Understanding Diagnostics

Trial and error creates inconvenience for the Customer and the Service Department when misdiagnosis or longer waits occur as the technician tries different repair attempts. This is against BMW's promise to the customer to "Fix it right the first time, on time, every time".

If the vehicle is not repaired efficiently the productivity of the technician suffers. Taking some time at the beginning to plan a diagnostic course of action can help give structure to what may appear in the beginning to be a chaotic situation.

As future systems increase in complexity so does their dependency on the Diagnosis Program as the principle tool for troubleshooting. However, the importance of understanding the calculated steps of a basic troubleshooting plan is just as important as before.

There will always be instances where the Test Modules provided by ISTA need to be supplemented by a thoughtful diagnostic plan that is created by the skilled technician. A parallel diagnostic plan that includes proper recording of test data along with the Diagnosis Program is a good habit to follow every time that troubleshooting is required.

A successful diagnostic plan will:

- Save repair time.
- Satisfy the customer by reducing vehicle down time.
- Increase Center profitability.
- Increase technician pride and earnings.

Diagnostic Plan

The Diagnostic Plan consists of 5 steps:

1. Verify the Customer Complaint -"Experience the Symptom!"
2. Analyze the Problem
3. Isolate the Problem
4. Repair the Problem
5. Verify the Repair

Verify the Customer Complaint: Experience the symptom!
Most troubleshooting starts the moment you receive a written description of the customer complaint. The complaint is the customer's description of a symptom that they are experiencing with the vehicle.

Symptom
A symptom is any circumstance, event or condition that accompanies something and indicates its existence or occurrence.

There may be multiple symptoms that are created with one problem.

An example is a defective thermostat: If the thermostat is stuck open the heater output will be insufficient, also, if the engine can never reach operating temperature then fuel mileage and performance will suffer. Which one of these complaints (symptoms) would lead you to the problem faster?

What is important to remember is that the customer may only complain about one symptom. It is the job of the technician to be a detective and carefully observe. There may be another symptom not complained of that directly points to the root cause of the problem.

Steps to Verify the Complaint

- Before getting in the vehicle, review the R.O., confirm this is the correct vehicle.
- Is any additional information needed about the complaint? Certain questions to the customer can help narrow this step.
- Is the problem intermittent? What are the conditions (roads, temp., speed, etc.)? What is the frequency of the occurrence?
- Test drive if drivability related or the conditions require, duplicate conditions as stated by customer.
- Was the complaint reproduced?
- Is knowledge of system or vehicle sufficient?
- Review reference training material and owner's handbook for a description of feature operation.
- Research complaint in SIB's.
- Research past repair history on vehicle.

Analyze the Problem

After verification of the complaint, analyze the problem. Use all resource available to aid in system diagnostics:

- Vehicle Fault Memory
- ETM, Repair Manual, SIB, etc.
- Vehicle Repair History
- Training Handouts
- Round Table Information
- Hotline
- Known Good Vehicle

Analyzing the problem allows for the development of a repair plan.

Steps in Analyzing the Problem

- Perform a Short Test.
- Does an SIB pertain to this vehicle?
- Refer to the Function Description for additional system information.
- Is a test plan available for this system?
- Use fault symptom selection.
- Perform Diagnosis Request.

Isolate the Problem

To isolate the problem is “to place apart from others”.

The object here is to zoom in on the problem area. It is easy to be overwhelmed by a problem, just reaching for an ETM can add to the confusion. ISTA provides automatic tests in test modules to aid in the determination of the exact area or cause of the problem.

The elimination of components from the diagnostic trail, shortens the path.
The first question asked should be:

- Is the problem Hydraulic, Mechanical or Electrical?

Save time by **NOT** testing components that could not create the problem.

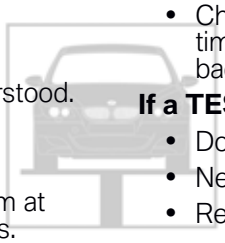
Steps in Isolating the Problem

- Use Test Modules.
- Perform electrical tests with the IMIB or a DVOM.
- Consult fault charts in Repair or Diagnostic Procedures Manuals.
- Control Module Self Diagnosis.
- Use appropriate special tools (e.g. battery draw tester, tank leakage adapters, breakout boxes, etc.).
- Substitute a known good part.
- Log step and results on paper for review.

Workshop Hint

If a TEST PLAN is <u>not</u> available:

- Think about the system in its entirety.
- Be sure the normal operation is understood.
- Develop a PLAN.
- Use all available resources.
- Don’t try to diagnose the entire system at once, break it into manageable chunks.
- Check the easy things first. It would waste time to install the breakout boxes to find a bad bulb.



If a TEST PLAN <u>is</u> available:

- Do not skip steps.
- Never assume results without doing a step.
- Recheck your work.

Repair the Problem

Repair the problem using approved repair techniques and parts. Having verified, isolated and analyzed the problem the last step is to repair or replace the component. Before installing that shiny new part, take one last step back from the vehicle to ask a final set of questions.

- Could another component have caused this part to fail?
- Were all the instructions in the Test Plan or Diagnostic Procedures followed?
- Is there anything that might have been overlooked?

Confident that the proper diagnosis has been made, complete the repairs.

Steps to Repairing the Problem

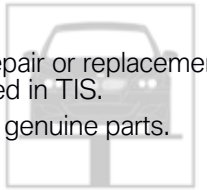
- Follow the instructions in the repair manual.
- Refer to Construction Groups in the microfiche if necessary.
- Follow specific guidelines for wire harness repair or replacement.
- Make proper adjustments after installing the part.
- Perform Coding or Programming if required.
- Make sure another problem is not created in performing this repair.

Verify the Repair

Always recheck for the complaint under the same conditions used to verify. The object is to prove the problem does not resurface.

- Clear the fault codes.
- Test drive the car.
- Check for re-occurring fault codes.
- Clear adaptations if necessary.
- Recheck the part installation for missing bolts or tie wraps.
- Verify operation of all systems to ensure the repair did not cause an unrelated problem due to repair, i.e. Working behind the dash and forgetting to connect a component during reassembly.

Workshop Hints



- Follow repair or replacement procedures as detailed in TIS.
- Use only genuine parts.

Diagnosis with ISTA

Introduction

The programs and documents of the ISTA workshop system contain information on troubleshooting vehicles built by the BMW Group. The technical content is coordinated within the BMW Group and with the supplier companies. The proper vehicle repair will only be guaranteed if this information is followed and the scope of repair is carried out in accordance with the displayed instructions.

A poorly or inadequately carried-out diagnosis may result in the testing or repair expenditure you are claiming for within the framework of a warranty or goodwill claim not being accepted or not being fully accepted.

Diagnostic Procedure

Diagnostic procedures/test plans (ABL's) are available for all electrical and electromechanical vehicle systems. Diagnostic ABL's are also available for selected mechanical systems or fault patterns (Non-electric Diagnosis).

Troubleshooting using the ISTA workshop system will then always be necessary:

a. If the fault falls within the functional range of electrical components and the faulty component or fault source is not clearly and demonstrably identifiable.

b. If the fault causes an indicator light to come on.

c. If the fault falls within the area of the mechanical system and the fault cause is not clearly and demonstrably identifiable.

d. If the fault falls within the area of the mechanical system and troubleshooting or repair is too costly.

e. If a TeileClearing is active for the faulty component.

Please observe!

Detailed information on which electrical or electromechanical scopes require no diagnosis can be found in "Component repair without diagnosis" elsewhere in this training manual.

Detailed information on which mechanical scopes absolutely require a diagnosis (non-electrical diagnosis) before repair can be found in the ISTA document "Contents of non-electrical diagnosis (NED)".

Diagnosis Sequence

1. Starting diagnosis
The current software version including the current program and data updates must be installed on the workshop system before the start of diagnosis.

2. Troubleshooting with a test schedule and hit list
It is not technically possible for all fault states of a system to be contained in the fault memory. For this reason, the following procedure must be followed for the full troubleshooting of a system:

2.1 Test schedule for stored faults
If a <Test schedule> is calculated after the <Brief test>, only the procedures (ABL's) that are displayed are needed for working through the stored faults. It is therefore possible by selecting <Fault pattern> to additionally select the vehicle subsystems which demonstrate a malfunction.

2.2 Test schedule for stored faults and known fault patterns
If a vehicle subsystem was selected in the <Fault pattern> selection, the procedures for stored faults are displayed in the <Test schedule>, as are the procedures for faults currently known to occur frequently.

2.3 Information search
If the fault cannot be identified by using the procedures in the <Test schedule> additional procedures must be selected via the <Information search>. The search for procedures must take place via the <Function structure>.

2.4 [!] Current fault patterns
<Fault Pattern> now has its own tab and it is structured similar to <Function Structure>. Here you can find an overview of known fault patterns for which separate procedures are available.

Note that all software dependent scopes are determined on the basis of the integration level of the connected vehicle. Therefore this list is specific to the vehicle.

2.5 Procedures (ABL's)
All other known malfunctions and the entire scope of functional checks are contained in the procedures that are associated with the vehicle functions in the <Function structure>. These procedures make it possible to check all relevant components of a subfunction.

2.6 NED non-electrical diagnosis procedures

Access to the NED non-electrical diagnosis procedures has been simplified as of ISTA 2.28.

Direct access is available from the function structure through:

- Non-electrical diagnosis- NED

You can filter by:

- Engine
- Chassis and suspension
- Body
- Types of fault
- Customer experience

2.7 Hit list

The procedures found in this way via the function structure are displayed in the <Hit list>. By working through the relevant procedures, you ensure that the current troubleshooting information is displayed.

3. Carrying out procedures

In the case of the procedures mentioned in the <Test schedule> and <Hit list>, it is first necessary to check which procedures are connected with the customer complaint or the identified malfunction. These procedures must be called up as a matter of priority and worked through. Procedures, once they have been started, must be worked through in their entirety. Processing is finished when, after the message "Procedure ended Continue in test schedule" is output, the user clicks on the <Next> button to return to the <Test schedule> or the <Hit list>. Only then will all the diagnostic codes displayed in the procedure be stored in the diagnosis report. Aborting a procedure early will only then be permitted if one of the following factors exists:

a. Procedure selected by mistake

b. Program fault requires cancelling

Also, not all the procedures take the form of guided test sequences. In many of the procedures the diagnosis user has the opportunity to decide for him-/herself which tests are to be conducted. These procedures end with a prompt to report back (feedback dialogue) the established test result. Here the user must select the test result which, on the basis of the available information and test results, has led to the decision to implement a repair measure.

Procedures which are obviously not connected with the customer complaint, the identified malfunction or an indicator light coming on can be ignored.

Please observe!
If, in the case of sporadically occurring malfunctions, no fault can be identified in the course of a procedure, the diagnosis user can decide for him-/herself which repair measure is to be implemented. The following information must be taken into consideration:

- Fault description by the customer
- Fault memory and fault memory details
- Fault code descriptions
- Documents and notes displayed in the procedure
- Current information from Technical Support
  (Service Information Bulletins, PuMA measures, Training manuals, etc.).
- Findings from previous troubleshooting and repair measures

In the case of procedures with feedback dialogue, the repair measure that has been carried out must be selected.

Furthermore, in those cases where the fault cause could not be clearly identified using a procedure, the user must enter a technical reason for the repair in the comment field for the warranty or goodwill claim.

4. Dealing with stored faults

The situation may arise where a control unit stores a fault even though no malfunction is perceived. In addition, it is possible for faults, whose causes have already been eliminated, to be stored in the vehicle. It is therefore not unusual - above all in vehicles with high mileage - for faults to be stored which are not connected with a customer complaint or an identified fault pattern. It is therefore necessary when performing diagnosis to use the fault memory details to check which fault entries can be ignored.

The following fault memory details is particularly important in this context:

- Current fault status (permanent fault/non-permanent fault)
- Kilometer reading/mileage when the fault last occurred
- Fault frequency

Replacing a component on the basis of the fault entry will only then be justified if it is clear from the fault memory details that the stored fault is connected with the customer complaint or the fault pattern.

Please observe!
In the procedures the faults are generally not read out of the vehicle again. The ABL always uses the fault memory scope that was determined during the <Brief test>. Therefore, if additional faults occur or if a fault status was eliminated by a repair, this does not automatically change the fault list stored in ISTA.

Please observe! (cont.)
The fault memory list stored in ISTA is only updated if a new brief test is carried out or if a <Control unit test> is performed via the <Control unit functions> for an individual control unit.

The current status of a stored fault can be read out in the <Procedure> or via the <Fault memory list> by selecting <Update>.

5. Taking current technical information into account

In addition to the diagnostic programs information on current technical problems, there is also useful information published through special media and systems (e.g. Training Manuals, Service Round Tables, Service Information Bulletins or PuMA measures). This information must also be taken into account in the course of troubleshooting.

If the repair measure recommended in the procedure differs from the current information, this must be entered in the comment field for the warranty or goodwill claim.

6. Implementing programming or encoding measures

Programming, encoding, enabling and replacement of control units are carried out with the ISTA/P programming system. The currently valid user documentation and the additional information on ISTA/P must be read and observed. When performing control unit replacement actions it is necessary above all to follow the procedure "Replacement with/without session interruption" described in the user documentation.

As of now it is no longer necessary to transfer "Warranty code" displayed in the procedure to the warranty or goodwill claim. In the future the "Warranty code" will no longer be output in the procedure.

7. Using control unit functions

The <Control unit functions> offer the opportunity to access known diagnostic functions quickly. However, using the Control unit functions does not replace carrying out the procedures, as:

a. No additional notes and instructions are provided in the control unit functions.

b. No setpoint values are displayed in the control unit functions.

8. Delete fault memory

When the vehicle has been repaired, all the stored faults must be deleted using the <Delete fault memory> function.

9. Feedback of faults in the diagnostic programs

If faults/errors are found in the diagnostic programs or documents in the course of a diagnosis, they should be reported via the feedback function integrated in ISTA.

Component Repair without Diagnosis

Essentially, in the case of electrical or electromechanical components, it is always necessary to perform troubleshooting using the ISTA workshop system. However there are faults which are clearly and obviously identifiable.

For the following cases it is not absolutely necessary to use the ISTA workshop system for troubleshooting; Replacement of:

- faulty bulbs (with the exception of xenon bulbs and light sources for LED headlights)
- operating elements with identifiable visual deficiencies
- electrical components whose retaining elements are broken
- electrical components which are faulty as a result of water ingress or a thermal event (excluding control units)
- mechanical engine components which demonstrate clear leaks or mechanical damage
- display elements with identifiable visual or mechanical faults
- faulty fanfare horns, cigarette lighters or power sockets.

Components for which a TeileClearing is active are excluded from this!

The specifications in the document "Contents of Non-electrical Diagnosis" found on ISTA, must also be observed!

As a rule, there are no special tests in the test modules or sometimes no test modules for the mentioned cases. It must be noted that faulty electrical components which are connected to control units usually result in fault entries. Replacing the component can also result in fault entries. Following repair the fault memories of the control units must therefore be deleted.

The repair must be made in accordance with the directions in the repair instructions (REP).

Test Schedule and Priority

The result of the calculated test schedule is displayed on the Test schedule tab.

The importance of the suspected objects is listed in the 'Priority' column. The Service employee uses this as a guide to sequence which test schedule procedures should be carried out.

The test schedule is calculated and a certain processing sequence defined based on specific technical algorithms. However, the algorithm cannot reflect the valuable experiences of BMW Service employees or specific customer statements. Consequently the fault cause in the vehicle does not always match the sequence (priority) in the test schedule. For example, if a problem with the vehicle has already been described in some detail by a customer statement, compare the test schedule against the customer statement. Start working as appropriate, even if the test procedure you start with is not the first procedure in the test schedule.

Retrofitting or converting

For retrofitting or conversion work using ISTA/P, a new process must be created in ISTA otherwise the new control unit will not be recognized.

Displaying and logging diagnosis codes

The diagnosis codes and repair instructions shown on the display screen are saved in the diagnosis report only after exiting the screen mask by pressing "Continue". When the testing procedure is discontinued at this point, it is not logged.

Moreover it is necessary to point out that repair instructions can still be displayed even after output of an instruction in the testing procedure. For this reason a testing procedure should always be performed until the message "Testing procedure concluded" appears.

Fault memory list with filter function

The fault memory list can be filtered using the KM axis and by filtering fault classes (e.g. undervoltage, overvoltage, information).

The fault codes are entered on the vertical axis of the "KM Axis" mask and kilometer readings are entered on the horizontal axis.

All fault classes that appear on the fault list are listed in the "Class" mask. Because all prepared fault memories are always displayed first on the fault list, the individual classes are preselected by default. The service employee can uncheck the check boxes to hide the individual classes including assigned fault memories in the fault memory list, but the fault memories will remain in the vehicle. If a fault memory could not be assigned to a class in the fault list, the "Class" tab will be disabled in the workshop system.

If the "Information" class is assigned to a specific fault memory, then this is not a fault to which a specific fault cause must be assigned. Rather, this fault memory serves as information indicating that a specific function is justifiably limited or it has been switched off (e.g. due to excess temperature). Detailed information about this fault memory is available via "Display fault code".

If the service employee filters by kilometer axis and by classes, the fault memory list will be reduced by both filter criteria. The test schedule calculation that is subsequently performed in the workshop system relates to the filtered fault memory list in addition to the fault patterns that were entered. The service employee can cancel the filter and recalculate the test schedule at any time.

Notice!!! **The service employee can cancel the filter and recalculate the test schedule at any time.**

NOTES

General instructions for line check

 **Instruction** **The following instructions can be shown on the diagnosis system**	 **Scope of checks / measurements** **The following checks/measurements must be performed depending on the shown instruction.**
Check lines and plug connections **Check line between the following components** **Check lines with the following signal name**	Visual inspection of the lines: • Line damaged, crushed or disconnected Check the plug connections and cable connectors: • Correct engagement/connection • Connector housing damaged • Damage through corrosion • Crimping of the cable • Pushed back or bent pins Electrical line check: • Open circuit • Line short-circuited to ground or B+
Check voltage supply	Check whether component is supplied with voltage. Points to be checked in the event of a fault: • Fuse • Load-shedding relay • Cable and ground connection for visible and electrical damage
Check fuse	Check or replacement of a fuse
Check ground connection	Check ground connection for visible and electrical damage. Check ground connection to body for corrosion or poor connection.
Check lines for short circuit to B+	Check the cable only for short circuit to B+. Visual and electrical check.
Check lines for short circuit to ground	Check the cable only for short circuit to ground. Visual and electrical check.
Check relay	Check that relay is correctly mounted in the relay base. Check by ear or electrical check to ascertain whether relay switches.

NOTES PAGE

Control Unit Functions in ISTA

The control unit functions offer the opportunity to access known diagnostic functions quickly. The control unit functions are opened in the **Control unit tree** or **Control unit list** mask. After a control unit is selected, the selected control unit is opened via the "Open CU functions" button. The control unit functions are distributed on the following tabs:

Identification

Display of the control unit name and the identification data of the control unit. By selecting the "CU test" button, the identification data and the fault memory of the control unit are read in anew (single control unit test).

In the faulty memory list and generally in the procedures (ABL's), the only fault codes that are evaluated are those that were read out during the "Brief test" or the "CU test". There is no running update of the fault memory. Therefore, a "CU test" always needs to be performed if the fault memory of a control unit is read in anew during a diagnosis session. After the CU test is performed, the "Fault memory list" in the "Guided troubleshooting" menu is updated automatically.

Diagnosis Query

Display of the current states of a control unit (status display).

The status displays (control unit functions) are subdivided into functional groups.

Multiple control unit functions can be selected within a functional group. By selecting the "Query status" button, the selected control unit functions are transferred to the right side of the screen and the current values are read out of the vehicle. The displays are updated continually.

The query is ended when the "Query status" button is pressed again.

Component Activation

Activation of control unit outputs and control unit inputs.

The activations (control unit functions) are subdivided into functional groups.

Only one control unit function can be selected within a function group. The activation is executed when the "Activate component" is pressed. The details of the activation (duration or type of activation) are displayed in the "Status" line.

Depending on the type and duration of the activation, an active activation can be ended or repeated via the "Activate component" button (the button is optically pressed during the activation). The component activation also contains the "Delete fault memory" control functions. This control unit function can delete the fault memory of the selected control unit. After a fault memory is deleted, the "CU test" function must be executed on the "Identification" tab. Then the fault memory of the control unit is read in again and the fault memory list in the "Guided troubleshooting" menu is updated.

Restrictions

The control unit functions do not contain setpoint values or additional text instructions. In addition, not all diagnosis and test options for functions and components are available in the control unit functions. Troubleshooting in the vehicle must therefore primarily be performed with the procedures.

NOTES

Fault Memory List in ISTA

In the "fault memory" mask, the fault memories that are displayed are the ones that have been read out of the vehicle during the brief test or "control unit test" (individual control unit test).

Furthermore, so-called service fault codes are also displayed (e.g. S 0001 No communication possible with: instrument panel). Service fault codes are generated during the brief test (e.g. if no communication is possible with an installed control unit). However, they are not stored in the vehicle.

Structure of the Fault Memory List

The fault memory list is divided into 4 table columns:

Code
Display of the internal control unit fault code

Description
Brief description of the fault

Kilometer reading
Kilometer reading/ kilometer when the fault last occurred in the vehicle.

The kilometer reading is recorded by all control units from series E65.

If no kilometer reading is displayed for a fault, the control unit was unable to record a valid kilometer reading when the fault occurred.

Category
Starting with F0x, a fault can be allocated to a special fault category. The fault categories that are currently available are as follows:

- **Battery voltage < 9 V:** At the time the fault occurred, the battery voltage was less than 9 volts.
- **Battery voltage > 16 V:** At the time the fault occurred, the battery voltage was greater than16 volts.
- **Information:** The control unit has detected a functional limitation that can be traced back to an operating error, a function-related safety cutout (excess temperature, repeat interlock etc.) or a fault in a different control unit.

The fault memory list can be sorted differently by tapping the column heading (e.g. kilometer reading). How the fault memory list is sorted does not affect the calculation of the test schedule.

Display Fault Code

Further information on the fault memory can be displayed for a selected fault code entry (select fault memory in the table) via the "Display fault code" button.

Description

Fault code description on stored fault. The document contains basic information on when the fault is detected by the control unit and which fault causes lead to a fault code entry.

Fault code descriptions are available for all fault memories starting F01.

Details

Display of the fault details of the fault memory stored in the control unit.

By selecting the "Update" button, the fault details are re-read from the control unit.

System context

In the case of vehicles from the F series (starting F01), additional vehicle information (ambient conditions) are stored in a central fault memory (diagnosis master) if a fault occurs. In contrast to the fault details, the same ambient conditions are detected for all fault memories in a system context. This makes it possible to identify links between faults e.g. occurrence of secondary faults.

Filter Fault Memory

The filter function can reduce the size of the list of displayed faults without deleting faults from the control units. In the calculation of the test schedule, only the faults that correspond to the filter criteria and are therefore visible in the fault memory list will be taken into consideration.

The fault memory list can be filtered via the kilometer axis and via fault category.

Kilometer axis

The fault codes (vertical axis) and the corresponding kilometer readings (horizontal axis) are displayed in the screen. Selecting the "Cursor" button activates the "Arrow buttons", which can be used to reduce the display to a certain kilometer range. In the case of vehicles from the Fx series, the kilometer readings from the diagnosis master are displayed. In the case of sporadic faults, a kilometer reading is given if the fault changes from "non-permanent fault" to "permanent fault". For all series from E65, the kilometer readings for the first and last occurrence of the sporadic fault are displayed.

Category

All fault classes that appear on the fault memory list are listed in the Category mask. By deselecting the selection fields, the faults from a certain fault category (e.g. information) can be hidden from the fault memory list. If no fault memory in the fault memory list is assigned to a category, the "Category" tab is inactive. For troubleshooting on the vehicle, it is recommended to only use the fault memories that are not assigned to a category for the initial test schedule calculation. The filter settings of both masks are activated by selecting the "Apply" button.

Calculate Test Schedule

Selecting the "Calculate test schedule" button calculates a test schedule and calls up the "test schedule" mask. The test schedule only contains the fault memories that are displayed in the fault memory list.