

## Metrology Process Studio (MPS)

Release Notes Version 2.0

## Overview

This document describes new features, enhancements, and error corrections included in this version of MPS.

MPS 2.0 has a greatly expanded test point uncertainty modeling system with both improvements to existing tools and the addition of many new tools to assist you in creating and managing more sophisticated test point uncertainty models. The new "Uncertainty Analysis Editor" form also has features to document your uncertainty analysis.

MPS 2.0 still has all the same uncertainty modeling features that were present in MPS 1.0. MPS 2.0 still automatically creates and manages uncertainty budgets for quantitative test points that use MetSpec Instruments as calibration standards. The features that automatically manage uncertainty budgets work the same way in MPS 2.0 as they did in MPS 1.0. Except for manually added uncertainty budget items, you are not required to do anything differently in MPS 2.0 unless you want to use its new tools and features. For manually added budget items in MPS 2.0, you now enter an error limit, select an error limit distribution and MPS will automatically calculate the k=1 uncertainty for the budget item. You can now also override the error limit distribution MPS assigns to its automatically added uncertainty budget items.

These new features are described in the "New Features (Major)" section of this document.

The application has been rebranded to "MOX" from "MetBench," although some minor elements of the software retain the term "MetBench," such as the system database name ("MetBench\_MPS") and default file system directories used when saving application files ("..\Documents\MetBench"). These were retained to minimize impact on users of the new version of the application.

A new update of the MetSpec application, with some new features and error corrections, is also being released along with MPS version 2.0. While this is not a major update of the MetSpec application, its version number was advanced to 2.0 along with

this major update of MPS 2.0. This also delineates the application's rebranding to "MOX." All MPS and MetSpec 1.x versions were "MetBench." Starting with version 2.0 they are "MOX."

## Upgrades

• **SQL Scripts**: This update requires SQL scripts to update your existing MetBench\_MPS database. See the instructions in your update package.

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## 1. System Requirements

The following are minimum system requirements for this version of CPM:

**Operating System:** Windows 7 or greater

Database Server: MS SQL Server 2012 or greater

## 2. Critical Changes

None

## 3. New Features (Major)

## 1. Major expansion of the MPS uncertainty modelling system

### **Description:**

MPS 2.0 has a greatly expanded test point uncertainty modeling system with both improvements to existing tools and the addition of many new tools to assist you in creating and managing more sophisticated test point uncertainty models. The new "Uncertainty Analysis Editor" form also has features to document your uncertainty analysis.

MPS 2.0 still has all the same uncertainty modeling features that were present in MPS 1.0. MPS still automatically creates and manages uncertainty budgets for quantitative test points that use MetSpec instruments as calibration standards. The features that automatically manage uncertainty budgets work the same way in MPS 2.0 as they did in MPS 1.0. Except for manually added uncertainty budget items, you are not required to do anything differently in MPS 2.0 unless you want to use its new tools and features. For manually added budget items in MPS 2.0, you now enter an error limit and select an error limit distribution and MPS will automatically calculate the k=1 uncertainty for the budget item. You can now also override the error limit distribution MPS assigns to its automatically added uncertainty budget items.

## What happens to my MPS 1.0 uncertainty models?

MPS 2.0 is reverse compatible with the uncertainty modeling system of MPS 1.0. Your existing data sheets' test point uncertainty models will automatically be updated when an MPS 1.0 data sheet is loaded into MPS 2.0.

As MPS 2.0 now features error limits and selectable distributions for budget items, MPS 2.0 will use its knowledge of the distributions used in MPS 1.0 to convert these budget items. MPS 2.0 will take your existing k=1 uncertainties in the existing uncertainty budget items and assign the distribution MPS 1.0 would have used and then automatically calculate the error limit from the k=1 value and the distribution. In MPS 2.0, when you manually add budget items, you enter the error limit, select a distribution, and MPS calculates the k=1 value for you. MPS 1.0 did this internally with automatically added budget items, such as with MetSpec Instrument Ranges and the Measurement Resolution. MPS 1.0 used the following rules to determine which distribution it would use to calculate the k=1 uncertainty value for these automatically added budget items:

- Measurement Resolution (Type B): The "Rectangular (Resolution)" (k = √12) distribution was always used.
- Standard Deviation of Samples (Type A): The "Standard" (k = 1) distribution was always used.
- Assigned Standards [MetSpec Instrument Ranges] (Type B): The "Normal" Distribution was used with a probability specified in the "[Measurement Uncty].[In Tolerance Probability]"

master configuration option. If the "[Measurement Uncty].[Use MetSpec Confidence]" master configuration option is True ("1"), then the MetSpec Instrument Confidence value is used if it is > 0.

MPS 2.0 calculates the error limits for these automatically added budget items the same way MPS 1.0 did and uses the same rules to set the error limit distributions, so there is nothing special it must do. It just recalculates them as it always did, and you end up with the same k=1 values in MPS 2.0 that you got in MPS 1.0.

For manually added budget items in MPS 1.0, you provided the k=1 uncertainty values. This is a little trickier because MPS has no idea what distribution you used to determine your k=1 value for these manual budget items. MPS 2.0 will assign and use the following distributions to calculate the error limit values for these items.

- **Type A Budget Items**: MPS 2.0 will assign the "Standard" (k = 1) distribution
- **Type B Budget Items**: MPS 2.0 will assign the "Rectangular" ( $k = \sqrt{3}$ ) distribution

Once MPS 2.0 sets the manual budget item's distribution, it will calculate the error limit from the MPS 1.0 k=1 uncertainty value. While you will end up with the same k=1 uncertainty value for these manual budget items, the distribution displayed might be incorrect. The error limit will be correctly calculated, but may be based on the wrong distribution. As MPS 1.0 did not document the distribution used to derive the k=1 value for manually added budget items, there is nothing else that MPS 2.0 can do to convert them. The default distributions chosen for type A and B were just based on an assumption about the most commonly used distribution for manually added budget items of each type.

## **Two Primary Model Editing Tools**

There are two model editing tools that can be used to create uncertainty models for test points:

• **Test Point Uncertainty Editor**: MPS 2.0 still has the "Test Point Uncertainty Editor" that you are familiar with from MPS 1.0, but new features have been added to it. You can still use this tool to view and manage uncertainty budgets when you don't need the more advanced model documentation and detail viewing features of the advanced model editor. This is still probably the best tool to use for rapid data sheet development for most working level M&TE.

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• Uncertainty Analysis Editor: This is a new and much more sophisticated tool for creating, viewing, and documenting uncertainty models and analysis. This tool has all the features of the familiar "Test Point Uncertainty Editor," but also enables you to document the model/analysis and view more details about the test point uncertainty models summary result and risk calculations.

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## The Enhanced "Test Point Uncertainty Editor" form

The "Test Point Uncertainty Editor" form has the following new features:

Note: The new features are described briefly here but will be described in more detail later.

- Use Advanced Model Editor : Click this button to display the new "Uncertainty Analysis Editor" form for advanced uncertainty model editing. The button is located near the top of the "Uncertainty Analysis Editor" form you have been using in MPS 1.0.
- Click this "Print an analysis report for the currently selected test points or data sheet" button to have MPS display/print an RTF (Rich Text Formatted) report with uncertainty model details for either the currently selected test points or the entire data sheet. This feature is described in detail in a separate section of this document.
- **Model Type**: MPS 2.0 supports two types of uncertainty models:
  - **Budget Items**: This is the normal type of uncertainty model that includes a list of budget items that contribute to the test points' uncertainty model. This feature is described in detail in a separate section of this document.
  - Multi-TP Meas. Equation: This model type uses data from multiple other test points, along with a measurement equation, to compute the data for this test point. This model combines the uncertainty models of the other test points, automatically calculates sensitivity coefficients, and uses an optional correlation matrix for the

composite uncertainty model. This feature is described in detail in a separate section of this document.

- Use Degrees of Freedom: MPS 2.0 supports the optional use of degrees of freedom.
- **Repeatability from Resolution**: This is a new, optional automatically assigned budget item. If checked, a pseudo "Repeatability" budget item is added. This creates a budget item exactly like the automatically added "Measurement Resolution" budget item, except that the description label is "Repeatability." Use this item when you want to automatically add a repeatability budget item but have no actual repeatability data. Note: MPS 2.0 also has a new "Repeatability Analysis Tool" to create a real repeatability budget item using actual sample data. This feature is described in detail in a separate section of this document.
- **Budget Items Grid Enhancements**: The budget items grid is displayed when the "Budget Items" model type is in use and has the following new features:
  - No longer has separate tree nodes for type A and B items.
  - Includes the following new fields: "Error Limit," "Error Limit Distribution," and "A/B."
  - The "Description" field also is a virtual Influence chart. The relative influence of each budget item is indicated by a blue bar behind the description text. The description field is used for this as it is simply the widest grid cell (field) and provides the most resolution for the influence bars. The left edge of the cell is 0%, and the right edge is 100%.
- **Multiple Test Point Measurement Equation Grid**: This new grid is displayed instead of the budget items grid when the "Multi-TP Meas. Equation" model type is in use. This feature is described in detail in a separate section of this document.

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Me	asurement Inputs (Test Points)	Measurement Equ	ation Correlation	Matrix	
	Measurement Equation	Measured Value	Degrees of Freedom	Standard Uncertainty	Sensitivity Coeff (Calculated)
1	Length	1.42 in	14	0.0015 in	6.02999999854223
2	Width	2.01 in	14	0.0015 in	4.25999999897013
3	Height	3 in	14	0.0015 in	2.85419999930999

## Which tool should I use?

Two different model editing/viewing tools can be used to create uncertainty models for test points:

• **Test Point Uncertainty Editor**: This is the tool that you are familiar with from MPS 1.0, but new features have been added to it. Use this tool when you don't need the more advanced model documentation and detail viewing features of the advanced model editor. This form is probably the best tool to use for rapid creation/viewing of basic uncertainty budgets. This is

especially true when using MetSpec Instruments for calibration standards and MPS' automatic uncertainty modeling features.

Test Point	<b>Uncertainty E</b>	ditor	Use Advance	d Model Edi	tor				
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ltem E <b>Items</b>	Unc (k=1)								
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- Uncertainty Analysis Editor: This is a much more sophisticated tool for creating, viewing, and documenting uncertainty models and analysis. This tool has all the features of the "Test Point Uncertainty Editor" form, but also enables you to document the analysis and view more details about the test point uncertainty model's summary result and risk calculations.
  - This tool is a pop-up form that is displayed by clicking the
     Use Advanced Model Editor
     button on the top of the "Test Point Uncertainty Editor" form.
  - While this form is displayed, you can still navigate to other test points by either clicking the form's Test Point: 
     buttons or pressing the ALT + UP or ALT + DOWN keyboard keys.

	ALC: UN	inty Analysis Editor										-		×
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Tes	st Point	t Nominal Value: 2.700 V@ 100 Hz			Dat	Date: 5/30/2017				Organization: West Region				
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Test	t Point	Model: 🙈 🧷 🛇 🧎 门 🖺   Test i	Point: 🛫 🔺											
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## The case for using both tools together

The choice is not necessarily one or the other. You can use the "Test Point Uncertainty Editor" tool to rapidly develop basic uncertainty budgets, and you can also use it as a viewer/editor for uncertainty models created with the "Uncertainty Analysis Editor" form. You only must use the "Uncertainty Analysis Editor" form for editing uncertainty analysis documentation or when you want to view a more complete picture of the uncertainty analysis for test points.

## 2. Displaying and printing Uncertainty Analysis Reports

## **Description:**

MPS has a built in Uncertainty Analysis Reporting system that generates uncertainty analysis documentation for either currently selected test points or the entire data sheet. The report is generated in RTF (Rich Text Format) to allow you to copy all or a portion of the report to the MS Windows clipboard and then paste that into a word processing application such as MS Word. The report can be displayed/printed from either the "Test Point Uncertainty Editor" or "Uncertainty

Analysis Editor" forms. Both forms have a button that can be clicked to generate the report. When the button is clicked, a pop-up form will give you the option to generate the report for the currently selected test points or the entire data sheet:

Select an Item
Select a Test Point Scope
Selected test point/s All test point/s
✓ <u>O</u> K X Cancel

The report is displayed in the "Measurement Uncertainty Analysis" viewer form.

Report Actions: Image: Colspan="2">Analysis Information         Document (Equipment)       NAVAIR-XXXX-XXXX         Analyst       Casto, Curt V       Corganization       West Region         Date (MM/DD/YYYY)       5/30/2017       Comments       Uncertainty Analysis Testing Data Sheet         This data sheet contains various testing scenarios for MPS' enhance uncertainty analysis system.       About RTF Comments: Analysis comments can be added to points using the RTF (Rich Text Format) editor or pasted intereditor from a word processor application.	nced
Analysis Information           Document (Equipment)         NAVAIR-XXXX-XXXX           Analysi         Casto, Curt V           Organization         West Region           Date (MM/DD/YYYY)         5/30/2017           Comments         Uncertainty Analysis Testing Data Sheet           This data sheet contains various testing scenarios for MPS' enhance uncertainty analysis system.         About RTF Comments: Analysis comments can be added to points using the RTF (Rich Text Format) editor or pasted inteditor from a word processor application.	nced
Document (Equipment)         NAVAIR-XXXX-XXXX           Analyst         Casto, Curt V           Organization         West Region           Date (MM/DD/YYYY)         5/30/2017           Comments         Uncertainty Analysis Testing Data Sheet           This data sheet contains various testing scenarios for MPS' enhance uncertainty analysis system.         About RTF Comments: Analysis comments can be added to points using the RTF (Rich Text Format) editor or pasted intervent editor from a word processor application.	nced
Analyst       Casto, Curt V         Organization       West Region         Date (MM/DD/YYYY)       5/30/2017         Comments       Uncertainty Analysis Testing Data Sheet         This data sheet contains various testing scenarios for MPS' enhance uncertainty analysis system.         About RTF Comments: Analysis comments can be added to points using the RTF (Rich Text Format) editor or pasted intereditor from a word processor application.	liced
Organization       West Region         Date (MM/DD/YYYY)       5/30/2017         Comments       Uncertainty Analysis Testing Data Sheet         This data sheet contains various testing scenarios for MPS' enhance uncertainty analysis system.       About RTF Comments: Analysis comments can be added to points using the RTF (Rich Text Format) editor or pasted intereditor from a word processor application.	iced
Date (MM/DD/YYYY)         5/30/2017           Comments         Uncertainty Analysis Testing Data Sheet           This data sheet contains various testing scenarios for MPS' enhance uncertainty analysis system.         About RTF Comments: Analysis comments can be added to points using the RTF (Rich Text Format) editor or pasted intereditor from a word processor application.	nced
Comments         Uncertainty Analysis Testing Data Sheet           This data sheet contains various testing scenarios for MPS' enhance         uncertainty analysis system.           About RTF Comments: Analysis comments can be added to points using the RTF (Rich Text Format) editor or pasted intereditor from a word processor application.	nced
This data sheet contains various testing scenarios for MPS' enhance uncertainty analysis system. About RTF Comments: Analysis comments can be added to points using the RTF (Rich Text Format) editor or pasted inte editor from a word processor application.	iced
About RTF Comments: Analysis comments can be added to points using the RTF (Rich Text Format) editor or pasted int editor from a word processor application.	I
points using the RTF (Rich Text Format) editor or pasted int editor from a word processor application.	o test
editor from a word processor application.	to the RTF
MPS Data Sheet	
Make/Model Fluke 77_NGC Digital Multimeter	
ICP Fluke 77 Service Manual, Sep. 1992 Checklist Number	
Document ID {D6644539-4754-439E-9741 -C0545CA21182} Document Version ID {1F346651-{ 962C-4E733	-8A78-48CA- 34F29956}
Approved By Casto, Curt V Approved Date 4/18/2018	
[Data Sheet Test Point (1 of 36)]	
Step Function Tested Nominal Tolerance TAR TUR	EMU
Num Value Display Test Pass Pass/Fail	

## **Report Content Examples**

Note: The information displayed in these examples is from a software testing data sheet and contains budget items and other settings intended to test various aspects of the MPS uncertainty modeling and analysis systems. This data sheet is used for these examples as it also illustrates a wide variety of model types, budget items, error limit distributions, etc. This data is used here for illustration purposes and is not intended to reflect the actual model or analysis content for a real-world calibration of a specific item of M&TE.

## Data Sheet Header Example

Whether printing selected test points or the entire data sheet, the report always begins with the data sheet header section. The following is an example of what this section looks like:

	Analysis Inf	ormation								
Document (Equipment)	NAVAIR-XXXX-XXXX									
Analyst	Casto, Curt V									
Organization	West Region	West Region								
Date (MM/DD/YYYY)	5/30/2017									
Comments	Uncertaint	Uncertainty Analysis Testing Data Sheet								
	This data sheet contains vari uncertainty analysis system. About RTF Comments: A points using the RTF (Rich editor from a word proces	ous testing scenarios for nalysis comments can n Text Format) editor of sor application.	MPS' enhanced be added to test r pasted into the RTF							
	MPS Data	Sheet								
Make/Model	Fluke 77_NGC Digital Multimet	er								
ICP	Fluke 77 Service Manual, Sep. 1992 Checklist Number									
Document ID	{D6644539-4754-439E-9741         Document Version ID         {1F346651-8A78-480           -C0545CA21182}         962C-4E7334F29956									
Approved By	Casto, Curt V	Approved Date	4/18/2018							

## Test Point with no uncertainty model example

Each test point section begins with a display of the data sheet test point and is followed by the uncertainty information. Test points that do not have an uncertainty model include only the test point information.

Example of a test point that has no uncertainty model:

		[Data S	Sheet Test Point (1 of 36)]			
Step	Function Tested	Nominal	Tolerance	TAR	TUR	EMU
Num		Value				
	Display Test	Pass	Pass/Fail			

This "Pass/Fail" test point is non quantitative and has no uncertainty model

**"Budget Items" uncertainty model type (manual and automatic budget items) example** Example of a test point configured to use the "Budget Items" uncertainty model type. This example includes both automatically and manually added budget items.

Note: The manually added item descriptions begin with the word "Manual" for illustration purposes in this example.

			[Data	Sheet 1	Fest Po	oint (13 of	36)]															
St	tep	Function Tested	Nominal		Tol	erance		TAR	TUR	EMU												
Nu	um		Value																			
		3.2 V AC Range	2.700 V		2.644	to 2.756 V		120:1	26:1	± 2.2 mV												
			@ 100 Hz																			
	0	E de la contraction de la cont	Test Poin	t Measure	ement L	Incertainty A	haly	sis														
	Calib	oration Equipment	Fluke 55X	Pudget items included in this test point's upor this to a del																		
		Comments	Note: Bu	udget items included in this test point's uncertainty mode																		
			are for N	APS syste	m testi	ing only. Th	ey do	not ne	ecessarily	y apply to												
			the actu	al calibra	tion pr	ocedure use	d to	calibrat	te the TI.													
				Uncer	tainty E	Budget																
		Error Sources	E	rror Limit	En	ror Limit	Unce	ertaint	Degrees	Standard												
		(Description)		(or Std	Dis	tribution		у	of	Uncertainty												
				Unc)	(or Std	Uncertainty)	Тур	e (A/B)	Freedo													
	_								m	000 7.11/												
1		Measurement Resolut	ion	1 mV	Rectangular (Resolution)			в	3	288.7 µV												
2		Manual Budget Item	1	200 µV	Normal	Normal (95% k=1.96)		В	2	102 µV												
3		Manual Repeatability	y	816.5 µV	Standa	rd Uncertainty	В	5	816.5 µV													
4		Manual Standard		375.5 µV	Re	ctangular		В		216.8 µV												
5	Fluk	ke 5522A-SC1100, Ca	librator	465 µV	Normal (	Normal	Normal	Normal	Normal (	Normal (	Normal (	Normal (	Normal	Normal	Normal	Normal	Normal	(99% k=2.576)		B		180.5 µV
6		Repeatability		1 mV	Re	ctangular		A		288.7 µV												
	L	Maaauran	ant Equation	n (Additin	(R	esolution)			6	mbined												
		weasuren	ient Equatio	Additiv	e)					cortainty												
v	- True	+ e/Measurement Re	solution) + el	Manual Bud	laet Item)	+ e/Manual				60.0 uV												
Ř	epeata	bility) + e(Manual Stan	dard) + e(Flu	ke 5522A-S	C1100. C	alibrator) +			°	00.5 µV												
			e(Repeatabili	ty)																		
Con	nbine	d Uncertainty Re	sults																			
		Combined	Uncertainty	/ 960.9	٧u		1															
				0.5.01			1															
		Uncertainty	Confidence	95 %																		
		Effective Degrees	of freedom	1 9																		
		Coverag	e Factor (k	) 2.2622																		
		Expanded	Uncertainty	/ 2.2 m\	/																	
				Meas	uremei	nt Risk																
		Risk Type		PF	A	PFR		Total	Risk	<b>GB Multiplier</b>												
	De	sign Tolerance (Norm	al)	0.1593	33%	0.1756%		0.334	93%													

The Fluke calibrator in this example uses a 99% probability in the "Normal" distribution because MPS was configured to use MetSpec Instrument specification confidence and that is the spec confidence setting for the instrument in the MetSpec spec sheet. *Note: If the MPS Master Configuration option "[Measurement Uncty].*[Use MetSpec Confidence]" is True, and the MetSpec Instrument has a Spec Confidence value > 0, The MetSpec Confidence is used as the "Normal" distribution probability.

## "Budget Items" uncertainty model type (Guard Band) example

Example of a test point configured to use the "Budget Items" uncertainty model type. This example displays guard band information in the "Measurement Risk" section of the test point analysis.

_											
			[Dat	a Sl	heet T	est Po	oint (15 of	36)]			
S	tep	Function Tested	Nomin	al		To	lerance		TAR	TUR	EMU
N	um		Value	•							
		750 V AC Range	750.000	0 V	7	49.4650	to 750.5350 V		2.3:1	3.0:1	± 180 mV
			@ 100	100 Hz g: 749.4802 to 750.5198 V							
	Calib	antion Frankrant	Test Poi	nt M	easure	ment l	Incertainty A	Analy	SIS		
	Calib	ration Equipment									
		Comments									
				-	Uncer	tainty l	Budget			-	
		Error Sources		Erro	r Limit	En	ror Limit	Unc	ertaint	Degrees	Standard
		(Description)		(0)	r Sta	UIS (or Std	(Incertainty)	Typ	y e (A/B)	OT	Uncertainty
					110)	(01 310	oncertainty)	1,26	e (A)D)	m	
1		Measurement Resolut	tion	10	0 uV	Re	ctangular		В	5	28.9 uV
					(Resolution)						
2	Fluk	e 5522A-SC1100, Ca	librator	23	5 mV	Normal	(99% k=2.576)		В	_	91.2 mV
		Measuren	nent Equa	tion (	Additive	e)				Co	mbined
										Unc	certainty
V	/ = True	+ e(Measurement Re	solution) +	e(Fluk	e 5522A	-SC1100	, Calibrator)			9	1.2 mV
Cor	nbine	d Uncertainty Re	sults								
		Combined	Uncertair	nty	91.2 m	V					
			0		05.0/						
		Uncertainty	Contiden	ce	93 %	C 4 C 2 4 2	107				
		Effective Degrees	of freedo	m	498810	646242	407				
		Coverag	e Factor	(k)	1.96						
		Expanded	Uncertair	ity	180 m\	/					
					Meas	uremei	nt Risk				
		Risk Type			PFA	4	PFR		Total	Risk	<b>GB Multiplier</b>
	De	sign Tolerance (Norm	al)		0.9771	7%	2.21183%		3.18	9%	
	Guard	d Banded (Method: Z5	640.3)		0.800	6%	2.77899%		3.579	59%	97.17698%

Guard banded risk information is displayed in the "Measurement Risk" section

"Multiple Test Point Measurement Equation" uncertainty model type (Uses Correlation) example When using a "Multiple Test Point Measurement Equation," the test points that will provide the inputs to the equation each have a unique "Uncertainty Bookmark Name" assigned. The bookmark name will also be the variable name, which is used to represent the measured value of the test point within the measurement equation. Sensitivity coefficients (partial derivatives) are automatically calculated based on the measurement equation. The use of a correlation matrix is optional.

Example of a "Volume" test point configured to use the "Multi-TP Meas. Equation" uncertainty model type. The equation uses three other test points that have been assigned "Length," "Width," and "Height" Uncertainty Bookmark Names. The measurement equation used to obtain the "Volume" measured value is "{Length} \* {Width} \* {Height}". (See: "Model Type: Multi-TP Meas. Equation Editing section of this document" for information about this uncertainty model type): Note: This example uses an optional correlation matrix. Two of the correlations in the example use the MPS "Measurement Equation Variable Correlation Analysis" tool to obtain their correlation value. The third correlation value is just a manually entered value. You can either use the tool or just manually enter values; it's your decision.

			[D	ata S	hee	t Tes	st Po	oint	(36 o	f 36)]					
St Nu	ep Function T Im	ested	Non Va	ninal lue			Tole	eran	ce		TAF	2	TUR	EN	NU
	Volum	•	9.0	)0 in		8	.000 to	0 10.0	000 in				33:1	± 0.0	03 in
			Test P	oint N	leas	urem	ent U	nce	rtainty	Analy	/sis				
	Calibration Equip	ment	<u> </u>												
	Comr	ents					-								
	deseursement Fau	tion b		Mea	isure	ment	Equa	atio	n Inpu	ts Sto	ndard	6	a na litika	the Cool	fielent
'	Variable	tion II	iput	'	Weast Valı	urea		egre Free	dom	Unce	ndard ertainty	,   30	ensitiv (Ca	iculated	ncient
1	Leng	th			1.42	in		1	4	0.0	015 in		6.0299	9999854	223
2	Widt	h		+	2.01	in	+	1	4	0.0	015 in	-	4.2599	9999897	7013
3	Heig	it			3 ir	n		14	4	0.0	015 in		2.8541	9999930	999
	Mea	surem	ent Equ	ation [	Descri	iption							Co	mbined certaint	i y
	Measu	ement	= {Lengt	h} * {Wi	idth} * ·	(Height	1}						0	.015 in	
Con	nbined Uncertai	nty Re	sults									_			
	Con	bined	Uncert	ainty	0.01	5 in									
		tol t	0		05.0										
	Unce	tainty	Confid	ence	95 %	0				_					
	Effective D	grees	of free	dom	4.00					_					
	C	overa	e Facto	DF (K)	1.96					_					
	Exp	anded	Uncert	ainty	0.03	IN									
	Diels Tu				Me	asure	emen	IT RI	SK		Te	al Dial		CP Mult	tinling
	Design Tolerance	e Norr	nal)	-	0.1	2449%		_	0 13421	%	0.0	ai Kisi		GB MUI	upiler
	Design rolerand		Mea	surem	ent l	Fouat	tion (	`orro	elation	Matri	×	200776			
Meas	surement Equation		4					-		-	_		40		40
	Input Variable	Var	1	2	3	4		5	6	· ·	8	9	10	11	12
	Length	1	1.00												
	Width	2	0.16	1.00											
	Height	3	0.36	0.99	1.0	0	+						$\vdash$		+
			(A)	(M)							C - 11				
	Mea Input Va	surer	nent E	quatio	on Co	orrela	tion /	Ana	iysis (I	viatrix	Cell =	• <b>RZ</b> :U	<u>1)</u>		
		th								ath	2		_		
	Error Sources		St	andard			Erro	or So	urces	gui	S	tandar	d		
	(Description)		Unc	ertaint	ty		(De	scri	ption)		Un	certair	nty	Correl	ation
1	Measurement Res	lution	28	8.7 µin		1	Meas	urem	ent Res	olution	2	88.7 µi	n	1	
2	Repeatability		0	001 in		2		Rep	eatability	/		0.001 ir		0.2	25
3	Cal Std		1	00 µin		3		0	al Std		-	100 µin		0.5	5
4	Environment	1	25	2.8 uin		5	(	Envi	ronment	л: t		82.8 mi			
-	Combined Und	ertain	ty 0.	0015 in		-	Co	ombi	ned Un	certain	ty 0	.0015 i	n		
_				Comb	ined (	Correl	ation	Betv	veen V	ariable	1 and	Varial	ole 2	0.1	6
	Mea	surer	nent E	quatio	on Co	orrela	tion /	Ana	lysis (N	Matrix	Cell =	• R3:C	1)		
		riahlo	1					In	put Va	riable	2				
	Input Va	nabic							Len	gth					
	Input Va Hei	ght									0	tandar			
	Input Va Hei Error Sources (Description)	ght	St Und	andard ertaint	l ty		Erro (De	or So scri	urces ption)		Un	certair	nty	Correl	ation
1	Input Va Hei Error Sources (Description) Measurement Res	ght	St Und 28	andard ertaint 8.7 µin	l ty	1	Erro (De Meas	or So scri urem	urces ption) ent Res	olution	Un 2	certair 88.7 µi	nty n	Correl	ation
1 2	Input Va Hei Error Sources (Description) Measurement Res Repeatability	ght	St Und 28	andard ertaint 8.7 µin .001 in	ty	1 2	Erro (De Meas	or So scrip urem Rep	ption) ent Res eatability	olution /	2 2	certair 88.7 µi	nty n	Correl	ation
1 2 3 4	Input Va Hei Error Sources (Description) Measurement Res Repeatability Cal Std	ght	St Unc 28 0	andard ertaint 8.7 µin .001 in .001 in	ty	1 2 3	Erro (De Meas	or So scrip urem Rep C	ent Res eatability al Std	olution /	2 2	certair 88.7 µi 0.001 in 100 µin	nty	Correl	ation
1 2 3 4 5	Input Va Hei Error Sources (Description) Measurement Res Repeatability Cal Std Operator Erro Environment	ght	St Unc 28 0 1 1 0	andard ertaint 8.7 µin .001 in .001 in .001 in	l ty	1 2 3 4	Erro (De Meas	or So escrip urem Rep C Opera	ent Res eatability al Std ator Erro	olution /	2 2	certair 88.7 µi 0.001 ir 100 µin 0.001 ir		0.7	ation 75
1 2 3 4 5	Input Va Hei Error Sources (Description) Measurement Res Repeatability Cal Std Operator Erro Environment Combined Upo	plution r ertain	St Unc 28 0 1 1 0 28 ty 0.4	andard ertaint 8.7 µin 001 in 00 µin 001 in 2.8 µin 0015 in	l y	1 2 3 4 5	Erro (De Meas	or So scrip urem Rep C Oper Envi	ent Res eatability al Std ator Erro ironment	olution / or t	2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	certair 88.7 µi 0.001 ir 100 µin 0.001 ir 82.8 µi .0015 i	nty n n n n	0.7	ation 75 5

The "Measurement Equation Correlation Matrix" shows two of the correlations with the "(A)" symbol and one with the "(M)" symbol. The "(A)" symbol indicates that that the value is calculated result of a Correlation **A**nalysis and the "(M)" symbol indicates that the value was manually entered by the analyst. Therefore, only two "Measurement Equation Correlation Analysis" sections are displayed below the matrix.

## 3. Model Type: "Budget Items" editing

## **Description:**

This is the common test point uncertainty model type that is comprised of one or more budget items. Each budget item will have a description, error limit, error limit distribution, and other optional properties. MPS will automatically calculate the standard (k=1) uncertainty for each budget item from its error limit and error limit distribution.

When manually adding budget items In MPS 1.0, you had to calculate the k=1 uncertainty yourself and enter the k=1 value. In MPS 2.0, you enter the error limit, select the applicable error limit distribution, and MPS will calculate the k=1 uncertainty for you. You can now also override the default error limit distribution MPS assigns to its automatically created budget items, such as calibration standard ranges and measurement uncertainty. If you override the error limit distribution, MPS will recalculate the k=1 uncertainty of the automatically added budget item using the selected error limit distribution. See the "Major expansion of the MPS uncertainty modelling system" (item #1 in this section of the document) for information about how MPS 2.0 will automatically transform your legacy data sheet budget items to the MPS 2.0 "Budget Items" format.

## **Configuring the test point uncertainty model's properties**

You can configure properties for each test point uncertainty model to control behaviors, such as:

- Letting MPS have full control over the uncertainty model, using default settings for the behavior control items included on this panel (form section).
- Automatically adding MPS managed budget items for "Assigned Standards," "Measurement Resolution," "Repeatability from Resolution," and "Measurement Samples" (added to calibration measurement uncertainty models only).
  - "Repeatability from Resolution" is a new option in MPS 2.0. When selected, a type "B" budget item will be automatically created by MPS for "Repeatability" using the test point's measurement resolution as the error limit and "Rectangular (Resolution)" (k = v12) error limit distribution.
    - Note: This creates a budget item exactly like the automatically added "Measurement Resolution" budget item, except that the description label is "Repeatability." Use this item when you want to automatically add a repeatability budget item but have no actual repeatability data.
    - Note: Use the "Repeatability Analysis Tool" (described later in a separate section of this document) to create a real repeatability budget item using actual repeatability data.
- The optional use of degrees of freedom.
- Overriding the default Uncertainty Confidence.

Configuration Properties	
Model Type: <ul> <li>Budget Items</li> </ul>	O Mutli-TP Meas. Equation
Use Model Defaults	
Automatically included budget item	15
Assigned Standards	Measurement Resolution
Repeatability from Resolution	Measurement Samples
Use Degrees of Freedom?	
Uncertainty Confidence: 95	96
Note: If "Use Model Defaults" is Cheo manually and MPS will not calculate a assigned to the test point.	ked, no budget items can be added In EMU or TUR if no MetSpec Range is

## **Budget Items**

			Data Src		Error (Des	Sourc	es n)		Error Lin (or Std U	nit nc)	Error Lin Distribut or Std Uncer	nit ion rtainty)	
			Auto	Measurer	nent Reso	lution		1	l mV	Re	ctangular (Re	solution)	
		1		Manual B	udget Iten	n		2	200 µV	Re	ctangular		
		/	RA	Manual R	epeatabili	ty		8	316.5 µV	Sta	andard Uncer	tainty	
		1	TL	Manual S	tandard			3	375.5 µV	N	ormal (95% k	=1.96)	
	1		Auto	Fluke 552	2A-SC110	), Calib	rator	4	465 μV	N	ormal (99% k:	=2.576)	
	Data Src		Erro (Der	r Sources scription)	Err (or	or Limit Std Unc)	Error Limit Distributio (or Std Uncerta	: n inty)	Uncertainty Type (A/B)	Degrees of Freedom	Standard Uncertainty	Sensitiv Coeffici	vity Distribution ient Controlled by
1	Auto	Land	amant Ras	olution	1 m	1	Cor Std Uncerta	inty)	R	Freedom	288.7 10/	2	SysBasolycon
2	1	Manual	Budget Ite	m	200	μV	Rectangular		В	2	115.5 µV	1	None
3	RA	Manual	Repeatabi	lity	816.	5 µV	Standard Uncertai	inty	B	5	816.5 µV	1	Nore
4	T <sub>to</sub>	Manual Fluire 55	Standard 224-SC110	0 Calibrator	375.	s μv uv	Normal (95% k=1. Normal (99% k=2	.96) 576)	B	2	191.6 µV	1	MetSpecConf
			Un Ty	certainty pe (A/B)	Degrees of Freedon	; 1 U	Standard Incertainty		Sensitiv Coefficie	ity ent	Distribu Controll	ution ed by	
			В		3	288.	7 μV	2			SysResolutio	on	
			В		2	115.	5 µV	1			None		
			В		5	816.	5 µV	1			None		
			В		2	191.	6 µV	1			None		
			В		2	180.	5 µV	1			MetSpecCo	nf	/

Note: The budget items displayed in this example illustrate a wide variety of budget item types, distributions, data sources, etc. The data used here is for illustration purposes and is not intended to reflect the actual model or analysis content for a real-world calibration of a specific item of M&TE.

### **Uncertainty Budget Item Editor form**

This form replace	es the old budget item editor	form in MPS 1.0 and h	nas many new fe	atures. Use this
form to edit an u	incertainty model budget iten	n's properties.	-	
Oncertainty Budget Item Editor				
🔽 Repearability Tool 🛛 🛇 Clear Rep	reatibility Data			
🗒 Tolerance Limit Tool. 🔕 Clear Tolera	ance Limit Data			
Test Point Nominal Value: 2.700 Vo. 100 Ha	1			
Error Source (Description):	Uncertainty Budget Item Editor			
Error Limit (or Std Unc) Value: 0.0				
Error Limit Distribution (or Std Line):	💭 Repeatability Tool 🛛 🛇 Clea	r Repeatibility Data		
k (error source coverage factor): 1.95	59			
	Tolerance Limit Tool 🛇 Clear	Tolerance Limit Data		
Uncertainty Type (A/B): 8				
Degrees of Freedom: 2	Test Point Nominal Value: 2.700 V@ 1	00 Hz		
Sensitivity Coefficient: 1.0	Error Source (Description):	Fluke 55224-SC1100, Calibrate		1
Standard Uncertainty Value (k=1): 0.0	Error Source (Description):	Fluke 5522A-SC1100, Calibrato	or	J
\	Error Limit (or Std Unc) Value:	0.0004650000000016	v	
		Manual Error Limit Distribut	ion Selection	
	Error Limit Distribution (or Std Unc):	Normal [Custom Probability]	~	
\				
\	k (error source coverage factor):	1.78046434169202		
	Custom Probability Value:	92.5	96	
	Uncertainty Type (A/B):	в ~		
\		-		
	Degrees of Freedom:			
\	Sensitivity Coefficient:	1.000		
\	Standard Uncertainty Value (k=1):	0.000261167825219267	] v	

Note: The form is shown editing an automatically added "Assigned Standard" budget item. This displays all the form's editing GUI objects, but several are shown disabled. Most of the disabled objects would be enabled when editing a manually added budget item.

### **Test Point Analysis Documentation**

Note: There are editing feature restrictions when editing a budget item automatically created by MPS. See the "Editing budget items automatically created and managed by MPS" section below for details about these restrictions.

GUI Element	Туре	Description
😡 Repeatability Tool	Button	Use the Repeatability Analysis Tool. See the separate section of this document that describes the "Repeatability Analysis Tool" for more information about using this tool. Note: The Repeatability Analysis data is saved with the budget item and can be viewed or edited anytime in the future.

O Clear Repeatibility Data	Button	Clear any Repeatability Analysis data currently saved with the budget item.
		Note: This button is only enabled when a budget item has saved Repeatability Analysis data.
Tolerance Limit Tool	Button	Use the Tolerance Limit Tool. See the separate section of this document that describes the "Tolerance Limit Tool" for more information about using this tool.
		Note: The Tolerance Limit data is saved with the budget item and can be viewed or edited anytime in the future.
O Clear Tolerance Limit Data	Button	Clear any Tolerance Limit data currently saved with the budget item.
		Note: This button is only enabled when a budget item has saved Tolerance Limit data.
Test Point Nominal Value	Label	Displays the currently selected test point's Nominal Value parameters.
		Note: This label is the test point's Nominal Value display text.
Error Source (Description)	Editor	Enter a description (label) that Identifies the error source (e.g., Repeatability, Resolution).
Error Limit (or Std Unc) Value	Editor	Enter the maximum error source or the standard uncertainty value.
Manual Error Limit Distribution Selection	Check Box	Disable automatic selection of the error limit distribution for an automatically created "Assigned Standards" budget item. When this feature is checked, the editing features for selecting an error limit distribution are enabled.
		Note: This item is only visible when editing an "Assigned Standards" automatically created budget item.
Error Limit Distribution (or Std Unc)	Pick List	Choose the probability distribution for the error source or select standard uncertainty.
k (error source coverage factor)	Label	The coverage factor associated with the selected distribution (Uncty = Error Limit / k).
Custom Probability Value	Editor	Enter a probability value when the "Normal [Custom Probability]" error limit distribution is selected. When this feature is used, MPS will display the distribution as "Normal (x% $k=y$ )," where "x" is the value entered into this field and "y" is the k value calculated from "x" for a normal distribution.
		Note: This item is only visible when the "Normal [Custom Probability]" error limit distribution is selected.

Uncertainty Type (A/B)	Pick List	Identify whether the uncertainty calculation is Type A or B (optional).
Degrees of Freedom	Editor	Enter the degrees of freedom (Optional). Note: The degrees of freedom can be obtained from the Repeatability Tool when its use is applicable.
Sensitivity Coefficient	Editor	Enter a sensitivity coefficient value. (Default value is one). The k=1 uncertainty value of the budget item is multiplied by the sensitivity coefficient when calculating the combined uncertainty value for the test point.
Standard Uncertainty Value (k=1)	Label	Calculated based on the error limit and error distribution.
<ul> <li>✓ <u>о</u>к</li> </ul>	Button	Click this button to accept edits and disable editing features. Note: This button is displayed in a yellow bar at the bottom of the tab page that is only visible when editing features are enabled.
X Cancel	Button	Click this button to cancel edits and disable editing features. Note: This button is displayed in a yellow bar at the bottom of the tab page that is only visible when editing features are enabled.

## Editing budget items automatically created and managed by MPS

You can now edit a limited number of budget item properties for budget items automatically created and managed by MPS. This section will describe the properties you can edit by automatically created budget item type.

Note: If you uncheck the test point uncertainty model property, to automatically create one of these types of automatically created budget items, and later check that option again, any changes previously made to the test point budget items of that type will be lost. The same applies for any MetSpec ranges assigned to test points. If you delete and re-add the assignment, any changes you made are lost. The reason for losing your property overrides is that the budget item has been destroyed (deleted) along with your property overrides. When they are subsequently recreated by MPS, there are no user overrides.

- "Assigned Standards" (MetSpec Range):
  - Error Limit Distribution: You can check the "Manual Error Limit Distribution Selection" check box to override the distribution that MPS automatically applies. If this item is checked, you can select the error limit distribution as you would with a manually created budget item. If you uncheck the "Manual Error Limit Distribution Selection" check box, MPS will restore its automatically chosen distribution when you click the

form's <u>v</u> button to accept edits.

- Degrees of Freedom: MPS cannot automatically determine the degrees of freedom for an automatically created budget item, so it is always up to you to set this value if using degrees of freedom.
- "Repeatability from Resolution" and "Measurement Resolution":
  - Sensitivity Coefficient: MPS defaults this value to one, but you can enter whatever value you like.
  - Degrees of Freedom: MPS cannot automatically determine the degrees of freedom for an automatically created budget item, so it is always up to you to set this value if using degrees of freedom.
- "Measurement Samples": There are no properties that you can set for these items because they do not exist until a measurement is made while executing a calibration.

### 4. Repeatability Analysis Tools

### **Description:**

The new Repeatability Analysis Tool estimates repeatability uncertainty.

This tool can be displayed by clicking the "Repeatability Tool" button on the new Uncertainty Budget Item Editor form.

	Measuremen	t Samples
Measurement Values	Enter the measurement valu For calibration scenarios: 1. UUT measures CALSTD 2. CALSTD measures UUT	- Enter UUT measurements - Enter the CALSTD measurements
5 2.7 6 2.7 7 8 9 10 11 12 13 14 1c	4. UUT and CALSTD are o	ompared - Enter the comparator measurements
Measuremen For Reported Averages, enter the Number of Values Used (n):	t Values          1	Usually, reported measurements for a TMDE user will be based on a single value. If, in practice, the reported measurement is based on an average of n measurements (e.g., n=3), enter the number of values the reported measurement will be based on in the Sample Size row (36).
Standard Deviation:	0.000816496580927854	The Number of Values Used will usually be 1 (i.e., n=1) meaning the user of the TMDE will report a single value rather than an average.
Number of Measurements:	6	
Degrees of Freedom:	2	

## How this tool calculates the Repeatability Uncertainty

## The Sample Standard Deviation and The Standard Uncertainty

- The standard uncertainty is **not** the same as the sample standard deviation
- Sample Standard Deviation

$$s = \sqrt{\sum_{i=1}^{n} \frac{(x_i - \overline{x})^2}{(n-1)}}$$

- The standard uncertainty characterizes the variability in the measurement error probability distribution (k=1)
- The sample standard deviation is used to estimate the repeatability part of the standard uncertainty

### **Repeatability Uncertainty for Averaged Measurements**

• Repeatability Error Source when the measurement is averaged

• Calculate Sample Standard Deviation

$$s = \sqrt{\sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{(n-1)}}$$

 Repeatability Uncertainty for Mean (Uses sample standard deviation of the mean)

$$u_{Repeatability} = s/\sqrt{n}$$

### 5. Tolerance Limit Tool

### **Description:**

This tool is used to calculate an error limit for a manually added budget item using an instrument's specifications. This can be useful for adding uncertainty budget items for instruments that will not be added as MetSpec Calibration Standard Instruments. The tool allows you to provide the specifications in one of two ways:

- **Manually Entered**: Enter specification components, such as % or ppm of indicated value, % or ppm of full scale, floor error, and dB (log) error. Entering specifications manually is similar to entering specifications in the MPS "Test Point Builder" form.
- MetSpec Instrument: Select a MetSpec Instrument and Range. This is similar to, but not the same as, assigning MetSpec Instruments to the data sheet and MetSpec Ranges to test points as calibration standards, for the TI (Test Instrument) calibration. This feature allows you to use MetSpec Instruments directly with uncertainty budget items that are not directly used in the TI calibration. MPS maintains a separate list of MetSpec Instruments that are used directly in uncertainty budget items (not used for range assignment to calibration test points). This sounds confusing, but an example might be if you wanted to include a budget item for an instrument that is used to calibrate one of the calibration standards that is used to calibrate the TI. If you are still confused, just suffice it to know that these MetSpec Instruments are independent of the MetSpec Instruments normally assigned to the data sheet as calibration standards, and you can use them directly with uncertainty budget items. If you use them for this purpose is entirely up to you.

The form has two data source modes that represent the two specification data sources described above. The two modes are "Manually Entered" and "MetSpec Instrument."

"MetSpec Instrument" Data Source Mode:

MetSpi	ec Instrument (365 Day), Fluke 8508A, Make/Model: Fluke 8 Description: Refere Spec Interval: 365 Da	Reference Multimeter Absolute Uncertainties V 💟 👁 + 🗕 508A nce Multimeter Absolute Uncertainties 95	Specifications data source:	MetSpec Instrument Specs
MelSpi	ec Range Eurotion: Voltage, AC Range: 20 V to calculated range accuracy (UUT units)	(Notes: 1,2,4,6,7,9,15)	Measurement Tolerance Low Value: Measurement Tolerance High Value: Error Tolerance Low Value:	2.7003755 0.0003755
Anual Manual	Range Accuracy: // // X	3./536-4 /	Error Tolerance High Value:	0.0003755
Note: A	Tolerance Limit Tool Test Point Nominal Value: Specifications data source	2.700 V@ 100 Hz e: ○ Manually Entered		
m	MetSpec Instrument	(365 Day), Fluke 8508A, Reference Multimeter Absolut         Make/Model:       Fluke 8508A         Description:       Reference Multimeter Absolute Unce         Spec Interval:       365 Days	te Uncertainties ertainties	~ <b>0 2 + -</b>
	MetSpec Range	Kernetion: Voltage, AC (Notes: 1,2,4,6,7,9,15)     Range: 20 V		
	Auto calculated rand	ge accuracy (UUT units): 3.75	5E-4 ?	
l	Manual Range Accuracy	: ℤ ⊻ <b>×</b>		
Ì	Note: Accuracy must be	stated in the test point's unit of measure.	Override	Accuracy of Selected Std.
	Linear Units Conversion	Calculator		
	Std Units Value ap	oplicable to this TP (expressed in the range's native uni	its):	?
	S	td Range Accuracy (expressed in the range's native uni	its): 📃 Calc	V
ł	TI Units by Ratio =	(TP Nominal Value * Std Range Accuracy)/Std Units Val	lue: 🔰 Apply	?
	Manually calcu	lated Std Accuracy (expressed in the range's native uni	its):	?
1				

S Clear Calcul	lator	To	lerance timit Analysis Results	
Specification Typ Symmetrical		Sp	ecifications data source:	MetSpec Instrument Specs
Specifications		M	easurement Tolerance High Value:	2.7003755
Specif Indicated Value	Tolerance         Modifier           Error (% or ppm):         65         ppm	En	ror Tolerance Low Value:	0.0003755
Full Scale Value	Tolerance Limit Tool			
Full Scale Error	Test Point Nominal Value: 2.700 V@ 100 Hz	MatCoas Instrum	aant	
dB (log) Error	Specifications data source.  Manually Entered	) MetSpec Instrun	nent	
Custom Calcu	S Clear Calculator			
	Specification Type			
	Symmetrical			
	Symmetrical			
۱ ۱	Specifications			
1	Specification Type	Tolerance	Modifier	
	Indicated Value Error (% or ppm):	65	ppm	~
	Full Scale Value:	20	v	
	Full Scale Error (% or ppm):	10	ppm	~
	Floor Error (Test Point Linits)			
11	riou chor (rest Point onits).		*	
- \	dB (log) Error:		Volt/Amp	~
- \	Custom Calculators Manage: 🛓 🗕 🧷 View:	۲		
- N				^
- N				
\				Ŷ
1		Calculate Re	sult	
	L			

### 6. Model Type: "Multi-TP Meas. Equation" Editing

#### **Description:**

MPS 1.0 only had one uncertainty model type, which was based on a list of uncertainty budget items that were added to the uncertainty model either automatically or manually by the user. This is still the default uncertainty model type for MPS. MPS 2.0 supports two uncertainty model types:

- **Budget Items**: This is the uncertainty model type that you are already familiar with from MPS 1.0 that has a list of Type "A" and "B" uncertainty budget items.
- **Muti-TP Meas. Equation**: The new Multiple Test Point Equation (MTPE) facilitates combining multiple other test points with a measurement equation to calculate the measured values for the MTPE test point. This is described in detail below.

The uncertainty model type can be selected as shown in the following image:

Test Point Uncertainty	y Editor	Use Advanced Model Editor
TP Model: 🗎 🥖 🚺 🖺	Ĝ	
TP Nominal Value: 3.	.000 in	
Model Type: 🔘	Budget Items	Mutli-TP Meas. Equation
		Use Degrees of Freedom?

### Multiple Test Point Equation (MTPE) description

MPS 2.0 supports the use of Multiple Test Point Equation (MTPE) for test points whose measured value is obtained by performing an equation that combines measured values from two or more other test points. For instance, you could have an "Area" test point that uses the "Length" and "Width" test point's measured values and the equation: "Area = Length \* Width".

When calibrations are performed, the measured values for these test points are automatically calculated and assigned when a measured value is present in all test points that are inputs to the MPTE measurement equation.

Uncertainty calculations are fully dynamic. When the uncertainty model of one of the input test points is changed, the uncertainty, correlation input variable analyses, input sensitivity coefficients, etc. are automatically recalculated.

As with all other test point uncertainty models, the uncertainty model (input uncertainty models) may differ between "As Found" and "As left" measurements based on factors such as the calibration standards used.

Tes	t Point Uncertain	nty Editor	Use Advance	ed Model Editor		1
TP N	vodel: 📄 🥖 📋	Ĉ				
TP	Nominal Value:	3.000 in				
	Model Type:	O Budget Items	Mutli-TP	Meas. Equation		
			Use Degrees o	f Freedom?		
k	= 2.0595 (0	Coverage Factor)	<b>EMU</b> = 0.00	09063 in	<b>TUR =</b> 55	: 1
k	= 2.0595 (Correlated	Coverage Factor) Mul	EMU = 0.00	09063 in	TUR = 55	:1
k Eq	= 2.0595 (Correlated uation Tools: fx	Coverage Factor) Mu Correlation Too	EMU = 0.00 Itiple Test Point	09063 in Measurement Ec relation	TUR = 55 quation	: 1
k Eq Me	= 2.0595 (C Correlated uation Tools: fx easurement Inputs	Coverage Factor) Mul Correlation Too s (Test Points) M	EMU = 0.00 Itiple Test Point Is: 🞲 🖸 Use Con easurement Equi	99063 in Measurement Ed relation ation Correlation	TUR = 55 quation Matrix	:1
<b>k</b> Eq	= 2.0595 (Correlated uation Tools: fx easurement Inputs Measurem Input Boo	Coverage Factor) Mu Correlation Too s (Test Points) M ent Equation kmark Name	EMU = 0.00 Itiple Test Point Is: D Use Con easurement Equa Measured Value	09063 in Measurement Ed relation ation Correlation Degrees of Freedom	TUR = 55 quation Matrix Standard Uncertainty	: 1 Sensitivity Coeff (Calculated)
k Eq Me	= 2.0595 (Correlated uation Tools: fx easurement Inputs Measurem Input Boo Length	Coverage Factor) Mul Correlation Too s (Test Points) M ent Equation kmark Name	EMU = 0.00 Itiple Test Point Is: Duse Contended Reasurement Equal Measured Value 1.42 in	09063 in Measurement Economic relation Correlation Degrees of Freedom 14	TUR = 55 quation Matrix Standard Uncertainty 0.0015 in	: 1 Sensitivity Coeff (Calculated) 2.0100000055654

- Test points that will be used as inputs to MTPEs must be assigned a unique "Uncertainty Model Bookmark Name" in the "Uncertainty Analysis Editor" form (Advanced Uncertainty Model Editor) before they can be used as inputs to an MTPE.
  - The bookmark name assigned will also be used as the variable name in the equation editor. The value assigned to this variable when the equation is executed, is based on context:

- **Test Point (design) context**: This value defaults to the first Nominal Value parameter but may be overridden in the form used to manage input test points to the equation.
- **Measurement (calibration) context**: When a measurement is processed (equation executed) by MPS, the applicable Measured Values of the input test points are used as the variable values in the equation.
- Automatically calculates the partial derivative-based sensitivity coefficients of the contributing test points and the measurement equation used.
- Supports a Correlation Matrix and has correlation analysis tools to help correlate the uncertainty budget items of the test point's uncertainty models that are used in the MTPE.

## How to create a MPTE test point:

- 1. Create the input test points using the Test Point Builder.
  - a. Input test points must use the "Budget Items" (normal) uncertainty model type.
- 2. Configure the uncertainty budget items of the input test points in the normal manner. This can be any combination of automatically or manually created budget items.
- 3. Assign a unique "Uncertainty Model Bookmark Name" in the "Uncertainty Analysis Editor" form (Advanced Uncertainty Model Editor) for each of the input test points to make them available for selection in the MTPE Equation editor. This bookmark name will also be the name of the variable in the equation editor that represents the input's value.
- 4. Create the MTPE test point using the Test Point Builder as you would any other test point.
- 5. Set this test point's Uncertainty Model Type to "Multi-TP Meas. Equation." Setting this model type causes MPS to change the features of the uncertainty model display/editor forms to support MTPE display/editing instead of "Budget Items."
- 6. Use the f button to edit the Measurement Equation:

N	lanade inputs: 📕 📛 👝 🧷 d	Clear all 1	Tool Data:			
IV	Manage inputs. T = 2		Degreer of	Standard	Sonsitivity Cooff	
	Input Bookmark Name	Value	Freedom	Uncertainty	(Calculated)	
1	Length	1.42 in	14	0.0015 in	2.0100000055654	
2	Width	2.01 in	14	0.0015 in	1.4200000039318	
21	Section Name: Section Parameter:		Step Number:		Function Tested: Nominal Value:	Length 1.420 in
	Measurement Equation Des	cription:		Me	asurement Equation	
	Measurement E	quation: {Length lation	1} * {Width}			
	Calcu	late				
	Equation Value (Calc Degrees of Fi	Result): 2.8542	? in	in		
_				1	OK 🗙 Cancel	

N	Aultiple TP Equation Test Point Ed	itor					×
	Multiple TP Equation Test Po	oint Editor					
	Test Point Unc Model	Bookmark Name:	Length				~
	Selected Input (Test Point)	Information					
	Section Name:		Section F	Parameter:			
	Step Number:						
	Function Tested:	Length					
	Nominal Value:	1.420 in					
			Manually Enter a Mea	asured Value	•		
	Measured	Value (expected):	1.42	in		Reset to TP Nomina	I.
	Dec	grees of Freedom:	14				
	Star	ndard Uncertainty:	0.0015 in	7			
	Sensitivity Coeff	icient (Calculated):		-			
				_			
		1	OK X Cancel				
γ Afto	radding Inputs use	tho 🦉 Edit Eq	uation button to	odit tho	Moo	suromont Fau	ation Th
. Alle	mon MPS equation (	ditor form i	s displayed and y	vill inclu	de a v	variable for ea	acion. mi ich innut
(Unc	certainty Model Bool	kmark Name	). Edit and accep	t the eau	uatio	n.	en input
	Calculate						
J. Click	the b	utton to hav	e MPS execute t	he equat	tion a	and calculate s	sensitivity
coer	incients for each of th	ne inputs. se	insitivity coefficie	ents are o	calcu	lated from the	equatio
10. If yo	u wish to use correla	ation, check t	the 🗹 Use Correlation	checkbo	ox an	d then click th	ie 💷 bu
to us	se the Correlation M	atrix Editor t	o either manuall	y assign	corre	elation values	or use th
Varia	able Correlation Ana	lysis tool to p	perform the anal	ysis for t	the it	em currently s	selected i
displ	layed correlation ma	trix:					

					Correlation M	latrix	
	Measurement Equation Input Variable	Variable	1	2			
.en	gth	1	1.00				
Nic	ith	2	0.50 (A) 1	.00			
					Measurement Equation Variable	e Correlation Analysis	*
	Input Variable	1	Input V	/ar 1	Input Variable 2	Input Var 2	
	"Width" Error Sources (Description)		Standa	ard ainty	Error Sources (Description)	Standard Uncertainty	[Enter Value]
1	"Width" Error Sources (Description) Auto: Measurement Resoluti	ion	288.7 µin	ard ainty	Length Error Sources (Description) 1 Auto: Measurement Resolution	288.7 µin	[Enter Value]
1 2	"Width" Error Sources (Description) Auto: Measurement Resolut Repeatability	ion	288.7 µin 0.001 in	ard ainty	Length <sup>-</sup> Error Sources (Description)     Auto: Measurement Resolution     Repeatability	288.7 µin 0.001 in	0.5 0.5
1 2 3	"Width" Error Sources (Description) Auto: Measurement Resoluti Repeatability Cal Std	ion	288.7 µin 0.001 in 100 µin	ard ainty	Length <sup>-</sup> Error Sources (Description)           1         Auto: Measurement Resolution           2         Repeatability           3         Cal Std	288.7 µin 0.001 in 100 µin	0.5 0.5 0.5
1 2 3 4	Width" Error Sources (Description) Auto: Measurement Resoluti Repeatability Cal Std Operator Error	ion	288.7 µin 0.001 in 100 µin 0.001 in	ard ainty	Length <sup>-</sup> Error Sources (Description)           1         Auto: Measurement Resolution           2         Repeatability           3         Cal Std           4         Operator Error	288.7 µin 0.001 in 100 µin 0.001 in	Correlation [Enter Value] 0.5 0.5 0.5 0.5
1 2 3 4 5	Width" Error Sources (Description) Auto: Measurement Resolut Repeatability Cal Std Operator Error Environment	ion	288.7 µin 0.001 in 100 µin 0.001 in 282.8 µin	ard ainty	Length           Error Sources (Description)           1         Auto: Measurement Resolution           2         Repeatability           3         Cal Std           4         Operator Error           5         Environment	288.7 µin 0.001 in 100 µin 282.8 µin	Correlation [Enter Value]           0.5           0.5           0.5           0.5           0.5           0.5           0.5           0.5           0.5
1 2 3 4 5	Width" Error Sources (Description) Auto: Measurement Resolut Repeatability Cal Std Operator Error Environment Combined	ion I Uncertainty	288.7 µin 0.001 in 100 µin 0.001 in 282.8 µin <b>282.8 µin</b>	ard sinty	Length <sup>-</sup> Error Sources (Description)     Auto: Measurement Resolution     Repeatability     Gal Std     Operator Error     Environment     Combined Uncert	288.7 µin 0.001 in 100 µin 0.001 in 282.8 µin 282.8 µin 282.8 µin	Correlation [Enter Value]           0.5           0.5           0.5           0.5           0.5

Note: There is a master/child relationship between the correlation matrix grid (top half of the form) and the correlation analysis tool (bottom half of the form). When you select a cell in the correlation matrix grid, the correlation analysis is displayed for the applicable pair of inputs.

11. You can decide to use either manually estimated correlation values or use the correlation analysis tool to calculate them by selecting one of the following:

"Manual Entry," you simply type in the matrix item value. Otherwise, the result of the correlation analysis tool is automatically applied.

12. Using the correlation analysis tool: MPS automatically populates the correlation analysis tool with all the budget items from input variable 1 (left side item). MPS will then populate the input variable 2 budget items that it is able to automatically match to items in input variable 1. You can then override MPS' choices by selecting a different input variable 2 item for each input variable 1 item or clear (none applicable) any of the input variable 2 selections. Entering correlation values for each input variable 1 and 2 budget items pair (left and right side) is entirely up to you.

## 7. Calibration Interval and other analysis tools that use MPS and CMS calibration history data

## **Description:**

Whether in the "Calibration" or the "Design" MPS Master Mode, you can display and analyze calibration history data for the currently loaded data sheet and its test points. When one or more calibration channels are in use, a "This Asset" option is available to use only history data from the currently selected calibration channel (asset ID).

//(	X	Master M	ode: 👔 👻 Display	Areas: 🚛 🔀 Template Editin	ng: 🛕 Casto, Curt V SCE
Navigati	on: 🕹 🛧 💌	🔺 Manage Chai	nnels: 🧱 🔚 🗎 All:	🚰   Display: 🛄   Timer: 🕨 🏢	Display (Cal): 🛒 Display (Script): 🍙 Analysis: 🌚 📷 😁
-	M	easurement Data En	try	Selected Calibration Chann	ne Cal History Analysis
Copy A	F to AL	Nominal: 1.0000	00 V~@ 50 kHz	Channel:	🔺 Data Scope
Data M	lode	Def Valuer 1 00000		Found	Start Date: 11/25/1999 🗷 End Date: 11/25/2019 🗷 Asset ID*:
• "As	ound"	Rel. value. 1.00000	, v	Found.	
O "As	.eft" M	eas. Value:	V	🟹 Adjusted	Test Point History
Measur	ements				This Asset I are the all the all the all the set (the site use the "Files" & the set
Meas T	vne Refere	nce Value Measu	red Value OT	Tolerance	This Asset search uses the selected cal channel (otherwise, use the "Hiter" reature's "Asset" option)
meda. I	ype Refere	ince value measu	Ned Valde OI	Tolerance	"MyMetSpec" Instrument Range Usage (Reverse Trace in calibrations)
AS FOU	nd 1.0	00000		0.998300 to 1.001700 V	Execute Range Usage Report     "MvMetSpec" Instrument range assigned.
As Le	ft 1.0	00000		0.998300 to 1.001700 V	· · · · · · · · · · · · · · · · · · ·
					Filter
<					
				>	As Found
	Step Num	Function Tested	Nominal Value	As Found As Left ^	Show: Show All V =
	Step Num	Function Tested	Nominal Value	As Found As Left	Show: Show All V =
0	Step Num	Function Tested I 100 V Range	Nominal Value 10.00000 V 100.0000 V	As Found As Left	Show: Show All V =
0	Step Num	Function Tested I 100 V Range 1000 V Range	Nominal Value 10.00000 V 100.0000 V 1000.000 V	As Found As Left	Show All $\checkmark$ = $\square$ As Found $\square$ As Left
0	Step Num       4.3.2.3	Function Tested I 100 V Range 1000 V Range AC Voltage 100 mV Range	Nominal Value 10.00000 V 100.0000 V 1000.000 V 100.0000 mV @ 10 Hz	As Found As Left	Show All v = As Found As Left
0	Step Num 1 1 4.3.2.3 4.3.2.4	Function Tested I 100 V Range 1000 V Range AC Voltage 100 mV Range I	Nominal Value           10.00000 V           100.0000 V           100.0000 V           1000.000 V           100.0000 mV           @ 10 Hz           100.0000 mV           @ 20 kHz	As Found As Left ^	Show: Show All v = As Found As Left
0	Step Num           I           I           I           4.3.2.3           4.3.2.4	Function Tested I 100 V Range 1000 V Range AC Voltage 100 mV Range I I	Nominal Value           10.00000 V           100.0000 V           1000.0000 V           1000.0000 V           1000.0000 W           @ 10 Hz           100.0000 mV           @ 20 kHz           100.0000 mV           @ 50 kHz	As Found As Left As Left	Show: Show All v = As Found As Left
0	Step Num           I           I           I           4.3.2.3           4.3.2.4           I           I	Function Tested I 1000 V Range 1000 V Range AC Voltage 100 mV Range I I I I	Nominal Value           10.0000 V           100.0000 V           100.0000 V           100.0000 W           20.000 mV           20.000 mV           20.012           100.0000 mV           © 50 kHz           100.0000 mV           © 50 kHz           100.0000 mV	As Found As Left As Left	Show All v = As Found As Left
0	Step Num           I           I           4.3.2.3           4.3.2.4           I           I           I           I           I           I           I           I           I	Function Tested I 100 V Range 1000 V Range AC Voltage 100 mV Range I I I I I	Nominal Value           10.0000 V           100.0000 V           100.0000 V           100.0000 W           1010.0000 mV           © 10 Hz           100.0000 mV           © 50 Hz           100.0000 mV           © 10 Hz NO000 mV           © 50 Hz           100.0000 mV           © 10 Hz NO000 mV           © 10 Hz           100.0000 mV           © 100 Hz           100.0000 Hz           © 300 Hz	As Found As Left As Left	Show. Show All         ✓         ■         ✓ As Found           I.001         ✓         As Left         ✓           0.999         ✓         ✓         ✓           Date (UTC)         TP Nom         AF Ref         AF Meas         AL Nom         AL           06/11/2012         1.000000 V~@ 5 1.000000         0.9998985         1.000000 V~@ 5 1.0         0.9998985         1.000000 V~@ 5 1.0

- The data displayed in the "Cal History Analysis" chart and grid are for the currently selected test point in the MPS master data sheet grid. The data displayed changes as you select different test points in the MPS master data sheet grid.
- The data can be filtered by date range, asset ID, and calibration technician.
- Interval Analysis
- An interval analysis report can be displayed that includes analyses for both the data sheet as a whole and an independent analysis for each test point. This includes both interval and end of period reliability. The report can also optionally include measurement history:

### **Calibration Interval Analysis**

for

#### Hewlett Packard 34401A, Digital Multimeter Asset ID: 001908 From: 11/25/1999 to: 11/25/2019

#### Configuration Parameters

Note: These parameters are set in the	MPS Maaster configurations and may differ from t	hose set in the Staistics Miner application	l
Reliability Target: 85 %	Min Allowed Interval: 0 Days	Min Allowed Interval: 70 %	
OOT Rate Target: 15 %	Max Albwed Interval: 360 Days	Max hrwval Extension: 20 %	

Note: Only calibrations with a calibration interval > 0 days are used in interval analysis.

#### Instrument Summary

Average Interval: 512 Days Longest Interval: 720 Days Number of Tests: 6	Number In Tolerance 6 Number O OT: 0	Observed Reliability: Observed OOT Rate: Recommended Interval:	100 % 0 % <b>20 %</b>
Apparent Reliability: 87.5 %	Upper EoP Con f. Limit: 6	Avg. tests per year:	0.713
	Lower EoP Con f. Limit: 81.819 %	Consecutive successes:	6

#### Test Point Detail

Step#	Function Teste	d	Nominal Value		Calibration Toleran	ce
4.3.1.3	DC Voltage 100 mV Range	•	0.0000 mV		-0.0035 to 0.0035 m	V
Average Int Longest Int Number of T	erval: 512 Days erval: 720 Days ests: 6 Days	Numb	er In Tolerance 6 Number OOT: 0		Observed Reliability: Observed OOT Rate: Recommended Interval:	100 % 0 % 360 Days
Apparent Reliat	oility: 87.5 %	Upper I Lower	EoP Con f. Limit: 100 EoP Con f. Limit: 81.	% 819 %	Avg. tests per year: Consecutive successes:	0.713 6
As Found Measu	rements					
Cal Date	Test Number	Interval	As Found Value	OOT	As Found Tolerance	EMU
1/4/2012	655176	720	0.0001		-0.0035 to 0.0035 mV	± 0.39 µV
12/30/2010	607667	720	-0.0007		-0.0035 to 0.0035 mV	± 0.39 μV
12/31/2008	564814	540	-0.0001		-0.0035 to 0.0035 mV	± 0.39 µV
2/9/2007	524449	365	0.0011		-0.0035 to 0.0035 mV	± 0.39 µV
7/12/2005	488661	365	0.0004		-0.0035 to 0.0035 mV	± 0.39 μV
3/11/2004	405658	365	-0.0001		-0.0035 to 0.0035 mV	± 0.39 µV

Execute Range Usage Report

If the currently selected test point has a "MyMetSpec" instrument range assigned, you can display a reverse traceability report that shows utilization of the assigned "MyMetSpec" instrument and range as a calibration standard in other MPS calibrations. This is very helpful for doing reverse traceability assessments when you view a calibration document in MPS for a calibration standard. Select a failed (out of tolerance) test point and execute this report. The report will be filtered on the calibration standard's applicable asset ID and date range (typically the date range from the last calibration until the next calibration):



### 8. "MOX Statistics Miner" application

#### **Description:**

"MOX Statistics Miner" application. This application performs calibration interval analyses for all MPS Data Sheets and CMS Make/Models. The application generates summary analysis data records and stores them in the MPS and CMS database.

	OX			
Tran	saction Delay			
Service	Control: 🕨 🔢 🕅 N	1anual Contr	rol: 🜔 ဝ	
Active	Task Name	Status	Duration	Asset Analysis: M3-6996
0	MPS Interval Analysis	Running	0:0:0	
	CMS Interval Analysis		-:-:-	Processing Data Sheet:
				Starrett 120A
				Dial Caliper
				Data Sheets 184 of 8650
				Processing Test Points & Assets:
				Cal Test Point Data Points Found: 5170
				Test Point Analyses: 252 of 760

The summary data can be viewed from reports within either the MOX Statistics Miner or MPS applications. The report system has options that allow you to select multiple ways of looking at the data such as: by equipment reliability, recommended interval changes, data sheets with one or a few test points that are resulting in shortened calibration intervals, etc.

		×
IPS Interval Analysis Reports		
Report Type: Delta Cal Interval Summary	~	
Sort Order: By Reliability	$\sim$	
Min Samples >: 5 Min RCI Dellta >: 10 Days		
Do the Report		

	0	ata Sheet Interval	l Analysis Su or	ummary		
		Where (Sample>5) at	of (PCI Dolta >	10 %)		
		Order by	Deliability	10 76)		
		Order by	Reliability			
Crawler Configuration Par	ameter's	Note: These are the curr	ent parameters. Th	ey may not be the I	basis of displa	ayed data.
Reliability Target: 85	.000 %	Min Allowed Interval:	30 Days	Interval Change	Confidence:	70.000 %
OOT Rate Target: 15.	000 %	Max Allowed Interval:	720 Days	Max Interv	al Extension:	20.000 %
Test Point Analysis F	lag Trigger Spe	ecifications		Includes da	ta beginning:	1/1/1900
Minus:(TP RCI < DS Mea Plus: (TP RCI > DS Mea	n RCI) Min Sampl In RCI) Min Sampl	es: 10 RCI Days Delta es: 10 RCI Days Delta	10 Mean Da 1000 Mean Da	ays Delta 0 ays Delta 0	RCI Std De RCI Std De	vs 1 vs 1
Tektronix TM5000 Series,	Mainframe			Analysis Dat	e (UTC): 8/	28/2019
DocUID: {6AAF DocVerUID: {6B881	BF03-D6CD-40C4-88 1054-9CA7-40C0-AC	374-A646C6D8440C} 267-5F0B04717414}	Data S	heet Approved Dat	e (UTC): 5/	10/2002
Average Interval:	360 Days	Number In-Tolerance:	0	Observed R	eliability:	0.000 %
Longest Interval:	360 Days	Number OOT:	13	Observed O	OT Rate: 1	00.000 %
Number of Tests:	13			Recommended	Interval:	180 Days
Apparent Reliability:	0.000 %	Upper EoP Con f. Limit: Lower EoP Conf. Limit:	8.845 % 0.000 %	Avg. tests	per year:	1.015
Test Point Count:	9	TP Interval Mean:	348	TP Trigger	s (Plus):	0
(Std Dev / Mean) %: Catalog Notes:	36.207	TP Interval Std Dev:	126.000	TP Triggers	(Minus):	0
Tektronix 2236, Oscillosc	ope/CTM			Analysis Dat	e (UTC): 8/	28/2019
DocUID: {905E8 DocVerUID: {A8C8	32FB-ED9E-4217-8F 7B03-3C8B-4087-9A	BD-30D04BB2C6E2} EA-46B0895A465E}	Data S	heet Approved Dat	e (UTC): 7/	20/2002
Average Interval:	364 Days	Number In-Tolerance:	0	Observed R	eliability:	0.000 %
Longest interval:	365 Days	Number OOT:	7	Observed O	OT Rate: 1	00.000 %
Number of Tests:	7			Recommended	interval:	182 Days
Apparent Reliability:	0.000 %	Upper EoP Con f. Limit: Lower EoP Conf. Limit:	15.802 % 0.000 %	Avg. tests	per year:	1.005
Test Point Count:	141	TP Interval Mean:	351	TP Trigger	s (Plus):	0
(Std Dev / Mean) %: Catalog Notes:	13.354	TP Interval Std Dev:	46.830	TP Triggers	(Minus):	0

The summary analyses are stored in the system databases for all the following grouping types of their included analysis data (each grouping listed has a separate table that stores its summary analysis results):

- CMS Make/Models
  - All CMS calibrations for the make/model
  - o All CMS calibrations for the combination of each customer and make/model
  - o All CMS calibrations for the combination of each asset and make/model
- MPS Data Sheets

Note: The following groupings have analyses for both the data sheet as a whole and a separate analysis summary table and records for each test point in the data sheet.

- All MPS calibrations for the data sheet
- All MPS calibrations for the combination of each asset and data sheet

### 9. Interval Analysis Reports

### **Description:**

Reports of interval analyses performed by the MOX Statistics Miner and stored in the system database can be displayed from within the MPS application. These reports can be accessed from the MPS main menu's "Tools," "Interval Analysis Reports" menu. You can choose to view reports MPS data reports or CMS data reports.

	Data Sheet merv		f	or	y515 3	ummary			
		Whe	re (Sample>5) a	nd (RC	Delta >	> 10 %)			
		Order by R	CI(Recommended	d Cal In	terval)	Deviation Days			
Crawler Configuration Pa	arameter's	i Not	e: These are the curr	ent parar	neters. Ti	hey may not be the	basis of	displayed	idata.
Reliability Target: 8	5.000 %	м	n Allowed Interval:	3	0 Days	Interval Chang	e Confide	nce:	70.000 %
OOT Rate Target 15	.000 %	Ma	x Allowed Interval:	72	0 Days	Max Interv	al Extens	sion:	20.000 %
Test Point Analysis	Flag Tri	gger Specifica	tions			includes da	ata begin	ning:	1/1/1900
Minus:(TP RCI < DS Mea Plus: (TP RCI > DS Me	an RCI) san RCI)	Min Samples: 10 Min Samples: 10	RCI Days Delta RCI Days Delta	10 1000	Mean D Mean D	Days Delta 0 Days Delta 0	RCI SI RCI SI	d Devs d Devs	1
shcroft 2174 (Loop), Dig	jital Press	ure Gauge				Analysis Dat	e (UTC):	8/28/20	19
DocUID: (63144 DocVed JD: / R9EE	9D5-8862	2-42EC-8E5B-33F6	1345F09D}		Data S	Sheet Approved Date	e (UTC):	4/13/20	011
Average Interval:	180 0	2/5	abaala Tabaaaaa		**	G	C.L.T.	74.0	
Longest Interval:	180 D	avs Nun	Number OOT:		10	Observed R	Bability:	/1.4 20.5	23 76 71 9/
Number of Tests:	14		Number COT.		-	Recommended I	nterval:	20.0	14 Days
Apparent Reliability:	71.429	9 % Uppe Lower	r EoPConf. Limit EoPConf. Limit	84 54	.869 % .058 %	Avg. tests (	er year.	2.0	29
Test Point Count:	2	2	TP Interval Mean:		201	TP Trigger	s (Plus):		0
(Std Dev / Mean) %:	10.559	9 TP	Interval Std Dev:	21	252	TP Triggers	(Minus):		0
Catalog Notes: R	ange:0 to	20000 psig, Accura	ecy: 0.25 % F.S. (Us	ing Oil D	WT 500 j	psi/Kg)			
/itutoyo 329-711-30, Dep	oth Micror	meter				Analysis Dat	e (UTC):	8/28/20	19
DocUID: {FDDE DocVerUID: {3D234	B3D2-B54 4C8D-141	A1-11D8-AA15-000 7-4F91-91E1-8AD8	:04F287D80} :5A35EC0D}		Data S	Sheet Approved Date	e (UTC):	10/1/20	010
Average Interval:	333 D	ays Nun	ber In-Tolerance:		36	Observed R	eliability:	78.2	81 %
Longest Interval:	720 D	ays	Number OOT:		10	Observed OC	OT Rate:	21.7	39 %
Number of Tests:	48					Recommended I	nterval:	2	98 Days
Apparent Reliability:	78.261	1% Upper Lower	r EoPConf. Limit EoPConf. Limit	84 70	.828 % .200 %	Avg. tests (	oer year.	1.0	97
Test Point Count:	12	2	TP Interval Mean:		349	TP Trigger	s (Plus):		0
(Std Dev / Mean) %: Catalog Notes: 0	4.006 to 6 in	9 TP	Interval Std Dev:	13	.970	TP Triggers	(Minus):		5

### **10.** Data Sheet Document Inspector

#### Description:

The new Data Sheet Document Inspector allows you to view and, in very few cases, edit document properties of the data sheet or active (currently selected) test point:

Data Sheet Document inspecto		رلكان
Data Sheet Active Test Point		
Property	Values	^
MeasNominal Value	5	
Tol: MeasOrigin	DSDesign	
Tol: Meas_Low	4.99978	
Tol: Meas_High	5.00022	
Tol: MeasRaw_Low	4.999775	
Tol: MeasRaw_High	5.000225	
TP Statistics		
TP Accuracy	0.0002250000000364	
Stds Accuracy	0.000017999999998515	
Stds Uncertainty	0	
Stds 4:1 Req. %	0.0011250000000182	
- EMU	0.0000151216462207124	
TAR	12.500000001234	
TUR	14.8793323634418	_
E TP Risk		
ZFactor	30	
KFactor	97.9837805039083	
PFA	0.266409722092129	
PFR	0.315237778991877	
- Total	0.581647501084006	
PFA (gb)	0.114343205764491	~
Selected Item Description:		
statistics: lest Uncertainty Ratio (	TUK) (n:1)	<u>^</u>

## **11.** Application License and Sessions Manager

### **Description:**

This tool can be used by anyone who is currently logged into MPS and MetSpec to see (read only) how many user licenses are currently in use. Additional features are available for system administrators to help notify users of an upcoming maintenance outage, terminate specific current user sessions, and set a flag to prevent new sessions from starting (running):

	in Sessions							
/								
App Session Monitor	App Version	Control						
Computer Name	Login ID	Work Phone	Session Created (UTC)	Session Last Updated (UTC)	Sessions	Force App Term	ination	1
ATS119	ccasto		11/25/2019 22:41:39	11/26/2019 1:44:09	1			
¢								>

### The tool also displays minimum application and database version requirements

	Sessions				
Manage Applicatio	n Sessions				
2 × ×					
App Session Monitor	App Version Control				
Database: MetBench	_MPS Database Version: 2	019.9.18.0			
Application	App	lication Version	Custom Message	Custom Msg On	Allow to Rur ^
MeasurementProce	ssor.exe 2.0.	0.0	(MEMO)		
MetSpec.exe	2.0.	0.0	(MEMO)		2
MoxStatsMiner.exe	2.0.	0.0	(MEMO)		
MoxStatsMiner.exe	2.0.	Custom Messac	(MEMO)		
<	2.0.1 ication Name asurementProcessor.exe	0.0 Custom Messag Please exit MPS	(MEMO)  P  S by 4PM for scheduled maintenance. Any open		×
MoxStatsMiner.exe <	2.0.1 ication Name asurementProcessor.exe cation Version	Custom Messag Please exit MPS sessions will be	(MEMO)  Pe 5 by 4PM for scheduled maintenance. Any open forcibly terminated after 4PM.	Custom Msg On	,
MoxStatsMiner.exe	2.0.	0.0	(MEMO)		M
xStatsMiner.exe	2.0.1	0.0	(MEMO)		
MoxStatsMiner.exe	2.0.1 ication Name asurementProcessor.exe	0.0 Custom Messag Please exit MPS	(MEMO)  P  S by 4PM for scheduled maintenance. Any open		×
MoxStatsMiner.exe < Appl Me Appli	2.0.1 ication Name asurementProcessor.exe cation Version	Custom Messag Please exit MP3 sessions will be	(MEMO) ge 5 by 4PM for scheduled maintenance. Any open e forcibly terminated after 4PM.	Custom Msg On	
MoxStatsMiner.exe <  Appl Appli 2.0	2.0. ication Name asurementProcessor.exe cation Version .0.0	<b>Custom Messag</b> Please exit MPS sessions will be	(MEMO) ge 5 by 4PM for scheduled maintenance. Any open 6 forcibly terminated after 4PM.	Custom Msg On	×

## 12. Editing assigned calibration standards while in the MPS "Calibration" master mode

## **Description:**

A new "[Calibrations].[Allow Calibration Standards Editing]" master configuration option has been added to optionally allow users to add, remove, or edit calibration standards assigned to the data sheet or MetSpec Ranges assigned to test points while performing a calibration. The default setting for this new configuration is False (not allowed). You must set this configuration to True to enable calibration standards editing during a calibration. If the feature is enabled, MPS does not have to be in the master edit mode to manage the standards while MPS is in its "Calibration" master mode. This means that changes to the standards configuration will be considered as an allowable modification of the approved data sheet and MPS will accept calibrations performed with the data sheet.

When the feature is enabled	a 💿 button appears on the right side of the calibration tool's
workspace tool buttons bar:	Display (Cal): 📑 Display (Script): 👔 🛛 Analysis: 🎡 📰 🥌

The editor is exactly the same as the "Data Sheet Standards and MetSpec Instruments" form that used to manage calibration standards and MetSpec instrument range assignments when in the MPS "Design" master mode.

							-
ata Sheet	t Standards an	d MetSpe	c Instruments				Ţ,
/lanage Sta	andards (Data	Sheet) As	sign Standards	(Test Point)	TII	MetSpec File (MyMetSpec)	
Test Point	Calibration St	tandard A	ssignments				
Standards:	: 🏂 🗕 🚘 🗉	Instrument	s: 👩 ★ 👁	Ranges: 🤱	•	-	
E 🌆 Cal	ibrator, Multil	Function,	w/Amplifier				
ē- 📕 (	🥑 苯 (90 Day),	Fluke 570	0A-EP/5725A, C	alibrator, M	ultiFu	nction, w/Amplifier	
	(TAR: 200:1)	) (±0.5 µV)	Voltage, DC, R	ange: 220 n	nV {M	Notes: 5}, [90 day] Accuracy: +/-	(7 ppn
÷ 📃	(365 Day), F	luke 5522A	-SC1100, Calib	rator			
	(TAR: 100:1)	) (±1 µV) V	oltage, DC, Rai	nge: 329.999	9 m\	/, [1 yr] Accuracy: +/-(20 ppm I.)	V. + 0.0
÷. 📕	(365 Day), F	luke 5500A	, Calibrator				
	(TAR: 33:1)	(±3 µV) Vo	oltage, DC, Rang	ge: 0 mV to	329.9	999 mV, [1 yr] Accuracy: +/-(0.0	06% 1.
	(90 Day), Flu (TAR: 100:1)	ike 5520A- ) (±1 μV) V	SC600, Calibrat /oltage, DC, Rai	or nge: 329.999	9 m\	/, [90 day] Accuracy: +/-(15 ppm	n I.V. +
	(90 Day), Flu (TAR: 100:1)	ke 5520A- ) (±1 μV) V	SC600, Calibrat /oltage, DC, Rai	or nge: 329.999	99 m\	/, [90 day] Accuracy: +/-(15 ppn	n I.V. +
Accuracy a	(90 Day), Flu (TAR: 100:1) and Uncertaint	ike 5520A- ) (±1 μV) V	SC600, Calibrat /oltage, DC, Rai Risk 7.	or nge: 329.999	99 m\	/, [90 day] Accuracy: +/-(15 ppn Parametric Matching Criteria	n I.V. +
Accuracy a TI Acc:	(90 Day), Flu (TAR: 100:1) and Uncertaint 100 μV	ike 5520A- ) (±1 μV) V	SC600, Calibrat /oltage, DC, Ran Risk Z: K	or nge: 329.999	99 m\	/, [90 day] Accuracy: +/-(15 ppn Parametric Matching Criteria <b>0 mV</b> (millivolt)	n I.V. +
Accuracy of TI Acc: Std Acc:	(90 Day), Flu (TAR: 100:1) and Uncertaint 100 μV 0.5 μV (0.5 μV	ike 5520A- ) (±1 μV) V y	SC600, Calibrat /oltage, DC, Rar Risk Z: K: DPF4:	or nge: 329.999  100	99 m\ 96	/, [90 day] Accuracy: +/-(15 ppn Parametric Matching Criteria <b>0 mV (millivolt)</b>	n I.V. +
Accuracy of TI Acc: Std Acc: TAR:	(90 Day), Flu (TAR: 100:1) and Uncertaint 100 μV 0.5 μV (0.5 μV 200	ike 5520A- ) (±1 μV) V y .1 .1	SC600, Calibrat /oltage, DC, Rar Risk Z: K: pPFA: pPFA:	or nge: 329.999  100 0.03148	99 m\ 96 96	/, [90 day] Accuracy: +/-(15 ppn Parametric Matching Criteria <b>0 mV</b> (millivolt)	n I.V. +
Accuracy of TI Acc: Std Acc: TAR: TUR: EMU:	(90 Day), Flu (TAR: 100:1) and Uncertaint 100 μV 0.5 μV (0.5 μV 200 258	ike 5520A- ) (±1 μV) V y y :1 :1 :1 e	SC600, Calibrat /oltage, DC, Rar Risk Z: K: pPFA: pPFA: Total:	ror nge: 329.999  100 0.03148 0.03164 0.06312	99 m\ % %	/, [90 day] Accuracy: +/-(15 ppn Parametric Matching Criteria <b>0 mV</b> (millivolt)	n I.V. +
Accuracy TI Acc: Std Acc: TAR: TUR: EMU:	(90 Day), Flu (TAR: 100:1) 100 μV 0.5 μV (0.5 μV 200 258 0.39	ike 5520A- ) (±1 μV) V (±1 μV) V :1 :1 μV μV 0pes	SC600, Calibrat /oltage, DC, Rar Risk Z: K: pPFA: pPFA: Total: dbPFA:	ror nge: 329.999  100 0.03148 0.03164 0.06312 0.02148	99 m\ % % %	/, [90 day] Accuracy: +/-(15 ppn Parametric Matching Criteria <b>0 mV</b> (millivolt)	n I.V. +
Accuracy a TI Acc: Std Acc: TUR: EMU: O RP10	(90 Day), Flu (TAR: 100:1) and Uncertainth 100 μV 0.5 μV (0.5 μV 200 258 0.39 © Z540 0	ike 5520A- ) (±1 μV) V (±1 μV) V (±1 μV) (±1 :1 € μV () RSS	SC600, Calibrat /oltage, DC, Rar Risk Z: K: pPFA: pPFA: gbPFA: gbPFA: gpPFA:	 100 0.03148 0.03164 0.03164 0.031264	99 m\ % % %	/, [90 day] Accuracy: +/-(15 ppn Parametric Matching Criteria <b>0 mV</b> (millivolt)	n I.V. +
Accuracy TI Acc: TI Acc: Std Acc: TUR: EMU: O RP10 MT Low:	(90 Day), Flu (TAR: 100:1) 100 μV 0.5 μV (0.5 μV 200 258 0.39	ıke 5520A- ) (±1 μV) V (±1 μV) V (±1 μV) V (±1 :1 :1 € μV () RSS	SC600, Calibrat /oltage, DC, Rad Risk Z: K: pPFA: pPFA: gbPFA: gbPFA: gbPFA: gbPFA:	 100 0.03148 0.03164 0.06312 0.03148 0.03164 0.06312	99 m\ % % % %	/, [90 day] Accuracy: +/-(15 ppn Parametric Matching Criteria <b>0 mV</b> (millivolt)	n I.V. +

## 4. New Features (Minor)

## 1. "MyMetSpec" Enhancements

## Description:

When a MetSpec Instrument is assigned to a data sheet as its "MyMetSpec" instrument (The MetSpec spec sheet that is the source of, or mirrors, the data sheet's test point specifications), the following new features are present in MPS 2.0:

- The header fields of the MetSpec Instrument (Model, Manufacturer, Description, spec interval, etc.) are automatically applied to the data sheet header if these fields are currently empty (blank) when selecting the MetSpec Instrument. If the fields are not blank, an option is displayed that offers to replace these fields' content. Both the form used to assign a "MyMetSpec" instrument to the data sheet and the form that is used to edit the data sheet header have a button to update these fields from the assigned "MyMetSpec" instrument.
- The Test Point builder now supports custom calculators in "MyMetSpec" Range Specifications. If MPS does not already have the applicable custom calculator assigned to the data sheet, it will now be added. The Test Point Builder will then add a reference to the custom calculator, so it will be included in the new test point created with the Test Point Builder. MPS 1.0 (and MudCats CPM for that matter) could not use custom calculators in "MyMetSpec" Range Specifications.

# 2. The Auto Assign MetSpec Calibration Instrument Ranges wizard now supports multiple test point selection

### **Description:**

Previously, you could only use the Auto Assign Standard Ranges wizard to assign ranges to either one currently selected test point or the entire data sheet. In addition, you can now multiple select a contiguous (sequential) range of test points before clicking on the wizard feature to auto assign to that group of test points. This is very useful when you want to use the feature for a subset of the data sheet's test points.

## 5. Error Corrections

These items have been identified as errors in the application and have been corrected in this version.

# **1.** Script Commands that read and write other script commands to/from script procedures and variables

### **Description:**

When using the "Utils.ProcCmndsToVar" or "DS.TPCommandsToVar" commands to save a script procedure's commands to a variable and then using one of the "DS.VarToTPCommands," "Utils\_VarToProcCmnds," or "Utils.CreateATEObject" commands to load the script procedure's commands from a variable, an error message may be displayed.

## **Resolution:**

There was a formatting inconsistency between script commands that save a script procedure's commands to a variable and commands that load the script procedure's commands from a variable. This has been corrected to ensure the same formatting is used for all these commands.

## 2. "Sys.ExecCommandGroup" command was not setting the "Unit Global" command group.

### **Description:**

The "Sys.ExecCommandGroup" command was not actually setting the "Unit Global" command group when the "[Unit Global]" constant was specified as the "CmndGroupType" parameter value.

### **Resolution:**

This has been corrected.

### 3. Audit Report "File Name" field and Sort Order

### **Description:**

There is a "File Name" field in the sort options selection list, but selecting it results in an error when the report is executed. Also, the report is not always sorted in the order specified by the sequence of sort options selected, depending on which fields are included in the sort field selections.

### **Resolution:**

The error that resulted from selecting the "File Name" field was caused by the database field name being incorrect when the item is added to the SQL WHERE clause. This was corrected, but the field is not actually included in the report, so this field option was removed from the selection lists. There is no point sorting on a field that is not displayed in the report.

The source code that builds the composite SQL WHERE clause from the selection options was modified to ensure that they are added to the WHERE clause in the order of appearance in the four sort field drop down lists. The "Sort 1" drop down list is first, "Sort 2" is second, etc.