CheckSum System Architecture

In-Circuit Test Systems	*Stable. Accurate. Reliable.*
Device Programming Systems	*Fast. Flexible. Dependable.*

CHECKSUM

Fully Tested

- An open test platform for all types of circuit assemblies
- In-Circuit Test (ICT) and part programming
- Boundary-scan and functional test
- Single assembly or a panel of multiple boards

CheckSum systems are based on the architecture developed for the IBM PC-AT bus and MS-DOS software. This bus structure and bios control allowed direct communication and control of the modules from the test system software.

Over the years, Microsoft changed the underlying software such that direct control was not feasible. Beginning with Windows 2000/XP, using the new methods to access CheckSum boards became too slow, cumbersome and the real-time control was not possible. To provide the speed and timing control necessary for the CheckSum test system software to make accurate and reliable measurements required several fundamental changes.

A USB control module was designed to access the system hardware bus with the fast, real-time control required for stimulus and measurements. With first generation of USB control module, the test system software executed the test steps "across" the USB bus from the PC to the chassis with the USB control module and other CheckSum modules. The USB 2 bus data transfer rate is specified to be up to 480 Mbit/s. Although the transfer rate is high, the overhead to initiate transfers can be time consuming with Windows if the test steps are individually or even grouped together. For test programs with less than 200 component steps, the overhead can be significant. A test that "executes" the ICT steps in less than 2 seconds might take 5-10 seconds to complete. The second generation USB control module was designed to store the entire test program, execute the test steps, and transfer test results to the test system PC.

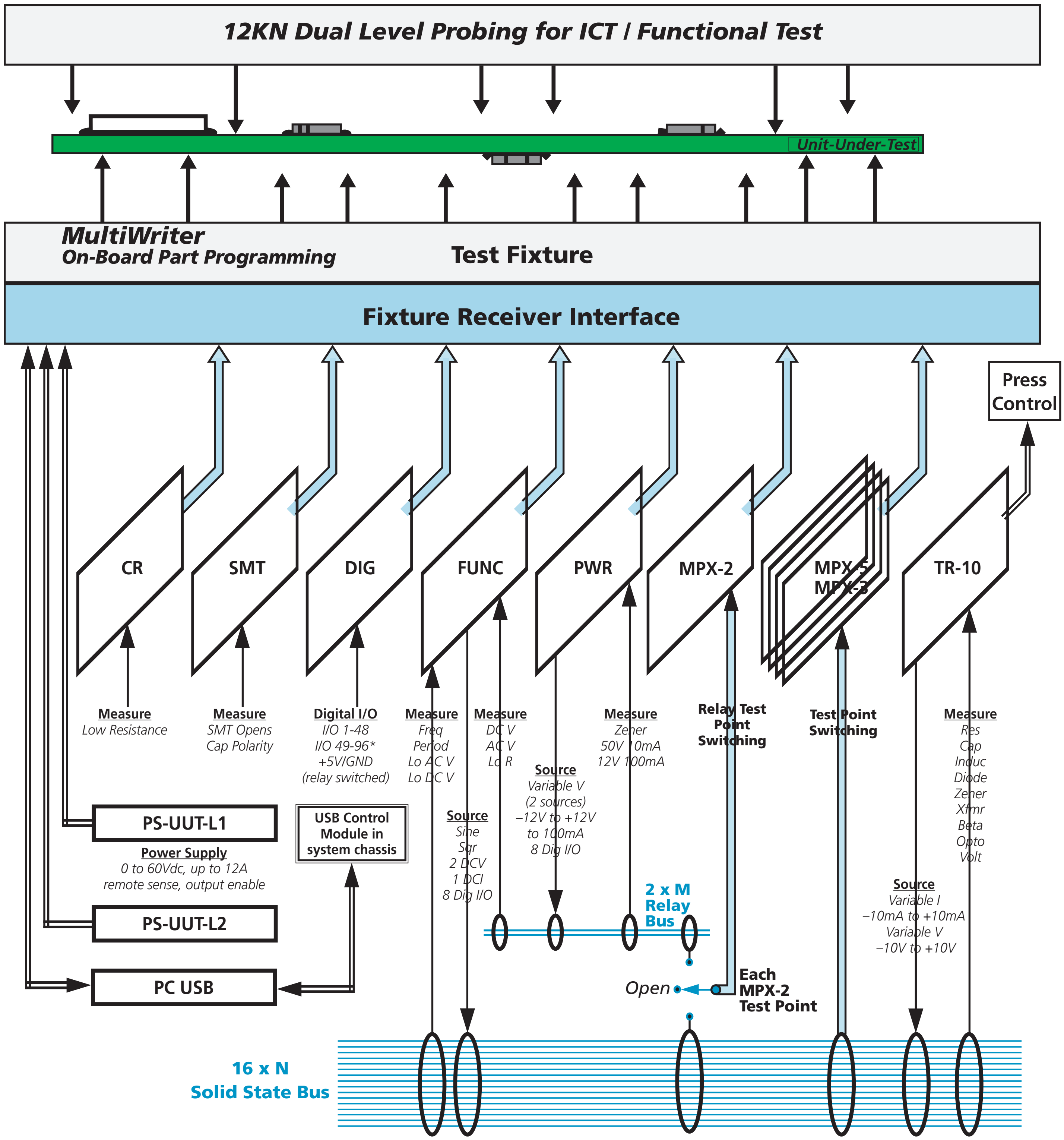
Under normal use, the system uses the same program for each UUT, therefore reloading the test program over USB is not required until a different UUT needs to be tested. This allows the system to control the USB module with only limited instructions and transfer the test results at the end of each test. The overhead to transfer data is significantly reduced and the overall throughput is increased.

The PC provides the resources to create test programs, save the programs, run them and view the test results. In addition, the PC has network connectivity to store programs and test data anywhere a connection is possible.

The USB connection divides the system hardware into the "personal computer" resources and test system resources. A chassis, or several chassis with multiple slots can be used to configure test system with a few hundred to thousands of test connections. A typical industrial chassis has 20 slots available and adequate power supplies for a variety of CheckSum modules. Multiple chassis can be interconnected with bus expansion boards and analog/digital cables.

A list of CheckSum modules includes (**bold** indicates current product):

Name / ID	Description
System module **TR-10**, TR-8, TR-4	Impedance measurement, AC/DC
Functional Test **FUNC-2B**, FUNC-2, TR-6	DMM, UCT, DIG I/O, Relay Bus, DC/AC Sine/Square-wave voltage source, DC current source, +5V, +12V & -12V fused power supply outputs (relay switched on the FUNC)
Multiplexer **MPX-5-200,** **MPX-3-200,** **MPX-2-50** TR-8-1, TR-4-1	Test point solid-state switching, 200 points per module (50 for the MPX-2-50)
Power Module **PWR-2** TR-8-PWR	2 power outputs up to ±12V with 100mA, 8 bits of digital I/O, relay switched +5V, +12V & -12V fused power supply outputs
TestJet **SMT-2, SMT-3** TR-8-SMT/CAP	TestJet technology to detect open pins on ICs and other devices plus detect capacitor polarity
Digital I/O **DIG-1** G-80	48 digital bits per module with relay switched +5V fused power supply output
HiPot **HP-1**	24 test points per module, up to 500Vdc, or to 500MΩ
Milli-Ohm Meter **CR-1**	24 source and 24 sense test points per module, 20mΩ to 2Ω
Cross Point Relay **XPoint-1**	Switch matrix with 6 x 2-wire busses, 12 x 2-wire connections
Relay Bus **TR-6-1**	50 relay switched test connections, 2-wire (Hi/Lo) bus
Relay Module **RM-1**	8 undedicated relays, four form-C and four form-A, rated at 1A
IEEE-488 **GPIB-USB** GPIB	General Purpose Interface Bus, IEEE-488 control module and software



Typical test system modules and fixture connections

System Switching Topology

CheckSum test systems offer a flexible switching topology to minimize custom circuitry and to allow test programs to be easily generated for almost any type of assembly.

For all of the standard component measurements, the system software tools setup all of the switching with simple user selections. The test point rules are simple, any test point can be used to measure, source, sense or guard any node on the UUT. This is unlike the other "big-iron" ICT systems that have special MUX Ratios that the programmer must understand and apply.

The system uses a 16 by N (where N is set by the number of test points; 2000 test points would be typical and 25,000 quite large) solid-state analog bus that allows each test point to be connected to one of 16 places. Each point can be a measure source high, measure source low, measure sense high, measure sense low, guard source, guard sense, or DC/AC signal source. The solid-state matrix provides high-speed and reliability for power-down testing, or for functional testing of points that do not exceed ±12V referenced to the controller chassis.

A 2 by M relay matrix bus is also available for signals up to 250VAC @ 1A(i.e., Zener measurements). The power-on modules that support connections to the relay matrix bus are the TR-10, FUNC, MPX-2-50, PWR, Cross Point, HP-1, and TR-6-1.

For power-on testing (functional testing), modules are available to source and measure digital and analog test points. For test points with voltages that are less than ±12Vdc, the solid-state test points can be used for analog signals.

Digital test points are available at the fixture interface blocks. They can be relay-disconnected during power-down test, then enabled (by byte) during power-up test.

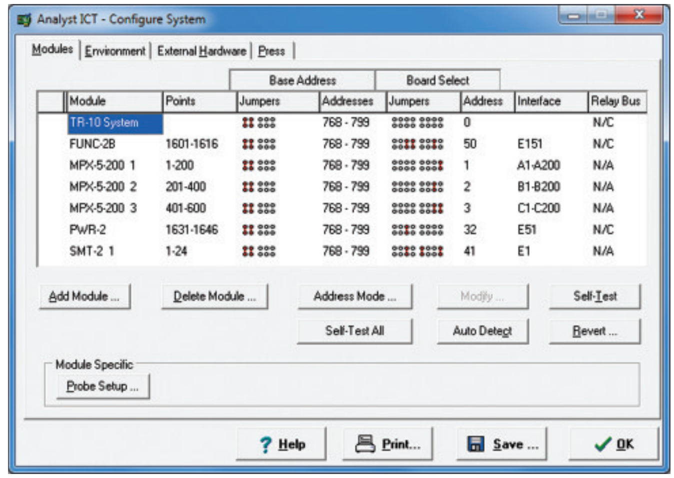
Power outputs are available at the fixture interface blocks. They can be relay disconnected during power-down test. This includes the ground signals so that the UUT is fully floating.

System Software

Test systems include a comprehensive, yet easy-to-use software package. Running in the Windows OS environment, users find it to be intuitive and efficient and includes comprehensive on-line help. The system software package includes System Configuration Control, Test Setup Environment, and Data Logging with Statistical Process Control.

System Configuration

The system configuration is used to setup the system software and hardware as needed. In the actual test system, all of the modules shown in the modules window should match the actual system hardware. There should not be any more or any less modules than are actually installed in the system chassis. In an offline PC, the configuration should match the actual final system. The modules installed in the chassis do not necessarily have to match the order in the system configuration. All of the chassis slots have the identical module signal and power connections.



Older modules used base address only selection. The older module base addresses must have unique, non-overlapping ranges. Newer modules have base address and secondary address selections. With newer modules, the base address must all be the same. The secondary address selections must all be unique. The expected address jumpers are shown and must match the actual module jumpers.

On system power-up, with newer modules, the software verifies the configured modules matches the installed modules. Missing modules are noted, extra modules are not. For older modules, the system cannot verify the modules are installed or not.

The MPX modules do not have to be installed in numerical order, however for simplicity, numerical order is the standard method. Due to internal cable installation requirements, if a FUNC-2B/-2 module is installed, it will be located next to the system module. The board slot next to the system module is normally reserved (open) otherwise.

The modules can be added to a chassis as desired and systems can include multiple chassis. This allows almost unlimited variations and expansion of test connections.

The Interface connections are only used by the CAD conversion software to indicate wiring connections. These entries should match the fixture press (use the Press tab, on the top right).

Typically 6 month (or less) intervals, a complete self-test of all modules should be performed. Whenever any modules are replaced or added, self-test of the modules is required. Start the self-test process with the system module and then the functional module (if installed), prior to any other specific module self-test. The system module uses the first MPX module for the last few self-test steps and if the MPX module fails, the system module will also fail (although, the system module may be working properly). The MPX self-test automatically measures the resistance to the shorting fixture and stores each test point in a table. This allows the system to automatically remove this resistance to more accurately measure low resistance components. Software tools are available to measure and remove stray capacitance to accurately measure low-valued capacitors.

Test Setup Environment

The system can be setup to accommodate a variety of philosophies about how the system is operated.

An unskilled operator can simply place each board on the test fixture and press Start test. Once the test is completed, the screen shows a large red FAIL or green PASS indication. Paperless repair is also possible including built-in serial number tracking.

You can view a real-time Pareto report of failures to quickly detect repetitive process faults.

A panel of assemblies can be tested together. The status of each board in the panel is color-coded with Pass/Fail/Skip.

The test can be setup to Halt on Failure to allow skilled operators an opportunity to examine the assembly.

The system can be configured to input a serial number for each assembly or each board on a panel. The serial number is saved with the test results data log.

A CheckSum test program can call windows compatible executable files. A COM interface is available to access CheckSum tests from external programs such as Visual Basic.

Test Program Generation

The system includes all the software necessary to write and modify the test programs. The system's login capability will prevent program changes by unauthorized personnel.

The CAD data can be used to generate the preliminary test program and a wiring report. The system accepts many popular CAD formats. Once the fixture is built and wired, you can load the generated program, then fine-tune test steps as necessary. Functional programming is hand-entered to meet the specific needs of the board.

Test programs call be created and edited in an interactive spreadsheet-like environment, with each line specifying one test. Programs can be created with a standard text editor, such as notepad, wordpad, TextPad. Programs and data arrays can be input and output with the program editor.

The test programming language is rich in features. In addition to normal measurement and stimulus test types, features include mathematics functions, file I/O, jump based on measurements, math, or operator input, display of messages, operator input, interactive adjustment routines, calling of external programs plus a host of other capabilities. With ActiveX Automation Server, you can automate our software test functions from your application.

Entry or generation of programs can be done off-line in your office. Optimizing the program is done on the test station.

Other tools include measurement X-Bar/Sigma, average, and time for each measurement type.

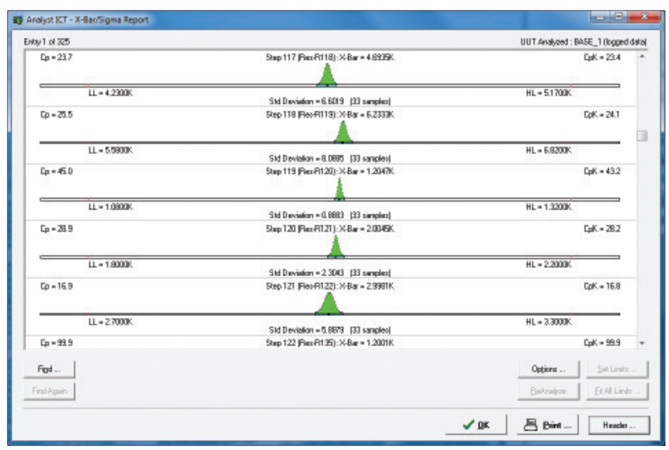
The panelization tools includes a step-and-repeat capability. Once you have debugged the first board in the panel, the system will then automatically generate the steps for the other PCBs. At run-time, the operator can elect to skip PCBs in the panel that are not populated or known-defective. The test data log file saves the test results for each assembly so you know if an assembly was not tested.

Data Logging and Statistical Process Control

The system will log statistical data for each board. Several types of reports, over specified dates are available. These reports can be for all assemblies, or choose particular ones to analyze.

The Production report lists which boards have been tested, the failure rate and how many defects have occurred. The Pareto report lists the faults sorted by occurrence.

The X-Bar/Sigma reports are used to show, by individual measurement, the mean (average), standard deviation, 3-Sigma limits, Cp and Cpk. This data is graphically displayed with a predicted distribution curve and high/low test limits.



While this information can be used to monitor process measurements, it is more often used to help fine-tune test program tolerances. By observing the data, even with a relatively small programming sample size, it is practical to set control limits that are applicable to a wider range of assemblies.

Statistics data is logged in CSV (comma-delimited) format, so that you can access the data with other statistical process control (SPC) software packages.

CheckSum LLC

CheckSum is an American multinational corporation headquartered in Arlington, Washington, United States.

CheckSum test systems utilize sophisticated capabilities such as guarding, complex-impedance measurement, vectorless test with TestJet Technology, in-system programming with the CheckSum MultiWriter on-board part programming system, and fully integrated functional test.

By providing reliable, high-performance, easy-to-use, PC-based in-circuit test (ICT) systems with excellent support and documentation, CheckSum is able to sell its products at a fraction of the cost of comparable test systems from traditional ATE companies.

Our installed base of over 3000 systems worldwide is a proven solution for customers ranging from consumer, automotive, and industrial OEMs to global contract manufacturers. In addition, CheckSum is the only U.S. ATE vendor supplying complete turnkey bed-of-nails test fixtures, program and support.

CheckSum designs, develops and manufactures the critical components of its test systems. Test systems include the measurement electronics, software and fixturing components that provide a complete system solution. In addition, CheckSum can provide custom fixturing and programming for your assemblies.

This fundamental product and engineering-oriented approach to design, sales and support has allowed CheckSum sales to grow significantly each year, from its start in 1987 to a multi-million dollar corporation today.

In the U.S., CheckSum sells directly from our headquarters in Arlington, Washington. If a CheckSum Test System doesn't work to your complete satisfaction, it can be returned within 30 days for a prompt refund or cancellation of the invoice.

Visit our web site at ***www.checksum.com*** for up-to-date, on-line information.

- Reasonably priced in-circuit test systems to over 5000 points.
- The world's first gang programming system for programmable parts already mounted on circuit boards and panels.
- Bed-of-nails fixtures—pneumatic and vacuum; single- and double-sided; single-stage and dual-stage.
- Complete part programming and test programs, including boundary-scan and functional test.
- Engineer-to-engineer telephone support.

CheckSum LLC

6120 195th Street NE

Arlington, WA 98223

1-877-CHECKSUM / +1 360.435.5510

FAX +1 360.435.5535

Email: sales.support@checksum.com

www.checksum.com

Specifications subject to change (20140915)