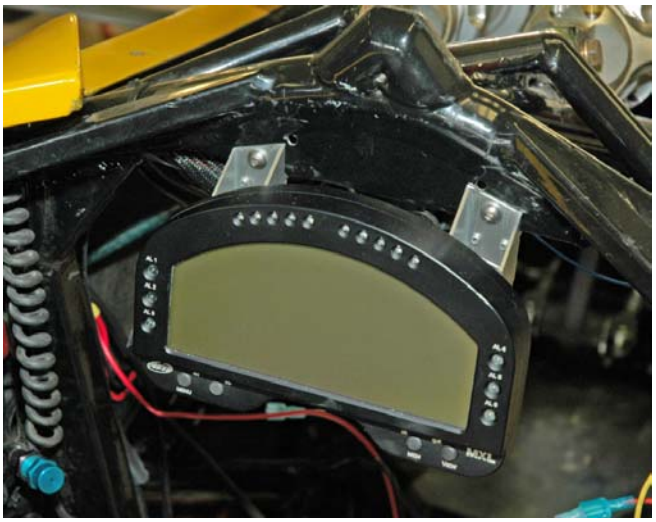
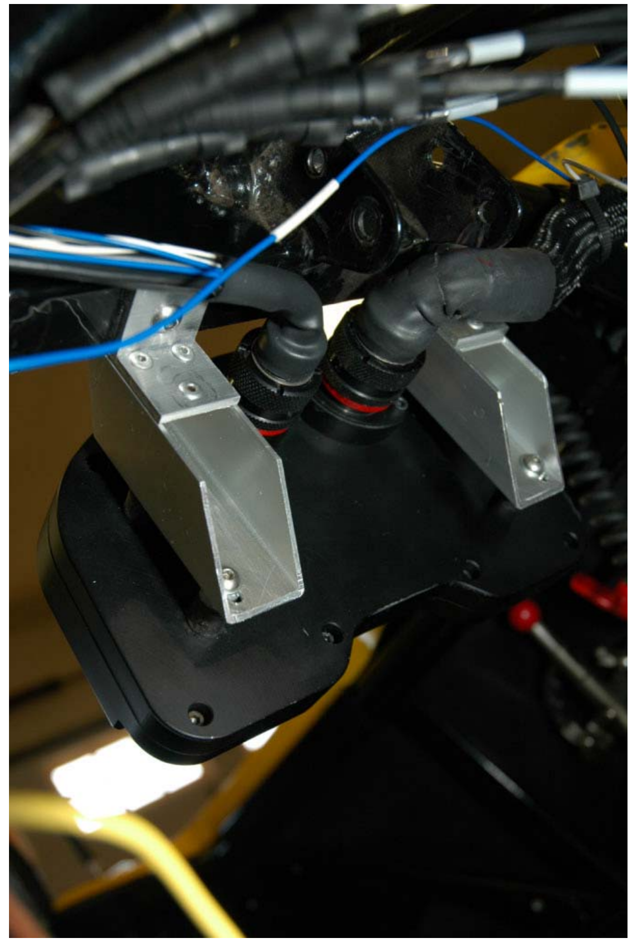
AIM MXL Pro-05 Dash installation – Van Diemen RF00 FF1600

The dash is installed using sections of 1" square aluminum tube, machined to allow access to mounting screws onto the dash and the frame.

L-section aluminum is riveted to the back of the tube to allow for mounting both on the front and underside of the frame tube.

It was necessary to re-do the main wiring harness heat-shrink and grind the steering block tabs a little in order to make it all fit, and still allow the dash to move freely on its rubber mounts.

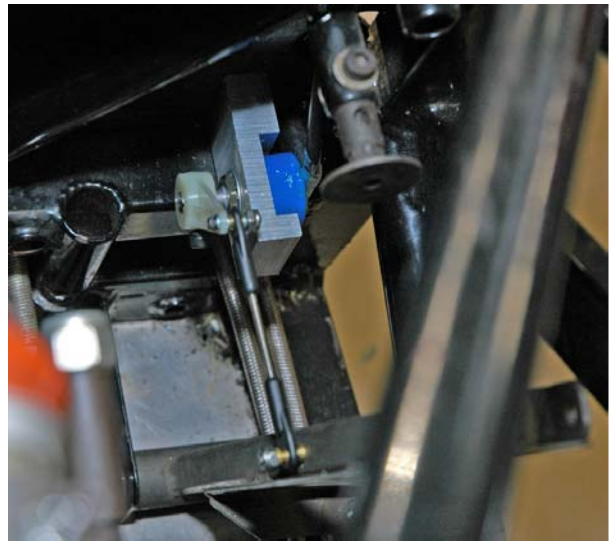




It was necessary to create a second wiring harness for the 22-pin Deutsch connector – in order to accept inputs for wheel speeds 3 and 4. The harness also allows for remote control of the MEM and VIEW buttons, plus an external USB connection, and ECU interfacing via CAN and RS232. In due course, a button for VIEW may be placed on the steering wheel.

Creating the harness is not especially difficult, but a special crimp tool is required.

Throttle sensor

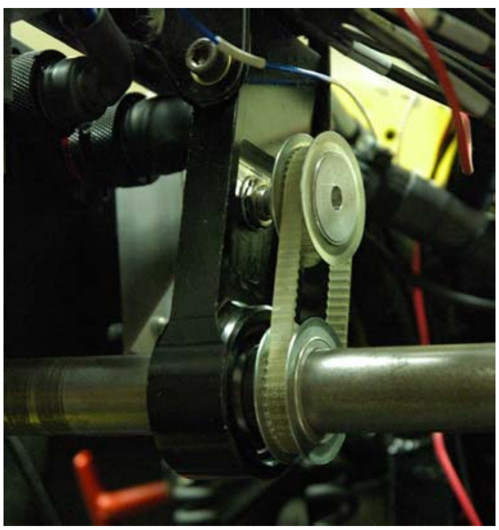


The throttle sensor is a Bourns 10k linear continuous sealed potentiometer (Bourns 6639S-1-103). The hardware is designed for model aircraft - a 2-256 threaded rod with miniature plastic/brass rod ends. The lever operating the pot is intended for a steering undercarriage, or operating the rudder on an r/c boat. It was necessary to drill out the lever's mounting collar to work with the ¼" shaft of the pot.

The mounting block was machined from 2" x ½" 6061-T6 aluminum bar. The block is drilled and tapped to allow for mounting onto the front bulkhead. A piece of L-section aluminum would have worked just as well.

The aircraft hardware came from Sheldon's Hobbies in San Jose, CA.

Steering sensor

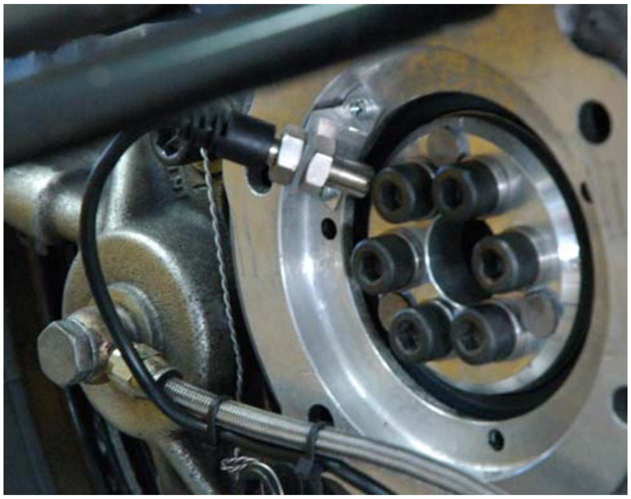


Another Bourns 6639S-1-103 pot is used – this time mounted directly to the steering column support block. The pot is operated by a ¼" wide toothed belt connecting pulleys on the steering column and the pot.

The pulleys came from AIM as a steering hardware kit, but similar pulleys can be obtained from McMaster-Carr – however some machining would be required for the large-diameter ¾" I.D. for the steering column side. The standard pulleys seem to be designed to fit onto much smaller shafts.

The continuous pot is very useful since the steering can go beyond the 340 degrees allowed by the pot without any problems other than bogus data. This is rarely a problem in normal driving in a formula car.

Front wheel speed



Speed is measured on both front wheels.

A small mounting block was made to mount an AIM-supplied magnetic wheel speed sensor (‘bike’ type) onto the left-front upright.

As with the throttle sensor, a piece of bent aluminum would probably work just as well.

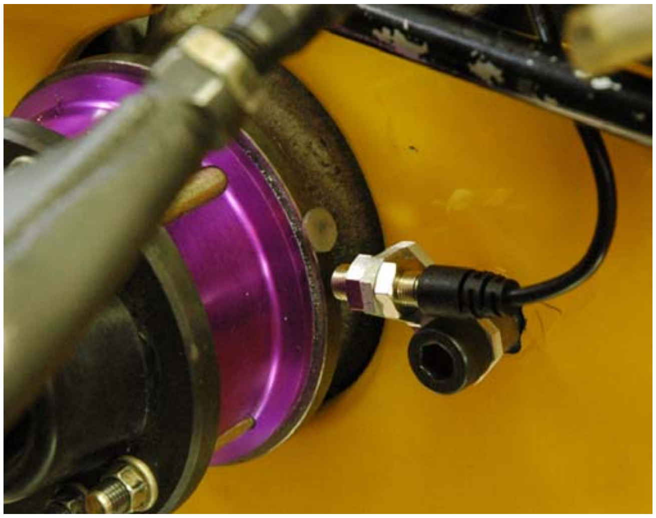
The sensor picks up the passing of three small circular magnets, glued to the hub with 3M 2216 epoxy. One or two magnets would work just as well, but three are used for increased accuracy.

The magnets are ‘traction magnets’ from a local slot car supplier.

The right-front wheel uses the sensor setup already on the car when it was purchased with an AIM Mychron3 Gold installed.

It also uses the AIM ‘bike’ type sensor, and the magnet supplied by AIM mounted on a special plate. This looks like some type of chopper wheel designed for a proximity sensor – perhaps for the PI dash typically found on this type of Van Diemen.

Rear wheel speeds



Speed is measured on both sides at the rear at the inboard tripod joints.

A mounting bracket was machined from 1 ½″ x 1 ½″ x 1/8″ L-section aluminum, to allow the AIM magnetic speed sensor to be mounted. A M10 x 30 bolt is used along with a 1″ x 3/8″ spacer to mount the bracket onto a handy hole on the side of the gearbox. The hole was already present in the bodywork panel, previously used just for mounting the panel.

The slot-car traction magnets are again used to operate the speed sensor. They will most likely be able to hold themselves onto the steel gearbox output flange, but they are attached with 3M 2216 epoxy.

Suspension movement (front)

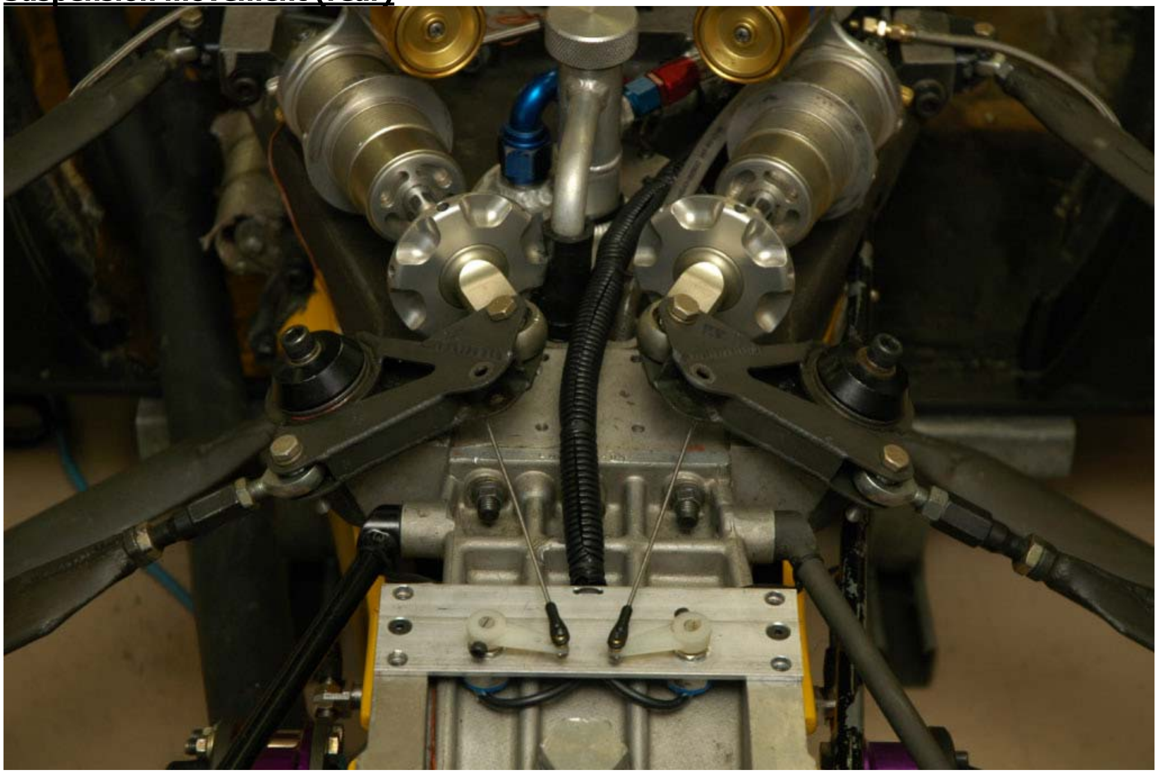
A Bourns 6639S-1-103 pot is used, mounted to a piece of 1 ½" x 1/8" L-section aluminum, glued to the frame with 3M 2216 epoxy. The mounting surface of the L-section was machined to add an 8 degree slope to nicely match the shape of the box section in the frame.

"MXL" continuous belt from McMaster-Carr is glued to the bellcrank, using contact adhesive, and a small amount of 5-minute epoxy at the ends. A loop is created with ¼" continuous belt, and a small piece of aluminum attached with safety wire and 3m 2216 epoxy. The MXL name is nothing to do with AIM – just a coincidence.

The pulley on the pot is also MXL from McMaster, and allows the range of suspension movement to drive the pot through approx 270 degrees – for great analog-to-digital sensitivity.

The continuous pot allows for rapid spring changes without the need to worry about damaging the suspension sensors.

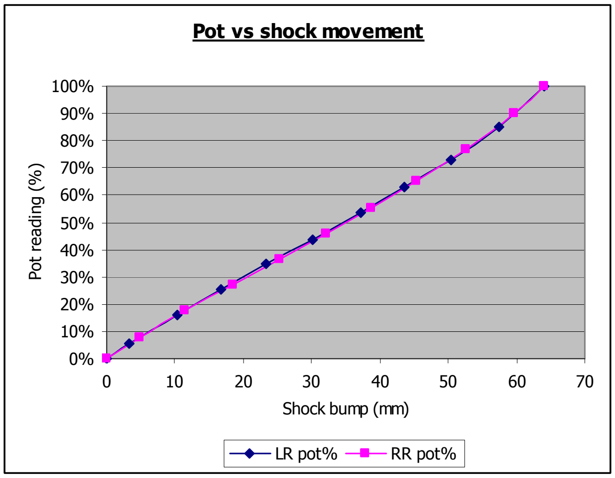
Suspension movement (rear)



The rear suspension movement sensors are once again Bourns pots (6639S-1-103). The hardware is the same as that used on the throttle – radio-control aircraft control linkages. This setup requires a bit more care than the front sensors, as it is possible to damage the linkages if the spring is removed and the wheel is allowed to drop. The linkages are mounted on the underside of the bellcrank, at a position to give a reasonable range of motion at the lever.

Rear Suspension calibration

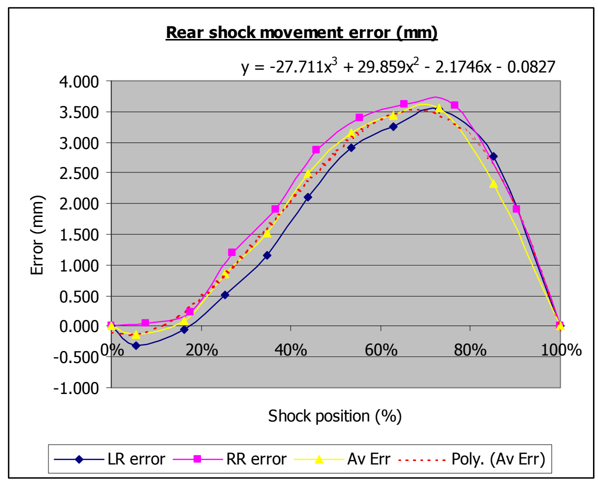
This setup presents an interesting challenge for calibration – when the suspension moves, the action of the linkages causes a rotation of the potentiometer. Full movement of the shock results in the pot moving through around 90 degrees.



As can be seen in the chart to the left, the relationship between shock movement and pot movement is fairly linear, but goes non-linear towards the end of the shock travel – due to the design of the linkage.

The pots are calibrated for shock movement of 0% at full droop, and 100% at maximum bump.

However, due to the non-linearity of the relationship between shock and pot, there must be an error in the reported readings between the 0% and 100% point.



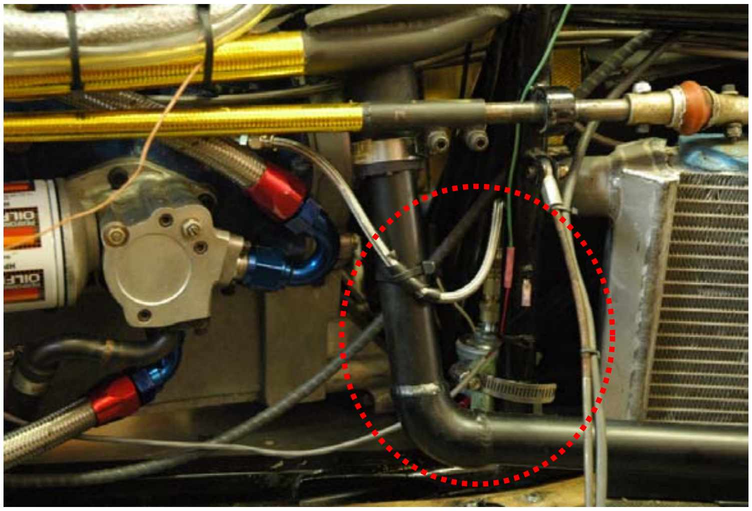
This error is shown in the second chart to the right. The maximum error is >3.5mm, but worse is that the error is not constant – which will be a problem when the shock position data is differentiated to generate shock speed traces.

Fortunately, the error is predictable and can be corrected by use of a math channel. A function of Excel is used to show the equation of a third-order polynomial curve that fits the average error (shown on the chart). This can be used to correct the output when calculating wheel/shock position from the raw percentage data provided by the sensor.

If the position of the pot levers to the suspension were changed (e.g. change of length of the linkages), this calibration would have to be repeated.

The design of the front suspension sensors results in much smaller errors across the range – less than 0.5mm. This is not a major concern, but the errors are again predictable and could be corrected using a similar technique.

Oil pressure



A VDO 0-10 bar pressure sender is used for oil pressure, mounted remotely.

AN3 braided line (with 1/8" NPT adaptors) connects the sender to the engine.

The sensor is mounted remotely due to its large size. Mounting on the side of the engine would result in destruction of the part due to the high levels of vibration. This had happened to the sensor that was on the car when it was received.

Oil Temperature

An M5 thermocouple (from AIM) was used – mounted in the left side of the oil tank. A hole was drilled and tapped into a plug used to fill in a hole in the side of the tank. The corresponding hole on the opposite side is used for the oil pump pickup line.

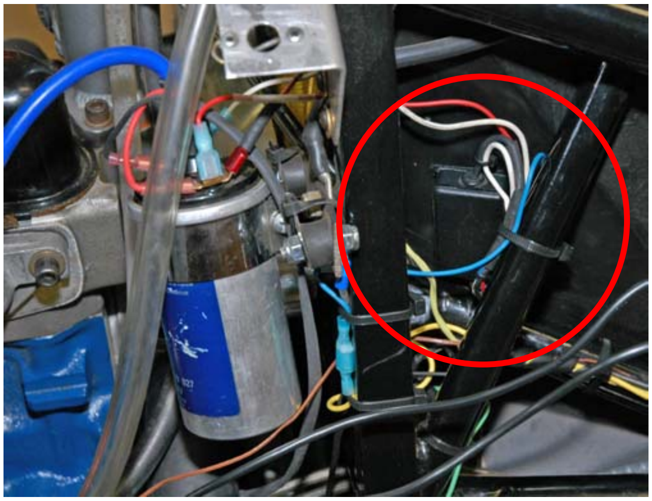
Water Temperature

The water temperature sensor is another M5 thermocouple, mounted in a pipe between the left-side radiator and the thermostat housing.

An alternative location (not used), is a 1/8" NPT tapped hole in the side of the cylinder head.

Measuring the temperature of flowing water should give a better indication of true water temperature.

RPM



The RPM signal comes from a filter box attached to the LT side of the coil. The box came with the car – and it looks fairly home-made inside. The output signal from the box is connected to the low-voltage input on the dash.

The standard scheme for detecting RPM (i.e. using the high-voltage input onto the dash) did not work successfully, so this filter box from the old setup was re-instated.

The apparently home-made box proved to be unreliable, and was replaced by an AIM 'RPM Coil/ECU adapter'.

Epoxy on Bourns pot

Each of the Bourns potentiometers used is protected with 5-minute epoxy – after the wires have been attached and the sensor tested, epoxy is used to seal the connections and provide strain relief for the cable.

The wires must be cut very short and stripped carefully to allow this to be done.

Miniature machine tool – Taig Micro Lathe II with milling attachment

The tiny benchtop lathe/milling machine used to create the various brackets and spacers required. It's small, but big enough for many urgent or would-be-nice jobs – and relatively inexpensive at $650 for the machine, motor and a variety other stuff like the milling attachment, chucks, end-stock, cutters, milling vice, cross-slide etc.