Technical Notes on The EEC-IV MCU

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(all fonts are Courier New)

(The information supplied here was gotten through researching e-mail correspondence, technical publications and from information given to the author. If it helps you, great! If you learn more about the EEC, please return the favor by sharing what you learn with me and others.)

If you were a contributor and didn't get acknowledged, flame me and I'll get it right in the "next" edition. There were many contributors who didn't want me to remember them, so I chose to delete most original correspondences, hence the high probability that I may have failed to acknowledge someone who wanted to be given credit.

DISCLAIMER: Beware -- none of this data is guaranteed to be accurate! Use it at your own risk and please let me know what you learn so that I can add to and correct this.

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INTRODUCTION

I've collected and compiled data to help you decipher the EEC-IV inner workings. Software algorithms and automotive control techniques are purposely absent as the EEC hardware and chip set are what I'm primarily interested in figuring out. The EEC MCU probably controls one or more vehicles you own plus it contains all the components necessary to build an efi system for any vehicle -- if only we could program and modify it. That is my purpose -- to uncloak the EEC-IV so that we can play with what we bought!

The sections titled EEC DIAGNOSTICS, FUEL CONTROL, IGNITION & TIMING CONTROL, FUNCTIONS, SCALARS AND TABLES are departures from the goals stated above -- but I felt it was informative and hated to discard it. If this were a formal document, I would probably either ditch those sections, re-structure the document's purpose to include them or write a separate document on control algorithms.
THE MCU

The EEC-IV was introduced in 1983 and has gone through several major physical changes, with the earliest models showing a fairly simple two board design using through hole soldered components. The last of the EEC-IV designs were much more current in technology, showing extensive use of surface mount components and a much more finished and complex appearance. In between, there appears to be a variety of mother/daughter board and other designs. Still, they are all called EEC-IV, although somewhere in its life there was a Ford P/N generational change.

Roy <spectric@globalnet.co.uk> writes: "The processor used is the 8065 along with several supporting peripheral chips like the DUCE chip which can provide up to 8 PWM outputs and the DARC chip which has 6 channels of timer capture inputs." (Is he talking about the EEC-V here?)

"This control unit is more suited to a history class than modern engine management systems. All of the functions within the EEC, apart from the actual power drivers, are now found within the micro controller such as the 68332 and 336."

The EEC module is rated to 80C (185F) continuous, 100C intermittent, so it will be much happier and live longer in the passenger compartment. Some of the later generation 15 and 18 MHz Motorola 8061 processors have a bus loading/edge timing sensitivity that only gets worse at high temperature, so it's best to keep the EEC in a more hospitable environment. Additionally, mounting the EEC in the passenger compartment will give you better access to the J3 test port, which is where you'll be plugging in a chip and/or the Calibrator.

The J3 test port on the side of the ECU box is for developers to plug into -- this is how the after-market chipmakers and others get into the box. The test connector has the micro-controller's multiplexed address/data bus signals on it. It also, very conveniently, has a PROM disable signal. So the chip makers design something that hangs off that connector, disables the computer's PROM, and substitutes its own PROM in its place.
THE MICROPROCESSOR:

The micro-controller is an Intel 8061, a close cousin to the Intel 8096. It is supplied by three manufacturers: Intel, Toshiba (6127) and Motorola, though the Motorola units seem to slip spec a little and differ in their timing slightly from the others. There are some major differences between the 8061 and 8096 (e.g. pinouts, bus layout, etc.), but most of the code is transferable.

The 8061 is an 8096 with a few extra instructions added. One is a very powerful conditional jump to complement the high speed I/O units. This instruction, the jump on bit equals zero, is used to test any one of the eight bits of a given byte and jump if the bit equals zero (is this the JBC/JNB command?). Other conditional jumps were added to avoid extensive data shifts. With a 15 MHz input frequency, the 8061 can perform a 16-bit addition in 0.8 microseconds and a 16 x 16 bit multiply or a 32/16 bit divide in 5.2 microseconds (using the hardware multiply and divide feature). For typical applications, based on a normal instruction mix, instruction execution times average 1 to 2 microseconds. It seems to have the same functional pins as the 8096, but it's in a custom package, so the pinout is different. Most of the signals should be able to be found with a scope or logic analyzer. The 8096 has a
multiplexed address/data bus. The address/data bus signals are on the service port connector (J3) along with a few others, possibly including the address latch enable, read strobe, write strobe, and EPROM disable.

There are at least two hardware versions of the 8061 chip. One is a 40 pin DIP and the other is a square LCC 68 pin package. The 68 pin version has more I/O and perhaps other functions.

The address/multiplexing scheme is similar to that of the 8085 which has AD0 .. AD7 and then A8 .. A15 so the 8085 "latches" the address information A7:0, and maintains A8:15 while it is using AD0 .. AD7 as D7:0 ....

On the 8061 there are ONLY AD0 .. AD7 none of the "other" address lines so ...

1) present 8 bits of the address and send the latch signal
2) present the OTHER 8 bits of the address and send the latch
3) enable the "Read Enable" flag, and read the 8 data bits

<table>
<thead>
<tr>
<th>LEGEND</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ADDR ADDRESS</td>
<td>I/O</td>
</tr>
<tr>
<td>ASSY ASSEMBLY</td>
<td>LO LOW</td>
</tr>
<tr>
<td>A-BUS ADDRESS BUS</td>
<td>LSB LS</td>
</tr>
<tr>
<td>BIDIRECT BIDIRECTIONAL</td>
<td>MBus</td>
</tr>
<tr>
<td>BUFF BUFFER</td>
<td>EPROM</td>
</tr>
<tr>
<td>CTRL CONTROL</td>
<td>MUX</td>
</tr>
<tr>
<td>D-BUS DATA BUS</td>
<td>RAM</td>
</tr>
<tr>
<td>HI HIGH</td>
<td>RPn</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CPU, ROM, RAM PINOUT**

**8061 CPU (IC-1)**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35</td>
<td>GND</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>Vss+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 87C61 RAM/IO (IC-7)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| /OE | 13 | CPU-65, J3-13 MB3 | | | CPU-64, J3-11 MB4 | | | CPU-63, J3-9 MB5 | | | CPU-62, J3-7 MB6 | | | CPU-61, J3-5 MB7 | | | | | | |
| GND (?) | 14 | | | | | | | | | | | | | | | | | | |
| GND (?) | 15 | | | | | | | | | | | | | | | | | | |
| GND (?) | 16 | | | | | | | | | | | | | | | | | | |
| GND (?) | 17 | | | | | | | | | | | | | | | | | | |
| GND (?) | 18 | | | | | | | | | | | | | | | | | | |
| CPU-68, J3-19 MB0 | 19 | GND (?) | | | | | | | | | | | | | | | | | |
| CPU-67, J3-17 MB1 | 20 | address bit | | | | | | | | | | | | | | | | | |
| CPU-66, J3-15 MB2 | 21 | address bit | | | | | | | | | | | | | | | | | |
| CPU is IC-1, J3 is service connector |

### 8763 EPROM (IC-8)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| J3-22, 1K to +5V | 13 | CPU-65, J3-13 MB3 | | | CPU-64, J3-11 MB4 | | | CPU-63, J3-9 MB5 | | | CPU-62, J3-7 MB6 | | | CPU-61, J3-5 MB7 | | | | | | |
| J3-16, 10K to +5 | 14 | | | | | | | | | | | | | | | | | | |
| GND | 15 | | | | | | | | | | | | | | | | | | |
| +5 | 16 | | | | | | | | | | | | | | | | | | |
| GND | 17 | | | | | | | | | | | | | | | | | | |
| J3-12 | 18 | +5V | | | | | | | | | | | | | | | | | |
| | 19 | +5V | | | | | | | | | | | | | | | | | |
| | 20 | | | | | | | | | | | | | | | | | |
| | 21 | CPU-58, J3-23 | | | | | | | | | | | | | | | | | |
8061 MEMORY MAP

The 8061 uses the same address space for program and for data memory and can execute instructions from any memory address. Its addressing range is 64k locations and the first 256 locations are on-chip and refer to the internal register file. All other memory resides externally.

- **REG** at 00.
- Anything with "?" in it. The number of "?" shows the number of characters I think are there.
- The OA00H address at the beginning of the KAM area.
- The Interrupt Vector addresses: 2010H – 201FH.
- The D000H/E000H address at the beginning of the Engineering Console area.

(This memory map came from a difficult to read picture. The things I'm unsure of are:

- The "REG" at 00.
- Anything with "?" in it. The number of "?" shows the number of characters I think are there.
- The OA00H address at the beginning of the KAM area.
- The Interrupt Vector addresses: 2010H – 201FH.
- The D000H/E000H address at the beginning of the Engineering Console area.)
# 8061 Instruction Set

Summary, 8096 instructions vs. 8061 instructions

- 32 instructions the same
- 43 instructions the same, but renamed
- 8 instructions the same, but split into 2 pseudo-ops (2 vs. 3 operands)
- 7 instructions in 8061, not in 8096
  -- bank0/1/2/3
  -- retei
  -- rombank
  -- signd
- 6 instructions in 8096, not in 8061
  -- br
  -- divu/divub
  -- mulu/mulub
  -- rst

---

<table>
<thead>
<tr>
<th>op-code</th>
<th>8096</th>
<th>8061</th>
<th>description</th>
<th>difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>64-67</td>
<td>add</td>
<td>ad2w</td>
<td>add words (2 operands)</td>
<td>-- split</td>
</tr>
<tr>
<td>44-47</td>
<td>&quot;</td>
<td>ad3w</td>
<td>add words (3 operands)</td>
<td>-- split</td>
</tr>
<tr>
<td>74-77</td>
<td>addb</td>
<td>ad2b</td>
<td>add bytes (2 operands)</td>
<td>-- split</td>
</tr>
<tr>
<td>54-57</td>
<td>&quot;</td>
<td>ad3b</td>
<td>add bytes (3 operands)</td>
<td>-- split</td>
</tr>
<tr>
<td>A4-A7</td>
<td>addc</td>
<td>adcw</td>
<td>add words with carry</td>
<td>-- rename</td>
</tr>
<tr>
<td>B4-B7</td>
<td>adcb</td>
<td>adcb</td>
<td>add bytes with carry</td>
<td>-- rename</td>
</tr>
<tr>
<td>60-63</td>
<td>and</td>
<td>an2w</td>
<td>logical and words (2 operands)</td>
<td>-- split</td>
</tr>
<tr>
<td>40-43</td>
<td>&quot;</td>
<td>an3w</td>
<td>logical and words (3 operands)</td>
<td>-- split</td>
</tr>
<tr>
<td>70-73</td>
<td>andb</td>
<td>an2b</td>
<td>logical and bytes (2 operands)</td>
<td>-- split</td>
</tr>
<tr>
<td>50-57</td>
<td>&quot;</td>
<td>an3b</td>
<td>logical and bytes (3 operands)</td>
<td>-- split</td>
</tr>
<tr>
<td>-----</td>
<td>bank0</td>
<td>-----</td>
<td>-- not in 96</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>bank1</td>
<td>-----</td>
<td>-- not in 96</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>bank2</td>
<td>-----</td>
<td>-- not in 96</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>bank3</td>
<td>-----</td>
<td>-- not in 96</td>
<td></td>
</tr>
<tr>
<td>E3</td>
<td>br</td>
<td>-----</td>
<td>branch indirect</td>
<td>-- not in 61</td>
</tr>
<tr>
<td>01</td>
<td>clr</td>
<td>clrw</td>
<td>clear word</td>
<td>-- rename</td>
</tr>
<tr>
<td>11</td>
<td>clrb</td>
<td>clrb</td>
<td>clear byte</td>
<td>-- same</td>
</tr>
<tr>
<td>F8</td>
<td>clrc</td>
<td>clc</td>
<td>clear carry flag</td>
<td>-- same</td>
</tr>
<tr>
<td>FC</td>
<td>clrvt</td>
<td>clrvt</td>
<td>clear overflow trap</td>
<td>-- same</td>
</tr>
<tr>
<td>88-8B</td>
<td>cmp</td>
<td>cmpw</td>
<td>compare words</td>
<td>-- rename</td>
</tr>
<tr>
<td>98-9B</td>
<td>cmpb</td>
<td>cmpb</td>
<td>compare bytes</td>
<td>-- same</td>
</tr>
<tr>
<td>05</td>
<td>dec</td>
<td>decw</td>
<td>decrement word</td>
<td>-- rename</td>
</tr>
<tr>
<td>15</td>
<td>decb</td>
<td>decb</td>
<td>decrement byte</td>
<td>-- same</td>
</tr>
<tr>
<td>FA</td>
<td>di</td>
<td>di</td>
<td>disable interrupts</td>
<td>-- same</td>
</tr>
<tr>
<td>FE/8C-8F</td>
<td>div</td>
<td>divw</td>
<td>divide signed integers (FE prefix)</td>
<td>-- rename</td>
</tr>
<tr>
<td>FE/9C-9F</td>
<td>divb</td>
<td>divb</td>
<td>divide signed bytes (FE prefix)</td>
<td>-- same</td>
</tr>
<tr>
<td>8C-8F</td>
<td>divu</td>
<td>-----</td>
<td>divide unsigned words</td>
<td>-- not in 61</td>
</tr>
<tr>
<td>9C-9F</td>
<td>divub</td>
<td>-----</td>
<td>divide unsigned bytes</td>
<td>-- not in 61</td>
</tr>
<tr>
<td>E0</td>
<td>djnz</td>
<td>djnz</td>
<td>decrement and jump if not zero</td>
<td>-- same</td>
</tr>
<tr>
<td>FB</td>
<td>ei</td>
<td>ei</td>
<td>enable interrupts</td>
<td>-- same</td>
</tr>
<tr>
<td>06</td>
<td>ext</td>
<td>sexw</td>
<td>sign extend int to long</td>
<td>-- rename</td>
</tr>
<tr>
<td>16</td>
<td>extb</td>
<td>sexb</td>
<td>sign extend 8-bit int to 16 bit int</td>
<td>-- rename</td>
</tr>
<tr>
<td>07</td>
<td>inc</td>
<td>incw</td>
<td>increment word</td>
<td>-- rename</td>
</tr>
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<td>17</td>
<td>incb</td>
<td>incb</td>
<td>increment byte</td>
<td>-- same</td>
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<td>30-37</td>
<td>jbc</td>
<td>jnb</td>
<td>jump if bit clear</td>
<td>-- rename</td>
</tr>
<tr>
<td>38-3F</td>
<td>jbs</td>
<td>jb</td>
<td>jump if bit set</td>
<td>-- rename</td>
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<tr>
<td>DB</td>
<td>jc</td>
<td>jc</td>
<td>jump if carry flag is set</td>
<td>-- same</td>
</tr>
<tr>
<td>DF</td>
<td>je</td>
<td>je</td>
<td>jump if equal</td>
<td>-- same</td>
</tr>
<tr>
<td>Code</td>
<td>Opcode</td>
<td>Description</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>-------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>D6</td>
<td>jge</td>
<td>jump if signed greater than or equal</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>jgt</td>
<td>jump if signed greater than</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>D9</td>
<td>jh</td>
<td>jump if unsigned higher</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>DA</td>
<td>jle</td>
<td>jump if signed less than or equal</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>DE</td>
<td>jlt</td>
<td>jump if signed less than</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>jnc</td>
<td>jump if carry flag is clear</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>D7</td>
<td>jne</td>
<td>jump if not equal</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>jnh</td>
<td>jump if unsigned not higher</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>D0</td>
<td>jnst</td>
<td>jump if sticky bit is clear</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>D5</td>
<td>jnv</td>
<td>jump if overflow flag is clear</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td>jnvt</td>
<td>jump if overflow trap is clear</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>D8</td>
<td>jst</td>
<td>jump if sticky bit is set</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>DD</td>
<td>jv</td>
<td>jump if overflow flag is set</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>DC</td>
<td>jvt</td>
<td>jump if overflow trap is set</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>EF</td>
<td>lcall</td>
<td>long call</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>A0-A3</td>
<td>ld</td>
<td>load word</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>B0-B3</td>
<td>ldb</td>
<td>load byte</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>BC-BF</td>
<td>ldbse</td>
<td>load integer with byte, sign extended</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>AC-AF</td>
<td>ldbze</td>
<td>load word with byte, zero extended</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>E7</td>
<td>ljmp</td>
<td>long jump</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>FE/6C-6F</td>
<td>mul</td>
<td>multiply integers (2 operands)</td>
<td>-- split</td>
<td></td>
</tr>
<tr>
<td>FE/4C-4F</td>
<td>&quot;</td>
<td>multiply integers (3 operands)</td>
<td>-- split</td>
<td></td>
</tr>
<tr>
<td>FE/7C-7F</td>
<td>mulb</td>
<td>multiply bytes (2 operands)</td>
<td>-- split</td>
<td></td>
</tr>
<tr>
<td>FE/5C-5F</td>
<td>&quot;</td>
<td>multiply bytes (3 operands)</td>
<td>-- split</td>
<td></td>
</tr>
<tr>
<td>6C-6F</td>
<td>mulu</td>
<td>multiply unsigned words (2 operands)</td>
<td>-- not in 61</td>
<td></td>
</tr>
<tr>
<td>4C-4F</td>
<td>&quot;</td>
<td>multiply unsigned words (3 operands)</td>
<td>-- not in 61</td>
<td></td>
</tr>
<tr>
<td>7C-7F</td>
<td>mulub</td>
<td>multiply unsigned bytes (2 operands)</td>
<td>-- not in 61</td>
<td></td>
</tr>
<tr>
<td>5C-5F</td>
<td>&quot;</td>
<td>multiply unsigned bytes (3 operands)</td>
<td>-- not in 61</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>neg</td>
<td>negate integer</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>negb</td>
<td>negate byte</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>FD</td>
<td>nop</td>
<td>no operation</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>0F</td>
<td>norml</td>
<td>normalize long integer</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>not</td>
<td>complement word</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>notb</td>
<td>complement byte</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>80-83</td>
<td>or</td>
<td>logical or words</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>90-93</td>
<td>orb</td>
<td>logical or bytes</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>CC/E/F</td>
<td>pop</td>
<td>pop word</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>F3</td>
<td>popf</td>
<td>pop flags</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>push</td>
<td>push word</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>F2</td>
<td>pushf</td>
<td>push flags</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>F0</td>
<td>ret</td>
<td>return from subroutine</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>retei</td>
<td>return from subroutine</td>
<td>-- not in 96</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>rombank</td>
<td></td>
<td>-- not in 96</td>
<td></td>
</tr>
<tr>
<td>FF</td>
<td>rst</td>
<td>reset system</td>
<td>-- not in 61</td>
<td></td>
</tr>
<tr>
<td>28-2F</td>
<td>scall</td>
<td>short call</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>F9</td>
<td>setc</td>
<td>set carry flag</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>shl</td>
<td>shift word left</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>shlb</td>
<td>shift byte left</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>0D</td>
<td>shll</td>
<td>shift double word left</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>shr</td>
<td>logical right shift word</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>0A</td>
<td>shra</td>
<td>arithmetic right shift word</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>1A</td>
<td>shrab</td>
<td>arithmetic right shift byte</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>0E</td>
<td>shral</td>
<td>arithmetic right shift double word</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>shrb</td>
<td>logical right shift byte</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>0C</td>
<td>shr1</td>
<td>logical right shift double word</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>signd</td>
<td></td>
<td>-- not in 96</td>
<td></td>
</tr>
<tr>
<td>20-27</td>
<td>sjmp</td>
<td>short jump</td>
<td>-- same</td>
<td></td>
</tr>
<tr>
<td>00</td>
<td>skip</td>
<td>skip - 2 byte no operation</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>C0/2/3</td>
<td>st</td>
<td>store word</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>C4/6/7</td>
<td>stb</td>
<td>store byte</td>
<td>-- rename</td>
<td></td>
</tr>
<tr>
<td>68-6B</td>
<td>sub</td>
<td>subtract words (2 operands)</td>
<td>-- split</td>
<td></td>
</tr>
<tr>
<td>48-4B</td>
<td>&quot;</td>
<td>subtract words (3 operands)</td>
<td>-- split</td>
<td></td>
</tr>
</tbody>
</table>
78-7B    subb  sb2b  subtract bytes (2 operands)  -- split
58-5B    "      sb3b  subtract bytes (3 operands)  -- split
A8-AB    subc  sbbw  subtract words with borrow  -- rename
B8-BB    subcb  sbbb  subtract bytes with borrow  -- rename
F7       trap  -- software trap (internal use only, not in assembler)
84-87    xor   xrw   logical exclusive or words  -- rename
94-97    xorb  xrb   logical exclusive or bytes  -- rename

The bank selection opcodes are 8063 -- as that is the difference between them, memory bank selection capabilities...

8061 Interrupt Vectors and Priorities:

<table>
<thead>
<tr>
<th>Priority:</th>
<th>Interrupt</th>
<th>16-Bit Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest</td>
<td>High-Speed Input #0</td>
<td>0x201E</td>
</tr>
<tr>
<td>High</td>
<td>High-Speed Input #1</td>
<td>0x201C</td>
</tr>
<tr>
<td>High</td>
<td>HSO Port Output Interrupt #1</td>
<td>0x201A</td>
</tr>
<tr>
<td>Low</td>
<td>External Interrupt</td>
<td>0x2018</td>
</tr>
<tr>
<td>Low</td>
<td>HSI Port Input Data Available</td>
<td>0x2016</td>
</tr>
<tr>
<td>Low</td>
<td>A/D End-Of-Conversion</td>
<td>0x2014</td>
</tr>
<tr>
<td>Low</td>
<td>Master I/O Timer Overflow</td>
<td>0x2012</td>
</tr>
<tr>
<td>Lowest</td>
<td>HSO Port Output Interrupt #2</td>
<td>0x2010</td>
</tr>
</tbody>
</table>

At Reset, PC = 0x2000 in Memory Bank #8

**MCU PARTS LIST**

<table>
<thead>
<tr>
<th>Ref Designator</th>
<th>Part Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC1</td>
<td>P8061BH-3</td>
<td>68-pin</td>
</tr>
<tr>
<td>IC2</td>
<td>74003PC</td>
<td>16 pin DIP</td>
</tr>
<tr>
<td>IC3</td>
<td>74001MC</td>
<td>16 pin DIP</td>
</tr>
<tr>
<td>IC4</td>
<td>71001FB</td>
<td>16 pin DIP</td>
</tr>
<tr>
<td>IC5</td>
<td>71001FB</td>
<td>16 pin DIP</td>
</tr>
<tr>
<td>IC6</td>
<td>81C61-A</td>
<td>24 pin DIP</td>
</tr>
<tr>
<td>IC7</td>
<td>D8763-1</td>
<td>24 pin DIP</td>
</tr>
<tr>
<td>IC8</td>
<td>74003PC</td>
<td>16 pin DIP</td>
</tr>
<tr>
<td>IC9</td>
<td>74003PC</td>
<td>16 pin DIP</td>
</tr>
<tr>
<td>IC10</td>
<td>7007FB</td>
<td>TO-92</td>
</tr>
</tbody>
</table>
THE MCU:

* For a discussion of the EEC-IV, see SAE paper 820900 (and when you get it, please send me a copy <g>.)

There is custom EPROM and RAM in the EEC that is integral with the 8061 in that it works directly with the multiplexed address/data bus of the 8061. The test connector also has the micro-controller's multiplexed address/data bus signals on it as well as a PROM disable signal. Almost all Intel 8 bit processors used this multiplexed address and data bus. Anyone with an old IBM PC or PC-XT, or anything using the Intel 8088 processor uses this scheme. The chips in the EEC are soldered in and the things that look like PROMs don't have useful markings on them. The memory chips are not industry standard types, which is why EEC modifiers always use the service port to attach external memory.

Mike Wesley said: "None of the CPU's seem to have any on board ROM, just some scratchpad RAM. Everything is outside either in an EPROM or FLASH, and it's not a standard EPROM so exercise caution when trying to read these devices -- they are easily destroyed using typical procedures.

"... to do word transfers, put the address of the low byte data on the bus, strobe it in, put on the low byte data, strobe that in, put on the high byte data and strobe that in. You don't need to place the address for the high order byte on the bus. The OEM code (especially in the EEC-V) places the low byte address on the bus, strobes, places the low byte data on the bus, strobes, places the high byte address on the bus, strobes, places the high byte data, and strobes. The CPU will do the high byte addressing for you."

ECM TEST PORT (J3) PINOUT

The pinouts are derived from the J3 Test Port on a SD unit for an '87 Mustang (DA1 / E7SF-12A650-A1B). Looking at the MCU facing the service port (from the rear of the mating plug) the connector is numbered from right-to-left with odd numbers on the component side and the even numbers on the wiring side. It is a 15/30 terminal, card-edge connector with .1" spacing. (The table below is arranged for the pins to be read from left-to-right, top first.)

<table>
<thead>
<tr>
<th>PIN NO.</th>
<th>SIGNAL / FUNCTION</th>
<th>MCU PIN</th>
<th>CPU 8061</th>
<th>RAM 81C61</th>
<th>EPROM 8763</th>
<th>notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>PWR GND</td>
<td>40,60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>VPWR</td>
<td>37,57</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>address</td>
<td>57 22 22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>address</td>
<td>58 21 21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>address</td>
<td>59 20 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>D7</td>
<td>68 10 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>D6</td>
<td>67 11 11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>D5</td>
<td>66 12 12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>D4</td>
<td>65 13 13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>D3</td>
<td>64 14 14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>D2</td>
<td>63 15 15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
There are 14 pins from the 8763 EPROM on the connector, 2 pins from the 87C61 RAM-I/O on the connector, 1 pin from the 8061 CPU and 1 pin from a 16-pin logic chip.

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Wire Color</th>
<th>Name</th>
<th>Wire Color</th>
<th>Name</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BK/O</td>
<td>Kapwr</td>
<td>Y</td>
<td>Kapwr</td>
<td>keep-alive power</td>
</tr>
<tr>
<td>2</td>
<td>LGN</td>
<td>BOO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>DGN/W</td>
<td>Vss +</td>
<td>GY/BK</td>
<td>Vss +</td>
<td>Vehicle speed sensor positive</td>
</tr>
<tr>
<td>4</td>
<td>DGN/Y</td>
<td>IDM</td>
<td>DGN/Y</td>
<td>IDM</td>
<td>Ignition Diagnostic monitor</td>
</tr>
<tr>
<td>5</td>
<td>O/Y</td>
<td>Vss -</td>
<td>PK/O</td>
<td>Vss -</td>
<td>Vehicle speed sensor negative</td>
</tr>
<tr>
<td>6</td>
<td>LGN/Y</td>
<td>ECT</td>
<td>LGN/R</td>
<td>ECT</td>
<td>Engine coolant temp sensor</td>
</tr>
<tr>
<td>7</td>
<td>O/LBU</td>
<td>FPM</td>
<td>DGN/Y</td>
<td>FPM</td>
<td>Fuel pump monitor</td>
</tr>
<tr>
<td>8</td>
<td>PK/LBU</td>
<td>DATA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>BK/Y</td>
<td>ACC</td>
<td>DGN/O</td>
<td>ACC</td>
<td>A/C compressor clutch</td>
</tr>
<tr>
<td>10</td>
<td>W/BK</td>
<td>AM 2</td>
<td></td>
<td></td>
<td>Air management solenoid 2</td>
</tr>
<tr>
<td>11</td>
<td>LBU/R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>LBN/BU</td>
<td>MAF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>LBU/R</td>
<td>MAF (CA only)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>LBN/BU</td>
<td>MAF RTN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Color</td>
<td>Code</td>
<td>Description</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-------</td>
<td>------</td>
<td>------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>BK/O</td>
<td>IGN GND</td>
<td>Ignition ground</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>LBN/R</td>
<td>STO/MIL</td>
<td>Self-test output check Engine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>BK</td>
<td>CSE GND</td>
<td>Case ground</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>GY/W</td>
<td>ISC/BPA</td>
<td>Idle speed control bypass air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>LBN/LGN</td>
<td>FP</td>
<td>Fuel pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>LGN/BK</td>
<td>KS</td>
<td>Knock sensor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Y/LGN</td>
<td>PSPS</td>
<td>Power steering pressure switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Y/R</td>
<td>ACT</td>
<td>Air charge temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>O/W</td>
<td>VREF</td>
<td>Reference voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>RB/LGN</td>
<td>EVP</td>
<td>EGR valve position sensor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>DGN/P</td>
<td>HEGO</td>
<td>Heat exhaust gas oxygen sensor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>LBU/W</td>
<td>NDS</td>
<td>Neutral drive switch (automatic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>DGN</td>
<td>EVR</td>
<td>EGR vacuum regulator solenoid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Y/LGN</td>
<td>SPOUT</td>
<td>Spark out timing control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>R</td>
<td>VPWR</td>
<td>Vehicle power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>BK/LGN</td>
<td>PWR GND</td>
<td>Power ground</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>PU</td>
<td>ACD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>DBU/LGN</td>
<td>MAP</td>
<td>Manifold absolute pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>BK/W</td>
<td>SIG RTN</td>
<td>Signal return</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>DGN/LGN</td>
<td>TPS</td>
<td>Throttle position sensor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>W/R</td>
<td>STI</td>
<td>Self-test input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>O</td>
<td>HEGOG</td>
<td>Heated EGO sensor ground</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>W/R</td>
<td>AM 1</td>
<td>Air management solenoid 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>O/Y</td>
<td>SS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>PU/Y</td>
<td>CCO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>PK/Y</td>
<td>WAC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>DBU</td>
<td>PIP</td>
<td>Profile ignition pickup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>R</td>
<td>VPWR</td>
<td>Vehicle power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>LBN/O</td>
<td>INJ 1</td>
<td>Injector bank 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>LBN/R</td>
<td>INJ 2</td>
<td>Injector bank 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>BK/LGN</td>
<td>PWR/GND</td>
<td>Power ground</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wire Color Xref (sorry, it's in semi color code order):
- BK - black
- BN - brown
- R - red
- O - orange
- Y - yellow
- GN - green
- PU - purple
- GY - grey
- W - white
- PK - pink
- T - tan

prefixes:
- D - dashed / dark
- L - light
EEC DIAGNOSTICS

Two types of diagnostics are performed by the EEC (this was written for early 80's model units so it may be expanded now). They are On-Demand and Continuous. On-Demand is conducted during key-on/engine-off and during engine running modes to permit the microprocessor to test itself. Continuous, as the name implies, is on-going whenever the system is in operation. Beginning in the latter part of 1983, the EEC-IV began to remember conditions found during continuous testing, even after the key is turned off with a special custom memory chip called Keep Alive Memory (KAM). The KAM chip, which contains 128 bytes of read/write memory, is powered by a separate low current connection to the vehicle battery. Faults, even intermittent ones, are recognized and stored away for recall during dealer service.

EEC FUEL CONTROL

The Air Flow sensor used in production EFI's typically compensates for temperature and density changes in the intake air mass. Then the oxygen sensor is used to fine tune the mixture. Almost all use barometric compensation in one form or another. Some systems take a barometric reading from the MAP sensor after the ignition key is turned on, but before the engine starts, and store this as a reference. This can also be updated at WOT, since manifold pressure is essentially = barometric pressure at this point (with some flow related pressure drop). Some systems have a separate barometric sensor in addition to MAP. Some MAP's are not absolute sensors at all, but differential sensors, referenced on one side to the atmosphere. So as the atmospheric pressure changes, the MAP reference point changes as well. Some compensation is possible with the fuel pressure regulator, since it is usually referenced to manifold pressure and thus atmospheric indirectly. This helps regulate the pressure across the injector so the amount of fuel delivered is related to only the injector pulse width. Some systems have no barometric pressure compensation at all.

The EEC does 4 point interpolation on all tables. There is a minimal number of cells in the fuel lookup tables. The EEC doesn't look up 'injector on time', it calculates the injector pulse width by looking at the desired Lambda and then, using the mass of air entering the engine and the injector size, it calculates the duty cycle needed to get the desired A/F ratio. (Lambda is an engineering term where stoich is 1, anything smaller than 1 is rich, anything larger than 1 is lean. To get A/F numbers from Lambda, multiply lambda value by 14.64. For example, an A/F ratio of 14.05:1 is a lambda of .85 lambda.)

Mike Wesley wrote: "The ECU controls both the fuel mixture and the timing. The fuel mixture operates in either "open loop" or "closed loop" mode. Anything external to the EEC that tries to mess with fuel mixture at points where the engine is in closed loop operation will cause the computer to try and compensate. This can cause more problems than it's likely to solve. Timing and WOT fuel settings aren't closed loop functions, and can be changed without the computer trying to correct them. This is why "piggy-back" units, i.e. units that connect between the cable and the ECU, aren't very effective.

"Closed loop operation can sometimes be altered without problems. This ability has allowed some manufacturers to be able to market cars and parts that are fully emissions legal (e.g. KB, Saleen, etc). The after-market devices that go between the engine harness and the EEC interfere with closed loop. The software modules that connect to the service connector (Hypertech, Superchips, Calibrator, etc.) do not interfere with closed loop - rather they can define new values for closed loop. The EEC will do whatever it's told -- it's a computer
running a program and your data can be substituted for the factory's through the service port connector. The EEC can not 'learn' around a software module.

"Closed loop operation basically consists of a controller with a target A/F ratio, HEGO information as its feedback and the injectors as the main control mechanism. The 'factory' target A/F ratio is 14.64:1, but this can be changed.

"Approximately 900 items can be changed or logged in a 93 5.0 Mustang. For example, during a shift, the EEC might look at spark, load, TP, fuel, and transient fuel. By logging this data, you can tell exactly where in the spark tables the EEC is travelling and tune just those cells. Most people would normally tweak the whole curve down or try and tune in areas the EEC isn't even looking at. With the data-logging, you can see exactly where it's pulling its data from.

"Examples of some of the functions controlled by the EEC are: A:F ratio in closed loop, transient fuel, EGR, Canister Purge, Thermactor, adaptive control system, control of OBD-I and OBD-II testing (on/off/change test values...), fuel, spark, MAF's, VE tables, injectors, rev limits speed limits, electronic transmission control, and lots more.

"If you have a later car (91 or newer), there is an integrated controller module (ICM) (12B577 basic #). This is located in the engine compartment. It is a black metal box about 8"x6"x1.5". It runs the cooling fan, the fuel pump, and the EEC power.

EEC IGNITION and TIMING CONTROL:

The EEC only sees one Crankshaft Position Sensor signal, but where it comes from depends on the age of the EEC. Early EEC's used a sectored wheel in the distributor which produced a square wave of frequency of Number-Cylinders per 2-revs with a nominal 50% duty cycle unless SEFI was used whereupon there was a "short" tooth. The spark was output by a TFI unit.

Later and perhaps all current EEC's, including the EEC-V, utilize a 36-1 tooth wheel for CPS which is pre-processed by a unit known as the EDIS (Electronic DIStributor). The EDIS converts the 36-1 into a 2 pulses/rev 50% duty cycle square wave which is then fed into the EEC to be used for RPM and injector timing calculations. The EEC sends a PWM signal to the EDIS defining the spark advance required, and the EDIS unit then times out the signals to the coils (wasted spark). This gives a more accurate spark delivery as the EDIS has access to timing data which is updated every 10 crank degrees whereas the EEC only gets timing data every 90 degrees.

The EEC gets one and only one timing signal from the TFI unit. It is called the PIP (Profile Ignition Pickup). The PIP signal is 45 - 55Hz @ 1000 RPM, for 4, 6 and 8 cylinder engines and, with the exception of SEFI, has a duty cycle of 50%. SEFI uses Signature PIP where the #1 vane on the PIP reluctor is roughly 35% duty cycle and the rest are roughly 50%. The EEC uses this to detect cylinder #1. On a stock car, the leading edge of the PIP signal is @ 10 BTDC.

The EEC controls the spark timing. The TFI's function at this point is to basically clean up the PIP signal, charge and fire the coil. The TFI module conditions the hall sensor output and sends it off to the EEC. The only delay is just propagation delay through the TFI electronics. The EEC sends out the SPOUT signal which starts the TFI modules charging the coil. Depending on what advance the EEC is looking for, the falling edge of the SPOUT can vary. The coil fires on the falling edge. Since the EEC 'knows' where 10 BTDC of each cylinder is, by using timers and things, it can calculate when to drop the SPOUT signal. The MCU uses the previous PIP value to determine where the crank was.
The TFI module can handle acceleration rates of up to 250 HZ/sec. Another function of the TFI modules is to provide LOS spark (limp mode). If the TFI detects a loss of SPOUT, it will generate it's own 'SPOUT' to coincide with the rising edge of PIP (10 BTDC...assuming you haven't moved the distributor).

To determine timing values, the EEC uses crank position (CPS), engine temperature (ECT), air-charge temperature (ACT), throttle position (TPS), EGO data and Cylinder-ID to name the significant ones. It's relatively easy to calculate the spark required for optimum power from these, but the compromises made to meet emissions and driveability complicate matters.

The "TFI" (EDIS) units are all very similar. The differences are in the EECs which, though electrically similar, are totally different in terms of code and calibration content. The EDIS gets the required spark advance from the EEC and, using the regularly updated crankshaft position, determines the ignition firing time.

The return from the EEC to the TFI module (SPOUT or SPark OUT) is the timing information and has the same specifications as PIP. What I gleaned from this is that the PIP does 2 things:

1) It lets the EEC know how fast the engine is turning (frequency alone).
2) It gives a base signal to be sent back to the TFI after being delayed a bit. This delay or phase change (relative to the PIP) is what lets the EEC control timing. But indirectly, the TFI is doing _most_ of the work.

The EEC does the timing. The TFI's function is to charge and fire the coil. The TFI basically just cleans up the PIP signal. If you measure it right off the Hall effect sensor, it can look pretty nasty. It goes into the TFI module, gets cleaned up and sent off to the EEC. The only delay is propagation delay through the TFI electronics. The EEC sends out the SPOUT signal which starts the TFI modules charging the coil. The coil fires on the falling edge and, depending on what advance the EEC is looking for, the falling edge of the SPOUT varies. Since the EEC knows where 10 BTDC of each cylinder is, by using timers and things, it can calculate when to drop the SPOUT signal. The PIP information the EEC uses to calculate SPOUT is not current, it uses the previous PIP value to determine where the crank was. The TFI module can handle acceleration rates of up to 250 HZ/sec. Another function of the TFI modules is to provide LOS spark (limp mode). If the TFI detects a loss of SPOUT, it will generate it's own 'SPOUT' to coincide with the rising edge of PIP (10 BTDC...assuming you haven't moved the distributor).

The return signal from the EEC to the EDIS is unrelated to the PIP. It purely indicates to the EDIS unit the amount of spark advance required.

**EEC FUNCTIONS**

(Taken from Mike Wesley's Calibrator demo and other sources.)

- load scaling
- MAF transfer
- WOT spark advance vs RPM
- WOT spark advance vs ECT
- WOT spark advance vs ACT
- accelerator enrichment
- WOT fuel multiplier vs RPM
- WOT fuel multiplier vs TP
- part throttle spark advance vs ACT
- open loop fuel vs ACT
- closed throttle open loop fuel multiplier
spark advance vs BAP
spark advance rate
dwell
altitude fuel adjustment
cranking fuel vs ECT
injector adjustment for low battery
dashpot clip and decrement rate
transmission TV pressure vs TP
torque convertor lockup vs TP
upshift speed vs TP
downshift speed vs TP
idle airflow

**EEC SCALARS**

(Taken from Mike Wesley's Calibrator demo and other sources.)

injector size
injector slope
minimum injector pulse width
accelerator pump multiplier
open loop fuel multiplier
part throttle timing adder
dwell minimum
dwell maximum
ACT minimum for adaptive control
ACT maximum for adaptive control
minimum ECT for deceleration fuel shutoff
minimum RPM for deceleration fuel shutoff
minimum load (MAP) for closed loop
hi-load timeout to open loop
idle speed neutral
idle speed drive
CID
number HEGO sensors
WOT TPS value
EGR multiplier
EGR type
PIP filter
half fuel rev limit
speed limit
maximum spark retard
cooling fan ECT hi/lo/hysteresis
intake manifold volume
thermactor presence

**EEC TABLES**

(Taken from Mike Wesley's Calibrator demo and other sources.)

accelerator enrichment (lb/min)
startup fuel (A:F ratio)
base fuel (A:F ratio)
injector timing (crank degrees)
injector firing order
base spark (deg BTDC)
limp mode spark (deg BTDC)
injector output port
borderline detonation spark
borderline compensation vs ECT
borderline compensation vs ACT
borderline compensation vs lambda
acceleration fuel time constant
exhaust pulse delay
HEGO amplitude
HEGO bias
engine torque
engine frictional torque

MAF CONVERSION

Information on MAF conversion sent to me by Bob Nell <bnell@utk.edu>

attach these 4 wires from the MAF to the EEC

Air Meter Pin C-T/LB to EEC pin #9
Air Meter Pin D-DB/O to EEC pin #50
Air Meter Pin A- Red to EEC (splice into the existing red wire on pin #37)
   (this is VPWR)
Air Meter Pin B- Black to EEC (splice this into the existing blk wire on #40
   or #60)
   (this is PWR GRND)

Also, these changes must be made:

Pin 51 must be moved to pin 38 on EEC
Pin 11 must be moved to pin 32 on EEC

To hook up the VSS:

VSS + must be hooked up to Pin #3 on EEC
VSS - must be hooked up to pin #6 on EEC

you can get the VSS signal right from the VSS or tap it off the speed control
amplifier which is located near the dead pedal

Its the yellowish box in the corner there.
The DG/W wire is VSS+ and the black wire is VSS -

To hook up Fuel Pump Signal:

Hook up from Fuel pump relay under drivers seat ( I believe the pink wire
with stripe) to Pin #19 on EEC

Mike Wesley said: "The setup for the '95 Mustang Cobra R, (351 CID) was an 80
mm Lincoln Mark VIII MAF and 24# per hour injectors. These injectors will easily
support 350 HP and the 80mm MAF is a better choice than the 70mm, as you get to
use more of its linear range, so fueling can be more accurate.

To convert SD trucks with E4OD/AODE transmissions to MAF, Mike suggested: "The
one most people use is the CA 5.8 MAF/E4OD (F5TF-12A650-BYA). It is obtainable
through any Ford dealer (Pro-M, Kenne Bell, LCA, Downs Ford). I use the F5TF-
12A650-HB (95 CA 5.0 MAF/E4OD) on a 750+ HP daily driver 415 stroker Lightning
with a Vortech S trim. It is running open loop, has been reprogrammed, drives
like stock, gets 17 MPG and will run low 10's at 130+ in the 1/4 mile and A/C
and cruise work great. Both of these EEC's are set to use 4.10 gears. If a
smaller ratio is used, say 3.55, you could use the F5TF-12A650-GB. There are probably 15-20 EEC's available to convert a SD (later model) to MAF.

"If you have an early SD truck with AOD, re-wire to the Mustang EEC (Ford MotorSport sells this kit). You'll have to move/add quite a few wires, and you might not like the results if you're not able to re-calibrate the EEC (like the Pro-M 'low cost' kit, Kenne Bell, LCA and Downs Ford come pre-re-calibrated). The engine shuts down at 85 MPH, shifting is fairly sloppy and too early (at least on a Lightning). All Ford EECs shift poorly -- except for the Lightning which is only slightly firmer."

"To use the Mustang EEC on a truck with an E4OD/AODE, you would need to run two EECs in parallel. The Mustang EEC runs the engine, the existing truck EEC controls the trans. Pro-M sells a kit like this."

**TESTING AFMs**

To test a MAF, supply it with +12V and ground. The output will vary from roughly 0.25V to 0.5V at no flow, up to 4.75 to 5.00V at full flow.

John Lloyd <john@anergy.demon.co.uk> sent the following MAF calibration tables

"I calibrated an air meter the other day in the lab... A slight discontinuity between the hi and lo flow masters but it may be of use?

Calibration of air meters with Ford AFM  
Vs=5.0  
Tamb=19C  
19-Mar-97

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Vs=5.00  
Tamb=19C

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**TERMS**

A/C    Air Conditioning
ACCS   A/C Cycling Switch
ACC    A/C Clutch Compressor
ACT    Air Charge Temperature sensor
ACV    Thermactor Air Control Valve
AXOD   Automatic Transaxle Overdrive
BOO    Brake On/Off switch
BP     Barometric Pressure sensor
CANP   Canister Purge solenoid
CCO    Converter Clutch Override
CFI    Central Fuel Injection
CID    Cylinder Identification sensor
CKT    Circuit
DIS    Direct Ignition System (see also EDIS, TFI)
DVOM   Digital Volt/Ohm Meter
ECA    Electronic Control Assembly (processor, computer)
ECM    Electronic Control Module (see MCU)
ECT    Engine Coolant Temperature sensor
ECU    Electronic Control Unit (see MCU)
EDF    Electric Drive Fan relay assembly
EDIS   Electronic DIStributor (see also DIS, TFI)
EED    Electronic Engine Control
EGO    Exhaust Gas Oxygen sensor (see HEGO)
EGR    Exhaust Gas Recirculation system
EGRC   EGR Control solenoid or system
EGRV   EGR Vent solenoid or system
EVP    EGR Position sensor
EVR    EGR Valve Regulator
FI     Fuel Injector or Fuel Injection
FP     Fuel Pump
FPM    Fuel Pump Monitor
GND or GRND Ground
HEDF   High Speed Electro Drive Fan relay or circuit
HEGO   Heated EGO sensor
HEGOG  HEGO Ground circuit
HO     High Output
HSC             High Swirl Combustion, engine type
IDM             Ignition Diagnostic Module
IGN             Ignition system or circuit
INJ             Injector or Injection
ISC             Idle Speed Control
ITS             Idle Tracking Switch
KAM             Keep Alive Memory
KAPWR           Keep Alive Power
KOEO            Key On Engine Off
KOER            Key On Engine Running
KS              Knock Sensor
L               Liter(s)
LOS             Limited Operation Strategy (computer function)
LUS             Lock-Up Solenoid
MAF             Mass Air Flow sensor, meter or circuit
MA PFI          Mass Air Sequential Port Fuel Injection system
MCU             Microprocessor Control Unit
MIL             Malfunction Indicator Light
MPFI            Multi Port Fuel Injection
NDS             Neutral Drive Switch
NGS             Neutral Gear Switch
NPS             Neutral Pressure Switch
OCC             Output Circuit Check
OHC             Over Head Camshaft (engine type)
OSC             Output State Check
PFE             Pressure Feedback EGR sensor or circuit
PFI             Port Fuel Injection
PIP             Profile Ignition Pickup
PSPS            Power Steering Pressure Switch
PWR GND         Power Ground circuit
RWD             Rear Wheel Drive
SC              Super Charged (engine type)
SIG RTN         Signal Return circuit
SIL             Shift Indicator Light
SPOUT           Spark Output Signal from ECA
SS 3/4 - 4/3    Shift Solenoid circuit
STAR            Self Test Automatic Readout (test equipment)
STI             Self Test Input circuit
STO             Self Test Output circuit
TAB/TAD         Thermactor Air Bypass/Diverter Tandem solenoid valves
TFI             Thick Film Ignition system (see DIS, EDIS)
TGS             Top Gear Switch (cancels SIL operation in top gear)
THS             Transmission Hydraulic Switch
TP/TPS          Throttle Position Sensor
TTS             Transmission Temperature Switch
VAF             Vane Air Flow sensor or circuit
VAT             Vane Air Temperature
VBATT           Vehicle Battery Voltage
VM              Vane Meter
VOM             Analog Volt/Ohm Meter
VPWR            Vehicle Power supply voltage (regulated 10-14 volts)
VREF            Voltage Reference (ECA supplied reference voltage 4-6 volts)
VSC             Vehicle Speed Control sensor or signal
VSS             Vehicle Speed Sensor or signal
WAC             WOT A/C Cut-off switch or circuit
WOT             Wide Open Throttle

EEC APPLICATIONS
(sorted on CID and Code)
A9L is the most common 89–93 MAF 5-speed computer catch code
T4M0 is the most common 94–95 MAF 5-speed/E0D computer catch code
J4J1 is the catch code on 94–95 Cobra computers
ZA0 is the catch code used on the Cobra-R!!!

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There seem to be two channels of ECM availability:

1 - OEMs and the companies they authorize, who together provide remanufactured ECMs through dealer channels;

2 - and those involved in the remanufacturing of ECMs for the true automotive aftermarket.

- A1 Cardone
- Echlin
- Micro-Tech Automotive
- Standard Motor Parts

Some of these companies catalog and offer product (or repair service) on almost 800 different ECM configurations for Ford-made vehicles in the model years from 1977-1993. Some of these are consolidations of applications, where units have been sold under the Ford nameplate would add to this population of ECMs, since the above count is only Ford units.

For an idea of what the EEC does, and what can be done with it, get a demo of Mike Wesley's calibrator for the EEC-IV at:

http://www.tiac.net/users/goape/index.htm