Welcome!

The Visible Welding V2016-Z Camera System is specially designed to handle the ultra-wide dynamic range of light given off by arc welding. The WeldWatch software included makes this camera easy to set up and use.

By combining state-of-the-art computer digital signal processing with a high-functioning digital camera, the V2016-Z captures and tames the arc light. Don’t let the simple controls fool you; like a great athlete, the V2016-Z makes this amazing photographic feat seem easy.

Since we are all-digital in both camera and processing, we will continue to add features to make your job easier. You can help; please tell us what features you’d like, what you don’t like and what you’d like to see in future versions. Email us any time of the day or night at 2016@VisibleWelding.com
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Fast Start

The system consists of a camera head connected to a Windows computer running the WeldWatch software.

1. Install the software

Download the software from http://visiblewelding.com/weldwatch-software/software-downloads/ and save the file to your hard disk. Then run the downloaded setup program to install WeldWatch and the camera USB drivers. Simply run setup.WeldWatch<release>.exe, where <release> is a version number. Install the software before connecting the camera.

2. Connect the camera

Plug the USB cables into two free USB ports on the computer you installed WeldWatch on:

![USB connection](image)

3. Start the software

![WeldWatch icon](image) Double-click the WeldWatch icon on your desktop or in the Program menu.

Once the software is running, you should see live camera video in the upper-right portion of your screen. If
the camera is not active, you can choose the camera by clicking the Camera button on the left of the WeldWatch window:

If the buttons are not visible, press the SHOW button in the lower left corner:

4. Aim, focus, and zoom the camera image

Mount the camera on a tripod or camera bracket, and point the camera towards your welding work area. You can change the amount of optical zoom and the lens focus using controls displayed by clicking the Camera button on the left side of the WeldWatch software window.

5. Record video to disk

Use the Record button to see buttons that start, stop, and pause recording of video to disk.
Installation

The following items are typically found in a Visible Welding USB Camera package:

1. High temperature protective sleeve
2. Visible Welding software CD (if not included the software is available from Visible Welding’s web site)
3. Camera head
4. USB camera cable
5. LED spatter shield tool (optional)
6. Lens spatter shield wrench
7. Additional hardware

In addition, a VAmpWatch box may have been included or be part of the package you purchased:

Before connecting the camera to your computer, you must install the software first.
Follow these steps to install the software and camera:

1. If you received a CD with the system, insert the Visible Welding software CD into your computer's CD drive. If your package did not include a CD, download the software from the Visible Welding web site (www.VisibleWelding.com). On the Products page, there is a link to the software downloads page on the right side. Alternately, the direct page with the software download links is http://visiblewelding.com/weldwatch-software/software-downloads/

On this software downloads page, download the installation package by clicking on the “WeldWatch-EDU Beta for V2014 and V2016-Z” prompt and save the file to your local computer.

2. Run the run setup.WeldWatch<release>.exe application (on the CD or saved download), where <release> is the version number. First you will see the WeldWatch opening screen:
The software license is displayed on the License Agreement window shown below. Read the agreement and if you agree select the "I accept the agreement" button and click Next. If you do not accept the agreement, the software installation will not proceed.

Next you are prompted to install the camera USB driver. Make sure the "V2014Z, V2016Z USB-2" component is selected.
You then have the option of installing a desktop shortcut to WeldWatch. This provides quick access to the software and is recommended for a touch screen setup.

The setup program then summarizes your choices and gives you the option of continuing on into the install. Click Install to continue.
The software then installs itself and the camera USB driver onto your computer. You will likely be asked about installation of a "Arduino USB driver", as shown below:

Click the Install button to proceed with this. As it installs, you will see two Windows warnings indicating that the publisher of the driver cannot be verified, as below:

This is because these USB drivers are not signed through the formal Microsoft process. These drivers are still safe, so you can click on the "Install this driver software anyway" button both times.
The installation is complete when this dialog is displayed:

![Setup - WeldWatch](image1)

You should restart your computer after the install finishes, to ensure that the camera and other drivers will function properly.

3. After the computer reboot, plug the two USB cables into two available USB ports on your computer. The USB cable with a blue jacket connects to the camera data stream, while the other black cable is the connection used for hardware handshaking and control:

![USB Cables](image2)
The camera drivers will automatically install and the two LEDs on the front of the camera will turn on:

4. At this point, you are ready to go. Start the WeldWatch software with the camera connected, and a live picture will be displayed in the software window.
Installing the VAmpWatch Module

The VAmpWatch box monitors the welding current and voltage as you weld. WeldWatch software reads the results from this box and provides a real-time graph of the voltage and current in a corner of the video.

When a VAmpWatch is installed, WeldWatch shows a new Recordings-Settings option that uses the Amps to trigger automatic video recording.

In order for the VAmpWatch box to work, its sensors must be connected to the welding unit.

The VAmpWatch box has 3 connections:

- the Cat-5 Ethernet cable connects to the current sensor
- the BNC cable monitors voltage and must be attached to hot and ground points
- A USB cable attaches to the computer USB port (or a hub)

The power connector is not used, as power is provided through the USB cable.

These connections are shown schematically below:

Welding current is measured by clamping a current meter around the torch cable. Alternately, if the welding table is not grounded, then the current meter can be clamped around the ground cable.

The current sensor with clamp open, attached to the VAmpWatch box, is shown below:
The current sensor clamped around a cable looks like this:

The clamp simply snaps shut around the power cable. To open the clamp, insert a standard screwdriver as shown below and gently pry the clamp until it clicks and then opens.

Gently pry the clamp open

Clamp opened around power cable
The voltage is measured through a BNC cable. The supplied cables are shown below:

One long BNC cable attaches to the BNC connector on the VAmpWatch box. This is a standard BNC coax cable, so other BNC cables can be used if different lengths are needed or for permanent cabling.

The volt sense cable uses a standard BNC “T” coupling to split off two cables with clamps for actual attachment to the welding power source. The black clamp is attached to the welding ground (e.g. work table). The red clamp attaches to the torch cable voltage. Connections vary between models, brands, and with the age of the equipment. These connections are sometimes easily accessible, and sometimes well insulated. It is left to the professional at the facility to determine the best access point.

The VAmpWatch box is attached to the computer through a standard USB cable:
With the computer provided in the EDU system, the computer USB connection is brought out to a common USB hub attached to the back of the computer enclosure. Attach the VAmpWatch USB cable to this hub. If the VAmpWatch box is left in its standard location (a Velcro attachment to the back of the computer enclosure), then the short USB cable provided can be used. If the VAmpWatch module is positioned elsewhere, a longer USB cable (up to 15 feet in length) can be substituted in.

Shown below is the VAmpWatch box attached (via Velcro) on the back of the computer enclosure. It is the blue box to the right of the mounting arm. The VAmpWatch USB cable is connected to the USB hub immediately to the left of the mounting arm, into any open USB port.
How to use the controls

The easiest way to use WeldWatch, especially with a touch screen interface, is the column of buttons on the window left side.

Clicking or touching any of these buttons expands a panel with controls for relevant options. Below is an example displayed after the Play Video button is clicked:

The top of the panel has several types of inputs. Buttons are intended for clicking or touching. Buttons with a "sticky" setting that persists after they are touched are highlighted in yellow.

If keyboard shortcuts are available, the key combination is shown.

Yes-No options are selected with a paired check-mark and "X" buttons. They change color to indicate state.

Green "check" means "Enabled".

Red "X" means "Disabled".

The WeldWatch Picture screen contains slider controls for range adjustments:
A single slider control looks like this:

![Contrast Slider](image)

All slider controls can be adjusted in three ways:
1. Click or tap the slider and drag it left or right.
2. Click or tap the "+" and "-" buttons to step up or down in value. For touch screens, this is easier than dragging the slider.
3. Double-click the control name to return it to a default value.

The Zoom slider has an additional numeric input in the upper left where the zoom power can be entered directly.

At the bottom of each panel are Close and Settings buttons. Close hides the panel. Settings is a shortcut to a panel with additional options. In the lower example we are on the Picture panel, and clicking Settings takes us directly to the Picture Settings screen.
Create and Use an Enhanced Region

WeldWatch software includes an option of defining a small section of the video display with different picture settings. This is called an enhanced region. It is most useful over the arc and surrounding area, but you can place it anywhere within the image. It can be circular or square, and can optionally follow the arc's location in the image.

There are two locations important to the enhanced region: the part of the image it comes from (the "Source Area") and the place in the image where it is shown (the "Destination").

The enhanced region is set up using the Enhanced Region panel. The picture settings of the enhanced region can be set on the Picture panel.

An example of an enhanced region directly overlaid onto the video is here:

The enhanced region can also be moved off to any corner of the image, so the user can view both the regular and enhanced displays while working. This is similar to a "Picture in Picture" effect.
How to Flip or Mirror the Video

Video can be flipped (left-to-right, or top-to-bottom) or rotated in 90 degree increments, using the Settings button on the Picture panel. The rotation controls are shown in the upper half of the panel:

Flipping is useful if mirrors are used to direct the camera video onto the weld. The Rotation buttons are useful for situations where the camera is mounted at an unusual angle, leading to a confusing orientation of the welding video. Rotation can be combined with the image flip settings if needed.
How to Record Video to Disk

WeldWatch can automatically record video when an arc is detected or when a current threshold is crossed (if you have the VAmpWatch hardware installed). You can also manually record the current camera video to disk. Clicking on the Record button shows the panel controls below; simply click Record to start:

From the Record menu, you can click on Begin Recording.

Alternatively, the keyboard shortcut Ctrl-R starts recording and this shortcut is always active. The keyboard shortcut to stop recording is Ctrl-T (always active).

The Settings button in the lower right of the panel provides access to options that select automatic or manual video recording.
**Automatic Recording When an Arc is Active**

WeldWatch can be configured to automatically record camera video to disk whenever an active arc is detected, either in the image or by the amps measured by the VAmpWatch module. This can be a very convenient feature for hands-off recording, whenever an arc is active.

Automatic recording is enabled using the Video Recording Settings panel. The relevant buttons are circled:

The sensitivity threshold used to trigger automatic recording can be adjusted on the Camera Settings panel.

![Video Recording Settings Panel](image-url)
Take a Video Snapshot

You can save a snapshot of the currently displayed video frame to the Windows clipboard or directly to Windows Paint.

To capture an image, use the Image Capture buttons displayed by the Video Recording Options screen:
How to Change the Volt-Amp Display

When you have the optional VAmpWatch box attached while using your camera, you will see a plot of the voltage and amperage overlaid on the camera video. The VAmpWatch box is automatically recognized and used by the WeldWatch software if attached:

The Volt-Amp display size and position can be changed using the Picture Settings screen. You can get to this by first tapping the Picture button on the left, and then the Settings button:

The buttons near the bottom let you position the plot in any corner of the image, as well as change between two sizes (small or large), or disable the display completely. These controls are displayed if the VAmpWatch box is attached.
Save and Re-Use Software Setups

You can save and later recall all software settings, which is handy if you frequently change between several hardware configurations or welding procedures. You can also set a default set of software parameters to be loaded on power up. This option is found on the Advanced Settings Misc panel, which is displayed using the Advanced Settings menu. The panel is shown below:
**Keep the Screen Buttons from Disappearing**

By default the buttons along the left side of the WeldWatch screen disappear after 60 seconds of input inactivity. This makes the maximum screen area available for viewing camera video. If you want to change the time interval that triggers this feature, or disable it entirely, you can do this in the Advanced Settings > Misc panel which is shown below:

![Advanced Settings Panel](image)

The relevant control is in the Auto-Hide Control Panel. You can specify the number of seconds of inactivity that elapse before the buttons are hidden. The default value is 60. Auto-hide can be disabled by setting the time interval to 0.
List of Keyboard Shortcuts

The following keyboard shortcuts are always active in WeldWatch:

Ctrl-A  autofocus on the current image center

Ctrl-F  move lens focus nearer
Ctrl-G  move lens focus further

Ctrl-I  open lens iris for more light
Ctrl-O  close lens iris for less light
Ctrl-N  toggle auto-iris function on or off

Ctrl-R  Begin video recording to disk
Ctrl-T  Stop video recording to disk

Ctrl-Z  increase lens zoom (image detail larger)
Ctrl-X  decrease lens zoom (image detail smaller)
Eliminate Camera Connection USB Errors

Visible Welding's cameras transmit image data over a standard USB 2.0 interface. Real-time video streaming pushes the data limits of the USB interface. With some computers the USB interface experiences errors that can reduce video frame rates - or even block the camera from working at all.

One technique that helps this USB mismatch is to add a USB hub between the camera and computer. Even an unpowered USB hub can sometimes help reduce errors and improve the frame rate.
Changing Spatter Shields

Changing the spatter shields over either the lens or the LEDs is straightforward.

**Changing the lens shield**

1. Insert a spanner wrench into the recessed notches of the silver retaining ring in front of the camera lens, as shown below:

2. Unthread the retaining ring by rotating it counter-clockwise and remove it:

3. With the ring removed, the spatter shield comes right out. Replace it with a new one.
4. Put the silver retaining ring back in front of the shield and rotate it clockwise, using the spanner wrench, until secure:

![Image of a device with a retaining ring being rotated]

**Changing a LED shield**

1. Use a nut driver to remove the 4-40 x 1/4 hex head screw that holds the spatter shield mount over the LED:

![Image of a device with a screw being removed]

2. Remove the holder and the old spatter shield:

![Image of the device with the holder and shield removed]
3. Replace the spatter shield in the holder. Both are shown below:

4. Place the spatter shield holder back in its original position over the LED and screw in the 4-40 1/4 head screw to secure it to the camera case.
How to Hook Up Camera Air-Cooling

If you purchased the air-cooled case with your VS2016-Z camera, this page provides information about air quality and pressure requirements, as well as instructions for hooking up your air supply.

The air supplied must be clean, oil free, and dry (dewpoint of 40 F or less). We recommend filtering the supply to block particles larger than 5 microns. The maximum pressure allowed is 120 PSI. At an air temperature of 72 F, the air flow ranges from 1.2 SCFM (standard cubic feet per minute) at 20 PSI to 2.5 SCFM at 90 PSI. Tests have shown that with 90 PSI of 70 F air, the camera can operate continuously in a 260 F convective oven. A convective oven is a more severe heat transfer condition than is found in a typical welding environment.

Installation instructions
1. For the inflow line, firmly insert the 1/4” tubing provided into the "push to connect" fitting indicated below.
2. For the outflow line, insert the 1/4" tubing into the "push to connect" fitting directly below the signal cable, as shown below.

3. The outflow line fitting has a bleed valve to regulate the amount of air that blows across the front spatter shield. To get all of the air to flow across the spatter shield, close the bleed valve. Opening the bleed valve allows the total airflow to increase, which creates more cooling but which reduces the pressure in the case, so this reduces the air-flow out of the air-knife. You will probably need to experiment in your conditions to determine the best trade-off. Turn counter-clockwise for less air across the spatter shield, clockwise for more air flow.
Removal instructions
1. To remove the air supply tubing, push on the collar of each fitting and then pull the tubing to disconnect it.
Controls Overview

The WeldWatch home screen is shown below:

It has a large area for camera video and a column of 6 interface buttons on the left side. The menu along the top duplicates the button functions, while the status bar along the bottom provides useful information about the current video and recording state. The controls are bold, easy to read and large enough for easy touchscreen use. WeldWatch is designed to maximize display space for the welding video, especially on small industrial screens, and can be easily hidden using the bottom "Hide" button.

The button functions are:

**CAMERA**
Adjust camera settings like "Focus" and "Zoom".

**PICTURE**
Adjust the screen image with controls like "Brightness" and "Contrast".

**VIDEO RECORDING**
Set up and record video to the hard drive.

**PLAY VIDEO**
Play back recorded video files

**HIDE**
Hide all buttons except "HIDE". When the other buttons are hidden, this one changes to "SHOW", so you can redisplay the buttons.
The menu functions are:

**FILE**
Quick image capture and program exit

**PICTURE**
Functions for the screen display.

**CAMERA**
Functions to control camera.

**SETTINGS**
Save and recall program setting configurations.

**RECORD**
Functions to control recording

**HELP**
Help and about functions.
Camera

The Camera button allows adjustment of the lens focus, zoom, and iris. It also provides some details about the video stream and access to the camera setup panel. The Camera button is highlighted below:

The panel displayed after clicking or touching the camera button is shown below:

The **Live button** at the top turns the live video stream from the camera on and off. The **Pause button** captures and displays a single frame from the camera. Each time it is clicked or touched, a fresh image is captured from the camera and displayed.
The **Autofocus button** finds the best focus in the center of the current image. It should not be used on a scene with an arc. The image region being used for focus is enclosed in a red rectangle, displayed while focus is being measured. Depending on the contrast in the scene, this can take up to several seconds. If the autofocus takes more than a second a progress bar is displayed, as shown:

If you are not satisfied with the Autofocus result, you can repeat the process or make further adjustments using the **Focus buttons**. Starting from a different point, or repeating after a small movement of the image, can improve the results. Autofocus works better with additional light, and also requires some scene texture in the focus area (it struggles on a blank area).

The focus, zoom, and iris buttons let you manually set these parameters for the best picture.

The **Focus buttons** move the focus when clicked or tapped. By default the button is active when clicked and the mouse button is held down while over the button. Touch screens can be used in the click and hold mode if your touch moves while you hold (gently rub the button, don't stay in one spot). The focus changes slowly at first and then quicker if the button is active for an extended time. This allows fine focus adjustments when you are close to best focus.

Each button also has an associated keyboard shortcut. Type Ctrl-F and the lens will focus nearer. The focus will continue to adjust as long as the key is held down. Type Ctrl-G and the lens will focus further away. These keyboard shortcuts are always active.

The **Zoom buttons** work like the focus buttons: the button is active when clicked and the mouse button is held down while over the button. When active the optical zoom will increase or decrease. The zoom lens has a range of 1x to 10x. Touch screens can be used in the click and hold mode if your touch moves while you hold (gently rub the button, don't stay in one spot).

Lens zoom can also be controlled from a keyboard. Type Ctrl-Z and the zoom factor will increase (image detail grows larger). Type Ctrl-X and the zoom factor decreases (detail decreases as the total image coverage grows larger). As with focus, the changes continue as long as the key is held down, until the limit of the lens is reached. These shortcuts are always active.

The lens Iris controls the amount of light coming into the lens. The **Auto Iris** check mark allows either
automatic or manual lens iris control. Automatic iris control is the best option for most setups. When **Auto Iris** is disabled, the lens aperture can be manually controlled using the **Close** and **Open** buttons, or their corresponding keyboard shortcuts (Ctrl-I and Ctrl-O). Each time the button is clicked, the lens iris changes by approximately 1 f-stop, which is a 2x change (increase or decrease) in scene brightness. The stock camera lens has 4 iris stops available, so the iris can change the incoming light by a factor of 16. The effect on the video from iris changes is not always apparent because the camera image processing will partially compensate for scene brightness changes, which is why the automatic iris is usually best.
Camera Settings

Clicking the settings button on the camera panel displays a panel with commonly used camera settings:

The **Reset Camera** button restores the camera to its default state.

The **Arc Detect Level** setting controls the sensitivity of the algorithm used to detect a welding arc. The camera watches for arc-on and arc-off conditions to quickly adjust itself to provide the optimum image. This control sets the brightness threshold that triggers arc detection. A typical value is around 20. If the camera is not detecting your arc, make this number lower. If the camera is triggering off non-arc light (perhaps the reflections of other arcs from welding nearby), then increase this number. This control is not used when the video recording start is set to “Auto Start by Amps”.

**Camera Resolution** offers seven pre-set image sizes. **1280x1024** is the complete camera array. This provides the widest viewing field for a given lens zoom setting. The downside is that the video displays fewer frames per second and increases the time latency between image collection and display. The smaller image sizes increase the displayed frame rate and reduce the time lag, which can be useful for real-time adjustments or weld-by-goggle operation. If image display time lag is causing problems, try a smaller camera resolution mode and, if necessary, increase the optical zoom to compensate. Smaller image sizes also increase the range of arc-following.

The **Advanced** button on the bottom accesses less commonly changed camera settings.
**Picture**

The Picture button adjusts the image display. These adjustments do not affect the camera settings, and only affect the displayed image.

Once pressed, it turns yellow and displayed next to it is a panel of six sliders that affect different aspects of the image:
This panel of slider controls can either apply to the entire image or a special enhanced region. If the Main Image button above the panel is yellow, the control settings apply to the entire scene. If the Enhanced Region button above the panel is yellow, the displayed controls apply to the enhanced region only.
The main image controls are shown below. Each control has a - and + key for discrete steps and a slider for continuous adjustment. These adjustments affect the entire image.

The slider lets you increase or decrease the image property affected by the control. Click (or tap) the slider control and drag it to the left or right to increase or decrease the effect. Alternately, click or tap on the "+" and "-" buttons to adjust the effect in fixed steps.

The six controls are:

**BRIGHT**
Adjust overall picture brightness. This can improve the display when either the ambient lighting is low, or when the monitor itself is dim.

**CONTRAST**
Change display contrast. Contrast is the display range between dark and light features.

**SHARPEN**
Change image crispness. More sharpening can help pull out fine details in an image. Less sharpening can reduce image noise.

**ZOOM**
Add digital zoom to the image. Digital zoom can improve view of small features in the picture, but does not change the image resolution. Once the zoom is greater than one, you can use the mouse or your finger (on a touchscreen) to move the zoomed area on the video. This zoom is separate from the optical zoom on the camera lens, which is controlled on the Camera options panel.
COLOR
This adjusts the color saturation in the video. At minimum setting, the image has no color and is essentially a black-and-white image. At maximum setting, the colors will be gaudy and fluorescent. Adjusting this can help in pulling details out of a welding scene.

TINT
Shifts the color tint from red to blue, similar to the tint control on a TV or monitor.

These sliders control the whole screen. Another set can be enabled to separately adjust the Enhanced Region. When the Enhanced Region is enabled, a small area of the screen is given separate controls for Brightness, Contrast and Sharpen.
Enhanced Region Controls

When the Enhanced Region display feature is enabled, the Picture control panel includes three controls that affect the enhanced region only, if enabled:

The slider lets you increase or decrease the image property affected by the control. Click (or tap) the slider control and drag it to the left or right to increase or decrease the effect. Alternately, click or tap on the "+" and "-" buttons to adjust the effect in fixed steps.

The three controls are:

**BRIGHT**
Adjust overall picture brightness. This can improve the display when either the ambient lighting is low, or when the monitor itself is dim.

**CONTRAST**
Change display contrast. Contrast is the display range between dark and light features.

**SHARPEN**
Change image crispness. More sharpening can help pull out fine details in an image. Less sharpening can reduce image noise.
Picture Settings

The Settings panel for the Picture button contains these commonly used settings:

At the top are a series of controls for rotating and flipping the camera video display. This is useful for situations where the camera is mounted at an unusual angle, leading to a confusing orientation of the welding video. Rotation can be combined with the image flip settings.
The rotation buttons apply none or 3 rotation settings:

**No Rotation**

**90 Degrees (CCW)**

**180 Degrees**

**270 Degrees (CCW)**
The **Flip Vertical** and **Mirror Horizontal** inputs are useful for correcting image inversions caused by mirrors:

**Example reference image**

![Reference Image](image1)

**Flip vertical**

This reverses bottom and top in the image, as if it was flipped over.

**Mirror horizontal**

This reverses left and right in an image, as if you were looking in a mirror.

The Volt-Amp Graph Position controls affect the size and location of the volt-amp graph overlays on the video:

- **Upper Left** Overlay graphs in upper left corner of image.
- **Upper Right** Overlay graphs in upper right corner of image
- **Lower Left** Overlay graphs on video lower left corner.
- **Lower Right** Overlay graphs on video lower right corner.

The presence of the graph overlay, and its size, are controlled by the bottom three buttons:
Small  Relatively small display of volt-amp graphs

Off    Disable display of volt-amp graphs

Large  Relatively large display of volt-amp graphs

The **Advanced** button at the bottom takes you to the Advanced Settings screen.
**Enhanced Region Settings**

The Settings panel for the Enhanced Region is shown below.

The **Enabled** check box turns the enhanced region on and off.

**Circular edge**: this sets the shape of the enhanced region.

- ![circular region](image)
- ![rectangular region](image)

**Follow arc**: this option makes the enhanced region follow the arc as it moves.

The **Source Area** controls are used to define the region of the image that will be enhanced. To specify the area for enhancement, click the draw button and then click and drag the area on the screen. Circular regions are drawn from the center point outwards.
Below is an example of drawing a circular region:

Rectangular regions are drawn from corner to corner:

During drawing, the area will have a highlighted border to show the region, as shown in the two examples above. This border fades away after a few seconds. If you want to view the border after it fades out, click the Hi-Lite button.
The Destination box buttons control where the enhanced region will be added to the video. Overlay source places the enhanced region over the same image pixels being enhanced, as shown below:

The other 4 buttons let you place the enhanced region display in any of the image corners for a picture-in-picture effect. Below is an example of the enhanced region displayed in the lower right corner:
Video Recording

The Record panel is displayed by clicking or touching the video recording button:

This panel lets you start, pause, and stop recording of the camera video to a disk file. The panel and its controls are shown below:
**Name:** Recorded video files are by default named using a long date-time string, which gives both a unique name for every file and also identifies the recording time at a glance. A typical default filename would be "2014-Jan-09_13-20-17.vwR". This file prefix is added to the front of the filename and lets you identify welders, jobs, or specific tasks. In the example above, the Name is "Steve", which could indicate, for example, a specific welder. This setting will add the prefix onto the filename so the filename might be "Steve.2016-Jan-09_13-20-17.vwR".

The four buttons that control manual disk recording are:

**Record**
This starts recording video to disk. If the recording was paused, then clicking this button resumes the recording. The keyboard shortcut key is Ctrl-R. During recording information about the current recording (number of frames, file format, and arc detection) is displayed in the status bar along the bottom.

**Stop**
Clicking this ends the recording. The file is saved into the current Temp directory and WeldWatch immediately jumps to the Play Video screen and starts playing it back.

**Pause**
This temporarily stops recording video, but keeps the file open for more recording to come. When paused, you can resume recording by clicking the RECORD button. You can also STOP or CANCEL the recording.

**Cancel**
This stops the recording and deletes any temporary data from the hard drive.

Under Image Capture, there are two buttons that let you take a snapshot of the current video image.

**To Paint** This button takes the snapshot and opens it up as a temporary BMP file in the Windows Paint
program. You can use the features of Paint for rudimentary edits to the image, and save it to a disk file for future use.

**To Clipboard** This button stores the snapshot in the Windows clipboard. It can now be pasted into any Windows application that supports graphics.

The Settings button in the lower right of this panel provides access to additional Video Recording parameters.
Video Recording Settings

The Video Recording Settings panel, displayed by clicking the Settings button in the lower right of the Video Recording panel, is shown below:

There are three ways to start recording video:

**Manual**  This starts and stops disk recording using the buttons on the Video Recording options panel.

**Auto-Start by Amps**  This starts recording when current is flowing. This option only applies if you have the optional VampWatch hardware installed.

**Auto when Arc Visible**  This starts recording when an arc is detected in the video

The two automatic start options make it easy to record whenever welding is taking place, without user intervention.

The buttons in Output File Type select the file format for recorded video

**AVI**  This records video into standard Windows AVI files at screen resolution. The AVI file includes exactly what is shown on screen, including all picture scaling (such as brightness and contrast) and any annotations such as text or graphics.

**RAW**  This records video into a proprietary format that includes additional information, including the data needed for the Volts-Amp display in playback.

Next are options that record additional video around the time that welding is detected, either by an arc or through amperage:

**Pre-record 5s**  When checked, this adds the 5 seconds of video prior to arc-detection to the recorded
Post-Record  This adds the number of seconds specified of video to the end of a file, after welding is no longer detected. The default value shown is 5 seconds.

Max Recording Length  Assign a maximum recording time duration to any single video. This acts as a safety valve to prevent the accidental recording of hours of video, which could fill your computer's disk and lead to other complications.

Auto Replay Count  This is the number of times the video is replayed after recording stops. The default value is 1, but you can set it to a higher value if you prefer.
Play Video

Recorded video playback is controlled through the Play panel. This is displayed by clicking or touching the play button:

The Play panel is shown below:
At the top, the name of the file being played is shown. If it is too long to fit on the screen, the horizontal scroll bar lets you see the entire filename. The Browse button displays a Windows dialog that lets you select the file to play. Note that files stored in the Temp or Keep directories (described below) can be directly played by clicking on them.

Next are a set of buttons controlling video playback. Each button is summarized in the following section on playback controls.

**Repeat** If enabled, this will continuously loop through the video until you press the pause button.

**Export to AVI** This button is only seen if you have a file in raw format loaded. It takes the current raw file and exports it, with the current video and overlay settings, to an AVI file. This function plays through the entire raw file while exporting, so if the video file is long the export can take a while. The converted file is stored in the Keep directory.

**Browse** displays a standard Windows file dialog that lets you select an arbitrary file to play in WeldWatch.

Next are controls for the **Temp** and **Keep** options for storing videos. Temp and Keep point to two separate default locations for video on your computer. The file list displayed corresponds to the yellow Temp or Keep buttons. On the screen above, the **Temp** button has been clicked, so it is yellow and the Temp list of files is shown. If the **Keep** button is clicked, it turns yellow and the files in the Keep directory are displayed, as shown in the screenshot below:
The Temp and Keep scheme provides a convenient way to access videos just recorded, and then organizes them into a collection to preserve (the Keep directory). All recorded video is stored in the Temp directory, which holds videos for review. The disk location of this directory can be viewed, or changed, on the Advanced Settings Video Recording panel. As videos are recorded, they are added to the Temp directory display and you can play any file simply by double-clicking it. WeldWatch monitors available disk space and will automatically delete the oldest videos in Temp when space is needed. The minimum free disk space limit can be changed in Advanced Settings. Files from the Keep folder are never deleted by WeldWatch.

To move files from Temp to Keep, right click mouse or touch-screen press on the filename and hold until a submenu comes up. The submenu has two options: “Rename” and “Move to Keep”.

- Choose “Move to Keep” and the file is instantly moved to the Keep list
- Choose “Rename” and you can edit the name right in the name box

Keep has the same submenu to rename or move to Temp.

The file display of the Temp directory is sorted by time, while the file display of the Keep directory is alphabetical.

Filenames can be edited directly in the display by double-clicking the white area. The non-date leading fraction of the filename can then be changed within the rules that apply to Windows filenames.

The Close button at the bottom hides this panel, making more screen space available to view the video playback.
Play Controls

Once a video is selected, you can change the playback using the following controls:

- Play forward
- Play in reverse
- Pause playback
- Step one frame forward (pauses playback)
- Step one frame backward (pauses playback)

The following two buttons decrease or increase playback speed by a factor of 2. The available speeds are: 1/16, 1/8, 1/4, 1/2, 1, 2, 4, 8, and 16

- Play slower
- Play faster

The number in the center indicates the current playback speed:

Current playback speed

The To Arc button will fast forward the video to the first image with an arc detected. When playing a video where arc is off-screen, this button auto fast-forwards until arc becomes visible. This can be helpful for videos where video started automatically with current, but camera was aimed down the seam, waiting for the weld.

Auto Repeat allows a video to be played over and over as a loop until stopped, either forward or backwards.

- If checked, the video will repeat
- If set, the video will stop when the end (or beginning) is reached
Advanced Settings

Less frequently used software settings are controlled on a series of panels under Advanced Settings. You can get to this screen either from the menu entry Settings > Advanced or via the Settings buttons on some of the button option panels. This screen is shown below without any of the panels opened:

Each yellow bar can be clicked to open a panel of inputs or information prompts. Multiple panels can be open at once. If all the open panels do not fit on your screen a vertical scroll bar is displayed to the right so you can slide the entire panel up and down to view different panels as needed.

The program parameters covered by these 5 panels are summarized below:

**CAMERA**
Less commonly used camera settings.

**PICTURE**
Adjustments for the video displayed on-screen.

**VIDEO RECORDING**
Settings for recording video.

**MISC**
Auto-Hide interval and stored settings.

**ADVANCED INFORMATION**
Detailed information on camera and Volt Amp meter.
Camera (Advanced Settings)

The Camera panel in Advanced Settings is shown below:

In the Camera Resolution frame, the first inputs are the screen width and height in pixels. This lets you specify a custom image readout size, within the following restrictions:

**Width** must be a multiple of 16 in the range 320 to 1232

**Height** must be a multiple of 8 in the range 240 to 1008

This option lets you adjust the location and size of the camera video in situations such as limited space for camera mounts that prevent centering the arc in the default video setups.

Smaller images allow higher video frame rates and also increase the effectiveness of arc-following, if you use this feature.

Region of Interest (Arc-following):
The camera can electronically steer the image so that the displayed region moves within the field of view to follow the arc, just as if you had a camera man moving the camera. And, like a good camera man, the computer works to keep this movement as smooth as possible.

In 640x480 pixel resolution, arc-following can double the range where a moving arc is viewed. In 320x240, the range is quadrupled.
You have four ways to accomplish this:

If **Digital Pan: Arc-Centering** is selected, the computer works to keep the arc centered. This is a typical mode for machine vision applications.

**Digital Pan: Arc-Following** slows down arc centering, creating motion in the arc image. This is useful for welding by camera (usually with video goggles). In this case, having the arc remain stationary in the center, even though the welder is moving their hand, can be somewhat distracting. By allowing some movement, but less than normal, this mode can provide good hand-eye feedback to the welder while still extending the range.

**Centered** keeps the arc centered in every image, updating the location of the region of interest for every frame with an arc detected.

**Specify offsets** lets you apply a fixed offset to the image. If checked, the Offset X and Offset Y are specified in pixels immediately below the button. These values must be multiples of 4. This is useful for industrial applications where the camera mounting may make it impossible to center the arc. WeldWatch displays a rectangular subset of all the pixels in the welding camera. The diagram below shows the physical meaning of the size and offset inputs:

![Diagram showing the physical meaning of size and offset inputs](image)

The full sensor has 1280 x 1024 pixels. The WeldWatch displayed image is represented by the smaller green rectangle. These inputs control the size of the green rectangle, its position on the full sensor, and options to move the window around the array without physically moving the camera. This is primarily useful for adjusting the image when the camera is mounted at an unusual angle in a tight space and the arc is away from the image center.

The **Low Light Options** let you change some camera defaults that affect operation when an arc is not present.
Low-Light Averaging is an option that averages successive frames to reduce image noise. This leads to a cleaner image, but reduces the video frame rate, which can lead to lag in image updates. If you don’t mind the higher noise but the image lag is causing problems (while mounting and pointing a camera), you can disable the multiple frame averaging here.

Long Exposure Time alters another default setting used in arc-off situations. The normal exposure time with the arc off is 50 ms, which leads to a maximum frame update rate of nearly 20 Hz. If you turn this option on, the non-arc exposure time is doubled to 100 ms. This increases the scene signal but limits the maximum frame rate to less than 10 Hz (for any size region of interest). With this you can choose whether the increased exposure time is more useful in your application than the slower video image update.

Low-Light Noise Reduction enables a feature that subtracts fixed pattern noise from every image. When adding a new camera to a WeldWatch PC, it will need calibrating so the software learns the camera sensor. This is done using the Run Low light Noise Calibration button immediately below. If you click this, the camera closes its lens iris and compares many frames to determine the underlying noise pattern. The pattern changes a little as the camera warms up. For best results, the camera should be powered on for 15 minutes or more before calibrating. Calibration may be repeated at any time to replace the old calibration. During calibration a status bar is displayed as below:

After the new calibration file is created you can use this option to turn it on and off, to see if it worked well and improves the video appearance.

The camera fixed pattern noise depends on the camera temperature. Prior to using this calibration procedure, we recommend that you have the camera on for at least 15 minutes so that it stabilizes at its operating temperature.
Picture (Advanced Settings)

The Picture panel in Advanced Settings controls use of text annotation and drawings as overlays on the video display. The panel's annotation inputs are shown below:

Show Annotations, when checked, will add any annotations enabled to the video.

Show Date adds the current computer date (PC / Windows date)

Show Time adds display of the current computer time (PC / Windows time)

The Location box lets you choose which corner of the image to display the annotations in. In the example above, the annotations are added to the lower right.

The Color box lets you set one of 4 possible colors for the annotation display text.

On-Screen Text includes a box where you can type any text string. This can be used to document the welding machine in use or the job being performed.

The User Drawing inputs are shown below:
These controls let you add simple line markup to the video.

Show User Drawing, when checked, turns drawings on or off.

The **Clear Drawing** button erases all current drawings and lets you restart from scratch.

The **Color** box lets you select up to 4 colors for annotations.

The **Drawing Tool** box provides two methods of drawing:

**Line:** this draws straight lines. Click once to establish the start point, and click again to set the ending point. The example above uses straight lines to highlight the tool centerline and the seam, showing the alignment.

**Freehand:** this tool provides free-hand drawing using the mouse or touch. In the example above, a free-hand sketch has been drawn around the plasma ball surrounding the arc.

In addition, the **Off** button, lets you temporarily disable drawing so you can move the mouse over the image without accidentally adding marks. This is useful for panning around in zoomed images.

The **Pen Width** box gives 3 thicknesses of drawn lines, from thin to thick.

Both Color and Pen Width affect all of the lines drawn, including those already drawn onto the video. Thus all annotations are the same color and width.
Video Recording (Advanced Settings)

The Video Recording panel of the Advanced Settings screen provides control over disk locations and space:

The buttons under Select Storage Folders let you change where the default Keep and Temp directories are located on your hard disk.

**Keep**  This button displays a Windows directory dialog box and you can view and/or change the disk directory to store files used in the Keep list on the Play control panel.

**Temp**  This button first displays a confirmation box to verify that you want to change the folder for automatic recordings and the Temp list on the Play control panel. If you click OK, you then get a Windows directory dialog where you can view and/or change the disk directory to store recorded files to.

**The Max Temp Video Disk Space** is an option to limit the maximum space that recorded video can use on your computer. This option is enabled by checking the green check, and then the value used as a maximum is specified on the input to the right of it.

**Minimum Free Disk-Space** specifies the minimum which must be available for disk recording. This option prevents the hard disk from getting completely filled with video, which can lead to unstable behavior by the Windows operating system. The minimum value for this parameter is 20 Gb, but a higher value can be specified here.
**Misc (Advanced Settings)**

The Misc panel of the Advanced Settings screen contains user interface options and tools for loading/saving program settings. The panel is shown below:

The **Auto-Hide Control Panel** controls the time interval between the last screen activity and an automatic transition to the Hide mode, when the screen buttons are hidden to maximize the screen area available for video display. You can specify the number of seconds of inactivity that elapse before this event. The default value is 60. Auto-hide can be disabled by setting the time interval to 0.

The Stored Settings inputs let you preserve or reuse program settings. For example, once you optimize the WeldWatch software for a given camera installation, you may want to save the software settings away so that for future runs you can reuse the exact same settings without having to re-input each value. This is especially useful for multiple camera configurations or different welding setups.

**Save as Power Up** This saves current software settings away as defaults to be loaded every time WeldWatch is started.

**Save to File** Save current settings to an arbitrary file on disk.

**Load from File** This button lets you load software settings from a file previously created using the Save to File button.

**Reset to Factory Defaults** This button restores the initial default values shipped with each copy of WeldWatch.
Advanced Information

The last panel on the Advanced Settings screen displays some additional information about the attached hardware:

The Exposure Details box provides some technical detail on how the camera is currently operating. The Frames parameter shows the number of frames per second being received and processed on the computer. Latency is the time between the image collected by the camera (reality) and its display on the screen. This is independent of the frame time spacing, as a very slow 1 Hz frame rate can also have a very short latency time. Shutter is the exposure time of each frame in milliseconds. Clock is the pixel clock or the rate at which image pixels are being output by the camera. Resolution is the current size of the video window. X-Offset and Y-Offset show the current offsets (in pixels) of the window from the upper left corner of the camera detector array (which is natively 1280 x 1024 pixels).

The status of hardware components is also displayed:

Arc status (on or off) indicates whether an arc is detected in the current video
Volt-Amp meter (connected or not) indicates whether the Volt-Amp meter is connected and responding to software commands
Camera (paused, active, or not connected) indicates if a supported Visible Welding camera is attached
Show / Hide

The **Hide** button clears out all of the buttons on the left so that maximum screen area is available for video. The only button displayed in the video area is a small **Show** button in the lower left corner, which is used to reverse the effect:

Click on this **Show** button and the buttons along the left are restored to view. The **Show** button becomes a **Hide** button, which you can click again to hide the buttons along the left.
Program Menus

File Menu

The File menu contains 8 items:

**Play Video**
This lets you load an existing video file in and play it in WeldWatch. A Windows dialog is displayed and you can navigate to the file folder and select the file in a standard way. WeldWatch supports both raw files (*.wvR) and AVI files created in WeldWatch. The raw files contain additional information that enables more control over the picture display than an AVI file.

The next 3 menu items let you preserve or reuse program settings. For example, once you optimize the WeldWatch software for a given camera installation, you may want to save the software settings away so that for future runs you can reuse the exact same settings without having to re-input each value. This is especially useful for multiple camera configurations or different welding setups.

**Load 'Settings' File**
This loads a file containing software settings previously created in WeldWatch.

**Save 'Settings' File**
Save current settings to an arbitrary file on disk.

**Save 'Power Up' Settings File**
This saves current software settings away as defaults to be loaded every time WeldWatch is started.

**Copy Image to Clipboard**
This feature allows you to save a snapshot the video and place it on the Windows clipboard. From there, you can Paste it into any Windows app.

**Copy Image to Paint**
This saves a snapshot of the video and opens the Windows Paint program with the image already pasted in, ready to edit and save.

**Copy Log Files**
This is for diagnosing camera or software problems. WeldWatch maintains log files for the last 10 runs, and this option lets you save these logs to a separate directory for inspection or to provide to Visible Welding for support. There are two types of log files, starting with Cpp and Cs, for each run.

**Exit WeldWatch**
This closes the WeldWatch application.
**Picture Menu**

The Picture menu contains the following items:

**Enhanced Region**  
This enables operation of the enhanced region option for display, and gives menu access to the enhanced region settings. There are 5 sub-menu entries under Enhanced Region.

**Show Enhanced Region**  
When checked, this adds the enhanced region to the current video display.

**Circular Edge**  
When checked, the enhanced region is circular. When not checked, the enhanced region is a rectangle. You can customize the size of the enhanced region using the Source Area controls on the Region Settings panel.

**Follow Arc**  
When checked, the enhanced region is centered on the detected arc location in the video.

**Destination Location**  
This displays a further submenu that lets you position the enhanced region overlay either directly over the arc or in any of the 4 image corners.

**Size**  
This provides 3 generic size options for the enhanced region overlay.

The remaining two Picture menu items are:

**Orientation**  
This provides access to the image flip and rotation options.

**Annotation**  
This lets you enable video annotations and set all of their properties, with the exception of a user-defined string for annotation.
**Camera Menu**

The camera menu has 3 items:

**Auto-Focus**
This runs autofocus on the current scene. Autofocus is also always available with the keyboard shortcut ctrl-A or as a live button in the WeldWatch status bar at the bottom of the window.

**Live**
When checked, this enables live streaming of the camera video to the computer screen. Clicking the menu item toggles the checkmark. When unchecked, streaming stops and the last frame streamed is displayed.

**Resolution**
This lets you quickly select one of preset resolutions for camera video.
**Settings**

The settings menu provides quick access to all of the WeldWatch settings screens. It has 5 items:

- **Camera**
  This displays the Camera Settings screen.

- **Picture**
  This displays the Picture Settings screen.

- **Recording**
  This displays the Video Recording Settings screen.

- **Advanced**
  This displays the top level screen of Advanced Settings, which has several panels of input providing access to less frequently used parameters.

- **Enhanced Region**
  This displays the Enhanced Region Settings screen.
Record Menu

This menu contains 5 items that let you start and stop recording of camera video.

Begin Recording
This starts recording video to disk. The keyboard shortcut key is Ctrl-R.

Pause Recording
This temporarily stops recording video, but keeps the file open for more recording to come. When paused, you can resume recording by clicking the RECORD button. You can also STOP or CANCEL the recording.

Resume Recording
This resumes recording of video to disk.

Stop Recording
Clicking this ends the recording. The keyboard shortcut is Ctrl-T. The recorded video is saved in the Temp directory.

Cancel Recording
This stops the recording and deletes the partially recorded data from your hard drive.
Help Menu

This menu has 2 items:

Help
Displays this help file.

About WeldWatch
This displays an about box with program version information. The Details button in the version window can show additional information about the serial numbers of attached camera components.
Sales and Support

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