DECADE ENGINEERING

COG-5 MSD Operator's Guide
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Introduction

COG-5 is a video information overlay generator with input and output interfaces to complement the requirements of commercial and industrial video systems. It superimposes text over video from composite or Y/C (S-Video) sources and distributes video output to as many as six destinations. Overlay data comes from a local keyboard, distance encoder, pan/tilt angle sensors, GPS receiver, on-board clock, and other peripheral devices. COG-5 is also capable of driving camera pan/tilt platforms through analog output channels. COG-5 may be controlled locally from a PC-compatible USB keyboard, or remotely through an RS-232 serial link to a host computer.

COG-5 MSD (Multi-Sensor Display) firmware adds a set of general-purpose measurement features. MSD allows linear voltage-output sensors to be configured for real-time video data display in the customer's preferred units of measurement. Four of the six MSD input channels are shared with original COG-5 functions, but all six MSD channels are configured via completely separate setup screens. Any desired mix of original and MSD data display fields may be configured to appear on screen simultaneously, subject to input channel sharing. See the COG-5 Application Guide for hardware details.

About Key Combinations

Abbreviations such as **<Alt>P** are used to specify combinations of two keys on the keyboard. To enter the **<Alt>P** command, for instance, press and hold the **Alt** key down while striking the **P** key, then release the **Alt** key. This action is much the same as typing an upper-case (capital) letter. **<Ctrl>A - <Ctrl>Z** indicates a range of key combinations, in this case the 26 possible combinations of the **Ctrl** key with a letter key.

About Column and Line Numbering

Configuration fields that control on-screen placement of text and data use column and line numbers beginning with zero, which is the upper left corner of the screen. There are 52 available columns (0~51) of character cells. Column number fields specify the location for the first character of a text/data object, which must be located to the left of column 51 in order to allow room for subsequent characters on the same line. COG-5 internally limits the range of some setup fields to insure that sufficient print space is allocated. MSD data fields are automatically adjusted to the left if the user attempts configuration with insufficient space to display all characters, including the measurement units label. Text and data fields will go off-screen at the bottom if configured for greater than line 15 in NTSC video systems. The limit for PAL video systems is line 18.

About the Screen Shots

For the sake of clarity, a gray matte background with black text overlay has been used for all of the video display examples in this document. In most COG-5 installations, camera video will appear instead of gray background and text will be rendered as selected by the **F8** key command.

Basic Operation

At power-up time, system measurement data normally appears on screen as text superimposed over video from the camera. A company logo or other graphic object may be the first thing you see. Strike the **Esc** and **F5** keys if you don't see any data on-screen. Live data fields may appear grouped into a compact moveable *Data Stack* or fixed in *Custom* screen locations, which may be configured as described later in this document. The stack format accommodates up to seven data fields. Here's a *Data Stack* display example:

```
05:22PM
23Sep11
PAN:329
TLT:180
ID Text
 000.0f
```
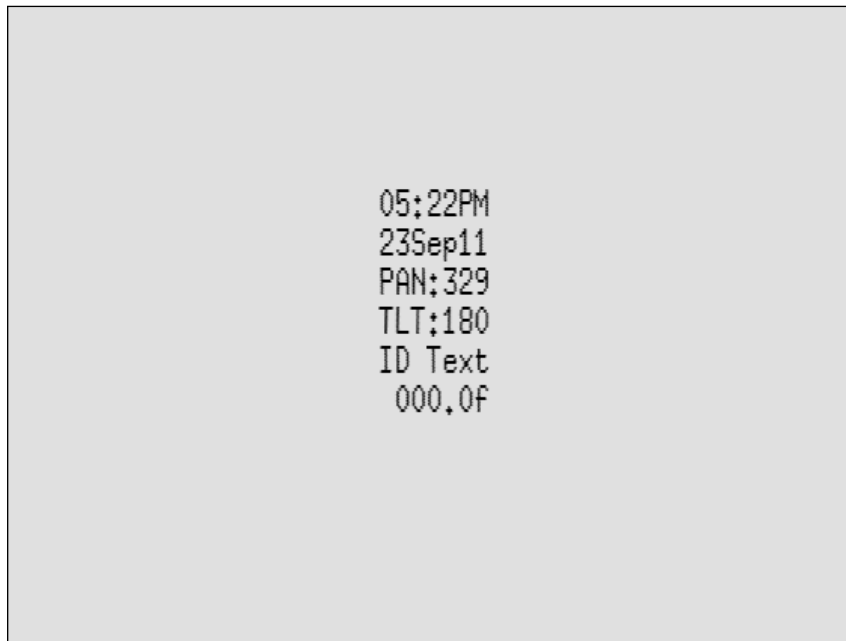
Example *Data Stack* includes:

Time in AM/PM format
Date
Camera Pan angle in degrees
Camera Tilt angle in degrees
Seven characters of user text
Distance in feet

Blank lines are automatically removed from the stack when data fields are disabled, so the display you see may appear substantially different from this example. Keyboard arrow keys shift the entire data stack to any desired position on screen. Data stack movement rate increases if an arrow key is held down.

Here's an example of what might be seen if the data display format is set to *Custom*. Data field locations are unaffected by the arrow keys when using this format:

```
05:41PM                          PAN:329
23Sep11                          TLT:180




ID Text                          000.0f
```
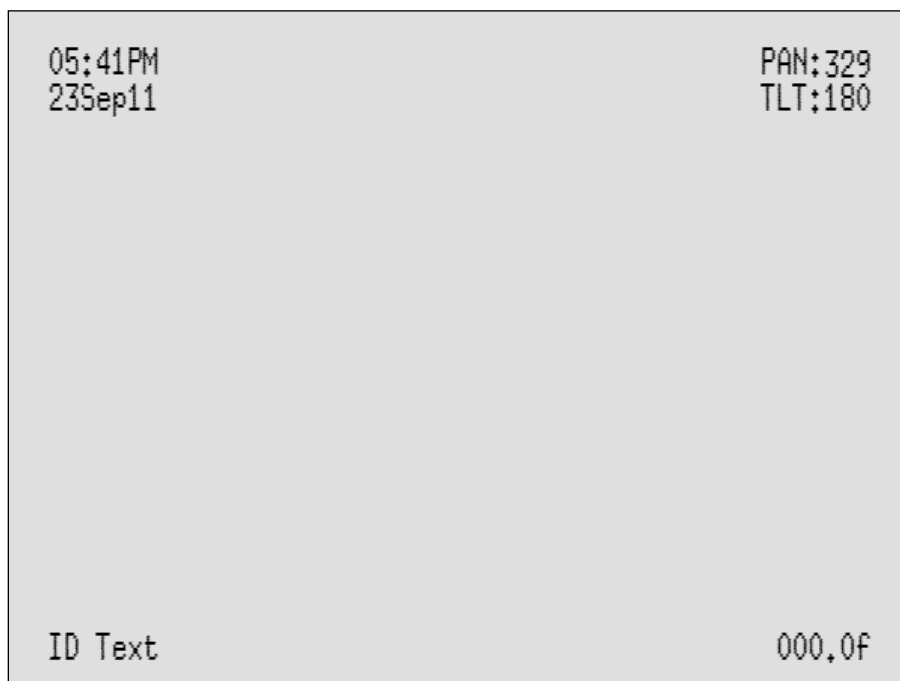
The **F1** key brings up the primary *Help* screen, which lists the most commonly used keyboard commands:

```
F1 Display Help Screen
F2 Pointer On | <Esc> Pointer Off
F3 Comment Mode On | <Esc> Comment Mode Off
F4 Clear Comment Text
F5 Toggle Overlay On/Off
F6 Toggle Distance Units (Primary/Alternate)
F7 Display Title Screens Sequentially
F8 Change Text Appearance
F12 Setup Menu




<Enter> More
<Esc> Return To Overlay
```

Once memorized, the commands listed in the primary Help screen may be entered during normal operation without first striking **F1**. Additional description for each command follows:

- **F2** and the **Esc** key switch the video pointer on and off. When it's on, the pointer may be moved to any position in the display with the arrow keys on the keyboard.

- **F3** and **Esc** switch the comment mode on and off. When it's on, comment text may be typed freely at any location on screen. Use the arrow keys to move the cursor before typing. Only simple typewriter-like functions are supported — the Backspace, Enter, Home, and End keys work as expected, but words break if typed past the right margin. Comment text is erased when exiting comment mode.

- **F4** erases comment text from the screen but does not exit comment mode.

- **F5** non-destructively toggles the entire text overlay on or off. It does not affect the underlying video image, and it does not clear any text from display memory.

- **F6** toggles the distance data display between primary and alternate measurement units. Distance units are feet and meters by default, but other units are easily configured.

- **F7** triggers an automatic sequential display of the Title Screen memories, much like a slide show. Title Screens are full-page text memories that can be edited and saved in semi-permanent memory space as described later in this document.

- **F8** cycles through a number of character-rendering options that can improve overlay contrast in situations where the video background image is very dark, bright, or cluttered. Be aware that on-screen response to **F8** may be delayed if data isn't being refreshed frequently. GPS data displays can seem rather sluggish in this respect, due to the one-second refresh interval.

- **F12** enters the COG-5 setup/configuration system. See later discussions.

Press **Esc** to abandon the Help system. Press **Enter** to proceed through additional Help screens.

Here's the second Help screen:

```
<Alt>P Preset Distance

<Alt>Z Zero Distance

<Alt>E Toggle All but Distance Display

<Alt>F1 - <Alt>F5 Display Single Title Screen




<Enter> More | <Shift><Enter> Back
<Esc> Return To Overlay
```

- **<Alt>P** causes a pre-configured distance value to be loaded into the distance register, which is part of the distance encoder interface in COG-5. The preset value immediately appears in the distance data display field (if enabled). This operation cannot be reversed, so a two-key combination was chosen to reduce the risk of accidental command execution.

- **<Alt>Z** immediately clears the distance register to zero. This operation is not reversible.

- **<Alt>E** is similar to the **F5** non-destructive overlay defeat command, but leaves the distance data field (only) on display.

- **<Alt>F1** through <**Alt>F5** display just one of the five Title Screens instead of the complete 'slide-show' presented in response to **F7**.

Note that it's possible to back up through the sequence of Help screens by using the **<Shift><Enter>** key combination. The **Enter** and **Esc** keys have similar functions elsewhere in COG-5, so they're omitted in subsequent discussions.

Here's the third Help screen:

```
                    Observation Codes

Key Combo      Observation Code
<Ctrl>A-This is observation code number 1
<Ctrl>B-This is observation code number 2
<Ctrl>C-This is observation code number 3
<Ctrl>D-This is observation code number 4
<Ctrl>E-This is observation code number 5
<Ctrl>F-This is observation code number 6
<Ctrl>G-This is observation code number 7
<Ctrl>H-This is observation code number 8
<Ctrl>I-This is observation code number 9
<Ctrl>J-This is observation code number 10


 <Enter> More | <Shift><Enter> Back
 <Esc> Return To Overlay
```

There are 26 "Observation Code" memories, one for each letter of the alphabet. These memories each hold a single line of text, which may be displayed during normal operation by entering one of the listed two-key combinations. Note that Help screens might not display all of the text in each memory, due to space limitations. These listings are intended only to refresh operator memory — Observation Code text editing capability is provided in the configuration system.

All of the text memories shown above contain factory-default text, but the next screen shows a couple of user message examples:

```
                    Observation Codes

Key Combo      Observation Code
<Ctrl>K-This is observation code number 11
<Ctrl>L-LATERAL CONNECTION
<Ctrl>M-L and M memories now contain user text
<Ctrl>N-This is observation code number 14
<Ctrl>O-This is observation code number 15
<Ctrl>P-This is observation code number 16
<Ctrl>Q-This is observation code number 17
<Ctrl>R-This is observation code number 18
<Ctrl>S-This is observation code number 19
<Ctrl>T-This is observation code number 20


 <Enter> More | <Shift><Enter> Back
 <Esc> Return To Overlay
```

Observation Code text, display location, and loiter time may be edited as described later in this document.

For the sake of completeness, here's the remaining Observation Code Help screen:

```
                    Observation Codes

Key Combo      Observation Code
<Ctrl>U-This is observation code number 21
<Ctrl>V-This is observation code number 22
<Ctrl>W-This is observation code number 23
<Ctrl>X-This is observation code number 24
<Ctrl>Y-This is observation code number 25
<Ctrl>Z-This is observation code number 26




    <Enter> More | <Shift><Enter> Back
    <Esc> Return To Overlay
```

The next Help screen is a list of commands that are used only in COG-5 installations with camera pan & tilt platform control via keyboard:

```
<Ctrl>Arrow keys
    Move Camera Slow Speed
<Alt>Arrow keys
    Move Camera Medium Speed
<Ctrl><Alt>Arrow keys
    Move Camera Fast Speed
<Shift>F1 - <Shift>F12
    Save Current Camera Position
<Ctrl>F1 - <Ctrl>F12
    Restore Saved Camera Position



    <Enter> About COG-5 | <Shift><Enter> Back
    <Esc> Return To Overlay
```

- **<Ctrl>Arrow** keys drive the pan/tilt platform at a pre-configured "slow" speed in any of four directions.

- **<Alt>Arrow** drives the camera platform at a pre-configured "medium" speed.

- **<Ctrl><Alt>Arrow** drives the camera platform at its highest pre-configured rate.

- **<Shift>F1** through **<Shift>F12** stores the current camera aim into one of 12 memory locations.

- **<Ctrl>F1** through **<Ctrl>F12** re-aims the camera to positions recalled from corresponding memories.

And finally, here's an example of the last Help screen in the sequence. If you request technical support, you may be asked to supply information from this screen:

```
                COG-5 Firmware Rev. 5.4.0
           Copyright Decade Engineering 2010,2011
             Compiled with ARM GCC Nov 16 2011




<Shift><Enter> Back
<Enter> or <Esc> Return To Overlay
```

COG-5 Configuration

Here's the primary COG-5 configuration menu that appears in response to the **F12** key:

```
                  Configuration Menu

        F1   Time/Date
        F2   Data Display
        F3   Motor Speeds
        F4   Distance Display
        F5   Title Screens
        F6   Observation Codes
        F7   Header Line
        F8   Calibrate Compass
        F9   MSD Display Options
        F10  MSD Channel Options
        F11  MSD Titles
        F12  GPS Display Options

        <Esc> Return To Overlay
```

Secondary configuration screens are called up as follows:

- **F1** brings up the clock & calendar setting screen.

- **F2** allows the standard *Data Stack* and *Custom* (non-MSD) data display fields to be configured.

- **F3** allows the pan/tilt platform motor drive speeds to be configured (if equipped).

- **F4** is for calibrating and configuring the distance data display (for both data display modes).

- **F5** allows for editing Title Screen text and Title Screen display options. Note the distinction between Title Screens, which are full screens of text, and MSD Titles (**F11**), which are limited to one line.

- **F6** brings up the Observation Code configuration and text-editing screen.

- **F7** is for editing Header Line text and Header Line display options.

- **F8** invokes the compass sensor calibration procedure (if equipped).

- **F9** and **F10** control MSD (multi-sensor display) field appearance and data processing parameters.

- **F11** is for configuring MSD Titles, which are useful for describing MSD data fields. MSD Titles are not coupled to MSD data fields, however, and may be used for any desired purpose.

- **F12** proceeds into the GPS data display configuration screens.

Each of these items is shown and described in detail on the following pages. The Pan & Tilt calibration page isn't available here due to the sometimes-extreme difficulty of correcting accidental miscalibration. Please request an access code from Decade Engineering if your system implements camera Pan & Tilt angle display features and recalibration becomes necessary.

```
                        Time and Date


        Hour      [01 PM]
        Minute  [43]
        Date     [23]
        Month   [Nov]
        Year     [11]




           <Enter> - Save changes and exit
           <Esc> - Discard changes and exit
           <Tab> - Change selected field
           <Arrow UP/DOWN> - Change value of selected field
```

[F12, F1] Here's the clock and calendar setting screen. Use the **Tab** key to select an edit field, which is indicated by highlighting. The ▲ and ▼ keys (up and down arrows) may then be used to alter the value in the selected field. Hit **Enter** to set the real-time clock in COG-5 to the new values, or **Esc** to exit the configuration system without consequences.

```
                      Data  Display
        Show Time                [Yes]
        Show Date                [Yes]
        Show Pan/Tilt            [Yes]
        Show ID                  [Yes]
        ID Text                  [Nemesis]
        Show Distance            [Yes]
        Show Compass             [No ]
        Display Type             [Custom ]
        Show Graphic at Startup  [No ]
        Graphic Loc.    column   [17]  line [07]

        <Enter> - Save changes and set data field positions
        <Esc> - Discard changes and exit
        <Tab> - Change selected field
        <Arrow UP/DOWN> - Change value of selected field
```

[F12, F2] This is the standard (non-MSD) data display configuration screen. It behaves much like the clock-setting screen, except that a text-editing field is included. A character cursor appears when this field is selected, and ID text may then be freely edited. *Show Distance* refers to the distance data display field.

Show Graphic at Startup refers to an image, such as a company logo, that may be automatically displayed at power-up time, until the **Esc** key is pressed. Image data must be pre-loaded into the BOB-4 module (part of COG-

5) by the system installer. If this feature is enabled while image data is missing, then COG-5 boots up with nothing in the information overlay (until **Esc** is detected). See the COG-5 Application Guide for additional information.

Display Type may be *Stacked* or *Custom*. If Custom is selected, then the **Enter** key proceeds to the following data field placement screen instead of exiting:

```
                  Custom Data Display Locations


      Time----column [10]      line [01]
      Date----column [10]      line [03]
      Pan-----column [10]      line [05]
      Tilt----column [10]      line [07]
      ID Text-column [10]      line [09]
      Encoder-column [10]      line [11]
      Compass-column [10]      line [13]



        <Enter> - Save changes and exit
        <Esc> - Discard changes and exit
        <Tab> - Change selected field
        <Arrow UP/DOWN> - Change value of selected field
```

For NTSC video systems, data will be off-screen if placed on line numbers greater than 15. PAL video systems may use all available display lines.

```
                     Pan/Tilt Rates


      Pan Fast          [100]
      Pan Medium        [075]
      Pan Slow          [050]
      Tilt Fast         [100]
      Tilt Medium       [075]
      Tilt Slow         [050]



        <Enter> - Save changes and exit
        <Esc> - Discard changes and exit
        <Tab> - Change selected field
        <Arrow UP/DOWN> - Change value of selected field
        <Arrow LEFT/RIGHT> - Test value
```

[F12, F3] If your system is equipped with the keyboard-controlled camera pan/tilt feature, then here's where you configure camera platform slew rates. Rate values are in percent of maximum motor control output voltage. The best values to use depend heavily on individual system hardware parameters, so be sure to consult system

technical support staff before altering these settings. A test function appears in the last line. This enables new slew rate values to be tested without leaving the COG-5 configuration system.

```
                    Primary Distance Display

        Counting Sense     [Up]
        Decimal Places     [1]
        Units Label        [f]
        Show Units Label   [Yes]
        Preset Value       [+0010.0]
        Scale Factor       [+00.10000] (units per count)
        Save Count on Power Failure  [No ]


          <Enter> - Save changes and proceed to
                    alternate mode setup
          <Esc> - Discard changes and exit
          <Tab> - Change selected field
          <Arrow UP/DOWN> - Change value of selected field
          F9 - Interactive encoder calibration
```

[F12, F4] The first distance data display setup screen, for configuring the primary distance data display format. Do not change any of these values without consulting technical support staff.

- *Counting Sense* refers to the encoder count register, which can count in either direction relative to actual encoder shaft movement.

- *Decimal Places* is the number of digits to the right of the displayed decimal point.

- *Units Label* is a single character to denote the units of distance, usually "f" for feet or "m" for meters.

- *Preset Value* is the distance that is loaded by the **<Alt>P** command. Use the keyboard to enter a decimal number value in this field and the next.

    The *Preset Value* is used internally to calculate an integer value, which is loaded into the raw count register when **<Alt>P** is invoked. As a result of rounding to a relatively small integer (depending on encoder resolution), the computed value may not yield the same displayed value as configured. This is a fundamental physical limitation, so it may be necessary to test multiple candidate preset values in order to find one that yields a displayed preset value equal to the configured value.

- *Scale Factor* is the multiplier used internally to convert raw encoder counts to displayed distance units. Encoder calibration may be achieved by directly entering the scale factor here if it is known. The default value (0.1) is correct for encoder installations yielding 10 quadrature cycles per foot and a primary distance data display in feet. We strongly recommend that system operators and support staff keep written records of this value!

- *Save Count on Power Failure* makes COG-5 capture and preserve the most recent distance data when power is cut. Saved data will be reloaded into the distance display at power-up time if possible. COG-5 power must be cycled off and back on again after changing this setting. There's random data in distance memory initially, but it's replaced by good data at first activation. Just clear the spurious value with **<Alt>Z** before proceeding. This feature isn't available if not supported by installed hardware (see COG-5 Application Guide).

- The **Enter** key, in this case, proceeds to another distance data display setup screen, for the second of two available distance display formats.

- **F9** invokes an interactive encoder calibration procedure that requires a precisely measured length of cable. Consult technical support staff before using this function. The interactive calibration screens are shown immediately below.

```
                    Encoder Calibration
                         Procedure
     Press <Enter> to begin calibration or <Esc> to abort

     1. On the next screen enter a fixed distance to
     move the encoder, ie: a measured length of cable.

     2. After distance is entered, press <Enter>.

     3. Move the encoder the specified distance.

     4. Press <Enter> to complete calibration. You will
     return to the encoder set up screen.
     Note: Calibration may change the preset value,
     correct it if needed.
```

The first interactive calibration screen gives the user another chance to exit without consequences, and provides instructions for successful completion of the process.

```
                    Encoder Calibration


  Enter calibration distance in Primary distance units
  then press <Enter>

   Calibration Distance     [0020.0]


  Or press <Esc> to abort
```
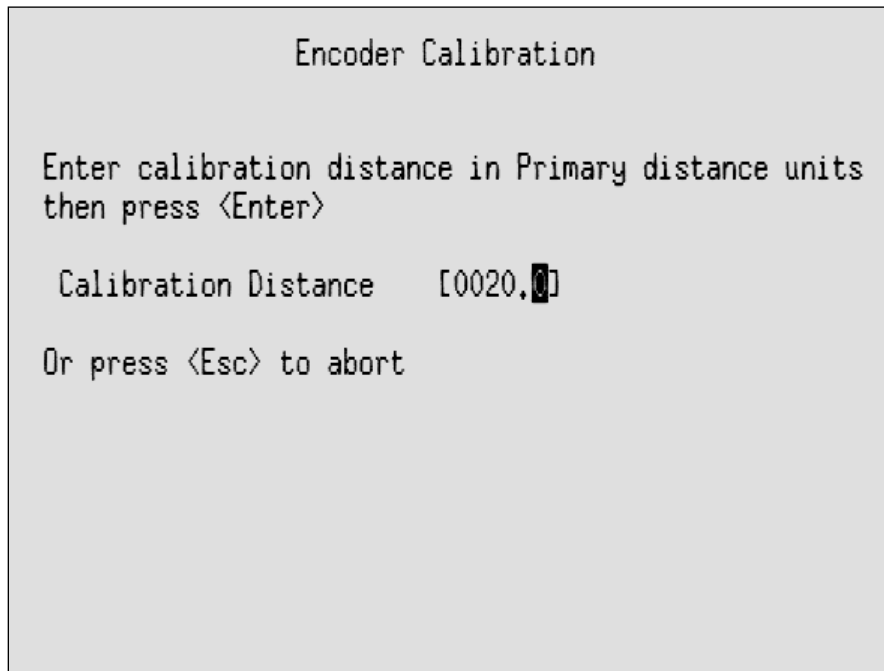
The second interactive calibration screen calls for the precisely known length of cable that will pass over the measuring pulley. The value entered here must be in the same units selected for the primary distance display. This value may be entered with a decimal fraction if desired. Only th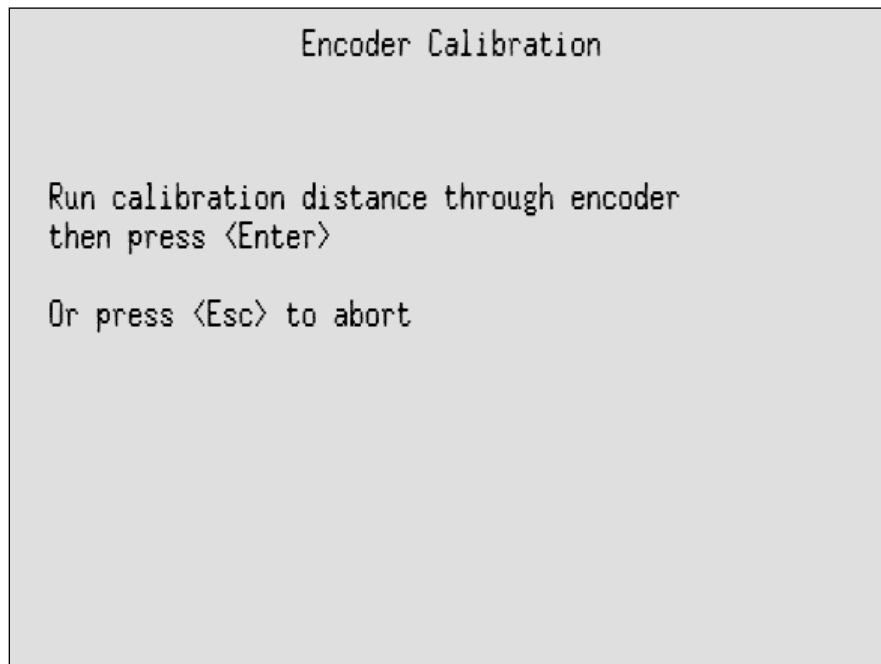e number and decimal (period) keys work in this field – just overtype with zeros and numbers if an error must be corrected.

```
                    Encoder Calibration



  Run calibration distance through encoder
  then press <Enter>

  Or press <Esc> to abort
```

When the third interactive calibration screen appears, pull the precisely measured length of cable through the distance encoder assembly and stop. Upon detecting the **Enter** key, COG-5 calculates a new primary scale factor and stores it in flash memory. Open the *Set Encoder Primary Mode* configuration screen [F12, F4] and record the new scale factor in your system maintenance log for future reference, then check and reconfigure (if necessary) the distance preset value.

```
                Alternate Distance Display


     Units Label       [m]
     Decimal Places    [1]
     Scale Factor      [█.3048]
                       (Alt/Main)


     If Main = feet and Alternate = meters
        Set Scale Factor to .3048
     If Main = meters and Alternate = feet
        Set Scale Factor to 3.281
        <Enter> - Save changes and exit
        <Esc> - Discard changes and exit
        <Tab> - Change selected field
        NUMBER KEYS - Enter value directly.
```

Here's the alternate distance display configuration screen, which allows a different units label and number of digits after the decimal point in the alternate display format. The alternate mode scale factor (multiplier) operates on the primary distance display value, not on the raw encoder cycle count as in primary mode. During normal COG-5 operation, **F6** toggles between primary and alternate distance data display formats.

```
                      Title Screens



     Number of screens    [5]
     Seconds to display   [10]
     Edit screen number   [█]




        <Enter> - Save changes and exit
        <Esc> - Discard changes and exit
        <Tab> - Change selected field
        <Arrow UP/DOWN> - Change value of selected field
        F1 - Edit selected screen
```

[F12, F5] Begin editing and configuring the Title Screen displays here. During normal operation, **F7** causes the specified number of Title Screens to be displayed sequentially, much like a slide show, with each screen appearing for the number of seconds specified here. These text memories are intended for use in much the same way as movie titles. Up to five full screens of text may be edited and stored in semi-permanent memory. Title Screens not currently configured for display in sequential mode are still retained in memory. Individual Title Screens may be displayed with key combinations **<Alt>F1** through **<Alt>F5** during normal operation. Title Screens displayed in this

way are cleared automatically after the specified time delay. When the "Edit screen number" field is selected (as shown), the bottom instruction line appears. Hit **F1** to edit the selected Title Screen.

```
█



                    Title Screen 4










F1-Save/exit | <Esc>-Cancel | F4-Clear | Screen # 4
```

The Title Screen edit screen initially appears as shown above, with operator hints printed on the bottom line. Except for the area where hints appear, the entire screen is available for editing.

```
                    Observation Codes



    Seconds to display  [05]
    Display on line     [15]
    Edit code <Ctrl> +  [A]


    ------------------------------------------------------
    Now editing fault code memory #1 █
    ------------------------------------------------------



        <Enter> - Save changes and exit
        <Esc> - Discard changes and exit
        <Tab> - Change selected field
        LETTER KEYS - Enter Observation code.
```
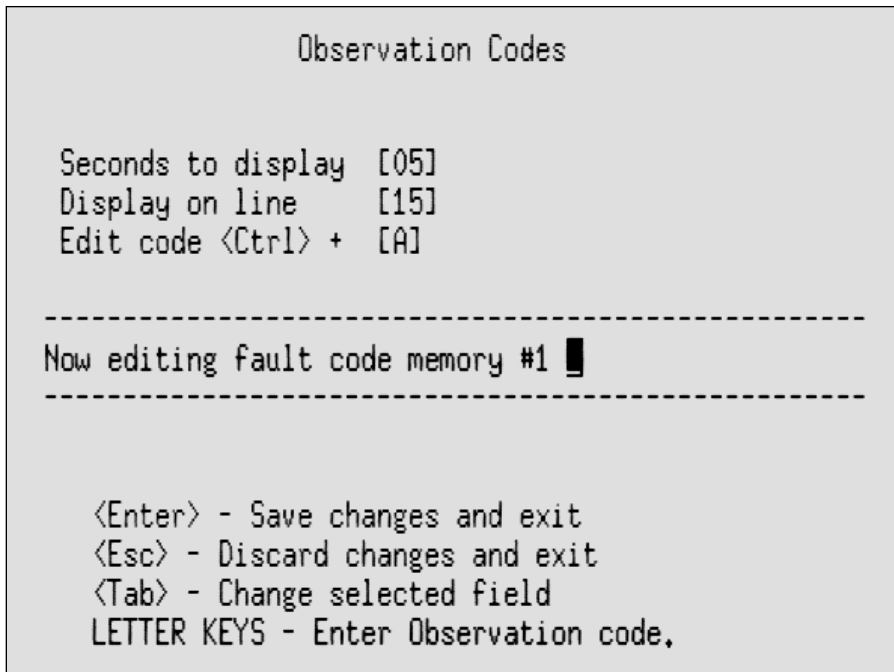
[F12, F6] Up to 26 Observation Codes may be stored in semi-permanent memory. Observation Codes are single-line text messages, intended to visually log the standardized findings of video inspection activities. During normal operation, Observation Codes may be displayed for the specified loiter time, at the specified location, by typing any of the 26 key combinations from **<Ctrl>A** through **<Ctrl>Z**.

Display line positions are enumerated from zero to 18 starting at the top of the screen, but line numbers greater than 15 must not be used in NTSC video systems. PAL video systems may use any available setting.

For editing, the contents of Observation Code memories are displayed in the center of this screen. Choose the memory to be edited by stepping through the letters of the alphabet when "Edit code <Ctrl> + [ ]" is selected. The current contents of each memory are displayed instantly as the selected letter changes. The **Tab** key will then put a character editing cursor into the Observation Code editing area. Edited text is automatically saved when another code is selected (use the **Tab** key), and when leaving this screen by hitting **Enter**. Observation Code command letters should be chosen to assist the operator's memory whenever possible.

```
                        Header Line


        Display on line      [00]
        Show Header          [No ]


        -------------------------------------------------
        MH 241█                   TO              MH 242
        -------------------------------------------------




            <Enter> - Save changes and exit
            <Esc> - Discard changes and exit
            <Tab> - Change selected field
            LETTER KEYS - Edit header line
```

[F12, F7] A single Header Line may be stored in semi-permanent memory. During normal operation, Header Line text appears on screen persistently at the chosen location if enabled. Header Line editing is similar to Observation Code editing, as discussed above. In most cases, the Header Line should display at the top of the screen as configured here.

```
                    Compass Calibration


 1 Rotate compass slowly 360 degrees

 2 Orient compass to point north

 3 Press <Enter> to save or <Esc> to cancel
```

[F12, F8] This screen launches an interactive calibration procedure for the magnetic heading sensor, if equipped.

```
                    MSD Display Options

      Select ADC Channel                    [0]
      Show This Channel                      [No ]
      Horizontal Loc, column                 [00]
      Vertical Loc, line                     [01]
      Total Digits inc Sign and Dec Pt       [08]
      Least Significant Digits               [03]
      Show Units Label                       [Yes]
      Units Label Text                       [ Volts █]
         <Alt>D for Degree Symbol


         <Enter> - Save changes and exit
         <Esc> - Discard changes and exit
         <Tab> - Change selected field
         LETTER KEYS - Enter label text
```
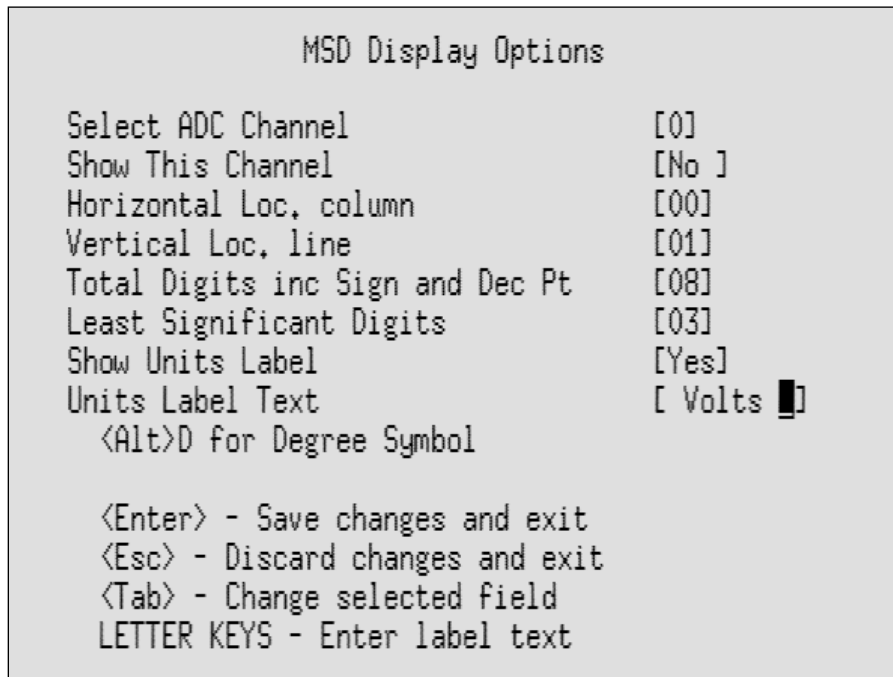
[F12, F9] Multi-sensor display options: This configuration screen controls MSD data field appearance, one channel at a time. Data processing functions are configured on another screen (see next page). Up to six analog input channels may be placed in service, but ADC channel numbers are not contiguous. Possible channel numbers are 0, 1, 4, 5, 6, and 7, corresponding to the COG-5 hardware documentation.

Choose a column for the first character of each active data field that allows print space for all subsequent characters, including the measurement units label (if enabled). MSD data field placement is automatically adjusted to the left if configuration is attempted with insufficient right-side space to display all characters, including the label. It is therefore okay to simply set horizontal location to the maximum value if placement closest to the right edge of the screen is desired. This feature does not detect on-screen text collisions. Users are responsible for planning screen layout to avoid display field interference.

Vertical line number must not exceed 15 (screen bottom) in NTSC systems. Data field placement is automatically adjusted to line 15 if configuration is attempted on line 16~18 with NTSC video, which can produce collisions. This feature becomes a special hazard in systems that must accommodate PAL as well as NTSC video standards.
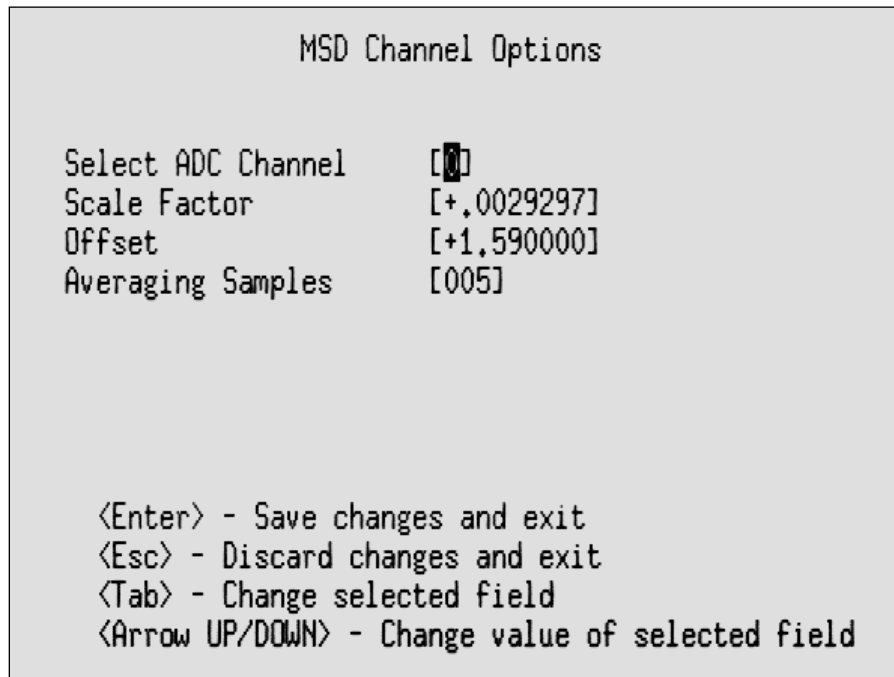
MSD data fields may have up to 12 characters including sign, decimal point, and digits to the right of the decimal point (least significant digits), but not including the units label. Put a leading space character in the units label text field if you want a space between displayed data and label.

MSD display fields may have titles as well as units labels. Units always follow numeric data fields on screen, i.e. they're printed immediately to the right of corresponding data fields. Note the on-screen hint for entering a degree symbol in the units label text field, which appears only when the cursor is moved into that field. Titles can appear anywhere, but they're most commonly placed immediately above or to the left of live measurement data. For example:

SPEED: 000.0 mph

In this case, "SPEED:" is an MSD Title field placed left of the data field, " 000.0" is the live data field, and " mph" (with a leading space) is the units label field. See MSD Title configuration screen below.

Data is displayed with a leading "+" or "-" polarity symbol unless it's zero. In that case, a space character 'appears' instead of a polarity sign.

```
                    MSD Channel Options


      Select ADC Channel      [0]
      Scale Factor            [+.0029297]
      Offset                  [+1.590000]
      Averaging Samples       [005]






      <Enter> - Save changes and exit
      <Esc> - Discard changes and exit
      <Tab> - Change selected field
      <Arrow UP/DOWN> - Change value of selected field
```

[F12, F10] Multi-sensor channel options: The second MSD setup screen controls sensor signal processing parameters, one channel at a time.

The scale factor is a multiplier that scales raw ADC data in the range of 0~1023 to the desired measurement units. Note that default scale factors yield a final display dimensioned in DC volts at each channel input pin. The defaults are 0.0029297 for channels 0~1, and 0.0048828 for channels 4~7. These values reflect a difference in hardware input voltage range, which is 3V for channels 0~1 and 5V for channels 4~7.

Offset is added to the measurement after scaling, and may be used to null sensor offset or deliberately shift readings to an arbitrary reference point. This allows measurement data to be presented as deviation above or below zero, for instance, even though COG-5 hardware accepts only positive input voltage.

Averaging may be used to improve measurement resolution and reduce 'bobble' in the data display. COG-5 basic hardware resolution is 10 bits, or one part in 1024, which is roughly 0.1%. Resolution doubles for each quadrupling of the number of samples included in the average (assuming that measurement noise is random). For example, averaging 16 samples yields 12-bit resolution (1/4096 or 0.0244%). COG-5 allows anything from one to 128 samples in each averaging cycle. Absolute measurement *accuracy* remains captive to the usual hardware error budget. Display responsiveness becomes increasingly sluggish as the number of samples included in the average is increased.

Here's an example that should help to understand the ADC calibration process:
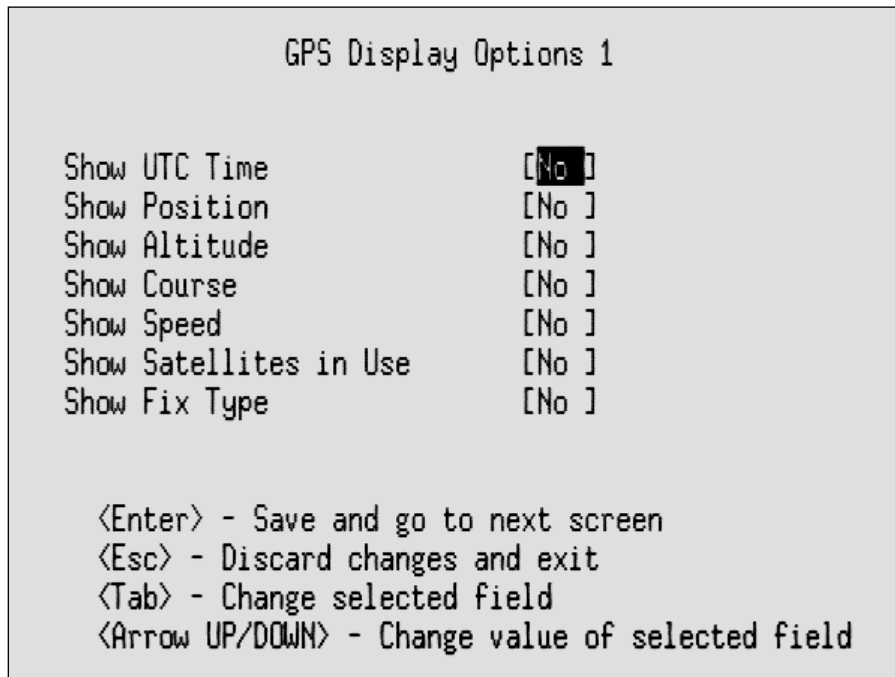
> Suppose we have an inclination sensor that outputs 2.5V at zero inclination and swings from 0.5V at -90 degrees to 4.5V at +90 degrees, and it's connected to one of the 5V ADC input channels. Raw ADC output ranges from 104 to 922 (10% and 90% of 1024, for a 10-bit ADC). That's a range of 818 counts over 4V, which we wish to scale to a displayed range of 180. The scale factor therefore should be 180 / 818 = 0.220. Raw ADC output for zero inclination is 512 (50% of 1024) which will be scaled to 512 * 0.220 = 113. So an offset value of -113 ideally yields zero in the display for zero inclination, but errors in the measurement system are likely to make a little offset trimming necessary. Also note that we rounded off some of the math results in this example.

```
                        MSD Titles


    Select Title                    [6]
    Show Title                      [Yes]
    Horizontal Loc, column          [00]
    Vertical Loc, row               [15]
    Title Text
   [SPEED: █                                          ]




      <Enter> - Save changes and exit
      <Esc> - Discard changes and exit
      <Tab> - Change selected field
      LETTER KEYS - Enter title text
```

[F12, F11] The MSD Titles configured here are intended principally to add descriptive information to MSD data fields, but they're not directly linked to the MSD subsystem and may be used in any desired way. Up to six MSD Title fields may be active. Title text length is limited to the space provided between edit field brackets (50 characters). MSD titles are automatically adjusted upward or leftward if necessary to display all characters on-screen, but in most cases the user is still fully responsible for on-screen text location.

```
                    GPS Display Options 1


        Show UTC Time              [No ]
        Show Position              [No ]
        Show Altitude              [No ]
        Show Course                [No ]
        Show Speed                 [No ]
        Show Satellites in Use     [No ]
        Show Fix Type              [No ]



          <Enter> - Save and go to next screen
          <Esc> - Discard changes and exit
          <Tab> - Change selected field
          <Arrow UP/DOWN> - Change value of selected field
```

[F12, F12] The GPS data display subsystem has a total of four configuration screens. GPS display fields enabled on this first screen may be configured for screen position and other parameters on the following three screens. "No Data" will be displayed in every enabled GPS field location if data isn't available from a connected GPS receiver. Field titles are displayed along with current data when the GPS receiver is operating normally.

UTC Time (coordinated universal time) is derived from GPS resources and is therefore more accurate than COG-5's on-board RTC (real-time clock). Either or both may be displayed. *UTC Time* display format is 24-hour time:

HH:MM:SS

Note that fractional seconds also appear in the UTC time display, if supplied by your GPS receiver, but they're not meaningful due to unpredictable data processing latency.

Position includes latitude and longitude. They're both displayed, one above the other, if this item is enabled. See the next screen, "Set GPS Display Options 2," for *Position* format selection.

Altitude, *Course*, and *Speed* formats are configurable on subsequent setup screens.

Satellites in Use and *Fix Type* are independent indicators of received signal quality. Either or both data fields may be displayed if desired. Three *Fix Types* are possible: [0] = no fix; [1] = 2D fix; [3] = 3D fix.

```
                    GPS Display Options 2


Position Format                        [DD°MM'SS.SS']
Lat. Horizontal Loc. column                      [20]
Lat. Vertical Loc. line                          [03]
Lon. Horizontal Loc. column                      [20]
Lon. Vertical Loc. line                          [04]
Time Horizontal Loc. column                      [20]
Time Vertical Loc. line                          [02]



    <Enter> - Save and go to next screen
    <Esc> - Discard changes and exit
    <Tab> - Change selected field
    <Arrow UP/DOWN> - Change value of selected field
```

Latitude and longitude may be displayed in minutes and seconds format, or in minutes with decimal fraction.

```
                    GPS Display Options 3


Altitude Units                                   [F]
Alt. Horizontal Loc. column                      [20]
Alt. Vertical Loc. line                          [05]
Speed Units                                      [MPH]
Speed Horizontal Loc. column                     [20]
Speed Vertical Loc. line                         [06]



    <Enter> - Save and go to next screen
    <Esc> - Discard changes and exit
    <Tab> - Change selected field
    <Arrow UP/DOWN> - Change value of selected field
```

Altitude may be displayed in feet or meters, with uppercase or lowercase labels. Speed may be displayed in mph, knots, or kph, also using uppercase or lowercase.

```
                    GPS Display Options 4


Course Type True/Magnetic              [Mag ]
Course Horizontal Loc, column          [20]
Course Vertical Loc, line              [07]
Sats Horizontal Loc, column            [20]
Sats Vertical Loc, line                [08]
Fix Horizontal Loc, column             [20]
Fix Vertical Loc, line                 [09]



   <Enter> - Save changes and exit
   <Esc> - Discard changes and exit
   <Tab> - Change selected field
   <Arrow UP/DOWN> - Change value of selected field
```

GPS course data may be displayed relative to true north or magnetic north.

—o—