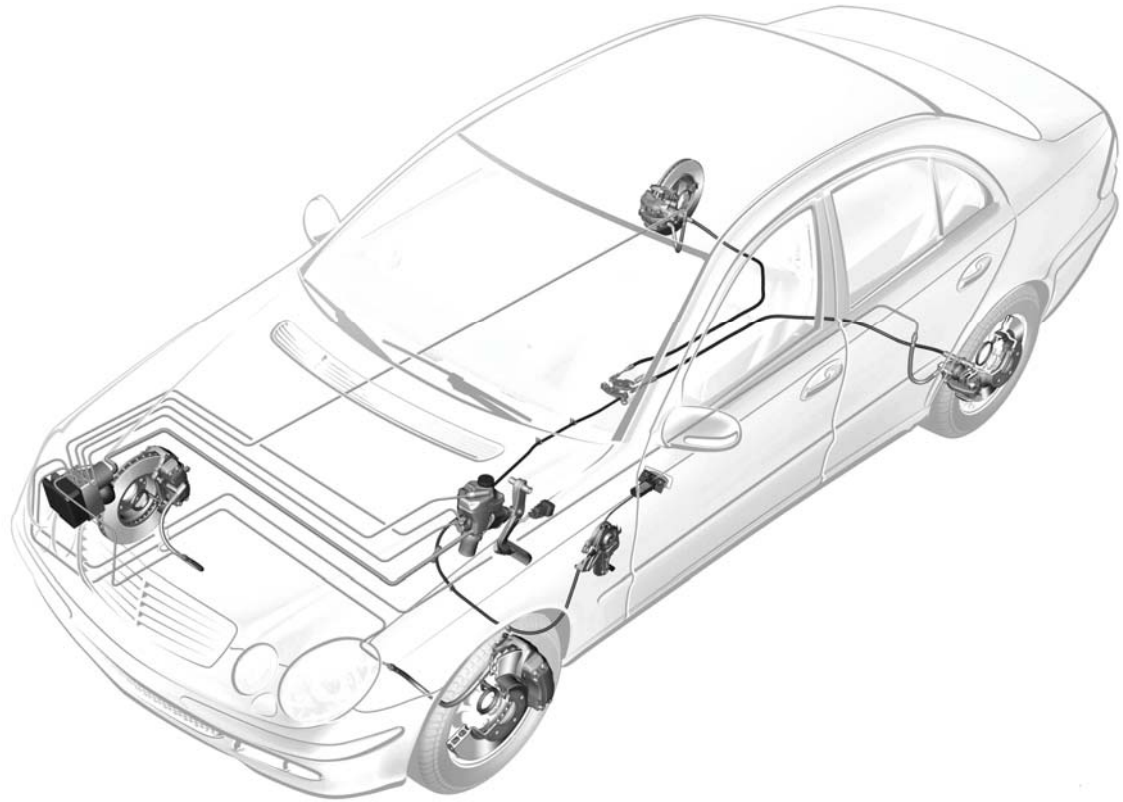




Mercedes-Benz

Sensotronic Brake Control (W211 SBC)



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Index

Introduction	4
Advantages	5
Components	10
Overview	11
X11/4	12
Warning Displays	13
Brake Operating Unit (BOU)	16
Pedal Value Sensor	19
Hydraulic Unit (A7/3)	26
Emergency Operation	29
Pressure Supply	30
Temperature Compensation	38
Wake up	39
Predrive Check (PDC)	40
Delayed Off	41
Deactivation	42
Activation	45
Warning Buzzer	52
Bleeding the System	54
Acronyms	57

Evolution!

ABS (Anti lock Brakes 1984)

+ ASR (Automatic Slip Regulation 1991)

+ ETS (Electronic Traction System 1994)

+ ESP (Electronic Stability Program 1996)

+ BAS (Brake Assist System 1998)

= SBC (Sensotronic Brake Control 2002)

SBC = Sensotronic Brake Control, the next level of
brake control !

ABS Function

ABS - prevents the wheels from locking up during braking, maintaining steerability and directional control during deceleration

ASR, EBR and ESP Functions

ASR (braking moment) - prevents drive wheel from spinning while driving.

EBR - reduces brake slip at the drive wheels during deceleration to ensure directional control.

ESP - prevents the vehicle from breaking away when oversteering or understeering.

Advantages of SBC

- Improves metering of required brake pressure
 - each wheel can be precisely controlled
- Improved BAS function
 - monitors release of accelerator pedal
 - application of brake
 - maximum pressure available immediately
 - Pre-filling of system (overcoming play)
 - when the BAS function is anticipated (identified by the rapid release of the gas pedal), slight pressure is applied

Advantages of SBC

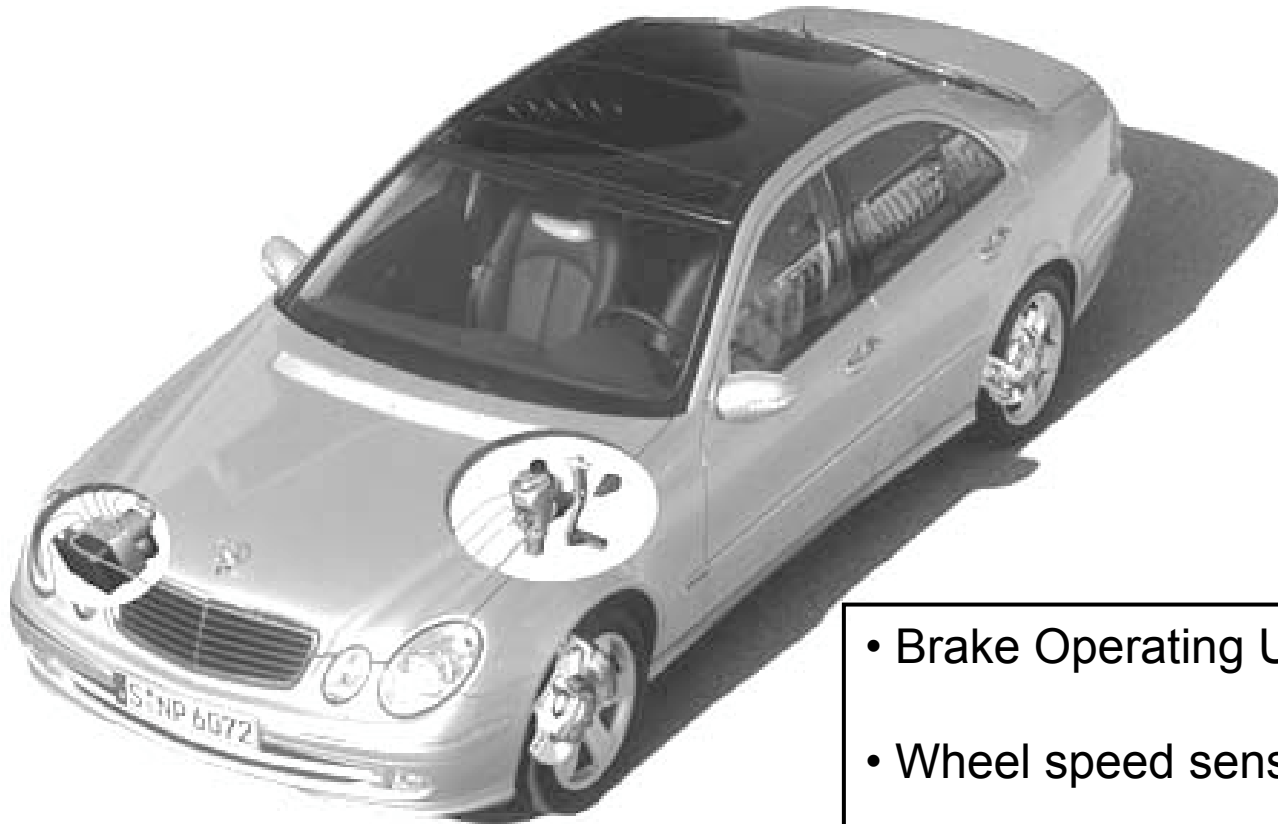
- Optimal brake force distribution front to rear and side to side (EBP)
 - allows brake proportioning front to back and side to side
- No pedal vibration during ABS operation
 - eliminates “distracted” to the driver during critical moments
 - indicator light in instrument cluster signals traction loss
- Improved driving dynamics: ABS, ASR, and ESP
 - faster response to brake request inputs

Advantages of SBC

- Pressure reduction at standstill
 - reduces stress on components
- Dry braking function
 - wiper input via CAN
 - ~every 7 to 14 minutes
 - brake actuation changes time interval

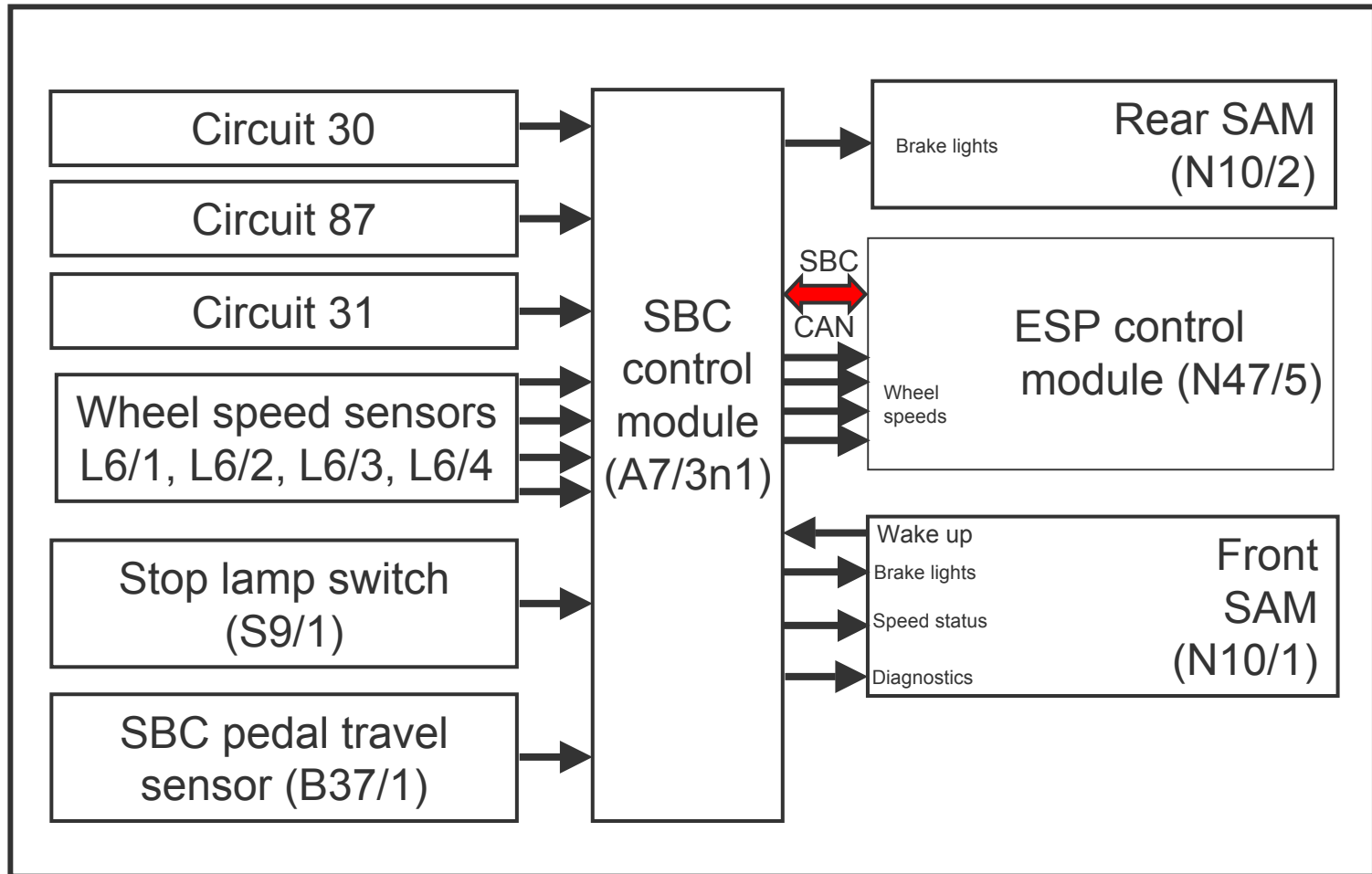


SBC Components

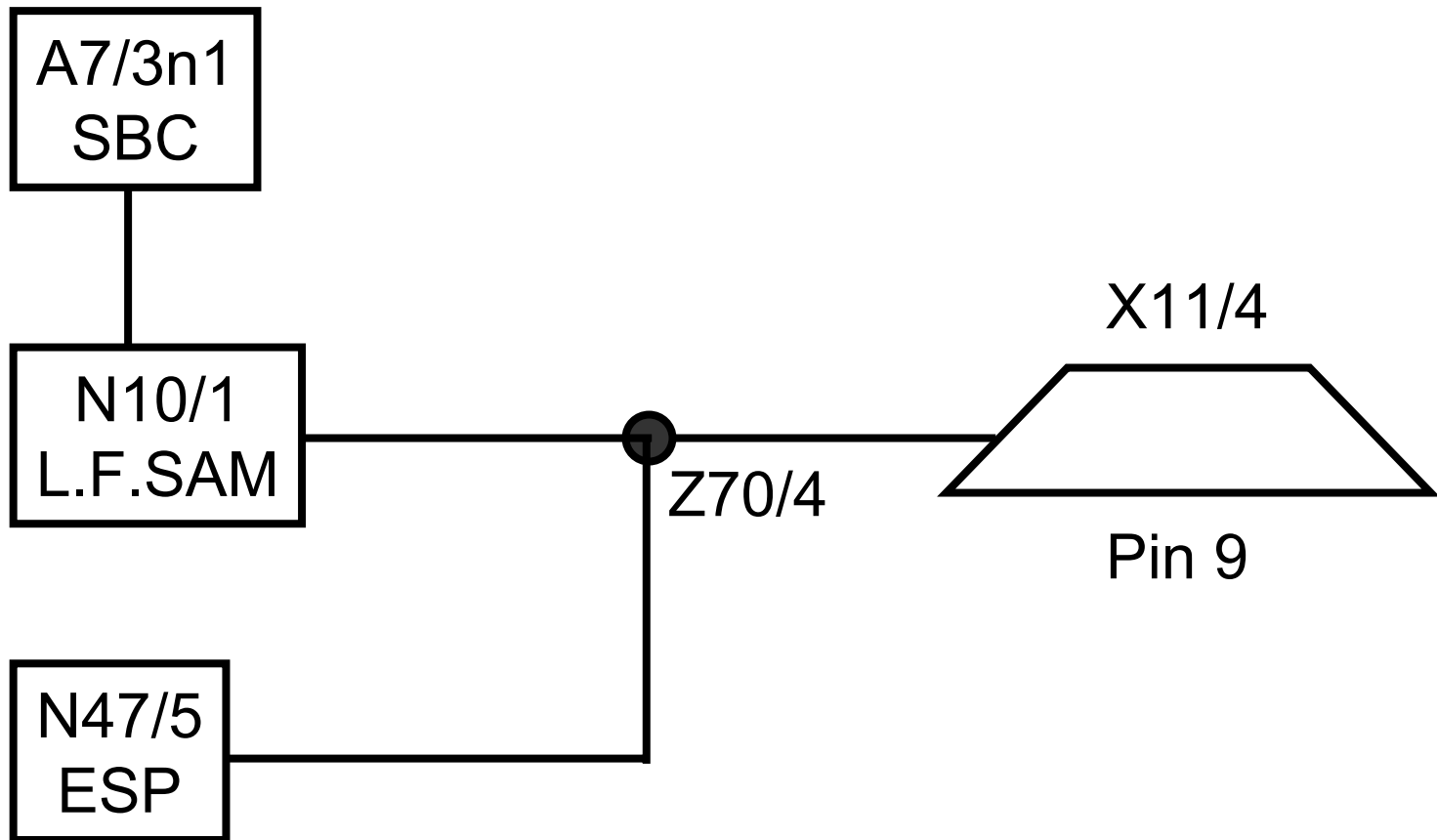


- Brake Operating Unit (BOU)
- Wheel speed sensors
- Traction System Hydraulic Unit A7/3

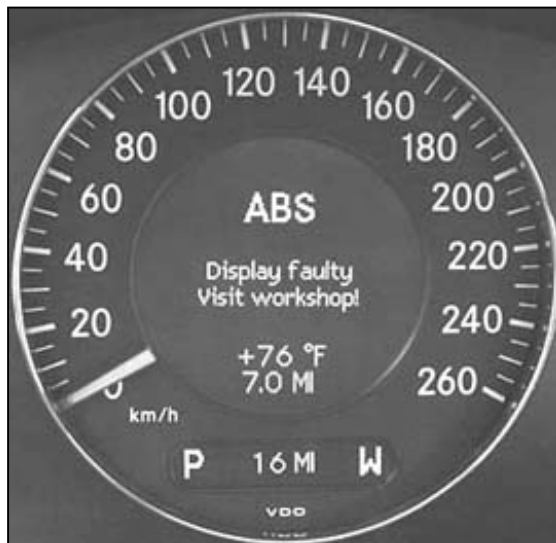
System Overview



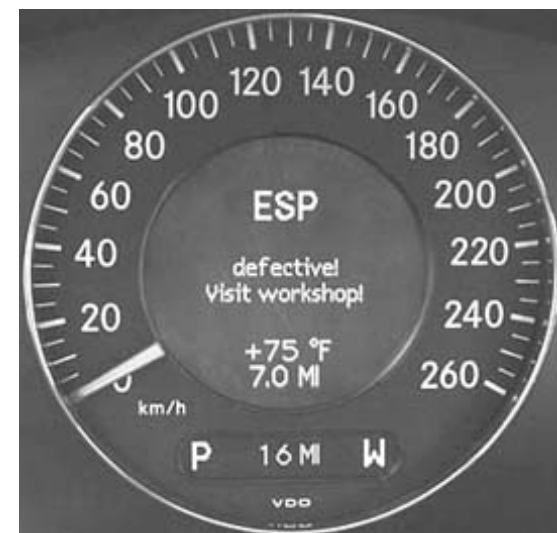
X11/4 Connection



Warning Display



Complete ESP control module failure - Instrument cluster will scroll through failure displays



Warning Display

SBC control module failure



Certain faults will trigger audible signal

Quick Quiz

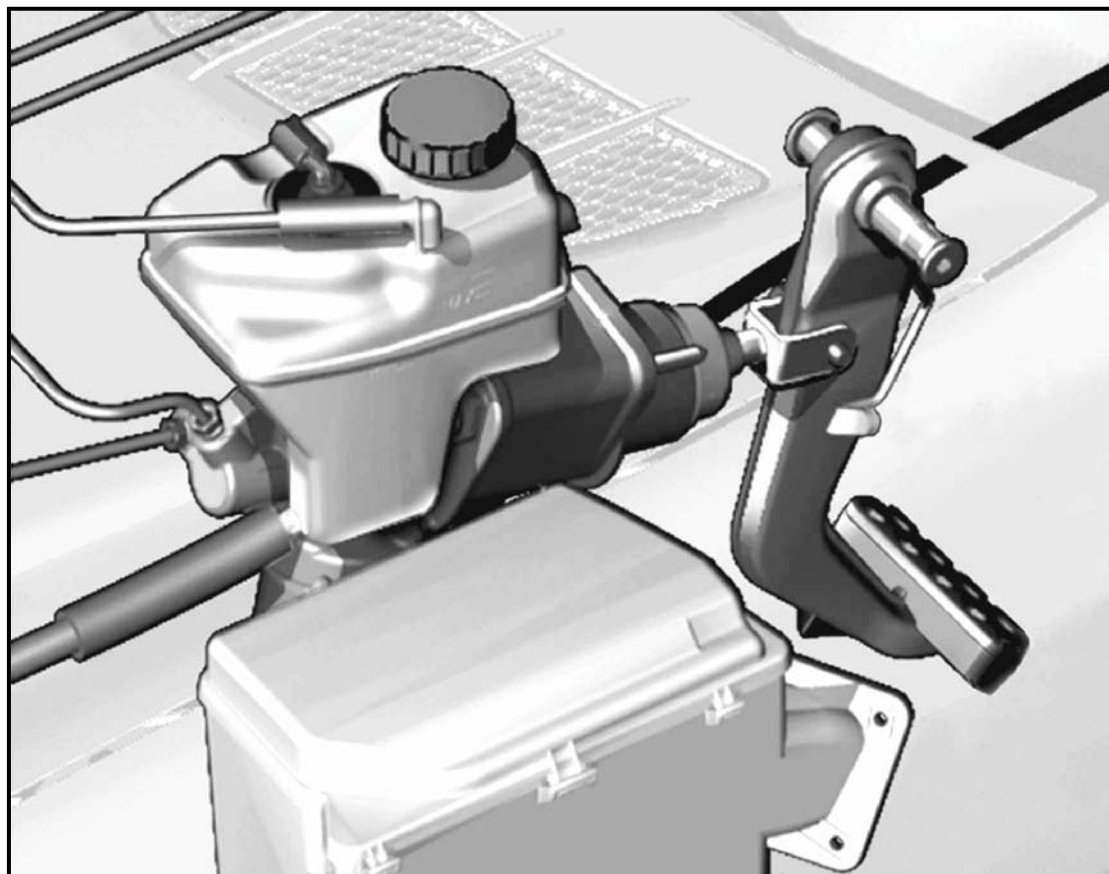
Q1. The 211 has how many wheel speed sensors?

A1. _____

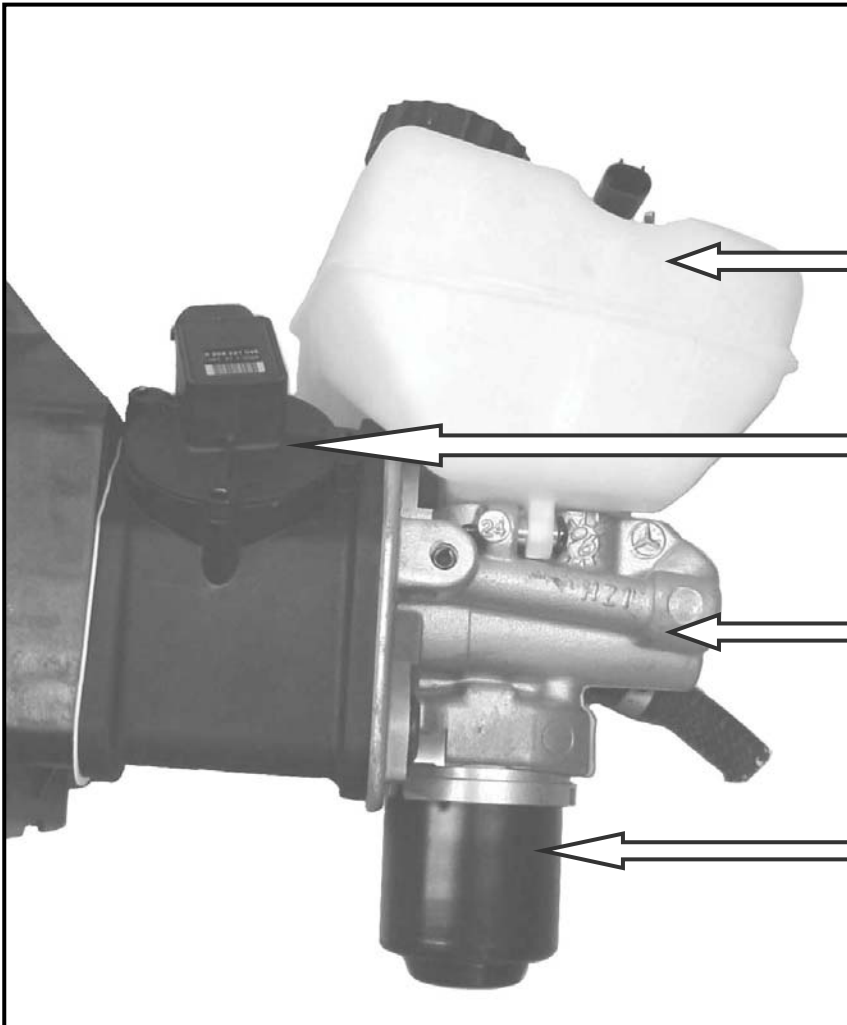
Q2. Which CAN is used for SBC communication?

A3. _____

Brake Operating Unit - (BOU)



Brake Operating Unit



The Brake Operating Unit (BOU) consists of the following:

- Brake fluid reservoir
(Do not overfill!)
- SBC pedal value sensor (B37/1)
- Tandem master cylinder
- Brake pressure simulator
(Note: no vacuum booster)

Fluid Reservoir

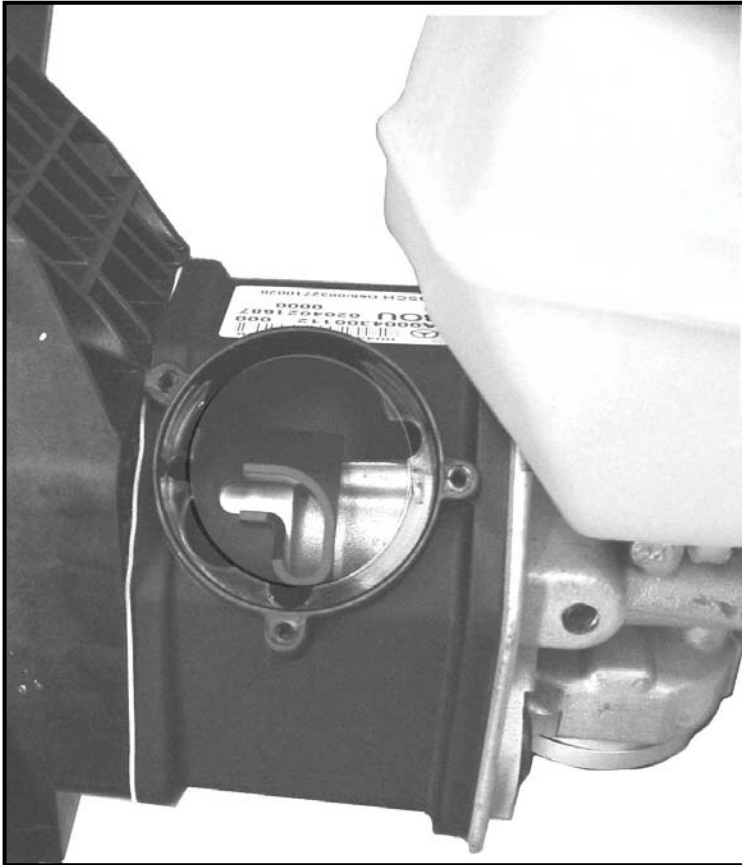


- Do not overfill!
- Ultraviolet protection

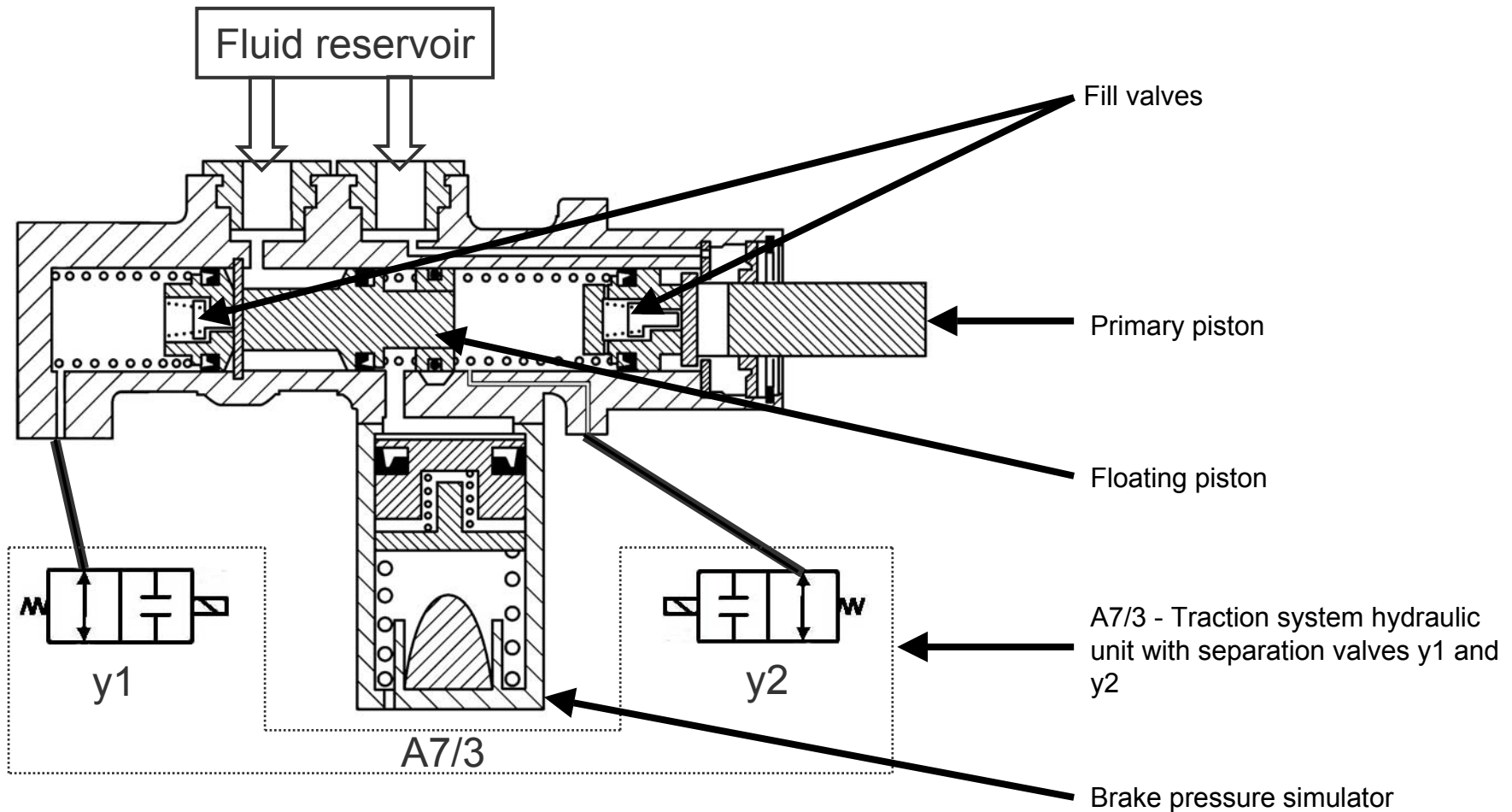


Pedal Value Sensor - B37/1

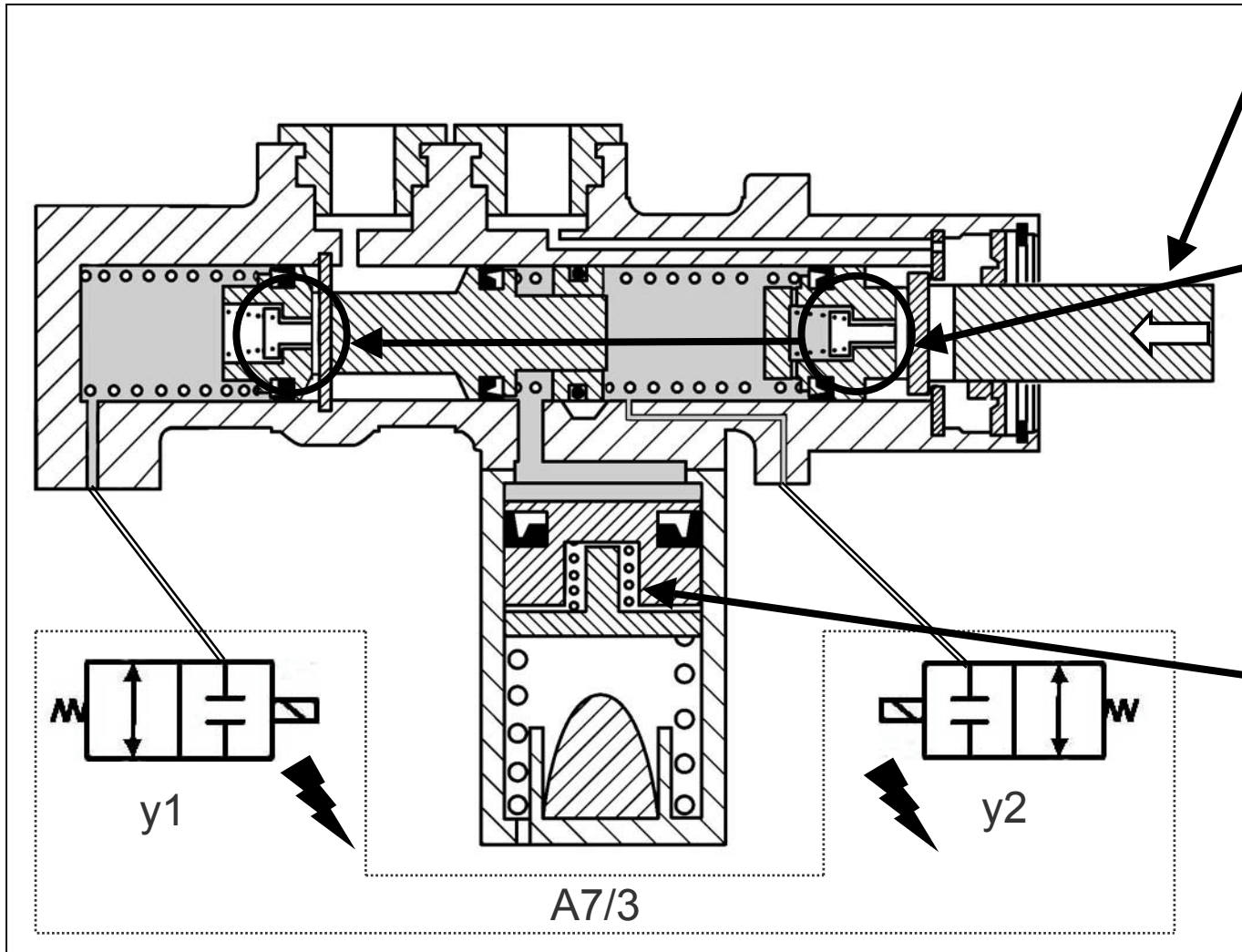
- Contains two Hall Effect sensors
- Converts pedal travel to electrical signal
- Provides input to SBC control module A7/3



BOU Tandem Master Cylinder

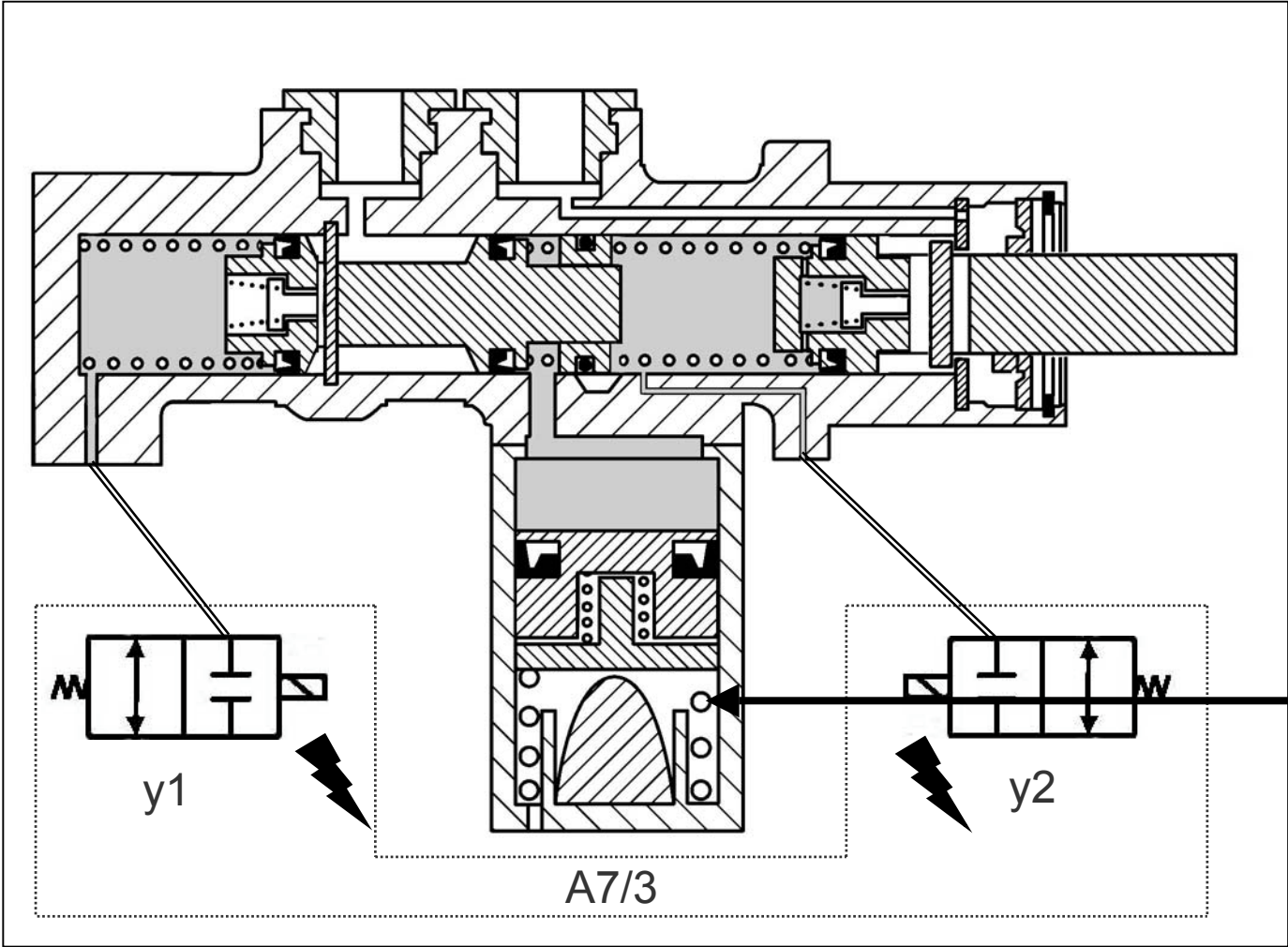


Normal Braking - Light Pressure



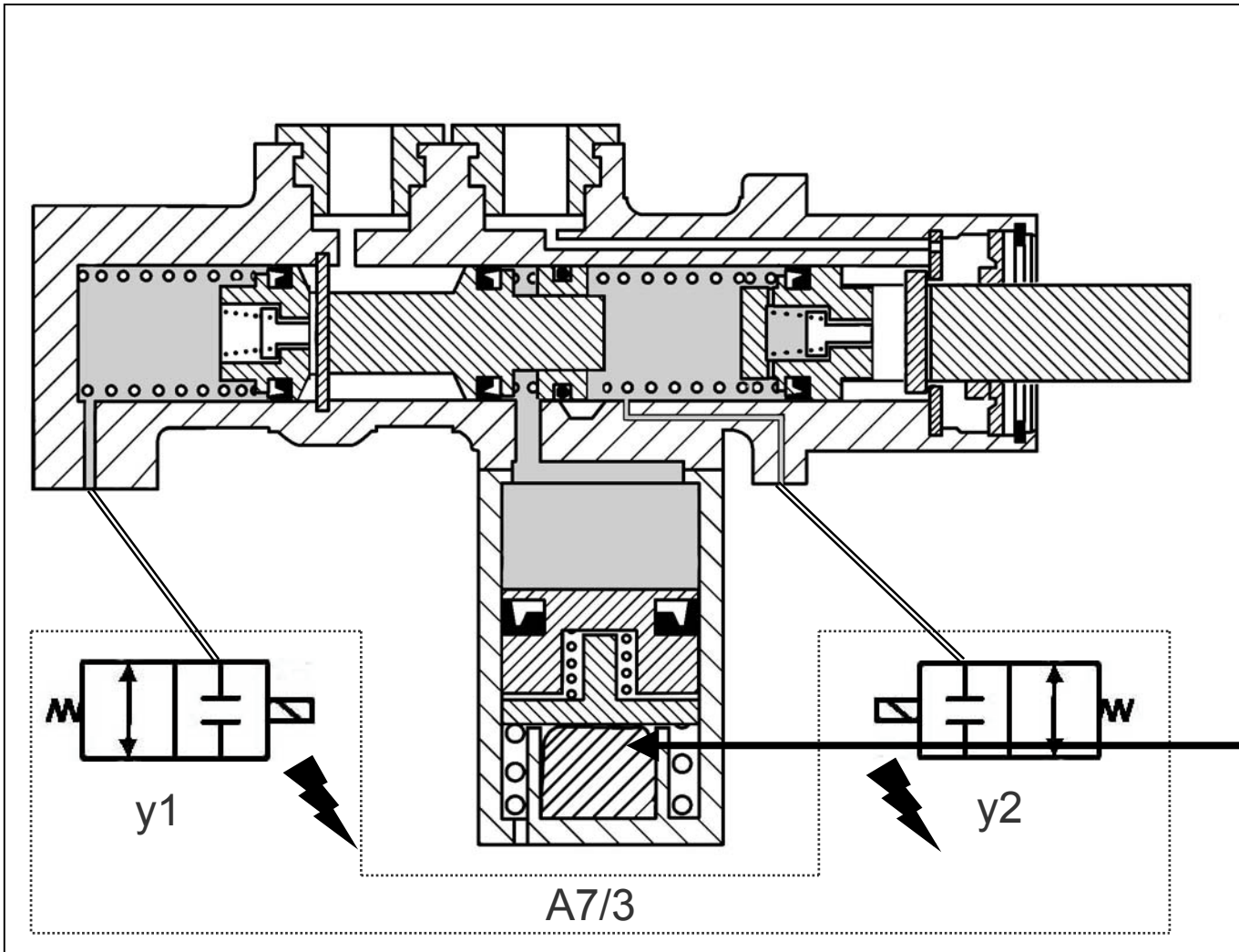
- Driver applies pressure to the brake pedal
- Fill valves close
- Pedal travel sensor sends a signal to A7/3
- y1 and y2 energized, preventing fluid movement externally
- Floating piston allows fluid to enter simulator, compressing the light spring, providing pedal feel to the driver

Normal Braking - Increased Pressure



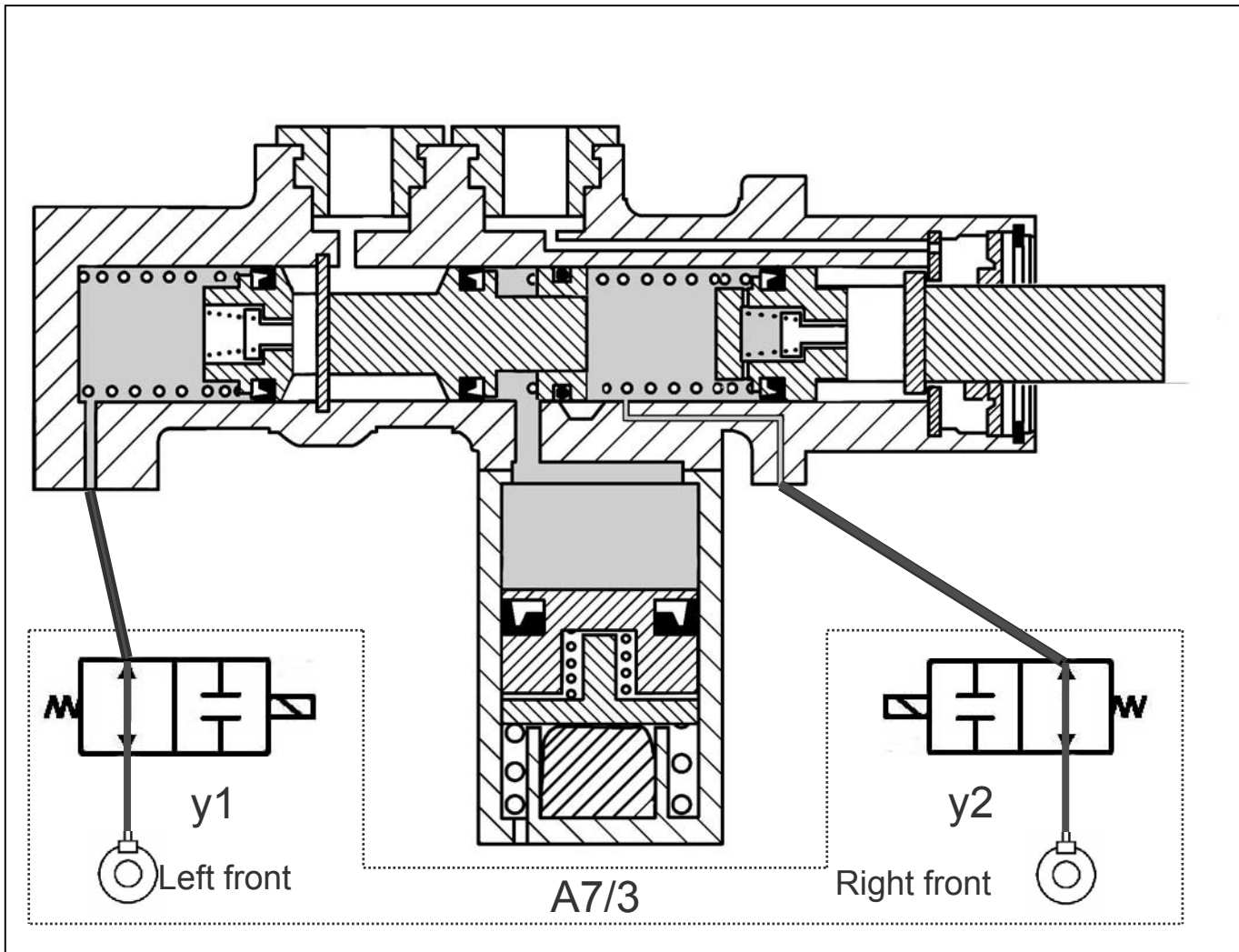
- Increasing pedal travel causes the larger spring to compress, providing harder pedal feel

Normal Braking - Strongest Feedback



- Further pedal travel causes piston to compress rubber bumper, providing greatly increased pedal pressure

Emergency Operation



- All electrical functions canceled
- Hydraulic pressure created with NO power assist
- Pressure directed through A7/3 y1 and y2 to

Left Front and
Right Front calipers
only!

Quick Quiz

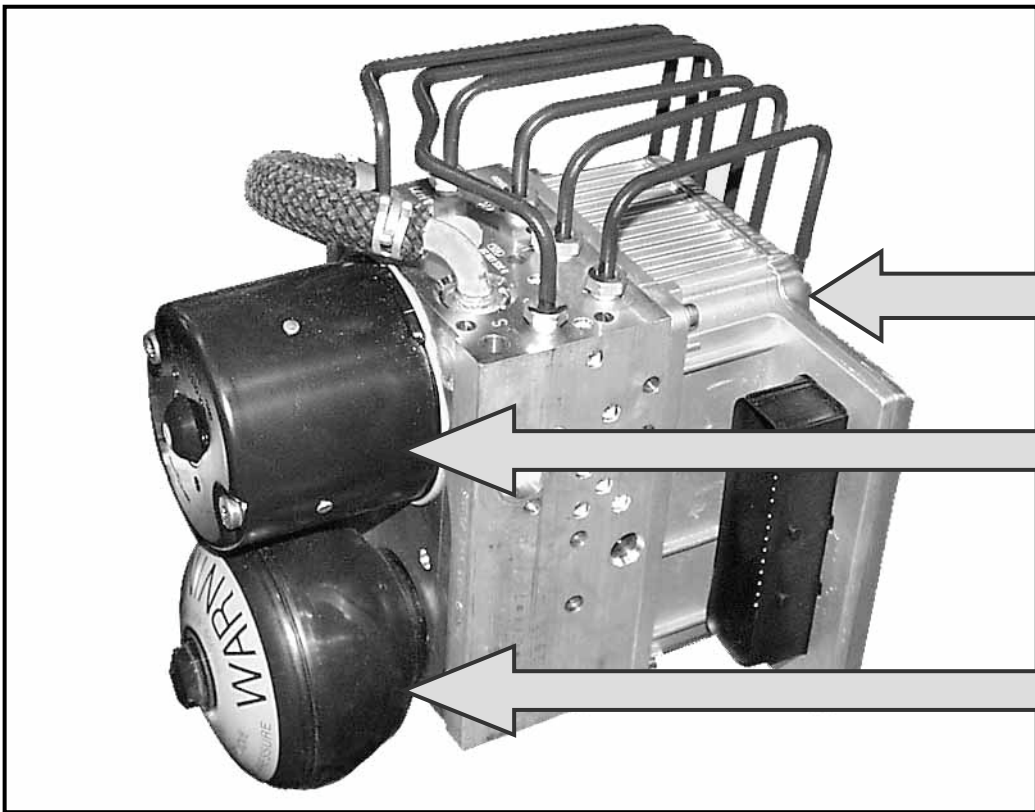
Q1. Why is there a plastic cover over the brake reservoir?

A1. _____

Q2. Which wheels will have the brakes applied during a major failure?

A2. _____

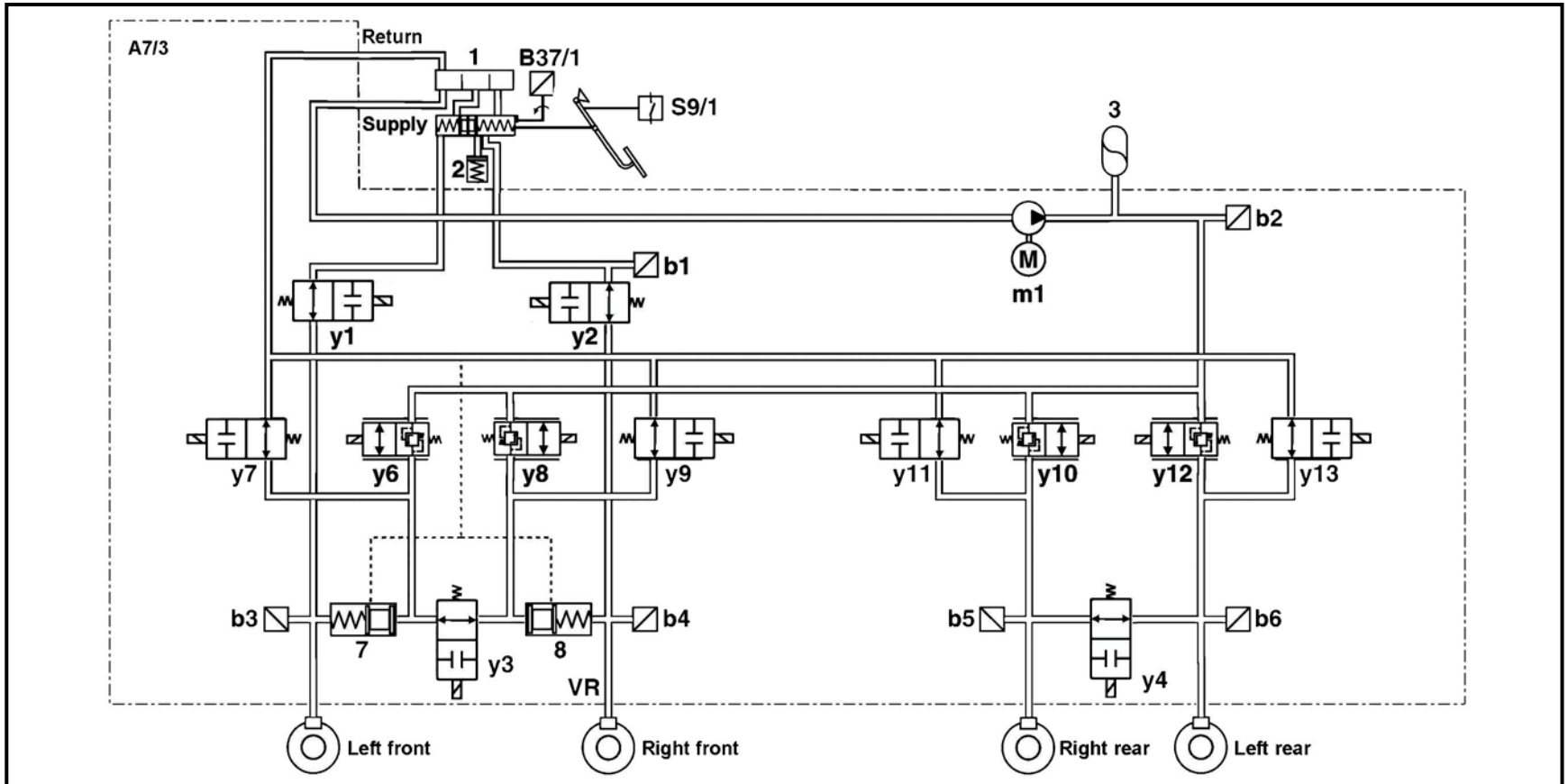
Traction System Hydraulic Unit (A7/3)



Consists of:

- SBC control module (A7/3n1)
- High pressure charge pump (A7/3m1)
- Pressure reservoir

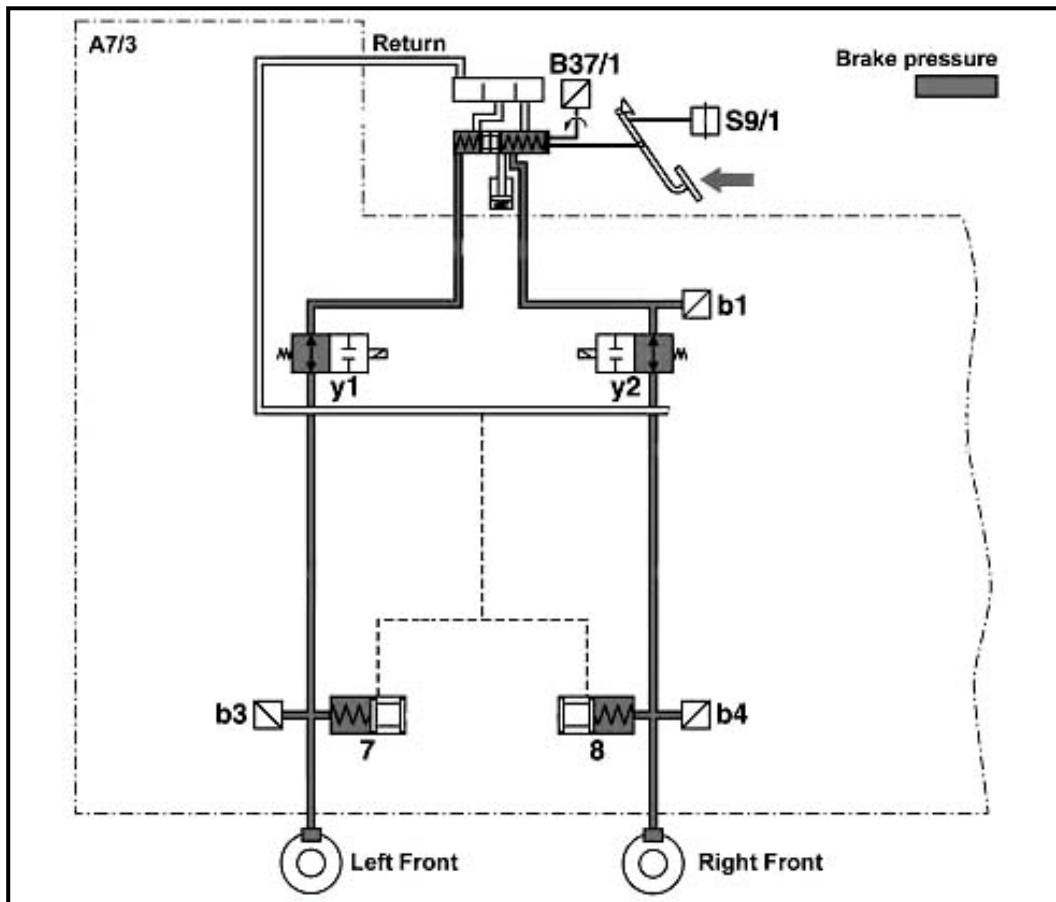
Traction System Hydraulic Unit A7/3



Legend

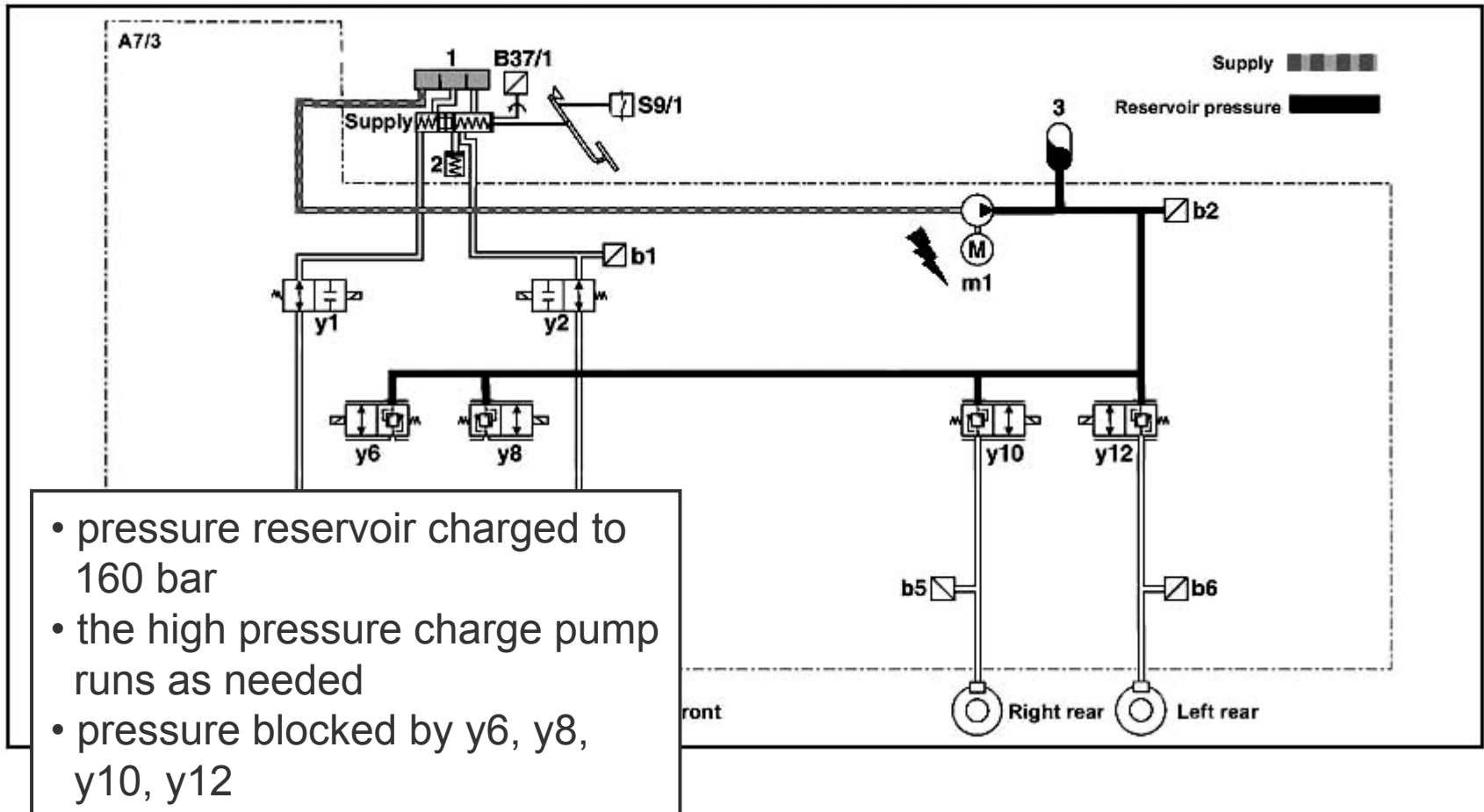
1	Brake Operating Unit	A7/3y1	Left front separation valve
2	Brake pressure simulator	A7/3y2	Right front separation valve
3	Pressure reservoir	A7/3y3	Front axle balance valve
7	Left front media separator (dividing piston)	A7/3y4	Rear axle balance valve
8	Right front media separators (dividing piston)	A7/3y6	Left front intake control valve
A7/3	Traction system hydraulic unit	A7/3y7	Left front outlet control valve
A7/3b1	Front axle pre-pressure sensor	A7/3y8	Right front intake control valve
A7/3b2	Reservoir pressure sensor	A7/3y9	Right front outlet control valve
A7/3b3	Left front pressure sensor	A7/3y10	Left rear intake control valve
A7/3b4	Right front pressure sensor	A7/3y11	Left rear outlet control valve
A7/3b5	Left rear pressure sensor	A7/3y12	Right rear intake control valve
A7/3b6	Right rear pressure sensor	A7/3y13	Right rear outlet control valve
A7/3m1	High-pressure charge pump	B37/1	SBC pedal value sensor
		S9/1	Stop lamp switch (4-pin)

Emergency Operation Circuit



- Pressure applied directly to front calipers
- y1 and y2 not energized
- b1, b3, and b4 pressure sensors may provide information to SBC control module
- Media separator/Dividing piston 7 and 8 isolate emergency circuit from normal circuit

Brake Pressure Supply

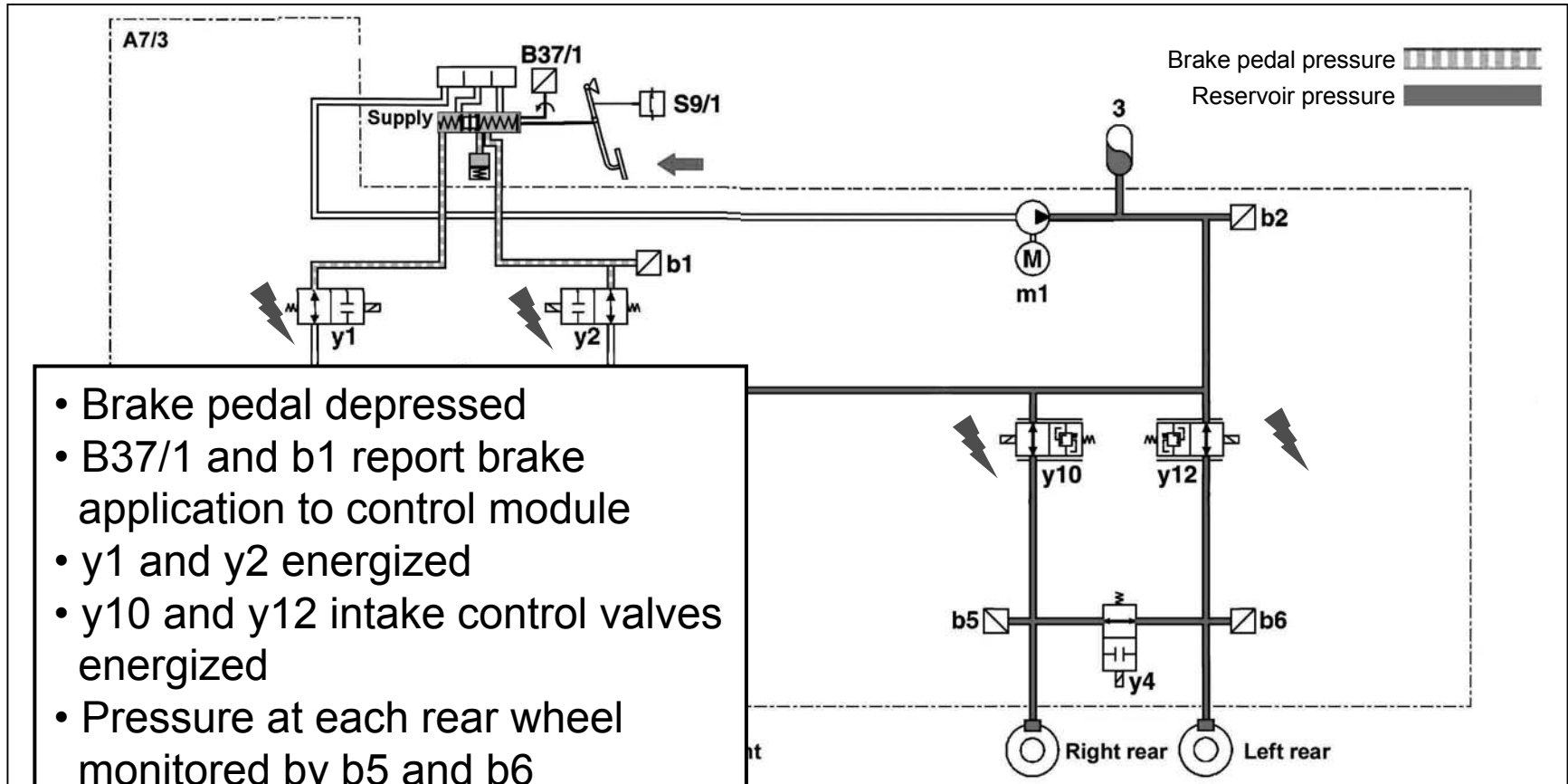


Three Pressure Stages

Same pressure stages as used with ABS functions:

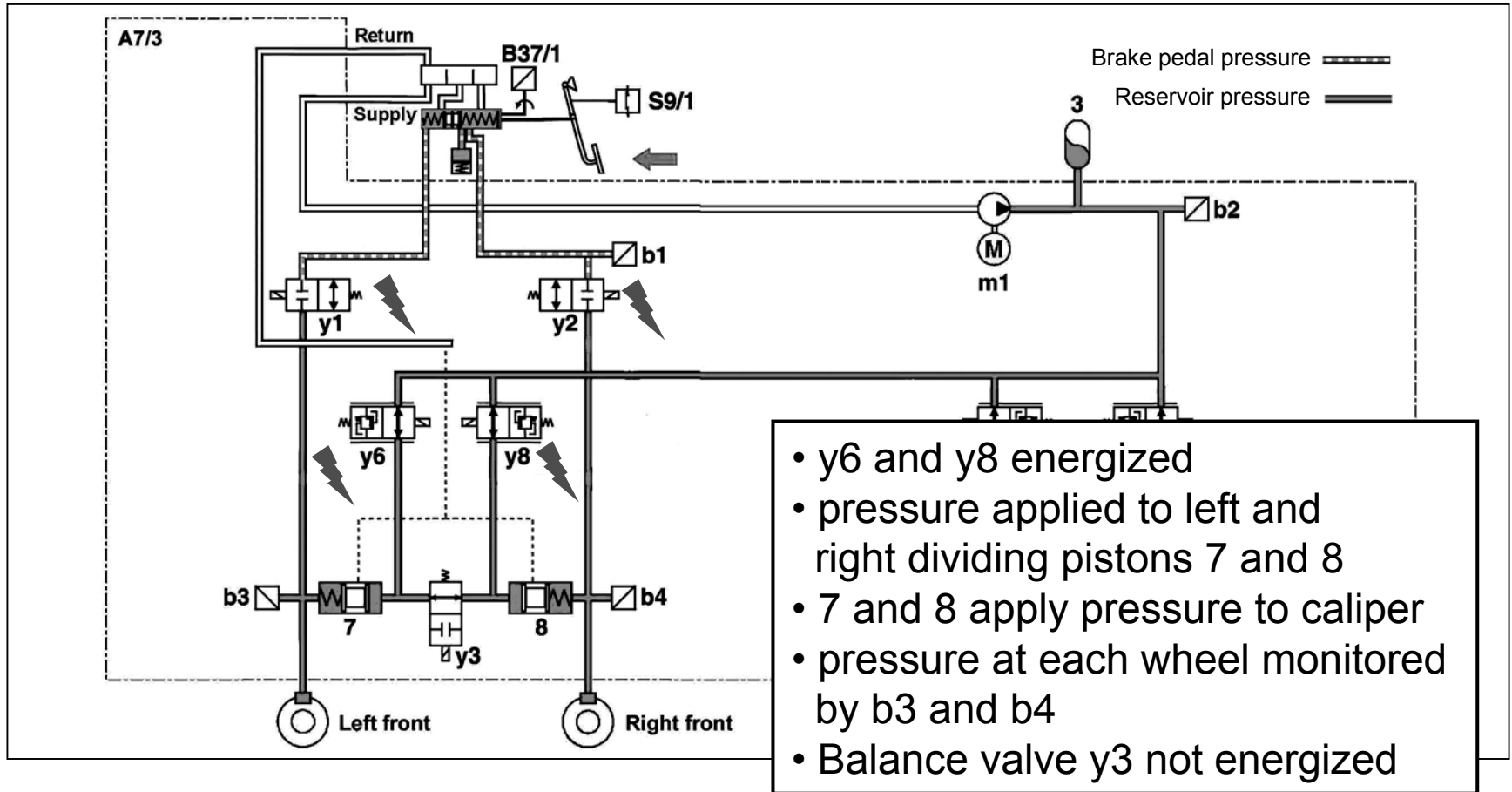
- Pressure apply
- Pressure hold
- Pressure release

Pressure Apply - Rear Wheels

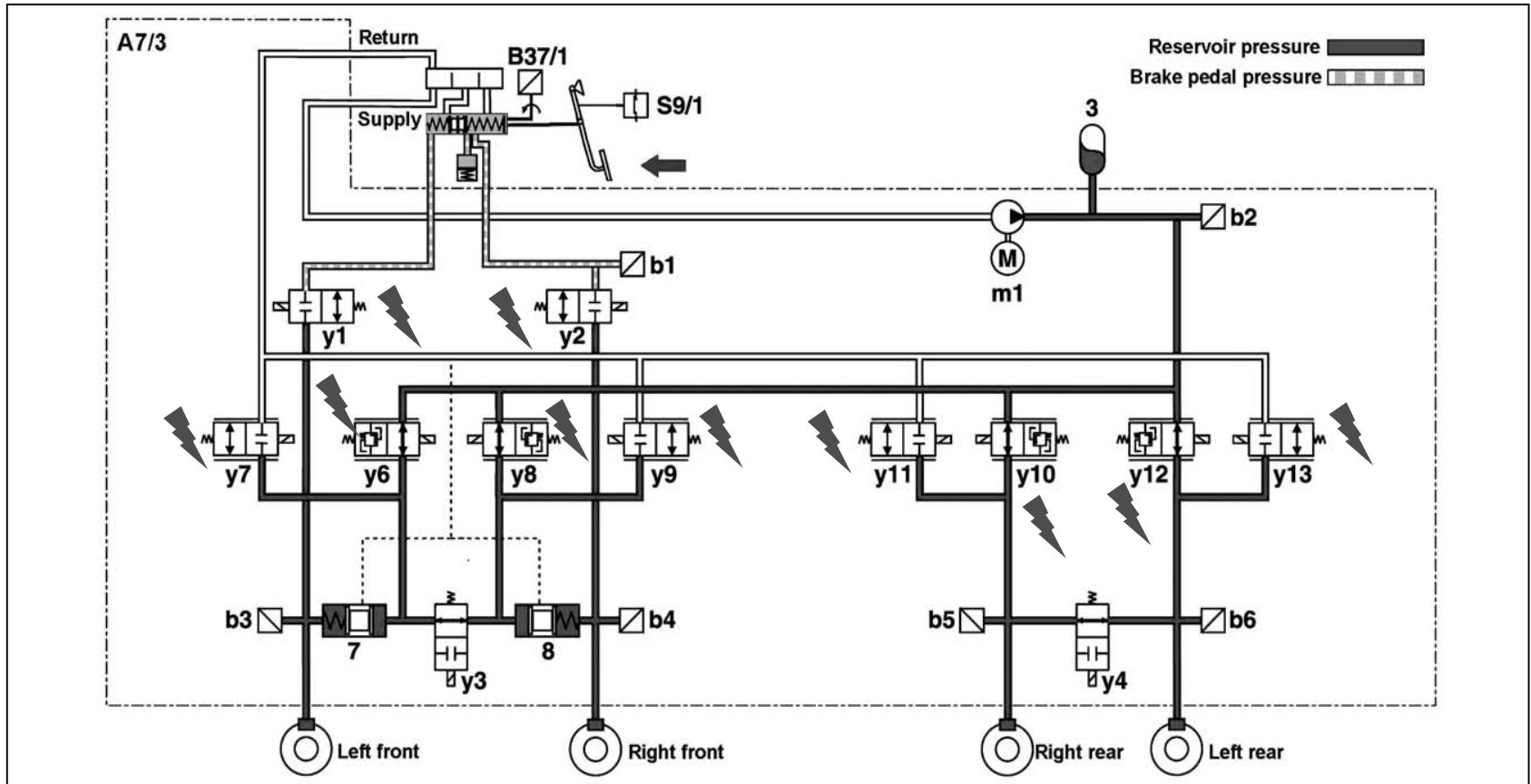


- Brake pedal depressed
- B37/1 and b1 report brake application to control module
- y1 and y2 energized
- y10 and y12 intake control valves energized
- Pressure at each rear wheel monitored by b5 and b6
- Balance valve y4 not energized

Pressure Apply - Front Wheels



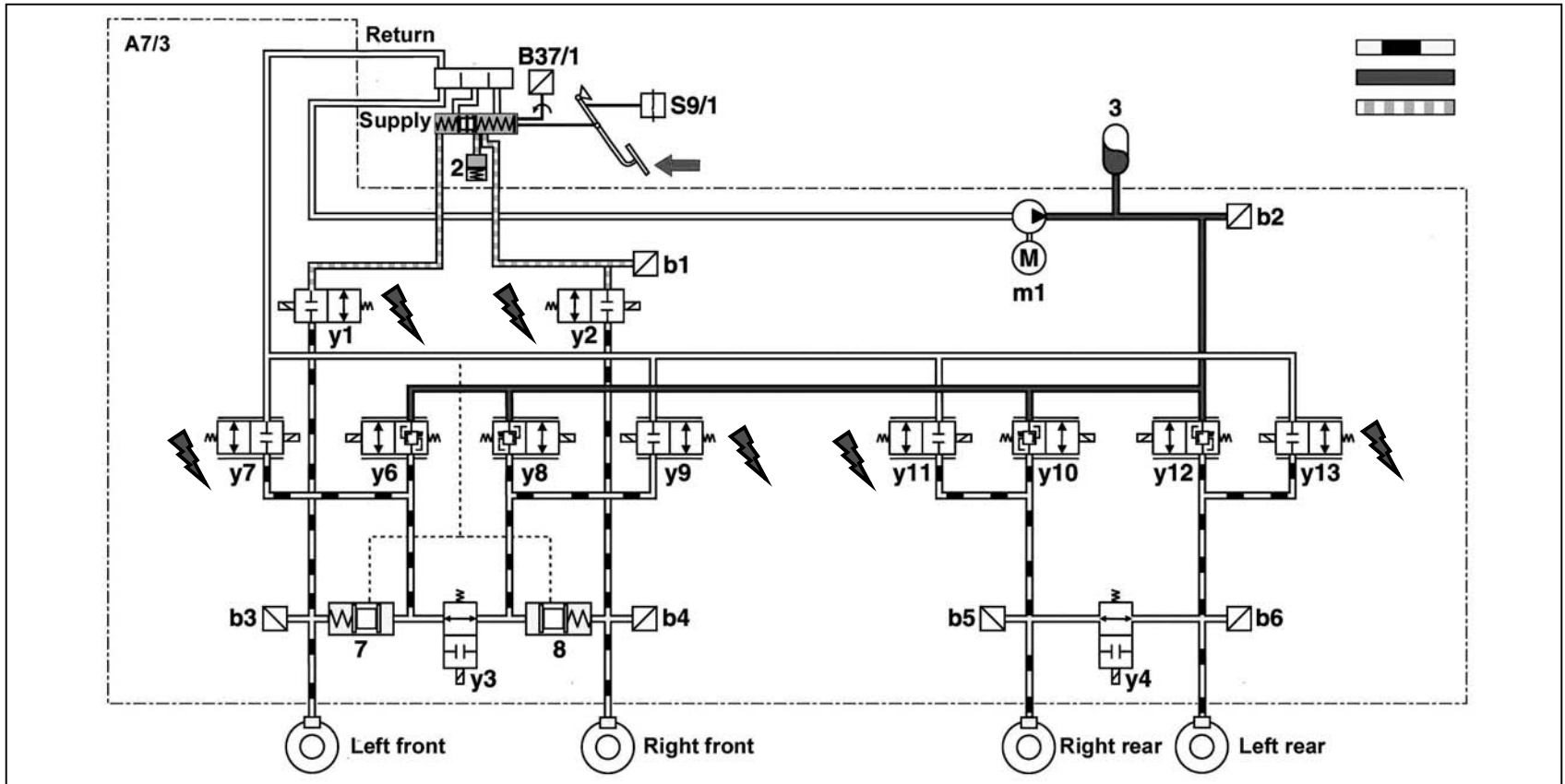
Pressure Apply - All Wheels



- Outlet control valves y7, y9, y11, y13 energized

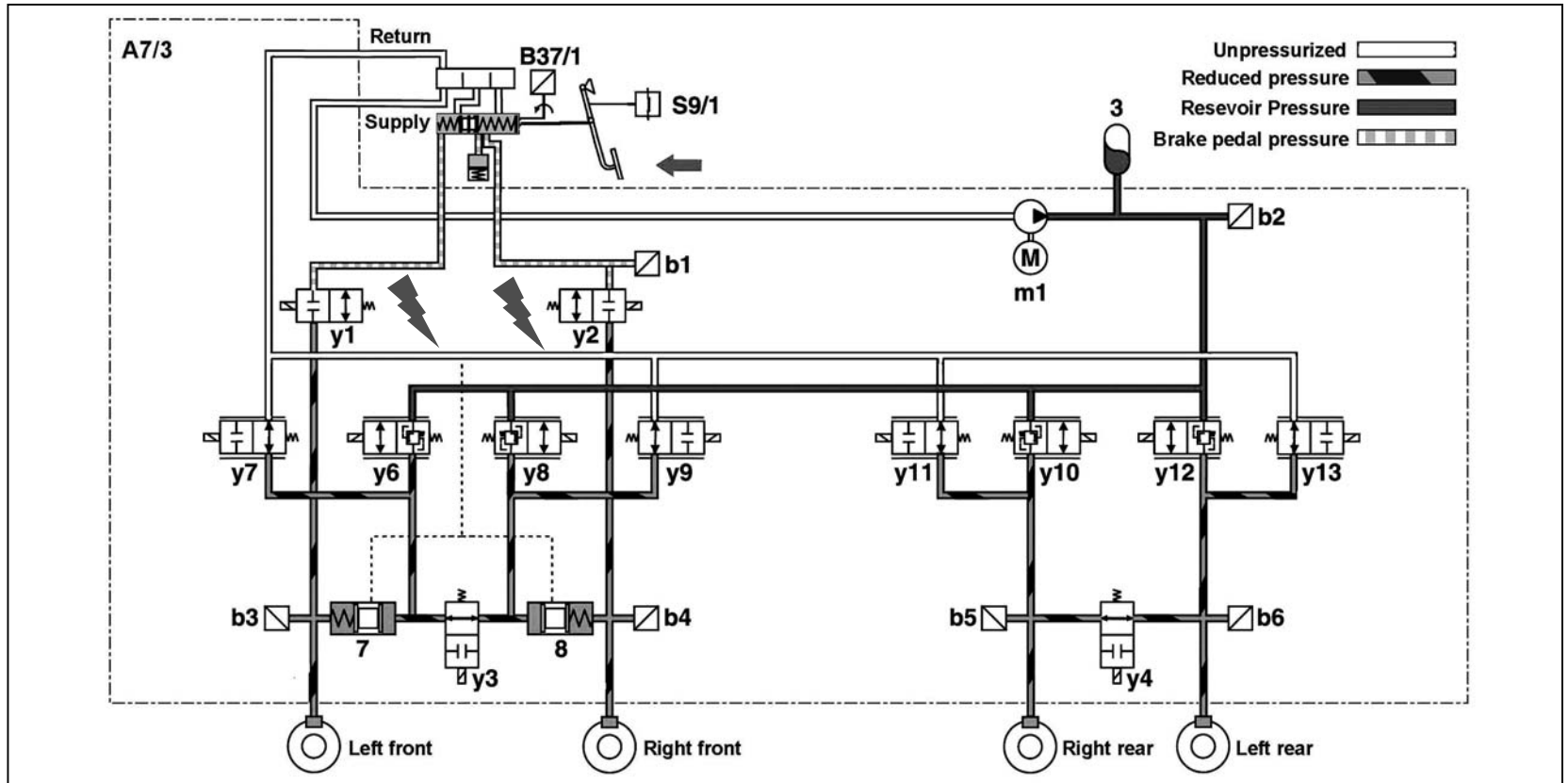
Pressure Hold - All Wheels

- y6, y8, y10, y12 de-energized



Pressure Reduction - All Wheels

- y7, y9, y11, y13 de-energized



Quick Quiz

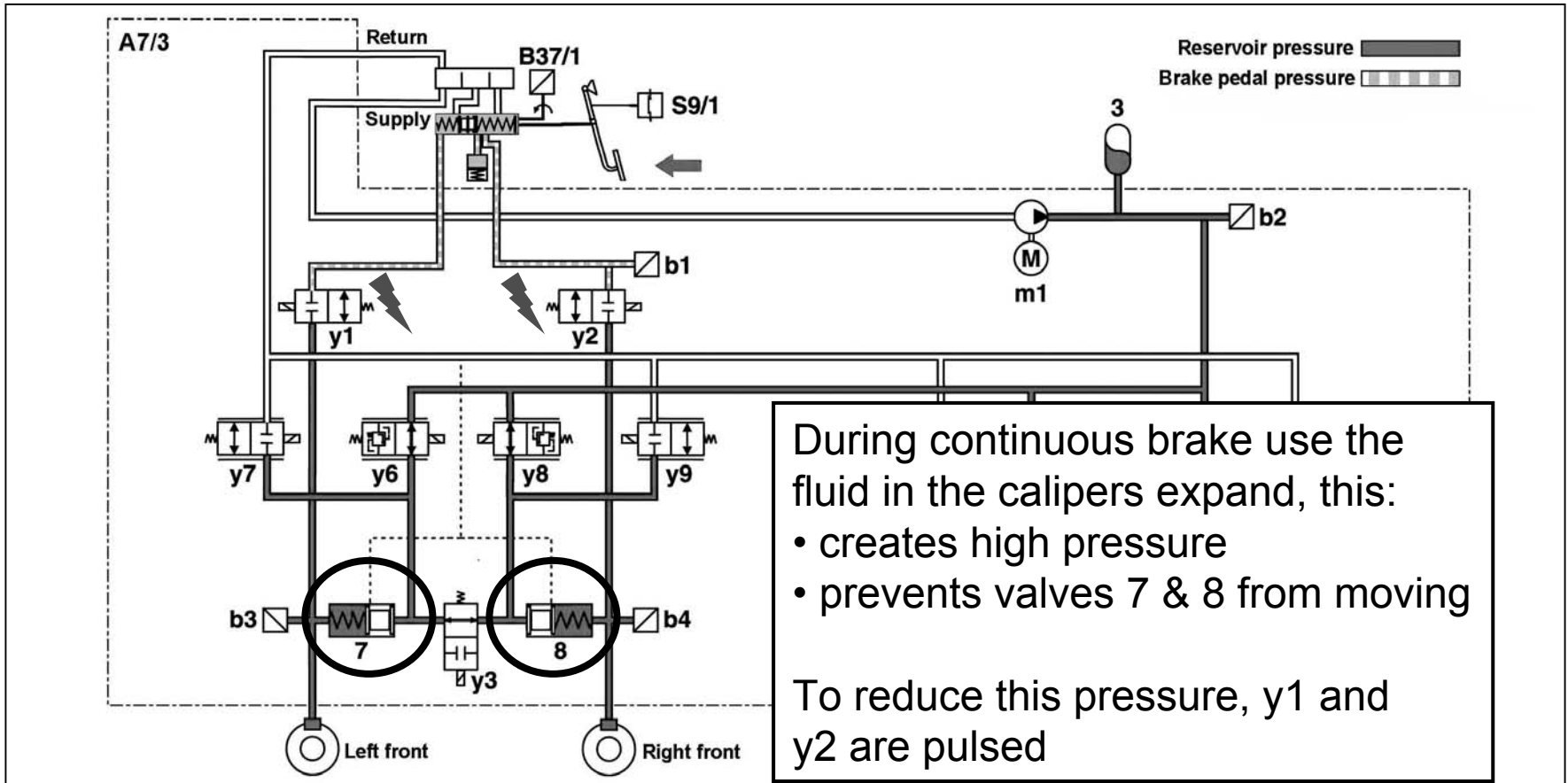
Q1. Where is the SBC control module located?

A1. _____

Q2. Which control module calculates the required brake pressure?

A2. _____

Temperature Compensation



Wake-up

SBC is functional as soon as it is “wakened” by:

- opening a door
- operating the central locking system
- depressing the brake pedal
- turning the key to position 1
- operating the parking brake

The wake up signal comes from the left front SAM

Predrive Check (PDC)

SBC may perform a PDC after wake up, the following are checked:
(Warning! Pressure applied to brake calipers.)

- reservoir pressure (and corrected if necessary)
- pressure sensors (~ 60 bar of pressure applied to each wheel)
- control valves
- leak tests
- operational checks

The PDC is cancelled if the driver operates the accelerator.

Self-test are constantly conducted during driving. (About every 16 brake applications.)

Delayed Off Function

Time that SBC remains operational after use:

- with vehicle stationary and was locked = 20 seconds
- with vehicle stationary and ignition in “0”,
brake pedal not operated = 2 minutes
- with vehicle stationary, ignition in “0”,
brake pedal operated in delayed off phase
and released again = 4 minutes

Deactivation

The system must be deactivated with SDS before working on the system to prevent the Predrive Check (PDC) from being performed and possibly causing injury.

Deactivating the system will:

- empty the pressure reservoir
(a lower pressure with no volume may be retained)
- prevent the charge pump from operating

Note: the warning buzzer is deactivated when accessing SBC with the SDS.

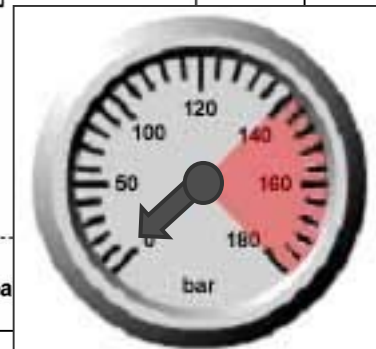
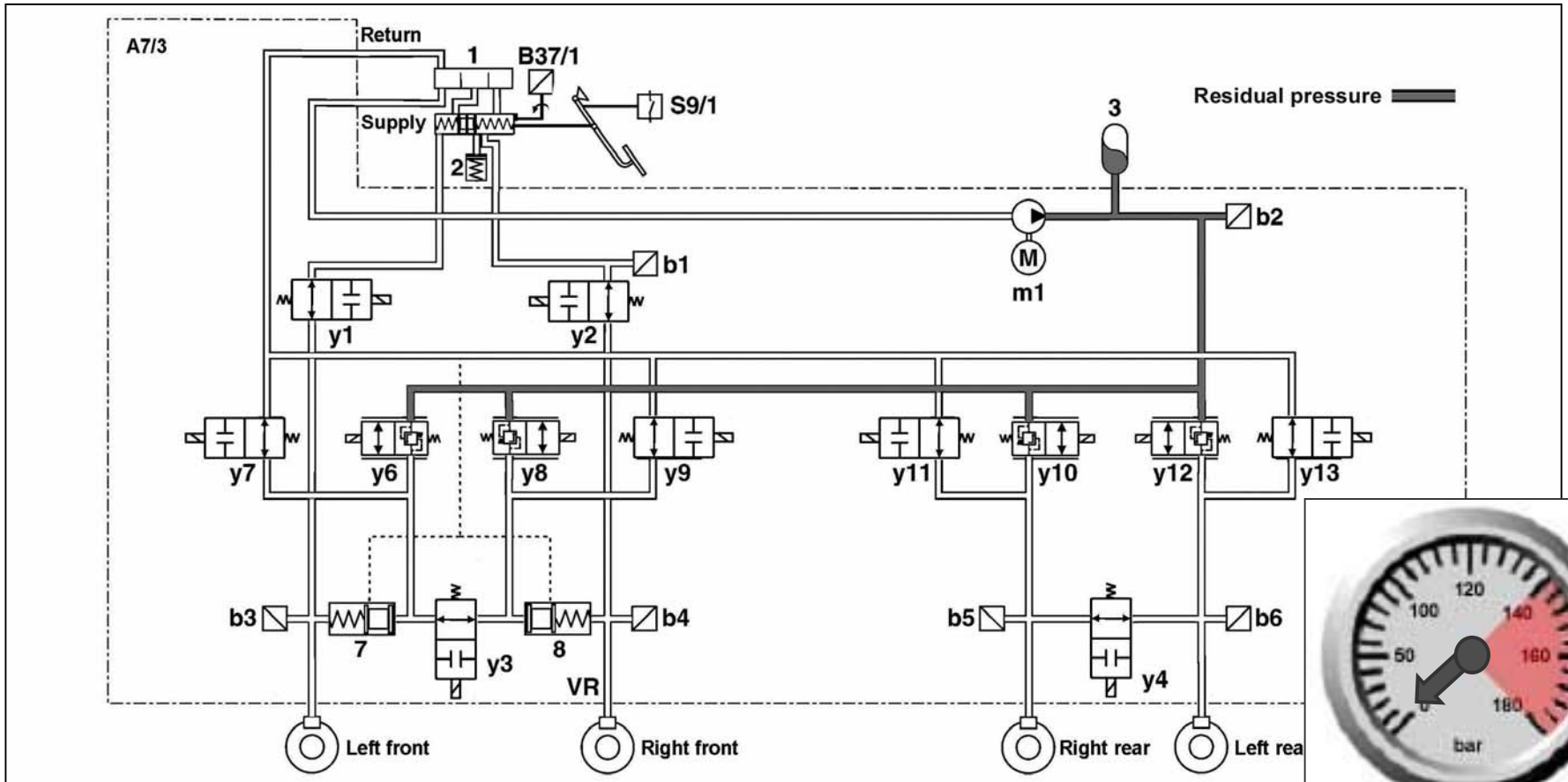
Deactivation

SBC must be deactivated *PRIOR* to:

- working on the hydraulic system
- removing or installing brake pads
- replacing rotors
- replacing the pressure reservoir
- replacing the BOU
- replacing the SBC hydraulic unit (A7/3)

Deactivation

Charge pump disabled and accumulator fluid returned to the reservoir!



Pressure at A7/3b2 44

System Activation

Activation must be performed anytime the system has been deactivated, *BEFORE* the engine is started!

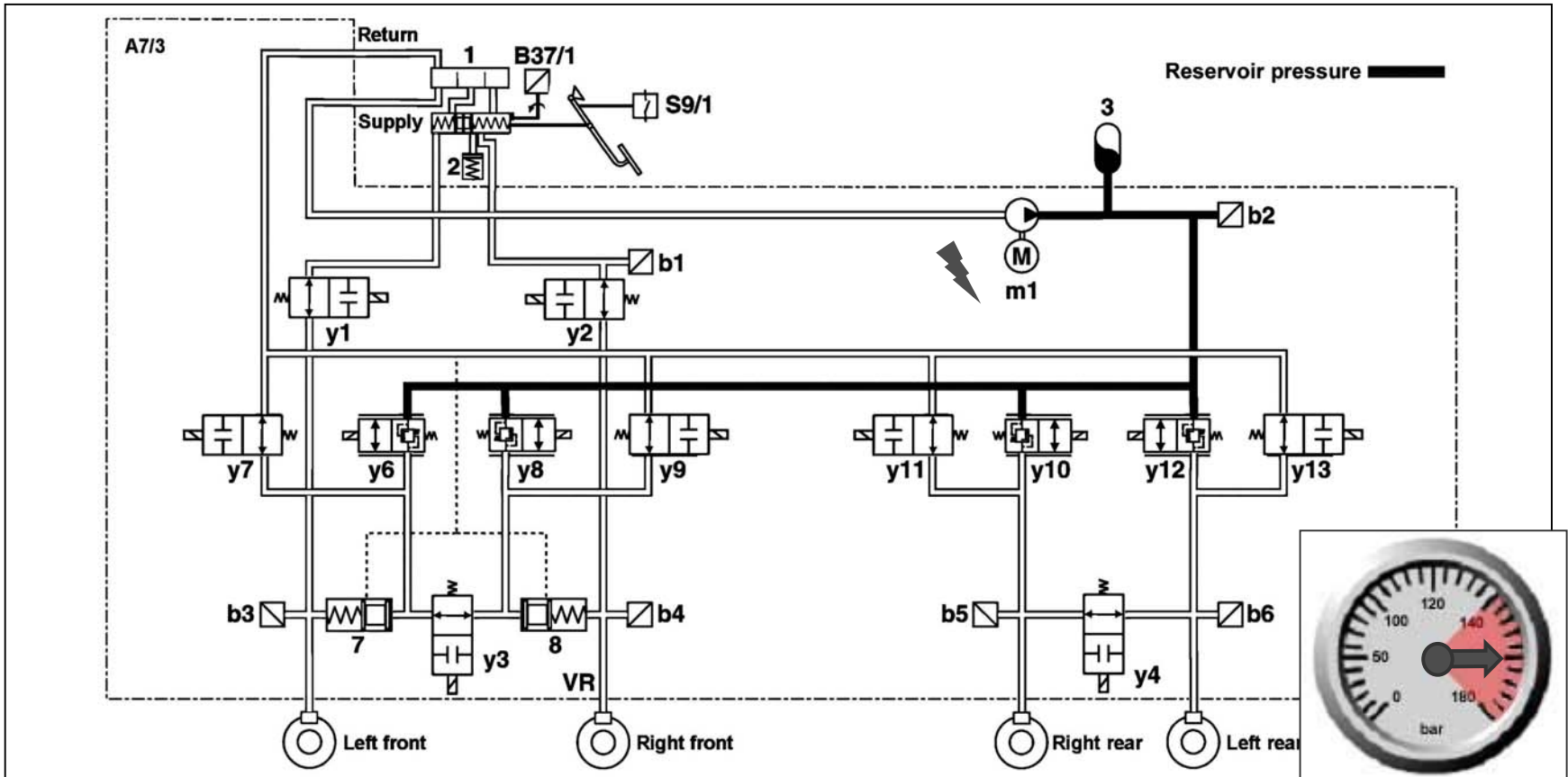
Failure to activate will prevent proper operation and create fault codes!

Activating SBC with SDS will:

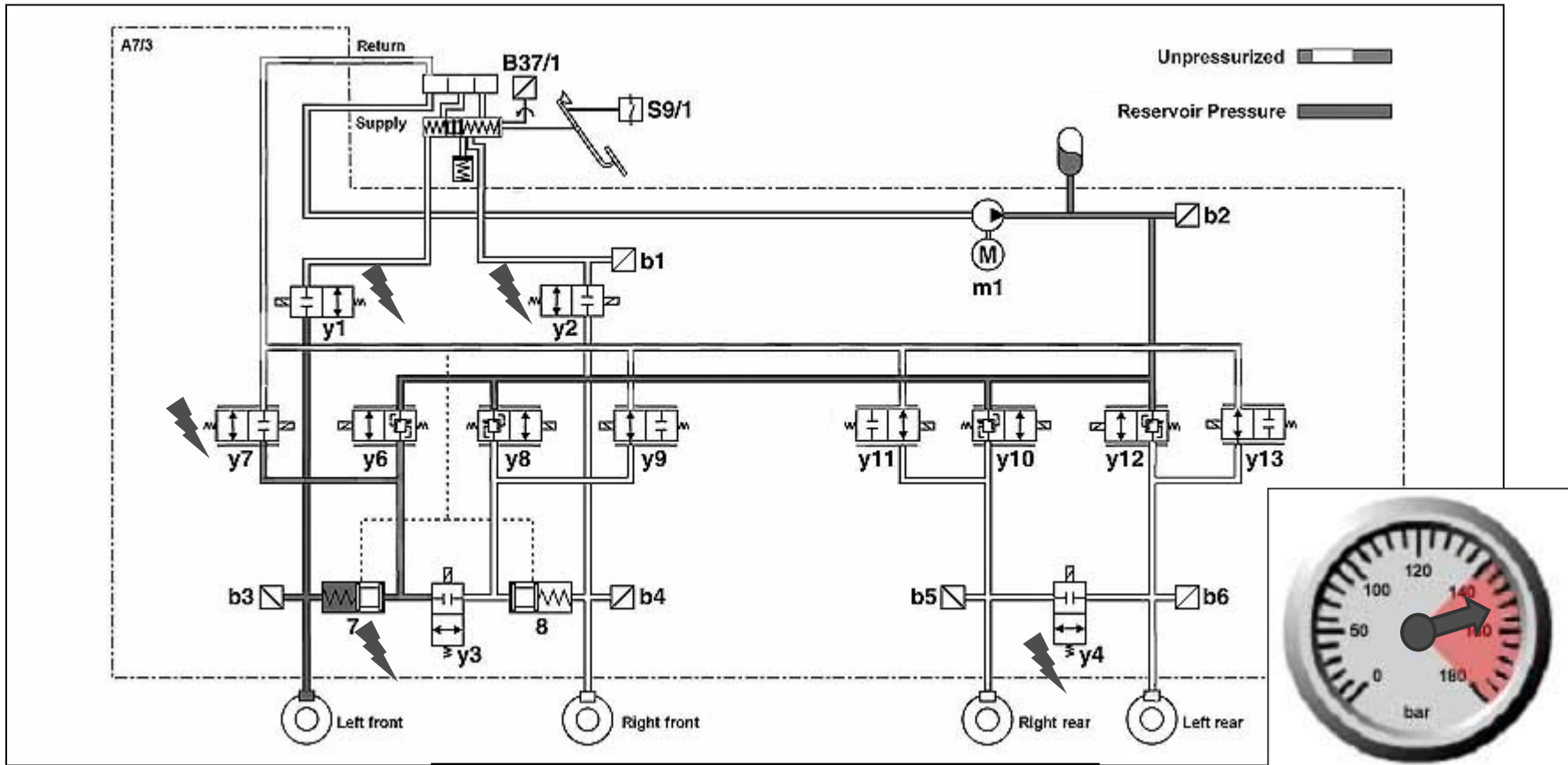
- charge the accumulator
- perform a Predrive Check
- move the pads towards the rotors with ~60 bar pressure
- erase the fault memory

(Note: may have to activate several times to position the brake pads)

System Activation



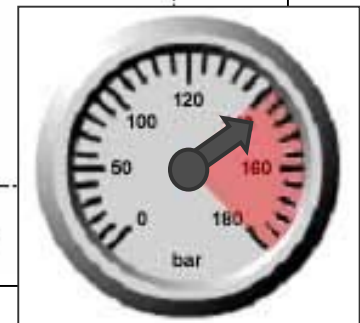
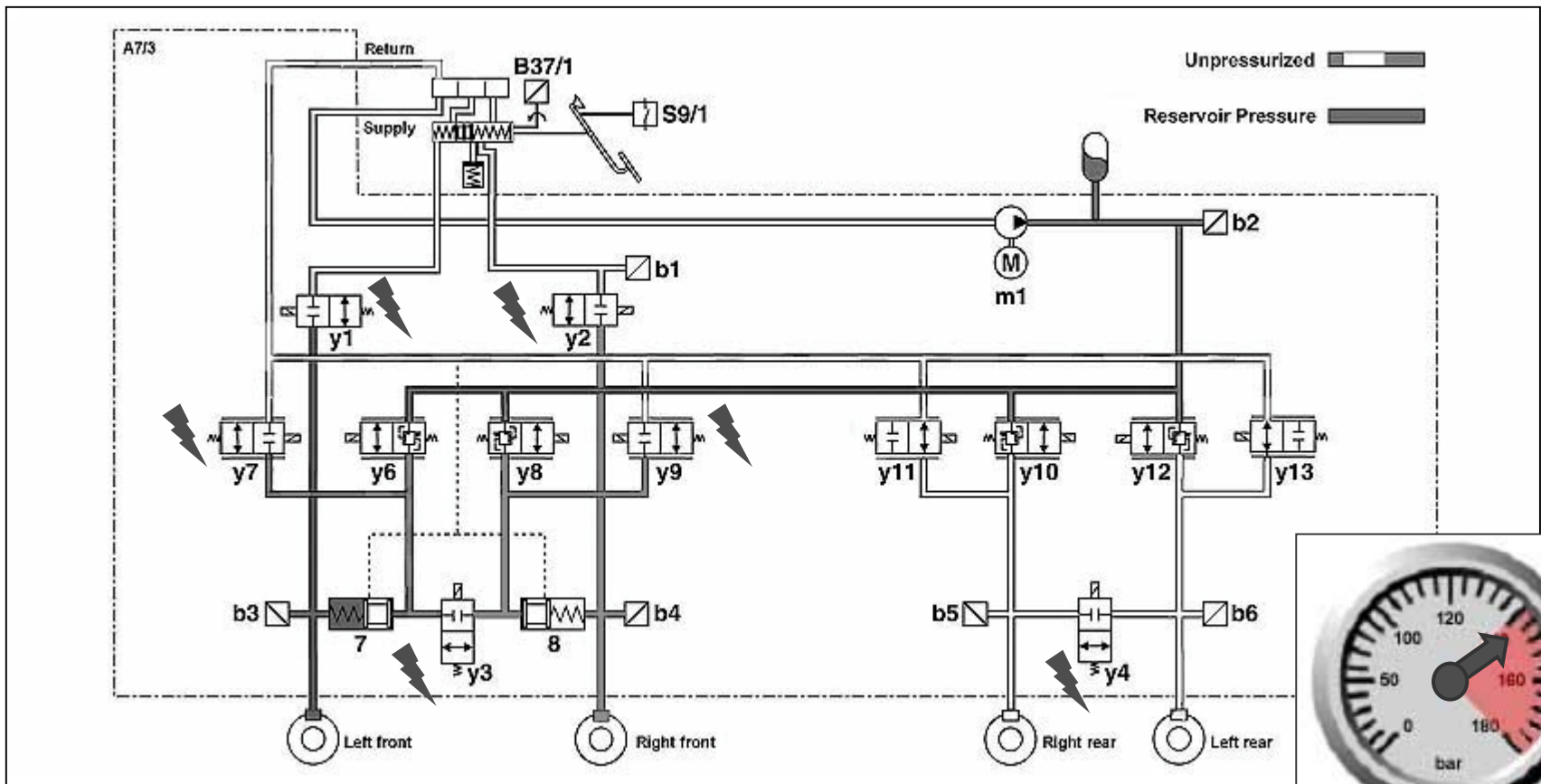
Activation - Left Front



Caliper held with ~60 bar

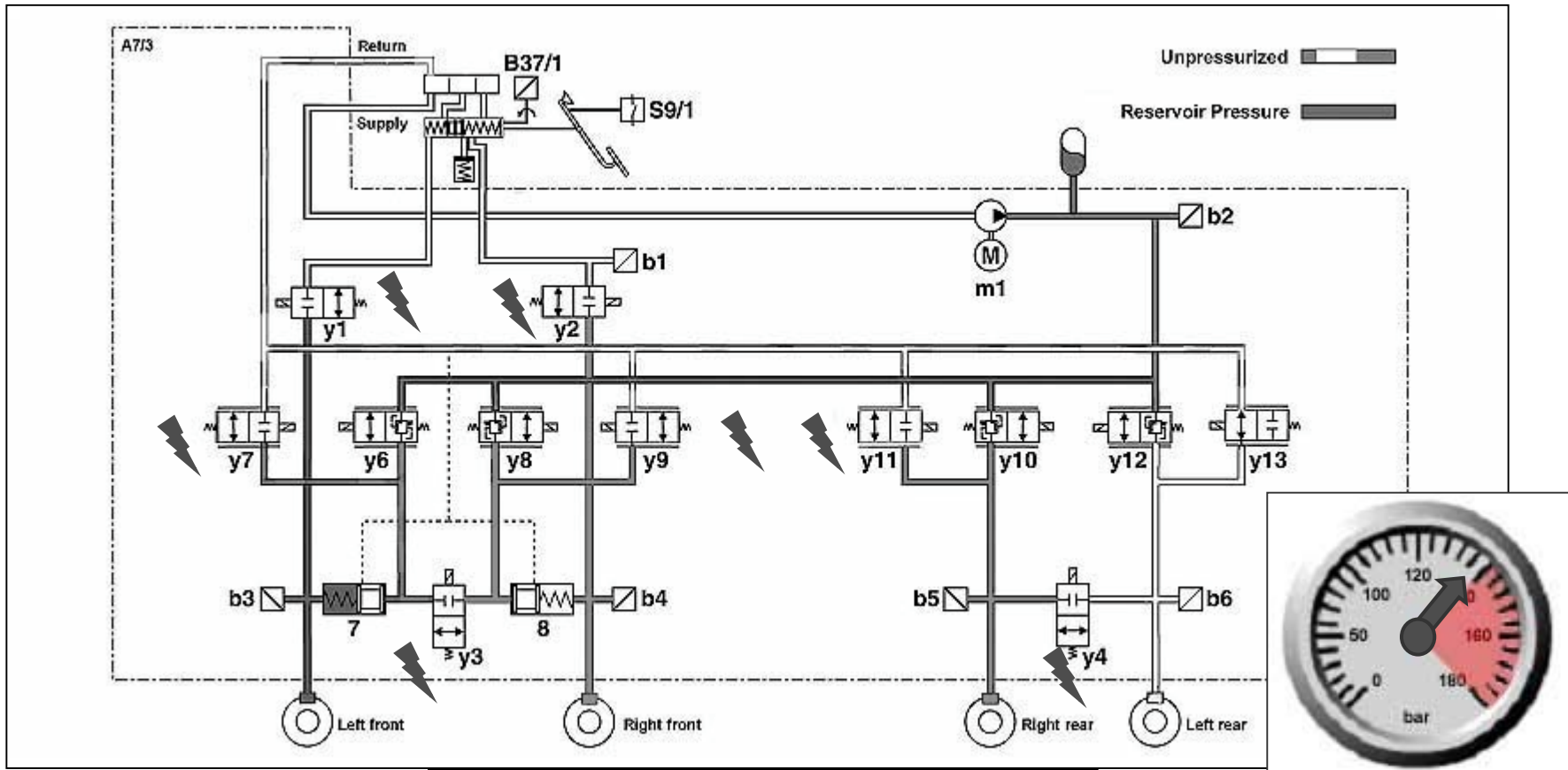


Activation - Right Front



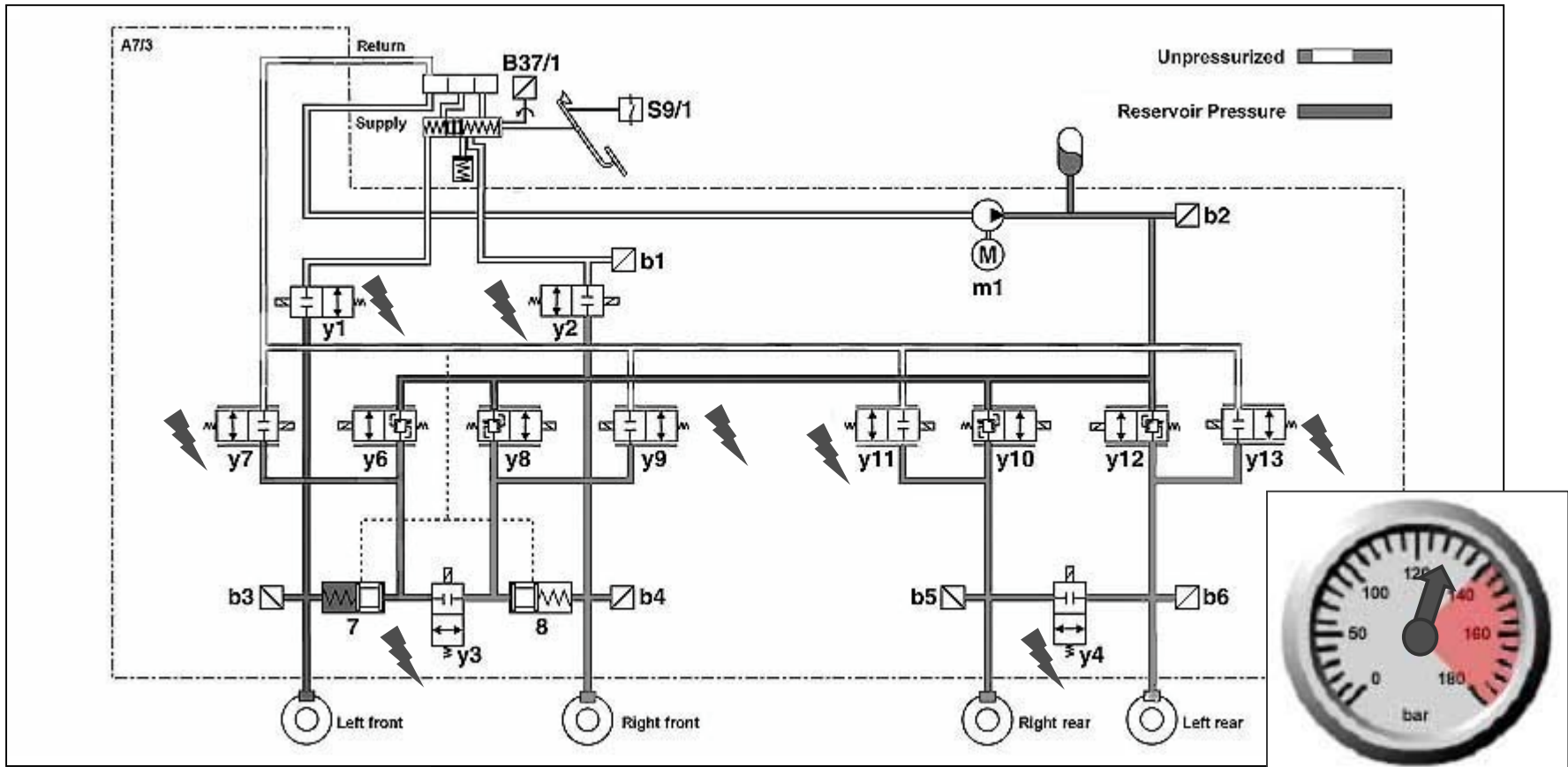
Caliper held with ~60 bar

Activation - Right Rear



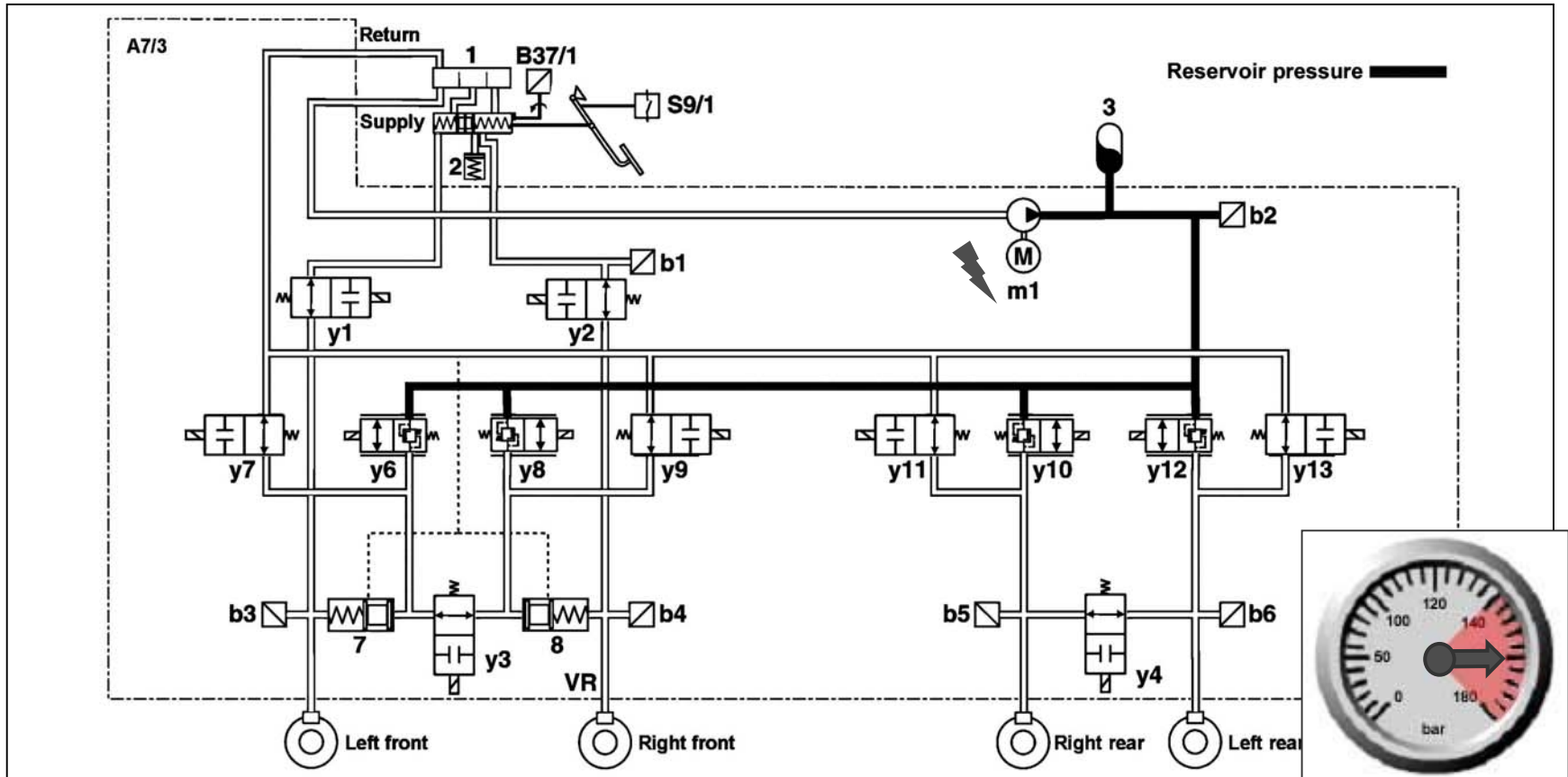
Caliper held with ~60 bar

Activation - Left Rear



Caliper held with ~60 bar

Activation - Recharge



Quick Quiz

Q1. SBC must be deactivated before what?

A1.

- _____
- _____
- _____
- _____
- _____
- _____
- _____

Q2. Before disconnecting the SDS, make sure that you:

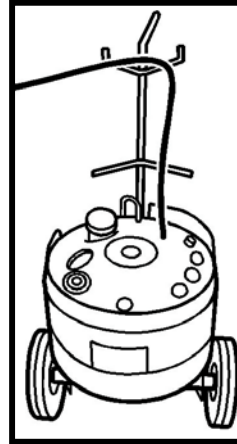
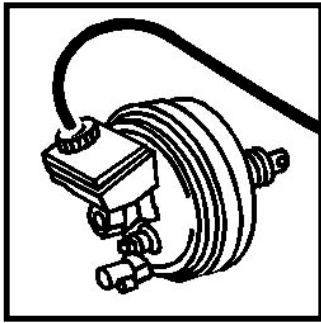
A2. _____

Bleeding the Brake System

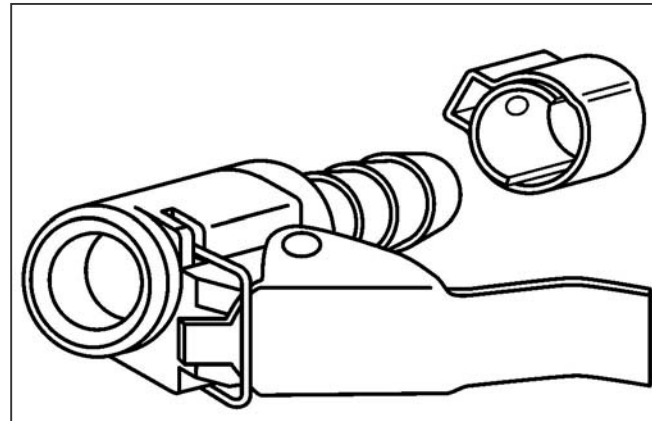
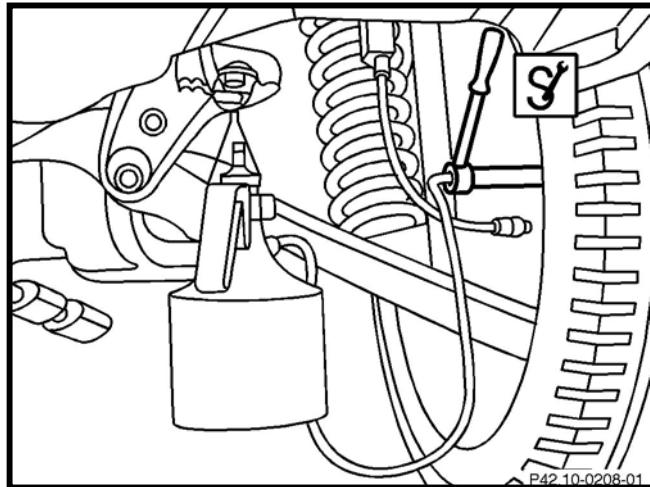
Proper system bleeding is critical!
Follow directions in SDS

- Bleeding must be performed using the SDS
- Pressure at bleeder valves will exceed 100 bar
(Hold the bleeder hose securely)
- Bleeding may require ~1.5 hours
- Bleeding may use ~ 1.5 liters of brake fluid

Equipment Required



- Pressure bleeder
- Adapters
- Fluid receptacle
- SDS - follow instructions carefully

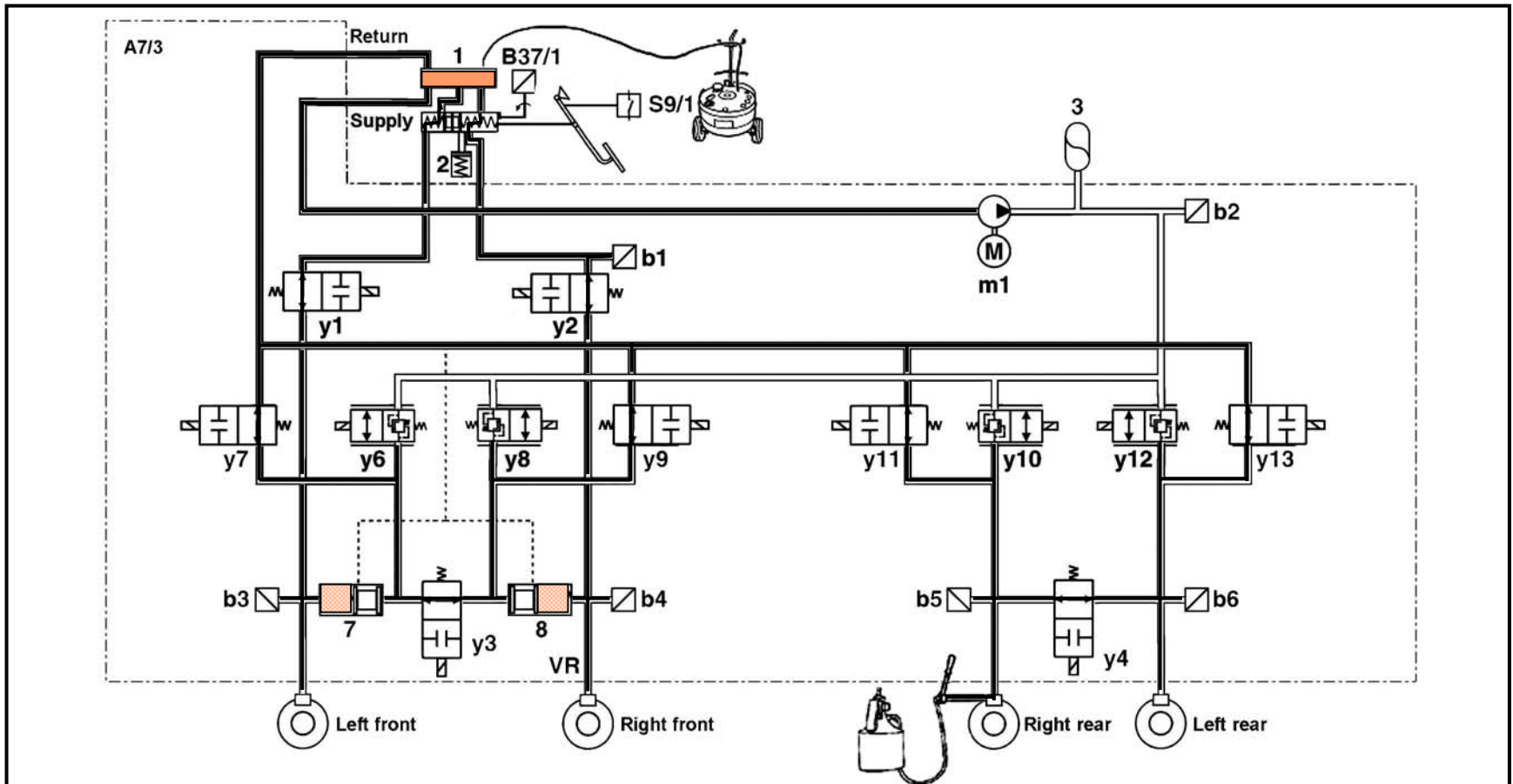


211 589 01 91 00

CAUTION:
Extremely high pressure at bleeder!

Bleeding the Brake System

Connect equipment and follow steps in SDS



Acronym List

(Used in This Handout.)

ABS - Anti-lock Brake System

ASR - Anti Slip Regulation

BAS - Brake Assist System

BOU - Brake Operating Unit

CAN - Controller Area Network

EBP - Electronic Brake Proportioning

EBR - Electronic Brake Regulation

E-Gas - Electronic Accelerator

ESP - Electronic Stability Program

ETS - Electronic Traction System

PDC - Predrive Check

SAM - Signal Acquisition Module

SBC - Sensotronic Brake Control

Appendix

AR42.10-P-0010I	Carrying out bleeding operation
AR42.10-P-0012R	Bleeding system with Star Diagnosis
AR42.10-P-4251R	Checking lining thickness
GF42.45-P-0001-04SL	ESP driver information
GF42.45-P-0001SL	ESP function
GF42.45-P-2000SL	ESP brake moment control
GF42.45-P-3500SL	ASR control mode function
GF42.46-P-0001SL	SBC function
GF42.46-P-1000SL	SBC Normal braking function
GF42.46-P-2000SL	SBC additional braking functions
GF42.46-P-3000SL	SBC braking with malfunction
GF42.46-P-4200-03SL	BOU function
GF42.46-P-4210SL	SBC pedal value sensor
GF42.46-P-4500-02SL	SBC control module – task
GF42.50-P-4000-03S	Hydraulic unit design
GF42.50-P-4000-04S	Hydraulic unit function
GF42.50-P-4000S	Hydraulic unit task/location/function
WS42.00-P-0048B	EHB adaptor

Page 5

This is a quick review of the ABS function, the main points of interest here are the facts that the brakes have been applied by the driver stepping on the brake pedal. The ESP control module (N47/5) is making the control decisions which are carried out by A7/3.

An ABS sequence starts with a normal brake application, when the ESP ECM determines that one of the wheels is about to lock up, the ABS function intervenes as previously.

Page 6

The major difference between any of these modes and the normal braking or ABS mode is the fact that the driver has not operated the brake pedal, the ESP control module (N47/5) has initiated the pressure request.

All of the known inputs for ASR and ESP still exist, and the interfacing with the ETC and ME controls has not changed.

EBR is actually a function of E-Gas. (It is mentioned here as a review of the system function even though A7/3 is not hydraulically involved.) When engine braking causes the rear wheels to reduce speed quicker than the front wheels (causing the rear of the vehicle to slide), the throttle is opened slightly to reduce the engine braking affect.

Supplemental text pages

Page 8

Optimal brake force distribution is basically four wheel electronic brake proportioning.

No pedal vibration due to the fact that the pedal is not directly connected to the fluid that is doing the actual braking.

FYI - Note: Once vehicle is stationary, the brake pressure in the calipers is reduced to a minimum holding pressure in order to relieve stress and to reduce the number of reservoir charge cycles required.

Page 11

The block diagram shows the basic inputs and outputs to A7/3n1(the module part of A7/3), one of the main points of this page is that there is still an ESP control module (N47/5) and that the wheel speed sensor now report directly to SBC.

The inputs are:

- Power from F32f72 & F32f74 (40A).
- Circuit 87 from N10/1
- Circuit 31 at W3/1.
- All four wheel speed sensors are connected directly to A7/3.
- The stop lamp switch S9/1 has a single wire input to A7/3.
- The SBC pedal travel sensor (B37/1) is a double hall effect type sensor that reports pedal travel directly to A7/3 (will be covered in later).
- Wake up signal from rear SAM (N10/2).[via CAN B and N10/1] (Door contact switch, trunk switch, brake light switch, or remote key.)

The outputs are:

- Diagnostic wire to N10/1
- Brake light signal to the rear SAM (N10/2).
- There is a private CAN (referred to as SBC CAN or CAN EHB) between A7/3 and N47/5, all shared information such as ABS, ESR, ESP, BAS requests are communicated over this CAN.
- There are four separate wires going between A7/3 and N47/5 to share wheel speed information.

Normal braking pressure is regulated by the SBC control module, this mode exists even if there is a malfunction in the ESP circuit.

(In other words, if the ESP quits working, you will still have 4 wheel pressure assisted braking. What you won't have is any brake pressure modification, such as BAS, ABS, ASR, or EBR. There is a very strong forward brake bias but all 4 wheels will be braked.)

If the SBC control module cannot operate, then you default to the Emergency braking mode.

Note: If BAS, ABS, ASR, EBR, ESP or DTR brake function is required the ESP control module takes priority over the SBC control module. The SBC control module transmits data regarding the driver's braking request and the pressures in the system to the ESP control module. There, the specified pressures required are calculated and transmitted to the SBC control module. In the SBC control module the pressures for the braking control are then set and the actual pressures signaled back.

The front SAM (N10/1) receives a brake light signal as well as a system status signal. The vehicle speed status prevents the system from switching off when a vehicle is coasting (e.g. coasting down a slope or in traffic congestion) when the ignition is switched off.

Page 13

If the ESP control module has a complete failure the dash will cycle through it's displays. The SBC system is still functional but without any pressure modification including brake proportioning. The system has a strong forward bias.

Depending on the failure, all other systems that require a vehicle speed signal with also be in-op. (Transmission in second gear, no SPS steering , etc.)

Page 14

If the SBC system shuts down, you default to the emergency braking mode, all vehicle speed related functions may also stop depending on the failure.

Page 20

1. The fill valves are used in all of our master cylinders but have never been explained. The limit stops open the blue fill valves against the small spring pressure, allowing the fluid from the reservoir into the body of the master cylinder. When the pedal is depressed, the fill valve seats and prevents the fluid from returning to the master cylinder reservoir.
2. The floating piston and the primary pistons perform the same functions as in a normal master cylinder, that is to create pressure at the outlet ports.
3. The outlets ports are connected to A7/3, which contains separation valves y1 and y2. The separation valves will be explained further, but basically they separate the master cylinder from the rest of the brake system during normal operation.
4. The most unique feature of this unit is the "Brake pressure simulator".

Page 21

1. The first four bullet points all occur almost simultaneously, the light spring feedback to the driver is progressive to simulate pedal feel.
2. The travel sensor moves ~2mm to signal A7/3 that a brake request has occurred.
3. When y1 and y2 are energized, the fluid cannot move from the master cylinder, therefore the floating piston compresses the fluid in the simulator chamber causing a hydraulic counter pressure that the driver interprets to be normal light brake pressure feel.

Page 22

Here we introduce A7/3, stressing that it is the SBC control module as well as the hydraulic unit. The ESP control module is still a separate module that is connected by a private CAN (Listed on the wiring diagram as a CAN EHB H and CAN EHB L) to the SBC module.

Page 29

This page shows a different view of the “Emergency Operation”, but here we expand on what actually happens in A7/3.

Here we take the emergency operation into A7/3 and introduce some of the components that are inside, like the pressure sensors b1, b3 and b4.

The left and right media separators/dividing piston 7 and 8. These pistons divide the emergency hydraulic circuit from the normal operating system. The pistons are double sealed pistons with the dotted line representing where the brake fluid would go if there was a seal failure. In this case the fluid would return to the reservoir. Further explanation will be provided when we introduce the pressure apply circuit for normal operation.

Page 30

The following pages will introduce the components of A7/3 in small steps.

On this page we introduce the pressure supply circuit. Showing that that reservoir is the source of the brake fluid, m1 is the high pressure charge pump and #3 is the pressure regulator.

The system “wakes up” when a signal is received from the door contact switches, the trunk switch, brake light switch or remote key function to recognize that a brake application may be pending.

Pressure sensors and control valves are also tested after each “waking”, various leak tests and operational test are also performed.

SAFETY NOTE: (Will be covered in detail later.) Pressure will be applied to the calipers as part of the self test. Improper repair procedures could cause injury.

Pressure sensor b2 monitors the available stored pressure and turns the charge pump on and off as needed. The intake control valves prevent the pressure from reaching the calipers.

Page 32

Due to the differences between the front and the rear wheel circuits, two pages are used to explain the simple rear wheel circuit first and then add the front wheel circuit.

When the brake pedal is depressed, B37/1 (pedal travel sensor) and b1 (pre-pressure sensor) send braking message to the control module (b1 is used as a back-up input), which activates y1, and y2 to prevent the master cylinder from applying the pressure. y10 and y12 are activated to allow the pressure to go to the rear calipers. Pressure to each rear wheel is monitored by b5 and b6.

The Balance valve y4 is not energized unless side to side pressure adjustment is required [side to side proportioning], this allows maximum braking while braking in a corner or an ABS or ESP intervention.

The next page “Pressure Apply - Front Wheels” will continue the the pressure application function.

Page 33

Continuing, y1 and y2 are already energized, y6 and y8 are also energized, however, this time instead of applying pressure directly to the calipers, the pressure is applied to the left and right media separators/dividing pistons. The dividing pistons separate the control circuit from the limp-home circuit and transfer the pressure to the caliper circuits. y1 and y2 prevent the pressure from returning to the master cylinder circuit. The function of the balance valve y3 is the same as y4 on the rear axle.

Page 34

Now that the pressure has been applied to both the front and rear, we add the outlet control valves (y7, y9, y11, and y13) to the illustration.

In order to keep the pressure from bleeding off, the outlet control valves (y7, y9, y11, and y13) are also energized during the pressure build up phase.

Page 35

By de-energizing y6, y8, y10, and y12, the pressure at the calipers can no longer be increased, just maintained. In order to keep the pressure from bleeding off, the outlet control valves (y7, y9, y11, and y13) stay energized.

Page 36

The pressure release stage is achieved by de-energizing y7, y9, y11, y13. On this page all of the wheels are being released equally even though the brake pedal is still applied. This apply, hold, release sequence on all wheels is the method used to control the applied brake pressure during normal operation.

Each wheel can be controlled separately simply by energizing y3, or y4 and then using the apply, hold, release sequence at the appropriate wheel.

Page 38

During continuous brake applications, the brake fluid in the calipers may heat up and expand. (Front wheels only.) As the volume of the brake fluid at the wheel side of media separators (7 & 8) is locked in by the separation valves (y1 & y2), it is not possible for any volume compensation to take place in the direction of the reservoir during brake application. If the media separators (7 & 8) are now in the basic position of the specified pressure, the pressure must be dissipated differently in order to set the specified pressure.

This is sensed by monitoring the B37/1 and A7/3b1 relationship compared to A7/3b3 and 4.

Temperature compensation is achieved by pulsed opening of the separation valves (y1 & y2) at the front wheels.

When this occurs, a pulsing of the brake pedal may be felt.

Page 39

The following statement is from the owners manual

"If you activate the SBC brake system by depressing the brake pedal, the pedal resistance is reduced and pedal travel is longer the first time you depress the brake pedal. Pedal travel returns to normal when you release the brake pedal.

When releasing the brake pedal you may feel the pedal pulsate and hear a sound.

This sound is caused by the activation of the SBC pump."

(If the pedal is pressed while the system is not awake, the emergency circuit is pressurized and the system will try to stabilize similar to a temperature compensation function.)

Page 40

Self-tests of the separation and balance valves are constantly and alternately conducted when driving. (About every 16 brake applications.)

To reduce wear on the system the PDC is not run after every wake up.

Only after:

- 35 brake operations
- 25 kph attained since last PDC
- a previous failure

Page 41

Delayed off function

In order to prevent the SBC switching off at the same time as the ignition is switched off, the brake force assistance is additionally maintained for a specific time period as a result of the voltage supply through the passenger side SAM. If the occurrence which defines a time period re-occurs, the respective time period is then started once again from the beginning.

Page 42

The system must be deactivated before working on the system to prevent the Pre-Drive Check (PDC) from being performed and possibly causing injury.

The PDC is performed:

- after 35 brake operations
- if 25 kph has been exceeded since the last check
- if there was a previous failure reported

When deactivated the system may retain a 90 bar pressure with virtually no volume to match the accumulator gas charge.

Page 46

This page shows that when the “Activation” is started, the fluid comes from the BOU reservoir and charges the accumulator to 160bar.

Activating the system using the SDS:

- This step will place the brake pads on the rotors.
- Pressure at the calipers temporarily 60 bar.
- Fault memory erased

This process should be performed after:

- Working on the brake system
- “Deactivating” the brake system.

Not performing this operation will set fault codes.

Page 47

The next several pages will illustrate that each wheel will be cycled through a pressure application and reduction. This process not only pushes the pads out to the rotors, but the individual pressure sensors report to the control module that the circuit was able to obtain the required pressure.

The steps that will occur are:

1. Valves y1, y2, y3, and y4 are energized.
2. The appropriate pressure reduction valve is energized.
3. The appropriate pressure apply valve is energized and pressure is applied to the caliper.
4. The apply valve is de-energized, the reduction valve is de-energized and the pressure is released from the caliper.

This will occur for each wheel circuit. Then the pump will recharge the accumulator.

As each wheel is cycled, the pressure in the accumulator drops. By monitoring this pressure, the system can determine if the accumulator can still maintain the correct volume and pressure.

Page 55

This page is used to illustrate that the pressure bleeder is still used.

First the equipment is hooked up following the instructions for your equipment.

The first SDS step (after the pressure bleeder has been installed and the system pressurized) is to open the RR bleeder screw and have the SDS start the bleeding sequence.

The pressure bleeder will fill the majority of the passages.

A large quantity of fluid will be recovered in the catch can.

After this phase, SDS will then run the charge pump and continue to bleed the various circuits from that direction.

When the SDS is done at the RR wheel, proceed as directed by the SDS. The other wheels do not use as much fluid because the entire system has already been flushed in the first step.

Bleeding procedure will include testing of accumulator and a test for air in the system.

All of the valves and the charge pump will be activated in a set sequence and should be followed as described in the SDS.