TOYOTA MOTOR CORPORATION
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February 10, 1987

Mr. Philip Davis, Director
Office of Defects Investigation, Enforcement
National Highway Traffic Safety Administration
400 Seventh Street, S. W.
Washington, D. C. 20590

RE: NEF-12 gdc, EA85-045

Dear Mr. Davis:

In response to your letter of November 14, 1986, in which you requested additional information concerning alleged sudden acceleration of certain 1981-1984 Toyota Cressida vehicles, we hereby submit, in triplicate, the data you requested.

Please note that the information claimed to be confidential is deleted and is being sent to the Chief Counsel's office under separate cover in accordance with the directions in your letter above.

If you have any technical questions concerning this matter, please contact our Washington branch office at (202) 775-1707.

Sincerely,

TOYOTA MOTOR CORPORATION

K. Kato

Kenichi Kato
General Manager
U.S. Office

KK:cc
Enclosures

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**RESPONSE TO NHTSA INQUIRY ON
SUDDEN ACCELERATION OF 1981 THROUGH 1984
TOYOTA CRESSIDA VEHICLES (EA85-045)**

Q.1. In reference to your letter of September 30, 1986, concerning the safety recall of certain 1982 model year Cressida, Celica and Celica Supra vehicles, provide the following information:

a. Describe in detail how the improper application of the printed circuit board coating could cause the soldered terminals of the integrated circuit to develop cracks, and the difference between the proper and improper application of the coating.

b. State when Toyota discovered the improper application of the printed circuit board coating.

c. Provide with English translation the relevant manufacturing processes and production records which provide the basis for the number of vehicles in 86V-132.

d. Describe in detail criterion for selecting 4,561 subject vehicles to be recalled.

e. Explain what Toyota intends to do about the vast majority of owner complaints pertaining to the alleged problem which are not covered by this recall. Out of the total of 54 owner complaints we have received, only 2 are in the group of vehicles being recalled.

Response 1:

a., b., c. The response to items a., b., and c. were provided in our letter, dated October 13, 1986, to your office.

d. In reference to item d., the subject recall vehicles were selected from those vehicles produced in the time frames indicated in the table below. As indicated in our letters dated September 30, 1986 and October 13, 1986, the subject vehicles were potentially fitted with computers that were produced between March 20, 1981 and August 20, 1981, which may have had improper coating of the circuit board due to inadequate coating viscosity control. Computers manufactured before March 20, 1981 were of a totally different design (analog vs. digital).

The vehicles produced after the date specified in the following table were equipped with computers that had been manufactured with the appropriate coating viscosity controls and a different coating material. Thus, it was determined that other computer units were not affected and did not warrant inclusion in the recall.

Model	Model Year	Production Period	No. of Units
Toyota Cressida	1982	Aug. 1, 1981 to Sept. 10, 1981	1801
Toyota Celica	1982	Aug. 18, 1981 to Sept. 4, 1981	1936
Toyota Supra	1982	Aug. 7, 1981 to Oct. 20, 1981	824
			4561

The above production period varies due to different vehicle model assembly line and cruise control system installation rates.

e. It is our policy that once an identifiable systematic defect is found, we initiate proper action to rectify it. Although we have investigated more than 60% of the alleged sudden acceleration incidents, no problems were found other than the two in which NHTSA recovered the defective cruise control computers. Once we were able to verify the defect, we initiated a voluntary recall campaign of those early production 1982 models which may have been equipped with defective computers.

However, in spite of our intense efforts, we have not been able to reproduce nor verify the existence of the alleged problem for the rest of the subject vehicles. Therefore, there is no justification to expand the scope of the recall. Needless to say, we continue to monitor and investigate the problem.

Q.2. Furnish the number and copies of all owner reports or consumer complaints received by Toyota, or of which Toyota is otherwise aware, pertaining to the alleged problem. Furnish all reports or complaints whether or not Toyota has verified each report.

Response 2:

See Response 5 below.

Q.3. Furnish the number and copies of all other reports, complaints, surveys, or investigations from all sources either received or authorized by Toyota, or of which Toyota is otherwise aware, pertaining to the alleged problem on the subject vehicles. Furnish all reports whether or not Toyota has verified each report.

Response 3

See Response 5 below.

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Q.4. Identify and describe each accident or subrogation claim (including the names, addresses, and telephone numbers of the owner/occupants involved) of which Toyota is aware on the subject vehicles and which may have occurred due to circumstances, conditions, or problems caused by the alleged problem. Furnish all reports whether or not Toyota has verified each report.

Response 4:

See Response 5 below.

Q.5. Identify all lawsuits, both pending and closed, by title, location, and docket number in which Toyota is or was a defendant (or co-defendant) pertaining to, at least in part, the alleged problem on the subject vehicles. Provide a brief synopsis of each case, including Toyota's analysis of the incident, the identification of the vehicle (model series, model year, and VIN), the date of the incident which was the basis for the lawsuit, the date the lawsuit was filed, and the vehicle owner's name, address and telephone number. Identify all parties involved in the lawsuit.

Response 5:

The following is in response to questions 2, 3, 4 and 5.

The following information is that which we are aware of and/or received up to November 30, 1986 and does not include those reports previously submitted to your office or those previously received from your office.

(1) Owner reports

Attachment I contains 2 owner reports.

(2) Verbal reports

Attachment II contains 4 verbal reports.

(3) Field reports

There are no further field reports.

(4) Accident reports or subrogation claims

Attachment III contains 7 accident reports and 1 subrogation claim.

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Accident Reports:

a) Owner: Walter Donaldson
   Passenger: Owner and spouse
   Address: 7935 [illegible] Drive, Charlotte, NC
   Telephone: Unknown
   VIN: JT2MX63E7D0020459
   Allegation: On Labor Day 1985, when my wife shifted from P in the driveway, the vehicle crashed into the house. In March 1986, when the vehicle was shifted from P at a steak house parking lot, the vehicle bolted away.

b) Owner: Barbara Schneider
   Passenger: Spouse of owner
   Address: 3418 Poplar St., Oceanside, NY
   Telephone: (516) 764-3[illegible]
   VIN: JT2MX63E5E0[illegible]
   Allegation: Husband shifted the vehicle into R, the vehicle shot backwards and hit parked vehicles.

c) Owner: Joseph K[illegible]
   Passenger: Self
   Address: 81[illegible] Pear Ave., Sunnyvale, CA
   Telephone: (408) 732-[illegible]
   VIN: JT2MX62[illegible]
   Allegation: The vehicle accelerated and hit garage at 60 mph. Then, he put vehicle in Reverse and hit neighbor's garage.

d) Owner: Helen Asgian
   Passenger: Self
   Address: 228 Sandy Knoll Dr., Doylestown, PA
   Telephone: (215) 348-5047
   VIN: JT2MX63E7E0058517
   Allegation: On March 17, 1986, while driving at 35 mph, the vehicle suddenly accelerated without warning. Could not control vehicle at high speed, resulting in complete rollover and vehicle was damaged.

e) Owner: Gilda Smith
   Passenger: Self
   Address: 60 Wendel Ave., Kenmore, NY
   Telephone: Unknown
   VIN: JT2MX63E1E0069416
   Allegation: On 6/27/85, shifted the vehicle to D at a parking lot, the vehicle flew forward hitting 2 parked cars within a few seconds.

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f) Owner: Morris Schwartz
Passenger: Self
Address: RR1 Box 274B, 10 East Dr., Montauk, NY
Telephone: (516) 668-3849
VIN: JT2MX62E6B0025036
Allegation: Shifted to D and left parking lot. Stopped at cross street by braking. When brake was released, the vehicle suddenly shot forward at uncontrollable speed and struck a vehicle.

g) Owner: E. Dickson
Passenger: Self
Address: 33 Sharon Ave., Piedmont, CA
Telephone: (415) 428-2218
VIN: JT2MX63E8D0020017
Allegation: On Oct. 15, 1985, started the vehicle at hamburger shop parking lot, but the car accelerated very rapidly backward toward the street. Put the car in drive and it accelerated rapidly forward.

Subrogation Claims

h) Owner: D. Jordan
Passenger: Self
Address: 19653 S.W. 68th Ave., Tualatin, OR
Telephone: (503) 692-4354
VIN: JT2MX63B5E0061299
Allegation: When traffic signal changed, shifted into D and the vehicle accelerated fast enough that his foot was pulled from the brake pedal. His vehicle struck the one ahead of his.

Legal cases

We are aware of one legal case.

a) Plaintiff : Marc Leaderman
b) Defendants : Pacific Gas & Electric Co.
Toyota Motor Sales Co., Ltd.
Toyota Motor Sales, U.S.A., Inc.
Dexter Toyota Inc.
Great American Insurance Co.
c) Cross Complaint: Dexter Toyota Inc.
d) Location : Superior Court of the State of California for the County of Los Angeles
e) Docket Number : 827977
f) Vehicle/VIN : 1981 model Cressida
JT2MX62E8B0004933

C00464

g) Owner : Dexter Toyota Inc.
456 Francisco, San Rafael, CA

h) Description : While driving, he lost control, crossed centerline divider and violently struck street lighting pole.

i) Status : Pending

Q.6. Provide the following technical information relating to engine performance on 1980 through 1984 model year subject vehicles:

a. Provide a copy of a training publication or other description of the engine control system including, but not necessarily limited to, control of air intake, air fuel ratio, ignition timing, and any other components which directly or indirectly affect engine speed or power output.

b. Provide a copy of the Part I submission to the Environmental Protection Agency describing engine control systems for the 1984 Cressida vehicles (with and without turbocharger).

c. If not included in your response to parts a. and b. above, provide the following:

(1) Identify by name and function all computers or microprocessors which can affect engine speed or efficiency and identify all sensors and other electrical input signals received by each computer.

(2) A flow chart or similar description of how the relevant control units control the idle stabilization valve and the deceleration cut-off valve, and under which conditions each control system action occurs.

For each input and output signal to or from the computers or microprocessors which can affect engine speed or efficiency, specify the maximum and minimum voltage which would exist during any phase of normal vehicle use.

(4) A description of the cold acceleration enrichment system.

(5) A description of the ignition timing control system.

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d. Provide charts showing engine torque versus engine speed for the following conditions:

   (1) After a cold engine was started with the air conditioner on and off (specify ambient or engine temperature and time delay between engine start-up and torque measurement) with the throttle position at: closed, open 5 degrees, 1/4 open, half open, and fully open.

   (2) Engine at normal operating temperature (warm) with the throttle position at: closed, open 5 degrees, 1/4 open, half open, and fully open.

   (3) Throttle closed, but the idle stabilization valve is fully open (due to a simulated or actual malfunction) with the engine cold and also with the engine warm.

e. Specify the maximum and minimum power or engine torque required to operate the power steering vane pump, the water pump, the alternator, and the air conditioning compressor, and describe the conditions when the maximum and minimum power requirements occur. Provide separate data for each of these accessories.

f. Describe the differences between engines (and engine control systems) used with manual transmissions and those used with automatic transmissions.

Response 6:

The information requested is provided in alphanumeric part sequence to the above questions.

a. Please refer to Attachment IV, "Repair Manual/Emission Control Systems", for part a. information.

   Attachment IV-1 for 1981/1982 models (Section 3 - Emission Control System)
   IV-2 for 1981/1982 models (Section 3 - EFI System)
   IV-3 for 1983 models (Emission Control System/EFI System)
   IV-4 for 1984 models (Emission Control System/EFI System)

b. Applicable section of Part I submission made to EPA is submitted as Attachment V for part b. information.

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c-1 Please refer to Attachment IV for above part a. and information for part c.(1).

Attachment IV-[illegible] Section [illegible], Fig. 3-1 [illegible]
IV-[illegible] Section [illegible]
IV-[illegible] Section [illegible]-2

c-2 The idle stabilization valve control method related to the part c.(2) request is submitted as Attachment VI. [illegible]

Attachment VI-1 for 1981/1982 models
VI-2 for 1983/1984 models

c-3 Please refer to repair manuals submitted as Attachment IV for part a. above, which also describes the information requested in part c.(3).

Attachment IV-2 Section [illegible] to 3-[illegible] [illegible] to 3-78
IV-[illegible] Service Specification [illegible] All
IV-[illegible] Service Specification [illegible] All

c-4 The control method for the cold acceleration enrichment system is described in Attachment VII for part c.(4).

Attachment VII-1 for 1981/1982 models
VII-2 for 1983/1984 models

c-5 The control method for the ignition timing control system is described in Attachment VIII for part c.(5).

Attachment VIII-1 for 1981/1982 models
VIII-2 for 1983/1984 models

d. The information charts for part d.(1), (2) and (3) above are submitted as Attachment IX, showing engine torque versus engine speed.

Attachment IX-1 for 1981/1982 models (CONFIDENTIAL)
IX-2 for 1983/1984 models (CONFIDENTIAL)

e. The power requirements for part e. are as follows:

- Power Steering Pump:
  The chart showing the power required versus vane pump speed is provided as Attachment X-1 (CONFIDENTIAL).

- Water Pump:
  The chart showing the power required versus water pump speed is provided as Attachment X-2 (CONFIDENTIAL).

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- Alternator:
  The chart showing the power required versus alternator speed is provided as Attachment X-3 (CONFIDENTIAL).

- Air Conditioner Compressor:
  The table showing the power required versus compressor speed is provided as Attachment X-4 (CONFIDENTIAL).

f. The information requested in part f. above is as follows:

The 1981 and 1982 year models were equipped with automatic transmission only. Thus, the difference between the automatic and manual transmission-equipped engine control system for 1983 and 1984 year models only will be described.

The primary differences for automatic transmission-equipped vehicles are:

(1) on the throttle positioner switch an angle sensor is additionally provided;

(2) the fuel cut system control specification is different (manual transmissions have higher R.P.M. control parameters to reduce fuel return shock);

(3) the starting idle speed control and warm idle speed control method (for automatic transmission-equipped vehicles, maintaining proper idling speed is required to activate the air conditioner, to control creep power and stabilize idling vibration);

(4) the throttle body linkage configuration (the driving feel might be affected due to the difference in the response of the accelerator between automatic and manual transmission-equipped models).

The above differences are indicated in Attachment XI.

Differences	Attachment No.
Throttle position switch	Attachment XI-1
Fuel cut controls	Attachment XI-2
Starting idle speed control	See part c.(2)
& warm idle speed control	Attachment VI
Throttle body linkage configuration	Attachment XI-3 (CONFIDENTIAL)

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Q.7. Provide the following technical information relating to performance of automatic transmissions on 1984 model year subject vehicles:

a. With the transmission in reverse, specify the maximum force (or drive wheel torque) acting to accelerate the vehicle if the idle stabilization valve is fully open (due to an actual or simulated malfunction). Provide a graph showing vehicle acceleration, speed, and distance as a function of time.

b. With the transmission in drive, specify the maximum force (or drive wheel torque) acting to accelerate the vehicle if the idle stabilization valve is fully open (due to an actual or simulated malfunction). Provide a graph showing vehicle acceleration, speed, and distance as a function of time.

c. Provide a graph showing vehicle acceleration from a stationary position in reverse and also in drive if the throttle is one quarter open and the brakes are released.

d. Could a different gear ratio result from any type of clutch failure or other failure when the transmission is in reverse? Explain.

Response 7:

Since a 1984 model year Cressida was not available, we obtained actual data by using a used 1983 model that was purchased in the U.S. as indicated in our letter of December 6, 1985, of which the engine, transmission, differential and tires are identical to the 1984 model. The actual measured data are submitted as Attachment XII (CONFIDENTIAL).

Regarding our response to part d., a different gear ratio resulting from failures when in reverse is technically impossible because of mechanical construction and hydraulic oil system design. We are not aware of this type of alleged complaint.

Q.8. Provide a graph showing the magnitude of forces acting to close the throttle as a function of throttle plate angle.

Response 8:

The graph showing the relation of the throttle plate angle at throttle body and the force to close the throttle is provided as Attachment XIII (CONFIDENTIAL). The data was obtained with the throttle body itself, not the actual vehicle.

Q.9. Provide a training publication or other description of the design and operation of the cruise control system installed on 1984 and 1985 model year subject vehicles.

Response 9:

See Attachment XIV.

Attachment XIV-1 for 1984 model
XIV-2 for 1985 model

Q.10. Provide, to the extent possible, the interior driver compartment measurements, as defined by the Society of Automotive Engineers (SAE) in SAE Standard J1100, listed in enclosed Table I for each model year of the subject vehicles.

Response 10:

See the MVMA Specification in Attachment XV.

Q.11. Provide demographic data describing the average United States subject vehicle purchaser.

Response 11:

The demographic data available at Toyota by model year and ownership is indicated in the table below.

Table 1

Model Year	Male %	Female %	Average Age	Annual family income ($)
1981	42	58	44	$ 41,800
1982	45	55	46	$ 45,700
1983	50	50	46	$ 48,300
1984	40	60	43	$ 49,900

Q.12. Compare the rate of sudden acceleration related accidents which have allegedly occurred in the United States with the Japanese accident rate for comparable Japanese vehicles.

Response 12:

The Cressida model in Japan is marketed as "Mark II". In addition, the same is also known as "Chaser" or "Cresta", depending on which Japanese dealership it is being marketed by.

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Based on the above equivalent Japanese Toyota vehicles for 1981 to 1984 models, the number of accidents reported in Japan which have occurred due to the alleged subject problem is about 1/100 of the U.S. alleged occurrence.

Q.13. Describe the differences, if any, between the design and location of the control pedals, steering wheels, and driver seats of the United States and Japanese versions of the subject vehicles.

Response 13:

The subject models' U.S. version and Japanese version mentioned in response 12 above was checked for comparison.

The major difference in the U.S. models versus the Japanese market models is that the steering and driving controls are located on the left side while the Japanese vehicles have the steering and controls on the right side of the vehicle.

However, there are no other significant differences other than the position and configuration for the difference of physical body structure of American and Japanese people.

Q.14. Provide the results of Toyota's analysis into possible mechanical or electrical causes of the alleged problem in the subject vehicles. Your response should include, but not necessarily be limited to, a discussion of the following:

a. Possibility that movement of the transmission selector linkage may cause movement of the throttle linkage due to friction, mechanical interference, or hydraulic action.

b. Possibility that the brakes will fail or that power assist will not function for the braking system.

c. Possibility of cruise control system malfunction.

d. Possibility engine speed can be increased by the idle speed control system, emission control system, fuel injection control system, or by some other malfunction.

Include actual measured values of pressure, force, RPM etc., and explain how the measurements were taken.

Response 14:

Toyota's analysis of possible causes for the alleged problem listed above are:

a. The transmission selector linkage is mechanically and electrically independent from the throttle linkage. Thus it is impossible for the transmission selector linkage to cause movement of the throttle linkage.

b. Based on investigation of complaint vehicles to date, we have not found any brake failure problems. In any case, a simultaneous brake and throttle failure would be necessary to result in sudden unexpected vehicle acceleration.

c. Other than these vehicles currently being recalled for the cruise control computer problem, we have no cases of cruise control system malfunction.

d. No malfunction of the engine control system will cause a runaway throttle condition. We have not found any abnormalities in vehicles investigated to date.

Q.15 Provide the results of Toyota's analysis relating to possible driver activation of the accelerator pedal on the subject vehicles when the driver believes he or she is applying the brake pedal. Include all measurements of control pedal dimensions and relevant vehicle dimensions which were taken of the subject vehicles and of other vehicles for comparison, and explain how each measurement was taken. Include an analysis of factors relating to the likelihood that drivers may not become aware that they may be applying the wrong pedal when such an error occurs. Measurements of pedal force-displacement characteristics for the brake and the accelerator pedals on the subject vehicles as well as all other vehicles measured for comparison shall also be provided.

Response 15:

As indicated in the previous letter to your office, we cannot provide quantitative and/or objective analytical results relating to possible driver inadvertent activation of the brake or acceleration pedal. (Reference our letter of March 2, 1984, response 5.)

The measurements of control pedal/pedal positions of the subject vehicle and other comparison vehicles are provided in Attachment XVI (CONFIDENTIAL). The measurement of pedal force-displacement characteristic results are provided in Attachment XVII (CONFIDENTIAL). From these data we did not observe any specific trends or characteristics.

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Q.16. If Toyota has repurchased, leased, or inspected/tested any of the subject vehicles which has reportedly experienced the alleged problem, identify each such vehicle by VIN and owner's name, describe the circumstances of the reported sudden acceleration incident involving each such vehicle, describe the vehicle inspection or tests to which the vehicles were subjected after the alleged sudden acceleration incident had occurred, and present the results of each such test or inspection.

Response 16:

In addition to information provided in responses to other questions in this letter, we have previously submitted the following investigation reports:

Date of Letter	Attachment No.
June 13, 1983	Attachment XVIII-1 to XVIII-3 XI-1, XI-2
March 2, 1984	Attachment IV-1 to IV-7 VI-1 to VI-3
June 24, 1985	Tarwater Case
December 6, 1985	Attachment IX-1 to IX-3 IX-5 to IX--10

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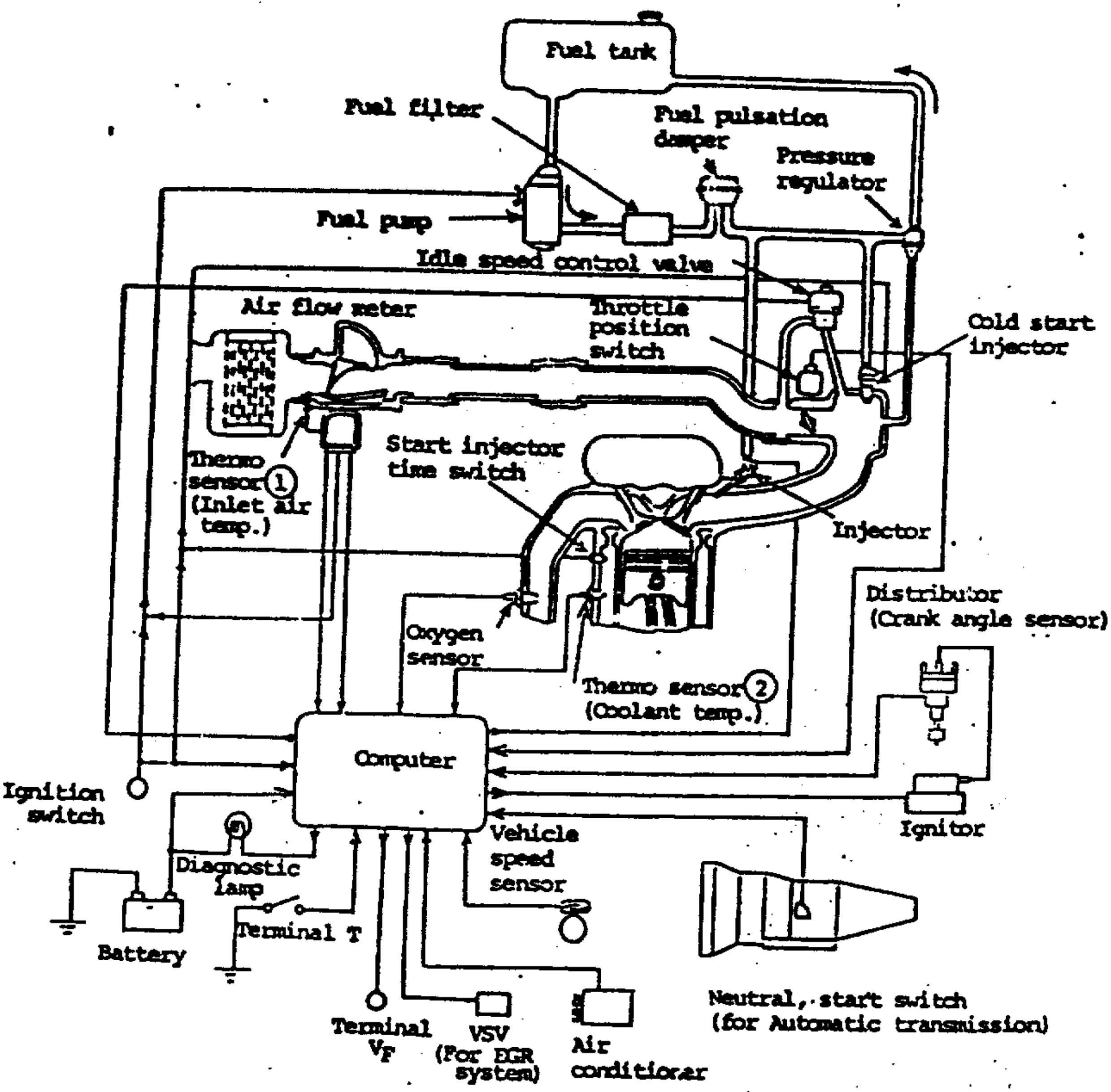
08.01.02.01 **Electronic fuel injection (EFI) system conf. and method of operation 2.8L (2.8V5B - MX63L & MX62LG)** 08.01.02.01

1) System conf.



2) General strategy

As shown graphically on the engine controlled functions chart the Electronic Control Unit (ECU) controls all engine functions of fuel injection, spark advance, idle speed, EGR and diagnostics.

a) Fuel injection control

The fuel injection strategy shown on the attached flow charts is based on a speed-mass calculation where the appropriate quantity (pulse width) of fuel is calculated to yield a desired A/F ratio for each particular operating condition.
The volme of induced air through the air flow meter is converted into an electrical signal by a potentiometer and the signal is transmitted to the electronic control unit for the calculation.

Closed loop control is used to adjust the calculated pulse width to yield a near stoichiometric A/F ratio when required. In addition, various enrichment pulses are delivered as required.

i) Inlet air temperature compensation ; f(THA)

This compensation serves to compensate the change in air density depending on inlet air temperature change.

ii) Warm-up enrichment : f(WL)

This enrichment is provided during engine warm-up.
The initial value of f(WL) is determined just after engine cranking and then the value of f(WL) decreases proportionally to the number of injections until the value reaches the minimum value of f(WL) corresponding to coolant temperature.

iii) After start enrichment ; f(ASE)

Just after engine cranking, this enrichment is provided to obtain stable combustion. At first, the initial value, $f(ASE)_0$ is calculated using the initial value of f(WL), and then the f(ASE) decreases proportionally to the number of injections.

iv) Acceleration enrichment ; f(AEW)

The initial value, $f(AEW)_0$ which corresponds to coolant temperature is determined when turning off the idle switch and then the f(AEW) is decreased proportional to the number of injection.

Thus, when accelerated this enrichment is adopted to insure proper vehicle operation.

v) A/F feedback compensation ; f(A/F) and
Based A/F compensation ; f(LAF)

The continuously varying output voltage of the oxygen sensor is interpreted to feedback control signal by two compensations. One is f(A/F) which is used to control the air fuel ratio at stoichiometric, another is f(LAF) which is used to compensate for altitude changes and changes in base air-fuel ratio calibrations.

vi) OTP enrichment ; f(OTP)

This enrichment is provided to prevent over temperature of the exhaust system and to insure the driveability under full load condition.

vii) Battery voltage compensation ; Tv

This compensation pulse is delivered to compensate for the change in injection delay caused by battery voltage change.

Calculations

i) Based pulse width calculation

$$Tp = C_1 \times \frac{1000}{U \times N}$$

where
- Tp : Based pulse width
- U : Output voltage ratio of air flow meter ($U = C_2/Q$, C_2 : Constant)
- N : Engine RPM
- Q : Inlet air flow rate
- C_1 : Constant

ii) Corrected based pulse width calculation

$$T = Tp \times f(THA) \times f(WL) \times [f(A/F) + f(LAF)]$$
$$\times [1 + f(ASE) + f(AEW) + f(OTP)] + Tv$$

o At engine cranking, the corrected based pulse width is calculated as follows;

$$T = T_{STA} \times f(THA) + Tv$$

where T_{STA} : Starting pulse width

Fuel cut

Fuel injection is terminated by the signal from electronic control unit in order to prevent excess unburned HC emissions when throttle valve is fully closed and engine speed exceeds a certain value, and also to prevent the engine over-revolution during the extremely high engine speed operation.

b) Spark advance control, θ

The spark timing is controlled by the electronic control unit. The two basic operating modes are cranking and normal engine operation. When the engine is in the cranking mode, spark timing occurs at a specified setting regardless of other engine operating parameters. Under all other operating conditions engine spark timing is controlled as shown on the flow charts.

- Spark advance calculation

$$\theta = \theta_{BASE} + \theta_{COLD} + \theta_{HOT}$$

where θ_{BASE} : Base spark advance

θ_{COLD} : Coolant temperature compensation

θ_{HOT} : Overheating compensation

c) Idle speed control

The idle speed control system is controlled by the electronic control unit as shown on the attached flow charts. The electronic control unit determines the appropriate idle speed according to the engine condition and provides the electric signal to the ISC step motor corresponding to the difference between aimed idle speed and actual idle speed. The ISC step motor operates the ISC valve which controls bypass air.

d) EGR control

The EGR system is controlled by the electronic control unit sensing coolant temperature. The electric signal from the control unit is transmitted to the vacuum switching valve which controls the EGR valve.

:) Diagnostics

By analyzing various signals as shown in the later table the electronic control unit detects system malfunctions and abnormalities which may be related to the various operating parameter sensors or to the actuator. The electronic control unit stores the failure code associated with the detected failure until the diagnostic system is cleared by taking off the battery terminal.

i) Diagnostic lamp

A "Check Engine" lamp is used to inform the driver of the detected system malfunction or abnormalities. The lamp resets automatically when the fault clears.

ii) Output of diagnostic code

Diagnostic codes corresponding to diagnostic items are turned out from the terminal, V_F when the terminal T is shorted and idle switch is ON. (The terminal V_F and T are located in the engine room.)

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iii) Back-up function

When the microprocessor fails, a back-up circuit takes over to provide minimal driveability. If the electronic control unit detects an improper thermosensor signal, the data is replaced with an alternate value. Simultaneously, the lamp is activated.

iv) Diagnostic items

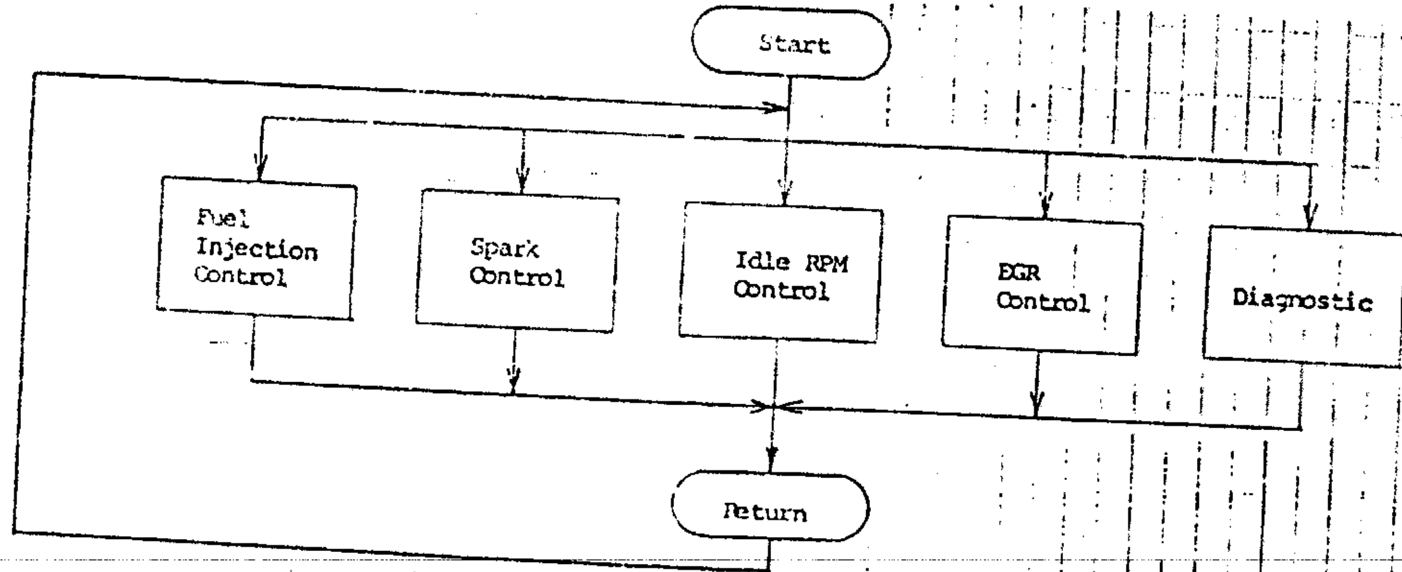
Diagnostic code	Malfunction indication	Diagnostic lamp
11	Power supply fail	No indication
12	No crank angle pulses	ON
13	Crank angle pulse fail	ON
14	Igniter fail	ON
21	Oxygen sensor fail	ON
22	Thermo sensor fail (Coolant temp.)	ON
23	Thermo sensor fail (Inlet air temp.)	No indication
31	Output signal of air flow meter failed low	ON
32	Output signal of air flow meter failed high	ON
41	Throttle position sensor fail	No indication
42	Vehicle speed sensor fail	No indication
43	No start switch signal	No indication
51	Air conditioner signal fail or neutral start signal fail	No indication

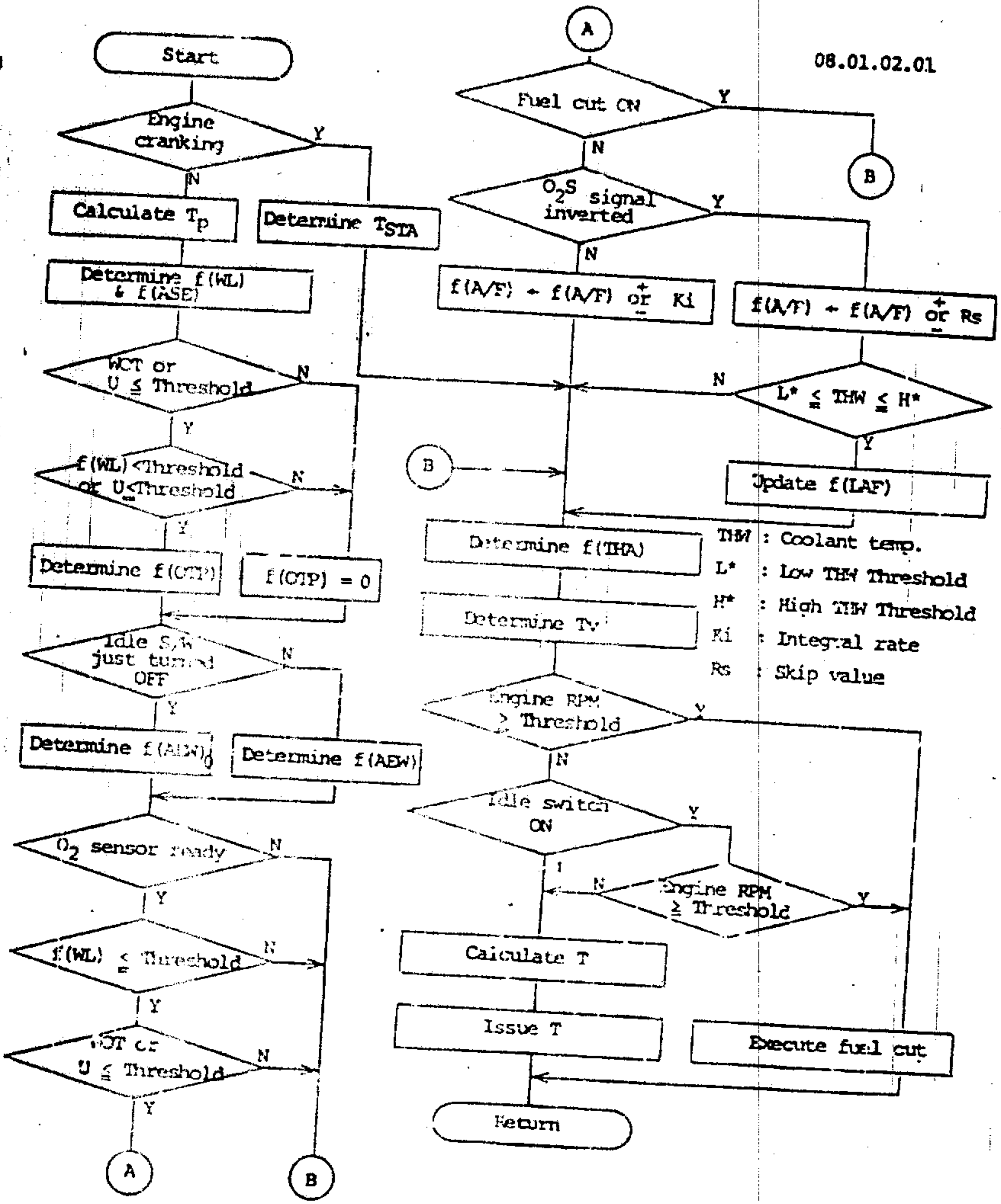
3) Engine controlled functions charts

a) Relationship between sensed and controlled parameters

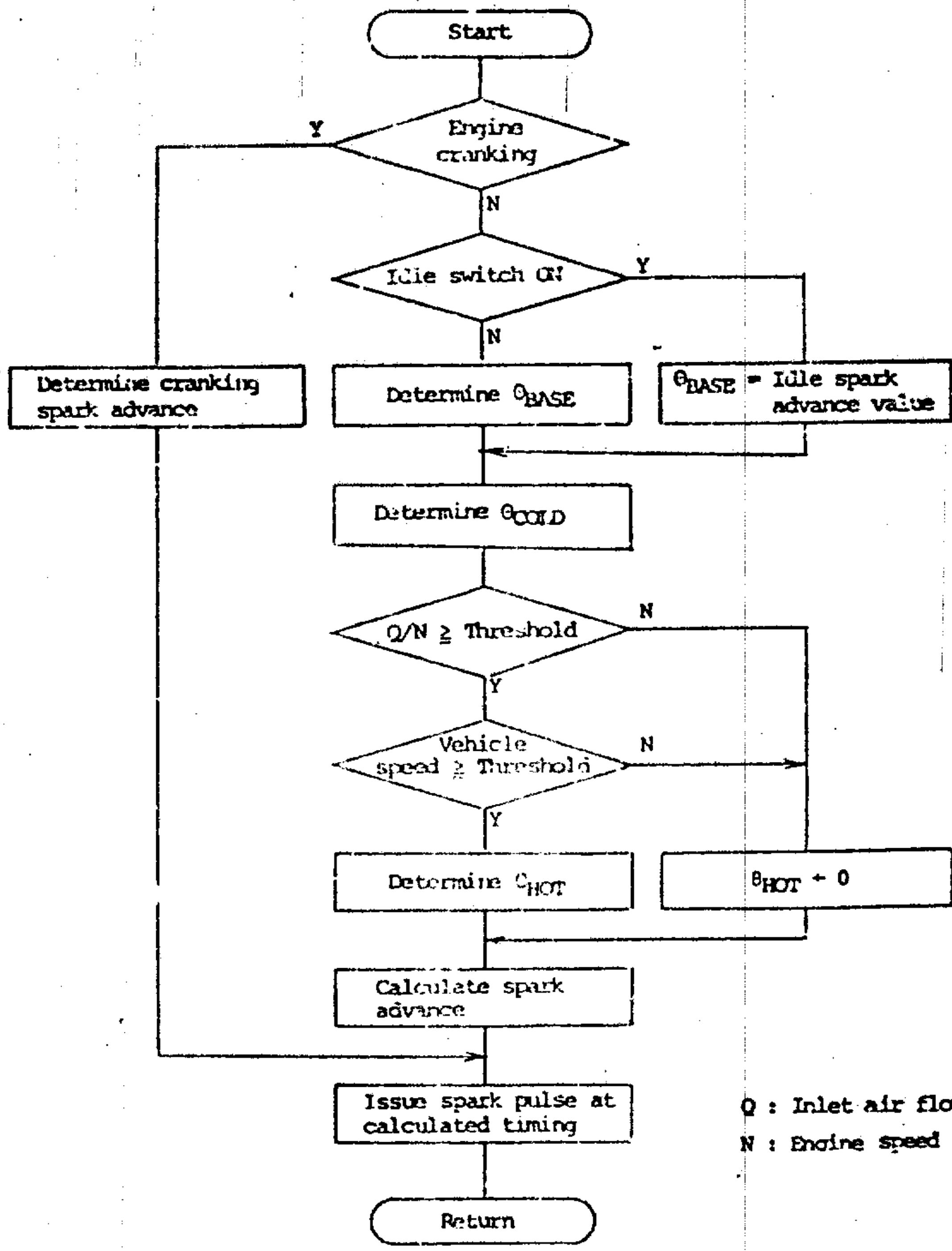
Sensed parameter	Sensor	Controlled parameter				
		Fuel injection	Spark advance	Idle RPM	EGR gas flow	Diagnostic lamp
Crank angle and/or Engine RPM	Crank angle sensor	X	X	X		X
Inlet air flow rate	Air flow meter	X	X			X
Inlet air temperature	Inlet air temperature sensor	X				X
Coolant temperature	Coolant temperature sensor	X	X	X	X	X
Exhaust O_2	Oxygen sensor	X				X
Throttle angle	Throttle position sensor	X	X	X		X
Vehicle speed	Vehicle speed sensor	X	X	X		X
Cranking	Starter switch		X	X		X
Air con. switch ON & OFF	Air conditioner switch		X	X		X
Shift position	Neutral start switch			X		X
Battery voltage	Battery	X				X

b) Functional logic flow charts




Start
Engine cranking
Calculate T_p
Determine T_{STA}
Determine f(WL) & f(ASE)
WOT or U ≤ Threshold
f(WL) < Threshold or U ≤ Threshold
Determine f(OTP)
f(OTP) = 0
Idle S/W just turned OFF
Determine f(AEW)
Determine f(AEW)
O_2 sensor ready
f(WL) ≤ Threshold
WOT or U ≤ Threshold
A
B
A
Fuel cut ON
B
O_2S signal inverted
f(A/F) ← f(A/F) ± Ki
f(A/F) ← f(A/F) ± Rs
L* ≤ THW ≤ H*
Update f(LAF)
Determine f(THA)
Determine Tv
THW : Coolant temp.
L* : Low THW Threshold
H* : High THW Threshold
Ki : Integral rate
Rs : Skip value
Engine RPM ≥ Threshold
Idle switch ON
Engine RPM ≥ Threshold
Calculate T
Issue T
Execute fuel cut
Return

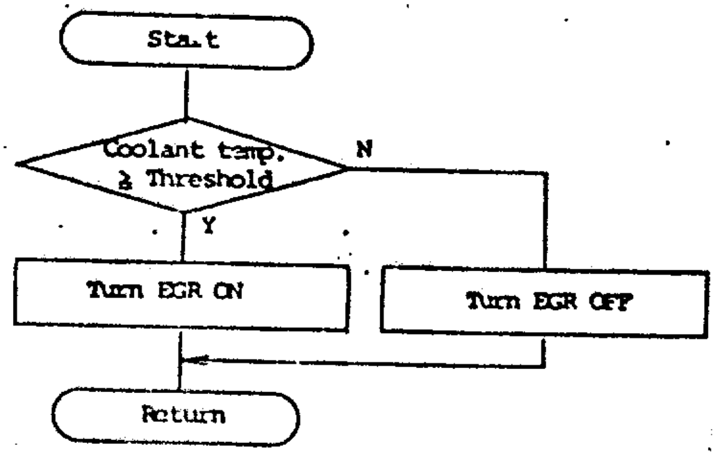
ii) Spark advance control



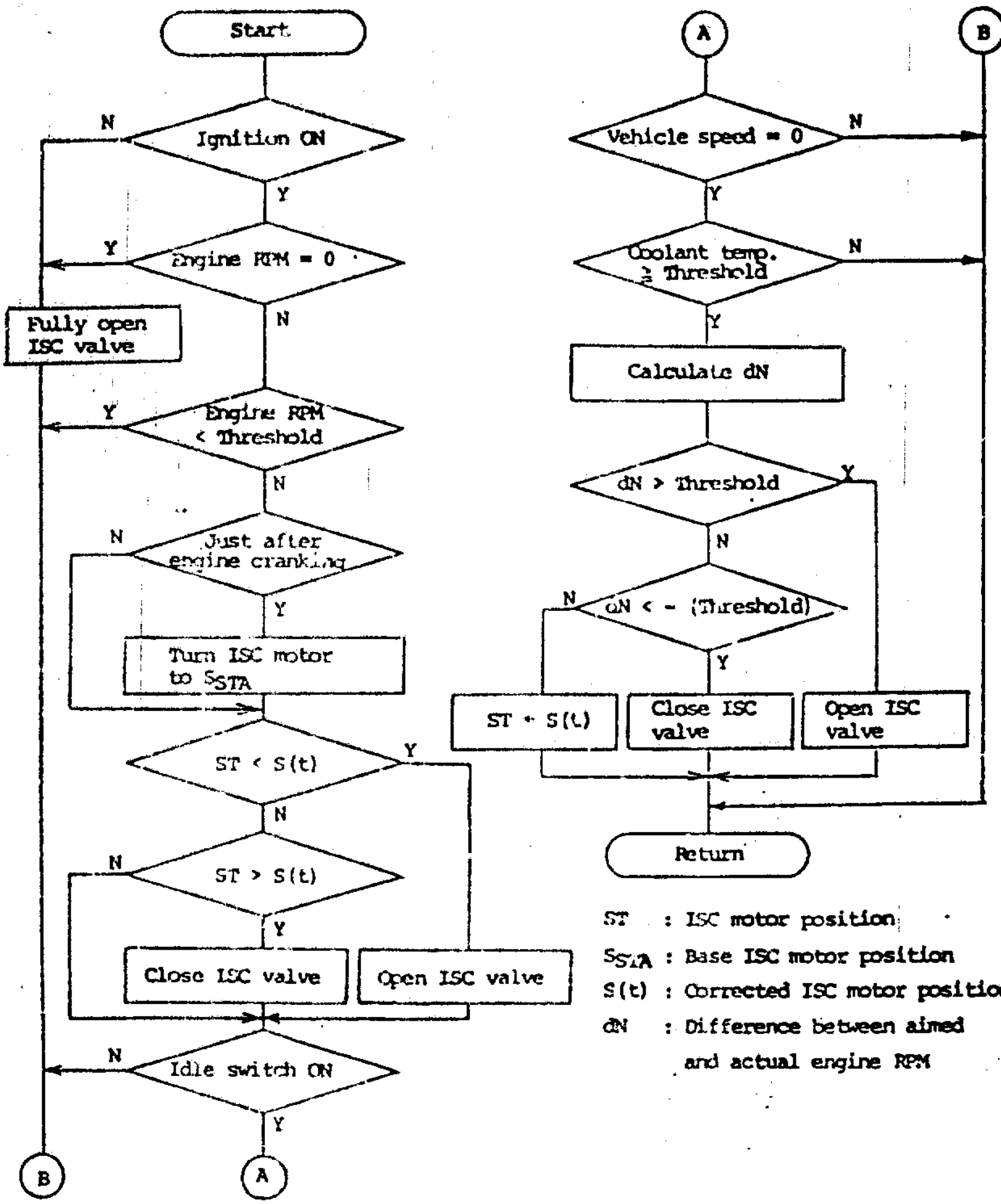
Q : Inlet air flow rate

N : Engine speed

iii) EGR control



iv) Idle speed control



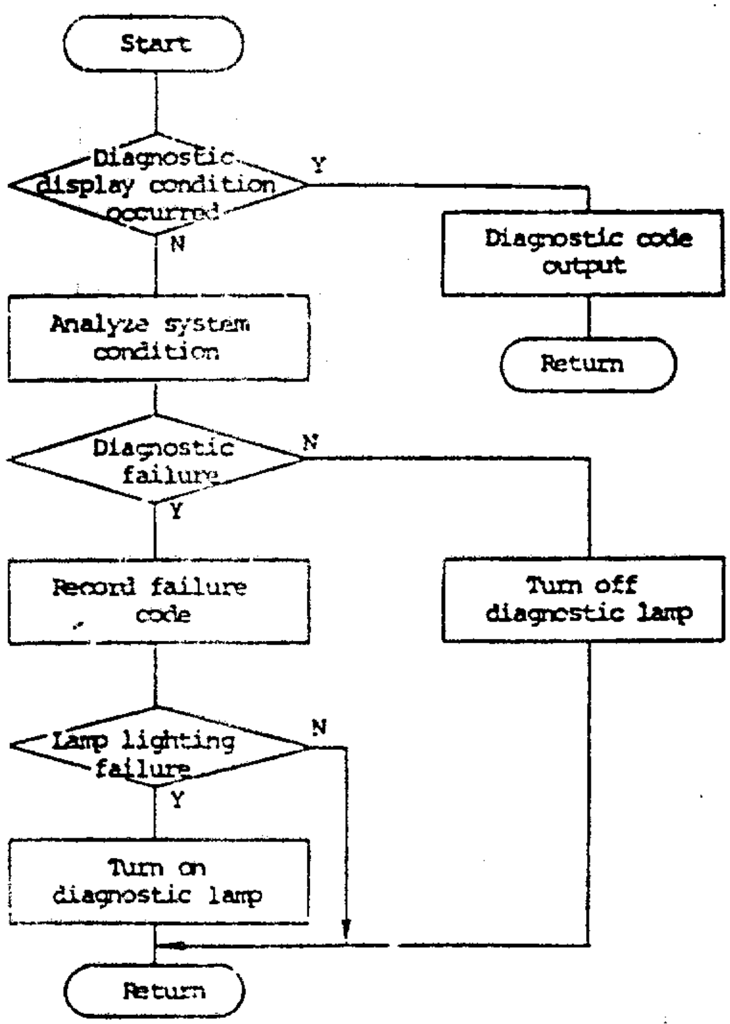
ST : ISC motor position

S_{STA} : Base ISC motor position

S(t) : Corrected ISC motor position

dN : Difference between aimed and actual engine RPM

v) Diagnostics



08.02.01.00 Ignition system (2.8V5B)

1) Ingnition system

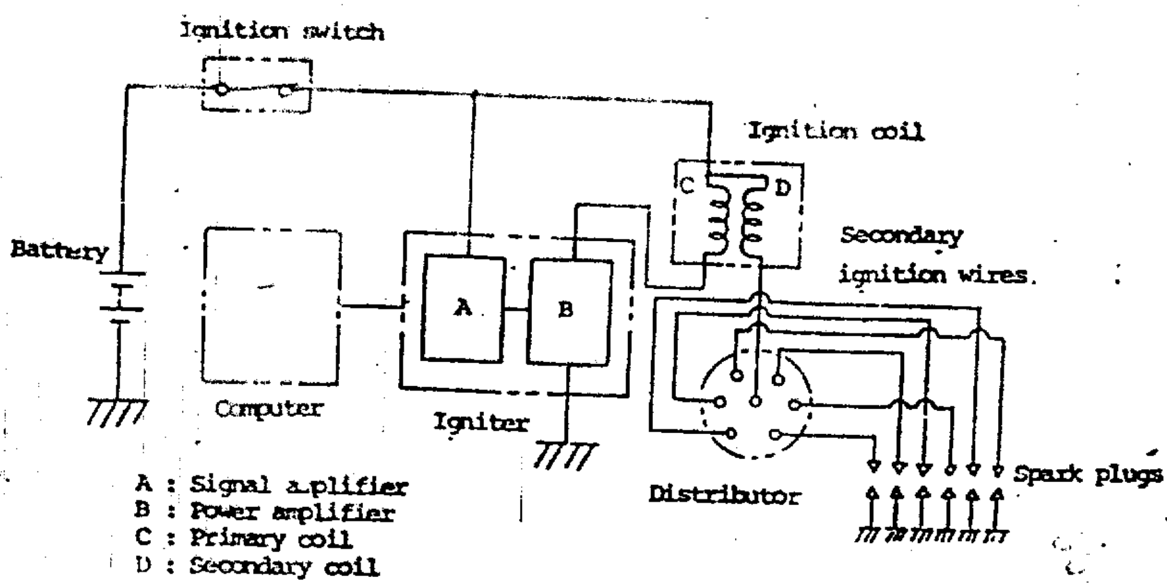
The ignition system is a series of systems in the engine electrical system which ignites the air-fuel mixture in the combustion chamber.
It consists of an igniter, ignition coil, distributor, spark plugs, ignition wires and computer.

o Igniter

In this system, the "ON" and "OFF" signals which are calculated at ECU cause the igniter to turn the primary current "ON" and "OFF", respectively. The voltage is then transformed to a stepwise "ON" and "OFF" current in the signal amplifier "A" and amplified to a certain level through amplifier "B". The benefits of this system are:

i) Improvement in engine performance when starting and at low speed because of its ability to maintain higher secondary voltage in the low speed range.

ii) Improvement in the durability and life of the ignition system.



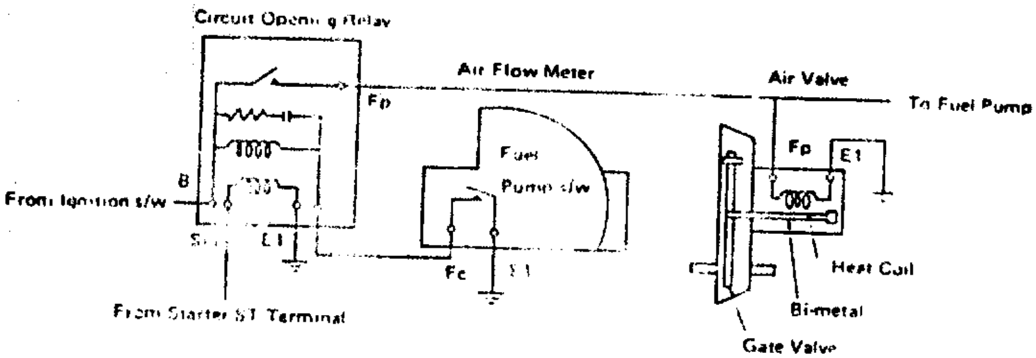
2) High energy ignition (HEI) system

HEI system consists of a high energy coil and an igniter. Basically, its operation is the same as the previously mentioned conventional ignition system. Since the high energy coil is a closed circuit type, as opposed to the open circuit type of the conventional ignition system coil, magnetic flux leakage is less. Therefore, the closed circuit type, although more compact than the conventional type coil, yields higher energy.

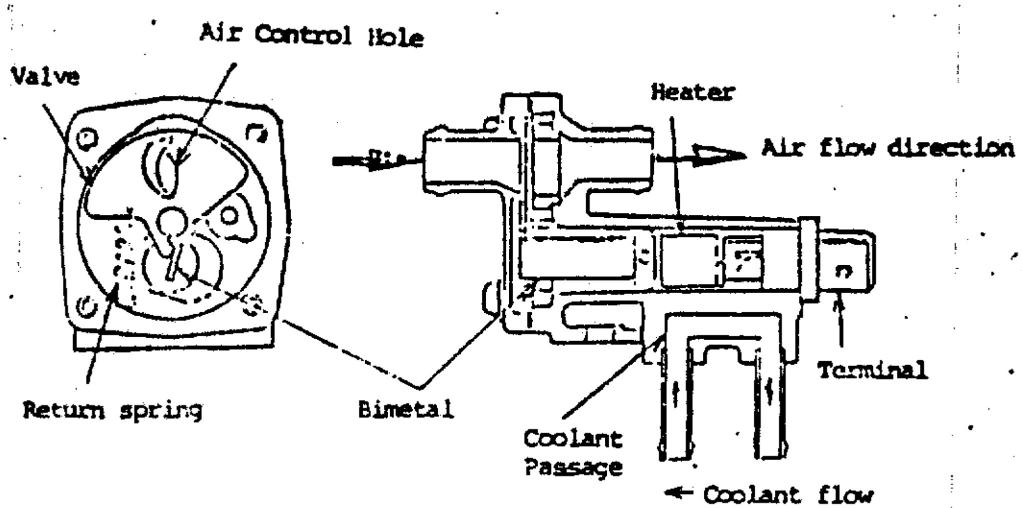
AIR INDUCTION SYSTEM
4. AIR VALVE 5. AIR VALVE ELECTRICAL CIRCUIT

INSTRUCTION POINTS	REMARKS
4. AIR VALVE The air valve is a device which keeps the engine at high RPM during cold engine operation.	STI Page 7 OHP 12-6

5. AIR VALVE ELECTRICAL CIRCUIT



1. Battery voltage is applied to terminal B of the circuit opening relay through the ignition switch.
2. During cranking and engine operation, the contact points of the circuit opening relay are closed, providing current flow to the air valve and fuel pump.
3. As current flows through the heat coil in the air valve, the bi-metal is heated and the gate valve gradually closes.
4. During engine operation, there is a continuous current flow to the heat coil.



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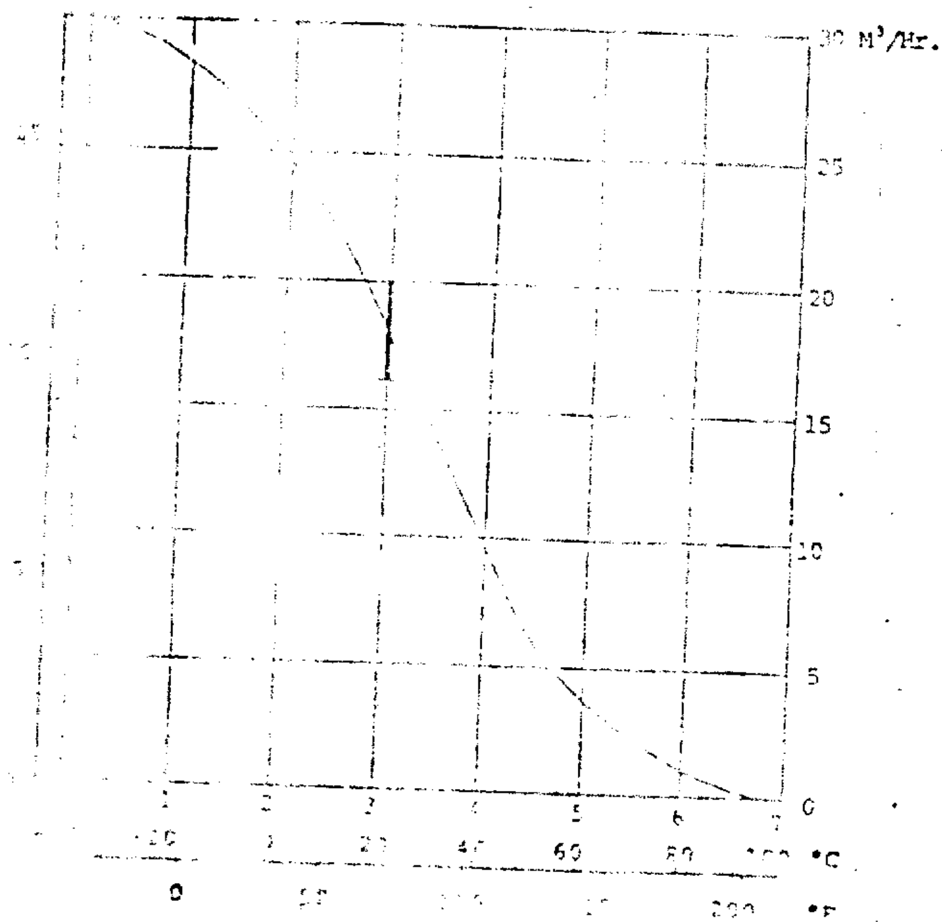
Engine family : BTY2.8V5HB4
Engine code : A11

Auxiliary ... characteristic ...

o Auxiliary air valve ... No. ____________



Inlet air temperature

[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	Rev.-3
[illegible]	[illegible]		-4
[illegible]	[illegible]		-5

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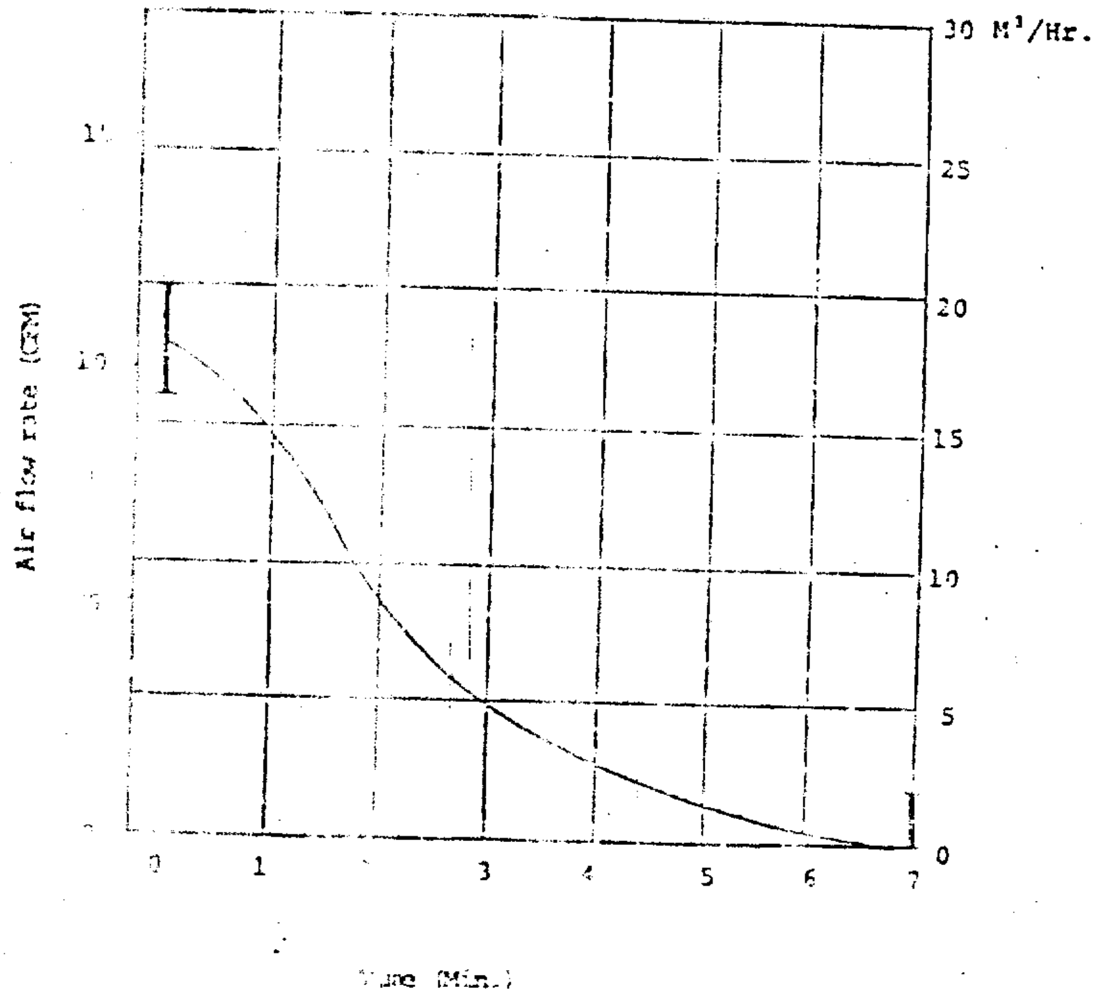
EPA REP. ______ 03

10.27.[illegible] [illegible] air valve characteristic - 2/2

[illegible] temperature - 68°F

Supplies voltage - 14V



c) Idle speed control

The idle speed control system is controlled by the electronic control unit as shown on the attached flow charts. The electronic control unit determines the appropriate idle speed according to the engine condition and provides the electric signal to the ISC step motor corresponding to the difference between aimed idle speed and actual idle speed. The ISC step motor operates the ISC valve which controls bypass air.

d) EGR control

The EGR system is controlled by the electronic control unit sensing coolant temperature. The electric signal from the control unit is transmitted to the vacuum switching valve which controls the EGR valve.

e) Diagnostics

By analyzing various signals as shown in the later table the electronic control unit detects system malfunctions and abnormalities which may be related to the various operating parameter sensors or to the actuator. The electronic control unit stores the failure code associated with the detected failure until the diagnostic system is cleared by taking off the battery terminal.

i) Diagnostic lamp

A "Check Engine" lamp is used to inform the driver of the detected system malfunction or abnormalities. The lamp resets automatically when the fault clears.

ii) Output of diagnostic code

Diagnostic codes corresponding to diagnostic items are turned out from the terminal, V_F when the terminal T is shorted and idle switch is ON. (The terminal V_F and T are located in the engine room.)

iii) Back-up function

When the microprocessor fails, back-up circuit takes over to provide minimal driveability. If the electronic control unit detects an improper thermosensor signal, the data is replaced with an alternate value. Simultaneously, the lamp is activated.

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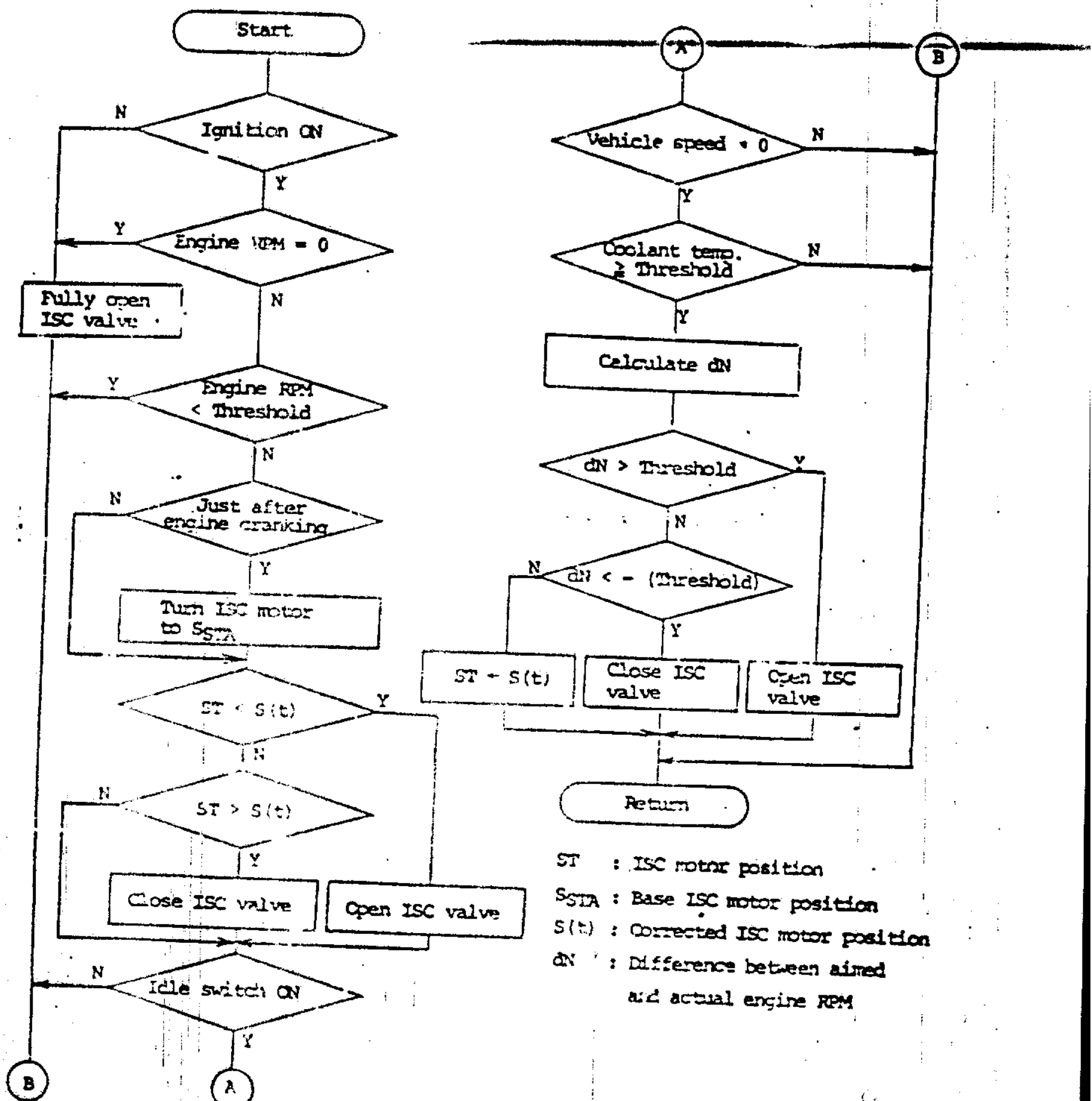
3) Engine controlled functions charts

a) Relationship between sensed and controlled parameters

Sensed parameter	Sensor (Controlled parameter →)	Fuel injection	Spark advance	Idle RPM	EGR gas flow	Diagnostic lamp
Crank angle and/or Engine RPM	Crank angle sensor	○	○	○		○
Inlet air flow rate	Air flow meter	○	○			○
Inlet air temperature	Inlet air temperature sensor	○				○
Coolant temperature	Coolant temperature sensor	○	○	○	○	○
Exhaust O_2	O_2 sensor	○				○
Throttle angle	Throttle position sensor	○	○	○		○
Vehicle speed	Vehicle speed sensor		○	○		○
Cranking	Starter switch		○	○		○
Air con. switch ON & OFF	Air conditioner switch		○	○		○
Shift position	Neutral start switch			○		○
Battery voltage	Battery	○				○

iv) Idle speed control



ST : ISC motor position

S_{STA} : Base ISC motor position

S(t) : Corrected ISC motor position

dN : Difference between aimed and actual engine RPM

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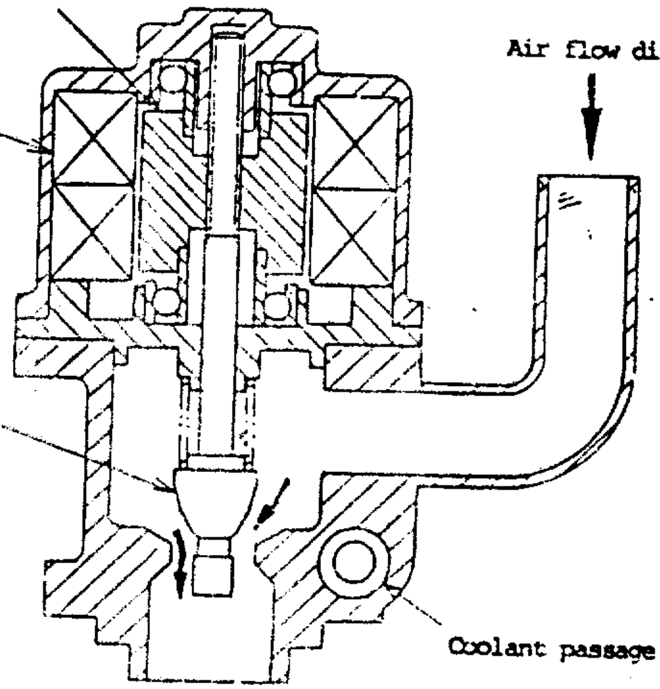
EPA REP. 94

94

000559

08.01.02.02 Component conf.
Idle speed control valve type A



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12) Coolant temperature compensation ; θ COLD (deg.)

Idle switch	Coolant temp. (°C) / Q/N	-20	0	20	40	50
ON	-	16	10	6	4	0
OFF	≥ 0.75					
	≤ 0.45	16	10	-7	-10	0

13) Over temperature compensation ; θ HOT (deg.)

i) θ HOT activation criteria

Q/N ≥ 0.771

ii) θ HOT

Coolant temp. (°C)	95	105
θ HOT	0	-6

14) Cranking idle advance

Cranking idle advance = 0 deg.

15) Basic ISC motor position ; S_{STA}

Coolant temp. (°C)	-20	40	60	70
S_{STA} (step)	125	74	60	50

M/T Engine code:1,3,5,7: S_{STA} is increased by 12 steps when air conditioner
5R1,7R1 switch is ON.

A/T Engine code:2,4,6,8: S_{STA} is increased by 8 steps when air conditioner
6R1,8R1 switch is ON.

16) Corrected ISC motor position ; S (t)

Coolant temp. (°C)	-35	-20	20	40	60	70
S (t) (step)	125	100	65	50	39	33

ISC motor is extended or retracted by one step at every 3 sec.

17) Idle speed control

i) Engine RPM threshold = 300 rpm

ii) coolant temperature threshold = 70°C

iii) dN threshold |dN| = 20 rpm

dN is defined as follows.

dN = Aimed Engine RPM - Actual Engine RPM

iv) Aimed Engine RPM

	Engine code	Air conditioner Switch	Neutral Switch	Aimed engine RPM (rpm)
M/T	1,3,5,7, 5R1,7R1	ON	—	900
		OFF	—	650
A/T	2,4,6,8, 6R1,8R1	ON	ON	900
			OFF	750
		OFF	ON	650
			OFF	600

18) Base line of air fuel ratio

Measuring condition		Injection time (m.sec.)
US/UB	Engine speed (rpm)	
0.600	800	2.06 ± 0.10
0.100	2000	3.91 ± 0.17
0.020	6000	6.92 ± 0.95

Note *1 US/UB denotes the air flow meter voltage ratio

*2 Other measuring condition

THW = 85°C, THA = 20°C, +B = 14V, Feedback OFF

Throttle position switch (WOT) OFF, Idle switch OFF,

Starter switch OFF

Engine family : DTY2.8V5FBB4

Engine code : A1J

* Thermo sensor (Inlet air temp.)

Resistance at -4.0 °F : 16.0 ± 2.4 kΩ

Resistance at 68 °F : 2.45 ± 0.24 kΩ

Resistance at 140 °F : 0.580 ± 0.087 kΩ

* ISC valve

Step number	Air flow rate *1 (CFM)	
	Design value	Actual value *2
7	$1.47^{+0}_{-1.47}$	
55	9.12 ± 1.12	Q_{55}
70	13.54 ± 2.24	Q_{70}
95	22.66 ± 2.44	Q_{95}
125	$28.84^{+2.06}_{-1.18}$	

Air flow rate *1 (CFM)	Step number	
	Design value	Actual value *2
4.71	30 ± 6	S_0

Note *1 : At pressure difference of 19.69 in.Hg

*2 : ISC valve is calibrated also by the deviation from standard step number calculated by the equation stated below using the actual value, Q_{55}, Q_{70}, Q_{95} and S_0 under individual measuring condition.

Step number

$$X_1 = \frac{Q_{55} - 9.12}{0.182} - (30 - S_0) \quad : \quad 0 \pm 4$$

$$X_2 = \frac{Q_{70} - 13.54}{0.365} - (30 - S_0) \quad : \quad 0 \pm 4$$

$$X_3 = \frac{Q_{95} - 22.66}{0.365} - (30 - S_0) \quad : \quad 0 \pm 4$$

$$X_{max} - X_{min} \quad : \quad 4^{+0}_{-4}$$

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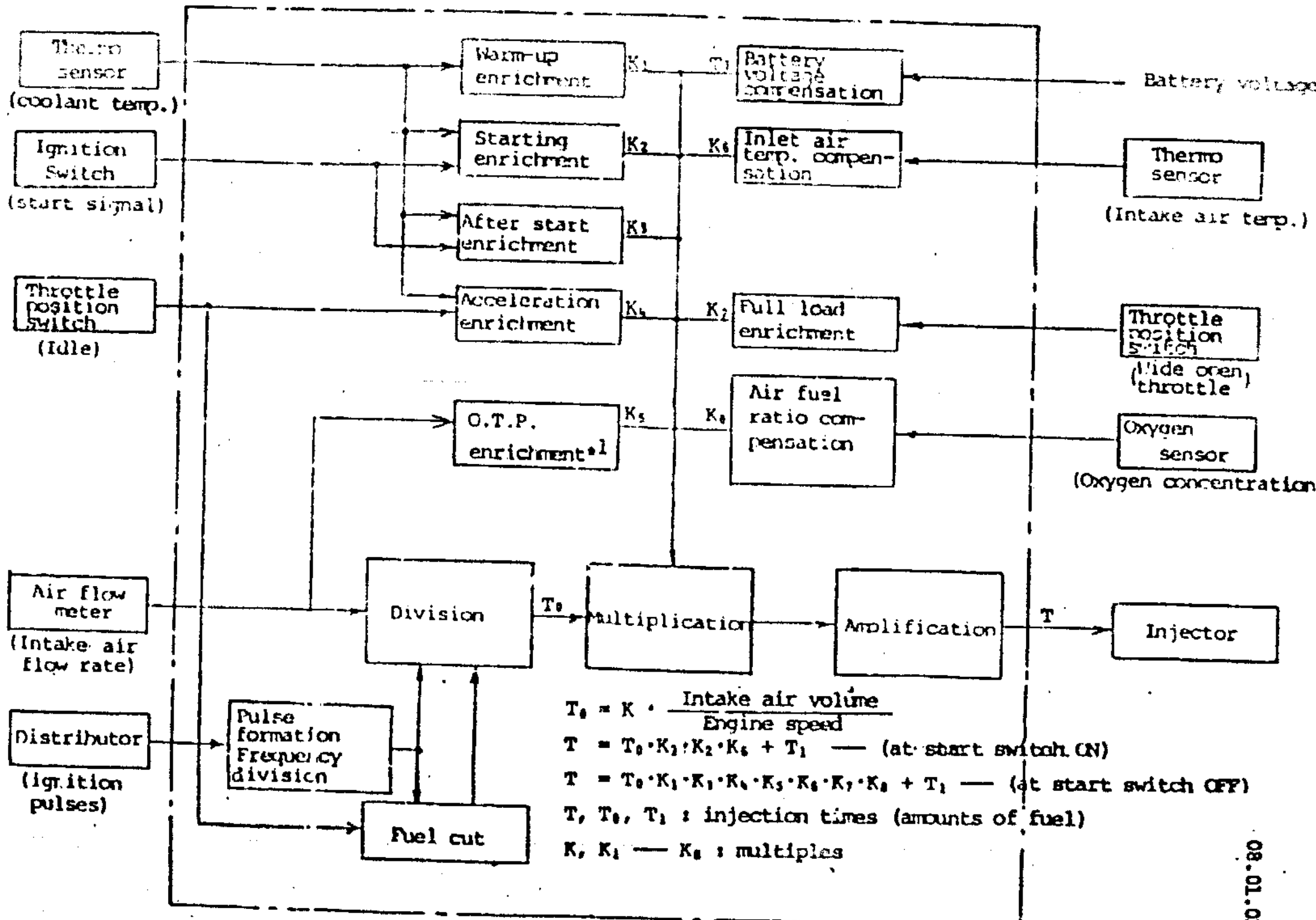
EPA REP. 57

08.01.02.01 7.8 liter engine

Electronic fuel injection (EFI) system conf. type A1 (2/2)
(Connecting diaphragm of computer).



$T_0 = K \cdot \frac{\text{Intake air volume}}{\text{Engine speed}}$

$T = T_0 \cdot K_2 \cdot K_2 \cdot K_6 + T_1$ — (at start switch ON)

$T = T_0 \cdot K_1 \cdot K_3 \cdot K_4 \cdot K_5 \cdot K_6 \cdot K_7 \cdot K_8 + T_1$ — (at start switch OFF)

T, T_0, T_1 : injection times (amounts of fuel)

K, K_1 — K_8 : multiples

Note *1 Over temperature protection enrichment

08.01.02.01

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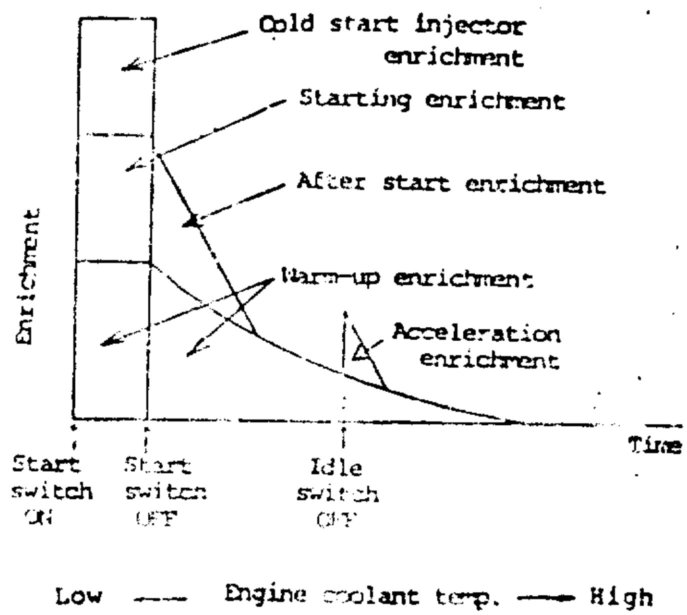
EPA REP. 150

e) Acceleration enrichment

During the warm-up period, the acceleration enrichment is adopted to insure the proper vehicle operation during acceleration in a cold condition. It is activated by a signal from the electronic control unit which is transmitted in response to signals received from the throttle position switch and the thermo sensor of the coolant temperature.

Fuel enrichment conf.



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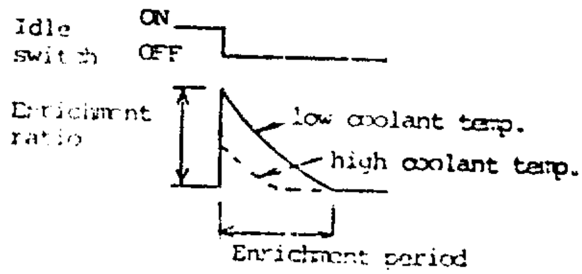
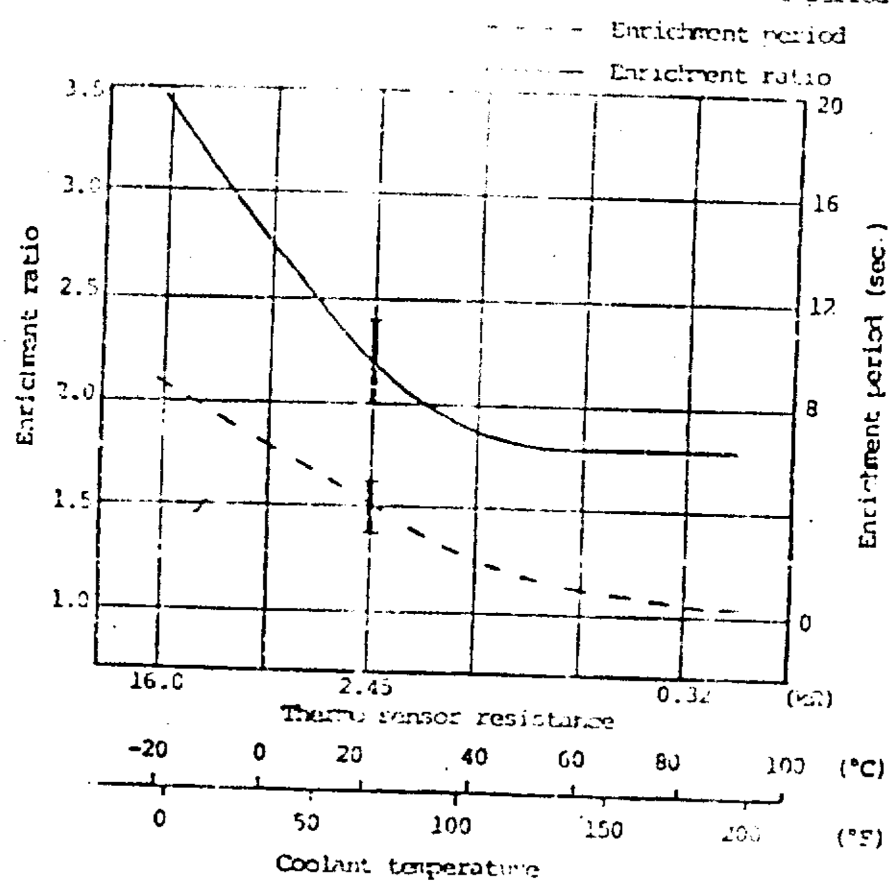
Engine family : BTY2.8V5HB4
Engine code : All

10.22.01.14

o Acceleration enrichment characteristic

Enrichment ratio = $\frac{\text{Amount of fuel - just after idle switch OFF}}{\text{Amount of fuel at coolant temperature 176°F (80°C)}}$





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EPA REP. 1512

iv) Acceleration enrichment ; f(AEW)

The initial value, $f(AEW)_0$ which corresponds to coolant temperature is determined when turning off the idle switch and then the f(AEW) is decreased proportional to the number of injection.

Thus, when accelerated this enrichment is adopted to insure proper vehicle operation.

v) A/F beedback compensation ; f(A/F) and

Based A/F compensation ; f(LAFM)

The continuously varying output voltage of the oxygen sensor is interpreted to feedback control signal by two compensations. One is f(A/F) which is used to control the air fuel ratio at stoichiometry, another is f(LAFM) which is used to compensate for altitude changes and changes in base air-fuel ratio calibrations.

vi) OTP enrichment ; f(OTP)

This enrichment is provided to prevent over temperature of the exhaust system and to insure the driveability under full load condition.

vii) Battery voltage compensation ; Tv

This compensation pulse is delivered to compensate the change in injection delay caused by battery voltage change.

Calculations

i) Based pulse width calculation

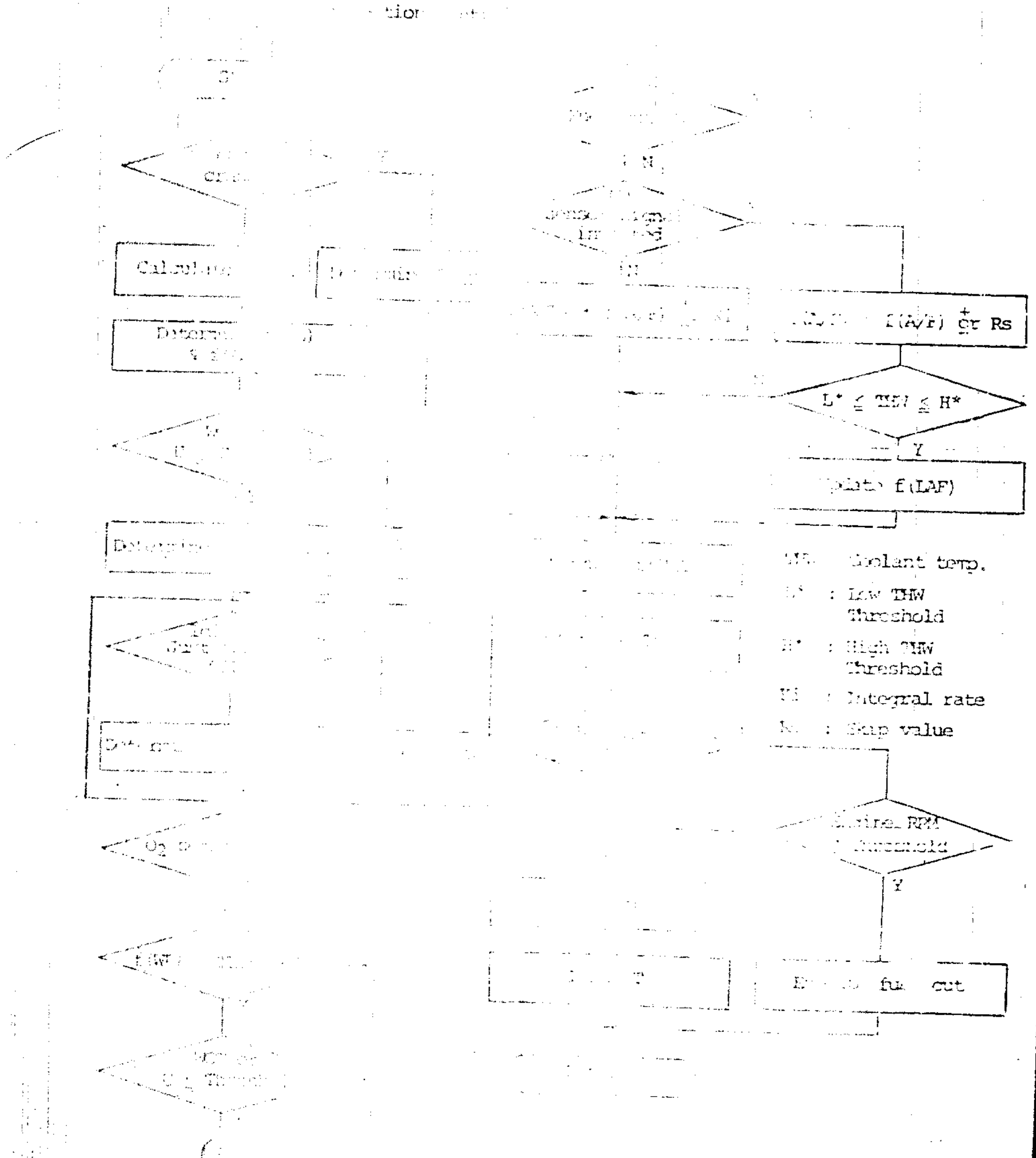
$$Tp = 0.634 \times \frac{1000}{U \times N}$$

where Tp : Based pulse width

U : Output voltage ratio of air flow meter (U = 6.45/Q)

N : Engine RPM

Q : Inlet air flow rate



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5) After start enrichment compensation ; f(ASE)

a) Initial value

Coolant temp. (°C)	-30	-15	15	30	60
f(ASE)	0.60	0.5	0.18	0.16	0.05

b) Decrement ; 0.00293 per 4 times of injection

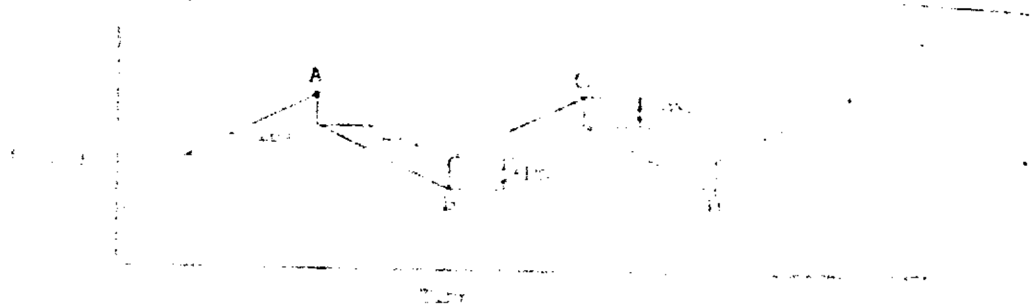
6) Acceleration enrichment compensation ; f(AEW)

a) Initial value

Coolant temp. (°C)	-20	20	60
f(AEW) [illegible]	0.60	0.40	[illegible]

b) Decrement ; [illegible]00488 per injection

7) A/F feedback compensation ; f(A/F)



a) Initial value

f(A/F)[illegible] = 1.00

b) Skip value

Idle switch	Skip value [illegible]
ON	0.020[illegible]
[illegible]	0.0[illegible]

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EPA REP. ________

08.02.00.02 Method of operation type A4

1) Ignition system

The ignition system is a series of systems in the engine electrical system which ignites the air-fuel mixture in the combustion chamber.
It consists of an igniter, ignition coil, distributor, spark plugs, and ignition wires.

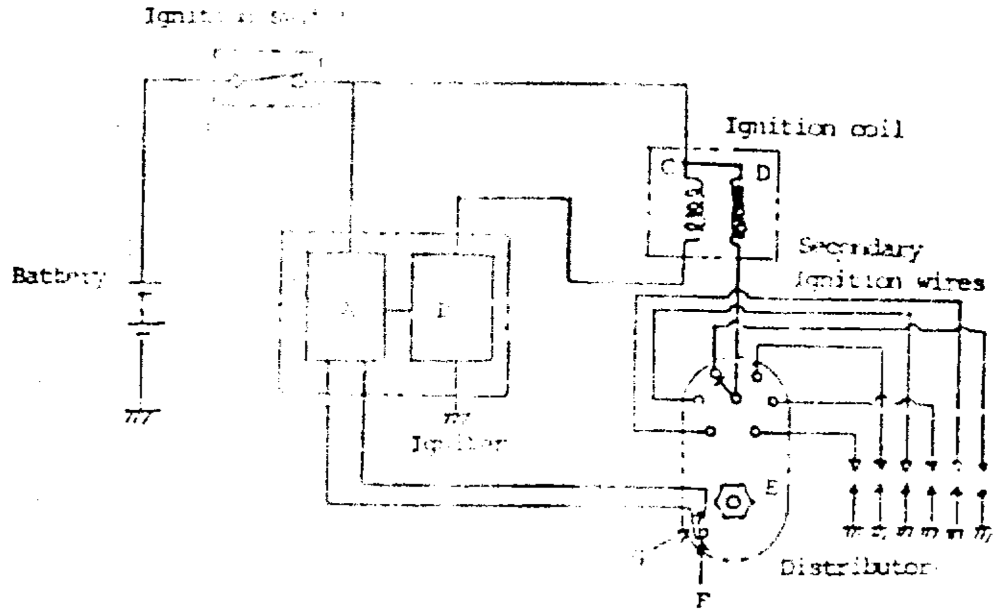
o Igniter

a) Description

In this system, the "ON" and "OFF" signals of the distributor rotor cause the igniter to turn the primary current "ON" and "OFF".
The benefits of this system are:

i) Improvement in engine performance when starting and at low speed because of its ability to maintain higher secondary voltage in the low speed range.

ii) Improvement in the durability and life of the ignition system.



A : Signal amplifier B : Power amplifier C : Primary coil
D : Secondary coil E : Signal rotor F : Permanent magnet
G : Pick-up coil

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EPA REF. 201

The signal rotor generates an alternating voltage in the pick-up coil when the rotor tip passes the coil.

The voltage is then transformed to a stepwise "ON" and 'OFF" current in the signal amplifier "A" and amplified to a certain level through amplifier "B".

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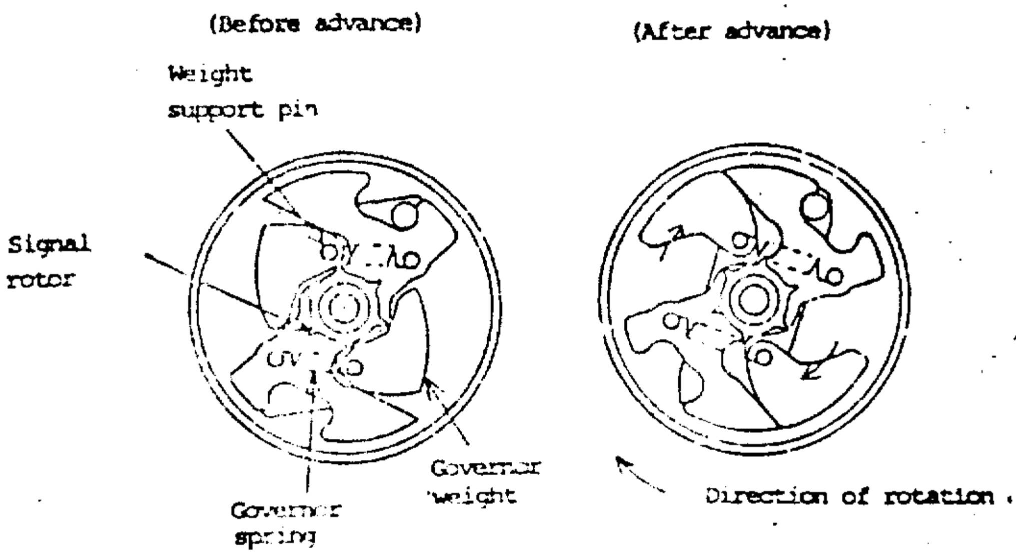
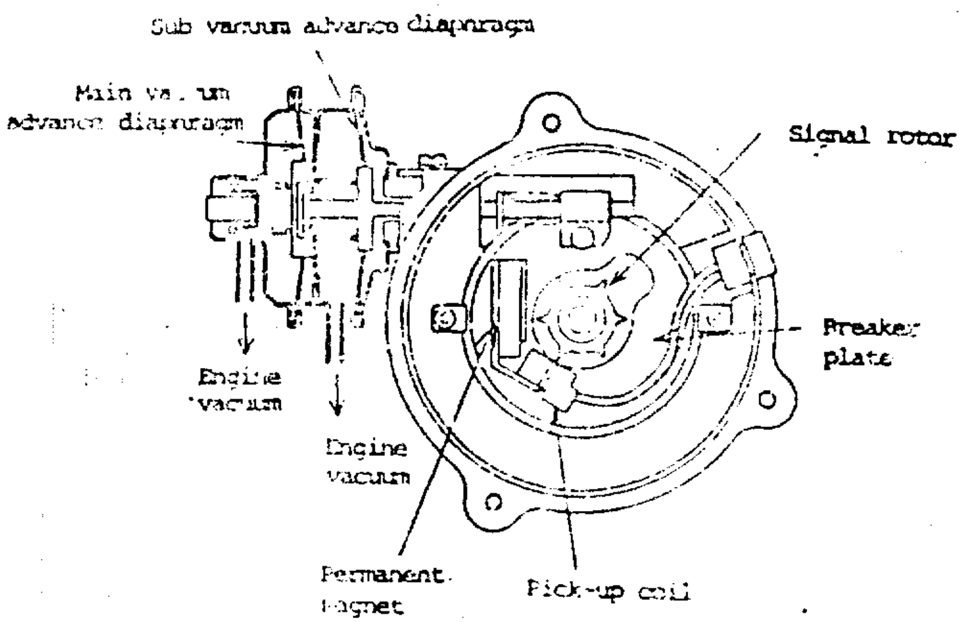
EPA REP. 202

08.02.01.01 Distributor conf. type E1

(1) Centrifugal advance mechanism conf.



(2) Vacuum advance mechanism conf.



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EPA REP. 209

08.02.01.02 Method of operation type A1

1) Description

The distributor performs the following functions:

a) Generation of alternating voltage in the pick-up coil

b) Distribution of the secondary current

c) Adjustment of the ignition timing

The function of ignition timing adjustment, which is regarded as an especially important function, is explained below.

2) Operation

Ignition timing needs to be controlled adequately according to the engine conditions. Therefore, the distributor has centrifugal and vacuum advancing mechanisms. They are:

a) Centrifugal advance

As engine speed increases, the combustion cycle is shortened. Therefore, ignition should occur at more advanced degrees before the piston reaches top dead center. To accomplish this the ignition timing is advanced by centrifugal force working on governor weights.

b) Vacuum advance

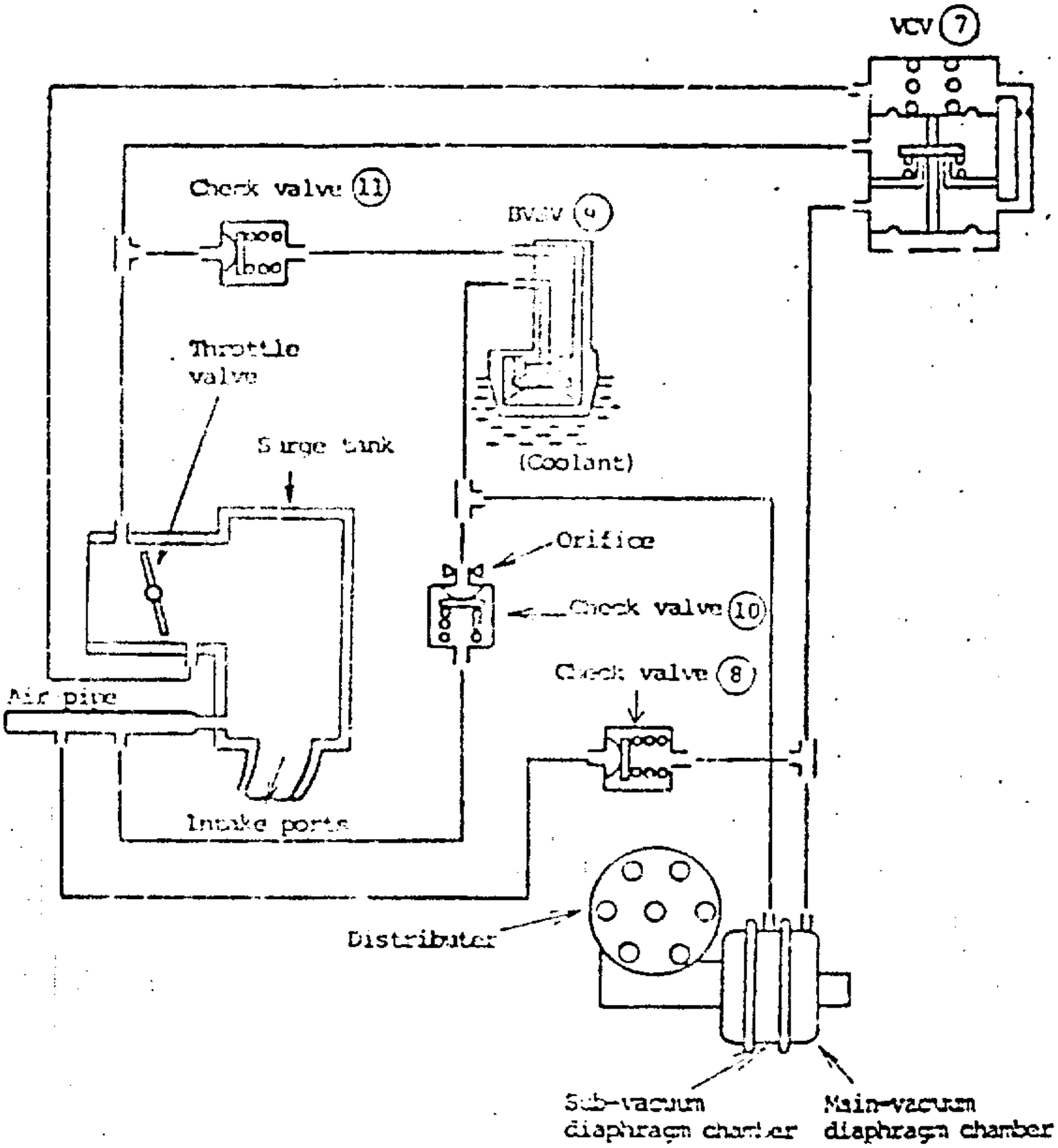
In the partial throttle condition, the air/fuel ratio is matched toward the lean side and combustion speed becomes slower. Also, in high altitude condition, combustion speed becomes slower than in low altitude because of lower air density at high altitude. And, similarly, combustion speed is low during idling under cold coolant temperature condition. Therefore ignition timing should be advanced to compensate.

In the wide open throttle condition, the air/fuel ratio is on the rich side and combustion speed becomes faster. Accordingly, ignition timing in a wide open throttle condition need not be as advanced as in the partial throttle condition. Engine vacuum which acts on the vacuum advance diaphragm is employed in order to control ignition timing in proportion to the load of the engine.

The engines' ignition timing is controlled with higher accuracy by the use of two (main and sub) diaphragms.

Engine family : BTY2.8V5HB4
Engine code : All

10.20.02.00 Spark control system configuration & description



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EPA REP. 1490

Engine family : BTY2.8V5HB4
Engine code : All

10.20.02.00 Spark control system configuration & description

Method of operation :

This system adopts a double diaphragm distributor having two functions, one of which is to keep the ignition timing advancing by the sub-vacuum advancing mechanism during the cold engine operation for the purpose of ensuring the driveability and the other of which is the normal vacuum advancing mechanism. In the former function, the BVSV is closed during the cold engine operation and the intake manifold vacuum is supplied to the sub-vacuum advance diaphragm through the check valve (10). The check valve (10) serves to reserve the high vacuum in the sub-vacuum advance diaphragm chamber and, as a result, the ignition timing is always advanced by the sub-vacuum advancing mechanism. When the coolant temperature rises up to the normal operating temperature, the BVSV is opened and the intake manifold vacuum is supplied to the sub-vacuum advance diaphragm chamber under all vehicle operations except for idling. In this case the ignition timing is advanced depending on the engine load because the sub-vacuum advance circuit is an open loop. During idling, the ignition timing is not advanced by an air fleed fed from the advance port. In the latter function, under idle condition the resultant vacuum of the atmosphere and the intake manifold vacuum is supplied to the main-vacuum advance diaphragm through VCV. Further, under the other vehicle operations the intake manifold vacuum alone acts on the main-vacuum advance diaphragm. By this principle, the ignition timing is always advanced under all vehicle operations.

Engine family : BTY2.8V5HB4

Engine code : All

10.21.00.00 Calibration (Auxiliary exhaust emission control system)

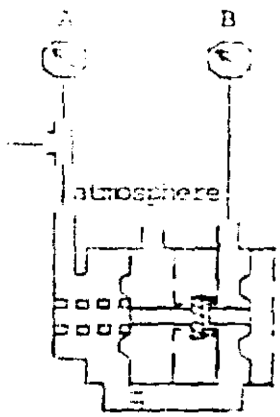
o Dash pot (6)

	Unit	Design value	Actual data	I.D. No.
Operation time from NOT to close	sec.	3.0 ± 0.5		

o VCV (7) (Spark control)

A : Vacuum (in.Hg)	B : Vacuum (in.Hg)		I.D. No.
	Design value	Actual data	
16.14	11.02 ± 1.57		
18.11	3.35 ± 1.18		

Measurement system



o BVSV (9) (Spark control & EGR)

	Unit	Design value	Actual data	I.D. No.
Activative coolant temp.	°F	140.0 ± 7.2		
Deactivative coolant temp.		min. 122		

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" -2		-5	

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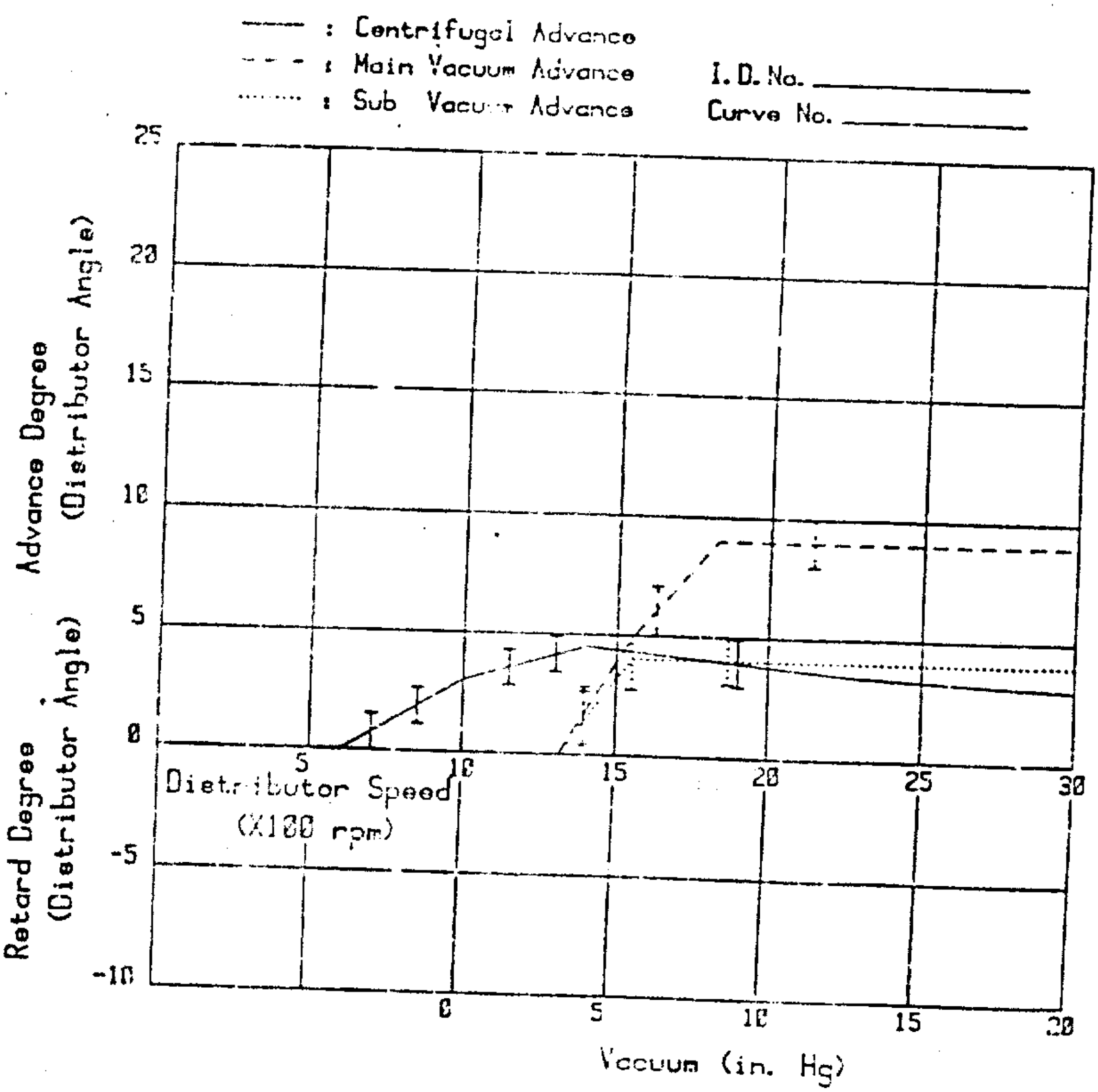
EPA REP. 1206

Engine family : BTY2.8V5HB4
Engine code : All

10.22.02.00 Ignition system
.01

Distributor Characteristic Curves



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Issued	DEC 20 1979	Rev.-3	
Rev.-1	DEC 27 1979	-4	
" -2		-5	

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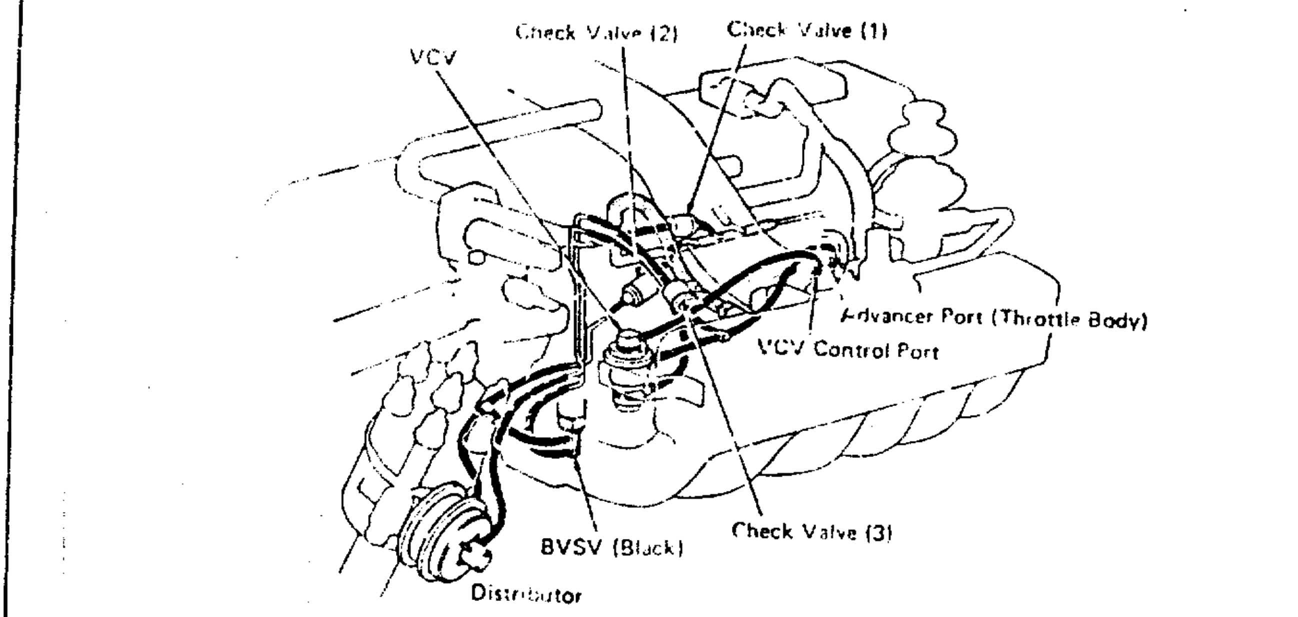
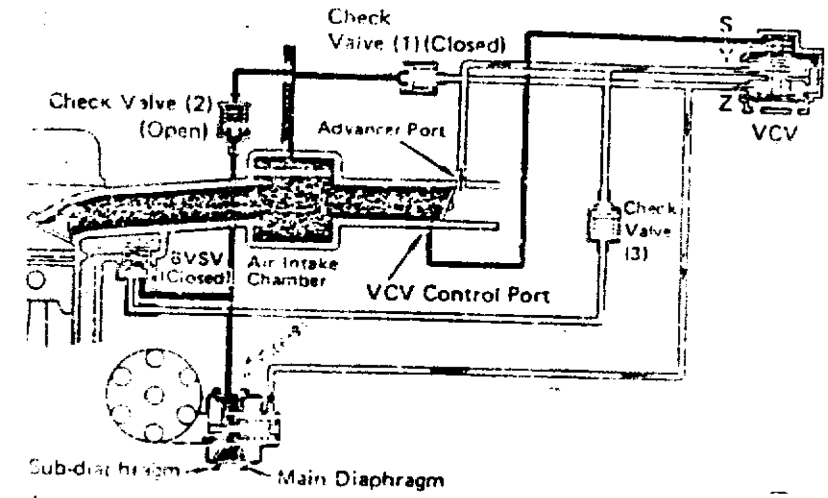
DATE
EPA REP. 1518

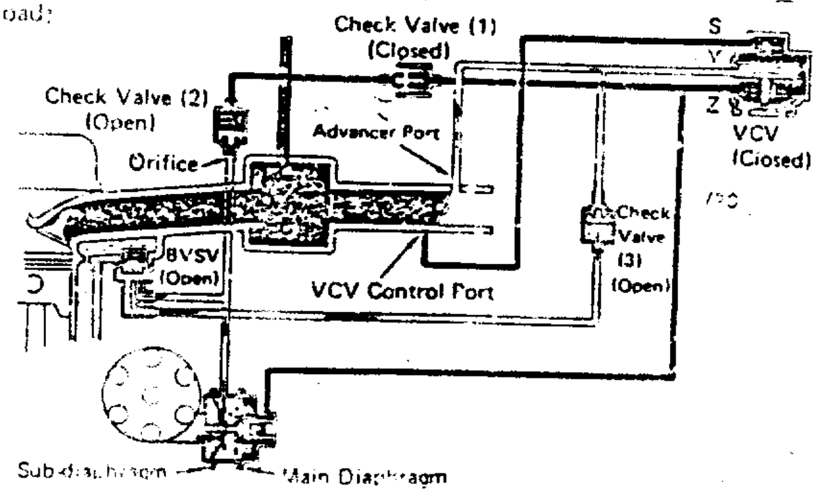
SPARK CONTROL (SC) SYSTEM



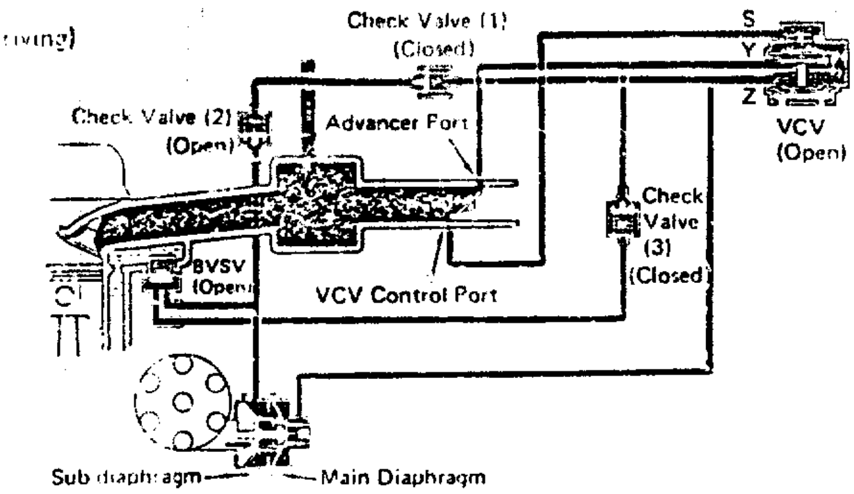
COLD (Idling)



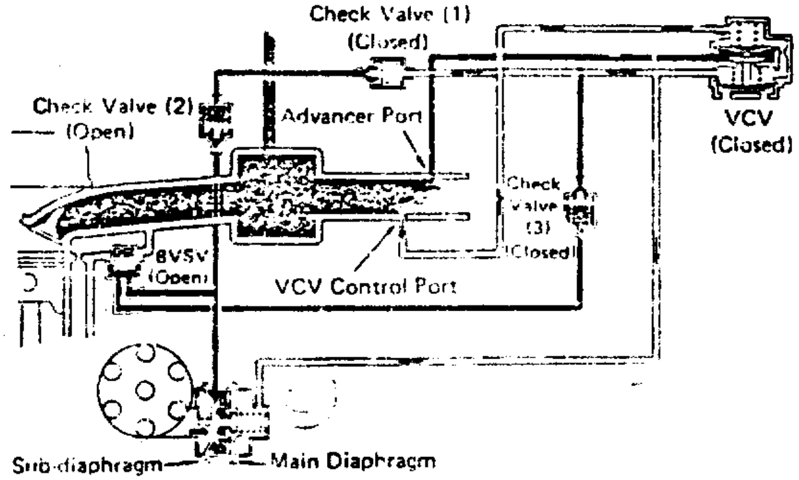
HOT (Idling with load)



HOT (Normal Driv[illegible])



HOT (High Speed)



To improve cold engine performance, this igniti[illegible] system advances the ignition timing when the engine is cold, and to improve idle performance, advances the ignition timing when there is a load on the engine. The distributor is equipped with two diaphragms that have different vacuum advance characteristics.

Coolant Temp.	BVSV	Throttle Valve Opening		Distributor Sub-diaphragm	Vacuum at Advancer Port	Vacuum at Control Port		VCV	Distributor Main Diaphragm	Vacuum Ignition Timing
Below 50°C (122°F)	CLOSED	Positioned below advan··er port		Pulled (Maintains intake manifold vacuum at check valve)	No Vacuum	Intake manifold ··cuum	LOW	CLOSED	Pulled	8° (Sub) ⊕ Main vacuum advance angle ⊕ (initial timing)
							HIGH	OPEN	Not pulled	8° (sub) ⊕ (initial timing)
		Positioned above advancer port	Partial open		Vacuum	Vacuum		O··EN	Pulled	8° (sub) ⊕ Main vacuum advance angle ⊕ (initial timing)
			Full open		Vacuum	No vacuum		CLOSED	Not pulled	8° (sub) ⊕ (initial timing)
Above 64°C (147°F)	OPEN	Positioned below advancer port		Not pulled	No Vacuum	Intake manifold vacuum	LOW	CLOSED	Pulled	Main vacuum advance angle ⊕ (initial timing)
							HIGH	OPEN	Not pulled	(Initial timing)
		Positioned above advancer port	Partial open	Pulled	Vacuum	Vacuum		OPEN	Pulled	Sub-vacuum a··vance a··gle ⊕ Main vacuum advance angle ⊕ (initial timing)
			Full open	Pulled	Vacuum	No vacuum		CLOSED	Not pulled	Sub-vacuum advance angle ⊕ (initial timing)

08.02.00.02 Method of operation type B

1) Ignition system

The ignition system is a series of systems in the engine electrical sytem which ignites the air-fuel mixture in the combustion chamber.

It consists of an igniter, ignition coil, distributor spark plugs, ignition wires and computer.

o Igniter

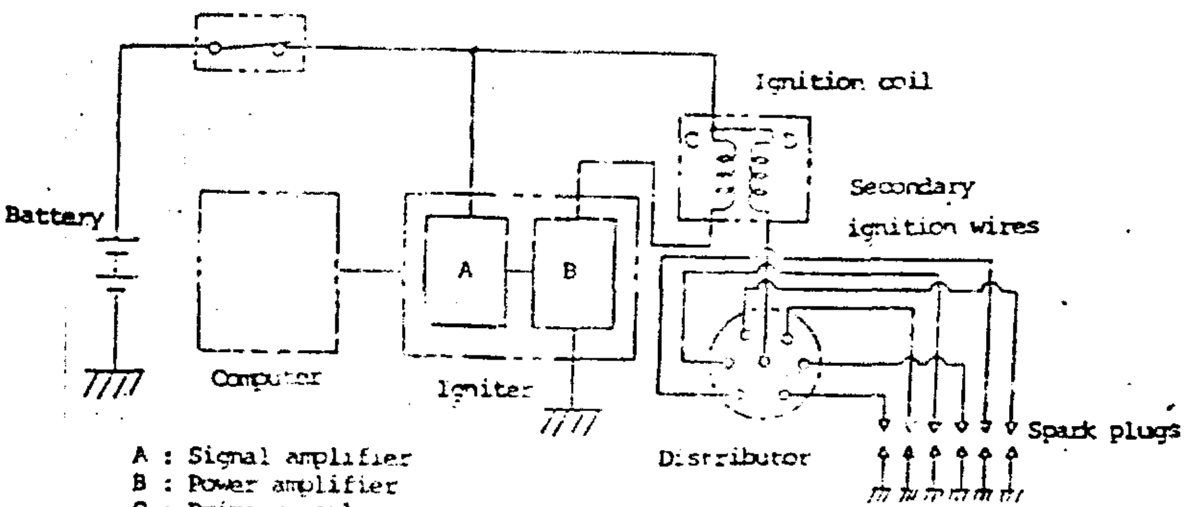
a) Description

In this system, the "ON" and "OFF" signals which are calculated at ECU cause the igniter to turn the primary current "ON" and "OFF", respectively. The voltage is then transformed to a stepwise "ON" and "OFF" current in the signal amplifier "A" and amplified to a certain level through amplifier "B".

The benefits of this system are:

i) Improvement in engine performance when starting and at low speed because of its ability to maintain higher secondary voltage in the low speed range.

ii) Improvement in the durability and life of the ignition system.



A : Signal amplifier
B : Power amplifier
C : Primary coil
D : Secondary coil

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[illegible] circuit type, [illegible] system [illegible] circuit [illegible]

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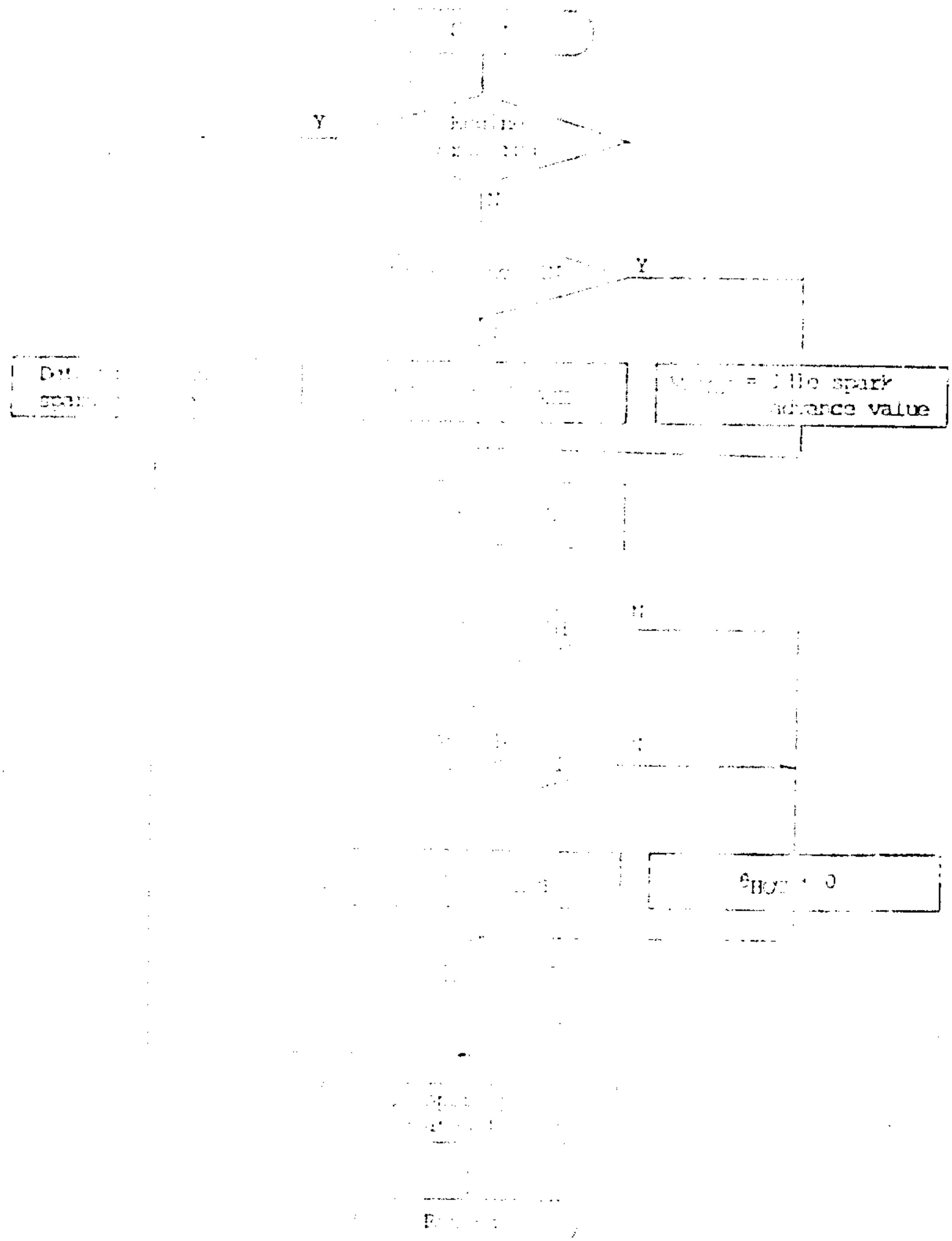
REP. 142



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Engine [illegible] : [illegible]2.BV5[illegible]
Engine [illegible] : A[illegible]

10) Base spark advance ; θ BSE (deg.)

Q/N (ℓ/rev.) Engine: 1,3,5,7, 5R1,7R1	Q/N (ℓ/rev.) Engine: 2,4,[illegible],8, 6R1,8R1	[illegible]	1200	1600	2000	2400	2800	3200	3600	[illegible]	4400	4800	5200	5600
1.05	1.05	[illegible]	-2	0	4	7	[illegible]	[illegible]	13	[illegible]	11	13	15	17
0.95	0.95	[illegible]	-1	2	6	9	12	[illegible]	14	[illegible]	13	16	18	19
0.85	0.85	[illegible]	4	8	12	15	[illegible]	[illegible]	19	[illegible]	17	20	22	22
0.75	0.75	4	10	15	19	21	[illegible]	[illegible]	24	[illegible]	22	24	26	26
0.65	0.65	[illegible]	16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30	[illegible]	27	28	30	30
0.55	[illegible]	[illegible]	21	28	32	34	[illegible]	[illegible]	35	[illegible]	32	32	34	34
0.45	[illegible]	[illegible]	[illegible]	31	[illegible]	[illegible]	[illegible]	[illegible]	37	[illegible]	35	36	37	37
0.35	[illegible]	[illegible]	[illegible]	23	[illegible]	37	[illegible]	[illegible]	[illegible]	[illegible]	35	37	37	37
-	[illegible]	[illegible]	[illegible]	22	[illegible]	30	[illegible]	[illegible]	30	[illegible]	26	30	30	30
-	[illegible]	[illegible]	[illegible]	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11	11	11	11

Q/N [illegible] according to [illegible] equation.

[illegible] 1000/60 [illegible]

11) Idle [illegible]

Air [illegible] switch	Engine revolution	[illegible] spark advance value
ON	2,[illegible] rpm or less	[illegible] deg.
	2,400 rpm or more	[illegible] deg.
OFF	1,[illegible] rpm or less	[illegible] deg.
	2,4[illegible] rpm or more	[illegible] deg.

Page	30-2.BV5[illegible]-36		
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Engine family : DTY2.8V5FBB4
Engine code : All

12) Coolant temperature compensation ; θ COLD (deg.)

Idle switch	Q/N \ Coolant temp. (°C)	-20	0	20	40	50
ON	-	16	10	6	4	0
OFF	≥ 0.75					
	≤ 0.45	16	20	-7	-10	0

13) Over temperature compensation ; θ HOT (deg.)

i) θ HOT actuation criteria

Q/N ≥ 0.771

ii) θ HOT

Coolant temp. (°C)	95	105
θ HOT	0	-4

14) Cranking idle advance

Cranking idle advance = 0 deg.

15) Basic ISC motor position ; S_{STA}

Coolant temp. (°C)	-20	40	60	70
S_{STA} (step)	125	74	60	[illegible]

Engine code:1,3,5,7;: S_{STA} is increased by 12 steps when air conditioner
5R1,7R1 switch is ON.

Engine code:2,4,6,8;: S_{STA} is increased by 6 steps when air conditioner
6R1,8R1 switch is ON.

16) Corrected ISC motor position ; S (t)

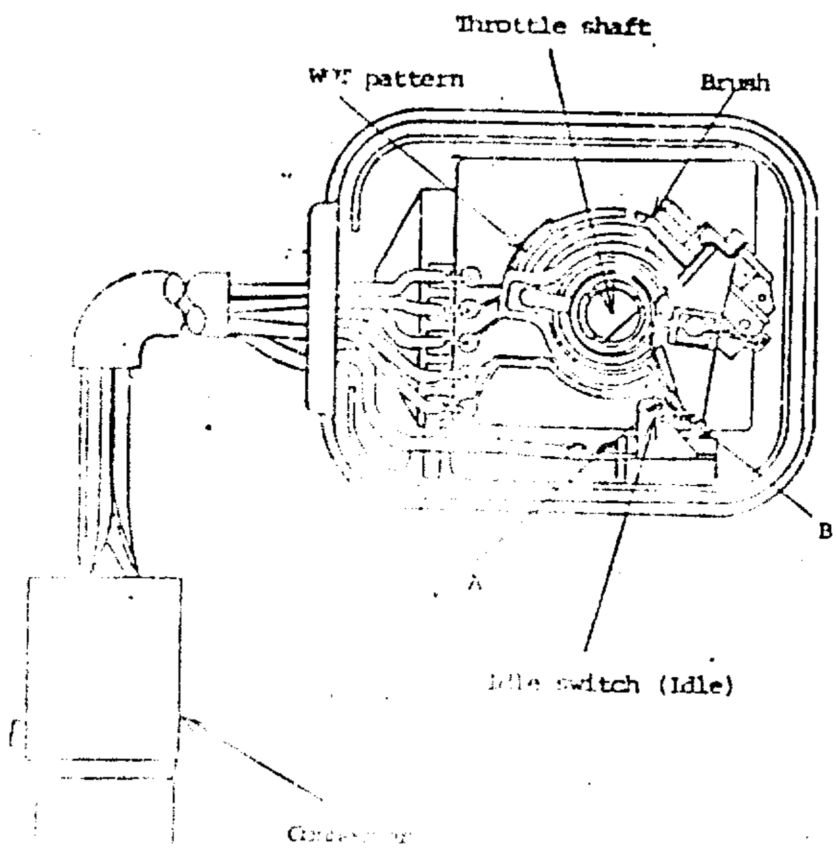
Coolant temp. (°C)	-35	-20	20	40	60	70
S (t) (step)	125	100	65	50	39	33

ISC motor is extended or retracted by one step at every 3 sec.

For [illegible] and 1984 [illegible] Cressida with automatic transmission

08.01.02.02 Component conf.

Throttle position switch type B

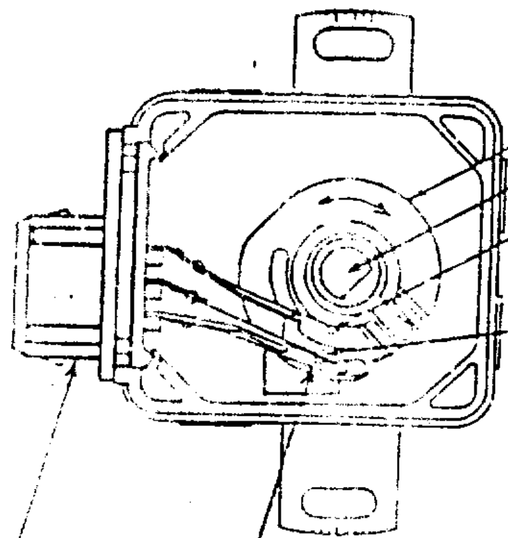


[Note] "Idle switch ON" means contact of A on B.

"WOT switch ON" means contact of brush on the WOT pattern.

08.01.02.02 Component conf.

Throttle position switch type A



[Note]

"WOT switch ON" means contacting of terminal (TL) on terminal (WOT)

"Idle switch ON" means contacting of terminal (TL) on terminal (Idle)

10.21.00.00 Calibrations (AECD) Engine family : DTY2.8V5FBB4

* Computer Engine code : All

1) Feedback control disablement criteria

Feedback control is deactivated when

* Fuel cut is executed,
* OTP enrichment is provided,
* Warm-up enrichment is provided at more than the specified value, or
* O_2 sensor is unready.

a) Fuel cut execution control

i) Fuel cut activation criteria

(1) For engine code 1,2,3,4
Engine RPM $\geq N_B$ and idle switch ON

(2) For engine code 5,6,7,8, 5R1,6R1,7R1,8R1
(A) Engine RPM $\geq$ 7,000 rpm
(B) Engine RPM $\geq N_B$ and idle switch ON

ii) Fuel cut deactivation criteria

(1) Engine RPM $\leq N_A$ or

(2) Idle switch OFF

(a) N_A

For automatic transmission

* For engine codes 2,4,6,8,6R1,8R1 N_A is determined as follows:

Coolant temp. (°C)	N_A (rpm)
-20	2200
60	1400

For manual transmission

* For engine codes 1,3,5,7,5R1,7R1 N_A is determined as follows:

$N_A = N_C + N_D$

(i) N_C

Coolant temp. (°C)	N_C (rpm)
-20	900
60	0

(ii) N_D

$N_D = 2250 - 35 \times V$ (N_D min = 1200)

V : Vehicle speed (km/h)

If calculated N_D is less than 1200, it is substituted by 1200.

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(b) N_B

$N_B = N_A + N_{HYS}$

(c) N_{HYS}

For automatic transmission

- For engine codes 2,4,6,8,6R1,8R1 N_{HYS} is definded as 800 rpm except in the following condition.
  When idle switch is turned off, N_{HYS} is changed to 200 rpm until the idle switch is turned on.

For manual transmission

- For engine codes 1,3,5,7,5R1,7R1 N_{HYS} is changed as follows:
  - (i) In case that fuel cut has never been executed since the engine had been started, N_{HYS} is defined as 600 rpm.
  - (ii) When the previous fuel cut execution was terminated by turning off the idle switch, N_{HYS} is defined as 600 rpm.
  - (iii) When the previous fuel cut execution was terminated by engine RPM falling below N_A, N_{HYS} is defined as 800 rpm except in the following condition.
    When idle switch is turned off, N_{HYS} is changed to 200 rpm until the idle switch is turned on.

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Engine family : DTY2.8V5FBR4
Engine code : All

2) EGR control

Active coolant temp. : 63 °C

Deactive coolant temp. : 57 °C

• VTV #3 (Dash pot)

Air flow rate at pressure of 19.69 in.Hg. : 24.41 ± 4.88 cu.in./min.

• Throttle position switch

(1) WOT switch (WOT enrichment) — For manual transmission

WOT switch

Engine codes 1,3,5,7,5R1,7R1 : 60 ± 1.8 deg.

Engine codes 2,4,6,8,6R1,8R1 : 60 ± 2.5 deg.

(2) Idle switch (Fuel cut) — For manual transmission

Idle switch : 1.5 ± 0.3 deg.

• Thermo sensor #2 (EGR & DTI)

Resistance at -4.0 °F : 16.2 ± 1.6 KΩ

Resistance at 68 °F : 2.45 ± 0.24 KΩ

Resistance at 176.0 °F : 0.322 ± 0.032 KΩ

Page	10-2.8VSB-32.1		
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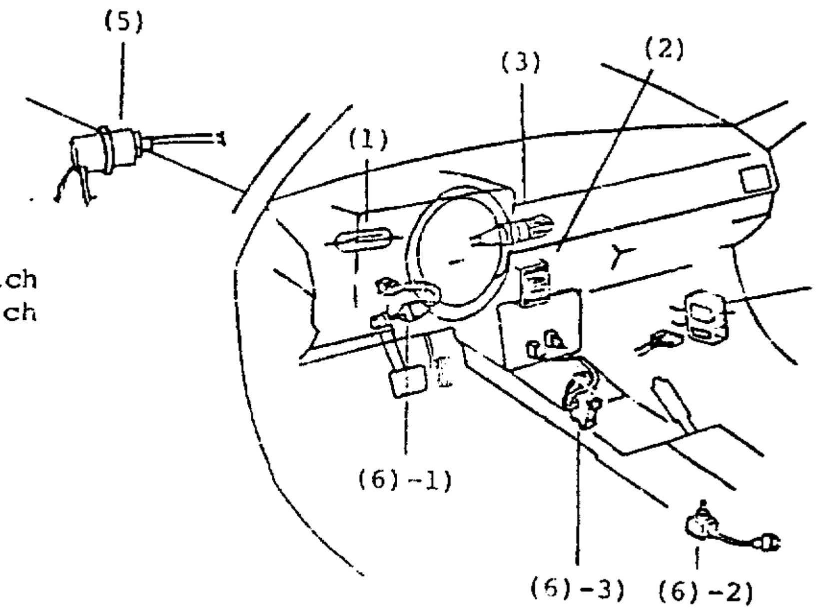
Description of Cruise Control System (CCS)

The Cruise Control System (CCS) used on the 1984 model Cressida is described below :

1 Component Location of CCS

(1) Speed Sensor
(2) Main Switch
(3) Control Switch
(4) Computer
(5) Actuator
(6) Cancel Switch
  1) Stop Light Switch
  2) Parking Brake Switch
  3) Neutral Start Switch



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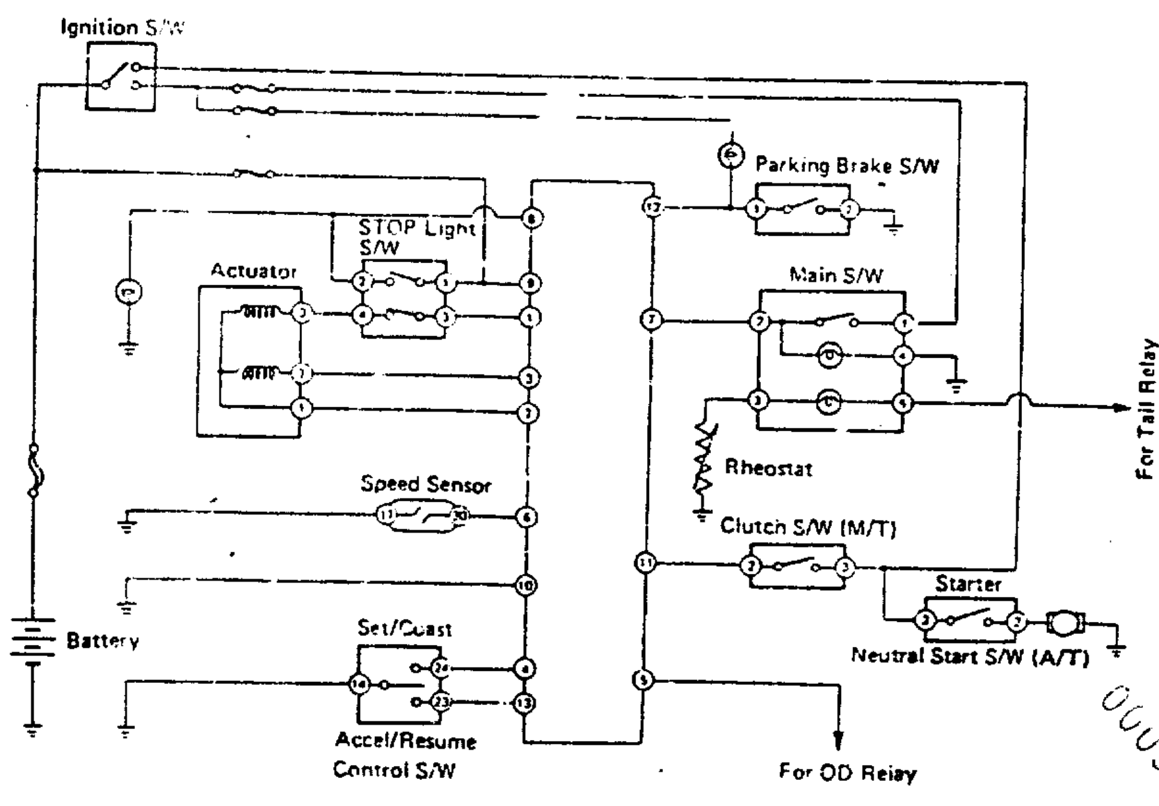

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3 Components and Its Functions

(1) Speed Sensor

Sends pulse signals to the computer proportionately to vehicle speed.

(2) Main and Control Switch

1) Main Switch

Supplies the power to the CCS and activates the indicator light.

2) Control Switch

The control switch has following 4 functions :

i) Set

When the switch is selected to SET position, a signal is inputted to the computer to set the cruise control.

ii) Deceleration

During cruise control operation, the vehicle speed will decrease while the control switch is held in SET position. When the SET position is released the vehicle speed will be maintained at the speed when the SET is released.

iii) Resume

After the cruise control has temporarily been cancelled and the vehicle speed has not decreased below 40 KPH (25 MPH), selecting the control switch to RESUME position will return the vehicle to the preset speed prior to cancellation.

iv) Acceleration

During cruise control operation, the vehicle speed will increase above preset speed while the control switch is held in RESUME position. When the RESUME position is released, the vehicle will be maintained at new speed when the RESUME is released.

(3) Computer

The control functions of the computer are :

1) Set

With the main CCS switch ON during vehicle operation (speed range of 40 KPH or over), the computer will initiate the cruise control function at the vehicle speed which the SET position was activated by the control switch.

2) Coast

The cruise control will continue to decrease vehicle speed while the control switch is held in SET position. Then the vehicle speed will be maintained at the vehicle speed when the SET position is released.

3) Resume

After cancellation of cruise control setting and providing that the vehicle speed does not drop below the speed limit (40 KPH), the activation of RESUME position will return the vehicle to the preset speed before the cancellation.

0005

4) Acceleration
The vehicle speed will continue to increase vehicle speed while the RESUME position is held on the control switch. When the RESUME position is released, the vehicle will preset the new speed at which the RESUME position is released.

5) High Speed Limit
The computer control is limited so that CCS cannot be engaged above 200 KPH (125 MPH).

6) Transmission Control
Under CCS operation with the automatic transmission in over-drive position, if the vehicle speed decreases more than 6 to 10 KPH (4-6 MPH) the computer will cancel the over-drive position and the vehicle operates in the normal "Drive" range. Thus the vehicle speed be maintained with lower gear ratio even on up hill grade conditions.
After the over-drive position is cancelled, if the vehicle speed return within 4 KPH (3 MPH) of the set speed, a computer timer (14 secs.) will be activated to return the transmission to over-drive position. If the vehicle speed does not stay within 4 KPH during this mode, the timer will preset again and the cycle is repeated until the set vehicle speed is achieved.

7) Cancellation
The cruise control function will be cancelled when :
- Stop light switch ON (apply brake)
- Neutral start switch ON (transmission in neutral)
- Parking brake switch ON (apply parking brake)
- Main CCS switch OFF

8) Automatic Cancellation of Cruise Control
The CCS computer automatically cancels cruise control when any of the following conditions exists. The preset speed registered in the CCS computer is also erased if this occurs.
- Vehicle speed drops below 40 km/h.
- SET and RESUME signals are simultaneously input into the computer due to a malfunction.
- Vehicle speed falls below 3/4 of the preset speed during cruising.
- The vehicle speed signal is not supplied to the CCS computer for a certain duration of time.
- The power circuit of the computer is disconnected for over 0.005 sec.
- The stop lamp switch circuit disconnected.

9) Low Speed Limit
When the vehicle speed drops below 40 KPH (25 MPH), the CCS IS AUTOMATICALLY CANCELLED AND CLEARED THE PRESET SPEED, also the system is designed so that the CCS cannot be engaged when the vehicle speed is below 40 KPH.

000599

(4) Actuator

The actuator device controls the throttle valve operation during the cruise control mode. The signal from the CCS computer activates the control valve and release valve in the actuator and the engine vacuum source and/or atmospheric pressure moves the diaphram which in turn controls the throttle valve opening and closing.
The control valve in the actuator is energized by computer signal to close the atmospheric pressure and allows the manifold vacuum to move the diaphram or de-energized to allow atmospheric pressure only to enter.
The release valve when energized through computer signal will close the atmospheric pressure or open the valve for atmospheric pressure when de-energized.
In addition, the function for the release valve is a safety valve to permit atmospheric pressure to close the throttle valve if any malfunction occurs in the control valve circuit to activate the actuator.

(5) Cancel Switch

The cancelling switch includes stop light switch, parking brake switch and neutral start switch. Whenever any of these switch is activated the CCS operation is cancelled.

- Stop light switch
  Whenever the brake pedal is applied, signal from the computer activates the release valve in the actuator and cancel the CCS.
- Parking brake switch
  Whenever the parking brake is activated, the computer is grounded and cancels the CCS.
- Neutral start switch
  Whenever the automatic transmission is positioned into neutral, the computer is grounded and cancels the CCS.

000600

(6) Cruise Control Operating Procedures

<table>
<tr><td colspan="2">Engage

Cruise Control System</td><td>1. Turn on main switch, indicator lamp will light.

2. Obtain desired vehicle speed (between 40 KPH to 200 KPH) by accelerater pedal.

3. Turn the control switch to SET position and then release. This will preset the CCS speed.</td></tr>
<tr><td rowspan="2">Change

Preset Speed</td><td>Increase

Preset Speed (Accel)</td><td>Activate the control switch to RESUME position and hold until desired increased speed is obtained, then release. This will set the CCS at the new desired vehicle speed.

On automatic transmission vehicle, it will disengage over-drive until the new vehicle speed is set.

Alternative procedure is to accelerate by accelerator pedal until desired speed is obtained then use the SET position procedure.</td></tr>
<tr><td>Decrease

Preset Speed (Coast)</td><td>Activate the control switch to SET position and hold until desired decreased speed is obtained, then release. This will set the CCS at the new desired vehicle speed.

Alternative procedure is to apply the brakes until desired speed is obtained then use the SET position procedure.</td></tr>
<tr><td colspan="2">Cancel CCS</td><td>1. Apply brake pedal.

2. Put transmission into neutral.

3. Apply parking brake.

4. Turn off CCS main switch.</td></tr>
<tr><td colspan="2">Resume CCS</td><td>Activate the control switch to RESUME position and release. This will return the vehicle to the preset speed prior to above 1.2.3 temporary cancellation if the vehicle speed has not decreased below low speed limit.

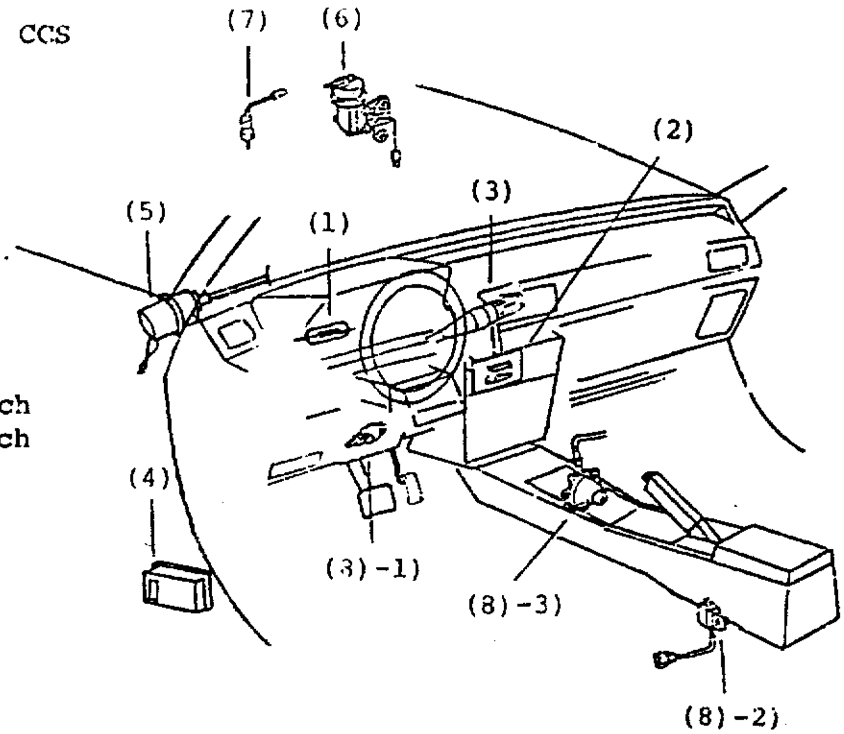
If the vehicle speed has decreased below the low limit speed, the CCS computer will not retain the preset speed, thus the CCS speed must be reset by using the SET procedure.</td></tr>
</table>

Description of Cruise Control System (CCS)

The Cruise Control System (CCS) used on the 1985 model Cressida is described below :

1 Component Location of CCS

(1) Speed Sensor
(2) Main Switch
(3) Control Switch
(4) Computer
(5) Actuator
(6) Vacuum Pump
(7) Vacuum Switch
(8) Cancel Switch
  1) Stop Light Switch
  2) Parking Brake Switch
  3) Neutral Start Switch



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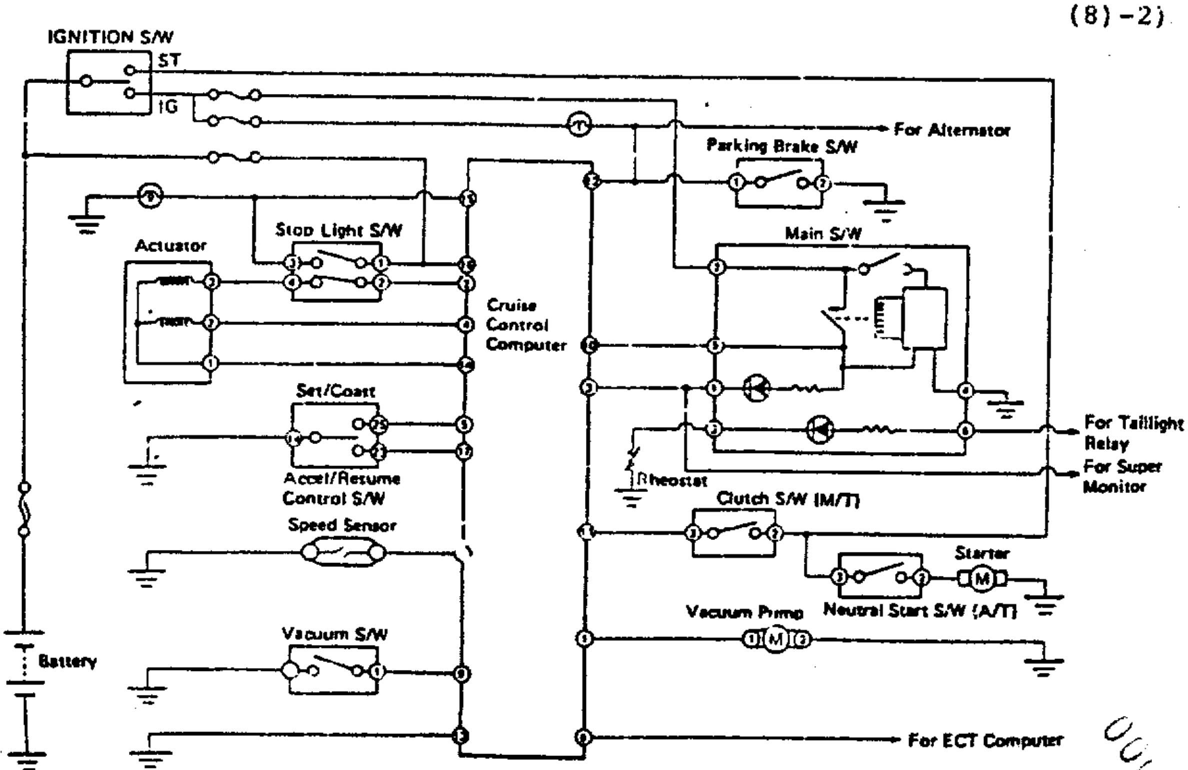

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3 Components and Its Functions

(1) Speed Sensor

Sends pulse signals to the computer proportionately to vehicle speed.

(2) Main and Control Switch

1) Main Switch

Supplies the power to the CCS and activates the indicator light.

-NOTE-

When the ignition switch is turned to OFF with the main switch on, the latter is turned off automatically. It remains off when the ignition is turned to ON again.

2) Control Switch

The control switch has following 4 functions :

i) Set

When the switch is selected to SET position, a signal is inputted to the computer to set the cruise control.

ii) Deceleration

During cruise control operation, the vehicle speed will decrease while the control switch is held in SET position. When the SET position is released the vehicle speed will be maintained at the speed when the SET is released.

iii) Resume

After the cruise control has temporarily been cancelled and the vehicle speed has not decreased below 40 KPH (25 MPH), selecting the control switch to RESUME position will return the vehicle to the preset speed prior to cancellation.

iv) Acceleration

During cruise control operation, the vehicle speed will increase above preset speed while the control switch is held in RESUME position. When the RESUME position is released, the vehicle will be maintained at new speed when the RESUME is released.

(3) Computer

The control functions of the computer are :

1) Set

With the main CCS switch ON during vehicle operation (speed range of 40 KPH or over), the computer will initiate the cruise control function at the vehicle speed which the SET position was activated by the control switch.

2) Coast

The cruise control will continue to decrease vehicle speed while the control switch is held in SET position. Then the vehicle speed will be maintained at the vehicle speed when the SET position is released.

3) Resume

After cancellation of cruise control setting and providing that the vehicle speed does not drop below the speed limit (40 KPH), the activation of RESUME position will return the vehicle to the preset speed before the cancellation.

4) Acceleration

The vehicle speed will continue to increase vehicle speed while the RESUME position is held on the control switch. When the RESUME position is released, the vehicle will preset the new speed at which the RESUME position is released.

5) High Speed Limit

The computer control is limited so that CCS cannot be engaged above 200 KPH (125 MPH).

6) Transmission Control

Under CCS operation with the automatic transmission in over-drive position, if the vehicle speed decreases more than 6 to 10 KPH (4-6 MPH) the computer will cancel the over-drive position and the vehicle operates in the normal "Drive" range. Thus the vehicle speed be maintained with lower gear ratio even on up hill grade conditions.

After the over-drive position is cancelled, if the vehicle speed return within 4 KPH (3 MPH) of the set speed, a computer timer (14 secs.) will be activated to return the transmission to over-drive position. If the vehicle speed does not stay within 4 KPH during this mode, the timer will preset again and the cycle is repeated until the set vehicle speed is achieved.

7) Cancellation

The cruise control function will be cancelled when :

- Stop light switch ON (apply brake)
- Neutral start switch ON (transmission in neutral)
- Parking brake switch ON (apply parking brake)
- Main CCS switch OFF
- Ignition switch OFF

8) Automatic Cancellation of Cruise Control

The CCS computer automatically cancels cruise control when any of the following conditions exists. The preset speed registered in the CCS computer is also erased if this occurs.

- Vehicle speed drops below 40 km/h.
- SET and RESUME signals are simultaneously input into the computer due to a malfunction.
- Vehicle speed falls below 3/4 of the preset speed during cruising.
- The vehicle speed signal is not supplied to the CCS computer for a certain duration of time.
- The power circuit of the computer is disconnected for over 0.005 sec.
- The stop lamp switch circuit disconnected.

9) Low Speed Limit
When the vehicle speed drops below 40 KPH (25 MPH), the CCS IS AUTOMATICALLY CANCELLED AND CLEARED THE PRESET SPEED, also the system is designed so that the CCS cannot be engaged when the vehicle speed is below 40 KPH.

(4) Actuator
The actuator device controls the throttle valve operation during the cruise control mode. The signal from the CCS computer activates the control valve and release valve in the actuator and the engine vacuum source and/or atmospheric pressure moves the diaphram which in turn controls the throttle valve opening and closing.
The control valve in the actuator is energized by computer signal to close the atmospheric pressure and allows the manifold vacuum to move the diaphram or de-energized to allow atmospheric pressure only to enter.
The release valve when energized through computer signal will close the atmospheric pressure or open the valve for atmospheric pressure when de-energized.
In addition, the function for the release valve is a safety valve to permit atmospheric pressure to close the throttle valve if any malfunction occurs in the control valve circuit to activate the actuator.

(5) Cancel Switch
The cancelling switch includes stop light switch, parking brake switch and neutral start switch. Whenever any of these switch is activated the CCS operation is cancelled.
- Stop light switch
  Whenever the brake pedal is applied, signal from the computer activates the release valve in the actuator and cancel the CCS.
- Parking brake switch
  Whenever the parking brake is activated, the computer is grounded and cancels the CCS.
- Neutral start switch
  Whenever he automatic transmission is positioned into neutral, the computer is grounded and cancels the CCS.

(6) Vacuum Pump
1) Vacuum pump is inoperative even below about 60 KPH.
2) Vacuum pump operates for 12-16 seconds when vehicle speed is below vehicle speed of vacuum pump operating [Memorized vehicle speed - (2-4 KPH)].
After that, vacuum pump operates continuously unless the condition is changed.
3) Vacuum pump operates for 12-16 seconds when vacuum switch is on and vehicle speed is below memorized vehicle speed.

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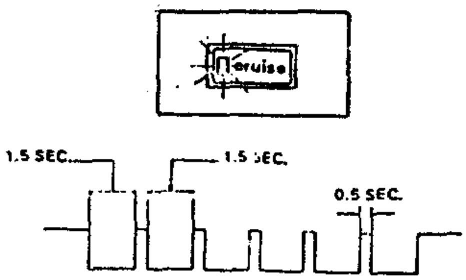
After that, vacuum pump operates continuously unless the condition is changed.

4) Vacuum pump operates during acceleration and resume setting operation. Vacuum pump operating is cancelled after finishing their setting operation.

(7) Diagnosis

Malfunction warning

If the vehicle speed signal is not supplied to the computer for a predetermined time or the CCS is released due to a malfunction of the actuator during CCS cruising, the POWER indicator lamp immediately blinks five times to warn the driver of the abnormal situation.



Self-diagnostic function

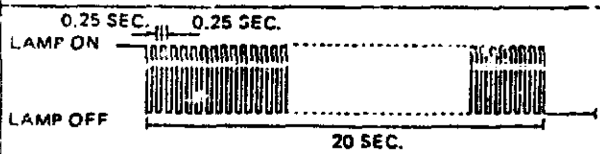
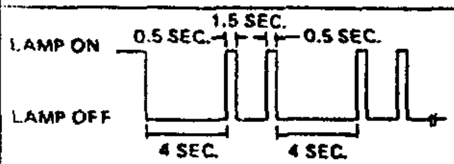
When the vehicle is moving at a speed of under 16 km/h and the main switch is on, the technician may obtain a CCS diagnositic reading by turning the control switch to SET/COAST three times within 2 seconds. This causes the POWER indicator lamp to blink at a certain frequency, indicating the diagnostic code or codes.

-NOTES-

a. The code for normal operation is indicated once for 20 seconds, while codes for abnormal situations are indicated three times repeatedly.

b. If there are two or more malfunctions, the code with the smallest code number is indicated first, followed by the next large code number.

c. Do not turn the ignition switch and main switch off.

CODE	MALFUNCTION	POWER INDICATOR BLINKING MODE	MEANING
—	—		Normal
11	Actuator drive circuitry		Overcurrent in actuator drive circuit
21	Vehicle speed sensor and its circuitry		Vehicle speed signal not supplied for 0.1 second or longer

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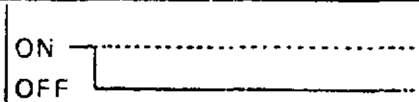
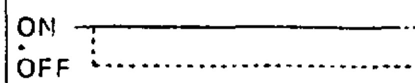
Checking of computer input signal

The technician can determine whether the various circuits of CCS are normal or not by following the steps listed below.

1) Turn the ignition switch on.
2) Turn the SET/COAST switch on, and keep it.
3) Turn the main switch on.
4) Meet the conditions listed below.
5) Read the blinking pattern of the POWER indicator lamp.

-NOTES-

a. Signals are not supplied to the actuator during this inspection.
b. Checks with display priority Nos. 4, 5 and 6 are performed while driving.
c. Since the codes appear with priority from No.1, the vacuum switch connector should be disconnected for checking Nos. 4, 5 and 6.

No.	CONDITIONS	POWER INDICATOR BLINKING MODE	DIAGNOSIS
1	SET/COAST switch on		SET/COAST switch circuitry is normal
2	ACCEL/RESUME switch on		ACCEL/RESUME switch circuitry is normal
3	Vacuum switch on		Vacuum switch circuitry is normal
4	Each cancellation switch on (Stop light switch, Parking brake switch, Clutch switch, Neutral start switch)		Each cancellation switch circuitry is normal
5	Drive 30 km/h (19 mph) or over		Speed sensor circuitry is normal
6	Drive 30 km/h (19 mph) or below		Speed sensor circuitry is normal

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(8) Cruise Control Operating Procedures

Engage **Cruise Control System**		1. Turn on main switch, indicater lamp will light. 2. Obtain desired vehicle speed (between 40 KPH to 200 KPH) by accelerater pedal. 3. Turn the control switch to SET position and then release. This will preset the CCS speed.
Change **Preset Speed**	Increase Preset Speed (Accel)	Activate the control switch to RESUME position and hold until desired increased speed is obtained, then release. This will set the CCS at the new desired vehicle speed. On automatic transmission vehicle, it will disengage over-drive until the new vehicle speed is set. Alternative procedure is to accelerate by accelerator pedal until desired speed is obtained then use the SET position procedure.
	Decrease Preset Speed (Coast)	Activate the control switch to SET position and hold until desired decreased speed is obtained, then release. This will set the CCS at the new desired vehicle speed. Alternative procedure is to apply the brakes until desired speed is obtained then use the SET position procedure.
Cancel CCS		1. Apply brake pedal. 2. Put transmission into neutral. 3. Apply parking brake. 4. Turn off CCS main switch.
Resume CCS		Activate the control switch to RESUME position and release. This will return the vehicle to the preset speed prior to above 1.2.3 temporary cancellation if the vehicle speed has not decreased below low speed limit. If the vehicle speed has decreased below the low limit speed, the CCS computer will not retain the preset speed, thus the CCS speed must be reset by using the SET procedure.

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