the bimmer pub®

June 2012 Volume 1 Number 2

Technical Knowledge for Independent BMW Service Professionals

Welcome.

'the bimmer pub' is sponsored by your local BMW wholesaling dealer parts department, and is dedicated specifically to independent technicians who service BMW vehicles.

Our position is simple. If you are able to repair and maintain BMW vehicles properly and efficiently, your reputation will be enhanced, as well as the reputation of BMW. To this end, feature articles are intended to provide hands-on diagnostic and repair procedures, service and maintenance techniques, with content sourced from both BMW and successful independent BMW repair specialists.

With a driving combination of the proper repair procedures and the correct Original BMW replacement parts, you can expect to fix that BMW right the first time, on time, every time.

Included in this effort is the development of a highly informative and user-friendly web site that will be home to article archives and more. We expect to launch the new bimmer pub website during the third quarter 2012.

We want to make "the bimmer pub" the most useful and interesting technical magazine you receive, and you can help us do that. Please email our publisher at: cayers@thebimmerpub.com and let us know what topics you would like to see covered in upcoming issues. Your suggestions and comments are welcome, and with your involvement, this publication can become one of your most important tools.

Thanks for your continued interest.

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Technical Knowledge for BMW Service Professionals

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Finally, Some Definitive Answers to Help You Set BMW Rotor-Service Policies

BMW 5er-Reihe/Leichtbau-Bremse
BMW 5 Series/lightweight brake design

P0010235 BMW Group PressClub: www.press.bmwgroup.com
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It's about time somebody told you the truth about BMW discs, including hanging pads, machining, rotor forecasting, and O.E. vs. aftermarket replacements.

Except maybe for some impractical exotics, nothing has more powerful, fade-resistant brakes than a BMW. As one "Bremsen" (brakes *auf Deutsch*) engineer once said to us, "They'll stop on a dime and give you nine cents change." We've always called them "Autobahn brakes," referring to the German highways that have no speed limits and require serious vehicular control if your survival is of any importance to you.

A necessary consequence of this sophistication in stopping and BMW's focus on maximum all-around performance is that the company's rotors aren't the heaviest out there. There's the matter of reducing unsprung weight to improve handling, but another factor is keeping the mass down to aid heat dissipation and cut the potential for fade. Also, to enhance cooling the air passages have been opened up with the result that the wear surfaces are a bit thinner than they are on mundane vehicles. In most cases, BMW only allows 0.064 in. (1.6mm) of wear before the discard thickness is reached, whereas other carmakers might permit 0.100 in. (2.5mm).

Eyeballing

We remember years ago removing a wheel from a BMW with maybe 39K on the odometer and being able to see with the naked eye the excessive rotor wear that was going to make replacement necessary. We're not talking grooves. We mean a visible wide depression made by pad contact. But it turned out that this was on a car that had high-performance modifications and was presumably driven aggressively, so such a situation shouldn't form the basis of your decisions where the majority of these cars are concerned.

So, disc service and replacement policies become a delicate balance on a high-performance car such as a BMW. Some frugal techs say you can usually hang pads twice before installing new rotors, but more and more have come to believe that new-on-new is the only way to insure excellence in stopping characteristics and safety.

Almost nobody turns BMW discs anymore. As one successful upscale Euro specialists says, "We threw our brake lathe in the trash." That's a big change from traditional American brake service, and something your patrons may give you an argument about since they've probably been hearing about brake rotor machining ever since they bought their first car (a ponderous domestic with 40-lb. discs, perhaps?). Well, this is a BMW. If you want the cheapest thing to drive and the least expensive to service, choose some old-fashioned slug of a vehicle. Besides, when you subtract the labor of turning rotors in a workmanlike manner on a well-maintained lathe, then cleaning them thoroughly (the avoidance of which task is a common cause of squeak and squeal), the difference between that alternative and installing new isn't so great after all. In the case of cross-drilled discs, machining is not allowed, period.

In 2003, the company proudly announced a light brake design for the 5 Series. While the wear surfaces may be thinner than they are on lesser vehicles, you can't argue with the performance. (Image courtesy BMW Group PressClub.)

It may not be as accurate or rugged as a mechanical disc micrometer, but since our eyes aren't what they once were we've come to love our digital rotor caliper.

Hearsay

Given the rumors circulating out there in the trenches of independent auto repair, we decided to submit some straightforward questions to the service engineers of BMW North America to be sure we weren't saying anything outrageous in the pages of The Bimmer Pub, and they graciously responded through the company's excellent P.R. department in Montvale, NJ. To wit:

Q There's a rumor out there that in order to provide the best possible stopping power, BMW uses relatively soft rotors, and that's

Even if they're not down to the discard thickness yet, how much iron was lost during the last wear cycle? If that same amount will take a used disc below the throw-away spec, you should have a talk with the customer about "rotor forecasting.

why they tend to wear faster than they do on lesser vehicles. Some technicians even claim that the discs and linings are designed to wear out at the same rate. What's the truth about BMW rotor metallurgy?

A Not true. Generally speaking, BMW brake rotors are designed to support more than one set of brake pads during their normal service life. As you can imagine, the life of any brake system component is subject to the customer driving profile. When brake system components are subject to high heat loads with insufficient cooling time, accelerated wear can occur. BMW brake systems are designed to match the overall performance nature of the vehicle, having the ability to provide braking as superior as the acceleration and handling to complete the whole package.

Q Are there any circumstances in which you would recommend that BMW rotors be machined?

A Yes, when irregular wear, brake pulsations or vibrations are present before the brakes are to be serviced and there is enough material thickness remaining to support machining (not below minimal wear tolerance). BMW brake rotors are similar to any other manufacturer's rotors and can be machined, with the exception of the cross-drilled rotors used on M models and other performance vehicles. When the frictional surface of a cross-drilled rotor is questionable, BMW recommends the replacement of the rotor.

Q If no pulsation is present, grooving is minimal, and there is enough thickness left so that the next wear cycle will not bring the discs down below the "throw-away" spec, is it ever acceptable to simply "hang pads" (as techs call it)? In other words, put new linings on worn rotors.

A Yes, absolutely. Provided there is no obvious "irregular" wear, BMW brake pads will conform to the friction surface of the rotor within the normal 'bedding-in' period (300-400 miles).

Reasonable responses, indeed. It would be foolish to disagree with any of them, but there is a little more to the story.

What's the forecast?

Take the subject of "rotor forecasting," for instance. We first heard of this years ago, and it always made sense to us. The idea is to take the original thickness of the disc (look it up, or measure an unworn area), then subtract the current thickness from that number, which will give you the amount of iron reduction the wearing out of one set of linings results in (or, if this is a second reline, two sets, and so on). Typically, this will be 0.032 to 0.040 in., or 0.8 to 1.0mm per cycle. If the rotor has more than that left, and no machining is necessary, you can reuse the discs and just hang those pads. On the other hand, if that subtraction puts you below throw-away, you're leaving yourself open to both complaints and liability. It's easy math to explain to your customers, and if you handle it right you should sell a lot more new rotors.

One subtlety most people don't know about is the angle of the chamfer of the center hub hole. Is it identical to O.E. on that aftermarket replacement?

Thoroughbred

Whenever you've decided that replacement is the proper course of action, you're faced with another big question: O.E., or aftermarket? While people who work on domestics and run-of-the-mill imports generally opt for the latter to save money, what should you be doing? After all, you've chosen to pursue the servicing of thoroughbred vehicles. Is the cheapest route appropriate?

Probably not. In the first place, while that aftermarket rotor may claim to meet factory specs, that might just mean that it shares the same dimensions and will fit physically. While the original might have an aluminum "hat," or be of the floating variety that both saves weight and optimizes airflow, what you get from your local jobber will often just be a plain, relatively crude iron casting. We've seen pictures of discs sawn in half to reveal the configuration of the cooling fins in the air gap, which is an engineered feature. Do the makers of cheap parts follow that exactly, or just do what's easiest?

Besides metallurgy and structure, there's a factor that might cause serious problems

Some guys like to compare the weight of aftermarket replacements to that of the originals, figuring the heavier, the better. But BMW wants good heat dissipation and reduced unsprung weight, not a massive, perhaps crude, casting, so your scale won't really tell you anything about quality.

with aftermarket rotors that most people aren't aware of: hub chamfer. If the angle doesn't match the hub exactly, the disc won't seat right, leading to big trouble with runout and heat dissipation, yet some cheap items just use, say, 45 deg. as a one-size-fits-all manufacturing convenience.

We've never seen a cracked BMW rotor, but according to expensive and extensive research by some European brake parts

BMW Group Fuel System Cleaner

makers who supply O.E. and genuine replacement parts, Asian discs are much more prone to this failure than theirs are. We don't find that hard to believe.

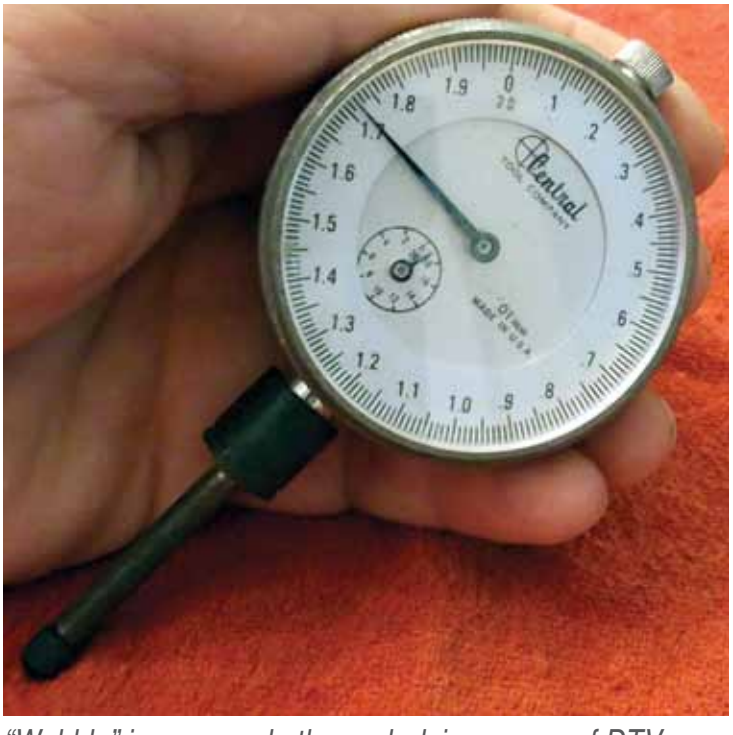
At BMW, it's corporate policy not to disclose suppliers, so it would be poor form for us to tell you what companies actually manufacture its O.E. and replacement rotors (except, of course, for the high-profile Brembos on models such as the M3 GTS that can go from 100 to zero kph in a mere 32.6 meters). Suffice it to say that they're long-established European companies with impeccable reputations for research, testing, and manufacturing quality. And there's no difference between what they supply for BMW assembly lines and what your local dealer sells. Opting for them will pretty much eliminate comebacks, keep your customers happy with your work, and allow you to sleep well.

We'll conclude with a few practical points:

- Brake pull can be the result of a restriction in the hydraulics, or a discrepancy in the characteristics of the friction components from one side to the other. Using a set of load-cell pressure testers will tell you if you've got equal squeeze left and right. If so, a reline is called for.

- Runout per se doesn't cause pedal pulsation, but it's still often at the root of the problem. What happens is that the disc surface strikes the

Is that brake pull being caused by a hydraulics issue, or did somebody do something strange like mixing brands of linings? Comparing the squeeze of each side will tell you.



"Wobble" is commonly the underlying cause of DTV (Disc Thickness Variation), which in turn results in pedal pulsation. Use that dial indicator to head off comebacks.

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pads just in certain areas as it rotates, which wears them unevenly and produces DTC (Disc Thickness Variation, once known as "lack of parallelism"), the true culprit. During a stop, each time the thicker parts of the disc pass between the pads, the hydraulic column gets a kick, which the driver feels. A common maximum spec for DTV is 0.0002 in., yet one lathe manufacturer tells us that 0.002 in. of runout will cause about .0004 in. of DTV in 3,000 to 5,000 miles.

- So, get rid of runout or installing even the best new discs won't protect you from a repeat "bumpy braking" complaint.

- Speaking of runout, disc mounting errors are a common cause. That is, any rust or dirt between the hub and the inner hat of the rotor that keeps them apart, even ever so slightly -- the effect is magnified out from the center. Fortunately, BMWs use lug bolts instead of studs and nuts so it's a lot easier to make sure that surface is perfectly clean than it would be if you had to go around all those studs.

- Genuine BMW replacement rotors commonly come with an even, light-gray rust-preventative coating. While you may have read that this should be removed before installation, the premium European disc manufacturers assure us that it should stay on. As one puts it, "This highly effective surface protection enables installation without additional cleaning of the brake disc and full braking effect from the first braking movement is fully guaranteed." ●

Perhaps you've been expending a lot of work cleaning that nice rust-preventative coating off a new rotor before putting it into service. You can stop now. It's meant to stay on and actually helps the bedding-in process to prevent squeaks and squeals.

You'd be hard pressed to find such a premium coating on an aftermarket replacement, such as this no-name Asian specimen.

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Information Station

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Coming Attractions
August 2012 Issue

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Diagnosing fuel trim problems doesn't have to be hit and miss.

Window Pain
Operation, diagnosis & repair procedures for power window systems.

Beating Around the Bush
How will you know if it is a bushing problem or something else?

Protecting the Occupants
A review of restraint systems and proper repair methods.

Questions/Comments?
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BMW Assist

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Climate

Getting the MOST

Any technological advance adds a level of complexity, and when it breaks we're the ones who are going to have to fix it. This includes the sophisticated MOST bus. How should we approach this "beast"?

BMW owners expect a lot from their vehicles. From the moment of purchase, they were treated to technological advancements they may not even have noticed. The operation and integration of systems was so seamless that they took all this wizardry for granted. The driver utilized the navigation system, the passenger changed stations on the satellite radio, and others in the back were entertained by the latest DVD. And all of this was being controlled through the MOST (Media Oriented System Transport) bus.

Settings

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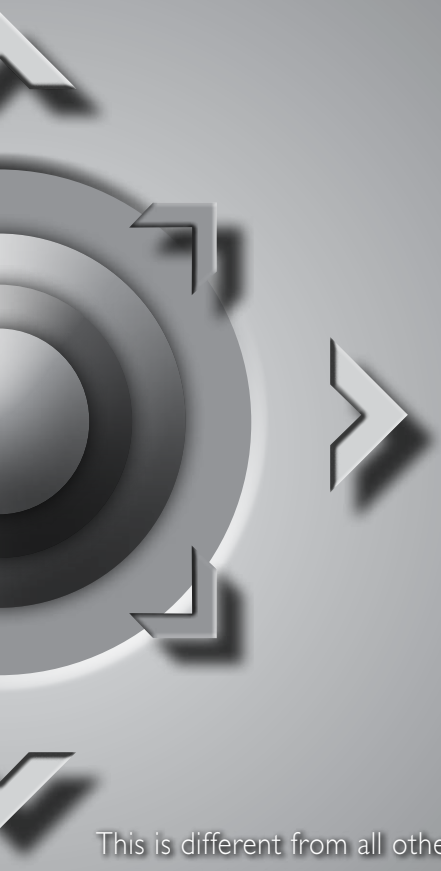


This is different from all other bus systems in that it does not use pulse-width modulated electrical signals across a wire. MOST uses light pulses traveling across fiber-optic cable to transmit and receive data. Fiber optics have been around for many years and has proved successful in transmitting large amounts of data very efficiently.

Why Fiber Optics?

CAN systems have been in automotive use since the mid-'80s. They are communication lines that carry digital square wave signals along a wire from one control unit to another. With a CAN, numerous computers can share information with one another instead of having multiple separate sensors doing the same job for each control unit. This reduces the number of sensors and wires, and the overall complexity of a vehicle. A huge amount of data gets passed around on a CAN.

Today, instead of a few control units on the network, there are many. And wires carrying signals are prone to interference from other wiring. Remember, as electrical current flows through a wire it generates a magnetic field. If the field is strong enough, it can interfere with sensitive data-line communication. In contrast, fiber optic cable carries a wave of light, which is not affected by the electromagnetic fields of any wires.

Light Beams for Automotive Use

The type of fiber optic cable used in your community's communications infrastructure is made up of glass fibers. These installations are permanent and isolated from vibration. If fiber optics are to be used in automotive applications, a cable is needed that can handle temperature extremes and vibration. Dow-Corning developed a polymer fiber optic cable that is well-suited for automotive use. Small amounts of dust to not interfere with the data transmission, and the cables can be installed within the tight confines of a vehicle body. They can be routed with a wiring harness without any worry of electromagnetic interference and can handle a large amount of data. This is not to say fiber optics do not have limits. The longer the light has to travel through a cable, the weaker the signal becomes. This is known as attenuation, the loss of signal strength.

In order to communicate through the fiber-optic network you need to access the diagnostic connector. On the 3 – Series vehicles the connector is mounted behind a cover by the hood release handle. On the 5 and 7 – Series it is mounted in the upper panel of the glove box.

This loss of the signal strength can be caused by several factors. Any sharp bends less than two inches in diameter will impede a signal, and a kinked cable will cause interference. A crushed cable will distort the light signal, so be wary of this on vehicles with body damage. If the cable is stretched in any way it will result in corrupt data transmissions. Excessive dirt or grease on the cable tip, as well as scratches on the cable ends will distort the light signal. Also, watch out for damaged insulation. The fiber optic cable has an internal sheathing as well as a cover that keeps the signal from refracting outwards, therefore ruining it. The general rule is to avoid any undue stress on the cables when tugging a wiring harness in the process of repairing a vehicle. Even a small, temporary stress on the cable can cause communication problems, and affect the whole system.

The Layout of the MOST bus

If you are familiar with communication networks, you probably know that BMW CAN systems use the Bosch CAN two-wire parallel setup. Each control unit has two wires for the CAN. One is CAN High and the other is CAN Low. The CAN High signal starts off close to ground and pulses upwards. The CAN Low signal starts off at a higher voltage and is pulsed downward. The two signals mirror each other and carry the same information. This way, if one line goes down the control units can operate on the other line. To put it another way, the control units are wired in parallel so if one unit fails the others can continue communicating.

There are multiple CANs for the different systems of the vehicle. There is the Powertrain CAN, Chassis CAN, Diagnosis CAN, and FlexRay CAN, depending on the year, make and model of the BMW you are working on, and they may be connected together through a central gateway computer.

The MOST bus system is different. It is not connected in parallel. Since it is passing a light transmission, the signal has to have a starting point and an end point. The starting point is referred to as the master or multi audio system controller. All the control units on the MOST bus can pass information, but only the master can share communication with other bus systems on the car. A ring structure is used to connect the control units on the bus. This means the signal originates from the master control unit on the "transmit" cable and is sent to the second control unit to the "receive" terminal. Each control unit has a "transmit" and a "receive" terminal (two fiber optic cables). Terminal 1 is always the "receive" terminal or input cable, and terminal 2 is always for the "transmit" or output cable. The output cable of the first control unit is sent to the receive terminal of the second, and so on.

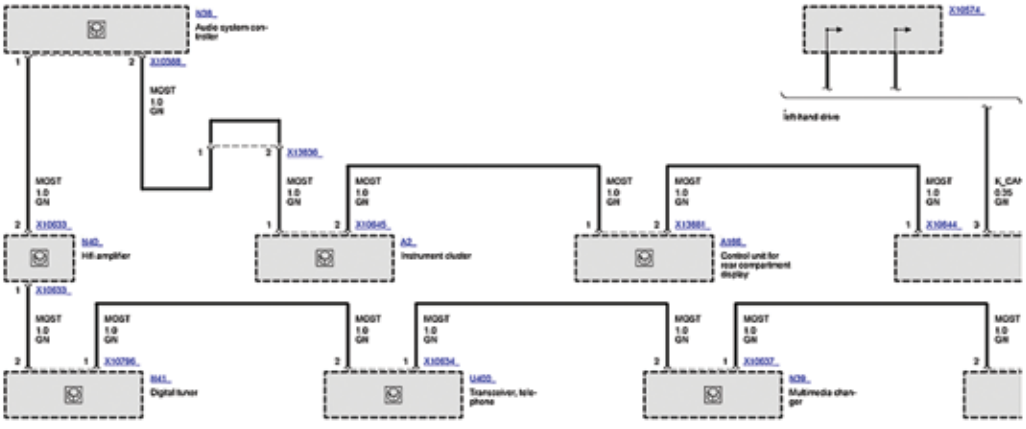
Can You See the Glow?

To ensure a strong light signal, the second control unit copies the signal and retransmits it. This is done until the control unit the message is sent to receives the signal. Each control unit on the MOST can send a signal to the others; it simply may have to pass through other control units in the process. The corresponding cables form a ring between each of the control units.

This also means if the ring is broken, the system will not function. It a control unit is not powered up, the fiber optic input and output cables are connected together. This allows the signal to pass through it to allow the rest of the system to keep working. However, if there is a malfunction in a control unit the signal will stop there and all of the MOST components will not work. You will need to identify which control unit is in trouble to fix the problem.

What Happens When it Stops Working?

Manual ring break diagnosis is quite simple, but it does require a bit of labor. You are going to have to pull up a diagram of the MOST bus components. Each vehicle is going to be slightly different depending on the chassis layout of the MOST bus and the options the vehicle came with. You can start at the beginning of the MOST circuit, or at the end. Simply unplug the fiber optic connector and look at the receive terminal. You should see a red blinking light. This light's frequency is 650 nanometers, which is the frequency of red light. An LED, not a laser, is used to generate the signal, so it is safe to look at directly. If the red light is not visible, you can reconnect and move to the next component in the loop. Keep doing this until you reach the control unit that is not emitting a signal.



By visiting www.bmwtechinfo.com you can access ISTA for service information. You can pull up a MOST bus fiber optic cable diagram. This lets you know what control units may be in the vehicle you are working on and where you have to check for the fiber optic signals.

ORIGINAL BMW REMANUFAC

Series	Engine	Production Years	Models	Reman Part Number
E30	M42	Up to 04/1991	318i, 318is	64 52 8 385 916
E31	M62 M60	M60: 9/1993 - 11/19/95 M62: From 05/1995	840Ci, 840i	64 52 8 385 908
E32	M60	From 06/1992	740i, 740iL	64 52 8 385 908
E34	M60	From 01/1988	530i, 540i	64 52 8 385 908
E34	M50	Up to 07/1993	525i	64 52 8 385 915
E36	M50, M52, S52	Up to 09/1992	320i, 323i, 325i, 325is, 328i, M3	64 52 8 385 915
E36	S50	From 11/1993	M3	64 52 8 385 909
E38	M60, M62	Up to 09/1997	740i, 740iL	64 52 8 385 917
E38	M73, M73N	From 09/1997	750iL, 750iLP	64 52 6 911 348
E38	M73, M73N	04/1997 to 09/1997	750iL	64 52 2 147 456
E39	M52	Up to 09/1997	528i	64 52 8 385 919
E39	M62	Up to 09/1997	540i, 540iP	64 52 8 385 921
E46	M52, M54, M56, S54	M52, M54, M56: Up to 09/2002 S54: 09/1997 - 09/2002	320i, 323i, 323Ci, 325i, 325Ci, 325xi, 328i, 328Ci, 330i, 330xi, 330Ci, M3	64 52 6 911 340
E38, E39, E52	M62, S62	From 09/1997	740i, 740iL, 740iLP, 540i, 540iP, M5, ALPINA V8 Roadster, Z8 Roadster	64 52 6 911 342
E53	M62	From 10/1998	X5 4.4i / 4.6is	64 52 6 921 651
E53	M54	Up to 10/2002	X5 3.0i	64 52 6 921 650
E65, E66	N62, N62N, N73	Up to 4/2008	745i, 745iL, 750i, 750iL, 760i, 760iL	64 52 2 147 458
E60, E60N, E61	N52, N52N	Up to 9/2008	525i, 525xi, 528i, 528xi, 530i, 530xi	64 52 2 147 460
E46, E83	M54, M56, S54	From 09/2002	325i, 325Ci, 330Ci, M3, X3 2.5i / 3.0i	64 52 6 936 883
E60	M54	Up to 10/2005	525i, 525xi, 530i, 530xi	64 52 2 147 457
E60, E63, E64	N62, N62N	Up to 4/2008	545i, 550i, 645Ci, 650i	64 52 2 147 459
E82, E88	N51	Up to 3/2007	128i	64 52 2 151 495
E90, E90N, E91, E91N	N51, N52, N52N	Up to 10/2006	323i, 325i, 325xi, 328i, 328xi, 330i, 330xi	64 52 2 151 495
E92	N51, N52N	N51: Up to 3/2007 N52N: Up to 10/2006	328i, 328xi	64 52 2 151 495
E93	N51	Up to 3/2007	328i	64 52 2 151 495

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Series	Engine	Production Years	Models	Reman Part Number
E82, E88	N54	From 11/2006	135i	64 52 2 151 496
E90	N54	From 3/2006	335i, 335xi	64 52 2 151 496
E90N	N54	From 04/2008	335i, 335xi	64 52 2 151 496
E92	N54	From 06/2005	335i, 335xi	64 52 2 151 496
E93	N54	From 10/2005	335i	64 52 2 151 496
E82	N51, N52N	N51: From 03/2007, N52N: From 10/2006	128i	64 52 2 153 227
E88	N51, N52N	N51: From 03/2007, N52N: From 10/2006	128i	64 52 2 153 227
E90	N51, N52, N52N	N51: From 03/2007 N52, N52N: From 10/2006	323i, 325i, 325xi, 328i, 328xi, 330i, 330xi	64 52 2 153 227
E90N	N51, N52N	N51: From 03/2007 N52N: From 10/2006	328i, 328xi	64 52 2 153 227
E91	N52, N52N	From 10/2006	325xi 328i	64 52 2 153 227
E91N	N52N	From 10/2006	328i, 328xi	64 52 2 153 227
E92	N51, N52N	N51: From 03/2007 N52N: From 10/2006	328i, 328xi	64 52 2 153 227
E93	N51, N52N	N51: From 03/2007 N52N: From 10/2006	328i	64 52 2 153 227

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The More Things Change . . .

Another way of approaching the diagnosis is to unplug each control unit and install a connector loop. This component is found in the glove box of the E65/E66 7-Series vehicles connected to the diagnostic plug for the fiber optic adapter. You can purchase these fiber optic loops from you BMW dealer's parts department. The connectors are standardized, so you can plug in your loop to bypass any component on the MOST bus. Also, you can use your iComm/iSTA software to find out which options the vehicle has. The MOST bus components are assigned a node in the master control unit, and you can look at a list of installed components. Although many BMWs have SAT radio, some customers did not order that option at the time of purchase so their vehicles will not have a SAT radio receiver.

By the same token, if a customer added an optional system down the road you will have to use iComm/ISTA to program the multi-audio master control unit to accept the change before the component can become operational. The MOST bus is flexible in that a car owner can add new MOST bus components without the worry of overtaxing the system. BMW provides additional fiber optic cable already in the vehicle for this very purpose. You can connect a retrofitted component to an existing plug for an option that is not installed, but you still need to let the master control unit know. Also, when replacing a component you are going to have to code it to the vehicle. On the MOST bus, this requires a few steps. Every component on the MOST bus must coded for the new or additional component. Denision and MoBridge are two aftermarket companies that provide MOST bus components that can be programmed into the system.

What to Do When Things Go Wrong?

When the system goes down, it usually means one or all of the components are either not functioning or not powering up. This can be caused by any of the individual control units on the MOST bus. Picture the MOST system as a single control unit with multiple power supplies and grounds. The system can also be shut down if one of the components reaches 160 deg. F. (70 deg. C). The overheated unit will shut off and take the system with it. Through the Service menu, you can use the display panel to call up all of the components that are installed on the vehicle if the optical ring is functional. Each of these power supplies and grounds must be there to get the entire system operational. If only one is missing, the whole system will not work. A visit to *www.bmwtechinfo.com* can provide you with the necessary wiring and fiber optic diagrams so you can follow the power supply.

As an example, on the early E90 chassis the power supply for the CCC/M-ASK module, which wakes up and controls the MOST bus, comes from the bi-stable relays mounted in the junction box control module. With BMW iComm/ISTA, you can activate these relays on and off while testing the power supply at the CCC/M-ASK module mounted in the center console. On early E60 chassis 5-Series vehicles that do not have a KGM Body Gateway

As a preliminary check, you can unplug each component and look for a blinking red light signal while the MOST bus is active. If you unplug a component and the cable is not blinking, do not blame the component you unplugged, but the one the signal is coming from.

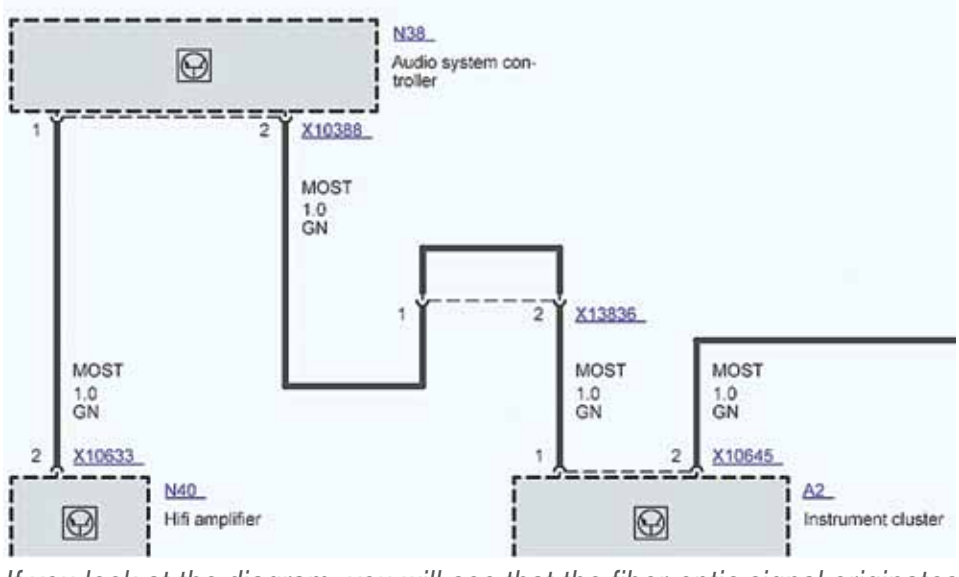
Module, the power supply comes from a Micro Power Module mounted in a styrofoam insert under the spare tire. The Micro Power Module has two constant power supplies (terminal 30) and one ignition-on power supply (terminal 15). It is on the K-CAN, which tells it when to power up fuse #34 that powers up the CCC/M-ASK unit. On a 7-Series (E66 Chassis), the MOST bus Audio System Controller is powered up by the Power Module through fuse #65.

You can order a 7–Series fiber optic loop from your local BMW dealer's parts department. This can be plugged into the fiber optic harness plug to bypass the component you believe to be the problem.

Early 7-Series

The difference with the early E66 chassis is that the MOST network is connected to the Instrument cluster and Control Display. You can enter these control units through the K-CAN to run a quick test and see if you have codes informing you that the MOST is down. Problems in the electrical system (low voltage supply) will tell the Power Module to shut off unnecessary accessories to conserve amperage. The iComm/ISTA diagnostic tool is critical to system diagnosis once voltage supplies have been checked. After that, it comes down to manual ring break diagnosis. As mentioned earlier, this means going to each control unit in order and checking for the red blinking light. MOST fiber optic cables can be repaired with one terminal connection per line before the signal is in danger of becoming distorted. The ByteFlight system is also fiber optic, but since it is safety-related no repairs are allowed to any of the cables. They must be replaced.

The MOST bus fiber optic system is complex, but if you break it down to its essential components you should be able to get through diagnostics with a wiring and fiber optic diagram. Be prepared to check powers and grounds at multiple control units, and check the light signal at each component. This can be labor-intensive, but you will eventually find the solution to your customer's problem. This is the kind of effort that keeps your customers coming back to you for service. ●



If you look at the diagram, you will see that the fiber-optic signal originates from the Audio System Controller. The next stop is the instrument cluster, and after passing through the loop and the Amplifier, it returns to the Audio System Controller.

Comfy Customers

How BMW HVAC Systems Work, & How to Work on Them

BMW owners expect their cars to be not only fun to drive, but comfortable to spend time in. Doing HVAC repairs right the first time can make you a hero in their eyes.

Being some of the most sophisticated vehicles in the world, just about every aspect of BMWs is a technological marvel. Think about how these vehicles have evolved over the last couple of decades and you might put the engineering that went into them right up there with that of the space shuttle. Take their HVAC systems, for example. To say they're extremely advanced is an understatement, which requires considerable discipline on your part if you want to understand how they work and interact with the rest of the vehicle. Never forget, however, that the basics still apply. You still need to check such things as the refrigerant charge, blower operation, blend door movement, coolant level and condition, etc.

Once you go beyond those essentials, you must learn a considerable amount of additional information about the various climate control systems BMW offers so you will be prepared when problems arise. Knowing the subtleties of how these systems function can make the difference between being profitable and struggling to break even. You need to know how the A/C compressor is controlled, how heat is provided, and what controls blower motor operation. This may sound simple enough, but there are three available options and all are electronically controlled to some extent, which takes this area of service onto another level.

In The Old Days

BMW has used several systems to control the interior temperature of its vehicles over the years, each with its own level of sophistication. For example, IHKS is a manual system typically found on 3-Series cars such as the 318ti, Z3 and Z8. The driver is in control of temperature settings, mode door position, and blower speed. Despite the fact that it's basically manual, many of the components are electronically-controlled. For instance, the A/C compressor is ruled by the DME, which also handles fuel injection. It directly controls the compressor through a relay, and it can increase idle speed to handle the additional load. An input from the IHKS system tells the DME when to energize the clutch. Blower speed is handled by multiple resistors through a switch. Mode door control is by means of a manual cable except for the motor that handles fresh air recirculation. This motor receives a pulse width-modulated signal from the IHKS control unit and opens or closes the door accordingly.

The next level of sophistication is IHKR. This was an option on the 3-Series and standard on most 5-Series, and is considered semi-automatic. Blower speed is still controlled with multiple resistors, and mode door control is still by means of cable, but cabin temperature is regulated by the IHKR control unit. Sensors send interior and exterior temperature readings to the electronics, which use that data to make decisions about how best to control the compressor and blend door.

Both IHKS and IHKR have pressure switches that will only pass along the A/C request if there is enough refrigerant in the system. They also shut off the compressor if the pressure exceeds approximately 450 psi on the high side. Another sensor reading that can shut off compressor operation is that from the evaporator temperature sensor. This is mounted in the evaporator core and its resistance rises as it gets colder, which keeps the signal voltage high. If the signal voltage drops too low, the IHKS/R control unit will shut off the compressor. While IHKR automatically responds to temperature changes, it still can only provide the same temperature air to all of the vehicle's occupants.

The Flagship of AC Systems

BMW's most sophisticated HVAC is IHKA. It's fully automatic, so it reacts to changes in temperature load by controlling blower speed, compressor operation, and mode door control. That's right, the A/C compressor is now controlled by the IHKA control unit, not the DME. This information is passed along to the DME so it can adjust idle speed for the additional load. The IKHA control unit is integrated with the switch assembly, and blower speed control is computer-controlled. A final-stage blower module uses integrated circuitry (a power transistor) to vary the amperage on the ground side of the motor. An analog signal is sent from the IHKA control unit to this module. As the voltage increases,

so does the blower speed. Usually, this voltage command varies from 0V to approximately 7V. This allows the control unit to regulate blower speed as temperature inputs change without any assistance from the driver. The mode doors are also controlled by the IHKA unit, which sends signals on a single wire to each servo motor. This is known as the MI-Bus. Specific pulse width-modulated signals command specific doors to open or close.

On more recent high-end chassis such as E66 and later 7-Series, FKA (rear climate control) has been implemented. This is a three-zone system where the two front passengers and the rear passengers can control temperature independently. On the E70, a true four-zone system is used wherein each individual passenger has control of the temperature in his or her own area. This is achieved with an HVAC unit mounted in the front of the trunk that handles the temperature control of the rear cabin. It has independent control of mode doors and blower speed, but shares the same A/C system otherwise. However, there are two separate refrigerant control valves for the front and rear evaporators. This requires some additional service procedures. You will need to use the iComm/ISTA diagnostic interface to put the dual system into a filling mode. This fully opens the refrigerant control valves so the system can be evacuated and refilled.

Bringing Up The Rear

Some specific service procedures are required if the rear system is to continue to function properly. There are two independent control panels, one for each side of the rear seats, but only the right-side panel has the intelligence to learn the stops for all the servo motors. The left

Here we are measuring the command signal from the IHKA control unit to the blower module, and the motor's amp draw. With the highest blower speed selected, 7.5V is being sent to the blower module, which then grounds the motor. Draw is about 30 amps.

The duo-valve is a two-part heater valve that can independently control coolant flow to two separate heater cores. This is critical to the water-based control of interior temperatures. The valves are normally open, and are pulsed closed to reduce the heat supply.

side must be calibrated to the right side after service work is performed. You can find these procedures on www.bmwtechinfo.com. On 2007 and later X5s, there is an additional third-row heater option that is different from conventional heating systems. This new system is referred to as HB3SR, and uses a PTC (Positive Temperature Coefficient) heater element for the rearmost seats. This is an electrical system that is not part of IHKA. It is part of the vehicle's electrical system and can be shut off, or heating output can be reduced by 50% through the LIN bus if the amperage load exceeds what is available from the charging system. A HB3SR control unit manages the 300-watt ceramic element, which is heated by electric coils. This is only activated when maximum heat is selected.

BMW uses both water-based and air-based temperature control. This allows greater flexibility in individual temperature control of the separate passenger zones. For instance, the two front zones of a 745Li have separate heater cores. The air is cooled as is passes through the single evaporator core. It is then heated to the set temperature for that side of the cabin by the heater core for that zone. Two water valves or duo-valves control the quantity of heated coolant into each heater core. In an air-based system, either fresh or recirculated air is directed through the evaporator and the heater core. The position of the temperature blend door is controlled to combine heated and cooled air until the desired temperature is reached. BMW employs both single- and dual-zone air-based systems. These provide greater control over interior temperatures, but take up a larger volume of space inside the dashboard.

Sensing the Change

Either IHKA water- or air-based systems require sensors for feedback to work properly. The interior temperature sensor is mounted in the control panel of the IHKA unit. Very small voltage changes occur in this sensor since the temperature range is relatively small. There may be footwell temperature sensors as well to enhance the overall interior temperature reading. The outside temperature is also read by its own sensor, which is typically mounted in the front bumper area and is wired to the instrument cluster. This information is put on the CAN bus and distributed to all the control units that require it. The IHKA unit is one of them and uses the outside temperature signal to detect the overall load on the system. There are many other temperature sensors involved. An evaporator temperature sensor is still used to determine if the evaporator is freezing. Condensation build-up in the evaporator can freeze and block air flow, reducing the quantity of cool air.

The A/C compressor shuts off if the evaporator starts to freeze up. On older models, the DME controls the compressor, but more modern BMWs use the IHKA control unit. This is no longer done by cycling the compressor on and off as BMW now uses variable-displacement compressors. In place of an electrical/magnetic clutch, a rubber coupling connects the outer pulley with the inner compressor drive shaft. So, if the compressor seizes the rubber decouples

Engines with conventional belt-driven water pumps may have an auxiliary electric pump to increase the supply of heated coolant for the cabin (it draws about one amp). BMW engines with electric water pumps no longer use the auxiliary pump.

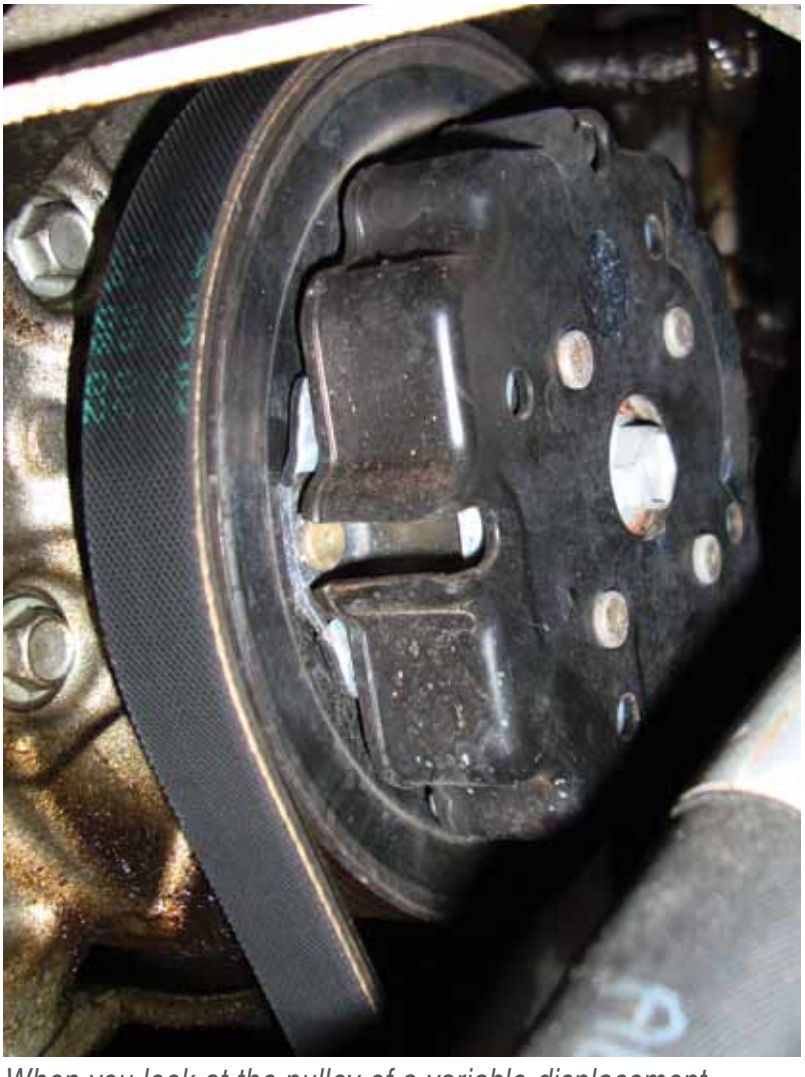
and allows the single serpentine belt to continue to spin other, more crucial components, such as the water pump. Compressor output is adjusted by means of a control valve that uses low-side pressure to position the swash plate inside the compressor and adjust the length of the pistons' stroke. The plate can be positioned to produce a minimal stroke and offer little to no load on the engine. When A/C demand is high, the compressor displacement is increased by repositioning the swash plate to maximum stroke.

A Flexible Compressor

This changes the way you look at A/C pressure readings. Of course, you have to verify that you have the correct quantity of R-134 in the system. The specified charge can be found on a green sticker mounted under the hood. With modern evacuation and recovery equipment, you can easily verify a proper fill. On dual-zone systems, remember to use iComm/ISTA to engage the fill mode. While checking system pressures, you need to make sure the compressor is commanded fully open. This may require that you set the A/C system to MAX and open all the doors. The interior temperature sensors will read the warmer air and request greater cooling. The compressor will be commanded to maximum stroke and you can watch the high- and low-side pressures. As a guideline, the low-side pressure will ideally drop below 30 psi while under maximum load. The high-side will vary more with ambient temperature. On cool days, you may only see 150 psi or so, but on hot days it may go as high a 400 psi.

You should have a large fan blowing through the condenser to simulate road speed for accurate performance information.

With hot weather approaching, your customers will want their air conditioning systems to work just as it did when the vehicle was new. Deep knowledge of BMW climate control systems we will enable to address their concerns with accurate diagnosis and genuine BMW parts. Utilize the three biggest tools in your arsenal: www.bmwtechinfo.com, iComm/ISTA, and your local BMW dealer's parts department. ●



When you look at the pulley of a variable-displacement compressor, you'll see a rubber coupling instead of a clutch. A control valve in the rear of the compressor adjusts the output according to commands from the IHKA control unit.

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Bonding Ramps Up

Bonding is becoming the preferred joining technology for new and emerging materials

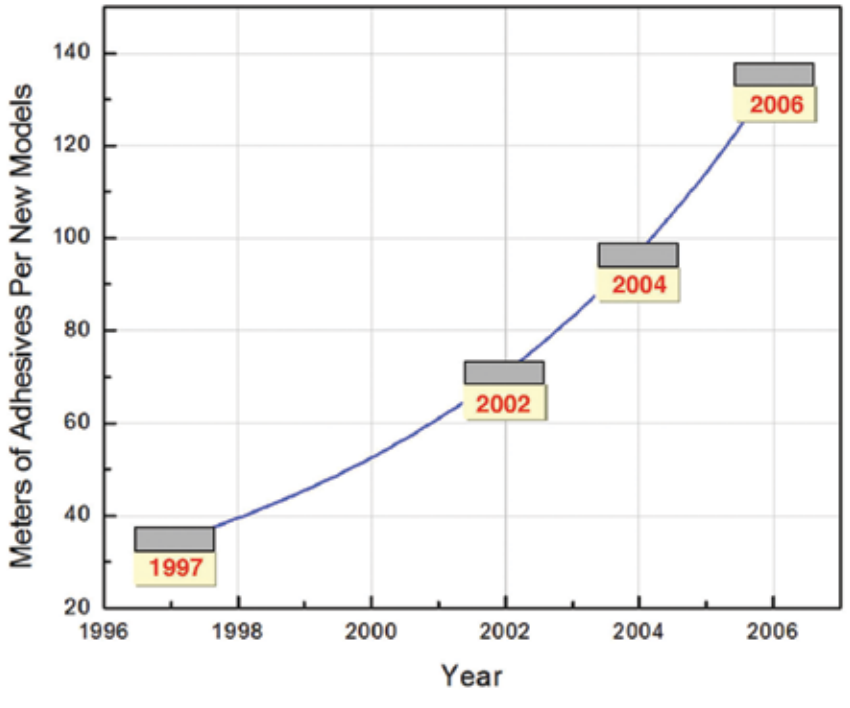
In today's collision industry, materials, manufacturing processes, and fastening technologies are advancing at an incredible rate. To keep pace with these changes, collision professionals must ensure they are up-to-date with the innovations being employed by automakers, such as BMW AG (BMW) and its subsidiary, BMW North America LLC (BMWNA).

Chemical bonding is one such emerging and growing trend in collision repair, and it's being driven by the increased use of lighter, yet stronger materials such as high-strength steels and alloys, innovative plastics, and carbon fiber. Though the use of structural adhesives is not new to the collision industry, the current rate of change and depth of penetration is. It's critical that repair professionals get familiar with innovative adhesives, tools and equipment, and procedures now.

BMW first introduced new bonding and riveting repair procedures in 2009. Since then, the use of rivet-bonding has expanded to all current models. In addition, improvements in adhesive technology have been incorporated into BMW collision resources. More recently — in response to demands for lighter vehicle weight, better driving and environmental

The Collision Repair Sweetspot: Collision professionals must remain current in the four key resource areas shown above. Only then can they be fully competent to perform complete, safe repairs for customers (courtesy ManicMedia LLC).

Structural Bonding is Ramping Up



performance, improved safety, and lower manufacturing costs — the introduction of thinner components and new materials is driving the increased use of bonding.

These new high-strength steels, alloys, and plastics come in different grades, which affect how they perform under various stresses not only in normal operation, but also during a collision and the subsequent repair. Body panel repair instructions increasingly prescribe chemical bonding procedures. Others may require the use of adhesives and rivets — a process known as rivet-bonding — or the combination of riveting and spot-welding.

Automakers are now aware that the mix of material choices used to manufacture a vehicle requires adhesives that were specifically formulated to match those materials and the time needed to make a repair. Going forward, the repair of BMW body panels, roofs,

Left: The amount of adhesives used in new vehicle models has been accelerating since their introduction (courtesy Dow Automotive Systems).

and other components on production-series vehicles, such as the M3 or M5, demands an understanding and commitment to training to ensure that the correct bonding techniques and practices are employed. It's also an opportunity.

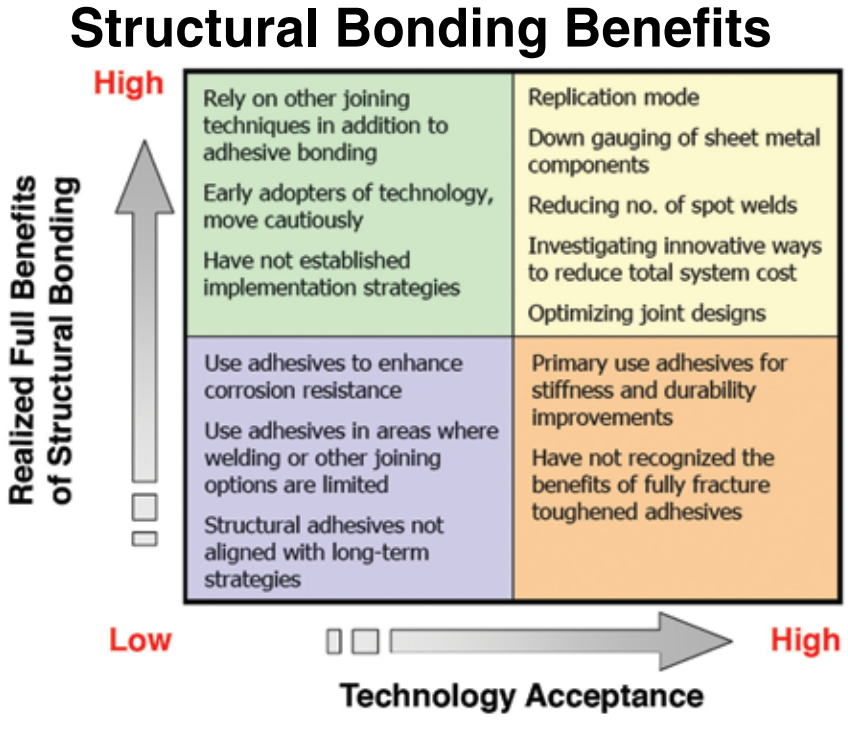
Advanced adhesive formulations are now available

Adhesives are nonmetallic, malleable, liquid, or solid materials that connect one part to another through surface bonding (i.e. adhesion) and internal strength (i.e. cohesion). There are two primary types of adhesives: physically-curing (escaping solvents-seam sealer) and chemically-hardening (typically epoxy resins). Only the latter type is suitable for BMW repairs.

These chemically-reactive adhesives require a mixing ratio specified by BMW. When placed into a joint, the adhesive's components react with one another and solidify. They are available as one-, two-, or multiple-component products. Their processing time, known as pot life, begins immediately upon mixing; the adhesion forces develop during this period. The processing time depends primarily on environmental conditions, such as humidity and temperature. To ensure proper curing, the temperature of the components and adhesive must be at or above the minimum listed in BMW ISTA information.

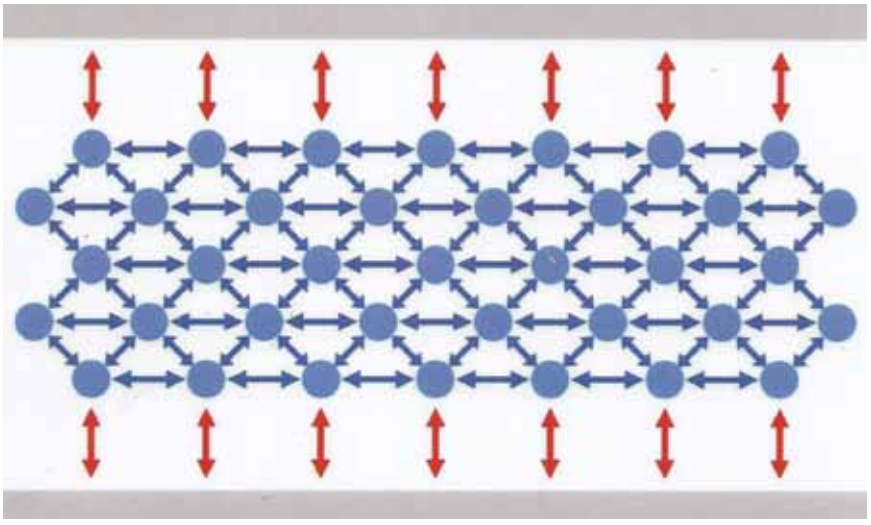
Adhesives offer a number of advantages. They prevent thermal component distortion, improve strength and NVH dampening, allow the joining of very thin parts, and reduce weight. The best place to use a structural adhesive is in a location where the primary stress is either compression, where the joined pieces are pushed together, or shear, where the force tries to slide the joined surfaces against one another, like pressing your hands together and trying to slide them apart. In many BMW-approved repair procedures, the combination of adhesives and rivets, screws, etc. can further increase strength.

There are also some disadvantages to using adhesives that limit repair possibilities. These include



Many benefits have been realized from the shift to chemical bonding, some of them pleasant surprises. One example is the use of thinner body panels without sacrificing strength or safety (courtesy Dow Automotive Systems).

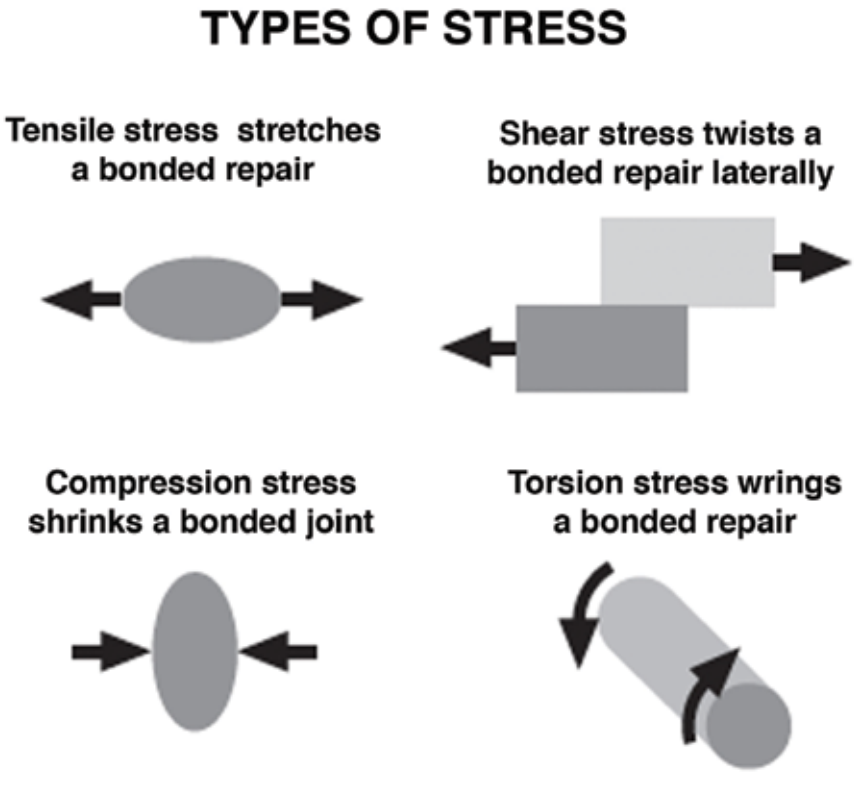
low peel stress resistance, limited thermal resistance, and the need for meticulous process control including the use of special tools and equipment, and surface treatment of the parts to be bonded with cleaners and primers. For example, structural adhesives are typically not good to use if the force acting on the joint would pull the two pieces apart. Another poor location for a structural adhesive would be one where there are forces that would bend the joint, which could allow it to cleave, then peel. In these latter two cases, repair procedures may specify that adhesives be used together with rivets (rivet-bonding), or in conjunction with certain welding techniques.



Adhesion and cohesion are the two fundamental properties of adhesives. Adhesion is the attraction between the materials being bonded and the adhesive (red arrows). Cohesion is the attraction between the molecules of the adhesive itself, which occurs as the adhesive cures (blue arrows). To ensure proper adhesion and cohesion, the mixing ratio of the chemically-hardening adhesive used is crucial. In addition, dirt, fingerprints, and other contaminants cannot be allowed between the adhesive and the materials (courtesy BMWNA).

Chemical bonding enables stronger, more durable repairs

Modern automotive structural adhesives are made from chemicals called



Chemical bonding can often better handle various types of stress than other joining technologies. The diagram above illustrates the major forces involved (courtesy BMWNA).

epoxies, which typically come with two parts — a resin and a catalyst — that are kept separate until use.

Applying adhesive is no longer a process of just slathering on some glue and clamping the parts together. The surfaces to be bonded require a thorough cleaning, and sometimes, such as with aluminum, primers are also necessary. Once combined, the catalyst initiates curing, a chemical reaction in the resin. Expect to feel the bonded parts heating up as the resin develops its bonding properties.

The curing ability built into an adhesive requires extensive testing and some impressive chemistry to meet BMW specifications. Curing time can range from minutes to days. In some cases, curing may be aided by baking or some other recommended procedure involving applied heat. For example, some epoxies cure when exposed to ultraviolet light.

Automakers know their vehicles best, so following BMW-recommended collision repair procedures and using the approved resources ensures that technicians have adequate working time to effect a safe, complete repair. Refer to www.bmwtechinfo.com. It provides key BMW resources, including collision and mechanical service information, tools, procedures, training, and more.

BMWNA's recommends five chemically-hardening adhesive formulations. Each has its own storage requirements, shelf life, surface preparation, application, hardening, disposal, and other properties. They also have advanced special polymers, epoxy resins, adhesion promoters, and other additives that improve bonding, manage stress more effectively, provide better mechanical properties, and resist corrosion better than alternative joining technologies. These enhancements enable the adhesives to:

- **Provide more durable and stronger repairs** with less corrosion risk than

Rivet-bonding is on the Rise

In cases where neither welding nor bonding will restore the integrity of a vehicle, BMWNA may specify a different repair procedure. In rivet-bonding, there are several key considerations that will help conserve limited working time and perform a complete, safe repair:

- *Technicians must know the composition of what they are going to cut into beforehand.*
- *Application instructions and repair procedures must be understood before using an adhesive.*
- *The use of approved parts, tools, fasteners, and adhesives is essential. In particular, this new method requires the use of a punch riveting tool.*
- *Avoiding cross contamination by working on the separate metals in different areas and with different tools may be necessary.*
- *Clean surfaces are required for proper bonding. It is also important that bare metal be bonded to bare metal and not painted surfaces.*
- *When rivet-bonding , be sure to bevel the drill holes so that panels can be compressed snugly together.*
- *During the final assembly, ensure that the new panel aligns properly to where it will be attached and check for gaps. The use of a reinforcement plate may be specified.*

convention welds. As carbon fiber composites are increasingly used for roof panels and other components, adhesives will have to be used to bond them, as they cannot be welded together.

- **Reduce the number of welds** that would have otherwise been required. For example, BMW rivets and approved structural adhesives may be specified in areas that squeeze-type resistance spot welding arms cannot access, or when replacing boron components. Adhesive bonding also helps resolve problems with cracks around spot welds occurring as a result of fatigue loads.

- **Better manage the various stresses** during vehicle operation or a collision by more evenly distributing them across a region than would be possible with welding or riveting. This enables the flow of forces during an accident to remain truer to BMW's designed intent.

- **Facilitate the down-gauging of metals** (e.g. thinner and lighter body panels, less steel reinforcement) for lightweight, optimized vehicle construction.

- **Replace other inferior sealant materials.** These adhesives not only seal out water better, they also improve noise, vibration, and harshness control by dampening noise distribution and minimizing body vibrations.

- **Allow the introduction of lighter weight materials,** such as carbon fiber roofs and other non-steel and non-alloy components without compromising strength, safety or durability.

- **Enable hybrid sandwich construction** to be employed in manufacturing, using different grades of steel and alloys. For instance, carbon fiber and other advanced thermoplastics can be sandwiched between aluminum sheets for the front flexural and supporting structures.

Don't let adhesive bonding be the weakest link. Like the shift from mild steel to higher strength steels and alloys, the introduction of new composite and plastic materials requires that repairers learn and use BMWNA-approved repair procedures, supplies, tools, equipment and training. To provide acceptable

BMW Information Resources

BMWNA has dedicated much effort to creating a secure, single website, www.bmwtechinfo.com, where technicians can access needed collision and mechanical technical service information. Once logged in, reprogramming professionals can access a myriad of technical information including service and reprogramming data, repair instructions, special tools database, wiring diagrams, electronic troubleshooting manuals, technical training material, and more. If you are unable to view or log-in to the website, visit http://www.nastf.org/i4a/pages/index.cfm?pageid=3456 for answers to FAQs and a list of computer system requirements (courtesy BMWNA).

elasticity and flexibility (in addition to better tensile and shear stress strength than the materials being bonded), professionals must be cognizant that BMW specifies certain adhesives that are matched to the repair.

Otherwise, a repair that looks fine cosmetically may in fact stick the car owner with durability- and corrosion-related concerns, as well as compromised occupant safety should another accident occur. Being responsible for a substandard repair before that second collision could be devastating, especially if BMW recommendations were not followed in the previous repair.

BMW provides industry-leading collision training

In April, we attended ToolTech Week 2012, an annual conference hosted by the Equipment and Tool Institute. The event is a gathering of automakers, aftermarket tool and equipment manufacturers, insurers, educators, and repair associations and facilities. One afternoon during the conference was focused on the topic, "Collision Repair in the Aftermarket." The panel discussed new materials, required joining technologies, and training. After this session, we met with some of the presenters to discuss BMW training.

First, we spoke with Tom Brizuela, BMWNA's Body and Paint Technical team leader at its technical training center in California. In addition to directing curriculum development for BMW's Body & Paint Service Technician Education Program (STEP), his other duties include training development, insurance company technical presentations, and industry relations. We asked him to share what distinguishes BMWNA training from the rest of the industry.

"New lightweight, thinner, yet stronger materials are increasingly part of new BMW vehicle model builds," says Brizuela. "Similar to the STEP program for mechanical service, BMWNA has developed a collision-focused STEP training program as well. This training is provided to both dealer-owned collision facility technicians and dealer-sponsored independent collision shop technicians at BMWNA's four technical training centers in the United States. In addition, it is provided to aspiring and entry-level technicians at several leading educational facilities throughout the country."

"To provide a complete, safe repair of customers' vehicles, collision professionals must be aware of and be able to properly identify and repair new high-strength steels and alloys, plastics, carbon fiber and other innovative materials," adds Jason Bartanen, technical training director for the Inter-Industry Conference on Auto Collision Repair (I-CAR). "To do this, technicians must have access to genuine collision-related service information; automaker-approved tools and equipment; be capable of employing the correct methods and techniques; and maintain the currency of their repair knowledge and skills through ongoing training and education."

"Compared to other automakers, BMW collision training is second to none," notes Bartanen. "While I-CAR works with all automakers, the BMW collision training model is one that other automakers would do well to emulate."

That kind of recognition doesn't come easy. And it's yours for the taking. ●

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