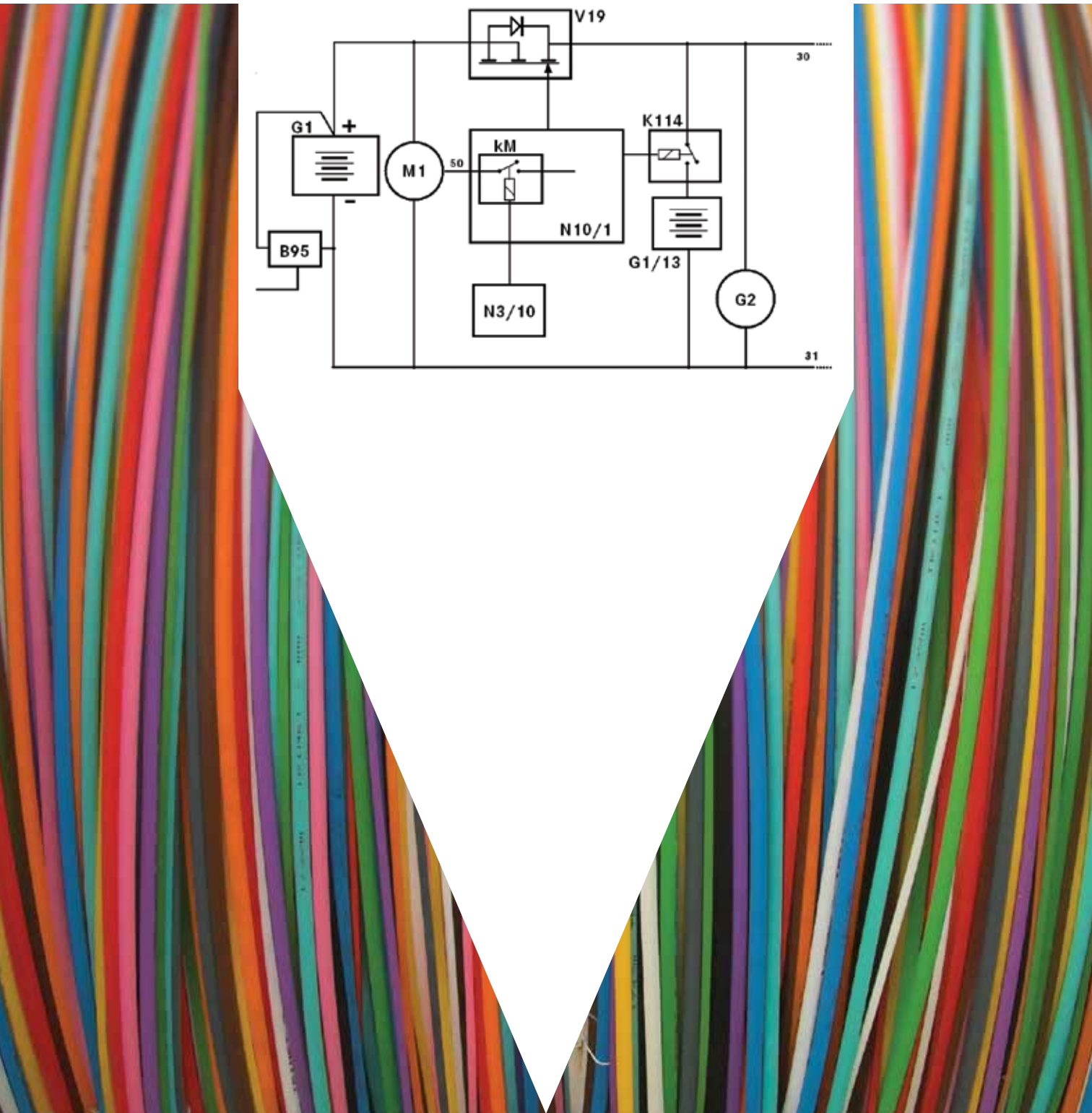
Wiring & Function Diagrams & Descriptions

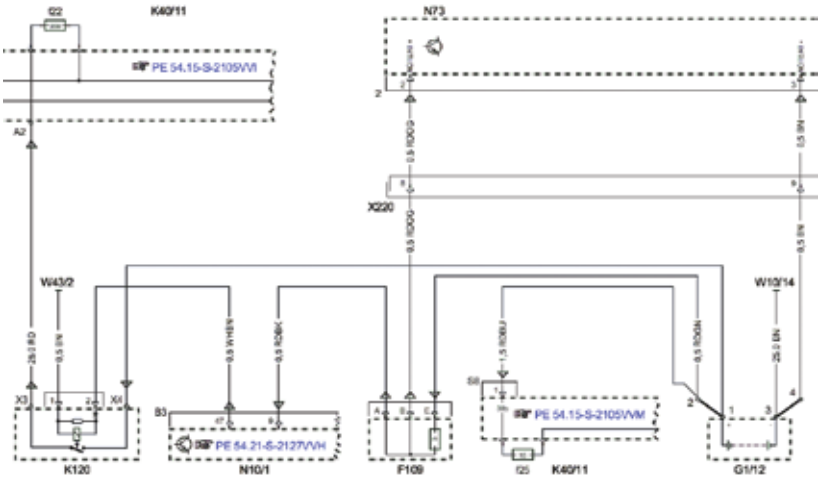


This focused tour of the Wiring and Function Diagrams, and Function Descriptions found in STAR Wiring and WIS will help you use this resource more effectively.

Unless you've been hiding under a rock, or you never see electrical problems in your shop (ha!), you're already familiar with the electrical wiring diagrams found on STAR TekInfo and in WIS. What might still be a mystery are those Function Diagrams found in the same place, which are just as important to a solid electrical diagnosis as the wiring diagrams. Today, we'll show you how these, along with the Function Description documents in WIS (the so-called GF documents) can help you perform a focused and professional electrical diagnosis.

Let's start by taking a quick look at wiring diagrams. As examples we'll use the ones found in STAR TekInfo, but the diagrams in WIS are nearly identical, the main difference being the way we can navigate inside these diagrams: In STAR TekInfo, we can use the mouse to drag the diagram to what we want to see, while in WIS we have to use the scroll bars at the edge of the window.

A wiring diagram is a two-dimensional representation of the physical wiring. We see the components and the wires that connect them, along with information about those wires and connections. For example, we might see a wire labeled as 0.75 GNBU, which means it has a cross-section of 0.75 mm2 (about 18 AWG) and has green insulation with a blue marking stripe. Note that this doesn't mean it is 0.75 mm in diameter – in fact, the copper wire is just over one mm in diameter – it is the cross sectional area of the wire.



This section of the wiring diagram for the ECO Start system in a new Metris van (Model type 447) shows the auxiliary battery (G1/12) that powers the vehicle for the brief moment that the main battery is running the starter. Relay K120 switches the auxiliary battery on-line for that instant. Only a small part of the wiring diagram is shown here.

If we look closely at the connections to a component (including a wiring connector such as X220), we can see that one side of the connection is shown as a pin (usually on the component side) and the other side is shown as a socket. This tells you whether the electrical contact is male or female, helpful when you're not sure which side of a connector you're looking at. Of course, you can also see the component designation for each component (such as N10/1), along with the connector number (B3 on N10/1) and pin number (Pin 47 on N10/1 for the control signal to K120) for each individual wire connection.

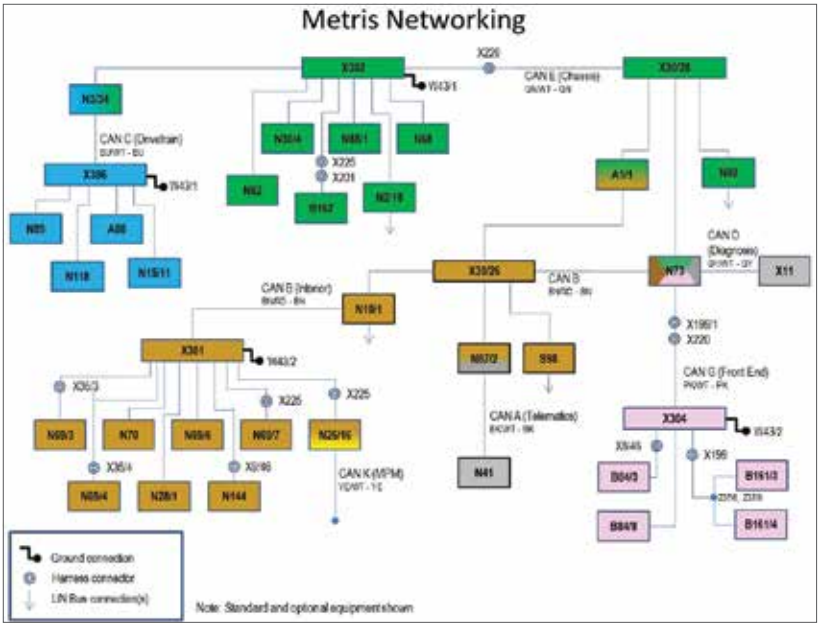
These symbols and features should be familiar, but some newer features in WIS and STAR Wiring are worth mentioning. In WIS, if you have a computer mouse with a wheel, you can use the wheel to scroll up and down in a document, zoom in or out by moving the wheel while holding the <Ctrl> key, or scroll horizontally by moving the wheel while holding the <Shift> key. This is especially handy in wiring diagrams. Also in WIS, if you're not sure which Service Group contains the wiring diagram for a particular system, you can now search by Option (SA) Code. So if you need the diagram for PARKTRONIC (Code 220), you can search by SA Code (one of the options in "additional" Search Mode).

In STAR Wiring, you'll find Signal Flow arrows. These don't show the direction that current goes,

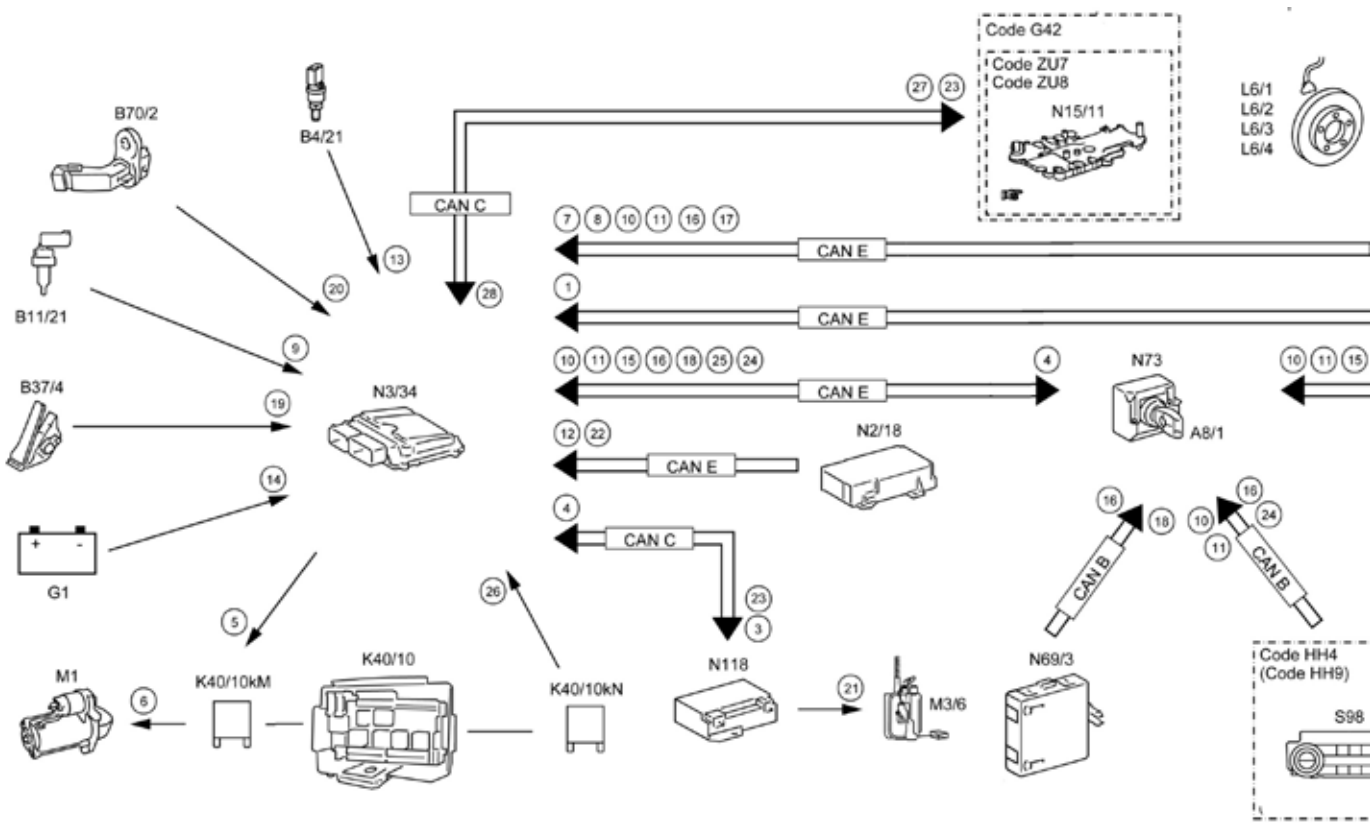
but the direction that the signal goes. In other words, whether it is an input or an output (or both!). Additionally, you can now find the General Function documents (we'll get to those in just a moment) on the System Information tab. These same documents can be found in WIS as document type "GF."

Back to our topic. We can clearly see that the wiring diagram is showing the physical wiring layout in the vehicle. It doesn't show how long the wires are, or where they are located (although STAR Finder shows component locations), so it is not a perfect physical representation of the wiring, but it is close. If we wanted to check a wire, we should have little trouble finding each end for testing.

Until the early 1990s, wiring diagrams were all there was, and, really, all we needed. But then came networking, where a single wire could carry a multitude of information, with the technician having no way to see or measure what exactly was on that wire. Oh sure, we can measure the voltage



The use of data networks such as CAN Bus in vehicles has definitely simplified wiring and reduced weight, but it made diagnosis using only a wiring diagram nearly impossible. This shows the CAN networking used in the new Metris van, a relatively simple vehicle. To understand how a signal gets from here to there, you need to use the Function Diagrams found right next to the wiring diagrams in STAR Wiring and WIS.



to see if the CAN Bus is working normally, but without some kind of specialized test equipment, we could not, for example, tell what outside temperature value the A/C module was getting off the CAN Bus. Indeed, we couldn't even know where the outside temperature signal was coming from.

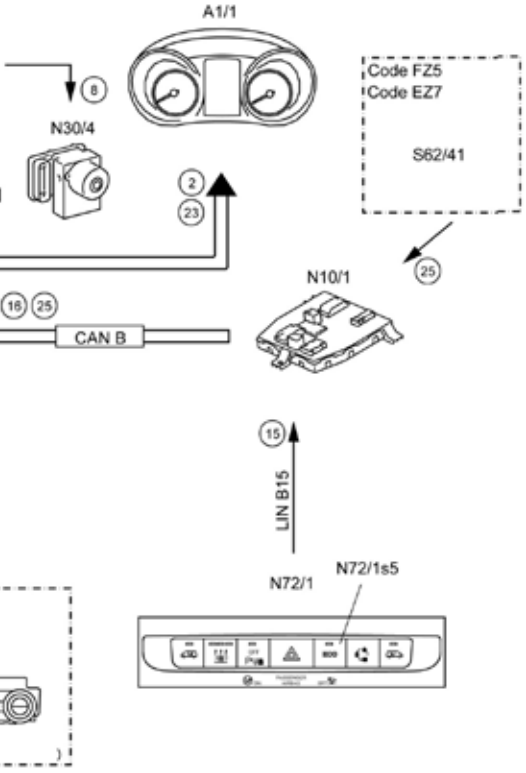
After Mercedes-Benz introduced the CAN Bus for its products in the mid-1990s, technicians quickly identified the need to understand all the CAN messages that were being sent and received by the various control modules. Mercedes-Benz responded by introducing the so-called Function Diagrams. Instead of a pure physical layout, these diagrams show the signal flow between and among components, particularly the signals on the CAN Buses (and other networks). If we want to understand where a particular signal starts from, or which signals are being received off the CAN Bus, we can turn to the electrical Function Diagram.

Taking this one step further, if we want to understand what a system is doing with these signals – in other words, information on how a system operates – we can then use the Function Diagram together with the General Function ("GF") document. In WIS, we need to search for the GF document as a separate document type, but in STAR Wiring there is a direct link to this function description.

We already know about wiring diagrams, so let's take a closer look at a Function Diagram. For this example, we'll use the ECO Start function from the new Metris mid-size van, chassis type 447, and follow two signals from their origin to their destination.

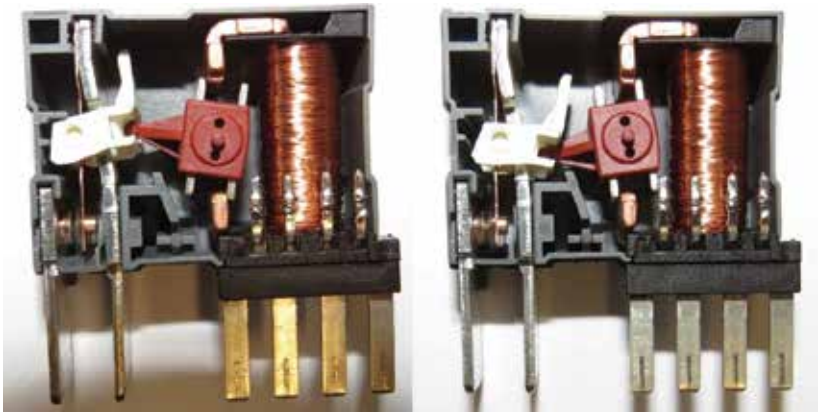
The first signal is the coolant temperature sensor, B11/21. Looking at the far left of the diagram, we see that B11/21 sends Signal #9 (Coolant temperature sensor, signal) on a directly-connected wire to the ME-SFI control unit (N3/34). We could also have seen this on the wiring diagram for N3/34, which would include physical details such as the wire size, color, and the specific connector and pin numbers, but would not tell us

Diagram below: This Function Diagram shows the components involved in the ECO Start system in a Metris van and how the many signals get from their origin to their destination. In this age of networking, a wiring diagram cannot show the information being delivered by the network. This diagram shows exactly that.



1	Vehicle speed, signal
2	Instrument cluster, message
3	Fuel pump, specified pressure request
4	Fuel pressure, status
5	Starter circuit 50 relay, actuation
6	Starter, actuation
7	Electronic Stability Program (ESP) control unit, status
8	Wheel speed, signal
9	Coolant temperature sensor, signal
10	Engine start, request
11	Engine stop enable, status
12	Crash, signal
13	Fuel temperature, signal
14	Circuit 30, status
15	ECO start/stop function button, status
16	Engine stop prohibited, request
17	Braking torque, signal
18	Door rotary tumbler switch, status
19	Accelerator pedal module, signal
20	Engine speed, signal
21	Fuel pump with fill level sensor, actuation
22	Seat belt buckle restraint system switch, status
23	Engine running, signal
24	Automatic air conditioning (AAC) control and operating unit, status
25	Engine hood contact switch, status
26	Circuit 87, status
27	Gear range, request
28	Gear range, status
A1/1	Instrument cluster (KI) control unit
A8/1	Transmitter key
B11/21	Coolant temperature sensor
B37/4	Accelerator pedal module
B4/21	Fuel tank pressure and temperature sensor
B70/2	Crankshaft Hall sensor

CAN B	Interior CAN
CAN C	Drive train CAN
CAN E	Chassis CAN
Code, EZ7	Active Parking Assist
Code, FZ5	ATA I, anti-theft alarm system
Code, G42	7G-TRONIC PLUS automatic transmission
Code, HH4	THERMOTRONIC automatic air conditioning
Code,HH9	TEMPMATIC semi-automatic air confditioning
Code ZU7	Canada version
Code ZU8	USA version
G1	On-board electrical system battery
K40/10	Engine compartment fuse and relay module
K40/10kM	Starter circuit 50 relay
K40/10kN	Circuit 87M relay
L6/1	Left front rpm sensor
L6/2	Right front rpm sensor
L6/3	Left rear rpm sensor
L6/4	Right rear rpm sensor
LIN B15	Battery sensor LIN
M1	Starter
M3/6	Fuel pump with fill level sensor
N10/1	SAM control unit
N118	Fuel system control unit (FSCU)
N15/11	Fully integrated transmission control (VGS) electric controller unit
N2/ 18	Supplemental restraint system (SRS) control unit
N3/ 34	ME-SFI [ME] control unit
N30/ 4	Electronic Stability Program (ESP) control unit
N69/ 3	Left front door control unit
N72/ 1	Upper control panel (UCP [OBF]) control unit
N72/ 1s5	ECO start/stop function button
N73	Electronic ignition lock (EZS) control unit
S62/ 41	Engine hood switch
S98	Air conditioning control and operating unit



This "bi-stable" relay is used to switch off power to some consumers when the vehicle is parked to help reduce parasitic battery current draw. A momentary pulse to the coil switches the relay from on to off and vice-versa without drawing any current continuously. At left, the contacts are open, and at right they are closed. You'd never have known this relay existed if you didn't look at the General Function (GF) document that describes the energy management system, just one simple example of the value of this information.

what the signal was. Of course, in this case the signal is obvious (the coolant temperature!), but the point is that the wiring diagram does not tell us that.

The second signal is from the engine hood switch, S62/41. If we look at the far right of the diagram, we see that S62/41 sends signal #25 (Engine hood contact switch, status) on a directly-connected wire to the SAM control unit (N10/1). If we look just to the left of N10/1, we see Signal #25 is sent over CAN B (the Interior CAN) to N73 (Electronic Ignition Switch). N73 then sends Signal #25 over CAN E to N3/34. If we look closely at the function diagram, we cannot find Signal #25 anywhere else, so we can be certain that no other control unit also receives Signal #25 for this particular vehicle function. From experience (and from the hint "Code FZ5" at S62/41), we can tell you that the hood switch signal is also used by the anti-theft alarm, but since ATA has nothing to do with ECO Start, that information is not shown on this diagram.

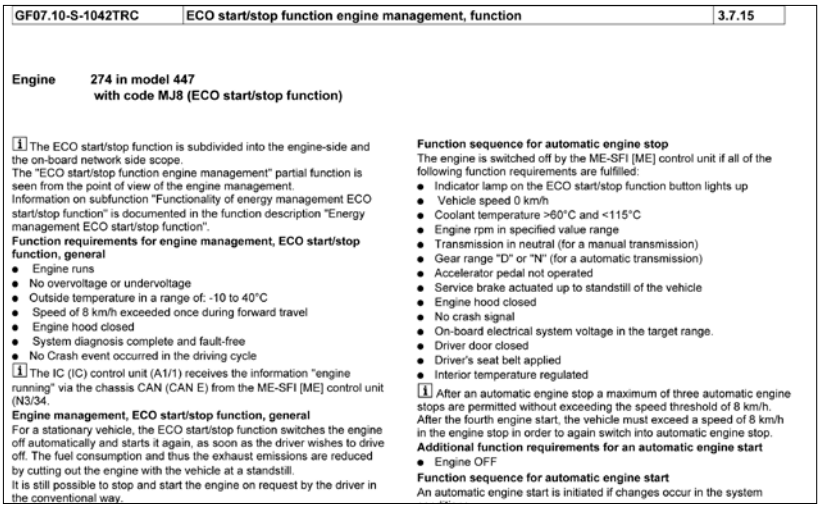
As a side note: Thin lines on a function diagram show a direct wired connection, while the wide "Bus" lines show signals carried over the CAN Bus. Dashed boxes tell us that the information only relates to vehicles with the option code or codes shown. And, as we saw, the numbers in circles are signals, and we can see where these signals go by following the numbers. These signals sometimes go to more than one place: Signal 23 (Engine running, signal) is sent by the ME-SFI control unit (N3/34) to both N118 (Fuel system, control unit) and N15/11 (Transmission control unit). Sometimes it takes a sharp eye to find all these, but the information is there for those who look.

Getting back to the basic idea for these: If we were trying to diagnose a problem with the ECO Start system, no matter how hard we looked at the wiring diagram for the ME-SFI control unit, we'd never figure out that the engine hood switch was being considered in the operation of this system. It would be just as hard to figure out exactly how the engine control unit was even getting that information. But a quick look at the function diagram, and Viola!, the mystery is solved in plain sight.

The ECO Start system is found in nearly every new model. Seeing the symbol (the "A" with the arrow around it) in the instrument cluster display or on a switch on the dash should alert you that the system is installed. If you read through the GF document carefully, you'll find that you should take extra safety precautions to ensure the engine doesn't start by itself while you're working on it.

So now we can see just how the signals needed by the ECO Start system get around, and we have an almost fighting chance to understand how the system works: If we start with Signal #1 and work our way down the list, we (almost) have a bunch of clues as to what the system is looking at to decide if the engine can be shut down or not. For example, we can see that the A/C system (S98) has something to do with it, as does the left front door control unit (N69/3) and the SRS control unit (N2/18). But what, exactly, are these signals used for in ECO Start?

From our knowledge of professional diagnosis, we know that in order to diagnose all but the simplest of problems, we need two things: one is an accurate idea of the symptoms, and the other a thorough understanding of the system and how it is supposed to operate – exactly how it does what it is supposed to do (its Function). We get the symptoms from customers (why would they be in your shop otherwise?) and from our own attempts to duplicate the complaint, while using our knowledge of how



GF07.10-S-1042TRC	ECO start/stop function engine management, function	3.7.15

Engine **274 in model 447 with code MJ8 (ECO start/stop function)**

The ECO start/stop function is subdivided into the engine-side and the on-board network side scope.
The "ECO start/stop function engine management" partial function is seen from the point of view of the engine management.
Information on subfunction "Functionality of energy management ECO start/stop function" is documented in the function description "Energy management ECO start/stop function".

Function requirements for engine management, ECO start/stop function, general

- Engine runs
- No overvoltage or undervoltage
- Outside temperature in a range of: -10 to 40°C
- Speed of 8 km/h exceeded once during forward travel
- Engine hood closed
- System diagnosis complete and fault-free
- No Crash event occurred in the driving cycle

The IC (IC) control unit (A1/1) receives the information "engine running" via the chassis CAN (CAN E) from the ME-SFI [ME] control unit (N3/34.

Engine management, ECO start/stop function, general

For a stationary vehicle, the ECO start/stop function switches the engine off automatically and starts it again, as soon as the driver wishes to drive off. The fuel consumption and thus the exhaust emissions are reduced by cutting out the engine with the vehicle at a standstill.
It is still possible to stop and start the engine on request by the driver in the conventional way.

Function sequence for automatic engine stop

The engine is switched off by the ME-SFI [ME] control unit if all of the following function requirements are fulfilled:

- Indicator lamp on the ECO start/stop function button lights up
- Vehicle speed 0 km/h
- Coolant temperature >60°C and <115°C
- Engine rpm in specified value range
- Transmission in neutral (for a manual transmission)
- Gear range "D" or "N" (for a automatic transmission)
- Accelerator pedal not operated
- Service brake actuated up to standstill of the vehicle
- Engine hood closed
- No crash signal
- On-board electrical system voltage in the target range.
- Driver door closed
- Driver's seat belt applied
- Interior temperature regulated

After an automatic engine stop a maximum of three automatic engine stops are permitted without exceeding the speed threshold of 8 km/h. After the fourth engine start, the vehicle must exceed a speed of 8 km/h in the engine stop in order to again switch into automatic engine stop.

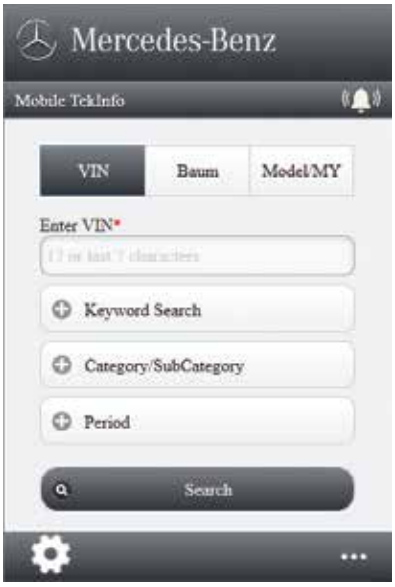
Additional function requirements for an automatic engine start

- Engine OFF

Function sequence for automatic engine start

An automatic engine start is initiated if changes occur in the system

This General Function document explains in detail how the system does what it does. See the text for details on how this document, when combined with the Function diagram, can help you better understand the system so you can perform a more professional diagnosis.



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the system is supposed to operate (gleaned from the operator's manual). But understanding how the system functions is a little more complicated. Even if training is available, who could possibly remember the tiny, intricate details of how each system functions in every car ever made since forever?

Even the best of the best can't remember everything. But all you need to remember is how to find the General Function document in WIS or STAR Wiring, and you have all the details right there in writing. If you use this document, along with the function diagram and the wiring diagram, and spend a few minutes studying the system, you will have all the information you need to thoroughly understand its function in great detail.

We've reprinted a portion of the General Function document GF07.10-S-1042TRC, which describes part of the ECO Start function as it applies to the M274 engine installed in USA-version Metris vans. Here, we can see that the engine is switched off by the ME-SFI control unit if all of the listed function requirements are met. One of these requirements is that the coolant temperature is between 60 and 115 degrees Celsius, and another is that the hood is closed. Looking closer, we can also see that the interior temperature must be in regulating phase – the A/C or heat has the temperature at or near where it's supposed to be – and that there must not be any Crash Signal received from the SRS control unit.

As you'll remember, we saw all four of those signals – engine coolant, hood switch, A/C unit, and SRS unit – on the function diagram, but didn't have any real information on what, exactly, they had to do with ECO Start. Now, using the GF document, together with the function diagram, we know what they do, and can consider what might happen (what symptoms we might see) if these were not working properly.

Which is the whole point: We want to fix the customer's car (or van) as quickly as possible, and we want to be certain that we really fixed the problem. This makes for happy customers, and we all know that happy customers come back when they need us again. So if we make the investment in Mercedes-Benz information systems, we know we're able to get the detailed information we need to really understand the system's function, make a professional diagnosis, and perform a permanent repair. For sure, we can get wiring diagrams from other sources, but Function Diagrams and General Function documents, especially from The Source, can prove more valuable than we realize.

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