

Relays: FAQ and Tech

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Monday, 01 March 2004
Last Updated Tuesday, 14 August 2007

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Relay info for BMW motorcycles 1970-1995 aka airheads

RELAYS 101: relay basics

What's a relay?

How's it work?

What do they mean by. . . (relay terms)?

Are there other types?

RELAYS 102: BMW info & specs

What relays do Airheads use?

What do #'s like 86a mean?

How are Airhead relays different?

How are Airhead relays wired?

RELAYS 103: tinkering

Can I repair a relay?

Can I substitute relays?

Any cross-references?

Can I add relays for horns or headlights?

RELAYS 101: relay basics

What's a relay?

A relay is an electrical switch that is operated by remotely triggering its electromagnet. Relays are useful for switching heavy electrical loads using only small trigger wires. A wire's resistance increases as it gets smaller or longer reducing the power transmitted. Thus, it would be very impractical and inefficient to run wires big

enough to handle a starter motor from the battery terminal, to a handlebar switch and back to the starter. Relays allow the use of short, thick wiring directly between the battery and starter so only a couple small wires need to be routed to the switch to trigger the starter. In fact, the solenoid on a starter is doubles as a big heavy-duty relay itself to power the starter. The *START* button is really a trigger for one relay that triggers a still bigger relay!

How's it work?

The key to the basic relay is an electromagnet.

An electromagnet is generally a core of magnetic material (like soft iron) with wire coiled around it. When an electrical current is applied, a magnetic field is produced just like a common refrigerator magnet. Relays use electromagnets to pull a spring-loaded contact arm to close an electrical circuit so current can pass through, open it or to switch current from one path to another. Diodes and Resistors are used to prevent damage from voltage spikes that can occur when a relay is switched off. Diodes (electrical "one-way" gates) are often used to "check" current from backtracking into other circuits.

What do they mean by . . . (Relay Terms)?

A relay that does not pass current when at rest is referred to as Normally Open (NO). Likewise a Normally Closed (NC) relay passes current at rest, but opens thereby shutting off power when triggered.

A relay that opens one circuit but closes another is called a switching or change-over relay (see double throw). Abbreviations like SPST and DPDT are also used to describe how many switching contact arms or poles as well as how many contacts or throws a given pole has in a relay. DPST would indicate a double pole, single throw relay like the one used for a '78 R100/7 headlight. After looking at these pics, can you draw up a diagram of a 3PST-NC?

An electrical diagram or schematic of the relay depicting it at rest is often stamped on its side.

Are there other types?

Solid state relays

have no moving parts because they use transistors instead of electromagnets to direct current. While these relays have longer cycle life (number of switchings they can perform), faster switching rates and other advantages, they're also more expensive, produce heat, leak voltage when "off" and offer no real advantage for motorcycles compared to tried-n-true, inexpensive and abundant OEM mini-relays that often have operation-cycle lives in the millions.

Thermal relays

used for flashing turn signals and hazard lights exploit the way certain metals expand when heated thru various methods. One example is when switched on, the electrical current rapidly heats up a thin taut resistance wire (18.6 Ohms on one I tested); the heated wire expands allowing the contacts to snap closed; the current now flows through the less restrictive contacts to the signal bulbs allowing the wire to rapidly cool; the cooled wire contracts snapping open the contacts; current now resumes passing through the wire; the wire re-expands as it heats; and the cycle continues. That back-and-forth action is what switches the turn signal's power "ON-off-ON-off-..." These are often variable load flashers designed for older, pre-electronic motorcycles; generally have a slight delay before the signals light as the wire first warms; and over time the heated wire can elongate or burn out leaving the bulbs always on or off respectively.

Electro-mechanical or electronic relays are a hybrid of mechanical and solid state electronics for their relative strong points of load capacity, reliability and load sensing. In addition to regulate flashing rates (tank circuit), they can register cancellation commands, often incorporate a "bulb-out" indicator, come in a wide variety of load capacities and have been the automotive industry standard for decades. While this type is more expensive, they actuate faster (no thermal delay), and their components can outlast thermals ten times over making their relative cost the same and hassle-factor low for those nine times you don't have to replace it.

RELAYS 102: BMW info & specs

What relays do Airheads use?

Below

is a cheat-sheet of relays common to Airheads from 1970-'95 that includes their use, BMW part number, corresponding schematic in the following picture, and notes.

BMW Part #

[pic]

Use (relay terminals, notes)

Starter Relays

12 41 1 350 775

[A]

/5 (GN/SW-->15, three RT-->30, BR/SW-->31b, SW-->87, two BL-->D+)

61 31 1 357 104

[B]

/6 ('74: SW, BR/GE, three GN/SW, two RT, two BL; later wired like /7?)

61 31 1 243 207

[C]

'77 to '84 (30, 85, 86, 87, 87 w/ Clutch/Neutral diode in Headlight Contact Board)

61 36 1 389 105

[D]

'85 on & all 'GS, R45, R65 (30, 85, 86, 86a, 87 w/ Clutch/Neutral diode 86-86a)

Turn/Hazard/Warning/Flasher Relays

61 31 1 352 941

[E]

/5 (15, 54, ?)

61 31 1 358 194

[F]

/6 to 9/80 (31, 49, 49a, C)

61 31 1 244 392

[G]

9/80 on (31, 49, 49a) and R45, R65, G/S and ST

61 31 2 306 014

[H]

all 'GS, 'R and 'MYS '91 on ("K-Bike" L, R, Cancel buttons)

Headlight Relays

61 32 1 358 193

[I]

9/74 to '77 "Main" (30, 85, 86, 87, 87b)

61 32 1 243 049

[J]

'78 to '84 "Day-Light/Time" (30, 85, 86, 87, 87b w/ diode 86-87b, park lights lit while starting)

61 32 1 244 411

[J]

'85 on (30, 85, 86, 87, 87b w/ diode 85-coil & 86-87b, park lights lit while starting)

61 31 1 373 585

[K]

some R65 "Day-Light" (30, 85, 86, 87 with resistor 85-86)

Hazard/4-Way Relays

61 32 1 358 193

[I]

Hazard Warning Relay '76 to '84 (30, 85, 86, 87, 87b)

61 31 1 373 585

[L]

Hazard Warning Relay '85 on (30, 85, 86, 87 w/ resistor 85-86)

61 31 1 459 224

[M]

Hazard Flasher Relay all 'GS, 'R and 'MYS '91 on ("K-bike" style)

Other Relays

61 31 1 373 916

[N]

Buzzer Relay (30, 85, 86, 87a w/ resistor 85-86)

61 31 1 373 585

[L]

Horn Relay up to 9/78 (30, 85, 86, 87 w/ resistor 85-86)

61 31 1 459 677

[O]

"Load Shedding" Relay for all 'GS, 'R and 'MYS '91 on (30, 85, 86, 87 w/ 680ohm resistor 85-86)

Wire Colors

RT

= Rot, Red; GE = Gelb, Yellow; GN = Gruen, Green; BL = Blau, Blue; VI = Violet; BR = Braun, Brown; WS = Weiss, White; GR = Grau, Grey; SW = Schwarz, Black;

wc/tc = wire color / tracer (stripe) color

What do #'s like 86a mean?

Terminal # = function

15 = Switched positive output from battery

30 = Positive output direct from battery (+)**

31 = Direct to battery negative (-), ground

31b = Return to battery negative via switch or relay

49 = Positive input for turn signal flasher

49a = Turn signal flasher trigger power to switch (54); marking used after /5

54 = Turn signal switch contact from flasher (49a); marking used on /5

85 = Relay trigger wire, generally for negative/ground winding on electromagnet**

86 = Relay trigger wire, generally for positive winding on electromagnet**

86a = Path to ground via neutral switch with diode (prevents "NEU" from lighting via clutch switch [contact 86])**

87 = Normally open relay output, generally**

87a = Normally closed relay output

87b = Second normally open relay output on a separate throw

D+ = Voltage Regulator/Dynamo (Alternator) positive

C or KBL = power to turn signal indicator light in gauge cluster

**

For some applications, BMW relay wiring uses 85 for the positive winding and 86 for the negative, and sometimes 30 is the output and 87 the input. Double check wire colors, relay pin numbers and wiring diagrams to avoid "sparks."

How are Airhead relays different?

All Airhead starter relay circuits try to prevent starter misuse. The /5 relay will not operate if it senses the motor is running via alternators BL output wires; the GN wire switches to GN/SW wire in '72 when fuses are added; and is prone to cold weather stubbornness in stock form as noted by folks like Snowbum

and others. Though outwardly similar, the /6 relay's BL wires only make a remote connection on this otherwise standard relay. Bridging the /5 to the /7, /6 relay wires eventually changed from GN/SW to GN/BL, from BR/GE to BL/GE, and both the /5 and /6 relays may have different pin configurations on their base depending on when they were made (like 85 switching

places with 86) so double check all connections. All starter relays from /6 on are enabled only in neutral or with the clutch pulled in and use a diode to prevent the clutch switch from tripping the neutral light. Like the /6's, the /7 relay used through 1984 located that diode in the headlight's contact board, but the relay is the conventional "cube" mini-relay type and has two RT wires connecting at its dual 87 terminals. From 1985 on, the diode was located in the starter relay with the clutch and neutral switches making connections at 86 and 86a respectively.

Turn signal relays need to regulate the rate of flashing sets them apart. The /5 uses a thermal flasher. The /6 thru '80 models 4-pin relay use an electro-mechanical relay to regulate and actuate flashing, power the gauge cluster's indicator light separately, and to disrupt that indicator light if the draw is significantly below 42-watts meaning a turn signal bulbs is out. For '81 and later models, a 3-pin relay did away with the separate indicator wire by have that light bridge the left and right signal wires -- powered by one and grounding through the other. Models with K-bike switchgear like '91-on GS, R and MYS use a multi-pin relay that acutates seperate L and R indicator lights via the respective signal's circuit and has a seperate cancel button.

All headlight relays are DPSTs, except for some R45/65s that used a SPST with a voltage-spike-suppressing resistor. Headlight relays started with the /6 models. The switching load is split between two contacts: one throw powers the headlight (87) and the other powers the taillight, parklight and gauge lights (87b). Around '78 concurrent to the implementation of daytime headlight laws, a connection via a diode was made linking 86 (positive winding) to 87b so the park lights remain on during starting or if the relay fails. A second diode was added to the 85 terminal for '85-on models.

Hazard / 4-way relays recycle the early headlight relay for '76-'84 models, the early horn relay for '85-on models, and an internally spifier relay on '91-on GS, R and MYS models that's outwardly similar to their turn signal relay.

Other relays include the turn signal buzzer relay (the only normally-closed mini-relay), the SPST with resistor horn mini-relay, and the SPST with resistor micro-relay used on late model R and GS models.

How are Airhead relays wired?

Here are some on-line diagrams to aid one's understanding of how Airheads' relays are wired. Note that their are occasionally mistakes, like 87b being mislabeled as 87a or a relay with two 86's but no 85.

/5 Wiring Diagram (Owner's Manual, B/W)

B/W Wiring Diagrams (Haynes)

http://www.powerboxer.de/index.php?option=com_content&task=view&id=62&Itemid=174

RELAYS 103: tinkering

Can I repair a relay?

Often

times you can repair a relay. It just depends on the reason for failure and whether it's worth the hassle to fix it. First, test it. If you hear a *click* when you attach 12v +/- to 86/85, there's a good chance you can fix it. Otherwise you could have a failed coil winding which is often impractical to fix. Also check the wires going to the relay with a volt-ohm meter to make the correct wires are supplying current or a path to ground when the should. Second, can you get the cover off? If it's a glued plastic housing, you could destroy it trying (hey, it's dead anyhow, right?). You can get most others off if you pry their locking tabs up and over the catch points. Common failures and fixes:

Dirty connections: Sometimes just pulling a relay out and putting in back in fixes things. If the relay tests good. Clean all relay terminals, terminal plug-ins, check each plug-in for snug fit and apply some dielectric grease to aid conductivity and ward off corrosion.

Failed wire to relay: Sometimes it's not the actor, but the supporting cast. Check wire functions per bike wiring diagram.

Dirty contacts: You might've noticed in the pic of the pin #'s on the bottom of some relays (see next section) that the starter and turn signal buzzer relays, [C] and [N] respectively, have a vent holes on the bottom. While this let condensation out, it can also let water and vapor in leading to the corrosion you saw in the "How's it work?" picture in Relays 101. If there is no continuity between 30 and 87 when you manually close the contacts, you can usually use some fine sandpaper to dress up the contacts to restore it.

Obstructed contacts: Sometimes a piece of solder or such can get caught under the contact arm preventing it from closing. Remove it.

Open, burnt-out or corroded coil windings: Not practical to fix

unless it's a broken lead wire to 85 or 86 (delicate re-soldering).

Worn or broken spring: Depending on how the relay is oriented, this could manifest as a relay that's always on, off, or flutters when jiggled. Replace spring if coil type. If it's a leaf spring, get creative or junk it.

Open circuit board connection: Check for continuity with between ends of circuit paths on back of board. If open, carefully re-solder.

Dead thermal wire: Thermal relays either tests open (infinite resistance) or closed (0 ohms). Replace with another thermal or upgrade to longer lasting electro-mechanical relay.

Failed diode: Symptoms include neutral light coming on when clutch pulled in or inability to start in neutral for starter relay, and park lights remain on with the ignition off for headlight relay. Remove old and solder in new diode. Failed diode allowed current to go two-ways or was open. Be sure new diode (one-way current) has its anode (+) and cathode (-) properly oriented, often indicated by mark on one end.

Can I substitute relays?

The quick answer is "it depends..." Just because a relay fits, DOES NOT mean it's right; it must have the same or better specs.

1. See what the original's voltage and amp ratings were labeled as.

"12V 30A" designates 12-volt, 30-amp, and should only be replaced with a 12V relay rated for 30-or-more amps -- never a lower amp rating.

2. Identify the original's load capacity, mostly with flashers. "1-4 x 21W - 12V" means this relay can power one-to-four 21-watt bulbs at 12-volts and shouldn't be used to power more. Some will add "+ 5W" for powering the dash indicator. Also note that some relays split the load across two sets of contacts like the park/headlight relays do.

3.
Compare the pin layout and terminal numbers to make sure they're the same -- 87 is NOT the same as 87a.

4. Lastly, it's very important to make sure the substitute has the same circuit functions. Most non-flasher relays have their wiring schematic 1, 2 stamped on the side. Some have diodes to prevent the current from back-tracking into other circuits, resistors to suppress voltage spikes, electronics to sense load demand for warning lights and or other features needed to keep your Airhead operating normally.

Remember:

Bone-stock relays, wiring (size and color) and connectors and the like are the easiest and fastest to trouble-shoot and work on. For example, you do not want to use red insulation for a ground wire. IMHO, the worst substitutions are non-matching penny-pinching ones, like replacing a 20-year-old /6 flasher with a generic variable-load thermal (no "bulb out" warning, fraction of OEMs lifespan) just to save a couple bucks for today. Not a good trade-off, especially when plentiful good used ones often go for \$5.

With the

all the info above (Relays 101-103), you should now have an idea what will work and what won't. It's always handy to pack extra wire (insulated), OEM double-crimp connectors (male and female), fine sand paper, a little dielectric grease, heat shrink tubing, a couple large/small paper clips and electrical tape (wrapped around a small dowel rod or such) in a film canister for a "field repair" kit to get you home. The paper clips will aid in releasing the catch should you need to remove a connector from a relay block housing. Remember to disconnect the ground wire from the (-) battery terminal before you start and make all new connections are insulated from chance ground contacts.

Any cross-references?

DISCLAIMER

Always double check and compare relay specifications before purchase and or installation. Read what the IBMWR and Rick at

Motorrad Elektrik have to say about part substitutions first.

* Possible cross-reference but not verified

Relays listed by schematic
letter in airheads relay list, above.

[A]

BMW: 12 41 1 350 775

Type: 12V, 30A; relay

Notes: /5 (GN/SW-->15, three
RT-->30, BR/SW-->31b, SW-->87, two BL-->D+)

Stribel: SR 9570

[B]

BMW: 61 31 1 357 104

Type: 12V, 30A; relay

Notes: /6 ('74: SW, BR/GE, three
GN/SW, two RT, two BL; later wired like /7?)

Stribel: SR 9572 (type 1 357
104.3)

[C]

BMW: 61 31 1 243 207

Type: 12V, 30A; mini-relay

Notes: '77 to '84 (30, 85, 86, 87,
87 w/ Clutch/Neutral diode in Headlight Contact Board)

Audi: w/tab KDWHL09663*,
KDWHLO9663*

Bosch: 0 332 014 118, 0 332 014
150, 0 332 019 150

Hella: 87483 (4RA-003-510-261),
w/tab 87118 (4RA 003 510-262, 4RA 003 510-267)

J.I. Case (like John Deere):
L108425

John Deere: AR74411

VMRS Codes: 053-007-002 RELAY

Fiat: 82461739*

[D]

BMW: 61 36 1 389 105

Type: 12V, 30A; mini-relay

Notes: '85 on & all 'GS, R45,
R65 (30, 85, 86, 86a, 87 w/ Clutch/Neutral diode 86-86a)

[E]

BMW: 61 31 1 352 941

Type: 2 x 21W - 12V; thermal
flasher

Notes: /5 (15, 54, ?)

Hella: 91 M2 E2 x 21W - 12V (OEM
markings), 4NB 001 823-017

Hella (electro-mechanical): 4LZ
961 553-122*, 87712*, 3004*

Stant/Trico/Tridon (thermal): 552
(4 x 27w max), 536 (6 x 27W max)

Stant/Trico/Tridon
(electro-mechanical): EL12 (10 x 27W max)

EAN: 4082300102895*

[F]

BMW: 61 31 1 358 194, 61 31 1 364
984* ('68-'76 BMW 2002 flasher)

Type: 1-4 x 21W - 12V;
electro-mechanical flasher

Notes: /6 to 9/80 (31, 49, 49a, C)

Hella: 4DB 003 425-017 "TBB44
4DB 003 425-01" NOT same as 4DB 003 425-001, supercedes TBB26 DOT, 4DB 002
479-08, 1-4 x 21W - 12V

Hella: 4DB 003 425-001*

BMW: 61 31 1 364 984* (used on
68-76 2002, 77-79 320i, 79-81 528i, 75-78 530i, 1977 630CSi, 78-81 633CSi and
78-81 733i)

[G]

BMW: 61 31 1 244 392

Type: 2 x 21W + 5W, 4 x 21W - 12V;
electro-mechanical flasher

Notes: 9/80 on (31, 49, 49a) and
R45, R65, G/S and ST

Hella: 4DB 003 750-151 "TBB53
4DB 003 750-15"

Hella: 4DB 003 750-###* (any 750
prefixed flasher)

Bosch: 0 335 200 003, 0 335 200
043 "12V2 (4) x 21W 13-7W"

Wehrle: 54 201 101 "2/4 x 21W
12V -PA 6.6 - GF 30-"

Hella: 66051*, 87400* (Heavy Duty)

Ford: 6048781*

Opel: 12 26 919*

Saab: 85 83 627*

Sanel: SSF283, 01109

Volvo: 1 363 786

Demag: 97802173

Krone: 0302504/0

Mercedes Benz: 003 544 27 32

VW / Audi: 1H0 953 227

[H]

BMW: 61 31 2 306 014

Type: 12V; electronic flasher

Notes: all 'GS, 'R and 'MYS '91 on
("K-Bike" L, R, Cancel buttons)

Hella: 4DB 009 138-001

EAN: 4082300101188

[I]

BMW: 61 32 1 358 193

Type: 12V, 2 x 30A; mini-relay

Notes: 9/74 to '77 "Main"
Headlight Relay; Hazard Warning Relay '76 to '84 (30, 85, 86, 87, 87b)

Stribel: SR 9725 "12V, 2 x
30A"

Bosch: 0 332 015 006*, 0 332 015
012* (?mounting tab, rating?)

[J]

BMW: 61 32 1 243 049

Type: 12V, 2 x 30A; mini-relay

Notes: '78 to '84 "Day-Light/Time"
Headlight Relay (30, 85, 86, 87, 87b w/ diode 86-87b, park lights lit while
starting)

[K]

BMW: 61 32 1 244 411

Type: 12V, 2 x 30A; mini-relay

Notes: '85 on (30, 85, 86, 87, 87b
w/ diode 85-coil & 86-87b, park lights lit while starting)

Stribel: 89 9675?

[L]

BMW: 61 31 1 373 585, 1 459 676*

Type: 12V, 30A; mini-relay w/
resistor

Notes: some R65
"Day-Light" Headlight; Hazard Warning Relay '85 on; and Horn Relay up
to 9/78 (30, 85, 86, 87 with resistor 85-86)

Hella: 66126, 4RA 003 510-421, 4RA
003 510-461

VW / Audi: 171 937 503, 191 937
503, 431 951 253 H, 431 958 253H

Krone 0302181/0

VW / AUDI: 141-951-253B

[M]

BMW: 61 31 1 459 224

Type: 12V; electronic flasher

Notes: Hazard Flasher Relay all
'GS, 'R and 'MYS '91 on ("K-bike" style)

Hella: 4DB 009 138-011

EAN: 4082300131123

[N]

BMW: 61 31 1 373 916

Type: 12V, 30A; mini-relay w/
resistor

Notes: Buzzer Relay (30, 85, 86,
87a w/ resistor 85-86)

Hella: 66215, 87415, 66203, 87423,
4RD-960-388-10, and 4RD-960-388-20

Bosch: 0332-204-133, 0332-204-159,
0332-209-137, and 0332-209-167

[O]

BMW: 61 31 1 459 677

Type: 12V; micro-relay

Notes: "Load Shedding"
Relay for all 'GS, 'R and 'MYS '91 on (30, 85, 86, 87 w/ 680ohm resistor 85-86)

Bosch: 0 332 017 100*, 0 332 207
100*, 0 332 207 300*, 0 332 207 301*, 0 332 207 310*

Relay Block (/7
starter and horn relays)

Bosch: 3 334 485 008

Hella: 87122 (slightly different
than OEM)

Female Disconnect
(Spade Connector)

6.3mm (.250") blade w/ Catch
for relay block (most common, useful)

BMW: 61 13 1 352 810, 61 13 8 608 021
(may be for different wire sizes)

Hella: 87272 (14-16ga) package of
100 (OEM) for standard relays like starter and headlight

AMP: 42100 or 42281 (14-18ga),
42904 or 60249 (12-16ga)

Interlock Terminal Corporation: JW

1230-2 (12-14ga), JW 1630-2 (16-18ga)

6.3mm (.250") blade w/o Catch

BMW: 61 13 8 061 769

2.8mm (.110") blade width
(clutch switch connector)

Hella: 87271 (16-20ga)

4.75mm (.187") blade

Hella: 87276 (18ga)

Grote & Hartmann: 23613213011
(18ga)

9.5mm (.375") blade

Hella: 87279 (6-10ga), 87269
(10-12ga)

Helpful Links

Relay Basics by Hella, p.99 at www.hellausa.com/maineng/NewLook/ProdServ/pdfs/ElecProd1.pdf

Hella Relay Catalog www.hellausa.com/maineng/NewLook/ProdServ/catalogs/2001_02_catalog.html

Hella Connectors, p. 129 at www.hellausa.com/maineng/NewLook/ProdServ/pdfs/ElecProd2.pdf

B/W Wiring Diagrams (Haynes)

http://www.powerboxer.de/index.php?option=com_content&task=view&id=62&Itemid=174

/5 Wiring Diagram (Owner's Manual) www.eecs.umich.edu/~deroo/bike.dir/owners-manual.dir/fig.dir/bmw-om-wiring.jpg

Can I add relays for headlights or horns?

Here, a picture is really worth a thousand words. Running heavier wires to the headlight via an added relay is for the purposes of increasing headlight efficiency. Consult local and or state authorities regarding limits of headlight output for road vehicles. Play nice and DO NOT ABUSE your headlights in any way as to impair the vision of other motorists (repercussions, being 'brighted' by oncoming cars, road rage, brake slams, etc.). Usual other disclaimers...

Left: Stock headlight wiring loom connected directly to board in back of headlight shell in a '78 R80/7.

Center: Upgraded high-beam circuit via routing 14-gauge wire (minimum) from battery to high-beam filament via a relay. Greater capacity of 14ga wire allows for bright stock high-beam or the use of a high-beam greater than 60-watts for off-road. Wiring should be well-insulated and routed clear of anything that could rub, cut or otherwise ground out the wires. This is the easiest setup to do (example below).

Right: Upgraded low- and high-beam circuits via type '87a' change-over relay AND 14ga wire that's routed through the stock headlight relay. Stock headlight relay is supplied current via 14ga wire. 14ga ground goes straight to bulb with jumper to park light. 14ga wire from change-over relays 87a to low- and 87 to high-beam. You must connect the GE/WS wire from the handlebar High/Low-beam switch to either 87 or 87b on the OEM relay (via a piggy-back connector or such) or some other connector that's hot when the ignition is on so you can switch to high-beam. This depicts a 'daytime headlight' set up. Euro switch models (headlight 'Off / Park / On') lose momentary high-beam flash when not "On." Upping the low beam's wattage is NOT advised as it'll be used around other vehicles when you can use their lights to help see and in the city where you have street lights, in addition to legal restrictions.

Parts needed: well-insulated 14ga wire or larger, 8mm+/- right-angle headlight double-crimp connectors, 6.3mm double-crimp spade connectors, various sizes/colors heat shrink tubing, extra relay, ... etc.

Here's an example of my rat's nest . . . I mean headlight bucket wiring. It's roughly like the middle picture above where only the high-beam wiring has been upgraded. This was my first shot at one and I'll make some changes at rebuild. Some things to notice:

- 14ga high-beam power wires have white shrink wrap to denote them as high beam (the one from the battery will get a red cover next time I'm in there)
- I used a Hella relay that has a blade fuse in it (in the headlight where BMW put the fuses) versus an in-line near the battery (safer)
- Extra insulation: spiral cut vinyl tubing on 14ga (+) wire, connector coverings slit off of cheap connectors and put over proper double-crimp ones
- Hard plastic Hella relay mount tab buffered with a rubber washer
- Some heat shrink tubing on park light jumper to avoid excess bending
- Change over relay piggy-backed off of OEM relay 87 to a NC relay that turns off 20w park light when high- or low-beam are on.

Relaying Horns

Even if your horn switch is "supposed" to be able to handle two horns (many aren't though it'll work . . . until it fries the switch), ANY horn setup can benefit from larger and more direct wiring that relaying offers. More juice = more *HONK* = loud horns save lives. Dual horns also get more attention because their non-complementary Hertz rates. See Rebuilding Fiamm Horns. Give them an angry siren-like sound versus that of two notes in a musical chord.

From a BMW dealer, you'll need a pair of horns #61 31 1 365 968, horn relay socket and wire harness #61 12 1 243 249 or 61 12 1 243 261, 30-amp horn relay with resistor #61 31 1 373 585, second horn bracket #61 33 2 243 239 for likely more than \$50.

To DIY, you'll need:

- a pair of horns like Hella 3FG 002 924-021 or Fiamms from the local auto store, or ...
- a second horn (remember one high, one low), \$5 used ones can often be rebuilt.
- at least 5 female spade connectors w/ catch
- two loop connectors for ground and power connections
- in-line fuse
- heat shrink tubing (black, brown and red)
- solder and gun
- relay block (see bottom of cross-references)
- 30-amp relay with diode or resistor between 85-86 (one on left)
- 60cm of 14ga wiring
- 70cm of 16ga wiring (or 40cm of 16/2 lamp cord)

The red 60cm 14ga wire runs from an insulated loop connector at the battery, thru a fuse, to 30 at the relay block. The brown 30cm 16ga wire runs from a loop connector grounded at the ignition coil mount to 85 at the block. Two black 20cm 16ga wires split from a single connector at 87 to their respective horn connectors. The stock BR/WS wire usually has a catch that will plug directly into 86 at the block. With some heat shrink tubing, make sure to cover the 30 wire and it's loop connector red, ground brown and the horn connectors black so they're easily identified and or less prone to accidental grounding.

Hope it helps.

Joe 'Cuda' #3335

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