Power MOSFET Characterization for Portable Electronics (SJK1-14)

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Introduction
Nowadays, portable devices are extremely popular and prevalent in daily life. Power MOSFETs are used extensively in their power circuits. The performance and reliability of the Power MOSFETs directly influence the quality of these portable devices.

The characterization of Power MOSFETs determines the parameters to engineers and researchers. With this knowledge, engineers may choose suitable MOSFETs for their power circuits. The characterization process, involving many steps for the many parameters of Power MOSFETs, is complicated and time consuming. Through the automation of characterization, parameters can be measured rapidly and accurately.

Objectives
- Automate the High Temperature Resistance Test (HTRT) test, the Drain Source Breakdown Voltage Test (VBBD) and the Threshold Voltage (VTH) Test
- Control common laboratory instruments to program automated characterization
- Require smaller space, lower cost compared to professional device testers
- Engineers and researchers hence save time from repetitive tasks

System Block Diagram

Methodology
Programs are written in VBA. User interfaces are made on Excel spreadsheets to allow user input. The programs send instructions to the instruments through the General Purpose Interface Bus (GPIB). The instrument responds to the parameters of the test after they receive the instructions. Auxiliary circuit and test equipment may also be used. Their programs can instruct all GPIB and provide the environment for the test. The instruments then return the parameters back to the program. The program acquires the readings and processes them into information. Finally, the data are stored in Excel spreadsheets.

Implementation

The HTRT Test Program
The Power MOSFETs are mounted on an auxiliary circuit and put into the oven. The oven is set to 200°C. The circuit shorts the gate and source terminals of the MOSFETs and parallel connected the drain and source terminals. The biased is connected to the DC power supply. After the temperature achieves the required temperatures, the program starts to take readings.

The program allows the user to define a time interval, with which, the VBBD program will schedule Digital Multimeter (DMM) measurements. The program operates until the user cancels the scheduled tests.

The program has five channels. Each channel can control its corresponding DMM. The user can take different measurements by different DMMs at the same time. For example, Channel 1 is set to control DMM1 and take a record of the leakage. Channel 1 is set to control DMM3 and monitor the biasing voltage.

The VBBD test & VTH test Program

The VBBD test & VTH test Program controls the curve tracer to perform VBBD test and VTH test in different resolutions and then combine them into one graph.

The user interface allows users to select which test to be performed. VBBD test, VTH test, or both. The test configurations can also be set. The users can add the desired resolution in a list. Another setting is the curve file. The readings that are smaller than the set value will be filtered out.

After the users start the program, it sends commands to the curve tracers and curves will be plotted in the resolutions set by the user. The curve will be plotted in terms of the data points and will be plotted into one graph after the user triggers the plot function.

Evaluation

The automation of the HTRT test was successful. The equipment used in this project is lower in price and requires smaller space than the testers. The automation of the VBBD test and VTH test was also successful. The efficiency of program controlled characterization is much higher than the manual operation. The end result in this project suggests that cheaper, smaller, automatic, more efficient and more accurate characterization can be done. Furthermore, the ability to program with custom instruments, they may be rearranged to determine multiple Power MOSFET parameters.

Conclusion

A solution for achieving automated characterization has been shown. The solution suggests a cost-effective, accurate, efficient and smaller characterization option. The solution utilizes common instruments in laboratories. By controlling such instruments, measurements are made automatically. This approach reduces the needs for purchasing expensive and high testing machines. It also has much higher efficiency in manual operations.