

FrameScan FX 2.0 FAQ

This document answers frequently asked questions about the FrameScan vectorless test techniques that are used for detecting open pins on Teradyne TestStation and Spectrum in-circuit testers.

Q: What is FrameScan?

A: FrameScan is a vectorless test technique that was originally developed by Teradyne for detecting open pins on component packages and connectors. FrameScan uses a capacitive test technique that tests for open pins by applying an AC signal to a node on an un-powered printed circuit board and measuring the voltage that is coupled to a plate that is positioned in close proximity to the component package or connector that is being tested.

The FrameScan software automatically learns the voltages that are coupled to the capacitive plate for each pin and sets appropriate voltage thresholds. During production testing, any pins that fall below the minimum learned voltage thresholds are reported as open.

The capacitive opens technique is popular with programmers because it is an un-powered technique that is fast to implement, provides precise pin diagnostics, and does not require the creation of complicated test vectors.

The FrameScan technique was developed originally for Teradyne's Z18XX and Spectrum in-circuit testers and is equivalent to Agilent's TestJet vectorless test technique. GenRad implemented a capacitive opens technique on their GR228X and TestStation in-circuit testers called Opens Xpress. The difference between Opens Xpress and FrameScan is the fixture hardware that is used to make the measurements. Opens Xpress uses passive pickup plates with the raw signal fed from the capacitive plates to a combined buffer/multiplexer board. FrameScan and TestJet use active pickup plates, where each plate has a buffer amplifier mounted directly on it, with the amplified signal fed to a multiplexer/selector board.

Since the FrameScan technique provides better fault coverage of small lead frame packages and connectors, and it is less susceptible to noise that may occur in the test environment, Teradyne upgraded the GR228X/TestStation software in June of 2004 (version 5.8.0) to support both the Opens Xpress and FrameScan vectorless test techniques.

FrameScan is usually quite effective at detecting open pins on most device packages and connectors, however some device packages are untestable with FrameScan because they have internal ground planes that shield the AC signal or have very small lead frames that minimize the voltage that is coupled to the capacitive plate.

Q: What is FrameScan FX 2.0?

A: FrameScan FX 2.0 is Teradyne's 3rd generation vectorless test solution that was developed in response to the smaller device packages and connector technologies that are being used on new board designs. FrameScan FX 2.0 has advanced measurement hardware and improved software algorithms that dramatically improve its ability to measure opens reliably on today's small geometry packages and complex connectors. The hardware improvements include a new low noise amplifier that increases the front-end gain of the active probe to minimize the effects of noise components at other stages in the measurement circuit and a new multiplexer/selector board designed with low noise circuit devices and a circuit topology that rejects common mode noise. The software improvements include an automatic precision mode that increases the number of measurement samples for low measurement signals and a new threshold setting algorithm that is optimized for increased fault coverage and the elimination of false positive and false failure diagnostic results.

Teradyne markets these collective vectorless test hardware and software features under the product name **FrameScan FX 2.0**.

Q: What fixture hardware does FrameScan FX 2.0 require?

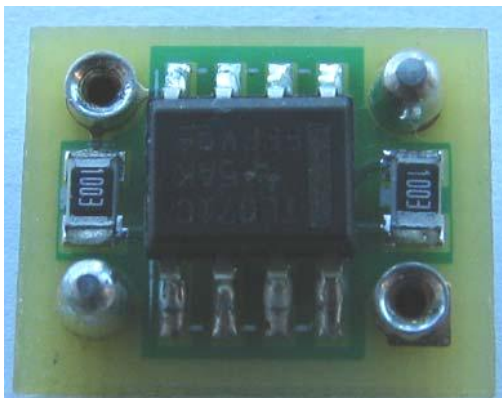
A: FrameScan FX 2.0 uses a different Amplifier and Selector board than the previous generation Framescan Plus solution. The pictures below show the amplifier and Selector boards for both the Framescan Plus and Framescan FX 2.0 solutions:



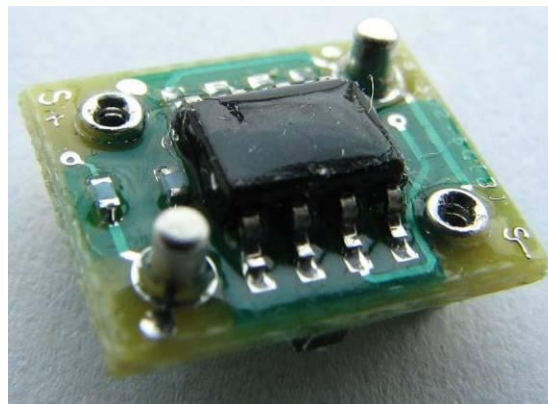
Framescan Plus Amp (Bottom)



Framescan FX Amp (Bottom)

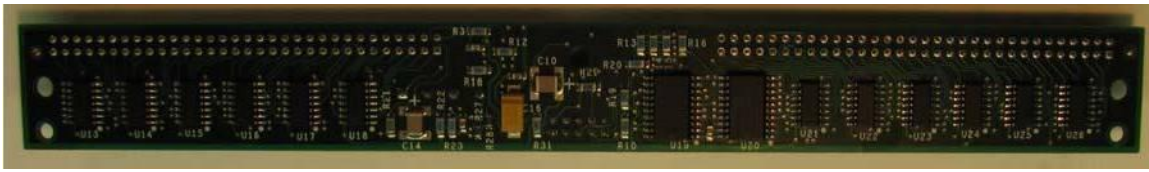


Framescan Plus Amp (Top)



Framescan FX Amp (Top)

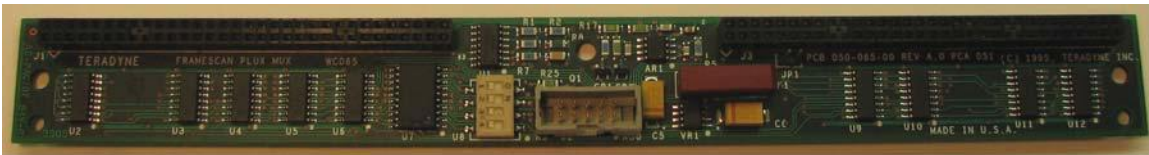
Note that the Framescan FX amplifier has the Teradyne logo and silkscreen to identify the positive and negative terminals of the amplifier. The Framescan FX amplifier also has a conformal coating to improve its noise immunity.



Framescan Plus Selector Board (Bottom)



Framescan FX 2.0 Selector Board (Bottom)



Framescan Plus Selector Board (Top)



Framescan FX 2.0 Selector Board (Top)

The Selector board routes the signals from the sensor plate/amplifiers in the fixture to the tester's voltmeter. The Selector board requires three separate voltages to power-up (+5V and +/-15V). This means that to run FrameScan on TestStation systems, they must be configured with the Fixed Power Supply option.

Note that you can tell which selector board is being used in your fixture by comparing it to the pictures above, The newer Framescan FX 2.0 Selector Board uses different components and the difference in component placement is significant between the two board types.

It is possible to use either the traditional Framescan Plus active amplifier or the new low-noise FX amplifier with increased signal gain with either selector board. Both amplifier types can be mixed in the same fixture allowing developers to easily switch to FX amplifiers if they find that the fault coverage is insufficient when using the traditional amplifier to test a micro-BGA or small connector packages. Switching is as easy as replacing the standard amplifier with the FX amplifier and re-learning the voltage measurements for the part.

However, Teradyne recommends that new fixtures designs always use the latest Framescan FX 2.0 Selector board and FX Amplifiers because they provide improved noise rejection, increased signal path gain, and higher signal to noise ratio.

Teradyne has also learned that some customers are using cloned versions of the Framescan Selector board. These cloned boards do not meet Teradyne's electrical and functional specifications and have been shown to provide inferior performance. Please make sure that your fixture manufacturer purchases your Framescan hardware components from Teradyne Part Sales. Teradyne can only guarantee adequate performance when authentic Teradyne Framescan Selector boards and amplifiers are used. Please refer to the pictures above to confirm that your fixture is using the right parts.

Q: How do I order the Framescan hardware?

A: Most in-circuit fixture manufacturers keep a stock of FrameScan hardware components so that they can quickly satisfy customer requests. You can also order parts directly by calling your local Teradyne sales office.

Teradyne sells two FrameScan Fixture Kits to support both the original Framescan Plus solution and the new Framescan FX 2.0 solution. Each kit includes the following elements that make it possible to install up to 64 amplifiers / sensor plates:

PN 047-530-00 Framescan Plus Fixture Kit:

- 1 FrameScan Plus Selector Board, PN 051-065-00
(Not recommended for use on new fixture developments)

PN 602-946-00 Framescan FX 2.0 Kit:

- 1 FrameScan FX Selector Board, PN 026-013-00

Both of these kits include the following cables which are used by the fixture assembler to connect the Framescan Selector board to the tester interface:

- 2 HDR, 64 pin, double row, w/w, PN 359-489-64
- 1 HDR, 10 pin, ribbon, w/w, PN 359-490-10
- 2 CONN, 10 pin, ribbon, PN 063-079-00
- 24" CBL, 10 conductor ribbon, PN 084-34X-00

Three different amplifier kits can be purchased for use with Teradyne's Framescan technique. Each kit comes with 10 amplifiers and associated hanger probes for attaching the probe sensor plate to the amplifier:

PN 047-531-00 FrameScan 10 Amp Kit

- This is the lowest performance amplifier, equivalent to Agilent's TestJet amplifier.
(Not recommended for use on new fixture developments)

PN 093-284-00 FrameScan FX Horizontal 10 Amp Kit

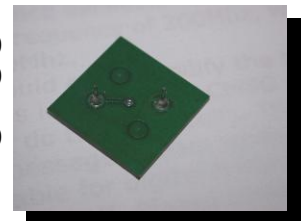
- This is a kit of 10 high performance Framescan FX amplifiers with a standard horizontal orientation.

PN 093-318-00 FrameScan FX Vertical 10 Amp Kit

- This is a kit of 10 high performance Framescan FX amplifiers with a vertical orientation to make it easier to test very small parts with tight spacing.

Finally, Teradyne also sells various size capacitive sensor plates. These plates are typically cut to size by the fixture manufacturer to match the dimensions of the component or connector that is being tested by Framescan. The available Framescan sensor plate kits are:

- FrameScan Sensor .375" x .475", (kit of 10 assemblies) PN 090-360-00
- FrameScan Sensor .425" x .575", (kit of 10 assemblies) PN 090-361-00
- FrameScan Sensor .500" x 6.25", (kit of 1 assembly) PN 090-362-00
- FrameScan Sensor 1.25" x 1.25", (kit of 10 assemblies) PN 090-363-00
- FrameScan Sensor 2.56" x 2.56", (kit of 1 assembly) PN 090-364-00
- INSULATOR, Sheet 5.25" x 7.25" (kit of 10 sheets) PN 047-533-00



Refer to Appendix J of Teradyne's **Vectorless Test Techniques User's Guide** (PN 606-247-XX) for complete FrameScan assembly information and instructions.

Q: What ICT tester models will support FrameScan FX?

A: Framescan FX was originally developed on software version 5.9.0 and Spectrum version 5.0 software. The new software algorithms were not added to the older software versions therefore it is **NOT** supported on the discontinued GR228X, TS8X, and Z18XX tester models.

Teradyne announced in 2004 that software release 5.8.0 would be the last software version that would support Combo based test systems. Teradyne stopped selling Combo based systems when the UltraPin boards were introduced back in 2001.

Manufacturers with these older model testers must upgrade to the latest TestStation UltraPin or Spectrum testers before they can take full advantage of the FrameScan FX 2.0 capabilities. Alternatively, these manufacturers can continue to use the original FrameScan, Opens Xpress, DeltaScan, and Junctions Xpress vectorless test techniques that remain available on those older tester models.

It is possible for customers with Combo based testers to experience some of the hardware benefits of Framescan FX (they can use the low noise high gain FX selector board and amplifiers in their fixtures), but they will not experience the full benefits because the enhanced FX software algorithms are not available in the 5.8.0 software. This makes it possible to design a single fixture that will run on both Combo and UltraPin based systems. But, because of the software differences between the two systems, it will be necessary to learn and maintain two separate Pin Opens Data files (POD) for the two systems. And, since the 5.8.0 software does not contain the improved high accuracy mode algorithms that are only available in later versions of the software, measurement readings will be lower and the overall pin fault coverage may be reduced when running on Combo based test systems.

If developers want to maintain a single POD file for both their Combo and UltraPin based testers, they can learn and create the POD file on their 5.8.0 software and then move it to their UltraPin based tester. Doing this will maintain compatibility, but the developer will not gain the benefits of the higher performance FX software algorithms. POD files that are created on later versions of the software cannot be moved back to Combo based systems running version 5.8.0 software (the software is forward compatible, but not backward compatible).

Teradyne offers attractive programs that allow customers to trade-in their Combo based test systems (at more than 3 times their fair market value) for brand new UltraPin based test systems. Taking advantage of these programs will allow manufacturers to get all the benefits of the new Framescan FX and SafeTest technology and numerous software enhancements.

Q: How much does Framescan FX cost?

A: Contact your local Teradyne Representative or atd-parts-sales@teradyne.com for the latest pricing information. There may be additional costs to run FrameScan FX 2.0 on the TestStation that depend on what hardware is in the tester, what software options are licensed, and the status of the manufacturer's support contract:

- If the TestStation UltraPin based tester has an active Software Support Contract (SSA), a FrameScan/Opens Xpress software license, and a Fixed Power Supply; then there are no additional costs. As soon as the latest TestStation version software is installed on the tester, FrameScan FX 2.0 will be available.
- If the tester is not under an active SSA contract, then the manufacturer must purchase an SSA contract before they can install the new software on their TestStation system. Software support contracts can be purchased from Teradyne by contacting atd-parts-sales@teradyne.com.
- If the target TestStation system does not have the +5V/±15V (PN 9010034101) or +5V/±12V (PN 9010078901) Fixed User Power Supply option, then the manufacture must purchase and install one of these fixed supplies in their TestStation system before they can run FrameScan.
- If the TestStation target tester is not licensed to run the FrameScan/Opens Xpress capacitive opens vectorless test technique, then it will not be able to run any FrameScan tests.

To encourage manufacturers that have older ICT tester models, Teradyne offers generous trade-in programs that allow them to upgrade to the latest TestStation UltraPin test systems so that they can receive all the benefits of SafeTest and enhanced FrameScan FX technologies. Refer to Teradyne's Assembly Test Division website or your local Sales representative for more information.

Q: When should Opens Xpress be Used?

A: The Opens Xpress capacitive opens technique is available as an option on all GR228X and TestStation testers and still remains effective for many device packages and connector components. If manufacturers are developing programs and fixtures that need to run on older GR228X and TestStation non-UltraPin test systems, then Opens Xpress or the original FrameScan hardware can be used.

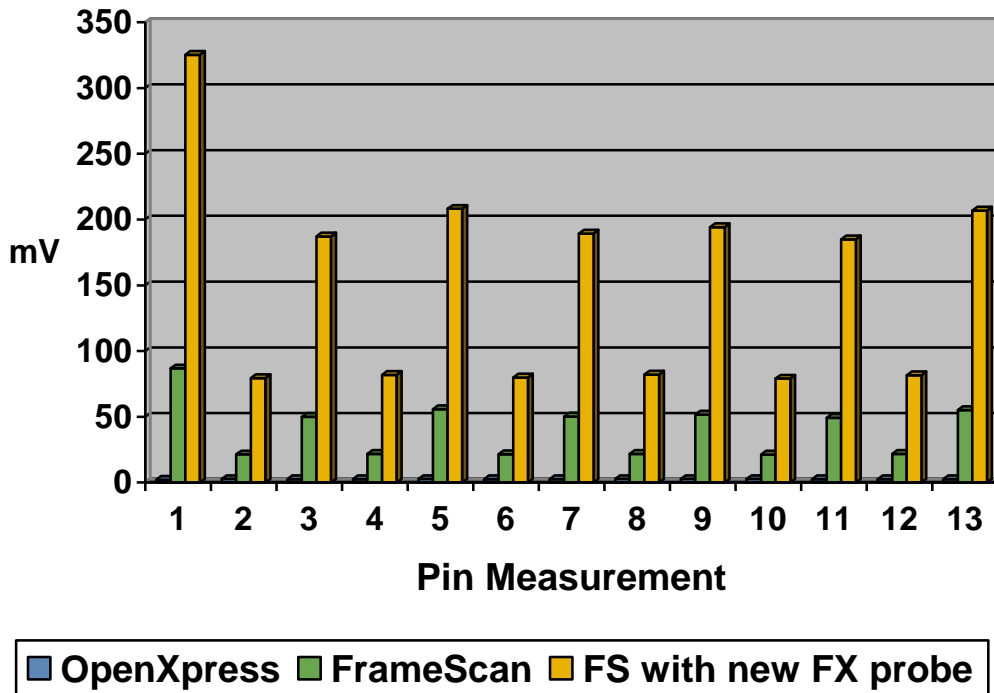
Since the FrameScan vectorless technique is capable of measuring smaller signals and is less susceptible to noise in the manufacturing environment, Teradyne recommends that FrameScan be used instead of Opens Xpress in most situations.

Q: How does FrameScan FX 2.0 compare with Framescan and Opens Xpress?

A: Teradyne has performed evaluations comparing the capabilities of Opens Xpress, FrameScan, and FrameScan FX 2.0. Here is a summary of the findings that were reported during those evaluations:

- The active probe plate used by the original FrameScan technique improved the Signal-to-Noise Ratio by more than 3 to 1 (9.5dB) compared to the passive probe plate (no amplifier) approach that is employed by Opens Xpress.
- The low impedance measurement path of the FrameScan hardware is less likely to be affected by noise sources in the Manufacturing environment (fluorescent lighting, other capital equipment, proximity of operator, etc.). Using a signal generator as a noise source and placing it close to the measurement probe proved this. The FrameScan S/N ratio was only slightly affected by the noise source (reduction of 2dbV: 43dbV to 41dbV) while the effect on the Opens Xpress S/N ratio was much greater (reduction of 46dbV: 50dbV to 4dbV).
- Standard FrameScan measurements averaged 2-4 times higher than Opens Xpress measurements (some pins measured greater than 10 times higher with FrameScan).
- Standard FrameScan measurements with FX amplifier probes averaged 6-7 times higher than Opens Xpress measurements (some pins measured greater than 70 times higher with FrameScan FX). The comparison chart below shows the typical difference in measurement magnitudes between the three different techniques.

Capacitive Opens Technique Comparison



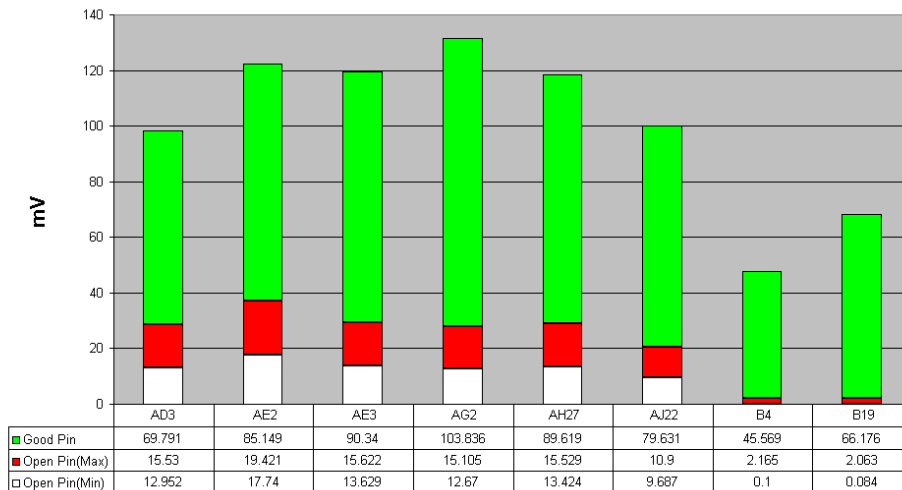
The opens pin fault coverage differences between the three techniques had small to large variations depending on the device packaging and lead frame sizes. The chart below shows that the FrameScan with FX probe vectorless opens test technique had the best pin fault coverage for all package types.

Capacitive Opens Fault Coverage Comparison

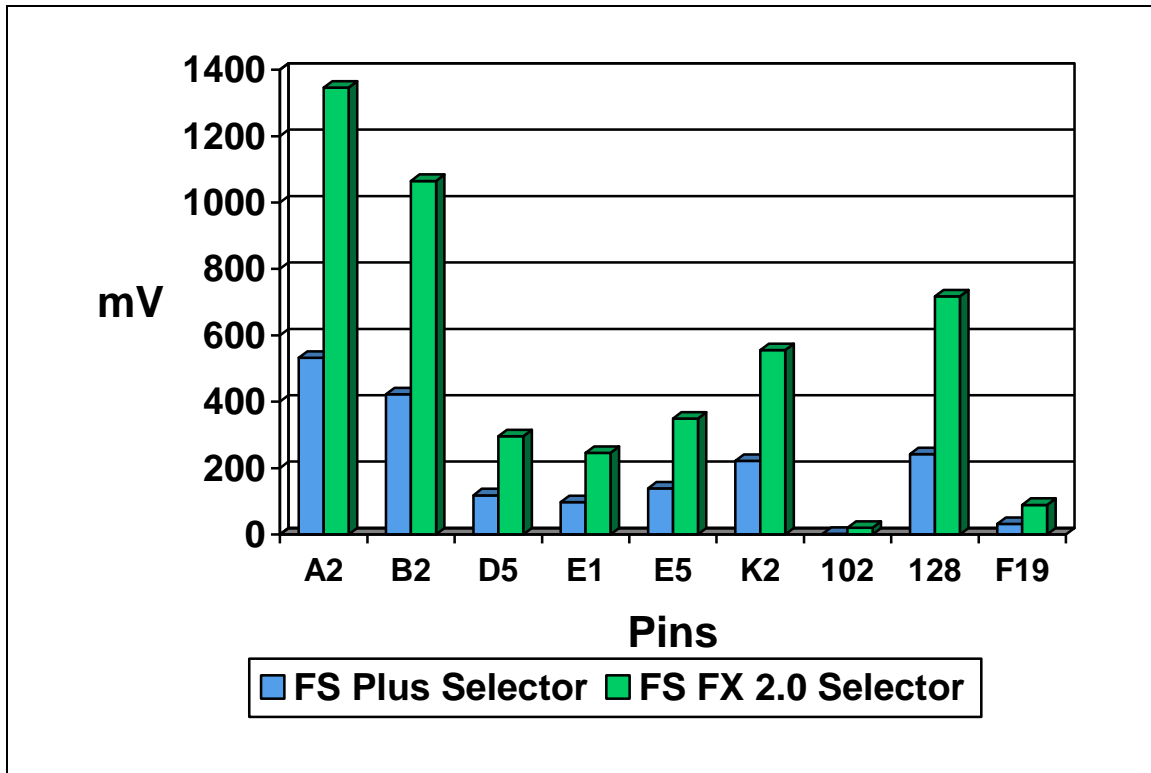
Device	Type	OX Coverage	FrameScan Coverage	FrameScan with FX Probe
U8A1	82562EZ	3.0%	36.3%	74.71%
U8G1	82801F	56.5%	62.6%	93.01%
U2J1		90.09%	90.09%	100%
U34	Northbridge	90.1%	91%	95.8%
U58	CPU Socket	82.8%	98.9%	98.9%
J1	DIMM Connector	92.8%	100%	100%

- The higher measurement signal and Signal-to-Noise ratio of the FrameScan with FX amplifier technique decreased the likelihood of false failure and false passes. The chart below shows the large difference in voltage potentials that were measured when open pin faults were intentionally injected on the board. FrameScan FX was able to correctly diagnose all the device pins that had open pin faults.

Open Pin Vs Good Pin(U34)



- The new Framescan FX 2.0 Selector board had on average a 2 to 1 improvement in measurement signal, a 2 to 1 improvement in Signal-to-Noise ratio, and a better than 10 to 1 improvement in noise rejection compared to the original Framescan Plus Selector board. The following chart shows the difference in the magnitude of measurement signal between the Framescan Plus and Framescan FX 2.0 selector boards.



- The Framescan FX 2.0 Selector board also demonstrated the same or better open pin fault coverage compared to the Framescan Plus Selector board. The following chart shows the open pin fault coverage results for several components on a Networking board using the two different Selector boards.

Selector Board Fault Coverage Comparison

Device	Type	Total Pins	FrameScan Plus Selector	FrameScan FX Selector
J_CMC_B		65	72%	100%
J_CMC_A		65	49%	83%
U5		38	8%	95%
U11		45	2%	56%
U_FPGA		176	99%	99%
U_SWITCH		320	66%	80%

Q: How does Framescan FX compare with Agilent's VTEP?

A: Agilent's literature indicates that their VTEP solution has an average S/N ratio improvement of 12dbV compared to their TestJet solution. Teradyne's FrameScan FX solution provides a 17-18dbV improvement compared to TestJet. A 6db difference is equivalent to a 2:1 improvement in the S/N ratio. Therefore we calculate that the FrameScan FX solution will be equivalent or better than VTEP at detecting low measurement signals.

Early benchmarks conducted at two manufacturing facilities showed that VTEP and FrameScan FX were both able to obtain maximum pin fault coverage on challenging micro-BGAs and connectors.

Teradyne's FrameScan solution is also more flexible and easier to implement because it works on existing test systems, can easily be added to existing test fixtures without re-wiring, and supports traditional as well as FX probes. In contrast, Agilent's VTEP solution only works on testers with PC controllers, does not work with the standard TestJet hardware, and does not allow TestJet and VTEP probes to be mixed in the same fixture.

Q: Will my existing Opens Xpress and FrameScan tests be compatible?

A: Existing test programs and fixtures that are using Opens Xpress and Framescan will not be affected by the vectorless test improvements in the new FrameScan FX 2.0 software release. These tests will continue to work and users do not have to re-learn their Opens Xpress data or create new POD files.

If you want to take advantage of the new Framescan FX 2.0 software algorithms that are available in software version 6.3.0 and later software releases, then you must relearn and create a new POD file to obtain new measurement limits. Re-learning the FrameScan tests is fast and simple and can be accomplished in seconds using the Vectorless Test user interface.

Q: What are Teradyne's other Vectorless Test Techniques?

A: Teradyne also offers the following vectorless test techniques on their in-circuit test equipment.

- Junctions Xpress and DeltaScan – These techniques detect open pins on semiconductor devices by injecting a signal on a pin and measuring the affect of that signal at another pin on the device. These tests are fast and easy to implement since they do not require any special fixture hardware or wiring. They can only be used on devices that have semiconductor junctions and unlike the capacitive vectorless tests they do not work on connectors and sockets. These junction diode techniques are more susceptible to false failures because they require a reliable low impedance fixture connection, however they can be very effective at supplementing the coverage of pins that are not detected by other techniques.
- Orient Xpress – This is an extension of the Opens Xpress capacitive technique that detects when components are placed on the PCB with an incorrect orientation. FrameScan FX does not support the Orient Xpress technique because it requires an active guard instrument setup and FrameScan uses a fixed ground guard technique. Mis-oriented components will usually be diagnosed as open pins by Framescan FX.
- Cap Xpress – This also is an extension of the Opens Xpress technique that is able to detect when polarized capacitors are mis-oriented on the PCB. FrameScan FX also supports the Cap Xpress feature.

Q: How do I create and Debug the Vectorless Test Techniques?

A: Teradyne has made creation of the Vectorless tests simple and fast. At test generation time, the user simply selects which components they want to test with the vectorless test tools. The fixture generation software then creates a file that the fixture manufacturer can use to assemble the fixture with the appropriate vectorless test hardware.

During debug, the test developer uses a graphical user interface that can automatically learn the measurement values for the vectorless tests in seconds. The user interface also has options that allow the user to customize the tests and view the measurement values.

Shown below are screen shots of the new vectorless test user interface that was added to the TestStation software in release 5.8.0:

