McLagan Enterprises LLC

Current Sensor-6 Instructions

Measuring current with a current shunt and an electronic EMS is often difficult in the high electrical noise environment of an experimental aircraft, particularly ones with a Permanent Magnet (PM) alternator. The shunt method also requires breaking a wire to insert the shunt and care in mounting the shunt to protect it from shorts. Magnetic current sensors have been developed to avoid these problems, but many magnetic sensors on the market are sensitive to stray magnetic fields and can be very inaccurate, sometimes off as much as +/- 5 amps.

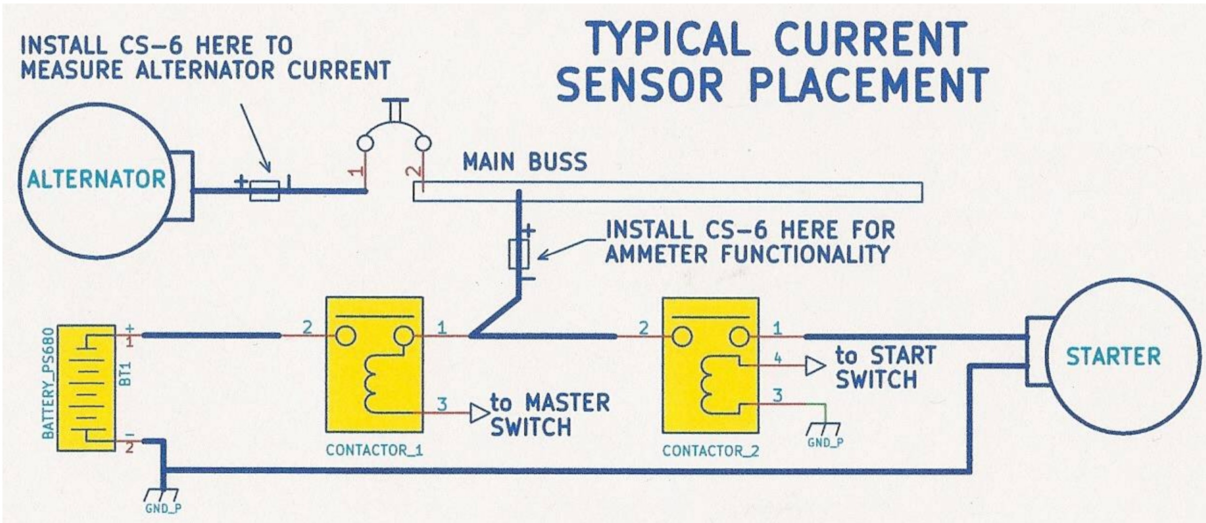
When monitoring sensitive aircraft equipment this just isn't good enough.

The **ME CS-6** is a **HIGHLY ACCURATE** magnetic current sensor that uses special technology to read current loads down to +/- 0.1amps by intelligently ignoring error caused by the earth magnetic field and other stray magnetic fields found within your aircraft. It is easy to install using just shrink tubing and zip-ties, and is compatible with any display device expecting 0-5v current sensor input. It is easy to calibrate using a simple process that yields exceptional accuracy.

VERSIONS:
The CS-6 is available in three versions:
The **CS-6AB** is powered by 5 Volts
The **CS-6CB** is powered by 7 to 30 Volts.
The **CS-6CBX** is powered by 5 to 20 Volts and replaces the CS-6AB and CS6CB

INSTALLATION:

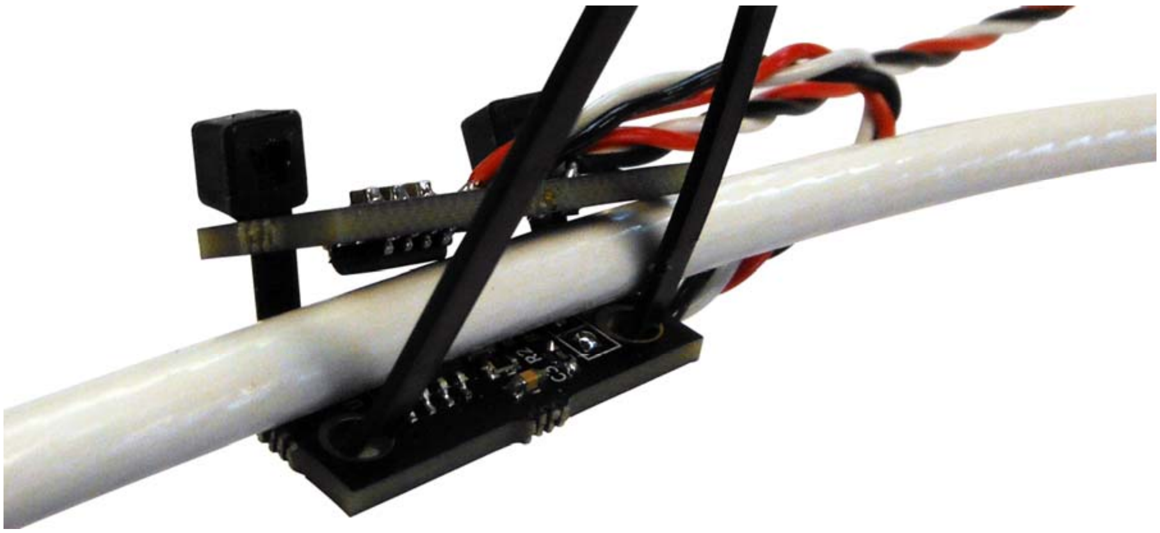
Mechanical
Position in a typical electrical system



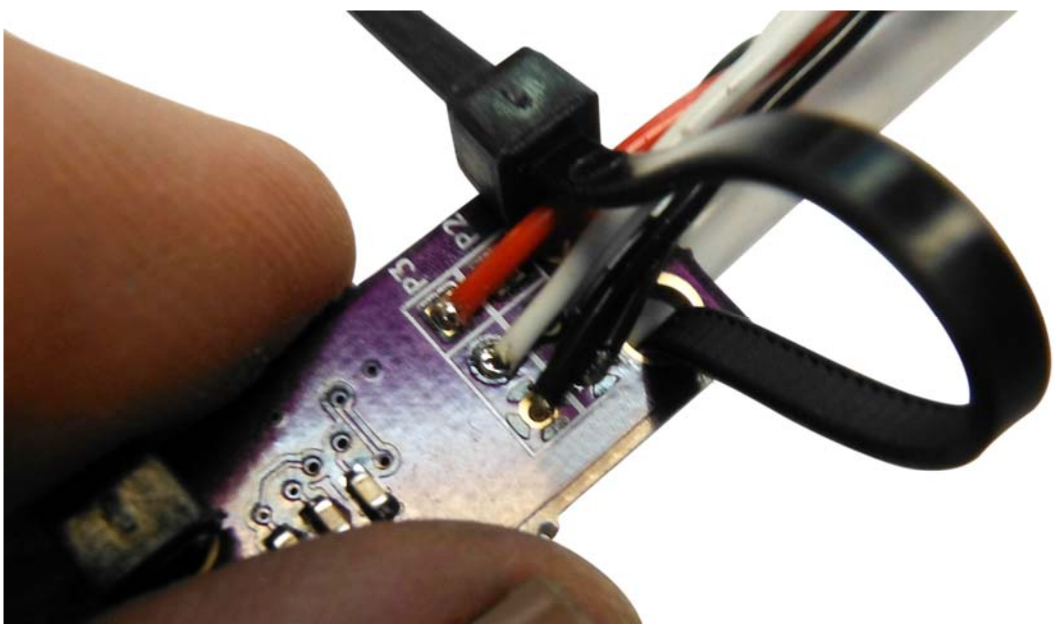
Choose a place in the system that minimizes heat and moisture exposure.

Position the tie wraps as shown. Note that the tie wraps must enclose all wires as this provides strain relief for the wires and prevents them from breaking due to vibration.

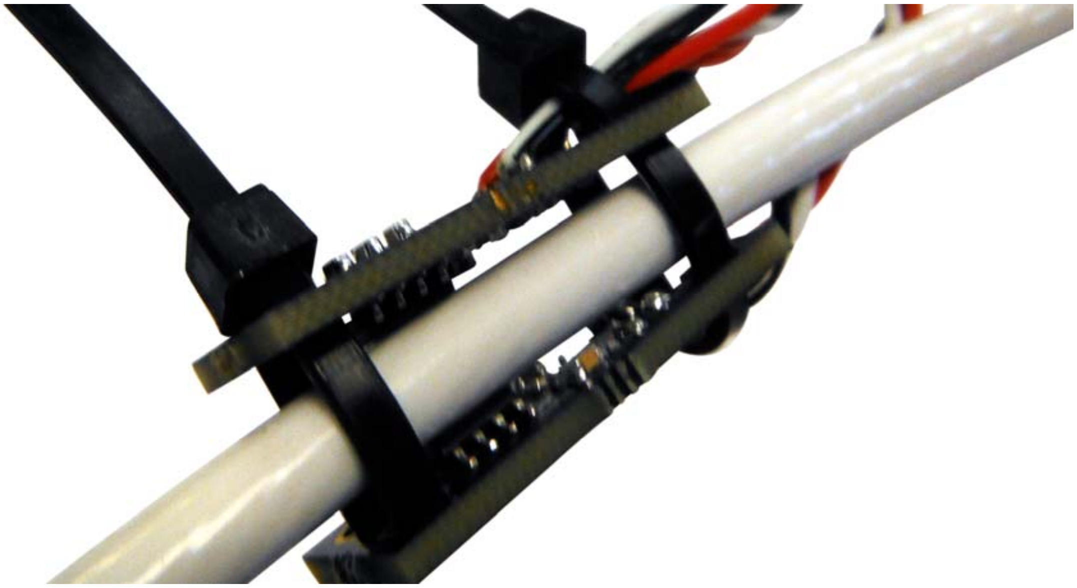
Position the sensor on the cable. Orient the sensor for the desired polarity reading. The end with the cables is the plus end should be toward the source (alternator or generator) of the current when a positive reading (2.5Vout at zero, +5V out at max current) is desired.



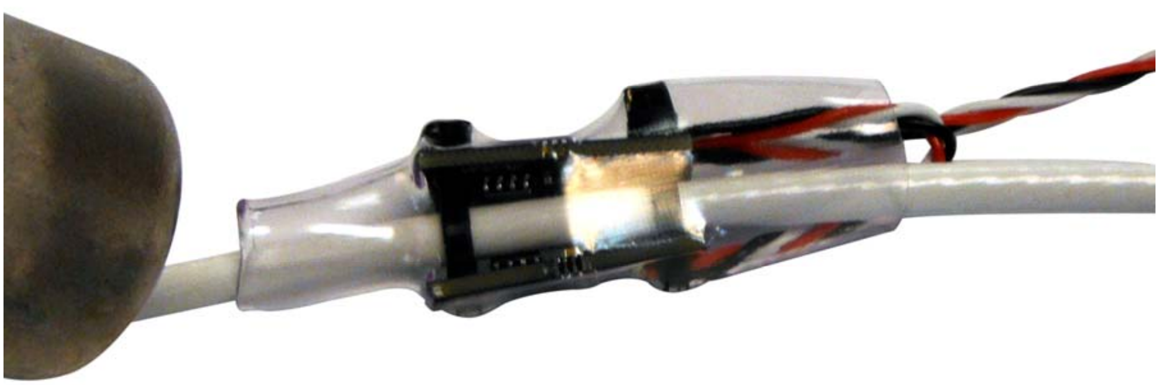
Thread the tie wrap as shown. Make sure to enclose the wires so as to provide strain relief.



Cinch down the tie wraps just enough to hold the boards tightly to the wire. To function properly the boards must be centered on the wire and parallel to each other.



Place the shrink wrap over the installation and shrink with a heat gun.



Seal on one end if desired. Use 3M 5200 sealant or equivalent.

Electrical

Connect the black wire (ground) to a ground pin on the EFIS, EMS, or RDAC. Connect the white wire (signal) to a current monitor input pin on the EFIS, EMS, or RDAC.

For **CS-6AB** sensors connect the red wire (+5V) to a 5 volt output pin on the EFIS, EMS, or RDAC. This pin should be able to provide 30 mA of current.

For **CS-6CB** sensors, connect the red wire (+7-30 V) to a fuse or circuit breaker on the electrical bus (usually the same buss that the EFIS, EMS, or RDAC is connected to). Fuse or Circuit breaker should be no more that 1A.

For **CS-6CBX** sensors, the red wire (+5-20 V) may be connected either to a 5 volt output pin on the EFIS EMS, or RDAC or to a 14V source. A 14V source should use a fuse or circuit breaker on the electrical bus (usually the same buss that the EFIS, EMS, or RDAC is connected to). Fuse or Circuit breaker should be no more than 1A.

Wires may be extended if necessary. Use #24 minimum.

CALIBRATION:

Calibration depends upon the adjustment features of the display EMS (Engine Management System). Typically a setting at zero current is required, followed by applying a known current and adjusting a calibration factor to match. It is often difficult to get an accurate zero with the system is on, and even more difficult to set an accurate current through the device when it is installed.

A simple substitution method can be used instead. In this case a voltage representing zero (2.5 Volts) can be substituted for the device and the zero adjustment done. Then a voltage representing a desired calibration current (see below) can be calculated and applied to the EMS current monitor input. Then the other gain or cal factor in the EMS can be adjusted so the current reading matches.

Disconnect the CS-6 white wire from the EMS current monitor input. On 5 volt systems, a 10 k pot can be connected to a 5 volt output and to ground (black wire on the CS-6), with the wiper connected to the EMS current monitor input.

For the zero adjustment, set the voltage on the pot wiper to exactly 2.5 volts. Set the calibration zero on the EMS. Then set the voltage to the desired calibration point and adjust the EMS cal factors to get the same reading. Disconnect the pot and reconnect the CS-6 white wire to the EMS current sensor input.

The Sensitivity of the device is a function of the size of the conductor and the thickness of the insulation. It is very consistent.

Some known sensitivities are:

#14 MIL-W-22759/16 Wire:	62 mV/A	+/- 40A range	O.D. 0.090
#12 MIL-W-22759/16 Wire:	58 mV/A	+/- 43A range	O.D. 0.112"
#10 MIL-W-22759/16 Wire:	48 mV/A	+/- 52A range	O.D 0.138"
#8 MIL-W-22759/16 Wire:	38 mV/A	+/- 65A range	O.D. 0.198"
#6 MIL-W-22759/16 Wire	30 mV/A	+/- 83A range	O.D. 0.250"
#4 Welding Cable	24 mV/A	+/- 100A range	O.D. 0.364"
#4 Welding Cable w/2 shrink tube	17 mV/A	+/- 147A range	O.D. 0.500"

For example, to set a calibration voltage for +20 A when using a #8 wire:
20A X 38mV/A = 760mV or 0.76 V. Add 2.5 to get 3.26 volts. Set the pot at 3.26 volts and adjust the EMS to read +20 A.

Note: On the smaller cables (#12 and #14), great care must be made to ensure the sensor is exactly centered on the cable, and the two boards are parallel.

MGL Extreme Calibration Example:
Set the zero (place 2.5 volts on the RDAC X CURR input or operate the sensor with it not attached to the wire) per the MGL zero Current function.
Then calculate the full scale current:
For # 8 wire, 2500 mV/38mV/A =65.8 A.
Enter this value into the full scale current function.

Dynon systems:

A custom sensor definition file is available that includes the CS-6 for several wire sizes (organized by maximum current). Contact Dynon or McLagan Enterprises to obtain this file. See the end of this document for more detailed and legacy Dynon installation information.

SPECIFICATIONS:

CS-6AB This is the basic version designed to be operated with Engine or Flight monitoring systems that provide 5 volts to supply external sensors and accept a 0-5v input with zero current being at 2.5 volts. No input voltage or polarity protection.

Output: 0-5V with 2.5 volts a zero current.
Sensitivity when mounted on a #8 aircraft wire: 38 mV/A
This results in a maximum current sensing of: +/- 65 A
DC Voltage input: 5 V
Current draw 30 mA
Power on is indicated by a LED.

CS-6CB Same functionality as the CS-6AB but is fed by 7 to 30 VDC. DC Input is reverse voltage protected.

DC Voltage input (reverse voltage protected): 7-30 V
Current draw (at 7-30 volts input):: 35 mA

CS-6CBX Same functionality as the CS-6AB but is fed by 5 to 20 VDC. This version is intended to replace both the CS-6AB and the CS-6CB.

DC Voltage input (NOT reverse voltage protected): 5-20 V
Current draw (at 7-20 volts input):: 31 mA

TROUBLE SHOOTING:

1. Verify that power is applied. The LED should be on.
2. Verify that the output signal wire (white) is at 2.5 V (+/-.1V) with power applied and no current flowing through the wire to be sensed (or with the sensor not attached to the wire to be sensed.) The white wire should not be attached to the EMS for this test. If 2.5 V is not present, the CS-6 is defective and should be returned for replacement.

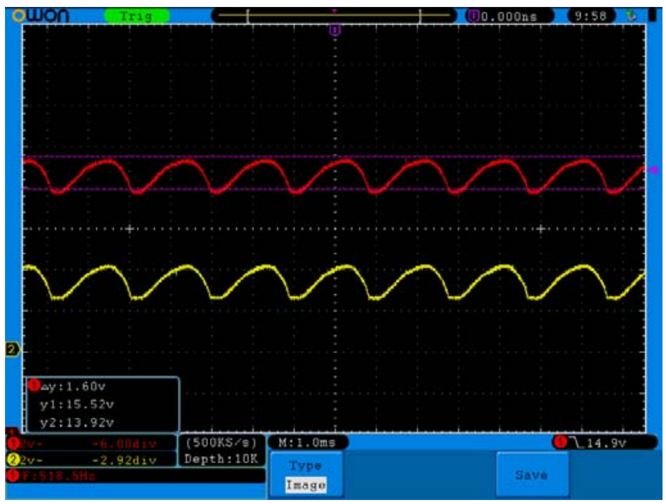
3. Repeat step 2 but with the wire attached to the EMS. 2.5 V should be present. If not, check to see that any pullup or pulldown resistors built into the EMS and associated with the current input pin are switched off. The CS-6 with built in filter has a relatively high output impedance (10k) and is intended to drive EMS input circuits that are high impedance.

4. System shows opposite desired polarity (for example, shows positive current with alternator off and negative current when alternator on in an “ammeter” system): Reverse the orientation of the sensor on the wire or change the calibration polarity in the EMS calibration if available.

Additional Considerations for use with a Permanent Magnet Alternator:

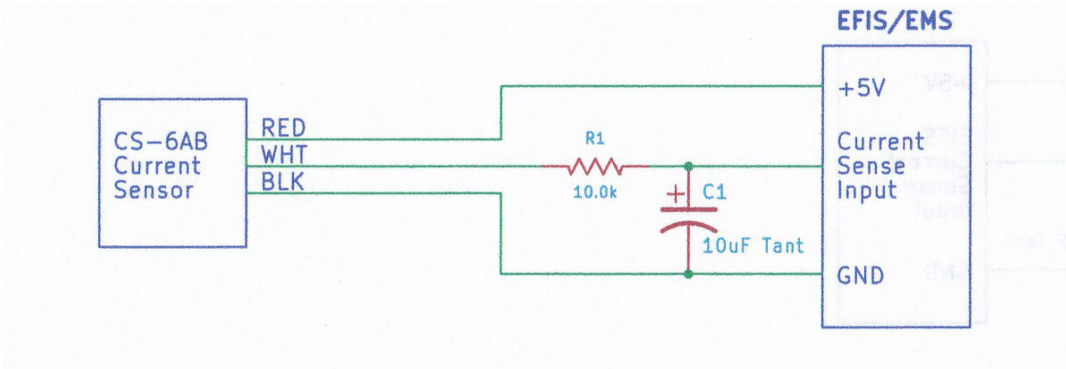
The CS-6 is a fairly fast sensor. This can cause problems in a system using a permanent magnet alternator and when the display uses a sampling system to read the voltage. This can result in unstable readings.

In the oscilloscope display below (a Jabiru 3300 operating at 3100 RPM and 20A load) the top (red) trace is the system voltage showing the pulses of power going into the battery. The lower trace (yellow) shows the output of a connected CS-6. A sampling display may pick a peak or a valley to display – resulting in apparent instability.



The following is the same system but with a filter at the output of the CS-6. This will give stable readings with any system:

Typical filter:



A very low leakage capacitor should be used such as a tantalum or ceramic. The voltage rating should be 10 volts or more.

Note: All versions now shipping have the filter built in.

Dynon Skyview Installation Instructions

Note:
A Dynon sensor definition file is now available that includes the CS-6 on several different wire sizes. This file (custom_cs6_sensor_all_68298) is available from Dynon or McLagan Enterprises. The CS-6 entries are organized by the maximum current readable for each wire size.

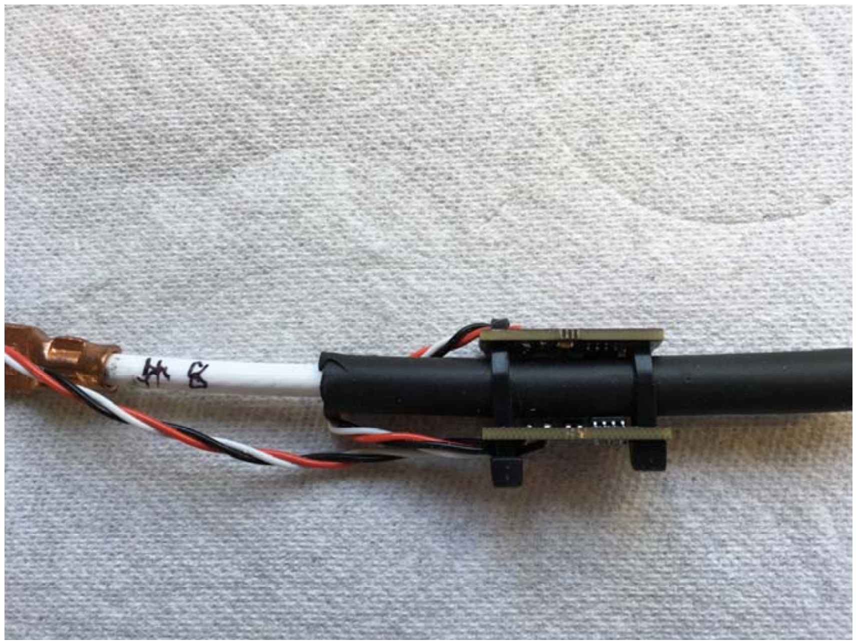
The following is left for reference:

Overview
Dynon only provides provisions for 3 current sensor types – the traditional shunt method, and two hall effect systems provided by GRT Avionics, the CS-01 (+/- 100A) and the CS-02 (+/- 50A). For the GRT Sensors they provide for a zero adjustment (which they call “offset”), but the sensitivity is fixed – 25 mV/A (CS-01) amd 50 mV/A (CS-02). See the Dynon Skyview Install Manual document 101320-029, revision AD, published February 2018, P. 7-63 thru 7-65.

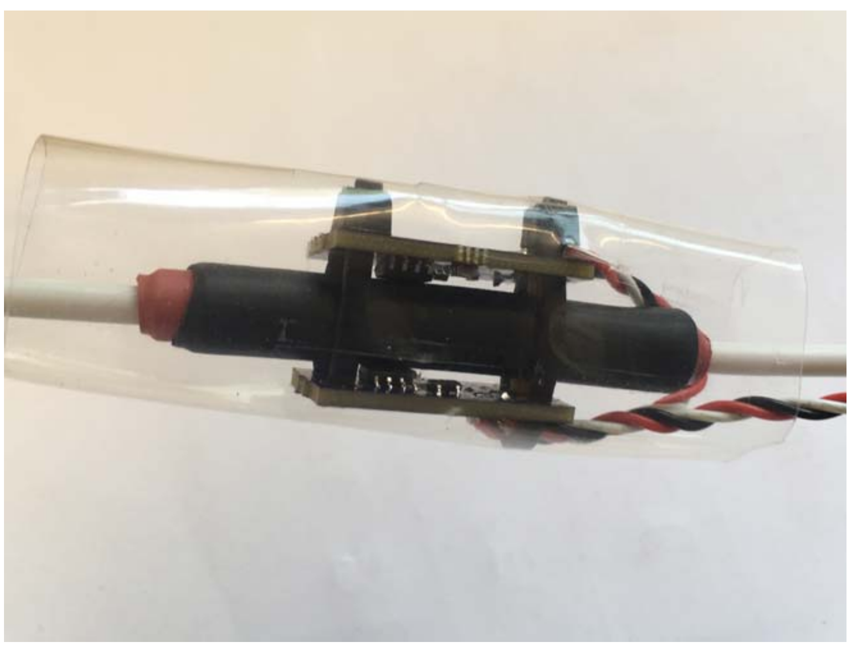
The McLagan Enterprises (ME) CS-6 models are electrically compatible with the GRT Avionics CS-01 and CS-02, however external means must be used to match the sensitivity to the GRT devices.

Adjustment
Since the ME CS-6 sensitivity is dependent on the wire size used, the sensitivity of the chosen wire/CS6 combination must be adjusted downward to match one of the two GRT CS sensitivities (100 mV/A for the CS-01 and 50 mV/A for the CS-02.

One way is to enlarge the area where the CS-6 is installed using shrink tube.



Shrink tube on #8 wire



Shrink Tube on #10 wire

The important dimension is the final diameter of the wire/shrink tube area. Additional layers of shrink tube are added until the desired diameter is reached. (note that the first entry, #10 wire, is close enough to 50 mV/A to not need shrink tube)

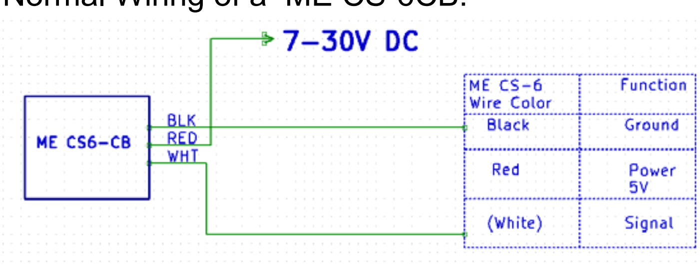
Wire Size	Initial mV/A	Final mV/A	Final Diameter	Approx Layers	Matches GRT	Current Range
#10	48	48	0.138”	0	CS-02	+/- 50A
#10	48	25	0.328”	6	CS-01	+/- 100A
#8	38	24.4	0.335”	5	CS-01	+/- 100A
#6	31.1	24.4	0.320”	2	CS-01	+/- 100A
#4	24	24	0.364	0	CS-01	+/- 100A

Setup as a CS-01 or CS-02, see P 7-64 or the SkyView manual.

ME CS-6AB Wire Color	EMS Harness Wire Color	SV-EMS-220/221 Pin Number	Function
Black	Black	Any of 3, 5, 13, 16, 17, or 30 It is acceptable to share this Ground with other sensors.	Ground
Red	White/Red It is acceptable to share this pin / wire with other sensors;	18 (+5V) It is acceptable to share this pin / wire with other sensors;	Power
White	Any of Pin 8 (Brown), Pin 22 (Violet/Yellow), Pin 23 (Violet/Green), Pin 31 (White/Orange)		Signal

Note that the CS-6AB consumes 30 mA of 5V power. The total of all sensors connected to Pin 18 should be less than 300 mA.
If excess 5V current is used, a ME CS6-CB can be used with an external 12 Volt source.

Normal Wiring of a ME CS-6CB:



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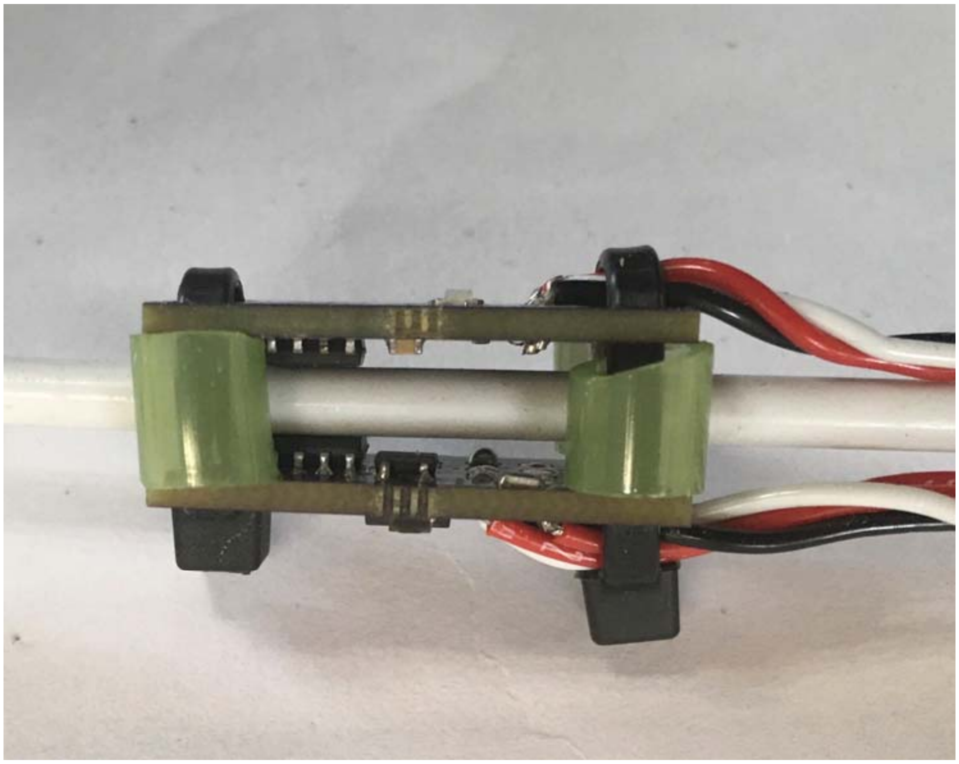
Use of Alignment Spacers

One of the more annoying aspects of mounting a CS-6 is keeping both sides parallel, particularly on smaller wires. One solution is to use 1/4" polyurethane tube (typically used on pitot static systems) as spacers as shown below:



The tubes should be cut 0.125" (1/8") longer than the diameter of the wire. It is important to ensure that the current sensor integrated circuits (black chips on the left, top and bottom) contact the wire.

Done correctly, this will ensure that the sensors chips are parallel and that the sensor is centered on the wire. This gives best accuracy and stray magnetic field rejection.

For technical support contact:
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