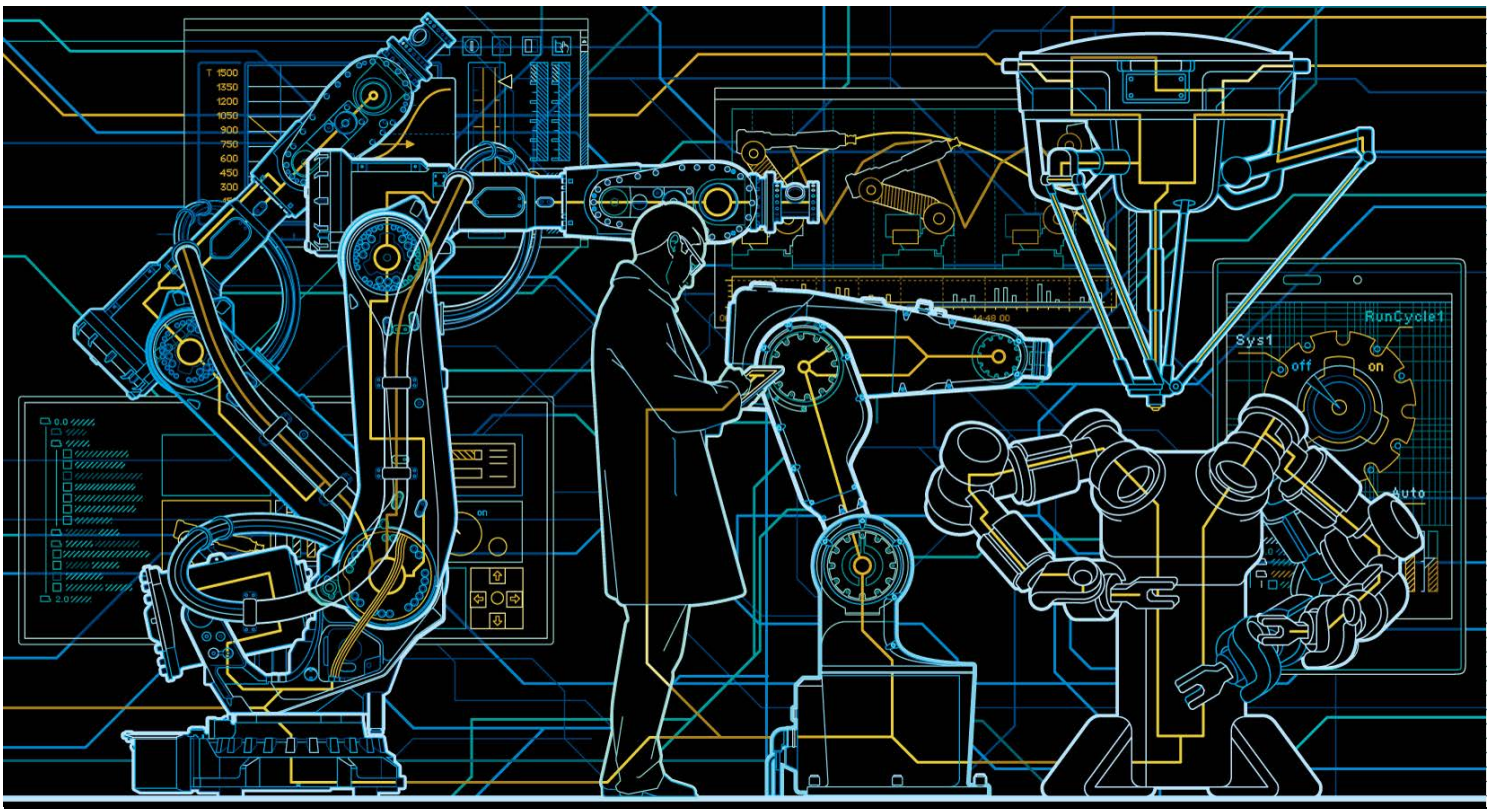

Application manual
Weld Data Monitor

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Application manual
Weld Data Monitor

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Table of contents

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Overview of this manual

About this manual

This manual contains reference information for all procedures described in the product manuals.

Usage

This manual should be used during:

- installation.
- maintenance work.
- repair work.

Who should read this manual?

This manual is intended for:

- installation personnel
- maintenance personnel
- repair personnel

Prerequisites

The reader should:

- be a trained maintenance/repair craftsman.
- have the required knowledge of mechanical and electrical installation/maintenance/ repair work.

Reference documents

References	Document ID
Technical reference manual - RAPID Instructions, Functions and Data types	*3HAC050917-001*
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*
Technical reference manual - System parameters	*3HAC050948-001*
Operating manual - RobotStudio	*3HAC032104-001*
Application manual - Production Manager	*3HAC052855-001*
Application manual - Production Monitor	*3HAC050963-001*

Revisions

Revision	Description
-	Released with RobotWare 6.0.
A	Minor corrections.

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1 Introduction

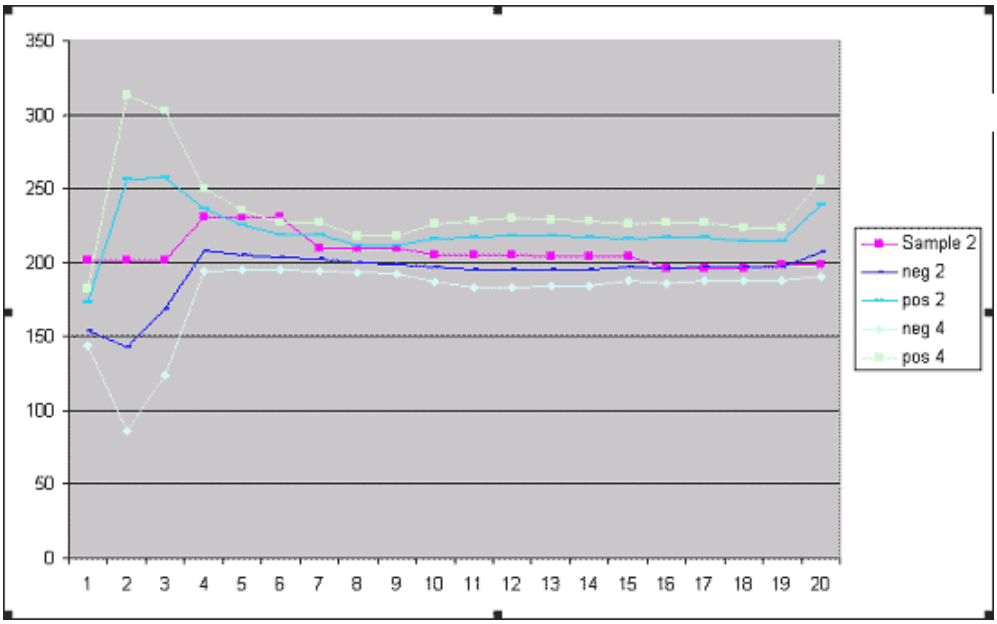
Introduction to Weld Data Monitor

Weld Data Monitor is a sub-option to *RobotWare Arc* that works as an add-in to *Production Monitor* providing additional weld quality analysis based on weld system sensors. The results contribute to the statistical and event data logging capabilities of *Production Monitor*. Weld Data Monitor is also capable of providing immediate operator notification of severe quality problems, through the error handling framework of RobotWare Arc.

Commonly monitored signals are voltage and current, which can provide important indications of weld problems. Additionally users may monitor up to two other signals. These could include actual wirefeed speed based on feedback from a wirefeed speed measurement device, motor torque, based on feedback from the weld controller hardware, or shielding gas pressure from a pressure sensor.

Product overview

The Weld Data Monitor package, or WDM, makes use of a position-correlated *Weld Signature Monitor* analysis tool.



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The position-correlated monitoring method employed by the Signature Monitor, compares measured weld parameters with a stored signature. The signature, or profile of the weld seam, is obtained by storing measured welding data while processing several reference seams. Storing the data while welding a part is referred to as *learning* the weld seams. Each seam, or weld joint, will have a unique signature.

Weld Data Monitor makes extensive use of the arc welding capabilities for Arc and Production Monitor. For this reason, it is always necessary to use the optional argument `SeamName` on the `ArcLStart` instruction. The `SeamName` is used to identify the stored data.

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Operating overview

Weld Data Monitor may be enabled for specific weld seams using a simple RAPID interface. Signatures are automatically learned the first time the weld seam is executed, and learning progress is reported in the process error log. Stored signatures are easily re-learned by simply deleting the signature file from the controller.

Prerequisites

System prerequisites

- IRC5 robot controller
- RobotWare 5.10 or higher with Arc, Weld Data Monitor, and Production Monitor sub-options
- WebWare Server 4.6 or higher with Reports Module, if configured to write to WebWare database
- Weld System Sensors: Up to four analog or group inputs. Some weld equipment, for example the Fronius TPS4000/5000, is capable of providing data through their DeviceNet weld interface. Other systems may require add-on sensors from another vendor, such as the Dart product from CWT.

User requirements

- Operator: No additional training required.
- Data analyst: Users viewing weld data must be trained welders to fully understand the measured results. This person must be involved during the commissioning phase.

Limitations

Weld Data Monitor is not very effective when using a short-arc process. For more information, see *Application guide on page 13*.

Weld Data Monitor results are dependent on the quality of the measurement signals and the quality of the weld process.

2 Installation

Component list

Weld Data Monitor is a RobotWare Arc sub-option. Purchasing the option provides the necessary components in the robot controller to perform the monitoring functions. The option does not include WebWare Server or the hardware required to run WebWare Server. WebWare provides a valuable data store of the potential weld quality problems, but is not necessary for basic Weld Data Monitor features.

Additionally, the Arc sub-option, *Production Monitor*, must be installed, see *Application manual - Production Monitor*. If a WebWare server is available, Production Monitor will provide the framework for data storage related to Weld Data Monitor infractions.

Weld Data Monitor does not store entire weld signatures to WebWare. It only records infractions in the data tables provided by Production Monitor. It cannot be used as a tool to analyze detailed weld process behavior, such as pulse characteristics in pulsed arc welding.

Hardware set-up

Weld Data Monitor receives data from up to four analog or group inputs. See the weld equipment manufacturer's documentation for information regarding sensor installation. Note that for some weld equipment, such as the Fronius TPS4000/5000 power source, sensor hardware may be resident in the system and require no further installation work.

Software installation

The Weld Data Monitor and the Production Monitor licenses must be available when building a system in RobotStudio.

For more information regarding Production Monitor setup and WebWare database configuration, see *Application manual - Production Monitor*. Weld Data Monitor makes use of the Production Monitor features for WebWare logging and cycle-complete notifications. These features must be configured in Production Monitor to fully utilize Weld Data Monitor analysis.

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3 Application guide

Overview

Weld Data Monitor is capable of monitoring up to four analog or group inputs. These configurable signals are referred to as "channels". The data collected for each channel is stored in a file on the robot controller. There are typically two channels reserved for voltage and current, plus two additional auxiliary channels for parameters like, wirefeed speed, motor torque, or gas pressure.

Production Monitor add-in

Weld Data Monitor looks for abnormal variations in the channels based on a previously stored reference signature. The system can report minor infractions to the WebWare database tables using the Production Monitor framework. It may also respond to major infractions by stopping the process and reporting the infraction on the FlexPendant for an operator response. Minor infractions may suggest quality problems and will trigger the "incomplete part" condition in the Production Monitor.

Position correlated method

Weld Data Monitor stores reference information as a signature that includes a nominal value and standard deviation for each sample point along a seam. This is called the *Position Correlated Method*. The reference data is established by "learning" the same seam multiple times. At least three learn cycles are recommended to establish reliable data. More learn cycles will provide more robust results.

The position correlated method allows Weld Data Monitor to be very responsive in sections of the weld seam that are historically very consistent, while ignoring variation in sections that are historically variable. Weld Data Monitor evaluates each channel separately from completely separate signature data.

Signal filters

Weld Data Monitor does not apply any filtering to the signals. The signals should be filtered such that samples do not show unwanted noise without being overly damped. If the signal is under-filtered, the noise may trigger nuisance analysis errors. If the signal is over-filtered, Weld Data Monitor will be very slow to respond to weld variations. A good rule of thumb is to have a time constant of about 100 ms for the current and voltage signals.

Scaling

Weld Data Monitor channels that are tied to group inputs typically require some additional scaling. Weld Data Monitor includes a scaling factor for each channel to handle this case. A Miller AutoAxcess DeviceNet power source, for example, uses group signals and scaling factors.

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Process types

Not all weld processes are good candidates for Weld Data Monitor. The extent to which Weld Data Monitor will be able to detect weld defects can only be determined by conducting live tests on production parts with the production weld equipment. Three basic MIG processes are discussed in more detail here.

Spray arc

A clean spray arc provides excellent data that allows Weld Data Monitor to respond to very small process variations. Measurement signals taken directly from some power sources may be suitable for spray-arc monitoring.

Short arc

Short arc processes are difficult to monitor with Weld Data Monitor due to the large variations in current and voltage. When attempting short-arc monitoring, you will need adequately filtered signals. Most power sources, with available measurement signals, do not adequately filter the measurement signals for short-arc monitoring. External measurement equipment, that gives you control over the low-pass filtering, is almost always required.

Pulsed arc

Depending on the pulse parameters and the type of power source, it may be possible to monitor pulsed welds well enough to detect weld imperfections. The data source must be filtered sufficiently to smooth out the current and voltage variations between high and low pulse levels. If the measurement signals from the welder are insufficiently filtered, external measurement equipment, that gives you control over the filtering, is required.

4 User guide

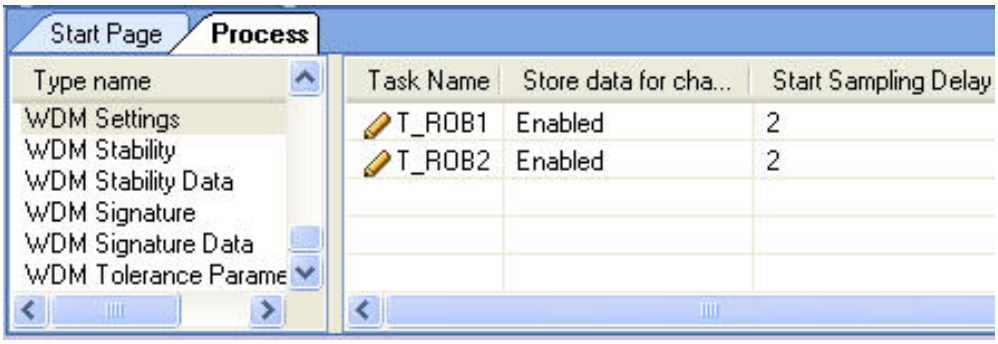
4.1 Weld Data Monitor parameters

System parameters

Weld Data Monitor system parameters are configured in the process configuration, topic *Process* (proc.cfg).

The configuration includes I/O mapping for the measurement signals, I/O scaling factors, and parameters that influence how the collected data will be evaluated.

The configuration settings are best made through RobotStudio.



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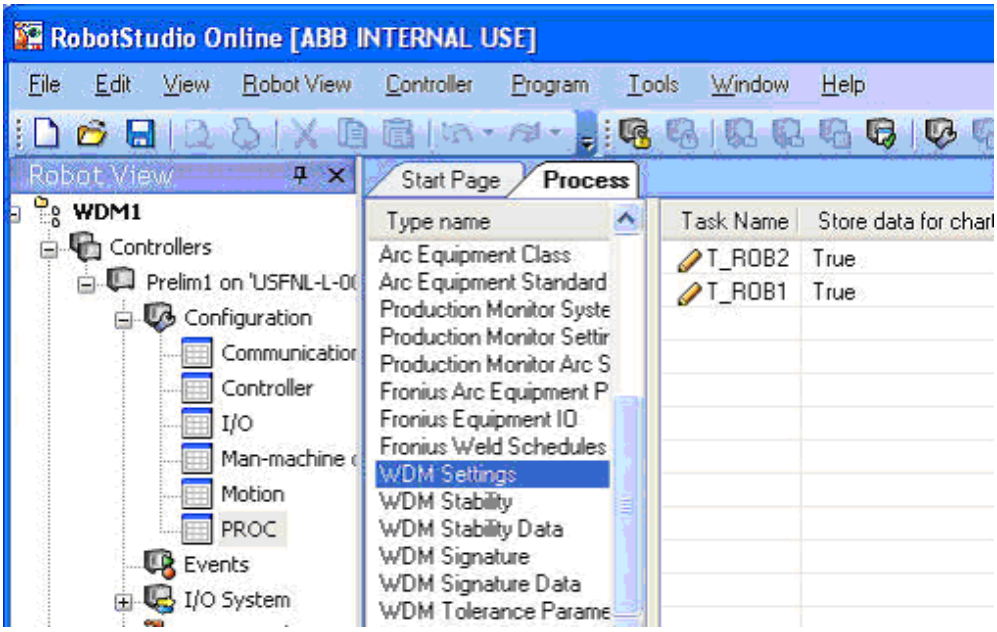

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These same settings can also be loaded from a system parameter file. Below you can see the syntax used to define *WDM_SETTINGS* and *WDM_TOLERANCE*.

WDM_SETTINGS

```
WDM_SETTINGS
-name "T_ROB1" \
-chart \
```

Continues on next page

```
-start_delay 2 \
-restart_delay 5 \
-voltage_signal "aiFr1Volt_M" \
-voltage_scaling_factor 1 \
-current_signal "aiFr1Current_M" \
-current_scaling_factor 1 \
-auxillary_1_signal "aiFr1MotorCurr_M" \
-aux_1_scaling_factor 1 \
-auxillary_2_signal "aiFr1WireFeed_M"
-aux_2_scaling_factor 1
-name "T_ROB2" \
-chart \
-start_delay 2 \
-restart_delay 5 \
-voltage_signal "aiFr2Volt_M" \
-voltage_scaling_factor 1 \
-current_signal "aiFr2Current_M" \
-current_scaling_factor 1 \
-auxillary_1_signal "aiFr2MotorCurr_M" \
-aux_1_scaling_factor 1 \
-auxillary_2_signal "aiFr2WireFeed_M"
-aux_2_scaling_factor 1
```

Parameter	Data type	Description
chart	boolean	Reserved for future use.
start_delay	positive integer	Number of samples to be ignored at the start of the weld seam.
restart_delay	positive integer	Number of samples to be ignored at the re-start of the weld seam.
voltage_signal	analog or group input name	This is the input from the welding power supply, or monitoring device.
voltage_scaling_factor	float	Scaling factor for input. Set to 1 if scaling is fully handled in I/O signal definition.
current_signal	analog or group input name	This is the input from the welding power supply, or monitoring device.
current_scaling_factor	float	Scaling factor for input. Set to 1 if scaling is fully handled in I/O signal definition.
auxilliary_1_signal	analog or group input name	This is the input from the welding power supply, or monitoring device.
aux_1_scaling_factor	float	Scaling factor for input. Set to 1 if scaling is fully handled in I/O signal definition.
auxilliary_2_signal	analog or group input name	This is the input from the welding power supply, or monitoring device.
aux_2_scaling_factor	float	Scaling factor for input. Set to 1 if scaling is fully handled in I/O signal definition.

WDM_TOLERANCE

The type *WDM_TOLERANCE* contains parameters for the tolerance data.

```
# WDM_TOLERANCE:
-name "stability_data" \
```

Continues on next page

```
-minor_variation_filter 0 \
-minor_variation_allowance 1 \
-major_variation_allowance 3 \
-flatness 50
-name "signature_data" \
-minor_variation_filter 0 \
-minor_variation_allowance 1 \
-major_variation_allowance 3 \
-flatness 50
```

Parameter	Data type	Description
minor_variation_filter	Positive integer	This is the number of sequential sample readings outside of the minor tolerance threshold allowed before recognizing and logging the error.
minor_variation_allowance	decimal	This is the factor, in standard deviations, used to determine the minor threshold limits. This tolerance window, around the in-process samples, describes the area or zone into which good data must fall. A minor variation is noteworthy, and will be logged, but does not justify a halt to the weld process.
flatness	Positive integer	This value applies to both the Minor and Major variation allowances (`minor_variation_allowance` and `major_variation_allowance`). It has no intuitive scale, but can be thought of as a 0-100% softening or flattening of the threshold values. This value minimizes the effect of large deviations. It also prevents clamping of the thresholds when the standard deviation nears zero.

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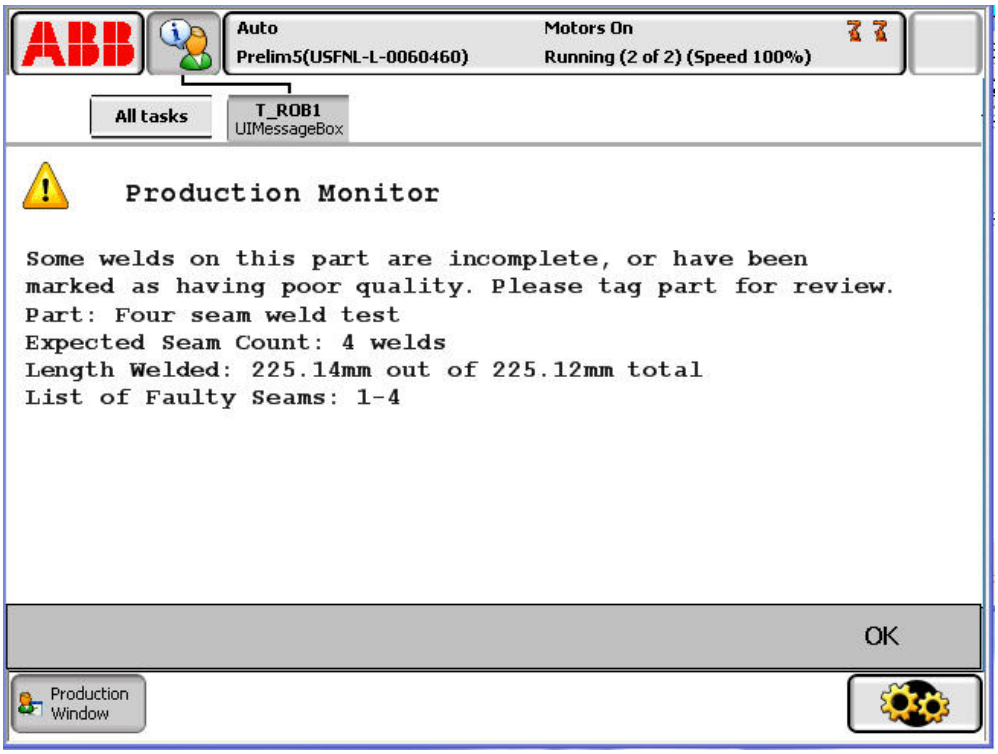
Behavior

Weld Data Monitor makes extensive use of the capabilities of RobotWare Arc and Production Monitor. Because of this, it is always necessary to use the `SeamName` optional argument on the `ArcLStart` instruction. The `SeamName` is used to identify the data.

Weld seam overall quality

The overall quality of the weld is analyzed at the weld end. No errors will be written, or data logged until that time. Production Monitor will launch a dialog box at the end of the part cycle and stop production until the user acknowledges that the part quality was not satisfactory.



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Minor infractions

Minor variation is usually not an issue worthy of stopping the weld process. Instead, it is often just an indication of quality. With this in mind, the filter feature will help remove erroneous events and single points of inaccurate data.

When the number of minor infractions exceeds the configurable "filter" value, a quality warning message will be logged to the error log and WebWare.

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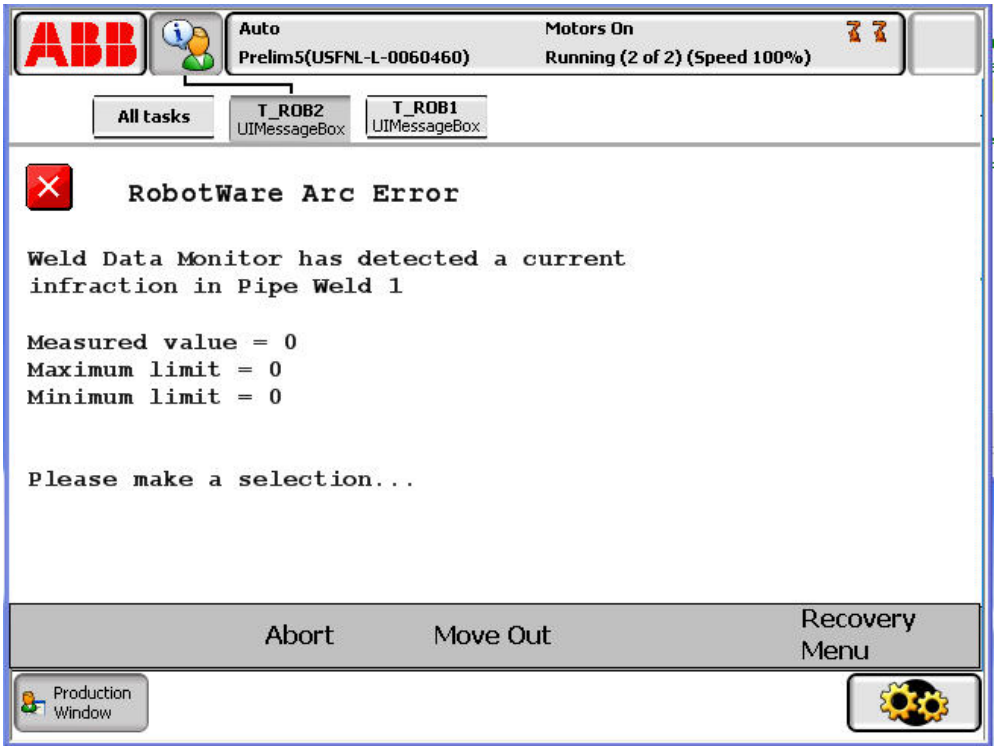
Major infractions

Infractions of the "major" threshold, or limits, will result in an immediate arc process error. A major variation is a significant or catastrophic variation. A variation of this magnitude will trigger Arc to stop processing and enter Arc's error handler, if configured.

The Production Monitor and Arc welding options will then generate the appropriate user interface screens, errors and data logs.



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4.2 Signature Monitor parameters

System parameters

The system parameters for the Signature Monitor are part of the topic *Process*.

WDM_SIGNATURE

```
WDM_SIGNATURE
#
-name "T_ROB1" \
-uses_data "signature_data_A"
name "T_ROB2" \
-uses_data "signature_data_A"
```

WDM_SIGNATURE_DATA

```
WDM_SIGNATURE_DATA
#
-name "signature_data_A"\
-learn_cycles 3 \
-quality 85 \
-voltage_data "signature_data" \
-current_data "signature_data" \
-auxillary_1_data "signature_data" \
-auxillary_2_data "signature_data" \
```

Parameter	Data type	Description
learn_cycles	integer	This is the number of *learned* weld seams, or cycles of this joint, used for the signature. For instance: a 3 would designate that this joint learns the first 3 times it is performed. The 4th, and all consecutive times this joint is welded, the learned signature will be used to analyze the weld process.
quality	decimal	This is the percentage of in- tolerance sample readings required for the joint to be considered successful.
voltage_data	tolerance	See *wdm_data - Weld Data Monitor tolerance data on page 35*.
current_data	tolerance	See *wdm_data - Weld Data Monitor tolerance data on page 35*.
auxilliary_1_data	tolerance	See *wdm_data - Weld Data Monitor tolerance data on page 35*.
auxilliary_2_data	tolerance	See *wdm_data - Weld Data Monitor tolerance data on page 35*.

4.3 Programming

Overview

Weld Data Monitor is activated and deactivated using modal RAPID instructions. The signature monitor is controlled with the instruction `WDM_Signature`. The monitor may be left on for one or more seams. The following example shows the monitor active for three of four seams.

```
10    PROC FourSeams()
11      RecoveryPosSet\ServRoutine:="ServiceRoutine";
12      WDM_Signature\On;   ! Activate WDM
13      MoveJ *, v400, z50, tWeldGun;
14      MoveL *, v200, z50, tWeldGun;
15      ArcLStart *, v200, seamPipe, weldPipe\Weave:=weavePipe,
16            fine, tWeldGun\SeamName:="Pipe Weld 1";
17      ArcL *, v200, seamPipe, weldPipe\Weave:=weavePipe, z5, tWeldGu
18      ArcLEnd *, v200, seamPipe, weldPipe\Weave:=weavePipe, fine, tW
19      MoveL *, v200, z5, tWeldGun;
20      ArcLStart *, v200, seamPipe, weldPipe\Weave:=weavePipe,
21            fine, tWeldGun\SeamName:="Pipe Weld 2";
22      ArcL *, v200, seamPipe, weldPipe\Weave:=weavePipe, z5, tWeldGu
23      ArcLEnd *, v200, seamPipe, weldPipe\Weave:=weavePipe, fine, tW
24      MoveL *, v200, z5, tWeldGun;
25      ArcLStart *, v200, seamPipe, weldPipe\Weave:=weavePipe,
26            fine, tWeldGun\SeamName:="Pipe Weld 3";
27      ArcL *, v200, seamPipe, weldPipe\Weave:=weavePipe, z5, tWeldGu
28      ArcLEnd *, v200, seamPipe, weldPipe\Weave:=weavePipe, fine, tW
29      MoveL *, v200, z5, tWeldGun;
30      WDM_Signature\Off;  ! Deactivate WDM
31      ArcLStart *, v200, seamPipe, weldPipe\Weave:=weavePipe,
32            fine, tWeldGun\SeamName:="Pipe Weld 4";
33      ArcL *, v200, seamPipe, weldPipe\Weave:=weavePipe, z5, tWeldGu
34      ArcLEnd *, v200, seamPipe, weldPipe\Weave:=weavePipe, fine, tW
35      MoveL *, v200, z50, tWeldGun;
36      MoveJ *, v400, fine, tWeldGun;
37    ENDPROC
```

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During the learning phase, Weld Data Monitor will store a signature file for each of the seams between the instructions `WDM_Signature\On` and `WDM_Signature\Off`. The files will be grouped under separate directories for each task.

After learning is complete the signature files will remain unchanged from cycle to cycle. Signature files have names like `Sig_myWeldSeamName.wdm`. The result files will be updated each new cycle with the latest measured data. They have names like, `Res_MyWeldSeamName.wdm`.

To take full advantage of all Weld Data Monitor and Production Monitor features, it is necessary to use the Production Manager Execution Engine, see *Application manual - Production Monitor*.

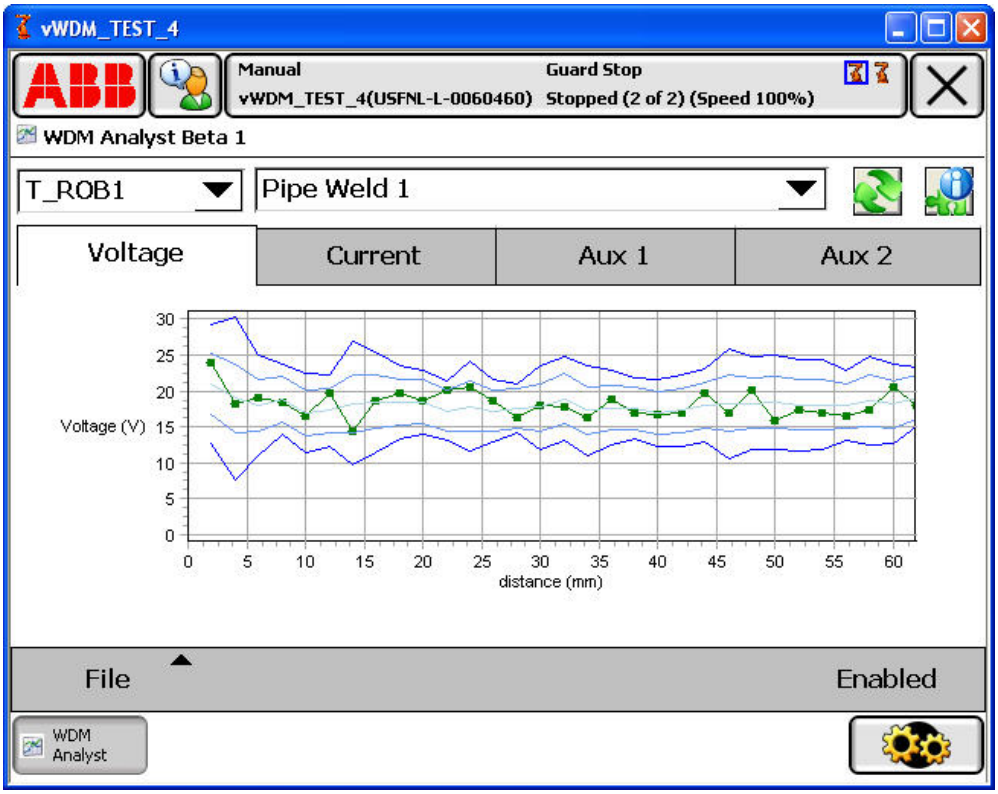
4.4 WDM Analyst

Overview

The WDM Analyst is a FlexPendant application used to simplify setup of Weld Data Monitor. The application is available as a separate additional option for 5.08 and 5.09, and included internally with RobotWare 5.10 and higher.

WDM Analyst provides a graphical evaluation tool to assist users in setting appropriate parameters for Weld Data Monitor. *WDM Analyst* is easy to use. The FlexPendant application allows the user to open a superimposed signature and results file based on the task name and seam name.

Choosing good Weld Data Monitor parameters takes practice. The WDM Analyst helps you visualize the results of your parameter choices immediately after welding a seam.



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Once open, WDM Analyst will scan the system for arc robots and stored Weld Data Monitor data. If data is found, it will be displayed in the chart window.

Data presentation

WDM Analyst will provide graphs for all four available measurement channels. It will also provide information pop-ups showing all the parameter settings used to generate the signature.

Note that Weld Data Monitor performs all threshold calculations in the controller and stores them in the signature file. WDM Analyst simply presents the stored data in a convenient layout without re-calculating the data.

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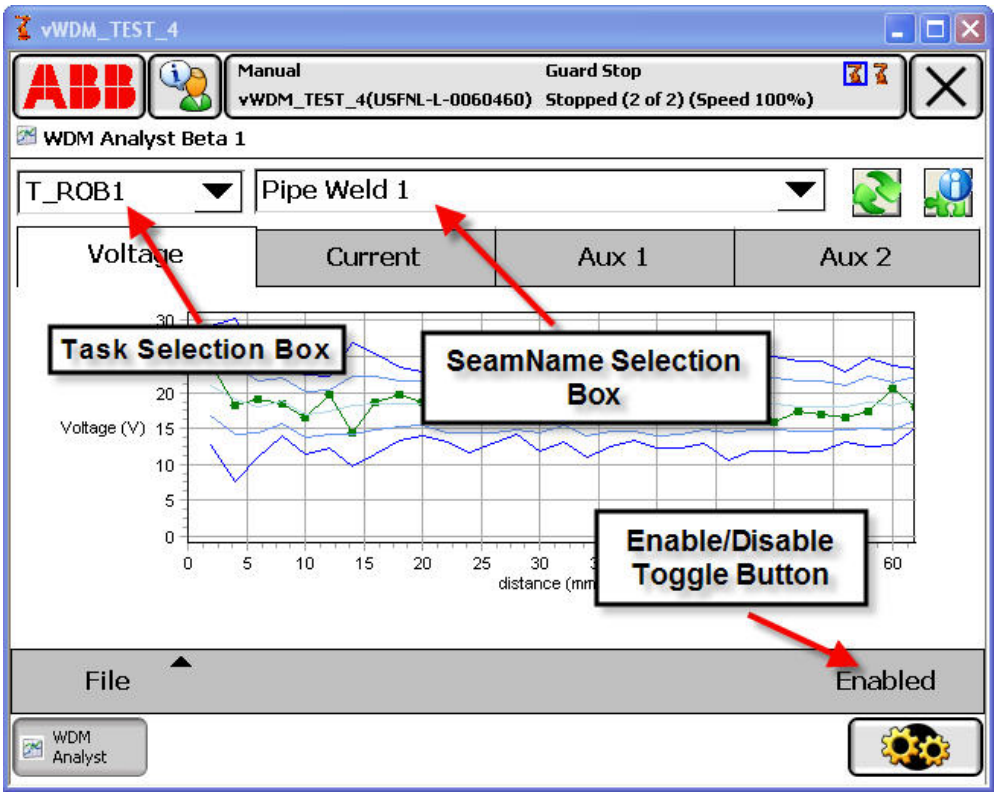
WDM Analyst does not provide real-time feedback. The user must refresh the view manually when a new update is available.

Choosing a weld seam

WDM Analyst adheres to the data organization standard set by Weld Data Monitor. Data is grouped into separate views for each available welding robot in the system. The data is identified by the `SeamName` used in the `ArcStart` instruction.

A new seam may be selected using the SeamName selection box. Similarly, a different robot task name may be selected using the task selection box.



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Enable button

Weld Data Monitor may be enabled or disabled per task using the enable toggle button located at the lower right corner of the screen. The task selected in the task selection box will be affected.

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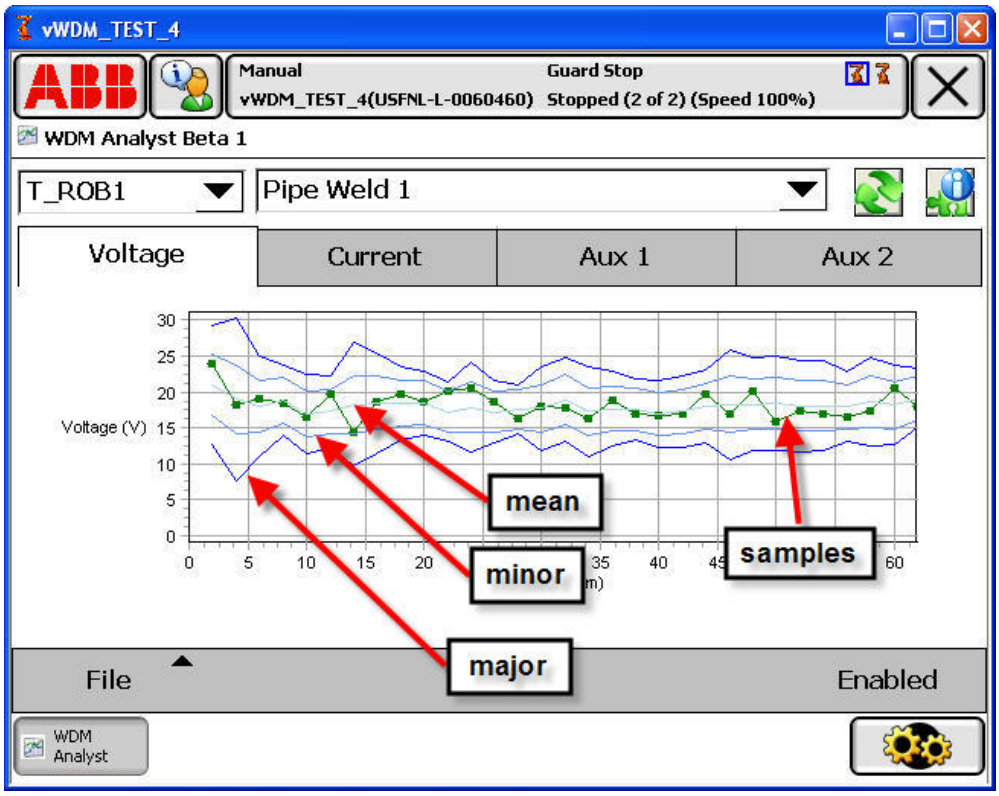
Interpreting results

The data is present in graphical form. Major and Minor Threshold levels, as well as, the Mean level are presented in shades of blue. The measured samples are shown in green.



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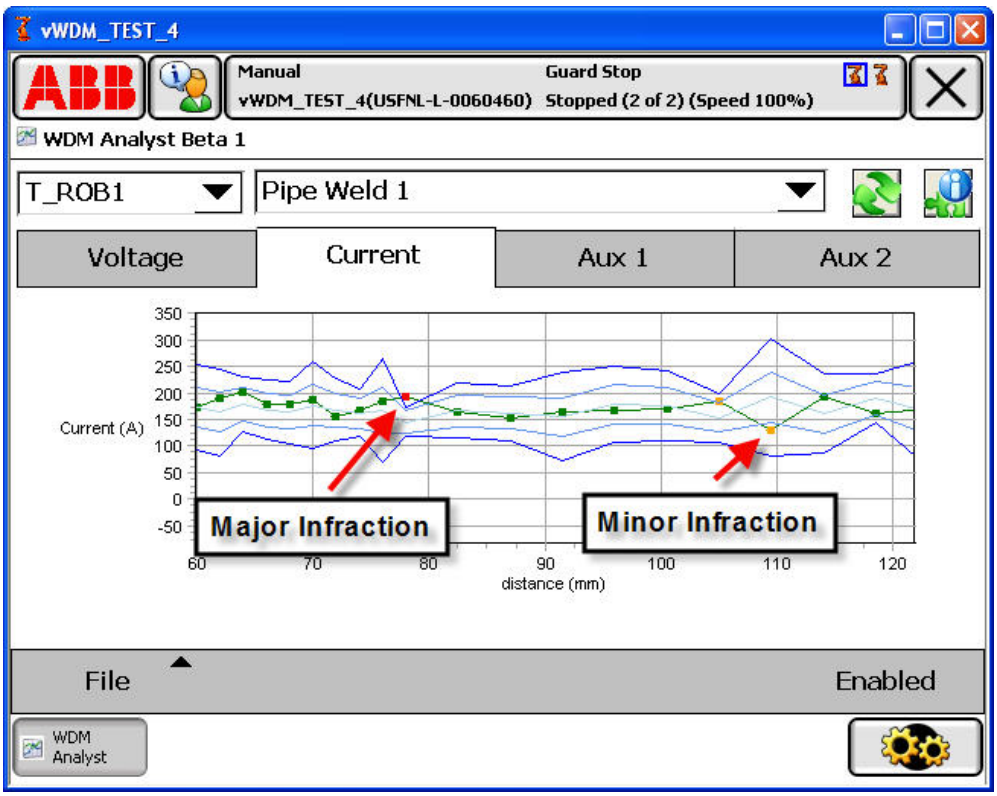
Minor infractions are shown with orange markers, while major infractions are shown with red markers.



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Weld Data Monitor uses configurable filters when evaluating the data. Not all infractions result in quality reductions or production stops. For example, although minor infractions contribute to quality reductions, they do so only when the minor infraction filter is exceeded.

The filter, configured through RobotStudio, specifies the number of consecutive minor infractions that must occur before the measured quality is reduced.

Also, filters at the start of the weld seam, and at restarts, are used to ignore noisy data during those violent events. Data will still be present in the graph, and may show major infractions, although Weld Data Monitor never reacted to the infraction in real-time.

If a portion of a weld seam was skipped using Weld Error Recovery, Weld Data Monitor will continue to store data to mark the position in the graph. The following

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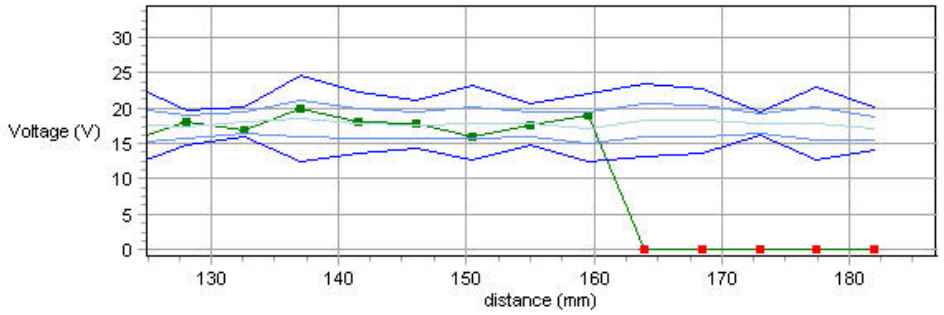
figure shows a seam that was left incomplete due to a "Skip Forward" request in Weld Error Recovery.



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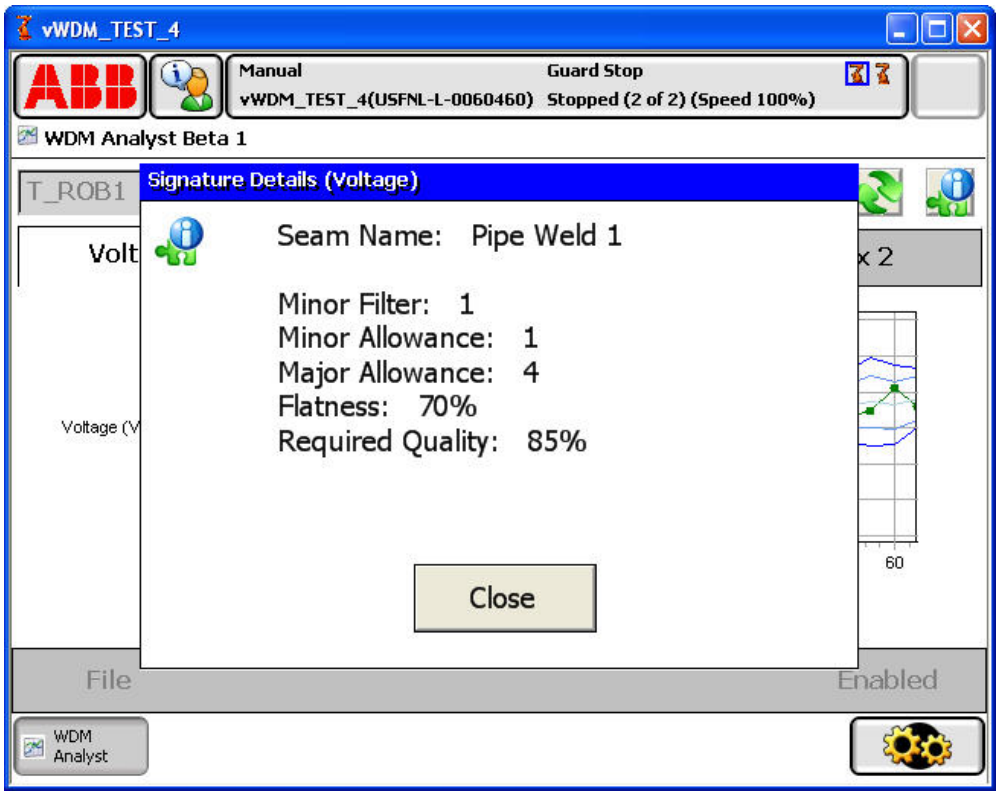
Scrolling the view

The chart window displays approximately 30 data points in an auto-scaled view. Longer weld seams will contain more than 30 data samples. To scroll the view simply tap and hold your finger in the chart window and drag left or right. The view will update when you remove your finger.

Viewing details

Details about the seam can be viewed by tapping **Info**.

Tap **More** to show more details about the parameters.



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Managing data

The data files can be managed using the selections under the **File** menu.

Tap **Relearn** to delete the signature file that is currently viewed, which instructs Weld Data Monitor to resume learning the next time the seam is run.

Tap **Archive** to save the currently shown data files to another location for later analysis or recovery.

UAS

User Authentication backup rights are needed to access the *Archive* function. *RAPID Editing* or *RAPID Loading* rights are needed to use the *Relearn* and *Enable* functions. If insufficient rights are detected, the features will be grayed out.

4.5 Disabling Weld Data Monitor

Disabling from WDM Analyst

The WDM Analyst FlexPendant application includes an enable/disable toggle button for each available robot task. Disabling Weld Data Monitor will cause it to ignore the `WDM_Signature\On` requests. The task selected in the task selection box will be affected.

Disabling from RAPID

Weld Data Monitor may be disabled programmatically from RAPID. A shared Boolean array is supplied to give programmatic access to the enable flags:

```
PERS wdmbool WDM_Enabled{10} :=
[TRUE,TRUE,TRUE,TRUE,TRUE,TRUE,TRUE,TRUE,TRUE,TRUE];
```

The array index corresponds to the task number of the robot. The flags may be changed at any time, but will not take affect until the next weld seam.

By default these flags are set to `TRUE` enabling Weld Data Monitor for all available tasks. The WDM Analyst also manipulates this array.

4.6 Fault logging

Overview

Two types of problems can be logged to WebWare and/or csv file if this is enabled in Production Monitor, in the *PROC* settings.

1. Major infractions that result in an immediate process halt.
2. Minor infractions that lead to questions in quality. If the filter is active, the location is represented by the first sample to exceed filter.

Fault log table

Minor and Major infractions will be logged to the Seam Events WebWare database table immediately after detection. Major infractions that trigger the Arc process to stop also generate Production Monitor log entries in *SeamResults* and *CycleResults* tables.

4.7 Setup tips

Overview

This section describes how to set up the Weld Data Monitor tolerance parameters. Setting the Weld Data Monitor tolerance parameters requires patience and skill. This section will help you develop your settings using a logical method.

Fine tuning the process

Before Weld Data Monitor parameters can be set, the weld process must be thoroughly developed. Once Weld Data Monitor learning is done, it will not be possible to make changes to your weld process parameters without invalidating the Weld Data Monitor settings. Weld process parameters should be fine-tuned in a production environment before attempting to set up Weld Data Monitor.

Finding good settings with `Override` settings

The `WDM_Signature` instruction includes an optional argument called `Override` that turns on monitoring and overrides the settings found in the process configuration database. Using `Override` simplifies setup because you can make your changes in your RAPID routine and test them without restarting the controller.

Create a new `wdm_settings` data instance to use in the `Override` argument of the `WDM_Signature` instruction. Then add the `WDM_Signature` instruction ahead of the seams you want to monitor, and reference the new `wdm_settings` data instance. The default values provided when creating the `wdm_settings` data instance will give you a good starting point.

```
CONST wdm_settings wdmMyOverride :=
      [3,80,[1,1,3,50],[1,1,3,50],[1,1,3,50],[1,1,3,50]];

PROC TestWDM()
  WDM_Signature\Override:=wdmMyOverride;
  MoveJ *, v400, z50, tWeldGun;
  MoveL *, v200, z50, tWeldGun;
  ArcLStart *, v200, seam1, weld1, fine, tWeldGun\SeamName:="Weld Seam 1";
  ArcL *, v200, seam1, weld1, z5, tWeldGun;
  ArcLEnd *, v200, seam1, weld1, fine, tWeldGun;
  MoveL *, v200, v10, tWeldGun;
  ArcLStart *, v200, seam1, weld1, fine, tWeldGun\SeamName:="Weld Seam 2";
  ArcL *, v200, seam1, weld1, z5, tWeldGun;
  ArcLEnd *, v200, seam1, weld2, fine, tWeldGun;
  WDM_Signature\Off;
  MoveL *, v200, z50, tWeldGun;
  MoveJ *, v400, fine, tWeldGun;
ENDPROC
```

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You should develop your Weld Data Monitor settings on one or two weld seams before introducing the monitoring to the rest of the part program. Use `WDM_Signature\Off` to suspend the monitoring activities.

Finally, be sure to include unique `SeamName` descriptions on the `ArcLStart` instructions you wish to monitor. If you forget to include the `SeamName`, no monitoring activities will occur and no error message will indicate the problem. If

Continues on next page

you use the same `SeamName` on two different seams, Weld Data Monitor will consider them the same seam.

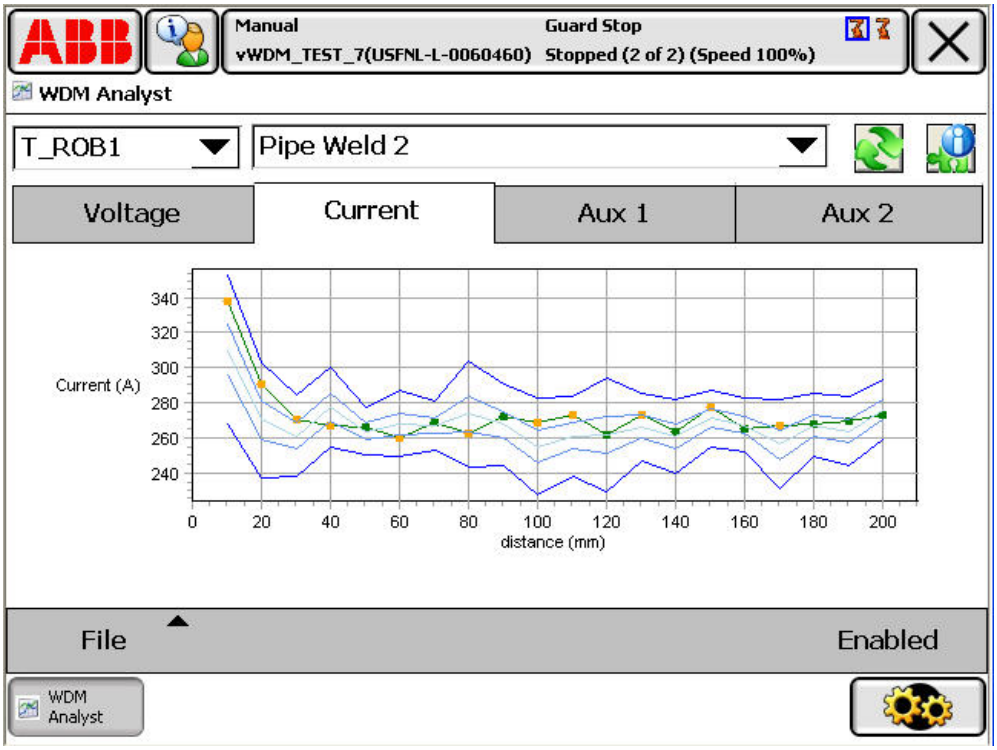
Start learning

Run the routine with the seams to be monitored. You should see a message in the elog list, for each seam, stating that learning has started. After the first cycle you should be able to view the data in the WDM Analyst FlexPendant application.

Run at least three good learning cycles to establish a baseline. Look at the data in the WDM Analyst to determine the validity of your settings. The display will show the minor and major threshold levels, the mean level, and the measured data samples from the last cycle.

Update tolerance settings and relearning

The following graphic shows that the minor threshold for `Current` is set too low.



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In this example, multiple samples are outside the signature's minor threshold settings. To rectify the problem, the value of `minor_allow` must be increased.

Once the overrides have been changed, you must do more learning. If learning was previously completed, you must increment the value of the component `learn_cycles` in the `wdm_override` data instance so that Weld Data Monitor understands that more learning is required.

You may increase the number of learn cycles at anytime. New learning cycles will use the latest tolerance settings for the calculations.

Run your routine again. You should see messages in the elog list showing that you have completed another learning cycle. Look at the data again in the WDM

Continues on next page

Analyst. Most likely you will need to complete several more iterations to develop your Weld Data Monitor settings for the first time.

Advantages of relearning

It may take several iterations to develop good settings for your weld process. Each time you learn you also establish a more accurate nominal baseline and more representative statistical variation information for each sample data point in the seam. The more learning cycles you complete, the more representative your baseline will be. You should have at least five learning cycles to establish a good signature. Ten cycles is an excellent goal.

`Flatness`

The `Flatness` setting in the tolerance settings can be difficult to use without some understanding of its effect. The signature thresholds are influenced by two different variables. The `Flatness` setting controls each variable's influence on the signature threshold calculations.

Statistical variation

The first variable to influence the threshold calculations is the statistical variation of each sample. If a sample's value changes a lot from cycle to cycle, this variable will have a large impact on the threshold calculations. The effects of variation will result in fat and narrow threshold bands along the signature when viewed in WDM Analyst.

Percentage of the mean

The second variable to influence the threshold calculations is a percentage of the mean value of the sample. Regardless of the statistical variation of the sample, the threshold will be influenced by a fraction of the mean value of the sample. This variable becomes very important if the process is extremely stable resulting in no significant contribution from the statistical variation.

Combined effect

The threshold calculations are made by combining the effects of the statistical variation and the percentage of the mean. The `Flatness` setting controls which variable has more influence. By default we normally start with 50% to give each of the two variables equal weighting.

When `Flatness` is set to zero, the threshold levels are calculated solely on the minor and major allowance values and the statistical variation of the samples. If there is little or no variation, the resulting threshold values become very small.

When `Flatness` is set to 100% the threshold levels are calculated solely on the minor and major allowances multiplied by 10% of the mean for each sample. So, if `Flatness` is set to 100% and the minor allowance is set to 2. A mean value of 20 would result in a minor threshold offset of 20*0.1*2 = 4. This gives minor threshold values of 16 and 24 for the sample.

Continues on next page

Verifying the settings

Before you apply Weld Data Monitor to all the weld seams in your part routine, run your settings in a production setting on a single seam. If you have more than one robot, test on only one robot. This minimizes the productivity impact of poorly adjusted settings.

Once you are confident with your settings, apply them to the rest of your seams and allow learning to start. Learning may be done in manual teach mode, or in automatic mode.

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5 RAPID references

5.1 Data types

5.1.1 wdm_data - Weld Data Monitor tolerance data

Usage

`wdm_data` is used with the instruction `WDM_Signature`.

This data type is a subset of `wdm_settings`. The data is used to override the default monitor settings specified in the process system parameter configuration database (PROC). The defaults are not overwritten. The new data is used in place of the defaults.

Components

`filter`

Data type: num

This is the number of sequential sample readings outside of the minor tolerance threshold that should be ignored before a minor threshold infraction may be recognized.

Units: integer 0 or higher.

`minor`

Data type: num

This is a multiple used to determine the minor threshold limits. This value multiplied by the standard deviation is used to determine the upper and lower bounds for the minor thresholds. Typical values are between 1 and 10.

A minor variation is noteworthy, and will be logged, but does not justify a halt to the weld process.

`major`

Data type: num

This is a multiple used to determine the major threshold limits. This value multiplied by the standard deviation is used to determine the upper and lower bounds for the major thresholds. Typical values are between 1 and 10 and should be greater than the value specified for `minor`.

A major variation indicates a catastrophic failure. The event will be logged and an arc process error will be raised.

`flatness`

Data type: num

This value applies to both the `minor` and `major` variation allowances. It can be thought of as a 0-100% softening or *flattening* of the threshold values. This value minimizes the effect of large deviations. It also prevents clamping when the standard deviation of the learned samples approaches zero.

A typical value is 50%. Unit: percent.

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5.1.1 wdm_data - Weld Data Monitor tolerance data
Continued

Example

```
CONST wdm_data dTac5:= [3, 2, 4, 50];
```

The `wdm_data dTac5` is defined as follows:

- `filter` is set to 3.
- `minor` limit is 2 SD.
- `major` limit is 4 SD.
- `flatness` factor is 50.

Structure

```
< dataobject of wdm_data >
  < filter of num >
  < minor of num >
  < major of num >
  < flatness of num >
```

Related information

For more information about	See
WDM_Signature	*WDM_Signature - Weld Data Signature Monitor on page 40*
wdm_settings	*wdm_settings - Weld Data Monitor settings data on page 37*

5.1.2 wdm_settings - Weld Data Monitor settings data

Usage

`wdm_settings` is used with the instruction `WDM_Signature`.

This data is used to override the default monitor settings specified in the process system parameter configuration database (PROC). The defaults are not overwritten. The new data is used in place of the defaults.

Components

`learncycles`

Data type: num

This is the number of required learning cycles for the weld seam. For example, if a 3 were used, the weld seam would have to be completed three times to complete the learning. On the 4th time, real-time monitoring would begin.

Units: integer 3 or higher.

`quality`

Data type: num

This is the percentage of in-tolerance sample readings required for the weld seam to be considered successful.

Overall quality of the weld is analyzed at the weld end. No errors will be written, or data logged until that time. If measured quality is less than quality, Production Monitor will launch a dialog box at the end of the part cycle and stop production until the user acknowledges that the part quality was not satisfactory.

`WireScanMargin`

Data type: num

This distance (mm) plus half the `WireDia` from `be_tooldesign` gives the start offset of the wire scan.

`voltage`

Data type: wdm_data

The threshold settings related to the voltage measurement.

`current`

Data type: wdm_data

The threshold settings related to the current measurement.

`aux_1`

Data type: wdm_data

The threshold settings related to the 1st auxiliary signal measurement.

`aux_2`

Data type: wdm_data

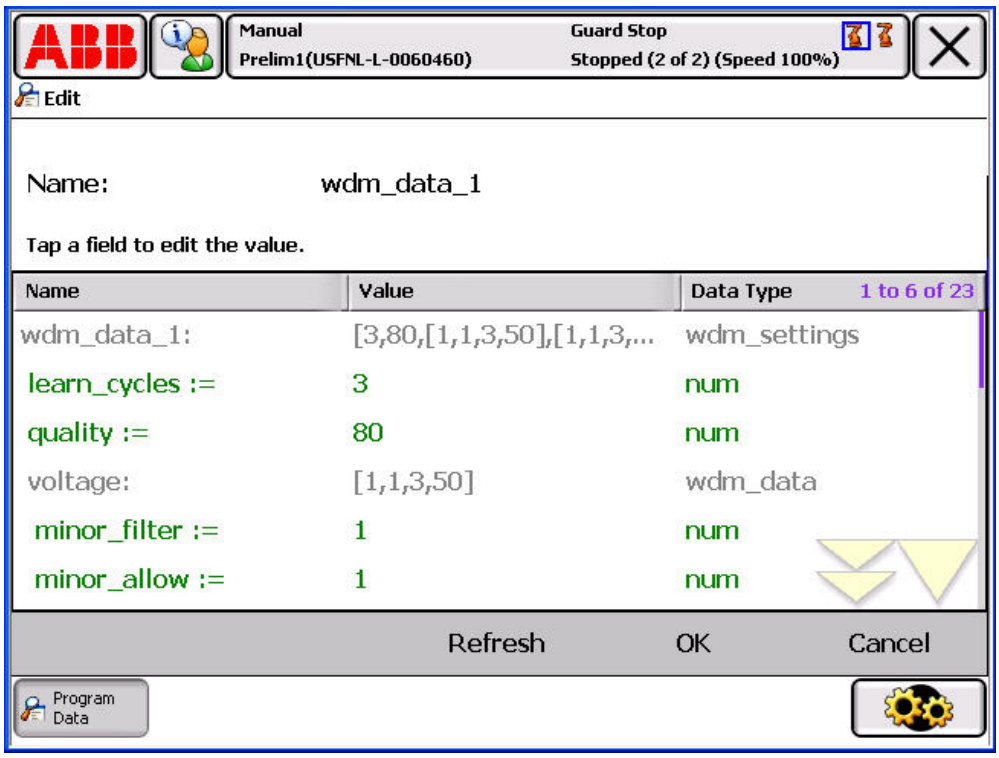
The threshold settings related to the 2nd auxiliary signal measurement.

Continues on next page

5.1.2 wdm_settings - Weld Data Monitor settings data
Continued

Example

In this example we have a new override data, `wdm_data_1`.



xx1400002418

```
CONST wdm_settings wdm_data_1 := [3, 80,[1,1, 3, 20], [1,1, 3,
30], [1,3, 4, 40], [0,0, 0, 0]];
```

This instance of `wdm_settings` `wdm_data_1` is defined as follows:

- `learncycle` is set to 3 learning cycles for creation of the weld signature.
- `quality` is set to 80%, determining that at least this percentage of samples must be within the minor threshold.
- `voltage`, `current`, and auxiliary channels have the filter set to 1. Only one minor infraction will be required to trigger a quality fault.
- `voltage` uses a minor SD of 1, a major SD of 3, and a flatness factor of 20.
- `current` uses a minor SD of 1, a major SD of 3, and a flatness factor of 30.
- `aux_1` uses a minor SD of 3, a major SD of 4, and a flatness factor of 40.
- `aux_2` is not used in this system.

Structure

```
< dataobject of wdm_settings >
  < learncycles of num >
  < quality of num >
  < voltage of wdm_data >
  < filter of num >
  < minor of num >
  < major of num >
  < flatness of num >
```

Continues on next page

```
< current of wdm_data >
< filter of num >
< minor of num >
< major of num >
< flatness of num >
< aux_1 of wdm_data >
< filter of num >
< minor of num >
< major of num >
< flatness of num >
< aux_2 of wdm_data >
< filter of num >
< minor of num >
< major of num >
< flatness of num >
```

Related information

For more information about	See
WDM_Signature	*WDM_Signature - Weld Data Signature Monitor on page 40*
wdm_data	*wdm_data - Weld Data Monitor tolerance data on page 35*

5.2 Instructions

5.2.1 WDM_Signature - Weld Data Signature Monitor

Usage

`WDM_Signature` is a modal instruction that is used to enable and disable the signature monitor.

Basic examples

Example 1

```
WDM_Signature\On;
ArcLStart * v200, seamPipe, weldPipe \Weave:=weavePipe, fine,
     tWeldGun\SeamName:="Pipe Weld 1";
```

If a previously stored signature is available, Weld Data Monitor will perform a real-time analysis of the process. The data is evaluated in comparison to the signature for `Pipe Weld 1`, using the default values in the process parameter.

If no signature has been stored, learning begins and the data is stored on the controller.

Example 2

```
WDM_Signature\Override:=data_1;
ArcLStart * v200, seamPipe, weldPipe \Weave:=weavePipe, fine,
     tWeldGun\SeamName:="Pipe Weld 1";
```

The signature monitor is enabled, but rather than using settings specified in the process system parameter configuration database, it uses the override values defined in `data_1`.

Example 3

```
WDM_Signature\Off;
```

The signature monitor is turned off.

Arguments

```
WDM_Signature [\On] | [\Override] | [\Off]
```

`[ \ On]`

Data type: switch

If selected, the signature monitor is enabled. If a seam is encountered that requires learning, the learning process will continue. If a seam is encountered that has a previously stored signature associated with it, real-time monitoring will commence.

The enabled state remains active until `WDM_Signature` is called again with the `Off` switch.

`[ | Override]`

Data type: switch

If selected, the signature monitor is enabled. The values provided in the `wdm_settings` data instance will be used for analysis, rather than the values specified in the process system parameter configuration.

Continues on next page

If a seam is encountered that requires learning, the learning process will continue. If a seam is encountered that has a previously stored signature associated with it, real-time monitoring will commence.

The enabled state remains active until `WDM_Signature` is called again with the `Off` switch.

`[ \ Off]`

Data type: switch

If selected, the signature monitor is disabled.

Program execution

If the default parameter data has been overridden with `Override`, the data will remain active until the instruction is executed again. If it is executed with the `\On` or `\Off` arguments the data being used will revert to the default data.

The state of the monitoring tool stays in the condition specified by the last executed instance of the instruction, except for the specific circumstances listed below.

- after a restart.
- when a new program is loaded.
- when starting program executing from the beginning.

Execution in stepwise mode

Forward: Fully executed.

Backward: Not supported.

Error handling

No error handlers.

Syntax

```
WDM_Signature
  [ '\' On ] < switch >
  [ '|' Override ':=' ] < expression (IN) of wdm_settings >
  [ '|' Off ] < switch > ';'
```

Related information

For more information about	See
wdm_settings	*wdm_settings - Weld Data Monitor settings data on page 37*
wdm_data	*wdm_data - Weld Data Monitor tolerance data on page 35*

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