

BMW ABS II
(Non-Integral)
Disassembly and Analysis

BMW PN 3451 233 1637
2002 and earlier

Contact Info:
PM me: Terry at ADVRider.com

Background:

One merry day while commuting to work on my 2002 R1150GS, I stopped at a traffic light. When I pulled away, the ABS made a louder than usual KER_CHUNK noise and then the ABS lights on the dash started to flash alternately, signifying my ABS was no longer working normally. When I got to work, I did the ABS reset procedure (shorting pin 2 to pin 4 of the diagnostic connector and holding the ABS button down for 8 seconds as detailed here:

<http://advwisdom.hogranh.com/Wisdom/ABSResetProcedurev1.0.pdf>

That cleared the fault, and everything was happy again. But later that day, after about a 20 minute ride, the same thing happened again. I tried bleeding four pints of BMW DOT 4 brake fluid through the system. Two through the front circuit, and two through the back. I bled the ABS modulator as well as the wheel slave cylinders. That didn't help. I read out the fault code and it indicated a code 7 – ABS hydro unit. \$2137!!!!!!!

I ended up purchasing a used ABS hydro unit on ebay. It was from a R1100S, so I swapped the computer “brain” portion of it with my old one since I was pretty sure the problem with my old one was with the hydro portion, not the computer. If I hadn't swapped the brain, I would have had to take the bike to a dealer to have the brain from the R1100S “re-coded” to work in my R1150GS. Swapping the ABS unit and swapping the brain was easy and it got my ABS working again for much less than the \$2200 the dealer would charge for putting a new ABS controller in my bike.

Curiosity got the best of me and I decided I just had to take my old failed unit apart and see what makes it tick, and what was likely to have failed.

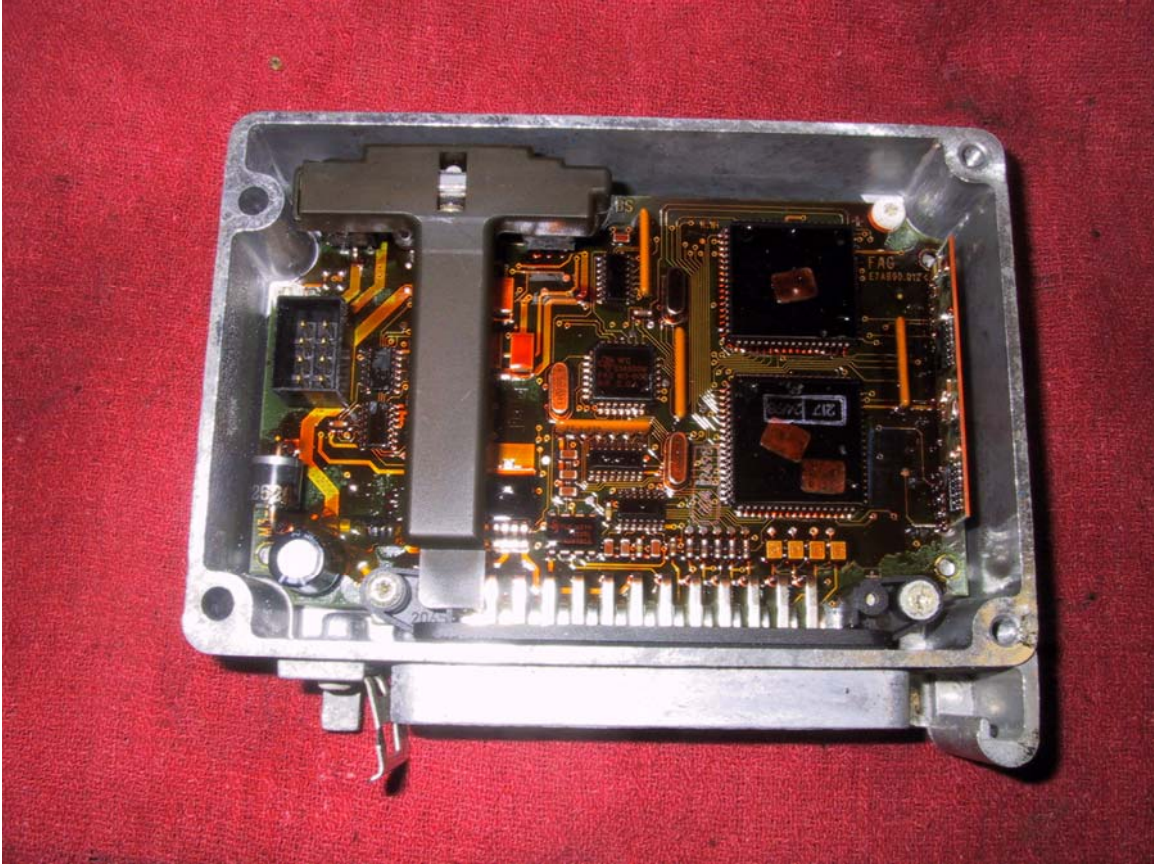
It turns out I could probably have fixed my old unit and had it working in about 15 minutes had I known how it was put together, without even having to remove it from the bike.

I took pictures of the disassembled mess, and here are the results....

The “brain” is attached to the side of the hydro unit with four screws. You will need a “tri-wing” driver to get them out. Once you remove the four “tri-wing” screws, the brain just unplugs from the hydro unit. There is a rubber gasket around the edge to keep dirt out. It is kind of sticky and it takes a bit of pulling to pull it loose.



The connector is the eight pin connector on the left side of the below picture.



The eight pin connector mates with the hydro unit. It connects the two clutches and the two position sensors in the hydro unit. If you measure the resistance at the mating connector on the hydro unit, you can check the relative health of the clutches and position sensors.

Clutch ---- O O
Sensor ---- O O
Sensor ---- O O
Clutch ---- O O

The clutches read about 2.4 Ohms and the sensors read about 11.7 ohms.

The failure in my unit was most likely a stuck piston in the rear brake circuit. If I had known what I was doing, I probably could have removed the piston, cleaned the seal on the piston, and put it back together in about 15 minutes without even taking the unit off the bike.

You can get to the pistons from the top of the unit with the unit still in the bike.

The picture below shows the top of the hydro unit. The unit has been removed from the bike, so the brake lines are not shown in this picture. The nipple on the left side (HZ) bleeds the rear brake circuit. The one on the right side (RZ) bleeds the front.



The pistons can be accessed by unscrewing the two large fittings under the nipples. I used a 1/2" drive socket. They were pretty tight, but not too bad. Clean the area around the fittings really well before you unscrew them to keep dirt from falling into the bores when you remove the fittings. Use a small screw driver, tooth-picks, dental tools, or whatever to clean all around those fittings before unscrewing them. Blow it clean with compressed air. There are rubber O-Ring seals under the fittings, so I wouldn't use anything that might damage the rubber. I didn't clean mine because I was just taking it apart with no intention of fixing it.

When you unscrew the fitting, it looks like this:



And where it came from looks like this:



You can see the rubber O ring and a metal ball bearing at the bottom. Carefully remove the O-ring. It belongs on the bottom of the fitting you unscrewed. It may have come out with the fitting. You don't have to fish the ball bearing out yet, it will come out in the next step.

You can see the ball is sitting in a valve body with two small holes in the side of it. You can barely see one of the holes in the picture above.

Take a piece of stiff wire with a bend on the end or something similar to hook the holes and pull that valve body out carefully. It is just held in by another O-ring. Don't stick the wire into the hole further than necessary. There is a filter screen behind it that you don't want to poke. Don't lose the ball bearing.

When it all comes out, it looks like this:



And where it came from looks like this:



Now you are looking at the top of the piston. It has a little tit on the top that pushes up through the valve body you just removed and holds the ball bearing just barely off the seat when the piston is at the top, which is where it normally sits.

You can now use a pair of needle nose pliers and pull the piston straight up and out. Be careful. There is a small rubber cup type seal at the top of the piston. Needless to say, you don't want to damage the seal or any of the O-rings since I doubt that it is possible to buy replacements.

Once you have it out it looks like this:



The front and back circuits are the same except that the piston for the front circuit is bigger.

Now you can see the bore that the piston fits in. Don't drop any dirt in there, although if you do, don't panic, it probably doesn't matter. You'll see why later.



Clean everything up, being really careful not to damage the seals or O-rings. You could even clean the bore out with a Q-tip or similar. Make sure that no strands of cotton are left behind.

Put it back together, and hopefully you have just saved yourself some big bucks.

That was the entire hydraulics portion. My theory is that the piston gets stuck at the top of the bore so that during the self test of the unit, it does not move down like it should, There is not much pressure pushing it down during the self check, because you are not on the brakes, so there is no brake pressure forcing it down. So it is pretty easy for it to stay stuck at the top, which I think causes the brain to indicate a fault and disable the unit. Hopefully cleaning it up takes care of this, but I don't know for sure.

The rest of the unit looks like this:

Under those little pistons that you just cleaned are two cups that ride in large bores. The cups are pushed upward by some very serious springs. Here is a look at the springs and the cups. The pistons sit in the cups (inside their little bores that you saw from the top). The rods connected to the side of the cup are for the position sensors that tell the computer how far it has pulled down the cups (and thus the pistons) when the ABS has been activated.



The cups and springs go into the lower part of the unit:



Don't even think about disassembling this portion without some way to deal with those springs. You will just end up damaging things. I did.

So how does the computer move those big-assed springs to activate the ABS?

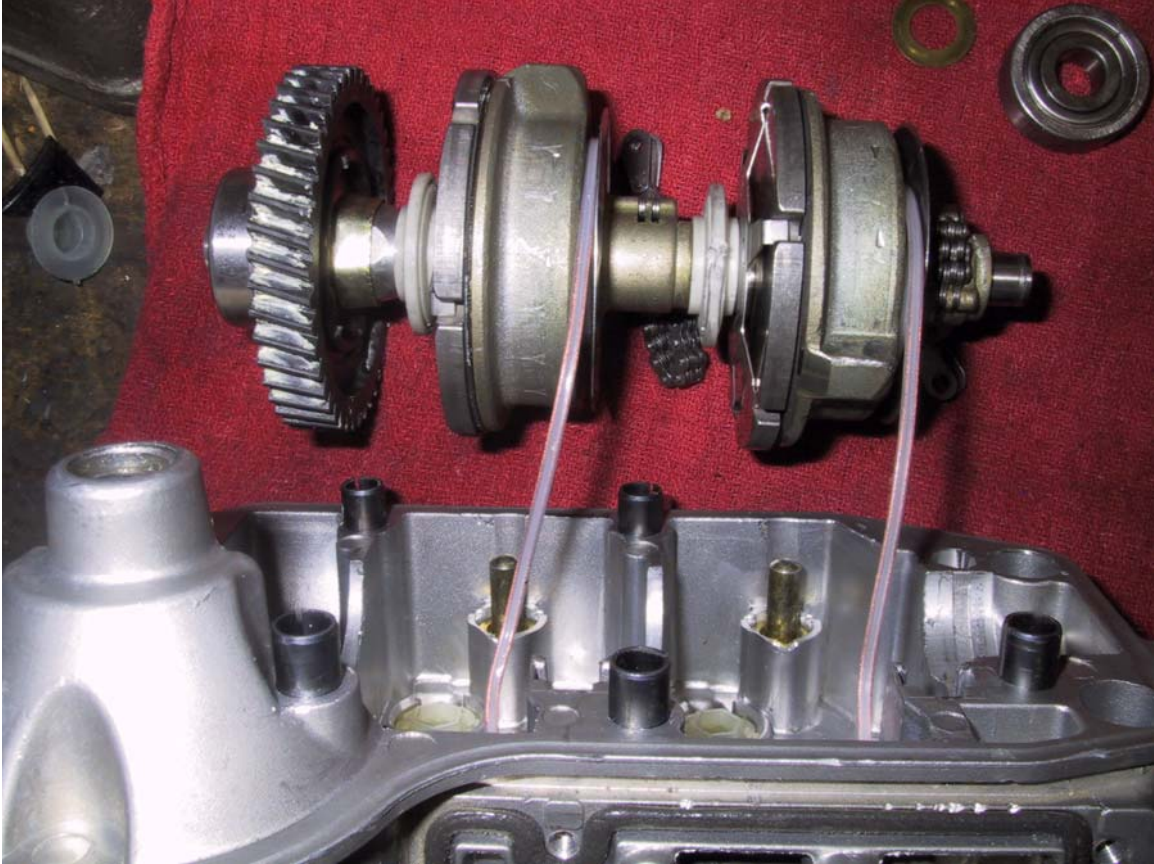
On the very bottom of the unit is a worm gear driven by a big motor. The worm gear turns a shaft when the motor is running. On the shaft are a couple of clutches that can be activated electrically.



This picture shows the gear (motor is removed) and the two clutches.

When the computer activates one of the clutches, the shaft now turns the body of the clutch. Attached to the body of the clutch is a triple chain that pulls the cups down against the springs, allowing the piston to fall down the bore.

Here is a shot of the clutches removed from the housing. You can see the chains. I got the thing apart by brute force (stupidity). To remove the shaft with the clutches, you must disconnect the chains. But they are held in place by those massive springs. The chains wrap around the bottom of the cups and come back next to the clutches, where they are held in place by pins. You need to pull against the springs and remove the pins. I think the only way to do this without damaging things would be to remove the pistons from the bores like you did above and devise something to push down into the bores and push down the cups to compress the springs. Then you could disconnect the pins that hold the end of the chains. Once the chains are released, the rest of the assembly is easy to take apart.



There is a couple of C-Clips on each end of the shaft. Take them off and the shaft components just slide off.

Here is what the motor looks like:



The motor is under a plastic cover. Also under the cover is the ABS relay and the connections that must be unscrewed to remove the ABS unit from the bike. The connections are under a cover that must be slid off. To slide it off, you have to push a sharp tool through the cover and depress a latch inside the plastic housing. Press a sharp tool (small screw driver or an awl or similar) right where there is a small circle above the FTW logo. You can see the hole I left in the picture below.



Then press in with the tool and slide the cover up.

The manual makes a big deal about disposing of the cover and getting a new one. I don't see any reason for that. It's not like it is a sealed assembly. It is open at the bottom. Put a piece of tape or some glue over the hole you made and reuse it.

Also the manual makes a big deal about using new "self locking" nuts on the terminals that you disconnect to remove the ABS unit. They aren't self locking nuts. Just plain old nuts with a star washer. No reason to not re-use them in my opinion. But hey, it's your butt if something goes wrong. You decide.

Good Luck.

After fussing with all of this, here is my best guess as to how this all works:

When the ABS is not active, the cups are pushed all the way up by the springs. This pushes the piston to the top of the bore. The tip at the top of the piston holds the ball off the seat of the valve body. This allows pressure from the brake master cylinders to flow unimpeded to the brake slave cylinders on the wheels. No amount of brake pressure will change that. The springs are just too strong.

When the brain decides that one of the tires is decelerating faster than the other, it assumes a wheel is about to lock up and does something about it: It first starts the ABS motor spinning. It probably spins up pretty quickly since without the clutches being activated, there isn't any load on it to speak of.

Then the computer activates the clutch for the wheel it wants to reduce brake force on. Activating the clutch allows the motor to turn the body of the clutch. This wraps the chain around the clutch body and pulls on the spring, compressing it. This pulls the cup down against the spring pressure, allowing the piston to fall in the bore.

As the piston starts to fall, the first thing that happens is the ball seats against the valve body. This blocks brake fluid from the master cylinder from getting to the slave. So the brake lever (pedal) still feels solid. Then the piston falling down the bore pulls fluid from the slave cylinder. This gets the tire spinning again.

The computer can then "modulate" the clutch on and off very quickly to move the piston up and down in the bore and just barely keep the wheels from locking up. So when the clutch is engaged, the motor pulls the cup, with the piston, down and when the clutch is released, the springs push the cup and piston back up.

Self Check:

More guess-work here...

The computer can read the position of the cups, but not the actual pistons. So I think the only way it would know if a piston was stuck would be to pull the cup down and then release the clutch to allow the spring to push the cup back up. If the piston went down with the cup as it should, then brake fluid would have to be squeezed out of the bore through the smallish ports as the piston rises. This means the cup will move slowly up (comparatively). But if the piston was stuck at the top of the bore and didn't move down with the cup, the cup would move back up very rapidly. The computer can sense this rapid movement and flag a failure. I think this explains the very loud "KER CHUNK" sound I heard when mine failed. That is the sound of the cup coming back up unimpeded by fluid pressure.

The problem here is that during the self check, the brakes are not applied, so there isn't much to force the pistons down in the bores when the cups are lowered. The pistons need to be able to move pretty freely in the bore to pass the self test.

And there you have it, my disassembly and analysis of this non-integral ABS II modulator. If anyone has any input I'd welcome the additional information.