

Comprehensive brake bleeding procedure

All BMW Motorrad models, model-years 2004 to 2007

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Introduction and rationale

BMW motorcycles dating between 2004 and 2007 possess an electrically-assisted braking system. This system utilizes an unusually complex ABS regulator which incorporates an electric servo pump. This braking system is active whenever the ignition is switched on.

By most accounts, the system was generally reliable after early problems were cured. However, BMWs equipped with this system are not as desirable as later variants which incorporate non-servo-assisted ABS brakes. This is due to the high cost of dealer servicing (the servo-assisted brakes are time-consuming and more complicated than usual to maintain, with a lower-than-normal level of built-in redundancy, and expensive to repair if the regulator malfunctions or fails).

There is also a common misconception among owners of these variants, more-or-less actively promoted by BMW Motorrad as well as third-party technical-manual compilation firms, that bleeding, maintenance and repair of the servo-assisted brakes is beyond the scope of ordinary owners and enthusiasts.

As will be demonstrated in this article, this notion is false. Although certain peripheral checks surrounding the brake bleed require specialized electronic diagnostic equipment, any enthusiast possessing a reasonable level of technical competence and previous experience in bleeding brake systems should not find these tasks unusually difficult.

This document illustrates the procedure whereby all hydraulic circuits on the BMW EVO ABS braking system are flushed and bled of air.

This procedure was written with extensive reference to a 2006 R1200GS. However, it is also applicable to all other BMW Motorrad R-series and K-series models manufactured between 2004 and 2007 which utilize the EVO braking system, as the entire flush and bleeding procedure is identical for all such models.

With minor modifications, this procedure can also be utilized for EVO-braked Oilhead (R850, R1100 and R1150), 'Flying brick' (second-generation K1200) and Slant-four (third-generation K1200) models. The servo-assisted braking layout on these models is nearly identical to that on R1200 models, differing only in the appearance of some peripheral components.

If you are unfamiliar with the procedures required to remove any components from the motorcycle before proceeding, consult the appropriate section(s) of the relevant BMW, Haynes or Clymer workshop manual as required. Note that unrestricted access to the ABS regulator, both external fluid reservoirs and all brake calipers will be required no matter what motorcycle this procedure is performed on.

The information in this technical article is used and adapted at the readers' personal discretion, as is any deviation from the technical standards stipulated by BMW.

Since this procedure will be carried out beyond the control of the author, the author accepts no liability whatsoever for any consequences as a result of following steps contained in this article, whether intended or unintended.

This procedure was compiled and documented by independent enthusiasts, and is not sanctioned or supported in any way by Bayerische Motorenwerke (BMW), BMW Motorrad or any other BMW subsidiary or affiliate.

You are warned that BMW Motorrad do not consider this procedure an appropriate 'DIY' task, and do not recommend that this procedure be undertaken by any party not officially sanctioned by BMW Motorrad. Undertaking this procedure will void the motorcycle's warranty (if present). Therefore, it is recommended that this conversion be carried out only on motorcycles on which the factory warranty period has expired. By proceeding with this procedure, the party maintaining and/or repairing the motorcycle(s) accepts unconditional responsibility for their actions, and undertakes to hold the author of this document blameless in the event of any consequences which may arise as a result of said procedure.

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Warnings: Do not carry out this procedure with sparks, naked flames, sources of heat or incandescent materials in the vicinity. If any fuel lines are disconnected and/or the fuel tank is removed, fuel vapour which is both flammable and explosive will be released from the fuel tank during this procedure.

Perform this conversion only in a well-ventilated area. Petrol contains aromatic solvents which have the potential to cause physical and genetic harm. If at any stage you feel faintness and/or nausea, move away from your work and into an open, ventilated area immediately.

Cautions: It is strongly recommended that this procedure be undertaken only by persons possessing advanced knowledge of motor-vehicle technicalities. In particular, knowledge of workshop safety principles and current hydraulic braking-system trends is essential.

All tools, consumables and work areas used to perform this conversion must be scrupulously clean. Anti-lock braking systems utilize precision components which are intolerant of dirt and dust. Even minute foreign particles have the potential to cause braking system malfunction or failure.

Equipment List

- BMW EVO brake-fluid filler funnel. If this funnel is unobtainable, an equivalent funnel can be easily and cheaply improvised by pushing an appropriate tapered rubber plug over the outlet of a common plastic kitchen funnel, using cyanoacrylate ('superglue') to bond the plug in place, as in the example below:



- 8mm Allen wrench.
- 7mm ring-set spanner.
- 8 mm ring-set spanner.
- Approximately one metre of clear glycol-resistant 5mm inside-diameter plastic hose.
- Suitable plastic container for waste brake fluid.
- A large veterinary syringe. These are available from vets and medical-supply houses. If one is unobtainable, a supermarket turkey baster or rubber enema bulb (available from a pharmacy) can be substituted.
- T30 Torx wrench.
- T45 Torx wrench.
- Large plastic bucket.
- Large-handled soft-bristled brush.

Brake-caliper blanking plates will also be needed. These can be fashioned from industrial aluminium off-cuts as per the dimensions below:

- 2x front plates (3x64x44mm each).
- 2x rear plates (3x25x44mm each).

Consumables List

Warnings: Use ethylene glycol-based DOT 4 brake fluids only. Do not use silicone-based fluids such as DOT 5 – they will destroy rubber parts in the braking system, possibly causing catastrophic brake failure.

All brake fluids are toxic. Do not ingest brake fluids or allow them to come into contact with skin or mucous membranes. Also, brake fluids are corrosive to painted finishes and certain plastics. If brake fluid is ingested, seek medical advice immediately. If brake fluid is spilled, wash it away immediately with a mild soap solution and rinse with clean water.

Do not re-use brake fluid where the fluid container was previously opened. There is no practical way of knowing how much moisture the fluid may have absorbed since the container was last opened. Water-contaminated brake fluid has a reduced boiling point compared to uncontaminated fluid, and may lead to water vapour being trapped in the braking circuits.

Do not attempt to use ethylene glycol-based brake fluids in the clutch hydraulic circuit of any BMW manufactured from 2004 onward. These hydraulic clutches require a specialized mineral-based hydraulic fluid, and are not compatible with conventional brake fluids.

Do not attempt to use the mineral-based hydraulic fluid used for BMW clutches in the brake circuits. This hydraulic fluid will severely damage all rubber parts of the braking circuits, possibly causing catastrophic brake failure.

- Approximately one litre of DOT 4 ethylene glycol-based brake fluid.
- Clean rags.
- Dishwashing liquid.

Procedure

Initial Disassembly

1. Remove the plastic side panels, steel side panels and fuel tank from the motorcycle. Consult the appropriate BMW, Haynes or Clymer workshop manual if you are unfamiliar with the required procedures.
2. Remove the rubber bleed nipple caps from all brake caliper and ABS regulator bleed nipples (there will be six bleed nipple caps on the ABS regulator, and one on each brake caliper). Clean the entire ABS regulator and surrounding areas well with a strong solution of dishwashing liquid in warm water, rinse well with clean water, and allow to dry.

Wheel circuits

The procedure for bleeding the front wheel circuits and rear wheel circuit is nearly identical. Therefore, one 'universal' wheel-circuit bleed procedure is described, with important differences between the front and rear circuits highlighted where necessary.

1. Park the motorcycle outside if possible. If you have not already done so, clean the ABS regulator and surrounding areas with a strong solution of dishwashing liquid in warm water. Rinse well with clean water.
2. Repeat the step above for the front brake fluid reservoir, rear brake fluid reservoir and all brake calipers.
3. Allow the motorcycle to dry completely before proceeding. It is critical that there be no trace of water or dirt whatsoever around any brake fluid entry or exit point before any interior part of the braking system is exposed to outside air.
4. Park the motorcycle securely on it's centre stand. If the motorcycle does not have a centre stand, use an appropriate paddock stand.
5. FOR FRONT BRAKES:
 - a. Remove the brake pad locating-pin safety wire clip.
 - b. Using a T30 Torx wrench, remove the brake pad centering pin.
 - c. Remove the stainless steel anti-rattle spring.
 - d. Carefully inspect the brake pads in the relevant caliper for wear. If any pads have worn down to the level of the wear indicator grooves, they are unserviceable and must be replaced.

Warning: Replace worn brake pads only with a matched set of brand-new brake pads of the correct type.

If any front brake pads are unserviceable, replace all four brake pads as a matched set.

- e. Gently insert an appropriate tool (a blunt-ended flat screwdriver works well) between one of the brake pads and the caliper pistons. DO NOT insert the tool between the brake pad and brake disc. Slowly force the pistons back into the caliper body.
 - f. Repeat the step above for the other side of the caliper.
 - g. Insert the brake caliper blanking plates between the brake pads and caliper pistons.
 - h. Repeat the entire procedure above for the opposite front caliper.
6. FOR REAR BRAKES:
 - a. Carefully inspect the brake pads in the rear caliper for wear. If any pads have worn down to the level of the wear indicator grooves, they are unserviceable and must be replaced.

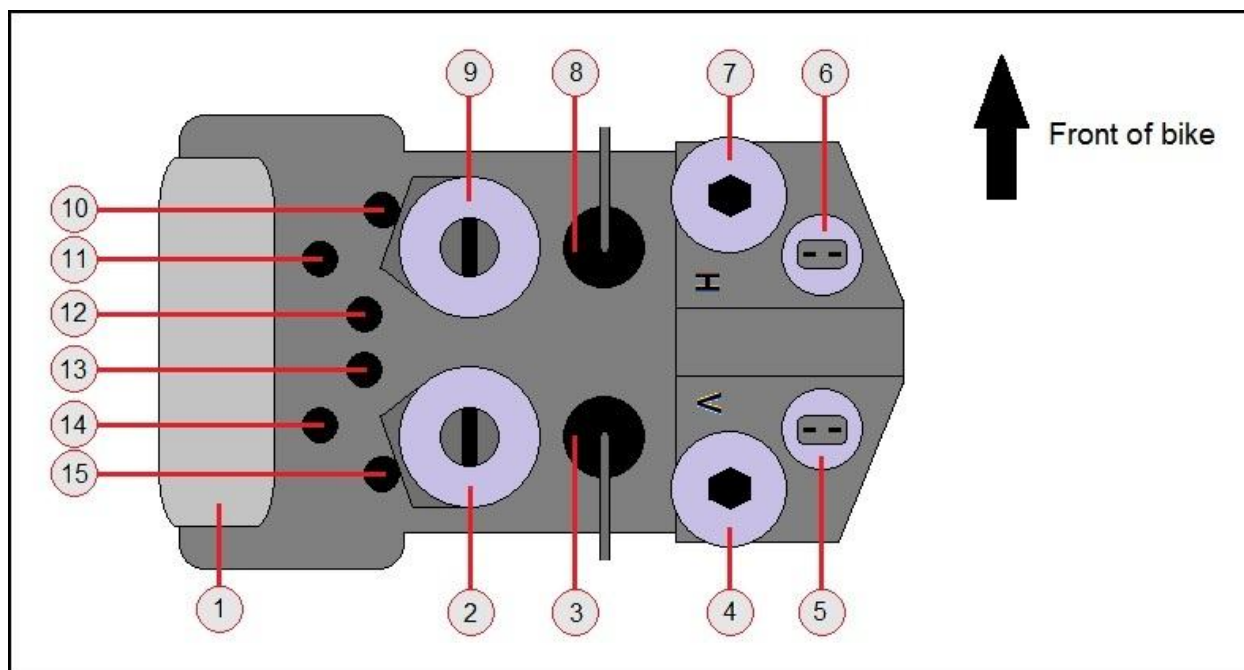
Warning: Replace worn brake pads only with a matched set of brand-new brake pads of the correct type.

- b. Gently insert an appropriate tool (a blunt-ended flat screwdriver works well) between the outer brake pad and the caliper pistons. DO NOT insert the tool between the brake pad and brake disc. Slowly force the pistons back into the caliper body.

- c. Remove the brake pad locating-pin safety wire clip.
- d. Using a hammer and suitable drift, drive out the brake pad locating-pin.
- e. Remove the brake pads.
- f. Insert the rear brake caliper blanking plates between the caliper body and brake disc (inner side) and between the caliper pistons and brake disc (outer side).

7. TO BLEED THE WHEEL CIRCUITS:

Carefully inspect the ABS regulator. Identify and familiarize yourself with the target components as per the list and figure below:



- 4: Front-circuit fluid reservoir cap. Note that the front circuit is marked 'V' for 'Vorderrad' (Front wheel).
 7: Rear-circuit fluid reservoir cap. Note that the rear circuit is marked 'H' for 'Hinterrad' (Rear wheel).

- a. Using an 8mm Allen key, remove the appropriate wheel-circuit fluid reservoir cap.
- b. Note the white plastic level mark just inside the reservoir housing (below). Under normal conditions, with all brake pads for the relevant circuit at full thickness, the brake fluid level should just cover this mark.



- c. Open a new, sealed container of DOT 4 brake fluid.
- d. Use the syringe to add fluid to the reservoir until the fluid level is approximately 5mm from the top of the reservoir cap threads.
- e. If using the BMW fluid filler funnel, thread it into the open fluid reservoir orifice. If using the home-made funnel described in the 'Required Tools' section, thread the rubber plug into the open fluid reservoir orifice by pressing the plug gently but firmly into the open fluid orifice and turning it clockwise.
- f. Slowly pour about 20ml of brake fluid into the funnel.

Caution: Do not pour the brake fluid straight down the funnel orifice. Pour fluid very slowly into the side of the funnel, allowing it to percolate down into the orifice. This will help prevent air bubbles being trapped in any crevices, and thereafter sucked into the ABS regulator.

8. Leave the funnel to stand for about a minute. Inspect for fluid leaks around the funnel seal. If leaks are present, rectify them before continuing.
9. When there are no fluid leaks from the funnel, pour an additional 30ml of brake fluid into the funnel. Pour very slowly to avoid trapping air bubbles in the fluid. If air bubbles are visible in the fluid, allow the motorcycle to stand for about an hour so that the bubbles can escape from the fluid.
10. The caliper bleed nipples are likely to have 'seated' in place and be somewhat difficult to open. Using the ring end of a 7mm or 8mm wrench as appropriate, turn the relevant bleed nipple anti-clockwise just enough to break the seal, then gently 'nip' it closed.

Warnings: Do not use penetrating oils or similar lubricants to free siezed bleed nipples. Any petroleum-based lubricant which enters the braking system will severely damage any rubber parts it touches.

Petroleum-based lubricants must not be allowed to contaminate the brake discs and brake pads. Petroleum-contaminated brake pads must be discarded and replaced, and the brake discs washed well with a strong soap solution.

11. Connect a clear, flexible plastic hose to the bleed nipple of the caliper being bled. Route the other end of the hose into a suitable waste-fluid container.

Tip: The EVO braking system consumes much electrical power when in operation. If the motorcycle's battery is not in excellent condition and optimally charged, it is recommended that an intelligent battery trickle charger be connected to the battery terminals and powered on before proceeding, in order to supply additional power.

12. Turn on the ignition and kill switches. As the braking system initializes, you should hear a short, sharp 'whirr' from the ABS regulator. This sound is the regulator performing a self-diagnostic check.
13. To familiarize yourself with the different levels of power at which the servo pump is capable of operating, do not open any bleed nipples at this time. Squeeze the relevant brake lever until the servo pump begins to operate. Squeeze the lever progressively harder, noting the changes in servo pump pitch and volume until, when maximum effort is applied at the lever, the pump stops operating. You will soon be familiar with the different servo 'power levels'. Release the brake lever.
14. Squeezing the relevant brake lever just enough for the servo pump to begin to operate, open the relevant caliper bleed nipple.

Caution: Do not 'pump' the lever, and do not exceed half of the lever's total travel.

15. Fluid will flow from the bleed nipple. Watching the fluid level inside the funnel, gently vary the brake lever travel to adjust the fluid flow.

Caution: Do not allow the fluid level inside the filler funnel to fall less than 20mm above the level of the fluid level mark. If the fluid level drops lower than this, add more fluid.

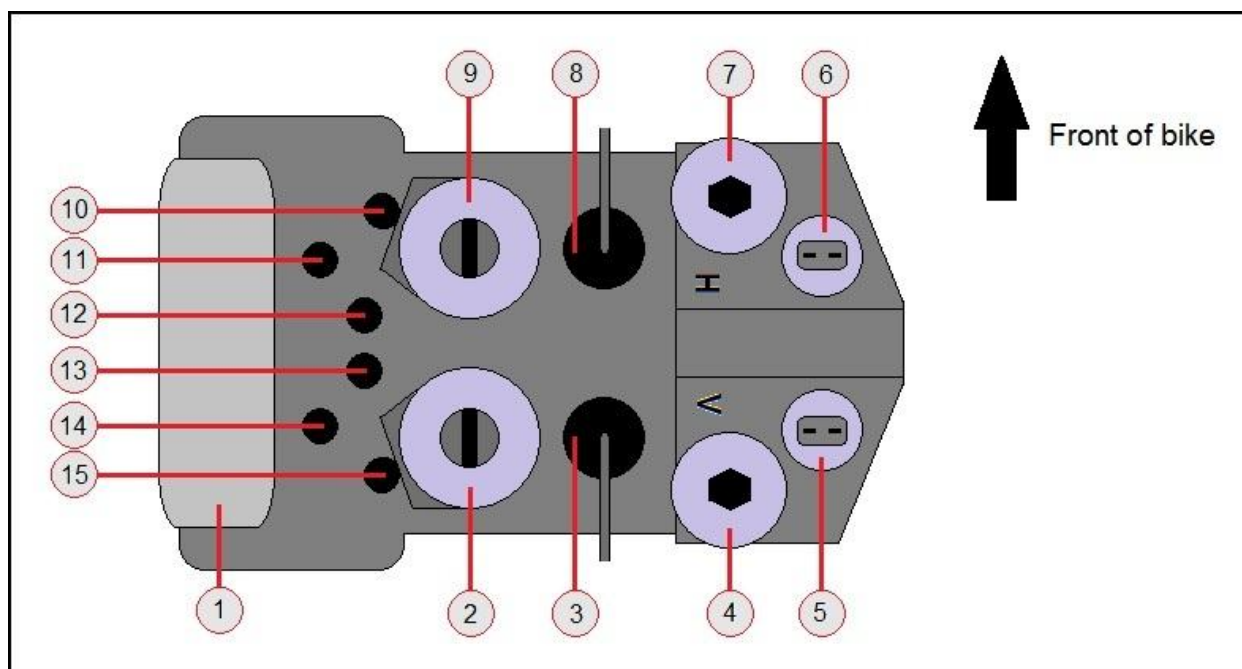
16. FOR FRONT BRAKES: Perform the above bleed procedure first on the left front caliper, then the right front caliper.
17. Continue bleeding fresh brake fluid through the relevant circuit until the fluid coming from all caliper bleed nipples is identical in appearance to the new fluid. There should be no trace of fluid darkening, loose debris or air bubbles – if any of these are visible, continue the bleed procedure until they disappear.
18. With the funnel fluid level at least 10mm above the level of the white plastic reservoir fluid level mark, close the bleed nipple.
19. Release the relevant brake lever.
20. FOR FRONT BRAKES: When the left front caliper has been bled, repeat the bleed procedure for the right front caliper.
21. Pack a clean rag around the base of the funnel orifice. Remove the funnel, holding the rag around the fluid filling area to catch any fluid spillage.
22. Inspect the ABS regulator reservoir fluid level. The fluid level should be only just above the white plastic level marking. If the level is too low, slowly fill the reservoir with fresh fluid using a clean syringe. If too high, draw off the excess fluid using the syringe and dispose of the waste fluid.
23. Close and tighten the relevant ABS regulator fluid reservoir cap.
24. Remove the aluminium caliper blanking plates from the caliper. Re-assemble all components which have been removed from the caliper. For front calipers, ensure that the embossed arrow on the steel anti-rattle spring faces in the direction of wheel rotation.
25. With the ignition switched on, gently squeeze the relevant brake lever to no more than half of it's travel and release. Repeat this step until the brake pads are seated against the brake discs, and lever resistance is as normal.
26. Turn off the ignition switch.
27. Repeat the entire bleed procedure above from step 1 for the other wheel circuit.
28. Ensure that both ABS regulator fluid filler caps are closed and sealed.
29. Flush the area around the ABS regulator with a generous amount of clean water to remove any fluid spills.

Control circuits

The procedure for the front control circuit and rear control circuit is nearly identical. Therefore, one 'universal' control-circuit bleed procedure will be described, with important differences highlighted where necessary.

Note that there is no need to turn on the ignition switch for this procedure.

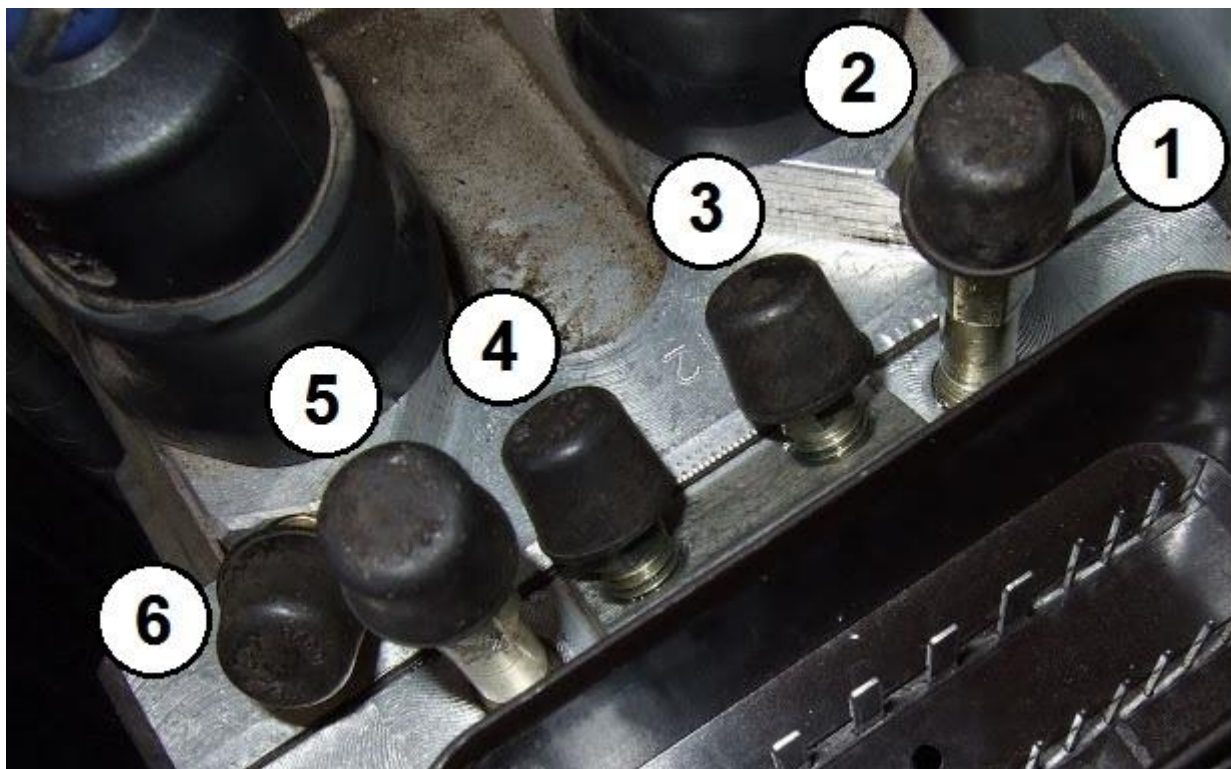
1. Carefully inspect the ABS regulator. Identify and familiarize yourself with the target components as per the list and figure below:



- 1: ABS regulator ECU control interface multi-plug.
- 2: Front metering cylinder.
- 3: Front caliper connecting line.
- 4: Front-circuit fluid reservoir cap. Note that the front circuit is marked 'V' for 'Vorderrad' (Front wheel).
- 5: Front-circuit fluid reservoir low-level warning sensor electrical connection.
- 6: Rear-circuit fluid reservoir low-level warning sensor electrical connection.
- 7: Rear-circuit fluid reservoir cap. Note that the rear circuit is marked 'H' for 'Hinterrad' (Rear wheel).
- 8: Rear caliper connecting line.
- 9: Rear metering cylinder.
- 10: Rear metering cylinder bleed nipple.
- 11: Rear control circuit bleed nipple.
- 12: Front integral circuit bleed nipple.
- 13: Rear integral circuit bleed nipple. (Note that both integral circuit bleed nipples are on the 'wrong' side of the ABS regulator.)
- 14: Front control circuit bleed nipple.
- 15: Front metering cylinder bleed nipple.

Tip: Disconnect the ABS regulator ECU control interface multi-plug ('1' above) from the ABS regulator. This will allow easy access to all six bleed nipples. Do not turn on the ignition switch while the multi-plug is disconnected.

2. Remove the handlebar (front) or right-hand rear frame (rear) brake fluid reservoir cap as appropriate. Note that for the front reservoir cap to be removed, the two securing tabs just under the cap must be pressed inward while the cap is turned anti-clockwise.
3. Using a large syringe, draw off all old brake fluid in the relevant reservoir and dispose of it. Immediately refill the reservoir with fresh DOT 4 brake fluid.
4. Using a permanent marker, write on the ABS regulator body, marking each of the ABS regulator bleed nipples from one to six, as per the figure below (note the orientation of the bleed nipples in relation to the multi-plug connector):



5. To bleed from each of the nipples:
 - i. Ensure that the relevant control-circuit reservoir is filled with fresh DOT 4 brake fluid.
 - ii. Press the brake lever, opening the relevant bleed nipple at the same time. Flush until the fluid is clean and clear.
 - iii. Close the bleed nipple, letting go of the brake lever shortly after the nipple is fully closed.
6. For the front control circuit, the bleed sequence should be as follows: 1, 2, 4, 1 (re-filling with fluid through the handlebar reservoir). Note that fluid must be bled from the front metering-cylinder nipple a second time after completing the control-circuit bleed.
7. For the rear control circuit, the bleed sequence should be 6, 5, 3, 6 (re-filling with fluid through the right-hand rear frame reservoir). Note that fluid must be bled from the rear metering-cylinder nipple a second time after completing the control-circuit bleed.
8. When the relevant circuit bleed is complete, ensure that the fluid reservoir is filled with fluid to the 'Full' mark. Do not overfill the fluid reservoirs.

Note: On BMW EVO brake systems, the fluid levels in the front (handlebar) and rear (right-hand rear frame) brake fluid reservoirs do not drop as the brake pads wear. Instead, the 'fluid gap' is taken up by the wheel-circuit fluid reservoirs within the ABS regulator.

Do not attempt to 'top-up' any fluid levels as the brake pads wear. The fluid levels will return to normal when the caliper pistons are forced back into the calipers during the next brake pad change.

9. Any excess fluid in the relevant reservoir can be disposed of by continuing to bleed through the relevant metering-cylinder bleed nipple. Alternatively, draw off any excess fluid using the syringe.
10. Close the relevant fluid reservoir cap.

11. When both control circuits have been bled, re-connect the ABS regulator ECU control interface multi-plug to the ABS regulator.

Brake micro-switches

On BMW EVO braking systems, correct adjustment of the micro-switches at the front and rear brake levers is a safety-critical service item. Unlike non-servo-assisted ABS braking systems, the micro-switches perform a number of crucial functions:

- a. They perform the conventional function of actuators for the rear brake light.
- b. With the motorcycle stationary, just after the ignition has been turned on and with hands and feet off the brake levers, they provide a 'No-load' reference signal (in other words, a signal that the brakes are not currently being operated) to the ZFE-High and ABS ECU. This allows the braking system to perform a diagnostic self-check by comparing the 'No-load' reference hydraulic pressure (i.e. 0 Bar) when there is no pressure on the system, to the test pressure registered when the system momentarily tests the servo pump.

If a 'No-load' reference signal is not received, the braking system will be unable to perform the diagnostic self-check.

Should the check not be successfully completed, the EVO braking system will be unserviceable. Servo assistance and anti-lock functionality will not be available, the brakes will require much greater pressure to operate, and the ABS warning light on the digital display will continue to flash.

- c. Where:
 - i. The ignition is turned on,
 - ii. The diagnostic self-check has been successfully completed, and
 - iii. The rider operates either of the two brake levers,
 the relevant micro-switch(es) send a signal to activate the brake servo pump. This enables power-assisted braking.

The brake micro-switches are adjusted as follows. This procedure relies on a working tail light as a visual indication of correct micro-switch adjustment:

1. Turn on the ignition and kill switches.
2. Check the digital display. If all rear-end lights are in order, there should be no lamp warnings registered. If a 'LAMPR!' warning is given, check for correct operation of the brake light bulb or LED brake light as applicable.

Note: If a 'LAMPR!' warning appears on the digital display but all rear lights appear to be operating normally, remove and inspect the rear parking-light/brake-light bulb. It is likely that one of the bulb's two filaments may have blown.

To verify correct adjustment of the micro-switches:

3. Turn on the ignition and kill switches.
4. As the ABS system initializes, you should hear a short, sharp 'whirr' from the ABS regulator within four seconds of turning on the ignition switch. This sound is the regulator performing a self-diagnostic check.
5. If you do not hear the ABS perform the self-check, operate the front, then rear, brake levers whilst observing the operation of the rear brake light. If the light remains at 'double' brightness when either or both levers are operated and then released, one or both of the brake micro-switches may be incorrectly adjusted.
6. To correctly adjust the micro-switches:
 - i. Check that both brake levers are able to move freely and easily through their entire range of movement. A seized or over-tightened lever pivot or damaged lever could cause the micro-switch to remain permanently 'On' even if correctly adjusted.
 - ii. Locate the fastener holding the micro-switch in place (for front brakes, it is an Allen-head grub screw). Loosen the grub screw by turning it anti-clockwise until the micro-switch can move more-or-less freely.

- iii. Move the micro-switch in and out in relation to the brake-lever pivot. You should hear a faint 'click' each time the switch contacts open and close.
- iv. Remember that the brake switches are normally closed (NC)-type switches. This means that their default switch contact position, with the brake lever at rest, is closed. Therefore, with both switches at 'rest' position, the brake light should be off.
- v. With the relevant brake lever at it's rest position, move the micro-switch until the brake light goes out. Tighten the relevant switch securing screw to hold the switch in position.
- vi. Test the switch actuation by operating the brake lever. If all is in order, the brake light should activate when the lever travels only a few millimetres, and de-activate instantly when the lever is released. If adjustment is not correct, re-adjust the switch position.
- vii. Perform a final check by turning off the ignition switch, then turning it on again. If the tail light remains at half-brightness, and you hear the self-diagnostic 'whirr' from the ABS regulator within four seconds of turning on the ignition switch, the brake switches are correctly adjusted.

Brake pressure-hold test

In this procedure, the ability of the ABS regulator to maintain hydraulic pressure is tested and confirmation of the result given.

It is strongly recommended that this test be performed after all work involving bleeding of EVO brakes. This test can be carried out in one of two ways:

1. The motorcycle can be taken to a BMW dealer and tested using the dealership's GT1 diagnostic equipment. The GT1 will issue the brake-pressure test results as a two-dimensional graph readout.
2. The motorcycle can be tested using the commercially-available Hexcode GS911 diagnostic tool (available from www.hexcode.co.za). The GS911 issues a brake-pressure test result as a switch parameter, indicating whether the system has passed or failed the pressure-hold test.

Warning: The brake pressure-hold test must be performed using one of the correct electronic diagnostic tools above. The test cannot be improvised by other means.