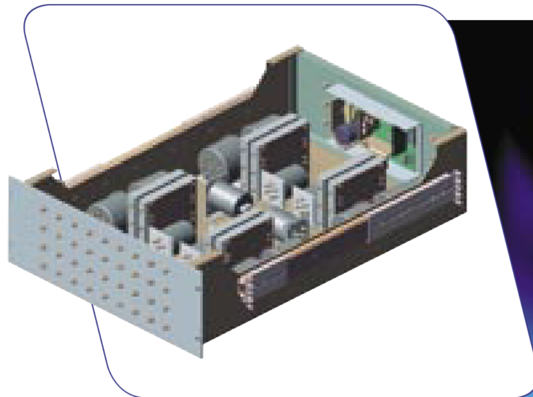
Switching

This section outlines our products and services for automated signal routing

SMIP*II*™ switching solutions for:

- High Fidelity Analog
- RF
- Audio
- Microwave
- Optical



The introduction of the Switch Modularity and Interface Platform (SMIPII™) revolutionized the automated signal switching marketplace by providing a level of modularity, density, and performance that continues to be unparalleled in the marketplace.

The SMIPII™ product family is at the heart of many test stations worldwide, ranging from large military and aerospace installations to smaller commercial testers. Reliability, functionality, and ease of use have resulted in successes with programs such as the F-35 Joint Strike Fighter LM-STAR, the Navy's RT-CASS, and the F22 CATS.

Commercial manufacturers are also leveraging these advantages to serve markets including automotive, medical, personal computers, oil exploration, and home entertainment. Whether the product is a critical engine control module, a life sustaining pacemaker, or the power supply for your laptop, performance is essential, and SMIPII™ switching solutions ensure reliable test performance.

The Switch Modularity and Interface Platform (SMIP*II*™) Family (dc to RF)

Base Units

SMP1100	Single-slot Plug-in Base Unit (holds up to two switch modules)
SMP1200	Double-slot Plug-in Base Unit (holds up to six switch modules)

Power and High-Voltage Switch Modules

SMP2001A	20 SPST 16 A Power Switch
SMP2002A	12 SPDT 16 A Power Switch
SMP2003	8 SPDT 20 A Power Switch (SMP1100 only)
SMP2004	12 SPST 20 A Power Switch (SMP1100 only)
SMP2005	3 SPDT & 3 (1x4) 20 A Power Switch (SMP1100 only)
SMP2007	1x48 High-voltage Multiplexer
SMP2008	16-channel DPST 500 V Relay
SMP2009	16-channel SPDT 500 V Relay
SMP2012	10 SPST 30 A Power Switch (SMP1100 Only)
SMP2104	10-ch 20 A dc Solid State Switch (70 A dc in-Rush Current)
SMP2300	24 SPST or 12 SPDT 500V, 2 A Carry (50 Ω)
SMP2300-93	24 SPST or 12 SPDT 500V, 2 A Carry (93 Ω)

General Purpose Multiplexers

SMP3001	64x1 2-wire Multiplexer or 128x1 1-wire
SMP3001DS	64x1 2-wire Multiplexer, Discharge Capability
SMP3002	16 (1x8) 1-wire Multiplexer
SMP3005	12 (1x5) 2-wire Multiplexer

Matrix Switching

SMP4001	9 (4x4) 2-wire, 2 A per Channel
SMP4002	1 (4x36) 2-wire, 2 A per Channel
SMP4003	2 (4x16) 2-wire + 1 (4x4) 2-wire, 2 A per Channel
SMP4004	1 (8x16) 2-wire + 1 (4x4) 2-wire, 2 A per Channel
SMP4005	1 (12x12) 2-wire, 2 A per Channel
SMP4006	3 (4x12) 2-wire, 2 A per Channel
SMP4007	2 (8x8) 2-wire + 1 (4x4) 2-wire, 2 A per Channel
SMP4001-S	User-definable, 2 A per Channel
SMP4028	8 (2x8) 50 Ω Coaxial Matrix
SMP4044	8x20 50 Ω Coaxial Matrix

General Purpose Relays

SMP5001	80 SPST Relays, 2 A per Channel
SMP5002	50 SPDT Relays, 2 A per Channel
SMP5003	26 (1x4) 2 A Switch Module
SMP5004	30 SPDT 5 A
SMP5005	48 SPST 5 A, 220 V

Coaxial

SMP6001	10 (1x4) Coaxial Trees >900 MHz
SMP6002	17 (1x2) Coaxial Switches >900 MHz
SMP6004	3 (1x8) 3 (1x2) Star Switches >500 MHz
SMP6005	8 (1x4) Star Switches >500 MHz
SMP6006	2 (1x16) 500V, Star Switches >250 MHz
SMP6101	10 (1x4) Coaxial Trees >1.3 GHz
SMP6102	17 (1x2) Coaxial Switches >1.3 GHz
SMP6122	6 (2x2) Matrix >1 GHz
SMP6144	4x4 Matrix >1 GHz
SMP6103	1x31 RF Mux
SMP6201	10 (1x4) Coaxial Trees - 75 Ω (less than 500 MHz)
SMP6202	17 (1x2) Coaxial Switches - 75 Ω (less than 500 MHz)
SMP6301	4 (1x4) Self-terminated >1.8 GHz (SMB Connectors)
SMP6905	6 2-way 10 MHz-1 GHz Splitters, 2-wide SMIP Module

Digital I/O

SMP7500	96-channel 300 mA Open-collector Digital I/O - Relay Driver

Programmable Load

SMP7600	Single-channel Programmable 5 W Load

Connector Information

Microwave Switch Modules

SM7000N	Single-slot Base Unit
SM7001A	Self-Terminating 18 GHz Switch Base Unit
SM7001L	Self-Terminating 18 GHz Microwave Latching Switch Base Unit
7374	SP6T 18 GHz Relay Terminated
7374L	SP6T 18 GHz Latching Relay Terminated
SM7012L	12 SPDT 20 GHz Latching Relays Terminated
SM7013L	3 SPDT 20 GHz Latching Relays Terminated
SM7016L	6 SPDT 20 GHz Latching Relays Terminated
SM7002-1	1 (1x6) 40 GHz Microwave Module
SM7002-2	2 (1x6) 40 GHz Microwave Modules
SM7002-3	3 (1x6) 40 GHz Microwave Modules
SM7002-4	4 (1x6) 40 GHz Microwave Modules
SM7100 4x4	20 GHz Non-blocking Matrix
SM7100-26	4x4 26.5 GHz Non-blocking Matrix

Custom Microwave Switch Matrices

SM700x-S	User defined matrix configurations

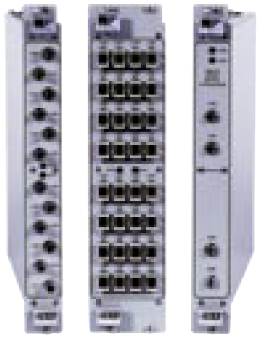
Optical Switch Modules

SM8001	Single-slot, Multi-channel Base Unit
SM8002	Double-slot, Multi-channel Base Unit
SM8003	Single-slot Prism Switch Base Unit
SM8101	Single-channel Programmable Attenuator
SM8102	Double-channel Programmable Attenuator

VMEbus

SVM2001	60 SPDT 1 A Relay Switch Module
SVM2002	26 SPST 5 A Protected Switch Module
SVM2003	100 SPST 2 A Protected Switch Module
SVM2004	4 SPST 10 A, 2 SPST 10 A, 20 SPDT 5 A, Switch

(SMIP *II*™) Switch Modularity & Interface Platform



DC to RF
SMP1200 and SMP1100

OPTICAL
SM8001, SM8002, SM8003, SM8101, SM8102

MICROWAVE
SM7000N, SM7001A, SM7002, SM7100, Custom Matrices

The only switch family on the market offering comprehensive signal switching from "dc to Light"

Modular building blocks in each frequency range allow flexibility and increased density

Designed to offer the switching features of VXI message-based systems, with the throughput of register-based systems

Extensive non-volatile memory allows storage of data such as module serial numbers, maintenance dates, plus more

VXI*plug&play* drivers and logical relay mapping ease programming and reduce software maintenance

Hardware based switch control interface eliminates communication latencies associated with other common implementations and platforms

Extensive triggering, scan lists, and failure interrupts significantly improve overall system throughput

Designed to reduce the size by at least 30%, and the cost by at least 20% from previously available switching solutions

The SMIP*II*™ family is comprised of three distinct switching groups divided by frequency range. Each switching group has its own base units designed to maximize the modularity and flexibility of switching within that frequency range. Switch control and programming features remain consistent with the overall SMIP*II*™ family.

Switching

Overview

SMIP*II*™ is designed with modularity, density, and cost in mind. Unlike "first generation" VXIbus switching solutions, the SMIP*II*™ family consists of switch modules that can be mixed and combined within a VXIbus card to form flexible, high-density switch configurations. The SMIP*II*™ family reduces the size of switching solutions by at least 30%, and the overall cost by at least 20% compared to solutions from other manufacturers - regardless of the platform (GPIB, VME, VXI or PC).

Each SMIP*II*™ base unit includes a switch control interface board, which has one of the most advanced switch control designs on the market. The interface has been designed to provide all the features of an intelligent message-based switching system, but with the speed and flexibility of a register-based device. These features are achieved in hardware on the control interface board, rather than in a driver or via on-board microprocessor based firmware. This approach to the interface design guarantees the user that all communications to the switch occur in microseconds, as opposed to several milliseconds, considerably improving system throughput.

The advanced register-based interface design allows new switching modules to be introduced into the product family without the need to reprogram EEPROMs or exchange control modules, as is common with other switching systems.

The SMIP*II*™ interface supports direct register control of all relays, the ability to download scan lists with backplane trigger advance, and hardware implemented break-before-make and make-before-break switching. By using direct register access, switching speeds are maximized while keeping VXIbus backplane traffic to a minimum. By using the trigger feature, large switching systems across multiple mainframes can be controlled with a single command.

The supplied VXI*plug&play* drivers provide support for higher level commands and a unified switch interface.

Signal Integrity

All SMIP*II*™ switch modules have been designed with over a decade of experience in signal switch design and are optimized to preserve signal integrity. All switch modules employ multi-layer PCB designs with extensive ground planes and shielding where appropriate, with relays also being selected to maximize signal integrity. Signal ground planes are isolated from the control circuit grounds, and signal paths are designed to minimize crosstalk between channels.

To further minimize any digital noise, the control circuitry goes into a quiescent state when not processing commands, making it possible to switch low-level signals. Mating connector shrouds are also available to permit cable harnesses to be crimped, soldered or connected via terminal blocks, so the user can select the best method of cabling for the application.

Programming

The SMIP*II*™ family of switch modules is programmed using direct register access for fast data throughput and boasts the following features for easy programming and integration:

Automatic Scanning: A predefined sequence of channels or set-ups can be programmed into 1 MB of RAM, and can be incremented by software or hardware trigger sources. This approach relieves the host controller from having to tie up the VXIbus backplane when scanning.

Programmable Timing Delays: A delay can be programmed between relay closures to allow for settling times of other system resources. When used with triggers and automatic scanning, a controlled synchronous switching system can easily be configured.

Confidence Checking: Internal feedBack provides confidence of relay closures.

Extensive Triggering: Triggers can be generated when a relay closes and settles, and programmed relays can be actuated upon receipt of a trigger to allow for synchronization between other devices. Since trigger management is performed in hardware, triggers command a relay to open or close within microseconds, as opposed to several milliseconds from competing systems that support triggers.

Make-Before-Break and Break-Before-Make: Relay control implemented in hardware eases software burden and considerably improves system throughput.

Safety Interrupt: This is a programmable fail-safe feature that allows all relays to open based upon external or TTL backplane triggers. Signals can be removed from the unit under test if a system fail-safe occurs, such as inadvertent removal of a test adapter.

Non-volatile Memory: Allows users to store pertinent information such as maintenance records, relay specs, installation dates, serial numbers, and last user's id.

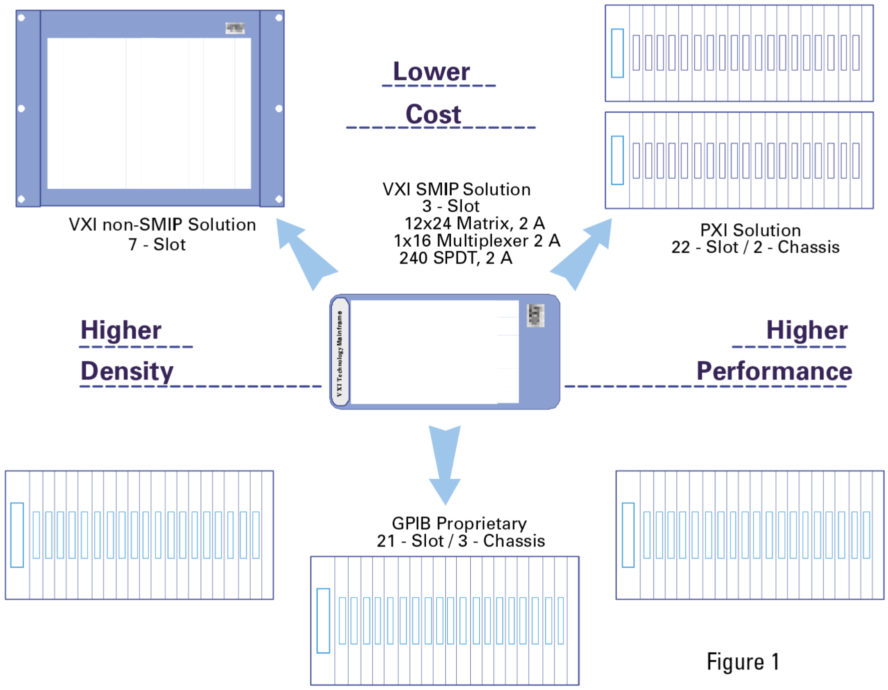


Figure 1

Overview

There are many different types of Automated Test Equipment (ATE) systems available to help manufacturers improve production quality and throughput. Although these test stations are used in different applications, they all share one common denominator - a signal switching system - that directs the 'input/output traffic' between the test stand instrumentation and the devices being tested.

The budget allocated to ATE for manufacturing test, or even for service and repair, is considered part of the overhead in bringing the final product to market. Reducing this cost, therefore, is an important consideration. The goal of meeting the budget can be achieved by decreasing the purchase price of the ATE station, or increasing its throughput (i.e., increase the number of units being tested per day).

With advancements in technology, and competitive constraints increasing, the need to drive down overhead costs has intensified. Modular high-density VXIbus instruments, such as the VMIP™ family, have helped improve the size, cost and throughput of VXIbus systems; virtually every new test station being designed today utilizes modular VXIbus instruments. The SMIP//™ switch family architecture leveraged off this trend, and continues to improve the cost/benefit ratio of the production test cycle.

Reduced System Size and Cost, Improved Density and Modularity

There are numerous standards and platforms for ATE equipment, and price and performance are key factors in determining the correct platform for the application. Whenever a large amount of signal switching is required in an ATE system, VXIbus always makes cost-effective sense, and in many cases helps justify the decision to select a VXIbus system. While first generation VXI products made very real and measurable improvements in ATE signal switching, the "next generation" of signal switching systems, driven by the SMIP//™ series, have vaulted the VXIbus to a higher level in terms of performance, density and value.

First generation VXIbus switch cards contained one switch configuration per card slot (e.g., 32 SPDT, 64x1 2-wire scanner, 4x64 matrix), very similar to first generation VXIbus instruments. These switch systems are typically GPIB/VME-based products converted over to the VXIbus. The SMIP//™ series takes advantage of the recent advancements in relay and driver technology, providing higher performance switches in a smaller footprint.

The SMIP//™ family provides a level of modularity and density that is unatainable from other manufacturers by reducing the number of required slots, and cost, associated with VXI based solutions. These advantages span beyond the VXIbus platform to provide a price and performance advantage over GPIB, psuedo-standards, and proprietary solutions.

An application for testing engine control modules called for the following switch requirements and demonstrates the size and cost advantages of the SMIP//™ family, compared to platforms and solutions from other manufacturers:

12x24 matrix	-	**Connect engine control module I/O to test station**
64-ch multiplexer	-	**Connect DMM to multiple measurement points**
240 Form-C Relays	-	**High-density general purpose switching**

The three switch systems proposed are detailed in Figure 1. A competitive solution occupies seven slots, whereas the modular switch system (SMIP//™) occupies only three. Comparable solutions in GPIB and other psuedo-standards can also be seen. The SMIP//™ was selected because an additional four slots were freed up for instrumentation purposes, and also because the switches are rated for 2 A as opposed to 1 A in the first generation system. Additionally, this system could have been reduced to a six-slot mainframe, had portability been an issue. Subsequent hardware costs are considerably reduced (30-40%) because the modular system utilizes shared resources (i.e., connectors, VXIbus interface, sheet metal, etc.).

Improved Throughput and Performance

The VXIbus offers tremendous advantages in reducing test cycle times because the instruments and switches share a common backplane. The VXI specification reserves eight lines dedicated to triggering back and forth between instruments. VXI switch cards that utilize scan lists (a sequence of relay states) can then be triggered to advance through this list by an instrument on the bus.

For example, test specifications of a device often require the verification of continuity or isolation between connector pins. A DMM is most often the instrument used to verify the results. The continuity/isolation test can involve a large number of pins. Thus, the DMM needs to be switched to a connector pair and take its measurement before moving to the next pair. This sequence of events can take a significant amount of time, due to the overhead in handshaking between the DMM and the switch card, particularly if pre-programmed scan lists are not utilized. By utilizing a VXI-based card with a scan list, all handshaking can be done across the backplane, and since the scan list is stored in memory, no software overhead is incurred. Large channel counts can be scanned in a fraction of the time through the use of on-board scan lists.

GPIB and other switching solutions implement scan list capabilities several different ways. A GPIB switch or message-based switch card requires an 'intelligent interpreter' that usually takes the form of a plug-in card. Scan lists are stored on this card and message-based commands are parsed by the interpreter. Traditional register-based switch cards must have a driver downloaded to the Slot 0 controller and this driver acts as the interpreter. In both cases, ASCII strings (messages) are sent via the host controller to set up the switch card and scan list. There is also a relatively substantial amount of latency between the time a trigger is received by the switch card and the time the card issues a trigger to the backplane indicating that the relays have settled (10 ms - 40 ms).

The SMIP//™ series builds the intelligence (scan lists) into the hardware registers. The time delta between TTL trigger in (command to close the relays) and TTL trigger out (indicating relays have settled) is effectively reduced to the settling time of the relay itself (about 3-5 ms). An excellent example highlighting the effectiveness of this technique was demonstrated by a defense contractor exercising a missile simulator (See Figure 2). Stimulus is applied to the launch sequencer via a Form C switch. The launch sequencer replies with an 'initiate fire ready' command and the stimulus must be removed to ground within 10 ms. The only viable solution was to use a switch card with its scan list and control built into the hardware, as the latency times were well within the window of acceptance. The switch card selected in this case was VXI Technology's SMP5002.

1 Stimulus is applied to the sequencer via the normally closed contact of a Form C relay on an SMP5002 card.

2 The sequencer processes the data and issues an 'initiate fire' command, sending out a pulse on TTL0 of the VXI backplane. The Time Stamp module records TTL0 pulse as t0.

3 The SMP5002 also detects the pulse on TTL0 and the relay changes state.

4 The SMP5002 issues a 'relay settled' pulse on TTL1, which the Time Stamp records at t1. D_t (t1-t0) needed to be less than 10 ms to meet specification for this application (verified to be under 3 ms).

This was compared to a D_t of over 40 ms from a switch module that used an intelligent interpreter plug-on card.

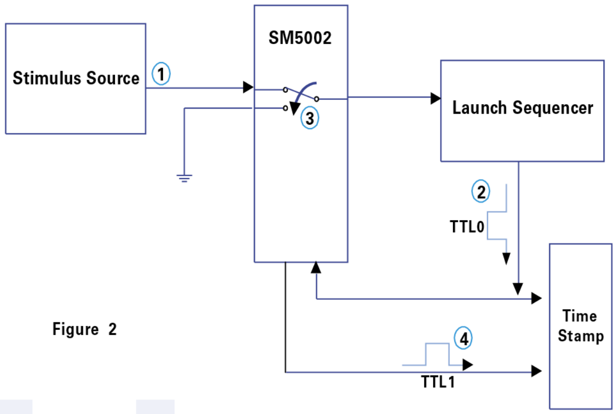


Figure 2

Switching