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ELECTRIC GOVERNOR INSTALLATION MANUAL

Precision Governors E-611 Multipurpose Controller.

E-611A with Terminal Strip P/N 9078
E-611B with 8 pin Plug P/N 9077

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INTRODUCTION:

The E-611 controller is a general-purpose controller intended to control engine speed for spark ignited or diesel engines. It is intended to feature more robust speed regulation over the E-301 and E-361 products when retrofitted to system using other brands of controllers and low resistance low current actuators.

For spark-ignited engines it may be configured to sense engine speed via ignition system frequency. For both spark ignited and diesel engines, it may be configured to sense engine speed via magnetic pickup sensing flywheel teeth.

The E-611 controller may be configured to govern speed in either discrete mode where the application can select 1 of 4 speeds or it can be configured to operate in “ramp mode” where the controller has a “increase speed” and a “decrease speed” input. This is similar to cruise control.

The E-611 controller requires no computer adjustments by the user. It features speed and gain adjustments via potentiometer and governing style and speed signal frequency range determined by setting of an 8 position DIP switch.

Discrete governing features 4 independent speed settings from 1000 to 3400 RPM.
Ramp governing features independent minimum, maximum, and initial (engine off) speed settings and a set speed ramp rate.

All governing modes feature gain, integral, and derivative adjustments.
The E-611 controller is 12 and 24 volt compatible. It is reverse polarity protected.

GENERAL

The following information is intended as an aid to properly installing a Precision Governors Model E-611. Since these governors are used on a wide range of engines in many different applications, much of the information is somewhat general in nature. If you need assistance concerning a specific detail on your application, please consult Precision Governors Application Engineering at 815/229-5300.

These instructions presume no electrical test equipment other than a Multimeter for making the electrical measurements called for on the following pages. If no meter is available, inexpensive but adequate meters, are available from many consumer electronics stores such as Radio Shack.

Many "governor problems" turn out to be installation problems, particularly in first-time applications. Careful attention to the directions provided will go far toward a successful installation made in the least amount of time.

The E-611 is available with a 8 pin terminal strip (E-611A) or with a 8 pin Packard Disconnect (E-611B.

QUICK-START INSTRUCTIONS

If you are experienced in installing and adjusting Electric Governors, follow these steps. Otherwise, refer to the more detailed instructions, which begin on Page 8, starting with "Governor Assembly.”

1) Mount Controller in a dry, fairly cool location. Accessibility for adjusting is required.

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2) Wire per the appropriate system schematic. BE SURE TO OBSERVE CORRECT POLARITY. Note some wire locations are different than the original controller.
3) Set the machine to command the various speeds and adjust. Turn CW to increase speed, CCW to decrease speed.
4) Set Gain as required, using **Gain** pot. CW increases sensitivity. Load and unload the engine to check for proper gain.

CARBURETOR IDLE ADJUSTMENT

Engines with Integrated actuator / carburetor:
For carburetors with no idle adjustment stop screw, the mechanical idle is adjusted by disconnecting the actuator wires then loosening the 3 actuator mounting screws and turning the actuator to obtain the desired idle speed. This should be set with a fully warmed up engine and hydraulic system. This setting must be at least 100 RPM below the lowest governed speed. Setting this too low may cause the engine to stall during operation while setting this too high may create delays in engine governing or cause the engine to continue running after power has been removed. Tighten the screws. After turning off the engine, reconnect the actuator. Failure to turn off the engine may result in the engine over-speeding.

Engines with separate actuator / carburetor:
Engines with separate actuator / carburetor should have the mechanical idle set by disconnecting the actuator wires and adjusting engine speed with the carburetor stop screw. This should be set with a fully warmed up engine and hydraulic system. This setting must be at least 100 RPM below the lowest governed speed. Setting this too low may cause the engine to stall during operation while setting this too high may create delays in engine governing or cause the engine to continue running after power has been removed. Tighten the screws. After turning off the engine, reconnect the actuator. Failure to turn off the engine may result in the engine over-speeding.

Diesel Engines:

Diesel engines typically have speed regulated electronically via an actuator controlling the fuel shutoff lever or rack. On these engines, the mechanical governor should be set ABOVE the maximum desired governed engine speed by 10% or more as speed can only be reduced by the electronic governor.

MOUNTING--CONTROLLER

The replacement controller will require new mounting holes to be drilled.

The controller is water and weather resistant when the cover plate is filleted with RTV by the user. However, attention to the following points will enhance its performance and reliability:

Select a reasonably **cool, dry,** and **vibration free** location.

The rear cover will probably need to be removed during set-up in order to make adjustments for speed-setting and gain. You may wish to defer final installation until this is done.

After completing these adjustments, **replace** cover, and **seal** with a finger-fillet of RTV. Mount so that water cannot pool on this cover. Mounting with this cover out of sight discourages "fiddling."

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WIRING

CAUTION:
Improper hook-up can damage electronics. Re-check wiring *before* applying power.

When retrofitting another manufacturer's controller:
For retrofitting Barber Coleman controllers with terminal strips, wires may need to be moved.
For retrofitting Barber Coleman controllers with an 8-pin plug, the E-611 should not need any wiring changes.

E-611A:

See Figure 1 for the controller wiring changes.

The original controller wires on pins 3 and 4 must be moved to the E-611 pins 5 and 6 (the order is not important)

The original controller wires on pins 5 and 6 must be moved to the E-611 pins 3 and 4 (the order is not important). Note, the controller does NOT use pin 4 but this pin is provided to fasten an existing second DIS speed signal wire to an isolated pin. DO NOT short both speed signal wires together.

Wires attached to pins 1, 2,7, and 8 of the original controller governor should be connected to the same pins on the E-611.

If the machine had a wire connected to pin 9 of the Barber Coleman governor, this wire should be connected to pin #1 of the E-611 in addition to the original power wire. This pin is simply a + battery supply for the speed select switches.

E-611B Wiring:

Refer to Figure 2 for pin functionality. E-611B terminal "A" corresponds to E-611A pin 1, terminal "B" to pin 2, terminal "C" to pin 3,etc. Again, the E-611B does not require wiring modifications.

A properly functioning 12 volt engine electrical system will supply 13.5-14.8 VDC when the engine is running. If wiring size is adequate, with good connections and proper grounds, you will get this reading between the wires to terminals 1 & 2 of the 8 pin terminal strip when the Governor is controlling engine speed. Verify this.

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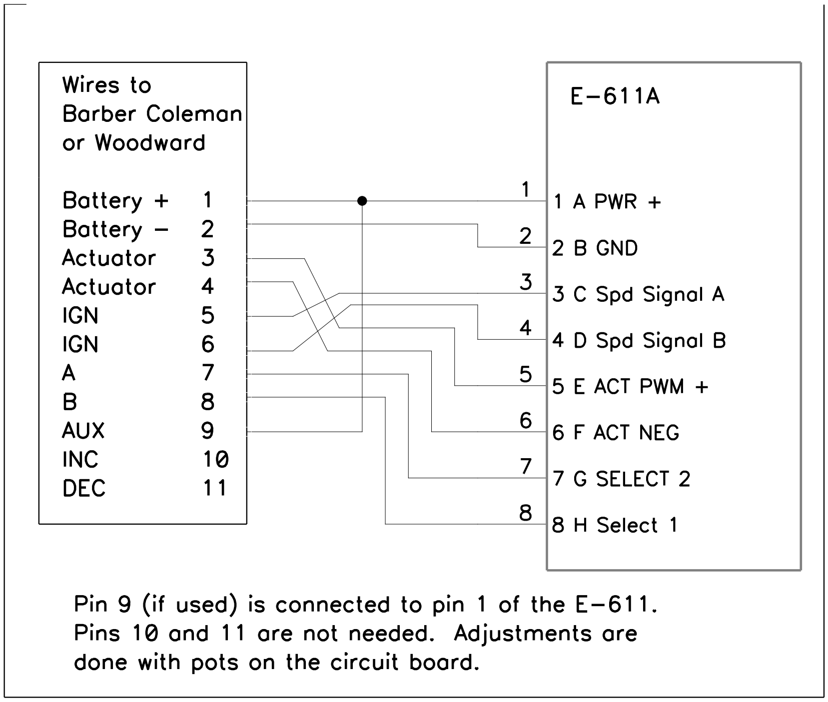

Figure 1 E-611A Retrofit Wiring

Distributor less Engine Wiring:

For use with distributor less engines, the controller's speed signal inputs are connected to the DIS ignition module coil output wires. Refer to engine schematics for the engine's ignition wiring. Normally these signals are the outer 2 leads (pins 1 and 3) of the coil pack 3 pin connector. Refer to Figure 2: DIS wiring for the basic governing wiring schematic.

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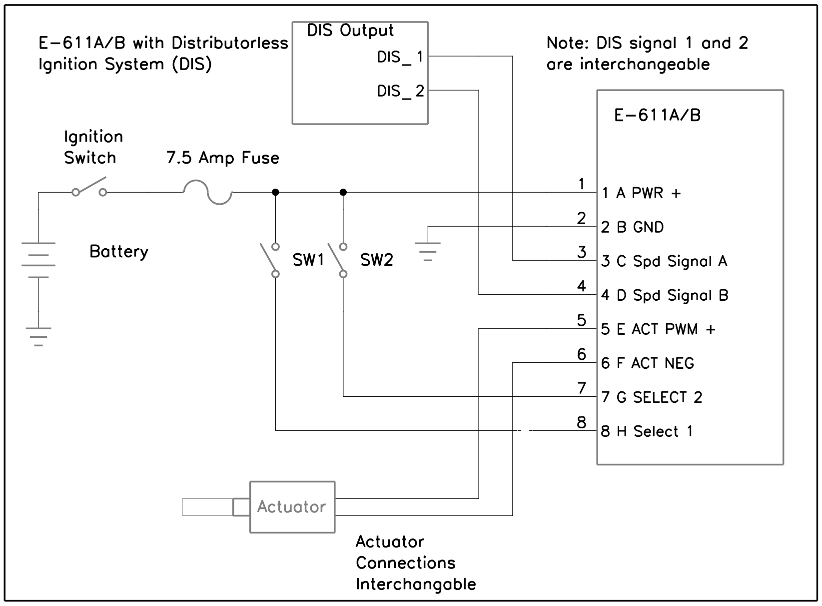

Figure 2: DIS wiring

Distributor Engine Wiring:

For use with distributor engines, the controller's speed signal A input is connected to the ignition coil NEGATIVE lead. Refer to Figure 3: Distributor Engine Wiring for the basic governing wiring schematic.

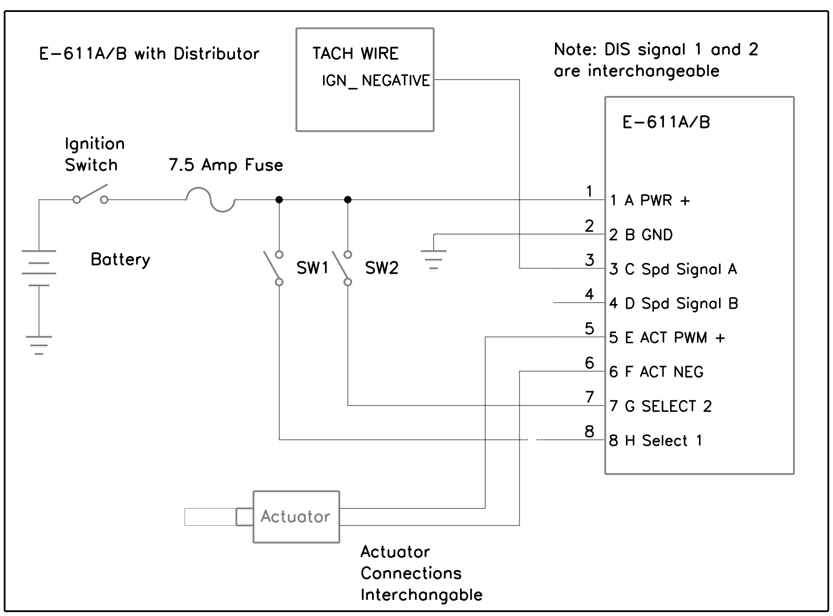

Figure 3: Distributor Engine Wiring

Diesel Engine or spark ignited engine using a mag pickup:

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For engines utilizing a magnetic speed pickup, the mag pickup has one lead connected to ground and the other to the controller's speed signal A terminal. The mag pickup ground lead should be as close to the controller's ground terminal as feasible to minimize electrical noise. Refer Figure 4: Mag Speed Pickup Wiring for the basic governing wiring schematic.

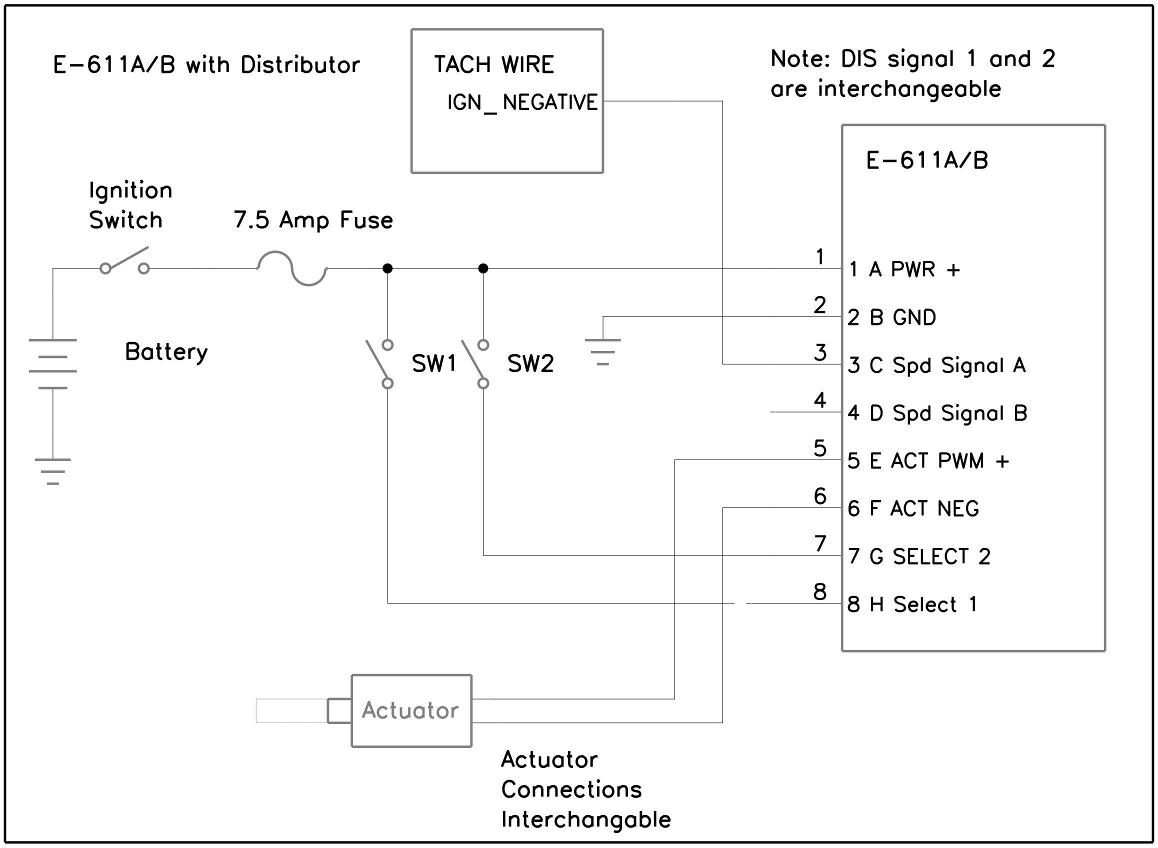

Figure 4: Mag Speed Pickup Wiring

CONTROLLER INITIAL SETUP:

The E-611 controller requires a DIP switch to be configure to select the proper engine speed signal type and frequency ratio. It additionally can be configured to operate as either a fixed speed where it runs 1 of up to 4 different speeds based on 2 speed select inputs OR operates as a cruise control where the user can ramp the speed up or down with momentary contact faster / slower input switch(s). Refer to Figure 5 for the location of DIP switches and adjustments.

Controller power MUST Be removed and reapplied for DIP switch changes to be used. If it is changed during operation, any changes will NOT take effect until controller power is cycled OFF and back ON.

Potentiometer adjustments take effect immediately.

The controller is initially configured for a 4 cylinder distributor less engines using in discrete governing mode. All DIP switches will be in the OFF position.

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For 4 cylinder DISTRIBUTOR-LESS engines, set DIP switches 1-7 OFF.
For 4 cylinder DISTRIBUTOR engines, set DIP switch 1 ON and switches 2-7 OFF.
For 6 cylinder DISTRIBUTOR engines, set DIP switch 2 ON and switches 1 and 3-7 OFF.
For 8 cylinder DISTRIBUTOR engines, set DIP switch 1 and 2 ON and switches 3-7 OFF.

For other speed inputs, refer to the speed range adjustment in Figure 5. The controller needs to know the speed pickup frequency to engine speed ratio to obtain the correct speed range. Diesel engines typically have between 90 and 130 flywheel teeth (Pulses / Rev). If in doubt, select a lower pulse per rev setting and change to a higher setting if engine speed cannot be adjusted high enough. The mag pickup frequency can be measured and compared to the high and low limits in the table.

CHECK-OUT & INITIAL START-UP PROCEDURES

As machines have different speed settings and wiring differs between machines, consult machine service manuals for machine specific wiring, speed settings, and methods to command each set speed. Precision Governors does not have information as to how particular machines are configured, wired, or the proper speed settings.

Assuming that the Governor Assembly and Controller are mounted and the wiring is run and checked, proceed as follows:

1) Set DIP switch to the desired governing mode and proper pulse per Rev count.

2) Turn ignition switch **on**. Do not start engine. The throttle actuator should not be powered when the engine is NOT running.

3) Use a Multimeter to check battery voltage at battery terminals, and record. Now check voltage at the machine connection points for terminals 1 & 2 (1 is +, 2 is -).This voltage reading should be the same as at battery. If not, shut down, and correct wiring.

4) Before proceeding, familiarize yourself with the locations of the **Speed adjustment** pots and the **Gain, Integral, and Derivative** Pots, see Figure 5. Read the section on **Adjustments.**

5) Start engine then set machine controls as necessary to adjust all applicable set speeds. If engine speed surges or is not stable, reduce Gain and / or adjust integral and derivative as needed.

6) Re-check voltage between the connections for terminals A & B as in step 2. Voltage reading should be between 13.5--14.6 VDC. If less, look for undersized wiring somewhere in the system, or for other components wired in parallel with the Governor.

7) Carefully adjust **Gain**. You are looking for the best compromise between quick response and good stability. Make very small adjustments, then load and unload engine. Usually, a good set-up is one that makes 1 to 3 small bounces and then steadies down after a large load change. Too much **Gain** shows up as a rapid (once per second) instability, most commonly at light loads. Too little **Gain** shows up in large over-shoots on start-up or large load changes, and generally sluggish operation. A good initial setting for the gain is to turn fully counterclockwise and then turn clockwise 3/8 of a turn. Changing the gain may affect the set speed.

8) Integral Adjustment. This adjustment is typically not critical for most applications. A good initial setting for the integral is to turn fully counterclockwise and then turn clockwise 1/2 of a turn. This adjustment affects how long the controller takes to completely recover from a load change. If, after applying a load, the engine recovers below set speed then creeps up to the set speed over

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several seconds, this adjustment may be increased. If, after a load application, the engine recovers to a speed above set speed and then creeps down to the set speed, this adjustment may be decreased. Setting this too high may also introduce a slow engine speed wander at lower engine speeds or load factors. Changing the integral will affect the set speed. Note, the Integral has previously been referred to as "factory set" in Precision Governors literature.

9) Re-install the back cover on the control unit. Add a finger fillet of RTV around the edge of this cover to seal against dirt and moisture. Final-mount the controller.

GOVERNOR ADJUSTMENTS

Adjustment Ranges:

Speed Adjustments: The discrete speed settings and up/down speed settings all have a range of 1000 to 3400 RPM. 1000 RPM corresponds to fully counterclockwise while 3400 RPM corresponds to fully clockwise.

Gain and speed rate adjustments are low at counterclockwise and high when clockwise.

All adjustment potentiometers have about ¾ rotation of adjustment. Forcing them beyond this may damage the adjustment.

Adjustments for each Governing Mode:

Discrete Mode:

For "Discrete" governing mode where the controller chooses 1 of up to 4 fixed engine speeds, set DIP switch #8 OFF (Default).

Discrete Governing Speed Adjustments:
Discrete governing mode allows for up to 4 different set speeds based on the voltage applied to inputs 1 and 2. Each speed adjustment is independent of the other and can be set above, below, or the same as any other speed adjustment.

The adjustment for each combination of input pins 1 and 2 can be found in Table 1 and can be determined by commanding each speed from the machine and either measuring for voltage on pins 1 and 2 or counting the blinks of the controller's diagnostic LED and finding the appropriate adjustment pot from the table below.

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Input	1	2	Discrete Governing Mode: DIP SWITCH 8 OFF				
Terminal	8	7					
Pigtail Pin	H	G				Blinks	
Color	Green	Orange	Adjustment Pot	E-361 Setting	E-301 Setting	Engine Running	Engine Off
	0	0	1	1400	2800	1	5
Level	12	0	2	1800	2200	3	7
	0	12	3	2200	1800	2	6
	12	12	4	2800	1400 ?	4	8

Table 1: Discrete Governing Speed Settings

Ramp – UP/DOWN Mode:

For “Ramp” or “UP / DOWN” governing mode where the controller has a variable speed controlled by “faster” and “Slower” inputs, set DIP switch #8 to ON. Speed related adjustments for UP / DOWN mode are detailed in Table 2.

Minimum Speed:
The minimum speed is set with adjustment P1. While the engine is running, the minimum speed can be set by continually requesting engine speed DOWN and adjusting P1.

Maximum Speed:
The maximum speed is set with adjustment P2. While the engine is running, the maximum speed can be set by continually requesting engine speed UP and adjusting P2. Note, Maximum speed should be set ABOVE the minimum speed.

Initial (Startup) Speed:
While the engine is running, the initial speed can be set by continually holding BOTH UP and DOWN and adjusting P3. If normal machine wiring does not allow this, it may be necessary to apply +12v to both UP and DOWN separately from the machine. It is up to the user to determine the most feasible manner of doing this.

Ramp Rate:
For UP / DOWN mode, the user can adjust how fast the set speed changes with P4. Turn P4 clockwise to change speeds faster and counter clockwise to change speeds SLOWER.

Input	1	2	UP / Down Governing Mode: DIP SWITCH 8 ON			
Terminal	8	7				
Pigtail Pin	H	G			Blinks	
Color	Green	Orange	UP / Dn Function	Adjustment Pot	Engine Running	Engine Off
	0	0	No Change		1	5
Level	12	0	Decrease	1	3	7
	0	12	Increase	2	2	6
	12	12	Initial Spd	3	4	8
			Speed Change Rate	Pot P4		
			Minimum	62	rpm per second	
			Maximum	3000	rpm per second	

Table 2: UP Down Governing Adjustments

Gain Adjustments:

The controller has 3 gain adjustments that are used to obtain the fastest and most stable engine speed control. Increasing each component will cause the controller to respond faster and more aggressive. Higher gain values will

P5 adjusts the overall gain (Master Gain) of the controller.
P6 adjusts the derivative gain.
P7 adjusts the integral gain.

GAIN COMPONENTS:

Gain settings control how aggressively the controller attempts to change fueling in order to maintain engine speed. Too little gain results in sluggish response while too much gain results in an engine that does not maintain a constant speed.

The controller uses 3 types of adjustments to maintain the desired engine speed:

Proportional Gain

This is a correction that is directly related to how much the engine is above or below the desired set speed. Proportional gain does not consider how fast the engine speed changes or how long it has been away from the desired speed. Proportional gain will correct for a portion of the error but may result in the engine turning too fast or too slow. Excessive proportional gain can cause the engine to have jitter in the engine speed and /or vibrate. Too low of a proportional gain will cause slow recovery to load changes. In some engine families, too low of gain may result in slow speed wanders. For this controller, Proportional is fixed and the master gain should be used to adjust this portion.

Integral Gain

This is a “long term” correction that adds up the error over time. It is used to get the engine to the exact set speed. The integral adjustment changes how long it takes to get back to the set speed after a load change. Excessive integral will cause the engine to pass the set speed then creep back to the set speed. Excessive integral will often cause the engine speed to go up and down

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once every 2-10 seconds. Too low of an integral setting will cause the engine to creep to the set speed without first crossing it.

Derivative Gain:

This is a correction that is applied as the engine changes speed. If the engine quickly slows in speed, the derivative will cause an immediate increase in fuel. If the engine quickly increases in speed, the derivative will cause an immediate decrease in fuel. If the engine is not changing speed, the derivative will not affect the fuel request. Some engines respond well without any derivative. Some engines require derivative gain to stabilize. Too high of a derivative may show as a quick oscillation (1 or more times per second) in engine speed or a random changes in engine speed. High derivative settings can slow the normal recovery to load changes.

Master Gain:

This is an overall factor applied to the proportional, derivative, and integral components. This is typically assigned to an adjustment pot so that the whole system can be made more or less aggressive with one adjustment. The integral and derivative can be adjusted to obtain the optimal balance of proportional, derivative, and integral gain.

Rough Gain Adjustment:

Turn the gain up until the engine gets unstable – it will quickly randomly change speeds, shake, and / or vibrate.
Reduce the gain until the engine stabilizes.

(If the engine will not stabilize or wanders, attempt to stabilize the engine with the derivative.)

Rough Derivative Adjustment:

Increase the derivative until the engine has a fast oscillation to it, that is more than 1 per second. Decrease the derivative until the engine stabilizes. For some applications, the system will provide optimal response with the derivative set to minimum. Some applications will not be stable without derivative. Many systems will show improved stability with some derivative.

Rough Integral Adjustment:

Increase the integral until the engine has a 2-10 second speed pulsation. Reduce the integral so that the engine stabilizes. If, upon adding a large load, the engine speed drops, goes above set speed as the governor responds, then wanders down slowly, reduce the integral. If the engine drops, recovers to a speed below the set speed then creeps up to the set speed, increase the integral.

Diagnostic LED:

The controller has a diagnostic LED. This blinks a code from 1 to 8 blinks followed by a pause. The LED indicates: If engine speed is measured on the speed input and the status of inputs 1 and 2. Refer to Table 1 and Table 2 for blink codes. This also allows the technician to determine the proper speed adjustment to use for the present combination of inputs.

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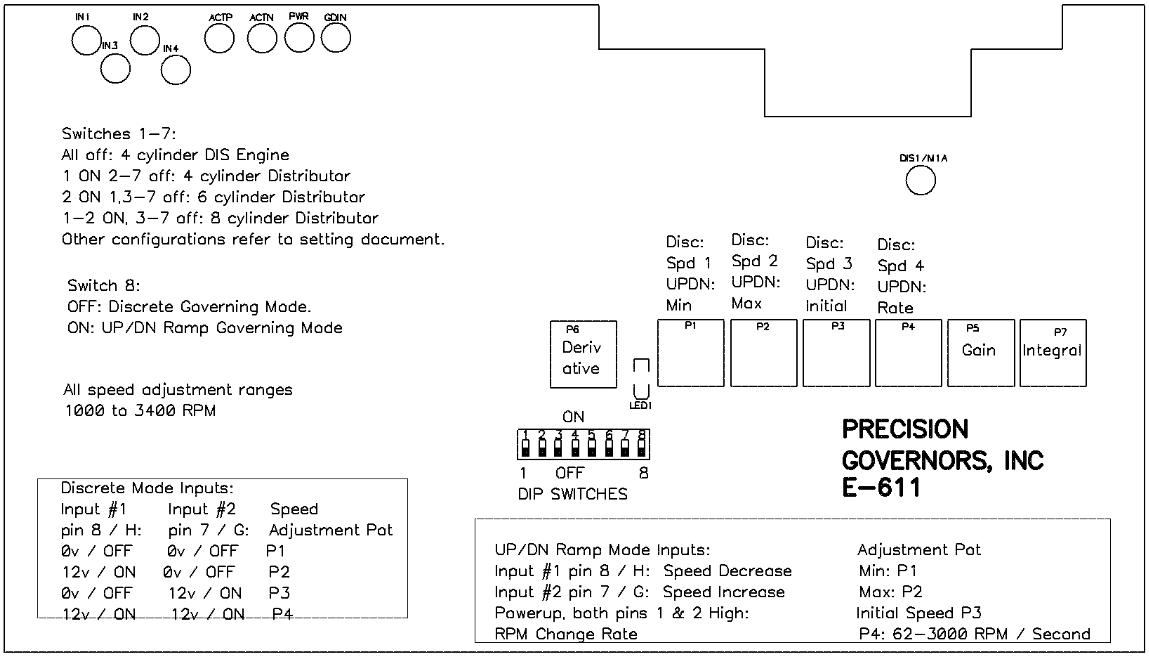

Figure 5: Controller Adjustments and DIP switch

Over speed Shutdown:

The controller is factory configured to shut the actuator output OFF if engine speed is measured to be greater than 3900 RPM for more than 1 second.

If the over speed thresholds are hit, the controller will turn the actuator OFF until the engine speed has been determined to be stopped. Once the engine is considered to be stopped, the controller will allow the actuator to be energized.

Short Circuit Shutdown:

If the controller determines the actuator coil current is shorted or current is greater than 6-7 amps, the controller will shut the actuator off for 4 seconds. It will then attempt to govern again. A system with an intermittent short circuit may operate normally some times and other times drop out the actuator for 4 seconds at a time.

Note, the short circuit protection assists in protecting circuitry and wires but is NOT a substitute for a properly fused system. A 7.5 amp normal or fast blow fuse is recommended in series with the power lead.

Additionally, the short circuit protection does NOT protect against damage due to a short of the ACT + lead to ground.

TROUBLESHOOTING

We will discuss Troubleshooting in two general categories:

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A) Governor won't work
B) Governor works, but can't be set up to give satisfactory performance

There is, of course, some overlap between these categories. Read both sections and apply the fixes that seem appropriate.

***During troubleshooting, be prepared to control the engine manually to prevent overspeeds*.**

A. Governor won't work.

No reaction from Governor. Actuator output never moves, engine off or engine running.
Can be caused by:

1. No power.
2. Incorrect electrical hook-up.
3. No speed signal to Governor.
4. Damaged Actuator.
5. Damaged Controller.

1. No power Use a Multimeter to check for 12-15 VDC between terminals 1 & 2 on the controller. Check during engine off and engine running conditions. If voltage is absent or low, check for:

a. Wiring error
b. Hook-up on wrong side of ballast resistor
c. Low battery
d. Bad Voltage Regulator
e. Bad ground connection
f. Corroded terminals
g. Undersized wiring

2) Incorrect Electrical Hook-up Re-check all wiring and connections to the governor assembly and controller.

3) No speed signal to Controller

a. Check the voltage between terminals 3 and/ or 4 and ground with the engine running. You should see 5-30 VDC for ignition signals and > 1vac for mag pickup signals.
b. The above check does not guarantee a good speed signal, but its absence proves that there is a problem

4. Damaged Actuator: See Actuator Troubleshooting, below.
5. **Internal Governor fault** If steps 1-4 above have not revealed the problem, the Governor may have been damaged, either in shipping or during hook-up and test.

B. Governor reacts, but can't be set up to give proper performance

This kind of trouble usually falls into 3 main categories:

1. Actual Governor malfunction
2. Governor installation problems and improper installation
3. Governor not tuned or adjusted for engine/application

1. Actual Governor malfunction The Governor was engine-tested for proper operation just prior to being shipped. Unless damaged in shipment or by improper handling, it should be serviceable. To check for proper operation, proceed as follows:

a. Control the engine speed manually (if possible).

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b. By carefully varying engine speed, you should be able to feel the actuator come to a neutral force position. This engine speed is the approximately the set speed for which the Governor is adjusted.
c. No rubbing or binding should be felt during these movements.

If steps 1a. through 1d. can be accomplished as described, the Governor is probably OK. It recognizes underspeed, overspeed, onspeed, and is not binding internally. If the above steps cannot be accomplished satisfactorily, there is probably an actual Governor malfunction.

2. **Installation and adjustment problems**
   a. If actuator is unable to move freely look for:
      1. Actuator or carburetor binding
      2. Low voltage at Governor during operation: Measure the voltage as discussed previously and observe voltage during operation.
   b. Governor experiences sudden, momentary spikes toward max. or min. at random intervals, then recovers.
      1. Look for loose wiring or momentary shorts in wiring.
      2. Noise or occasionally missing speed signal.

3. **Governor not tuned or adjusted for engine/application**
   The basic adjustment to set sensitivity/stability is the Gain pot. A good starting point for many engines is full CCW, then CW 1/2 turn. (See "Governor adjustment" section.) To increase stability, turn CCW. If satisfactory governing cannot be achieved with this one adjustment, the **Integral** adjustment may be needed. Normal starting point for this adjustment is fully CCW, then CW 1/2 turn . (Before changing this pot, mark the original position.)

Damaged Actuator.
For retrofit applications using Zenith carburetors with a direct mount actuator or other brands of actuators: As the throttle actuator on this system is not a Precision Governor Product, please refer to original service information for detailed troubleshooting information. Precision Governors does not manufacture a bolt in replacement for this throttle actuator.

Precision Governors has measured the resistance of a known good 12 volt direct mount actuator at 2.9Ω. Actuator voltage measured while running an unloaded 2.5L Ford engine at 1500 –2000 RPM were 1.9-2.1 volts and at 2600 RPM with load were 2.9 volts. The actuator should be near wide open with 6-8 volts present. Steady state voltage readings stayed with 0.3 volts of the average value measured on the machine. The average voltage will vary with engine speed and load. If the steady state value changes considerably without engine speed changes, the actuator or carburetor may be "sticky". If the actuator voltage measures near 0 volts, the controller may be attempting to reduce engine speed below the mechanical idle setting or (for idle speed) may be configured for a carburetor idle. Reduce the mechanical idle speed, configure the controller for controlled idle, or increase the selected engine speed adjustment to regain control.

Any sticky feeling, rubbing, or binding in the actuator or carburetor can be the cause of engine instability. These should be repaired.

It is up to the technician to decide if the actuator is functioning properly or not.

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Table 3: Speed Range Settings

		DIP SWITCHES 0 = OFF, 1 = ON								
Pulses / Rev	Typical Use	1	2	3	4	5	6	7	Freq Min (Hz)	Freq Max (Hz)
1	distributorless engine	0	0	0	0	0	0	0	16.7	56.67
2	4 cyl distributor	1	0	0	0	0	0	0	33.3	113.3
3	6 cyl distributor	0	1	0	0	0	0	0	50	170
4	8 cyl distributor	1	1	0	0	0	0	0	66.7	226.7
5	Diesel / Mag 5 Teeth	0	0	1	0	0	0	0	83.3	283.3
6	Diesel / Mag 6 Teeth	1	0	1	0	0	0	0	100	340
7	Diesel / Mag 7 Teeth	0	1	1	0	0	0	0	117	396.7
8	Diesel / Mag 8 Teeth	1	1	1	0	0	0	0	133	453.3
10	Diesel / Mag 10 Teeth	0	0	0	1	0	0	0	167	566.7
12	Diesel / Mag 12 Teeth	1	0	0	1	0	0	0	200	680
14	Diesel / Mag 14 Teeth	0	1	0	1	0	0	0	233	793.3
16	Diesel / Mag 16 Teeth	1	1	0	1	0	0	0	267	906.7
18	Diesel / Mag 18 Teeth	0	0	1	1	0	0	0	300	1020
20	Diesel / Mag 20 Teeth	1	0	1	1	0	0	0	333	1133
22	Diesel / Mag 22 Teeth	0	1	1	1	0	0	0	367	1247
24	Diesel / Mag 24 Teeth	1	1	1	1	0	0	0	400	1360
26	Diesel / Mag 26 Teeth	0	0	0	0	1	0	0	433	1473
28	Diesel / Mag 28 Teeth	1	0	0	0	1	0	0	467	1587
30	Diesel / Mag 30 Teeth	0	1	0	0	1	0	0	500	1700
32	Diesel / Mag 32 Teeth	1	1	0	0	1	0	0	533	1813
34	Diesel / Mag 34 Teeth	0	0	1	0	1	0	0	567	1927
36	Diesel / Mag 36 Teeth	1	0	1	0	1	0	0	600	2040
38	Diesel / Mag 38 Teeth	0	1	1	0	1	0	0	633	2153
40	Diesel / Mag 40 Teeth	1	1	1	0	1	0	0	667	2267
42	Diesel / Mag 42 Teeth	0	0	0	1	1	0	0	700	2380
44	Diesel / Mag 44 Teeth	1	0	0	1	1	0	0	733	2493
46	Diesel / Mag 46 Teeth	0	1	0	1	1	0	0	767	2607
48	Diesel / Mag 48 Teeth	1	1	0	1	1	0	0	800	2720
50	Diesel / Mag 50 Teeth	0	0	1	1	1	0	0	833	2833
52	Diesel / Mag 52 Teeth	1	0	1	1	1	0	0	867	2947
54	Diesel / Mag 54 Teeth	0	1	1	1	1	0	0	900	3060
56	Diesel / Mag 56 Teeth	1	1	1	1	1	0	0	933	3173
58	Diesel / Mag 58 Teeth	0	0	0	0	0	1	0	967	3287
60	Diesel / Mag 60 Teeth	1	0	0	0	0	1	0	1000	3400
62	Diesel / Mag 62 Teeth	0	1	0	0	0	1	0	1033	3513
64	Diesel / Mag 64 Teeth	1	1	0	0	0	1	0	1067	3627
66	Diesel / Mag 66 Teeth	0	0	1	0	0	1	0	1100	3740
68	Diesel / Mag 68 Teeth	1	0	1	0	0	1	0	1133	3853
70	Diesel / Mag 70 Teeth	0	1	1	0	0	1	0	1167	3967

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		DIP SWITCHES 0 = OFF, 1 = ON								
Pulses / Rev	Typical Use	1	2	3	4	5	6	7	Freq Min (Hz)	Freq Max (Hz)
72	Diesel / Mag 72 Teeth	1	1	1	0	0	1	0	1200	4080
74	Diesel / Mag 74 Teeth	0	0	0	1	0	1	0	1233	4193
76	Diesel / Mag 76 Teeth	1	0	0	1	0	1	0	1267	4307
78	Diesel / Mag 78 Teeth	0	1	0	1	0	1	0	1300	4420
80	Diesel / Mag 80 Teeth	1	1	0	1	0	1	0	1333	4533
82	Diesel / Mag 82 Teeth	0	0	1	1	0	1	0	1367	4647
84	Diesel / Mag 84 Teeth	1	0	1	1	0	1	0	1400	4760
86	Diesel / Mag 86 Teeth	0	1	1	1	0	1	0	1433	4873
88	Diesel / Mag 88 Teeth	1	1	1	1	0	1	0	1467	4987
90	Diesel / Mag 90 Teeth	0	0	0	0	1	1	0	1500	5100
92	Diesel / Mag 92 Teeth	1	0	0	0	1	1	0	1533	5213
94	Diesel / Mag 94 Teeth	0	1	0	0	1	1	0	1567	5327
96	Diesel / Mag 96 Teeth	1	1	0	0	1	1	0	1600	5440
98	Diesel / Mag 98 Teeth	0	0	1	0	1	1	0	1633	5553
100	Diesel / Mag 100 Teeth	1	0	1	0	1	1	0	1667	5667
102	Diesel / Mag 102 Teeth	0	1	1	0	1	1	0	1700	5780
104	Diesel / Mag 104 Teeth	1	1	1	0	1	1	0	1733	5893
106	Diesel / Mag 106 Teeth	0	0	0	1	1	1	0	1767	6007
108	Diesel / Mag 108 Teeth	1	0	0	1	1	1	0	1800	6120
110	Diesel / Mag 110 Teeth	0	1	0	1	1	1	0	1833	6233
112	Diesel / Mag 112 Teeth	1	1	0	1	1	1	0	1867	6347
114	Diesel / Mag 114 Teeth	0	0	1	1	1	1	0	1900	6460
116	Diesel / Mag 116 Teeth	1	0	1	1	1	1	0	1933	6573
118	Diesel / Mag 118 Teeth	0	1	1	1	1	1	0	1967	6687
120	Diesel / Mag 120 Teeth	1	1	1	1	1	1	0	2000	6800
122	Diesel / Mag 122 Teeth	0	0	0	0	0	0	1	2033	6913
124	Diesel / Mag 124 Teeth	1	0	0	0	0	0	1	2067	7027
126	Diesel / Mag 126 Teeth	0	1	0	0	0	0	1	2100	7140
128	Diesel / Mag 128 Teeth	1	1	0	0	0	0	1	2133	7253
130	Diesel / Mag 130 Teeth	0	0	1	0	0	0	1	2167	7367
132	Diesel / Mag 132 Teeth	1	0	1	0	0	0	1	2200	7480
134	Diesel / Mag 134 Teeth	0	1	1	0	0	0	1	2233	7593
136	Diesel / Mag 136 Teeth	1	1	1	0	0	0	1	2267	7707
138	Diesel / Mag 138 Teeth	0	0	0	1	0	0	1	2300	7820
140	Diesel / Mag 140 Teeth	1	0	0	1	0	0	1	2333	7933
142	Diesel / Mag 142 Teeth	0	1	0	1	0	0	1	2367	8047
144	Diesel / Mag 144 Teeth	1	1	0	1	0	0	1	2400	8160
146	Diesel / Mag 146 Teeth	0	0	1	1	0	0	1	2433	8273

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Pulses / Rev	Typical Use	1	2	3	4	5	6	7	Freq Min (Hz)	Freq Max (Hz)
148	Diesel / Mag 148 Teeth	1	0	1	1	0	0	1	2467	8387
150	Diesel / Mag 150 Teeth	0	1	1	1	0	0	1	2500	8500
152	Diesel / Mag 152 Teeth	1	1	1	1	0	0	1	2533	8613
154	Diesel / Mag 154 Teeth	0	0	0	0	1	0	1	2567	8727
156	Diesel / Mag 156 Teeth	1	0	0	0	1	0	1	2600	8840
158	Diesel / Mag 158 Teeth	0	1	0	0	1	0	1	2633	8953
160	Diesel / Mag 160 Teeth	1	1	0	0	1	0	1	2667	9067
162	Diesel / Mag 162 Teeth	0	0	1	0	1	0	1	2700	9180
164	Diesel / Mag 164 Teeth	1	0	1	0	1	0	1	2733	9293
166	Diesel / Mag 166 Teeth	0	1	1	0	1	0	1	2767	9407
168	Diesel / Mag 168 Teeth	1	1	1	0	1	0	1	2800	9520
170	Diesel / Mag 170 Teeth	0	0	0	1	1	0	1	2833	9633
172	Diesel / Mag 172 Teeth	1	0	0	1	1	0	1	2867	9747
174	Diesel / Mag 174 Teeth	0	1	0	1	1	0	1	2900	9860
176	Diesel / Mag 176 Teeth	1	1	0	1	1	0	1	2933	9973
178	Diesel / Mag 178 Teeth	0	0	1	1	1	0	1	2967	10087
180	Diesel / Mag 180 Teeth	1	0	1	1	1	0	1	3000	10200
182	Diesel / Mag 182 Teeth	0	1	1	1	1	0	1	3033	10313
184	Diesel / Mag 184 Teeth	1	1	1	1	1	0	1	3067	10427
186	Diesel / Mag 186 Teeth	0	0	0	0	0	1	1	3100	10540
188	Diesel / Mag 188 Teeth	1	0	0	0	0	1	1	3133	10653
190	Diesel / Mag 190 Teeth	0	1	0	0	0	1	1	3167	10767
192	Diesel / Mag 192 Teeth	1	1	0	0	0	1	1	3200	10880
194	Diesel / Mag 194 Teeth	0	0	1	0	0	1	1	3233	10993
196	Diesel / Mag 196 Teeth	1	0	1	0	0	1	1	3267	11107
198	Diesel / Mag 198 Teeth	0	1	1	0	0	1	1	3300	11220
200	Diesel / Mag 200 Teeth	1	1	1	0	0	1	1	3333	11333
202	Diesel / Mag 202 Teeth	0	0	0	1	0	1	1	3367	11447
204	Diesel / Mag 204 Teeth	1	0	0	1	0	1	1	3400	11560
206	Diesel / Mag 206 Teeth	0	1	0	1	0	1	1	3433	11673
208	Diesel / Mag 208 Teeth	1	1	0	1	0	1	1	3467	11787
210	Diesel / Mag 210 Teeth	0	0	1	1	0	1	1	3500	11900
212	Diesel / Mag 212 Teeth	1	0	1	1	0	1	1	3533	12013
214	Diesel / Mag 214 Teeth	0	1	1	1	0	1	1	3567	12127
216	Diesel / Mag 216 Teeth	1	1	1	1	0	1	1	3600	12240
218	Diesel / Mag 218 Teeth	0	0	0	0	1	1	1	3633	12353
220	Diesel / Mag 220 Teeth	1	0	0	0	1	1	1	3667	12467
222	Diesel / Mag 222 Teeth	0	1	0	0	1	1	1	3700	12580
224	Diesel / Mag 224 Teeth	1	1	0	0	1	1	1	3733	12693
226	Diesel / Mag 226 Teeth	0	0	1	0	1	1	1	3767	12807
228	Diesel / Mag 228 Teeth	1	0	1	0	1	1	1	3800	12920
230	Diesel / Mag 230 Teeth	0	1	1	0	1	1	1	3833	13033
232	Diesel / Mag 232 Teeth	1	1	1	0	1	1	1	3867	13147
234	Diesel / Mag 234 Teeth	0	0	0	1	1	1	1	3900	13260

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Pulses / Rev	Typical Use	1	2	3	4	5	6	7	Freq Min (Hz)	Freq Max (Hz)
236	Diesel / Mag 236 Teeth	1	0	0	1	1	1	1	3933	13373
238	Diesel / Mag 238 Teeth	0	1	0	1	1	1	1	3967	13487
240	Diesel / Mag 240 Teeth	1	1	0	1	1	1	1	4000	13600
242	Diesel / Mag 242 Teeth	0	0	1	1	1	1	1	4033	13713
244	Diesel / Mag 244 Teeth	1	0	1	1	1	1	1	4067	13827
246	Diesel / Mag 246 Teeth	0	1	1	1	1	1	1	4100	13940
248	Diesel / Mag 248 Teeth	1	1	1	1	1	1	1	4133	14053

ANALOG / POTENTIOMETER MODE:

8/15/17:

Analog potentiometer mode allows a potentiometer to set the desired speed. This is refered to as "Drive By Wire" or DBW.

For this, input #1 wire is moved to the "A1" terminal of the PCB and IN3 terminal gets connected to PWR / +12v.

DIP switches 1-7 function as detailed above: They select the pulses per revolution the controller measures on the speed signal.

DIP Switch 8: If DIP switch is ON, the controller normalizes the automatically adjusts the DBW % voltage at minimum range and maximum range such that the minimum speed setting occurs exactly at the minimum position and the maximum speed setting occurs exactly at the maximum position.

If DIP switch is OFF, the controller will NOT adjust the minimum and maximum set points. These will be set by the limit POTs.

Normalization is usually used for volume applications where adjustment is NOT desired on each machine. The system will adjust the pot endpoint. For small volume use, it is often simplier to use NON normalized mode and simply adjust the pot end points as needed.

Speed Request:
The DBW potentiometer is connected with the low side to ground and the high side to + POWER / 12v. The wiper is connected to input #1: terminal #8 or pin H. As the +12v system voltage fluctuates, the controller measures the voltage on input #1 as a percentage of battery voltage rather than a fixed voltage.

POT functionality:

P1 functions as the desired speed at MINIMUM throttle %.
P2 functions as the desired speed at MAXIMUM throttle %.
Note, P1 can be set above or below P2. Thereforce, MIN speed could be at maximum throttle %.
P3 sets the % of battery voltage to consider the potiometer to be at MINIMUM. This should be set BELOW P4.

P4 sets the % of battery voltage to consider the potiometer to be at MINIMUM. This should be set BELOW P4.

P1 and P2 can be adjusted anytime.
P3 and P4 may be checked by the controller only at powerup.

For normalize modes, these set the INITIAL % for min and max limits. The limits will automatically adjust down to 0% for MIN and up to 100% for maximum IF the DBW% adjusts over that range. The pots are used to set the initial limit then not checked again. It is suggested to calculate pot % at min and max (100 * voltage / battery voltage) then set the pots to the respective pot %. Alternatively, power up the controller in non normalized mode and set the min and max such that a small amount of movement exists near mininmum and maximum where the engine speed does NOT change. Then shut the system down and turn DIP switch #8 to the ON position to enable normalization.

For non normalized mode, P3 and P4 are continuously applied as the minimum and maximum end points for the desired minimum and maximum speeds.

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