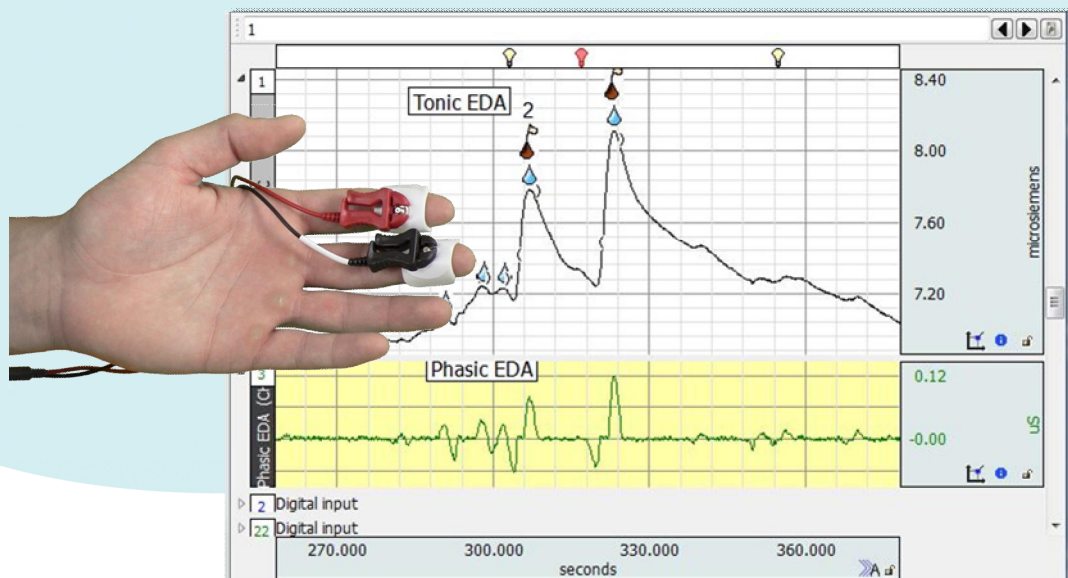


EDA INTRODUCTORY GUIDE

Introduction to EDA

Introduction to Electrodermal Activity (EDA)



Welcome to BIOPAC's Introduction to EDA, the aim of which is to offer a brief glimpse into the concepts behind Electrodermal Activity (EDA), plus demonstrate guidelines for collecting high-quality EDA data. In addition to the basic steps outlined in this guide, links to detailed instructional videos, webinars, and other BIOPAC resources are included. These can be of assistance in offering an enhanced level of instructional detail about acquiring and analyzing EDA data.

What is EDA?

EDA is an abbreviation for **Electrodermal Activity** (historically referred to as GSR, or Galvanic Skin Response). EDA is a measurement of eccrine activity that is influenced by sympathetic nervous system activity, resulting from environmental stimuli. EDA is an *autonomic* (involuntary) response. Stimulus types that elicit changes in EDA can be sourced via touch, sight, sound, odor and taste.

The physiological basis for EDA is neurological control of the rate of sweat gland production in the extremities, most notably the fingertips, palms of the hand, and soles of the feet. EDA increases with excitement, exemplified by the sweaty palms one may experience before an exhibition, such as giving a speech or musical performance. EDA also increases in conjunction with activity presaged by nervousness, such as visiting the dentist or being interviewed for a job. Conversely, if a participant is neutral, EDA will generally be low.

***Cited in over 33,000** peer-reviewed journal articles and trusted by the world's premier laboratories and leading researchers, BIOPAC's world-class life science research and education platforms provide the most advanced acquisition and analysis of ECG, EDA (GSR), EEG, EGG, EMG, EOG, and over 300 other signals and physiological measurements. *Over 99% of the world's top universities use BIOPAC equipment.*

A Brief History of EDA

In 1849, Dubois-Reymond in Germany discovered that human skin was electrically active. In 1879, a French researcher, Vigouroux, was the first to associate EDA to psychological activity, while working with emotionally distressed patients. In 1889, Russian physiologist, Tarkhnishvili, observed variations in skin electrical potentials (independent of an external source of current) and developed a meter to observe the variations in real-time.

Scientific study of EDA began in earnest in the early 1900s. One of the earliest noted references, to EDA instruments in psychoanalysis, can be found in Carl G. Jung's book "Studies in Word Analysis" (1906), in which Jung and his colleagues used a meter to evaluate patients' emotional sensitivity during word association tasks.

Jung was so impressed with EDA monitoring, he allegedly remarked, "Aha, a looking glass into the unconscious!" Jung also described use of EDA monitoring during counseling in a subsequent book, "Studies in Word Association" (1919), and such use has continued to present day.

By the early 1970s more than 1,500 articles on electrodermal activity had been published in professional publications, and today EDA is regarded as the most popular method for investigating human psychophysiological phenomena.

How does EDA work?

The physiological basis of EDA is an *autonomic* (involuntary) reaction that occurs in the skin and subcutaneous tissue in response to changes in affect. Affect is an observable expression of emotion. In particular, EDA is an indicator of arousal.

Arousal changes can be initiated by external sensory stimuli. Additionally, internal emotional states may modulate autonomic function and thereby produce overt changes in affect. A common example is the vasodilation of facial blood vessels (blushing) and an associated increase in sweat production when subjects are embarrassed.

Measuring EDA involves measuring skin conductance. Conductance is the inverse of resistance. As skin conductance increases, skin resistance drops, which is defined as the improvement in the skin's ability to conduct electric current. In practice, if a sudden stimulus (such as a pinprick) is applied to the skin, the stimulus will trigger a sympathetic discharge to the eccrine sweat glands, increasing secretion.





Introduction to EDA

Secretion of sweat, comprised mainly of water and electrolytes, increases the skin's electrical conductivity. This reaction has two components: Skin Conductance Level (SCL or Tonic) and Skin Conductance Response (SCR or Phasic). These two types of skin conductance measurements are observed as a combination of a smooth, underlying, slowly-changing baseline level (Tonic) punctuated by rapidly changing peaks (Phasic).

Tonic Tonic skin conductance is generally considered to be conductance activity encountered in the absence of any discrete environmental event or external stimuli. A participant's tonic skin conductance level can slowly vary over time depending upon psychological state, hydration, skin dryness, and autonomic regulation. Tonic changes in the skin conductance level typically occur in a period of from tens of seconds to minutes. The measure of this slow-changing level is referred to as Skin Conductance Level (SCL).

Phasic Phasic skin conductance measurements are typically associated with short-term events and occur in the presence of discrete environmental stimuli (sensory stimuli and cognitive processes that precede an event such as anticipation, decision making, etc.). Phasic changes show as abrupt increases, called "peaks," in the skin conductance. These peaks are referred to as Skin Conductance Responses (SCRs). Tonic and phasic, taken together, comprise what is referred to as the EDA Complex.

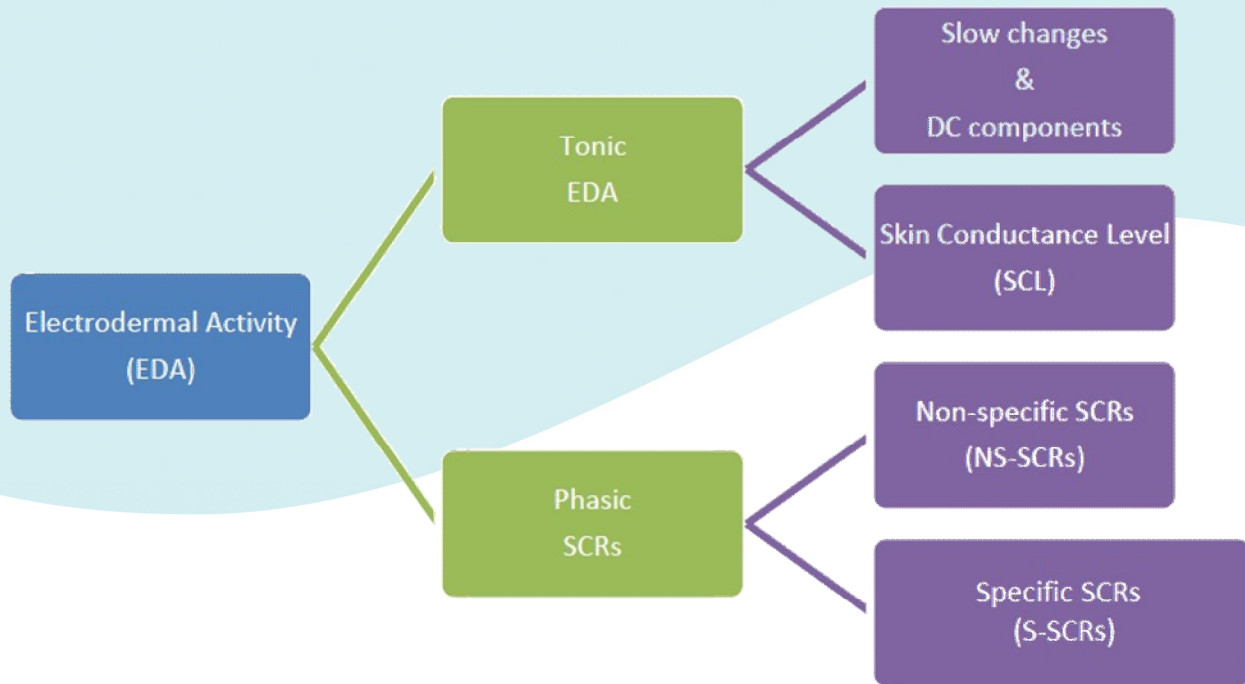
The psychophysiological responses elicited by EDA changes can be accurately extracted and measured using specialized BIOPAC electrodes, hardware, and software. The recorded data (including Tonic and Phasic EDA) can be subsequently analyzed in detail.

- The units used for measuring EDA electrical conductance are **microsiemens (μS)**
- Typical skin conductance levels are in the range of **2-20 μS**

Definitions of EDA Components

Measure	Definition
Skin conductance level (SCL)	Tonic level of electrical activity of skin
Skin conductance response (SCR)	Phasic change in electrical conductivity of skin
Non-specific SCRs (NS-SCRs)	SCRs occurring in the absence of identifiable eliciting stimuli
Frequency of NS-SCRs	Rate of NS-SCRs occurring in the absence of identifiable stimuli
Specific SCRs	SCRs that can be attributed to a specific stimulus eliciting specific SCRs.

The EDA Complex



For more detailed information, see the [EDA Application](#) page on the BIOPAC website.

What is Required to Measure EDA?

Measurement of EDA is actually rather simple. Two electrodes are placed on the participant's fingers, palms, or feet and a very low constant voltage applied (not felt by the participant). Then the current flowing as a result of this applied voltage is measured and converted to a conductance in accordance with Ohm's law. As previously stated, skin conductance is measured in units of **microsiemens**, with normal human EDA ranging from 1 to 20 microsiemens. Along with heart rate and respiration, EDA is one of the principal measurements used in modern polygraph tests and biofeedback studies.

Common Applications for EDA Measurement

Psychological Research

Psychological research studies utilize EDA to identify how humans respond emotionally towards various stimuli. Sensory stimuli (vision, hearing, equilibrium, taste, smell) also exerts an effect on a participant's emotional state. Interestingly (although highly subjective), the perception of color may also elicit changes in autonomic tone, which in turn, affect a participant's mood and behavior. Warm colors such as red, orange, and yellow evoke emotions of warmth and comfort in some persons, feelings of anger and hostility in others. The phrase "seeing red" refers to an angry person. Cool colors such as green, pink, and blue evoke feelings ranging from enviousness ("green with envy"), tranquility, and sadness or indifference ("feeling blue").

Psychotherapy

EDA is often used in the treatment and assessment of patients suffering from various phobias, post-traumatic stress disorder (PTSD) and other emotional conditions. By monitoring EDA, the physiological arousal of the patient can be a helpful barometer for assessing severity of the condition as well as the success of subsequent therapeutic measures.

Physiology Education

EDA is an important component in physiology education and one of the many physiological signals fully explored in Biopac Student Lab 4, BIOPAC's Educational System. Comprehensive EDA Lessons include Polygraph and Biofeedback studies.

Neuromarketing and Media Research

EDA can be used to track emotional arousal resulting from exposure to products, commercials, trailers and TV shows during consumer research studies. Many shopping and viewing preferences are based upon sub-conscious processes. EDA data can be helpful in assessing customer preferences on a subliminal level and providing researchers with objective subject feedback.

Software Usability and User Experience Testing

EDA is often used as a barometer when testing ease-of-use for software and other interactive applications. These applications can include stimulus presentation, video, and virtual reality. If a participant becomes silently confused or frustrated, EDA data is a good indicator of these types of emotional responses and at which point during the experience the responses occur.



Introduction to EDA

Setup

Preparing for an EDA Recording

An initial step is to decide which type of EDA electrodes to use. There are two types of BIOPAC EDA electrode and lead sets, **disposable** and **reusable**. Whichever type is used, proper preparation and application of electrodes/leads is vital for obtaining great EDA data.

Disposable EDA electrode setups consist of two adhesive electrodes (BIOPAC EL507*) and an EDA electrode lead set. The BIOPAC EDA lead sets are the LEAD110A (for BIOPAC MP160 hardware) or SS57L (for BIOPAC MP36/36R hardware). BIOPAC recommends using disposable electrodes because you get a new set of electrodes with each subject and don't have to worry about cleaning the electrodes. Reusable electrodes can deteriorate over time, which may go unnoticed until you have already run several subjects.

*The EL507 electrode uses isotonic gel that is the same as GEL101

Reusable EDA electrode setups consist of two Velcro straps attached to electrodes with internal cavities for holding conductive electrode gel. The reusable BIOPAC EDA electrodes are the TSD203 (for BIOPAC MP160 hardware) or SS3L (for BIOPAC MP36/36R hardware).

Tips for Preparing Skin prior to Recording EDA

For electrodermal activity (skin conductance) measurements, the conductivity of the skin at the electrode site is the variable to be measured so no steps should be taken to artificially modify that conductance:

- Clean skin with water only- do not use alcohol, soap, or skin prep gel.
- Never abrade skin prior to recording EDA.
- Place electrodes at least 5 minutes in advance of recording.
- Make sure to use isotonic gel (GEL101)

Recommended reading: [Guidelines – EDA, EDR, GSR, SCL, and SCR](#)

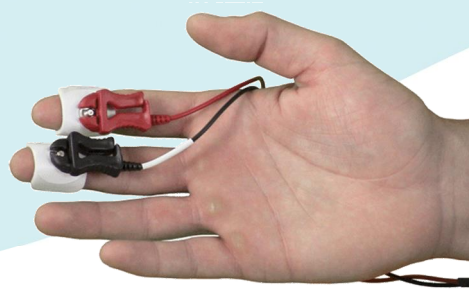
[Click here for more specifics about EDA subject preparation.](#)

Subject Setup

Suggestions for attaching EDA Transducers, Leads & Electrodes

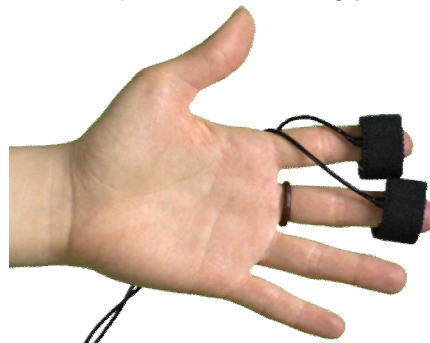
DISPOSABLE Wired EDA setup - 2x BIOPAC LEAD110A or 1x SS57L + 2x EL507 Electrodes:

1. Apply a drop of GEL101 isotonic gel to both EDA electrodes.
2. Attach the electrodes to the participant's fingertips as shown.



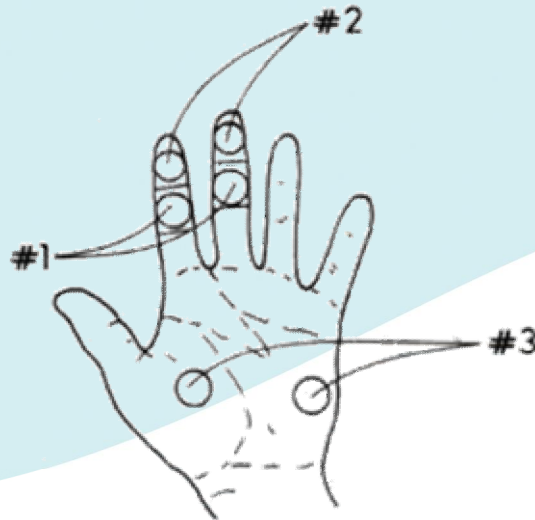
REUSABLE Wired EDA Transducer (BIOPAC TSD203 or SS3L):

1. Fill both cavities of the EDA transducer with GEL101 isotonic gel. **NOTE:** Only use isotonic gel (GEL101) for EDA.
IMPORTANT: If necessary, thoroughly clean existing gel from the cavities before replacing with new gel and always clean transducer after each use. Do not allow gel to dry in or on the transducer.
2. Attach the transducer to the participant as shown, one band on the middle finger and the other on the index finger. The Velcro® straps should fit snugly, but not enough to cut off circulation.



[Click to watch a webinar about EDA setup & recording.](#)

Alternate Electrode Placements



Three electrode hand placements for recording electrodermal activity.

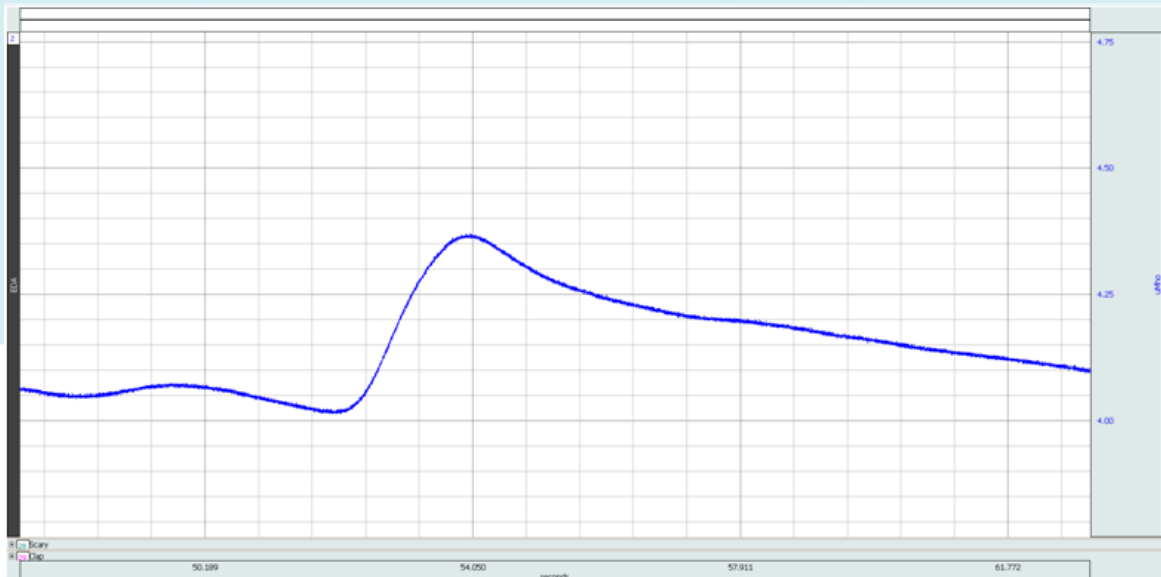
- Placement #1 involves volar surfaces on medial phalanges.
- Placement #2 involves volar surfaces of distal phalanges.
- Placement #3 involves thenar and hypothenar eminences of palms.

Scerbo et al. (1992) made a direct comparison of EDA recorded from the distal and medial phalange sites simultaneously and found that both the elicited SCR amplitude and SCL were significantly higher from the distal recording site. The greater level of reactivity at the distal site was found to be directly related to a larger number of active sweat glands at that location (Freedman et al., 1994).

Researchers should consider electrode placement based on the task a participant will perform. The location should avoid places where the electrodes will be knocked or banged by the subject while the task is performed, i.e., fingertips on a keyboard.

Tips for Ensuring Great Data

- Make sure electrodes, leads or transducers are properly attached and cables secured.
- Ask the participant to take a long deep breath, hold it for a second, then relax and exhale. This should result in an increase in SCL (see below example).



- Participant should breathe slowly and regularly.
- Participant should sit comfortably in a natural position with feet supported.
- If the data appears distorted or as a flat line, check to make sure the connections are in place and that the electrodes have not lost adhesion.
- If despite your best efforts, data quality does not improve, it may be an indication that you have a non-responder participant. If so, repeat the recording using a different participant. (About 10% of participants may be non-responders.)

Introduction to EDA

Means and SEs for the three responsiveness measures, the mean skin conductance level (SCL), the number of skin conductance responses per minute (SCRs) and the sum of skin conductance response amplitudes per minute (S-AMPL), for each of the 16 positions. The positions are sorted on the mean SCL.

Position	SCL [μ S]		SCRs [1/min]		S-AMPL [μ S/min]	
	M	SE	M	SE	M	SE
Forehead	8.72	0.72	2.97	0.54	0.32	0.07
Foot (instep)	8.50	0.88	4.88	0.76	0.92	0.18
Finger	6.50	0.53	3.80	0.64	0.53	0.13
Shoulders	5.96	0.94	2.41	0.69	0.43	0.12
Neck	5.38	0.84	1.57	0.42	0.19	0.07
Abdomen	5.15	0.91	1.26	0.63	0.29	0.14
Calf (sock)	4.70	0.95	1.63	0.47	0.28	0.09
Wrist (vertical)	4.65	0.73	2.10	0.62	0.44	0.15
Buttock	4.33	0.59	0.98	0.35	0.19	0.07
Wrist (distal)	4.23	0.89	1.43	0.42	0.31	0.11
Chest	4.20	0.69	1.57	0.50	0.35	0.10
Wrist (central)	4.18	0.72	1.77	0.57	0.44	0.14
Thighbone	3.72	0.58	0.90	0.33	0.18	0.07
Arm	3.04	0.52	0.62	0.23	0.13	0.05
Back	2.18	0.60	1.21	0.43	0.26	0.09
Armpit	1.61	0.34	0.71	0.27	0.10	0.05

[Click to watch a Webinar about recording EDA data.](#)

Responsiveness measures table courtesy of: van Dooren, Marieke & De Vries, Gert-Jan & H Janssen, Joris. (2012). Emotional sweating across the body: Comparing 16 different skin conductance measurement locations. *Physiology & behavior*. 106. 298-304. 10.1016/j.physbeh.2012.01.020.

Introduction to EDA

Hardware Setup

Hardware required to record EDA

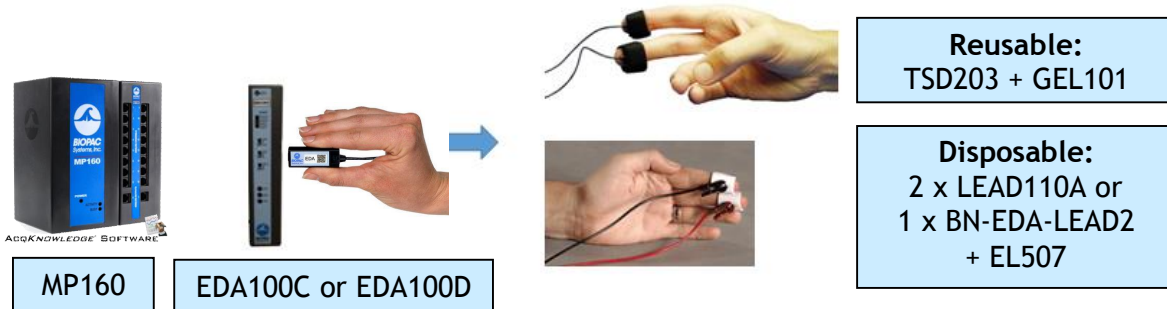
BIOPAC hardware provides three basic methods for acquiring EDA data. Wired, wireless, and cabled in the MRI environment.

Hardware Components—Wired Methods

Wired methods for collecting EDA data are appropriate for experiments where participants remain relatively still and in close proximity to the data acquisition system.

MP160 System

The MP160 System is a 16-channel Data Acquisition System with *AcqKnowledge* software specifically designed for the Research market. New small-form 100D Series [Smart Amplifiers](#) provide the same advanced functionality as the proven BIOPAC 100C Series modules and support 11 biopotential and transducer signals.



BIOPAC MP160 Research System with EDA100C/100D Amplifier Module, plus EDA Leads/Electrodes

[Click to learn about BIOPAC MP160 Systems.](#)

Introduction to EDA

Hardware Components—Wired Methods (continued)

MP36/36R Systems

BIOPAC's 4-channel Data Acquisition System is available for

- Educators: MP36 unit for Biopac Student Lab software



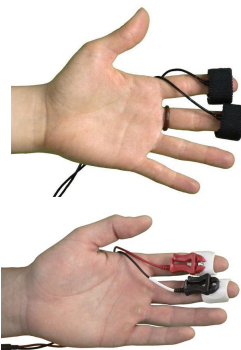
- Researchers: MP36R unit for AcqKnowledge software



Transducers and accessories are the same for MP36 and MP36R units.



MP36R



Reusable:
SS3LA + GEL101

Disposable:
SS57LA + EL507

BIOPAC MP36/36R System, plus EDA Leads/Electrodes

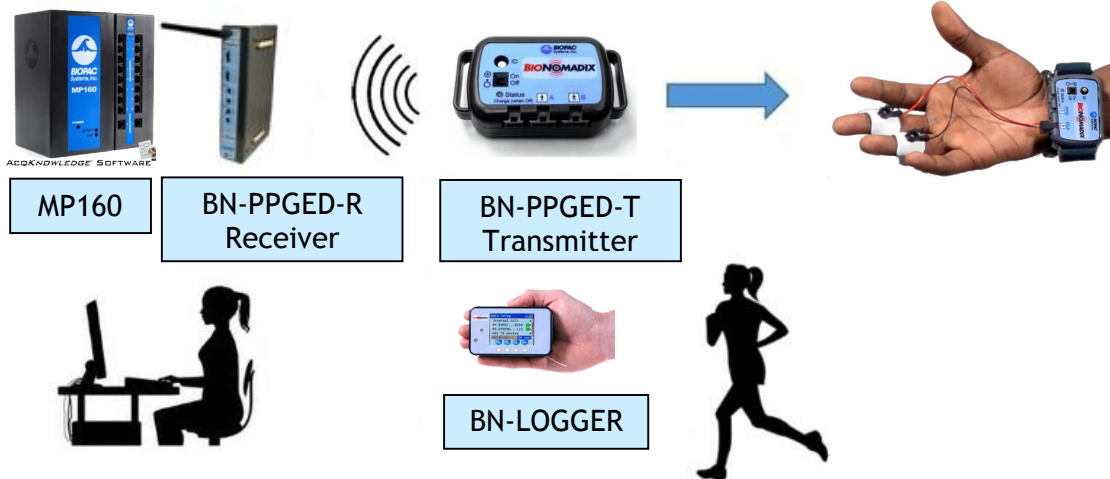
[Click to learn about BIOPAC MP36R Systems.](#)

Introduction to EDA

Hardware Components–Wireless

BioNomadix System

The BioNomadix System allows EDA data to be collected from ambulatory or untethered participants. The EDA Transmitter is attached to the participant with a Velcro strap, and the data wirelessly streamed to an EDA receiver unit attached to the MP160 System. The BioNomadix EDA Transmitter also supports simultaneous recording of blood volume pulse (PPG) via a separate fingertip or ear transducer.



BIOPAC MP160 Research System with BioNomadix Receiver, Transmitter, or BioNomadix Logger

[Click to learn about the BIOPAC BioNomadix PPGED System.](#)

Introduction to EDA

BioNomadix Smart Center and BioNomadix Logger

BioNomadix Smart Center (lower left) is a portable small-form data acquisition system that allows EDA data to be collected from ambulatory or untethered participants. The EDA Transmitter is attached to the participant with a Velcro strap, and the data wirelessly streamed to the Smart Center unit. The BioNomadix EDA Transmitter also supports simultaneous recording of blood volume pulse (PPG) via a separate fingertip or ear transducer.

Offering the industry's only system that delivers a comprehensive, 24-hour data logging solution in an easy-to-use, easy-to-wear package, the BioNomadix Logger (lower right) truly delivers % physiology anywhere. The BioNomadix Logger is the perfect tool for applications that demand greater degrees of subject freedom and complex experimental design.



BIOPAC Smart Center with BioNomadix Transmitter, or BioNomadix Logger

[Click to learn about the BIOPAC BioNomadix Smart Center System.](#)

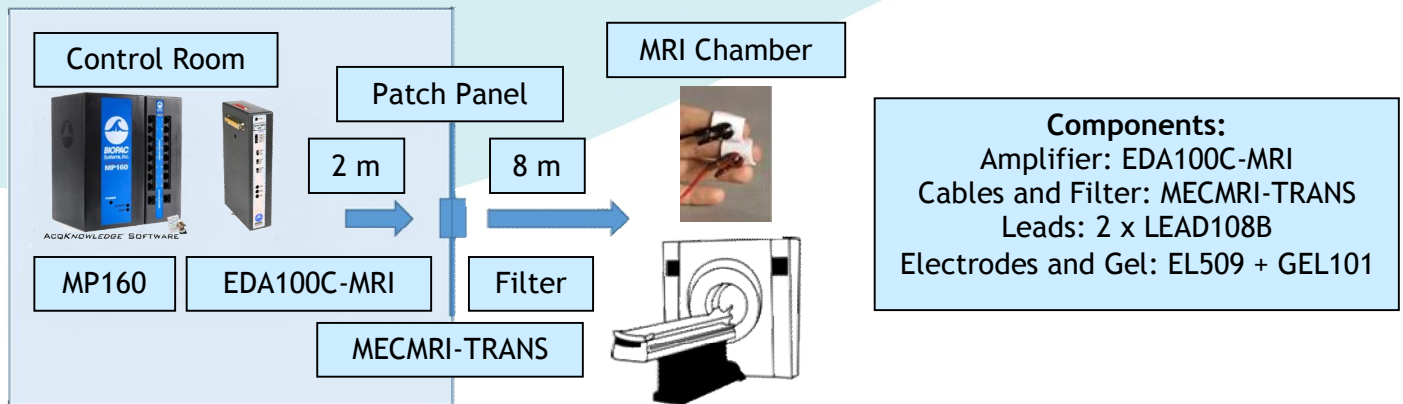
[Click to learn about the BIOPAC BioNomadix Logger](#)

Introduction to EDA

Hardware Components—MRI Environment

Special cabling, filters, and a BIOPAC EDA100C-MRI Smart Amplifier module are required for acquiring EDA data in the MRI chamber. BIOPAC MRI Smart Amplifiers incorporate advanced signal processing to remove signal artifacts introduced by the MRI environment. Only components rated **MR Safe+** are used inside the chamber with non-MRI components isolated outside the chamber.

The following figure depicts the BIOPAC MP160 System with components necessary for recording in the MRI. Note that a MECMRI-TRANS cable is required to record data in the MRI.



BIOPAC MP160 Research System with EDA100C-MRI Amplifier Module cabled for MRI environment

[Click to learn about recording in the MRI environment.](#)

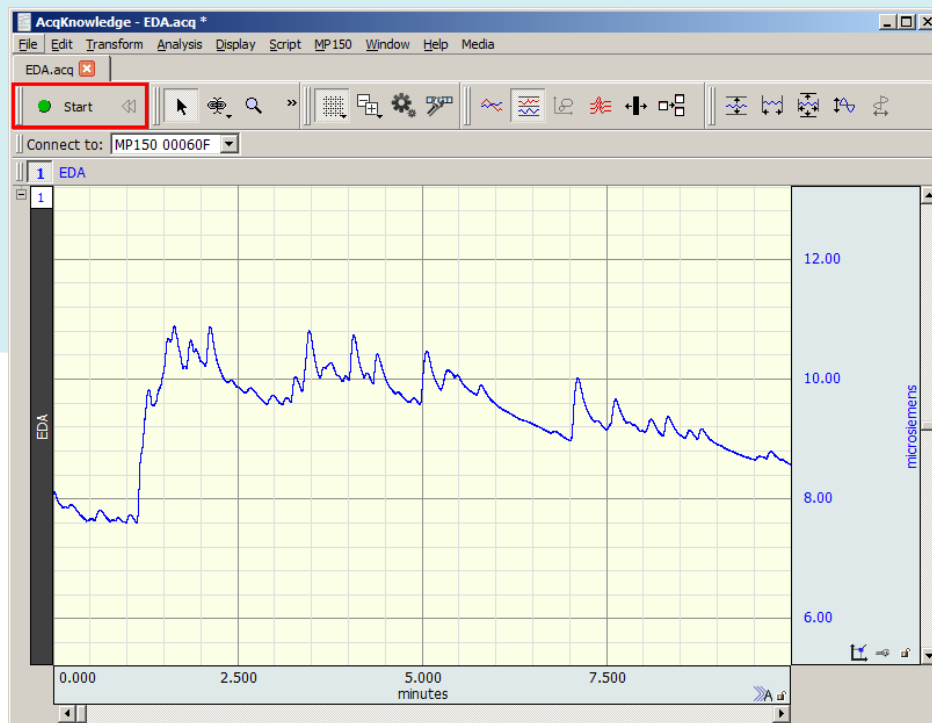
Introduction to EDA

Software Setup

BIOPAC Data Acquisition and Analysis Software

AcqKnowledge Research software or Biopac Student Lab Educational software is used to record, view and analyze EDA data.

AcqKnowledge Research Software



AcqKnowledge is used by thousands of research labs around the world and has been cited in thousands of peer reviewed publications. *AcqKnowledge* is included with each MP160, MP36R, BioNomadix Smart Center System, and BioNomadix Logger.

AcqKnowledge is an interactive, intuitive program that allows you instantly view, measure, transform, replay, and analyze data.

With the wired or wireless MP160 Systems, up to 16 channels of physiological data can be recorded simultaneously, ECG, EMG, EEG, EDA, EEG, EOG, Respiration, and more. Additionally, up to 16 digital and 16 online calculation channels are available.

With the MP36R System, up to 4 channels of physiological data, 8 digital channels, and 16 online calculation channels are available. Pre-configured software presets assist in simplifying setup.



Introduction to EDA

The Smart Center System supports up to 9 channels of physiological data from up to three BioNomadix transmitters at a time. Online calculation channels are available for many transmitters, easily selectable by checking a box. The full range of 14 BioNomadix transmitter types are supported. Guided prompts in *AcqKnowledge* for Smart Center software assist with setup and pairing to have you recording data within minutes.

The BioNomadix Logger wirelessly records physiological data as subjects freely and naturally live their lives. Connect up to three transmitters to the Logger for data logging or use with BioNomadix receivers operating in the lab and view data in *AcqKnowledge*. Or sync the BioNomadix Logger with GPS for a correlation between physiological and location data.

So, regardless of which system you choose, EDA data can be easily and accurately recorded in conjunction with other body signals.

With *AcqKnowledge*, perform complex data acquisition, stimulation, triggering and analyses using simple pull-down menus and dialogs- no need to learn a programming language or new protocol.

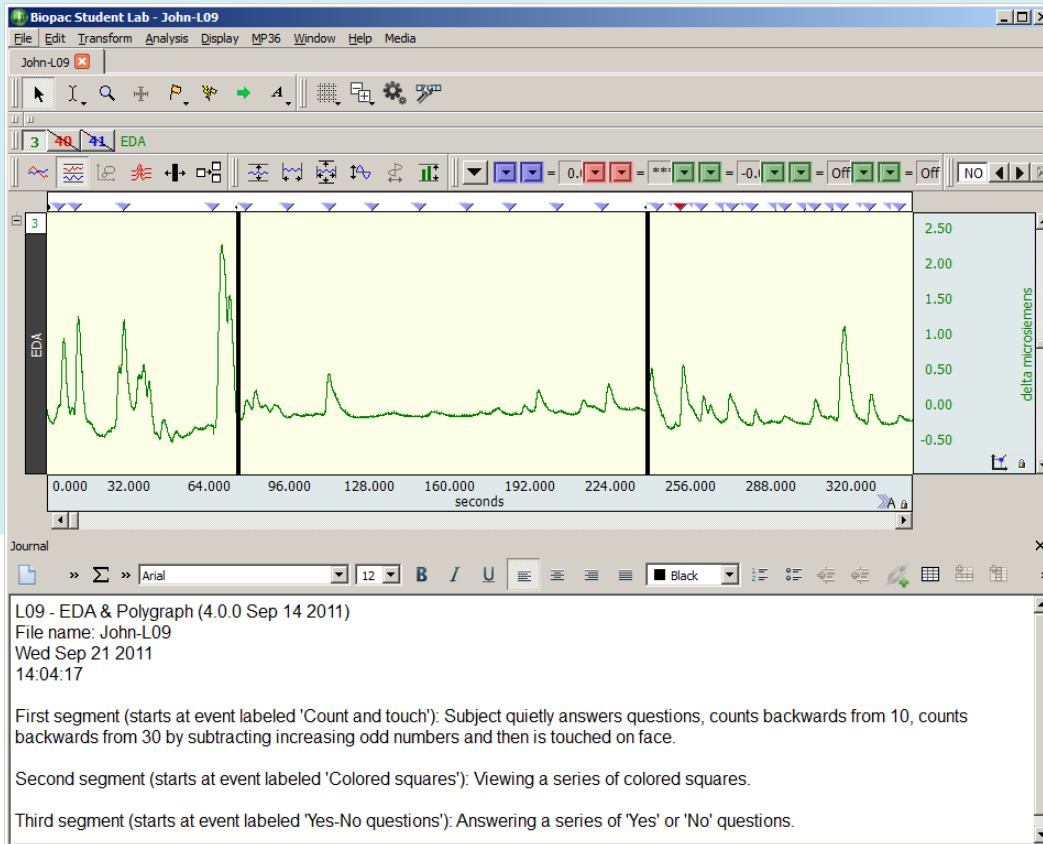
Online analysis settings, filters, and transformations provide real-time feedback, or choose from a wide variety of off-line analysis tools. Multiple display options are available during and after acquisition- click an icon to flip between Chart, Scope, X/Y, Overlapped segments. Histograms, FFTs, and other essential transformations are easily applied, offering enhanced data analysis.

[Click to learn about AcqKnowledge Software.](#)

[Click to watch a Webinar about recording EDA data.](#)

Introduction to EDA

Biopac Student Lab Educational System



The Biopac Student Lab system is an integrated life science teaching solution that includes MP36 hardware, BSL 4 software and [curriculum materials](#) that students use in undergraduate laboratories to record data from their own bodies, animals or tissue preparations.

With the MP36 System, up to 4 channels of physiological data, 8 digital channels, and 16 online calculation channels are available. Pre-configured software presets assist in simplifying setup.

Use BSL Lessons for lab curriculum or powerful BSL *PRO* for advanced lessons, custom experiments and analysis. Both applications are included in the BSL 4 software.

The system includes over sixty-five complete lessons that educators use as part of undergraduate lab courses.



Introduction to EDA

EDA Lessons for Education include:

[Lesson 9 . EDA and Polygraph](#)

[Lesson 14 . Biofeedback](#)

[PRO Lesson H11 . Mirror Test EDA](#)

[Click to review the Biopac Student Lab Curriculum page.](#)

[Click to learn about Biopac Student Lab Educational Systems.](#)

Analysis

AcqKnowledge EDA Data Analysis

In *AcqKnowledge* research software and Biopac Student Lab educational software, powerful viewing tools allow for the selection, editing, and zooming of data. More than 40 measurement types can be extracted, and over 20 transformations and filters can be applied to clean the data.

There are three main ways to approach, explore and analyze EDA data.

1. Via a series of EDA automated analysis routines included in *AcqKnowledge* software.
2. Manually, by using the software's I-Beam selection tool in conjunction with selected measurements.
3. Using the software's Analysis > Find Cycle routine.

In *AcqKnowledge* software, **fully automated advanced analysis** routines are available for extracting, enhancing, and adding events to EDA data. The EDA analysis routines are separated into three menu options that transform the tonic EDA signal to create a phasic waveform, locate and score skin conductance responses, or perform a detailed event-related EDA analysis by combining event information from the Stim-Response > Digital Input to Stim Events routine to the event-related EDA Analysis routine. The Event-related routine will automatically derive the phasic waveform and locate SCRs.



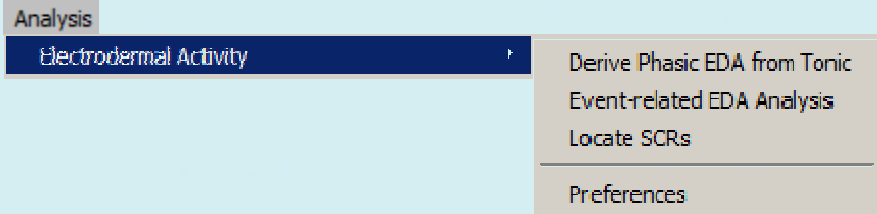
The routines employ a scoring system that marks the waveform and the point of stimulus delivery. It's easy to manually adjust the automated scoring by relocating the event onset/peak/end before rerunning the analysis. The event-related analysis provides a variety of measures from the SCR data, including classification of specific and non-specific responses. The results are pasted into the Journal or Excel for further analysis. Digital Input to Stim Events converts digital TTL triggers for stim presentation systems such as SuperLab[®] and ePrime[®] and converts them into *AcqKnowledge* event markers. For more information about stimulus presentation and event markup, we invite you to view the following BIOPAC webinars:

- [ePrime Webinar](#)
- [SuperLab Webinar](#)



Introduction to EDA

Additional AcqKnowledge EDA Automated Analysis tools:



- Derive Phasic EDA from Tonic: creates a new phasic signal from the original tonic EDA and places it in a separate channel for easy viewing.
- Event-related EDA Analysis is the most comprehensive of the EDA Analysis routines and assists in the extraction of EDA measures linked to specific stimuli. Event-related EDA Analysis requires presence of a tonic signal, and that defined stimulation events be present.
- Locate SCRs: identifies all significant SCRs from the background signal. (SCR options are defined in the EDA Analysis Preferences.)

See following page for example EDA Analysis setups.

Introduction to EDA

EDA Analysis

Tonic EDA Channel: CH1, EDA

Phasic EDA: Construct new
 Use channel: CH1, EDA

Stimulus event type: Stimulus Delivery

Stimulus event location: Anywhere
 Global events only
 Only on channel: CH1, EDA

Minimum separation between Stimulus Event and SCR: 1 seconds

Maximum separation between Stimulus Event and SCR: 4 seconds

Amplitude Summary Output Options
 Sort tables by time
 Sort tables by event label

SSCR/NSSCR Summary Count Options
 Fixed width time epochs: 10 seconds
 Between pairs of events of type: Default
 Select area manually in graph

Output events for specific SCRs

Analyze: entire graph
 focus areas only

Display results as: Text Only

OK Cancel

Event-related EDA Analysis

Locate SCRs

Tonic EDA Channel: CH1, EDA

Phasic EDA: Construct new
 Use channel: CH1, EDA

OK Cancel

Locate Skin Conductance Responses (SCRs)

EDA Preferences

Display results as: Text Only

Construct phasic EDA using: Smoothing Baseline Removal

Baseline estimation window width: 5 seconds

SCR Threshold Level: 0.02 uS

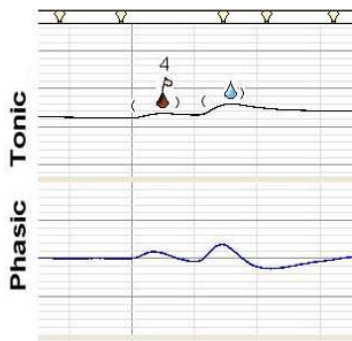
Reject SCRs under: 10 % of max

OK Cancel

EDA Preferences for setting up custom analysis parameters



	A	B	C	D	E	F	G	H
1	Event-related EDA Analysis of CH 1, EDA100C							
2								
3	Stimulus eve	Stimulus Delivery						
4	Located:	Anywhere						
5								
6	Stim Time	SCL	Latency	SCR Amplitude	SCR Rise Time	SCR Size	SCR Onset	Stim Label
7	1283.832	10.0036625	2.4	4.44641113	4.6	14.5355229	10.0891117	3
8	1383.832	9.18273968	2.1	2.9510498	5	12.316895	9.36584515	3
9	1419.032	9.79309124	1.4	0.0579834	1	10.0921635	10.0341801	6
10	1473.032	8.93859905	3.1	0.05493164	1	9.38110393	9.32617229	4
11	1493.332	9.60998577	3.8	0.03662109	0.8	9.80529827	9.76867718	1
12	1509.732	9.51538128	1.6	1.02844238	2.6	10.7391362	9.71069378	4
13	1516.932	10.2478032	2.2	0.14343262	1	10.6079106	10.464478	4
14	1521.432	10.4553227	2	0.03051758	0.5	10.4919438	10.4614262	1
15	1560.932	9.42993206	2.7	0.03967285	1.1	9.7595219	9.71984905	1
16	1570.832	9.74426311	2.8	0.57373047	1.9	10.5041508	9.93042034	4
17	1712.132	8.55712933	3.3	0.03662109	0.7	8.9569096	8.92028851	1
18	1741.232	8.55407757	3.7	0.05493164	0.9	8.93554729	8.88061565	4
19								

Excel Spreadsheet Output of Event-related EDA Analysis



Sample EDA Analysis Output

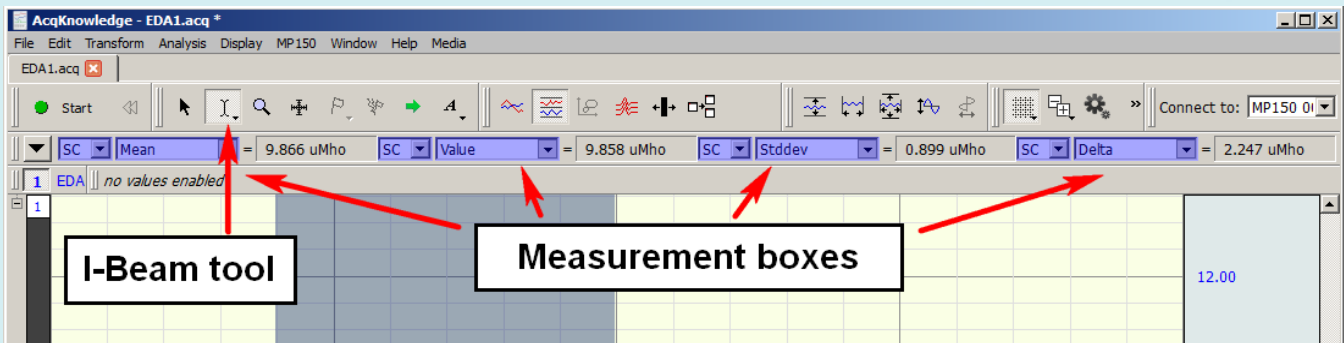
All SCR events are marked on the tonic waveform as follows:

- (*open paren.* The point at which the phasic signal crosses the SCR threshold level.
-  *blue waterdrop* blue marks the peak response of a nonspecific, event-related SCR.
-  *red waterdrop* marks a specific SCR %SRR+ with a flag numbered with the stimulus event type
-) *close paren.* The point at which the phasic signal crosses the zero threshold level.

Introduction to EDA

Using the AcqKnowledge Measurement Tools

The I-Beam tool in BIOPAC software allows highlighting of specific regions of the signal for analysis. This tool works in conjunction with the measurement boxes (which provide the output from the region highlighted by the I-Beam tool), which can be configured to provide specific mathematical information via individual pop-up menus.



Measurements useful for analyzing EDA data

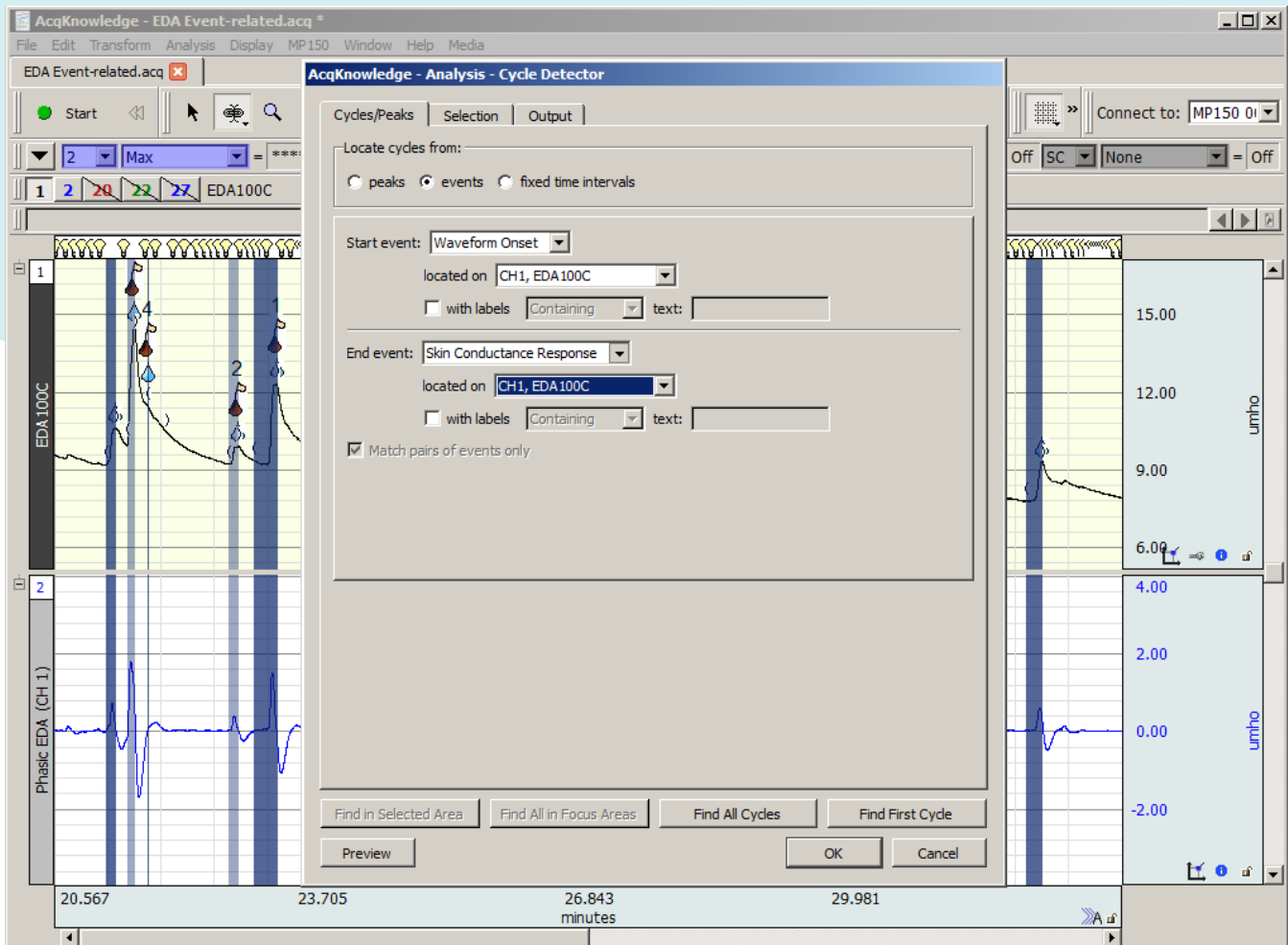
- Mean: returns the arithmetic mean for the whole area highlighted by the I-Beam (averaged across peaks, troughs, etc).
- Value: returns the exact value (level of the signal) at the point where the mouse button was last released.
- Standard deviation: provides a standard deviation statistic for the area highlighted by the I-Beam.
- Delta: provides the difference between the values at the left and right edges of the selected data. Particularly useful when used in conjunction with the %Find Cycle+ routine.
- Delta T: provides an accurate time period of the area being highlighted.
- Min / Max: provides values for the minimum and maximum EDA values encountered in the highlighted areas and is useful for calculating the range of values.
- Mean amplitude of events (Evt ampl): returns the mean of the peak amplitudes only from events that have been identified in the area that has been highlighted.
- Number of events: a count of the number of events of a particular type, such as SCRs.

Introduction to EDA

Find Cycle Analysis

A third method for automatically extracting amplitudes and other variables from all significant EDA events is the Find Cycle Analysis routine. This feature can provide a spreadsheet or Journal output of values corresponding to selected EDA events and measurements.

[Click to watch tutorials about the automated Find Cycle routine.](#)



[Click to watch a webinar about EDA Analysis Essentials.](#)

[Click to read an in-depth BIOPAC tutorial about EDA Analysis.](#)

[Click to read a comprehensive list of EDA F.A.Q.](#)

We also encourage you to review the linked EDA resources on the following pages.



Introduction to EDA

EDA Troubleshooting Table

Problem	Probable cause and solution
Data units are volts	To calibrate in $\mu\text{Mho}/\text{uSiemens}$, multiply the data by the amplifier gain setting. For example, if amplifier was set to $5\mu\text{Mho}$ per Volt, then, using Waveform Math, multiply the EDA waveform by 5. Use the Add New Module feature in current versions of <i>AcqKnowledge</i> software to automatically scale the data.
ECG complex present in EDA data or the waveform looks like a mix of EDA and some other signal	May have a channel conflict . make sure all amplifier channel selection switches are set to unique channels.
Flat line at 10V or equivalent	The gain is too high.
Flat signal at zero	Make sure the amplifiers are physically well-attached. There may simply be loose contact. Make sure the leads are plugged into VIN- and VIN+. If using shielded leads make sure that the shield is not plugged in by accident. 0.5 Hz or 0.05 Hz high-pass filters may be switched on. Switch to DC mode.
Interference from bioimpedance	See the special cases section here: http://www.biopac.com/knowledge-base/multiple-amplifiers-per-subject-or-multiple-subjects-per-system/
Movement artifact	Frequency can increase when gel is getting dry. Using fresh electrodes is key. Leads pulling on electrodes as well as electrodes losing contact because of poor gel cause momentary signal loss which appears as spikes in the signal. Tape leads against the skin or use Velcro straps, etc. to hold in place. If artifacts cannot be prevented, they can still often be removed by a median smooth filter with 1 second width (resample data to 50-100Hz first to reduce computational load).
No signal visible onscreen	This is likely an issue with vertical scaling. Display->Autoscale waveforms will make the data visible.

Introduction to EDA

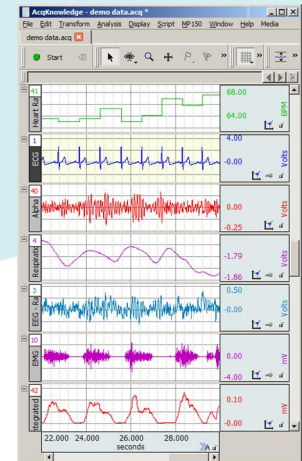
Problem	Probable cause and solution
Noise throughout the signal	This could be 50 Hz/60 Hz noise that has been aliased into the data after the 10 Hz LP has been applied in the amplifier. It indicates poor connection, most often due to drying gel. Can be usually cleaned up well with 1 Hz FIR low pass filter.
Signal looks flat	We are simply zoomed out. Electrodes are dry, gel cannot saturate the skin.
Signal looks flat and is close to zero	The amplifier is not DC mode; one of the high-pass filters, 0.05 Hz or 0.5 Hz is enabled.
Skin conductance level keeps rising and there are no more responses after some time	The gel used is not isotonic. Sweat glands have saturated. Use GEL101 only.
Small response size and or low tonic levels	Location of the electrodes on the body can affect this. Make sure electrodes have fresh gel. Reusable electrodes must be well-cleaned or maintained or will lose conductive properties over time. Allow at least 5-10 minutes for the gel to be absorbed in the skin. With approximately 10% of all participants, however, you will not see any or only very small responses. If the participant does not get a reaction after holding a deep breath, try recording on yourself to rule out a problem with the equipment.
Step-like plot	The gain should be increased; or we could simply be too zoomed in. Set Horizontal scaling to 2 sec per division, vertical scaling to 0.5 μ Mho per division. You can also apply a 1Hz FIR filter.

Introduction to EDA

This is a list of EDA supplemental materials to assist with your research. These items can also be found on our [EDA Application](#) page.

Relevant Products

- [MP160 System](#)
- [MP36R System](#)
- [Smart Center](#) Wireless
- [BN-LOGGER](#) Wireless
- [EDA100C Amp](#)
- [EDA100C-MRI Amp](#)
- [BN-PPGED](#) Transmitter
- [ACK100W](#) Software
- [EL507](#) Electrodes



Advanced Features

- [Event Related EDA Analysis](#)
- [Electrodermal Activity Scoring](#)
- [Stimulus Presentation Event Marking](#)



Knowledge Base

- [Gel for EDA](#)
- [Negative EDA](#)
- [EDA Subject Preparation](#)
- [Guidelines . EDA, EDR, GSR, SCL, and SCR](#)
- [Phasic EDA: Methods for Computing Phasic Skin Conductance from Tonic](#)

Application Notes

- 216 - [EDA Scoring Methods](#)
- 187 - [Electrodermal Response Guidelines](#)
- 279 - [ECG and EDA Recording in 7-Tesla fMRI](#)
- 276 - [Emotional State Recognition via Physiological Measures and Processing](#)

Video Tutorials for Analysis

- [EDA . SCR Event Related Analysis](#)
- [Focus Areas | AcqKnowledge Tutorial](#)
- [Noldus Observer XT Import/Export in AcqKnowledge](#)





Introduction to EDA

Selected publications: the authors of the following publications have cited BIOPAC products in their procedure or methods:

[On the relationship between emotional state and abnormal unfairness sensitivity in alcohol dependence](#)

Brevers, et al

[Comparing affective responses to standardized pictures and videos: A study report](#)

Horvat, et al

[Blunted responses to reward in remitted post-traumatic stress disorder](#)

Wass, et al

[The Relationship Between Attachment, Couple Conflict, and Recovery From Conflict](#)

Taylor N.C.

[Worry as an adaptive avoidance strategy in healthy controls but not in pathological worriers](#)

Ottaviani, et al

[Observation and imitation of actions performed by humans, androids, and robots: an EMG study](#)

Gajewski J.F., et al

[Vicarious Fear Learning depends on Empathic Appraisals and Trait Empathy](#)

Olsson, et al

[Autonomic Nervous System Responses Can Reveal Visual Fatigue Induced by 3D Displays](#)

Kim C.J, Park S., Won M.J., Whang M. and Lee E.C.

[Modeling event-related skin conductance responses](#)

Bach D.R., Flandin G., Friston K.J. and Dolan R.J.

[Sympathetic Arousal during a Touch-Based Healing Ritual Predicts Increased Well-Being](#)

Meissner K, Koch A.

[The Relationship between Arousal, Personality, and Perception of Control in a Gambling Task](#)

Pagnier, G.J.