



**CAUTION: CAREFULLY READ INSTRUCTIONS BEFORE PROCEEDING. NOT LEGAL FOR USE OR SALE ON POLLUTION CONTROLLED VEHICLES.**

## OVERVIEW

The TC-1 Turbo Controller P/N 118001 is intended for professional racing applications.

- Flexible turbo control system adaptable to most turbocharged vehicle.
- Open and closed loop control modes. Includes programmable duty cycle or boost curves based on RPM, vehicle speed and or time.
- Closed loop control implements full proportional-integral-derivative (PID) control loop with access to all parameters.
- Compatible with most boost control solenoid valves.
- Built-in 4-bar MAP sensor. User selectable units (In-Hg, kPa, or psi).
- Bright transfective LCD display with backlight is readable in direct sunlight.
- Built-in data logging capability with 16 Mbit DataFLASH memory. Rates ranging from 2 samples/sec for 5 hours to 100 samples/sec for 6 minutes.
- Logs boost (MAP), RPM, vehicle speed, throttle position, solenoid duty cycle, battery volts, and two 0-5V analog inputs.
- 0-5V analog inputs are compatible with Daytona Sensors single or dual channel WEGO units for logging wide-band air/fuel ratio data.
- Programmable general purpose input/output can be used for an external scramble switch or to control a water/methanol injection system.
- USB interface to PC. Windows software for data logging and advanced setup functions.
- Heavy duty industrial grade clamping terminal blocks allow easy and reliable hookup without soldering or crimping.
- Compact size: 4-1/2"L x 3"W x 1"H.

## ADDITIONAL REQUIRED PARTS

The TC-1 comes with a USB cable and software on CDROM. Depending on your application, you may require wire, crimp terminals, and other electrical parts such as fuses, switches, and relays to complete the installation. If you are adding the TC-1 to an existing turbocharger system installation, you may already have most of these items but some rewiring may be required. The Appendix includes a list of recommended parts and suppliers.

You will require a suitable boost control solenoid valve if your vehicle does not already have one installed. You can use our P/N 118002. Unlike some competitors that use a cheap valve imported from China, we use a genuine MAC valve with Viton seals intended for automotive boost control applications.

Throttle position sensor (TPS), RPM, and vehicle speed sensor (VSS) signal connections are required to utilize all the capabilities of the TC-1. **You will require a vehicle wiring diagram to locate these signal connections.**

Figure 1 – Typical TC-1 Installation



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## WIRING OVERVIEW

10 Position Clamping Terminal Block Signals (Refer to Figure 2)		
1 (right)	+12V Continuous Battery Power	Connects to continuous battery power (always on) via a fuse
2	+12V Switched Power	Connects to ignition switch
3	RPM	Connects to RPM signal from ECM or coil. Signal level set by 3-position jumper at right (refer to page 11 for details)
4	VSS	Connects to vehicle speed sensor signal
5	TPS	Connects to throttle position sensor. Connect to +12V on pin 2 if not used.
6	VIN1	Connects to 0-5V analog signal. Used for data logging only
7	VIN2	Connects to 0-5V analog signal. Used for data logging only
8	GPIO	General purpose input/output
9	Solenoid	Connects to boost control solenoid valve
10 (left)	Ground	Connects to chassis ground

## INSTALLATION

1. Turn off the ignition switch and disconnect the battery ground cable before proceeding.
2. Select a convenient mounting location for the TC-1 unit. The unit is not waterproof and must be mounted in a dry location. The unit is not intended for underhood mounting. Optimum viewing angle is with the LCD slightly below eye level. The unit can be mounted with Velcro material. Convenient mounts, such as the cup holder mount shown in Figure 1 are available from RAM Mounting Systems ([www.ram-mount.com](http://www.ram-mount.com)).
3. Refer to Figure 2 for basic hookup. All signal and power connections can be made with 18-20 AWG wire. 16 AWG wire should be used for the ground connection.
4. Power, ground, solenoid, and manifold pressure connections are required for all applications. RPM, throttle position (TPS), and vehicle speed (VSS) connections are required to utilize the full capabilities of the TC-1. Optional connections for the general purpose input/output (GPIO), and analog inputs (VIN1 and VIN2) are shown in Figures 3 and 4.
5. **Working with the clamping terminal block.** All connections to the TC-1 terminal block must be clearly identified either by means of distinct wire colors or the use of wire labels. If you use distinct wires colors, mark up Figure 2 for future reference. Refer to the Appendix for recommended wire labels. Wire should be stripped back 3/16-1/4 inch. No bare wire should be visible outside the terminal block. Use a miniature flat screwdriver to tighten the screws. The terminal block is removable and can be pulled straight out by the wires.
6. **Manifold pressure connection.** Using a joiner fitting and appropriate rubber or silicone hose (1/8" ID recommended), connect the 3/32" ID manifold pressure hose from the TC-1 to an appropriate fitting on the intake manifold. You can also use a "T" fitting to connect to an existing hose.

Figure 2 – Basic TC-1 Hookup

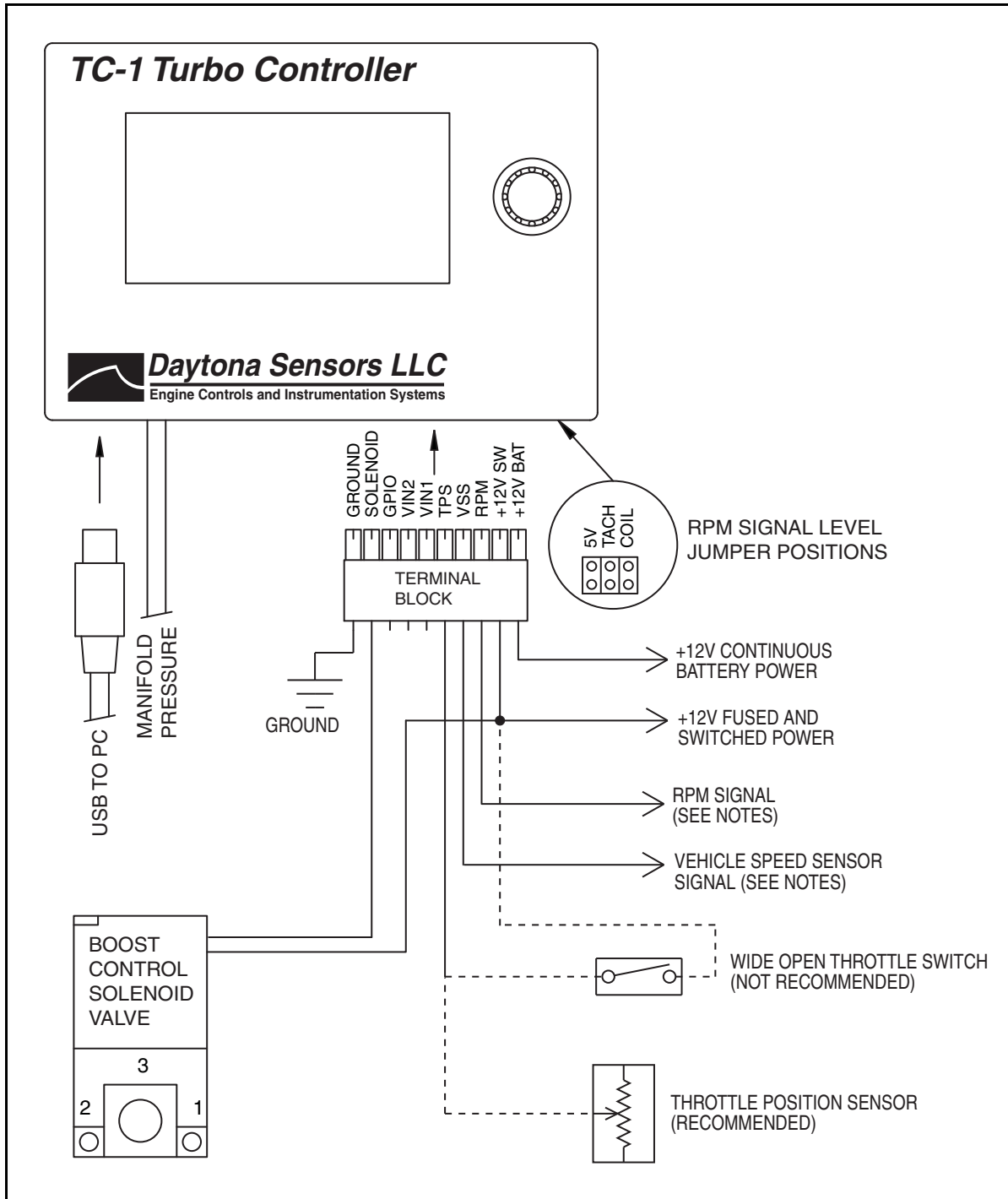
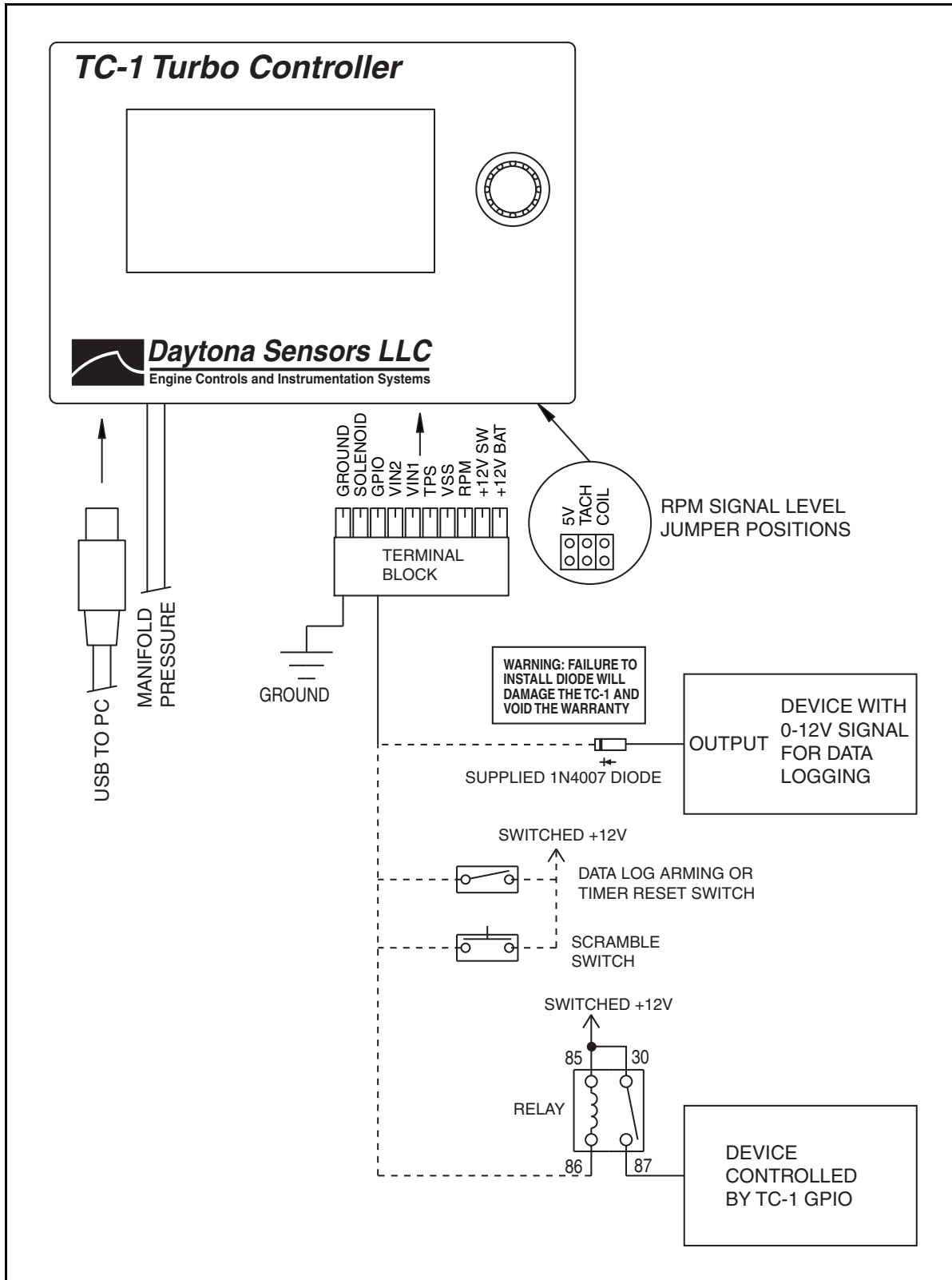


Figure 3 – TC-1 GPIO Hookup Options



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7. **Throttle position sensor (TPS) signal.** This connection is required to utilize the full capabilities of the TC-1. Most vehicles manufactured since 1981 will have a TPS with 0-5V output located on the throttle body. Refer to the vehicle wiring diagram for details. You can check the TPS signal with a DVM. Some late model vehicles with drive-by-wire electronic throttle bodies will have a dual output accelerator pedal sensor. The signal voltage on one output will rise with increasing pedal position and the other output will drop. Connect the TC-1 TPS input to the rising signal. Solder this signal connection and wrap with self vulcanizing electrical tape (refer to the Appendix). If a suitable 0-5V signal is not available, you can use a wide open throttle switch as shown in Figure 2. If the TPS input is not used, connect it to switched +12V.
  8. **RPM signal.** This connection is required to utilize the full capabilities of the TC-1. Depending on your vehicle type and engine control, there are three possible sources for the RPM signal:
    - a. **High level signal on the Coil- terminal of most inductive discharge type ignitions.** This includes most original equipment (OE) ignitions except coil-on-plug with integrated drive electronics. For distributorless systems with multiple coils or coil packs, you can use any one of the Coil- signals. Refer to the vehicle wiring diagram for details. The Coil-terminal will connect to an ignition module or engine control module (ECM). The Coil+ terminal will connect to switched +12V.
    - b. **Tach signal (preferred for best noise immunity).** The TC-1 is compatible with industry standard 12V square wave tach signals such as what would be used to drive an Autometer or similar aftermarket tach. Most aftermarket capacitive discharge (CD) ignitions including the Daytona Sensors CD-1, MSD-6 and Crane HI-6 series have a tach output that you can use.
    - c. **Low level logic signal.** This type of signal is found on late model vehicles, including many imports, that use coil-on-plug with integrated drive electronics. Refer to the vehicle wiring diagram for details. You can use the signal that goes from the ECM to any one of the coil-on-plug units.

Unless you are using the tach terminal on an aftermarket ignition or a screw terminal on a coil, you should solder the RPM signal connection and

wrap with self vulcanizing electrical tape (refer to the Appendix). During initial setup, you must configure the RPM signal level jumper on the right side of the TC-1. Refer to the Initial Setup section on page 11 for details.

9. **Vehicle speed sensor (VSS) signal.** This connection is required to utilize the full capabilities of the TC-1. Most vehicles manufactured since 1981 will have a VSS. Refer to the vehicle wiring diagram for details. Some late model vehicles with anti-skid braking (ABS) and electronic stability control (ECS) systems utilize individual wheel sensors used to calculate an average vehicle speed and in many cases this signal is available. You can also install a driveshaft sensor (contact tech support for details).
10. **Optional general purpose input/output (GPIO) signal.** Refer to Figure 3 for GPIO hookup options. If you use the GPIO as a data logging input, you should install the supplied 1N4007 diode to protect the input circuitry from any inductive voltage transients caused by solenoids (such as a line lock or trans brake) that may be part of the circuit. If you use the GPIO window switch feature to drive an external device that draws more than 1 amp current, you must use a relay as shown. Refer to the Appendix for recommended relays.
11. **Optional analog input signals.** The TC-1 will log 0-5V data on two analog inputs (VIN1 and VIN2). Uses include logging air/fuel ratio (AFR) from a wide-band sensor system such as the Daytona Sensors WEGO IIID shown in Figure 4. You can also use a single channel WEGO III connected to either analog input. All Daytona Sensors WEGO systems have the same AFR scaling and are compatible with the TC-1.

***WARNING: If GPIO1 is used as an input and some inductive device such as a solenoid is also part of the circuit, a diode is required to protect the input from transients. Failure to install the required diode will damage the TC-1 and void the warranty.***

Figure 4 – Analog Input Hookup to Daytona Sensors WEGO IIID Wide-Band System

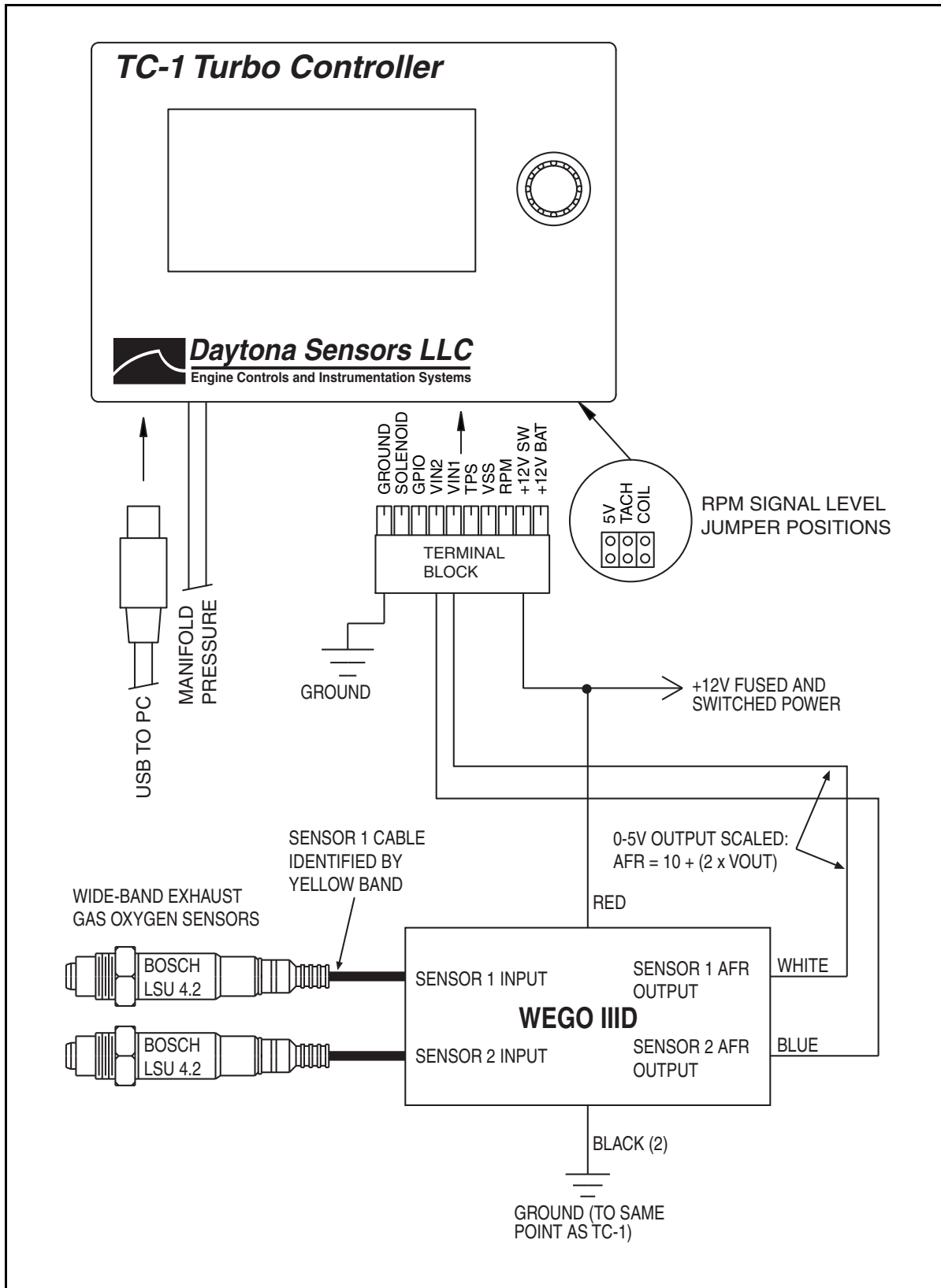


Figure 5 – Boost Control Solenoid Valve Installation for Pressure Operated Wastegates

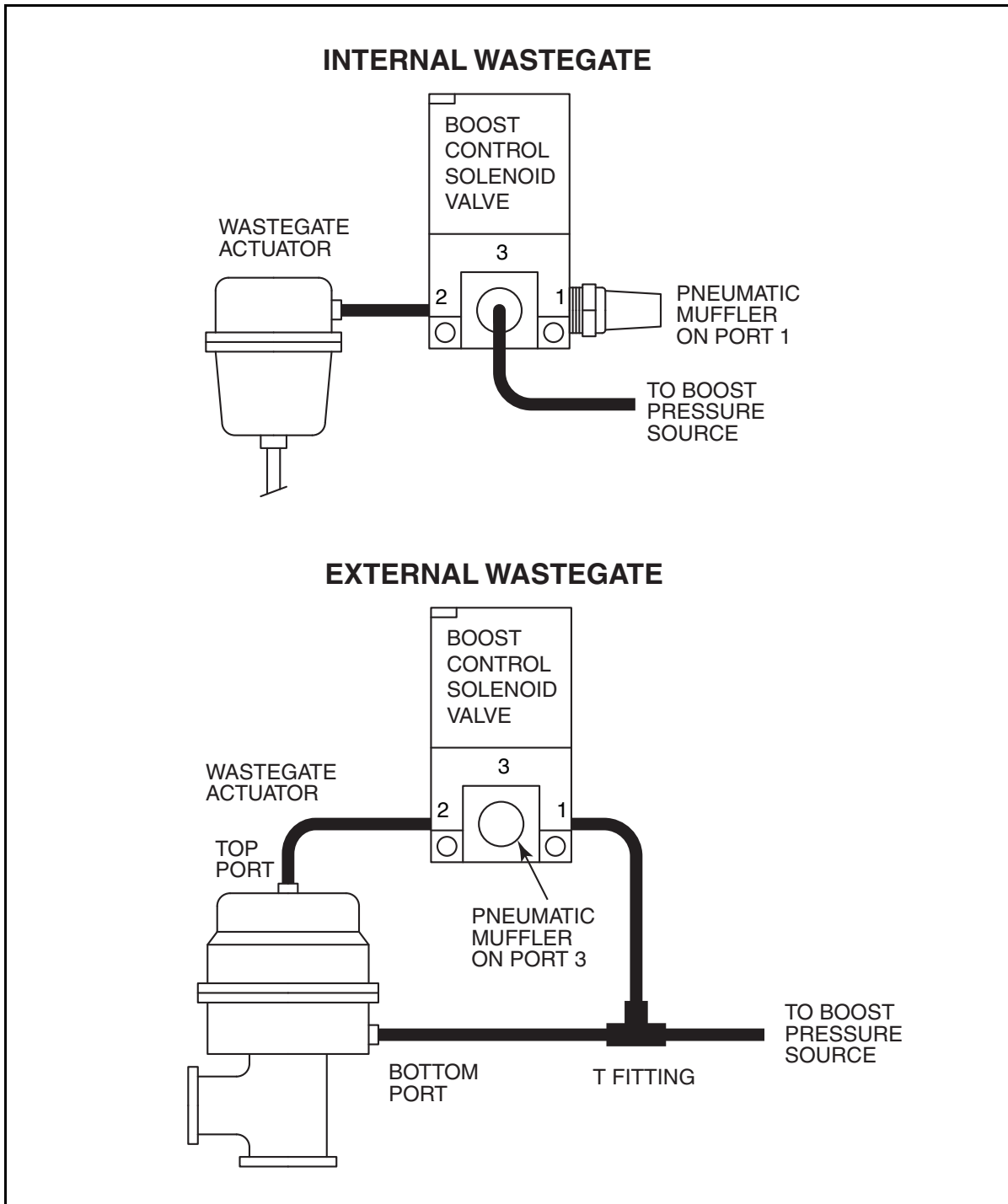
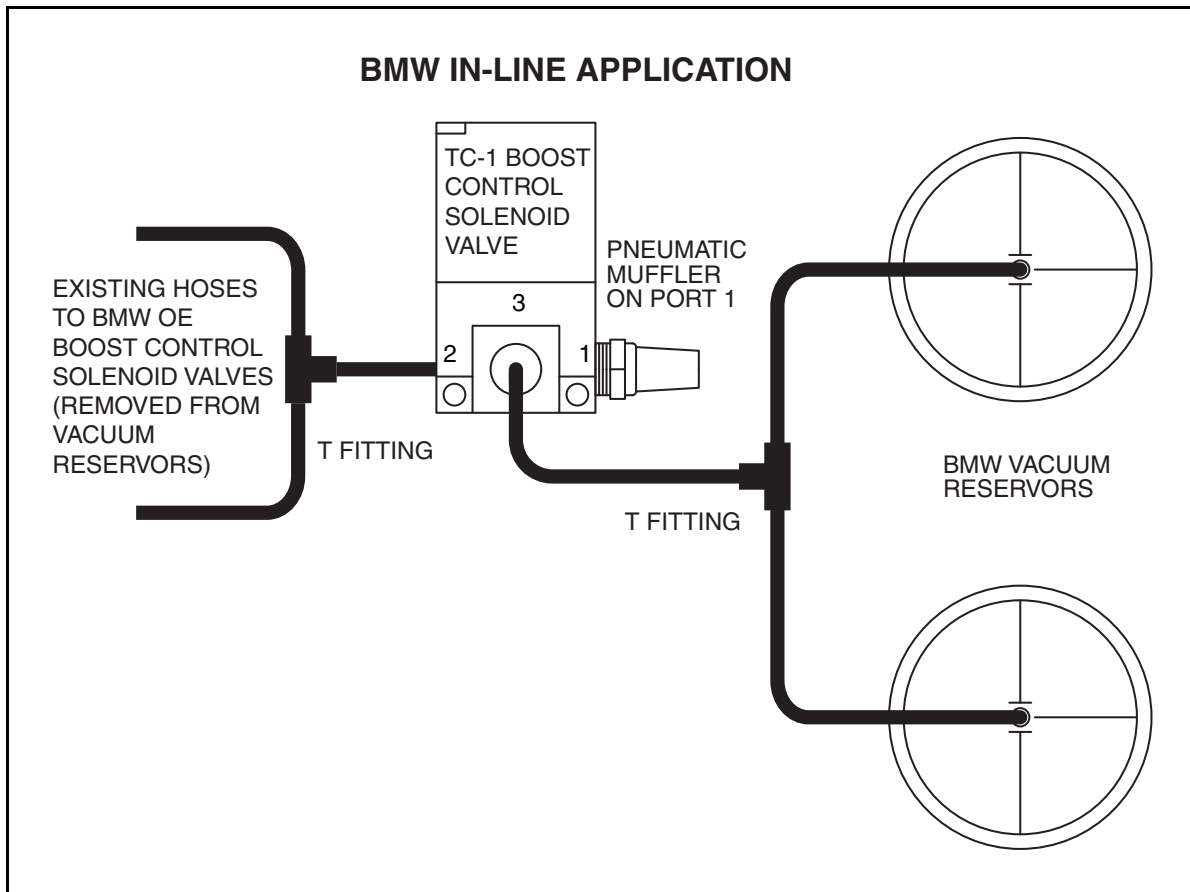


Figure 6 – Boost Control Solenoid Valve Installation for BMW Vacuum Operated Wastegates



12. **Ground connection.** Use 16 AWG wire. Keep the ground connection as short as possible. The ground connection must go to a chassis ground stud (you can usually find one under the dash or near the vehicle ECM). If you are using the analog inputs, use the same ground point for any associated devices in order to avoid signals errors due to a ground loop.
13. **Boost control solenoid valve installation.** Figure 5 shows installation for typical pressure operated wastegates found on most turbocharged applications. Figure 6 shows installation for a BMW application using vacuum operated wastegates. If you are using our P/N 1180002 valve, install the supplied pneumatic muffler as shown. The function of the muffler is to protect the valve from ingress of dirt.
14. Reconnect the battery ground cable.

### **SPARK PLUGS AND WIRES**

To avoid electrical noise that may interfere with the TC-1 or other onboard computer and radio equipment, resistor spark plugs are recommended and spiral core RFI/EMI suppression type spark plug wires are required. Do not use solid copper spark plug wires. Optimum spark plug wire resistance is 50-500 ohms per foot, such as Taylor Vertex ([www.taylorvertex.com](http://www.taylorvertex.com)) ThunderVolt 50 or 8.2mm spiral core.

## TC-1 USER INTERFACE

On initial power up, the TC-1 displays a graphics data screen shown in Figure 7 that includes the current operating mode and data. Elements include (from top to bottom):

1. Operating mode. CLS LP MODE for closed loop mode or OPN LP MODE for open loop mode. In open loop mode the boost control solenoid runs at a set duty cycle. In closed loop mode, the boost control solenoid duty cycle varies and is reduced when the boost pressure exceeds the set point.
2. Boost set point in closed loop or solenoid duty cycle in open loop. Example shows 280 kPa boost set point.
3. Scramble (momentary higher boost or duty cycle level). Rotate the encoder knob clockwise (slowly) to turn on scramble mode. The SCRAMBLE legend appears. The scramble boost set point (in closed loop) or solenoid duty cycle (in open loop) becomes active for the scramble time and the higher value is displayed while scramble is active. An external switch can also be wired up to the GPIO terminal to activate the scramble feature.
4. Graph showing current manifold pressure. The graph starts at zero kPa. The 300 legend shows the full scale kPa value. The current manifold pressure value is displayed. Note that normal sea level pressure is about 101 kPa.
5. Peak manifold pressure (example shows 202 kPa). The peak value is remembered. To clear the peak value, press the encoder knob to bring up the parameter entry screen and then press the knob again to return to the graphics data screen.

Figure 7 – TC-1 Graphics Data Screen



Pressing the encoder knob while in the normal graphics data screen brings up the parameter entry screen shown in Figure 8. Parameters required for basic installation or quick on-vehicle adjustments can

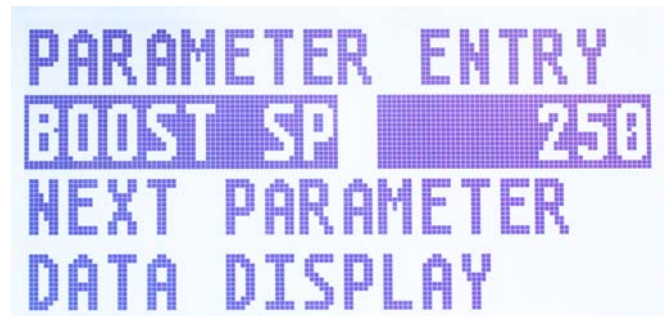
be set on this parameter entry screen. Advanced parameters, such as duty cycle or boost curves based on RPM, vehicle speed and or time and data logging setup are set via the USB interface and PC Link TC software.

Rotate the encoder knob clockwise to highlight the first parameter. Press the encoder knob to display and highlight the parameter value. Edit the parameter value by rotating the encoder knob clockwise or counterclockwise (slowly). Press the encoder knob to save the value and highlight NEXT PARAMETER. Press the encoder knob again to cause the next parameter to appear ready for editing.

Rotate the encoder knob clockwise while NEXT PARAMETER is highlighted and DATA DISPLAY is highlighted. Press the encoder knob to return to the graphics data screen. If you continue to rotate the encoder knob, the parameter will be highlighted again.

**HINT: Rotate the encoder knob slowly. The TC-1 filters out rapid movements.**

Figure 8 – TC-1 Parameter Entry Screen



Parameters include:

1. **CLS LOOP** sets closed loop mode. Values are YES or NO. Rotate encoder knob clockwise for YES or counterclockwise for NO. If NO is selected, the TC-1 will operate in open loop mode. In closed loop mode, the TC-1 will control solenoid valve duty cycle based on boost pressure. In open loop mode, the solenoid valve duty cycle will not vary with boost pressure.
2. **SCRAMBLE**. Values are YES or NO. Rotate encoder knob clockwise for YES or counterclockwise for NO. Select YES to enable scramble.
3. **BOOST SP** sets the boost set point in closed loop mode (scramble can be set higher) when no boost tables are enabled.

4. **DUTY CYC** sets the solenoid duty cycle in percent. In open loop mode, the boost control solenoid will be modulated at this duty cycle (scramble can be set higher) when no duty cycle tables are enabled. In closed loop mode, this is the initial estimate for duty cycle prior to closed loop correction based on manifold pressure. If the boost set point is exceeded, the duty cycle will be reduced to limit manifold pressure.
5. **SCRM SEC** sets the scramble timeout in seconds.
6. **SCRM BST** sets the scramble manifold pressure in closed loop mode when no boost tables are enabled.
7. **SCRM DTY** sets the scramble solenoid duty cycle in percent. In open loop mode, the boost control solenoid will be modulated at this duty cycle when no duty cycle tables are enabled. In closed loop mode, this is the initial estimate for duty cycle prior to closed loop correction based on manifold pressure. If the scramble boost is exceeded, the duty cycle will be reduced to limit manifold pressure.
8. **P GAIN** sets the closed loop proportional gain (0-100). Higher values immediately reduce the boost error but may lead to boost instability.
9. **I GAIN** sets the closed loop integral gain (0-100). A zero value is appropriate for most drag race applications with short boost durations. For road race cars, some integral gain will reduce the boost error during prolonged periods of relatively steady boost and allow a lower value of proportional gain.
10. **D GAIN** sets the closed loop derivative gain (0-100). Higher values reduce boost spikes (overshoot of boost level during throttle roll-on).
11. **DEADBAND**. The boost control solenoid will remain energized (100% duty cycle) to bleed off feedback pressure until manifold pressure exceeds this value. A low value reduces boost spikes (the wastegate starts to open earlier) and a high value reduces turbo spool up time (the wastegate stays closed longer).
12. **SOL FREQ** sets the solenoid frequency in Hz. Normal values will be around 25 Hz. Large boost control solenoids used with twin turbo systems and external wastegates may require a lower frequency.
13. **OUT MODE** sets the solenoid output mode. Values are NORMAL or INVERT. Standard turbo systems used on most vehicles with the wastegate opened by boost pressure require the default NORMAL

setting. BMW turbo systems using vacuum to close the wastegate require the INVERT setting.

14. **GRAPH MAX** sets the maximum (full scale) graph value. The range is 150-400 kPa.
15. **CONTRAST** sets the display contrast. A higher value causes the display to appear darker.
16. **DSP UNITS** sets the pressure units used for display (In-Hg, kPa, or psi). Note that all pressure data is absolute. IN, KPA, and PS are used as abbreviations for In-Hg, kPa, and psi respectively.

**HINT: To rapidly scroll through the parameters, start with NEXT PARAMETER highlighted and then repeatedly press the encoder knob.**

## TC-1 GENERAL NOTES

1. The TC-1 stores manifold pressure in kPa units. The manifold pressure sensor is a Motorola MPXH6400A. This is the most accurate sensor available with a range of 20-400 kPa.
2. While the TC-1 supports display of data in psi and in-Hg (inches of mercury) manifold pressure units, kPa (kilopascals absolute) is the preferred unit now used throughout the automotive industry. KPa units are easy to deal with, since standard sea level atmospheric pressure is about 100 kPa. Precise values of standard sea level atmospheric pressure are: 29.92 in-Hg = 14.696 psia = 101.325 kPa. 400 kPa (maximum pressure read by the TC-1) is 118 in-Hg or 58 psia.
3. The TC-1 uses absolute manifold pressure units (total vacuum would be 0 kPa). **Using absolute pressure units is standard throughout the automotive industry and is important in any system with data logging, since it allows accurate comparisons between runs under different conditions.** An engine running at 150 kPa manifold pressure puts out the same horsepower at high elevation as at sea level. Older systems used "gauge pressure." Gauge pressure is referenced to atmospheric pressure. 10 psig (psi gauge pressure) boost doesn't give the same engine performance at Pikes Peak as in Death Valley.
4. The TC-1 uses non-volatile DataFLASH memory for data logging. A continuous battery power connection is required for power down sequencing and proper storage of the last data logged by the unit. This process requires about 5 seconds. With

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the ignition key off, battery drain is only about 1 microamp. Once the power down sequence is completed, data is not lost even if the battery is disconnected.

## **TC-1 INITIAL SETUP AND OPERATION**

1. Complete the installation of the TC-1 following the steps described on pages 2-8. Skip any steps below that are not relevant to your application.
2. Turn on the ignition key and verify that the TC-1 display turns on. The unit should display atmospheric manifold pressure when the engine is not running. Turn off the ignition key. The display backlight should immediately go off and the display will blank out after about 2-3 seconds. This indicates proper power and ground connections.
3. Temporarily connect a handheld vacuum/pressure pump such as Mityvac P/N 04050 or Sears Craftsman Model 14005 to the TC-1 manifold pressure line. With the ignition key on and positive pressure applied, verify that the boost control solenoid is clicking.
4. Use of the PC Link TC and TC Log software programs is optional and not required for basic operation of the TC-1. However the TC Log software is very useful during initial setup as it is much easier and safer to download and examine data than trying to make observations while the vehicle is being operated. Use of the TC Log software is the only practical means of accurately tuning the system parameters for closed loop operation. If you plan to use the software, carefully read the material starting on page 14. Then install the USB driver and software before proceeding. If you will not be using the software, you can skip ahead to step 13.
5. Connect the USB cable, start PC Link TC software, and open the TC1\_Sample.dat setup file.
6. **RPM input setup.** Refer to page 18 for RPM Pulses/Rev setting. Enter the setting corresponding to your application and upload to the TC-1. If you are not using the RPM input, use the default value and skip to step 10.
7. Start the engine and let it run for about a minute at idle. Note the idle RPM on your tach. Start TC Log software, download data from the TC-1, and verify correct engine RPM trace on the chart (should show idle RPM value same as vehicle tachometer).
8. If the RPM trace is incorrect (too high or too low) but not zero, you will need to change the RPM Pulses/Rev setting. Turn off the ignition switch in between tests. If the RPM trace is too low, use a lower RPM Pulses/Rev setting. If the RPM trace is too high, use a higher RPM Pulses/Rev Setting. Change the setting as required in PC Link TC and upload to the TC-1.
9. If the RPM display is zero, you may need to change the RPM signal level jumper at the right corner of the TC-1. Turn off the ignition switch in between tests. The jumper has three positions labeled 5V, TACH, and COIL (refer to Figure 1). The default factory setting is in the COIL position (for a high voltage coil signal). Move the jumper to the TACH position (for a 12V tach signal) and repeat the test. If the RPM display is still zero and your engine has coil-on-plug ignition, move the jumper to the 5V position (for a logic level signal). **Do not attempt to use the 5V position for any other type of ignition system.** If the RPM display is still zero, call tech support. If required, go back to step 6 to establish the correct RPM Pulses/Rev setting.
10. **Throttle position sensor (TPS) input setup.** If you are not using the TPS input, jumper it to +12V switched power and skip ahead to step 12. Turn on the ignition key, but **do not start the engine.** Use a DVM to measure the TPS voltage by probing between the TPS and ground terminals on the TC-1. Write down the voltage levels for zero (closed) and 100% (wide open) TPS. Enter the zero and 100% TPS values in the PC Link TC software and upload to the TC-1.
11. Cycle the ignition key off/on but **do not start the engine.** Allow the TC-1 to log data for 30 seconds with the throttle closed and then again with the throttle wide open. Start TC Log software, download data from the TC-1, and verify correct TPS trace on the chart (should go from zero to 100% as the throttle is opened).
12. **Vehicle speed sensor (VSS) input setup.** Skip this step if you are not using the VSS connection. Establishing the correct VSS scale factor in PC Link TC will require some trial and error. Start with the default setting. Log speed data while operating the vehicle at a known speed. Use TC Log software and download data from the TC-1 to read the logged speed data. Use the following formula to calculate the correct scale factor:  
**New VSS Freq =  $\frac{\text{Original VSS Freq} \times \text{Speed Reading}}{\text{Actual Vehicle Speed}}$**   
For example, if the original VSS frequency parameter was 145 Hz, the speed reading is 40

MPH and the actual vehicle speed is 50 MPH, then the new VSS frequency parameter should be:

$$116 \text{ Hz} = \frac{145 \text{ Hz} \times 40 \text{ MPH}}{50 \text{ MPH}}$$

You may have repeat this process several times for maximum accuracy.

13. Test operation of the TC-1 in open loop mode. Proper operation in open loop and establishing a duty cycle value that will give the target boost value is key to operation of the unit. Start with 20% duty cycle and do a test run. Gradually increase the duty cycle in 5-10% increments until you reach the target boost pressure. Higher duty cycle values bleed off more of the wastegate pressure and result in higher boost levels. The data logging feature is very helpful during this initial setup phase as you can quickly do test runs at different duty cycles and then download and analyze the data. Examine the MAP and Valve Duty traces on the chart. Repeat the above process for scramble mode. **Note: BMW applications using vacuum operated wastegates and the invert output mode function in the opposite manner. Higher duty cycle values bleed off more of the vacuum that causes the wastegate to close and result in lower boost pressure. For BMW applications start at 80% duty cycle and gradually decrease the duty cycle.**
14. For closed loop operation, first carefully read the following section so that you understand the

influence of proportional-integral-derivative (PID) control parameters. Then follow the steps in the section of tuning PID control parameters on page 13.

## INFLUENCE OF PID CONTROL PARAMETERS

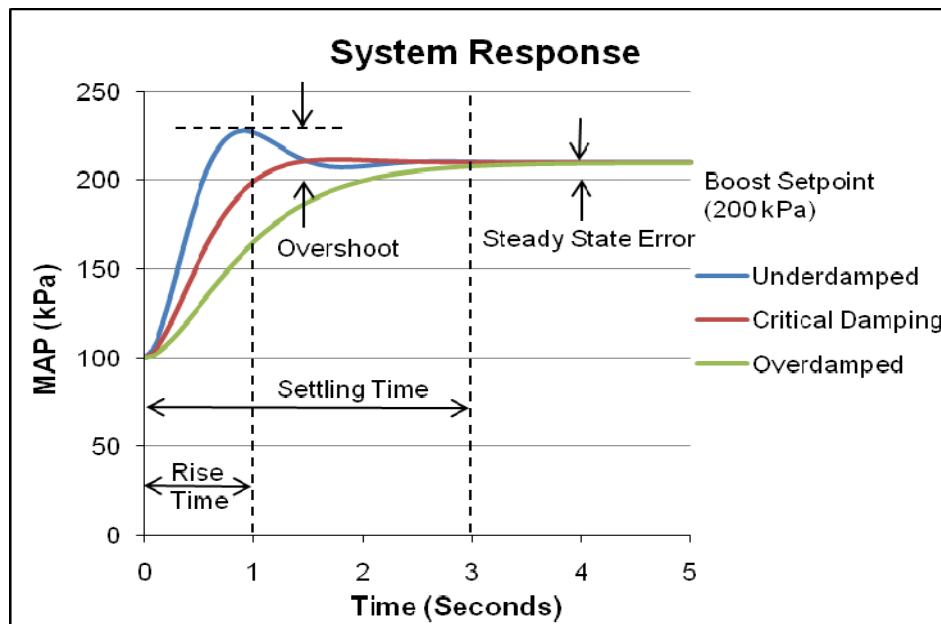
For closed loop operation, the TC-1 implements a proportional-integral-derivative (PID) control algorithm that has been optimized for turbocharger applications. PID control is widely used in industrial control applications. For more background information, we suggest that you do a Google search on the term PID control.

Figure 9 shows an idealized system response with manifold absolute pressure (MAP) rising to a setpoint of 200 kPa upon wide open throttle application.

The system is said to underdamped if a considerable MAP overshoot (spike) or oscillation occurs. The system is said to be overdamped if MAP rises very slowly. A critically damped system has a rapid rise with minimal overshoot. The ratio of derivative gain to proportional and integral gain has a significant effect on system response. Higher derivative gain increases damping and reduces overshoot.

Table 1 shows the influence of **increasing** individual PID control parameters on system response.

Figure 9 – PID System Response



**Table 1 – Influence of PID Control Parameters**

Parameter	Rise Time	Overshoot	Settling Time	Steady-state Error	Stability
<b>Proportional Gain</b>	Decrease	Increase	Minimal	Decrease	Degrade
<b>Integral Gain</b>	Decrease	Increase	Increase	Significant Decrease	Degrade
<b>Derivative Gain</b>	Minimal	Decrease	Minimal	None	Improve (for small values)
<b>Deadband</b>	Reduce	Significant Increase	Minimal	None	None

**TUNING PID CONTROL PARAMETERS**

1. Verify that the TC-1 is operating correctly in open loop and that you have established a duty cycle value that results in a boost level close to your desired setpoint.
2. Set initial PID parameters. Set the desired boost setpoint. Set the duty cycle about 5% higher (lower for BMW) than the value that gave the desired boost level in the previous open loop tests. Start with a low value of proportional gain, zero derivative gain, zero integral gain, and a deadband value of 120 kPa. Do a test run. Again, data logging will be very useful in analyzing the results and tuning the PID control parameters for optimum system response.
3. Ignore any initial boost (MAP) overshoot. Increase proportional gain until some instability (oscillation) is observed in boost and duty cycle levels. Use no more than half of the proportional gain value that resulted in small oscillations.
4. Next increase the derivative gain until boost overshoot is reduced. If overshoot is not an issue and boost seems to rise slowly, try increasing the deadband value.
5. If boost error is excessive or boost drops off, try adding some integral gain. If oscillations are observed after adding modest integral gain, try lowering the value of proportional gain.
6. Additional fine tuning using the same steps above may be required for scramble mode.

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## TC-1 SOFTWARE OVERVIEW

The Windows software suite for the TC-1 Turbo Controller consists of the PC Link TC and TC Log programs. PC Link TC allows the user to program TC-1 units for module parameters, duty cycle and boost tables, and to configure the function of the general purpose input/output (GPIO) terminal. TC Log software allows you to download data from the TC-1 unit, open and save files to disk, display data on a chart, and print chart graphics. Chart display for downloaded data allows you to monitor vehicle operation on the track.

Use of the software programs is optional and not required for basic operation of the TC-1 system. If you are not planning on using the software, you can skip the rest of the material in this instruction manual.

## PC REQUIREMENTS

The TC-1 connects to your PC by means of a USB interface. A USB cable is supplied with the unit. The PC must have a free USB port. If you have an older PC without USB capability, you cannot use the TC-1 software.

We recommend a laptop PC with Pentium processor and super VGA display (SVGA with 1024 x 768 pixel resolution) running Windows XP/Vista/7. Some netbooks have inadequate resolution to display the entire program screens and cannot be used. Data chart display is graphics intensive and a high speed Pentium processor is recommended. Processors slower than 300 MHz will exhibit sluggish program loading and response. The PC must have a CDROM drive for program loading.

PC Link TC and TC Log software include print commands to print downloaded data. The programs have been tested with Hewlett-Packard laser and inkjet printers and Epson inkjet printers. We recommend using a color inkjet printer.

## USB INSTALLATION

The USB interface for the TC-1 is based on the FTDI FT232R chip and drivers that allow the unit to emulate a standard Windows RS-232 COM port. Updated Windows drivers, installation instructions and troubleshooting tips are available on the FTDI website at [www.ftdichip.com](http://www.ftdichip.com). Additional information and troubleshooting tips can be found on the PC Link Tech FAQ on our website at [www.daytona-sensors.com](http://www.daytona-sensors.com).

A new USB driver that simplifies the installation process is available. This installs as an executable file, similar to other Windows programs. The Windows Found New Hardware Wizard will then detect the USB device when it is first connected and automatically

install the correct driver without the user having to browse out to the CDROM.

Before proceeding with installation, shutdown any other applications that may be running. For Windows Vista, you must disable the User Account Control (UAC) during installation. If you are not familiar with the UAC, please refer to the Vista UAC Tech Note on our website's PC Link Tech FAQ for details.

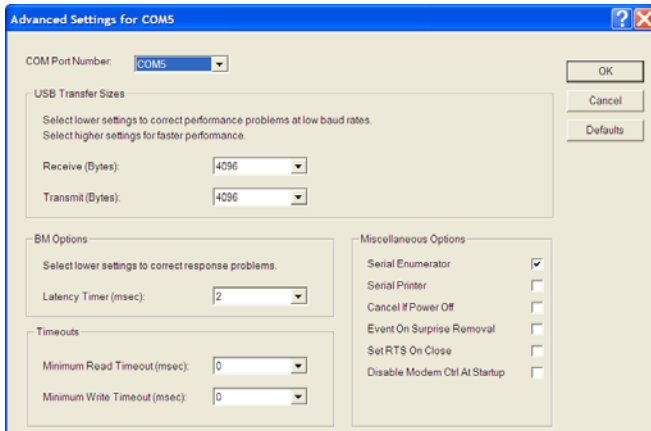
1. Make sure the unit is not connected to your PC.
2. Insert the Daytona Sensors CDROM. When the Daytona Sensors autorun menu appears, click on Software. Scroll down and click on the USB Driver link. When the File Download dialog box appears, click on "Run this program from its current location." Ignore any security warnings and click on Yes to continue.
3. After installation of the driver is complete, connect the unit to the PC with the supplied USB cable. The Windows Found New Hardware Wizard will appear and complete installation of the USB interface.

## COM Port Configuration

After completing the installation steps outlined above, you must configure the new COM port using Device Manager.

1. Click Start, Settings, Control Panel, System, Hardware, and then Device Manager. Scroll down to Ports (COM and LPT).
2. The new unit will appear as USB Serial Port. Click on this new port.
3. Click on the Port Settings tab.
4. Click on Advanced. In most cases the wizard will have installed your new unit as COM5. Note the COM port number assigned for your system. For optimum performance, you should also change the BM Options Latency Timer to 2 msec as shown in the Figure 10.
5. Once you have configured a COM port number for your new unit, make sure that you use this same COM port selection in the TC-1 software by using the Port Setup command from the Communications menu.

Figure 10 – COM Port Configuration



## SOFTWARE INSTALLATION

The software is supplied on CDROM media or in the form of a compressed file downloaded from our website. The installation process uses InstallShield. This industry standard installer is based the new Microsoft Windows Installer service that greatly reduces potential problems such as version conflicts and allows for application self-repair.

There are two programs to install: PC Link TC and TC Log. Start by installing PC Link TC. If you are downloading software from the web, only download and install one program at a time. Before proceeding with installation, shutdown any other applications that may be running. For Windows Vista, you must disable the User Account Control (UAC) during installation. If you are not familiar with the UAC, please refer to the Vista UAC Tech Note on our website's Tech FAQ for details.

Use the Windows Explorer or the Run command from the Windows Start Menu to launch setup.exe in the PC\_Link\_TC folder on the CDROM or the setup.exe file downloaded from our website. InstallShield will install the software in an appropriate folder under Program Files.

Repeat the installation process for TC Log. Use the Windows Explorer or the Run command from the Windows Start Menu to launch setup.exe in the TC\_Log folder on the CDROM or the setup.exe file downloaded from our website. InstallShield will install the software in an appropriate folder under Program Files.

Once InstallShield has completed the installation, PC Link TC and TC Log will appear on the Windows Start Menu. You can then launch them just as you would any other Windows program.

The programs require the Monospace 821 BT fixed pitch printer font in order to properly align columns when printing. The Monospace 821 BT font is

included in the distribution media and automatically copied to your Windows Fonts folder during installation. A backup copy is also placed in the program folder. If you accidentally delete this font, use the Install New Font command from the Fonts folder File menu. The filename associated with Monospace 821 BT is monos.ttf.

## PC LINK TC SOFTWARE

After PC Link TC is launched, the main screen appears blank. You have two options for obtaining setup data for editing. You can open a previously saved setup file by using the Open Table command on the File menu or you can download data from an attached TC-1 module by using the Download From EEPROM command on the Communications menu.

Note that setup files use a .dat extension. You should create a separate folder to store these files.

You can edit duty cycle or boost table data by clicking on and dragging individual points on the chart display or you can directly edit numeric data on the spreadsheet grid.

Once the appropriate parameters and table data have been entered, you can print the data using the Print Parameters and Table command on the Print Menu. You can save the edited setup file by using the Save Table command on the File menu.

You can upload the setup data to an attached TC-1 module by using the Upload to EEPROM command on the Communications menu.

A setup file (TC1\_Sample.dat) is included in the program folder.

## DOWNLOADING DATA FROM EEPROM

Turn the ignition switch on to provide power to the TC-1. Do not start the engine. **Please note that the TC-1 must be powered up during PC communications.**

When launched for the first time, the program uses COM1 as the default port. In most cases, you will have configured the USB interface to use a different COM port, such as COM5. Use the Port Setup command on the Communications menu to select the correct COM port. The program will remember the new port setup.

Download data by using the Download From EEPROM command on the Communications menu.

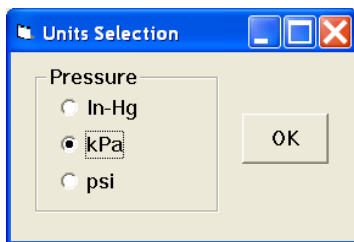
If the download process is successful, the module parameters are displayed. You can then edit setup data as explained in subsequent sections.

TC-1 units are shipped from the factory with default parameters and tables loaded into EEPROM memory. If you have never uploaded any custom setup file to EEPROM memory, these defaults are what you will see.

## UNITS SELECTION

You can use the Units Selection command from the Edit menu to select pressure units.

Figure 11 – Display Units



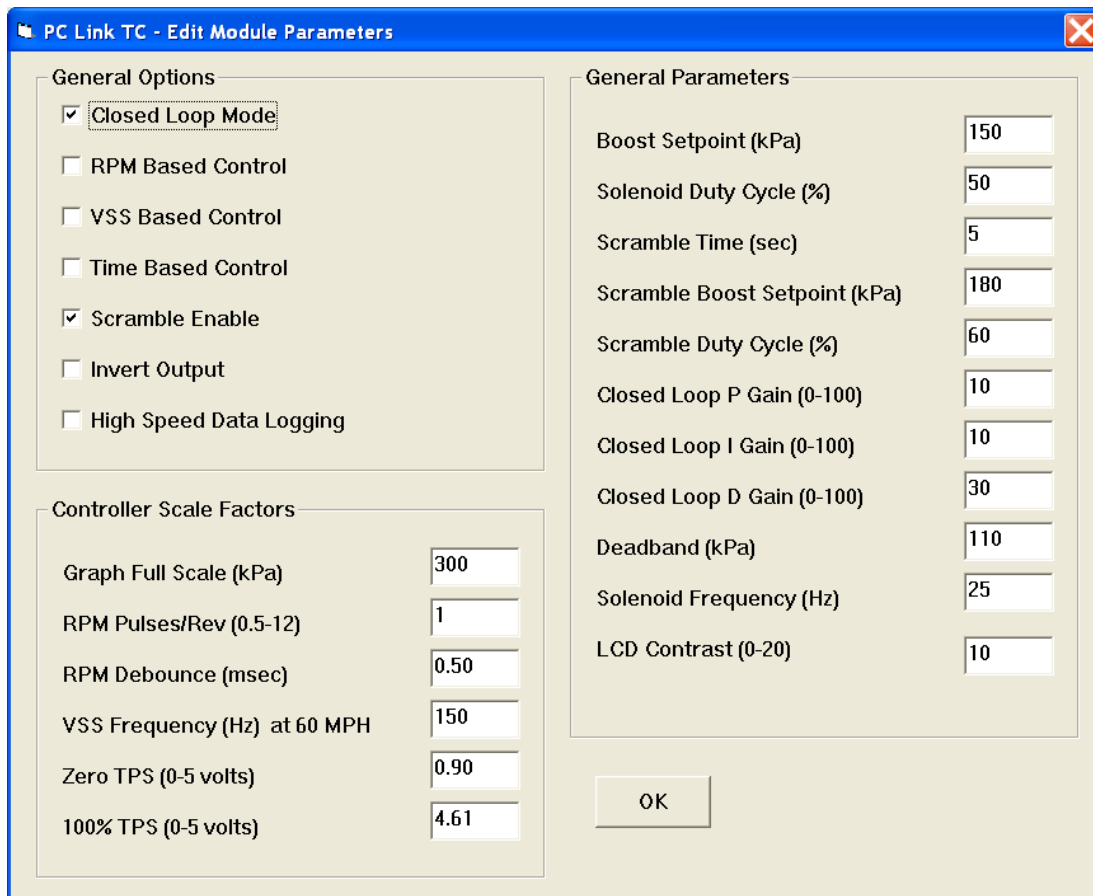
If setup data has already been downloaded from the TC-1 or an existing file is open, the Units Selection command overrides any existing value. Note that pressure data is stored internally in kPa units and converted to the selected units for display.

## MODULE PARAMETERS

Module parameters are displayed in a dialog box by using the Edit Module Parameters command on the Edit menu. Module parameters control the overall operation of the TC-1 unit. The general options and parameters are also accessible directly on the TC-1 via the user interface (LCD and encoder knob).

When PC Link TC is first started, default module parameters are loaded. Module parameters are updated whenever you download data from a TC-1 unit or open a setup file. Module parameters are saved along with the GPIO parameters and table data when you save a setup file. **Always check the module parameters before uploading data to the TC-1.**

Figure 12 – Module Parameters



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## General Options

**Closed Loop Mode** - in open loop mode the boost control solenoid runs at a set duty cycle. In closed loop mode, the boost control solenoid duty cycle varies and is reduced when the boost pressure exceeds the set point.

**RPM Based Control** - a RPM based table will be enabled. In open loop mode, the RPM based duty cycle table will be enabled. In closed loop mode, the RPM based boost table will be enabled. RPM based control can only be used if a RPM signal is connected to the TC-1.

**VSS Based Control** - a vehicle speed sensor (VSS) based table will be enabled. In open loop mode, the VSS based duty cycle table will be enabled. In closed loop mode, the VSS based boost table will be enabled. VSS based control can only be used if a VSS signal is connected to the TC-1.

**Time Based Control** - a time based table will be enabled. In open loop mode, the time based duty cycle table will be enabled. In closed loop mode, the time based boost table will be enabled. Time based control relies on an internal timer that is started based on parameters set on the GPIO and Timer Parameters dialog box described in the next topic.

**When one or more tables are enabled, the lowest duty cycle or boost value in any enabled table or value set under General Parameters is used.**

**Scramble Enable** - selecting this option enables the scramble feature.

**Invert Output** - standard turbo systems used on most vehicles with the wastegate opened by boost pressure require the default setting (Invert Output not selected). BMW turbo systems using vacuum to close the wastegate require the Invert Output selection.

## General Parameters

**Boost Setpoint** – sets the boost setpoint (kPa units) in closed loop mode (scramble can be set higher) when no boost tables are enabled.

**Solenoid Duty Cycle** - sets the solenoid duty cycle in percent. In open loop mode, the boost control solenoid will be modulated at this duty cycle (scramble can be set higher) when no duty cycle tables are enabled. In closed loop mode, this is the initial estimate for duty cycle prior to closed loop correction based on manifold pressure. If the boost set point is exceeded, the duty

cycle will be reduced to limit manifold pressure.  
**Scramble Time** - sets the scramble timeout in seconds.

**Scramble Boost Setpoint** – sets the scramble manifold pressure (kPa units) in closed loop mode when no boost tables are enabled.

**Scramble Duty Cycle** - sets the solenoid duty cycle in percent during scramble. In open loop mode, the boost control solenoid will be modulated at this duty cycle when no duty cycle tables are enabled. In closed loop mode, this is the initial estimate for duty cycle prior to closed loop correction based on manifold pressure. If the scramble boost setpoint is exceeded, the duty cycle will be reduced to limit manifold pressure

The TC-1 uses a proportional-integral-derivative (PID) control algorithm for closed loop control. Refer to page 12 for more details.

**Closed Loop P Gain** - proportional gain term. Higher values immediately reduce the boost error but may lead to boost instability.

**Closed Loop I Gain** - integral gain term. A zero value is appropriate for most drag race applications with short boost durations. For road race cars, some integral gain will reduce the boost error during prolonged periods of relatively steady boost and allow a lower value of proportional gain.

**Closed Loop D Gain** - derivative gain term. Higher values reduce boost spikes (overshoot of boost level during throttle roll-on).

**Deadband** - the boost control solenoid will remain energized (100% duty cycle) to bleed off feedback pressure until manifold pressure exceeds this value. A low value reduces boost spikes (the wastegate starts to open earlier) and a high value reduces turbo spool up time (the wastegate stays closed longer).

**Solenoid Frequency** - sets the boost control solenoid frequency in Hz. Normal values will be around 25 Hz. Large boost control solenoids used with twin turbo systems and external wastegates may require a lower frequency.

**LCD Contrast** - sets the TC-1 display contrast. A higher value causes the display to appear darker.

## Controller Scale Factors

Controller scale factors are generally established during initial setup (refer to TC-1 instructions) and will

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probably remain unchanged for a particular vehicle. Scale factors that you can set include:

**Graph Full Scale** - sets the full scale (maximum) graph value shown on the TC-1 display in kPa units. The range is 150-400 kPa.

**RPM Pulses/Rev** – RPM pulses per revolution (PPR). Some general guidelines follow, based on the type of signal connected to the RPM input:

**Tach signal.** This includes aftermarket CD type ignitions with a tach output. In most cases  $PPR = N/2$  where N is the number of cylinders. For example a 4 cylinder engine would require  $PPR=2$  and a V8 engine would require  $PPR=4$

**Distributor type ignition with connection to Coil- terminal.** Same as for a tach signal. Use  $PPR = N/2$  where N is the number of cylinders.

**Wasted spark coil pack (distributorless system) with connection to Coil- terminal.** Use  $PPR=1$ .

**Coil on plug (no wasted spark) with connection to Coil- terminal or logic level drive signal from the ECM.** Use  $PPR=0.5$

**RPM Debounce** – RPM signal filtering in milliseconds (msec). Use the default value of 0.50 msec for most applications. Ford 4.6L modular V8 engines will require a value of 3.5 msec.

**VSS Frequency** – sets the correct scaling for vehicle speed based on the signal frequency at 60 MPH. Values vary widely between different vehicle applications. Unless you have a scopemeter to

measure the actual signal frequency, some trial and error using the TC Log software to display the vehicle speed will be required to establish the correct setting. If you are not using the VSS input, you can ignore this parameter.

Start with the default VSS setting. Log speed data while operating the vehicle at a known speed. Use TC Log software and download data to read the logged speed data. Use the following formula to calculate the correct scale factor:

$$\text{New VSS Freq} = \frac{\text{Original VSS Freq} \times \text{Speed Reading}}{\text{Actual Vehicle Speed}}$$

For example, if the original VSS frequency parameter was 145 Hz, the speed reading is 40 MPH and the actual vehicle speed is 50 MPH, then the new VSS frequency parameter should be:

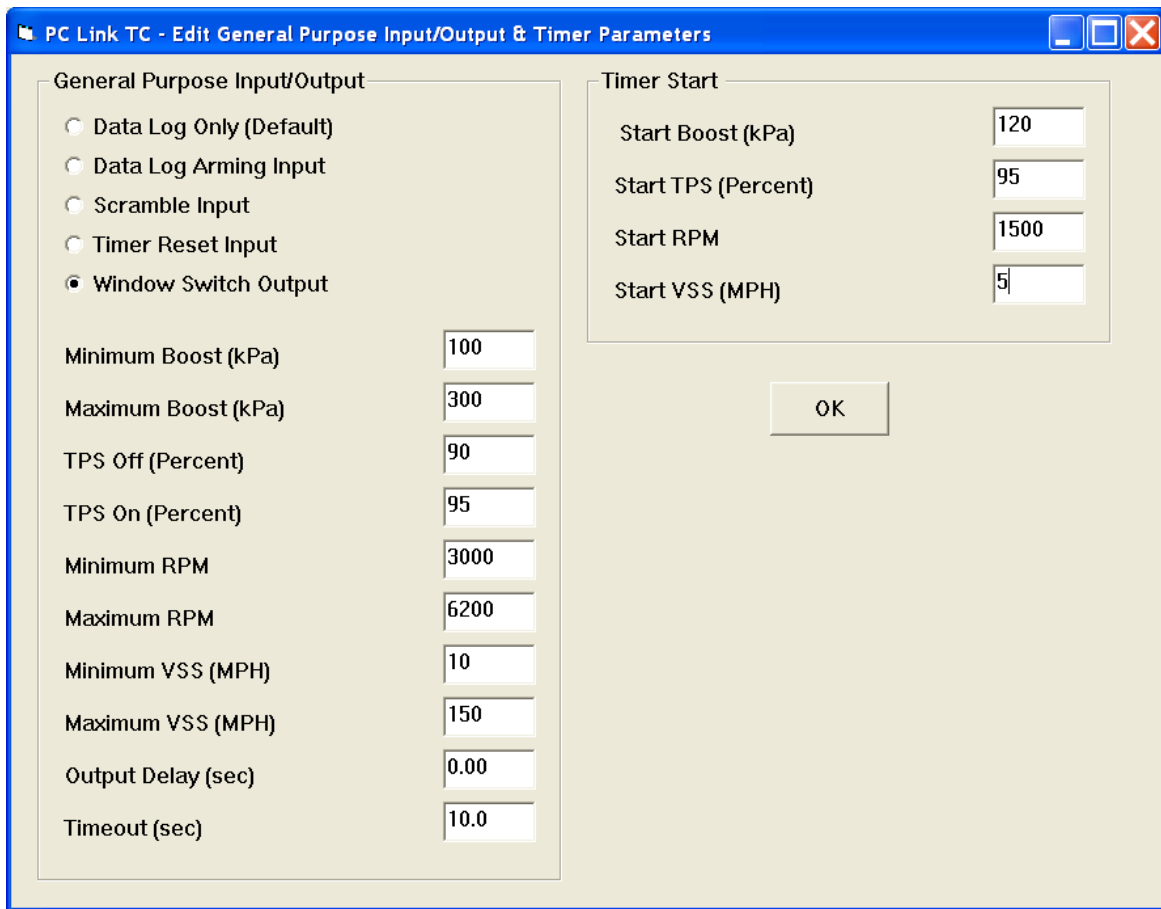
$$116 \text{ Hz} = \frac{145 \text{ Hz} \times 40 \text{ MPH}}{50 \text{ MPH}}$$

You may have repeat this process several times for maximum accuracy.

**Zero TPS** – throttle position sensor voltage corresponding to zero percent (closed) throttle. You can use a DVM to establish the correct setting.

**100% TPS** – throttle position sensor voltage corresponding to wide open throttle. You can use a DVM to establish the correct setting. The unit requires a rising throttle voltage where the 100% value is higher than the zero value.

Figure 13 – GPIO and Timer Parameters



## GENERAL PURPOSE INPUT/OUTPUT AND TIMER PARAMETERS

General purpose input/output (GPIO) and timer start parameters are displayed in a dialog box by using the Edit GPIO and Timer Parameters command on the Edit menu. GPIO parameters control the function of the GPIO terminal on the TC-1 unit. Timer start parameters control the operation of the internal timer used for time based duty cycle or boost tables.

GPIO and timer start parameters are updated whenever you download data from a TC-1 unit or open a setup file. These parameters are saved along with the module parameters and table data when you save a setup file. **Always check the parameters before uploading data to the TC-1.**

## General Purpose Input/Output (GPIO) Parameters

The GPIO has five modes:

**Data Log Only** - the system will log data on the GPIO terminal. You can log a digital signal with zero and +12V levels.

**Data Log Arming Input** - the TC-1 will start logging data when a +12V signal level is applied to the GPIO terminal. If this mode is not selected, the TC-1 will continuously log data.

**Scramble Input** - a +12V signal applied to the GPIO terminal will activate scramble mode. A momentary signal (from a pushbutton switch) will activate scramble mode for the set scramble time. A continuous signal will cause the TC-1 to remain in scramble mode regardless of the set scramble time.

**Timer Reset Input** - a +12V signal applied to the GPIO terminal will force the internal timer used for time

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based duty cycle or boost tables to remain reset. The timer will start when the signal is removed and any other programmed timer start conditions are satisfied.

**Window Switch Output**- the GPIO output will be active (switched to ground) whenever all the programmed conditions listed below are satisfied:

**Minimum Boost** - minimum boost level for window switch output active. A value for this parameter is always required for the window switch output function.

**Maximum Boost** - maximum boost level for window switch output active. A value for this parameter is always required for the window switch output function.

**TPS Off** - throttle position below which window switch output is deactivated. This value should always be 5-10% less than TPS On in order to provide some hysteresis for noise immunity. If TPS based window switch activation is not desired, tie the TPS terminal to +12V and use 50% for this parameter.

**TPS On** - throttle position above which window switch output is active. This value should always be 5-10% higher than TPS Off in order to provide some hysteresis for noise immunity. If TPS based window switch activation is not desired, tie the TPS terminal to +12V and use 90% for this parameter.

**Minimum RPM** - minimum RPM level for window switch output active. If RPM based window switch activation is not desired, enter zero.

**Maximum RPM** - maximum boost level for window switch output active. If RPM based window switch activation is not desired, enter 10,000 RPM.

**Minimum VSS** - minimum vehicle speed level for window switch output active. If VSS based window switch activation is not desired, enter zero.

**Maximum VSS** - maximum vehicle speed level for window switch output active. If VSS based window switch activation is not desired, enter 250 MPH.

**Output Delay** - delay time that window switch output is active once all other programmed conditions have been satisfied.

**Timeout** - maximum time window switch output is active once all programmed conditions have been satisfied.

## Timer Start Parameters

The internal timer used for time based duty cycle or boost tables will remain reset until all the programmed timer start conditions listed below are satisfied:

**Start Boost** - boost level for timer start. A value for this parameter is always required.

**Start TPS** - throttle position for timer start. If TPS based timer start is not desired, tie the TPS terminal to +12V and use 90% for this parameter.

**Start RPM** - RPM level for timer start. If RPM based timer start is not desired, enter zero.

**Start VSS** - vehicle speed level for timer start. If VSS based timer start is not desired, enter zero.

## EDITING DUTY CYCLE AND BOOST TABLE DATA

Six duty cycle and boost tables are accessible via individual commands on the Edit menu. The duty cycle tables are applicable only during open loop operation and the boost tables are applicable only during closed loop operation. RPM, vehicle speed (VSS), and time based tables are available. Each table includes nominal (normal operation) and scramble values. Once you have selected a table, you can edit the data by clicking on and dragging individual points on the chart display or you can directly edit numeric data on the spreadsheet grid.

RPM and VSS based tables consist of 21 columns corresponding to 500 RPM increments from zero to 10,000 RPM or 10 MPH increments from zero to 200 MPH. The 10,000 RPM or 200 MPH values are used at all higher levels. Time base tables consist of 33 columns corresponding to 0.25 second increments from zero to 8.0 seconds on the internal timer. When the timer is reset, the zero values are used. The 8.0 second values continue to be used after 8.0 seconds have elapsed. A typical table is shown on the next page.

Figure 14 – RPM Based Duty Cycle Table



PC Link TC is intended to be an open system and uses the Component One Chart 7.0 2D charting control. The adventurous user can experiment with the chart property pages by right clicking on the chart. Almost any chart property can be changed. Click on the Help button for more information. If you corrupt the chart, exit and restart PC Link TC.

**Notes on Using Table Based Control Strategies**

1. RPM and VSS based tables can only be used if RPM and VSS signals are available and properly scaled (refer to Module Parameters section on page 16 for details). Time based tables require setup of the timer start parameters (refer to the GPIO and Timer Parameters section on page 19 for details).

2. As explained previously, duty cycle tables are applicable only during open loop operation and the boost tables are only applicable during closed loop operation.
3. RPM, VSS, or time based tables can be individually enabled under General Options (refer to Module Parameters section for details).
4. When one or more tables are enabled, the lowest duty cycle or boost value in any enabled table or value set under General Parameters is used.

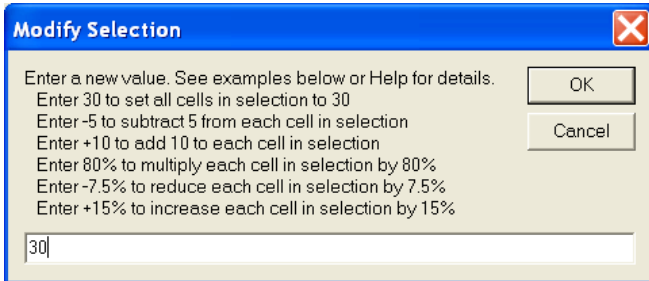
**Editing Spreadsheet Table Data**

You can edit table data using standard Windows copy and paste operations by selecting cells and then clicking the right mouse button to pop-up the edit menu. You can select cells by dragging the mouse with

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the left button down. You can also use the Modify command on the pop-up menu. When you enter a value, the presence of optional sign (+ or -) or percent (%) characters affects the outcome of the Modify command.

Figure 15 – Modify Command



## Data Export and Import by Means of Copy and Paste

You might want to export or import table data to or from another application such as Microsoft Excel and other programs with tables that support copy and paste operations. You can directly copy and paste data to and from the PC Link TC program. In the PC Link TC program, you can select a range of cells with the mouse and right click to bring up a copy and paste menu. When you paste data into the PC Link TC program, the data is automatically checked and any out-of-range data corrected.

## UPLOADING DATA TO EEPROM

Refer to the Downloading Data from EEPROM section on page 15 for details about USB interface and COM port setup. Before uploading, make sure the parameters and tables are correct.

Upload data by using the Upload To EEPROM command on the Communications menu. A status message is displayed when the upload process has been successfully completed.

## TC LOG SOFTWARE

When launched for the first time, the program uses COM1 as the default port. In most cases, you will have configured the unit's USB interface to use a different COM port, such as COM5. Use the Port Setup command on the Communications menu to select the correct COM port. The program will remember the new port setup.

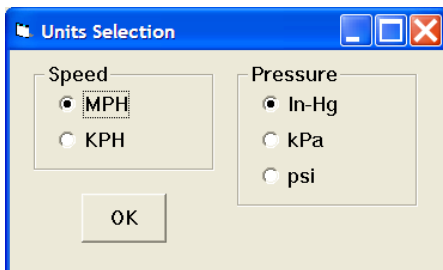
After TC Log is launched, the screen initially appears blank. You can use the Units Selection command from the Edit menu to select speed and pressure units if your TC-1 is configured to log this data, i.e. a vehicle speed sensor is connected. The program will remember your selections. You can display data logged by the unit on a chart recorder type screen. Data logged by the unit must be downloaded before it can be displayed, by using the Download Data command on the Communications menu. Once data has been downloaded, it is automatically displayed on a chart recorder type screen. You can save downloaded data by closing the chart display and then using the Save File command from the File menu. You can display a previously saved data file by first using the Open File command on the File menu and then using the View Chart command on the View menu.

A sample data file (TC1\_Sample.log) is included in the program folder. The sample file has data from a BMW 135i using the TC-1 to reduce excessive boost.

## UNITS SELECTION

You can use the Units Selection command from the Edit menu to select speed and pressure units. Note that speed data is only available if a vehicle speed sensor is connected to the TC-1. The program will remember your selections. When you save downloaded data to a file, the units settings are saved along with the data. If you later open the file, the same units settings will remain in effect.

Figure 16 – Units Selection Dialog Box



## DATA LOGGING CHART DISPLAY

You can display data logged by the unit on a chart recorder type screen. Turn the ignition switch on to provide power to the TC-1. Do not start the engine. Please note that the TC-1 must be powered up during PC communications. Data logged by the unit must be downloaded before it can be displayed, by using the Download Data command on the Communications menu. Once data has been downloaded, it is automatically displayed. **The last data logged will appear at the right end of the chart.** You can save the data by closing the chart display and then using the Save File command from the File menu. You can display a previously saved data file by first using the Open File command on the File menu and then using the View Chart command on the View menu.

The data logging memory within the TC-1 stores the last 180,000 data points at 10 samples/second (default sample rate) or 100 samples/second (if the high speed data logging mode is selected by means of the PC Link TC software). This corresponds to 5 hours of data at 10 samples/second or 30 minutes of data at 100 samples/sec. When you use the Download Data command on the Communications menu, one of the pop up menus shown below will appear based on the sampling rate you have configured. You can select the length of the data set that will be downloaded.

Figure 17 – Download Options Dialog Box (TC-1 Configured for 10 Samples/Second)

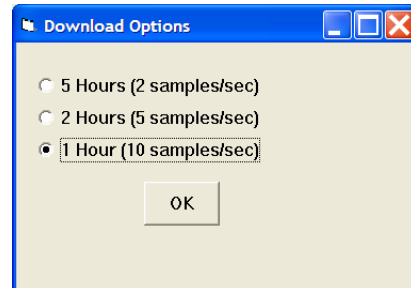
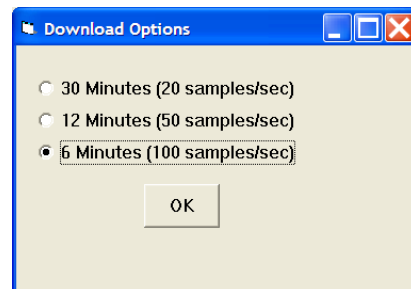


Figure 18 – Download Options Dialog Box (TC-1 Configured for 100 Samples/Second)



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Note that TC-1 data files use a .log extension. You should create a separate folder to store these files. A sample data file (TC1\_Sample.log) is included in the program folder.

You have a range of capabilities for analyzing downloaded data displayed in the chart recorder format.

You can select two parameters for display. Trace 1 is displayed in red with its Y axis legends on the left side of the chart. Trace 2 is displayed in green with its Y axis legends on the right side of the chart. The X axis is always elapsed time. You can zoom in, zoom out, or zoom all (displays entire data file). At the maximum zoom in level, approximately 100 data samples will be displayed on the chart. You can use the scroll bar to move the chart display window in terms of elapsed time. If you hold the left mouse button down within the chart area, a cursor line appears. The exact values of the parameters displayed on trace 1 and trace 2 and the elapsed time appear in windows above the chart. When you zoom in or zoom out, the displayed data will always be centered about the cursor line. This allows you to quickly select and closely examine an area of interest. If you want to analyze the elapsed time between two events (for example the time required to accelerate from 0 to 60 MPH), you can move the cursor to the first event and then click on the Reset Time Display button. You can print the displayed chart to any Windows printer by clicking on the Print button (a color inkjet printer is recommended for best results). Data parameters include:

**RPM** – engine crankshaft RPM. If the RPM input is not connected, a zero value will be displayed.

**MAP** – manifold pressure in In-Hg, kilopascals (kPa), or psi (29.92 In-Hg, 101.3 kPa, or 14.696 psi corresponds to sea level atmospheric pressure).

**VSS** – vehicle speed in MPH or KPH. If a vehicle speed sensor is not connected, a zero value will be displayed.

**TPS** – throttle position (0 to 100%). If the TPS input is not connected, a zero value will be displayed.

**BAT** – battery voltage

**GPIO** – this terminal can be configured as an input or output for various functions with the PC Link TC software. When configured as an input, the level is displayed as a digital (on/off) signal. On means that the GPIO terminal is at +12V. When configured as output, the status is also displayed as a digital (on/off) signal. On means that the GPIO terminal is switched to ground. This is referred to as an active low output

**VALVE DUTY** – boost control solenoid valve duty cycle (0-100%). Zero duty cycle means the valve is not energized. 100% duty cycle means the valve is constantly energized.

**INPUT 1 VOLTS, INPUT 2 VOLTS** – analog input voltage

**INPUT 1 AFR, INPUT 2 AFR** – air/fuel ratio based on the exhaust gas oxygen sensor reading (10:1 to 20:1). Only applicable if a Daytona Sensors WEGO wide-band system has been connected to the analog inputs

**TABLE TIMER** – status of the internal timer used for time based duty cycle or boost control. Displayed as a digital (on/off) signal. Off means the timer is reset. On means the timer is running.

The maximum MAP, RPM and VSS values displayed on the chart can be set by means of commands on the Chart Display Edit Menu. Caution: If these maximum values are set lower than the actual logged data, the chart cursor function will not update the display correctly.

Additional data is displayed at the lower right side of the screen. This data includes:

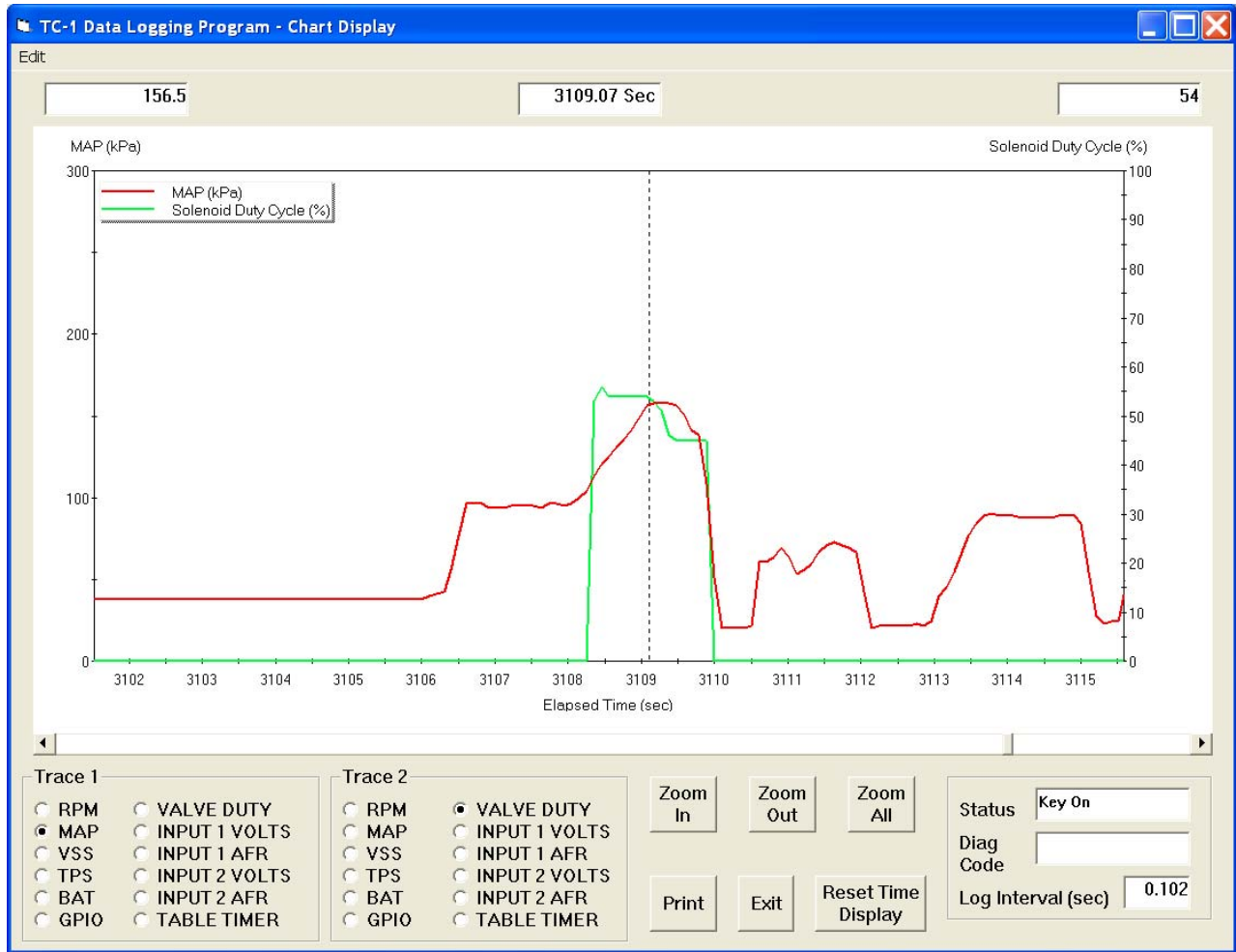
**Status** - displays TC-1 status

**Diagnostic Code** – normally blank unless a diagnostic code is set.

**Log Interval** – the actual data logging interval in seconds

You can clear the data within the unit by using the Clear TC-1 Data Buffer command from the Communications menu. If you change the data logging mode with the PC Link TC software, you should also clear the data buffer within the unit.

Figure 19 – Data Logging Chart Display



## IMPORTING DATA INTO EXCEL

Data files saved from TC Log are in comma delimited ASCII format. Note that VSS data is scaled in MPH units and MAP data is scaled in kPa units. You can easily import a data file into other programs such as Microsoft Excel for further analysis. You can also view data files with a text editor such as Windows WordPad. To import a data file into Excel:

1. Start Excel. In the File Open dialog box, select Files of type: All Files (\*.\*). Then browse for the data file.
2. The Text Import Wizard appears. For step 1, select delimited file type. For step 2, select comma delimiter. For step 3, select general column data format. Then click on Finish.
3. You can then format the data and save the spreadsheet as an Excel file.

## APPENDIX – RECOMMENDED PARTS AND SUPPLIERS

### WIRE

Wire supplied with most automotive accessories is usually un-tinned copper with a low number of strands. The unprotected copper in this inexpensive wire quickly oxidizes, especially when in contact with dissimilar metals on terminals. The low number of strands limits life in applications where flexing occurs. We recommend the use of high quality industrial grade wire with tinned copper strands and a high strand count.

18-20 AWG sizes can be used for all signal and low current applications. 16 AWG is adequate for ground. Carol UL grade 1007/1015 wire is available from Digi-Key.

P/N	Description
C2040X-100	20 AWG wire (100 foot spool)
C2064X-100	18 AWG wire (100 foot spool)
C2104X-100	16 AWG wire (100 foot spool)
C2105X-100	14 AWG wire (100 foot spool)

Note: replace X with color code B=Black, W=White, R=Red, G=Green, A=Orange, Y=Yellow, L=Blue, N=Brown, S=Gray, V=Violet

### CRIMP TERMINALS

High quality crimp terminals and a proper crimping tool are required to make reliable electrical connections. Crimp terminals commonly sold in automotive and hardware stores have brittle vinyl insulation that easily cracks. We recommend the use of high quality industrial grade nylon insulated crimp terminals. The following parts are available from Digi-Key.

P/N	Description
A27241	16-20 AWG #10 ring tongue terminal
A27246	16-20 AWG 1/4" ring tongue terminal
A27248	16-20 AWG 3/8" ring tongue terminal
A27262	14-16 AWG 1/4" ring tongue terminal
A27264	14-16 AWG 3/8" ring tongue terminal
A27288	10-12 AWG 1/4" ring tongue terminal
A27291	10-12 AWG 3/8" ring tongue terminal
A0911	18-22 AWG .110" female quick disconnect terminal
MNU18-187DFIK	18-22 AWG .187" female quick disconnect terminal

MNU18-250DFIK	18-22 AWG 1/4" female quick disconnect terminal
MNU14-250DFIK	14-16 AWG 1/4" female quick disconnect terminal
A1069	16-22 AWG butt splice
A1080	14-16 AWG butt splice
A1086	10-12 AWG butt splice

### RELAYS

The typical import brand 30-40 amp relays leave little safety margin. When used to switch heavy inductive solenoid loads, arcing can result in the contacts welding together – a potentially catastrophic failure mode. We recommend using Tyco/P&B automotive OE grade relays available from Newark Electronics and Digi-Key. Use the 40 amp version for most applications and the 70 amp version for heavy duty applications such as fuel/nitrous solenoid activation. We recommend that you use the relay sockets and crimp terminals listed along with the relays.

P/N	Description
1432791-1	40 amp VF4 series relay
VCF4-1001	Socket for VF4 series relay
60249-1	12-16 AWG terminal for VF4
VF7-41F11	70 amp VF7 series relay
VCF7-1000	Socket for VF7 series relay
42281-1	14-18 AWG terminal for VF4 coil connections (2 required)
280756-4	10-14 AWG terminal for VF7 contact connections (2 required)

### FUSES AND FUSE TAPS

ATC series fuses and fuse holders commonly used for automotive applications are only available in 40 amp and lower ratings. For high current applications, we recommend the heavy duty 50 amp Littlefuse Maxi Fuse series available from Digi-Key.

P/N	Description
F1085	Maxi fuse block
F1038	50 amp Maxi fuse

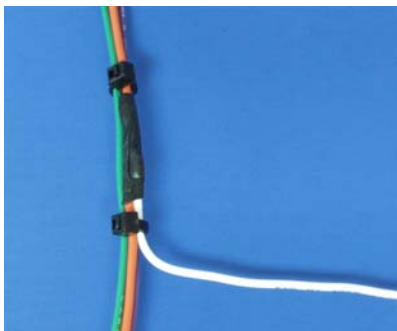
### SWITCHES

All switches used in performance applications should be sealed. Representative sealed toggle and rocker style switches available from Digi-Key are listed below.

P/N	Description
480-2191	Honeywell SPDT toggle switch
360-2278	NKK SPDT rocker switch

### **RELIABLE CONNECTIONS TO EXISTING SIGNALS**

For some applications, you may have to tap into existing signal wires on the vehicle. We caution against using any of the so called “vampire clips” that make an insulation displacement connection. These have proven very unreliable in racing applications. They may even cause the original wire to fray and break. We suggest soldering any connections to existing signals. Use a stripping tool to cut through and push back about 1/4” of insulation at the spot on the original wire where you plan to make the connection. Wrap several turns of the new wire around, solder, insulate with self vulcanizing electrical tape, and use two cable ties to secure the splice as shown. Regular electrical tape will tend to unravel. Self vulcanizing electrical tape is available from Digi-Key as their P/N W213.



### **SUPPLIERS**

Suppliers referenced in the Appendix are listed in the table below. Additional suppliers for connectors, electronic tools, mechanical hardware, and test equipment are listed on our website at [www.daytona-sensors.com/tech\\_tools.htm](http://www.daytona-sensors.com/tech_tools.htm).

Supplier	Phone	Website
Digi-Key	1-800-344-4539	<a href="http://www.digi-key.com">www.digi-key.com</a>
Mouser	1-800-346-6873	<a href="http://www.mouser.com">www.mouser.com</a>
Newark	1-800-463-9275	<a href="http://www.newarkinone.com">www.newarkinone.com</a>
State Wire & Terminal	1-800-922-6527	<a href="http://www.statewire.com">www.statewire.com</a>