ELECTRONIC THROTTLE CONTROL (ETC)
AIR CONTROL VALVE ASSEMBLY
APPLICATION MANUAL

- VÁLVULA BORBOLETA

Figura 2.1: Visualização da válvula de controle de ar eletrônica (Fonte: Delphi)

Figura 2.2: Modelos de válvula (Fonte: Delphi)

Uma visualização mais detalhada pode ser realizada na figura (2.3)

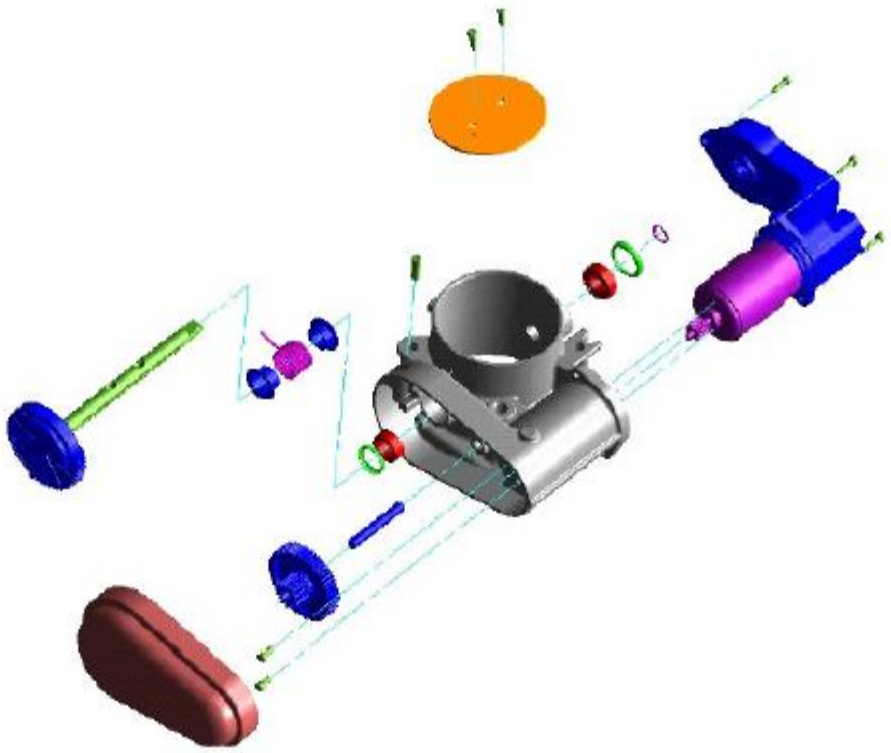


Figura 2.3: Vista explodida de uma válvula de controle de ar eletrônica (Fonte: Delphi)

componentes básicos e opcionais.

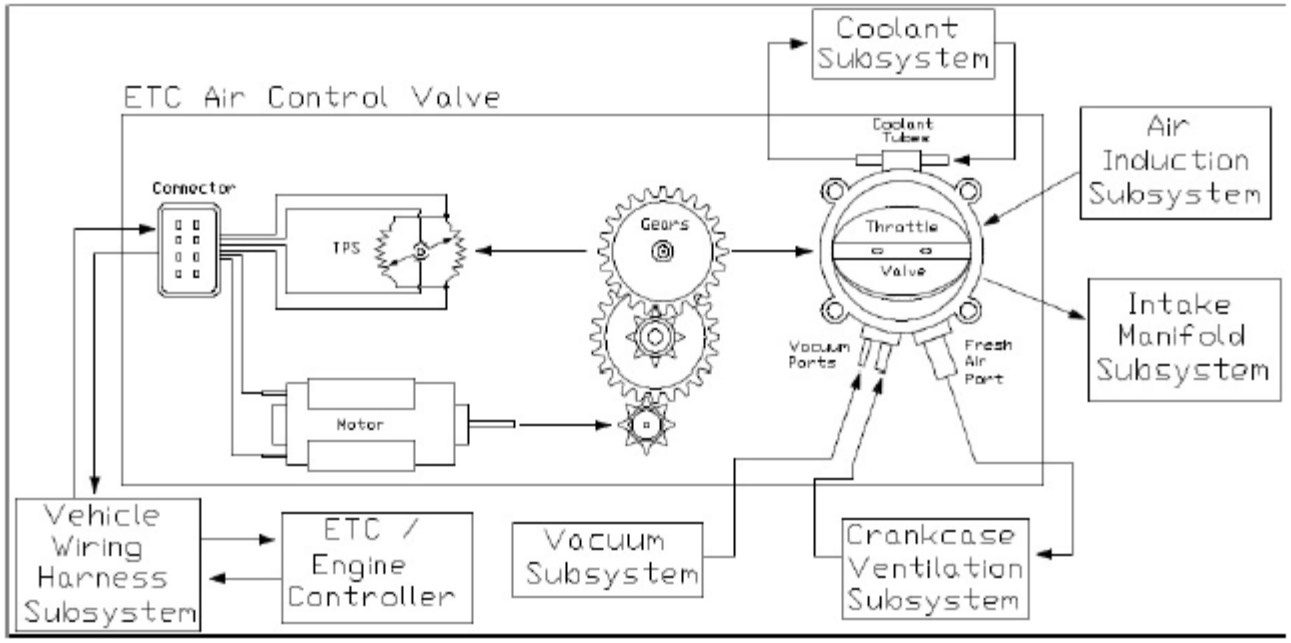


Figura 2.4: Diagrama esquemático da válvula de controle de ar eletrônica. (Fonte: Delphi)

2.3 Operação da válvula de controle de ar eletrônica.

Inicialmente, sem a tração do motor, a válvula borboleta através de sistema de fim de curso elástico, deixa a válvula (naturalmente) ligeiramente aberta, com o fluxo de ar necessário para o regime de marcha lenta.

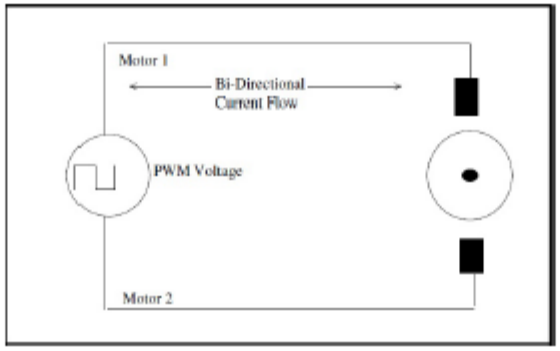


Figura 2.5: Diagrama de motor atuador. (Fonte: Delphi)

Dados caracteristicos do motor podem ser visualizados na tabela (2.1).

Parameter	Conditions	Minimum	Typical	Maximum	Units
Design Voltage		5.5	12.0	16.5	V
Current, Average	$\succ$ 10 sec	2.2			A
Current, Peak	$\prec$ 10 sec			9.6	A
Inductance, Pin A-B	@100Hz		0.83		mH
PWM Frequency		1.5	varies	24	KHz

Tabela 2.1: Dados caracteristicos de funcionamento do motor. (Fonte: Delphi)

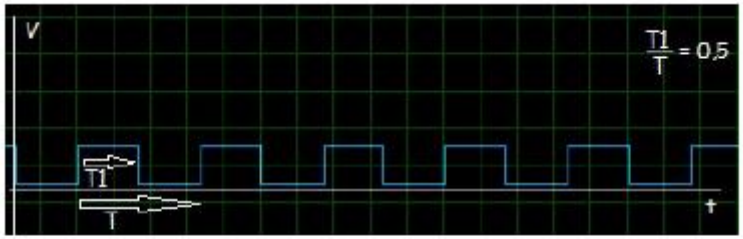


Figura 2.6: Sinal PWM com 50% de duty cicle.

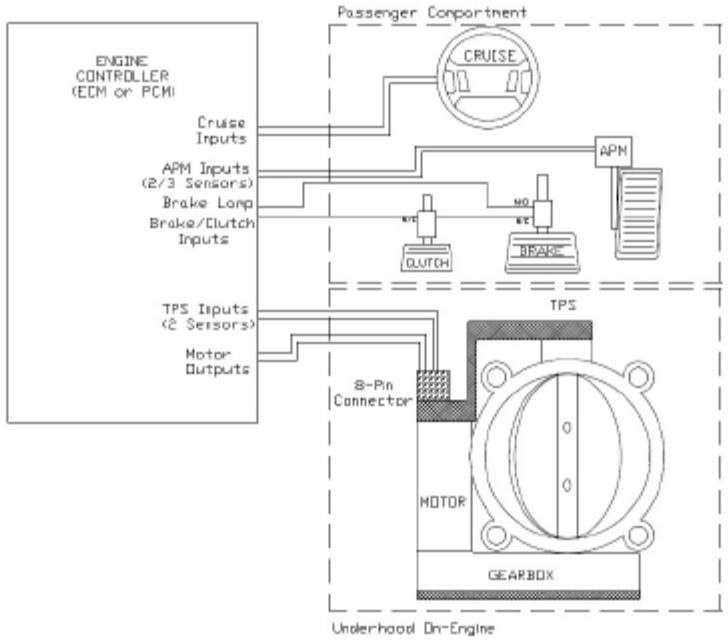


Figura 2.7: Diagrama para visualização da interação da válvula de controle de ar com o carro.(Fonte: Delphi)

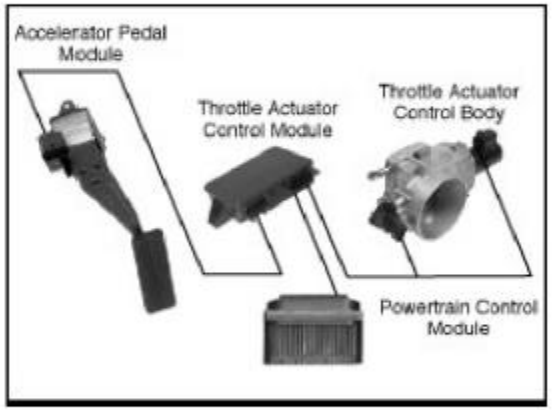
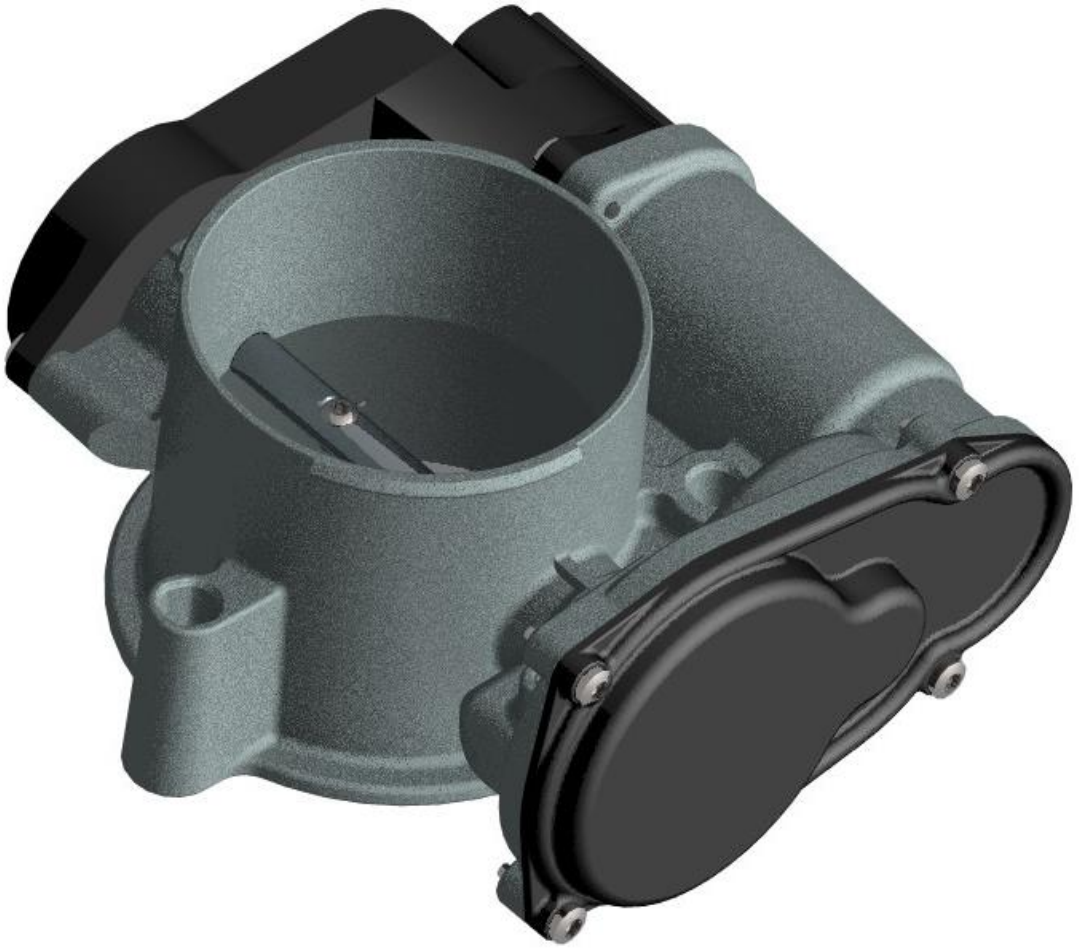


Figura 2.8: Visualização da integração de componentes do carro para o controle da válvula de controle de ar.(Fonte: Delphi)

ETC Air Control Valve (ETC-ACV)

Application Manual

DELPHI



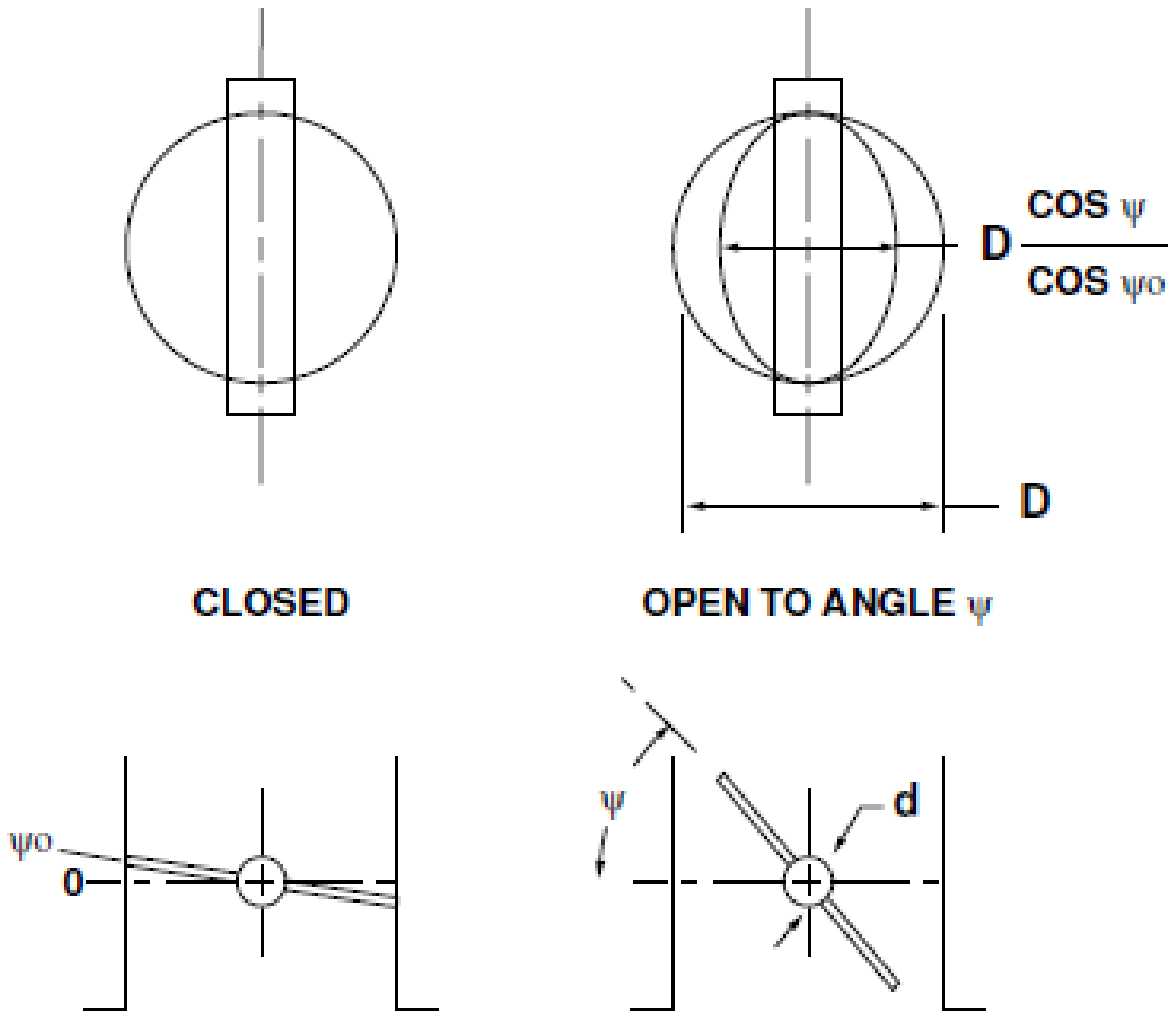


Figure 2-1. Air Control Valve Sizing.

$$\dot{m}_{th} = \frac{C_D A_{th} P_O}{\sqrt{R T_O}} \left(\frac{P_T}{P_O}\right)^{1/\gamma} \left\{ \frac{2\gamma}{\gamma - 1} \left[1 - \left(\frac{P_T}{P_O}\right)^{(\gamma-1)/\gamma} \right] \right\}^{1/2}$$

where: P_o and T_o are the upstream pressure and temperature

P_T is the pressure downstream of the throttle valve

C_D is the discharge coefficient (determined experimentally)

R is the Reynolds number

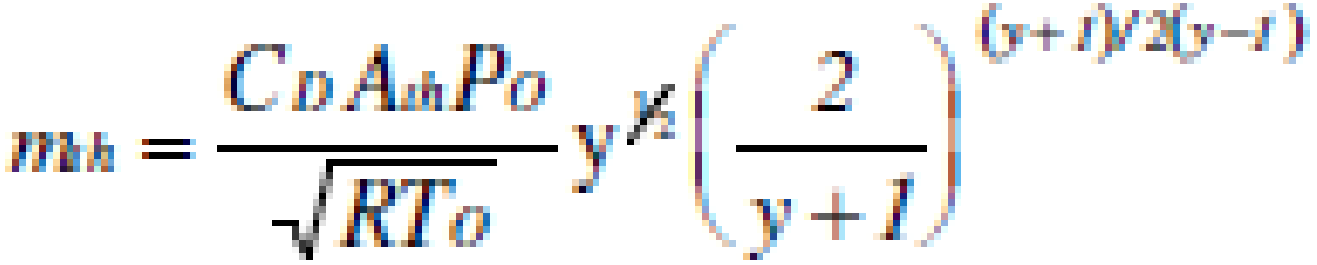
γ is the specific heat ratio

$$\frac{4A_{sh}}{\pi D^2} = \left(1 - \frac{\cos\psi}{\cos\psi o}\right) + \frac{2}{\pi}\left[\frac{a}{\cos\psi}\left(\cos^2\psi - a^2\cos^2\psi o\right)^{1/2} + \frac{\cos\psi}{\cos\psi o}\sin^{-1}\left(\frac{a\cos\psi o}{\cos\psi}\right) - a\left(1 - a^2\right)^{1/2}\sin^{-1}a\right]$$

where: a = d/D, d is the throttle shaft diameter, D is the throttle bore diameter

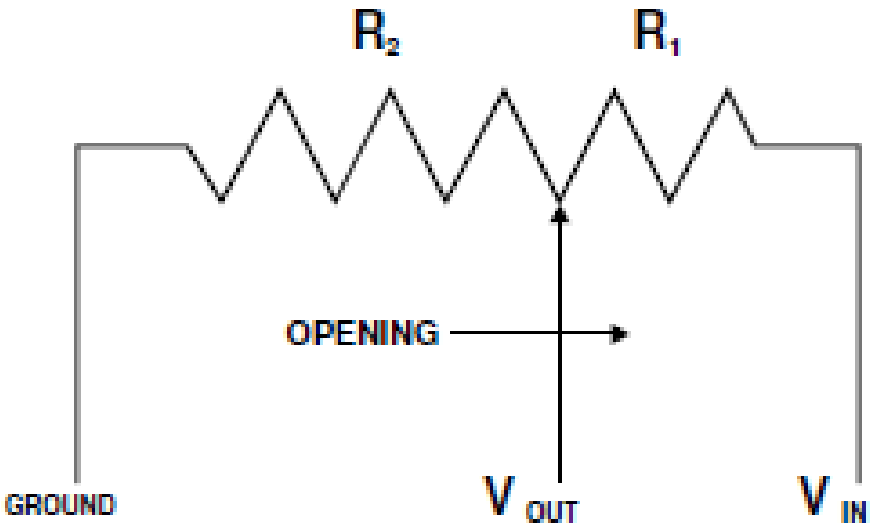
Ψ_o is the throttle plate angle at the closed bore position

Ψ is any opening angle



2.3.1 Throttle Position Sensor Technology

In most cases, a TPS is a thick-film resistive potentiometer with a movable contact that instantaneously provides a signal proportional to the throttle shaft position (see Figure 2-2).



$$V_{OUT} = \frac{V_{IN} * R_2}{(R_1 + R_2)}$$

2.3.2 Electrical Output vs. Angle

A Throttle Position Sensor's output is typically a linear function from idle to WOT.

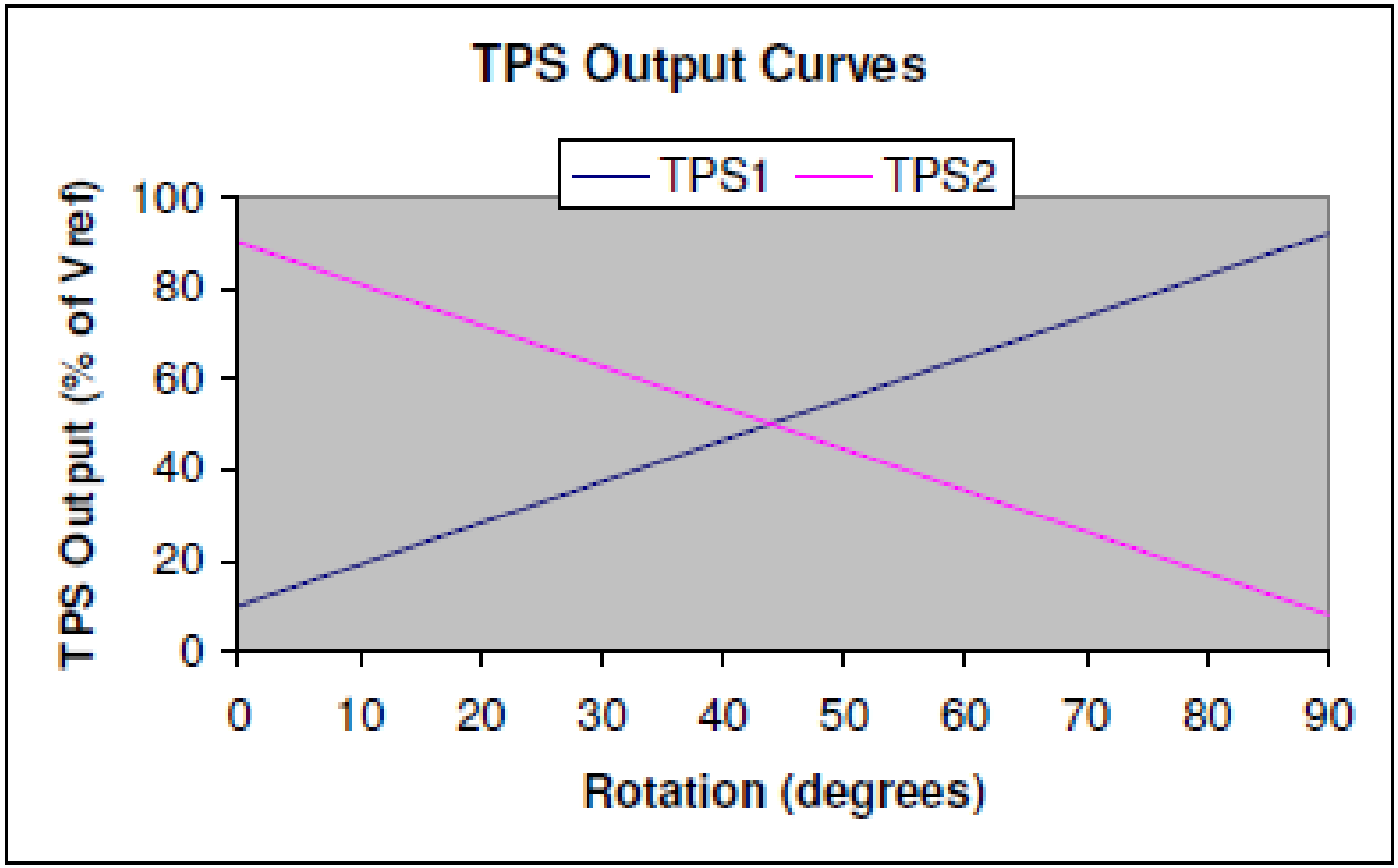


Figure 2-3. Typical Dual Track TPS Output vs. Throttle Rotation (Linear).

3.2.1 Product Examples

Shown are some pictures of Delphi ETC Air Control Valves with various bore sizes:

Figure 3-1. Wrap-around 90mm, inline and wrap-around 75mm ETC-ACV's

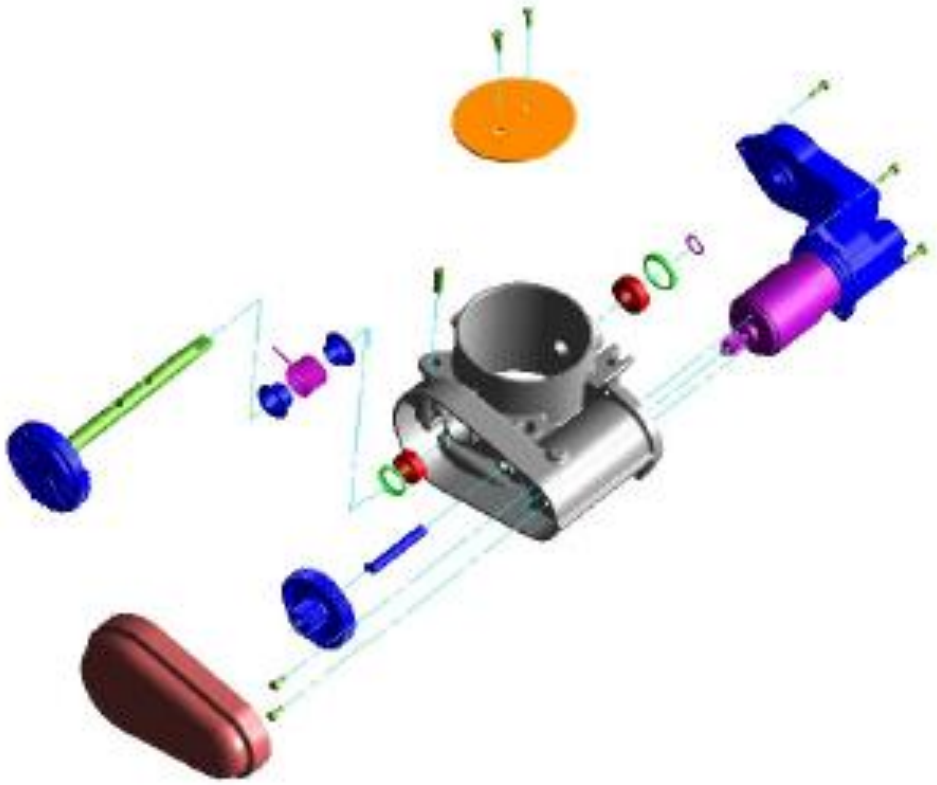


Figure 3-2 Breakout picture of a Delphi ETC

3.2.2 Functions, Performance Requirements and Features

The functions, performance requirements and features of typical ETC-Air Control Valve Assemblies are listed in Table 3-1.

ETC-A CV Functions:	• Regulate intake air flow • Sense throttle position • Provide vacuum signals (i.e. the brake booster, EGR valve, and canister purge system if required) • Provide filtered air source if required (i.e. PCV fresh air) • Provide mounting features if required
Design Performance Requirements:	• Maximum air flow capacity • Idle air flow resolution (and minimum controllable air flow) • Default Position Airflow • Throttle Response Time • Maximum leak rate (through throttle shaft bearings)
Design Features:	• Various bore sizes • Various valve and bore geometry and valve angles • Throttle position sensor (shaft drive) • Various Connector Configurations • Various Actuator Configurations • Optional coolant flow passageway • Optional Vacuum ports • Optional Fresh Air Port

Table 3-1. Functions, Performance Requirements and Features of Typical Throttle Bodies.

- Valve angle – The edge of the valve is manufactured to provide an angular position when the valve is at the closed bore condition. The higher the valve angle, the more sensitive the air rate is per degree valve rotation.

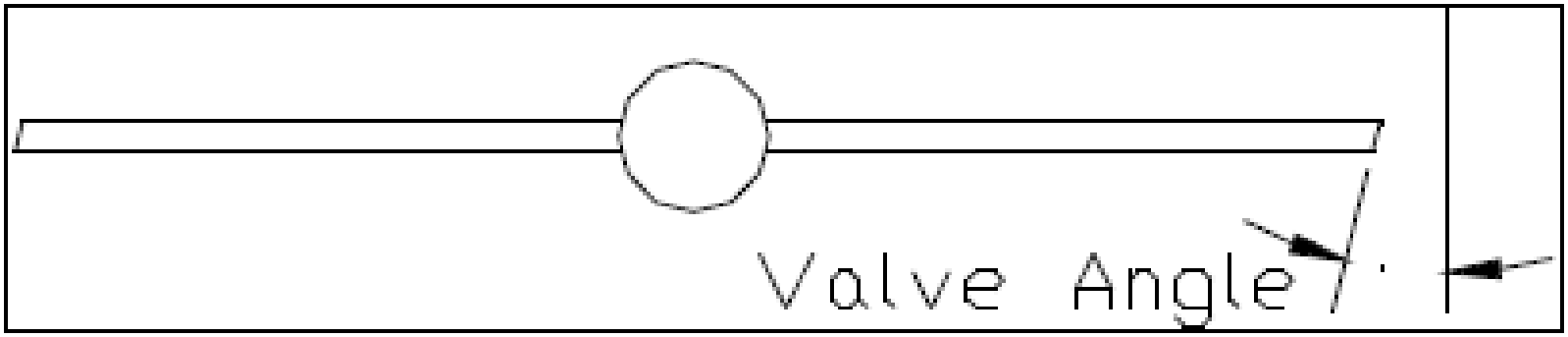


Figure 3-3 Description of Valve Angle

Characteristic	Specifications	Definition
Regulate Air Flow	Maximum Air Flow Rate	Specify the maximum (wide open throttle) air flow rate with the vacuum level required by the engine. Section 2.0 provides a procedure for determining a rough estimate of required airflow at WOT.
	Minimum Air Flow Rate	Specify the vacuum level and maximum airflow rate when the throttle is at its minimum mechanical position
	Default Air Rate	Specify the vacuum level and airflow rate that the ETC-ACV provides when there is no actuator power.
	Air Flow Curve	A curve of the required airflow rate versus throttle rotation. (The airflow progression is important to consider for idle air control.)
	Noise	The allowable audible noise for the ETC Air Control Valve Assembly at all airflow rates.
	System Voltage	Specify the voltages at which the ETC-ACV actuator is expected to operate.
	System Current	Specify the maximum electrical current to allocate to Air Control Valve actuation. This will also determine wiring harness specifications.
Provide Clean Air Source	Air Flow Rate	Specify the airflow rate required for the clean air source. (Or specify port size or diameter).
Provide a Constant Vacuum Source	Air Flow Rate	List the airflow rate required for each of the manifold vacuum ports. (Or specify port size or diameter).

Table 3-2. (Part 1 of 2) Application Specifications and Characteristics (Applied Under Engine Operating Conditions).

Characteristic	Specifications	Definition
Sense Throttle Position	Sensors supply voltage	Specify the voltage and tolerance of the sensors supply circuitry from the ETC controller.
	Sensors Resistance (Contacting TPS design)	The two sensors can have different resistances. Specify the minimum resistances for the two sensors. (Or specify the maximum supply current for the sensors.)
	Output at Minimum Mechanical Position	Throttle position in percent of the supplied reference voltage on the Throttle Position Sensor output when the throttle is closed to the minimum mechanical position stop. Vibration and vacuum may contribute to the position output. Tolerance must be accounted for when specifying the acceptable output range at minimum mechanical position.
	Output at WOT (Span Angle) ***Note**: This is typically not the same position as the maximum mechanical position)*	Minimum throttle travel output from idle to WOT is sometimes referred to as "span angle". WOT is the engine controller's 100% throttle position. For current systems, the output at WOT is 78% of reference voltage higher than the output at the minimum mechanical position. This is obtained from nominally 87° of rotation with a 0.9% per degree TPS slope. Actual output would be around 88% of Vref (± the tolerance at minimum mechanical position).
	Correlation	Correlation is the maximum variation between the two outputs of a dual track TPS after they have been converted to the same scale. (One output is inverted).
	Repeatability	Repeatability is the maximum variation for the TPS Output at any given Throttle shaft angular position. This is strictly a TPS specification that is difficult (at best) to measure when installed on an Air Control Valve.

Table 3-2. (Part 2 of 2) Application Specifications and Characteristics (Applied Under Engine Operating Conditions).

3.4 Operating Conditions

The ETC-Air Control Valve Assembly operates normally in the modes in Table 3-5.

Operating Mode	Operating Conditions
Air Temp.	-40°C to 40°C
Underhood Temp.	-40°C to 125°C
Intermittent Temp.	150°C (1 hour maximum)
Max. Vacuum Load Across Throttle Shaft	90 kPa

4.0 System Interface

4.1 General

The ETC-ACV Assembly interfaces with the other powertrain subsystems as described in this section and shown in Figure 4-1.

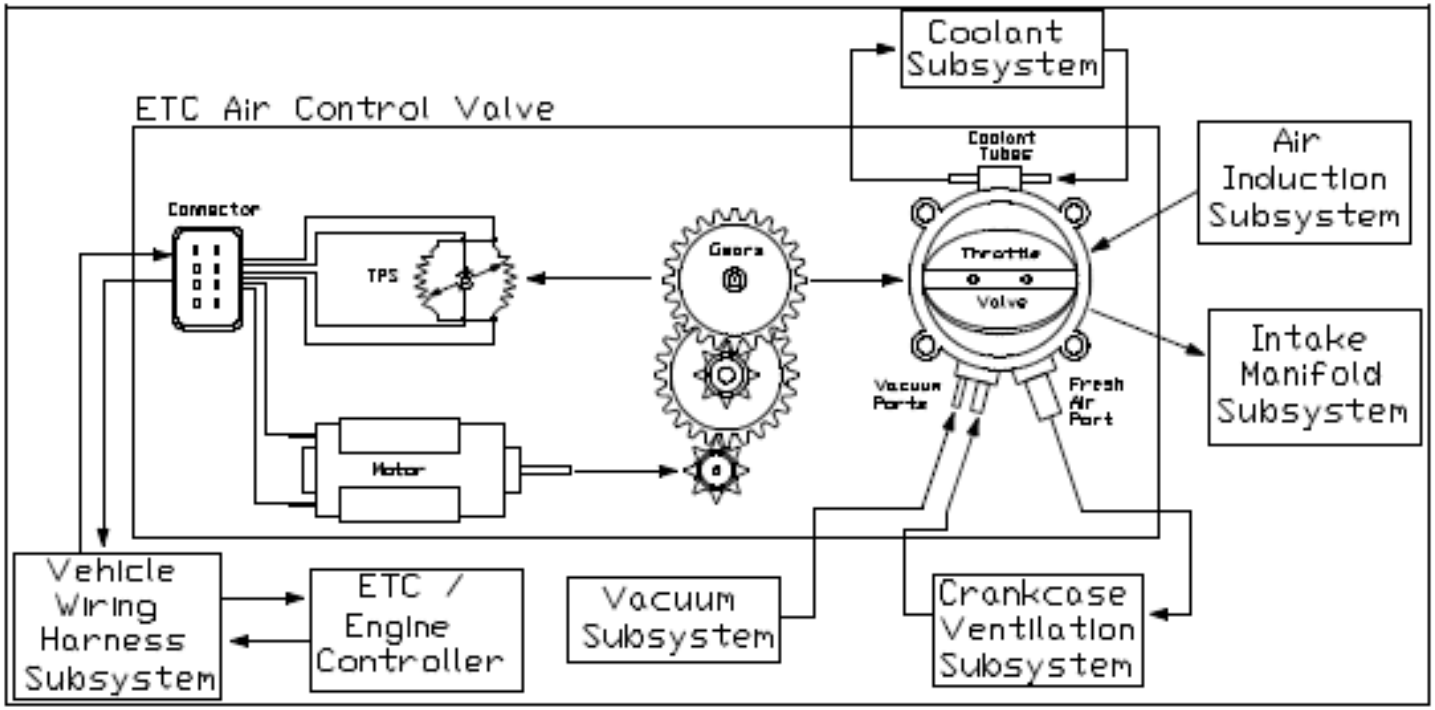


Figure 4-1. ETC-ACV Interfaces.

4.2.2 Electrical Interfaces

The ETC Air Control Valve electrical interfaces are achieved through the throttle position sensor(s) and the electrical actuator (motor).

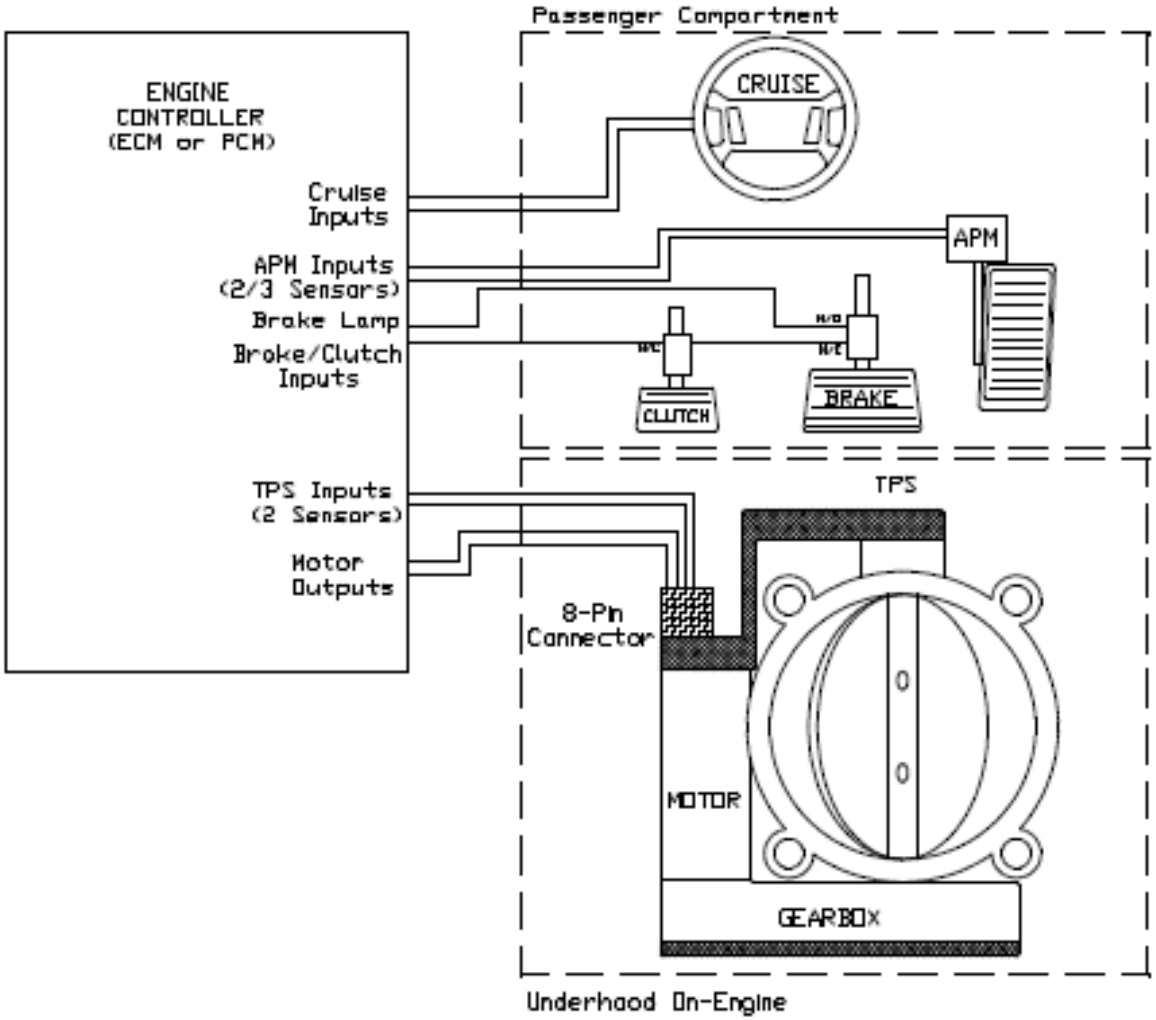


Figure 4-3. Diagram of ETC Subsystem Electrical Interfaces.

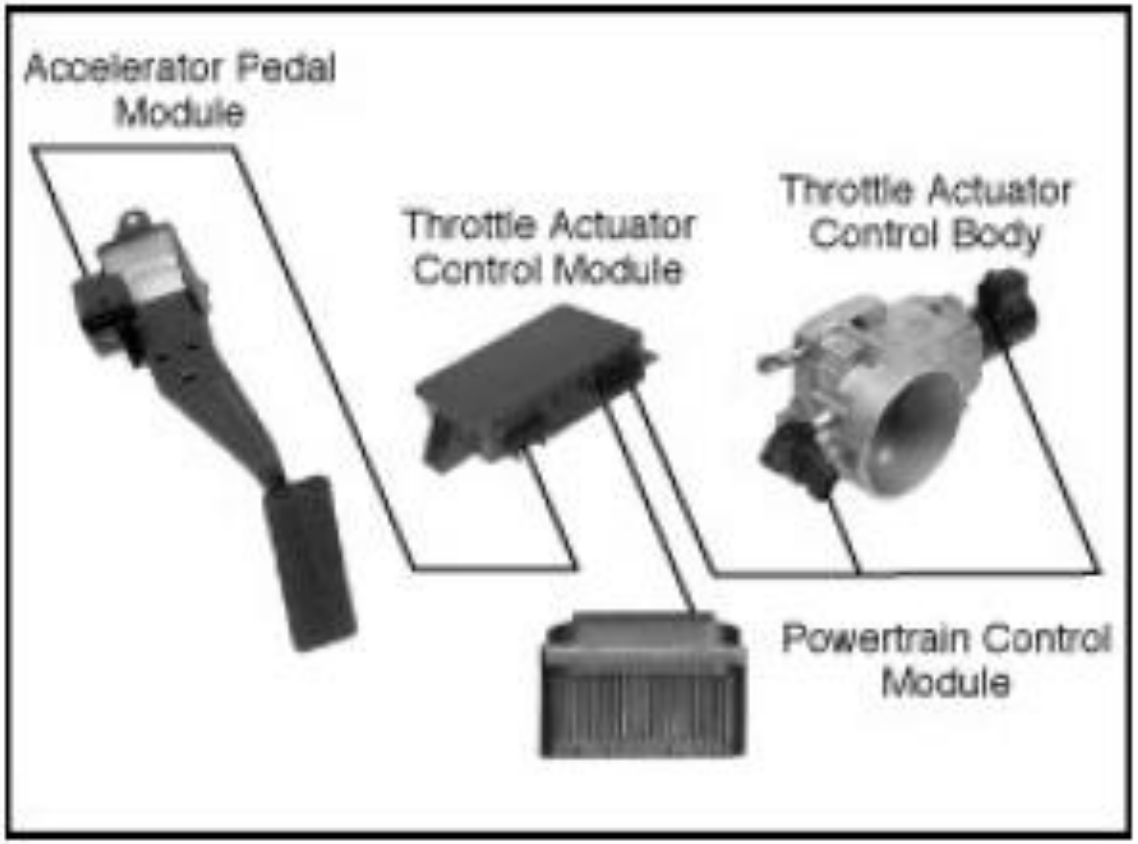


Figure 4-4. ETC-ACV Interface Visual Aid.

- The sensors' output voltages move in opposite directions as the throttle shaft rotates.

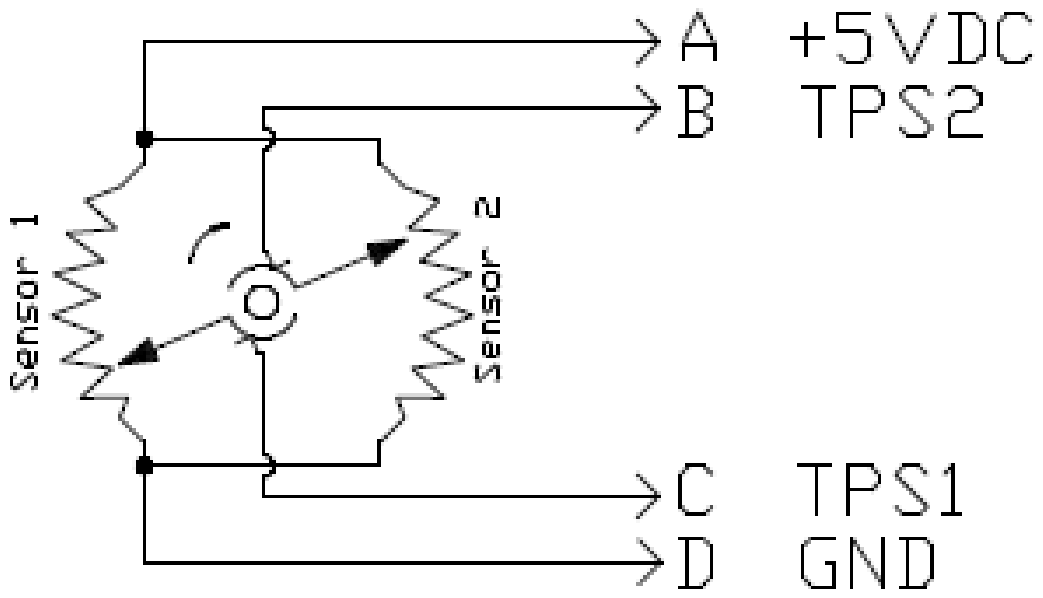


Figure 4-5. Dual Track TPS Circuit Diagram.

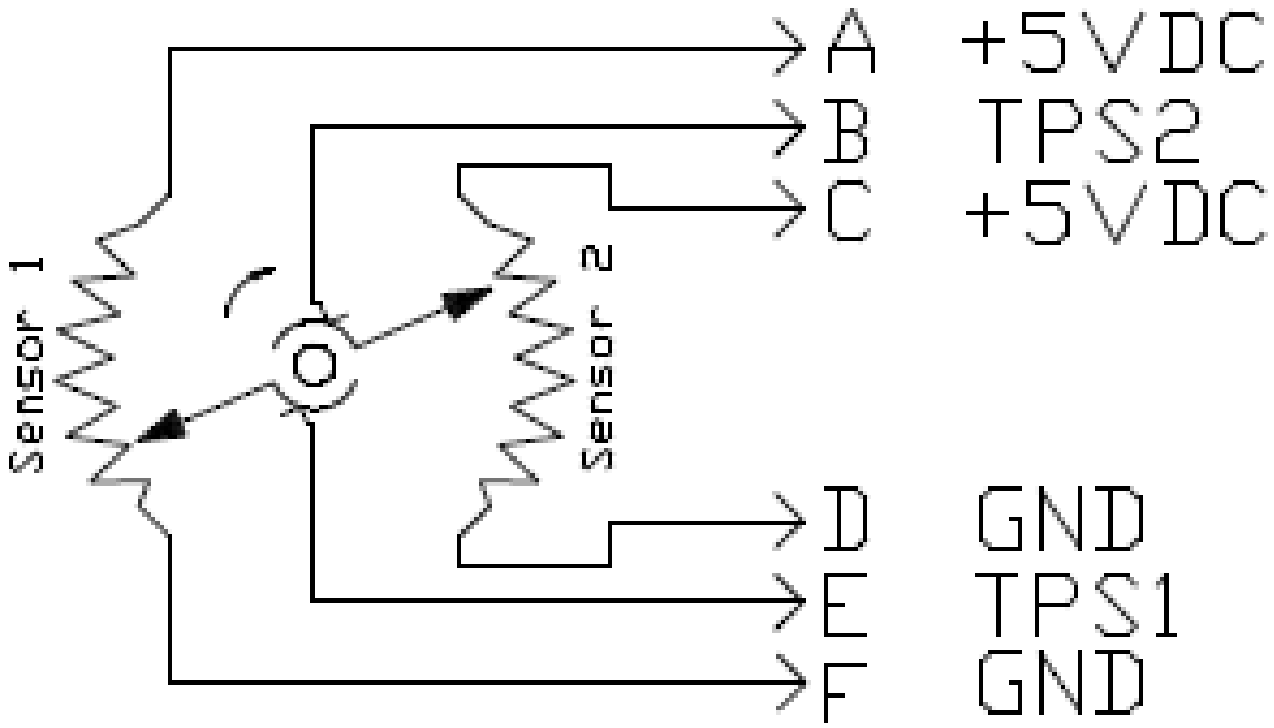


Figure 4-6. TPS Circuit Diagram with separate reference voltages for two sensors.

Parameter	Conditions	Minimum	Typical	Maximum	Units
Resistance, Pin A-C	All	4K	5K	6K	Ω
Contact Resistance, Pin B-Wiper	All	N/A	750	2.5K	Ω

Table 4-1 TPS 1 Parameters

Parameter	Conditions	Minimum	Typical	Maximum	Units
Resistance, Pin B-C	All	2.7K	3.4K	4.1K	Ω
Contact Resistance, Pin A-Wiper	All	N/A	750	2.5K	Ω

Table 4-2 TPS 2 Parameters

4.2.2.2 Actuator Motor Electrical Interface

This manual will discuss the DC brush type motor actuator. Other electrical motor actuators are possible.

Pin:	A	B
Name:	Motor1	Motor2
Function:	Actuator motor operating current1	Actuator motor operating current2

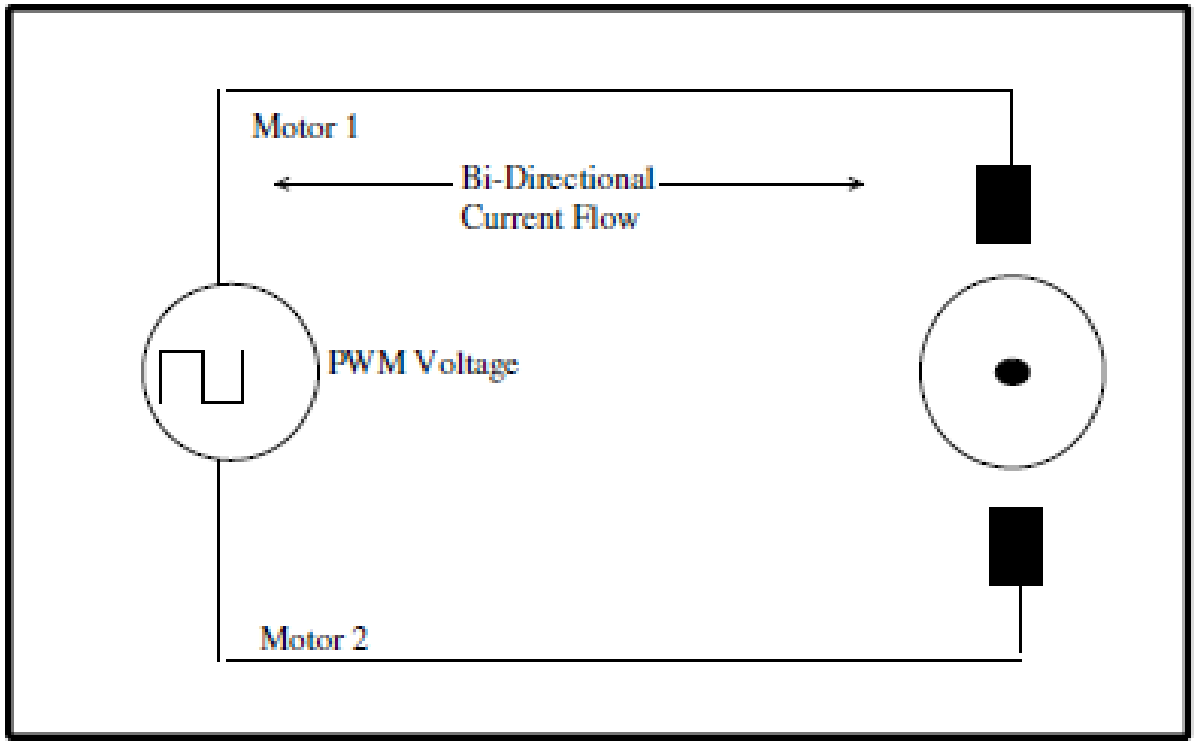


Figure 4-9. Actuator Brush Motor Mechanization Diagram

Parameter	Conditions	Minimum	Typical	Maximum	Units
Design Voltage		5.5	12.0	16.5	V
Current, Average	>10 sec	2.2			A
Current, Peak	< 10 sec			9.6	A
Inductance, Pin A-B	@ 100 Hz		0.83		mH
PWM Frequency		1.5	varies	24	KHz

Table 4-3 Typical Brush Motor Parameters. This is application dependant.

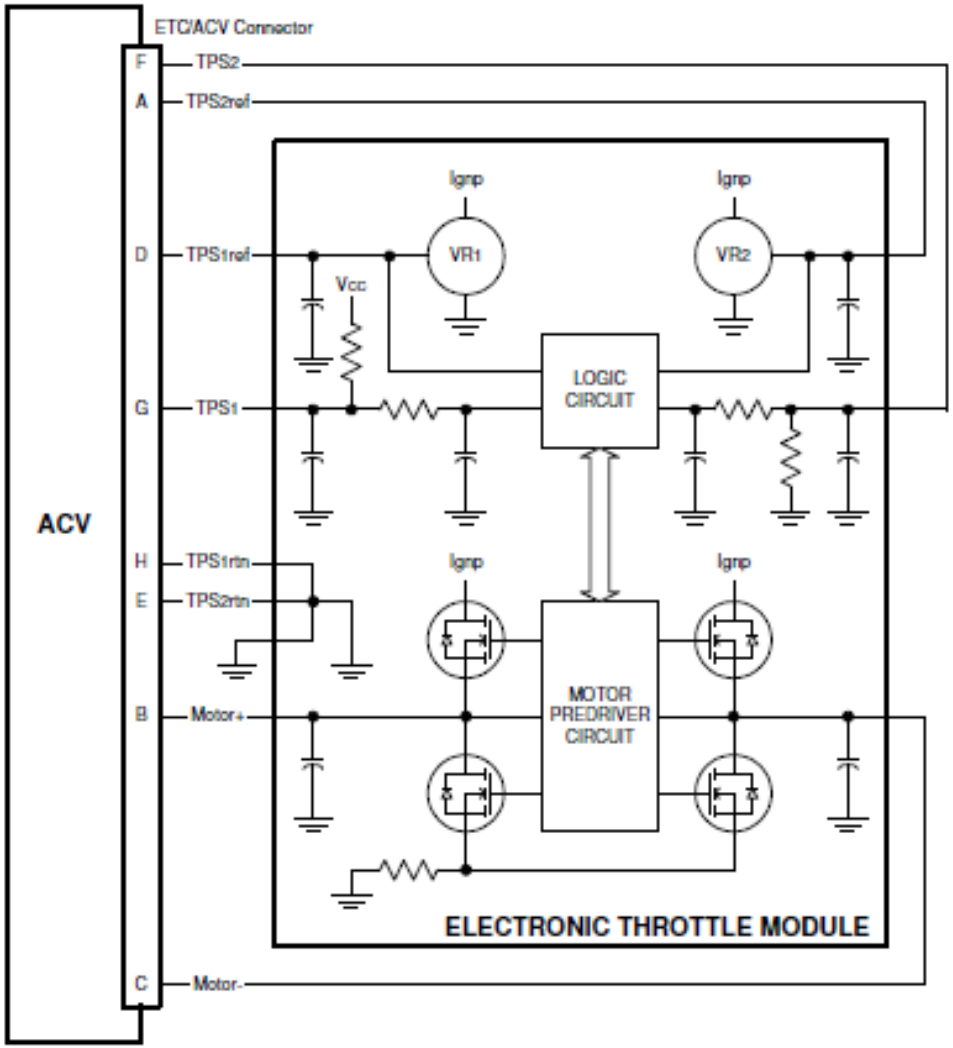


Figure 5-1 ETC Subsystem Schematic

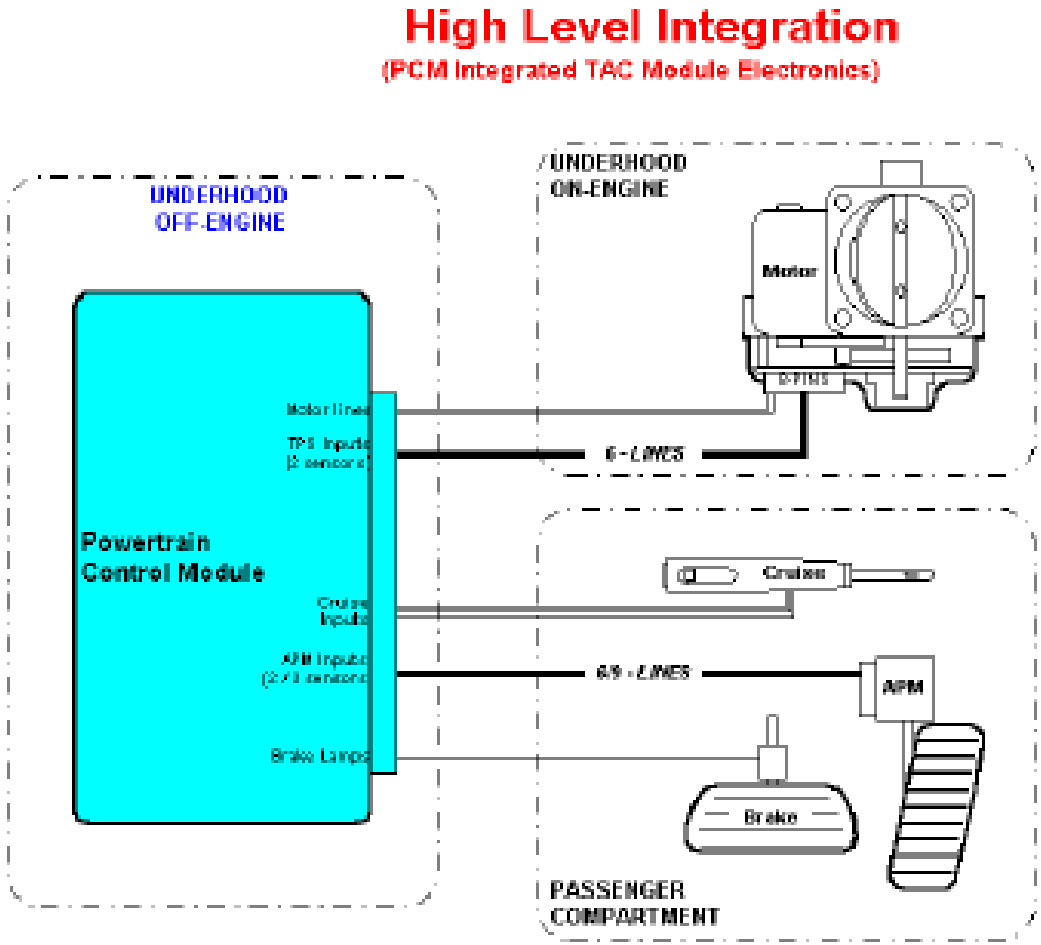
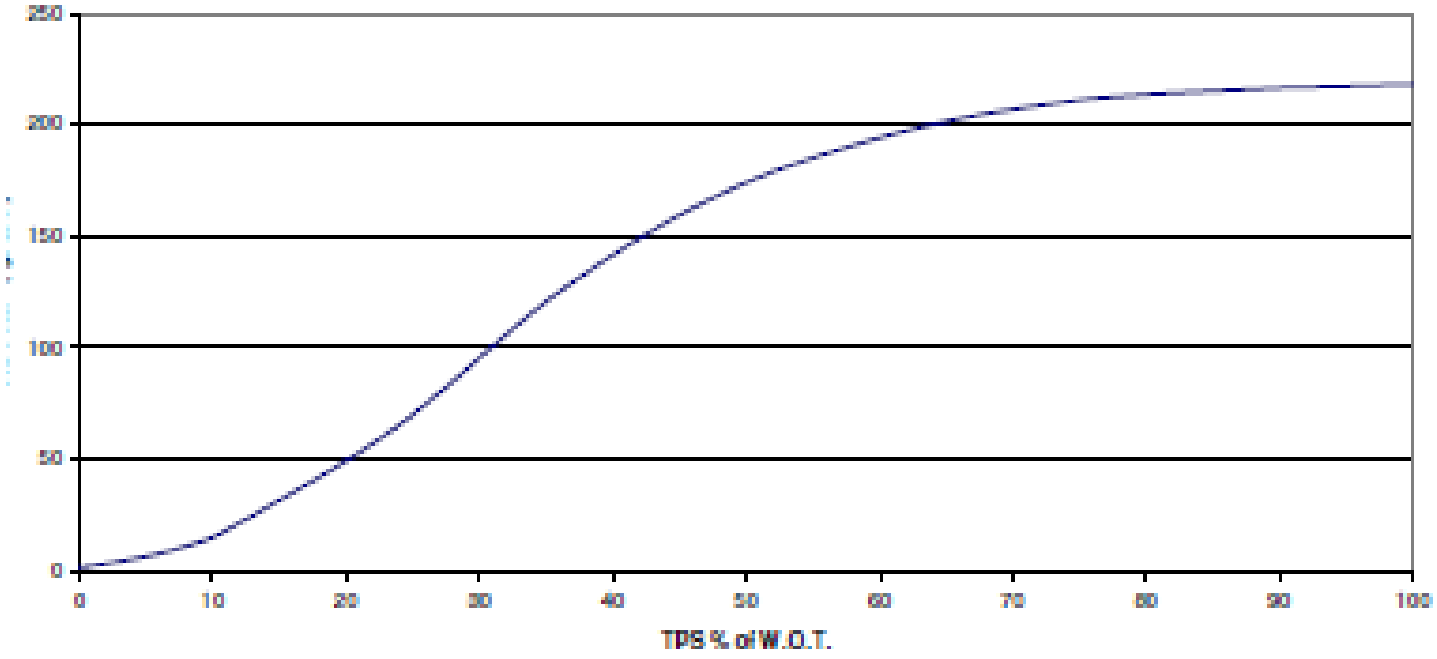


Figure 5-2 High Level ETC System Integration

75 mm ETC Average Air Flow