UPGRADE BMW INDIVIDUAL AUDIO (S752A) with BMW BOWERS & WILKINS AUDIO (S6F1A) SPEAKERS

1. SUMMARY

This DIY describes upgrading the fifteen (15) speaker BMW Individual Audio (S752A) to sixteen (16) BMW Bowers & Wilkins (B&W) Audio (S6F1A) speakers. The S752A has component (midrange/tweeter) speakers in the doors and d-pillars which are upgraded to B&W component (midrange/tweeter) sets. The center dash is upgraded from a single S752A coaxial speaker to a B&W component set. Both under-seat subwoofers are upgraded to high wattage capacity B&W subwoofers. The BMW OEM Infotainment (CIC) system and 825-watt S752A amplifier remain to power the upgraded B&W speakers.

This DIY specifically uses B&W speaker components from BMW G-Series X-series vehicles which are plug and play into the E70/E71 S752A audio system (others audio systems may also apply). As a further upgrade, all component set speaker locations use custom bandpass crossovers that are frequency-matched to the B&W midrange and tweeter speakers. Crossovers are professionally fabricated with a small footprint and high-end electronic components meant to significantly improve crossover quality and longevity. As described in this DIY, the crossover hookup leads are crimped with OEM connectors to allow 1) plug and play connection from the crossovers to the OEM speakers and 2) facilitate easy reversibility of the B&W upgrade back to the S752A audio option.

This is not an audiophile upgrade, but an OEM audio enhancement utilizing the effective DSP and Individual amp already integrated into the vehicle. After installation, and equalizer tuning, the result is tangible audio clarity and significantly improved bass response.

2. DISCLAIMERS

I am not an audiophile but am also not a novice. I collected information from various sources to perform this retrofit. This DIY does not intend to imply that upgrading with OEM components is equivalent to or better than any aftermarket solution. This DIY intends to only provide OEM audio upgrade options and disseminate the information required to do so. Everyone's hearing is subjective, so any references to sound quality are for reference only. This DIY assumes the audience has knowledge and capabilities to access vehicle speaker locations, speaker removal, basic electrical connections, basic fabrication, and multimeter use.

3. INSTALL NOTES

a. There are alternative OEM upgrade options to consider in Section 15 - OTHER CONSIDERATIONS IN LIEU OF COMPLETE B&W UPGRADE
b. The terms "capacitor" and/or "inline filter", within this DIY, are interchangeable. This is defined as a speaker with a capacitor (capacitance unit = uF) inline to the wiring harness that acts as a high-pass filter (passes signals with a frequency (Hz) higher than a specified cutoff frequency, defined by the capacitor capacitance uF). FWIW, the midrange speakers have features that were, at one time, used to house a capacitor, however the S752A and S6F1A midrange speakers do not use this feature.
c. The term 'component speakers' or 'component set', in this document, implies a tweeter and a midrange pair in the same location.
d. When the capitalized word "Individual" is used or the term "S752A", it is meant to imply the BMW S752A Individual audio system as opposed to "Top HI-FI" (S677A) or "HI-FI" (S676A) audio systems in the E70/E71+. The S752A system differs from the S677A system in that the S752A has a different amplifier, adds diplexers (OEM crossover system) to the front doors, and all speakers are made of stiff (yellow) hexacone membranes. In addition, the center dash speaker is not a component set, but a single coaxial hexacone speaker. The S752A Individual System is also known as "Premium Sound Package (0ZPS)" and early-on was known as the "Enhanced Premium Sound" system found in the E60 M5 and E63 M6 vehicles.
e. Each OEM Individual (S752A) component speaker set has some sort of crossover design. Some component speakers utilize inline filters in the tweeter wiring harness. The front doors in the S752A system utilize a separate OEM crossover box (diplexer). Low pass cutoff frequencies for component speakers are assumed

to be managed by the OEM S752A amplifier. The low pass cutoff frequency is not managed by the custom crossovers used in this DIY, however the crossover designer can potentially add that feature upon order. Without knowing the amplifier low pass cutoff frequency, it's hard to know if a low pass value for the crossover is above or below the OEM amp low pass cutoff. The subwoofers don't have inline filters and likely also rely on the OEM S752A amplifier for low pass cutoff frequency.

f. Individual S752A component speakers (midrange and tweeter combination) have [total load] calculated impedances of 4.0 ohms (Center Dash), 2.7 ohms (Front Doors), 2.0 ohms (Rear Doors), and 2.0 ohms (D-Pillars). The S6F1A component speakers (midrange-774 and tweeter-773 combination) have [total load] calculated impedance of 3.8 ohms. See Section 6 - IMPEDANCE: INDIVIDUAL S752A vs. B&W S6F1A AUDIO SYSTEMS.

g. You may notice in some pictures a difference in crossover hookup wire color. This was because there were two different orders for crossovers as I at first intended not to add crossovers to the d-pillars. However, without crossovers at the d-pillars the sound output was harmful to the overall upgraded audio. The first order of Qty.5 arrived with red (+) and black (-) hookup wire. The second order of Qty.2 (front doors) arrived with white (+) and grey/white (-) hookup wire, which were ultimately used in the front doors.

h. REFERENC ONLY: S752A Individual Audio System: DSP Amplifier 9 Channel/825 max watts, 18Hz-24kHz (*reference: BMW Group VZ-42, June 2007, "752 BMW Individual High End Audio System*); Subwoofers 2x150W, 75W et al.

i. REFERENCE ONLY: S677A Top HIFI Audio System: Logic 7 DSP Amplifier 9 Channel/420-480 watts (*reference: BMW Group VM-42, June 2007, "677 Hi-Fi System Professional"*)

4. TOOLS USED

DESCRIPTION	MFG, MODEL	USE	NOTES
Wire Cutters	Klein Tools, 300SCR	Cutting 18-20awg wire	Or equivalent, best to be clean and uncorroded
Wire Stripper	Klein Tools, 11063W	Stripping 18-20awg wire	Or equivalent, best to be clean and uncorroded
Heat Gun	Any	For use with heat shrink and hot glue	Also used to soften OEM glue for removal from speaker mounting locations
Multimeter	Any	Continuity check of fabricated looms and connectors, as needed	You'll want to purchase extra connectors to make testing loops and confirm continuity
Polarity Tester	Mobile Solutions, PT9A+	Determining polarity of B&W speakers & OEM source wires from amp	May not be needed if installing speakers listed herein and have same SOURCE wire colors as described in Section 9 Polarity
Micro Connector Pin Crimping Tool	Colors, SN-48B	Used for crimping MQS Bushings and MQS Pins	I had these on hand; Trial and error helped me determine how to properly crimp
Mini Pliers, 90°	Any	As needed	Used mainly to re-form crimped MQS pins and contact bushings so that they properly fit into OEM connectors
Hot Glue Gun	Adtech, PRO200	Used to mount speakers into locations	Or equivalent, definitely with needle nose dispenser, which is purchased separately
Label Maker	Brady, BMP21-PLUS	To label XO leads and connector looms	[Optional] Creates oem-style labels, limited function, but extremely reliable, duty-oriented labels. Battery doesn't last.
Flat Head Screwdriver, 1.5mm	Wiha	Remove MQS pins and bushings from OEM Connector; Also for installing MQS pins into sockets.	To remove the pins and bushing from the OEM connectors you must press down on the MQS locking flap with flathead while simultaneously pulling outward on the wire.
Terminal Removal Key Tool	Kweiny, XZAMTT01	Remove pins from -043 (M2K) and -583 (F2C) connectors	Or equivalent. Found on Amazon and these aren't made exactly for this application, but they work well enough for removal

5. COMPONENTS USED

ITEM	DESCRIPTION, MFG	P/N	QTY	DWG ID	NOTES
1.1	TWEETER, Non-Filtered, BMW, Bowers & Wilkens	65-13-2-622-773	7	-773	OEM; 6.5 Ω, BMW G-Series; no inline filter because custom crossover performs filtering; plug and play
1.2	MIDRANGE, BMW Bowers & Wilkens	65-13-2-622-774	7	-774	OEM; 9.3 Ω, no inline filter; BMW G-Series; Used at all locations; plug and play.
1.3	SUBWOOFER, Underseat, BMW Bowers & Wilkens	65-13-2-622-510	2	-510	OEM; 5.5-6.0 ohms measured; no inline filter; BMW G-Series; Low pass controlled by OEM Amp; plug and play, but requires shaving lock feature on E70 OEM subwoofer connector.
1.4	CROSSOVER, 4300Hz XO Point, Loudspeakerchef.com	Custom	7	XO	Matched to BMW Bowers & Wilkens Speakers; Uses OEM S752A Amplifier Low Pass; Request 30" minimum silver lead wires and maximum insulation diameter 0.070"
1.5	Connector, 2-pin, Female, BMW OEM	61-13-8-373-583	14	F2C	Does not include MQS Contact Pins (MQSP, Item 1.6); (Sn) Tin; Min qty shown, order spares;
1.6	Pins, MQS Contact, 18awg, Tin (Sn), TE Connectivity	5-965908-1	28	MQSP	Equivalent to those used in BMW OEM 61-13-0-005-198; See TE Connectivity drawing for details; Recommended to order Qty.50-100
1.7	Connector, 2-pin, Male, with MQSB*, BMW OEM	61-13-2-360-043	7	M2K, MQSB	OEM Connector includes MQS Contact Bushings* and spares for crimping; (Sn) Tin; Min qty shown, order spares;
1.8	Heat Shrink, Black, Polyolefin, 2:1, TYCO	RNF-100-KIT-BLACK-FEC	AR	N/A	Heat Aging 168hrs @ 175C, or equivalent
1.9	Tape, Black PET Fleece Interior Loop Tape 19mm x 15m Roll, TESA	SG_B017OECD7W_US	AR	N/A	OEM-Style Wiring Loom Fabric Tape for crossover looms
1.10	Velcro, Dual Lock Reclosable Fastener, Type 400, Black, 3M	SJ3551	AR	N/A	Used to mount crossovers in vehicle; 400 Stems/inch; High tensile strength; Up to 200F
1.11	Label, Black on White, Self-Laminating Wire Wrap Style, 1.25L Brady	M21-1250-427	AR	N/A	Used to label connectors and leads; Label wraps around wire diameter;
1.12	Hot Glue Sticks, Black, Rapid	1215108	AR	N/A	Sets in 20-40 seconds; This glue material was made for automotive applications; Its sturdy, but easily removes when heated by heat gun. It does create a lot of spider webbing, but easily cleaned up. I based my glue gun purchase on these sticks. Matches glue used on crossovers and provides additional support for mounted crossover
	[OPTIONAL] Hookup Wire, 18awg, Stranded, Copper or Silver OCC or OFC equivalent Neotech or DH Labs Silver Sonic	STDCT-18 SH-18	AR	N/A	If the custom crossover hookup leads are not long enough, you may need audio wire to create wiring looms to extend length.
	[OPTIONAL] Soldering Wire, Quad Eutectic Silver Solder with Rosin Flux, Cardas	KAWER	AR	N/A	If needed, use to solder looms to crossover hookup leads. DIA 0.032"; Melting Point = 185°-195°C; Quad Eutectic Roll Materials: Sn, Pb, Cu, Ag. Silver for higher conductivity and stregth
	[OPTIONAL CONFIGURATION] Tweeter, Filtered, BMW, Bowers & Wilkens	65-13-9-279-629	1	-629	This tweeter has an inline capacitor. IF only upgrading the center dash coaxial speaker to B&W component set (without crossover), then use this -629 tweeter in lieu of the -773 tweeter. This plugs directly into the -774 Midrange Speaker. Source audio also plugs into the Midrange speaker and the midrange directs the source audio to the Tweeter, as well as the midrange speaker itself; Plug and Play.

**Commercial Sourcing of additional OEM-equivalent MQS (contact bushings) for 61-13-2-360-043 connector: Newark, TE Connectivity P/N 5-963715-1*

6. IMPEDANCE: INDIVIDUAL S752A vs. B&W S6F1A AUDIO SYSTEMS

E70/71 LOCATION	S752A SPEAKER	QTY	P/N	SPEAKER IMPEDANCE	TOTAL IMPEDANCE	CROSSOVER FREQUENCY
Center Dash	Coaxial, 3.7"	1	65-13-7-838-915	4 ohms	4.0 ohms	No filter/capacitor; crossover frequency controlled by S752A Amp
Front Doors	Tweeter, 28mm	2	65-13-7-842-193	8 ohms	2.7 ohms	Diplexer (65-13-7-838-929); High Pass 8.2uF/1715Hz; Low Pass 6.8uF/4150Hz
	Midrange, 93mm	2	65-13-7-838-904	4 ohms		
Rear Doors	Tweeter, 19mm	2	65-13-7-842-194	4 ohms	2.0 ohms	High Pass Filter: 12uF/3317Hz
	Midrange, 93mm	2	65-13-7-838-904	4 ohms		Low pass filter controlled by Amp
D-Pillars	Tweeter, 19mm	2	65-13-7-842-194	4 ohms	2.0 ohms	High Pass Filter: 12uF/3317Hz
	Midrange, 93mm	2	65-13-7-838-904	4 ohms		Low pass filter controlled by Amp
Under-Seat Front	Subwoofer	2	65-13-7-842-195	8 ohms	8 ohms	Low pass filter controlled by S752A Amp

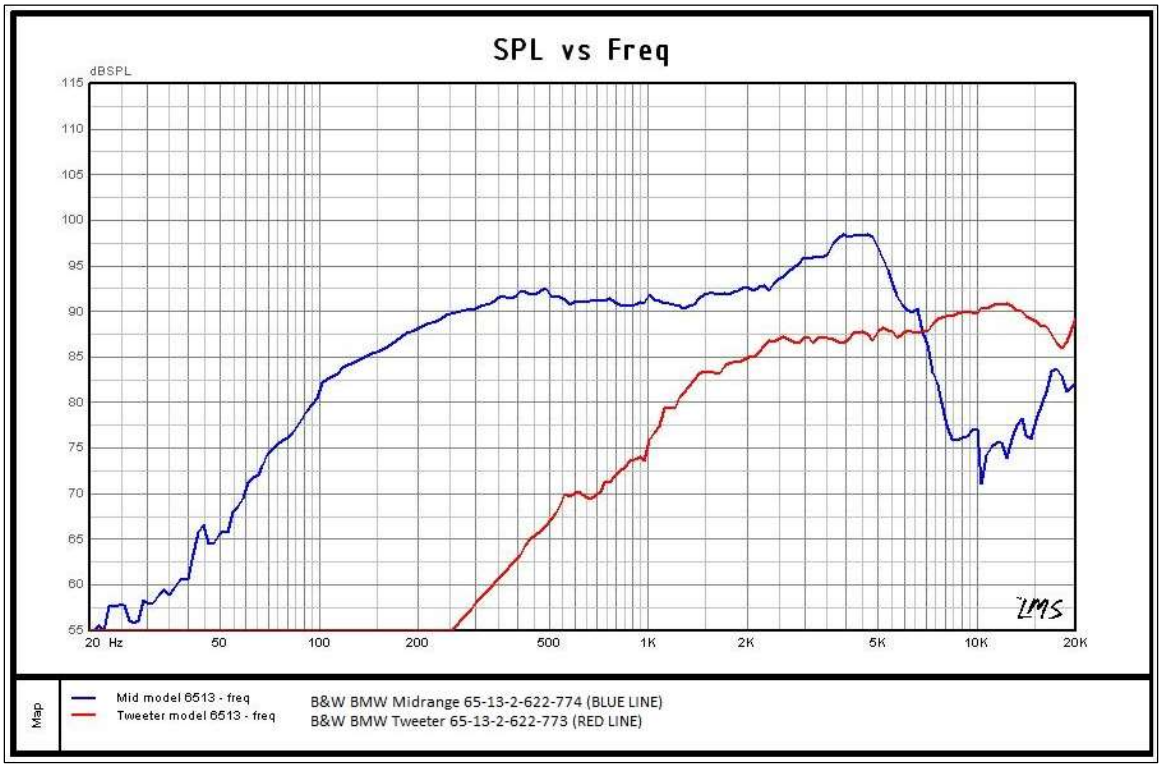
E70/71 LOCATION	S6F1A SPEAKER	QTY	P/N	SPEAKER IMPEDANCE	TOTAL IMPEDANCE	CROSSOVER FREQUENCY
Center Dash	Tweeter, 34mm	1	65-13-2-622-773	6.5 ohms	3.8 ohms	Custom Crossover, 1X Crossover Point: 4300Hz
	Midrange, 93mm	1	65-13-2-622-774	9.3 ohms		
Front Doors	Tweeter, 34mm	2	65-13-2-622-773	6.5 ohms	3.8 ohms	Custom Crossover, 2X Crossover Point: 4300Hz
	Midrange, 93mm	2	65-13-2-622-774	9.3 ohms		
Rear Doors	Tweeter, 34mm	2	65-13-2-622-773	6.5 ohms	3.8 ohms	Custom Crossover, 2X Crossover Point: 4300Hz
	Midrange, 93mm	2	65-13-2-622-774	9.3 ohms		
D-Pillars	Tweeter, 34mm	2	65-13-2-622-773	6.5 ohms	3.8 ohms	Custom Crossover, 2X Crossover Point: 4300Hz
	Midrange, 93mm	2	65-13-2-622-774	9.3 ohms		
Under-Seat Front	Subwoofer, G05	2	65-13-2-622-510	5.5-6.0 ohms measured	5.5-6.0 ohms measured	No inline filters, uses OEM Amp

7. CROSSOVERS – B&W CUSTOM MATCHED

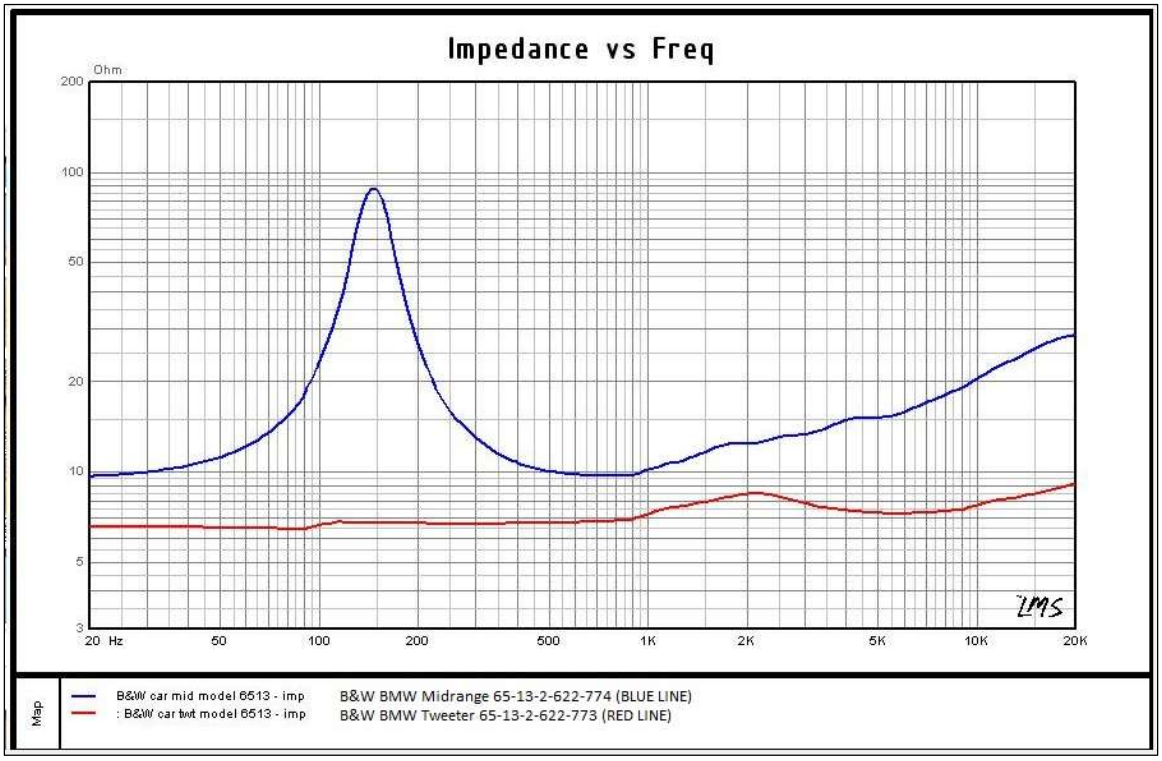
I used the services of a former high-end speaker designer that also builds high-end crossovers for various applications, Loudspeakerchef.com. The short version is that I worked extensively with the designer to develop a crossover for this application that 1) matches the B&W S6F1A component speakers, 2) takes into account the E70 physical dimensions between the listener and the speakers, 3) has a small enough footprint for easy install, 4) uses only high-end quality electronics for reliability and longevity, and 5) are reproducible so anyone wanting to install this upgrade can directly buy the custom crossovers from the designer given that the analysis and legwork has already been done. The crossovers do not filter the low-end frequencies from the source signal/S752A amp. This is because I assumed the S752A amp was performing this function adequately in combination with the under-seat subwoofers.

I ordered the crossovers with 18awg wire to align to the OEM wire size in the vehicle. The fabricator provided pure silver hookup leads, however other wire options are Ohno Continuous Casting (OCC) or Oxygen-Free Copper (OFC). Ensure you request 18awg wire with insulation diameter equal to or less than 0.070" or else the wire may not allow the crimped pins to fit into the OEM connector sockets. The OEM insulation diameter is approx. 0.059" and fits easily. The crossover wire pair lengths vary depending on speaker location. Ordering at least 30" of hookup leads is sufficient to cover all mounting configurations, except the front door tweeters. Once you intertwine the wire pairs you lose about 4" and I created a separate 10" extension harness for the front door tweeters. This served two purposes, 1) the tweeter connector barely reaches out from behind the tweeter enclosure, so having the extension allows easier disconnection lower down in the door panel. 2) The extra length also allows room to pull the door panel away from the door for easier access to the connections. Lastly, I ordered the crossovers with the smallest footprint possible. The crossovers arrive with components mounted on MDF-type board approximately 1/8" thick. With components, the crossover physical volume was approximately 3.5"L x 2.75"W x 1.0"H.

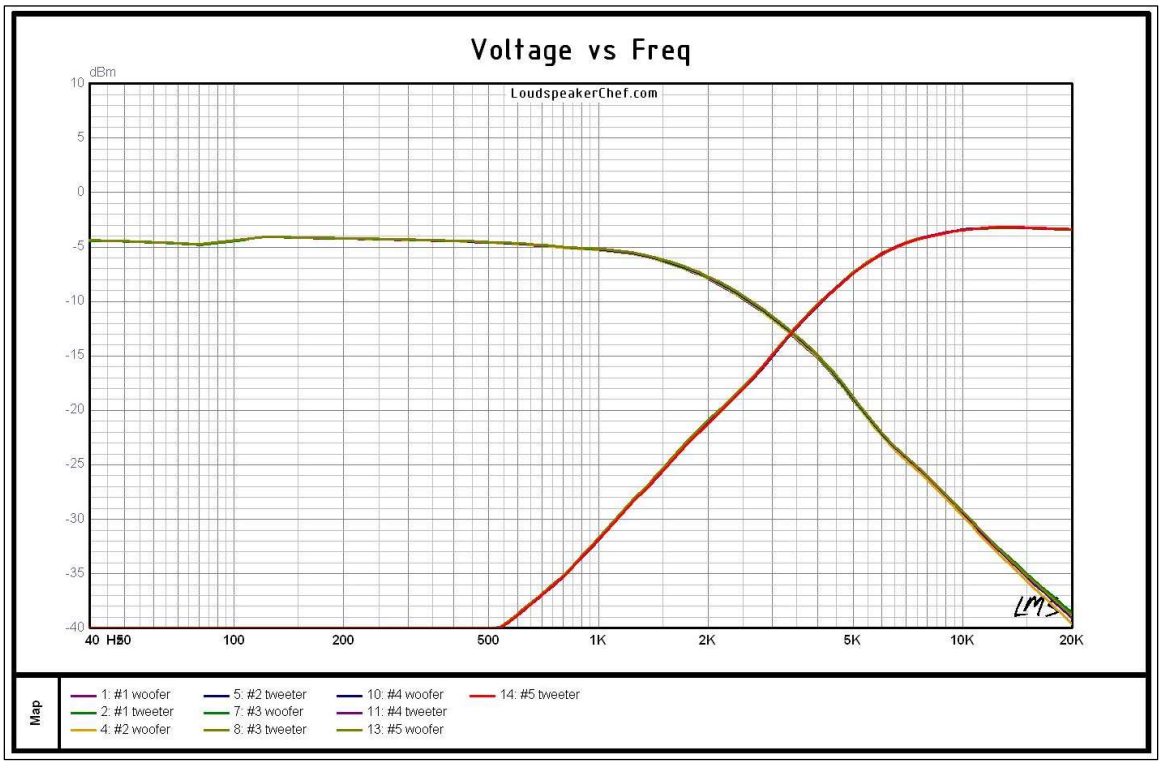
The graphs below show the B&W speaker frequency analyses used for crossover design and the quality tests after fabrication.



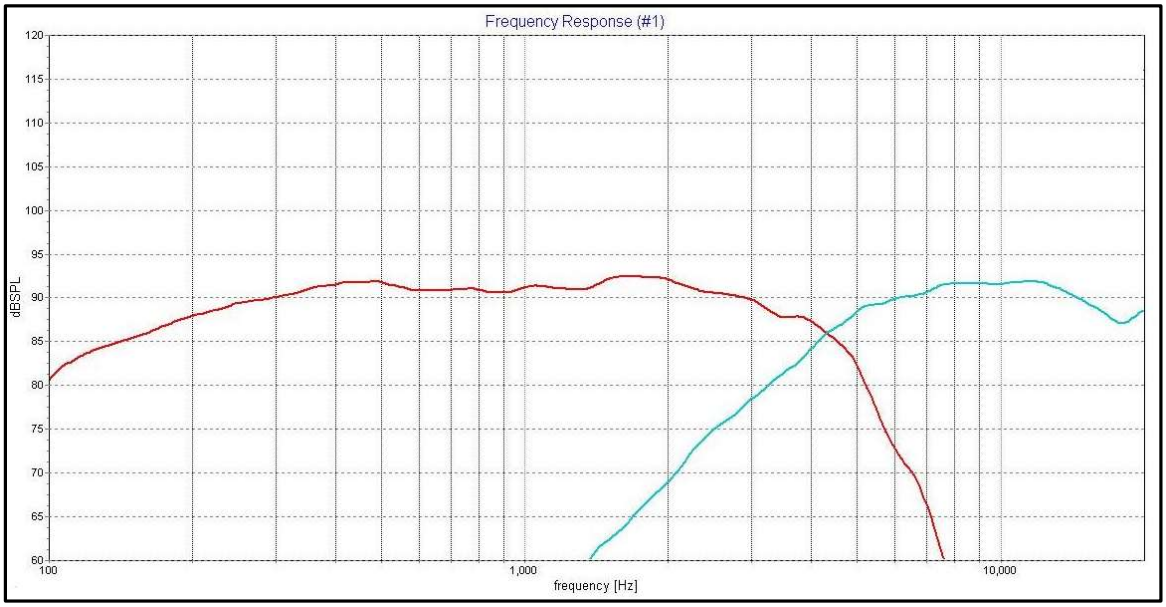
B&W Midrange and Tweeter Frequency Analysis Testing



B&W Midrange and Tweeter Impedance vs Frequency Testing



Crossover Response of Qty.5/7 fabricated Crossovers (near perfect match)



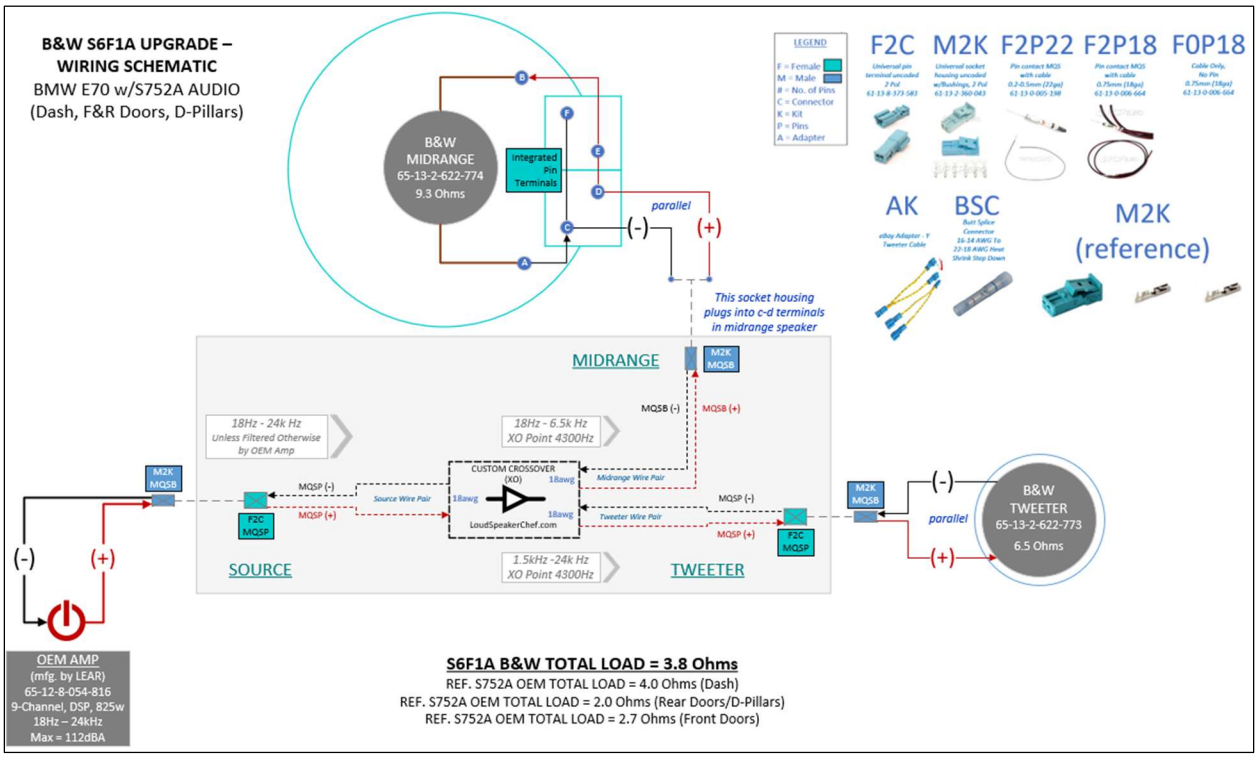
Final System Response with Crossovers connected to B&W drivers

TWEETER NOTES/OPINION: B&W diamond tweeters were considered as they are usually matched with the G-Series B&W S6f1A option, but not used because: 1) diamond tweeters are 3-6 times more costly and 2) I decided to go with the technical opinion of the speaker designer:

"*The main advantage they [diamond tweeters] have is that the membrane works as a piston higher in frequency allowing greater clarity but other than that, they have a rolled off top end and sound harsher than metal. The metal domes can be made thinner and easier to dampen the ringing, also the metal domes weigh less and had more output at the top.....there is much more to be said, but won't go into it too much here. I designed many hi-fi tweeters. Personally, I would go with the metal dome over the diamond dome as the diamond will have a lack of air due to its fall off above 10khz. Since you are listening off axis mostly in a car, you want a boost above 10khz, not a roll-off*"

As a result, the crossovers were matched to BMW B&W metal dome G-series tweeters (PN: 65-13-2-622-773). FWIW, the speaker designer's opinion on these BMW B&W speakers was that they were 'decent', however he also mentioned that he sees many 'high-end' speaker brands on the market that produce very poor results. In the end, I wanted OEM components for my BMW and the sound output is a tangible improvement over the S752A Individual Audio system.

8. SCHEMATIC - B&W S6F1A RETROFIT



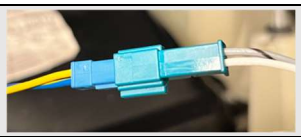
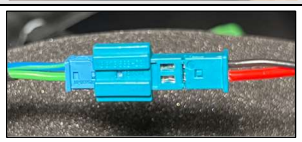
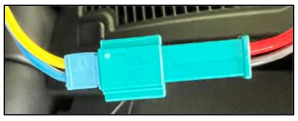
9. POLARITY, OEM CONNECTORS, & CRIMPING

a. POLARITY

Getting polarity correctly wired can make a tangible difference in sound. For each location identify the two OEM audio source wires with M2K connector (plugs into the S752A midrange) and determine polarity to properly connect the custom crossover SOURCE leads. Create test connectors by adding two different color wire leads to spare M2K and F2C connectors to facilitate polarity testing of source and speaker connections.

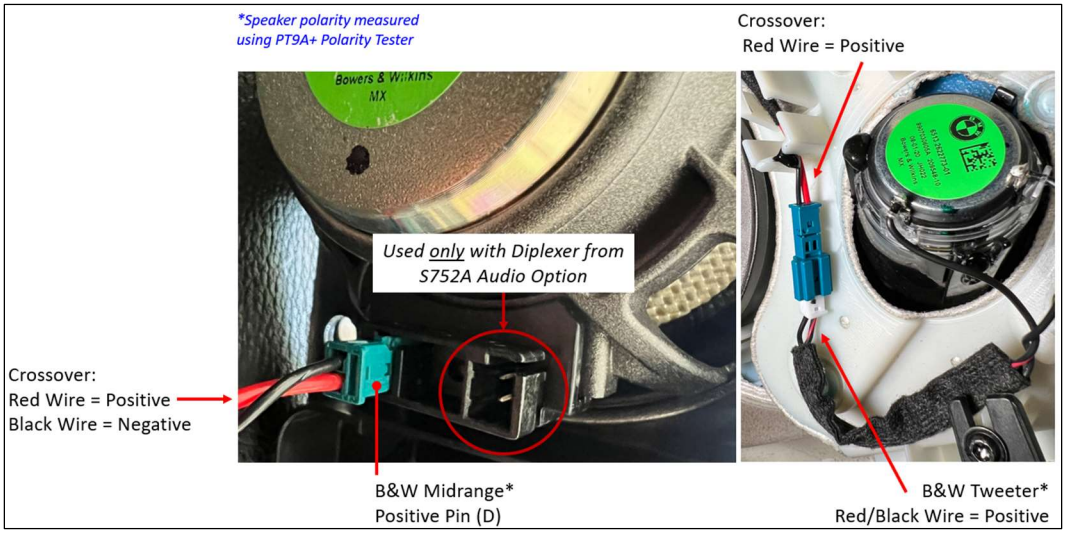
For HIFI or TOP HIFI systems, ISTA+ provides the electrical schematics for the amplifier that identifies wire color and polarity for each speaker location. If your wire colors don't match those schematics, or you don't have access to ISTA+, or you can't find your amplifier in ISTA+ then use a polarity tool (*IE: Mobile Solutions PT9A+ Polarity Tester*) to identify polarity of the OEM source wires. The table below provides OEM source/input (specific to my vehicle) wire polarity at each location, in addition to images to ensure proper connector pin placement. Don't make any assumptions on OEM polarity, just follow the testing.

SOURCE/INPUT SIGNAL FROM AMP to CROSSOVER
(2013 BMW E70 X5M, Premium Sound Package 0ZPS, S752A Audio Option)

VEHICLE LOCATION	OEM S752A Amp SOURCE WIRE COLOR	OEM POLARITY	OEM S752A Amp SOURCE CONNECTOR	AMP M2K to *CROSSOVER F2C CONNECTION
Center Dash	Black with gold stripe	(+)	M2K 61-13-2-360-043	
	Black with white stripe	(-)	M2K 61-13-2-360-043	
Front Left Door	Blue with yellow stripe	(+)	M2K 61-13-2-360-043	
	Yellow, solid	(-)	M2K 61-13-2-360-043	
Rear Left Door	Green, solid	(+)	M2K 61-13-2-360-043	
	Blue with green stripe	(-)	M2K 61-13-2-360-043	
Rear Left D-Pillar	Blue with white stripe	(+)	M2K 61-13-2-360-043	
	White, solid	(-)	M2K 61-13-2-360-043	
Front Right Door	Blue with white stripe	(+)	M2K 61-13-2-360-043	
	White, solid	(-)	M2K 61-13-2-360-043	
Rear Right Door	Green, solid	(+)	M2K 61-13-2-360-043	
	Blue with green stripe	(-)	M2K 61-13-2-360-043	
Rear Right D-Pillar	Yellow, solid	(+)	M2K 61-13-2-360-043	
	Blue with yellow stripe	(-)	M2K 61-13-2-360-043	

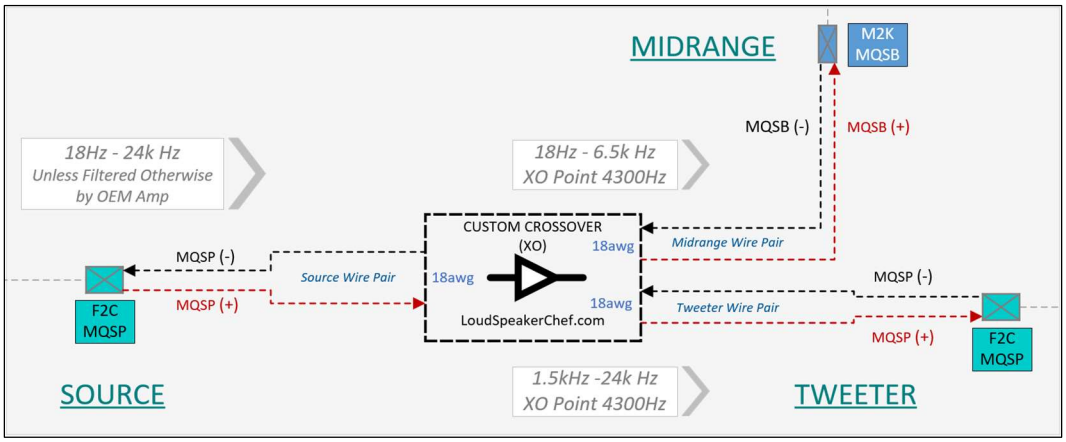
**Front Door Crossover wires shown in images: White (+), Grey/Black (-); Remaining locations: Red (+), Black (-); All source wire colors tested with Polarity Tester to confirm positive and negative outputs.*

The B&W midrange speaker polarity was tested using PT9A+ Polarity Tester and the schematic above in Section 8 identifies the positive (+) pin (D). The B&W tweeter polarity was also tested using the Polarity Tester and the red/black wire was determined to be positive with solid black wire as negative. Ensure all interfacing connectors from the custom crossover have the positive wire aligned to the speaker positive pins/wires. The image below summarizes the B&W midrange and tweeter polarity.



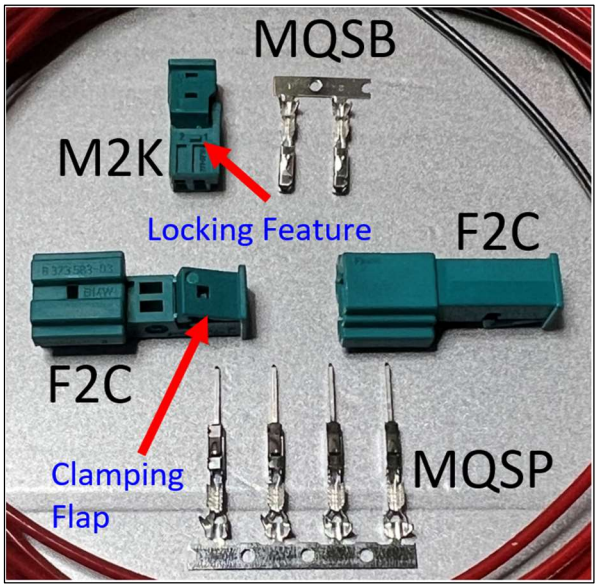
b. OEM CONNECTORS

As shown in the schematic below, for each crossover there are three hookup wiring pairs that need OEM connectors crimped to interface with the OEM source, tweeter, and midrange speakers. With these OEM connectors installed on the hookup wires, the crossover installation is completely plug-n-play. The source wires, with M2K connector, for each component set is found at each speaker location in the vehicle. Installing a corresponding F2C connector on the crossover SOURCE wiring pair allows easy mating to the vehicle source connector and provides the crossover with power from the OEM Amp, as well as the full frequency (Hz) range of sound as output by the OEM S752A Amp. The OEM B&W tweeters come with M2K connectors, and thus require installing an F2C connector on the crossover tweeter wire pair to mate to the B&W tweeter speaker. The B&W midrange speaker has two, 2-pin, integrated pin terminals. This feature of two pin terminals in the midrange is used by the S752A system where one pin terminal receives the signal and the second pin terminal forwards the signal to the tweeter or diplexer. As shown in the schematic above, the second pin terminal is not used in this DIY. As a result, it requires installation of an M2K connector on the crossover midrange wire pair to mate to the B&W midrange speaker.



As mentioned, there are two types of OEM connectors installed on the crossover wire pairs: pin terminal (61-13-8-373-583, "F2C") and socket housing (61-13-2-360-043, "M2K"). MQS Contact Pins ("MQSP") are crimped to the wire pair and then inserted into the two-pole pin terminals of the F2C OEM connector. These MQS pins were not available individually from BMW and were sourced separately to match exactly, see

Wiring Loom BOM below. MQS Contact Bushings ("MQSB") are crimped to the wire pair and then inserted into the two-pole socket housings of the M2K OEM connector. The MQS contact bushings and spares are included with the M2K connector (P/N: 61-13-2-360-043) when purchased. The BOM below assumes crossover wiring lengths have been ordered sufficiently long enough and no additional wire looms, to extend wiring sets, are needed. Note that ordering spare OEM connectors is highly recommended.



LOOM	BOM - PARTS	P/N	ID	QTY PER	NOTES
SOURCE Qty.7	PIN TERMINAL: 2-pole, OEM	61-13-8-373-583	F2C	1	Connector Only; Interfaces with Qty.2 18awg MQS contact pins.
	PINS: MQS Contact, 18awg, SN (tin)	5-965908-1	MQSP	2	18awg MQS contact pins by TE Connectivity; equivalent to those used on 61-13-0-005-198.
	WIRE (+): Hookup, 18awg, Red (+)	STDCT-18 or SH-18	WOCC (+)	AR	OEM, OFC, or OCC wire cut to length and MQS pins crimped.
	WIRE (-): Hookup, 18awg, Black (-)	61-13-0-005-198 or SH-18	W198 (-)	AR	OEM, OFC, or OCC wire cut to length and MQS pins crimped.
MIDRANGE Qty.7	SOCKET HOUSING: 2-pole, SN (tin), OEM	61-13-2-360-043	M2K	1	Connector and MQS Contact Bushings included
	BUSHING: MQS Contact, OEM	61-13-2-360-043	MQSB	2	Connector and MQS Contact Bushings; Contact Bushing crimped to loom red and black wires
	WIRE (+): Hookup, 18awg, Red (+)	STDCT-18 or SH-18	WOCC (+)	AR	OEM, OFC, or OCC wire cut to length and MQS bushings crimped.
	WIRE (-): Hookup, 18awg, Black (-)	61-13-0-005-198 or SH-18	WOCC (-)	AR	OEM, OFC, or OCC wire cut to length and MQS bushings crimped
TWEETER Qty.7	PIN TERMINAL: 2-pole, OEM	61-13-8-373-583	F2C	1	Connector Only; Interfaces with Qty.2 18awg MQS contact pins.
	PINS: MQS Contact, 18awg, SN (tin)	5-965908-1	MQSP	2	18awg MQS contact pins by TE Connectivity; equivalent to those used on 61-13-0-005-198.
	WIRE (+): Hookup, 18awg, Red (+)	STDCT-18 or SH-18	WOCC (+)	AR	OEM, OFC, or OCC wire cut to length and MQS pins crimped.
	WIRE (-): Hookup, 18awg, Black (-)	61-13-0-005-198 or SH-18	W198 (-)	AR	OEM, OFC, or OCC wire cut to length and MQS pins crimped.

WIRING LOOM Bill of Materials (BOM)

c. CRIMPING

Unless you have the exact tooling, crimping the OEM MQS Pins and Contact Bushings requires patience and a lighted magnifying glass. The MQS pins and bushings are tiny and fragile. Crimping too hard can easily cause the MQS contacts to break. As you learn to crimp these, expect to use more MQS pins and bushings

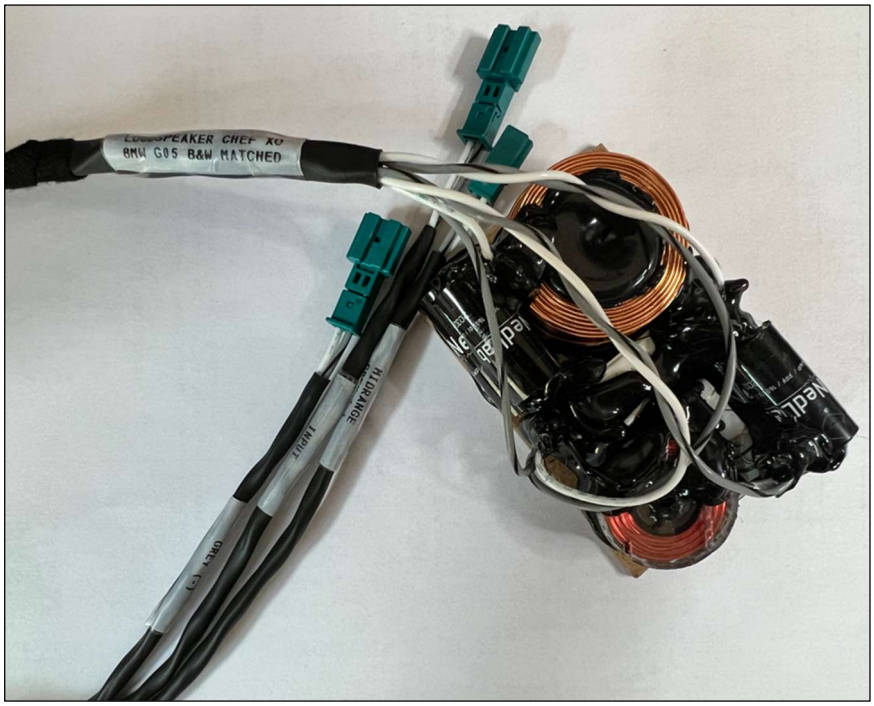
than listed in the quantities above. The crimpers I list above sufficed, but it took some iteration to learn. Given the tight tolerances of the holes in the OEM connectors, I had to use mini pliers to re-form and clean up the crimp so that it fit easily (without force) into the OEM connector sockets. My advice is once you start crimping, do it all at once or within days because the more you do the better you become at doing the job. I've done nearly 100 crimps and feel pretty comfortable about the procedure.

NOTE: Crossover wire pairs are roughly labeled from the fabricator. Clearly label or make distinguishable each wire pair so as not to mix wires. One way to do this is to intertwine wire pairs immediately and label. Then add shrink tubing at the base of the wire loom, near the crossover to reduce stress on the soldering points by individual wire movement/handling.

i. Trim wire pairs to the proper length
ii. For each wire strip approximately 0.120" off one wire end
iii. For each connector type identify the positive and negative socket PRIOR to MQS contact installation
iv. When inserting the MQS contacts into the connector, listen for two clicks for full insertion.
v. Using the Colors tool, position the MQS contact in 0.5mm slot as shown below. Compress tool, listening for three clicks which holds the contact secure but still allows wire to be fed through*.

vi. Insert stripped wire such that it is flush with tool on the opposite side. Support the contact with your finger while compressing handle. NOTE: do not insert the wire too far and crimp as this will result in the bare wire preventing the clamping flap on the connector from closing.
vii. Compress tool fully to crimp. Tool auto opens after full compression has been achieved.
viii. Using calipers set to dimension value of socket holes, test crimp for clearance. Use mini-pliers to clean up insulation side crimp so it easily inserts into the OEM connector. In almost every crimp the insulation crip required adjustment to fit.
ix. If needed, use 1.5mm flat head to push pin into connector socket through second click. Confirm both locking pins visibly set in connector window.
x. Close plastic clamping flap on OEM connector.
xi. Use shrink wrap, label maker, and fleece tape to complete wiring loom.
xii. OPTIONAL: The M2K connector has a tiny square protruding 'locking feature' on the top that locks the connection when mated to the F2C connector. Once mated it requires significant force to

remove. I shaved down the locking feature slightly to allow easier disconnection. The mating friction between the M2K and F2C connector maintains the connection irrespective of locking feature. If concerned, fleece tape can be wrapped around the connection to keep it secure.



10. CENTER DASH B&W SPEAKER UPGRADE

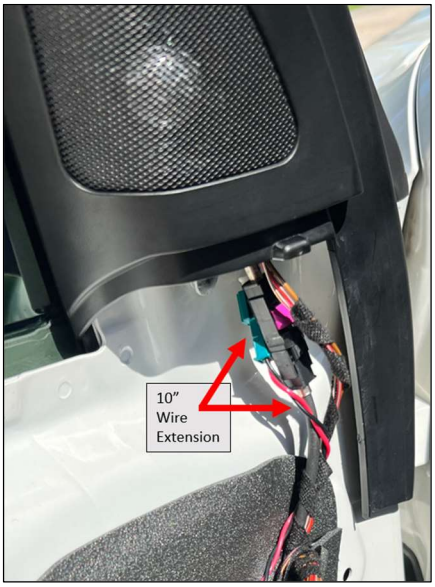
The S752A Individual audio system uses a single coaxial hexacone speaker in the center dash location. This upgrade replaces the Individual coaxial speaker with a B&W component speaker set. However, because only a coaxial speaker is used, the Individual mounting bracket blanks out the location where the tweeter is normally located in the S676A and S677A audio systems. To mount a component set in this location grind out the blank or purchase a used S676A or S677A center dash speaker mounting bracket.

The B&W speakers are plug and play in these brackets. If the bracket arrives with S676A or S677A speakers, they can easily be removed. The midrange is held in place with nuts. The tweeter is held in place using pry tabs and factory glue. Use a heat gun to warm up the glue to a clay-like consistency and remove. Once all the hot glue is removed, pry the tabs and the tweeter should pop out. Installation is the reverse of removal; except I strongly recommend the hot glue I note in the components list. It goes on easily, holds very well, and removes even easier. When you apply the heat gun to this glue, the texture goes from a hard glossy finish to a soft matte finish and that's when you know the glue is ready to remove. It leaves no residue behind when removed. Overheating changes the hot glue consistency back to glossy, but gooey. The glue dries within seconds but needs several minutes to become hard. The B&W speakers are plug and play into this enclosure using the reverse of removal. Be sure to use glue on the tweeter tabs upon installation.

Next find an area close to the center dash to mount the crossover. I used the heaviest duty Velcro 3M fabricates on the back of the crossover as a mounting aide. Under the dash is tight, but I felt was a possible mounting location because of the crossover's size. My vehicle has an Android monitor and there was plenty of room to mount the crossover in the space behind the monitor. When choosing a mounting location consider what would happen if the crossover came loose and try to mitigate.

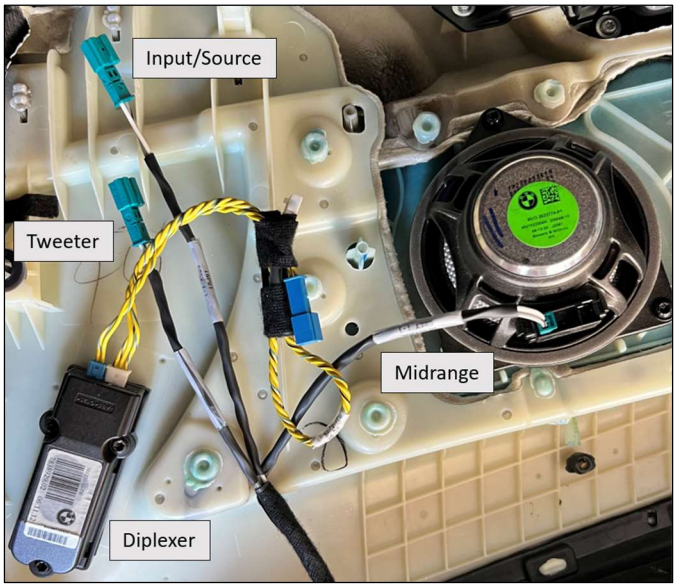
11. FRONT DOOR B&W SPEAKER UPGRADE

In the S752A option, the front doors already have a crossover (diplexer) installed. This is disconnected from the Individual midrange and tweeter and connectors tied back. With the tweeter located above the door panel in the window area, a longer wire set from the crossover is required. To avoid excess cost for longer silver wire on the crossover, I added a 10" OCC wire extension with OEM connectors that goes from the B&W tweeter to the crossover tweeter connector. Doing so requires extra connectors than the quantity specified in the BOM. BMW does the same in the S752A option, except the wire loom extension goes from the tweeter to the diplexer. Unfortunately, this OEM wire extension has a connector that does not mate with the B&W tweeter, so it cannot be reused.



The B&W midrange mounts plug and play with three existing T20 screws. The tweeter mounts plug and play, which is the same as all other locations with three tabs locking the tweeter in place. However, it appears the front door tweeter has more play after installation than other locations, so be sure to use hot glue to lock the tweeter in place.

Mounting the crossovers is the same for the front and rear door panels. On the back side of each door panel is a cutout/pocket feature between the door panel pockets. Place 3M Velcro on the backside of the crossovers and mount them in the cutout/pocket. From this location you can route the wire sets to the input/source, midrange and tweeter. Use gaffer tape as needed to secure the wire loom as it's routed toward the speaker components. Tie back the diplexer wire harnesses so they can be easily reused if the stock audio option is reinstalled.



12. REAR DOORS B&W SPEAKER UPGRADE

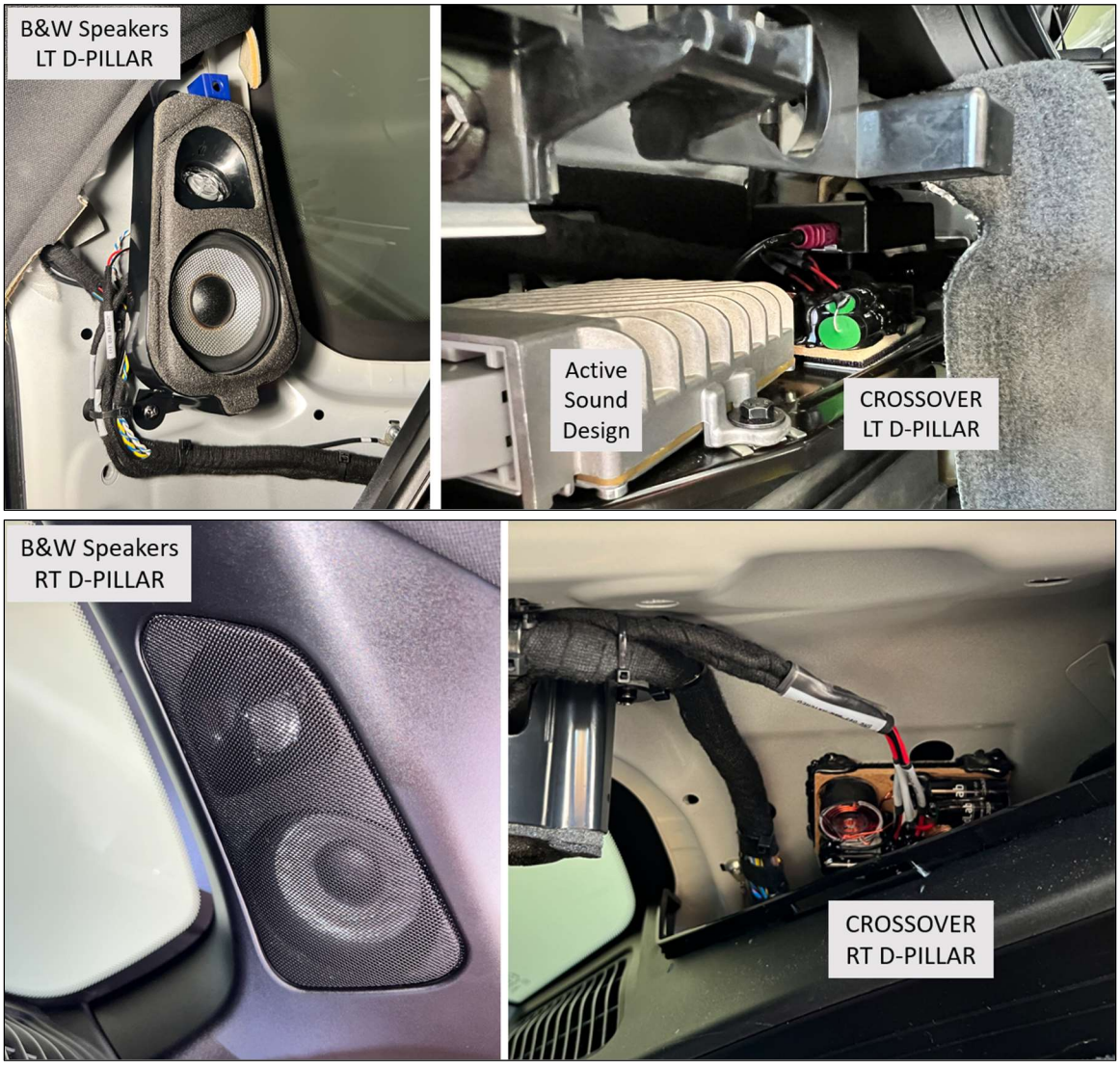
Installing B&W speakers and crossover in the rear doors is identical to the front door installation, with a few exceptions. In any BMW audio option, the rear doors do not have diplexers mounted. The tweeters are installed near the midrange, which does not require an extension or longer length of crossover wire. The B&W midrange mounts plug and play with three existing T20 screws. The tweeter mounts plug and play, which is the same as all other locations with three tabs locking the tweeter in place.

13. D-PILLAR B&W SPEAKER UPGRADE

I had originally thought there was no need to use custom crossovers on the D-Pillar locations. As such, I planned to just replace the existing S752A speakers with B&W speakers. This involved using the -629 B&W tweeter with inline filter and -774 B&W midrange. However, after sitting in the rear seat location and listening to the result, it became very clear that this D-Pillar setup sounded poorly (improperly matched) in combination with the B&W speakers and custom crossovers in the rear door panels. As a result, custom crossovers in the D-pillars were installed with the -773/-774 B&W component speaker set.

Purchasing a used separate set of D-Pillar speaker enclosures can save you some time if you ever decide to return to the S752A option. I bought used OEM enclosures on eBay, enclosure P/N: 65-13-9-211-047. The same enclosure is used on the S677A audio system as in the S752A audio system and you can purchase with or without speakers. If your purchase includes speakers, then uninstalling the speakers is not difficult as described previously.

Next, mount the crossovers using 3M Velcro. On LHD vehicles the right side (passenger side) crossover is vertically mounted to the aluminum body wall frame using the 3M Velcro cited in the Components Used table. I then used hot glue between the accessible crossover board edges and the body to provide additional support. On the left side I mounted the crossover horizontally on the OEM brackets used for the amp and other accessories.



14. UNDER-SEAT B&W SUBWOOFER UPGRADE

Adding B&W subwoofers was a relatively easy swap and made a significant impact. Note that not all B&W subwoofers are created equal, but I can attest to the fact that the 65-13-2-622-510 B&W subwoofers are certainly an improvement over the set of Bavsound Ghost Subwoofers I was running. IMO, the clarity remains with increased SPL, fullness, and the addition of modest low frequency (~31hz) output. This upgrade requires removing the S752A subwoofer assembly from under the front seats, disassembling the enclosure, removing the S752A subwoofer, and reassembling the enclosure with the S6F1A subwoofer. A minor modification is required to the OEM S752A subwoofer source connector to allow plug and play.

The -510 B&W subwoofer fits within the S752A subwoofer enclosure. However, due to the shape of the S6F1A subwoofer frame, it seats in the enclosure like a bowl seated in a hole. A 1/8" gap remains between the enclosure sealing surface and the subwoofer lip. I used 5/16" wide by 1/8" thick foam tape around the perimeter of the bottom enclosure to compensate. However, as seated, the subwoofer is susceptible to wobble during fastening. To mitigate this, take care to evenly tighten the bolts holding the subwoofer to the enclosure.

Prior to reinstalling the subwoofer enclosure into the vehicle, the S752A subwoofer connector must be removed and modified. A test fit of the connector will show there is a tab on the connector that interferes with the S6F1A subwoofer. The S752A under-seat subwoofer connector must be modified to interface with S6F1A B&W sub OR new universal connectors and pins must be purchased. The under-seat subwoofer replacement connector is P/N: 61-13-2-359-996 and comes with three sizes of pins. It also appears to be universal so fits S752A and S6F1A under-seat subwoofer systems. Cost is about $25/each. Prior to removing the pins, note carefully where the pins are located within the connector. To remove pins from the connector, lift connector top tab carefully (fragile). Using a tiny flat head, press down pin locks while simultaneously pulling on wires Pry up connector tab. Press pin locks and remove both wires from connector. Using a vise and a sharp chisel, remove the long tab that prevents insertion into B&W subwoofer connector shell. Note that the S752A connector does not lock into S6F1A B&W sub connector.

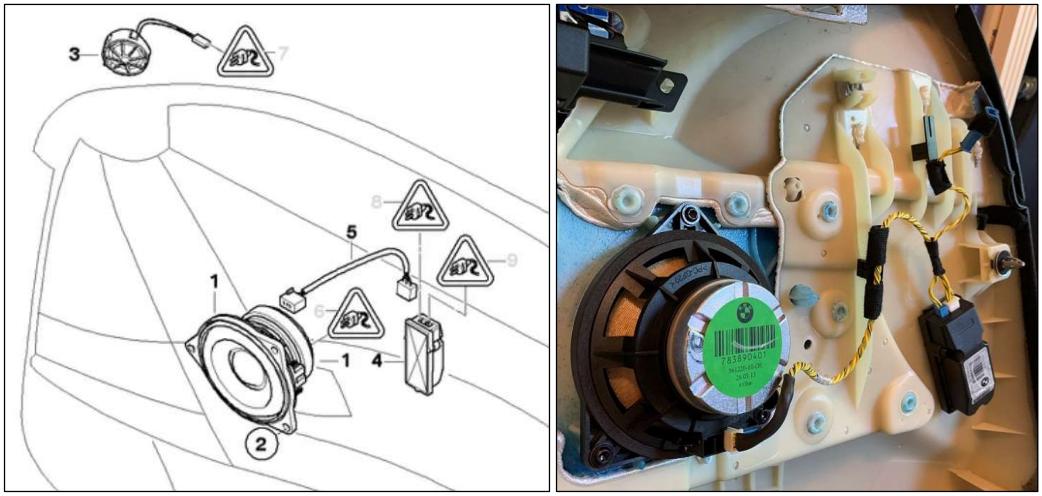

Upon reassembly of the enclosure under the seats, the S752 enclosure is mounted to the floor using 10mm Hex bolts making sure to screw them in evenly at all four corners to ensure the top trim piece remains flat/even. Tighten only by hand and then ensure the subwoofer enclosure assembly is fixed to the floor and does not move. Then the top trim piece is reinstalled to protect the subwoofer and provide a finishing cap for the exposed carpet edges. Note that the top trim piece may deflect slightly as it interferes slightly with the S6F1A B&W subwoofer top frame, but it shouldn't be enough to affect installation.

Optionally, the B&W under-seat subwoofers can be independently powered by a separate aftermarket amp and DSP up to 250W each.

15. OTHER CONSIDERATIONS IN LIEU OF COMPLETE B&W UPGRADE

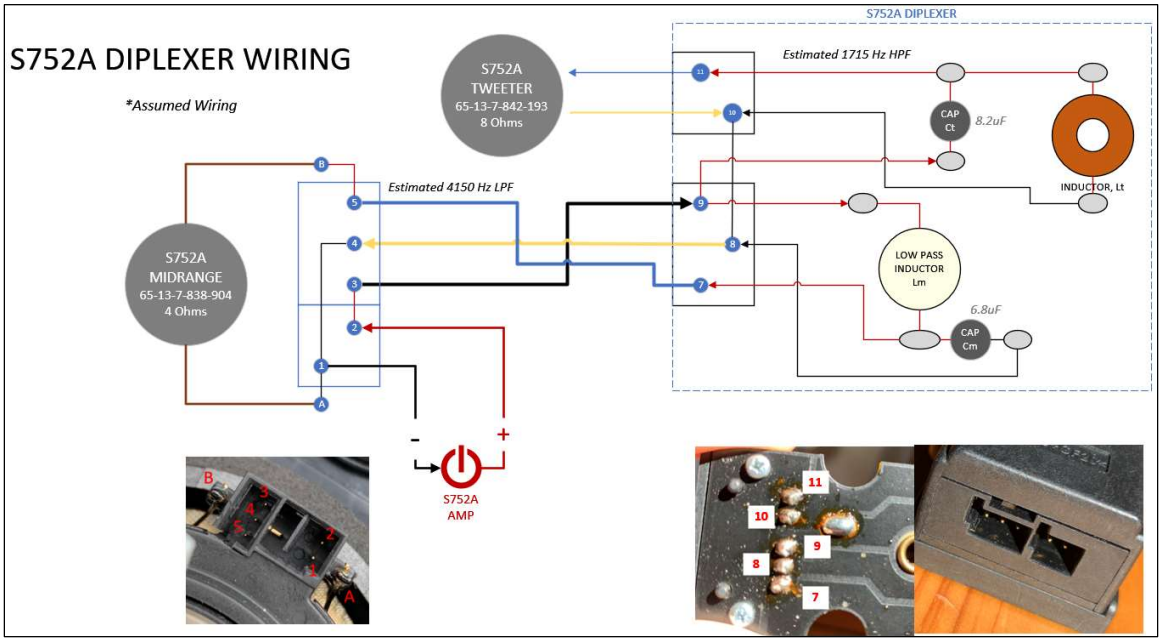
There is always the option of off-the-shelf speakers from a wide range of manufacturers and wide range of configurations. But this upgrade, as I and others have concluded, can deliver excellent audio while maintaining OEM components. However, if you have no interest in an extensive upgrade, there are a few minor changes that you may consider helping make significant improvements in an aging S752A Individual audio system.

a. The best bang for the buck is to upgrade the center dash single coaxial speaker with a B&W component set. I ran this setup first before performing the entire upgrade. If this is the only upgrade you plan on making, then use the B&W midrange (-774) and tweeter with inline filter (65-13-9-279-629). This option involves the cost for a new set of B&W component speakers and possibly a used S677A mounting bracket. Note the -629 B&W tweeter is from an F90 M5 and is selected because it includes an inline filter, similar to the S752A co-axial speaker to be replaced. *NOTE: If you have the S752A system, the S677A center dash speaker bracket is needed for this application or modification of existing bracket. The S752A center dash speaker bracket allows only for the mounting of a coaxial speaker, with the tweeter mounting location filled with a solid blank.*
b. The next best OEM upgrade option would be to upgrade to the B&W underseat subwoofers (65-13-2-622-510) <u>in addition to</u> the center dash upgrade described above. There are several B&W underseat subwoofers depending on the vehicle, but the ones ending in -510 provided a remarkable improvement in my vehicle.
c. Another option is to consider replacing the front door aging diplexers (65-13-7-838-929) with new, relatively inexpensive (<$100/ea), OEM diplexers. As the capacitors in the diplexer age (10+ years), they no longer maintain the designed crossover frequency intended by the manufacturer. If you're capable, you can disassemble the diplexer and solder in new capacitors (capacitor size shown in S752 Diplexer Wiring diagram below).



OEM Diplexer, Item 4, OEM P/N: 65-13-7-838-929, Front Doors Only, S752A Midrange Shown

d. In lieu of custom crossovers all around, another configuration would be to use the OEM diplexer (~$50/ea) at other component speaker locations (rear doors, center dash, d-pillars) not already used. As far as connections are concerned, the wiring would be plug and play at each location in the exact way the components are connected in the front door. The OEM source connector plugs into the midrange, and the midrange and tweeter plug into the diplexer (see diplexer wiring schematic below). The wiring schematic below is for reference only. I purchased a used diplexer, disassembled, and trial/error tested to develop the schematic. But the components and their values are accurate as found labeled in the diplexer. Knowing the value of the capacitors and the impedance of the speakers when calculated yields a high pass frequency of 1715 Hz and a low pass frequency of 4150 Hz for the diplexer. *NOTE: this audio option was not tested, so the sound at each location based on using OEM diplexers is unknown. However, the addition of diplexers at the front doors was advertised by BMW as an improvement given the same component speakers without diplexers.*



e. Another option is to have custom crossovers designed specifically for the OEM Individual S752A speakers. Then you only have to invest in the cost of crossovers and not the cost of all new B&W speakers. Given the different Individual speaker components available, there are various configurations of this plan. If you have the S752A system, one configuration would be to:
    i. Send one each front door Individual midrange (-904) and tweeter (-193, no inline filter) speakers for analysis by the crossover designer and have Qty.7 custom crossovers designed and fabricated based on those speakers. This assumes you plan to replace the center dash coaxial speaker with an S752A midrange and front door tweeter. Else, order Qty.6 and/or submit the coaxial to the speaker designer to create a specific crossover for that location. I believe fabricating a unique crossover for the center dash coaxial would be cheaper than buying the -904 midrange and -193 tweeter as center dash replacements.
    ii. Reuse all midrange speakers and front door tweeters. Purchase additional -193 tweeters (Qty.5) for rear doors, d-pillar locations, and center dash. Purchase one -904 midrange for center dash.
    iii. Finally, install the new custom crossovers at all 7 speaker locations, plug and play.

16. AUDIO SETTINGS, CONFIGURATIONS, & CONCLUSIONS

The custom crossovers in this DIY are designed assuming default settings (equalizer flat) in the OEM Tone menu with surround sound unchecked. Obviously, adjustments and tuning can help achieve individual sound preferences. See the REFERENCES section below "S677 HiFi System Professional DSP Equalizer Settings (Frequency Tested)" on how to tune the equalizer settings in an E70/E71.

A quick (subjective) recap on sound quality, digital, and analog signals. Digital music (CD, music files, streamed, downloaded, etc.) must go through a digital to analog converter (DAC) to be played by the amplifier and subsequent speakers. To simplify, I can generally state that streamed or downloaded music played wirelessly (IE: Bluetooth) produces lower sound quality. This is based on streaming/downloading files having an approximate bitrate of 256bps, whereas CDs and music file bitrates approach 1000bps. In the OEM audio system, there are two ways to get digital music to the OEM amplifier. One is through the CIC (OEM headunit) and its internal OEM DAC, where digital AM/FM, CD/DVD, SAT, External Device (Bluetooth), or stored music is converted to analog and sent to the amplifier. The other method is through the OEM AUX-IN, which requires the connecting device to have an internal DAC and output an analog signal to the AUX-IN which is then sent to the amplifier. DAC quality varies significantly and can have a profound effect on the signal delivered to the amplifier and sound output by the speakers.

In my vehicle I have a popular Android Monitor setup which effectively results in two manually selectable modes: 1) OEM mode and 2) Android mode. OEM mode is the typical audio heard when playing sound through one of the OEM audio sources: AM/FM (digital), CD/DVD, Satellite Radio, External Device (Bluetooth), or Stored Music. The sound is adjustable using the OEM Tone menu. The OEM and Android modes are independent of each other, however, use the same vehicle speakers. Audio played through OEM mode cannot be heard through Android Mode and vice versa. There is one exception: you can be in OEM mode playing audio, touch the Android screen (switching to Android Mode) and continue to hear OEM mode audio. This can continue until you press the Apps menu or some other menu or App that switches the source to the Android monitor.

In the Android Mode I use an Android 10 Snapdragon Qualcom 10.25" monitor installed in place of the OEM monitor. You have a choice whether to use the Android's internal DAC or to add a custom USB DAC. Using the internal DAC only requires an aux cable from the monitor to the center console and OEM AUX-IN. Going the route of a USB DAC requires the sourcing of a DAC that plays well with the system and an appropriate player app. You'll need a USB extension to get the DAC to the center console and an aux cable that goes from the USB DAC to the OEM AUX-IN. It won't be difficult to find a USB DAC with better technology and audio sound than the Internal monitor DAC. I tested at least 7 different DACs and the best solution was the AudioQuest Dragonfly Red or Cobalt. The drawback of a USB

DAC is that it is mainly used to play audio files through a player app with disregard to most other Android monitor features requiring sound output. You cannot have both Internal and USB DAC connected at the same time b/c there's only one OEM AUX-IN. I did route both aux cables to the center console and investigated methods to use an AQ aux splitter and a source switch app but have yet to be practically successful. You can manually swap the connections at the center console, but it's not too practical.

My final configuration is to play audio files using an audiophile player app, UAPP, which outputs the audio signal through an AudioQuest Jitterbug (USB noise filter), then to an AudioQuest (AQ) Dragonfly Cobalt USB DAC, and then plugged into the OEM AUX-IN with an AQ Big Sur aux cable. The AQ DAC has equipment level settings (gain, format, bass boost, surround, correction, loudness) as does the UAPP app which utilizes a 10-band equalizer and numerous additional sound adjustments. The UAPP player app can also control the DAC gain.

OEM MODE SETTINGS – In this mode, sound is adjustable using the OEM Tone menu where you can control Treble, Bass, Fader, Balance, Surround, and 7-Band equalizer (100, 200, 500, 1k, 2k, 5k, 10k HZ). Digital audio is received by the OEM CIC, converted to analog by the internal OEM DAC, and sent to the OEM amplifier. There is also an AUX-IN level setting on the OEM side, however it does not affect the OEM mode sound quality. This setting feature is only for external devices (IE: phones, players, android monitor, etc.) with their own internal DAC which when connected to the OEM AUX-IN bypass the CIC OEM DAC. In general, the lower this value can be set, but remain audibly functional, the better the sound quality. A lower setting can be achieved if the source device DAC is of high quality. Important: Any settings made in the OEM Tone menu are cumulative to any other connected devices sound settings. For instance, connecting your device via Bluetooth and using a device app to play music through the OEM audio system will result in the music being modified by your device app equalizer/sound settings, then being adjusted again by the OEM Tone settings before being played through the vehicle speakers.

ANDROID MODE SETTINGS – This mode utilizes the OEM AUX-IN to send audio signal from the Android monitor to the OEM amplifier. The Android 10 monitor's internal DAC is much better than its predecessors and there are minimal tone settings available to adjust using the monitor's default music player. The Draonfly Cobalt DAC selected has internal settings disabled and the UAPP 10-band equalizer is used without additional app adjustment features (parametric EQ, morphit, bit-perfect, crossfeed, balance). The DAC gain can be set in the UAPP app and is set at 100%. The OEM AUX-IN setting, in the OEM mode side, is set to 5-clicks (of 22). Lastly, sound in this mode is affected by any OEM Mode setting adjustments, unless they are disabled or if the OEM 7-band EQ is set to flat.

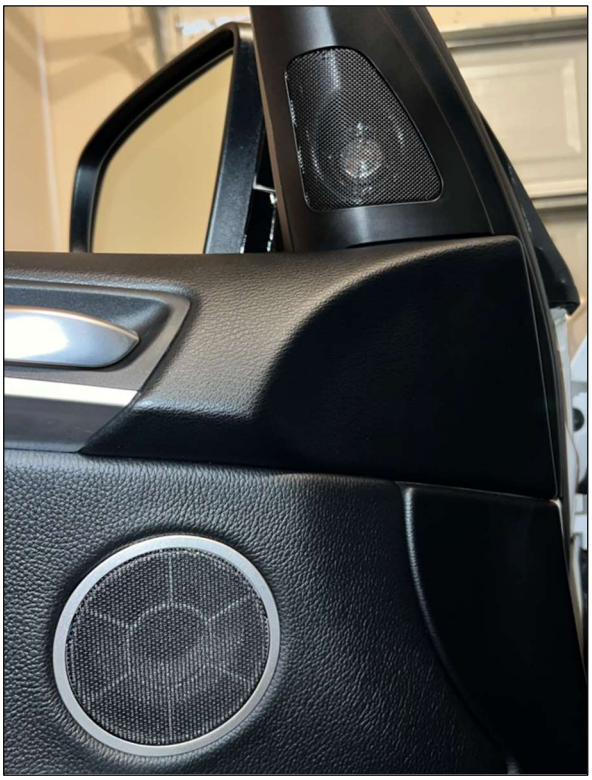
CONCLUSIONS – I have not technically completed my settings as I need to continue my research on tuning my system given the copious number of adjustments available. But the sound is already tangibly better. Tuning is made more complex given two modes of sound each controlled by different sounding and quality DACs. I've determined by comparing the OEM vs Android modes audio sound prior to this B&W speaker upgrade, resulted in the Android mode eclipsing the OEM mode in sound quality and clarity. I attribute the OEM mode's muddy sound to 1) lack of tuning and 2) the S752A audio system capacitors age and change the crossover frequency for the worse. Once these old S752A capacitors/filters were replaced by the upgrades in this DIY, the OEM mode sound improved significantly. However, it's still very clear that the AQ DAC is higher quality than the OEM CIC DAC.

I found a new respect for the OEM AUX-IN's ability to reproduce great sound. If you're hearing crackling or static via the AUX-IN then your connection is dirty (microfibers can have this effect) and/or the aux cable is faulty or low quality and/or the AUX module is failing. Another massive impact on sound was the addition of the B&W subwoofers. These alone can significantly improve the bass response in your E70/E71.

One setback on the Android mode side, as mentioned above, is that the USB DAC only works with apps sophisticated enough to recognize that a USB DAC is connected. As a result, not every app or feature in the Android monitor has

sound when the USB DAC is connected. As a result, I cannot fully take advantage of all the Android monitor capabilities easily. I hope future Android monitor versions may have already resolved this setback.

Lastly, I'm very happy with the upgrade in sound quality. However, realistically, this was as a pricey retrofit at just under $3,500 all told. **You can undoubtedly purchase an equal or better sounding, extremely sophisticated, aftermarket system for less than this amount.** As with most aftermarket systems you'll need to find space and mounting solutions for your amps, DSP, etc., plus routing of thicker gauge wiring to all locations. There are still options available to upgrade your sound dramatically using some of the findings in this DIY without a complete retrofit (see Section "Other Considerations in lieu of Complete B&W Upgrade"). This project is a powerful and easily reversable upgrade that is seamlessly OEM in quality and aesthetics.



17. REFERENCES

Thanks to all who contributed their knowledge to these threads:

a. Xbimmers BMW X5 (E70) and X5M Forum (2006-2013): "The best audio upgrade for the [E70] X5", https://www.xbimmers.com/forums/showthread.php?t=1774331
b. Xbimmers BMW X5 (E70) and X5M Forum (2006-2013): "S677 HiFi System Professional DSP Equalizer Settings (Frequency Tested)": https://www.xbimmers.com/forums/showthread.php?t=1924334
c. Mobile Solutions PT9A+ Polarity Tester: https://www.youtube.com/watch?v=tlIZVn-bO0I
d. Tuning with RTA & Equalizer: https://www.youtube.com/watch?v=1Rs2ZghGXEc
e. This PDF posted here: https://www.xbimmers.com/forums/showthread.php?t=1499820&page=15