

The ATS-2 Static Parameter Tester

An Introduction

The **Static Parameters** of a power semiconductor are a group of measurements taken when the device under test (DUT) is in a steady or static state.

The common Static Parameters used in Igbt, Power-fet and diode testing, together with their labels, are;

<u>Test name</u>	<u>Igbt</u>	<u>Power-fets</u>	<u>Diodes</u>
Leakage current		Ices	Idss
			Ir
Gate Leakage current		Iges +/-	Igss +/-
			na (not applicable)
Breakdown Voltage		BVces	BVdss
			BVr
Gate Breakdown Voltage		BVges +/-	BVgss +/-
			na
Saturation Voltage		Vce(on)	Vds(on)
			Vf
			Vsd (Diode)
			Vf(r)
		Rds(on)	
Threshold Voltage		Vge(th)	Vgs(th)
			na

Please refer to the **Standard Definitions** for all these tests or contact **Challenge Innovations** for our own descriptive test definition sheets.

All the above tests can also be used for other device types, for example bipolar transistors, thyristors and so on without modifications. Some test types for these devices will need some extra circuitry made as plug-in cards.

A typical test sequence will;

- apply the “forcing” function to the DUT. This will be a voltage in the Leakage tests and a current in the Saturation and Breakdown tests. A third terminal will be suitably driven.
- wait for a suitable settling time until a stable or static state has been reached,
- measure the required parameter. This will be a current in the Leakage tests and a voltage in the Saturation and Breakdown tests.
- remove the “forcing” function/s and terminate the test.

The wait time must be long enough for the DUT to reach a steady state but not long enough to start altering the DUT's characteristics. In the early days of test equipment design, the contact bridging time inherent in some mercury wetted relays was used to generate these current and voltage pulses. This bridging time was found to be around 300 usec. This time has been carried over to modern Tester design even though the technique has not. As voltages and currents used in static testing increase, this time compromise becomes very important. There are many design details used in the ATS-2 which minimise the capacitance and inductance effects of the DUT and its

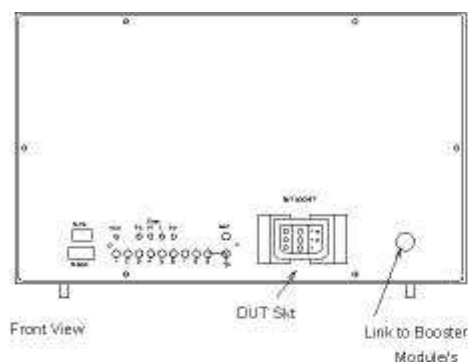
connections to keep these delays as short as possible.

All the ATS-2 Static Parameter Testers provide at least the above test types. They differ only in their forcing function and parameter measurement capabilities.

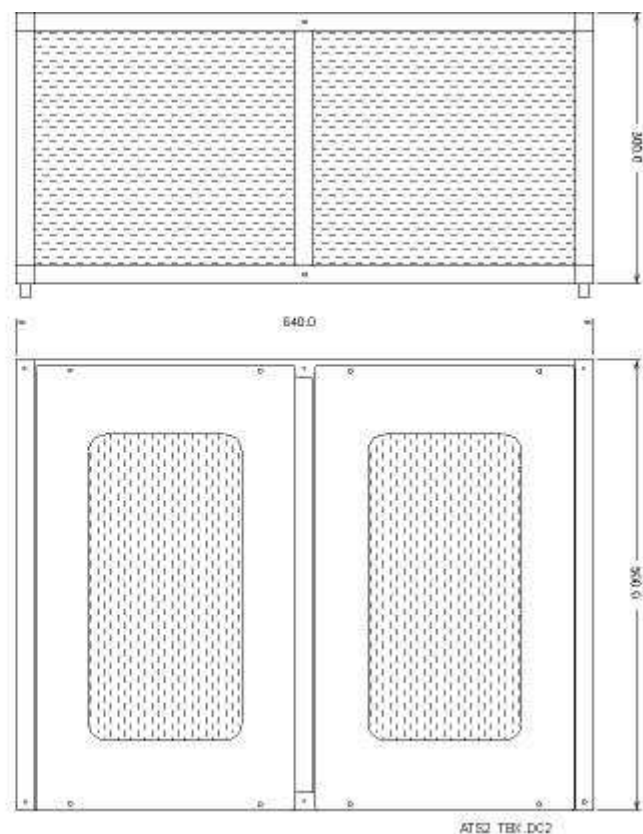
The “Basic” ATS-2 Tester provides;

- Leakage Testing to 2kV and 1uA to 10mA full scale,
- Gate Leakage Testing to +/- 30V or +/- 100V and 1uA to 10mA full scale,
- Breakdown Voltage Testing to 50mA and 2kV full scale,
- Saturation Voltage Testing to +/- 100A with +300A extension and 6 voltage measure ranges from 100mV to 40V full scale.
- Threshold Voltage Testing from 1uA to 100A full scale and 6 voltage measure ranges from 100mV to 40V full scale.
- Single-shot measuring techniques used for all tests. The forcing parameters use 12 bit Daconverters and all the measurements are made using a 12 bit AD converter. This gives a resolution of 1 part on 4095, a good compromise between speed and accuracy.

The complete “Basic” Tester housing is;



ATS-2 Static Parameter Tester Box.



ATS2_TBR.DC2



The ATS-2 Tester is mounted on an optional floor standing trolley type **TROLY02**

The active circuitry is divided into **two parts**, all housed inside one card cage situated just behind the DUT connector;

- The digital section consists of five dual Eurocards including the microcomputer, programmed in "C" and held in Eprom, used to drive all the hardware, the Adconverter, the RS-232 interface with 8 lines of I/O and two optically coupled Daconverter and load driver cards. There is a design upgrade of this digital section now taking place. This upgrade will reduce this section to 3 cards, increase the Adconverter to 14 bits and change the micro computer to a much more powerful 16 bit flash type.

- The Analogue section consists of six dual Eurocards each performing one of the forcing and measurement functions. Only one potentiometer on each sets up the +/- 10V reference on the forcing cards. One card carries all the internal calibration resistors. These are used to calibrate the Tester in the pre-start internal test sequence and in the more complex test runs used in the full calibration.

The above circuitry is all powered by a collection of linear power supplies all housed within 3 removable modules in the rear section of the housing. These power supplies are continuously monitored to show up any problems. All can be repaired and fully tested outside the housing.

The Tester is driven by the RS-232 output of any PC running most DOS and "Windows" type operating systems. The PC's **Challenge Innovations** supplied software sends out a text string with the test type and parameter information. The Tester's microcomputer converts it to a test with all the

required relays, current and voltage sources etc. activated as required in the correct sequence, then sends back that test's result. Each test is therefore one self contained entity. The PC's software receives the result then decides on the next step in the test sequence. The RS-232 is chosen for it's simplicity and universality. Other link types are under review.

Any PC can provide these text strings and receive the test results.

The **ATS-2 handbook** shows the construction on these string. Even the most complex strings are only 14 characters long.

The **“Basic” ATS-2** is suitable for static testing of the low and medium power range of Igbts, Power-fets and diodes. It's design is optimised for manual device handling and low volume production to around 4000 devices per hour. The Tester must include an external control PC, either customer or Challenge provided, the chosen software suite, the optional Multiplexer and the optional Safety Test Head.

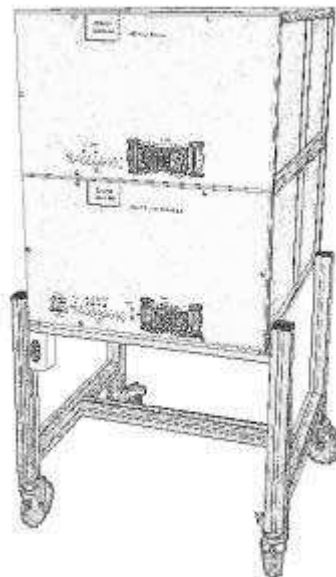
The **“Current Booster”** extensions to the Basic ATS-2 Tester.

When over +300A is required for Saturation Voltage testing, the Basic ATS-2 can be extended in steps of +600A by adding Current Booster units. These are self contained circuits, housed in boxes similar to the basic ATS-2. One such unit can be made to carry from 3 to 16 dual 100A cards making a total of 3200A. Extra such Units can be added to a practical limit of 4 Units.

These additional Units give the basic ATS-2 an extended capability of > 13,000A.

All these units work on a current sharing principle. Each 100A max. is kept separate until all are joined at the DUT contacts. This design minimises the inductance effects of DUT and multiplexer leads. The current sharing is organised by software in the ATS-2's microcomputer and is transparent to the user.

The normal testing speeds can therefore be maintained to the highest currents.



The connections to the DUT are normally made inside the Safety Test Head. This is made to suit the package or range of packages to be tested.

Please refer to the separate data on Safety Test Heads and Multiplexers.

Various Test Boxes are provided which calibrate each of the separate 100A max current generators and ensure that the full current flows in the DUT.

The “High Voltage” extensions to the Basic ATS-2 Tester.

When over 2kV is required for Leakage current testing (Breakdown Voltage testing is not normally used at these higher voltages), the internal 2kV supply is supplemented by an external supply integrated into microcomputer software and internal hardware of the basic ATS-2.

Challenge Innovations have made such supplies to 4500V at 100mA used for testing the 3300V power Igbts.

There is also a range of units from other manufacturer which are similarly used. These go to over 10kV with currents to > 100mA. These can be used to test modern 6500V working Igbt traction modules and diodes / thyristors.

Again these units are fully integrated into the basic ATS-2 hardware and software and their use is transparent to the user. The connections to the DUT are made inside the required Safety Test Head which must be used in this application, by using a suitable high voltage multiplexer. This is chosen to suit the package or range of packages to be tested.

Please refer to the separate data on **Safety Test Heads** and **Multiplexers**.

The packaging of this high voltage extension will depend on the type of supply chosen. All use the same aluminium extrusions to form an enclosure frame and screw-on steel panels. Please note that both of these extensions can be applied to one Tester. This means that the ATS-2 can be expanded to > 10kA and > 10kV.

Some examples of such extended Testers in use today include;

Basic ATS-2 / one 1200A Current Booster / 4 position Multiplexer / type MCP- 3 Safety Test Head.

Basic ATS-2 / one 900A Current Booster / 12 position Multiplexer / type >MCP- 3 Safety Test Head.

Basic ATS-2 / one 1200A Current Booster / 4.5kV + 8kV high voltage extension /3 position Multiplexer / MCP-3HV Safety Test Head.



Shows an integrated MCP-3 Safety Test Head with an internal 2 x 1500A pneumatic multiplexer plus an 8kV/75mA high voltage power supply made to be part of an ATS-2 installation.

Basic ATS-2 / two 1200A Current Boosters / 4500 V high voltage extension / 5 position Multiplexer / type MCP-3 Safety Test Head.

Basic ATS-2 / 4500 V high voltage extension linked to a Prober Unit. Used to test wafers at high voltages.

Any of the ATS-2 Tester packages can be supplied as a complete unit including PC, software all the hardware, tables, trolleys etc. or in any combination as required by the customer.

Some of our customers start with a "Basic" ATS-2 with Multiplexer and Safety Test Head to suit one range of DUT packages then, after some time, expand by adding a Current Booster Unit with a larger Multiplexer and a different Safety Test Head to suit a higher current range of DUTs, then expand further to adding a second Current Booster Unit plus a High Voltage Extension with a larger Multiplexer and another different Safety Test Head.

The basic "look-and-feel" of the software is maintained and only the required hardware is purchased to suit the range of DUTs that need to be tested.

The software:

The ATS-2 Tester package contains a collection of programmes designed to provide a wide range of facilities. These programmes are expanded with a range of calibration and repair software mostly running in the Qbasic environment.

The "DOS" based packages consisting of ATS2ED and ATS2ENG are being replaced by the "Windows" based packages ATS2WED and ATS2PROD.

ATS2WED - The Editor, which guides the operator through the task of producing new test files or modifying existing test files, then storing them into the database.

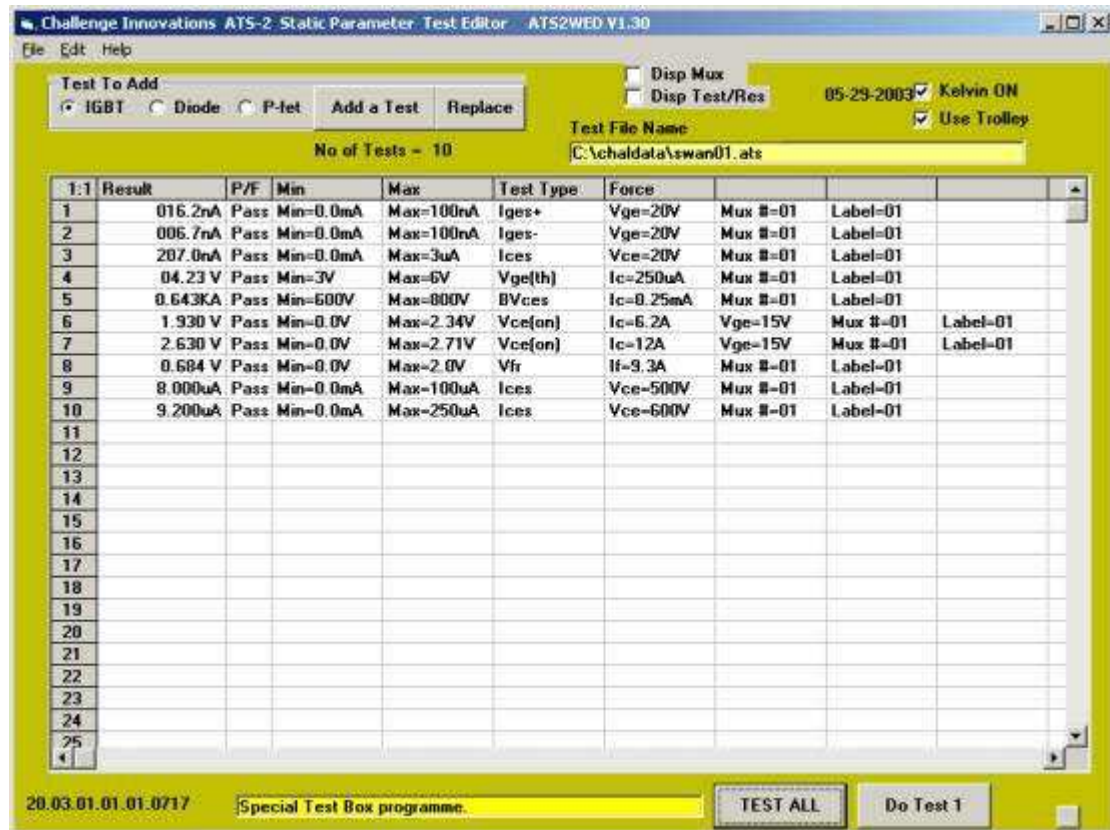
There are many facilities provided including:

- Test type menus and available parameters, all the test are made to suit the Tester's hardware.
- Up to 100 tests per test file .
- All the usual editing facilities, i.e. add, delete, insert, change etc.
- Direct printout and/or storage into .doc file of all or part of the test file.
- Retrieval and storage of the file to/from any part of the PC's disk with listing of directories.
- Key disk feature to stop unauthorised entry.
- As each test is entered, the text string that will drive the ATS-2 will be displayed.

Perhaps the most useful facility is that, if the ATS-2 is connected to the PC, then the **tests on the list can be performed immediately** and the results displayed. This means that the text file can be thoroughly tested and verified as it is written and before storing into the PC's disk, all inside one programme.

A typical example of an ATS2WED page is shown below. Here a multi lgbt module is to be tested.

The example shows the 10 tests that will be used on each lgbt.



The “Test All” button will initiate the test sequence on to the Igbt which is connected to the MUX number chosen. The results will be displayed in the first column together with the Pass/Fail flag. The highlighted test line will be individually tested by the “Do Test n” button.

Now the test sequence can be tested and verified before storage for later use. Changing the MUX= column on each test line (if a suitable Multiplexer is connected) will test the other Igbts. This column is not used within the ATS2PROD software.

The normal “pull down” menus provide all the usual facilities.

ATS2PROD - The new “Windows” based production environment.

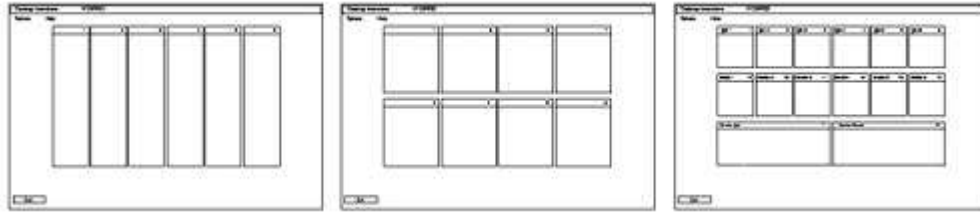
This is a visual display of the pass/fail performance of a multiple device module.

It is ideal for use by non-engineering people. It is a big change from the “test results column” approach of the ATS2ENG and many of the other commercial packages.

It presents the whole module’s test plan on one screen, it shows, in real time, all the tests taking place, then shows the final test sequence result. When first loaded, the user is presented with a display of 30 columns arranged in a 10 wide by 3 deep matrix. Each column represents all the tests that will be done on one device in a multi device module.

The user then sets up this matrix to suit the module to be tested.

Three examples are;



A

B

C

Note that the widths and heights of the columns are sized by the software automatically to suit the screen space available.

A shows a six-pack module with devices 1 thro 6 sequenced from left to right,

B shows a similar six-pack plus brake lgbt and diode module with the three “upper” Igbts plus the brake diode on the top row and the three “lower” lgbt plus the brake lgbt on the bottom row,

C shows a PIM module with the six lgbt on the top row, the six power diodes on the middle row and the brake lgbt plus diode on the bottom row..

The choice is completely open within the 10 wide by 3 deep matrix.

Each column is now given a descriptive label, a multiplexer number which conforms to that device’s wiring to the Multiplexer and a test file name previously generated and tested within ATS2WED. This means that up to 3000 tests (30 x 100) can be performed in a test sequence.

The columns are automatically graduated with the number of tests represented by that column.

This matrix design is now saved for future use.

One example is a six (2 x 3) column matrix used for testing a 6 pack of Igbts.

The test sequence is started by the "Start Test" button, by closing the DUT trolley etc.

As the testing proceeds, as each device is tested, that column's graduations will display green for a passed and red for a failed test.

At the end of the test sequence, a legend at the bottom of the screen will show a large "PASS", "FAIL", "O/RANGE" etc. depending on the overall module test result.



In this example, the module results are;

lgbt1, all pass,

lgbt2, failed test #7 12A Vce(on),

lgbt3, failed test #7,

lgbt4, failed test #4 Vge(th), #5 Bvces and #7,

lgbt5, failed #5 and #7 and

lgbt6, failed test #7.



Refer to the ATS2WED screen display for the tests used.

Now any graduation of any column can be inspected by clicking on it. This will display the test type, parameters and the result obtained.

Most of the facilities previously available are duplicated plus;

- Direct loading of the test results into EXCEL running as a parallel task. This facility allows special macros to "massage" the results and display them in a format required by the customer. If testing is aborted during a sequence, only the testing task will need to be re-started. The test results previously obtained are kept within

the Excel task.

- The statistics, graphs, printout options etc. are all produced by macros within Excel. There is a wide range available or can be provided by Challenge.
- Facility to “Skip failed multiplexer position” or “Abort testing completely on fail”.
- Facility for reading DUT’s bar-code before testing the device.
- Full control of any included Multiplexer and Safety Test Head with “Bed-of-Nails”.
- Ethernet link between the Testers and people in QA, Test Specifications etc. is a simple and proven option that works well.

All the desired programmes are run from the operating system in use by typing the programme's name or clicking on the “desktop” logo. Because this is a “windows” based package, all the usual multi tasking facilities can be used.

There is a separate handbook provided which details all the software supplied.

The ATS-2 system is supplied with:

- One A4 size **manual** containing:
 - Operating instruction on the hardware.
 - Calibration procedures and Certificate.
 - Listings of all the diagrams supplied.
 - All the A3 and A4 size diagrams.
 - All the printed circuit card layouts and parts lists.
 - Maintenance and repair advice.
 - Details of the character strings used to set up the system and the result strings returned. Any customer

produced software (i.e. QBASIC etc.) can use these strings to work the ATS-2.

- List of spare parts included.
- All the A2 size **electrical diagrams** in a wallet.
- All the standard **software** provided with this Tester together with its **handbook**.

- **Spare parts** of all the items that are not readily available within the EC, US etc. markets. More comprehensive spares kits are available. The Challenge website carries a selection of relevant distributors and manufacturers.
- **Certificates of conformance** to the LVD and EMC regulations.
- The **external control PC package plus the printer** if this is a Challenge Innovations supplied option.

Most of the modern “Windows” / “Intel” products will work well.
- An **optional trolley** to carry the ATS-2 Tester plus any Current Booster units and/or High Voltage units supplied.
- An **optional table** to carry any Safety Test Head, Multiplexer, Tester etc..

Challenge Innovations have many table designs available.

To obtain the latest options and prices, contact Challenge Innovations or their Agents. Please provide a list of DUT packages and the parameter requirements. A price plus delivery time will then be provided.