

The Complete *Beams* 3S-GE Wiring Guide

By James Seal (jamesrseal@gmail.com)

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[1. Disclaimer](#)

[2. Acknowledgements](#)

[3. Background](#)

[4. Assumptions](#)

[4.1. Harness Identification and Obvious Differences](#)

[5. Wire Colors](#)

[6. Grounds](#)

[7. ECU Connections](#)

[7.1. Pin Color Codes](#)

[7.2. P Connector](#)

[7.3. O Connector](#)

[7.4. Q Connector](#)

[7.5. N Connector](#)

[7.6. Relays, Fuses, and Junction Blocks](#)

[7.6.1. Fuse Boxes With Relays](#)

[7.6.2. Power Distribution Fuse Block](#)

[7.6.3. Junction Blocks](#)

[7.7. ECU Connections With Relays](#)

[7.7.1. Relays Triggered by the ECU or Ignition Start](#)

[7.7.1.1. EFI Relay](#)

[7.7.1.2. Starter Relay](#)

[7.7.2. Relays Triggered by Switched Ignition Power](#)

[7.7.2.1. Ignition Relay](#)

[7.7.2.2. Coils Relay](#)

[7.7.2.3. Injectors Relay](#)

[7.7.3. ECU Circuit Opening Relay](#)

[7.7.3.1. Circuit Opening Relay Function](#)

[7.7.3.2. Circuit Opening Relay Trigger 2 - MAP Sensor & Non Flap Type Air Flow Meter Equipped Engines](#)

[8. Additional Connections](#)

[8.1. BA1 Connector](#)

[8.2. BA2 Connector](#)

[8.3. J4 Connector](#)

[8.4. D and m Connectors](#)

[8.5. Connections With Constant Power](#)

[8.6. DLC3 Connector](#)

[8.7. Alternator](#)

[8.8. Oxygen Sensor](#)

[8.9. Vehicle Speed Sensor](#)

[8.9.1. Solution 1: Using a Dakota Digital Universal Speedometer Signal Interface](#)

[8.9.2. Solution 2: Bypassing the Vehicle Speed Sensor](#)

[9. Conclusion](#)

[10. Appendix](#)

[10.1. Part Numbers](#)

[10.2. Replacement Connectors](#)

[10.3. Wire Gauges](#)

[10.4. Fan Relay](#)

[11. Changelog](#)

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2. Acknowledgements

Lu Malave, the first person to introduce me to BEAMS swapping a Corolla. Thank you for answering all of my initial questions and inspiring me to swap my TE72.

Corax (<https://www.celica-gts.com/forums/index.php?topic=30239.0>) for providing a marked-up copy of the BEAMS ECU pinouts and connectors that allowed me to complete my motor swap.

Devin Crezee (<https://doctoredgarage.com>) for providing a clean copy of the BEAMS ECU pinouts and a quick reference guide to get a BEAMS running in an AE86 chassis. Additionally, for providing insightful conversation covering myriad technical topics.

- <https://doctoredgarage.files.wordpress.com/2019/06/beams-3sge-blacktop-wiring-diagrams.pdf>
- <https://doctoredgarage.files.wordpress.com/2019/06/blacktop-beams-3sge-to-ae86-wiring-v1.1.pdf>

SQ Engineering for providing additional workshop and wiring information.
(<https://www.sq-engineering.com/tech-articles/wiring-diagrams-and-diagnosis/>)

Wilbo666 (<http://wilbo666.pbworks.com/w/page/116359153/Wiki%20-%20wilbo666>) for providing detailed explanations of Toyota's Circuit Opening Relay and Speed Sensor wiring as well as making a colored table of JDM to English wire colors.

- <http://wilbo666.pbworks.com/w/page/43601637/Circuit%20Opening%20Relay>
- <http://wilbo666.pbworks.com/w/page/54771723/Toyota%20Speed%20Sensors>
- <http://wilbo666.pbworks.com/w/file/52754128/20160811%20JDM%20to%20English%20Wiring%20Colour%20Translations.jpg>

Mark Panic for being the first to document the difference between G1 and G3 / G5(?) coil wiring in the engine harness

(<https://www.facebook.com/groups/beams3sgeae86s/permalink/1881988902020622>) and inspiring me to dig deeper and do a more thorough comparison on my own.

Matt Ball for selling me a complete and unmolested G3 BEAMS engine harness.

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3. Background

My name is James, I have a 1981 Toyota Corolla (TE72) with a running 5th generation 3S-GE blacktop BEAMS (G1, manual transmission) motor swap that I wired by myself based on the information referenced within and using my own knowledge and experience.

- First start-up: <https://youtu.be/Yofznub0J8>
- Second start-up: <https://youtu.be/5cBJ5rXY-bQ>
- Warm idle: <https://youtu.be/1QGIdlEsu1Y>
- First drive: <https://youtu.be/XDO2dV2gmLE>

I decided to write this guide because in researching and doing the swap myself I didn't feel there was a truly complete guide that explained all of the necessary steps that needed to be done to get the motor running.

While all of the information anyone would need to get the motor running is freely available online (as evidenced above in the [acknowledgements](#)) I wanted to give back to the community and those that helped me with my project. This guide also serves as a reference manual for myself as it documents exactly how I wired my car.

My approach to wiring the car was to emulate the wiring approach of Toyota as much as possible. As a result, you may feel that I used more relays than necessary or made things overly complicated etc. All I can say is that this is what worked for me and in my opinion makes the wiring more robust and easier to troubleshoot because circuits are properly isolated, fused, and the wiring can be directly paired to the stock Toyota diagrams I'll be referencing.

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4. Assumptions

For anyone using this guide I have made several assumptions that may or may not be applicable to your specific situation. In the event your situation differs from the assumptions I have made, it does not preclude you from using the information in this guide to get your motor running, however everything I've written may not be 1-1 applicable.

My assumptions for this guide are as follows:

- You have a G1, G3, or G5 3S-GE Blacktop BEAMS motor. **Your coils are matched to your ECU, are matched to your engine harness!**

Engine	ECU	Coil Packs
G1	89661-53070	90919-02236
G3	89661-53151	90919-02239
G5	89661-53510	90919-02239

It may be possible to use G3 and G5 ECUs and engine harnesses interchangeably but I was not able to probe and compare a G5 harness (as of January 2023) and thus can only make a comparison between G1 and G3 harnesses. Additionally, because I only have access to a G1 and G3 harness I cannot claim that the G3 and G5 harness are exactly the same. As a result, I am purposely putting a question mark (?) after G5 when I refer to pins and wire colors in this guide.

Finally, a matched set of G1, G3 or G5 ECU, coils, and harness can be put on a G1, G3, G5 engine without issue. Or more simply, the wires care what they plug into, they don't care what motor those plugs happen to be on.

The ECU must be matched to the coils, must be matched to the harness because:

1. There are differences in the coil's properties between G1 and G3/G5 engines. The ECU is calibrated to expect certain resistances and dwell times from the coils and this is why the coils and the ECU must be a matched set.
2. There are differences between G1 harness and G3 / G5(?) harness pin locations and wire signals/purposes.

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- You have a stock, working ECU and the associated male Gray BA1, Blue BA2 and White or Black J4 connectors that are normally housed in the ECU box of the stock Altezza engine bay. It is possible to use this guide without the male BA1, BA2, and J4 connectors however it is your responsibility to ensure the necessary signals and power are getting to the appropriate components on your engine harness.
- You have a decent understanding of wiring diagrams, circuit layouts, and wiring symbols.
- You know what a relay is and why you need one. If not, Google it.
- You have the necessary tools to tackle this type of wiring job. This includes (but is not limited to):
 - Wire (of the appropriate gauge for the circuit being run)
 - Fuses
 - Relays
 - Wire cutters/strippers
 - Wire connectors & crimpers ([NO SOLDERING!](#))
 - A multimeter to check voltages and continuity (Check your connections, don't just assume they are correct even if you use this guide!)

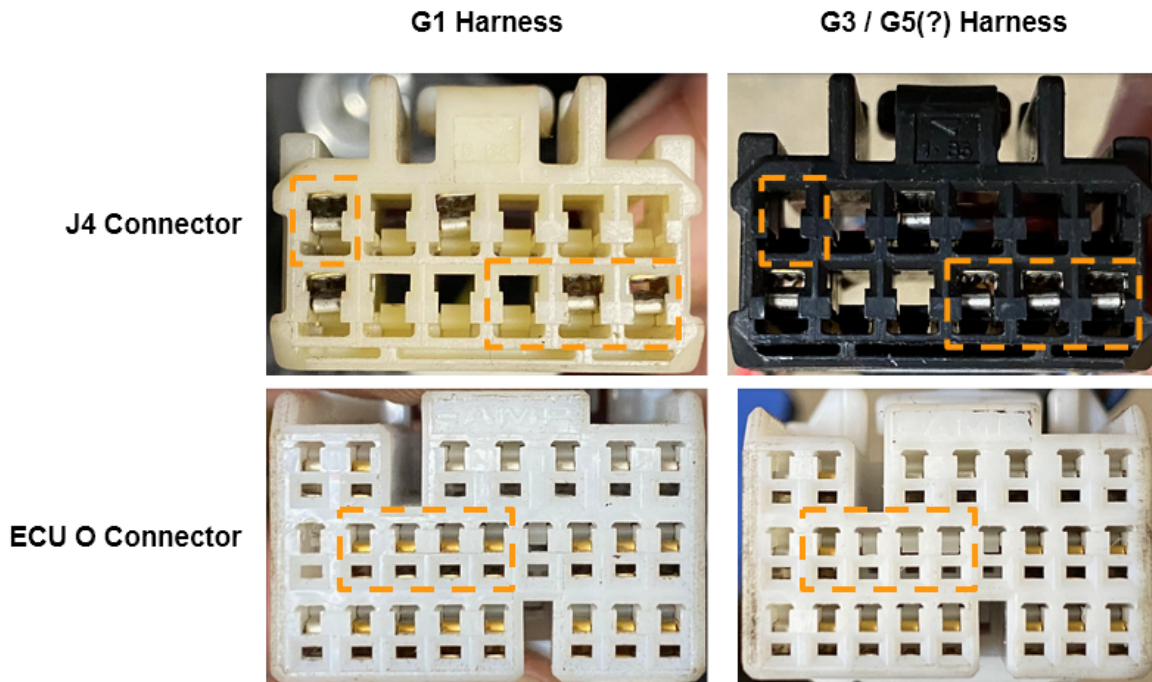
Finally, this wiring guide is intended to be vehicle indifferent. While many people swap BEAMS motors into AE86s or other Toyotas this guide makes no assumptions about the vehicle you will be putting the motor into.

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4.1. Harness Identification and Obvious Differences

This information is based on my comparison of a G1 engine harness (that is installed and used to run my engine) and a G3 engine harness that has been unmodified.

Based on my observations (and other anecdotal evidence from the internet) the two obvious visual differences between a G1 and G3 / G5(?) harness are as follows:



1. J4 Connector
 - a. G1 engine harnesses have a white J4 connector while G3 / G5(?) engine harnesses have a black J4 connector.
 - b. The position and number of pins in the J4 connector is different between a G1 engine harness and G3 / G5(?) engine harness.
2. ECU O Connector
 - a. Pins 10 - 12 are not present in the ECU O connector for G3 / G5(?) engine harnesses. In a G3 / G5(?) engine harness all four ION signals to the coils share a common signal coming from Pin 9. In contrast, A G1 engine harness has four individual pins (9 - 12) and wires for the ION signal to each coil.

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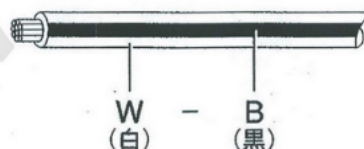
Based on this information, a visual inspection should be sufficient to ensure that you have the correct engine harness to use with either a G1 ECU and coils or a G3 / G5(?) ECU and coils.

As stated previously, because I only have access to a G1 and G3 harness I cannot claim that the G5 harness is exactly the same.

5. Wire Colors

Toyota uses the following abbreviations to indicate wire colors:

ABBR.	COLOUR	SYMBOL
B	BLACK	黒
BR	BROWN	茶
DG	DARK GREY	濃灰
G	GREEN	緑
GR	GREY	灰
L	BLUE	青
LG	LIGHT GREEN	黄緑
O	ORANGE	橙
P	PINK	桃
R	RED	赤
SB	SKY BLUE	空色
V	VIOLET	紫
W	WHITE	白
Y	YELLOW	黄



例：W - B

Example: W-B indicates a white wire with a black trace (stripe).

The table is borrowed from wilbo666's wiki.

<http://wilbo666.pbworks.com/w/file/52754128/20160811%20JDM%20to%20English%20Wiring%20Colour%20Translations.jpg>

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6. Grounds

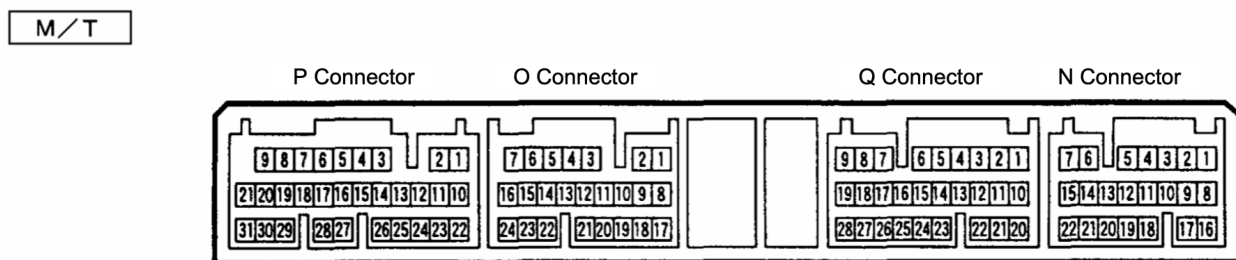
Before even beginning with ECU connections make sure you have good grounds between the:

- Battery negative to chassis
- Engine block to chassis
- Engine head to chassis
- Engine block to engine head
- Starter to engine block
- Transmission to chassis

Use good, thick cables for your grounds. Avoid the hassle of chasing wiring gremlins and know you have grounded everything appropriately. Don't skip this step!

7. ECU Connections

For manual transmission cars there are four connectors that plug into the ECU (N, O, P, Q) as shown below. Again, I'm assuming you have a fairly unmolested wiring harness that came with your motor.



Engine control computer terminal configuration

Also keep in mind, when looking at the ECU (the male side) the pins are counted from right to left. However, when looking at the face of the connector (the female side) the terminal numbers count from left to right.

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7.1. Pin Color Codes

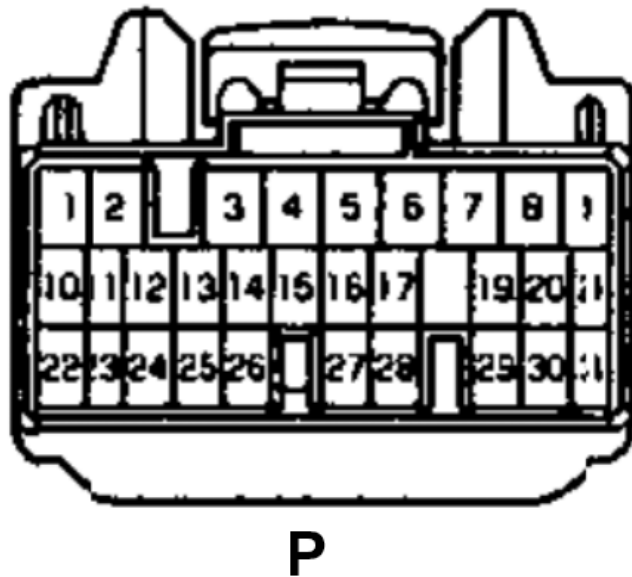
Building off the work of SQ Engineering I have labeled all of the ECU pins with their function and wire color in the tables below. If a pin is left blank then there was never a wire there from the factory (keep in mind I'm talking about a car with a manual transmission, automatic G2 and G4 motors are different).

- Pins highlighted in **GREEN** **ARE NECESSARY FOR THE MOTOR TO RUN!** While many of these pins require no intervention, and are correctly connected when the harness is plugged into the ECU and sensors on the motor, it is still important to check that the connections are not broken in the harness and the grounds are properly connected.
- Pins highlighted in **YELLOW** are not necessary for the motor to run but are advised to connect. Otherwise you may have a check engine light or engine code but you won't be able to diagnose anything because you didn't wire up the check engine light or diagnosis connector in the first place...
- Pins highlighted in **RED** can be ignored. De-pinning the wires from the ECU is the preferred method to ensure that you don't accidentally ground a pin to the chassis and fry your ECU. It also makes for a cleaner, more professional looking installation.
- Pins outlined in **ORANGE** are different between G1 harnesses and G3 / G5(?) harnesses. Take special care with these pins when reading this guide and applying the information to your harness.
- All other non-highlighted (i.e. White) pins are necessary for the motor to run but require no intervention. As with the green highlighted pins, it is still important to check that the connections are not broken in the harness and the grounds are properly connected.

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7.2. P Connector

There is no difference in pins or wires on the ECU P connector between G1 and G3 (and possibly G5) engines.



ECU PIN #	Function	Wire Color
		G1 / G3 / G5(?)
P1	Injection signal #10	R
P2	Injection signal #20	L
P3	Injection signal #30	G
P4	Injection signal #40	R-W
P5	Variable intake control VSV, ACIS	Y-G
P6	Power, Engine stopped IG ON BM+	L-W
P7	Canister purge VSV, PRG	GR
P8	Ground ME01	BR
P9	Ground GE01	S
P10	Ignition signal IGT1	B-L
P11	Ignition signal IGT2	BR-R
P12	Ignition signal IGT3	BR-W
P13	Ignition signal IGT4	L-R
P14		
P15	Power steering pressure switch PSW	L-Y
P16	Inlet temperature sensor, THA	W-R
P17	Water temperature sensor, THW	R-W
P18		
P19	Throttle motor M+	B-W
P20	Throttle motor clutch CL+	R
P21	Ground E01	W-B
P22	Alternator Regulator output RL	B-R
P23		
P24		
P25		
P26		
P27	Knock sensor output KNK	B
P28	Oxygen sensor OX1A	W
P29	Throttle Motor M-	L
P30	Throttle motor clutch CL-	Y
P31	Ground E02	W-B

If you are missing the Gray BA1, Blue BA2, or White / Black J4 connectors that normally live in the ECU box on the stock Altezza ensure you have a battery positive signal going to Pin P6 and ensure Pins P8, P9, P21, and P31 are grounded.

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7.3. O Connector

Note Pins 10 - 12 are not present in the ECU O connector for G3 / G5(?) engine harnesses compared to a G1 engine harness. In a G3 / G5(?) engine harness all four ION signals to the coils share a common signal coming from Pin 9. In contrast, A G1 engine harness has individual pins (9 - 12) and wires for the ION signal to each coil. This is the only difference in pins or wires on the ECU O connector between G1 and G3 (and possibly G5) engines.



O

ECU PIN #	Function	Wire Color	
		G1	G3 / G5(?)
O1	Airflow meter EVG	Y	Y
O2	Throttle/Acceleration position sensor VC	L-Y	L-Y
O3	Oxygen sensor heater HT1A	R-W	R-W
O4	Intake VVT signal OCV-	Y-B	Y-B
O5	Intake VVT signal OCV+	W-R	W-R
O6	Exhaust VVT signal OCV2-	GR-B	GR-B
O7	Exhaust VVT signal OCV2+	GR	GR
O8	Air conditioner clutch lock sensor LCK1	W-L	W-L
O9	Ignition signal ION1	L-R	L-R
O10	Ignition signal ION2	W	
O11	Ignition signal ION3	G-R	
O12	Ignition signal ION4	B	
O13			
O14	Exhaust Revolution signal GEX	Y	Y
O15	Intake Revolution signal G2+	G	G
O16	Revolution signal NE+	B-W	B-W
O17	ECU Ground E1	BR	BR
O18	ECU Ground E2	BR	BR
O19	Accelerator position sensor VPA2	L-W	L-W
O20	Accelerator position sensor VPA	G-B	G-B
O21	Airflow meter VG	R	R
O22	Throttle position sensor VTA2	R-B	R-B
O23	Throttle position sensor VTA	Y-G	Y-G
O24	Revolution signal NE-	L	L

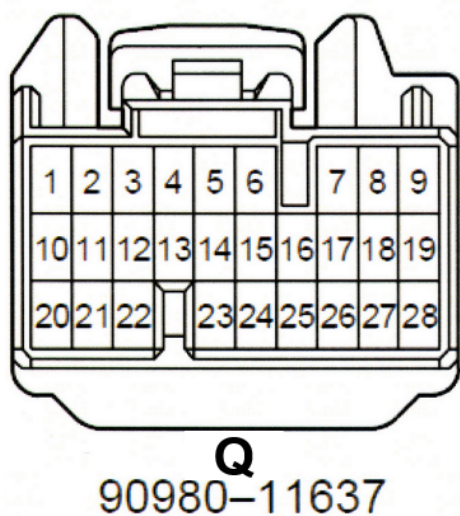
If you are missing the Gray BA1, Blue BA2, or White / Black J4 connectors that normally live in the ECU box on the stock Altezza ensure Pins O17 and O18 are grounded.

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7.4. Q Connector

None of the Here's what you're missing by not connecting the optional pins in the Q connector:

- Without a speed signal going into Q19 you will get a VSS code. Solutions to this issue are presented in the [Vehicle Speed Sensor](#) section.
- Without Q24 going to the DLC3 connector you won't be able to scan any codes from the motor.
- Without Q26 you won't have a tachometer signal.
- Without Q28 you may have minor issues cold starting the motor.



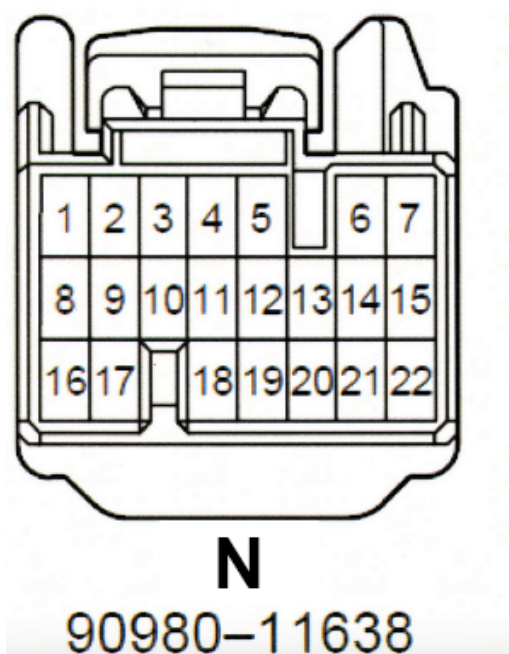
ECU PIN #	G1		G3 / G5(?)	
	Function	Wire Color	Function	Wire Color
Q1	Air conditioner relay AMCG	L-W	Air conditioner relay AMCG	B
Q2			Unknown	G-W
Q3			Unknown	B
Q4				
Q5			Unknown	Y-G
Q6				
Q7				
Q8				
Q9				
Q10	Oxygen sensor OX2A	W	Oxygen sensor OX2A	B
Q11	Oxygen sensor heater HT2A	R-W	Oxygen sensor heater HT2A	R-L
Q12				
Q13				
Q14	Outside temperature sensor TAM	LG-R	Outside temperature sensor TAM	LG-R
Q15				
Q16				
Q17	ABS ECU comms NEO	G	ABS ECU comms NEO	G
Q18				
Q19	Speed sensor output SPD	W-L	Speed sensor output SPD	W-L
Q20				
Q21				
Q22				
Q23				
Q24	Test Terminal TC	Y-G	Test Terminal TC	Y-G
Q25				
Q26	Tachometer output TACO	B	Tachometer output TACO	B
Q27	Alternator Stop Switch STP	G-W	Alternator Stop Switch STP	G-W
Q28	Starter relay signal input STA+	B	Starter relay signal input STA+	B

In comparing my G1 engine harness and an unmolested G3 harness I observed three additional pins and wires in the G3 / G5(?) harness (Pins 2, 3 and 5 in the Q connector). I was unable to determine what these three additional wires are for as they are not referenced in the attached wiring diagram and they do not connect to a sensor or plug on the engine.

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7.5. N Connector

The N connector has fewer unnecessary/optional wires. You can get away with not connecting Pin N7 and N11 but again you won't be able to monitor a check engine light or diagnose any error codes because N7 is the ground for the check engine light and N11 is the communication signal to the DLC3 connector.



ECU PIN #	Function	Wire Color
		G1 / G3 / G5(?)
N1	Constant power BATT	B-Y
N2		
N3	Circuit opening relay ECU switched power FC	G-Y
N4	Cooling fan relay FAN	L-B
N5	Body multiplex communication MPX1	O
N6	Air conditioner pressure switch PRE	L-Y
N7	Check engine warning W	R-L
N8	Power with ignition on from EFI relay B1+	B-R
N9		
N10	Switched Ignition Power IGSW	B-R
N11	Diagnosis communication SIL	W
N12	Body multiplex communication MPX2	L
N13	ABS ECU comms ENG-	P
N14	ABS ECU comms ENG+	L-R
N15	ECU Ground EC	W-B
N16	Power with ignition on from EFI relay B+	B-R
N17		
N18	Transmission shift switch SFTU	GR-R
N19	Transmission shift switch SFTD	GR-G
N20	ABS ECU comms TRC-	W-G
N21	ABS ECU comms TRC+	R-Y
N22	EFI main relay switched power MREL	B-O

In the following sections I'll show you exactly how/where to connect all of the yellow and green highlighted pins from Connectors P, O, Q and N, in addition to the important connections from the Gray BA1, Blue BA2, and White / Black J4 connectors.

If you don't have the Gray BA1, Blue BA2, and White / Black J4 connectors with your harness you will have to make sure the appropriate components (coils, injectors, etc...) are receiving power or ground as necessary.

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7.6. Relays, Fuses, and Junction Blocks

For reference, I'm listing some of the components I used to create my power distribution panel. Assuming your car was not fuel injected to begin with you will have to add new circuits for the coils, injectors, circuit opening relay (COR) and other components. If your car was already fuel injected you should be able to modify the existing circuits for the coils, injectors, fuel pump, etc to work with the motor. However, before adapting any existing wiring you should confirm the wiring is adequate for the load it will carry.

7.6.1. Fuse Boxes With Relays

I used two HT-030201 fuse boxes from Haltech. I chose these because they are well made, compact and contain spaces for six, five-pin relays. I used two because I added more than six circuits (however I'm not going to describe them all here because some of them are unique to my application and have nothing to do with getting the motor to run).



<https://www.haltech.com/product/ht-030102-6-circuit-haltech-fuse-box-with-lid/>

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7.6.2. Power Distribution Fuse Block

I used one Dorman 85668 fuse block to distribute constant power to the ECU, alternator, and DLC3 connector.



<https://www.amazon.com/gp/product/B000CO7I04/>

7.6.3. Junction Blocks

I used these junction blocks to distribute power and ground wires to all of the triggered relay circuits in addition to other circuits that exist in the car's body harness.



<https://www.amazon.com/gp/product/B07C4W7YKG/>

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7.7. ECU Connections With Relays

This section will cover all circuits that are powered by a relay. Some relays are triggered by signals from the ECU and some relays are triggered by power signals from the ignition cylinder when it is in the start or run position.

All of the relays and circuits in this guide are named to match the titles on the Toyota wiring diagram found at the end of this guide.

7.7.1. Relays Triggered by the ECU or Ignition Start

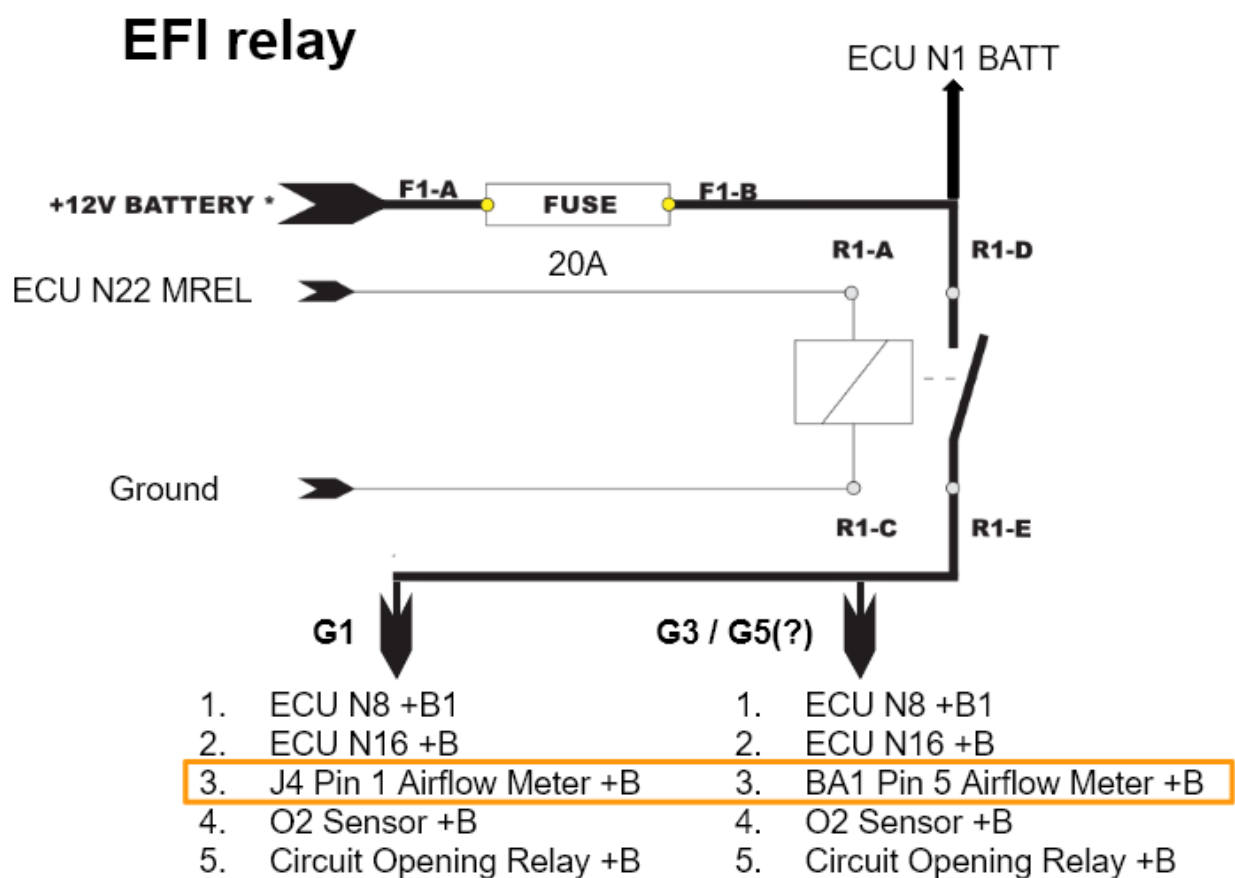
This section will cover circuits with relays that are triggered by power signals from the ECU, ground signals from the ECU or a power on start signal from the car's ignition cylinder.

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7.7.1.1. EFI Relay

The EFI relay is positive triggered by the ECU from Pin N22. The EFI relay provides power to the ECU's Pin N8 and N16 as well as power to the airflow meter, oxygen sensor and the [Circuit Opening Relay \(COR\)](#).

Additionally, the same power source supplying power to all of the components triggered by the EFI relay also supplies constant power to ECU Pin N1. This is a constant power source and is powered regardless of the trigger signal from the ECU Pin N22.



Pay careful attention to how you supply power to your airflow meter depending on your harness.

- G1 - The airflow meter gets power from Pin 1 of the J4 connector.
- G3 / G5(?) - The airflow meter gets power from Pin 5 of the BA1 connector.

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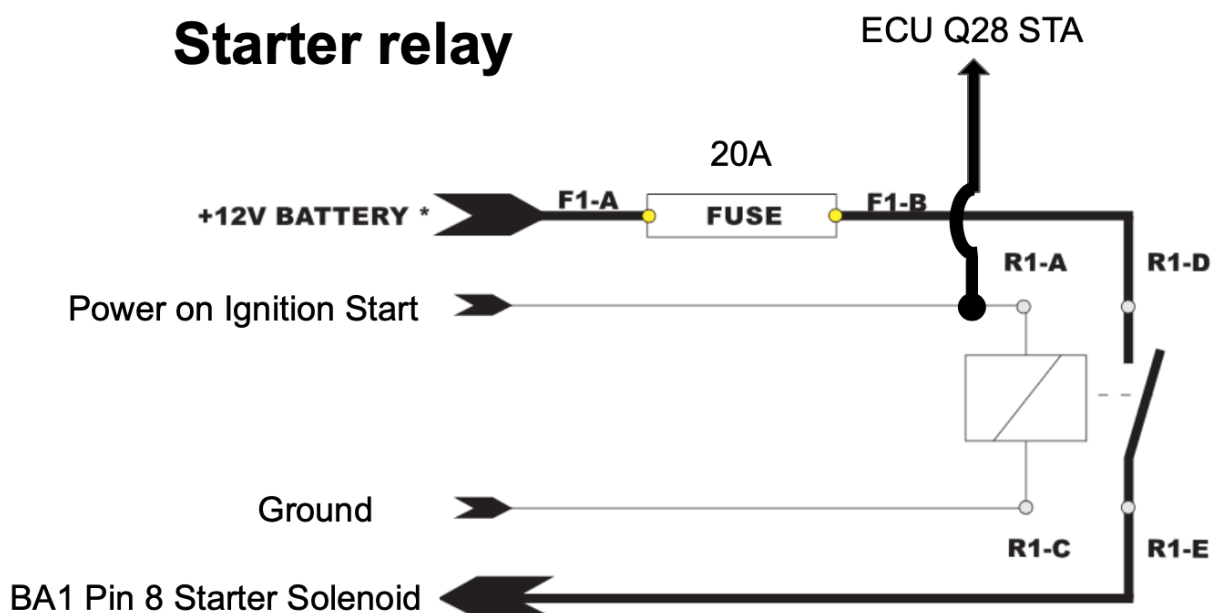
7.7.1.2. Starter Relay

Most cars are already wired to include a starter relay. However, if your car was not originally wired with one (like mine was) it is important to add one to mirror the wiring of the stock motor and to preserve your ignition cylinder contacts.

The starter relay is positive triggered by the ignition cylinder when the ignition is in the start position (not the run position!). The starter relay provides power to the starter solenoid, activating the starter motor and cranking the engine.

Note that the same trigger source activating the starter relay also supplies power to the ECU on Pin Q28.

If your car already had a starter relay you can connect the original triggered power output to the BEAMS starter solenoid and tee off of the original starter relay trigger wire to connect to Pin Q28 of the ECU.



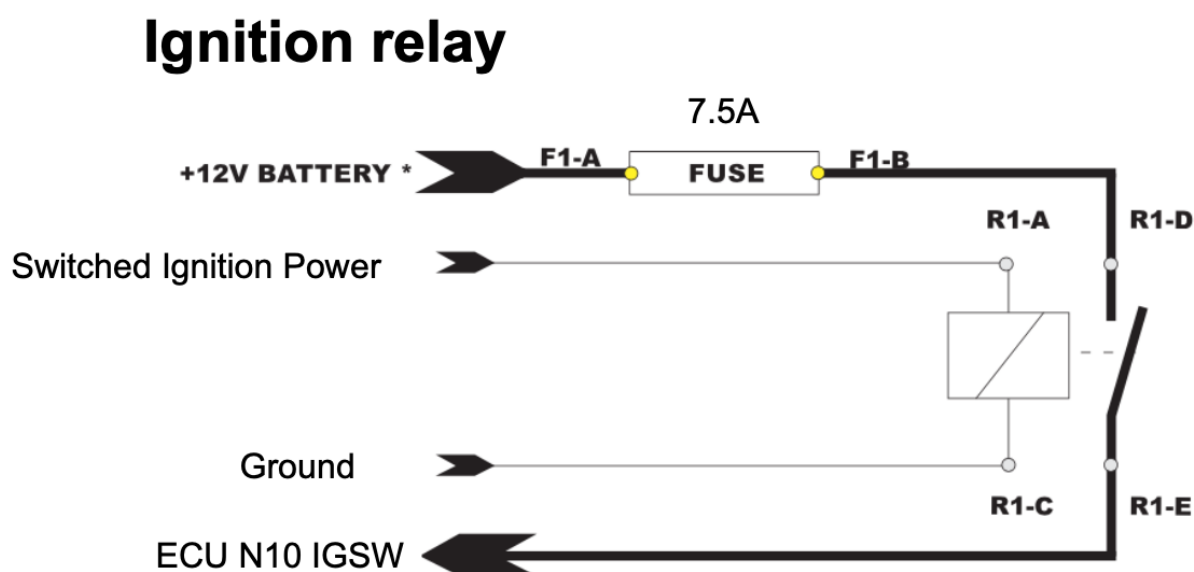
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7.7.2. Relays Triggered by Switched Ignition Power

All of the relays in the following section are triggered by the same switched ignition power wire coming from the ignition cylinder. Any wire that is powered when the ignition is in the run position (not the start position!) should work for these circuits. However, be mindful to not use a circuit that is powered when the ignition is in the accessory position as it may lead to premature battery drain or serious safety hazards.

7.7.2.1. Ignition Relay

The ignition relay is positive triggered by the ignition cylinder when the ignition is in the run position. The ignition relay provides power to the ECU on Pin N10.

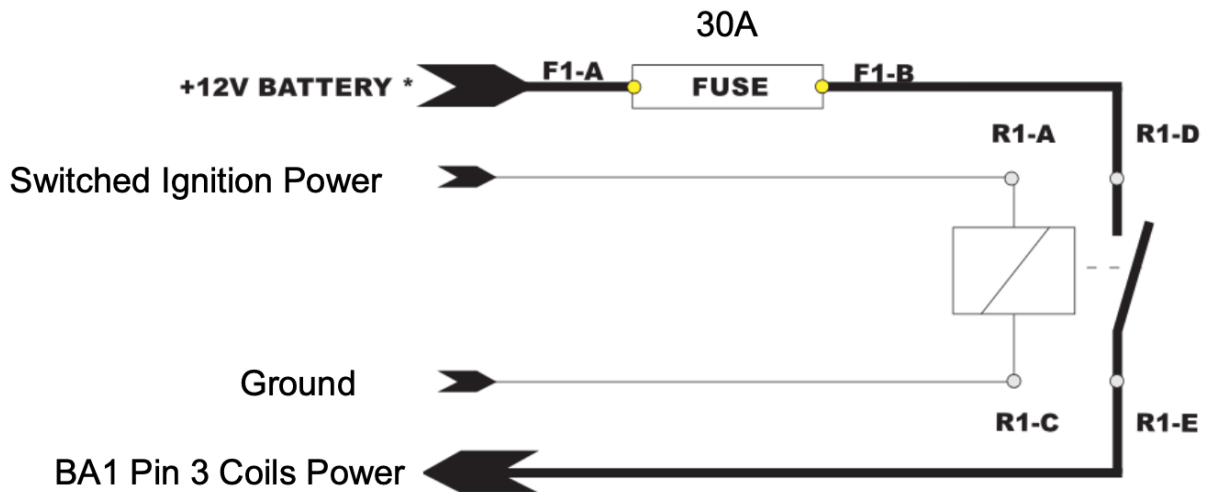


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7.7.2.2. Coils Relay

The coils relay is positive triggered by the ignition cylinder when the ignition is in the run position. The coils relay provides power to the ignition coils when the car is running.

Coils relay

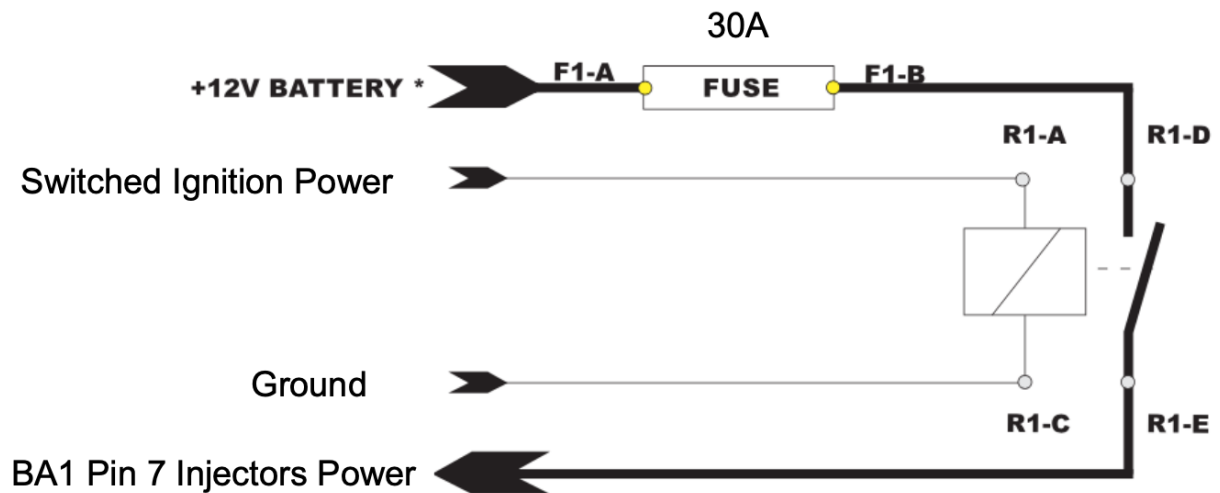


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7.7.2.3. Injectors Relay

The injectors relay is positive triggered by the ignition cylinder when the ignition is in the run position. The injectors relay provides power to the fuel injectors when the car is running.

Injectors relay



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7.7.3. ECU Circuit Opening Relay

The circuit opening relay (COR) is much like a normal relay, however it has two 'triggers', either of which can be used to turn the COR on and switch power to the fuel pump. The COR is triggered by both power on ignition start and by power from the EFI relay.

For my application I used a circuit opening relay from a 1998-2004 Toyota Tacoma, Toyota part number 85910-33010. However, any 5 pin Toyota circuit opening relay should be fine.

The content in this section is taken from wilbo666's wiki and repeated below (<http://wilbo666.pbworks.com/w/page/43601637/Circuit%20Opening%20Relay>).

7.7.3.1. Circuit Opening Relay Function

"The function of the COR is to switch power to the fuel pump when the engine is running or being started. Having power to the fuel pump only when the engine is being started or is running is a safety feature.

An example of an event in which the COR would disconnect power to the fuel pump would be an accident, where:

- The driver is unconscious (and hence the ignition has been left on)
- The engine has stalled
- The fuel line has been ruptured

In this scenario the COR will be controlled to turn the fuel pump off (as the engine is not running) and this will stop fuel from leaking at high pressure from the ruptured fuel line. This is a desirable (and legally required) safety feature that would not exist if the fuel pump was wired to come on directly with the ignition.

7.7.3.2. Circuit Opening Relay Trigger 2 - MAP Sensor & Non Flap Type Air Flow Meter Equipped Engines

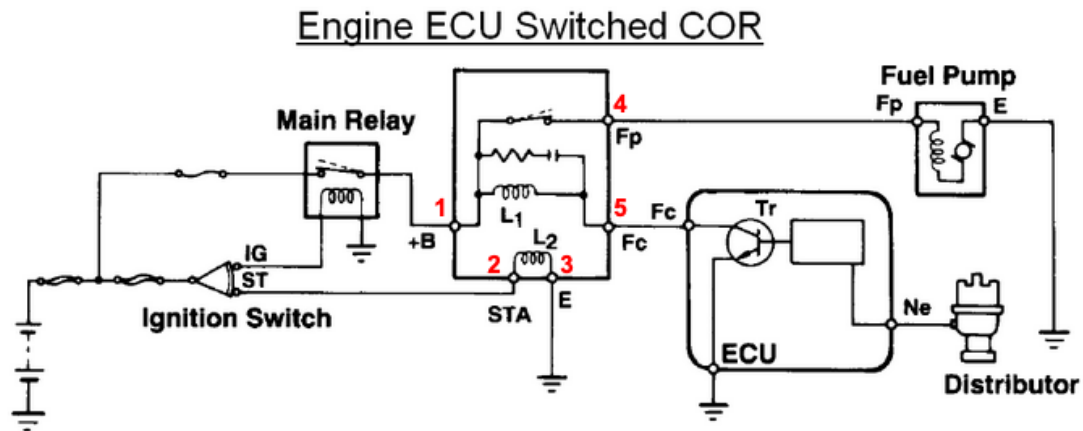
In cars without flap type AFMs the engine ECU detects the engine speed (via the distributor or crank angle sensor, etc) and the engine ECU has a dedicated output pin (Usually labeled FC in Toyotas) that is connected to ground inside the engine ECU (via a transistor), to turn the COR on when the engine ECU determines that the engine is running.

When the ECU determines that the engine is not running the ECU FC output is turned off which causes the COR to turn off and the fuel pump to be turned off."

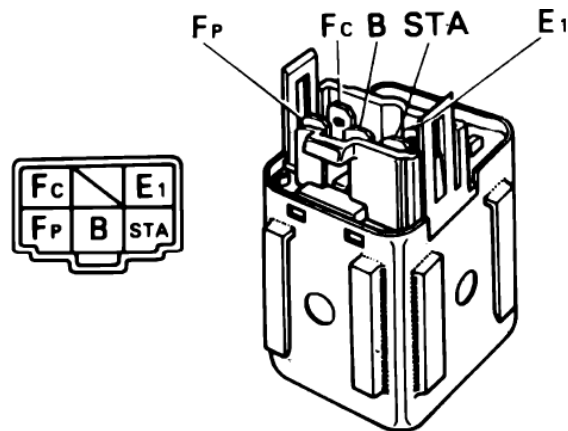
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To correctly wire in a COR to your BEAMS engine do the following:

1. Connect a triggered output of the EFI relay to +B of the COR
2. Connect a positive trigger from the ignition cylinder when it is in the start position to STA
3. Connect E to ground
4. Connect FP to the positive input of your fuel pump
5. Connect FC to ECU Pin N3



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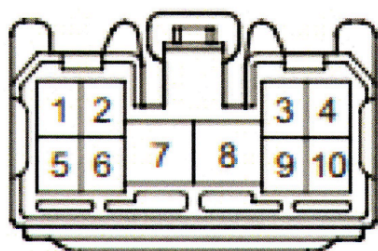


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8. Additional Connections

There are three additional junction connectors in the ECU box which need to be addressed in order to get the engine running. As stated previously, I'm assuming your motor came with these connectors. If it didn't, it is still possible to wire your motor following this guide but you must pay special attention and make sure you supply power to the airflow meter, alternator, transmission reverse light switch, and transmission speed sensor.

8.1. BA1 Connector



Gray BA1
90980-11527

BA1 Pin #	G1		G3 / G5(?)	
	Function	Wire Color	Function	Wire Color
1	Oil Pressure Sensor	Y-B	Oil Pressure Sensor	Y-B
2	Linked to BA1 Pin 6	B	Linked to BA1 Pin 6	B
3	Coils Power	B-W	Coils Power	B-W
4	Ground	BR	Airflow Meter +B	B-R
5	A/C Clutch	P	A/C Clutch	P
6	Linked to BA1 Pin 2	B	Linked to BA1 Pin 2	B
7	Injectors Power	B-R	Injectors Power	B-R
8	Starter Solenoid	B-Y	Starter Solenoid	B-Y
9	7.5A Alternator (S) wire	W-L	7.5A Alternator (S) wire	W-L
10	ECU P28 Oxygen Sensor OX1A	W	ECU P28 Oxygen Sensor OX1A	W

- Pin 1 is the signal from the stock Altezza oil pressure gauge.
- Connections to Pin 3, Pin 7 and Pin 8 are addressed in the [Coils Relay](#), [Injectors Relay](#), and [Starter Relay](#) sections respectively.
- Pin 4 differs between G1 and G3 / G5(?) harnesses:
 - G1 - Pin 4 should be grounded.
 - G3 / G5(?) - Pin 4 should be connected to switched power from the EFI Relay to supply power to the airflow meter
- Pin 9 is addressed in the [Connections with Constant Power](#) section.
- If you install an oxygen sensor in your car (you absolutely should) the output of the oxygen sensor is connected to BA1 Pin 10 which is then connected to ECU Pin P28.

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8.2. BA2 Connector

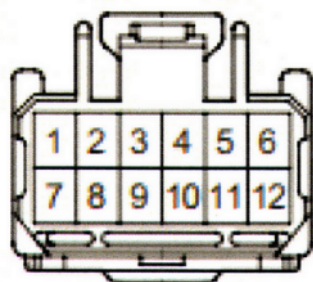


BA2 Pin #	G1		G3 / G5(?)	
	Function	Wire Color	Function	Wire Color
1				
2	ECU P6 15A ETCS +B	L-W	ECU P6 15A ETCS +B	L-W
3	Speed Sensor Power - Connected to J4 Pin 11	R-L		
4				
5			Airflow Meter Ground	BR
6	Speed Sensor Ground	R	Speed Sensor Ground	R
7				
8	Speed Sensor Output SP1	R-Y	Speed Sensor Output SP1	R-Y
9	ECU Oxygen Sensor HT1A	R-W	ECU Oxygen Sensor HT1A	R-W

- Pin 2 is connected to ECU Pin P6 and supplies constant power to the electronic throttle motor. The connection to Pin 2 is addressed in the [Connections with Constant Power](#) section.
- Pin 3 differs between G1 and G3 / G5(?) harnesses:
 - G1 - BA2 Pin 3 is connected to J4 Pin 11 and J4 Pin 12 via switched ignition to provide power to the speed sensor in the transmission.
 - G3 / G5(?) - Pin 3 is not used.
- Pin 5 differs between G1 and G3 / G5(?) harnesses:
 - G1 - Pin 5 is not used.
 - G3 / G5(?) - Pin 5 is connected to switched power from the EFI Relay and supplies power to the airflow meter.
- Pin 6 is the ground reference for the transmission speed sensor.
- Pin 8 is the transmission speed sensor output SP1. While the car will run without a speed signal input to ECU Pin Q19 you will get a VSS code. Approaches to converting the SP1 output of the speed sensor to an input that the ECU can accept on ECU Pin Q19 are discussed in the [Vehicle Speed Sensor](#) section.
- Pin 9 should be connected from the oxygen sensors heater ground circuit (HTL2) to ECU Pin O3.

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8.3. J4 Connector



J4

G1: White

G3 / G5(?): Black

90980-11661

J4 Pin #	G1		G3 / G5(?)	
	Function	Wire Color	Function	Wire Color
1	Airflow Meter +B	B-R		
2				
3	Transmission Reverse Light Switch Ground	R-B	Transmission Reverse Light Switch Ground	R-B
4				
5				
6				
7	Ground	BR	Ground	BR
8				
9				
10			Speed Sensor Power Connect to 10A switched ignition	R-L
11	Alternator Power Connected to J4 Pin 12 and BA2 Pin 3	R-L	Alternator Power Connect to 10A switched ignition	R-L
12	Transmission Reverse Light Switch Power (Internally Connected to J4 Pin 11) Connect to 10A switched ignition	R-L	Transmission Reverse Light Switch Power Connect to 10A switched ignition	R-L

- Pin 1 differs between G1 and G3 / G5(?) harnesses:
 - G1 - Pin 1 is connected to switched power from the EFI Relay and supplies power to the airflow meter.
 - G3 / G5(?) - Pin 1 is not used in harnesses. Instead Pin 5 of the BA2 connector supplies power to the airflow meter.
- Pin 3 is switched power for the reverse lights. When the transmission is shifted into reverse, power from Pin 12 flows through the transmission reverse switch and out Pin 3, powering your reverse lights.
- Pin 7 should be grounded.
- Pin 10 differs between G1 and G3 / G5(?) harnesses:
 - G1 - Pin 10 is not used in G1 harnesses. Instead Pin 3 of the BA2 connector supplies power to the speed sensor.
 - G3 / G5(?) - Pin 10 supplies power to the transmission speed sensor.

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- Pins 11 and 12 differ between G1 and G3 / G5(?) harnesses:
 - G1
 - Pins 11 and 12 are internally bridged in the J4 connector and are powered by a switched ignition source.
 - Pin 11 is the power supply to the alternator. Without switched ignition power to the alternator it will not charge the battery.
 - Pin 12 is the power supply to the transmission reverse light switch. A wire from the male end of the J4 connector on Pin 12 should be connected to a switched ignition power source. Upon ignition power, Pin 12 supplies power to Pin 11 as well as power to BA2 Pin 3 via a jumper wire.
 - G3 / G5(?)
 - Pins 11 and 12 should be powered by a 10A switched ignition source.
 - Pin 11 supplies power to the alternator. Without switched ignition power to the alternator it will not charge the battery.
 - Pin 12 supplies power to the transmission reverse light switch.

8.4. D and m Connectors

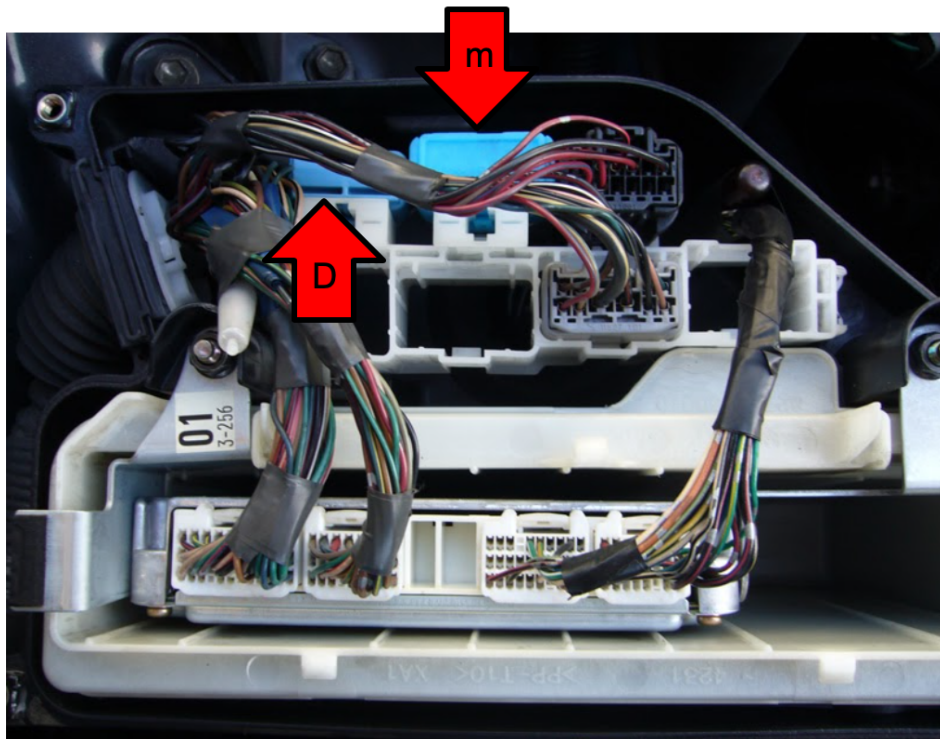
If your motor came with the stock ECU housing, in addition to the BA1, BA2 and J4 connectors you may also notice two additional blue connectors, the D and m connectors.

The D connector is a ground junction for ECU Pins O17 and P8 as well as shielded wires that isolate the following sensors on the motor:

- Oxygen sensor
- Crank position sensor
- Cam Position sensors
- VVT sensors
- Knock sensor

All wires in the D connector should be grounded! A single common ground can be connected from the D connector to the chassis ground to accomplish this.

The m connector is a junction that splits the ground trigger from ECU Pin N4 into separate wires in order to trigger Fan Relay No. 1, Fan Relay No. 2, and Fan Relay No. 3. The m connector is not used in this guide.

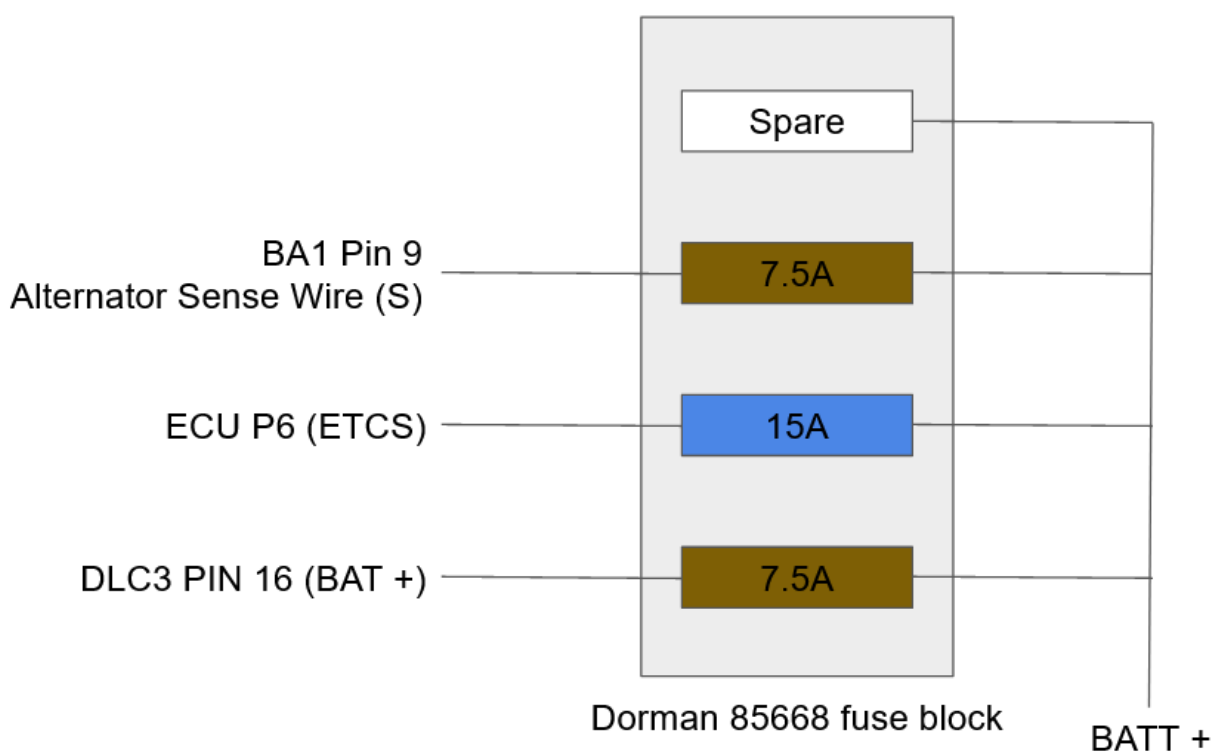


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8.5. Connections With Constant Power

There are three circuits in the BEAMS engine that require constant power. One for the ECU, one for the alternator, and one for the DLC3 connector.

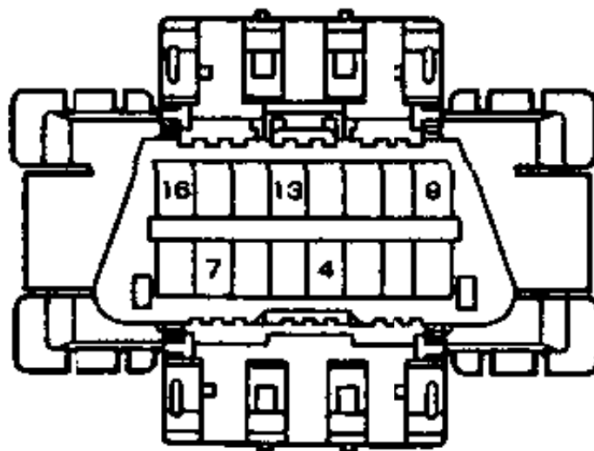
- Pin 16 of the DLC3 connector should be connected to battery positive through a 7.5A fused circuit. This provides power to the DLC3 connector.
- ECU Pin P6 should be connected to battery positive through a 15A fused circuit. This provides power to the electronic throttle motor.
- Pin 9 of connector BA1 is the alternator sense wire (S) and must be connected to battery positive through a 7.5A fused circuit. If you fail to do this your alternator will not measure battery voltage and will not charge the battery.



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8.6. DLC3 Connector

While the BEAMS motor does not use the traditional OBD (on board diagnostics) protocol it does use a variant called JOBD. By wiring a regular DLC (data link connector) as described below it is possible to read codes using a OBD bluetooth adapter and the Torque app for Android. Anecdotally, the OBD adapter by [Veepeak](#) has been reported to produce the most success.



- Pin 4 - Ground
- Pin 7 - ECU N11 SIL
- Pin 9 - ECU Q26 TACO
- Pin 13 - ECU Q24 TC
- Pin 16 - Battery positive, 7.5A fused circuit from engine fuse block

The information below is hosted on the BEAMS 3SGE AE86s Facebook page and was confirmed to work via input from Mathieu Bryan and Drew Atkins.

With the OBD port wired as shown above, Inside of the Torque app you can create car profiles for different vehicles. In the vehicle profile at the bottom of the profile page is a line that says *Very Advanced ELM327*. There is a line in that section to add text. Add the following text to that line:

```
attp4\n atia13\n atib96\n atsh8113f1\n atsw00\n atat
```

Once complete, hit *SAVE* and go back into the app. The app is now configured to read the JOBD protocol. With the app configured and your OBD 2 adapter plugged into the DLC 3 connector on your car, you can now read all of your engine data with the Torque app.

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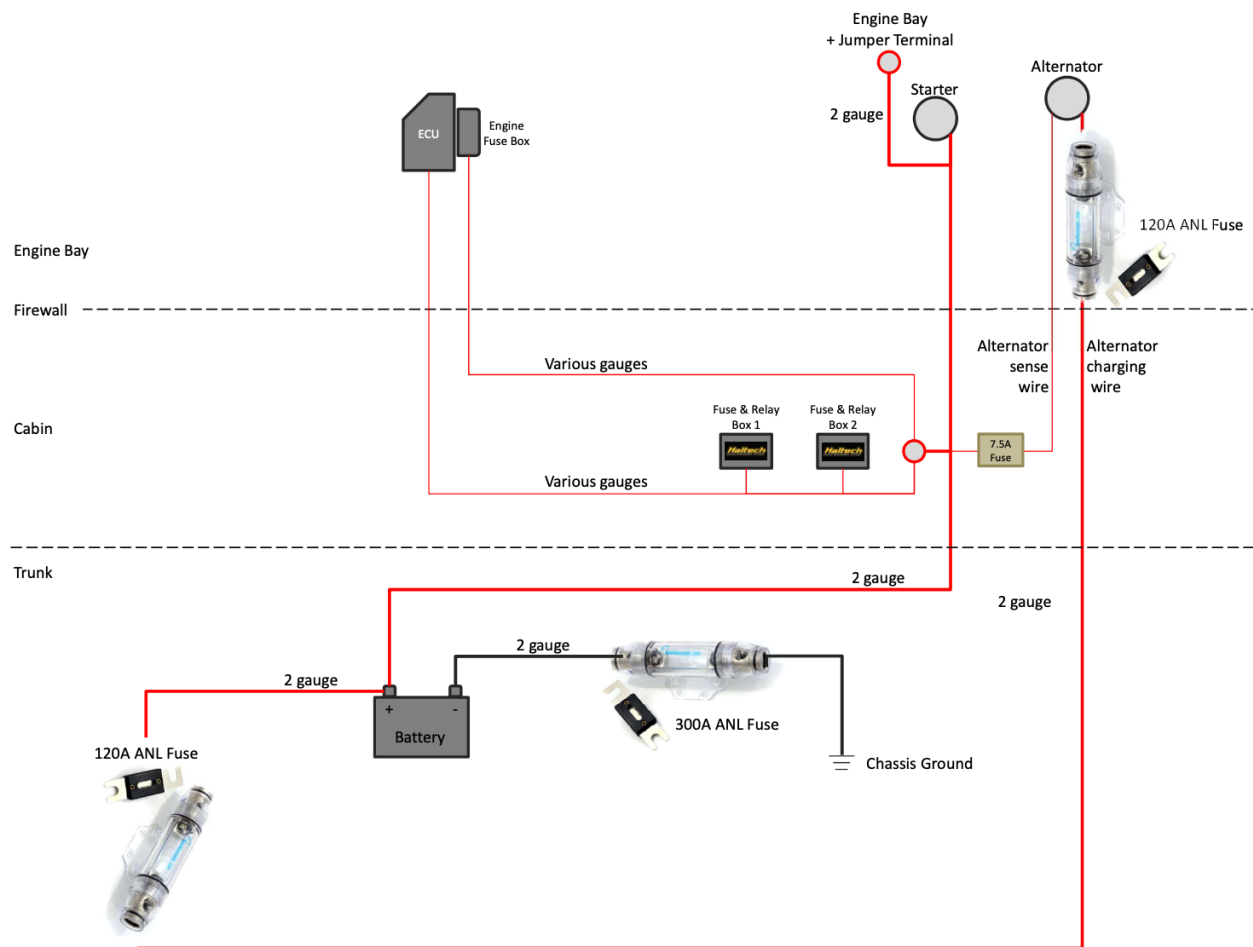
8.7. Alternator

I chose to relocate the battery to the trunk of my car because I mounted the stock Altezza ECU box in the battery's original location.

I used information from the following link to safely relocate my battery:

https://www.w8ji.com/safe_battery_installation_guidelines.htm

A schematic of my alternator circuit and the main power circuit is shown below. Your set-up may be different but I've included my approach for reference.



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A stock Altezza uses a 120A fuse to isolate the alternator charging circuit from the battery. This is confirmed by viewing the underside of the Altezza fuse box cover (pictured below).



Additional information about Toyota alternator wiring can be found on wilbo666's website here: <http://wilbo666.pbworks.com/w/page/39441708/Toyota%20Alternators>

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8.8. Oxygen Sensor

An oxygen sensor that's compatible with the BEAMS motor can be found here (any 4 wire Toyota oxygen sensor should work).

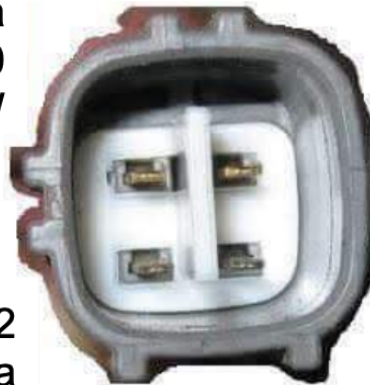
<https://www.amazon.com/Oxygen-Sensor-Lambda-Altezza-89465-53060/dp/B071NLHQR6>

The matching female connector can be purchased from Wiring Specialties here:

<https://www.wiringspecialties.com/usdm-4-pin-o2-sensor-connector/>

With the plug end of the oxygen sensor in the orientation shown below connect the matching wire from the female pigtail to the correct wire in the engine harness.

Sensor Signal OXL2
ECU Pin P28 (OX1A) via
BA1 connector Pin 10
Wire Color: W



Ground E1
Wire Color: BR

Heater Ground HTL2
ECU Pin O3 (HT1A) via
BA2 connector Pin 9
Wire Color: R-W

12V Battery Positive
Wire Color: B-R

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8.9. Vehicle Speed Sensor

Information about Toyota speed sensors can be found on wilbo666's wiki. I have modified the table on his wiki slightly in reference to the wire colors to be specific to the BEAMS motor.

<http://wilbo666.pbworks.com/w/page/54771723/Toyota%20Speed%20Sensors>

90980-11143 Toyota 3 Wire Speed Sensor



90980-11143

Pin	Symbol	Definition	Input / Output (To Sensor = Input) (From Sensor = Output)	Description	Wire Color
1	IGN	Sensor Power (Ignition Switched)	Input	This pin is used to supply ignition switched battery power (+12V) to the speed sensor. This pin needs to be connected to an ignition switched power source that supplies battery voltage when the ignition is in the Run and Start Positions.	R-B
2	GND	Sensor Ground	Input	This pin is used to supply the power ground for the speed sensor. This pin needs to be connected to ground.	R
3	SP1	Sensor Output	Output	This pin is used to output the speed signal that goes to the dash. The signal from this pin needs to be modified to become an input to ECU Pin Q19.	R-Y

You will get a VSS (vehicle speed sensor) error code if you don't have a VSS input to the ECU on Pin Q19. In addition to the VSS error code, without a VSS input to Pin Q19 of the ECU the VVTi and ignition timing tables will be more conservative (allegedly), resulting in reduced power. There are two solutions to getting a usable signal into ECU Pin Q19 to avoid a VSS error code.

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8.9.1. Solution 1: Using a Dakota Digital Universal Speedometer Signal Interface

Connect the output of the vehicle speed sensor Pin 3 to the Dakota Digital Universal Speedometer Signal Interface and connect the modified output from the Dakota Digital Universal Speedometer Signal Interface to ECU Pin Q19.

https://www.dakotadigital.com/index.cfm/page/ptype=results/category_id=287/mode=cat/cat287.htm

This solution can allow you to make the BEAMS vehicle speed sensor output work with your stock gauge cluster.

8.9.2. Solution 2: Bypassing the Vehicle Speed Sensor

Take the signal wire from injector 2 on ECU Pin P2 and splice a wire into it and connect it to ECU Pin Q19.

This is a quick and effective solution that avoids having to purchase any additional hardware. However, it does not provide a solution to reading the vehicle speed to be displayed on your gauge cluster.

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9. Conclusion

If you've followed this guide to this point then you should have all the knowledge you need to successfully wire your BEAMS motor yourself. Congratulations! Hopefully you are able to get your motor started and continue working towards finishing your motor swap.

If you are still having trouble after following this guide then you may need to seek additional help. Below are links to helpful Facebook communities that may be able to answer your questions:

- [BEAMS 3SGE AE86s](#)
- [3sge BEAMS America](#)
- [Toyota 3SGE Beams Swap & builds](#)

If you think you have done everything exactly as this guide says and are still not having any luck then begin by determining if your motor has the three essential ingredients needed to run: fuel, air, and spark. Check each connection and circuit one by one to make sure it has continuity and does not have abnormally high resistance values.

Finally, don't get frustrated or overwhelmed. Take it one wire at a time and eventually there will be none left.

Good luck!

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10. Appendix

10.1. Part Numbers

Part numbers for the Toyota Altezza can be found here:

<https://toyota.epc-data.com/altezza/sxe10/153375/>

10.2. Replacement Connectors

It is possible to buy new connectors from the following locations:

- <https://www.nzefi.com/products/wiring/connectors/toyota-vehicle-specific-connectors/>
- <https://www.sq-engineering.com/product/ecu-plug-connector-kit-3sge-beams-set/>
- <https://www.driftnotion.com/category-s/1847.htm>

10.3. Wire Gauges

A useful link for understanding what wire and gauge to use for a given circuit can be found here:

<http://info.waytekwire.com/blog/automotive-wire-gauge-guide/>

I used the following table to help guide my wire gauge selection for all of the circuits that I ran.

Wire Gauge	Current Draw in Amps (12 Volt System, 2% Drop)																					
	1	2	3	4	5	7.5	10	15	20	25	30	40	50	60	70	80	90	100	150	200		250
22	14.4	7.2	4.8	3.6	2.9	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
20	23.0	11.5	7.5	5.5	4.5	3.0	2.0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
18	36.5	18.3	12.2	9.1	7.3	4.9	3.7	2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	
16	57.5	28.8	19.2	14.4	11.5	7.7	5.8	3.8	2.9	x	x	x	x	x	x	x	x	x	x	x	x	
14	92.0	46.0	30.7	23.0	18.4	12.3	9.2	6.1	4.6	3.7	3.1	x	x	x	x	x	x	x	x	x	x	
12	x	73.5	49.0	36.8	29.4	19.6	14.7	9.8	7.4	5.9	4.9	3.7	x	x	x	x	x	x	x	x	x	
10	x	x	78.0	58.5	46.8	31.2	23.4	15.6	11.7	9.4	7.8	5.9	4.7	x	x	x	x	x	x	x	x	
8	x	x	x	93.0	74.4	49.6	37.2	24.8	18.6	14.9	12.4	9.3	7.4	6.2	5.3	x	x	x	x	x	x	Max Length of Wire in Feet
6	x	x	x	x	x	78.7	59.0	39.3	29.5	23.6	19.7	14.8	11.8	9.8	8.4	7.4	6.6	5.9	x	x	x	
4	x	x	x	x	x	x	94.0	62.7	47.0	37.6	31.3	23.5	18.8	15.7	13.4	11.8	10.4	9.4	x	x	x	
2	x	x	x	x	x	x	x	99.5	74.6	59.7	49.7	37.3	29.8	24.9	21.3	18.7	16.6	14.9	9.9	x	x	
1	x	x	x	x	x	x	x	x	94.3	75.4	62.8	47.1	37.7	31.4	26.9	23.6	20.9	18.9	12.6	9.4	x	
1/0	x	x	x	x	x	x	x	x	x	95.2	79.3	59.5	47.6	39.7	34.0	29.8	26.4	23.8	15.9	11.9	x	
2/0	x	x	x	x	x	x	x	x	x	x	x	100.0	75.0	60.0	50.0	42.9	37.5	33.3	30.0	20.0	15.0	12.0
3/0	x	x	x	x	x	x	x	x	x	x	x	x	94.5	75.6	63.0	54.0	47.3	42.0	37.8	25.2	18.9	15.1
4/0	x	x	x	x	x	x	x	x	x	x	x	x	x	95.2	79.3	68.0	59.5	52.9	47.6	31.7	23.8	19.0

Max Length
of Wire in
Feet

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10.4. Fan Relay

I suggest using an adjustable fan controller relay:

<https://www.mishimoto.com/adjustable-fan-controller-kit.html>

Follow the instructions that come with your kit to wire it correctly.

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11. Changelog

Version 1.0 - 11/20/2019

- Original guide published

Version 1.1 - 03/25/2020

- Corrected the input string to allow for communication via a bluetooth adapter on the DLC3 port

Version 2.0 - 05/30/2020

- Added 2 additional links to videos of warm idle with fans running and first drive
- Removed Fan 1 and Fan 2 wiring instructions and added recommendation for adjustable fan controller relay
- Embedded ECU diagram

Version 2.1 12/03/2020

- Updated the Circuit Opening Relay diagram and text. Credit to Masa Fujiwara for finding an error in the wording.
- Added additional links to purchase replacement connectors
- Added additional links to BEAMS Facebook communities
- Fixed some grammar and typos

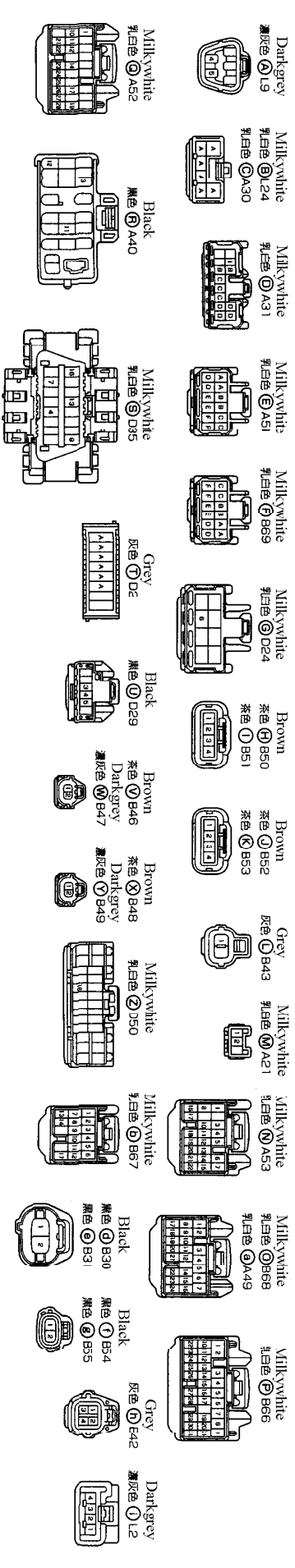
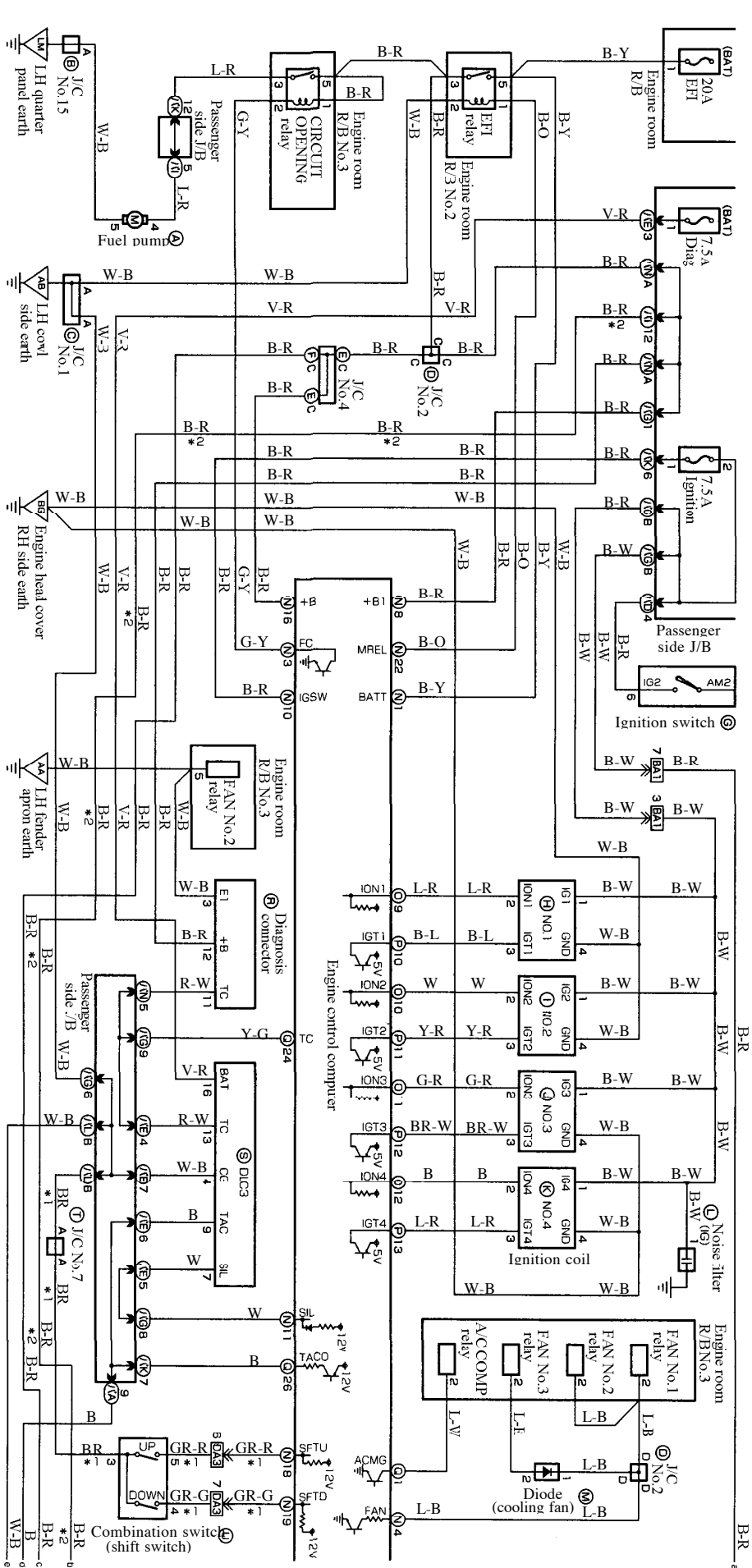
Version 3

- Extensive documentation of differences between early G1 engine harnesses and later G3 / G5(?) engine harnesses. Documentation includes updated figures as well as supporting text identifying and explain the differences
- Added heading numbers and performed document-wide reformatting and reorganization
- Added links to sections within the document for improved navigation
- Added additional acknowledgements to Mark Panic and Matt Ball
- Added diagrams for P & O connectors
- Added link to Veepeak adapter on Amazon
- Added link to Altezza part number catalog
- Removed vehicle speed sensor waveforms
- Replaced Haltech fuse box image
- Corrected wire coloring errors in connector tables
- Corrected link to Dakota digital speedometer interfaces
- Corrected text that swapped descriptions of the m and D connectors
- Corrected more grammar and typos

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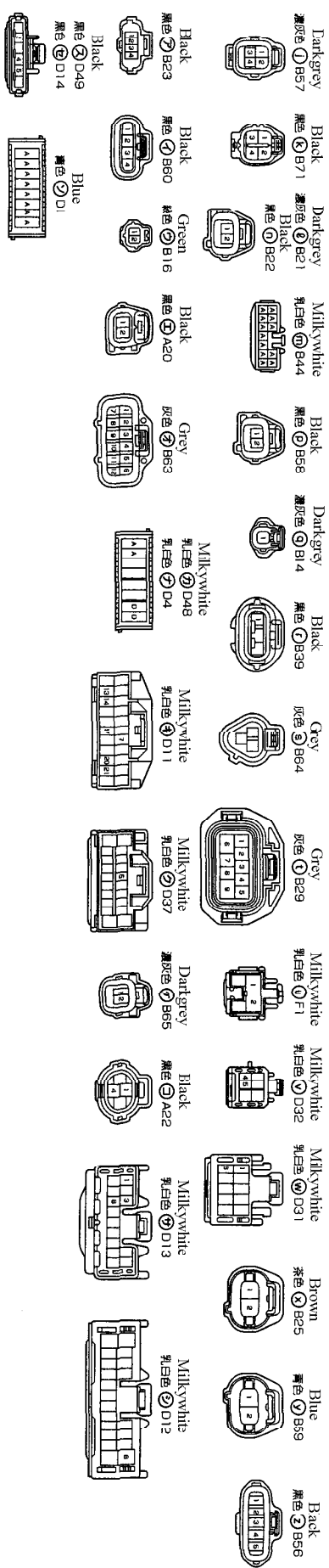
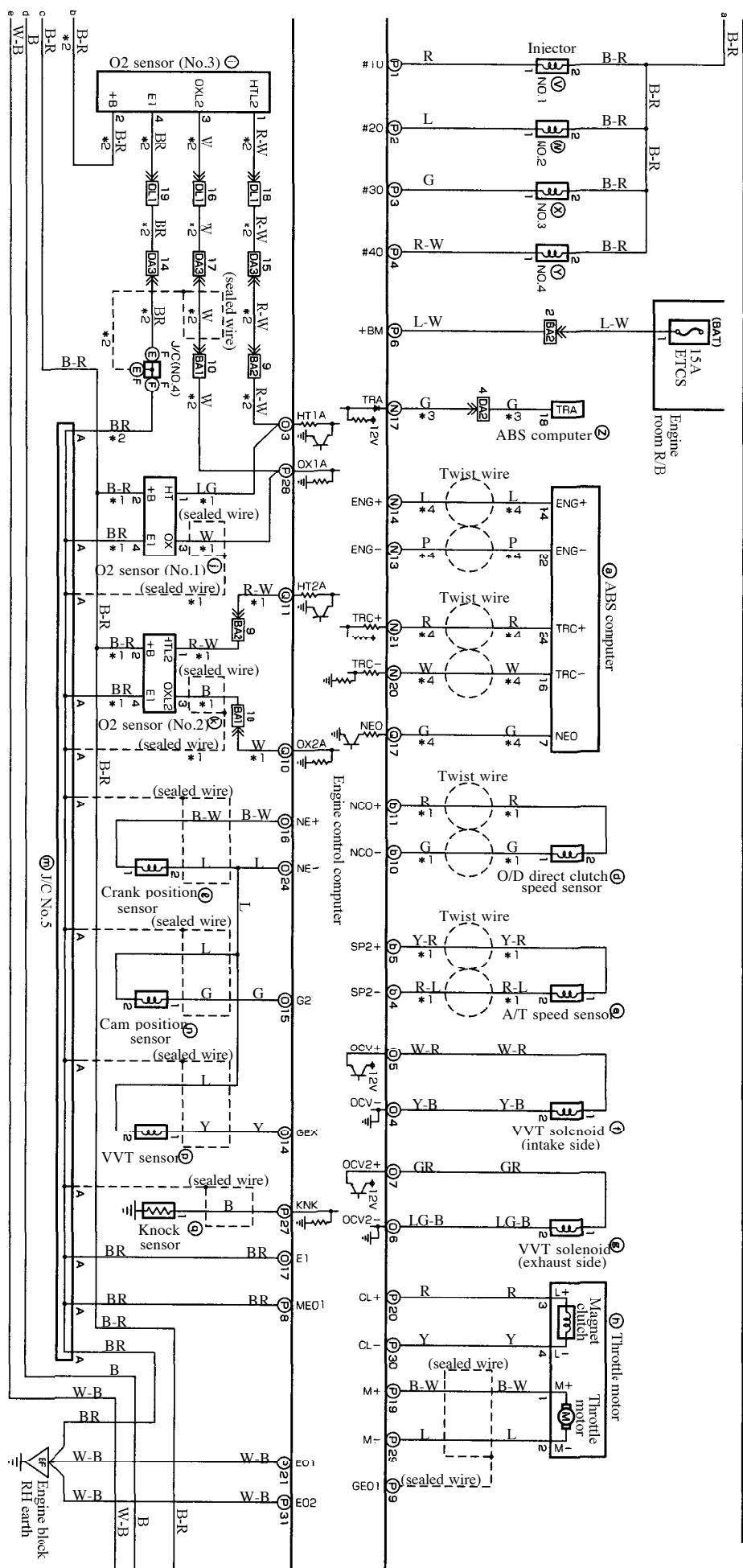
Engine control (3S-GE) & ECT

*1: A/T *3: no TRC *5: 8 speakers, no Navigation
*2: M/T *4: w/TRC *6: 8 speakers, except no Navigation



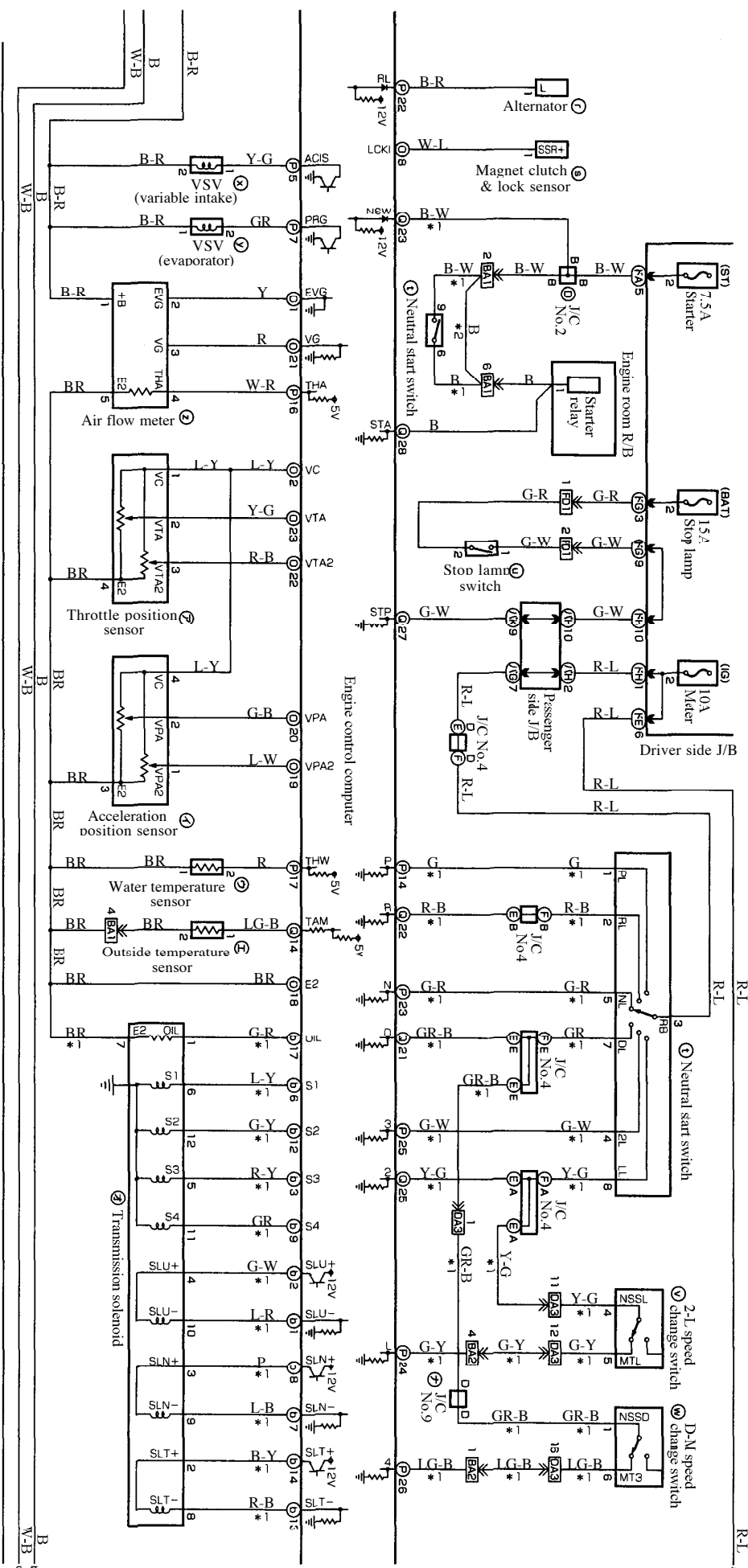
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