Course Text

EEC IV

CALIBRATION DEVELOPMENT SUPPORT SYSTEM

TECHNICAL EDUCATION SECTION

Powertrain Electronics Development Department

4/13

EEC-IV
CALIBRATION CONSOLE
AND
DAC MODULE

Produced by
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Chapter 1

INTRODUCTION

The Calibration Console (Cal Console) and Remote Box communicate with the EEC-IV Processor Module either directly or via an EPROM Assembly. The Digital to Analog Converter (DAC) Module stores in the lid of the Cal Console. The Cal Console and DAC Module assist in development, testing, and evaluation of EEC-IV engine calibration. Although primarily designed for in-vehicle development/test operations, laboratory bench-test are also possible.

The Cal Console enables the operator to experimentally determine the engine calibration constants that result in favorable engine performance. In addition, its use as a system monitor allows the operator to monitor signals to and from the processor and the state of various timers and calibratable constants.

The DAC module provides for the real-time digital display of selected engine operating parameters and provides analog outputs to a strip chart recorder. It is also used for sending digital outputs to a data logging device. This is useful for both on-line and off-line evaluation of engine performance under development/test conditions.

Two basic versions of the Cal Console exist. These are 7.6 and 8.2. This course deals primarily with Version 8.2.

CAL CONSOLE OVERVIEW

The EEC-IV Cal Console is a portable unit housed in a metal carrying case. The case measures 13 inches high, 12 inches wide, 7.5 inches deep, and weighs 8 pounds. All operating controls and indicators are on the console front panel assembly. Input power and interface connections to the DAC Module and external peripheral devices are made via connectors located on the console left side. A 5.0A console power fuse, a 2.0A peripheral power fuse, and a cooling fan are also located on the left side.

OPERATING VOLTAGES

A +12 VDC (nominal) input from either the vehicle battery or an external power source provides operating voltage for the Cal Console. The voltage is then regulated at +5 VDC and is the primary operating voltage for the Cal Console circuits. A separate +5 VDC MEM voltage is the operating power source for the console RAM.

Applying a +12 VDC input supply to the console charges a battery back-up power source included in the console circuits. Removal of the +12 VDC input causes this battery backup to supply +5 VDC MEM power. This ensures retention of altered console RAM constants for up to 24 hours. This permits shutdown and resumption of test operations without loss of these RAM parameters. A subminiature BATTERY TEST plug, located on the back of the console, allows measurement of the internal battery voltage.

CONSOLE IDENTIFICATION

A nameplate identifying the console part number, design level, and revision level is also located on the back of the console.

CAL CONSOLE MEMORY CIRCUITS

The Cal Console contains 4 2K by 8-bit Bi-polar PROMS (Programmable Read Only Memory) and a 4K by 8-bit RAM (Random Access Memory). These PROM assemblies contain the Cal Console Executive Program. The contents of the slave program counter addresses the Executive Program (see below). The RAM stores calibration constants read from the EEC-IV strategy and is also used as a scratchpad memory for the Calibration Console Software Program. As required during program execution, control signals generated by console control logic enable the PROM, RAM, and related read/write buffers.

The Cal Console does not contain a microprocessor of its own. Rather, it shares time with the EEC-IV microprocessor (8061). A 16-bit slave program counter allows access to program instructions in the console PROM. The slave program counter is initially loaded with address 2000H upon reset of the 8061 microprocessor located in the Development Module and is subsequently maintained in sync with a master program counter contained in the EEC-IV microprocessor.

INTRODUCTION

DAC MODULE OVERVIEW

The DAC Module is physically housed in the Cal Console lid. It comes equipped with a flat, shielded ribbon cable used for electrical interface of the DAC Module to the Cal Console.

The front panel contains all operating controls and indicators. In addition, the front panel also includes eight BNC type connectors. These connectors output analog data to an externally connected strip chart recorder, oscilloscope, or other types of output devices.

CONNECTORS

The DAC module left side contains three "D" type connectors. The PERIPHERAL PORT IN connector provides for interface of the DAC Module to the Cal Console. The RS232C #1 and RS232C #2 connectors function as digital data outputs to external data logging devices. These output rates are 1200 to 19200 baud and 300 to 9600 baud, respectively.

INPUT VOLTAGES

Either the vehicle battery or the external power supply from within the Cal Console supplies input power for DAC module operation. The DAC Module power supply circuits provide +5, +15, and -15 VDC outputs for operation of internal circuits.

DAC MODULE MICROPROCESSOR

The DAC Module contains an Intel 8085 microprocessor which provides control of circuit operations. An internal 10 MHz clock generator circuit provides basic system timing. Three 2732A (4K by 8-bit) EPROM assemblies (Erasable Programmable Read Only Memories) store the program which controls the 8085. The program reads the state of the front panel switches to determine:

- Whether the DAC channel resolution is to be 8 bits or 10 bits
- Whether to enable or disable data logging
- Which two of the eight channels to display on the alphanumeric display indicator

Display of the parameters addresses is in Hex or Unscaled Decimal Radix. If the two channel select switches are set to "AA" or "BB" upon power-up, the program begins an internal DAC Module diagnostic routine.

Processed data is written to one of eight (8) DAC circuits as determined by the control parameters. The outputs from these circuits are 0 to 10 VDC signals proportional to the digital value of the parameter contained in RAM. If needed, these outputs are strip chart recorded which provides a permanent record of various engine operating parameters.

DAC MODULE MEMORY CIRCUITS

The DAC also contains a 2K by 8-bit static RAM. The 8085 microprocessor uses this RAM for scratch pad memory, storage of Extended Data Logger configuration menu default parameters and frame data storage in the Extended Data Logger's Gather and Display mode.

DAC PERIPHERAL PORT INTERFACE

The DAC Peripheral Port Interface Circuits provide for the parallel transfer of digital data (DAC channel control parameters, data which represents engine operating parameters, and the results of the compare routine) to the DAC Module. If the DAC Module is present (i.e. connected to the Cal Console) and ready to accept data, the DAC Module status inputs that reflect this condition are then applied to the Console Status Register via the Peripheral Port Interface circuits. When data is to be sent to the DAC Module, the contents of the Console Status Register are first read to determine if the DAC is present and ready. If so, data is written to the peripheral port in two 8-bit bytes and the DATA VALID signal is output to the DAC Module. Upon accepting data from the Cal Console, the DAC Module outputs a handshake signal to inform the Cal Console that it is ready to accept the next data word. This process repeats until all data transfers to the DAC Module.

INTRODUCTION

REMOTE BOX OVERVIEW

The EEC-IV Cal Console comes equipped with a Remote Box which interfaces the console to the EEC-IV processor (either directly or via an EPROM Assembly). The Remote Box contains drivers and buffers which enable the console to be physically located up to four feet away from the EEC-IV processor.

REMOTE BOX VERSIONS

There are four Remote Box versions that interface the Cal Console to the EEC-IV processor; 1-A "standard" Remote Box, 2-An SMP (Scaling and Modifiable Parameters) Remote Box, 3-A Bi-Input Remote Box and 4-An SMP Bi-Input Remote Box. The SMP Remote Box includes provisions for installation of SMP memory chips which enable Cal Console display of engine operating parameters in easy-to-read engineering units and identify which parameters are modifiable. An SMP Remote Box connects directly to the EEC-IV Processor Module (providing processor contains custom EPROM and RAM-I/O chips) or connects to the EEC-IV processor via an EEC-IV EPROM Assembly.

The standard version of the Remote Box does not include provisions for installation of SMP memory chips and must be interfaced to the EEC-IV processor via an EPROM Assembly (which can accommodate SMP memory). The Bi-Input Remote Box (both SMP and non-SMP) supplied with the EEC-IV Engineering Console enables simultaneous connection of both the Engineering Console and Cal Console to the EEC-IV processor.

EPROM ASSEMBLY OVERVIEW

The EPROM Assembly is an electronic control unit which accepts EPROM and SMP chips. These chips in turn emulate EEC-IV custom designed memory. This allows test and evaluation of development type engine control strategies programmed into standard UV (Ultra Violet) erasable EPROM chips. The EPROM assembly contributes as a development support tool which allows time for custom-designed, MBUS compatible, EPROM assembly availability. There are two basic versions of the EPROM Assembly, First Generation and Second Generation EPROM Assemblies.

FIRST GENERATION

The First Generation EPROM Assembly design emulates the first generation EEC-IV memory. It includes provisions for installing up to 40K bytes of standard EPROM and 256 bytes of RAM and includes the circuitry required for interface compatibility with the EEC-IV MBUS. In addition, it contains an internal power supply and provisions for installing an additional custom designed printed circuit board such as an optional Communications Link Emulator Board.

SECOND GENERATION

The Second Generation EPROM Assemblies design emulates second generation EEC-IV memory systems and includes provision for installing up to 40K bytes of standard EPROM and 2K bytes of RAM. It also includes a 5-bit quasi-bidirectional I/O port and also trapping provisions which enable generation of any 1 of 32 codes used for default selection of a specific calibration within a multicalibration strategy. The second generation EPROM Assembly provides a more positive clamping mechanism to secure the development module.

EPROM ASSEMBLY SUMMARY

The EPROM Assembly provides the operating environment for EPROM chips containing both the baseline engine control strategies, and the SMP (Scaling and Modifiable Parameters) code. SMP memory enables the Cal Console display of engine operating parameters in easy-to-read engineering units. Using an SMP Remote Box for interfacing the Cal Console to the EPROM Assembly, memory space (normally reserved for SMP code) is used for additional strategy development.

CUSTOM EPROM

Custom EPROM chips containing a baseline engine control strategy and engine calibration constants, installed along with a 2K RAM-I/O in a development module, are sometimes used in place of an EPROM Assembly. This provides a simple and reliable means for development, test, and evaluation of engine control strategies and engine calibrations. Custom EPROM chips are programmable for a specific engine application to replace MROM chips used in production units in the event that the MROM required for a given engine application is not available.

DOC FILES

DOC Files are a list or map of the calibratable parameters for a particular calibration. The DOC File contains a dictionary and information about:

- RAM Listings
- ROM Listings including:
  - Function Charts
  - Tables

RAM and ROM listings contain the following information:

- Parameter name and hexadecimal address
- Whether the parameter is a byte (8-bits) or word (16-bits) value
- Whether it is signed (positive or negative) or unsigned (positive only)
- The Binary Point value used for scaling (contained in the SMP chip)
- Comments which explain the parameter

In addition, the ROM listings include the value of the parameter in both engineering form and hexadecimal, and a Region Level which shows the strategy region and parameter location.

STRATEGY

STRATEGY is a computer program that the 8061 microprocessor executes. The EEC-IV module contains this program and through the microprocessor manages the hardware in the EEC-IV module which in turn controls the engine. A different strategy is usually written for each engine family during a given model year. Examples of engine families are: 5.0L SEFI, 3.8L CFI, etc.

CALIBRATION

Calibration or Calibration Parameters are a set of scalars, functions, and tables that are data referenced by the microprocessor. A calibration exists for each engine application. Examples of engine applications are: 49-State/Automatic, California/Automatic, 50-State/Manual Trans, etc.

Chapter 2

CONTROLS AND INDICATORS

The Cal Console and DAC Module incorporate several controls and indicators. This makes possible a full range of control and ease of use. The following explains the controls and indicators:

CAL CONSOLE CONTROLS

The controls of the Cal Console are the:

- PWR ON/OFF Switch
- CS/NORM Switch
- Alphanumeric Keypad
- Function Keypad

PWR ON/OFF SWITCH

The PWR (Power) ON/OFF switch controls the application of DC power to the console. When set to ON position, the PWR indicator lights up. The 8061 CPU reset pulse transmission occurs when this switch is set to the ON or OFF position.

CS/NORM SWITCH

The CS/NORM switch selects the calibration constants for engine control when the console is initially powered up. If set to CS (Console Select) position, this selects console RAM calibration constants. If set to NORM (Normal) position, this enables the CS key on the function keypad and calibration constants in either console RAM or ECA EPROM/MROM are selected. The CS indicator lights shows the selection of Console RAM.

NOTE: Do not operate the CS/NORM switch after powering the console. Damage to the console or processor may result.

ALPHANUMERIC KEYPAD

Used to input addresses and data in either hexadecimal or exponential notation formats.

FUNCTION KEYPAD

Used for initiating various console operations. The explanation that follows incorporates both a visual representation of the key and complete function explanation.

CONTROLS AND INDICATORS

Function Keys Definition:

PAS

The PAS (Password) key is used for password entry. Prior to entering the password, the user is permitted access to CPU registers, EEC-IV RAM, and calibration constants in both EPROM/MROM and in console RAM but is not permitted to alter any parameters. After keying in a valid password and pressing the PAS key, the PASS indicator lights, the console initialization function is enabled, and the "alter" function is enabled. The PASS indicator is turned off (if lit) by pressing the PAS key without entering a password or by entering an invalid password. For Version 8.2 software, there are two valid passwords: "normal memory access" and "full memory access" passwords.

INT

The INT (Initialize) key copies engine calibration data from EEC-IV memory (EPROM/MROM) into console RAM. In order to transfer this data, the console requires a password. This key also initializes DAC channel operating parameters in console RAM (to values located in SMP) and turns off the DAC function to speed up the initialization process.

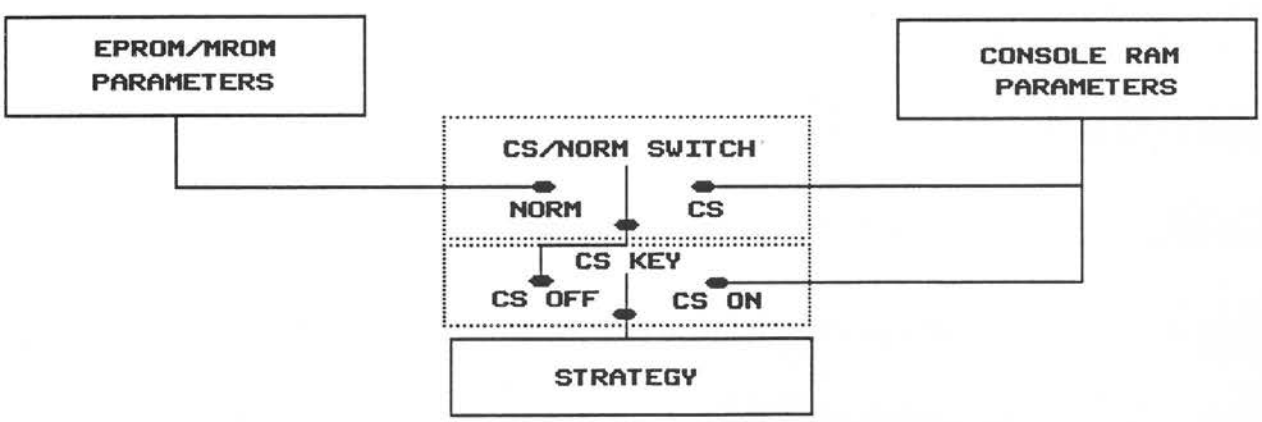
For Version 8.2 software, a specific calibration region, numbered 0 through 7, is entered using the CS (Console Select) key. The desired calibration region(s), numbered 0 through 7, are specified before pressing the INT key. Without specification of a calibration, default calibration copy occurs.
NOTE: No region specification copies all regions of the calibration into console RAM.

Pressing INT without first entering a valid password displays the calibration and region numbers (separated by an asterisk) that now occupy console RAM.

CS

The CS (Console Select) key is used to select either alterable calibration constants in console RAM or original baseline calibration constants in EPROM/MROM as engine control parameters. When the key is pressed, the current state of the CS LED changes state to indicate the change of selection. The CS/NORM switch must be in the NORM position for the CS key to be active.

NOTE: For Version 8.2 software, the CS key can also be used to enter the calibration number to be copied into console RAM during console initialization (see INT key).



CONTROLS AND INDICATORS

DSO

The DSO (Display Original) key is normally used to display the contents of EEC-IV CPU registers, EEC-IV RAM, and calibration constants in EPROM/MROM. Display of any EEC-IV memory location occurs providing a "Full Memory Access Password" has been entered.

To display the contents of an EEC-IV memory location, enter the address (the parameter index for Version 7.6 software) and press the DSO key. The contents of that memory location is then updated every 300ms for version 8.2 or 500ms for version 7.6. Pressing the DSO key without entering an address causes the last address contents (or parameter index) to display.

NOTE: The contents of the next higher or next lower memory address displays by pressing the NXT (Next) or LST (Last) key.

If SMP data is available for a parameter, the parameter value is then scaled and displayed in engineering units. Otherwise, data display is in unscaled byte mode.

NOTE: Selection of hexadecimal display radix causes the hexadecimal number and hexadecimal BIN number to display.

DSA

The DSA (Display Alterable) key is normally used to display the contents of EEC-IV CPU registers, EEC-IV RAM, and calibration constants in console RAM. If a "Full Memory Access Password" was entered, any EEC-IV memory location may be displayed. Use of the DSA key to display the contents of a read/write location enables alteration of the parameter at that location.

To display the contents of a memory location, enter the address (the parameter index for Version 7.6 software) and press the DSA key. Data is then sampled once and displayed (snap-shot mode). If the DSA key is pressed without entering an address, the contents of the last address (or parameter index) displays.

NOTE: The contents of the next higher or next lower memory address may be displayed by pressing the NXT (Next) or LST (Last) key, respectively.

If SMP data is available for a parameter, the parameter value is scaled and displayed in engineering units. Otherwise, data displays in unscaled byte mode.

NOTE: If hexadecimal displayed radix is selected, data is displayed as a hexadecimal number with a hexadecimal BIN number.

	RAM	ROM
DSO	UPDATING (OPERATING)	ORIGINAL (EPROM/MROM)
DSA	SNAPSHOT	ALTERABLE (CONSOLE RAM)

ALT

The ALT (Alter) key changes the contents of EEC-IV read/write memory locations and calibration constants in console RAM. To alter a parameter value, first display the parameter. Enter the new value with the alphanumeric keypad and press the ALT key.

Normally, parameter alteration is limited to EEC-IV RAM, calibration constants and DAC parameters in console RAM. For consoles incorporating Version 8.2 software, entry of the Full-Memory Access password enables the alteration of any read/write memory location.

For consoles incorporating Version 8.2 software, depressing the ALT key after depressing the DSA key increments the value of that parameter by one unit. Keeping the ALT key depressed slews the parameter value rapidly. The blank key (upper right-most key) toggles the direction of change (increment to decrement and vise' versa).

For consoles incorporating Version 7.6 software, the ALT key, when used together with the NXT (Next) and LST (Last) keys, rapidly changes the contents of contiguous memory locations such as the values of a table in memory.

DAC

The DAC (Digital-to-Analog Converter) key is used to enable and disable DAC operations and to gain access to DAC channel operating parameters. If the DAC Module is connected when the Cal Console is powered up, digital data outputs to the DAC are automatically enabled and the front panel DAC LED lights. Depressing the DAC key without entering a channel number (0 through 7) toggles the digital output function. Entering a valid channel number and then pressing the DAC key displays the operating parameters assigned to that channel. The operator may then alter the various operating parameters for that channel.

If the DAC key is depressed when the DAC Module is not attached to the console, the message "NO PERIPHERAL" message is then displayed.

NXT

The NXT (Next) key is a multifunction key used along with the DSO, DSA, and CMP keys. When momentarily depressed after the DSO or DSA key, the NXT key increments the current address to display the contents of the next higher memory location. During the compare routine, the NXT key resumes the comparison test after detection and display of a memory address containing a different value.

For consoles incorporating Version 8.2 software, holding the NXT key depressed increments the display address rapidly. In addition, the NXT key sequences through the DAC channel control parameter display.

LST

The LST (Last) key is a multifunction key used together with the DSA and DSO keys. When momentarily depressed, after DSA or DSO key entry, LST decrements the current address to select the contents of the next lower memory address for display.

For consoles incorporating Version 8.2 software, holding the LST key depressed decrements the display address rapidly. In addition, the LST key sequences through the DAC channel control parameter displays.

CONTROLS AND INDICATORS

CMP

The CMP (Compare) key initiates a sequential byte-by-byte comparison of calibration constants in console RAM to unscaled baseline calibration constants in the EPROM/MROM. Initiating the compare function ends DAC operation and data logging. Detection of a difference suspends the comparison routine and displays the address (or parameter index number) along with the value of that parameter in both EPROM/MROM (identified by an asterisk) and console RAM. To continue the compare routine the operator must press the NXT key. The COMPARE COMPLETE message displays after comparison of all memory locations. To abort the compare function, press the CMP key while a message displays.

For consoles incorporating Version 8.2 software, comparison of parameters in console RAM occurs against a specific calibration. To specify a calibration, enter a calibration number before pressing the CMP key. Without specification, internal console parameters and the default calibration value selected are compared. Activation of data logging sends these compare differences to the data logger before the console displays them.

H/D

The H/D (Hexadecimal/Decimal) key is used to change the console radix operating mode. If the DCML indicator is lit, data entry and display (except for addresses) is in the decimal format. Otherwise, data entry and display is in hexadecimal format.

Depressing the H/D key alters the operating mode, changes the state of the DCML indicator. This key also converts any currently displayed data into the new radix mode, and sends the new radix to the DAC.

NOTE: Data values are unchanged when using the H/D key. The H/D key is a conversion feature only.

EE

The EE (Enter Exponent) key enters exponential data while in the decimal radix operating mode. Entering data with a floating point format is possible. This can include a factor raised to a power of ten. The power of ten term, n, can vary from +9 to -9.

For example, in the expression "a X 10^n, if a = 5 and n = 2, then enter data in the following sequence:

5 + EE + 2

The display should read "5 E 2" in decimal mode.

CE

The CE (Clear Entry) key clears the most recent data entry and display along with any random cursers. For Version 7.6 software, the CE key only clears the display momentarily if DSO (Display Original) was the last function performed.

.

Using this key enters a decimal point while entering decimal values via the data entry keypad.

-

This key is used for entry of the minus sign, when entering negative decimal or exponent values via the data entry keypad.

For Version 8.2 software, pressing the blank key alters the direction of change (from increment to decrement or vise' versa) after selection of the ALT key.

NOTE: In either software version, the blank key allows acceptance of the "4B1D" password. For Version 7.6 software, "4B1D" enables the display of any parameter in EEC-IV memory. NOTE: Operator must enter a parameter address (not the parameter index)when using the "4B1D" password. That parameter is always displayed in unscaled byte mode.

For Version 8.2 software, the "4B1D" password is exactly equivalent to entering the "Full Memory Access Password." Parameters are displayed in engineering units providing SMP memory is available and it defines the parameter.

INDICATORS

The LED indicators on the Cal Console include the following:

CS

The CS (Console Select) LED shows that console RAM calibration constants are controlling engine operation. If the indicator is unlit, calibration data in ECA EPROM/MROM is selected.

PASS

Entering a valid pass word illuminates the PASS LED. It remains lit until an invalid password is entered.

DCML

The DCML (Decimal) LED, when lit, shows that the data entry/display format is set for decimal (base 10). When extinguished, the format is hexadecimal (base 16). Pressing the H/D (hex/decimal) key toggles the LED and console accordingly.

NOTE: Parameter addresses are always entered and displayed as 4-digit hexadecimal numbers regardless of the DCML indicator state for Version 8.2 software.

DAC

The DAC (Digital-to-Analog Converter) LED shows when the DAC Module is connected and its outputs are enabled. When unlit the DAC outputs are disabled. Pressing the DAC function key without specifying a DAC channel number changes the output state.

CONTROLS AND INDICATORS

PWR

When lit, this LED shows that the console has DC power applied.

ALPHANUMERIC DISPLAY

This LED panel displays addresses, data, and messages.

DAC MODULE CONTROLS

The following information details the DAC Module controls.

CHANNEL SELECT SWITCHES

Used to select the DAC channels (any two of eight) for display on the DAC Module front panel. Setting both switches to either "A" or "B" while powering the DAC Module up enables the DAC Diagnostic Routine.

DATA LOG SWITCH

Used to enable/disable the data logging function. DATA LOG indicator (in front panel display window) lites when DATA LOG switch is set to ON.

CALIBRATION SWITCH

When the DAC LED is not lit, DAC analog outputs and front panel displays are controlled by the calibration switch. These are described as follows:

Position	DAC Module Operation
FULL SCALE	Output of all channels is +10 VDC and display reads "ALL HIGH."
CENTER	Output of all channels is zero volts and displays the message "VD2B OFF" (Version 7.6) or the "V82X OFF" (Version 8.2).
ZERO SCALE	Output of all channels is 0 VDC and displays the message "ALL ZERO."

NOTE: When the DAC LED is lit, normal analog outputs and front panel display are provided regardless of the CALIBRATION switch position.

CONTROLS AND INDICATORS

FUNCTION SWITCH

Used to select DAC resolution as noted below:

Position	DAC Resolution Selected
F0	Used for 8-bit resolution
F1	Used for 10-bit resolution

DAC MODULE ALPHANUMERIC DISPLAY

Displays the digital value of engine operating parameters assigned to DAC channels selected by the CHANNEL SELECT switches. Display provides for 4-digit hexadecimal display of any two of the eight DAC channels. Also provides an LED indication of when data logging is enabled and displays messages.

Chapter 3

DOC FILES

A DOC (Documentation) File is a list of all the data values used in a particular strategy. The DOC File is divided into two major sections:

- RAM listings
- ROM listings

The RAM Listings contain values located in either system RAM or KAM (Keep Alive Memory). Values in RAM, such as the various sensor inputs, are constantly altered and updated.

The ROM Listing contains values used by the strategy to solve equations and make decisions.

There are three different types of data shown in the DOC file:

- Scalars
- Functions
- Tables

These are illustrated within this section.

DATA FORMATS

Electronic control systems require sending information through circuits. There are two basic ways to do this: ANALOG and DIGITAL. Analog controls handle information by regulating the current and voltage. Digital controls handle information by switching the current or voltage ON or OFF.

The Digital signal (yes or no, ON or OFF, B+ or 0) is capable of being directly used by the computer. The Analog signal has to be "processed" into a digital signal which can be used in digital control. The Analog-to-Digital (A/D) Converter is a circuit, contained within the CPU, which converts analog inputs to digital outputs. The A/D Converter used in the 8061 employs a 10-bit output code. This output code is called the A/D Count or "COUNTS". In Base 10, Counts are expressed in a range from 0 to 1023 (10-bits total). A typical analog sensor used in the EEC-IV system has a voltage range of 0 to 5 VDC. The output of the A/D will result in 0V being equal to 0 Counts and 5V being equal to 1023 Counts. A voltage level between 0V and 5V would result in an output between 0 and 1023 Counts.

For example, the Engine Coolant Temperature (ECT) sensor analog signal to the ECA represents the engine coolant temperature. A temperature of 71° F results in an analog signal of 3.0V. The A/D Converter will convert this into a 10-bit binary code which is stored as a 16-bit word in RAM. For an analog signal of 3.0V, the CPU will receive a signal from the A/D of 614 Counts. A signal of 1.5V would result of an A/D output of 308 Counts.

We can calculate the A/D output in Counts for any analog voltage input using this formula:

$$\text{Digital Signal (Counts)} = \frac{\text{Analog Signal (V)}}{\text{Reference Voltage (V)}} * 1023$$

where:
SIGRTN < = Analog Signal < = ReferenceVoltage

The CPU uses the resulting data from A/D conversion to generate the appropriate inputs to the logic controls.

HARDWARE CALIBRATION SWITCHES

Most strategies are designed to be compatible with many different hardware applications which may be utilized in all calibrations. Hardware complexity is taken into account via a set of user accessible software calibration switches. We refer to these switches as "HARDWARE CALIBRATION SWITCHES".

The Hardware Calibration Switches reside in ROM and are 8-bits (1 Byte) in length. They are generally set to either 0 or 1 indicating to the strategy the presence or absence of certain calibration hardware. If the ROM location is set to 1, calibration hardware is present and the logic controlling that hardware is enabled. If the location is set to 0, calibration hardware is absent and the controlling logic is disabled.

For example, if the "LU" strategy ROM location THRMHP (Thermactor Hardware Present) is equal to 1, Thermactor air pump hardware is present and the controlling logic is enabled. If THRMHP = 0, the hardware is absent, controlling logic is disabled, and the strategy will set CHKAIR = 1. CHKAIR is a bit flag which is controlled by the Thermactor logic and allows the proper function of the Closed Loop/Open Loop fuel logic.

MULTIPLE HARDWARE LOGIC

Some strategies have the ability to support more than one type of calibration hardware. For example, the "LU" strategy supports both the Pressure Feedback EGR (PFE) and Sonic EGR systems. The ROM location, PFEHP (PFE Hardware Present) indicates whether PFE, Sonic, or no EGR hardware is present. If PFEHP = 0, then a Sonic EGR system is in use and the strategy will enable the correct operating logic. If PFEHP = 1, then a PFE system is in use. If PFEHP = 2, then no EGR system is present and the strategy will disable any EGR logic.

SUB-SYSTEM LOGIC

The EEC-IV system consists of many different sub-systems controlled by a common microprocessor. The strategy needs a way of allowing the individual parts to communicate their current operating states to each other. The actions of one part may affect how other parts of the system react to certain conditions. For example, Thermactor logic controlled by the "LU" strategy cannot force the air into the "downstream" mode unless the fuel control system is in the Closed Loop mode. In order for the Thermactor logic to determine whether fuel control is in Closed or Open Loop mode, the Open Loop/Closed Loop Fuel logic indicates its current state to the Thermactor logic. There are only two states in which Fuel system control can be, Open or Closed Loop. Open Loop can be represented by the number "1", while not Open Loop, which means Closed Loop, can be represented by the number "0". This number is stored in a memory location which can be accessed by the Thermactor logic. This type of memory location is called a FLAG.

MEMORY FLAGS

A FLAG is a RAM location which indicates one of two possible operational states. Because a Flag will have a value of either 0 or 1, the Flag is a single Binary Digit or BIT. This type of Flag is called a BIT FLAG.

DATA STORAGE

Three ways of storing data are discussed in the following text. These are: a BIT, a BYTE, and a WORD.

- A BIT (Binary Digit) is the smallest possible memory location. A BIT may contain one of two numbers: 0 or 1.
- A BYTE is a sequence of adjacent binary digits operated upon as a unit - usually 8 BITs. A BYTE can contain any number from 0 to 255 (0 - FFH).
- A WORD is a sequence of adjacent binary digits operated upon as a unit - usually 16 BITs. A WORD can contain any number from 0 to 65535 (0 - FFFFH).

BIT FLAGS

A BIT Flag is always stored with other BIT Flags in a single byte location. The eight BITs stored in a Byte are numbered from right to left, 0 to 7. In order to determine the status of each BIT flag contained in a particular byte, first break the value contained in the byte into its binary equivalent. For example, the value 193, which can be stored in a byte, gives us the following binary number:

11000001

Numbering the BITs as follows causes the following value:

BIT #:	7	6	5	4	3	2	1	0
Value:	1	1	0	0	0	0	0	1

Checking the status of any BIT flag contained within that byte is now simplified. For example, the value contained in BIT Flag 6 is 1. The value in BIT Flag 3 is 0.

To simplify this conversion, a decimal-to-binary conversion table for byte values from 0 to 255 is provided in Appendix A.

Values for some parameters are displayed in "Real Unit" form. These units include: Degrees Fahrenheit (^{o}F), Inches Mercury ("Hg), milliseconds (ms), seconds, and clock ticks. Examples of parameters which are read in "Real

Unit" form include: ECT and ACT (°F), BP ("Hg), and timers (seconds).

SUMMARY

Many different display formats contained within the DOC file have been described. The Cal Console, by itself, is only capable of displaying values in unscaled byte mode. However, for ease of use by the operator, it is desirable for values to be displayed in "Engineering Units". Displaying values in Engineering Units causes the information to be more understandable. Parameter values are displayed in the same format as in the DOC file. The value is always displayed in Exponential Notation. For example, the value displayed as:

2.9875 E1

is actually:

29.875

and:

2.9875 E-1

is actually:

.29875

The "E", or exponent, indicates how many positions to shift the decimal point. A positive exponent indicates a shift to the right and a negative exponent indicates a shift to the left. An exponent of "0" indicates no shift.

SMP MEMORY

In order to allow the Cal Console to display parameter values in Engineering Units, the memory contains a software decoder called SMP (Scaling and Modifiable Parameters). If SMP memory is available and the selected parameter is defined by SMP, the data is displayed in engineering units. SMP data is stored on a pair of 2732A EPROM chips installed in either an EPROM Assembly or a Remote Box. SMP chips must be changed for each different strategy and revision level, but can be used for any calibration within that strategy.

RAM LISTINGS

The "RAM Listings" are the portion of the DOC file which describe the parameters contained in the EEC-IV RAM and KAM memory. Each description consists of 6 elements, as illustrated in callouts A-F in the figure on the following page.

A. The "Acronym" or "Label" is a cryptic descriptor which identifies the parameter.

B. The "Storage Location Size" is a single letter indicating the size of the memory location. If letter "B" appears, the parameter is stored as a byte value. If letter "W" appears, the parameter is stored as a word value.

C. "Unsigned/Signed" is a single letter which indicates whether the value at that location is unsigned (positive only) or signed (positive or negative). "U" indicates an unsigned value and "S" indicates a signed value. Unsigned values contained in a byte can have a value from 0 to 255. If contained in a word, the value can range from 0 to 65535. Signed values contained in a byte have a range from -128 to +127. If contained in a word, the value can range from -32768 to +32767.

D. The "Address" is a hexadecimal memory location of a parameter.

E. The "Binary Point" is a value used by the microprocessor for binary scaling and by the SMP memory for converting unscaled values into Engineering Units. It is not necessary for reading values or using the Cal Console.

F. The "Comments" are one line descriptions of a parameter. This description may also include the value's unit of measure (ie.: seconds, °F, etc.).

A	B (1)	C (2)	D ADDR	E BINARY POINT	F RAM LISTING COMMENTS
LTMTBL79	B	U	0453	8	
LUTIMR	B	U	00AF	3	LOCK-UP Timer
MAP	B	U	00BE	3	Manifold Absolute Pressure BIN 3
MAPBAR	B	U	0131	3	Filtered MAP used by Normal Strategy
MAPBARL	B	U	0130	0	Filtered MAP Word Value used by INFERRED BP
MAPCNT	W	U	012A	11	NUMBER OF MAP EDGES INTERPOLATED BETWEEN PIPS
MAPOPE	B	U	01F7	7	MAP / ABS Exhaust Pressure
MAPPA'	B	U	00AB	7	MAP / BP
MAPSAV	B	U	01C9	3	MAP Value saved in VIP
MAPTMR	B	U	0212	10	Manifold Pressure Update (msecs.)
MAP_FREQ	W	U	0126	8	INTEGRATED MAP FREQ. OVER PIP PERIOD
MAP_WORD	W	U	0128	8	WORD VALUE OF MANIFOLD ABS. PRES.
MDELTA	W	U	01FE	0	
MILTMR	W	U	01CE	3	MIL MULTIPURPOSE TIMER
MINTIM2	W	U	0138	0	Last MAP Transition Time
MKAY	W	U	00D0	15	DUTY CYCLE Correction Factor
MPGTMR	W	U	00DA	0	MPG Mode Timer
MPHCNT	B	U	00C1	0	Number of VSS high transitions
MULTMR	B	U	01F4	10	LAMMUL Timer
N	W	U	00B8	2	RPM BIN 2
NACTMR	W	U	00DC	3	NOT AT CLOSED THROTTLE Timer
NBAR	W	U	01BA	2	Rolling Average RPM
NDDTIM	B	U	00D9	3	NEUTRAL / DRIVE Timer
NEW_DATA	B	U	0083	0	Inputs that Changed States
NEXT_SPOUT	W	U	024A	15	BETA for Next Spout Edge

(1) B = BYTE W = WORD
(2) U = UNSIGNED S = SIGNED

FIGURE 3-1

ROM LISTINGS

The "ROM Listings" are the portion of the DOC file which describe the calibratable parameters contained in the EEC-IV ROM memory. It is divided into three parts:

- Scalar listings
- Function charts
- Look-Up Tables

These are illustrated in Fig 3-2.

SCALARS

A scalar is a single numerical value that is assigned a label. The scalars are recorded in the DOC file in much the same manner as the RAM listings. In addition to the 6 elements in the RAM listings, the scalar listings include 3 elements we have not previously discussed:

G. The "Engineering Form" is the decimal equivalent of the value contained in the storage location. When using the Cal Console in the "Decimal" mode, the value addressed by the Cal Console should match the value in the column.

H. The "Chip Form" is the hexadecimal equivalent of the value contained in the storage location. When using the Cal Console in the "Hexadecimal" mode, the value addressed by the Cal Console should match the value in the column.

I. The value contained in the "Region Level" indicates to the operator the region of the calibration in which the parameter is located. The regions are numbered from 0 to 7. If the value contained in the Region Level is -1, then the parameter is not calibratable via the Cal Console.

[ON] LULODV STEENECK-NTCA

A	B (1)	C (2)	D ADDR	E BINARY POINT	G ENGRG. FORM	H CHIP FORM (HEX)	I REG. LEV.	R O M UNITS	L I S T I N G COMMENTS (F)
MINPW	W	U	9002	18	.0005	0083	7		MINIMUM PW CLIP VALUE
NLMBSE	B	U	853F	1	4	0008	1		LAMBSE MULTIPLIER FOR DISPLAY PURPOSES
NPANIN	B	U	8FF6	7	.03	0004	7		HYSTERESIS VALUE FOR FN397
NPGCTH	B	S	8FFA	-1	230	0073	7		MAXIMUM ECT FOR NPG MODE
NPGCTL	B	S	8FFB	-1	188	005E	7		MINIMUM ECT FOR NPG MODE
NPGDEC	W	U	8472	15	.023	02F2	1		LAMBSE DECREMENT WHEN EXIT FROM NPG MODE
NPGLSW	B	U	8470	0	0	0000	1		NPG MODE CONVERTER CLUTCH DEVELOPMENT SWITCH 1 = ENABLE TRANSW LOGIC, 0 = DISABLE TRANSW LOGIC
NPGRPH	B	U	8FF9	-4	100	0006	7		Hysteresis for NPGRPM
NPGRPM	B	U	8FF8	-4	4080	00FF	7		Minimum RPM to enter NPG mode
NPGRT	W	U	8FFC	0	10	000A	7		MINIMUM NPG MODE RE-ENTRY TIME
NPMNBP	B	U	8FFE	3	22	00B0	7		MINIMUM BP TO ENABLE NPG MODE
NPNBPH	B	U	8474	3	.5	0004	1		HYSTERESIS FOR MIN BP TO ENABLE NPG MODE
NTEISF	B	U	8ED4	5	.1	0003	5		EQUILIBRIUM INTAKE SURFACE FUEL MULTIPLIER
NTXSW	B	U	85EA	0	0	0000	1		TRANSMISSION SWITCH: 0=AUTO,1=MANUAL
NULTM	B	U	8FB6	10	.1	0066	5		MINIMUM TIME INTERVAL INCREMENTING LAMMUL
NCNT	B	U	8549	0	6	0006	1		NUMBER OF CONSECUTIVE PIP SIGNALS REQUIRED TO EXI
NDDELT	B	U	8F8B	3	.25	0002	5		TIME BEFORE N/D,D/N SWITCH REGISTERS
NDIF	W	U	8F6A	2	32	0080	5		TIME DEPENDENT RPM LIMIT TO DIFFERENTIATE DECEL FROM IDLE
NDPPM	W	U	9108	11	.15	0133	7		FAN DELTA AM FOR NEUTRAL/DRIVE TRANSITIONS
NGCSNP	B	U	8EAA	0	1	0001	5		NEUTRAL GEAR/CLUTCH SWITCH "Hardware Present" in 0 = No switches present
NGOOSE	W	U	9120	-3	900	0071	7		GOOSE TEST IDLE CLISC DESIRED RPM
NLMT	W	U	847E	2	5000	4E20	1		MAXIMUM ENGINE RPM
NLMTH	W	U	8480	2	200	0320	1		HYSTERESIS FOR MAXIMUM ENGINE RPM
NRUN	W	U	9006	2	208	0340	7		MINIMUM ENGINE SPEED TO EXIT CRANK MODE

(1) B = BYTE W = WORD T = TRIPLE PRECISION Q = QUAD PRECISION L = LOGICAL
(2) U = UNSIGNED S = SIGNED

FIGURE 3-2

DOC FILES

MULTIPLE CALIBRATIONS

GENERAL DESCRIPTION

With expanded ROM and I/O capability came the opportunity to place up to eight different calibrations on one production MROM (Multi-Cal) and thereby reduce the total number of binary "blueprints" (masks) by seven. Fewer masks translates into lower tooling costs and somewhat more flexible MROM release dates. Besides these two benefits, Multi-Cal can potentially reduce obsolescence costs due to market shifts (or other changes). Rather than scrap obsolete MROMs, the factory can select an alternate calibration on the same chip.

IMPACT ON DEVELOPMENT PROCESS

The Multi-Cal concept cannot work if each calibration is unique. Under those circumstances, calibration parameters would occupy over 24K of the 32K bytes of available memory. Thus, calibrations assigned to a specific MROM must share many common parameter values.

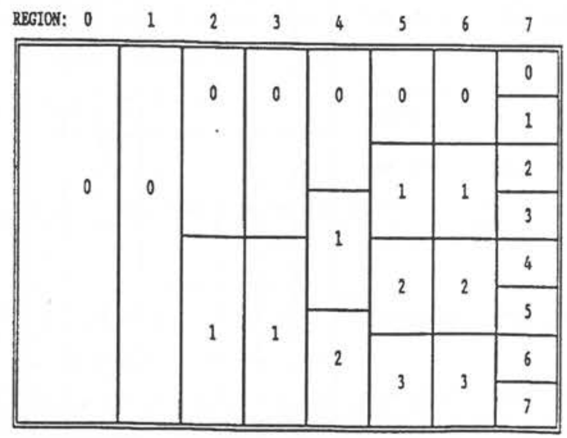
In addition to restrictions on calibration flexibility, (which is not obvious until Sign-off time), the Multi-Cal software requires use of a version 8.0 (or later) Cal Console.

HOW IT WORKS

Each calibration constant, fox function and table is allocated to one of eight regions. The region assignments are determined primarily by the number of different values a parameter is permitted, and secondarily, by the desire to keep the regions nearly equal in size.

If all calibrations share the same value for a parameter, that parameter is classified as COMMON and assigned to Region 0 or 1. If the parameter has a unique value for each calibration, it is classified UNCOMMON and assigned to Region 7 (or Region 6, if necessary). All other parameters are classified SEMI-COMMON and assigned to one of the remaining regions.

The SEMI-COMMON and UNCOMMON regions are further subdivided into "blocks"; the number of blocks is equal to the number of different values allowed in that region. As an example, a Memory map is diagramed below. The numbers refer to block numbers.



As each calibration is signed off, it is assigned a calibration number and a "pointer". The pointer selects a block from each region. The combination of blocks selected by the pointer makes the calibration unique. For example, calibration 0's pointer might contain (00000000); calibrations 1's pointer might have (00101001). In this example, calibration 1's pointer would select block 0 from Regions 0, 1, 3, 5, 6 and block 1 from Regions 2, 4, and 7. Although two parameters may have the same value of blocks, two calibrations which share a common block cannot assign different values to the parameters within the block. The earlier calibration will define the values for the parameters in the blocks it has selected.

All subsequent calibrations which select a block fixed by the earlier calibration must conform. An example using the 1986 5.0L HO MROM is shown below.

1986 5.0L HO
MULTI-CAL CALIBRATION MATRIX

CAL.	APPL.	CALIBRATION LABEL	0 C	1 C	2 SC	3 SC	4 SC	5 SC	6 UC	7 UC	REGION
0	M/C	6-22A 50S	0	0	0	0	0	0	0	0	
1	M/C	6-22A 50S R01	0	0	0	0	0	0	0	1	
2	MARK	6-22L 50S	0	0	0	0	0	1	1	2	
3	M/C	6-21A 49S	0	0	1	1	1	2	2	3	
4	M/C	6-21P CAL	0	0	1	1	1	2	2	4	
5	MUST	6-21C 49S	0	0	1	1	1	2	2	5	
6	M/C	6-21B 49S	0	0	1	1	2	3	3	6	
7	M/C	6-21B 49S R01	0	0	1	1	2	3	3	7	

REGION ASSIGNMENTS

Calibration parameters are classified into three groupings:

- COMMON - Parameters in the common group use the same calibration value in each of the eight calibrations. Examples are most VIP parameters or Sensor Transfer functions.
- SEMI-COMMON - Parameters in the semi-common group use common calibration values in some, but not all calibrations. Examples are different idle speeds between automatic transmission and manual transmission calibrations.
- UNCOMMON - Parameters in the uncommon group use unique calibration values across all eight calibrations.

At a minimum, the requestor must assign the parameter to a group. The EMR writer must define the Region assignment.

In order to save memory space, it is desirable to use as many common and as few semi-common and uncommon parameters as possible. One byte classified as uncommon will take up eight bytes in memory due to the eight unique values it can have.

Region assignments for parameters defined in the MX strategy would conform to the following guidelines (for the sake of consistency).

COMMON

REGION 0: All Common parameters EXCEPT:

- 1) Those explicitly assigned to Region 1.

REGION 1: All Common parameters used in/as:

- 1) Normalizing functions.
- 2) Injector Timing.
- 3) Inferred BP.
- 4) Idle Speed Control.
- 5) Self-Test (VIP).

SEMI-COMMON (Two Values)

REGION 2: Fuel Strategy (except Managed Fuel Air)

REGION 3: All two-valued parameters not assigned to Region 2.

SEMI-COMMON (Three Values)

REGION 4: All three-valued parameters.

SEMI-COMMON (Four Values)

REGION 5: Four-valued parameters in:

- 1) Spark Strategy.
- 2) Fuel Strategy.

REGION6: Four-valued parameters not assigned to Region 5.

UNCOMMON

REGION 7: All Unique parameters.

FUNCTIONS

A "Function" uses a single input to determine a single output. Sometimes called a "Function of X", it is labeled from FN 000 to FN 900. Functions are displayed in the DOC files as an X/Y axis line graph. The shape of the line is defined by calibratable "Breakpoints". The Cal Console allows the user to change the X and Y location of the breakpoints. By changing the locations of these breakpoints, the shape of the Function is altered. Breakpoints may be stored as word or byte values which may be signed or unsigned.

The DOC file always contains an "X/Y" chart for each Function. Some DOC files may also contain a page (Fig. 3-4) which shows the decimal and hexadecimal values and addresses for each Function. There are eight important elements of the Function chart (Fig. 3-3):

A. The "Function Number" gives us the number assigned to this particular Function.

B. The "Function Name" assigns a descriptive label to the Function.

C. The "Address" describes the starting address of the Function in hexadecimal.

D. "X-Range" and "Y-Range" indicates to the user the upper and lower value limits in Engineering Units for each respective axis of the chart.

E. The "X-Axis Label" describes the RAM parameter which is used as an input to the Function.

F. The "Y-Axis Label" identifies the output of the Function.

G. "Maximum Repetition" indicates the maximum number of breakpoints which can be defined by the calibrator.

H. Within the line graph itself, the letter "B" indicates the location of the breakpoint.

I. "Breakpoint Locators" indicate the X and Y value for each individual breakpoint.

J. The "Region Level" describes the region of the calibration in which the function is contained.

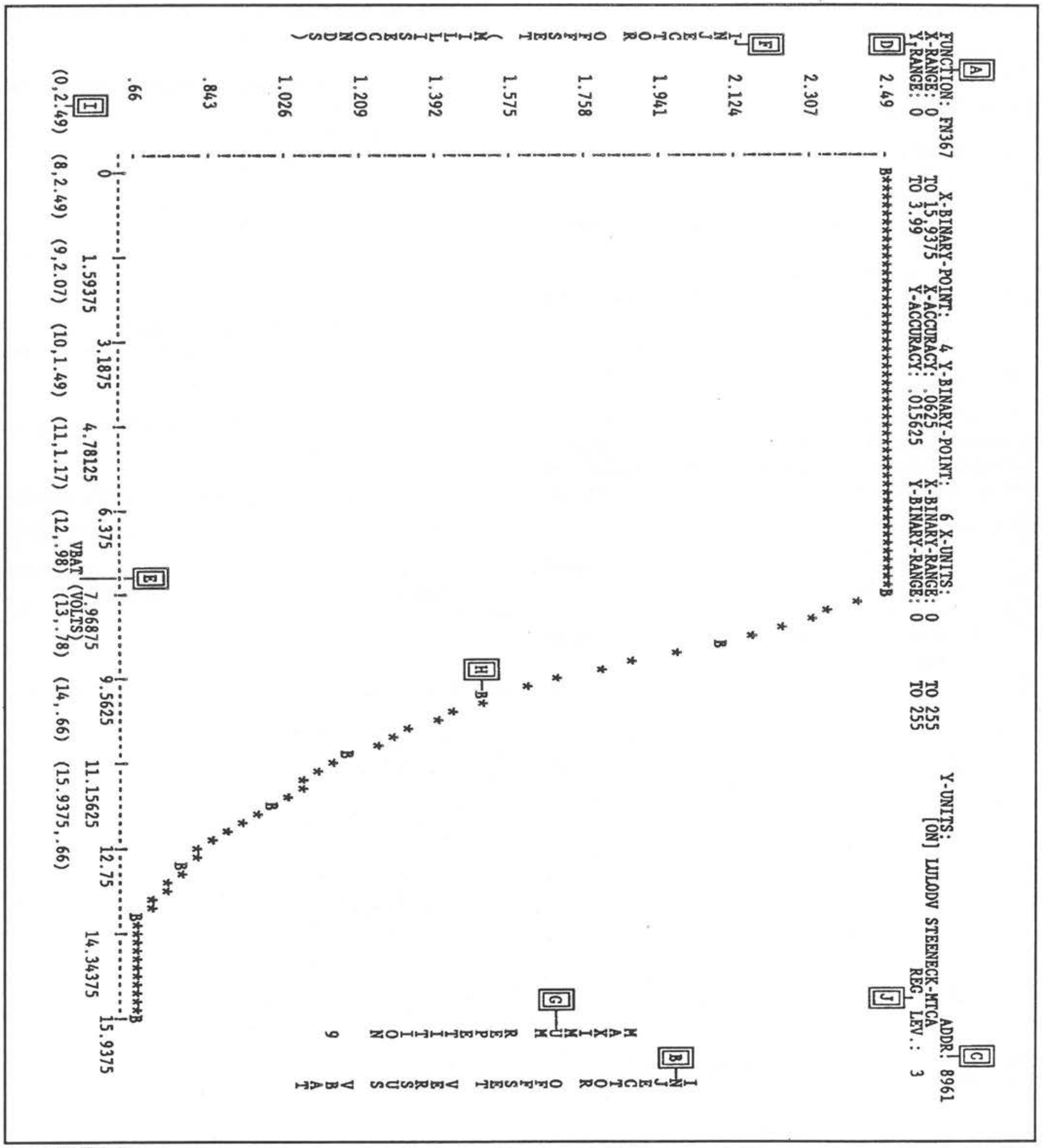

FUNCTION: FN367 X-BINARY-POINT: 4 Y-BINARY-POINT: 6 X-UNITS: Y-UNITS:
X-RANGE: 0 TO 15.9375 X-ACCURACY: .0625 X-BINARY-RANGE: 0 TO 255 [ON] LULODV STEENECK-MTCA ADDR: 8961
Y-RANGE: 0 TO 3.99 Y-ACCURACY: .015625 Y-BINARY-RANGE: 0 TO 255 REG. LEV.: 3
A
B
C
D
E
F
G
H
I
J
INJECTOR OFFSET TEST (MILLISECONDS)
2.49
2.307
2.124
1.941
1.758
1.575
1.392
1.209
1.026
.843
.66
0
1.59375
3.1875
4.78125
6.375
7.96875
9.5625
11.15625
12.75
14.34375
15.9375
VBAT (VOLTS)
MAXIMUM REPETITION
9
INJECTOR OFFSET VERSUS VBAT
(0,2.49) (8,2.49) (9,2.07) (10,1.49) (11,1.17) (12,.98) (13,.78) (14,.66) (15.9375,.66)

FIGURE 3-3

Chart Usage

To use the chart, the user locates the correct input value on the X-axis, moves vertical until the line graph is intersected, and then moves horizontally and reads the Y-axis output.

If a second page is defined in the DOC file for Functions, (Fig. 3-4), the user will have access to the address of each X and Y value used in the breakpoints.

Callouts A, C, J, and I are carryovers from the previous page. K indicates the actual address listing.

```
[A]                                                                                           [C]
FUNCTION: FN367   X-BINARY-POINT:   4 Y-BINARY-POINT:   6 X-UNITS:               Y-UNITS:          ADDR: 8961
X-RANGE: 0        TO 15.9375   X-ACCURACY: .0625      X-BINARY-RANGE: 0    TO 255        [ON] LULODV STEENECK-MTCA
Y-RANGE: 0        TO 3.99      Y-ACCURACY: .015625    Y-BINARY-RANGE: 0    TO 255             REG. LEV.:  3
                                                                                               [J]
                                                          (HEX. ADDRESS)
          X-VALUE        Y-VALUE               X-VALUE                 Y-VALUE
          ..........     ..........            ................        ................
          0              2.49                  0         (896F)        2.484375   (8970)

          8              2.49                  8         (896D)        2.484375   (896E)

          9              2.07                  9         (896B)        2.0625     (896C)-[K]

          10             1.49                  10        (8969)        1.484375   (896A)

          11             1.17                  11        (8967)        1.171875   (8968)

          Pair has been eliminated

          13             .78                   13        (8965)        .78125     (8966)

          14             .66                   14        (8963)        .65625     (8964)

          15.9375        .66                   15.9375   (8961)        .65625     (8962)
                  [I]
```

FIGURE 3-4

LOOK-UP TABLES

A "Look-Up Table"(Fig 3-5) enables the microprocessor to generate a single output based on two inputs. The Look-up Table contains a series of "cells" or memory locations which are graphically represented as an "X,Y" axis chart with each axis containing a set number of cells. To use the table, the user finds the column for the X value and follows it vertically until it intersects with the row containing the Y value. The resulting value is then used by strategy to solve an equation.

The total number of cells and their arrangement will be different for each table within the strategy. However, the table "format" will not change from calibration to calibration. The size of the matrix will cover all expected engine operating points for the particular function for which it is designed. The different features of the tables are described as follows:

A. The tables are labeled from FN1000 to FN3000.

B. Value in Engineering Units for the cell.

C. Hexadecimal address for the cell.

D. The "Name" and "Purpose" describe the function of the table.

E. "X Input" and "Y Input" describe the input parameters to the table.

F. "Output" describes the final output.

G. The "Region" indicates the region of the calibration in which the table is located.

A

TABLE: FN1121 Z-BINARY-POINT: 6 Z-UNITS [ON] LULODV STEENECK-MTCA
Z-RANGE: 0 TO 3.98 ACCURACY: .0156 Z-BINARY-RANGE: 0 TO 255 REGION: 4

G

NORMALIZED MAP - FN071	0	1	2	3	4	5	6	7	8	9
7	0	0	0	0	0	0	0	0	0	0
	8CCC	8CCD	8CCE	8CCF	8CD0	8CD1	8CD2	8CD3	8CD4	8CD5
6	0	1.17	.86	.86	.53	0	0	0	0	0
	8CC2	8CC3	8CC4	8CC5	8CC6	8CC7	8CC8	8CC9	8CCA	8CCB
5	0	1.15	.78	.36	.47	0	0	0	0	0 (B)
	8CB8	8CB9	8CBA	8CBB	8CBC	8CBD	8CBE	8CBF	8CC0	8CC1 (C)
4	0	.86	.47	.55	.54	.18	0	0	0	0
	8CAE	8CAF	8CB0	8CB1	8CB2	8CB3	8CB4	8CB5	8CB6	8CB7
3	0	.97	.43	.67	.51	.33	0	0	0	0
	8CA4	8CA5	8CA6	8CA7	8CA8	8CA9	8CAA	8CAB	8CAC	8CAD
2	0	0	.61	.57	.3	.24	0	.46	.49	0
	8C9A	8C9B	8C9C	8C9D	8C9E	8C9F	8CA0	8CA1	8CA2	8CA3
1	0	0	0	0	0	0	0	0	0	0
	8C90	8C91	8C92	8C93	8C94	8C95	8C96	8C97	8C98	8C99
0	0	0	0	0	0	0	0	0	0	0
	8C86	8C87	8C88	8C89	8C8A	8C8B	8C8C	8C8D	8C8E	8C8F

NORMALIZED RPM - FN070

D — NAME: SPARK ADVANCE ADDER FOR EGR AS A FUNCTION OF RPM AND MAP
PURPOSE:
E — X INPUT: NORMALIZED RPM - FN070
Y INPUT: NORMALIZED MAP - FN071
F — OUTPUT: SPARK ADVANCE ADDER FOR EGR, DEG PER 1 PERCENT EGR

FIGURE 3-5

Chapter 4

EQUIPMENT PREPARATION AND SET-UP

EEC-IV engine calibration development and testing is done in both the laboratory and vehicle operating environment. The test set-up in each case is similar except for the following:

1. For in-vehicle operations, the EEC-IV Development Module connects to the vehicle engine harness connector. Cal Console input power can be supplied by the vehicle battery.
2. For laboratory operations, the Development Module is generally connected to a Static Engine Simulator. The simulator provides the input power for the Development Module.

NOTE: If a Static Engine Simulator or vehicle is not used, input power and ground must be supplied by an external power source via the Development Module engine harness connector.

CAL CONSOLE PREPARATION

There are no special requirements for preparation of the Cal Console other than to check the internal "data save" battery voltage to ensure console RAM data retention after shut-down. If the battery voltage level is not to specification, charge the battery for 24 hours before operation.

A BATTERY TEST jack at the rear of the console allows for battery voltage measurement. The battery voltage is nominally 6.3 +/- 0.5 VDC. For proper operation, this voltage must be greater than 4 VDC.

The console battery recharges whenever power is applied to the console POWER connector. This voltage must be at least 8 volts for proper battery charging.

DEVELOPMENT MODULE PREPARATION

To install baseline engine strategy (contained on custom EPROMs) in the Development Module, do the following:

1. Remove the access cover on the EEC-IV Development Module.
2. Remove the custom EPROMs that may be installed in theEEC-IV Development Module and install the custom EPROMs containing the development/test baseline engine control strategy.
3. Reinstall the access cover on the EEC-IV Development Module.

SECOND GENERATION EPROM ASSEMBLY PREPARATION

Using an EPROM Assembly for EEC-IV calibration development/test set-up, it may be necessary to perform the following procedures before using the EPROM Assembly in your test set-up.

The following procedures provide instructions for:

- Installation of EPROM chips containing the baseline engine control strategy and SMP memory chips.
- Setting the default calibration number used when operating with multicalibration strategy memories.
- Reconfiguration of 2nd Generation EPROM Assemblies for compatibility with either a 1st generation or a 2nd generation EEC-IV Development Module memory system.

1. ACCESSING THE EPROM CHIPS AND MULTI-CALIBRATION SELECT SWITCHES

   A. Position EPROM Assembly so that the EPROM access door is facing up.

   B. Loosen the thumbscrew securing the EPROM access cover and slide the cover off to gain access to the EPROM sockets and multicalibration selector switches.

2. INSTALLING EPROMS CONTAINING ENGINE STRATEGY AND SMP DATA

   A. Turn locking screws on all EPROM sockets to their counterclockwise (unlocked) positions.

   B. If EPROM chips are being used, remove these chips.

NOTE: The baseline engine strategy is stored in either 2732A (4K byte) or 2764 (8K byte) standard EPROM chips. Only use 2764 EPROMs if the EPROM Assembly is equipped with special order 28-pin socket. Mark each EPROM chip to identify the address range and odd or even contents. Install these in the proper location as shown by the markings.

C. Install each memory chip in the proper socket according to the address range and the odd or even byte address markings on the engine strategy EPROM chips.

NOTE: Install SMP data memory in either the EPROM Assembly or the SMP Remote Box. Omit Step D if using SMP memory chips in the SMP Remote Box.

D. Install SMP Data Memory chips in the EPROM Assembly in the unused sockets next to the engine strategy EPROMs with the highest address. Observe the odd and even address markings while installing the memory chips.

E. Secure the EPROM chips into their sockets by turning the lock screw clockwise.

F. Install the appropriate memory configuration jumper pack in the EPROM Assembly.

CAUTION:1st and 2nd Generation EPROM Assemblies use a specially designed memory configuration jumper pack. These are not interchangeable. Be sure to install the correct jumper pack as described in step F.

NOTE: Earlier versions of the memory configuration jumper packs used in 2nd Generation EPROM Assemblies are 18-pin printed circuit type. These jumper packs are marked for use with either "2732A" or "2764" EPROM chips. A black 16-pin jumper pack that is marked "2732" is also available if "2732A" EPROM chips are used with the 2nd Generation EPROM Assembly. Install this jumper pack so that pins 1 and 18 of the socket are not used.

CAUTION: Do not use the orange "2732A" jumper packs designed for 1st generation EPROM Assemblies.

3. SETTING THE MULTICALIBRATION DEFAULT CALIBRATION SELECTOR SWITCHES

The 2nd Generation EPROM Assembly contains DIP switches which enable selection of a default calibration that are used when operating with multicalibration engine strategies. To select the default calibration, set the DIP switches to the desired default calibration as specified in figure 4-1. Although the 5-position DIP switch enables selection of up to 32 different calibrations, current engine strategy designs limit selection to one of eight different calibrations.

Default Calibration	1	2	3	4	5
Calibration 0	X	OPEN	X	OPEN	OPEN
Calibration 1	X	CLOSE	X	OPEN	OPEN
Calibration 2	X	OPEN	X	CLOSE	OPEN
Calibration 3	X	CLOSE	X	CLOSE	OPEN
Calibration 4	X	OPEN	X	OPEN	CLOSE
Calibration 5	X	CLOSE	X	OPEN	CLOSE
Calibration 6	X	OPEN	X	CLOSE	CLOSE
Calibration 7	X	CLOSE	X	CLOSE	CLOSE

Fig. 4-1

4. EPROM ASSEMBLY RECONFIGURATION FOR EEC-IV COMPATIBILITY

NOTE: Second generation EPROM Assemblies are configured for compatibility with EEC-IV Development Modules requiring either first or second generation memories. If the EPROM Assembly is not configured for compatibility with the memory system required in the Development Module used, do the following operations:

A. Remove the entire top cover from the EPROM Assembly by removing the two top screws on the end of the EPROM Assembly and slide the entire top cover off the assembly.

B. Locate the memory compatibility configuration strapping socket. Place the memory configuration shunt pack into the socket positions which correspond to the type of memory used in the Development Module as displayed in Figure 4-2.

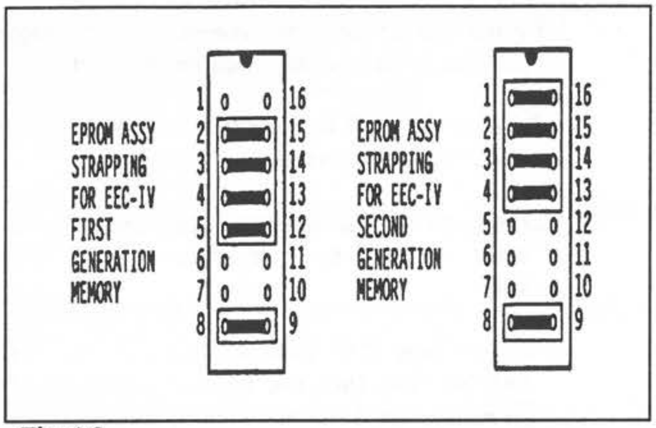


Fig. 4-2

NOTE: The EPROM Assembly is normally shipped with the memory configuration shunt pack installed for compatibility with EEC-IV 2nd Generation memory.

CAUTION:The illustrated shunt strap installed between pins 8 and 9 prevents disabling the EPROM Assembly RAM during cold weather starts when the VBATT input to the EPROM Assembly drops to 6 VDC. The shunt indicates to the EPROM Assembly that a custom RAM-I/O chip is installed in the EEC-IV Processor Module, when it isn't.

CAUTION: To prevent damage to the EEC-IV Development Module chips, remove the shunt strap if custom RAM-I/O chips are installed.

5. REASSEMBLY OF THE EPROM ASSEMBLY

   A. Reinstall the top cover and secure with the two screws removed in step 4A.

   B. Reinstall the EPROM access cover and tighten the thumbscrew.

SMP REMOTE BOX PREPARATION

When using a Remote Box other than an SMP Remote Box, no prior preparation is required for hook-up of the unit into the development test system. When using an SMP Remote Box without an EPROM assembly, install SMP memory chips in the Remote Box. When using an SMP Remote Box with an EPROM assembly, install SMP memory chips in either the SMP Remote Box or the EPROM Assembly. In any case, the SMP Address Selector Switch must be set to the proper position as determined by the location of SMP memory in EEC-IV memory space and must be set to the "EPR" position if SMP memory is installed in the EPROM Assembly.

NOTE: These procedures are listed under the headings "SMP Remote Box Preparation For Use Without EPROM Assembly" and "SMP Remote Box Preparation For Use With EPROM Assemblies." Be sure to follow the correct instructions.

SMP REMOTE BOX PREPARATION FOR USE WITHOUT EPROM ASSEMBLY

When connecting the SMP Remote Box directly to the EEC-IV Development Module, prepare the SMP Remote Box as described below:

1. Position the SMP Remote Box so that the access cover is facing upward.

2. Loosen the two thumbscrews securing the access cover and remove the cover.

3. Turn the locking screws on the EPROM sockets counterclockwise 1/4 turn to unlock the chips. If SMP memory chips were installed, remove them.

4. Install the new SMP memory chips (these must be 2732A EPROMs) in the proper sockets as shown by the odd/even address markings on the chips. The circuit board indicates the even address socket.

5. Turn the locking screw on each of the EPROM sockets 1/4 turn clockwise to lock the EPROM chips in the socket.

6. Verify the size of strategy memory contained in the EEC-IV Development Module (Fig. 4-3) and set the memory size selector switch to the position that matches the size of memory in the Development Module (either 8k, 16k, or 32k). This locates SMP memory at the appropriate address location at the end of strategy memory (memory locations 4000H, 6000H, or A000H, respective-

ly). If SMP memory is not used, set the memory size selector switch to "EPR".

7. Replace the access cover and tighten the thumbscrews.

8. Remove the connector assembly from its storage position on the module clamping bracket by loosening the two screws securing it to the bracket.

9. Loosen the three module clamping bracket thumbscrews, raise the bracket fully, and lightly tighten the thumbscrews.

10. Insert the black (keyed) connector of the connector assembly into the Remote Box and alternately tighten both screws on the connector assembly until the connector is fully seated. The SMP Remote Box is now ready to accept the EEC-IV Development Module.

CHIP NUMBER	MEMORY VALUE (K BYTES)
2716	2 (16 KBits/8)
2732	4 (32 KBits/8)
2732A	4 (32 KBits/8)
8762	16
8762A	16
8763 (7700020)	32

Fig. 4-3

SMP REMOTE BOX PREPARATION FOR USE WITH EPROM ASSEMBLY

To connect the SMP Remote Box to the EEC-IV Development Module via an EPROM Assembly, prepare the SMP Remote Box as follows:

1. Ensure that the connector assembly is in its storage position on the module clamping bracket.

2. Position the SMP Remote Box so that the access cover is facing upward.

3. Loosen the two thumbscrews which secure the access cover and remove the access cover from the unit.

4. If installing SMP memory chips in the SMP Remote Box, turn the locking screws on the EPROM sockets to their counterclockwise position. If SMP memory chips are already installed, remove them.

5. Install the new SMP memory chips (2732A EPROMs only) in the proper sockets as determined by the odd and even byte address markings. The even byte address socket is marked on the circuit board next to the socket.

6. Turn the EPROM socket locking screw 1/4 clockwise to lock the EPROM chips.

7. If SMP memory chips are installed in the SMP Remote Box, verify the size of engine strategy memory contained in the EPROM Assembly. Then, set the SMP memory size selector switch in the SMP Remote Box to the position that corresponds accordingly (either 8k, 16k, or 32k). This places the SMP memory at the appropriate address location at the end of strategy memory (memory locations 4000H, 6000H, or A000H, respectively).

8. If installing SMP memory chips in the EPROM Assembly, set the SMP selector switch to the "EPR" position.

9. Replace the access cover and tighten the two thumbscrews.

EQUIPMENT PREPARATION AND SET-UP

CAL CONSOLE TO DEVELOPMENT MODULE INTERFACE

A Remote Box is supplied with the Calibration Console for interface to the EEC-IV Development Module. This allows location of the console up to four feet away from the Development Module. If the console is equipped with an SMP Remote Box and the EEC strategy is contained in the installed custom EPROM, connect the Remote Box directly to the Development Module. Otherwise, connect the Remote Box to the Development Module via an EPROM Assembly containing the SMP memory. The following procedures describe how to connect the Cal Console to the Development Module either directly or via a second generation EPROM Assembly.

NOTE: Two methods detail interface. These are "Console/Module Interface Via SMP Remote Box" and "Console/Module Interface using 2nd Generation EPROM Assembly." Be sure to use the correct procedures.

CONSOLE/MODULE INTERFACE VIA SMP REMOTE BOX

To interface the Cal Console to the EEC-IV Development Module using the SMP Remote Box for direct connection to the Development Module, proceed as follows:

1. Loosen the three module clamping bracket thumbscrews, raise the bracket fully, and lightly tighten the thumbscrews.

2. Gain access to edgecard connector (J3) on the EEC-IV Development Module and insert the Development Module edgecard connector into the gray connector on the Remote Box connector assembly until fully seated.

3. Loosen the three module clamping bracket thumbscrews. Compress the bracket so that the rubber strips contact the module, then secure the thumbscrews.

4. Connect the cables on the Remote Box to REMOTE IN and REMOTE OUT connectors of the Calibration Console.

NOTE: The cables are marked on the ends. They are easily connected wrong. Be sure to verify proper connection before powering the console.

CONSOLE/MODULE INTERFACE VIA 2ND GENERATION EPROM ASSEMBLY

To interface the Calibration Console to the EEC-IV Development Module via a 2nd Generation EPROM Assembly, proceed as follows:

1. Do the following operations to connect the 2nd Generation EPROM Assembly to the EEC-IV Development Module:

   A. Position EPROM Assembly with the module clamping bracket facing upward.

   B. Loosen the four module clamping bracket thumbscrews and raise the bracket so that it is level with the housing.

   C. Insert the J3 edgecard connector (rear of EEC-IV Development Module) into the floating connector of the EPROM Assembly. Be sure it is fully seated.

   D. Lower the module holding bracket so that slot edge of bracket fits into the corporate connector slot.

NOTE: Motorola modules are slightly longer than EED modules. Loosen the two connector adjustment screws to slide the bracket toward the motherboard and then retightened.

   E. Compress the module bracket so that the rubber strips contact the module firmly. Securely tighten the thumbscrews.

2. Do the following operations to connect the Remote Box to the EPROM Assembly:

   A. Loosen the two thumbscrews used to secure the Remote Box to the EPROM Assembly.

B. Align and seat the "D" connectors of the Remote Box and EPROM Assembly. Tighten thumbscrews on EPROM Assembly until secure.

3. Connect the two Remote Box cables to the Calibration Console. These cables are marked REMOTE IN and REMOTE OUT.

NOTE: Remote Box cables can be attached incorrectly to the Calibration Console.

DAC MODULE TO CALIBRATION CONSOLE CONNECTION

The DAC Module is equipped with a shielded ribbon cable used to interface the DAC Module and Calibration Console. Connect this cable between the DAC Module's PERIPHERAL PORT IN connector and the Calibration Console's unlabelled "D" type connector (located below the blower fan on the side of the Cal Console). Secure both ends with the screws and washers supplied with DAC interface cable. Alternately tighten the two screws on each end until the connectors are seated.

CONSOLE POWER INPUT CONNECTION

Input power for operation of the Calibration Console and DAC Module (if used) is obtained from either the vehicle battery or separate power supply. Use only the power cable supplied with the Calibration Console. Do not use power cables from other types of equipment that look the same. The input power source must be between 11 and 17 VDC at 3.5 to 4.0 amperes.

SYSTEM GROUND CONNECTIONS

For in-vehicle test operations, connect a braided ground strap from the vehicle chassis to the wing nut located on either the EPROM Assembly or the Remote Box.

Chapter 5

CAL CONSOLE OPERATION

The Calibration Console provides a means for test and development of EEC-IV engine calibration data. Baseline calibration data contained in the EPROM/MROM originates from analytical studies and test operations conducted earlier in the EEC-IV electronic engine control strategy development phase.

CONSOLE INITIALIZATION

Applying power to the console initially enables you to display the contents of:

- EEC-IV CPU registers
- EEC-IV RAM locations
- Stored engine calibration constants in EPROM/MROM and console RAM

NOTE: Console RAM calibration constants remain valid if the RAM was previously initialized (EPROM/MROM constants were copied) and the internal console battery maintained the RAM memory.

Console Password

To initialization console RAM and alter parameters, the operator must first enter a password. Entering a normal calibration password and pressing the PAS function key lights the PASS indicator and allows you to alter EEC-IV RAM contents and calibration constants contained in console RAM. Entering a full memory access password allows you to display any portion of the 8061 microprocessor memory space and to alter the contents of any read/write memory address location.

To initialize a console using Version 7.6 software (first generation EEC-IV strategy) press the INT (initialization) key after entering a valid password. For consoles using Version 8.2 software (second generation EEC-IV multi-cal strategy) you can load selective console RAM regions of the EEC-IV calibration. If you do not specify a calibration number the current default calibration is loaded into console RAM. If you do not specify any regions, the console attempts to copy all regions which results in RAM overflow.

NOTE: The regions loaded before the overflow are usabled but may not be desired. Research the regions to load before using the console. This is necessary because other regions cannot be loaded without losing all current console changes.

PARAMETER IDENTIFIER

To display a parameter value, key in the parameter identifier.

- For Version 8.2 software, this identifier is the parameter hexadecimal address. It is always entered and displayed in hexadecimal, regardless of the front panel DCML (Decimal) switch and indicator state.
- For Version 7.6 software, use the parameter index numbers as identifiers instead of the parameter address. The display shows either decimal or hexadecimal, depending on the DCML switch and indicator state. You can change the console display by momentarily pressing the H/D (Hexadecimal/Decimal) key. This key also changes the DCML indicator.

After entering the parameter identifier, press the DSO (Display Original) or DSA (Display Alterable) function key to display the value of that parameter. Use either key except when the specified parameter is that of a calibration constant that resides in both EPROM/MROM and console RAM. The DSO key displays the value of the parameter in EPROM/MROM while the DSA key displays the value of the same parameter in console RAM. The DSO key provides for uninterrupted sample and display of the parameter value while the DSA key samples the parameter once and displays the value.

PARAMETER VALUE DISPLAY

Parameter values are displayed on the console front panel in either decimal or hexadecimal format as determined by the current state of the DCML indicator. When SMP memory defines the selected parameter, the data displays in engineering units. Otherwise, the display is in unscaled byte mode.

To change alterable parameters within version 8.2, first display the parameter using the DSA key. Then enter the new value for the parameter and finally press the ALT (alter) function key. Version 7.6 software provides a rapid table alter feature which enables convenient change of sequential memory locations providing the contents contain identical values. After altering the first of a sequential string of memory locations in the normal manner, pressing the NXT (Next) or LST (Last) key displays the current contents of the next higher or next lower memory address. Then simply press the ALT key to enter the same value from the previously altered memory location.

You may change an alterable parameter for Version 8.2 consoles in one of three ways:

- Instantaneous change by direct entry of the desired value.
- Incrementing or decrementing the parameter value one unit at a time with the ALT key.
- Continuous incrementing or decrementing (slewing) of the parameter value one unit at a time until the desired parameter value or the desired engine operation is achieved.

NOTE: After obtaining the best engine performance, the console RAM should contain the desired calibration values.

COMPARE ROUTINE EXECUTION

To determine altered calibration parameters in console RAM, the console software includes a compare routine. The compare routine does a byte-by-byte comparison of parameter values in console RAM to corresponding parameter values in EPROM/MROM.

To start the compare routine, press the CMP (Compare) key. Detection of a difference causes the parameter identifier and values from both EPROM/MROM and console RAM to display on the console front panel. To resume the compare routine, press the NXT (Next) key. This finds the next difference. To abort the compare routine, press the CMP key while a difference is displayed. The message "Compare Aborted" is then displayed. Display of "Compare Complete" occurs after all parameters are compared.

NOTE: Version 8.2 software requires that you specify a reference calibration by entering its number before pressing the CMP key. Also, suspension of all processing and data logging occurs when the console is executing the compare routine.

For version 8.2 software, the compare routine executes twice. The first compare completes without interruption. These results are sent to the data logger (if attached). The second comparison displays as described earlier.

DIGITAL DATA SIGNAL OUTPUT

The Calibration Console also provides for the output of digital data signals representing selected engine operating parameters (e.g. engine coolant temperature, manifold absolute pressure, air charge temperature, etc.) to the DAC Module. Up to eight channels of engine operating parameter data can be applied to the DAC Module, converted to equivalent analog levels and then sent out to an external strip chart recorder or other type of monitoring device. Two of these parameters can be displayed via the DAC Module front panel display in digital format. Two rotary knobs control these selected parameters.

DEFAULT PARAMETERS

Initializing the Cal Console causes default SMP memory DAC channel control parameters load into console RAM. For Version 7.6 software, the DAC channel control parameters consist of the DAC channel parameter identifier and the parameter scaling factor. For Version 8.2 software, the DAC channel control parameters include the:

- Monitored engine parameter identifier (address)
- Channel offset
- Zero reference position
- Shift count value of single bit to be processed as applicable to each channel

You can change the default control parameters via the Cal Console front panel. This allows selection of a different engine operating parameter or different channel data processing parameters. After console shutdown, the altered channel operating parameters are retained in console RAM for 24 hours.

DAC MODULE OPERATION

The following describes the functions of the DAC Module:

- 8-bit or 10-bit digital-to-analog signal conversions
- Selective real-time digital display of any two data channels via a front panel LED display
- Full-scale and zero-scale analog voltage outputs for calibration of external recording equipment
- ASCII-encoded digital data outputs to an external data logging device for each of the DAC channels

VERSION 8.2 SOFTWARE OPERATING INSTRUCTIONS

Preliminary Operating Procedures

Perform the following preliminary operations before operating the Cal Console and DAC Module.

1. Verify installation of memory chips with the baseline engine control strategy that is to undergo development or testing. Install these in the EEC-IV Development Module or the EPROM Assembly.
2. Verify that SMP memory chips containing the correct code are installed for the engine undergoing test. Install the SMP chips in either the EPROM assembly or the SMP Remote Box.
3. Obtain a DOC File (documentation file) for the engine control strategy undergoing development.
4. Using Figure 5-1, set the Cal Console and DAC Module front panel switches accordingly:

OPERATING CONTROLS	LOCATION	SWITCH POSITION
POWER ON/OFF Switch	Console	OFF Position
CS/NORM Switch	Console	CS or NORM Position (If Cal Console RAM contents are needed for the operations, set the CS/NORM switch to the CS position. If you require Console RAM initialization, set the CS/NORM switch to NORM.)
CHANNEL SELECT Switches	DAC	Any Position except "AA" or "BB"
FUNCTION Switch	DAC	FO or F1 as required
DATA LOG Switch	DAC	OFF
CALIBRATION Switch	DAC	Center (Normal Position)

Figure 5-1

CAL CONSOLE OPERATION

CONSOLE POWER-UP

The following describes Calibration Console power-up:

- Turn the vehicle ignition switch to the "on" position or apply power to the external power source (laboratory bench testing).

- Set the console POWER ON-OFF switch to the ON position. The following indicators should light:

  - Console PWR
  - DCML
  - DAC (with DAC Module connected)

The display should read:

CAL CON V8.2.X

SELECTING DATA ENTRY/DISPLAY MODE

You can display data (not addresses) in either decimal or hexadecimal format. Selection of the decimal format turns the DCML LED ON while hexadecimal format selection turns the LED OFF. Pressing the H/D (hexadecimal/decimal) function key changes the format.

NOTE: Entry and display of memory addresses is always in hexadecimal format regardless of the state of the DCML indicator.

ENTERING MEMORY ADDRESSES

To enter a memory address, enter the hexadecimal address (ignore leading zeros) using the alpha-numeric keypad and press the appropriate function key (DSO for EEC-IV memory contents or DSA for console RAM locations). Ignore the DCML indicator state for address entries.

ENTERING DATA VALUES

The following explains the procedures to enter data:

- Select the decimal or hexadecimal operating mode

- Enter the numeric value with the alpha-numeric keypad

- Press the appropriate function key to initiate actual data entry (e.g. DAC for entering DAC channel numbers).

NOTE: Enter decimal data with the function keypad using the minus sign, decimal point and power exponent designator (function key labeled "EE")

CLEARING DATA ENTRIES

To clear incorrect data entry, press the CE (Clear Entry) key.

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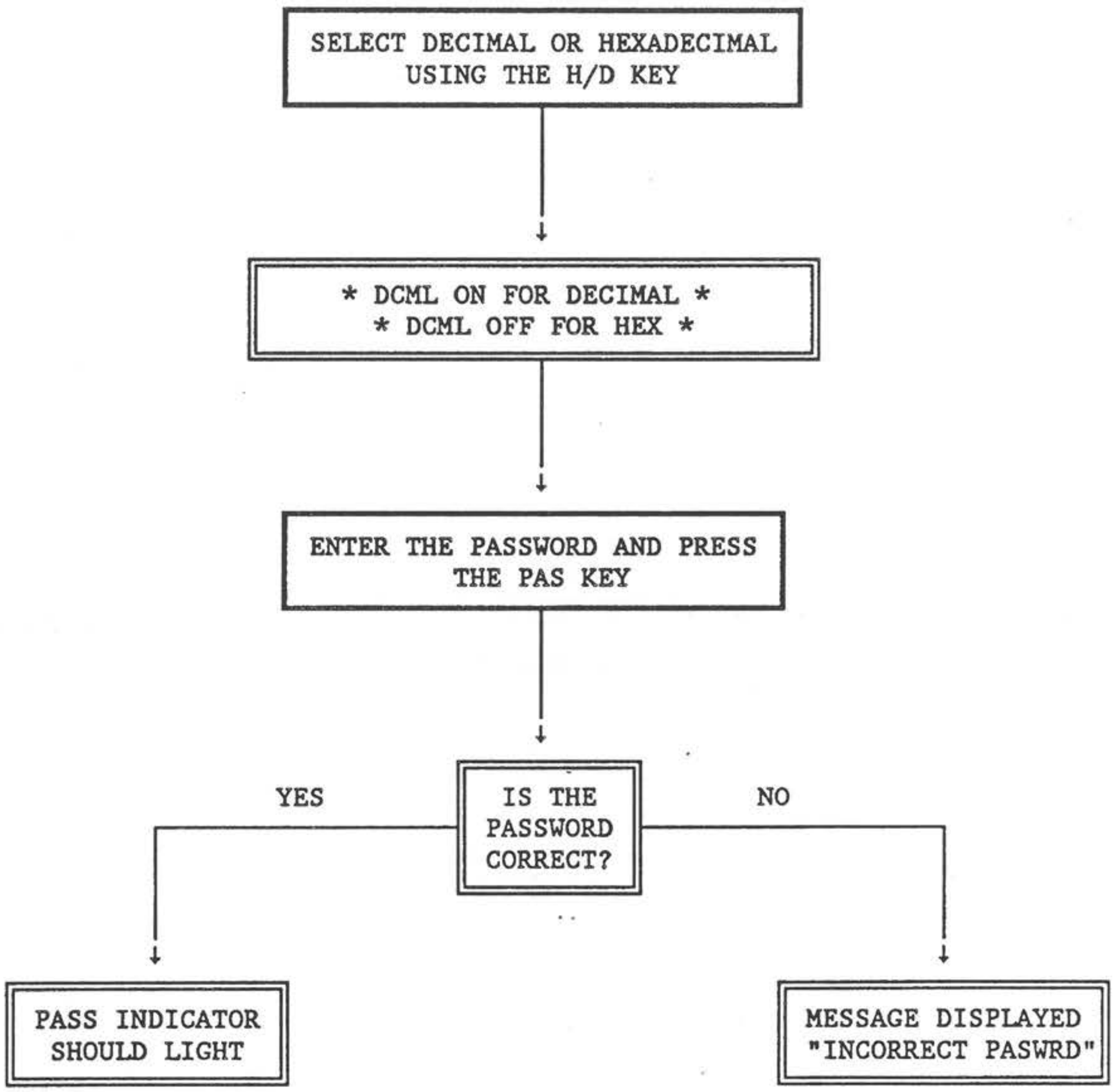
PASSWORD ENTRY FLOW CHART



NOTE: The bolded single line box shows information <u>you</u> enter.

Figure 5-2

ENTERING A PASSWORD

Entering a valid password (Figure 5-2) enables the initialization of console RAM and defines the range of addresses you can display and alter. Version 8.2 software allows two levels of access to EEC-IV memory space. SMP memory data controls the two levels.

The "Normal Calibration Password" allows you to access:

- EEC-IV CPU registers
- EEC-IV RAM
- Calibration parameters in both EEC-IV program memory and console RAM.

NOTE: You may only alter the contents of EEC-IV RAM and calibration constants in console RAM with the Normal Access Password.

The "Full Memory Access Password" allows access to all EEC-IV memory space and altering of all read/write devices.

If the "Normal Calibration Password" in SMP memory is 200H, you are automatically allowed "Normal Calibration Password" rights immediately upon power-up of the console. If set to FFH, you are automatically allowed "Full Memory Access Password" rights. Codes 00H and FFH are not allowed as values for the "Full Memory Access Password". If the two passwords are identical, the "Full Memory Access Password" is ignored.

Without SMP data <u>and</u> Version 8.2 software, Full Memory Access rights are granted when the console powers-up.

To enter the password, proceed as follows:

STEP	PROCEDURE	RESULTS
1.	Enter the appropriate password code and press the PAS function key. **NOTE:** Press blank key instead of PAS if "4B1D" password is used.	PASS indicator lights and display should blank. If invalid code was entered, the following error message displays: INCORRECT PASWRD
2.	If you do not intend to initialize console RAM, press the DSO or DSA function key.	Ignore the display. This step is a precaution against the inadvertent re-initialization of console RAM.

DETERMINING CURRENT CALIBRATION DATA

FLOW CHART

PRESS DSO OR DSA KEY

↓

IGNORE THE CONSOLE DISPLAY

↓

PRESS THE INT KEY

↓

THE FOLLOWING DISPLAYS:

C *R1 R2 . . . Rn

WHERE:

C	IS THE CALIBRATION NUMBER
R1 R2...	ARE REGIONS CURRENTLY RESIDING IN CONSOLE RAM

NOTE: The bolded single line box shows information you enter.

Figure 5-3

CAL CONSOLE OPERATION

DETERMINING CURRENT CONSOLE RAM CALIBRATION DATA

To determine the specific calibration and regions that are stored in console RAM, use Figure 5-3 and proceed as follows:

CAUTION: Be sure to do Step 1 before proceeding to step 2. Failure to do so will result in an unintended initialization of console RAM. This re-initialization result in loss of all calibration data currently contained in the console RAM.

STEP	PROCEDURE	RESULTS
1.	As a precaution against inadvertent initialization of console RAM, momentarily press the DSO or DSA function keys.	None, ignore console display
2.	Press the INT key	The calibration data currently in console RAM displays as shown: C *R1 R2 . . . Rn Where: "C" is the calibration number, and R1, R2 are the regions of that calibration which are in Console RAM. **NOTE:** The calibration number "C" may be any number from 0 to 7. Up to eight region numbers in the range of 0 to 7 can be displayed.

INITIALIZING CONSOLE RAM FLOW CHART

CAUTION

This procedure results in loss of <u>all</u> altered calibration constants and DAC channel control parameters that are now in console RAM. Be sure that the contents <u>are not needed</u> before re-initializing console RAM.

ENTER THE PASSWORD

↓

PASS LIGHT IS ON

↓

ENTER ENGINE CALIBRATION NUMBER AND PRESS CS KEY

↓

CALIBRATION NUMBER DISPLAYS; THEN SCREEN BLANKS

↓

ENTER REGION NUMBER(S)

↓

PRESS THE INT KEY

↓

DURING INITIALIZATION THE FOLLOWING MESSAGE DISPLAYS: "INITIALIZE..."

↓

AFTER INITIALIZATION, THE CONSOLE DISPLAYS: "INITIALIZE DONE"

NOTE: The bolded single line box shows information <u>you</u> enter.

Figure 5-4

CAL CONSOLE OPERATION

INITIALIZATION OF CONSOLE RAM

To load the desired calibration data from EEC-IV multiple calibration memory into console RAM, use Figure 5-4 and proceed as follows:

CAUTION: This procedure results in loss of all altered calibration constants and DAC channel control parameters that are in console RAM. Be sure that the contents are not needed before re-initializing console RAM.

STEP	PROCEDURE	RESULTS
1.	Enter a valid password code and press the PAS key. (NOTE: Do not press either the DSO or DSA key.)	PASS indicator should be ON.
2.	Enter engine calibration number (0-7) to be copied into console RAM and press CS key.	Selected calibration number displays, then the screen blanks.
3.	Enter the region (0-7) number(s) within the selected calibration that needs copying to console RAM and press the INT key.	Specified region(s) of the selected calibration copy into console RAM. While initializing, the following message displays: INITIALIZE . . . .
	NOTE: If calibration is not specified, the console copies the calibration selected by the hard port. If no region number(s) are entered, the console tries to copy all regions of the selected calibration.	After completion of initialization, the console shows: INITIALIZE DONE

Possible Error Messages:

INVALID CAL BLK, RAM OVERFLOW, INVALID STATE-CS, INITIALIZE FAIL.

NOTE: If initialization fails for any reason, the Calibration Console stops you from entering the CS (Console Select) mode. In addition, the DAC channel control parameters are not be copied into console RAM.

DISPLAYING PARAMETER VALUES

As stated earlier, Version 8.2 software provides two levels of access to EEC-IV memory. The "Normal Calibration Password" allows the operator to display the contents of EEC-IV CPU registers (addresses 00h through FFH), external RAM (100H through 8FFH), and calibration constants in both EPROM/MROM and console RAM. If a specified memory location is not within the range of addresses authorized for access, the console displays the error message "NOT ACCESSIBLE". The "Full Memory Access" and "4B1D" passwords allow you to display the contents of any address in EEC-IV memory space.

Upon entering a parameter address in hexadecimal, you can use one of two Calibration Console function keys to obtain desired operation. These are the:

- DSO (Display Original) key which displays the value of the parameter within that address. This address is updated every 300 milliseconds.
- DSA (Display Alterable) key which displays a snapshot of the same parameter and enables the alter function.

If the chosen parameter is located in console RAM, the DSA key accesses the parameter. Parameters within console RAM display with a plus (+) sign before the address.

Parameter values display in either decimal or hexadecimal format (as desired) depending on the current state of the DCML indicator. Pressing the DCML function key changes the current state of the Console and related indicator. With SMP data available, the displayed parameter value is scaled and displayed in engineering units. Without SMP data, it is displayed in unscaled byte mode. Figure 5-5 contains a summary of this information.

PARAMETER LOCATION	DSA KEY	DSO KEY	ENTRY/DISPLAY FORMAT
For Normal Password Access			
CPU Registers	Snapshot	Cont Update	[Address]-[Contents]
EEC-IV RAM	Snapshot	Cont Update	[Address]-[Contents]
EPROM/MROM	--------	Cont Update (ROM does not change)	[Address]-[Contents]
Console RAM	Snapshot	----------	+[Address]-[Contents]
For Full Memory and "4B1D" Passwords			
All locations	Snapshot	Cont Update	[Address]=[Contents]

Figure 5-5

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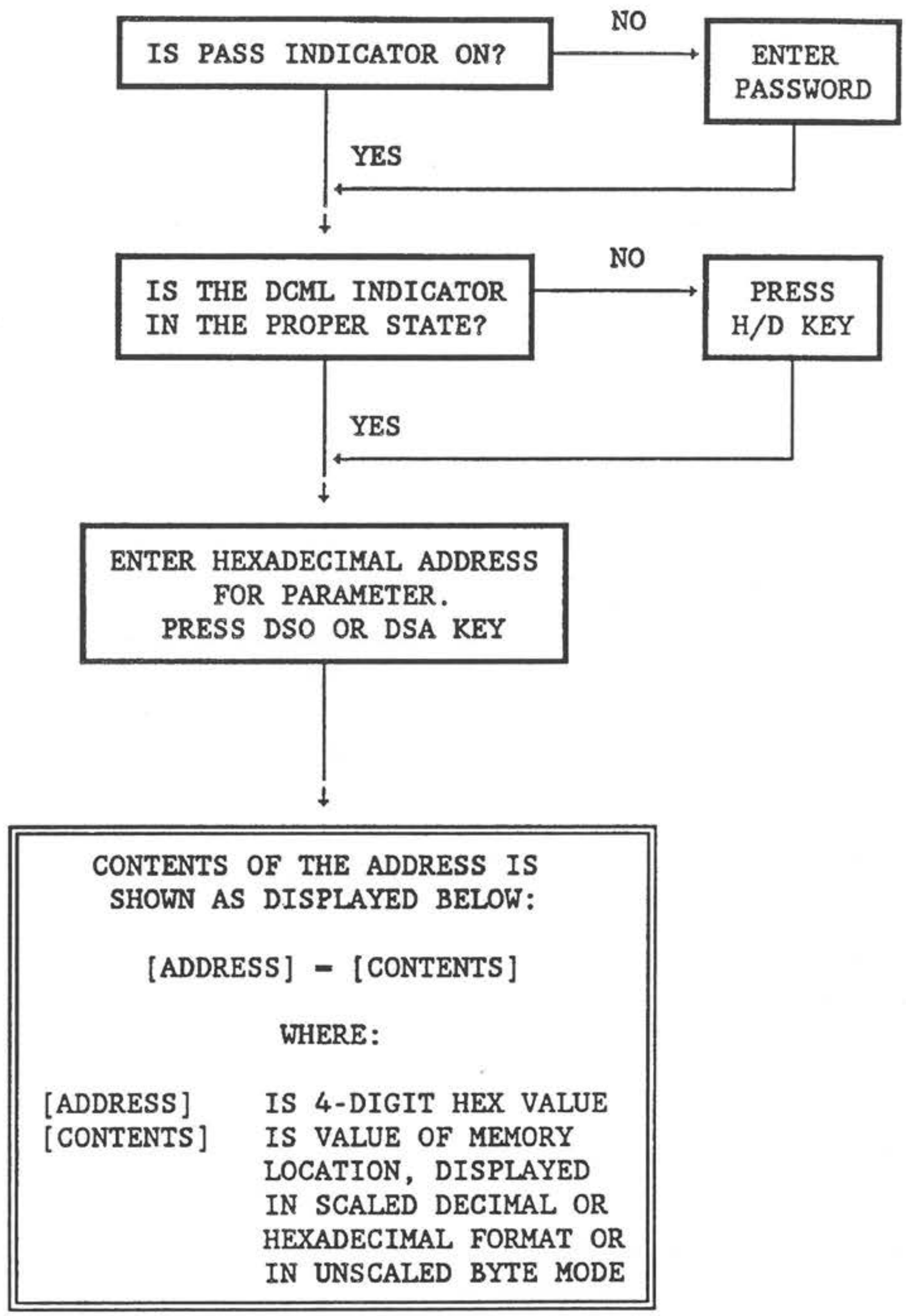
DISPLAYING MEMORY LOCATION CONTENTS

FLOW CHART



NOTE: The bolded single line box shows information you enter.

Figure 5-6

MEMORY LOCATION DISPLAY

To display the contents of a memory location, use the following procedures and example. Figure 5-6 serves as a flow chart reference.

STEP	PROCEDURE	RESULTS
1.	If PASS indicator is not ON, enter the correct password and press the PAS key.	PASS indicator ON.
2.	If the DCML indicator is not in the desired state (ON for decimal display, OFF for hex display), press the H/D key.	DCML indicator changes to desired state.
3.	Now press the DSO or DSA key. This displays the value of the parameter address last entered by the operator.	The contents of that memory address displays as shown: [Address] = [Contents] NOTE: The address displays as a 4-digit hexadecimal value. You can display the contents in either: - Scaled decimal - Hexadecimal format - Unscaled byte mode (See Memory Location Display Example that follows)
4.	To display the value of a parameter other than the one whose address is currently stored in the console, enter the hexadecimal address for that parameter and press the DSO or DSA key.	The contents of the specified memory location displays as shown in Step 3.
5.	To display the contents of the next higher or lower address, momentarily press the NXT or LST key. Holding these keys depressed causes the address to slew in the selected direction at a 300-millisecond rate (7.5 MHz modules).	The contents of adjacent memory location(s) displays as shown in Step 3.

MEMORY LOCATION DISPLAY EXAMPLE

This example illustrates how the console displays the contents of memory address 046C in the decimal and hexadecimal display format. Note that in both cases the address displays in hexadecimal.

DECIMAL DISPLAY

046C = 2.9874 E 1

HEX DISPLAY

046C = EF B 03

For the decimal display format, the designation "E 1" indicates that the number 2.9874 is multiplied by the factor 10 raised to the first power or 10^1. The actual value stored in location 2500H is 29.874.

In the hex display format, the hexadecimal value EFH is multiplied by the factor 2 raised to the minus 3 power or 2^{-3}. The actual hexadecimal notation is equivalent to 29.874 in decimal. Note that the BIN number (B 03) is a hexadecimal value.

If the memory location specified is not defined by an SMP parameter, the memory location contents displays in unscaled byte mode. Also, the displayed value may be either decimal or hexadecimal format. This is controlled by the current state of the DCML indicator (ON for decimal and OFF for hexadecimal).

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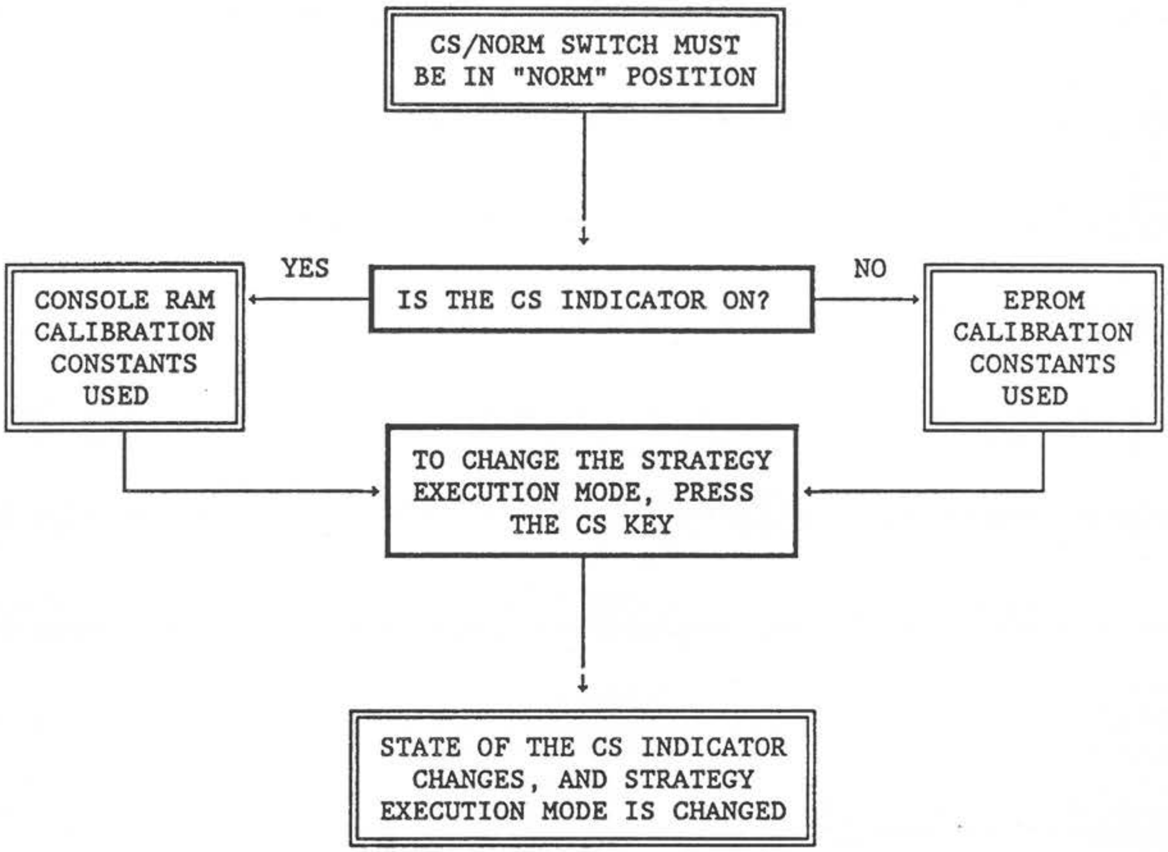
STRATEGY EXECUTION MODE SELECTION
FLOW CHART



NOTE: The bolded single line box shows information you enter

Figure 5-7

SELECTING STRATEGY EXECUTION MODE

You can operate the vehicle processor from calibration constants contained in EPROM/MROM or constants contained in console RAM. To select the desired strategy execution mode, use Figure 5-7 and proceed as follows:

STEP	PROCEDURE	RESULTS
1.	Ensure that the CS/NORM switch is set to the NORM position.	None
2.	Observe the state of the CS indicator.	If CS indicator is OFF, engine control strategy is executed using calibration constants in console RAM. If CS indicator is ON, engine control strategy is executed from calibration constants in EPROM/MROM.
3.	To change the strategy execution mode, press the CS function key.	State of the CS indicator changes and strategy execution mode changes.

NOTE: If initialization fails for any reason, the Calibration Console stops you from entering the CS (Console Select) mode. In addition, the DAC channel control parameters don't copy into console RAM and engine strategy only executes from EPROM/MROM.

ALTERING MODIFYABLE PARAMETERS

FLOW CHART

ENTER THE PASSWORD

↓

SELECT THE DESIRED ENTRY MODE (DECIMAL OR HEX)

↓

ENTER THE ADDRESS AND PRESS THE DSA KEY

↓

THE FOLLOWING DISPLAYS: [ADDRESS] - [VALUE]

↓

TO CHANGE THE VALUE, TYPE IN THE NEW VALUE AND PRESS THE ALT KEY

NOTE: The bolded single line box shows information <u>you</u> enter.

Figure 5-8

CAL CONSOLE OPERATION

MODIFYING ALTERABLE PARAMETERS

To modify the value of an alterable parameter, the address of that parameter must first be stored in the console and the "Last Function = DSA" flag must be set. The "Normal Calibration Password" allows you to alter the calibration constants in console RAM and the contents of EEC-IV RAM. The "Full Memory Access Password" allows you to alter the contents of any read/write device address. To alter a parameter, use Figure 5-8 as a reference and proceed as follows:

STEP	PROCEDURE	RESULTS
1.	If PASS indicator is not already ON, enter the correct password and press the PAS key.	PASS indicator should be ON.
2.	If the address of the parameter requiring alteration is already in the console, press the DSA key. If not,enter the hexadecimal parameter address and press DSA key. Then proceed to the desired state. These states are: - 3 Direct alter - 4 Incremental alter - 5 Slewing alter - 6 Change slew direction	Contents of memory address stored in console displays as shown: [[Address] = [Contents]] NOTE: The address is displayed as a 4-place hexadecimal value. The contents display is in scaled decimal, hexadecimal format or unscaled byte mode, depending on your choice.
3.	To enter a specific parameter value, enter the desired value and press the ALT key.	The altered value displays on the console front panel as shown above.
4.	To change a displayed parameter value one unit at a time, momentarily press the ALT key.	The altered value displays on the console front panel as shown above.
5.	To slew a displayed parameter value, press the ALT key until the correct value displays or the desired engine operation occurs.	Parameter value changes according to the selected direction at a 300-millisecond rate (7.5 Mhz modules).
6.	When using the ALT key, the direction of change can be altered by momentarily pressing the blank key.	The direction of change displays as noted: [INCREMNTING SLEW] or [DECREMNTING SLEW]

POSSIBLE ERROR MESSAGES

ILLEGAL ALTER and INVALID SEQUENCE

COMPARING EPROM AND CAL CONSOLE VALUES

FLOW CHART

PRESS THE CMP KEY

↓

THE CAL CONSOLE BEGINS EXECUTING THE COMPARE ROUTINE AND DISPLAYS FOLLOWING MESSAGE: "COMPARE...."

↓

WHEN A DIFFERENCE IS FOUND BETWEEN THE VALUES IN THE CAL CONSOLE AND THE VALUES IN THE EPROM, THE FOLLOWING MESSAGE DISPLAYS:

[XXXX] *[YY] [ZZ]

WHERE:

[XXXX] IS A 4-DIGIT PARAMETER ADDRESS
[YY] IS THE VALUE IN EPROM
[ZZ] IS THE VALUE IN CAL CONSOLE

↓

TO CONTINUE THE COMPARE ROUTINE PRESS THE NXT KEY

↓

WHEN THE COMPARE ROUTINE IS COMPLETE, THE FOLLOWING MESSAGE DISPLAYS: "COMPARE COMPLETE"

↓

TO ABORT THE COMPARE ROUTINE, PRESS THE CMP KEY WHILE A DIFFERENCE DISPLAYS.
THE FOLLOWING MESSAGE DISPLAYS:

"COMPARE ABORTED"

Figure 5-9

CAL CONSOLE OPERATION

DETERMINING ALTERED CALIBRATION CONSTANTS

To determine which Calibration Console constants are altered from the original values within console RAM, run a compare routine. This routine executes a sequential byte-by-byte comparison of calibration constants in console RAM with corresponding parameters in EPROM/MROM and displays all memory locations containing different values.

The comparison program is executed twice. The first time, all detected differences are sent to the data logger. The second time, the program halts at the first location were a difference exists. The program then displays the:

- Address
- EPROM/MROM contents
- Console RAM constants

With the DAC Module and data logger connected and enabled, DAC operation and data logging suspend during the execution of the compare routine. The procedures necessary to alter calibration constants follow. Use Figure 5-9 as a reference.

STEP	PROCEDURE	RESULTS
1.	If the comparison results are sent to a data logger, set DATA LOG switch on the DAC Module to the ON position.	With the DAC module on, the Data LOG indicator is ON.
	NOTE: The DAC Module can be on or off.	
2.	To start the comparison check, enter the calibration number and press the CMP key.	With the data logger enabled, the detected diffences are first sent to the data logger and then displayed as shown: ADDR RAM ROM XXXX1 ZZ1 YY1 XXXX2 ZZ2 YY2 XXXX3 ZZ3 YY3 The first parameter with a different value is displayed on the console as shown: [XXXX] *[YY] [ZZ] Where: [XXXX] is a 4-digit hex address, *[YY] is the hex value in EPROM/MROM [ZZ] is the hex value in console RAM
	NOTE: Without specifying a calibration number, the console defaults to the hardport selected calibration. When an invalid calibration number is specified, the console displays the error message "INVALID CAL BLK".	

(continues)

3.	To continue the comparison after a (if any) difference displays, press the NXT key.	Comparison continues. Next difference displays as shown above. When comparison is complete, the following message displays: COMPARE COMPLETE
4.	To abort the comparison check after detection of a difference, press the CMP key while the difference is displayed.	Comparison check terminated while the following message is displayed: COMPARE ABORTED

POSSIBLE ERROR MESSAGES

INVALID CAL BLK

CAL CONSOLE MESSAGES

The Calibration Console operating software includes extensive diagnostic capability to prevent invalid operation of the console. This capability also includes visual messages on the front panel display. Figures 5-10, A Through D, list the Calibration Console messages and an interpretation of their meaning. The messages that follow are listed in alphabetical order to simplify reference.

MESSAGES	MEANING
CAL CONSOLE V8.2	Message displayed after 8061 microprocessor hardware or software reset.
COMPARE	Indicates compare routine in progress.
COMPARE ABORTED	This message displays when the CMP key is pressed after detecting a difference between ROM and RAM. Pressing the CMP key when NCALS or NPNTRS is zero also causes this display.
COMPARE COMPLETE	Shows that the compare routine is complete.
DECREMNTING SLEW	Shows parameter value is decreasing.
ILLEGAL ALTER	Shows the password code entered does not match the "Normal Calibration Access Password" or the "Full Memory Access Password" codes stored in SMP memory.
INCREMNTING SLEW	Shows parameter value is increasing.
INITIALIZE . . .	Shows that console initialization is in progress.

Figure 5-10A

<table>
<tr><th>MESSAGES</th><th>MEANING</th></tr>
<tr><td>INITIALIZE DONE</td><td>Shows that console initialization is complete.</td></tr>
<tr><td>INITIALIZE FAIL</td><td>Shows either NCALS or NPTRS in the calibration parameter pointer table at address 2020H is equal to zero or the ending address of a region is less than the beginning address.</td></tr>
<tr><td>INVALID CAL BLK</td><td>Shows that the selected calibration region(s) do not exist. (NOTE: Valid <u>and</u> invalid regions during initialization causes only valid regions to copy and the message not to display.)</td></tr>
<tr><td>INVALID ENTRY</td><td>Shows one of the following invalid entries:

Decimal (.), minus (-), or EE key key while in Hexadecimal mode,

Decimal (.), minus (-), or EE key out of sequence while in decimal mode.

Decimal (.), minus (-), or EE key after one has already been entered,

Decimal (.), minus (-), or EE key when specifying an address, or,

Characters A through F after a decimal (.), minus (-), or EE key entry when in the decimal mode.

This message displays for four seconds, then the current entry (or last valid entry) displays and data entry may continue.</td></tr>
</table>

Figure 5-10B

MESSAGES	MEANING
INVALID SEQUENCE	DSA key entry did not precede a parameter alter attempt.
INVALID STATE-CS	CS light was ON when attempting to copy parameters into console RAM. The CS light must be OFF when initializing console RAM.
MAGNITUDE ERROR	The entered value is outside the range chosen in SMP for that particular parameter or the selected DAC channel was greater than "7".
NO DAC RESPONSE	DAC didn't send a "ready" handshake within 15 counts of the I/O extension register.
NO PERIPHERAL	Used DAC key with no peripheral device.
NOT ACCESSIBLE	The SMP defined address is non-alterable and cannot display, alter, or DAC unless the Full Memory Access Password is entered.
PASSWORD OFF	Valid password not entered prior to alter attempt.
PAS2-00/FF INVAL	Shows a value of 00H or FFH was entered as the correct "Full Memory Access Password". Message shows if the "Normal Calibration Access Password" is not set to FFH.
PW2 IGNRD PW1-FF	Shows that the correct value of the "Full Memory Access Password" was entered, but the "Normal Calibration Access Password" is FFH.
RAM ERROR	The console RAM could not accept data or 8061 was unable to write the correct data to the console RAM.

Figure 5-10C

MESSAGE	MEANING
RAM OVERFLOW	Shows that the selected calibration data exceeds the size of console RAM. The console did correctly copy as much as possible. To determine what did copy, follow the procedure for "determining the Calibration Data currently in Console RAM".
ROM ERROR	The 8061 CPU did not read the correct ROM data.
UNSIGNED ONLY	Shows an attempt to alter an unsigned parameter, as defined in the SMP software, with a signed entry.
0 5 OR 10V ONLY	Entered a value other than 0, 5, or 10 as the DAC zero reference point.
	Entered a value other than 0 through 7 as mask bit.
	Entered a value outside the range of -15 to +15 as the shift count. NOTE: Hexadecimal characters "A" through "F" is treated as a zero and all less significant numbers [0 through 9] are ignored when entering the shift count.

Figure 5-10D

Chapter 6

DAC OPERATING PROCEDURES

The following information details the operation of the DAC Module.

ACTIVATION

Version 8.2 Cal Console software updates all eight DAC channels during each Cal Console background loop. If the DAC Module is connected to the Cal Console at time of power-up, the DAC Module digital outputs automatically switch ON. Pressing the Cal Console DAC key without first entering a channel number switches ON or OFF the digital output function. The Cal Console DAC light is ON when DAC digital outputs enable.

NOTE: Entering number 0 through 7 before pressing the DAC key accesses the DAC channel control parameter.

SETTING DAC RESOLUTION

The DAC Module allows either 8-bit or 10-bit digital-to-analog resolution. To select the desired DAC resolution, set the DAC Module FUNCTION switch as shown in the following chart.

NOTE: For byte length parameters, place function switch to F0.

FUNCTION Switch Position	DAC Resolution
F0	8-Bit Resolution
F1	10-Bit Resolution

DISPLAYING DAC CHANNEL DATA

To display the value of the engine operating parameter assigned to any two of the eight DAC channels, set the front panel CHANNEL SELECT switches on the DAC Module to the channel number used for DAC operation of that engine operating parameter. The value of the parameter assigned to those channels displays on the DAC Module in the operating radix defined by the state of the Cal Console DCML indicator. See the following examples for typical DAC Module displays.

NOTE: The DAC Module displays in the DSO mode. That is, the data is updated each Cal Console background loop and the calibration parameters in EPROM are DAC processed when using the Normal Calibration Password.

Example #1 - DAC Module Display of Engine Parameter

This example illustrates display of a 180o F engine coolant temperature. NOTE: The DAC module displays raw data only.

DECIMAL DISPLAY

| 218 218 |

HEXADECIMAL DISPLAY

| DA DA |

If display of a parameter on the Cal Console and DAC Module at the same time is required, the indicated parameter value (in most cases) is different because of DAC channel scaling and other data processing operations. If you require monitoring three or more engine operating parameters simultaneously, it is necessary that you be able to convert Cal Console values to the equivalent value displayed on the DAC Module and vice versa.

The following provides equations which enable you to make these conversions. The following definitions apply to the various factors used in the equations for converting displayed data:

DAC DISPLAY --value displayed on the DAC Module

CAL DISPLAY --value displayed on the Cal Console

BIN --parameter scaling value stored in SMP memory

SHIFT --currently defined DAC channel scaling factor stored in console RAM

OFFSET --currently defined DAC channel offset factor stored in console RAM

FS DAC COUNT --DAC full-scale count as indicated:

- FS DAC COUNT = 256 for F0
- FS DAC COUNT = 1024 for F1

ZP DAC COUNT --DAC count as determined by the presently specified zero position output voltage stored in console RAM and the setting of the FUNCTION selector switch as shown in the chart:

ZERO POSITION SETTINGS	ZP DAC COUNT	
	F0	F1
ZERO @ 0 Volts	0	0
ZERO @ 5 Volts	128	512
ZERO @ 10 Volts	256	1024

Figure 6-1

CONVERTING DAC MODULE DISPLAYS TO CAL CONSOLE DISPLAYS

To convert a DAC Module parameter value to an equivalent Cal Console display value, use the equation shown:

FOR POSITIVE VALUES:

$$\text{CAL DISPLAY} = \frac{(\text{DAC DISPLAY} - \text{ZP DAC COUNT})\ 2^{\text{SHIFT}}}{2^{\text{BIN}}} - \text{OFFSET}$$

FOR NEGATIVE VALUES:

$$|\text{CAL DISPLAY}| = \frac{(\text{ZP DAC COUNT} - \text{DAC DISPLAY})\ 2^{\text{SHIFT}}}{2^{\text{BIN}}} + \text{OFFSET}$$

CONVERTING CAL CONSOLE DISPLAYS TO DAC MODULE DISPLAYS

To convert a Cal Console parameter value to the equivalent DAC Module display, use the equation shown:

FOR POSITIVE VALUES:

$$\text{DAC DISPLAY} = \frac{[(\text{CAL DISPLAY}) + \text{OFFSET}]\ 2^{\text{BIN}}}{2^{\text{SHIFT}}} + (\text{ZP DAC COUNT})$$

FOR NEGATIVE VALUES:

$$\text{DAC DISPLAY} = (\text{ZP DAC COUNT}) - \frac{[|\text{CAL DISPLAY}| - \text{OFFSET}]\ 2^{\text{BIN}}}{2^{\text{SHIFT}}}$$

Example #2 - Improperly Scaled Data

If incorrect scaling information is assigned a DAC channel, the channel output voltage remains at +10 VDC until the digital input value is less than 257 (with function switch set to "F0") or 1025 (with function switch is set to "F1"). The following error message also displays:

SE *SE*

To obtain proper scaling, increasing the channel's shift value.

Example #3 - Unused Channel Select Switch Positions

Positions "A" and "B" on the DAC channel select switches are used only during power-up to initiate the DAC Module Diagnostic Test. These switch positions result in display of the following error message when used during normal operation.

BAD BAD

DAC MODULE TEST OPERATIONS

The DAC Module contains a diagnostic program that tests itself. This permits you to determine operational integrity or to verify suspected faults in the DAC Module before return for repair.

The DAC Module's on-board diagnostic test program is capable of testing all DAC Module circuits except for the FIFO (First In-First Out) and the UART (Universal Asynchronous Receiver Transmitter) contained in the DAC Module. Using the Calibration Console and DAC Module in the normal operating mode verifies data transfer between the two units. This verifies the functional operation of the FIFO. Verify UART operation by attaching a remote computer terminal (set for operation at the appropriate data transmission baud rate) to the RS-232C #1 port while various DAC parameters output.

With a FIFO Tester and a UART Tester, you can test all DAC circuits. The FIFO Tester supplies power to the DAC Module. This eliminates the possibility that the Calibration Console is not supplying power to the DAC Module.

DAC OPERATING PROCEDURES

To perform the field diagnostic test of a DAC Module without a FIFO Tester, proceed accordingly:

1. Connect the Calibration Console to the DAC Module in the normal operating manner. If a UART Tester is used, connect it to the RS-232 ports.

   NOTE: If the console will not power-up, obtain a FIFO tester to eliminate the possibility of Calibration Console failure. Do not power-up at this time.

2. Before applying power, set both CHANNEL SELECT switches on the DAC Module to positions "A-A" or "B-B" as determined by the version of software that is installed in the DAC Module:

   NOTE: Use position "A" for software version V82X and position "B" for software version VD2B.

   ABOUT VERSION VD2B: Powering-up the DAC Module with both CHANNEL SELECT switches in position "A" accesses the EED-PEO in-house self-diagnostic test.

   ABOUT VERSION V82X: Powering up the DAC Module with both CHANNEL SELECT switches in position "B" enables the RAM retention test.

   ABOUT EITHER VERSION: Powering-up the DAC Module with the CHANNEL SELECT switches in any other position results in normal operation.

3. Apply power to the Calibration Console or FIFO Tester.

4. If using the Calibration Console, press the DAC function key and CHECK the DAC LED function.

   NOTE: The DAC Module should display moving cursors. This indicates that diagnostics has begun.

5. Set CHANNEL SELECT switches to each position indicated in Table 6-2. The Table indicates the DAC circuit being tested and the expected results.

DAC MODULE DIAGNOSTIC TEST OPERATIONS

NOTE: DAC Module test activation begins by powering up the DAC system with both channel select switches in the "A" or "B" position.

CHANNEL SELECT SETTINGS		DAC CIRCUIT TESTED	DAC MODULE TEST INDICATIONS
LEFT	RIGHT		
0	0	RAM	Displays Pass or Fail
1	1	ROM	Displays Pass or Fail
2	2	FIFO	Displays Pass or Fail †
3	3	COM1 COM2 COM3	Displays Pass or Fail † Requires tester † Requires tester †
4	4	Data Log Switch	Switch controls Data Log LED (On-lit/Off-not lit)
5	5	Function Switch	Switch controls Data Log LED (On-lit/Off- not lit)
6	6	Calibration Switch	Switch controls Data Log LED: --Full scale position-lit --Normal position-blinking --Zero scale-not lit
7 2 VOLT/DIV	7 20 MILSEC	DAC's	Switch controls analog outputs: --Full scale-10 volts --Normal position=ramped outputs --Zero scale-0 volts
A	A	All	Used to intiate on-board diagnostics
B	B	All	Used to initiate RAM retention test

† NOTE: Peripheral and Serial port testers MUST be installed for this test output. Without testers, display indicates "FAIL" or COM1 indicates "FAIL" while COM2 and COM3 won't generate a display.

Figure 6-2

SEQUENCE TO DISPLAY DAC CHANNEL CONTROL PARAMETERS

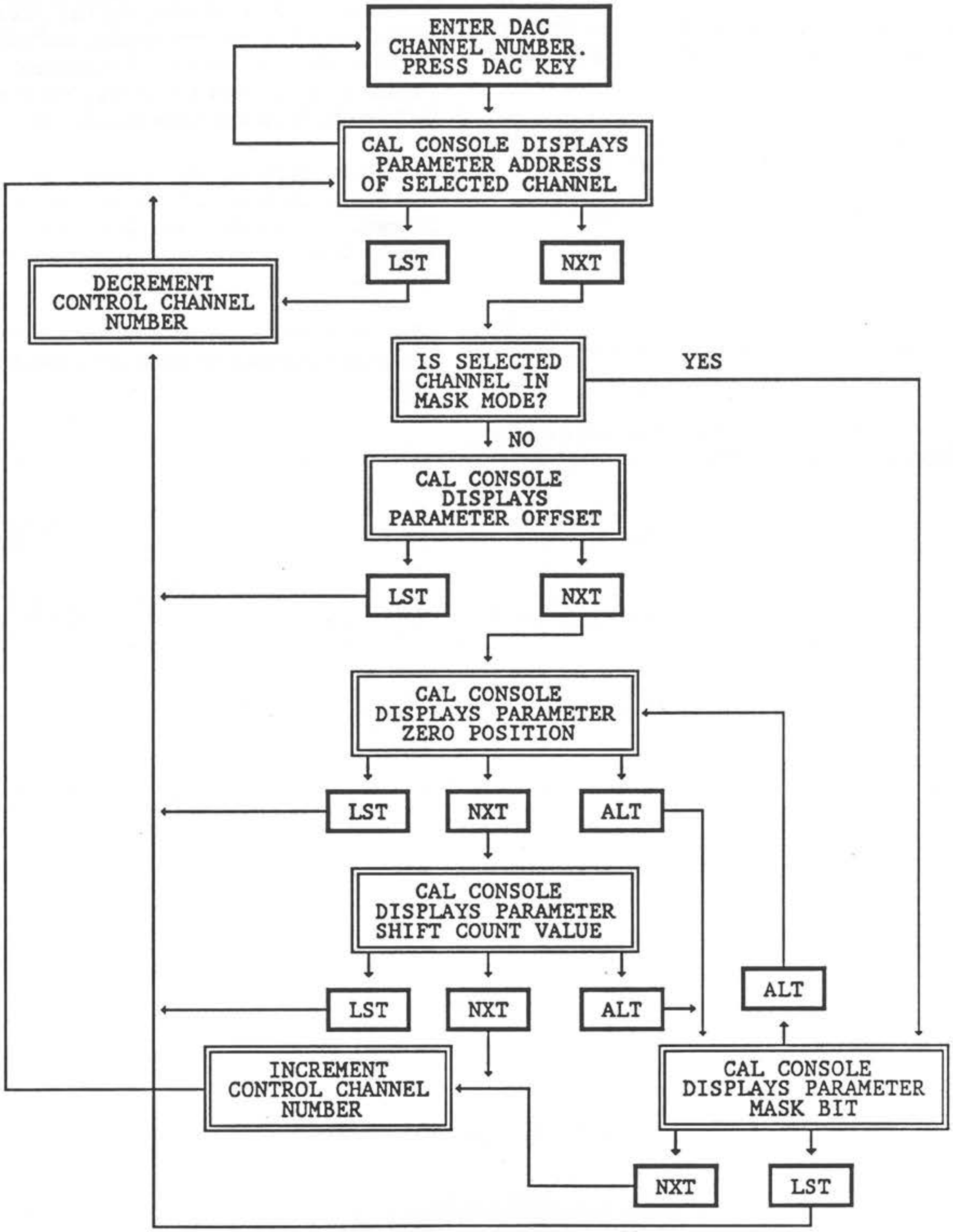


Figure 6-3

DISPLAY AND ALTERATION OF DAC CHANNEL CONTROL PARAMETERS

The DAC channel control parameters define how each DAC channel is programmed to operate. These options include:

- Memory addresses of engine operating parameters assigned to each DAC channel
- Parameter offset and shift count values
- Channel zero output voltage
- Masks which define a specific bit to be DAC processed by channels operating in the single-bit DAC mode.

Default DAC channel control parameters are stored in SMP memory and copied into Cal Console RAM during console initialization. You may alter displayed parameters in console RAM (if desired) for a specific development/test operation. When the console is shut OFF, the stored DAC channel control parameters are safely retained for 24 hours (providing the battery backup is fully charged). The stored parameters are then used when the console is started-up the following day, providing the console is not re-initialized.

To display or alter a DAC channel control parameters, use the example found in Figure 6-3. In the example, all parameter entries and console displays are shown in boxes. The function key operations are indicated by remarks on the lines.

The following example shows the entire procedure. The remaining information breaks down the procedure, step by step.

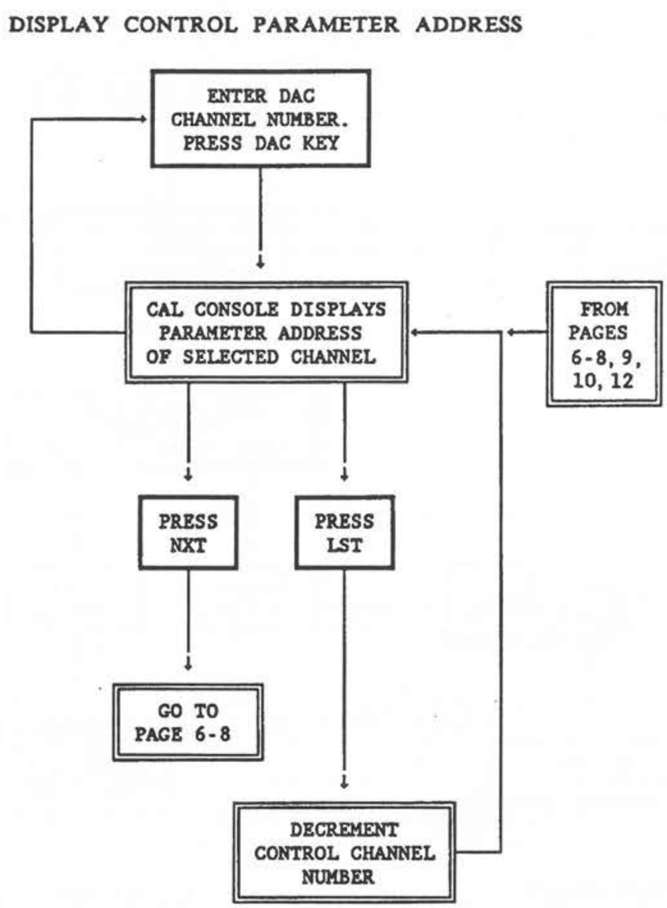


Figure 6-4

DISPLAY CONTROL PARAMETER ADDRESS

Parameter Name: Channel Parameter Address

Console Display: DAC [C] = [AAAA]

Valid Parameter Ranges: C = 0-7 (All displays)
AAAA = 0000 to FFFF (Hex)

Purpose: Displays the Hexadecimal address of the parameter assigned to the specified DAC channel.

EXPLANATION OF BLOCK FUNCTION:

- The block allows you to enter one of eight DAC Channel numbers (0-7).
- Pressing the DAC key then selects that channel and displays the assigned channel address.
- Once the address displays, the NXT and LST keys toggle the following:
  - NXT key causes the DAC Module to go to the next parameter associated with the address currently called (see Parameter Display Format).
  - LST key causes the DAC Module to go back to the preceding channel address.
- Another channel is selected by pressing the appropriate channel number and then the DAC key.

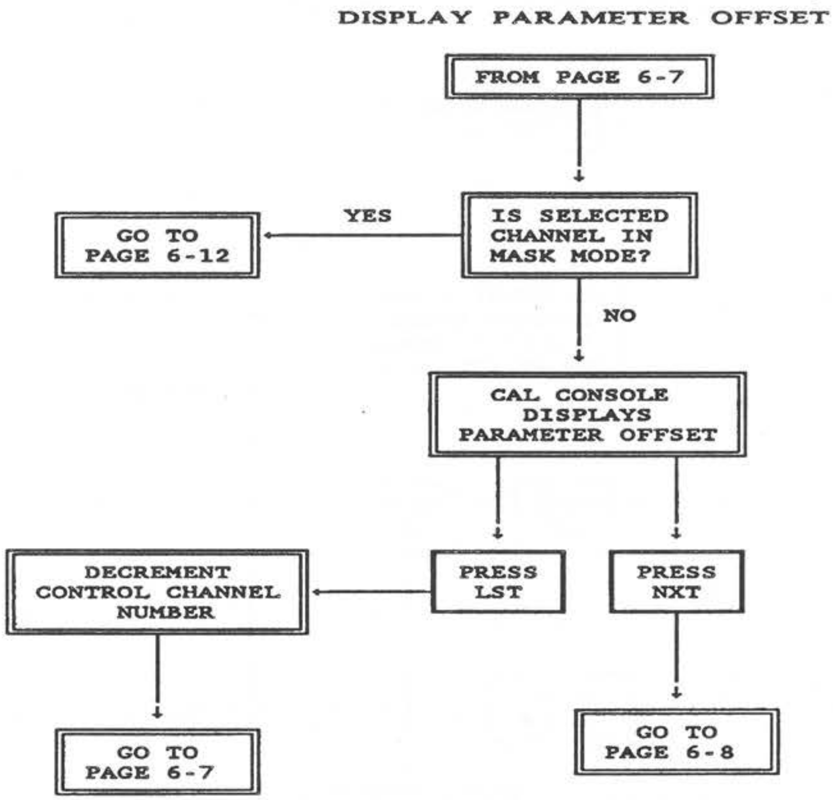


Figure 6-5

DISPLAY PARAMETER OFFSET VALUE

Parameter Name = Parameter Offset Value

Console Display = OFF [C] = [D] E [d]
OFF [C] = [H] B [h]

Valid Parameter Ranges = D x 10d (Engineering Units)
H x 2-h (Hexadecimal Value)

Range from 0 to +/- 65,535

Purpose: The offset is either added to, or subtracted from the DAC parameter value. Benefits are the ability to "trim" a value to a specified position.

EXPLANATION OF BLOCK FUNCTIONS:

- Entered from the Display Control Parameter Address Block.
- Allows you to either continue within the parameter selection blocks or display (jump) directly to the Parameter Mask Bit. This depends on the current status of the Mask Mode as shown:
  - If the Mask Mode is established for the DAC address, the DAC Module steps directly to "Parameter Mask Bit Display".
  - If the Parameter Mask Bit is not established, the DAC Module goes to "Parameter Offset Display".
- Entering "Parameter Offset Display" causes the display to offset for that particular channel.
- LST key allows you to decrement the channel number and re-enter "Parameter Address Selection".
- NXT key causes the DAC Module to proceed to the next parameter associated with the address currently called.

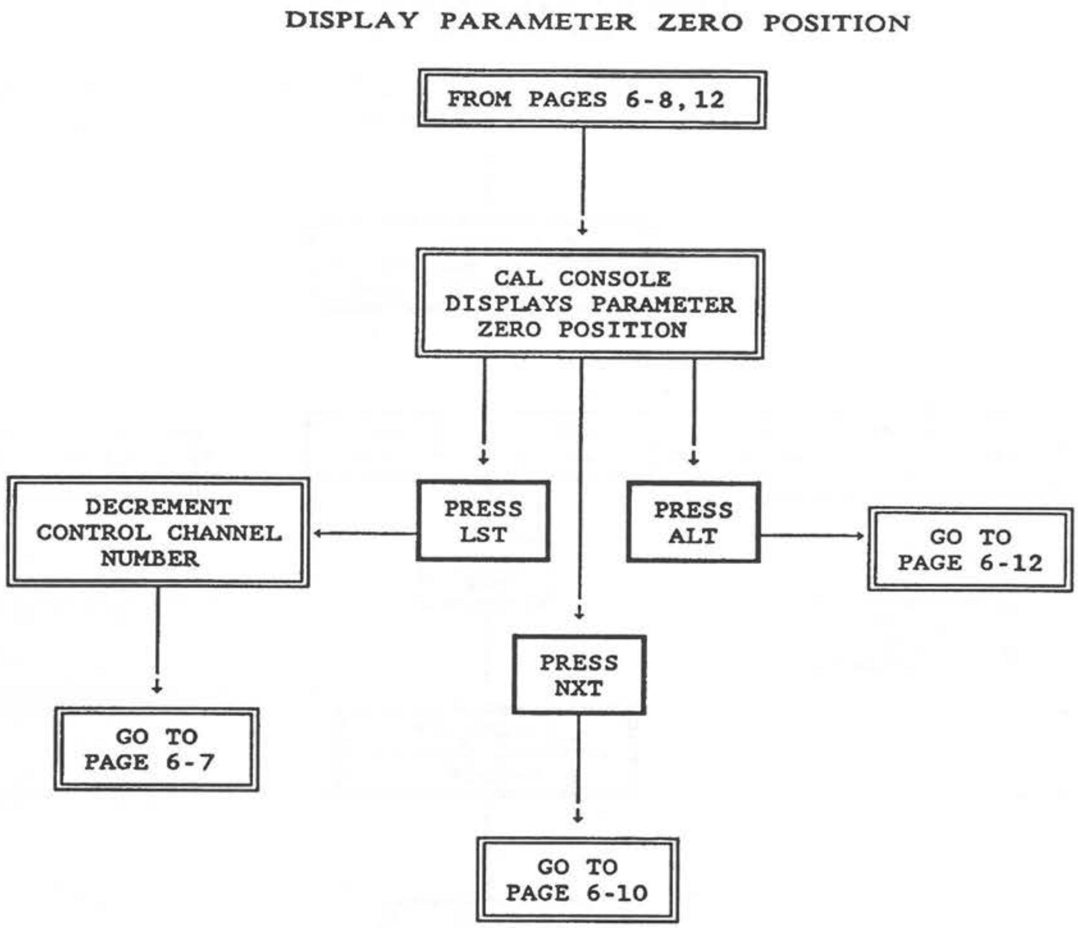


Figure 6-6

DISPLAY PARAMETER ZERO POSITION

Parameter Name = Channel Zero Position

Console Display = DAC [C] = 0 AT [X] V

Valid Parameter Ranges = X = 0, 5, or 10 only

Purpose:The zero position assigns the digital input value "0" to a specific DAC voltage level (0V, 5V or 10V).

EXPLANATION OF BLOCK FUNCTIONS:

- This area is entered from the "Parameter Display Format Block" or "Display Parameter Mask Bit".
- The Cal Console displays the current parameter zero position.
- The following choices are available:
  - LST key decrements the channel control number and re-enter the "Parameter Address Selection".
  - NXT key causes the DAC Module to proceed into the next parameter associated with the address currently called (see page 6-12).
  - ALT key causes the DAC Module to proceed into the "Display Parameter Mask Bit" allowing alteration.

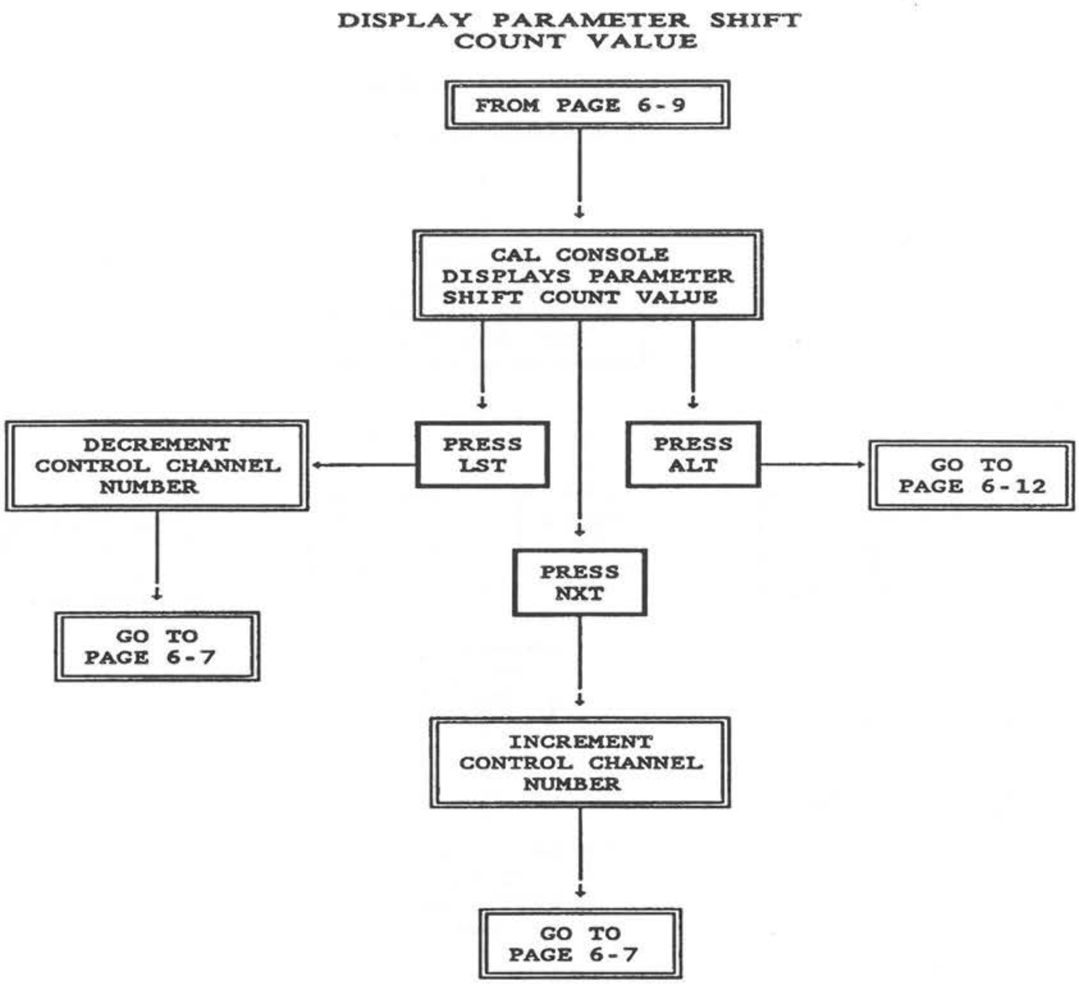


Figure 6-7

DISPLAY PARAMETER SHIFT COUNT VALUE

Parameter Name = Parameter Shift Count Value

Console Display = DAC [C] = SHIFT [X]

Valid Parameter Ranges = X = -15 to +15

EXPLANATION OF BLOCK FUNCTIONS:

- Entered from the "Display Parameter Zero Position Block".
- Cal Console displays the parameter shift control value.
- The following are available choices:
  - LST key decrements the channel control number and re-enters "Parameter Address Selection".
  - NXT key increments the channel control number and re-enters "Parameter Address Selection".
  - ALT key causes the DAC Module to jump to "Display Parameter Mask Bit" (see page 6-12).

DAC OPERATING PROCEDURES

CALCULATION OF DAC SHIFT COUNT

The shift count used as the DAC channel control parameter enables examination of engine operating parameters in terms handled by the DAC hardware. A positive scaling factor (shift count) moves the binary point left, decreasing the base value of the DACed parameter. Bits to the right of the new binary point are discarded and an equal number of leading zeros fill the most significant bit positions.

NOTE: A negative scaling factor moves the binary point right, increasing the base value of the parameter.

EXAMPLE

Given the unscaled number 2FC3H, the equivalent binary representation is:

0010 1111 1100 0011

Since the DAC Module is capable of either an 8-bit or 10-bit resolution (depending on the front panel FUNCTION switch setting), the binary value results in a *SE* (scale exceeded message). Shifting the binary point to the left (positive shift count value) reduces the base value of the parameter to be DACed as shown:

NOTE: Bits /x--x are shifted out (written into a bit bucket) and an update does not occur until the shifted least significant bit value is exceeded.

COUNT	BINARY REPRESENTATION	HEX VALUE	REMARKS
0	0010 1111 1100 0011.	2FC3	Displays the *SE* message
2	0000 1011 1111 0000./xx	0BF0	Displays the *SE* message
4	0000 0010 1111 1100./xxxx	02FC	DACs with FUNCTION switch on F1
6	0000 0000 1011 1111./xxxxxx	00BF	DACs with FUNCTION switch on F0

DETERMINING THE MINIMUM SHIFT COUNT

The following equations calculate the minimum SHIFT COUNT which ensures that the DAC does not display the *SE* (Scale Exceeded) message.

FOR POSITIVE NUMBERS:

$$\text{Let,}\quad X = \frac{(\text{MAX. CAL. VALUE} + \text{OFFSET})\ 2^{BIN}}{(\text{FS DAC COUNT} - \text{ZP DAC COUNT})}$$

FOR NEGATIVE NUMBERS:

$$\text{Let,}\quad X = \left| \frac{(|\text{MAX. CAL. VALUE}| - \text{OFFSET})\ (2^{BIN})}{(\text{ZP DAC COUNT})} \right|$$

Where:

- MAX. CAL. VALUE is the maximum expected attainable value in engineering units.
- BIN is the Binary point value for that parameter.
- OFFSET is the currently defined offset value for that parameter (stored in console RAM).
- FS DAC COUNT is the DAC full scale resolution count which depends upon the DAC FUNCTION switch position:
  - FS DAC COUNT = 256 (For FUNCTION switch position F0)
  - FS DAC COUNT = 1024 (For FUNCTION switch position F1)
- ZP DAC COUNT is a value determined by the currently defined zero position (stored in console RAM) and the setting of the front panel FUNCTION selector switch as shown in the chart:

ZERO POSITION SETTINGS	ZP DAC COUNT	
	F0	F1
ZERO @ 0 Volts	0	0
ZERO @ 5 Volts	128	512
ZERO @ 10 Volts	256	1024

After determining the value of "X", the minimum shift value is:

$$\text{MINIMUM SHIFT} = \frac{\text{LOG } X}{.301}$$

NOTE: Always round off the shift value to the next higher value.

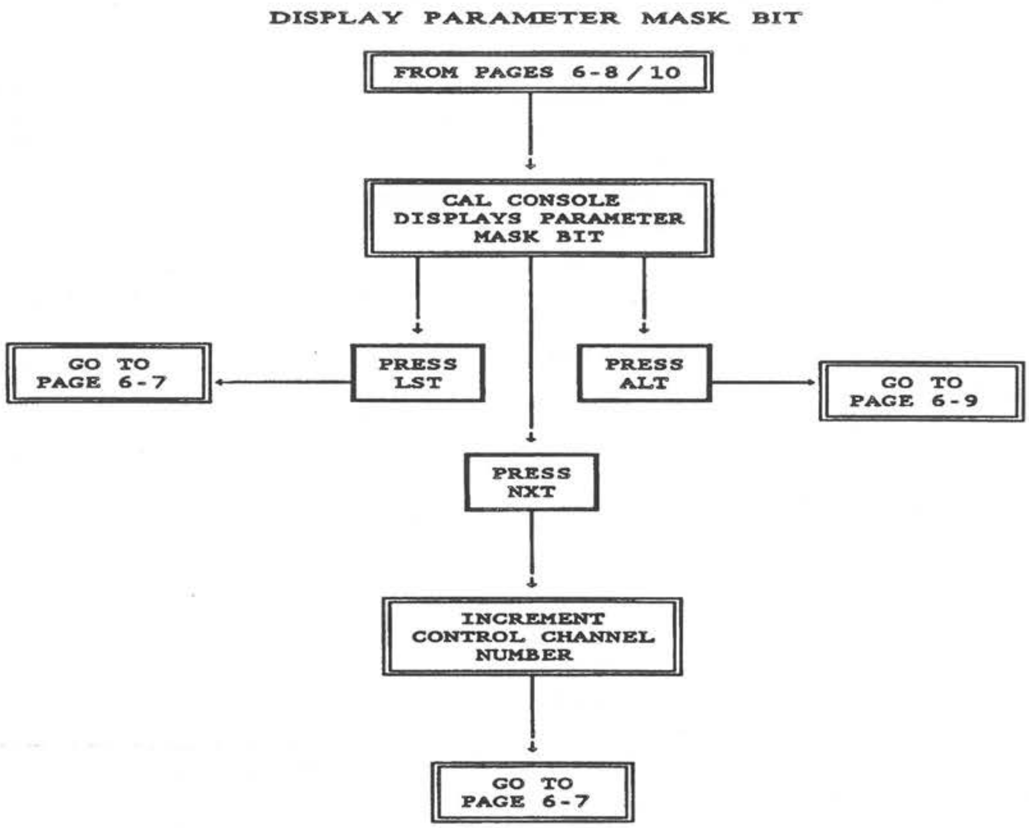


Figure 6-8

DISPLAY PARAMETER MASK BIT

Parameter Name = Parameter Mask Bit

Console Display = DAC [C] = BIT [X]

Valid Parameter Ranges = X = 0-7

Purpose: Allows the DAC to isolate and display a particular bit contained within a byte value.

EXPLANATION OF BLOCK FUNCTIONS:

- Enter this area from the:
  - Selected channel in Mask Mode from the "Parameter Display Format" block.
  - "Display Parameters Zero Position" block.
  - "Display Parameter Shift Count Value" block.
- Cal Console displays parameter mask mode bit.
- The following choices are available:
  - NXT key increments the channel control number and re-enters the "Parameter Address Selection".
  - ALT key causes the DAC Module to proceed to "Display Parameter Zero Position" (see page 6-9).
  - LST key decrements the channel control number and re-enters the "Parameter Address Selection.

ALTER CONTROL PARAMETERS

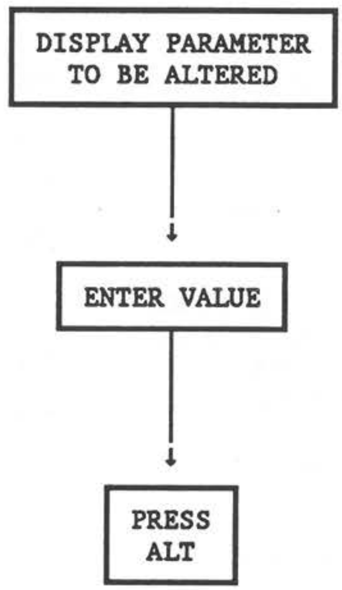


Figure 6-9

ALTERATION OF CHANNEL CONTROL PARAMETERS

NOTE: This mode may be executed from ANY block position.

- Allows alteration of any DAC Channel Control Parameter.
- It is used as follows:
  - From any block position, enter the desired **current** channel value.
  - Press the ALT key.
  - The new parameter now displays on the DAC Module.
- If a different channel address is required, press the NXT or LST key to re-enter "Parameter Address Selection". From here the ALT key changes the parameter.

DAC OPERATING PROCEDURES

CALIBRATING THE ANALOG INPUT DEVICE

The following procedure provides instructions for calibrating an analog input device for recording data outputs from the DAC Module. To calibrate, proceed as follows:

STEP	PROCEDURE	RESULTS
1.	If the DAC indicator is ON, press the DAC function key on the Cal Console.	DAC indicator should be OFF for Steps 2 and 3. The following message displays on DAC Module: VE.B OFF
2.	Set DAC CALIBRATION switch to ZERO SCALE position and adjust all channels of the analog input device for zero scale reading.	All recording channels should indicate zero volts. The following message displays on DAC Module: ALL ZERO
3.	Set the CALIBRATION switch to FULL SCALE position and adjust all channels of the analog input device for full scale reading.	All recording channels should indicate 10 volts. The following message displays on DAC Module: ALL HIGH
4.	Press the DAC function key.	DAC indicator on the Cal Console should light and the analog input device should record the output of each DAC output channel in used.

DATA LOGGING OPERATIONS

The following information details the procedures for DAC Module data logging.

LOGGING DEVICE CONNECTION

With the current software, the DAC assembly communicates to remote peripherals through ports RS-232C #1 and RS-232C #2. Port #1 communicates from 1200 to 19200 baud while port #2 communicates from 300 to 9600. Both ports support either hardware or software handshaking.

NOTE: If you are using two peripheral devices at one time, connect port #2 to the printer. Port #1 then connects to the interface computer. If only one peripheral device is used, connect it to port #1.

You have to check and correct the baud rate for the peripheral devices connected. To change the channel baud rate, remove the CPU board (middle board) from the card cage and change the appropriate baud rate jumper for the port. The row of jumpers nearest the edge controls port #1, and the row of jumpers nearest the center controls port #2. Refer to the following chart for the available jumper/baud rate positions.

CAUTION: ONLY ONE JUMPER MAY BE INSTALLED PER HEADER.

BAUD RATES FOR RS-232C PORT #1	BAUD RATES FOR RS-232C PORT #2
Jumper F3 - 19200	Jumper F1 - 9600
Jumper F5 - 9600	Jumper F3 - 4800
Jumper F7 - 4800	Jumper F5 - 2400
Jumper F8 - 2400	Jumper F7 - 1200
Jumper F9 - 1200	Jumper F8 - 600
	Jumper F9 - 300

Invoke the printer echo option by issuing the Control-P character from the remote keyboard. The printer echo option is a toggle function. Pressing Control-P again cancels the echo option.

When the printer echo option is ON, data output to port #1 simultaneously outputs to port #2.

DATA LOGGER ACTIVATION

To activate data logging, be sure that the DAC outputs are enabled (Cal Console DAC indicator ON). Switch on the DATA LOG switch on the DAC Module. The DAC Module data logging LED should be ON. Data logging outputs are sent to the external device in the following format:

NOTE: Bracketed items are not displayed.

```
 [HEADER]     CH0  CH1  CH2  CH3  CH4  CH5  CH6  CH7  [CR][LF]
              AAAA AAAA AAAA AAAA AAAA AAAA AAAA AAAA [CR][LF]
[CR][LF]
[1st Frame]   dddd dddd dddd dddd dddd dddd dddd dddd [CR][LF]
[2nd Frame]   dddd dddd dddd dddd dddd dddd dddd dddd [CR][LF]
[3rd Frame]   dddd dddd dddd dddd dddd dddd dddd dddd [CR][LF]
[4th Frame]   dddd dddd dddd dddd dddd dddd dddd dddd [CR][LF]
[5th Frame]   dddd dddd dddd dddd dddd dddd dddd dddd [CR][LF]
[6th Frame]   dddd dddd dddd dddd dddd dddd dddd dddd [CR][LF]

    DATA       {High Byte
ARRANGEMENT    {Low Byte
```

Figure 6-10

Upon initial activation, a header consisting of the eight DAC channel numbers (CH0 through CH7) and the assigned channel parameter addresses (AAAA) are sent to the data logging device. Also, the most significant byte is shown first followed by the least significant byte.

DATA LOGGING UPDATE

Data logging information for each channel updates until the channel's data is captured and sent out. Although digital data inputs to the DAC (and subsequently the data logging information) are updated every CAL CONSOLE loop instruction, data logging information is only refreshed every 35 milliseconds (approximately every fifth CAL CONSOLE loop depending on the software loop time).

Each word of information transmits asynchronously to the data logging device. The transmitted word is formatted as follows:

- 1 start bit
- even parity
- 7 bit ASCII character
- 2 stop bits.

CONTROL LINES

Two control lines are used for asyncronous transmission of data to the data logging device:

- RTS (ready to send) signal output to the device on pin 5 of each port connector
- CTS (clear to send) signal input from the device on pin 3 of each port connector. Data is not sent until the CTS signal is received.

Data log information is asynchronous to the analog output update. The data is the most recent at the time a particular channel is issued to the data logging device.

USE OF THE DATA LOGGER FOR THE COMPARE FUNCTION

Initiating a comparison check with data logging enabled, all DAC processing stops, data logging is disabled and comparison results go to the data logging device then to the Cal Console display. To prevent unnecessary paper consumption, turn the DAC switch OFF and then enable the DATA LOG switch while executing a comparison check. Comparison results are still sent to the data logger even though the DAC is turned off.

Detected differences between the calibration contents of EPROM/MROM and the corresponding console RAM parameters display as shown (Figure 6-11):

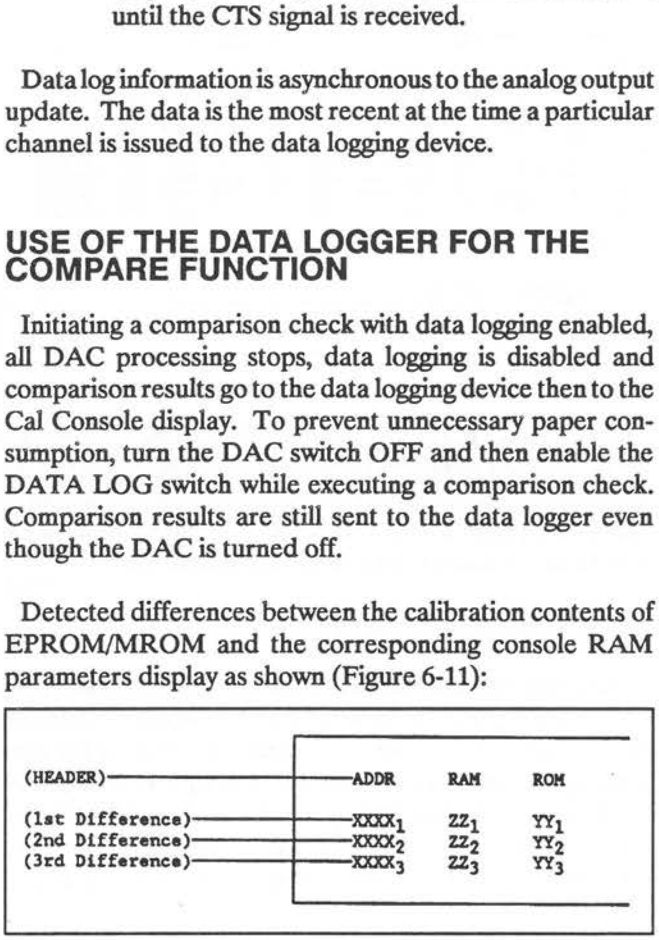


Figure 6-11

Where:

[XXXX] --4-digit hex address containing a difference
[YY] --Value in EPROM/MROM
[ZZ] --Value in console RAM

EXTENDED DATA LOGGER OPERATION OVERVIEW

Version 8.2 DAC assembly contains software which communicates formatted data to a multi-channel remote display. The communication software function is referred to as Extended Data Logging. The display can be any type of terminal, such as the TRS-80 Model 100. Communication to a remote display is provided through DAC Module port #1. A second device, such as a printer, is attached to port #2. The software also contains a PRINTER-ECHO option that simultaneously sends information to the remote display and printer.

NOTE: If a terminal and printer are connected to the DAC assembly, the terminal must be on port #1 for the printer to operate.

PORTABLE APPLICATIONS

For portable applications, a TRS-80 Model 100 is used as the remote display. The DAC Module can supply power to the unit by using an optional remote display cable, part #XF-252834-TRS.

CAUTION: If this cable is used, be careful, damage to the 2-AMP fuse on the Cal Console may occur.

The TRS-80 Model 100 contains a 40 character by 7 line LCD, and is used as a terminal by running the built-in program "TELCOM".

When the TRS-80 is reset, a menu displays the application programs that are available. Use the cursor control keys to select the TELCOM program. Once there, type the following character sequence to select proper configuration: STAT 67E2E <ENTER>. To enter the terminal mode, respond to the TELCOM prompt by typing TERM and the ENTER key. Then type "#" <ENTER> to enable extended data logging and start the configuration sequence.

Select option 3 in the terminal select menu in order for the DAC Module to properly truncate the display. When the Model 100 is used, the DAC sends the data for 7 channels only. The first seven channels are selected by default. Depressing the space bar at any time causes the display to "scroll", such that the last seven channels (1-7) are sent. The space bar causes the first seven channels to re-appear.

Restarting Configuration

The "#" character allows the operator to restart the configuration procedure from the beginning. This key is used to enter the configuration sequence when the display is updating. It is also used to re-start the configuration sequence if you decide to change the information programmed in a previous step.

The "!" character toggles the mode of the data logger from standard mode to extended mode, and back again. It is useful when you inadvertently enter configuration from the standard data logger mode. When the data logger mode is changed from the extended mode back to the standard mode, all configuration parameters are retained in the battery backed-up RAM.

System Reset

The ESC key provides a Master System Reset function in all the extended data logger routines. If the ESC key is pressed when the DAC is waiting for a key, a complete system re-initialization is performed, which clears all default values out, and the data logger is changed back to the standard operating mode. The master system reset forces all internal variables to their null value. It is recommended that after the ESC key is pressed, issue the DAC OFF command from the Cal Console, followed by the DAC ON command. This will assure that the SMP data is restored to the DAC along with the channel information and current system radix.

CONFIGURATION SEQUENCE

Extended data logger set-up is done by stepping through the configuration sequence. Once the configuration information has been programmed into the DAC Module, it is stored in battery-backed up RAM. This allows the DAC to use all previous entries as default values for each configuration option. After you enter a series of configuration parameters, exercise the default parameter option by simply responding to a data entry prompt by pressing the "Return" key. The data entry routine echoes the default parameter value to the screen and proceeds to the next step of the configuration sequence.

The data entry routine provides you with a full command line editor. The keys are:

KEY	MEANING
CONTROL-R	Show default entry and reprint the line
CONTROL-U OR "&"	Erase to beginning of line
DELETE	Erase one character and echo to screen
BACKSPACE	Erase one character and back-up the cursor
CARRIAGE RETURN	Accept input string
@	Exit the configuration sequence
#	Restart the configuration sequence from the beginning
!	Toggle back to the standard data logger mode
ESC	Master system reset

Figure 6-12

The configuration sequence establishes a maximum character length for each parameter. This value is always one character longer than the maximum valid value, in order to facilitate the use of the character deletion keys. (BACKSPACE, DEL, CTRL-U, and &). If the maximum character length is exceeded, the terminal beeps and the prompt is repeated. If the input string is entered and an invalid character is supplied, the beep is again issued and the prompt repeated.

When a default parameter exists, and the CTRL-R is the first key typed, the default parameter is echoed to the screen and the cursor is positioned directly after the last character. Any subsequent character typed is appended to the end of the parameter. You can use the character deletion keys to alter the default parameter without having to completely re-enter the string.

Altering Configuration Parameters

The use of the "@" character and the "Return" key provide a quick and easy means of altering the configuration parameters. Once the defaults are entered for the configuration sequence, the "Return" key passes you through each configuration step without changing the parameter. To quickly move through the configuration sequence, repeatedly depress the "Return" key until the desired option is displayed. After altering the desired parameter, depress the "@" character when the next configuration parameter is presented. All remaining parameters are set to the default value, and the configuration sequence is immediately exited. This function does not work during the first pass through the configuration sequence, since all of the parameters have not been established. When the GATHER mode is used, the "@" key is used to change the display format without having to collect new data.

Remote Display Operation

In order for the remote display to work properly, you must establish the exact character sequence required to "Home the Cursor" for the terminal in use. The first step of the configuration sequence is to specify the type of terminal being used for the remote display. The DAC software provides a menu of pre-defined terminal types, along with an option to specify the codes for any other type. The menu is invoked by typing the "#" character. The following terminals are available:

- D.E.C. VT100
- Lear Siegler ADM-3A or TeleVideo 950 or 925
- Radio Shack TRS-80 Model 100 portable computer
- Other

Make a selection by typing in a number from 1 to 4, and press the "Return" key. If you enter any other selection, the menu re-displays. If option four is selected, the DAC Module prompts specification of the exact character sequence required to "Home the Cursor". As each character is received, an "X" is echoed to the screen. The DAC accepts a maximum of seven characters. The "Return" key signals the end of the character sequence.

Data Field Display

After selecting the terminal type, the DAC prompts you to specify which data fields to display. Each of the three questions must be answered with either a "Y" or "N". All data entries are accepted when the "Return" key is pressed. Both upper and lower case characters are accepted. Whenever an invalid entry is entered, the terminal beeps, and the question is repeated. When the REAL number display is enabled, the DAC prompts you to select which form the REAL display is to use. Valid selections for the REAL display menu are 1 - 3. The remaining configuration sequence proceeds the same way. At any point in the configuration sequence, the user can restart the selection process by typing the "#" character.

DISPLAY FORMAT

The display shows data in either Integer, Binary or Engineering Units:

- Integer displays the unscaled binary data as it is received from the Cal Console.
- Binary can display a signed character depending upon the SMP data provided, with a length set to either a byte or word. The binary format shows strings of ones and zeros whose length is 8 characters for bytes or 16 characters for words.
- Engineering units is data converted to a practical number.

Any combination of these formats can be shown at one time. The real format display shows SMP scaled data in either scientific, engineering, or fixed decimal point notation.

Integer Display Form

The form of the integer display varies depending on:

- The system radix
- Whether the data is a byte or word
- Whether it is signed or unsigned

If the data is a byte, it is displayed with 2 or 3 digits depending upon the radix. If it is a word, 4 or 5 digits are used. If the data is signed, either a plus or minus character will precede the leading digit. Where it is unsigned, no sign character displays. Since sign characters display for signed parameters, the parameters themselves are not shown in 2's compliment format. In all cases the data is right justified in the field.

The second data display is for binary bit strings. If the data is a word, the string is 16 characters long, while a byte is 8 characters long. The most significant digit is to the left, and the left-most positions are filled with blanks when the data is a byte.

The last data field can display the data in scientific notation, engineering notation, or fixed point notation. When scientific notation is selected, the DAC displays data in the same format that the Cal Console uses. The DAC display does not exhibit the 2's compliment round-off error that the Cal Console usually does. If engineering notation is selected, the number of digits before the decimal point varies from 1 to 3, and the exponent is to the power of 3. The fixed point format aligns the data in a decimal field that provides 6 positions before, and 6 positions after it. If the data will not fit within this field, "*SCALE ERROR*" is displayed. This only occurs if the most significant digit does not fit in the decimal field. Any unused digits are truncated. Unused digits are those that wont fit in the decimal field to the right of the decimal point. The fixed point and the engineering formats do not pad the trailing decimal places with zeroes. Only the digits of actual precision are displayed numerically.

DISPLAY FORMAT

The extended data logger displays a maximum of eight lines of information, with a maximum of four data fields to a line. Each line contains the data for one DAC channel with the address, followed by data expressed in the user specified formats. The display provides three data display fields. The first field is used for INTEGER display format, the second is for BINARY format, and the third is for REAL display format. You are given the option to enable or disable each display field individually. When you enable the REAL display field, the option of selecting scientific, engineering or fixed decimal point notation are allowed. The following example shows how the display would appear if all fields were enabled, and engineering notation was selected for the REAL display. The first case is where the system radix is hex. In the second, the radix is decimal.

Extended data logger display with radix = HEX:

0	00BC	DB	11011000	27.000 E+00
1	0276	-706B	1000111110010101	-439.15 E-03
2	0012	C548	1100010101001000	50.504 E+03
3	00BA	+4B	01001011	+150.00 E+00
4	0102	A280	1010001010000000	650.00 E+00
5	0114	FFC0	1111111111000000	1.0239E+03
6	01B6	+0010	0000000000010000	+ 62.500 E-03
7	010F	ED	11101101	3.7034E+00

Extended data logger display with radix = DEC:

0	00BC	216	11011000	27.000 E+00
1	0276	-28779	1000111110010101	-439.15 E-03
2	0012	53699	1100010101001000	53.699 E+03
3	00BA	+075	01001011	+150.00 E+00
4	0102	41600	1010001010000000	650.00 E+00
5	0114	65472	1111111111000000	1.0239E+03
6	01B6	+00016	0000000000010000	+ 62.500 E-03
7	010F	237	11101101	3.7034E+00

The first field of the extended data logger display indicates which channel the line of data represents. The second field indicates the absolute address of that parameter. The address is always displayed in hexadecimal, regardless of the current system radix. The last three fields display the data in integer, binary, and scientific notation.

OPERATING MODES

The data logger runs in one of three modes:

- Continuous mode
- Sample and Repeat mode
- Gather mode

Continuous mode displays the most recent channel data at a continuous update rate. This mode is useful in observing changing data steams.

Sample and Repeat mode maintains the data for each channel in the same time frame. Pressing the "." key enables the Sample and Stop feature, which is used to hold-off the display update until the "Return" key is activated. A trigger condition is available which tests incoming data before it is displayed. When the trigger condition is used, only data that passes the trigger test is displayed.

Gather mode is the most powerful. It allows the DAC to record a sequence of real-time events, and save it in battery backed-up RAM for later study. The number of samples collected varies from 100 to 800 depending upon the number of active channels. A channel with address 0000 marks the first inactive channel. The sample rate is variable from the maximum rate of Cal Console data transfer, to once every 3.25 seconds. Once data has been collected, it can be studied by using the various Gather mode commands.

Continuous Mode

The first mode of operation is called the CONTINUOUS mode. In this mode, the DAC samples the channel data just before its conversion to ASCII formats. The most recent data is always displayed, however the time orientation between different channels is not maintained.

Sample/Repeat Mode

The second operating mode is called the Sample/Repeat mode. In this mode, all display data is kept within the same time frame. Just before channel 0 displays, the data for all eight channels is sampled and internally saved while the conversion routines convert the binary data into the specified formats. Within the Sample/Repeat mode there are two sub-options; the sample and stop option, and the trigger condition option.

The sample and stop option is enabled while the display is changing. When this option is not used, new data is sampled and displayed at the completion of each frame. For this configuration, the display operates the same way as CONTINUOUS update mode. When you press the "." key, the Sample and Stop option starts, which causes the DAC to finish displaying the current frame of data, and then stop. This allows examination of the data in the frame before it changes again. New data is sampled and displayed depending upon whether the second option (trigger condition) was selected. During the configuration sequence, the DAC prompts whether or not to use the trigger condition. If the response is NO, then when the Sample and Stop option is used, the next frame is displayed when the "Return" key is pressed. This allows MANUAL triggering of the display. Each time the "Return" key is pressed, the screen is cleared, new data for each channel is sampled, and it is displayed in the specified formats.

THE TRIGGER CONDITION

The trigger condition option is enabled in the configuration sequence and provides a logic analyzer type function for the multi-channel display. You have the option to specify a test condition in which the DAC tests all incoming data. When the test passes (i.e., the trigger condition is met), the last sample of data is displayed in the specified formats. The trigger condition works in conjunction with the Sample and Stop option in that when the Sample and Stop option is DISABLED, the display is updated every time the trigger condition is met. When the Sample and Stop option is ENABLED, you can activate the "Return" key and the DAC begins testing the incoming data with the trigger condition. When the test passes, the sample of data which passed is displayed, and the DAC waits for you to press the "Return" key again. The trigger condition is comprised of a one or two level test. When you specify a single level trigger condition, the result of the trigger test is the result of the level one test. If you specify a two level trigger test, then each level is tested independently, and the results of the two tests are logically related according to the user's configuration. This two level triggering scheme gives the DAC the functionality of a powerful logic analyzer. The results of the two level tests are related in one of two ways:

```
(level 1)  AND      (level 2)
(level 1)  OR       (level 2)
(level 1)  AND NOT  (level 2)
(level 1)  OR  NOT  (level 2)
```

The test for each level can take one of two forms. The first form is to test the data to see if it is within a specified range of values. The second form is to see if some or all of the bits in the binary data match a specified binary bit pattern. When the trigger option is selected in the configuration sequence, the DAC requires the channel number of the source data. This determines which data is used for the trigger test. Any of the eight data channels may be specified. The DAC then prompts whether to use the RANGE or PATTERN MATCH form of the trigger test.

Masking Pattern

If the PATTERN MATCH form of the trigger test is used, the DAC requires that you enter the Masking Pattern. The Masking Pattern is a series of ones and zeros that form a bit mask which is logically ANDed with the data before it is compared against the test pattern. The use of the bit mask allows testing of any combination of bits for any possible pattern. The DAC only accepts ones and zeros as valid data for the Mask Pattern, and the bits are accepted in a right justified manner. This means that if you enter three ones and press the "Return" key, the DAC creates a Masking Pattern that has the three least significant bits set. After the Mask Pattern is entered, the DAC requires that you enter the Data Pattern. The Data Pattern is the bit pattern used to compare against the result of the logical

AND between the source data and the Mask Pattern. This arrangement gives the flexibility of specifying any combination of ones and zeros for any combination of bits. The following example shows how a Mask Pattern and Data Pattern is entered:

```
Use range or bit pattern? (R/M): m
data for channel 7 is unsigned word
                      | | | | | | | |
Enter mask pattern:  1111000000000000
Enter data pattern:  1010000000000000
```

Figure 6-13

In the previous example, the high nibble of the data word on channel seven would be compared against hexadecimal "A".

The DAC contains SMP data concerning each of the eight channels of data. When requesting the Mask Pattern and the Data pattern, the DAC issues a prompt that confirms which channel was selected, states whether the data for that channel is signed or unsigned, and whether it is a byte or word. This data is provided for the following reason: If the source data is a byte, and you specify a bit string with one of the upper eight bits set, then the DAC doesn't accept the binary input string. If the Data Pattern contains a "1" in a digit position which does not have a corresponding "1" in the Mask Pattern, the trigger test for that level wont pass, thus the DAC doesn't accept the Data Pattern.

Trigger Test Range Form

The RANGE form of the trigger test is used when the source data is a numeric parameter, not a bit field. The test simply checks that the number is not below a lower limit or above an upper limit. In order to accommodate the needs of both Strategy Developers and Engine Calibrators, you specify the upper and lower limits in either direct binary or SMP scaled exponential notation. When the RANGE form of a trigger test is selected, the DAC prompts whether to use REAL format. If the response to this prompt is a "Y", the DAC accepts numbers for the upper and lower limits in any REAL format.

The following examples demonstrate valid forms of input when REAL format is selected.

```
1234.5
+1234.5E0
123.45E1
12.345E+2
1.2345E+03
+.000012345E+8
0.00000012345E+10
12345E-1
12345.0E-01
```

Figure 6-14

NOTE: All forms represent the same number.

The previous example illustrates that the sign or the decimal point need not be entered if the real number is also an integer. The exponent as a whole is optional along with its sign and tens digit. Upper and lower case is accepted for the "E" character. The REAL format input routine ignores all leading zeros when the mantissa is less than one. Since the maximum number of binary precision is 16 bits, the REAL format input routine first adjusts the exponent by removing all leading zeros, then it will accumulate the next five digits of the mantissa. If an "E" symbol is not encountered by the sixth digit, the routine assumes that none was supplied. The input routine accepts a maximum of five decimal digits <u>before</u> the decimal point, regardless of whether the decimal point is present or implied. This means that for the previous example, the data entry routine will not accept either 123450.0E-02 or 123450 as a valid REAL number.

Integer Data Acceptance

When the REAL format option is not used, the DAC accepts integer data for the low and high end of the range. The DAC issues a message as to which channel is selected, whether the data is signed or unsigned, whether it is a byte or word, and the current default system radix. Depending upon the current radix, you can enter the data in hex or decimal. The radix ban be forced by appending at the end of a number a "Q" for decimal or "H" for hex. Both upper and lower case are accepted. An optional sign character may precede the number, however the DAC rejects the data entry if a negative sign is specified for an unsigned parameter. The DAC also rejects the input if the quantity overflows the number of bits of precision; 7 bits for signed byte, 8 for unsigned byte, 15 for signed word, and 16 for unsigned word.

GATHER MODE

GATHER mode is the third mode of operation for the Extended Data Logger. It provides a custom logic analyzer function for the DAC Module. It is a completely self-contained operating system whose primary task is to gather data and test it against a provided trigger condition. It does not service any Cal Console functions other than the NEW data function, and it does not service any of the analog outputs. The GATHER mode allows the user to accumulate data samples in real-time, and save them in a non-volatile storage buffer for later study. The length of the buffer is adjustable by setting the address of one of the data channels to 0000. The sampling rate is adjustable from the nominal rate of update (about 20ms) to a maximum delay of one sample every 3.25 seconds. The sample hold-off count is specified in the configuration sequence as shown below:

```
Gather Buffer is 100 frames long
Default Radix is DEC
1 Sample Rate Delay Count = 200 microseconds
Enter delay count (2 - 16383): 200
Test for TRIGGER continuously? (Y/N): y
```

Figure 6-15

When you specify a large sample hold-off count, data is only sampled when the count has timed-out, and any data received prior to the timer "tick" is ignored. When a trigger condition is specified, you are given the option of testing all data received against the trigger conditions, or only data that is sampled when the timer "ticks". For example, specifying the maximum hold-off count (sample once every 3.25 seconds), and the continuous trigger prompt was answered with a "N" reply, the sample data will only be tested for trigger once every 3.25 seconds. If the continuous trigger prompt was answered with a "Y" reply, then when the triggering began, all incoming data would be tested, regardless of whether the hold-off count had expired. This option allows you to "catch" fast changing or spurious events within a stretched-out sample interval. The status of this option will have no effect when the hold-off count specifies a delay time that is smaller than the rate of Cal Console update.

Data Buffer Configuration

You can configure the data buffer to either 100 frames of 3 channels each, 200 frames of 4 channels each, 400 frames of 2 channels each, or 800 frames of 1 channel. When the GATHER mode is selected in the configuration sequence, the DAC checks to see if address 0000 was specified for any channel, and if so, the data buffer and frame width is re-configured so that only the ACTIVE channels are stored. Hence, address 0000 is used to MARK the 1st inactive channel, and any channel after the 1st one with address 0000 is not saved or displayed. For example, if channel 1 has address 0000 then only channel 0 is gathered, and the buffer is 800 frames long. If channel 2 has 0000 then only channels 0 and 1 are recorded and the buffer is 400 frames long. If either channel 3 or 4 has 0000, then channels 0 through 3 are recorded and the buffer is 200 frames long, otherwise all eight channels are accumulated and the buffer is 100 frames long. For the case where channel 3 has address 0000 and the buffer is 200 frames long, even though the data for channel 3 is stored in the buffer, the format routines will not display it. The same holds true for when either channel 5, 6, or 7 has address 0000 and the 100 frame buffer is used. This condition is necessary in order to keep the buffer lengths in even steps of 100. Fig. 6-16 shows the length of the overall sample interval for different buffer lengths and hold-off counts.

ACTIVE CHANNELS	BUFFER LENGTH	SAMPLE INTERVAL hold-off=100 cnts	SAMPLE INTERVAL hold-off=16383 c
channel 0	800 frames	16 seconds	43 min 41 sec
channels 0,1	400 frames	8 seconds	21 min 51 sec
channels 0-3	200 frames	4 seconds	10 min 55 sec
channels 0-7	100 frames	2 seconds	5 min 28 sec

Figure 6-16

When you specify a trigger condition, the collection function stops when the trigger occurs. If the trigger condition is not used, then the data gather stops when a key is pressed. You can specify that the trigger frame is to appear at the beginning, middle, or end of the buffer. If the trigger is to appear in the beginning of the buffer, then PRE-triggering is used, which means the buffer records the events that occur immediately AFTER the trigger event. The GATHER mode collects one complete buffer full of data AFTER the trigger event occurs. If POST-triggering is used, the trigger appears at the end of the buffer, and the data collection stops as soon as the trigger event occurs. The buffer records the events that occurred immediately BEFORE the trigger event. For MID triggering, the trigger event is centered in the data buffer.

The trigger position is selected in the configuration sequence as shown in Fig. 6-17:

```
Location of Trigger Frame
1 - Beginning of Buffer          :PRE  - triggering
2 - Middle of Buffer             :MID  - triggering
3 - End of Buffer                :POST - triggering
Selection (1-3): 2
```

Figure 6-17

Once the configuration is completed, the DAC begins collecting data samples. Depending upon whether a trigger condition was used, the DAC either prompts you to press a key when data collection is to start, or prompts to press a key to mark the trigger frame. In either case, you can abort the data collection function and return to the configuration sequence by pressing a key whenever one of the other Gather Mode messages is displayed.

After the trigger event occurs, and all post-trigger data has been collected (as in PRE and MID triggering), the handshake line to the Cal Console is brought low to stop all further data transfers. Next, the trigger frame is displayed, and you are allowed to study the data in the buffer by using one of several GATHER mode commands. The data collected during the GATHER sequence is maintained in internal battery backed-up RAM along with all the configuration parameters provided by you. This allows you to collect data with the GATHER Mode, and power-down the DAC without losing what was previously collected. In order to support this feature, the DAC, when first turned ON, always returns to the state it was in just before being turned OFF. When a CRT terminal is used with the GATHER mode, the menu of commands are shown directly below the data display (Fig. 6-18). When the TRS-80 is used, the menu is only displayed when an invalid command is typed.

```
0 0012  01537 0000011000000001     1537.0
1 0006  44185 1010110010011001    44185.
2 0006  44185 1010110010011001    44185.
3 0006  44186 1010110010011010    44186.
4 0006  44186 1010110010011010    44186.
5 0006  44187 1010110010011011    44187.
6 0006  44187 1010110010011011    44187.
7 0006  44188 1010110010011100    44188.
Frame Number  50  Selection:
          GATHER MODE OPTIONS
     "B" - beginning of buffer
     "E" - end of buffer
     "N" - next frame
     "P" - previous frame
     "+" - ahead 10 frames
     "-" - back 10 frames
     "F" - forward scan
     "R" - reverse scan
     "T" - trigger and gather new data
     "C" - enter configuration sequence
```

Figure 6-18

The "B" and "E" commands display the first and last frame in the buffer, and the "N" and "P" commands show the next and previous frames. The "+" and "-" commands are used to jump ahead or behind by 10 frames, and the "F" and "R" commands cause the display to automatically sequence through the buffer either forward or backward. The "T" command causes the gather mode to dump the current data buffer and collect new data, and the "C" command allows you to go back to the configuration sequence.

Summary

When you enter the GATHER Mode for the first time, the collection function is automatically performed to fill the data buffer with valid data. Once the collection function is complete and the frame data is displayed, you have the option of changing the form of the data display without losing the data currently in the data buffer (i.e., he may not want to re-trigger). When the configuration sequence is re-entered from the GATHER Mode, you may change the display format without invalidating the data buffer. At this time you can exit the configuration sequence, and goes directly back to the frame display function in the GATHER Mode. While in the configuration sequence, if you attempt to change either the mode, the trigger sequence, the hold-off count, or the trigger frame location, the data buffer is invalidated and the data collection function is re-invoked when the GATHER Mode is re-entered.

Because of the incompatibility between the GATHER Mode and the standard DAC operating system, the DAC goes through a full system re-initialization whenever you change from the GATHER Mode to one of the other data logger modes. When the DAC Module begins complete re-initialization, all system variables are reset, all default configuration is cleared, and the data logger is reset to the STANDARD Mode. The details for the format of standard data logger mode are outlined in the EEC-IV Calibration Development Support System Manual.

DAC MODULE MESSAGES

The DAC Module operating software includes extensive diagnostic capability which prevents invalid operation of the module. This capability also includes visual messages which are observed on the front panel display indicators. Figures 6-19 and 6-20 list the messages that are displayed by the DAC Module and provides interpretation. Messages are listed in alphabetical order to facilitate reference.

MESSAGE	MEANING
ALL HIGH	The console DAC LED is off, the DAC CALIBRATION select switch is set to the FULL SCALE position, and all output channels are at +10 volts.
ALL ZERO	The console DAC LED is off, the DAC CALIBRATION select switch is set to the ZERO SCALE position, and all output channels are at zero volts.
BAD	The CHANNEL SELECT switch is set to A or B. Do not use either of these two switch positions except to initiate diagnostic testing under power-up.
OVER RUN	This error can only occur if the DAC module receives too much data. The DAC Module power must be turned off and on before proceeding.
SE	Improper scale information has been assigned to the DAC channel. The channel output will remain at +10V until the digital input value is less than 100H (if the function switch is set to the "F0" position for 8-bit resolution) or less than 400H (if the function switch is set to "F1" position for 10-bit resolution).

Figure 6-19

MESSAGE	MEANING
VD2B OFF or V82K OFF	DAC Module has been turned off by the console. All output channels are at zero volts.
BATT LOW	Indicates that the voltage output of the lithium battery used for RAM data retention (when input power is removed) is low.
TIME BAD	Indicates that the internal real-time clock is not running.
RAMR FAIL	Indicates that the RAM is not retaining its contents when power is removed and restored during self-test. NOTE: This message is only valid when displayed during DAC self-test sequence. DAC will always display this message if powered up with CHANNEL SELECT switches set at position BB after operating the DAC in the standard operating mode.

Figure 6-20

Appendix A

BIT # / VALUE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	1	0
3	0	0	0	0	0	0	1	1
4	0	0	0	0	0	1	0	0
5	0	0	0	0	0	1	0	1
6	0	0	0	0	0	1	1	0
7	0	0	0	0	0	1	1	1
8	0	0	0	0	1	0	0	0
9	0	0	0	0	1	0	0	1
10	0	0	0	0	1	0	1	0
11	0	0	0	0	1	0	1	1
12	0	0	0	0	1	1	0	0
13	0	0	0	0	1	1	0	1
14	0	0	0	0	1	1	1	0
15	0	0	0	0	1	1	1	1
16	0	0	0	1	0	0	0	0
17	0	0	0	1	0	0	0	1
18	0	0	0	1	0	0	1	0
19	0	0	0	1	0	0	1	1
20	0	0	0	1	0	1	0	0
21	0	0	0	1	0	1	0	1

BIT # VALUE	7	6	5	4	3	2	1	0
22	0	0	0	1	0	1	1	0
23	0	0	0	1	0	1	1	1
24	0	0	0	1	1	0	0	0
25	0	0	0	1	1	0	0	1
26	0	0	0	1	1	0	1	0
27	0	0	0	1	1	0	1	1
28	0	0	0	1	1	1	0	0
29	0	0	0	1	1	1	0	1
30	0	0	0	1	1	1	1	0
31	0	0	0	1	1	1	1	1
32	0	0	1	0	0	0	0	0
33	0	0	1	0	0	0	0	1
34	0	0	1	0	0	0	1	0
35	0	0	1	0	0	0	1	1
36	0	0	1	0	0	1	0	0
37	0	0	1	0	0	1	0	1
38	0	0	1	0	0	1	1	0
39	0	0	1	0	0	1	1	1
40	0	0	1	0	1	0	0	0
41	0	0	1	0	1	0	0	1
42	0	0	1	0	1	0	1	0
43	0	0	1	0	1	0	1	1

BIT # / VALUE	7	6	5	4	3	2	1	0
44	0	0	1	0	1	1	0	0
45	0	0	1	0	1	1	0	1
46	0	0	1	0	1	1	1	0
47	0	0	1	0	1	1	1	1
48	0	0	1	1	0	0	0	0
49	0	0	1	1	0	0	0	1
50	0	0	1	1	0	0	1	0
51	0	0	1	1	0	0	1	1
52	0	0	1	1	0	1	0	0
53	0	0	1	1	0	1	0	1
54	0	0	1	1	0	1	1	0
55	0	0	1	1	0	1	1	1
56	0	0	1	1	1	0	0	0
57	0	0	1	1	1	0	0	1
58	0	0	1	1	1	0	1	0
59	0	0	1	1	1	0	1	1
60	0	0	1	1	1	1	0	0
61	0	0	1	1	1	1	0	1
62	0	0	1	1	1	1	1	0
63	0	0	1	1	1	1	1	1
64	0	1	0	0	0	0	0	0
65	0	1	0	0	0	0	0	1

BIT # / VALUE	7	6	5	4	3	2	1	0
66	0	1	0	0	0	0	1	0
67	0	1	0	0	0	0	1	1
68	0	1	0	0	0	1	0	0
69	0	1	0	0	0	1	0	1
70	0	1	0	0	0	1	1	0
71	0	1	0	0	0	1	1	1
72	0	1	0	0	1	0	0	0
73	0	1	0	0	1	0	0	1
74	0	1	0	0	1	0	1	0
75	0	1	0	0	1	0	1	1
76	0	1	0	0	1	1	0	0
77	0	1	0	0	1	1	0	1
78	0	1	0	0	1	1	1	0
79	0	1	0	0	1	1	1	1
80	0	1	0	1	0	0	0	0
81	0	1	0	1	0	0	0	1
82	0	1	0	1	0	0	1	0
83	0	1	0	1	0	0	1	1
84	0	1	0	1	0	1	0	0
85	0	1	0	1	0	1	0	1
86	0	1	0	1	0	1	1	0
87	0	1	0	1	0	1	1	1

BIT # / VALUE	7	6	5	4	3	2	1	0
88	0	1	0	1	1	0	0	0
89	0	1	0	1	1	0	0	1
90	0	1	0	1	1	0	1	0
91	0	1	0	1	1	0	1	1
92	0	1	0	1	1	1	0	0
93	0	1	0	1	1	1	0	1
94	0	1	0	1	1	1	1	0
95	0	1	0	1	1	1	1	1
96	0	1	1	0	0	0	0	0
97	0	1	1	0	0	0	0	1
98	0	1	1	0	0	0	1	0
99	0	1	1	0	0	0	1	1
100	0	1	1	0	0	1	0	0
101	0	1	1	0	0	1	0	1
102	0	1	1	0	0	1	1	0
103	0	1	1	0	0	1	1	1
104	0	1	1	0	1	0	0	0
105	0	1	1	0	1	0	0	1
106	0	1	1	0	1	0	1	0
107	0	1	1	0	1	0	1	1
108	0	1	1	0	1	1	0	0
109	0	1	1	0	1	1	0	1

BIT # / VALUE	7	6	5	4	3	2	1	0
110	0	1	1	0	1	1	1	0
111	0	1	1	0	1	1	1	1
112	0	1	1	1	0	0	0	0
113	0	1	1	1	0	0	0	1
114	0	1	1	1	0	0	1	0
115	0	1	1	1	0	0	1	1
116	0	1	1	1	0	1	0	0
117	0	1	1	1	0	1	0	1
118	0	1	1	1	0	1	1	0
119	0	1	1	1	0	1	1	1
120	0	1	1	1	1	0	0	0
121	0	1	1	1	1	0	0	1
122	0	1	1	1	1	0	1	0
123	0	1	1	1	1	0	1	1
124	0	1	1	1	1	1	0	0
125	0	1	1	1	1	1	0	1
126	0	1	1	1	1	1	1	0
127	0	1	1	1	1	1	1	1
128	1	0	0	0	0	0	0	0
129	1	0	0	0	0	0	0	1
130	1	0	0	0	0	0	1	0
131	1	0	0	0	0	0	1	1

BIT # / VALUE	7	6	5	4	3	2	1	0
132	1	0	0	0	0	1	0	0
133	1	0	0	0	0	1	0	1
134	1	0	0	0	0	1	1	0
135	1	0	0	0	0	1	1	1
136	1	0	0	0	1	0	0	0
137	1	0	0	0	1	0	0	1
138	1	0	0	0	1	0	1	0
139	1	0	0	0	1	0	1	1
140	1	0	0	0	1	1	0	0
141	1	0	0	0	1	1	0	1
142	1	0	0	0	1	1	1	0
143	1	0	0	0	1	1	1	1
144	1	0	0	1	0	0	0	0
145	1	0	0	1	0	0	0	1
146	1	0	0	1	0	0	1	0
147	1	0	0	1	0	0	1	1
148	1	0	0	1	0	1	0	0
149	1	0	0	1	0	1	0	1
150	1	0	0	1	0	1	1	0
151	1	0	0	1	0	1	1	1
152	1	0	0	1	1	0	0	0
153	1	0	0	1	1	0	0	1

BIT # / VALUE	7	6	5	4	3	2	1	0
154	1	0	0	1	1	0	1	0
155	1	0	0	1	1	0	1	1
156	1	0	0	1	1	1	0	0
157	1	0	0	1	1	1	0	1
158	1	0	0	1	1	1	1	0
159	1	0	0	1	1	1	1	1
160	1	0	1	0	0	0	0	0
161	1	0	1	0	0	0	0	1
162	1	0	1	0	0	0	1	0
163	1	0	1	0	0	0	1	1
164	1	0	1	0	0	1	0	0
165	1	0	1	0	0	1	0	1
166	1	0	1	0	0	1	1	0
167	1	0	1	0	0	1	1	1
168	1	0	1	0	1	0	0	0
169	1	0	1	0	1	0	0	1
170	1	0	1	0	1	0	1	0
171	1	0	1	0	1	0	1	1
172	1	0	1	0	1	1	0	0
173	1	0	1	0	1	1	0	1
174	1	0	1	0	1	1	1	0
175	1	0	1	0	1	1	1	1

BIT # / VALUE	7	6	5	4	3	2	1	0
176	1	0	1	1	0	0	0	0
177	1	0	1	1	0	0	0	1
178	1	0	1	1	0	0	1	0
179	1	0	1	1	0	0	1	1
180	1	0	1	1	0	1	0	0
181	1	0	1	1	0	1	0	1
182	1	0	1	1	0	1	1	0
183	1	0	1	1	0	1	1	1
184	1	0	1	1	1	0	0	0
185	1	0	1	1	1	0	0	1
186	1	0	1	1	1	0	1	0
187	1	0	1	1	1	0	1	1
188	1	0	1	1	1	1	0	0
189	1	0	1	1	1	1	0	1
190	1	0	1	1	1	1	1	0
191	1	0	1	1	1	1	1	1
192	1	1	0	0	0	0	0	0
193	1	1	0	0	0	0	0	1
194	1	1	0	0	0	0	1	0
195	1	1	0	0	0	0	1	1
196	1	1	0	0	0	1	0	0
197	1	1	0	0	0	1	0	1

BIT # / VALUE	7	6	5	4	3	2	1	0
198	1	1	0	0	0	1	1	0
199	1	1	0	0	0	1	1	1
200	1	1	0	0	1	0	0	0
201	1	1	0	0	1	0	0	1
202	1	1	0	0	1	0	1	0
203	1	1	0	0	1	0	1	1
204	1	1	0	0	1	1	0	0
205	1	1	0	0	1	1	0	1
206	1	1	0	0	1	1	1	0
207	1	1	0	0	1	1	1	1
208	1	1	0	1	0	0	0	0
209	1	1	0	1	0	0	0	1
210	1	1	0	1	0	0	1	0
211	1	1	0	1	0	0	1	1
212	1	1	0	1	0	1	0	0
213	1	1	0	1	0	1	0	1
214	1	1	0	1	0	1	1	0
215	1	1	0	1	0	1	1	1
216	1	1	0	1	1	0	0	0
217	1	1	0	1	1	0	0	1
218	1	1	0	1	1	0	1	0
219	1	1	0	1	1	0	1	1

BIT # / VALUE	7	6	5	4	3	2	1	0
220	1	1	0	1	1	1	0	0
221	1	1	0	1	1	1	0	1
222	1	1	0	1	1	1	1	0
223	1	1	0	1	1	1	1	1
224	1	1	1	0	0	0	0	0
225	1	1	1	0	0	0	0	1
226	1	1	1	0	0	0	1	0
227	1	1	1	0	0	0	1	1
228	1	1	1	0	0	1	0	0
229	1	1	1	0	0	1	0	1
230	1	1	1	0	0	1	1	0
231	1	1	1	0	0	1	1	1
232	1	1	1	0	1	0	0	0
233	1	1	1	0	1	0	0	1
234	1	1	1	0	1	0	1	0
235	1	1	1	0	1	0	1	1
236	1	1	1	0	1	1	0	0
237	1	1	1	0	1	1	0	1
238	1	1	1	0	1	1	1	0
239	1	1	1	0	1	1	1	1
240	1	1	1	1	0	0	0	0
241	1	1	1	1	0	0	0	1

BIT # / VALUE	7	6	5	4	3	2	1	0
242	1	1	1	1	0	0	1	0
243	1	1	1	1	0	0	1	1
244	1	1	1	1	0	1	0	0
245	1	1	1	1	0	1	0	1
246	1	1	1	1	0	1	1	0
247	1	1	1	1	0	1	1	1
248	1	1	1	1	1	0	0	0
249	1	1	1	1	1	0	0	1
250	1	1	1	1	1	0	1	0
251	1	1	1	1	1	0	1	1
252	1	1	1	1	1	1	0	0
253	1	1	1	1	1	1	0	1
254	1	1	1	1	1	1	1	0
255	1	1	1	1	1	1	1	1

Appendix B

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
-4	-15	4.882813E-04	-15.875	
-4	-14	9.765625E-04	-15.75	
-4	-13	1.953125E-03	-15.5	
-4	-12	3.90625E-03	-15	
-4	-11	.0078125	-14	
-4	-10	.015625	-12	
-4	-9	.03125	-8	
-4	-8	.0625	0	
-4	-7	.125	16	-8 - 0 - +8
-4	-6	.25	48	-24 - 0 - +24
-4	-5	.5	112	-56 - 0 - +56
-4	-4	1	240	-120 - 0 - +120
-4	-3	2	496	-248 - 0 - +248
-4	-2	4	1008	-504 - 0 - +504
-4	-1	8	2032	-1016 - 0 - +1016
-4	0	16	4080	-2040 - 0 - +2040
-4	1	32	8176	-4088 - 0 - +4088
-4	2	64	16368	-8184 - 0 - +8184
-4	3	128	32752	-16376 - 0 - +16376
-4	4	256	65520	-32760 - 0 - +32760
-4	5	512	131056	-65528 - 0 - +65528
-4	6	1024	262128	-131064 - 0 - +131064
-4	7	2048	524272	-262136 - 0 - +262136
-4	8	4096	1048560	-524280 - 0 - +524280
-4	9	8192	2097136	-1048568 - 0 - +1048568
-4	10	16384	4194288	-2097144 - 0 - +2097144
-4	11	32768	8388592	-4194296 - 0 - +4194296
-4	12	65536	1.67772E+07	-8.3886E06 - 0 - +8.3886E06
-4	13	131072	3.355442E+07	-1.677721E07 - 0 - +1.677721E07
-4	14	262144	6.710885E+07	-3.3554425E07 - 0 - +3.3554425E0
-4	15	524288	1.342177E+08	-6.710885E07 - 0 - +6.710885E07

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
-3	-15	2.441406E-04	-7.9375	
-3	-14	4.882813E-04	-7.875	
-3	-13	9.765625E-04	-7.75	
-3	-12	1.953125E-03	-7.5	
-3	-11	3.90625E-03	-7	
-3	-10	.0078125	-6	
-3	-9	.015625	-4	
-3	-8	.03125	0	
-3	-7	.0625	8	-8 - 0 - +8
-3	-6	.125	24	-12 - 0 - +12
-3	-5	.25	56	-28 - 0 - +28
-3	-4	.5	120	-60 - 0 - +60
-3	-3	1	248	-124 - 0 - +124
-3	-2	2	504	-252 - 0 - +252
-3	-1	4	1016	-508 - 0 - +508
-3	0	8	2040	-1020 - 0 - +1020
-3	1	16	4088	-2044 - 0 - +2044
-3	2	32	8184	-4092 - 0 - +4092
-3	3	64	16376	-8188 - 0 - +8188
-3	4	128	32760	-16380 - 0 - +16380
-3	5	256	65528	-32764 - 0 - +32764
-3	6	512	131064	-65532 - 0 - +65532
-3	7	1024	262136	-131068 - 0 - +131068
-3	8	2048	524280	-262140 - 0 - +262140
-3	9	4096	1048568	-524284 - 0 - +524284
-3	10	8192	2097144	-1048572 - 0 - +1048572
-3	11	16384	4194296	-2097148 - 0 - +2097148
-3	12	32768	8388600	-4194300 - 0 - +4194300
-3	13	65536	1.677721E+07	-8388605 - 0 - +8388605
-3	14	131072	3.355443E+07	-16777215 - 0 - +16777215
-3	15	262144	6.710886E+07	-33554430 - 0 - +33554430

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
-2	-15	1.220703E-04	-3.96875	
-2	-14	2.441406E-04	-3.9375	
-2	-13	4.882813E-04	-3.875	
-2	-12	9.765625E-04	-3.75	
-2	-11	1.953125E-03	-3.5	
-2	-10	3.90625E-03	-3	
-2	-9	.0078125	-2	
-2	-8	.015625	0	
-2	-7	.03125	4	-2 - 0 - +2
-2	-6	.0625	12	-6 - 0 - +6
-2	-5	.125	28	-14 - 0 - +14
-2	-4	.25	60	-30 - 0 - +30
-2	-3	.5	124	-62 - 0 - +62
-2	-2	1	252	-126 - 0 - +126
-2	-1	2	508	-254 - 0 - +254
-2	0	4	1020	-510 - 0 - +510
-2	1	8	2044	-1022 - 0 - +1022
-2	2	16	4092	-2046 - 0 - +2046
-2	3	32	8188	-4094 - 0 - +4094
-2	4	64	16380	-8190 - 0 - +8190
-2	5	128	32764	-16382 - 0 - +16382
-2	6	256	65532	-32766 - 0 - +32766
-2	7	512	131068	-65534 - 0 - +65534
-2	8	1024	262140	-131070 - 0 - +131070
-2	9	2048	524284	-262142 - 0 - +262142
-2	10	4096	1048572	-524286 - 0 - +524286
-2	11	8192	2097148	-1048574 - 0 - +1048574
-2	12	16384	4194300	-2097150 - 0 - +2097150
-2	13	32768	8388604	-4194302 - 0 - +4194302
-2	14	65536	1.677721E+07	-8388605 - 0 - +8388605
-2	15	131072	3.355443E+07	-16777215 - 0 - +16777215

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
-1	-15	6.103516E-05	-1.984375	
-1	-14	1.220703E-04	-1.96875	
-1	-13	2.441406E-04	-1.9375	
-1	-12	4.882813E-04	-1.875	
-1	-11	9.765625E-04	-1.75	
-1	-10	1.953125E-03	-1.5	
-1	-9	3.90625E-03	-1	
-1	-8	.0078125	0	
-1	-7	.015625	2	-1 - 0 - +1
-1	-6	.03125	6	-3 - 0 - +3
-1	-5	.0625	14	-7 - 0 - +7
-1	-4	.125	30	-15 - 0 - +15
-1	-3	.25	62	-31 - 0 - +31
-1	-2	.5	126	-63 - 0 - +63
-1	-1	1	254	-127 - 0 - +127
-1	0	2	510	-255 - 0 - +255
-1	1	4	1022	-511 - 0 - +511
-1	2	8	2046	-1023 - 0 - +1023
-1	3	16	4094	-2047 - 0 - +2047
-1	4	32	8190	-4095 - 0 - +4095
-1	5	64	16382	-8191 - 0 - +8191
-1	6	128	32766	-16383 - 0 - +16383
-1	7	256	65534	-32767 - 0 - +32767
-1	8	512	131070	-65535 - 0 - +65535
-1	9	1024	262142	-131071 - 0 - +131071
-1	10	2048	524286	-262143 - 0 - +262143
-1	11	4096	1048574	-524287 - 0 - +524287
-1	12	8192	2097150	-1048575 - 0 - +1048575
-1	13	16384	4194302	-2097151 - 0 - +2097151
-1	14	32768	8388606	-4194303 - 0 - +4194303
-1	15	65536	1.677721E+07	-8388605 - 0 - +8388605

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
0	-15	3.051758E-05	-.9921875	
0	-14	6.103516E-05	-.984375	
0	-13	1.220703E-04	-.96875	
0	-12	2.441406E-04	-.9375	
0	-11	4.882813E-04	-.875	
0	-10	9.765625E-04	-.75	
0	-9	1.953125E-03	-.5	
0	-8	3.90625E-03	0	
0	-7	.0078125	1	-.5 - 0 - +.5
0	-6	.015625	3	-1.5 - 0 - +1.5
0	-5	.03125	7	-3.5 - 0 - +3.5
0	-4	.0625	15	-7.5 - 0 - +7.5
0	-3	.125	31	-15.5 - 0 - +15.5
0	-2	.25	63	-31.5 - 0 - +31.5
0	-1	.5	127	-63.5 - 0 - +63.5
0	0	1	255	-127.5 - 0 - +127.5
0	1	2	511	-255.5 - 0 - +255.5
0	2	4	1023	-511.5 - 0 - +511.5
0	3	8	2047	-1023.5 - 0 - +1023.5
0	4	16	4095	-2047.5 - 0 - +2047.5
0	5	32	8191	-4095.5 - 0 - +4095.5
0	6	64	16383	-8191.5 - 0 - +8191.5
0	7	128	32767	-16383.5 - 0 - +16383.5
0	8	256	65535	-32767.5 - 0 - +32767.5
0	9	512	131071	-65535.5 - 0 - +65535.5
0	10	1024	262143	-131071.5 - 0 - +131071.5
0	11	2048	524287	-262143.5 - 0 - +262143.5
0	12	4096	1048575	-524287.5 - 0 - +524287.5
0	13	8192	2097151	-1048575.5 - 0 - +1048575.5
0	14	16384	4194303	-2097151.5 - 0 - +2097151.5
0	15	32768	8388607	-4194303.5 - 0 - +4194303.5

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
1	-15	1.525879E-05	-.4960938	
1	-14	3.051758E-05	-.4921875	
1	-13	6.103516E-05	-.484375	
1	-12	1.220703E-04	-.46875	
1	-11	2.441406E-04	-.4375	
1	-10	4.882813E-04	-.375	
1	-9	9.765625E-04	-.25	
1	-8	1.953125E-03	0	
1	-7	3.90625E-03	.5	-.25 - 0 - +.25
1	-6	.0078125	1.5	-.75 - 0 - +.75
1	-5	.015625	3.5	-1.75 - 0 - +1.75
1	-4	.03125	7.5	-3.75 - 0 - +3.75
1	-3	.0625	15.5	-7.75 - 0 - +7.75
1	-2	.125	31.5	-15.75 - 0 - +15.75
1	-1	.25	63.5	-31.75 - 0 - +31.75
1	0	.5	127.5	-63.75 - 0 - +63.75
1	1	1	255.5	-127.75 - 0 - +127.75
1	2	2	511.5	-255.75 - 0 - +255.75
1	3	4	1023.5	-511.75 - 0 - +511.75
1	4	8	2047.5	-1023.75 - 0 - +1023.75
1	5	16	4095.5	-2047.75 - 0 - +2047.75
1	6	32	8191.5	-4095.75 - 0 - +4095.75
1	7	64	16383.5	-8191.75 - 0 - +8191.75
1	8	128	32767.5	-16383.75 - 0 - +16383.75
1	9	256	65535.5	-32767.75 - 0 - +32767.75
1	10	512	131071.5	-65535.75 - 0 - +65535.75
1	11	1024	262143.5	-131071.75 - 0 - +131071.75
1	12	2048	524287.5	-262143.75 - 0 - +262143.75
1	13	4096	1048576	-524288 - 0 - +524288
1	14	8192	2097152	-1048576 - 0 - +1048576
1	15	16384	4194304	-2097152 - 0 - +2097152

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
2	-15	7.629395E-06	-.2480469	
2	-14	1.525879E-05	-.2460938	
2	-13	3.051758E-05	-.2421875	
2	-12	6.103516E-05	-.234375	
2	-11	1.220703E-04	-.21875	
2	-10	2.441406E-04	-.1875	
2	-9	4.882813E-04	-.125	
2	-8	9.765625E-04	0	
2	-7	1.953125E-03	.25	-.125 - 0 - +.125
2	-6	3.90625E-03	.75	-.375 - 0 - +.375
2	-5	.0078125	1.75	-.875 - 0 - +.875
2	-4	.015625	3.75	-1.875 - 0 - +1.875
2	-3	.03125	7.75	-3.875 - 0 - +3.875
2	-2	.0625	15.75	-7.875 - 0 - +7.875
2	-1	.125	31.75	-15.875 - 0 - +15.875
2	0	.25	63.75	-31.875 - 0 - +31.875
2	1	.5	127.75	-63.875 - 0 - +63.875
2	2	1	255.75	-127.875 - 0 - +127.875
2	3	2	511.75	-255.875 - 0 - +255.875
2	4	4	1023.75	-511.875 - 0 - +511.875
2	5	8	2047.75	-1023.875 - 0 - +1023.875
2	6	16	4095.75	-2047.875 - 0 - +2047.875
2	7	32	8191.75	-4095.875 - 0 - +4095.875
2	8	64	16383.75	-8191.875 - 0 - +8191.875
2	9	128	32767.75	-16383.875 - 0 - +16383.875
2	10	256	65535.75	-32767.875 - 0 - +32767.875
2	11	512	131071.8	-65535.9 - 0 - +65535.9
2	12	1024	262143.8	-131071.9 - 0 - +131071.9
2	13	2048	524287.8	-262143.9 - 0 - +262143.9
2	14	4096	1048576	-524288 - 0 - +524288
2	15	8192	2097152	-1048576 - 0 - +1048576

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
3	-15	3.814697E-06	-.1240234	
3	-14	7.629395E-06	-.1230469	
3	-13	1.525879E-05	-.1210938	
3	-12	3.051758E-05	-.1171875	
3	-11	6.103516E-05	-.109375	
3	-10	1.220703E-04	-.09375	
3	-9	2.441406E-04	-.0625	
3	-8	4.882813E-04	0	
3	-7	9.765625E-04	.125	-.0625 - 0 - +.0625
3	-6	1.953125E-03	.375	-.1875 - 0 - +.1875
3	-5	3.90625E-03	.875	-.4375 - 0 - +.4375
3	-4	.0078125	1.875	-.9375 - 0 - +.9375
3	-3	.015625	3.875	-1.9375 - 0 - +1.9375
3	-2	.03125	7.875	-3.9375 - 0 - +3.9375
3	-1	.0625	15.875	-7.9375 - 0 - +7.9375
3	0	.125	31.875	-15.9375 - 0 - +15.9375
3	1	.25	63.875	-31.9375 - 0 - +31.9375
3	2	.5	127.875	-63.9375 - 0 - +63.9375
3	3	1	255.875	-127.9375 - 0 - +127.9375
3	4	2	511.875	-255.9375 - 0 - +255.9375
3	5	4	1023.875	-511.9375 - 0 - +511.9375
3	6	8	2047.875	-1023.9375 - 0 - +1023.9375
3	7	16	4095.875	-2047.9375 - 0 - +2047.9375
3	8	32	8191.875	-4095.9375 - 0 - +4095.9375
3	9	64	16383.88	-8191.94 - 0 - +8191.94
3	10	128	32767.88	-16383.94 - 0 - +16383.94
3	11	256	65535.88	-32767.94 - 0 - +32767.94
3	12	512	131071.9	-65535.95 - 0 - +65535.95
3	13	1024	262143.9	-131071.95 - 0 - +131071.95
3	14	2048	524287.9	-262143.95 - 0 - +262143.95
3	15	4096	1048576	-524288 - 0 - +524288

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
4	-15	1.907349E-06	-6.201172E-02	
4	-14	3.814697E-06	-6.152344E-02	
4	-13	7.629395E-06	-6.054688E-02	
4	-12	1.525879E-05	-5.859375E-02	
4	-11	3.051758E-05	-.0546875	
4	-10	6.103516E-05	-.046875	
4	-9	1.220703E-04	-.03125	
4	-8	2.441406E-04	0	
4	-7	4.882813E-04	.0625	-.03125 - 0 - +.03125
4	-6	9.765625E-04	.1875	-.09375 - 0 - +.09375
4	-5	1.953125E-03	.4375	-.21875 - 0 - +.21875
4	-4	3.90625E-03	.9375	-.46875 - 0 - +.46875
4	-3	.0078125	1.9375	-.96875 - 0 - +.96875
4	-2	.015625	3.9375	-1.96875 - 0 - +1.96875
4	-1	.03125	7.9375	-3.96875 - 0 - +3.96875
4	0	.0625	15.9375	-7.96875 - 0 - +7.96875
4	1	.125	31.9375	-15.96875 - 0 - +15.96875
4	2	.25	63.9375	-31.96875 - 0 - +31.96875
4	3	.5	127.9375	-63.96875 - 0 - +63.96875
4	4	1	255.9375	-127.96875 - 0 - +127.96875
4	5	2	511.9375	-255.96875 - 0 - +255.96875
4	6	4	1023.938	-511.969 - 0 - +511.969
4	7	8	2047.938	-1023.969 - 0 - +1023.969
4	8	16	4095.938	-2047.969 - 0 - +2047.969
4	9	32	8191.938	-4095.969 - 0 - +4095.969
4	10	64	16383.94	-8191.97 - 0 - +8191.97
4	11	128	32767.94	-16383.97 - 0 - +16383.97
4	12	256	65535.94	-32767.97 - 0 - +32767.97
4	13	512	131071.9	-65535.95 - 0 - +65535.95
4	14	1024	262144	-131072 - 0 - +131072
4	15	2048	524288	-262144 - 0 - +262144

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
5	-15	9.536743E-07	-3.100586E-02	
5	-14	1.907349E-06	-3.076172E-02	
5	-13	3.814697E-06	-3.027344E-02	
5	-12	7.629395E-06	-2.929688E-02	
5	-11	1.525879E-05	-2.734375E-02	
5	-10	3.051758E-05	-.0234375	
5	-9	6.103516E-05	-.015625	
5	-8	1.220703E-04	0	
5	-7	2.441406E-04	.03125	-.015625 - 0 - +.015625
5	-6	4.882813E-04	.09375	-.046875 - 0 - +.046875
5	-5	9.765625E-04	.21875	-.109375 - 0 - +.109375
5	-4	1.953125E-03	.46875	-.234375 - 0 - +.234375
5	-3	3.90625E-03	.96875	-.484375 - 0 - +.484375
5	-2	.0078125	1.96875	-.984375 - 0 - +.984375
5	-1	.015625	3.96875	-1.984375 - 0 - +1.984375
5	0	.03125	7.96875	-3.984375 - 0 - +3.984375
5	1	.0625	15.96875	-7.984375 - 0 - +7.984375
5	2	.125	31.96875	-15.984375 - 0 - +15.984375
5	3	.25	63.96875	-31.984375 - 0 - +31.984375
5	4	.5	127.9688	-63.9844 - 0 - +63.9844
5	5	1	255.9688	-127.9844 - 0 - +127.9844
5	6	2	511.9688	-255.9844 - 0 - +255.9844
5	7	4	1023.969	-511.9845 - 0 - +511.9845
5	8	8	2047.969	-1023.9845 - 0 - +1023.9845
5	9	16	4095.969	-2047.9845 - 0 - +2047.9845
5	10	32	8191.969	-4095.9845 - 0 - +4095.9845
5	11	64	16383.97	-8191.985 - 0 - +8191.985
5	12	128	32767.97	-16383.985 - 0 - +16383.985
5	13	256	65535.97	-32767.985 - 0 - +32767.985
5	14	512	131072	-65536 - 0 - +65536
5	15	1024	262144	-131072 - 0 - +131072

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
6	-15	4.768372E-07	-1.550293E-02	
6	-14	9.536743E-07	-1.538086E-02	
6	-13	1.907349E-06	-1.513672E-02	
6	-12	3.814697E-06	-1.464844E-02	
6	-11	7.629395E-06	-1.367188E-02	
6	-10	1.525879E-05	-1.171875E-02	
6	-9	3.051758E-05	-.0078125	
6	-8	6.103516E-05	0	
6	-7	1.220703E-04	.015625	-.0078125 - 0 - +.0078125
6	-6	2.441406E-04	.046875	-.0234375 - 0 - +.0234375
6	-5	4.882813E-04	.109375	-.0546875 - 0 - +.0546875
6	-4	9.765625E-04	.234375	-.1171875 - 0 - +.1171875
6	-3	1.953125E-03	.484375	-.2421875 - 0 - +.2421875
6	-2	3.90625E-03	.984375	-.4921875 - 0 - +.4921875
6	-1	.0078125	1.984375	-.9921875 - 0 - +.9921875
6	0	.015625	3.984375	-1.9921875 - 0 - +1.9921875
6	1	.03125	7.984375	-3.9921875 - 0 - +3.9921875
6	2	.0625	15.98438	-7.99219 - 0 - +7.99219
6	3	.125	31.98438	-15.99174 - 0 - +15.99174
6	4	.25	63.98438	-31.99219 - 0 - +31.99219
6	5	.5	127.9844	-63.9922 - 0 - +63.9922
6	6	1	255.9844	-127.9922 - 0 - +127.9922
6	7	2	511.9844	-255.9922 - 0 - +255.9922
6	8	4	1023.984	-511.992 - 0 - +511.992
6	9	8	2047.984	-1023.992 - 0 - +1023.992
6	10	16	4095.985	-2047.9925 - 0 - +2047.9925
6	11	32	8191.985	-4095.9925 - 0 - +4095.9925
6	12	64	16383.99	-8191.995 - 0 - +8191.995
6	13	128	32767.99	-16383.995 - 0 - +16383.995
6	14	256	65535.99	-32767.995 - 0 - +32767.995
6	15	512	131072	-65536 - 0 - +65536

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
7	-15	2.384186E-07	-7.751465E-03	
7	-14	4.768372E-07	-7.69043E-03	
7	-13	9.536743E-07	-7.56836E-03	
7	-12	1.907349E-06	-7.324219E-03	
7	-11	3.814697E-06	-6.835938E-03	
7	-10	7.629395E-06	-5.859375E-03	
7	-9	1.525879E-05	-3.90625E-03	
7	-8	3.051758E-05	0	
7	-7	6.103516E-05	.0078125	-.0039062 - 0 - +.0039062
7	-6	1.220703E-04	.0234375	-.0117187 - 0 - +.0117187
7	-5	2.441406E-04	.0546875	-.0273437 - 0 - +.0273437
7	-4	4.882813E-04	.1171875	-.0585937 - 0 - +.0585937
7	-3	9.765625E-04	.2421875	-.1210937 - 0 - +.1210937
7	-2	1.953125E-03	.4921875	-.2460937 - 0 - +.2460937
7	-1	3.90625E-03	.9921875	-.4960937 - 0 - +.4960937
7	0	.0078125	1.992188	-.996094 - 0 - +.996094
7	1	.015625	3.992188	-1.996094 - 0 - +1.996094
7	2	.03125	7.992188	-3.996094 - 0 - +3.996094
7	3	.0625	15.99219	-7.996095 - 0 - +7.996095
7	4	.125	31.99219	-15.996095 - 0 - +15.996095
7	5	.25	63.99219	-31.996095 - 0 - +31.996095
7	6	.5	127.9922	-63.9961 - 0 - +63.9961
7	7	1	255.9922	-127.9961 - 0 - +127.9961
7	8	2	511.9922	-255.9961 - 0 - +255.9961
7	9	4	1023.992	-511.996 - 0 - +511.996
7	10	8	2047.992	-1023.996 - 0 - +1023.996
7	11	16	4095.992	-2047.996 - 0 - +2047.996
7	12	32	8191.992	-4095.996 - 0 - +4095.996
7	13	64	16383.99	-8191.995 - 0 - +8191.995
7	14	128	32767.99	-16383.995 - 0 - +16383.995
7	15	256	65535.99	-32767.995 - 0 - +32767.995

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
8	-15	1.192093E-07	-3.875733E-03	
8	-14	2.384186E-07	-3.845215E-03	
8	-13	4.768372E-07	-3.78418E-03	
8	-12	9.536743E-07	-3.66211E-03	
8	-11	1.907349E-06	-3.417969E-03	
8	-10	3.814697E-06	-2.929688E-03	
8	-9	7.629395E-06	-1.953125E-03	
8	-8	1.525879E-05	0	
8	-7	3.051758E-05	3.90625E-03	-.0019531 - 0 - +.0019531
8	-6	6.103516E-05	1.171875E-02	-.0058593 - 0 - +.0058593
8	-5	1.220703E-04	2.734375E-02	-.0136718 - 0 - +.0136718
8	-4	2.441406E-04	5.859375E-02	-.0292968 - 0 - +.0292968
8	-3	4.882813E-04	.1210938	-.0605469 - 0 - +.0605469
8	-2	9.765625E-04	.2460938	-.1230469 - 0 - +.1230469
8	-1	1.953125E-03	.4960938	-.2480469 - 0 - +.2480469
8	0	3.90625E-03	.9960938	-.4980469 - 0 - +.4980469
8	1	.0078125	1.996094	-.998047 - 0 - +.998047
8	2	.015625	3.996094	-1.998047 - 0 - +1.998047
8	3	.03125	7.996094	-3.998047 - 0 - +3.998047
8	4	.0625	15.99609	-7.998045 - 0 - +7.998045
8	5	.125	31.9961	-15.99805 - 0 - +15.99805
8	6	.25	63.9961	-31.99805 - 0 - +31.99805
8	7	.5	127.9961	-63.99805 - 0 - +63.99805
8	8	1	255.9961	-127.99805 - 0 - +127.99805
8	9	2	511.9961	-255.99805 - 0 - +255.99805
8	10	4	1023.996	-511.998 - 0 - +511.998
8	11	8	2047.996	-1023.998 - 0 - +1023.998
8	12	16	4095.996	-2047.998 - 0 - +2047.998
8	13	32	8191.996	-4095.998 - 0 - +4095.998
8	14	64	16384	-8192 - 0 - +8192
8	15	128	32768	-16384 - 0 - +16384

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
9	-15	5.960465E-08	-1.937866E-03	
9	-14	1.192093E-07	-1.922607E-03	
9	-13	2.384186E-07	-1.89209E-03	
9	-12	4.768372E-07	-1.831055E-03	
9	-11	9.536743E-07	-1.708984E-03	
9	-10	1.907349E-06	-1.464844E-03	
9	-9	3.814697E-06	-9.765625E-04	
9	-8	7.629395E-06	0	
9	-7	1.525879E-05	1.953125E-03	-.0009765 - 0 - +.0009765
9	-6	3.051758E-05	5.859375E-03	-.0029296 - 0 - +.0029296
9	-5	6.103516E-05	1.367188E-02	-.0068359 - 0 - +.0068359
9	-4	1.220703E-04	2.929688E-02	-.0146484 - 0 - +.0146484
9	-3	2.441406E-04	6.054688E-02	-.0302734 - 0 - +.0302734
9	-2	4.882813E-04	.1230469	-.0615234 - 0 - +.0615234
9	-1	9.765625E-04	.2480469	-.1240234 - 0 - +.1240234
9	0	1.953125E-03	.4980469	-.2490234 - 0 - +.2490234
9	1	3.90625E-03	.9980469	-.4990234 - 0 - +.4990234
9	2	.0078125	1.998047	-.9990235 - 0 - +.9990235
9	3	.015625	3.998047	-1.9990235 - 0 - +1.9990235
9	4	.03125	7.998047	-3.9990235 - 0 - +3.9990235
9	5	.0625	15.99805	-7.999025 - 0 - +7.999025
9	6	.125	31.99805	-15.999025 - 0 - +15.999025
9	7	.25	63.99805	-31.999025 - 0 - +31.999025
9	8	.5	127.9981	-63.99905 - 0 - +63.99905
9	9	1	255.9981	-127.99905 - 0 - +127.99905
9	10	2	511.9981	-255.99905 - 0 - +255.99905
9	11	4	1023.998	-511.999 - 0 - +511.999
9	12	8	2047.998	-1023.999 - 0 - +1023.999
9	13	16	4095.998	-2047.999 - 0 - +2047.999
9	14	32	8191.998	-4095.999 - 0 - +4095.999
9	15	64	16384	-8192 - 0 - +8192

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
10	-15	2.980232E-08	-9.689331E-04	
10	-14	5.960465E-08	-9.613037E-04	
10	-13	1.192093E-07	-9.460449E-04	
10	-12	2.384186E-07	-9.155273E-04	
10	-11	4.768372E-07	-8.544922E-04	
10	-10	9.536743E-07	-7.324219E-04	
10	-9	1.907349E-06	-4.882813E-04	
10	-8	3.814697E-06	0	
10	-7	7.629395E-06	9.765625E-04	-.0004882 - 0 - +.0004882
10	-6	1.525879E-05	2.929688E-03	-.0014648 - 0 - +.0014648
10	-5	3.051758E-05	6.835938E-03	-.0034179 - 0 - +.0034179
10	-4	6.103516E-05	1.464844E-02	-.0073242 - 0 - +.0073242
10	-3	1.220703E-04	3.027344E-02	-.0151367 - 0 - +.0151367
10	-2	2.441406E-04	6.152344E-02	-.0307617 - 0 - +.0307617
10	-1	4.882813E-04	.1240234	-.0620117 - 0 - +.0620117
10	0	9.765625E-04	.2490235	-.1245117 - 0 - +.1245117
10	1	1.953125E-03	.4990235	-.2495117 - 0 - +.2495117
10	2	3.90625E-03	.9990234	-.4995117 - 0 - +.4995117
10	3	.0078125	1.999024	-.999512 - 0 - +.999512
10	4	.015625	3.999024	-1.999512 - 0 - +1.999512
10	5	.03125	7.999024	-3.999512 - 0 - +3.999512
10	6	.0625	15.99902	-7.99951 - 0 - +7.99951
10	7	.125	31.99902	-15.99951 - 0 - +15.99951
10	8	.25	63.99903	-31.999515 - 0 - +31.999515
10	9	.5	127.999	-63.9995 - 0 - +63.9995
10	10	1	255.999	-127.9995 - 0 - +127.9995
10	11	2	511.999	-255.9995 - 0 - +255.9995
10	12	4	1023.999	-511.9995 - 0 - +511.9995
10	13	8	2047.999	-1023.9995 - 0 - +1023.9995
10	14	16	4095.999	-2047.9995 - 0 - +2047.9995
10	15	32	8191.999	-4095.9995 - 0 - +4095.9995

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
11	-15	1.490116E-08	-4.844666E-04	
11	-14	2.980232E-08	-4.806519E-04	
11	-13	5.960465E-08	-4.730225E-04	
11	-12	1.192093E-07	-4.577637E-04	
11	-11	2.384186E-07	-4.272461E-04	
11	-10	4.768372E-07	-3.66211E-04	
11	-9	9.536743E-07	-2.441406E-04	
11	-8	1.907349E-06	0	
11	-7	3.814697E-06	4.882813E-04	-.0002441 - 0 - +.0002441
11	-6	7.629395E-06	1.464844E-03	-.0007324 - 0 - +.0007324
11	-5	1.525879E-05	3.417969E-03	-.0017089 - 0 - +.0017089
11	-4	3.051758E-05	7.324219E-03	-.0036621 - 0 - +.0036621
11	-3	6.103516E-05	1.513672E-02	-.0075683 - 0 - +.0075683
11	-2	1.220703E-04	3.076172E-02	-.0153808 - 0 - +.0153808
11	-1	2.441406E-04	6.201172E-02	-.0310058 - 0 - +.0310058
11	0	4.882813E-04	.1245117	-.0622558 - 0 - +.0622558
11	1	9.765625E-04	.2495117	-.1247558 - 0 - +.1247558
11	2	1.953125E-03	.4995117	-.2497558 - 0 - +.2497558
11	3	3.90625E-03	.9995118	-.4997559 - 0 - +.4997559
11	4	.0078125	1.999512	-.999756 - 0 - +.999756
11	5	.015625	3.999512	-1.999756 - 0 - +1.999756
11	6	.03125	7.999512	-3.999756 - 0 - +3.999756
11	7	.0625	15.99951	-7.999755 - 0 - +7.999755
11	8	.125	31.99951	-15.999755 - 0 - +15.999755
11	9	.25	63.99951	-31.999755 - 0 - +31.999755
11	10	.5	127.9995	-63.99975 - 0 - +63.99975
11	11	1	255.9995	-127.99975 - 0 - +127.99975
11	12	2	511.9995	-255.99975 - 0 - +255.99975
11	13	4	1024	-512 - 0 - +512
11	14	8	2048	-1024 - 0 - +1024
11	15	16	4096	-2048 - 0 - +2048

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
12	-15	7.450581E-09	-2.422333E-04	
12	-14	1.490116E-08	-2.403259E-04	
12	-13	2.980232E-08	-2.365112E-04	
12	-12	5.960465E-08	-2.288818E-04	
12	-11	1.192093E-07	-2.136231E-04	
12	-10	2.384186E-07	-1.831055E-04	
12	-9	4.768372E-07	-1.220703E-04	
12	-8	9.536743E-07	0	
12	-7	1.907349E-06	2.441406E-04	-.000122 - 0 - +.000122
12	-6	3.814697E-06	7.324219E-04	-.0003662 - 0 - +.0003662
12	-5	7.629395E-06	1.708984E-03	-.0008544 - 0 - +.0008544
12	-4	1.525879E-05	3.66211E-03	-.001831 - 0 - +.001831
12	-3	3.051758E-05	7.56836E-03	-.0037841 - 0 - +.0037841
12	-2	6.103516E-05	1.538086E-02	-.0076904 - 0 - +.0076904
12	-1	1.220703E-04	3.100586E-02	-.0155029 - 0 - +.0155029
12	0	2.441406E-04	6.225586E-02	-.0311279 - 0 - +.0311279
12	1	4.882813E-04	.1247559	-.0623779 - 0 - +.0623779
12	2	9.765625E-04	.2497559	-.1248779 - 0 - +.1248779
12	3	1.953125E-03	.4997559	-.2498779 - 0 - +.2498779
12	4	3.90625E-03	.9997559	-.4998779 - 0 - +.4998779
12	5	.0078125	1.999756	-.999878 - 0 - +.999878
12	6	.015625	3.999756	-1.999878 - 0 - +1.999878
12	7	.03125	7.999756	-3.999878 - 0 - +3.999878
12	8	.0625	15.99976	-7.99988 - 0 - +7.99988
12	9	.125	31.99976	-15.99988 - 0 - +15.99988
12	10	.25	63.99976	-31.99988 - 0 - +31.99988
12	11	.5	127.9998	-63.9999 - 0 - +63.9999
12	12	1	255.9998	-127.9999 - 0 - +127.9999
12	13	2	511.9998	-255.9999 - 0 - +255.9999
12	14	4	1024	-512 - 0 - +512
12	15	8	2048	-1024 - 0 - +1024

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
14	-15	1.862645E-09	-6.055832E-05	
14	-14	3.72529E-09	-6.008148E-05	
14	-13	7.450581E-09	-5.912781E-05	
14	-12	1.490116E-08	-5.722046E-05	
14	-11	2.980232E-08	-5.340576E-05	
14	-10	5.960465E-08	-4.577637E-05	
14	-9	1.192093E-07	-3.051758E-05	
14	-8	2.384186E-07	0	
14	-7	4.768372E-07	6.103516E-05	-3.05E-05 - 0 - +3.05E-05
14	-6	9.536743E-07	1.831055E-04	-9.15E-05 - 0 - +9.15E-05
14	-5	1.907349E-06	4.272461E-04	-.0002136 - 0 - +.0002136
14	-4	3.814697E-06	9.155273E-04	-.0004577 - 0 - +.0004577
14	-3	7.629395E-06	1.89209E-03	-.000946 - 0 - +.000946
14	-2	1.525879E-05	3.845215E-03	-.0019226 - 0 - +.0019226
14	-1	3.051758E-05	7.751465E-03	-.0038757 - 0 - +.0038757
14	0	6.103516E-05	1.556397E-02	-.0077819 - 0 - +.0077819
14	1	1.220703E-04	3.118897E-02	-.0155944 - 0 - +.0155944
14	2	2.441406E-04	6.243897E-02	-.0312194 - 0 - +.0312194
14	3	4.882813E-04	.124939	-.0624695 - 0 - +.0624695
14	4	9.765625E-04	.249939	-.1249695 - 0 - +.1249695
14	5	1.953125E-03	.499939	-.2499695 - 0 - +.2499695
14	6	3.90625E-03	.9999389	-.4999694 - 0 - +.4999694
14	7	.0078125	1.999939	-.9999695 - 0 - +.9999695
14	8	.015625	3.999939	-1.9999695 - 0 - +1.9999695
14	9	.03125	7.999939	-3.9999695 - 0 - +3.9999695
14	10	.0625	15.99994	-7.99997 - 0 - +7.99997
14	11	.125	31.99994	-15.99997 - 0 - +15.99997
14	12	.25	63.99994	-31.99997 - 0 - +31.99997
14	13	.5	127.9999	-63.99995 - 0 - +63.99995
14	14	1	256	-128 - 0 - +128
14	15	2	512	-256 - 0 - +256

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
15	-15	9.313226E-10	-3.027916E-05	
15	-14	1.862645E-09	-3.004074E-05	
15	-13	3.72529E-09	-2.956391E-05	
15	-12	7.450581E-09	-2.861023E-05	
15	-11	1.490116E-08	-2.670288E-05	
15	-10	2.980232E-08	-2.288818E-05	
15	-9	5.960465E-08	-1.525879E-05	
15	-8	1.192093E-07	0	
15	-7	2.384186E-07	3.051758E-05	-1.52E-05 - 0 - +1.52E-05
15	-6	4.768372E-07	9.155274E-05	-4.57E-05 - 0 - +4.57E-05
15	-5	9.536743E-07	2.136231E-04	-.0001068 - 0 - +.0001068
15	-4	1.907349E-06	4.577637E-04	-.0002288 - 0 - +.0002288
15	-3	3.814697E-06	9.460449E-04	-.000473 - 0 - +.000473
15	-2	7.629395E-06	1.922607E-03	-.0009613 - 0 - +.0009613
15	-1	1.525879E-05	3.875733E-03	-.0019378 - 0 - +.0019378
15	0	3.051758E-05	7.781983E-03	-.0038909 - 0 - +.0038909
15	1	6.103516E-05	1.559448E-02	-.0077972 - 0 - +.0077972
15	2	1.220703E-04	3.121948E-02	-.0156097 - 0 - +.0156097
15	3	2.441406E-04	6.246948E-02	-.0312347 - 0 - +.0312347
15	4	4.882813E-04	.1249695	-.0624847 - 0 - +.0624847
15	5	9.765625E-04	.2499695	-.1249847 - 0 - +.1249847
15	6	1.953125E-03	.4999695	-.2499847 - 0 - +.2499847
15	7	3.90625E-03	.9999695	-.4999847 - 0 - +.4999847
15	8	.0078125	1.99997	-.999985 - 0 - +.999985
15	9	.015625	3.99997	-1.999985 - 0 - +1.999985
15	10	.03125	7.99997	-3.999985 - 0 - +3.999985
15	11	.0625	15.99997	-7.999985 - 0 - +7.999985
15	12	.125	31.99997	-15.999985 - 0 - +15.999985
15	13	.25	63.99997	-31.999985 - 0 - +31.999985
15	14	.5	128	-64 - 0 - +64
15	15	1	256	-128 - 0 - +128

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
16	-15	4.656613E-10	-1.513958E-05	
16	-14	9.313226E-10	-1.502037E-05	
16	-13	1.862645E-09	-1.478195E-05	
16	-12	3.72529E-09	-1.430512E-05	
16	-11	7.450581E-09	-1.335144E-05	
16	-10	1.490116E-08	-1.144409E-05	
16	-9	2.980232E-08	-7.629395E-06	
16	-8	5.960465E-08	0	
16	-7	1.192093E-07	1.525879E-05	-7.6E-06 - 0 - +7.6E-06
16	-6	2.384186E-07	4.577637E-05	-2.28E-05 - 0 - +2.28E-05
16	-5	4.768372E-07	1.068115E-04	-5.34E-05 - 0 - +5.34E-05
16	-4	9.536743E-07	2.288818E-04	-.0001144 - 0 - +.0001144
16	-3	1.907349E-06	4.730225E-04	-.0002365 - 0 - +.0002365
16	-2	3.814697E-06	9.613037E-04	-.0004806 - 0 - +.0004806
16	-1	7.629395E-06	1.937866E-03	-.0009689 - 0 - +.0009689
16	0	1.525879E-05	3.890991E-03	-.0019454 - 0 - +.0019454
16	1	3.051758E-05	7.797241E-03	-.0038986 - 0 - +.0038986
16	2	6.103516E-05	1.560974E-02	-.0078048 - 0 - +.0078048
16	3	1.220703E-04	3.123474E-02	-.0156173 - 0 - +.0156173
16	4	2.441406E-04	6.248474E-02	-.0312423 - 0 - +.0312423
16	5	4.882813E-04	.1249847	-.0624923 - 0 - +.0624923
16	6	9.765625E-04	.2499848	-.1249924 - 0 - +.1249924
16	7	1.953125E-03	.4999848	-.2499924 - 0 - +.2499924
16	8	3.90625E-03	.9999848	-.4999924 - 0 - +.4999924
16	9	.0078125	1.999985	-.9999925 - 0 - +.9999925
16	10	.015625	3.999985	-1.9999925 - 0 - +1.9999925
16	11	.03125	7.999985	-3.9999925 - 0 - +3.9999925
16	12	.0625	15.99999	-7.999995 - 0 - +7.999995
16	13	.125	31.99999	-15.999995 - 0 - +15.999995
16	14	.25	63.99999	-31.999995 - 0 - +31.999995
16	15	.5	128	-64 - 0 - +64

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
18	-15	1.164153E-10	-3.784895E-06	
18	-14	2.328307E-10	-3.755093E-06	
18	-13	4.656613E-10	-3.695488E-06	
18	-12	9.313226E-10	-3.576279E-06	
18	-11	1.862645E-09	-3.33786E-06	
18	-10	3.72529E-09	-2.861023E-06	
18	-9	7.450581E-09	-1.907349E-06	
18	-8	1.490116E-08	0	
18	-7	2.980232E-08	3.814697E-06	-1.9E-06 - 0 - +1.9E-06
18	-6	5.960465E-08	1.144409E-05	-5.7E-06 - 0 - +5.7E-06
18	-5	1.192093E-07	2.670288E-05	-1.33E-05 - 0 - +1.33E-05
18	-4	2.384186E-07	5.722046E-05	-2.86E-05 - 0 - +2.86E-05
18	-3	4.768372E-07	1.182556E-04	-5.91E-05 - 0 - +5.91E-05
18	-2	9.536743E-07	2.403259E-04	-.0001201 - 0 - +.0001201
18	-1	1.907349E-06	4.844666E-04	-.0002422 - 0 - +.0002422
18	0	3.814697E-06	9.727478E-04	-.0004863 - 0 - +.0004863
18	1	7.629395E-06	1.94931E-03	-.0009746 - 0 - +.0009746
18	2	1.525879E-05	3.902435E-03	-.0019512 - 0 - +.0019512
18	3	3.051758E-05	7.808686E-03	-.0039043 - 0 - +.0039043
18	4	6.103516E-05	1.562119E-02	-.0078105 - 0 - +.0078105
18	5	1.220703E-04	3.124619E-02	-.015623 - 0 - +.015623
18	6	2.441406E-04	6.249619E-02	-.031248 - 0 - +.031248
18	7	4.882813E-04	.1249962	-.0624981 - 0 - +.0624981
18	8	9.765625E-04	.2499962	-.1249981 - 0 - +.1249981
18	9	1.953125E-03	.4999962	-.2499981 - 0 - +.2499981
18	10	3.90625E-03	.9999962	-.4999981 - 0 - +.4999981
18	11	.0078125	1.999996	-.999998 - 0 - +.999998
18	12	.015625	3.999996	-1.999998 - 0 - +1.999998
18	13	.03125	7.999996	-3.999998 - 0 - +3.999998
18	14	.0625	16	-8 - 0 - +8
18	15	.125	32	-16 - 0 - +16

MINIMUM SHIFT VALUES
(0 OFFSET, FUNCTION F0)

BINARY POINT	SHIFT VALUE	MIN VALUE (ZP = 0V)	MAX VALUE (ZP = 0V)	RANGE (ZP = 5V)
25	-15	9.094947E-13	-2.956949E-08	
25	-14	1.818989E-12	-2.933666E-08	
25	-13	3.637979E-12	-2.8871E-08	
25	-12	7.275958E-12	-2.793968E-08	
25	-11	1.455192E-11	-2.607703E-08	
25	-10	2.910383E-11	-2.235174E-08	
25	-9	5.820766E-11	-1.490116E-08	
25	-8	1.164153E-10	0	
25	-7	2.328307E-10	2.980232E-08	-1.4901E-08 - 0 - +1.4901E-08
25	-6	4.656613E-10	8.940697E-08	-4.4703E-08 - 0 - +4.4703E-08
25	-5	9.313226E-10	2.086163E-07	-1.0E-07 - 0 - +1.0E-07
25	-4	1.862645E-09	4.470349E-07	-2.0E-07 - 0 - +2.0E-07
25	-3	3.72529E-09	9.23872E-07	-4.0E-07 - 0 - +4.0E-07
25	-2	7.450581E-09	1.877546E-06	-9.0E-07 - 0 - +9.0E-07
25	-1	1.490116E-08	3.784895E-06	-1.8E-06 - 0 - +1.8E-06
25	0	2.980232E-08	7.599592E-06	-3.7E-06 - 0 - +3.7E-06
25	1	5.960465E-08	1.522899E-05	-7.6E-06 - 0 - +7.6E-06
25	2	1.192093E-07	3.048778E-05	-1.52E-05 - 0 - +1.52E-05
25	3	2.384186E-07	6.100536E-05	-3.05E-05 - 0 - +3.05E-05
25	4	4.768372E-07	1.220405E-04	-6.1E-05 - 0 - +6.1E-05
25	5	9.536743E-07	2.441108E-04	-.000122 - 0 - +.000122
25	6	1.907349E-06	4.882515E-04	-.0002441 - 0 - +.0002441
25	7	3.814697E-06	9.765327E-04	-.0004882 - 0 - +.0004882
25	8	7.629395E-06	1.953095E-03	-.0009765 - 0 - +.0009765
25	9	1.525879E-05	3.90622E-03	-.0019531 - 0 - +.0019531
25	10	3.051758E-05	7.81247E-03	-.0039062 - 0 - +.0039062
25	11	6.103516E-05	1.562497E-02	-.0078124 - 0 - +.0078124
25	12	1.220703E-04	3.124997E-02	-.0156249 - 0 - +.0156249
25	13	2.441406E-04	6.249997E-02	-.0312499 - 0 - +.0312499
25	14	4.882813E-04	.125	-.0625 - 0 - +.0625
25	15	9.765625E-04	.25	-.125 - 0 - +.125

Appendix C

STRATEGY TERMS

A

A3C	Flag that is set if the A/C cycling pressure switch is closed and A/C panel switch is closed
A3CTMR	A/C state transition timer
ACBTMR	Time since brake was applied, secs
ACCFLG	A/C Engaged Flag (1 or 0)
ACCPM	Airflow increment required with A/C on
ACCUM	Accumulator for CL LAMBSE ramp increments. Used for jumpback when TSLEGO <= transport lag.
ACDFLG	Flag that is set to 1 which indicates that the A/C has been disabled
ACDHP	A/C Demand Hardware Present Flag (1 or 0)
ACDTMR	Time since A/C was disabled, secs
ACIFLG	A/C Engagement Impending Flag (1 or 0)
ACITMR	Time since the ISC began to respond to increased A/C load
ACMAP	An adder to LOWMAP when A/C is on
ACMNDT	Minimum A/C Disable time, secs
ACNTMR	Not at WOT mode, secs
ACOFFN	Low RPM condition at which the A/C should be disabled, RPM
ACPPM	Airflow increment required to A/C on.
ACSTRD	Time delay after start up before enabling A/C
ACT	Air Charge Temperature, deg F.
ACTFMM	Default value for ACT sensor, deg F.
ACTMIN	Minimum valid A/D value for ACT sensor, counts
ACTMAX	Maximum valid A/D value for ACT sensor, counts

ACWTMR	Time since WAC, secs
ADAPTM	Adaptive learning enable time delay, seconds
ADEFTR	Maximum transient fuel compensation fuel flow to allow adaptive learning, lb/sec
ADEGCT	Number of EGO switches required to permit Adaptive Learning within the cell boundaries
ADPTMR	Adaptive Learning Enable Timer
ADVLIM	maximum spark advance allowed for SPKAD registers, deg
AE	Acceleration Enrichment
AEACCL	Change in MAP indicating that the intake manifold is filling, Hg
AEDLMP	Minimum change in MAP to indicate manifold filling, in Hg
AEFUEL	Acceleration enrichment fuel flow, lb/hr
AELIM	Maximum acceleration enrichment fuel flow to allow adaptive learning, lb/hr
AEM	Multiplier used for development
AEMAP	Acceleration Enrichment Filtered MAP
AEOFLG	Indicates status of Manifold filling 1=manifold fulling, 0=stable engine.
AEPP	The AE pulse period as defined by FN332, seconds
AETAR	TAR above which AE may be enabled
AETP	Filtered TP for recognizing stable TP after AE
AFACT1	Minimum ACT to update Adaptive Fuel Table, deg F.
AFACT2	Maximum ACT to update Adaptive Fuel Table, deg F.
AFMFLG	ACT Failure flag set to 1 if the ACT fails range check
AISF	Actual Intake Surface Fuel Calculation, lb
AISFM	Multiplier on AISF when in DFSO. Determines Fuel Puddle size upon re-entering Normal Fuel
ALPHA	Multiplier proportioning the dependency of ACT to ECT

AM Air Mass flow

AMDESN Defines the desired engine speed below which air mass filtering can be enabled

AMPEM Air Mass plus EGR Mass Flow, lb/min

AMRPM Incremental adder to DSDRPM; total defines an engine speed limit below which air mass filtering can occur

AMRPMH Hysteresis term for AMRPM

AO Injector rate of fuel delivery, lb/sec

AOCOR Corrected fuel injector slope

APT Throttle Mode Flag -1=CT, 0=PT, 1=WOT.

ATMR1 Time since start-up (entering RUN mode), seconds

ATMR2 Time since coolant temperature reached TEMPFB degrees, seconds

ATMR3 Time since entering run mode, seconds

AWOTMR Time in WOT mode, seconds

B

B Multiplier to ramp first EGR turn-on

BASE_EM Fuel requirement based on EGR flow (non-displayable)

BASEFF Fuel amount to provide stoichiometric operation based on inducted air mass

BFULSW Calibration switch to force use of background calculation of fuel pulsewidth.

BGCNT Background counter used to pace the filtered AM algorithm

BGFUEL Background fuel pulsewidth, seconds

BIFLG Flag that is set if brake is applied

BIHP Brake On/off Switch Hardware Present Flag (1 or 0)

BPCOR Corrected BP

BPKAM BP pressure stored in KAM

BPKFLG	KAM flag indicating state of BPKYON
BPKYON	Calculated BP while KEY ON
BPPTWT	BP calculated during PT or WOT
BPUFLG	Flag which indicates that BP update is or is not permitted
BRKCOT	Maximum time that the A/C is disabled after the brakes are applied, secs
BYPTMR	Thermactor air bypass-enable timer, secs
BYSTM8	Time delay to bypass air during decel
BZZRPM	RPM adder intended to provide a short increase in RPM for engine cleanout on start-up
BZZTM	Time for which BZZRPM adder is in effect

C

C31FIL	Self-test register which counts the number of PFE EGR low failures or EVP low failures
C32FIL	Continuous Self Test fault counter for low EPT sensor signal at idle
C34FIL	Continuous Self Test fault counter for high EPT sensor signal at idle
C35FIL	Self Test register which counts the number of PFE EGR high failures or EVP high failures
C41FIL	Continuous Self Test fault counter which counts the number of EGO1 sensor failures
C51FIL	Self Test register which counts the number of ECT low failures
C53FIL	Self Test register which counts the number of TP high failures
C54FIL	Self Test register which counts the number of ACT low failures
C61FIL	Self Test register which counts the number of ECT high failures

C63FIL	Self Test register which counts the number of TP low failures
C64FIL	Self test register which counts the number of ACT high failures
C91FIL	Continuous Self Test fault counter which counts the number of EGO2 sensor failures
C31LVL, C32LVL, C34LVL, C35LVL	Threshold level for storing the respective fault code during Continuous Self Test. The FMEM strategy uses these thresholds to delay EPT recovery recognition until confident that the recovery is permanent
C41LVL	Threshold level for recognition of EGO1 failure
C51LVL	Threshold level for recognition of ECT low failure
C53LVL	Threshold level for recognition of TP high failure
C54LVL	Threshold level for recognition of ACT high failure
C61LVL	Threshold level for recognition of ECT high failure
C63LVL	Threshold level for recognition of TP low failure
C64LVL	Threshold level for recognition of ACT low failure
C91LVL	Threshold level for recognition of EGO2 failure
C53UP	Counter to increment C53FIL
C63UP	Counter to increment C63FIL
CANPHP	EEC-controlled Canister Purge Hardware Present Flag (1 or 0)
CCALTC	Converter clutch lockup altitude compensation factor
CFMFLG	ECT Failure flag set to 1 if the ECT fails range check
CHGRPM	Maximum RPM delta above base to enable battery charge, I/M logic
CHGTM	Time delay after leaving closed throttle to permit VOLTMR to decrement, secs
CHKAIR	Thermactor Forced Open Loop Flag. 0=open loop, 1=closed loop.
CHKSUM	KAM word containing the sum of the LTMTBL contents

CIBETA	Number of PIPs to delay Bank A from rising edge of Signature PIP
CL	Closed Loop
CLDEGO	Time delay at idle to set WRMEGO at 0
COLTBU	Column address of Adaptive cell to be updated
CRKFLG	Flag indicating engine mode. 1=cranking. 0=underspeed or run
CRKPIP	Number of PIPs between injector firing
CRKTIM	Time in run mode to clear 100% cranking duty cycle
CRKTMR	Timer indicating time in crank mode
CSSFLG	Cold Start Spark Flag (1 or 0)
CSSMAF	Cold Start spark DESMAF multiplier
CTAC	Overheat temperature to disable A/C, deg F.
CTDSFO	Time at closed throttle for DFSO, seconds
CTEDSO	Time at extended decel for DFSO, seconds
CTEHI	A calibration constant for minimum engine coolant temperature to enable EPTZER at idle
CTFFLG	Stuck in WOT Flag
CTFLG	Flag set to 1 to indicate CT tip-in
CTHIGH	Hot start engine coolant temp, deg F.
CTLOW	Cold start engine coolant temp, deg F.
CTOLDC	Time at closed throttle before open loop decel, seconds
CTPTFG	Closed throttle to PT/WOT transition Flag
CTTIME	Minimum time unlocked after closed throttle, secs
CTTMR	Time at closed throttle, seconds
CWCTR	Cancel Window Counter incorporated each PIP period

D

D	Decel fuel shutoff multiplier
DACTM	Time to maintain A/C RPM adder after A/C has been disengaged
DASPOT	ISC dashpot pre-position airflow
DASPTK	Gain associated with the desired DASPOT airflow
DASPTO	An offset term applied to the DASPOT calculation
DATA_TIME	Current time
DCOFF	Duty cycle required to start to open the valve equivalent to LGAOD in the Vent/Vac system
DDVS	Maximum vehicle speed, MPH
DDVSH	Hysteresis for maximum vehicle speed, MPH
DEBYCP	Minimum allowed airflow through the ISC actuator
DELAMB	Deadband (around LAMBSE = 1.0) within which loop counter values are not altered
DELCOL	Calibration constant (normalized engine speed N) which provides the ability to lock out table updates under transient conditions; establishes an operating range (engine speed) within which the appropriate loop counter may be incremented
DELOPT	Filtered desired EGR valve position
DELPR	Pressure drop across the control orifice
DELRAT	Throttle position adder to RATCH
DELROW	Same function as DELCOL but for normalized load MAPOPE
DELTA	CT/PT breakpoint value above RATCH
DELTAM	Air mass delta to enter/exit filtered air mass region at idle
DELTIM	Time since last AISF update, sec
DESDP	Filtered desired downstream pressure
DESEM	Desired EM

DESHYS	Hysteresis for MINDES
DESMAF	The desired airflow necessary to operate at a specified idle condition
DESNLO	High cam portion of the DSDRPM register
DFMIN0	Minimum number of TLOFLG 1 to 0 state changes required to use steady state spark
DFMIN1	Minimum number of TLOFLG 0 to 1 state changes required to use transient spark
DFNDSW	Decel fuel neutral/drive switch: 0=use N/D input, 1=ignore N/D input.
DFNOVS	NOVS value below which DFSO is permitted. Used to disable DFSO in lower transmission gears to prevent large torque changes
DFSECT	Minimum ECT to do DFSO
DFSMAP	Minimum MAP to do DFSO
DFSMPH	Hysteresis value for DFSMAP
DFSO	Decel Fuel Shut-off
DFSVS	Minimum vehicle speed to do DFSO
DFSVSH	Hysteresis value for DFSVS
DIFF0	Steady State Spark TLO error
DIFF1	Transient Spark TLO error
DIFCTR	Counter for TLOFLG state changes
DIS_FMFLG	Flag which is set when any fault filter exceeds threshold
DNAC	RPM increment requested with the A/C on
DNDSUP	Delayed Neutral/Drive flag: 0=Neutral, 1=Drive.
DNPOWS	If a power steering pressure switch is used, this parameter increments the desired RPM when an increased load is sensed
DNPPN	Feed forward mechanism for fuel control. Decrements filtered air mass for drive/neutral transition

DOLHP	Data Output Link Hardware Present Flag (1 or 0)
DP	Downstream Pressure
DP'	PE - DESDEL
DPI	Dual Plug Inhibit
DPICS	Flag which is set when DPI_STATE changes state and cleared in VIP
DPICTR	Counter used in VIP to delay IDM processing after DPI_STATE changes state
DPI_STATE	Flag indicating when dual plug is enabled (1 or 0)
DPLGHP	Dual Plug Hardware Present Flag (1 or 0)
DRBASE	Base desired engine speed in drive
DSDRPM	Desired engine speed
DSEFTR	Special display version of EFTR
DSFFLG	Decel Fuel Shut-off Flag. 1=decel fuel shut-off.
DSFRPH	Hysteresis value for DSFRPM
DSFRPM	Minimum RPM for DFSO
DSFTM	Time delay before DFSO, seconds
DSLMBS	Special display version of LAMBSE
DT12S	The value, in clock ticks, of the current pip period
DT12SA	An accumulation of DT12S over a SCAP averaging period
DT23S	Previous PIP period before DT12S
DTPCYC	PIP period ENGCYL for 2 cylinders previous
DTSIG	PIP period of last signature PIP
DWLBSE	Base amount of dwell as a function of VBAT and DEMDWL, seconds
DWLTBP	Temperature switch point that controls function use, deg F.
DWLTOT	Dwell_Turn_On_Time; the time when the SPOUT output will transition from high to low

DWLWF	Weighting factor determining effect of ECT and ACT on Base Dwell, unitless

E

EACTMX	Maximum ACT to enable EGR, deg F.
EACTMH	Hysteresis for EGR disable ACT, deg F.
ECT	Engine Coolant Temperature
ECT301	Minimum ECT for using FN301, closed throttle fuel multiplier, deg F.
ECTBP	Temperature at which inferred BP in enabled
ECTCNT	Number of times ECT sensor input was read
ECTFMM	Default value for ECT sensor, deg F.
ECTIP	Minimum ECT to enable tip-in knock logic, deg F
ECTMIN	Minimum valid A/D value for ECT sensor, counts
ECTMAX	Maximum valid A/D value for ECT sensor, counts
ECTNOK	Minimum ECT to enable Knock Strategy, deg F
EECTMX	Maximum ECT to enable EGR, deg F.
EECTMH	Hysteresis for EGR disable ECT, deg F.
EFFLG1	Equilibrium Fuel Transfer Flag
EFMFLG	Flag indicating that PFE or EVP has failed
EFTR	Transient fuel compensation fuel flow, lb/sec
EFTRFF	Equilibrium fuel transfer rate for transient fuel compensation, lb/min
EGOCL1	Number of EGO switches required to enter CL
EGOCNT	Number of EGO switches required before allowing updates to the Adaptive Fuel cell
EGOSSS	Number of EGO switches since start-up
EGRACT	Filtered actual EGR percentage
EGRATE	Desired EGR rate in percent

EGRDC	Desired EVR duty cycle
EGRDED	Deadband value for IEVP
EGRFLG	Flag which indicates whether DCOFF has been added to EGRDC
EGRTB1	Throttle angle breakpoint to disable EGR, counts
EGRTD1	Hot Start Time Delay before enabling EGR, secs
EGRTD2	Time delay before enabling EGR when the coolant temperature at Start-up is mid-range, secs
EGRTD3	Cold start Time Delay before enabling EGR after the coolant temperature exceeds TEMPFB, secs
EGRTD4	Hot Start Time Delay before enabling EGR, secs
EGRTD5	Time Delay before enabling EGR when the coolant temp at start-up was in the midrange, secs
EGRTD6	Cold Start Time Delay before enabling EGR after the coolant temp exceeds TEMPFB, secs
EGRTD7	Calibration time delay to ramp on EGR, sec
EGRTD8	Time Delay at part throttle before EGR enabled
EGRTMR	Accumulated time EGR is enabled, secs
EGTB1H	Hysteresis for EGR disable throttle angle, counts
EM	EGR mass indicted, lb/min
ENGCYL	Number of PIPs (or injections) per revolution
EOFF	The EGR valve reading when the valve is full closed in A/D counts
EPTBAR	Rolling average of the EPT sensor
EPTSW	A calibration switch to enable or disable rolling average EPTZER at idle
EPTZER	Rolling average of the EPT sensor at idle
ETLUMN	Low temperature limit for lockup, deg F.
ETLUMX	High temperature limit for lockup, deg F.
EVPMIN	Minimum EGR valve position, counts

EVPMAX	Maximum EGR valve position, counts

F

FAEGCT	Fast Adaptive EGO count. Number of EGO switches required to permit adaptive learning when KWUCTR < KWUCNT. Should be set to 0 to permit fast adaptive learning for the first few warm-up cycles.
FAM	Filtered Air Mass
FAMINC	FAM increment/decrement when entering FAM region
FAMLIM	Establishes a pseudo-deadband approximately centered around the instantaneous AM into which the filtered AM is driven
FAMREG	register for development purposes which indicates what register is feeding the AM register used in the fuel calculation
FFULC	The constant that is added in the foreground fuel pulsewidth equation, lb/cyl
FFULFG	Foreground fuel flag (1 or 0)
FFULM	The value that is multiplied by MAP_WORD in the foreground fuel pulsewidth equation, lb/cyl
FILHYS	Hysteresis term to permit normal TP update, if sensor is functioning normally
FIRST_PIP	Flag indicating first PIP has been received
FKBP	BPPTWT filter constant
FKDESN	Filter constant for the desired engine speed calculated value
FKDLOP	Filter constant for DELOPT
FKEACT	Filter constant for EFRACT
FKMKAY	Filter constant of update rate to MKAY
FKSKAY	Filter constant of update rate to SIGKAL
FKTAR	S/W TAR "down" filter constant
FK_TMR	Sampling rate, secs

FMAP1	Frequency below which MAP sensor does not provide accurate data
FMAP2	Frequency above which MAP sensor does not provide accurate data
FMDTM	Time delay after fault is detected to start flashing MIL, secs
FMECNT	Number of background loops between incrementing/decrementing ECT register by 2 deg F.
FMECTR	Background loop counter used to ramp failed ECT from ACT in CRANK mode to ECTFMM
FMMDSD	Failure mode management default desired RPM
FN002A	VACCOR normalizing function for A4LD, in Hg
FN003A	TP normalizing function for A4LD, counts
FN004	Empirical correction to PEXH for altitude with input a function of barometric pressure
FN022A	Temperature normalizing function as x-input to FN1321 and FN1322
FN046A	Normalizing function for AM/BP as Y-input to FN1033
FN047A	Normalizing function for TP input to FN1033
FN071	MAPBAR normalizing function as y-input to FN1321 and FN1322
FN074	Upstream pressure as a function of (AM * KAMREF)
FN074A	Exhaust pressure as a function of AM
FN090	Change in TP as a function of MAP
FN099	Predicted Manifold vacuum during CRANK
FN143	Retard Increment as function of N
FN144	Width of KTS as a function of N, fraction of PIP period
FN145	Position of KTS as a function of N, fraction of PIP period
FN146B	Spark Advance Rate as a function of N, secs
FN151	An Octane Table Multiplier vs ECT

FN152	An Octane Table Multiplier vs ACT
FN153	An Adder during WOT Fuel Enrichment
FN160A	Minimum DWELL time versus VBAT (below 77 deg F.)
FN160B	Minimum DWELL time versus VBAT (above 77 deg F.)
FN180	Idle spark subtractor
FN211	Multiplier as a function of Engine Coolant Temperature ECT
FN212A	Multiplier as a function of BP
FN218	Ratio of mass flow to choked flow as a function of MAP/PEXH
FN219	EGR mass flow as a function of DELPR
FN220	EGR multiplier vs ACT
FN221	Desired pressure drop as a function of desired EM
FN239	Change in EVR duty cycle as a function of the pressure error
FN301	Multiplier for closed throttle as a function of engine speed N
FN303	Multiplier for WOT as a function of engine speed N
FN305	Multiplier of air mass as a function of ACT, deg F.
FN306	Cranking fuel pulsewidth multiplier vs. time in crank, sec.
FN307	MTEFTC Multiplier as a function of N
FN310	WOT fuel multiplier as a function of time in WOT mode.
FN312	Air/fuel bias: negative =>rich, positive=>lean.
FN326	Multiplier of air mass as a function of ECT, deg F.
FN331A	A multiplier as a function of the present throttle angle minus the lowest measured throttle angle
FN332	AE fuel pulse period as a function of desired AE fuel flow
FN348	Cranking fuel PW as a function of ECT, sec.

FN367	Injector offset as a function of VBAT
FN371	LAMMUL multiplier as a function of ECT for Neutral to Drive transitions
FN378	Multiplier as a function of BP
FN379	Multiplier as a function of NBAR
FN387	Underspeed fuel pulsewidth multiplier as a function of ECT
FN397	Maximum MAPPA value for MPG mode
FN398	Minimum MAP value for MPG mode
FN399	Minimum VSBAR value for MPG mode
FN686	Inferred converter clutch slip RPM multiplier, counts
FN703	ECT/ACT transfer function
FN800	Transfer function for the ISC actuator
FN820A	ISC duty cycle multiplier vs manifold absolute pressure
FN821A	RPM adder as a function of VOLTMR to provide battery charge control
FN824A	Gain multiplier vs RPMERR
FN825A	RPM adder as a function of ECT
FN825B	RPM adder as a function of ACT
FN826A	RPM adder as a function of ECT at start
FN839	Spark multiplier as a function of dashpot air flow
FN841	Spark multiplier as a function of RPM error
FN860	Function which paces the integration of C/L RPM correction
FN862	Decel MAP value as a function of BP
FN875D	Airflow required for closed throttle operation in drive
FN875N	Airflow required for closed throttle operation in neutral

FN879	A background driven decrement to the dashpot preposition airflow register
FN880	DSDRPM adder vs time at idle
FN882	DASPOT maximum clip
FN887	AXOD airflow and fuel ramp for coasting downshift
FN900	Time Delay before enabling MPG mode as a function of VSBAR
FN1033	The pressure drop/BP table as a function of relative throttle position and air mass flow
FN1119	Spark Reduction for Torque Truncation, deg BTDC
FN1120	Base MBT Spark Table, deg BTDC
FN1121	Spark Advance Adder Table for EGR, deg BTDC
FN1122	Spark Advance Reduction Table for Octane, deg BTDC
FN1126	Spark Advance Table for Fuel Economy Mode, deg
FN1127	Spark Advance Adder Table for Cold Temps and Tip-ins
FN1128	Multiplier vs Temp and TP
FN1129	Spark Advance Adder Table for EGR for Fuel Economy Mode (deg BTDC)
FN1220	EGR table as a function of LOAD and N, percent
FN1222	Fuel Economy EGR Rate Table, percent
FN1303	An 8 by 7 table of fuel flow as a function of TAR and temp.
FN1317	Base fuel table-an 8 by 10 table of lambda values
FN1318	Start-up fuel table-an 8 by 10 table of lambda values
FN1320	A 10 by 8 table of volumetric efficiency multipliers for air mass as a function of normalized engine speed, and normalized MAPOPE
FN1331	MPG fuel table, lambdas. an 8 by 10 table of fuel economy open loop lambda values as a function of N and MAPPA

FN1343 Table of times from when a fuel flow change is made until the EGO sensor detects the change, as a function of N and MAP

FN1348 Time multiplier. x input is FN008, y input is FN007

FN1349 Fuel enrichment factor. X input is FN005, Y input is FN005

FN1350 Cranking fuel pulsewidth multiplier as a function of time in crank and air charge temperature

FN1600 Third gear lock up region table

FN1601 Third gear unlock region table

FN1610 Fourth gear lock up region table

FN1611 Fourth gear unlock region table

FN1620 3-4 upshift curve table

FN1621 4-3 downshift curve table

FN1861 Airflow multiplier vs ECT and ATMR3

FRACTOT Total of fractional computed edges and whole edges from SCAP sensor

FRCHIC Fraction of ECT or ACT to use in FN1349. 0=ECT, 1=ACT

FRCTAE Fraction which proportions ACT and ECT as input to AE Fuel Table

FREQ18 Seconds to clock ticks conversion factor

FUEL_A Fuel pulsewidth multiplier for underspeed and decel operations (non-displayable)

FUEL_PIPS Number of PIPs between injections

FUELPW Fuel pulsewidth displayed in clock ticks

FUEL_SYNC Flag which indicates that PIP and fuel are in synch

G

GMAPPA — Maximum MAPPA for high governor gain

GMAPPH — Hysteresis for GMAPPA

GNRPML — Minimum RPM to do inferred gear calculation, RPM

GNRPMH — Maximum RPM to do inferred gear calculation, RPM

GNTPLO — Minimum TP to do inferred gear calculation, counts

GNTPHI — Maximum TP to do inferred gear calculation, counts

GOVMAP — Maximum MAP for high governor gain

GOVMAH — Hysteresis for GOVMAP

GRFLG — AXOD flag used to indicate transmission gear range. -1=1st or 2nd, 0=3rd, 1=4th.

H

HCAMFG — Flag indicating the completion of Hi-Cam. 0=no desired engine speed adder, 1=an RPM adder above base idle is present.

HCAMSW — Calibration switch which allows the developer to select how the adaptive fuel idle cells are to be used.

HFDLTA — Most recent PIP first half period

HFPCYC — Period of PIP up to down-edge ENGCYL for 2 cylinders previous

HMAP — Maximum MAPPA for CL operation. Permits OL fuel control during crowds

HMAPH — Hysteresis term for HMAP

HMAPTM — Time at part throttle prior to OL crowd enrichment

HMUTMR — High MAPPA upstream air timer

HP — "Hardware Present" flag

HTPTMR — Hear protection timer, secs

HYST2 — Hysteresis term to enter WOT mode

HYSTS — Hysteresis term to exit CT mode

I

IACT	A/D conversion of ACT input, counts
IBGPSI	Background counter used to control pacing of the C/L integrator value
IDLCOT	Minimum time that A/C is disabled at Idle due to delay in ISC response to anticipated A/C load, secs
IDLDEL	A/D count equivalent of idle backpressure
IDLFLG	Idle Mode Flag
IDLRPM	Max RPM for closed throttle mode idle, RPM
IDLTMR	Time since entering idle mode, seconds
IDRPMH	Hysteresis for IDLRPM
IECT	A/D Conversion of the ECT input, counts
IEPT	A/D Conversion of the EPT input, counts
IERPMH	A calibration constant for idle hysteresis
IEVP	A/D Conversion of the EVP input, counts
IGNFL	Flag indicating the state of the Ignition Switch (1 or 0)
IKTDRN	Initial value for number of speedometer driven gear teeth
IMS	Inferred Mileage Sensor Hardware Present Flag (1 or 0)
INJOUT	Number of injectors fired by each output port
IPSBFG	State of engine load last background pass
IPSIBR	Integrated value of the proportional C/L RPM correction
ISCFLG	ISC MODE Flag
ISCLPD	A clip on the maximum desired speed that can be requested with vehicle in drive
ISCTM	Time interval over which the rate of change in engine speed is evaluated

ISF	Initial sample fraction; the ratio of time between last PIP up-edge and latest SCAP transition, and the time between the most recent two SCAP transitions
ISFLAG	Indication of engine load state at Idle: 0=Drive 1=Drive with A/C 2=Neutral 3=Neutral with A/C
ISLAST	Register which tracks the state of engine load from the previous background pass
ISNDSW	Idle speed neutral/drive switch: 1=ignore INDS input for ISC, 0=allow normal function
ITHBMA	Total mass air flow into the engine with throttle plate at idle screw stop and 0% ISC duty cycle
ITP	Throttle position value from A/D conversion, counts

J

JMPFLG	First pass flag for FAM entry/exit logic
JUMP	Amount of jumpback after an EGO switch

K

KACRAT	Minimum change in TP that indicates a tip-in, counts
KAM	Keep Alive Memory
KAMOK	Flag indicating whether or not KAM error exits
KAMREF	Total learned fuel system correction
KAYCTR	A counter to indicate how often to update MKAY
KDFLG	Kickdown in Progress Flag (1 or 0)
KDTHBP	Kickdown flag WOT breakpoint, counts
KDHP	Kickdown Input Hardware Present Flag (1 or 0)
KFT	Multiplier when not in MPG mode
KFTMPG	Transient fuel multiplier in MPG mode
KI	Knock Indicated
KIHP	Knock Hardware Present Flag

KLLIM	Lowest value for MKAY multiplier
KNKCYL	Calibration constant which can be calibrated equal to number of cylinders, or 1. Determines whether it is an individual cylinder knock, or multi-cylinder knock strategy
KPEI	Constant EGR adder
KPSIND	Gain for overspeed conditions
KPSINU	Gain for underspeed conditions
KS1	Spark Adder, deg BTDC
KTDRN	KAM register for calculated number of speedometer driven gear teeth
KTDTMR	Speedometer gear sampling timer
KTS	Pulsewidth (clock ticks) of the charging pulse. Internal to the EEC
KULMT	Highest value for MKAY multiplier
KVEFF	AMPEM multiplier
KWUCNT	Maximum number of warm-up cycles to use fast adaptive EGO count. Should be set to approximately 3 to 5 warm-ups.
KWUCTR	KAM Warm Up counter. Stores number of warm-ups in KAM.

L

LAMBSE	Desired air/fuel ratio
LAMMAX	Maximum closed loop LAMBSE clip
LAMMIN	Minimum closed loop LAMBSE clip
LAMMUL	Fuel multiplier for Neutral-to-Drive transitions used to prevent cold engine stalls following transmission engagement
LAST_MAP	Time of most recent processed SCAP transition
LAST_MAP2	Time of the second most recent processed SCAP transition
LCKTD1	Time delay from solenoid energized to converter actually locked, secs

LCKTD2	Time delay between TDRN calculations, secs
LCKTMR	Converter lock signal timer
LESFLG	Lack of EGO Switching Flag. 0=switching, 1=not switching
LKDTA	Minimum kickdown unlock time
LMAP	Decel MAP OL breakpoint, in. Hg.
LMBJMP	Amount of rich bias (to be subtracted from LAMBSE) when exiting filtered air mass
LMBMAP	Minimum decel MAP to increment LMBTMR
LMBMUL	Fuel multiplier to ramp into MPG mode
LMBOF	The LAMBSE displacement factor which serves as the zero voltage reference point. The value of LMBOF will normally be 1.0
LMBOFF	LMBMUL starting value for ramp-in
LMBTMR	Low MAP bypass timer
LODNOK	Minimum MAPPA at which Knock Strategy is enabled
LOMAPH	Hysteresis for LMAP, in. Hg.
LOPCT1	Number of background loops that the LAMBSE exceeded a deadband value in the lean direction
LOPCT2	Number of background loops that the LAMBSE was less than a deadband value in the rich direction
LOWMAP	Decel MAP value
LOWVOL	System voltage level, below which the battery is discharging, V
LSTCOL	Last pass normalized column
LSTROW	Last pass normalized row
LTMTBL	Adaptive Fuel Table
LTMTBL80	Adaptive fuel cell - Drive
LTMTBL81	Adaptive fuel cell - Drive, A/C panel switch on
LTMTBL82	Adaptive fuel cell - Drive, A/C clutch on

LTMTBL83	Adaptive fuel cell - Neutral
LTMTBL84	Adaptive fuel cell - Neutral, A/C panel switch on
LTMTBL85	Adaptive fuel cell - Neutral, A/C clutch on
LUDELY	Minimum time unlocked after reaching normal conditions, secs
LUTIMR	Converter Lock-up timer

M

MAPAHIH	Hysteresis for FN397
MAPBAR	Time-dependent rolling average filter of filtered MAP
MAPBK1	Point OF intersection of the first two line segments describing MAP function (frequency vs inches)
MAPBK2	Point of intersection of the second and third line segments describing the MAP function (frequency vs inches)
MAPCNT	Number of SCAP transitions occurring between PIP up-edges
MAPEDG	minimum number of SCAP edges to calculate a MAP value
MAPFMM	Value that MAP is set equal to if both SCAP and TP sensors fail
MAP_FREQ	Integrated value of frequency in Hertz of the output of SCAP sensor
MAP_INT	Flag that indicates new transition of SCAP input is available
MAPLOH	Hysteresis for FN398, in Hg
MAPOFL	Flag that indicates that MAPCNT has reached the overflow limit ant that MAP calculations will be performed as during crank
MAPOPE	MAP/PEXH, unitless
MAPPA	Barometric reading taken by the MAP sensor
MAPTMR	Free=running timer which is cleared in background if at least one SCAP edge is recognized in the foreground. Its purpose is to provide detection of a sensor failure

MAPWBG	MAP_WORD updated once per background pass at calculation of AMPEM. Used in fuel pulsewidth calculation
MAP_WORD	Same function as MAP, but with greater precision
MAXADP	Maximum adaptive correction
MAXAET	Maximum time before turning off AE
MAXFAM	Multiplier of the instantaneous AM value
MAXPGT	Air charge temperature above which dual plug mode may be disabled
MAXTTM	Maximum time delay before updating OLDTP
MDELTA	Latest SCAP half period
MEFTR	A multiplier which can be used to accentuate small departures from 5 volts
MEFTRA	Transient fuel PW multiplier during accels
MEFTRD	Transient fuel PW multiplier during decels
MFMFLG	MAP Failure flag set to 1 if MAP sensor fails
MHPFD	Signature PIP difference check value
MILLIM	Software switch to enable/disable bulb check (1 or 0)
MILTM1	MIL flashing on/off period, secs
MILTMR	Timer used to record the time that an FMEM fault has been present, secs
MINAM	A global clip on the AM register
MINDES	Minimum desired EM to turn on EGR
MINDLA	Minimum DWELL clip above 20msec PIP period
MINDLB	Minimum DWELL clip below 20msec PIP period
MINDWL	Minimum software controlled duty cycle for dwell, percent of PIP

MINMPH	Minimum speed to enter C/L RPM control. Applies to systems having VSS. Should be set below the speed at which the vehicle rolls along in drive or in gear without the brakes on level ground to prevent going into RPM control during parking lot maneuvers. This prevents the learning of erroneous load states based on the grade of the road.
MINPGT	Minimum temperature at engine start for use of dual plug
MINPW	Minimum pulsewidth clip value
MKAY	Half period multiplier to correct for average error caused by Hall Effect sensor in distributor and armature
MLMBSE	A multiplier which can be used to accentuate small departures from 5 volts
MPGCTH	Maximum ECT for Fuel economy mode, deg F
MPGCTL	Minimum ECT for Fuel economy mode, deg F
MPGFLG	Fuel Economy Mode Flag (1 or 0)
MPGLSW	MPG mode converter clutch development switch
MPGRPM	Minimum RPM for Fuel Economy mode, RPM
MPGRPH	Hysteresis for MPGRPM, RPM
MPGRT	Minimum MPG Mode re-enter time, seconds
MPGTFG	MPG Mode Exit Transition Flag. 1=exiting MPG mode, 0=not exiting MPG mode.
MPGTMR	MPG mode control timer, secs
MPMNBP	Minimum BP for Fuel economy mode, in Hg
MPNBPH	Hysteresis for MPMNBP, in Hg
MTEISF	Multiplier for FN1321
MTXSW	A software switch indicating transmission type. 1=manual, 0=automatic
MULTM	Time between LAMMUL increments, msec.
MULTMR	Time since incrementing LAMMUL

N

N	Engine RPM
N34KD	Minimum RPM for 3-4 kickdown upshift, RPM
N43KD	Maximum RPM for 3-4 kickdown downshift, RPM
NACTMR	Time since leaving CT mode
NBAR	Filtered engine RPM
NDDTMR	Time since neutral/drive switch state change, secs
NDIF	The deviation in engine speed allowed over the ISCTM specified time interval
NDPPM	Expected change in airflow between engine in neutral and in drive
NDSFLG	Flag that indicates Neutral/Drive switch position. 0=Neutral, 1=Drive.
NEUFLG	Last pass Neutral/Drive state
NEW_DELAY	Flag to indicate that new TOTAL_DELAY is being requested by the FUEL SERVICE module
NEW_MAP	Flag indicating whether SCAP edge has been received to allow clearing of MAPTMR in background
NLKDH	Minimum RPM for converter clutch kickdown lockup, RPM
NLKDL	Minimum RPM for kickdown unlock, RPM
NLMT	Overspeed RPM
NLMTH	Hysteresis for overspeed RPM
NOVS	The ratio of engine speed (NBAR) over vehicle speed (VSBAR)
NRUN	Minimum engine speed to exit CRANK mode
NSTALL	Engine stall speed to re-enter CRANK mode
NTIP	Maximum RPM to enable tip-in logic, RPM
NUBASE	Base desired engine speed in neutral
NUMCYL	Number of engine cylinders

NUMOUT	Number of injector output ports
NV32	N/VSBAR second to third gear breakpoint
NV43	N/VSBAR third to fourth gear breakpoint
NV4	N/VSBAR fourth gear breakpoint

O

OASPRK	Service octane adjust spark retard
OFSET1	Offset for the first linear equation describing MAP as function of frequency and inches of mercury
OFSET2	Offset for the second linear equation describing MAP as function of frequency and inches of mercury
OFSET3	Offset for the third linear equation describing MAP as function of frequency and inches of mercury
OL	Open Loop
OLDTP	Previous TP sensor value, counts
OLEXM1	LAMBSE multiplier for extended idle
OLFLG	Open Loop Flag. 1=OL, 0=CL
OLITD1	Time delay to go OL fuel at idle, seconds
OLITD3	Time to go back to closed loop fuel control, seconds
OPCLT1	Cold start closed loop delay, seconds
OPCLT2	Mid-ambient start closed loop delay, seconds
OPCLT3	Hot start closed loop delay time, seconds
OPCLT4	Part-throttle closed loop delay time, seconds
OUTINJ	Injector scheme selection switch. 1=alternate injections, 0=simultaneous injections.

PACOFF Offset for linear equation describing PIP period and percent of PIP period for acceleration

PACPER PIP period when equation for PIPACL changes

PACSLO Slope for linear equation describing PIP period and percent of PIP period for acceleration

PE Upstream pressure, in Hg

PEXH Absolute exhaust pressure, in Hg

PFEHP EGR Hardware Present Flag (1=PFE, 0=EVP, 2=none)

PHFDLT Previous PIP first half period

PIPACL Percentage of PIP that PIP will decrease under Maximum Acceleration, Beta

PIPCNT Number of PIPs which have occurred

PIPNUM Number of PIPs to remain in OL fuel after DFSO. prevents LAMBSE from ramping off rich due to normal transport delay time.

PIPOUT Number of PIP periods between injector outputs on each injector port

PLGNHI Engine speed to enable dual plug mode

PLGNLO Engine speed to disable dual plug mode

PLGNNH Engine speed hysteresis for single plug mode

PLGMAH MAP hysteresis value to allow reactivation of second plug

PLGMAP MAP value to disable dual plug mode

POWSFG Flag used to indicate that power steering load is high (1 or 0)

PPCTR PIP counter: updated at PIP rising edge before injector pulsewidth is calculated and output

PRGTMR Canister purge accumulation timer, secs

PSFLAG Flag to indicate last pass value of power steering to check for transitions

PSGDLT	Previous uncorrected signature PIP half period
PSIBRM	Maximum allowed value for IPSIBR
PSPPM	Airflow increment required when power steering load is sensed
PSPSHP	Power Steering Pressure Switch Hardware Present Flag (1 or 0)
PTDRN	Number of speedometer driven gear teeth from previous calculation
PTPFLG	Flag indicating engine is running
PTSCR	Part throttle mode since exiting CRANK Flag
PUTMR	Time since CPU power-up, secs
PWCF	Pulsewidth Conversion Factor. Converts total computed for engine into amount per injector

R

R	Ramp Rate. Can be set to either RF or RS
RAMPSW	Ramp EGR on switch: 0=ramp on every EGR on, 1=ramp on first EGR on only.
RANNUM	Random numbers used to statistically distribute the corrections to the Adaptive Fuel Table among four adjacent cells
RATCH	Closed Throttle Position, counts
RATDC1	Maximum negative throttle rate to maintain lockup when at large throttle opening, counts
RATDC2	Maximum negative throttle rate to maintain lockup when at small throttle opening, counts
RATEAC	Maximum possible throttle rate to maintain lockup, counts
RATIMA	Time delay for lockup after accel, secs
RATIMD	Time delay for lockup after decel, secs
REFFLG	Indication of Idle Air Flow. 1=Idle Air Flow
REFLG	Reinitialization Flag (1 or 0)

REINIT	Reinitialization
RETINC	Calculated as a function of RPM and is subtracted from each SPKAD corresponding to a knocking cylinder
RETLIM	Means of preventing excessive retard
RF	Fast ramp rate used on the side of stoichiometry that bias is desired
ROLAV	Rolling Average Routine
ROM_TO	ROM identification code
ROWTBU	Row address of adaptive cell to be updated
RPMCNL	Threshold RPM below which the window is always open, RPM
RPMCTL	Adder to DSDRPM. The total defines the engine speed threshold below which entry into C/L RPM control is allowed
RPMDED	Specifies the engine speed deadband within which the C/L RPM integrator is frozen
RPMERR	RPM error
RPMMIN	Minimum RPM to enable Knock Strategy
RS	Slow ramp rate used on the side of stoichiometry that bias is not desired
RULTMR	Transmission ramped Unlock Timer
RUNNING	Flag which indicates that idle speed is being controlled by Engine Running VIP (1 or 0)

S

SAF	Final Spark Advance, degrees
SAFTOT	Total spark advance, including knock and tip-in retard
SAMRAT	Due to a resolution issue in using very small filter constants with the common rolling average filter routine to filter the calculated air mass value, development of a modified algorithm was required to pace the filter such that proper function was obtained. SAMRAT is used to pace the filter in terms of background loop counts between filter calculations
SHALTC	Upshift/downshift altitude compensation factor
SHIRPM	"Overspeed" RPM
SIGDLT	Uncorrected signature PIP half period
SIGKAL	Signature PIP half period multiplier initial value 1.66666 for 30% duty cycle signature PIP 1.42857 for 35% duty cycle signature PIP
SIGKLL	Lowest value for signature PIP multiplier 1.42857 for 30% duty cycle signature PIP 1.25000 for 35% duty cycle signature PIP
SIGKLU	Highest value for signature PIP multiplier 1.99996 for 30% duty cycle signature PIP 1.66666 for 35% duty cycle signature PIP
SIGPIP	Signature PIP Hardware Present Flag (1 or 0)
SIL	Shift Indicator Light
SLOPE1	Slope for the first linear equation for MAP
SLOPE2	Slope for the second linear equation for MAP
SLOPE3	Slope for the third linear equation for MAP
SLTIM1	Time delay to validate the Shift Indicator Light
SLTIM2	Maximum time that the SIL is on
SLTMR	Shift Light Timer
SMTPDL	Deadband for stable TP - AETP, counts
SPKAD	Spark adder terms for the nth cylinder

SPKSWH	The value, in clock ticks, which will cause the spark out calculation to switch to Rising-edge calculation when the PIP period is less than this value
SPKSWL	The value, in clock ticks, which will cause the spark out calculation to switch to Falling-edge calculation when the PIP period is greater than this value and other conditions are met.
SPLCLP	Lower Spark clip for total spark advance
SPKMUL	A spark multiplier used to enhance idle speed control- used at closed throttle only.
SPTADV	Percentage of PIP that spark may be advanced
SPUCLP	Upper Spark clip for total spark advance
SSFCTR	A non-calibratable factor
SSMAP	Steady state MAP
STALLN	Stall RPM: If the first RPM calculated is greater than this value, assume that there was a reinit
STIFLG	Flag indicating the state of STI (1 or 0)
SWTFL	Ego Switch Flag. 0=EGO switched
SYNCTR	Counter which counts PIP signals until its value is equal to NUMCYL. Initialized to 0.
SYNFLG	Signature PIP Correctly Identified Flag (1 or 0)

T

T70LSW	7.0L thermactor application switch
TAPMAX	Maximum valid TP value, counts
TAPMIN	Minimum valid TP value, counts
TAR	Throttle Angle Rate, deg/sec
TARFLG	0=Manifold not filling, 1= Manifold filling.
TARHP	Throttle Angle Rate Circuit Hardware Present Flag (1 or 0)
TARTMR	Time since OLDTP was updated, secs
TBART	Filtered Throttle Position

TBPMN	Minimum BP for lockup, in Hg
TCDASD	Filter constant used when TP is less than or equal to the filtered TP value
TCDASU	Filter constant used when TP is greater than the filtered TP value
TCF	VAlue indicating difference between TP and TBART
TCFAM	Filter constant for the rolling average FAM filter
TCSTRT	Temperature of engine coolant at startup, deg F.
TDCTP	Transmission throttle count breakpoint for negative throttle rate decision, counts
TDELTA	Counts above RATCH to disable lockup solenoid, counts
TDELU	TP counts above RATCH for WOT lockup, counts
TDRIVE	Number of speedometer driven gear teeth
TDRN	Number of speedometer driven gear teeth from current calculation
TDRNOK	3=three consecutive values for TDRN are the same. Store TDRN in KAM
TEMDWL	Time required for coil to charge to 100% of desired value
TEMPFB	Warm Engine Temperature
TFCDED	Percentage deadband around equilibrium intake surface fuel to turn off Transient Fuel
TFCISW	Switch for Transient Fuel Control
TFCTM	Time since entering Transient Fuel, sec.
TFMFLG	TP Failure flag set to 1 if TP sensor fails range check
TGFLG	AXOD flag used to indicate transmission in high gear
THBP2	PT/WOT breakpoint value above RATCH
THBP4	PT/WOT TP breakpoint
THBPT	Transmission WOT breakpoint, counts
THRMHP	Thermactor Air Pump Hardware Present Flag (1 or 0)

THYST	Transmission WOT breakpoint hysteresis, counts
TIPFLG	Flag set to 1 to indicate a Tip-in
TIPINC	Advance per PIP following a tip-in retard, deg
TIPMAX	Initial amount of retard following a tip-in
TIPRET	Degrees of tip-in retard added to SAF
TKDTM	Time since start after which FN826A is eliminated as a desired RPM adder
TKYON1	Time at which PIP sensing is enabled
TKYON2	Time at which BPKYON update begins
TKYON3	Maximum time at which BPKYON update may begin
TKYON4	Locks out additional KEYON inferred BP updates
TLO	Predicated PIP up edge
TLOFLG	Transient Spark Calculation Flag
TP	Throttle Position, counts
TPDLTA	Minimum TP change to not zero TAR
TPFK	Calibratible filter constant
TPPLW	Actual time at PIP down edge (SPOUT reference)
TRANSW	Enables proper Transmission strategy. 0 enables A4LD strategy without Vehicle Speed Sensor. 1 enables Shift Indicator Light logic. 2 enables A4LD strategy with Vehicle Speed Sensor.
TRSRPM	Minimum RPM to enable transient spark routine
TRSRPH	Hysteresis for TRSRPM
TSLAMU	Time since the last LAMBSE update
TSLEGO	Time since the last EGO switch occurred, seconds
TSLPIP	A timer that indicates the time since last PIP low-to-high transition
TSPKUP	Predicted time for spark up (SPOUT)

TTHP	Torque Truncation Hardware Present Flag (3.8L AXOD) (1 or 0)
TTNOV	The minimum N/VSBAR for Torque Truncation (3.8L AXOD)
TTSPK	The spark reduction required for torque truncation

U

ULCKTD	Time for converter clutch to unlock, secs
UNDSP	Underspeed Mode Flag (1 or 0)
UNRPM	Underspeed engine speed
UNRPMH	Hysteresis term for UNDERSPEED mode
UPDATM	Pacing at which the IPSIBR correction factor is rolled into KAM
UPDISC	Time that engine speed must be within the specified deadband prior to KAM update
UPSMAP	Maximum time for upstream air at high MAPPA
UPSWOT	Maximum time for upstream air at WOT

V

V860	VIP calibration parameter which sets pacing integration of the C/L RPM correction
VBAT	Battery Voltage
VECT3	Minimum coolant temp, engine on
VECT5	Starting coolant temp for warm-up counter
VIECT1	Minimum Engine off ECT range, counts
VIECT2	Maximum Engine off ECT range, counts
VIPRPM	Desired RPM controlled by Engine Running VIP Strategy
VMDEL1	Minimum MAP during Engine off self test, ticks
VMDEL2	Maximum MAP during Engine off self test, ticks
VMPMAX	Maximum amount of time to wait for next SCAP edge before deciding sensor has failed
VOLHYS	Hysteresis term for LOWVOL

VOLTMR	Timer which records time that the system voltage is below battery charging level, secs
VPSIND	VIP gain for overspeed conditions
VPSINU	VIP gain for underspeed conditions
VS34KD	Minimum VSBAR for converter clutch kickdown lockup, MPH
VSBAR	Time dependent rolling average of instantaneous vehicle speed, MPH
VSCTSW	Calibration switch to disable VSBAR condition in open loop "B" logic. can be set to 1 if it is desired to have FN301 used at idle
VSGN3	Minimum vehicle speed to be in third gear, A4LD
VSIBRM	Maximum allowed value for IPSIBR when in Running VIP
VSIBRN	Minimum allowed value for IPSIBR when in Running VIP
VSLUKD	Minimum VSBAR for converter clutch kickdown lockup, MPH
VSMPGH	Hysteresis for FN399, MPH
VSOLDC	Minimum vehicle speed for OL decel, MPH
VSS1	Minimum speed below which normal drive airflow is restored
VSS2	Speed above which a valid AXOD 3-2 downshift has occurred
VSS3	Speed below which a valid AXOD 3-2 downshift has occurred
VSTYPE	Vehicle Speed Sensor Hardware Present Flag (1 or 0)

W

WAC	WOT A/C Cutoff
WACHP	WOT A/C Cutoff Hardware Present Flag (1 or 0)
WARM_UP	Engine warm-up Flag. 1=engine warmed up
WINCLD	Maximum number of PIP periods to withhold KTS during periods of sustained knock
WINLEN	Minimum KTS pulsewidth, fraction of PIP period
WMEGOL	Flag that is set when WRMEGO is set. Never reset except during the power-up sequence.
WOPEN	Minimum delay after the rising edge of PIP before the KTS pulse will be output, fraction of PIP period
WOTCOT	Time delay during WOT during which A/C is disabled, secs
WOTLOC	Minimum vehicle speed for WOT lockup, MPH
WOTRPH	Maximum RPM to use FN310 for WOT enleanment
WOTRPL	Minimum RPM to use FN310 for WOT enleanment. Set to WOTRPL to 10,000 RPM to disable use of FN310
WOTTMR	Time at WOT
WRMEGO	Warm EGO Flag. 1=switching, 0=not switching.

X

X	EGRATE multiplier for development
XFREPT	Transfer function of EPT sensor

GLOSSARY

A

A to D	The conversion of input data from an analog to a digital format.
ADDRESS	A number that identifies a single location in memory.
AND	A logic function where the output is 1 only if all the inputs are 1.
ASCII	American Standard Code for Information Interchange. A 7-bit character code.

B

BAUD	A unit of signal-speed derived from the duration of the shortest code element. Speed in Bauds is the number of code elements per second.
BIT	A binary digit
BUS	A set of wires used to transmit information among two or more devices.
BYTE	A set of eight bits

C

CLOCK	A device that produces a series of regular pulses that synchronize the operations within a microcomputer.

D

DAC	Digital to Analog Converter

E

ENGINEERING UNITS	A value displayed in Base 10 Notation
EPROM	Erasable Programmable Read Only Memory

F

FUNCTION	Where the computer selects an output based on a single input.

H

HARDWARE	The physical parts of a computer.
HEX	An abbreviation of hexadecimal.
HEXADECIMAL	Base sixteen number system.
HYSTERESIS	The difference in response of a unit or system depending on whether its input signal is increasing or decreasing.

I

INITIALIZE	Set up the initial operating parameters, and erase all pre-existing data.
INPUT	Data to the microprocessor.
INTEGER	A whole number, as distinguished from a fraction or a mixed number.
I/O	"Input/Output" - The link between the microprocessor and its sensors and actuators.

L

LOGARITHM	The exponent of that power to which a fixed number (called the base) must be raised in order to produce a given number.

M

MANTISSA	The decimal part of a logarithm.
MEMORY	A set of physical locations that can contain numbers.
MROM	Masked Read Only Memory

N

NAND	A logic function that inverts the result of the AND function.
NIBBLE	Half a byte (4 bits).
NOR	A logic function that inverts the result of the OR function.
NOT	A logic function that inverts the result of any other logic function.

O

OR	A logic function where the output is 1 if any of the inputs are 1.
OUTPUT	Data from the microprocessor.
OVERFLOW	A condition resulting from the addition of signed numbers where the result exceeds the range of signed numbers allowed by the number of digits available.

P

PARALLEL	With reference to data transmission, a number of bits simultaneously.
PERIPHERAL	A unit of processing equipment external to the CPU, such as a keypad, display, or printer.
PROCESSOR	That part of a computer that fetches, decodes, and executes instructions; it contains the control, calculating, and decision-making sections of a computer.
PROM	Programmable Read Only Memory. A type of semiconductor memory which can be programmed only once.

R

RADIX	Also called 'base'. The total number of distinct symbols used in a numbering system.
RAM	Random Access Memory. A type of semiconductor memory which can be written to and read from.
REAL-TIME	Time at which an event actually occurs.
REGISTER	A physical location that can contain a binary value.
ROM	Read Only Memory. A type of semiconductor memory which is programmed at the time of manufacture, and cannot be changed.

S

SCALAR	A single numerical value that is assigned a value.
SCAP	"Silicon Capacitive Absolute Pressure". A pressure or vacuum sensor.
SERIAL	With reference to data transmission, one bit at a time.
SIGN BIT	The most significant bit in a signed binary number.
SIGNED NUMBER	A binary number that can be specified either as positive or negative.
SLEW	To twist; swing round; turn.
SMP	"Scaling & Modifiable Parameters"
SNAPSHOT	An action where data is sampled once and displayed, but is not updated.
SOFTWARE	Computer programs.
START BIT	A low voltage at the beginning of a serial character.
STOP BIT	A high voltage that denotes the end of a serial character
SUBROUTINE	A routine that causes the microprocessor to return to the main program automatically at the point of departure.

T

TABLE	A systematic arrangement of data in rows and columns for ready reference.
TOGGLE	To reverse the state of a bit or switch.
TRUNCATE	To shorten by cutting off a part.

U

UNSIGNED NUMBER — A binary number that can only be specified as positive.

USART — A device which performs synchronous or asynchronous communication functions by converting parallel digital output from a DTE (Data Terminal Equipment) into serial bit transmission, and vice versa.

W

WORD — A set of bits, usually two bytes (sixteen bits).

Appendix D

EEC-IV SUPPORT EQUIPMENT

EQUIPMENT NAME	PART NUMBER	COST
Cal Console w/SMP Remote Box		$2,400
Version 7.6	XF-246458	
Version 8.2	XF-252833	
SMP Remote Box	XF-251351	
Cal Console Version 9.0		
w/SMP Remote Box	XF-287730	$2,300
SMP Remote Box	XF-287729	$500
SMP Remote Box Edgecard Connector Assembly	XF-251351-C	$30
Cal Console Tester	XF-246458-T	$780
Peripheral Port Tester	X-5-966	$300
DAC Module		
VD2B (V7.6 Compatible)	XF-247954	$1,550
V8.2 (V8.2 Compatible)	XF-252854	$1,780
DAC to TRS-80 Connector	XF-252834-TRS	$40
DAC to Cal Console Cable	XF-247954-C	$65
DAC Tester	XF-247954-T	$70

Contact: Ken Balkcom
L-030
Material Control
DPTC
X-21598

Appendix E

CONVERTING UNSCALED DECIMAL INTO ENGINEERING UNITS

BINARY POINT NUMBER EQUIVALENCY CHART
BIN -8 = 256
BIN -2 = 4
BIN -1 = 2
BIN 0 = 1
BIN 2 = .25
BIN 3 = .125
BIN 4 = .0625
BIN 6 = .015625
BIN 7 = .0078125
BIN 8 = .0039062
BIN 10 = .0009766
BIN 11 = .0004882
BIN 12 = .0002441
BIN 14 = .000061
BIN 15 = .0000305
BIN 16 = .0000152
BIN 17 = .0000076
BIN 18 = .0000038
BIN 21 = .0000004
BIN 22 = .0000002
BIN 30 = $9.3132 * 10^{-10}$

In the case of a byte, go to step F.

In the case of a word,
The least significant byte is stored first.
The most significant byte is stored last.

A. Key in the address, then push "DSO". The value now displayed is the least significant byte.

B. Push "NXT". The value now displayed is the most significant byte. Read it in decimal.

C. Multiply the number now displayed by 256.

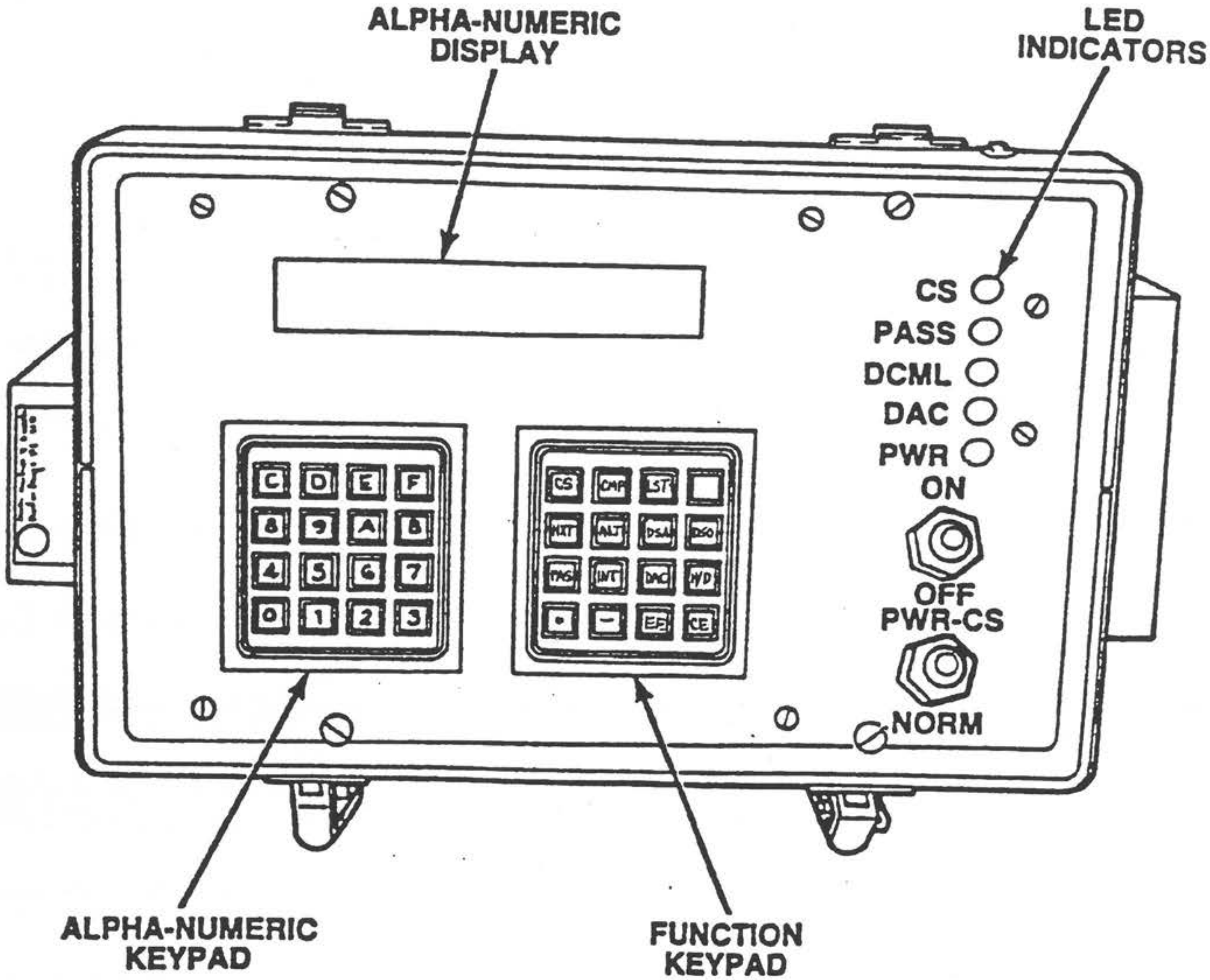
D. Push "LST". The value now displayed is the least significant byte.

E. Add it to the sum you already have. You now have the unscaled decimal value of the address.

F. Multiply it by the value of the binary point, as shown in the chart above.

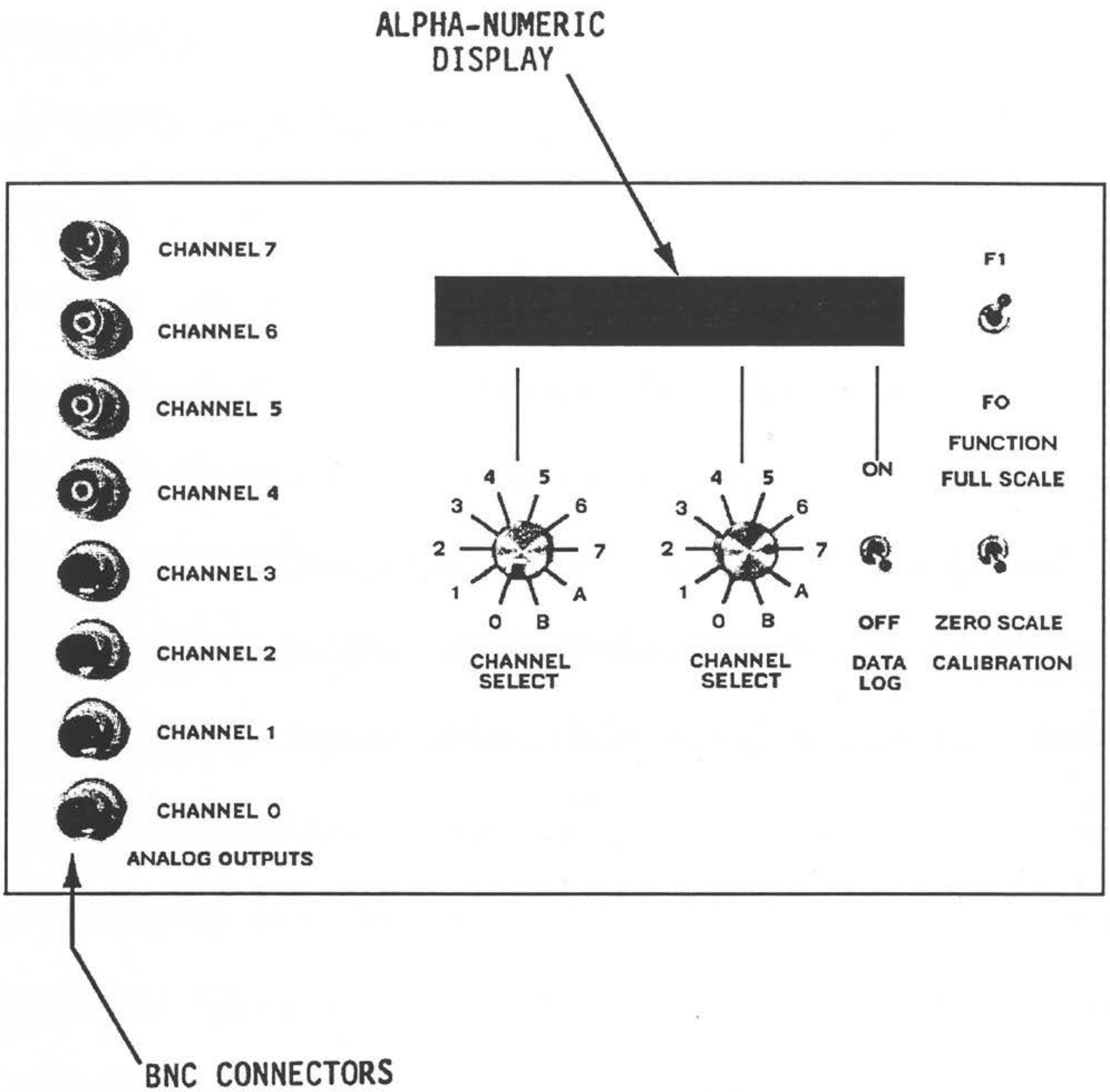
Appendix F

APPENDIX F



EEC-IV CALIBRATION CONSOLE

APPENDIX F



EEC-IV DAC MODULE

APPENDIX F

TRS-80 MODEL 102

CALIBRATION DEVELOPMENT SUPPORT SYSTEM
USER'S GUIDE

CHANGE NOTICE

FROM: Leons Liepa / Ben Sung

TO: All Calibration Console Users

SUBJECT: **EEC-IV Calibration Hardware / Software Compatibility**

The attached pages contain information relating to the compatibility of various EEC-IV Calibration Console executive software versions with Calibration Console/Remote Box hardware design levels E4 though E7 which are currently being supported by ED-PEO and PEDD. This information has been prepared as an appendix to the EEC-IV Calibration Development Support System User's Guide (Revised July 1986) and should be inserted in back of your manual (following Appendix G) for future reference.

20 OCTOBER 1988

FORD MOTOR COMPANY
ELECTRONICS DIVISION

APPENDIX J

CONSOLE HARDWARE/SOFTWARE COMPATIBILITY

J-0 SCOPE

This appendix contains information relating to the compatibility of currently used Calibration Console executive software versions with various hardware design levels. In addition, it also identifies the hardware configuration requirements that are applicable to each of the current software versions, how to upgrade earlier hardware design levels to run the latest version (V9.0) of the console executive software, and where to obtain the pre-programmed chips (V7.6 and V8.2) and/or console executive code (V9.0).

J-1 CURRENTLY SUPPORTED CALIBRATION HARDWARE/SOFTWARE

ED & PEDD currently support four (4) different design levels of the Calibration Console and Remote Box and three (3) different versions of the Calibration Console executive software. Hardware design levels E4 through E6 are compatible with console executive software versions V7.6 and V8.2, each of which can be used with engine control strategies utilizing up to 32 KB of memory. Version V8.2 supports the multicalibration engine strategies.

Hardware design level E7 supports engine control strategies of up to 48 KB when operating with console executive software version V9.0. In addition, however, it can also be operated with the earlier console executive software (V7.6 and V8.2). Table J-1 provides a summary of which console executive software versions are compatible with the various hardware design levels and the maximum engine strategy size that can be supported.

Table J-1
Calibration Hardware/Software Compatibility

DESIGN LEVEL	CALIBRATION CONSOLE PART NOS.	REMOTE BOX PART NOS.	SOFTWARE COMPATIBILITY	ENGINE STRATEGY SIZE (MAX)
E4-E6	XF-252833/246458	XF-251351	Vers. 7.6 Vers. 8.2	32K or less 32K or less (Multi-Cal)
E7	XF-287730	XF-287729	Vers. 7.6 Vers. 8.2 Vers. 9.0	32K or less 32K or less (Multi-Cal) Up to 48K

J-2 CHANGING THE CONSOLE EXECUTIVE VERSION ON HARDWARE DESIGN LEVELS E4 THRU E6 (V7.6 TO V8.2 OR VICE VERSA)

Hardware design levels E4 thru E6 may be operated with console executive versions V7.6 or V8.2. To convert from console executive version V7.6 to version V8.2 (or vice versa), addressing chip IC23 on the Calibration Console Memory Board and four (4) console executive program chips on the Memory Adaptor Board must be replaced with pre-programmed PROM chips applicable to the desired executive software version. Figure J-1 shows the physical locations of addressing chip IC23 and the four (4) console executive chips on the Memory Board and Memory Adaptor Board, respectively.

NOTE

It is recommended that reconfiguration of a Calibration Console from one version of the console executive software to another be accomplished by the supplier or an experienced technician, only.

J-3 CONFIGURATION OF HARDWARE DESIGN LEVEL E7 TO OPERATE WITH ANY CONSOLE EXECUTIVE VERSION (V7.6, V8.2 OR V9.0)

Design level E7 Calibration Consoles and Remote Boxes must be uniquely configured to operate with each of the current console executive software versions. Unless otherwise specified, these units are normally delivered in a configuration compatible with version V9.0 console executive software but the V9.0 console executive software chip is not supplied. The user must obtain the current release of version V9.0 console executive from the Vector System and program a custom 8763 32K EPROM chip which must then be installed in Remote Box socket U5.

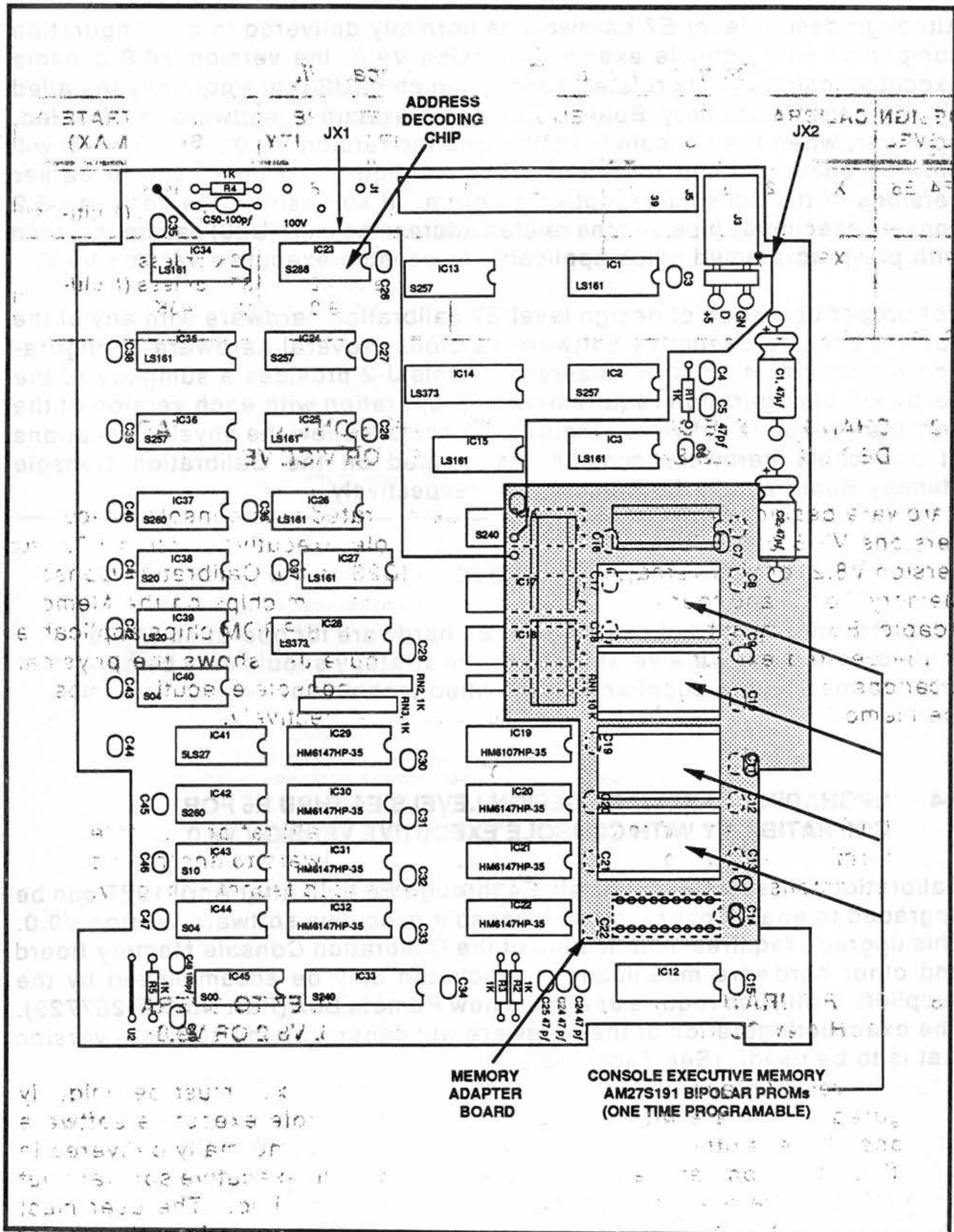


Figure J-1. Console Memory Board Layout (Design Level E4 through E7)

Although design level E7 hardware is normally delivered in a configuration compatible with console executive version V9.0, the version V8.2 console executive chips and its related addressing chip (U23) are normally installed on the console Memory Board. The V8.2 executive software is disabled, however, when the console is configured for version V9.0 operation. It will only be enabled when the hardware is configured to operate with earlier versions of the console executive program. If so desired, the version V8.2 console executive chips and the related addressing chip (U23) can be replaced with pre-programmed chips applicable to console executive version V7.6.

For proper operation of design level E7 calibration hardware with any of the current console executive software versions, several hardware configuration requirements must be observed. Table J-2 provides a summary of the hardware configuration requirements for operation with each version of the console executive software. Figures J-2 and J-3 show the physical locations of applicable hardware components located on the Calibration Console Memory Board and in the Remote Box, respectively.

NOTE

Reconfiguration of design level E7 hardware for operation with a different software version or engine strategy should only be performed by the supplier or a qualified technician.

J-4 UPGRADING HARDWARE DESIGN LEVELS E4 THRU E6 FOR COMPATIBILITY WITH CONSOLE EXECUTIVE VERSION V9.0

Calibration Console design levels E4 through E6 built after April 1987 can be upgraded to enable operation with console executive software version V9.0. This upgrade requires modification of the Calibration Console Memory Board and other hardware modifications which can only be accomplished by the supplier. It will also require use of the new Remote Box (Part No. XF-287729). The exact configuration of the hardware will depend on the software version that is to be used. (See Table J-2.)

Table J-2

Hardware Design Level E7 Configuration Requirements for Various Console-Executive Versions and Strategy Sizes

EXECUTIVE SOFTWARE VERSION	ENGINE STRATEGY SIZE	SMP DATA LOCATION (4)	REMOTE BOX PAL CHIP U7 CHECKSUM (5)	REMOTE BOX MICROSHUNT POSITION (6)	CAL CONSOLE MICROSHUNTS POSITIONS (7)
V9.0 or later	48K	Remote Box U6	8878	EF	All 7 to 40/48K
	40K	Remote Box U6	8878	CD	All 7 to 40/48K
V8.2.1 or earlier	32K	EEC-IV Module Remote Box U6	8878 8856	Don't Care EF	All 7 to 32K All 7 to 32K
	16K	EEC-IV Module EEC-IV Module Remote Box U6	8878 8856 8856	Don't Care EF CD	All 7 to 32K All 7 to 32K All 7 to 32K

NOTES:

1. Unless otherwise specified, design level E7 hardware is delivered configured for operation with Version V9.0 executive software but the executive software chip is not supplied. The user must download the current V9.0 release from VECTOR and place the programmed 8763 chip in Remote Box socket U5. Version V8.2 executive software and addressing chips are installed in the Calibration Console memory, but the executive software is disabled.

2. Configuration of the hardware for operation with console executive versions V8.2 or V7.6 automatically disables the version V9.0 executive operation. The version V9.0 executive software chip does not have to be removed from the Remote Box socket U5.

3. To change from version V8.2 to version V7.6 operation or vice versa, the addressing code chip U23 on the Calibration Console Memory Board and the four (4) console executive chips on the console's Memory Expansion Board must be replaced with the applicable addressing and executive code chips.

4. For version V7.6 and V8.2 operation, SMP data may be located in either the EEC-IV Module EPROM or installed in Remote Box socket U6. For version V9.0 operation, the SMP data must be installed in Remote Box socket U6.

5. The PAL chip to be installed in Remote Box socket location U7 is identified by a checksum value marking. Be sure to use the correct PAL chip as designated by the checksum values shown in the chart above.

6. A microshunt must be installed across pins CD or EF (located adjacent to the PAL chip socket U7 in the Remote Box) as indicated in the chart above.

7. The seven (7) microshunts located between IC chips U40 and U41 on the Calibration Console Memory Board must all be placed in the 32K position (left) or 40K/48K position (right) depending upon the size of the engine strategy shown in the chart above.

8. The switch located behind the removable plate on the console front panel should always be left in the "on" position and the plate installed such that it properly identifies the range of engine strategy sizes for which the console is configured.

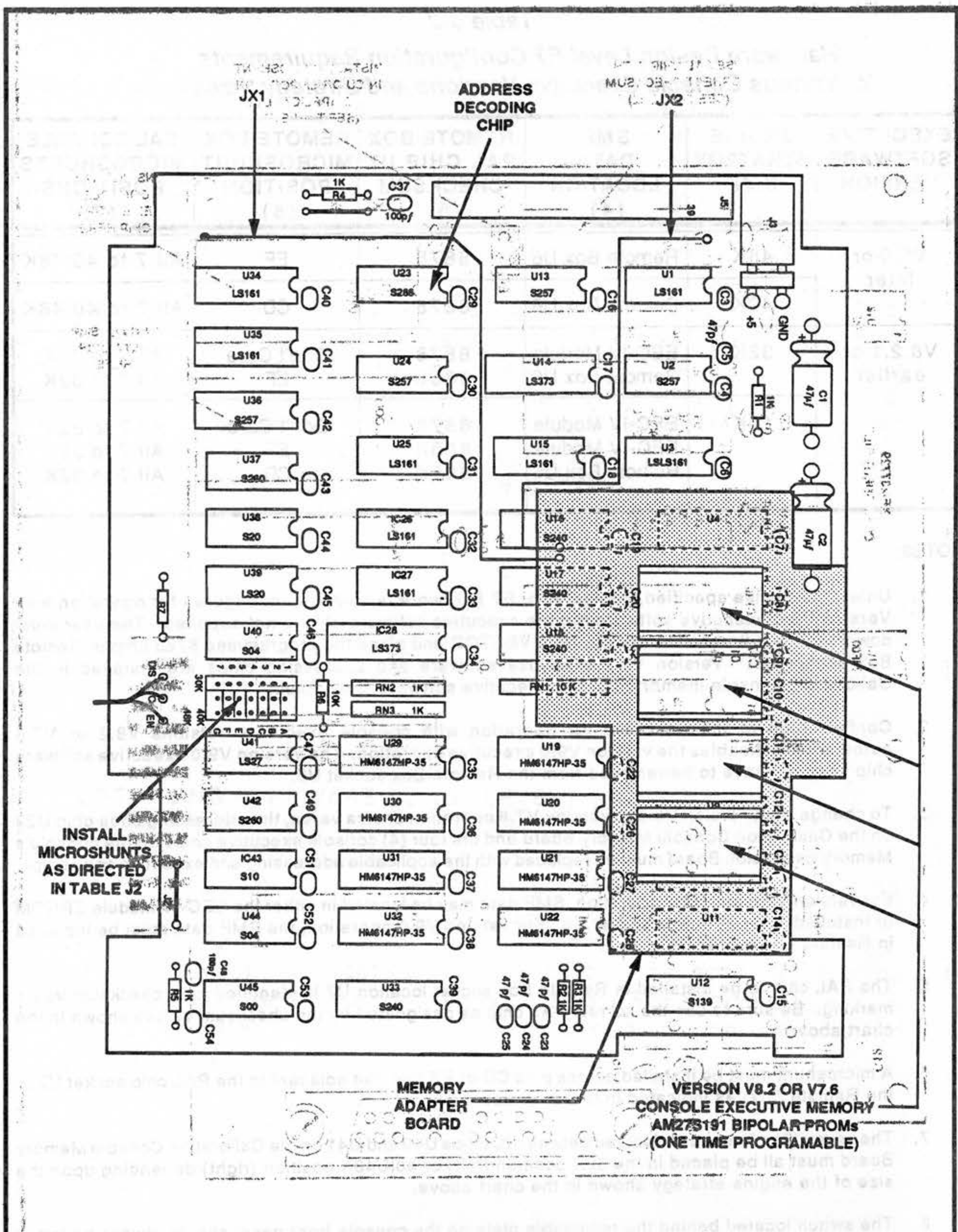


Figure J-2. Console Memory Board Layout (Design Level E7)

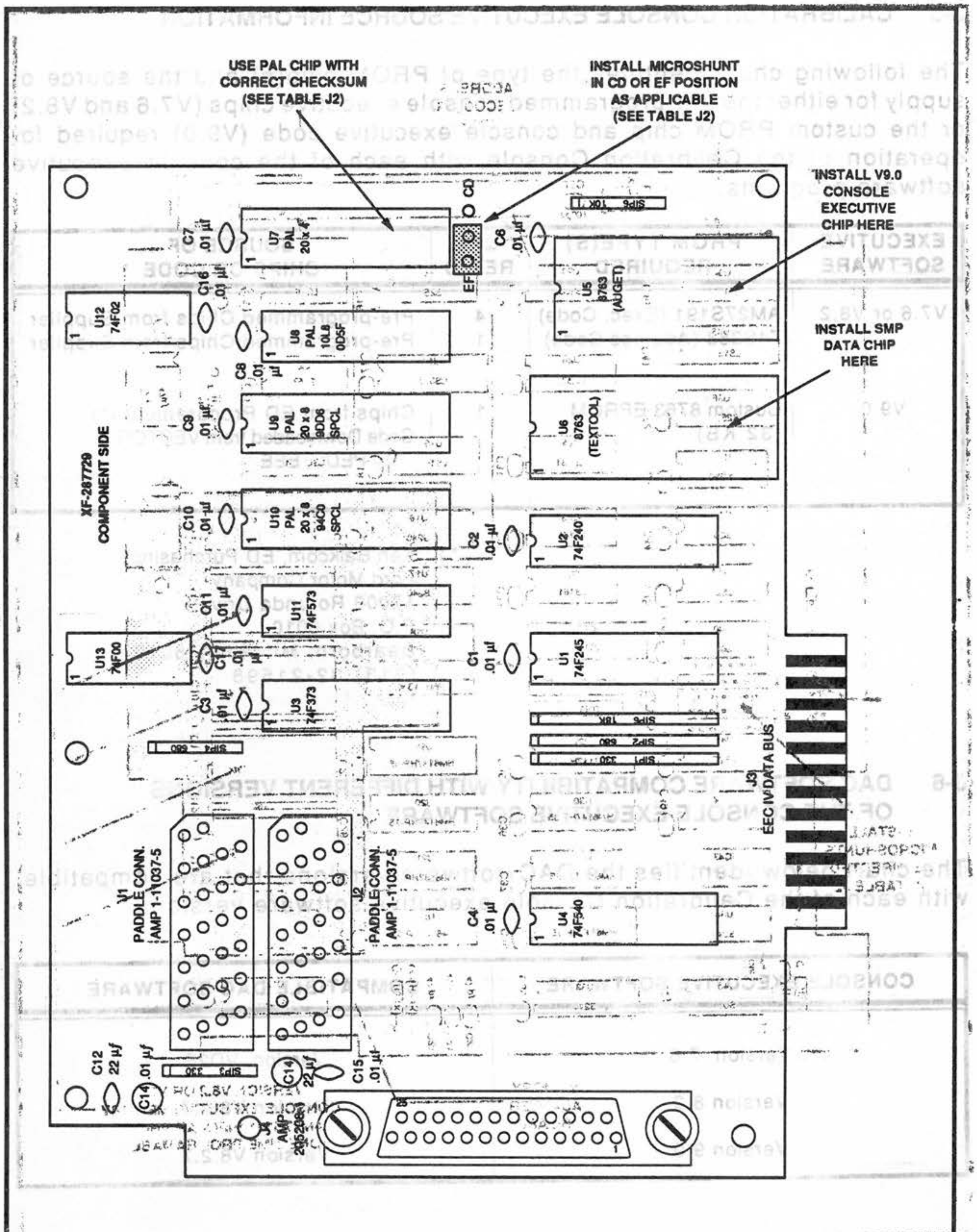


Figure J-3. Remote Box Component Layout (Design Level E7)

J-5 CALIBRATION CONSOLE EXECUTIVE SOURCE INFORMATION

The following chart identifies the type of PROM chip(s) and the source of supply for either the pre-programmed console executive chips (V7.6 and V8.2) or the custom PROM chip and console executive code (V9.0) required for operation of the Calibration Console with each of the console executive software programs.

EXECUTIVE SOFTWARE	PROM TYPE(S) REQUIRED	QTY REQ'D	SOURCE OF CHIPS OR CODE
V7.6 or V8.2	AM27S191 (Exec. Code) 74S288 (Address Code)	4 1	Pre-programmed Chips from Supplier Pre-programmed Chips from Supplier
V9.0	Custom 8763 EPROM (32 KB)	1	Chips from ED Procurement (*) Code Downloaded from VECTOR @ PEDD, EEE

(*) Ken Balkcom, ED Purchasing
Ford Motor Company
17000 Rotunda Drive
P.O. Box 6010
Dearborn, MI 48121-6010
(313) 32-21598

J-6 DAC SOFTWARE COMPATIBILITY WITH DIFFERENT VERSIONS OF THE CONSOLE EXECUTIVE SOFTWARE

The chart below identifies the DAC software versions that are compatible with each of the Calibration Console executive software versions.

CONSOLE EXECUTIVE SOFTWARE	COMPATIBLE DAC SOFTWARE
Version 7.6	Version VD2B
Version 8.2	Version V8.2.7
Version 9.0	Version V8.2.7

Labs

CAL CONSOLE / DAC MODULE

DOC FILE WORK SHEET

Using the DOC file, fill in all information.

This data will be used with Labs #1 and 2.

PARAMETER	ADDR	BIT #	COMMENTS
ACT			
APT			
BPKAM			
CHKAIR			
CTOLDC			
CTTMR			
ECT			
EGOFL			
HMAP			
HMAPH			
HMAPTM			
IACT			
IDLTMR			
IECT			
IEVP			
ITP			
LESFLG			
LMAP			
LOMAPH			

PARAMETER	ADDR	BIT #	COMMENTS
MAP			
MAPPA			
MPGFLG			
N			
NACTMR			
NDSFLG			
OLFLG			
OLITD1			
PFEHP			
PIPNUM			
PPCTR			
SAF			
VSBAR			
VSOLDC			
WRMEGO			

CALIBRATION CONSOLE/DAC MODULE

LAB #1
EXPLORING STRATEGY

PURPOSE: To familiarize the student with the use of DOC files.

EQUIPMENT:

Calibration Console

Remote SMP Box

EEC-IV Vehicle Simulator II and power supply

EEC-IV Processor (SD-21 w/LUL0)

Personality Cards (for Simulator)

Transfer Tables

Calculator

Sonic EGR Valve, EVR, and Remote Harness

NOTE: Before Power-up, turn MAP and TP adjustments fully COUNTER-CLOCKWISE and place the PIP, EVP, and EGO1 switches in external (left).

NDS = ON

VSS = 3 MPH

ALTER EGO = ON

SETUP:

Power up system (AC, DC, KAM). Put PIP switch to internal (right). Using the Cal Console and the EEC-IV Simulator, set the following parameters (in order):

PIP (N) = 1500 RPM

MAP (MAP) = 12.5"Hg

ACT (ACT) = 72°F

ECT (ECT) = 72°F

TP (ITP) = 160 counts

Using the equipment provided and your transfer tables, make the following measurements and calculations. NOTE THE ADDRESSES OF THE PARAMETER NAMES (in parenthesis) FOR LATER REFERENCE. Additional parameter and flag information can be found on page 7.

I. COLD START

1. What is the coolant temperature (ECT)? ________

2. What are the counts (IECT)? ________

3. As listed in the Transfer Tables, do the coolant temperature, voltage, and counts agree? ________

4. What is the air charge temperature (ACT)? ________

5. What are the counts (IACT)? ________

6. As listed in the Transfer Tables, do the air charge temperature, voltage, and counts agree? ________

7. What throttle mode is the TP in (APT)? ________

8. What are the TP counts (ITP)? ________

9. As listed in the Transfer Tables, do the throttle position voltage and counts agree? ________

10. What is the manifold pressure (MAP)? ________

11. As listed in the Transfer Tables, does the manifold pressure and the frequency agree? ________

12. What is the barometric pressure (BPKAM)? ________

13. Which type of EGR system is enabled (PFEHP) (0 = Sonic; 1 = PFE; 2 = None)? ________

14.What is the amount of EGR valve opening in counts(IEVP)? _________

15.Does the NDS indicate neutral or drive (NDSFLG)? _________

16. Is the EGO sensor indicating Rich, Lean, or is it switching (EGOFL)? ________

17.What is the total spark advance (SAF)? _________

18.Does this agree with the total spark advance displayed by the monitor? _________

II. COLD DRIVE AWAY

1.Turn off NDS. Does the NDS indicate neutral or drive (NDSFLG)? _________

2.Increase TP to 410 counts (ITP). What throttle mode is the TP in (APT)? _________

3.Increase MAP to 16.3"Hg (MAP).

4.Increase VSS to 30 MPH and verify with the Cal Console (VSBAR).

5.Increase ECT to 131°F (ECT). What are the counts (IECT)? _________

6. Increase ACT to 131°F (ACT). What are the counts (IACT)? _________

7.What is the barometric pressure (BPKAM)? _________

8.What is the total spark advance (SAF)? _________

9.What is the amount of EGR opening in counts (IEVP)? _________

10.Using the CLOSED LOOP/OPEN LOOP LOGIC on the following page, determine if the system is in Open Loop or Closed Loop Control.

11.Verify your conclusion by checking the status of the Open Loop Flag (OLFLG)? _________

```
IDLTMR <= OLITD1 ------------------------------|
                                               |
WRMEGO = 1 ------------------------------------|
                                               |
PPCTR = PIPNUM --------------------------------|
                                               |
LESFLG = 0 ------------------------------------|
                                               |
CHKAIR = 1 ------------------------------------|
                                               |
MAPPA < HMAP - HMAPH -|                        |
                      |                        |
                      |AND -----|S   Q --------|AND -|CLOSED LOOP
                      |         |              |     |
MAP > LMAP + LOMAPH --|         |              |     |
                                |              |     |
                                |              |     |---ELSE---
                                |              |     |
MAPPA > HMAP ---------|         |              |     |
                      |         |              |     |
                      |AND -|   |              |     | OPEN LOOP
                      |     |   |              |
NACTMR >OR= HMAPTM ---|     |OR-|C             |
                            |                  |
                            |                  |
MAP < LMAP -----------------|                  |
                                               |
CTTMR <OR= CTOLDC -|                           |
                   |                           |
VSBAR <OR= VSOLDC -|OR ------------------------|
                   |                           |
APT = 0 -----------|                           |
                                               |
APT < 1 ---------------------------------------|
                                               |
MPGFLG = 0 ------------------------------------|
```

HYSTERESIS FLIP-FLOP
TRUTH TABLE

S(SET) A	C(CLEAR) B	Q-OUTPUT C
0	0	no change
0	1	0
1	0	1
1	1	1

III. WARM CRUISE

1.Increase ACT to 181°F (ACT). What are the counts (IACT)? ________

2.Increase ECT to 181°F (ECT). What are the counts (IECT)? ________

3.What is the barometric pressure (BPKAM)? ________

4.Has it changed? ________

The strategy enables part throttle BP update when ECT exceeds 180°F.

5.Increase VSS to 60 MPH and verify (VSBAR).

6.Increase PIP to 3000 RPM (N).

7.Increase TP to 506 counts (ITP).

8.Increase MAP to 19.6"Hg (MAP).

9.What is the amount of EGR opening in counts (IEVP)? ________

10.Decrease ACT to 159°F (ACT). What are the counts (IACT)? ________

11.Is the system in Open Loop or Closed Loop control (OLFLG)? ________

12.What is the total spark advance (SAF)? ________

13.Increase PIP to 4000 RPM (N).

14.Increase TP to 807 counts (ITP)

15.Increase MAP to 27.0"Hg (MAP).

16.What is the throttle mode (APT)? ________

17.Is the system in Open Loop or Closed Loop control (OLFLG)? ________

18.What is the total spark advance (SAF)? ________

19.What is the amount of EGR opening in counts (IEVP)? ________

IV. HOT IDLE

1.Decrease TP to 160 counts (ITP).

2.Decrease VSS to 3 MPH and verify (VSBAR).

3.Decrease MAP to 9.0"Hg (MAP).

4.Decrease PIP to 600 RPM (N).

5.What is the throttle mode (APT)? _________

6.What is the total spark advance (SAF)? _________

7.What is the amount of EGR opening in counts (IEVP)? _________

8.Is the system in Open Loop or Closed Loop control (OLFLG)? _________

__ADDITIONAL PARAMETER NOTES__

APT -1 = Closed Throttle; 0 = Part Throttle; 1 = Wide-Open Throttle

BPKAM Inches Mercury

EGOFL 0 = Lean; 1 = Rich

MAP Inches Mercury

OLFLG 0 = Closed Loop; 1 = Open Loop

SAF Degrees at Crankshaft

VSBAR Miles per Hour

CAL CONSOLE/DAC MODULE

LAB #2
STRATEGY TROUBLESHOOTING

PURPOSE: To familiarize the student with the use of the Calibration Console in troubleshooting.

EQUIPMENT:

Calibration Console

Remote SMP Box

EEC-IV Vehicle Simulator II and power supply

EEC-IV Processor (SD-21 w/LUL0)

Personality Cards (for Simulator)

Calculator

Sonic EGR Valve, EVR, and Remote Harness

NOTE: Before Power-up, turn MAP and TP adjustments fully COUNTER-CLOCKWISE and place the PIP, EVP, and EGO1 switches in external (left).

NDS = ON

VSS = 3 MPH

ALTER EGO = ON

SETUP: Power up system (AC, DC, KAM). Put PIP switch to internal (right). Using the Cal Console and the EEC-IV Simulator, set the following parameters (in order):

PIP (N) = 1500 RPM

MAP (MAP) = 12.5"Hg

ACT (ACT) = 72°F

ECT (ECT) = 72°F

TP (ITP) = 160 counts

Using the data gathered in Lab #1 (Exploring Strategy) as a reference, make the following measurements noting any differences from Lab #1. If a difference is detected, find the cause and correct it using the Cal Console RAM and the ALT function. When the corrections have been made, rerun the lab using the parameters contained in console RAM and verify the corrections. NOTE THE ADDRESSES OF THE PARAMETER NAMES (in parenthesis) FOR LATER REFERENCE. Additional parameter and flag information can be found on page 3.

I. COLD DRIVE AWAY

1.Turn off NDS. Does the NDS indicate neutral or drive (NDSFLG)? ________

2.Increase TP to 410 counts (ITP). What throttle mode is the TP in (APT)? ________

3.Increase MAP to 16.3"Hg (MAP).

4.Increase VSS to 30 MPH and verify with the Cal Console (VSBAR).

5.Increase ECT to 131°F (ECT). What are the counts (IECT)? ________

6. Increase ACT to 131°F (ACT). What are the counts (IACT)? ________

7.What is the barometric pressure (BPKAM)? ________

8.What is the total spark advance (SAF)? ________

9.What is the amount of EGR opening in counts (IEVP)? ________

10.Is the system in Open Loop or Closed Loop control (OLFLG)? ________

ADDITIONAL PARAMETER NOTES

APT -1 = Closed Throttle; 0 = Part Throttle; 1 = Wide-Open Throttle

BPKAM Inches Mercury

EGOFL 0 = Lean; 1 = Rich

MAP Inches Mercury

OLFLG 0 = Closed Loop; 1 = Open Loop

SAF Degrees at Crankshaft

VSBAR Miles per Hour

CAL CONSOLE/DAC MODULE

LAB #3
5.0L MUSTANG
GUFA

Using the Cal Console and DOC file, locate the following information on the 5.0L Mustang. Initialize the cal console prior to use. All measurements are made with the transmission in neutral.

1. What is the arrangement of the fuel injectors (NUMOUT, INJOUT) (ie., Sequential, Throttle Body, Bank-to-Bank, etc.)?

   ____

2. How many EGO sensors are used (NUMEGO)?

   ____

3. What is the "Overspeed RPM" (NLMT)?

   ____

4. Is there a Knock Sensor (KIHP)?

   ____

5. Is there a Power Steering Pressure Switch (PSPSHP)?

   ____

6. What is the minimum spark advance (SPLCLP)?

   ____

7. What is the maximum spark advance (SPUCLP)?

   ____

8. With the key on, check and record the following outputs.

ACT ________

BPKAM ________

ECT ________

EGRACT ________ *(Actual EGR Percent)*

EGRATE ________ *(Desired EGR Rate in Percent)*

EGRDC ________

EVP ________

MAF ________

SAF ________

TSLPIP ________

TP ________

9. Start the engine and stabilize at normal operating temperature. Check and record the following outputs:

   ACT ________

   BPKAM ________

   ECT ________

   EGOSSS ________ *(EGO Switches Since Start)*

   EGRACT ________ *(Actual EGR Percent)*

   EGRATE ________ *(Desired EGR Rate in Percent)*

   EGRDC ________

   EVP ________

   ISCDTY ________

   ISCFLG ________ *(ISC MODE Flag; 1 = RPM CONTROL Mode)*

   MAF ________

   SAF ________

   TP ________

   TSLPIP ________

10. Check SAF. Perform a brief Wide Open Throttle acceleration. Did the SAF reading change?

    ____

11. Check the current engine idle speed (N) and record. What is the desired base idle speed in neutral (NUBASE)? Does it agree with the current idle speed? Alter the desired base idle speed to 1000. Check the current idle speed (N). Has it changed?

CAL CONSOLE/DAC MODULE

LAB #4
2.3L RANGER
LLF1

Using the Cal Console and DOC file, locate the following information on the 2.3L DP Ranger. Initialize the cal console prior to use. All measurements are made with the transmission in neutral.

1. What is the arrangement of the fuel injectors (NUMOUT, INJOUT) (ie., Sequential, Throttle Body, Bank-to-Bank, etc.)?

   ____

2. What type of EGR system is used (PFEHP)?

   ____

3. What is the "Overspeed RPM" (NLMT)?

   ____

4. Is there a Knock Sensor (KIHP)?

   ____

5. Is there a Power Steering Pressure Switch (PSPSHP)?

   ____

6. What is the minimum engine speed to exit crank mode (NRUN)?

   ____

7. What is the minimum engine speed to re-enter crank mode (NSTALL)?

   ____

8. Does this system use thermactor air (THRMHP)?

   ____

9. What is the minimum spark advance (SPLCLP)?

____

10. What is the maximum spark advance (SPUCLP)?

____

11. With the key on, check and record the following outputs.

ACT	________
AM	________
BP	________
ECT	________
MAP	________
N	________
SAF	________
TP	________
TSLPIP	________

12. Start the engine and stabilize at normal operating temperature. Check and record the following outputs:

ACT	________
AM	________
BP	________
ECT	________
MAP	________
N	________
SAF	________
TP	________
TSLPIP	________

13. Check SAF. Perform a brief Wide Open Throttle acceleration. Did the SAF reading change?

____

14. Check the current engine idle speed (N) and record. What is the desired base idle speed in neutral (NUBASE)? Does it agree with the current idle speed? Alter the desired base idle speed to 1000. Check the current idle speed (N). Has it changed?

CAL CONSOLE/DAC MODULE

LAB #5
2.3L T-BIRD

Using the Cal Console and DOC file, locate the following information on the 2.3 Turbocharged T-bird.

1. Based on the following Hardware Calibration Switches, what is the current configuration of this system?

   CTDFSW

   MTXSWH

   PACSW

   ____

2. What is the minimum spark advance (SPLCLP)?

   ____

3. What is the maximum spark advance (SPUCLP)?

   ____

4. What is the "Overspeed RPM" (HIRPM)?

   ____

5. What is the minimum coolant temperature required to turn on the Low Speed fan (LSFECT)?

   ____

6. At what vehicle speed is the Low Speed fan disabled (LSFVS)?

   ____

7. What is the minimum coolant temperature required to turn on the High Speed fan (HSFECT)?

   ____

8. At what engine speed will the strategy re-enter the CRANK mode (NSTALL)?

   ____

9. What is the base desired idle RPM (NBASE)?

   ____

10. With the key on, check and record the following outputs.

ACT	________
BP	________
ECT	________
IACT	________
IECT	________
ISCDTY	________
ITP	________
IVAF	________
IVAT	________
MAF	________
SAF	________
VAT	________

11. Start the engine and stabilize at normal operating temperature. Check and record the following outputs:

ACT	________
APT	________
BP	________
ECT	________
IACT	________
IECT	________
ISCDTY	________
ITP	________
IVAF	________
IVAT	________
MAF	________
N	________
SAF	________
TCSTRT	________
VAT	________

12. Check SAF. Perform a brief Wide Open Throttle acceleration. Did the SAF reading change?

____

CAL CONSOLE/DAC MODULE

LAB #6
2.5L TAURUS
NXH1

Using the Cal Console and DOC file, locate the following information on the 2.5L Taurus. Initialize the cal console prior to use. All measurements are made with the transmission in park or neutral.

1. What is the arrangement of the fuel injectors (NUMOUT, INJOUT) (ie., Sequential, Throttle Body, Bank-to-Bank, etc.)

   ____

2. What is the minimum speed to exit Crank Mode (NRUN)?

   ____

3. What is the maximum speed to re-enter Crank Mode (NSTALL)?

   ____

4. What is the underspeed engine RPM (UNRPM)?

   ____

5. What is the minimum spark advance (SPLCLP)?

   ____

6. What is the maximum spark advance (SPUCLP)?

   ____

7. With the key on, check and record the following outputs.

ACT	________
BPKAM	________
ECT	________
IACT	________
IECT	________
IEGR	________
MAP	________
SAF	________
TP	________

8. Start the engine and stabilize at normal operating temperature. Check and record the following outputs:

ACT	________
BPKAM	________
ECT	________
IACT	________
IECT	________
IEGR	________
MAP	________
N	________
SAF	________
TCSTRT	________
TP	________

9. Check SAF. Perform a brief Wide Open Throttle acceleration. Did the SAF reading change?

____

10. Check the current engine idle speed (N) and record. What is the desired base idle speed in neutral (NBASE)? Does it agree with the current idle speed? Alter the desired base idle speed to 1000. Check the current idle speed (N). Has it changed?

CAL CONSOLE/DAC MODULE

LAB #6A
4.9L BRONCO
LUL0

Using the Cal Console and DOC file, locate the following information on the 4.9L Bronco. Initialize the cal console prior to use. All measurements are made with the transmission in park or neutral.

1. What is the arrangement of the fuel injectors (NUMOUT, INJOUT) (ie., Sequential, Throttle Body, Bank-to-Bank, etc.)

   ____

2. Based on the following Hardware Calibration Switches, what is the current configuration of this system?

   ACDHP

   BIHP

   CANPHP

   DOLHP

   DPLGHP

   GOOSW

   KIHP

   MTXSW

   NGCSHP

   PFEHP

   PSPSHP

   THRMHP

   VSSHP

   WACHP

   ____

3. What is the desired idle RPM in drive (DRBASE)?

____

4. What is the desired idle RPM in neutral (NUBASE)?

____

5. What is the minimum engine speed to exit Crank Mode (NRUN)?

____

6. What is the maximum engine speed to re-enter Crank Mode (NSTALL)?

____

7. What is the maximum engine speed (NLMT)?

____

8. What is the minimum spark advance (SPLCLP)?

____

9. What is the maximum spark advance (SPUCLP)?

____

10. With the key on, check and record the following outputs.

ACT	________
BPKAM	________
ECT	________
IACT	________
IECT	________
IEVP	________
ISCDTY	________
MAP	________
MAP_FREQ	________
SAF	________
TP	________

11. Start the engine and stabilize at normal operating temperature. Check and record the following outputs:

ACT	________
APT	________
BPKAM	________
ECT	________
IACT	________
IECT	________
IEVP	________
ISCDTY	________
MAP	________
MAP_FREQ	________
N	________
SAF	________
TCSTRT	________
TP	________

12. Check SAF. Perform a brief Wide Open Throttle acceleration. Did the SAF reading change?

____

13. Check the current engine idle speed (N) and record. What is the desired base idle speed in neutral (NUBASE)? Does it agree with the current idle speed? Alter the desired base idle speed to 1000. Check the current idle speed (N). Has it changed?

CAL CONSOLE/DAC MODULE

LAB #6B
3.0L TAURUS

Using the Cal Console and DOC file, locate the following information on the 3.0L Taurus.

1. What is the arrangement of the fuel injectors (NUMOUT, INJOUT) (ie., Sequential, Throttle Body, Bank-to-Bank, etc.)

   ____

2. How many EGO sensors are used (NUMEGO)?

   ____

3. Based on the following Hardware Calibration Switches, what is the current configuration of this system?

   BIHP

   GOOSW

   KIHP

   MTXSW

   NPSSW

   PFEHP

   THRMHP

   TRANSW

   VBISW

   VSTYPE

   ____

4. What is the minimum speed to exit Crank Mode (NRUN)?

   ____

5. What is the maximum speed to re-enter Crank Mode (NSTALL)?

   ____

6. What is the underspeed engine RPM (UNRPM)?

____

7. What is the minimum spark advance (SPLCLP)?

____

8. What is the maximum spark advance (SPUCLP)?

____

9. What is the maximum vehicle speed allowed by the processor (DDVS)?

____

10. What is the minumum coolant temperature required to turn on the Low Speed fan (LSFECT)?

____

11. At what vehicle speed will the Low Speed fan no longer run (LSFVS)?

____

12. What is the maximum vehicle speed at which the Vehicle Speed Control will operate (MAXVSP)?

____

13. What is the minimum vehicle speed at which the Vehicle Speed Control will operate (MINVSP)?

____

14. What is the maximum engine speed (NLMT)?

____

15. What is the desired idle RPM in neutral (NUBASE)?

____

16. What is the maximum engine speed at which the Vehicle Speed Control will function (VSNMAX)?

____

17. With the key on, check and record the following outputs.

ACT	________
BPKAM	________
ECT	________
IACT	________
IECT	________
ISCDTY	________
MAP	________
MAP_FREQ	________
SAF	________
TCSTRT	________
TP	________
VBAT	________

18. Start the engine and stabilize at normal operating temperature. Check and record the following outputs:

ACT	________
BPKAM	________
ECT	________
EGOSSS	________
IACT	________
IECT	________
ISCDTY	________
ISCFLG	________
MAP	________
MAP_FREQ	________
N	________
SAF	________
TCSTRT	________
TP	________
VBAT	________

19. Check SAF. Perform a brief Wide Open Throttle acceleration. Did the SAF reading change?

____

CAL CONSOLE/DAC MODULE

LAB #6B
3.0L TAURUS
CKF4

Using the Cal Console and DOC file, locate the following information on the 3.0L Taurus. Initialize the cal console prior to use. All measurements are made with the transmission in park or neutral.

1. What is the arrangement of the fuel injectors (NUMOUT, INJOUT) (ie., Sequential, Throttle Body, Bank-to-Bank, etc.)

   ____

2. How many EGO sensors are used (NUMEGO)?

   ____

3. Based on the following Hardware Calibration Switches, what is the current configuration of this system?

   BIHP

   GOOSW

   KIHP

   PFEHP

   VSTYPE

   ____

4. What is the minimum speed to exit Crank Mode (NRUN)?

   ____

5. What is the maximum speed to re-enter Crank Mode (NSTALL)?

   ____

6. What is the underspeed engine RPM (UNRPM)?

____

7. What is the minimum spark advance (SPLCLP)?

____

8. What is the maximum spark advance (SPUCLP)?

____

9. What is the minumum coolant temperature required to turn on the Low Speed fan (LSFECT)?

____

10. At what vehicle speed will the Low Speed fan no longer run (LSFVS)?

____

11. What is the maximum vehicle speed at which the Vehicle Speed Control will operate (MAXVSP)?

____

12. What is the minimum vehicle speed at which the Vehicle Speed Control will operate (MINVSP)?

____

13. What is the maximum engine speed at which the Vehicle Speed Control will function (VSNMAX)?

____

14. With the key on, check and record the following outputs.

ACT	________
BPKAM	________
ECT	________
IACT	________
IECT	________
ISCDTY	________
MAP	________
MAP_FREQ	________
SAF	________
TCSTRT	________
TP	________

15. Start the engine and stabilize at normal operating temperature. Check and record the following outputs:

ACT	________
BPKAM	________
ECT	________
EGOSSS	________
IACT	________
IECT	________
ISCDTY	________
ISCFLG	________
MAP	________
MAP_FREQ	________
N	________
SAF	________
TCSTRT	________
TP	________

16. Check SAF. Perform a brief Wide Open Throttle acceleration. Did the SAF reading change?

____

17. Check the current engine idle speed (N) and record. What is the desired base idle speed in neutral (NUBASE)? Does it agree with the current idle speed? Alter the desired base idle speed to 1000. Check the current idle speed (N). Has it changed?

EEC-IV CALIBRATION CONSOLE AND DAC MODULE

LAB #7
DAC PRINCIPLES

PURPOSE: To familiarize the student with DAC parameter setup and recording device output.

EQUIPMENT:

Calibration Console

DAC Module

Remote SMP Box

EEC-IV Vehicle Simulator II and power supply

EEC-IV Processor (SD-21 w/LUL0)

Personality Cards (for Simulator)

Oscilloscope

One Coaxial Cable

Calculator

Shift Count Tables

SETUP: Power up system (AC, DC, KAM). Using the Cal Console and the EEC-IV Simulator, set the following parameters (in order):

VSS (VSBAR) = 3 MPH 1D1

PIP (N) = 500 RPM A8

MAP (MAP) = 11.0"Hg BE

ACT (ACT) = -35°F CB

ECT (IECT) = 925 Counts 110

TP (ITP) = 160 Counts 11E

Turn on oscilloscope and set as follows (see sketch):

TIME/DIV = .2ms

VOLTS/DIV = 2

MODE #1- = Auto

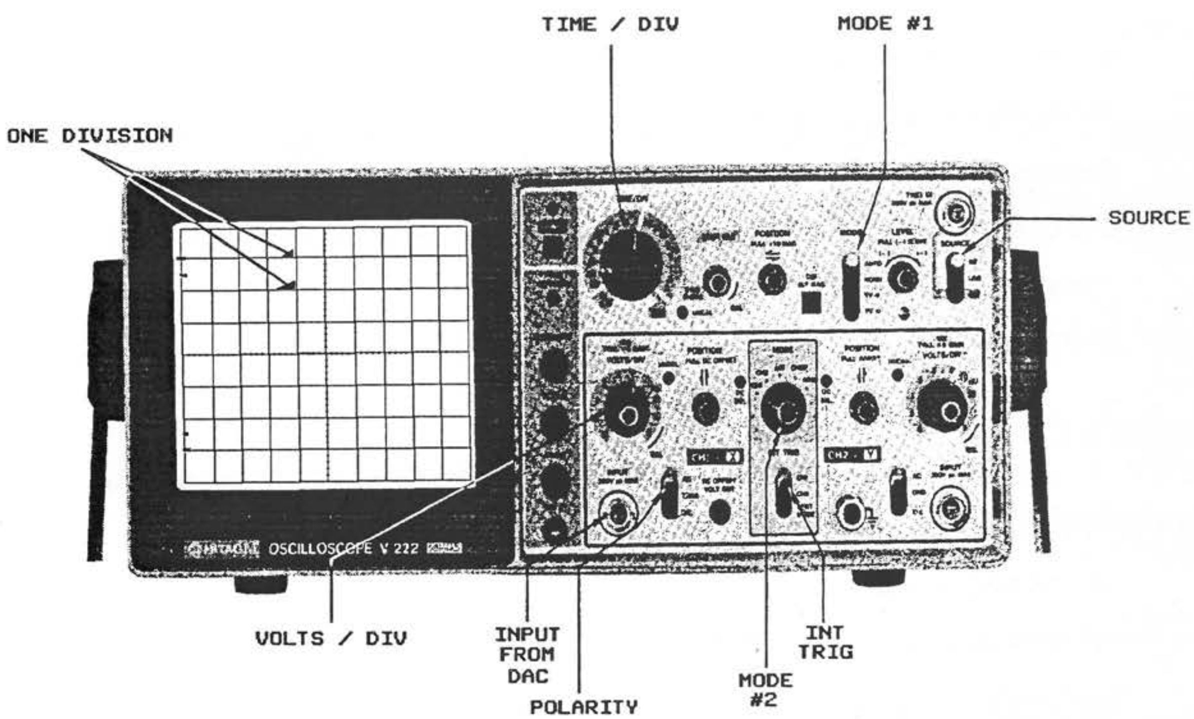
SOURCE = Int

MODE #2 = Ch1

INT TRIG = Ch1

POLARITY = DC

Attach one end of the coaxial cable to the CH1 input.



Using the equipment provided, determine the maximum values (in engineering units) the following parameters will attain under conditions of closed throttle, part throttle, wide-open throttle, and ambient temperatures ranging from -35°F to 225°F. Calculate the zero position and minimum shift count value which will allow these parameters to be DACed to the oscilloscope at 8-bit resolution. Finally, assign the parameter addresses to the DAC channel indicated and set the zero position and shift count.

DAC CHANNEL	PARAMETER NAME	ADD	BIN.
0	ACT	BB	-1
1	AM	9A	+11
2	FUELPW	17H	-1
3	N	8E	2
4	IECT	110	6
5	SAF	D2	2

NOTE: AM, FUELPW, and SAF will need to be run under all conditions before a maximum value can be determined.

Calibrate the oscilloscope using any of the DAC channels.

Attach the coaxial cable to the Channel 0 BNC connector.

Shift Value 0 Zero Position 5

1. What is the value of ACT as displayed on the DAC Module display? 110

2. What is the voltage level displayed on the oscilloscope? 4.3

3. Increase ACT to 0°F.

4. What is the value of ACT displayed on the DAC Module? 128

5. What is the voltage level displayed on the oscilloscope? 5.0

6. Increase ACT to 100°F.

7. What is the value of ACT displayed on the DAC Module? 178

8. What is the voltage level displayed on the oscilloscope? 7.0v

9. Increase ACT to 225°F.

10. What is the value of ACT displayed on the DAC Module? 247

SCT 0 = 0VOLTS

11. What is the voltage level displayed on the oscilloscope? 9.6

Attach the coaxial connector to the Channel 1 BNC connector.

Shift Value 5 Zero Position 0

12. What is the value of AM displayed on the DAC Module? 35

13. What is the voltage level displayed on the oscilloscope? 1.2

14. Increase MAP to 16.3"Hg.

15. Decrease ACT to 200°F.

16. What is the value of AM displayed on the DAC Module? 60

17. What is the voltage level displayed on the oscilloscope? 2.3

18. Increase MAP to 27.0"HG.

19. What is the value of AM displayed on the DAC Module? 120

20. What is the voltage level displayed on the oscilloscope? 4.6

Attach the coaxial cable to the Channel 2 BNC connector.

Shift Value 4 Zero Position 0

21. What is the value of FUELPW displayed on the DAC Module? 203

22. What is the voltage level displayed on the oscilloscope? 8

23. Decrease MAP to 16.3"Hg.

24. What is the value of FUELPW displayed on the DAC Module? 103

25. What is the voltage level displayed on the oscilloscope? 4

26. Decrease MAP to 11.0"Hg.

27. Increase ACT to 225°F.

28. What is the value of FUELPW displayed on the DAC Module? 58

29. What is the voltage level displayed on the oscilloscope? 2.2

Attach the coaxial cable to the Channel 3 BNC connector.

Shift Value 7 Zero Position 0

30. What is the value of N displayed on the DAC Module? 16 (525)

31. What is the voltage level displayed on the oscilloscope? .4

32. Increase N to 1500 RPM.

33. What is the value of N displayed on the DAC Module? 47

34. What is the voltage level displayed on the oscilloscope? 1.6

35. Increase N to 3000 RPM.

36. What is the value of N displayed on the DAC Module? 93

37. What is the voltage level displayed on the oscilloscope? 3.6

38. Increase N to 4700 RPM.

39. What is the value of N displayed on the DAC Module? 147

40. What is the voltage level displayed on the oscilloscope? 5.6

Attach the coaxial cable to the Channel 4 BNC connector.

Shift Value 7 Zero Position 0

41. What is the value of IECT displayed on the DAC Module? 241

42. What is the voltage level displayed on the oscilloscope? 9.6

43. Decrease IECT to 880 counts.

44. What is the value of IECT displayed on the DAC Module? 220

45. What is the voltage level displayed on the oscilloscope? 8.8

46. Decrease IECT to 450 counts.

47. What is the value of IECT displayed on the DAC Module? 113

48. What is the voltage level displayed on the oscilloscope? 4.4

49. Decrease IECT to 80 counts.

50. What is the value of IECT displayed on the DAC Module? 20

51. What is the voltage level displayed on the oscilloscope? .8

Attach the coaxial connector to the Channel 5 BNC connector.

Shift Value 6 Zero Position 0

52. What is the value of SAF displayed on the DAC Module? 126

53. What is the voltage level displayed on the oscilloscope? 4.8

54. Decrease MAP to 9.0"Hg.

55. Decrease N to 600 RPM.

56. What is the value of SAF displayed on the DAC Module? 127

57. What is the voltage level displayed on the oscilloscope? 5.0

58. Increase MAP to 19.0"Hg.

59. Increase N to 2000 RPM.

60. What is the value of SAF displayed on the DAC Module? 59

61. What is the voltage level displayed on the oscilloscope? 2.2

62. Increase MAP to 27.0"Hg.

63. Increase N to 4000 RPM.

64. What is the value of SAF displayed on the DAC Module? 4/4 - 4/2

65. What is the voltage level displayed on the oscilloscope? 1.6

Be prepared to share your group's results with the rest of the class!!

CALIBRATION CONSOLE/DAC MODULE

LAB #8

EXTENDED DATA LOGGING

Use the GATHER AND DISPLAY mode for the following exercises.

1. Assign the bit flag EGOFL to Channel 6. Set the SAMPLE RATE DELAY COUNT so that EGOFL changes state in each successive frame.

   Note: The EGO signal generator contained in the simulator outputs alternating voltage levels of .3 VDC and .7 VDC at a 1 Hz rate (.5 sec @ .3 VDC; .5 sec @ .7 VDC). 1 Sample Rate Delay Count = .0002 seconds.

2. Using the parameters IECT and N, create each of the following multi-level triggers:

	IECT		N	
IECT and N	359		2028	
IECT or N	208	318	2004	1266
IECT and not N	382		1768	
IECT or not N	584	732	2848	3408

1 IS TRUE OR → *IECT or not N*
2 IS FALSE IECT IS TRUE & RPM FALSE

   Set IECT trigger range from 300 to 600 counts and set N trigger range from 2000 to 3000 RPM. Using the Beginning of Buffer option, note the Frame #1 value for both IECT and N.

3. Configure the GATHER and DISPLAY mode to collect the following number of data frames:

   200

   400

   800