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## Basic Stability Systems

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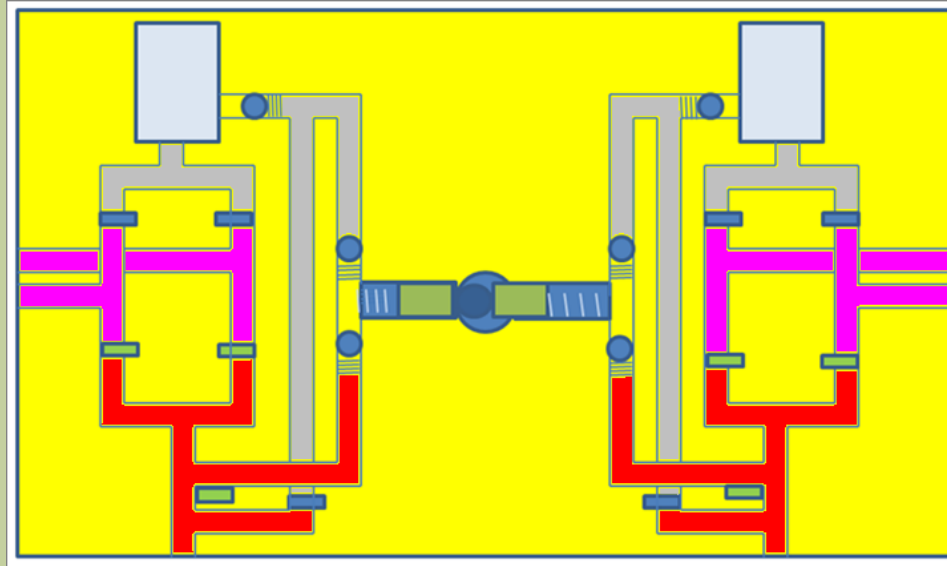
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# Basic Stability Systems



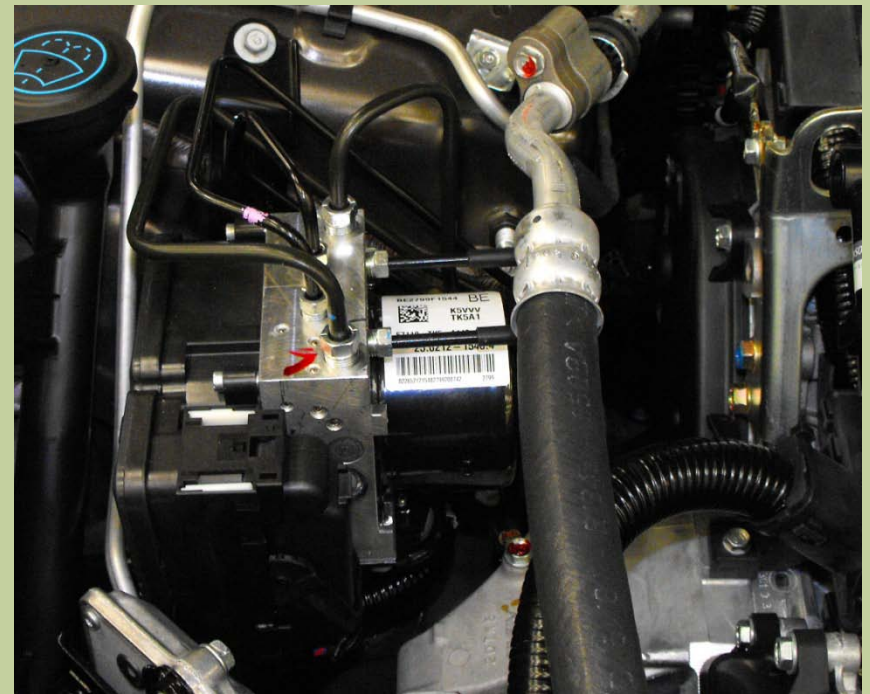
Presented by Matthew Dixon  
Assistant Professor, SIU Carbondale  
Fall 2010 ICAIA Conference

# Basic Stability Systems:

A progression beyond ABS/TRAC with additional components that monitor for and react to situations such as oversteer and understeer.

# Basic Stability Systems:

Required for all new models under 10,000 lbs. GVW for 2012  
M.Y. by **FMVSS 126**



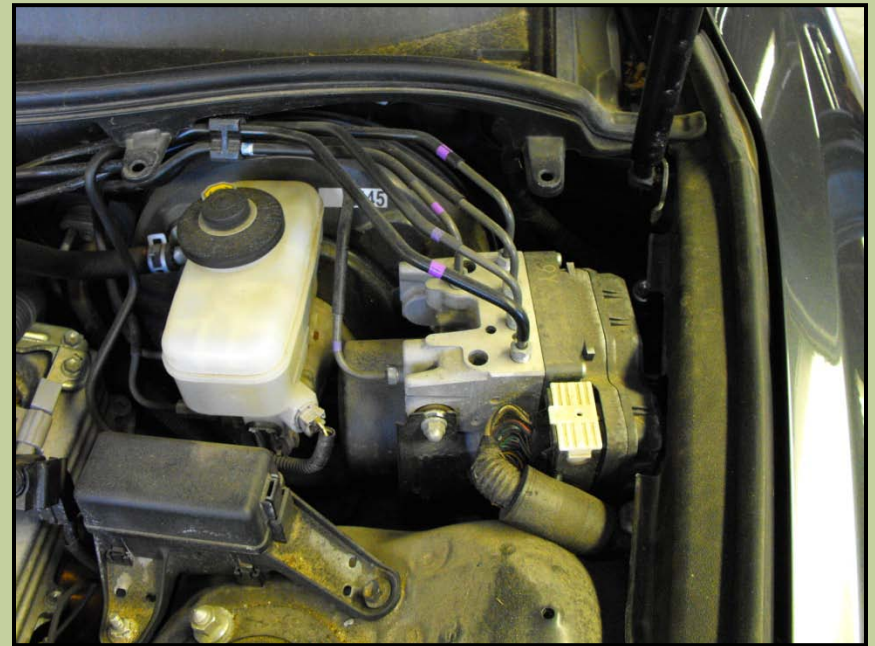
2010 Acura TL  
ABS/TCS/VSA unit

# Stability: Components

## *Master Cylinder:*

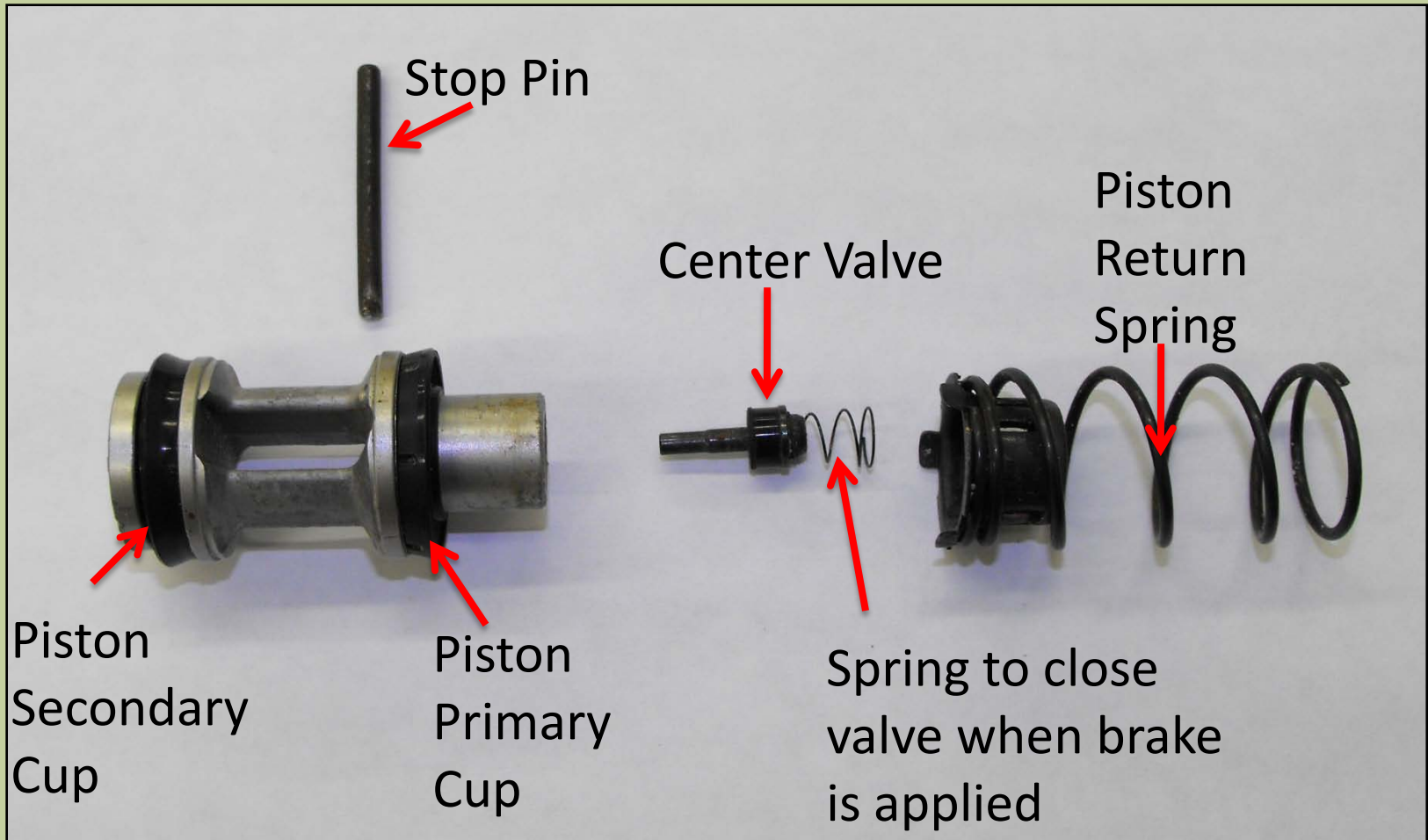
### *Center valve type*

allows for rapid fluid transfer from reservoir to pump inlet



Replaces compensating  
port style

# Stability: Components

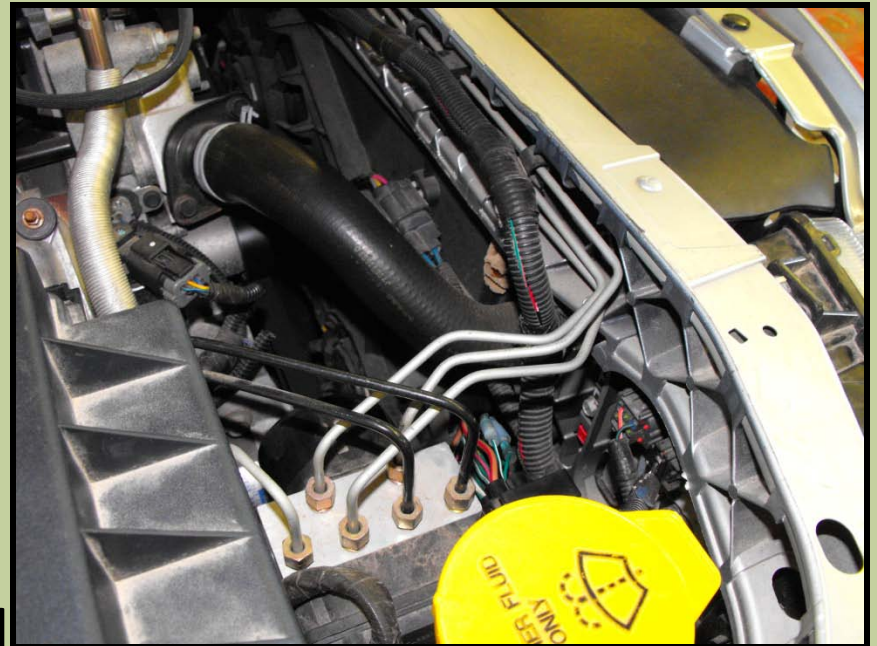


# Stability: Components

Integral *ECU* and  
*hydraulic control unit*

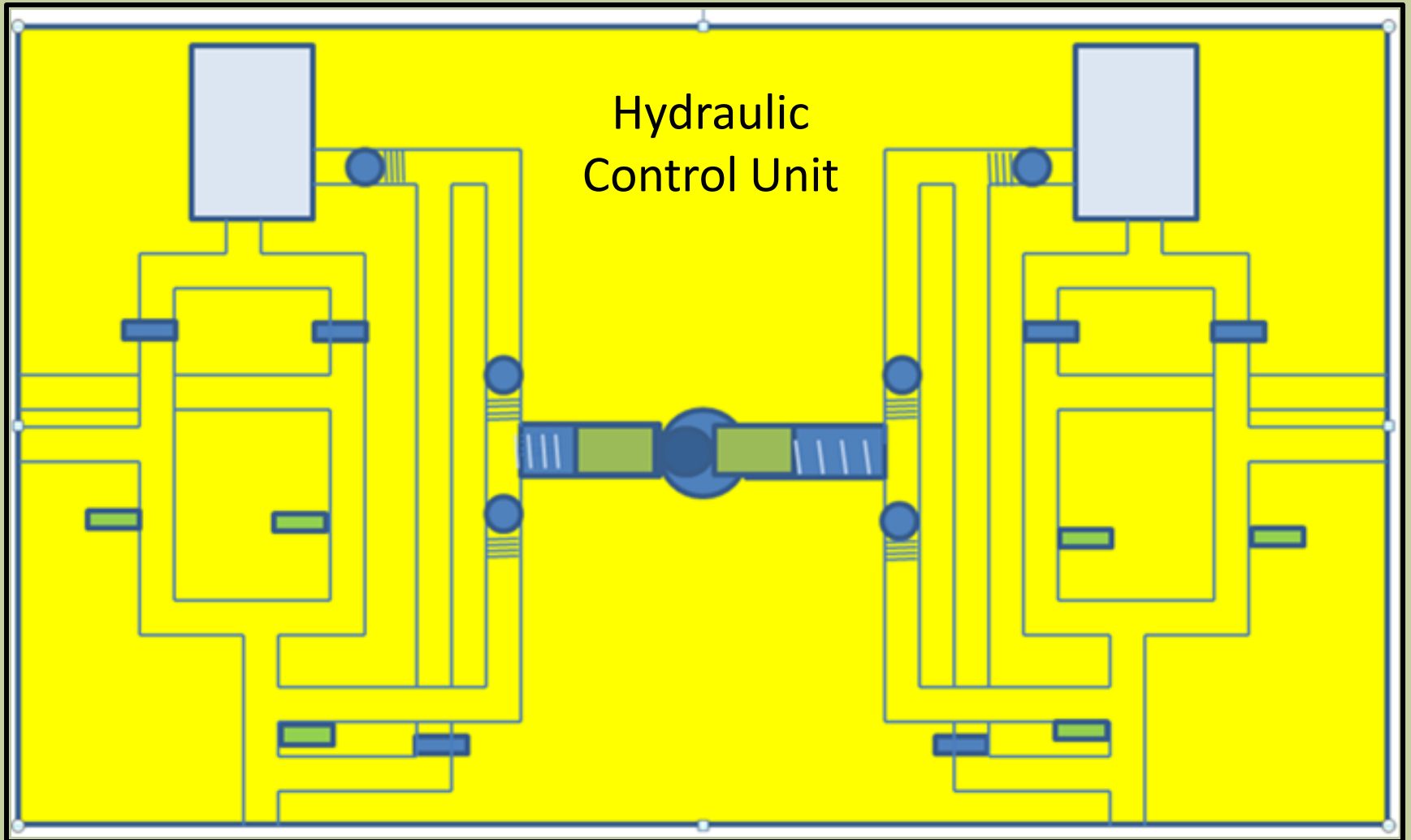
ESC requires 4 channels

Typical system utilizes  
12 valves/ solenoids and  
integral motor/pump



'05 Chrysler 300C,  
notice line routing

# Stability: Components





# Stability: Components



*ECU*

Contains the electronics and the solenoids that react on the valves

# Stability: Components



## *ESC Off switch*

Not required, if used  
default is “on” for  
every ignition cycle

“Off icon” required

Input may be to another  
ECU

# Stability: Components

*Indicator on  
instrument cluster*

Standardized symbol

Option to flash icon  
during a stability  
event



# Stability: Components

## *Accelerator Pedal Position Sensor (APPS 1 and 2)*

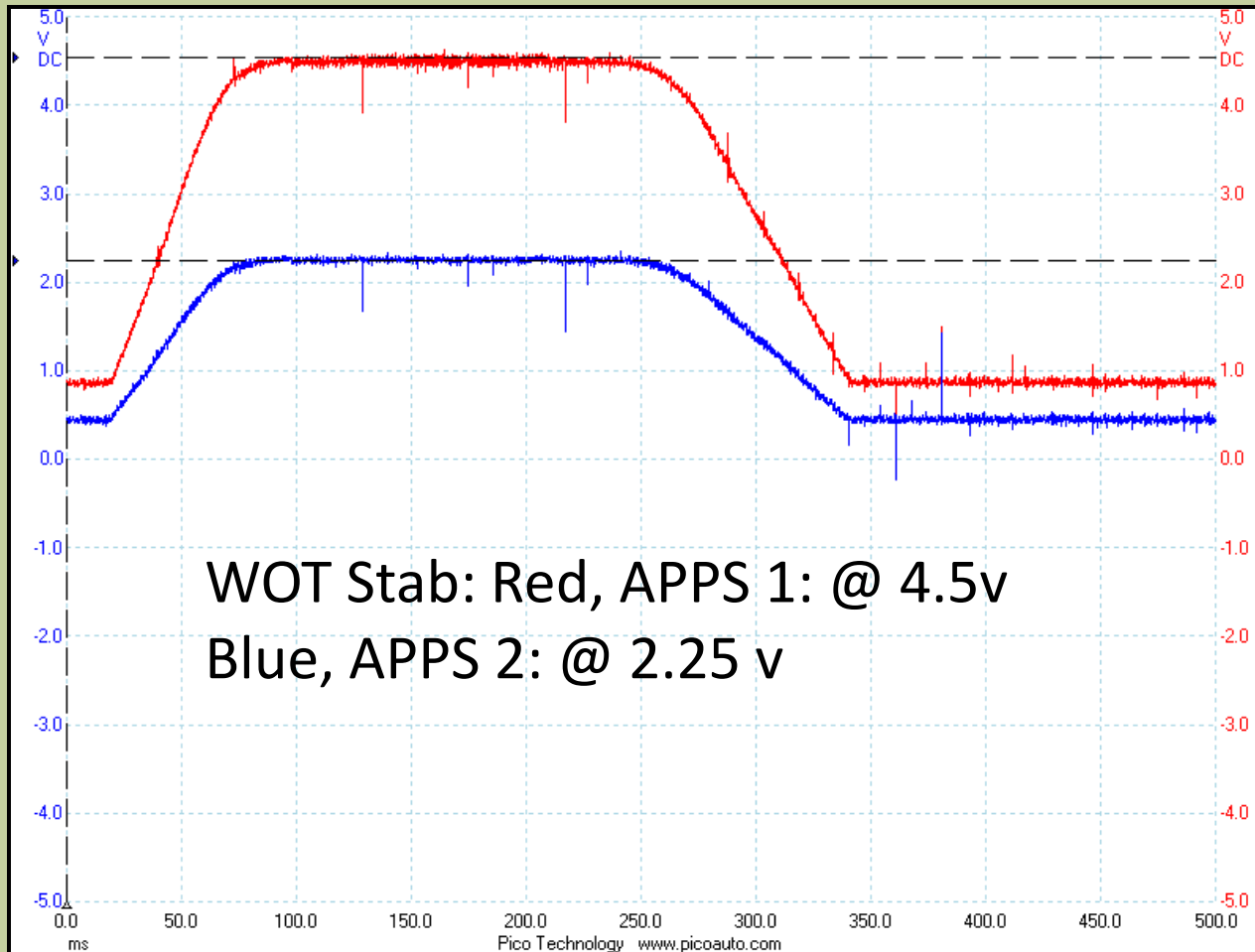
Position % calculated by PCM and broadcast over network

Driver intention necessary for torque reduction requests



# Stability: Components

## *APPS 1 and 2 on '08 Dodge*



# Stability: Components

## *Electronic Throttle Control*

Primary output of PCM to  
reduce engine torque

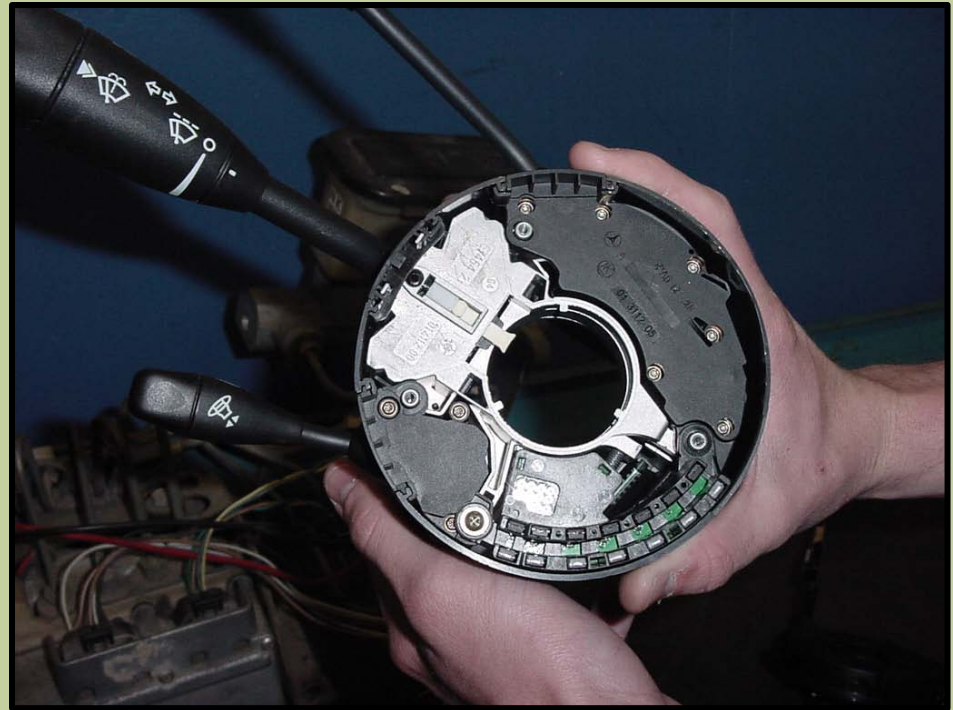
PCM can also reduce spark  
advance, cut injector  
pulsewidth



# Stability: Components

## *Steering Angle Sensor (SAS)*

Most late model units provide serial data over dedicated or non dedicated CAN




'05 Chrysler 300 SAS  
photo diode/LED;  
part of SCM

# Stability: Components

## *Steering Angle Sensor (SAS)*

May be several sensors within one

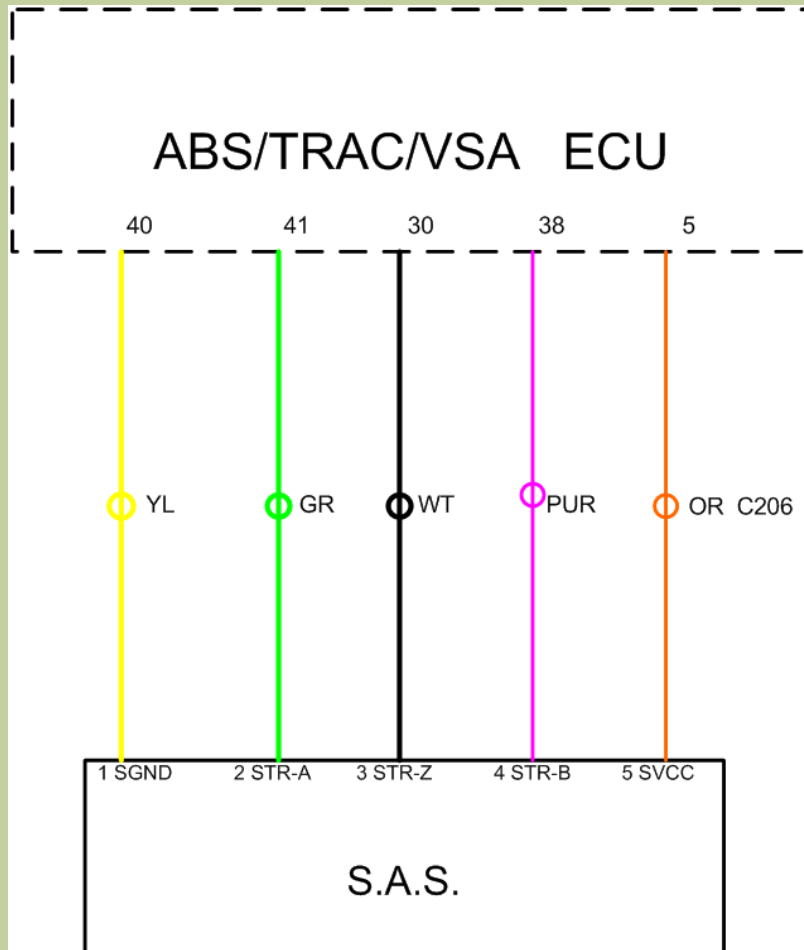
Measures driver intent usually in degrees

|  |               |          |
|--|---------------|----------|
| <b>STEERING ANGLE SENSOR STATUS</b>  | <b>Normal</b> |          |
| <b>STEERING ANGLE</b>  | <b>18.00</b>  | <b>°</b> |
| <b>Z-PHASE</b>   | <b>3.56</b>   | <b>V</b> |



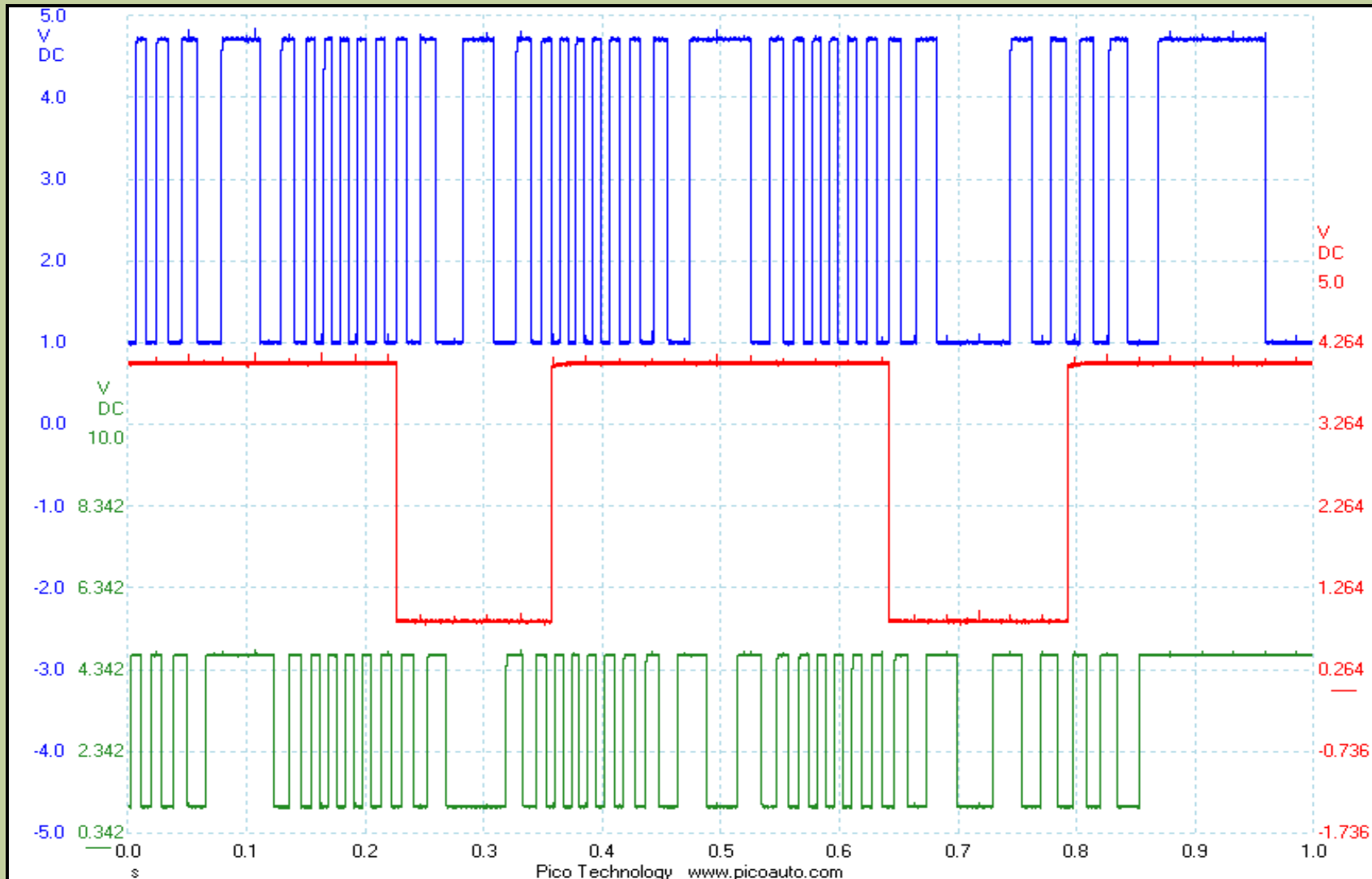
# Stability: Components

Typical wires: Power, Ground,  
Communication lines



S.A.S. on 2010 Acura TL

# SAS: '04 Acura TL non serial type



# Stability: Components

## *Lateral Accelerometer:*

Units: g force

## *Yaw Accelerometer:*

Units: degrees per second

Compare to steering input, and wheel speed sensors to determine understeer, oversteer



2004 Acura TL analog unit

# Stability: Components

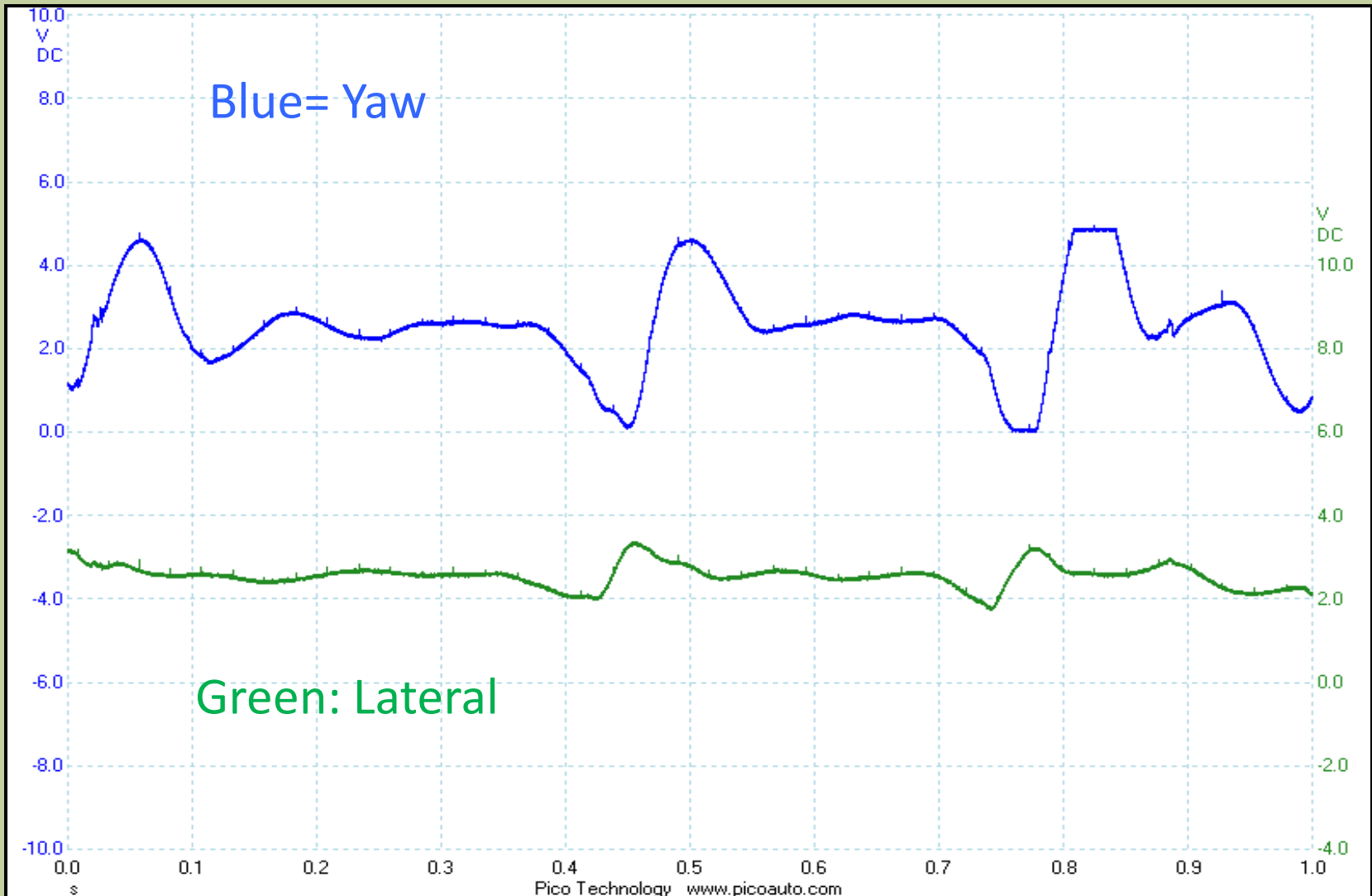
Common units for lateral and longitudinal movement is *g's*

Common unit for yaw is *degrees per second*

|   |               |     |
|---|---------------|-----|
| LATERAL ACCELERATION SENSOR STATUS      | Normal        |     |
| LATERAL ACCELERATION SENSOR             | 0.00          | G   |
| LONGITUDINAL ACCELERATION SENSOR STATUS | Not Installed |     |
| LONGITUDINAL ACCELERATION SENSOR        | 0.00          | G   |
| YAW RATE SENSOR STATUS                  | Normal        |     |
| YAW RATE SENSOR                         | 0             | °/s |

# '04 Acura TL non serial data type

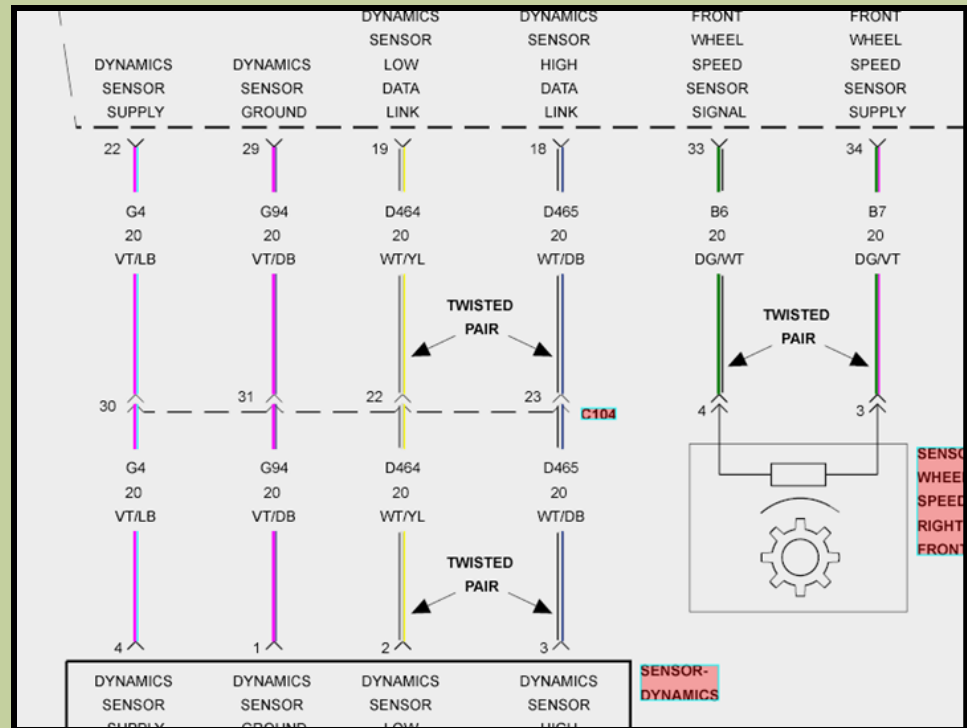
*Moving sensor by hand*



# Stability: Components

Lateral, Yaw sensors may be combined into a **sensor cluster**, may also include a longitudinal sensor and or a roll sensor

Typically provide serial data on a dedicated C.A.N.



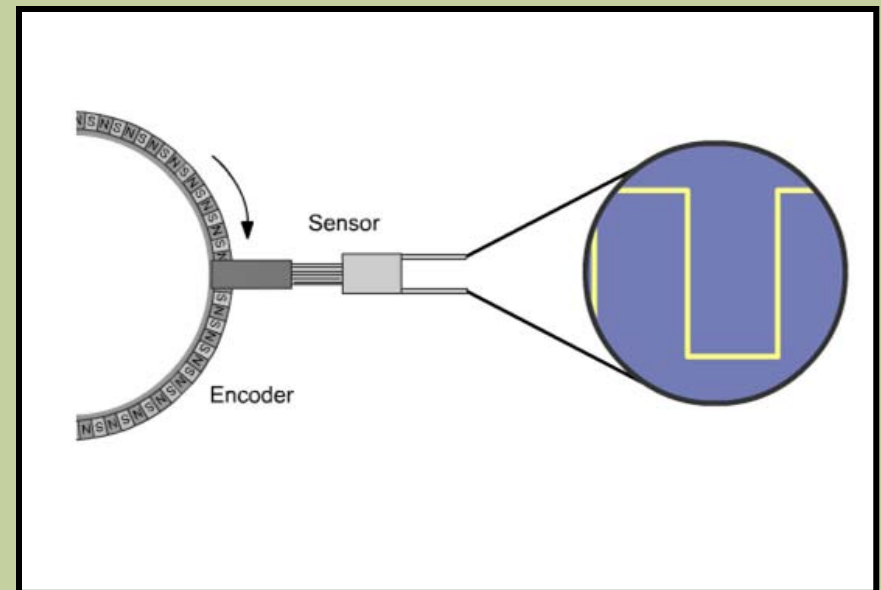
Chrysler 300C sensor cluster  
4 wires: Power, Ground,  
Network+, Network -

# Stability: Components

## *Wheel Speed Sensors*

Current vehicles  
provide DC signals

Digital type sensors  
can read under 1  
MPH



Magnetic Encoder type  
sensors do not use a  
conventional tone ring

# Stability: Components

## *Wheel Speed Sensors*

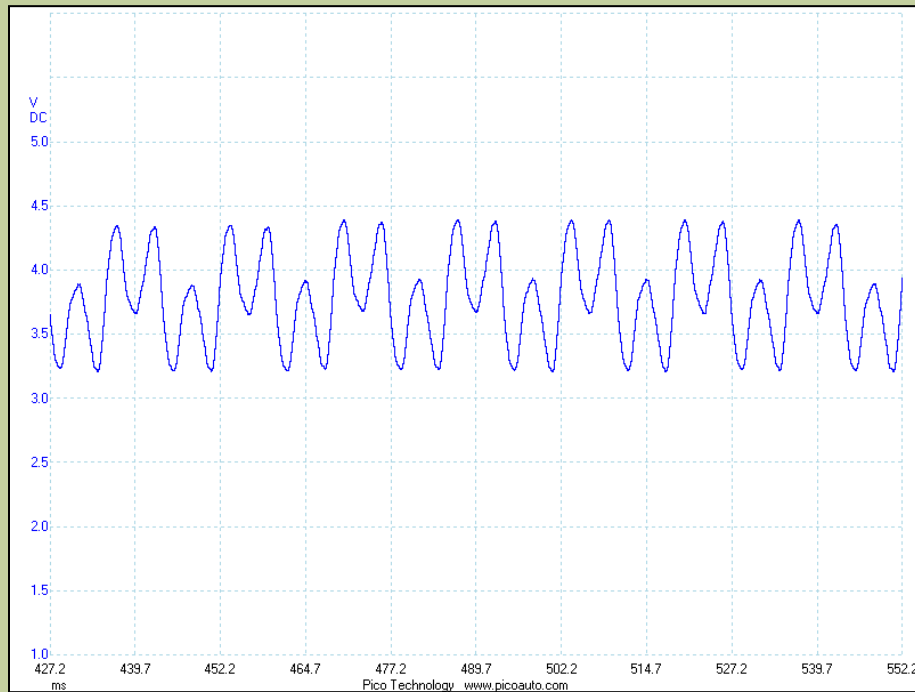
Toyota/Lexus magnetic encoder sensor provides different amplitudes forward vs. reverse rotation?



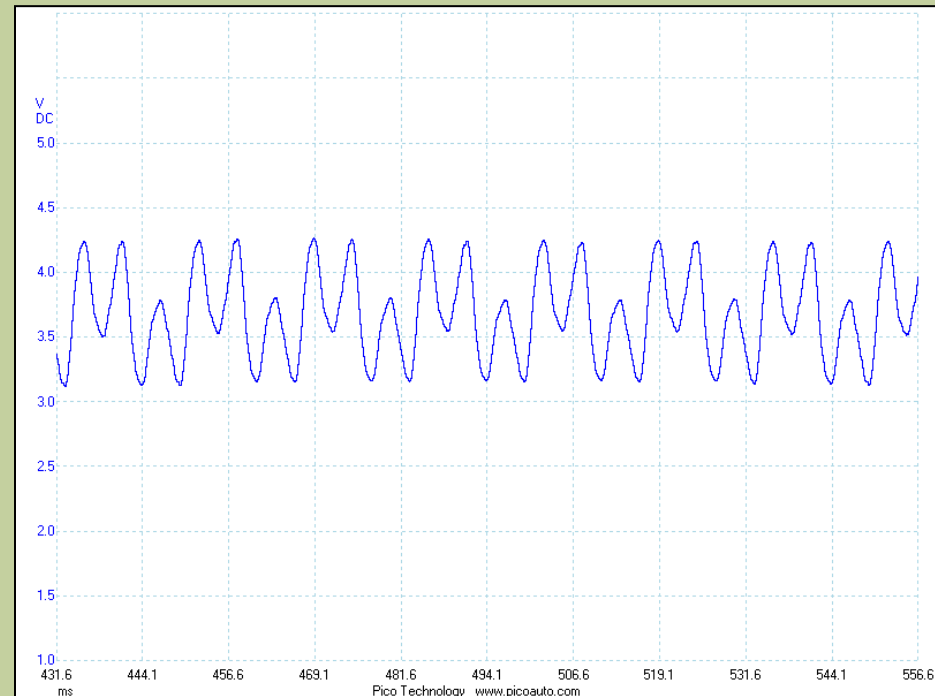


# Stability: Components

*'06 Lexus IS 350*: no rotational  
difference noted



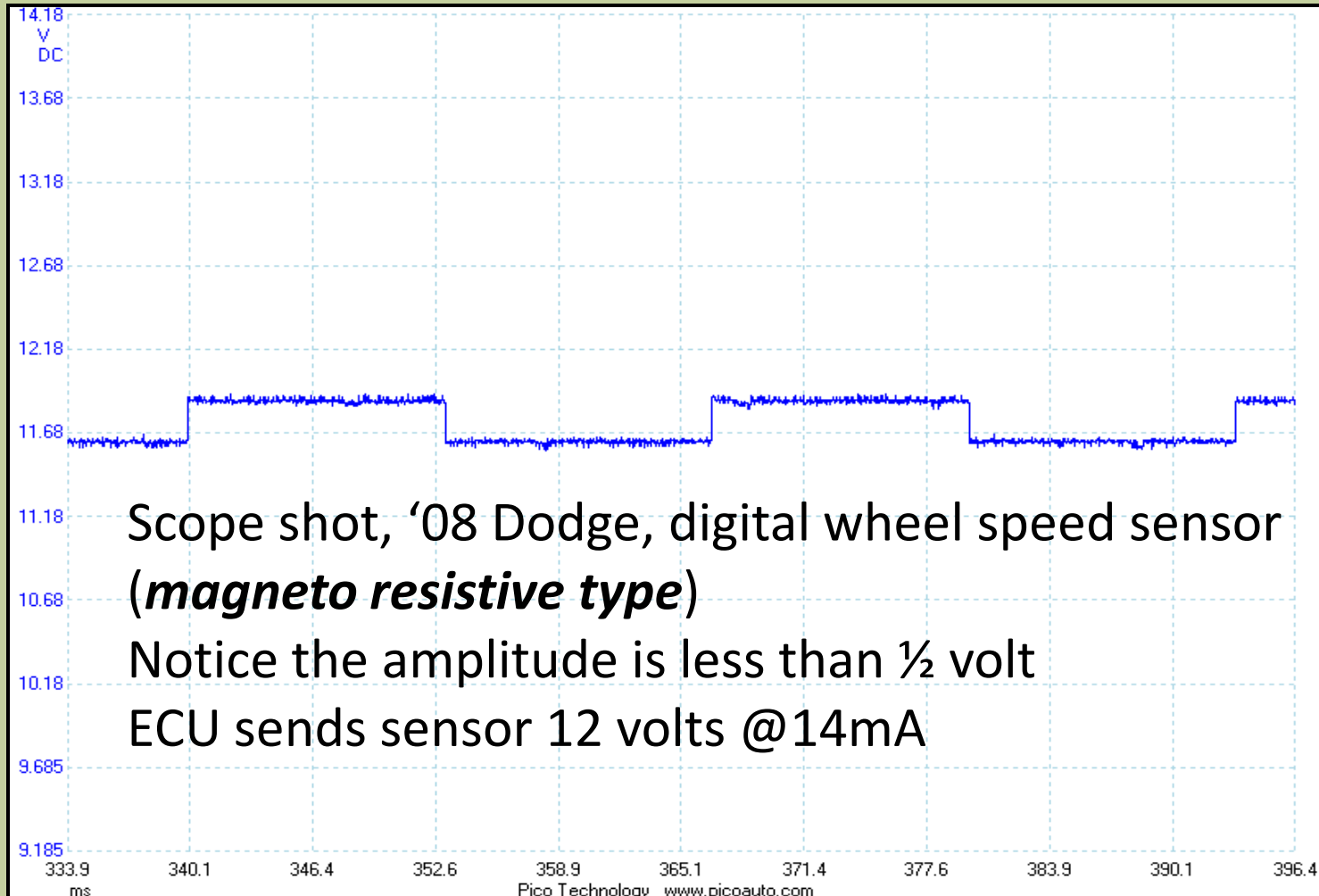
Forward



Reverse

# Stability: Components

## *Wheel Speed Sensors*



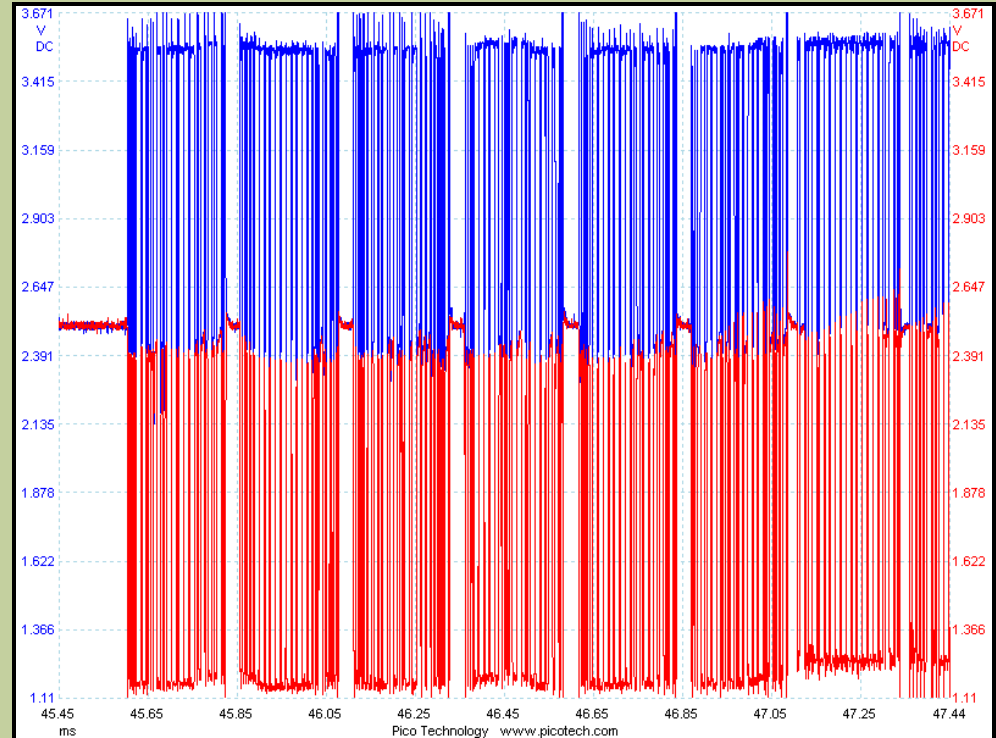
# Stability: Components

## *Networks:*

CAN high speed (F CAN, CAN C, GM LAN)

Many use “private” networks for SAS or sensor cluster

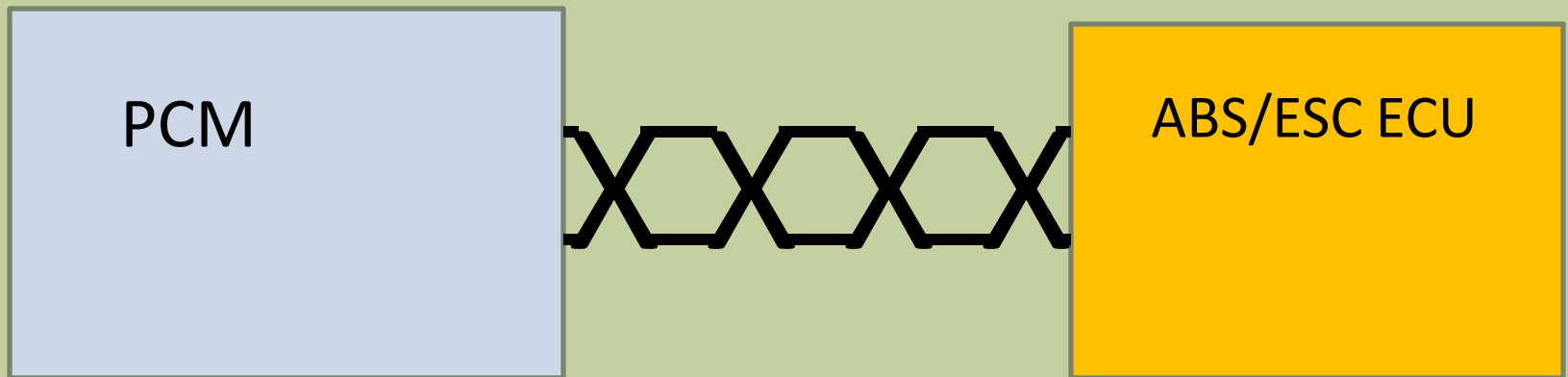
Other CAN's or an ISO K-Line may also be used



Blue: CAN + Red: CAN – at  
DLC on '07 Nissan Maxima

# Stability: Components

## *Networks:*



Torque reduction request and confirmation rely on high speed C.A.N. two wire twisted pair

# Stability: Components

## *Brake Switch*

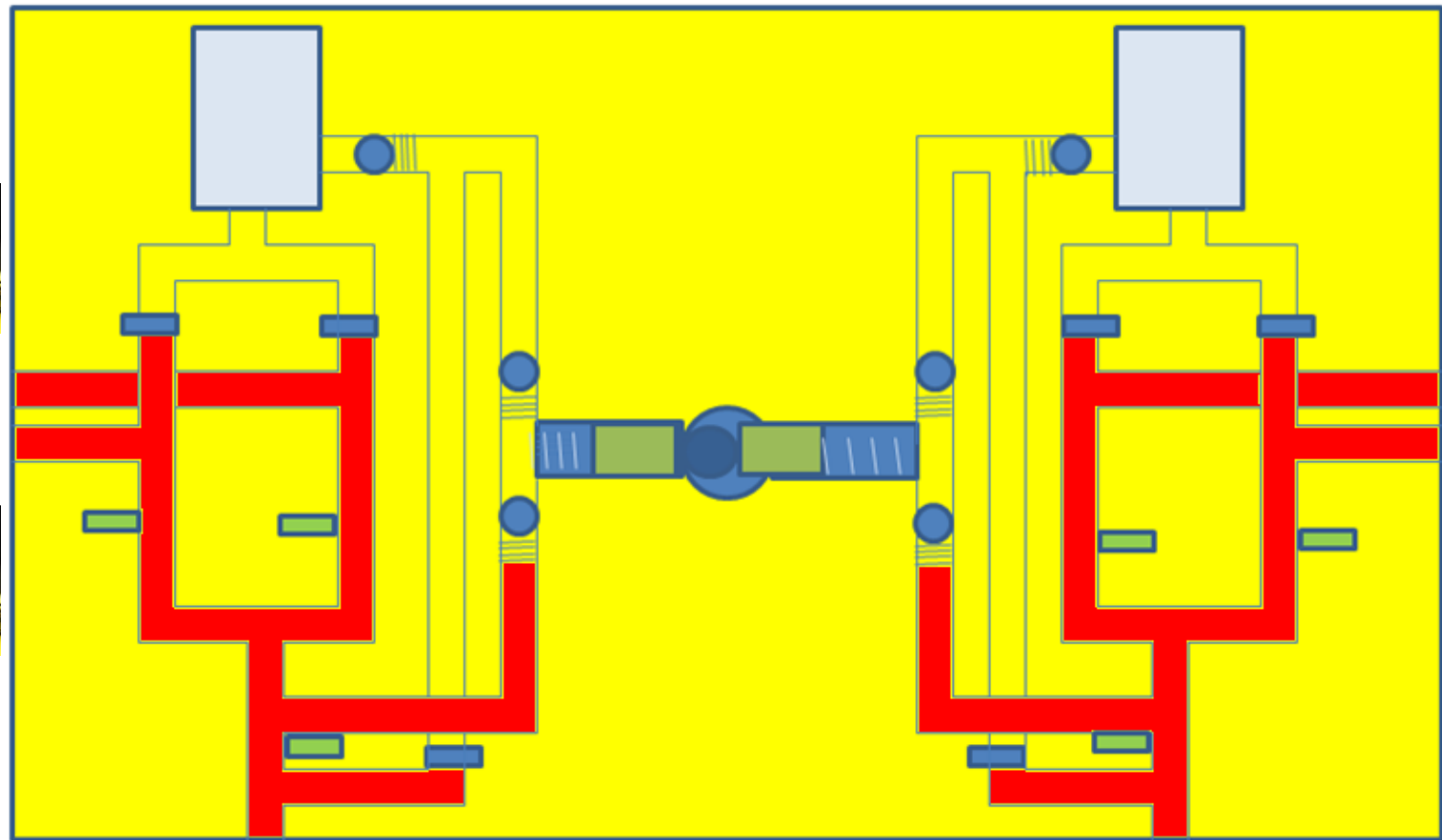
Some systems may use a pressure sensor or travel rate sensor

Alerts ECU of driver intention and used for traction control



This example: 3 momentary contact switches:  
2 normally closed,  
1 normally open

# Default pressure build mode



To RF  
To LR



To LF  
To RR



From M/C  
secondary



*High Pressure*

From M/C  
primary

# Situation1: Vehicle Understeer



Wheels turn, vehicle “pushes” in straight line,  
front wheels typically slow compared to rears

# Vehicle Understeer: ECU view point

## INPUTS

|                 |                      |
|-----------------|----------------------|
| <b>SAS:</b>     | <b>+ 47°</b>         |
| <b>Yaw:</b>     | <b>1° per second</b> |
| <b>Lateral:</b> | <b>.002 G</b>        |
| <b>APPS:</b>    | <b>0%</b>            |
| <b>Brake:</b>   | <b>not applied</b>   |
| <b>VSS:</b>     | <b>39 MPH</b>        |
| <b>LF:</b>      | <b>34 MPH</b>        |
| <b>RF:</b>      | <b>33 MPH</b>        |
| <b>LR:</b>      | <b>42 MPH</b>        |
| <b>RR:</b>      | <b>42 MPH</b>        |

## OUTPUTS

Energize pump

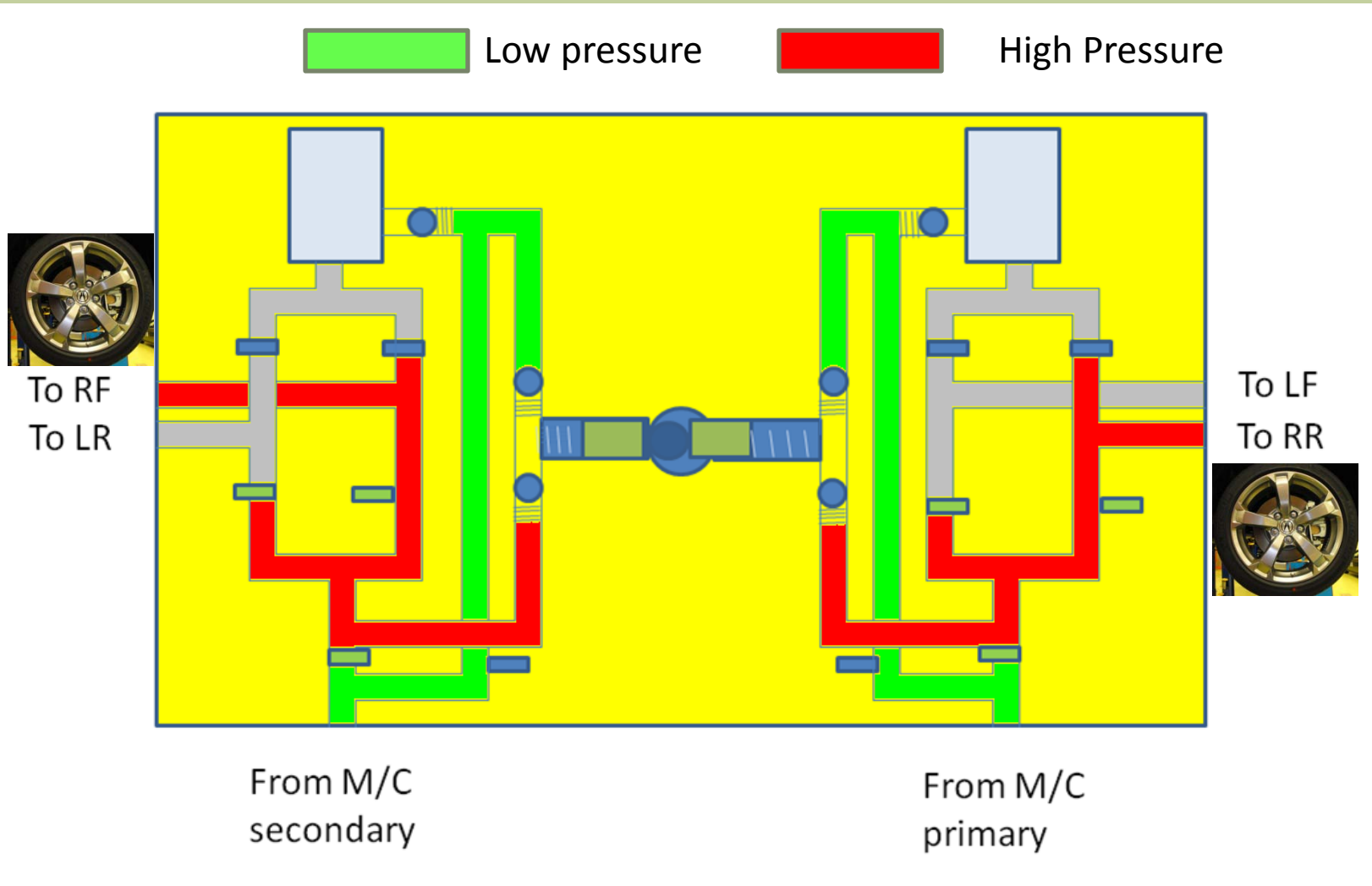
Energize HCU isolation valves 1+2 to close (to block)

Energize pump inlet valves 1+2 to open ( to flow)

Energize LR and LF inlet valves to close ( to block)



# Response: apply inside brakes (right)



# Response: apply inside brake(s)



# Situation 2: Vehicle Oversteer



Vehicle over responds to steering input and becomes “loose”; Rear wheels slow if not torque induced

# Vehicle Oversteer: ECU view point

## INPUTS

|                 |                       |
|-----------------|-----------------------|
| <b>SAS:</b>     | <b>+ 17°</b>          |
| <b>Yaw:</b>     | <b>14° per second</b> |
| <b>Lateral:</b> | <b>.87 G</b>          |
| <b>APPS:</b>    | <b>0%</b>             |
| <b>Brake:</b>   | <b>not applied</b>    |
| <b>VSS:</b>     | <b>32 MPH</b>         |
| <b>LF:</b>      | <b>34 MPH</b>         |
| <b>RF:</b>      | <b>33 MPH</b>         |
| <b>LR:</b>      | <b>28 MPH</b>         |
| <b>RR:</b>      | <b>26 MPH</b>         |

## OUTPUTS

Energize pump

Energize HCU isolation valves 1+2 to close (to block)

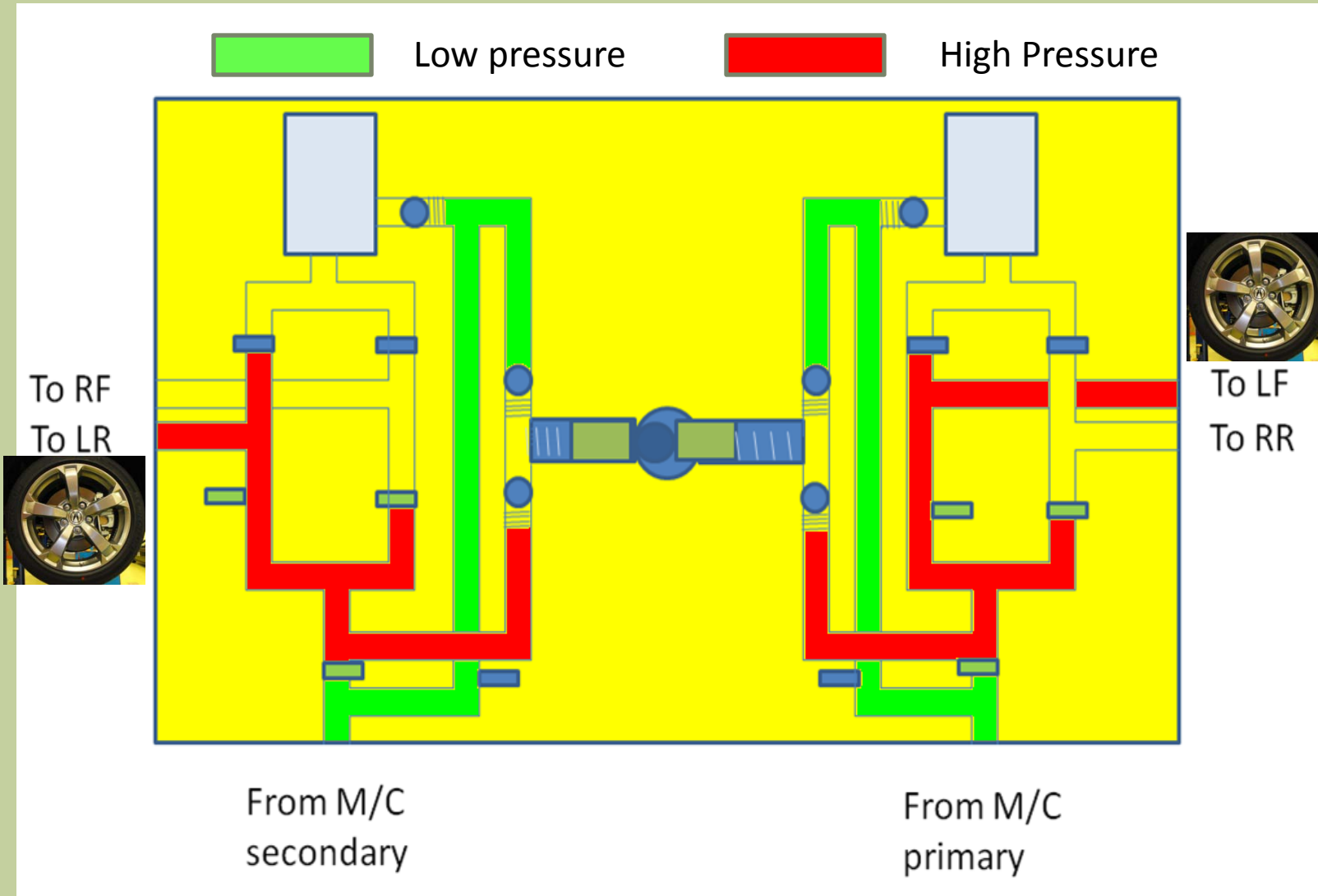
Energize pump inlet valves 1+2 to open ( to flow)

Energize RR and RF inlet valves to close ( to block)

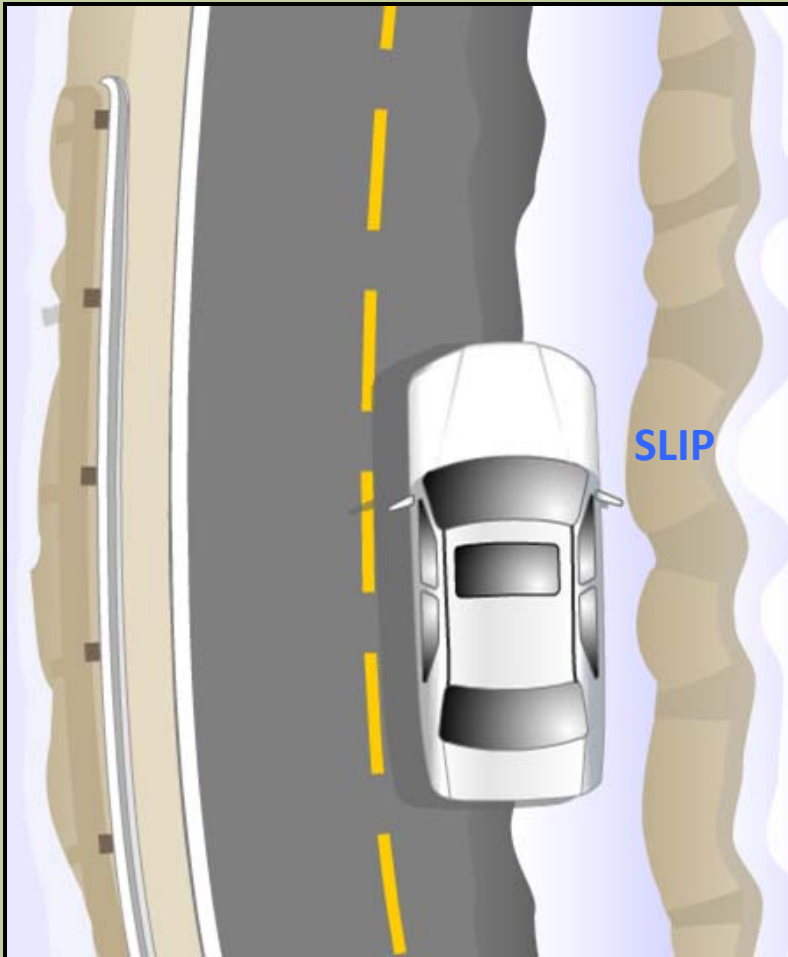
# Response: Apply outer brake(s)



# Response: Apply outer brakes (left)



# Situation 3: Positive wheel slip



Front drive vehicle

*Traction control:*

Drive wheel encounters  
positive slip

Can happen to both  
wheels, this example  
right side only

# Situation 3: Positive wheel slip

## INPUTS

|              |               |
|--------------|---------------|
| SAS:         | 0°            |
| Yaw:         | 0° per second |
| Lateral:     | .00 G         |
| <b>APPS:</b> | <b>27%</b>    |
| Brake:       | not applied   |
| VSS:         | 32 MPH        |
| LF:          | 29 MPH        |
| <b>RF:</b>   | <b>68 MPH</b> |
| LR:          | 29 MPH        |
| RR:          | 29 MPH        |

## OUTPUTS

Send torque reduction request

Activate pump + thermal limiter program

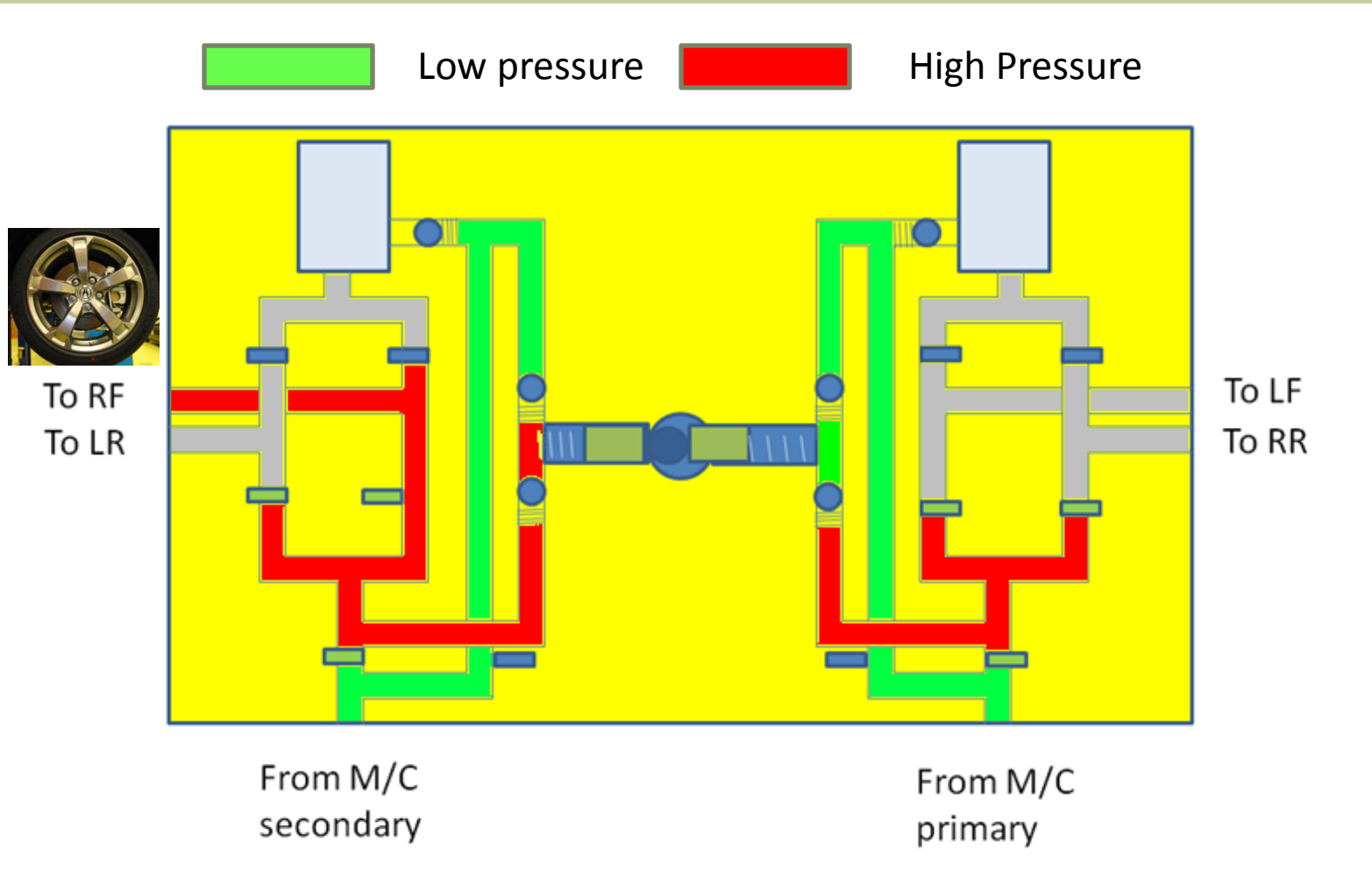
Energize HCU isolation valves 1+2 to close (to block)

Energize pump inlet valves 1+2 to open ( to flow)

Energize inlet valves LF, RR, LR, (to close)

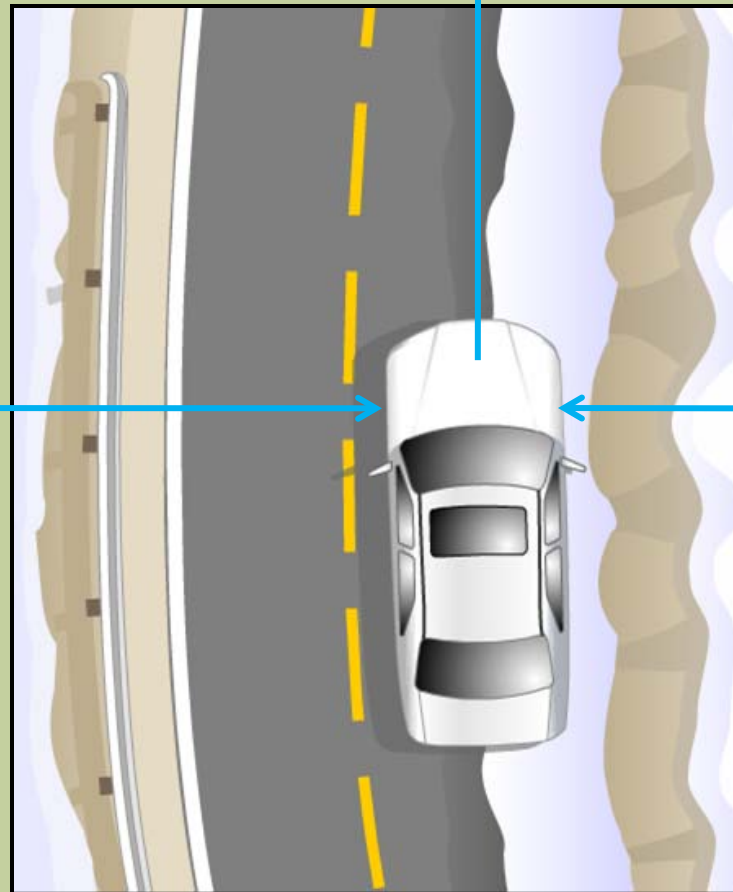


# Response: Pressure to RF wheel brake



# Response: Pressure to RF wheel brake

4. Vehicle moves ahead

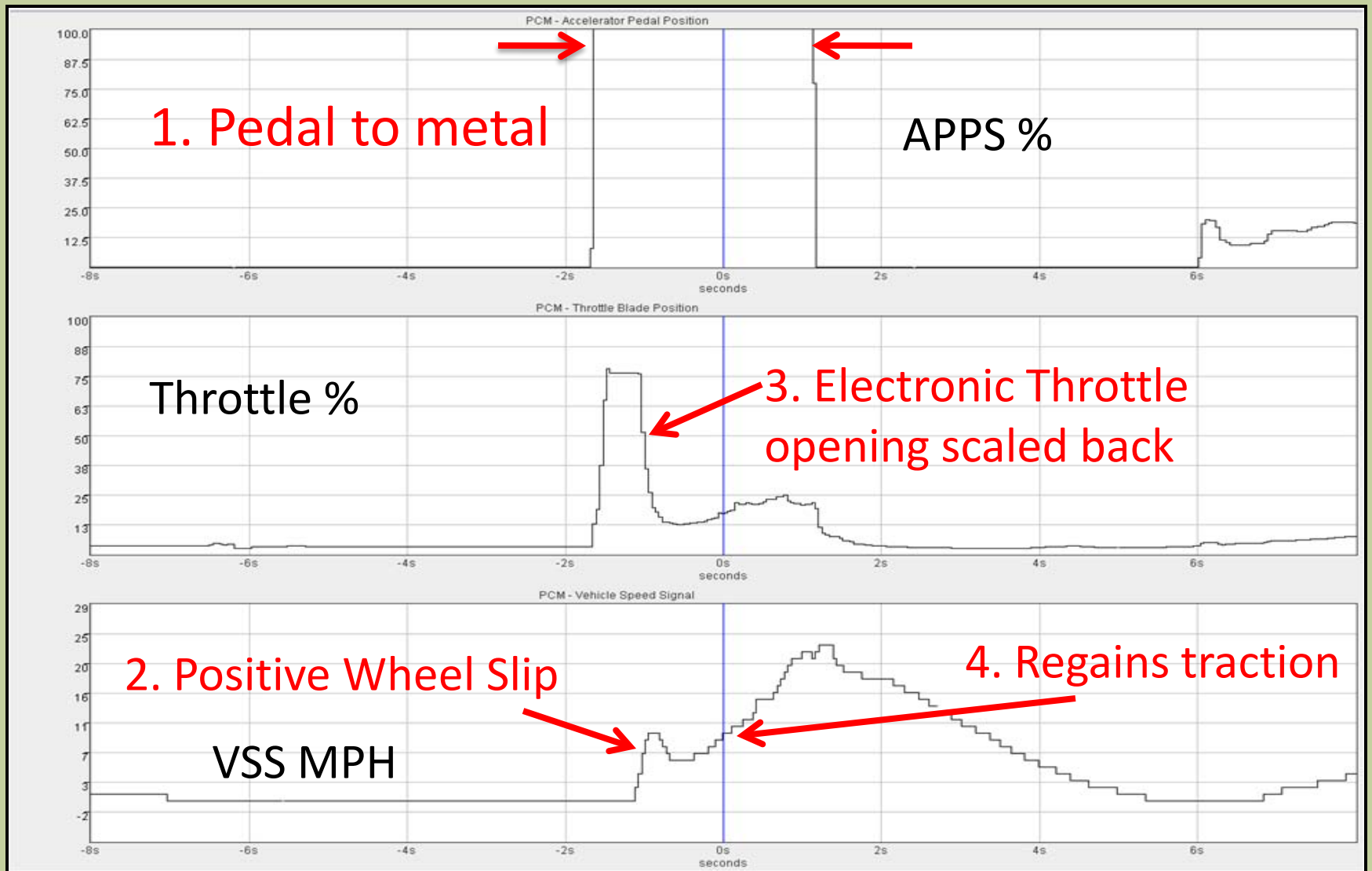


3. Torque applied to wheel with greater traction

2. Brake Pulsed

1. Engine torque reduced

# Response: Engine Torque Reduction

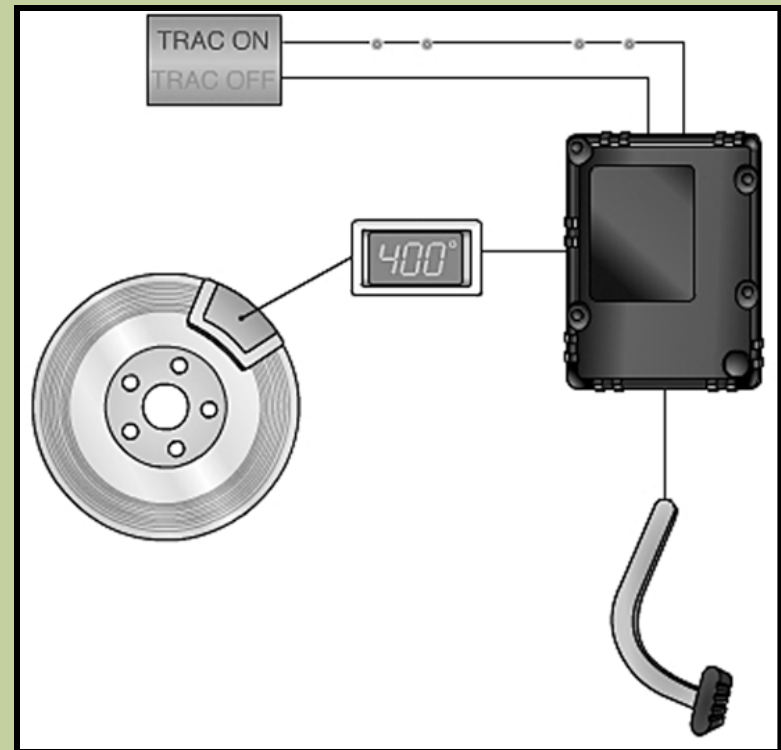


# Response: Pressure to RF wheel brake

## *Thermal Limiter:*

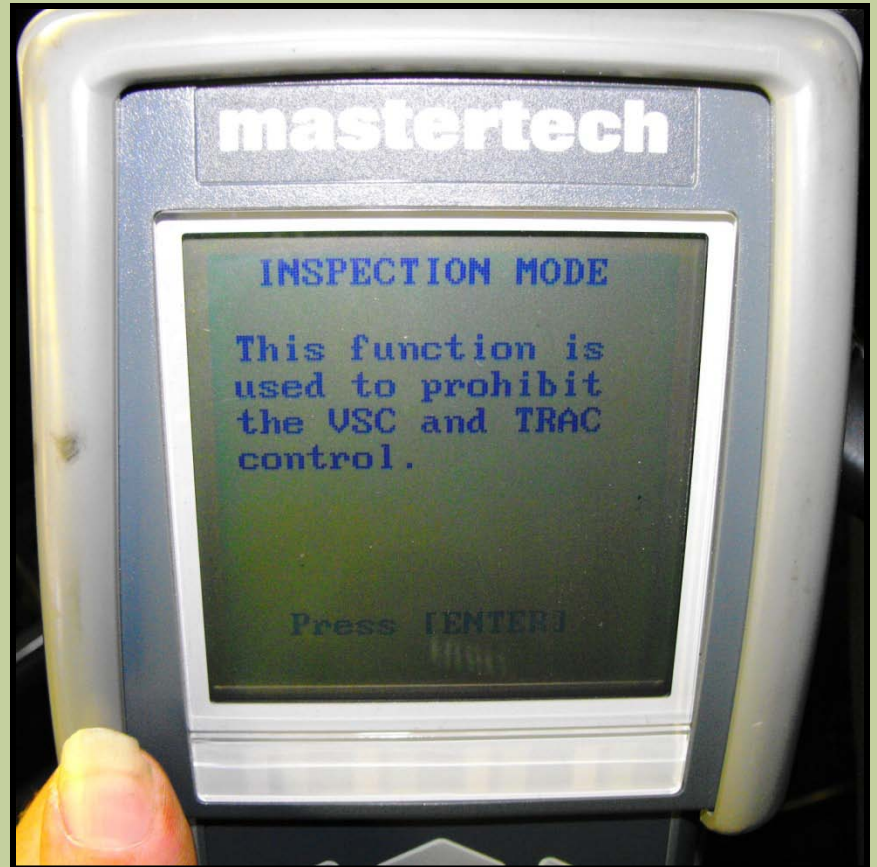
ECU calculates  
temperature based  
on application time  
and wheel speeds

If linings exceed  
programmed value  
traction control is  
halted temporarily



# Service Procedures: Inspection Mode

May be necessary for  
run on dynamometer,  
transmission testing  
etc.

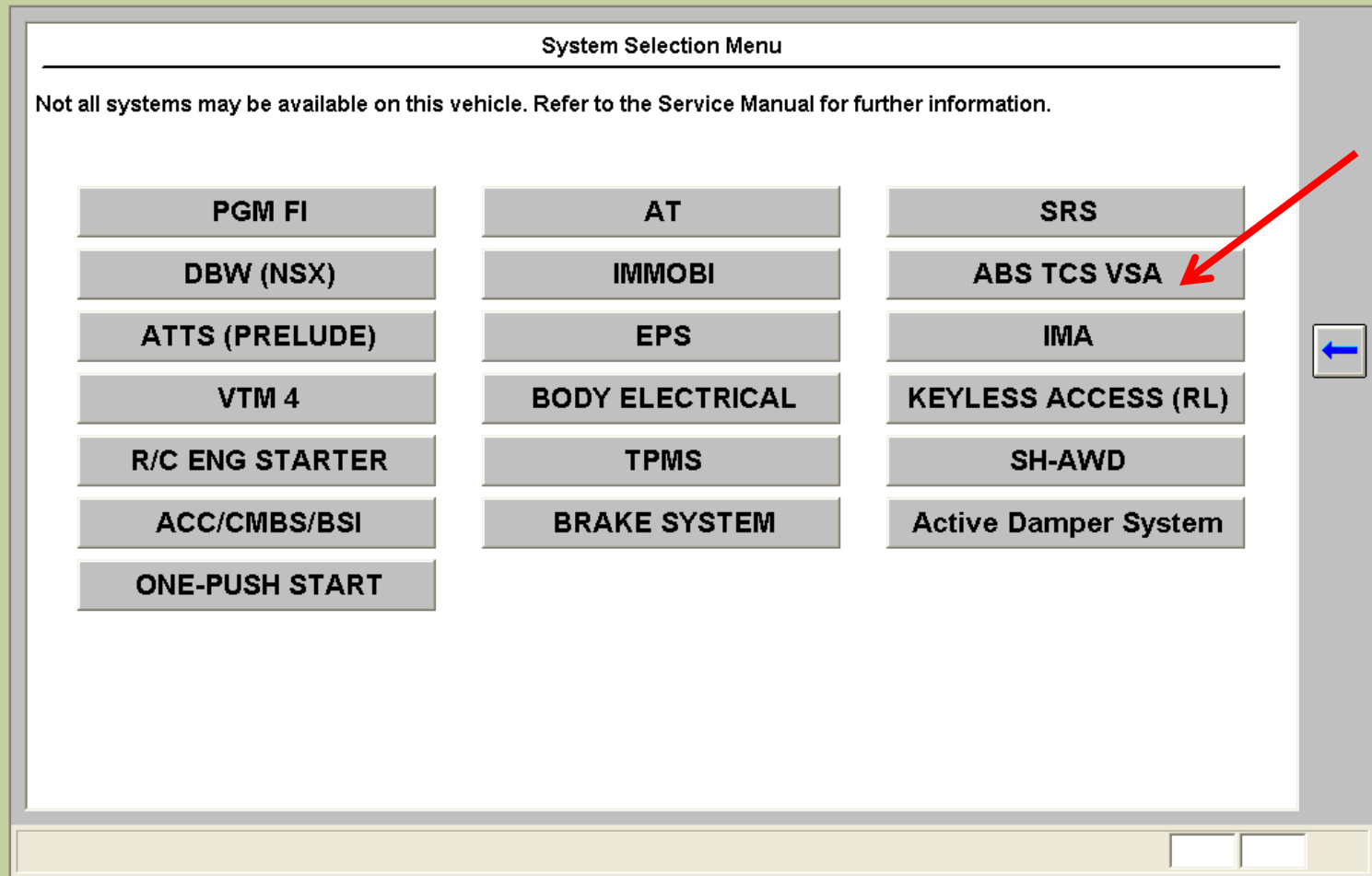


# Service Procedures: SAS, or Accelerometer replacement

Components such as a sensor cluster must be correctly **positioned** and **torqued** to specification and **initialized** using a scan tool.



# Service Procedures: SAS, or Accelerometer replacement



2010 Acura TL screen shots, Honda MVCI scan tool

# Service Procedures: SAS, or Accelerometer replacement

## Neutral Memorization Procedure

After replacing the VSA control unit or Sensor cluster, do the neutral position memorization procedure for all sensors

- \* Steering angle sensor
- \* Brake pressure sensor
- \* Lateral G sensor



2010 Acura TL screen shots, Honda MVCI scan tool



# Service Procedures: SAS, or Accelerometer replacement

## Neutral Memorization Procedure

### Test Conditions

No DTC except for 84-1 is stored in the VSA control unit

The engine is stopped

The vehicle must be level, foot off brake pedal and set the steering wheel straight-ahead.

Steering should be straight ahead

The brake pedal is not pressed



2010 Acura TL screen shots, Honda MVCI scan tool

# Service Procedures: SAS, or Accelerometer replacement

## Neutral Memorization Procedure

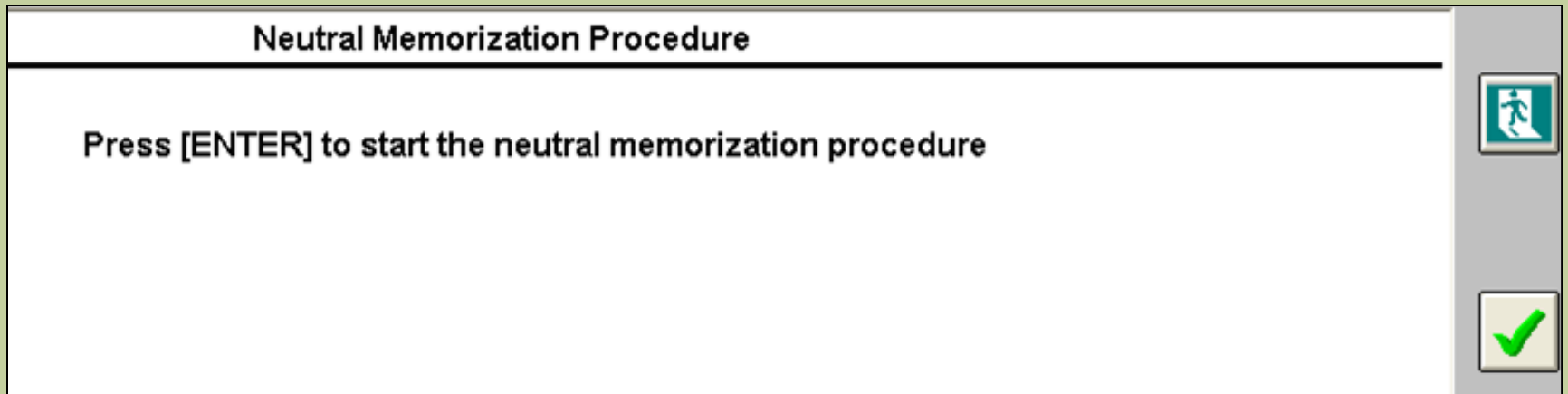
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Turn the ignition switch on



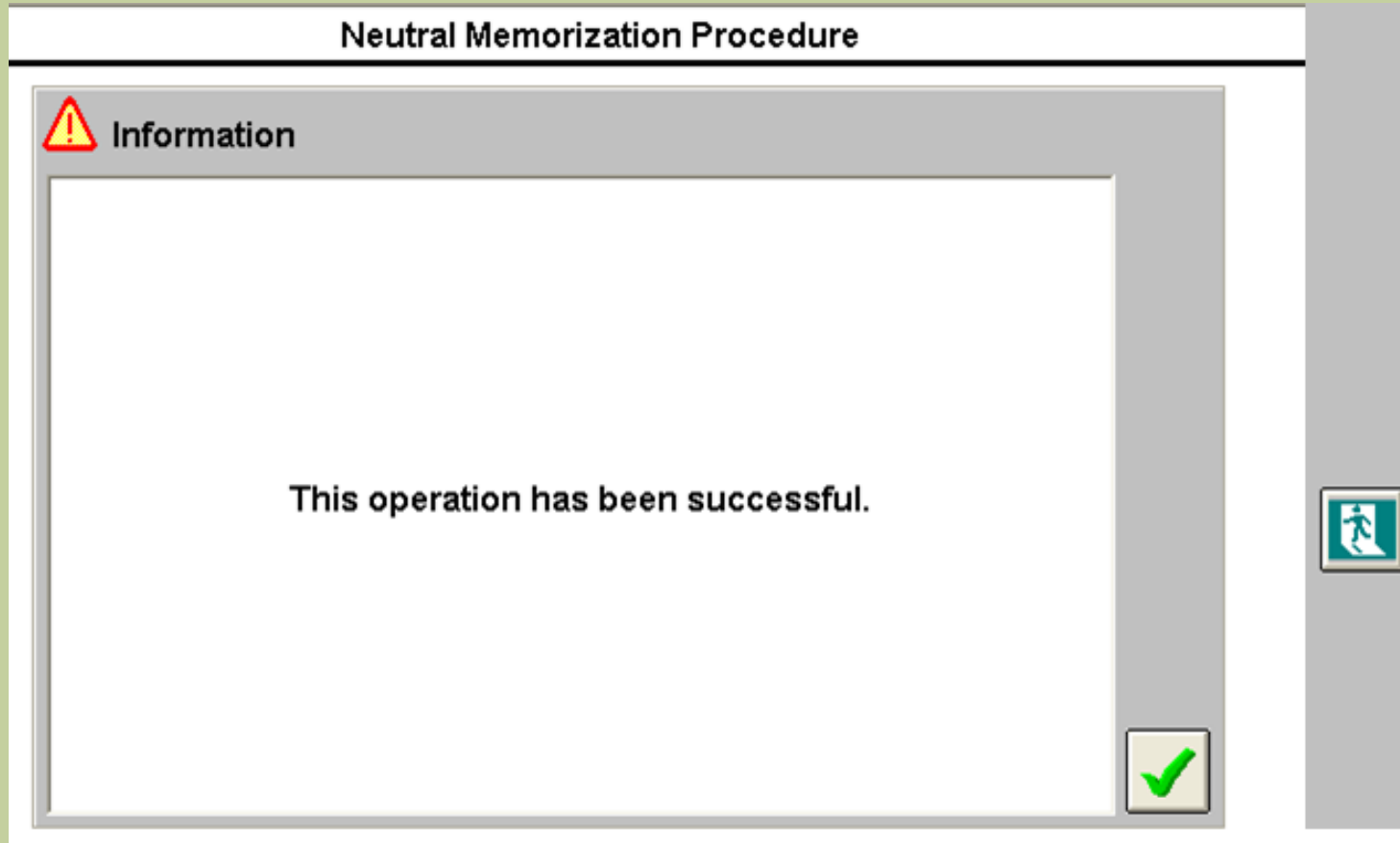
2010 Acura TL screen shots, Honda MVCI scan tool

# Service Procedures: SAS, or Accelerometer replacement








2010 Acura TL screen shots, Honda MVCI scan tool

# Service Procedures: SAS, or Accelerometer replacement



2010 Acura TL screen shots, Honda MVCI scan tool

# Service Procedures: SAS, or Accelerometer replacement

|   |           |   |
|---|-----------|---|
| ADJUSTMENT STATUS OF YAW RATE SENSOR                  | COMPLETED |  |
| ADJUSTMENT STATUS OF LATERAL ACCELERATION SENSOR      | COMPLETED |  |
| ADJUSTMENT STATUS OF LONGITUDINAL ACCELERATION SENSOR | COMPLETED |  |
| ADJUSTMENT STATUS OF SAS                              | COMPLETED |  |
| ADJUSTMENT STATUS OF BRAKE PRESSURE SENSOR            | COMPLETED |  |

2010 Acura TL screen shots, Honda MVCI scan tool

# Service Procedures: Bleeding

Hydraulic Control Unit  
replacement typical  
bleed procedure:

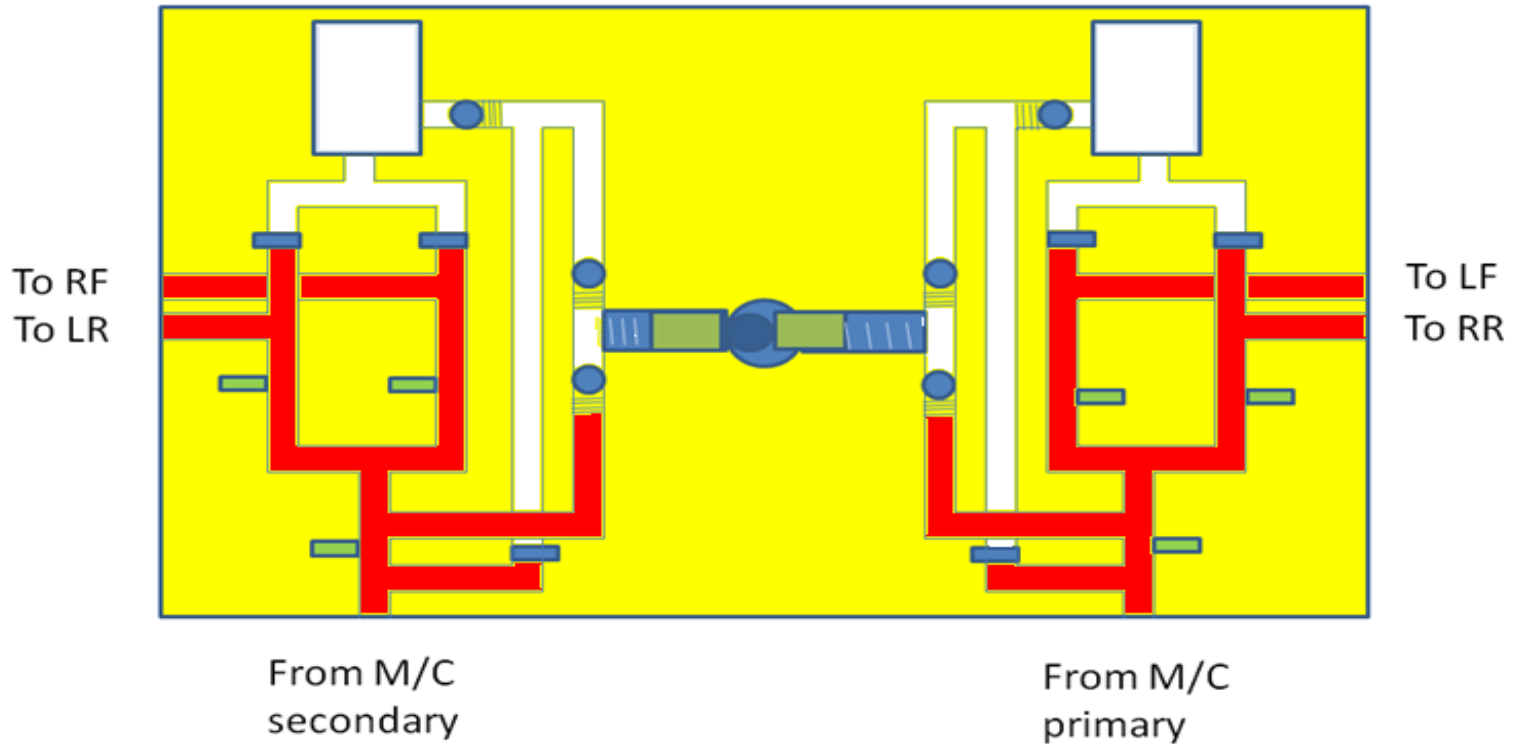
1. Manual Bleed
2. Scan tool bleed
3. Followed by a manual bleed



# Service Procedures: Bleeding



Portion with potential air still trapped during conventional bleed



# Service Procedures: Bleeding

**Vehicle View**  
Roll over an ECU to see full name. Click on an ECU for complete details.

2007 JS 2.7L  
VIN: 1B3LC56R98N671075  
Battery: 12.17 volts

Search  
Service Information

**Select ABS**

**Legend**

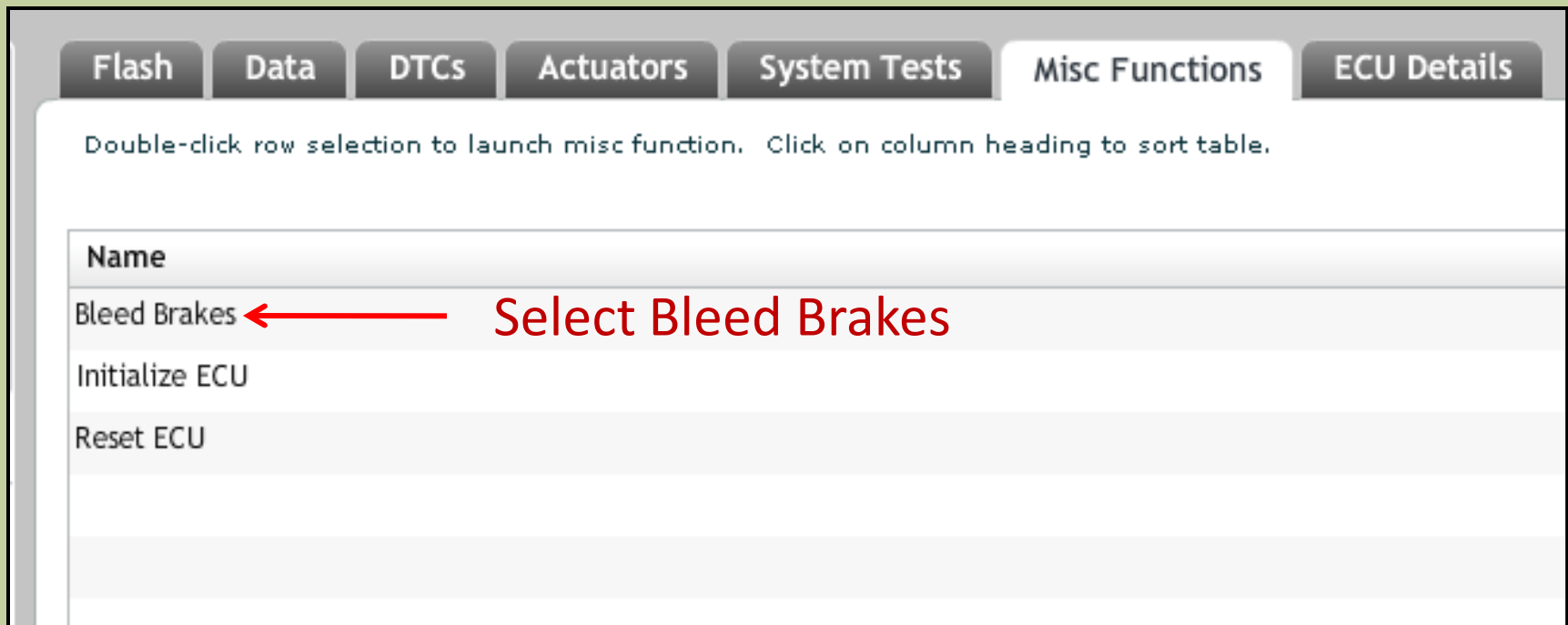
- Active ECU
- Non-responsive ECU
- DTCs Present
- ECU Not Built
- Scanning ECU
- New Flash Available
- Diag CAN C Bus Line
- CAN C Bus Line
- CAN B Bus Line

The diagram illustrates the vehicle's ECU network. The ABS ECU is highlighted in blue and selected with a red arrow. It is connected to the TIPMCGW (Transmission Input Module Control Gateway) via a CAN B Bus Line (blue line). The TIPMCGW is connected to the vehicle's diagnostic port. Other ECUs shown include PCM, AWD, TCM, SAS, VE53, DDM, PDM, PTCA, ITM, CCN, ORC, WCM, HFM, RADIO, HVAC, and AMP. The network is organized into two main branches: one for the front-end ECUs (PCM, AWD, TCM, ABS, SAS) and another for the rear-end ECUs (VE53, DDM, PDM, PTCA, ITM). The TIPMCGW acts as a central hub connecting these two branches.

2008 Dodge screen shots, Wi-Tech scan tool

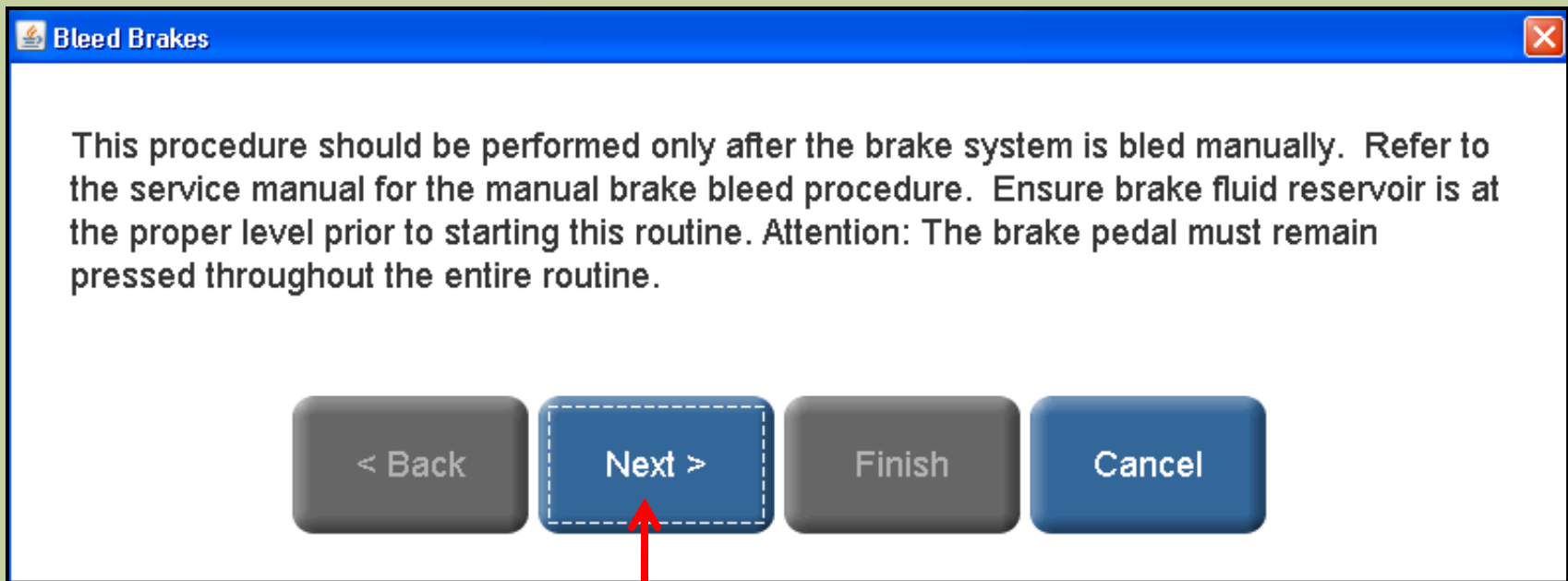


# Service Procedures: Bleeding



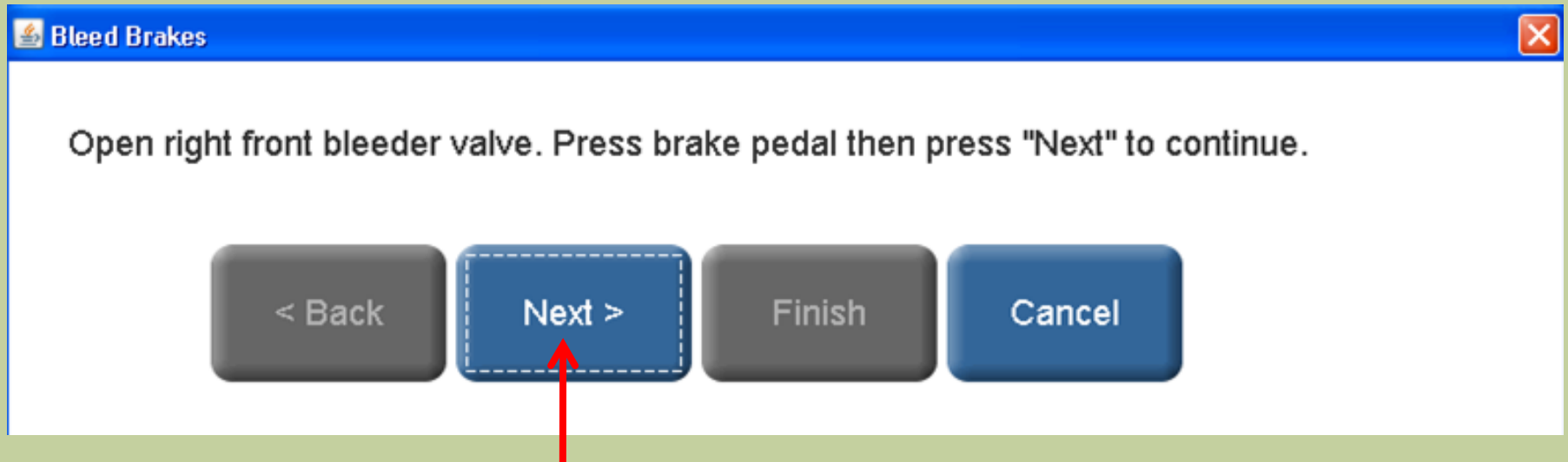
2008 Dodge screen shots, Wi-Tech scan tool

# Service Procedures: Bleeding



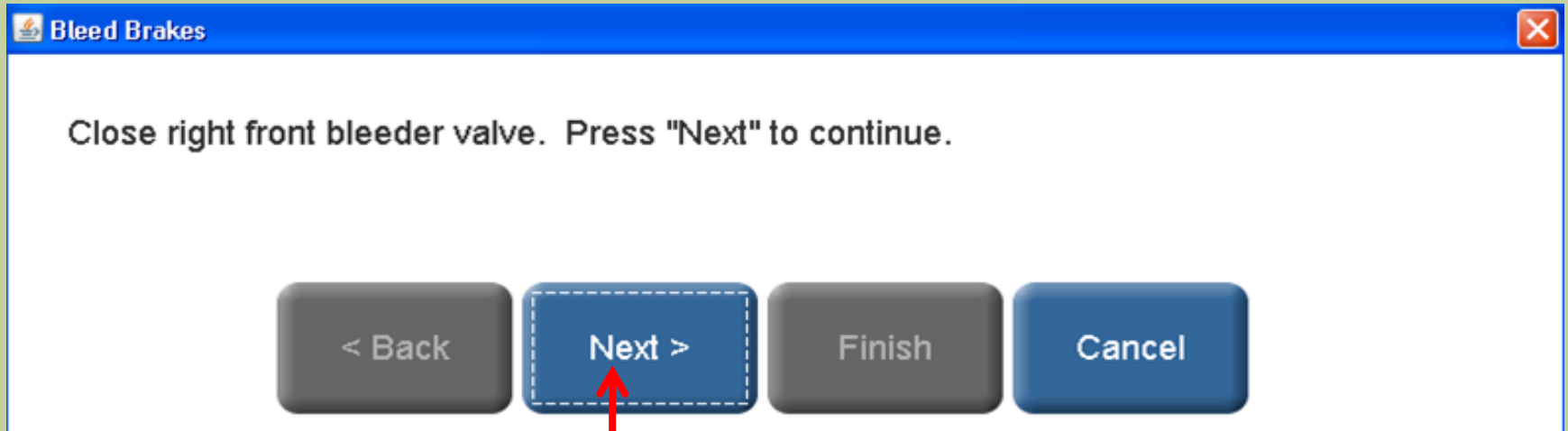
2008 Dodge screen shots, Wi-Tech scan tool

# Service Procedures: Bleeding



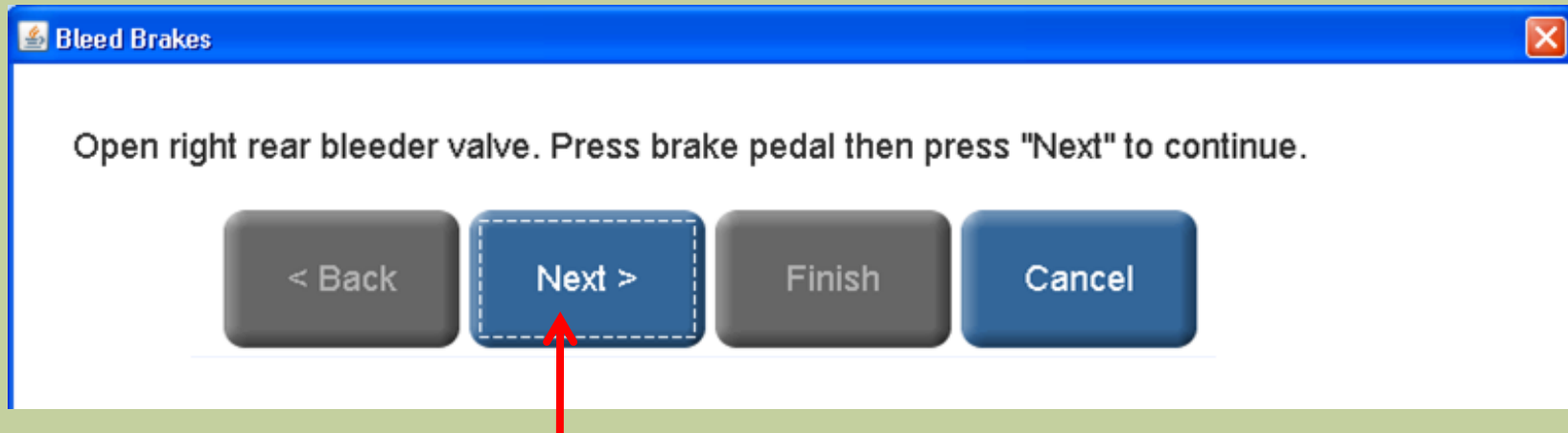
(at this point the pump runs and HCU valves cycled)

# Service Procedures: Bleeding



2008 Dodge screen shots, Wi-Tech scan tool

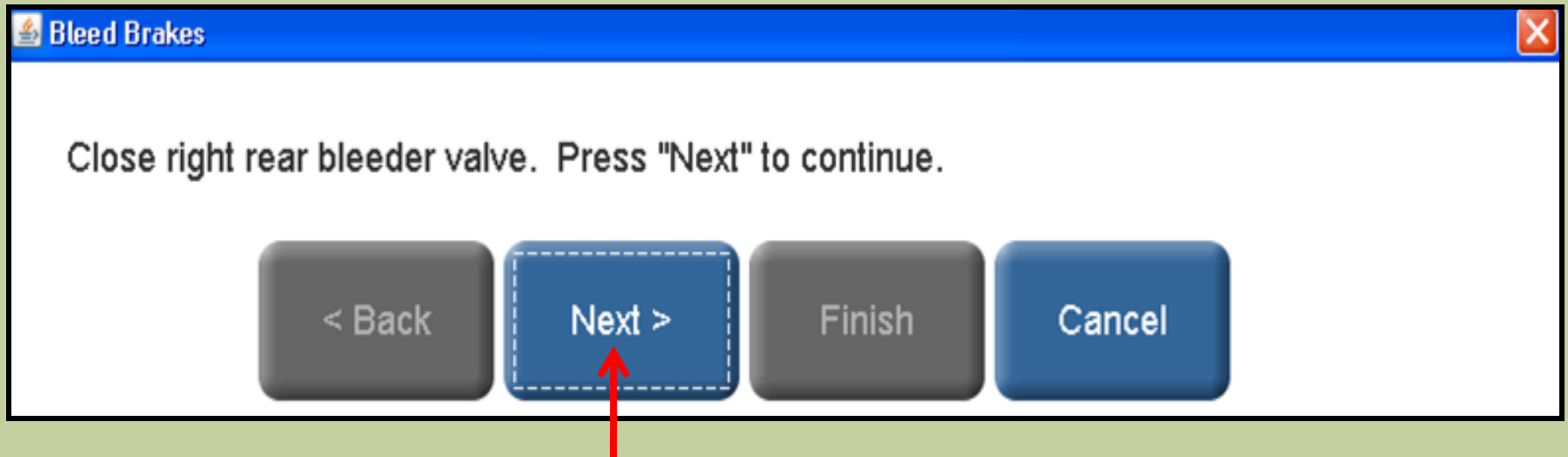
# Service Procedures: Bleeding



(at this point the pump runs and HCU valves cycled)

2008 Dodge screen shots, Wi-Tech scan tool

# Service Procedures: Bleeding



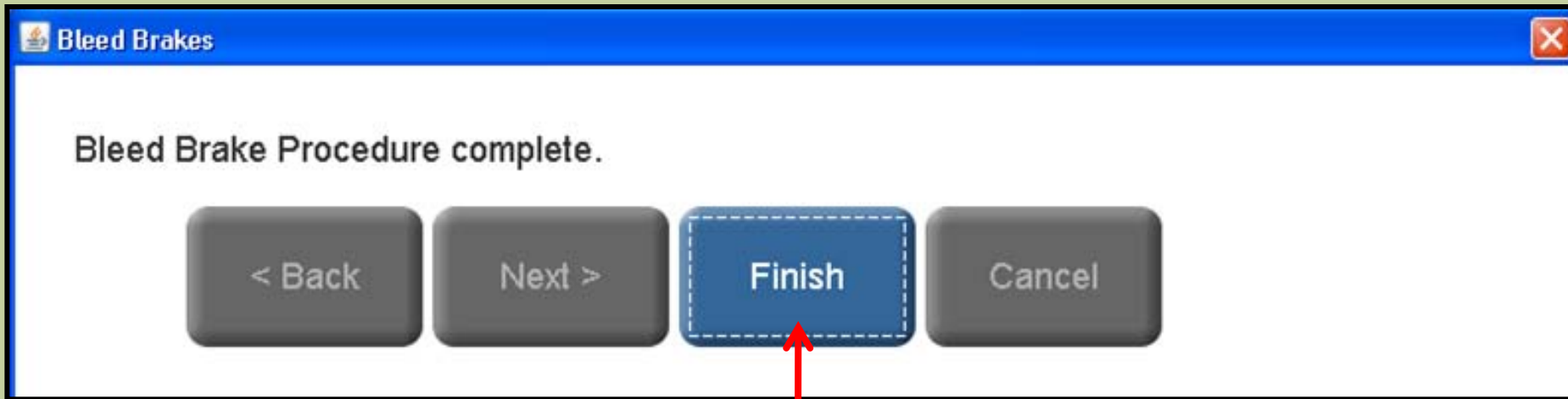
2008 Dodge screen shots, Wi-Tech scan tool

# Service Procedures: Bleeding



2008 Dodge screen shots, Wi-Tech scan tool

# Service Procedures: Bleeding



2008 Dodge screen shots, Wi-Tech scan tool



# Basic No Code Diagnostics:

1. Load test **battery** and test terminal connections
2. Verify matching and correct **tire size** along with proper inflation **pressure**
3. Inspect **tone rings** both visually and with scope
4. Measure for wheel **bearing play**
5. May need to perform **system bleed** and or **neutral memorization** procedures

# Presentation Conclusion

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Questions, comments: [dixonm@siu.edu](mailto:dixonm@siu.edu)

*Thank You*