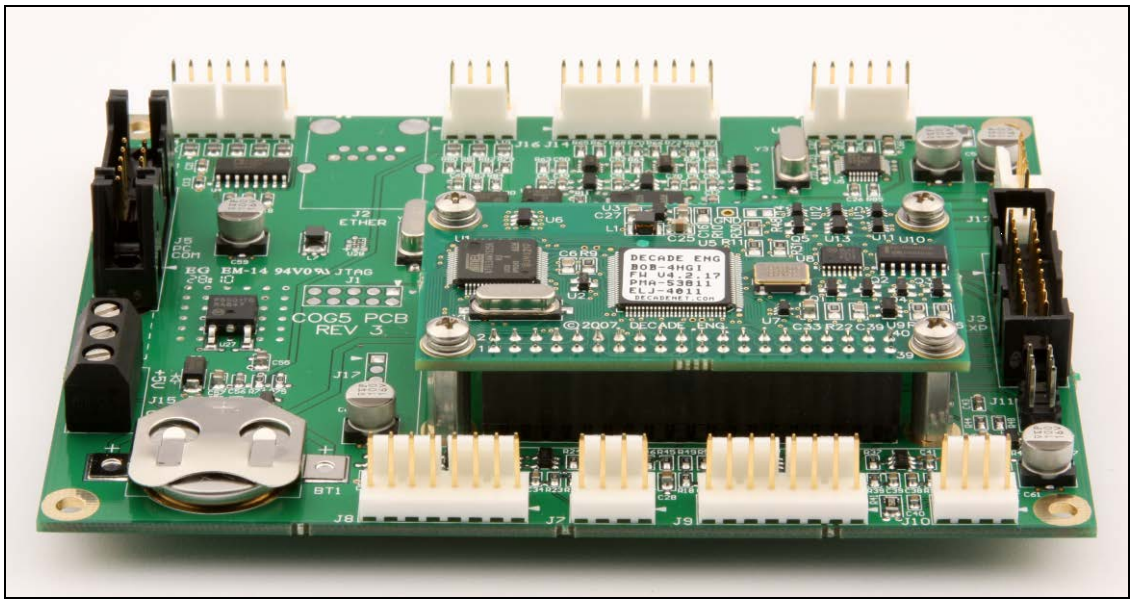
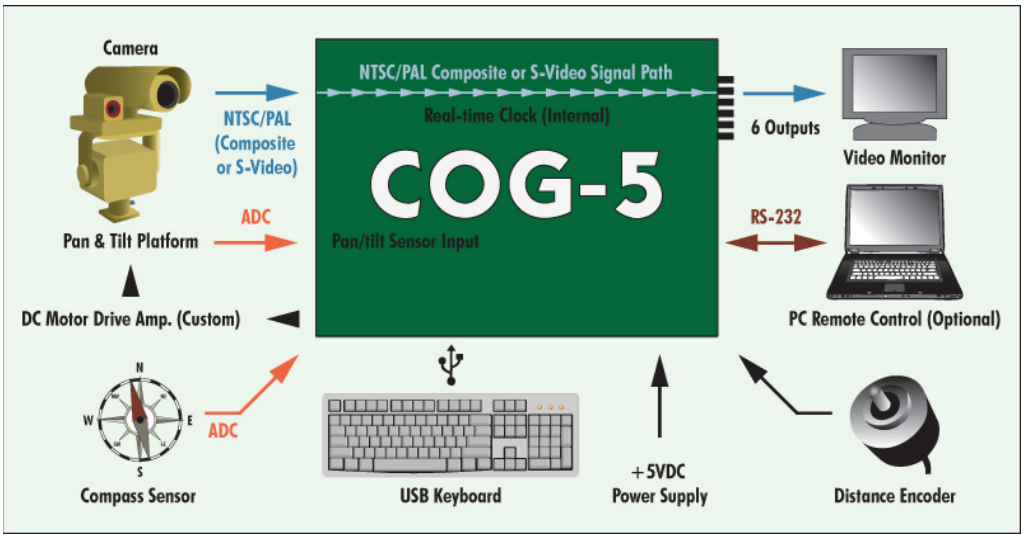
COG-5 MSD Application Guide (Firmware V5.4.4)

03 May 2017





Introduction

COG-5 MSD (Multi-Sensor Display) is an intelligent video information overlay generator. Overlay text and data comes from a keyboard, distance encoder, GPS receiver, compass sensor, and on-board clock. Up to six user-customized on-screen data display fields may be derived from off-board analog sensors. COG-5 accepts video from NTSC/PAL composite or Y/C (S-Video) sources and drives up to six video outputs. Camera pan/tilt platforms are controllable via analog output channels. COG-5 is operated directly from a USB keyboard (stand-alone), or through an RS-232 serial data link to a host computer.

Features

MSD (multi-sensor display)

Up to six analog voltage inputs are available for use with arbitrary linear sensors, shared with the pan/tilt and compass heading display features described below. Each of these inputs may be independently averaged, for noise reduction and resolution enhancement. Scale and offset calibration factors are applied in real time. Processed data can be displayed anywhere on-screen with user-configurable MSD Titles and measurement units labels.

GPS data display

Displayable GPS data fields include Latitude, Longitude, Altitude, Speed, Course (true or magnetic), UTC Time, Number of Satellites, and Fix Type. This feature may not be used simultaneously with RS-232 remote control. COG-5 has been tested with Garmin 60cx and 18x receivers, and with GlobalSat SiRF Star III receivers.

Text display functions

A seven-character ID field may be displayed in addition to Distance, Time, Date, Pan Angle, Tilt Angle, and Compass Heading Angle fields in a compact 'data stack' that moves *en masse* to any screen position. Gaps left in the stack from unused data fields are closed automatically.

- A 'TV Typewriter' function allows free-form comment typing anywhere on screen.
- A persistent one-line title bar (Header Line) may be configured to appear on any screen line.
- One of 26 one-line Observation Codes can display briefly (cleared after programmable delay) on any line.
- Up to five full screens of text (Title Screens) can appear individually or in a timed 'slide-show' sequence.
- Help screens and configuration screens make COG-5 easy to install and operate. Hit **F1** to see.

Video pointer

A single flashing triangular pointer may be moved to any position on screen.

Distance data display

COG-5 accepts industry-standard 5V quadrature incremental encoders for distance measurement. Distance information may be displayed in conveniently selectable Primary and Alternate formats, such feet and meters, and precise distance display calibration for any reasonable combination of encoder and measuring wheel can be achieved via on-screen instructions.

Time & date display

The real-time clock/calendar (RTC) circuit is powered by a Lithium coin cell with design lifetime in excess of five years. Date and time setup is performed via on-screen prompting. System operators may enable date and time display fields individually. The on-board RTC operates independently of GPS timekeeping services.

Compass heading display

A pair of analog voltage inputs may be used for the sine and cosine outputs of a low-cost compass sensor, such as Dinsmore's R1655. Sine and cosine voltage input ranges are zero to +5VDC. A simple compass calibration procedure automatically compensates for normal sensor tolerances. Display resolution is one degree. The compass heading display may be enabled or disabled independently of other data display fields.

Camera pan & tilt functions

A pair of analog voltage inputs is provided for pan and tilt position sensors with outputs in the zero to +5VDC range. A calibration procedure compensates for individual sensor variation to allow precise display of pan/tilt angles.

DC voltage outputs are provided to operate camera pan/tilt platforms through external motor drive amplifiers (not supplied by Decade Engineering). These outputs may be controlled through the keyboard, with high, medium, and low preset speeds configured via on-screen setup, and with external switches and speed control pots. Compatible motor drive amplifiers must have differential inputs with zero to +5VDC minimum common-mode input range.

Up to 12 camera platform positions may be stored in non-volatile memory and recalled to automatically drive the platform back to stored positions.

RS-232 remote control

Remote computers can assume full control of COG-5 through the RS-232 serial port, using it as a peripheral device to collect measurement data, superimpose text on the TV image, and output control signals. This feature may not be used simultaneously with the GPS data display feature. COG-5 configuration memory may be uploaded (to a PC) and downloaded, which allows multiple COG-5s to be configured identically with minimum installer effort. Decade Engineering encourages all customers to upload and save configuration data in case it becomes necessary to repair or replace individual COG-5 boards.

Field firmware upgrade

Customers can replace the firmware program that controls COG-5 (in flash memory), by using a Windows PC utility program from Decade Engineering and a simple RS-232 adaptor cable. See upgrade procedure in this document.

Specifications

Physical	Board outline dimensions are 4.00 x 5.00 inches. Overall height, exclusive of (optional) ejector handles on J5, is 0.86 inches, with 0.70 inches of this above the surface of the board, which is 0.06 inches in thickness. Weight is 0.226 pounds (102g) including Lithium coin cell and BOB-4H video module. COG-5 is currently specified for the commercial operating temperature range: 0~50°C.
Power Supply	COG-5 requires **high-quality** 5VDC ±5% regulated power at J15 and consumes about 260mA with a keyboard attached, no distance encoder or other peripheral devices, and driving a single video output. The Ethernet option (not yet available) increases load current by up to 300mA. Power supply rise time must be 25mS or less with monotonic slope (no dips). To insure ample margin, Decade Engineering recommends 1A or greater power supply current rating. Installers must include over-current and overvoltage protection in COG-5 power supply arrangements. See the COG-5 Power Supply App Note. A BR2032 (Panasonic) or equivalent 3V Lithium coin cell is required for timekeeping. This item is normally pre-installed at the factory and has an expected lifetime in excess of five years. A raw power failure detector (PFD) for 12VDC upstream sources is provided on a separate pin of J15. If connected and configured, PFD triggers storage of distance data to flash memory when system power drops below +9.0V. This is not a main power supply input option! The main +5VDC power input must hold up for at least 35mS subsequent to the PFD event.
Async Serial I/O	J4 and J5 both provide access to the processor's UART0 RXD and TXD lines, interfaced to RS-232 specs through an industry-standard IC. The pinout at J5 accommodates hookup to a 9-pin PC COM port with ribbon cable and IDC connectors. J4 also carries the processor's debug UART RXD and TXD lines (with RS-232 hardware interfacing) and additional factory test pins.

Keyboard Interface	COG-5 uses a standard PC USB keyboard connected at J6. Keyboard power supply current adds directly to COG-5 power supply input requirement.
Distance Encoder Interface	Incremental quadrature distance encoders operating on 5VDC power may be connected at J16. Encoder power supply current adds directly to COG-5 power supply input requirement. Maximum encoder count rate is 900KHz in early production boards.
Analog Input	Four analog voltage (ADC) inputs are provided at J13. The J13 inputs are low-pass filtered to 5Hz and scaled with 1% resistors to yield 0~+5V input range with 1.34 megohms load resistance. Two additional ADC inputs with 0~+3V range are provided at J3. The J3 inputs tie directly to ADC input pins on the microcontroller, and must be driven from source impedance below 10K. Basic measurement resolution is 10 bits (about 0.1%). The ADC voltage reference is an LM4040AIM3-3.0 (3.000V) chip with ±0.1% specified tolerance at 25°C. Refer to Atmel's AT91SAM7S256 datasheet for additional details on ADC hardware accuracy. Legacy COG-5 firmware uses the J13 inputs to measure camera pan/tilt angles and compass heading (with a Dinsmore R1655 sine/cosine sensor). COG-5 MSD firmware can use all six ADC inputs for any compatible purpose.
Analog Output	Three analog voltage outputs with zero to +5V range are provided at J14. These are low-pass filtered (5Hz) and buffered PWM outputs from the local microcontroller. Two outputs include 511R series resistors. The third is direct from its OPA2348 buffer chip, and requires at least 470R in series if capacitive load is significant. Arbitrary output voltages are possible via remote control. COG-5 firmware can use these outputs to drive camera pan/tilt platforms via differential-input DC motor drive amplifiers. Additional circuitry provides direct analog inputs at J14 for manual pan/tilt controls, such as joysticks, which are preferred over keyboard control in some installations.
Misc. I/O	System Expansion Port (J3): I^2C bus pins have internal 4.7K pullups to +5V. Eight additional digital I/O pins conform to 3.3V CMOS logic specs. Inputs are 5V-tolerant, except that hard 5V drive is not allowed during system reset. Resistance in series to logic input pins must not exceed 500 ohms. Maximum logic output current is 2~8mA depending on the pin. Two of the digital I/O pins may also serve as ADC inputs, and this the only function of J3 currently supported by COG-5 firmware. See J3 pin assignment table for details. An optional JTAG TAP (debug port) for the system processor is provided at J1 (not factory-installed). An optional BOB-4 debug serial port is provided at J17 (not factory-installed). This port is hard-coded to run at 115.2kbps, 8N1, without handshake, and requires an external 3.3V RS-232 hardware interface adapter if used. See BOB-4 Application Guide for additional information.
Ethernet LAN	Not currently implemented (J2).
Video I/O	COG-5's video environment is RS-170A (NTSC) or PAL-B composite baseband, 1Vpp 75 ohms unbalanced. Video AGC (automatic gain control) with ±6dB range is provided in the composite/luma input channel only. Y/C video (S-Video) is directly accommodated. The video inputs tolerate up to 2.5VDC bias mixed with incoming video. Four independent composite or Y/C video outputs are provided, as well as two independent composite video outputs derived by mixing Y/C video. All video outputs contain a small DC bias (about +1V when properly terminated), which is common to many video sources and is well tolerated at the inputs to most video equipment. A 'local' video signal (black background) is generated by default if video input is not present.
OSD Character Format	On-screen data display capabilities are provided by Decade's BOB-4H module. Please refer to the BOB-4 Application Guide for a full description, but note that only a subset of these functions will be implemented in COG-5 unless additional customer requirements are identified. Text is displayed within a grid of 52 character columns and 16 (NTSC) or 19 (PAL) rows.
System Processor	The compute engine in COG-5 is Atmel's 32-bit AT91SAM7S256 microcontroller with ARM7 TDMI core operating at 48MHz. This processor has 64KB of embedded SRAM and 256KB of flash memory.
Data Memory	COG-5 includes supplemental non-volatile data memory; currently a 512KB Atmel DataFlash® chip with SPI serial interface. This memory is currently used only for configuration data storage.

Cautions!

Do not allow the board to rest on bare metal or other conductive surfaces! COG-5 is supplied with a Lithium coin cell installed, which means that some circuits on the board are always live.

ESD (electro-static discharge) safety precautions must be followed at all times when handling COG-5 boards. Use a grounded wrist strap and grounded static-dissipative work surface. COG-5 boards must be stored and shipped in static-shield (metallic, not pink poly) packaging with buried metal or outside metal layers.

COG-5 is not designed to tolerate power supply shortcomings. Be certain that you have a stable 5VDC power supply, regulated to ±5% or better, BEFORE proceeding with COG-5 application development. Applied voltage must never exceed +5.500V under any circumstances, even for a microsecond. Higher voltage or poor regulation can cause flash memory corruption as well as permanent hardware damage, and such damage is not covered by the warranty. Power supply voltage overshoots must not occur at turn-on or turn-off time, or when power supply load conditions change. Switch-mode power converters should include at least one extra L/C filter stage beyond the basic L/C components required for operation. Residual switching spikes should be suppressed to no more than a few millivolts at COG-5's power supply input pin. Please refer to the COG-5 Power Supply Application Note for additional information on this topic.

Decade Engineering has confirmed that low-cost benchtop power supplies such as Elenco model XP-660 and XP-760 can generate severe output voltage transients at turn-off time, apparently due to arcing at power switch contacts and lack of inter-winding shields in the transformer. It's almost certain that other low-cost power supply units exhibit similar defects. Severe transients can easily propagate through downstream voltage regulator chips and destroy modern high-density ICs such as those in COG-5. IC damage may be slight at first, but it's cumulative, and total failure soon develops. An arc suppression network added across AC power switch contacts might solve the problem, but full confirmation is required. Don't attempt power supply modifications of this nature without a complete understanding of the safety issues.

External circuitry connected to COG-5 must prevent ESD strikes (electrostatic discharge) from reaching any connector. It's best to treat all pins with the same ESD preventive measures as industry-standard CMOS logic chips. Consult with Decade Engineering on countermeasures and exceptions if necessary.

Use the correct mating connectors. Soldering directly to COG-5 voids the warranty.

Differences Relative To COG-4

Hardware

COG-5 is designed in the same mechanical 'form-factor' as COG-4 boards, so there's no change in basic mounting arrangements, but it needs a bit more vertical clearance (see specs). A BOB-4H module is mounted piggyback on COG-5, hence the added height. COG-5 boards are delivered with the BOB-4H module installed and tested, as a single purchasing line item. Lithium coin cell mounting arrangements differ, but frequent access isn't necessary.

COG-5 requires a USB keyboard (at J6), which is probably the only installation change that affects all customers. The auxiliary RS-232 port is now J4, and its pinout has been modified to facilitate factory testing. The remaining connector locations and reference designators have shifted relative to COG-4, which could alter mating cable length requirements, but **pin assignments within those connectors are unchanged**.

The video standard is configured automatically to match incoming video (NTSC or PAL). The video gain trimmer in COG-4 was deleted because COG-5 has video AGC (automatic gain control).

The power fail detector (PFD) voltage threshold trimmer of COG-4 has also been deleted, in favor of a fixed threshold intended for 12VDC raw power supply systems. **Do not misinterpret this comment — COG-5 requires 5VDC power, just like COG-4**. The PFD input is an optional connection **upstream** of the customer's 5V power supply regulator. Do not link the PFD input to +5V if power failure detection isn't implemented. Just leave it unconnected.

Firmware

COG-5 operation will seem little changed from COG-4. Displayed character size is slightly smaller, yielding increased on-screen information density. Operators will notice improved organization and additional content in the help and configuration screens.

Most customers don't have application software for COG-4 because they operate it in stand-alone mode, but if you are using the RS-232 remote control port on COG-4, then be aware that Decade Engineering has changed the control protocol in COG-5 for conformance with other current products (BOB-4 and XBOB-4).

Operating Instructions

Press **F1** to view the Help and system configuration screens. Decade Engineering has attempted to make all of these items self-explanatory with improved on-screen prompting, but a separate COG-5 Operator's Guide is available at www.decadenet.com.

Connector Pinout & Hookup Notes

The pin #1 location is marked with a triangular symbol on the PCB at all COG-5 connectors. Connectors not called out in this document are reserved for product development or manufacturing use.

Most of the COG-5 user connectors (except J3, J5, and J15) are Molex KK series 0.100" friction-lock square-post headers. They mate with Molex 'crimp & poke' female connector housings or with Amp MTA-100 series IDC female plugs. We like the IDC plugs, but a compatible punch-down tool is required, and they're restricted to a single wire size within each plug. Crimp & poke housings allow different wire sizes to be mixed in the same plug. Note that contacts are usually sold separately for the Molex connector housings. Digi-Key stocks a lot of the Molex stuff. Amp's CST-100 series is a similar product. See mating connector summary below this section.

J15: Power supply input connector

Pin	Function
1	**+5VDC input, regulated to ±5%. DO NOT CONNECT 12-VOLT POWER HERE. DAMAGE WILL RESULT.**
2	Power fail detector (PFD) input; +9.0V threshold
3	Ground

It is critically important to avoid connecting 12V power to J15 pin 1. COG-5 (without Ethernet option) requires up to 300mA plus additional power supply current for all peripheral loads (keyboard, encoder, etc.). A power supply current rating of 1A is suggested. Customer must provide over-current protection. Please read the COG-5 Power Supply Application Note.

COG-5 may be configured to preserve the most recent distance data through power failures. This feature depends on detecting power supply voltage decay prior to complete dropout. If power failure detection is required, connect the raw +12VDC supply voltage upstream of your 5V regulator to J15 pin 2. The +5VDC input must hold up for 35mS subsequent to PFD going below +9.0VDC, which allows time for writing distance data to flash memory. This would normally be achieved by using a large energy-storage capacitor on the raw power supply input to the customer's 5V regulator subsystem. It's usually wise to add a series diode as well, so that upstream loads cannot drain the capacitor prematurely.

J6: USB keyboard

Pin	Function	Pigtail Color
1	Ground (shield)	Gray
2	Ground (signal and power)	Black
3	D+ (differential data plus)	Green
4	D– (differential data minus)	White
5	+5VDC power output for keyboard	Red
6	Power detect input option (do not connect)	N/A

Keyboard power adds to COG-5 main power supply current requirement.

Color callouts above refer to Molex connector part numbers 84729-0001 (28ga) and 84729-0002 (20ga). L-Com ECJ504B-UA may also be suitable (unconfirmed). These are chassis-mounting industrial USB jacks with pigtail wires that may be convenient for customer installation with COG-5. Don't increase pigtail length — use six inches or less for reliable USB keyboard communication — and twist the D+/D– pair to maintain differential signal balance.

Note that COG-5 does **not** automatically engage keyboard "Num Lock" at power-up time, as expected with desktop PCs. This feature, beginning with firmware V5.3.8, is intended to make operation with ultra-compact keyboards more convenient.

J16: Encoder

Pin	Function
1	+5VDC power output for encoder
2	Channel A signal input (with 1K pullup to +5V)
3	Channel B signal input (with 1K pullup to +5V)
4	Ground

Uses industry-standard 5VDC quadrature incremental encoder. The internal pullups also allow open-collector encoders to be used if cable length isn't excessive (depends on maximum count rate). Encoder index output, if present, is not connected. Encoder load current adds directly to COG-5 main power supply current drain.

J10: Composite video input or Y/C (S-Video) input

Pin	Function
1	Chroma (C) input for Y/C video; 0.3Vpp into 75 ohms (leave open unless using S-Video)
2	Ground
3	Composite video input, or luma (Y) input for Y/C video; 1Vpp into 75 ohms
4	Ground

The composite NTSC/PAL video input on J10 pin 3 has internal AGC that corrects video input level errors within a ±6dB range. In addition, J11 pins 1~2 may be shunted to roughly compensate for high-frequency video losses in a long cable. These features do not eliminate the need for cable pre-compensation in the camera head, but they can help some remote viewing systems work better under difficult conditions.

J8: Chroma (C) outputs for Y/C video

Pin	Function
1	Ground
2	Chroma output A
3	Ground
4	Chroma output B
5	Ground
6	Chroma output C
7	Ground
8	Chroma output D

J8 is not used in standard composite video applications. For best performance, use pin 2 if only one output is needed. All outputs deliver 0.3Vpp into 75-ohm loads.

J9: Composite video outputs or luma (Y) outputs for Y/C video

Pin	Function
1	Ground
2	CV/Luma output A
3	Ground
4	CV/Luma output B
5	Ground
6	CV/Luma output C
7	Ground
8	CV/Luma output D

J9 is the primary video output port for standard composite video applications. For best performance, use pin 2 if only one output is needed. All outputs deliver 1Vpp into 75 ohms.

J7: Composite video outputs for Y/C video

Pin	Function
1	Ground
2	CV output A
3	Ground
4	CV output B

J7 provides two composite video outputs derived by mixing the Y/C inputs in S-Video applications. J7 also provides two additional CV outputs in composite video applications. For best performance, use pin 2 if only one output is needed. Both outputs deliver 1Vpp into 75 ohms.

J5: Primary RS-232 serial data port

Function	Pin		Function
1, 2, and 7 are linked	1	2	1, 2, and 7 are linked
TXD0 - transmit data 0	3	4	4 and 6 are linked
RXD0 - receive data 0	5	6	4 and 6 are linked
1, 2, and 7 are linked	7	8	N/C
Ground	9	10	N/C

The primary serial port may be used for remote control or GPS data input, but it cannot simultaneously serve both purposes. If any GPS data fields are enabled in the first GPS setup screen, then COG-5 enters GPS mode with the main serial port operating at 4800bps. If all GPS fields are disabled (default configuration), then the main port operates at 115.2kbps and remote control is possible.

COG-5 GPS performance has been tested with Garmin 60cx and 18x receivers, and with GlobalSat SiRF Star III receivers. Be aware that some GPS receivers require a null-modem adapter for correct connection to J5 when using the suggested ribbon cable with 9-pin D-sub (DE9) connector.

J5 may be connected to a 9-pin PC COM port, or equivalent, by using ribbon cable and IDC connectors at both ends with pin 1 routed to pin 1. The linked pins in J5 are loop-back connections for PC hardware handshake signals, which can simplify PC application programming. TXD0 and RXD0 are duplicated at J4.

3M part number D89110-0131HK (with polarizing bump) is one of numerous possible female plug connectors to mate with J5. The matching cable strain relief option is 3M part number D3448-89110. Use a DE9 style female plug at the opposite end of this cable, to mate with PC COM ports. Trim the tenth conductor away, to make the cable fit into this connector. Amp part number 1658614-4 is one example among many possibilities for the DE9 connector.

Decade Engineering is currently using 3M part number N3793-6002RB (without ejectors) for the box header receptacle at J5, leaving customers the option of adding short or long ejector handles if desired. The short handles, which accommodate plugs **without** cable strain relief, are 3M part number N3505-30B. Long handles, for plugs **with** strain relief, are 3M part number N3505-31B. Both items are stocked by Digi-Key at this writing. Note that connectors other than the planned 3M type may appear in early production COG-5 boards.

J4: Auxiliary RS-232 serial data port

Pin	Function
1	+3.3VDC power output
2	Test (do not connect)
3	RXD0 - receive data 0
4	TXD0 - transmit data 0
5	DRXD - debug receive data
6	DTXD - debug transmit data
7	Ground

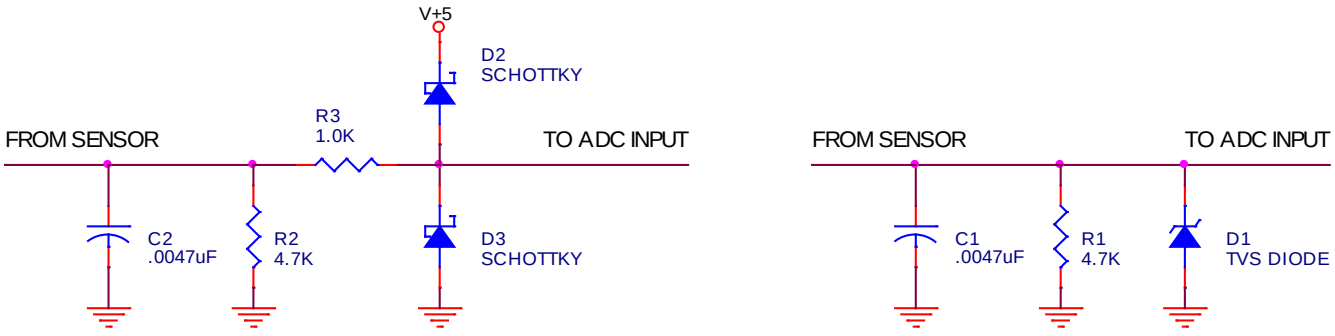
The primary RS-232 port (J5) TXD0 and RXD0 signals are duplicated here. Debug port pins are reserved for firmware development and firmware loading/upgrading purposes.

J13: Analog voltage inputs (see **J3: System Expansion Port** for additional ADC inputs)

Pin	Function
1	ADC7 input; zero to +5V range (curve 2 sensor)
2	ADC6 input; zero to +5V range (curve 1 sensor)
3	ADC5 input; zero to +5V range (pan angle sensor)
4	ADC4 input; zero to +5V range (tilt angle sensor)
5	Analog ground

References to “curve 1” and “curve 2” above apply to Dinsmore’s R1655 compass sensor documentation supplied by The Robson Company. The sensor must be oriented with leads down for correct operation of the COG-5 compass heading display feature. +5VDC sensor power is available on other COG-5 connectors, or directly from the customer’s main +5VDC power supply. Sensor supply voltage changes subsequent to calibration, e.g. from altered cable length, can degrade heading measurement accuracy. The Hall ICs in the Dinsmore sensor require 10nF (0.01uF) power supply bypass capacitors installed local to the sensor. The manufacturer recommends 4.7nF (0.0047uF) capacitors across the ground and sensor signal output pins to protect against EMC hazards. Ceramic capacitors rated at 50V or greater should be used in this application.

If the sensor will be installed remotely, Decade Engineering recommends supplementary ESD protection networks at the ADC inputs to COG-5. These networks could take the form of a series resistor followed by reverse-biased schottky diodes (e.g. BAT42 or BAT43) to V+5 and ground, or a single unidirectional TVS (zener) diode connected to ground. TVS reverse leakage current can be significant in this application. Suitable axial-lead TVS diodes include part numbers P6KE8.2 and P6KE8.2A from Diodes Inc., and SA7.0A, SA7.5A, SA8.0A, and SA8.5A from On Semi. All four ADC inputs at J13 have series resistors to limit fault current due to brief input voltage overloads. Here are example input networks, including the capacitor and pulldown resistor recommended by the Hall device manufacturer:



COG-5 pan/tilt angle measurement firmware relies on averaging to improve resolution and stability of the reading, as well as calibration to remove measurement error. The passive input filters offer substantial ESD protection, so that supplementary outboard networks are unnecessary except in hostile application environments.

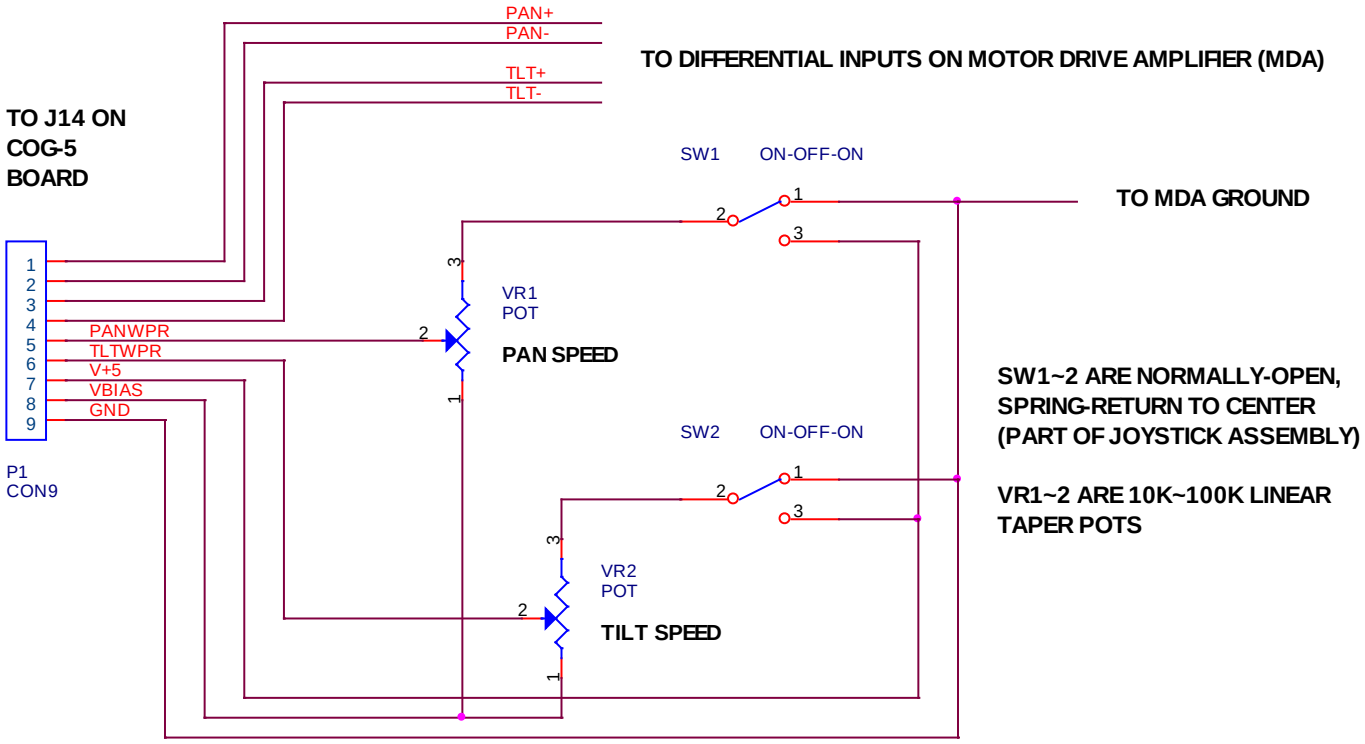
J14: PWM DAC outputs or pan/tilt platform control

Pin	Basic Function	Pan/Tilt Control Function
1	PWM0 output	Pan + drive output
2	Do not connect	Pan – drive output
3	PWM1 output	Tilt + drive output
4	Do not connect	Tilt – drive output
5	Do not connect	Pan speed control input
6	Do not connect	Tilt speed control input
7	+5VDC power output	+5VDC power output
8	PWM2 output	Bias output for manual controls (+2.5V reference)
9	Ground	Ground

PWM output 2 requires capacitive load isolation of 470 ohms or more in series.

Motor drive amplifier input common mode range must be at least zero to +5V.

External manual controls are optional. The following is an external hookup schematic for the standard pan/tilt control application. Add 470R in series at P1 pin 8 if a long cable is used.



J3: System Expansion Port

Function	Pin		Function
I^2C bus SDA	1	2	+5VDC power output
I^2C bus SCL	3	4	+3.3VDC power output
Processor GPIO port PA28	5	6	Ground
Processor GPIO port PA7	7	8	Ground
Processor GPIO port PA8	9	10	Ground
Processor GPIO port PA26	11	12	Ground
Processor GPIO port PA15	13	14	Ground
Processor GPIO port PA16	15	16	Ground
ADC1 input ~ Processor GPIO port PA18	17	18	Ground
ADC0 input ~ Processor GPIO port PA17	19*	20*	Ground

Pin 17 and pin 19 are limited to 2mA maximum output current. These pins also serve as ADC inputs with zero to +3.000V range, for use with the COG-5 MSD feature set, and provide maximum voltage measurement accuracy from this hardware. The remaining GPIO pins are good for 8mA in output mode. See Atmel's AT91SAM7S256 technical literature for alternate applications of all GPIO pins. Only ADC0 and ADC1 functionality is supported in current COG-5 firmware.

* Note: A shunt may be installed on pins 19~20 in COG-5 boards with early release firmware. If present, it must be left in place until firmware is upgraded.

COG-5 Mating Connector Summary

Most applications don't use all connectors. In order by description above:

J15 (power) No mating connector required. This terminal block is designed for direct insertion of stripped power supply wires. Do be sure to read the COG-5 Power Supply Application Note.

J6 (keyboard) Use Molex 22-01-3067 terminal housing and five 0008550102 crimp terminals, or equivalent. For the USB keyboard jack, Molex connector part numbers 84729-0001 (28ga wires) or 84729-0002 (20ga wires) are suitable, depending on enclosure design. L-Com ECJ504B-UA may also be suitable (unconfirmed). These are chassis-mounting industrial USB jacks with pigtail wires. Don't increase pigtail length — use six inches or less for reliable USB keyboard communication. Twist the D+/D- pair to maintain differential signal balance.

J16 (encoder) Use Molex 22-01-3047 terminal housing and four 0008550102 crimp terminals, or equivalent.

J10 (video input) Use Molex 22-01-3047 terminal housing and two or four 0008550102 crimp terminals, depending on video system (composite or S-Video).

J8 (chroma outputs) Use Molex 22-01-3087 terminal housing and up to eight 0008550102 crimp terminals, depending on video system and required number of S-Video outputs.

J9 (luma or composite video outputs) Use a Molex 22-01-3087 terminal housing and up to eight 0008550102 crimp terminals, depending on video system and required number of video outputs. Most installations will use pin-1 and pin-2 of this connector, at least.

J7 (supplementary composite video outputs) Use a Molex 22-01-3047 terminal housing and up to four 0008550102 crimp terminals, if required.

J5 (GPS/remote control port) Use 3M type 89110-0103, with polarizing bump and strain relief, or equivalent. J5 may be connected to a 9-pin PC COM port by using ribbon cable such as 3M type 3302/10 and IDC connectors at both ends (pin-1 to pin-1). To mate with PC COM ports, use a DE9 style female plug, such as Amp 1658614-4, at the opposite end of this cable. Trim the tenth ribbon conductor away, to make the cable fit into this connector. Decade Engineering currently uses 3M part number N3793-6002RB (without ejectors) for the box header receptacle at J5, leaving customers the option of adding short or long ejector handles if desired. The short handles, which accommodate plugs without cable strain relief, are 3M type N3505-30B. Long handles, for plugs with strain relief, are 3M type N3505-31B.

J4 (auxiliary serial port) Use a Molex 22-01-3077 terminal housing and up to six 0008550102 crimp terminals, as required.

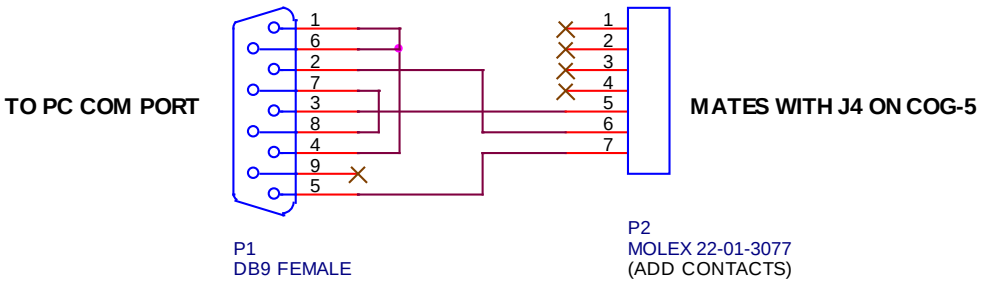
J13 (5V ADC inputs) Use a Molex 22-01-3057 terminal housing and up to five 0008550102 crimp terminals.

J14 (DAC outputs) Use a Molex 22-01-3097 terminal housing and up to nine 0008550102 crimp terminals.

J3 (3V ADC inputs) Use 3M part number 89120-0103 (with polarizing bump and strain relief) and 3M ribbon cable 3302/20, or equivalent. Note: This 20-conductor cable may be split to make 10-conductor cables for J5. It's reasonable to assemble the mating connector with a ribbon cable reduced to only four conductors, located at pins 17~20, because the remaining 16 pins are unassigned in current COG-5 firmware.

Firmware Upgrade Procedure

COG-5 firmware upgrades require the use of a Windows (XP) PC equipped with an RS-232 serial COM port or USB/serial adapter device. The field service technician must install the free BOB-4 Conscriptor program from Decade Engineering's website on his PC, and connect to COG-5's debug serial port using a customer-supplied serial data cable assembly. Here's a hookup diagram for the required cable:



Use this firmware upgrade procedure with BOB-4 Conscriptor V1.14 or later:

1. Connect the COG-5 debug serial port (pins 5~7 of J4) to a PC serial COM port.
2. Launch BOB-4 Conscriptor and select the connected serial port.
3. From the Serial menu, select: 'Download/Firmware (debug port).'
4. In the Open File dialog, navigate to and select the desired *.enc COG-5 firmware file (from Decade Engineering).
5. A dialog window should pop up showing progress of the flash memory write operation.
6. When the 'Download Complete' message box appears, click the OK button.

Use this firmware upgrade procedure with BOB-4 Conscriptor versions prior to V1.14:

1. Connect the COG-5 debug serial port (pins 5~7 of J4) to a PC serial COM port.
2. Launch BOB-4 Conscriptor, set the serial data rate to 115,200bps, and select the connected serial port.
3. Select 'Terminal' from the Serial menu, and click the Connect button. (Any terminal emulation program may be used for steps 3~5. just be sure the port is disconnected prior to step 6!)
4. Type "reset d" in the Transmit window, and hit the Enter key. This action should be echoed in the Receive window and followed by the message: "---- COG5 boot loader (xs: 5.1.2)"
5. Click the Disconnect button, then the Quit button.
6. From the Serial menu, select: 'Download/Firmware (repair).'
7. In the Open File dialog, navigate to and select the desired *.enc COG-5 firmware file (from Decade Engineering).
8. A dialog window should pop up showing progress of the flash memory write operation.
9. When the 'Download Complete' message box appears, click the OK button.

Configuration File Transfers

COG-5 allows the contents of its configuration memory to be stored on a PC for safekeeping and for duplicating the configuration in multiple COG-5 installations. A backward-compatible default configuration file for version 5.3.5 and later firmware releases is available from Decade Engineering on request. These operations require the use of a PC terminal emulation program that supports XModem CRC file transfer protocol. Hyperterminal is acceptable. In the command sequences given below, note that <ESC> represents the Escape key.

To export current configuration from COG-5 to PC file:

1. Connect PC serial COM port to primary serial port on COG-5
2. Set terminal baud rate to 115,200 (8N1, no flow control)
3. Transmit "<ESC>[1m" to switch COG-5 into remote control mode
4. Transmit "<ESC>[1@" to launch the file export sequence
5. Initiate XModem file receive in terminal program
6. Press Enter key on COG-5 keyboard to ship the data
7. After a few seconds, a confirmation message appears on the TV monitor

To import configuration to COG-5 from PC file:

1. Connect PC serial COM port to primary serial port on COG-5
2. Set terminal baud rate to 115,200 (8N1, no flow control)
3. Transmit "<ESC>[1m" to switch COG-5 into remote control mode
4. Transmit "<ESC>[2@" to launch file import sequence
5. Initiate XModem file transmit in terminal program
6. Press Enter key on COG-5 keyboard to accept the data transfer
7. Observe confirmation messages on the terminal screen for each segment of the process
8. COG-5 resets and uses the new configuration automatically after the transfer

To export Observation Codes only to PC file (for printing a 'cheat sheet'):

1. Connect PC serial COM port to primary serial port on COG-5
2. Set terminal baud rate to 115,200 (8N1, XON/XOFF or 'software' flow control)
3. Transmit "<ESC>[1m" to switch COG-5 into remote control mode
4. Transmit "<ESC>[3@" to launch ObCode export sequence
5. Set terminal program to capture input as text file (if necessary)
6. Press Enter key on COG-5 keyboard to ship the data
7. Open the captured file in a word processor and print it

Observation Codes are included in the configuration file, so it's also practical to print a quick-reference card by opening an exported config file and simply hacking out everything but the desired information.

Configuration File Format

COG-5 configuration files are human-readable ASCII text files beginning with a header line formatted as "COG-5 Version 5.x.x" where 5.x.x is the firmware version. This is followed by up to three data segments as described below. Each configuration data field is on a separate line, preceded by identifying text and a colon. Colons are permitted in text data fields. All lines terminate with <CR> (Carriage Return ~ 0x0D) and <LF> (Line Feed ~ 0x0A). Configuration file ends are terminated with *End Configuration* followed by <CR><LF>.

Configuration files may be edited with a text editor but care must be taken to insure that text length and numeric values stay within normal operating ranges. In particular, be aware that a full screen of Title Screen text is confined to a single line in the config file, and that words break at the screen edge if they fall across COG-5 display line breaks. For this reason, it's probably best to edit Title Screen text at the COG-5 keyboard instead of editing the config file on a PC. Comment text may be placed on lines beginning with the number sign (#), but those lines are not retained in COG-5's internal file format. Individual lines and entire data segments may be omitted, which allows users to conveniently alter only selected configuration items.

Data Segments

1. The first data segment is identified as *Configuration Data* and contains COG-5 system operating parameters. This segment also includes the contents of all text memories except those described immediately below. Each entry consists of a three-digit numeric identifier, text identifier, colon, text or numeric argument, another colon, and <CR><LF> termination.

2. The second data segment is identified as *Observation Codes* and contains 26 text fields. Each line begins with the key combination used for display, followed by a colon, text, another colon, and then <CR><LF>.

3. The third data segment is identified as *Title Screens* and contains five text fields large enough for a full screen of text. Each line begins with "Screen" and the screen number, followed by a colon, text, another colon, and the <CR><LF> termination.

RS-232 Remote Control Interface

RS-232 remote control is possible through COG-5's primary serial port only. The primary serial port's Remote Control function is shared with its GPS function, so that simultaneous COG-5 remote control and GPS data display is not possible. The local COG-5 keyboard is disabled and its Scroll Lock LED is lit when remote control is enabled. The communication bit rate for this port is fixed at 115,200 bps, with eight data bits, no parity, and one stop bit (8N1). <XON>/<XOFF> software data flow control is implemented.

COG-5 commands begin with an 'escape sequence' of two special code bytes: <ESC> (0x1B), and "[" (0x5B); abbreviated as <CSI> (Control Sequence Introducer). PC terminal programs such as HyperTerminal generate <CSI> with just two keystrokes: "Esc" followed by "[". In this document, "<CSI>" is used interchangeably with "<ESC>[".

COG-5 command syntax is **postfix**, meaning that parameters precede the operator. Numeric arguments are transmitted in an intuitive variable-length ASCII decimal format, separated by semicolons. Semicolons are necessary only if arguments are present. If an argument is omitted, then a zero/null argument is normally assumed for that parameter. Some commands elicit response strings, which are always terminated with <CR><LF> (carriage return & line feed).

Character cells (character row/column locations) are numbered from the top left corner, where row=0 and column=0. In the vertical axis, row index values increase downward. In the horizontal axis, column index values increase rightward.

COG-5 Remote Command Set

@	Configuration	Syntax: <CSI>n@ (for debug port: config n <CR>)
n=1	Transmit binary COG-5 configuration data to remote computer using XModem protocol	
n=2	Receive and store binary COG-5 configuration data using XModem protocol	
n=3	Transmit observation codes only, as a formatted text file for printing	

a	ADC Read	Syntax: <CSI>na
n=1	Read analog input channel 0; return format: **ADC0 0000<CR><LF>** (data range is 0000~1023)	
n=2	Read analog input channel 1; return format: **ADC1 0000<CR><LF>** (data range is 0000~1023)	
n=4	Read analog input channel 4; return format: **ADC4 0000<CR><LF>** (data range is 0000~1023)	
n=8	Read analog input channel 5; return format: **ADC5 0000<CR><LF>** (data range is 0000~1023)	
n=16	Read analog input channel 6; return format: **ADC6 0000<CR><LF>** (data range is 0000~1023)	
n=32	Read analog input channel 7; return format: **ADC7 0000<CR><LF>** (data range is 0000~1023)	

This command supports multiple ADC readings. Just sum the '**n**' numbers listed above, to specify the desired combination of ADC channels to read in a single command. The return string includes a sequence of labels and data formatted as above, with one space between each field and a final **<CR><LF>**. For example, **<CSI>3a** yields the following return string (if input voltages are zero): **ADC0 0000 ADC1 0000<CR><LF>**

b	Bypass to BOB-4	Syntax: <CSI>b
Bypass mode is terminated by receipt of a code byte containing all ones (0xFF).		

Allows direct control of the BOB-4 module by the remote computer, which is a versatile way to print text and data into the video display. Refer to the BOB-4 Application Guide for command language details. BOB-4 commands unrelated to printing may not be supported. During bypass mode, COG-5 continues to display and refresh all data fields as configured. See **d** command if that's not desired.

c	Camera Pan/Tilt	Syntax: <CSI>n;<parameter1>;<parameter2>c
n=0	Stop camera movement; syntax: **<CSI>0c**	
n=1	Read pan/tilt angles in degrees; return format: **pan:047 tilt:342<CR><LF>**	
n=2	Drive camera to specified position; syntax: **<CSI>2;<pan>;<tilt>c** with pan/tilt values in degrees	
n=5	Store camera position; syntax is **<CSI>5<index>c** with index of 1~12 corresponding to F-keys	
n=6	Drive camera to stored position; syntax: **<CSI>6;<index>c** with F-key index of 1~12 as above	
n=7	Tilt up; syntax is **<CSI>7;<speed>c** with speed of 1 (slow), 2 (medium), or 3 (fast)	
n=8	Tilt down; syntax is **<CSI>8;<speed>c** with speed options as above	
n=9	Pan left; syntax is **<CSI>9;<speed>c** with speed options as above	
n=10	Pan right; syntax is **<CSI>10;<speed>c** with speed options as above	

Provides remote access to COG-5's camera aiming control features. This command allows simultaneously driving the camera platform on both axes. All three PWM output channels are used, one as a fixed center-of-range voltage reference for motor drive amplifiers with differential inputs. See **p** command for direct low-level access to PWM output hardware.

d	Disable Display	Syntax: <CSI>nd
n=0	Disable refreshing and clear the locally generated display; printing via BOB-4 bypass remains functional	
n=1	Enable COG-5 local display generation	

e	Encoder Register R/W	Syntax: <CSI>n;<count>e
n=1	**<CSI>1e** Return contents of encoder count register; return format: **[0/-]000000000<CR><LF>** (The leading zero is replaced by a minus sign if reading is negative.)	
n=2	Load count register with specified value; syntax: **<CSI>2;<count>e** (use ”<” instead of “-“ to specify a negative count value)	
n=3	**<CSI>3e** Clear count register to zero	
n=4	**<CSI>4e** Load count register with the value manually stored by operator in distance-preset memory	

k	Key Input	Syntax: <CSI><keycode>;<modifier>;<modifier>k
Allows remote controller to emulate operator input from the local keyboard. **<keycode>** is a number from the table below. **<modifier>** is **1** for **Ctrl**, **2** for **Shift**, or **4** for **Alt**. Key modifiers are optional and modifier sequence is immaterial. Codes listed in the rightmost column are examples of a keycode with **Shift** modifier.		

Key	Code	Key	Code	Key	Code	Key	Code
A	4	1	30	-	45	!	30;2
B	5	2	31	=	46	@	31;2
C	6	3	32	[	47	#	32;2
D	7	4	33	]	48	$	33;2
E	8	5	34	\	49	%	34;2
F	9	6	35	;	51	^	35;2
G	10	7	36	‘	52	&	36;2
H	11	8	37	`	53	*	37;2
I	12	9	38	,	54	(	38;2
J	13	0	39	.	55	)	39;2
K	14			/	56	_	45;2
L	15	Enter	40			+	46;2
M	16	Esc	41	Scroll Lock	71	{	47;2
N	17	Backspace	42	Break	72	}	48;2
O	18	Tab	43	Insert	73	|	49;2
P	19	Space	44	Home	74	:	51;2
Q	20	Caps Lock	57	Delete	76	“	52;2
R	21			End	77	~	53;2
S	22			Right Arrow	79	<	54;2
T	23			Left Arrow	80	>	55;2
U	24			Down Arrow	81	?	56;2
V	25			Up Arrow	82		
W	26			Num Lock	83		
X	27						
Y	28						
Z	29						

m	Remote Mode	Syntax: <CSI>nm
n=0	Disables remote control and returns control to local COG-5 keyboard	
n=1	Enables remote control; local COG-5 keyboard is disabled and Scroll Lock LED is lit	

p	PWM Direct	Syntax: <CSI>n;<channel>;<value>p
n=1	Read PWM generator settings; syntax: **<CSI>1;<channel>p** with channel of 0~7 (see note); return format length depends on command; max length as follows: **PWM1 000 PWM2 000 PWM3 000<CR><LF>**	
n=2	Load PWM generator; syntax: **<CSI>2;<channel>;<value>p** with channel of 1~3; value of 1~210 with inverse relationship to final output of zero to +5.00V. Value argument of 105 yields +2.50V output, and this is the default setting.	

The PWM (pulse width modulator) command provides an alternate method of controlling the same COG-5 outputs used by the **c** command. It supports multiple channel reading, but not multiple channel writing. The read channel argument is derived by summing bit values for the three possible channels, with bit-0 for PWM1, bit-1 for PWM2, and bit-2 for PWM3. Thus an argument of 7 (binary 111) commands a read of all three channels, while an argument of 4 (binary 100) reads only PWM3.

r	Real-Time Clock	Syntax: <CSI>n;<min>;<hour>;<day>;<month>;<year>r
n=1	**<CSI>1r** Read clock; return format: **03:30PM 10 Sep 09<CR><LF>**	
n=2	Set clock; argument ranges: min; 0~59, hour; 1~24, day; 1~31, month; 1~12, year; 0~99	

t	Text Print	Syntax: <CSI>n;<column>;<row>t
n=1	Enable printing & set print position to specified row and column numbers. Column range is 0~51. Row range is 0~15 for NTSC, 0~18 for PAL. Defaults are both zero (upper left corner position).	
n=2	**<CSI>2t** Print; subsequent printable ASCII character codes appear on TV screen; also handles the following control codes: <CR> (carriage return), <BS> (backspace)	
n=3	**<CSI>3t** Clear the text overlay and disable printing	

Text does not scroll automatically, but wraps to the upper left corner position. Words break at screen edge. See **b** command for expanded printing options.

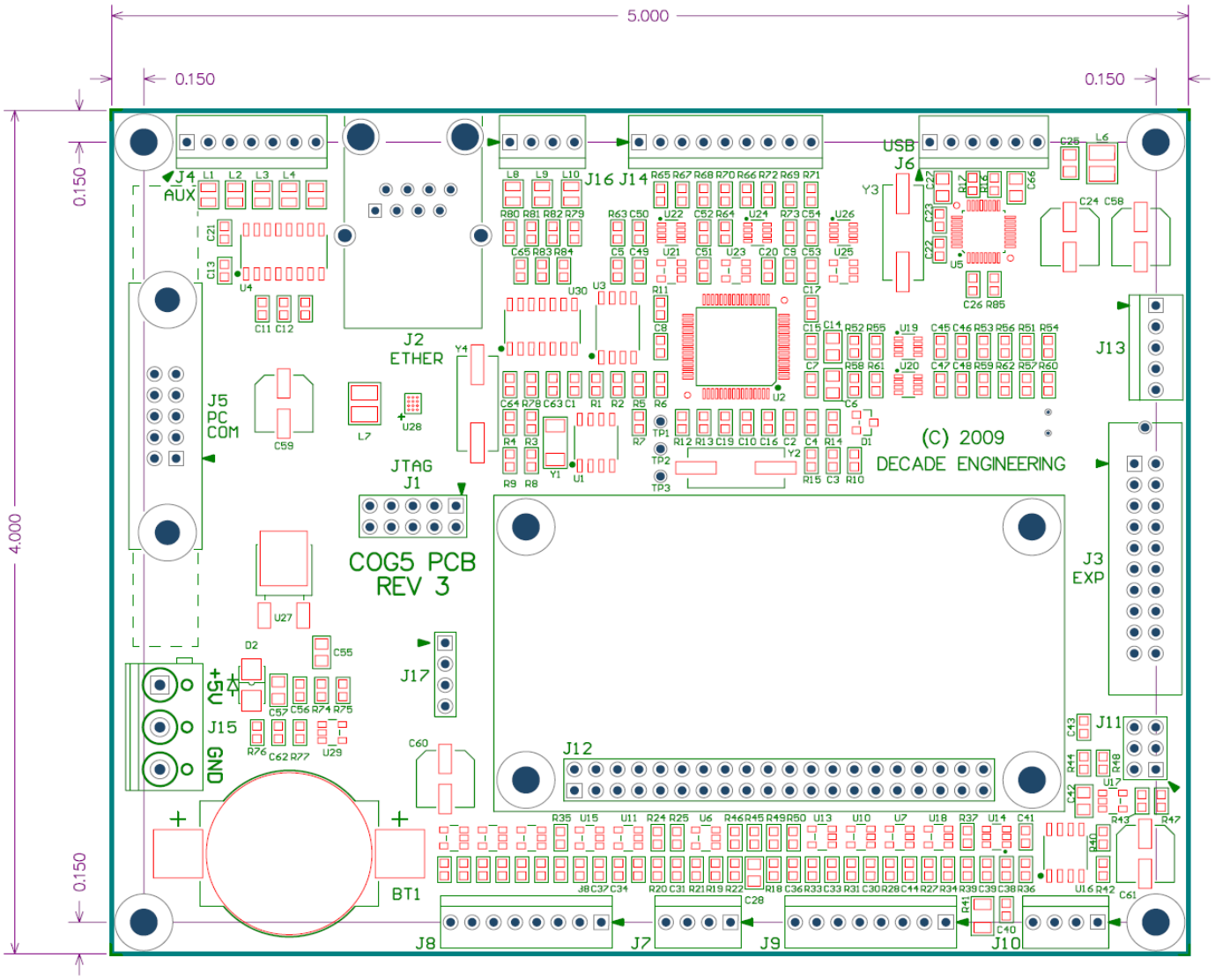
z	Default Configuration	Syntax: <CSI>4321z
n=4321	Clears all text memories and calibration settings, including Pan/Tilt calibration.	

Corrupted configuration memory can cause bizarre symptoms. Try this command as a last resort, if local keyboard communication fails.

Firmware Revision History

Version & Release Date	Description
V5.4.4 [26 July 2012]	Fixed power-fail response and comment text redraw bugs. Expanded remote command set for remote keyboard emulation with k command.
V5.4.2 [16 December 2011]	Added software handshake to RS-232 remote control interface.
V5.4.1 [08 December 2011]	Revised config file format to allow colons in text fields, fixed distance-preset bug.
V5.3.8 [27 June 2011]	Made keyboard Num-Lock off by default, improved GPS data processing.
V5.3.7 [13 April 2011]	Beta release with GPS data display
V5.3.5 [10 January 2011]	Beta release with MSD and human-readable configuration file
V5.3.2 [15 July 2010]	First production release
V5.2.0 [18 January 2010]	Revised USB keyboard interface to remedy keyboard compatibility problems.
V5.1.0 [14 September 2009]	Added RS-232 serial remote control interface. Activated watchdog timer. Added option to preserve distance data upon power failure. Fixed keyboard LED operation. Added Num-Lock and Caps-Lock keyboard functions.
V5.0.0 [01 September 2009]	Early production release, offering only basic functionality

Mounting Hole & Connector Locations



Dimensions are given in inches. The four corner mounting holes are 0.128” ID, to clear #4 size machine hardware.

Decade Engineering Contact Information

Please check our website for the most recent version of this document before concluding that a defect exists. Decade's standard hardware warranty and service information is posted within the online ordering system. See below for this product's software warranty statement.

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Obligatory Boilerplate

Intellectual property acknowledgements

Trademarks owned by other companies are hereby acknowledged.

This product includes open source software developed by Neil Russell.

This product may include code developed by the Enlightenment Project.

Software Warranty Statement

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