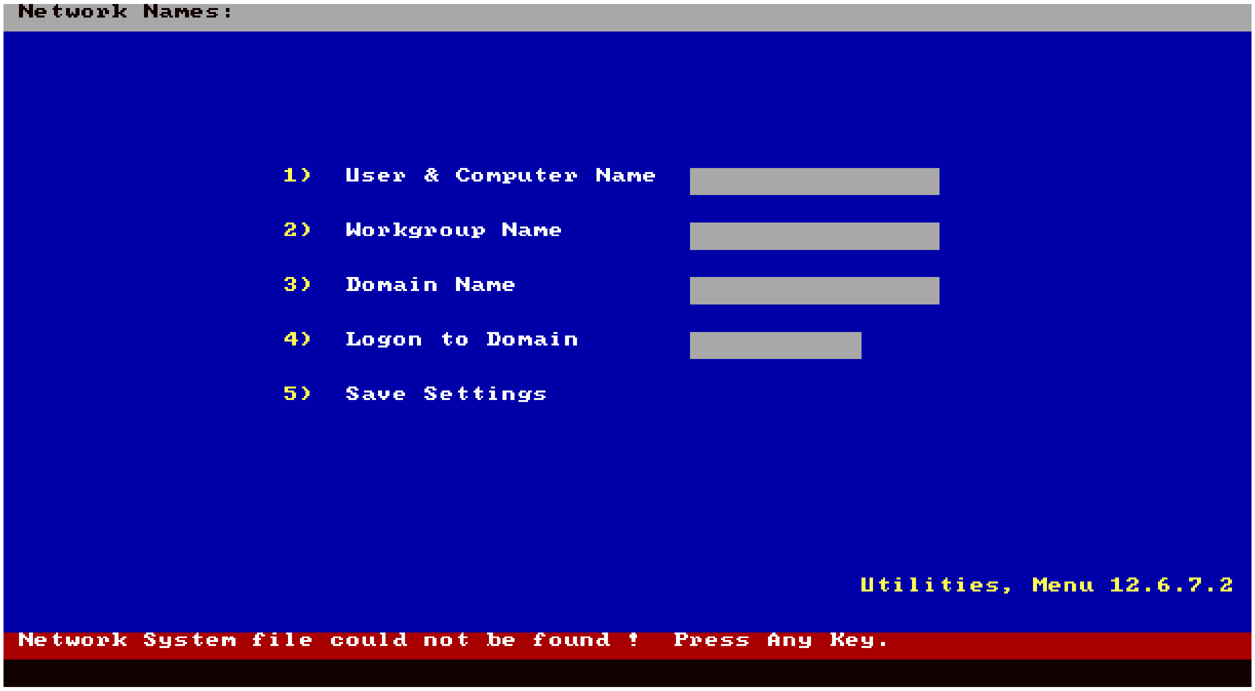
```
*********************************************
Loading CAG for…
Hardware Platform: (LCB, ECB)
Network Protocol: (NetBEUI or TCP/IP)
*********************************************
```

2) Select option (4), "Select Network Interface Protocol"
3) From the Network Interface menu select the desired network protocol.
4) If the network protocols are changed, the CAG will prompt the operator the power the system off and on.
5) If the network protocols are changed then when the CAG powers up the operator will be prompted as follows:
   a) "Type your User Name, or press ENTER if is "(current name)". **At this prompt press ENTER.**
   b) "Type your password" **At this prompt press ENTER.** (This will enter no password)
   c) "There is no password-list file for (current name). Do you want to create one (Y/N)". **At this prompt press "YES", ENTER.**
   d) "Please confirm your password so that a password list may be created." **At this prompt press ENTER.** This will confirm no password entered. The CAG will continue to load after this.

If the TCP/IP network protocol is used, the system administrator must provide an unused IP address for the CAG^{QCM}, and the subnet mask. This information is then entered in menu 12.6.7.1, "IP Address Setup".

Configuring Network Names

Once the network protocol is selected, the CAG^{QCM} needs to be identified to other users on the network. Menu 12.6.7.2, "Network Names", allows the operator to enter the "User & Computer Name", "Workgroup Name" and "Domain Name" for logging on to the network. There is also an option to log on to the domain, if desired. Once all of the information is entered, the settings must be saved using option 5, **and then the CAG^{QCM} must be powered off and back on to utilize the new settings**.



```
Network System file could not be found !  Press Any Key.
```

Default Network Setup

Protocol: NetBEUI
User & Computer Name: <CAG SERIAL NUMBER> example – 0303123 (on side of CAG)
Workrgoup Name: CAG - not needed if not logon domain
Domain Name: WORKGROUP - not need if not logon domain
Logon to Domain: DISABLED

Note: User & Computer Name must be a unique name on the network. It is recommended this remain the default CAG Serial Number.

If the User & Computer Name is changed in Menu 12.6.7.2 the system must be powered off/on for the changed to be used. When powering up, the system will prompt for a new user password. A blank (no password) should be setup for the system to operated properly. When the system prompts for a new password the following responses should be made.

- Press ‘ENTER’ to select the user name.
- Press ‘ENTER’ for your password (no password).
- Press ‘YES’ and then ‘ENTER’ to create a password list.
- Press ‘ENTER’ to confirm your password (no password).

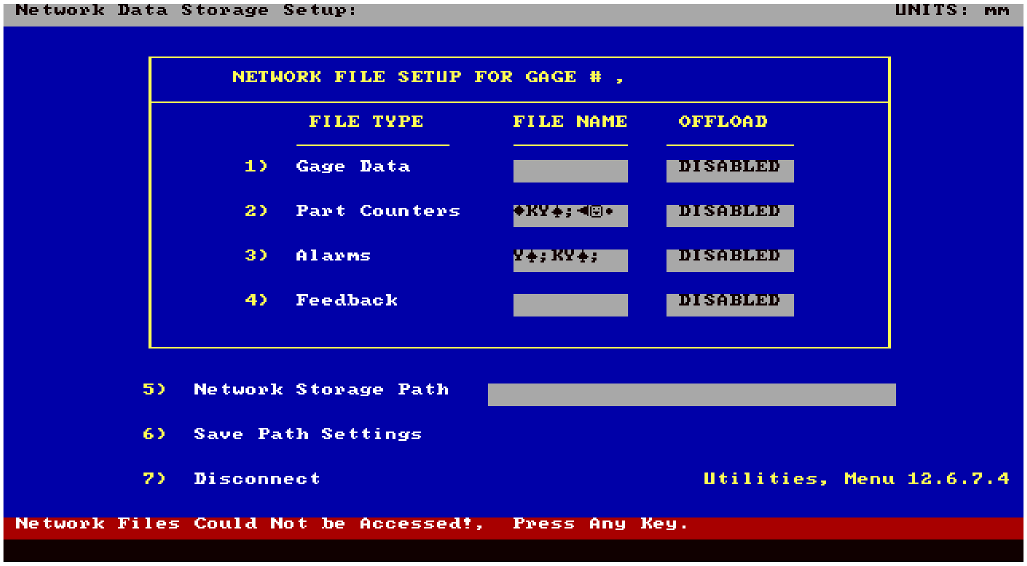
Network File Storage Specifications

Using menu 12.6.7.4 "Network Part Data Storage" the operator can program the CAG to offload the gage data file, part counter file, alarm file, and/or the feedback file to a network location.

Since the CAG is writing directly to the networked location the operator does not need to map a drive to the CAG. Each CAG can write to a different location, or they can all write to a common location, provided a shared folder exists on the network. When writing to a common network location, care should be taken to insure the filenames defined in each CAG are different. Otherwise, one CAG can overwrite the data from another CAG. The network location and filenames are defined in menu 12.6.7.4, "Network Part Data Storage".

Menu 12.6.7.4

This screen is divided into two areas. The upper box with options 1 - 4 is used to select the file name and offload status for each gage programmed in the CAG. The lower section allows the operator to select the desire network storage location.



```
Network Data Storage Setup:                                        UNITS: mm

          NETWORK FILE SETUP FOR GAGE # ,

               FILE TYPE          FILE NAME     OFFLOAD

          1)   Gage Data                        DISABLED
          2)   Part Counters      ♦KY♠;◄☺•      DISABLED
          3)   Alarms             Y♠;KY♠;       DISABLED
          4)   Feedback                         DISABLED

      5)  Network Storage Path
      6)  Save Path Settings
      7)  Disconnect                           Utilities, Menu 12.6.7.4
Network Files Could Not be Accessed!,  Press Any Key.
```

Options 1-4:

The current gage name and number are listed at the top of the box. If more than one gage is programmed press [SHIFT][9] to cycle to the next gage.

For each gage the operator can select to enable or disable the offload of the gage data, part counters, alarms, and/or feedback. For any file that is enabled for offloading the operator can program a file name for the data. These fields are all gage dependant, meaning each gage on the CAG can have a different value for these fields.

Options 5:

This item allows the operator to enter the network location to store the network data files. The network storage path can be a maximum of 30 characters, and all backslashes need to be included. For example, if the name of the network server is DATA_SERVER and the name of the shared folder on the server is CAG_DATA, then the network storage path would be entered as \\DATA_SERVER\CAG_DATA. **The network data files for all gages on the CAG are written to this location.**

Options 6:

Whenever changing the network storage path, the changes must be saved using option #6, "Save Path Settings". Once saved, the CAG must be powered off and on again for the changes to take effect.

Gage Data

The filename for the gage data is the operator-entered gage data filename from option #1 on menu 12.6.7.4 with a .txt extension. If four different names are entered for the four gages, then there will be four separate files. However, if the same name is entered for two or more gages, then their data will be combined into the same file. The gage name is present in each record in the network gage data file, so the data can still be segregated by gage in the user's software. This provides greater flexibility to handle most users requirements. The chart below shows the gage data network filenames.

Gage #	Filename
1	"*gage1 gage data filename*".txt
2	"*gage2 gage data filename*".txt
3	"*gage3 gage data filename*".txt
4	"*gage4 gage data filename*".txt

The gage data file consists of a series of records, one for each part gaged, where each record consists of a series of comma-delimited fields. The fields are described below.

Field #	Description
1	Date-Time stamp in the format: MM/DD/YY-HH:MM:SS
2	Gage Name as programmed in menu 12.2.1
3	Part Status: "ACP" for Accept, "REJ" for Reject and "REW" for Rework
4	Part Class if classes are programmed; blank otherwise
5	Part Class Value if classes are programmed; blank otherwise
6	Annotation: 2-digit numeric annotation number
7	Check #1 Result: 10 character numeric value of check #1, including the sign, padded with spaces as needed
8	Check #1 Status: " " for within tolerance, "UN" for under tolerance, "OV" for over tolerance, "SA" for saturated reading, "OR" for over reasonable limit, "UR" for under reasonable limit
:	:
7+n	Check #n Result: 10 character numeric value of check #n, including the sign, padded with spaces as needed
8+n	Check #n Status: " " for within tolerance, "UN" for under tolerance, "OV" for over tolerance, "SA" for saturated reading, "OR" for over reasonable limit, "UR" for under reasonable limit

Part Counters

The filename for the part counters is the operator-entered part counters filename with a unique filename extension for each gage. Gage #1's filename extension is .pc1, gage #2's filename extension is .pc2, gage #3's filename extension is .pc3 and gage #4's filename extension is .pc4. This eliminates the possibility of overwriting data for one gage with another gages data. If the same name is programmed for multiple gages, there are still separate files for each gage because the filename extension is different.

The chart below shows the part counters network filenames.

Gage #	Filename
1	"*gage1 part counters filename*".pc1
2	"*gage2 part counters filename*".pc2
3	"*gage3 part counters filename*".pc3
4	"*gage4 part counters filename*".pc4

The part counter file is updated on every normal gaging cycle. It is not updated during mastering, verification, or R&R Study gage cycles.

The file contains the Start Date/Time and End Date/Time over which the part counters have been accumulated. The number of Accept, Reject, Rework and Total parts gaged. For each check the number of parts over the upper spec limit and the number of parts under the lower spec limit. All data is comma delimited. The data in the part counter file is described below.

.

Part Counter File Data Format:

- Line 1&2 contain the date and time the file was written.
- Line 3 contains the gage name.
- Line 8 contains the Start Date/Time and End Date/Time header.
- Line 9 contains the Start Date/Time and End Date/Time.
- Line 11 contains part counters header.
- Line 12 contains the Accept, Reject, Rework and Total part counters.
- Line 14 contains the check counters header.
- Lines 15 to 30 contains the Check number, Check Name, Over count,
- Under count.

Alarms

The filename for the alarms is the operator-entered alarms filename with a unique filename extension for each gage. Gage #1's filename extension is .al1, gage #2's filename extension is .al2, gage #3's filename extension is .al3 and gage #4's filename extension is .al4. This eliminates the possibility of overwriting data for one gage with another gages data. If the same name is programmed for multiple gages, there are still separate files for each gage because the filename extension is different. The chart below shows the alarms network filenames.

Gage #	Filename
1	"*gage1 alarms filename*".al1
2	"*gage2 alarms filename*".al2
3	"*gage3 alarms filename*".al3
4	"*gage4 alarms filename*".al4

The alarm file is updated when an alarm is triggered.

The file contains the CAG and Machine control alarms that have been triggered. The Alarm Description, Date/Time of Alarm and Alarm type is provided. The data in the part counter file is described below.

Alarm File Data Format:

- Line 1&2 contain the date and time the file was written.
- Line 3 contains the gage name.
- Line 8 contain the field description header.
- Lines 9 to 54 contains the Alarm Description, Date/Time of
- Alarm, and Alarm type (CAG or Machine control).

Feedback

The filename for the feedback is the operator-entered feedback filename with a unique filename extension for each gage. Gage #1's filename extension is .fb1, gage #2's filename extension is .fb2, gage #3's filename extension is .fb3 and gage #4's filename extension is .fb4. This eliminates the possibility of overwriting data for one gage with another gages data. If the same name is programmed for multiple gages, there are still separate files for each gage because the filename extension is different. The chart below shows the feedback network filenames.

Gage #	Filename
1	"*gage1 feedback filename"*.fb1
2	"*gage2 feedback filename"*.fb2
3	"*gage3 feedback filename"*.fb3
4	"*gage4 feedback filename"*.fb4

The feedback file is updated every gage cycle on gages that feedback is utilized and enabled. It is not updated during mastering, verification, or R&R Study gage cycles.

The file contains the feedback offset data for the last part gaged included the feedback mode, running average, calculated offset, transmitted offset and total tool adjustment. The data in the part counter file is described below.

Feedback File Data Format:

- Line 1 & 2 contain the date and time the file was written.
- Line 3 contains the gage name.
- Line 8 contains the feedback data in one continuous line with each field separated by comma. The amount of data will vary depending on how may feedback offsets are setup in the gage.

Data Field Description

Feedback Mode, Offset 1 Running Average, Offset 1 Calculated Offset, Offset 1 Transmitted Offset, Offset 1 Total Tooling Adjustment, Offset 2 Running Average, Offset 2 Calculated Offset, Offset 2 Transmitted Offset, Offset 2 Total Tooling Adjustment, ... Offset 8.

Map Drive From Host

When the CAG^{QCM} configuration is complete, it is time to connect to the CAG^{QCM} from the host PC. For the following examples, assume the CAG^{QCM} is programmed as shown:

User & Computer Name: CAGX
Workgroup Name: CAG
Domain Name: WORKGROUP

There are three directories available to link to on the CAG^{QCM}, as described below:

\\CAGX \GDF to gain access to the Gage Data Files. For a description of the gage data file format, see document titled the menu description in section 5 for menu 7.3, Gage Data File.

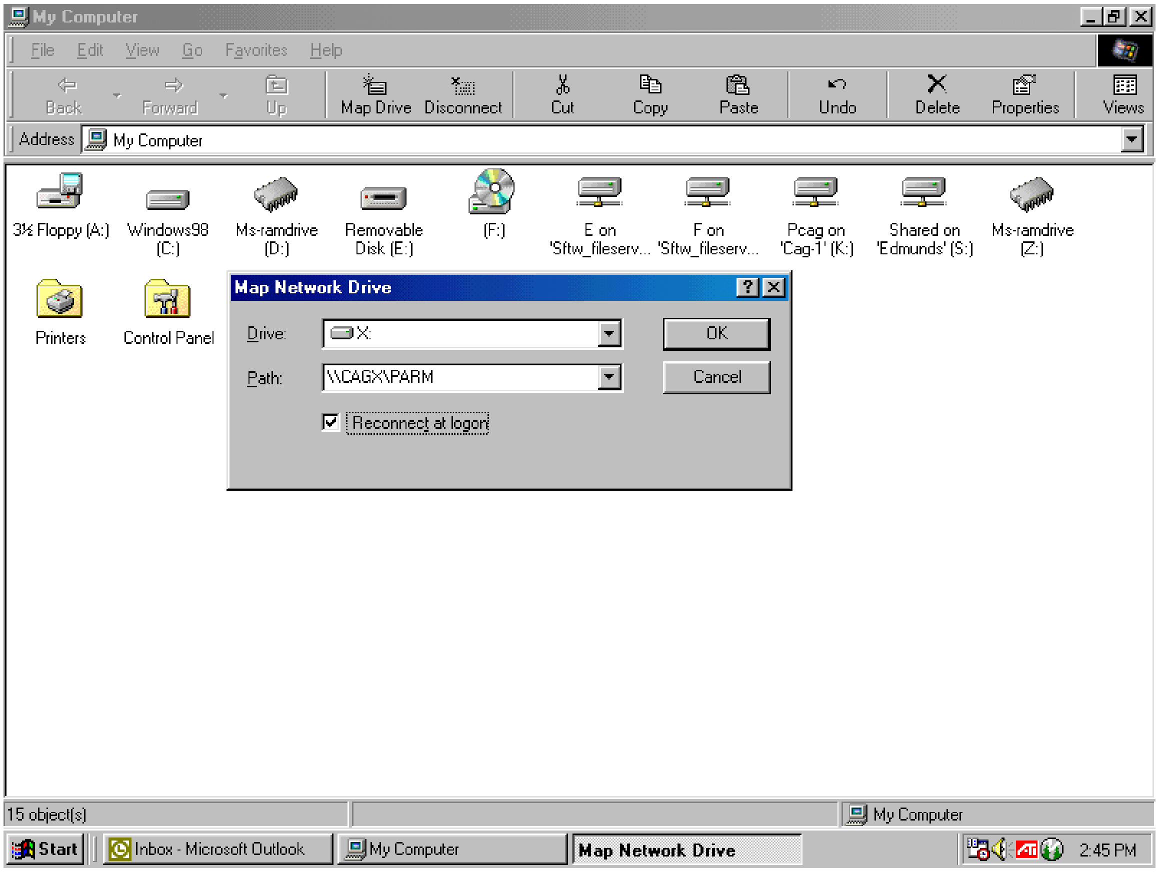
\\CAGX \PARM to gain access to the Setup Parameter Files.

\\CAGX \CYCLDATA to gain access to the Per Cycle Data Files. For a description of the files available in this directory, see Cycle Information Data Files below.

The procedure for mapping a drive to a directory on the CAG^{QCM} is similar for most operating systems. Specific directions for Windows 98, Windows 2000 and Windows XP are given on the following pages. The screen shots show mapping drive "X:" to the "PARM" directory on the CAG^{QCM} named "CAGX".

Microsoft Windows 98
4.10.1998

Double-click on the "My Computer" icon on the desktop, then click on the "Map Drive" button on the toolbar. If there is no "Map Drive" button on the toolbar, right-click on the "My Computer" icon on the desktop and select "Map Network Drive…" from the list. In the textbox labeled "Drive", select a drive letter to map to from the pull down list. In the textbox labeled "Path", enter the path to the desired CAG^{QCM} and directory. Select "Reconnect at logon" if you want your computer to automatically reconnect the drive to the CAG^{QCM} directory when the computer logs on to the network.



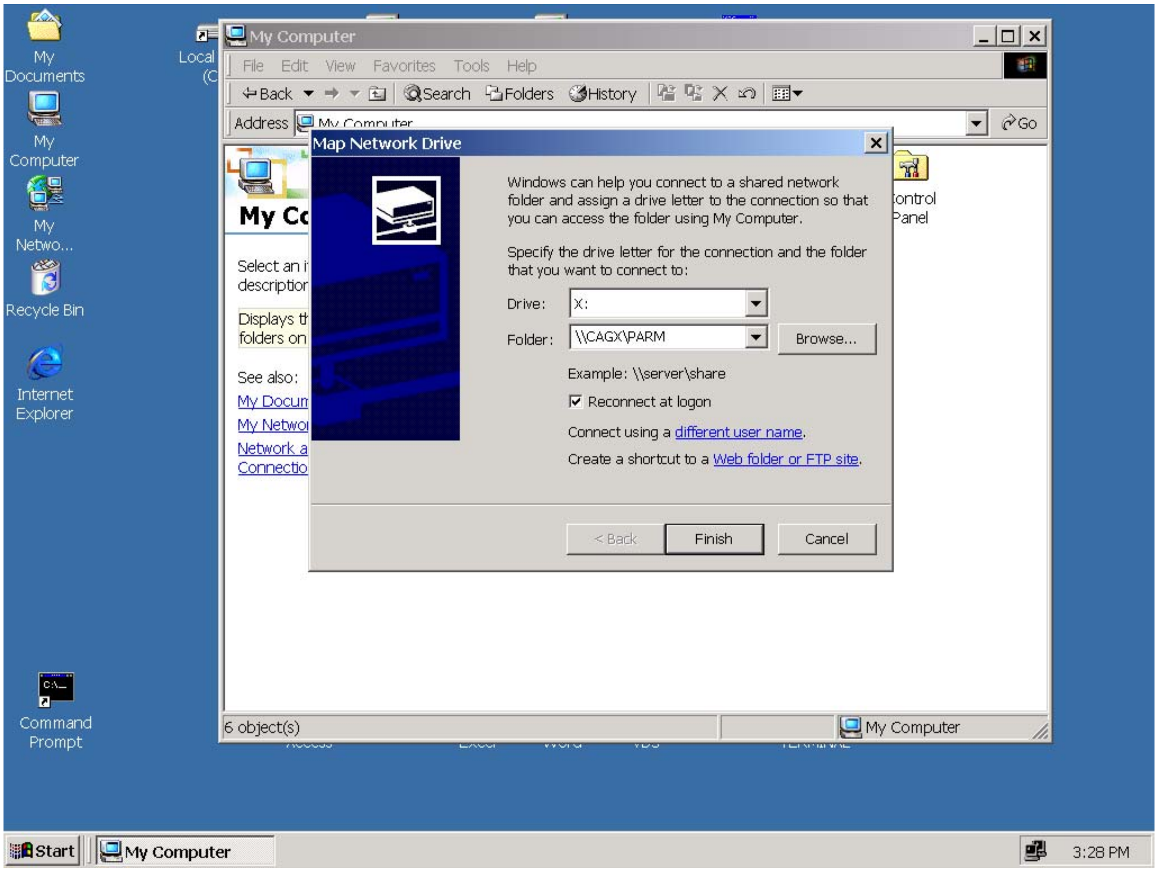
Drive: X:

Path: \\CAGX\PARM

☑ Reconnect at logon

Microsoft Windows 2000
5.00.2195

Double-click on the "My Computer" icon on the desktop, then click on the "Tools" menu in the menu bar. Select the "Map Network Drive…" selection from the pull down menu. In the textbox labeled "Drive", select a drive letter to map to from the pull down list. In the textbox labeled "Folder", enter the path to the desired CAG^{QCM} and directory. Select "Reconnect at logon" if you want your computer to automatically reconnect the drive to the CAG^{QCM} directory when the computer logs on to the network.



Windows can help you connect to a shared network folder and assign a drive letter to the connection so that you can access the folder using My Computer.

Specify the drive letter for the connection and the folder that you want to connect to:

Drive: X:

Folder: \\CAGX\PARM

Example: \\server\share

☑ Reconnect at logon

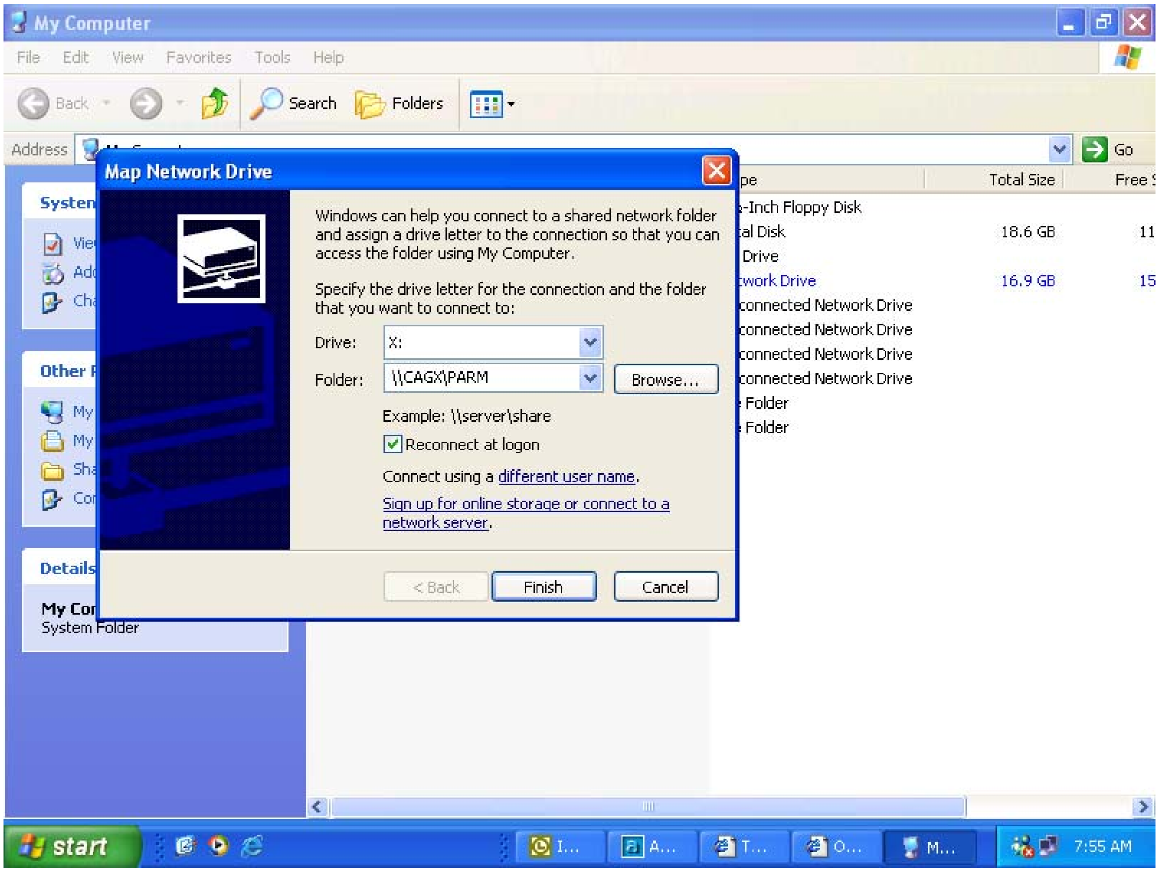
Connect using a different user name.

Create a shortcut to a Web folder or FTP site.

Microsoft Windows XP Professional Version 2002 Service Pack 1

Double-click on the "My Computer" icon on the desktop, then click on the "Tools" menu in the menu bar. Select the "Map Network Drive…" selection from the pull down menu. In the textbox labeled "Drive", select a drive letter to map to from the pull down list. In the textbox labeled "Folder", enter the path to the desired CAG^{QCM} and directory. Select "Reconnect at logon" if you want your computer to automatically reconnect the drive to the CAG^{QCM} directory when the computer logs on to the network.

Note: Since Microsoft Windows XP does not come with support for NetBEUI, the CAG^{QCM} will have to be configured for the TCP/IP network protocol.



Windows can help you connect to a shared network folder and assign a drive letter to the connection so that you can access the folder using My Computer.

Specify the drive letter for the connection and the folder that you want to connect to:

Drive: X:

Folder: \\CAGX\PARM

Example: \\server\share

☑ Reconnect at logon

Connect using a different user name.

Sign up for online storage or connect to a network server.

Cycle Information Data Files

The CAG-QCM writes gage cycle information to ASCII data files. These files reside in either the CYCLDATA or GDF directory on the CAG-QCM. These directories can be accessed through network connection and are setup with full access privileges. The data files provide raw data that makes it possible to externally monitor the gaging, accumulated data, and archive data.

Each gage that is setup in the CAG-QCM has its own set of data files associated with it. The file names and extensions refer to the type of data the file contains. The last two character of the file name identify the gage it is associated with. For example, the alarmsG1.alm file contains alarm information for gage 1. All the data files are comma delimited.

A description of the files and their contents is provided below:

LAST PART GAGED

FILE NAME: LstPrtG1.lpg, LstPrtG2.lpg, LstPrtG3.lpg, LstPrtG4.lpg.

LOCATION: CYCLDATA directory.

UPDATED: File updated on every normal gage cycle and duringe RR-Study.
Not updated during mastering and verification gage cycles.

CONTENTS: The file contains Part Status, Class Information,
Check Results and Check Status for the last part that was gaged.

DETAILED DESCRIPTION OF DATA FORMAT:
- Line 1 & 2 contain the date and time the file was written.
- Line 3 contains the gage name.
- Line 8 contains the data in one continuous line with each field separated by a comma. The amount of data will vary depending on how many checks are setup in the gage.

DATA FEILD DESCRIPTION:
Part Status, Class, Class Value, Number of Check, Chk1 Result, Chk1 Status, Chk2 Result, Chk2 Status, ... Chk16 Result, Chk16 Status.

PART COUNTERS

FILE NAME: CountsG1.cnt, CountsG2.cnt, CountsG3.cnt, CountsG4.cnt

LOCATION: CYCLDATA directory.

UPDATED: File updated on every normal gage cycle. Not updated during mastering, verification and RR-Study gage cycles.

CONTENTS: The file contains the Start Date/Time and End Date/Time over which the part counters have been accumulated. The number of Accept, Reject, Rework and Total parts gaged. For each check the number of parts over the upper spec limit and the number of parts under the lower spec limit. All data comma delimited.

DETAILED DESCRIPTION OF DATA FORMAT:
- Line 1&2 contain the date and time the file was written.
- Line 3 contains the gage name.
- Line 8 contains the Start Date/Time and End Date/Time header.
- Line 9 contains the Start Date/Time and End Date/Time.
- Line 11 contains part counters header.
- Line 12 contains the Accept, Reject, Rework and Total part counters.
- Line 14 contains the check counters header.
- Lines 15 to 30 contains the Check number, Check Name, Over count, Under count.

ALARMS

FILE NAME: AlarmsG1.alm, AlarmsG2.alm, AlarmsG3.alm, AlarmsG4.alm

LOCATION: CYCLDATA directory.

UPDATED: When an alarm is triggered.

CONTENTS: The file contains the CAG and Machine control alarms that have been triggered. The Alarm Description, Date/Time of Alarm and Alarm type is provided.

DETAILED DESCRIPTION OF DATA FORMAT:
- Line 1&2 contain the date and time the file was written.
- Line 3 contains the gage name.
- Line 8 contain the field description header.
- Lines 9 to 54 contains the Alarm Description, Date/Time of Alarm, and Alarm type (CAG or Machine control).

GAGE DATA FILE

FILE NAME: GAGE1.dat, GAGE2.dat, GAGE3.dat, GAGE3.dat.

LOCATION: GDF directory.

UPDATED: Update on every gage cycle when the gage data file is enabled in the CAG-QCM setup and valid results have been recorded. Not update during mastering, verification and RR-Study gage cycles.

CONTENTS: The file contains information on each part gaged. Part data is accumulated with the max number of parts stored controlled by CAG-QCM setup. Part status, time/date, check results and check status is contained in the file.

DETAILED DESCRIPTION OF DATA FORMAT:

- Line 1 identifies start of file header information.
- Line 2 contains the number of checks setup in the gage.
- Line 3 contains the max number of parts that can be stored in the file.
- Line 4 identifies if file wrapping is enabled NW - No wrapping, YW - Yes wrapping.
- Line 5 identifies units of measurement, IN - inch, MM - millimeter.
- Line 6 identifies start of part gage data.
- Line 7 contains the 1st part information record. The data is comma delimited and each part record is contained in one line.

DATA FEILD DESCRIPTION:
Part Index, Date/Time Part Gaged, Part Status, Annotation, SPC Member, Number of Checks, Chk1 Result, Chk1 Status, Chk2 Result, Chk2 Status, ... Chk16 Result, Chk16 Status.

FEEDBACK DATA

FILE NAME: FeedbkG1.fbk, FeedbkG2.fbk, FeedbkG3.fbk, FeedbkG4.fbk

LOCATION: CYCLDATA directory.

UPDATED: Every gage cycle on gages that feedback is utilized and enabled. Not updated during mastering, verification and RR-Study gage cycles.

CONTENTS: Feedback offset data for the last part gaged included the feedback mode, running average, calculated offset, transmitted offset and total tool adjustment.

DETAILED DESCRIPTION OF DATA FORMAT:
- Line 1 & 2 contain the date and time the file was written.
- Line 3 contains the gage name.
- Line 8 contains the feedback data in one continuous line with each field separated by comma. The amount of data will vary depending on how may feedback offsets are setup in the gage.

DATA FEILD DESCRIPTION:
Feedback Mode, Offset 1 Running Average, Offset 1 Calculated Offset, Offset 1 Transmitted Offset, Offset 1 Total Tooling Adjustment, Offset 2 Running Average, Offset 2 Calculated Offset, Offset 2 Transmitted Offset, Offset 2 Total Tooling Adjustment, ... Offset 8.

9 TROUBLESHOOTING

The foremost step in the troubleshooting procedure is to identify the problem and its source. Do this by observing the symptoms and noting each. Review these notes and attempt to determine the particular area of concern. As an example, if the CAG is experiencing a problem where the monitor is blank, it is advantageous to note which components are functioning and which are not. Is the fan running, are the accept and reject lights on after power is reset, and is the CAG updating the accept/reject lights when expected? These are only a few conditions that will aid in the diagnosing effort. The following tables describe a problem and a probable cause. Your initial observations will aid in determining which problem most resembles the one at hand and which do not apply.

POWER DISTRIBUTION CONSIDERATIONS

Description	**Probable Cause**	**Recommended Action**
Display is blank after reset	No Line Power	Check 120 VAC input power
Poor Power Cable Connection		Inspect power cable connections.
Fuse		Check fuse in power entry module
		If condition occurs again check input power and inspect CAG wiring for shorts.
Improper Video Connections		Inspect all video cable connections.

CAG SEEMS INOPERABLE		
Description	**Probable Cause**	**Recommended Action**
CAG is not Responsive to key pad (displays a menu)	CAG is no longer active	Reset the CAG Disconnect power, then reconnect power
	Keypad assembly	Ensure keypad cable is properly connected at both ends If symptom continues initiate a gage cycle and notice the accept/reject lights. If the lights update, replace the keypad assembly.
CAG does not Start		Power CAG down, wait 1 min, and power up again.
After power up CAG still not Responsive.	Corrupt system	Power CAG Down. Power CAG up When message "Starting CAG" Appears on display, Press "." (3) Times to reload default system files.

GAGING CONSIDERATIONS

Description	Probable Cause	Recommended Action
CAG does not Gage.	GAGE is not enabled	Enable gage in the gage set up menu. If keypad gaging, ensure keypad gaging is enabled as well. Determine if the CAG is gaging by Confirming if the accept/reject lights update, if they do in fact update, the CAG is gaging
Unable to enter Master sizes.	Setup variables	Ensure the check(s) are NOT defined as multiple checks.
Unable to enter "Master the Gage menu	Setup variables	Ensure the master sizes and numbers are entered

PARALLEL COMMUNICATIONS CONSIDERATIONS

Description	Probable Cause	Recommended Action
Unable to Communicate with CAG unit	Improper Interface	Ensure interface connections are correct Refer to opto wiring interface. See comment 1 below
CAG ignores ENDGAGE Message	Only one interrupt received.	Ensure the interrupt for START GAGE message is off before attempting the ENDGAGE message
Fault code message is not displayed	Fault code must be defined and enabled	The selected fault code must be defined and enabled or the CAG will not display the message.

COMMENTS:

1. If interfacing with a PLC, force the PLC outputs and verify integrity by monitoring the CAG inputs menu. Reference the opto number to the corresponding input.

   Force the CAG outputs and verify the integrity of each at the receiving end. Use the CAG force outputs menu.

ANALOG INPUT CONSIDERATIONS		
Description	**Probable Cause**	**Recommended Action**
No readings displayed in menu Display All Inputs 6.1	Inputs not designated	Select corresponding inputs in the check formula menu.
	Balancing Input MAG has Reset to zero.	Reset balance MAG to 1.0000
Input reading is displayed but does not change in Display All Inputs	No input is present	Ensure an input (i.e. LVDT) is plugged into the correct signal conditioning socket.
	Signal Conditioning Card is not properly Seated.	Disconnect power to the CAG and re-seat the signal conditioning board which coincides with the input in Question.
	A/D converter is not Seated properly.	Disconnect power to the CAG and re-seat the A/D controller board. Also ensure all cabling is secure to and from the controller.
"LVDT input" - Full travel of the LVDT can't be achieved	Signal Conditioning card not properly seated	Disconnect power to the CAG and re-seat the signal conditioning board which coincides with the input in question

MISCELLANEOUS

Description	Probable Cause	Recommended Action
Unable to print via LPT1 port connected .	Printer cable is not properly connected.	Ensure the CAG end of the cable is is connected to the LPT1 connector on the side panel.
	Wrong printer cable.	Cable for previous CAG hardware versions may not be compatible. The printer cable must be compatible with the printer.

10 FEEDBACK DESCRIPTION

The CAG can be configured to compute machine tool offsets and transmit the offsets to the machine for tool adjustments. The standard number of offsets is 8, with the option of 16 with the addition of special software.

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.

Feedback Setup Menu 12.2.7

1) NUMBER OF OFFSETS - The number of offsets that the CAG will evaluate and compute compensation data.

STATUS- Select enable to turn on feedback. Select disable to turn off the feedback.

RESET TIMER- This timer will reset the feedback to Startup mode if the gage has been idle for the time entered.

2) START-UP MODE UTILIZED - "YES" if Start-up mode is used, "NO" if not used.

START-UP MODE LIMIT - Maximum number of consecutive parts allowed to be gaged in the Start-up Mode. If the Limit is exceeded an alarm is triggered which can be programmed to send a shutdown command.

3) RUN MODE TRIGGER - The Number of Consecutive Gaged Good parts that must be Measured in the Start-up Mode before advancing to the Run Mode.

RUN MODE REJECTS- INCLUDED allows feedback to be calculated on rejected parts in the run mode. EXCLUDED will not calculate feedback on rejected parts in the run mode. Excluded is the default setting.

4) PART LAG START-UP MODE - The Number of consecutive parts following a compensation in the Start-up mode that will not be included in the data accumulation for the new running average. For example, there may be 3 parts on the track from a Grinder to the CAG. These parts were not machined to the specifications of the last feedback, and should not be included in the new sample.

PART LAG RUN MODE - Number of consecutive parts following a compensation in the Run mode that will not be included in the data accumulation for the new running average. For example, there may be 3 parts on the track from a Grinder to the CAG. These parts were not machined to the specifications of the last feedback, and should not be included in the new sample.

5) OFFSET DEFINITION:

DESCRIPTION - Each offset can have a programmable name which will be used in subsequent displays to associate data with a specific Offset.

 # CHECK - The measured part feature that the running average will be performed on for an offset.

 # OFFSET - An offset can be a function of one to three additional offsets. This is useful when other offsets computed for the same measurement cycle will affect the amount of compensation that is to be applied for this offset.

MULTIPLIER - The percentage of the other offsets that should be added or subtracted to this offset during the same measurement cycle.

I. FEEDBACK CONTROL VARIABLES AND SETUP, MENU 4.4:

1) 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.

2) COMPENSATION RATES

 # SAMPLES = MAX - Compensation rate applied to the running average when the following conditions exist:

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

 # SAMPLES < MAX - Compensation rate applied to the running average when the following conditions exist:

1) The Gage is in the Run Mode.
2) The running average exceeds 1 of the Feedback Control Limits.
3) The number of Samples accumulated for the offset is equal to or greater than the Min Sample Size and less than the Max Sample Size.

START-UP MODE - Compensation rate applied to the running average when the following conditions exist:

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

3) 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.

4) TOOLING ADJUST 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.

TOTAL - The Total Tooling Adjust Limit is the maximum allowed adjustment since the last tool change. 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.

5) COMPENSATION COUNT RESOLUTION

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

NUMBER OF OFFSETS - The number of offsets that the CAG will evaluate and compute compensation data.

II. FEEDBACK DISPLAY, MENU 7.6

A Feedback display can be viewed or printed from the CAG. The display contains the following information on all computed offsets:

1) Feedback Mode
2) Part Status
3) Sample Count
4) Running Average
5) Comp Status
6) Feedback Offset
7) Total Part Counters
8) Sample Data

III. FEEDBACK OPERATION

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 Check #01 to illustrate start-up mode operation.

NUMBER OF OFFSETS: 1 STATUS: ENABLED
START-UP MODE UTILIZED: YES START-UP MODE LIMIT: 5
RUN MODE TRIGGER: 2
PART LAG START-UP MODE: 1 / RUN MODE: 1

FEEDBACK OFFSET DEFINITION:

DESCRIPTION = # CHECK + # OFFSET x MULTIPLIER

01 OFFSET 01 01 CHECK -- ----------

OFFSET 01 SPECIFIC INFORMATION:

SAMPLE SIZE MIN: 1 MAX: 3

COMPENSATION RATES
#SAMPLES = MAX: +0.50000
#SAMPLES < MAX: +0.75000
#START-UP MODE: +1.00000

FEEDBACK CONTROL LIMITS
UCL: +0.00500
SETPOINT: +0.00100
LCL: -0.00500

TOOLING ADJUST LIMITS
PER CYCLE: 0.02000
TOTAL: 0.80000

A) On power-up, or when resetting the feedback data in DATA RESET, menu 5.4, the feedback data is initialized to the values shown in Figure #1. The part status and check result values correspond to the last part gaged and, therefore, will vary each time feedback is reset.

The part counters and sample count are set to 0. The lag count is set to the user defined start-up mode part lag, 1, 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.

```
PART STATUS:  ACCEPT                  FEEDBACK DATA
                                      MODE:  START-UP
CHECK RESULT: +0.00344                RUNNING AVERAGE:      0
                                      CALCULATED  OFFSET:    0
PART COUNTERS                         TRANSMITTED OFFSET:    0
  TOTAL:           0                  TOOL ADJUST. TOTAL:   0
  CONSECUTIVE GOOD: 0
  START-UP MODE:    0                      SAMPLE DATA

SAMPLE COUNTERS                       [00]
  SAMPLE COUNT:   0                   [01]
  LAG COUNT:      1                   [02]
```

FIGURE #1

B) The first part is gaged, the part status is REJECT, and the check result for Check #01 is +0.01035. The feedback data is updated as shown in Figure #2.

The part counters were updated as follows: TOTAL was incremented from 0 to 1 because a part was gaged, CONSECUTIVE GOOD remained unchanged because the part status was not ACCEPT, and START-UP MODE 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 1 to 2 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 GOOD 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.

PART STATUS: REJECT

CHECK RESULT: +0.01035 OV

PART COUNTERS
TOTAL: 1
CONSECUTIVE GOOD: 0
START-UP MODE: 1

SAMPLE COUNTERS
SAMPLE COUNT: 1
LAG COUNT: 2

FEEDBACK DATA
MODE: **START-UP**
RUNNING AVERAGE: +0.01035
CALCULATED OFFSET: +0.00935
TRANSMITTED OFFSET: +0.00935
TOOL ADJUST. TOTAL: +0.00935

SAMPLE DATA

[00] +0.01035
[01]
[02]

FIGURE #2

C) 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 for Check #01 is +0.00624. The feedback data is updated as shown in Figure #3.

The part counters were updated as follows: TOTAL was incremented from 1 to 2 because a part was gaged, CONSECUTIVE GOOD was incremented from 0 to 1 because the part status was ACCEPT, and START-UP MODE 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.

PART STATUS: ACCEPT

CHECK RESULT: +0.00624

PART COUNTERS
TOTAL: 2
CONSECUTIVE GOOD: 1
START-UP MODE: 2

SAMPLE COUNTERS
SAMPLE COUNT: 0
LAG COUNT: 1

FEEDBACK DATA
MODE: **START-UP**
RUNNING AVERAGE: 0
CALCULATED OFFSET: 0
TRANSMITTED OFFSET: 0
TOOL ADJUST. TOTAL: +0.00935

SAMPLE DATA

[00]
[01]
[02]

FIGURE #3

D) The next part is gaged, the part status is ACCEPT, and the check result for Check #01 is +0.00552. The feedback data is updated as shown in Figure #4.

The part counters were updated as follows: TOTAL was incremented from 2 to 3 because a part was gaged, CONSECUTIVE GOOD was incremented from 1 to 2

because the part status was ACCEPT, and START-UP MODE was unchanged because the part was gaged in RUN mode (because the consecutive good counter, 2, was greater than or equal to the run mode trigger, 2).

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 is RUN because the CONSECUTIVE GOOD counter was greater than or equal to the run mode trigger. The running average, +0.00552, is the average of the sample data. The calculated offset, +0.00339, is the running average minus the setpoint value, multiplied by the #SAMPLES < MAX compensation rate of +0.75000. ((0.00552 -0.00100) * 0.75000) = 0.00339. 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.

PART STATUS: ACCEPT

CHECK RESULT: +0.00552

PART COUNTERS
TOTAL: 3
CONSECUTIVE GOOD: 2
START-UP MODE: 2

SAMPLE COUNTERS
SAMPLE COUNT: 1
LAG COUNT: 2

FEEDBACK DATA
MODE: **RUN**
RUNNING AVERAGE: +0.00552
CALCULATED OFFSET: +0.00339
TRANSMITTED OFFSET: +0.00339
TOOL ADJUST. TOTAL: +0.01274

SAMPLE DATA

[00] +0.00552
[01]
[02]

FIGURE #4

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 DATA RESET, menu 5.4.

3) Special software to communicate with an external source that instructs the CAG^{TM} 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 section D above, and the feedback data from Figure #4 is repeated here for reference.

PART STATUS: ACCEPT

CHECK RESULT: +0.00552

PART COUNTERS
TOTAL: 3
CONSECUTIVE GOOD: 2
START-UP MODE: 2

SAMPLE COUNTERS
SAMPLE COUNT: 1
LAG COUNT: 2

FEEDBACK DATA
MODE: **RUN**
RUNNING AVERAGE: +0.00552
CALCULATED OFFSET: +0.00339
TRANSMITTED OFFSET: +0.00339
TOOL ADJUST. TOTAL: +0.01274

SAMPLE DATA

[00] +0.00552
[01]
[02]

FIGURE # 4

A) 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 for Check #01 is +0.00152. The feedback data is updated as shown in Figure #5.

The part counters were updated as follows: TOTAL was incremented from 3 to 4 because a part was gaged, CONSECUTIVE GOOD was incremented from 2 to 3 because the part status was ACCEPT, and START-UP MODE 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.

PART STATUS: ACCEPT

CHECK RESULT: +0.00152

PART COUNTERS
TOTAL: 4
CONSECUTIVE GOOD: 3
START-UP MODE: 2

SAMPLE COUNTERS
SAMPLE COUNT: 0
LAG COUNT: 1

FEEDBACK DATA
MODE: **RUN**
RUNNING AVERAGE: 0
CALCULATED OFFSET: 0
TRANSMITTED OFFSET: 0
TOOL ADJUST. TOTAL: +0.01274

SAMPLE DATA

[00]
[01]
[02]

FIGURE #5

B) The next part is gaged, the part status is ACCEPT, and the check result for Check #01 is +0.00178. The feedback data is updated as shown in Figure #6.

The part counters were updated as follows: TOTAL was incremented from 4 to 5 because a part was gaged, CONSECUTIVE GOOD was incremented from 3 to 4

because the part status was ACCEPT, and START-UP MODE 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.

PART STATUS: ACCEPT

CHECK RESULT: +0.00178

PART COUNTERS
TOTAL: 5
CONSECUTIVE GOOD: 4
START-UP MODE: 2

SAMPLE COUNTERS
SAMPLE COUNT: 1
LAG COUNT: 2

FEEDBACK DATA
MODE: **RUN**
RUNNING AVERAGE: +0.00178
CALCULATED OFFSET: 0
TRANSMITTED OFFSET: 0
TOOL ADJUST. TOTAL: +0.01274

SAMPLE DATA

[00] +0.00178
[01]
[02]

FIGURE #6

C) The next part is gaged, the part status is ACCEPT, and the check result for Check #01 is +0.00347. The feedback data is updated as shown in Figure #7.

The part counters were updated as follows: TOTAL was incremented from 5 to 6 because a part was gaged, CONSECUTIVE GOOD was incremented from 4 to 5

because the part status was ACCEPT, and START-UP MODE 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, +0.00262, 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.

PART STATUS: ACCEPT

CHECK RESULT: +0.00347

PART COUNTERS
TOTAL: 6
CONSECUTIVE GOOD: 5
START-UP MODE: 2

SAMPLE COUNTERS
SAMPLE COUNT: 2
LAG COUNT: 2

FEEDBACK DATA
MODE: **RUN**
RUNNING AVERAGE: +0.00262
CALCULATED OFFSET: 0
TRANSMITTED OFFSET: 0
TOOL ADJUST. TOTAL: +0.01274

SAMPLE DATA

[00] +0.00178
[01] +0.00347
[02]

FIGURE #7

D) The next part is gaged, the part status is ACCEPT, and the check result for Check #01 is +0.00518. The feedback data is updated as shown in Figure #8.

The part counters were updated as follows: TOTAL was incremented from 6 to 7 because a part was gaged, CONSECUTIVE GOOD was incremented from 5 to 6

because the part status was ACCEPT, and START-UP MODE 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.

```
PART STATUS:  ACCEPT                  FEEDBACK DATA
                                      MODE:  RUN
CHECK RESULT: +0.00518                RUNNING AVERAGE:    +0.00348
                                      CALCULATED  OFFSET:    0
PART COUNTERS                         TRANSMITTED OFFSET:    0
  TOTAL:                 7            TOOL ADJUST. TOTAL: +0.01274
  CONSECUTIVE GOOD: 6
  START-UP MODE:         2            ┌──── SAMPLE DATA ────┐
                                      │                     │
SAMPLE COUNTERS                       │ [00] +0.00178       │
  SAMPLE COUNT:          3            │ [01] +0.00347       │
  LAG COUNT:             2            │ [02] +0.00518       │
                                      └─────────────────────┘
```

FIGURE #8

E) The next part is gaged, the part status is ACCEPT, and the check result for Check #01 is +0.00776. The feedback data is updated as shown in Figure #9.

The part counters were updated as follows: TOTAL was incremented from 7 to 8 because a part was gaged, CONSECUTIVE GOOD was incremented from 6 to 7

because the part status was ACCEPT, and START-UP MODE 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, +0.00223, 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.

PART STATUS: ACCEPT

CHECK RESULT: +0.00776

PART COUNTERS
TOTAL: 8
CONSECUTIVE GOOD: 7
START-UP MODE: 2

SAMPLE COUNTERS
SAMPLE COUNT: 3
LAG COUNT: 2

FEEDBACK DATA
MODE: **RUN**
RUNNING AVERAGE: +0.00547
CALCULATED OFFSET: +0.00223
TRANSMITTED OFFSET: +0.00223
TOOL ADJUST. TOTAL: +0.01497

SAMPLE DATA

[00] +0.00347
[01] +0.00518
[02] +0.00776

FIGURE #9

CAG <-> PLC COMMUNICATIONS

Communications between the CAG and a PLC is performed through the use of Binary coded messages via Parallel I/O lines. The CAG has 6 Input lines and 14 Output lines which are optically isolated at 115 VAC. The 6 Input lines are defined as follows:

1) data bit 0
2) data bit 1
3) data bit 2
4) data bit 3
5) data bit 4
6) Interrupt

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.

There are 5 binary coded message types that can be transmitted to the CAG from the PLC:

1) SG Gage (1 - 4) Manual - The Start Gage Manual message specifies the Gage that is to take the measurement. The CAG will respond with an End Gage message as a response. SPC and Feedback data will not be accumulated in this mode.

2) SG Gage (1 - 4) Auto - The Start Gage Auto message specifies the Gage that is to take the measurement. In this mode SPC and Feedback data will be accumulated. The CAG will Respond with the Part Status followed by the # of Offsets and Offset data.

3) End Gage - The End Gage message is used to inform the CAG to stop taking Part Measurements during a dynamic Gage Cycle.

4) Fault Code (1 - 8) - The PLC can transmit from 1 to 8 programmable fault codes that will be displayed on the CAG Screen. This is typically used to alert the operator of a Gage Jam condition. The CAG response will be an ACKN message.

5) Reset FDBCK Gage (1 - 4) - The Reset Feed Back message specifies the Gage for Resetting the accumulated Feedback. The Gage will also go into the Start-up Mode. This message is typically transmitted during a cold start or a tool change.

-

OPTO CAG Port	C7	C4	C3	C2	C1	C0
Pin# on 37 Pin Connector	23	19	17	16	14	13
Description	Intr.	bit 4	bit 3	bit 2	bit 1	bit 0
-----------	-----	-----	-----	-----	-----	-----

SG Gage 1 Manual	1	0	0	0	0	1
SG Gage 1 Auto	1	0	0	0	1	0
SG Gage 2 Manual	1	0	0	0	1	1
SG Gage 2 Auto	1	0	0	1	0	0
SG Gage 3 Manual	1	0	0	1	0	1
SG Gage 3 Auto	1	0	0	1	1	0
SG Gage 4 Manual	1	0	0	1	1	1
SG Gage 4 Auto	1	0	1	0	0	0
End Gage	1	0	1	0	0	1
Fault Code 1	1	0	1	0	1	0
Fault Code 2	1	0	1	0	1	1
Fault Code 3	1	0	1	1	0	0
Fault Code 4	1	0	1	1	0	1
Fault Code 5	1	0	1	1	1	0
Fault Code 6	1	0	1	1	1	1
Fault Code 7	1	1	0	0	0	0
Fault Code 8	1	1	0	0	0	1
Reset FDBCK Gage 1	1	1	0	0	1	0
Reset FDBCK Gage 2	1	1	0	0	1	1
Reset FDBCK Gage 3	1	1	0	1	0	0
Reset FDBCK Gage 4	1	1	0	1	0	1

The 14 Output lines are defined as follows:

1) data bit 0 - data bit 12
2) data available

The CAG will set the binary coded message 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 Menu 12.6.5.5. If the CAG is configured for Feedback, it is up to the PLC to count the Data Available strobes in order to identify the Offset data during a measurement cycle.

Example: The PLC initiates a measurement cycle to a CAG configured for computing 2 Offsets by transmitting a Start Gage Signal. The CAG will Respond with the following message sequence.

Data Avail. Strobe #1 = Part Status
Data Avail. Strobe #2 = # of Offsets (2)
Data Avail. Strobe #3 = Offset Data #1
Data Avail. Strove #4 = Offset Data #2

There are 9 binary coded message types:

1) Ackn. - Acknowledges the receipt of a Fault code message or a Reset FDBCK message.

2) Shutdown - This message will be transmitted when any internal CAG alarm is

triggered and is programmed to inform the machine control. The message indicates that there is a problem with the gage or the machine tool and operator intervention is necessary. This message can be triggered by any CAG alarm such as:

1) Consecutively Gaged Rejects in Auto Mode
2) Tooling Adjustment Limits exceeded
3) Start-up Mode Limit exceeded

3) End Gage - This message is a response to a Manual Start Gage Message.

4) Good Part - This message is a response to an Auto Start Gage Message.

5) Reject Part - This message is a response to an Auto Start Gage Message.

6) R&R Sort (#1 - #3) - One of three possible response messages to a Start Gage message can be received during an R & R study.

7) Class - The CAG can classify a part into 10 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.

8) Offset # - The Offset # specifies the number of Offsets the CAG is configured to compute. This value specifies the number of data strobes that will follow with offset data. If the CAG is setup to compute offsets then the Offset # will always be present on the second data available strobe during an Auto Start gage. If the CAG is classifying then it will be present on the third data available strobe.

9) Offset Data - The Offset Data will always follow the Offset # data available strobe. If the CAG is configured to compute Feedback data for 4 offsets then 4 data strobes will follow. If a particular offset does not need compensation then Zero will be transmitted.

BINARY MESSAGES

OPTO CAG Port	B5	A4	A3	A2	A1	A0
Pin # on 37 Pin Connector	32	7	5	4	2	1

Description	DA	4	3	2	1	0
			Data bit			
Ackn.	1	0	0	0	0	1
Shutdown	1	1	1	1	1	1
End Gage	1	0	0	0	1	0
Good Part	1	0	0	0	1	1
Reject Part	1	0	1	0	0	0
R&R Sort #1	1	0	0	1	1	0
R&R Sort #2	1	0	0	1	1	1
R&R Sort #3	1	0	1	0	0	0
Class Err.	1	0	0	0	0	0
Class #1	1	0	0	0	0	1
Class #2	1	0	0	0	1	0
.						
.						
.						
Class #10	1	0	1	0	1	0

Example #1:

Application:	1) Single Gage
	2) No Classifying
	3) No Feedback Defined

Typical Automatic Gage Cycle:

PLC -> CAG

OPTO CAG Port	C7	C4	C3	C2	C1	C0
Pin # on 37 Pin Connector	23	19	17	16	14	13
Description	Intr.	bit 4	bit 3	bit 2	bit 1	bit 0
----------------	-----	------	-----	-----	-----	-----
SG Gage 1 Auto	1	0	0	0	1	0

CAG -> PLC

OPTO CAG Port	B5	A4	A3	A2	A1	A0
Pin # on 37 Pin Connector	32	7	5	4	2	1

		Data bit				
Description	DA	4	3	2	1	0
1 Good Part	1	0	0	0	1	1

****

Example #2:

Application:
1) Single Gage
2) Classifying
3) NO Feedback Defined

Typical Automatic Gage Cycle:

PLC -> CAG

OPTO CAG Port	C7	C4	C3	C2	C1	C0
Pin # on 37 Pin Connector	23	19	17	16	14	13
Description	Intr.	bit 4	bit 3	bit 2	bit 1	bit 0
----------------	-----	------	-----	-----	-----	-----
SG Gage 1 Auto	1	0	0	0	1	0

CAG -> PLC

OPTO CAG Port	B5	A4	A3	A2	A1	A0
Pin # on 37 Pin Connector	32	7	5	4	2	1

		Data bit				
Description	DA	4	3	2	1	0
1 Good Part	1	0	0	0	1	1
2 Class #2	1	0	0	0	1	0

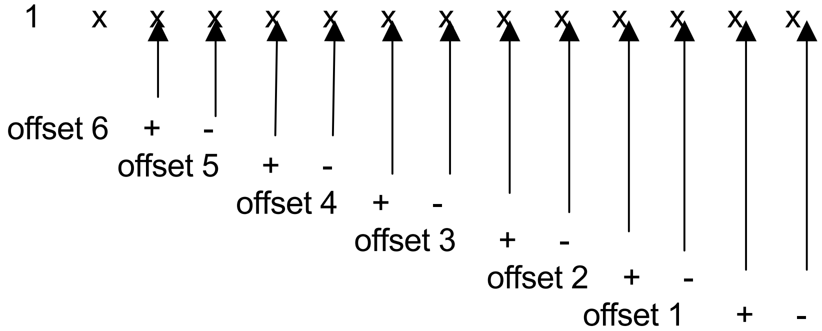
The Offset data can be transmitted in two distinct forms:
1) Absolute - Actual numeric data
2) Incremental - (+-) Comp Signals

The Absolute method allocates bits 0 - 11 for a binary numeric value and bit 12 for a sign (1 - minus, 0 - plus). The precision of the binary value is a function of the programmed resolution in the CAG.

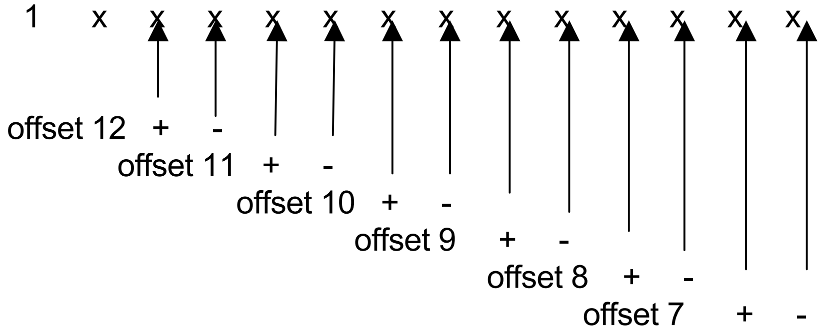
Example: The programmed resolution in the CAG is 0.00001, the binary numeric value

has a range of +-0.04095.
The Incremental method allocates bits 0 - 11 as discrete compensation lines.
Example: The CAG can be configured to compute a maximum of 16 Feedback Offsets.

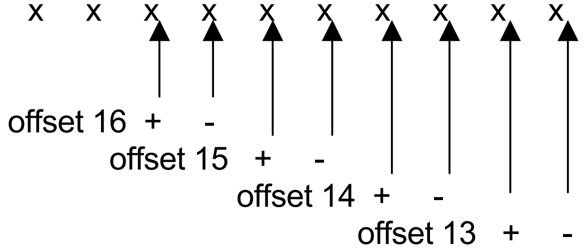
OPTO CAG Port	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	AO
Pin # on 37 pin I/O connector	32	31	29	28	26	25	11	10	8	7	5	4	2	1
						Data bit								
Description	DA	12	11	10	9	8	7	6	5	4	3	2	1	0
----------------														
3 Offset DATA (3)	1	0	0	0	0	0	0	0	0	0	0	0	1	1
4 Offset DATA #1	1	x	x	x	x	x	x	x	x	x	x	x	x	x



5 Offset DATA #1	1	x	x	x	x	x	x	x	x	x	x	x	x	x



6 Offset DATA #1	1	x	x	x	x	x	x	x	x	x	x	x	x	x



Example: The CAG is configured for 2 Feedback Offsets

OPTO CAG Port	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	AO
Pin # on 37 pin I/O connector	32	31	29	28	26	25	11	10	8	7	5	4	2	1

	Data bit													
Description	DA	12	11	10	9	8	7	6	5	4	3	2	1	0
----------------														
3 Offset Data (1)	1	0	0	0	0	0	0	0	0	0	0	0	0	1
4 Offset DATA #1	1	x	x	x	x	x	x	x	x	x	x	x	x	x

offset 2 + -
offset 1 + -

Edmunds Gages Parallel Feedback Signals

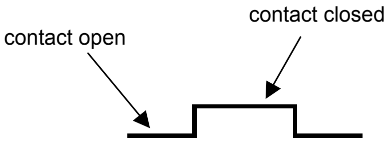
This section contains a description of the signals that pass between a Machine Tool Controller and the Edmunds Gage. It includes a description of the signals and the sequence that those signals produce.

Signal descriptions

Signals are to be dry contact, typically relays. The equipment supplier shall supply a relay for each signal originating from their equipment. The I/O LABEL as shown in the table below shall be consistently applied throughout the equipment documentation including program listings, schematics, etc.

General notes on sequences and signals:

The figure below illustrates contact state as shown in the diagrams:



Feedback Results

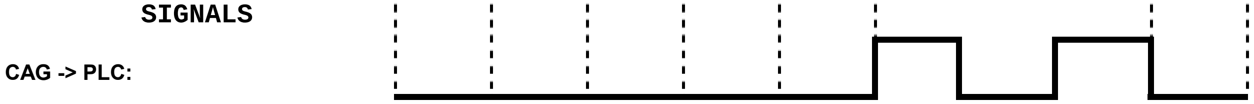
The following is an example of a typical automatic measurement cycle with feedback enabled. Assume the data transmission from the CAG to the PLC contained the following data:

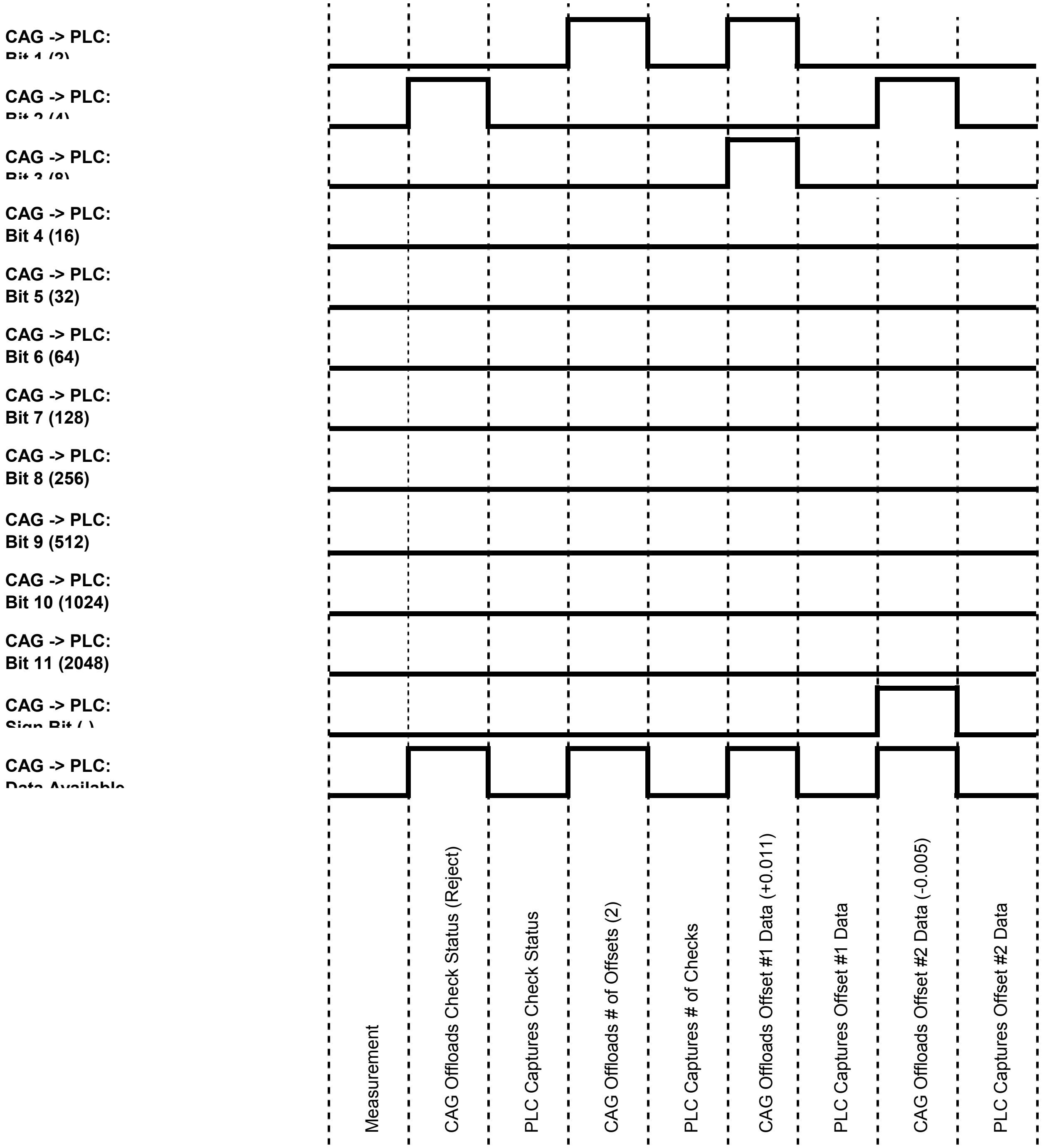
Part Status = REJECT
# of Offsets = 2
Offset #1 = +0.011
Offset #2 = -0.005

The offsets are calculated by the CAG with the following conditions:

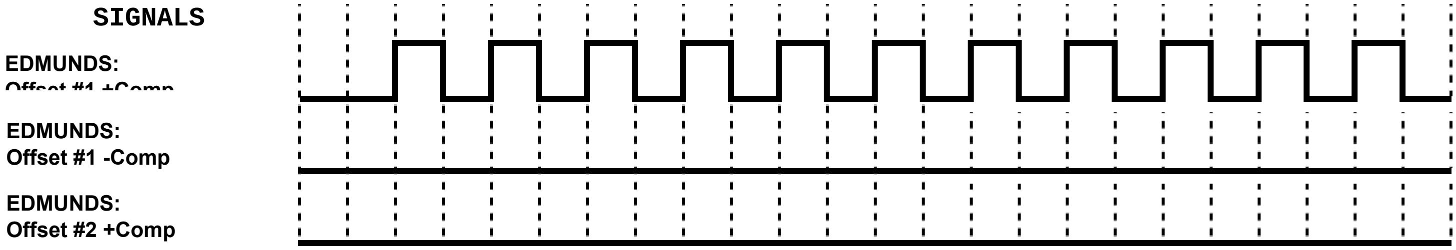
Offset #	Units	Comp Resolution
1	mm.	0.001
2	mm.	0.001

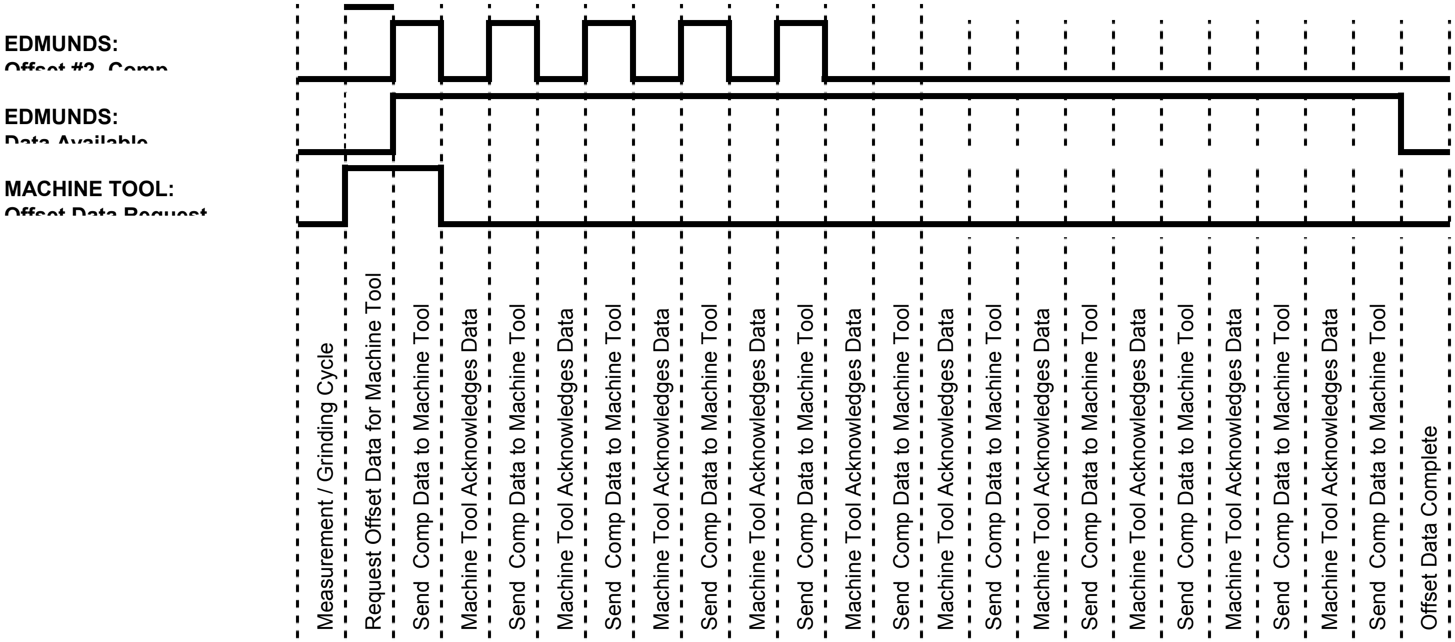
Sequence Diagram: CAG Offloading Data to PLC



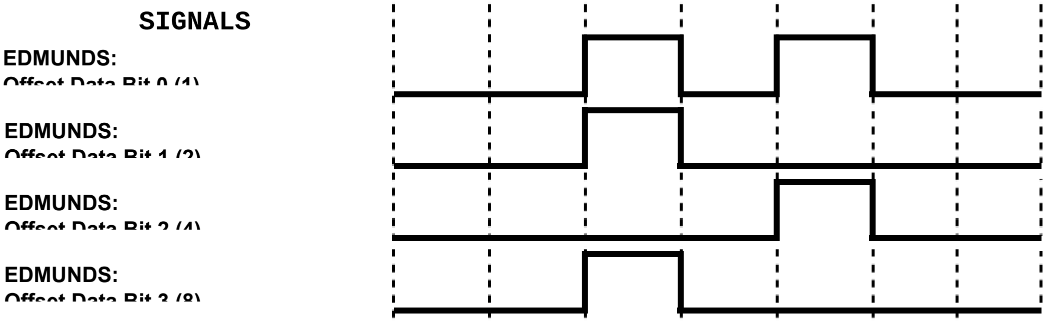


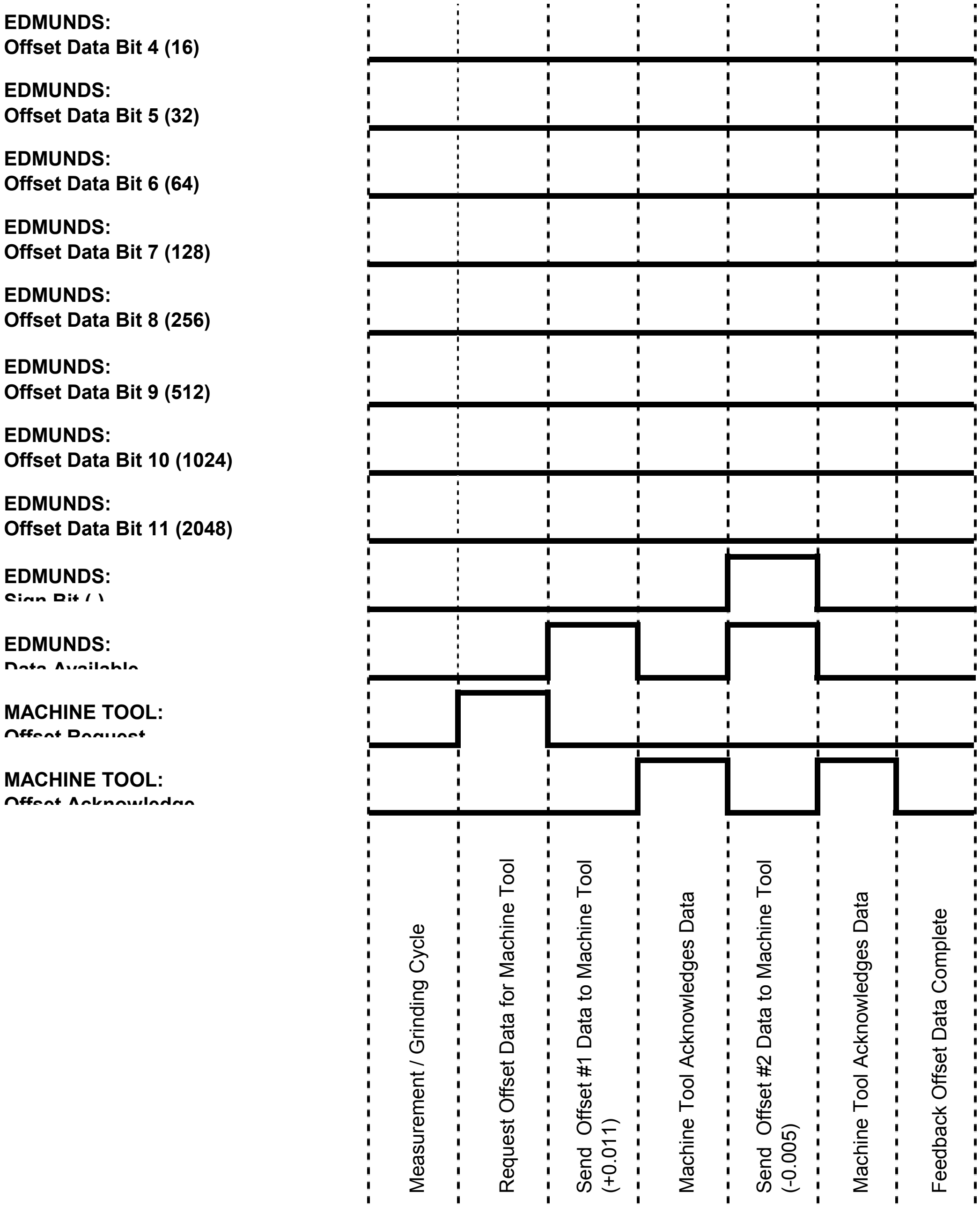
Sequence Diagram: +/- Comp Feedback



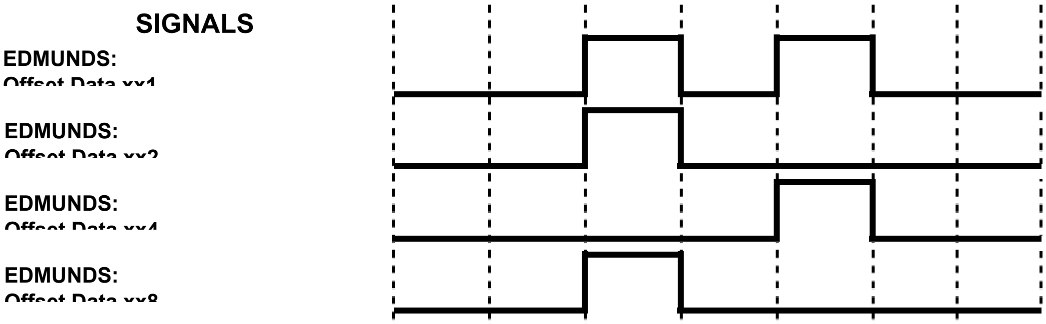


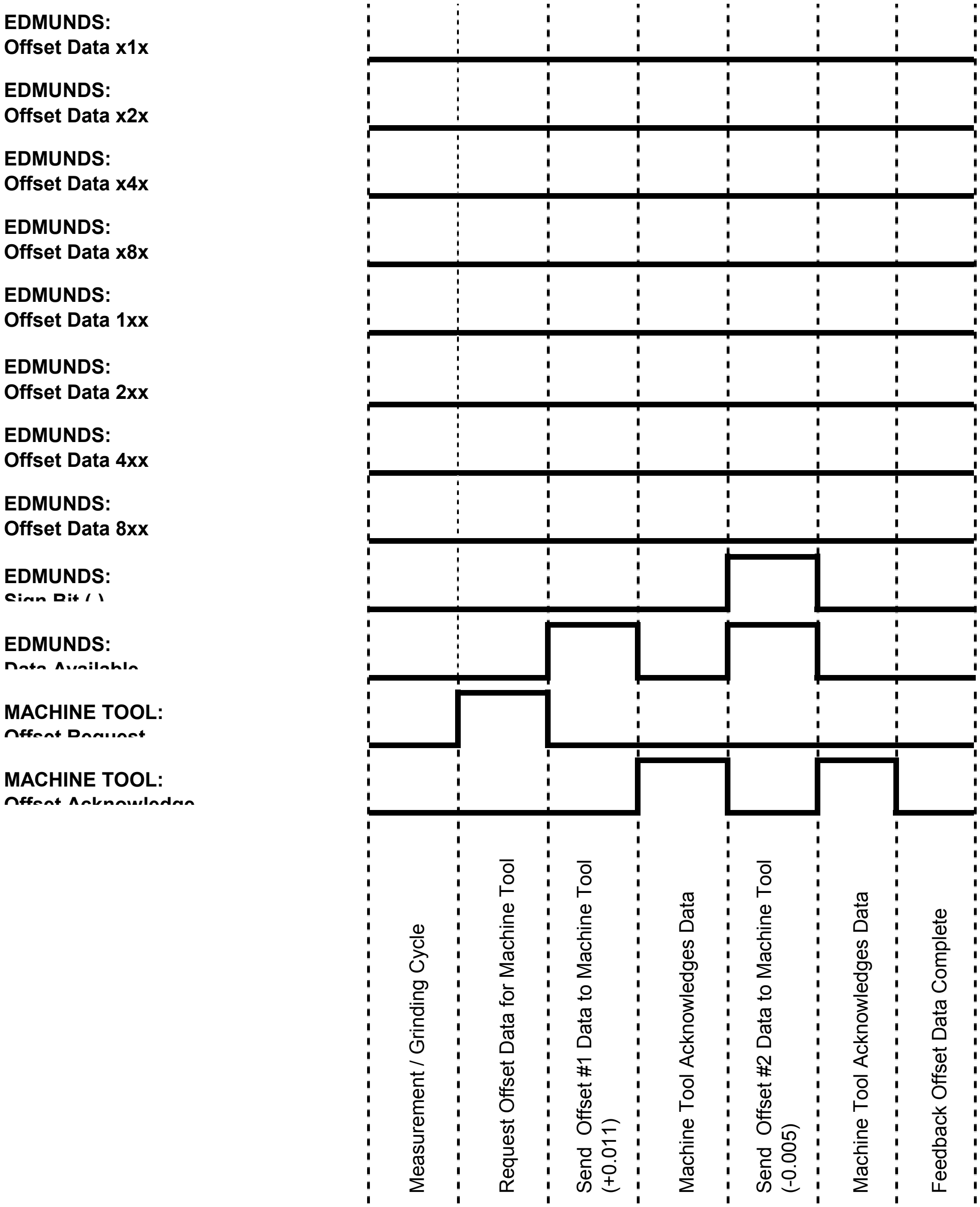
Sequence Diagram: Binary Data Feedback





Sequence Diagram: BCD Data Feedback





Edmunds Gages Serial Feedback Signals

Overview:
The following is a description of the serial data offload protocol between an Edmunds Gages CAG and a Machine Tool.

---

1. The data offload will be a solicited serial data transfer from the Edmunds CAG^{TM} 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 CAG^{TM}.

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^{TM} by transmitting a DC1 (11H) character to the CAG. The CAG^{TM} will respond with the data.

2. 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 retransmit the DC1 (11H) character. If the CAG^{TM} 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^{TM} screen.

The CAG^{TM} will reset the offset data when it receives the DC3 (13H) character.

3. 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 tem byte field.

For example, if the offset result is –0.12345, then the ten byte filed would contain the following bytes:

Byte #	Hex Value	ASCII
1	2DH	“-“
2	3OH	“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.

4. The following is an example of a typical automatic measurement cycle and data transmission. Assume the data transmission is from the CAG^{TM} 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:

Packet length = (#offsets x 10) + 9

= (2 x 10) + 9
= 29 decimal

The Machine Tool solicits the measurement data from the CAG^{TM} 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:

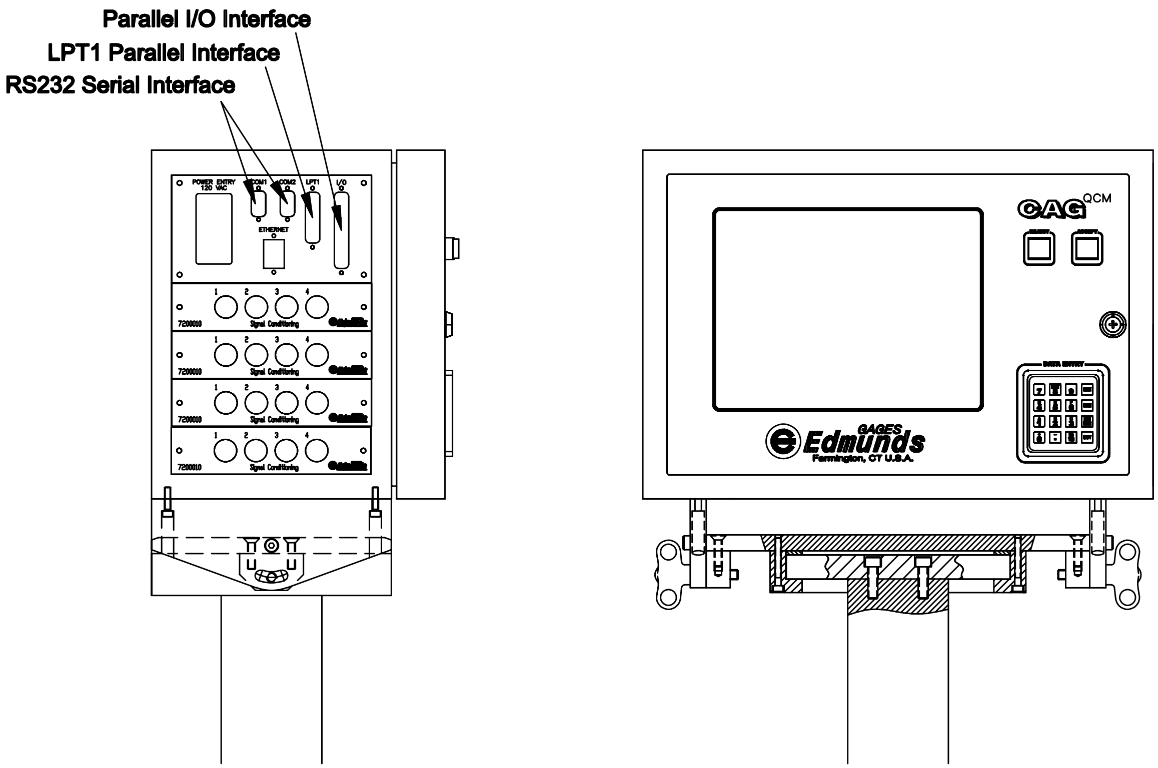
Byte #	Hex value	ACSII	Description
1	02H		STX, Start of Text
2	30H	“0”	Packet length (100)
3	32H	“2”	Packet length (10)
4	39H	“9”	Packet length (1)
5	42H	“B”	Bad, Reject part
6	30H	“0”	Number of offsets (10)
7	32H	“2”	Number of offsets (1)
8	2BH	“+”	--+
9	30H	“0”	|

10	2EH	“.”	| Offset Result for
11	30H	“0”	| Offset #1, padded
12	31H	“1”	+-→ with four spaces at
13	31H	“1”	| the end:
14	20H	“ ”	|
15	20H	“ ”	|
16	20H	“ ”	|
17	20H	“ “	--+
18	2DH	“-“	--+
19	30H	“0”	|
20	2EH	“.”	| Offset result for
21	30H	“0”	| Offset #2 padded
22	30H	“0”	+-→ with four spaces at
23	35H	“5”	| the end:
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 CAGTM consists of the following byte:

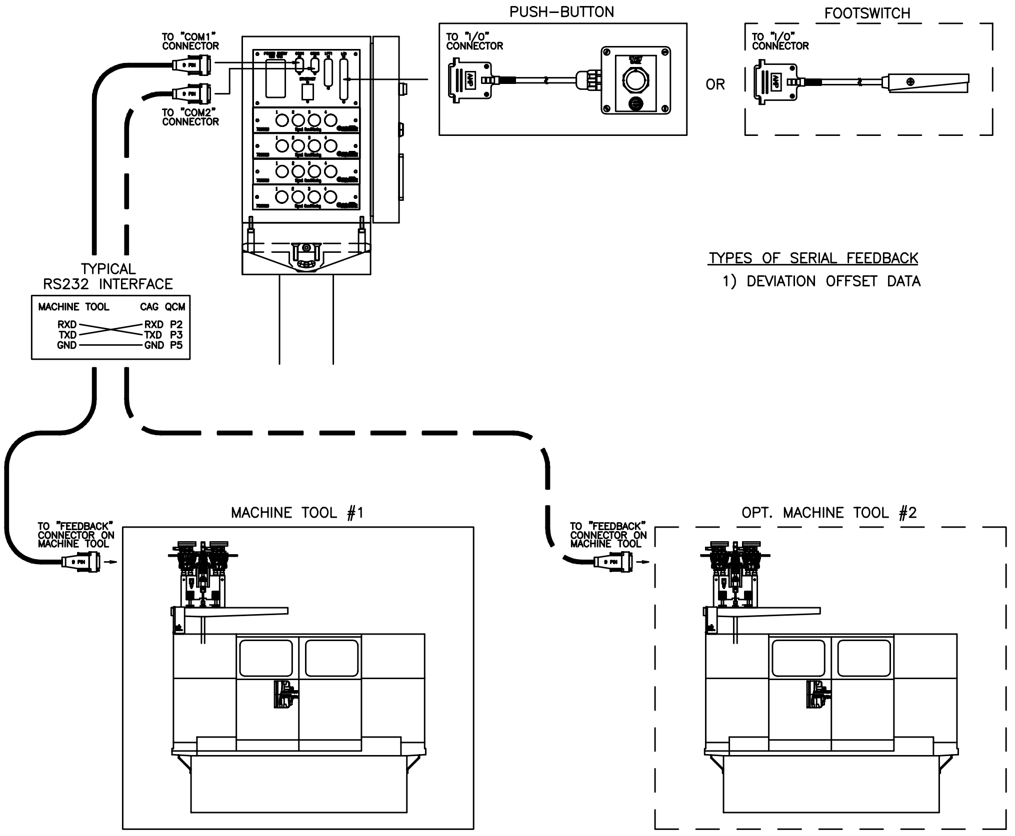
Byte #	Hex value	ACSII	Description
1	13H	DC3	

Edmunds Gages CAG^{QCM} Gaging System

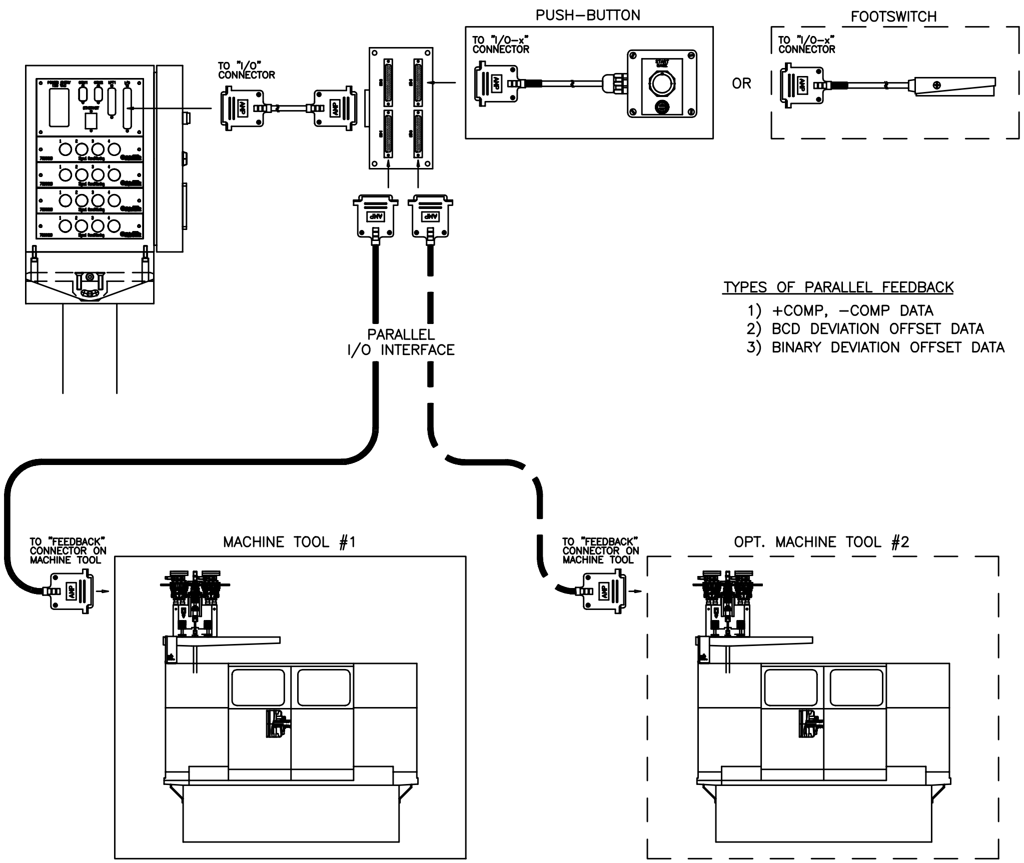


1

Manual CAG^{QCM} Application with Serial Feedback



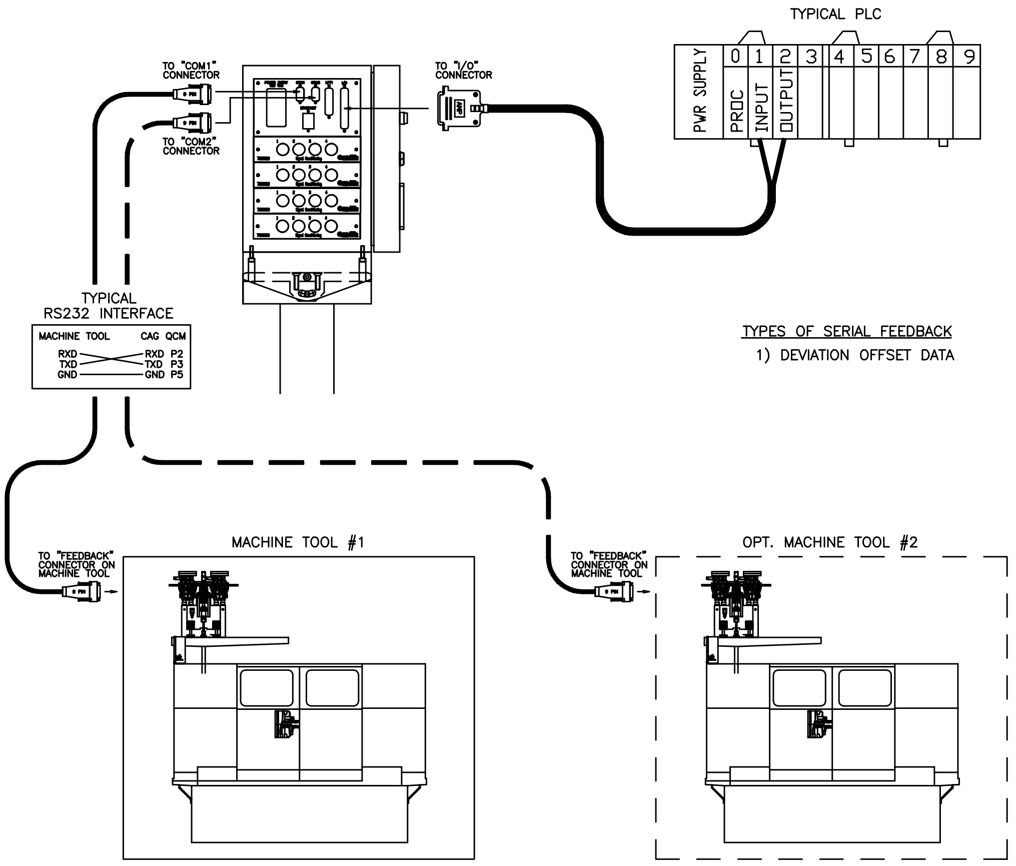
Manual CAG^{QCM} Application with Parallel Feedback



TYPES OF PARALLEL FEEDBACK

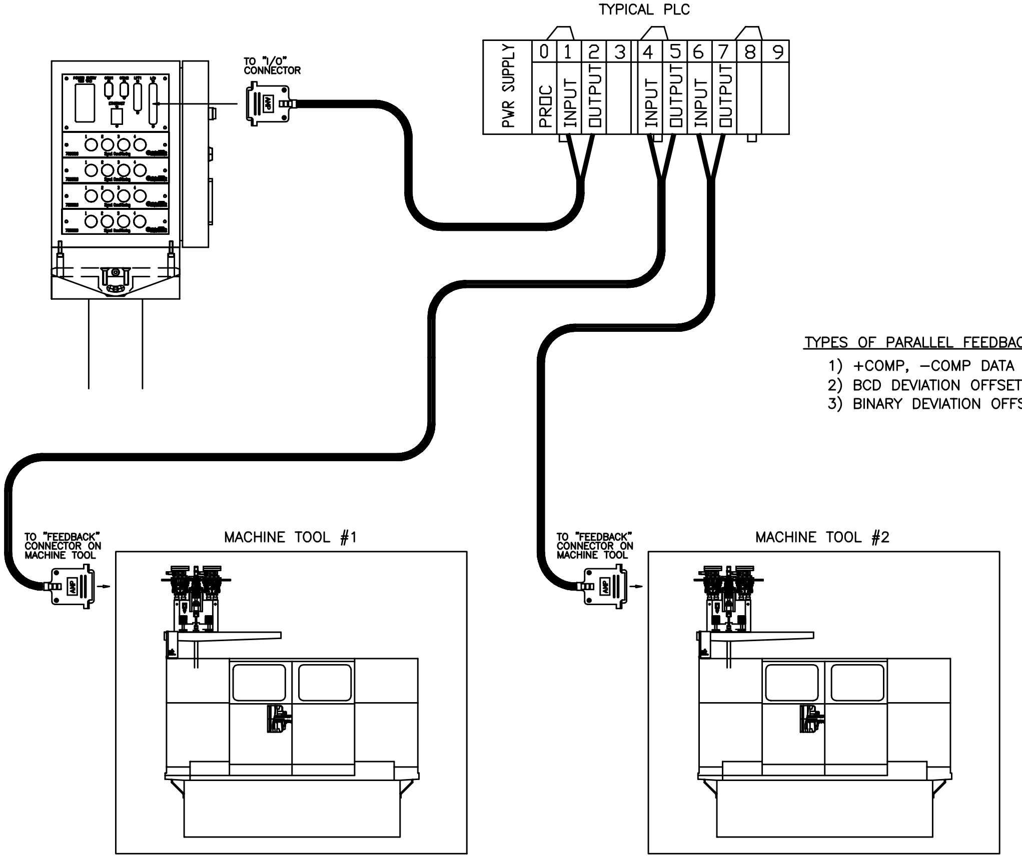
1) +COMP, –COMP DATA
2) BCD DEVIATION OFFSET DATA
3) BINARY DEVIATION OFFSET DATA

Automatic CAG^{QCM} Application with Serial Feedback



4

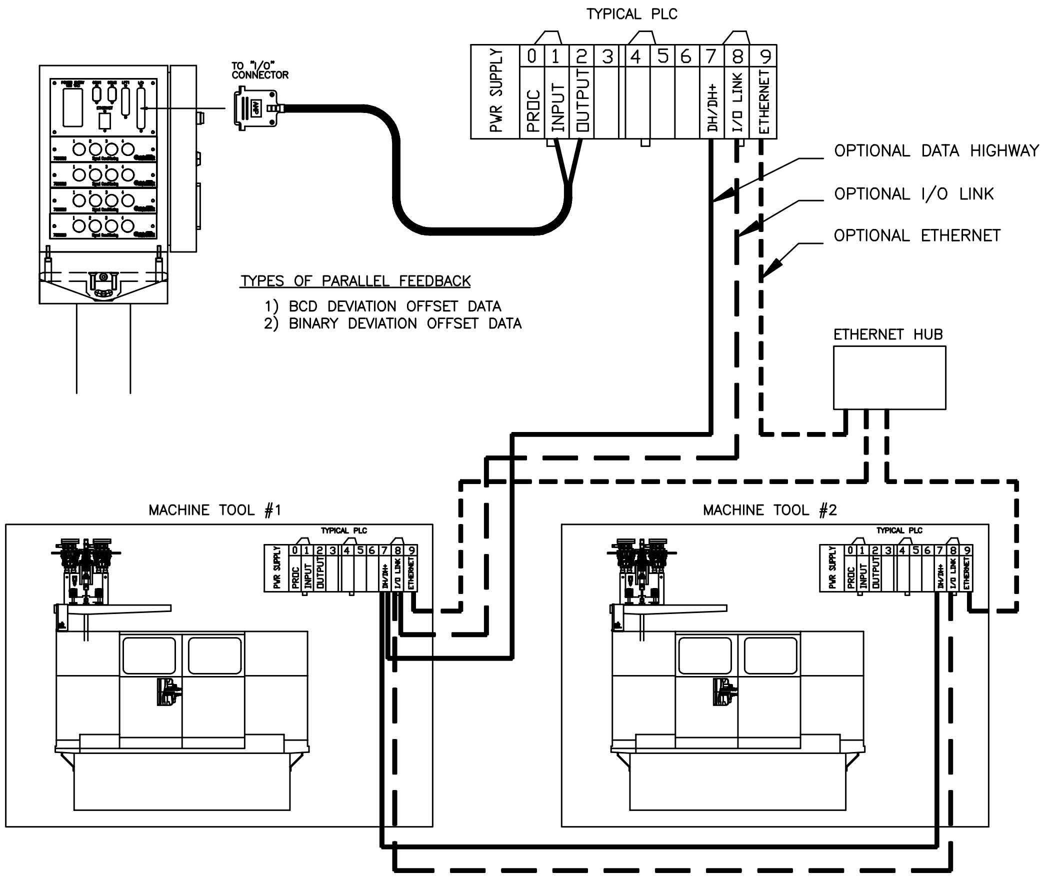
Automatic CAG^{QCM} Application with Parallel Feedback



TYPES OF PARALLEL FEEDBACK

1) +COMP, −COMP DATA
2) BCD DEVIATION OFFSET DATA
3) BINARY DEVIATION OFFSET DATA

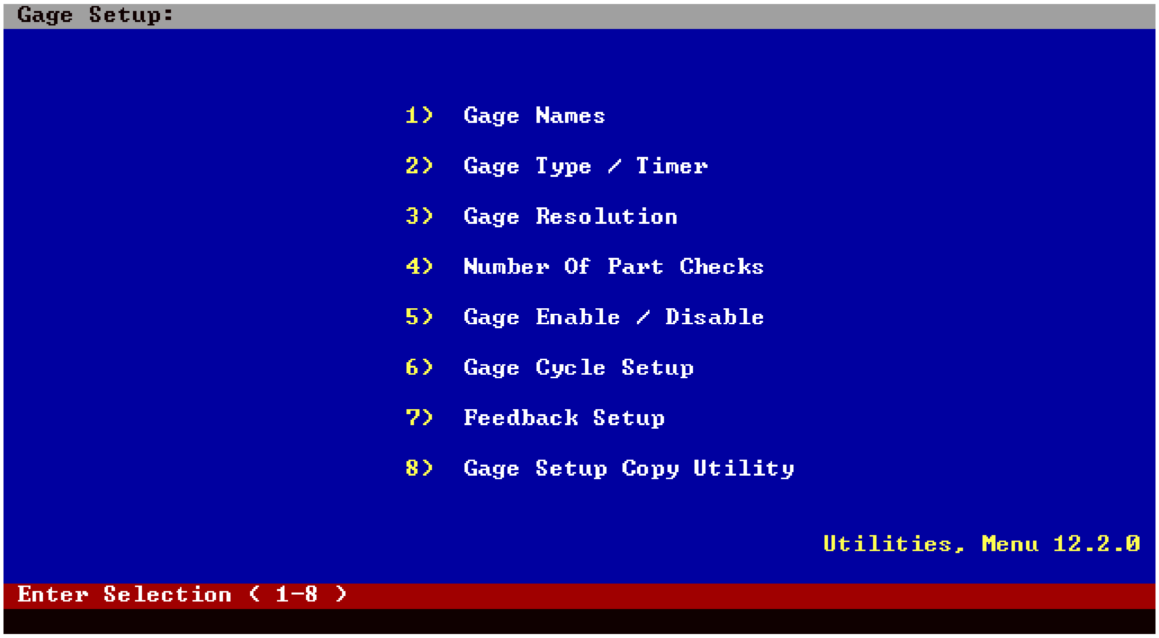
Automatic CAG^{QCM}Application with Parallel Feedback



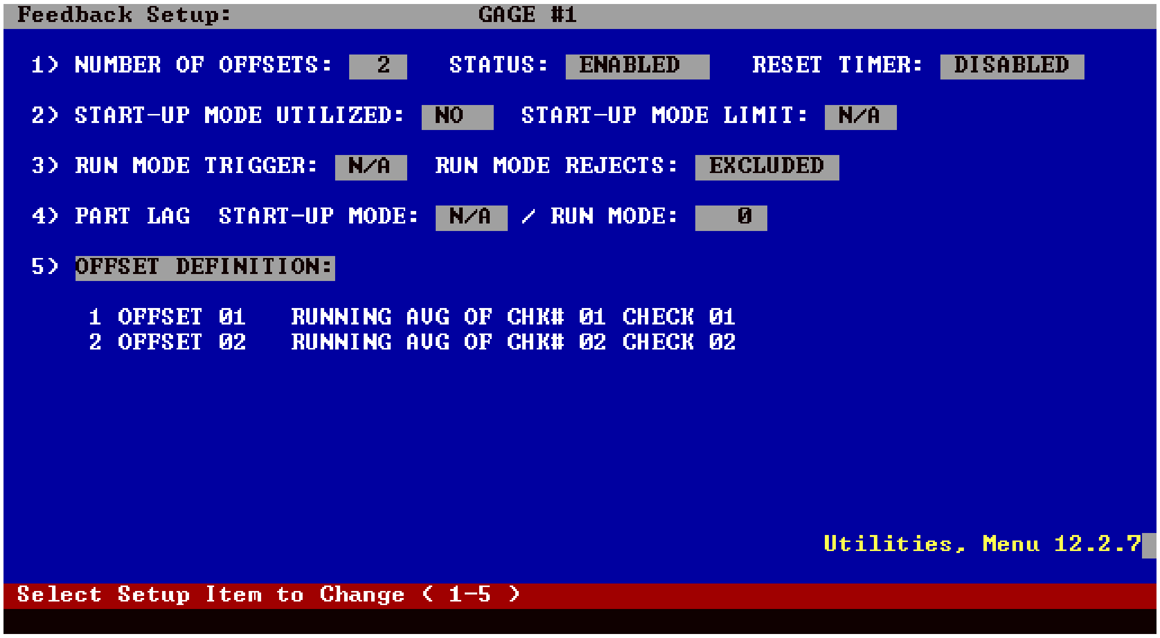
TYPES OF PARALLEL FEEDBACK
1) BCD DEVIATION OFFSET DATA
2) BINARY DEVIATION OFFSET DATA

6

Parallel and Standard Serial Feedback Screens:

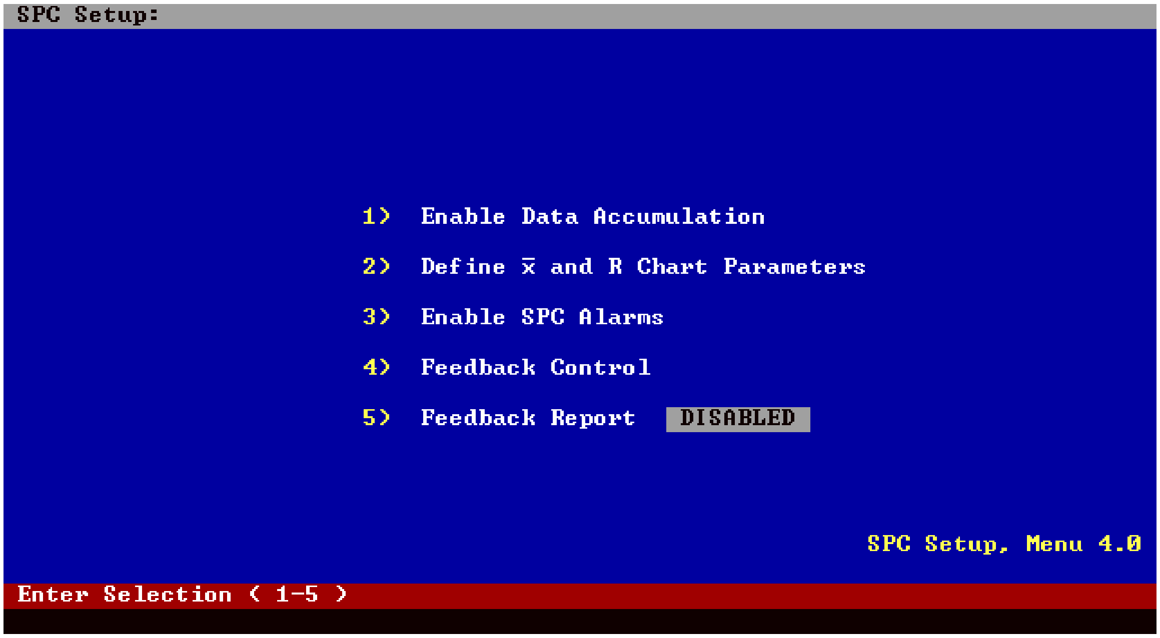


```
Gage Setup:

                         1)   Gage Names

                         2)   Gage Type / Timer

                         3)   Gage Resolution

                         4)   Number Of Part Checks

                         5)   Gage Enable / Disable

                         6)   Gage Cycle Setup

                         7)   Feedback Setup

                         8)   Gage Setup Copy Utility

                                                     Utilities, Menu 12.2.0
Enter Selection ( 1-8 )
```

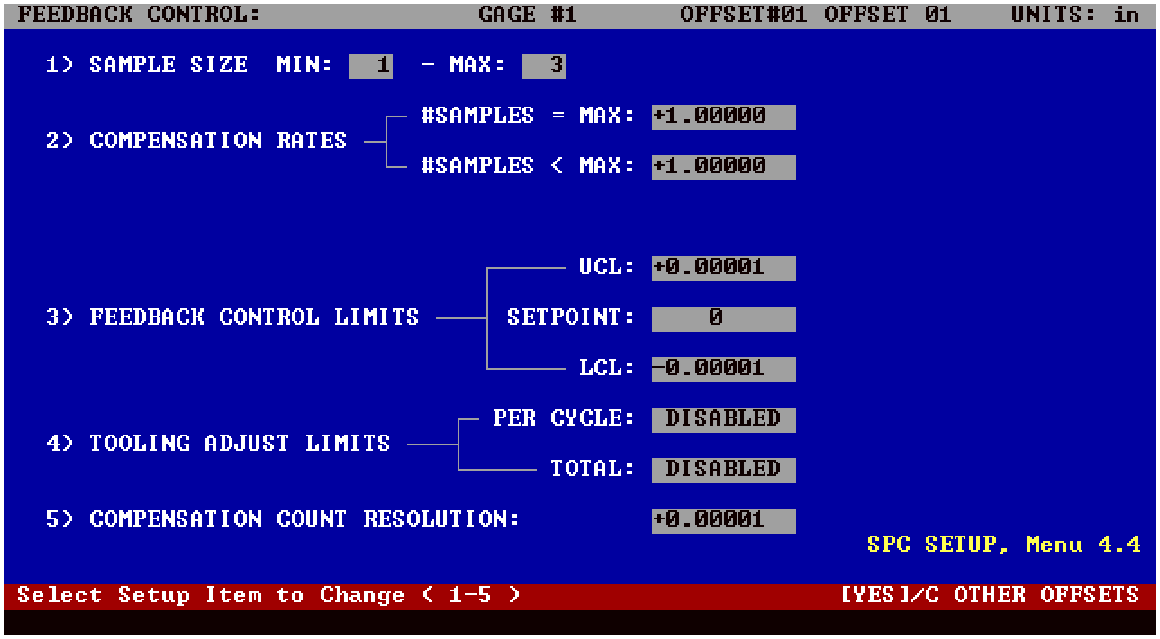


```
Feedback Setup:                 GAGE #1
 1) NUMBER OF OFFSETS:    2    STATUS:  ENABLED    RESET TIMER:  DISABLED

 2) START-UP MODE UTILIZED:  NO    START-UP MODE LIMIT:  N/A

 3) RUN MODE TRIGGER:  N/A   RUN MODE REJECTS:  EXCLUDED

 4) PART LAG  START-UP MODE:  N/A  / RUN MODE:     0

 5) OFFSET DEFINITION:

     1 OFFSET 01    RUNNING AVG OF CHK# 01 CHECK 01
     2 OFFSET 02    RUNNING AVG OF CHK# 02 CHECK 02




                                                     Utilities, Menu 12.2.7
Select Setup Item to Change ( 1-5 )
```

Feedback Control Screens:

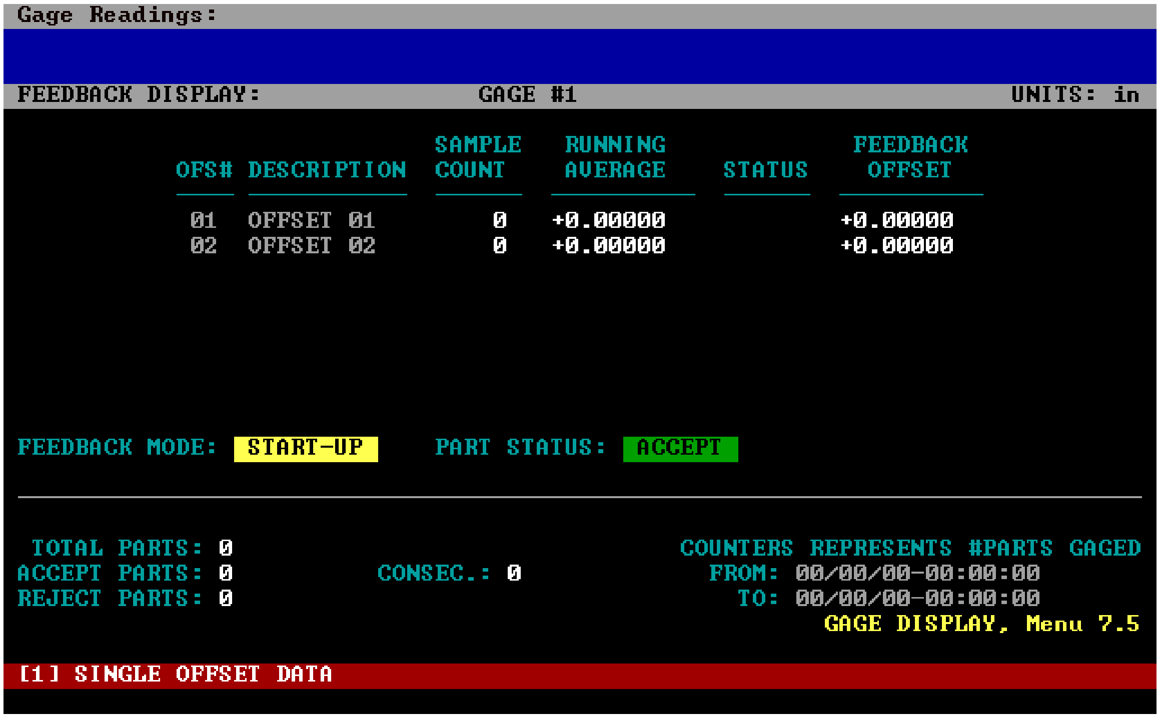


```
SPC Setup:

                  1)  Enable Data Accumulation
                  2)  Define x̄ and R Chart Parameters
                  3)  Enable SPC Alarms
                  4)  Feedback Control
                  5)  Feedback Report  DISABLED

                                              SPC Setup, Menu 4.0
Enter Selection ( 1-5 )
```



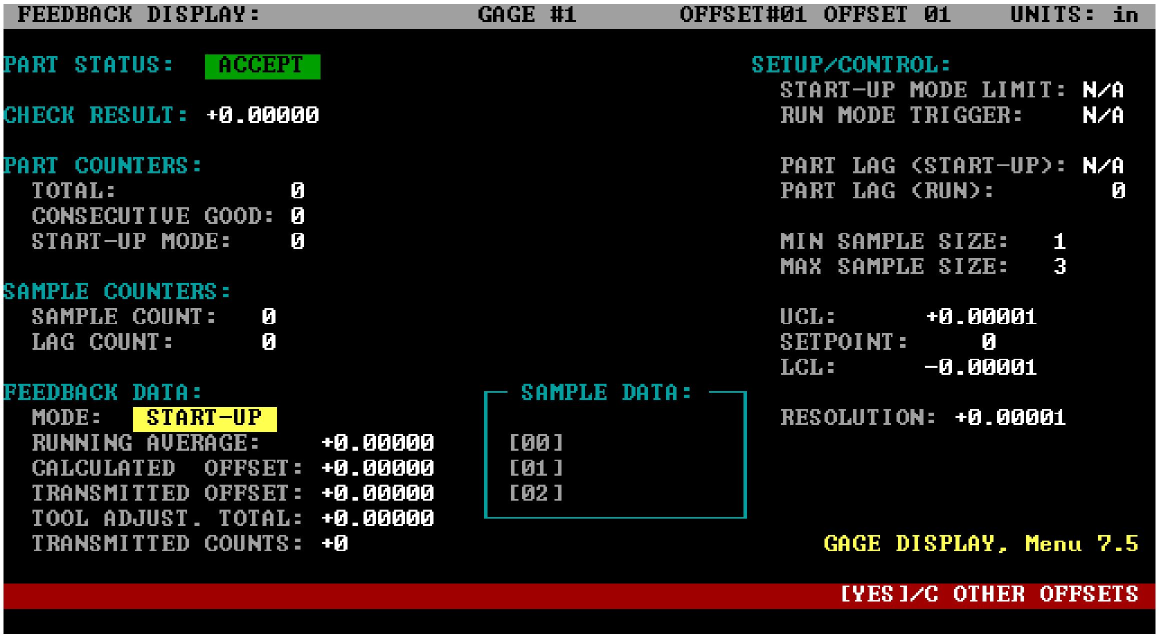
```
FEEDBACK CONTROL:               GAGE #1       OFFSET#01 OFFSET 01    UNITS: in
  1) SAMPLE SIZE  MIN:   1  - MAX:   3
                             #SAMPLES = MAX: +1.00000
  2) COMPENSATION RATES  ─┤
                             #SAMPLES < MAX: +1.00000

                                       UCL: +0.00001
  3) FEEDBACK CONTROL LIMITS  ──  SETPOINT:     0
                                       LCL: -0.00001
                                 PER CYCLE: DISABLED
  4) TOOLING ADJUST LIMITS  ──
                                     TOTAL: DISABLED
  5) COMPENSATION COUNT RESOLUTION:         +0.00001
                                              SPC SETUP, Menu 4.4
Select Setup Item to Change ( 1-5 )                [YES]/C OTHER OFFSETS
```

Feedback Display Screens:



```
Gage Readings:

FEEDBACK DISPLAY:                GAGE #1                        UNITS: in

                                   SAMPLE   RUNNING              FEEDBACK
           OFS# DESCRIPTION        COUNT    AVERAGE     STATUS    OFFSET

            01  OFFSET 01             0   +0.00000              +0.00000
            02  OFFSET 02             0   +0.00000              +0.00000




FEEDBACK MODE:  START-UP     PART STATUS:  ACCEPT


 TOTAL PARTS: 0                               COUNTERS REPRESENTS #PARTS GAGED
ACCEPT PARTS: 0          CONSEC.: 0             FROM: 00/00/00-00:00:00
REJECT PARTS: 0                                   TO: 00/00/00-00:00:00
                                                    GAGE DISPLAY, Menu 7.5
[1] SINGLE OFFSET DATA
```

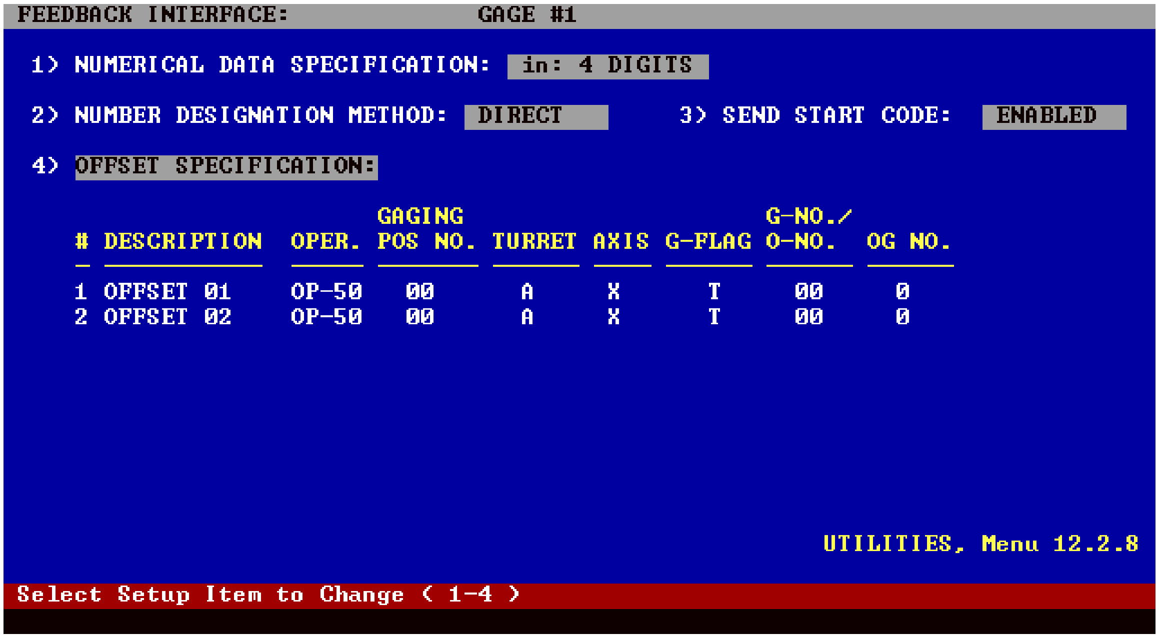
Feedback Display Screens:



```
 FEEDBACK DISPLAY:                 GAGE #1       OFFSET#01 OFFSET 01     UNITS: in

PART STATUS:  ACCEPT                                    SETUP/CONTROL:
                                                          START-UP MODE LIMIT: N/A
CHECK RESULT: +0.00000                                    RUN MODE TRIGGER:    N/A

PART COUNTERS:                                            PART LAG (START-UP): N/A
  TOTAL:                0                                 PART LAG (RUN):        0
  CONSECUTIVE GOOD: 0
  START-UP MODE:    0                                     MIN SAMPLE SIZE:   1
                                                          MAX SAMPLE SIZE:   3
SAMPLE COUNTERS:
  SAMPLE COUNT:   0                                       UCL:       +0.00001
  LAG COUNT:      0                                       SETPOINT:       0
                                                          LCL:       -0.00001
FEEDBACK DATA:                      SAMPLE DATA:
  MODE:   START-UP                                        RESOLUTION: +0.00001
  RUNNING AVERAGE:     +0.00000    [00]
  CALCULATED  OFFSET:  +0.00000    [01]
  TRANSMITTED OFFSET:  +0.00000    [02]
  TOOL ADJUST. TOTAL:  +0.00000
  TRANSMITTED COUNTS:  +0                                  GAGE DISPLAY, Menu 7.5

                                                        [YES]/C OTHER OFFSETS
```

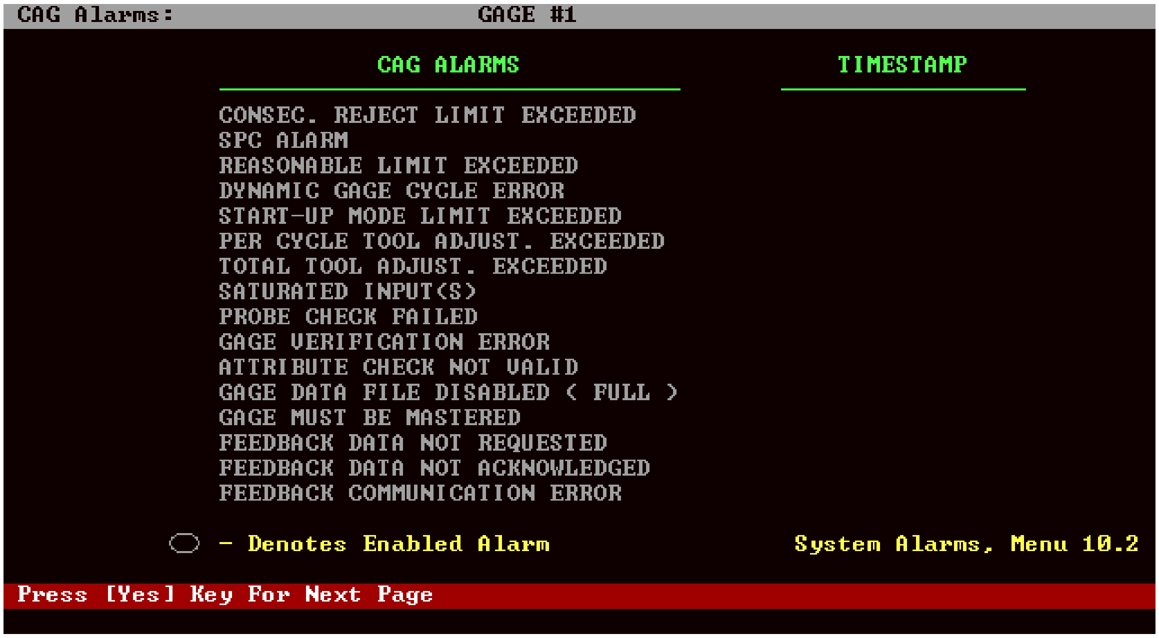
Okuma Serial Feedback Screens:

```
Gage Setup:

                    1)  Gage Names

                    2)  Gage Type / Timer

                    3)  Gage Resolution

                    4)  Number Of Part Checks

                    5)  Gage Enable / Disable

                    6)  Gage Cycle Setup

                    7)  Feedback Setup

                    8)  Feedback Interface

                    9)  Gage Setup Copy Utility
                                                          Utilities, Menu 12.2.0

Enter Selection ( 1-9 )
```



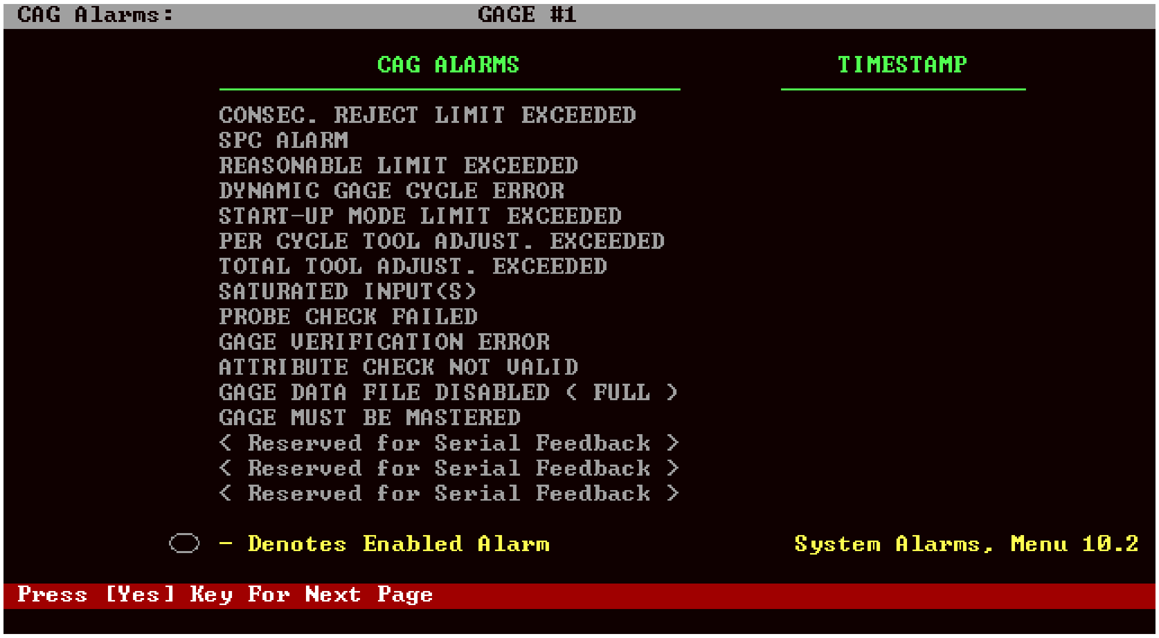
```
FEEDBACK INTERFACE:                     GAGE #1

 1) NUMERICAL DATA SPECIFICATION:  in: 4 DIGITS

 2) NUMBER DESIGNATION METHOD: DIRECT      3) SEND START CODE:  ENABLED

 4) OFFSET SPECIFICATION:

                                GAGING                       G-NO./
    # DESCRIPTION    OPER.  POS NO. TURRET AXIS G-FLAG O-NO.  OG NO.
    - -----------    -----  ------- ------ ---- ------ -----  ------

    1 OFFSET 01      OP-50    00      A     X     T     00      0
    2 OFFSET 02      OP-50    00      A     X     T     00      0





                                                          UTILITIES, Menu 12.2.8

Select Setup Item to Change ( 1-4 )
```

Alarms with Serial Feedback



```
CAG Alarms:                     GAGE #1

               CAG ALARMS                      TIMESTAMP

               CONSEC. REJECT LIMIT EXCEEDED
               SPC ALARM
               REASONABLE LIMIT EXCEEDED
               DYNAMIC GAGE CYCLE ERROR
               START-UP MODE LIMIT EXCEEDED
               PER CYCLE TOOL ADJUST. EXCEEDED
               TOTAL TOOL ADJUST. EXCEEDED
               SATURATED INPUT(S)
               PROBE CHECK FAILED
               GAGE VERIFICATION ERROR
               ATTRIBUTE CHECK NOT VALID
               GAGE DATA FILE DISABLED ( FULL )
               GAGE MUST BE MASTERED
               FEEDBACK DATA NOT REQUESTED
               FEEDBACK DATA NOT ACKNOWLEDGED
               FEEDBACK COMMUNICATION ERROR

            ○ - Denotes Enabled Alarm            System Alarms, Menu 10.2

Press [Yes] Key For Next Page
```

Alarms with Parallel Feedback



```
CAG Alarms:                     GAGE #1

               CAG ALARMS                      TIMESTAMP

               CONSEC. REJECT LIMIT EXCEEDED
               SPC ALARM
               REASONABLE LIMIT EXCEEDED
               DYNAMIC GAGE CYCLE ERROR
               START-UP MODE LIMIT EXCEEDED
               PER CYCLE TOOL ADJUST. EXCEEDED
               TOTAL TOOL ADJUST. EXCEEDED
               SATURATED INPUT(S)
               PROBE CHECK FAILED
               GAGE VERIFICATION ERROR
               ATTRIBUTE CHECK NOT VALID
               GAGE DATA FILE DISABLED ( FULL )
               GAGE MUST BE MASTERED
               ( Reserved for Serial Feedback )
               ( Reserved for Serial Feedback )
               ( Reserved for Serial Feedback )

            ○ - Denotes Enabled Alarm            System Alarms, Menu 10.2

Press [Yes] Key For Next Page
```

11 SYSTEM MAINTENACE & CONFIGURATION UTILITIES

When the CAG is powering up several messages appear on the screen before the main CAG menu appears. One message will appear as below.

```
*********************************************
              Loading CAG for…
       Hardware Platform: (LCB, ECB)
    Network Protocol: (NetBEUI or TCP/IP)
*********************************************
```

If the operator presses the decimal point "." three times on the keyboard when this screen is being displayed the system maintenance and configuration utilities menu will be displayed as shown below:

```
*********************************************
            Current Configuration
       Hardware Platform: (LCB, ECB)
    Network Protocol: (NetBEUI or TCP/IP)
*********************************************

    Available Options:

    1.)  Run Remote File
    2.)  Run Scandisk
    3.)  Select Hardware Platform
    4.)  Select Network Interface Protocol
    5.)  Delete User Network Password
    6.)  Create Disaster Recovery Disk
    7.)  Create System Backup on Flash Card
    8.)  Continue Loading CAG
```

The current configuration lists the hardware platform and network protocol that will be loaded. The follow options are available from the System Maintenance and Configuration Utilities menu:

1) Run Remote File

Use this option to upgrade a previous version of the CAG-QCM software to version 7.08 or greater. It is strongly recommended that you have a printed copy of the setup parameters on file, especially before performing any software changes.

The Gage Data Files for version 7.08 and greater are not compatible with previous versions of the CAG, and, therefore, are automatically reset during the installation. As part of the installation procedure, the old Gage Data Files will be copied to the Zip Disk, USB compact flash drive, or Compact Flash card.

Preparing the external Disk

The following files must be placed in the specified directories on the external Disk, where D is the drive letter of the drive:

File	Zip Disk Directory
CAGRMT.BAT	D:\
CAG.EXE	D:\REMOTE\PARM
PCAGMEM.MAP	D:\REMOTE\PARM

Installing the Software

1) Turn off the CAG and connect the Zip Drive to the parallel port of the CAG, or the USB compact flash drive, or the USB compact flash reader/writer.

2) Apply power to the Zip Drive, insert the Zip Disk, or Compact Flash card and turn on the CAG.

3) During the start up sequence press the decimal point "." three times on the keyboard when "Loading CAG For…" appears to display the system maintenance/configuration utilities menu. The CAG will then display the System Maintenace/Configuration Utilities Menu.

4) Press the [1] key to select "Run Remote File".

5) The following prompt will be displayed:

   DO YOU WANT TO RUN REMOTE FILE
   Press [1] YES, [2] NO

6) Press the [1] key to run the remote file.

(Continued)

7) The following screen is then displayed:

```
=================================================================
     CAG SOFTWARE INSTALLATION PROGRAM FOR VERSION 7.xx
=================================================================

The old Gage Data Files will be backed up on this ZIP disk in the
directory: \REMOTE\OLD\GDF

Existing duplicate filenames in the \REMOTE\OLD\GDF directory of this
ZIP disk will be OVERWRITTEN!

If you have already used this ZIP disk to upgrade another CAG, and you
wish to save those Gage Data Files, copy the Gage Data Files off of
this ZIP disk first, then proceed with this installation.


Do You Want To Proceed?
Press [1] for YES, [2] for NO
```

8) The first paragraph is telling you where the existing Gage Data Files on the CAG are going to be copied onto the external Disk. The second paragraph is simply telling you that if the file names already exist on the external disk, they will be overwritten with the files from the CAG. The third paragraph is then telling you that if you want to save the files that may already be on the external disk from a previous installation, copy them to another computer first so you don't lose them.

9) At the prompt, press the [1] key to proceed with the installation.

10) The Gage Data Files will be copied to the external disk, and the appropriate files will be copied to the CAG.

11) When the installation is complete, the following screen is displayed:

```
Software installation completed!
The new version x.xx is now installed!

Reboot the CAG by turning it off and then on again.
```

12) Turn off the CAG, disconnect the external drive, and turn the CAG back on.

13) Check the software version in menu 1 of the CAG to verify the updated software is running.

2) Run Scan Disk

If this option is selected the CAG will automatically begin to perform a scandisk diagnostic.

3) Select Hardware Platform

The current hardware platform is displayed under "Current Configuration". To select a different hardware platform select either option (1), "LBC-586 Plus" or option (2) "EBC-TXPlus/EBC-C3". This menu would be used if a new compact flash disk is installed in a CAG from another CAG or a backup disk that used a different hardware platform.

4) Select Network Interface Protocol

The current internet protocol is displayed under "Current Configuration". To select a different internet protocol select either option (1), "NetBEUI" or option (2) "TCP/IP". Refer to section 8, Communications, Network Connections for additional information on the different protocols.

If the network protocols are changed, the CAG will prompt the operator to power the CAG off and back on. When the CAG is powered back up the operator will be prompted as follows:

a) "Type your User Name, or press ENTER if is "(current name)". **At this prompt press ENTER.**
b) "Type your password" **At this prompt press ENTER.** (This will enter no password)
c) "There is no password-list file for (current name). Do you want to create one (Y/N)". **At this prompt press "YES", ENTER.**
d) "Please confirm your password so that a password list may be created." **At this prompt press ENTER.** This will confirm no password entered. The CAG will continue to load after this.

5) Delete User Network Password

If a password is entered during the sequence described in option 4, "Select Network Interface Protocol" then it can be deleted by selecting this option.

6) Create Disaster Recovery Disk

General Description: A disaster recovery disk provides a means of backing up all software files required for CAG operation and the ability to restore these files at a later time. When a backup is run all files residing on the CAG (compact flash card) are copied to the disaster recovery disk. The disaster recovery disk can be a zip disk created using an Iomega zip drive, a USB compact flash drive, or a compact flash disk created using a USB compact flash reader/writer. The disaster recovery disk can then be used to restore the backup files to the CAG for a complete file recovery.

Creating a Disaster Recovery Disk From a Blank Zip Disk, USB Drive, or Compact Flash Card.

A disaster recovery disk contains software utilities that make it possible to backup/restore files from the CAG. A disaster recovery disk can be created (load software utilities to blank zip disk) from the CAG. The procedures for creating a disaster recover disk is as follows:

1. Power off CAG and connect Zip drive, USB compact flash drive, or USB compact flash reader/writer.
2. Insert a blank Zip Disk, if using a Zip Drive or a blank Compact Flash Card if using a compact flash reader/writer.
3. Power on the CAG.
4. During the start up sequence press the decimal point "." three times on the keyboard when "Loading CAG For…" appears to display the system maintenance/configuration utilities menu.
5. Select option (6), Create Disaster Recovery Disk.
6. A prompt will then appear stating "DO YOU WANT TO COPY UTILIITIES TO DISK". Press [1] Yes to copy the utilities. Once the utilities have been copied, the disaster recovery utilities will be run. A backup of the CAG system can be made at this time.
7. The disaster recovery disk can now be used at any time to backup/restore the CAG system by following operating procedures in "Run Remote File" above.

Running Disaster Recovery Disk:

Requirements:

1. Iomega Zip Drive & Disaster Recovery Zip disk (containing special software utilities to backup and restore CAG files), **or**
2. Edmunds qualified USB compact flash drive, (containing special software utilities to backup and restore CAG files), **or**
3. Edmunds qualified compact flash reader/writer & compact flash card (containing special software utilities to backup and restore CAG files)

Procedure:

1. Power off CAG and connect Zip drive, USB compact flash drive, or USB compact flash reader/writer.
2. Insert Disaster Recovery Zip Disk, if using a Zip Drive or the Disaster Recovery Compact Flash Card if using a compact flash reader/writer.
3. Power On CAG.
4. The CAG will recognize the Disaster Recovery Disk at power up and start the disaster recovery utilities. The operator will be prompted (1) Backup System (2) Run Disaster Recovery (3) Exit. The date/time of the last backup will also be displayed. If a backup had never been run on the disk, the date/time will not be displayed and a backup should be made.
5. If (1) Backup System is selected all CAG files will be copied to the disaster recovery disk. The previous backup files will be overwritten.
6. If (2) Run Disaster Recovery is selected the following will occur:
   A. The system will check if a valid backup resides on the disaster recovery disk.
   B. The CAG compact flash (storage device) will be formatted. All files currently on the CAG will be deleted during the format process.
   C. The CAG operating files will be restored from the disaster recovery disk.

   Warning Notes:

   The disaster recovery should be run at last resort. When the disaster recovery is run, the CAG setup and statistical data will be replaced by the backup data. Setup and statistical data will be lost if this data had changed since the last backup was make.

Setup of Older CAG Systems (before 01/01) to Run Disaster Recover Disk:

CAG systems shipped before 01/01 do not have the software required run the disaster recovery disk utilities. The older CAG software can be updated to run the disaster recovery utilities using a disaster recover zip disk. Follow the following procedures to update the CAG software:

1. Power off CAG and connect Zip drive and Zip drive power.

2. Insert disaster recovery disk in Zip drive. Power on CAG.

3. When the CAG is powering up several messages appear on the screen before the main CAG menu appears. One message will say "LOADING CAG". When you see the message "LOADING CAG" appear on the screen press the decimal point "." three times on the keypad. A prompt will then appear, select option to “Run Remote File”. This will run a file on the disaster recovery disk that will update the CAG software. Once the CAG is updated the disaster recovery utilities will be run and a disaster recovery backup can be made.

7) Create System Backup on Flash Card

This option is only available on CAG software ver. 7.21 or later used on a CAG with an EBC hardware platform. (The LBC hardware platform does not support the USB Compact Flash Reader/Writer).

This option allows the operator to create a complete bootable system backup. The backup compact flash card is formatted, the operating system is installed and then all the system files are copied from the existing compact flash card in the CAG. The backup compact flash card can then be used as a direct replacement of the existing compact flash card in the CAG or be used to duplicate the system to run on another CAG. Use the following procedure:

1) Power down the CAG.
2) Connect an Edmunds qualified Compact Flash Reader/Writer to the USB port.
3) Install a blank compact flash card in the reader/writer. **NOTE: Any existing data on the card will be lost.**
4) Power up the CAG. During the start up sequence press the decimal point "." three times on the keyboard when "Loading CAG For…" appears to display the system maintenance/configuration utilities menu.
5) Select option 7, "Create System Backup on Flash Card" from the system maintenance/configuration utilities menu.
6) At the prompt "Do you want to create a system backup on flash card", press **[1]** for yes.
7) The CAG will copy the currently installed compact flash card to the blank card in the reader.

12 TEMPERATURE COMPENSATION

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 CAG^{QCM} 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 CAG^{QCM} 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 CAG^{QCM} 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 CAG^{QCM} software program (menu 12.9.2). Each part check 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 CAG^{QCM} 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 = $[\text{Coeff}_{\text{master}} \times (\text{temp}_{\text{master}} - 68°)] + [\text{Coeff}_{\text{tool}} \times (\text{temp}_{\text{tool}} - 68°)]$

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 CAG^{QCM} 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.

HARDWARE REQUIRED

Temperature compensation is accomplished via special CAG^{QCM} software and external hardware. The additional hardware required allowing a CAG^{QCM} to provide 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^{QCM} signal conditioning rack. Once installed, the displayed readings in menu 6.1 **“DISPLAY ALL INPUTS”** will be in degrees Fahrenheit with .1 degree resolution. Example: +78.4

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.

Steps to Setting up the CAG Temperature Compensation .

1. Setup the means of acquiring part and tooling temperatures (Temperature Probe Setup menu12.9.1)
    a. If temperatures are going to be entered manually (no temperature sensor probes) menu 12.9.1.1 is used to enable manual temperature and enter part, master and tooling temperatures.
    b. Select number of probe sets menu 12.9.1.2. A typical probe set will be (1) probe for part and (1) probe for tooling. If manual temperature entry is used set number of probes sets to 1.
    c. Name probe sets as desired menu 12.9.1.3
    d. If probe sensors are being used (not manual temperature entry) the probe set 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 menu 12.9.1.4.
    e. If probe sensors are being used (not manual temperature entry) menu 12.9.1.5 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.
    f. If probe sensors are being used (not manual temperature entry) menu 12.9.1.6 allow for entering temperature settle time. See Menu Description section of manual for description.
2. Assign probe sets to checks. For a part check to receive temperature compensation a probe set has to be assigned to it. menu 12.9.2 allows assignment of probe sets to part checks.
3. Enable the type of temperature compensation menu 12.9.3. 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.
    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 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.

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 pages from temperature compensation study). Menu 7.5 Temperature Reading can be used to view the temperatures and offsets applied during gaging.

TEMP. COMPENSATION STUDY

A temperature compensation study must be performed on each component (part, master and tooling) to establish the coefficient of expansion for each individual component. Once the temperature compensation study has been performed and saved for the component, it need not be performed again unless there is a part/tooling change or the file is deleted.

If the CAG has optional temperature compensation software, the hidden menus are changed to menus 12.9.1 – 12.9.7 instead of 12.9.1 – 12.9.7 and all temperature compensation menus are located under menu 12.9.

The temperature compensation study can be performed automatically using menu 12.9.4.1, Auto Temp Comp Study, or a manual temperature compensation can be performed and the calculated coefficients can be entered in menu 12.9.4.2, Define Linear Coefficients.

AUTOMATIC TEMP. COMPENSATION STUDY

A temperature compensation study can be performed only after all of the variables in menu 12.9 **"TEMPERATURE COMPENSATION"** have been entered and the gage has been calibrated. A GAGE R & R should be performed on the gage to assure the repeatablitiy of the gage. The temperature compensation studies should then be performed in the following sequence: Master, Tooling and Part.

To compute the coefficient of expansion for the components, the size of the component (master or part) must be recorded at ambient temperature (68°F). When the master temperature compensation study is being performed, the MAX master sizes will be used as the ambient reference. The MAX master will then be heated and cooled and the size deviations from ambient will be utilized to calculate the coefficients of expansion.

To perform a study on the tooling, the MAX master will be measured while the tooling temperature is elevated and lowered. The difference in the MAX master gaged readings from the MAX master size at ambient will be utilized to calculate the coefficients of expansion. **NOTE:** If the MAX master is not at ambient when the study is performed, the coefficient of expansion for the master will be applied to the master sizes to correct it to ambient temperature size, and the effects of the tooling temperature will be determined.

To perform a temperature compensation study on a part, the part's size must first be determined at ambient temperature. The sizes will then be entered into CAG^{QCM} menu 12.4.3 **"VERIFICATION SIZES"**. These sizes will be utilized as the ambient temperature reference to calculate the coefficients of expansion for the part as it is heated and cooled.

The procedure for performing a study is as follows:

1) Select menu 12.9.4 **“TEMPERATURE COMPENSATION STUDY”**.

2) Select sub-menu 12.9.4.1.4 **“GAGE SELECTION”**. Select the gage that the study will be performed on.

3) Select sub-menu 12.9.4.1.5 **“STUDY TYPE”**. Select the type of study (part, tool, or master) that the study will be performed on.

4) Select sub-menu 12.9.4.1.6 **“PROBE SET SELECTION”**. Enable the probe set that will be utilized during the study and disable the probe set(s) not used.

5) Select sub-menu 12.9.4.1.3 **“RESET TC STUDY”** to reset the current study data.

6) Select sub-menu 12.9.4.1.2 **“START/STOP STUDY”**. Toggle the status to “Active”.

7) Select sub-menu 12.9.4.1.1 **“TC STUDY DISPLAY”**.

   NOTE: If gage measured ambient reference is going to be used, place component, at ambient, in gage and perform manual gage cycle. Select "Yes" to use reading as ambient reference. If manually entered ambient reference is going to be used, continue to step 8.

8) Preheat the component (part, master or tooling) to a temperature of approximately 90 - 95° F.

9) Place the pre-heated component in the gage according to the probe set selected.

10) Perform a manual gaging cycle. Or select the [3] key to start an automatic temperature compensation gaging cycle. The automatic cycle will monitor the temperature of the component being studied and automatically gage the component at 1°F intervals. **NOTE:** Do not remove the part from the gage during the temp. study. At the completion of the cycle, Sample #001 will update showing the current component temperature and coefficient.

11) The gage will need to be cycled at intervals so that the temperature of the component changes approximately 1-2° between readings.

12) Continue to cycle the gage until the temperature reaches ambient.

13) Remove the component from the gage.

14) Cool the component (part, master or tooling) to a temperature of approximately 5-10° F below the minimum temperature the component will attain.

15) Perform a manual gaging cycle. Or select the [3] key to start an automatic temperature compensation gaging cycle. The automatic cycle will monitor the temperature of the component being studied and automatically gage the component at 1°F intervals. **NOTE:** Do not remove the part from the gage during the temp.

study. At the completion of the cycle, Sample #001 will update showing the current component temperature and coefficient.

16) The gage will need to be cycled at intervals so that the temperature of the component changes approximately 1-2° between readings.

17) Continue to cycle the gage until the temperature reaches ambient.

18) Select sub-menu 12.9.4.1.7.2 **“SAVE COEFFICIENTS”**. Select 1, Save Average Coefficients, to save coefficients to an internal file. Temperature compensation will not be applied until coefficients are saved.

19) Select sub-menu 12.9.4.1.7.3 **“FILL TC STUDY FILES”**. Any missed temperature coefficients will be calculated and filled in.

Perform a temperature compensation study for each component. Once all of the studies have been completed, exit the temperature compensation menu and calibrate the gage.

Manual Temperature Composition Study

Use the following procedure to calculate the values of the master, part, and tooling coefficients which can be entered in menu 12.9.4.2.

Begin by determining the coefficient for the Max Master and then for a sample part.
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) Measure the Max master or part in the gage, with the master or part and tooling at ambient, and record gaged size readings as well as master or part and tooling temperatures.

2) Select menu 6.1, Display All Inputs.

3) Heat the Max master or part to a temperature of approximately 90 – 95 ◦F.

4) Load the Max master or part into the gage. Wait 3 seconds for the temperature probe readings to settle. Record the temperature reported by the Part Temperature Probe. Select menu 6.2, Display Part Dimensions, and record the size of the feature being compensated from the corrected reading column.

5) Calculate the Master or Part coefficient by dividing the change in size by the change in temperature of the master or part from the ambient readings to the reading of the heated part.

6) Enter the coefficient in the appropriate location in menu 12.9.4.2 Define Linear Coefficients.

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.

1) Using menu 12.9.3, Temp Compensation Type, enable Master Part temperature compensation.

2) Measure the Max master in the gage, with the master and tooling at ambient, and record gaged size readings as well as master/part and tooling temperatures.

3) Select menu 6.1, Display All Inputs.

4) Heat the tooling to a temperature of approximately 90 – 95 ◦F.

5) Load the Max master into the gage. Wait 3 seconds for the temperature probe readings to settle. Record the temperature reported by the Tooling Temperature Probe. Select menu 6.2, Display Part Dimensions, and record the size of the feature being compensated from the corrected reading column.

6) Calculate the Tooling coefficient by dividing the change in size measured by the change

in temperature of the tooling.

7) Enter the coefficient in the appropriate location in menu 12.9.4.2, Define Linear Coefficients.

8) Enable the temperature compensation in menu 12.9.3 and enter in # 2 MASTER PART.

10) Master the gage with all components at ambient.

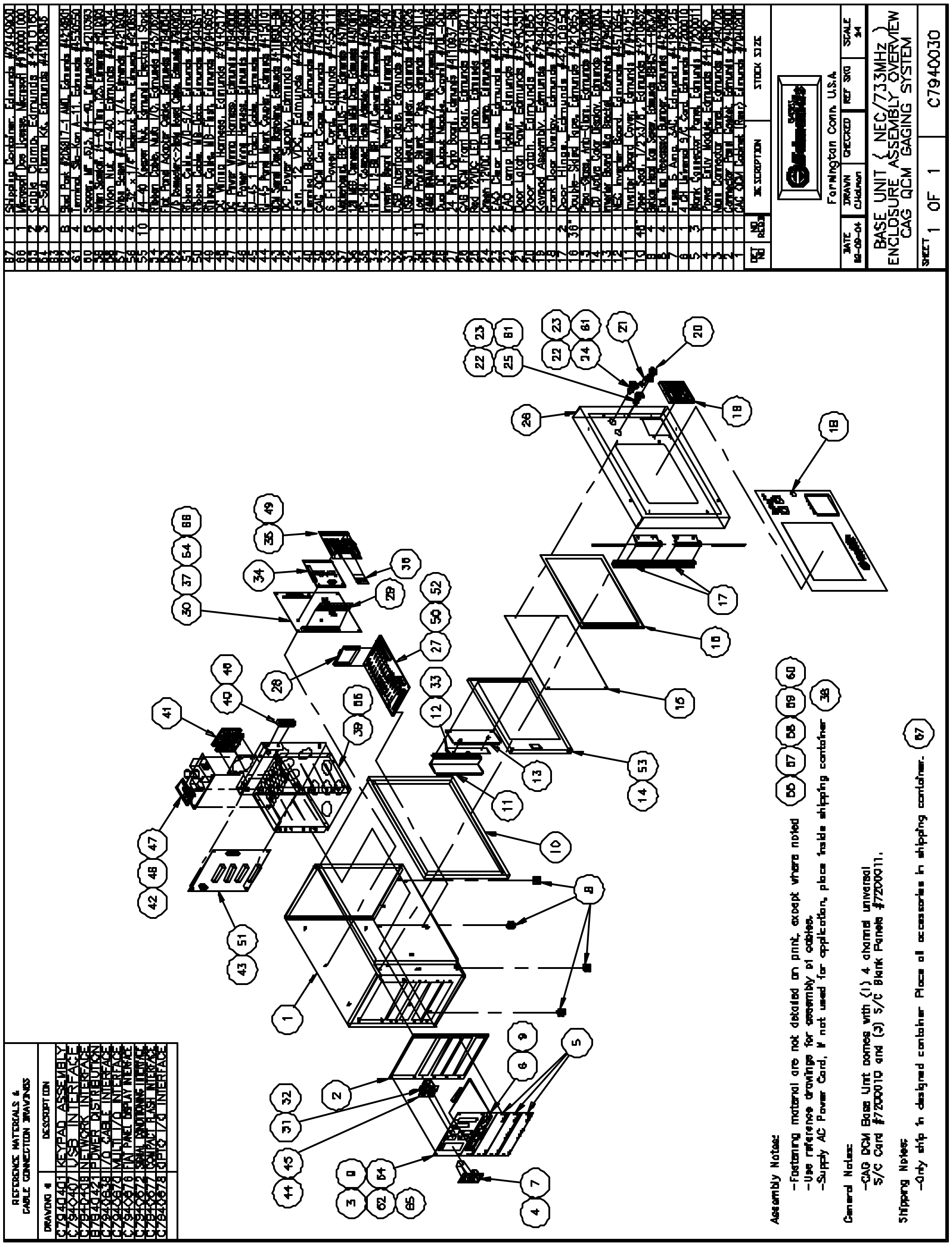
11) Heat the Max Master and do a gage R&R as the master cools down. This will show how the gage repeats with varying temperatures. If the gage R & R is acceptable then the Master coefficient is good.

12) Repeat the process but heating the tooling and keeping the master the same temperature. Does a G R&R and if the R & R is Acceptable then the tooling coefficient is good.

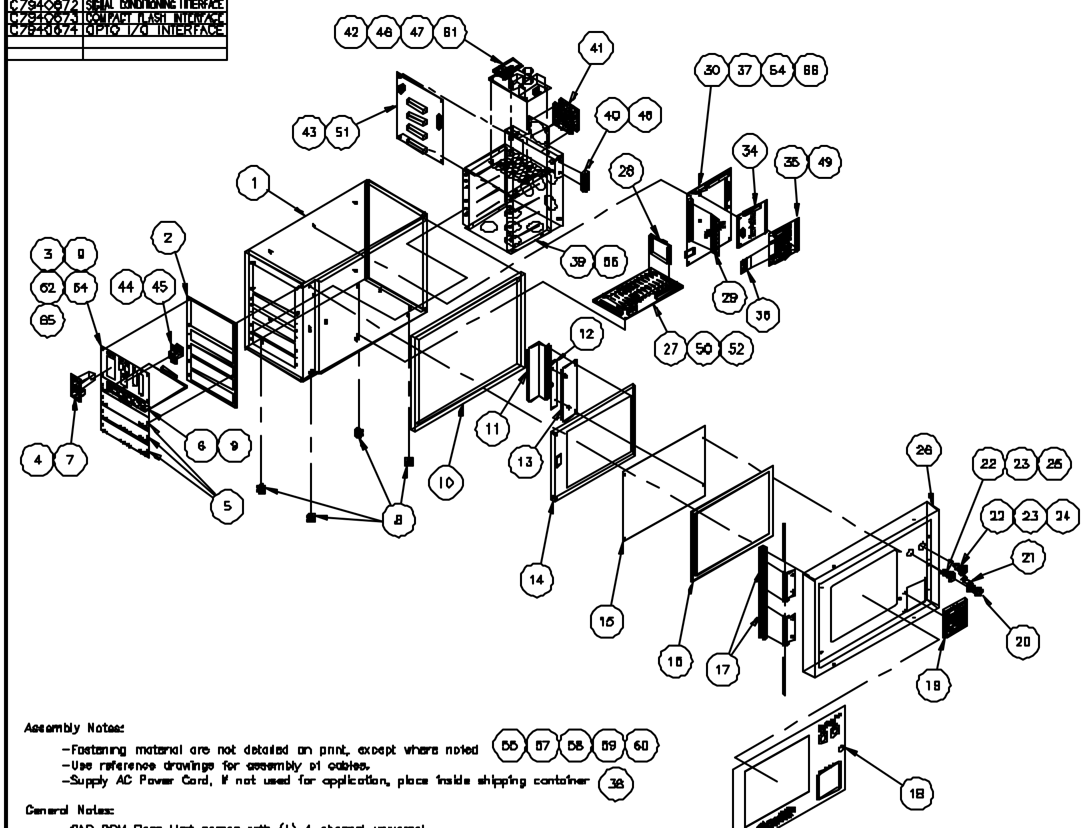
13) Enable the temperature compensation in menu 12.9.3 and enter #1 PART.

14) 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.

13 SCHEMATICS



REFERENCE MATERIALS & CABLE CONNECTION DRAWINGS	
DRAWING #	DESCRIPTION
C7940400	KEYPAD ASSEMBLY
C7940406	NETWORK INTERFACE
B7940421	POWER DISTRIBUTION
C7940638	I/O CABLE INTERFACE
C7940670	MULTI I/O INTERFACE
C7940675	FLAT PANEL DISPLAY INTERFACE
C7940672	SIGNAL CONDITIONING INTERFACE
C7940673	COMPACT FLASH INTERFACE
C7940674	OPTO I/O INTERFACE



Assembly Notes:

-Fastening material are not detailed on print, except where noted 55 57 58 59 60
-Use reference drawings for assembly of cables.
-Supply AC Power Cord, if not used for application, place inside shipping container 38

General Notes:

-CAG QCM Base Unit comes with (1) 4 channel universal
S/C Card #7200010 and (3) S/C Blank Panels #7200011.

Shipping Notes:

-Only ship in designed container Place all accessories in shipping container. 67

DET NO	NO REQ'D	DESCRIPTION	STOCK SIZE
67	1	Shipping Container, Edmunds #7940900	
66	1	Microsoft Dos License, Microsoft #9100001000	
65	2	Cable Clamp, Edmunds #4210160	
64	3	D-Sub Clamp Kit, Edmunds #4150835	
63			
62	8	Stud Post #206817-1 AMP, Edmunds #4210801	
61	4	Terminal, Sta-Kon A-11, Edmunds #4530550	
60	6	Spacer, MF .625, #4-40, Edmunds #4210393	
59	6	Nylon Standoff, #4-40 Thru .125, Edmunds #4210305	
58	4	Nylon Nut, #4-40, Edmunds #4210304	
57	4	Nylon Screw #4-40 x 1/4, Edmunds #4210300	
56	4	6-32" x 1/4" Undercut Screw, Edmunds #4210855	
55	14	#4-40 Keeper Nut, Edmunds Electrical Stock	
54	1	Ribbon Cable, Multi I/O, Edmunds #4570620	
53			
52	1	I/O Connector<->Opto Board Cable, Edmunds #7940620	
51	1	Ribbon Cable, A/D-S/C, Edmunds #7940616	
50	1	Ribbon Cable, MB-Opto, Edmunds #7940611	
49	1	Ribbon Cable, MB-Flash, Edmunds #7940605	
48	1	DC Wiring Harness, Edmunds #7940517	
47	1	DC Power Wiring Harness, Edmunds #7940505	
46	1	AC Power Wiring Harness, Edmunds #7940500	
45	1	RJ-45 1 ft Patch Cable, Edmunds #4570625	
44	1	RJ-45 Panel Mount Coupler, Edmunds #4150101	
43	1	QCM Serial Card, Backplane, Edmunds #4110930-BM	
42	1	DC Power Supply, Edmunds #4330210	
41	1	Fan, 12 VDC, Edmunds #4290200	
40	1	Terminal Block, 6 Pos., Edmunds #4630350	
39	1	CAG QCM Card Cage, Edmunds #7940203	
38	1	6 Ft Power Cord, Edmunds #4550111	
37	1	Motherboard, AMD 400MHz, Edmunds #4570614	
36	1	128 MEG Compact Flash MEM Card, Edmunds #4570610	
35	1	PC-104 Compact Flash Adapter, Edmunds #4570607	
34	1	16 CH, 12-Bit, A/D Converter, Edmunds #4570604	
33			
32			
31			
30	10	Low Profile Shunt, 2 Pos, Edmunds #4570113	
29	1	64MB DRAM SIMM Module 72 PIN, Edmunds #4570616	
28	1	Dual DC Output Module, Grayhill #70L-ODC	
27	1	24 Point Opto Board, Edmunds #4110937-BM	
26	1	CAG QCM Front Door, Edmunds #7940211	
25	1	Red 12VDC LED Lamp, Edmunds #4270442	
24	1	Green 12VDC LED Lamp, Edmunds #4270443	
23	2	EAO Clear Lens, Edmunds #4270441	
22	2	EAO Lamp Holder, Edmunds #4270444	
21	1	Door Latch Pawl, Edmunds #7940550	
20	1	Door Latch, Edmunds #4210851	
19	1	Keypad Assembly, Edmunds #7940400	
18	1	Front Door Overlay, Edmunds #7940700	
17	2	Door Hinge, Edmunds #4210850	
16	36"	Double-Sided Tape, Edmunds #4210053	
15	1	Plexi-Glass, Anti-Glare, Edmunds #7940800	
14	1	LCD Active Color Display, Edmunds #4570602	
13	1	Inverter Board Mtg Bracket, Edmunds #7940214	
12	1	Display Adapter Kit, Edmunds #4570618	
11	1	Inverter Board Cover, Edmunds #7940215	
10	48"	Door Seal, 1/2"x3/8", Edmunds #4210852	
9	4	Button Head Cap Screw, Edmunds #BHCS-4-40X3/8	
8	4	Flat Top Recessed Bumper, Edmunds #4210856	
7	1	Fuse, 5 Amp, 3AC, Edmunds #4190125	
6	1	4 CH Universal S/C Card, Edmunds #7200010	
5	3	Blank Connector Panel, Edmunds #7200011	
4	1	Power Entry Module, Edmunds #4410969	
3	1	Main Connector Panel, Edmunds #7940705	
2	1	Connector Panel Gasket, Edmunds #7940800	
1	1	CAG QCM Cabinet (Rear) Edmunds #7940200	

GAGES Edmunds
Farmington Conn. U.S.A.

DATE	DRAWN	CHECKED	REF SKG	SCALE
02-27-02	C.Holman			1:4

BASE UNIT (NEC/400MHz)
ENCLOSURE ASSEMBLY OVERVIEW
CAG QCM GAGING SYSTEM

SHEET 1 OF 1 C7940020

Edmunds GAGES
Farmington, CT. U S A.

CAG^{QCM} Gaging System
Standard Configuration
Document A-7940030AAC

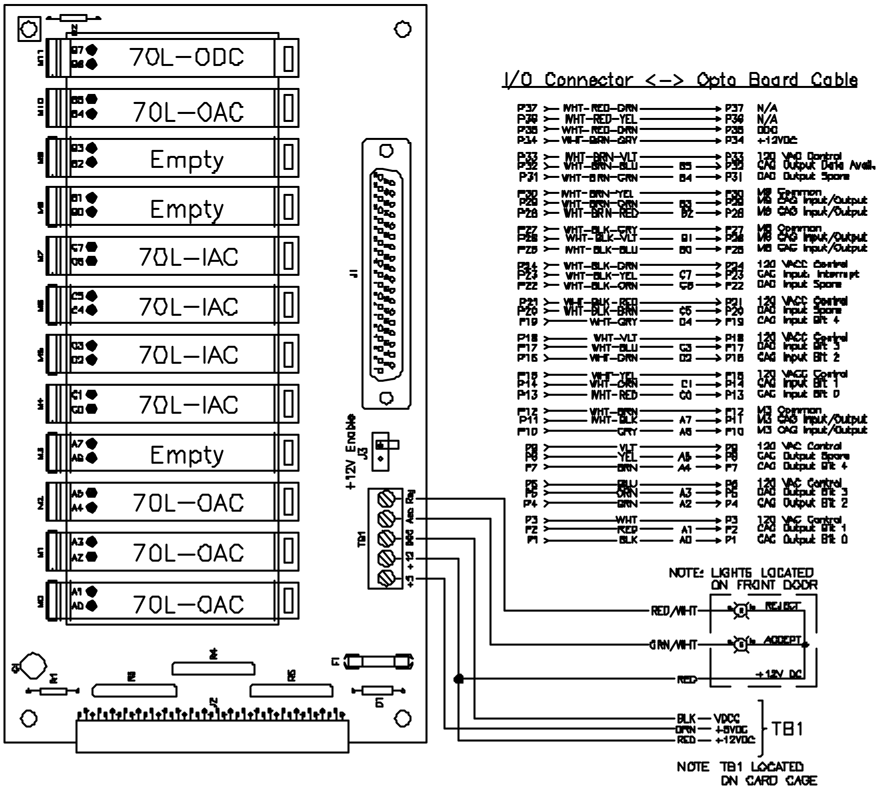
Sht. 1 of 1
Date Mar 24, 2004

Reference No. 7940030AAC

1 GENERAL INFORMATION

Customer Edmunds Gages
CAG Assem. No. 7940030
Tooling "G" No. Tooling G No
Edmunds SO No Edmunds S.O.
Customer P.O. No. Customer P.O.
CAG S.O. No. CAG SO No
Tooling SO No Tooling S.O. No

2. PARALLEL INTERFACE SPECIFICATIONS



3 SOFTWARE

Latest Automatic Version

OPTO CHOICES	FUSE RATING	ADDITIONAL QTY.
DC INPUT, GRAYHILL #70L-IDC	–	0
AC INPUT, GRAYHILL #70L-IAC	–	4
DC OUTPUT, GRAYHILL #70L-ODCR	1.00A/CH	0
AC OUTPUT, GRAYHILL #70L-OAC	3.15A/CH	4

4. NON STANDARD OPTIONS

Add (1) CAG QCM Mate Kit, Edmunds #7940905

Edmunds GAGES
Farmington, CT U.S.A.

CAG^{QCM} Gaging System
Standard Configuration
Document A-7940020AAC

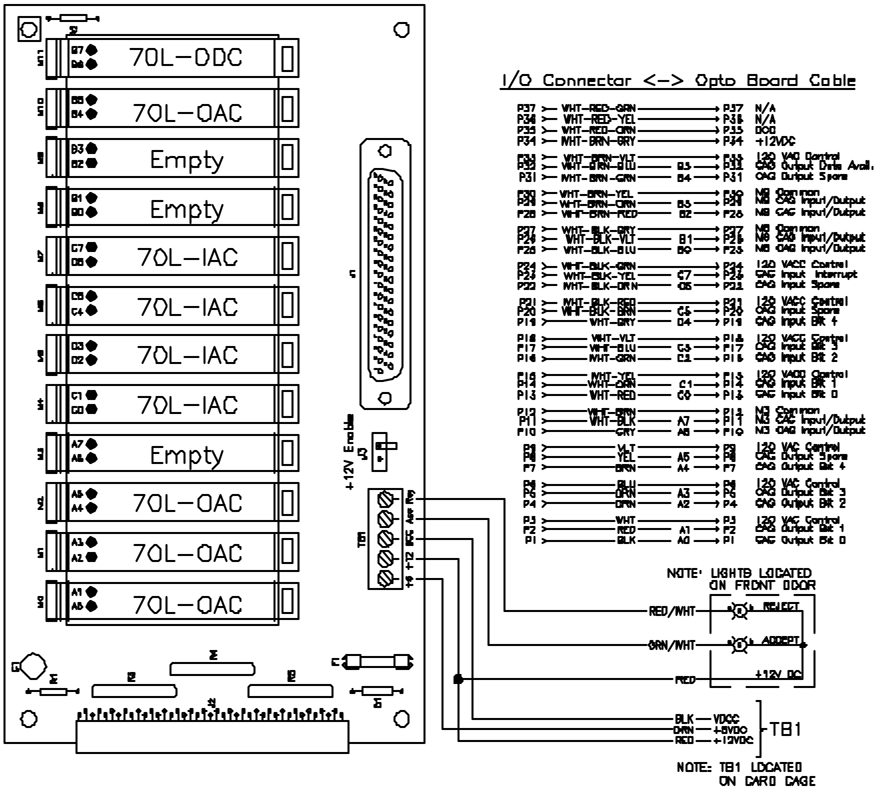
Sht. 1 of 1
Date Feb 28, 2002

Reference No. 7940020AAC

1. GENERAL INFORMATION

Customer	Edmunds Gages	Edmunds S.O. No.	Edmunds S.O.
CAG Assem. No.	7940020	Customer P.O. No	Customer P.O.
Tooling "G" No.	Tooling G No	CAG S.O. No.	CAG S.O. No
		Tooling S.O. No.	Tooling S.O. No

2. PARALLEL INTERFACE SPECIFICATIONS



I/O Connector <-> Opto Board Cable

P37	WHT-RED-GRN		P37	N/A
P36	WHT-RED-YEL		P36	N/A
P35	WHT-RED-ORN		P35	DCC
P34	WHT-BRN-GRY		P34	+12VDC
P33	WHT-BRN-VLT		P33	120 VAC Control
P32	WHT-BRN-BLU	B5	P32	CAG Output Data Avail.
P31	WHT-BRN-GRN	B4	P31	CAG Output Spare
P30	WHT-BRN-YEL		P30	N8 Common
P29	WHT-BRN-ORN	B3	P29	N8 CAG Input/Output
P28	WHT-BRN-RED	B2	P28	N8 CAG Input/Output
P27	WHT-BLK-GRY		P27	N8 Common
P26	WHT-BLK-VLT	B1	P26	N8 CAG Input/Output
P25	WHT-BLK-BLU	B0	P25	N8 CAG Input/Output
P24	WHT-BLK-GRN		P24	120 VACC Control
P23	WHT-BLK-YEL	C7	P23	CAG Input Interrupt
P22	WHT-BLK-ORN	C6	P22	CAG Input Spare
P21	WHT-BLK-RED		P21	120 VACC Control
P20	WHT-BLK-BRN	C5	P20	CAG Input Spare
P19	WHT-GRY	C4	P19	CAG Input Bit 4
P18	WHT-VLT		P18	120 VACC Control
P17	WHT-BLU	C3	P17	CAG Input Bit 3
P16	WHT-GRN	C2	P16	CAG Input Bit 2
P15	WHT-YEL		P15	120 VACC Control
P14	WHT-ORN	C1	P14	CAG Input Bit 1
P13	WHT-RED	C0	P13	CAG Input Bit 0
P12	WHT-BRN		P12	N3 Common
P11	WHT-BLK	A7	P11	N3 CAG Input/Output
P10	GRY	A6	P10	N3 CAG Input/Output
P9	VLT		P9	120 VAC Control
P8	YEL	A5	P8	CAG Output Spare
P7	BRN	A4	P7	CAG Output Bit 4
P6	BLU		P6	120 VAC Control
P5	ORN	A3	P5	CAG Output Bit 3
P4	ORN	A2	P4	CAG Output Bit 2
P3	WHT		P3	120 VAC Control
P2	RED	A1	P2	CAG Output Bit 1
P1	BLK	A0	P1	CAG Output Bit 0

3. SOFTWARE

Latest Automatic Version

OPTO CHOICES	FUSE RATING	ADDITIONAL QTY.
DC INPUT, GRAYHILL #70L-IDC	–	0
AC INPUT, GRAYHILL #70L-IAC	–	4
DC OUTPUT, GRAYHILL #70L-ODCR	1.00A/CH	0
AC OUTPUT, GRAYHILL #70L-OAC	3.15A/CH	4

4 NON STANDARD OPTIONS

Add (1) CAG QCM Mate Kit, Edmunds #7940905

Farmington, CT. U.S.A.

CAG^{QCM} Gaging System
Standard Configuration
Document A-7940030ADC

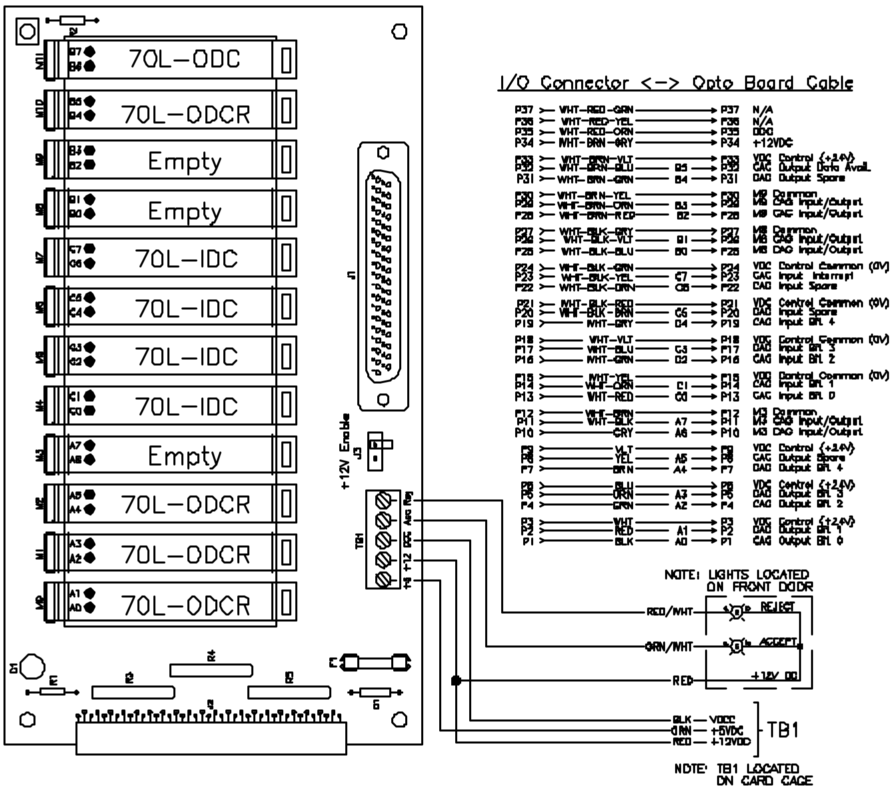
Sht. 1 of 1
Date Mar 24, 2004

Reference No. 7940030ADC

1. GENERAL INFORMATION

Customer	Edmunds Gages	Edmunds S.O. No.	Edmunds S O
CAG Assem. No.	7940030	Customer P.O. No.	Customer P.O.
Tooling "G" No	Tooling G No	CAG S.O. No.	CAG S.O. No
		Tooling S.O. No.	Tooling S.O. No

2. PARALLEL INTERFACE SPECIFICATIONS



3. SOFTWARE

Latest Automatic Version

OPTO CHOICES	FUSE RATING	ADDITIONAL QTY.
DC INPUT, GRAYHILL #70L-IDC	–	4
AC INPUT, GRAYHILL #70L-IAC	–	0
DC OUTPUT, GRAYHILL #70L-ODCR	1.00A/CH	4
AC OUTPUT, GRAYHILL #70L-OAC	3.15A/CH	0

4. NON STANDARD OPTIONS

Add (1) CAG QCM Mate Kit, Edmunds #7940905

Edmunds GAGES
Farmington, CT. U S A.

CAG^{QCM} Gaging System
Standard Configuration
Document A-7940020ADC

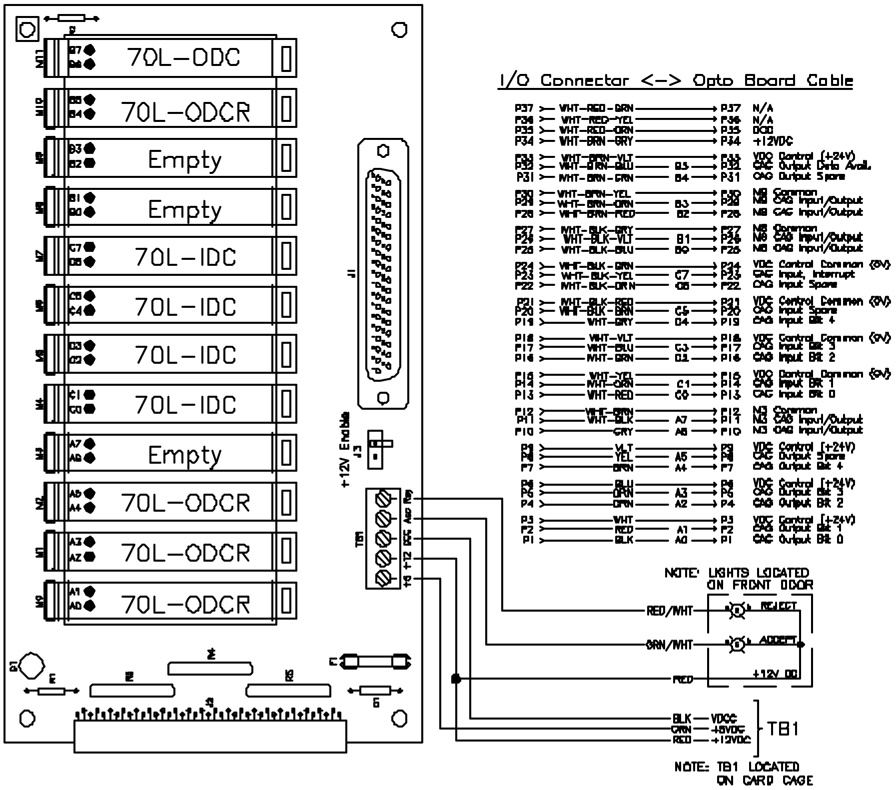
Sht. 1 of 1
Date Feb 28, 2002

Reference No. 7940020ADC

1. GENERAL INFORMATION

Customer	Edmunds Gages
CAG Assem. No.	7940020
Tooling "G" No.	Tooling G No
Edmunds S.O. No.	Edmunds S.O.
Customer P.O. No.	Customer P.O.
CAG S.O. No.	CAG S.O. No
Tooling S.O. No.	Tooling S.O. No

2. PARALLEL INTERFACE SPECIFICATIONS



3. SOFTWARE

Latest Automatic Version

OPTO CHOICES	FUSE RATING	ADDITIONAL QTY.
DC INPUT, GRAYHILL #70L-IDC	–	4
AC INPUT, GRAYHILL #70L-IAC	–	0
DC OUTPUT, GRAYHILL #70L-ODCR	1.00A/CH	4
AC OUTPUT, GRAYHILL #70L-OAC	3.15A/CH	0

4 NON STANDARD OPTIONS

Add (1) CAG QCM Mate Kit, Edmunds #7940905

Edmunds GAGES
Farmington, CT U.S.A

CAG^{QCM} Gaging System Standard Configuration Document A-7940030M

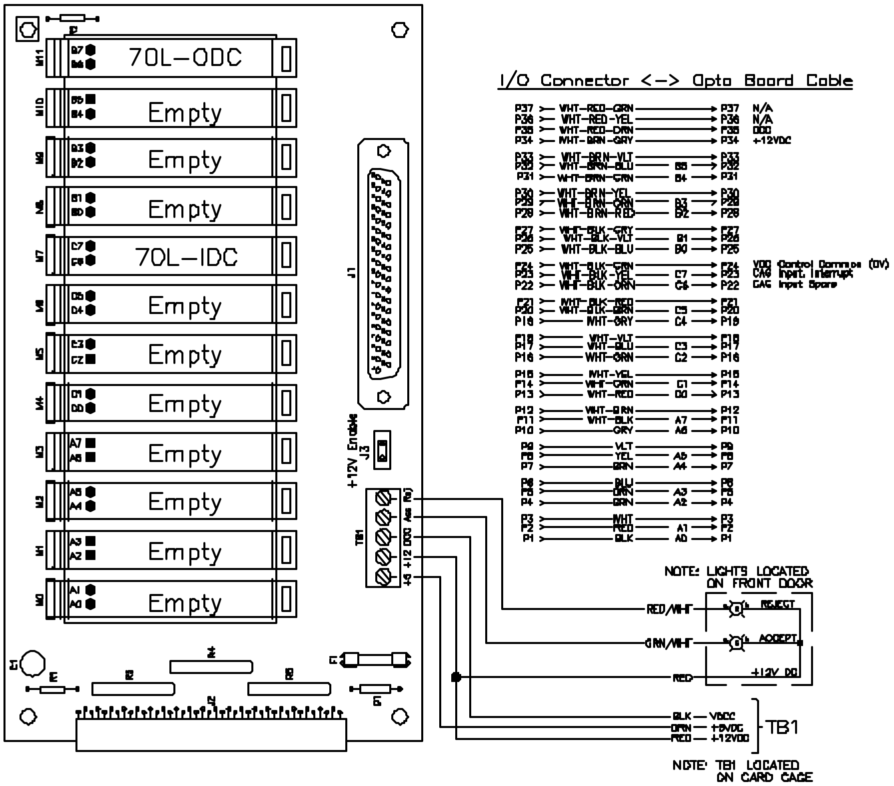
Sht. 1 of 1
Date Mar 24, 2004

Reference No. 7940030M

1. GENERAL INFORMATION

Customer	Edmunds Gages	Edmunds S.O. No.	Edmunds S.O.
CAG Assem. No.	7940030	Customer P.O. No.	Customer P.O.
Tooling "G" No.	Tooling G No	CAG S.O. No.	CAG S.O. No
		Tooling S.O. No.	Tooling S O No

2. PARALLEL INTERFACE SPECIFICATIONS



3. SOFTWARE

Latest Manual Version

OPTO CHOICES	FUSE RATING	ADDITIONAL QTY.
DC INPUT, GRAYHILL #70L–IDC	–	1
AC INPUT, GRAYHILL #70L–IAC	–	0
DC OUTPUT, GRAYHILL #70L–ODCR	1.00A/CH	0
AC OUTPUT, GRAYHILL #70L–OAC	3.15A/CH	0

4. NON STANDARD OPTIONS

Add (2) Tilt Feet, Edmunds #4030350

Edmunds GAGES
Farmington, CT, U.S.A.

CAG^{QCM} Gaging System
Standard Configuration
Document A-7940020M

Sht 1 of 1
Date Feb 28, 2002

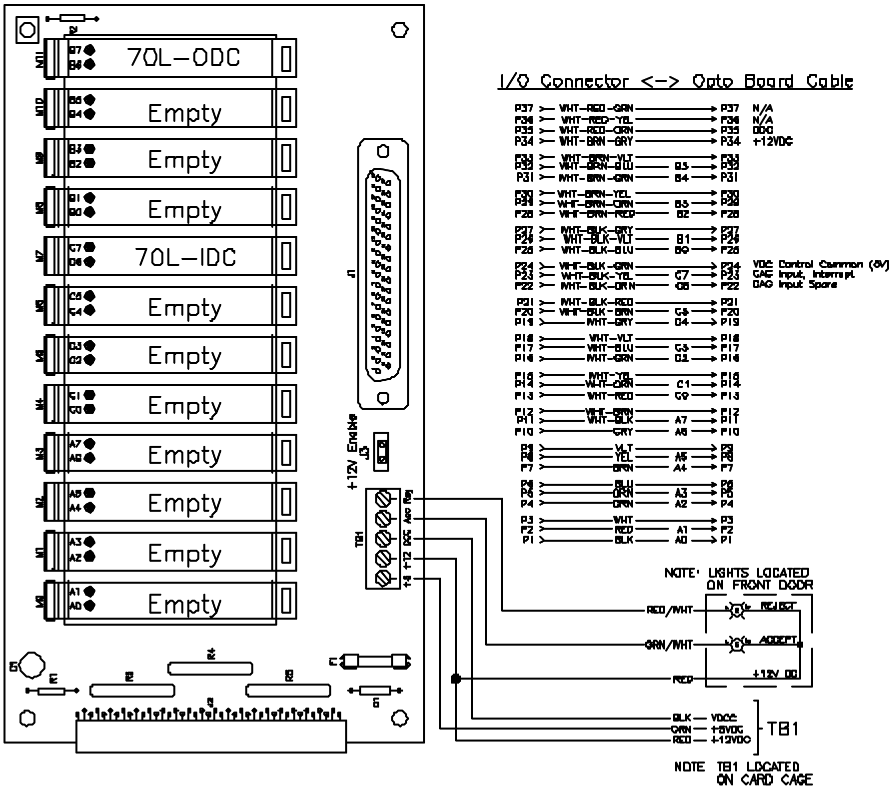
Reference No. 7940020M

1. GENERAL INFORMATION

Customer Edmunds Gages
CAG Assem. No. 7940020
Tooling "G" No Tooling G No

Edmunds S.O. No. Edmunds S.O
Customer P.O. No. Customer P.O.
CAG S.O. No. CAG S.O. No
Tooling S.O. No. Tooling S.O. No

2 PARALLEL INTERFACE SPECIFICATIONS



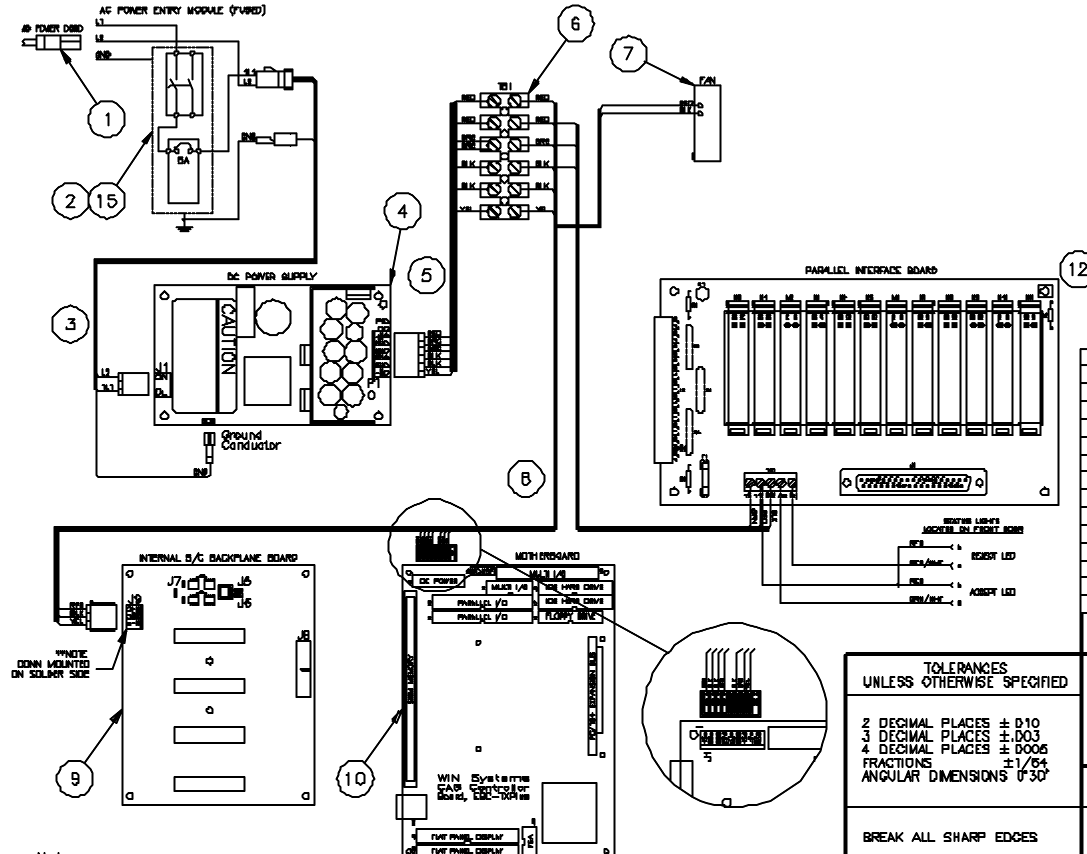
3. SOFTWARE

Latest Manual Version

OPTO CHOICES	FUSE RATING	ADDITIONAL QTY.
DC INPUT, GRAYHILL #70L-IDC	–	1
AC INPUT, GRAYHILL #70L-IAC	–	0
DC OUTPUT, GRAYHILL #70L-ODCR	1 00A/CH	0
AC OUTPUT, GRAYHILL #70L-OAC	3.15A/CH	0

4. NON STANDARD OPTIONS

Add (2) Tilt Feet, Edmunds #4030350



DC POWER WIRING		
Description	Color	Symbol
+5 VDC	ORG	⊞
+12 VDC	RED	⊕
−12 VDC	YEL	⊖
COM (DCC)	BLK	▽

* FOR REFERENCE ONLY

DET NO	NO REQD	DESCRIPTION	STOCK SIZE
15	*	5 Amp Fuse, Edmunds #419D125	
14			
13			
12	*	Parallel Interface Board, See Base Hardware	
11			
10	*	Motherboard, Win Systems #EBC-TXPlus	
9	*	DCM Signal Cond. Backplane, Edmunds #411093D-BN	
8	*	DC Wiring Harness, Edmunds #7940517	
7	*	Fan, 12 VDC, Edmunds #4290200	
6	*	Terminal Block, 6 Pos., Edmunds #453D350	
5	*	PS DC Wiring Harness, Edmunds #7940505	
4	*	DC Power Supply, Edmunds #433021D	
3	*	AC Wiring Harness, Edmunds #7940500	
2	*	Power Entry Module, Edmunds #4410960	
1	*	AC Power Entry Cord, Edmunds #4550111	

Notes:

Use 18 AWG wire for all Power Wiring
Components other than Connectors are listed on the Base Hardware List of Materials.

Fan has leads and is not a quick disconnect.

TOLERANCES
UNLESS OTHERWISE SPECIFIED

2 DECIMAL PLACES ± .010
3 DECIMAL PLACES ±.003
4 DECIMAL PLACES ± .0005
FRACTIONS ±1/64
ANGULAR DIMENSIONS 0°30'

BREAK ALL SHARP EDGES

BLACK OXIDE ALL
UNGROUND SURFACES

STRESS RELIEVE WELDMENTS

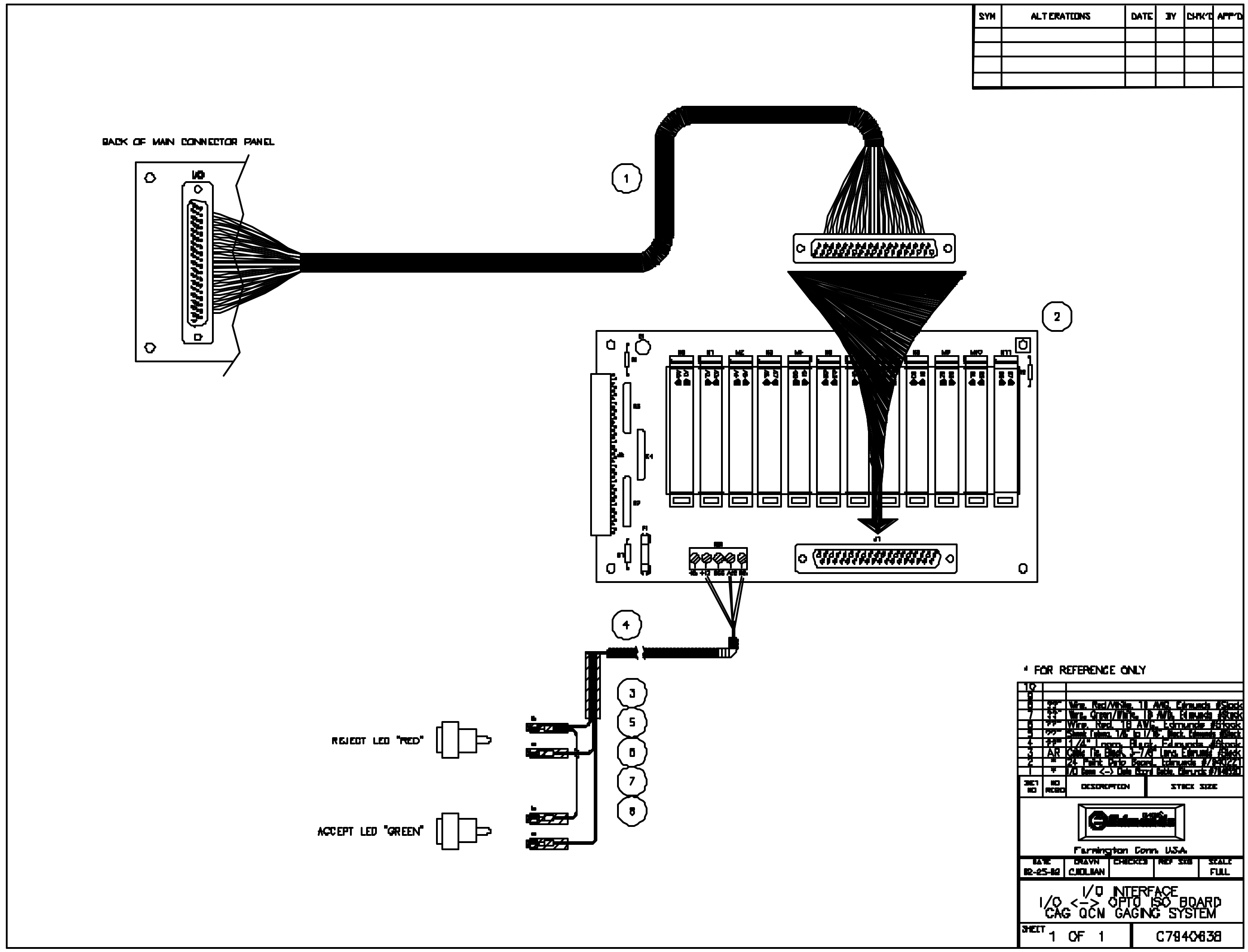
Edmunds GAGES
Farmington Conn. U.S.A.

DATE	DRAWN	CHECKED	REF SKC	SCALE
03-01-02	C.HOLMAN			

POWER DISTRIBUTION (7940020)
INTERNAL S/C
CAG QCM GAGING SYSTEM

SHEET 1 OF 1

B7940421



DET NO	NO REQD	DESCRIPTION	STOCK SIZE
10			
9			
8	[illegible]	Wire, Red/White, 18 AWG, Edmunds #Stock	
7	[illegible]	Wire, Green/White, 18 AWG, Edmunds #Stock	
6	[illegible]	Wire, Red, 18 AWG, Edmunds #Stock	
5	[illegible]	Shrink Tubing, 1/8" to 1/16", Black, Edmunds #Stock	
4	[illegible]	1/4" Loom, Black, Edmunds #Stock	
3	AR	Cable Tie, Black, 3-7/8" Long, Edmunds #Stock	
2	*	24 Point Opto Board, Edmunds #7940221	
1	*	I/O Conn <-> Opto Board Cable, Edmunds #7940[illegible]	

PARALLEL PRINTER PORT (LPT1)

PIN #	DESCRIPTION	DIRECTION
1	STROBE	OUT
2-9	PD0-PD7	BI
10	ACK	IN
11	BUSY	IN
12	PE	IN
13	SLCT	IN
14	AUTOFD	OUT
15	ERROR	IN
16	INIT	OUT
17	SLIN	OUT
18-25	GND	-

RS-232 SERIAL PORTS (COM1, COM2)

PIN #	DESCRIPTION	DIRECTION
1	CD	IN
2	RX Data	IN
3	TX Data	OUT
4	DTR	OUT
5	GND	-
6	DSR	IN
7	RTS	OUT
8	CTS	IN
9	RI	IN

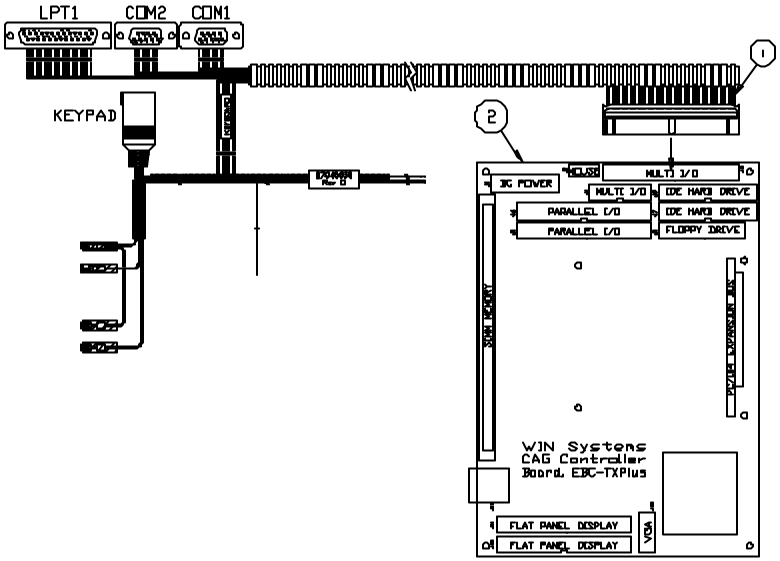
JUMPER CONFIGURATION FOR RS-232

J18 1 2 3 ○○○ J21 1 2 3 ○○○

U4 - Installed
U5 - Not Installed
U6 - Not Installed

J19 1 2 3 ○○○ J22 1 2 3 ○○○

U7 - Installed
U8 - Not Installed
U9 - Not Installed



Notes:

COM1, COM2, and LPT1 connectors are mounted on the CAG's Main Connector Panel. (Unless otherwise noted).

KEYBOARD connector is located in the CAG's door.

Configure jumpers for proper operation.

* FOR REFERENCE ONLY

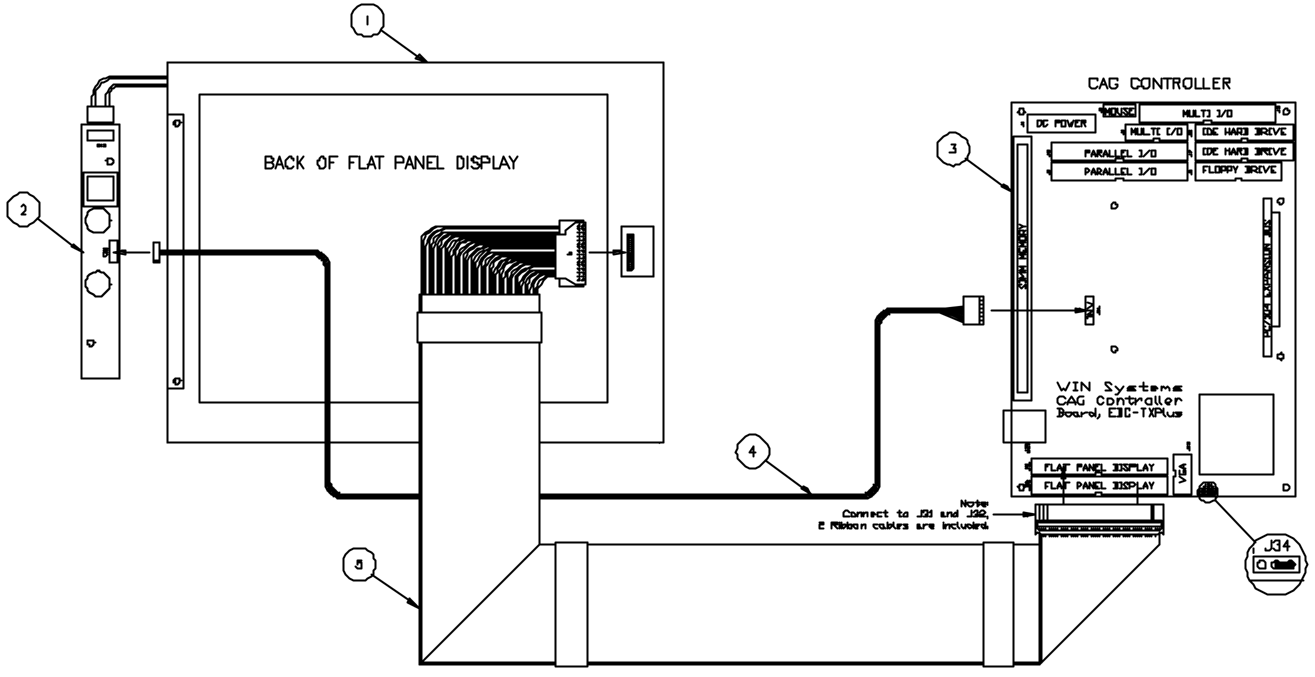
3			
2	*	CAG Controller Board, See Base Hardware	
1	*	Ribbon Cable, Multi I/O, Edmunds #4570620	
DET NO	NO REQD	DESCRIPTION	STOCK SIZE

Farmington Conn. U.S.A.

DATE	DRAWN	CHECKED	REF SKG	SCALE
05-09-10	G.Holman			FULL

MULTI I/O INTERFACE
ENCLOSURE ASSEMBLY (400MHz)
CAG QCM GAGING SYSTEM

SHEET 1 OF 1 C7940670



Note:
Connect to J31 and J32,
2 Ribbon cables are included.

* FOR REFERENCE ONLY

DET NO	NO REQD	DESCRIPTION	STOCK SIZE
5	*	Ribbon Cable, Flat Panel <-> MB, See Base Hardware	
4	*	Power Cable, MB <-> Inverter, See Base Hardware	
3	*	CAG Controller Board, See Base Hardware	
2	*	Inverter Board, WinSystems #LS700	
1	*	Active Color LCD Screen, Edmunds #4579652	

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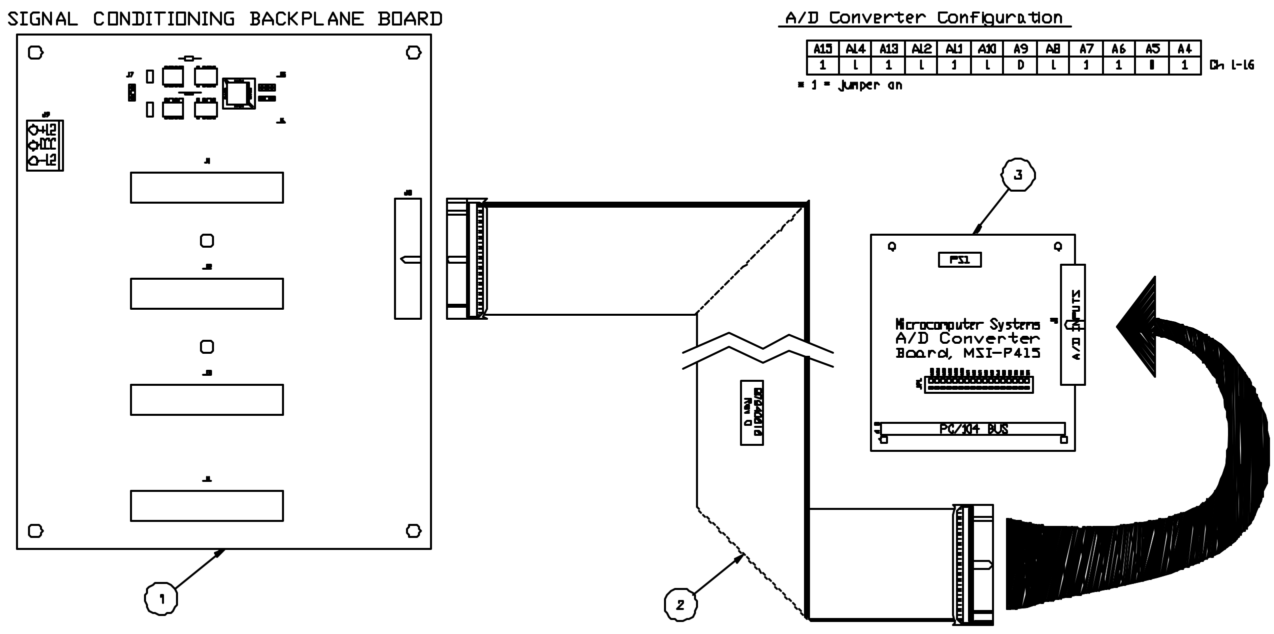
DATE	DRAWN	CHECKED	REF SKG	SCALE
02-28-02	C.Holmen			N/S

FLAT PANEL DISPLAY INTERFACE
ENCLOSURE ASSEMBLY (400MHz)
CAG QCM GAGING SYSTEM

SHEET 1 OF 1
C7940675

Jumpers
J34 must be jumpered 2-3 for NEC type panels

Notes:
Refer to assembly drawing for mounting of components.
Inverter board and cables are included as a kit, ref Edmunds #xxxxxxxx



A/D Converter Configuration

A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	
1	L	1	L	1	L	D	L	1	1	▮	1	Ch 1-16

* 1 = Jumper on

* FOR REFERENCE ONLY

DET NO	NO REQ'D	DESCRIPTION	STOCK SIZE
3	*	16 CH., 12-Bit Diff. A/D Converter, Edmunds #[illegible]	
2	*	Ribbon Cable, A/D Converter <-> S/C, Edmunds #7940818	
1	*	QCM Signal Card Backplane, Edmunds #[illegible]	

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DATE	DRAWN	CHECKED	REF SKG	SCALE
05-20-01	C.HOLMAN			N/S

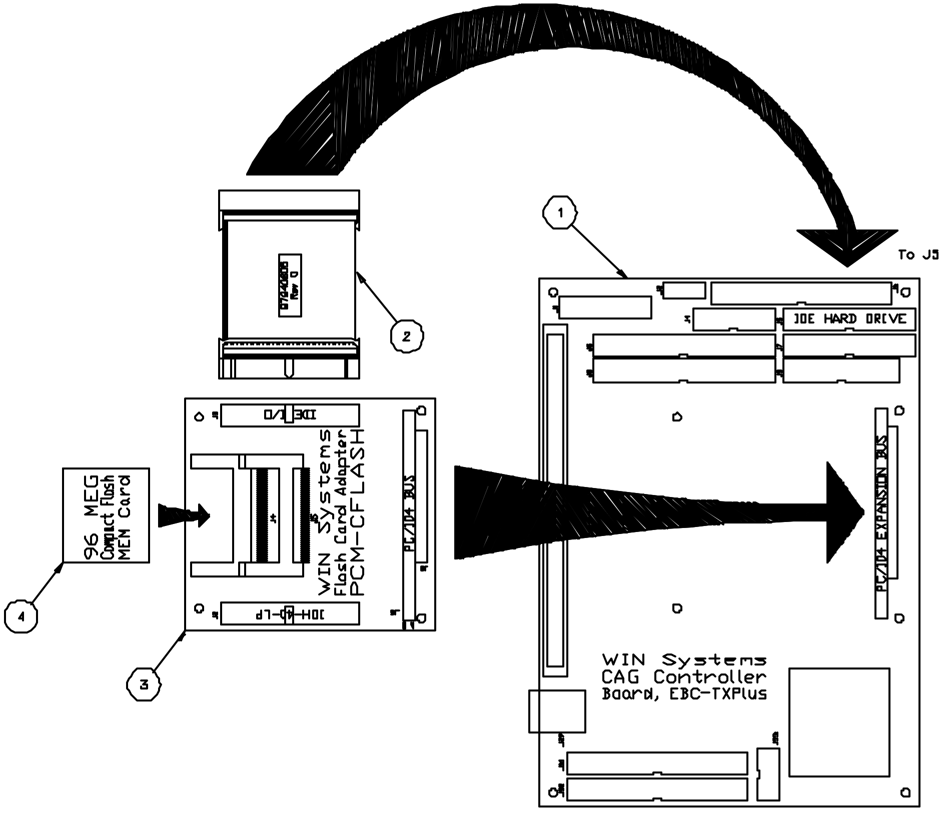
A/D CONVERTER <-> S/C
ENCLOSURE ASSEMBLY (400MHz)
CAG QCM GAGING SYSTEM

SHEET 1 OF 1
C7940672

Notes

Configure address jumpers on the A/D Converter Board for proper amount of channels.
Mount A/D Converter Board according to enclosure assembly drawing.

Mount the S/C Board in the QCM card cage (Edmunds #7940203) according to enclosure assembly drawing



Notes:

Mount Compact Flash Adapter Board atop the Mother Board via PC-104 using 1" plastic standoffs.
Compact Flash Adapter Board is connected to the IDE Hard Drive (J5) on the Mother Board
Insert Programmed Compact Flash Card before delivering to assembly.

* FOR REFERENCE ONLY

DET NO	NO REQ'D	DESCRIPTION	STOCK SIZE
7			
6			
5			
4	*	96 MB, Compact Flash MEM Card, Edmunds #4570610	
3	*	PC-104 Compact Flash Adapter, Edmunds #4570607	
2	*	Ribbon Cable, MOTHER BOARD <-> FLASH, Edmunds #[illegible]	
1	*	CAG Controller Board, See Base Hardware	

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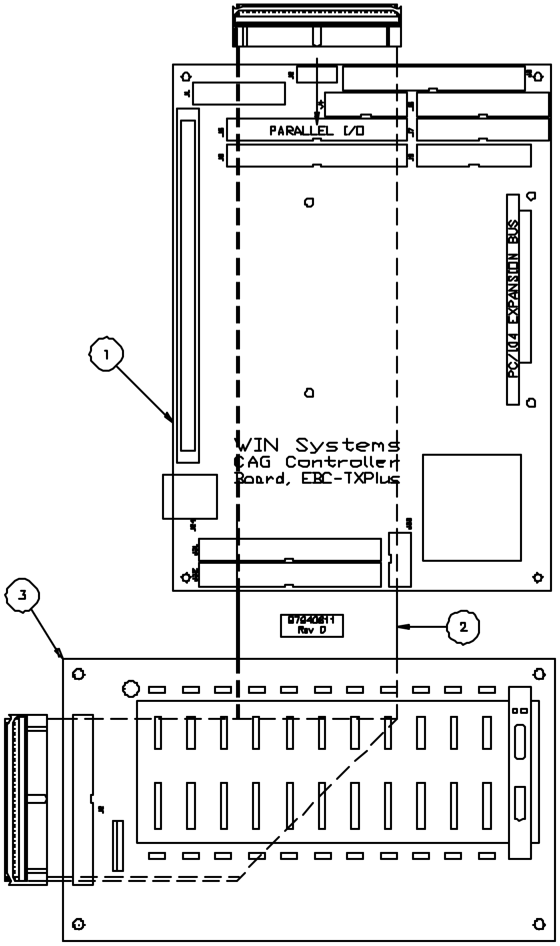
Farmington Conn. U.S.A.

DATE	DRAWN	CHECKED	REF SKG	SCALE
05-09-01	C.Holman			N/S

MOTHERBOARD <-> FLASH
ENCLOSURE ASSEMBLY (400MHz)
CAG QCM GAGING SYSTEM

SHEET 1 OF 1 C7940673



Notes

Mount Opto—Board to the bottom of the CAG QCM box (as shown in the assembly drawing).
Connect the ribbon cable to J2 on Opto Board and J6 on the Mother Board.

* FOR REFERENCE ONLY

DET NO	NO REQD	DESCRIPTION	STOCK SIZE
5			
4			
3	*	24 Point Opto-Board, See Base Hardware	
2	*	Ribbon Cable, MB <-> OPTO RACK, Edmunds #7940611	
1	*	CAG Controller Board, See Base Hardware	

Edmunds Gages
Farmington Conn. U.S.A.

DATE	DRAWN	CHECKED	REF SKG	SCALE
05-11-01	D HOLMAN			N/S

M.BOARD <-> OPTO ISO BOARD
ENCLOSURE ASSEMBLY(400 MHz)
CAG QCM GAGING SYSTEM

SHEET 1 OF 1
C7940674

Technical Note

#8130401

Rev 0
Date 04/14/05

Signal Conditioning Modifications when using 31017xx A/E Blocks

Introduction:

The 31017xx series A/E block contains a different solid-state pressure transducer than that of its 31012xx series counterparts. Although the new pressure transducer provides the same basic function as the legacy pressure transducer, it has an output sensitivity that is lower. The lower output sensitivity requires modifications to the configuration jumpers, program setup and in some cases, hardware. The modification summary is listed below.

Author: Scott Sokolik

7200010 Cag Universal Signal Conditioning Modules

1. For each A/E input that contains a new 31017xx A/E block, place the corresponding *Input Range* jumpers in the **.010** position. Jumper assignments are as follows: (**J11** for Input **#1**), (**J12** for Input **#2**), (**J13** for Input **#3**), and (**J14** for Input **#4**). See Figure 1 below.
2. For each A/E input that contains a new 31017xx series A/E block, multiply the existing software mag factor by (1.500). For example, if the existing mag factor is (.120), change the software mag factor to: (.120) x (1.500) = (.180).

   If no software mag factors are present (i.e. new application), refer to the mag factors listed in the Cag manual (Air/Electric Signal Conditioning, Chapter 7).

7100021 Cag A/E Signal Conditioning Modules

1. Factory-performed hardware modification per *SKE#46293*
2. No program setup modifications are necessary.

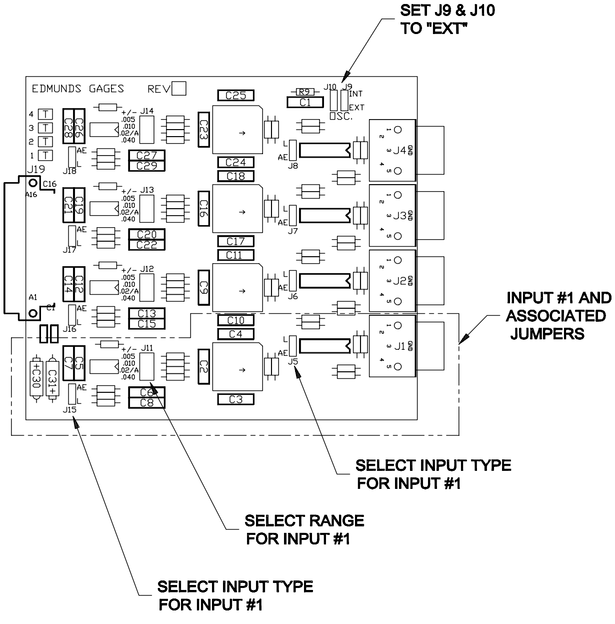


Figure 1