TOYOTA

TOYOTA MOTOR NORTH AMERICA, INC.

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May 7, 2010

Mr. Jeffrey L. Quandt, Chief
Vehicle Control Division
Office of Defects Investigation
National Highway Traffic Safety Administration
1200 New Jersey Avenue, SE
Washington, DC 20590

Re: NVS-213cnl; PE10-008

Dear Mr. Quandt:

On behalf of Toyota Motor Corporation, this letter is being sent in response to your March 19, 2010 letter regarding PE10-008. Enclosed you will find two copies with responses to questions 1-9 and 11.

Thank you very much for granting an extension until May 21, 2010 to respond to questions 10, 12-14 and the confidential portions of other questions.

Should you have any questions about this response, please contact me at (202) 775-1707.

Sincerely,

Chris Santucci/by MH

Chris Santucci, Manager
Technical and Regulatory Affairs
TOYOTA MOTOR NORTH AMERICA, INC.

CS:mh
Enclosures

1. State, by model and model year, the number of subject and peer vehicles Toyota has manufactured for sale or lease in the United States. Separately, for each subject and peer vehicle manufactured to date by Toyota, state the following:

   a. Vehicle identification number (VIN);
   b. Make;
   c. Model;
   d. Model Year;
   e. Plant of manufacture;
   f. Date of manufacture;
   g. Date warranty coverage commenced; and
   h. The State in the United States where the vehicle was originally sold or leased (or delivered for sale or lease).

   Provide the table in Microsoft Access 2003, or a compatible format, entitled "PRODUCTION DATA." See Enclosure 1, Data Collection Disc, for a pre-formatted table that provides further details regarding this submission.

Response 1

The number of MY 2009-2010 Toyota Corolla and Corolla Matrix vehicles manufactured for sale or lease in the United States by model and model year is as follows:

Model	Engine	Model Year		Total
		'09	'10	
Corolla	2AZ-FE	5,947	1,119	7,066
	2ZR-FE	358,830	306,301	665,131
Corolla Matrix	2AZ-FE	26,629	5,830	32,459
	2ZR-FE	31,611	13,418	45,029
Total	-	423,017	326,668	749,685

In addition, the detailed information responsive to "a" through "h" is provided electronically on CD-ROM in Microsoft Access 2000 format entitled "PRODUCTION DATA (PE10-008).mdb" stored in the folder "Attachment-Response 1."

We assume that the reference to "peer vehicles" in this and other questions is in error, as no "peer vehicles" are defined. These responses will pertain to the "subject vehicles" unless otherwise noted, and we will provide responsive information about the EPS system as defined in the Information Request ("subject system").

2. State the number of each of the following, received by Toyota, or of which Toyota is otherwise aware, which relate to, or may relate to, the alleged defect in the subject and peer vehicles:

   a. Consumer complaints, including those from fleet operators;
   b. Consumer complaints, including those from operators, were a failure or malfunction of the EPS system was reported;
   c. Field reports, including dealer field reports;
   d. Field reports, including dealer field reports were EPS failure was claimed;
   e. Reports involving a crash, injury, or fatality, based on claims against the manufacturer involving a death or injury, notices received by the manufacturer alleging or proving that a death or injury was caused by a possible defect in a subject vehicle, property damage claims, consumer complaints, or field reports;
   f. Property damage claims;
   g. Third-party arbitration proceedings where Toyota is or was a party to the arbitration; and
   h. Lawsuits, both pending and closed, in which Toyota is or was a defendant or codefendant.

   For subparts "a" through "f" state the total number of each item (e.g., consumer complaints, field reports, etc.) separately. Multiple incidents involving the same vehicle are to be counted separately. Multiple reports of the same incident are also to be counted separately (i.e., a consumer complaint and a field report involving the same incident in which a crash occurred are to be counted as a crash report, a field report and a consumer complaint).

   In addition, for items "e" through "h," provide a summary description of the alleged problem and causal and contributing factors and Toyota's assessment of the problem, with a summary of the significant underlying facts and evidence. For items g and h, identify the parties to the action, as well as the caption, court, docket number, and date on which the complaint or other document initiating the action was filed.

Response 2

Using the methodology described in your question above, the number of reports which relate to, or may relate to, the alleged defect on the subject vehicles are provided electronically on CD-ROM in Microsoft Excel 2000 format entitled "Total Count for Reports.xls" stored in the folder "Attachment- Response 2".

For items "e" through "g", a summary description is also provided in "Total Count for Reports.xls."

3. Separately, for each item (complaint, report, claim, notice, or matter) within the scope of your response to Request No. 2, state the following information:

a. Toyota's file number or other identifier used;
b. The category of the item, as identified in Request No. 2 (i.e., consumer complaint, field report, etc.);
c. Vehicle owner or fleet name (and fleet contact person), address, and telephone number;
d. Vehicle's VIN;
e. Vehicle's make, model and model year;
f. Vehicle's mileage at time of incident;
g. Incident date;
h. Report or claim date;
i. Whether any warning lights were illuminated at the time the alleged defect occurred;
j. Whether the vehicle was towed into the dealership;
k. Whether the driver was able to restart the vehicle, and reset the EPS system;
l. If the EPS was reset, did the failure occur more than once;
m. Diagnostic Trouble Code(s) (DTCs) indicated at the time of repair;
n. Repair(s) dealer made to the vehicle;
o. Whether a crash is alleged;
p. Whether property damage is alleged;
q. Number of alleged injuries;
r. Number of alleged fatalities; and
s. A summary of the incident.

Provide this information in Microsoft Access 2003, or a compatible format, entitled "REQUEST NUMBER TWO DATA." See Enclosure 1, Data Collection Disc, for a pre-formatted table that provides further details regarding this submission.

Response 3

The information "a" through "s" for each item (complaint, report, claim, notice, or matter) is provided electronically on CD-ROM in Microsoft Access 2003 format entitled "REQUEST NUMBER TWO DATA (PE10-008).mdb" stored in the folder "Attachment-Response 3".

4. Produce copies of all documents related to each item within the scope of Request No. 2. Organize the documents separately by category (i.e., consumer complaints, field reports, etc.) and describe the method Toyota used for organizing the documents.

Response 4

Lists of the consumer complaints, the copies of the field reports, and the documents related to the legal related claims and lawsuits are all provided electronically on CD-ROM in Microsoft Excel 2000, or PDF format stored in the folder "Attachment-Response 4." (The list of consumer complaints is stored in the sub-folder "Consumer Complaint." The copies of the field reports are stored in sub-folder "Field Report." The copies of the documents for the legal related claims are stored in the sub-folder "Legal Related Claims." Copies of the documents for the lawsuits are stored in the sub-folder "Lawsuit.")

5. State, by model and model year, total counts for all of the following categories of claims, collectively, that have been paid by Toyota to date that relate to repair or replacement of the subject system in the subject and peer vehicles: warranty claims; extended warranty claims; claims for good will services; and field, zone, or similar adjustments and reimbursements. This should include all claims made in accordance with procedures specified in any service bulletins issued by Toyota related to the subject components.

   Separately, for each such claim, state the following information:

   a. Toyota's claim number;
   b. Vehicle owner or fleet name (and fleet contact person) and telephone number;
   c. VIN;
   d. Repair date;
   e. Vehicle mileage at time of repair;
   f. Repairing dealer's or facility's name, telephone number, city and state or ZIP code;
   g. Whether there was a claim for towing within three days before or after the subject claim (yes/no);
   h. Whether there is any other reference to towing in the claim (yes/no);
   i. Labor operation number;
   j. Problem code;
   k. Diagnostic Trouble Code(s) (DTCs) indicated at the time of repair;
   l. Replacement part number(s) and description(s);
   m. Concern stated by customer;
   n. Comment, if any, by dealer/technician relating to claim and/or repair; and
   o. Toyota's assessment of whether the claim was associated with an EPS failure while driving.

   Provide this information in Microsoft Access 2003, or a compatible format, entitled "WARRANTY DATA." See Enclosure 1, Data Collection Disc, for a pre-formatted table that provides further details regarding this submission.

Response 5

The total count of warranty claims, extended warranty claims and claims for good will services paid by Toyota for the subject vehicles that relate to the repair or replacement of the subject system are provided electronically on CD-ROM in Microsoft Excel 2000 format entitled "Total Count for Claims.xls" stored in the folder "Attachment-Response 5".

The detailed information for each claim is also provided electronically on CD-ROM in Microsoft Access 2000 format entitled "Warranty Data (PE10-008).mdb" stored in the folder "Attachment- Response 5".

6. Describe in detail the search criteria used by Toyota to identify the claims identified in response to Request No. 5, including the labor operations, problem codes, part numbers

and any other pertinent parameters used. Provide a list of all labor operations, labor operation descriptions, problem codes, and problem code descriptions applicable to the alleged defect in the subject vehicles. State, by make and model year, the terms of the new vehicle warranty coverage offered by Toyota on the subject vehicles (i.e., the number of months and mileage for which coverage is provided and the vehicle systems that are covered). Describe any extended warranty coverage option(s) that Toyota offered for the subject vehicles and state by option, model, and model year, the number of vehicles that are covered under each such extended warranty.

Response 6

The search criteria used by Toyota to identify the claims is the following:

Toyota searched the warranty database for those claims that replaced any of the parts or that reported the problem codes identified in Microsoft Excel file entitled "Search Criteria, Operation & Problem Codes.xls" stored in the folder "Attachment- Response 6" on CD-ROM. In addition, a list of all labor operations, labor operation descriptions, problem codes and problem code descriptions identified in these warranty claims are also provided in the same Microsoft Excel file described above.

The terms that Toyota offers for new vehicle warranty coverage on MY 2009-2010 Corolla and Corolla Matrix vehicles are as follows;

For the EPS system
36 months or 36,000 miles from the vehicle's date-of-first-use, whichever occurs first.

There are some extended warranty coverage options that Toyota offered for purchase with the subject vehicles. Detailed information about these options is provided electronically on CD-ROM, in PDF format, entitled "Extended Warranty Option.pdf" stored in the folder "Attachment-Response 6."

The number of vehicles that are covered under each such extended warranty option, by option, model, and model year will be provided at a later time with a request that the information be afforded confidential treatment, because it contains trade secret and commercial information.

7. Produce copies of all service, warranty, and other documents that relate to, or may relate to, the alleged defect in the subject vehicles, that Toyota has issued to any dealers, regional or zone offices, field offices, fleet purchasers, or other entities. This includes, but is not limited to, bulletins, advisories, informational documents, training documents, or other documents or communications, with the exception of standard shop manuals.

Also include the latest draft copy of any communication that Toyota is planning to issue within the next 120 days.

Response 7

Toyota has issued two service bulletins concerning the subject system. One is for steering intermediate shaft noise and the other bulletin is intended to supplement the Repair Manual procedures for correcting pulling complaints.

Copies of the service bulletins are provided electronically on CD-ROM in PDF format stored in the folder "Attachment-Response 7".

8. Provide a description of how the EPS system functions within the subject vehicles, including a complete list of all components and the supplier for each.

Response 8

Toyota provides the appropriate pages of the New Car Features (NCF) for descriptions of the EPS system in the subject vehicles as "Attachment-Response 8-1" for the 2009MY Corolla and "Attachment-Response 8-2" for the 2009MY Corolla Matrix.
The list of all components and the supplier for each is provided electronically on CD-ROM in Microsoft Excel 2000 format entitled "Supplier information with other vehicles information.xls" stored in the folder "Attachment-Response 11".

9. If any of the subject vehicles comes equipped with a vehicle stability control (VSC) system, please describe:

a. The function of the VSC;
b. Specifically how that system interacts with the EPS; and
c. Explain how the VSC system responds when an EPS fault is detected.

Response 9

a. The subject vehicles by engine type or grade are equipped with the VSC as standard. Toyota provides appropriate pages of the NCF for the function of the VSC as "Attachment-Response 9a-1" for the 2009MY Corolla and "Attachment-Response 9a-2" for the 2009MY Corolla Matrix.

b. As explained in "System Diagram" in the "Attachment-Response 9a", the skid control ECU does not receive any commands or information form EPS ECU. Therefore, the VSC is not influenced at all by the EPS.

c. As mentioned above, since the VSC does not require any information form the EPS, nothing will happen to the VSC even if errors occur with the EPS.

10. Describe all assessments, analyses, tests, test results, studies, surveys, simulations, investigations, inquiries and/or evaluations (collectively, "actions") that relate to, or may relate to, the alleged defect in the subject vehicles that have been conducted, are being conducted, are planned, or are being planned by, or for, Toyota. For each such action, provide the following information:

a. Action title or identifier;

b. The actual or planned start date;

c. The actual or expected end date;

d. Brief summary of the subject and objective of the action;

e. Engineering group(s)/supplier(s) responsible for designing and for conducting the action; and

f. A brief summary of the findings and/or conclusions resulting from the action.

For each action identified, provide copies of all documents related to the action, regardless of whether the documents are in interim, draft, or final form. Organize the documents chronologically by action.

Response 10

To be supplied.

11. State the number of EPS system components; including motors, control modules, steering torque and position sensors, and steering column assemblies; that Toyota has sold that may be used in the subject vehicles by part number (both service and engineering/production) and month/year of sale *(including the cut-off date for sales, if applicable)*.

For each component part number, provide the supplier's name, address, and appropriate point of contact (name, title, and telephone number). Also identify by make, model and model year, all vehicle applications that use the component, whether installed in production or in service, and state the applicable dates of production or service usage.

Response 11

The number of EPS components that Toyota has sold that may be used in the subject vehicles are provided electronically on CD-ROM in Microsoft Excel 2000 format entitled "Number of components sold in the US.xls" stored in the folder "Attachment-Response 11".

In addition, the supplier's name, address, and appropriate point of contact (name, title, and telephone number) for the EPS component part number are also provided electronically in Microsoft Excel 2000 format entitled "Supplier Information with other vehicles information.xls".

As for other vehicles which contain the identical component, Toyota is providing make, model and model year in the same attachment "Supplier Information with other vehicles information.xls" above.

12. Provide one sample for each of the following:

a. One exemplar sample of each design version of the subject system for the subject vehicles;
b. Field return sample of the subject system, or any component of the subject system exhibiting the subject failure mode; and
c. Any kits that have been released, or may be relate, to the alleged defect in the subject vehicles.

Response 12

Samples will be provided under separate cover at a later time.

13. Provide the following information regarding the effect of the alleged defect on steering effort and vehicle control in the subject vehicles:

a. Steering effort as a function of lateral acceleration for normal system operation and after EPS failure;
b. Copies of all system test standards associated with steering effort/feel with normal operation and after a system failure;
c. Copies of all studies, reports or related material associated with each of the following for the subject vehicles or any other vehicles: (1) driving steering effort capability (for the full range from 5^{th} to 95^{th} percentile male and female drivers); and (2) human factors analyses/assessments of driver reactions to sudden changes in steering effort; and
d. Provide a table showing Toyota's assessment of each of the crash complaints provided with this letter and in Toyota's response material, including incident speed, road conditions, traffic conditions, description of the steering maneuver attempted, the approximate lateral acceleration, the driver's description of the effect on steering performance/effort, and Toyota's assessment of the crash severity and all causal factors.

Response 13

To be supplied

14. Provide Toyota's assessment of the alleged defect in the subject vehicles, including:
    a. Causal or contributory factor(s);
    b. The failure mechanism(s);
    c. The failure mode(s);
    d. The risk to motor vehicle safety that it posses;
    e. What warnings, if any, the operator of the vehicle would have that the alleged defect was occurring or subject system was malfunctioning, and
    f. The reports included with this inquiry.

Response 14

To be supplied.

* * *

Data provided in this document is current as of the following dates:

Response		Dates
Response 1	Production Data	3/24/2010
Response 2 - 4	Consumer Complaints	3/2/2010
	Field Reports	3/25/2010
	Lawsuits	4/1/2010
Response 5	Warranty claims	3/24/2010
	Goodwill	3/31/2010
	Extended warranty claims	3/29/2010
Response 7	Dealer communications	3/24/2010
Response 11	Part sales	4/6/2010

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In the foregoing responses to this Information Request ("IR"), information has been obtained from those departments and employees knowledgeable about the subject matter of this inquiry most likely to have such information in the regular and ordinary course of business. When a particular Request seeks "documents" as defined in the IR, reasonable,

good faith searches have been made of corporate records where such documents would ordinarily be expected to be found and to which Toyota would ordinarily refer when looking for such information.

The definitions of "documents" and "Toyota", however, are unreasonably broad, vague, and ambiguous, and Toyota objects to such definitions, because they exceed a reasonable understanding of such terms. For example, "calendars", "travel reports", "contracts" and "personnel records", to name a few, would not normally contain responsive information pertaining to the alleged defect subject of this inquiry. Toyota has also not provided information from electronic files that require extraordinary or expert means to retrieve that are generally unavailable to the computer user.

In addition, Toyota has not provided information from persons or entities over which it does not ordinarily exercise control, such as independent suppliers and contractors. Toyota also objects to the definition of "Toyota" to the extent it purports to include outside counsel. It would be unduly burdensome to require Toyota to request that outside counsel search files for responsive documents. Moreover, it is highly unlikely that outside counsel would possess any non-privileged documents responsive to this IR that are not already being produced by Toyota. In light of the significant burden and cost associated with canvassing outside counsel for potentially responsive documents and the very low probability of identifying any non-privileged document not already being produced, Toyota has not asked its outside counsel to search for responsive documents.

Toyota understands this IR to seek information on vehicles manufactured for sale in the United States and its territories. Also, we understand documents specifically related to the preparation of the responses are not sought.

The source of information used as a basis for the data in each Attachment, including the date the data were updated and retrieved, is identified above as applicable. If a document itself is the source for the requested information and it is provided, no further source identification is provided. If a document, drawing or component is requested, or if no responsive information is available, we assume no further source identification is called for.

Toyota is not providing privileged documents that may be responsive to this Information Request. With regard to claims of privilege, Toyota understands that it is acceptable to the Agency for Toyota to identify specific categories of privileged documents rather than any specific document within those categories. These categories include: (a) communications between outside counsel and employee's of Toyota's Law Department, other Toyota employees, or employees of parties represented by Toyota in litigation and claims; (b) communications between employees of Toyota's Law Department and other Toyota

employees, or employees of parties represented by Toyota in litigation and claims; (c) notes and other work product of outside counsel or of employees of Toyota's Law Department , including work product of employees or consultants done for or at the request of outside counsel or Toyota's law Department. For any privileged documents that are not included in these categories, if any, Toyota will provide a privilege log identifying any such document under separate cover. Toyota is not claiming a legal privilege for any documents provided with this response; however, Toyota does not waive the legal privilege or work-product protection with respect to other documents that may have been prepared in connection with a specific litigation or claim. In addition, Toyota may assert the attorney-client privilege or claim protection under the work-product protection for analyses or other documents that may be prepared in connection with litigation or claims in the future.

Toyota understands that NHTSA will protect any private information about persons that is contained in the Attachments to this response, based on privacy considerations. Such private information includes data such as names, addresses, phone or fax numbers, email addresses, license plate numbers, driver's license numbers and the last 6 digits of a vehicle's VIN.

PE10-008

TOYOTA

05/07/2010

Attachment-Response07
Intermediate Shaft Knock Noise
T-SB-0243-09

Steering Intermediate Shaft Knocking Noise

Service Category Steering

Section Steering Gear/Linkage **Market** USA

Toyota Supports ASE Certification

Applicability

YEAR(S)	MODEL(S)	ADDITIONAL INFORMATION
2009 – 2010	Corolla, Matrix	

Introduction

Some 2009 – 2010 Corolla and Matrix vehicles may exhibit a clunk, pop, or knocking noise when turning the steering wheel to the left or right. A new intermediate shaft has been developed to address this condition. Use the following repair procedure to remove and replace the steering intermediate shaft.

Production Change Information

This TSB applies to vehicles produced **BEFORE** the Production Change Effective VINs shown below.

MODEL	ENGINE TYPE		PLANT	PRODUCTION CHANGE EFFECTIVE VIN
Corolla	2AZ-FE		NUMMI	1NXBE4EE#AZ171406
			TMMC	2T1BE4EE#AC031001
	2ZR-FE		NUMMI	1NXBU4EE#AZ169743
			TMMC	2T1BU4EE#AC197503
			Takaoka	JTDBU40E#9J054516
			Kanto	JTDBL40E#99093141
Matrix	2AZ-FE	XRS	TMMC	2T1ME4EE#AC005811
		S		2T1KE4EE#AC030974
		AWD		2T1LE4EE#AC012021
	2ZR-FE			2T1KU4EE#AC197596

Steering Intermediate Shaft Knocking Noise

Warranty Information

OP CODE	DESCRIPTION	TIME	OFP	T1	T2
ST9009	R & R No. 2 Steering Intermediate Shaft Assembly	1.0	45260-#####	91	55

APPLICABLE WARRANTY

- **This repair is covered under the Toyota Comprehensive Warranty. This warranty is in effect for 36 months or 36,000 miles, whichever occurs first, from the vehicle's in-service date.**
- **Warranty application is limited to occurrence of the specified condition described in this bulletin.**

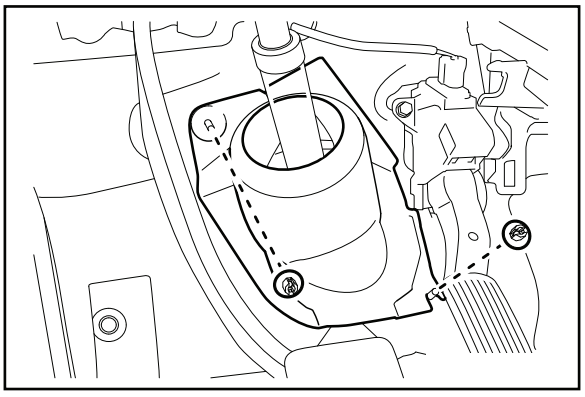
Parts Information

MODEL	PRODUCTION	PREVIOUS PART NUMBER	CURRENT PART NUMBER	PART NAME	QTY
Corolla, Matrix	NAP	45260-02110	Same	Shaft Assembly, Steering Intermediate, No. 2	1
Matrix (AWD)		45260-02120	Same		1
Corolla	Japan	45260-12620	Same		1

Repair Procedure

1. Install a steering wheel lock to ensure the wheels are straight and the steering wheel is centered before removing the steering intermediate shaft. Make sure the steering wheel and front wheels remain stationary. Once the intermediate shaft is removed, do NOT allow the steering wheel to spin freely.
2. Remove the column hole silencer sheet.

Figure 1.

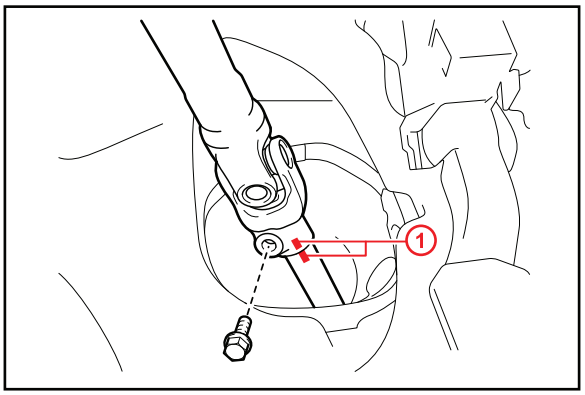


Steering Intermediate Shaft Knocking Noise

Repair Procedure (Continued)

3. Place a matchmark on the No. 2 steering intermediate shaft that will later be copied onto the new part, and remove the bolt.

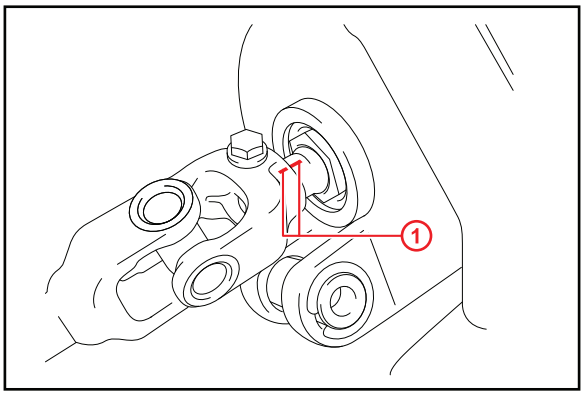
Figure 2.



1	Matchmark

4. Place a matchmark on the upper portion of the No. 2 steering intermediate shaft.

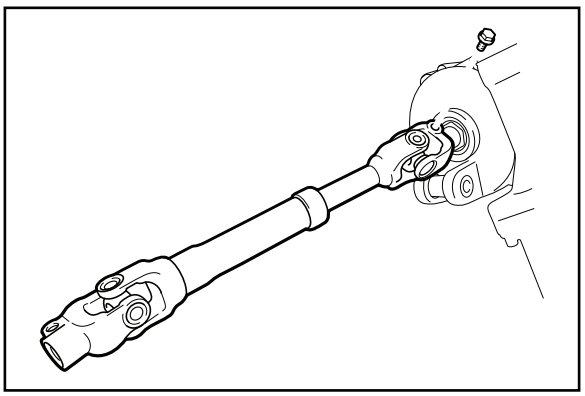
Figure 3.



1	Matchmark

5. Remove the bolt and the No. 2 steering intermediate shaft assembly from the steering column assembly.

Figure 4.



Steering Intermediate Shaft Knocking Noise

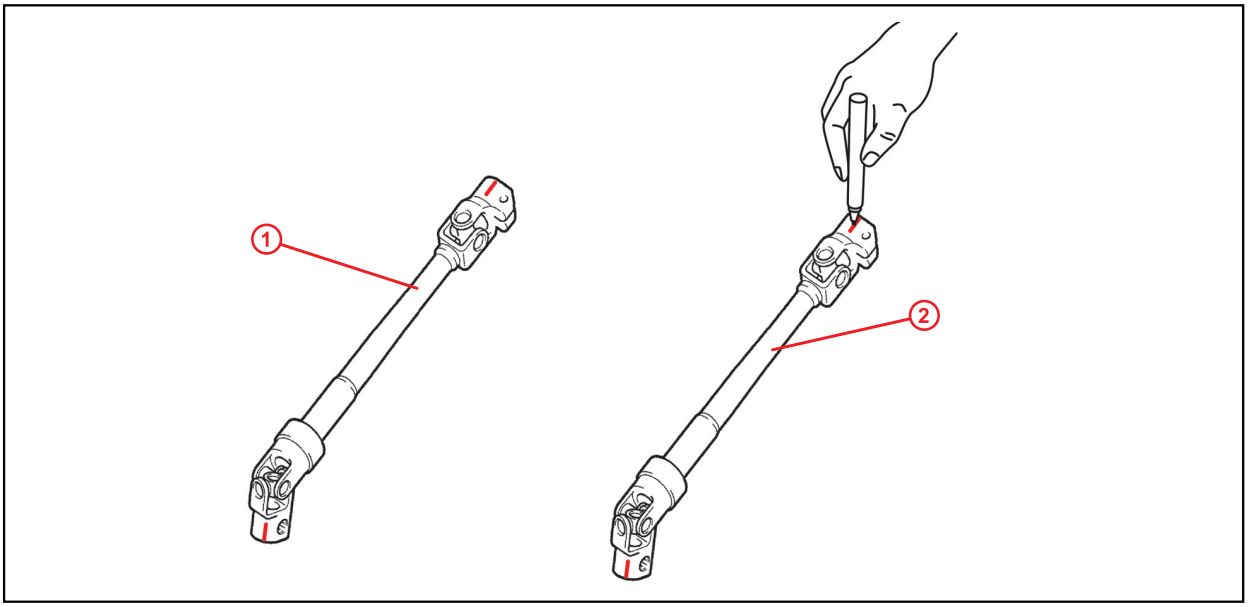
Repair Procedure (Continued)

6. Place the matchmarks on the NEW steering intermediate shaft sub-assembly.

   A. Place the NEW steering intermediate shaft next to the original steering intermediate shaft assembly (removed in the previous step).

   B. Transfer the matchmarks on the original steering intermediate shaft to the same locations on the NEW steering intermediate shaft.

Figure 5.

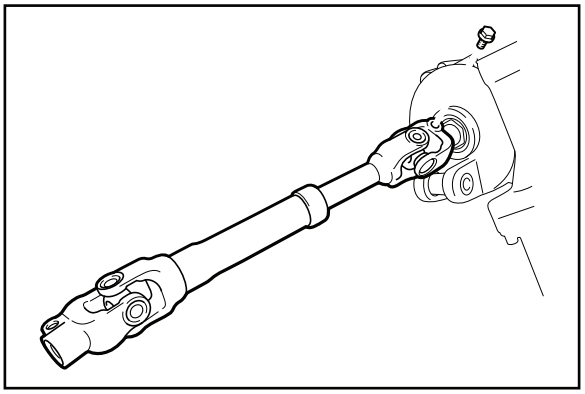


1	Original Steering Intermediate Shaft
2	New Steering Intermediate Shaft

7. Install the NEW No. 2 intermediate shaft and line up the matchmarks and tighten the bolt.

   Torque: 35 N*m (360 kgf*cm, 26 ft*lbf)

Figure 6.

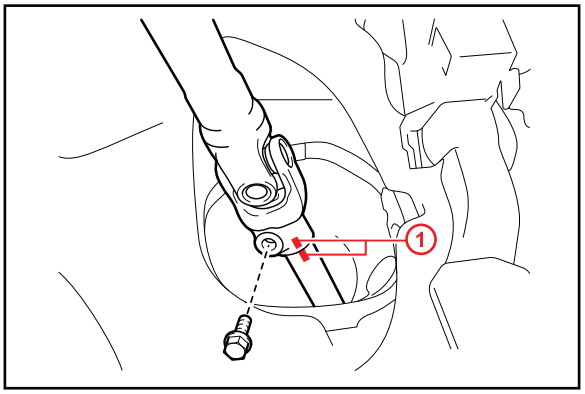


Steering Intermediate Shaft Knocking Noise

Repair Procedure (Continued)

8. Install the No. 2 intermediate shaft onto the No. 1 intermediate shaft and line up the matchmarks, and tighten the bolt.
   Torque: 35 N*m (360 kgf*cm, 26 ft*lbf)

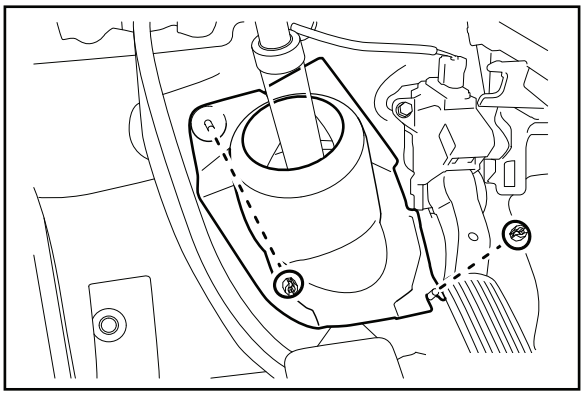
Figure 7.



1	Matchmark

9. Reinstall the column hole silencer sheet.

Figure 8.



10. Road test the vehicle to verify the repair and confirm that the steering wheel is centered.

PE10-008

TOYOTA

05/07/2010

Attachment-Response07

Repair Manual Supplement Vehicle Pulling to One side T-SB-0391-08

Repair Manual Supplement: Vehicle Pulling to One Side

Service Category Suspension

Section Alignment/Handling Diagnoses **Market** USA

Toyota Supports ASE Certification

Applicability

YEAR(S)	MODEL(S)	ADDITIONAL INFORMATION
2002 – 2009	4Runner, Avalon, Camry, Corolla, Highlander, Land Cruiser, Prius, RAV4, Sequoia, Sienna, Solara, Tacoma, Tundra	
2007 – 2009	Camry HV, FJ Cruiser	
2002 – 2005	Celica, Echo, MR2 Spyder	
2006 – 2009	Highlander HV	
2003 – 2009	Matrix	
2009	Venza	
2004 – 2009	Yaris	

TSB SUPERSESSION NOTICE

The information contained in this TSB supersedes the following TSBs:

- **ST005-01: Applicability has been updated to include 2008 – 2009 model year Toyota vehicles.**
- **SU001-08: Applicability has been updated to include all 2002 – 2009 model year vehicles.**

TSB Nos. ST005-01 and SU001-08 are Obsolete and any printed versions should be discarded. Be sure to review the entire content of this service bulletin before proceeding.

Introduction

This bulletin contains general vehicle pulling diagnosis and repair procedures along with specific information to help correct pulling complaints.

Repair Manual Supplement: Vehicle Pulling to One Side

Introduction (Continued)

This information supplements Repair Manual procedures when the symptoms are:

- The driver holds the steering wheel without exerting steering effort while driving straight ahead, the vehicle drifts to the right or the left.
- While driving straight ahead, the driver has to steer either to the right or the left to maintain straight driving.

Warranty Information

OP CODE	DESCRIPTION	TIME	OFP	T1	T2
044184	Preliminary Check & Road Test	0.6	45046-09020	31	99
Combo A	Switch Front Tire/Wheel & Road Test	0.5			
Combo B	Reverse the Front One Side Tire	0.7			
Combo C	Check Front Wheel Alignment	1.2			
Combo D	Adjust Front Wheel Alignment	0.7			
Combo E	Adjust Camber Setting	0.7			
420091	Dismount and Mount Tire and Balance Wheel and Tire Assembly	0.5	42611-08010		
Combo A	Each additional Wheel	0.3			

NOTE

OP Code 044184 and the above combination codes apply to all models with the EXCEPTION of Combo E for the MR2 Spyder model.

APPLICABLE WARRANTY

- **This repair is covered under the Toyota Comprehensive Warranty. This warranty is in effect for 12 months or 20,000 miles, whichever occurs first, from the vehicle's in-service date.**
- **Warranty application is limited to correction of a problem based upon a customer's specific complaint.**

Repair Manual Supplement: Vehicle Pulling to One Side

Contents

This bulletin is divided into the following sections:

- Wheel Alignment and Tire Characteristics
- Repair Procedure Flow Chart
- Repair Procedure
  - Important Notice
  - Troubleshooting
  - Vehicle Pulling Caused by Wheel Alignment
  - Vehicle Pulling Caused by Tire Conicity
  - Camber Adjustment Method

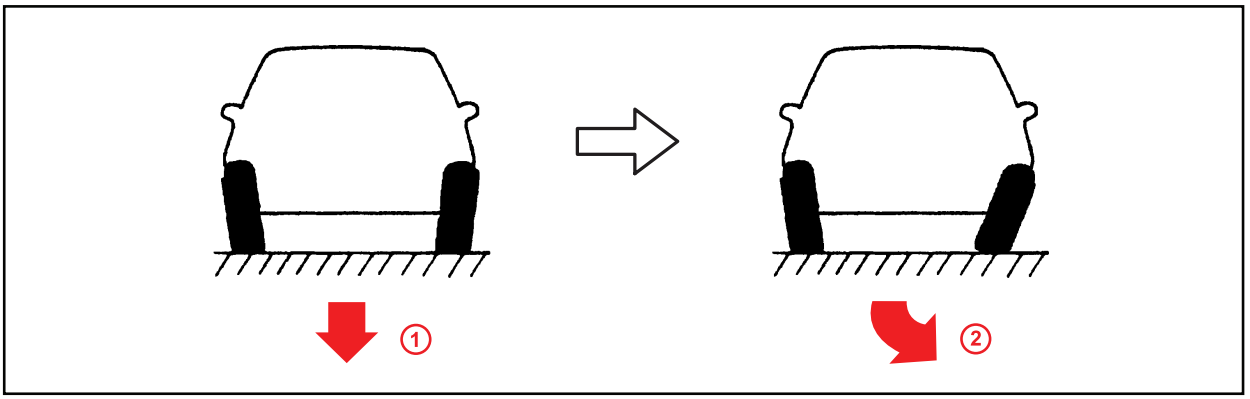
Wheel Alignment & Tire Characteristics

1. **Relationship Between Wheel Alignment and Vehicle Pulling to One Side**

When the cross camber or caster of the front wheel alignment is large, it can cause vehicle pulling.

WHEEL ALIGNMENT	DIRECTION OF VEHICLE PULLING
Camber	Vehicle Pulls in Direction of Wheel with Large Camber Value (See Figure 1)
Caster	Vehicle Pulls in Direction of Wheel with Small Caster Value (See Figure 2)

Figure 1. Camber

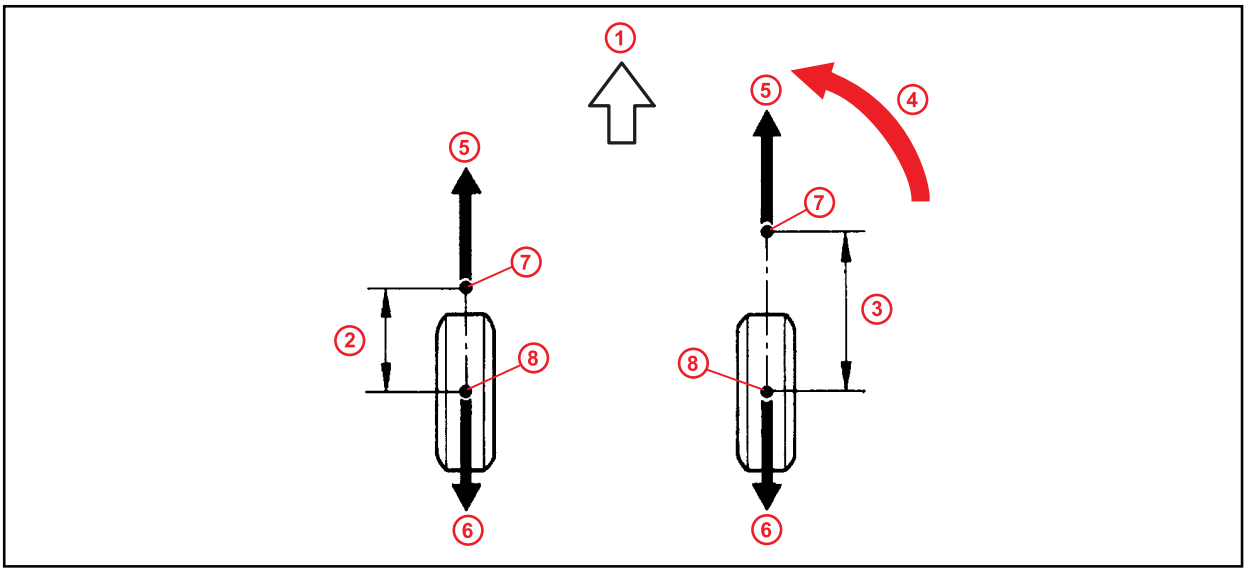


1	Straight-ahead Driving	2	Direction of Pull

Repair Manual Supplement: Vehicle Pulling to One Side

Wheel Alignment & Tire Characteristics (Continued)

Figure 2. Caster



1	Front
2	Caster Trail (Small)
3	Caster Trail (Large)
4	Direction of Pull

5	Driving Force
6	Reactive Force
7	Steering Axis
8	Center of Tire – Road Contact Area

If the cross camber or caster is within the specified range (30’ or less), noticeable vehicle pulling will not occur due to side-to-side differences in camber or caster.

NOTE

On a flat road, if the cross camber or caster is 30’ or less and the steering wheel is held without exerting steering effort for 109 yards (100 m) when driving at 62 mph (100 km/h), the alignment-induced drift distance is approximately 1.64 feet (0.5 m).

Repair Manual Supplement: Vehicle Pulling to One Side

Wheel Alignment & Tire Characteristics (Continued)

2. **Relationship Between Tire Characteristics and Vehicle Pulling to One Side**

When radial tires are rotating, they have the characteristic of generating force in the lateral direction between the tire and the road surface. This lateral force is comprised of two factors:

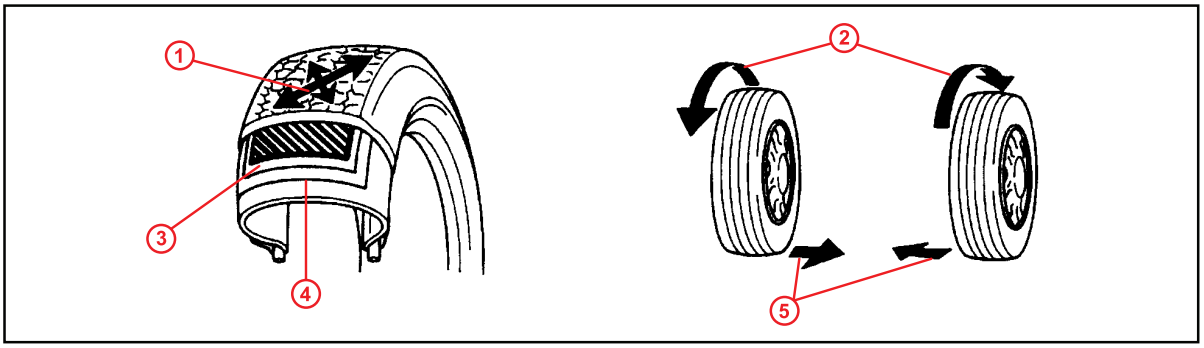
- Ply-steer, which changes direction according to the rotation direction of the tires.
- Conicity, which is generated in a fixed direction regardless of the tire rotation direction.

If these lateral forces are too strong, vehicle pulling will occur.

A. Ply-Steer

Lateral force due to ply-steer is produced by the construction of the belts inside the tire tread. With radial tires, the wire of the belt is slanted as shown in the illustration below. Thus, it is in the lateral direction that tire tread easily changes shape (stretches), and lateral force is generated between the tire and the road surface in the lateral direction.

Figure 3.



1	Easily Stretched Direction
2	Rotation Direction
3	Wire

4	Belt
5	Ply-Steer (Direction of Force Generation Varies According to Tire Rotation)

NOTE

Lateral force from ply-steer prevents vehicle drift caused by road slant, so in many cases lateral force to the left is provided to compensate for road slant to the right.

Repair Manual Supplement: Vehicle Pulling to One Side

Wheel Alignment & Tire Characteristics (Continued)

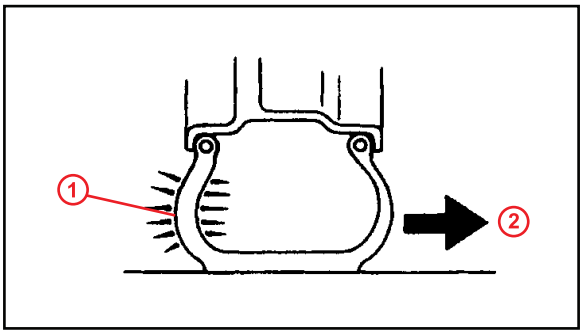
B. Conicity

Conicity is lateral force resulting from uneven formation of the left and right sides of the tire. The direction the lateral force is exerted depends on the hardness of the side walls and the difference in height between the left/right sides of the tire.

NOTE

- **In the case of vehicle pulling caused by tires, the lateral force which is exerted as a result of conicity has the greatest effect. On a flat road, if the steering wheel is held without exerting steering effort for 109 yards (100 m) when traveling at 62 mph (100 km/h), the vehicle may drift as much as 5 feet (1.5 m).**
- **When vehicle pulling is due to conicity, the amount of drift can be reduced and the direction of drift can be changed by changing the location of the tire or reversing the tire when installing it on the wheel.**

Figure 4.

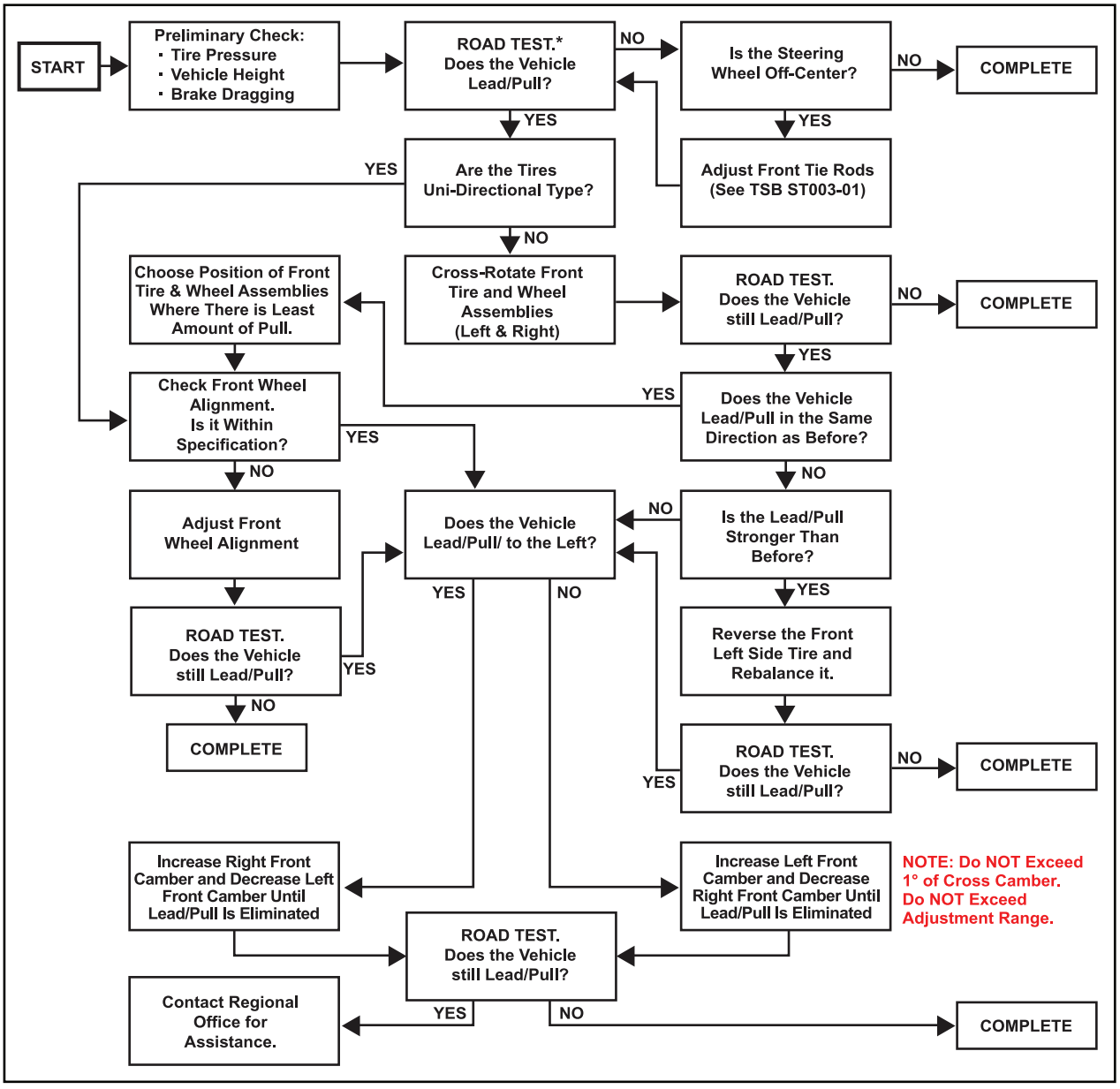


1	Hard Part
2	Conicity (Direction is Fixed Regardless of Direction of Tire Rotation)

Repair Manual Supplement: Vehicle Pulling to One Side

Repair Procedure Flow Chart

Figure 5.



*** Select a flat road where the vehicle can be driven in a straight line for 109 yards (100 meters) at a constant speed of 35 mph (56 km/h). Please confirm safety and set the steering wheel to its straight position. Drive the vehicle in a straight line for 109 yards (100 meters) at a constant speed of 35 mph (56 km/h) without exerting steering effort on the steering wheel.**

• Steering Off Center: The vehicle goes straight but the steering wheel has some angle.
• Steering Pull: The vehicle does NOT go straight.

Repair Manual Supplement: Vehicle Pulling to One Side

Repair Procedure

IMPORTANT NOTICE

Before repairing vehicle pulling to one side, it is necessary to clearly identify the cause of the pulling condition. Frequently, the cause of the vehicle pulling to one side is diagnosed as wheel alignment. However, the actual cause may be lateral force generated by the tires. Performing wheel alignment when tire force is the cause could result in the wheel alignment being set at a value outside of specifications. This would then cause other problems such as uneven tire wear, etc.

1. Troubleshooting

First determine whether vehicle pulling to one side is caused by a wheel alignment problem or tire characteristics, then decide which repairs to make.

A. Perform the following checks and correct as necessary.

(1) Check tires for size, wear and for proper inflation pressure.

(2) Check whether the vehicle is noticeably tilted backward/forward or left/right.

NOTE

Tilting of the vehicle produces a left-right difference in the camber and caster and can cause vehicle pulling to one side.

(3) Check brakes for dragging.

B. Confirm problem symptoms.

With the customer accompanying you, drive the vehicle to confirm if the customer's complaint involves vehicle pulling to one side or steering wheel off center.

If the problem is steering wheel off center, refer to the Repair Manual for the adjustment procedure. For 2002 model year vehicles only, refer to TSB No. ST003-01, *"Steering Wheel Off Center Adjustment Procedure"*. Also check the direction of vehicle pulling and the extent of pulling.

C. Decide if vehicle pulling is due to wheel alignment or tires.

(1) Switch the left and right front tires (If the tires are non-unidirectional).

(2) Conduct a drive test to check whether the direction that the vehicle pulls has changed.

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
No Change in Vehicle Pulling Condition	Front Wheel Alignment	Proceed to Repair Procedure Step 2. Vehicle Pulling Caused by Wheel Alignment
Vehicle Pulling Eliminated	Tire Conicity	Repair Complete. Vehicle Pulling Caused by Tire Conicity
Vehicle Pulling Direction Is Reversed	Tire Conicity	Proceed to Repair Procedure Step 3. Vehicle Pulling Caused by Tire Conicity

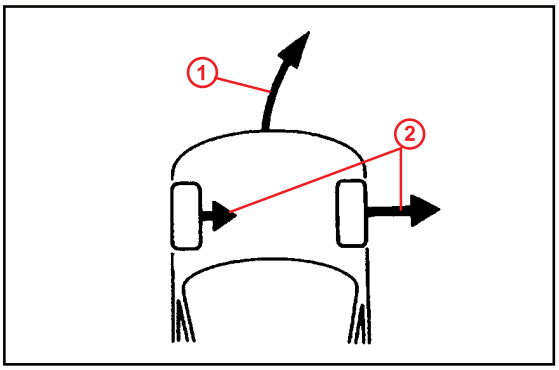
Repair Manual Supplement: Vehicle Pulling to One Side

Repair Procedure (Continued)

Helpful hints to determine cause of vehicle pulling:

- The direction of lateral force from tire conicity becomes reversed when the left and right tires are switched. Therefore, if the pulling direction changes when the tires are switched, it can be concluded that vehicle pulling is caused by tire conicity.
  - The vehicle is pulled to the right by the lateral force exerted to the right.

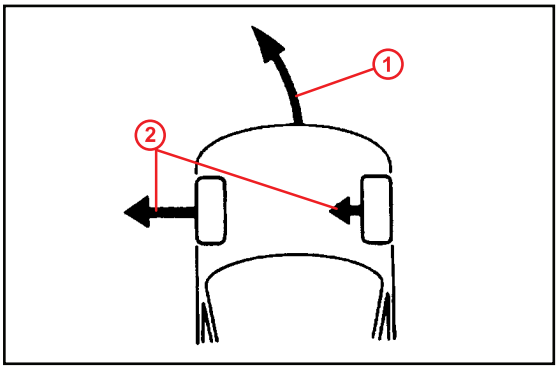
Figure 6. Original Tire Positions



1	Vehicle Pulling Direction (Right)
2	Lateral Force by Conicity

  - The direction of the tires which exerted lateral force to the right has been changed, so the tires now exert lateral force to the left and the vehicle now pulls to the left.

Figure 7. Tires Switched



1	Vehicle Pulling Direction (Left)
2	Lateral Force by Conicity

- If the pulling direction does not change after the front tires are switched, the cause of vehicle pulling is not tire conicity. In this case, the likely cause is a front wheel alignment condition.

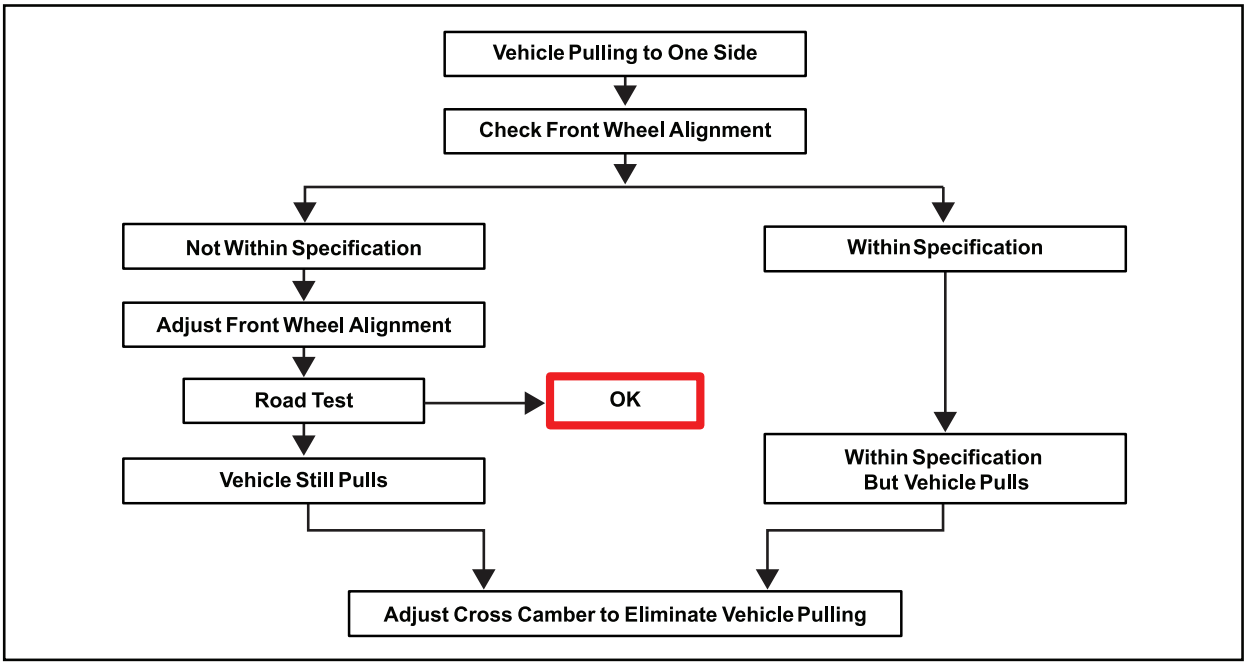
Repair Manual Supplement: Vehicle Pulling to One Side

Repair Procedure (Continued)

2. Vehicle Pulling Caused by Wheel Alignment.

When it is determined by troubleshooting that the vehicle pulling to one side is caused by wheel alignment, perform repairs according to the following procedure.

Figure 8.



WHEN VEHICLE PULLS TO LEFT	WHEN VEHICLE PULLS TO RIGHT
Increase right front camber and decrease left front camber until vehicle pulling is eliminated	Increase left front camber and decrease right front camber until vehicle pulling is eliminated

NOTE

- **Keep the cross camber within 1° or less.**
- **Keep the camber of each wheel within specifications (+/–45' of center value).**
- **If adjustment exceeds the specifications, uneven tire wear will result.**

Repair Manual Supplement: Vehicle Pulling to One Side

Repair Procedure (Continued)

3. Vehicle Pulling Caused by Tire Conicity.

When it is determined by troubleshooting that the vehicle pulling to one side is caused by tire conicity, perform repairs according to the following procedures.

Indication of Tire Conicity as a Cause:

When the front tires are switched, the pulling direction changes. Proceed to step 3A below.

A. Remove the front left tire from the wheel and reverse the tire. Then perform a road test and check for change in the pulling direction.

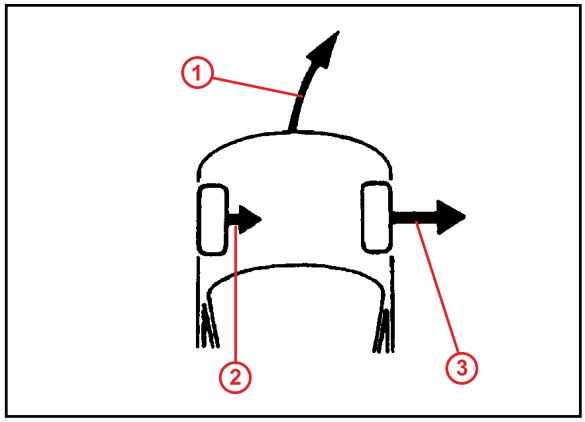
HINT

By performing this operation, it can be checked whether the left or right tire exerts a stronger lateral force. Either tire can be reversed. Shown here is an example of the left tire reversed.

If Vehicle Pulls in the Same Direction: Go to step 3B.

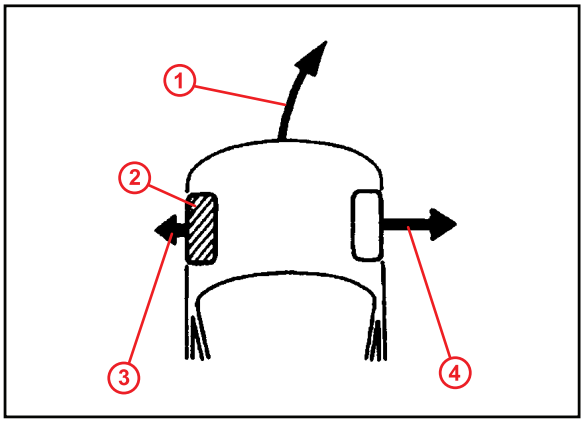
The lateral force generated by the right front tire is greater than the left tire, so the vehicle is pulling due to the lateral force of the right tire.

Figure 9. Original Tire Positions



1	Vehicle Pulling Direction
2	Lateral Force by Conicity (Smaller)
3	Lateral Force by Conicity (Larger)

Figure 10. Left Tire Reverse Installation



1	Vehicle Pulling Direction (Same Direction)
2	Reversed
3	Lateral Force by Conicity (Smaller)
4	Lateral Force by Conicity (Larger)

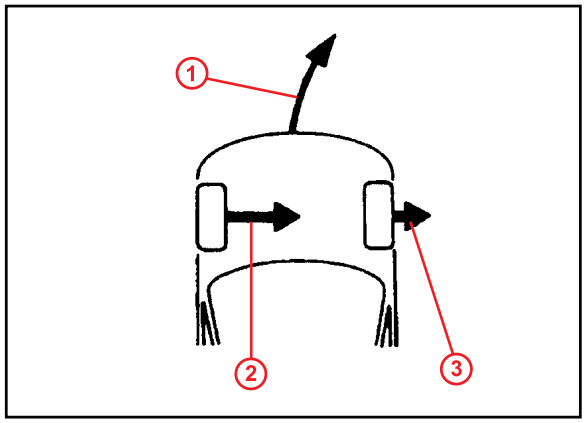
Repair Manual Supplement: Vehicle Pulling to One Side

Repair Procedure (Continued)

If Vehicle Pulls in the Opposite Direction: Go to step 3B.

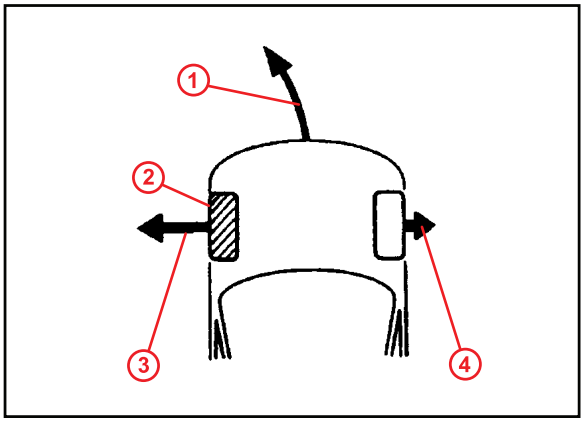
The lateral force generated by the left front tire is greater than the right tire, so the vehicle is pulling due to the lateral force of the left tire.

Figure 11. Original Tire Positions



1	Vehicle Pulling Direction
2	Lateral Force by Conicity (Larger)
3	Lateral Force by Conicity (Smaller)

Figure 12. Left Tire Reverse Installation



1	Vehicle Pulling Direction (Opposite Direction)
2	Reversed
3	Lateral Force by Conicity (Larger)
4	Lateral Force by Conicity (Smaller)

If Vehicle Pull Is Eliminated: Repair Is Now Complete.

The lateral force generated by the left and right front tires is virtually the same, so the lateral force is neutralized and the vehicle travels straight ahead. The repair operation is now completed.

B. Rotate the **larger** lateral force front tire with the rear tire and check the change in the vehicle pulling.

NOTE

By shifting the front tire with the larger lateral force to the rear, the vehicle pulling level is usually reduced.

If Vehicle Is Still Pulling: Go to step 3C.

If Vehicle Pull Is Eliminated: Repair Is Now Complete.

Repair Manual Supplement: Vehicle Pulling to One Side

Repair Procedure (Continued)

C. Adjust cross camber to eliminate vehicle pulling.

HINT

If the tires are placed in the positions they were in during tire rotation when the least amount of vehicle pulling occurred, wheel alignment can be performed with a minimal amount of adjustment.

WHEN VEHICLE PULLS TO LEFT	WHEN VEHICLE PULLS TO RIGHT
Increase right front camber and decrease left front camber until vehicle pulling is eliminated	Increase left front camber and decrease right front camber until vehicle pulling is eliminated

NOTE

- **Keep the cross camber within 1° or less.**
- **Keep the camber of each wheel within specifications (+/–45' of center value).**
- **If adjustment exceeds the specifications, uneven tire wear will result.**

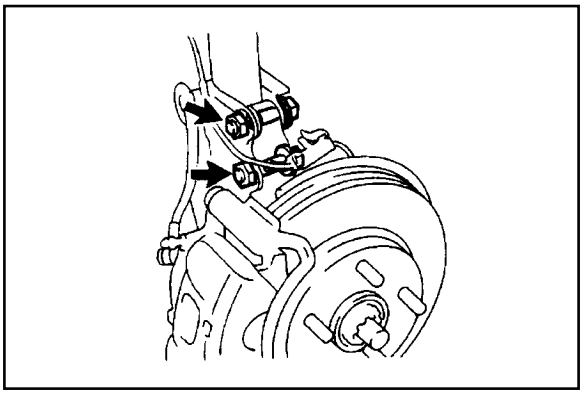
4. Camber Adjustment Method.

NOTE

- **After the camber has been adjusted, inspect the toe-in.**
- **The method of camber adjustment differs for different models, so please refer to the Repair Manual of the vehicle involved. (The information below are samples from the Sienna Repair Manual.)**

A. Remove the front wheels and ABS speed sensor clamp.

Figure 13.

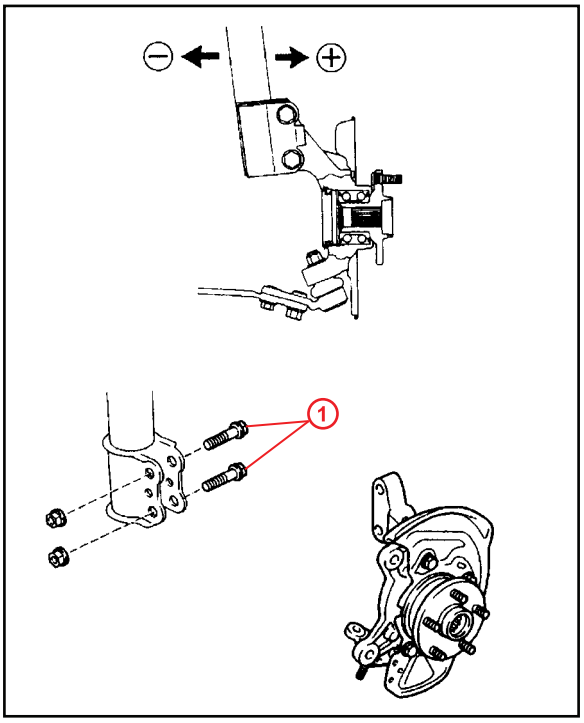


Repair Manual Supplement: Vehicle Pulling to One Side

Repair Procedure (Continued)

B. Remove the two nuts on the lower side of the shock absorber.

Figure 14.



1	Nuts

C. Coat the threads of the nuts with engine oil.

D. Temporarily install the two nuts.

E. Adjust the camber by pushing or pulling the lower side of the shock absorber in the direction in which the camber adjustment is required.

F. Tighten the nuts.

Torque: 210 N*m (2150 kgf*cm, 155 ft*lbf)

G. Install the front wheels.

Torque: 104 N*m (1050 kgf*cm, 77 ft*lbf)

Repair Manual Supplement: Vehicle Pulling to One Side

Repair Procedure (Continued)

H. Check the camber.

NOTE

Adjusting value for the set bolts is 6' – 30' (0.1° – 0.5°). When making an adjustment of more than 45', replace the upper and lower steering knuckle set bolts with the adjusting bolts. If the camber is NOT within the specification, use the table shown to estimate how much additional camber adjusting bolt.

	SET BOLT		ADJUSTING BOLT					
			1 DOT		2 DOTS		3 DOTS	
ADJUSTING VALUE	1	2	1	2	1	2	1	2
15'	X			X				
30'	X					X		
45'	X							X
1°00'			X					X
1°15'					X			X
1°30'							X	X

I. Follow steps 4A through 4H again. Between steps 4B and 4C, exchange one or two selected bolts.

HINT

When exchanging the two bolts, exchange one bolt at a time.

If Vehicle Pull Is Eliminated: Repair Is Now Complete.

PE10-008

TOYOTA

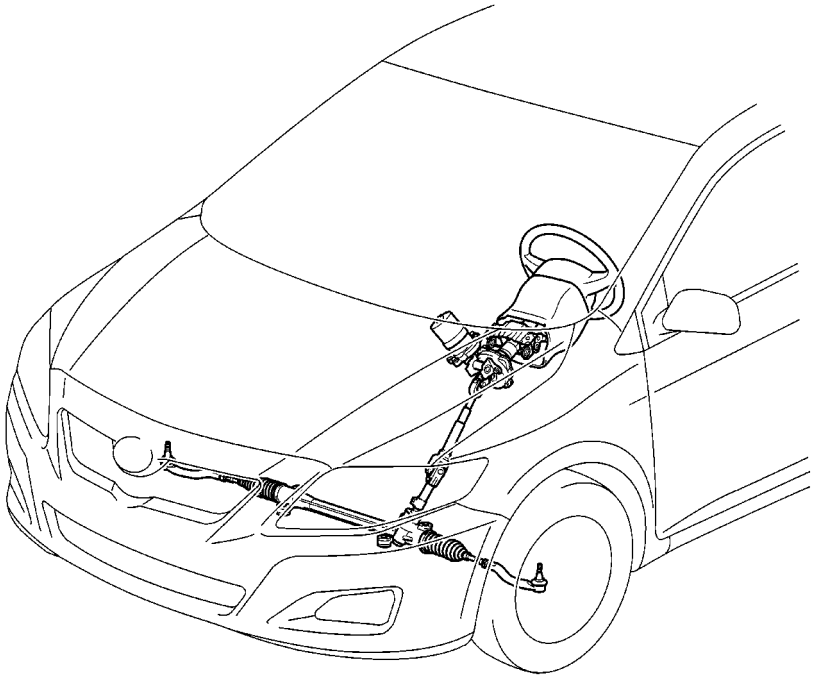
05/07/2010

Attachment-Response08
Attachment-Response 8-1
(Corolla) CH 112

STEERING

■ DESCRIPTION

- A vehicle speed sensing type EPS (Electric Power Steering) is provided as standard equipment on all models.
- A rack and pinion type steering gear is used on all models.
- A tilt and telescopic mechanism is used on all models.
- An energy absorbing mechanism is used in the steering column.



08MCH055Y

▶ Specifications ◀

Engine Type		2ZR-FE	2AZ-FE
Steering Type		Electric Power Steering	←
Gear Ratio (Overall)		17.43, 17.27*	16.30, 16.15*
No. of Turns Lock to Lock		3.40	3.10
Rack Stroke	mm (in.)	138.4 (5.5)	135.4 (5.4)

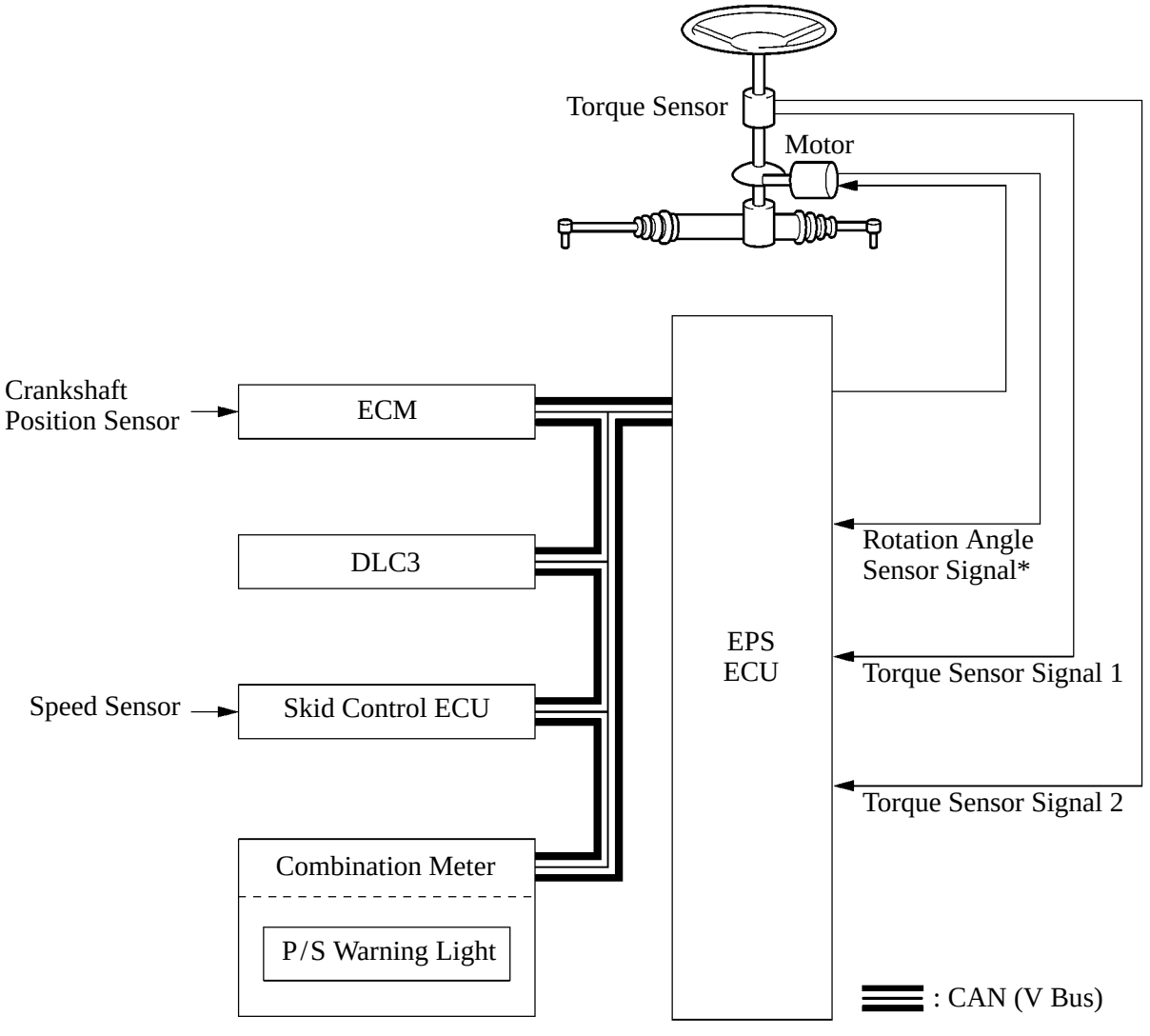
*: Mexican Package Models

■EPS (ELECTRIC POWER STEERING)

1. General

- This system generates torque using a motor and a reduction mechanism that are mounted on the steering column to assist the driver's steering. The amount of power assist is calculated by the EPS ECU.
- This system offers excellent fuel economy characteristics because the motor that is mounted on the steering column provides power assist, and this motor consumes energy only when power assist is required.
- A motor with a brush is used for the 2ZR-FE engine models, and a motor without a brush is used for the 2AZ-FE engine models.
- This system excels in serviceability because it does not require pipes, vane pump, pulley or power steering fluid.

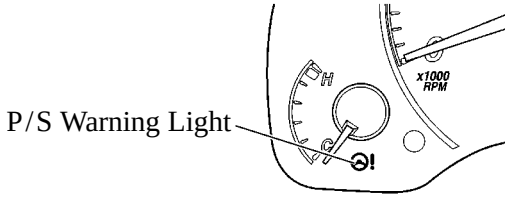
2. System Diagram



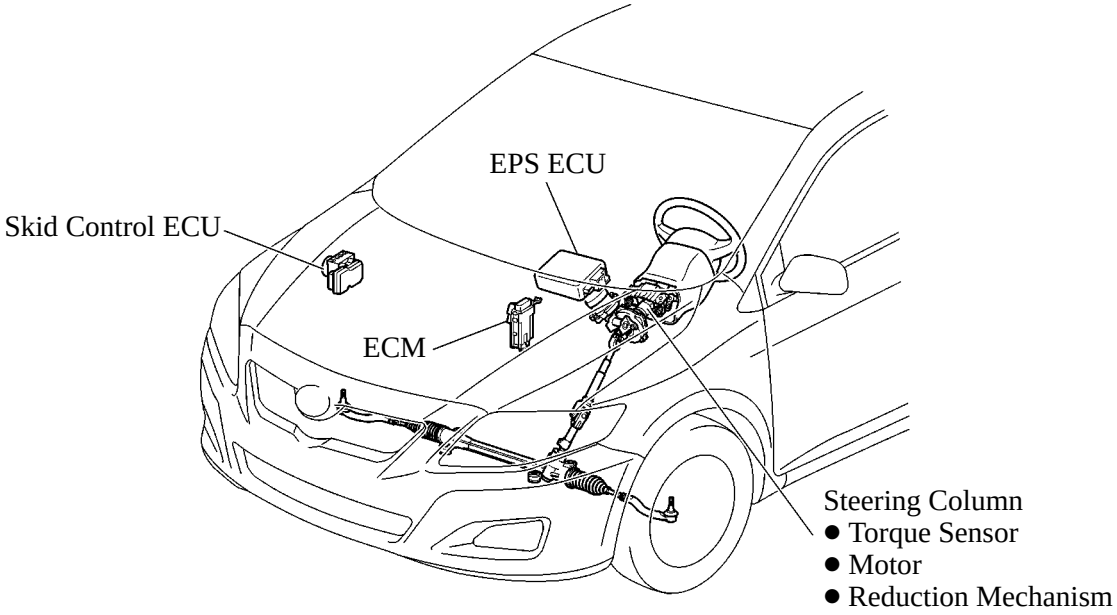
08MCH056Y

*: Only for 2AZ-FE Engine Models

3. Layout of Main Components



Combination Meter



08MCH057Y

4. Function of Main Components

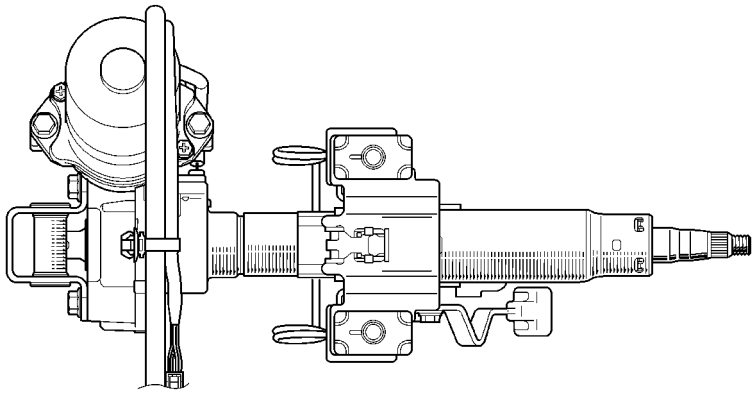
Component			Function
Steering Column	Torque Sensor		Detects the twist of the torsion bar, calculates the torque that is applied to the torsion bar by changing it into an electrical signal, and outputs this signal to the EPS ECU.
	Motor		Generates power assist in accordance with a signal received from the EPS ECU.
		Rotation Angle Sensor*	Outputs the rotation angle of the motor to the EPS ECU.
	Reduction Mechanism		Reduces the speed of the motor through the use of a worm gear and a wheel gear and transmits it to the column shaft.
EPS ECU			Actuates the motor mounted on the steering column to provide power assist, based on the signals received from various sensors and vehicle speed.
ECM			Outputs the engine speed signal to EPS ECU.
Skid Control ECU			Outputs the vehicle speed signal to combination meter.
Combination Meter			In case of a malfunction in the system, turns ON the P/S warning light.

*: Only for 2AZ-FE Engine Models

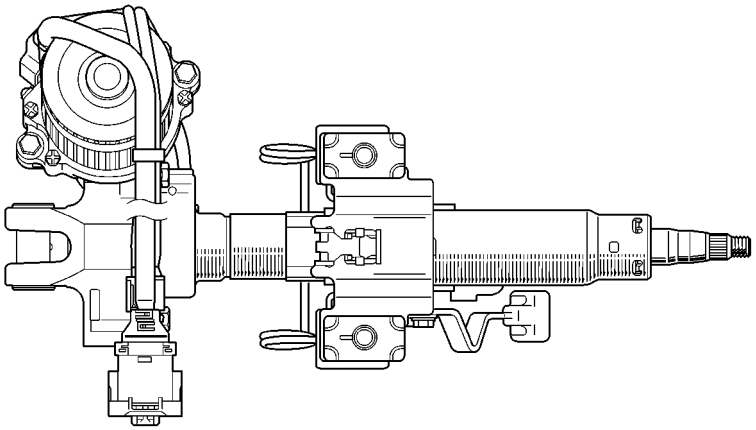
5. Construction and Operation of Main Components

Steering Column

A motor, reduction mechanism, and torque sensor are mounted on the steering column.



2ZR-FE Engine Models 08MCH058Y

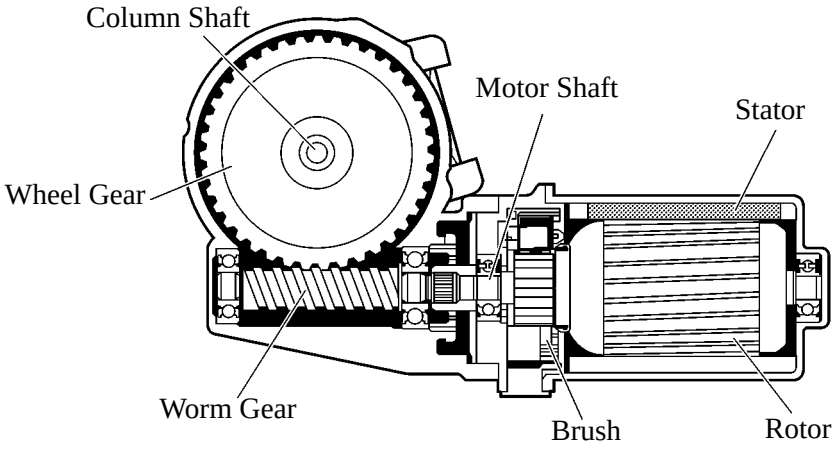


2AZ-FE Engine Models 08MCH059Y

Motor

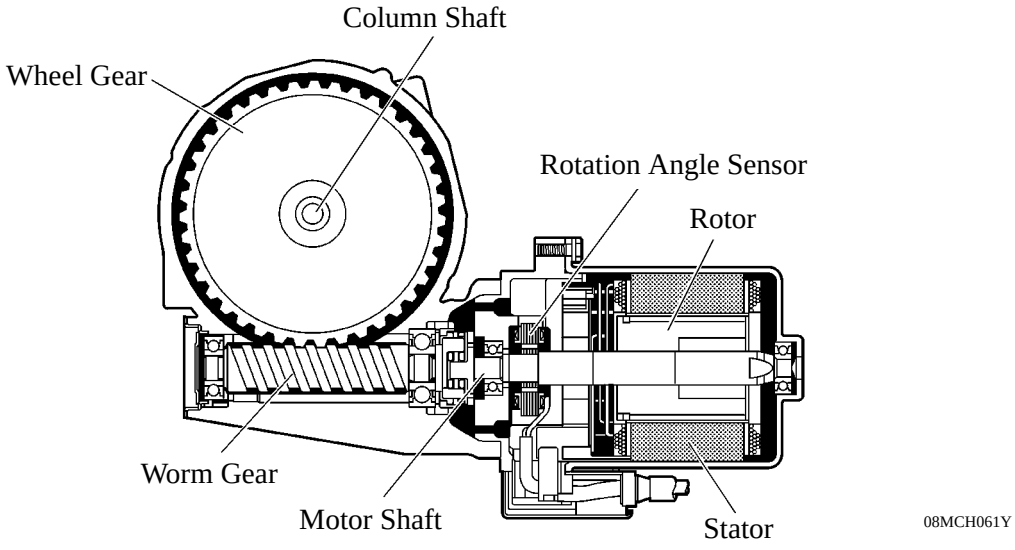
1) Motor with Brush (2ZR-FE Engine Models)

This motor consists of a rotor, a stator, a brush and a motor shaft. The torque that is generated by the motor is transmitted via the joint to the worm gear. Then this torque is transmitted via the wheel gear to the column shaft.



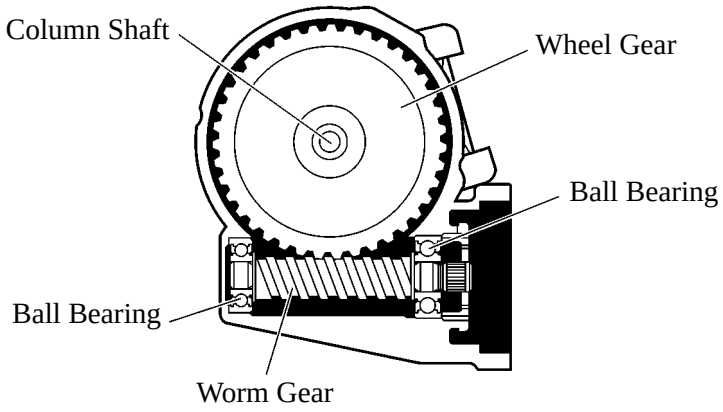
2) Motor without Brush (2AZ-FE Engine Models)

- This motor consists of a rotor, a stator, a rotation angle sensor and a motor shaft. The torque that is generated by the motor is transmitted via the joint to the worm gear. Then this torque is transmitted via the wheel gear to the column shaft.
- The rotation angle sensor consists of resolver sensor, which excels in reliability and durability. The rotation angle sensor detects the rotation angle of the motor and outputs it to the EPS ECU.

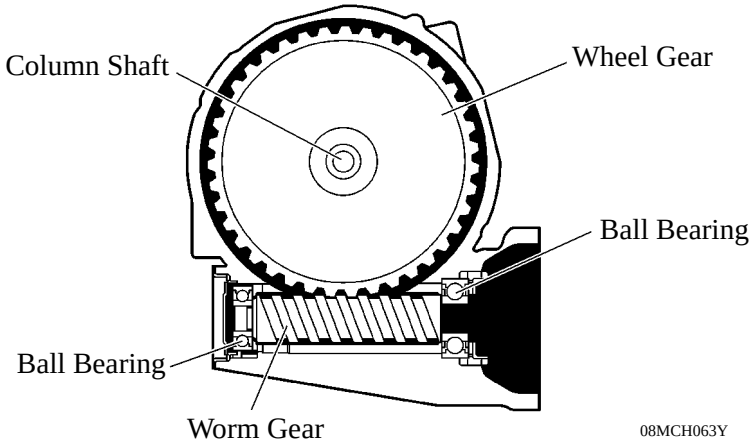


Reduction Mechanism

This mechanism reduces the speed of the motor via the worm gear and the wheel gear, and transmits it to the column shaft. The worm gear is supported by the ball bearings in order to reduce noise and frictions.



2ZR-FE Engine Models

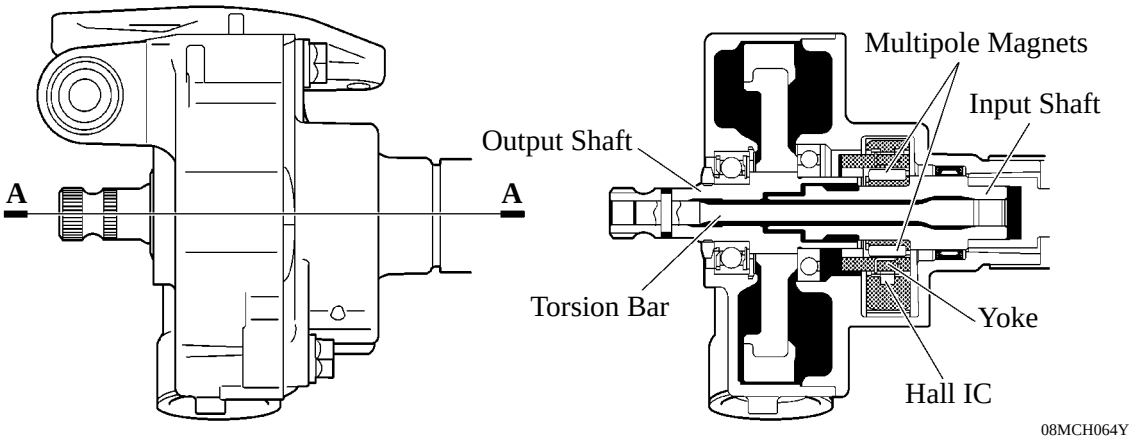


2AZ-FE Engine Models

Torque Sensor

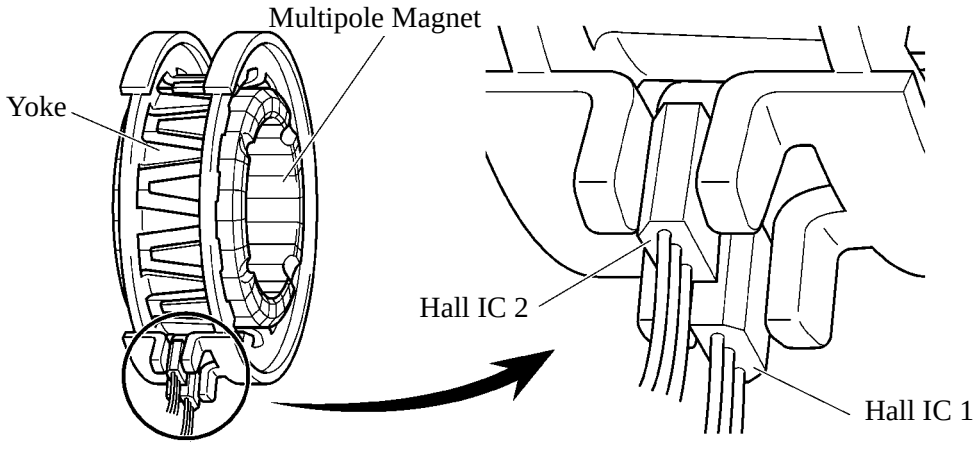
1) General

- A type of torque sensor with Hall ICs is used. This makes it possible to shorten the axial length of the sensor, thus increasing the extent of contraction of the steering column with the energy absorbing mechanism.
- The torque sensor is built into the steering column. A multipole magnet is mounted to the input shaft, and a yoke is mounted to the output shaft. The input and output shafts are joined by the torsion bar. A magnetic convergence ring assembly is placed outside of the yoke.



A – A Cross Section

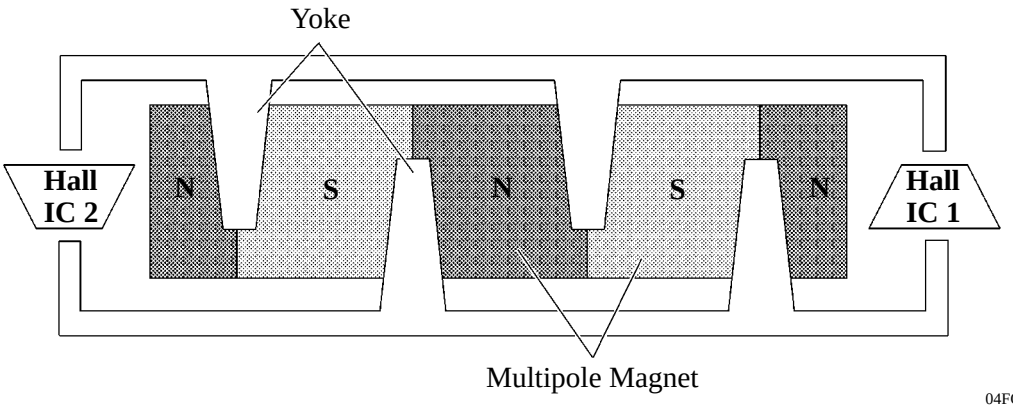
- The magnetic convergence ring assembly contains two Hall ICs, which face opposite to each other. The system detects the steering direction in accordance with the direction of the magnetic flux that passes between the Hall ICs. Furthermore, the system detects the steering torque in accordance with the amount of change in the magnetic flux density based on the relative displacement of the multipole magnet and the yoke. The EPS ECU monitors the torque sensor signals that are output by the two Hall ICs to detect malfunctions.



Torque Sensor

2) Straightline Driving

If the vehicle is driven straight and the driver does not turn the steering wheel, the yoke is located in the center between the N and S poles of the multipole magnet. Thus, no magnetic flux passes between the Hall ICs. In this case, the Hall ICs output a specified voltage to the EPS ECU, to indicate that the steering wheel is in the neutral position. Therefore, it does not apply current to the motor.



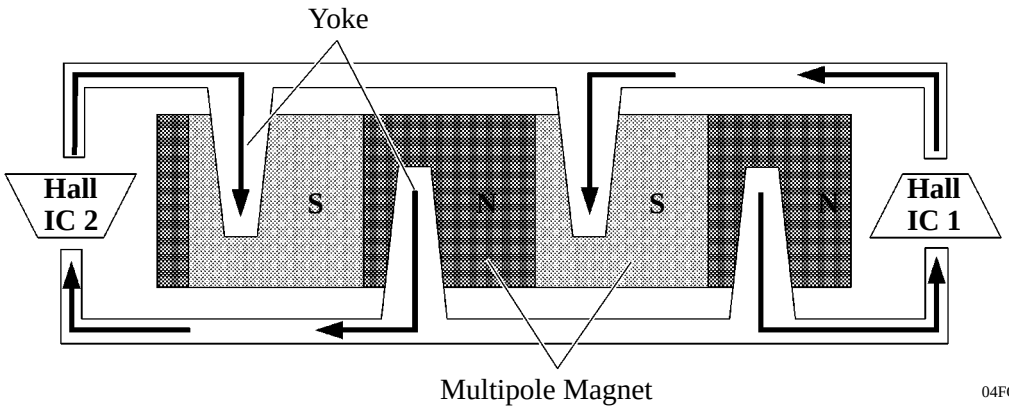
3) When Steering

When a driver turns the steering wheel to the right or left, the twist that is created in the torsion bar creates a relative displacement between the multipole magnet and yoke.

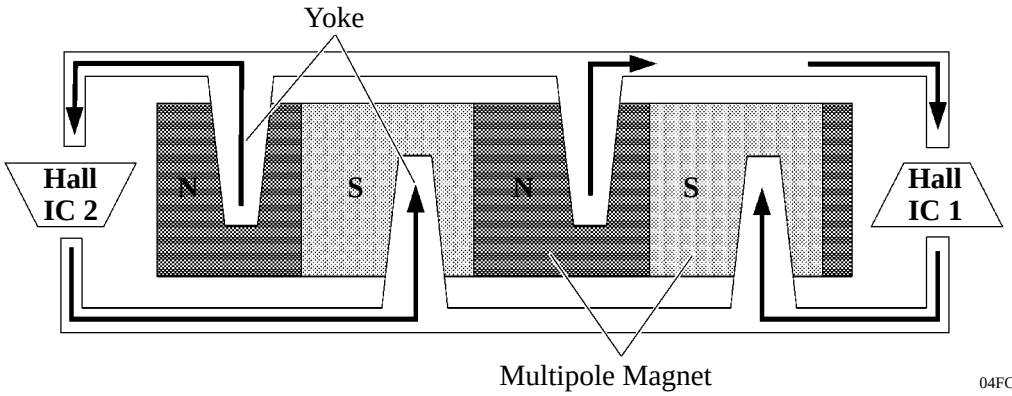
- At this time, the magnetic flux from the N to S pole of the multipole magnet passes between the Hall ICs. The system detects the steered direction of the steering wheel in accordance with the direction of the magnetic flux that passes between the Hall ICs. Hall IC1 and Hall IC2 are installed facing opposite to each other. As a result, the output characteristics of the two Hall ICs are constantly opposite each other. The system monitors the different outputs of these Hall ICs in order to detect malfunctions.
- The magnetic flux density becomes higher as it gets closer to the center of the respective pole. A Hall IC converts these magnetic flux fluctuations into voltage fluctuations, in order to transmit the turning torque of the steering wheel to the EPS ECU.

Upon receiving the signals from the torque sensor, the EPS ECU calculates the required assist torque and outputs it to the motor.

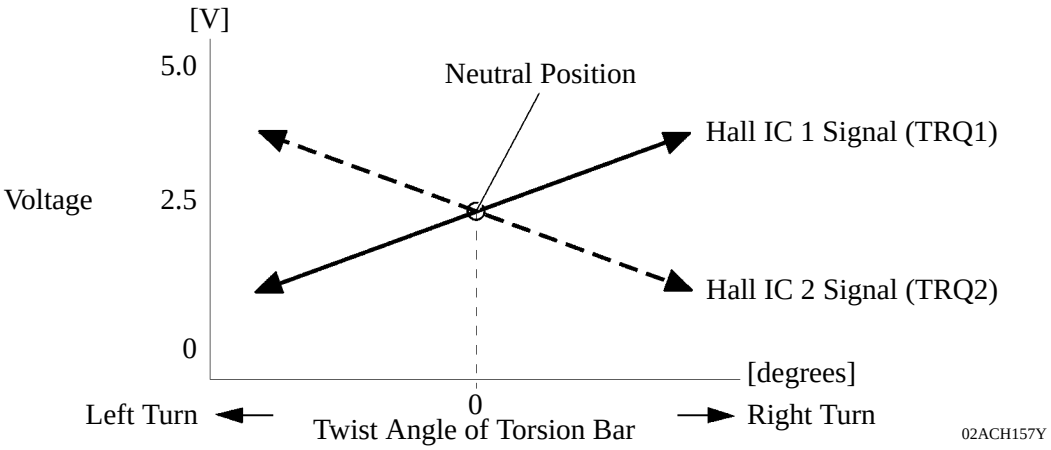
▶ Right Turn ◀



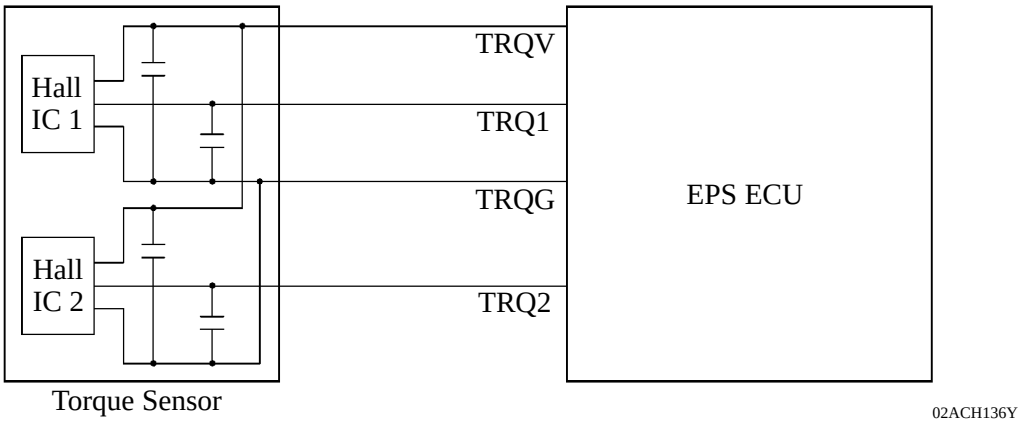
▶ Left Turn ◀



▶ Torque Sensor Output Characteristics ◀



▶ Torque Sensor System Diagram ◀



EPS ECU

1) General

- The EPS ECU receives signals from various sensors, judges the current vehicle condition, and determines the assist current to be applied to the motor accordingly.
- In case a malfunction occurs in the system, the fail-safe function stops the output current and reverts the control to manual steering. At this time, a P/S warning light illuminates to alert the driver of the malfunction.
- The EPS ECU of the '09 Corolla has the following functions:

Item	Function
Basic Control	Calculates the assist current from the steering torque valve and the vehicle speed, and actuates the motor.
Inertia Compensation Control	Ensures the starting movement of the motor when the driver starts to turn the steering wheel.
Recovery Control	During the short interval between the time the driver fully turns the steering wheel and the wheels try to recover, this control assists the recovery force.
Damper Control	Regulates the amount of assist when the driver turns the steering wheel while driving at high speeds, thus damping the changes in the yaw rate of the vehicle body.
System Overheat Protection Control	Estimates the motor temperature based on the amperage and the current duration. If the temperature exceeds the standard, it limits the amperage to prevent the motor from overheating.

2) Fail-safe

- If the EPS ECU detects a malfunction in the EPS system, it turns ON the warning light in the combination meter to inform the driver and stops the assist control. As a result, the EPS system operates in the same way as manual steering.
- In case of a malfunction, the fail-safe function activates and the EPS ECU effects various controls. For details, refer to the 2009 Corolla Repair Manual (Pub. No. RM08M0U).

3) Self-diagnosis

- If the EPS ECU detects a problem in the EPS system, the warning light that corresponds to the function in which the malfunction has been detected lights up to alert the driver of the malfunction.
- At the same time, the DTCs (Diagnosis Trouble Codes) are stored in memory. The DTCs can be read by connecting Techstream, or by connecting the SST (09843-18040) to the TC and CG terminals of the DLC3 and observing the blinking of the power steering warning light.
  For details of the DTCs that are stored in EPS ECU memory, see the 2009 Corolla Repair Manual (Pub. No. RM08M0U).

■TILT AND TELESCOPIC MECHANISM

1. General

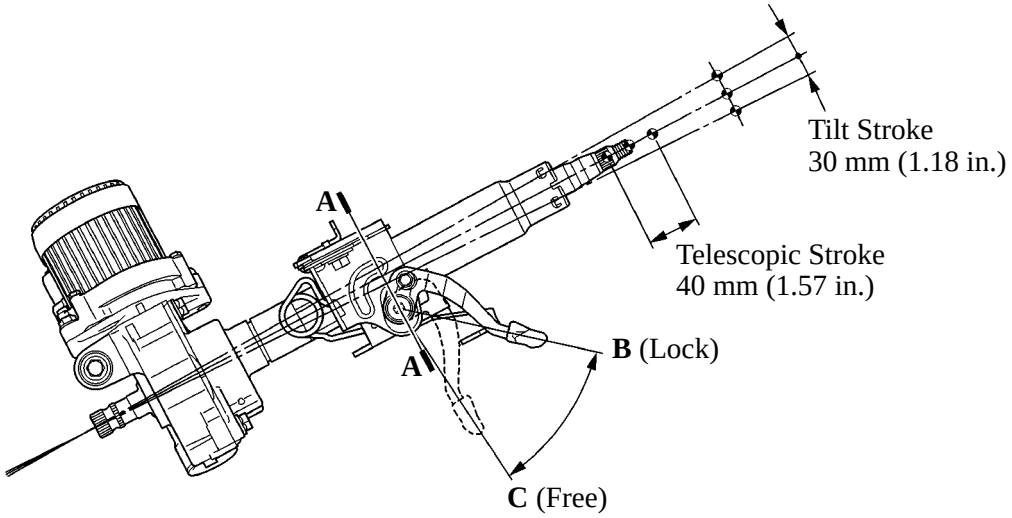
The tilt and telescopic mechanism consists mainly of the tilt and telescopic lever, column tube, steering column tube attachment, and tilt and telescopic steering stoppers.
In the tilt and telescopic mechanism, the steering column main shaft is connected at the serration engagement.

2. When Locked

When the tilt and telescopic mechanism is in its locked state, the tilt and telescopic lever at B position causes the cam of the tilt and telescopic steering stopper to tighten the steering column tube attachment and column bracket. This secures column tube, so movement in the tilt direction and in the telescopic direction is locked.

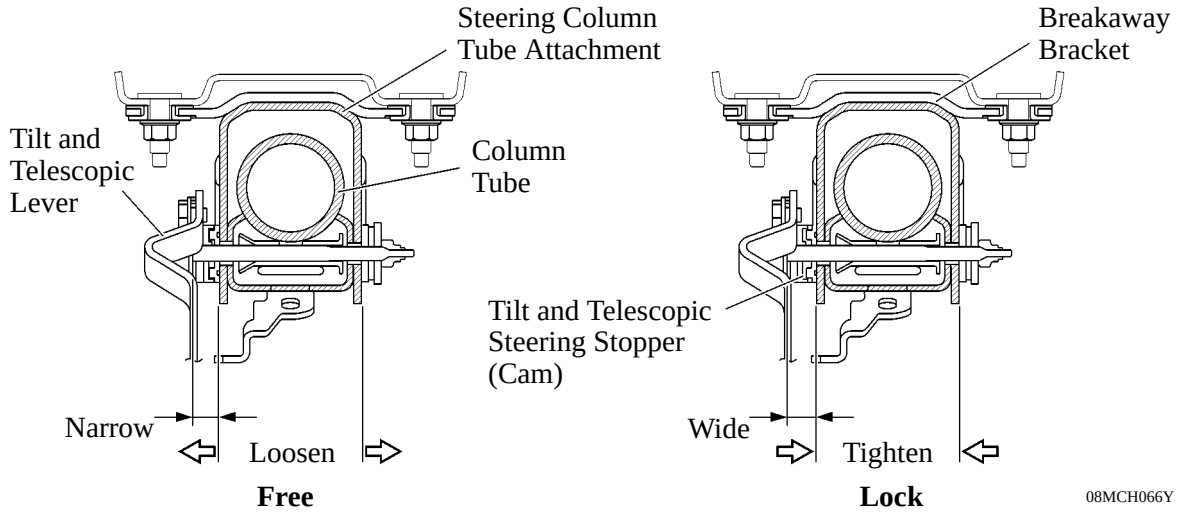
3. When Free State

When the tilt and telescopic mechanism is in its free state, the tilt and telescopic lever at C position causes the cam of the tilt and telescopic steering stoppers to loosen the steering column tube attachment and column tube. This frees the column tube to move in the tilt direction and in the telescopic direction, enabling adjustment.



08MCH065Y

▶ A – A Cross Section ◀



08MCH066Y

■ENERGY ABSORBING MECHANISM

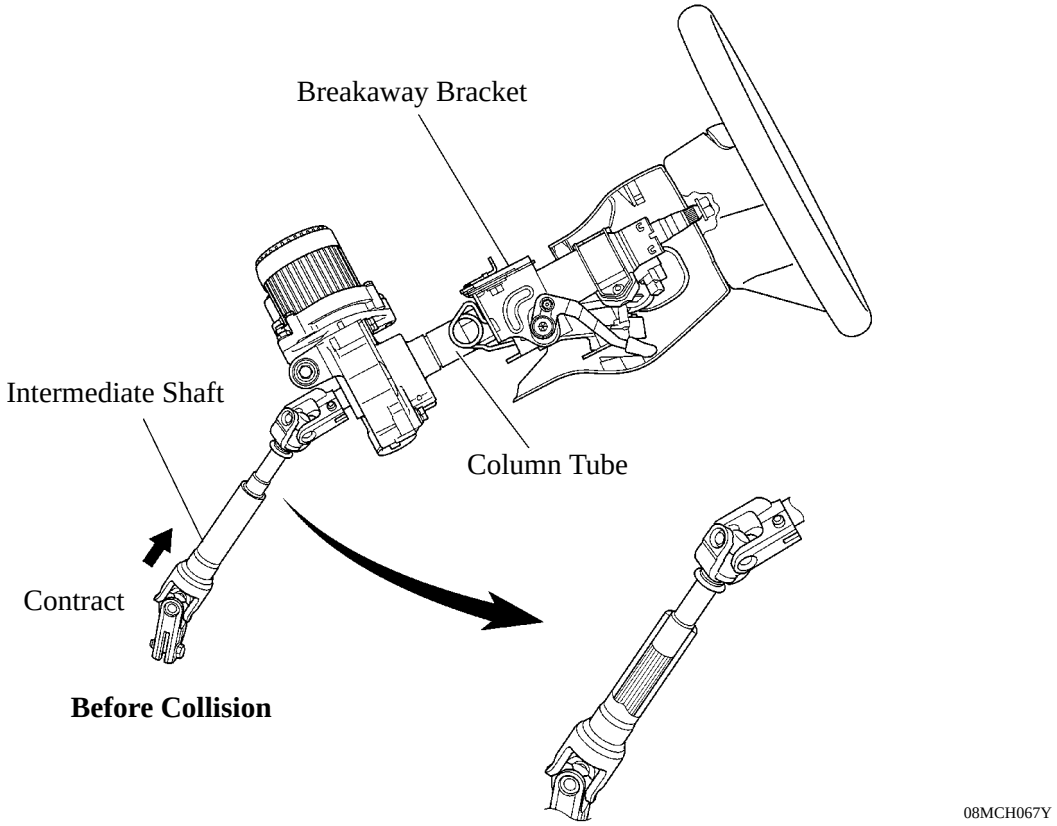
1. General

The energy absorbing mechanism in the steering column consists of the breakaway bracket, intermediate shaft, and column tube. The steering column is mounted on the instrument panel reinforcement via a breakaway bracket. The steering column and the steering gear are connected with a contractile intermediate shaft.

2. Operation

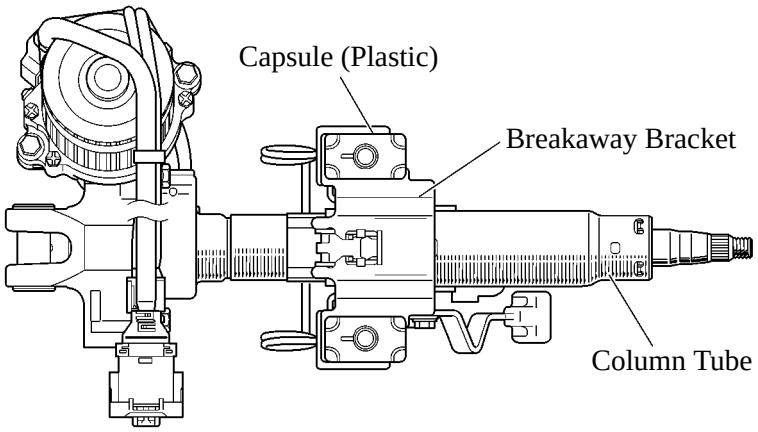
- When the steering gear moves during a collision (primary collision), the intermediate shaft contracts, thus helping reduce the possibility of the steering column and the steering wheel protruding into the cabin.

▶ Primary Collision ◀



- When a collision impact is transmitted to the steering wheel (secondary collision), the steering wheel and the driver's airbag help absorb the impact. In addition, the breakaway bracket separates, and the column tube contracts. At this time, the friction resistance of the sliding portion, which is staked to the column tube, absorbs the energy. This sequential energy absorbing mechanism helps absorb the impact of the secondary collision.

▶ Secondary Collision ◀



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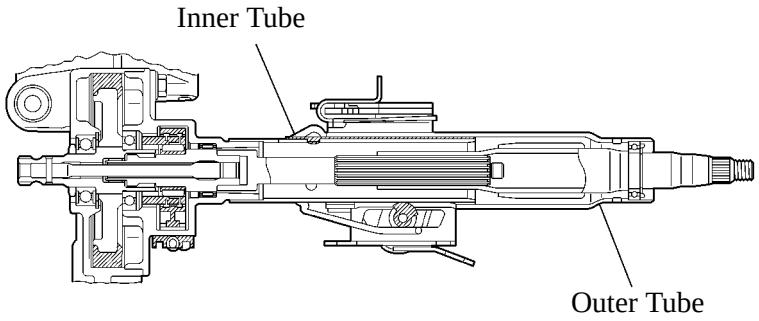
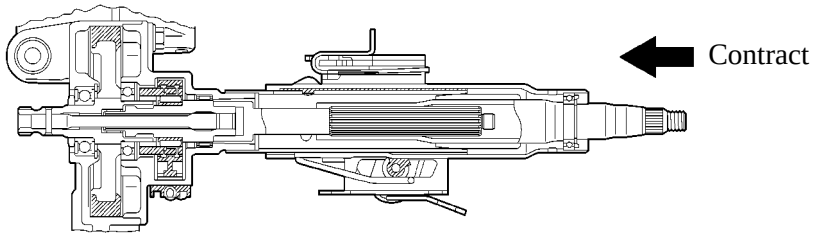


Before Collision

08MCH069Y



After Collision
(Maximum Contraction)

08MCH070Y

PE10-008

TOYOTA

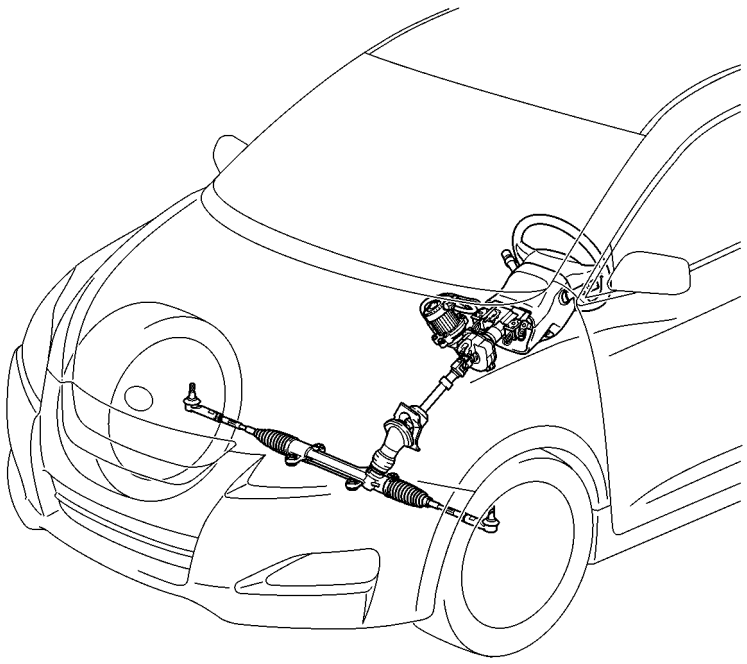
05/07/2010

Attachment-Response08
Attachment-Response 8-2
(Corolla Matrix) CH 360

STEERING

■DESCRIPTION

- Rack and pinion type steering is used on all models.
- A vehicle speed sensing type EPS (Electric Power Steering) is provided as standard equipment on all models.
- An energy absorbing mechanism is used in the steering column.
- A tilt and telescopic mechanism is provided as standard equipment on all models.



08R0CH96C

▶ Specifications ◀

Engine Type	2ZR-FE	2AZ-FE	
Grade	**-**	**S/XR**	**XRS**
Gear Ratio (Overall)	16.2	16.3, 16.5*	16.5
No. of Turns Lock to Lock	3.1	3.1	3.0
Rack Stroke mm (in.)	135.4 (5.3)	135.4 (5.3)	129.0 (5.1)

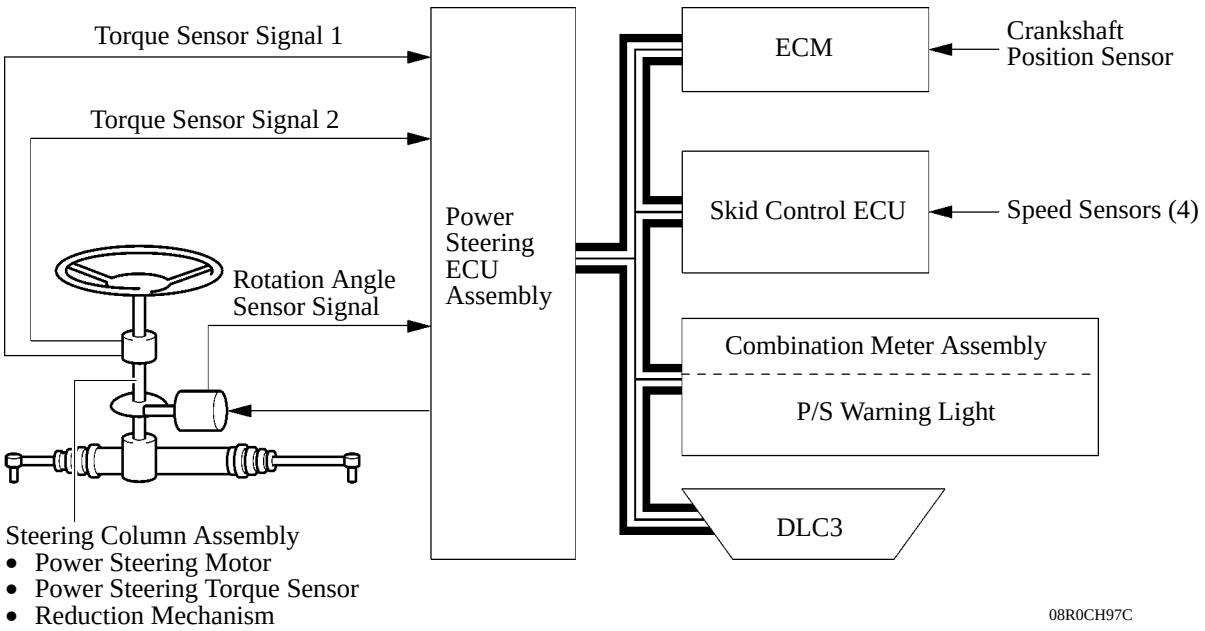
*: AWD Models

■EPS SYSTEM

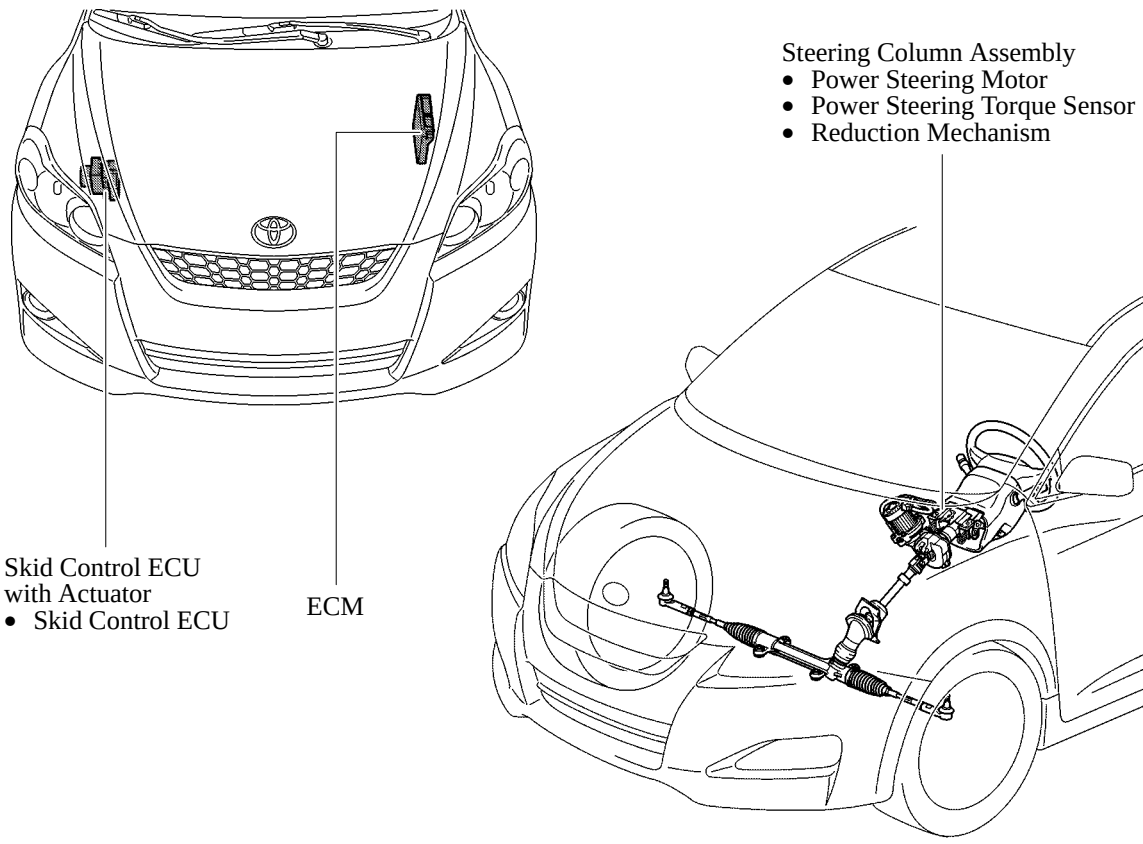
1. General

- The EPS (Electric Power Steering) system uses a motor and reduction mechanism built into the steering gear housing to generate assist torque for the driver's steering effort. The amount of assist torque is calculated by the power steering ECU assembly.
- This system offers excellent fuel economy as the motor mounted on the steering column consumes energy only when power assist is required.
- This system excels in serviceability because it does not require pipes, a vane pump, pulleys or power steering fluid.

2. System Diagram



3. Layout of Main Components



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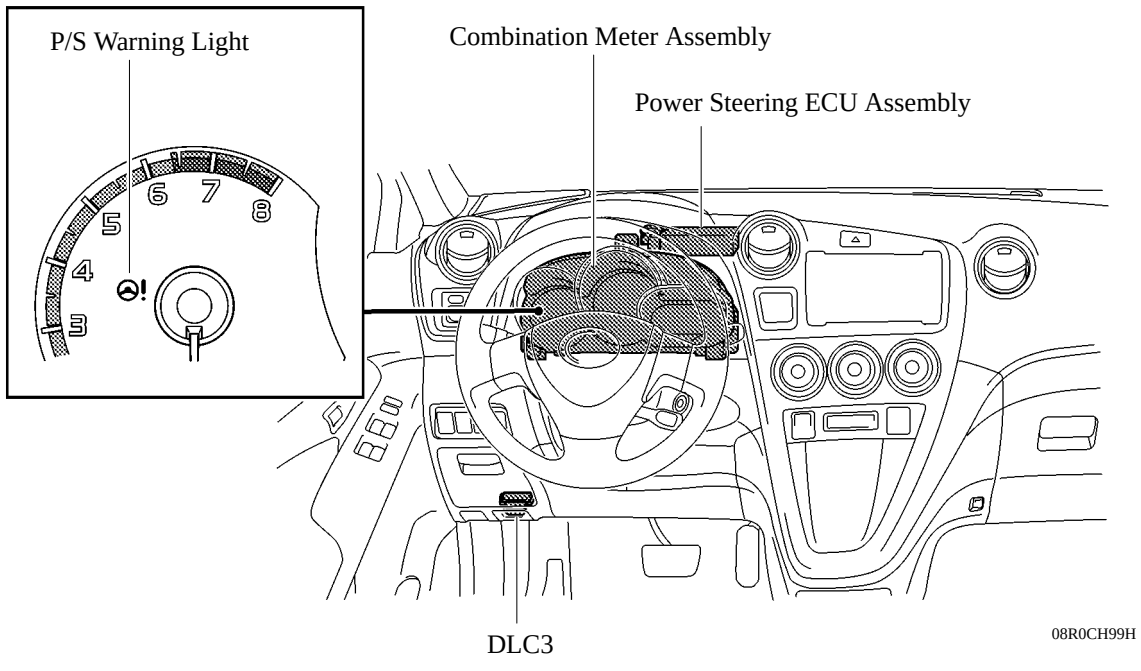


08R0CH99H

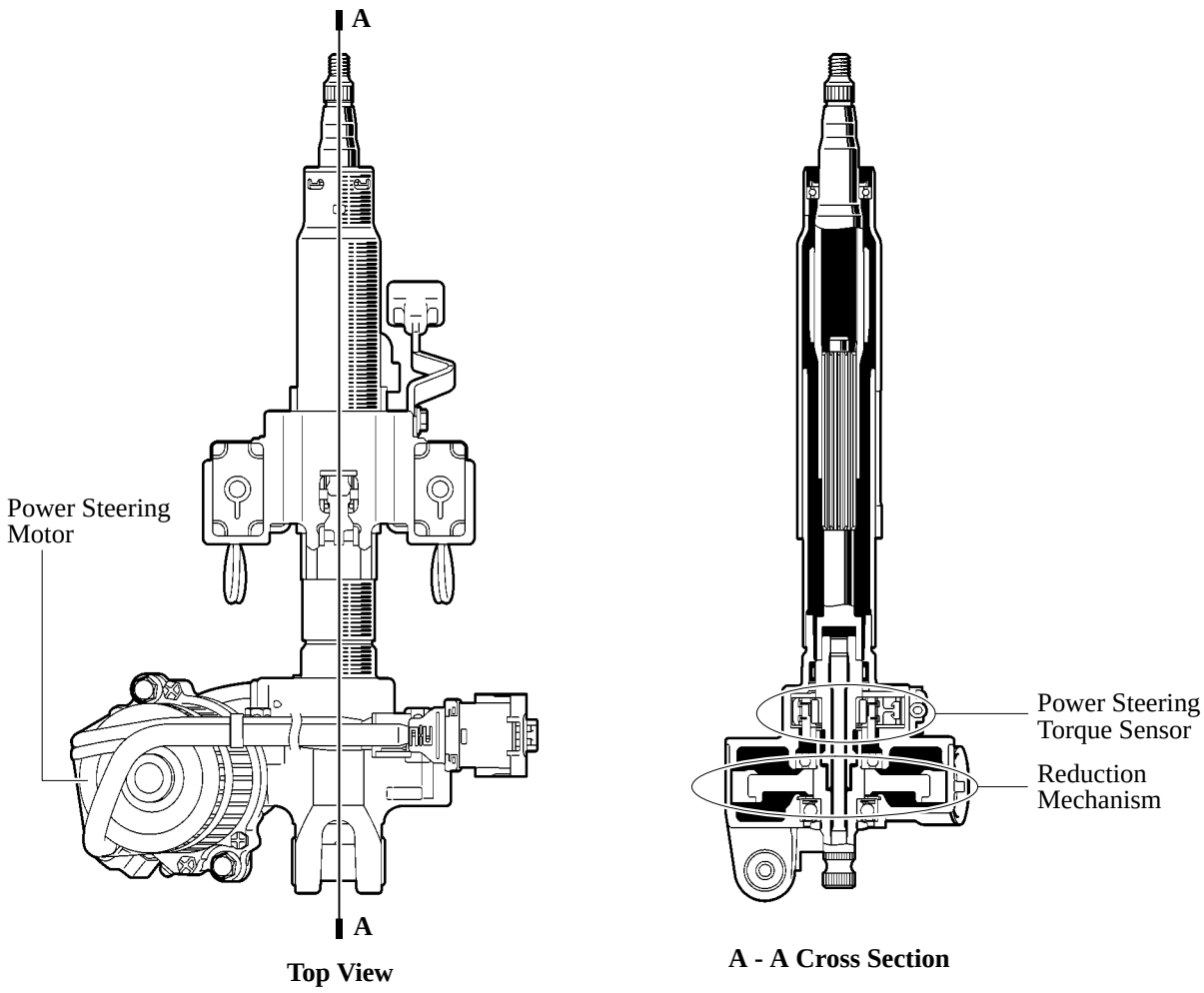
4. Function of Main Components

Component			Function
Steering Column Assembly	Power Steering Torque Sensor		Detects the twist of the torsion bar. Based on the torque that is applied to the torsion bar, the sensor creates an electrical signal, and outputs this signal to the Power Steering ECU.
	Power Steering Motor		Generates power assist in accordance with a signal received from the Power Steering ECU.
		Motor Rotation Angle Sensor	Outputs the rotation angle of the power steering motor to the power steering ECU assembly.
	Reduction Mechanism		Reduces the speed of the power steering motor through the use of a worm gear and wheel gear and transmits the torque to the column shaft.
Power Steering ECU Assembly			Actuates the power steering motor mounted on the steering column assembly to provide power assist, based on the signals received from various sensors and vehicle speed.
P/S Warning Light			Lights up to alert the driver when the power steering ECU assembly detects a malfunction in the EPS system.
ECM			Outputs the engine speed signal to the power steering ECU assembly.
Skid Control ECU			Outputs the vehicle speed signal to power steering ECU assembly.

5. Steering Column Assembly

General

A power steering torque sensor, power steering motor and a reduction mechanism are mounted on the steering column assembly.



Top View

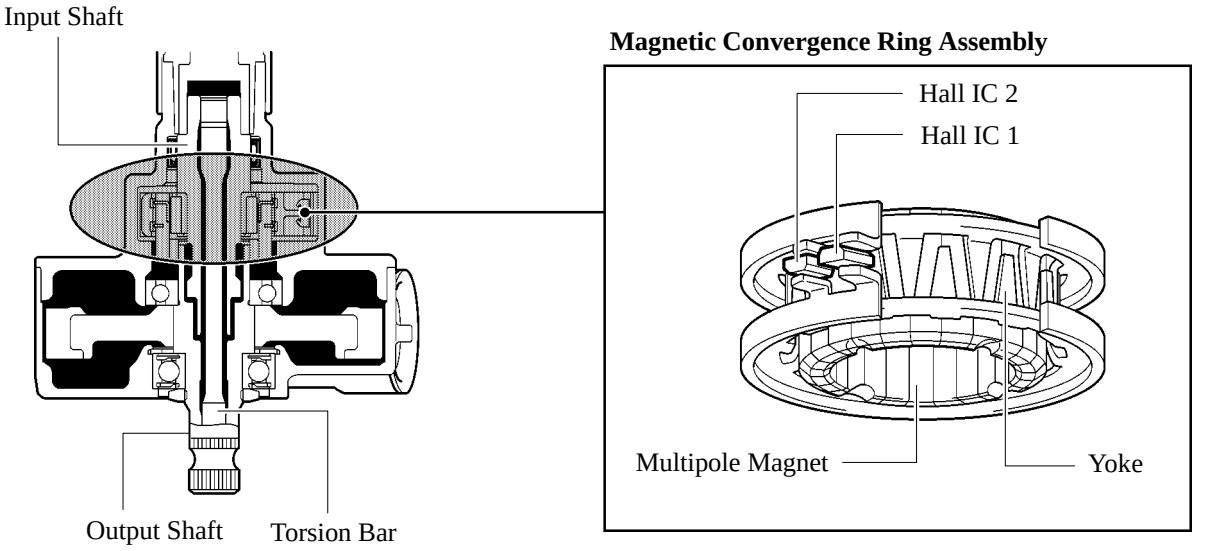
A - A Cross Section

08R0CH100C

Power Steering Torque Sensor

1) General

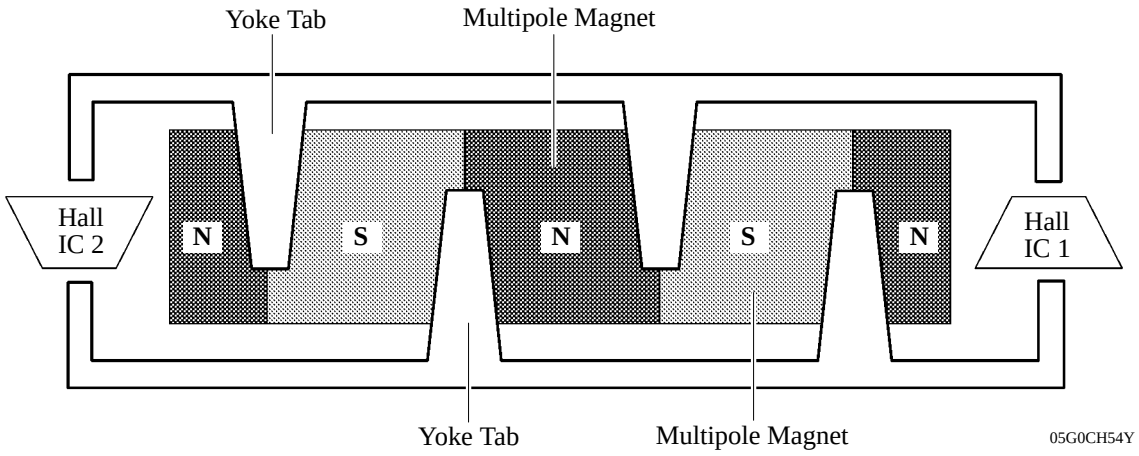
- The power steering torque sensor is built into the steering column. A multipole magnet is mounted to the input shaft, and a yoke is mounted to the output shaft. The input and output shafts are joined by a torsion bar. A magnetic convergence ring assembly is placed outside of the yoke.
- Hall IC torque sensors are used. This makes it possible to shorten the axial length of the sensor, increasing the extent of steering column contraction through the energy absorbing mechanism.
- The magnetic convergence ring assembly contains two Hall ICs which face opposite to each other. The system detects the steering direction in accordance with the direction of the magnetic flux that passes between the Hall ICs. Furthermore, the system detects steering torque in accordance with the amount of change in the magnetic flux density based on the relative displacement of the multipole magnet and the yoke. The power steering ECU assembly monitors the torque sensor signals output by the two Hall ICs to detect malfunctions.



08R0CH101C

2) When the steering wheel is not turned

If the vehicle is driven straight and the driver does not turn the steering wheel, the yoke is centered between the N and S poles of the multipole magnet. Thus, no magnetic flux passes between the Hall ICs. In this case, the Hall ICs output a specified voltage to the power steering ECU assembly, to indicate that the steering wheel is in the neutral position. Therefore, current is not applied to the motor.



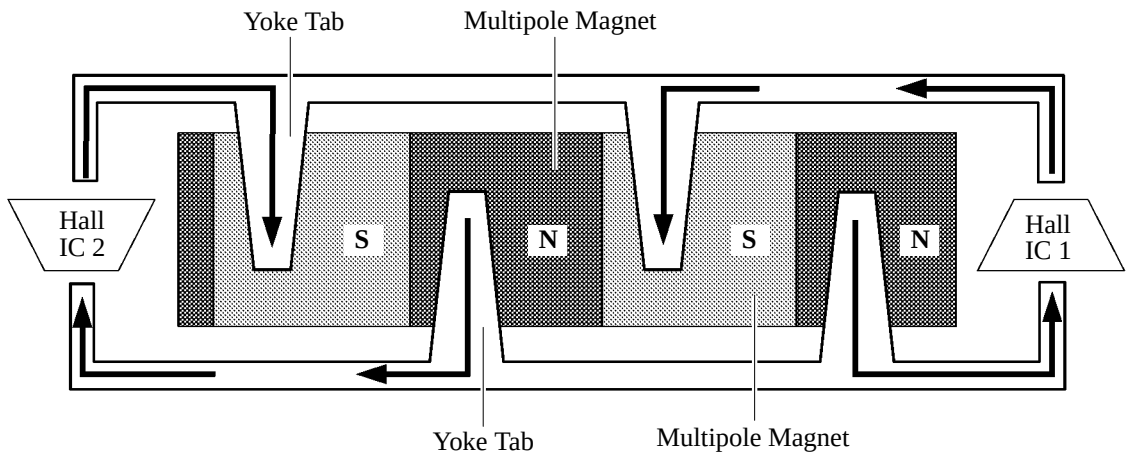
05G0CH54Y

3) When Steering

When a driver turns the steering wheel to the right or left, the twist created in the torsion bar creates a relative displacement between the multipole magnet and yoke.

- At this time, the magnetic flux from the N to S poles of the multipole magnet passes between the Hall ICs. The system detects the direction the steering wheel is being turned in accordance with the direction of the magnetic flux that passes between the Hall ICs. Hall IC1 and Hall IC2 are installed facing opposite to each other. As a result, the output characteristics of the two Hall ICs are constantly opposite each other. The system monitors the different outputs of these Hall ICs in order to detect malfunctions.
- The magnetic flux density becomes higher as the Hall ICs get closer to the center of each respective pole. Each Hall IC converts these magnetic flux fluctuations into voltage fluctuations in order to transmit the rotational torque of the steering wheel to the power steering ECU assembly.
- Upon receiving the signals from the torque sensor, the power steering ECU assembly calculates the required assist torque and outputs it to the motor.

▶ Right Turn ◀



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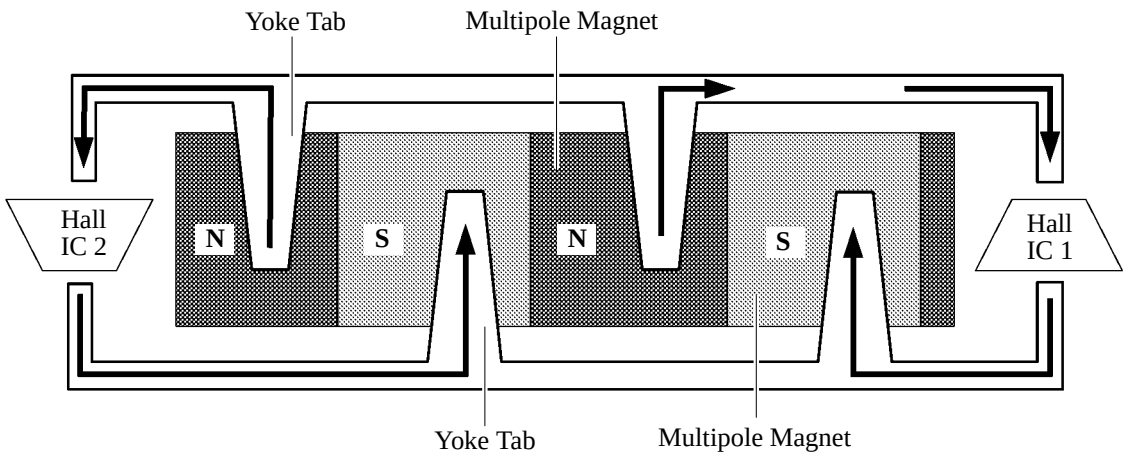
▶ Left Turn ◀



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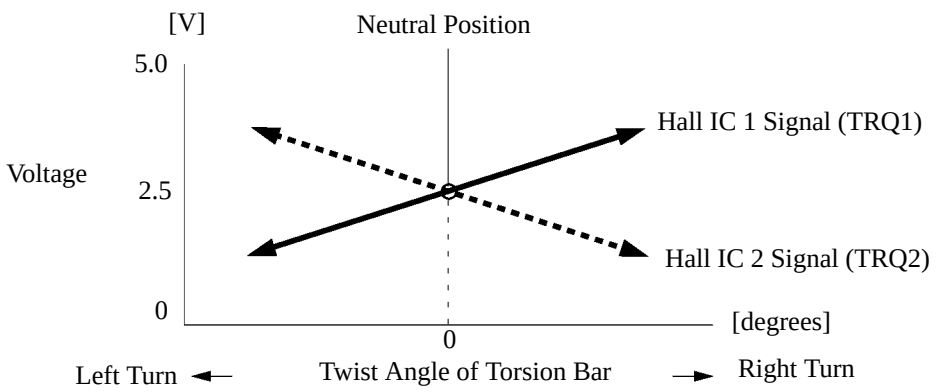
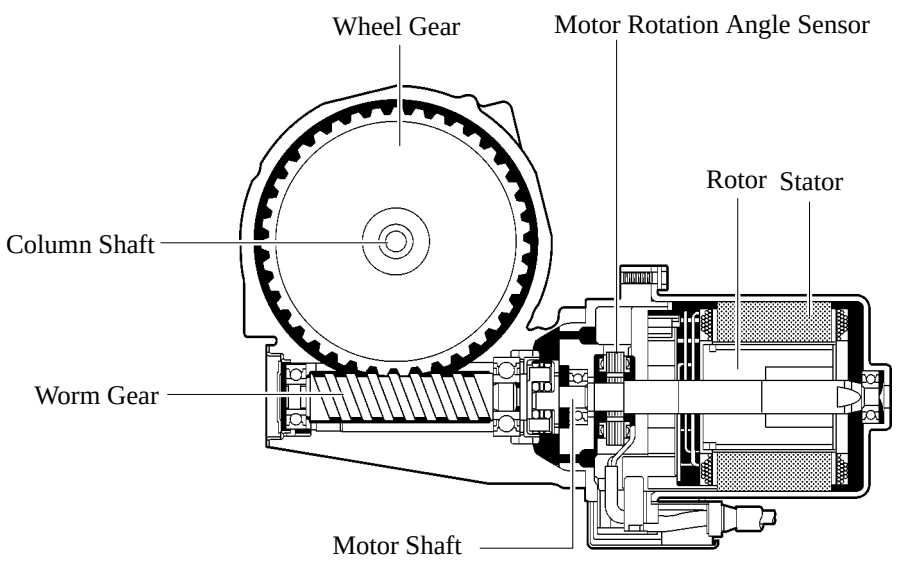
▶ Power Steering Torque Sensor Output Characteristics ◀



02ACH157Y

Power Steering Motor

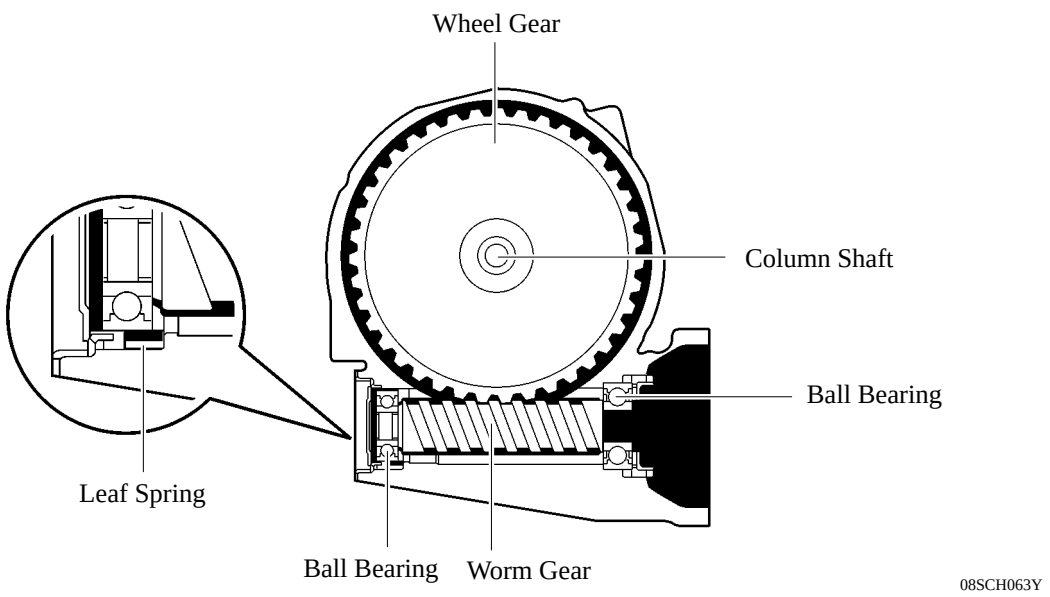
- A low inertia, low noise, and high power output power steering motor is used.
- The power steering motor consists of the rotor, stator, and motor shaft.
- Torque generated by the motor is transmitted via a joint to the worm gear. This torque is then transmitted via the wheel gear to the column shaft.
- The motor rotation angle sensor consists of a highly reliable and durable resolver sensor. The rotation angle sensor detects the rotation angle of the motor and outputs it to the power steering ECU assembly. As a result, it ensures efficient EPS control.



08SCH062Y

Reduction Mechanism

- This mechanism reduces the speed of the motor via the worm gear and the wheel gear, and transmits steering effort to the column shaft.
- The wheel gear is made of a high strength, low friction, and low wear plastic, to realize low noise and a lightweight construction.
- A worm gear supported by ball bearings is used. Also, a torsion spring is provided to ensure optimal gear engagement at all times.



08SCH063Y

6. Power Steering ECU Assembly

- The power steering ECU assembly receives signals from various sensors, judges the current vehicle condition, and determines the assist current to be applied to the motor accordingly.
- In the event of a system malfunction, the fail-safe function stops current from being output and reverts the power steering system to manual steering. At this time, the P/S warning light illuminates to alert the driver of the malfunction.
- The power steering ECU assembly has the following functions:

Item	Function
Basic Control	Calculates the assist current and actuates the motor based on the steering torque value and the vehicle speed.
Inertia Compensation Control	Ensures the starting movement of the motor when the driver starts to turn the steering wheel.
Recovery Control	During the short interval between when the driver fully turns the steering wheel and the wheels try to recover, this control assists the recovery force.
Damper Control	Regulates the amount of assist when the driver turns the steering wheel while driving at high speeds, thus damping the changes in the yaw rate of the vehicle body.
System Overheat Protection Control	Estimates the motor temperature based on the amperage and the current duration. If the temperature exceeds the standard, it limits the amperage to prevent the motor from overheating.

7. Fail-safe

- If the power steering ECU assembly detects a malfunction in the EPS system, it turns the warning light in the combination meter on to inform the driver and stops the assist control. As a result, the EPS system operates in the same way as manual steering.
- In case of a malfunction, the fail-safe function activates and the power steering ECU assembly performs various controls.

For details, refer to the 2009 Corolla Matrix Repair Manual (Pub. No. RM08R0U).

8. Diagnosis

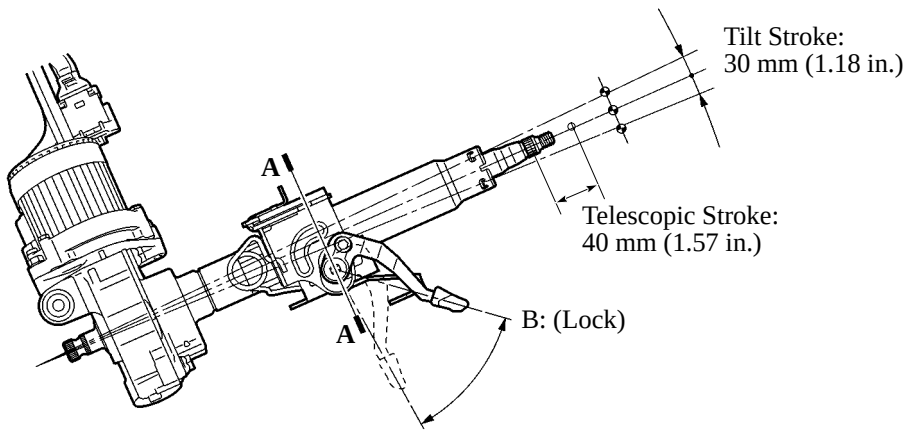
- If the power steering ECU assembly detects a malfunction in the EPS system, the EPS warning light lights up to alert the driver of the malfunction.
- At the same time, DTCs (Diagnosis Trouble Codes) are stored in memory. DTCs can be read by connecting the Techstream, or by connecting SST (09843-18040) to the TC and CG terminals of the DLC3 and observing the blinking pattern of the power steering warning light.
- For details of DTCs stored in power steering ECU assembly memory, see the 2009 Corolla Matrix Repair Manual (RM08R0U).

■TILT AND TELESCOPIC MECHANISM

The tilt and telescopic mechanism consists mainly of the tilt and telescopic lever, column tube, steering column tube attachment, and tilt and telescopic steering stoppers.

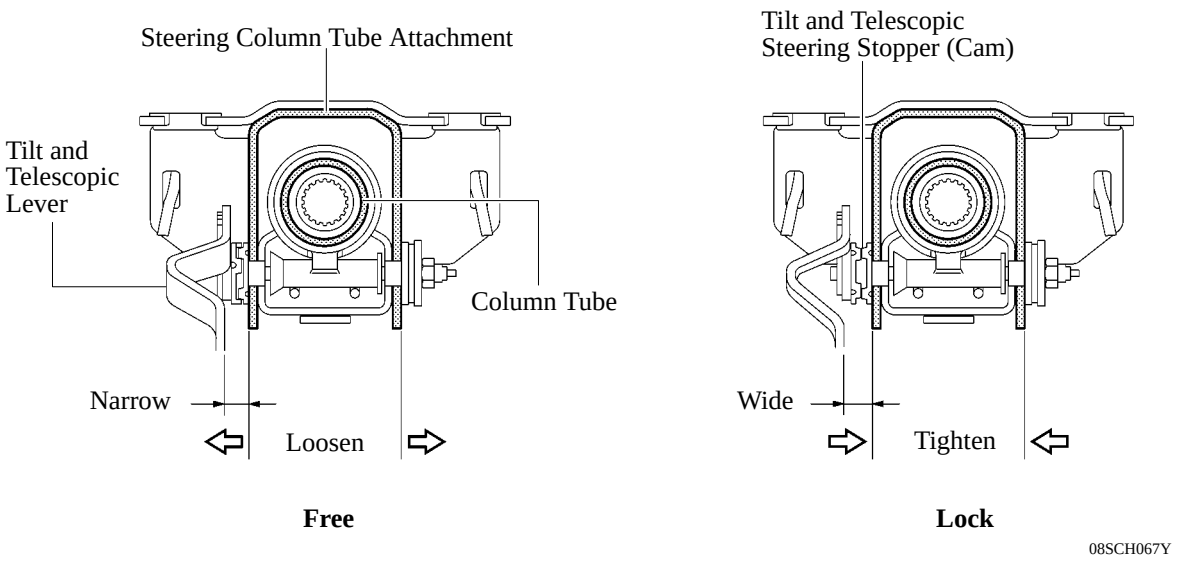
In the tilt and telescopic mechanism, the steering column main shaft is connected at the serration engagement.

- When the tilt and telescopic mechanism is locked, the tilt and telescopic lever in position B causes the cam of the tilt and telescopic steering stopper to tighten the steering column tube attachment and column bracket. This secures the column tube, prohibiting tilt and telescopic movement.
- When the tilt and telescopic mechanism is free, the tilt and telescopic lever in position C causes the cam of the tilt and telescopic steering stopper to loosen the steering column tube attachment and column tube. This allows the column tube to move in the tilt and telescopic directions, enabling adjustment.



08SCH066Y

▶ A - A Cross Section ◀

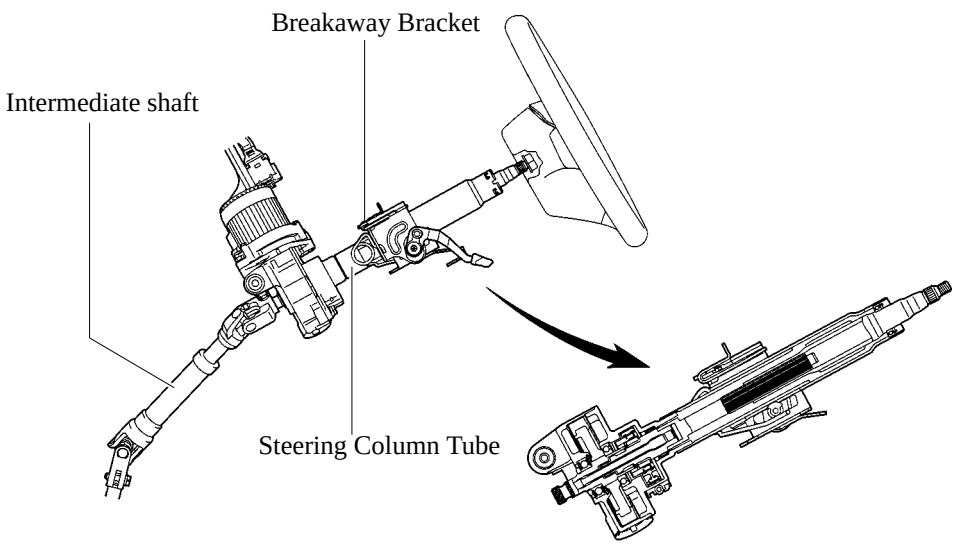


08SCH067Y

■ENERGY ABSORBING MECHANISM

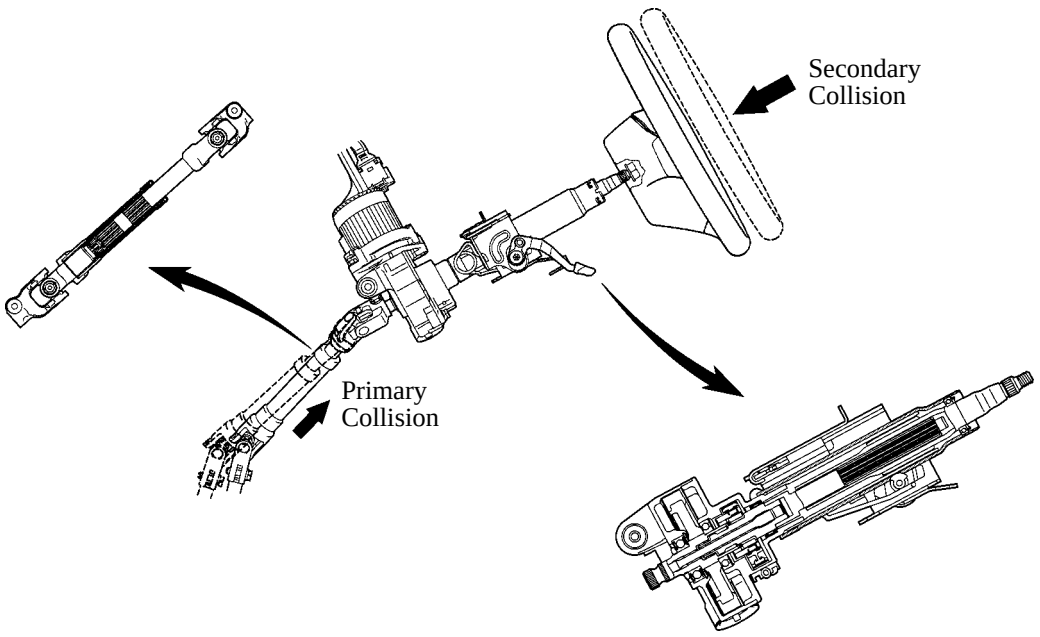
The energy absorbing mechanism in the steering column consists of a breakaway bracket, intermediate shaft, and column tube. The steering column is mounted on the instrument panel reinforcement via the breakaway bracket. The steering column and the steering gear are connected with a contractible intermediate shaft.

- When the steering gear moves during a collision (primary collision), the intermediate shaft contracts, thus helping reduce the possibility of the steering column and the steering wheel protruding into the cabin.
- When a collision impact is transmitted to the steering wheel (secondary collision), the steering wheel and the driver's airbag help absorb the impact. In addition, the breakaway bracket separates, and the column tube contracts. At this time, the frictional resistance of the contracting portion, attached to the column tube absorbs the energy. This sequential energy absorbing mechanism helps absorb the impact of a secondary collision.



Before Collision

08R0CH102C



After Collision

08R0CH103C

PE10-008

TOYOTA

05/07/2010

Attachment-Response 9a-1 (Corolla)

BRAKE

■DESCRIPTION

1. General

- The ’09 Corolla brake system has the following settings and specifications:

●: Standard OP: Option —: None

Engine Type		2ZR-FE	2AZ-FE
Front Brake Type	Ventilated Disc	●	●
Rear Brake Type	Leading-trailing Drum	●	—
	Solid Disc	OP*1	●
Brake Control System	ABS with EBD, Brake Assist (Mechanical Type)	●	—
	ABS with EBD, Brake Assist (Electrical Type), TRAC and VSC	OP*2	●
Parking Brake	Lever Type	●	●

*1: Only for Mexican Package Models
*2: Except Mexican Package Models

▶ Specifications ◀

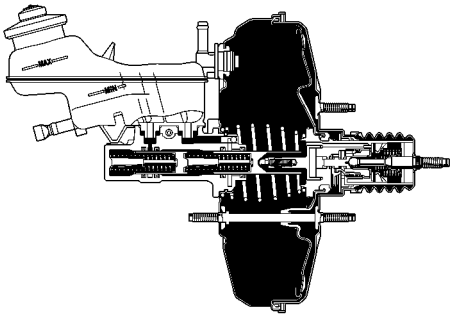
Master Cylinder		Type		Tandem
		Diameter	mm (in.)	20.64 (0.81), 22.22 (0.87)*1
Brake Booster		Type		Single
		Size	in.	10
Front Disc Brake		Pad Area	cm^2 ($in.^2$)	48.9 (7.58) × 2
		Wheel Cylinder Diameter	mm (in.)	60.33 (2.38)
		Rotor Size (D × T)*2	mm (in.)	275 × 22 (10.83 × 0.87)
Rear Brake	Drum Type	Lining Area	cm^2 ($in.^2$)	69.5 (10.77) × 2
		Wheel Cylinder Diameter	mm (in.)	22.22 (0.87)
		Drum Inner Diameter	mm (in.)	228.6 (9)
	Disc Type	Pad Area	cm^2 ($in.^2$)	24.9 (3.86) × 2
		Wheel Cylinder Diameter	mm (in.)	38.18 (1.50)
		Rotor Size (D × T)*2	mm (in.)	259 × 9 (10.20 × 0.35)
Parking Brake	Drum Type	Drum Inner Diameter	mm (in.)	228.6 (9)
	Disc Type	Rotor Size (D × T)*2	mm (in.)	259 × 9 (10.20 × 0.35)
Brake Actuator		Manufacturer		ADVICS

*1: Models with VSC
*2: (Diameter × Thickness)

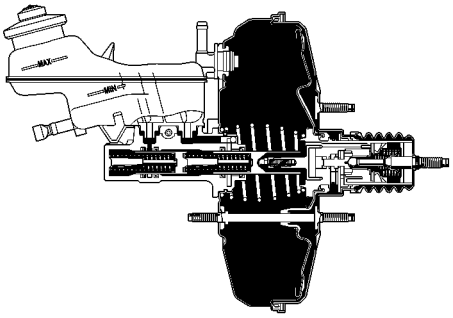
Service Tip

When brake control system (except mechanical type brake assist) is activated, the brake pedal could shudder, which is a normal occurrence of the system in operation and should not be considered as a malfunction.

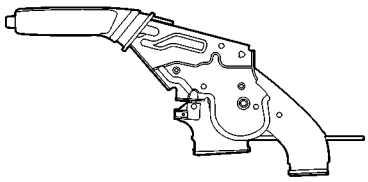
2. Components of Brake System



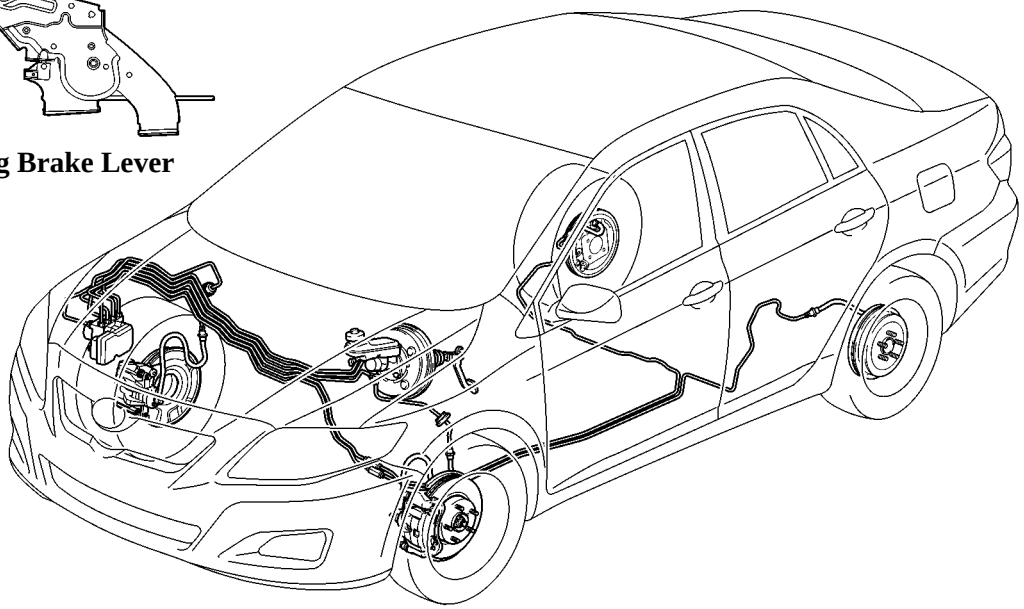
Master Cylinder & Brake Booster (With Brake Assist Mechanism)

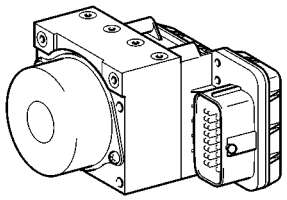


Master Cylinder & Brake Booster (Without Brake Assist Mechanism)

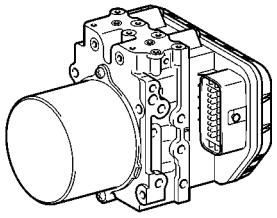


Parking Brake Lever

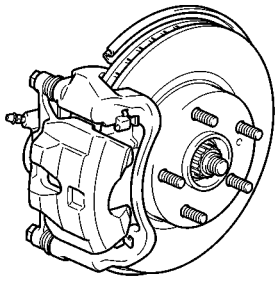




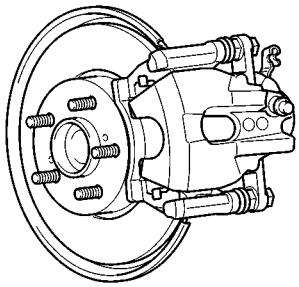
Brake Actuator (ABS, EBD Type)



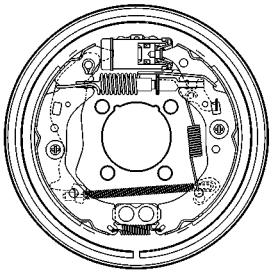
Brake Actuator (ABS, EBD, Brake Assist, TRAC, VSC Type)



Front Brake



Disc Brake Type



Drum Brake Type

Rear Brake

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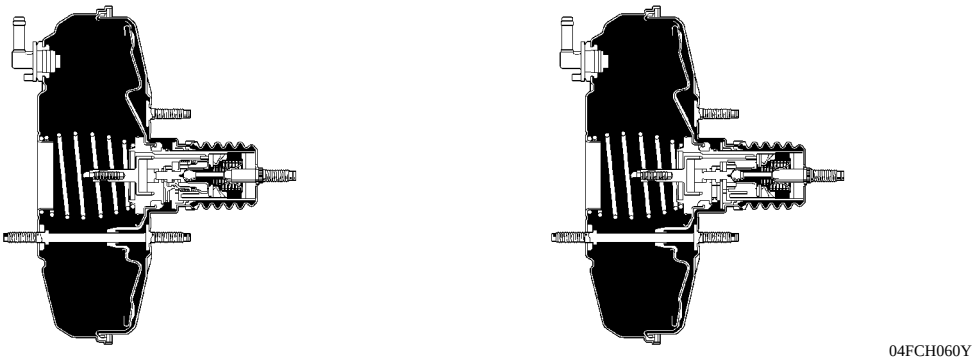
■BRAKE BOOSTER

1. General

- A 10-inch single type brake booster is used on all the models.
- A brake assist mechanism is integrated in the brake booster except for the models with VSC.



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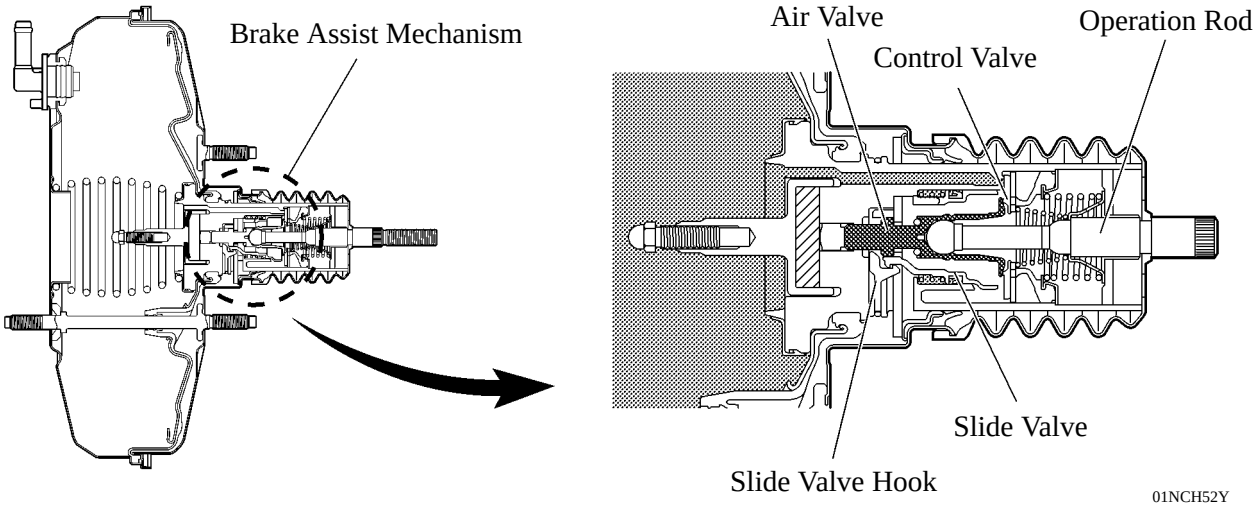
With Brake Assist Mechanism

Without Brake Assist Mechanism

2. Construction and Operation of Brake Assist Mechanism

General

Brake assist mechanism consists of the slide valve, slide valve hook, air valve, control valve and operation rod in the brake booster.



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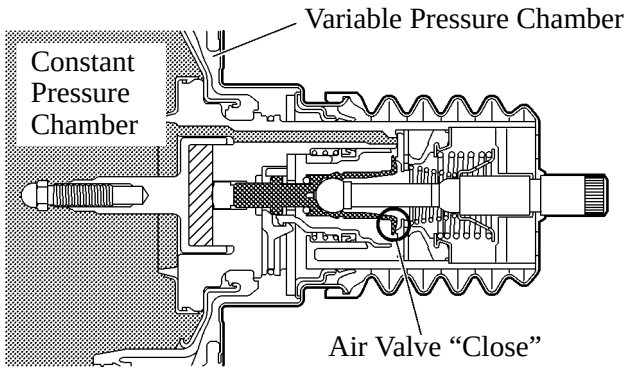
Operation

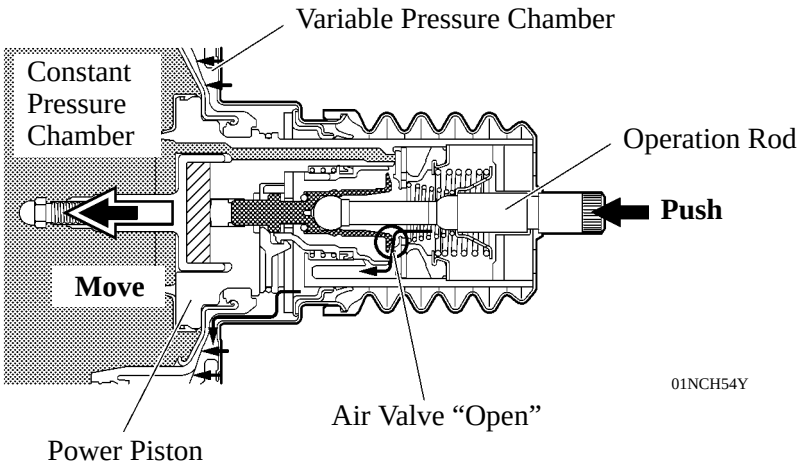
1) No Braking Condition

The air valve closes, and the pressure is the same in the variable pressure chamber and the constant pressure chamber.



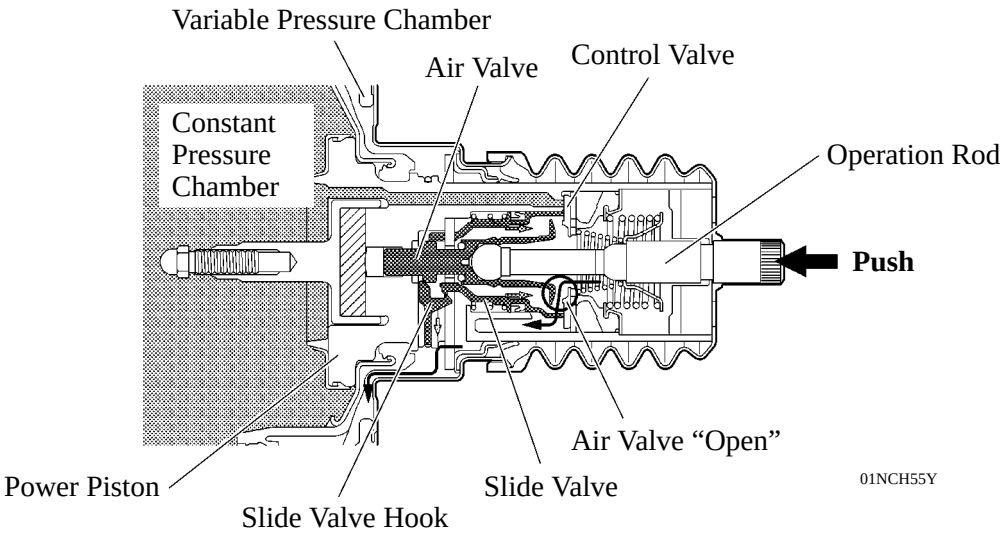
2) Normal Braking Condition (Operation Rod Speed = Power Piston Speed)

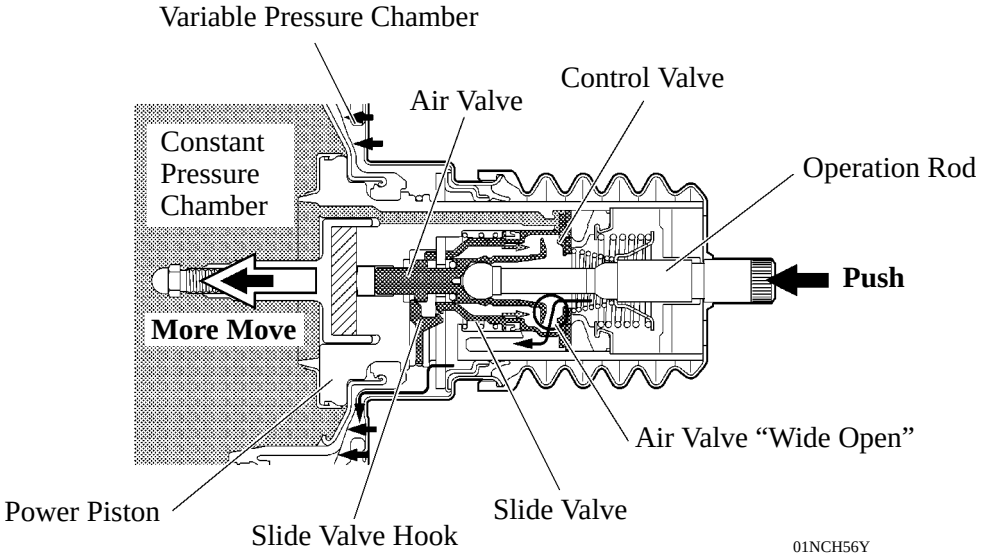
During normal braking, the air valve opens to activate the brake booster function.



3) Brake Assist Condition (Operation Rod Speed > Power Piston Speed)

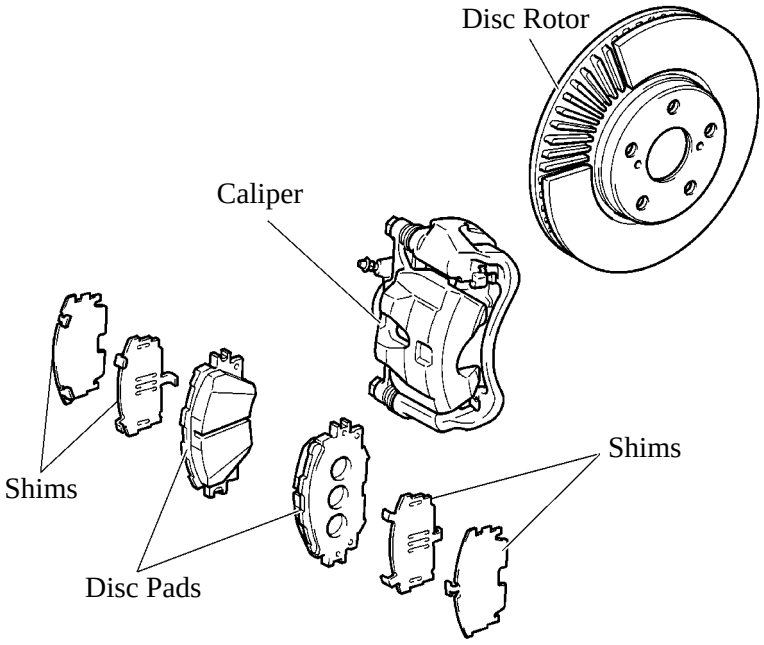
When the operation rod speed is faster than the power piston speed, the air valve pushes the slide valve hook. Consequently, the slide valve separates from the slide valve hook, and the slide valve pushes the control valve to open the air valve wider than in the normal brake condition. Thus, the air volume that is introduced increases. This results in a brake assist force to powerfully push the power piston.





■FRONT BRAKE

- The front brake uses a brake pad with a high friction coefficient, which improves the braking feeling.
- They are constructed to stabilize the state of contact between parts during braking in order to reduce braking noise during braking.
- The characteristics of the calipers have been optimized to suppress vibrations during braking.



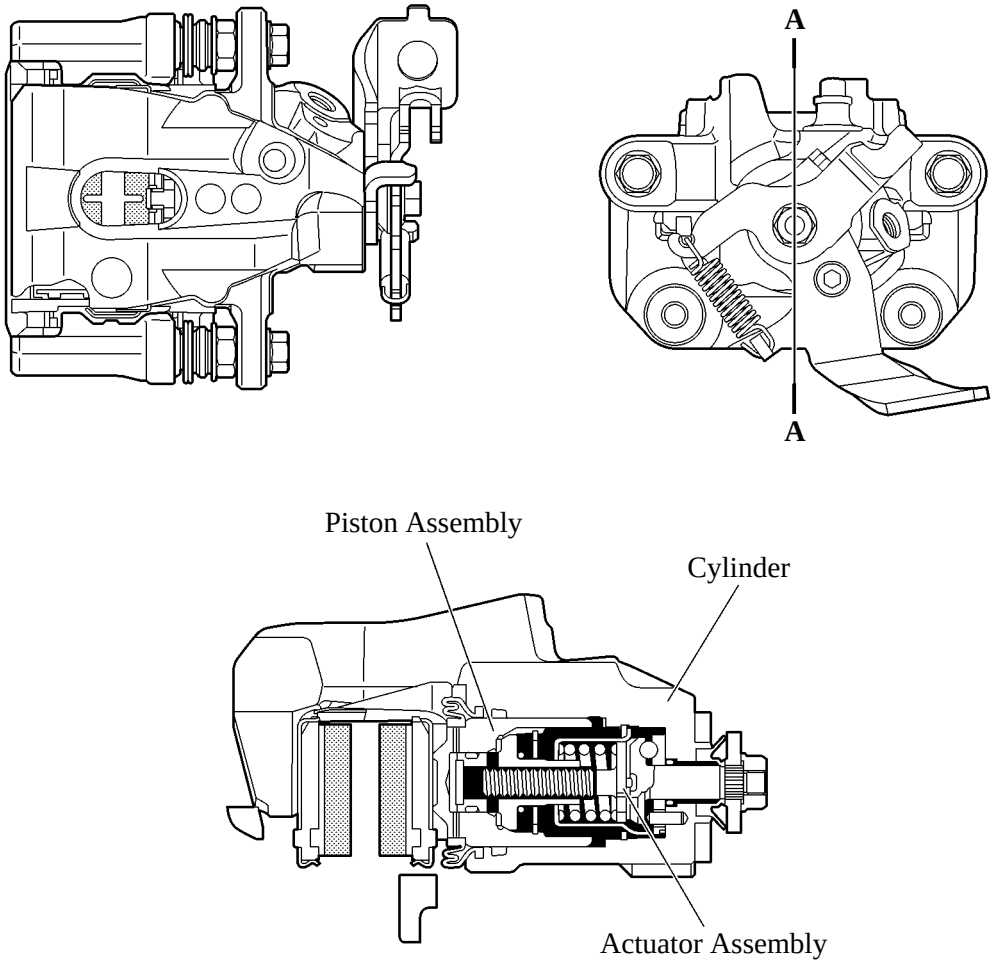
■REAR BRAKE (DISC BRAKE TYPE)

1. General

- A built-in type disc brake that has a built-in parking brake mechanism is provided on the 2AZ-FE engine models and Mexican package models with the 2ZR-FE engine.
- A caliper cylinder made of aluminum is used for weight reduction.
- The characteristics of the calipers have been optimized to suppress noise and vibrations during braking.

2. Construction and Operation of Built-in Type Disc Brake

The built-in type brake caliper assembly is comprised of a cylinder, piston assembly and actuator assembly, and has a built-in parking mechanism.



A – A Cross Section

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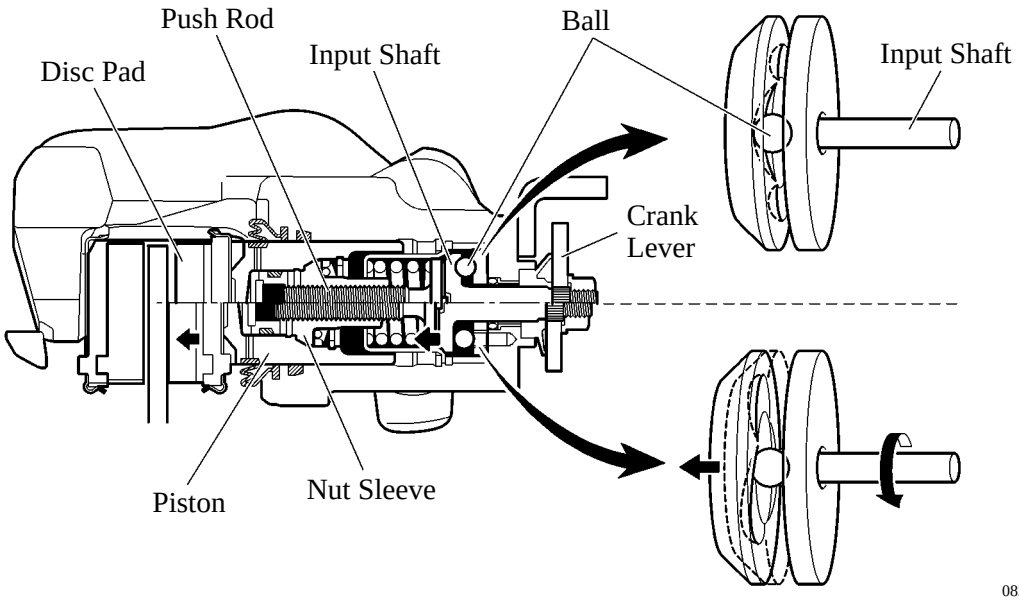
Parking Brake Operation

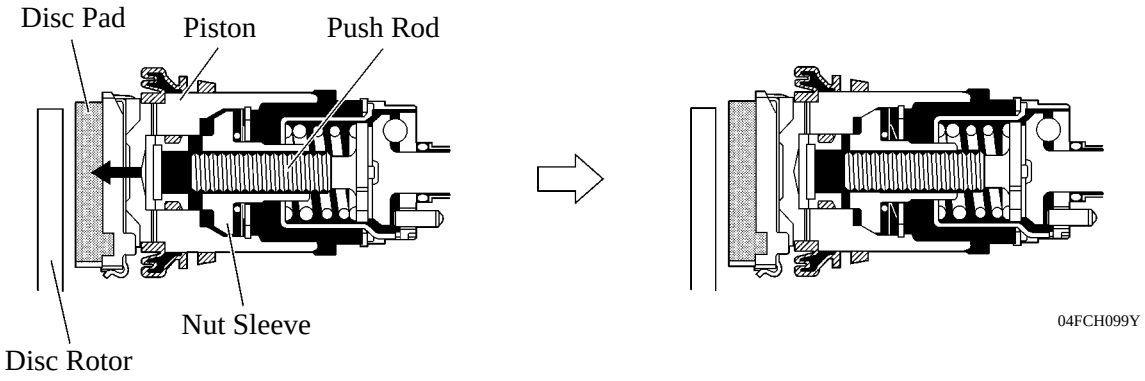
- When the parking brake lever is operated, the crank lever and the push rod (actuator assembly) that is connected to the crank lever rotate via the parking brake cable.
- At the same time, the input shaft slides the push rod through the movement of the ball.
- The nut sleeve in the piston that is connected to the push rod also slides, pushing out the piston and disc pad to generate braking force.



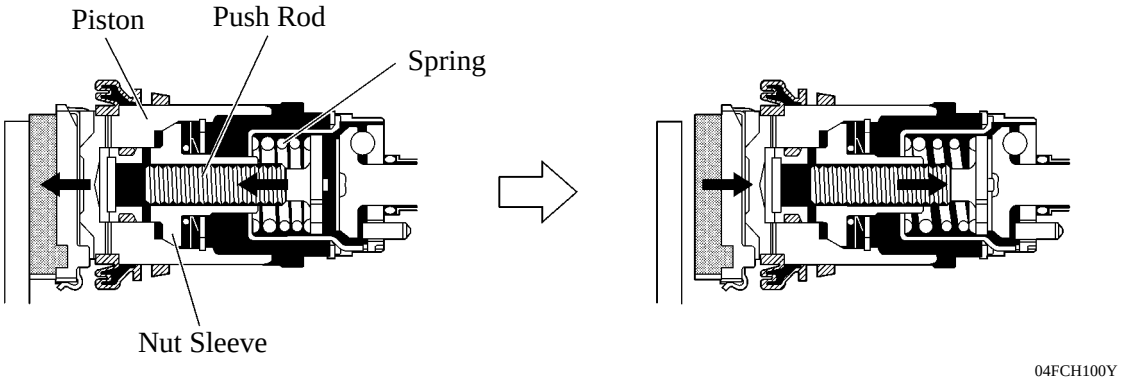
Adjust Operation

When the brake pad is worn and the clearance between the disc pad and disc rotor reaches a predetermined level, auto adjust operation is performed through hydraulic pressure when the brake pedal is operated.

- The piston slides until the disc pad makes contact with the disc rotor, and a clearance is created between the piston and nut sleeve. At this time, while rotating around the push rod, the nut sleeve moves until it makes contact with the piston and performs the adjust operation.



- When the hydraulic pressure rises further, the nut sleeve does not rotate and the push rod pushes down the spring. Overadjustment is prevented by the push rod sliding together with the piston, and the correct clearance between the disc pad and disc rotor is maintained.



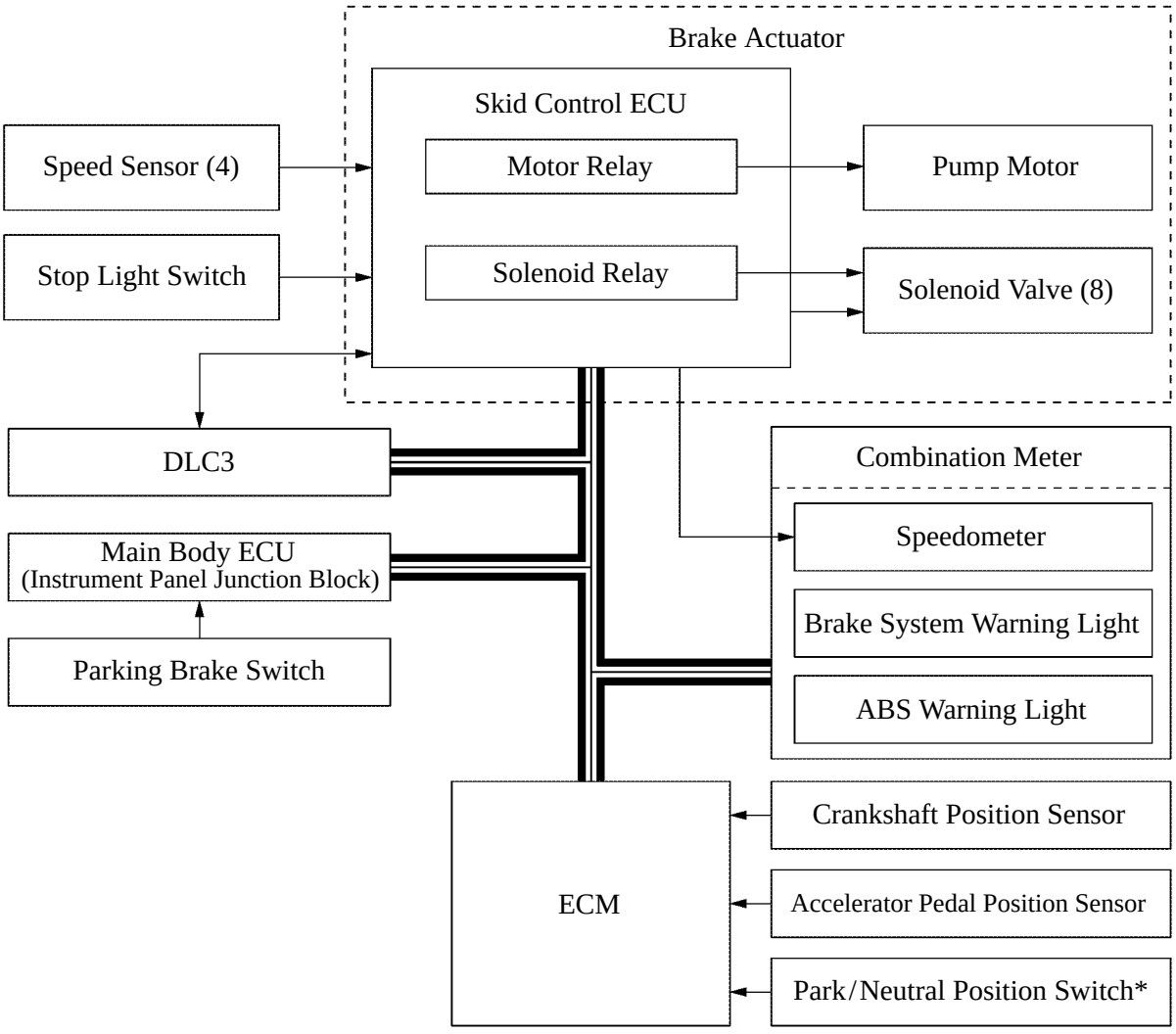
■BRAKE CONTROL SYSTEM

1. General

- The brake control functions (ABS, EBD, brake assist, TRAC, VSC) have been provided to ensure excellent brake performance and vehicle stability. For the provisions of the respective brake control functions, see page CH-76.
- The VSC OFF switch is provided to enable the driver to select the “Normal Mode”, “TRAC-OFF Mode”, or “VSC-OFF Mode”. (Only for models with VSC)

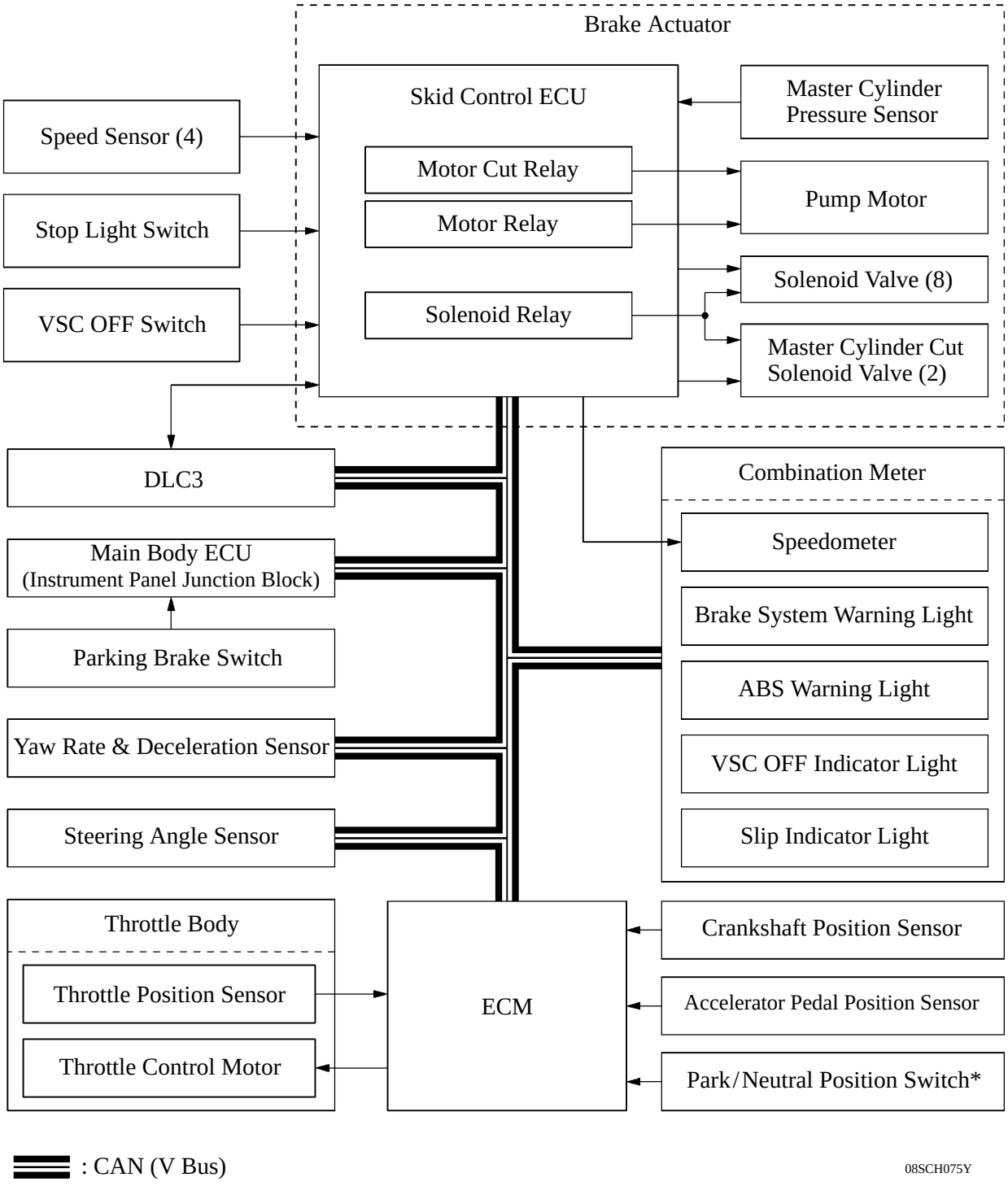
2. System Diagram

Models with ABS, EBD, Brake Assist (Mechanical Type)



*: Only for A/T Models

Models with ABS, EBD, Brake Assist (Electrical Type), TRAC, VSC

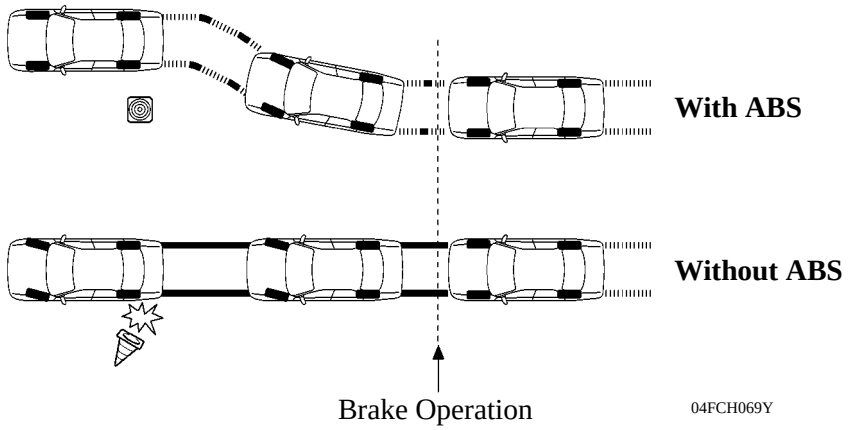


*: Only for A/T Models

3. Outline of Brake Control Functions

ABS (Anti-lock Brake System)

The ABS prevents the wheels from locking during sudden braking or braking on a slippery surface. This provides the proper braking force when the vehicle slips, thus ensuring vehicle stability and excellent braking performance.



◆: The illustration provides a conceptual image.

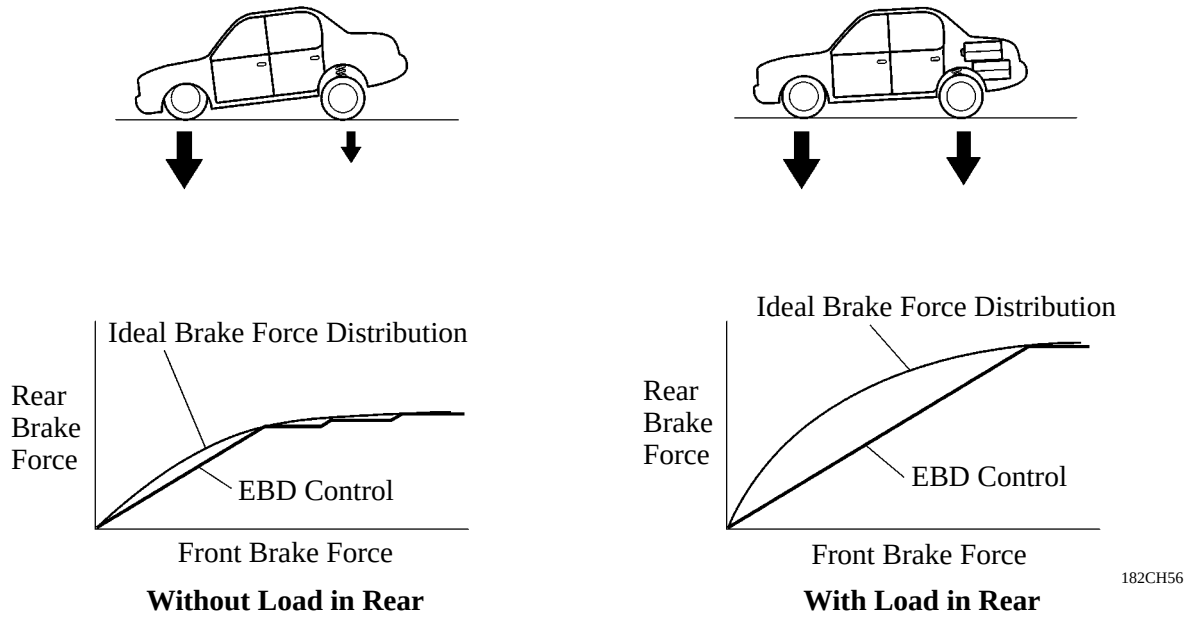
EBD (Electronic Brake force Distribution)

The EBD control utilizes the ABS, realizing the proper brake force distribution between the front and rear wheels in accordance with the driving conditions. In addition, during cornering braking, it also controls the brake forces of the right and left wheels, helping to maintain the vehicle behavior.

1) Front/Rear Wheels Brake Force Distribution

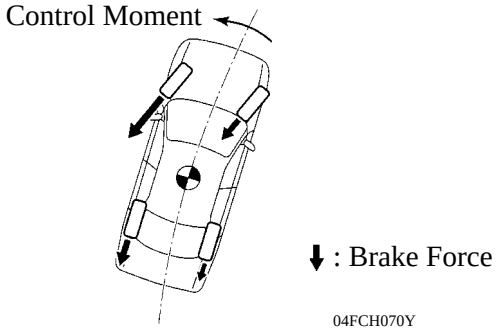
This function controls the brake force that acts on the rear wheels in accordance with the changes in the vehicle conditions such as load factors or deceleration, in order to ensure excellent braking performance.

▶ EBD Control Concept ◀



2) Right/Left Wheels Brake Force Distribution (During Cornering Braking)

During cornering braking, this function controls the brake force that acts on the left and right wheels in accordance with the vehicle conditions at that time. This ensures vehicle stability and excellent braking performance.

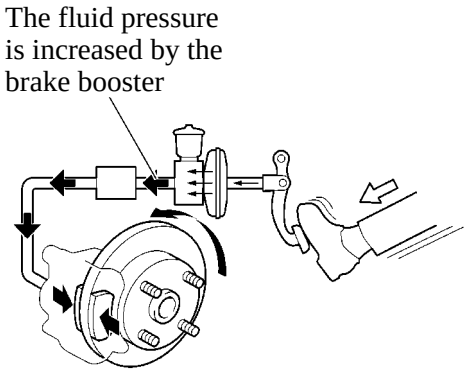


Brake Assist

The primary purpose of the brake assist is to provide an auxiliary brake force to assist the driver who cannot generate a large brake force during emergency braking, thus helping draw the vehicle's brake performance.

- The mechanical type brake assist uses the brake assist mechanism in the brake booster to mechanically activate the brake booster function in order to increase the brake force. For details, see page CH-78.
- In the electrical type brake assist, based on the signals from the master cylinder pressure sensor, the skid control ECU calculates the speed and the amount of the brake pedal application and then determines the intention of the driver to make an emergency braking. If the skid control ECU determines that the driver intends the emergency braking, this function activates the brake actuator to increase the brake fluid pressure, which increases the brake force. For details, see page CH-101.

▶ In case that the driver's depressing force is small when emergency braking is applied ◀



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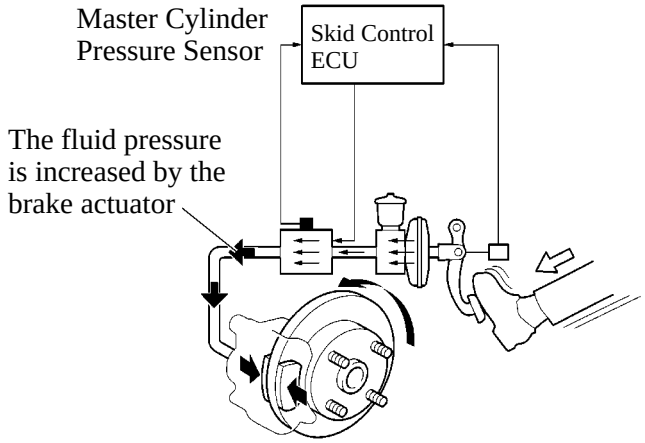
With Brake Assist
(Mechanical Type)



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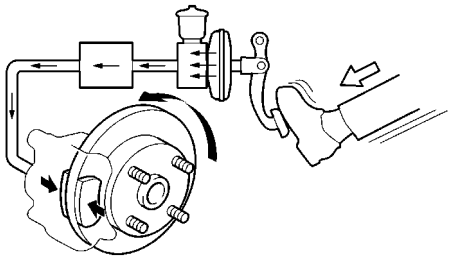
With Brake Assist
(Electrical Type)



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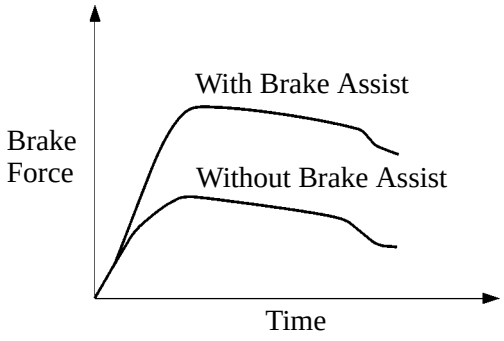
Without Brake Assist*



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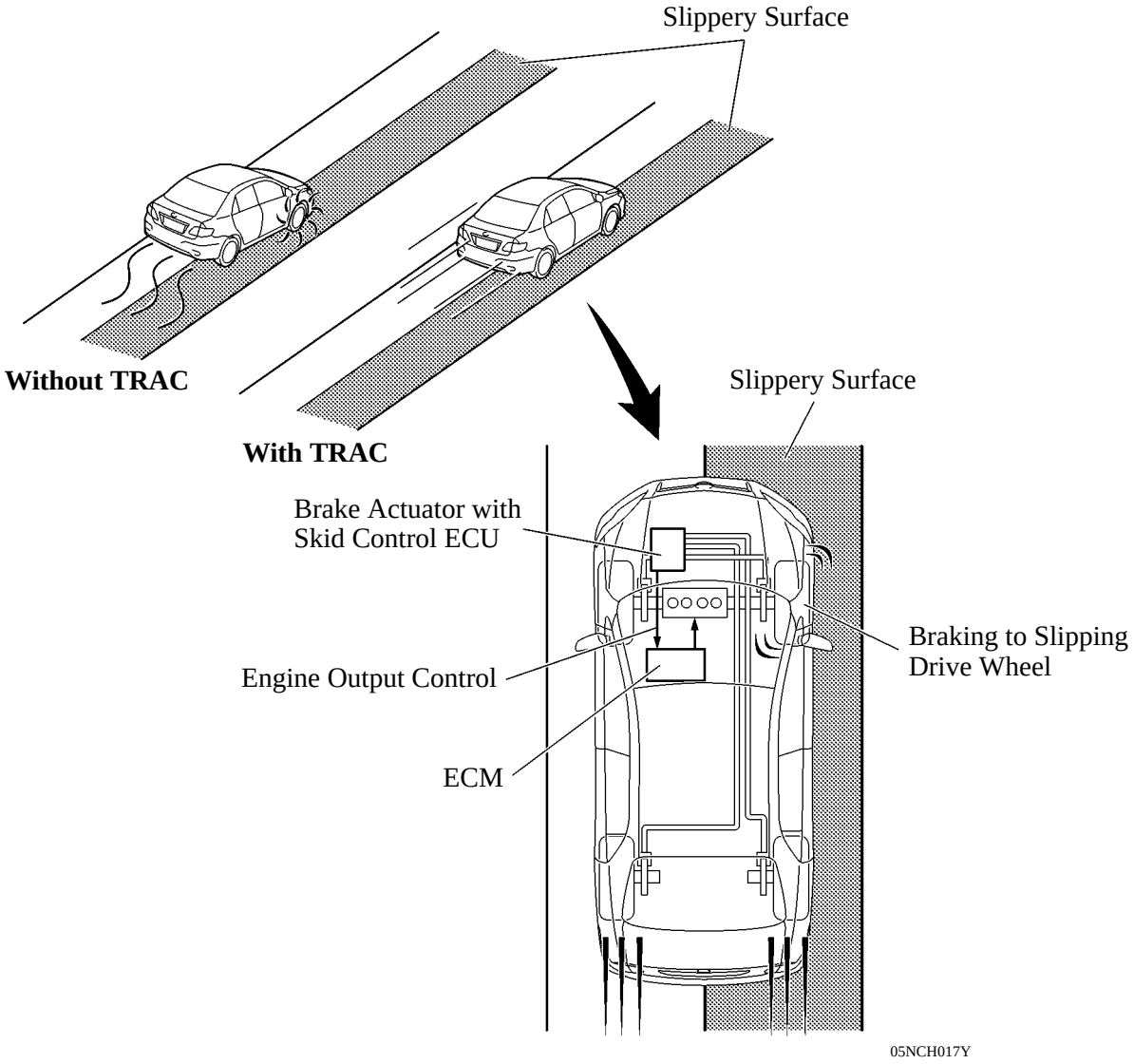
*: The basic performance of the brake is the same as that of the models with the brake assist

TRAC (Traction Control)

The TRAC helps prevent the drive wheels from slipping if the driver depresses the accelerator pedal excessively when starting off or accelerating on a slippery surface. Simultaneously with the hydraulic brake control of the drive wheels, the skid control ECU requests the ECM to effect engine output control. This produces the drive force that suits the driving conditions, in order to ensure the proper start-off acceleration.

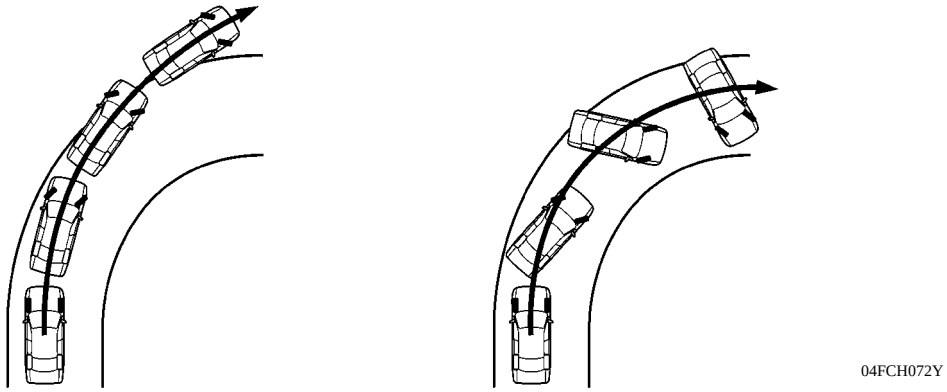
▶ Driving condition on road with different surface friction characteristics ◀



VSC (Vehicle Stability Control)

The followings are two examples that can be considered as circumstances in which the tires exceed their lateral grip limit. The VSC is designed to help control the vehicle behavior by controlling the engine output and the brakes at each wheel when the vehicle is under one of the conditions indicated below.

- When the front wheels lose grip in relation to the rear wheels (front wheel skid tendency).
- When the rear wheels lose grip in relation to the front wheels (rear wheel skid tendency).



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Front Wheel Skid Tendency **Rear Wheel Skid Tendency**

1) Method for Determining Vehicle Condition

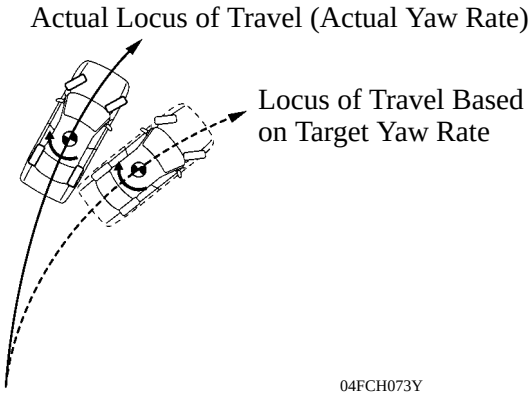
To determine the condition of the vehicle, sensors detect the steering angle, vehicle speed, vehicle's yaw rate, and vehicle's lateral acceleration, which are then calculated by the skid control ECU.

a. Determining Front Wheel Skid

Whether the vehicle is in the state of the front wheel skid or not is determined by the difference between the target yaw rate and the vehicle's actual yaw rate. When the vehicle's actual yaw rate is smaller than the yaw rate (a target yaw rate that is determined by the vehicle speed and steering angle) that should be rightfully generated when the driver operates the steering wheel, it means the vehicle is making a turn at a greater angle than the locus of travel. Thus, the skid control ECU determines that there is a large tendency to front wheel skid.

b. Determining Rear Wheel Skid

Whether the vehicle is in the state of the rear wheel skid or not is determined by the values of the vehicle's slip angle and the vehicle's slip angular velocity (time-dependent changes in the vehicle's slip angle). When the vehicle's slip angle and the slip angular velocity are large, the skid control ECU determines that the vehicle has a large rear wheel skid tendency.



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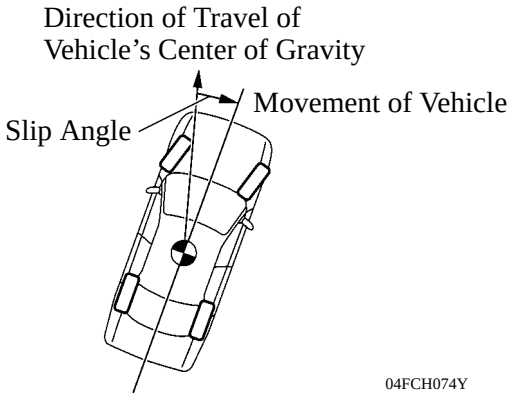
Determining Front Wheel Skid



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Determining Rear Wheel Skid

2) Method for VSC Operation

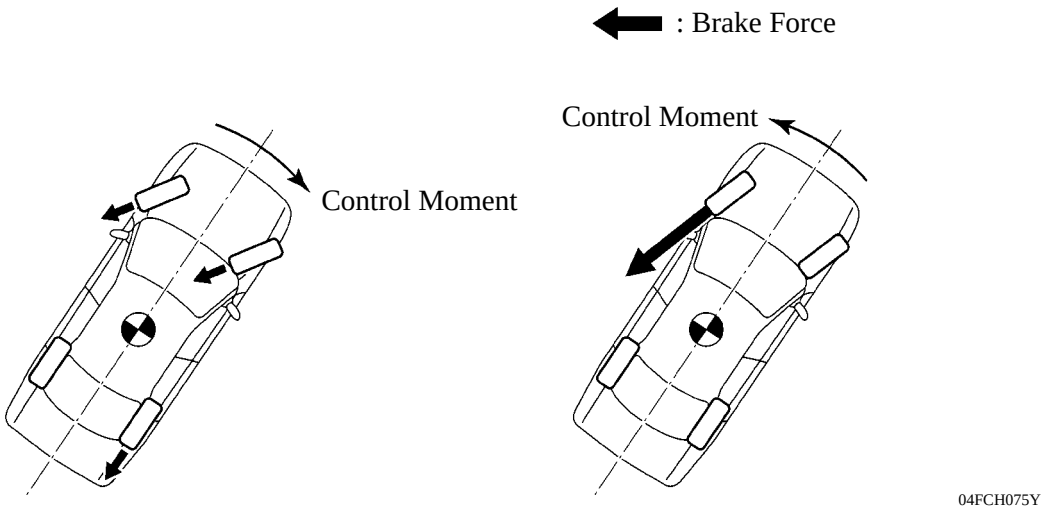
When the skid control ECU determines that the vehicle has a tendency to front wheel skid or rear wheel skid, it decreases the engine output and applies the brake of a front or rear wheel to control the vehicle's yaw moment.
The basic operation of the VSC is described below. However, the control method differs depending on the vehicle's characteristics and driving conditions.

a. Dampening a Front Wheel Skid

When the skid control ECU determines that there is a large front wheel skid tendency, it counteracts in accordance with the extent of that tendency. The skid control ECU controls the engine output and applies the brake to the rear wheel of the inner circle of the turn in order to help restrain the front wheel skid tendency.

b. Dampening a Rear Wheel Skid

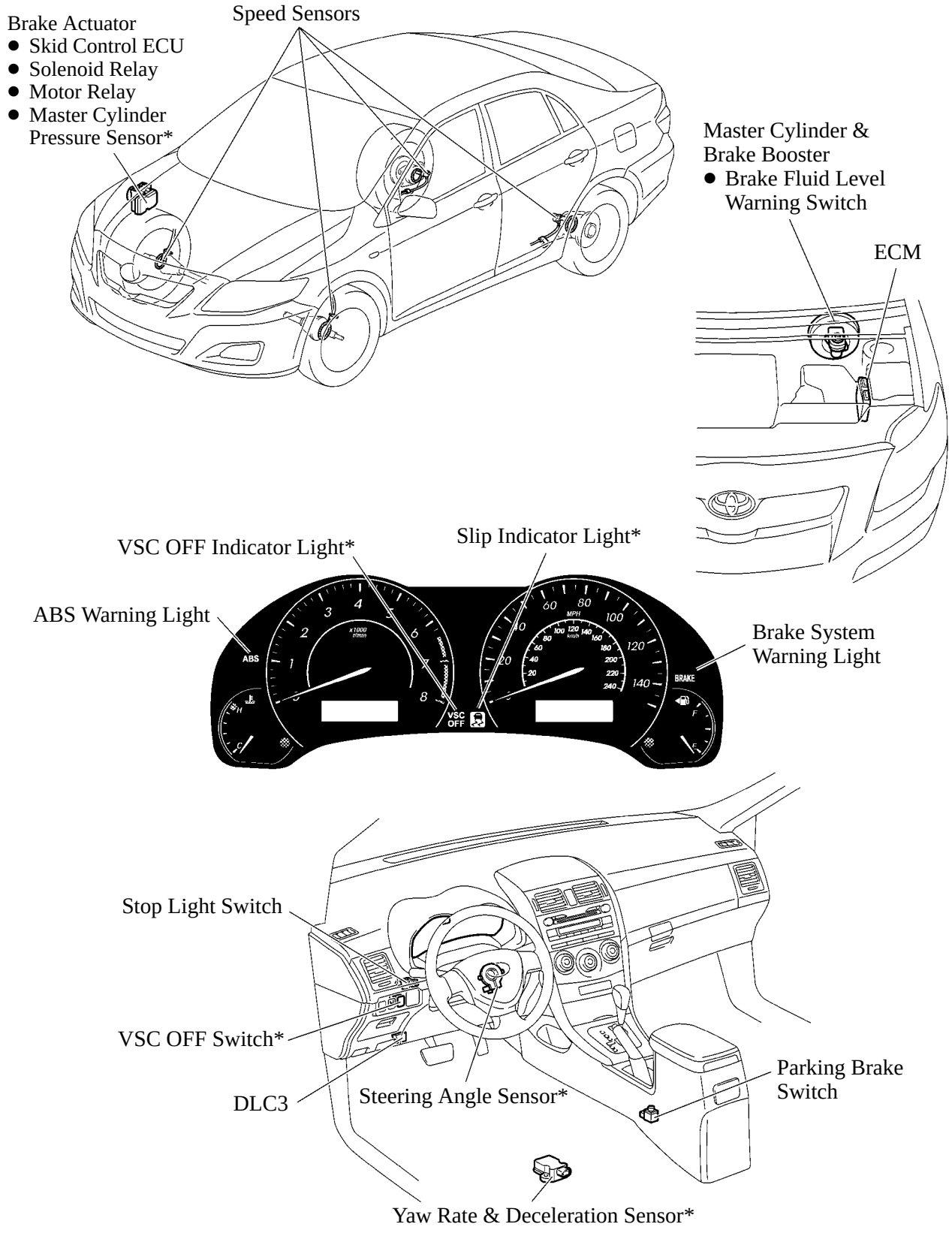
When the skid control ECU determines that there is a large rear wheel skid tendency, it counteracts in accordance with the extent of that tendency. It applies the brakes of the front and rear wheels of the outer circle of the turn, and generates an outward moment of inertia in the vehicle, in order to help restrain the rear wheel skid tendency. Along with the reduction in the vehicle speed caused by the brake force, the excellent vehicle's stability is ensured.
In some cases, the skid control ECU applies the brake of the rear wheels as necessary.



Dampening a Front Wheel Skid (Marking a Right Turn)

Dampening a Rear Wheel Skid (Marking a Right Turn)

4. Layout of Main Components



*: Only for Models with VSC

5. Function of Main Components

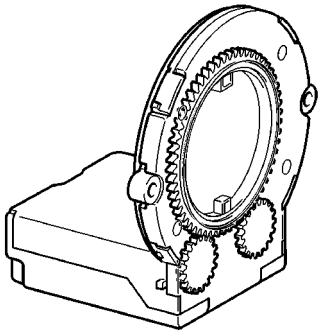
Component		Function
Combination Meter	Brake System Warning Light	● Lights up together with ABS warning light to alert the driver that the skid control ECU detects the malfunction not only in the ABS but also in the EBD. ● Lights up to alert the driver that the brake fluid level is low. ● Lights up to inform the driver that the parking brake lever is pulled up.
	ABS Warning Light	Lights up to alert the driver that the skid control ECU detects a malfunction in the ABS.
	VSC OFF Indicator Light*1	Lights up to inform the driver of the VSC-OFF mode. Lights up to alert the driver that the skid control ECU detects the malfunction in the TRAC or VSC.
	Slip Indicator Light*1	● Blinks to inform the driver that the TRAC or VSC is operated. ● Lights up to inform the driver of the TRAC-OFF mode.
	Multi Buzzer	Emits a warning sound to alert the driver if the vehicle is driven with the parking brake lever engaged, and the vehicle speed is over 15 km/h (9 mph).
Steering Angle Sensor*1		Detects the direction and angle of the steering wheel.
Yaw Rate & Deceleration Sensor*1		● Detects the vehicle's longitudinal and lateral acceleration and deceleration. ● Detects the vehicle's yaw rate.
Stop Light Switch		Detects the brake pedal depressing signal.
Parking Brake Switch		Detects the parking brake pedal depressing signal.
Brake Fluid Level Warning Switch		Detects the brake fluid level.
VSC OFF Switch*1		Enables the driver to select the "Normal Mode", "TRAC-OFF Mode", or "VSC-OFF Mode".
Speed Sensor		Detect the wheel speed of each of 4 wheels.
Brake Booster		Increases the brake pedal effort. (Operates the brake assist mechanism to mechanically activate the brake assist function.)*2
Brake Actuator		Changes the fluid path based on the signals from the skid control ECU during the operation of the brake control system functions, in order to control the fluid pressure that is applied to the wheel cylinders.
	Solenoid Relay	Supplies power to the solenoid valves.
	Motor Relay	Supplies power to the pump motor.
	Motor Cut Relay*1	Cuts the power to the pump motor in the brake actuator.
	Master Cylinder Pressure Sensor*1	Assembled in the brake actuator, detects the master cylinder pressure.
	Skid Control ECU	Judges the vehicle driving condition based on the signals from each sensor, and sends the brake control signals to the brake actuator.
ECM		● Sends the throttle position signal, accelerator pedal position signal, engine speed signal etc., to the skid control ECU. ● (Based on the signals receives from the skid control ECU, controls the engine output.)*1

*1: Only for Models with VSC
*2: Only for Models without VSC

6. Construction and Operation of Main Components

Steering Angle Sensor (Only for Models with VSC)

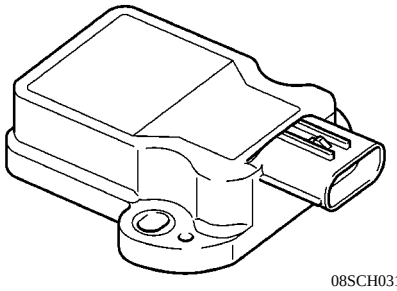
The steering angle sensor detects the steering direction and angle, and sends this signal to the skid control ECU.



08SCH030Y

Yaw Rate & Deceleration Sensor (Only for Models with VSC)

- The yaw rate sensor detects the vehicle's yaw rate.
- The deceleration sensor detects the vehicle's longitudinal and lateral acceleration and deceleration.



08SCH031Y

Service Tip

After the yaw rate & deceleration sensor or the skid control ECU is replaced, initialization of the yaw rate & deceleration sensor is required.

For the actual procedure, refer to the 2009 Corolla Repair Manual (Pub. No. RM08M0U).

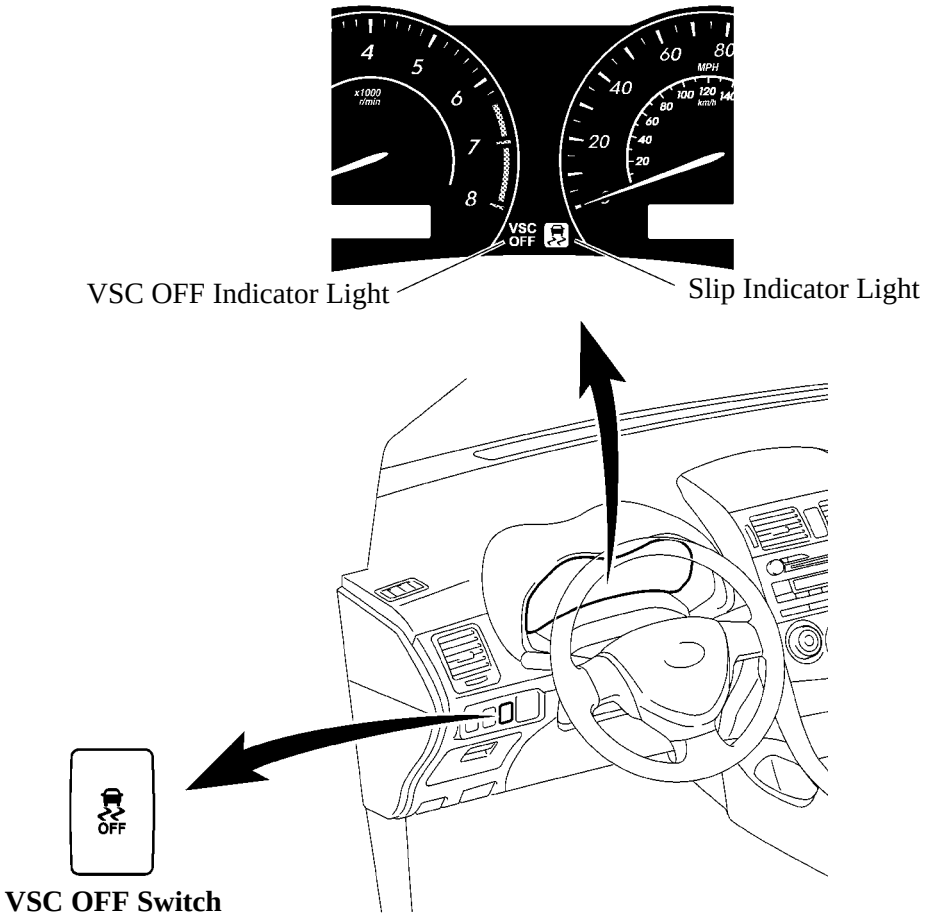
Speed Sensor

The speed sensor detects the wheel speed. For details, see page CH-66.

VSC OFF Switch (Only for Models with VSC)

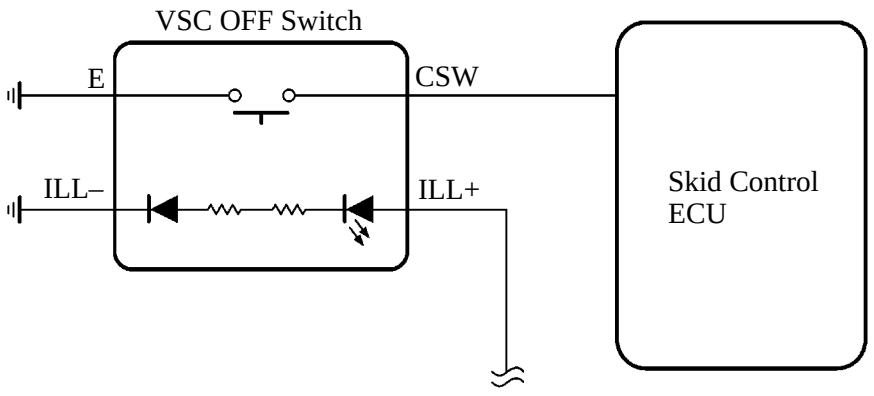
1) General

The VSC OFF switch has been provided on the models with VSC.
The operation of the VSC and TRAC functions can be stopped by the VSC OFF switch. While the vehicle is running off the shoulder of the road or running on the dirt road, the engine output control is stopped to maintain drive torque.



08MCH013Y

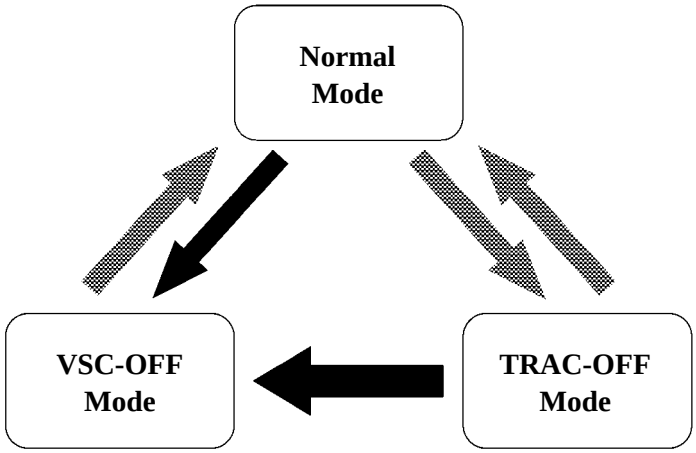
▶ Wiring Diagram ◀



04FCH080Y

2) Function of VSC OFF Switch

- The VSC OFF switch can select the 3 modes (Normal mode, TRAC-OFF mode, VSC-OFF mode).
- After the ignition switch*1 or engine switch*2 is turned OFF in the TRAC-OFF mode or VSC-OFF mode, turning the ignition switch*1 or engine switch*2 ON (IG) again selects the Normal mode.



04FCH153Y

: Switch Operation (Press shortly.)

: Switch Operation
(Keep pressing for 3 seconds with the vehicle at a standstill.)

- The operations of the brake control functions in each mode are as follows:

○: Controllable ×: Not Controllable

Item	Brake Control Function		Slip Indicator Light	VSC OFF Indicator Light
	TRAC	VSC	 04FCH124Y	VSC OFF 08SCH054Y
Normal Mode	○	○	—	—
TRAC-OFF Mode	×*3	○	Light ON	—
VSC-OFF Mode	×	×*4	Light ON	Light ON

*1: Models without Smart Key System
*2: Models with Smart Key System
*3: If only the TRAC system is turned OFF, the TRAC system will turn ON when vehicle speed increases.
*4: If the TRAC/VSC systems are turned OFF, the systems will not turn ON even when vehicle speed increases.

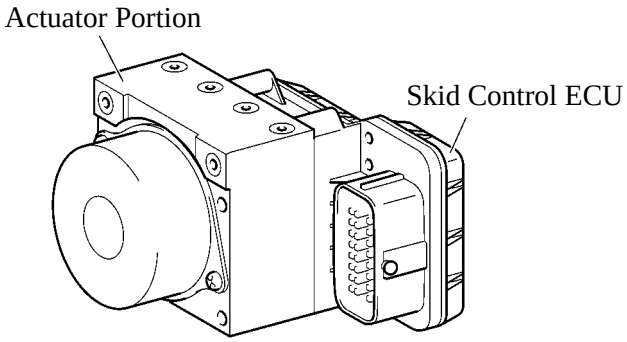
NOTE

The TRAC and VSC functions control brake hydraulic pressure and engine output to ensure vehicle stability.
Therefore, operate the VSC OFF switch (stop the operation of the TRAC and VSC functions) only when it is necessary.

Brake Actuator

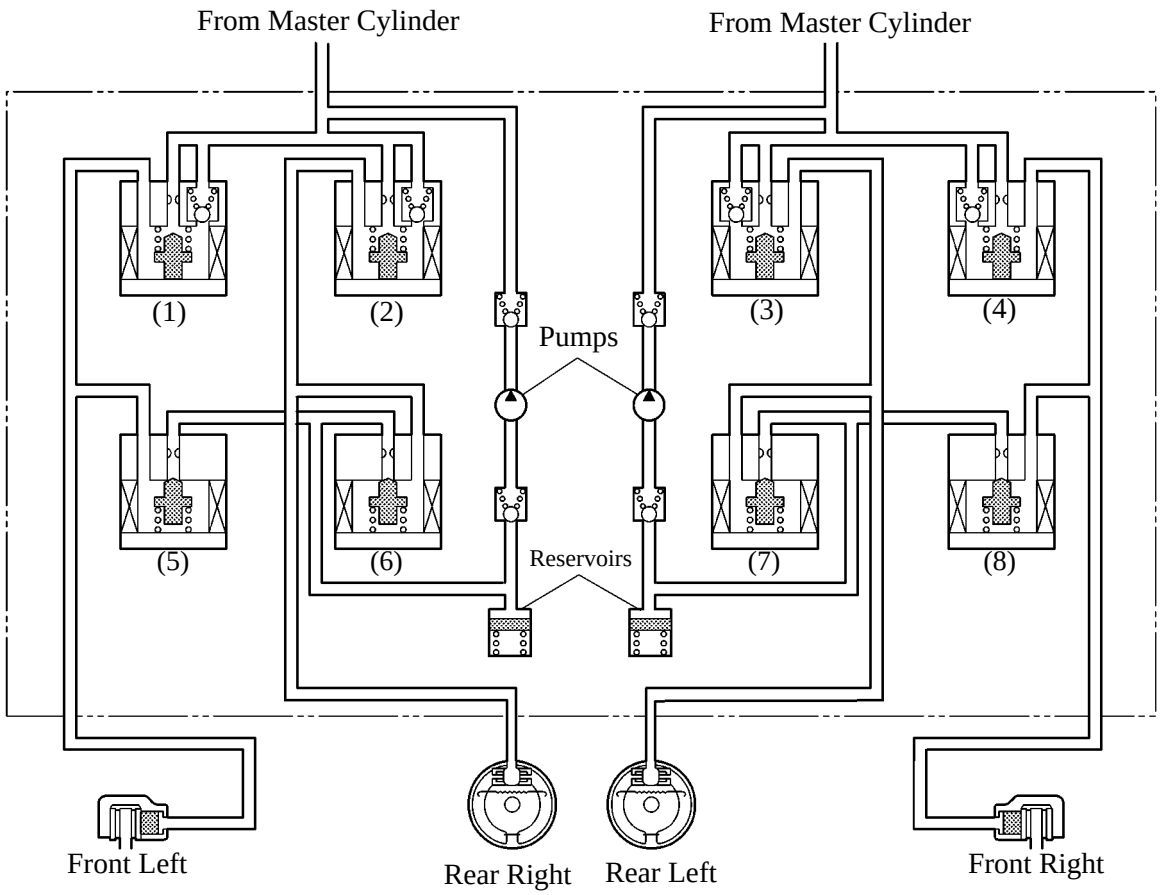
1) Models with ABS and EBD

- The brake actuator consists of the actuator portion and skid control ECU.
- The actuator portion consists of 8 solenoid valves, 2 pumps and 2 reservoirs.
- The 8 solenoid valves consist of 4 pressure holding solenoid valves [(1), (2), (3), (4)] and 4 pressure reduction solenoid valves [(5), (6), (7), (8)].



08MCH014Y

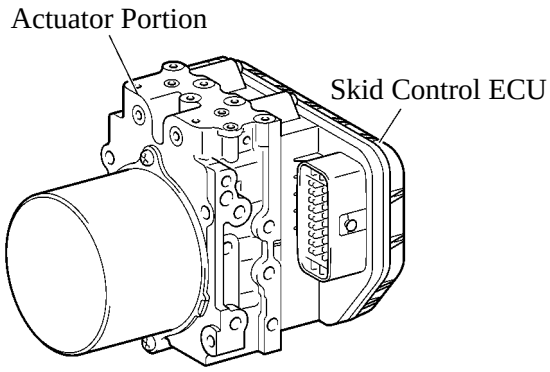
▶ Hydraulic Circuit ◀



05KCH17Y

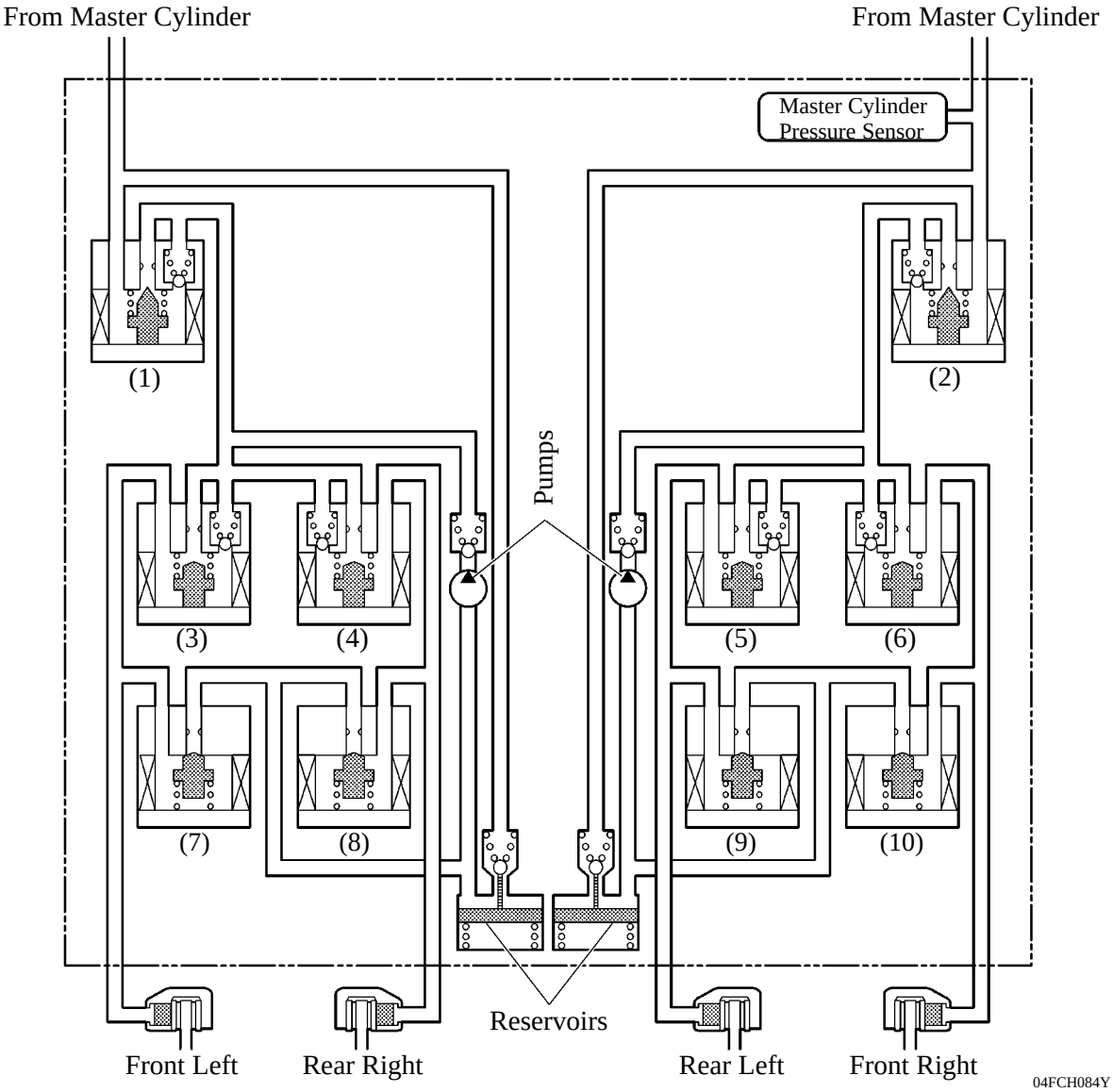
2) Models with ABS, EBD, Brake Assist (Electrical Type), TRAC and VSC

- The brake actuator consists of the actuator portion and skid control ECU.
- The actuator portion consists of 10 solenoid valves, 2 pumps, 2 reservoirs, and master cylinder pressure sensor.
- The 10 solenoid valves consist of 2 master cylinder cut solenoid valves [(1), (2)], 4 pressure holding solenoid valves [(3), (4), (5), (6)], and 4 pressure reduction solenoid valves [(7), (8), (9), (10)].



08MCH015Y

▶ Hydraulic Circuit ◀



04FCH084Y

PE10-008

TOYOTA

05/07/2010

Attachment-Response 9a-2 (Matrix)

BRAKE

■DESCRIPTION

1. General

The brake system has the following configurations and specifications:

Engine Type		**2ZR-FE**	**2AZ-FE**	
Grade		**-**	**S/XR**	**XRS**
Front Brake Type		Ventilated Disc		
Rear Brake Type		Solid Disc		
Brake Control System	ABS with EBD and Brake Assist (Mechanical Type)	Standard		Not Equipped
	ABS with EBD, Brake Assist (Electrical Type), TRAC and VSC	Optional		Standard

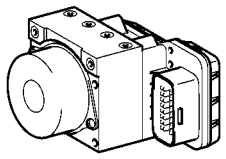
2. Specifications

Engine Type			**2ZR-FE**	**2AZ-FE**	
Grade (Drive Type)			**- (2WD)**	**S/XR (2WD)**	**S/XR (AWD), XRS (2WD)**
Rear Suspension Type			**Torsion-beam**		**Double-wishbone**
Brake Master Cylinder Sub-assembly	Type	mm (in.)	Tandem		
	Diameter	mm (in.)	20.64 (0.81)*2, 22.22 (0.87)*3	22.22 (0.87)	
Brake Booster Assembly	Type		• Single Diaphragm • Mechanical Brake Assist*2		
	Size	in.	10		
Front Disc Brake Caliper Assembly	Pad Area	cm^2 ($in.^2$)	48.9 (7.58) × 2	53.4(8.28) × 2	
	Wheel Cylinder Diameter	mm (in.)	60.33 (2.38)	63.5 (2.5)	
	Rotor Size (D × T)*1	mm (in.)	275 × 22 (10.83 × 0.87)	296 × 28 (11.65 × 1.10)	
Rear Disc Brake Caliper Assembly	Pad Area	cm^2 ($in.^2$)	24.9 (3.86) × 2		28.9 (4.48) × 2
	Wheel Cylinder Diameter	mm (in.)	38.18 (1.50)		38.10 (1.50)
	Rotor Size (D × T)*1	mm (in.)	259 × 9 (10.20 × 0.35)	279 × 10 (10.98 × 0.39)	281 × 10 (11.06 × 0.39)
Parking Brake	Type		Built into rear disc brake caliper assemblies		Duo-servo
	Rotor Size (D × T)*1	mm (in.)	259 × 9 (10.20 × 0.35)	279 × 10 (10.98 × 0.39)	-
	Drum Inner Diameter	mm (in.)	-		173 (6.81)

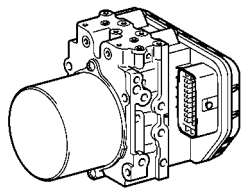
*1: (Diameter × Thickness) *2: Models for ABS with EBD and Brake Assist
*3: Models for ABS with EBD, Brake Assist, TRAC and VSC

3. Components of Brake System

Skid Control ECU with Actuator

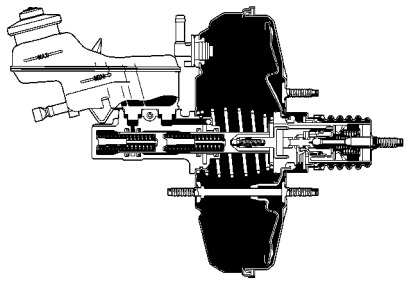


Models for ABS with EBD and Brake Assist

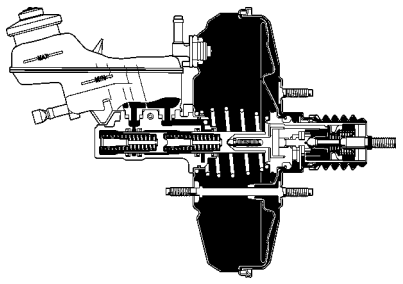


Models for ABS with EBD, Brake Assist, TRAC and VSC

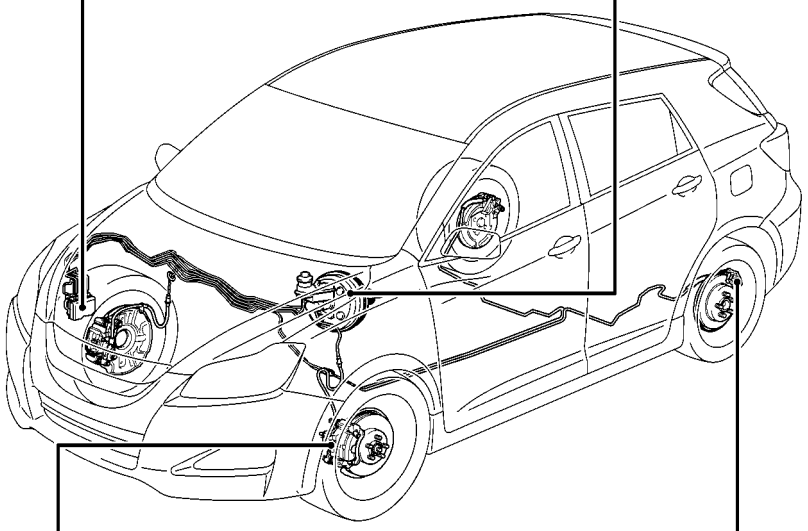
Brake Booster Assembly and Brake Master Cylinder Sub-assembly

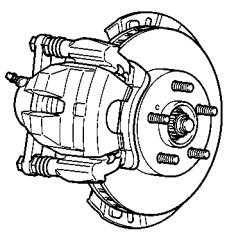


Models for ABS with EBD and Brake Assist

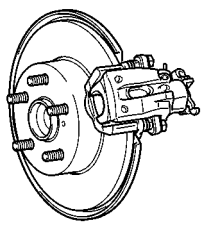


Models for ABS with EBD, Brake Assist, TRAC and VSC

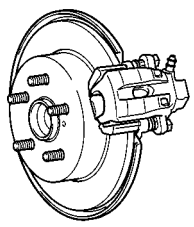




Front Brake



Rear Suspension Type: Torsion-beam



Rear Suspension Type: Double-wishbone

Rear Brake

08R0CH104C

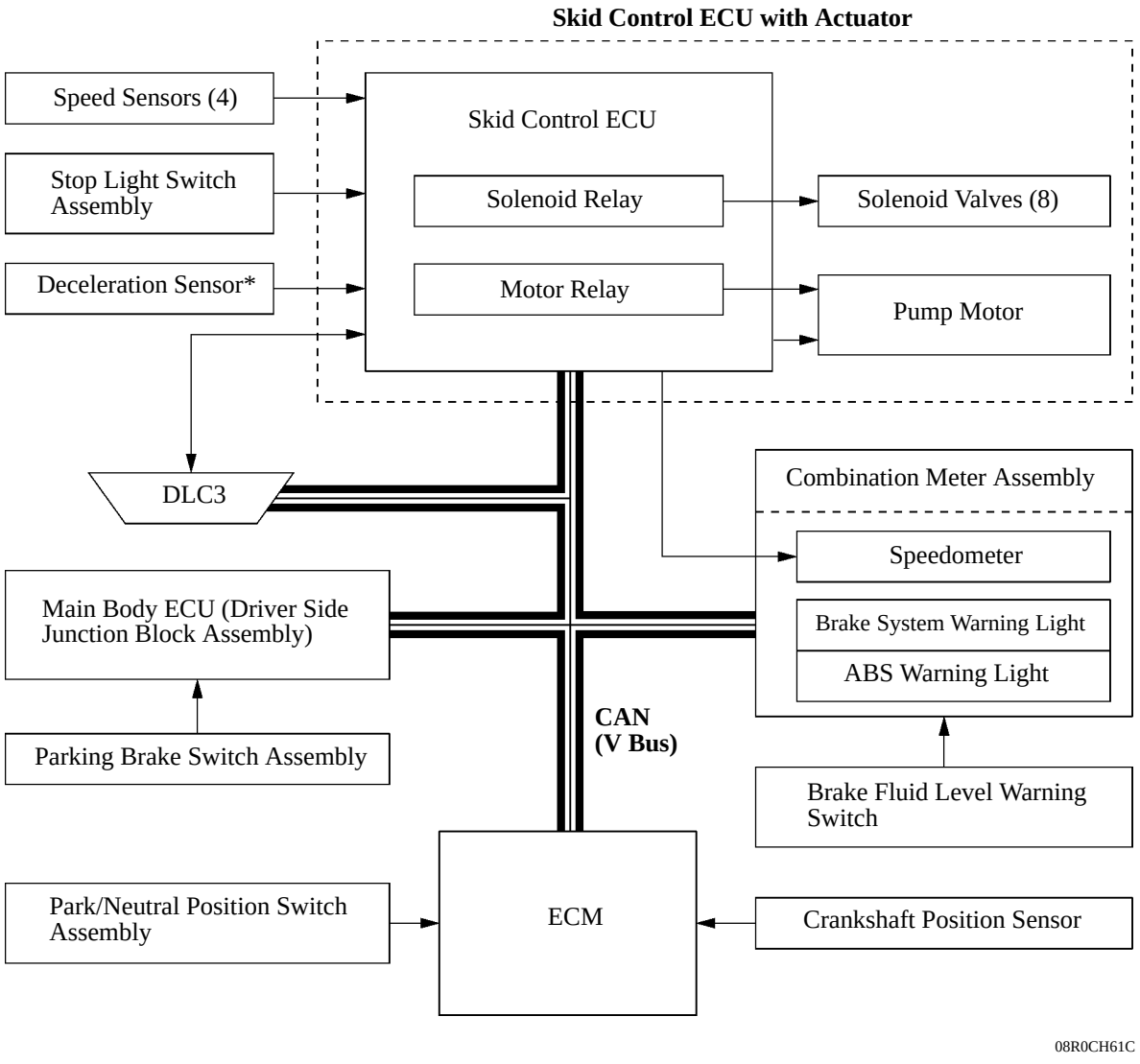
■BRAKE CONTROL SYSTEM (ABS with EBD and Brake Assist)

1. General

The brake control system (ABS with EBD and Brake Assist) has the following functions:

Function	Outline
ABS (Anti-lock Brake System)	The ABS helps prevent the wheels from locking when the brakes are applied firmly or when braking on a slippery surface.
EBD (Electronic Brake force Distribution)	The EBD control utilizes the ABS, realizing the proper brake force distribution between front and rear wheels in accordance with the driving conditions. In addition, during braking while cornering, it also controls the brake forces of the right and left wheels, helping to maintain the vehicle behavior.
Brake Assist (Mechanical Type)	The primary purpose of Brake Assist is to provide an auxiliary brake force to assist a driver who cannot generate a large brake force during emergency braking, thus helping ensure the vehicle's braking performance.

2. System Diagram

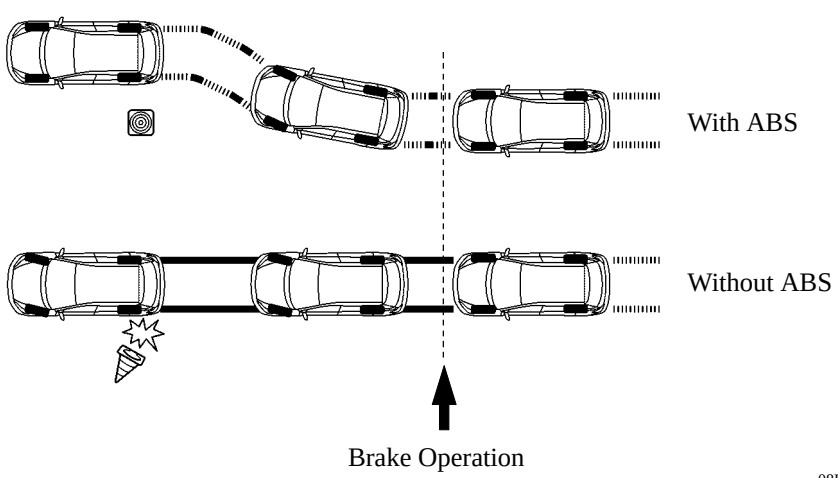


*: AWD Models

3. Outline of ABS

The ABS prevents the wheels from locking during sudden braking or braking on a slippery surface. This provides the proper braking force when the vehicle slips, thus ensuring vehicle stability and excellent braking performance.

▶ Conceptual Image ◀



08R0CH62C

4. Outline of EBD Control

General

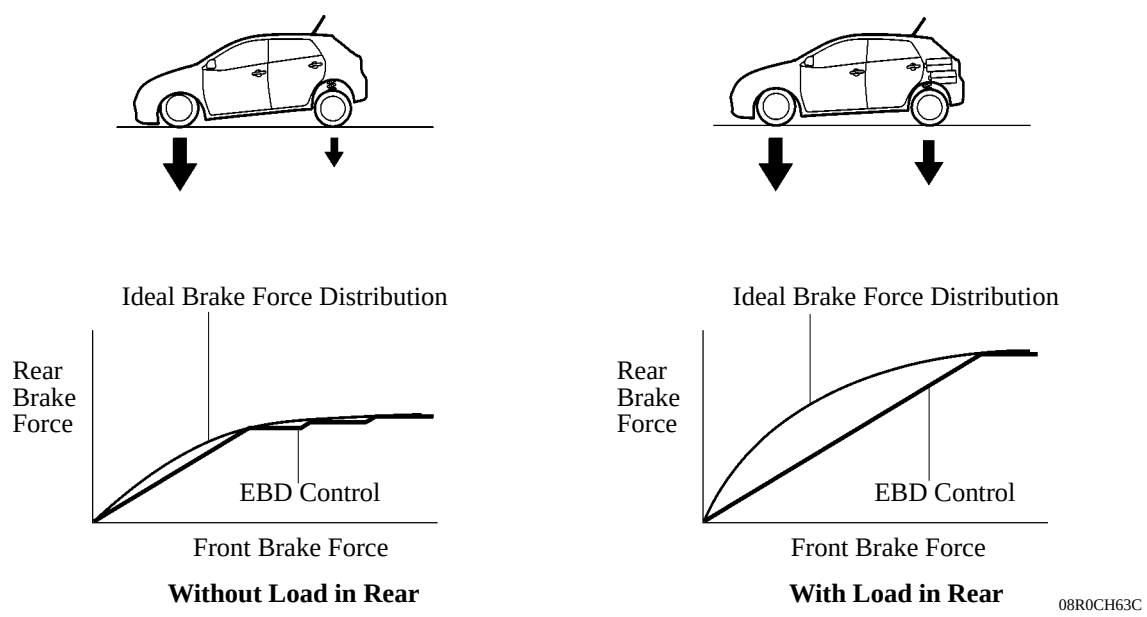
The EBD control distributes brake force in accordance with the vehicle's driving conditions. The skid control ECU electronically controls the control solenoid valves to distribute brake force.

- Brake force distribution is divided into two main categories: front and rear wheel brake force distribution and right to left wheel brake force distribution (braking while cornering).

Front/Rear Wheel Brake Force Distribution

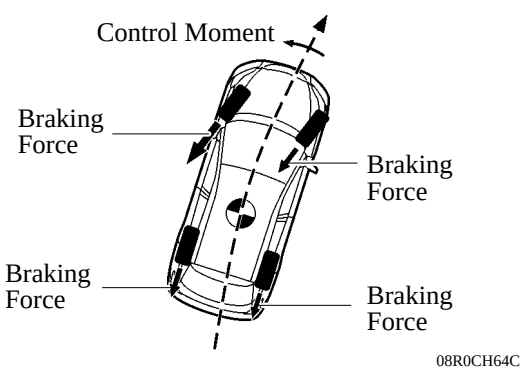
If the brakes are applied while the vehicle is moving in a straight line, the weight transfer reduces the load applied to the rear wheels. The skid control ECU determines this condition by way of the signals from the wheel speed sensors, and the brake actuator regulates the distribution of the brake force of the rear wheels to effect optimal control.
For example, the amount of brake force applied to the rear wheels during braking varies depending on whether or not the vehicle is carrying a load. The amount of brake force applied to the rear wheels also varies in accordance with the rate of deceleration.
Thus, the rear brake force distribution is optimally controlled in order to effectively utilize the braking force of the rear wheels under these conditions.

▶ EBD Control Concept ◀



Right/Left Wheels Brake Force Distribution (Cornering when Braking)

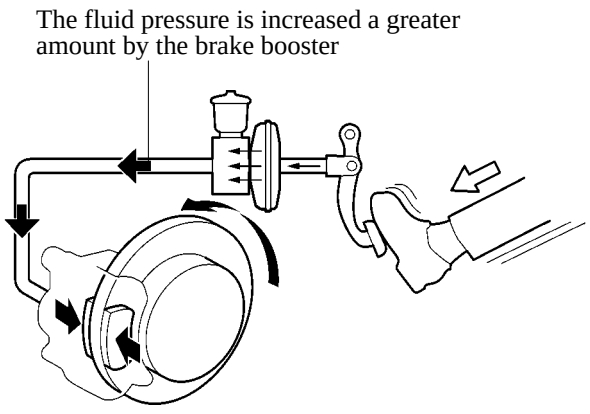
When the brakes are applied while cornering, the load applied to the inner wheels decreases and the load applied to the outer wheels increases.
The skid control ECU determines this condition by way of the signals from the wheel speed sensors, and the brake actuator regulates the brake force in order to optimally control the distribution of the brake force to the inner wheels and outer wheels.



5. Outline of Brake Assist (Mechanical Type)

- The Brake Assist, in combination with the ABS, helps improve the vehicle's brake performance.
- The Brake Assist system interprets a quick push of the brake pedal as emergency braking and supplements the brake power applied if the driver has not stepped hard enough on the brake pedal. In emergencies, drivers, especially inexperienced ones, often panic and do not apply sufficient pressure to the brake pedal.
- A key feature of the Brake Assist is that the timing and the degree of braking assistance are designed to ensure that the driver does not discern anything unusual about the braking operation. When the driver intentionally eases up on the brake pedal, this function reduces the amount of assistance it provides.
- The mechanical type Brake Assist uses the brake assist mechanism in the brake booster to mechanically activate the brake booster function in order to increase the brake force. For details, see page CH-134.

▶ In case that the driver's pedal application force is small during emergency braking ◀



With Brake Assist

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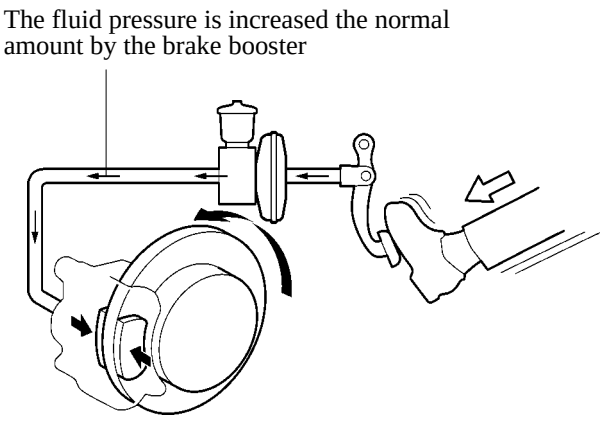
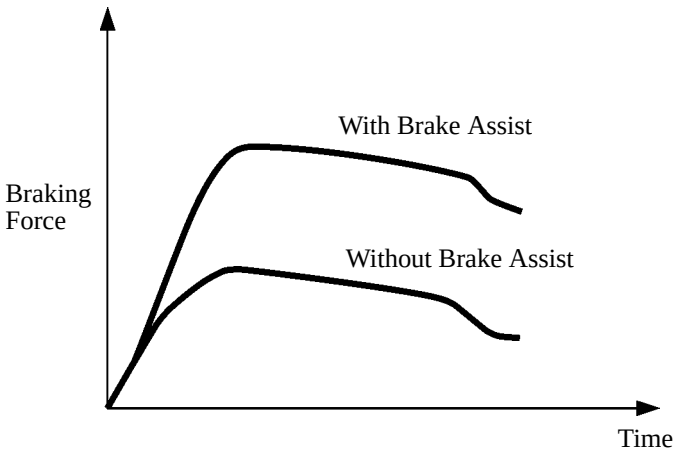


Without Brake Assist*

08R0CH119C

*: The fundamental performance capability of the brakes is the same as that of models with the brake assist system.



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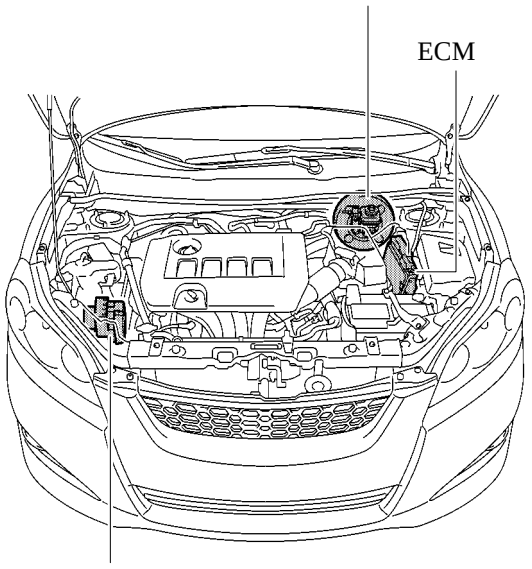
6. Layout of Main Components

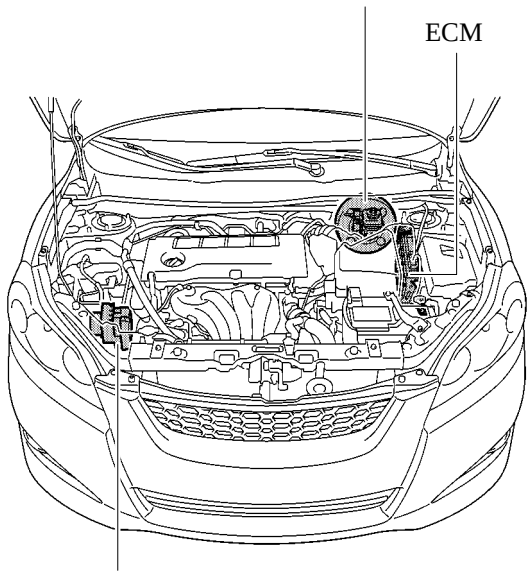
Brake Master Cylinder Sub-assembly
and Brake Booster Assembly
- Brake Fluid Level Warning Switch



Skid Control ECU with Actuator
- Skid Control ECU
- Solenoid Relay
- Motor Relay

Models with 2ZR-FE Engine

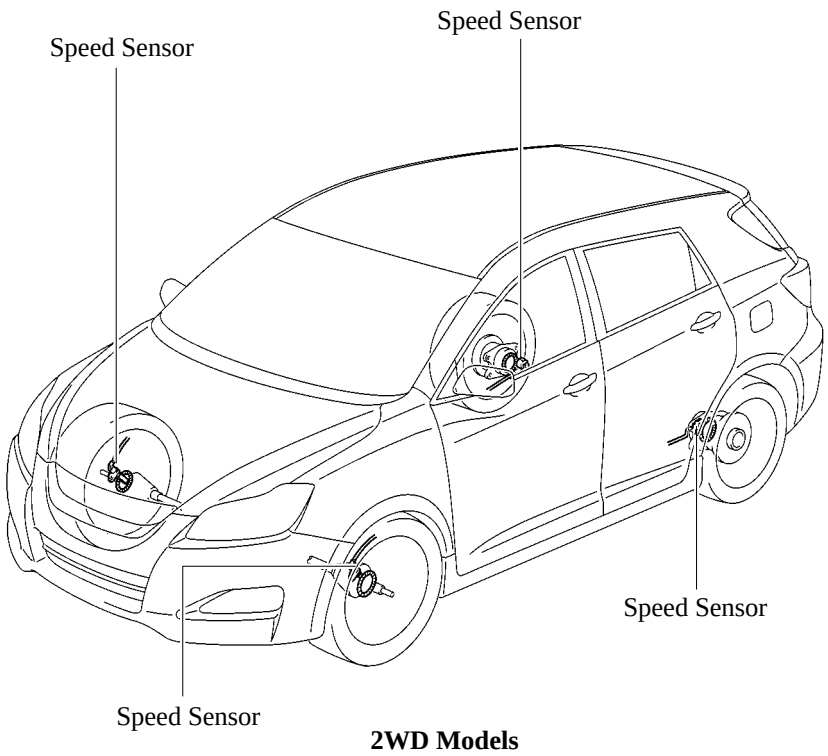
Brake Master Cylinder Sub-assembly
and Brake Booster Assembly
- Brake Fluid Level Warning Switch



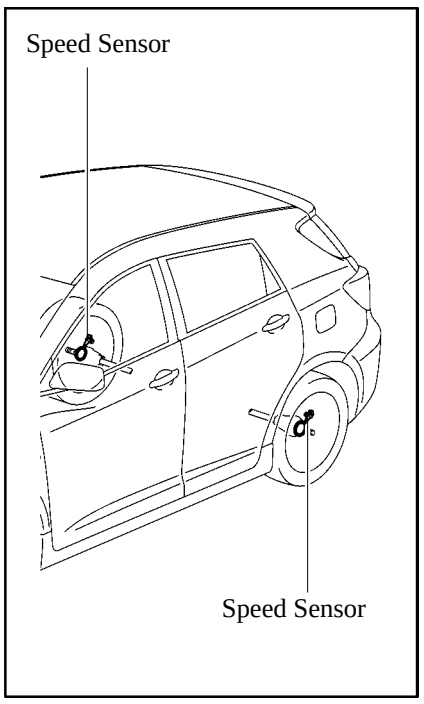
Skid Control ECU with Actuator
- Skid Control ECU
- Solenoid Relay
- Motor Relay

Models with 2AZ-FE Engine

08R0CH116C

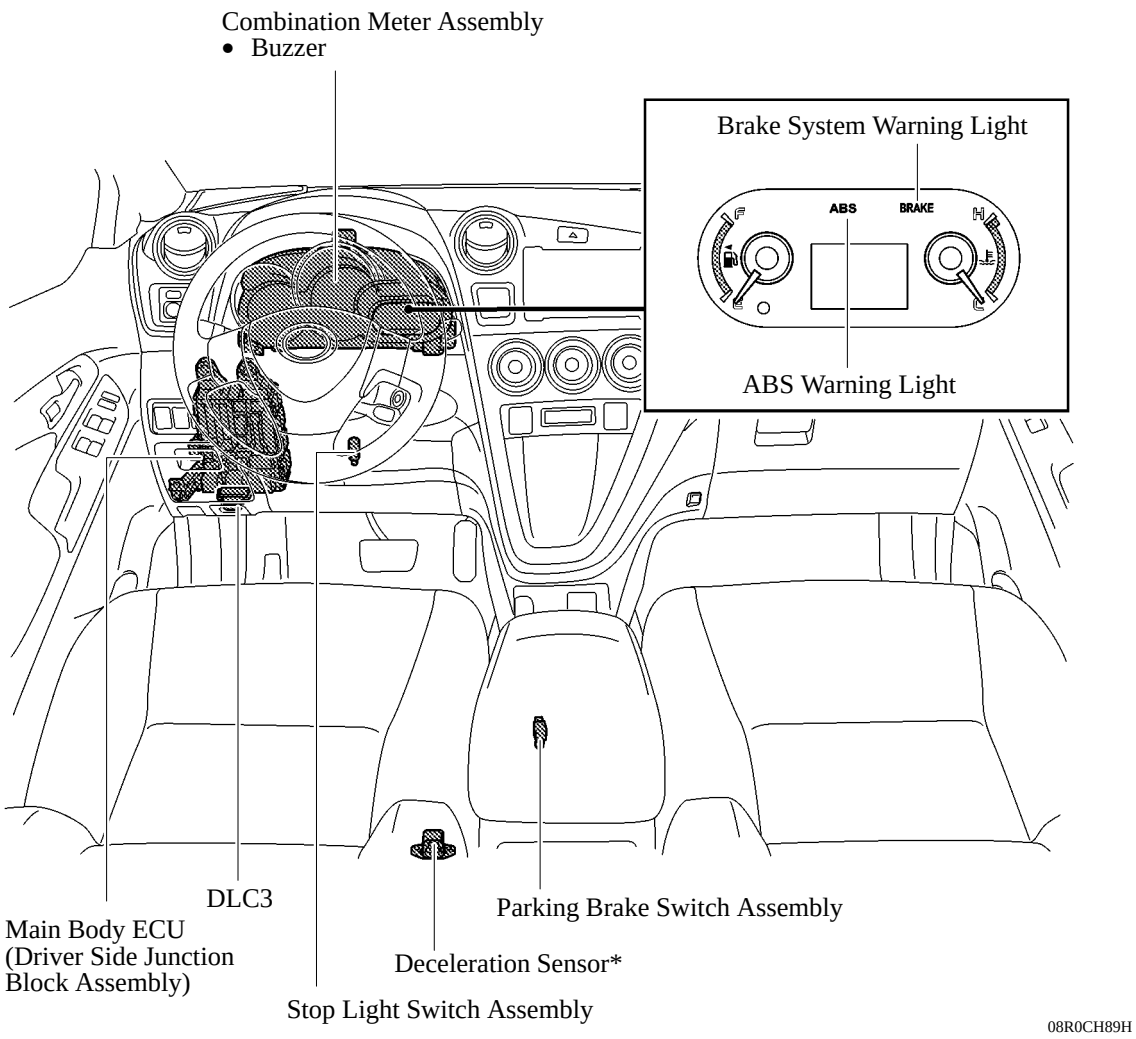


2WD Models



AWD Models

08R0CH88C


Combination Meter Assembly
• Buzzer
Brake System Warning Light
ABS
BRAKE
ABS Warning Light
DLC3
Main Body ECU
(Driver Side Junction
Block Assembly)
Parking Brake Switch Assembly
Deceleration Sensor*
Stop Light Switch Assembly
08R0CH89H

*: AWD Models

7. Function of Main Components

Component		Function
Combination Meter Assembly	Brake System Warning Light	• Lights up together with the ABS warning light to alert the driver when the skid control ECU detects a malfunction in the EBD control. • Lights up to alert the driver when the brake fluid level is low. • Lights up to alert the driver when the parking brake is applied.
	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects a malfunction in the ABS.
	Buzzer	Emits a warning sound to alert the driver if the vehicle is driven with the parking brake applied, and the vehicle speed is over 15 km/h.
Brake Fluid Level Warning Switch		Detects the brake fluid level.
Speed Sensors (4)		Detect the wheel speed of each wheel.
Stop Light Switch Assembly		Detects when the brake pedal is depressed.
Parking Brake Switch Assembly		Detects when the parking brake is applied.
Brake Booster Assembly		• Increases the force applied to the brake pedal. • Operates the Brake Assist mechanism to mechanically activate the brake booster function.
Deceleration Sensor*		Detects the vehicle's longitudinal acceleration and deceleration.
Skid Control ECU with Actuator		Changes the fluid path based on the signals from the skid control ECU during the operation of each brake control system function, in order to control the fluid pressure applied to each wheel cylinder.
	Solenoid Relay	Supplies power to the solenoid valves.
	Motor Relay	Supplies power to the pump motor in the brake actuator.
	Skid Control ECU	Judges the vehicle driving condition based on the signals from each sensor, and sends brake control signals to the brake actuator.
ECM		Sends the engine speed signal to the skid control ECU.

*: AWD Models

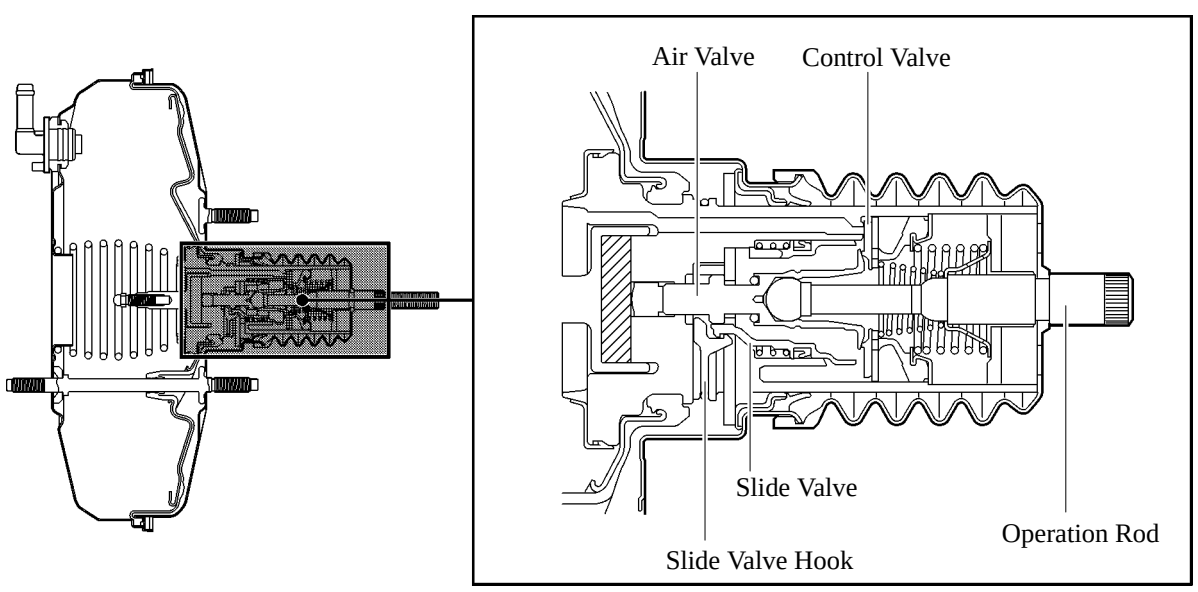
8. Brake Booster Assembly

General

A brake booster assembly containing a mechanical Brake Assist function is adopted.

- The brake assist mechanism consists of a slide valve, slide valve hook, air valve, control valve and operation rod in the brake booster assembly.

Brake Assist Mechanism

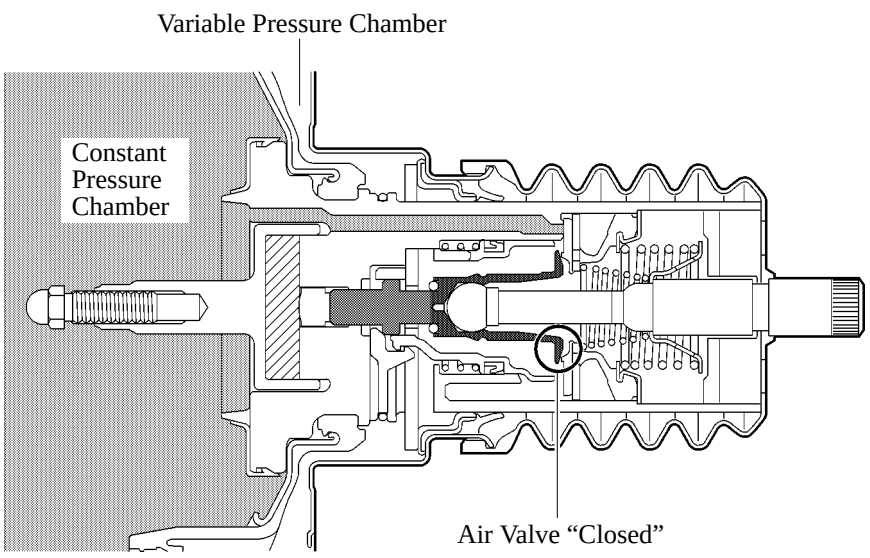


08R0CH106C

Operation

1) Not Braking

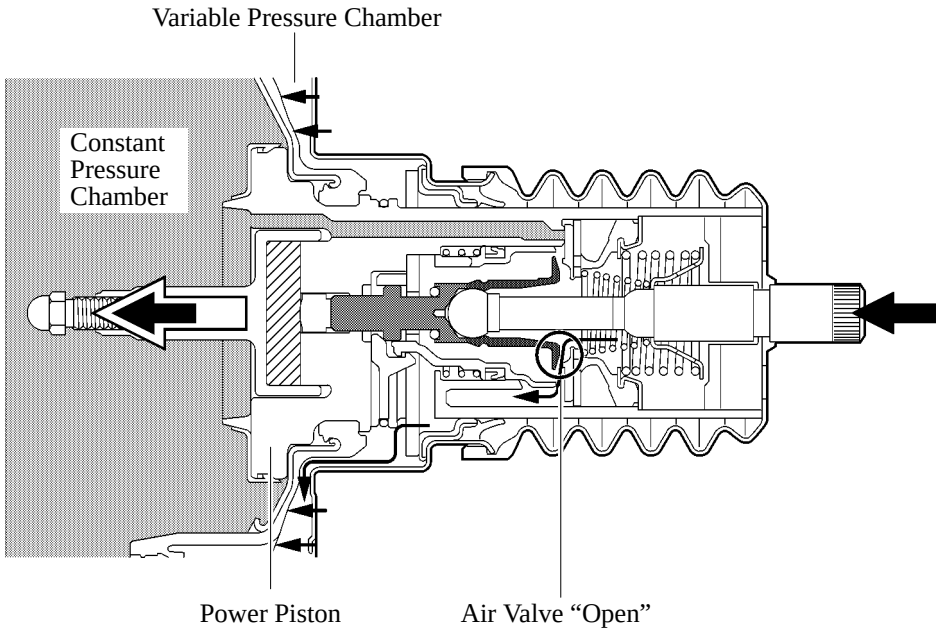
The air valve is closed, and the pressure in the variable pressure chamber is the same as the constant pressure chamber.



08R0CH107C

2) Normal Braking (Operation Rod Speed = Power Piston Speed)

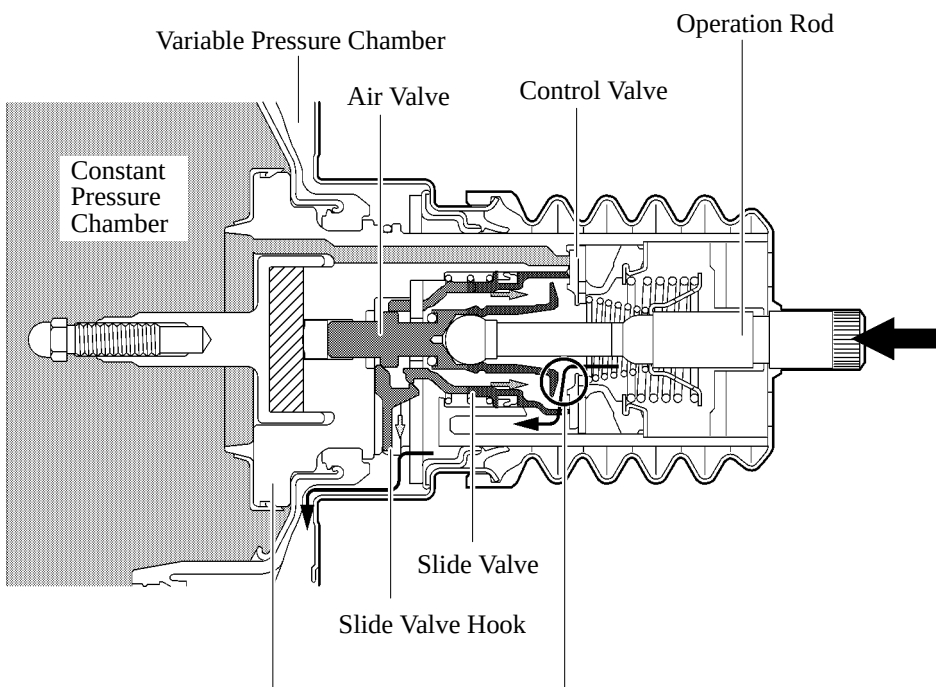
During normal braking, the air valve opens to activate the brake booster function.



08R0CH108C

3) Brake Assist (Operation Rod Speed Greater than Power Piston Speed)

When the operation rod speed is faster than the power piston speed, the air valve pushes the slide valve hook. Consequently, the slide valve separates from the slide valve hook, and the slide valve pushes the control valve to open the air valve wider than in during normal braking. Thus, the air volume that is introduced increases. This forcefully pushes the power piston resulting in a greater brake assist force.



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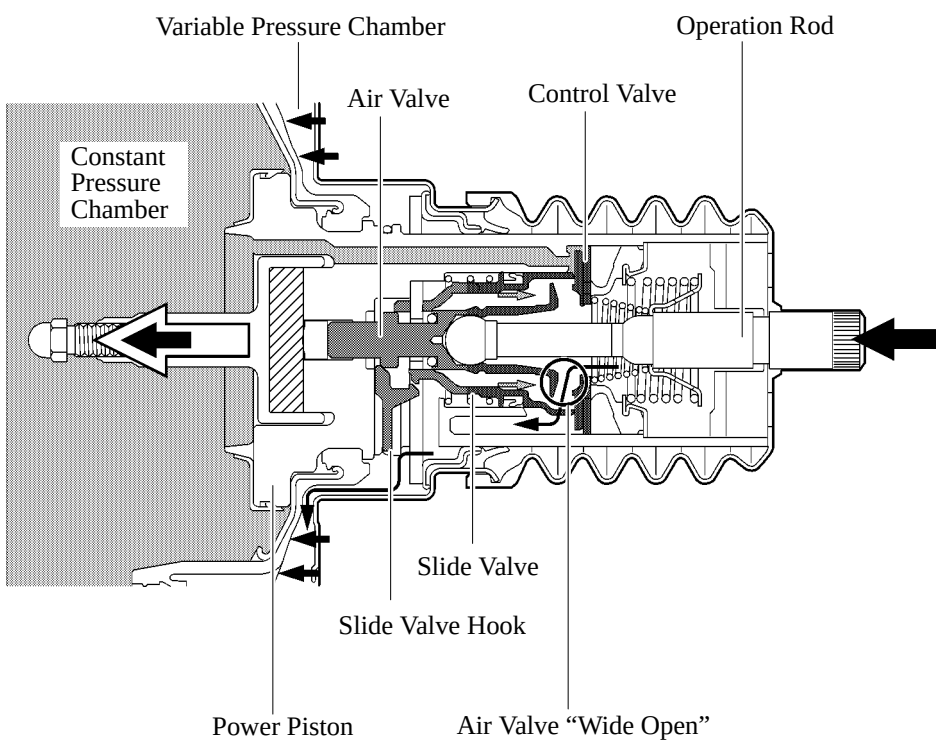

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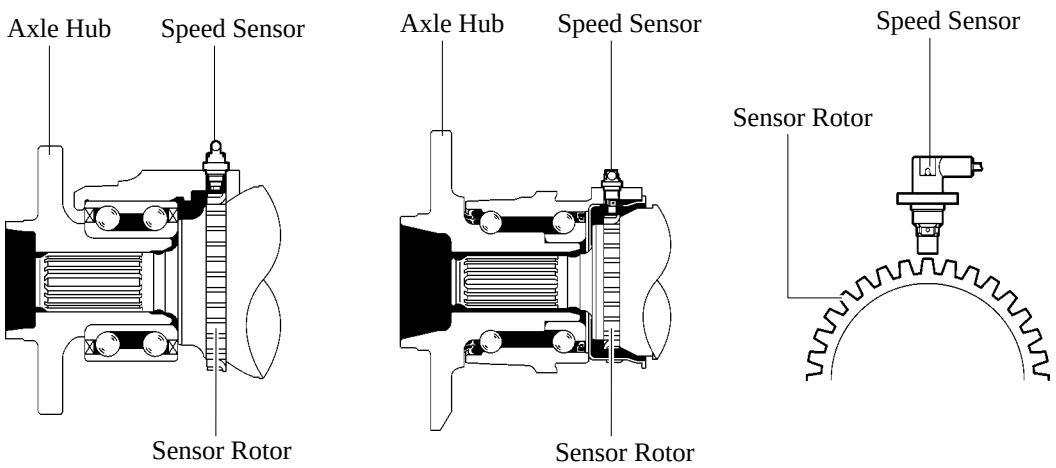
9. Speed Sensor

General

An active type speed sensor is used. This sensor contains a sensor IC, which consists of two MREs (Magnetic Resistance Elements).

▶ Front/Rear (AWD Models) Speed Sensor ◀



Front Speed Sensor **Rear (AWD Models) Speed Sensor**

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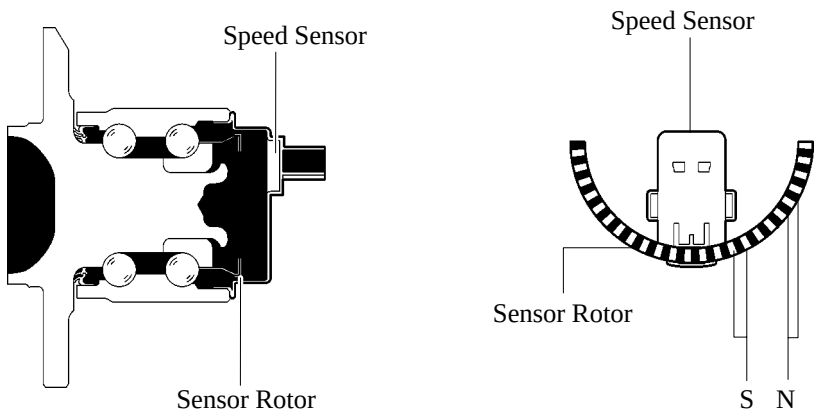
▶ Rear Speed Sensor (2WD Models) ◀



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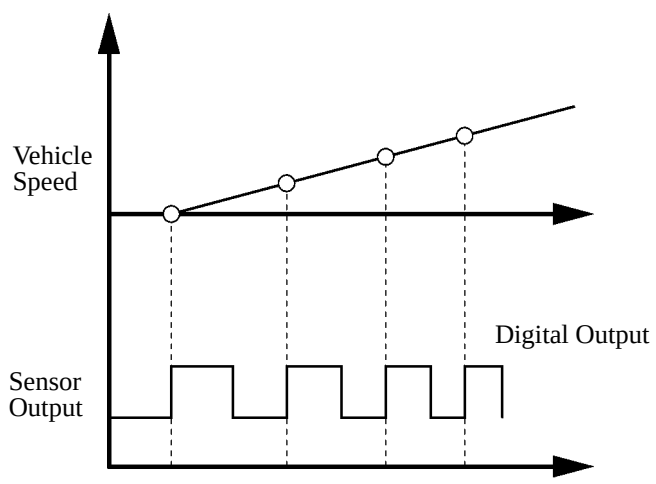
Vehicle Speed Detection Method

An active type speed sensor uses the frequency of output pulses to detect the vehicle speed.

- Because the sensor outputs digital pulses, it can detect vehicle speeds even when the vehicle is nearly stationary.



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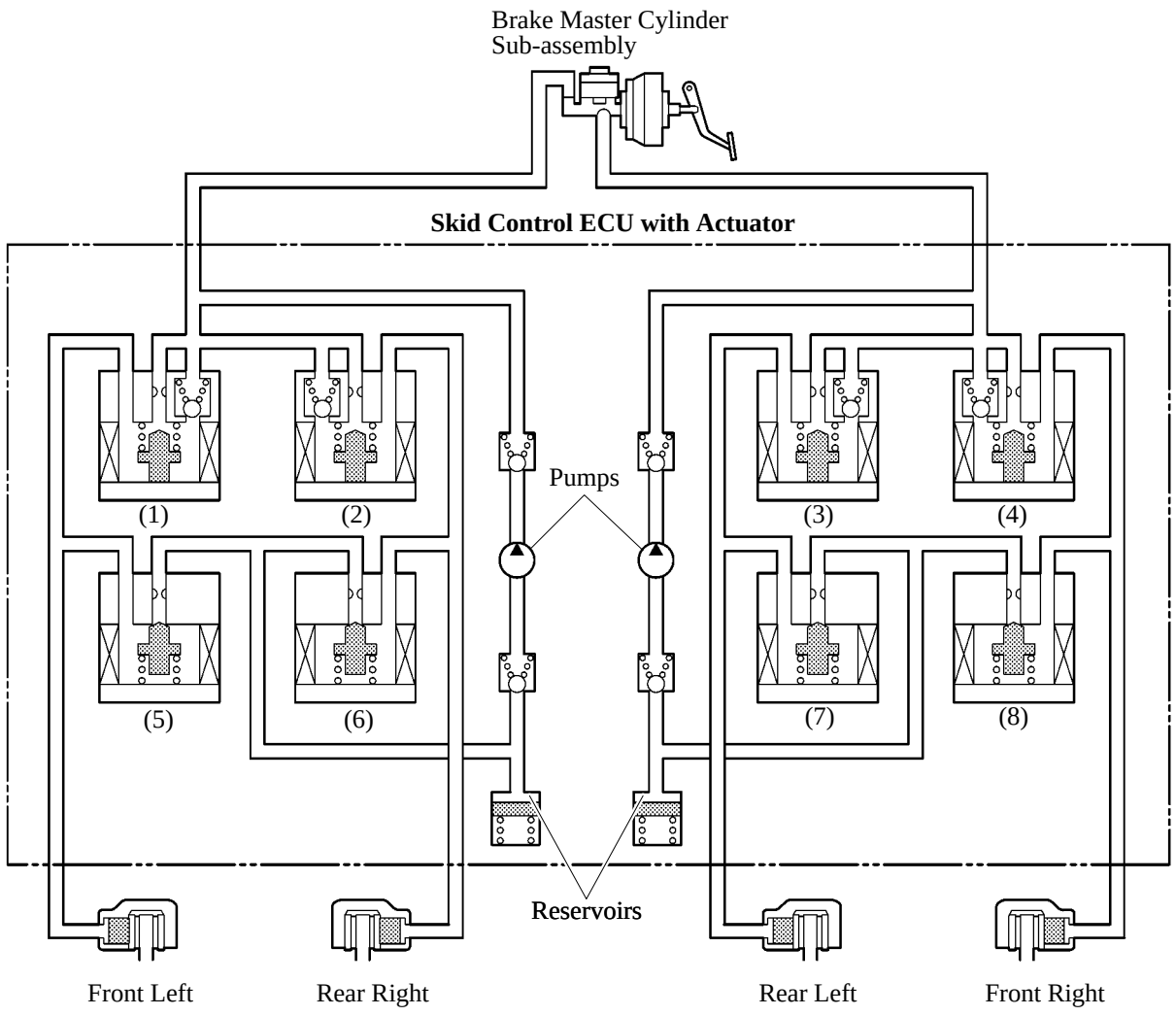
10. Brake Actuator

General

The brake actuator consists of an actuator portion and skid control ECU.

- The actuator portion consists of eight solenoid valves, a pump motor, two pumps and two reservoirs.
- The 8 solenoid valves consist of 4 pressure holding solenoid valves [(1), (2), (3), (4)], and 4 pressure reduction solenoid valves [(5), (6), (7), (8)].

▶ Hydraulic Circuit ◀



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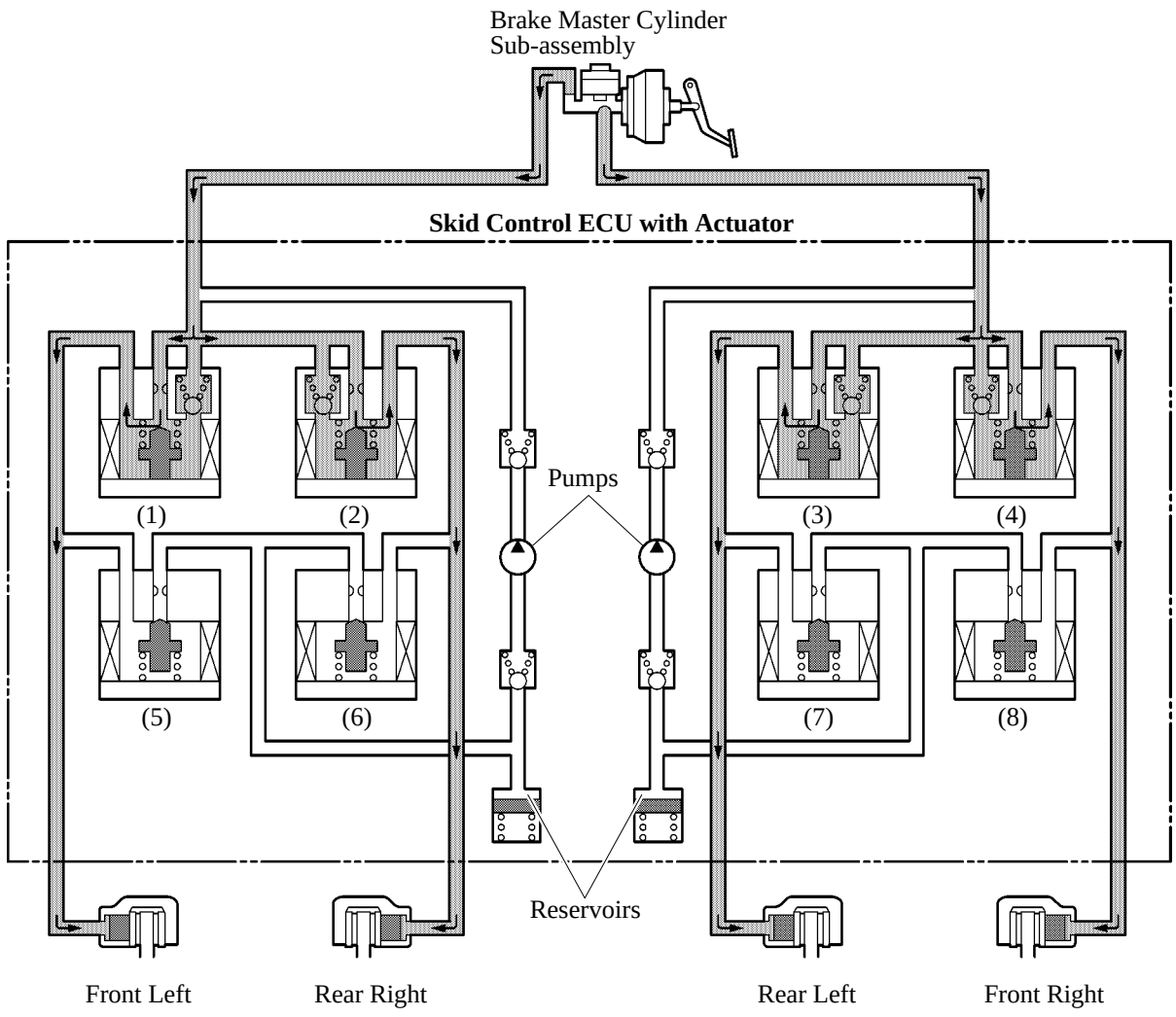
11. System Operation

Normal Braking

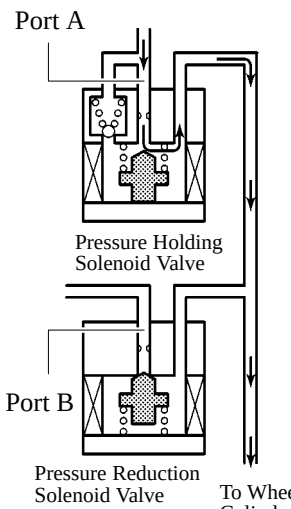
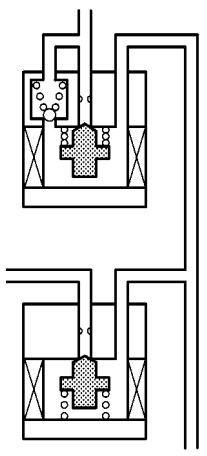
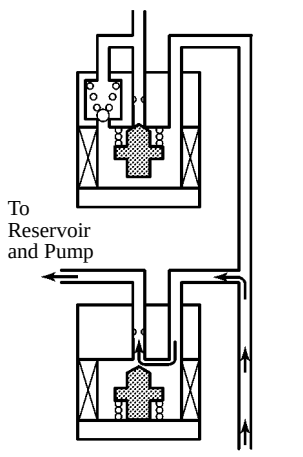
During normal braking, all solenoid valves remain OFF.



05G0CH13C

ABS with EBD Operation

Based on the signals received from the 4 wheel speed sensors, the skid control ECU calculates the wheel rotation speed and deceleration for each wheel, in order to check for a wheel slippage condition. According to the slippage condition, the ECU controls the pressure holding solenoid valves and pressure reduction solenoid valves in order to adjust the fluid pressure of the brakes for each of the wheels in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes.

Not Activated	Normal Braking	—	—
Activated	Increase Mode	Holding Mode	Reduction Mode
Hydraulic Circuit			
Pressure Holding Valve (Port A)	OFF (Open)	ON (Closed)	ON (Closed)
Pressure Reduction Valve (Port B)	OFF (Closed)	OFF (Closed)	ON (Open)
Wheel Cylinder Pressure	Increase	Hold	Reduce

12. Initial Check

Each time the ignition switch is turned on (IG), and the vehicle reaches a speed of approximately 6 km/h (4 mph) or more, the skid control ECU performs an initial check. The functions of each solenoid valve and pump motor in the brake actuator are checked in sequence.

13. CAN (Controller Area Network)

CAN communication is used among the skid control ECU, combination meter assembly, ECM and DLC3. For details of CAN communication, see page BE-5.

14. Diagnosis

If the skid control ECU detects a malfunction in the brake control system (ABS with EBD), the warning light lights up to alert the driver of the malfunction. At the same time, the skid control ECU stores the DTC (Diagnostic Trouble Code) in memory.

- These DTCs can be read by connecting SST (09843-18040) between the TC and CG terminals of the DLC3 and observing the blinking pattern of the ABS warning light or brake system warning light, or by connecting the Techstream to the DLC3.
- If the skid control ECU assembly detects a malfunction during a sensor signal check (test mode), it stores the DTCs in its memory.

For details, see the 2009 Corolla Matrix Repair Manual (Pub. No. RM08R0U).

Service Tip

The skid control ECU uses CAN for diagnostic communication. Therefore, the Techstream is required for accessing diagnostic data. For details, see the 2009 Corolla Matrix Repair Manual (Pub. No. RM08R0U).

15. Fail-safe

- In the event of a malfunction in the ABS, the skid control ECU prohibits the brake control system functions.
- In the event of a malfunction in the EBD control, the brake system functions remain operative as long as possible even if the ABS is prohibited. If EBD control becomes impossible, the brake system warning light illuminates to inform the driver. In this case, the brake system operates in the same way as a brake system without electronic brake control.

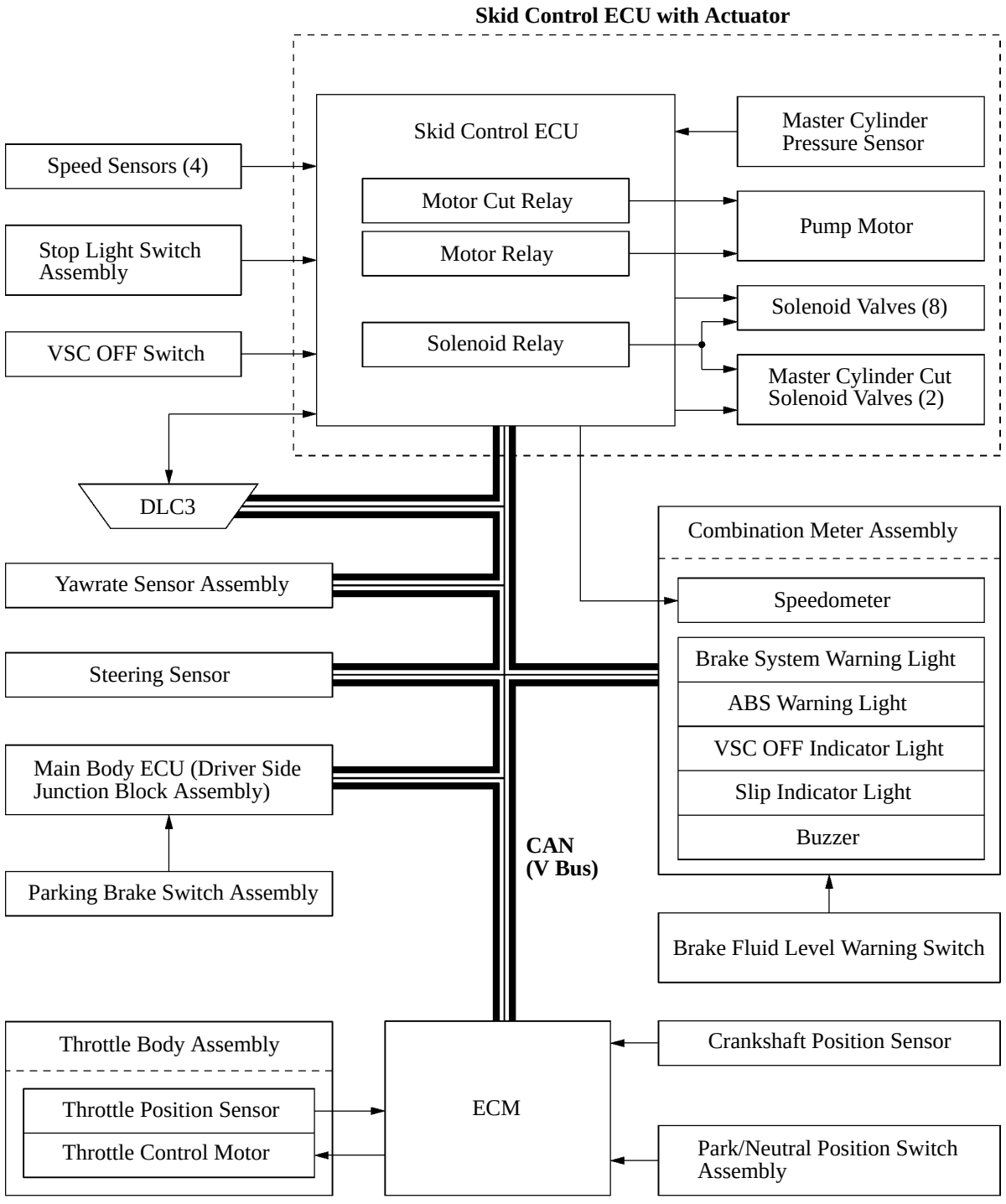
■BRAKE CONTROL SYSTEM (ABS with EBD, Brake Assist, TRAC and VSC)

1. General

The brake control system (ABS with EBD, Brake Assist, TRAC, VSC) has the following functions:

Function	Outline
ABS (Anti-lock Brake System) [See page CH-128]	The ABS helps prevent the wheels from locking when the brakes are applied firmly or when braking on a slippery surface.
EBD (Electronic Brake force Distribution) [See page CH-129]	The EBD control utilizes the ABS, realizing proper brake force distribution between the front and rear wheels in accordance with the driving conditions. In addition, during braking while cornering, it also controls the brake forces of the right and left wheels, helping maintain vehicle behavior.
Brake Assist (Electrical Type)	The primary purpose of Brake Assist is to provide an auxiliary brake force to assist a driver who cannot generate a large brake force during emergency braking, thus helping ensure the vehicle's braking performance.
TRAC (Traction Control)	The TRAC helps prevent the drive wheels from spinning if the driver depresses the accelerator pedal excessively when starting off or accelerating on a slippery surface.
VSC (Vehicle Stability Control)	The VSC helps prevent the vehicle from slipping sideways as a result of strong front wheel skid or strong rear wheel skid during cornering.

2. System Diagram



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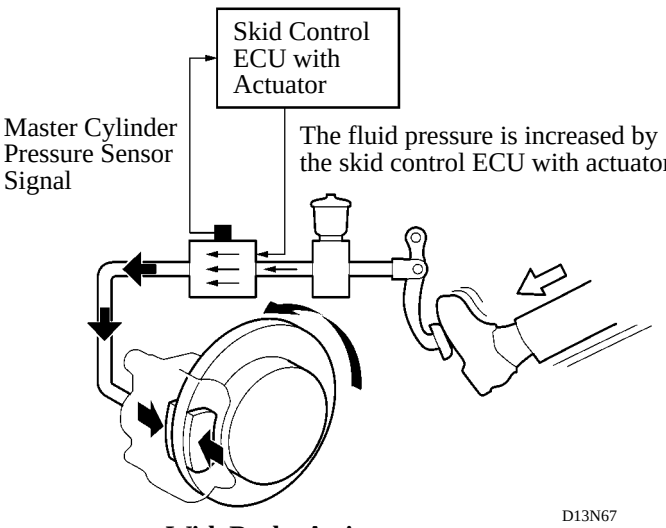
3. Outline of Brake Assist (Electrical Type)

- Brake Assist, in combination with the ABS, helps improve the vehicle's brake performance.
- Brake Assist interprets a quick push of the brake pedal as emergency braking and supplements the brake force applied if the driver has not stepped hard enough the brake pedal. In emergencies, drivers, especially inexperienced ones, often panic and do not apply sufficient pressure to the brake pedal.
- A key feature of Brake Assist is that the timing and the degree of braking assistance are designed to help ensure that the driver does not discern anything unusual about the braking operation. When the driver intentionally eases up on the brake pedal, the system reduces the amount of assistance it provides.
- Based on the signals from the master cylinder pressure sensor, the skid control ECU calculates the speed and the amount of the brake pedal application and then determines the intention of the driver to perform emergency braking. If the skid control ECU determines that the driver intends emergency braking, the system activates the brake actuator to increase the brake fluid pressure, which increases the brake force.

▶ In case that the driver's pedal application force is small during emergency braking ◀



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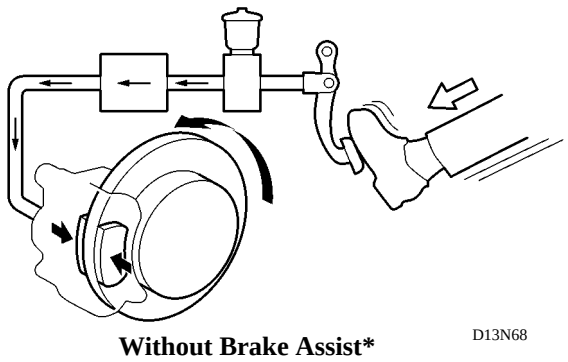
With Brake Assist



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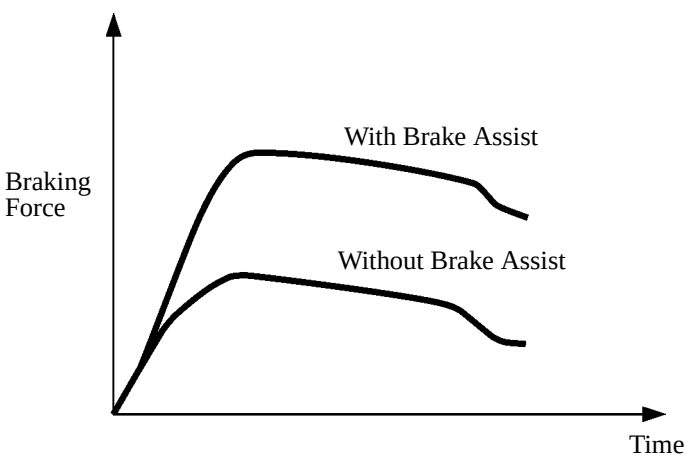
Without Brake Assist*

*: The fundamental performance capability of the brakes is the same as that of models with the brake assist system.



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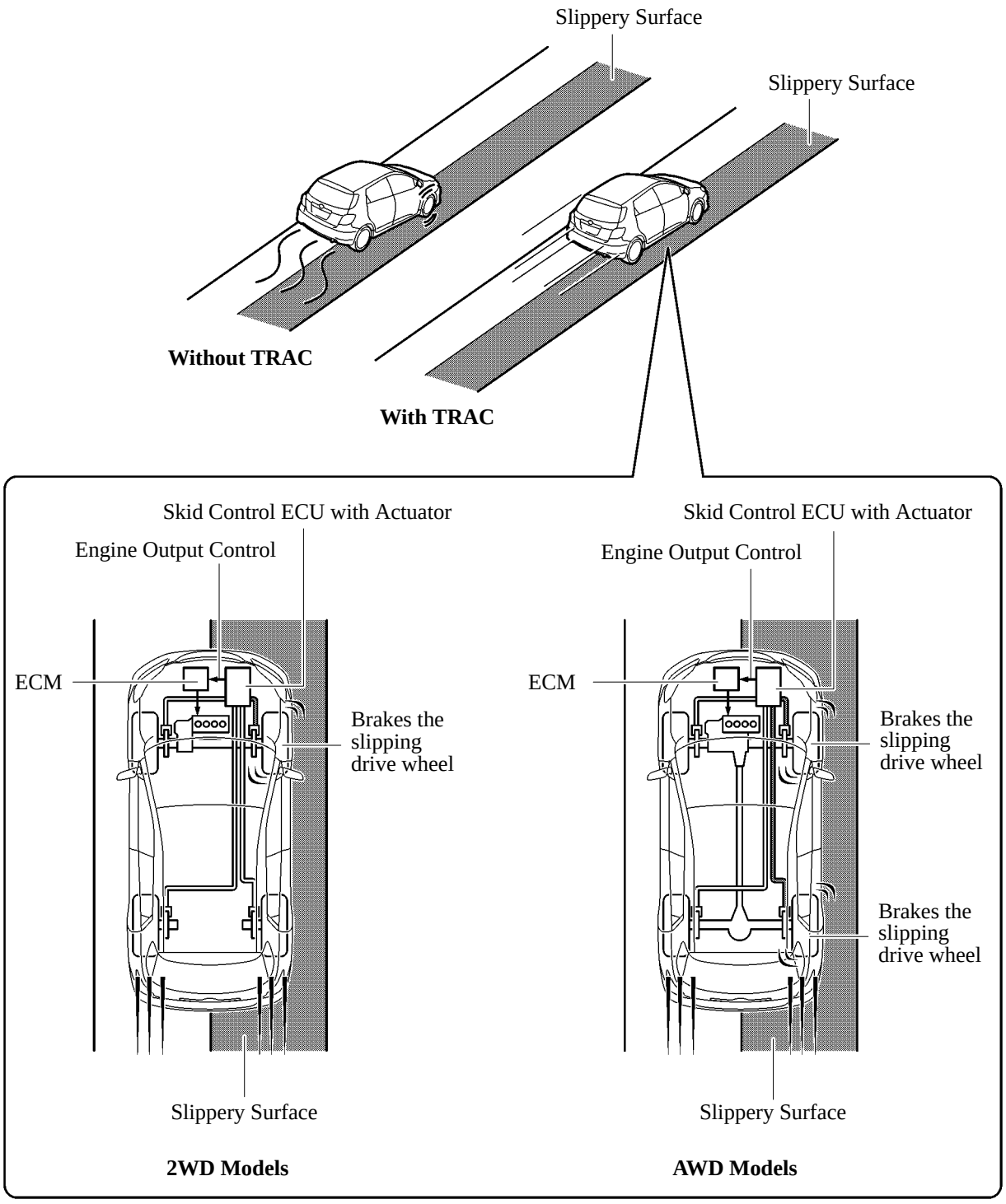
4. Outline of TRAC

TRAC (Traction Control) helps prevent the drive wheels from spinning if the driver depresses the accelerator pedal excessively when starting off or accelerating on a slippery surface. By applying hydraulic brake control to the drive wheels and requesting the ECM to regulate the throttle to control engine output, TRAC helps minimize the drive wheel spinning and slippage, generating an appropriate amount of drive force for the road surface conditions to ensure proper start off acceleration.

▶ Driving condition on road with different surface friction characteristics ◀



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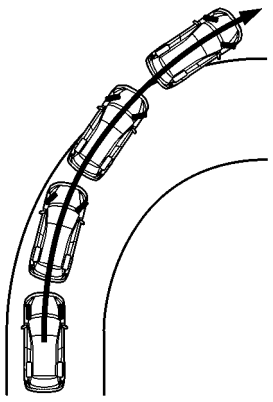
5. Outline of VSC

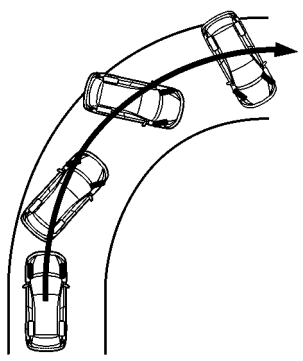
General

The following are two examples that can be considered as circumstances in which the tires exceed their lateral grip limit. The VSC (Vehicle Stability Control) is designed to help control the vehicle behavior by controlling the engine output and the brakes at each wheel when the vehicle is experiences one of the conditions indicated below.

- When the front wheels lose grip in relation to the rear wheels (understeer - front wheel skid tendency).
- When the rear wheels lose grip in relation to the front wheels (oversteer - rear wheel skid tendency).



Front Wheel Skid Tendency



Rear Wheel Skid Tendency

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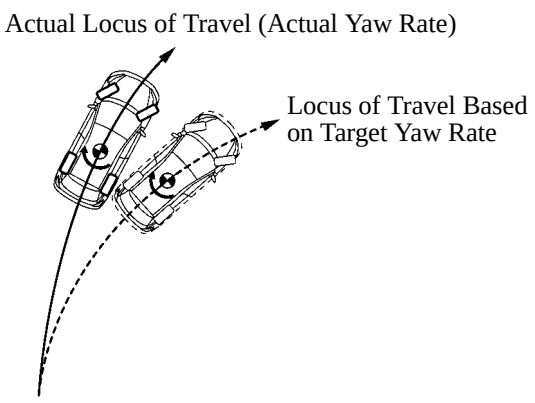
Method for Determining Vehicle Condition

To determine the condition of the vehicle, sensors detect the steering angle, vehicle speed, vehicle's yaw rate, and vehicle's lateral acceleration, which are then calculated by the skid control ECU.

1) Determining a Front Wheel Skid

Whether or not the vehicle is experiencing a front wheel skid is determined by the difference between the target yaw rate and the vehicle's actual yaw rate. When the vehicle's actual yaw rate is smaller than the target yaw rate (a yaw rate determined by the vehicle speed and steering angle) that should be rightfully generated by the driver's steering input, it means the vehicle is making a turn at a greater angle than the target locus of travel. Thus, the skid control ECU determines that there is a large front wheel skid tendency.

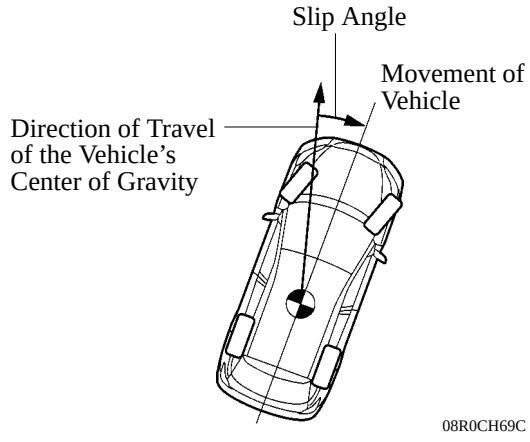


Determining Front Wheel Skid

08R0CH68C

2) Determining a Rear Wheel Skid

Whether or not the vehicle is experiencing a rear wheel skid is determined by the values of the vehicle's slip angle and the vehicle's slip angular velocity (time-dependent changes in the vehicle's slip angle). When the vehicle's slip angle is large, and the slip angular velocity is also large, the skid control ECU determines that the vehicle has a large rear wheel skid tendency.



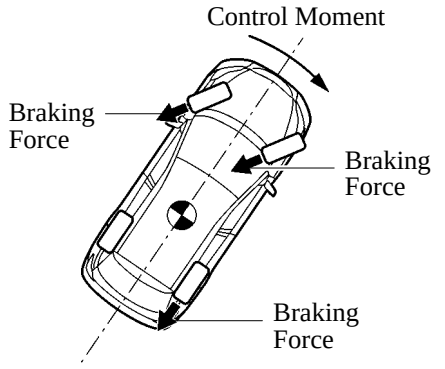
08R0CH69C

Method for VSC Operation

When the skid control ECU determines that the vehicle exhibits a tendency to experience a front wheel skid or a rear wheel skid, it decreases the engine output and applies the brake to a front or rear wheel to control the vehicle's yaw moment.
The basic operation of the VSC is described below. However, the control method differs depending on the vehicle's characteristics and driving conditions.

1) Dampening a Strong Front Wheel Skid

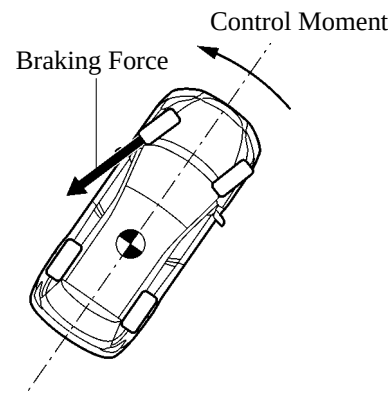
When the skid control ECU determines that there is a large front wheel skid tendency, it attempts to counteract the tendency based on the extent of that tendency. The skid control ECU controls the engine output and applies the brakes of the front outside wheel and rear inside wheel of the turn in order to help restrain the front wheel skid tendency.



Making a Right Turn
08R0CH70C

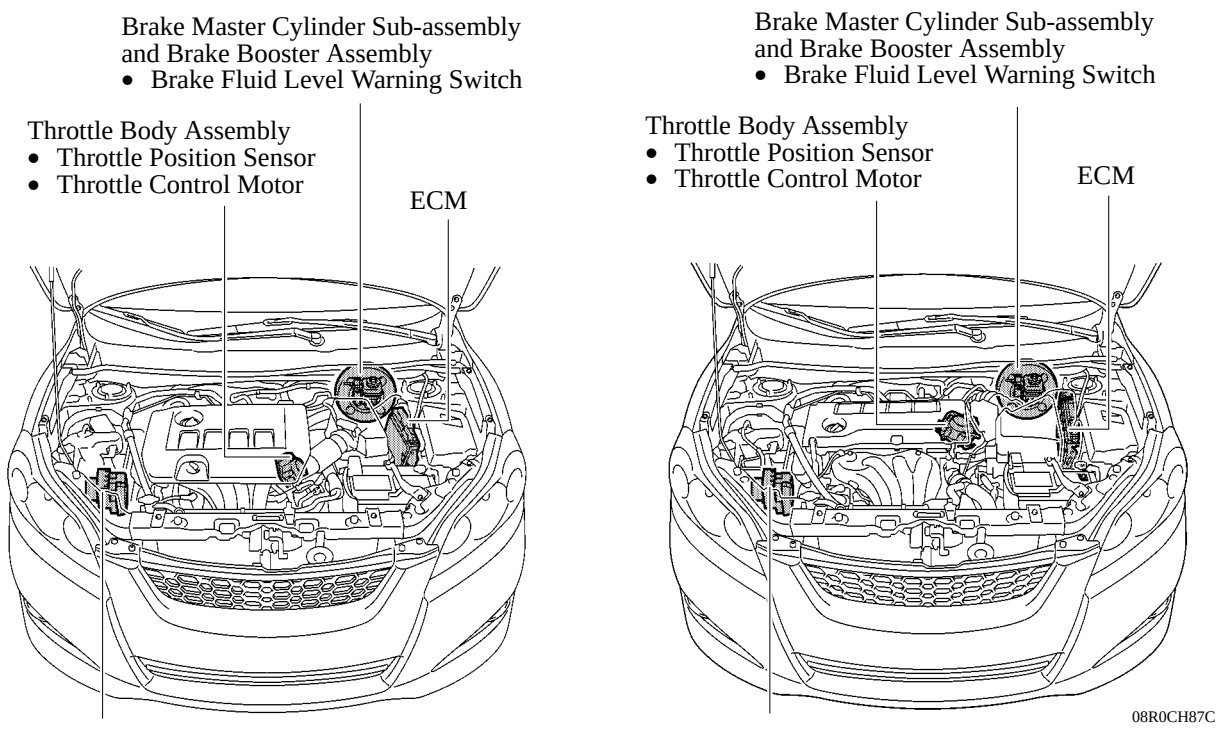
2) Dampening a Strong Rear Wheel Skid

When the skid control ECU determines that there is a large rear wheel skid tendency, it attempts to counteract the tendency based on the extent of that tendency. It applies the brake of the front wheel on the outside of the turn, and generates an outward moment of inertia in the vehicle in order to restrain the rear wheel skid tendency. Along with the reduction in vehicle speed caused by the braking force, excellent vehicle stability is ensured.
In some cases, the skid control ECU applies the rear brakes as necessary.

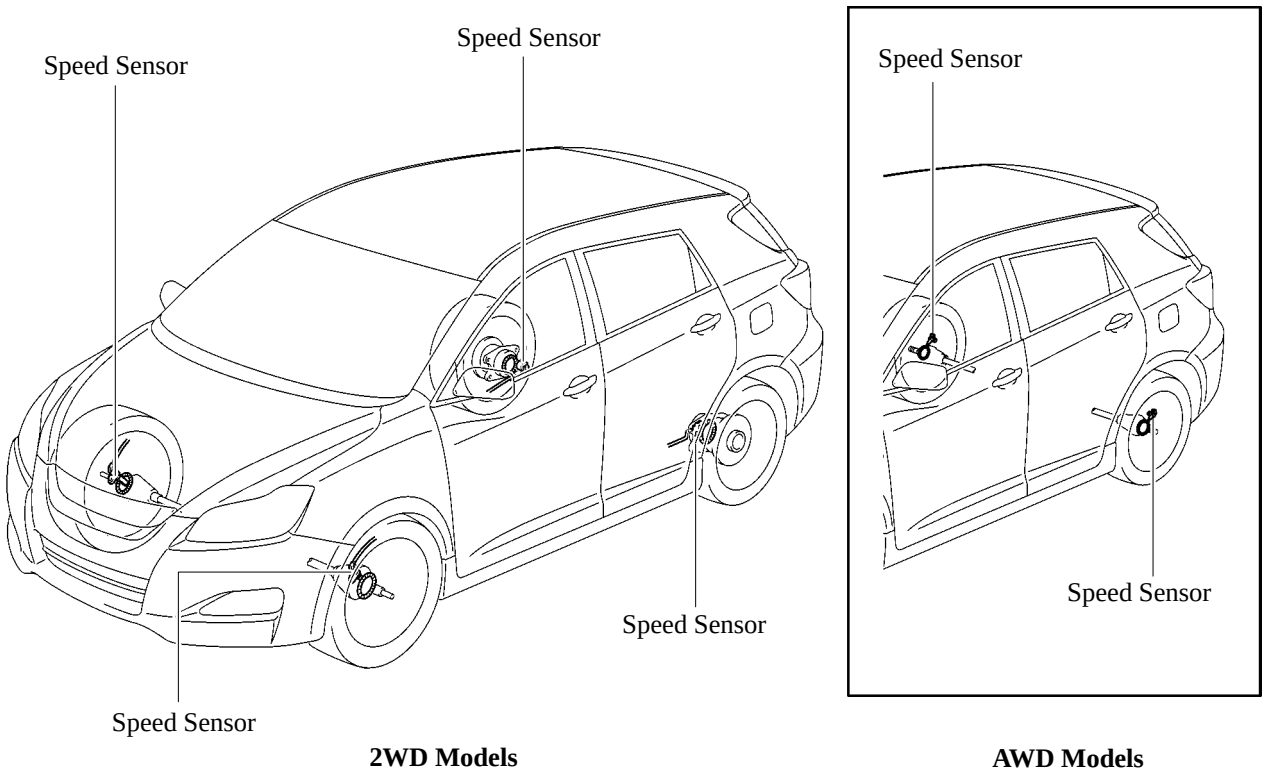


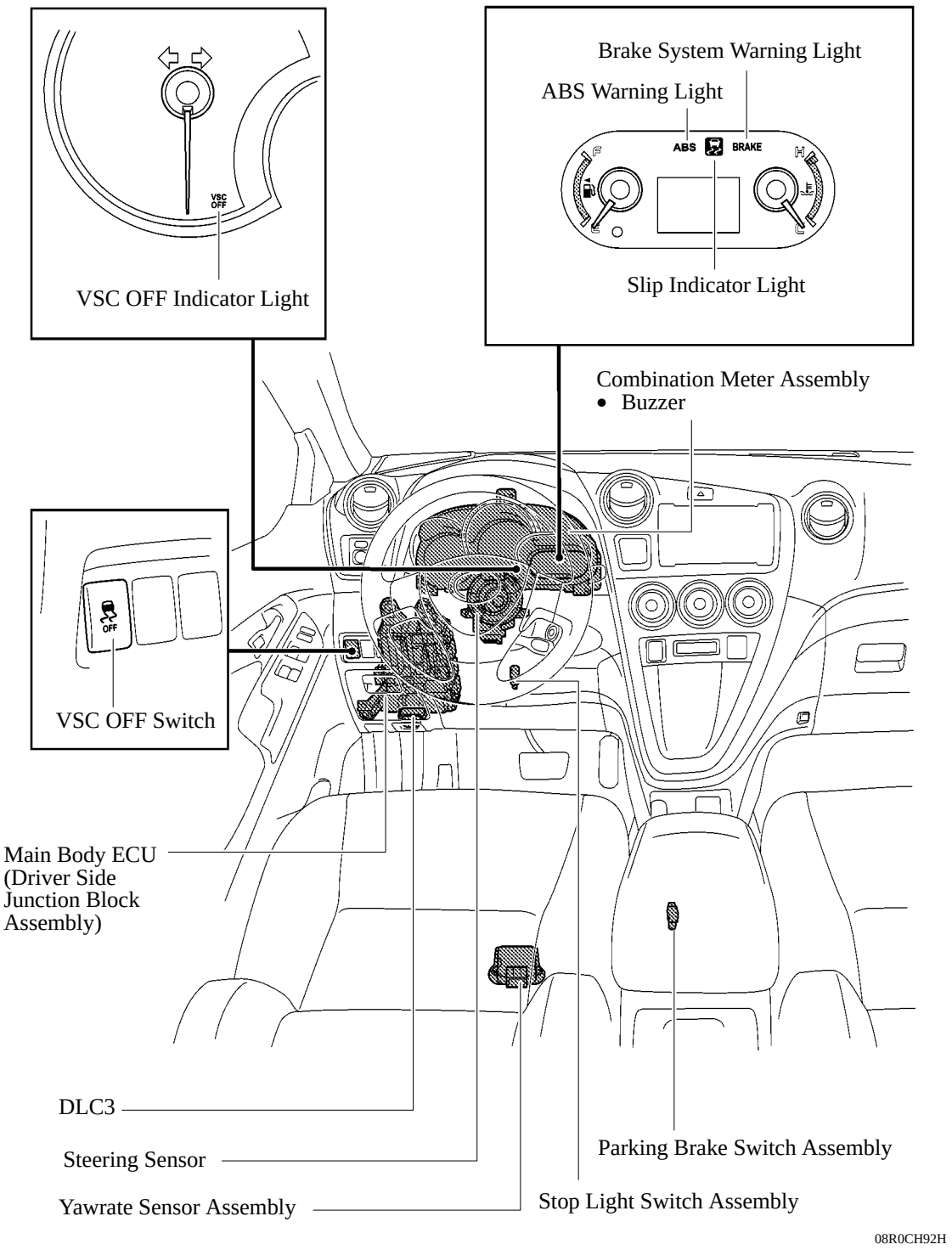
Making a Right Turn
08R0CH71C

6. Layout of Main Components



Models with 2ZR-FE Engine **Models with 2AZ-FE Engine**




VSC OFF Indicator Light
Brake System Warning Light
ABS Warning Light
ABS
BRAKE
Slip Indicator Light
Combination Meter Assembly
• Buzzer
OFF
VSC OFF Switch
Main Body ECU
(Driver Side
Junction Block
Assembly)
DLC3
Steering Sensor
Yawrate Sensor Assembly
Parking Brake Switch Assembly
Stop Light Switch Assembly

08R0CH92H

7. Function of Main Components

Component		Function
Combination Meter Assembly	Brake System Warning Light	• Lights up together with the ABS warning light to alert the driver when the skid control ECU detects a malfunction in the EBD control. • Lights up to alert the driver when the brake fluid level is low. • Lights up to alert the driver when the parking brake is applied.
	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects a malfunction in the ABS.
	VSC OFF Indicator Light	• Lights up to inform the driver of VSC OFF mode. • Lights up to alert the driver when the skid control ECU detects a malfunction in the TRAC or VSC.
	Slip Indicator Light	• Blinks to inform the driver when the TRAC or VSC is operated. • Lights up to inform the driver of TRAC OFF mode.
	Buzzer	• Emits an intermittent sound to inform the driver that the skid control ECU detects a strong front wheel skid tendency or strong rear wheel skid tendency. • Emits a warning sound to alert the driver if the vehicle is driven with the parking brake applied, and the vehicle speed is over 15 km/h (9 mph).
Brake Fluid Level Warning Switch		Detects the brake fluid level.
Speed Sensors (4)		Detect the wheel speed of each wheel. For details, see page CH-137.
Stop Light Switch Assembly		Detects when the brake pedal is depressed.
Parking Brake Switch Assembly		Detects when the parking brake is applied.
Yawrate Sensor Assembly		• Detects the vehicle's longitudinal and lateral acceleration and deceleration. • Detects the vehicle's yaw rate.
Steering Sensor		Detects the direction and angle of the steering wheel.
VSC OFF Switch		Enables the driver to select Normal Mode, TRAC OFF Mode, or VSC OFF Mode.
Brake Booster Assembly		Increases the force applied to the brake pedal.
Skid Control ECU with Actuator		Changes the fluid path based on the signals from the skid control ECU during the operation of each brake control system function in order to control the fluid pressure applied to each wheel cylinder.
	Solenoid Relay	Supplies power to the solenoid valves.
	Motor Relay	Supplies power to the pump motor in the brake actuator.
	Motor Cut Relay	Cuts the power to the pump motor in the brake actuator.
	Master Cylinder Pressure Sensor	Built into the brake actuator, detects the master cylinder pressure.
	Skid Control ECU	Judges the vehicle driving condition based on the signals from each sensor, and sends the brake control signals to the brake actuator.
ECM		• Sends the throttle position signal, accelerator pedal position signal, engine speed signal etc., to the skid control ECU. • Receives an engine output adjustment command signal from the skid control ECU. Based on this signal, the ECM controls engine output.

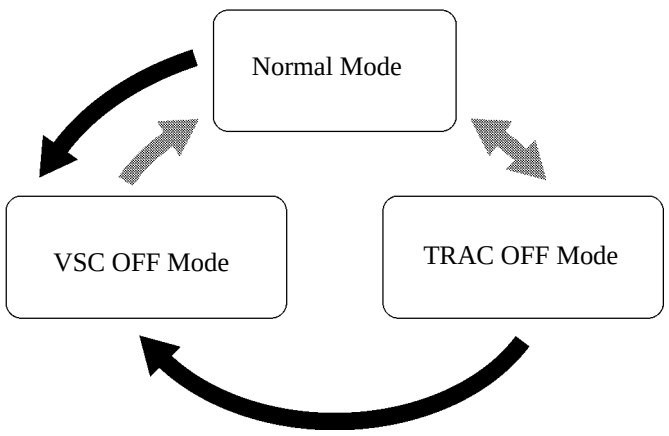
8. VSC OFF Switch

The VSC OFF switch can stop the operation of the VSC and TRAC functions. This switch can select any of the 3 modes (Normal mode, TRAC OFF mode, VSC OFF mode).

- Briefly pressing the VSC OFF switch in normal mode enters TRAC OFF mode.
- Pressing and holding the VSC OFF switch for 3 seconds or more with the vehicle stopped enters VSC OFF mode, disabling TRAC and VSC functions.
- Briefly pressing the VSC OFF switch in TRAC OFF or VSC OFF mode or turning the ignition switch off returns to normal mode.

: VSC OFF Switch (Briefly press)

: VSC OFF Switch (Press and hold for 3 seconds or more)



08R0CH115C

- The operations of the brake control functions in each mode are as follows:

Item	Brake Control Function		Slip Indicator Light	VSC OFF Indicator Light
	TRAC	VSC	 03NCH005Y	VSC OFF 08SCH054Y
Normal Mode	○	○	-	-
TRAC OFF Mode	×*1	○	Light ON	-
VSC OFF Mode	×	×*2	Light ON	Light ON

*1: If only TRAC is turned off, TRAC will turn on when vehicle speed increases.

*2: If both TRAC and VSC are turned off, the systems will not turn on even when vehicle speed increases.

NOTE

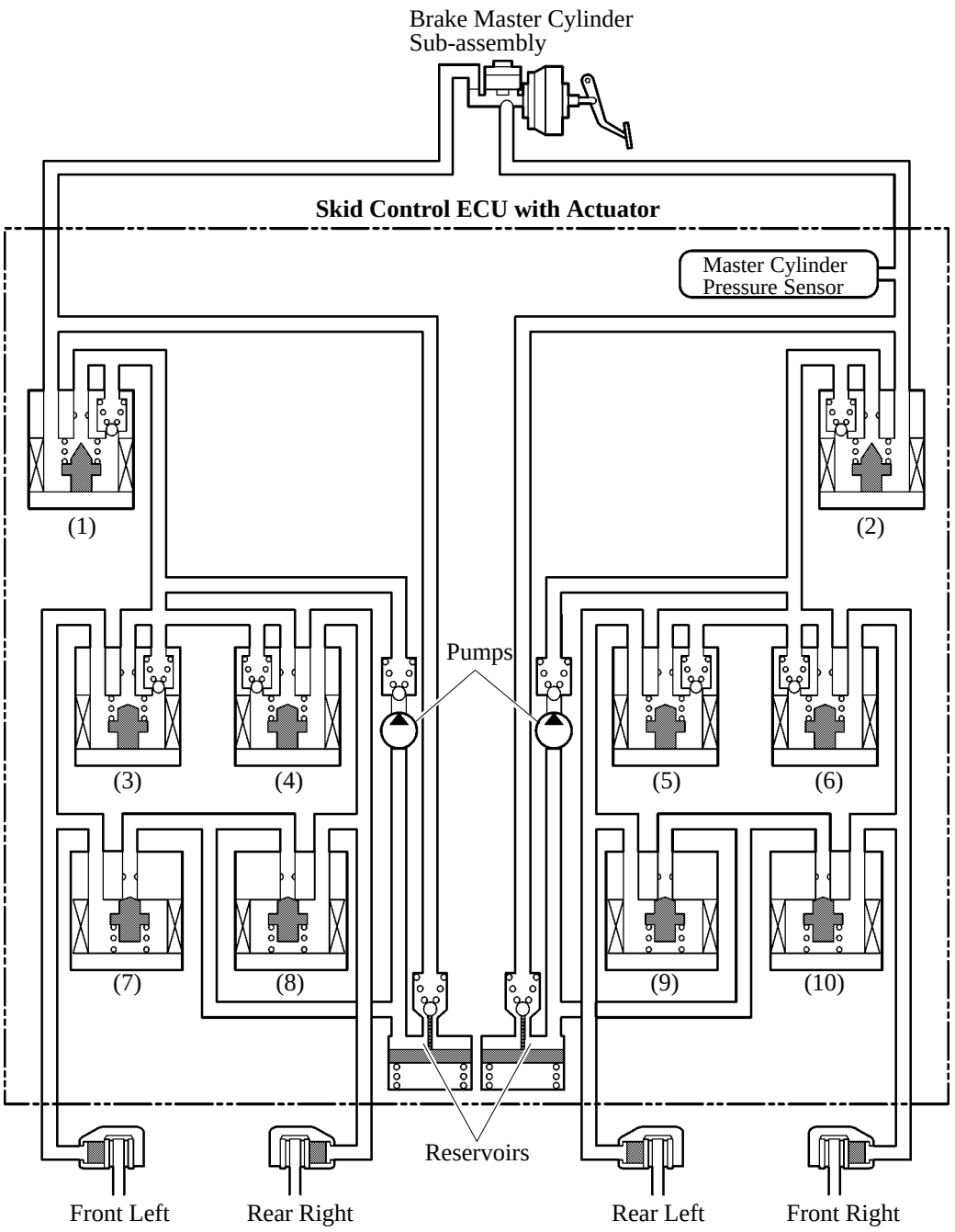
The TRAC and VSC functions control brake hydraulic pressure and engine output to ensure vehicle stability. Therefore, operate the VSC OFF switch (stop the operation of the TRAC and VSC functions) only when it is necessary.

9. Brake Actuator

The brake actuator consists of the actuator portion, skid control ECU, solenoid relay, pump motor, and master cylinder pressure sensor.

- The actuator portion consists of 10 solenoid valves, 2 pumps, 2 reservoirs, and master cylinder pressure sensor.
- The 10 solenoid valves consist of 2 master cylinder cut solenoid valves [(1), (2)], 4 pressure holding solenoid valves [(3), (4), (5), (6)], and 4 pressure reduction solenoid valves [(7), (8), (9), (10)].

▶ Hydraulic Circuit ◀



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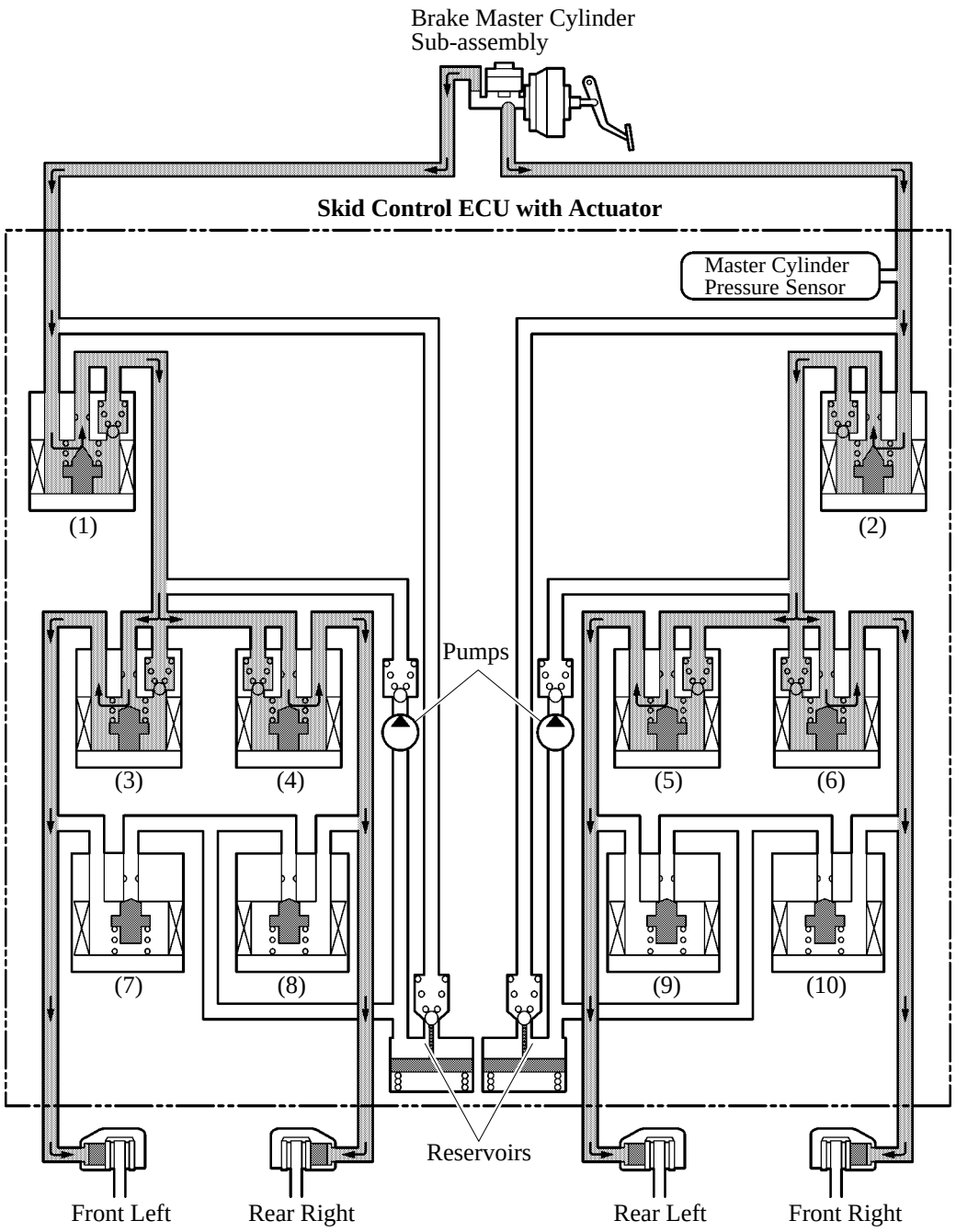
10. System Operation

Normal Operation

During normal braking, all solenoid valves remain OFF.



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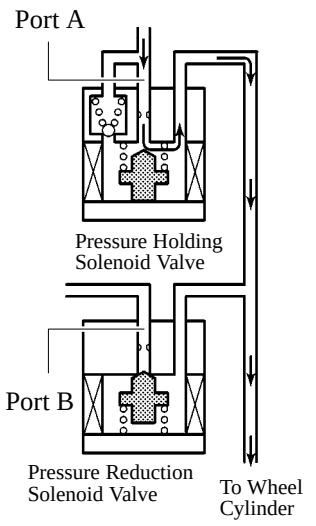
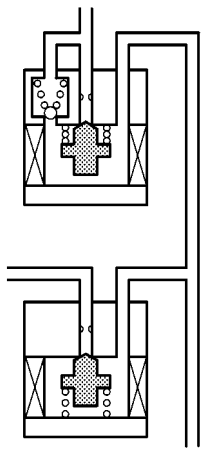
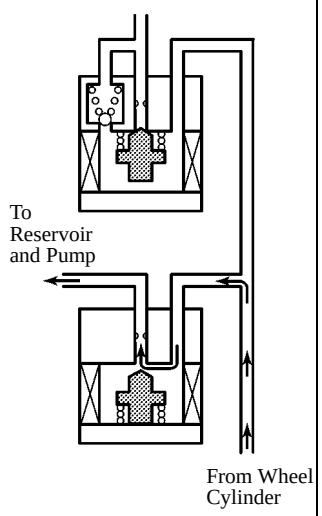
ABS and EBD Operation

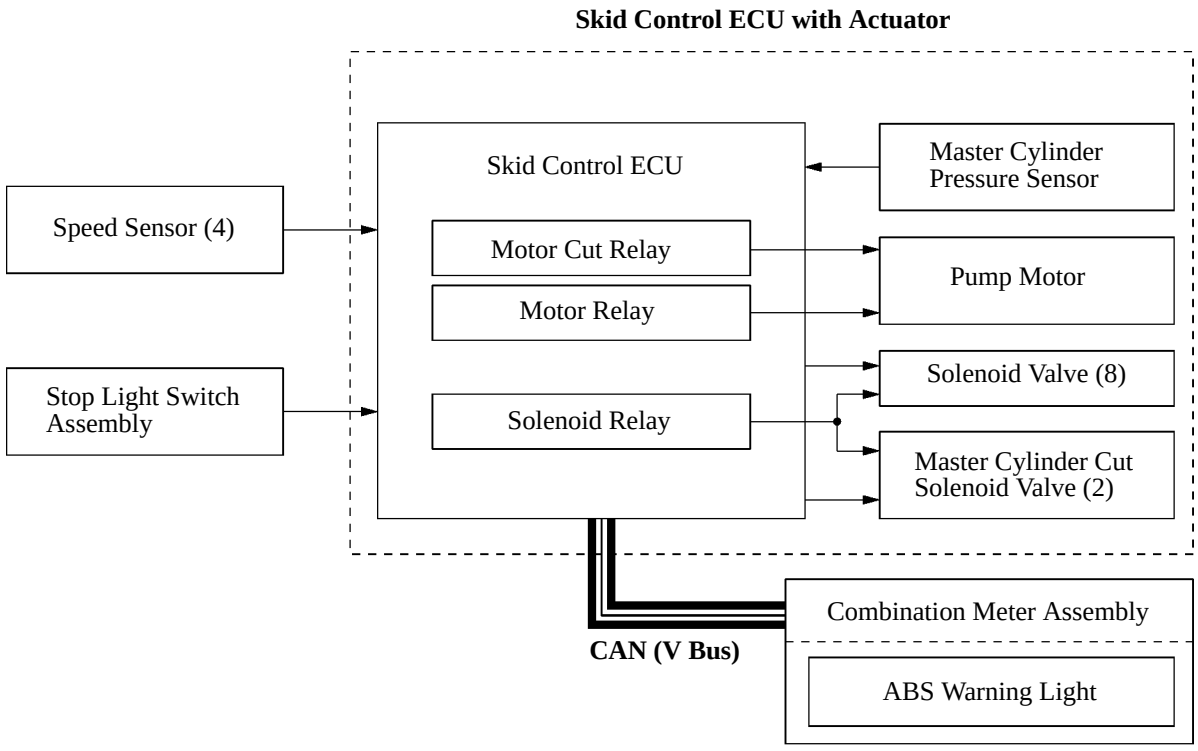
Based on the signals received from the 4 wheel speed sensors, the skid control ECU calculates each wheel speed and deceleration, to determine wheel slipping conditions. According to the slipping condition, the skid control ECU controls the pressure holding valve and pressure reduction valve in order to adjust the fluid pressure of each wheel cylinder in the following 3 modes: pressure reduction, pressure holding, and pressure increase.

Not Activated	Normal Braking	—	—
Activated	Increase Mode	Holding Mode	Reduction Mode
Hydraulic Circuit			
Pressure Holding Valve (Port A)	OFF (Open)	ON (Close)	ON (Close)
Pressure Reduction Valve (Port B)	OFF (Close)	OFF (Close)	ON (Open)
Wheel Cylinder Pressure	Increase	Hold	Reduce

Brake Assist Operation

In the event of emergency braking, the skid control ECU detects the driver's intention based on the speed of the pressure increase in the master cylinder determined by the master cylinder pressure sensor signal. If the skid control ECU judges the need for additional brake assist, pressure is generated by the pump in the brake actuator and directed to the wheel cylinders in order to apply greater fluid pressure than the master cylinder.
When the Brake Assist is activated, each solenoid valve operates as shown in the table on the next page.

▶ System Diagram ◀



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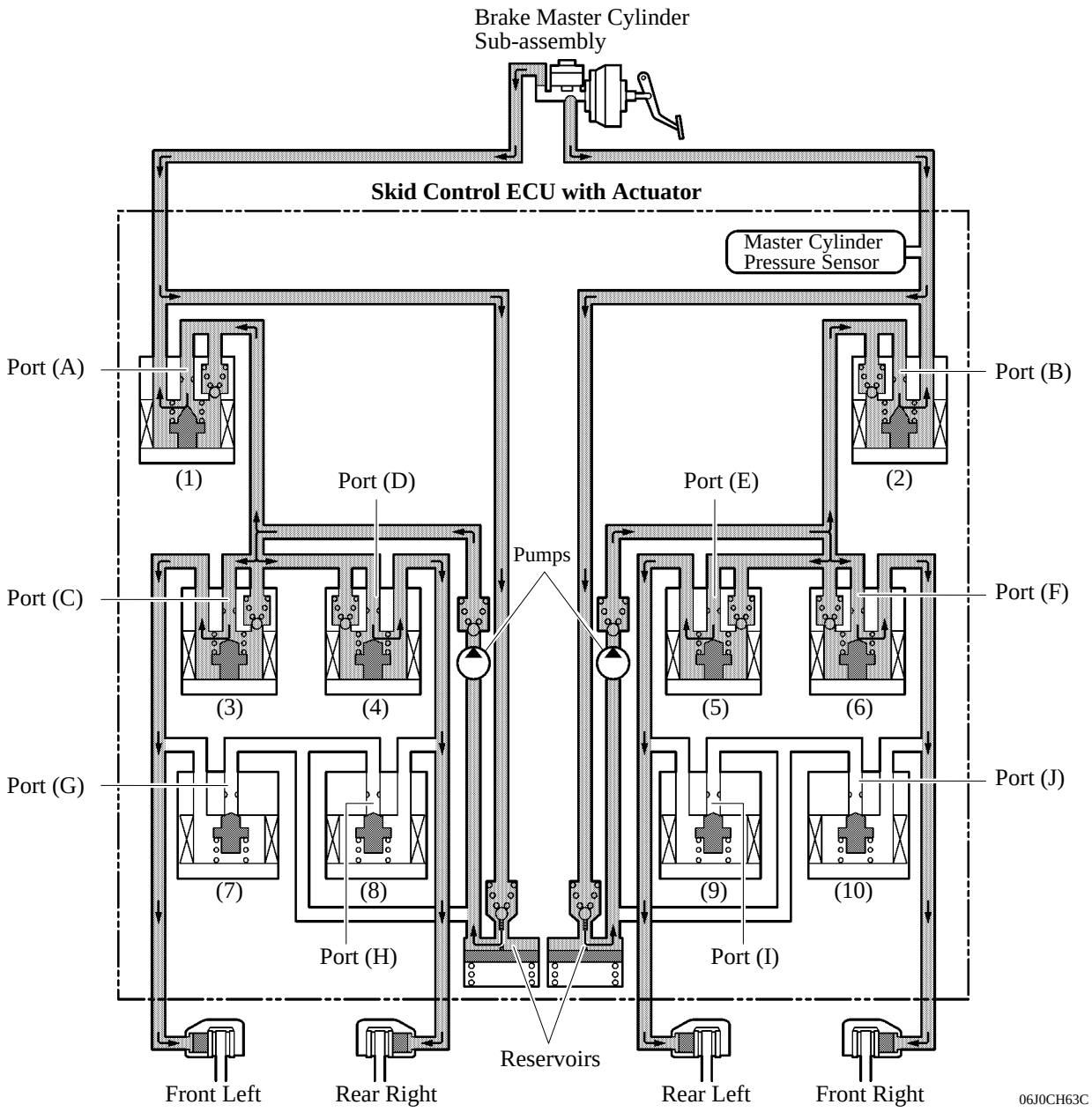
▶ Brake Assist Operation ◀



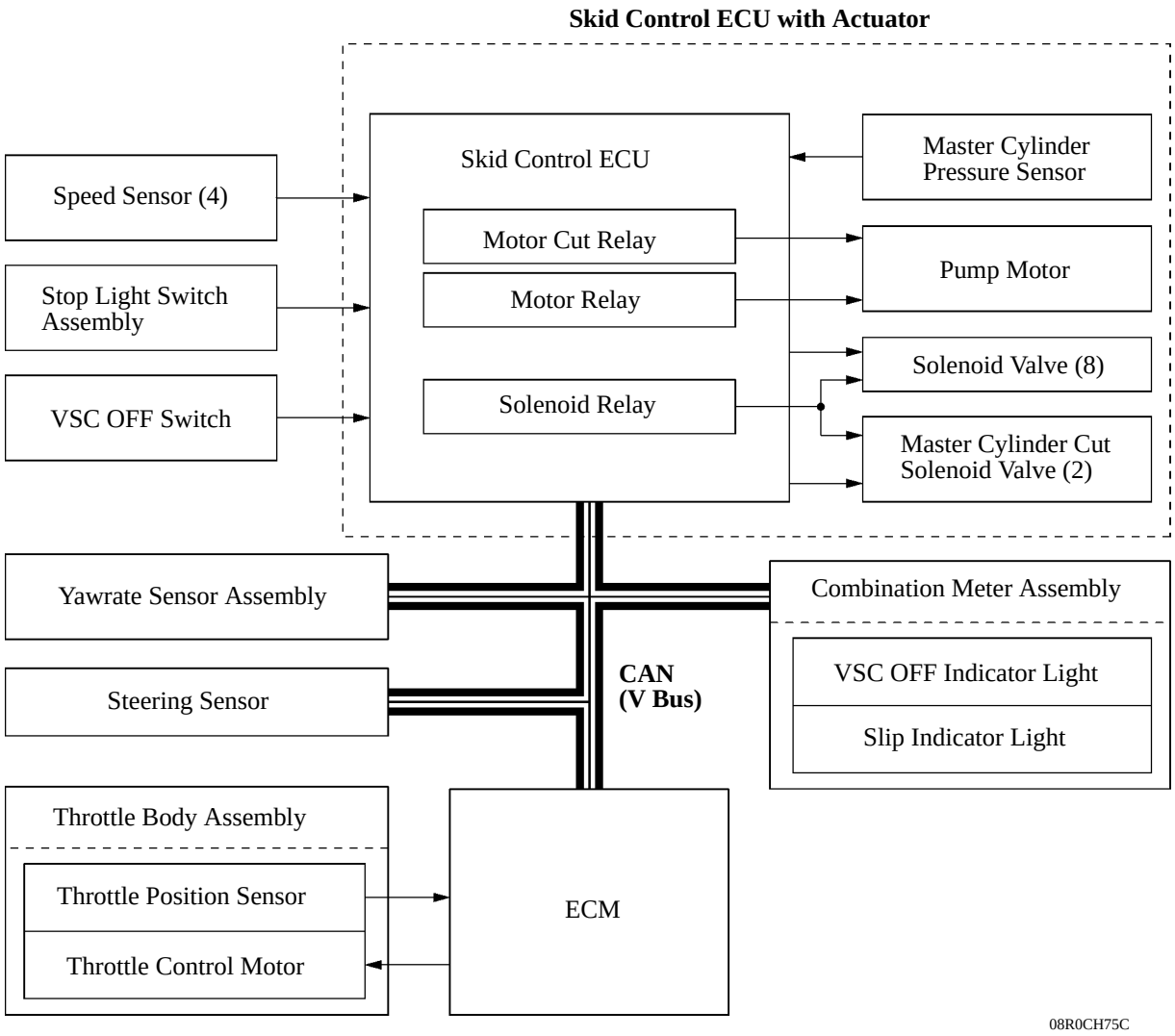
Item		Port	Brake Assist Not Activated	Brake Assist Activated
Master Cylinder Cut Solenoid Valves	(1), (2)	(A), (B)	OFF (Open)	ON*
Pressure Holding Solenoid Valves	(3), (4), (5), (6)	(C), (D) (E), (F)	OFF (Open)	OFF (Open)
Pressure Reduction Solenoid Valves	(7), (8), (9), (10)	(G), (H) (I), (J)	OFF (Closed)	OFF (Closed)
Pump			OFF	ON

*: Hydraulic pressure is controlled by continuously cycling the solenoid valves between open and closed, according to the operating conditions.

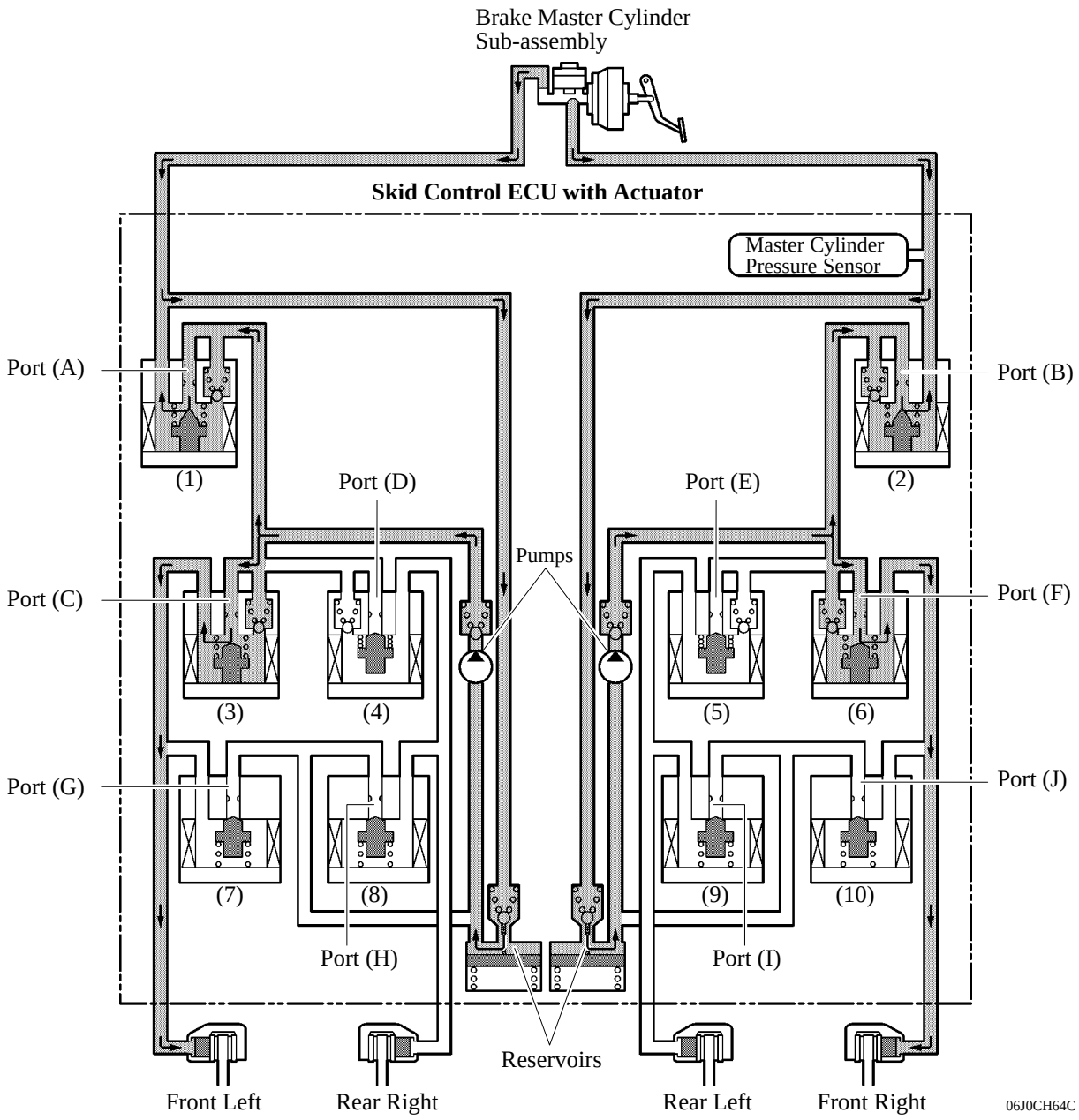
TRAC Operation

The master cylinder cut solenoid valve regulates the fluid pressure generated by the pump to achieve the required pressure. Thus, the brake of each drive wheel is controlled in the following 3 modes: pressure reduction, pressure holding, and pressure increase mode to control drive wheel slippage. The pressure holding solenoid valve and the pressure reduction solenoid valve are turned on and off according to the ABS and EBD operation pattern described on the previous page. When the TRAC is activated, each solenoid valve operates as shown in the table on page CH-160 (2WD models) and CH-162 (AWD models).

▶ System Diagram ◀



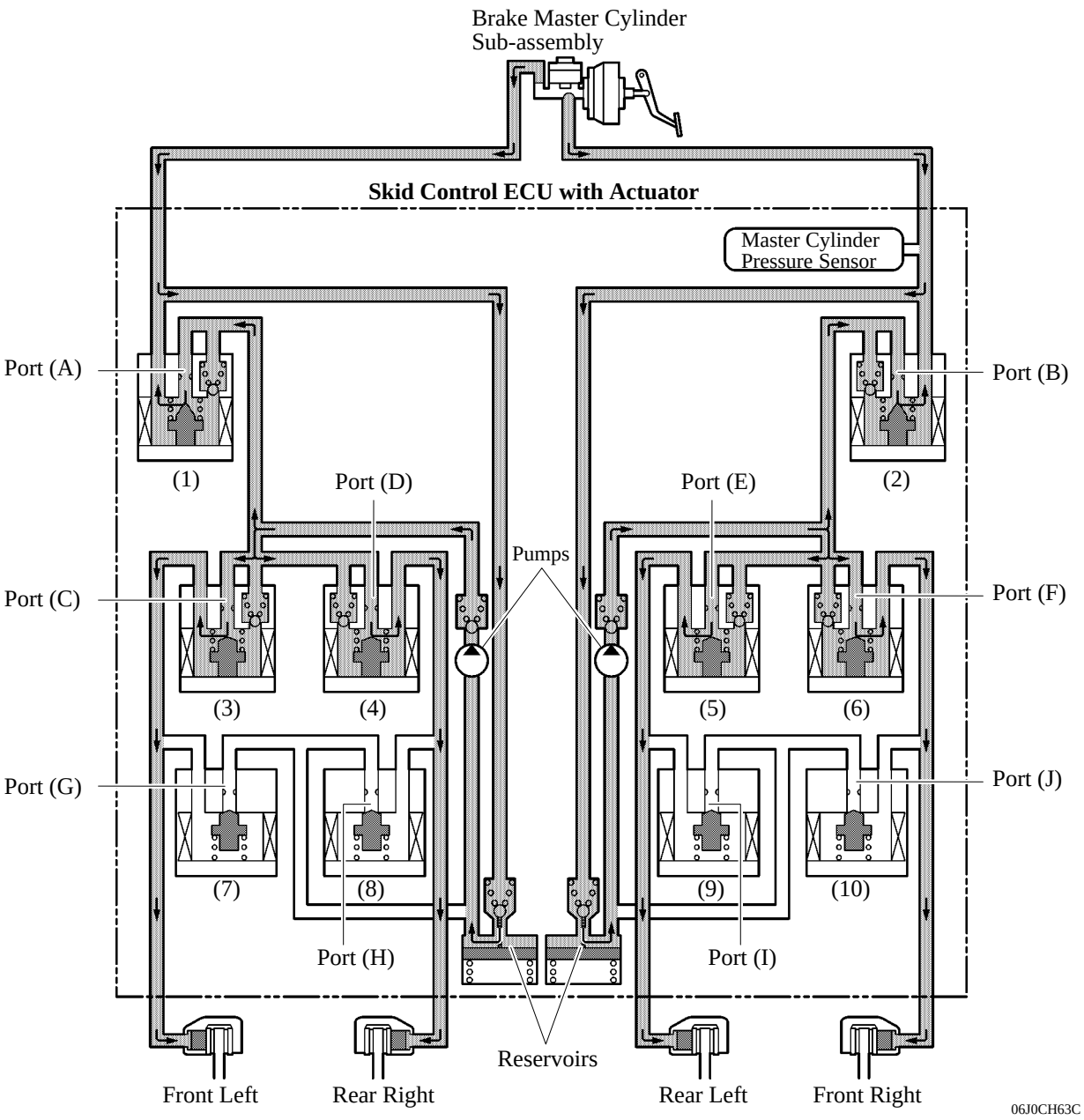
▶ TRAC Operation (2WD Models) ◀



Item				Port	TRAC Not Activated	TRAC Activated		
						Increase Mode	Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valves			(1), (2)	(A) (B)	OFF (Open)	ON*	ON*	ON*
Front Brake	Pressure Holding Solenoid Valves		(3), (6)	(C) (F)	OFF (Open)	OFF (Open)	ON (Closed)	ON (Closed)
	Pressure Reduction Solenoid Valves		(7), (10)	(G) (J)	OFF (Closed)	OFF (Closed)	OFF (Closed)	ON (Open)
	Wheel Cylinder Pressure	Right	-	-	-	Increase	Hold	Reduce
		Left	-	-	-	Increase	Hold	Reduce
Rear Brake	Pressure Holding Solenoid Valves		(4), (5)	(D) (E)	OFF (Open)	ON (Closed)	ON (Closed)	ON (Closed)
	Pressure Reduction Solenoid Valves		(8), (9)	(H) (I)	OFF (Closed)	OFF (Closed)	OFF (Closed)	OFF (Closed)
	Wheel Cylinder Pressure	Right	-	-	-	-	-	-
		Left	-	-	-	-	-	-
Pump					OFF	ON	ON	ON

*: Hydraulic pressure is controlled by continuously cycling the solenoid valves between open and closed, according to the operating conditions.

▶ TRAC Operation (AWD Models) ◀



Item				Port	TRAC Not Activated	TRAC Activated		
						Increase Mode	Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valves			(1), (2)	(A) (B)	OFF (Open)	ON*	ON*	ON*
Front Brakes	Pressure Holding Solenoid Valves		(3), (6)	(C) (F)	OFF (Open)	OFF (Open)	ON (Closed)	ON (Closed)
	Pressure Reduction Solenoid Valves		(7), (10)	(G) (J)	OFF (Closed)	OFF (Closed)	OFF (Closed)	ON (Open)
	Brake Wheel Cylinder Pressure	Right	-	-	-	Increase	Hold	Reduce
		Left	-	-	-	Increase	Hold	Reduce
Rear Brakes	Pressure Holding Solenoid Valves		(4), (5)	(D) (E)	OFF (Open)	OFF (Open)	ON (Closed)	ON (Closed)
	Pressure Reduction Solenoid Valves		(8), (9)	(H) (I)	OFF (Closed)	OFF (Closed)	OFF (Closed)	ON (Open)
	Brake Wheel Cylinder Pressure	Right	-	-	-	Increase	Hold	Reduce
		Left	-	-	-	Increase	Hold	Reduce
Pump					OFF	ON	ON	ON

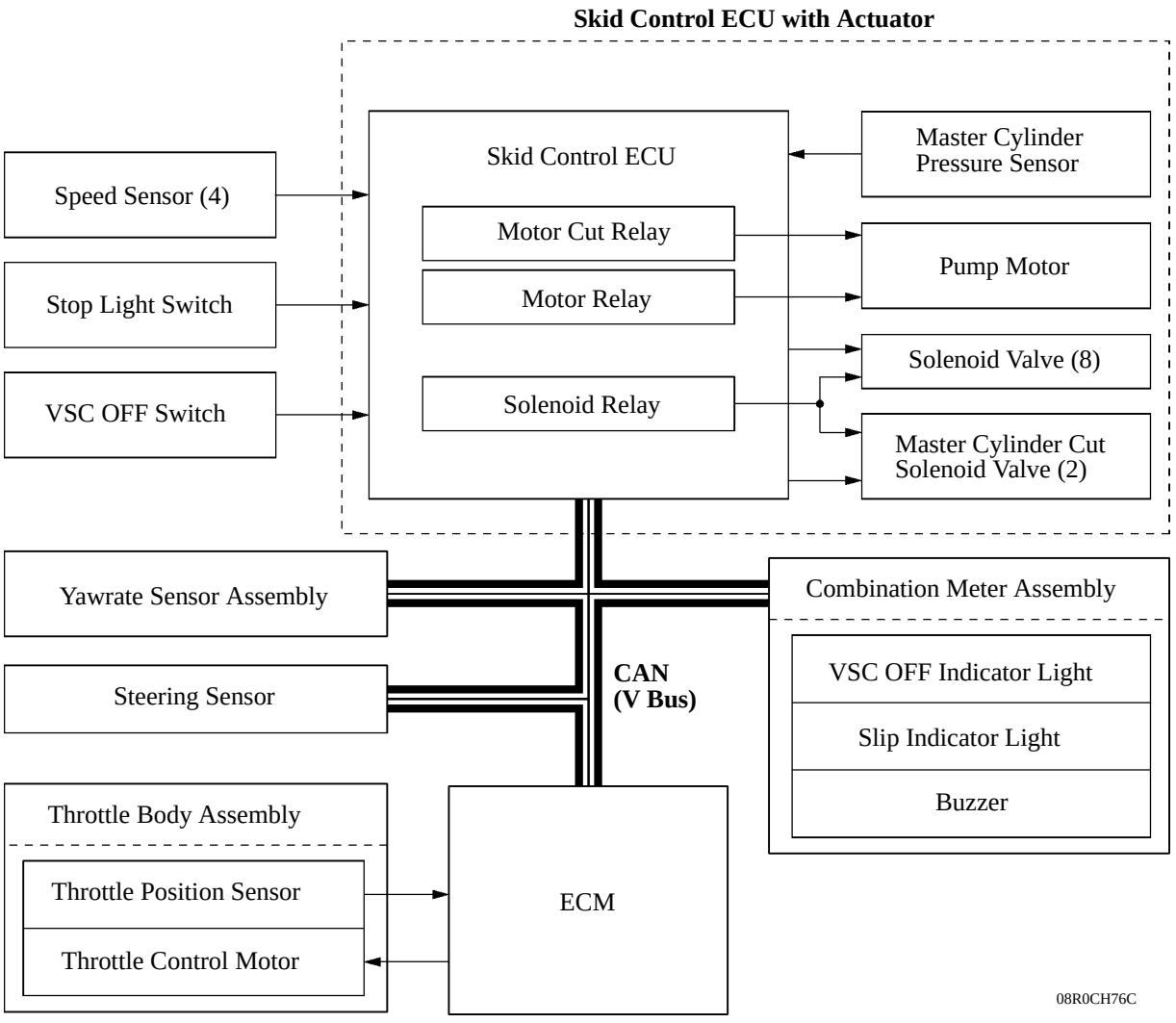
*: Hydraulic pressure is controlled by continuously cycling the solenoid valves between open and closed, according to the operating conditions.

VSC Operation

1) General

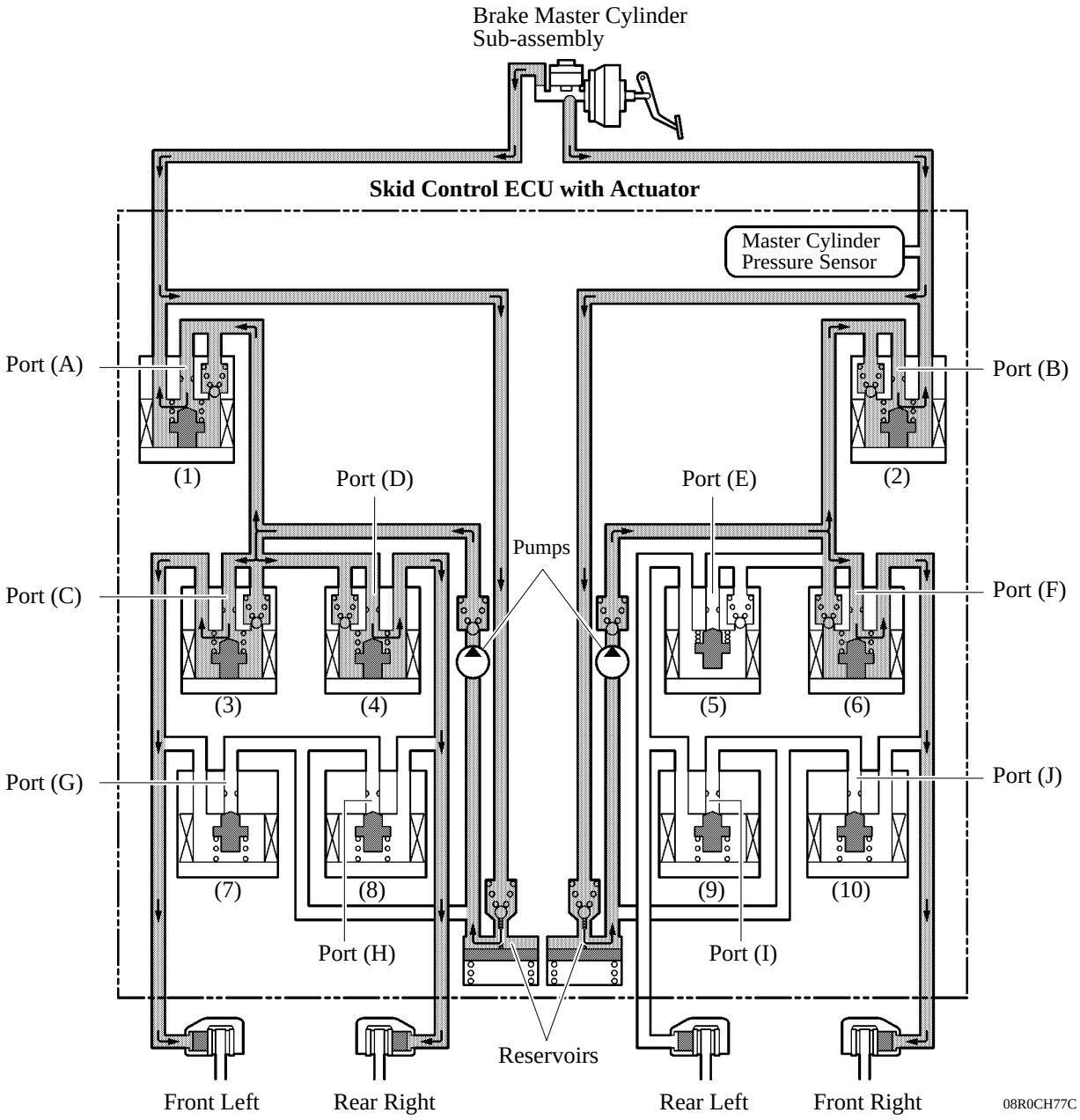
The VSC, using the solenoid valves, controls fluid pressure generated by the pump and applies it to the each wheel cylinder in the following 3 modes: pressure reduction, pressure holding, and pressure increase. As a result, both front wheel skid and rear wheel skid tendencies are controlled.

▶ System Diagram ◀



2) Front Wheel Skid Restraining Control (Making a Right Turn)

To restrain a front wheel skid, the brakes for the wheels on the inside of the turn are applied. Also, if the driver applies the brakes, depending on the operating conditions of the vehicle, there are circumstances in which the brakes might not be applied to specified wheels even if the wheels would otherwise be targeted for braking. The diagram below shows the hydraulic circuit in pressure increase mode, as it restrains a front wheel skid during a right turn. In other operating modes, the pressure holding valve and the pressure reduction valve are turned on or off according to the ABS and EBD operation pattern. When the front wheel skid restraining control is activated, each solenoid valve operates as shown in the table on the next page.

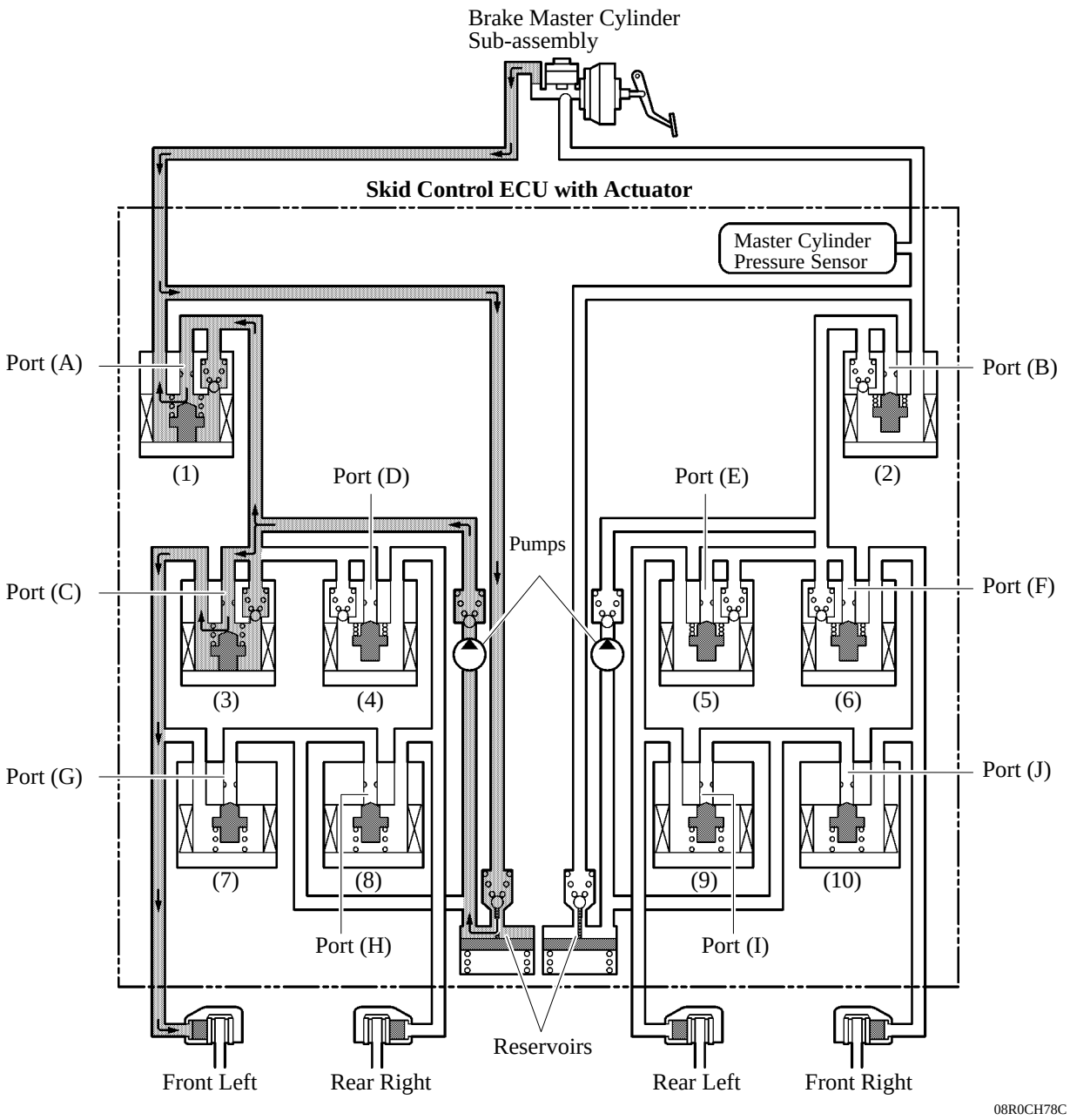


Item				Port	VSC Not Activated	VSC Activated		
						Increase Mode	Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valves			(1), (2)	(A) (B)	OFF (Open)	ON*	ON*	ON*
Front Brake	Pressure Holding Solenoid Valves		(3)	(C)	OFF (Open)	OFF (Open)	ON (Close)	ON (Close)
			(6)	(F)	OFF (Open)	OFF (Open)	ON (Closed)	ON (Closed)
	Pressure Reduction Solenoid Valves		(7)	(G)	OFF (Closed)	OFF (Closed)	OFF (Closed)	ON (Open)
			(10)	(J)	OFF (Closed)	OFF (Closed)	OFF (Closed)	ON (Open)
	Wheel Cylinder Pressure	Right	-	-	-	Increase	Hold	Reduce
		Left	-	-	-	Increase	Hold	Reduce
Rear Brake	Pressure Holding Solenoid Valves		(4)	(D)	OFF (Open)	OFF (Open)	ON (Closed)	ON (Closed)
			(5)	(E)	OFF (Open)	ON (Closed)	ON (Closed)	ON (Closed)
	Pressure Reduction Solenoid Valves		(8)	(H)	OFF (Closed)	OFF (Closed)	OFF (Closed)	ON (Open)
			(9)	(I)	OFF (Closed)	OFF (Closed)	OFF (Closed)	OFF (Closed)
	Wheel Cylinder Pressure	Right	-	-	-	Increase	Hold	Reduce
		Left	-	-	-	-	-	-
Pump					OFF	ON	ON	ON

*: Hydraulic pressure is controlled by continuously cycling the solenoid valves between open and closed, according to the operating conditions.

3) Rear Wheel Skid Restraining Control (Making a Right Turn)

To restrain a rear wheel skid, the brakes for the wheels on the outside of the turn are applied. Also, if the driver applies the brakes, depending on the operating conditions of the vehicle, there are circumstances in which the brakes might not be applied to specified wheels even if the wheels would otherwise be targeted for braking. The diagram below shows the hydraulic circuit in the pressure increase mode, as it restrains a rear wheel skid during a right turn. In other operating modes, the pressure holding valve and the pressure reduction valve are turned on or off according to the ABS and EBD operation patterns. When the rear wheel skid restraining control is activated, each solenoid valve operates as shown in the table on the next page.

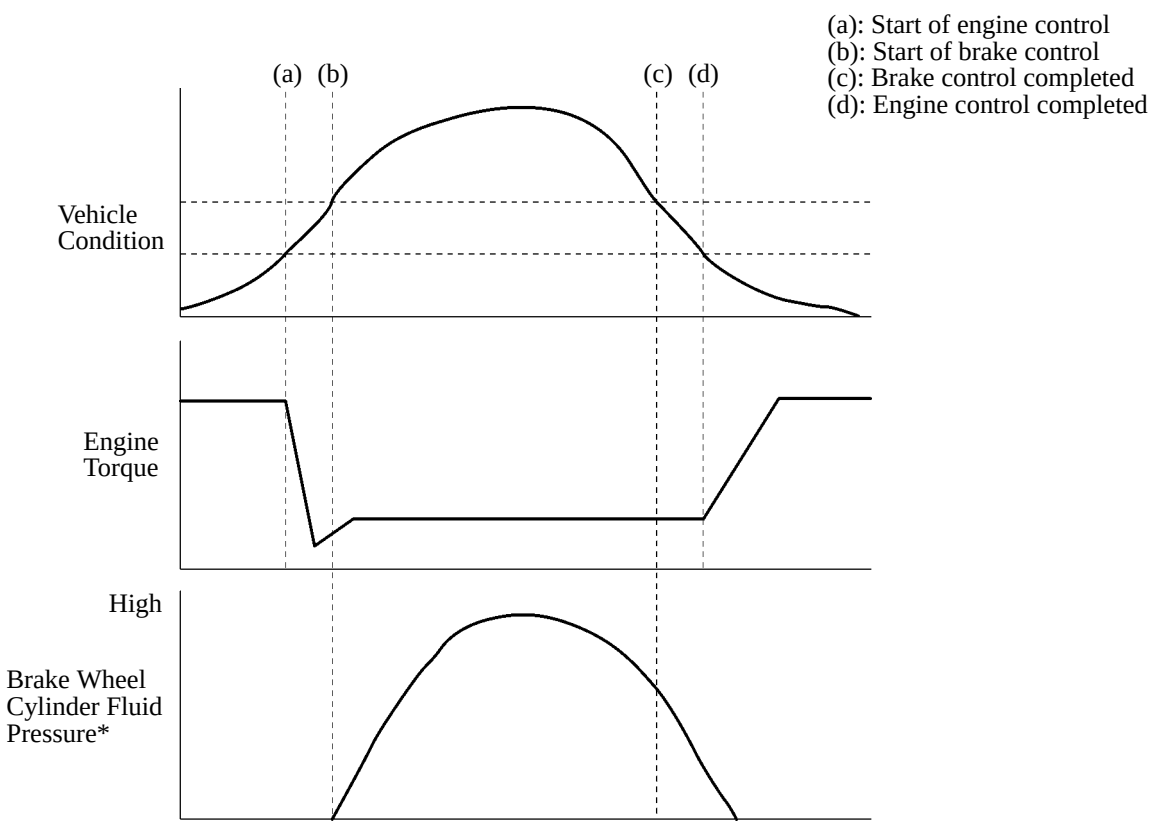


Item				Port	VSC Not Activated	VSC Activated		
						Increase Mode	Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valves			(1)	(A)	OFF (Open)	ON*	ON*	ON*
			(2)	(B)	OFF (Open)	OFF (Open)	OFF (Open)	OFF (Open)
Front Brake	Pressure Holding Solenoid Valves		(3)	(C)	OFF (Open)	OFF (Open)	ON (Closed)	ON (Closed)
			(6)	(F)	OFF (Open)	ON (Closed)	ON (Closed)	ON (Closed)
	Pressure Reduction Solenoid Valves		(7)	(G)	OFF (Closed)	OFF (Closed)	OFF (Closed)	ON (Open)
			(10)	(J)	OFF (Closed)	OFF (Closed)	OFF (Closed)	OFF (Closed)
	Wheel Cylinder Pressure	Right	-	-	-	-	-	-
		Left	-	-	-	Increase	Hold	Reduce
Rear Brake	Pressure Holding Solenoid Valves		(4)	(D)	OFF (Open)	ON (Closed)	ON (Closed)	ON (Closed)
			(5)	(E)	OFF (Open)	ON (Closed)	ON (Closed)	ON (Closed)
	Pressure Reduction Solenoid Valves		(8)	(H)	OFF (Closed)	OFF (Closed)	OFF (Closed)	OFF (Closed)
			(9)	(I)	OFF (Closed)	OFF (Closed)	OFF (Closed)	OFF (Closed)
	Wheel Cylinder Pressure	Right	-	-	-	-	-	-
		Left	-	-	-	-	-	-
Pump					OFF	ON	ON	ON

*: Hydraulic pressure is controlled by continuously cycling the solenoid valves between open and closed, according to the operating conditions.

11. Engine Output Control

During TRAC or VSC operation, the skid control ECU outputs an engine output control request signal to the ECM. Upon receiving this signal, the ECM performs throttle control to regulate engine output.



*: The cylinder that activates varies depending on the driving conditions experienced by the vehicle.

12. Initial Check

Each time the ignition switch is turned on (IG), and the vehicle reaches a speed of approximately 6 km/h (4 mph) or more, the skid control ECU performs an initial check. The functions of each solenoid valve and pump motor in the brake actuator are checked in sequence.

13. CAN (Controller Area Network)

CAN communication is used among the yawrate sensor assembly, steering sensor, skid control ECU, combination meter, ECM and DLC3. For details on CAN communication, see page BE-5.

14. Diagnosis

If the skid control ECU detects a malfunction in the brake control system (ABS with EBD, Brake Assist, TRAC and VSC), the warning lights in the combination meter light up to alert the driver of the malfunction. At the same time, the skid control ECU stores the DTC (Diagnostic Trouble Code) in memory.

- DTCs can be read by connecting SST (09843-18040) between the TC and CG terminals of DLC3 and observing the blinking pattern of the ABS warning light, the brake system warning light, VSC OFF indicator light or slip indicator light, or by connecting the Techstream to the DLC3.
- If the skid control ECU assembly detects any malfunctions during sensor signal check (test mode), it stores the DTCs in its memory.

For details, see the 2009 Corolla Matrix Repair Manual (Pub. No. RM08R0U).

15. Fail-safe

- In the event of a malfunction in the ABS, the skid control ECU prohibits the brake control system functions.
- In the event of an EBD control malfunction, the brake system functions remain operative as long as possible even if the ABS is prohibited. If EBD control becomes impossible, the brake system warning light illuminates to inform the driver. In this case, the brake system operates in the same way as a system without electronic brake control.
- In the event of a malfunction in the TRAC and/or VSC, the skid control ECU prohibits TRAC and VSC operation.
- If a communication malfunction occurs between the skid control ECU and the steering sensor, yawrate sensor assembly, or ECM, the skid control ECU stops TRAC and VSC operation.
- When the ECM detects a DTC, it will disable TRAC and VSC operation.